Errata

Title & Document Type: 3852A and 3853A Data Acquisition and Contol Unit Assembly Level Service Manual

Manual Part Number: 03852-90025

Revision Date: May 1, 1988

HP References in this Manual

This manual may contain references to HP or Hewlett-Packard. Please note that Hewlett-Packard's former test and measurement, semiconductor products and chemical analysis businesses are now part of Agilent Technologies. We have made no changes to this manual copy. The HP XXXX referred to in this document is now the Agilent XXXX. For example, model number HP8648A is now model number Agilent 8648A.

About this Manual

We've added this manual to the Agilent website in an effort to help you support your product. This manual provides the best information we could find. It may be incomplete or contain dated information, and the scan quality may not be ideal. If we find a better copy in the future, we will add it to the Agilent website.

Support for Your Product

Agilent no longer sells or supports this product. You will find any other available product information on the Agilent Test & Measurement website:

www.tm.agilent.com

Search for the model number of this product, and the resulting product page will guide you to any available information. Our service centers may be able to perform calibration if no repair parts are needed, but no other support from Agilent is available.

Agilent Technologies

HP 3852A/3853A Data Acquisition and Control Unit

HP 3852A/3853A
Assembly Level Service Manual

This manual applies to HP 3852A's with a serial number prefix of:

2525A and Above

This manual applies to HP 3853A's with a serial number prefix of:

2526A

WARNING

The information in this manual is to be used by qualified service-trained personnel only. To avoid personal injury, do not perform any procedure explained in this manual, or perform any servicing of the HP 3852A or HP 3853A unless you are qualified to do so.

HEWLETT PACKARD

Manual Part Number: 03852-90025
Microfiche Part Number: 03852-99025

Printed: MAY 1988 Edition 3
Printed in U.S.A.

Printing History

The Printing History shown below lists the printing dates of all Editions and Updates created for this manual. The Edition number changes as the manual undergoes subsequent revisions. Editions are numbered sequentially starting with Edition 1. Updates, which are issued between Editions, contain individual replacement pages which the customer uses to update the current Edition of the manual. Updates are numbered sequentially starting with Update 1. Each new Edition or Update also includes a revised copy of this printing history page.

Many product updates and revisions do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one-to-one correspondence between product updates and manual updates.

Edition 1 (Part Number 03852-90010) . . . . APRIL 1986
Edition 2 (Part Number 03852-90011) . . . . FEBRUARY 1987
Update 1 (Part Number 03852-90091) . . . . JULY 1987
Update 2 (Part Number 03852-90092) . . . . DECEMBER 1987
Edition 3 (Part Number 03852-90025) . . . . MAY 1988

Hewlett-Packard Company

3000 Hanover Street, Palo Alto, California 94304

HEWLETT PACKARD

Herstellerbescheinigung

Hiermit wird bescheinigt, daß das Gerät/System HP 3852A in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkentstört ist.

Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes/Systems angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt.

Zusatzinformation fur Meß- und Testgeräte

Werden Meß- und Testgeräte mit ungeschirmten Kabeln und/oder in offenen Meßaufbauten verwendet, so ist vom Betreiber sicherzustellen, daß die Funk-Entstörbestimmungen unter Betriebsbedingungen an seiner Grundstücksgrenze eingehalten werden.

Manufacturer's declaration

This is to certify that the equipment HP 3852A is in accordance with the Radio Interference Requirements of Directive FTZ 1046/84. The German Bundespost was notified that this equipment was put into circulation, the right to check the series for compliance with the requirements was granted.

Additional Information for Test- and Measurement Equipment

If Test- and Measurement Equipment is operated with unscreened cables and/or used for measurements on open set-ups, the user has to assure that under operating conditions the Radio Interference Limits are still met at the border of his premises.

HEWLETT PACKARD

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the National Institute of Standards and Technologies, to the extent allowed by the the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard instrument product is warranted against defects in materials and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by -hp-. Buyer shall prepay shipping charges to -hp- and -hp- shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to -hp- from another country.

Duration and conditions of warranty for this instrument may be superceded when the instrument is integrated into (becomes a part of) other -hp- instrument products.

Hewlett-Packard warrants that its software and firmware designated by -hp- for use with an instrument will execute its programming instructions when properly installed on that instrument. Hewlett-Packard does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HEWLETT-PACKARD SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HEWLETT-PACKARD SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

HEWLETT PACKARD

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

DO NOT OPERATE A DAMAGED INSTRUMENT

Whenever it is possible that the safety protection features built into this instrument have been impaired, either through physical damage, excessive moisture, or any other reason, REMOVE POWER and do not use the instrument until safe operation can be verified by service-trained personnel. If necessary, return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

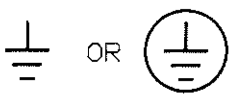
Operating and Safety Symbols

Symbols Used On Products And In Manuals

~ LINE — AC line voltage input receptacle.

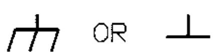
Instruction manual symbol affixed to product. Warns and cautions the user to refer to respective instruction manual procedures to avoid personal injury or possible damage to the product.

Indicates dangerous voltage – terminals connected to interior voltage exceeding 1000 volts.



Protective conductor terminal. Indicates the field wiring terminal that must be connected to earth ground before operating equipment – protects against electrical shock in case of fault.

Clean ground (low-noise). Indicates terminal that must be connected to earth ground before operating equipment – for single common connections and protection against electrical shock in case of fault.



Frame or chassis ground. Indicates equipment chassis ground terminal – normally connects to equipment frame and all metal parts.

Affixed to product containing static sensitive devices – use anti-static handling procedures to prevent electrostatic discharge damage to components.

NOTE

NOTE

Calls attention to a procedure, practice, or condition that requires special attention by the reader.

CAUTION

CAUTION

Calls attention to a procedure, practice, or condition that could possibly cause damage to equipment or permanent loss of data.

WARNING

WARNING

Calls attention to a procedure, practice, or condition that could possibly cause bodily injury or death.

HEWLETT PACKARD

HP 3852A Caution and Warning Labels

WARNING ⚠1
HAZARDOUS VOLTAGES MAY BE EXPOSED WHEN CONNECTOR IS REMOVED. DISCONNECT ALL FIELD WIRING POWER BEFORE REMOVING CONNECTOR.

This symbol and warning statement is found beside the Analog Extender port on the HP 3852A and HP 3853A. The analog extender port enables the HP 3852A backplane analog bus to be expanded to an extender. The analog bus routes signals from channels on multiplexer accessories to the voltmeter accessories. Depending on the multiplexer combinations installed and the application wired to the accessories, up to 350V peak (equivalent to 250V AC rms or 250V DC) can be present on the bus and, therefore, on the terminals of the port.

WARNING ⚠1
SHOCK HAZARD
DISCONNECT ALL
FIELD WIRING
POWER BEFORE
REMOVING
TERMINAL CARD

TURN OFF POWER SOURCES TO INSTRUMENT AND FIELD WIRING BEFORE INSTALLING/REMOVING ANY ACCESSORY.

The symbol and these statements are found below the locking ring on the terminal module and on the metal cover fastened to the component module of the plug-in accessories. Since all field wiring and most of the configuration involves the terminal module, the warnings serve as a reminder that even when the terminal module is separated from the component module, hazardous voltages can still be present on the terminal module due to the field wiring connected.

WARNING ⚠2 FOR SAFTY CONSIDER ALL CHANNELS TO BE AT THE HIGHEST VOLTAGE APPLIED TO ANY CHANNEL

⚠2 REGARD ALL ACCESSORY CHANNELS AS BEING AT THE SAME POTENTIAL AS THE HIGHEST VOLTAGE APPLIED TO ANY CHANNEL.

The symbol and these statements are found inside the terminal module and on the metal cover fastened to the component module of the plug-in accessories. The statements serve as a reminder to be careful when wiring in close proximity to other channels in which field wiring is already connected. Recall that hazardous voltages can still be present on the wiring terminals even though the accessory has been removed from the instrument. Note that all field wiring and configuration should be performed with the accessory removed from the instrument and with the terminal module separated from the component module.

⚠3 SEE MANUAL FOR MAXIMUM NUMBER OF THESE ASSEMBLIES PER 3852/3853

This symbol and statement is found above the locking ring on the terminal module of the HP 44727A, HP 44727B, and HP 44727C DAC (Digital-to-Analog Converter) accessories and on the side of the HP 44701A and HP 44702A/B voltmeter accessories. The symbol and statement refer to the fact that when a specific number of these accessories are installed in the same instrument, they place an excessive drain on the HP 3852A and HP 3853A power supply which in turn, causes degraded and often unpredictable system performance.

CAUTION ⚠4
IF PLUG-IN ACCESSORIES ARE PRESENT, DISCONNECT INTERNAL CABLE BEFORE REMOVING COMPLETELY

This symbol and statement is found on the name plate of the HP 44702A/B 13 bit High Speed Voltmeter accessory. The statement serves as a reminder that before removing the accessory, check to see that an HP 44711A, HP 44712A, or HP44713A High Speed FET multiplexer accessory is not connected to the voltmeter by the ribbon cable.

HEWLETT PACKARD

⚠4
STOP
INTERNAL
CABLE
MAY BE
CONNECTED

This symbol and statement is found on the bottom "rail" of the HP 44711A, HP 44712A, and HP 44713A High Speed FET multiplexer accessories and is exposed when the accessory's terminal module is removed. The "internal cable" is the ribbon cable that connects the FET multiplexer to the HP 44702A 13 bit High Speed Voltmeter accessory.

WARNING NO OPERATOR SERVICEABLE PARTS INSIDE.
REFER SERVICING TO SERVICE TRAINED PERSONNEL

This statement appears at the bottom of the HP 3852A and HP 3853A power modules and under the CAUTION label on the metal cover of an accessory's component module. All equipment configuration and repair should be performed by service-trained personnel only.

WARNING
FOR CONTINUED FIRE PROTECTION
USE SPECIFIED FUSE ONLY

This statement appears by the fuse socket on the HP 3852A and HP 3853A power modules. The HP 3852A and HP 3853A are shipped without the fuse installed. A 1.5 AT and 750 mAT fuse and a fuse cap are packaged together in a small static shielding bag which accompanies the instruments. A service-trained individual should install the correct fuse and set the LINE SELECTOR switches to the proper position before power is applied to the instrument.

CAUTION
- STATIC SENSITIVE.
- USE CLEAN HANDLING TECHNIQUES.
- DO NOT INSTALL ACCESSORY WITHOUT METAL COVERS
- NO OPERATOR SERVICEABLE PARTS INSIDE. REFER

These statements are found under the CAUTION label on the metal cover of an accessory's component module. The statements serve as a reminder to avoid touching the connector contacts and to use care when handling the accessory. Note that the protective cover should be attached following any necessary configuration in order to prevent damage to the components resulting from static discharge or when other accessories are installed.

CHAPTER 1
GENERAL INFORMATION

CHAPTER 1
GENERAL INFORMATION

1-1 INTRODUCTION

This manual contains information required to test and support the Hewlett-Packard Model 3852A Data Acquisition and Control Unit, the HP Model 3853A Extender, and any plug-in accessories that may be installed. This manual is intended for use only by service trained personnel. Operating and programming personnel should refer to the HP 3852A Mainframe Configuration and Programming Manual.

Installation instructions, power requirements, or detailed operating and programming information are excluded from this manual. For this information, refer to the HP 3852A Mainframe Configuration and Programming Manual.

WARNING

The information in this manual is for the use of Service Trained Personnel only. To avoid electrical shock, do not perform any procedures in this manual or do any servicing to the HP 3852A/3853A and plug-in accessories, unless you are qualified to do so.

1-2 HOW TO USE THIS MANUAL

This manual is divided into 17 chapters. Each chapter is tabbed for quick reference. Chapter 1 gives general information about the HP 3852A/3853A and plug-in accessories. Chapters 2 through 5 deal with the HP 3852A Mainframe and the HP 3853A Extender. The remaining chapters deal with the plug-in accessories. In some cases, similar accessories are grouped in a single tabbed chapter.

Each accessory chapter (Chapters 6 through 17) contains a technical description of the accessory, specifications, performance tests, assembly level replaceable parts lists, and where applicable, backdating information. This organization was chosen so that all information about a particular plug-in accessory is located in one part of the manual.

The manual is separated as follows:

Chapter 1 -- General Information
Chapter 2 -- Operating Information
Chapter 3 -- HP 3852A/3853A Performance Tests
Chapter 4 -- HP 3852A/3853A Module and Front Panel Removal/Installation Procedures and Mechanical Replaceable Parts
Chapter 5 -- Problem Isolation
Chapter 6 -- HP 44701A Integrating Voltmeter
Chapter 7 -- HP 44702A/B High Speed Voltmeter
Chapter 8 -- HP 44705A/44705H/44706A/44708A/44708H Relay Multiplexers, HP 44717A/44718A Strain Gages
Chapter 9 -- HP 44709A/44710A FET Multiplexers, HP 44719A/44720A Strain Gages
Chapter 10 -- HP 44711A/44712A/44713A High Speed FET Multiplexer

Chapter 11 -- HP 44715A 5 Channel Counter/Totalizer
Chapter 12 -- HP 44721A/44722A Digital Inputs
Chapter 13 -- HP 44724A Digital Output
Chapter 14 -- HP 44725A General Purpose Switch
Chapter 15 -- HP 44727A/B/C 4 Channel Voltage/Current DACs
Chapter 16 -- HP 44728A 8 Channel Relay Actuator
Chapter 17 -- HP 44729A 8 Channel Power controller

1-3 SERVICE KIT FOR HP 3852A SYSTEM

The operational verification and performance test procedures in this manual are extensive and time consuming. The HP 44743F Service Kit was therefore developed to perform operational verification tests on the HP 3852A and plug-in accessories. The kit also calibrates the accessories, where applicable. No service kit is available for the performance test procedures.

We highly recommend the use of the service kit if you have time contraints on testing and calibration of your HP 3852A system. Although the service kit does not perform any extensive performance tests, in most applications, the service kit will be more than adequate.

Included in the HP 44743F Service Kit are all the necessary test and calibration software. The software is menu driven for ease of use. An HP 9000 Series 200/300 computer is required to run the tests. The service kit uses various test fixtures to test the different plug-in accessories. The test fixtures provide proper connections to a digital voltmeter (like the HP 44701A) to make the necessary measurements.

The HP 44743F Service Kit can be purchased as a complete assembly or as separate components. However, if only the mainframe and/or one or two accessories are to be tested, purchase of the complete may be unnecessary. It is more economical to purchase the software and only the test fixtures for the accessories to be tested, instead of the complete kit. Table 1-1 gives the title, HP part numbers, and description of the software and test fixtures in the complete kit. Use this information to purchase the individual components of the kit.

1-4 GENERAL SYSTEM DESCRIPTION

The HP 3852A Data Acquisition and Control System is designed to allow rapid and easy configurations. At the heart of every system is the HP 3852A Data Acquisition and Control Unit. This mainframe has a full keyboard, two liquid crystal displays, a power supply, and a controller. The HP 3852A provides eight plug-in slots for accessories.

If more than eight plug-in accessories are required, the HP 3853A Extender is needed. A system may have up to seven such extenders. Each HP 3853A Extender provides 10 additional plug-in accessory slots. The HP 3853A contains a power supply and logic used to communicate with the mainframe.

System software is provided under accessory numbers 44456A and 44456B. This software runs on Hewlett-Packard Series 200 and 300 computers. The software provides the capabilities to configure the system, store data collected in the system, acquire high speed data, analyze data, present the data in a display, control a process, schedule a task, and distribute data.

Table 1-1 HP 44743A Service Kit Description

Multiplexer Test Fixture (Open/Close)		
Part Number	Accessory Number	Description
44743-66205	44705A/H 44706A 44708A 44709A 44710A 44717A 44718A 44719A 44720A	This fixture is used to functionally verify the operation of the Relay and FET Multiplexers. A resistor is connected to one side of each channel and to a common node. An ohmmeter is then used to measure the resistor value when the channels are closed one at a time. This determines if the channel did close or open when commanded to do so.

Multiplexer Test Fixture (Resistance)		
Part Number	Accessory Number	Description
44743-66206	44705A/H 44706A 44708A 44709A 44710A 44717A 44718A 44719A 44720A	The channel path resistance of the Relay and FET Multiplexers is determined using this test fixture. All channels are tied together to form a common node on the test fixture. An ohmmeter is connected across the multiplexer's common node and the test fixture's common node. The ohmmeter is then used to measure the channel path resistance of each channel when closed. Note: Functional testing using the 44743-66205 test fixture should be performed before doing this test.

High Speed FET Multiplexer Test Fixture		
Part Number	Accessory Number	Description
44743-66211	44711A 44712A 44713A	This fixture is used to both functionally verify the operation and determine the channel path resistance of the High Speed FET Multiplexers. All channels are tied together to form a common node on the test fixture. An ohmmeter is connected across the multiplexer's common node and the test fixture's common node. The ohmmeter is then used to measure the channel path resistance of each channel when closed. The ohmmeter reading determines the channel path resistance and functionality of the multiplexer. The test fixture is also used to test ribbon cable operation.

Counter Test Fixture		
Part Number	Accessory Number	Description
44743-66215	44715A	Operational verification of the Counter is performed using this test fixture. The PACER output from the HP 3852A mainframe is used to trigger a dual one-shot on the test fixture. The one-shot output is processed to provide low level AC signals along with TTL compatible signals. The counter's Period, Totalize, Frequency, and Interrupt functions are all tested.

Table 1-1 HP 44743A Service Kit Description (Cont.)

Digital Input Test Fixture		
Part Number	**Accessory Number**	**Description**
44743-66221	44721A 44722A	The Digital Input accessories are operationally verified using this test fixture. Pattern testing of the digital inputs are done by switching a "0101...1010..." pattern to the channel inputs. The counter function and interrupt operation are also tested using a 500 Hz TTL compatible signal. The signal is generated by a one-shot on the test fixture and the PACER output of the HP 3852A.
Digital Output and Form C Test Fixture (Open/Close)		
Part Number	**Accessory Number**	**Description**
44743-66224	44724A 44725A 44728A	This fixture is used to functionally verify the operation of the Digital Output, General Purpose Switch, and Relay Actuator accessories. A resistor is connected to one side of each channel and to a common node on the test fixture. The common of each channel is also tied together on the test fixture. An ohmmeter is then used to measure the resistor value when the channels are closed one at a time. This determines if the channel did close or open when commanded to do so.
Digital Output and Form C Test Fixture (Resistance)		
Part Number	**Accessory Number**	**Description**
44743-66225	44724A 44725A 44728A	The resistance of each channel of the Digital Output accessories are tested with this fixture. All channels are tied together to form a common node on the test fixture. One side of an ohmmeter is connected to this common node. The other side is switched to a common node of the NO contacts, NC contacts, or drain connections. The ohmmeter is then used to measure the resistance of each channel. Note: Functional testing using the 44743-66224 test fixture should be performed before doing this test.
DAC Test and Calibration Fixture		
Part Number	**Accessory Number**	**Description**
44743-66227	44727A	This test fixture is used to perform both output testing and calibration of the DAC accessories. A digital voltmeter with the test fixture is use to test and calibrate both the voltage and current outputs. A 250 Ω resistor is used as a shunt for current testing and calibration.

Table 1-1 HP 44743A Service Kit Description (Cont.)

Part Number	Accessory Number	Description
Power Controller Test Fixture		
44743-66229	44729A	This fixture is used to functionally verify the operation of the Power Controller. An AC voltmeter and a 12 V, 60 Hz AC signal source are required for the tests. Each Power Controller channel is connected to a resistive voltage divider on the test fixture. When a channel is closed, the AC voltmeter measures the voltage on a node of the divider. This determines if the channel did close or open when commanded to do so.
Test and Calibration Software (5.25 inch flexible disc)		
Part Number	Accessory Number	Description
44743-10205	All	This menu driven software is available on a 5.25 inch flexible disc. It is written for the HP Series 200/300 computer. The software provides semi-automated testing and calibration (where required) of the HP 3852A and plug-in accessories. The above listed test fixtures are required to run the tests. Instructions are given to the user for external connections, hookups, fixture switch settings, etc. The test data is displayed and optionally printed as a permanent test record.
Test and Calibration Software (3.5 inch flexible disc)		
Part Number	Accessory Number	Description
44743-10203	All	This menu driven software is available on a 3.5 inch flexible disc. It is written for the HP Series 200/300 computer. The software provides semi-automated testing and calibration (where required) of the HP 3852A and plug-in accessories. The above listed test fixtures are required to run the tests. Instructions are given to the user for external connections, hookups, fixture switch settings, etc. The test data is displayed and optionally printed as a permanent test record.
User Manual		
Part Number	Accessory Number	Description
44743-90001	All	This manual is provided in each Service Kit and explains the different test fixtures, software, and tests. Each test is explained such that the user has a good understanding of how the tests are performed. Schematics of the test fixtures are also included to show all connections made during testing.

1-5 PLUG-IN ACCESSORIES DESCRIPTION

The plug-in accessories for the HP 3852A/3853A can be separated into analog and digital inputs, counters, analog and digital outputs, switching, and breadboard. The following paragraphs describe the accessories.

1-6 Analog Input Accessories

The analog input accessories consist of the following:

HP 44701A Integrating Voltmeter
HP 44702A/B High Speed Voltmeter
HP 44705A/44705H/44706A/44708A/44708H Relay Multiplexers
HP 44709A/44710A/44711A/44712A/44713A FET Multiplexers
HP 44717A/44718A/44719A/44720A Strain Gages

The analog input accessories provide dc voltage, ac voltage, ohms measurement capability, and also provides the input measurement paths.

1-7 HP 44701A Integrating Voltmeter

The HP 44701A Integrating Voltmeter performs very accurate DC voltage, AC voltage, four-wire ohms, and offset compensated ohms measurements. The voltmeter uses an integrating technique for the analog to digital conversion.

The voltmeter's dc volt ranges are 30 mV, 300 mV, 3 V, 30 V, and 300 V. The ac volts ranges are 200 mV, 2 V, 20 V, and 200 V. The ohms ranges are 30 Ω, 300 Ω, 3 kΩ, 30 kΩ, 300 kΩ, and 30 MΩ. The ranges can be selected automatically or manually. The voltmeter resolution is selectable by choosing the integration time in Number of Power Line Cycles (NPLC). The corresponding integration time for 6 1/2, 5 1/2, 4 1/2, and 3 1/2 digit resolution is 1, 0.1, 0.005, and 0.0005 NPLC, respectively.

The voltmeter uses a current source for ohms measurements. The current source is part of the voltmeter circuitry but has to be externally connected (using a 4-wire ohms configuration) to the voltmeter's volts input terminals for ohms measurements. The current source ranges are 1 mA, 100 μA, 10 μA, and 1 μA. The appropriate current source range is automatically selected when the desired ohms range is selected.

1-8 HP 44702A/B High Speed Voltmeter

The HP 44702A/B High Speed Voltmeter performs DC voltage and ohms measurements at a 100,000 readings/second rate. The voltmeter uses an successive approximation technique for the analog to digital conversion.

The voltmeter has an on-board buffer to store readings. The readings can be transferred to the HP 3852A's internal memory or to a hard disk via GPIO and a DMA controller while making measurements. The HP 44702A can store over 8,000 readings and the HP 44702B can store over 64,000 readings. An extended memory card is available for the HP 44702A (not the HP 44702B) to extend its reading storage capability to 64,000.

The voltmeter resolution is 12 bits plus a sign bit. The voltmeter's dc volt ranges are 40 mV, 320 mV, 2.58 V, and 10.24 V. The ohms ranges depend on the ohms function (i.e., current source range) selected (see next paragraph for the ranges). The ranges can be selected automatically or manually.

The voltmeter uses a current source for ohms measurements. The current source is part of the voltmeter circuitry but needs to be externally connected (using a 4-wire ohms configuration) to the voltmeter's volts input terminals for ohms measurements. The current source ranges are 1 mA, 100 μA, and 10 μA and are selected by the 10 kΩ, 100 kΩ, and 1 MΩ ohms functions, respectively. The ranges for the 10 kΩ function are 40 Ω, 320 Ω, 2.56 kΩ, and 10.24 kΩ. The ranges for the 100 kΩ function are 400 Ω, 3.2 kΩ, 25.6 kΩ, and 102.4 kΩ. The ranges for the 1 MΩ function are 4 kΩ, 32 kΩ, 256 kΩ, and 1.024 MΩ.

1-9 HP 44705A/44705H/44706A/44708A/44708H Relay Multiplexers

These relay multiplexers provide the analog measurement paths to either the HP 3852A backplane and/or to a common point on the multiplexer's terminal module. All have High, Low, and Guard inputs for good common mode rejection.

The HP 44705A/H and HP 44708A/H can each multiplex 20 channels. Both are used for voltage, and 2-wire and 4-wire ohms measurements. The HP 44708A/H also has thermocouple compensation for temperature measurements using thermocouples. Individual relays are used to switch the High, Low, and Guard inputs of each channel. The only difference between the HP 44705A/44708A and 44705H/44708H is that the 44705H/44708H can operate at higher voltages.

The HP 44706A can multiplex 60 channels and can only be used for single ended measurements. The multiplexer is used for voltage and 2-wire (not 4-wire) ohms measurements. Individual relays are used to switch only the High input of each channel. The Low and Guard inputs of all channels are connected to a common point with no switching performed by any relays.

1-10 HP 44709A/44710A/44711A/44712A/44713A FET Multiplexers

These FET multiplexers provide the analog measurement paths to either the HP 3852A backplane and/or to a common point on the multiplexer's terminal module. The HP 44709A and HP 44710A have High, Low, and Guard inputs for good common mode rejection. The HP 44711A, HP 44712A, and HP 44713A only have High and Low inputs.

The HP 44709A and HP 44710A can each multiplex 20 channels. The HP 44709A is used for voltage, and 2-wire and 4-wire ohms measurements. The HP 44710A is used for voltage and 2-wire (not 4-wire) ohms measurements. The HP 44710A also has thermocouple compensation for temperature measurements using thermocouples. Individual FET switches are used to switch the High, Low, and Guard inputs of each channel.

The HP 44711A, HP 44712A, and HP 44713A are all High Speed FET Multiplexers. They are specifically designed to operate with the HP 44702A/B High Speed Voltmeter. The HP 44702A/B can directly control these multiplexers and take measurement via an externally connected ribbon cable. With ribbon cable control, the FETs can switch at a reading rate of up to 100,000 readings/second. If the ribbon cable is not used, they operate at the same speed as the HP 44709A and HP 44710A FET Multiplexers.

The HP 44711A and HP 44713A can each multiplex 24 channels. The HP 44712A can multiplex 48 channels and can only be used for single ended measurements. All are used for voltage measurement. The HP 44711A is also used for 4-wire (not 2-wire) ohms measurements. The HP 44711A and HP 44713A use individual FET switches to switch the High and Low inputs of each channel. The HP 44712A can only switch the High input of each channel. On the HP 44712A, all Low inputs are connected to a common point with no switching performed by any FET switches.

1-11 HP 44717A/44718A/44719A/44720A Strain Gages

The HP 44717A and HP 44718A are terminal modules that work in conjunction with the HP 44705A Relay Multiplexer component module. These can only be used for strain gage measurements. The HP 44717A is used for 120 Ω measurements and the HP 44718A is used for 350 Ω measurements.

The HP 44717A and HP 44718A are terminal modules that work in conjunction with the HP 44709A FET Multiplexer component module. These can only be used for strain gage measurements. The HP 44719A is used for 120 Ω measurements and the HP 44720A is used for 350 Ω measurements.

1-12 HP 44721A/44722A Digital Input Accessories

The HP 44721A has 16 channels and can detect the presence of DC voltage inputs. The HP 44722A has 8 channels and can detect the presence of both DC voltage inputs, and AC voltage inputs at sine wave frequencies between 47 Hz and 470 Hz. The input detection of both accessories are based on nominal voltages selected by movable jumpers. For the HP 44721A, the nominal voltages are 5, 12, 24, and 48 volts DC. For the HP 44722A, the nominal voltages are 24, 210, and 240 volts DC. All channels are isolated from chassis ground using opto-isolators.

Each channel of the accessories also has the ability to independently totalize both positive and negative logic transitions, whichever one is selected. The maximum on/off frequency for the HP 44721A is 500 cycles/second and for the HP 44722A is 10 cycles/second. Any channel can also be programmed to set an interrupt for an edge occurrence (positive or negative) or a counter rollover to zero.

The accessories have a common debounce circuitry for all channels to prevent erroneous readings. The debounce time is user selectable by changing the the debounce oscillator frequency (for the HP 44721A only). The frequencies are 10 Hz, 100 Hz, and 1 kHz. The oscillator frequency for the HP 44722A is not selectable and is set to 10 Hz.

The HP 44721A also has a non isolated low current 5 V DC supply with 9.4 kΩ pull-up resistors on each channel input. The supply can be used to detect contact closures.

1-13 HP 44715A 5 Channel Counter Accessory

The HP 44715A 5 Channel Counter/Totalizer is used to count transitions, and make period and frequency measurements. It can accurately measure logic or RMS AC inputs with frequencies up to 200 kHz. The counter has 5 isolated and 5 non-isolated channels.

Isolated channels independently count on either positive or negative transitions. Nominal DC voltages are selectable by movable jumpers. The voltages are 5, 12, and 24 volts DC. Non-isolated channels have either TTL or low level RMS voltage inputs available. The TTL level is 5 V and the low level RMS sensitivity is 50 mV from DC to 10 kHz and 25 mV from 10 kHz to 200 kHz. The TTL and RMS inputs are also selectable by movable jumpers. Non-isolated channels set for low level RMS inputs use a zero crossing technique for measurements. Any channel that is totalizing can also be programmed to set an interrupt for a counter rollover to zero.

The debounce time of the accessories is user selectable for all channels to prevent erroneous readings.

The HP 44715A also has a non isolated low current 5 V DC supply with pull-up resistors. The supply can be used to detect contact closures.

1-14 HP 44727A/B/C 4 Channel Voltage/Current DACs Accessories

The HP 44727A/B/C accessories are Digital to Analog Converters that output either voltage or current. Each accessory has 4 channels of output available. The channels configured for voltage also have remote sensing capabilities. The channels are isolated and can be connected in series for voltage and parallel for current.

The accessories have two voltage ranges and two current ranges. The voltage ranges are 0 to +10.235 V and -10.235 V to +10.235 V with 2.5 mV resolution (12 bits plus a sign bit). The current ranges are 0 to +20.16 mA and +4 mA to +20.16 mA with 2.5 μA resolution (13 bits).

Three configurations of the accessory are available. The HP 44727A accessory outputs voltage on 4 channels. The HP 44727B accessory outputs current on 4 channels. The HP 44727C accessory outputs voltage on 2 channels and current on the other 2 channels. However, each channel on the accessories can be reconfigured for voltage or current with movable jumpers on the accessories.

1-15 HP 44724A Digital Output Accessory

The HP 44724A accessory uses open drain digital outputs to control DC devices (up to 55 V) or to drive TTL logic levels. In either mode, an external power supply and pull-up resistors are needed. The accessory has 16 channels of output available.

1-16 Switching Accessories

There are three accessories for switching; HP 44725A 16 Channel general Purpose Switch, HP 44728A 8 Channel Relay Actuator, and HP 44729A 8 Channel Power Controller.

The HP 44725A and HP 44728A both use single pole double throw (SPDT) For C relays that return to the normally closed position at power down. The HP 44725A is used for low level power or moderate voltage and current switching. The HP 44728A is used for higher level power, and larger voltages and currents.

The HP 44729A is used to distribute AC line power. It switches on at the zero voltage crossing point and switches off at the zero current crossing point of the AC voltage. This method is used to prolong switch life and low channel path resistance.

1-17 HP 44736A Breadboard Accessory

The HP 44736A Breadboard is used to add specialized circuitry by the user. The breadboard consist of a printed circuit board (with no components installed), shield, and terminal module with 35 screw terminals. With the breadboard, the user has access to the HP 3852A/3853A backplane signals. Included are the control lines from the mainframe controller and power supplies.

1-18 INSTRUMENT IDENTIFICATION

Hewlett-Packard instruments are identified by a two part, ten digit serial number. This number is in the form 0000A00000. The first four digits, called the serial number prefix, is the same for all identical instruments, it changes only when a change is made to the instrument. The letter indicates the country of origin, A indicates the instrument was built in the United States of America. The last five digits, called the serial number suffix, are unique for each instrument.

Be sure to include the entire serial number, both prefix and suffix, in any correspondence about your instrument.

The serial number for the HP 3852A and HP 3853A is located on a label below the right side of the front panel. Each plug-in accessory also has a serial number. The accessory serial number is on a label affixed to the side frame of each accessory component module. The terminal modules are not serialized.

Table 1-2 Assemblies/Module Exchange Part Numbers

Accessory Number	Ref Desig	HP Part Number	Description
3852X	3852X	03852-69203	Controller Module without A24 Extended Memory
44703A	A24	09826-69524	Printed Circuit Assembly with 256 k bytes extended memory
44703B	A24	98257-69524	Printed Circuit Assembly with 1 M bytes extended memory
3852PS	3852PS	06852-69202	Mainframe Power Supply Module
3853PS	3852PS	03853-69202	Extender Power Supply and Logic Module
44701A	44701A	44701-69201	5 1/2 Digit Integrating Voltmeter
44702A	44702A	44702-69201	13-Bit High Speed Voltmeter with 8 k reading storage
44702B	44702B	44702-69203	13-Bit High Speed Vottmeter with 64 k reading storage
44709A	44709A	44709-69201	20 Channel FET Multiplexer Component Module
44710A	44710A	44709-69201	20 Channel FET Multiplexer Component Module
44719A	44719A	44709-69201	20 Channel FET Multiplexer Component Module
44720A	44720A	44709-69201	20 Channel FET Multiplexer Component Module
44711A	44711A	44711-69201	24/48 Channel High Speed FET Multiplexer Component Module
44712A	44712A	44711-69201	24/48 Channel High Speed FET Multiplexer Component Module
44713A	44713A	44711-69201	24/48 Channel High Speed FET Multiplexer Component Module
44715A	44715A	44715-69201	5 Channel Counter/Totalizer Component Module
44721A	44721A	44721-69201	16 Channel DC/8 Channel AC Digital Input Component Module
44722A	44722A	44721-69201	16 Channel DC/8 Channel AC Digital Input Component Module
44724A	44724A	44724-69201	16 Channel Digital Output Component Module
44727A	44727A	44727-69201	4 Channel Voltage/Current DAC Component Module
44727B	44727B	44727-69201	(use reconfigured & recalibrated 44727A)
44727C	44727C	44727-69201	(use reconfigured & recalibrated 44727A)
44729A	44729A	44729-69201	8 Channel Power Controller Component Module

1-19 HP 3852A SYSTEM ASSEMBLIES/MODULE EXCHANGE

Some of the replaceable assemblies and modules for the HP 3852A/3853A and plug-in accessories are available as restored products through the Hewlett-Packard Exchange Program. These products are sold at a discount and require the return for credit of your defective assembly. Table 1-2 lists the assemblies/modules that my be exchanged. Included in the table are reference designators, HP part numbers, and description.

When an exchange assembly or module is ordered, Hewlett-Packard will ship a restored assembly with instructions for returning your defective assembly. Upon receipt of your defective assembly, Hewlett-Packard then credits your bill (give you a discount) and invoice you accordingly. You are allowed a specific time period to return your defective assembly after receiving the replacement assembly from HP. If the defective assembly is not received within this period the discount will not be given.

For more information on this program contact your nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed in the back of this manual.

1-20 HP 3852A SYSTEM OPTIONS/ACCESSORIES AVAILABLE

The following lists all options and accessories available for the HP 3852A System. It is only intended to show possible configurations. It should not be used as an ordering guide for future accessories and systems. Ordering information can be obtained from your nearest Hewlett-Packard Sales Office. Sales Offices are listed at the back of this manual.

1-21 HP 3852A System Options Available

The following lists the options available for the HP 3852A System.

```
HP 3852A     Data Acquisition and Control Unit
  Opt 907    Front handle kit
  Opt 908    Rack mounting hardware
  Opt 909    Rack mounting hardware and front handle kit
  Opt 910    Extra set of HP 3852A/HP 3853A documentation

HP 3853A     Extender
  Opt 001    4 meter digital cable (replaces standard 1 meter cable)
  Opt 907    Front handle kit
  Opt 908    Rack mounting hardware
  Opt 909    Rack mounting hardware and front handle kit
  Opt C01    Add specified length of analog cable
  Opt C02    Add specified length of digital cable
  Opt K01    Specified length of analog cable (field kit) (100 meters max)
  Opt K02    Specified length of digital cable (field kit) (25 meters max)
```

1-22 HP 3852A System Accessories Available

Table 1-3 lists all accessories available for the HP 3852A System. Included are all plug-in modules, HP-IB cables, and system software.

1-23 HP 3852A Service Accessories and Support Courses Available

Table 1-4 lists all service accessories and support courses available for the HP 3852A System.

1-24 HP 3852A SYSTEM REQUIRED TEST EQUIPMENT

The required test equipment for the HP 3852A and plug-in accessories are listed in Table 1-5. This equipment is necessary to perform the Operational Verification Test, Performance Test, and Calibration procedures. The equipment is also listed in each applicable chapter.

1-25 HP 3852A/3853A SPECIFICATIONS

The HP 3852A/3583A specifications are listed in Table 1-6.

Table 1-3 HP 3852A System Accessories

Accessory Number	Title
44458A	System Software for Series 200/300 Computer on 3.5 inch Flexible Discs (BASIC 4.0)
44458B	System Software for Series 200 Computer on on 5.25 inch Flexible Discs (BASIC 4.0)
44458R	License to produce HP 44458A or 44458B; includes one set of Software Manuals
44701A	5 1/2 Digit Integrating Voltmeter
44702A	13 Bit High Speed Voltmeter - 100 kHz (with 8 k reading memory)
44702B	13 Bit High Speed Voltmeter - 100 kHz (with 64 k reading memory)
44703A	Mainframe 256 k byte Memory expansion (field installed)
44703B	Mainframe 1 M byte memory expansion (field installed)
44703C	Reading memory expansion to 64 k for HP 44702A (field installed)
44705A	20 Channel Relay Multiplexer
44705H	20 Channel High Voltage Relay Multiplexer
44706A	60 Channel Single Ended Relay Multiplexer
44708A	20 Channel Relay Multiplexer with Thermocouple Compensation
44717A	10 Bridge 120 Ohm Static Strain Gage Relay Multiplexer
44708H	20 Channel High Voltage Relay Multiplexer with Thermocouple Compensation
44718A	10 Bridge 350 Ohm Static Strain Gage Relay Multiplexer
44709A	20 Channel FET Multiplexer
44710A	20 Channel FET Multiplexer with Thermocouple Compensation
44719A	10 Bridge 120 Ohm Static Strain Gage FET Multiplexer
44720A	10 Bridge 350 Ohm Static Strain Gage FET Multiplexer
44711A	24 Channel High Speed FET Multiplexer
44712A	48 Channel Single Ended High Speed FET Multiplexer
44713A	24 Channel High Speed FET Multiplexer with Thermocouple Compensation
44715A	5 Channel Counter/Totalizer (200 kHz)
44721A	16 Channel Digital Input
44722A	8 Channel AC Digital Input
44724A	16 Channel Digital Output (open drain)
44725A	16 Channel General Purpose Switch
44727A	4 Channel Voltage DAC
44727B	4 Channel Current DAC
44727C	2 Channel Voltage and 2 Channel Current DAC
44728A	8 Channel Relay Actuator
44729A	8 Channel Power Controller
44736A	Breadboard
44705AT	Extra terminal module for HP 44705A 20 Channel Relay Multiplexer
44705HT	Extra terminal module for HP 44705H 20 Channel High Voltage Relay Multiplexer
44706AT	Extra Terminal Module for HP 44706A 60 Channel Single Ended Relay Multiplexer
44708AT	Extra Terminal Module for HP 44708A 20 Channel Relay Multiplexer with TC
44708HT	Extra Terminal Module for HP 44708H 20 Channel High Voltage Relay Mux with TC

Table 1-3 HP 3852A System Accessories (Cont.)

Accessory Number	Title
44709AT	Extra Terminal Module for 20 Channel FET Multiplexer
44710AT	Extra Terminal Module for 20 Channel FET Multiplexer with Thermocouple Compensation
44711AT	Extra Terminal Module for 24 Channel High Speed FET Multiplexer
44712AT	Extra Terminal Module for 48 Channel Single Ended High Speed FET Multiplexer
44713AT	Extra Terminal Module for 24 Channel High Speed FET Multiplexer with TC
44715AT	Extra Terminal Module for 5 Channel Counter/Totalizer (200 kHz)
44717AT	Extra Terminal Module for 10 Bridge 120 Ohm Static Strain Gage Relay Multiplexer
44718AT	Extra Terminal Module for 10 Bridge 350 Ohm Static Strain Gage Relay Multiplexer
44719AT	Extra Terminal Module for 10 Bridge 120 Ohm Static Strain Gage FET Multiplexer
44720AT	Extra Terminal Module for 10 Bridge 350 Ohm Static Strain Gage FET Multiplexer
44721AT	Extra Terminal Module for 16 Channel Digital Input
44722AT	Extra Terminal Module for 8 Channel AC Digital Input
44724AT	Extra Terminal Module for 16 Channel Digital Output (open drain)
44725AT	Extra Terminal Module for 16 Channel General Purpose Switch
44727AT	Extra Terminal Module for 4 Channel Voltage DAC
44727BT	Extra Terminal Module for 4 Channel Current DAC
44727CT	Extra Terminal Module for 2 Channel Voltage and 2 Channel Current DAC
44728AT	Extra Terminal Module for 8 Channel Relay Actuator
44729AT	Extra Terminal Module for 8 Channel Power Controller
44736AT	Extra Terminal Module for Breadboard
44740A	76.2 cm Rack with 110 V Power Panel and Instrument Installed
44740B	76.2 cm Rack with 220 V Power Panel and Instrument Installed
44741A	142.24 cm Rack with 110 V Power Panel and Instrument Installed
44741B	142.24 cm Rack with 220 V Power Panel and Instrument Installed
44495A	Field Wiring Terminal Panel (not rack installed)
98620B	2 Channel DMA Controller for HP Series 200/300 Computers
98622A	GPIO Interface for HP Series 200/300 Computers
98625A	High Speed HP-IB Disc Interface for HP Series 200/300 Computers
44744A	2 Meter GPIO Cable with Mating for HP 44702A/B and HP 98622A
44744B	4 Meter GPIO Cable with Mating for HP 44702A/B and HP 98622A
44745A	4 Meter GPIO Cable with Mating for HP 44702A/B and HP 12006A (GPIO for HP 1000)
10833A	1 Meter HP-IB Cable
10833B	2 Meter HP-IB Cable
10833C	4 Meter HP-IB Cable
10833D	0.5 Meter HP-IB Cable
8120-3448	6 Meter HP-IB Cable
8120-3449	8 Meter HP-IB Cable

Table 1-4 Service Accessories and Support Courses

Accessory Number	Title
44743A	Service Module for Plug-in Accessories (backplane extender)
44743B	Service Module for Power Supply (backplane extender)
44743F	Service Kit; includes software and test fixures for mainframe and plug-in accessories operational verification tests and calibration
50011B	HP-IB Course for HP Series 200/300 Computers
50015A	Data Acquisition and Control Fundamentals Course
50016E	HP-IB Course for HP 1000 Computers
500600B	Instrument Application Services (consulting)

Table 1-5 Equipment Required for HP 3852A System

Accessory or Model Number	Use*	Instrument	Recommended Model
3852A	O	System Controller	HP 9000 Series 200/300, Basic 3.0 or 4.0
3853A		HP-IB Cable	HP Number 10833A
		Printer	HP Model 9876A
		Pulse/Function Generator	HP Model 8116A
		BNC to BNC Cable	HP Number 10503A
44701A	OPC	DC Voltage Standard	Datron Model 4000 or 4000A
		Resistance Standard	Datron Model 4000 or 4000A
		AC Voltage Standard	Datron Model 4200
44702A/B	OPC	Test Cables (2 each)	HP Number 03498-61602
		DC Voltage Standard	Datron Model 4000 or 4000A
		Resistance Standard	Datron Model 4000 or 4000A
		Computer	HP 9000 Series 200/300, Basic 4.0
		High Speed FET Multiplexer	HP 44711A, 44712A, or 44713A with 44711AT Terminal Module
44705A	OP	Digital Multimeter	HP 3456A
44705H		Oscilloscope	HP 1740A
44708A		Test Fixure	Made from HP 44705AT Terminal Module
44708H		Service Module	HP 44743A
		+20 V Power Supply	HP 6212A
		1 kΩ Resistor	Any 1 kΩ Resistor ±5% or Better
		10 MΩ Resistor	Any 10 MΩ Resistor ±5% or Better
44706A	OP	Digital Multimeter	HP 3456A
		Oscilloscope	HP 1740A
		Test Fixure	Made from HP 44706AT Terminal Module
		Service Module	HP 44743A
		+20 V Power Supply	HP 6212A
		1 kΩ Resistor	Any 1 kΩ Resistor ±5% or Better
		10 MΩ Resistor	Any 10 MΩ Resistor ±5% or Better

Table 1-5 Equipment Required for HP 3852A System (Cont.)

Accessory or Model Number	Use*	Instrument	Recommended Model
44709A	OP	Digital Multimeter	HP 3456A
44710A		Oscilloscope	HP 1740A
		Test Fixure	Made from HP 44709AT Terminal Module
		Service Module	HP 44743A
		+20 V Power Supply	HP 6212A
		1 kΩ Resistor	Any 1 kΩ Resistor ±5% or Better
		10 MΩ Resistor	Any 10 MΩ Resistor ±5% or Better
		+10 V Power Supply	HP 6234A
		-10 V Power Supply	HP 6234A
44711A	OP	Digital Multimeter	HP 3456A
44713A		Oscilloscope	HP 1740A
		Test Fixture	Made from HP 44711AT Terminal Module
		Service Module	HP 44743A
		High Speed Voltmeter	HP 44702A/B
		1 kΩ Resistor	Any 1 kΩ Resistor ±5% or Better
		10 MΩ Resistor	Any 10 MΩ Resistor ±5% or Better
		+10 V Power Supply	HP 6234A
		-10 V Power Supply	HP 6234A
44712A	OP	Digital Multimeter	HP 3456A
		Oscilloscope	HP 1740A
		Test Fixture	Made from HP 44712AT Terminal Module
		Service Module	HP 44743A
		High Speed Voltmeter	HP 44702A/B
		1 kΩ Resistor	Any 1 kΩ Resistor ±5% or Better
		10 MΩ Resistor	Any 10 MΩ Resistor ±5% or Better
		+10 V Power Supply	HP 6234A
		-10 V Power Supply	HP 6234A
44715A	OP	Function Generator	HP Model 3325A
		Test Fixture	Made from HP 44715AT Terminal Module
44721A	OP	DC Voltmeter	Any DC Voltmeter able to read +5 V, ±10%
44722A		Function Generator	HP 8116A
		Test Fixture	Made from HP 44721AT Terminal Module
44724A	OP	Digital Multimeter	HP 3456A
		Test Fixture	Made from HP 44724AT Terminal Module
		+5 V Power Supply	HP 6214A
		10 Ω Resistor	Any 10 Ω 5 W Resistor 10% or Better
44725A	OP	Digital Multimeter	HP 3456A
		Test Fixture	Made from HP 44725AT Terminal Module
		Service Module	HP 44743A
		10 MΩ Resistor	Any 10 MΩ Resistor ±5% or Better
		+20 V Power Supply	HP 6212A

Table 1-5 Equipment Required for HP 3852A System (Cont.)

Accessory or Model Number	Use*	Instrument	Recommended Model
44727A/B/C	OPC	Digital Multimeter	HP 3456A
		Test Fixture	Made from HP 44727AT Terminal Module
		Service Module	HP 44743A
		500 Ω Resistor	Any 500 Ω .25 W Resistor ±5% or Better
		125 Ω Resistor	Any 125 Ω 5 W Low TC Resistor ±5% or Better
		600 Ω to 630 Ω Resistor	Any 600 Ω to 630 Ω .5 W Low TC Resistor ±5% or Better
44728A	OP	Digital Multimeter	HP 3456A
		Test Fixture	Made from HP 44728AT Terminal Module
		Service Module	HP 44743A
44729A	OP	Digital Multimeter	HP 3456A
		Function Generator	HP 8116A
		Test Fixture	Made from HP 44729AT Terminal Module
		Service Module	HP 44743A
*O=Operational Verification, P=Performance, and C=Calibration			

Table 1-6 HP 3852A/3853A Specifications

HP 3852A Mainframe

Real Time Clock:

Accuracy: ±0.004% of elapsed time since setting ±2 msec at temperature of setting.

Temperature Coefficient:

Add as an additional accuracy error, where Tdif is the absolute difference between the operating temperature and the temperature when the time was set.

$\pm((4.5*10^{-6})\%$ of elapsed time since setting$)*Tdif^2$

Resolution: 1 msec

Nonvolatile Lifetime: 4 years

Pacer:

Programmable Intervals: 1 μsec to 4.19 sec with 0.25 μsec resolution.

Accurcacy (First Pulse after Trigger):

Table 1-6 HP 3852A/3853A Specifications (Cont.)

Programmed Delay ±0.005% of delay + (0 to 1 μsec)

Accuracy (Additional Pulses):

Programmed pules interval ±0.005% of pulse interval ±50 nsec

Number of Pulses: 1 to 65,535 or continuous.

Pulse Widths: 0.5 μsec nominally (low true)

Backplane Trigger Delay: Maximum delay between System Trigger In and actual trigger on the backplane,

200 nsec

Physical Characteristics:

Size: 22.225 cm (8 3/4 in) H (with feet removed) X 42.55 cm (16 3/4 in) W X 50.8 cm (20 in) D. Add 1.27 cm (0.5 in) for feet.

Weight: 16.8 kg (37 lbs)without function modules; 31.8 kg (70 lbs) loaded.

HP 3853A Extender

Backplane Trigger Delay: Maximum delay between HP 3852A backplane trigger and the actual trigger on the HP 3853A Extender backplane,

75 nsec + 5 nsec per meter of extender control cable (between mainframe and extender)

Physical Characteristics:

Size: 22.225 cm (8 3/4 in) H (with feet removed) X 42.55 cm (16 3/4 in) W X 50.8 cm (20 in) D. Add 1.27 cm (0.5 in) for feet.

Weight: 15.0 kg (33 lbs) without function modules; 32.7 kg (72 lbs) loaded.

Chapter 2
Operating Information

CHAPTER 2
OPERATING INFORMATION

CHAPTER 2
OPERATING INFORMATION

2-1 INTRODUCTION

This chapter summarizes HP 3852A operation. Complete operating information is in the HP 3852A Mainframe Configuration and Programming Manual. Operating information about plug-in accessories are in the HP 3852A Plug-In Accessory Configuration and Programming Manuals.

The information in this chapter is about entering commands. Also included are the addressing conventions used in this and other manuals, the syntax rules for the commands, subroutines, and service related commands. A command reference that lists all commands in alphabetical order is in Table 2-2. Detailed information is given about the service related commands.

2-2 ENTERING COMMANDS

Most of the commands in the procedures and examples in this manual may be entered from the front panel. These commands may also be sent over the HP-IB. Some commands may only be sent over the HP-IB. These commands typically involve a symbol or parameter that cannot be entered from the front panel. For example, the FOR...NEXT construct cannot be entered from the front panel due to the lack of an "=" key.

Commands can be entered from the front panel in two ways. By pressing the key with the function name desired, if a key for that function is available, or by pressing the blue shift key and then entering the command name desired. After the blue shift key is pressed, the keyboard is a full alpha keyboard, laid out in a typewriter "QWERTY" fashion.

2-3 ADDRESSING CONVENTIONS

In this and other manuals about the HP 3852A, commands that contain parameters for a slot, channel, or channel list use the **ESCC** convention. In this convention:

E = Extender number
In the HP 3852A, E = 0
In the HP 3853A, E = 1 to 7

S = Slot number in extender **E**
In the HP 3852A, S = 0 to 7
In the HP 3853A, S = 0 to 9

CC = Channel number in slot **S**
If only a slot is specified, channel number is 00.

For example, the following command string (using the ID? command) asks the identity of the accessory installed in slot 5 of extender 3.

Select from front panel by executing:

ID? 3500

Select from a Basic language Computer by executing:

```
OUTPUT 709;"ID? 3500"
```

In the command string, leading zeros are not required, trailing zeros are required.

2-4 The USE Command

The accessory slot or channel specified by a **USE** command is the selected slot or channel for all following commands not specifying a different channel or slot. After power-on or reset, the default USE channel is the lowest slot number and channel number with an accessory installed.

2-5 SYNTAX RULES

These rules describe the format and programming conventions associated with the HP 3852A command set shown in Table 2-1.

1. Commands generally consist of a header and one or more parameters. Headers can be entered in either upper or lower case. However, in the command reference table they are shown in upper case and in bold print (e.g., **ADDR?**).

2. Parameters can be entered in either upper or lower case. However, in the command reference table they are shown in lower case italics (e.g., *mode*).

3. Parameters shown in the command reference table not enclosed in [ ] (brackets) are required parameters. They must be specified each time the command is used. Parameters enclosed in [ ] (brackets) are optional parameters and can be omitted when executing the command. If the optional parameter is not specified, a default parameter is assigned.

4. Numeric parameters can be either integer, floating point, or exponential format. Numbers in floating point format are rounded to the nearest integer if the command requires an integer.

5. Command headers and parameters must be separated by either a space or a comma. Multiple spaces and/or commas are also accepted.

6. Command delimiters are the ; (semicolon), **<LF>** (line feed) or **EOI** (HP-IB). When entered from the front panel, the ENT (enter) key signals the end of command.

7. Over the HP-IB, multiple commands can be sent as a single string by separating the commands with a semicolon.

2-6 SUBROUTINES

The HP 3852A allows subroutines to be entered and executed in mainframe memory. Subroutines may be entered from either the HP-IB or the front panel. The following guidelines apply when using subroutines.

1. The subroutine name may be any combination of alpha and numeric characters, up to eight characters. The first character of a subroutine name must be an alpha character. Special characters are not allowed in subroutine names.

2. Subroutines are erased from memory when the RESET or SCRATCH command is executed or at power-down.

Table 2-1 Format Specifiers

fmt	Definition	Restrictions
IASC	Short Integer number (+12345)	Output buffer & display format. Not a mainframe storage format.
LASC	Long Integer number (+1234567890)	Output buffer & display format. Not a mainframe storage format.
RASC	Real number (+1.234567E-12)	Output buffer & display format. Not a mainframe storage format.
DASC	Double Real number (+1.234567890123456E-123)	Output buffer & display format. Not a mainframe storage format.
PACK	Packed as received from the accessory	Output buffer & mainframe storage format. Not a display format.
RL64	64-bit REAL number	Output buffer & mainframe storage format. Not a display format.
IN16	16-bit INTEGER number	Output buffer & mainframe storage format. Not a display format.

3. The execution of a subroutine can be viewed by sending the **FASTDISP OFF** command prior to the subroutine call. The **STEP** command can also be used to control subroutine execution speed.

4. Variables and arrays are global. They can be declared and dimensioned inside or outside a subroutine and then used inside or outside a subroutine.

5. Math functions, trigonometric operations, and binary functions can be used in subroutines.

6. The following commands can only be used inside subroutines:

   FOR ... NEXT
   IF ... END IF
   WHILE ... END WHILE

7. The following commands cannot be used inside subroutines:

   DELSUB
   SCRATCH
   STEP
   CONT
   SUB ... SUBEND

8. A subroutine can be aborted by sending the HP-IB Device Clear command or pressing the front panel CLEAR button.

2-7 SERVICE COMMANDS

2-8 CAL Command

The **CAL** command is used to set the gain and offset of either the HP 44701A Integrating Voltmeter or the HP 44702A/B High Speed Voltmeter. The command syntax is shown in Figure 2-1. Complete calibration procedures are given in the appropriate chapter of this manual.

CAL, *number* **[,USE** *ch***]**

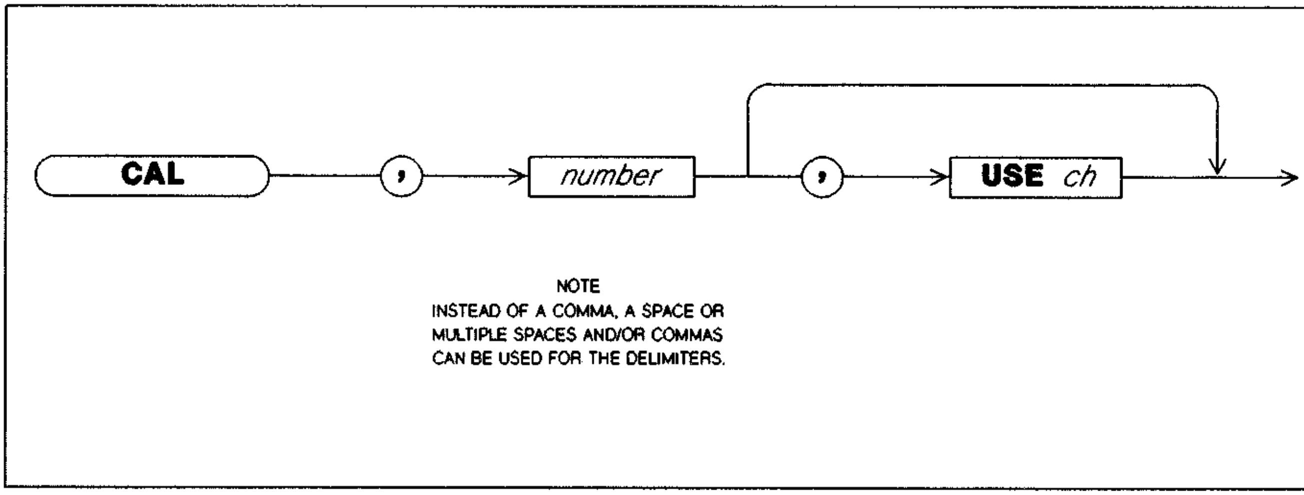


Figure 2-1 CAL Syntax

The *number* parameter represents what the reading should be in the range and function selected. To set the offset the *number* parameter is set to 0. To set the gain, the *number* parameter is set to the actual measurement value.

The optional **USE** *ch* parameter is the slot destination for the command. The **USE** *ch* parameter has the form **ESCC**, where **E** = the extender number, **S** = the slot number, and **CC** = 00 for the CAL command. The default for the **USE** *ch* parameter is the last slot assigned in a **USE** command or, if no **USE** command has been sent, the power-on **USE** *ch* value.

2-9 SREAD Command

This command interrogates registers on the accessory modules in the HP 3852A. The syntax for the command is shown in Figure 2-2.

SREAD, *slot, register_number* **[,INTO** *name*] or [,*fmt*]

NOTE

The accessory must not be busy when attempting to read a register.

The *slot* parameter has the form ES00, where E = extender number (HP 3852A = 0, HP 3853A = 1 to 7) and S = slot number (HP 3852A = 0 to 7, HP 3853A = 0 to 9). The *register_number* is specific to the accessory being interrogated. Refer to the specific accessory chapter for register numbers and their uses.

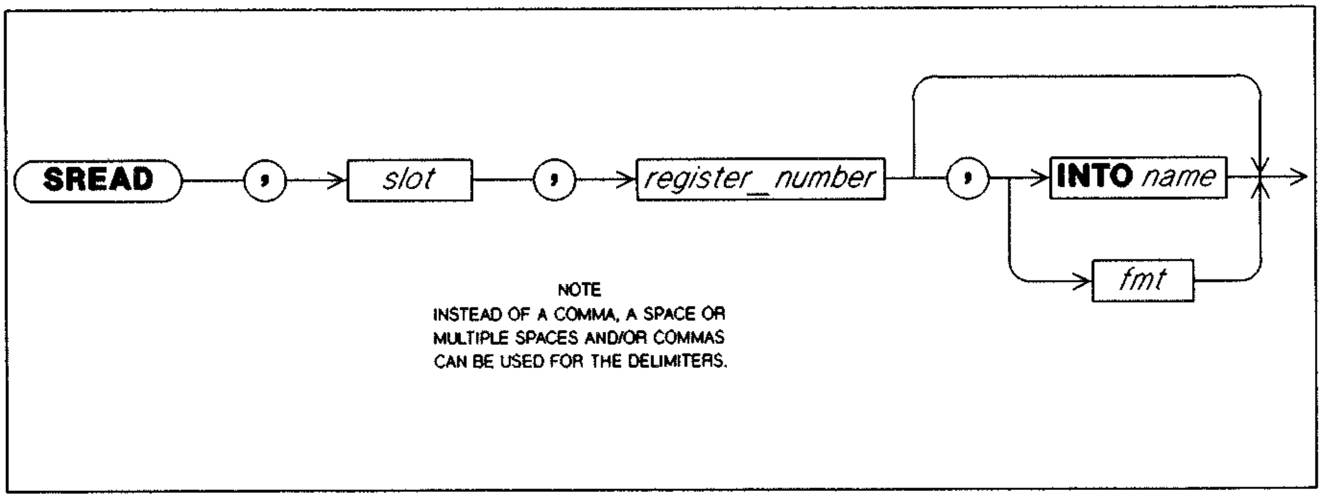


Figure 2-2 SREAD Syntax

The **INTO** *name* is an optional parameter for transferring the register reading into a variable or array. If **INTO** *name* is not used the reading will go to the output buffer and/or display. If **SREAD** was initiated from the front panel, the data is routed to the display. If **SREAD** was initiated from the HP-IB, the data is sent to the HP-IB output buffer and to the display.

The optional *fmt* parameter is the output buffer/display format specifier. Table 2-1 lists format specifiers. If the *fmt* parameter is not specified, the default format for SREAD is IASC.

NOTE

The read and write registers of an accessory are binary registers. The SREAD and SWRITE commands use a decimal representation of this two's compliment binary number. If using an HP Series 200 or 300 computer the IVAL$ and IVAL commands can be used to convert decimal to binary or binary to decimal. In the HP 85A/B the DTB$ and BTD commands can be used to perform these functions.

2-10 SWRITE Command

This command writes a specified value to a register on the accessory modules in the HP 3852A. The syntax for the SWRITE command is shown in Figure 2-3.

SWRITE, *slot, register_number, register_value*

NOTE

The accessory must not be busy when sending the SWRITE command.

The *slot* parameter has the form ES00, where E = extender number (HP 3852A = 0, HP 3853A = 1 to 7) and S = slot number (HP 3852A = 0 to 7, HP 3853A = 0 to 9). The *register_number* is specific to the accessory being addressed. Refer to the specific accessory chapter for register numbers and their uses.

The *register_value* is the decimal value you are sending to the register.

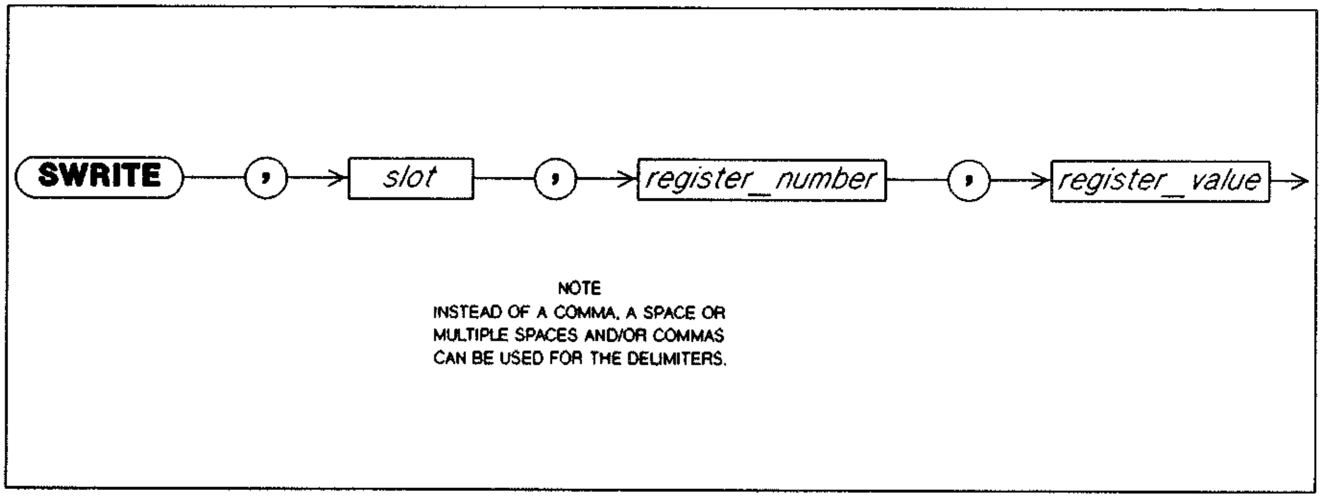


Figure 2-3 SWRITE Syntax

NOTE

The read and write registers of an accessory are binary registers. The SREAD and SWRITE commands use a decimal representation of this two's compliment binary number. If using an HP Series 200 or 300 computer the IVAL$ and IVAL commands can be used to convert decimal to binary or binary to decimal. In the HP 85A/B the DTB$ and BTD commands can be used to perform these functions.

Table 2-2 Command Reference

ADDR *number*
Set the HP-IB address
number = 0 to 30

ADDRESS - See ADDR

ADDR? [INTO *name*] **or** [*fmt*]
Read the HP-IB address

ALRM [INTO *name*] **or** [*fmt*]
Read current alarm setting

exp **AND** *exp* ********
Logical AND function
exp = variable or number

APPLY DCI *ch, number*
Set output current level on DAC
ch = HP 44727B/C channel
number = 0 to .0201675

APPLY DCV *ch, number*
Set output voltage level on DAC
ch = HP 44727A/C channel
number = -10.235 to 10.235

APPLY PERC *ch, number*
Set percentage of full scale output on DAC
ch = HP 44727A/B/C channel
number = -102.35 to 102.35

ARANGE [*mode*] **[USE** *ch*]
Set voltmeter autorange mode
mode = OFF or ON
USE *ch* = HP 44701A slot

ARMODE [*mode*] **[USE** *ch*]
Set voltmeter autorange mode, BEFORE or AFTER measure trigger
mode = BEFORE or AFTER
USE *ch* = HP 44702A/B slot

ASCAN [*mode*] **[USE** *ch*]
Set autoscan function
mode = ON or OFF
USE *ch* = HP 44702A/B slot

ATN (*number***) *****
Return arctangent in radians
number = number in controller range

AZERO [*mode*] **[USE** *ch*]
Autozero the voltmeter
mode = OFF, ON, ONCE
USE *ch* = HP 44701A/02A/B slot

BEEP [*mode*]
Enables or disables the mainframe beeper
mode = ON, OFF, ONCE

BINAND (*number, number***) ****
Bit-level binary AND function
number = -32768 through 32767

BINCMP (*number***) ****
Binary complement
number = -32768 through 32767

BINEOR (*number, number***) ****
Bit-level exclusive-OR function
number = -32768 through 32767

BINIOR (*number, number***) ****
Bit-level inclusive-OR function
number = -32768 through 32767

BIT (*number, bit_position***) ****
Bit test
number = -32768 through 32767
bit_position = 0 through 15

BLOCKOUT [*mode*]
Set the Block Output mode
mode = OFF or ON

CAL *number* **[USE** *ch*]
Calibrates the voltmeters
number = desired calibration value
USE *ch* = HP 44701A/02A/B slot

Table 2-2 Command Reference (Cont.)

CALL *name* [*number*]
Call a subroutine
name = subroutine name
number = 1 to 2147483647

CAT
Return list of variables, arrays, and subroutines

CHREAD *ch* **[INTO** *name***] or [***fmt***]**
Transfer a single reading
ch = HP 44715A/21A/22A channel or HP 44701A/02A/02B slot

CHREADZ *ch* **[INTO** *name***] or [***fmt***]**
Read and zero channel count
ch = HP 44715A/21A/22A channel

CHWRITE *ch, number*
Write a number to a channel
ch = HP 44724A/25A/28A/29A channel
number = -32768 to 32767

CLOSE *ch_list*
Close a channel
ch_list = HP 44705A/06A/08A/09A/ 10A/11A/12A/13A or HP 44724A/25A/28A/29A channels

CLOSE? *ch_list* **[INTO** *name***] or [***fmt***]**
Return the state of specified channel
ch_list = HP 44705A/06A/08A/09A/ 10A/11A/12A/13A or HP 44724A/25A/28A/29A channels list

CLR
Mainframe CLEAR.

CLROUT
Clear the HP-IB output buffer

CLWRITE [*ribbon_bus*] *ch_list* **[RANGE** *range_list***] [USE** *ch***]**
Set channel list and ranges to be scanned
ribbon_bus = SENSE, COM or SEP
ch_list = HP 44702A/B channel list
RANGE *range_list* = HP 44702A/B range or AUTO
USE *ch* = HP 44702A/B slot

CNTSET [*number*] **[USE** *ch***]**
Preset the counter channel
number = -2147483648 to 2147483647
USE *ch* = HP 44715A/21A/22A channel

CONF *function* **[USE** *ch***]**
Configure the voltmeter
function = ACV, DCV, OHM, TEMPtype, REFT, THMtype, OHMF, THMFtype, RTDtype, RTDFtype (HP 44701A); = DCV, OHM, OHM10K, OHM100K, OHM1M, OHMF, OHMF10K, OHM100K, OHMF1M, TEMPtype, REFT, THMtype, THMFtype, RTDtype, RTDFtype (HP 44702A/B); = TOTAL, TOTALM, UDC, UDCM, CD, CDM, RAT, PER, PERD (HP 44715A); = LVL (HP 44721A/22A)
USE *ch* = HP 44715A/21A/22A channel or HP 44701A/02A/B slot

CONFMEAS *function, ch_list* **[USE** *ch***][INTO** *name***] or [***fmt***]**
Configure the voltmeter and initiate a measurement
function = ACV, DCV, OHM, OHMF, TEMPtype, REFT, THMtype, THMFtype, RTDtype, RTDFtype (HP 44701A); = DCV, OHM, OHM10K, OHM100K, OHM1M, OHMF, OHMF10K, OHM100K, OHMF1M, TEMPtype, REFT, THMtype, THMFtype, RTDtype, RTDFtype HP 44702A/B
ch_list = HP 44705A/06A/08A/ 09A/10A/11A/12A/13A channels
USE *ch* = HP 44701A/02A/B slot

Table 2-2 Command Reference (Cont.)

CONT
Continue a paused or stepped subroutine

CONV *domain, range, var* **[INTO** *name***] or** [fmt**]**
Convert data from pre-defined look-up table
domain = x-coordinates array
range = y-coordinates array
var = array to be converted

COS (*number***) *****
Return the cosine of the number
number = number in radians

DELAY *trig_delay* **[USE** *ch***]**
Set delay between trigger and measurement
trig_delay = 0 to 4294.967295 sec
USE *ch* = HP 44701A slot

DELAY *trig_delay* **[***sample_period***] [USE** *ch***]**
Set delay between triger and measurement
trig_delay = 0 to 16.38375msec
sample_period = 0 to 1073.741823 sec
USE *ch* = HP 44702A/B slot

DELSUB *name*
Deletes subroutine contents
name = delete code for subname

DELVAR *name*
Deletes variable memory space
name = delete space for array name

DIM *name (max_index)* **[***name* (max_index) **...]**
Defines a REAL array
name (max_index) = REAL array name and max index

DISABLE *event*
Disables an event
event = ALRM, INTR SYS, INTR [USE ch], LMT, LOGCHAN

DISABLE INTR [USE *ch***]**
Disable the voltmeter interrupt
USE *ch* = HP 44715A/21A/22A channel or HP 44701A/02A/B slot

DISP *mode* **or [***message***]**
Set the display mode or display a message
mode = ON, OFF, or MSG [message]
message = string or numbers

EDGE *trans* **[***trans***] [USE** *ch***]**
Set the transition for counting or interrupt
trans = HL, LH, HI, LO
USE *ch* = HP 44715A/21A/22A channel

ELSE - See **IF**

ENABLE *event*
Enables an event to be recognized and serviced
event = ALRM, INTR SYS, INTR [USE ch], LMT, LOGCHAN

ENABLE INTR [USE *ch***]**
Enables voltmeter interrupt
USE *ch* = HP 44715A/21A/22A channel or HP 44701A/02A/B slot

END IF - See **IF...END IF**

END WHILE - See **WHILE..END WHILE**

ERR? [INTO *name***] or [***fmt***]**
Read mainframe error code

ERROR? - See **ERR?**

Table 2-2 Command Reference (Cont.)

ERRSTR?
Read the mainframe error message and error code
 	
EXP (*number***) ***
Raises base e to the number specified
number = -708.396418532264 through 709.7828933838
 	
EXTEND? [INTO *name***] or [***fmt***]**
Identifies the HP 3853A Extender Units connected to the mainframe
 	
FASTDISP [*mode***]**
Set the fast display mode
mode = OFF or ON
 	
FASTOUT [*mode***]**
Set the fast output mode
mode = OFF or ON
 	
FOR *counter = init_value* **TO** *final_value* **[STEP** *step_size***]**
program segment
NEXT *counter*
Defines a subroutine loop
counter = counter var. name
init_value = counter beginning value
final_value = counter ending value
step_size = up/down amount
 	
FUNC *function* **[***range***] [USE** *ch***]**
Set the voltmeter function
function = DCV, ACV, OHMF (HP 44701A); = DCV, OHMF10K, OHMF100K, OHMF1M (HP 44702A/B)
range = HP 44701A/02A/B range or AUTO
USE *ch* = HP 44701A/02A/B slot
 	
FUNC *function* **[***tbase***] [USE** *ch***]**
Set the counter function
function = TOTAL, TOTALM, UDC, UDCM, CD, CDM, RAT, PER, PERD
tbase = .000001 to .01 sec
USE *ch* = HP 44715A channel
	GET
	Mainframe Group Execute Trigger
	
	ID? [*slot***]**
	Read the accessory identity
	slot = slot addressed
	
	IDN?
	Read system identification
	
	IF *expression* **THEN**
	program segment
	[ELSE]
	[program segment]
	END IF
	Set a conditional subroutine branch
	expression = TRUE if <>0; FALSE if 0
	
	INBUF [*mode***]**
	Set the state of the command input buffer
	mode = OFF or ON
	
	INDEX *name, number*
	Set array index pointer for next data element
	name = name of array
	number = next element to store data
	
	INDEX? *name* **[INTO** *name***] or [***fmt***]**
	Read the index pointer
	name = array name
	
	INTEGER *name* **[(***max_index***)] [***name* **[(***max_index***)]...]**
	Define an INTEGER variable or array
	name (max_index) = INTEGER variable or array name and max index
	
	INTR? [INTO *name***] or [***fmt***]**
	Return the address of last channel interrupt serviced

Table 2-2 Command Reference (Cont.)

[LET] *variable* = *number*
Assign a value to a variable or array
variable = variable or array element
number = numeric expression

LGT (*number***) ***
Return the logarithm of the number
number = number >= 0

LMT *min, max, index_stor, var*
Post-processing limit testing
min = name that stores lower limits
max = name that stores upper limits
index_stor = name for index numbers
var = name that stores reading

LMT *min, max, index_stor*
Real time limit testing
min = name that stores lower limits
max = name that stores upper limits
index_stor = name for index numbers

LOCAL
Restores front panel control

LOCK [*mode*]
Enables or disables the front panel
mode = OFF or ON

LOG (*number***) ***
Return the natural logarithm of the number
number = number >0

LOGCHAN *var*
Designates array to receive channel numbers
var = name holding channel numbers

MEAS *function, ch_list* **[USE** *ch***]** **[INTO** *name***] or [***fmt***]**
Set the voltmeter measurement function
function = ACV, DCV, OHM, OHMF, TEMPtype, REFT, THMtype, THMFtype, RTDtype, RTDFtype (HP 44701A); = DCV, OHM, OHM10K, OHM100K, OHM1M, OHMF, OHMF10K, OHMF100K, OHMF1M, TEMPtype, REFT, THMtype, THMFtype, RTDtype, RTDFtype (HP 44702A/B)
ch_list HP 44705A/06A/08A/09A/10A/11A/12A/13A channels
USE *ch* = HP 44701A/02A/B slot

MON [*ch*] **or** [*mode*]
Enables or disables the monitor mode
ch = address of channel monitored
mode = OFF, ON, or ALL

MONITOR - See **MON**

MONMEAS *function, ch_list* **[USE** *ch***]**
Set the voltmeter function and initiate the measurement
function = ACV, DCV, OHM, OHMF, REFT, THMtype, THMFtype, RTDtype, RTDFtype (HP 44701A); = DCV, OHM, OHM10K, OHM100K, OHM1M, OHMF, OHMF10K, OHMF100K, OHMF1M, REFT, THMtype, THMFtype, RTDtype, RTDtype (HP 44702A/B)
ch_list = HP 44705A/06A/08A/09A/10A/11A/12A/13A channel list
USE *ch* = HP 44701A/02A/B slot

NEXT - See **FOR ...NEXT**

NPER *number* **[USE** *ch***]**
Set the number of periods the counter will measure over
number = 1 to 65535
USE *ch* = HP 44715A channel

Table 2-2 Command Reference (Cont.)

NPLC *number* **[USE** *ch***]** Set the integration time of the voltmeter *number* = 0 to 16 **USE** *ch* = HP 44701A slot	**PACER** *period* [*count*] Set pacer repetition period and number of pulses *period* = .000001 to 4.19430375 sec *count* = 0 to 65535
NRDGS *number* **[USE** *ch***]** Set the number of readings per trigger *number* = 1 to 65535 **USE** *ch* = HP 44701A/02A/B slot	**PACKED** *name (max_index)* [*name* (max_index)**...]** Defines a PACKED array *name (max_index)* = name/max index (bytes) of PACKED array
OCOMP [*mode*] **[USE** *ch***]** Enables or disables offset compensation *mode* = OFF or ON **USE** *ch* = HP 44701A slot	**PAUSE** Pauses subroutine execution
OFF *event* Disables interrupts *event* = ALRM, INTR [USE ch], LMT	**PDELAY** *trigger_delay* Set delay between pacer trigger and first pulse *trigger_delay* = 500 nsec to 4.19430375 sec
ON *event* **CALL** *name* Enables interrupts *event* = ALRM, INTR [USE ch], LMT *name* = name of subroutine called	**PERC** *threshold* **[USE** *ch***]** Set voltmeter trigger threshold *threshold* = number between -128% to 127% of HP 44702A/B full scale value **USE** *ch* = HP 44702A/B slot
OPEN *ch_list* Opens the specified channel *ch_list* = HP 44705A/06A/08A/09A/10A/11A/13A/ or HP 44724A/25A/28A/29A channel list	**POSTSCAN** *number* **[USE** *ch***]** Set number of scans for voltmeter after stop trigger *number* = 0 to 65535 **USE** *ch* = HP 44702A/B slot
exp **OR** *exp* ******** Logical inclusive-or function *exp* = variable or number	**POWEROFF** **[INTO** *name***] or [***fmt***]** Julian date and time of last power down
OUTBUF [*mode*] Enables or disables the HP-IB output buffer *mode* = OFF or ON	**PRESCAN** *number* **[USE** *ch***]** Set number of voltmeter scans before stop trigger *number* = 0 to 65535 **USE** *ch* = HP 44702A/B slot
	PTRIG [*source*] Set pacer trigger source *source* = EXT, SGL, or HOLD

Table 2-2 Command Reference (Cont.)

RANGE [*range*] **[USE** *ch***]**
Set voltmeter range
range = HP 44701A/02A/B range or AUTO
USE *ch* = HP 44701A/02A/B slot

RDGS *dest* **[USE** *ch***]**
Specify destination of measurement data
dest = SYS or GPIO
USE *ch* = HP 44702A/B slot

RDGSMODE *mode* **[USE** *ch***]**
Set voltmeter storage mode and interrupt condition
mode = BURST, DAV, END, or COMPLETE
USE *ch* = HP 44702A/B slot

READ *slot* **[INTO** *name***] or [***fmt***]**
Read the state of a channel
slot = HP 44721A/22A/24A/25A/28A/29A slot

REAL *name* **[***(max_index)***] [***name* **[***(max_index)***]...]**
Defines a REAL variable or array
name (max_index) = REAL variable or array name and max index

RQS *mode* or *unmask*
Enables the mainframe SRQ
mode = OFF or ON
unmask = number (0-3711) or mnemonic (ALRM, LMT, INTR, ERR, RDY, LCL, FPS, PWR, DAV)

RQS? [INTO *name***] or [***fmt***]**
Return decimal sum of status register bits

RESET - See **RST**

RST [*slot***]**
Resets to power-on state
slot = slot addressed

SADV *source*
Set channel scan advance source
source = SCAN, CHADV, KEY, or PACER

SCALE *offset, scale, readings* **[INTO** *name***] or [***fmt***]**
Post-processing scaling function
offset = name that stores offsets
scale = name that stores scale factors
readings = name that stores readings

SCAN [*backplane_bus***]** *ch_list*
Establishes a scan list
backplane_bus = SENSE, COM, or SEP
ch_list = HP 44705A/06A/08A/09A/10A/11A/12A/13A channel list

SCANMODE *mode* **[USE** *ch***]**
Set voltmeter operating mode
mode = OFF or ON
USE *ch* = HP 44702A/B slot

SCDELAY *trig_delay* **[***scan_pace***] [USE** *ch***]**
Set delay betwen scan trigger and start of scan
trig_delay = 0 to 16.38375 ms
scan_pace = 0 to 1073.741823 sec
USE *ch* = HP 44702A/B slot

SCRATCH
Deletes subroutines, arrays, and variables

SCSLOPE *mode* **[USE** *ch***]**
Specify scan trigger edge
mode = LH or HL
USE *ch* = HP 44702A/B slot

Table 2-2 Command Reference (Cont.)

SCTRIG [*source*] **[USE** *ch***]** Specify scan trgger source *source* = SCAN, SGL, HOLD, EXTO EXT1, SYS, INT, MEAS, or GPIO **USE** *ch* = HP 44702A/B slot **SET ALRM** *seconds* Set the alarm *seconds* = 0 to 86399.999 **SET TIME** *seconds* Set the real-time clock *seconds* = 0 to 86399.999 **SET TIMEDATE** *seconds* Set Julian time and date in real-time clock *seconds* = 2.08662912E+11 through 4.768629999E+11 **SIN** (*number*) *** Return sine of number in radians *number* = abs value <2.98156826E+8 radians **SIZE?** *name* **[INTO** *name***]** **or** **[***fmt***]** Return the maximum size of specified array *name* = array name **SLOPE** *mode* **[USE** *ch***]** Specify voltmeter trigger edge *mode* = LH or HL **USE** *ch* = HP 44702A/B slot **SPER** *sample_period* **[USE** *ch***]** Set sample period of voltmeter *sample_period* = 0 to 1073.741823 sec **USE** *ch* = HP 44702A/B slot **SPER** *number* **[USE** *ch***]** Set the sample period of accessory channels *number* = 0.000001 to 0.16 seconds **USE** *ch* = HP 44715A channel	**SQR** (*number*) * Return square root of number *number* = number >= 0 **SREAD** *slot, register_number* **[INTO** *name***]** **or** **[***fmt***]** Read specified accessory register *slot* = slot number *register_number* = register address **SRQ** Programmed HP-IB service request **STAT** *min, max, mean, std, var* Perform statistical analysis of data *min* = name to store lowest value *max* = name to store highest value *mean* = name storing mean value *std* = name storing std dev *var* = name that stores values **STA? [INTO** *name***]** **or** **[***fmt***]** Read system status register **STATE? [INTO** *name***]** **or** **[***fmt***]** Return present configuration of HP 3852A **STB? [INTO** *name***]** **or** **[***fmt***]** Read system status byte **STEP** [*name*] Steps through a subroutine *name* = subroutine name **STRIG** *source* Set scan trigger source *source* = SCAN, CHADV, KEY, or PACER **STSLOPE** *mode* **[USE** *ch***]** Set the stop trigger edge *mode* = LH or HL **USE** *ch* = HP 44702A/B slot

Table 2-2 Command Reference (Cont.)

STTRIG [*source*] **[USE** *ch***]** Specify stop trigger source *source* = SCAN, SGL, HOLD, EXT0 EXT1, SYS, INT, MEAS, or GPIO **USE** *ch* = HP 44702A/B slot **SUB** *name* commands **SUBEND** Subroutine construction *name* = subroutine name **SUBEND** - See **SUB** **SWRITE** *slot, register_number,* register_value Write a value to a specified accessory register *slot* = slot number *register_number* = register address *register_value* = desired value of register **SYSOUT** *mode* Set system output mode *mode* = OFF or ON **TBASE** [*tbase*] **[USE** *ch***]** Set the counter time base *tbase* = .000001 to 1 sec **USE** *ch* = HP 44715A channel **TERM** *terminal* **[USE** *ch***]** Select the voltmeter input terminals *terminal* = BOTH, INT, ZERO, RIBBON **USE** *ch* = HP 44701A/02A/B slot **TERM** *terminal* [*terminal*] **[USE** *ch***]** Set the input terminals for the counter *terminal* = ISO or NON **USE** *ch* = HP 44715A channel **TEST** [*slot*] Perform a self-test *slot* = mainframe or extender slot	**TIME [INTO** *name***] or [***fmt***]** Return current real-time clock reading in seconds **TIMEDATE [INTO** *name***] or [***fmt***]** Return Julian date and time **TRG** [*source*] Set system trigger source and mode *source* = EXT, GET, HOLD, SGL **TRIG** [*source*] **[USE** *ch***]** Set voltmeter trigger source or mode *source* = AUTO, EXT0, EXT1, GPIO, HOLD, MEAS, SCAN, SGL, SYS **USE** *ch* = HP 44701A/02A/B slot **TRIG** *source* **[USE** *ch***]** Set the counter trigger source and mode *source* = SGL, AUTO, HOLD, SYS **USE** *ch* = HP 44715A channel **TRIGOUT** [*mode*] **[USE** *ch***]** Set voltmeter EXT0 as trigger source *mode* = OFF or ON **USE** *ch* = voltmeter slot **USE** *ch* Specify accesory to receive subsequent commands *ch* = HP 44715A/21A/22A channel or HP 44701A/02A/B slot **USE? [INTO** *name***] or [***fmt***]** Return current use channel **VREAD** *array* **[***(indes)***] or** *variable* **[INTO** *name***] or [***fmt***]** Read contents of array or variable *array* **[***(index)***]** = array name or name and index to an element *variable* = variable name

Table 2-2 Command Reference (Cont.)

VWRITE *array, item_list or array (element), number or variable,* number Write data to array or variable *array, item_list* = write item list to array (<=10 items) *array (element), number* = write number to array element *variable, number* = write number to variable **WAIT** [*number*] Wait specified amout of time *number* = 0 to 86400 seconds **WAIT FOR** - See **WAITFOR** **WAITFOR** *condition* Wait for specified condition *condition* = ALRM, EVENT, INTR, PACER	**WHILE** *expression* program segment **END WHILE** Defines a subroutine loop *expression* = TRUE if <>0; FALSE if 0 **WRITE** *slot, number* Write a number to specified slot *slot* = HP 44724A/25A/28A/29A slot *number* = -32768 to 32767 **XRDGS** *ch* [*count*] [**INTO** *name*] **or** [*fmt*] Transfer specified number of readings from voltmeter *ch* = HP 44715A/21A/22A channel or HP 44701A/02A/02B slot *count* = 1 to 2147483647

* = Math Function
** = Binary Function
*** = Trigonometric Operation
**** = Logical Operators (only used within **IF...END IF** and **WHILE...END WHILE**)

Chapter 3
HP 3852A/3853A Performance Tests

CHAPTER 3
HP 3852A/3853A
PERFORMANCE TESTS

CHAPTER 3
HP 3852A/3853A
PERFORMANCE TESTS

3-1 INTRODUCTION

This chapter contains a series of tests designed to give a high confidence level that the HP 3852A and HP 3853A are operating within published specifications.

These tests can be used as a first step in system troubleshooting, as an "incoming inspection" procedure, or to verify that a repair was actually accomplished.

All tests given in this chapter can be performed from a system controller connected through HP-IB to the HP 3852A. Some of the tests can be performed from the front panel of the HP 3852A if desired. The tests that require a system controller and that cannot be performed from the front panel are the following:

HP-IB Test -- Section 3-7
Keyboard Test -- Section 3-8
Pacer Test -- Section 3-12
HP 3853A Test Procedures -- Section 3-15

3-2 HP 3852A PERFORMANCE TEST

3-3 Equipment Required

The following test equipment is required to run the performance tests:

1. System Controller -- HP 9000 Series 200/300 or equivalent

2. HP-IB Cable -- HP 10833A or equivalent

3. Printer -- HP 9876A or equivalent

4. Pulse/Function Generator -- HP 8116A or equivalent

5. BNC to BNC cable -- HP 10503A or equivalent

NOTE

The test programs listed in this Chapter require the I/O and HP-IB options for BASIC 3.0 and 4.0 on HP 9000 Series 200 and 300 computers.

3-4 3852A Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

3-5 Power-Up Self-Test

This test performs two internal self-test routines and, if passed, provides a high confidence level that the HP 3852A local controller is operational. The two routines are referred to as the fatal and non-fatal error test routines. A third routine can also be accessed from the front panel and is described in Section 3-6. Do the following:

1. Remove power from the HP 3852A.

2. Remove the digital extender cable from the connector on the rear panel of the power supply (not all applications use the digital extender cable). Remove all plug-in accessories from the mainframe. The accessory component module must be removed as well as the terminal module.

3. Apply power to the HP 3852A and observe the displays. As the HP 3852A cycles through the self-test routine the displays will indicate the area under test and provide other system information.

4. The self-test is sucessful if the word READY appears in the left display and the MON and PWR ON annunciators are on in the right display. No other messages should be in the displays and no other annunciators should be on (in particular, the ERR annunciator should not be on).

5. If a display other than READY is obtained, or if additional annunciators are on, a self-test error is indicated. Chapter 5 provides an in-depth explanation of the self-test routines and the possible errors that may be encountered.

NOTE

A successful self-test does not, by itself, ensure proper instrument operation. A self-test failure, however, does indicate an instrument malfunction.

3-6 Display Test and Self-Test

This test performs the front panel accessed self-test routine. This routine checks 60% of the HP 3852A local controller and includes a display test. It is important that the power-up self-test in Section 3-5 has been sucessfully performed before initiating this test. Do the following:

1. Initiate the self-test routine by executing:

TEST

2. Observe the HP 3852A displays. The beeper should sound and all display segments in both displays will be turned on (except the top dot of the colon). After the display test the message "SELF TEST OK" should be present in the right display. The MON and PWR ON annunciators in the right display should be on. No other messages should be in the displays and no other annunciators should be on.

The test can be repeated, if necessary, to allow enough time to check all display segments.

If a message other than "SELF TEST OK" is in the displays or if the ERR annunciator in the left display is on, a self-test error is indicated. Chapter 5 provides an in-depth explanation of the self-test and the errors that may be encountered. If all the display segments are not on during the self-test, a display failure is indicated. Chapter 5 provides a procedure to isolate the displays from the drive logic.

3-7 HP-IB Test

This test checks the ability of the HP 3852A to communicate with a system controller through the HP-IB connection. The test sets and checks the SRQ mask and performs a remote self-test. Do the following:

1. Ensure the system controller is connected to the HP 3852A with the HP-IB cable.

2. Verify that the HP 3852A HP-IB address is set to 9 by executing from the front panel:

    ADDR?

3. The right display should show the number 9. If the number 9 is obtained, proceed to Step 4. If a number other than 9 is obtained, record the number for later reference and change the HP-IB address by executing from the front panel:

    ADDR 9

4. Load Test Program 3-1 into the system controller. The program is located at the end of this chapter. Test Program 3-1 was written in BASIC on an HP 9000 System 200 computer. Other computers may differ slightly in syntax.

5. Run the program and observe the system controller print out. The system printer will indicate a sucessful test with the message HP 3852A PASSED HP-IB TEST. Any other message indicates a failure of the test. In some cases, an error message will be printed on the system printer. If the test fails, additional problem isolation tests can be found in Chapter 5.

If the Keyboard Test in Section 3-8 or Pacer Test in Section 3-12 is not to be performed, reset the HP-IB address to the value recorded in Step 3 (if the HP-IB address was 9, it is not necessary to reset the address). To reset the address, execute from the front panel:

    ADDR X   (where X = address recorded in Step 3)

3-8 Keyboard Test

This test checks for correct response from the keyboard. The keyboard is electrically arranged into a 6 by 8 matrix. This test checks each column and row of the matrix by pressing six keys.

1. Verify the system controller is connected to the HP 3852A with the HP-IB cable.

2. Verify that the HP 3852A HP-IB address is set to 09 by executing from the front panel:

ADDR?

3. The right display should show the number 9. If the number 9 is obtained, proceed to Step 4. If a number other than 9 is obtained, record the number for later reference and change the HP-IB address by executing from the front panel:

ADDR 9

4. Load Test Program 3-2 into the system controller. The program is located at the end of this chapter. Test Program 3-2 was written in BASIC on an HP 9000 System 200 computer. Other computers may differ slightly in syntax.

5. Run the program. Press the following keys on the HP 3852A front panel in the order given:

DISPLAY

TEST

SRQ

TRIG

TOTAL

CONF

5

3

6. The program will stay in a loop until all six required keys are pressed. A sucessful test is indicated by the message, HP 3852A PASSED KEYBOARD TEST, on the system printer. If the program will not terminate the loop (pressing additional keys will not affect the outcome of the test), a failure of the keyboard or drive logic is indicated. Should a failure be encountered, it will be necessary to reset the system controller and cycle power on the HP 3852A to exit the test loop. Chapter 5 contains additional problem isolation information.

If the Pacer Test in Section 3-12 is not to be performed, reset the HP-IB address to the value recorded in Step 3 (if the HP-IB address was 9, it is not necessary to reset the address). To reset the address, execute from the front panel:

ADDR X (where X = address recorded in Step 3)

3-9 Clock and Non-Volatile Memory Test

This test checks the operation of the system clock and verifies that the non-volatile memory is functional. Do the following:

NOTE

This test requires that the system clock be set to a known value. The clock must be reset to the correct time following this test. A procedure to set the correct time and date is given in Section 3-18. Because of the Julian format of the clock, setting the date is a tedious process. The currently set date can be retrieved by executing the TIMEDATE command and recording the number returned. If this number is then reprogrammed into the system clock, only the current time will need to be reset.

1. Set the timedate to September 10, 1985 by executing:

   SET TIMEDATE 2.113619616E+011

2. Verify that the new timedate is held in the memory by executing

   TIMEDATE

3. The value displayed in the right display should be close to the value entered in Step 2 (the display will have to be scrolled to see the entire number). The difference between the two numbers represents the amount of seconds that have elapsed since the original value was entered. In general, the nine most significant digits should not change (i.e., they should be 2.11361961)

4. Cycle power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence and the left display to show the message: READY. Obtain a display indicating the time that the power was removed by executing:

   POWEROFF

5. The value displayed in the right display should be close to the value entered in Step 2 (the display will have to be scrolled to see the entire number). The difference between the numbers represents the seconds that elapsed between the time Step 2 was executed and the time that power was removed from the HP 3852A. In general, the eight most significant digits should not change (i.e., they should be 2.1136196). This test is a check of the non-volatile memory operation. If the number returned is very different from the number entered in Step 2, the non-volatile memory may be failing.

If the Alarm Test in Section 3-10 is not to be performed, reset the system clock and date as described in Section 3-18.

3-10 Alarm Test

This test checks the operation of the system alarm and subsequently checks that the HP 3852A local controller can enter and execute a subroutine.

NOTE

This test requires that the system clock be set to a known value. The clock must be reset to the correct time following this test. A procedure to set the correct time and date is given in Section 3-18. Because of the Julian format of the clock, setting the date is a tedious process. The currently set date can be retrieved by executing the TIMEDATE command and recording the number returned. If this number is then reprogrammed into the system clock, only the current time will need to be reset.

1. Enter the alarm subroutine into memory by executing:

```
SUB ATST
WAITFOR ALRM
BEEP
SUBEND
```

NOTE

Steps 2, 3, 4, and 5 must be executed within 1.5 minutes. The test sets the time and then enables an alarm to occur within two minutes. If Steps 2, 3, 4, and 5 are not executed in less than two minutes the test will fail.

2. Set the time to 4:00 PM by executing:

```
SET TIME 58600
```

3. Set the system alarm to 4:03 PM by executing:

```
SET ALRM 58780
```

4. Enable the alarm by executing:

```
ENABLE ALRM
```

5. Initiate the system alarm test by executing:

```
CALL ATST
```

6. After executing the above command, the left display should show the message WAITFOR and the WAITING annunciator should be on. This condition will remain until the alarm occurs.

7. The HP 3852A alarm should beep once within 1 or 2 minutes, the message SUBEND should appear in the left display, and the ALRM annunciator should be on. If the alarm does not occur within the time frame expected, press the CLEAR key on the front panel (DO NOT press the RST key) and repeat the test starting at Step 3. (If the RST key has been pressed or if power has been cycled to the HP 3852A, the subroutine in Step 2 will have to be re-entered.) If the test does not pass a second time, a failure with the HP 3852A local controller is indicated.

8. Reset the system time and timedate as described in Section 3-18.

3-11 Event In BNC Test

This test checks for proper operation of the event in BNC circuitry and that the HP 3852A can respond to an external event. Do the following:

1. Connect the output of the pulse/function generator (HP 8116A) to the HP 3852A EVENT IN connector with a BNC to BNC cable. The EVENT IN connector is the top connector on the rear panel of the HP 3852A controller module.

2. Set the pulse/function generator to output a 5 volt square wave at a 2 Hz rate.

3. Enter the test subroutine by executing the following statements:

```
SUB EITST
WHILE 1
WAITFOR EVENT
BEEP
END WHILE
SUBEND
```

4. Initiate the test by executing:

```
CALL EITST
```

5. The HP 3852A should beep approximately two times per second continuously. If the HP 3852A is unable to respond, the HP 3852A local controller will be stuck in the subroutine. This indicates a failure of the HP 3852A local controller. If a failure is encountered, it will be necessary to cycle power on the HP3852A to exit the subroutine.

6. To exit from the test, press the front panel CLEAR key.

3-12 Pacer Test

This test checks that the internal pacer in the HP 3852A can initiate some event and that the pacer can be triggered externally. Do the following:

1. Verify the system controller is connected to the HP 3852A with the HP-IB cable.

2. Verify that the HP 3852A HP-IB address is set to 09 by executing from the front panel:

```
ADDR?
```

3. The right display should show the number 9. If the number 9 is obtained, proceed to Step 4. If a number other than 9 is obtained, record the number for later reference and change the HP-IB address by executing from the front panel:

```
ADDR 9
```

4. Connect the pulse/function generator (HP 8116A) output to the PACER TRIGGER IN connector. The PACER TRIGGER IN connector is the bottom BNC connector on the HP 3852A rear panel.

5. Set the pulse/function generator to output a 5 V square wave at a 2 Hz rate.

6. Load Test Program 3-3 into the system controller. The program is located at the end of this chapter. Test Program 3-3 was written in BASIC on an HP 9000 System 200 computer. Other computers may differ slightly in syntax.

7. Run the program. A sucessful test will be indicated when the HP 3852A beeper beeps four times and the system printer has the message, HP 3852A PASSED PACER TEST. If the test is not sucessful, the beeper will not be heard and the system printer may print an error message. Additional problem isolation tests can be found in Chapter 5. Reset the HP-IB address to the value recorded in Step 3 (if the HP-IB address was 9, it is not necessary to reset the address). To reset the address, execute from the front panel:

```
ADDR X   (where X = address recorded in Step 3)
```

3-13 HP 3853A PERFORMANCE TEST

3-14 Equipment Required

The following test equipment is required to run the performance test:

1. Mainframe -- HP 3852A

2. System Controller -- HP 9000 Series 200/300 or equivalent

3. HP-IB Cable -- HP 10833A or equivalent

4. Printer -- HP 9876A or equivalent

3-15 HP 3853A Test Procedures

These procedures test the ability of the HP 3853A Extender Unit to communicate with the HP 3852A over the digital bus. Because all system Extender Units are in parallel on this bus, only a single Extender Unit at a time should be connnected for these tests.

3-16 Power-On Test

This test checks that the HP 3853A will power-up and is not holding an illegal state on the digital bus. Do the following:

1. Remove power from the HP 3852A and HP 3853A. Connect the HP 3852A to the HP 3853A with the digital extender cable.

2. Apply power to the HP 3852A. The HP 3852A displays will remain blank indicating that the HP 3852A is not performing its wake-up sequence. After a brief period, the HP 3852A should beep and display:

   ERROR 38: CHECK POWER

3. Cycle power to the HP 3852A and apply power to the HP 3853A. observe the HP 3852A. The HP 3852A should perform its wake-up sequence and end with the display:

   READY

4. If the HP 3852A will not complete its wake-up sequence or appears to be lost, a failure of the HP 3853A or digital bus is indicated. To assure that the HP 3853A is at fault, remove any accessories from the HP 3853A (remove both the terminal module and the component module) and perform the test again. A second failure indicates a failure of the HP 3853A.

3-17 Extender Response Test

This test ensures that the HP 3853A can correctly identify itself to the HP 3852A. Do the following:

1. Load Test Program 3-4 into the system controller. The program is located at the end of this chapter. Test Program 3-4 was written in BASIC on an HP 9000 Series 200. Other computers may differ in syntax.

2. Run the test progam.

3. A sucessful test is indicated on the system printer by the message: HP 3852A PASSED EXTENDER TEST, followed by a list of the addresses of any installed Extender Units.

3-18 SETTING THE SYSTEM CLOCK

The system clock will have to be reset to the correct time and date after performance of the Clock and Non-Volatile Memory Test in Section 3-9 or the Alarm Test in Section 3-10.

Internally, the system clock maintains the year, month, day, hour, minute, and second as a single real number. This number is scaled to an arbitrary "dawn of time" thus allowing it to also represent the Julian date. In this system, the number 2.08662912E+011 represents midnight March 1, 1900.

Since a single number is used to represent the year, month, day, hour, minute, and second, it is necessary to set the TIMEDATE first (thus setting the system time to midnight of the year, month, and day desired) and then set the TIME (adding the time of the current day to the TIMEDATE number).

3-19 Setting the TIMEDATE

The following program example will convert the current date into the TIMEDATE format. The example was written in BASIC for an HP 9000 Series 200. On other computers the exact syntax may vary.

```
10     !CONVERT DAY, MONTH, AND YEAR TO TIMEDATE
20     PRINT "ENTER THE DESIRED DATE AS A SINGLE"
30     PRINT "NUMBER IN THE FORM   DDMMYY"
40     INPUT String$
50     Day = VAL (String$[1,2])
60     Month = VAL (String$[3,4])
70     Year = VAL (String$[5,6])
80     DIM X(1:12)
90     DATA 306,337,0,31,61,92,122,153,184,214,245,275
100    READ X(*)
110    Time_date = X(Month) + Day - 1
120    IF Month < 3 THEN Year = Year - 1
130    Time_date = Time_date + Year * 365 + Year DIV 4
140    Time_date = Time_date + Year DIV 100 + (Year + 300) DIV 400
150    Time_date = Time_date * 86400 + 2.08662912E+11
160    DISP "THE TIMEDATE IS:",Time_date
170    END
```

Once the TIMEDATE value has been obtained, it can be entered into the HP 3852A memory be executing:

SET TIMEDATE <*value*>

3-20 Setting the TIME

After the TIMEDATE value has been entered, set the TIME value. The following program can be used to compute the current value of the time in seconds since midnight. The example was written in BASIC on an HP 9000 Series 200. On other computers, the exact syntax may vary.

```
10    !SECONDS SINCE MIDNIGHT
20    PRINT "PLEASE ENTER THE DESIRED TIME AS A SINGLE"
30    PRINT "NUMBER IN THE FORM  HHMMSS"
40    INPUT String$
50    Hours = VAL (String$[1,2])
60    Mins = VAL (String$[3,4])
70    Secs = VAL (String$[5,6])
80    Total = Hours * 3600
90    Total = Total + Mins * 60
100   Total = Total + Secs
110   DISP "THE TIME, IN SECONDS, IS:",Total
120   END
```

Once the current time in seconds has been obtained, it can be entered in the HP 3852A memory by executing:

SET TIME <*value*>

TEST PROGRAM 3-1

```
10    !HP-IB TEST
20    !
30    DIM E$[80]
40    A=709
50    RESET 7
60    ON TIMEOUT 7,10 GOTO 840
70    !    EXECUTE MAINFRAME SELF TEST FROM HP-IB
80    OUTPUT A;"RST"
90    OUTPUT A;"INBUF OFF"
100   OUTPUT A;"RQS 32"
110   OUTPUT A;"RQS ON"
120   OUTPUT A;"TEST"         !SELF TEST FAILURE WILL
130   OUTPUT A;"STB?"         !BE REPORTED IN STATUS
140   ENTER A;B               !BITS 5 AND 6.
150   IF BIT(B,6) THEN
160      PRINT "HP 3852A FAILED SELF TEST OVER HP-IB"
170      IF BIT(B,5) THEN
180         PRINT "  THIS ERROR HAS OCCURRED:"
190         OUTPUT A;"ERRSTR?"
200         ENTER A;E$
210         PRINT "    ";E$
220      END IF
230   ELSE
240      PRINT "HP 3852A PASSED SELF TEST OVER HP-IB"
250   END IF
260   !    CLEAR SERVICE REQUEST MASK AND READ
270   OUTPUT A;"RQS OFF"
280   OUTPUT A;"RQS 0"
290   OUTPUT A;"RQS?"
300   ENTER A;B
310   IF B<>0 THEN
320      PRINT "HP 3852A FAILED SERVICE REQUEST MASK TEST FOR 0"
330      PRINT "  EXPECTED 0, READ";B
340   ELSE
350      PRINT "HP 3852A PASSED SERVICE REQUEST MASK TEST FOR 0"
360   END IF
370   !    SET ERROR BIT IN REQUEST MASK (ON SETS SRQ) AND READ
380   OUTPUT A;"RQS 32"
390   OUTPUT A;"RQS ON"
400   OUTPUT A;"RQS?"
410   ENTER A;B
420   IF B<>96 THEN
430      PRINT "HP 3852A FAILED SERVICE REQUEST MASK FOR 96"
440      PRINT "  EXPECTED 96, READ";B
450   ELSE
460      PRINT "HP 3852A PASSED SERVICE REQUEST MASK TEST FOR 96"
```

TEST PROGRAM 3-1 (Cont.)

```
470   END IF
480   !    REQUEST THE SYSTEM ID
490   OUTPUT A;"ID?"
500   ENTER A;E$
510   IF E$<>"HP3852A" THEN
520      PRINT "HP 3852A FAILED ID PART OF HP-IB TEST"
530      PRINT "EXPECTED HP3852A, READ   ";E$
540   ELSE
550      PRINT "HP 3852A PASSED ID PART OF HP-IB TEST"
560   END IF
570   !    CREATE AN ERROR WHICH SHOULD ASSERT SRQ
580   ENABLE INTR 7;2
590   ON INTR 7 GOTO 630
600   OUTPUT A;"SRT"
610   WAIT 1
620   Nosrq=1
630   IF Nosrq THEN
640      PRINT "HP 3852A FAILED SRQ ASSERTION TEST"
650   ELSE
660      PRINT "HP 3852A PASSED SRQ ASSERTION TEST"
670   END IF
680   OFF INTR 7
690   !   READ STATUS REGISTER, SHOULD REPORT ERR AND SRQ
700   OUTPUT A;"STB?;"
710   ENTER A;B
720   IF B<>96 THEN
730      PRINT "HP 3852A FAILED STATUS BYTE REPORT"
740      PRINT "  EXPECTED 96, READ";B
750   ELSE
760      PRINT "HP 3852A PASSED STATUS BYTE REPORT"
770      OUTPUT A;"ERRSTR?;"
780      ENTER A;E$
790      PRINT "  THIS ERROR WAS CAUSED ON PURPOSE AS PART OF TEST:"
800      PRINT E$
810   END IF
820   STOP
830   !  STOP IF I/O TIMEOUT OCCURS
840   PRINT "HP 3852A DID NOT RESPOND:"
850   PRINT "  HP-IB I/O TIMEOUT ERROR OCCURRED"
860   END
```

TEST PROGRAM 3-2

```
10     !KEYBOARD TEST
20     OPTION BASE 1
30     INTEGER I,J,K
40     DATA 2078,0078,43FA,001C,22A8,0002,43FA,0008,2149,0002
50     DATA 4E75,0839,0003,00E4,0001,6606,4EF9,0001,0000,2F09,43FA
60     DATA 000D,12B9,0081,0001,225F,4E73,0000!68000 CODE
70     DATA 247,228,227,246,232,245,181,179!KEYSTROKES
80     PRINT "PRESS THE FOLLOWING HP 3852A KEYS IN ORDER:"
90     PRINT "  DISPLAY->  TEST  SRQ  TRIG  TOTAL  CONF  5 3"
100    A=709
110    OUTPUT A;"RST;INTEGER A(27)"
120    FOR I=0 TO 27
130      READ J$
140      OUTPUT A;"VWRITE A";DVAL(J$,16)
150    NEXT I
160    OUTPUT A;"JSR A(0)"
170    FOR I=1 TO 8
180      READ K
190      REPEAT
200        OUTPUT A;"VREAD A(27)"
210        ENTER A;J
220      UNTIL J=K
230    NEXT I
240    PRINT "HP 3852A PASSED KEYBOARD TEST"
250    END
```

TEST PROGRAM 3-3

```
10    !PACER TEST
20    DIM E$[80]
30    A=709
40    RESET 7
50    ON TIMEOUT 7,5 GOTO 260
60    ENABLE INTR 7;2          !ENABLE HP-IB INTERRUPT ON SRQ
70    ON INTR 7 GOTO 290
80    OUTPUT A;"RST"
90    OUTPUT A;"INBUF OFF"
100   OUTPUT A;"RQS ON"        !ENABLE SERVICE REQUEST MASK
110   OUTPUT A;"RQS 32"        !ENABLE SERVICE MASK ERROR BIT
120   OUTPUT A;"INTEGER I"
130   OUTPUT A;"SUB PTST"
140   OUTPUT A;"PTRIG EXT"
150   OUTPUT A;"FOR I=1 TO 4"
160   OUTPUT A;"WAITFOR PACER"
170   OUTPUT A;"BEEP"
180   OUTPUT A;"NEXT I"
190   OUTPUT A;"SUBEND"
200   OUTPUT A;"PDELAY 1"
210   OUTPUT A;"PACER 1,4"     !COUNT FOUR PULSES ONE SECOND APART
220   OUTPUT A;"CALL PTST;"    !INITIATE THE TEST
230   PRINT "HP 3852A PASSED PACER TEST"
240   LOCAL A
250   STOP
260   PRINT "HP 3852A DID NOT RESPOND.  HP-IB TEST ERROR OCCURRED."
270   LOCAL A
280   STOP
290   OFF INTR 7
300   OUTPUT A;"STB?"
310   ENTER A;B
320   IF BIT(B,5) THEN
330     PRINT "AN ERROR HAS OCCURRED:"
340     OUTPUT A;"ERRSTR?"
350     ENTER A;E$
360     PRINT "  ";E$
370   END IF
380   LOCAL A
390   END
```

TEST PROGRAM 3-4

```
10     !EXTENDER TEST
20     DIM E$[80]
30     A=709
40     RESET 7
50     ON TIMEOUT 7,5 GOTO 240
60     ENABLE INTR 7;2             !ENABLE HP-IB INTERRUPT ON SRQ
70     ON INTR 7 GOTO 270
80     OUTPUT A;"RST"
90     OUTPUT A;"INBUF OFF"
100    OUTPUT A;"RQS ON"           !ENABLE SERVICE REQUEST MASK
110    OUTPUT A;"RQS 32"           !ENABLE SERVICE MASK ERROR BIT
120    OUTPUT A;"INTEGER I"
130    OUTPUT A;"EXTEND?;"         !DETERMINE NUMBER OF EXTENDERS
140    PRINT "HP 3852A PASSED EXTENDER TEST"
150    Tally=0
160    FOR I=1 TO 7
170      ENTER A;E$
180      IF VAL(E$)>0 THEN PRINT "  Extender";E$;" is connected"
190      Tally=Tally+VAL(E$)
200    NEXT I
210    IF Tally=0 then PRINT " No extender are connected"
220    LOCAL A
230    STOP
240    PRINT "HP 3852A did not respond. HP-IB timeout error occurred"
250    LOCAL A
260    STOP
270    OFF INTR 7
280    OUTPUT A;"STB?"
290    ENTER A;B
300    IF BIT(B,5) THEN
310      PRINT "An error has occurred:"
320      OUTPUT A;"ERRSTR?"
330      ENTER A;E$
340      PRINT "  ";E$
350    END IF
360    LOCAL A
370    END
```

Chapter 4
HP 3852A/3853A Installation
Procedures and Replaceable Parts

CHAPTER 4
HP 3852A/3853A
MODULE AND FRONT PANEL REMOVAL/INSTALLATION PROCEDURES AND MECHANICAL REPLACEABLE PARTS

CHAPTER 4
HP 3852A/3853A
MODULE AND FRONT PANEL
REMOVAL/INSTALLATION PROCEDURES
AND MECHANICAL REPLACEABLE PARTS

4-1 INTRODUCTION

This chapter contains removal and installation procedures for the HP 3852A Controller Module and Front Panel, and for both HP 3852A and HP 3853A Power Supply Modules. Mechanical replaceable parts are also listed in this chapter. Electrical assemblies are listed as replacement assemblies only. Electrical assembly components (e.g., resistors, capacitors, and ICs) are not documented in this manual. This chapter also covers new replacement part ordering information and the HP Exchange Program for restored assemblies and modules.

Replaceable mechanical parts for the plug-in assemblies are given in the appropriate chapter of this manual (see Chapter 1 for a listing of the chapters).

4-2 REMOVAL/INSTALLATION PROCEDURES

WARNING

To prevent personal injury, the ac line power cable and all other connections must be removed from the HP 3852A and/or HP 3853A before performing any disassembly or assembly procedures.

CAUTION

To prevent static discharge damage, observe static handling procedures during disassembly and assembly (see Chapter 5).

4-3 Controller Module Removal/Installation Procedures

The controller module is located at the left side of HP 3852A mainframe with the rear of the instrument facing forward. This module is the one with the HP-IB and extender connectors. The module plugs directly into the mainframe backplane via a 74 pin lead-edge connector.

4-4 Controller Module Removal Procedure

To remove the controller module, do the following:

1. Remove ac power from the HP 3852A.

2. Make sure the rear of the instrument is facing forward. Locate the controller module.

3. On the controller module, loosen the captive screw located at the bottom and center of the module. Turn the screw only two to three turns to the left.

4. Carefully pull the module straight out. Use the right edge of the module's rear panel as a hold. DO NOT hold or pull the module by the BNC, HP-IB, or digital extender connectors or damage to the connectors can result.

NOTE

Do not touch the controller module's printed circuit assemblies and edge connector after removal, or contamination to the assemblies/connector may result.

4-5 Controller Module Installation Procedure

1. Make sure the rear of the instrument is facing forward.

2. Locate the extreme left slot in the HP 3852A mainframe chassis. This slot is left of slot "0".

3. Carefully slide the module into the chassis. Make sure that both the top and bottom of the module lines up with the respective slots.

4. Make sure the module is firmly seated into the chassis. This is necessary for the module's edge connector to make good connections with the mother board connector.

5. Turn the captive screw located at the bottom and center of the module to the left until snug (about two to three turns). DO NOT over tighten the screw.

4-6 Power Supply Module Removal/Installation Procedures

The power supply module is located at the right side of HP 3852A/3853A with the rear of the instrument facing forward. This module is the one with the power connector at the rear and the main power line switch at the front of the module.

Attached to the power line switch is a long push-rod to which is attached a key cap that protrudes through the front panel. Keep the push-rod and switch in mind when removing/installing the power supply module since these can very easily be broken.

4-7 Power Supply Module Removal Procedure

To remove the power supply module, do the following:

1. Remove ac power from the HP 3852A.

2. Remove any plug-in accessories in slots 4, 5, 6, and 7. This is necessary to remove the power supply module.

3. Turn the instrument until its right side (i.e., side with the power supply module) is facing forward.

4. Remove the side handle strap from the instrument by removing a screw and handle retainer at each end of the strap.

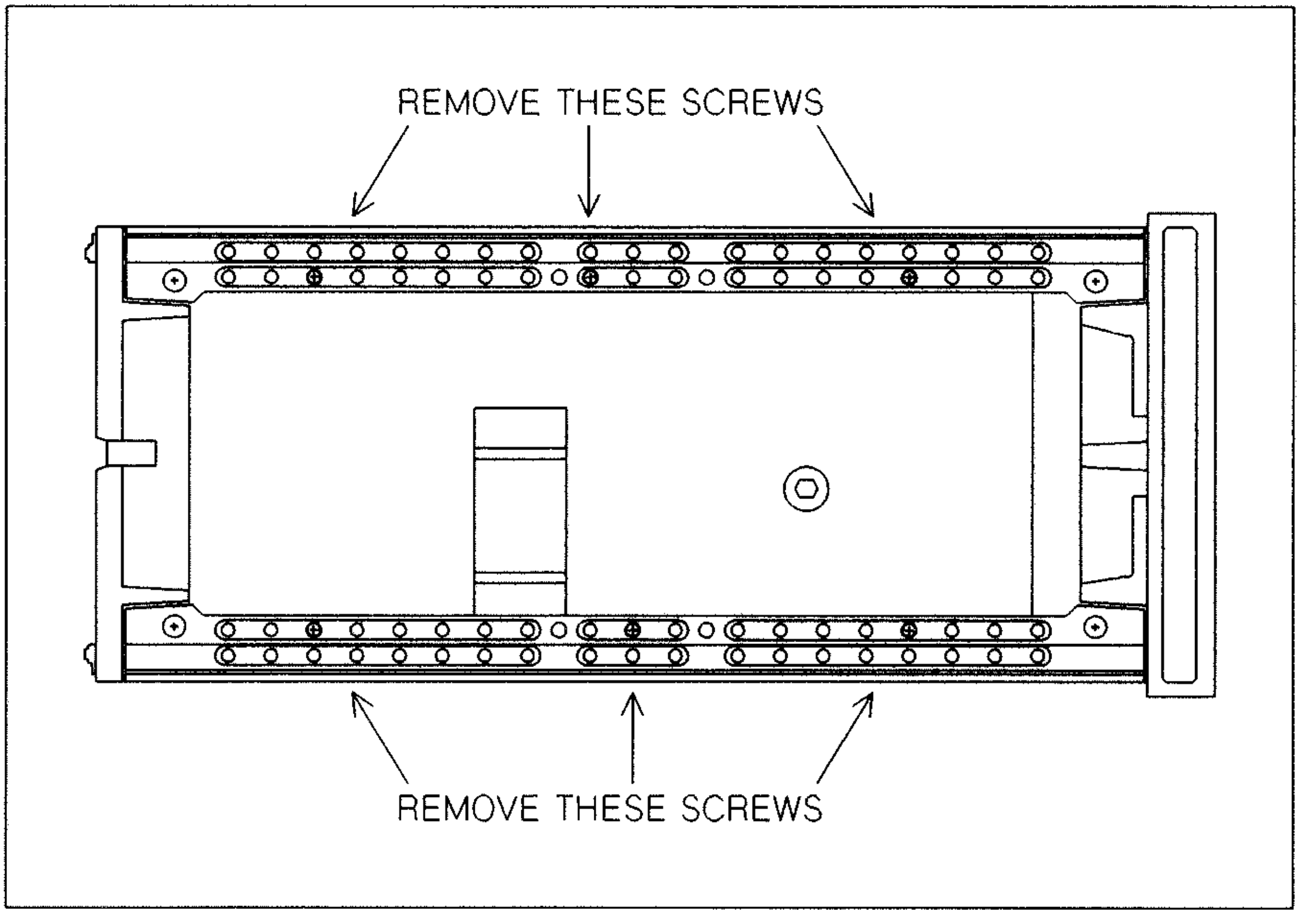


Figure 4-1 Power Supply Mounting Screws Locations

5. Remove the right side panel by pulling and sliding the panel towards the rear of the instrument.

6. Refer to Figure 4-1 and remove only the six power supply module retaining screws. DO NOT remove any other screws.

7. Turn the instrument until its right and rear sides are facing forward.

8. Refer to Figure 4-2 to determine how the power supply module is to be removed. The figure shows the path of the power supply module's front cover screw located at the bottom of the module. Carefully study the path before removing the module.

9. Refer to Figure 4-3-A (Figure A in Figure 4-3). Note that the figure shows the present location of the power supply module. The dashes lines in the figure represents the module.

NOTE

All figures in Figure 4-3 show a partial inside right view (with rear of instrument facing forward) of the chassis, as viewed from the top. The dashed lines in all figures represents the power supply module.

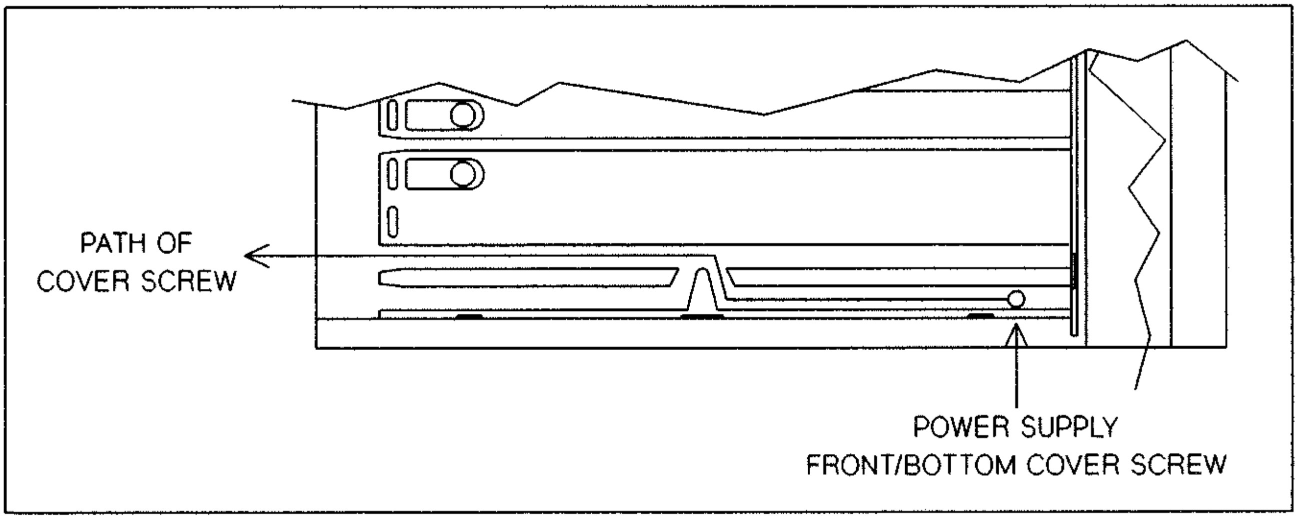


Figure 4-2 Power Supply Removal Path

10. Figure 4-3-A shows the direction at which the power supply module is to be pulled out first. Hold the power supply module by the rear panel. Carefully pull it straight out toward the rear of the instrument until it stops. The module should now be partially pulled out of the chassis as shown in Figure 4-3-B.

11. Figure 4-3-B shows the direction at which the module is to be pulled out next. However, before pulling on the module, locate the slot 7 grounding spring under the top part of the chassis. Depress the spring and then pull the power supply module to the left until it stops. Make sure the spring is depressed before moving the power supply module or damage to the spring can result. The module should now be in the position shown in Figure 4-3-C.

12. Figure 4-3-C shows the direction at which the module is to be pulled out last. Pull the power supply module completely out of the chassis until the power switch push-rod clears the chassis. Make sure that the module is pulled straight out and completely out to prevent the power switch push-rod from breaking. Place the module gently on a flat surface.

13. If the module is to be returned to the factory for repair, always return the module WITH the rear panel analog extender block and WITHOUT the power switch push-rod and key cap. The push-rod is removed by pulling it straight off the power line switch. Be careful not to exert lateral forces on the push-rod to prevent breakage of the switch.

4-8 Power Supply Module Installation Procedure

To install the power supply module, do the following:

1. Remove ac power from the HP 3852A.

2. Make sure the power switch push-rod and key cap assembly is attached to the power supply module's power switch. Be sure that the word "LINE" is correctly oriented on the key cap.

3. Remove any plug-in accessories in slots 4, 5, 6, and 7. This is necessary to install the power supply module.

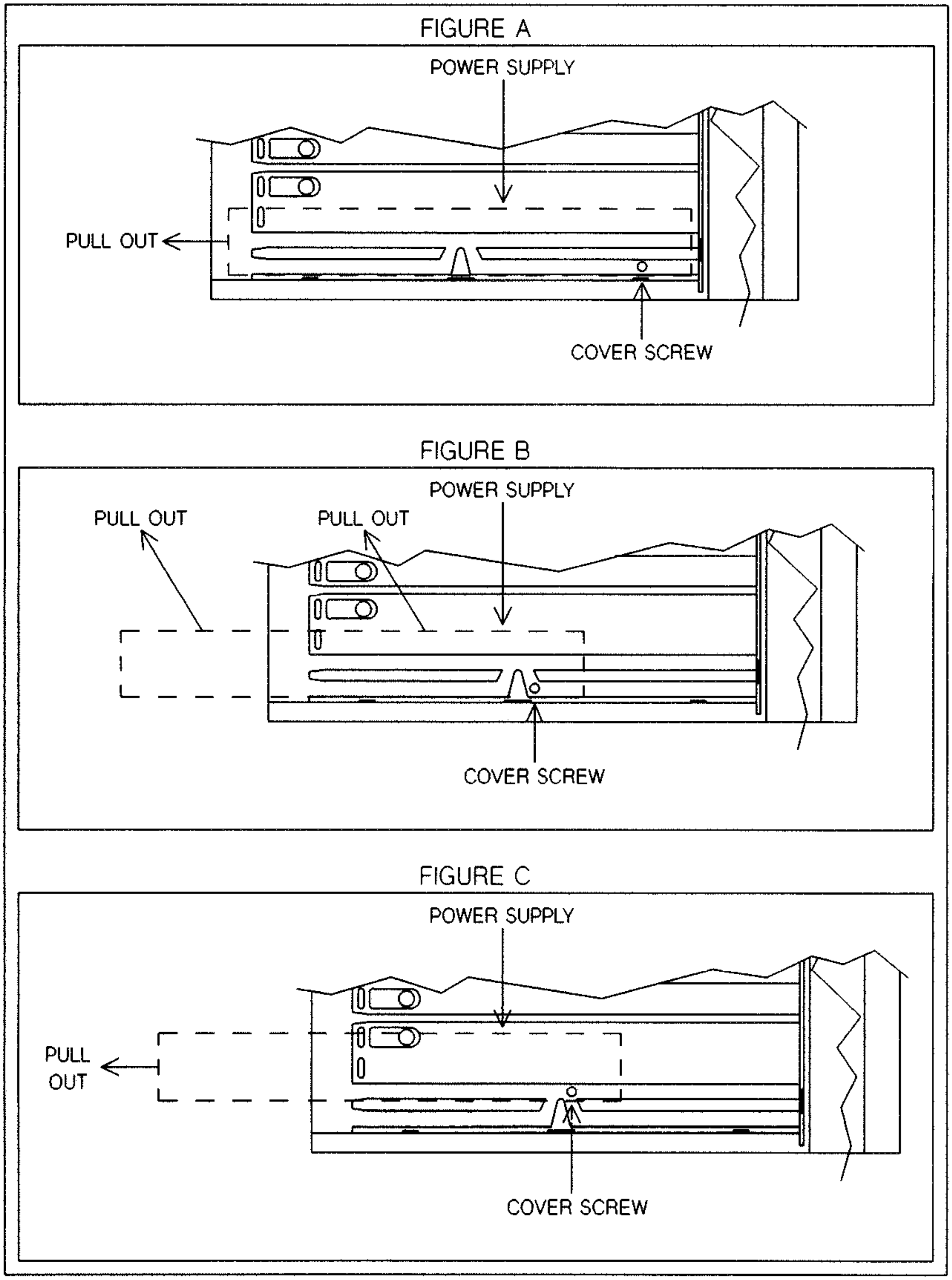


Figure 4-3 Power Supply Removal

4. Make sure the side handle strap and right side panel is removed from the instrument (see steps 4 and 5 in Section 4-7).

5. Turn the instrument until its right and rear sides are facing forward.

6. Refer to Figure 4-4-A (Figure A in Figure 4-4) to determine how the power supply module is to be installed. The figure shows the path of the power supply module's front cover screw located at the bottom of the module. Carefully study the path before installing the module. The dashes lines in the figure represents the module.

NOTE

All figures in Figure 4-4 show a partial inside right view (with rear of instrument facing forward) of the chassis. The dashed lines in all figures represents the power supply module.

7. Figure 4-4-A shows the direction at which the power supply module is to be pushed in first. Align the power supply module's cover screw with the slot next to slot 7, as shown in Figure 4-4-A. Carefully push the module into the chassis until the key cap on the power switch push-rod barely touches the mother board. The module should now be in the position shown in Figure 4-4-B.

CAUTION

Make sure that the power supply module is pushed in gently and no further than shown in Figure 4-4-B. This prevents the push-rod and/or power switch from breaking.

8. Figure 4-4-B shows the direction at which the module is to be pushed in next. However, before pushing on the module, locate the power supply grounding spring under the top part of the chassis. Depress the spring and then push the power supply module to the right until it stops. Make sure the spring is depressed before moving the power supply module or damage to the spring can result. The module should now be in the position shown in Figure 4-4-C.

9. Figure 4-4-C shows the direction at which the module is to be pushed in last. However, before pushing on the module, align the power switch push-rod with the center part of the opening on the mother board, as shown in Figure 4-4-C. Then push the power supply module completely into the chassis until its connector is firmly seated in the mother board connector.

10. Turn the instrument until its right side is facing forward.

11. Secure the power supply module with six mounting screws. Refer to Figure 4-1 for the location of the screws.

12. Install the instrument's right side cover. Slide the cover from the rear of the instrument over the rear frame and side frames.

13. Install and secure the handle strap using the handle strap retainers and retainer screws. Make sure the correct retainer is used at the ends of the strap. The right retainer slips under the front frame of the instrument and the left retainer slips over the rear frame.

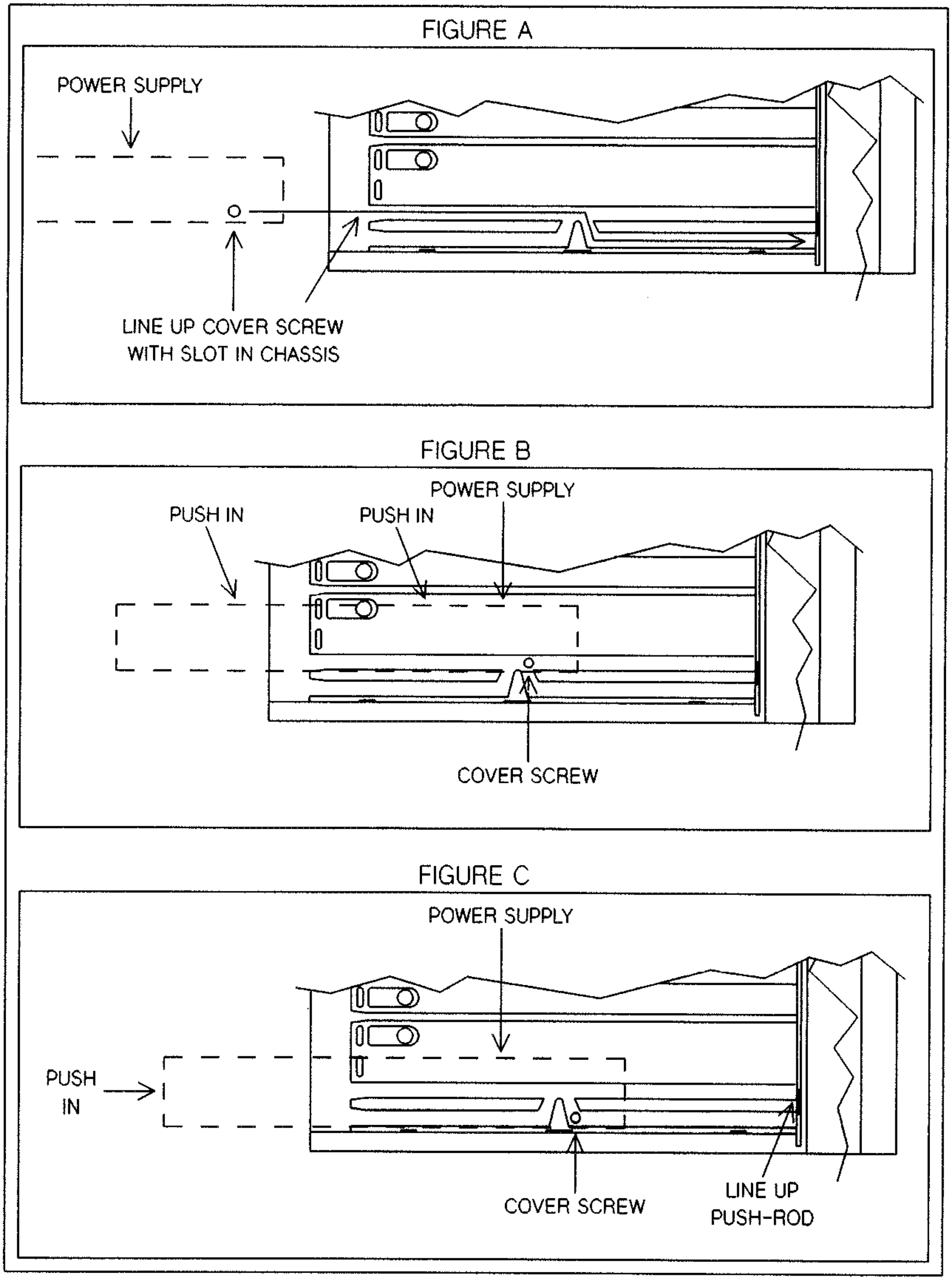


Figure 4-4 Power Supply Installation

4-9 Front Panel Removal/Installation Proceduress

The following procedure shows how to remove the front panel for both the HP 3852A Mainframe and HP 3853A Extender. Except for disconnecting a ribbon cable for the HP 3852A front panel, the procedures for both are the same.

4-10 Front Panel Removal Procedure

To remove the front panel assembly, do the following:

1. Remove ac power from the HP 3852A.

2. Locate the four front panel mounting screws. They are located at the front and bottom of the panel under the protrusion.

3. Lift the lower part of the panel out and up until the power switch key cap is completely out of the front panel assembly. Then lower the panel out of the front frame. If the front panel is from an HP 3852A Mainframe, disconnect the ribbon cable from the front panel printed circuit board.

4-11 Front Panel Installation Procedure

To install the front panel assembly, do the following:

1. Remove ac power from the HP 3852A.

2. If the front panel is to be installed into an HP 3853A Extender, continue with step 3. If the front panel is for an HP 3852A Mainframe, connect the ribbon cable into the front panel printed circuit board. Make sure the red band on the ribbon cable or the arrow on the ribbon cable connector is aligned with pin 1 on the front panel printed circuit board connector.

3. Place the top part of the front panel assembly under the top part of the instrument's front frame.

4. Carefully lower the bottom part of the front panel into the front frame.

5. Secure the panel with the four mounting screws located at the front and bottom of the panel under the protrusion.

4-12 THE HEWLETT-PACKARD EXCHANGE PROGRAM

Some of the replaceable assemblies and modules are available as restored products through the Hewlett-Packard Exchange Program. These products are sold at a discount and require the return for credit of your defective assembly.

When an exchange assembly or module is ordered, Hewlett-Packard will ship a restored assembly with instructions for returning your defective assembly. Upon receipt of your defective assembly, Hewlett-Packard then credits your bill (gives you a discount) and invoices you accordingly. You are allowed a specific time period to return your defective assembly after receiving the replacement assembly from HP. If the defective assembly is not received within this period the discount will not be given.

For more information on this program contact your nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed in the back of this manual.

4-13 MECHANICAL REPLACEABLE PARTS

4-14 Part Ordering Information

To order a part in the replaceable parts lists, quote the Hewlett-Packard part number, the check digit (abbreviated CD), and the quantity desired. Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed at the back of this manual.

4-15 Direct Mail Ordering

Within the U.S.A. only, Hewlett-Packard can supply parts to your location through a direct mail order system. Mail order forms and specific ordering information are available through you local Hewlett-Packard Sales Office.

Table 4-1 HP 3852X Controller Module

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
3852X	Module; controller (without A24)	1	03852-66203	5	MOD-CONTROLLER
A3	PCA; controller	1	03852-66503	8	PCA-CONTROLLER
A4	PCA; HP-IB & extender communication	1	03852-66504	9	PCA-HPIB/EXT COM
A21	PCA; mainframe memory interface	1	44703-66501	2	PCA-MF MEM INTFC
A24	PCA; 256 kB extnd mem; 44703A	1	09826-66524	3	256K MEMORY BD
	PCA; 1 MB extend mem; 44703B	1	98257-66524	1	1 MB MEMORY CARD
MP1	Screw; rear panel and A3 PCA	8	0515-0886	3	SCR-PH M3.0X6 LK
MP2	Hex standoff; extender connector	2	0380-1810	8	STDF-HX M/F M3TH
MP3	Lock washer; extender connector	2	2190-0913	9	WSHR-LK HLCL
MP4	Hex standoff; HP-IB connector	2	0380-1332	9	STDF-HEX .18-IN
MP5	Lock washer; HP-IB connector	2	2190-0577	1	WSHR-LK SCR-10
MP6	(NOT USED)				
MP7	(NOT USED)				
MP8	Panel; rear with screw latch	1	03852-00202	6	0601 PNL-CONT RR
MP9	Screw; cover	6	0515-0890	9	SCR-FH M3.0X6 LK
MP10	Shell; U shaped (aluminum)	1	03852-00101	4	0601 CVR-P/S LGE
MP11	Cover; (aluminum)	1	03852-00103	6	0601 CVR-CONTR
MP12	(NOT USED)				
MP13	Screw; A4 PCA	4	0515-1323	5	SCR-PH M3.0X30LK
MP14	Screw; A24 PCA	2	0515-0403	0	SCR-PH M2.5X8 LK
MP15	(NOT USED)				

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
3852X	Module; controller (without A24)		03852-69203	1	RBLT-03852-66203
A24	PCA; 256 kB extnd mem; 44703A		09826-69524	9	RBLT-09826-66524
	PCA; 1 MB extend mem; 44703B		98257-69524	7	RBLT-98257-66524

Table 4-2a HP 3852PS Mainframe Power Supply Module (older version)

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
3852PS	Module; mainframe power supply	1	03852-66202	4	MOD-MF PWR SPPLY
A2	PCA; power supply	1	03852-66502	7	PCA-POWER SUPPLY
F101	Fuse; 1.5A slow blow (100/120V line)	1	2110-0304	4	FUSE,1.5A 250VTD
	Fuse; .75A slow blow (220/240V line)	1	2110-0360	2	FU-.75A 250V TD
FC101	Fuse cap	1	2110-0565	9	FUHLR CAP 12A
MP16	Screw; rear panel, A2 PCA & cover	14	0515-0886	3	SCR-PH M3.0X6 LK
MP17	(NOT USED)			8	
MP18	Terminal; ground	1	1510-0038	8	BDG-POST SINGLE
MP19	Lock washer; ground terminal	1	2190-0060	7	WSHR-LK INTL T
MP20	Nut; ground terminal	1	2950-0006	3	NUT-HEX-DBL CHAM
MP21	Terminal block; analog ext. w/screws	1	03852-82101	6	CONN-6P F,VM I N
MP22	Screw; line receptacle	2	0515-0925	1	SCR-M3.0X10 SS
MP23	Lock washer; line receptacle	2	2190-0003	8	WSHR-LK HLCL
MP24	Panel; rear	1	03852-00201	5	0601 PNL-P/S RR
MP25	Screw; cover	2	0515-0890	9	SCR-FH M3.0X6 LK
MP26	Bolt; line transformer	1	0515-0759	9	SCR-CAP M6.0X20
MP27	Lock washer; line transformer	1	2190-0032	3	WSHR-LK HLCL
MP28	Flat washer; line transformer	1	3050-0190	9	WSHR-FLT .25X.87
MP29	Shell; U shaped (aluminum)	1	03852-00101	4	0601 CVR-MOD LGE
MP30	Cover; (aluminum)	1	03852-00102	5	0601 CVR P/S, MF
MP31	Screw; cover to heat sink	2	0515-0885	2	SCR-PH M4.0X8 LK
MP32	(NOT USED)				
MP33	(NOT USED)				
MP34	(NOT USED)				
MP35	(NOT USED)				
SW101	Switch; line power (on A2 PCA)	1	3101-2252	7	SW-PB-DPDT
T101	Transformer; line power (torroid)	1	9100-4467	4	XFMR-PWR, TOROID

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
3852PS	Module; mainframe power supply		03852-69202	0	RBLT-03852-66202

Table 4-2b HP 3852PS Mainframe Power Supply Module (newer version)

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
3852PS	Module; mainframe power supply	1	03852-66212	6	MOD-MF PWR SPPLY
A2	PCA; power supply	1	03852-66512	9	PCA-POWER SUPPLY
F101*	Fuse; 3.0A slow blow (120V line)	1	2110-0003	0	FUSE,3.0A 250NTD
	Fuse; 1.5A slow blow (240V line)	1	2110-0043	8	FUSE,1.5A 250NTD
FC101	Fuse cap	1	2110-0565	9	FUHLR CAP 12A
MP16	Screw; rear panel, A2 PCA & cover	5	0515-0886	3	SCR-PH M3.0X6 LK
MP17	(NOT USED)			8	
MP18	Terminal; ground	1	1510-0038	8	BDG-POST SINGLE
MP19	Lock washer; ground terminal	1	2190-0060	7	WSHR-LK INTL T
MP20	Nut; ground terminal	1	2950-0006	3	NUT-HEX-DBL CHAM
MP21	Terminal Block; analog ext. w/screws	1	03852-82101	6	CONN-6P F, VM IN
MP22	(NOT USED)				
MP23	(NOT USED)				
MP24	Panel; rear	1	03852-00203	7	0601 PNL-P/S RR
MP25	(NOT USED)				
MP26	(NOT USED)				
MP27	(NOT USED)				
MP28	(NOT USED)				
MP29	Shell; U shaped (aluminum)	1	03852-00105	8	0601 CVR-MOD LGE
MP30	(NOT USED)				
MP31	(NOT USED)				
MP32	(NOT USED)				
MP33	(NOT USED)				
MP34	(NOT USED)				
MP35	(NOT USED)				
MP36	Screw;	4	0515-0408	5	SCR-PH M3.0X12 LK
PWR1**	AC-DC Switching Power Supply	1	0950-1889	0	70 W AC-DC SW
SW101	Switch; line power (on A2 PCA)	1	3101-2252	7	SW-PB-DPDT

*CAUTION: Do not replace the fuse if blown; a blown fuse indicates a defective power supply that needs to be repaired.

**Please return any defective power modules to Hewlett-Packard for evaluation.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
3852PS	Module; mainframe power supply		03852-69212	2	RBLT-03852-66212

Table 4-3 Mainframe Front Panel

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
A7	PCA; front panel logic	1	03852-66507	2	PCA-FRNT PNL LOG
MP36	Screw; front panel	4	0515-0897	6	SCR-PH M3.0X8 LK
MP37	Screw; display and A7 PCA	7	0624-0333	6	SCR-PH 4-20X.25
MP38	(NOT USED)				
MP39	Assembly; LCD display and driver	2	5061-1190	6	LCD & DRVR ASSY
MP40	Assembly; front panel with keyboard	1	03852-60201	1	ASSY-FRNT PNL&KB
MP41	Leaf spring; front panel grounding	1	1460-1452	5	STPG--SPR LEAF
MP42	Screw; leaf spring	1	0515-0866	9	SCR-PH M3.0X8 CW
MP43	Screw; fan	2	0515-0885	2	SCR-PH M4.0X8 LK
MP44	Fan retainer; with foam	2	03852-61201	3	RETAINER-FAN
MP45	Fan boot; rubber	1	3160-0400	7	BOOT-FAN 80MM SQ
MP46	Fan; with wire and 1/2 connector	1	3160-0482	5	FAN-12V W/CONN
MP47	(NOT USED)				
MP48	Push rod; power switch	1	5041-3153	3	PUSH ROD
MP49	Key cap; power switch	1	5041-1682	9	KEY CAP-LINE
MP50	Clip; fan cable tie back w/adhesive	1	1400-0877	0	CLP-CBL .375-WD
W1	Cable; display, long with ends	1	03852-61602	8	CBL-16P DSPL,LG
W2	Cable; display, short with ends	1	03852-61603	9	CBL-16P DSPL,SHT
W3	Cable; keyboard with ends	1	03852-61604	0	CBL-16P KYBD

Table 4-4 Mainframe Chassis

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
A1	PCA; mainframe backplane	1	03852-66501	6	PCA MF BACKPLANE
MP51	Screw; backplane shield	4	0515-0886	3	SCR-PH M3.0X6 LK
MP52	Screw; A1 PCA	7	0515-0866	9	SCR-PH M3.0X8 CW
MP53	Screw; top and bottom subpanel	8	0515-0885	2	SCR-PH M4.0X8 LK
MP54	Screw; corner strut	16	0515-1331	5	SCR-MTRC SPCLY
MP55	Screw; power supply module securing	6	0515-1106	2	SCR-PH M4.0X16LK
MP56	Screw; slot ID label	8	0515-1232	5	SCR-PH M3.5X8LK
MP57	Subpanel; front (molded)	1	03852-40202	0	PNL-MLD,SUBPNL
MP58	Support; center (aluminum)	1	03852-04701	8	0601 SPRT-CD CAG
MP59	Label; mainframe slot ID w/adhesive	2	03852-84321	6	LBL-SLOT/ID,MF
MP60	Leaf spring strip; slot grounding	1	03852-89101	0	SPR-GROUNDING
MP61	(NOT USED)				
MP62	(NOT USED)				
MP63	Screw; front subpanel	4	0515-0896	5	SCR-FL M4.0X10LK
MP64	Shield; backplane (aluminum w/foam)	1	03852-00603	1	0601 SHLD-MTHR B
MP65	Subpanel; top (molded)	1	03852-66601	7	ASSY-CRD CAGE TP
MP66	Subpanel; bottom w/buttons (molded)	1	03852-66602	8	ASSY-CRD CAGE BT
MP67	Trim strip; front top	1	5040-7202	9	TRIM TOP
MP68	Trim strip; side	2	5001-0441	2	TRIM SIDE 8.75"
MP69	Frame; front	1	5021-5807	6	FRAME, FM, FRONT
MP70	Foot	4	5040-7201	8	FOOT
MP71	Tilt stand	2	1460-1345	5	TILT-STAND SST
MP72	Cover; top with screw	1	5061-9435	8	CVR, FM, TOP
MP73	Strut; corner	4	5021-5837	2	STRUT, CORNER
MP74	Frame; rear	1	5021-5808	7	FRAME, FM, REAR
MP75	Handle; metal strap and cover	2	5060-9804	3	STRAP HDL 18IN
MP76	Cap; rear of handle	2	5041-6820	7	CAP-STRP HDL RR
MP77	Screw; handle	4	0515-1132	4	SCR-MACH M5X0.8
MP78	Cover; side with handle slot	2	5060-9888	3	CVR-SIDE W/HDL
MP79	Cover; bottom with screw	1	5061-9447	2	CVR, FM, BTM
MP80	Cap; front of handle	2	5041-6819	4	CAP-STRP HDL FRT

Table 4-5a HP 3853PS Extender Power Supply Module (older version)

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
3853PS	Module; extender pwr supply & logic	1	03853-66202	5	MOD-EXT PS/LOGIC
A2	PCA; power supply	1	03852-66502	7	PCA-POWER SUPPLY
A3	PCA; extender logic	1	03853-66503	9	PCA-EXTNDR LOGIC
F101	Fuse; 1.5A slow blow (100/120V line)	1	2110-0304	4	FUSE,1.5A 250VTD
	Fuse; .75A slow blow (220/240V line)	1	2110-0360	2	FU-.75A 250V TD
FC101	Fuse cap	1	2110-0565	9	FUHLR CAP 12A
MP1-15	(NOT USED)				
MP16	Screw; rear panel, A2/A3 PCA & cover	21	0515-0886	3	SCR-PH M3.0X6 LK
MP17	(NOT USED)				
MP18	Terminal; ground	1	1510-0038	8	BDG-POST SINGLE
MP19	Lock washer; ground terminal	1	2190-0060	7	WSHR-LK INTL T
MP20	Nut; ground terminal	1	2950-0006	3	NUT-HEX-DBL CHAM
MP21	Terminal block; analog ext. w/screws	1	03852-82101	6	CONN-6P F,VM IN
MP22	Screw; line receptacle	2	0515-0925	1	SCR-M3.0X10 SS
MP23	Lock washer; line receptacle	2	2190-0003	8	WSHR-LK HLCL
MP24	Panel; rear	1	03853-00201	6	0601 PNL-P/S RR
MP25	Screw; cover	2	0515-0890	9	SCR-FH M3.0X6 LK
MP26	Bolt; line transformer	1	0515-0759	9	SCR-CAP M6.0X20
MP27	Lock washer; line transformer	1	2190-0032	3	WSHR-LK HLCL
MP28	Flat washer; line transformer	1	3050-0190	9	WSHR-FLT .25X.87
MP29	Shell; U shaped (aluminum)	1	03852-00101	4	0601 CVR-MOD LGE
MP30	Cover; (aluminum)	1	03853-00102	6	0601 CVR-PWRSPLY
MP31	Screw; cover to heat sink	2	0515-0885	2	SCR-PH M4.0X8 LK
MP32	Hex standoff; extender connector	4	0380-1810	8	STDF-HX M/F M3TH
MP33	Lock washer; extender connector	4	2190-0913	9	WSHR-LK HLCL
MP34	Cable; analog extender (1m, 3 cond.)	2	03498-61602	8	CBL-EXT H-L-G
MP35	Cable; digital extender (1 meter)	1	03853-61601	1	CBL-DIGITAL 1M
	Cable; digital extender (4 meter)	1	03853-61602	2	CBL-DIGITAL 4M
SW101	Switch; line power (on A2 PCA)	1	3101-2252	7	SW-PB-DPDT
T101	Transformer; line power (torroid)	1	9100-4467	4	XFMR-PWR,TOROID

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
3853PS	Module; extender pwr supply & logic		03853-69202	1	RBLT-03853-66202

Table 4-5b HP 3853PS Extender Power Supply Module (newer version)

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
3853PS	Module; extender pwr supply & logic	1	03853-66212	7	MOD-EXT PS/LOGIC
A2	PCA; power supply	1	03852-66512	9	PCA-POWER SUPPLY
A3	PCA; extender logic	1	03853-66503	9	PCA-EXTNDR LOGIC
F101*	Fuse; 3.0A slow blow (120V line)	1	2110-0004	0	FUSE,3.0A 250VNTD
	Fuse; 1.5A slow blow (240V line)	1	2110-0304	8	FUSE,1.5A 250VNTD
FC101	Fuse cap	1	2110-0565	9	FUHLR CAP 12A
MP16	Screw; rear panel	5	0515-0886	3	SCR-PH M3.0X6 LK
MP17	(NOT USED)			8	
MP18	Terminal; ground	1	1510-0038	8	BDG-POST SINGLE
MP19	Lock washer; ground terminal	1	2190-0060	7	WSHR-LK INTL T
MP20	Nut; ground terminal	1	2950-0006	3	NUT-HEX-DBL CHAM
MP21	Terminal block; analog ext. w/screws	1	03852-82101	6	CONN-6P F,VM IN
MP22	(NOT USED)				
MP23	(NOT USED)				
MP24	Panel; rear	1	03853-00203	8	0601 PNL-P/S RR
MP25	(NOT USED)				
MP26	(NOT USED)				
MP27	(NOT USED)				
MP28	(NOT USED)				
MP29	Shell; U shaped (aluminum)	1	03852-00105	8	0601 CVR-MOD LGE
MP30	(NOT USED)				
MP31	(NOT USED)				
MP32	Hex standoff; extender connector	4	0380-1810	8	STDF-HX M/F M3TH
MP33	Lock washer; extender connector	4	2190-0913	9	WSHR-LK HLCL
MP34	Cable; analog extender (1m, 3 cond.)	2	03498-61602	8	CBL-EXT H-L-G
MP35	Cable; digital extender (1 meter)	1	03853-61601	1	CBL-DIGITAL 1M
	Cable; digital extender (4 meter)	1	03853-61602	2	CBL-DIGITAL 4M
MP36	Screw;	4	0515-0408	5	SCR-PH M3.0X12 LK
PWR1**	AC-DC Switching Power Supply	1	0950-1889	0	70 W AC-DC SW
SW101	Switch; line power (on A2 PCA)	1	3101-2252	7	SW-PB-DPDT

*CAUTION: Do not replace the fuse if blown; a blown fuse indicates a defective power supply that needs to be repaired.

**Please return any defective power modules to Hewlett-Packard for evaluation.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
3853PS	Module; extender pwr supply & logic		03853-69212	3	RBLT-03853-66212

Table 4-6 Extender Front Panel

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
MP36	Screw; front panel	4	0515-0897	6	SCR-PH M3.0X8 LK
MP37	(NOT USED)				
MP38	(NOT USED)				
MP39	(NOT USED)				
MP40	Assembly; front panel w/label	1	03853-40203	2	PNL ASSY W/LBL
MP41	(NOT USED)				
MP42	(NOT USED)				
MP43	Screw; fan	2	0515-0885	2	SCR-PH M4.0X8 LK
MP44	Fan retainer; with foam	2	03852-61201	3	RETAINER-FAN
MP45	Fan boot; rubber	1	3160-0400	7	BOOT-FAN 80MM SQ
MP46	Fan; with wire and 1/2 connector	1	3160-0482	5	FAN-12V W/CONN
MP47	(NOT USED)				
MP48	Push rod; power switch	1	5041-3153	3	PUSH ROD
MP49	Key cap; power switch	1	5041-1682	9	KEY CAP-LINE
MP50	Clip; fan cable tie back w/adhesive	1	1400-0877	0	CLP-CBL .375-WD

Table 4-7 Extender Chassis

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
A1	PCA; extender backplane	1	03853-66501	7	PCA-EXTENDR BKPL
MP51	Screw; backplane shield	4	0515-0886	3	SCR-PH M3.0X6 LK
MP52	Screw; A1 PCA	6	0515-0866	9	SCR-PH M3.0X8 CW
MP53	Screw; top and bottom subpanel	8	0515-0885	2	SCR-PH M4.0X8 LK
MP54	Screw; corner strut	16	0515-1331	5	SCR-MTRC SPCLY
MP55	Screw; power supply module securing	6	0515-1106	2	SCR-PH M4.0X16LK
MP56	Screw; slot ID label	8	0515-1232	5	SCR-PH M3.5X8LK
MP57	Subpanel; front (molded)	1	03852-40202	0	PNL-MLD,SUBPNL
MP58	Support; center (aluminum)	1	03852-04701	8	0601 SPRT-CD CAG
MP59	Label; extender slot ID label	2	03853-84321	7	LBL-SLOT/ID,EXT
MP60	Leaf spring strip; slot grounding	1	03852-89101	0	SPR-GROUNDING
MP61	(NOT USED)				
MP62	(NOT USED)				
MP63	Screw; front subpanel	4	0515-0896	5	SCR-FL M4.0X10LK
MP64	Shield; backplane (aluminum w/foam)	1	03852-00603	1	0601 SHLD-MTHR B
MP65	Subpanel; top (molded)	1	03852-66601	7	ASSY-CRD CAGE TP
MP66	Subpanel; bottom w/buttons (molded)	1	03852-66602	8	ASSY-CRD CAGE BT
MP67	Trim strip; front top	1	5040-7202	9	TRIM TOP
MP68	Trim strip; side	2	5001-0441	2	TRIM SIDE 8.75"
MP69	Frame; front	1	5021-5807	6	FRAME, FM, FRONT
MP70	Foot	4	5040-7201	8	FOOT
MP71	Tilt stand	2	1460-1345	5	TILT-STAND SST
MP72	Cover; top with screw	1	5061-9435	8	CVR, FM, TOP
MP73	Strut; corner	4	5021-5837	2	STRUT, CORNER
MP74	Frame; rear	1	5021-5808	7	FRAME, FM, REAR
MP75	Handle; metal strap and cover	2	5060-9804	3	STRAP HDL 18IN
MP76	Cap; rear of handle	2	5041-6820	7	CAP-STRP HDL RR
MP77	Screw; handle	4	0515-1132	4	SCR-MACH M5X0.8
MP78	Cover; side with handle slot	2	5060-9888	3	CVR-SIDE W/HDL
MP79	Cover; bottom with screw	1	5061-9447	2	CVR, FM, BTM
MP80	Cap; front of handle	2	5041-6819	4	CAP-STRP HDL FRT

Table 4-8 HP 44743A Plug-In Accessory Service Module (backplane extender)

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44743A	Module; plug-in accessory service	1	44743A	8	MOD-ACCESRY SRVC
A1	PCAs; backplane & extended	1	44743-66501	0	PCA-ACCESRY SRVC
MP1	Screw; cover	4	0515-0160	6	SCR-PH M3.0X25
MP2	Guide rail; top (molded)	1	44743-21201	3	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	44743-21202	4	MLD-RAIL,BOTTOM
MP4	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC Rt
MP5	(NOT USED)				
MP6	Label; 44743A service module	1	44743-84321	0	LBL-SVC MOD "A"
MP7	Edge protector; 0.5 feet	6	0400-0163	6	GROMMET-CONT
W1-2	Cable; 1.3m ribbon (included w/PCAs)	2	03852-61607	3	CBL-RBN,40P 1.3M

Table 4-9 HP 44743B Power Supply Service Module (backplane extender)

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44743B	Module; power supply service	1	44743B	0	MOD-PWRSPLY SRVC
A2	PCAs; pwr supply, backpln & extended	1	44743-66502	1	PCA-PWRSPLY EXTN
A3	PCAs; extender logic, bckpln & extnd	1	44743-66503	2	PCA-EXTLOGC EXTN
MP1	Screw; A2/A3 PCAs & cover (ends)	16	0515-0886	3	SCR-PH M3.0X6 LK
MP2	Screw; cover (center)	2	0515-0890	9	SCR-FH M3.0X6 LK
MP3	Shell; U shaped (aluminum)	1	03852-00101	4	0601 CVR-MOD LGE
MP4	Cover; (aluminum)	1	03853-00102	6	0601 CVR-PWRSPLY
MP5	Label; 44743B service module	1	44743-84322	1	LBL-SVC MOD "B"
MP6	Edge protector; 0.5 feet	6	0400-0163	6	GROMMET-CONT
W1-4	Cable; 1.3m ribbon (included w/PCAs)	4	03852-61607	3	CBL-RBN,40P 1.3M

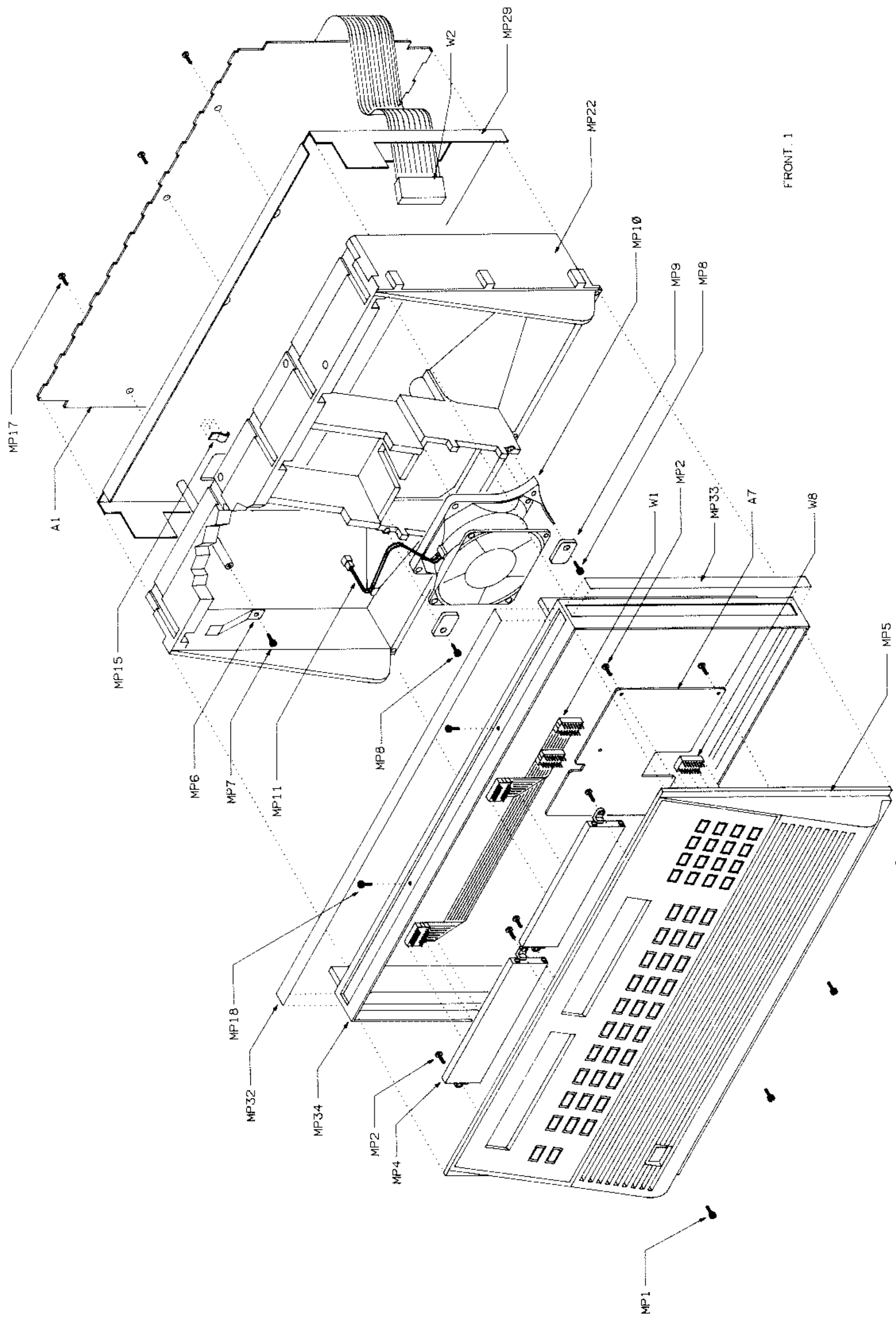


Figure 4-5 Mainframe/Extender Front Panel Exploded View

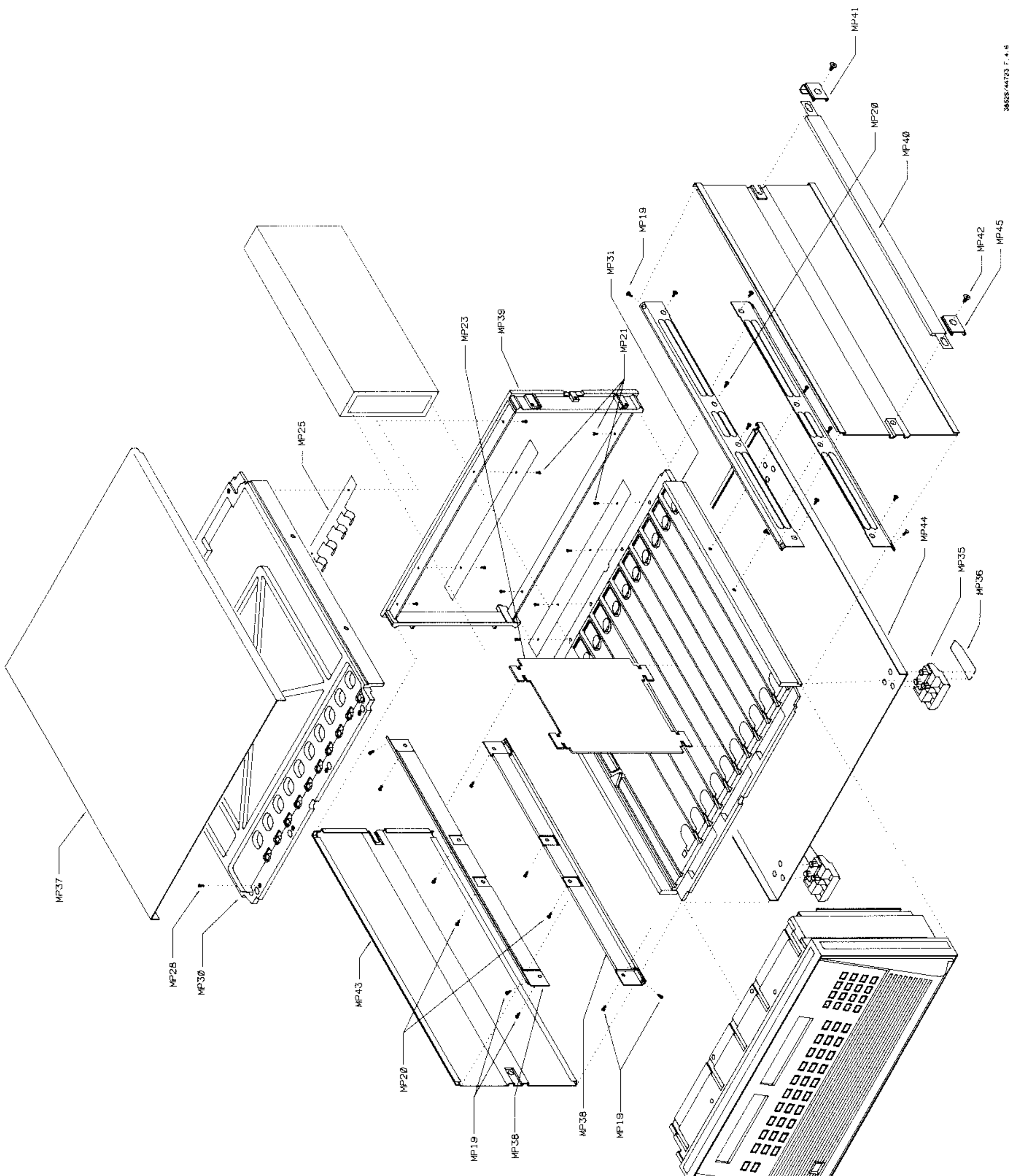


Figure 4-6 Mainframe/Extender Chassis Exploded View

Chapter 5
Problem Isolation

CHAPTER 5
PROBLEM ISOLATION

CHAPTER 5
PROBLEM ISOLATION

5-1 INTRODUCTION

This chapter contains information and procedures to aid in problem isolation. A block level technical description of the HP 3852A and HP 3853A is given to provide an understanding of the system functions and operation. This chapter also contains a description of the self-test and error codes. Finally, the chapter provides a series of troubleshooting hints to aid in problem isolation.

5-2 SAFETY CONSIDERATIONS

Only service trained personnel should attempt to repair the HP 3852A or HP 3853A. There are two places within the instrument where dangerous voltages may exist: the power supply module and analog backplane bus.

The ac line voltage present in the power supply module can only be contacted if the module's shields are removed. The line power switch is contained within the power supply module, so line power is not routed to the front panel.

The other potentially lethal voltage, and one that can be contacted by service personnel, is the analog backplane bus in the instrument. A voltage on this bus originates externally to the instrument. The power to external wiring and connections must be removed prior to servicing. Such external wiring is connected to the terminal modules. Depending upon the current configuration of the plug-in accessories, a voltage on the terminal modules may be present on the backplane analog bus. Once on the analog bus, this voltage will be present at each plug-in slot in the instrument. It will also be present at the analog extender connector on the rear of the power supply, and, if an analog extender cable is installed, on the analog bus of all installed extenders. It should be noted that if an analog extender cable is installed, voltages present on a plug-in at an extender (HP 3853A) can also be present on the HP 3852A analog bus.

WARNING

Only personnel with a knowledge of electronic circuitry and an awareness of the hazards involved should install, re-configure, or make any repairs to this instrument or assembly.

CAUTION

To prevent equipment circuit damage, always set the line power switch to off before removing or replacing any assembly. To prevent static zap of IC's, always observe anti-static techniques when assemblies are handled or serviced.

5-3 Static Handling

Static electricity is a familiar phenomenon which, except for an occasional shock, doesn't seem very serious. However, it has been proven that in the electronics industry electrostatic discharge (ESD) is a major cause of component failure. In many cases, the component damaged may not immediately fail, causing low instrument reliability and future repairs. ESD damage can occur at static levels below human perception. It has also been shown that ESD can affect both passive and active devices.

The following guidelines are the minimum requirements for a static safe service environment.

- The workbench should be equipped with a conductive table mat. The mat should be grounded to earth ground through a 1 M ohm resistor. The mat should be equipped with at least one swivel connector for connecting wrist straps.

- All service and handling personnel should wear a conductive wrist strap in contact with bare skin. This strap should be connected to the swivel connector on the conductive table mat through a 1 M ohm resistor.

- All metal equipment at a work station must be grounded. This includes soldering irons, solder removers, shelving, and equipment stands.

- Only one common ground should be provided at the workstation.

- The workstation should be kept free of nonconductors. No common plastics, polybags, cardboard, cigarette or candy wrappers should be allowed. There should not be rugs or carpet on the floor, shelving, or bench top.

- Only proper containers should be used for shipping, storing or transporting assemblies. This is *required* on any module or assembly shipped to Hewlett-Packard for repair or replacement.

Static precautions apply to all parts of the HP 3852A system, with the exception of the terminal modules. Any module or assembly removed from the instrument MUST be handled in accordance with anti-static procedures.

5-4 PRINTED CIRCUIT ASSEMBLY IDENTIFICATION

The printed circuit assemblies within the HP 3852A system are identified by the HP part number of the printed circuit board and the engineering revision code (ERC). These two sequences of numbers are used to exactly identify the electrical characteristics of the printed circuit board. In any correspondence concerning a particular printed circuit board, it is important to accurately identify the board configuration. This is done by using the board part number, followed by the engineering revision code (ERC) on the board. For example:

03852-66503-2528

would identify a particular printed circuit board in the HP 3852A. The board part number is 03852-66503 and the ERC is 2528.

5-5 Board Part Number

The Hewlett-Packard part number of a printed circuit board is etched on the board. This is a ten digit number, separated by a hyphen into two groups of five digits. The first five digits identify the model number or accessory number of which the printed circuit board is a part. The last five digits are a unique part number identifying the printed circuit board.

5-6 Engineering Revision Code

Figure 5-1 shows a typical Engineering Revision Code (ERC) label. This four digit code is in the form of YYWW, where YY represents the last two digits of the year minus 60 and WW is the week code. For example, an Engineering Revision Code of 2528 would identify a change made in the 28th week of 1985.

The ERC number is updated whenever a change is made to the assembly. This change may be a printed circuit board revision, a component change, or a revised test and assembly procedure. The ERC should be checked against schematics, component locator diagrams, and parts lists to ensure compatibility. ERC's with values lower than those noted on the schematics, component locator diagrams, and parts lists are described in a backdating section. ERC's with a value higher that those noted will be covered by manual change sheets or manual revisions.

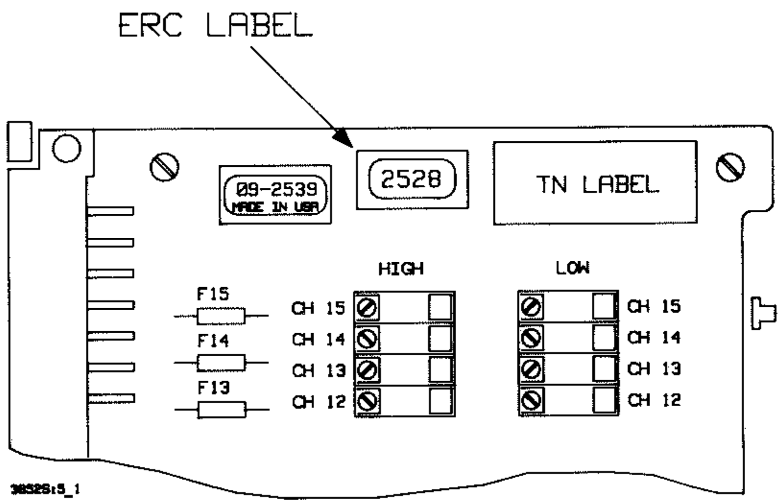


Figure 5-1 Typical ERC Label

5-7 HP 3852A TECHNICAL DESCRIPTION

The major assemblies of the HP 3852A are shown in Figure 5-2. The following discussion describes each of the major assemblies.

5-8 Local Controller

The microprocessor is the heart of the local controller. The microprocessor used is a Motorola MC68000. The MC68000 utilizes a 23 bit address bus and a 16 bit data bus. The microprocessor is clocked at a 4 MHz rate. The local controller uses a memory mapped system. In a memory mapped system, all peripherals to the microprocessor are treated as memory locations.

The firmware for the operation of the microprocessor is located in ROMs. The ROMs also contains special service routines. The standard HP 3852A contains 128 K words of ROM space, of which 5 K words are used for overhead.

The microprocessor uses 16 K word of addressable RAM. The RAM is used to store subprograms, variables, measurement results, scan lists, the HP-IB address, and the instrument serial number. A portion of the RAM is provided with a battery back-up circuit to prevent loss of data during power-down periods.

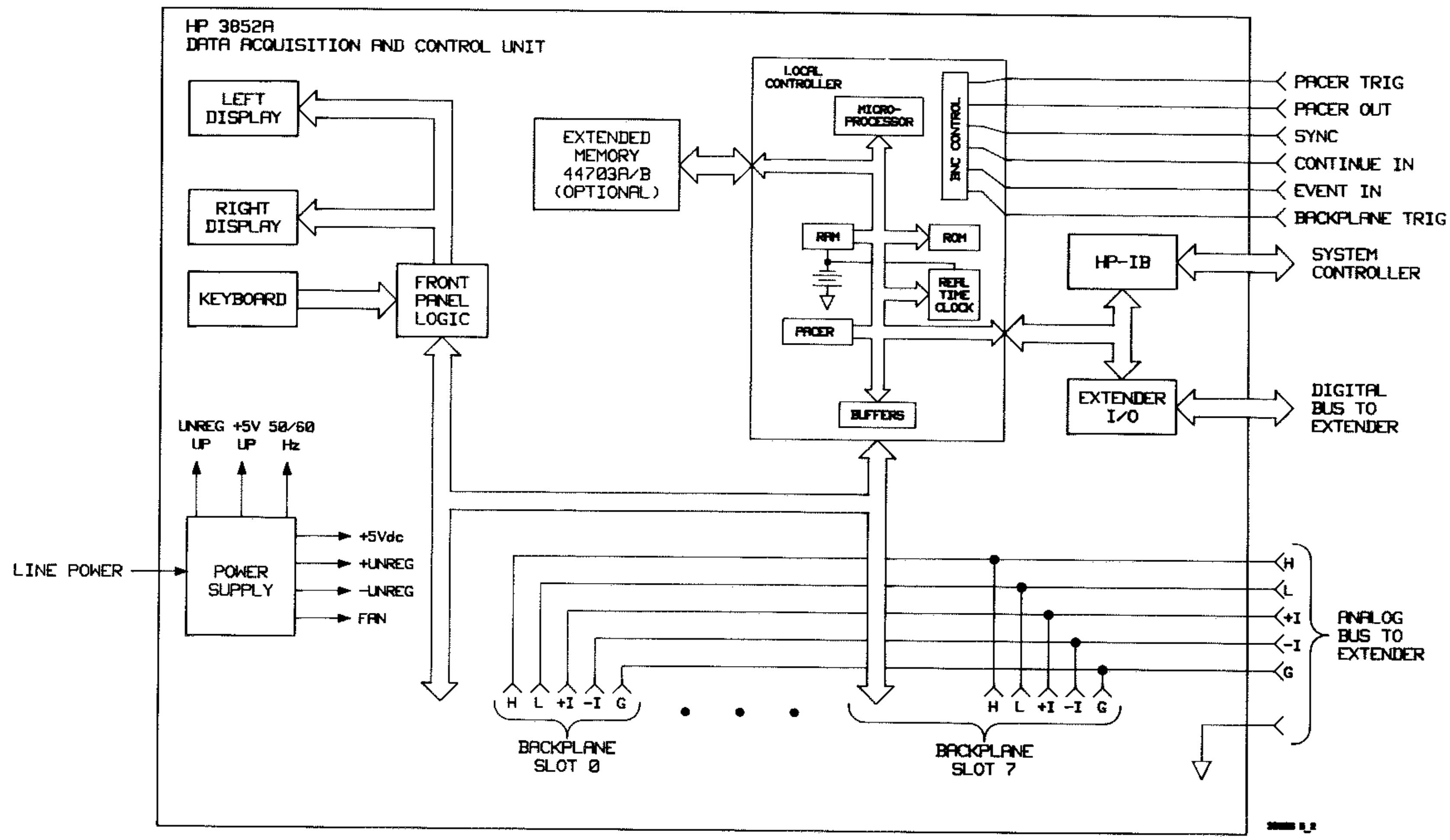


Figure 5-2. HP 3852A Block Diagram

The real time clock is also a part of the local controller. This clock contains the time, date, and alarm settings. The real time clock is provided with a battery back-up circuit to ensure that the time, data, and alarm settings are not lost during power-down periods. The real time clock is clocked by a 32 MHz crystal oscillator.

The local controller contains a pacer. This programmable pacer can be used to initiate scans, events, or measurements. The pacer can be programmed to output from one to 65,535 pulses or output continuously. The output pulse interval is programmable from 1 microsecond to 4.19 seconds in 0.25 microsecond steps. The width of the output pulse is not programmable, it is fixed at 0.5 microsecond. The pacer output is available at a BNC on the rear panel of the controller module. At the BNC, the pacer output is a negative pulse.

On the rear panel of the controller module are six BNC connectors. Four of the BNC's are inputs and two are outputs. The BNC's are physically attached to the controller printed circuit board. They are not directly attached to the rear panel sheet metal. Electrically, the BNC case is connected to earth ground. The six connectors and their functions are described in Table 5-1. Figure 5-3 shows a typical BNC input and BNC output circuit.

Table 5-1 BNC Input and BNC Output Description

Name	Description
EVENT IN	used with the "wait for event" command to initiate an action
CHANNEL ADVANCE	advances a scan to the next channel in the scan list
CHANNEL CLOSED	used to indicate that a channel is closed, may be used to trigger an external voltmeter
SYSTEM TRIGGER IN	allows an input to trigger all plug-in accessories
PACER OUT	output from the programmable system pacer
PACER TRIGGER IN	triggers the system pacer (when in the external trigger mode)

5-9 Extended Memory

The HP 3852A can support additional memory of 256 K bytes, 1 M bytes, 2 M bytes, and 4 M bytes. The 256 K bytes and 1 M bytes memory cards are available from Hewlett-Packard as Options 001 and 002, respectively. The optional memory cards can also be ordered as field installable kits under accessory numbers 44703A (256 K bytes) and 44703B (1 M byte). The 2 M bytes and 4 M bytes memory cards are available from Infotek Systems, 1400 N Baxter Street, Anaheim, California 92806-1201 as AM220B and AM244B, respectively. Unlike the 256 K bytes and 1 M byte cards, the 2 M byte and 4 M byte cards have been *functionally tested, but are not warranted or supported by HP.*

The optional memory cards are directly connected to the controller data and address buses. Memory allocation is dynamic and, to the local controller, the memory is an extension of RAM. The additional memory is used to store readings and sub-programs.

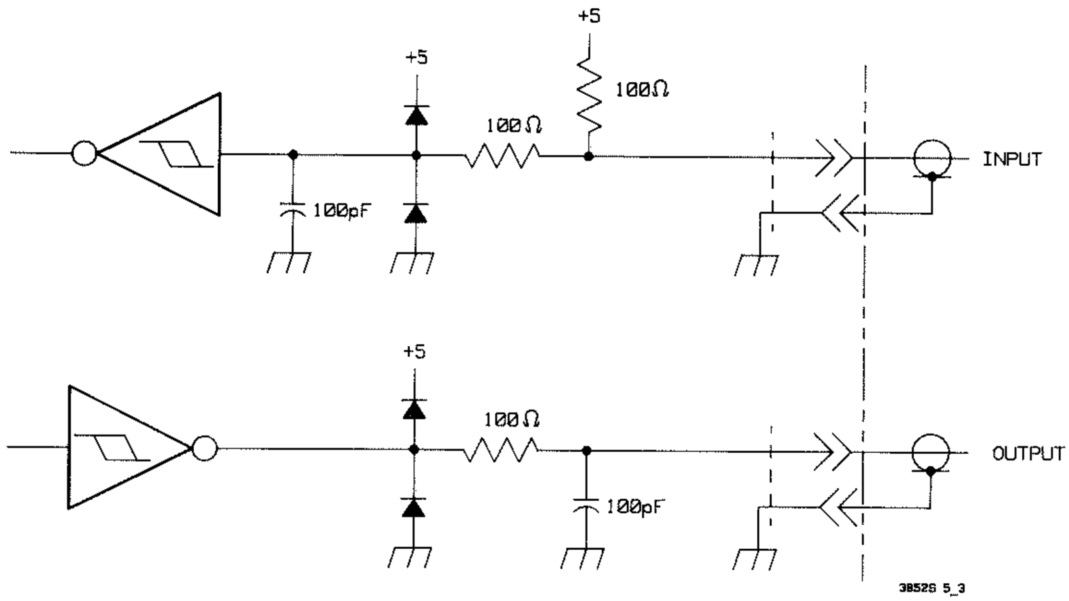


Figure 5-3 Typical BNC Input and BNC output Circuit

The HP memory cards used are the same as the optional memory cards for the HP 9000 Series 200 and 300 computers. The required address switch settings on the memory boards are shown in Figure 5-4.

5-10 HP-IB

The HP-IB section allows the HP 3852A to interface with the external system controller. HP-IB is a carefully defined parallel interface and is Hewlett-Packard's implementation of IEEE 488-1978. The HP-IB connector is located on the rear panel of the controller module.

HP-IB capabilities supported by the HP 3852A are: SH1, AH1, T6, L4, SR1, RL1, PP1, DC1, DT1, and C0. A complete explanation of these codes can be found in the IEEE 488-1978 standard. The HP-IB section is clocked at a 4 MHz rate. The maximum data transfer rate over the bus to an ideal listener is 140 K bytes/second.

Physically, the HP-IB section shares a part of the HP-IB/Extender Logic printed circuit board. This circuit board is mounted as a "piggy-back" board on the controller board, inside the controller module.

5-11 Extender I/O

The Extender I/O interfaces the HP 3852A with the HP 3853A Extender. This digital interface is accessed through a 37 pin connector located on the rear panel of the controller module. This digital interface allows up to seven HP 3853A Extenders to be connected in a daisy chain fashion to the HP 3852A. Electrically, all extenders are in parallel. The maximum interface cable length between units is 4 meters (a 1 meter cable is standard) and the entire system can have no more than 25 meters of digital extender cable.

The Extender I/O circuitry is located inside the controller module, on a "piggy-back" printed circuit board. This printed circuit board also contains the HP-IB circuitry.

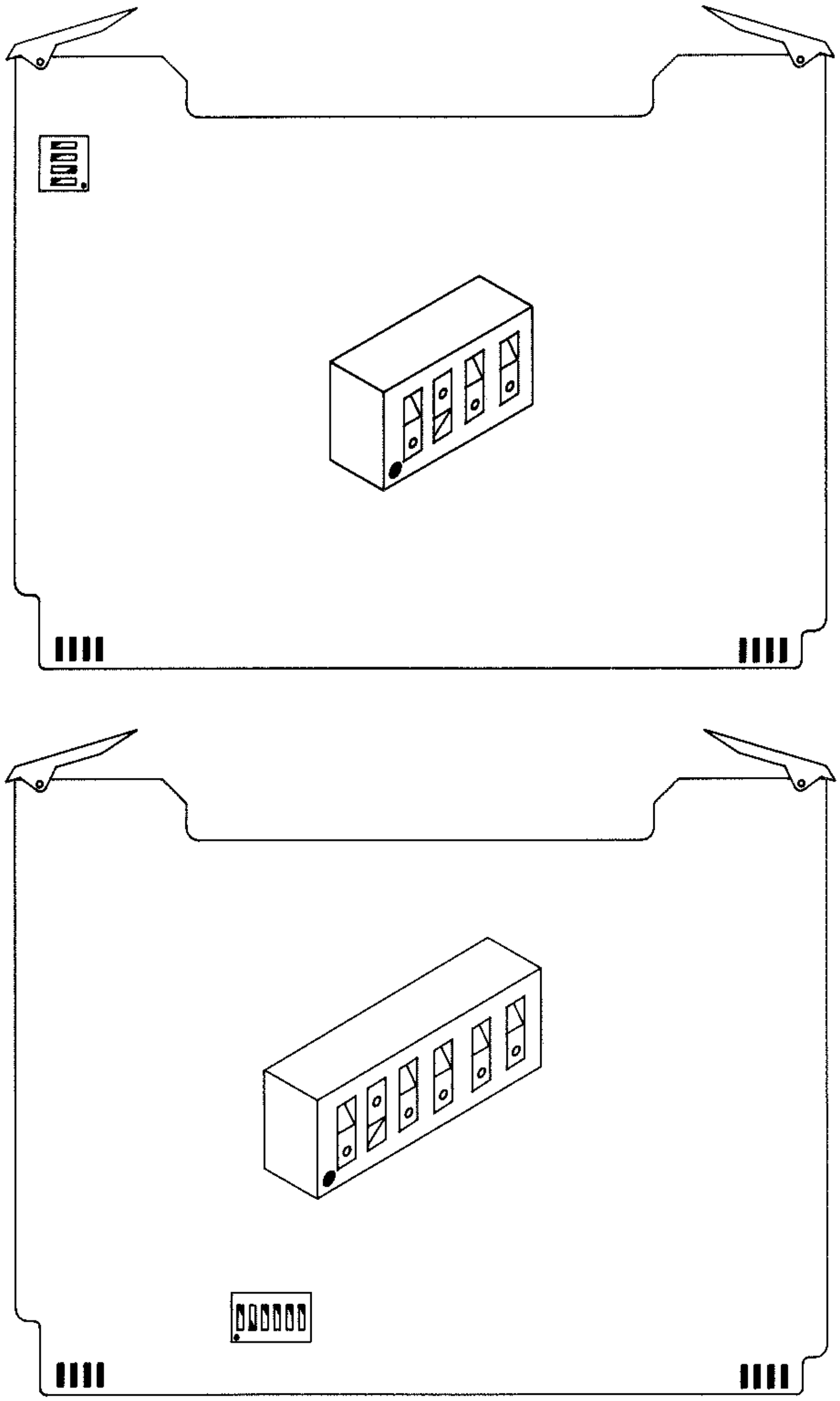


Figure 5-4 Extended Memory Address Settings

5-12 Front Panel Logic

The front panel logic functions as a bidirectional buffer between the keyboard, display, and the local controller. The front panel logic accepts data and commands from either the keyboard or the local controller. It also controls the two displays. Keyboard scanning is controlled by the front panel logic.

The front panel logic communicates with the local controller over the eight least significant backplane data lines (BD0 through BD7). Since the front panel communicates over the backplane data bus and control lines, a failure in the front panel may appear like a slot failure.

The front panel logic is contained on a printed circuit board mounted to the front panel. A ribbon cable to the backplane provides the necessary control and data lines. The beeper is mounted to the front panel logic circuit board.

5-13 Keyboard

The keyboard has 48 keys. The keys are electrically arranged into a 6 by 8 matrix that is scanned by the front panel logic. When a key is pressed, the front panel logic sends a byte corresponding to the key code to the local controller. On the keyboard, 30 of the keys have a shifted function. These keys are controlled by the blue SHIFT key. No byte is sent to the local controller when the SHIFT key is pressed. The shifted keys are arranged in a standard QWERTY keyboard arrangement.

The keyboard is heat staked to the front panel. The rubber keys, the contacts and the printed circuit board are not individually replaceable. Repair of the keyboard is accomplished by replacing the molded plastic panel and keyboard as an assembly.

5-14 Displays

There are two display assemblies on the front panel, referred to as the left and right display as seen looking at the front panel. Each Liquid Crystal Display has 12 starburst characters and 12 annunciators. During self test or when initiated by a service test jumper all segments of the display are turned on. Missing segments or annunciators indicate a failing display.

The display assemblies are connected to the front panel logic by ribbon cables. Repair of a failing display assembly is done by replacing the assembly. Chapter 4 of this manual gives replacement part numbers.

5-15 Backplane

The HP 3852A provides eight slots for plug-in accessories. Each accessory electrically connects to the backplane through a 74 pin connector. This connector contains all the digital and analog lines. The backplane provides a five line analog bus to each plug-in accessory. This bus may or may not be used, depending upon the plug-in accessories installed and the application.

If an HP 3853A Extender is connected, the digital bus is extended through the HP-IB/Extender logic. The analog bus is directly extended with a dedicated cable between the units. Not all systems require the analog bus of the HP 3853A. If a plug-in voltmeter accessory is used to measure a voltage through a multiplexer plug-in accessory that is not installed in the same unit, then the analog extension is needed. No analog extension is needed for a voltmeter to measure a voltage through a multiplexer accessory in the same unit.

A plug-in accessory backplane connector is shown in Figure 5-5. This 74 pin connector contains all the power supplies, grounds, analog bus lines and logic bus lines. Each of the lines is described in Table 5-2. The plug-in accessory backplane connector is the same in the HP 3852A and the HP 3853A.

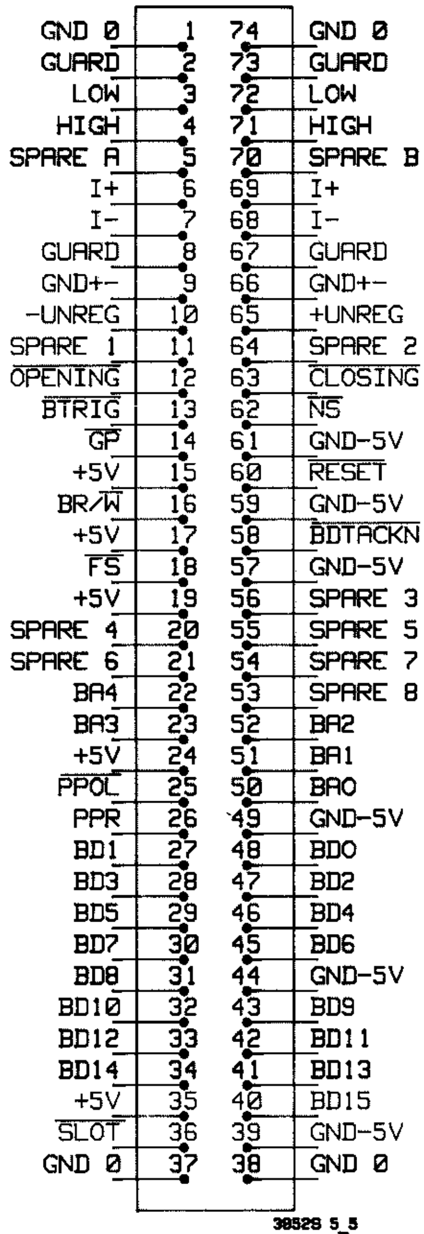


Figure 5-5 Backplane Connector

5-16 Power Supply

The power supply provides power for all the circuitry in the HP 3852A and all plug-in accessories installed. The power supply outputs four supplies and three control lines. The supplies output are: +5 VDC, +UNREG (+21 VDC unregulated), -UNREG (-24 VDC unregulated), and fan power (derived from the +UNREG supply). The power supply specifications are listed in Table 5-2.

Table 5-2 Plug-In Accessory Backplane Lines

Line Type	Line Name	Line Description
LOGIC BUS	RESET	Backplane reset input to plug-in accessories. Pulled low to reset.
	BR/W	Read/write direction control input to plug-in accessories. High = read, Low = write.
	SLOT	Slot select line input to plug-in accessories. Selects slot when low.
	BDTACKN	Data Acknowledged. Bus handshake line output from plug-in accessory. Pulsed low to handshake.
	BA0-BA4	Register address lines input to plug-in accessories. High = 1.
	BD0-BD15	Backplane data bus. These are bidirectional lines.
	PPOL	Parallel poll line input to plug-in accessories that have the capability of interrupting the local controller. Line is pulled low to poll.
	PPR	Parallel poll response line output from the plug-in accessories in response to a parallel poll. The plug-in pulls this line low to indicate an affirmative response. On the backplane, each PPR line is tied to the data line (BD) corresponding to the slot number.
	BTRIG	Backplane trigger input to plug-in accessories. A low initiates the trigger. Not all plug-in accessories can respond to this trigger.
	GP	General purpose interrupt output from plug-in accessory. Set low to interrupt.
	NS	Normal scan interrupt output from an HP 44701A. Set low to interrupt.
	FS	Fast scan interrupt output from an HP 44702A/B. Set low to interrupt.
	OPENING	Opening signal line used by the multiplexer plug-in accessories to synchronize the "break-before-make" channel openings. Each multiplexer inputs and outputs this line. Line is set low to indicate that a channel is in the process of opening.
	CLOSING	Closing signal line output from the multiplexer plug-in accessories to one of the voltmeter accessories. Line is pulled low to indicate a channel is in the process of closing.
	SPARE	All lines labeled SPARE are not connected.

Table 5-2 Plug-In Accessory Backplane Lines (Cont)

Line Type	Line Name	Line Description
GROUNDS	GND 0	ESD discharge path and safety ground. This ground is tied to all sheet metal on the plug-in accessories.
	GND-5	The reference for the +5 VDC power supply. This ground is the logic reference ground.
	GND+-	The reference for the -UNREG and +UNREG supplies.
POWER SUPPLIES	+5V	The 5 VDC supply. May range from +4.8 Vdc to +5.25 VDC Ripple and noise on this supply < 100 mV peak-to-peak.
	+UNREG	The positive unregulated supply. Voltage may range from +17.4 Vdc to +22.0 Vdc. Ripple and noise; <0.5 V peak-to-peak.
	-UNREG	The negative unregulated supply. Voltage may range from -17.4 Vdc to -31.0 Vdc. Ripple and noise are not specified.
ANALOG BUS	HIGH,LOW	The HP 44701A and HP 44702A/B can make measurements from these lines.
	GUARD	Used to guard measurements made by the HP 44701A. If an HP 44702A/B is installed, GUARD is tied to chassis ground (GND 0).
	I+,I-	Used to provide current source for ohms measurements. Both the HP 44701 and HP 44702 can source current on these lines.

The three control lines are output to the local controller. These three control lines are: UNREG UP (indicating that the unregulated supplies are operating), +5 UP (indicating that the + 5 VDC supply is operating), and 50/60 Hz (used by the local controller to set voltmeter integration times).

The local controller monitors the UNREG UP and +5 UP lines to determine if a power failure is occurring. The power supply outputs have enough filtering to allow the local controller to initiate a shut-down sequence if either of these control lines indicates an imminent failure.

5-17 HP 3853A TECHNICAL DESCRIPTION

The major assemblies of the HP 3853A Extender are shown in Figure 5-6. The HP 3853A provides an additional ten plug-in accessory slots. Up to seven HP 3853As may be installed in a single system.

5-18 Extender I/O

The Extender I/O interfaces the HP 3853A with the HP 3852A. This digital interface is accessed through a 37 pin connector located on the rear panel of the HP 3853A. There are two connectors on the rear panel of the HP 3853A. The two connectors are wired in parallel to allow several (up to seven) HP 3853As to be connected in a daisy chain fashion. Electrically, all extenders are in parallel.

The Extender I/O circuitry is located on a printed circuit board mounted inside the power supply module.

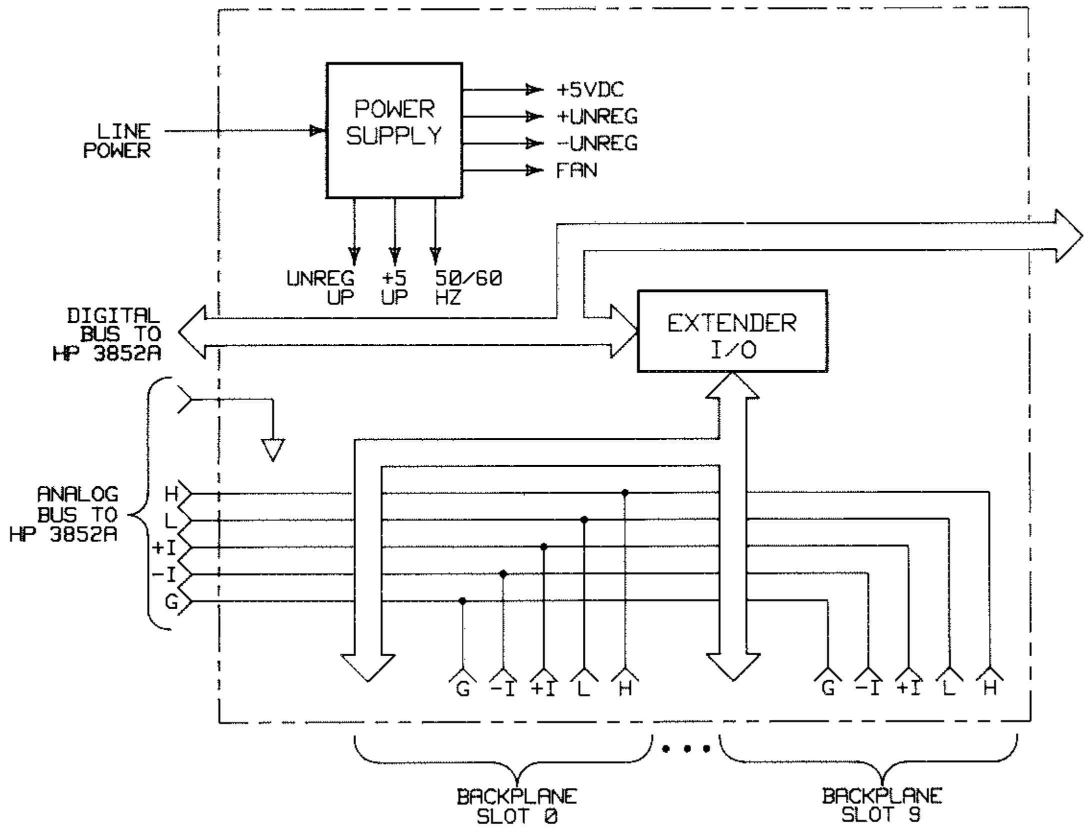


Figure 5-6 HP 3853A Block Diagram

5-19 Power Supply

The power supply in the HP 3853A is the same supply as that used in the HP 3852A. It provides power for the Extender I/O circuitry and all plug-in accessories installed. The power supply provides +UNREG, -UNREG, +5 VDC, and fan power. The +5 UP and UNREG UP control lines are combined into a single control line on the Extender I/O circuit board and placed on a dedicated line in the digital interface. This line is monitored by the HP 3852A local controller and, if the state of the line indicates an imminent power failure, initiates the power down sequence of the local controller.

Because the digital interface is shared by all the HP 3853A Extenders installed in the system, any one extender with a failing power supply will initiate the power down sequence (or prevent a proper wake up sequence) in the HP 3852A.

5-20 PROBLEM ISOLATION

The following procedures assume that reasonable steps have been taken to isolate the problem to the HP 3852A system. Such steps may include testing of the system controller, HP-IB, and system inputs.

Within the HP 3852A are five major electronic assemblies. These assemblies are: 1) the keyboard, 2) the displays, 3) front panel logic, 4) the power supply, and 5) the local controller. Because of the interaction of some of these assemblies problem isolation is limited to replacement of the suspected assembly. The following paragraphs detail problem isolation to each of the assemblies.

Within the HP 3853A Extender is only one electronic assembly. This assembly contains both the power supply and the Extender I/O logic. The HP 3853A power supply is tested in the same manner as the HP 3852A power supply. Section 5-34, System Troubleshooting Hints, contains information to isolate a problem to the HP 3853A Extender.

5-21 Keyboard

The keyboard printed circuit board is heat staked to the front panel. It is replaced as an assembly. Electrically, the keys are arranged into a 6 by 8 matrix that is scanned by the front panel logic. There are no active components on the keyboard printed circuit board.

Symptoms of a failing keyboard include: A single key failure or a set of keys failing (a bad row or column in the matrix). Multiple key closures, no response to any key, or an incorrect response to keys are indicative of failures in the front panel logic or the local controller; not necessarily the keyboard assembly.

5-22 Displays

The two displays are identical and interchangeable. Failing displays are evidenced by missing segments or fading characters. A display may also be completely dead. If both displays exhibit a failure, the front panel logic or local controller should be suspected. If one or the other display exhibits a failure, the display cables to the front panel logic board can be swapped to isolate the problem to the display or front panel logic.

CAUTION

The connectors used on the display cable are delicate connectors. Use care when removing or installing the cables to prevent damage to the connector.

Two ways are provided to test the displays. A test of the displays occurs following the execution of the TEST command. This self-test turns on all segments in both displays for a short time. There is also a test point on the front panel logic board that forces the front panel logic into a self-test routine and turn on all segments of both displays. The use of this test point is described in Section 5-23.

5-23 Front Panel Logic

The front panel logic scans the keyboard and controls both displays. The beeper is also located on the front panel logic. The front panel logic is tested in the self-test routines (see Sections 5-30, 5-31 and 5-32). An additional test can be initiated by use of a test point on the circuit board. Figure 5-7 shows the location of the test point and a ground test point. To use the test point:

1. Remove ac power from the HP 3852A.

2. Remove the front panel. A procedure to remove the front panel is in Chapter 4 of this manual.

2. Connect the TEST pin (TP202) to the ground pin (TP201). The test points are shown in Figure 5-7.

3. Apply ac power to the instrument and turn it on. The beeper should sound and all segments of the display should be on. The display segments will be on until the jumper is removed. Pressing the CLEAR key re-initiates the test.

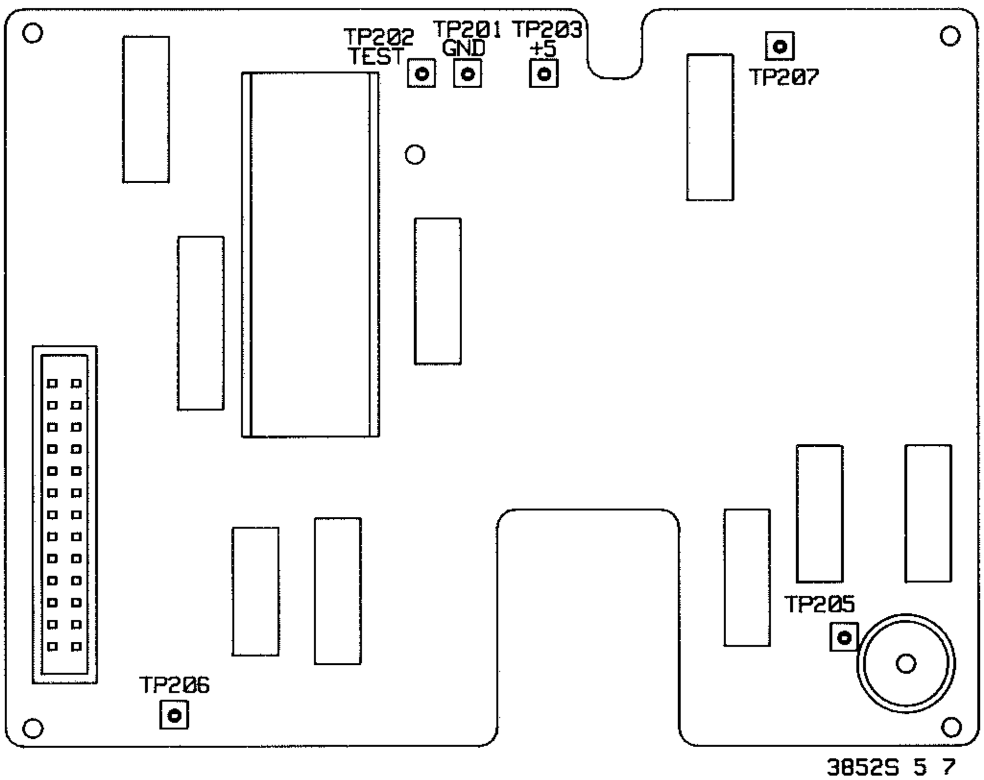


Figure 5-7 Front Panel Logic Circuit Board

The HP 3852A is able to operate with the front panel removed. If the front panel is suspected of a problem that inhibits the proper wake-up and self-test sequence of the HP 3852A, the cable can be removed from J201 on the front panel logic (this removes the front panel logic from the internal logic bus). After cycling power to the unit, it should respond normally to commands over the HP-IB. This test can be used to isolate a faulty front panel.

5-24 Power Supply

There are four outputs from the power supply assembly: +UNREG, -UNREG, +5 Vdc, and fan power. Fan power is derived from the +UNREG supply.

Testing the power supply for correct operation requires a voltmeter and an HP 44743A service module. A recommended voltmeter is the HP 3456A. The service module provides a means to extend the plug-in accessory backplane connector and includes marked test jumpers for all the backplane lines. Additionally, ripple and noise on the supplies can be checked with an oscilloscope. A recommended oscilloscope is the HP 1740A.

To test the power supply:

1. Remove ac power from the HP 3852A.

2. Install the service module in any available plug-in accessory slot.

3. Apply power to the instrument and turn it on.

4. Connect the negative lead of the voltmeter to the GND+- jumper on the service module.

4. Connect the positive lead of the voltmeter to the +UNREG jumper on the service module. The voltage should read between +17.4 Vdc and +22.0 Vdc. Ripple and noise on this supply should be less than 0.5 V peak-to-peak as measured on an oscilloscope.

5. Connect the positive lead of the voltmeter to the -UNREG jumper on the service module. The voltage should be between -17.4 Vdc and -31.0 Vdc.

6. Connect the negative lead of the voltmeter to the GND-5 jumper on the service module. Connect the positive lead of the voltmeter to the +5 jumper on the service module. The voltage should be between +4.8 Vdc and +5.25 Vdc. Ripple and noise on this supply should be less than 100 mV peak-to-peak as measured on an oscilloscope.

There are two control lines from the power supply that may cause problems with the local controller. These lines are the +5-UP and UNREG-UP lines. These lines are high in normal operation. The state of these lines can be checked at the test jumpers on the service module when it is installed in the controller slot in the backplane. If the UNREG-UP line does not go high after power is applied, both displays will be blank. If the +5-UP line does not go high after power is applied, the displays will contain random characters and the beeper will sound continuously. It is important to check the power supply outputs for correct voltages before checking these two control lines.

Another control line from the power supply is the 50/60 HZ line. This line allows the local controller to determine the line input frequency. The line provides a 5 volt square wave for a short time after power is applied to the unit. The 50/60 HZ line is available on the service module when it is installed in the local controller connector. A failing 50/60 HZ line will also be trapped by the power-on self-test and generate Error 26. Section 5-31 gives more information about the specific error code relating to the 50/60 HZ line.

5-25 Local Controller

Local controller failures should be trapped by the power-on self-test. There are three self-test routines run by the local controller. These routines are described in Section 5-30.

5-26 Error Codes

Table 5-3 lists all error codes that may be encountered when operating the HP 3852S system. Most of these error codes apply to programming, configuration or execution errors. The meaning of these codes is described in more detail in Appendix B of the HP 3852A Mainframe Configuration and Programming Manual. This section only describes the error codes that indicate an equipment failure or that may be useful for problem isolation.

Three error codes that are important for troubleshooting are: Error 80, Error 26, and Error 27. These codes will be returned following an unsuccessful internal self-test. Error 80 is described in more detail in section 5-30. Error 26 is described in section 5-31, and error 27 is described in section 5-32.

Other error codes that have significance to system troubleshooting are: Error 25 and Error 18. Error 25 is described in Section 5-27 and Error 18 is described in Section 5-28.

Table 5-3 HP 3852A Error Codes

Error Codes	Error Message	Error Codes	Error Message
ERROR 00:	NO ERROR	ERROR 43:	END OF ARRAY REACHED
ERROR 01:	OUT OF MEMORY	ERROR 44:	NOT ENOUGH VARIABLE SPACE
ERROR 02:	SYMBOL TOO LONG	ERROR 45:	ARRAY NOT REAL
ERROR 03:	BAD NUMBER FORMAT	ERROR 46:	VARIABLE NOT DEFINED
ERROR 04:	SYNTAX	ERROR 47:	PACKED NOT ALLOWED
ERROR 05:	SUBEND WITHOUT SUB	ERROR 48:	ARRAY SIZES DIFFER
ERROR 06:	MISSING FOR	ERROR 49:	DATA OUT OF BOUNDS
ERROR 07:	NOT ALLOWED IN SUB	ERROR 50:	EMPTY ARRAY
ERROR 08:	ALLOWED ONLY IN SUB	ERROR 51:	SYMBOL TABLE FULL
ERROR 09:	SUB CODE TOO LONG	ERROR 52:	SCAN IN PROGRESS
ERROR 10:	SUB WAS DELETED	ERROR 53:	NO SCAN LIST
ERROR 11:	NO ACTIVE SUB	ERROR 54:	NO VALID CHAN IN LIST
ERROR 12:	CANNOT RE-TYPE A VARIABLE	ERROR 55:	STRUCTURED COMMANDS NESTED TOO DEEP
ERROR 13:	MISSING IF	ERROR 56:	SUBEND IN STRUCTURED COMMAND
ERROR 14:	MISSING WHILE	ERROR 57:	LIST TOO LONG
ERROR 15:	IMPROPER FOR/NEXT MATCHING	ERROR 58:	SUBS NESTED TOO DEEP
ERROR 16:	SUBSCRIPT OUT OF BOUNDS	ERROR 59:	SUB ALREADY EXISTS
ERROR 17:	END OF COMMAND INSIDE STRING	ERROR 60:	ACCESSORY INTERFACE ERROR
ERROR 18:	SYSTEM ERROR	ERROR 61:	CALIBRATION RAM ERROR
ERROR 19:	INVALID CHAR RECEIVED	ERROR 62:	CALIBRATION FAILURE
ERROR 20:	COMMAND BUFFER OVERFLOW	ERROR 63:	SCAN LIST TOO BIG
ERROR 21:	TOO MANY ARGUMENTS	ERROR 64:	MUST_USE DIFFERENT VARIABLE
ERROR 22:	CANNOT EXECUTE	ERROR 65:	NO RESPONSE - ACCESSORY REMOVED
ERROR 23:	SETTINGS CONFLICT	ERROR 66:	INVALID CHANNEL FOR COMMAND
ERROR 24:	ARGUMENT OUT OF RANGE	ERROR 67:	OVERVOLTAGE ON BACKPLANE
ERROR 25:	DEVICE FAILURE	ERROR 68:	SUB NAME NOT EXPECTED
ERROR 26:	POWER ON TEST FAILED	ERROR 69:	SCALAR NAME NOT EXPECTED
ERROR 27:	INVALID SLOT	ERROR 70:	ARRAY NAME NOT EXPECTED
ERROR 29:	SPURIOUS FAST SCAN INTERRUPT	ERROR 71:	UNDEFINED WORD
ERROR 30:	SPURIOUS NORMAL SCAN INTERRUPT	ERROR 72:	THIS KEYWORD NOT EXPECTED
ERROR 31:	INVALID COMMAND FOR ACCESSORY	ERROR 73:	NO READINGS TO TRANSFER
ERROR 32:	NO ACCESSORY PRESENT	ERROR 74:	COMMAND END NOT EXPECTED
ERROR 33:	INVALID CHANNEL	ERROR 75:	INSIDE SUB CALLED MORE THAN ONCE
ERROR 34:	INVALID REGISTER	ERROR 76:	INSIDE NESTED SUB
ERROR 35:	DIFFERENT PACKED TYPES	ERROR 77:	NOT ALLOWED WHILE STORING SUB
ERROR 36:	DATA LOST DUE TO FORMAT	ERROR 78:	NOT ALLOWED DURING HP-IB COMMAND
ERROR 37:	TRIGGER TOO FAST	ERROR 79:	STANDARD DEVIATION NOT DEFINED
ERROR 38:	CHECK POWER	ERROR 80:	No message - power-on test failed, instrument locks up.
ERROR 39:	MEMORY LOST		
ERROR 40:	CANNOT EXECUTE IN REMOTE	ERROR 81:	TOO MANY READINGS REQUESTED
ERROR 41:	EXECUTE FROM FP ONLY	ERROR 82:	SYMBOL ALREADY EXISTS
ERROR 42:	MATH ERROR		

5-27 Error 25

Error 25, "DEVICE FAILURE", indicates that one of the plug-in accessories is incorrectly interrupting or is holding some illegal state on the backplane bus. Typically, this error is encountered immediately following a command. The failing plug-in module is most likely located at the address used in the last command executed.

5-28 Error 18

Error 18, "SYSTEM ERROR", occurs when either firmware or hardware has placed the internal processor in an illegal state. In some cases, an expanded error message will be shown in the display. When this error is received, the instrument locks up. The only active key on the front panel will be the CLEAR key. Pressing the CLEAR key returns control of the unit. The ERRSTR? command can be used to retrieve the error message in the display, and the display scrolled to the left to reveal the entire error message.

Do the following if Error 18 is encountered:

1. Note the action that caused the failure. If possible, determine the command sequence that was sent.

2. Press the CLEAR key to return control of the unit.

3. Execute the ERRSTR? command to show the error message in the display. Scroll the message to the left and note the entire error message.

4. Retrieve all stored data or subroutines from the HP 3852A memory. The next step cycles power and destroys any information stored.

5. Cycle power on the front panel. Observe any error messages or codes generated by the internal wake-up self-test. (The power-on self-test gives a more extensive test than the internal TEST command.) Sections 5-30 and 5-31 describe the internal self-tests and the error codes that may be obtained in each.

5-29 Internal Self-Test

The HP 3852A has three internal test routines. Two of the routines are automatically accessed when power is applied to the unit. These tests are referred to as the fatal error test and non-fatal error test routines. The third routine is accessed by use of the TEST command.

These tests only check the internal controller, HP-IB interface, and front panel. They do not check plug-in accessories or HP 3853A Extenders.

5-30 Fatal Error Test (Error 80)

When power is applied the HP 3852A begins the first of two internal self-tests. The first test routine is the fatal error routine. If a failure is detected in this routine, the unit will beep, display the error, and lock-up. A failure in this routine indicates that the system cannot function with any degree of confidence. When a fatal error is encountered the display indicates "ERROR 80:" followed by the error code. The error code will be four digits. The error code is in hexadecimal notation (Section 5-33 contains a description of hexadecimal notation). Each bit of the error code has an individual meaning. Table 5-4 lists the meaning of each bit. Bit 0 is the least significant bit of the least significant digit (the rightmost bit/digit). The errors are additive in the code.

This test routine also sends a reduced error code to the HP-IB section, allowing the fatal errors to be read over the bus (assuming that the HP-IB is functional). This reduced error code is given in Table 5-5.

The fatal error test routine checks the following functional areas:

ROM
RAM
DTACK
HP-IB

Table 5-4 Fatal Error Test Codes (Error 80)

Data Bit	Meaning	Data Bit	Meaning
0	Bad ROM check sum (U57)	8	Bad RAM read/write check sum (U92)
1	Bad ROM check sum (U58)	9	Bad RAM read/write check sum (U93)
2	Bad ROM check sum (U59)	10	General purpose DTACK error
3	Bad ROM check sum (U60)	11	HP-IB DTACK error
4	Bad ROM check sum (U61)	12	Bad data from HP-IB
5	Bad ROM check sum (U62)	13	Status error from HP-IB
6	Bad RAM check sum (U63 or U90)	14	Bad U90 (firmware Rev 3.5 or above)
7	Bad RAM check sum (U64 or U91)	15	Bad U91 (firmware Rev 3.5 or above)

Table 5-5 HP-IB Fatal Error Codes

Data Bit	Meaning
0	Check sum error in ROM
1	Check sum error in RAM
2	DTACK error
3	Not significant
4	HP-IB error
5	HP-IB status error
6	Always 0
7	Not significant

5-31 Non-Fatal Error Test (Error 26)

If the fatal error routine passes, the local controller begins the non-fatal error test routine. This routine tests 90% of the local controller. Failures detected during the routine do not stop the test. A failure of this routine is indicated by the message "ERROR 26:" in the left display and the words "POWER ON TEST FAILED" in the right display. Since these tests are not considered fatal, the unit will continue the wake-up sequence until the message "READY" is obtained in the left display. The error annunciator will be on in the left display. The error message and the error code can be retrieved by executing the ERRSTR? command. It will be necessary to scroll the display to the left to see the error code. The error code is a six digit code in hexadecimal notation (Section 5-33 describes hexadecimal notation). Each bit of the code has an individual meaning. Table 5-6 lists the bits and their meaning. Bit 0 is the least significant bit of the least significant digit. The errors are additive in the code.

The non-fatal test routine checks the following functional areas:

CHANNEL ADVANCE
EVENT IN
REAL TIME CLOCK
RAM RESET
PACER
LOCAL CONTROLLER CLOCKS
PARALLEL POLL/DTACK
BACKPLANE DATA LINES
50/60 Hz
OPTIONAL MEMORY
OPENING or CLOSING LINES
FRONT PANEL

Table 5-6 Non-Fatal Error Codes (Error 26)

Data Bit	Meaning
0	Channel advance latch is stuck
1	Event in latch is stuck
2	Real time clock not running
3	RAM has been reset
4	No DTACK from real time clock
5	Pacer running without start command
6	Pacer will not start upon command
7	Pacer will not stop at end of count
8	Crystal frequency incorrect (one of 2 crystals)
9	Parallel poll strobe or backplane DTACK failure
10	Backplane data line stuck (failed plug-in module)
11	50/60 Hz line failure
12	Optional memory failure (or wrong address)
13	Optional memory failure of read/write
14	Optional ROM failure
15	Optional ROM failure
16	Opening or Closing line stuck low
17	Front panel timeout (BUSY)
18	Front panel timeout (DATA_READY after reset)
19	Front panel timeout (self-test ON command)
20	Front panel self-test complete without ON echo
21	Front panel timeout (self-test OFF command)
22	Front panel self-test complete without OFF echo
23	Not used

5-32 Test (Error 27)

The TEST command can be executed at any time to provide a confidence check of the local controller operation. The TEST routine checks 60% of the local controller. It does this without changing any of the current data in memory, the pacer functions, or the rear panel BNC inputs and outputs.

As a part of the TEST routine, all the segments of both LCD displays are turned on. The beeper will provide a continuous tone while the displays are on. If no errors are encountered during the routine the message "SELF TEST OK" will be shown in the right display. Some annunciators may be on.

If the TEST routine detects a failure, the failure is indicated by a beep and the words "ERROR 27:" in the left display, and "SELF TEST FAILED" in the right display. Scrolling the display will show the failure error code. This is an eight digit code in hexadecimal notation. Each bit of the code has an individual meaning. Table 5-7 lists the bits and their meaning. Bit 0 is the least significant bit of the least significant digit. The errors are additive in the code.

Table 5-7 TEST Command Error Codes (Error 27)

Data Bit	Meaning
0	Bad ROM check sum (U57)
1	Bad ROM check sum (U58)
2	Bad ROM check sum (U59)
3	Bad ROM check sum (U60)
4	Bad ROM check sum (U90)
5	Bad ROM check sum (U91)
6	Bad RAM check sum
7	General purpose DTACK error
8	HP-IB DTACK error
9	Real time clock not running
10	Not used
11	Real time clock DTACK error
12	Parallel poll/backplane DTACK error
13	Backplane data line bad (dead plug-in module)
14	50/60 Hz line failure
15	Optional memory failure (or wrong address)
16	Optional memory read/write failure
17	Optional ROM check sum error
18	Optional ROM check sum error
19	Front panel timeout (BUSY)
20	Front panel timeout (DATA_READY after reset)
21	Front panel timeout (self-test ON command)
22	Front panel self-test complete without ON echo
23	Front panel timeout (self-test OFF command)
24	Front panel self-test complete without OFF echo
25	Not used
26	Not used
27	Not used
28	Not used
29	Not used
30	Not used
31	Not used

The TEST command tests the following functional areas:

ROM
RAM
DTACK
REAL TIME CLOCK
PARALLEL POLL
BACKPLANE DATA LINES
50/60 Hz
OPTIONAL MEMORY
FRONT PANEL

5-33 Decoding Hexadecimal Notation

Hexadecimal is a numbering system with a base of 16. The error codes used by the HP 3852A are in hexadecimal notation. In this notation, each digit of the error code represents four bits of information. The entire error code is thus divided into four bit groups, each group represented by a digit. For convenience, the error code tables presented in this chapter provide the bit codes in groups of four. To determine the meaning of an error code, each non-zero digit is analyzed as an individual group of bits. The least significant bits (data bits 0, 1, 2 and 3) are represented by the least significant digit (the rightmost digit). Table 5-8 decodes the four digit groups into the equivalent hexadecimal notation.

Table 5-8 Hexadecimal Codes

Hexadecimal Code	Bit Pattern	Hexadecimal Code	Bit Pattern
0	0000	8	1000
1	0001	9	1001
2	0010	A	1010
3	0011	B	1011
4	0100	C	1100
5	0101	D	1101
6	0110	E	1110
7	0111	F	1111

5-34 System Troubleshooting Hints

The following points should be kept in mind when troubleshooting a HP 3852S system:

- The HP 3852A self-test is an internal self-test. It does not check any plug-in accessories or extenders units. Descriptions of the three self-test routines begin in Section 5-29. Plug-in accessories that support an internal self-test can be tested using the TEST <slot> command.

- Any HP 3853A Extenders connected to the HP 3852A must have power applied and be correctly functioning for the system to operate. Failing extenders can be isolated by removing the digital extender cable from the HP 3852A and checking for correct operation. It may be necessary to cycle power on the HP 3852A after removing the cable. Analog extender cables, if installed, need not be removed for this test.

- Line power status is indicated in the HP 3852A right display by an annunciator. Line power status is not indicated on the extenders (HP 3853A). Line power indication can be obtained by listening to or testing for fan operation. The fan is strong enough to pull a piece of paper to the front panel. Since the fan receives its operating voltage from the power supply, fan operation is an indication of power supply operation. It is not, however, conclusive proof of correct power supply operation.

- The HP 3852A supports a DISP command that allows the display to be turned off. Even if the DISP OFF command has been sent, some display annunciators will still function. No display and no annunciators indicates a failure.

- Each of the plug-in modules share a common command line called DTACK (data acknowledged). The local controller in the HP 3852A must receive confirmation of bus activities through this line. If any plug-in module is holding the DTACK line in an incorrect state (low), the local controller will lock-up. This is true whether the plug-in module is located in the HP 3852A or in an HP 3853A Extender. If the DTACK line is stuck when power is first applied to the HP 3852A, there will be no display (including annunciators). If DTACK is stuck after the HP 3852A has completed its wake-up sequence, the displays will appear to be normal but the unit will not respond to key closures or HP-IB commands.

- The local controller compiles a reference table of all plug-in accessories installed in the system. It does this at power-on or after a system reset. For this reason, the local controller will not recognize any plug-in accessories installed after the power is applied (it is not recommended to install or remove plug-in accessories with the power applied). To make the reference table the local controller polls each slot in the system. One of three responses can be generated from each slot: 1) no response -- indicating no card is present, 2) a partial response -- indicating that the accessory module is installed without a terminal module, and 3) a full response -- indicating the model of the accessory installed at that slot.

Chapter 6

HP 44701A Integrating Voltmeter

CHAPTER 6
HP 44701A INTEGRATING VOLTMETER

CHAPTER 6

HP 44701A

INTEGRATING VOLTMETER

6-1 INTRODUCTION

This chapter provides a technical description, performance test procedures, calibration procedures, and replaceable parts lists for the HP 44701A Integrating Voltmeter.

6-2 Technical Description

The HP 44701A Integrating Voltmeter is a complete four function analog to digital converter. The functions available are DC volts, AC volts, four-wire ohms, and offset compensated ohms.

The voltmeter has an auto-range function that can select the appropriate range for the measurement in progress. This function can be disabled and a fixed range programmed. The ranges available in each function are listed in Table 6-2 (HP 44701A Specifications).

The HP 44701A's integration time can be programmed. It is specified as a number of power line cycles. Integration times from 0.0005 to 16 power line cycles are available. The choice of integration times produces measurement resolutions from 3 1/2 to 6 1/2 digits.

Calibration of the voltmeter is accomplished programatically. There are no mechanical adjustments in the voltmeter. Calibration constants for gain and offset are contained in non-volatile memory within the HP 44701A.

The HP 44701A can be divided into two main parts: the control logic and the analog to digital converter. The control logic is also referred to as the outguard section and the analog to digital converter as the inguard section.

A basic block diagram of the HP 44701A is shown in Figure 6-1. The control logic section interfaces the voltmeter with the HP 3852A. The control logic provides isolation between the HP 3852A mainframe and the analog to digital converter. The HP 3852A communicates with the HP 44701A through the use of read and write registers. These registers are located within the control logic section.

All circuitry needed to perform a full precision measurement and convert the measured value into digital representation is contained in the analog to digital converter. The functions and conversions are performed under microprocessor control. This processor is located in the analog to digital converter. Additionally, calibration constants are stored in the analog to digital converter in an EEPROM.

The control logic and the analog to digital converter are isolated by the crossguard data link. This link transmits data in a serial fashion. The data, clock, and reset information, having been converted to a serial format by the control logic, is optically transmitted to the analog to digital converter. The analog to digital converter returns an optically isolated latch pulse to the control logic to control the receipt of data. The analog to digital converter also transmits both the data and the clock information through a single transformer link to the control logic.

The HP 44701A takes its measurements from either the rear panel terminals or the HP 3852A backplane analog bus. These two sources of measurements are in parallel. The isolation relays provide a means to separate the voltmeter from the backplane analog bus.

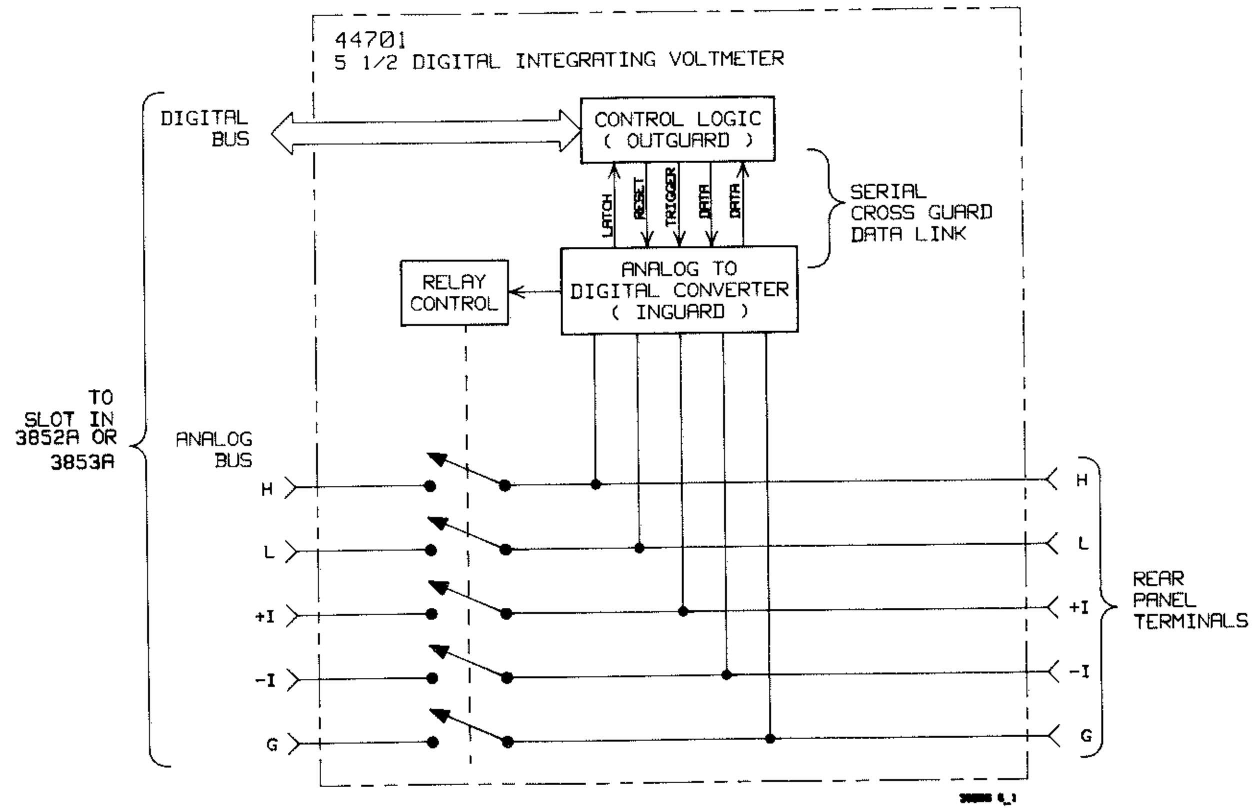


Figure 6-1 HP 44701A Basic Block Diagram

The measurement bus also provides a current path for resistance measurements. The analog to digital converter has a current source for this purpose. All resistance measurements made by the HP 44701A are four-wire ohms measurements. In some cases, the current source and measurement paths are combined on an accessory to allow a two-wire ohms measurement at a particular set of terminals.

6-3 Read And Write Registers

The HP 3852A mainframe communicates with the HP 44701A through the use of read and write registers. High level commands are translated into appropriate register commands. The SREAD and SWRITE commands can be used to directly control each register.

SREAD and SWRITE are described in Chapter 3 of this manual. Table 6-1 shows the read and write registers used by the HP 44701A.

CAUTION

Using the low level commands (SREAD and SWRITE) may cause unexpected and undesirable effects on the plug-in accessories. It is possible to program some plug-in accessories into unknown or unpredictable states with these commands. The commands are documented here for service purposes only.

Table 6-1 Integrating Voltmeter Read and Write Registers

Register #	READ Registers	WRITE Registers
0	Accessory Identification	Accessory Control
1	Accessory Status	Trigger Control
2	Data (most significant word)	Command Register
3	Data (least significant word)	Data Ready Acknowledge
4	Not Used	Not Used
5	Not Used	Not Used
6	Not Used	Parameter Register
7	Not Used	VM Complete Acknowledge

6-4 Read Registers

6-5 Register 0. Read Register 0 is the accessory identification register. This register uses eight bits. The eight bits are output to the HP 3852A local controller on the eight least significant backplane data lines (BD0 through BD7). The results returned from an SREAD of register 0 will be a two's compliment decimal number and for the HP 44701A should be -200.

6-6 Register 1. Read Register 1 is the accessory status register. This is an eight bit register output to the HP 3852A mainframe on the eight least significant backplane data lines (BD0 through BD7). Read Register 1 is read to obtain the current status of the voltmeter before a new command is sent. The meaning of each bit in the status word is defined in the following paragraphs. Note that an SREAD of the register returns a decimal value equivalent to the two's compliment of the register value.

The least significant bit, Bit 0, is the data ready bit. This bit is set by the HP 44701A to indicate that data is ready in one or both of the data registers. The bit is cleared by the HP 3852A local controller when the data is removed from the register. Having bit 0 set does not prevent the HP 44701A from placing new data in the registers.

Bit 1 is the command register status bit, or busy bit. This bit is set when the HP 3852A local controller writes to either the command or parameter register. The bit is cleared by the HP 44701A when the last command has been completely executed. This bit should be checked to prevent sending a new command before the last command has been executed.

Bit 2 indicates voltmeter complete. This bit is set by the HP 44701A when integrator run-up is complete. The bit is cleared when the HP 3852A local controller acknowledges the end of run-up.

Bit 3 is the error status bit. If bit 3 is set an error occurred. When the bit is set the data registers will contain a code indicating the error type.

Bit 4 is the done bit. This bit is cleared when the HP 3852A local controller writes to either the command or parameter registers. The HP 44701A will set bit 4 when the last command received has been completed. Bit 4 is used together with bit 1 to control the communication process between the HP 44701A and the HP 3852A local controller.

Bit 6 is a timing bit. It indicates the status of the sample rate of the measurements. Because the HP 3852A local controller can request N readings per trigger the sample rate of the measurements can become aperiodic. When this error occurs, bit 6 is set. If the voltmeter is operating in the autorange mode and N readings per trigger is requested, bit 6 is always set.

Bit 7 is not used.

6-7 Registers 2 and 3. Read Registers 2 and 3 are the data registers. Register 2 contains the most significant data word (bits 16 through 31). Register 3 contains the least significant data word (bits 0 through 15).

6-8 Write Registers

6-9 Register 0. Write register 0 is the control register. This eight bit register sets the reset and interrupt capability for the HP 44701A. Only the four least significant bits are used. Bits 4 through 7 are ignored.

Bit 0 is the master interrupt enable bit. When this bit is set the interrupts are enabled. Clearing this bit prevents any backplane interrupts.

Setting bit 1 true resets the HP 44701A. The HP 44701A requires a time of at least 500 µsec after bit 1 is cleared to perform the reset. Bit 1 in read register 1 can be used to determine when the HP 44701A has completed the reset.

Bit 2 is used to determine the type of interrupt that the HP 44701A will generate. When the bit is cleared the HP 44701A will interrupt on the HP 3852A general purpose interrupt line (GP). When bit 2 is set, the HP 44701A will interrupt on the HP 3852A normal scan interrupt line (NS).

Bit 3 sets the interrupt source. When bit 3 is cleared the HP 44701A will interrupt only when bit 0 in read register 1 is set (data is ready). When bit 3 is set the HP 44701A will interrupt either when bit 0 in read register 1 is set (data ready) or when bit 2 in read register 1 is set (voltmeter complete).

6-10 Register 1. Write register 1 is the trigger control register. The two least significant bits are used to control the trigger capability. When bit 0 is set the HP 44701A will allow triggers, when cleared the HP 44701A will ignore triggers. Bit 1 sets the type of trigger that will be allowed when bit 0 is set. Setting bit 1 sets the HP 44701A to trigger on the falling edge of the backplane trigger line. Clearing bit 1 sets the HP 44701A to trigger on the rising edge of the backplane CLOSING line.

6-11 Register 2. Write register 2 is the command register. The HP 3852A local controller uses this register to set the mode and function of the HP 44701A.

6-12 Register 3. Write register 3 controls the "data ready" interrupt. Any data written to this register will clear the "data ready" interrupt.

6-13 Register 6. Write register 6 is the parameter register. The HP 3852A local controller uses this register to send parameters in combination with the command register.

6-14 Register 7. Write register 7 controls the "voltmeter complete" interrupt. Any data written to this register will clear the "voltmeter complete" interrupt.

6-15 SPECIFICATIONS

Specifications for the HP 44701A are given in Table 6-2. Specifications are the performance standards or limits against which the integrating voltmeter may be tested.

Table 6-2 HP 44701A Specifications

DC VOLTAGE

Accuracy: ±(% of reading + volts) rear terminal, one hour warmup, specified over time since last calibration, and operating temperature.

90 Days, 18°C to 28°C, Autozero On

Range	Integration Time in Number of Power Line Cycles (NPLC) 1	0.1	0.005	0.0005
30 mV	0.02%+6µV	0.02%+8µV	0.02%+20µV	0.02%+60µV
300 mV	0.008%+6µV	0.008%+10µV	0.008%+40µV	0.008%+400µV
3 V	0.008%+8µV	0.008%+40µV	0.008%+400µV	0.008%+4mV
30 V	0.008%+300µV	0.008%+700µV	0.008%+4mV	0.008%+40mV
300 V	0.008%+700µV	0.008%+4mV	0.008%+40mV	0.008%+400mV

1 Year: Add 0.01% of reading to the 90 Days Specifications

Temperature Coefficient:

Add as an additional accuracy error using ±(% of reading + volts) per °C change outside 18° to 28°C, as long as the operating temperature is maintained between 0 to 18° or 28° to 55°C.

For 30 mV Range add 0.001% + 30 nV
For 300 mV and 3 V Ranges add 0.0006% + 300 nV
For 30 V and 300 V Ranges add 0.0006% + 30 µV

Auto-zero Off:

Add as an additional accuracy error if autozero is turned off. Assumes stable environment, ±1°C, for 24 hours.

For 30 mV, 300 mV, and 3 V Ranges add 10 µV
For 30 V Range add 100 µV
For 300 V Range add 1 mV

Resolution:

Range	Integration Time in Number of Power Line Cycles (NPLC) 1	0.1	0.005	0.0005
30 mV	10nV	100nV	1µV	10µV
300 mV	100nV	1µV	10µV	100µV
3 V	1µV	10µV	100µV	1mV
30 V	10µV	100µV	1mV	10mV
300 V	100µV	1mV	10mV	100mV

Over-ranging: 1% of full scale

Table 6-2 HP 44701A Specifications (Cont.)

Reading Rate/Noise Rejection:

	Integration Time in Number of Power Line Cycles (NPLC) 1	0.1	0.005	0.0005
Integration Time: 60 Hz 50 Hz	16.7mS 20.0mS	1.67mS 2.0mS	100MS 100MS	10MS 10MS
Number of Converted Digits	6 1/2	5 1/2	4 1/2	3 1/2
Reading Rate (reading/sec) with autozero and auto-range off: 60 Hz 50 Hz	57 48	415 360	1350 1350	1600 1600
Min. Noise Rejection (dB) Normal Mode Rejection at 50 or 60 Hz ±0.09%	60	0	0	0
DC Commom Mode Rejection with 1 kΩ in low lead	120	120	120	120
Effective Common Mode Rejection, DC to 60 Hz with 1 kΩ in low lead	150	90	90	90

RESISTANCE

Accuracy: ±(% of reading + ohms), 4-wire or 2-wire ohms, offset compensation on or off, rear terminal inputs, one hour warmup, specifeid over time since last calibration, and operating temperature. (Current source compliance voltage is at least 6 V).

90 Days, 18°C to 28°C, Autozero On

Range	Integration Time in Number of Power Line Cycles (NPLC) 1	0.1	0.005	0.0005
30 Ω	0.02%+6mΩ	0.02%+20mΩ	0.02%+40mΩ	0.02%+75mΩ
300 Ω	0.015%+6mΩ	0.015%+20mΩ	0.015%+60mΩ	0.015%+400mΩ
3 kΩ	0.015%+60mΩ	0.015%+200mΩ	0.015%+650mΩ	0.015%+4Ω
30 kΩ	0.015%+80mΩ	0.015%+400mΩ	0.015%+5Ω	0.015%+80Ω
300 kΩ	0.015%+1Ω	0.015%+4Ω	0.015%+50Ω	0.015%+800Ω
3 MΩ	0.1%+17Ω	0.1%+70Ω	0.1%+500Ω	0.1%+6kΩ

1 Year: Add 0.01% of reading to the 90 Days Specifications

Table 6-2 HP 44701A Specifications (Cont.)

Ohms Current Source Output:

30 Ω and 300 Ω Ranges: 1 mA
3 kΩ and 30 kΩ Ranges: 100 μA
300 kΩ Range: 10 μA
3 MΩ Range: 1 μA

Temperature Coefficient:

Add as an additional accuracy error using ±(% of reading + ohms) per °C change outside 18° to 28°C, as long as the operating temperature is maintained between 0 to 18°C or 28° to 55°C.

For 30 Ω, 300 Ω, and 3 kΩ Ranges add 0.0006% + 500 μΩ
For 30 kΩ Range add 0.0006% + 5 mΩ
For 300 kΩ Range add 0.001% + 50 mΩ
For 3 MΩ Range add 0.001% + 500 mΩ

Reading Rate:

	Integration Time in Number of Power Line Cycles (NPLC)			
	1	0.1	0.005	0.0005
Reading Rate (reading/sec) with autozero and auto-range off: 60 Hz	25	100	155	160
50 Hz	20	95	155	160

AC VOLTAGE

Accuracy: ±(% of reading + volts), 1 NPLC integration time, one hour warmup, specified over time since last calibration, and operating temperature. AC measurements are made with an average detector calibrated in RMS, and are intended to measure sine waves between 45 Hz to 500 Hz (AC coupled). The voltmeter accuracy is **specified only when the input voltage is greater than 10% of full scale.**

Range	90 Days, 18°C to 28°C	1 Year, 18°C to 28°C
200 mV	0.5% + 600 μV	0.75% + 900 μV
2 V	0.5% + 6 mV	0.75% + 9 mV
20 V	0.5% + 60 mV	0.75% + 90 mV
200 V	0.5% + 600 mV	0.75% + 900 mV

Table 6-2 HP 44701A Specifications (Cont.)

Temperature Coefficient:

Add as an additional accuracy error using ±(% of reading + volts per °C change outside 18° to 28°C, as long as the operating temperature is maintained between 0 to 18°C or 28° to 55°C.

For 200 mV Range add 0.01% + 7 µV
For 2 V Range add 0.01% + 70 µV
For 20 V Range add 0.01% + 700 µV
For 200 V Range add 0.01% + 7 mV

Reading Rate: 1.5 seconds/reading; changing to the AC Volts function requires approximately 4 seconds.

INPUT CHARACTERISTICS

Maximum Input Voltage: 350 V peak or 250 V DC between any two points (terminals or chassis).
Warning: This voltage is higher than the ratings for multiplexers or high-speed voltmeters that can share the analog backplane.

Input Impedance:

Ranges	Terminals High to Low	Low to Guard	Guard to Chassis
Resistance (Ω):			
30 mV to 3 V Ranges	$>10^9$	$>10^8$	$>10^8$
30 V, 300 V Ranges	10^7 ±5%	$>10^8$	$>10^8$
Max. Capacitance (pF) at 1 MHz, all Ranges	120	2700	2500

Maximum Bias Current: Current sourced by high to low into rear input terminals or backplane.
±1 nA DC

6-16 HP 44701A PERFORMANCE TESTS

6-17 Introduction

The following Performance Tests check the operation of the HP 44702A Integrating Voltmeter. Successful completion of all Performance Tests in this chapter provides a high confidence level that the voltmeter is meeting its listed specifications.

The Performance Tests should be performed in the order they are presented. The completion of each test increases the confidence level of the Integrating Voltmeter operation. A minimum set of tests is given as Operational Verification Tests. These tests are described in Section 6-22.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence that the Integrating Voltmeter is operating normally, it is not recommended that the Performance Tests be performed unless one of the tested specifications is in question. However, if a complete Performance Test is required, do not perform the Operational Verification Test but go to Section 6-34 for the Performance Tests.

6-18 Equipment Required

The following test equipment is required to run the Performance/Operational Verification Tests.

1. Low Thermal Short -- Use a solid copper wire

2. Test Leads

3. DC Voltage Standard -- Datron Model 4000/4000A

If the recommended DC Voltage Standard is not available, use one that is capable of outputting the following voltages at the specified limits. The listed specifications are at least four times better than the specifications of the HP 44701A Integrating Voltmeter.

*30 mV (±0.01%)
300 mV (±0.0025%)
3 V (±0.002%)
*2 V (±0.002%)
*1 V (±0.002%)
30 V (±0.002%)
*300 V (±0.002%)

*For Performance Test only

4. Resistance Standard -- Datron Model 4000/4000A

The Datron Model 4000/4000A normally have resistance values of 1 Ω though 1 MΩ. However, a special version is available with resistance values of 3 Ω through 3 MΩ. Either version will work for the HP 44701A Ohms Performance/Operational Verification Tests. Both the full scale test limits, using 3 Ω through 3 MΩ resistors, and the 1/3 scale test limits, using 1 Ω through 10 MΩ resistors, are given. You must use the appropriate test limits when performing the ohms tests.

If the recommended Resistance Standard is not available, use one that is capable of outputting the following resistance values at the specified limits. The listed specifications are at least four times better than the specifications of the HP 44701A Integrating Voltmeter.

Instead of using a resistance standard (like the Datron 4000/4000A), you can use standard resistors. Likewise with the resistance standard, you can also use either 30Ω through 30 MΩ resistors (full scale inputs) or 10 Ω through 10 MΩ resistors (1/3 scale inputs).

*30 Ω or 10 Ω (±0.01%)
*300 Ω or 100 Ω (±.004%)
3 kΩ or 1 kΩ (±0.004%)
30 kΩ or 10 kΩ (±0.0038%)
300 kΩ or 100 kΩ (±0.0038%)
*3 MΩ or 1 MΩ (±0.025%)

*For Performance Test only

5. AC Voltage Standard -- Datron Model 4200

If the recommended AC Voltage Standard is not available, use one that is capable of outputting the following voltages at the specified frequencies and limits. The listed specifications are at least four times better than the specifications of the HP 44701A Integrating Voltmeter.

20 mV (±0.1%) at 45 Hz, 150 Hz, and 500 Hz
200 mV (±0.1%) at 45 Hz, 150 Hz, and 500 Hz
2 V (±0.1%) at 45 Hz, 150 Hz, and 500 Hz
20 V (±0.1%) at 45 Hz, 150 Hz, and 500 Hz
*200 V (±0.1%) at 45 Hz, 150 Hz, and 500 Hz

*For Performance Test only

6-19 Test Considerations

Because the HP 44701A Integrating Voltmeter is capable of making very accurate measurements, use standards that are at least four times more accurate than the accessory. However, keep in mind that these standards may introduce potential uncertainties. To keep the uncertainties at a minimum, have these standards certified by the National Bureau of Standards (NBS) before using them. Ideally, standards that are ten times more accurate should be used.

6-20 Test Records

The results of the operational verification tests and performance tests may be recorded on Test Cards at the end of the respective procedures. The test cards include setup data and test limits of all operational verification and performance tests in this chapter.

6-21 Test Cycle

The HP 44701A Integrating Voltmeter requires periodic verification that it is meeting its specifications. The frequency at which the accessory may be tested depends on its usage and environmental operating conditions. To maintain the 90 day specifications, check the accessory at 90 day intervals. To maintain the 1 year specifications, check the accessory at 1 year intervals. For normal operation, check at the 90 day intervals.

6-22 Operational Verification Tests

Perform the Operational Verification Tests only if you do not plan to do the Performance Tests. If you plan to do the Performance Tests, do not perform the following tests but go to Section 6-28 instead.

The following tests are the minimum set of tests recommended for the Integrating Voltmeter. Successful completion of these tests provides a 90% confidence level that the voltmeter is operating normally and is within specification.

The Operational Verification Tests consist of the following:

Section 6-24 - Set-Up Procedure
Section 6-25 - DC Voltage Operational Verification Test
Section 6-26 - Ohms Operational Verification Test
Section 6-27 - AC Voltage Operational Verification Test

6-23 Operational Verification Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

NOTE

The temperature of the environment where the following tests are to be performed must be within ±5° C of the temperature of the environment where the instrument was last calibrated. The HP 44701A Integrating Voltmeter was calibrated at the factory at an environment temperature of 20° C.

6-24 Set-Up Procedure

1. Apply power to the HP 3852A and allow the HP 44701A Integrating Voltmeter a one hour warm-up period inside the mainframe. This is necessary to stabilize the voltmeter before performing any tests. Most DC, AC, and Ohms Standards also need a one hour warm-up period.

2. Press the RESET button on the HP 3852A front panel. Perform the HP 44701A Integrating Voltmeter self-test by executing:

TEST ES00 (where E = extender number, S = slot number)

3. The HP 3852A right display should show:

SELF TEST OK

If the display shows a different message, or if the ERR annunciator is on, the HP 44701A Integrating Voltmeter may be failing its self test. Test the voltmeter again by executing the command in step 2. If the voltmeter still fails, repair of the unit may be necessary.

4. Designate the HP 44701A to be tested by executing:

USE ES00 (where E = extender number, S = slot number)

This command establishes the extender/slot number used in all Performance/Operational Verification Tests for command destination. If the HP 3852A is reset or power is removed, it is necessary to perform step 4 again to re-establish the extender/slot number.

6-25 DC Voltage Operational Verification Test

This test determines if the dc offset and full scale accuracy of the HP 44701A Integrating Voltmeter are within the specified limits. The following procedure sets the HP 44701A to certain dc voltage ranges and then transfers the resultant readings to the mainframe.

1. DC VOLTAGE OFFSET TEST. The following test determines if the dc voltage offset readings of the HP 44701A are within the specified limits.

2. Perform the Set-Up Procedure in Section 6-21, if not previously performed.

3. Connect a low thermal short across the rear HI and LO Input Terminals of the HP 44701A Integrating Voltmeter accessory.

4. Set the HP 44701A to measure dc volts (at the rear terminals), to internal trigger, and to update the display every second by executing the following commands:

```
FUNC DCV
NPLC 16
TERM EXT
TRIG AUTO
DELAY 1
```

5. The 30 V Range is tested first to allow any thermal voltages that may affect the readings on other ranges to dissipate. Set the HP 44701A to the 30 V Range by executing:

```
RANGE 30
```

6. Transfer the HP 44701A readings to the HP 3852A right display by executing:

```
XRDGS ES00,100   (where E = extender number, S = slot number)
```

This causes the display to update continuously for 100 readings.

7. Note the readings on the HP 3852A display. If any offset reading is out of the limits specified in Table 6-3, perform the DC Volts Calibration procedure in Section 6-34.

8. The measurements can be stopped any time by pressing the HP 3852A front panel CLEAR button.

9. Repeat steps 6, 7, 8, and 9 for the 3 V and 300 mV Ranges. Set the range in step 5 by executing RANGE 3 for the 3 V Range and RANGE .3 for the 300 mV Range.

10. When all ranges are tested, stop the measurement by pressing the HP 3852A front panel CLEAR button. Leave the setup in step 4 for the next test. Remove the low thermal short from the HI and LO Input Terminals.

11. DC VOLTAGE GAIN TEST. The following test determines if the dc voltage full scale readings of the HP 44701A are within the specified limits.

12. Set the DC Voltage Standard output to +300 mV. Then connect the DC Voltage Standard to the rear HI and LO Input Terminals of the HP 44701A Integrating Voltmeter accessory. The connections are shown in Figure 6-2.

13. Test the 300 mV Range by executing:

RANGE .3

14. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

15. Note the reading on the HP 3852A display. If the full scale reading is out of the limits specified in Table 6-3, perform the DC Volts Calibration procedure in Section 6-34.

16. Repeat steps 13, 14, and 15 for the 3 V and 30 V Ranges. Set the range in step 13 by executing RANGE 3 for the 3 V Range and RANGE 30 for the 30 V Range. Also set the DC Standard output accordingly as listed in Table 6-3.

17. When all ranges are tested, reduce the DC Voltage Standard output to 0 V. Then remove the DC Voltage Standard from the HI and LO Input Terminals.

6-26 Ohms Operational Verification Test

This test determines if the ohms offset and full scale accuracy of the HP 44701A Integrating Voltmeter are within the specified limits. The following procedure sets the HP 44701A to certain ohms ranges and then transfer the resultant readings to the mainframe.

1. OHMS OFFSET TEST. The following test determines if the ohms offset readings of the HP 44701A are within the specified limits.

2. Perform the Set-Up Procedure in Section 6-21, if not previously performed.

3. Connect the HP 44701A rear panel Current Source HI Output Terminal to the rear panel HI Input Terminal. Connect the rear panel Current Source LO Output Terminal to the rear panel LO Input Terminal. Connect a low thermal short across the rear panel HI and LO Input Terminals. The connections are shown in Figure 6-3.

4. Set the HP 44701A to measure ohms (at the rear terminals), to internal trigger, and to update the display every second by executing:

FUNC OHMF
NPLC 16
TERM EXT
TRIG AUTO
DELAY 1

5. Set the HP 44701A to the 3 Kohm Range by executing:

RANGE 3E3

6. Transfer the HP 44701A readings to the HP 3852A right display by executing:

XRDGS ES00,100 (where E = extender number, S = slot number)

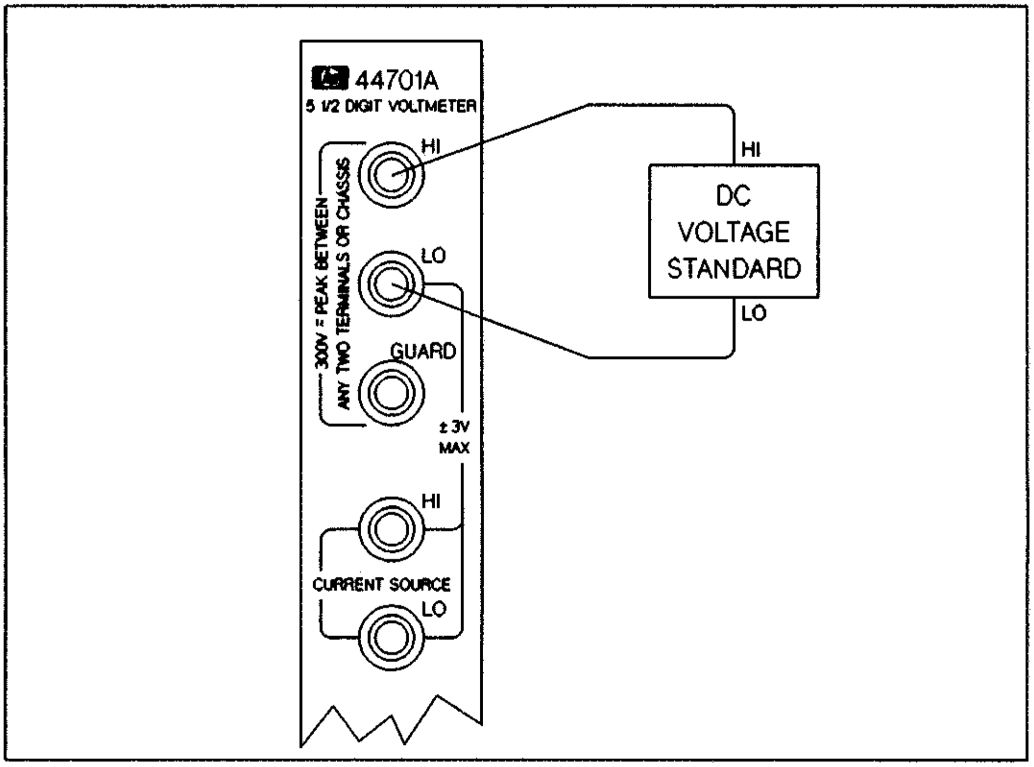


Figure 6-2 DC Voltage Test Connections

Table 6-3 DC Voltage Operational Verification Test Limits

DC Voltage Offset Test Limits						
44701A Input	44701A Range	44701A Set-Up	90 Day Test Limits High	90 Day Test Limits Low	1 Year Test Limits High	1 Year Test Limits Low
Short	30 V	FUNC DCV	+3.000000E-04	-3.000000E-04	+3.000000E-04	-3.000000E-04
Short	3 V	FUNC DCV	+8.000000E-06	-8.000000E-06	+8.000000E-06	-8.000000E-06
Short	300 mV	FUNC DCV	+6.000000E-06	-6.000000E-06	+6.000000E-06	-6.000000E-06
DC Voltage Gain Test Limits						
44701A Input	44701A Range	44701A Set-Up	90 Day Test Limits High	90 Day Test Limits Low	1 Year Test Limits High	1 Year Test Limits Low
+300 mV	300 mV	FUNC DCV	+3.000300E-01	+2.999700E-01	+3.000600E-01	+2.999400E-01
+3 V	3 V	FUNC DCV	+3.000248E+00	+2.999752E+00	+3.000548E+00	+2.999452E+00
+30 V	30 V	FUNC DCV	+3.000270E+01	+2.999730E+01	+3.000570E+01	+2.999430E+01

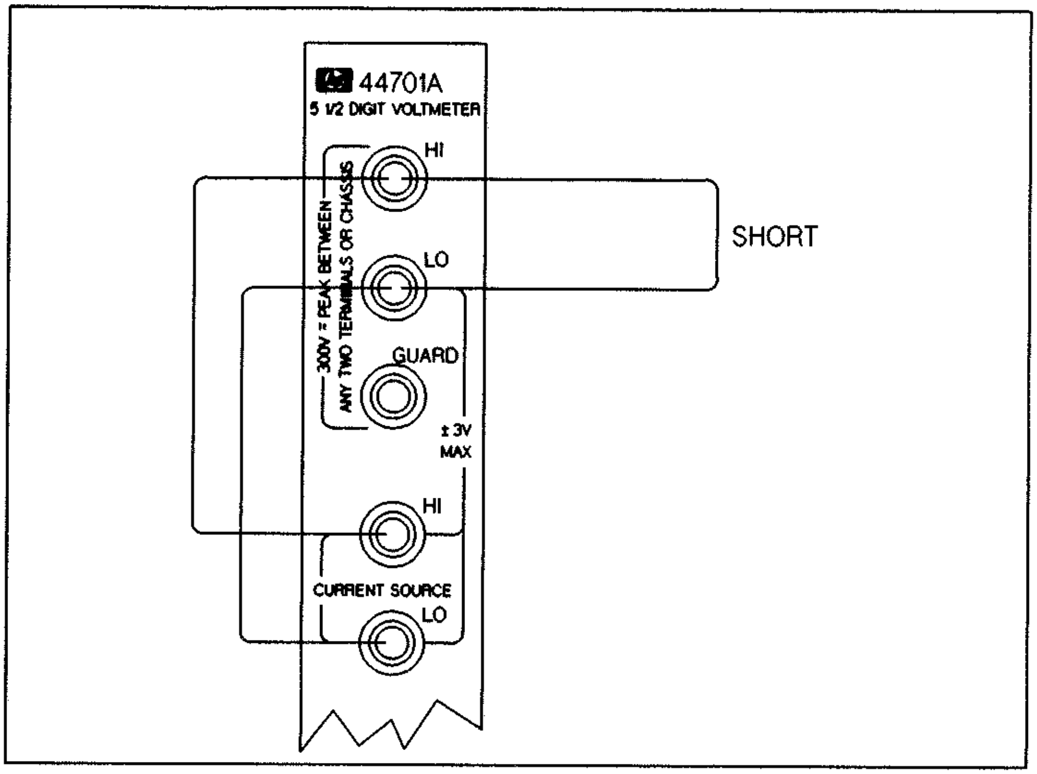


Figure 6-3 Ohms Offset Test Connections

Table 6-4 Ohms Operational Verification Test Limits

Ohms Offset Test Limits						
44701A Input	44701A Range	44701A Set-Up	90 Day Test Limits High	90 Day Test Limits Low	1 Year Test Limits High	1 Year Test Limits Low
Short	3 Kohm	FUNC OHMF	6.000000E-02	0.000000E+00	6.000000E-02	0.000000E+00
Short	30 Kohm	FUNC OHMF	8.000000E-02	0.000000E+00	8.000000E-02	0.000000E+00
Short	300 Kohm	FUNC OHMF	1.000000E+00	0.000000E+00	1.000000E+00	0.000000E+00
Ohms Gain Test Limits						
44701A Input	44701A Range	44701A Set-Up	90 Day Test Limits High	90 Day Test Limits Low	1 Year Test Limits High	1 Year Test Limits Low
3 Kohm	3 Kohm	FUNC OHMF	3.000510E+03	2.999490E+03	3.000810E+03	2.999190E+03
1 Kohm*	3 Kohm	FUNC OHMF	1.000210E+03	9.997900E+02	1.000310E+03	9.996900E+02
30 Kohm	30 Kohm	FUNC OHMF	3.000458E+04	2.999542E+04	3.000758E+04	2.999242E+04
10 Kohm*	30 Kohm	FUNC OHMF	1.000158E+04	9.998420E+03	1.000258E+04	9.997420E+03
300 Kohm	300 Kohm	FUNC OHMF	3.000460E+05	2.999540E+05	3.000760E+05	2.999240E+05
100 Kohm*	300 Kohm	FUNC OHMF	1.000160E+05	9.998400E+04	1.000260E+05	9.997400E+04
*For 1/3 scale inputs only						

This causes the display to update continuously for 100 readings.

7. Note the readings on the HP 3852A display. If any offset reading (i.e., with HP 44701A input shorted) is out of the limits specified in Table 6-4, perform the Ohms Calibration procedure in Section 6-34.

8. The measurements can be stopped any time by pressing the HP 3852A front panel CLEAR button.

9. Repeat steps 5, 6, 7, and 8 for the 30 Kohm and 300 Kohm Ranges. Set the range in step 3 by executing RANGE 30E3 for the 30 Kohm Range and RANGE 300E3 for the 300 Kohm Range.

10. Stop the measurement by pressing the HP 3852A front panel CLEAR button. Leave the setup in step 5 for the next test. Remove the low thermal short from the HI and LO Input Terminals, but do not remove the other connections.

11. OHMS GAIN TEST. The following test determines if the ohms full scale readings of the HP 44701A are within the specified limits. Either 3, 30, and 300 Kohm resistors (full scale inputs) or 1, 10, and 100 Kohm resistors (1/3 scale inputs) can be used for the test.

12. If using the Resistance Standard, set its output to either 3 Kohm or 1 Kohm. If using a Standard Resistor, select either a 3 Kohm or 1 Kohm value. Connect the Resistance Standard/Standard Resistor to the rear HI and LO Input Terminals of the HP 44701A Integrating Voltmeter accessory. The connections are shown in Figures 6-4a and 6-4b.

13. Test the 3 Kohm Range by executing:

    RANGE 3E3

14. Transfer the HP 44701A reading to the HP 3852A right display by executing:

    XRDGS ES00,1 (where E = extender number, S = slot number)

15. Note the reading on the HP 3852A display. If the full scale reading is out of the limits specified in Table 6-4 (use either the 3 Kohm or 1 Kohm limits), perform the Ohms Calibration procedure in Section 6-34.

16. Repeat steps 13, 14, and 15 for the 30 Kohm and 300 Kohm Ranges. Set the range in step 13 by executing RANGE 30E3 for the 30 Kohm Range and RANGE 300E3 for the 300 Kohm Range. Also set the Resistance Standard output or select a standard resistor accordingly as listed in Table 6-4.

17. When all ranges are tested, remove the Resistance Standard/Standard Resistor from the HI and LO Input Terminals. Remove the other terminal connections from the HP 44701A rear panel.

6-27 AC Voltage Operational Verification Test

This test determines if the ac offset voltage and the full scale accuracy of the HP 44701A Integrating Voltmeter are within the specified limits. Since the specified ac accuracy is for inputs greater than 10% of full scale, the offset is tested with a 10% of full scale input. The following procedure sets the HP 44701A to certain ac volts ranges and then transfers the resultant readings to the mainframe.

The following tests also checks the frequency response of the HP 44701A accessory.

1. AC VOLTAGE OFFSET/GAIN TEST. The following tests check if the ac offset and ac full scale readings of the HP 44701A Integrating Voltmeter are within the specified limits.

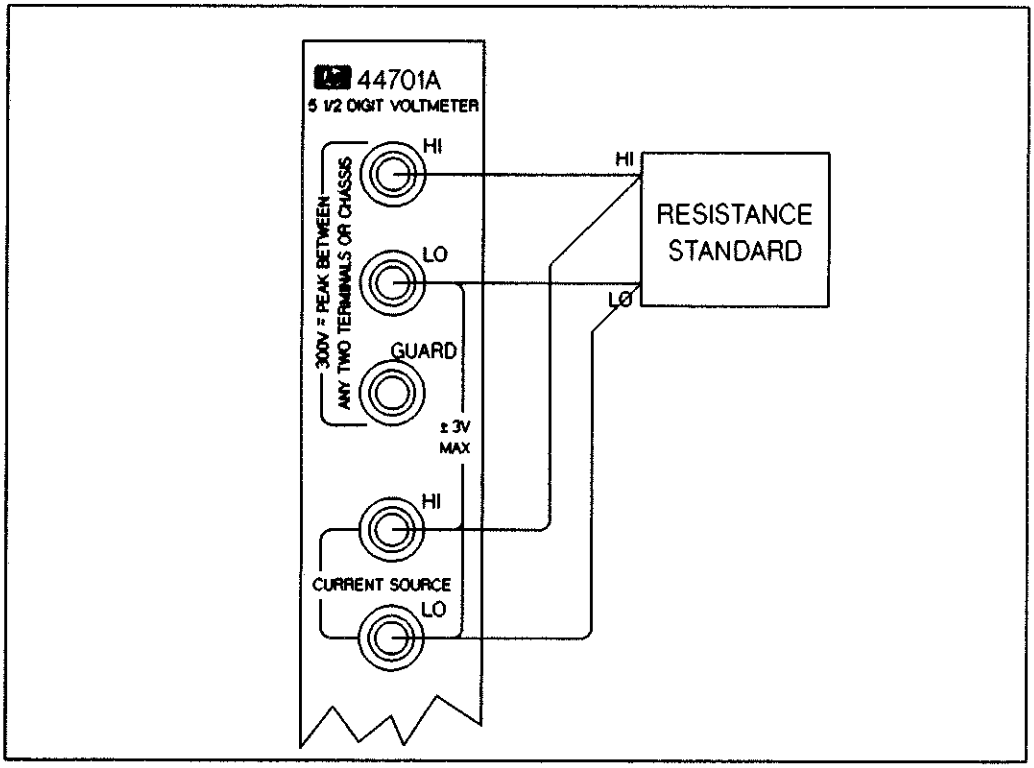


Figure 6-4a Ohms Gain Test Connections Using a Resistance Standard

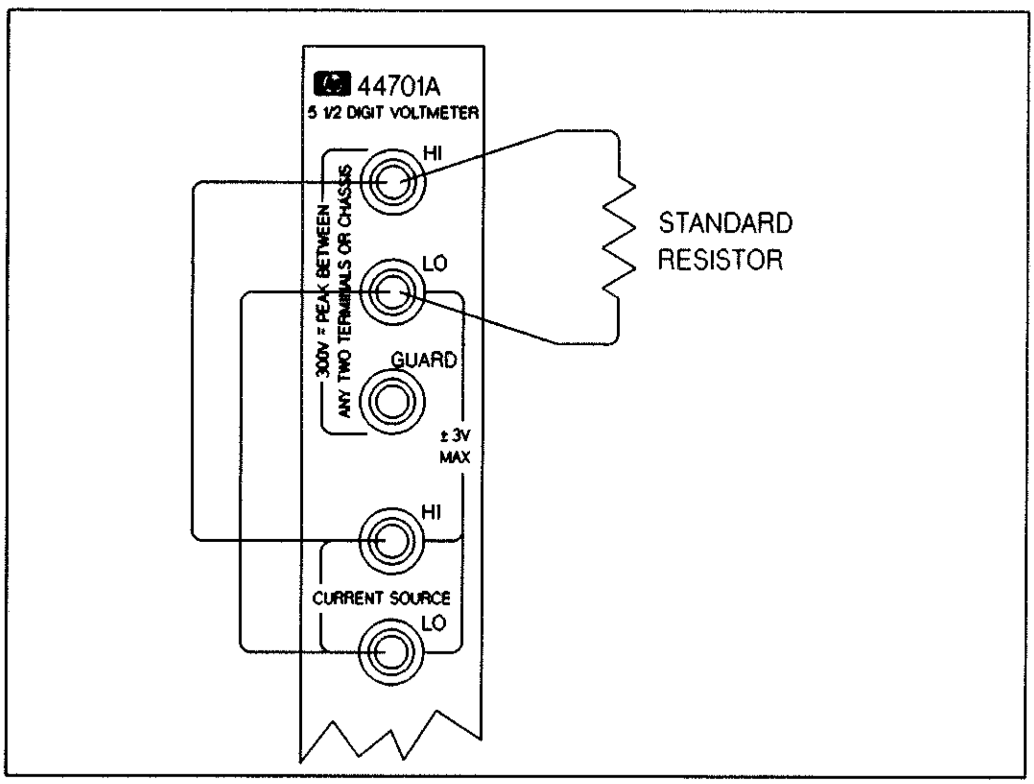


Figure 6-4b Ohms Gain Test Connections Using Standard Resistors

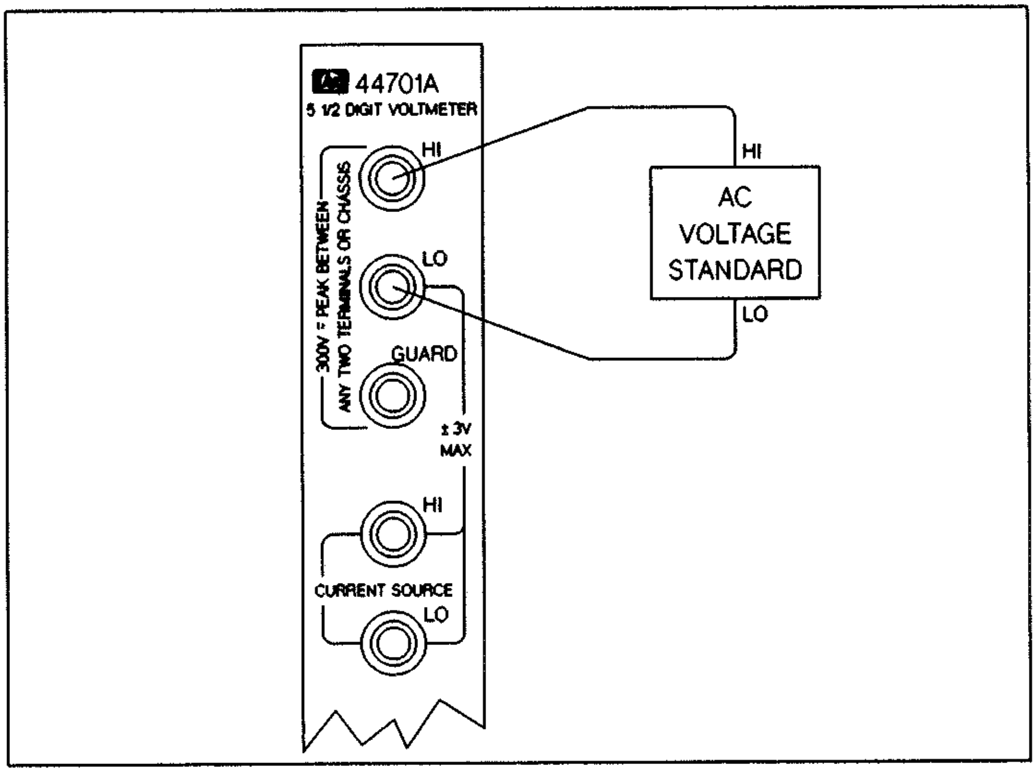


Figure 6-5 AC Voltage Test Connections

2. Perform the Set-Up Procedure in Section 6-21, if not previously performed.

3. Set the AC Voltage Standard output to 20 mV at 150 Hz. Then connect the AC Voltage Standard to the rear HI and LO Input Terminals of the HP 44701A Integrating Voltmeter accessory. The connections are shown in Figure 6-5.

4. Set the HP 44701A to measure ac volts (at the rear terminals), and to internal trigger by executing the following commands:

```
FUNC ACV
NPLC 16
TERM EXT
TRIG AUTO
```

5. Set the HP 44701A to the 200 mV Range by executing:

```
RANGE .2
```

6. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

7. Note the reading on the HP 3852A display. If the offset reading is out of the limits specified in Table 6-5, perform the AC Volts Calibration procedure in Section 6-34.

8. Check the HP 44701A 200 mV Range full scale accuracy by setting the AC Voltage Standard output to 200 mV at 150 Hz.

Table 6-5 AC Voltage Operational Verification Test Limits

AC Voltage Offset and Gain Test Limits							
44701A Input	Input Freq.	44701A Range	44701A Set-Up	90 Day Test Limits		1 Year Limits	
				High	Low	High	Low
20 mV	150 Hz	200 mV	FUNC ACV	2.070000E-02	1.930000E-02	2.105000E-02	1.895000E-02
200 mV	150 Hz	200 mV	FUNC ACV	2.016000E-01	1.984000E-01	2.024000E-01	1.976000E-01
200 mV	150 Hz	2 V	FUNC ACV	2.070000E-01	1.930000E-01	2.105000E-01	1.895000E-01
2 V	150 Hz	2 V	FUNC ACV	2.016000E+00	1.984000E+00	2.024000E+00	1.976000E+00
2 V	150 Hz	20 V	FUNC ACV	2.070000E+00	1.930000E+00	2.105000E+01	1.895000E+01
20 V	150 Hz	200 V	FUNC ACV	2.070000E+01	1.930000E+01	2.105000E+01	1.895000E+01

AC Voltage Frequency Response Test Limits							
44701A Input	Input Freq.	44701A Range	44701A Set-Up	90 Day Test Limits		1 Year Limits	
				High	Low	High	Low
200 mV	45 Hz	200 mV	FUNC ACV	2.016000E-01	1.984000E-01	2.024000E-01	1.976000E-01
200 mV	500 Hz	200 mV	FUNC ACV	2.016000E-01	1.984000E-01	2.024000E-01	1.976000E-01
2 V	45 Hz	2 V	FUNC ACV	2.016000E+00	1.984000E+00	2.024000E+00	1.976000E+00
2 V	500 Hz	2 V	FUNC ACV	2.016000E+00	1.984000E+00	2.024000E+00	1.976000E+00

9. Transfer the HP 44701A reading to the HP 3852A right display by executing:

    XRDGS ES00,1 (where E = extender number, S = slot number)

10. Note the reading on the HP 3852A display. If the full scale reading is out of the limits specified in Table 6-5, perform the AC Volts Calibration procedure in Section 6-34.

11. Set the HP 44701A to the 2 V Range by executing:

    RANGE 2

12. Transfer the HP 44701A reading to the HP 3852A right display by executing:

    XRDGS ES00,1 (where E = extender number, S = slot number)

13. Note the reading on the HP 3852A display. If the offset reading is out of the limits specified in Table 6-5, perform the AC Volts Calibration procedure in Section 6-34.

14. Check the HP 44701A 2 V Range full scale accuracy by setting the AC Voltage Standard output to 2 V at 150 Hz.

15. Transfer the HP 44701A reading to the HP 3852A right display by executing:

    XRDGS ES00,1 (where E = extender number, S = slot number)

16. Note the reading on the HP 3852A display. If the full scale reading is out of the limits specified in Table 6-5, perform the AC Volts Calibration procedure in Section 6-34.

17. Set the HP 44701A to the 20 V Range by executing:

RANGE 20

18. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

19. Note the reading on the HP 3852A display. If the offset reading is out of the limits specified in Table 6-5, perform the AC Volts Calibration procedure in Section 6-34.

20. Check the HP 44701A 200 V Range offset by setting the AC Voltage Standard output to 20 V at 150 Hz.

21. Set the HP 44701A to the 200 V Range by executing:

RANGE 200

22. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

23. Note the reading on the HP 3852A display. If the offset reading is out of the limits specified in Table 6-5, perform the AC Volts Calibration procedure in Section 6-34.

24. Reduce the AC Voltage Standard output to 0 V. Leave the setup in step 4 for the next test. Also leave the AC Voltage Standard connected to the HI and LO Input Terminals.

25. AC VOLTAGE FREQUENCY RESPONSE TEST. The following test checks the frequency response of the HP 44701A Integrating Voltmeter.

26. With the test setup shown in Figure 6-5, set the AC Voltage Standard to output 200 mV at 45 Hz.

27. Set the HP 44701A to the 200 mV Range by executing:

RANGE .2

28. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

29. Note the reading on the HP 3852A display. If the full scale reading at 45 Hz is out of the limits specified in Table 6-5, perform the AC Volts Calibration procedure in Section 6-34.

30. Change the AC Voltage Standard frequency to 500 Hz.

31. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

32. Note the reading on the HP 3852A display. If the full scale reading at 500 Hz is out of the limits specified in Table 6-5, perform the AC Volts Calibration procedure in Section 6-34.

33. Set the HP 44701A to the 2 V Range by executing:

RANGE 2

34. Set the AC Voltage Standard to output 2 V at 45 Hz.

35. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

36. Note the reading on the HP 3852A display. If the full scale reading at 45 Hz is out of the limits specified in Table 6-5, perform the AC Volts Calibration procedure in Section 6-34.

37. Change the AC Voltage Standard frequency to 500 Hz.

38. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

39. Note the reading on the HP 3852A display. If the full scale reading at 500 Hz is out of the limits specified in Table 6-5, perform the AC Volts Calibration procedure in Section 6-34.

40. Remove the AC Voltage Standard from the HP 44701A HI and LOW Input Terminals.

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44701A PERFORMANCE TESTS.

DC VOLTAGE OPERATIONAL VERIFICATION TEST CARD

90 DAY TEST LIMITS

Hewlett-Packard Model 44701A

Integrating Voltmeter

Test Performed By________________________

Date_______________ Reference Temperature___________

44701A Input	44701A Range	44701A Set-Up	High Limit	Reading	Low Limit	Test Pass	Test Fail
DC VOLTAGE OFFSET TEST							
Short	30 V	FUNC DCV	+3.000000E-04	____________________	-3.000000E-04	____	____
Short	3 V	FUNC DCV	+8.000000E-06	____________________	-8.000000E-06	____	____
Short	300 mV	FUNC DCV	+6.000000E-06	____________________	-6.000000E-06	____	____
DC VOLTAGE GAIN TEST							
+300 mV	300 mV	FUNC DCV	+3.000300E-01	____________________	+2.999700E-01	____	____
+3 V	3 V	FUNC DCV	+3.000248E+00	____________________	+2.999752E+00	____	____
+30 V	30 V	FUNC DCV	+3.000270E+01	____________________	+2.999730E+01	____	____

DC VOLTAGE OPERATIONAL VERIFICATION TEST CARD

1 YEAR TEST LIMITS

Hewlett-Packard Model 44701A

Integrating Voltmeter

Test Performed By______________________

Date______________ Reference Temperature__________

44701A Input	44701A Range	44701A Set-Up	High Limit	Reading	Low Limit	Test Pass	Test Fail
DC VOLTAGE OFFSET TEST							
Short	30 V	FUNC DCV	+3.000000E-04	______________	-3.000000E-04	___	___
Short	3 V	FUNC DCV	+8.000000E-06	______________	-8.000000E-06	___	___
Short	300 mV	FUNC DCV	+6.000000E-06	______________	-6.000000E-06	___	___
DC VOLTAGE GAIN TEST							
+300 mV	300 mV	FUNC DCV	+3.000600E-01	______________	+2.999400E-01	___	___
+3 V	3 V	FUNC DCV	+3.000548E+00	______________	+2.999452E+00	___	___
+30 V	30 V	FUNC DCV	+3.000570E+01	______________	+2.999430E+01	___	___

OHMS OPERATIONAL VERIFICATION TEST CARD

90 DAY TEST LIMITS

Hewlett-Packard Model 44701A

Integrating Voltmeter

Test Performed By________________________

Date_______________ Reference Temperature__________

44701A Input	44701A Range	44701A Set-Up	High Limit	Reading	Low Limit	Test Pass	Test Fail
OHMS OFFSET TEST							
Short	3 Kohm	FUNC OHMF	6.000000E-02	____________________	0.000000E+00	____	____
Short	30 Kohm	FUNC OHMF	8.000000E-02	____________________	0.000000E+00	____	____
Short	300 Kohm	FUNC OHMF	1.000000E+00	____________________	0.000000E+00	____	____
OHMS GAIN TEST							
3 Kohm	3 Kohm	FUNC OHMF	3.000510E+03	____________________	2.999490E+03	____	____
1 Kohm*	3 Kohm	FUNC OHMF	1.000210E+02	____________________	9.997900E+02	____	____
30 Kohm	30 Kohm	FUNC OHMF	3.000458E+04	____________________	2.999542E+04	____	____
10 Kohm*	30 Kohm	FUNC OHMF	1.000158E+04	____________________	9.998420E+03	____	____
300 Kohm	300 Kohm	FUNC OHMF	3.000460E+05	____________________	2.999540E+05	____	____
100 Kohm*	300 Kohm	FUNC OHMF	1.000160E+05	____________________	9.998400E+04	____	____

*For 1/3 scale inputs only

OHMS OPERATIONAL VERIFICATION TEST CARD

1 YEAR TEST LIMITS

Hewlett-Packard Model 44701A

Integrating Voltmeter

Test Performed By________________________

Date______________ Reference Temperature___________

44701A Input	44701A Range	44701A Set-Up	High Limit	Reading	Low Limit	Test Pass	Test Fail
OHMS OFFSET TEST							
Short	3 Kohm	FUNC OHMF	6.000000E-02	____________	0.000000E+00	____	____
Short	30 Kohm	FUNC OHMF	8.000000E-02	____________	0.000000E+00	____	____
Short	300 Kohm	FUNC OHMF	1.000000E+00	____________	0.000000E+00	____	____
OHMS GAIN TEST							
3 Kohm	3 Kohm	FUNC OHMF	3.000810E+03	____________	2.999190E+03	____	____
1 Kohm*	3 Kohm	FUNC OHMF	1.000310E+02	____________	9.996900E+02	____	____
30 Kohm	30 Kohm	FUNC OHMF	3.000758E+04	____________	2.999242E+04	____	____
10 Kohm*	30 Kohm	FUNC OHMF	1.000258E+04	____________	9.997420E+03	____	____
300 Kohm	300 Kohm	FUNC OHMF	3.000760E+05	____________	2.999240E+05	____	____
100 Kohm*	300 Kohm	FUNC OHMF	1.000260E+05	____________	9.997400E+04	____	____

*For 1/3 scale inputs only

AC VOLTAGE OPERATIONAL VERIFICATION TEST CARD

90 DAY TEST LIMITS

Hewlett-Packard Model 44701A

Integrating Voltmeter

Test Performed By________________________

Date_______________ Reference Temperature___________

44701A Input	44701A Range	44701A Set-Up	High Limit	Reading	Low Limit	Test Pass	Test Fail
AC VOLTAGE OFFSET AND GAIN TESTS							
20 mV, 150 Hz	200 mV	FUNC ACV	2.070000E-02	____________	1.930000E-02	____	____
200 mV, 150 Hz	200 mV	FUNC ACV	2.016000E-01	____________	1.984000E-01	____	____
200 mV, 150 Hz	2 V	FUNC ACV	2.070000E-01	____________	1.930000E-01	____	____
2 V, 150 Hz	2 V	FUNC ACV	2.016000E+00	____________	1.984000E+00	____	____
2 V, 150 Hz	20 V	FUNC ACV	2.070000E+00	____________	1.930000E+00	____	____
20 V, 150 Hz	200 V	FUNC ACV	2.070000E+01	____________	1.930000E+01	____	____
AC VOLTAGE FREQUENCY RESPONSE TEST							
200 mV, 45 Hz	200 mV	FUNC ACV	2.016000E-01	____________	1.984000E-01	____	____
200 mV, 500 Hz	200 mV	FUNC ACV	2.016000E-01	____________	1.984000E-01	____	____
2 V, 45 Hz	2 V	FUNC ACV	2.016000E+00	____________	1.984000E+00	____	____
2 V, 500 Hz	2 V	FUNC ACV	2.016000E+00	____________	1.984000E+00	____	____

AC VOLTAGE OPERATIONAL VERIFICATION TEST CARD

1 YEAR TEST LIMITS

Hewlett-Packard Model 44701A

Integrating Voltmeter

Test Performed By________________________

Date_______________ Reference Temperature___________

44701A Input	44701A Range	44701A Set-Up	High Limit	Reading	Low Limit	Test Pass	Test Fail
AC VOLTAGE OFFSET AND GAIN TESTS							
20 mV, 150 Hz	200 mV	FUNC ACV	2.105000E-02	____________	1.895000E-02	____	____
200 mV, 150 Hz	200 mV	FUNC ACV	2.024000E-01	____________	1.976000E-01	____	____
200 mV, 150 Hz	2 V	FUNC ACV	2.105000E-01	____________	1.895000E-01	____	____
2 V, 150 Hz	2 V	FUNC ACV	2.024000E+00	____________	1.976000E+00	____	____
2 V, 150 Hz	20 V	FUNC ACV	2.105000E+00	____________	1.895000E+00	____	____
20 V, 150 Hz	200 V	FUNC ACV	2.105000E+01	____________	1.895000E+01	____	____
AC VOLTAGE FREQUENCY RESPONSE TEST							
200 mV, 45 Hz	200 mV	FUNC ACV	2.024000E-01	____________	1.976000E-01	____	____
200 mV, 500 Hz	200 mV	FUNC ACV	2.024000E-01	____________	1.976000E-01	____	____
2 V, 45 Hz	2 V	FUNC ACV	2.024000E+00	____________	1.976000E+00	____	____
2 V, 500 Hz	2 V	FUNC ACV	2.024000E+00	____________	1.976000E+00	____	____

6-28 Performance Tests

Perform the Performance Tests only if you do not plan to do the Operational Verification Tests. If you plan to do the Operational Verification Tests, do not perform the following tests but go to Section 6-22 instead.

Do the following tests if you desire a high confidence level that the voltmeter is operating normally and is within specifications.

The Performance Tests consist of the following:

Section 6-30 - Set-Up Procedure
Section 6-31 - DC Voltage Performance Test
Section 6-32 - Ohms Performance Test
Section 6-33 - AC Voltage Performance Test

6-29 Performance Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

WARNING

The following procedures are intended for Service Trained Personnel who understand electronic circuitry and are aware of the hazards involved. Do not attempt to perform any of the procedures unless you are qualified to do so.

NOTE

The temperature of the environment where the following tests are to be performed must be within ±5° C of the temperature of the environment where the instrument was last calibrated. The HP 44701A Integrating Voltmeter was calibrated at the factory at an environment temperature of 20° C.

6-30 Set-Up Procedure

1. Apply power to the HP 3852A and allow the HP 44701A Integrating Voltmeter a one hour warm-up period inside the mainframe. This is necessary to stabilize the voltmeter before performing any tests.

2. Press the RESET button on the HP 3852A front panel. Perform the HP 44701A Integrating Voltmeter self-test by executing:

TEST ES00 (where E = extender number, S = slot number)

3. The HP 3852A right display should show:

SELF TEST OK

If the display shows a different message, or if the ERR annunciator is on, the HP 44701A Integrating Voltmeter may be failing its self test. Test the voltmeter again by executing the command in step 2. If the voltmeter still fails, repair of the unit may be necessary.

4. Designate the HP 44701A to be tested by executing:

USE ES00 (where E = extender number, S = slot number)

This command establishes the extender/slot number used in all Performance/Operational Verification Tests for command destination. If the HP 3852A is reset or power is removed, it is necessary to perform step 4 again to re-establish the extender/slot number.

6-31 DC Voltage Performance Test

This test determines if the dc offset voltage and the full scale accuracy of the HP 44701A Integrating Voltmeter are within the specified limits. The following procedure sets the HP 44701A to certain dc voltage ranges and then transfers the resultant readings to the mainframe.

1. DC VOLTAGE OFFSET TEST. The following test determines if the dc voltage offset readings of the HP 44701A are within the specified limits.

2. Perform the Set-Up Procedure in Section 6-30, if not previously performed.

3. Connect a low thermal short across the rear HI and LO Input Terminals of the HP 44701A Integrating Voltmeter accessory.

4. Set the HP 44701A to measure dc volts (at the rear terminals), to internal trigger, and to update the display every second by executing the following commands:

```
FUNC DCV
NPLC 16
TERM EXT
TRIG AUTO
DELAY 1
```

5. The 30 V Range is tested first to allow any thermal voltages that may affect the readings on other ranges to dissipate. Set the HP 44701A to the 30 V Range by executing:

RANGE 30

6. Transfer the HP 44701A readings to the HP 3852A right display by executing:

XRDGS ES00,100 (where E = extender number, S = slot number)

This causes the display to update continuously for 100 readings.

7. Note the readings on the HP 3852A display. If any offset reading is out of the limits specified in Table 6-6, perform the DC Volts Calibration procedure in Section 6-34.

Table 6-6 DC Voltage Performance Test Limits

DC Voltage Offset Test Limits

44701A Input	44701A Range	44701A Set-Up	90 Day Test Limits		1 Year Test Limits	
			High	Low	High	Low
Short	30 V	FUNC DCV	+3.000000E-04	-3.000000E-04	+3.000000E-04	-3.000000E-04
Short	300 V	FUNC DCV	+7.000000E-04	-7.000000E-04	+7.000000E-04	-7.000000E-04
Short	3 V	FUNC DCV	+8.000000E-06	-8.000000E-06	+8.000000E-06	-3.000000E-06
Short	300 mV	FUNC DCV	+6.000000E-06	-6.000000E-06	+6.000000E-06	-6.000000E-06
Short	30 mV	FUNC DCV	+6.000000E-06	-6.000000E-06	+6.000000E-06	-6.000000E-06

DC Voltage Gain Test Limits

44701A Input	44701A Range	44701A Set-Up	90 Day Test Limits		1 Year Test Limits	
			High	Low	High	Low
+30 mV	30 mV	FUNC DCV	+3.001200E-02	+2.998800E-02	+3.001500E-02	+2.998500E-02
+300 mV	300 mV	FUNC DCV	+3.000300E-01	+2.999700E-01	+3.000600E-01	+2.999400E-01
+3 V	3 V	FUNC DCV	+3.000248E+00	+2.999752E+00	+3.000548E+00	+2.999452E+00
+30 V	30 V	FUNC DCV	+3.000270E+01	+2.999730E+01	+3.000570E+01	+2.999430E+01
+300 V	300 V	FUNC DCV	+3.000247E+02	+2.999753E+02	+3.000547E+02	+2.999453E+02

DC Voltage Linearity Test Limits

44701A Input	44701A Range	44701A Set-Up	90 Day Test Limits		1 Year Test Limits	
			High	Low	High	Low
+2 V	3 V	FUNC DCV	+2.000168E+00	+1.999832E+00	+2.000368E+00	+1.999632E+00
+1 V	3 V	FUNC DCV	+1.000088E+00	+9.999120E-01	+1.000188E+00	+9.998120E-01
-1 V	3 V	FUNC DCV	-1.000088E+00	-9.999120E-01	-1.000188E+00	-9.998120E-01
-2 V	3 V	FUNC DCV	-2.000168E+00	-1.999832E+00	-2.000368E+00	-1.999632E+00
-3 V	3 V	FUNC DCV	-3.000248E+00	-2.999752E+00	-3.000548E+00	-2.999452E+00

8. The measurements can be stopped any time by pressing the HP 3852A front panel CLEAR button.

9. Repeat steps 6, 7, 8, and 9 for the 300 V, 3 V, 300 mV, and 30 mV Ranges. To set the different ranges in step 5, execute the following:

300 V Range - RANGE 300
3 V Range - RANGE 3
300 mV Range - RANGE .3
30 mV Range - RANGE .03

10. When all ranges are tested, stop the measurement by pressing the HP 3852A front panel CLEAR button. Leave the setup in step 4 for the next test and leave the HP 44701A in the 30 mV Range. Remove the low thermal short from the HI and LO Input Terminals.

11. DC VOLTAGE GAIN TEST. The following test determines if the dc voltage full scale readings of the HP 44701A are within the specified limits.

NOTE

Always uprange the HP 44701A Integrating Voltmeter before upranging the DC Voltage Standard and always downrange the DC Voltage Standard before downranging the HP 44701A.

12. Set the DC Voltage Standard output to +30 mV. Then connect the DC Voltage Standard to the rear HI and LO Input Terminals of the HP 44701A Integrating Voltmeter accessory. The connections are shown in Figure 6-2.

13. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

14. Note the reading on the HP 3852A display. If the full scale reading is out of the limits specified in Table 6-6, perform the DC Volts Calibration procedure in Section 6-34.

15. Repeat steps 12, 13, and 14 for the 300 mV, 3 V, 30 V and 300 V Ranges. To set the different ranges (see step 5), execute the following commands. Also set the DC Standard output accordingly as listed in Table 6-6.

300 mV Range - RANGE .3
3 V Range - RANGE 3
30 V Range - RANGE 30
300 V Ranges - RANGE 300

16. When all ranges are tested, reduce the DC Voltage Standard output to +2 V. Leave the DC Voltage Standard connected to the HI and LO Input Terminals.

17. DC VOLTAGE LINEARITY TEST. The following test determines if the dc voltage linearity of the HP 44701A is within the specified limits.

18. Set the HP 44701A to the 3 V Range by executing:

RANGE 3

19. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

20. Note the reading on the HP 3852A display. If the +2 V reading is out of the limits specified in Table 6-6, perform the DC Volts Calibration procedure in Section 6-34.

21. Set the DC Voltage Standard output to +1 V and repeat steps 19 and 20.

22. Set the DC Voltage Standard output to -1 V and repeat steps 19 and 20. (If the DC Voltage Standard is unable to output -1 V, reverse the connections to the HP 44701A rear terminals.)

23. Set the DC Voltage Standard output to -2 V and repeat steps 19 and 20.

24. Set the DC Voltage Standard output to -3 V and repeat steps 19 and 20.

25. Reduce the DC Voltage Standard output to 0 V. Then remove the DC Standard from the HI and LO Input Terminals.

6-32 Ohms Performance Test

This test determines if the ohms offset and full scale accuracy of the HP 44701A Integrating Voltmeter are within the specified limits. The following procedure sets the HP 44701A to certain ohms ranges and then transfers the resultant readings to the mainframe.

1. OHMS OFFSET TEST. The following test determines if the ohms offset readings of the HP 44701A are within the specified limits.

2. Perform the Set-Up Procedure in Section 6-30, if not previously performed.

3. Connect the HP 44701A rear panel Current Source HI Output Terminal to the rear panel HI Input Terminal. Connect the rear panel Current Source LO Output Terminal to the rear panel LO Input Terminal. Connect a low thermal short across the rear panel HI and LO Input Terminals. The connections are shown in Figure 6-3.

4. Set the HP 44701A to measure ohms (at the rear terminals), to internal trigger, and to update the display every second by executing:

```
FUNC OHMF
NPLC 16
TERM EXT
TRIG AUTO
DELAY 1
```

5. Set the HP 44701A to the 30 ohm Range by executing:

```
RANGE 30
```

6. Transfer the HP 44701A readings to the HP 3852A right display by executing:

```
XRDGS ES00,100   (where E = extender number, S = slot number)
```

This causes the display to update continuously for 100 readings.

7. Note the readings on the HP 3852A display. If any offset reading (i.e., with HP 44701A input shorted) is out of the limits specified in Table 6-7, perform the Ohms Calibration procedure in Section 6-34.

8. The measurements can be stopped any time by pressing the HP 3852A front panel CLEAR button.

9. Repeat steps 6, 7, 8, and 9 for the 300 ohm through 3 Mohm Ranges. To set the different ranges in step 5, execute the following:

300 Ω Range - RANGE 300
3 KΩ Range - RANGE 3E3
30 KΩ Range - RANGE 30E3
300 KΩ Range - RANGE 300E3
3 MΩ Range - RANGE 3E6

10. Stop the measurement by pressing the HP 3852A front panel CLEAR button. Leave the setup in step 5 for the next test. Remove the low thermal short from the HI and LO Input Terminals, but do not remove the other connections.

Table 6-7 Ohms Performance Test Limits

Ohms Offset Test Limits						
44701A Input	44701A Range	44701A Set-Up	90 Day Test Limits High	90 Day Test Limits Low	1 Year Test Limits High	1 Year Test Limits Low
30 ohm	30 ohm	FUNC OHMF	6.000000E-03	0.000000E+00	6.000000E-03	0.000000E+00
300 ohm	300 ohm	FUNC OHMF	6.000000E-03	0.000000E+00	6.000000E-03	0.000000E+00
3 Kohm	3 Kohm	FUNC OHMF	6.000000E-02	0.000000E+00	6.000000E-02	0.000000E+00
30 Kohm	30 Kohm	FUNC OHMF	8.000000E-02	0.000000E+00	8.000000E-02	0.000000E+00
300 Kohm	300 Kohm	FUNC OHMF	1.000000E+00	0.000000E+00	1.000000E+00	0.000000E+00
3 Mohm	3 Mohm	FUNC OHMF	1.700000E+01	0.000000E+00	1.700000E+01	0.000000E+00

Ohms Gain Test Limits						
44701A Input	44701A Range	44701A Set-Up	90 Day Test Limits High	90 Day Test Limits Low	1 Year Test Limits High	1 Year Test Limits Low
30 ohm	30 ohm	FUNC OHMF	3.001200E+01	2.998800E+01	3.001500E+01	2.998500E+01
10 ohm*	30 ohm	FUNC OHMF	1.000800E+01	9.992000E+00	1.000900E+01	9.991000E+00
300 ohm	300 ohm	FUNC OHMF	3.000510E+02	2.999490E+02	3.000810E+02	2.999190E+02
100 ohm*	300 ohm	FUNC OHMF	1.000210E+02	9.997900E+01	1.000310E+02	9.996900E+01
3 Kohm	3 Kohm	FUNC OHMF	3.000510E+03	2.999490E+03	3.000810E+03	2.999190E+03
1 Kohm*	3 Kohm	FUNC OHMF	1.000210E+03	9.997900E+02	1.000310E+03	9.996900E+02
30 Kohm	30 Kohm	FUNC OHMF	3.000458E+04	2.999542E+04	3.000758E+04	2.999242E+04
10 Kohm*	30 Kohm	FUNC OHMF	1.000158E+04	9.998420E+03	1.000258E+04	9.997420E+03
300 Kohm	300 Kohm	FUNC OHMF	3.000460E+05	2.999540E+05	3.000760E+05	2.999240E+05
100 Kohm*	300 Kohm	FUNC OHMF	1.000160E+05	9.998400E+04	1.000260E+05	9.997400E+04
3 Mohm	3 Mohm	FUNC OHMF	3.003017E+06	2.996983E+06	3.003317E+06	2.996683E+06
1 Mohm*	3 Mohm	FUNC OHMF	1.001017E+06	9.989830E+05	1.001117E+06	9.988830E+05
*For 1/3 scale inputs only						

11. OHMS GAIN TEST. The following test determines if the ohms full scale readings of the HP 44701A are within the specified limits. Either 30 ohm through 3 Mohm or 10 ohm through 1 Mohm resistors can be used for the test.

12. If using the Resistance Standard, set its output to either 30 ohm or 10 ohm. If using a Standard Resistor, select either a 30 ohm or 10 ohm value. Connect the Resistance Standard/Standard Resistor to the rear HI and LO Input Terminals of the HP 44701A Integrating Voltmeter accessory. The connections are shown in Figures 6-4a and 6-4b.

13. Test the 30 ohm Range by executing:

    RANGE 30

14. Transfer the HP 44701A reading to the HP 3852A right display by executing:

    XRDGS ES00,1 (where E = extender number, S = slot number)

15. Note the reading on the HP 3852A display. If the full scale reading is out of the limits specified in Table 6-7 (use either the 3 Kohm or 1 Kohm limits), perform the Ohms Calibration procedure in Section 6-34.

16. Repeat steps 13, 14, and 15 for the 300 ohm through 3 Mohm Ranges. To set the different ranges in step 13, execute the following commands. Also set the Resistance Standard output or select a standard resistor accordingly as listed in Table 6-7.

300Ω Range - RANGE 300
3 KΩ Range - RANGE 3E3
30 KΩ Range - RANGE 30E3
300 KΩ Range - RANGE 300E3
3 MΩ Range - RANGE 3E6

17. When all ranges are tested, remove the Resistance Standard/Standard Resistor from the HI and LO Input Terminals. Remove the other terminal connections from the HP 44701A rear panel.

6-33 AC Voltage Performance Test

This test determines if the ac offset voltage and the full scale accuracy of the HP 44701A Integrating Voltmeter are within the specified limits. Since the specified ac accuracy is for inputs greater than 10% of full scale, the offset is tested with a 10% of full scale input. The following procedure sets the HP 44701A to certain ac volts ranges and then transfers the resultant readings to the mainframe.

The following tests also checks the frequency response of the HP 44701A accessory.

1. AC VOLTAGE OFFSET/GAIN TEST. The following tests check if the ac offset and ac full scale readings of the HP 44701A Integrating Voltmeter are within the specified limits.

NOTE

Always uprange the HP 44701A Integrating Voltmeter before upranging the AC Voltage Standard and always downrange the AC Voltage Standard before downranging the HP 44701A.

2. Perform the Set-Up Procedure in Section 6-30, if not previously performed.

3. Set the AC Voltage Standard output to 20 mV at 150 Hz. Then connect the AC Voltage Standard to the rear HI and LO Input Terminals of the HP 44701A Integrating Voltmeter accessory. The connections are shown in Figure 6-5.

4. Set the HP 44701A to measure ac volts (at the rear terminals) and to internal trigger by executing the following commands:

```
FUNC ACV
NPLC 16
TERM EXT
TRIG AUTO
```

5. Set the HP 44701A to the 200 mV Range by executing:

```
RANGE .2
```

6. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

7. Note the reading on the HP 3852A display. If the offset reading is out of the limits specified in Table 6-8, perform the AC Volts Calibration procedure in Section 6-34.

Table 6-8 AC Voltage Performance Test Limits

AC Voltage Offset and Gain Test Limits							
44701A Input	Input Freq.	44701A Range	44701A Set-Up	90 Day Test Limits High	90 Day Test Limits Low	1 Year Limits High	1 Year Limits Low
20 mV	150 Hz	200 mV	FUNC ACV	2.070000E-02	1.930000E-02	2.105000E-02	1.895000E-02
200 mV	150 Hz	200 mV	FUNC ACV	2.016000E-01	1.984000E-01	2.024000E-01	1.976000E-01
200 mV	150 Hz	2 V	FUNC ACV	2.070000E-01	1.930000E-01	2.105000E-01	1.895000E-01
1 V	150 Hz	2 V	FUNC ACV	1.011000E+00	9.890000E-01	1.016500E+00	9.835000E-01
2 V	150 Hz	2 V	FUNC ACV	2.016000E+00	1.984000E+00	2.024000E+00	1.976000E+00
2 V	150 Hz	20 V	FUNC ACV	2.070000E+00	1.930000E+00	2.105000E+01	1.895000E+01
20 V	150 Hz	20 V	FUNC ACV	2.016000E+01	1.984000E+01	2.024000E+01	1.976000E+01
20 V	150 Hz	200 V	FUNC ACV	2.070000E+01	1.930000E+01	2.105000E+01	1.895000E+01
200 V	150 Hz	200 V	FUNC ACV	2.160000E+02	1.984000E+02	2.024000E+02	1.976000E+02
AC Voltage Frequency Response Test Limits							
44701A Input	Input Freq.	44701A Range	44701A Set-Up	90 Day Test Limits High	90 Day Test Limits Low	1 Year Limits High	1 Year Limits Low
200 mV	45 Hz	200 mV	FUNC ACV	2.016000E-01	1.984000E-01	2.024000E-01	1.976000E-01
200 mV	500 Hz	200 mV	FUNC ACV	2.016000E-01	1.984000E-01	2.024000E-01	1.976000E-01
2 V	45 Hz	2 V	FUNC ACV	2.016000E+00	1.984000E+00	2.024000E+00	1.976000E+00
2 V	500 Hz	2 V	FUNC ACV	2.016000E+00	1.984000E+00	2.024000E+00	1.976000E+00
20 V	45 Hz	20 V	FUNC ACV	2.016000E+01	1.984000E+01	2.024000E+01	1.976000E+01
20 V	500 Hz	20 V	FUNC ACV	2.016000E+01	1.984000E+01	2.024000E+01	1.976000E+01
200 V	45 Hz	200 V	FUNC ACV	2.016000E+02	1.984000E+02	2.024000E+02	1.976000E+02
200 V	500 Hz	200 V	FUNC ACV	2.016000E+02	1.984000E+02	2.024000E+02	1.976000E+02

8. Check the HP 44701A 200 mV Range full scale accuracy by setting the AC Voltage Standard output to 200 mV at 150 Hz.

9. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

10. Note the reading on the HP 3852A display. If the full scale reading is out of the limits specified in Table 6-8, perform the AC Volts Calibration procedure in Section 6-34.

11. Set the HP 44701A to the 2 V Range by executing:

RANGE 2

12. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

13. Note the reading on the HP 3852A display. If the offset reading is out of the limits specified in Table 6-8, perform the AC Volts Calibration procedure in Section 6-34.

14. Check the HP 44701A 2 V Range 1/2 scale accuracy by setting the AC Voltage Standard output to 1 V at 150 Hz.

15. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

16. Note the reading on the HP 3852A display. If the 1/2 scale reading is out of the limits specified in Table 6-8, perform the AC Volts Calibration procedure in Section 6-34.

17. Check the HP 44701A 2 V Range full scale accuracy by setting the AC Voltage Standard output to 2 V at 150 Hz.

18. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

19. Note the reading on the HP 3852A display. If the full scale reading is out of the limits specified in Table 6-8, perform the AC Volts Calibration procedure in Section 6-34.

20. Set the HP 44701A to the 20 V Range by executing:

RANGE 20

21. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

22. Note the reading on the HP 3852A display. If the offset reading is out of the limits specified in Table 6-8, perform the AC Volts Calibration procedure in Section 6-34.

23. Check the HP 44701A 20 V Range full scale accuracy by setting the AC Voltage Standard output to 20 V at 150 Hz.

24. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

25. Note the reading on the HP 3852A display. If the full scale reading is out of the limits specified in Table 6-8, perform the AC Volts Calibration procedure in Section 6-34.

26. Set the HP 44701A to the 200 V Range by executing:

RANGE 200

27. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

28. Note the reading on the HP 3852A display. If the offset reading is out of the limits specified in Table 6-8, perform the AC Volts Calibration procedure in Section 6-34.

29. Check the HP 44701A 200 V Range full scale accuracy by setting the AC Voltage Standard output to 200 V at 150 Hz.

30. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

31. Note the reading on the HP 3852A display. If the full scale reading is out of the limits specified in Table 6-8, perform the AC Volts Calibration procedure in Section 6-34.

32. Reduce the AC Voltage Standard output to 0 V. Leave the setup in step 4 for the next test and leave the AC Voltage Standard connected to the HI and LO Input Terminals.

33. AC VOLTAGE FREQUENCY RESPONSE TEST. The following test checks the frequency response of the HP 44701A Integrating Voltmeter.

34. With the test setup shown in Figure 6-5, set the AC Voltage Standard to output 200 mV at 45 Hz.

35. Set the HP 44701A to the 200 mV Range by executing:

RANGE .2

36. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

37. Note the reading on the HP 3852A display. If the full scale reading at 45 Hz is out of the limits specified in Table 6-8, perform the AC Volts Calibration procedure in Section 6-34.

38. Change the AC Voltage Standard frequency to 500 Hz.

39. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

40. Note the reading on the HP 3852A display. If the full scale reading at 500 Hz is out of the limits specified in Table 6-8, perform the AC Volts Calibration procedure in Section 6-34.

41. Set the HP 44701A to the 2 V Range by executing:

RANGE 2

42. Set the AC Voltage Standard to output 2 V at 45 Hz.

43. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

44. Note the reading on the HP 3852A display. If the full scale reading at 45 Hz is out of the limits specified in Table 6-8, perform the AC Volts Calibration procedure in Section 6-34.

45. Change the AC Voltage Standard frequency to 500 Hz.

46. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

47. Note the reading on the HP 3852A display. If the full scale reading at 500 Hz is out of the limits specified in Table 6-8, perform the AC Volts Calibration procedure in Section 6-34.

48. Set the HP 44701A to the 20 V Range by executing:

RANGE 20

49. Set the AC Voltage Standard to output 20 V at 45 Hz.

50. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

51. Note the reading on the HP 3852A display. If the full scale reading at 45 Hz is out of the limits specified in Table 6-8, perform the AC Volts Calibration procedure in Section 6-34.

52. Change the AC Voltage Standard frequency to 500 Hz.

53. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

54. Note the reading on the HP 3852A display. If the full scale reading at 500 Hz is out of the limits specified in Table 6-8, perform the AC Volts Calibration procedure in Section 6-34.

55. Set the HP 44701A to the 200 V Range by executing:

RANGE 200

56. Set the AC Voltage Standard to output 200 V at 45 Hz.

57. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

58. Note the reading on the HP 3852A display. If the full scale reading at 45 Hz is out of the limits specified in Table 6-8, perform the AC Volts Calibration procedure in Section 6-34.

59. Change the AC Voltage Standard frequency to 500 Hz.

60. Transfer the HP 44701A reading to the HP 3852A right display by executing:

XRDGS ES00,1 (where E = extender number, S = slot number)

61. Note the reading on the HP 3852A display. If the full scale reading at 500 Hz is out of the limits specified in Table 6-8, perform the AC Volts Calibration procedure in Section 6-34.

62. Set the AC Voltage Standard to its lowest voltage range. Then remove the AC Voltage Standard from the HP 44701A HI and LOW Input Terminals.

THIS CONCLUDES THE HP 44701A PERFORMANCE TESTS.

DC VOLTAGE PERFORMANCE TEST CARD

90 DAY TEST LIMITS

Hewlett-Packard Model 44701A

Integrating Voltmeter

Test Performed By________________________

Date_______________ Reference Temperature___________

44701A Input	44701A Range	44701A Set-Up	High Limit	Reading	Low Limit	Test Pass	Test Fail
DC VOLTAGE OFFSET TEST							
Short	30 V	FUNC DCV	+3.000000E-04		-3.000000E-04		
Short	300 V	FUNC DCV	+7.000000E-04		-7.000000E-04		
Short	3 V	FUNC DCV	+8.000000E-06		-8.000000E-06		
Short	300 mV	FUNC DCV	+6.000000E-06		-6.000000E-06		
Short	30 mV	FUNC DCV	+6.000000E-06		-6.000000E-06		
DC VOLTAGE GAIN TEST							
+30 mV	30 mV	FUNC DCV	+3.001200E-02		+2.998800E-02		
+300 mV	300 mV	FUNC DCV	+3.000300E-01		+2.999700E-01		
+3 V	3 V	FUNC DCV	+3.000248E+00		+2.999752E+00		
+30 V	30 V	FUNC DCV	+3.000270E+01		+2.999730E+01		
+300 V	300 V	FUNC DCV	+3.000247E+02		+2.999753E+02		
DC VOLTAGE LINEARITY TEST							
+2 V	3 V	FUNC DCV	+2.000168E+00		+1.999832E+00		
+1 V	3 V	FUNC DCV	+1.000088E+00		+9.999120E-01		
-1 V	3 V	FUNC DCV	-1.000088E+00		-9.999120E-01		
-2 V	3 V	FUNC DCV	-2.000168E+00		+1.999832E+00		
-3 V	3 V	FUNC DCV	-3.000248E+00		-2.999752E+00		

DC VOLTAGE PERFORMANCE TEST CARD

1 YEAR TEST LIMITS

Hewlett-Packard Model 44701A

Integrating Voltmeter

Test Performed By________________________

Date________________ Reference Temperature___________

44701A Input	44701A Range	44701A Set-Up	High Limit	Reading	Low Limit	Test Pass	Test Fail
DC VOLTAGE OFFSET TEST							
Short	30 V	FUNC DCV	+3.000000E-04	________	-3.000000E-04	____	____
Short	300 V	FUNC DCV	+7.000000E-04	________	-7.000000E-04	____	____
Short	3 V	FUNC DCV	+8.000000E-06	________	-8.000000E-06	____	____
Short	300 mV	FUNC DCV	+6.000000E-06	________	-6.000000E-06	____	____
Short	30 mV	FUNC DCV	+6.000000E-06	________	-6.000000E-06	____	____
DC VOLTAGE GAIN TEST							
+30 mV	30 mV	FUNC DCV	+3.001500E-02	________	+2.998500E-02	____	____
+300 mV	300 mV	FUNC DCV	+3.000600E-01	________	+2.999400E-01	____	____
+3 V	3 V	FUNC DCV	+3.000548E+00	________	+2.999452E+00	____	____
+30 V	30 V	FUNC DCV	+3.000570E+01	________	+2.999430E+01	____	____
+300 V	300 V	FUNC DCV	+3.000547E+02	________	+2.999453E+02	____	____
DC VOLTAGE LINEARITY TEST							
+2 V	3 V	FUNC DCV	+2.000368E+00	________	+1.999632E+00	____	____
+1 V	3 V	FUNC DCV	+1.000188E+00	________	+9.998120E-01	____	____
-1 V	3 V	FUNC DCV	-1.000188E+00	________	-9.998120E-01	____	____
-2 V	3 V	FUNC DCV	-2.000188E+00	________	+1.999632E+00	____	____
-3 V	3 V	FUNC DCV	-3.000548E+00	________	-2.999452E+00	____	____

OHMS PERFORMANCE TEST CARD

90 DAY TEST LIMITS

Hewlett-Packard Model 44701A

Integrating Voltmeter

Test Performed By________________________

Date_______________ Reference Temperature___________

44701A Input	44701A Range	44701A Set-Up	High Limit	Reading	Low Limit	Test Pass	Test Fail
OHMS OFFSET TEST							
Short	30 ohm	FUNC OHMF	6.000000E-03	____________	0.000000E+00	____	____
Short	300 ohm	FUNC OHMF	6.000000E-03	____________	0.000000E+00	____	____
Short	3 Kohm	FUNC OHMF	6.000000E-02	____________	0.000000E+00	____	____
Short	30 Kohm	FUNC OHMF	8.000000E-02	____________	0.000000E+00	____	____
Short	300 Kohm	FUNC OHMF	1.000000E+00	____________	0.000000E+00	____	____
Short	3 Mohm	FUNC OHMF	1.700000E+01	____________	0.000000E+00	____	____
OHMS GAIN TEST							
30 ohm	30 ohm	FUNC OHMF	3.001200E+01	____________	2.998800E+01	____	____
10 ohm*	30 ohm	FUNC OHMF	1.000800E+01	____________	9.992000E+01	____	____
300 ohm	300 ohm	FUNC OHMF	3.000510E+02	____________	2.999490E+02	____	____
100 ohm*	300 ohm	FUNC OHMF	1.000210E+02	____________	9.997900E+01	____	____
3 Kohm	3 Kohm	FUNC OHMF	3.000510E+03	____________	2.999490E+03	____	____
1 Kohm*	3 Kohm	FUNC OHMF	1.000210E+02	____________	9.997900E+02	____	____
30 Kohm	30 Kohm	FUNC OHMF	3.000458E+04	____________	2.999542E+04	____	____
10 Kohm*	30 Kohm	FUNC OHMF	1.000158E+04	____________	9.998420E+03	____	____
300 Kohm	300 Kohm	FUNC OHMF	3.000460E+05	____________	2.999540E+05	____	____
100 Kohm*	300 Kohm	FUNC OHMF	1.000160E+05	____________	9.998400E+04	____	____
3 Mohm	3 Mohm	FUNC OHMF	3.003017E+06	____________	2.996983E+06	____	____
1 Mohm*	3 Mohm	FUNC OHMF	1.001017E+06	____________	9.989830E+05	____	____

*For 1/3 scale inputs only

OHMS PERFORMANCE TEST CARD

1 YEAR TEST LIMITS

Hewlett-Packard Model 44701A

Integrating Voltmeter

Test Performed By________________________

Date________________ Reference Temperature___________

44701A Input	44701A Range	44701A Set-Up	High Limit	Reading	Low Limit	Test Pass	Test Fail
OHMS OFFSET TEST							
Short	30 ohm	FUNC OHMF	6.000000E-03		0.000000E+00		
Short	300 ohm	FUNC OHMF	6.000000E-03		0.000000E+00		
Short	3 Kohm	FUNC OHMF	6.000000E-02		0.000000E+00		
Short	30 Kohm	FUNC OHMF	8.000000E-02		0.000000E+00		
Short	300 Kohm	FUNC OHMF	1.000000E+00		0.000000E+00		
OHMS GAIN TEST							
30 ohm	30 ohm	FUNC OHMF	3.001500E+01		2.998500E+01		
10 ohm*	30 ohm	FUNC OHMF	1.000900E+01		9.991000E+00		
300 ohm	300 ohm	FUNC OHMF	3.000810E+02		2.999190E+02		
100 ohm*	300 ohm	FUNC OHMF	1.000310E+02		9.996900E+01		
3 Kohm	3 Kohm	FUNC OHMF	3.000810E+03		2.999190E+03		
1 Kohm*	3 Kohm	FUNC OHMF	1.000310E+02		9.996900E+02		
30 Kohm	30 Kohm	FUNC OHMF	3.000758E+04		2.999242E+04		
10 Kohm*	30 Kohm	FUNC OHMF	1.000258E+04		9.997420E+03		
300 Kohm	300 Kohm	FUNC OHMF	3.000760E+05		2.999240E+05		
100 Kohm*	300 Kohm	FUNC OHMF	1.000260E+05		9.997400E+04		
3 Mohm	3 Mohm	FUNC OHMF	3.003317E+06		2.996683E+06		
1 Mohm*	3 Mohm	FUNC OHMF	1.001117E+06		9.988830E+05		

*For 1/3 scale inputs only

AC VOLTAGE PERFORMANCE TEST CARD

90 DAY TEST LIMITS

Hewlett-Packard Model 44701A

Integrating Voltmeter

Test Performed By________________________

Date_______________ Reference Temperature__________

44701A Input	44701A Range	44701A Set-Up	High Limit	Reading	Low Limit	Test Pass	Test Fail
AC VOLTAGE OFFSET AND GAIN TESTS							
20 mV, 150 Hz	200 mV	FUNC ACV	2.070000E-02	________	1.930000E-02	____	____
200 mV, 150 Hz	200 mV	FUNC ACV	2.016000E-01	________	1.984000E-01	____	____
200 mV, 150 Hz	2 V	FUNC ACV	2.070000E-01	________	1.930000E-01	____	____
1 V, 150 Hz	2 V	FUNC ACV	1.011000E+00	________	9.890000E-01	____	____
2 V, 150 Hz	2 V	FUNC ACV	2.016000E+00	________	1.984000E+00	____	____
2 V, 150 Hz	20 V	FUNC ACV	2.070000E+00	________	1.930000E+00	____	____
20 V, 150 Hz	20 V	FUNC ACV	2.016000E+01	________	1.984000E+01	____	____
20 V, 150 Hz	200 V	FUNC ACV	2.070000E+01	________	1.930000E+01	____	____
200 V, 150 Hz	200 V	FUNC ACV	2.016000E+02	________	1.984000E+02	____	____
AC VOLTAGE FREQUENCY RESPONSE TEST							
200 mV, 45 Hz	200 mV	FUNC ACV	2.016000E-01	________	1.984000E-01	____	____
200 mV, 500 Hz	200 mV	FUNC ACV	2.016000E-01	________	1.984000E-01	____	____
2 V, 45 Hz	2 V	FUNC ACV	2.016000E+00	________	1.984000E+00	____	____
2 V, 500 Hz	2 V	FUNC ACV	2.016000E+00	________	1.984000E+00	____	____
20 V, 45 Hz	20 V	FUNC ACV	2.016000E+01	________	1.984000E+01	____	____
20 V, 500 Hz	20 V	FUNC ACV	2.016000E+01	________	1.984000E+01	____	____
200 V, 45 Hz	200 V	FUNC ACV	2.016000E+02	________	1.984000E+02	____	____
200 V, 500 Hz	200 V	FUNC ACV	2.016000E+02	________	1.984000E+02	____	____

AC VOLTAGE PERFORMANCE TEST CARD

1 YEAR TEST LIMITS

Hewlett-Packard Model 44701A

Integrating Voltmeter

Test Performed By________________________

Date_______________ Reference Temperature__________

44701A Input	44701A Range	44701A Set-Up	High Limit	Reading	Low Limit	Test Pass	Test Fail
AC VOLTAGE OFFSET AND GAIN TESTS							
20 mV, 150 Hz	200 mV	FUNC ACV	2.105000E-02	____________	1.895000E-02	____	____
200 mV, 150 Hz	200 mV	FUNC ACV	2.024000E-01	____________	1.976000E-01	____	____
200 mV, 150 Hz	2 V	FUNC ACV	2.105000E-01	____________	1.895000E-01	____	____
1 V, 150 Hz	2 V	FUNC ACV	1.016500E+00	____________	9.835000E-01	____	____
2 V, 150 Hz	2 V	FUNC ACV	2.024000E+00	____________	1.976000E+00	____	____
2 V, 150 Hz	20 V	FUNC ACV	2.105000E+00	____________	1.895000E+00	____	____
20 V, 150 Hz	20 V	FUNC ACV	2.024000E+01	____________	1.976000E+01	____	____
20 V, 150 Hz	200 V	FUNC ACV	2.105000E+01	____________	1.895000E+01	____	____
200 V, 150 Hz	200 V	FUNC ACV	2.024000E+02	____________	1.976000E+02	____	____
AC VOLTAGE FREQUENCY RESPONSE TEST							
200 mV, 45 Hz	200 mV	FUNC ACV	2.024000E-01	____________	1.976000E-01	____	____
200 mV, 500 Hz	200 mV	FUNC ACV	2.024000E-01	____________	1.976000E-01	____	____
2 V, 45 Hz	2 V	FUNC ACV	2.024000E+00	____________	1.976000E+00	____	____
2 V, 500 Hz	2 V	FUNC ACV	2.024000E+00	____________	1.976000E+00	____	____
20 V, 45 Hz	20 V	FUNC ACV	2.024000E+01	____________	1.976000E+01	____	____
20 V, 500 Hz	20 V	FUNC ACV	2.024000E+01	____________	1.976000E+01	____	____
200 V, 45 Hz	200 V	FUNC ACV	2.024000E+02	____________	1.976000E+02	____	____
200 V, 500 Hz	200 V	FUNC ACV	2.024000E+02	____________	1.976000E+02	____	____

6-34 CALIBRATION

6-35 Introduction

The calibration procedures in this section are used to calibrate the HP 44701A Integrating Voltmeter in all functions (DCV, ACV, and Ohms).

The HP 44701A Integrating Voltmeter is calibrated programatically; no internal adjustments are performed. All calibration is done from the front panel (or by computer control). Calibration is performed by applying a known calibration signal to the voltmeter input terminals. This signal is measured by the voltmeter from which calibration constants are calculated. These constants are then stored in an EEPROM and are used to correctly calculate the measurements normally made by the voltmeter.

WARNING

The following procedures are intended for Service Trained Personnel who understand electronic circuitry and are aware of the hazards involved. Do not attempt to perform any of the procedures unless you are qualified to do so.

6-36 Equipment Required

The following test equipment is required to calibrate the voltmeter accessory.

1. Low Thermal Short -- Use a solid copper wire

2. Test Leads

3. DC Voltage Standard -- Datron Model 4000/4000A

If the recommended DC Voltage Standard is not available, use one that is capable of outputting the following voltages at the specified limits. The listed specifications are at least eight times better than the specifications of the HP 44701A Integrating Voltmeter.

30 mV (±0.005%)
300 mV (±0.0012%)
3 V (±0.001%)
30 V (±0.0011%)
300 V (±0.001%)

4. Resistance Standard -- Datron Model 4000/4000A

The Datron Model 4000/4000A normally have resistance ranges of 1 Ω though 1 MΩ. However, a special version is available with resistance ranges of 3 Ω through 3 MΩ. Either version will work to calibrate the HP 44701A Ohms function.

If the recommended Resistance Standard is not available, use one that is capable of outputting the following resistance values at the specified limits. The listed specifications are at least eight times better than the specifications of the HP 44701A Integrating Voltmeter.

Instead of using a resistance standard (like the Datron 4000/4000A), you can use standard resistors. Likewise with the resistance standard, you can also use either 30 Ω through 30 MΩ resistors (full scale inputs) or 10 Ω through 10 MΩ resistors (1/3 scale inputs).

30 Ω or 10 Ω (±0.005%)
300 Ω or 100 Ω (±.0021%)
3 kΩ or 1 kΩ (±0.0021%)
30 kΩ or 10 kΩ (±0.0019%)
300 kΩ or 100 kΩ (±0.0018%)
3 MΩ or 1 MΩ (±0.012%)

5. AC Voltage Standard -- Datron Model 4200

If the recommended AC Voltage Standard is not available, use one that is capable of outputting the following voltages at the specified frequencies and limits. The listed specifications are at least eight times better than the specifications of the HP 44701A Integrating Voltmeter.

20 mV (±0.066%) at 45 Hz, 150 Hz, and 500 Hz
200 mV (±0.066%) at 45 Hz, 150 Hz, and 500 Hz
2 V (±0.066%) at 45 Hz, 150 Hz, and 500 Hz
20 V (±0.066%) at 45 Hz, 150 Hz, and 500 Hz
200 V (±0.066%) at 45 Hz, 150 Hz, and 500 Hz

6-37 Calibration Cycle

Periodic calibration should be performed to ensure that the voltmeter is meeting its accuracy specifications. All functions should be calibrated every 90 days or 1 year, dependent on accuracy requirements. Calibration should also be performed if it is determined by the Performance/Operational Verification Test procedures that it is needed.

6-38 Calibration Environment

The HP 44701A Integrating Voltmeter may be calibrated in a "bench" environment or system cabinet. For best accuracy, the temperature of the calibration environment should be within ±5° C of the actual operating environment. The HP 44701A was calibrated at the factory at an environment temperature of 20° C.

6-39 Calibration Procedures

The calibration procedures should be performed in the order they are given. It is especially important to perform the DC Volts Calibration Procedure before performing the Ohms Calibration Procedure. This is necessary because the ohms calibration constants depend on the dc volts calibration constants. The calibration procedures consist of the following:

Section 6-40 - Set-Up Procedure
Section 6-41 - DC Volts Calibration Procedure
Section 6-42 - Ohms Calibration Procedure
Section 6-43 - AC Volts Calibration Procedure

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

6-40 Set-Up Procedure

1. Apply power to the HP 3852A and allow the HP 44701A Integrating Voltmeter a one hour warm-up period inside the mainframe. This is necessary to stabilize the voltmeter before calibration.

2. Press the RESET button on the HP 3852A front panel. Perform the HP 44701A Integrating Voltmeter self-test by executing:

   TEST ES00 (where E = extender number, S = slot number)

3. The HP 3852A right display should show:

   SELF TEST OK

If the display shows a different message, or if the ERR annunciator is on, the HP 44701A Integrating Voltmeter may be failing its self test. Test the voltmeter again by executing the command in step 2. If the voltmeter still fails, repair of the unit may be necessary.

4. Designate the HP 44701A to be calibrated by executing:

   USE ES00 (where E = extender number, S = slot number)

This command establishes the extender/slot number used in all calibration procedures for command destination. If the HP 3852A is reset or power is removed, it is necessary to perform step 4 again to re-establish the extender/slot number.

6-41 DC Voltage Calibration

Calibration of the dc volts function consists of calibrating both the function's offset and gain on all ranges. Offset calibration is performed by applying 0 V. Gain calibration is performed by applying full scale voltages (i.e., 300 V, 30 V, 3 V, 300 mV, and 30 mV).

1. DC VOLTAGE OFFSET CALIBRATION. The following calibrates the dc volts function's offset on all ranges.

2. Perform the Set-Up Procedure in Section 6-40, if not previously performed.

3. Connect a low thermal short across the rear HI and LO Input Terminals of the HP 44701A Integrating Voltmeter accessory.

4. Set the HP 44701A to calibrate dc volts by executing:

```
FUNC DCV
NPLC 16
TERM EXT
TRIG HOLD
```

5. The 300 V Range is calibrated first. Set the HP 44701A to the 300 V Range by executing:

   RANGE 300

6. The value of the calibration signal is now entered in order for the voltmeter to calculate the offset calibration constant. Since a short is applied to the Input Terminals, the calibration signal value is 0. This

value is entered using the CAL *num* command (where *num* is the value of the calibration signal). Execute the following:

CAL 0

7. The BUSY annunciator in the HP 3852A display will be on while calibration is taking place. When the annunciator turns off, calibration is completed.

8. Repeat steps 5, 6, and 7 for the 30 V, 3 V, 300 mV, and 30 mV Ranges. To set the different ranges, use the following commands:

30 V Range - RANGE 30
3 V Range - RANGE 3
300 mV Range - RANGE .3
30 mV Range - RANGE .03

9. When all ranges are calibrated, leave the setup in step 4 for the next calibration procedure. Remove the low thermal short from the HI and LO Input Terminals.

10. DC VOLTAGE GAIN CALIBRATION. The following calibrates the dc volts function's gain on all ranges.

NOTE

Always uprange the HP 44701A Integrating Voltmeter before upranging the DC Voltage Standard and always downrange the DC Voltage Standard before downranging the HP 44701A.

WARNING

Since lethal voltages are used to calibrate the dc volts function, use extreme caution when performing the calibration procedure.

11. Make sure the DC Voltage Standard output is turned off or set the output to 0 volts. Then connect the DC Voltage Standard to the rear HI and LO Input Terminals of the HP 44701A Integrating Voltmeter accessory. The connections are shown in Figure 6-6.

12. Set the HP 44701A to the 300 V Range by executing:

RANGE 300

13. Set the DC Voltage Standard to output 300 Vdc.

14. The value of the calibration signal is now entered in order for the voltmeter to calculate the gain calibration constant. The value is entered using the CAL *num* command (where *num* is the value of the calibration signal). Execute the following:

CAL 300

15. The BUSY annunciator in the HP 3852A display will be on while calibration is taking place. When the annunciator turns off, calibration is completed.

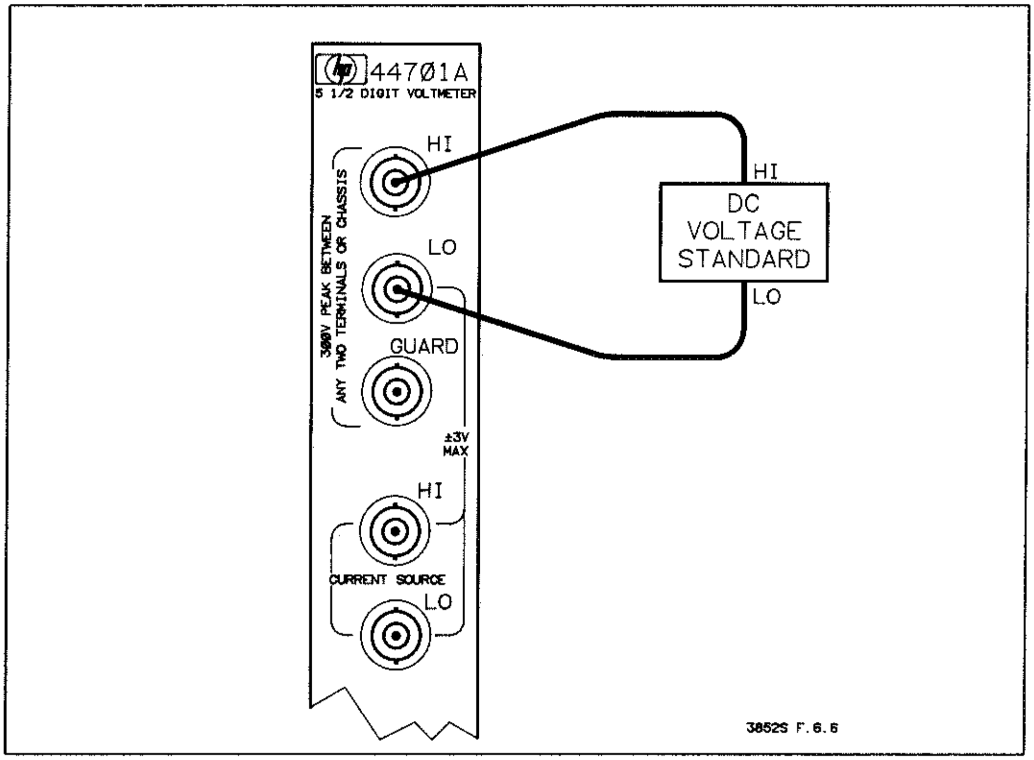


Figure 6-6 DC Voltage Gain Calibration

Table 6-9 DC Voltage Gain Calibration Configurations

44701A Range	Cal Signal	Range Select	Cal Select
300 V	+300 V	RANGE 300	CAL 300
30 V	+30 V	RANGE 30	CAL 30
3 V	+3 V	RANGE 3	CAL 3
300 mV	+0.3 V	RANGE .3	CAL .3
30 mV	+0.03 V	RANGE .03	CAL .03

16. Repeat steps 12, 13, 14, and 15 for the 30 V, 3 V, 300 mV, and 30 mV Ranges. To calibrate the next lower range, **first reduce the DC Voltage Standard to the appropriate calibration voltage. Then set the HP 44701A to the next lower range.** Table 6-9 lists the different dc volts ranges, the appropriate RANGE command to select the ranges, and the appropriate CAL command to calibrate the different ranges.

17. When all ranges are calibrated, turn the DC Voltage Standard output off or set the output to 0 volts. Then remove the DC Voltage Standard from the HI and LO Input Terminals.

6-42 Ohms Calibration

Make sure DC Volts Calibration in Section 6-41 has been performed before doing Ohms Calibration.

Calibration of the ohms function consists of calibrating both the function's offset and gain on all ranges. Offset calibration is performed by applying 0 Ω. Gain calibration is performed by applying full scale resistance values (i.e., 3 Mohm through 30 ohm) or 1/3 scale resistance values (i.e., 1 Mohm through 10 ohm).

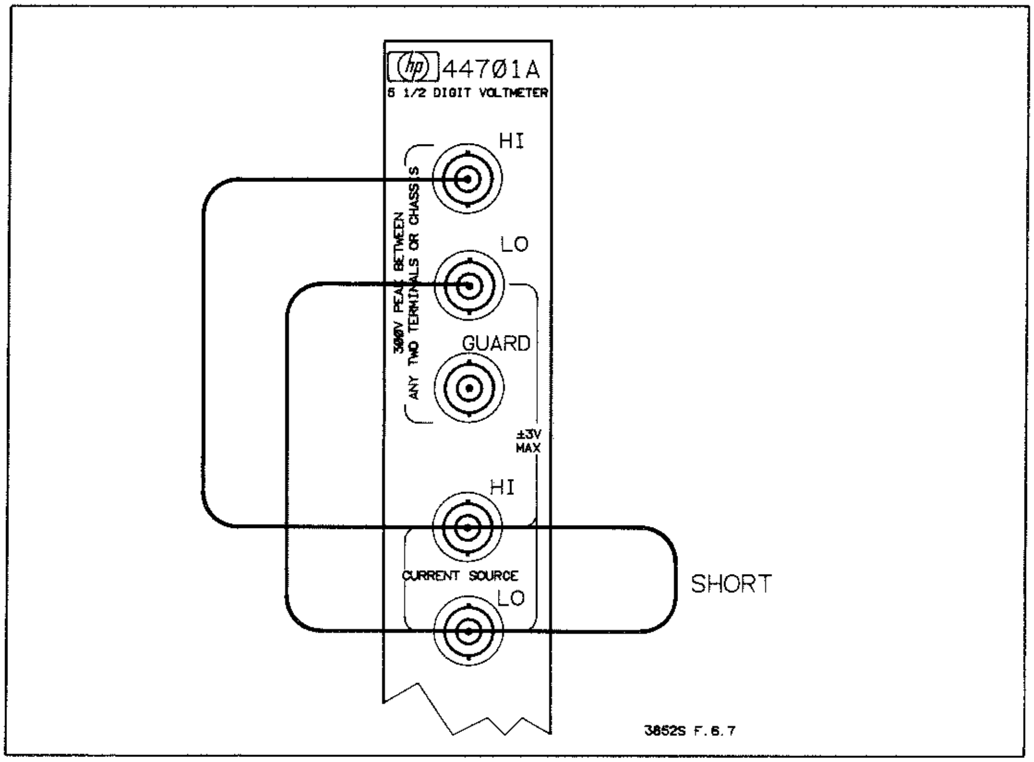


Figure 6-7 Ohms Offset Calibration

1. OHMS OFFSET CALIBRATION. The following calibrates the ohms function's offset on all ranges.

2. Perform the Set-Up Procedure in Section 6-40, if not previously performed.

3. Connect the HP 44701A rear panel Current Source HI Output Terminal to the rear panel HI Input Terminal. Connect the rear panel Current Source LO Output Terminal to the rear panel LO Input Terminal. Connect a low thermal short across the rear HI and LO Input Terminals of the HP 44701A Integrating Voltmeter accessory. The connections are shown in Figure 6-7.

4. Set the HP 44701A to calibrate ohms by executing:

```
FUNC OHMF
NPLC 16
TERM EXT
TRIG HOLD
```

5. The 3 Mohm Range is calibrated first. Set the HP 44701A to the 3 Mohm Range by executing:

```
RANGE 3E6
```

6. The value of the calibration signal is now entered in order for the voltmeter to calculate the offset calibration constant. Since a short is applied to the Input Terminals, the calibration signal value is 0. This value is entered using the CAL *num* command (where *num* is the value of the calibration signal). Execute the following:

```
CAL 0
```

7. The BUSY annunciator in the HP 3852A display will be on while calibration is taking place. When the annunciator turns off, calibration is completed.

8. Repeat steps 5, 6, and 7 for the 300 Kohm, 30 Kohm, 3 Kohm, 300 ohm, and 30 ohm Ranges. To set the different ranges, use the following commands:

300 Kohm Range - RANGE 3E5
30 Kohm Ranges - RANGE 3E4
3 Kohm Range - RANGE 3E3
300 ohm Range - RANGE 300
30 ohm Range - RANGE 30

9. When all ranges are calibrated, leave the setup in step 4 for the next calibration procedure. Remove the low thermal short from the HI and LO Input Terminals, but do not remove the other connections.

10. OHMS GAIN CALIBRATION. The following calibrates the ohms function's gain on all ranges. Either 3 Mohm through 30 ohm ohm resistors or 1 Mohm through 10 ohm resistors can be used to calibrate the ohms function.

11. If using the Resistance Standard, set its output to 3 Mohm or 1 Mohm. If using a Standard Resistor, select either a 3 Mohm or 1 Mohm resistor. Connect the Resistance Standard/Standard Resistor to the rear HI and LO Input Terminals of the HP 44701A Integrating Voltmeter. The connections are shown in Figure 6-8.

12. Set the HP 44701A to the 3 Mohm Range by executing:

RANGE 3E6

13. The value of the calibration signal is now entered in order for the voltmeter to calculate the gain calibration constant. The value is entered using the CAL *num* command (where *num* is the value of the calibration signal). Execute the following:

CAL 3E6

14. The BUSY annunciator in the HP 3852A display will be on while calibration is taking place. When the annunciator turns off, calibration is completed.

15. Repeat steps 11, 12, 13, and 14 for the 300 Kohm through 30 ohm Ranges. Table 6-10 lists the different ohms ranges, the appropriate RANGE command to select the ranges, and the appropriate CAL command to calibrate the different ranges.

16. When all ranges are calibrated, remove the Resistance Standard/Standard Resistor from the HI and LO Input Terminals.

6-43 AC Voltage Calibration

Calibration of the ac volts function consists of calibrating both the function's offset and gain on all ranges. Offset calibration is performed by applying 0 V. Gain calibration is performed by applying full scale voltages (i.e., 200 V, 20 V, 2 V, and 200 mV).

1. AC VOLTAGE OFFSET CALIBRATION. The following calibrates the ac volts function's offset on all ranges.

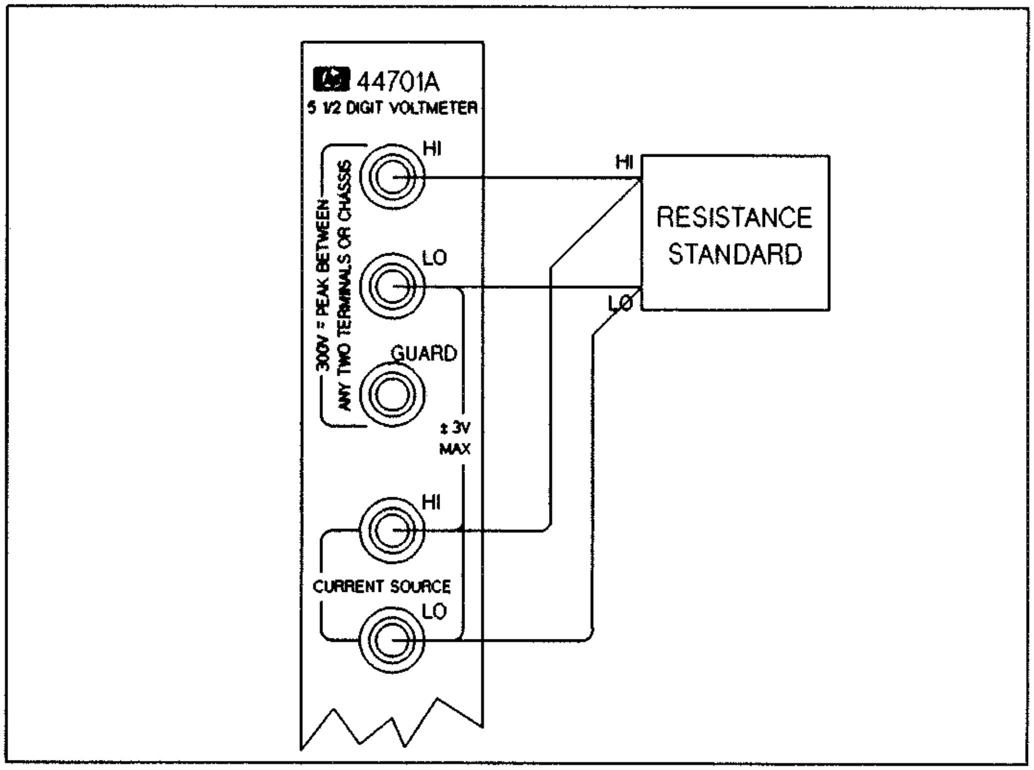


Figure 6-8a Ohms Gain Calibration Using a Resistance Standard

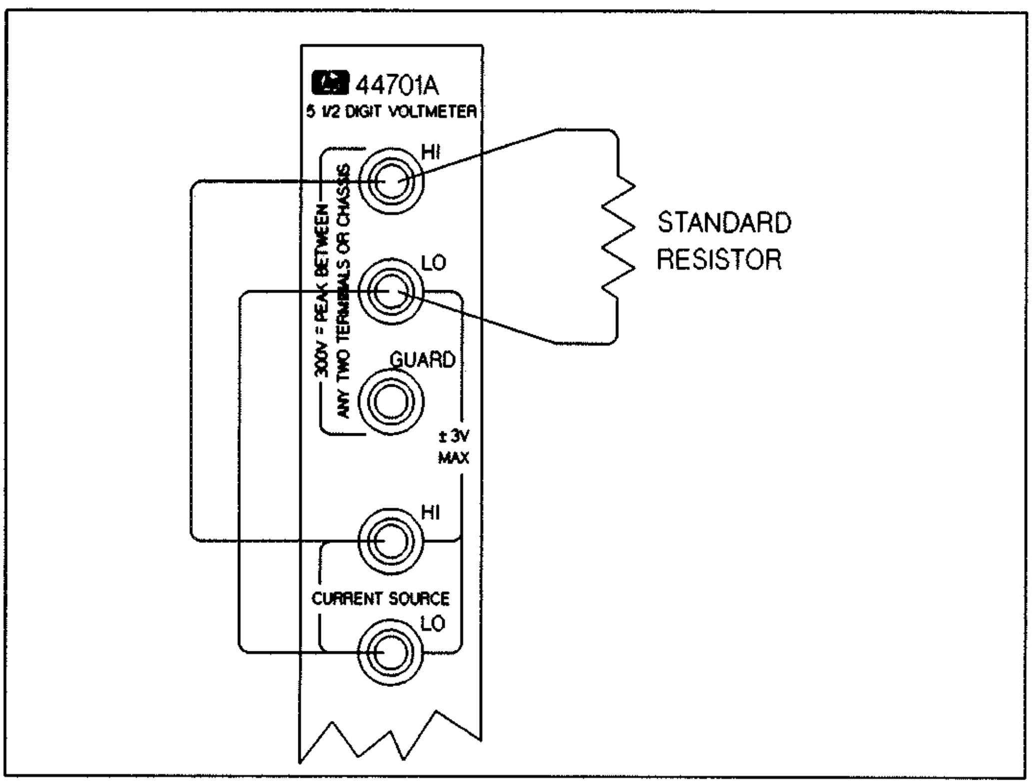


Figure 6-8b Ohms Gain Calibration Using Standard Resistors

Table 6-10 Ohms Gain Calibration Configurations

44701A Range	Cal Signal	Range Select	Cal Select
3 Mohm	3 Mohm	RANGE 3E6	CAL 3E6
3 Mohm*	1 Mohm	RANGE 3E6	CAL 1E6
300 Kohm	300 Kohm	RANGE 3E5	CAL 300E3
300 Kohm*	100 Kohm	RANGE 3E5	CAL 100E3
30 Kohm	30 Kohm	RANGE 3E4	CAL 30E3
30 Kohm*	10 Kohm	RANGE 3E4	CAL 10E3
3 Kohm	3 Kohm	RANGE 3E3	CAL 3E3
3 Kohm*	1 Kohm	RANGE 3E3	CAL 1E3
300 ohm	300 ohm	RANGE 300	CAL 300
300 ohm*	100 ohm	RANGE 300	CAL 100
30 ohm	30 ohm	RANGE 30	CAL 30
30 ohm*	10 ohm	RANGE 30	CAL 10
*For 1/3 scale inputs only			

2. Perform the Set-Up Procedure in Section 6-40, if not previously performed.

3. Connect a low thermal short across the rear HI and LO Input Terminals of the HP 44701A Integrating Voltmeter accessory.

4. Set the HP 44701A to calibrate ac volts by executing:

FUNC ACV
NPLC 16
TERM EXT
TRIG HOLD

5. The 200 V Range is calibrated first. Set the HP 44701A to the 200 V Range by executing:

RANGE 200

6. The value of the calibration signal is now entered in order for the voltmeter to calculate the offset calibration constant. Since a short is applied to the Input Terminals, the calibration signal value is 0. This value is entered using the CAL *num* command (where *num* is the value of the calibration signal). Execute the following:

CAL 0

7. The BUSY annunciator in the HP 3852A display will be on while calibration is taking place. When the annunciator turns off, calibration is completed.

8. Repeat steps 5, 6, and 7 for the 20 V, 2 V, and 200 mV Ranges. To set the different ranges, use the following commands:

20 V Range - RANGE 20
2 V Range - RANGE 2
200 mV Range - RANGE .2

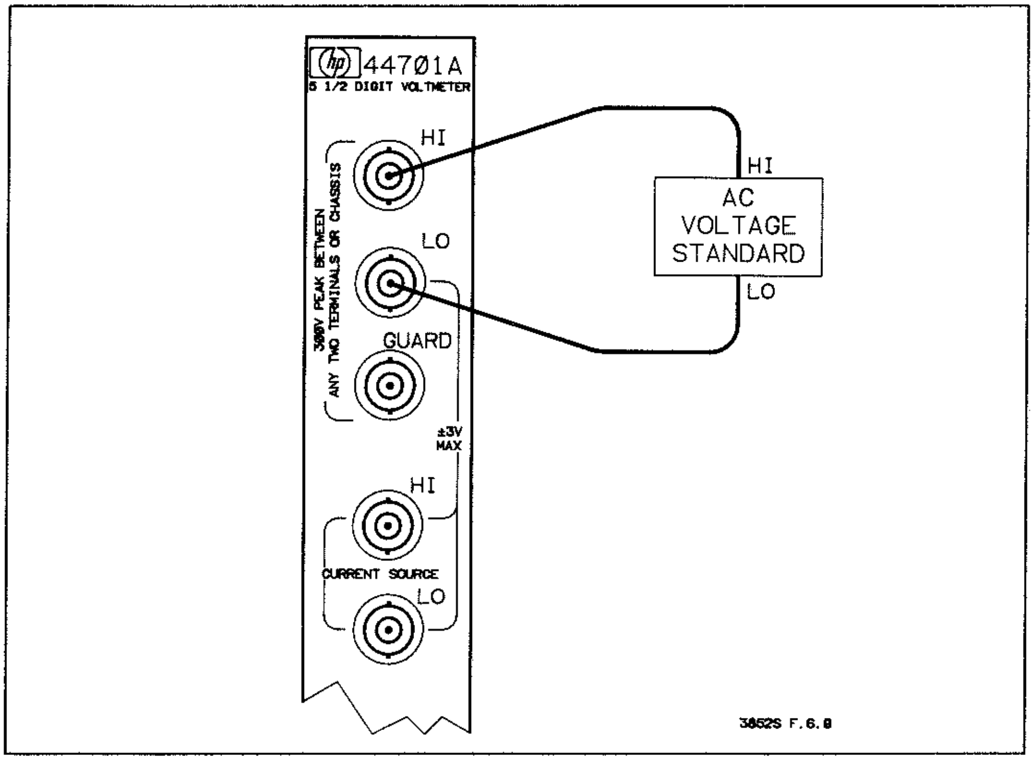


Figure 6-9 AC Voltage Gain Calibration

9. When all ranges are calibrated, leave the setup in step 4 for the next calibration procedure. Remove the low thermal short from the HI and LO Input Terminals.

10. AC VOLTAGE GAIN CALIBRATION. The following calibrates the ac volts function's gain on all ranges.

NOTE

Always uprange the HP 44701A Integrating Voltmeter before upranging the AC Voltage Standard and always downrange the AC Voltage Standard before downranging the HP 44701A.

WARNING

Since lethal voltages are used to calibrate the ac volts function, use extreme caution when performing the calibration procedure.

11. Make sure the AC Voltage Standard output is turned off or set the output to 0 volts. Then connect the AC Voltage Standard to the rear HI and LO Input Terminals of the HP 44701A Integrating Voltmeter accessory. The connections are shown in Figure 6-9.

12. Set the HP 44701A to the 200 V Range by executing:

RANGE 200

13. Set the AC Voltage Standard to output 200 VRMS at 50 Hz.

14. The value of the calibration signal is now entered in order for the voltmeter to calculate the gain calibration constant. The value is entered using the CAL *num* command (where *num* is the value of the calibration signal). Execute the following:

CAL 200

15. The BUSY annunciator in the HP 3852A display will be on while calibration is taking place. When the annunciator turns off, calibration is completed.

16. Repeat steps 12, 13, 14, and 15 for the 20 V, 2 V, and 200 mV Ranges. To calibrate the next lower range, first reduce the AC Voltage Standard to the appropriate calibration voltage. Then set the HP 44701A to the next lower range. Table 6-11 lists the different ac volts ranges, the appropriate RANGE command to select the ranges, and the appropriate CAL command to calibrate the different ranges.

Table 6-11 AC Voltage Gain Calibration Configurations

44701A Range	Cal Signal	Range Select	Cal Select
200 V	200 V, 50 Hz	RANGE 200	CAL 200
20 V	20 V, 50 Hz	RANGE 20	CAL 20
2 V	2 V, 50 Hz	RANGE 2	CAL 2
200 mV	0.2 V, 50 Hz	RANGE .2	CAL .2

17. When all ranges are calibrated, turn the AC Voltage Standard output off or set the output to 0 volts. Then remove the AC Voltage Standard from the HI and LO Input Terminals.

THIS CONCLUDES THE HP 44701A CALIBRATION PROCEDURES.

6-44 REPLACEABLE PARTS

Figure 6-10 shows the mechanical breakdown of the HP 44701A. This figure also provides assembly and disassembly information. The parts in Figure 6-10 are keyed to the parts list in Table 6-12.

To order a part listed in Table 6-12, quote the Hewlett-Packard part number, the check digit (abbreviated CD in Table 6-12), the HP factory reference, and the quantity desired. Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed at the back of this manual.

CAUTION

The printed circuit boards in the HP 44701A are static sensitive devices. Refer to Chapter 5 for additional information about handling static sensitive devices.

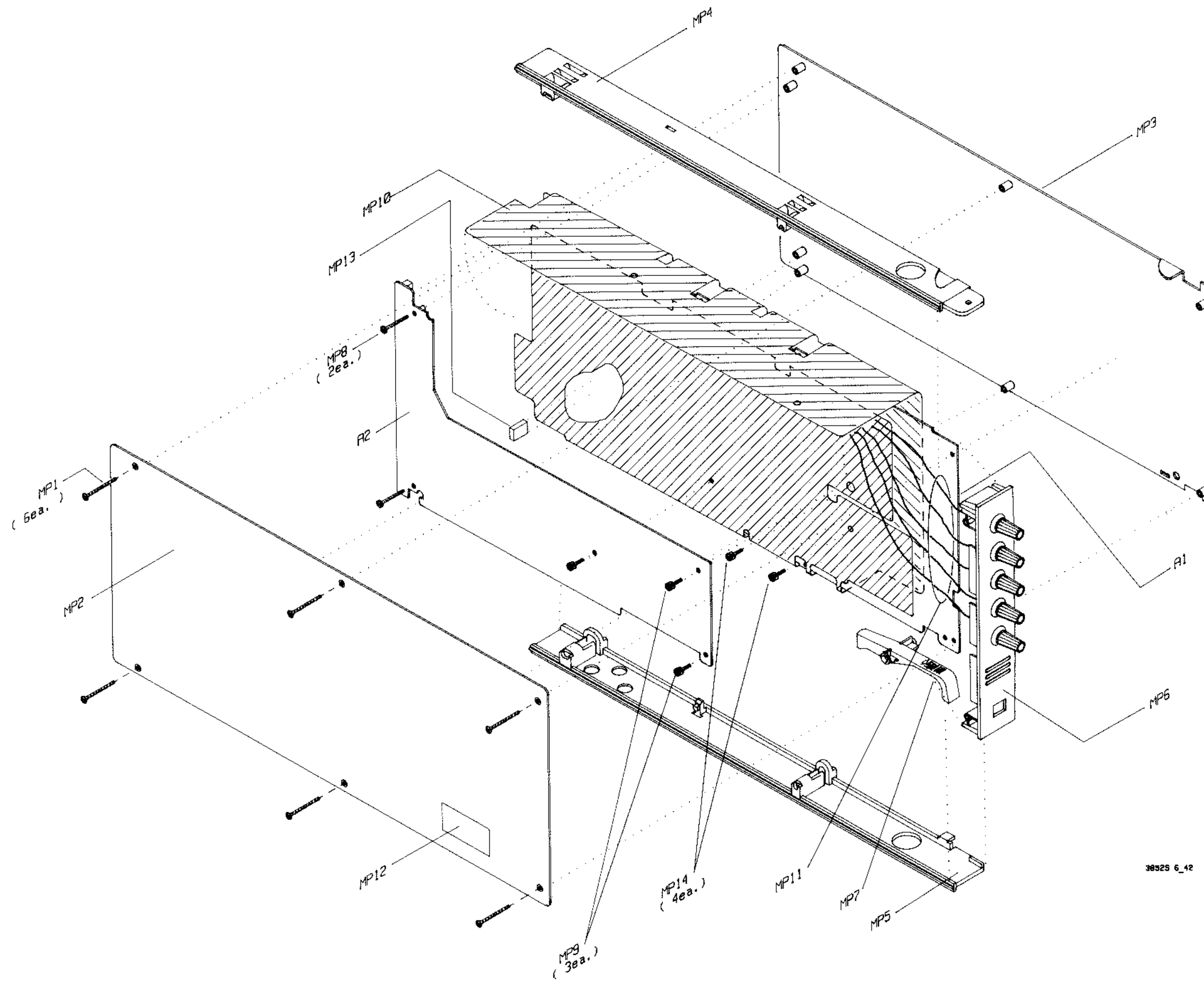


Figure 6-10 Integrating Voltmeter Exploded View

Table 6-12 HP 44701A 5-1/2 Digit Integrating Voltmeter

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44701A	5-1/2 digit integrating voltmeter	1	44701A	8	INTEGRATING VM
A1	PCA; integrating voltmeter analog	1	44701-66501	0	PCA-INT VM ANALG
A2	PCA; integrating voltmeter digital	1	44701-66502	1	PCA-INT VM DIGTL
MP1	Screw; cover	6	0515-1322	4	SCR-FH M3.0X30LK
MP2	Cover; left (aluminum)	1	44701-04101	6	0601 CVR-A/D LT
MP3	Cover; right (aluminum)	1	44701-04102	7	0601 CVR-A/D RT
MP4	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP5	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP6	Panel; rear (molded) with terminals	1	44701-60201	5	PNL-RR,PREC A/D
MP7	Pull lever; (molded)	1	03852-45002	8	MLD-PULL LEVER
MP8	Screw; A2 PCA (connector end of PCA)	2	0515-0845	4	SCR-PH M3.0X18LK
MP9	Screw; A2 PCA (with captive washer)	3	0515-0866	9	SCR-PH M3.0X8 CW
MP10	Shield; flexible poly covered foil	1	44701-60601	9	SHLD-FLM,POLY AL
MP11	Cable; voltmeter input (5 conductor)	1	44701-61602	2	CBL-VM INPUT
MP12	Label; "maximum number assemblies.."	1	03852-84326	1	LBL-CAUTION,PWR
MP13	Jumper; A1 PCA jumper J200	1	1258-0141	8	JMPR-REM .025P
MP14	Screw; flexible shield	4	0515-0886	3	SCR-PH M3.0X6LK

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44701A	5-1/2 digit integrating voltmeter		44701-69201	3	RBLT-44701A

Chapter 7
HP 44702A/B High-Speed Voltmeter

CHAPTER 7
HP 44702A/B 13-BIT HIGH SPEED VOLTMETER

CHAPTER 7
HP 44702A/B
13-BIT HIGH SPEED VOLTMETER

7-1 INTRODUCTION

This chapter provides a technical description, performance test procedures, calibration procedures and replaceable parts lists for the HP 44702A and HP 44702B 13-Bit High Speed Voltmeter.

7-2 HP 44702A and HP 44702B Differences

The HP 44702A allows up to 8 K readings to be stored in on board memory in the voltmeter. The HP 44702B increases this readings storage capacity to 64 K. The increase in the capacity is accomplished by the addition of an extended memory printed circuit board. With the exception of this extended memory the HP 44702A and HP 44702B are identical.

7-3 Technical Description

The HP 44702A/B is a two function voltmeter. The functions directly supported by the voltmeter are DC volts and four wire ohms measurements. The voltmeter is capable of measuring current when supplied with an external shunt.

The HP 44702A/B makes measurements from any of three input sources: the HP 3852A backplane analog bus, the rear panel terminals, or the ribbon cable analog bus.

The voltmeter measurement resolution is 12 bits plus a sign bit. The voltmeter is capable of auto-ranging and auto-zeroing the input. The maximum reading rate of 100,000 readings per second can only be achieved when the HP 44702A/B is used with a high-speed FET multiplexer accessory and the measurements are transferred over the ribbon cable analog bus.

The voltmeter may be controlled through the HP 3852A backplane digital bus or through a GPIO port. The GPIO port is located on the rear panel of the HP 44702A/B. The use of the GPIO port allows measurements to be transferred directly to computer memory.

Calibration of the HP 44702A/B is accomplished programatically. There are no mechanical adjustments in the voltmeter. Calibration constants for gain and offset are retained in non-volatile memory within the HP 44702A/B.

A block diagram of the HP 44702A/B is shown in Figure 7-1. As described in Section 7-2, the addition of the HP 44703C extended memory changes the HP 44702A into an HP 44702B.

The HP44702A/B has two internal address and data busses. The 16-bit Bus is used for data (reading) transfer from the analog-to-digital (A/D) converter to the Data Buffer/Memory. It is also used to transfer data from the Data Buffer/Memory to either the Backplane or GPIO Interface.

Commands from the mainframe via the backplane or commands from the GPIO Interface are also transferred by the 16-bit Bus to the Control/Data Registers. All external communications to and from the Local Controller go through these registers.

The HP 44702A/B local controller contains the voltmeter microprocessor. The local controller sets up the requested measurements, performs the voltmeter data conversions, and controls the high-speed ribbon cable bus. The calibration constants for the voltmeter are stored in the local controller in an EEPROM.

The Bus Controller controls the 16-bit Bus using a direct memory access technique (DMA).

The On-Board Input Multiplexer is a FET multiplexer which connects any one of three external analog busses to the A/D converter. These include the backplane input (through the isolation relays), rear panel input terminals on the voltmeter module, and High-Speed Ribbon Cable.

The High-Speed Ribbon Cable is designed to connect the HP 44702A/B to the high-speed FET multiplexers. There are three FET multiplexers available: the HP 44711A 24 Channel High-Speed FET Multiplexer, the HP 44712A 48 Channel Single Ended High-Speed FET Multiplexer, and the HP 44713A 24 Channel High-Speed FET Multiplexer with Thermocouple Compensation. These multiplexers can all be controlled through the ribbon cable digital bus. The ribbon cable bus can be connected in a daisy-chain fashion so that the HP 44702A/B can control several multiplexers at once. The connection of the ribbon cable forms a separate and independent sub-system within the HP 3852A system.

The controlling of the high-speed FET multiplexers is done by passing coded channel list information to the multiplexers over the ribbon cable. This is used to close the proper channel before a measurement is made. The coded channel list information is stored in the Scan RAM. The Scan Control circuitry consists of counters that are used to sequence (address) the Scan RAM causing its data to be sent to the Ribbon Cable Interface. The Ribbon Cable Interface sends this data over the ribbon cable to the high-speed FET multiplexer to close the appropriate channel. Both the Scan RAM and Scan Control circuitry are setup by the Local Controller prior to initiating a scan sequence.

The Scan and Meas Trigger/Pacer block contains the trigger selection circuitry and the trigger pacers. The trigger pacers are only used if selected as the trigger source.

The analog to digital converter performs the actual measurements. The measurements are input to the analog to digital converter from the input multiplexer. The local controller communicates with the analog to digital converter through the Control/Data Registers.

The Current Source contains the source and selection circuitry for the 1 mA, 100 µA, and 10 µA sources. These are used to make four-wire ohms measurements.

The ID, Status, Control, and Trigger Registers are used to allow the external mainframe or GPIO controller to directly control the voltmeter and transfer readings from the voltmeter.

The Data Buffer/Memory is used to store readings taken by the A/D converter. It can only be read through the GPIO and backplane by an external controller.

The Backplane interface and GPIO interface perform the necessary bus control functions such as handshaking and interrupting. The interfaces communicate with the HP 44702A/B through the Control/Data Registers.

The analog bus can be isolated from the HP 3852A backplane by isolation relays. These relays can be opened to reduce the backplane loading effect of the voltmeter.

7-4 SPECIFICATIONS

Specifications for the HP 44702A/B are given in Table 7-1. Specifications are the performance standards or limits against which the HIgh Speed Voltmeter may be tested.

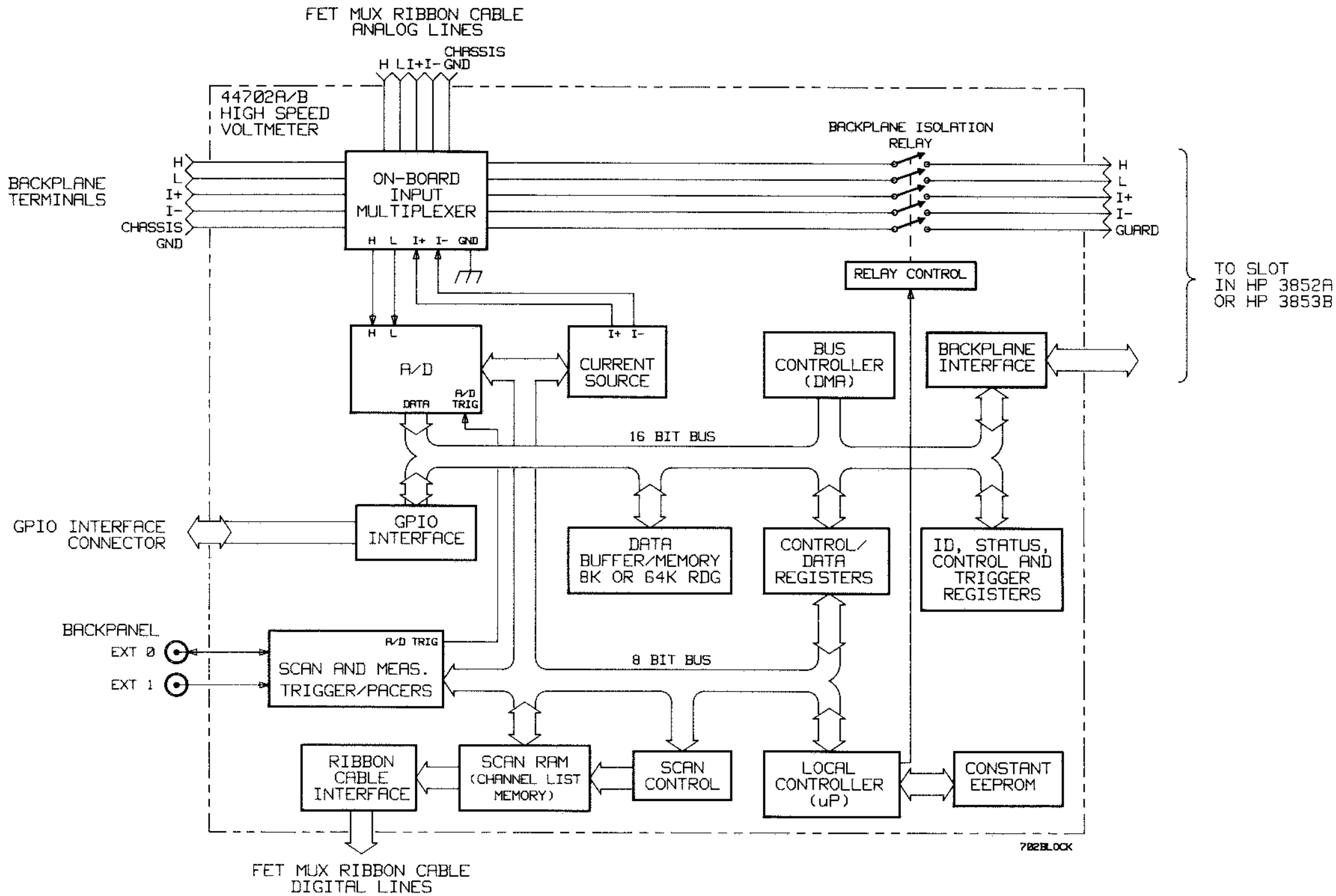


Figure 7-1 HP 44702A/B Block Diagram

Table 7-1 HP 44702A/B Specifications

DC VOLTAGE

Accuracy: ±(% of reading + volts) rear terminal, one hour warmup, specified over time since last calibration, and operating temperature, with auto-zeroing performed within one minute of measurement.

90 Days, 18°C to 28°C

40 mV Range:	0.05% + 68 µV
320 mV Range:	0.05% + 234 µV
2.56 V Range:	0.05% + 1.88 mV
10.24 V Range:	0.05% + 7.5 mV

Average Readings, 90 Days 18° to 28°C

Accuracy if 100 readings are averaged:

For 40 mV Range: 0.05% + 39 µV

Accuracy if 10 readings are averaged (little advantage to averaging more readings):

For 320 mV Range: 0.05% + 156 µV
For 2.56 V Range: 0.05% + 1.25 mV
For 10.24 V Range: 0.05% + 5 mV

1 Year: Add 0.05% of reading to the 90 Days Specifications

Temperature Coefficient:

Add as an additional accuracy error using ±(% of reading + volts) per °C change outside 18° to 28°C, as long as the operating temperature is maintained between 0 to 18° or 28° to 55°C.

For 40 mV Range add 0.004% + 0.488 µV
For 320 mV Range add 0.002% + 3.91 µV
For 2.56 V Range add 0.002% + 31.3 µV
For 10.24 V Range add 0.002% + 125 µV

Resolution: 12 bits plus a sign bit

Range	Resolution
40 mV	9.77 µV
320 mV	78.1 µV
2.56 V	625 µV
10.24 V	2.5 mV

Table 7-1 HP 44702A/B Specifications (Cont.)

Over-ranging: None; maximum signal (high to low) + common mode voltage (low to chassis) to prevent out-of-range indication is ±10.24 V.

Reading Rate: 100,000 readings/second with auto-ranging. Proper auto-ranging is ensured as long as a single-channel signal changes no more than 600 volts/second during auto-ranging.

RESISTANCE

Accuracy: ±(% of reading + ohms), 4-wire or 2-wire ohms, maximum expected (resistance function) determines the current source used, rear terminal inputs, one-hour warmup, specified over time since last calibration, and operating temperature, with auto-zeroing performed within one minute of measurement. (Current source compliance voltage is at least 17 V. Only the HP 44711A FET multiplexer is recommended for measuring resistance properly.

90 Days, 18°C to 28°C

Function	Range	Accuracy
10 KΩ (1 mA current source)	40 Ω 320 Ω 2.56 KΩ 10.24 KΩ	0.07% + 107 mΩ 0.07% + 234 mΩ 0.07% + 1.875 Ω 0.07% + 7.5 Ω
100 KΩ (100 µA current source)	400 Ω 3.2 KΩ 25.6 KΩ 102.4 KΩ	0.07% + 1.07 Ω 0.07% + 2.34 Ω 0.07% + 18.75 Ω 0.07% + 75 Ω
1 MΩ (10 µA current source)	4 KΩ 32 KΩ 256 KΩ 10.24 MΩ	0.07% + 12.7 Ω 0.07% + 39.1 Ω 0.07% + 312.5 Ω 0.07% + 1.25 KΩ

Average Readings, 90 Days 18° to 28°C

Accuracy if 100 readings are averaged:

For 40 Ω Range: 0.07% + 78.1 mΩ
For 400 Ω Range: 0.07% + 781 mΩ
For 4 KΩ Range: 0.07% + 9.77 Ω

Table 7-1 HP 44702A/B Specifications (Cont.)

Accuracy if 10 readings are averaged (little advantage to averaging more readings):

For 320 Ω Range: 0.07% + 156 mΩ
For 3.2 KΩ Range: 0.07% + 1.56 Ω
For 32 KΩ Range: 0.07% + 31.25 Ω
For 2.56 KΩ Range: 0.07% + 1.25 Ω
For 25.6 KΩ Range: 0.07% + 12.5 Ω
For 256 KΩ Range: 0.07% + 250 Ω
For 10.24 KΩ Range: 0.07% + 5 Ω
For 102.4 KΩ Range: 0.07% + 50 Ω
For 1.024 MΩ Range: 0.07% + 1 KΩ

1 Year: Add 0.03% of reading to the 90 Days Specifications

Temperature Coefficient:

Add as an additional accuracy error using ±(% of reading + ohms) per °C change outside 18° to 28°C, as long as the operating temperature is maintained between 0 to 18° or 28° to 55°C.

For 40 Ω Range add 0.005% + 0.488 mΩ
For 400 Ω Range add 0.005% + 4.88 mΩ
For 4 KΩ Range add 0.005% + 48.8 mΩ
For 320 Ω Range add 0.003% + 3.91 mΩ
For 3.2 KΩ Range add 0.003% + 39.1 mΩ
For 32 KΩ Range add 0.003% + 391 mΩ
For 2.56 KΩ Range add 0.003% + 31.3 m Ω
For 25.6 KΩ Range add 0.003% + 313 mΩ
For 256 KΩ Range add 0.003% + 3.13 Ω
For 10.24 KΩ Range add 0.7% + 5 Ω
For 102.4 KΩ Range add 0.07% + 50 Ω
For 1.024 MΩ Range add 0.07% + 1 KΩ

Reading Rate: 100,000 readings/second with auto-ranging. Proper auto-ranging is ensured as long as a single-channel signal changes no more than 600 volts/second during auto-ranging.

PACER

Programmable Intervals: 10 μsec to 17 minutes with .25 μsec resolution.

Accuracy: Programmed pulse interval ±0.01% of pulse interval

Pulse Widths: 0.5 μsec nominally (low true)

Table 7-1 HP 44702A/B Specifications (Cont.)

INPUT CHRACTERISTICS

Noise Rejection: Min effective common mode rejection specified in dB for DC to 60 Hz with 1 KΩ in low lead; maximum signal (high to low) + coomon mode voltage (low to chassis) for proper operation is ±10.24 volts.

Range	ECMR
40 mV	90
320 mV	80
2.56 V	70
10.24 V	70

Maximum Input Voltage: All inputs (ribbon, rear, and back-plane) are protected to 16 V peak. Input impedance, however, decreases abpve 12 V due to internal protection circuitry. The analog back-plane can be disconnected from the high-speed voltmeter, allowing the maximum back-plane voltage to be 42 V peak.

Bandwidth: 50 Ω source, 1 MΩ termination

Range	0.1% Flatness	1.0% Flatness	-3 dB Bandwidth
40 mV	10 kHz	45 kHz	250 kHz
320 mV to 10.24 V	15 kHz	55 kHz	400 kHz

Input Impedance: All Ranges.

Impedance	Terminals	
	High to Low	High or Low to Chassis
Power On Resistance (Ω)	$>10^8$	$>10^8$
Power Off Resistance (Ω) Vin 10 V	>1000	>1000
Power Off Resistance (Ω) Vin >10 V	>470	>470
Max. Capacitance (pf) at 1MHz	100	200

Table 7-1 HP 44702A/B Specifications (Cont.)

Maximum Bias Current: Currents sourced by high or low into rear terminals, ribbon cable, or back-plane. These currents may affect accuracy for source impedances >1 KΩ.

±1.4 nA DC (0 to 28°C)
±18 nA DC (28° to 55°C)

Settling Time: To within 0.1% of step change.

Fixed Rate: Any full scale step change (worst case) <10 µsec

Range Changes from Lower to Higher Range: <10 µsec

Rnage Changes from Higher to Lower Range (resulting in a step voltage change at the inputs):

2.56 V Destination Range:	<30 µsec (10.24 v step change)
320 mV Destination Range:	<20 µsec (2.56 V step change)
	<100 µsec (10.24 V step change)
40 mV Destination Range:	<20 µsec (320 mV step change)
	<120 µsec (2.56 V step change)
	<1 msec (10.24 V step change

7-5 HP 44702A/B PERFORMANCE TESTS

7-6 Introduction

The following Performance Tests check the operation of the HP 44702A High Speed Voltmeter. Successful completion of all Performance Tests in this chapter provides a high confidence level that the voltmeter is meeting its listed specifications.

The Performance Tests should be performed in the order they are presented. The completion of each test increases the confidence level in the High Speed Voltmeter operation. A minimum set of tests is given as Operational Verification Tests. These tests are described in Section 7-10.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence that the High Speed Voltmeter is operating normally, it is not recommended that the Performance Tests be performed unless one of the tested specifications is in question. However, if complete Performance Tests are required, do not perform the Operational Verification Tests but go to Section 7-16 for the Performance Tests.

7-7 Equipment Required

The following test equipment is required to run the Performance/Operational Verification Tests.

1. 2 Low Thermal Shorts -- Use solid copper wires

2. 2 Test Cables -- HP Part Number 03498-61602

To assure accurate readings when testing the HP 44702A/B, shielded twisted pair cables MUST be used for all input connections. Coaxial cables are NOT recommended for use. The shielded twisted pair cables are necessary for the HP 44702A/B to reject noise picked up by the input cables. The cables and cable connections are illustrated in the figures showing the different test setups. You can use the figures to to manufacture your own cables, but keep the length of the unshielded wires of the cables to a minimum.

3. DC Voltage Standard -- Datron Model 4000/4000A

If the recommended DC Voltage Standard is not available, use one that is capable of outputting the following voltages at the specified limits. The listed specifications are at least four times better than the specifications of the HP 447021A/B High Speed Voltmeter.

*36 mV (±0.056%)
300 mV (±0.031%)
*1.25 V (±0.15%)
2.5 V (±0.031%)
*5 V (±0.05%)
*10 V (±0.031%)

*For Performance Test only

4. Resistance Standard -- Datron Model 4000/4000A

The Datron Model 4000/4000A normally have resistance values of 1 Ω though 1 MΩ. However, a special version is available with resistance values of 3 Ω through 3 MΩ. Either version will work for the HP 44702A/B Ohms Performance/Operational Verification Tests.

If the recommended Resistance Standard is not available, use one that is capable of outputting the following resistance values at the specified limits. The listed specifications are at least four times better than the specifications of the HP 44702A/B High Speed Voltmeter.

Instead of using a resistance standard (like the Datron 4000/4000A), you can use standard resistors. Likewise with the resistance standard, you can also use either 10 kΩ, 100 kΩ, and 1 MΩ resistor values or 3 kΩ, 30 kΩ, and 300 kΩ resistor values.

10 kΩ or 3 kΩ (±0.036%)
*100 kΩ or 30 kΩ (±0.036%)
*1 MΩ or 300 kΩ (±0.036%)

*For Performance Test only

5. Computer with HP-IB Interface -- HP Series 200/300 with BASIC 4.0

The recommended computer is used to run various test programs that are part of the Performance/Operational Tests. The computer may also be used to execute the various setup commands, instead of executing them from the front panel.

If the recommended computer is not available, use one that is capable of executing the test program at the end of this chapter. Modification of the program may be necessary if a different computer is used.

6. High Speed FET Multiplexer with Test Fixure -- HP 44711A, HP 44712A, or HP 44713A with an HP 44711AT Terminal Module

The High Speed FET Multiplexer accessory and test fixure are NOT required if only the Operational Verification Tests are to be performed. The accessory and fixure are ONLY needed for the Ribbon Cable Test portion of the Performance Tests. The Ribbon Cable Test is ONLY required if you plan to use the HP 44702A/B to control and read an HP 44711A, 44712A, or 44713A High Speed FET Multiplexer accessory in your application.

In addition to the High Speed FET Multiplexer accessory, a test fixure is also needed. This is the same fixure used to test the High Speed FET Multiplexer accessories as described in Chapter 10. A schematic of the test fixure is shown in Figure 7-2a. The fixure can be manufactured using an HP 44711AT terminal module (see Figure 7-2b). Because wiring the test fixure will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

If the test fixure is to be fabricated from other than an HP 44711AT terminal module, it is important that the terminal ID lines, shown in Figure 7-2a, be correctly wired. The HP 3852A local controller will not allow the execution of some commands with an incorrect ID.

The test fixure consists of a short circuit between all channel HIGH lines and a short circuit between all channel LOW lines. The use of the test fixure minimizes the number of test connections required for the Ribbon Cable Test.

7. DMA Controller, GPIO Interface, and GPIO Cable -- HP 96620B 2 Channel DMA Controller, HP 98622A GPIO Interface, and HP 44744A/44B/45A GPIO Cable

The DMA Controller, GPIO Interface, and GPIO Cable are NOT required if only the Operational Verification Tests are to be performed. The GPIO accessories are ONLY needed for the GPIO Test portion of the Performance Tests. The GPIO Test is ONLY required if you plan to use the HP 44702A/B to transfer readings over the GPIO.

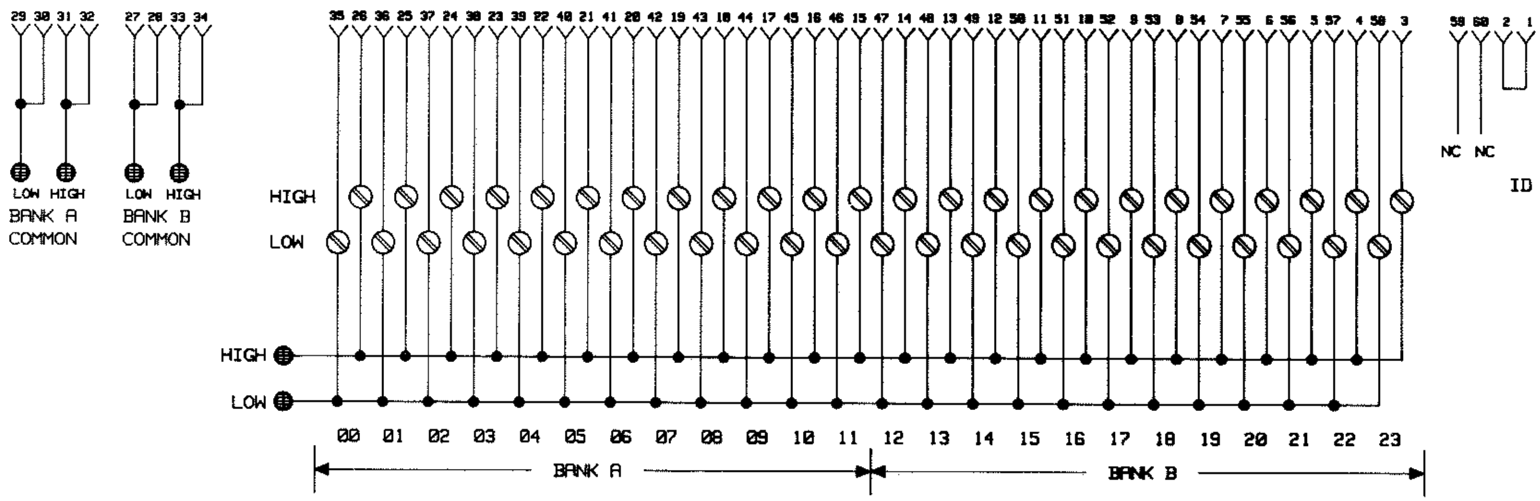


Figure 7-2a HP 44711A Test Fixure Schematic

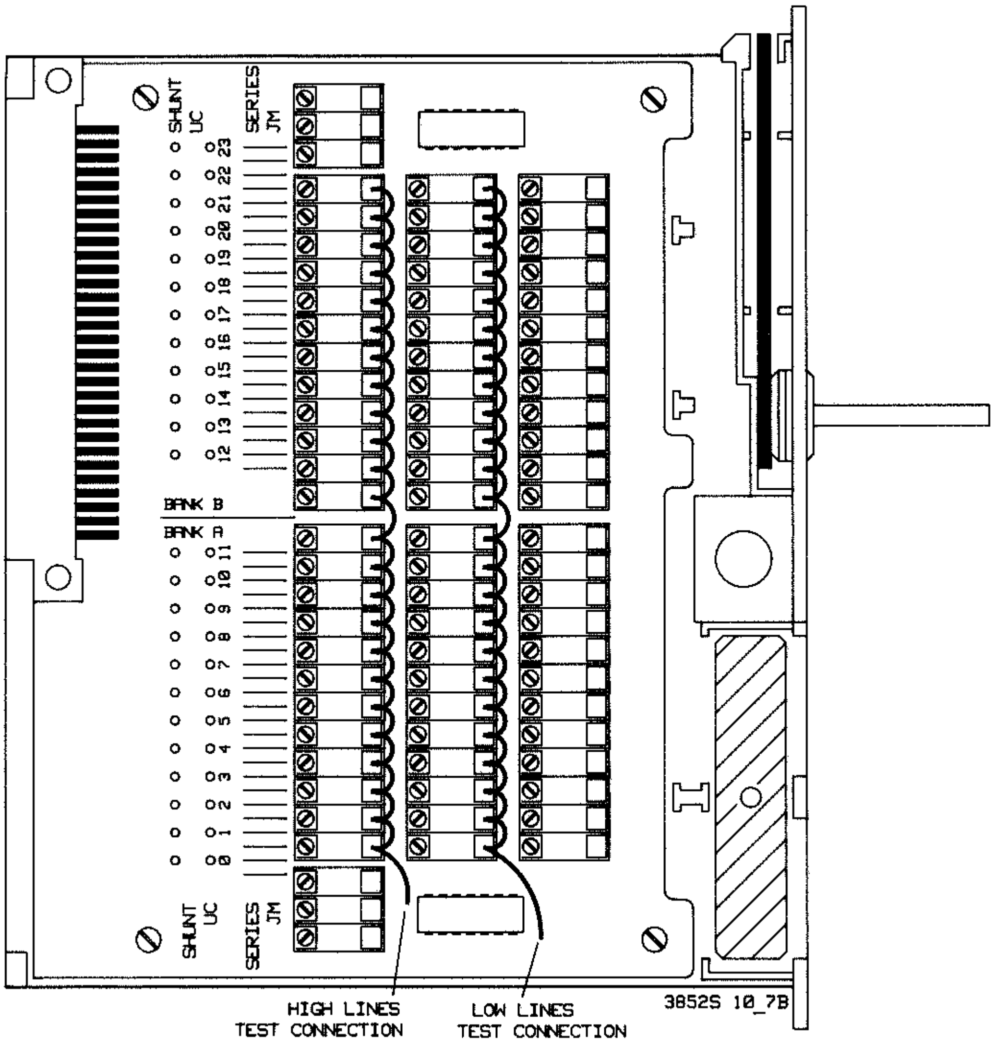


Figure 7-2b HP 44711A Test Fixure

To run the GPIO Test, the HP 98622A GPIO Interface card may need to be re-configured. The correct configuration is shown in Figure 7-3.

7-8 Test Considerations

Because the HP 44702A/B High Speed Voltmeter is capable of making accurate measurements, use standards that are at least four times more accurate than the accessory. However, keep in mind that these standards may introduce potential uncertainties. To keep the uncertainties at a minimum, have these standards certified by the National Bureau of Standards (NBS) before using them. Ideally, standards that are ten times more accurate should be used.

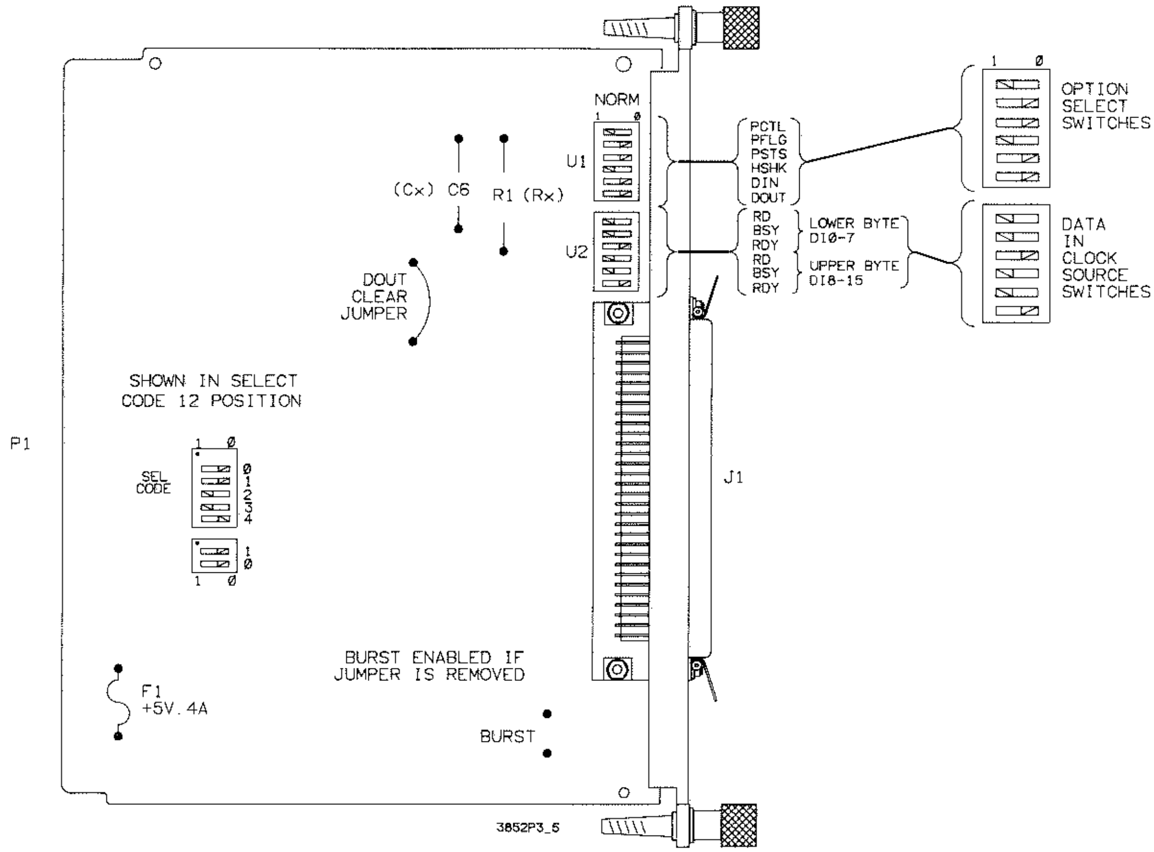


Figure 7-3 HP 98622A Configuration for GPIO Test

7-9 Test Cycle

The HP 44702A/B High Speed Voltmeter requires periodic verification that it is meeting its specifications. The frequency at which the accessory may be tested depends on its usage and environmental operating conditions. To maintain the 90 day specifications, check the accessory at 90 day intervals. To maintain the 1 year specifications, check the accessory at 1 year intervals. For normal operation, check at the 90 day intervals.

7-10 Operational Verification Tests

Perform the Operational Verification Tests only if you do not plan to do the Performance Tests. If you plan to do the Performance Tests, do not perform the following tests but go to Section 7-16 instead.

The following tests are the minimum set of tests recommended for the High Speed Voltmeter. Successful completion of these tests provides a 90% confidence level that the voltmeter is operating normally and is within specification.

The Operational Verification Tests consist of the following:

Section 7-12 - Set-Up Procedure
Section 7-13 - DC Voltage Operational Verification Test
Section 7-14 - Ohms Operational Verification Test
Section 7-14 - Autorange Test

7-11 Operational Verification Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

NOTE

The temperature of the environment where the following tests are to be performed must be within ±5° C of the temperature of the environment where the instrument was last calibrated. The HP 44702A/B High Speed Voltmeter was calibrated at the factory at an environment temperature of 20° C.

7-12 Set-Up Procedure

1. Apply power to the HP 3852A and allow the HP 44702A/B High Speed Voltmeter a one hour warm-up period inside the mainframe. This is necessary to stabilize the voltmeter before performing any tests.

2. Press the RESET button on the HP 3852A front panel. Perform the HP 44702A/B High Speed Voltmeter self-test by executing:

TEST ES00 (where E = extender number, S = slot number)

3. The HP 3852A right display should show:

SELF TEST OK

If the display shows a different message, or if the ERR annunciator is on, the HP 44702A/B High Speed Voltmeter may be failing its self test. Test the voltmeter again by executing the command in step 2. If the voltmeter still fails, repair of the unit may be necessary.

4. Designate the HP 44702A/B to be tested by executing:

USE ES00 (where E = extender number, S = slot number)

The command establishes the extender/slot number used in all Performance/Operational Verification Tests for command destination. If the HP 3852A is reset or power is removed, it is necessary to perform step 4 again to re-establish the setup parameters.

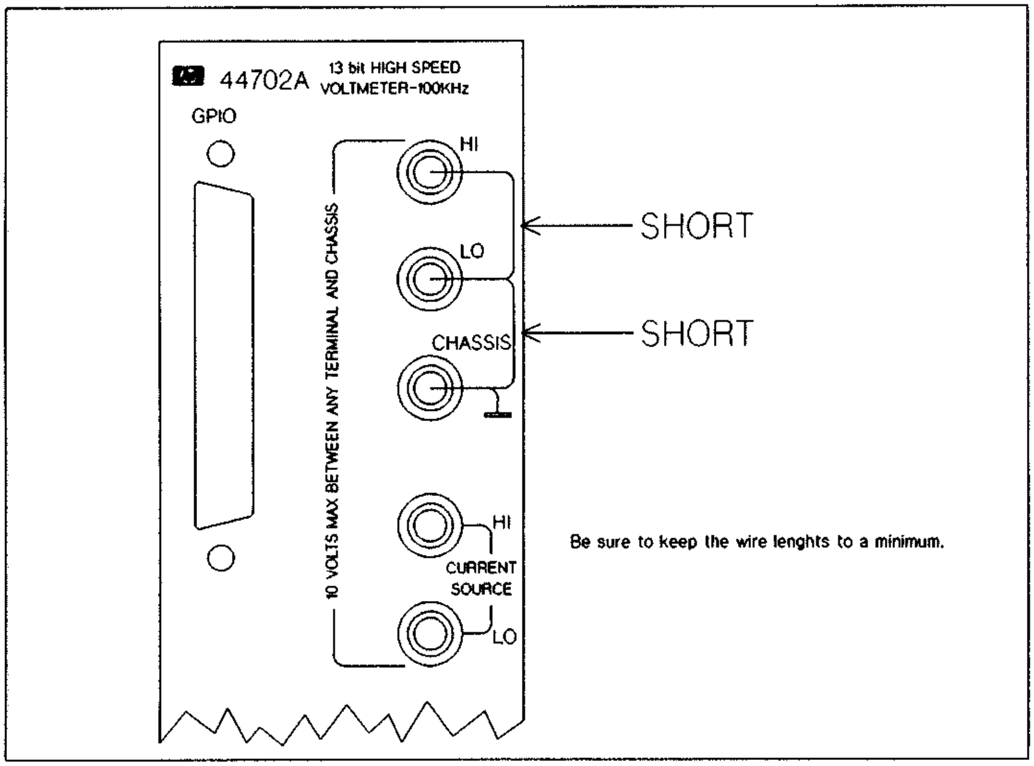


Figure 7-4 DC Voltage Offset Test Connections

7-13 DC Voltage Operational Verification Test

This test determines if the dc offset voltage and the full scale accuracy of the HP 44702A/B High Speed Voltmeter are within the specified limits. The following procedure sets the HP 44702A/B to certain dc volts ranges and take 1000 readings on each range. The minimum and maximum values of the readings are then compared with the limits shown in Table 7-2.

1. DC VOLTAGE OFFSET TEST. The following test determines if the dc voltage offset readings of the HP 44702A/B are within the specified limits.

2. Perform the Set-Up Procedure in Section 7-12, if not previously performed.

3. Connect a low thermal short across the rear HI and LO Input Terminals of the HP 44702A/B High Speed Voltmeter accessory. Then connect another low thermal short across the rear LO and CHASSIS Terminals. The connections are shown in Figure 7-4.

4. Set the HP 44702A/B to measure dc volts and take 1000 readings by executing:

```
REAL MIN,MAX,MEAN,STDD
DIM A(999)
TERM EXT
NRDGS 1000
FUNC DCV
```

If the HP 3852A is reset or power is removed, it is necessary to perform step 4 and step 4 in Section 7-12 again to re-establish the setup parameters.

Table 7-2 DC Voltage Operational Verification Test Limits

DC Voltage Offset Test Limits						
44702A/B Input	44702A/B Range	44702A/B Set-Up	90 Day Test Limits High	90 Day Test Limits Low	1 Year Test Limits High	1 Year Test Limits Low
Short	40 mV	FUNC DCV	+6.800000E-05	-6.800000E-05	+6.800000E-05	+6.800000E-05
Short	10.24 V	FUNC DCV	+7.500000E-02	-7.500000E-02	+7.500000E-02	+7.500000E-02
DC Voltage Gain Test Limits						
44702A/B Input	44702A/B Range	44702A/B Set-Up	90 Day Test Limits High	90 Day Test Limits Low	1 Year Test Limits High	1 Year Test Limits Low
+300 mV	320 mV	FUNC DCV	+3.003840E-01	+2.996160E-01	+3.005340E-01	+2.994660E-01
+2.5 V	2.56 V	FUNC DCV	+2.503130E+00	+2.496870E+00	+2.504380E+00	+2.495620E+00

5. Set the HP 44702A/B to the 40 mV Range by executing:

    RANGE .04

6. Trigger the HP 44702A/B and transfer the resulting readings to the HP 3852A by executing:

    TRIG SGL
    XRDGS ES00,1000 INTO A (where E = extender number, S = slot number)

7. Determine the minimum and maximum values of the readings by executing the following commands. The minimum value of all 1000 readings is first shown on the HP 3852A's right display followed by the maximum value. Note both values.

    STAT MIN,MAX,MEAN,STDD,A
    VREAD MIN (note the minimum reading)
    VREAD MAX (note the maximum reading)

8. If any of the maximum and minimum offset readings are out of the limits specified in Table 7-2, perform the DC Volts Calibration procedure in Section 7-32.

9. Repeat steps 5, 6, 7, and 8 for the 10.24 V Range. Set the range in step 5 by executing RANGE 10.24.

10. When both ranges are tested, leave the setup in step 4 for the next test. Remove the low thermal short from the HI and LO, and LO and CHASSIS Input Terminals.

11. DC VOLTAGE GAIN TEST. The following test determines if the dc voltage full scale readings of the HP 44702A/B are within the specified limits. Since the HP 44702A/B High Speed Voltmeter cannot measure inputs at full scale, the DC Voltage Gain Test is performed at <99.6% of full scale.

12. Set the DC Voltage Standard output to +300 mV. Then connect the DC Voltage Standard to the rear HI and LO Input Terminals of the HP 44702A/B High Speed Voltmeter accessory. The connections are shown in Figure 7-5. Make sure shielded twisted pair cables are used for the connections as shown in the figure.

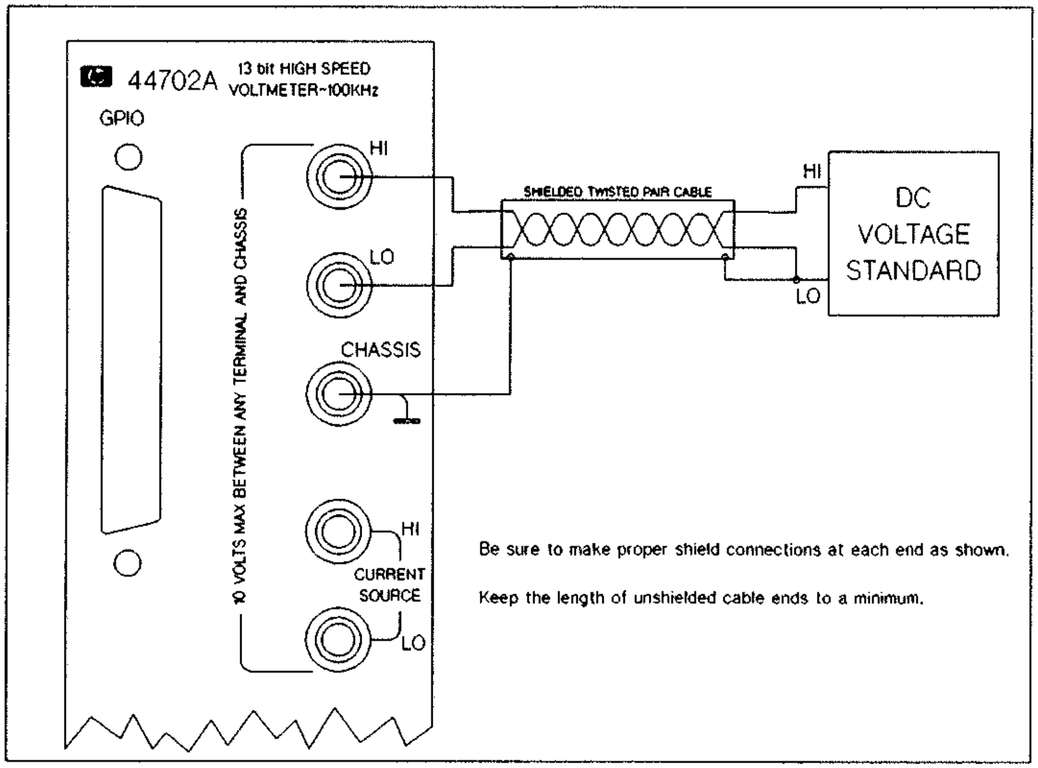


Figure 7-5 DC Voltage Gain Test Connections

13. Test the 320 mV Range by executing the following command. The voltmeter automatically selects the 320 mV Range, even though a value of .3 is used for the range instead of .32.

RANGE .3

14. Trigger the HP 44702A/B and transfer the resulting readings to the HP 3852A by executing:

TRIG SGL
XRDGS ES00,1000 INTO A (where E = extender number, S = slot number)

15. Determine the minimum and maximum values of the readings by executing the following. The minimum value of all 1000 readings is first shown on the HP 3852A's right display followed by the maximum value. Note both values.

STAT MIN,MAX,MEAN,STDD,A
VREAD MIN (note the minimum reading)
VREAD MAX (note the maximum reading)

16. If any of the maximum and minimum gain readings are out of the limits specified in Table 7-2, perform the DC Volts Calibration procedure in Section 7-32.

17. Repeat steps 13, 14, 15 and 16 for 2.56 V Range. Set the range in step 13 by executing RANGE 2.5 for the 2.56 V Range. Make sure the DC Voltage Standard output is set to +2.5 V as shown in Table 7-2.

18. Remove the DC Voltage Standard from the HI and LO Input Terminals.

Table 7-3 Ohms Operational Verification Gain Test Limits

44702A/B Input	44702A/B Range	44702A/B Set-Up	90 Day Test Limits High	90 Day Test Limits Low	1 Year Test Limits High	1 Year Test Limits Low
10 Kohm*	10.24 Kohm	OHMF10K	1.001450E+04	9.985500E+03	1.001750E+04	9.982500E+03
3 Kohm	10.24 Kohm	OHMF10K	3.009600E+03	2.990400E+03	3.010500E+03	2.989500E+03
*Preferred Resistance Value						

7-14 Ohms Operational Verification Test

This test determines if the ohms full scale accuracy of the HP 44702A/B High Speed Voltmeter is within the specified limits. The following procedure checks the accuracy of the 1 mA current source only (10 Kohm Function) but includes an operational check of the 10 µA (100 Kohm Function) and 100 µA (1 Mohm Function) current sources.

The recommended Resistance Standard or a Standard Resistor can be used to test the ohms function. In either case, use either a 10 Kohm resistance value (recommended value) or a 3 Kohm resistance value (optional value).

1. Perform the Set-Up Procedure in Section 7-12, if not previously performed.

2. If using the Resistance Standard, set its output to either 10 Kohm or 3 Kohm. If using a Standard Resistor, select either a 10 Kohm or 3 Kohm value. Connect the Resistance Standard or Standard Resistor to the rear HI and LO Input Terminals of the HP 44702A/B High Speed Voltmeter. The connections are shown in Figure 7-6a and 7-6b.

3. Set the HP 44702A/B to measure ohms using the 1 mA current source and take a single reading by executing:

   RESET ES00 (where E = extender number, S = slot number)
   TERM EXT
   FUNC OHMF10K
   NRDGS 1

4. Set the HP 44702A/B to the 10.24 Kohm Range by executing:

   RANGE 10E3

5. Trigger the HP 44702A/B and transfer the resulting reading to the HP 3852A by executing:

   TRIG SGL
   XRDGS ES00,1 (where E = extender number, S = slot number)

6. Note the gain reading on the HP 3852A right display. If the reading is out of the limits specified in Table 7-3, perform the Ohms Calibration procedure in Section 7-33. In the table, both the 90 Day and 1 Year test limits are listed for both 10 Kohm and 3 Kohm inputs.

7. Repeat steps 3 and 5 for the 100 µA and 10 µA current sources. Set the current source in step 3 by executing FUNC OHMF100K for the 100 µA current source and FUNC OHMF1M for the 10 µA current source. Make sure both current sources are operational.

8. Remove the Resistance Standard or Standard Resistor from the HP 44702A/B rear panel.

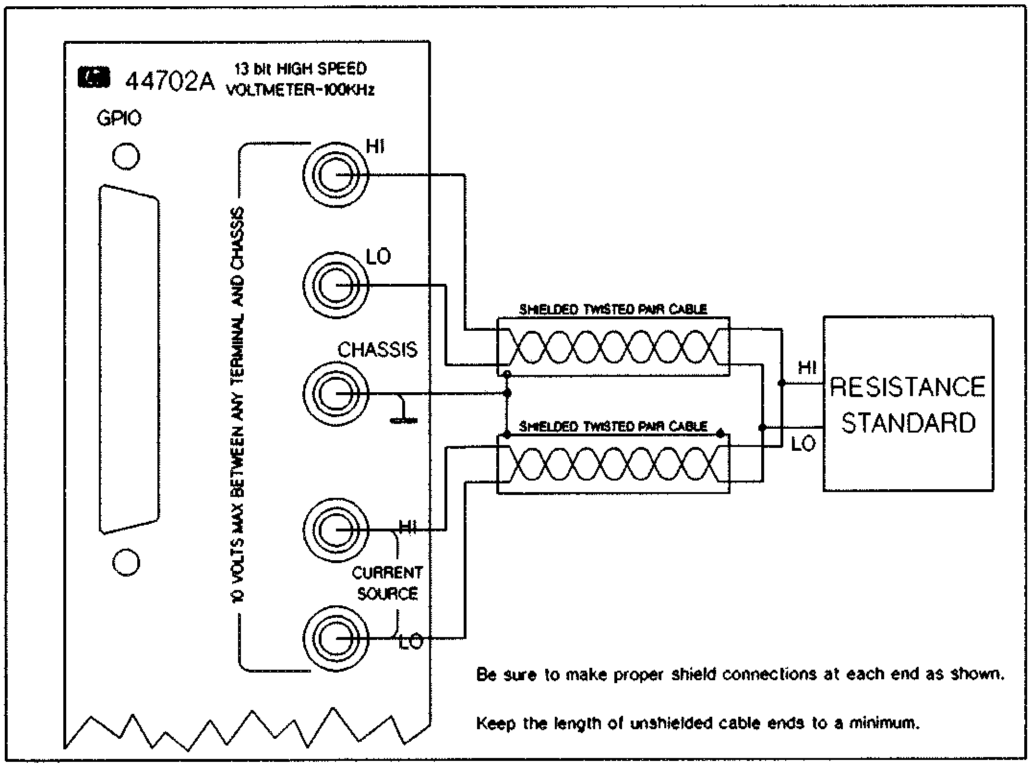


Figure 7-6a Ohms Gain Test Connections Using a Resistance Standard

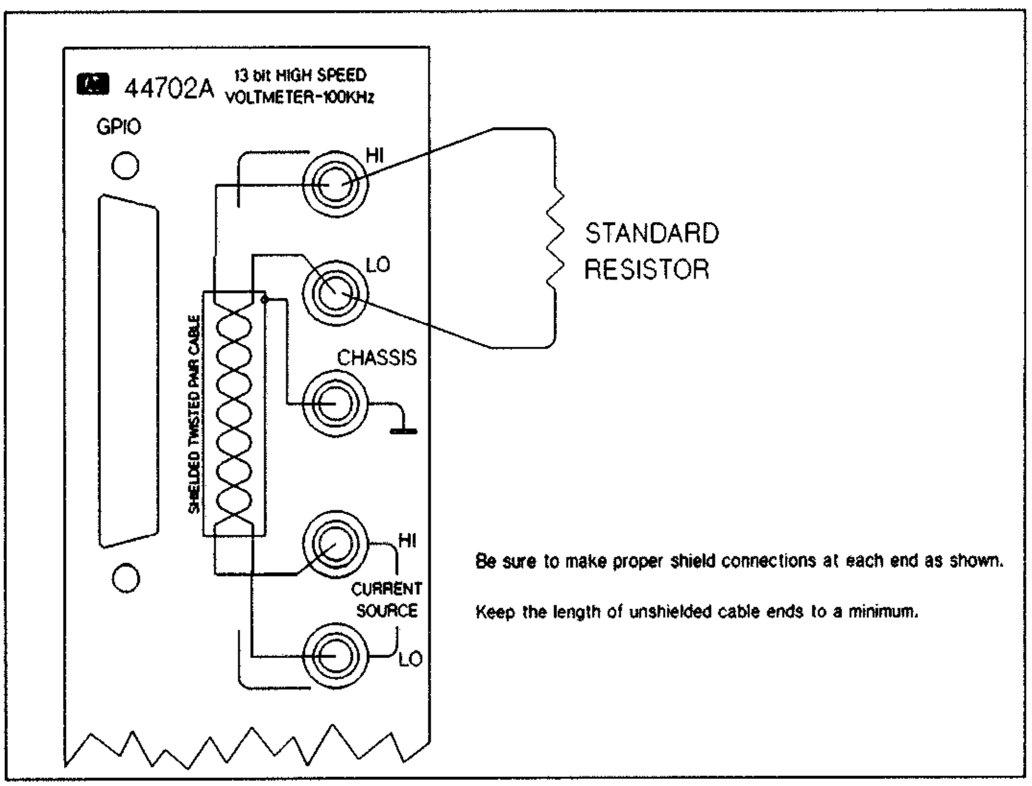


Figure 7-6b Ohms Gain Test Connections Using a Standard Resistor

Table 7-4 HP 44702A/B Autorange Test

44702A/B Range	44702A/B Initial Input Voltage	Input Voltage Incremented by	Maximum Voltage for Upranging	Range after Upranging
40 mV	+28 mV	+2 mV	+36 mV	320 mV
320 mV	+224 mV	+20 mV	+304 mV	2.56 V
2.56 V	+1.8 V	+200 mV	+2.4 V	10.24 V

7-15 Autorange Test

This test uses Test Program 7-1 to check the autorange capability of the HP 44702A/B High Speed Voltmeter. The program is located at the end of this chapter. The program continually displays the present voltmeter range on the computer. From the displayed range and the HP 44702A/B input voltage level, the voltmeter's uprange and downrange points are determined.

NOTE

Test Program 7-1 was created for the HP Series 200/300 Computer with Basic 4.0. However, the program is sufficiently simple that it may be translated into other languages and computers.

A dc voltage source is required to run the test. The voltage source must be capable of outputting a dc voltage ranging from +28 mV to +2.4 V dc. Some way of determining its output voltage level (i.e., the HP 44702A/B input voltage) is also necessary. A good choice is the recommended DC Voltage Standard, since it is used in other procedures. If using a different voltage source, like a power supply, a dc voltmeter may be necessary to determine the power supply's output voltage.

1. Enter Test Program 7-1 into the computer.

Two modifications to the test program may be necessary. These are the mainframe address in line 30 and the voltmeter slot location number in line 40. If needed, change line 30 to reflect the mainframe address. Likewise, change line 40 to reflect the slot location of the voltmeter. For example, if your voltmeter is in slot 5 of extender 1, line 40 should look like this:

```
40    Slot=1500
```

2. Set the dc voltage source output to +28 mV. Then connect it to the HP 44702A/B HI and LO Input Terminals. The connections are shown in Figure 7-5.

3. Execute RUN on the computer.

4. Use Table 7-4 to determine the uprange and downrange points of the HP 44702A/B. This is done by using the table in conjunction with the range displayed on the computer and the HP 44702A/B input voltage level. The following procedure shows how this is done.

   a. With the HP 44702A/B input at +28 mV, the 40 mV Range should be displayed on the computer.

   b. While observing the range on the computer, increment the dc voltage source output in approximately +2 mV steps until upranging occurs (i.e., range goes to 320 mV). Note the HP 44702A/B input voltage level where upranging occurred. If using the recommended DC Voltage Standard, the HP 44702A/B input level can easily be determined by noting the output voltage setting of the standard. Make sure this voltage is at or below the specified limit listed under "Maximum Voltage for Upranging" in Table 7-4.

c. Decrement the dc voltage source output by +2 mV. The HP 44702A/B should downrange back to the 40 mV Range.

d. Repeat steps a, b, and c for the 320 mV and 2.56 V Ranges. Use the appropriate data in Table 7-4 for these ranges.

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44702A/B PERFORMANCE TESTS.

7-16 Performance Tests

Perform the Performance Tests only if you do not plan to do the Operational Verifications Tests. If you plan to do the Operational Verification Tests, do not perform the following tests but go to Section 7-10 instead.

Do the following tests if you desire a high confidence level that the voltmeter is operating normally and is within specifications.

The Performance Tests consist of the following:

Section 7-18 - Set-Up Procedure
Section 7-19 - DC Voltage Performance Test
Section 7-20 - Ohms Performance Test
Section 7-21 - Autorange Test
Section 7-22 - Ribbon Cable Test
Section 7-23 - GPIO Test

7-17 Performance Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

NOTE

The temperature of the environment where the following tests are to be performed must be within ±5° C of the temperature of the environment where the instrument was last calibrated. The HP 44702A/B High Speed Voltmeter was calibrated at the factory at an environment temperature of 20° C.

7-18 Set-Up Procedure

1. Apply power to the HP 3852A and allow the HP 44702A/B High Speed Voltmeter a one hour warm-up period inside the mainframe. This is necessary to stabilize the voltmeter before performing any tests.

2. Press the RESET button on the HP 3852A front panel. Perform the HP 44702A/B High Speed Voltmeter self-test by executing:

TEST ES00 (where E = extender number, S = slot number)

3. The HP 3852A right display should show:

SELF TEST OK

If the display shows a different message, or if the ERR annunciator is on, the HP 44702A/B High Speed Voltmeter may be failing its self test. Test the voltmeter again by executing the command in step 2. If the voltmeter still fails, repair of the unit may be necessary.

4. Designate the HP 44702A/B to be tested by executing:

USE ES00 (where E = extender number, S = slot number)

The command establishes the extender/slot number used in all Performance/Operational Verification Tests for command destination. If the HP 3852A is reset or power is removed, it is necessary to perform step 4 again to re-establish the setup parameters.

7-19 DC Voltage Performance Test

This test determines if the dc offset voltage and the full scale accuracy of the HP 44702A/B High Speed Voltmeter are within the specified limits. The following procedure sets the HP 44702A/B to certain dc volts ranges and take 1000 readings on each range. The minimum and maximum values of the readings are then compared with the limits shown in Table 7-5.

1. DC VOLTAGE OFFSET TEST. The following test determines if the dc voltage offset readings of the HP 44702A/B are within the specified limits.

2. Perform the Set-Up Procedure in Section 7-18, if not previously performed.

3. Connect a low thermal short across the rear HI and LO Input Terminals of the HP 44702A/B High Speed Voltmeter accessory. Then connect another low thermal short across the rear LO and CHASSIS Terminals. The connections are shown in Figure 7-4.

4. Set the HP 44702A/B to measure dc volts and take 1000 readings by executing:

```
REAL MIN,MAX,MEAN,STDD
DIM A(999)
TERM EXT
NRDGS 1000
FUNC DCV
```

If the HP 3852A is reset or power is removed, it is necessary to perform step 4 and step 4 in Section 7-18 again to re-establish the setup parameters.

5. Set the HP 44702A/B to the 40 mV Range by executing:

```
RANGE .04
```

6. Trigger the HP 44702A/B and transfer the resulting readings to the HP 3852A by executing:

```
TRIG SGL
XRDGS ES00,1000 INTO A   (where E = extender number, S = slot number)
```

7. Determine the minimum and maximum values of the readings by executing the following commands. The minimum value of all 1000 readings is first shown on the HP 3852A's right display followed by the maximum value. Note both values.

```
STAT MIN,MAX,MEAN,STDD,A
VREAD MIN   (note the minimum reading)
VREAD MAX   (note the maximum reading)
```

8. If any of the maximum and minimum offset readings are out of the limits specified in Table 7-5, perform the DC Volts Calibration procedure in Section 7-32.

Table 7-5 DC Voltage Performance Test Limits

DC Voltage Offset Test Limits						
44702A/B Input	44702A/B Range	44702A/B Set-Up	90 Day Test Limits High	90 Day Test Limits Low	1 Year Test Limits High	1 Year Test Limits Low
Short	40 mV	FUNC DCV	+6.800000E-05	-6.800000E-05	+6.800000E-05	-6.800000E-05
Short	320 mV	FUNC DCV	+2.340000E-04	-2.340000E-04	+2.340000E-04	-2.340000E-04
Short	2.56 V	FUNC DCV	+1.880000E-03	-1.880000E-03	+1.880000E-03	-1.880000E-03
Short	10.24 V	FUNC DCV	+7.500000E-02	-7.500000E-02	+7.500000E-02	-7.500000E-02

DC Voltage Gain Test Limits						
44702A/B Input	44702A/B Range	44702A/B Set-Up	90 Day Test Limits High	90 Day Test Limits Low	1 Year Test Limits High	1 Year Test Limits Low
+36 mV	40 mV	FUNC DCV	+3.608600E-02	+3.591400E-02	+3.610400E-02	+3.589600E-02
-36 mV	40 mV	FUNC DCV	-3.608600E-02	-3.591400E-02	-3.610400E-02	-3.589600E-02
+300 mV	320 mV	FUNC DCV	+3.003840E-01	+2.996160E-01	+3.005340E-01	+2.994660E-01
-300 mV	320 mV	FUNC DCV	-3.003840E-01	-2.996160E-01	-3.005340E-01	-2.994660E-01
+2.5 V	2.56 V	FUNC DCV	+2.503130E+00	+2.496870E+00	+2.504380E+00	+2.495620E+00
-2.5 V	2.56 V	FUNC DCV	-2.503130E+00	-2.496870E+00	-2.504380E+00	-2.495620E+00
+10 V	10.24 V	FUNC DCV	+1.001250E+01	+9.987500E+00	+1.001750E+01	+9.982500E+00
-10 V	10.24 V	FUNC DCV	-1.001250E+01	-9.987500E+00	-1.001750E+01	-9.982500E+00

DC Voltage Linearity Test Limits						
44702A/B Input	44702A/B Range	44702A/B Set-Up	90 Day Test Limits High	90 Day Test Limits Low	1 Year Test Limits High	1 Year Test Limits Low
+5 V	10.24 V	FUNC DCV	+5.010000E+00	+4.990000E+00	+5.012500E+00	+4.987500E+00
+2.5 V	10.24 V	FUNC DCV	+2.508750E+00	+2.491250E+00	+2.51000 E+00	+2.490000E+00
+1.25 V	10.24 V	FUNC DCV	+1.258125E+00	+1.241875E+00	+1.258750E+00	+1.241250E+00

9. Repeat steps 5, 6, 7, and 8 for the 320 mV, 2.56 V, and 10.24 V Ranges. To set the different ranges in step 5, execute the following:

    320 mV Range - RANGE .32
    2.56 V Range - RANGE 2.56
    10.24 V Range - RANGE 10.24

10. When all ranges are tested, leave the setup in step 4 for the next test. Remove the low thermal short from the HI and LO, and LO and CHASSIS Input Terminals.

11. DC VOLTAGE GAIN TEST. The following test determines if the dc voltage full scale readings of the HP 44702A/B are within the specified limits. Since the HP 44702A/B High Speed Voltmeter cannot measure inputs at full scale, the DC Voltage Gain Test is performed at <99.6% of full scale.

12. Set the DC Voltage Standard output to +36 mV. Then connect the DC Voltage Standard to the rear HI and LO Input Terminals of the HP 44702A/B High Speed Voltmeter accessory. The connections are shown in Figure 7-5. Make sure shielded twisted pair cables are used for the connections as shown in the figure.

13. Test the 40 mV Range by executing the following command. The voltmeter automatically selects the 40 mV Range, even though a value of .036 is used for the range instead of .04.

RANGE .036

14. Trigger the HP 44702A/B and transfer the resulting readings to the HP 3852A by executing:

TRIG SGL
XRDGS ES00,1000 INTO A (where E = extender number, S = slot number)

15. Determine the minimum and maximum values of the readings by executing the following. The minimum value of all 1000 readings is first shown on the HP 3852A's right display followed by the maximum value. Note both values.

STAT MIN,MAX,MEAN,STDD,A
VREAD MIN (note the minimum reading)
VREAD MAX (note the maximum reading)

16. If any of the maximum and minimum gain readings are out of the limits specified in Table 7-5, perform the DC Volts Calibration procedure in Section 7-32.

17. Set the DC Voltage Standard output to -36 mV.

18. Trigger the HP 44702A/B and transfer the resulting readings to the HP 3852A by executing:

TRIG SGL
XRDGS ES00,1000 INTO A (where E = extender number, S = slot number)

19. Determine the minimum and maximum values of the readings by executing the following. The minimum value of all 1000 readings is first shown on the HP 3852A's right display followed by the maximum value. Note both values.

STAT MIN,MAX,MEAN,STDD,A
VREAD MIN (note the minimum reading)
VREAD MAX (note the maximum reading)

20. If any of the maximum and minimum gain readings are out of the limits specified in Table 7-5, perform the DC Volts Calibration procedure in Section 7-32.

21. Repeat steps 13 through 20 for the 320 mV, 2.56 V, and 10.24 V Ranges. To set the different ranges in step 13, execute the following. Also set the DC Standard output accordingly as listed in Table 7-5.

320 mV Range - RANGE .3
2.56 V Range - RANGE 2.5
10.24 V Range - RANGE 10

22. When all ranges are tested, set the DC Standard output to 2.5 mV. Leave the DC Voltage Standard connected to the HP 44702A/B for the next test.

23. DC VOLTAGE LINEARITY TEST. The following test determines if the dc voltage linearity of the HP 44702A/B is within the specified limits.

24. Set the HP 44702A/B to the 10.24 V Range by executing:

RANGE 10

25. Set the DC Voltage Standard output to +5 V.

26. Trigger the HP 44702A/B and transfer the resulting reading to the HP 3852A by executing:

TRIG SGL
XRGDS ES00,1 (where E = extender number, S = slot number)

27. Note the reading on the HP 3852A display. If the +5 V reading is out of the limits specified in Table 7-5, perform the DC Volts Calibration procedure in Section 7-32.

28. Set the DC Voltage Standard output to +2.5 V.

29. Trigger the HP 44702A/B and transfer the resulting reading to the HP 3852A by executing:

TRIG SGL
XRGDS ES00 (where E = extender number, S = slot number)

30. Note the reading on the HP 3852A display. If the +2.5 V reading is out of the limits specified in Table 7-5, perform the DC Volts Calibration procedure in Section 7-32.

31. Set the DC Voltage Standard output to +1.25 V.

32. Trigger the HP 44702A/B and transfer the resulting reading to the HP 3852A by executing:

TRIG SGL
XRGDS ES00 (where E = extender number, S = slot number)

33. Note the reading on the HP 3852A display. If the +1.25 V reading is out of the limits specified in Table 7-5, perform the DC Volts Calibration procedure in Section 7-32.

34. Remove the DC Voltage Standard from the HI and LO Input Terminals.

7-20 Ohms Performance Test

This test determines if the ohms full scale accuracy of the HP 44702A/B High Speed Voltmeter is within the specified limits. The following procedure checks the accuracy of the 1 mA (10 Kohm Function), 10 µA (100 Kohm Function), and 100 µA (1 Mohm Function) current sources.

The recommended Resistance Standard or Standard Resistors can be used to test the ohms function. In either case, use either 10 Kohm, 100 Kohm, and 1 Mohm resistance values (recommended values) or 3 Kohm, 30 Kohm, and 300 Kohm resistance values (optional values).

1. Perform the Set-Up Procedure in Section 7-18, if not previously performed.

2. If using the Resistance Standard, set its output to either 10 Kohm or 3 Kohm. If using a Standard Resistor, use either a 10 Kohm or 3 Kohm value. Connect the Resistance Standard/Standard Resistor to the rear HI and LO Input Terminals of the HP 44702A/B High Speed Voltmeter. The connections are shown in Figure 7-6a and 7-6b.

3. Set the HP 44702A/B to measure ohms using the 1 mA current source and take a single reading by executing:

Table 7-6 Ohms Performance Test Limits

44702A/B Input	44702A/B Range	44702A/B Set-Up	90 Day Test Limits High	90 Day Test Limits Low	1 Year Test Limits High	1 Year Test Limits Low
10 Kohm*	10.24 Kohm	OHMF10K	1.001450E+04	9.985500E+03	1.001750E+04	9.982500E+03
3 Kohm	10.24 Kohm	OHMF10K	3.009600E+03	2.990400E+03	3.010500E+03	2.989500E+03
100 Kohm*	102.4 Kohm	OHMF100K	1.001450E+05	9.985500E+04	1.001750E+05	9.982500E+04
30 Kohm	102.4 Kohm	OHMF100K	3.009600E+04	2.990400E+04	3.010500E+04	2.989500E+04
1 Mohm*	1.024 Mohm	OHMF1M	1.001950E+06	9.980500E+05	1.002250E+06	9.977500E+05
300 Kohm	1.024 Mohm	OHMF1M	3.014600E+05	2.985400E+05	3.015500E+05	2.984500E+05
*Preferred Resistance Values						

RESET ES00 (where E = extender number, S = slot number)
TERM EXT
FUNC OHMF10K
NRDGS 1

4. Set the HP 44702A/B to the 10.24 Kohm Range by executing:

RANGE 10E3

5. Trigger the HP 44702A/B and transfer the resulting reading to the HP 3852A by executing:

TRIG SGL
XRDGS ES00,1 (where E = extender number, S = slot number)

6. Note the gain reading on the HP 3852A right display. If the reading is out of the limits specified in Table 7-6, perform the Ohms Calibration procedure in Section 7-33. In the table, both the 90 Day and 1 Year test limits are listed for both 10 Kohm and 3 Kohm inputs.

7. If using the Resistance Standard, set its output to either 100 Kohm or 30 Kohm. If using a Standard Resistor, remove the 10 Kohm or 3 Kohm resistor from the HP 44702A/B and connect either a 100 Kohm or 30 Kohm resistor.

8. Set the HP 44702A/B to measure ohms using the 100 µA current source by executing:

FUNC OHMF100K

9. Set the HP 44702A/B to the 102.4 Kohm Range by executing:

RANGE 100E3

10. Trigger the HP 44702A/B and transfer the resulting reading to the HP 3852A by executing:

TRIG SGL
XRDGS ES00,1 (where E = extender number, S = slot number)

11. Note the gain reading on the HP 3852A right display. If the reading is out of the limits specified in Table 7-6, perform the Ohms Calibration procedure in Section 7-33.

12. If using the Resistance Standard, set its output to either 1 Mohm or 300 Kohm. If using a Standard Resistor, remove the 100 Kohm or 30 Kohm resistor from the HP 44702A/B and connect either a 1 Mohm or 300 Kohm resistor.

13. Set the HP 44702A/B to measure ohms using the 10 µA current source by executing:

```
FUNC OHMF1M
```

14. Set the HP 44702A/B to the 1.024 Mohm Range by executing:

```
RANGE 1E6
```

15. Trigger the HP 44702A/B and transfer the resulting reading to the HP 3852A by executing:

```
TRIG SGL
XRDGS ES00,1   (where E = extender number, S = slot number)
```

16. Note the gain reading on the HP 3852A right display. If the reading is out of the limits specified in Table 7-6, perform the Ohms Calibration procedure in Section 7-33.

17. Remove the Resistance Standard or Standard Resistor from the HP 44702A/B rear panel.

7-21 Autorange Test

This test uses Test Program 7-1 to check the autorange capability of the HP 44702A/B High Speed Voltmeter. The program is located at the end of this chapter. The program continually displays the present voltmeter range on the computer. From the displayed range and the HP 44702A/B input voltage level, the voltmeter's uprange and downrange points are determined.

NOTE

Test Program 7-1 was created for the HP Series 200/300 Computer with Basic 4.0. However, the program is sufficiently simple that it may be translated into other languages and computers.

A dc voltage source is required to run the test. The voltage source must be capable of outputting a dc voltage ranging from +28 mV to +2.4 V dc. Some way of determining its output voltage level (i.e., the HP 44702A/B input voltage) is also necessary. A good choice is the recommended DC Voltage Standard, since it is used in other procedures. If using a different voltage source, like a power supply, a dc voltmeter may be necessary to determine the power supply's output voltage.

1. Enter Test Program 7-1 into the computer.

Two modifications to the test program may be necessary. These are the mainframe address in line 30 and the voltmeter slot location number in line 40. If needed, change line 30 to reflect the mainframe address. Likewise, change line 40 to reflect the slot location of the voltmeter. For example, if your voltmeter is in slot 5 of extender 1, line 40 should look like this:

```
40   Slot=1500
```

2. Set the dc voltage source output to +28 mV. Then connect it to the HP 44702A/B HI and LO Input Terminals. The connections are shown in Figure 7-5.

3. Execute RUN on the computer.

4. Use Table 7-4 to determine the uprange and downrange points of the HP 44702A/B. This is done by using the table in conjunction with the range displayed on the computer and the HP 44702A/B input voltage level. The following procedure shows how this is done.

a. With the HP 44702A/B input at +28 mV, the 40 mV Range should be displayed on the computer.

b. While observing the range on the computer, increment the dc voltage source output in approximately +2 mV steps until upranging occurs (i.e., range goes to 320 mV). Note the HP 44702A/B input voltage level where upranging occurred. If using the recommended DC Voltage Standard, the HP 44702A/B input level can easily be determined by noting the output voltage setting of the standard. Make sure this voltage is at or below the specified limit listed under "Maximum Voltage for Upranging" in Table 7-4.

c. Decrement the dc voltage source output by +2 mV. The HP 44702A/B should downrange back to the 40 mV Range.

d. Repeat steps a, b, and c for the 320 mV and 2.56 V Ranges. Use the appropriate data in Table 7-4 for these ranges.

7-22 Ribbon Cable Test

This test verifies that the HP 44702A/B High-Speed Voltmeter can control the HP 44711A, 44712A, or 44713A High Speed FET Multiplexer accessories. It also verifies that measurement results can be transferred to the voltmeter over the ribbon cable. The ribbon cable is used by the voltmeter to communicate with and control the multiplexer.

NOTE

Due to extra test equipment required to perform the Ribbon Cable Test, perform the test only if the HP 44702A/B High Speed Voltmeter is to be used with an HP 44711A, 44712A, or 44713A/B High Speed FET Multiplexer accessory.

1. Remove power from the HP 3852A.

2. Install the HP 44711A component module in the mainframe next to an HP 44702A/B. Connect the ribbon cable between the FET multiplexer and the HP 44702A/B. Note the slot number where the FET under test is installed and the slot number where the HP 44702A/B is installed.

3. Install the test fixture on the High Speed FET Multiplexer.

4. Apply power to the HP 3852A.

5. Set up the tests by executing the following commands:

USE ES00 (where E = extender number, S = slot number for High Speed Voltmeter)
FASTDISP OFF
SCANMODE ON
TERM RIBBON

6. On the test fixture, connect a jumper between the shorted HIGH lines and the shorted LOW lines.

7. Enter, but do not execute, the following command:

CONFMEAS OHM ES00-ES23 (where E = extender number, S = FET mux. slot number)

8. When the command entered in step 7 is executed, the HP 44702A/B will perform a resistance measurement on all channels on the HP 44711A. With the FASTDISP OFF, each measurement will appear in the HP 3852A right display. The HP 3852A left display will indicate each channel as it is scanned. Observe the HP 3852A displays and press execute. The resistance indicated in the right display, for all channels, should be less than 6.2 kohms (the number in the display will be in exponential format). The resistance indicated includes the on-resistance of the channel FET switch, the on-resistance of the tree FET switch, and the resistance of the series protection resistors. The scan list can be repeated, if desired, by pressing the RECALL ENTRY key and then the ENTER key.

9. If any reading is incorrect, the voltmeter, ribbon cable, and/or multiplexer accessory may be defective. Go to Chapter 10 of this manual to test the multiplexer accessory before suspecting the voltmeter.

10. Disconnect and remove the High Speed FET Multiplexer accessory from the HP 44702A/B.

7-23 GPIO Test

This test verifies that the HP 44702A/B High-Speed Voltmeter can transfer readings over the GPIO to a hard disc using a DMA controller (i.e., Series 200/300 computer with DMA controller).

This test uses Test Program 7-2 to check the GPIO capability of the HP 44702A/B High Speed Voltmeter. The program is located at the end of this chapter. Make sure the HP 98622A GPIO Interface card for the Series 200/300 Computer is configured as shown in Figure 7-3 (see Section 7-7).

NOTE

Due to extra test equipment required to perform the GPIO Test, perform the test only if the HP 44702A/B High Speed Voltmeter is to be used to transfer readings over the GPIO.

Test Program 7-2 was created for the HP Series 200/300 Computer with Basic 4.0.

1. Remove power from the HP 3852A.

2. Connect the GPIO cable between the HP 44702A/B and computer.

3. Apply power to the HP 3852A.

4. Enter Test Program 7-2 into the computer. The program is written for select code 12 on the HP 98622A GPIO Interface card, as shown in Figure 7-3. If the select code is different, change the select code in line 150 of Test Program 7-2 accordingly. For example, for a select code of 20, change line 150 to the following.

```
150   Gpio=20
```

5. Execute RUN on the computer.

THIS CONCLUDES THE HP 44702A/B PERFORMANCE TESTS.

7-24 CALIBRATION

7-25 Introduction

The calibration procedures in this section are used to calibrate the HP 44702A/B High Speed Voltmeter in all functions (DCV and Ohms).

The HP 44702A/B High Speed Voltmeter is calibrated programatically; no internal adjustments are performed. Calibration is done from the front panel (or by computer control) by applying a known calibration signal to the voltmeter input terminals. This signal is measured by the voltmeter from which calibration constants are calculated.

WARNING

The following procedures are intended for Service Trained Personnel who understand electronic circuitry and are aware of the hazards involved. Do not attempt to perform any of the procedures unless you are qualified to do so.

7-26 Equipment Required

The following test equipment is required calibrate the voltmeter accessory.

1. 2 Test Cables -- HP Part Number 03498-61602

To assure accurate calibration of the HP 44702A/B, shielded twisted pair cables MUST be used for all input connections. Coaxial cables are NOT recommended for use. The shielded twisted pair cables are necessary for the HP 44702A/B to reject noise picked up by the input cables. The cables and cable connections are illustrated in the figures showing the different test setups. If you wish to manufacture your own cables, keep the length of the unshielded wires of the cables to a minimum.

2. DC Voltage Standard -- Datron Model 4000/4000A

If the recommended DC Voltage Standard is not available, use one that is capable of outputting the preferred voltage values at the specified limits, as listed in Table 7-7. However, Although it is other values may be used. Those are also listed in Table 7-7.

Table 7-7 DC Voltage Calibration Requirements

44702A/B Range	Preferred Cal Values	Permissable Cal Values	Required Accuracy
40 mV	36 mV	30 mV to 39 mV	+-0.022%
320 mV	300 mV	240 mV to 318 mV	+-0.012%
2.56 V	2.5 V	1.92 V to 2.5 V	+-0.012%
10.24 V	10 V	7.68 V to 10.1 V	+-0.012%

3. Resistance Standard -- Datron Model 4000/4000A

The Datron Model 4000/4000A normally have resistance values of 1 Ω though 1 MΩ. However, a special version is available with resistance values of 3 Ω through 3 MΩ. Either version will work to calibrate the HP 44702A/B Ohms function.

All the HP 44702A/B ohms ranges can be calibrated using a single resistance value. The preferred value is 10 Kohm with a required accuracy of ±.014%. However, other values may be used. These values are listed as follows:

240 Ω through 318 Ω (±0.014%)
1.92 kΩ through 3.18 k Ω (±0.014%)
7.68 kΩ through 10.1 kΩ (±0.014%)
19.2 kΩ through 31.8 kΩ (±0.014%)
76.8 kΩ through 101 kΩ (±0.014%)
192 kΩ through 250 kΩ (±0.014%)
768 kΩ through 1.01 MΩ (±0.014%)

Instead of using a resistance standard (like the Datron 4000/4000A), you can use a standard resistor with any of the resistance values listed above.

7-27 Calibration Cycle

Periodic calibration should be performed to ensure that the voltmeter is meeting its accuracy specifications. The voltmeter should be calibrated every 90 days or 1 year, dependent on accuracy requirements. Calibration should also be performed if determined by the Performance/Operational Verification Test procedures that calibration is needed.

7-28 Calibration Environment

The HP 44702A/B High Speed Voltmeter may be calibrated in a "bench" environment or system cabinet. For best accuracy, the temperature of the calibration environment should be within ±5° C of the actual operating environment. The HP 44702A/B was calibrated at the factory at an environment temperature of 20° C.

7-29 Calibration Error Codes

In the calibration procedures, the HP 3852A may beep after executing the CAL command. When this happens, look for an error message on the HP 3852A display. The error message most likely indicates some sort of calibration error code and description. These are described as follows:

ERROR 3: BAD NUMBER FORMAT - CAL XXXX (where XXXX is number entered)

This message shows that a letter or other than a number was included in the number executed with the CAL command. For example, typing "O" instead of "0" after another digit within the number causes this error message.

ERROR 71: UNDEFINED WORD - XXXX (where XXXX is number entered)

This shows that the command typed in was invalid. For example, the syntax of the command may be incorrect or an "O" instead of "0" was typed in as the first digit of the number in the CAL command.

ERROR 24: ARGUMENT OUT OF RANGE

This message shows that the number value entered with the CAL command was neither zero nor within the 75% to 99.6% of full scale for the range selected.

ERROR 62: CALIBRATION FAILURE

This shows that the voltmeter is unable to compensate for the difference between the voltage/resistance measured and the value entered with the CAL command. Use another voltmeter/ohmmeter to determine if the calibration voltage/resistance value applied Input Terminals to the HP 44702A/B is correct. If correct, reset the HP 44702A/B and repeat the calibration procedure. If the error returns, repair of the HP 44702A/B may be necessary.

For any other errors, refer to Appendix B of the HP 3852A Mainframe Configuration and Programming Manual.

7-30 Calibration Procedures

The calibration procedures should be performed in the order they are given. It is especially important to perform the DC Volts Calibration Procedure before performing the Ohms Calibration Procedure. This is necessary because the ohms calibration constants depend on the dc volts calibration constants. The calibration procedures consist of the following:

Section 7-31 - Set-Up Procedure
Section 7-32 - DC Volts Calibration Procedure
Section 7-33 - Ohms Calibration Procedure

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

7-31 Set-Up Procedure

1. Apply power to the HP 3852A and allow the HP 44702A/B High Speed Voltmeter a one hour warm-up period inside the mainframe. This is necessary to stabilize the voltmeter before calibration.

2. Press the RESET button on the HP 3852A front panel. Perform the HP 44702A/B Integrating Voltmeter self-test by executing:

TEST ES00 (where E = extender number, S = slot number)

3. The HP 3852A right display should show:

SELF TEST OK

If the display shows a different message, or if the ERR annunciator is on, the HP 44702A/B High Speed Voltmeter may be failing its self test. Test the voltmeter again by executing the command in step 2. If the voltmeter still fails, repair of the unit may be necessary.

4. Designate the HP 44702A/B to be calibrated by executing:

USE ES00 (where E = extender number, S = slot number)

This command establishes the extender/slot number used in all calibration procedures for command destination. If the HP 3852A is reset or power is removed, it is necessary to perform step 4 again to re-establish the extender/slot number.

7-32 DC Voltage Calibration

Calibration of the dc volts function consist of calibrating both the function's offset and gain on all ranges.

Offset calibration is performed by applying 0 V using the accessory's Internal Offset Switch. This switch is enabled by executing the CAL 0 command. The switch then disconnects the external connections from the voltmeter input and places a short across the input.

Gain calibration is performed by applying +36 mV, +300 mV, +2.5 V, and +10 V for the 40 mV, 320 mV, 2.56 V, and 10.24 V Ranges, respectively. Although these values are chosen for calibration, other values may be used. Any value that is between 75% and 99.6% of full scale can be used as listed in Table 7-7.

1. DC VOLTAGE OFFSET CALIBRATION. The following calibrates the dc volts function's offset on all ranges.

2. Perform the Set-Up Procedure in Section 7-31, if not previously performed.

3. Set the HP 44702A/B to calibrate dc volts by executing:

```
TERM EXT
FUNC DCV
TRIG SGL
```

If the HP 3852A is reset or power is removed, it is necessary to perform step 3 again to re-establish the setup parameters.

4. Calibrate the offset on all ranges by executing:

```
CAL 0
```

5. DC VOLTAGE GAIN CALIBRATION. The following calibrates the dc volts function's gain on all ranges.

6. Set the DC Voltage Standard output to +36 mV. Then connect the DC Voltage Standard to the rear HI and LO Input Terminals of the HP 44702A/B High Speed Voltmeter accessory. The connections are shown in Figure 7-7. Make sure shielded twisted pair cables are used for the connections as shown in the figure.

7. Calibrate the 40 mV Range by executing the following commands.

```
RANGE .036
CAL .036
```

8. Set the DC Voltage Standard output to +300 mV.

9. Calibrate the 320 mV Range by executing the following commands.

```
RANGE .3
CAL .3
```

10. Set the DC Voltage Standard output to +2.5 V.

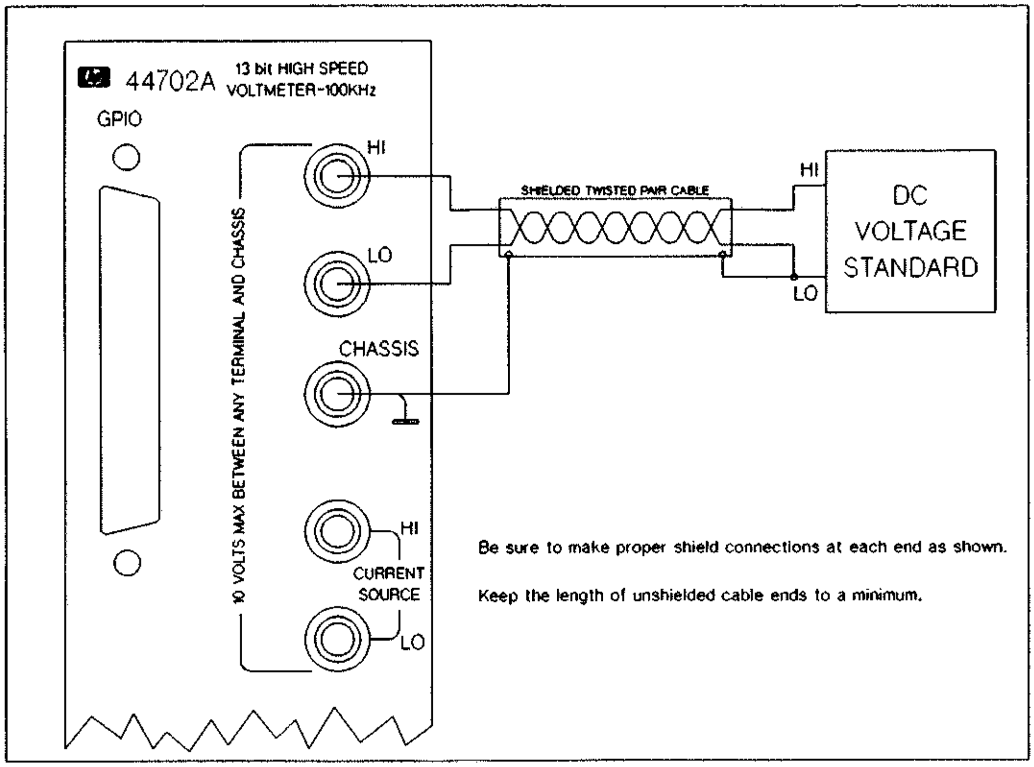


Figure 7-7 DC Voltage Gain Calibration Connections

11. Calibrate the 2.56 V Range by executing the following commands.

```
RANGE 2.5
CAL 2.5
```

12. Set the DC Voltage Standard output to +10 V.

13. Calibrate the 10.24 V Range by executing the following commands.

```
RANGE 10
CAL 10
```

14. Remove the DC Voltage Standard from the HI and LO Input Terminals.

7-33 Ohms Calibration

Make sure DC Volts Calibration in Section 7-32 has been performed before doing Ohms Calibration.

The current sources used for ohms measurements are precision matched and rely on a single gain constant. Therefore, only a single current source needs calibration using a single 10 Kohm resistance value. Although a 10 Kohm value is chosen, any value listed in Section 7-26 step 3 can be used.

Use the following priorities to select the resistance value other than the recommended value.

a. Use a value that calibrates the largest current source/lowest resistance function (i.e., 1 mA/10 Kohm function).

b. A value that is nearest to 99.6% of full scale of a range.

c. Use the highest range within a function.

1. OHMS GAIN CALIBRATION. The following calibrates the ohms function's gain on all ranges.

2. Perform the Set-Up Procedure in Section 7-31, if not previously performed.

3. Set the HP 44702A/B to calibrate ohms by executing:

```
FUNC OHMF10K
```

The command FUNC OHMF10K selects the 1 mA current source/10 Kohm function. This current source is selected when using a 10 Kohm resistance value for calibration. If a different resistance value is used, select the appropriate current source using the priorities previously listed. For example, select the 100 µA current source by executing FUNC OHMF100K if a 3 Kohm value is used.

11. If using the Resistance Standard, set its output to 10 Kohm (or 3 Kohm). If using a Standard Resistor, select any value listed in Section 7-26 step 3.

12. Connect the Resistance Standard/Standard Resistor to the rear HI and LO Input Terminals of the HP 447021A/B High Speed Voltmeter. The connections are shown in Figure 7-8. If using the Resistance Standard, the cable shields must be connected at the HP 44702A/B chassis and must be disconnected at the Resistance Standard

13. Calibrate ohms by executing:

```
RANGE 10E3
CAL 10E3
```

The commands RANGE 10E3 and CAL 10E3 are used only if a 10 Kohm resistance value is used for calibration. If a different resistance value is used, change the commands to reflect that value. For example, use RANGE 3E3 and CAL 3E3 if a 3 Kohm resistance value is used.

14. When calibration is completed, remove the Resistance Standard/Standard Resistor from the HI and LO Input Terminals.

THIS CONCLUDES THE HP 44702A/B CALIBRATION PROCEDURES.

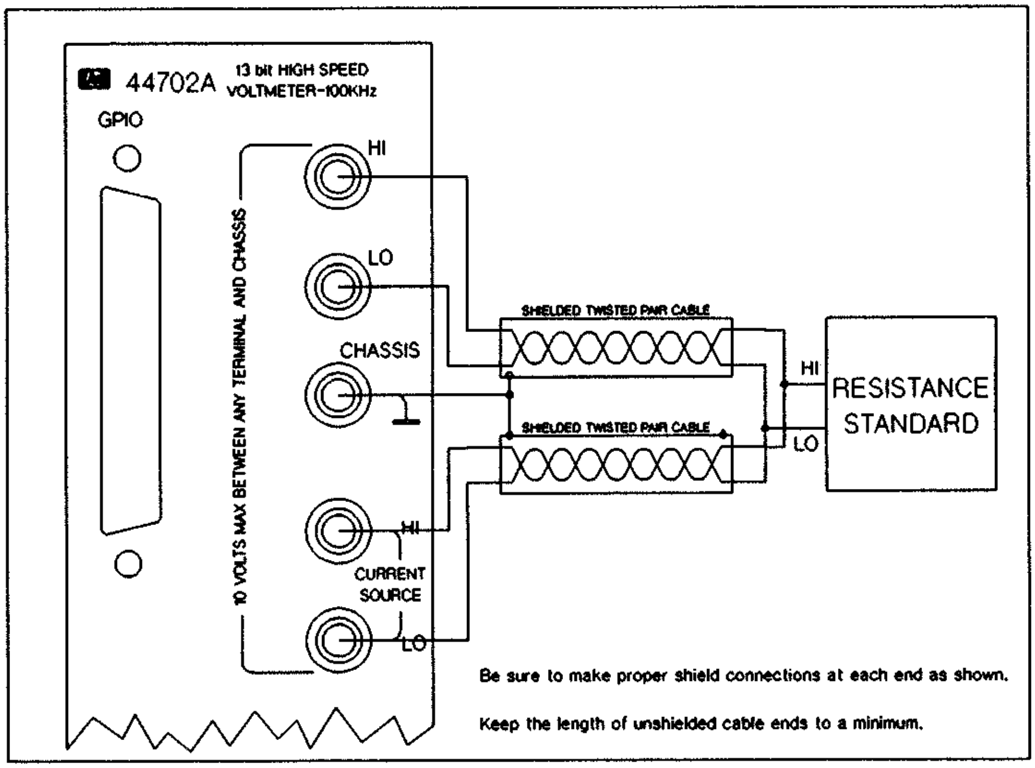


Figure 7-8a Ohms Gain Calibration Connections Using a Resistance Standard

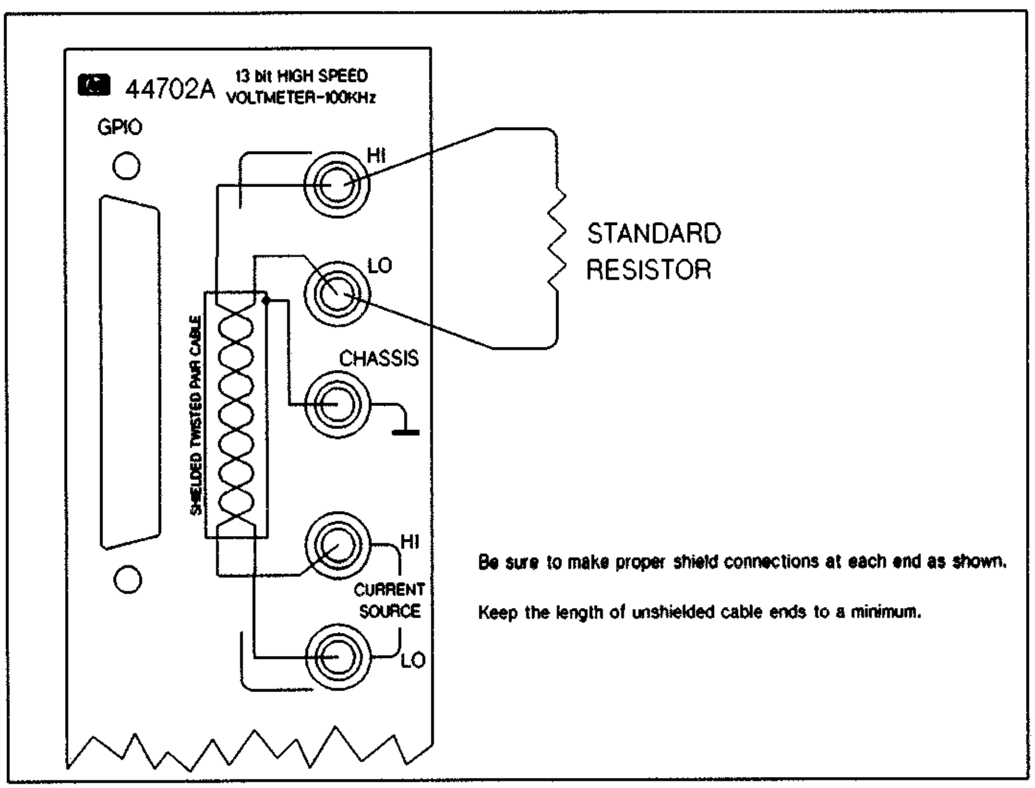


Figure 7-8b Ohms Gain Calibration Connections Using a Standard Resistor

7-34 REPLACEABLE PARTS

To order a part listed in Table 7-8, quote the Hewlett-Packard part number, the check digit (abbreviated CD in Table 7-8), the HP factory reference, and the quantity desired. Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed at the back of this manual.

CAUTION

The printed circuit boards in the HP 44702A/B are static sensitive devices. Refer to Chapter 5 for additional information about handling static sensitive devices.

Table 7-8 HP 44702A/B 13-bit High Speed Voltmeter

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44702A	13-bit high speed voltmeter (8kRdg)	1	44702A	9	HI-SPD VM/8KRDG
44702B	13-bit high speed voltmeter (64kRdg)	1	44702B	1	HI-SPD VM/64KRDG
A1	PCA; high speed voltmeter digital	1	44702-66501	1	PCA-HS VM,DIGITL
A2	PCA; high speed voltmeter analog	1	44702-66502	2	PCA-HS VM ANALOG
A3	PCA; high speed voltmeter 56kRdg mem	1	44702-66503	3	PCA-VM MEM 56KRD
MP1	Screw; rear panel and A1/A2 PCAs	8	0515-0886	3	SCR-PH M3.0X6 LK
MP2	Hex standoff; GPIO connector	2	0380-1332	9	STDF-HEX .18-IN
MP3	Lock washer; GPIO connector	2	2190-0577	1	WSHR-LK SCR-10
MP4	Terminal; rear panel input	5	1510-0091	3	BDG POST ASSYRED
MP5	Spring washer; rear panel input term	5	3050-0593	6	WSHR-SPR-CRVD
MP6	Nut; rear panel input terminal	5	2950-0001	8	NUT-HEX-DBL CHAM
MP7	Pull lever; (molded)	1	03852-45002	8	MLD-PULL LEVER
MP8	Panel; rear 44702A/B (no 44702B lbl)	1	44702-00201	0	0601 PNL-RR,A/D
MP9	Label; rear panel 44702B (only)	1	44702-84334	6	LBL-PNL,44702B
MP10	Screw; A3 PCA	2	0515-1060	7	SCR PH M3.0X25
MP11	Cable; rear panel input, with socket	1	44702-61602	3	CBL-6P VM IN
MP12	Label; "maximum number assemblies.."	1	03852-84326	1	LBL-CAUTION,PWR
MP13	Cover; left (aluminum)	1	44702-04101	7	0601 COVER,LEFT
MP14	Cover; right (aluminum)	1	44702-04102	8	0601 COVER-RIGHT
MP15	Shield; between A1 and A2 (aluminum)	1	44702-00601	4	0601 SHIELD-CNTR
MP16	Screw; right and left covers	4	0515-1322	4	SCR-FH M3.0X30LK
MP17	Cable; analog A1 to A2, with sockets	1	44702-61601	2	CBL-11P F/F KEYD
MP18	Label; "STOP" internal cable warning	1	44711-84321	2	LBL-CAUTION-STOP

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44702A	13-bit high speed voltmeter (8kRdg)		44702-69201	4	RBLT-44702A
44702B	13-bit high speed voltmeter (64kRdg)		44702-69203	6	RBLT-44702B

This Page Intentionally Left Blank

TEST PROGRAM 7-1

```
10    ! Autorange test program for the HP 44702A/B
20    !
30    Addr=709                              ! HP 3852A HP-IB Address.
40    Slot=100                              ! HP 44702A/B slot.
50    OUTPUT Addr;"RST"                     ! Resets HP 3852A.
60    DISP "RESETTING THE HP 3852A, PLEASE WAIT."
70    WAIT 2
80    DISP "Press STOP or PAUSE to stop program execution."
90    OUTPUT Addr;"USE "&VAL$(Slot)&";TERM EXT;FUNC DCV;TRIG INT"
100   OUTPUT Addr;"XRDGS "&VAL$(Slot)&",1,PACK"
110   ENTER Addr USING "%,W";Packed        ! Enter into packed.
120   Good_flag=BINAND(Packed,-32768)      ! Check bit 15.
130   IF NOT (BIT(Good_flag,15)) THEN
140     PRINT "Input amp saturation detected by HP 44702A/B."
150     PRINT "Program aborted."
160     STOP
170   ELSE
180     Range=SHIFT(BINAND(Packed,24576),13) ! Check bits 14 and 13.
190   END IF
200   Sign=1
210   IF BIT(Packed,12) THEN Sign=-1
220   Raw_mag=BINAND(Packed,4095)             ! Strips the 4 msb's.
230   IF Range=0 THEN Volts=Raw_mag*.04/4096*Sign
240   IF Range=1 THEN Volts=Raw_mag*.32/4096*Sign
250   IF Range=2 THEN Volts=Raw_mag*2.56/4096*Sign
260   IF Range=3 THEN Volts=Raw_mag*10.24/4096*Sign
270   PRINT "VOLTAGE = ",Volts
280   IF Range=0 THEN PRINT "RANGE = 40 mV"
290   IF Range=1 THEN PRINT "RANGE = 320 mV"
300   IF Range=2 THEN PRINT "RANGE = 2.56 V"
310   IF Range=3 THEN PRINT "RANGE = 10.24 V"
320   PRINT
330   WAIT 1
340   GOTO 100
350   END
```

TEST PROGRAM 7-2

```
10    ! Test Program to check the GPIO interface on the HP 44702A/B
20    ! High Speed Voltmeter.
30    !
40    ! Make sure the GPIO Interface Card is configured correctly.
50    !
60    ! Make sure the variable 'Gpio' matches the address selection
70    | switch on the GPIO Interface Card.
80    !============================================================
90 Main_program:   !
100   !============================================================
110   !
120   REAL Test_word,Not_test_word,Inverted,Non_inverted
130   INTEGER Gpio,Failed
140   !
150   Gpio=12                              ! GPIO Address
160   Failed=0                             ! Failure flag initialized
170   Test_word=21846                      | Pattern of 010101...
180   Not_test_word=-24846                 ! Pattern of 101010...
190   !
200   CONTROL Gpio,2;5                     ! Sends Echo command to
210   OUTPUT Gpio USING "#,W";3            ! the HP 44702A/B
220   CONTROL Gpio,2;4
230   OUTPUT Gpio USING "#,W";193
240   WAIT .1
250   !
260   CONTROL Gpio,2;5                     ! Sends data to be echo'd
270   OUTPUT Gpio USING "#,W";2            ! by the HP 44702A/B
280   CONTROL Gpio,2;4
290   OUTPUT Gpio USING "#,W";Test_word
300   WAIT .1
310   !
320   CONTROL Gpio,2;5                     ! Reads first echo'd data
330   OUTPUT Gpio USING "#,W";2            ! from the HP 44702A/B
340   CONTROL Gpio,2;4
350   ENTER Gpio USING "#,W";Inverted
360   WAIT .1
370   !
380   CONTROL Gpio,2;5                     ! Reads second echo'd data
390   OUTPUT Gpio USING "#,W";2            ! from the HP 44702A/B
400   CONTROL Gpio,2;4
410   ENTER Gpio USING "#,W";Non_inverted
420   !
430   IF Non_inverted<>Test_word THEN Failed=1
440   IF Inverted<>Not_test_word THEN Failed=1
450   !
```

TEST PROGRAM 7-2 (Cont.)

```
460   IF FAILED THEN
470      PRINT "HP 44702A/B's GPIO failed to echo data properly."
480      PRINT "Inverted = ",Inverted
490      PRINT "Non-inverted = ",Non_inverted
500      PRINT "This test is complete."
510   ELSE
520      PRINT "HP 44702A/B passed the GPIO Test."
530      PRINT "This test is complete."
540   END IF
550   !
560   END
```

Chapter 8
HP 44705A/05H/06A/08A/08H/17A/18A
Multiplexers/Strain Gages

CHAPTER 8
HP 44705A/44705H/44706A/44708A/44708H RELAY MULTIPLEXERS
HP 44717A/44718A STRAIN GAGES

CHAPTER 8

HP 44705A/44705H/44706A/44708A/44708H RELAY MULTIPLEXERS

HP 44717A/44718A STRAIN GAGES

8-1 INTRODUCTION

This chapter provides a technical description, performance test procedures, relay troubleshooting procedures, and replaceable parts lists for the HP 44705A/H 20 Channel Relay Multiplexer, the HP 44706A 60 Channel Single Ended Relay Multiplexer, and the HP 44708A/H 20 Channel Relay Multiplexer with Thermocouple Compensation. This chapter also has a technical description and replaceable parts list for the HP 44717A 10 Bridge 120Ω Static Strain Gage Relay Multiplexer and the HP 44718A 10 Bridge 350Ω Static Strain Relay Multiplexer Accessories.

NOTE

The Strain Gage accessories can only be used with instruments having a firmware revision of 2.0 or above. Determine the firmware revision by sending the "IDN?" *command.*

8-2 HP 44705A Technical Description

The HP 44705A/H 20 Channel Relay Multiplexer has two main assemblies: the component module and the terminal module. The component module contains the backplane interface electronics, the relay control logic, and the relays. The terminal module contains terminal strips for connecting external wiring and provides mounting holes for user installed components such as: one pole low pass filters, voltage dividers, current shunt resistors (to allow current measurements), surge current limit resistors or fuses.

Figure 8-1 shows a simplified schematic of the HP 44705A/H. In the component module, the relays are electrically arranged into channel relays and tree relays. The channel relays are further arranged into two banks of 10. These banks are referred to as Bank A and Bank B. Each bank has its own set of common terminals and can be controlled independently of the other bank. In normal operation, only one channel in each bank may be closed at a time. The relays used are triple-pole single-throw relays (TPST). This allows HIGH, LOW, and GUARD to be switched, in unison, for all channels.

The tree switch relays are controlled independently from the channel relays. There are four tree relays: two connected to the backplane analog source bus and two connected to the backplane analog sense bus. These relays allow channel connections to the backplane bus. The backplane analog bus can be used for measurements by either of the plug-in accessory voltmeters (HP 44701A or HP 44702A/B). The sense bus is used for voltage measurements. The source bus provides a current source (generated by either the HP 44701A or HP 44702A/B) for resistance measurements. The tree relays are controlled by giving them channel numbers. The relays have channel numbers 91, 92, 93, and 94. Channels 91 and 92 are the sense bus tree relays, channels 93 and 94 are the source bus tree relays.

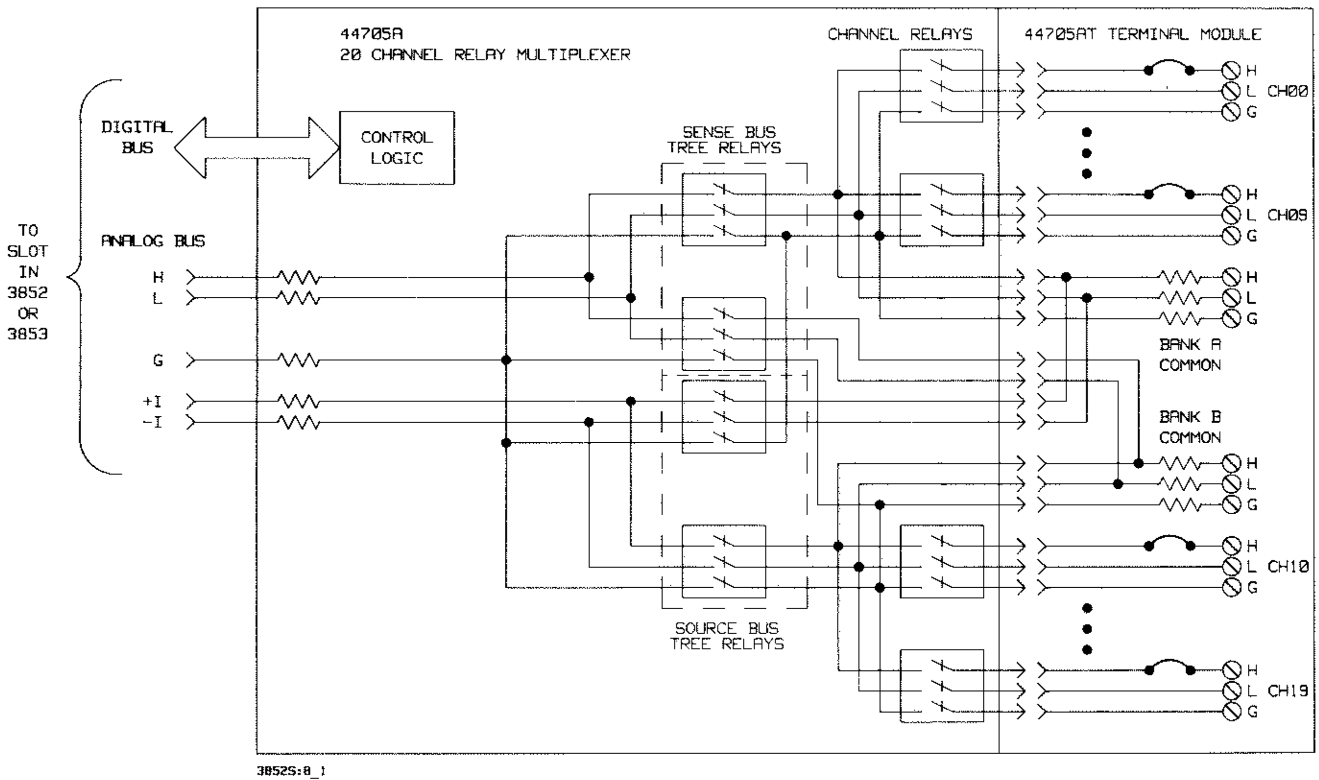


Figure 8-1 HP 44705A/H Simplified Schematic

Four-wire ohms measurements can be made by pairing a channel in Bank A with a channel in Bank B. One of the paired channels provides the current source from the backplane analog source bus and the other channel provides a voltage measurement path through the backplane analog sense bus. Two wire ohms measurements are possible at each channel by combining the backplane source bus and sense bus at the channel relay.

An isolation jumper is provided in the component module of the HP 44705A that enables or disables the tree relay drive lines. This jumper provides a positive means to isolate the backplane analog bus from the signals present on the channel inputs. The tree relay drive lines are isolated when the jumper is set to the disable position.

8-3 HP 44706A Technical Description

The HP 44706A 60 Channel Single Ended Relay Multiplexer has two main assemblies: the component module and the terminal module. The component module contains the backplane interface electronics, the relay control logic and the relays. The terminal module contains the terminal strips for connection to external wiring.

Figure 8-2 shows a simplified schematic of the HP 44706A. In the component module, the relays are arranged into channel relays and tree relays. For the HP 44706A, the backplane analog bus is the common connection of the multiplexer channels. On the terminal module, LOW and GUARD are common for all channels.

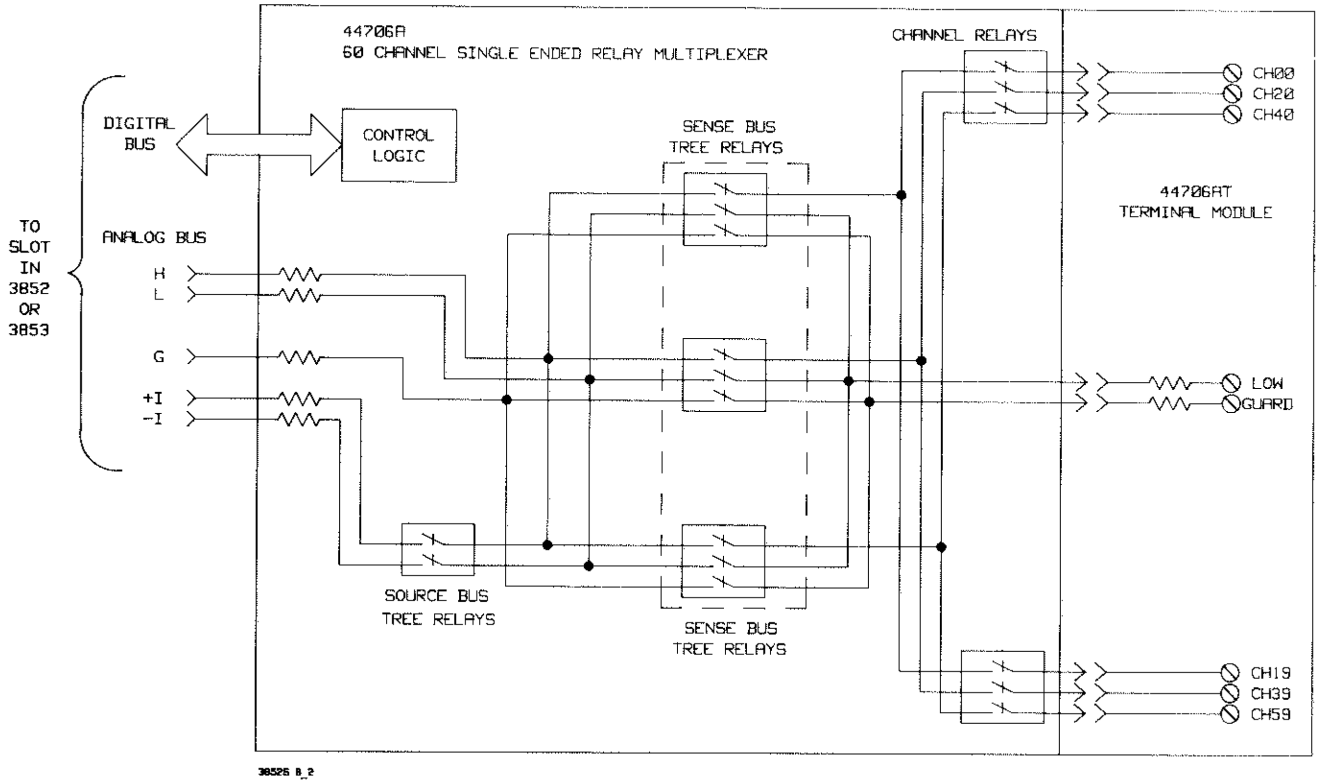


Figure 8-2 HP 44706A Simplified Schematic

The channel relays are triple-pole, single throw relays. Each channel relay switches three channels. Selection of the desired channel is accomplished by closing one of three sense bus tree relays. Thus, closing a specified channel closes the appropriate channel relay and one of the three sense bus tree relays. In normal operation, only one channel may be closed at a time.

The backplane analog source bus tree relay is used when the HP 44706A is programmed for resistance measurements and allows the current source bus to be connected to the desired channel. The current source is provided by one of the two plug-in voltmeter accessories (HP 44701A or HP 44702A/B). The source bus tree relay has a channel number of 91. The HP 44706A only supports two-wire ohms measurements at each channel.

8-4 HP 44708A/H Technical Description

The HP 44708A/H 20 Channel Relay Multiplexer with Thermocouple Compensation has two main assemblies: the component module and the terminal module. The component module contains the backplane interface electronics, the relay control logic, and the relays. The terminal module contains terminal strips for connecting external wiring, a thermocouple mounted in a thermal block, and provides mounting holes for user installed components such as: one pole low pass filters, voltage dividers, current shunt resistors (to allow current measurements), surge current limit resistors or fuses.

The HP 44708A/H component module is the same module used in the HP 44705A/H. The HP 44708A/H is made unique by the addition of the terminal module. A simplified schematic of the HP 44708A/H is given in Figure 8-3. Section 8-2 provides a technical description of the HP 44705A/H which also applies to the HP 44708A/H component module. Because the HP 44708A/H terminal module uses two of the tree switches to measure the thermocouple, ohms measurements at each channel are limited to two-wire ohms.

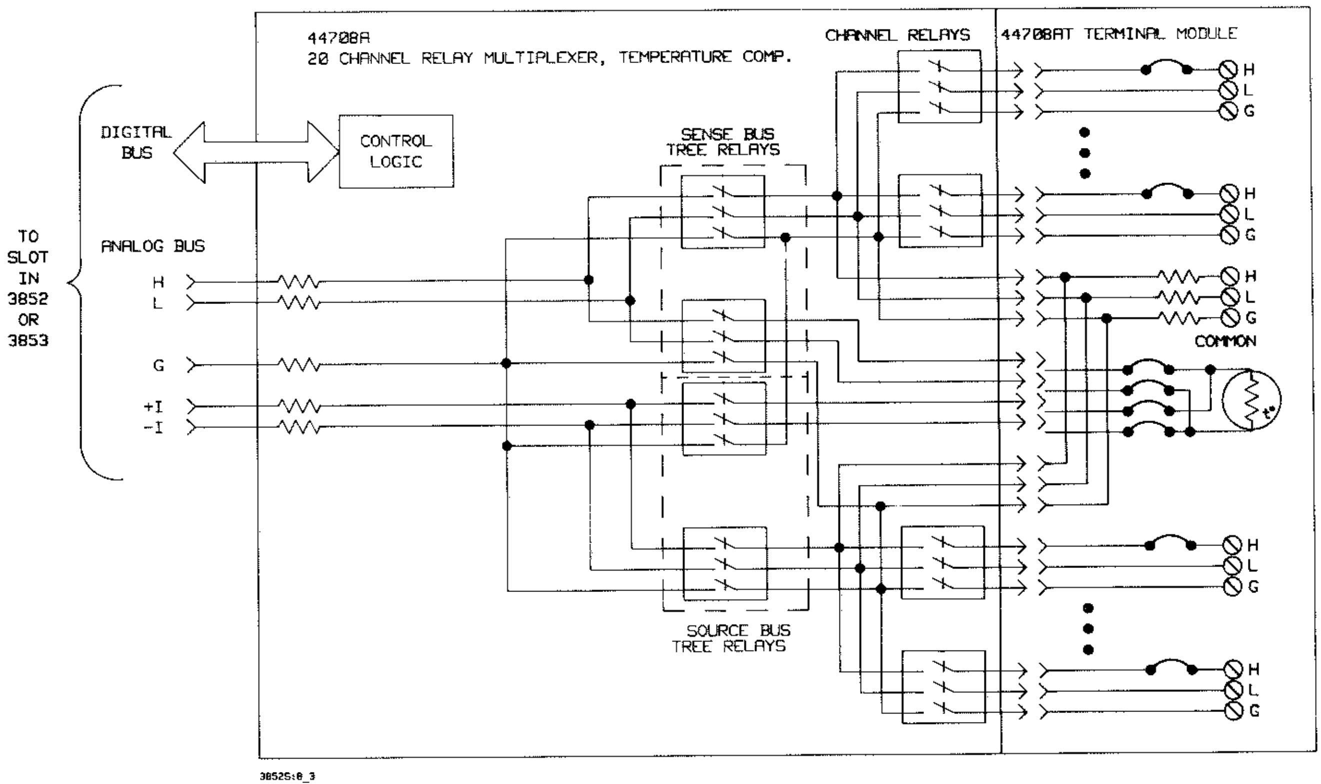


Figure 8-3 HP 44708A/H Simplified Schematic

On the terminal module, only one common connection is provided for all 20 channels. The addition of the thermistor in the thermal block on the terminal module provides for temperature compensation measurements. The thermistor is read as a four wire ohms measurement by closing a sense bus and a source bus tree relay.

8-5 HP 44717A and HP 44718A Technical Description

The HP 44717A and HP 44718A Strain Gages modules work in conjunction with HP 44705A 20 Channel Multiplexer Relay Assemblies to make strain gage measurements. (see Section 8-2 for a description of the multiplexer assembly) The HP 44717A is used for 120Ω strain gage measurements and the HP 44718A is used for 350Ω measurements. The modules contain terminal strips for making external connections for quarter, half, and/or full bridge configurations.

Figure 8-4 shows a simplified schematic of the HP 44717A and 44718A strain gage modules and also shows the different strain gage configurations. The actual strain gage measurements are made through the 20 Channel Relay Multiplexer using either the HP 44701A 5 1/2 Digit Integrating Voltmeter, the HP 44702A/B 13 Bit High Speed Voltmeter, or an external voltmeter. Only 10 channels of the multiplexer are used for strain gage measurements. The other 10 channels are used to measure the external bridge exitation voltage, shunt verification, gage isolation, internal half bridge voltage, guard voltage, and leadwire resistance. These channels only check the external connections to the strain gage module, and not the operation of the strain gage module itself.

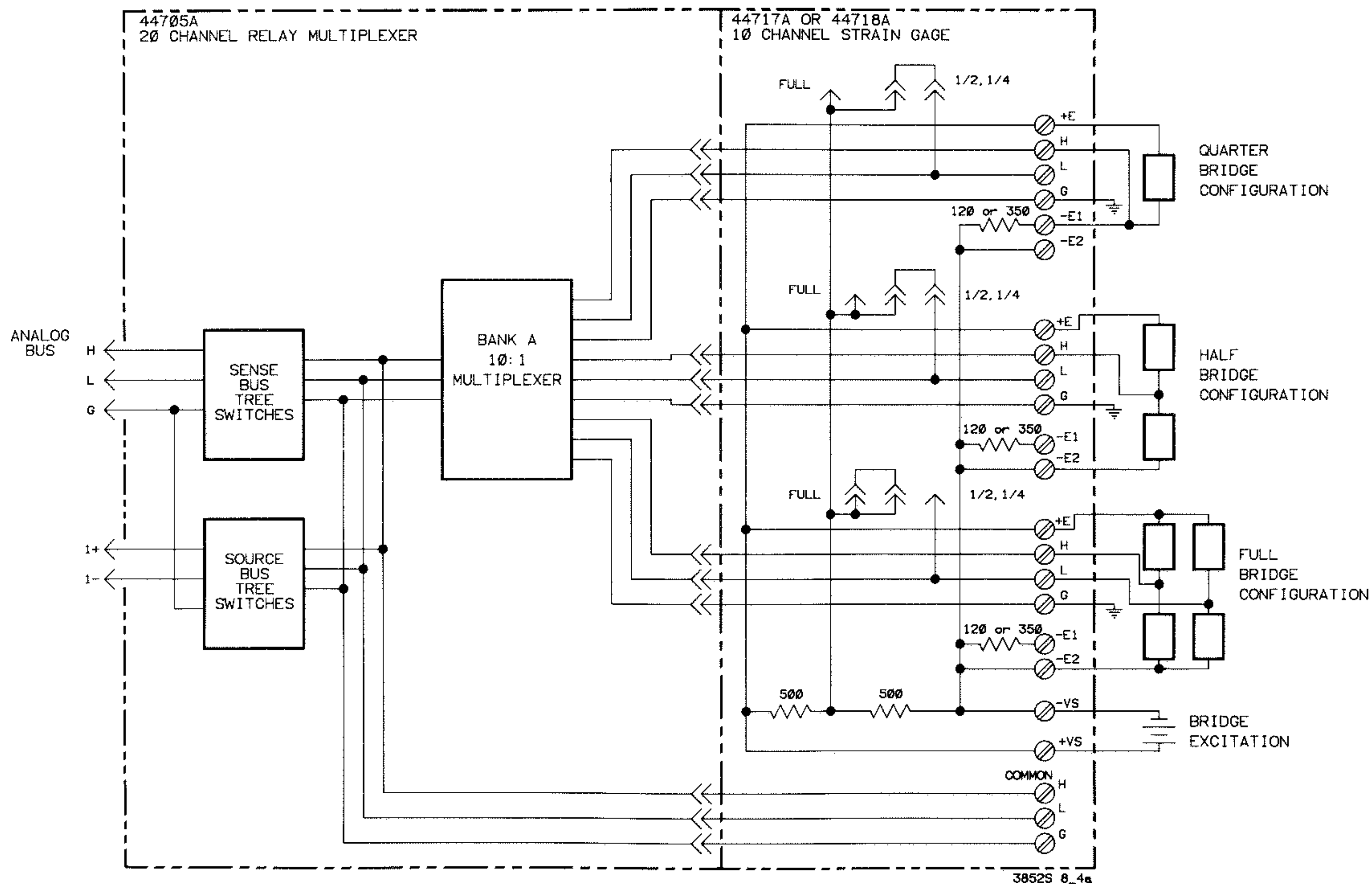


Figure 8-4 HP 44717A/44718A Simplified Schematic

8-6 Read And Write Registers

The HP 3852A local controller communicates with each plug-in accessory by using read and write registers. All accessory commands are translated into appropriate register commands by the HP 3852A local controller. The SREAD and SWRITE commands are used to directly control each accessory register.

SREAD and SWRITE are described in detail in Chapter 2 of this manual. Table 8-1 shows the registers implemented on the HP 44705A/H, HP 44706A, and HP 44708A/H.

CAUTION

Using the primitive commands (SREAD and SWRITE) may cause unexpected and undesirable effects on the plug-in accessories. It is possible to program some plug-in accessories into illegal and potentially damaging states with these commands. The commands are documented here for service purposes only.

Table 8-1 Relay Multiplexer Read and Write Registers

Register #	READ Registers	WRITE Registers
0	Accessory Identification	Accessory Reset
1	Accessory Status	Not Used
2	Relay Status	Not Used
3	Not Used	Relay Opening
4	Not Used	Not Used
5	Not Used	Not Used
6	Not Used	Relay Closing

8-7 Read Registers

8-8 Register 0. Read Register 0 contains the accessory identification. Eight bits are used for the identification. The eight bits are output from the register on the lower eight backplane data bits (BD0-BD7). The upper eight backplane data bits (BD8-BD15) are pulled high when the register is read.

The eight bit identification is a two part identification. The most significant five bits identify the component module, the least significant three bits identify the terminal module. If a terminal module is not present, the lower three bits are pulled high on the component module. The HP 3852A local controller can thus identify the type of plug-in accessory installed and determine if a terminal module is installed. If a terminal module is installed, the type of terminal is also identified.

At power-on or after a reset, the HP 3852A local controller reads the Accessory Identification register and determines the type of accessory installed. The local controller will then not allow incorrect accessory commands to be sent to that slot. If the local controller determines that a terminal module is not installed, the local controller will not allow any commands (except SREAD and SWRITE) to be sent to the slot.

Table 8-2 lists the two's compliment decimal equivalent codes returned in response to an SREAD of Register 0 for all combinations of the modules.

Table 8-2 HP 44705A, HP 44706A, and HP 44708A Identification Codes

Module Combinations	Codes
HP 44705A Component Module (no terminal module installed)	3847
HP 44705A Component Module, HP 44705AT Terminal Module installed	3840
HP 44705A Component Module, HP 44708AT Terminal Module installed	3842
HP 44705A Component Module, HP 44717AT Terminal Module installed	3844
HP 44705A Component Module, HP 44718AT Terminal Module installed	3845
HP 44706A Component Module, (no terminal module installed)	4087
HP 44706A Component Module, HP 44706AT Terminal Module installed	4080

8-9 Register 1. Read Register 1 contains the accessory status word. This status word is used by the local controller to control data and commands sent to the multiplexer. Bit 1 in this register is the BUSY bit, used to indicate to the local controller that the relay multiplexer is executing a previous command and is not ready to receive a new command.

8-10 Register 2. Read Register 2 is the relay status register. This register uses backplane data bits 0 through 11 to indicate the current status of each relay on the multiplexer. Figure 8-5 shows the relay status word.

```
Bits:      15  14  13  12 | 11  10  9   8 | 7  6  5  4 | 3  2  1  0
Meaning:   0   0   0   0  |  Tree Relays  |  Bank B    |   Bank A
                           94  93  92  91  (K10 - K19)   (K0 - K9)
```

Figure 8-5 Relay Multiplexer Read Register 2 Status Word

In the status word four bits (8 through 11) are used to indicate the the status of the tree relays (tree relays are referred to as channels 91 through 94. Four bits (4 through 7) represent the status of the relays in Bank B and four bits (0 through 3) represent the status of relays in Bank A. With no relays closed, the two most significant Bank A and Bank B status bits are set. When a channel is closed, the decimal equivalent of the four-bit binary code represents the channel number.

For example, reading Register 2 following a reset (no relays closed) will return a decimal value of 204 (binary 0000000011001100). Closing channel 00 would result in a register value of 192 (binary 0000000011000000). Note that the Bank B bits are not reset (since channel 00 is in Bank A). Closing channel 01 gives a register value of 193 (binary 0000000011000001).

The result of an opening or closing command is not placed in the register until the action has occurred. A delay of at least 1.1 milliseconds must be used between sending a relay close or open command and reading Register 2 to ensure that the register contains the new status.

8-11 Write Registers

8-12 Register 0. Write Register 0 is the accessory reset register. Any data written to this register will cause a reset of all relays and stop opening and closing coordination. A write to Register 0 produces the same result on the accessory as a system reset (backplane reset) or slot reset.

8-13 Register 3. Write Register 3 is the opening register. Writing a command word to register 4 will cause the OPENING pulse to be asserted on the backplane and will execute the relay opening indicated in the command word. The command word is described in Section 8-15.

8-14 Register 6. Write Register 6 is the closing register. Writing a command word to register 6 will cause the CLOSING pulse to be asserted on the backplane and will execute the relay closures indicated in the command word. However, the relay will only close after the opening pulse on the backplane is completed, if present. The command word is described in Section 8-15.

8-15 Command Word

The command word uses 15 bits. The bits are arranged into mask bits, tree relay bits, Bank A relay bits and Bank B relay bits. Figure 8-6 represents the command word. The command word is used for both opening and closing the relays. The opening or closing function is determined by the register number receiving the command word (Register 4 for opening, Register 6 for closing).

```
Bits:       15 14 13 12 | 11 10  9  8 | 7 6 5 4 | 3 2 1 0
Meaning:    X  T  B  A  | Tree Relays | Bank B  | Bank A
              (mask)
```

Figure 8-6 Relay Command Word

The mask bits in the command word determine which set of relays will be operated upon. Bit 14 sets the tree relay mask, bit 13 the Bank B relay mask, and bit 12 the Bank A relay mask. When the mask bit is set, the corresponding four bits of the command word are used to control the relays. More than one mask bit can be set at a time.

The correspondence of the Tree Relay bits are in Table 8-3.

Table 8-3 Relay Correspondence

Bit	HP 44705A/44708A HP 44705H/44708H	HP 44706A	Relay
11	Ch 94	Ch 40-59	K20
10	Ch 93	Ch 20-39	K21
9	Ch 92	Ch 00-19	K22
8	Ch 91	Ch 91	K23

The Bank A and Bank B bits can be decoded as a decimal number corresponding to the channel number. Each set of four bits (0 through 3 or 4 through 7) is individually decoded (depending upon the mask bits set). Bank B bits are also decimally decoded into channel numbers but are a decade ahead of the Bank A channel numbers (Bank A channel 00 corresponds to Bank B channel 10).

8-16 SPECIFICATIONS

Specifications for the HP 44705A/H, HP 44706A, and HP 44708A/H are given in Table 8-4. Specifications are the performance standards or limits against which the relay multiplexers may be tested.

NOTE

The installation of the HP 44705A/H or HP 44708A/H reduces the maximum allowable analog backplane voltages to ±170 V peak between any two points in the circuit or between the circuit and chassis.

The installation of the HP 44706A reduces the maximum allowable analog backplane voltages to ±42 V peak between any two points in the circuit or between the circuit and chassis.

Table 8-4 HP 44705A/05H/06A/08A/08H/17A/18A Specifications

HP 44705A 20 Channel Relay Multiplexer

Maximum Switch Rate: 450 channels/second

Maximum Input Voltage: 170 V peak or 120 V DC between any two points (Terminal or Chassis)

Maximum Input Current: 50 mA non-inductive per channel

Maximum Input Power: 1 VA RMS per channel

Characteristic Relay Lifetime:

Voltage*	Number of on/off Cycles
10 V peak or 7 V DC	10^8
40 V peak or 30 V DC	$1.5*10^7$
100 V peak or 70 V DC	10^7

Input Impedance: $>10^9$ Ω High to Low, Low to Guard, and Guard to Chassis Terminals

Bandwidth: 1.0% flatness at 1 MHz, -3 dB Bandwidth at 10 MHz (50 Ω source, 1 MΩ termination)

Crosstalk: -70 dB at 100 kHz (channel-to-channel, 50 Ω source, 1 MΩ termination)

Maximum Offset Voltage: 2 µV (between High and Low)

Maximum Bias Current: ±1 nA DC (Current sourced by High, Low, or Guard to Chassis into Input Terminals or back plane)

Maximum Wire Size: 16 AWG

HP 44705H 20 Channel High Voltage Relay Multiplexer

Maximum Switch Rate: 250 channels/second

Maximum Input Voltage: 354 V peak or 250 V DC between any two points (Terminal or Chassis)

Maximum Input Current: 50 mA non-inductive per channel (15 mA in Guard Terminal)

Maximum Input Power: 1 VA RMS per channel

Characteristic Relay Lifetime:

Voltage*	Number of on/off Cycles
10 V peak or 7 V DC	10^8
40 V peak or 30 V DC	$1.5*10^7$
100 V peak or 70 V DC	10^7
354 V peak (250 V RMS Sine)	10^6
200 V DC	$5*10^5$

Input Impedance: $>10^9$ Ω High to Low, Low to Guard, and Guard to Chassis Terminals

Bandwidth: 1.0% flatness at 1 MHz, -3 dB Bandwidth at 5 MHz (50 Ω source, 1 MΩ termination)

Crosstalk: -35 dB at 100 kHz (channel-to-channel, 50 Ω source, 1 MΩ termination)

Maximum Offset Voltage: 10 µV (between High and Low)

Maximum Bias Current: ±1 nA DC (Current sourced by High, Low, or Guard to Chassis into Input Terminals or back plane)

Maximum Wire Size: 16 AWG

HP 44706A 60 Channel Single Ended Relay Multiplexer

Maximum Switch Rate: 450 channels/second

Maximum Input Voltage: 42 V peak or 30 V DC between any two points (Terminal or Chassis)

Maximum Input Current: 50 mA non-inductive per channel

Maximum Input Power: 1 VA RMS per channel

Characteristic Relay Lifetime:

Voltage*	Number of on/off Cycles
10 V peak or 7 V DC	10^8
40 V peak or 30 V DC	$1.5*10^7$
100 V peak or 70 V DC	10^7

Input Impedance: $>10^9$ Ω High to Low, Low to Guard, and Guard to Chassis Terminals

Bandwidth: 1.0% flatness at 1 MHz, -3 dB Bandwidth at 10 MHz (50 Ω source, 1 MΩ termination)

Crosstalk: -70 dB at 100 kHz (channel-to-channel, 50 Ω source, 1 MΩ termination)

Maximum Offset Voltage: 200 µV (between High and Low)

Maximum Bias Current: ±1 nA DC (Current sourced by High, Low, or Guard to Chassis into Input Terminals or back plane)

Maximum Wire Size: 16 AWG

HP 44708A 20 Channel Relay Multiplexer With Thermocouple Compensation

Maximum Switch Rate: 450 channels/second

Maximum Input Voltage: 170 V peak or 120 V DC between any two points (Terminal or Chassis)

Maximum Input Current: 50 mA non-inductive per channel

Maximum Input Power: 1 VA RMS per channel

Characteristic Relay Lifetime:

Voltage*	Number of on/off Cycles
10 V peak or 7 V DC	10^8
40 V peak or 30 V DC	$1.5*10^7$
100 V peak or 70 V DC	10^7

Input Impedance: $>10^9$ Ω High to Low, Low to Guard, and Guard to Chassis Terminals

Bandwidth: 1.0% flatness at 1 MHz, -3 dB Bandwidth at 10 MHz (50 Ω source, 1 MΩ termination)

Crosstalk: -70 dB at 100 kHz (channel-to-channel, 50 Ω source, 1 MΩ termination)

Maximum Offset Voltage: 2 µV (between High and Low)

Maximum Bias Current: ±1 nA DC (Current sourced by High, Low, or Guard to Chassis into Input Terminals or back plane)

Maximum Wire Size: 16 AWG

Ref. Junction Compensation Accuracy: 0.1 °C (over 18 to 28 °C operating temperature)

Max Temperature Difference Across Isothermal Module: 0.2 °C

HP 44708H 20 Channel High Voltage Relay Multiplexer with Thermocouple Compensation

Maximum Switch Rate: 250 channels/second

Maximum Input Voltage: 354 V peak or 250 V DC between any two points (Terminal or Chassis)

Maximum Input Current: 50 mA non-inductive per channel (15 mA in Guard Terminal)

Maximum Input Power: 1 VA RMS per channel

Characteristic Relay Lifetime:

Voltage*	Number of on/off Cycles
10 V peak or 7 V DC	10^8
40 V peak or 30 V DC	$1.5*10^7$
100 V peak or 70 V DC	10^7
354 V peak 250 V RMS (sine)	10^6
200 V DC	$5*10^5$

Input Impedance: $>10^9$ Ω High to Low, Low to Guard, and Guard to Chassis Terminals

Bandwidth: 1.0% flatness at 1 MHz, -3 dB Bandwidth at 5 MHz (50 Ω source, 1 MΩ termination)

Crosstalk: -35 dB at 100 kHz (channel-to-channel, 50 Ω source, 1 MΩ termination)

Maximum Offset Voltage: 10 µV (between High and Low)

Maximum Bias Current: ±1 nA DC (Current sourced by High, Low, or Guard to Chassis into Input Terminals or back plane)

Maximum Wire Size: 16 AWG

Ref. Junction Compensation Accuracy: 0.1 °C (over 18 to 28 °C operating temperature)

Max Temperature Difference Across Isothermal Module: 0.2 °C

HP 44717A/44718A 10 Bridge Static Strain Gage Multiplexer**
(Use HP 44705A Specifications with these changes/additions)

Maximum Input Voltage: 42 V peak or 30 V DC between High and Low
170 V peak or 120 V DC between any other two points (Terminal or Chassis)

Strain Gage Resolution:

Bridge Configuration	Bridge Exitation Voltage 5 V	1 V	0.1 V
Full	0.01 με	0.05 με	0.5 με
1/2	0.02 με	0.1 με	1 με
1/4	0.04 με	0.2 με	2 με

Bridge Exitation Requirements: An inexpensive power supply, such as an HP 6214B can be used for the following requirements

Current Requirements for Exitation Voltage (5.4 V maximum for specified accuracy):

Bridge Type	Bridge Configuration	Current per Channel
120 Ω	Full	50 mA
120 Ω	1/2	25 mA
120 Ω	1/4	25 mA
350 Ω	Full	17 mA
350 Ω	1/2	8.5 mA
350 Ω	1/4	8.5 mA

Ripple and Noise Requirements for Exitation Voltage:

1 mV peak-to-peak (20 Hz to 20 MHz)

Max Self-Heating Offset Due to Change in number of Gages on One Assembly: 2 με per Gage for 120 Ω, 1/4 Bridge Configuration, and 5 V Exitation Voltage (worst-case)

Max Self-Heating Offset Due to a 0.1 V Change in Exitation Voltage: 0.38 με

*The voltage in the table is the total peak voltage between one scanned channel contact and the next, or from a scanned channel contact to 0 volts (i.e., chassis).
**Applies to HP 3852As with firmware revision 2.0 or above.

8-17 HP 44705A/H AND 44708A/H PERFORMANCE TESTS

8-18 Introduction

The following Performance Tests check the operation of the HP 44705A/H and HP 44708A/H component module. Performance Tests are not given for the terminal modules. Successful completion of all tests in this section provides a high confidence level that the relay multiplexer is meeting its listed specifications.

The Performance Tests should be performed in the order they are presented. The completion of each test increases the confidence level in the relay multiplexer operation. A minimum set of tests is given as the Operational Verification Tests. These tests are described in Section 8-19.

The Performance Test procedures in this chapter are involved and time consuming. Since the most likely parameter to change with time is the contact resistance of a relay, and since the contact resistance is checked as a part of the Operational Verification Tests, it is not recommended that all Performance Tests be performed unless one of the tested specifications is in question.

8-19 Operational Verification

The first tests given in this section are a minimal set of tests recommended for the relay multiplexer. These tests are designed to test the functionality and contact resistance of the relay multiplexer. Successful completion of the Operational Verification Tests provides a 90% confidence level that the relay multiplexer is operating normally and is within specification.

The Operational Verification Tests consist of the following:

Section 8-23 - Set-Up Procedure
Section 8-24 - Channel Relays Test
Section 8-25 - Tree Relays Test
Section 8-26 - Backplane Analog Bus Test

8-20 Equipment Required

The following list of equipment is required for the Performance Tests. Only the first three items in the list are required for the Operational Verification Tests.

1. Digital Multimeter -- HP 3456A or equivalent

2. Test Fixture -- as described in Section 8-21

3. Test Leads and Jumpers

4. Resistor -- 10 Mohm, ±5% or Better

4. Resistor -- 1 kohm, ±5% or Better

5. Oscilloscope -- HP 1740A or equivalent (dual trace with delayed sweep)

7. Service Module -- HP 44743A

8. +20 V Power Supply -- HP 6212 or equivalent

NOTE

Either of the accessory plug-in voltmeters (HP 44701A or HP 44702A/B) may be used for these tests. The tests do not describe the specific steps required to use the plug-in voltmeters. A description of the plug-in voltmeters can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

8-21 Test Fixture

A test fixture is required to run the Performance Tests. A schematic of the required test fixture is shown in Figure 8-7a. A test fixture can be made using the HP 44705AT terminal module for the HP 44705A or the HP 44705HT terminal module for the HP 44705H (see Figure 8-7b). Because wiring the test fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

NOTE

Make sure to use only the HP 44705AT terminal module for the HP 44705A/08A accessories and the HP 44705HT terminal module for the HP 44705H/08H accessories. This is necessary due to connector differences.

If the test fixture is to be fabricated from other than a HP 44705AT/HT terminal module, it is important that the terminal ID lines, shown in Figure 8-7a be correctly wired. The HP 3852A local controller will not allow the execution of some commands with an incorrect terminal ID.

The fixture consists of: a short circuit between all channel HIGH lines, a short circuit between all channel LOW lines, and a short circuit between all channel GUARD lines. The use of the fixture minimizes the number of test lead connections required for the tests.

8-22 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

8-23 Set-Up Procedure

1. Remove power from the HP 3852A.

NOTE

The complete Performance Test procedure requires that the isolation jumper (J1) on the HP 44705A/H be set to the enabled (EN) position (refer to Figure 8-51). Only the Channel Relays Test can be performed with the jumper in the disabled position.

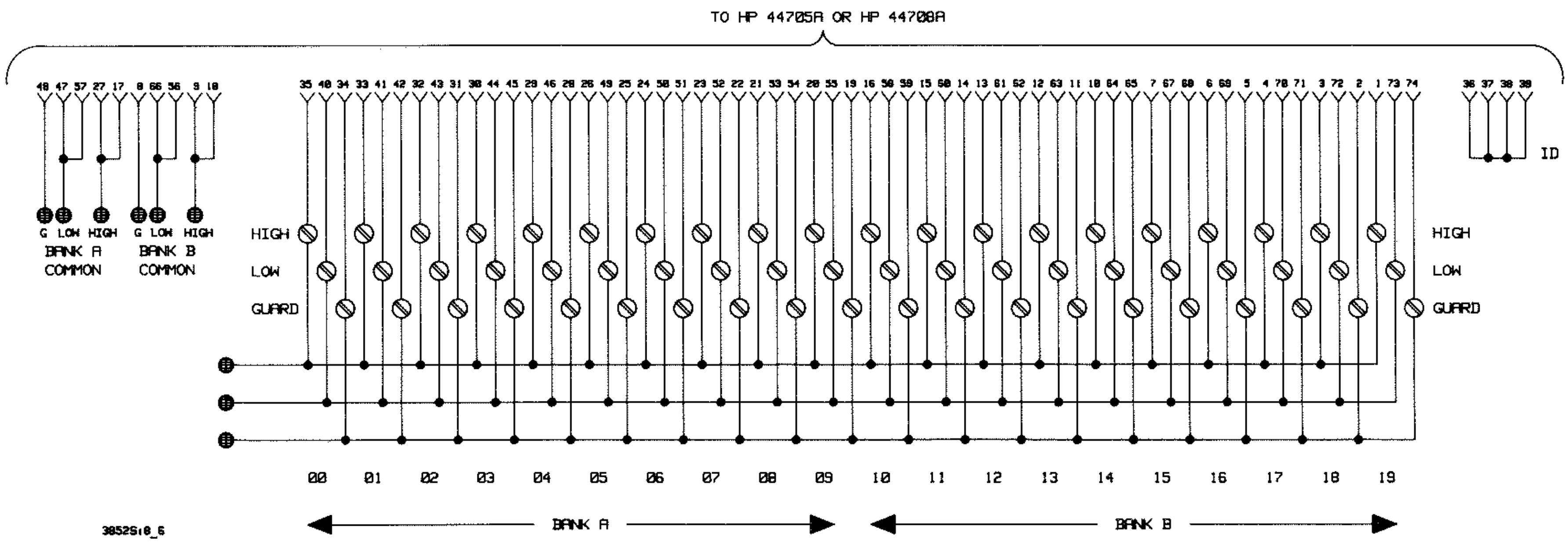


Figure 8-7a HP 44705A/H Test Fixure Schematic

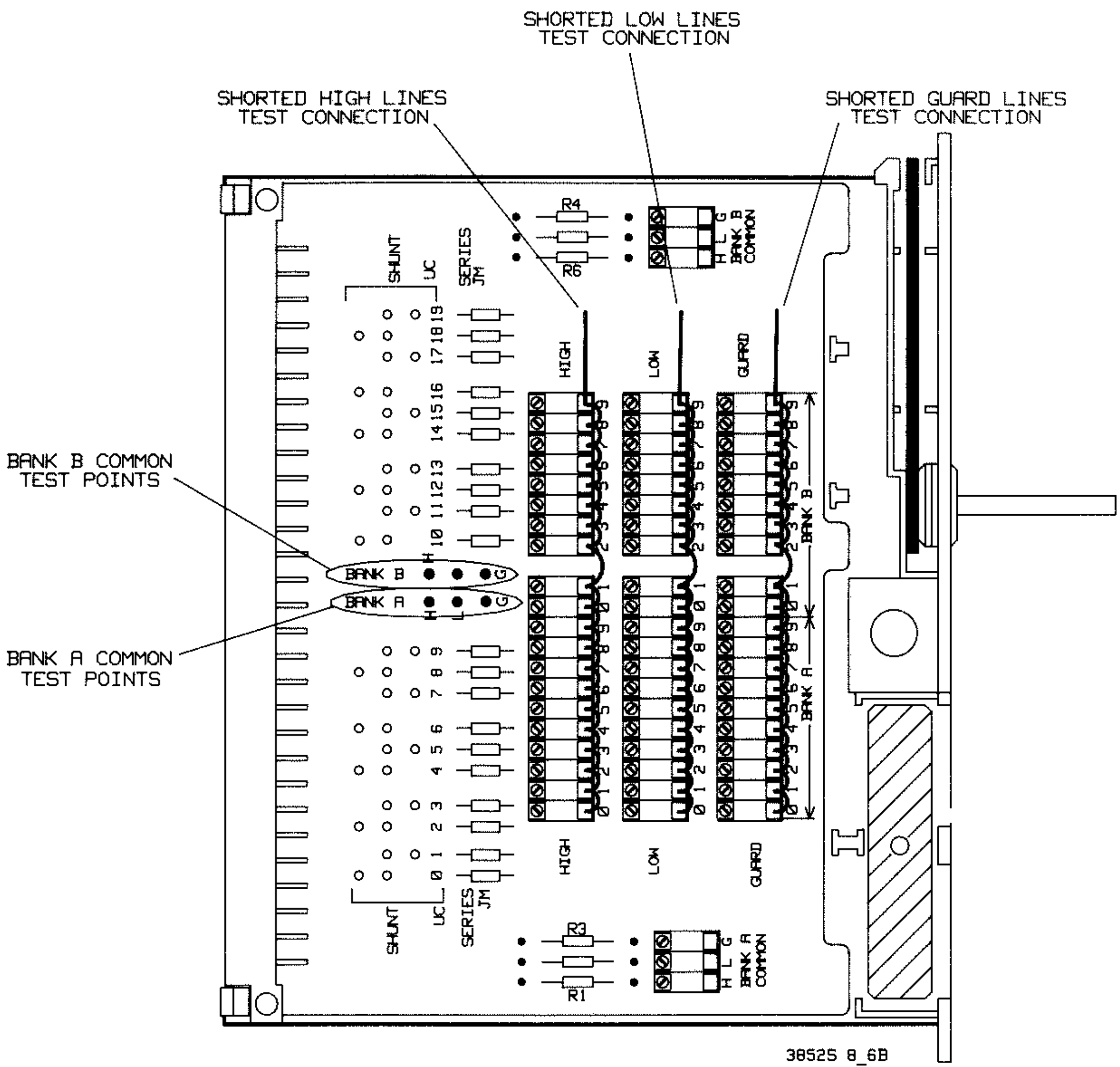


Figure 8-7b HP 44705A/H Test Fixure

2. Remove the terminal module from the rear of the HP 44705A/H component module and install the test fixture. Note the slot number where the HP 44705A/H under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

c. Verify that the HP 3852A right display shows:

44705A or 44705H

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

4. Set the multimeter to measure two-wire ohms.

8-24 Channel Relays Test

1. BANK A CHANNEL RELAYS TEST: This test checks the contact resistance of the HIGH, LOW and GUARD contacts for all Bank A channel relays.

2. Set the HP 44705A/H to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

3. Refer to Figure 8-7. Connect the multimeter DCV lead to the Bank A HIGH common test point on the test fixture. Connect the multimeter COM lead to the shorted HIGH connections of the channels.

4. Close channel 00 by executing:

CLOSE ES00 (where E = extender number, S = slot number)

5. Observe the reading on the multimeter. The multimeter should indicate less than 2 ohms resistance. If the reading is greater than 2 ohms, channel 00 relay may be faulty.

6. Open channel 00 by executing:

OPEN ES00 (where E = extender number, S = slot number)

7. Observe the reading on the multimeter. The multimeter should indicate an open circuit (>1 GΩ). It is important to perform this step to ensure that none of the relays are stuck closed. If the multimeter does not indicate an open, it will be necessary to troubleshoot to locate the stuck relay. Section 8-49 describes locating a stuck relay.

8. Repeat steps 4, 5, 6, and 7 for channels 01 through 09. In the CLOSE and OPEN commands the last two digits indicate the channel number. For example, CLOSE ES01 would close channel 01.

9. Refer to Figure 8-7. Connect the multimeter DCV lead to the Bank A LOW common test point on the test fixture. Connect the multimeter COM lead to the shorted LOW connections of the channels.

10. Repeat steps 4, 5, 6, 7, and 8. This checks the LOW contacts of the channel relays.

11. Refer to Figure 8-7. Connect the multimeter DCV lead to the Bank A GUARD common test point on the test fixture. Connect the multimeter COM lead to the shorted GUARD connections of the channels.

12. Repeat steps 4, 5, 6, 7, and 8. This checks the GUARD contacts of the channel relays.

13. BANK B CHANNEL RELAYS TEST: This test checks the contact resistance of the HIGH, LOW and GUARD contacts for all Bank B channel relays.

14. Set the HP 44705A/H to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

15. Refer to Figure 8-7. Connect the multimeter DCV lead to the Bank B HIGH common test point on the test fixture. Connect the multimeter COM lead to the shorted HIGH connections of the channels.

16. Close channel 10 by executing:

CLOSE ES10 (where E = extender number, S = slot number)

17. Observe the reading on the multimeter. The multimeter should indicate less than 2 ohms resistance. If the reading is greater than 2 ohms, channel 10 relay may be faulty.

18. Open channel 10 by executing:

OPEN ES10 (where E = extender number, S = slot number)

19. Observe the reading on the multimeter. The multimeter should indicate an open circuit (>1 GΩ). It is important to perform this step to ensure that none of the relays are stuck closed. If the multimeter does not indicate an open, it will be necessary to troubleshoot to locate the stuck relay. Section 8-49 describes locating a stuck relay.

20. Repeat steps 16, 17, 18, and 19 for channels 11 through 19. In the CLOSE and OPEN commands the last two digits indicate the channel number. For example, CLOSE ES11 would close channel 11.

21. Refer to Figure 8-7. Connect the multimeter DCV lead to the Bank B LOW common test point on the test fixture. Connect the multimeter COM lead to the shorted LOW connections of the channels.

22. Repeat steps 16, 17, 18, 19, and 20. This checks the LOW contacts of the channel relays.

23. Refer to Figure 8-7. Connect the multimeter DCV lead to the Bank B GUARD test point on the test fixture. Connect the multimeter COM lead to the shorted GUARD connections of the channels.

24. Repeat steps 16, 17, 18, 19, and 20. This checks the GUARD contacts of the channel relays.

8-25 Tree Relays Test

1. SENSE BUS TREE RELAY TEST: This test checks the contact resistance on the HIGH, LOW and GUARD contacts of the sense bus tree relays (channels 91 and 92).

2. Refer to Figure 8-7. Connect the multimeter DCV lead to the Bank B HIGH common test point on the test fixture. Connect the multimeter COM lead to Bank A HIGH common test point on the test fixture.

3. Close the sense bus tree relays by executing:

SWRITE ES00, 6, 17152 (where E = extender number, S = slot number)

4. Observe the multimeter reading. The HIGH contact resistance, as indicated on the multimeter, should be less than 2 ohms. If the reading is greater than 2 ohms, one of the two sense bus relays is failing.

5. Open the sense bus tree relays by executing:

SWRITE ES00, 4, 17152 (where E = extender number, S = slot number)

6. Observe the multimeter reading. The multimeter should indicate an open circuit (>1 GΩ). If the multimeter does not indicate an open circuit, the tree relays are stuck closed. If the multimeter does not indicate an open, it will be necessary to troubleshoot. Since both tree relays would have to be stuck for this condition to occur, the control logic is probably at fault. Section 8-48 gives a procedure for testing the control logic.

7. Refer to Figure 8-7. Connect the multimeter DCV lead to the Bank B LOW common test point on the test fixture. Connect the multimeter COM lead to the Bank A LOW common test point on the test fixture.

8. Close the sense bus tree relays by executing:

SWRITE ES00, 6, 17152 (where E = extender number, S = slot number)

9. Observe the multimeter reading. The LOW contact resistance, as indicated on the multimeter, should be less than 2 ohms. If the reading is greater than 2 ohms, one of the two sense bus relays is failing.

10. Open the sense bus tree relays by executing:

SWRITE ES00, 4, 17152 (where E = extender number, S = slot number)

11. Observe the multimeter reading. The multimeter should indicate an open circuit (>1 GΩ). If the multimeter does not indicate an open circuit, the sense bus tree relays are stuck closed. If the multimeter does not indicate an open, it will be necessary to troubleshoot. Since both tree relays would have to be stuck for this condition to occur, the control logic is probably at fault. Section 8-48 gives a procedure to test the control logic.

12. Refer to Figure 8-7. Connect the multimeter DCV lead to the Bank B GUARD common test point on the test fixture. Connect the multimeter COM lead to the Bank A GUARD common test point on the test fixture.

13. Close the sense bus tree relays by executing:

SWRITE ES00, 6, 17152 (where E = extender number, S = slot number)

14. Observe the multimeter reading. The GUARD contact resistance, as indicated on the multimeter, should be less than 2 ohms. If the reading is greater than 2 ohms, on of the two sense bus relays is failing.

15. Open the sense bus tree relays by executing:

SWRITE ES00, 4, 17152 (where E = extender number, S = slot number)

16. Observe the multimeter reading. The multimeter should indicate an open circuit (>1 GΩ). If the multimeter does not indicate an open circuit, the sense bus tree relays are stuck closed. If the multimeter does not indicate an open, it will be necessary to troubleshoot. Since both tree relays would have to be stuck for this condition to occur, the control logic is probably at fault. Section 8-48 gives a test procedure for the control logic.

17. SOURCE BUS TREE RELAY TEST: This test checks the contact resistance on the HIGH, LOW and GUARD contacts of the source bus tree relays (channels 93 and 94).

18. Refer to Figure 8-7. Connect the multimeter DCV lead to the Bank B HIGH common test point on the test fixture. Connect the multimeter COM lead to Bank A HIGH common test point on the test fixture.

19. Close the source bus tree relays by executing:

SWRITE ES00, 6, 19456 (where E = extender number, S = slot number)

20. Observe the multimeter reading. The HIGH contact resistance, as indicated on the multimeter, should be less than 2 ohms. If the reading is greater than 2 ohms, one of the two sense bus relays is failing.

21. Open the source bus tree relays by executing:

SWRITE ES00, 4, 19456 (where E = extender number, S = slot number)

22. Observe the multimeter reading. The multimeter should indicate an open circuit. If the multimeter does not indicate an open circuit, the source bus tree relays are stuck closed. If the multimeter does not indicate an open, it will be necessary to troubleshoot. Since both tree relays would have to be stuck for this condition to occur, the control logic is probably at fault. Section 8-48 gives a control logic test procedure.

23. Refer to Figure 8-7. Connect the multimeter DCV lead to the Bank B LOW common test point on the test fixture. Connect the multimeter COM lead to the Bank A LOW common test point on the test fixture.

24. Close the source bus tree relays by executing:

SWRITE ES00, 6, 19456 (where E = extender number, S = slot number)

25. Observe the multimeter reading. The LOW contact resistance, as indicated on the multimeter, should be less than 2 ohms. If the reading is greater than 2 ohms, one of the two source bus relays is failing.

26. Open the source bus tree relays by executing:

SWRITE ES00, 4, 19456 (where E = extender number, S = slot number)

27. Observe the multimeter reading. The multimeter should indicate an open circuit (>1 GΩ). If the multimeter does not indicate an open circuit, the source bus tree relays are stuck closed. If the multimeter does not indicate an open, it will be necessary to troubleshoot. Since both tree relays would have to be stuck for this condition to occur, the control logic is probably at fault. Section 8-48 gives a control logic test procedure.

28. Refer to Figure 8-7. Connect the multimeter DCV lead to the Bank B GUARD common test point on the test fixture. Connect the multimeter COM lead to the Bank A GUARD common test point on the test fixture.

29. Close the source bus tree relays by executing:

SWRITE ES00, 6, 19456 (where E = extender number, S = slot number)

30. Observe the multimeter reading. The GUARD contact resistance, as indicated on the multimeter, should be less than 2 ohms. If the reading is greater than 2 ohms, one of the two source bus relays is failing.

31. Open the source bus tree relays by executing:

SWRITE ES00, 4, 19456 (where E = extender number, S = slot number)

32. Observe the multimeter reading. The multimeter should indicate an open circuit (>1 GΩ). If the multimeter does not indicate an open circuit, the source bus tree relays are stuck closed. If the multimeter does not indicate an open, it will be necessary to troubleshoot. Since both tree relays would have to be stuck for this condition to occur, the control logic is probably at fault. Section 8-48 gives a control logic test procedure.

8-26 Backplane Analog Bus Test

1. ANALOG BUS HIGH AND LOW TEST: This test checks the backplane analog bus connections through the relay multiplexer.

2. Connect a jumper between the shorted HIGH connections to the shorted LOW connections on the test fixture.

3. Set the multimeter to measure four-wire ohms. Connect the multimeter ohms SENSE leads to the backplane analog bus sense HIGH and LOW lines. Connect the multimeter ohms SOURCE leads to the backplane analog bus current source HIGH and LOW lines.

NOTE

The backplane analog bus can be tested in one of three ways: 1) By connecting an external multimeter to the analog bus connector on the rear panel of the power supply module as shown in Figure 8-8, 2) By connecting an external multimeter to the backplane analog bus line jumpers provided on the 44743A service module as shown in Figure 8-9, or 3) By using a plug-in voltmeter (HP 44701A or HP 44702A/B) programmed to measure four-wire ohms from the backplane.

4. Close a channel relay and the tree relays on the HP 44705A/H by executing:

CLOSE ES00,ES91,ES93 (where E = extender number, S = slot number)

5. Observe the reading on the multimeter. The multimeter should indicate less than 2 ohms. The resistance indicated includes the resistance of the channel relay contacts and the resistance of the test jumpers.

If the resistance measured is not steady, indicating that a four-wire ohms connection is not being made, troubleshoot the connections to the analog bus (the relay contacts on the HP 44705A/H should have been checked in the operational verification tests in Sections 8-24 and 8-25). Note that the HP 44705A/H component module has a 100 ohm resistor in each HIGH and LOW line to the backplane. Note also that the HP 44705A coponent module has a 100 ohm resistor and the HP 44705H has a 1000 ohm resistor in each GUARD line to the backplane. When troubleshooting the connections using two-wire ohms measurements these resistors will be included in the circuit. Figure 8-52 provides a relay schematic.

6. ANALOG BUS GUARD CONNECTION TEST: This test checks the connection of the GUARD connection to the backplane analog bus.

7. Refer to Figure 8-7. Connect a jumper between the shorted HIGH lines and the shorted GUARD lines of the test fixture.

8. Set the multimeter to measure two-wire ohms. Connect the multimeter DCV lead to the backplane analog bus sense HI connection. Connect the multimeter COM lead to the backplane analog bus GUARD connection.

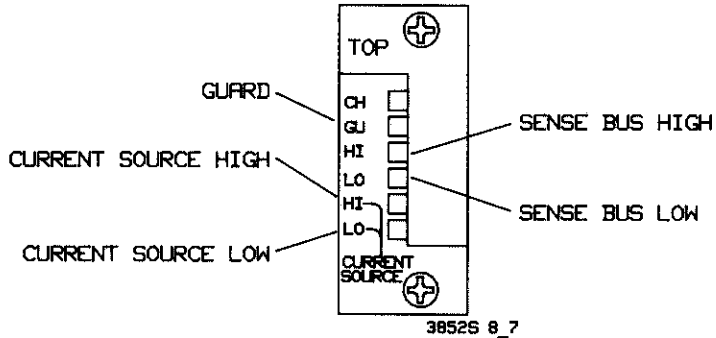


Figure 8-8 Analog Bus Connector

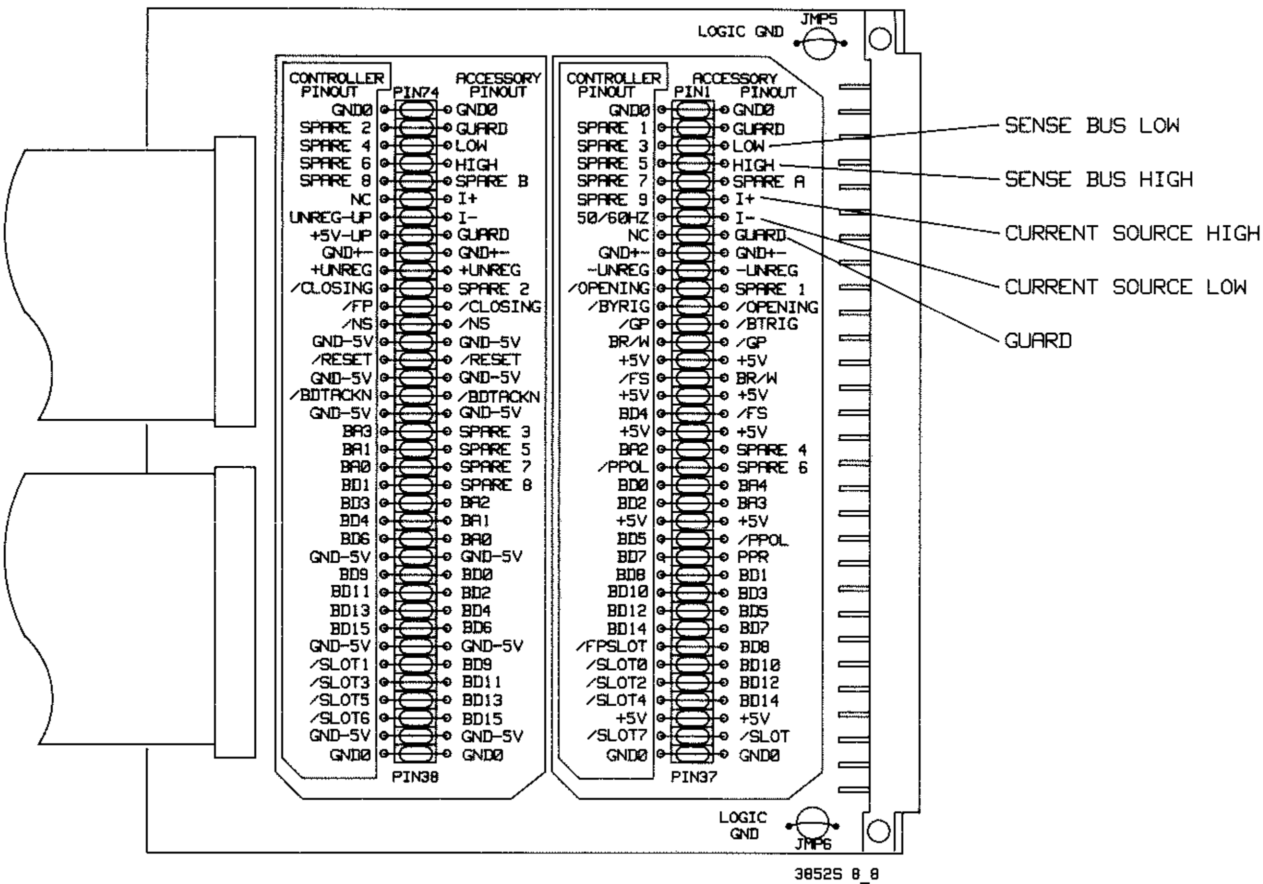


Figure 8-9 HP 44743A Service Module

9. Observe the reading on the multimeter. The multimeter should indicate approximately 200 ohms for the HP 44705H and 1100 ohms for the HP 44705H The resistance indicated includes the resistance of the channel and tree relay contacts, the resistance of all connections, and the resistance of the series protection resistors in the analog bus lines.

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44705A/H AND 44708A/H PERFORMANCE TESTS.

8-27 Opening and Closing Time Set-Up Procedure

The Opening and Closng Time test verifies that the channel relays will maintain break-before-make operation and that the multiplexer can scan the channels at the specified speed.

1. Remove power from the HP 3852A and unplug the relay multiplexer to be tested. Install the Service Module in a convenient slot in the HP 3852A. Note the slot number where the Service Module is installed. Install the relay multiplexer on the service module. Install the test fixture on the relay multiplexer. The Set-Up Procedure is shown in Figure 8-10.

2. On an oscilloscope, connect probes to the Channel A INPUT, Channel B INPUT, and EXT TRIGGER input. Set up the oscilloscope to the following:

Dual Trace
Channel A -- DC, 0.5 Volts/Div (if using 10:1 probes)
Channel B -- DC, 0.5 Volts/Div (if using 10:1 probes)
Trigger -- External
Vertical Display -- Chopped
Time -- 5 mses/Div (HP 44705A) or 10 msec/Div (HP 44705H)
Delayed Sweep -- 0.1 msec/Div (HP 44705A) or 0.2 msec/Div (HP 44705H)
Delayed Sweep Dial -- Minimum

3. Connect a jumper from the +5V test connection on the service module to the shorted HIGH connections on the test fixture.

4. Connect a jumper between the Bank A HIGH common test point and the Bank B HIGH common test point.

5. Connect the 1 kohm resistor between the HIGH common test points on the test fixture and the logic ground test connection on the service module.

6. Connect the Channel A oscilloscope probe to the HIGH common test points on the test fixture.

7. Connect the Channel B oscilloscope probe to the OPENING test connection on the service module.

8. Connect the EXT TRIGGER oscilloscope probe to the BTRIG test connection on the service module.

9. Apply power to the HP 3852A. Wait for the wake-up sequence to complete.

10. Set up the following subroutine in HP 3852A memory. When the first statement is entered the SUB ENTRY annunciator should be on in the left display. This annunciator should remain on until the SUBEND statement is entered.

```
SUB A
TRG
SCAN ES00-ES19   (where E = extender number, S = slot number)
SUBEND
```

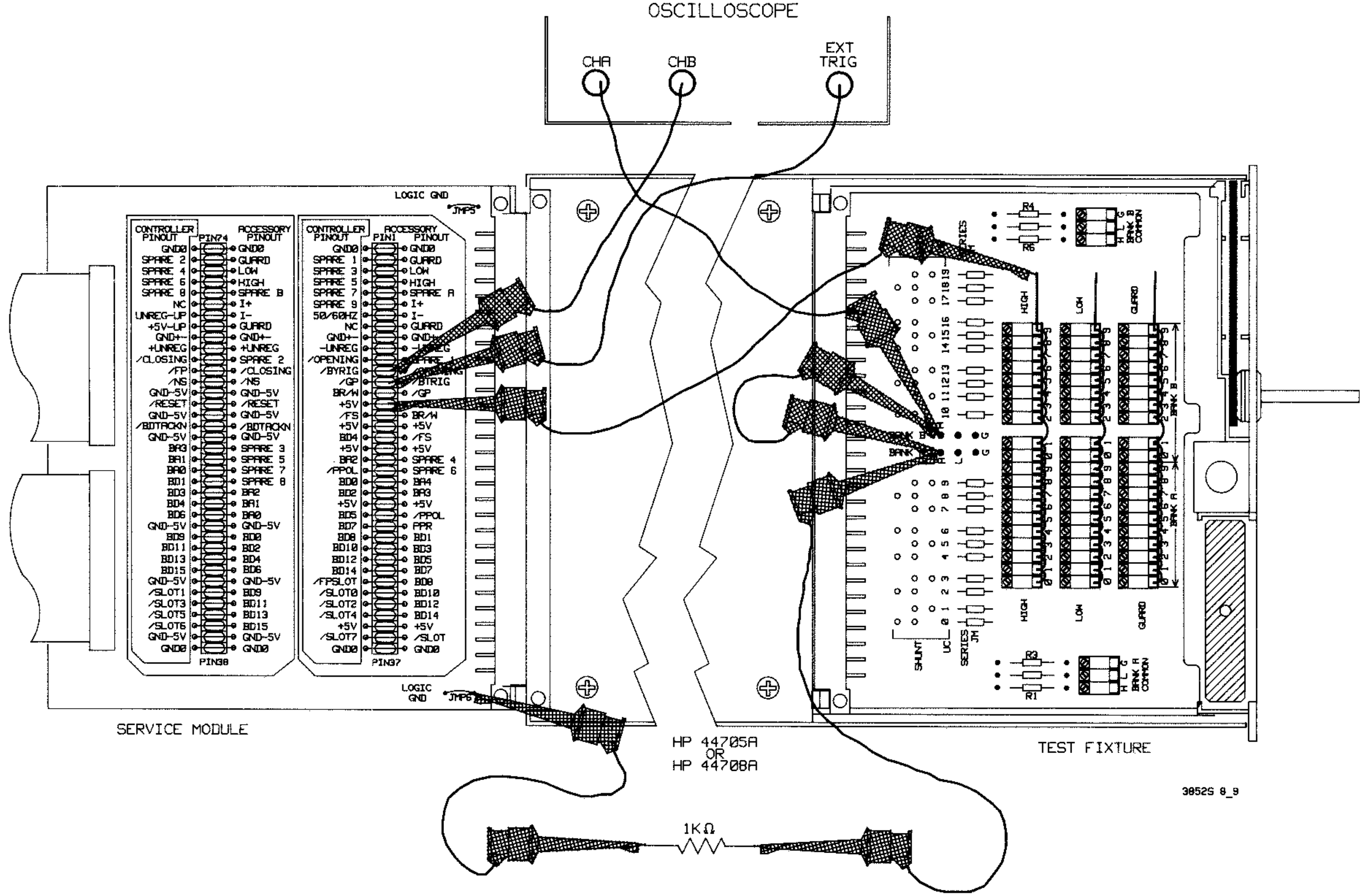


Figure 8-10 HP 44705A/H Opening Time Set-Up

The subroutine will scan all channels on the relay multiplexer in a break-before-make fashion. The scan will be preceded by a backplane trigger pulse (used to trigger the oscilloscope). Do not reset or cycle power to the HP 3852A or the subroutine will be erased from memory. The front panel CLEAR key may be used without disturbing the subroutine.

8-28 Opening Time Test

1. OPENING PULSE WIDTH TEST. This test checks the pulse width of the OPENING pulse output from the relay multiplexer.

2. Repetitively call the entered subroutine 1000 times by executing:

```
CALL A,1000
```

This statement will call the subroutine 1000 times.

3. Observe the waveform displayed on the Channel B trace and make sure all 20 channels are present. It may also be necessary to adjust the TRIGGER LEVEL and TRIGGER HOLD controls on the scope to synchronize the signal on the scope.

4. The OPENING pulse is a negative pulse. The width of the negative portion of the pulse must be between 0.77 and 0.94 milliseconds for the HP 44705A or between 1.54 and 1.88 milliseconds for the HP 44705H. If the pulse width is not within these limits, the relay multiplexer is failing. The OPENING pulse is shown in Figure 8-11. The waveform exhibits a small amount of jitter caused by the operating system.

NOTE

If necessary, repeat step 2 to allow more time to view the waveform. The 1000 repetitions of the subroutine take approximately 45 seconds to complete. The time may be extended by increasing the number of repetitions specified in step 2.

5. RELAY OPENING TIME TEST. This test checks the ability of each channel relay to open within the time specified.

6. Repetitively call the entered subroutine 10000 times by executing:

```
CALL A,10000
```

7. Rotate the DELAY SWEEP dial to the minimum position. Select the DELAYED sweep mode on the scope. Slowly rotate the DELAY SWEEP dial clockwise while observing the displayed waveforms. The Channel B waveform is the OPENING pulse. The Channel A waveform is the +5V supply as switched by the relays. As the DELAY SWEEP dial is rotated, one relay closure and the associated OPENING pulse will come in to view at a time. The relay opening time is the time between the falling edge of the OPENING pulse (Channel B) and the falling edge of the Channel A waveform. This time must be less than 0.94 milliseconds for the HP 44705A or 1.88 milliseconds for the HP 44705H. This time is illustrated in Figure 8-11.

Continue rotating the DELAY SWEEP dial until all 20 relay channels have been checked. A failing channel indicates a sticking relay contact.

To stop the test at any time press the front panel CLEAR key. The test may be extended by increasing the number of times the subroutine is called, as specified in step 6.

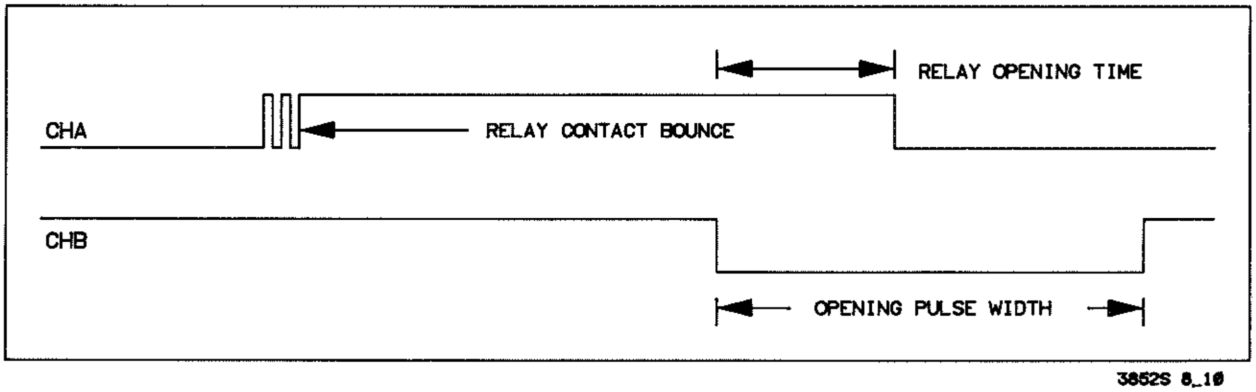


Figure 8-11 HP 44705A/H Opening Time

The waveforms will exhibit a small amount of jitter due to the overhead of the HP 3852A operating system.

8-29 Closing Time Test

1. CLOSING PULSE WIDTH TEST. This test checks the pulse width of the CLOSING pulse output from the relay multiplexer.

2. Move the Channel B oscilloscope probe to the CLOSING connection on the service module (as shown in Figure 8-12).

3. Repetitively call the entered subroutine 1000 times by executing:

CALL A,1000

4. Take the scope out of the DELAYED sweep mode. Observe the waveform displayed on the Channel B trace and make sure all 20 channels are present. It may also be necessary to adjust the TRIGGER LEVEL and TRIGGER HOLD controls on the scope to synchronize the signal on the scope.

5. The CLOSING pulse is a negative pulse. The width of the negative pulse must be between 0.9 and 1.1 milliseconds for the HP 44705A, or 1.8 and 2.2 milliseconds for the HP 44705H. If the pulse is not within these limits, the relay multiplexer is failing. The CLOSING pulse is shown in Figure 8-13. the waveform will exhibit a small amount of jitter caused by the operating system.

NOTE

If necessary, repeat step 2 to allow more time to view the waveform. The 1000 repetitions of the subroutine take approximately 45 seconds to complete. The time may be extended by increasing the number of repetitions specified in step 3.

6. RELAY CLOSING TIME TEST. This test checks the ability of the channel relays to close within the time specified.

7. Repetitively call the entered subroutine 10000 times by executing:

CALL A,10000

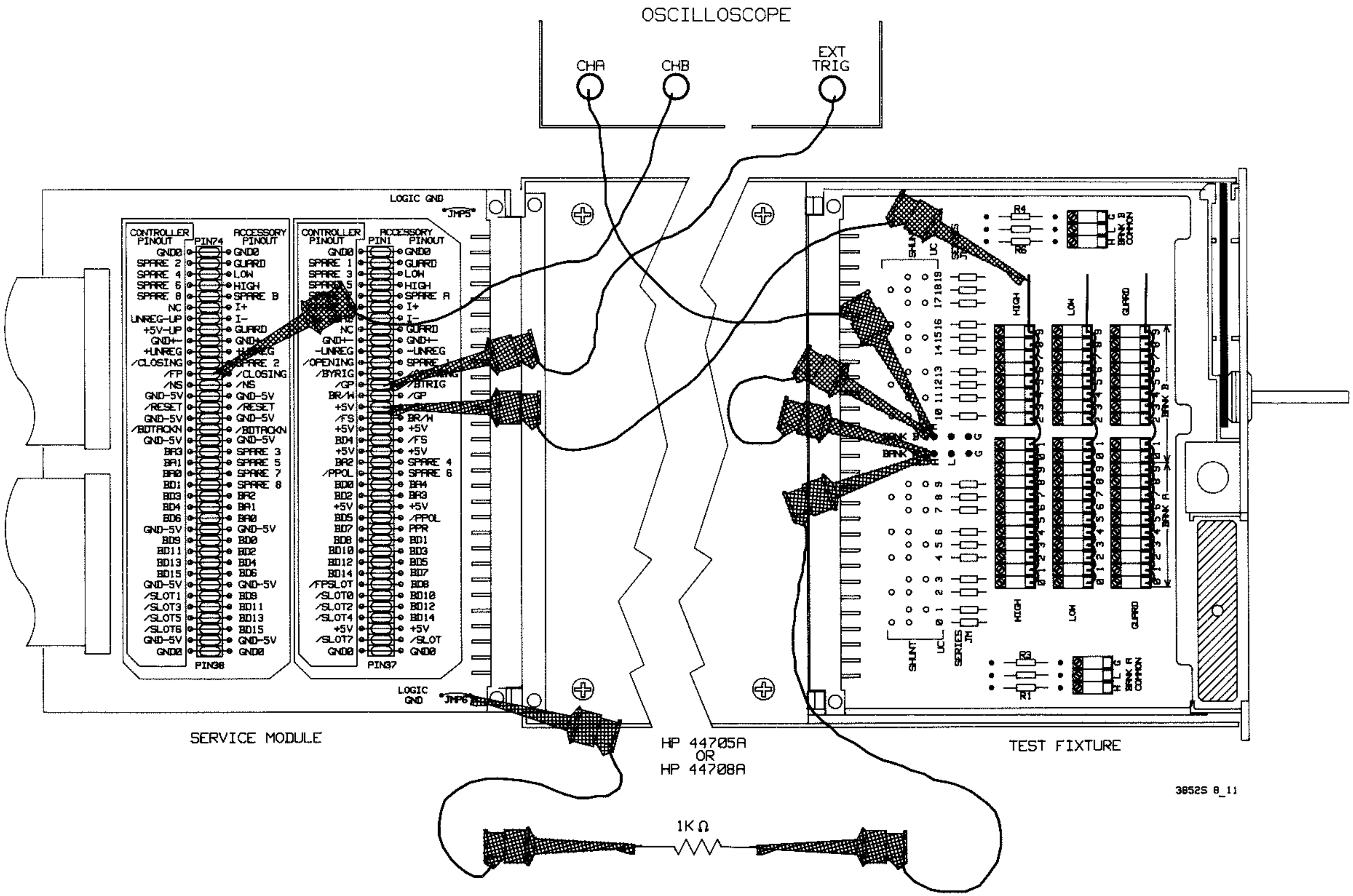


Figure 8-12 HP 44705A/H Closing Time Set-Up

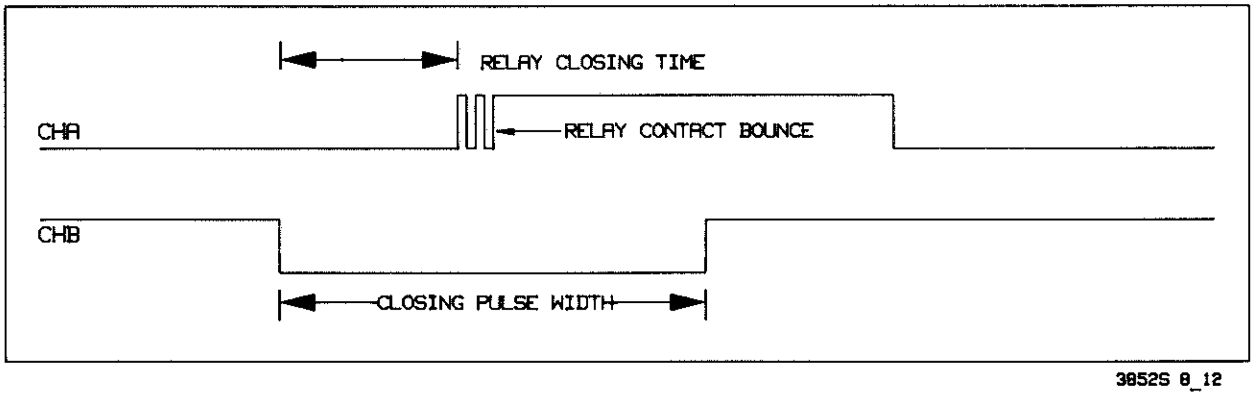


Figure 8-13 HP 44705A/H Closing Time

8. Rotate the DELAY SWEEP dial to the minimum position. Select the DELAYED sweep mode on the scope. Slowly rotate the DELAY SWEEP dial clockwise while observing the displayed waveforms. The Channel B waveform is the CLOSING pulse. The Channel A waveform is the +5V supply as switched by the relays. As the DELAY SWEEP dial is rotated, one relay closure and the associated CLOSING pulse will come in to view at a time. The relay closing time is the time between the falling edge of the CLOSING pulse (Channel B) and the rising edge of the Channel A waveform. This time must be less than 1.1 milliseconds for the HP 44705A or 2.2 milliseconds for the HP 44705H. This time is illustrated in Figure 8-13. Note that there will be some relay bounce indicated on the Channel A waveform.

Continue rotating the DELAY SWEEP dial until all 20 relay channels have been checked. A failing channel indicates a sticking relay contact.

To stop the test at any time press the front panel CLEAR key. The test may be extended by increasing the number of times the subroutine is called, as specified in step 7.

The waveforms will exhibit a small amount of jitter due to the overhead of the HP 3852A operating system.

8-30 DC Isolation Tests

The DC Isolation tests use a power supply, a resistor and the voltmeter to form a voltage divider. The channel being tested is then connected in parallel with this divider and the isolation resistance computed from the measured voltage across the divider.

NOTE

The best test results will be obtained when the resistor value used is the same value as the internal resistance of the voltmeter. The recommended 10 Mohm resistor was selected to match the input impedance of an HP 3456A multimeter set to the 100 Vdc range.

1. SET-UP PROCEDURE. Using the multimeter, measure the exact resistance of the 10 Mohm resistor. This resistance will be referred to as **R1** in the following steps.

2. Set the multimeter to measure DC volts and connect the multimeter to the DC power supply. Adjust the DC power supply output to +20 Vdc ±0.01 Vdc. This voltage will be referred to as **V1** in the following steps.

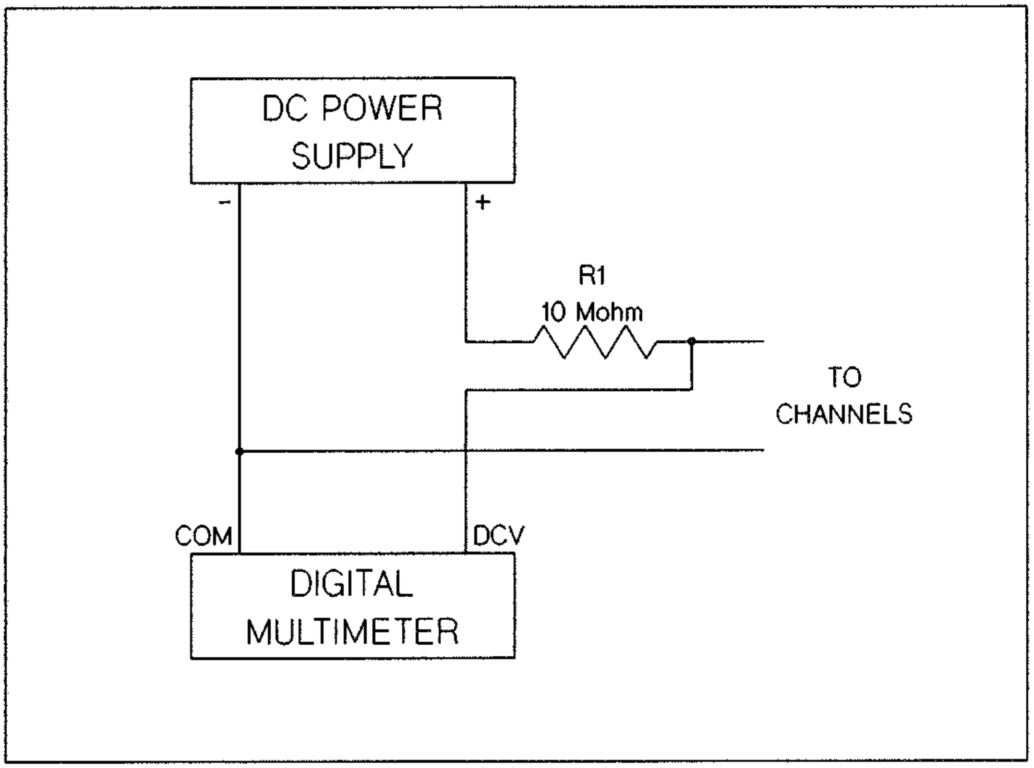


Figure 8-14 HP 44705A/H DC Isolation Set-Up

3. Connect the resistor, power supply and multimeter as shown in Figure 8-14.

4. Set the multimeter to the 100 Vdc range. Measure the exact voltage displayed on the multimeter. This voltage will be referred to as **V2** in the following steps.

5. Calculate the internal resistance of the multimeter (**Rm**) using the following equation:

$$\mathbf{Rm} = \frac{\mathbf{R1 \cdot V2}}{\mathbf{(V1 - V2)}}$$

NOTE

In most cases, the internal resistance of the multimeter is dependent upon the range selected. For this reason, do not change the multimeter range setting in the following procedure.

6. OPEN CHANNEL TO COMMON ISOLATION TEST. This test checks the open channel isolation between the HIGH, LOW and GUARD common connections.

7. Set the multiplexer to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

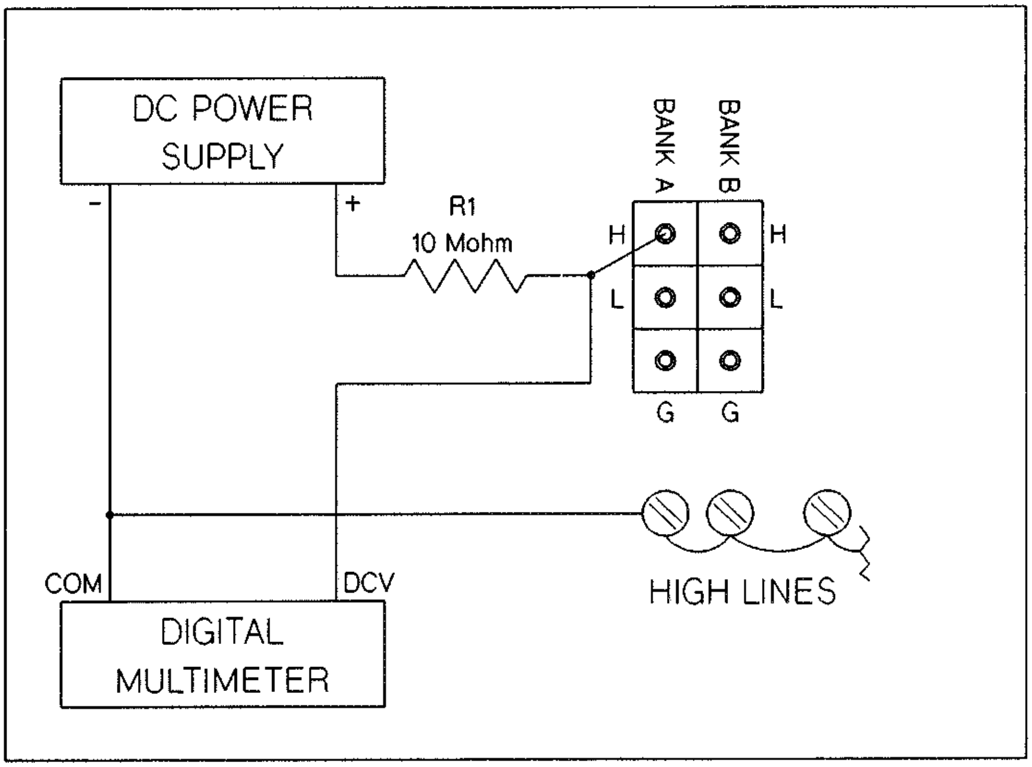


Figure 8-15 HP 44705A/H Bank A HIGH to Common DC Isolation

8. Connect the test circuit between the Bank A HIGH common test point and the shorted HIGH lines of the test fixture as shown in Figure 8-15.

9. Record the multimeter voltage measurement. This reading will be referred to as **V3**.

10. Calculate the DC isolation (**Rc**) using the following equation:

$$\mathbf{Rc} = \frac{\mathbf{V3 \bullet R1 \bullet Rm}}{\mathbf{Rm \bullet (V1 - V3) - (R1 \bullet V3)}}$$

The Open channel DC isolation should be greater than 10^9 ohms.

11. Connect the test circuit between the Bank B HIGH common test point and the shorted HIGH lines of the test fixture as shown in Figure 8-16.

12. Record the multimeter voltage measurement. This reading will be referred to as **V3**.

13. Calculate the DC isolation (**Rc**) using the equation in step 10. The Open channel DC isolation should be greater than 10^9 ohms.

14. Connect the test circuit between the Bank A LOW common test point and the shorted LOW lines of the test fixture as shown in Figure 8-17.

15. Record the multimeter voltage measurement. This reading will be referred to as **V3**.

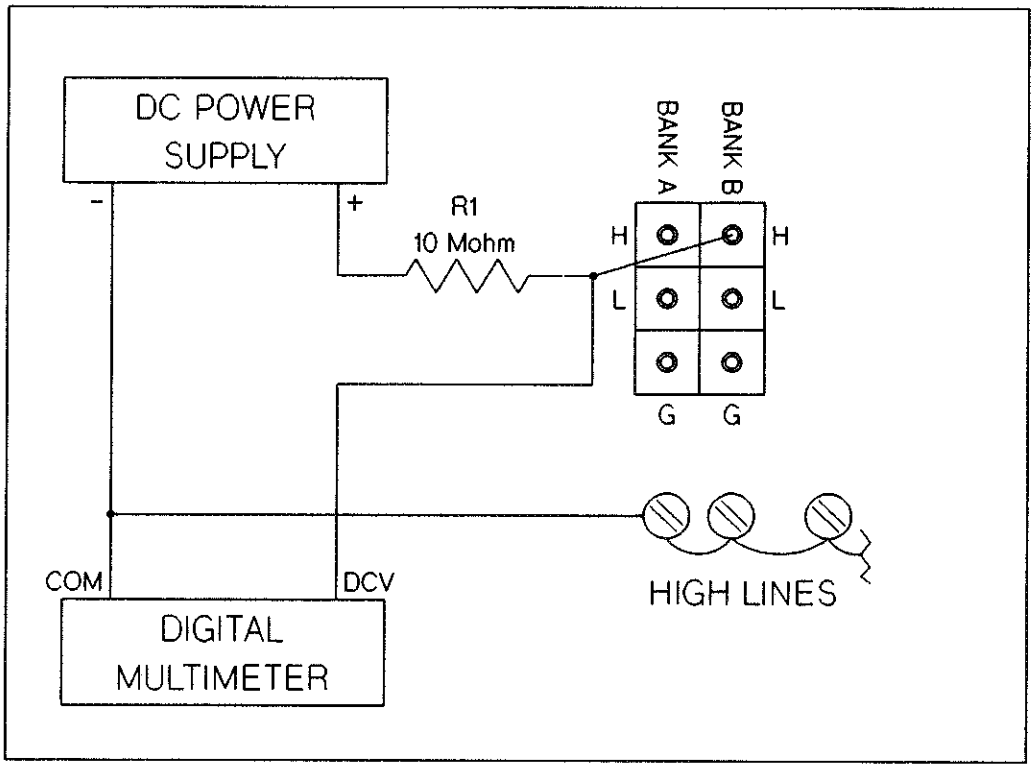


Figure 8-16 HP 44705A/H Bank B HIGH to Common DC Isolation

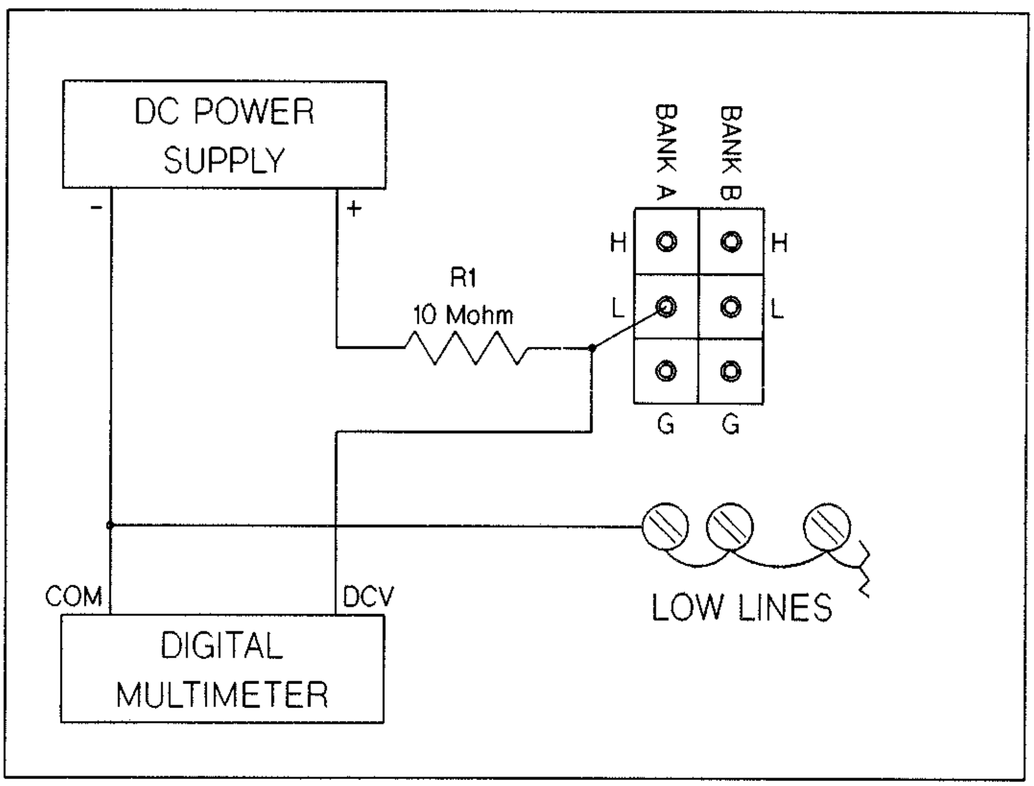


Figure 8-17 HP 44705A/H Bank A LOW to Common DC Isolation

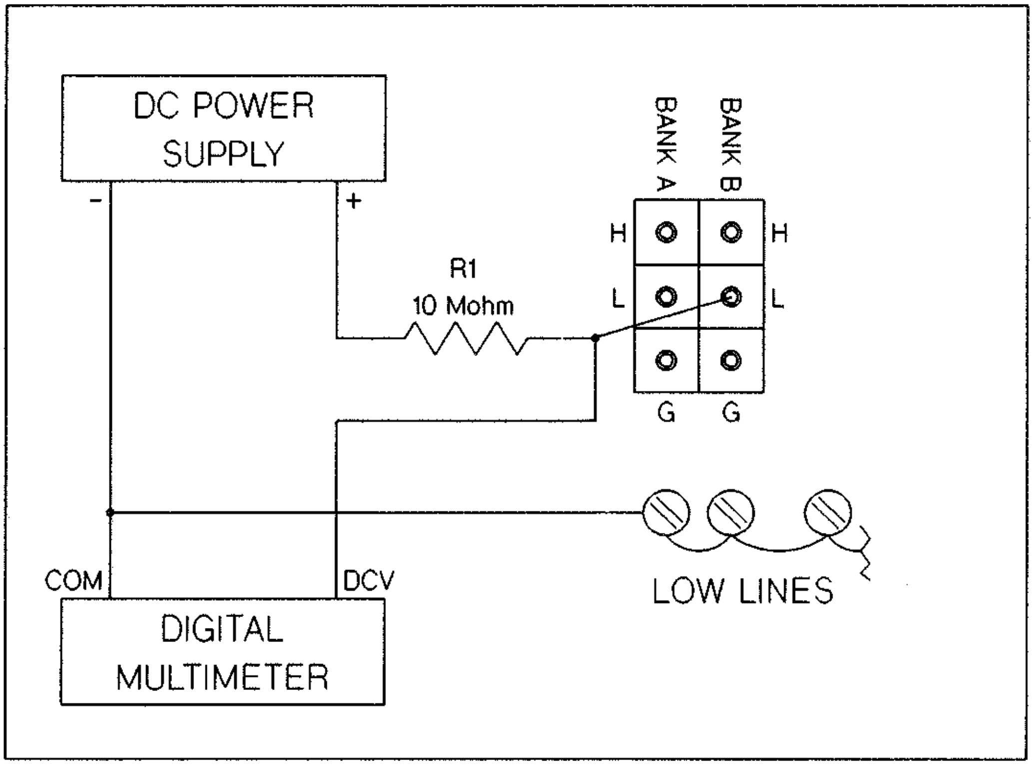


Figure 8-18 HP 44705A/H Bank B LOW to Common DC Isolation

16. Calculate the DC isolation (**Rc**) using the equation in step 10. The Open channel DC isolation should be greater than 10^9 ohms.

17. Connect the test circuit between the Bank B LOW common test point and the shorted LOW lines of the test fixture as shown in Figure 8-18.

18. Record the multimeter voltage measurement. This reading will be referred to as **V3**.

19. Calculate the DC isolation (**Rc**) using the equation in step 10. The Open channel DC isolation should be greater than 10^9 ohms.

20. Connect the test circuit between the Bank A GUARD common test point and the shorted guard lines of the test fixture as shown in Figure 8-19.

21. Record the multimeter voltage measurement. This reading will be referred to as **V3**.

22. Calculate the DC isolation (**Rc**) using the equation in step 10. The Open channel DC isolation should be greater than 10^9 ohms.

23. Connect the test circuit between the Bank B GUARD common test point and the shorted GUARD lines of the test fixture as shown in Figure 8-20.

24. Record the multimeter voltage measurement. This reading will be referred to as **V3**.

25. Calculate the DC isolation (**Rc**) using the equation in step 10. The Open channel DC isolation should be greater than 10^9 ohms.

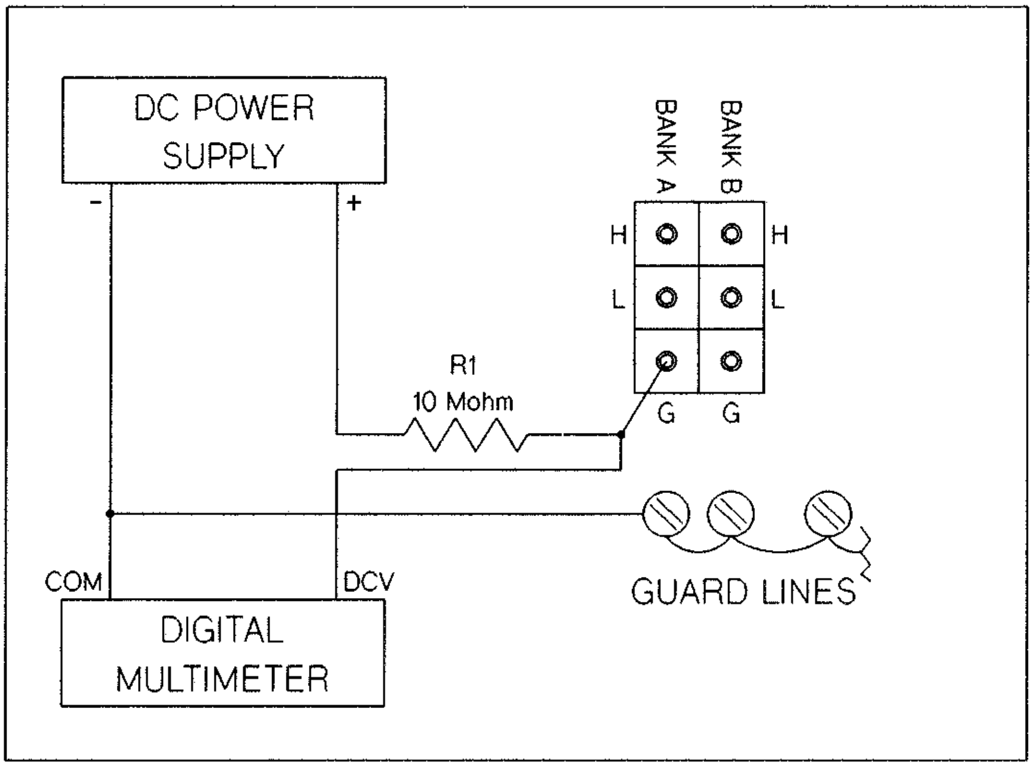


Figure 8-19 HP 44705A/H Bank A GUARD to Common DC Isolation

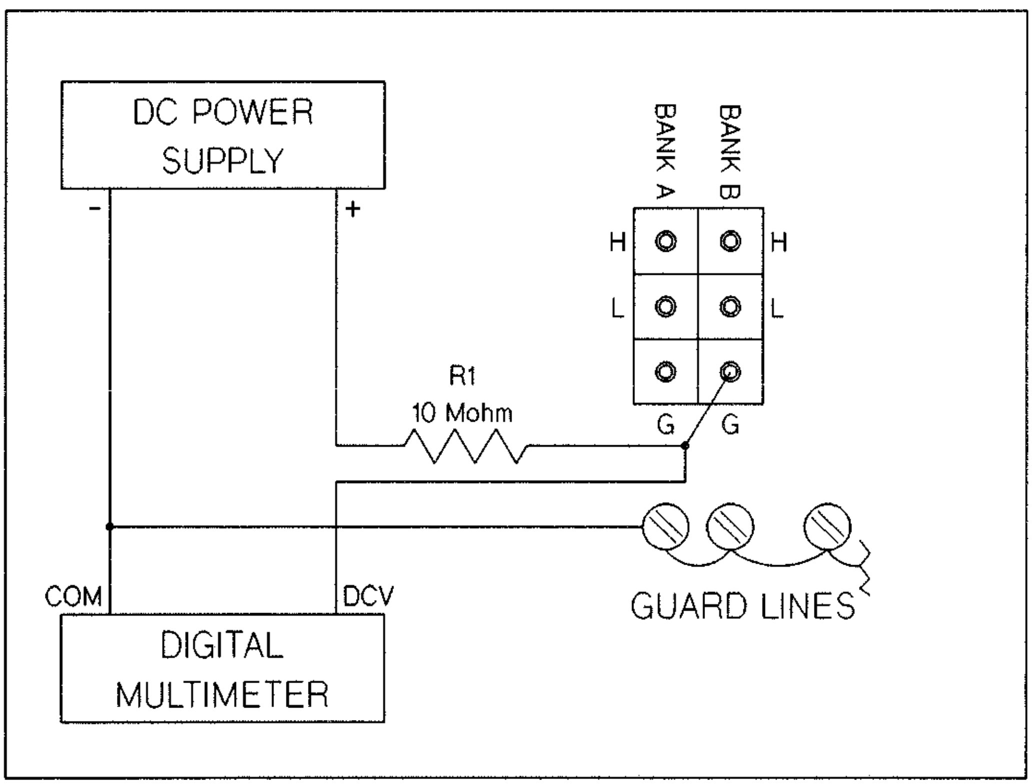


Figure 8-20 HP 44705A/H Bank B GUARD to Common DC Isolation

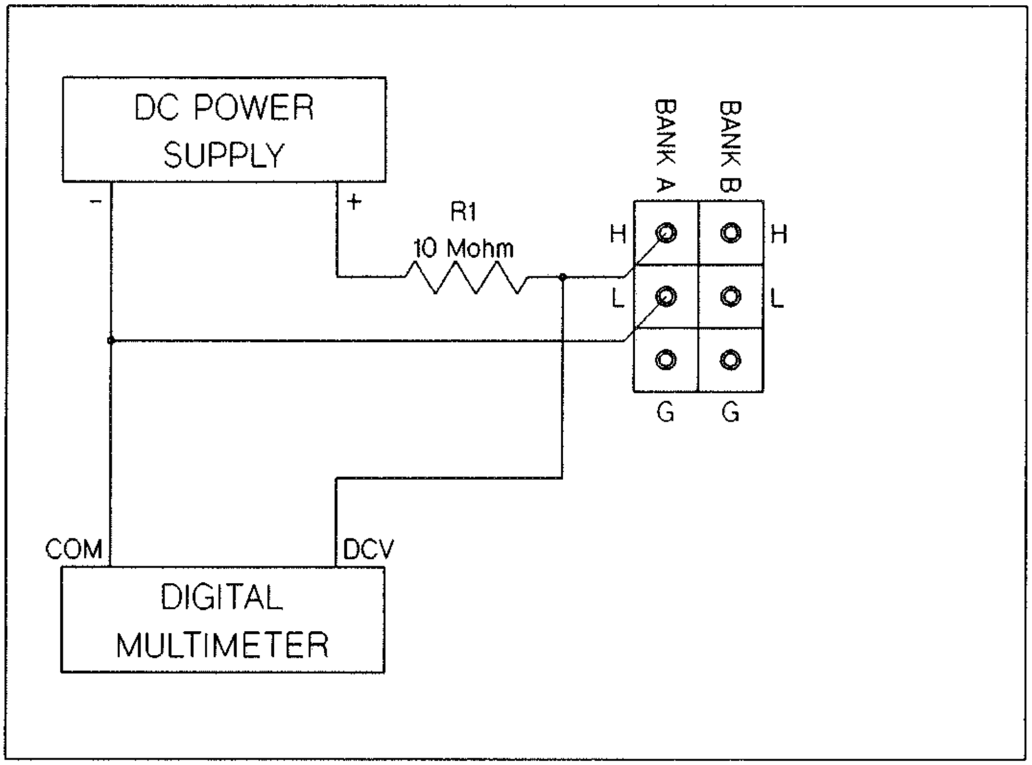


Figure 8-21 HP 44705A/H Bank A HIGH to LOW DC Isolation

26. COMMON HIGH TO LOW TEST. This test checks the DC isolation between the common terminals with a single channel closed.

27. Connect the test circuit between the Bank A HIGH and Bank A LOW common test points on the test fixture as shown in Figure 8-21.

28. Close a channel in Bank A by executing:

CLOSE ES00 (where E = extender number, S = slot number)

29. Record the multimeter voltage measurement. This reading will be referred to as **V4**.

30. Calculate the DC isolation (**Rc**) using the following equation:

$$\mathbf{Rc} = \frac{\mathbf{V4 \cdot R1 \cdot Rm}}{\mathbf{Rm \cdot (V1 - V4) - (R1 \cdot V4)}}$$

The Common HIGH to LOW DC isolation should be greater than 10^9 ohms.

31. Open the channel by executing:

OPEN ES00 (where E = extender number, S = slot number)

32. Repeat steps 28, 29, 30, and 31 for channels 01 through 09. In the CLOSE and OPEN commands the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

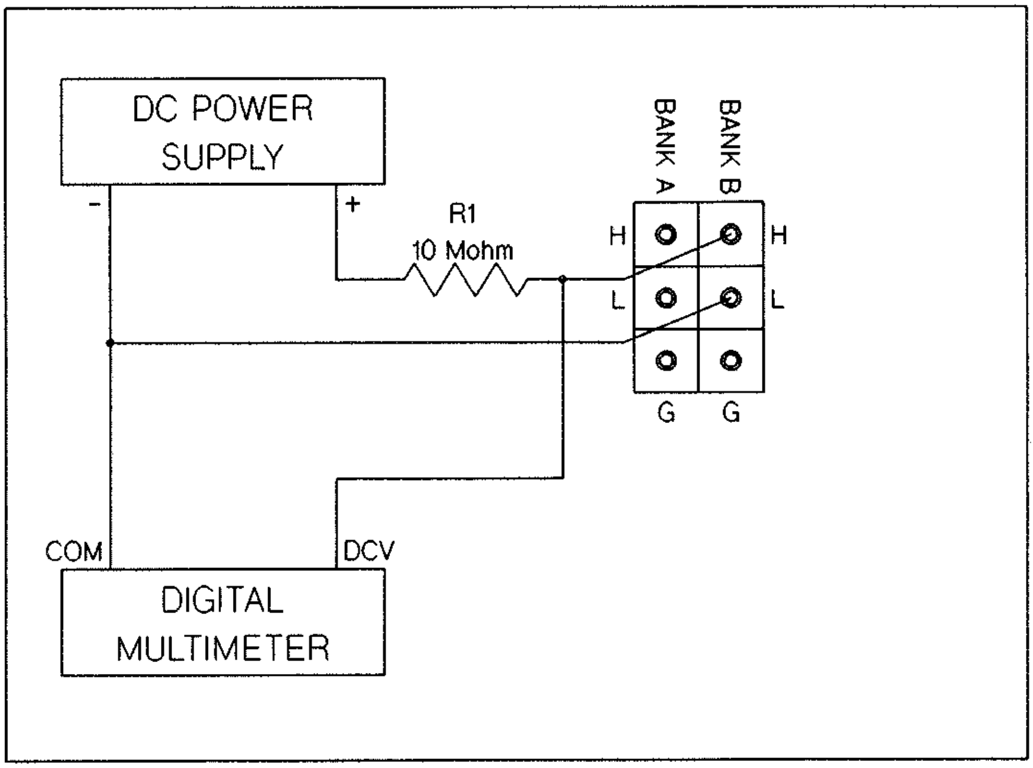


Figure 8-22 HP 44705A/H Bank B HIGH to LOW DC Isolation

33. Connect the test circuit between the Bank B HIGH and LOW common test points on the test fixture as shown in Figure 8-22.

34. Close a channel in Bank B by executing:

CLOSE ES10 (where E = extender number, S = slot number)

35. Record the multimeter voltage measurement. This reading will be referred to as **V4**.

36. Calculate the DC isolation (**Rc**) using the equation given in step 30. The isolation should be greater than 10^9 ohms.

37. Open the channel by executing:

OPEN ES00 (where E = extender number, S = slot number)

38. Repeat steps 34, 35, 36, and 37 for channels 11 through 19. In the CLOSE and OPEN commands the last two digits are the channel number (i.e., CLOSE ES11 for channel 11).

39. HIGH TO GUARD ISOLATION TEST. This test checks the DC isolation from the common HIGH terminal to the common GUARD terminal with a single channel closed.

40. Connect the test circuit between the Bank A common HIGH test point and the Bank A common GUARD test point on the test fixture as shown in Figure 8-23.

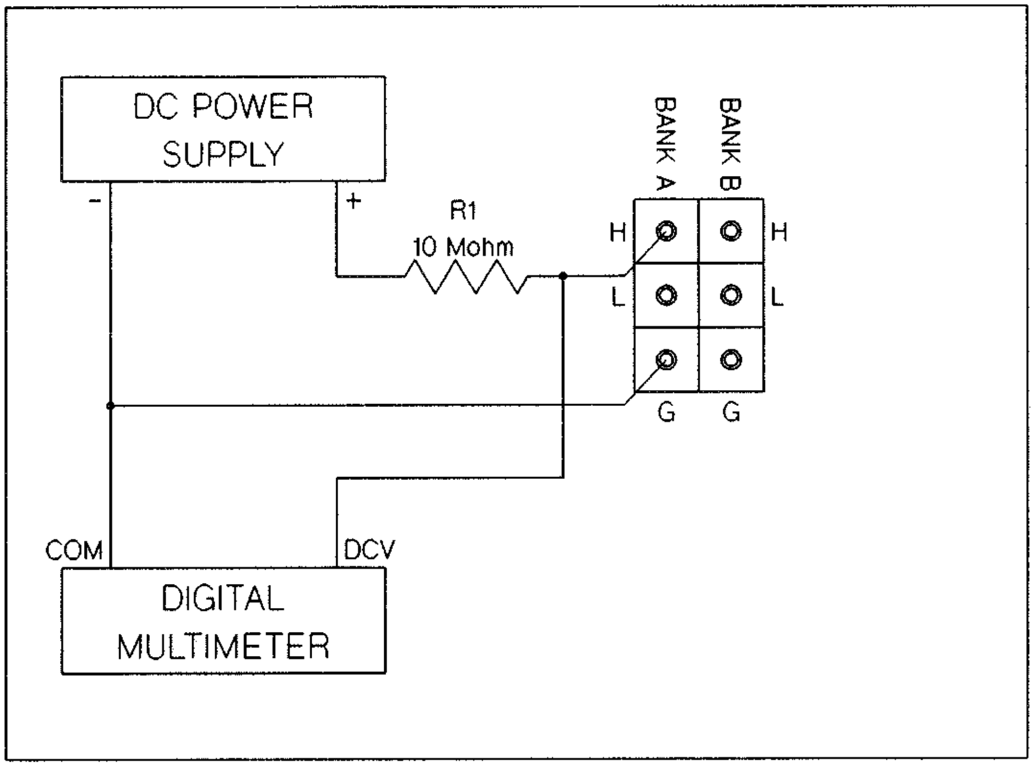


Figure 8-23 HP 44705A/H Bank A HIGH to GUARD DC Isolation

41. Close a channel in Bank A by executing:

CLOSE ES00 (where E = extender number, S = slot number)

42. Record the the multimeter voltage measurement. This reading will be referred to as **V4**.

43. Calculate the DC isolation by using the equation given in step 30. The isolation should be greater than 10^9 ohms.

44. Open the channel by executing:

OPEN ES00 (where E = extender number, S = slot number)

45. Repeat steps 41, 42, 43, and 44 for channels 01 through 09. In the CLOSE and OPEN commands the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

46. Connect the test circuit between the Bank B common HIGH test point and the Bank B common GUARD test point on the test fixture as shown in Figure 8-24.

47. Close a channel in Bank B by executing:

CLOSE ES10 (where E = extender number, S = slot number)

48. Record the multimeter voltage measurement. This reading will be referred to as **V4**.

49. Calculate the DC isolation by using the equation given in step 30. The isolation should be greater than 10^9 ohms.

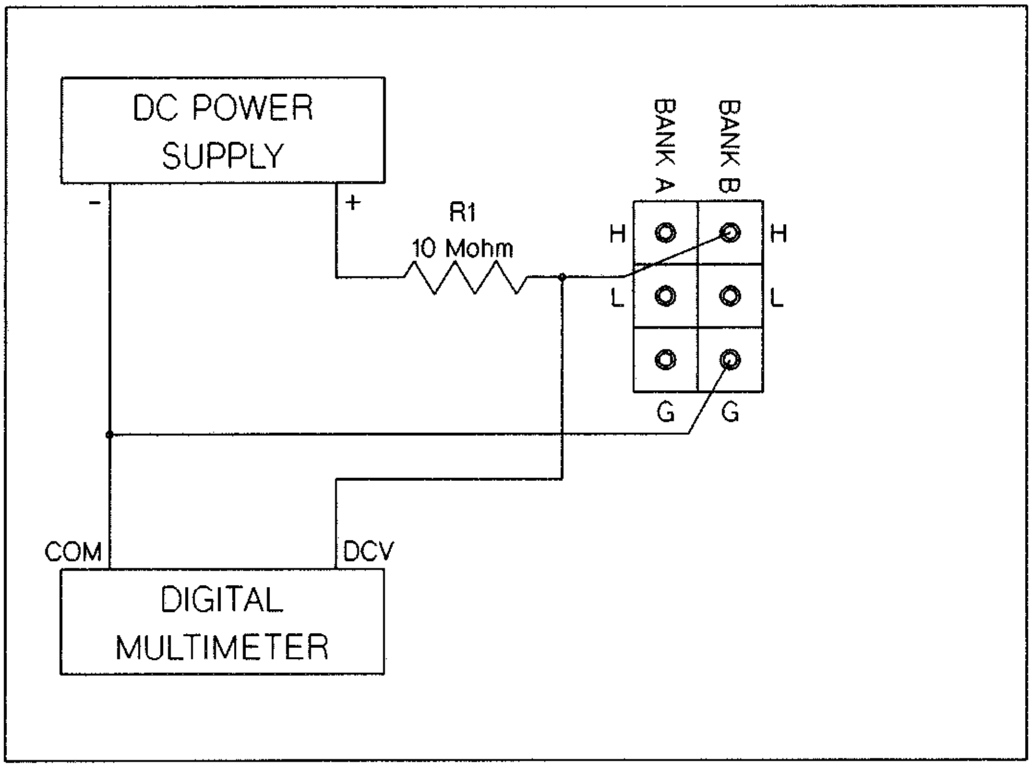


Figure 8-24 HP 44705A/H Bank B HIGH to GUARD DC Isolation

50. Open the channel by executing:

OPEN ES10 (where E = extender number, S = slot number)

51. Repeat steps 47, 48, 49, and 50 for channels 11 through 19. In the CLOSE and OPEN commands the last two digits are the channel number (i.e., CLOSE ES11 for channel 11).

52. LOW TO GUARD ISOLATION TEST. This test checks the DC isolation from the common LOW terminal to the common GUARD terminal with a single channel closed.

53. Connect the test circuit between the Bank A common LOW test point and the Bank A common GUARD test point on the test fixture as shown in Figure 8-25.

54. Close a channel in Bank A by executing:

CLOSE ES00 (where E = extender number, S = slot number)

55. Record the the multimeter voltage measurement. This reading will be referred to as **V4**.

56. Calculate the DC isolation by using the equation given in step 30. The isolation should be greater than 10^9 ohms.

57. Open the channel by executing:

OPEN ES00 (where E = extender number, S = slot number)

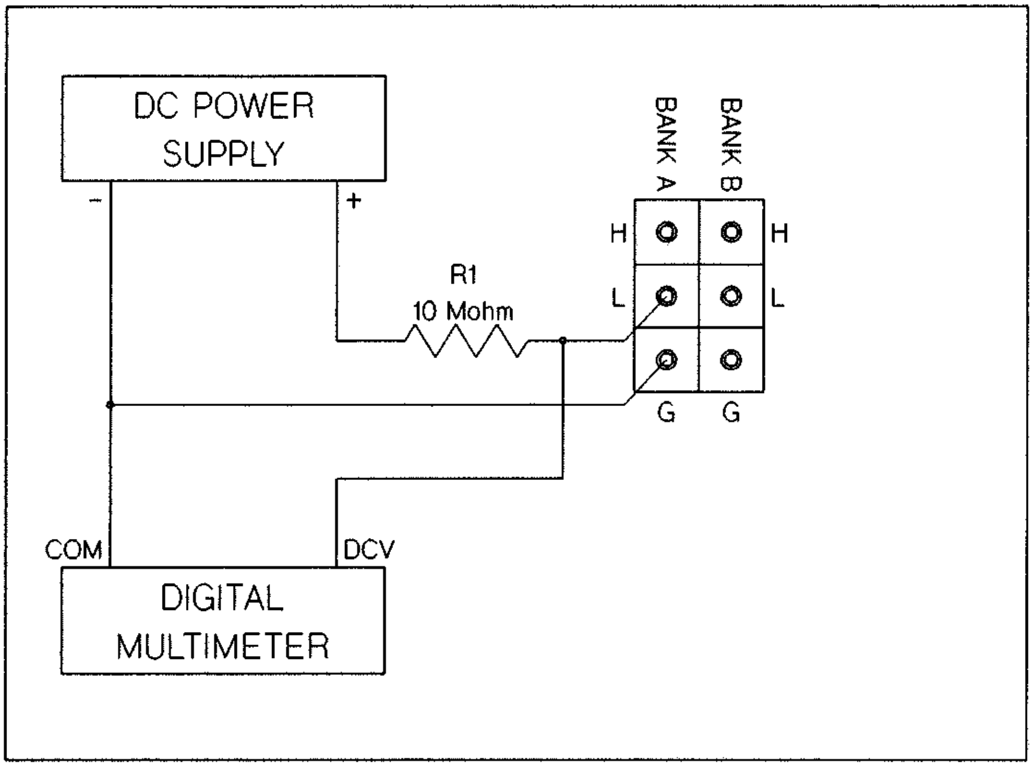


Figure 8-25 HP 44705A/H Bank A LOW to GUARD DC Isolation

58. Repeat steps 54, 55, 56, and 57 for channels 01 through 09. In the CLOSE and OPEN commands the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

59. Connect the test circuit between the Bank B common LOW test point and the Bank B common GUARD test point on the test fixture as shown in Figure 8-26.

60. Close a channel in Bank B by executing:

CLOSE ES10 (where E = extender number, S = slot number)

61. Record the multimeter voltage measurement. This reading will be referred to as **V4**.

62. Calculate the DC isolation by using the equation given in step 30. The isolation should be greater than 10^9 ohms.

63. Open the channel by executing:

OPEN ES10 (where E = extender number, S = slot number)

64. Repeat steps 60, 61, 62, and 63 for channels 11 through 19. In the CLOSE and OPEN commands the last two digits are the channel number (i.e., CLOSE ES11 for channel 11).

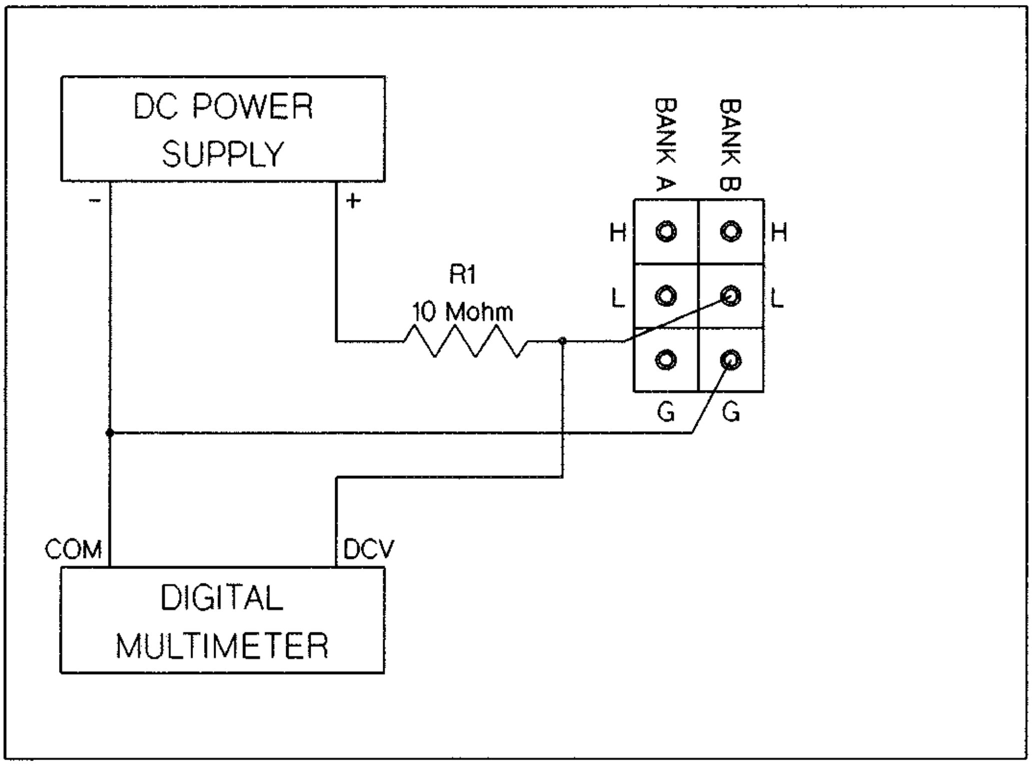


Figure 8-26 HP 44705A/H Bank B LOW to GUARD DC Isolation

8-31 Thermal Offset Test

This test measures the thermally generated voltages on the HP 44705A/H or HP 44708A/H. This test is very sensitive to ambient temperature changes and thermoelectricity generated at the junction of two dissimilar metals. For these reasons, it is important that the test be performed in an environment where the temperature is stable and that the number of test lead connections be kept to a minimum. During the test, care should be taken not to influence the measurements by holding or touching the test leads. The temperature of the leads and connections should be allowed to stabilize for one minute after moving or installing the connections.

1. BANK A CHANNEL-TO-COMMON THERMAL OFFSET TEST. This test checks the thermal offset of the channel relay contacts in Bank A.

2. Set the multimeter to the lowest DC voltage range. The resolution of the multimeter must be at least 0.1 µV. Connect the multimeter test leads together and record the offset voltage indicated on the multimeter. This voltage will be referred to as **V1** in the following steps.

3. Connect the multimeter test leads between the Bank A common HIGH test point and the shorted HIGH connections of the test fixture as shown in Figure 8-27.

4. Close a channel in Bank A by executing:

   CLOSE ES00 (where E = extender number, S = slot number)

5. Record the voltage indication on the multimeter. This reading will be referred to as **V2**. The difference between **V1** and **V2** must be less than 1 µV for the HP 44705A or 5 µV for the HP 44705H.

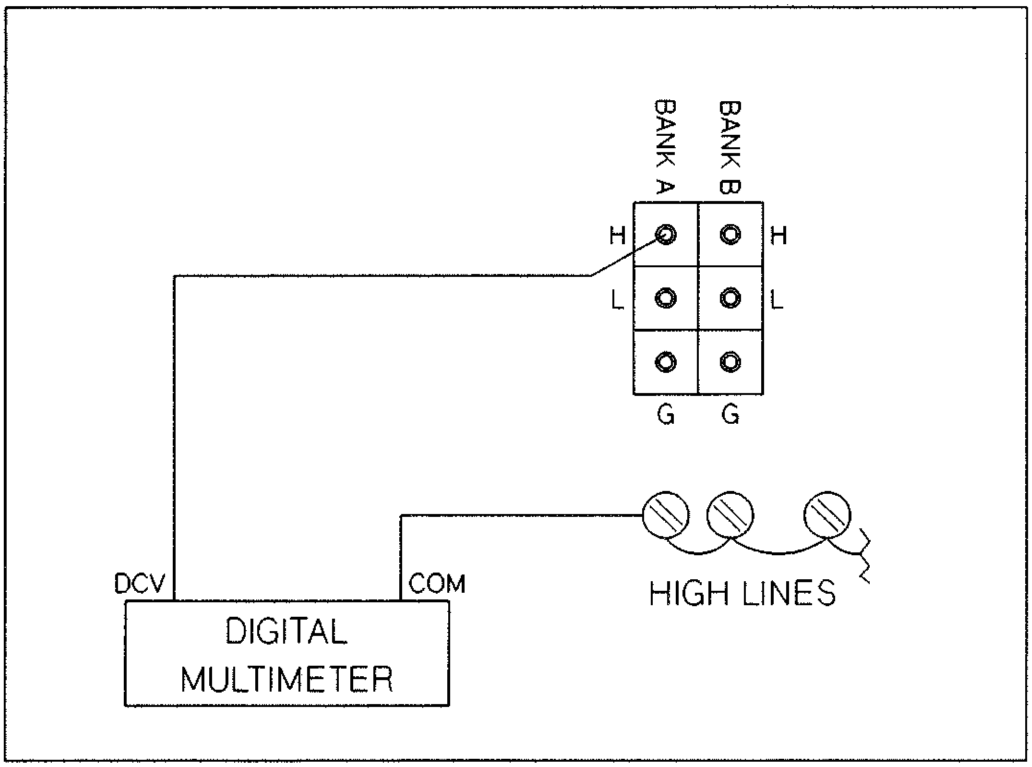


Figure 8-27 HP 44705A/H Bank A HIGH to Common Thermal Offset"

6. Repeat steps 4 and 5 for channels 01 through 09. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

NOTE

If a single channel fails the thermal offset test, the channel relay is probably at fault. If several or all channels fail the test, check the test fixture and test lead connections.

7. Connect the multimeter test leads between the Bank A common LOW test point and the shorted LOW connections of the test fixture as shown in Figure 8-28.

8. Close a channel in Bank A by executing:

CLOSE ES00 (where E = extender number, S = slot number)

9. Record the voltage indication on the multimeter. This reading will be referred to as **V2**. The difference between **V1** and **V2** must be less than 1 µV for the HP 44705A or 5 µV for the HP 44705H.

10. Repeat steps 8 and 9 for channels 01 through 09. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

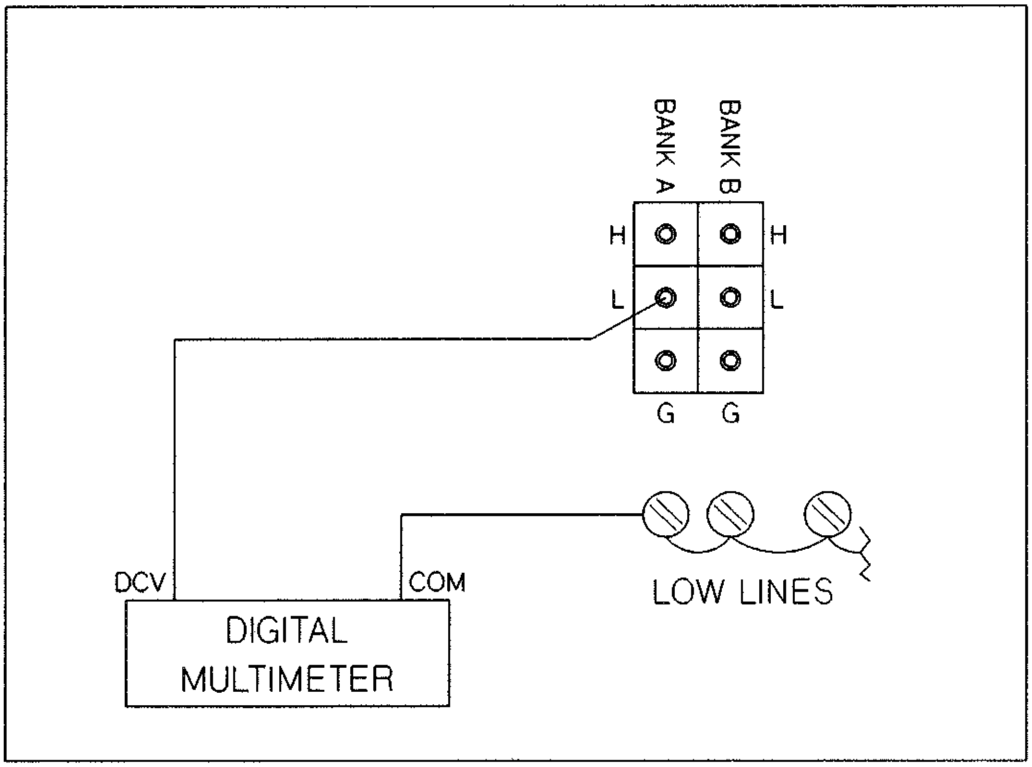


Figure 8-28 HP 44705A/H Bank A LOW to Common Thermal Offset

NOTE

If a single channel fails the thermal offset test, the channel relay is probably at fault. If several or all channels fail the test, check the test fixture and test lead connections.

11. BANK B CHANNEL-TO-COMMON THERMAL OFFSET TEST. This test checks the thermal offset of the channel relay contacts in Bank B.

12. Set the multimeter to the lowest DC voltage range. The resolution of the multimeter must be at least 0.1 µV. Connect the multimeter test leads together and record the offset voltage indicated on the multimeter. This voltage will be referred to as **V1** in the following steps.

13. Connect the multimeter test leads between the Bank B common HIGH test point and the shorted HIGH connections of the test fixture as shown in Figure 8-29.

14. Close a channel in Bank B by executing:

CLOSE ES10 (where E = extender number, S = slot number)

15. Record the voltage indication on the multimeter. This reading will be referred to as **V2**. The difference between **V1** and **V2** must be less than 1 µV for the HP 44705A or 5 µV for the HP 44705H.

16. Repeat steps 14 and 15 for channels 11 through 19. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES11 for channel 11).

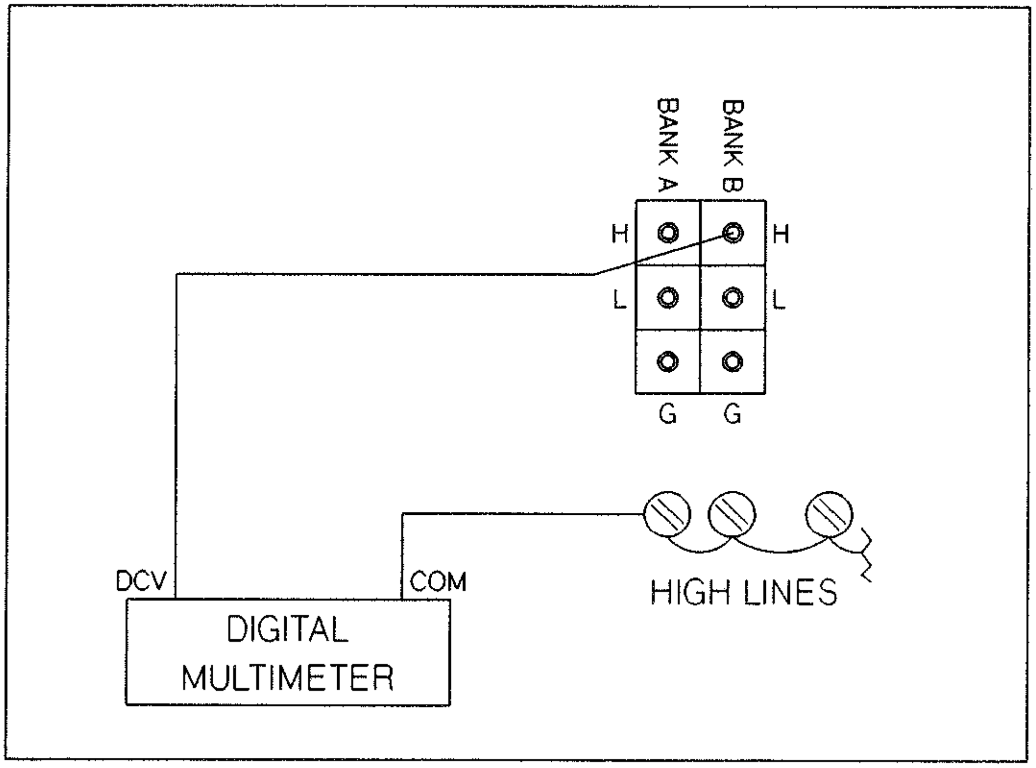


Figure 8-29 HP 44705A/H Bank B HIGH to Common Thermal Offset

NOTE

If a single channel fails the thermal offset test, the channel relay is probably at fault. If several or all channels fail the test, check the test fixture and test lead connections.

17. Connect the multimeter test leads between the Bank B common LOW test point and the shorted LOW connections of the test fixture as shown in Figure 8-30.

18. Close a channel in Bank B by executing:

CLOSE ES10 (where E = extender number, S = slot number)

19. Record the voltage indication on the multimeter. This reading will be referred to as **V2**. The difference between **V1** and **V2** must be less than 1 µV for the HP 44705A or 5 µV for the HP 44705H.

20. Repeat steps 18 and 19 for channels 11 through 19. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES11 for channel 11).

NOTE

If a single channel fails the thermal offset test, the channel relay is probably at fault. If several or all channels fail the test, check the test fixture and test lead connections.

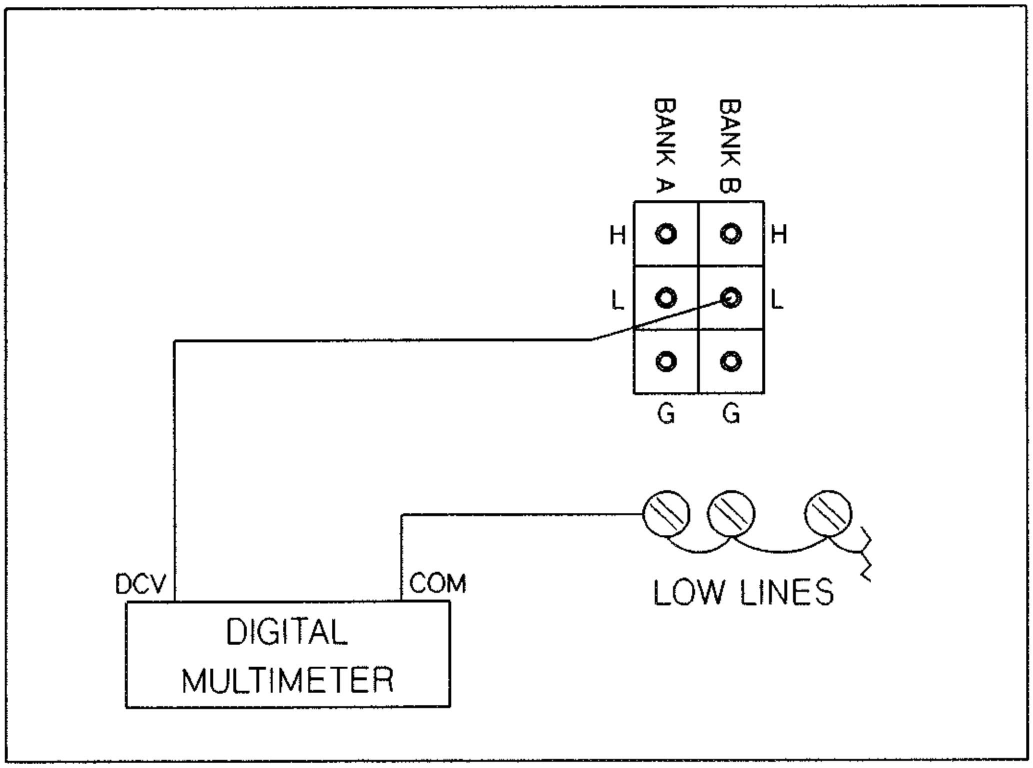


Figure 8-30 HP 44705A/H Bank B LOW to Common Thermal Offset

21. TREE RELAY THERMAL OFFSET TEST. This test checks the thermal offset of the Sense Bus and Source Bus tree relay contacts.

22. Connect the multimeter test leads between the Bank A HIGH common test point and the Bank B HIGH common test point on the test fixture as shown in Figure 8-31.

23. Close the Sense Bus Tree Relays by executing:

SWRITE ES00,6,17152 (where E = extender number, S = slot number)

24. Record the voltage indicated on the multimeter. This reading will be referred to as **V2**. The difference between **V1** and **V2** must be less than 2 µV for the HP 44705A or 10 µV for the HP 44705H.

25. Connect the multimeter test leads between the Bank A LOW common test point and the Bank B LOW common test point on the test fixture as shown in Figure 8-32.

26. Record the voltage indicated on the multimeter. This reading will be referred to as **V2**. The difference between **V1** and **V2** must be less than 2 µV for the HP 44705A or 10 µV for the HP 44705H.

27. Open the Sense Bus Tree Relays by executing:

SWRITE ES00,4,17152 (where E = extender number, S = slot number)

28. Close the Source Bus Tree Relays by executing:

SWRITE ES00,6,19456 (where E = extender number, S = slot number)

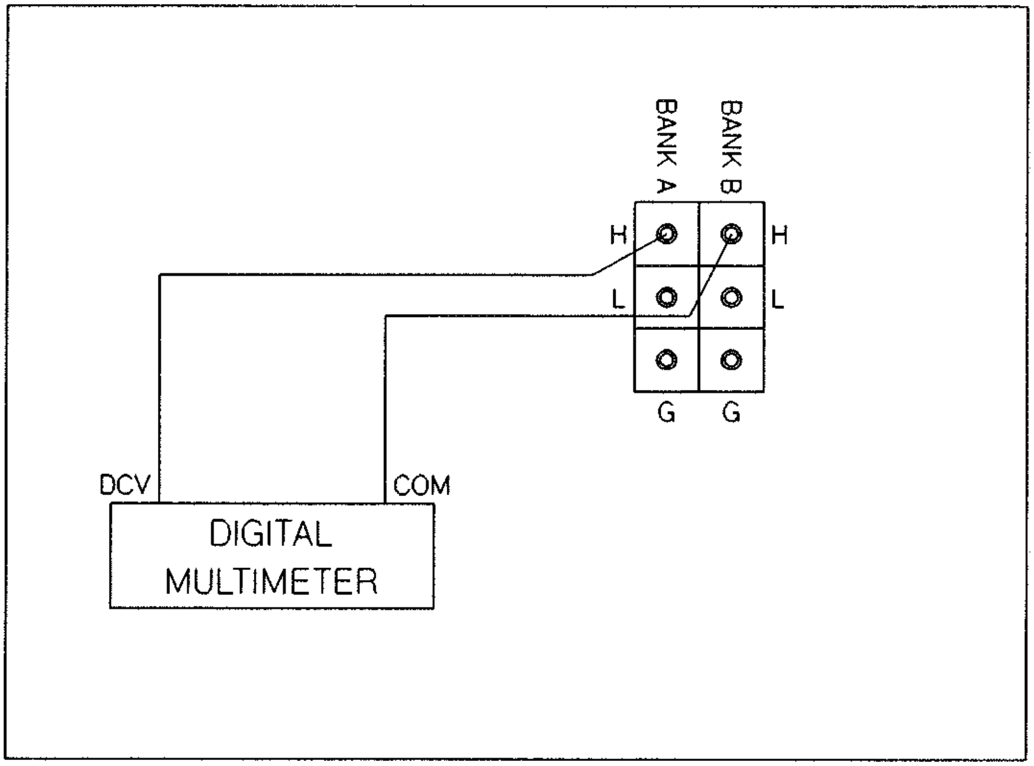


Figure 8-31 HP 44705A/H Sense Tree Thermal Offset

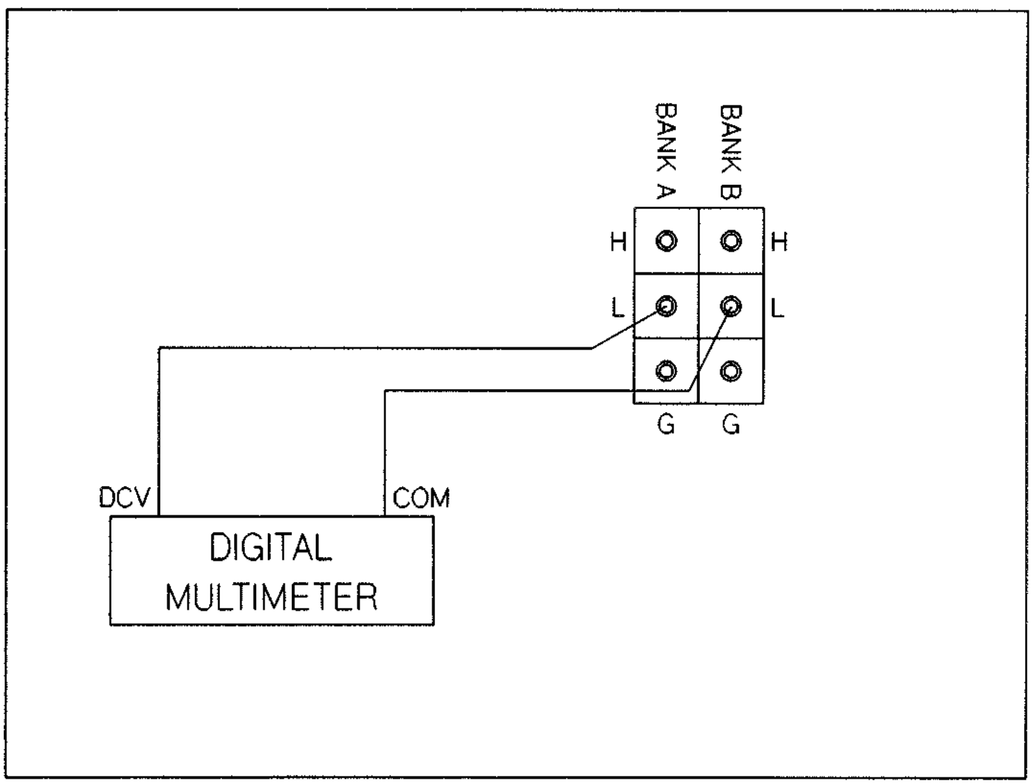


Figure 8-32 HP 44705A/H Source Tree Thermal Offset

29. Record the voltage indicated on the multimeter. This reading will be referred to as **V2**. The difference between **V1** and **V2** must be less than 2 µV for the HP 44705A or 10 µV for the HP 44705H.

30. Connect the multimeter test leads between the Bank A HIGH common test point and the Bank B HIGH common test point as shown in Figure 8-31.

31. Record the voltage indicated on the multimeter. This reading will be referred to as **V2**. The difference between **V1** and **V2** must be less than 2 µV for the HP 44705A or 10 µV for the HP 44705H.

32. Connect the multimeter test leads between the Bank A LOW common test point and the Bank B LOW common test point on the test fixture as shown in Figure 8-32.

33. Record the voltage indicated on the multimeter. This reading will be referred to as **V2**. The difference between **V1** and **V2** must be less than 2 µV for the HP 44705A or 10 µV for the HP 44705H.

34. Open the Source Bus Tree Relays by executing:

SWRITE ES00,4,19456 (where E = extender number, S = slot number)

8-32 Injected Current Test

This test measures the amount of current injected into the HIGH, LOW, and GUARD contacts of each channel relay. The amount of injected current is deduced by measuring the voltage drop across a known value resistor. A 10 Mohm resistor is recommended.

NOTE

The input resistance of the test digital multimeter could affect the value of R1 in the following tests, if using other than the recommended digital multimeter. The value of R1 should be determined by the 10 Mohm resistor in parallel with the input reistance of the digital multimeter.

1. HIGH LINES INJECTED CURRENT TEST. Set the multimeter to the DC volts function on a range with at least 100 µV of resolution. Install the 10 Mohm resistor across the input terminals of the multimeter. This resistance will be referred to as **R1** in the following steps.

2. Connect the multimeter DCV lead to the shorted HIGH test point of the test fixture. Connect the multimeter COM lead to the LOGIC GND connection on the service module as shown in Figure 8-33.

3. Close the first channel in the multiplexer by executing:

CLOSE ES00 (where E = extender number, S = slot number)

4. Record the voltage indicated on the multimeter. This voltage will be referred to as **V1**.

5. Calculate the injected current (I) from the formula:

$$I = \frac{V1}{R1}$$

The injected current must be less than 1 nA. Once the value of the resistor used is known, the specification can be checked by simply measuring the voltage. For example, using the recommended 10 Mohm resistor, the voltage indicated on the multimeter must be less than 0.01 VDC.

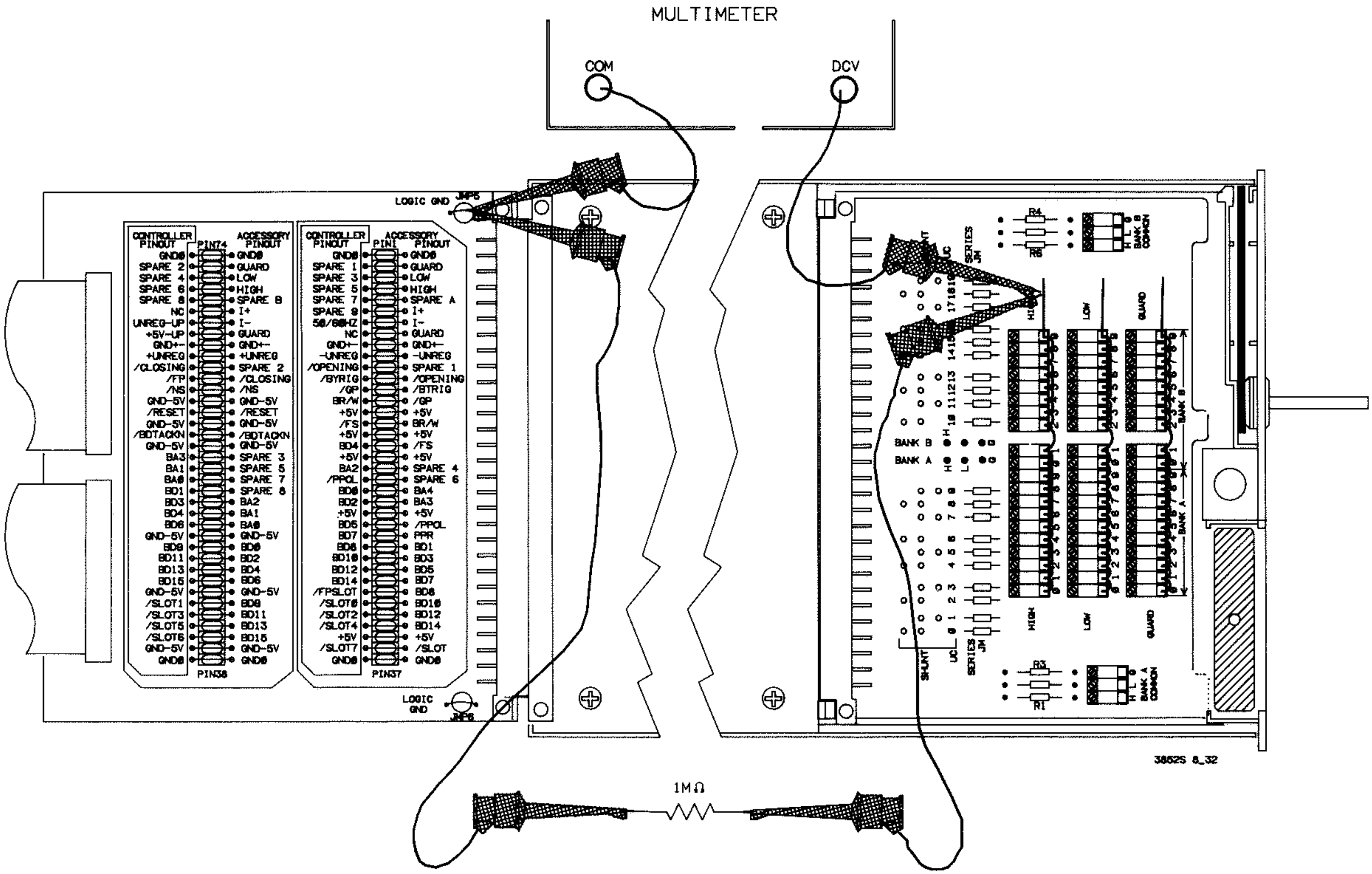


Figure 8-33 HP 44705A/H HIGH Lines Injected Current

6. Repeat steps 3, 4, and 5 for channels 01 through 19. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

7. LOW LINES INJECTED CURRENT TEST. Move the multimeter DCV lead to the shorted LOW test point on the test fixture as shown in Figure 8-34.

8. Close the first channel in the multiplexer by executing:

CLOSE ES00 (where E = extender number, S = slot number)

9. Record the voltage indicated on the multimeter. This voltage will be referred to as **V1**.

10. Calculate the injected current (I) from the formula:

$$I = \frac{V1}{R1}$$

The injected current must be less than 1 nA.

Once the value of the resistor used is known, the specification can be checked by simply measuring the voltage. For example, using the recommended 10 Mohm resistor, the voltage indicated on the multimeter must be less than 0.01 VDC.

11. Repeat steps 8, 9, and 10 for channels 01 through 19. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

12. GUARD LINES INJECTED CURRENT TEST. Move the multimeter DCV lead to the shorted GUARD test point on the test fixture as shown in Figure 8-35.

13. Close the first channel in the multiplexer by executing:

CLOSE ES00 (where E = extender number, S = slot number)

14. Record the voltage indicated on the multimeter. This voltage will be referred to as **V1**.

15. Calculate the injected current (I) from the formula:

$$I = \frac{V1}{R1}$$

The injected current must be less than 1 nA.

Once the value of the resistor used is known, the specification can be checked by simply measuring the voltage. For example, using the recommended 10 Mohm resistor, the voltage indicated on the multimeter must be less than 0.01 VDC.

16. Repeat steps 8, 9, and 10 for channels 01 through 19. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

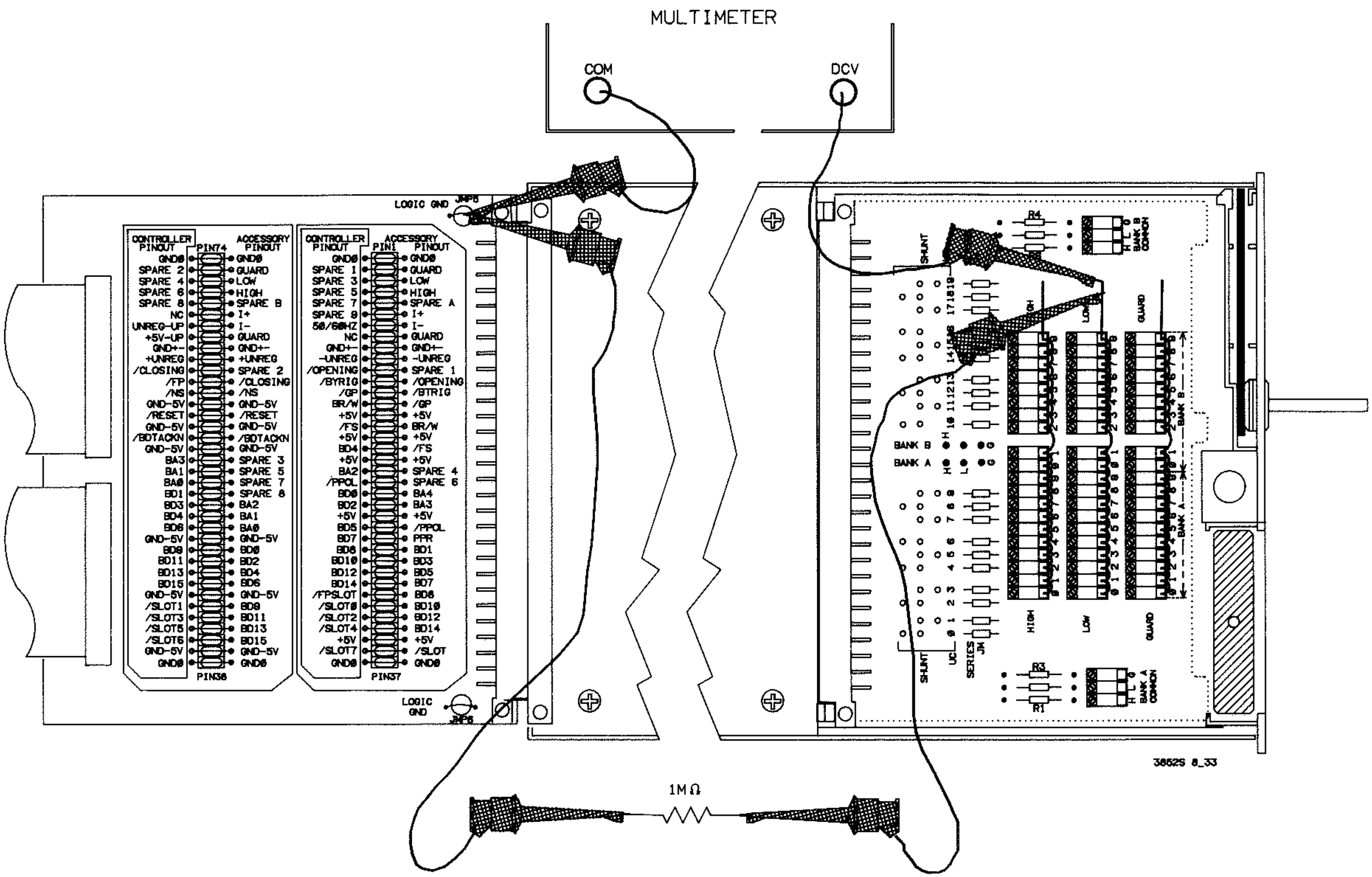


Figure 8-34 HP 44705A/H LOW Lines Injected Current

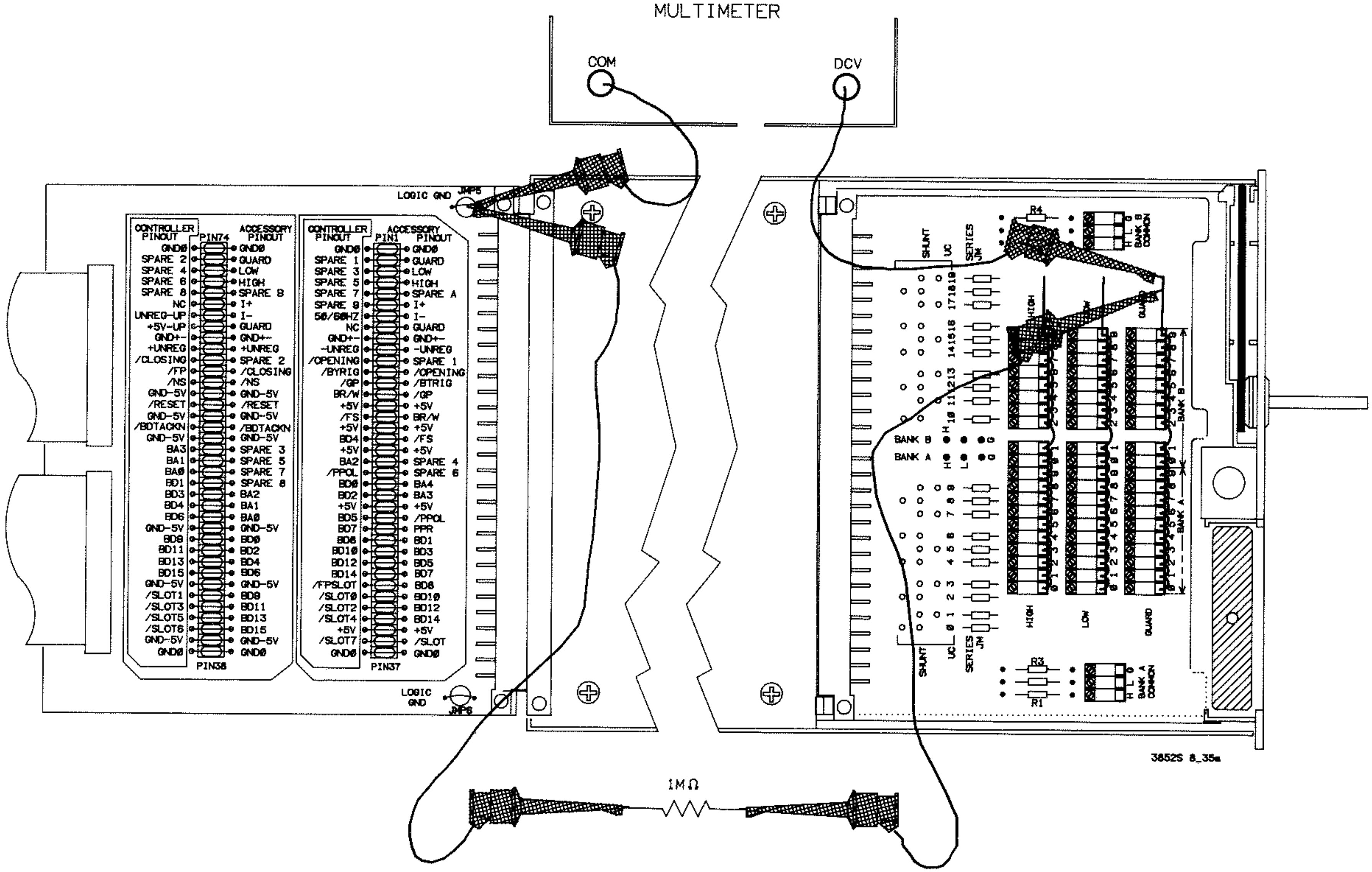


Figure 8-35 HP 44705A/H GUARD Lines Injected Current

8-33 HP 44706A PERFORMANCE TESTS

8-34 Introduction

The following Performance Tests check the operation of the HP 44706A component module. Performance Tests are not given for the terminal module. Successful completion of all tests in this section provides a high confidence level that the relay multiplexer is meeting its listed specifications.

The Performance Tests should be performed in the order they are presented. The completion of each test increases the confidence level in the relay multiplexer operation. A minimum set of tests is given as the Operational Verification Tests. These tests are described in Section 8-35.

The Performance Test procedures in this chapter are involved and time consuming. Since the most likely parameter to change with time is the contact resistance of a relay, and since the contact resistance is checked as a part of the Operational Verification Tests, it is not recommended that all Performance Tests be performed unless one of the tested specifications is in question.

8-35 Operational Verification

The first tests given in this section are a minimal set of tests recommended for the relay multiplexer. These tests are designed to test the functionality and contact resistance of the relay multiplexer. Successful completion of the Operational Verification Tests provides a 90% confidence level that the relay multiplexer is operating normally and is within specification.

The Operational Verification Tests consist of the following:

Section 8-39 - Set-Up Procedure
Section 8-40 - Relay Contact Resistance Test

8-36 Equipment Required

The following list of equipment is required for the Performance Tests. Only the first three items on the list are required for the Operational Verification Tests.

1. Digital Multimeter -- HP 3456A or equivalent

2. Test Fixture -- as described in Section 8-37

3. Test Leads and Jumpers

4. Resistor -- 10 Mohm

5. Resistor -- 1 kohm

6. Oscilloscope -- HP 1740A or equivalent (dual trace with delayed sweep)

7. Service Module -- HP 44743A

8. +20 V Power Supply -- HP 6212 or equivalent

NOTE

Either of the accessory plug-in multimeters (HP 44701A or HP 44702A/B) may be used for these tests. The tests do not describe the specific steps required to use the plug-in multimeters. A description of the plug-in multimeters can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

8-37 Test Fixture

A test fixture is required to run the Performance Tests. A schematic of the required test fixture is shown in Figure 8-36a. A test fixture can be made using the HP 44706AT terminal module (see Figure 8-36b). Because wiring the test fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

If the test fixture is to be fabricated from other than a HP 44706AT terminal module, it is important that the terminal ID lines, shown in Figure 8-36b be correctly wired. The HP 3852A local controller will not allow the execution of some commands with an incorrect terminal ID.

The fixture consists of: a short circuit between all channel HIGH lines and test connections for the common LOW and GUARD lines. The use of the fixture minimizes the number of test lead connections required for the tests.

8-38 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

8-39 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the HP 44706A component module and install the test fixture. Note the slot number where the HP 44706A under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

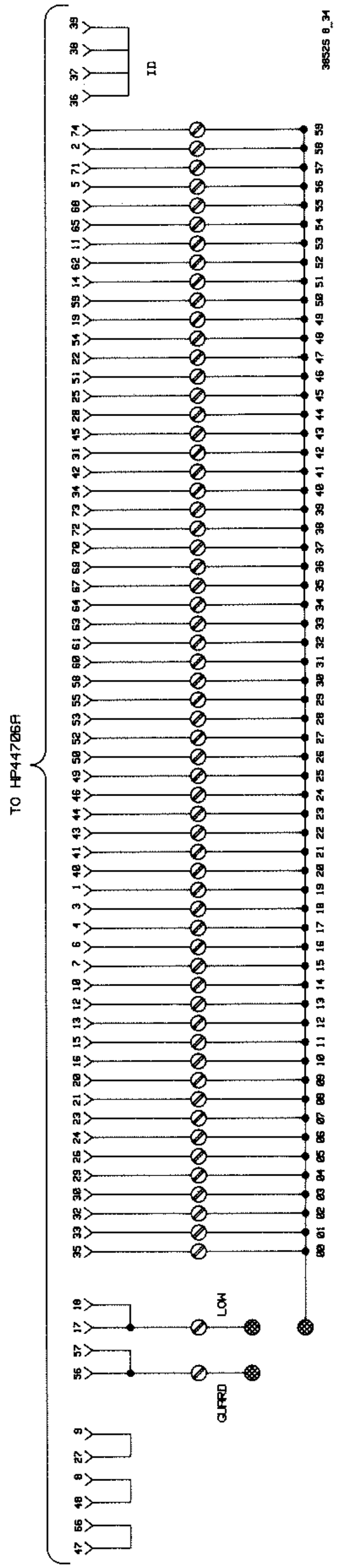


Figure 8-36a HP 44706A Test Fixture Wiring

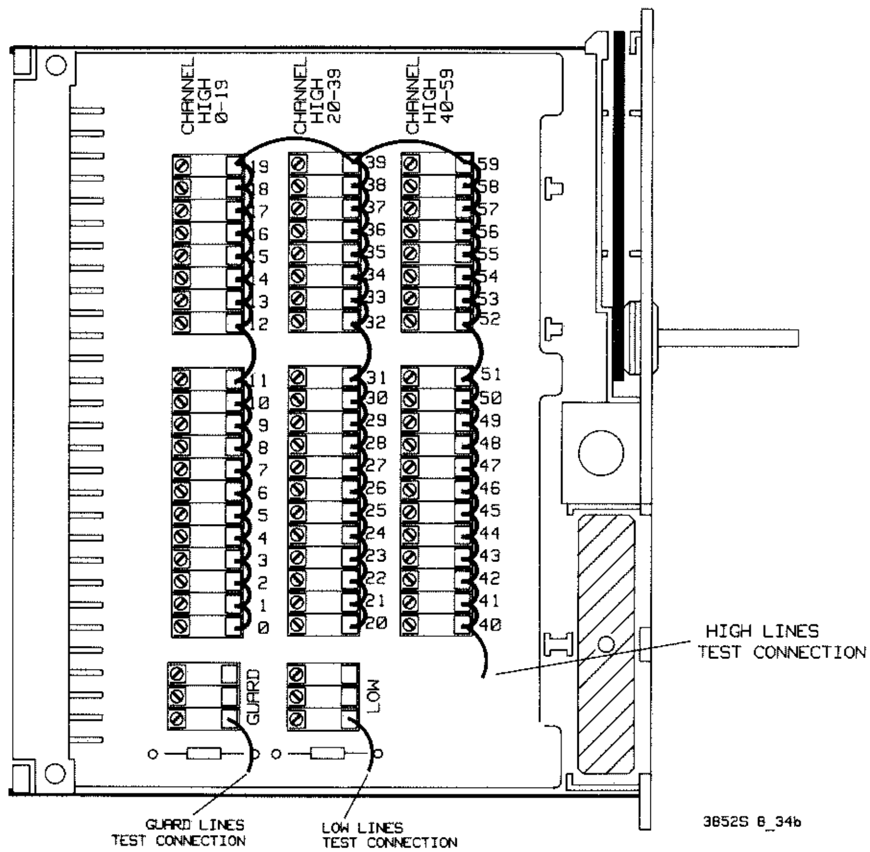


Figure 8-36 HP 44706A Test Fixure

c. Verify that the HP 3852A right display shows:

44706A

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

4. Set the multimeter to measure ohms.

5. Set the HP 44706A to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

This opens all relays on the HP 44706A.

6. Short the HIGH lines, LOW line and GUARD lines together on the test fixture with jumpers.

8-40 Relay Contact Resistance Test

1. HIGH AND LOW RELAY TEST: This test checks the relay contact resistance for the channel relays (switching the HIGH line) and the tree relays (switching both the HIGH line and the LOW line).

2. Set the multimeter to measure four-wire ohms. Connect the multimeter ohms SENSE leads to the backplane analog bus sense HIGH and LOW connections. Connect the multimeter ohms SOURCE leads to the backplane analog bus current source HIGH and LOW connections.

NOTE

The backplane analog bus can be tested in one of three ways: 1) By connecting an external multimeter to the analog bus connector on the rear panel of the power supply module as shown in Figure 8-8, 2) By connecting an external multimeter to the backplane analog bus line jumpers provided on the 44743A service module as shown in Figure 8-9, or 3) by using a plug-in multimeter (HP 44701A or HP 44702A/B) programmed to measure four-wire ohms from the backplane.

3. Close channel 00 by executing:

CLOSE ES00,ES91 (where E = extender number, S = slot number)

4. Observe the reading on the multimeter. The multimeter should indicate a resistance of less than 2 ohms.

5. Open the channel by executing:

OPEN ES00 (where E = extender number, S = slot number)

6. Observe the reading on the multimeter. The multimeter should indicate an open circuit (>1 GΩ).

7. Repeat steps 3, 4, 5, and 6 for channels 01 through 59. In the CLOSE and OPEN commands, the last two digits are the channel number. For example, CLOSE ES01 would close channel 01.

8. GUARD RELAY TEST: This test checks the guard connection through the tree relays.

9. Set the multimeter to measure two-wire ohms. Connect the multimeter DCV lead to the backplane analog bus sense LOW connection. Connect the multimeter COM lead to the backplane analog bus GUARD connection.

10. Close channel 00 by executing:

CLOSE ES00,ES91 (where E = extender number, S = slot number)

11. Observe the reading on the multimeter. The multimeter should indicate approximately 200 ohms. The resistance indicated is the sum of the resistance of the tree relay contacts, the resistance of the connections, and the resistance of the series protection resistors in the analog bus lines (there are 100 ohm resistors on the HP 44706A component module in series with each line to the analog bus).

12. Open the channel by executing:

OPEN ES00 (where E = extender number, S = slot number)

13. Observe the reading on the multimeter. The multimeter should indicate an open circuit (>1 GΩ).

14. Repeat steps 10, 11, 12, and 13 for channel 20 (CLOSE and OPEN ES20).

15. Repeat steps 10, 11, 12, and 13 for channel 40 (CLOSE and OPEN ES40).

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44706A PERFORMANCE TEST.

8-41 Opening and Closing Time Set-Up Procedure

This test verifies that the channel relays will maintain break-before-make operation and that the multiplexer can scan the channels at the specified speed. Only the first 20 channels, instead of all 60 channels, need testing because each channel relay switches three channel contacts at the same time.

1. Remove power from the HP 3852A and unplug the relay multiplexer to be tested. Install the Service Module in a convenient slot in the HP 3852A. Note the slot number where the Service Module is installed. Install the relay multiplexer on the service module. Install the test fixture on the relay multiplexer. The Set-Up Procedure is depicted in Figure 8-37.

2. On an oscilloscope, connect probes to the Channel A INPUT, Channel B INPUT, and EXT TRIGGER input. Set up the oscilloscope to the following:

Dual Trace
Channel A -- DC, 0.5 Volts/Div (if using 10:1 probes)
Channel B -- DC, 0.5 Volts/Div (if using 10:1 probes)
Trigger -- External
Vertical Display -- Chopped
Time -- 5 mses/Div
Delayed Sweep -- 0.1 msec/Div
Delayed Sweep Dial -- Minimum

3. Connect the 1 kohm resistor between the analog bus HIGH connection and the +5V connection on the service module with jumpers.

4. Connect a jumper between the analog bus LOW test connection and the logic ground test connection on the service module.

5. Connect the Channel A oscilloscope probe to the analog bus HIGH test connection on the service module.

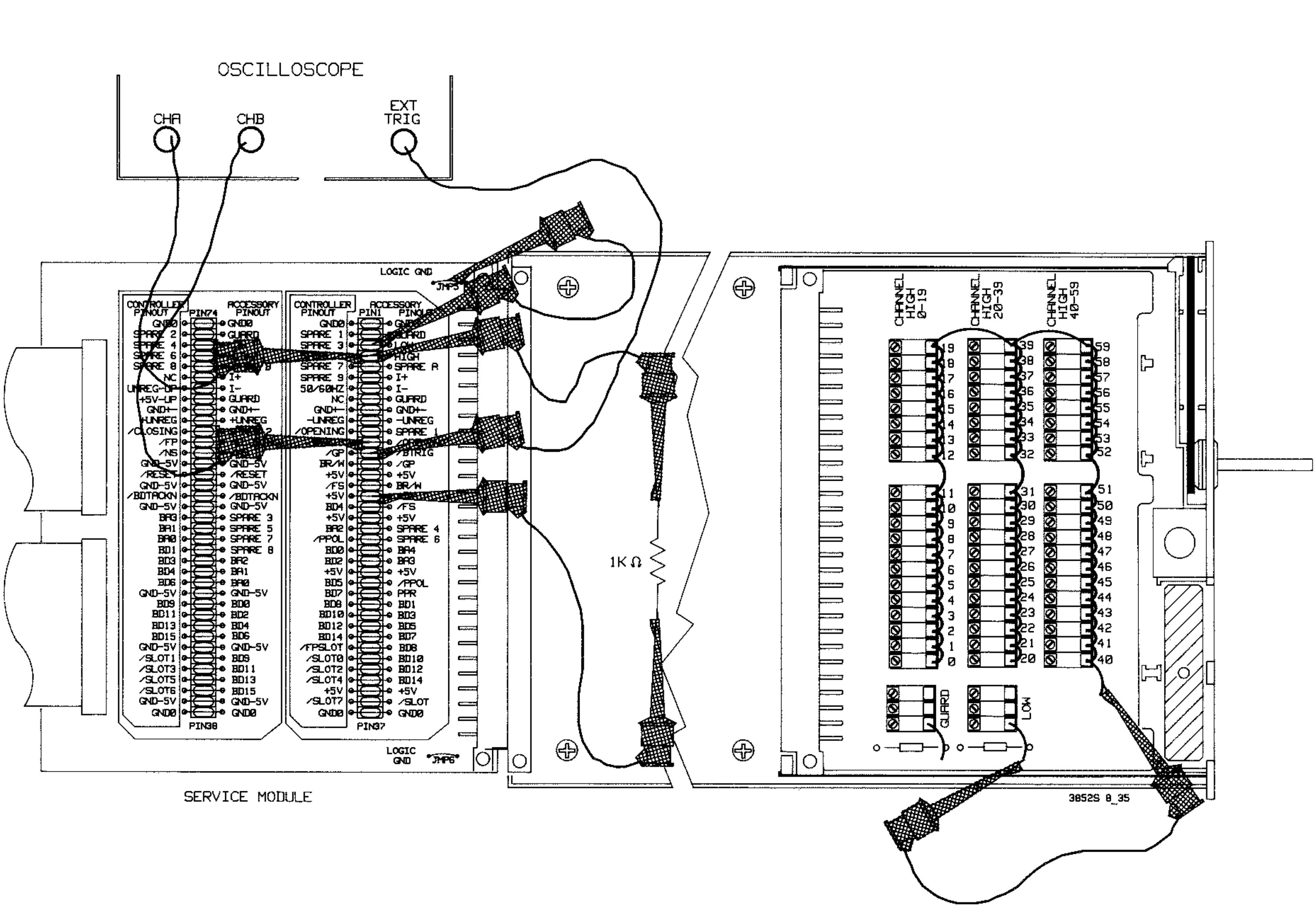


Figure 8-37 HP 44706A Opening Time Set-Up

6. Connect the Channel B oscilloscope probe to the OPENING test connection on the service module.

7. Connect the EXT TRIGGER oscilloscope probe to the BTRIG test connection on the service module.

8. Short the HIGH lines to the LOW lines on the test fixture with jumpers.

9. Apply power to the HP 3852A.

10. Set up the following subroutine in HP 3852A memory. When the first statement is entered the SUB ENTRY annunciator should be on in the left display. This annunciator should remain on until the SUBEND statement is entered.

```
SUB A
TRG
SCAN ES00-ES19   (where E = extender number, S = slot number)
SUBEND
```

The subroutine will scan all channels on the relay multiplexer in a break-before-make fashion. The scan will be preceded by a backplane trigger pulse (used to trigger the oscilloscope). Do not reset or cycle power to the HP 3852A or the subroutine will be erased from memory. The front panel CLEAR key may be used without disturbing the subroutine.

8-42 Opening Time Test

1. OPENING PULSE WIDTH TEST. This test checks the pulse width of the OPENING pulse output from the relay multiplexer.

2. Repetitively call the entered subroutine by executing:

```
CALL A,1000
```

This statement will call the subroutine 1000 times.

3. Observe the waveform displayed on the Channel B trace and make sure all 20 channels are present. It may also be necessary to adjust the TRIGGER LEVEL and TRIGGER HOLD controls on the scope to synchronize the signal on the scope.

4. The OPENING pulse is a negative pulse. The width of the negative portion of the pulse must be between 0.77 and 0.94 milliseconds. If the pulse width is not within these limits, the relay multiplexer is failing. The OPENING pulse is shown in Figure 8-38. The waveform will exhibit a small amount of jitter caused by the operating system.

NOTE

If necessary, repeat step 2 to allow more time to view the waveform. The 1000 repetitions of the subroutine take approximately 45 seconds to complete. The time may be extended by increasing the number of repetitions specified in step 2.

5. RELAY OPENING TIME TEST. This test checks the ability of each channel relay to open within the time specified.

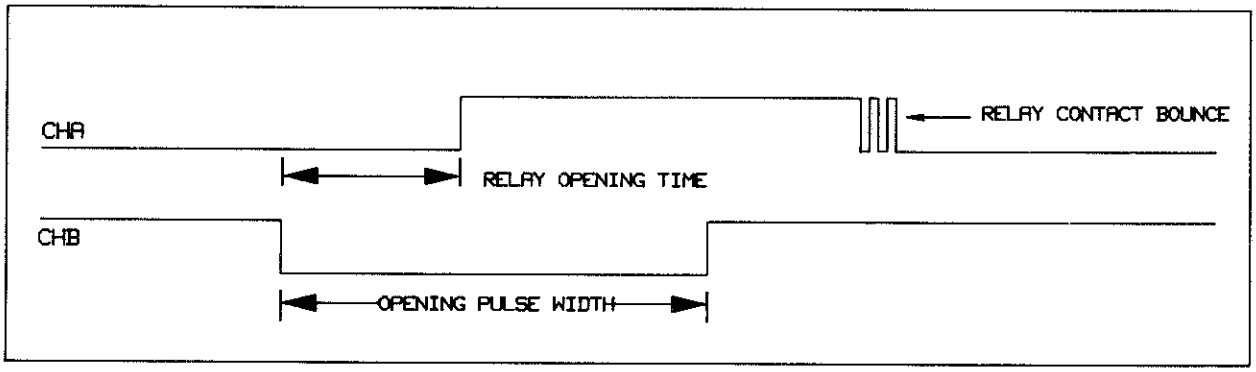


Figure 8-38 HP 44706A Opening Time

6. Repetitively call the entered subroutine by executing:

CALL A,10000

7. Rotate the DELAY SWEEP dial to the minimum position. Select the DELAYED sweep mode on the scope. Slowly rotate the DELAY SWEEP dial clockwise while observing the displayed waveforms. The Channel B waveform is the OPENING pulse. The Channel A waveform is the +5V supply as switched by the relays. As the DELAY SWEEP dial is rotated, one relay closure and the associated OPENING pulse will come in to view at a time. The relay opening time is the time between the falling edge of the OPENING pulse (Channel B) and the falling edge of the Channel A waveform. This time must be less than 0.94 milliseconds. This time is illustrated in Figure 8-38.

Continue rotating the DELAY SWEEP dial until all 20 relay channels have been checked. A failing channel indicates a sticking relay contact. Only the lower 20 channels are checked since channels 21 through 59 utilize different contacts in the same relays.

To stop the test at any time press the front panel CLEAR key. The test may be extended by increasing the number of times the subroutine is called, as specified in step 5.

The waveforms will exhibit a small amount of jitter due to the overhead of the HP 3852A operating system.

8-43 Closing Time Test

1. CLOSING PULSE WIDTH TEST. This test checks the pulse width of the CLOSING pulse output from the relay multiplexer.

2. Move the Channel B oscilloscope probe to the CLOSING connection on the service module. The Set-Up is shown in Figure 8-39.

3. Repetitively call the entered subroutine by executing:

CALL A,1000

4. Take the scope out of the DELAYED sweep mode. Observe the waveform displayed on the Channel B trace and make sure all 20 channels are present. It may also be necessary to adjust the TRIGGER LEVEL and TRIGGER HOLD controls on the scope to synchronize the signal on the scope.

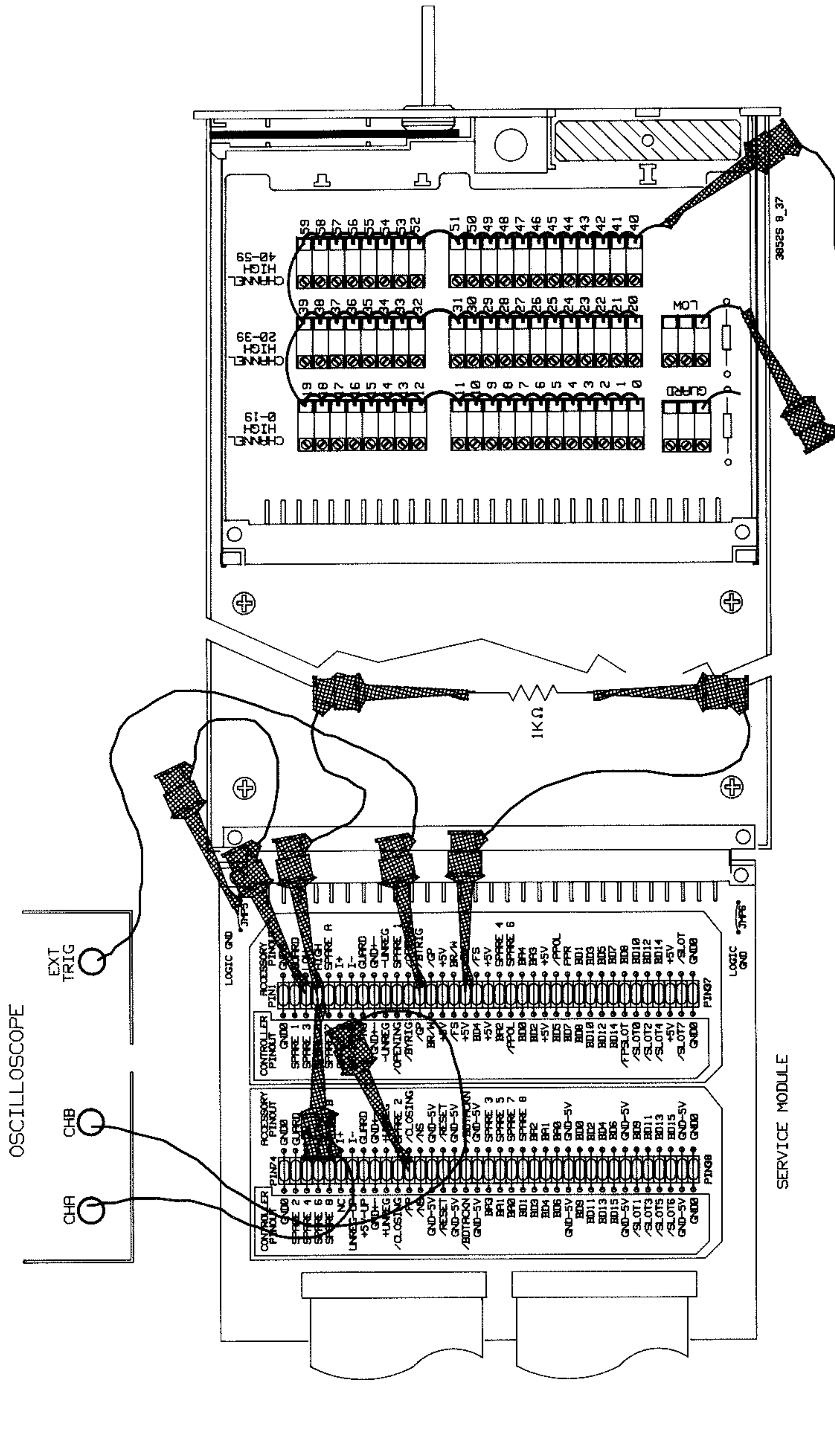


Figure 8-39 HP 44706A Closing Time Set-Up

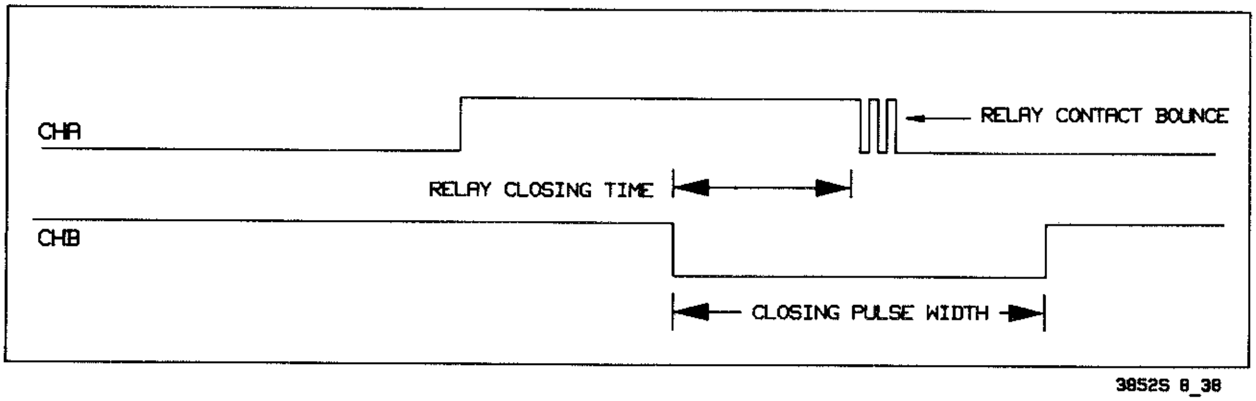


Figure 8-40 HP 44706A Closing Time

5. The CLOSING pulse is a negative pulse. The width of the negative pulse must be between 0.9 msec and 1.1 msec. If the pulse is not within these limits, the relay multiplexer is failing. The CLOSING pulse is shown in Figure 8-40. The waveform will exhibit a small amount of jitter caused by the operating system.

NOTE

If necessary, repeat step 2 to allow more time to view the waveform. The 1000 repetitions of the subroutine take approximately 45 seconds to complete. The time may be extended by increasing the number of repetitions specified in step 3.

6. RELAY CLOSING TIME TEST. This test checks the ability of the channel relays to close within the time specified.

7. Repetitively call the entered subroutine by executing:

   CALL A,10000

7. Rotate the DELAY SWEEP dial to the minimum position. Select the DELAYED sweep mode on the scope. Slowly rotate the DELAY SWEEP dial clockwise while observing the displayed waveforms. The Channel B waveform is the CLOSING pulse. The Channel A waveform is the +5V supply as switched by the relays. As the DELAY SWEEP dial is rotated, one relay closure and the associated CLOSING pulse will come in to view at a time. The relay closing time is the time between the falling edge of the CLOSING pulse (Channel B) and the falling edge of the Channel A waveform. This time must be less than 1.1 milliseconds. This time is illustrated in Figure 8-40. Note that there will be some relay bounce indicated on the Channel A waveform.

Continue rotating the DELAY SWEEP dial until all 20 relay channels have been checked. A failing channel indicates a sticking relay contact. Only the lower 20 channels are checked since channels 21 through 59 utilize different contacts in the same relays.

To stop the test at any time press the front panel CLEAR key. The test may be extended by increasing the number of times the subroutine is called, as specified in step 6.

The waveforms will exhibit a small amount of jitter due to the overhead of the HP 3852A operating system.

8-44 DC Isolation Tests

The DC isolation tests use a power supply, a resistor and the multimeter to form a voltage divider. The channel being tested is then connected in parallel with this divider and the isolation resistance computed from the measured voltage across the divider.

NOTE

The best test results will be obtained when the resistor value used is the same value as the internal resistance of the voltmeter. The recommended 10 Mohm resistor was selected to match the input impedance of an HP 3456A multimeter set to the 100 Vdc range.

1. SET-UP PROCEDURE. Using the multimeter, measure the resistance of the 10 Mohm resistor. This resistance will be referred to as **R1** in the following steps.

2. Set the multimeter to measure DC volts and connect the multimeter to the DC power supply. Adjust the DC power supply output to +20 Vdc ±0.01 Vdc. This voltage will be referred to as **V1** in the following steps.

3. Connect the resistor, power supply and multimeter as shown in Figure 8-41.

4. Set the multimeter to the 100 Vdc range. Measure the exact voltage displayed on the multimeter. This voltage will be referred to as **V2** in the following steps.

5. Calculate the internal resistance of the multimeter (**Rm**) using the following equation:

$$Rm = \frac{R1 \cdot V2}{(V1 - V2)}$$

NOTE

In most cases, the internal resistance of the multimeter is dependent upon the range selected. For this reason, do not change the multimeter range setting in the following procedure.

6. HIGH TO LOW ISOLATION TEST. This test checks the isolation between the HIGH and LOW lines with a single channel closed.

7. Set the multiplexer to a known state by executing:

   RESET ES00 (where E = extender number, S = slot number)

8. Connect the test circuit between the shorted HIGH lines and the LOW line on the test fixture as shown in Figure 8-42.

9. Close a channel on the multiplexer by executing:

   CLOSE ES00 (where E = extender number, S = slot number)

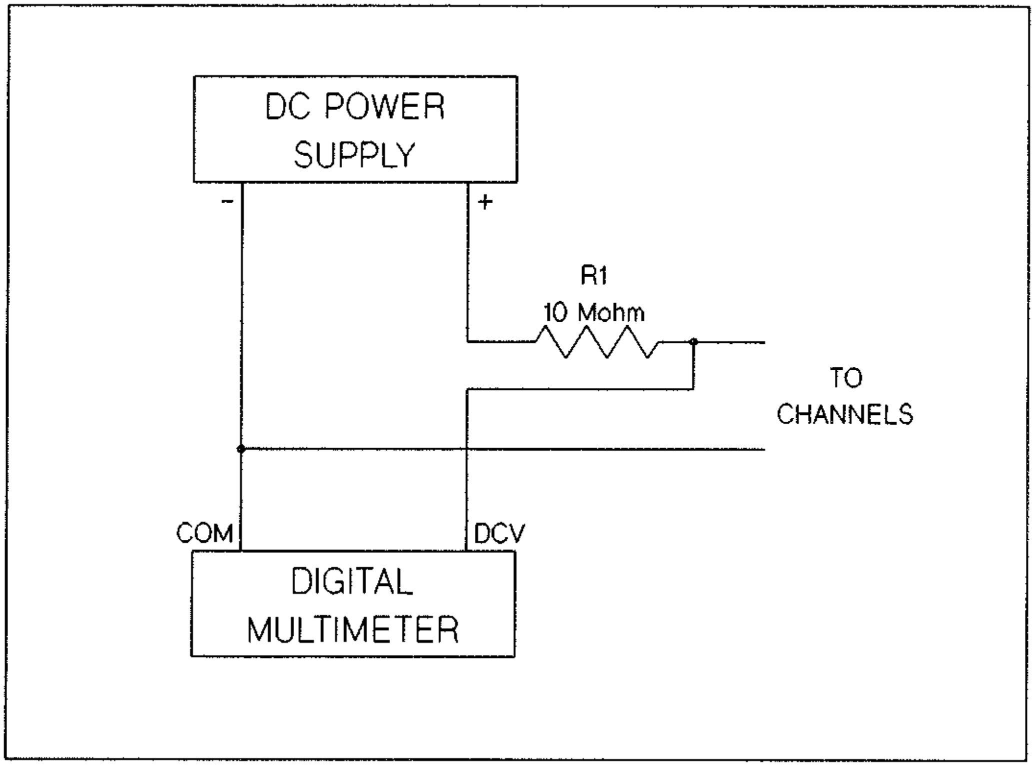


Figure 8-41 HP 44706A DC Isolation Set-Up

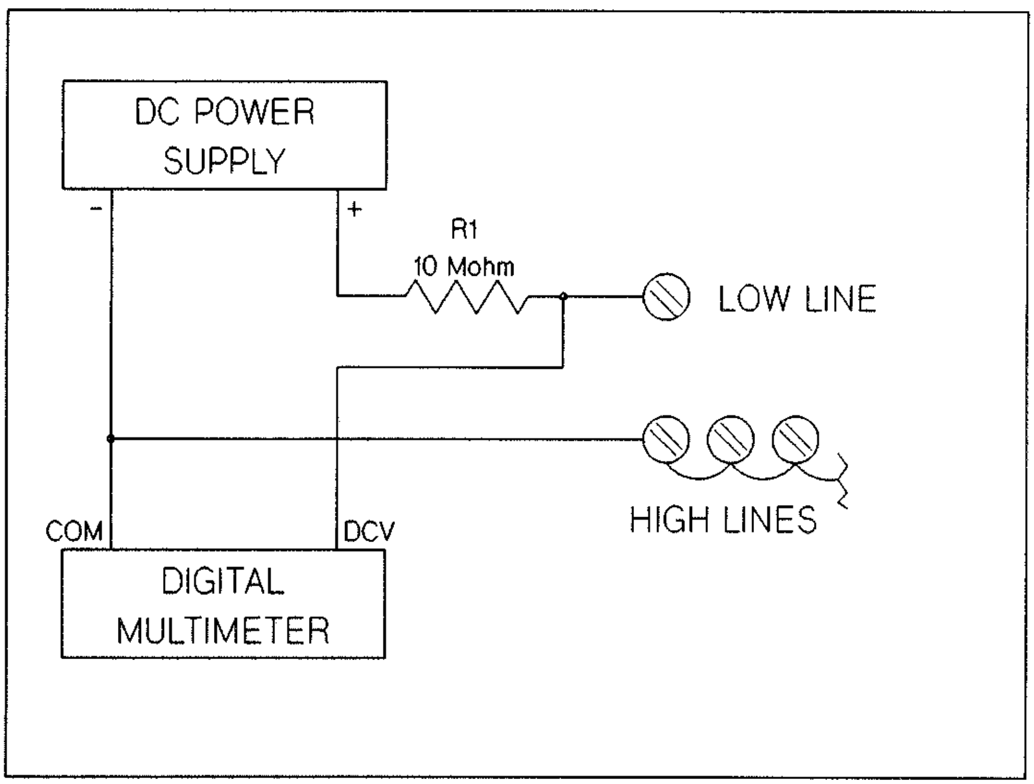


Figure 8-42 HP 44706A HIGH to LOW DC Isolation

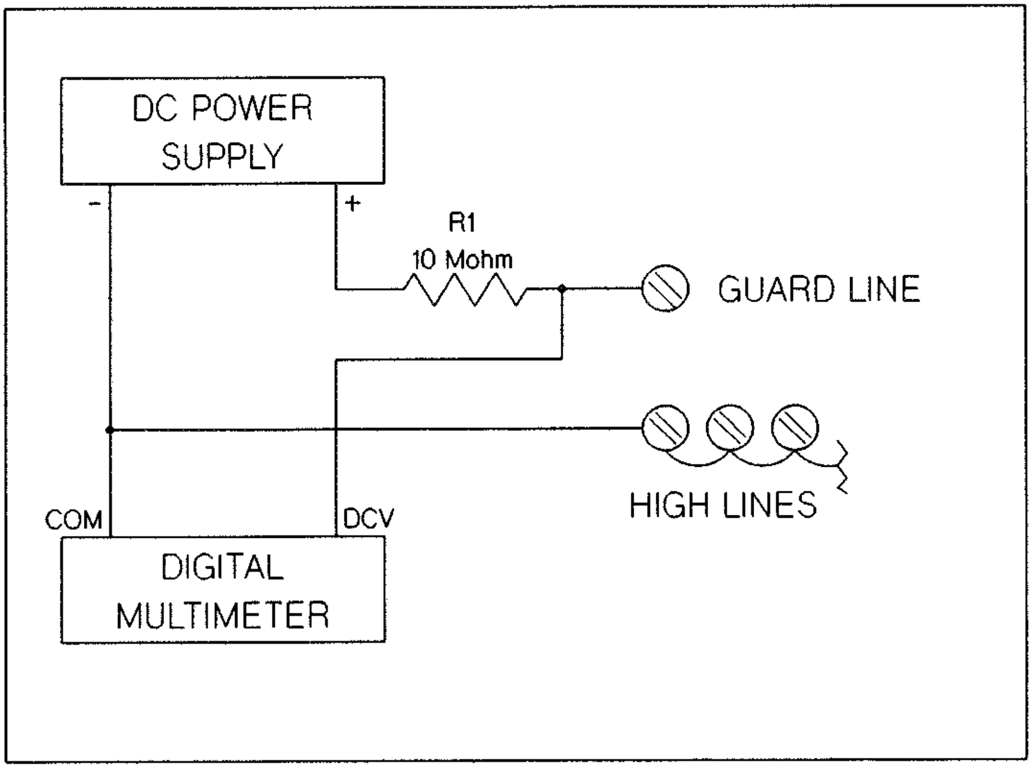


Figure 8-43 HP 44706A HIGH to GUARD DC Isolation

10. Record the multimeter voltage measurement. This reading will be referred to as **V3**.

11. Calculate the DC isolation (**Rc**) using the following equation:

$$\mathbf{Rc} = \frac{\mathbf{V3 \cdot R1 \cdot Rm}}{\mathbf{Rm \cdot (V1 - V3) - (R1 \cdot V3)}}$$

The DC isolation should be greater than 10^9 ohms.

12. Repeat steps 9, 10, and 11 for channels 01 through 59. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

13. HIGH TO GUARD ISOLATION TEST. This test checks the DC Isolation between the HIGH lines and the GUARD lines with a single channel closed.

14. Connect the test circuit between the shorted HIGH lines and the GUARD line of the test fixture as shown in Figure 8-43.

15. Close a channel on the multiplexer by executing:

CLOSE ES00 (where E = extender number, S = slot number)

16. Record the multimeter voltage measurement. This reading will be referred to as **V3**.

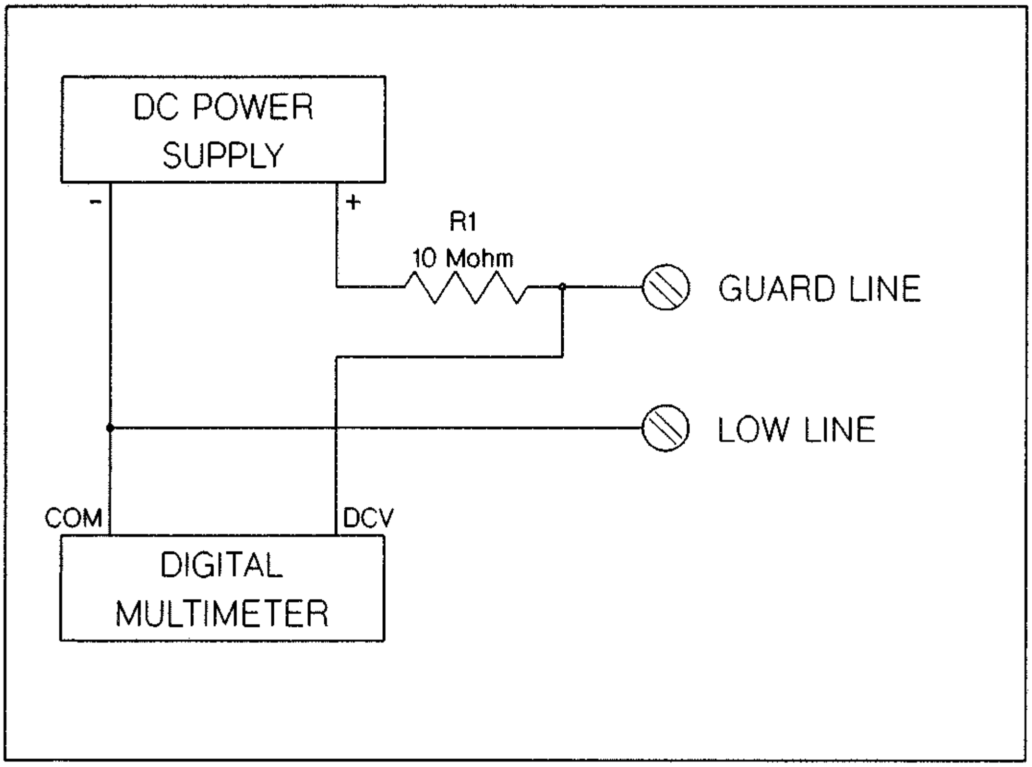


Figure 8-44 HP 44706A LOW to GUARD DC Isolation

17. Calculate the DC isolation (**Rc**) using the equation in step 10. The DC Isolation should be greater than 10^9 ohms.

18. Repeat steps 15, 16, and 17 for channels 01 through 59. In the CLOSE command the last two digits are the channel number. For example, CLOSE ES01 for channel 01.

19. LOW TO GUARD ISOLATION TEST. This test checks the DC Isolation between the LOW and GUARD lines with a single channel closed.

20. Connect the test circuit between the LOW line and the GUARD lines of the test fixture as shown in Figure 8-44.

21. Close a channel on the multiplexer by executing:

CLOSE ES00 (where E = extender number, S = slot number)

22. Record the multimeter voltage measurement. This reading will be referred to as **V3**.

23. Calculate the DC isolation (**Rc**) using the equation in step 10. The DC Isolation should be greater than 10^9 ohms.

24. Repeat steps 21, 22, and 23 for channels 01 through 59. In the CLOSE command the last two digits are the channel number. For example, CLOSE ES01 for channel 01.

8-45 Thermal Offset Test

This test measures the thermally generated voltages on the HP 44706A. This test is very sensitive to ambient temperature changes and thermoelectricity generated at the junction of two dissimilar metals. For these reasons, it is important that the test be performed in an environment where the temperature is stable and that the number of test lead connections be kept to a minimum. During the test, care should be taken not to influence the measurements by holding or touching the test leads. The temperature of the leads and connections should be allowed to stabilize for at least one minute after moving or installing the connections.

1. HIGH LINES THERMAL OFFSET TEST. This test checks the thermal offset of the channel relay HIGH contacts through the tree switches to the backplane analog bus.

2. Set the multimeter to the lowest DC voltage range. The resolution of the multimeter must be at least 100 µV. Connect the multimeter test leads together and record the offset voltage indicated on the multimeter. This voltage will be referred to as **V1** in the following steps.

3. Refer to Figure 8-45. Connect the multimeter test leads between the shorted HIGH test connections of the test fixture and the backplane analog bus HIGH connection of the service module.

4. Close a channel by executing:

    CLOSE ES00 (where E = extender number, S = slot number)

5. Record the voltage indication on the multimeter. This reading will be referred to as **V2**. The difference between **V1** and **V2** must be less than 100 µV.

6. Repeat steps 4 and 5 for channels 01 through 59. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

NOTE

If a single channel fails the thermal offset test, the channel relay is probably at fault. If several or all channels fail the test, check the test fixture and test lead connections. If groups of channels are failing the test, a failure in the tree switches is indicated. Section 8-47 provides additional tests of failing relays.

7. LOW LINES THERMAL OFFSET TEST. This test checks the thermal offset in the LOW lines of the multiplexer. Since the LOW lines are not switched by the channel relays, only the tree relay contacts are tested.

8. Refer to Figure 8-46. Connect the multimeter between the LOW lines test connection on the test fixture and the backplane analog bus LOW connection on the service module.

9. Close the first channel by executing:

    CLOSE ES00 (where E = extender number, S = slot number)

10. Record the voltage indication on the multimeter. This reading will be referred to as **V2**. The difference between **V1** and **V2** must be less than 100 µV.

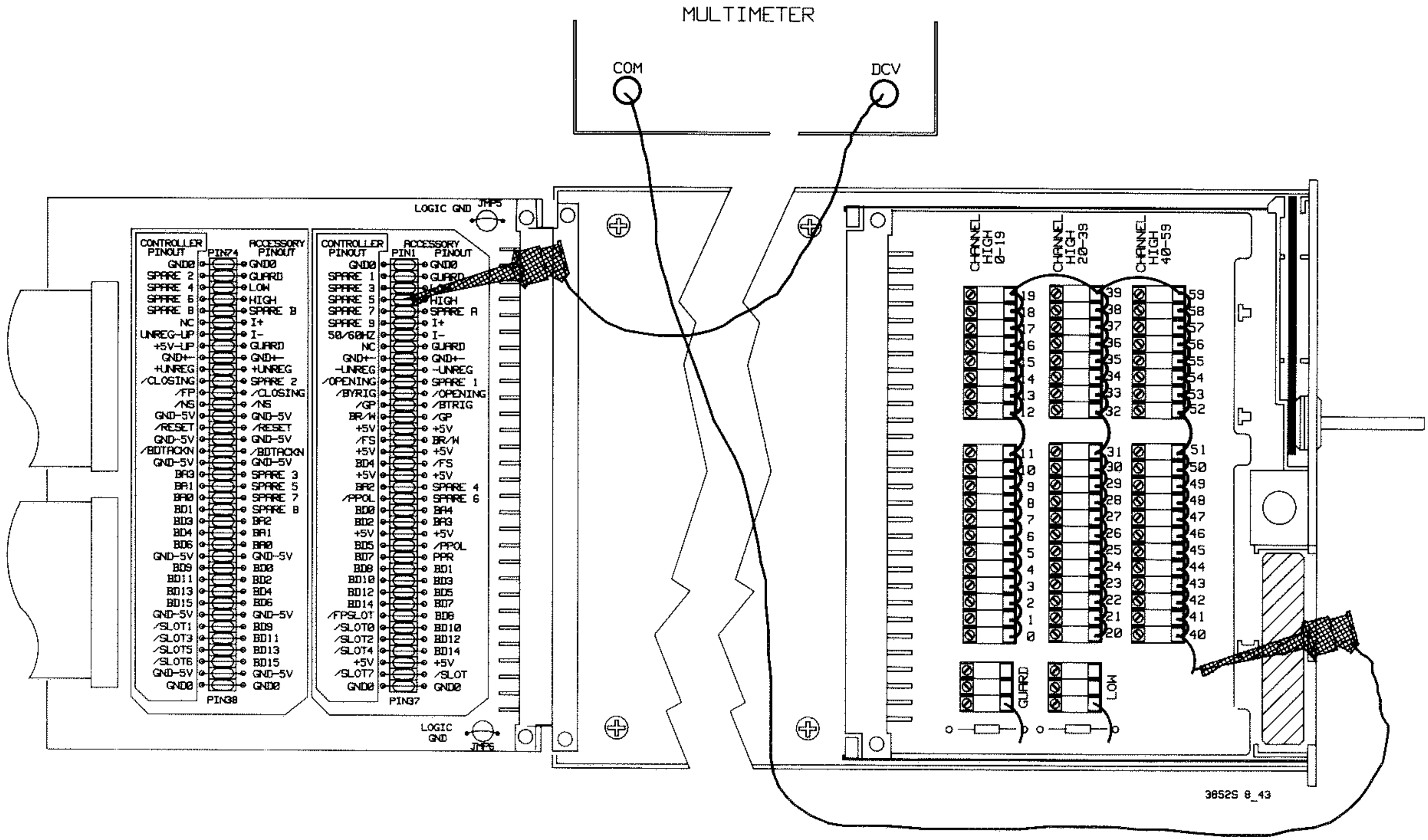


Figure 8-45 HP 44706A HIGH Lines Thermal Offset

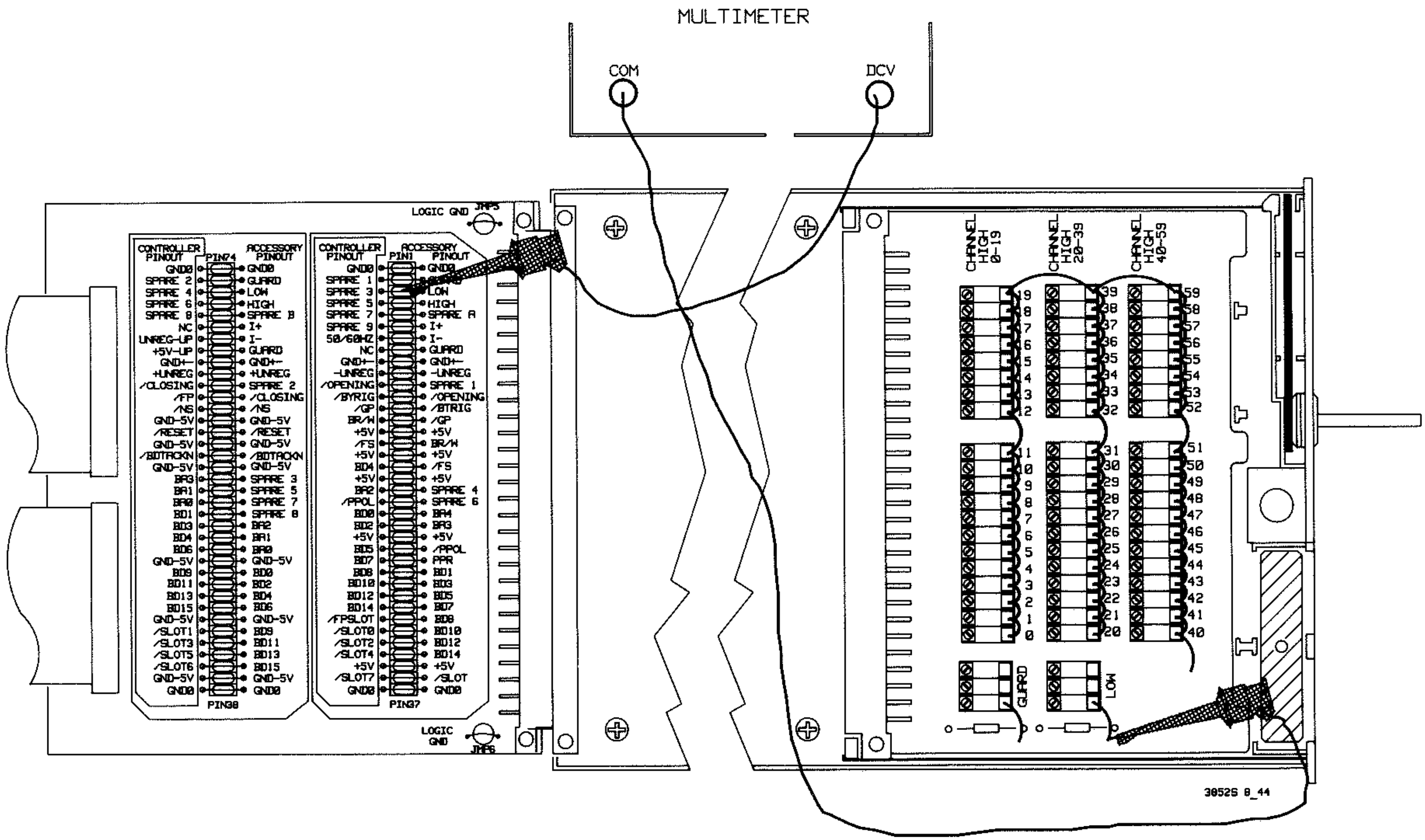


Figure 8-46 HP 44706A LOW Lines Thermal Offset

11. Repeat steps 8 and 9 for channels 20 and 40. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES20 for channel 20).

12. GUARD LINES THERMAL OFFSET TEST. This test checks the thermal offset of the GUARD lines. Since the GUARD lines are not switched by the channel relays, only the tree switch contacts are tested.

13. Refer to Figure 8-47. Connect the multimeter test leads between the GUARD test connection on the test fixture and the backplane analog bus GUARD line on the service module.

14. Close a channel by executing:

CLOSE ES00 (where E = extender number, S = slot number)

15. Record the voltage indication on the multimeter. This reading will be referred to as **V2**. The difference between **V1** and **V2** must be less than 100 µV.

16. Repeat steps 14 and 15 for channels 20 and 40. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES20 for channel 20).

8-46 Injected Current Test

This test measures the amount of current injected into the HIGH contacts of each channel relay. The LOW and GUARD lines are also tested for injected current by the tree switches. The amount of injected current is deduced by measuring the voltage drop across a known value resistor. A 10 Mohm resistor is recommended.

NOTE

The input resistance of the test digital multimeter could affect the value of R1 in the following tests, if using other than the recommended digital multimeter. The value of R1 should be determined by the 10 Mohm resistor in parallel with the input reistance of the digital multimeter.

1. HIGH LINES INJECTED CURRENT TEST. Set the multimeter to the DC volts function on a range with at least 10 µV of resolution. Install the 10 Mohm resistor across the input terminals of the multimeter. This resistance will be referred to as **R1** in the following steps.

2. Connect the multimeter DCV lead to the shorted HIGH connections of the test fixture. Connect the multimeter COM lead to the LOGIC GND connection on the service module as shown in Figure 8-48.

3. Close the first channel in the multiplexer by executing:

CLOSE ES00 (where E = extender number, S = slot number)

4. Record the voltage indicated on the multimeter. This voltage will be referred to as **V1**.

5. Calculate the injected current (I) using the following formula:

$$I = \frac{V1}{R1}$$

The injected current must be less than 1 nA.

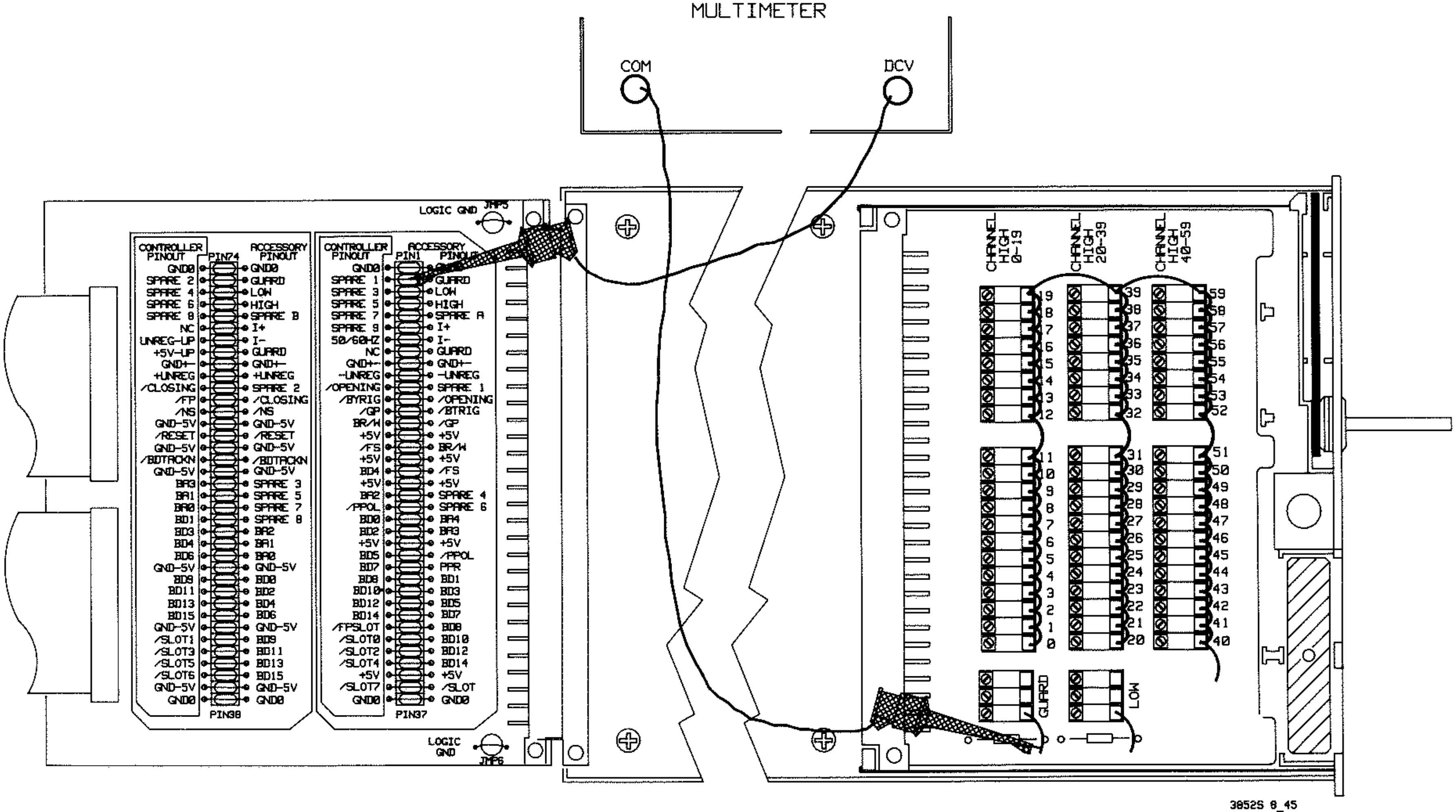


Figure 8-47 HP 44706A GUARD Lines Thermal Offset

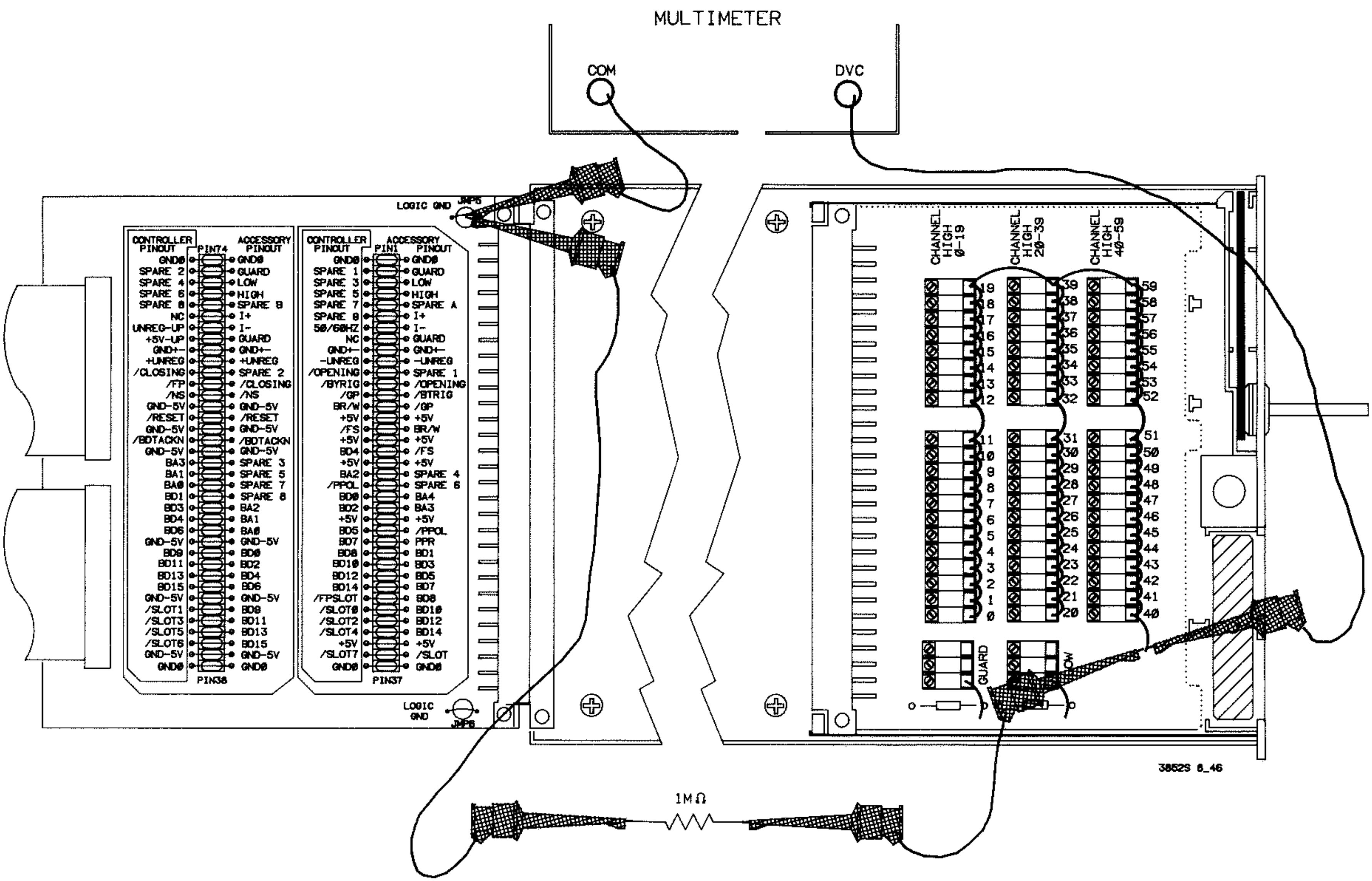


Figure 8-48 HP 44706A HIGH Lines Injected Current

Once the value of the resistor used is known, the specification can be checked by simply measuring the voltage. For example, using the recommended 10 Mohm resistor, the voltage indicated on the multimeter must be less than 0.01 VDC.

6. Repeat steps 3, 4, and 5 for channels 01 through 59. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

7. LOW LINES INJECTED CURRENT TEST. Move the multimeter DCV lead to the LOW connection test point on the test fixture as shown in Figure 8-49.

8. Close the first channel in the multiplexer by executing:

   CLOSE ES00 (where E = extender number, S = slot number)

9. Record the voltage indicated on the multimeter. This voltage will be referred to as **V1**.

10. Calculate the injected current (I) from the following formula:

$$I = \frac{V1}{R1}$$

The injected current must be less than 1 nA.

Once the value of the resistor used is known, the specification can be checked by simply measuring the voltage. For example, using the recommended 10 Mohm resistor, the voltage indicated on the multimeter must be less than 0.01 VDC.

11. Repeat steps 8, 9, and 10 for channels 20 and 40. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES20 for channel 20).

12. GUARD LINES INJECTED CURRENT TEST. Move the multimeter DCV lead to the GUARD connection test point on the test fixture as shown in Figure 8-50.

13. Close the first channel in the multiplexer by executing:

   CLOSE ES00 (where E = extender number, S = slot number)

14. Record the voltage indicated on the multimeter. This voltage will be referred to as **V1**.

15. Calculate the injected current (I) from the following formula:

$$I = \frac{V1}{R1}$$

The injected current must be less than 1 nA.

Once the value of the resistor used is known, the specification can be checked by simply measuring the voltage. For example, using the recommended 10 Mohm resistor, the voltage indicated on the multimeter must be less than 0.01 VDC.

16. Repeat steps 8, 9, and 10 for channels 20 and 40. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES20 for channel 20).

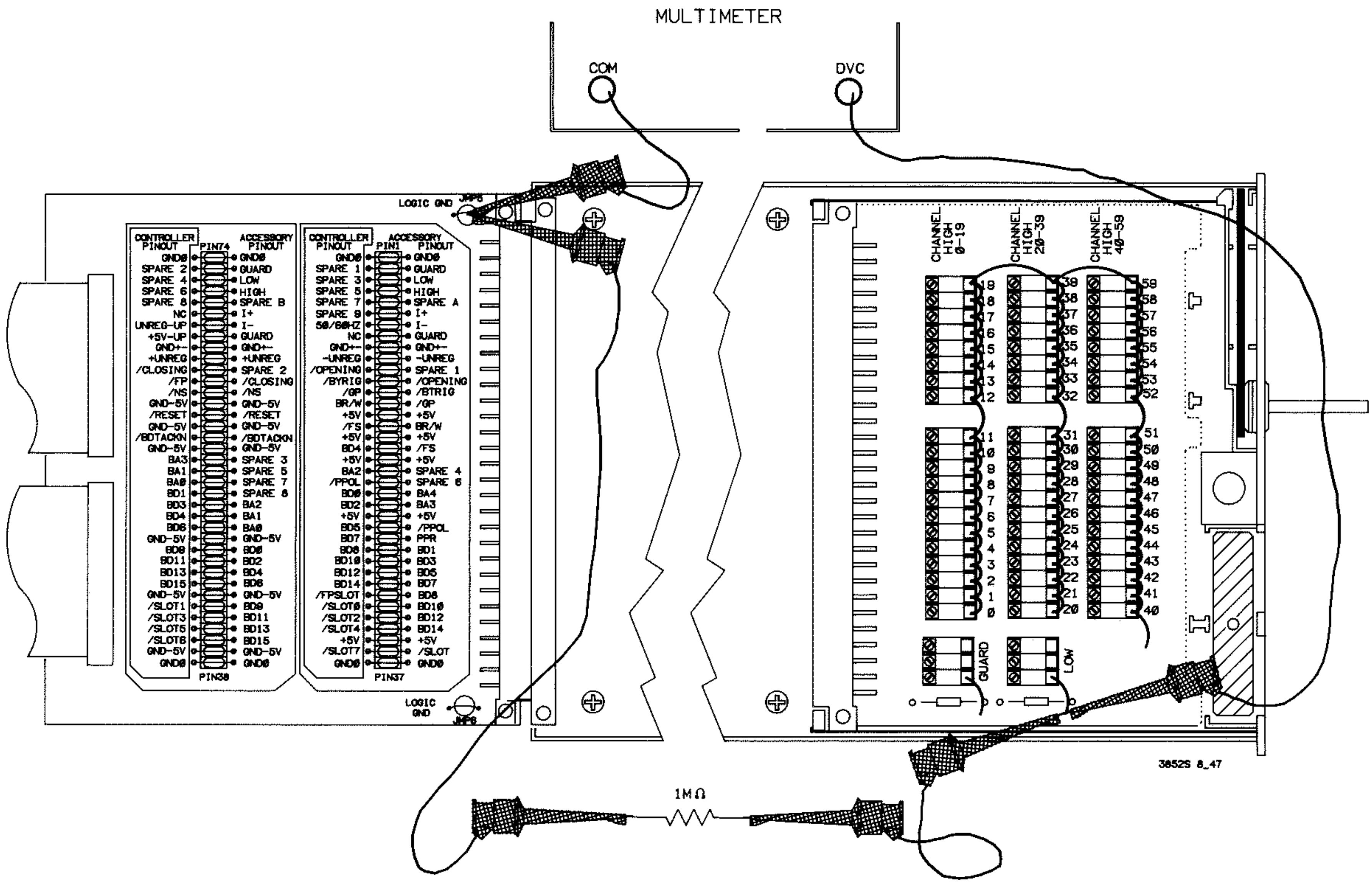


Figure 8-49 HP 44706A LOW Lines Injected Current

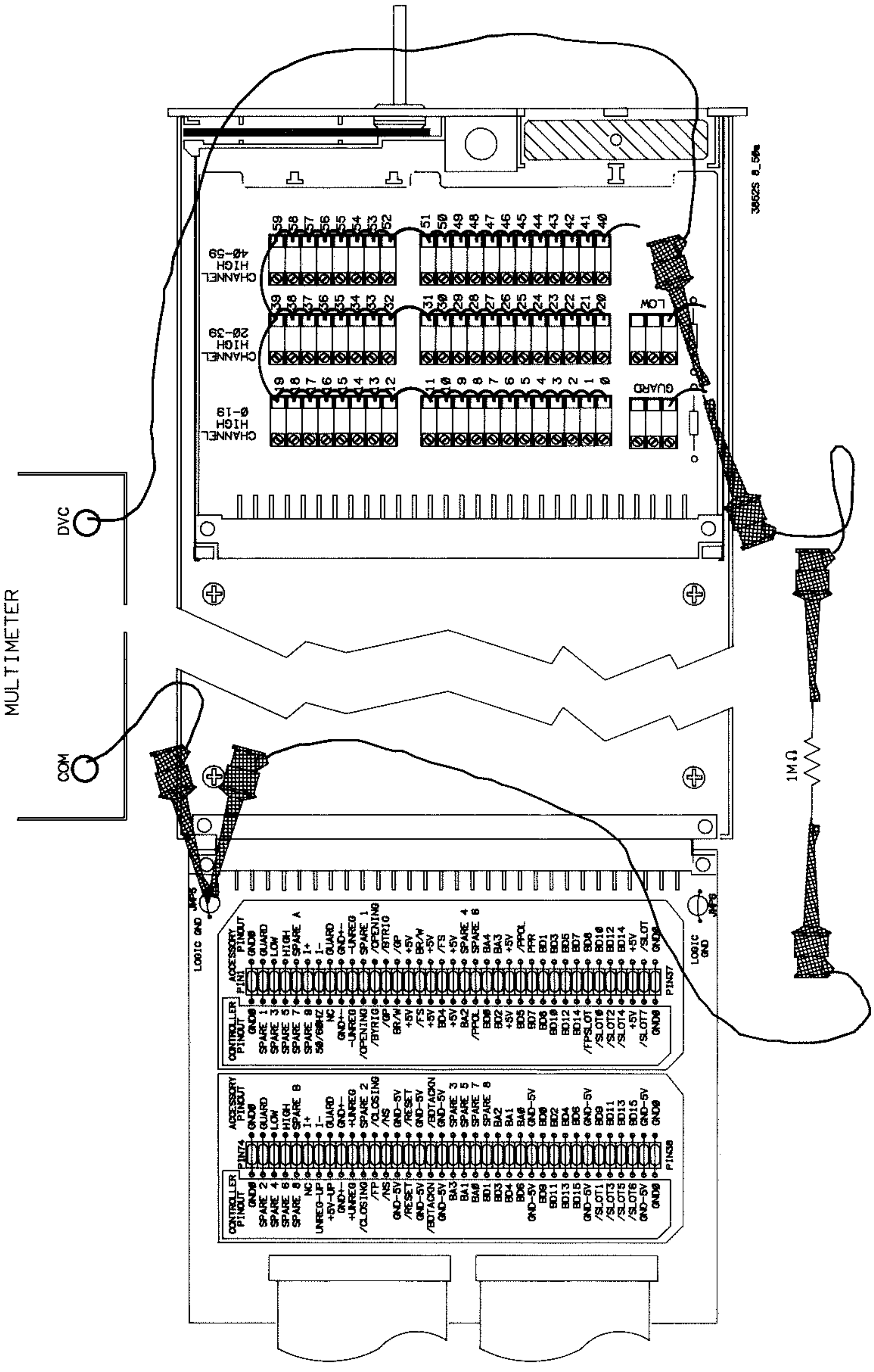


Figure 8-50 HP 44706A GUARD Lines Injected Current

8-47 RELAY TROUBLESHOOTING

This section describes troubleshooting the relay multiplexers. The troubleshooting procedures described here first determine if the problem is located in the relays or in the control logic. Individual relays may be replaced. If the problem is determined to be in the control logic, complete replacement of the printed circuit board is required.

The Operational Verification tests provide a starting point for problem isolation. Operational Verification tests for the HP 44705A/H and HP 44708A/H are described in Section 8-19. Operational Verification tests for the HP 44706A are described in Section 8-35.

A single failing channel indicates a failing channel relay. The tree switch operational verification tests will isolate a failing relay to within one or two tree relays. Table 8-5a and 8-5b are relay correspondence tables showing the relationship between channel numbers and relay numbers. Figure 8-51 shows the location of the relays on the printed circuit board.

CAUTION

To prevent equipment circuit damage always set the line power switch to off before removing or replacing any assembly. To prevent static zap of ICs always observe anti-static handling techniques when assemblies are handled or stored.

Table 8-5a HP 44705A and HP 44708A Relay Correspondance Table

Bank A		Bank B		Tree Relays	
Ch 00	K0	Ch 10	K10	Ch 91	K20
Ch 01	K1	Ch 11	K11	Ch 92	K21
Ch 02	K2	Ch 12	K12	Ch 93	K22
Ch 03	K3	Ch 13	K13	Ch 94	K23
Ch 04	K4	Ch 14	K14		
Ch 05	K5	Ch 15	K15		
Ch 06	K6	Ch 16	K16		
Ch 07	K7	Ch 17	K17		
Ch 08	K8	Ch 18	K18		
Ch 09	K9	Ch 19	K19		

Table 8-5b HP 44706A Relay Correspondance Table

Bank A		Bank B		Tree Relays	
Ch 00,20,40	K0	Ch 10,30,50	K10	Ch 40...59	K20
Ch 01,21,41	K1	Ch 11,31,51	K11	Ch 20...39	K21
Ch 02,22,42	K2	Ch 12,32,52	K12	Ch 00...19	K22
Ch 03,23,43	K3	Ch 13,33,53	K13	Ch 91	K23
Ch 04,24,44	K4	Ch 14,34,54	K14		
Ch 05,25,45	K5	Ch 15,35,55	K15		
Ch 06,26,46	K6	Ch 16,36,56	K16		
Ch 07,27,47	K7	Ch 17,37,57	K17		
Ch 08,28,48	K8	Ch 18,38,58	K18		
Ch 09,29,49	K9	Ch 19,39,59	K19		

8-48 Control Logic Problem Isolation

The following control logic test writes relay closing patterns to the relay multiplexer and then checks for an indication of the relay state in the relay status register (Read Register 2). Electrically, this test checks that the correct relay drive lines were enabled. It does not actually check the drive lines. The test does provide an indication that the control logic is performing as required and can communicate with the HP 3852A local controller.

CAUTION

Do not perform any of the following tests and troubleshooting procedures with any external connections made to the terminal module, or damage to the external connections/circuits may result.

NOTE

If using an HP 9000 Series 200 or Series 300 computer to perform this test, it may be necessary to program a delay between the SWRITE and SREAD commands (steps 1, 2, 4, 5, 7 and 8) to allow time for the relay states to be latched into the status register.

1. CONTROL LOGIC TEST: Reset the multiplexer by executing:

   RESET ES00 (E = extender number, S= slot number)

2. Read the relay status register by executing:

   SREAD ES00,2 (where E = extender number, S = slot number)

3. Verify that the 3852A right display shows:

   204

If the display shows 204 (all channels open), the multiplexer has been reset. Proceed to Step 4. If a number other than 204 is displayed, cycle power to the HP 3852A and perform steps 2 and 3 again. If the number is still incorrect, a problem exists with the relay multiplexer control logic or with the HP 3852A. If the HP 3852A seems to operate normally (see Chapter 5 for HP 3852A problem isolation) the problem most likely exists in the relay multiplexer control logic.

4. Send the first pattern to the multiplexer by executing:

   SWRITE ES00,6,31402 (where E = extender number, S = slot number)

5. Read the relay status register by executing:

   SREAD ES00,2 (where E = extender number, S = slot number)

6. Verify that the HP 3852A right display shows:

   2730

7. Send the second pattern to the multiplexer by executing:

   SWRITE ES00,6,30037 (where E = extender number, S = slot number)

8. Read the relay status register by executing:

   SREAD ES00,2 (where E = extender number, S = slot number)

9. Verify that the HP 3852A right display shows:

   1365

10. Reset the multiplexer by executing:

    RESET ES00 (E = extender number, S= slot number)

CAUTION

This procedure sets illegal and potentially damaging states on the relay multiplexer. Be sure to execute the RESET command in Step 10 to clear these states.

If the control logic test passed and a relay is not closing or opening, relay replacement is indicated. Figure 8-51 shows the locations of the relays on the multiplexer printed circuit board. Figures 8-52 and 8-53 are schematics of the relay multiplexers. Also shown in the figures is a package outline and pinout diagram of the type of relay used. Since the control logic test is not able to check the actual relay drive lines, an additional test of the drive can be performed at the relay coil. The relays should have a steady state voltage across the coil of approximately 4.0 Vdc when closed. When open, the coil voltage should be less than 0.2 Vdc.

8-49 Stuck Relay Troubleshooting

When a relay contact is stuck in the closed position it cannot be isolated with the test fixture installed. The test fixture parallels all the relays together. However, the test fixture, or a terminal module, must be installed to allow the HP 3852A to normally communicate with the component module.

There are two ways to isolate the stuck relay. The first, and easiest means is to install a regular terminal module on the failing component module. Each channel of the multiplexer can then be checked with a multimeter by measuring between the channel terminal block and the common terminal block on the terminal module. Once the stuck channel is isolated, Tables 8-5a and 8-5b identifies the stuck relay.

The second means to isolate a stuck relay involves checking for the stuck contacts on the component module connector. This method is not recommended for general use. To use this method, the test fixture or a terminal module must be installed and the HP 3852A power applied. When the wake-up sequence has completed, the test fixture or terminal module is removed. Removing the module after the wake-up sequence will allow commands to be processed since the local controller only queries the slots for accessory identification after power-on or reset. Schematics of the relays and connector are in Figures 8-52 and 8-53.

Stuck tree relays are more difficult to isolate. The Operational Verification tests in this chapter always test at least two of the tree relays at a time. If the tree relay operational verification test indicates stuck tree relays, the control logic is probably at fault (since two relays would have to be stuck at once). The control logic test is given in Section 8-48.

It is recommended that the entire component module be replaced if the relays are at or near the relay maximum specified life cycle (shown in Table 8-4) and the relays are sticking or the contact resistance is out of specification.

8-50 REPLACEABLE PARTS

Figure 8-54 shows the mechanical breakdown of the HP 44705A/H, HP 44706A, and HP 44708A/H. This figure also provides assembly or disassembly information. The parts shown in Figure 8-54 are keyed to the parts list in Table 8-6.

To order a part listed in Table 8-6, quote the Hewlett-Packard part number, the check digit (abbreviated CD in Table 8-6), and the quantity desired. Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board for the relay multiplexers is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

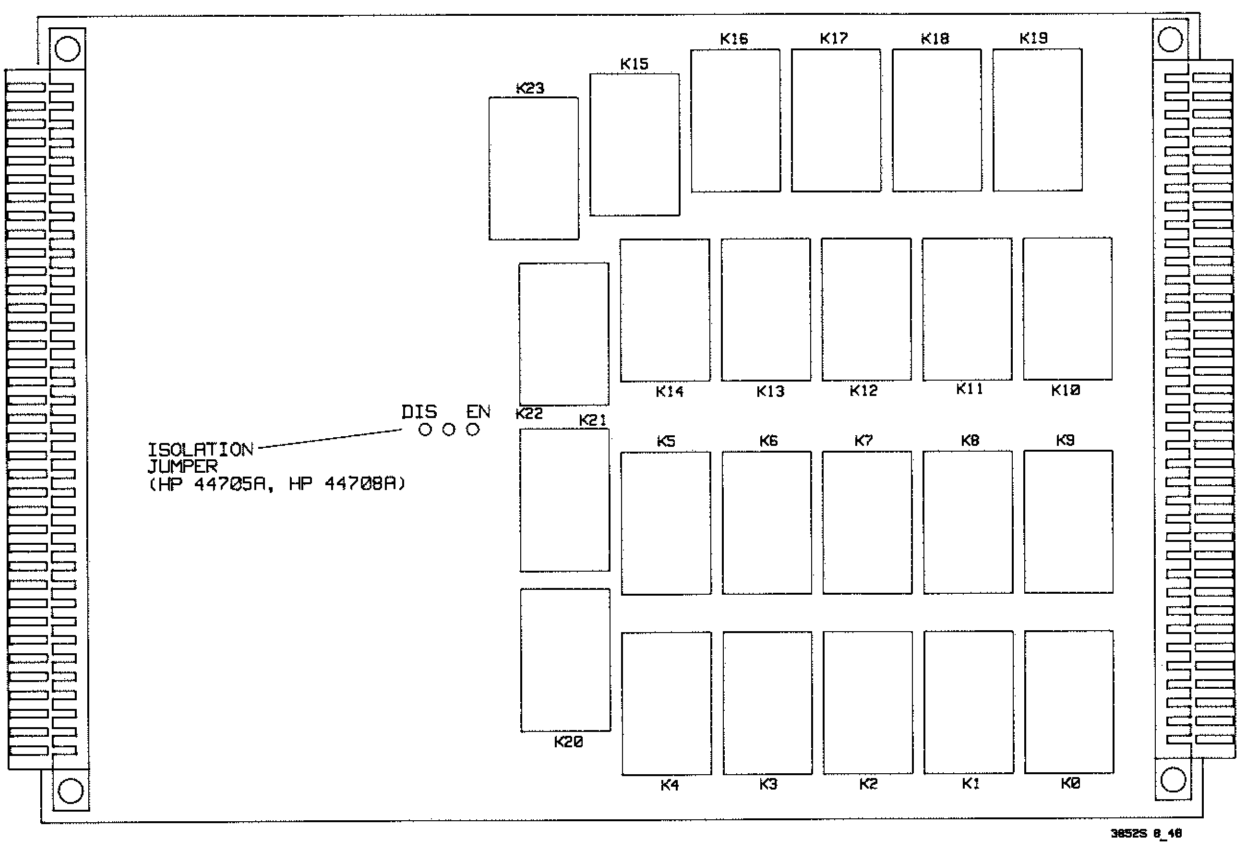
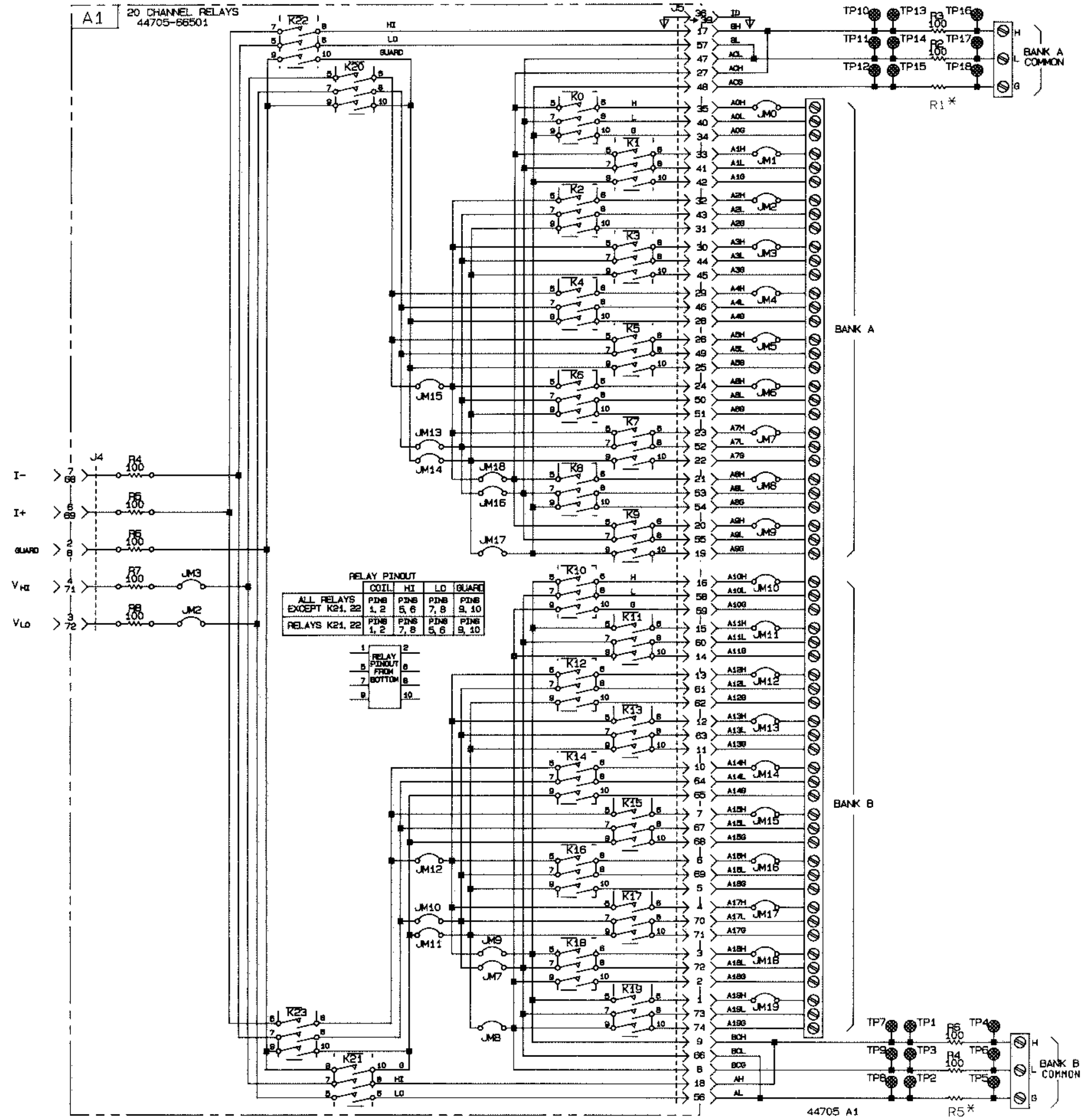


Figure 8-51 Relay Component Locator



* 1000 FOR HP 44705H/08H

Figure 8-52 20 Channel Mux Schematic

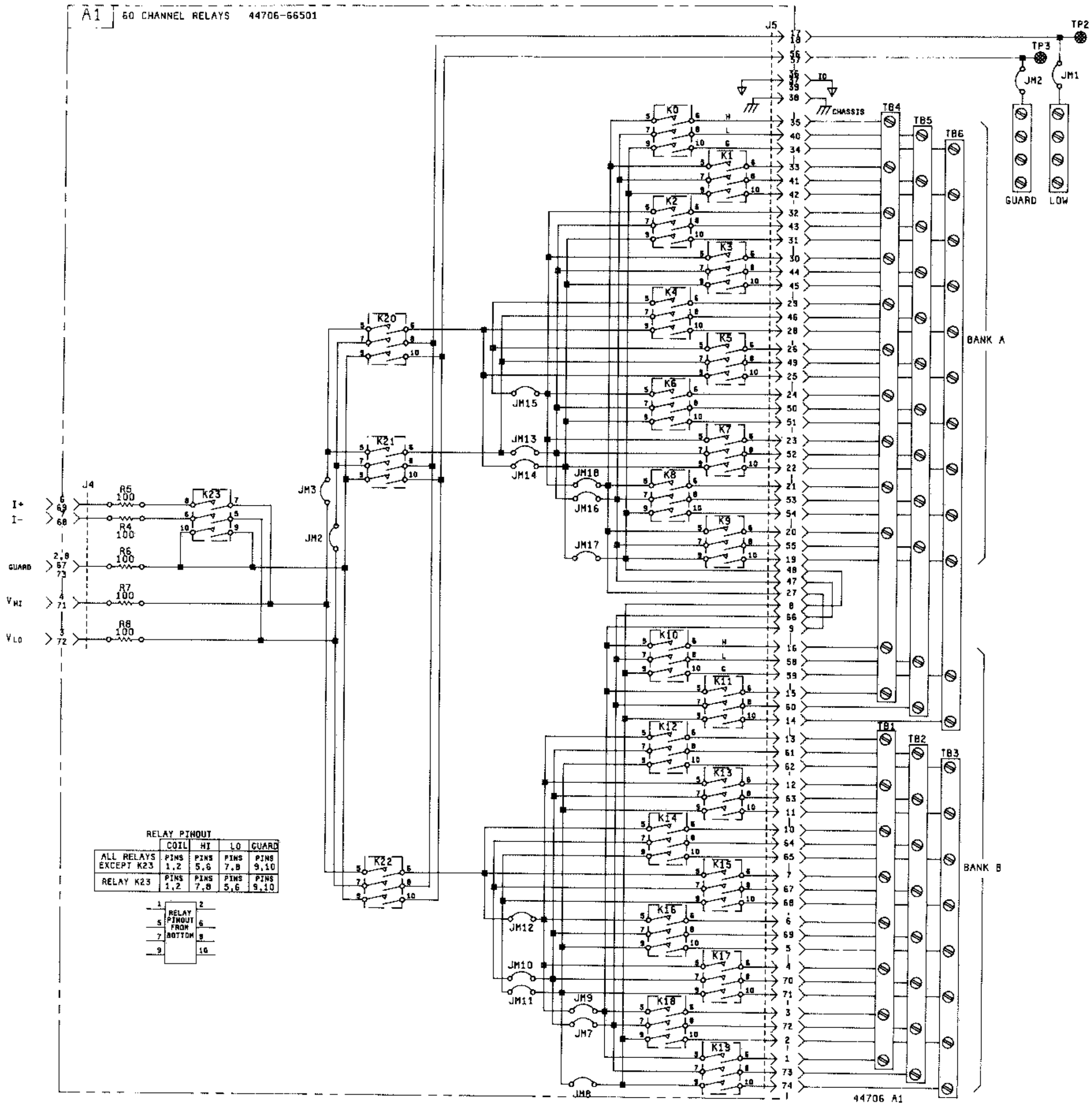


Figure 8-53 60 Channel Mux Schematic

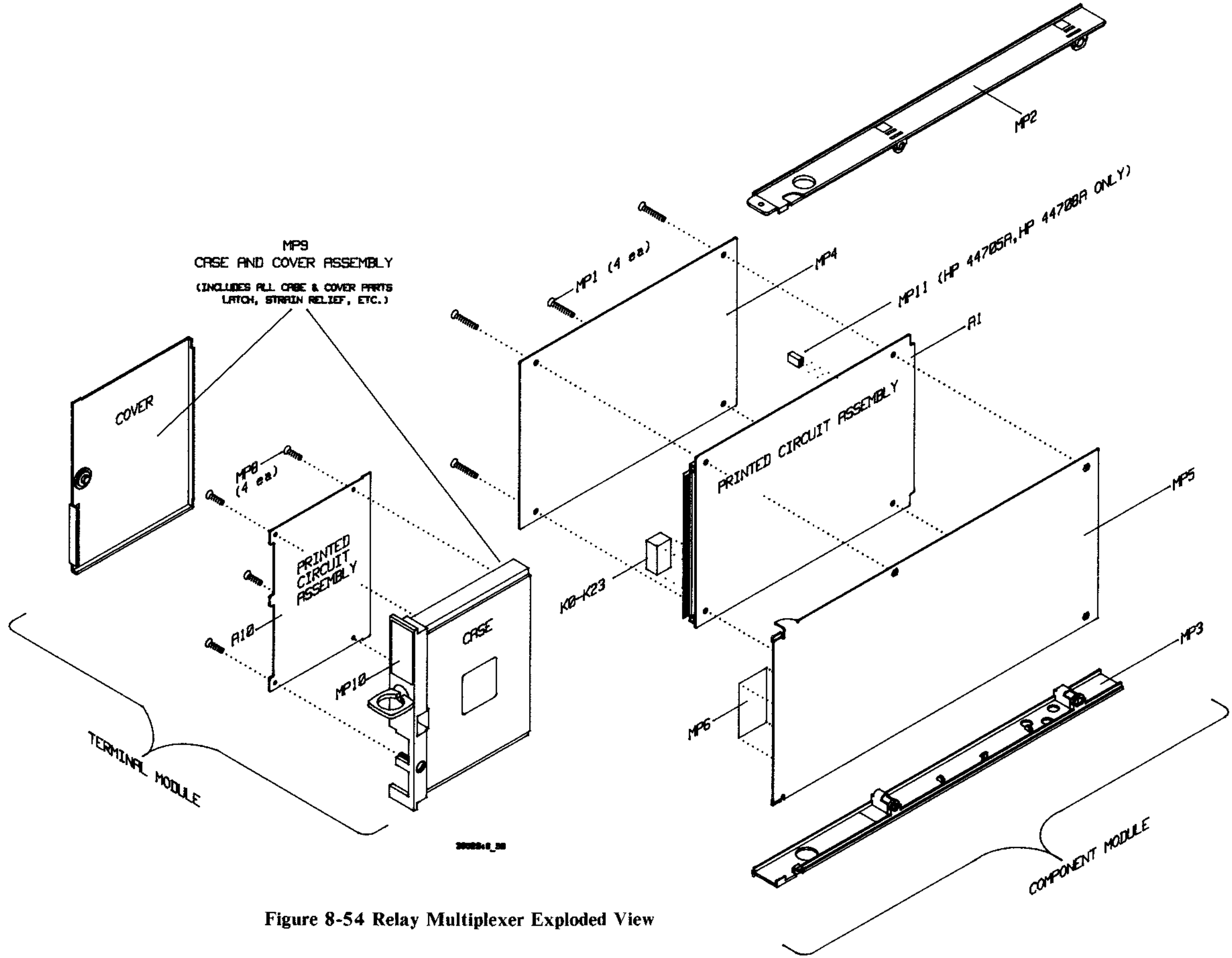


Figure 8-54 Relay Multiplexer Exploded View

Table 8-6a HP 44705A 20 Channel Relay Multiplexer

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44705A	Module; 20 chan relay mux component	1	44705-66201	1	MOD-20CH RLY MUX
A1	PCA; 20 channel relay mux component	1	44705-66501	4	PCA-20CH RLY MUX
A10	PCA; 20 channel mux terminal	1	44705-66510	5	PCA-20CH MX TERM
K0-K23	Relay; A1 PCA	24	0490-1576	6	RLY-RD FORM 3A
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44705/44708 component module	1	44705-84320	3	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44705A	1	44705-84325	8	LBL-ID,TERM ASSY
MP11	Jumper; removable, A1 PCA	1	1258-0141	8	JMPR-REM .025P

Completely assembled HP 44705A terminal modules can be ordered from your local HP Office by ordering Number 44705AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Table 8-6b HP 44705H 20 Channel High Voltage Relay Multiplexer

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44705H	Module; 20 chan relay HV mux component	1	44705-66202	2	MOD-20CH RLY HV
A4	PCA; 20 channel HV relay mux component	1	44705-66504	0	PCA-20CH RLY HV
A15	PCA; 20 channel HV mux terminal	1	44705-66515	5	PCA-20CH RLY/HV
K0-K23	Relay; A4 PCA	24	0490-1384	4	RLY-HV
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44705/44708 component module	1	44705-84321	4	LBL-I/O OPTS HV
MP7	(NOT USED)				
MP8	Screw; A15 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44705H	1	44705-84326	9	LBL-ID,TERM HV
MP11	Jumper; removable, A4 PCA	1	1258-0141	8	JMPR-REM .025P

Completely assembled HP 44705H terminal modules can be ordered from your local HP Office by ordering Number 44705HT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Table 8-6c HP 44706A 60 Channel Single Ended Relay Multiplexer

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44706A	Module; 60 ch se relay mux component	1	44706-66201	2	MOD-60CH SE RMUX
A1	PCA; 60 chan se relay mux component	1	44706-66501	5	PCA-60CH SE RMUX
A10	PCA; 60 chan single end mux terminal	1	44706-66510	6	PCA-60CH SE TERM
K0-23	Relay; A1 PCA	24	0490-1576	6	RLY-RD FORM 3A
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44706A component module	1	44706-84320	4	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel term module 44706A	1	44706-84325	9	LBL-ID,TERM ASSY

Completely assembled HP 44706A terminal modules can be ordered from your local HP Office by ordering Number 44706AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Table 5-6d HP 44708A 20 Channel Relay Multiplexer with TC

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44708A	Module; 20 chan relay mux component	1	44705-66201	1	MOD-20CH RLY MUX
A1	PCA; 20 channel relay mux component	1	44705-66501	4	PCA-20CH RLY MUX
A10	PCA; 20 chan mux term w/TC reference	1	44708-66510	8	PCA-20CH TERM/TC
K0-K23	Relay; A1 PCA	24	0490-1576	6	RLY-RD FORM 3A
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44705/44708 component module	1	44705-84320	3	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44708A	1	44708-84325	1	LBL-ID,TERM ASSY
MP11	Jumper; removable, A1 PCA	1	1258-0141	8	JMPR-REM.025P

Completely assembled HP 44708A terminal modules can be ordered from your local HP Office by ordering Number 44708AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Table 5-6e HP 44708A 20 Channel High Voltage Relay Multiplexer with TC

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44708H	Module; 20 chan HV relay mux component	1	44705-66202	2	MOD-20CH RLY HV
A4	PCA; 20 channel HV relay mux component	1	44705-66504	7	PCA-20CH RLY HV
A15	PCA; 20 chan HV mux term w/TC reference	1	44708-66515	3	PCA-20CH RLY/HV
K0-K23	Relay; A4 PCA	24	0490-1384	4	RLY-RD HV
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44705/44708 component module	1	44705-84321	4	LBL-I/O OPTS HV
MP7	(NOT USED)				
MP8	Screw; A15 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44708H	1	44708-84326	2	LBL-ID,TERM HV
MP11	Jumper; removable, A4 PCA	1	1258-0141	8	JMPR-REM.025P

Completely assembled HP 44708H terminal modules can be ordered from your local HP Office by ordering Number 44708HT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Table 8-6f HP 44717A 10 Bridge 120 ohm Strain Gage Multiplexer

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44717A	Module; 20 chan relay mux component	1	44705-66201	1	MOD-20CH RLY MUX
A1	PCA; 20 channel relay mux component	1	44705-66501	4	PCA-20CH RLY MUX
A10	PCA; 10 chan 120 ohm str. gage term	1	44717-66510	9	PCA-10CH 120 OHM
K0-K23	Relay; A1 PCA	24	0490-1576	6	RLY-RD FORM 3A
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44705/44708/44717/44718 mod	1	44705-84320	3	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44717A	1	44717-84325	2	LBL-ID,TERM ASSY
MP11	Jumper; removable, A1 PCA	1	1258-0141	8	JMPR-REM .025P

Completely assembled HP 44717A terminal modules can be ordered from your local HP Office by ordering Number 44717AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Table 8-6g HP 44718A 10 Bridge 350 ohm Strain Gage Multiplexer

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44718A	Module; 20 chan relay mux component	1	44705-66201	1	MOD-20CH RLY MUX
A1	PCA; 20 channel relay mux component	1	44705-66501	4	PCA-20CH RLY MUX
A10	PCA; 10 chan 350 ohm str. gage term	1	44718-66510	0	PCA-10CH 350 OHM
K0-K23	Relay; A1 PCA	24	0490-1576	6	RLY-RD FORM 3A
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44705/44708/44717/44718 mod	1	44705-84320	3	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44718A	1	44718-84325	3	LBL-ID,TERM ASSY
MP11	Jumper; removable, A1 PCA	1	1258-0141	8	JMPR-REM .025P

Completely assembled HP 44718A terminal modules can be ordered from your local HP Office by ordering Number 44718AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Chapter 9
HP 44709A/10A/19A/20A FET
Multiplexers/Strain Gages

CHAPTER 9
HP 44709A/44710A FET MULTIPLEXERS
HP 44719A/44720A STRAIN GAGES

CHAPTER 9

HP 44709A/44710A FET MULTIPLEXERS HP 44719A/44720A STRAIN GAGES

9-1 INTRODUCTION

This chapter provides a technical description, performance test procedures, and replaceable parts lists for the HP 44709A 20 Channel FET Multiplexer and the HP 44710A 20 Channel FET Multiplexer with Thermocouple Compensation. This chapter also has a technical description and replaceable parts list for the HP 44719A 10 Bridge 120Ω Static Strain Gage FET Multiplexer and the HP 44720A 10 Bridge 350Ω Static Strain FET Multiplexer Accessories.

NOTE

The Strain Gage accessories can only be used with instruments having a firmware revision of 2.0 or above. Determine the firmware revision by sending the "IDN?" command.

9-2 HP 44709A and HP 44710A Technical Description

The HP 44709A and HP 44710A have two main assemblies: a component module and a terminal module. The component module contains the backplane interface electronics, FET control logic, an isolation relay, and the FET switches. The same printed circuit board is used in both the HP 44709A and the HP 44710A component modules.

The HP 44709A and the HP 44710A are made unique by the addition of the terminal module. The terminal module for the HP 44709A contains terminal strips for connecting external wiring and provides mounting holes for user installed components such as: one pole low pass filters, voltage dividers, and current shunt resistors. The terminal module for the HP 44710A contains terminal strips for connecting external wiring, a thermocouple mounted in a thermal block, and provides mounting holes for user installed components. The printed circuit board used in the HP 44709AT terminal module is the same as that used in the HP 44705AT terminal module. The printed circuit board used in the HP 44710AT terminal module is the same as that used in the HP 44708AT terminal module.

Figures 9-1 and 9-2 show a simplified schematic for the HP 44709A and the HP 44710A. In the component module the FETs are electrically arranged into channel and tree switches. The channel FETs are further divided into two groups of ten channels. These groups are referred to as Bank A and Bank B. On the HP 44709A terminal module, each bank has its own set of common terminals. The HP 44710A terminal module only provides one set of common terminals for all channels.

Each channel FET switch is in a common package and switches both HIGH and LOW. A separate FET switch package is used for GUARD. HIGH and LOW are connected to the isolation relays through the source and sense bus FET switches. GUARD is routed directly to the isolation relays.

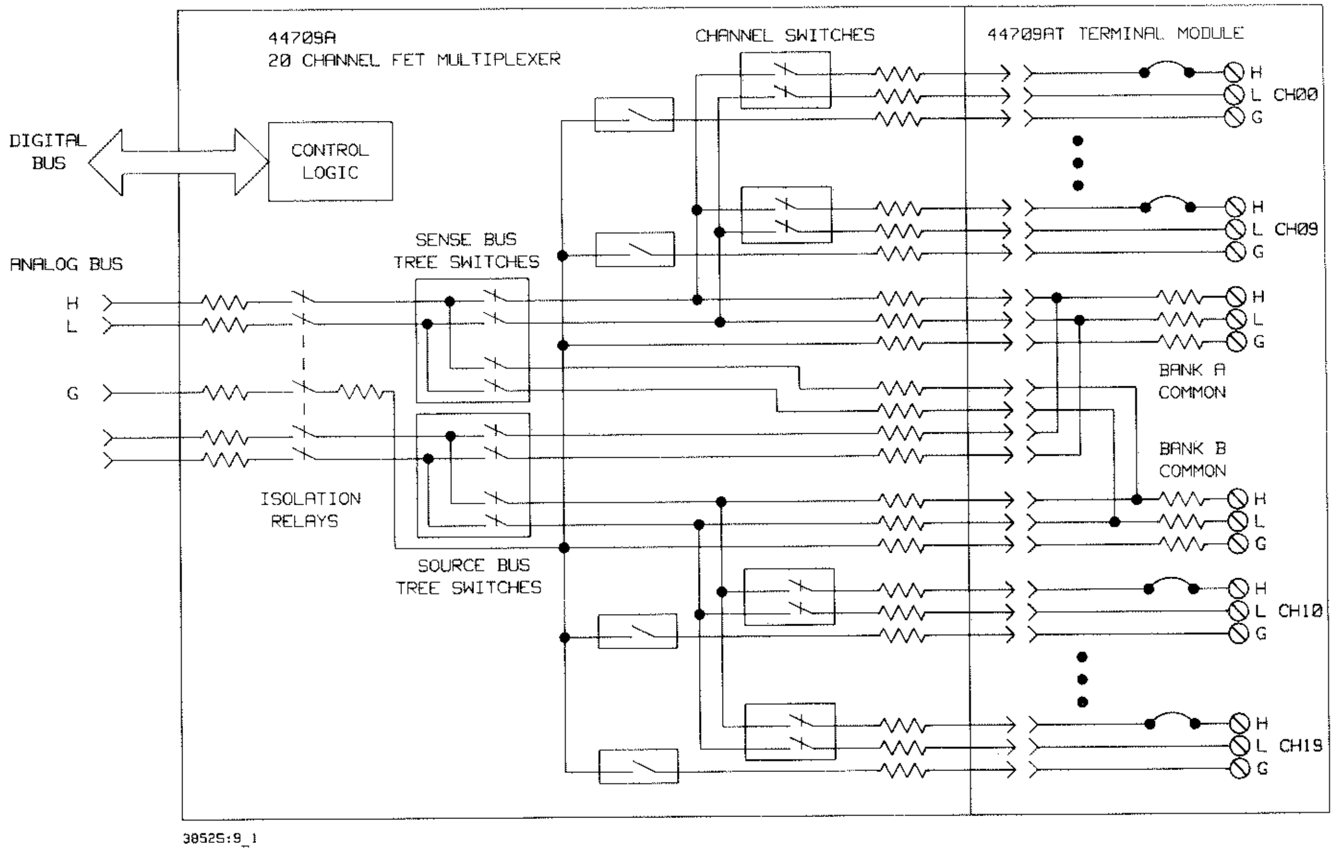


Figure 9-1 HP 44709A Simplified Schematic

The tree FET switches are controlled independently of the channel switches. There are four tree switches: two connected to the backplane analog sense bus and two connected to the backplane analog source bus. The tree switches allow the multiplexer channels to be connected to the backplane analog bus. The backplane analog bus can be used for measurements by either of the accessory plug-in voltmeters (HP 44701A or HP 44702A/B). The sense bus is used for voltage measurements. The source bus provides a current source (generated by either the HP 44701A or HP 44702A/B) for resistance measurements. In the high level commands the tree switches are controlled by giving them channel numbers. The switches have channel numbers 91, 92, 93, and 94. Channels 91 and 92 are the sense bus tree switches and channels 93 and 94 are the source bus tree switches.

On the HP 44709A, four-wire ohms measurements can be made by pairing a channel in Bank A with a channel in Bank B. One of the paired channels provides the current source from the backplane analog source bus and the other channel provides a voltage measurement path through the backplane analog sense bus. Two-wire ohms measurements can also be made by combining the current source bus and the sense bus at the channel switch. The HP 44710A can only support two-wire ohms measurements since two of the tree switches are dedicated to the measurement of the thermistor on the terminal module. In two-wire ohms, the current source bus and the sense bus are combined at the channel FET switch.

Isolation relays are provided on the HP44709A/44710A. These relays allow the FET multiplexer to be completely isolated from the backplane analog bus. The state of these relays are controlled by assigning them channel number 90. Once the isolation relays have been closed, they will remain closed until specifically instructed to open or a reset occurs. The isolation relays can be opened to reduce the leakage current on the backplane analog bus for critical measurements. Also, since the backplane analog sense bus can have up to 42 V peak (with an HP 44709A or HP 44710A installed), the isolation relays provide protection for the FET switches. If, for example, an application requires that the backplane analog sense bus voltage is greater than 12 V peak, the isolation relays should be opened to prevent damage to the FET switches. In addition, the FETs are protected from voltages above 15 Vdc by the overvoltage protection circuit on the multiplexer assembly (the input impedance to the FETs, however, decreases above 12 V peak). The overvoltage protection circuit automatically opens the isolation relays, if the backplane analog bus voltage exceeds 15 Vdc.

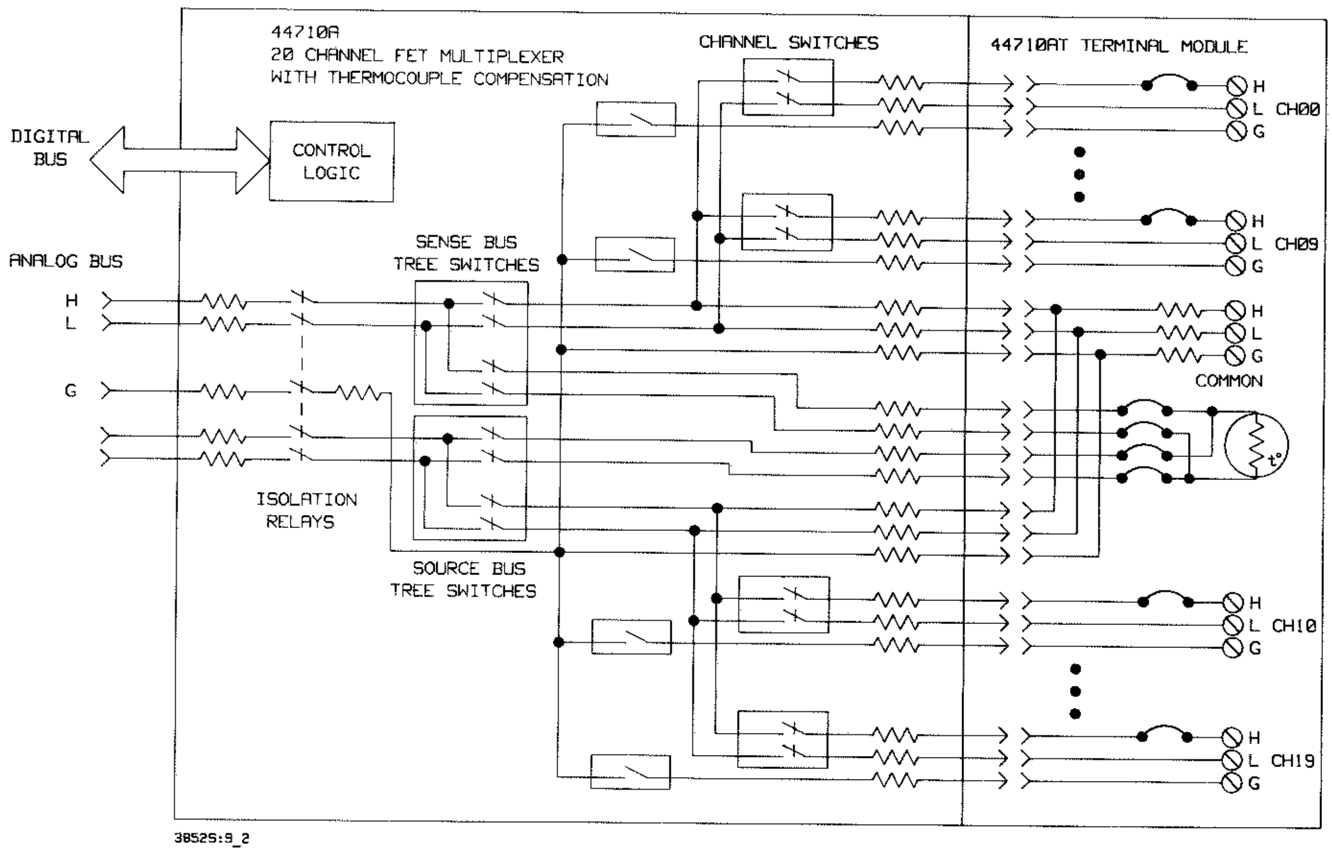


Figure 9-2 HP 44710A Simplified Schematic

9-3 HP 44719A and HP 44720A Technical Description

The HP 44719A and HP 44720A Strain Gages modules work in conjunction with HP 44709A 20 Channel FET Multiplexer Assemblies to make strain gage measurements (see Section 9-2 for a description of the multiplexer assembly). The HP 44719A is used for 120Ω strain gage measurements and the HP 44720A is used for 350Ω measurements. The modules contain terminal strips for making external connections for quarter, half, and/or full bridge configurations.

Figure 9-3 shows a simplified schematic of the HP 44719A and 44720A strain gage modules and also shows the different strain gage configurations. The actual strain gage measurements are made through the 20 Channel FET Multiplexer using either the HP 44701A 5 1/2 Digit Integrating Voltmeter, the HP 44702A/B 13 Bit High Speed Voltmeter, or an external voltmeter. Only 10 channels of the multiplexer are used for strain gage measurements. The other 10 channels are used to measure the external bridge exitation voltage, shunt verification, gage isolation, internal half bridge voltage, guard voltage, and leadwire resistance. These channels only check the external connections to the strain gage module, and not the operation of the strain gage module itself.

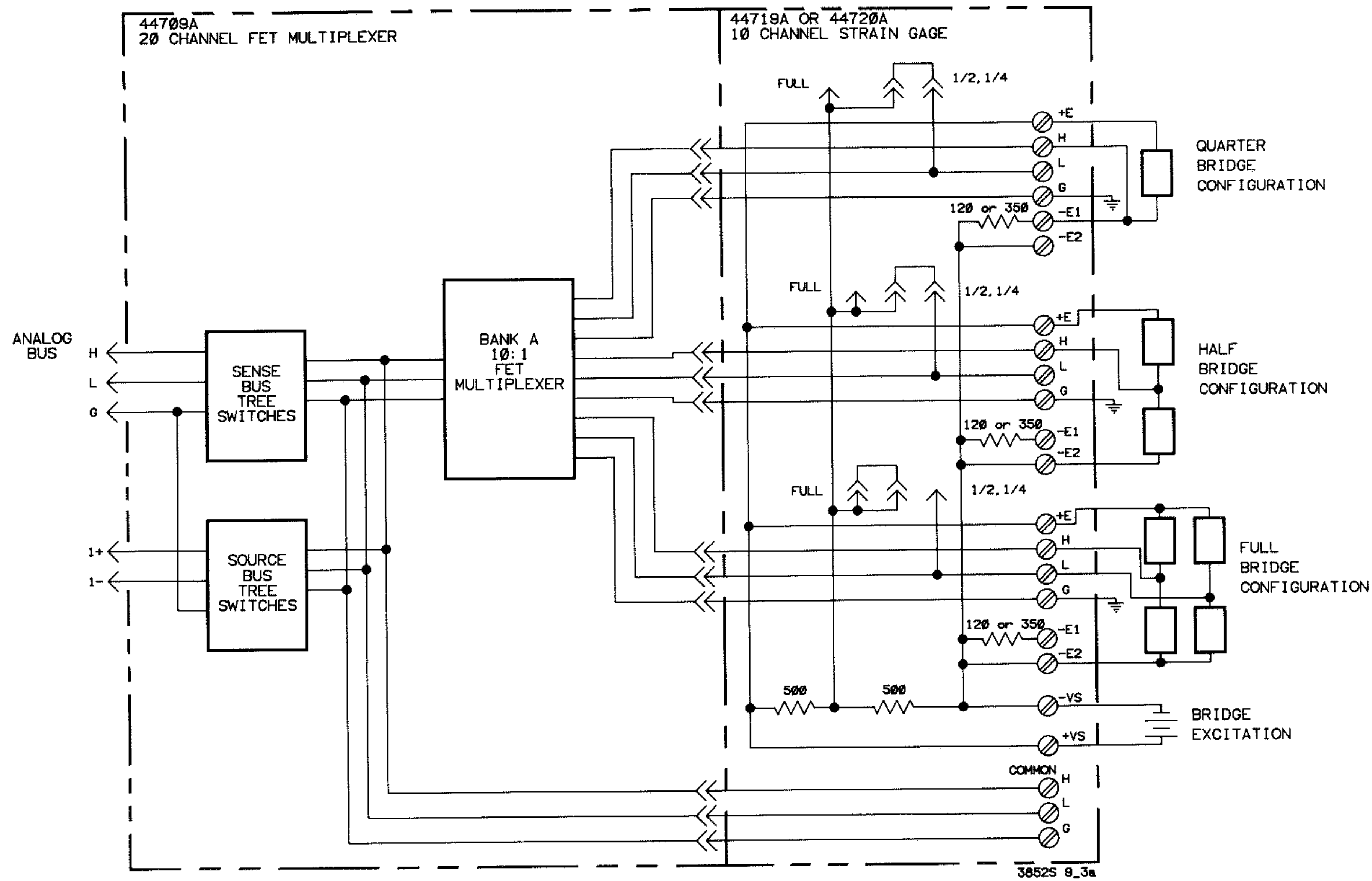


Figure 9-3 HP 44719A/44720A Simplified Schematic

9-4 Read and Write Registers

The HP 3852A local controller communicates with each plug-in accessory by using read and write registers. High level commands are translated into appropriate register commands. The SREAD and SWRITE commands can be used to directly control each register.

SREAD and SWRITE are described in Chapter 2 of this manual. Table 9-1 shows the registers used by the HP 44709A and HP 44710A.

CAUTION

Using the primitive commands (SREAD and SWRITE) may cause unexpected and undesirable effects on the plug-in accessories. It is possible to program some plug-in accessories into illegal and potentially damaging states with these commands. The commands are documented here for service purposes only.

Table 9-1 FET Multiplexer Read and Write Registers

Register #	READ Registers	WRITE Registers
0	Accessory Identification	Accessory Reset
1	Accessory Status	Not Used
2	FET Switch Status	Not Used
3	Not Used	FET Opening
4	Not Used	Isolation Relay Opening
5	Not Used	Isolation Relay Closing
6	Not Used	FET Closing
7	Not Used	Not Used

9-5 Read Registers

9-6 Read Register 0. Read Register 0 contains the accessory identification. Eight bits are used to uniquely identify the accessory. The eight bits are output on the lower eight bits of the backplane data lines. The upper eight bits of the backplane data bus are passively set true when register 0 is read.

The eight bit identification is in two parts. The five most significant bits identify the component module and the least three significant bits identify the type of terminal module installed. If a terminal module is not present, the lower three bits are set high by the component module. The HP 3852A local controller can thus identify the type of plug-in accessory installed and determine if a terminal module is installed. If a terminal module is installed, the type of terminal module is also identified.

Table 9-2 lists the decimal-equivalent codes returned in response to an SREAD of register 0 for all combinations of the modules. This decimal code is the two's compliment.

Table 9-2 HP 44709A and HP 44710A Identification Codes

Module Combinations	Codes
HP 44709A Component Module (no terminal module installed)	-201
HP 44709A Component Module, HP 44709AT Terminal Module installed	-208
HP 44709A Component Module, HP 44710AT Terminal Module installed	-206
HP 44709A Component Module, HP 44719AT Terminal Module installed	-204
HP 44709A Component Module, HP 44720AT Terminal Module installed	-203

9-7 Register 1. Read Register 1 is the accessory status register. This register is used by the HP 3852A local controller to coordinate data and commands sent to the FET multiplexer.

9-8 Register 2. Read Register 2 is the FET switch status register. This register uses backplane data bits 0 through 11 to indicate the current status of each FET switch on the multiplexer. Figure 9-4 shows the status word.

```
   Bits:    15 14 13 12 | 11 10  9  8 | 7 6 5 4 | 3 2 1 0
Meaning:    X  X  X  X  |Tree Switches| Bank B  | Bank A
                          94 93 92 91
```

Figure 9-4 Read Register 2 FET Switch Status Word

In the status word, bits 12 through 15 are undefined and can return any value.

Bits 8 through 11 define the status of the tree switches (the tree switches are referred to as channels 91 through 94 in the high level commands). A set bit indicates that the switch is closed.

Bits 4 through 7 define the status of the Bank B switches and bits 0 through 3 define the status of the Bank A switches. A set bit indicates a closed switch. Valid codes for the bank switches range from 0000 to 1001. Code 1111 indicates that all switches are open in the bank. The four bits are decimally decoded into the closed channel number. For example, if bits 7, 6, 5, and 4 are 0011 respectively, it would indicate that channel 3 in Bank B is closed (channel 3 in Bank B is referred to as channel 13).

NOTE

The decimal number returned after the execution of an SREAD command represents the two's compliment of the status word.

9-9 Write Registers

9-10 Register 0. Write Register 0 is the accessory reset register. Any data written to this register will cause a reset of all FET switches (set open) and stop opening and closing coordination on the backplane. A write to register 0 produces the same results as a system reset (backplane reset).

9-11 Register 3. Write Register 3 is the opening register. Writing a command word to register 3 will cause the OPENING pulse to be asserted on the backplane and will execute the FET switch openings indicated in the command word. The command word is described in Section 9-15.

9-12 Register 4. Write Register 4 is the isolation relays opening register. Any data written to this register will cause the isolation relays to open and the OPENING pulse be asserted on the backplane.

9-13 Register 5. Write Register 5 is the isolation relays closing register. Any data written to this register will cause the isolation relays to begin closing. The closing is controlled by the backplane OPENING line so that the break-before-make switching is assured. When the relays are closing the backplane CLOSING line is pulsed to indicate the closure to the HP 3852A local controller.

9-14 Register 6. Write Register 6 is the FET closing register. Writing a command word to register 6 will cause the CLOSING pulse to be asserted on the backplane and will execute the FET switch closures indicated in the command word. The command word is described in Section 9-15.

9-15 Command Word

The command word uses 15 bits. The bits are arranged into mask bits, tree switch bits, Bank A switch bits and Bank B switch bits. Figure 9-5 represents the command word. The command word is used for both opening and closing the switches. The opening or closing function is determined by the register number receiving the command word.

```
Bits:       15 14 13 12 | 11 10  9  8 | 7 6 5 4 | 3 2 1 0
Meaning:    I  T  B  A  | Tree Switch | Bank B  | Bank A
              (mask)
```

Figure 9-5 Command Word

The mask bits in the command word determine which set of switches will be operated upon. Bit 15 controls the channel 90 isolation relays. Setting this bit in the command word will close the isolation relays. Bit 14 sets the tree switch mask, bit 13 the Bank B switch mask, and bit 12 the Bank A switch mask. When the mask bit is set, the corresponding four bits of the command word are used to control the switches. More than one mask bit can be set at a time.

The Tree Switch bits have the following correspondence: Bit 11 sets channel 94 tree switch (source bus), Bit 10 sets channel 93 tree switch (source bus), bit 9 sets channel 92 tree switch (sense bus), and Bit 8 sets channel 91 tree switch (sense bus).

The Bank A and Bank B bits can be decoded as a decimal number corresponding to the channel number. Each set of four bits is individually decoded (depending upon the mask bits set). Bank B bits are decimally decoded into channel numbers but are a decade ahead of the Bank A channel numbers (Bank A channel 00 corresponds to Bank B channel 10).

9-16 SPECIFICATIONS

Specifications for the HP 44709A and HP 44710A are given in Table 9-3. Specifications are the performance standards or limits against which the FET multiplexers may be tested.

NOTE

The installation of an HP 44709A or HP 44710A reduces the maximum backplane voltages to 42 V peak.

Table 9-3 HP 44709A/44710A/44719A/44720A Specifications

HP 44709A 20 Channel FET Multiplexer

Maximum Switch Rates: 5500 channels/second*

Maximum Input Voltage: Rear and back-plane inputs protected to 16 V peak (input impedance decreases above 12 V due to internal protection circuitry). With analog back-plane disconnected from multiplexer, the back-plane voltage can go up to 42 V peak.

Maximum Input Current: 1 mA non-inductive per channel

Input Impedance:

Impedance	Terminals		
	High to Low	Low to Guard	Guard to Chassis
Power On Resistance (Ω)	$>10^8$	$>10^8$	$>10^8$
Power Off Resistance (Ω) Vin 10 V	>1000	>1000	>1000
Power Off Resistance (Ω) Vin >10 V	>200	>200	>200
Max. Capacitance (pf) at 1MHz	200	200	200

Closed Channel Path Resistance: 3.1 kΩ for either High or Low Inputs considered separately
2.1 kΩ for the Guard Input

Bandwidth: 1.0% flatness at 20 kHz, -3 dB Bandwidth at 200 kHz (50 Ω source, 1 MΩ termination)

Crosstalk: -50 dB at 10 kHz, -35 dB at 100 kHz (channel-to-channel, 50 Ω source, 1 MΩ termination)

Maximum Offset Voltage: 15 µV at 0 to 28 °C
185 µV at 28 to 55 °C
(offset voltage between High and Low)

Maximum Bias Current: ±5 nA DC at 0 to 28 °C
±15 nA DC at 28 to 55 °C
(Current sourced by High or Low to Chassis into Input Terminals or back-plane, with isolation relays closed)

±65 nA DC at 0 to 28 °C
±770 nA DC at 28 to 55 °C
(Current sourced by Guard to Chassis into Input Terminals, with isolation relays closed)

Table 9-3 HP 44709A/44710A/44719A/44720A Specifications (Cont.)

±1 nA DC at 0 to 55 °C
(Current sourced by High or Low to Chassis into back-plane, with isolation relays open) (Current sourced by Guard to Chassis into back-plane with isolation relays open)

Maximum Wire Size: 16 AWG

HP 44710A 20 Channel FET Multiplexer with Thermocouple Compensation

Maximum Switch Rates: 5500 channels/second*

Maximum Input Voltage: Rear and back-plane inputs protected to 16 V peak (input impedance decreases above 12 V due to internal protection circuitry). With analog back-plane disconnected from multiplexer, the back-plane voltage can go up to 42 V peak.

Maximum Input Current: 1 mA non-inductive per channel

Input Impedance:

Impedance	Terminals		
	High to Low	Low to Guard	Guard to Chassis
Power On Resistance (Ω)	$>10^8$	$>10^8$	$>10^8$
Power Off Resistance (Ω) Vin 10 V	>1000	>1000	>1000
Power Off Resistance (Ω) Vin >10 V	>200	>200	>200
Max. Capacitance (pf) at 1MHz	200	200	200

Closed Channel Path Resistance: 3.1 kΩ for either High or Low Inputs considered separately
2.1 kΩ for the Guard Input

Bandwidth: 1.0% flatness at 20 kHz, -3 dB Bandwidth at 200 kHz (50 Ω source, 1 MΩ termination)

Crosstalk: -50 dB at 10 kHz, -35 dB at 100 kHz (channel-to-channel, 50 Ω source, 1 MΩ termination)

Maximum Offset Voltage: 15 µV at 0 to 28 °C
185 µV at 28 to 55 °C
(offset voltage between High and Low)

Maximum Bias Current: ±5 nA DC at 0 to 28 °C
±15 nA DC at 28 to 55 °C
(Current sourced by High or Low to Chassis into Input Terminals or back-plane, with isolation relays closed)

±65 nA DC at 0 to 28 °C
±770 nA DC at 28 to 55 °C
(Current sourced by Guard to Chassis into Input Terminals, with isolation relays closed)

±1 nA DC at 0 to 55 °C
(Current sourced by High or Low to Chassis into back-plane, with isolation relays open) (Current sourced by Guard to Chassis into back-plane with isolation relays open)

Maximum Wire Size: 16 AWG

Ref. Junction Compensation Accuracy: 0.1 °C (over 18 to 28 °C operating temperature)

Max Temperature Difference Across Isothermal Module: 0.2 °C

HP 44719A/44720A 10 Bridge Static Strain Gage Multiplexer*
(Use HP 44709A Specifications with these changes/additions)

Strain Gage Resolution:

Bridge Configuration	Bridge Excitation Voltage 5 V	1 V	0.1 V
Full	0.01 με	0.05 με	0.5 με
1/2	0.02 με	0.1 με	1 με
1/4	0.04 με	0.2 με	2 με

Bridge Exitation Requirements: An inexpensive power supply, such as an HP 6214B can be used for the following requirements

Current Requirements for Excitation Voltage (5.4 V maximum for specified accuracy):

Bridge Type	Bridge Configuration	Current per Channel
120 Ω	Full	50 mA
120 Ω	1/2	25 mA
120 Ω	1/4	25 mA
350 Ω	Full	17 mA
350 Ω	1/2	8.5 mA
350 Ω	1/4	8.5 mA

Ripple and Noise Requirements for Excitation Voltage:

1 mV peak-to-peak (20 Hz to 20 MHz)

Table 9-3 HP 44709A/44710A/44719A/44720A Specifications (Cont.)

Max Self-Heating Offset Due to Change in number of Gages on One Assembly:	2 $\mu\epsilon$ per Gage for 120 Ω, 1/4 Bridge Configuration, and 5 V Excitation Voltage (worst-case)
Max Self-Heating Offset Due to a 0.1 V Change in Excitation Voltage:	0.38 $\mu\epsilon$

*Applies to HP 3852As with firmware revision 2.0 or above.

9-17 HP 44709A AND HP 44710A PERFORMANCE TESTS

9-18 Introduction

The following Performance Tests check the operation of the HP 44709A and HP 44710A component module. Performance Tests are not given for the terminal modules. Successful completion of all tests in this chapter provides a high confidence level that the FET Multiplexer is meeting its listed specifications.

The Performance Tests should be performed in the order they are presented. The completion of each test increases the confidence level in FET Multiplexer operation. A minimum set of tests is given as Operational Verification Tests. These tests are described in Section 9-19.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence that the FET Multiplexer is operating normally, it is not recommended that all the Performance Tests be performed unless one of the tested specifications is in question.

9-19 Operational Verification

The first tests given in this section are the minimum set of tests recommended for the FET Multiplexer. These tests are designed to test the functionality and the on resistance of the FET switches. Successful completion of the Operational Verification Tests provides a 90% confidence level that the FET Multiplexer is operating normally and is within specification.

The Operational Verification Tests consist of the following:

Section 9-23 - Set-Up Procedure
Section 9-24 - Channel Switches Test
Section 9-25 - Tree Switch and Isolation Relay Test

9-20 Equipment Required

The following test equipment is required to run the Performance Tests. Only the first three items in the list are required for the Operational Verification Tests.

1. Test Fixture (as described in Section 9-21)
2. Digital Multimeter -- HP 3456A or equivalent
3. Test Leads and Jumpers
4. Service Module -- HP 44743A
5. Resistor -- 10 Mohm
6. Resistor -- 1 kohm
7. Oscilloscope -- HP 1740A or equivalent (dual trace with delayed sweep)
8. +10 V Power Supply -- HP 6234 or equivalent
9. -10 V Power Supply -- HP 6234 or equivalent

NOTE

Either of the accessory plug-in voltmeters (HP 44701A or HP 44702A/B) may be used for this test. This test does not describe the specific steps required to use the plug-in voltmeters. A description of the plug-in voltmeters can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

9-21 Test Fixture

A test fixture is required to run the Performance Tests. A schematic of the required test fixture is shown in Figure 9-6a. A test fixture can be manufactured using an HP 44705AT terminal module (it is the same as an HP 44709AT terminal module; see Figure 9-6b). Because wiring the test fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

If the test fixture is to be fabricated from other than an HP 44705AT or HP 44709AT terminal module, it is important that the terminal ID lines, shown in Figure 9-6a, be correctly wired. The HP 3852A local controller will not allow the execution of some commands with an incorrect terminal ID.

The test fixture consists of: a short circuit between all channel HIGH lines, a short circuit between all channel LOW lines, and a short circuit between all channel GUARD lines. The use of the test fixture minimizes the number of test lead connections required for the tests.

9-22 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

9-23 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the FET Multiplexer component module and install the test fixture. Note the slot number where the FET Multiplexer under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

   c. Verify that the HP 3852A right display shows:

      44709A

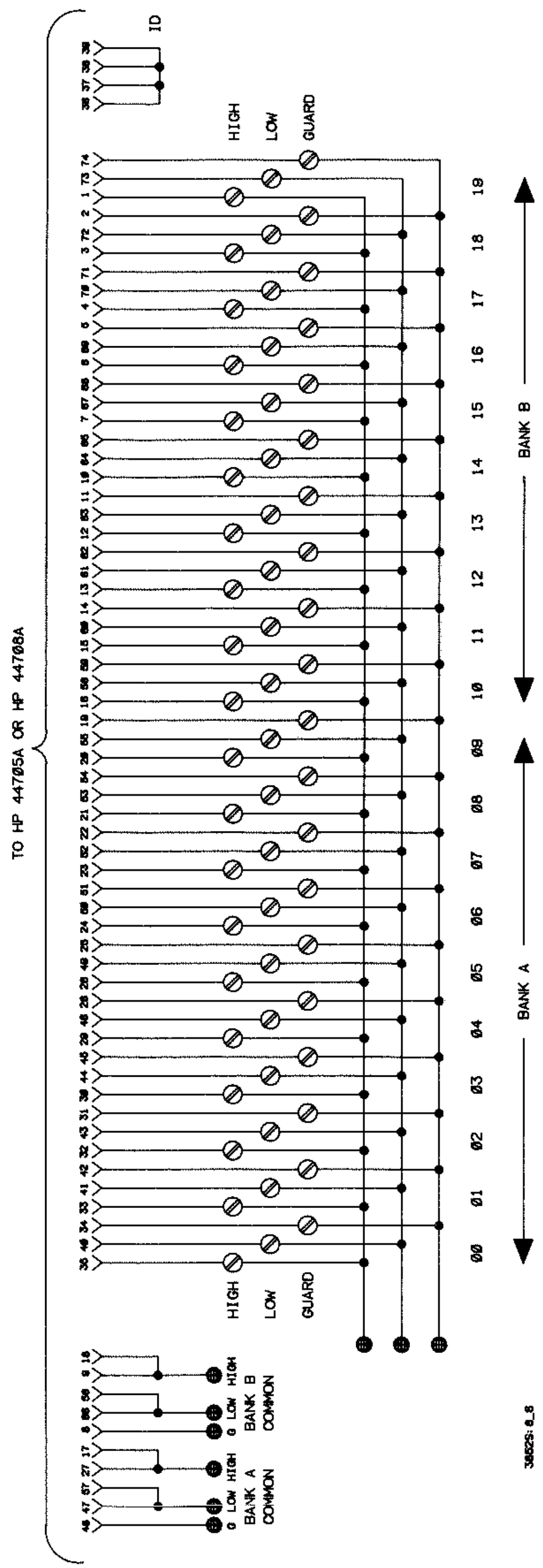


Figure 9-6a HP 44709A and HP 44710A Test Fixture Schematic

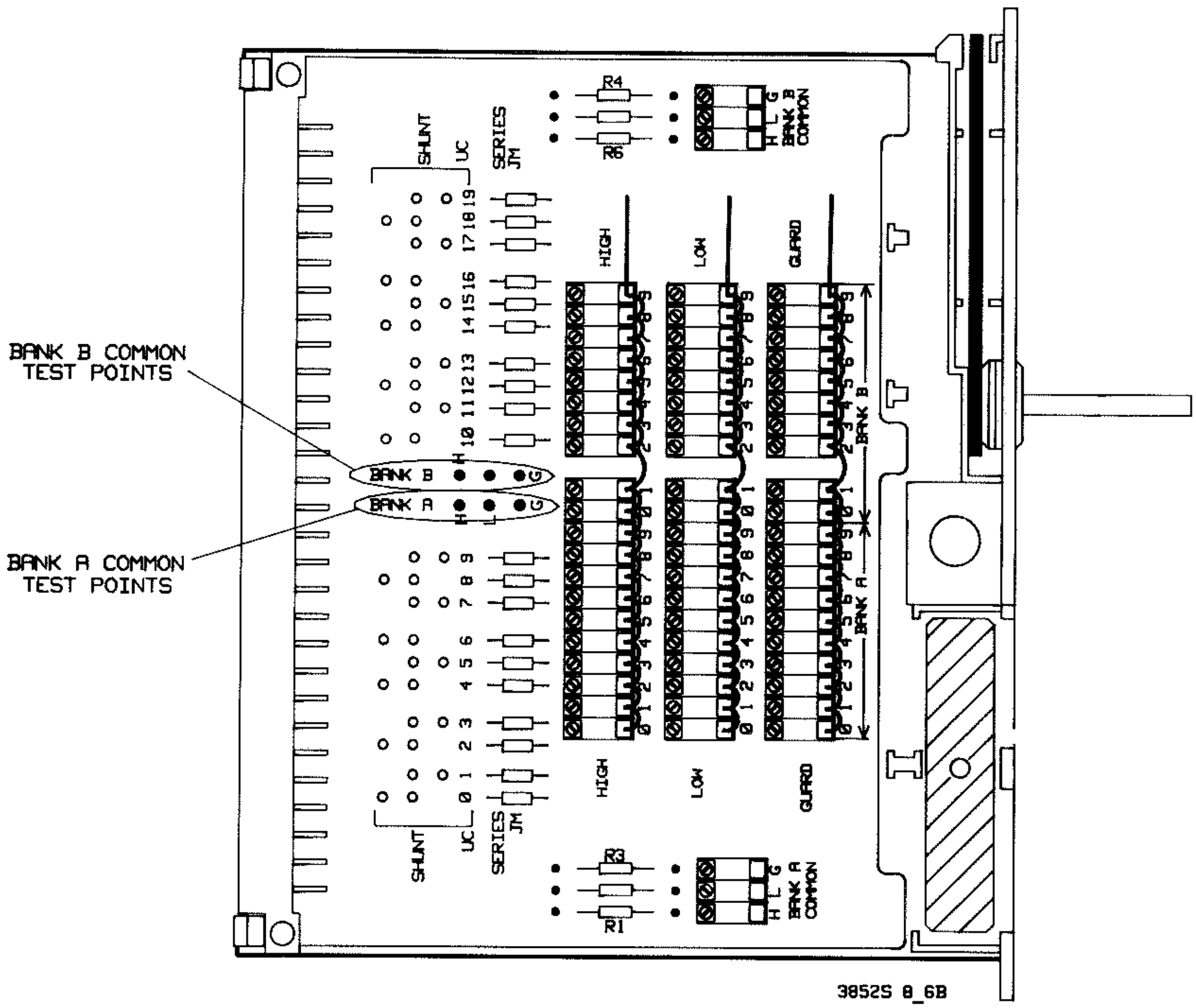


Figure 9-6b HP 44709A and HP 44710A Test Fixure

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

9-24 Channel Switches Test

This test checks the on resistance for the HIGH, LOW, and GUARD FET switches in both Banks A and B.

1. Set the HP 44709A to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

This opens all switches on the HP 44709A.

2. Refer to Figure 9-7. On the test fixture, connect the multimeter DCV lead to the Bank A HIGH common test point. Connect the multimeter COM lead to the shorted HIGH connections of the channels. Short the Bank A and Bank B HIGH common test points together. Set the multimeter to measure two-wire ohms.

3. Close the first channel by executing:

CLOSE ES00 (where E = extender number, S = slot number)

4. Observe the reading on the multimeter. The multimeter should indicate a resistance <1.6 kohms. If the reading is greater than 1.6 kohms, the channel FET switch may be faulty.

5. Open the channel by executing:

OPEN ES00 (where E = extender number, S = slot number)

6. Observe the reading on the multimeter. The multimeter should indicate a resistance greater than 100 Mohm. It is important to perform this step to ensure that none of the FET switches are stuck on or leaking.

7. Repeat steps 3, 4, 5, and 6 for channels 01 through 19. In the CLOSE and OPEN commands the last two digits indicate the channel number. For example, CLOSE ES01 closes channel 01 in extender E at slot S.

8. Refer to Figure 9-8. Connect the multimeter DCV lead to the Bank A LOW common test point on the test fixture. Connect the multimeter COM lead to the shorted LOW connections of the channels. Short the Bank A and Bank B LOW common test points together.

9. Repeat steps 3, 4, 5, 6, and 7. This checks the LOW path through the FET switches. Make sure the FET on resistance is <1.6 kohms and its off resistance is >100 Mohms as shown in steps 4 and 6, respectively.

10. Refer to Figure 9-9. Connect the multimeter DCV lead to the Bank A GUARD test point on the test fixture. Connect the multimeter COM lead to the shorted GUARD connections of the channels. Short the Bank A and Bank B GUARD common test points together.

11. Repeat steps 3, 4, 5, 6, and 7. This checks the GUARD contacts of the channel FET switches. The GUARD on resistance, measured in step 5, should be less than 2.1 kohms.

9-25 Tree Switch and Isolation Relay Test

1. SENSE BUS TREE SWITCH AND ISOLATION RELAY TEST: This test checks the measurement path from the backplane analog sense bus through the isolation relay and tree switches.

2. Connect a jumper between the Bank A common HIGH and Bank A common LOW connections on the test fixture.

3. Set the multimeter to measure two-wire ohms. Connect the multimeter test leads to the backplane analog bus sense HIGH and LOW lines.

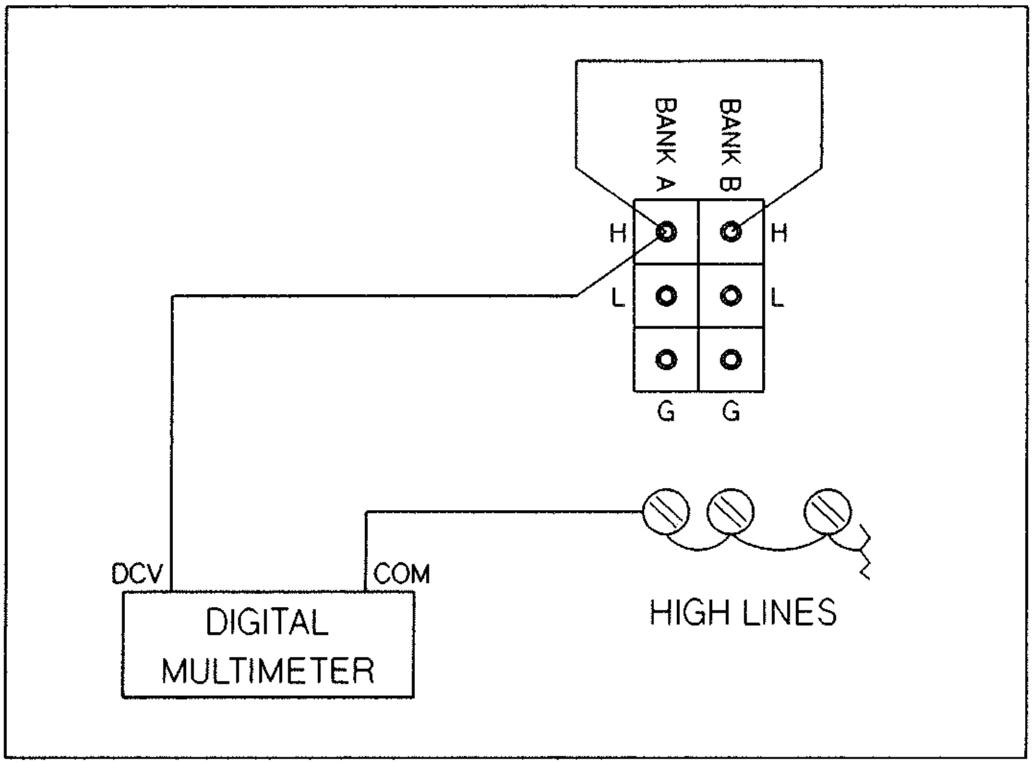


Figure 9-7 HP 44709A/44710A HIGH Channel Test Set-Up

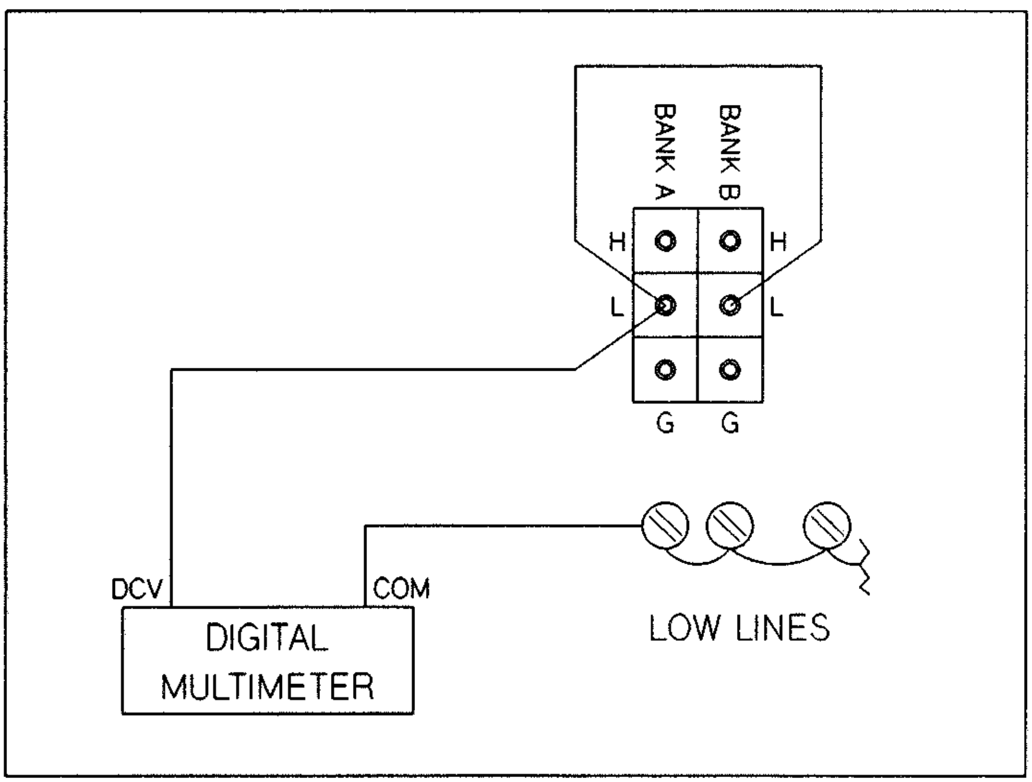


Figure 9-8 HP 44709A/44710A LOW Channel Test Set-Up

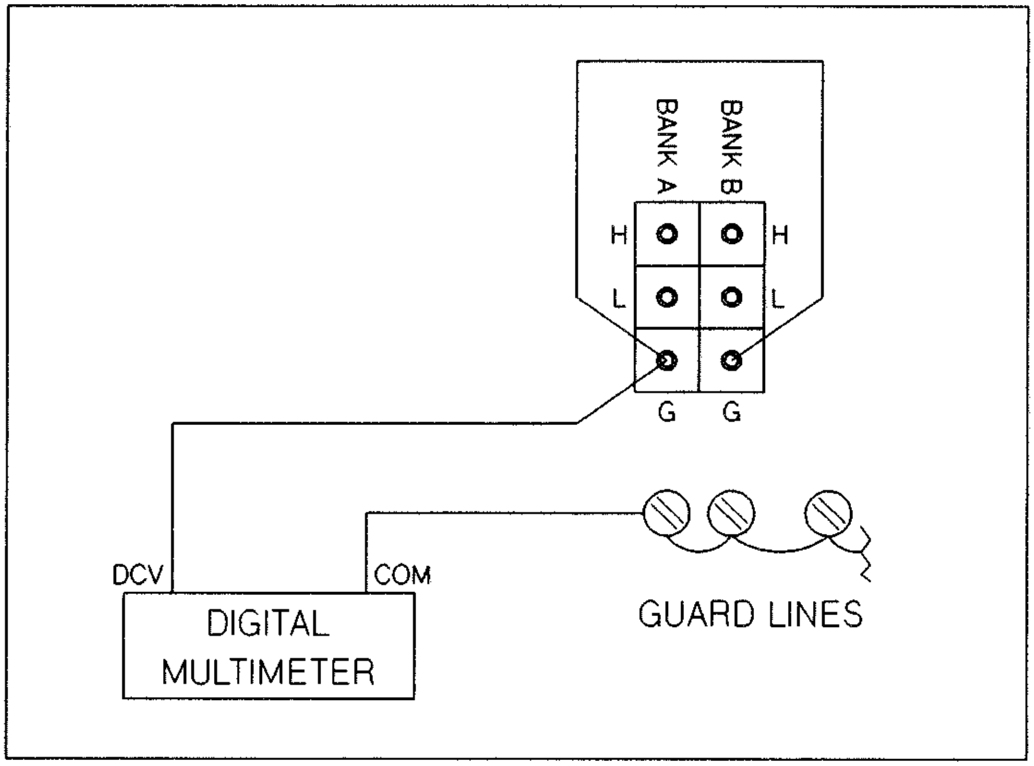


Figure 9-9 HP 44709A/44710A GUARD Channel Test Set-Up

NOTE

The backplane analog bus can be tested in one of two ways: 1) By connecting an external multimeter to the analog bus connector on the rear panel of the power supply module as shown in Figure 9-10, or 2) By connecting an external multimeter to the backplane analog bus line jumpers provided on the 44743A service module as shown in Figure 9-11.

4. Close Bank A sense tree switch and isolation relay by executing:

   CLOSE ES90,ES91 (where E = extender number, S = slot number)

5. Observe the indication on the multimeter. The multimeter should indicate less than 3.2 kohm.

6. Open the tree switch and isolation relay by executing:

   RESET ES00 (where E= extender number, S= slot number)

7. Observe the indication on the multimeter. The multimeter should indicate greater than 100 Mohm.

8. Disconnect the jumper between the Bank A common HIGH and the Bank A common low connection on the test fixure. Connect a jumper between the Bank B common HIGH and the Bank B common LOW connections on the test fixture.

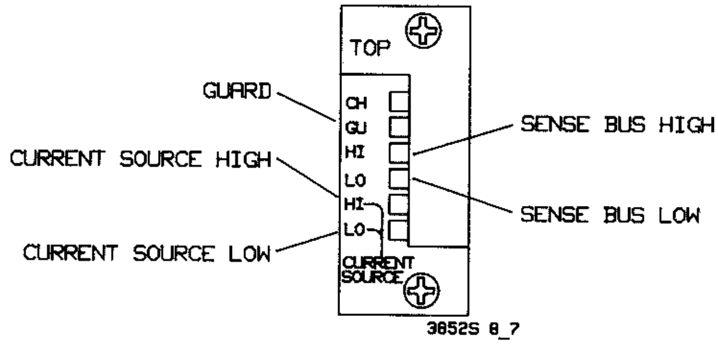


Figure 9-10 Analog Bus Connector

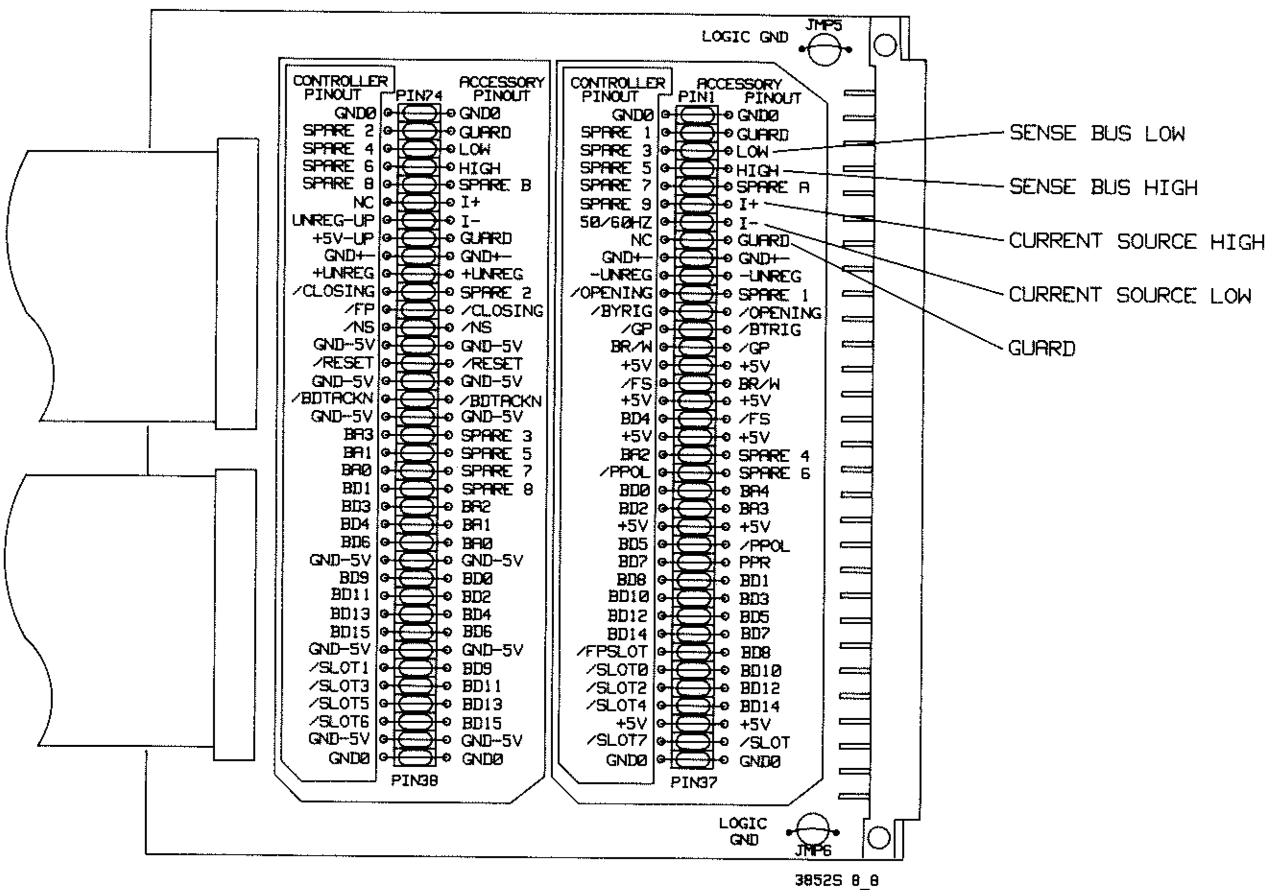


Figure 9-11 HP 44743A Service Module

9. Close the Bank B sense tree switch and isolation relay by executing:

CLOSE ES90,ES92 (where E = extender number, S = slot number)

10. Observe the indication on the multimeter. The multimeter should indicate less than 3.2 kohm.

11. Open the Bank B sense tree switch and isolation relay by executing:

RESET ES00 (where E= extender number, S= slot number)

12. Observe the indication on the multimeter. The multimeter should indicate greater than 100 Mohm.

13. SOURCE BUS TREE SWITCH AND ISOLATION RELAY TEST: This test checks the measurement path from the backplane analog source bus through the isolation relay and tree switches.

14. Set the multimeter to measure two-wire ohms. Connect the multimeter test leads to the backplane analog source bus HIGH and LOW lines.

15. Disconnect the jumper between the Bank B common HIGH and the Bank B common low connection on the test fixure. Connect a jumper between the Bank A common HIGH and the Bank A common LOW connections on the test fixture.

16. Close Bank A source tree switch and isolation relay by executing:

CLOSE ES90,ES93 (where E = extender number, S = slot number)

17. Observe the indication on the multimeter. The multimeter should indicate less than 3.2 kohm.

18. Open the tree switch and isolation relay by executing:

RESET ES00 (where E = extender number, S = slot number)

19. Observe the indication on the multimeter. The multimeter should indicate greater than 100 Mohm.

20. Disconnect the jumper between the Bank A common HIGH and the Bank A common low connection on the test fixure. Connect a jumper between the Bank B common HIGH and the Bank B common LOW connections on the test fixture.

21. Close the Bank B source tree switch and isolation relay by executing:

CLOSE ES90,ES94 (where E = extender number, S = slot number)

22. Observe the indication on the multimeter. The multimeter should indicate less than 3.0 kohm.

23. Open the Bank B source tree switch and isolation relay by executing:

RESET ES00 (where E = extender number, S = slot number)

24. Observe the indication on the multimeter. The multimeter should indicate greater than 100 Mohm.

25. GUARD ISOLATION RELAY TEST: This test checks the GUARD path through the backplane analog bus and the isolation relay.

26. Connect a jumper between the Bank A common LOW connection and the Bank A common GUARD connection on the test fixture.

27. Set the multimeter to measure two-wire ohms. Connect the multimeter DCV lead to the backplane analog sense bus LOW connection. Connect the multimeter COM lead to the backplane analog bus GUARD connection.

28. Close the isolation relays and the Bank A sense tree switch by executing:

CLOSE ES90,ES91 (where E = extender number, S = slot number)

29. Observe the reading on the multimeter. The multimeter should indicate <3.0 kohms. This resistance includes the resistance of the backplane bus connections, the Bank A tree switch, the protection resistors in the LOW and GUARD paths, and the isolation relays.

30. Reset the FET multiplexer by executing:

RESET ES00 (where E = extender number, S = slot number)

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44709A/44710A PERFORMANCE TESTS.

9-26 DC Offset Test

1. Perform the Set-Up Procedure given in Section 9-23. The DC Offset test set-up is shown in Figure 9-12.

2. Set the multimeter to measure DC volts, on a range with at least 10 µV resolution. Connect the multimeter DCV lead to the shorted HIGH lines of the test fixture. Connect the multimeter COM lead to the shorted LOW lines of the test fixture.

3. Connect the 1 kohm resistor across the multimeter input leads.

NOTE

The offset voltage is specified with a resistance of 1 kohm or less. A smaller value resistor may be used for this test.

4. Close the first channel in the multiplexer by executing:

CLOSE ES00 (where E = extender number, S = slot number)

5. Observe the indication on the multimeter. The voltage indicated should be less than 15 µV (0 to 28 °C) or less than 185 µV (28 to 55 °C). A failure of the DC Offset test indicates a failing channel FET switch.

6. Repeat steps 4 and 5 for channels 01 through 19. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES01 would close channel 01 in extender E at slot S).

9-27 Opening and Closing Time Set-Up Procedure

The Opening and Closing Time test verifies that the channel FETs will switch on and off and that the multiplexer can scan the channels at the specified speed.

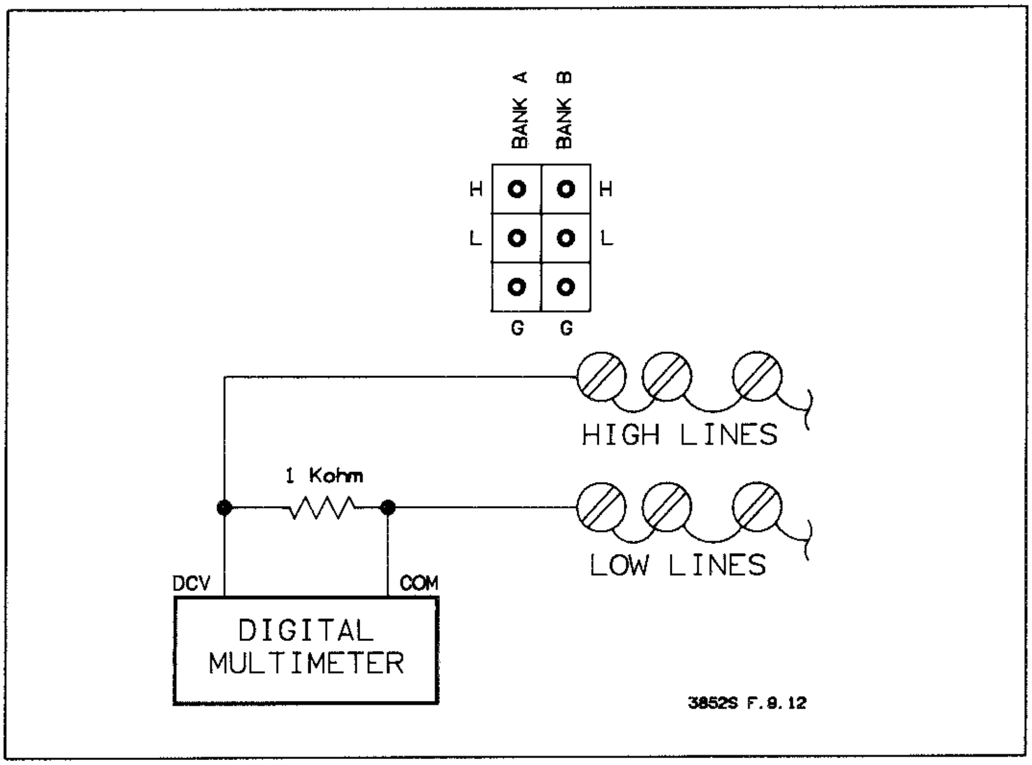


Figure 9-12 HP 44709A/44710A DC Offset Test Set-Up

1. Remove power from the HP 3852A and unplug the multiplexer to be tested. Install the Service Module in a convenient slot in the HP 3852A. Note the slot number where the Service Module is installed. Install the multiplexer on the service module. Install the test fixture on the multiplexer. The Set-Up Procedure is depicted in Figure 9-13.

2. On an oscilloscope, connect probes to the Channel A INPUT and Channel B INPUT. Set up the oscilloscope to the following:

Dual Trace
Channel A -- DC, 0.2 Volts/Div (if using 10:1 probes)
Channel B -- DC, 0.5 Volts/Div (if using 10:1 probes)
Trigger -- Internal, triggered on Channel B
Vertical Display -- Alternate
Time -- 0.2 mses/Div
Delayed Sweep -- 0.1 μsec/Div
Delayed Sweep Dial -- Minimum

3. Connect a jumper from the +5V test connection on the service module to the shorted HIGH connections on the test fixture.

4. Connect a jumper between the Bank A HIGH common test point and the Bank B HIGH common test point on the test fixure.

5. Connect the 1 kohm resistor between the HIGH common test points on the test fixture and the logic ground test connection on the service module.

6. Connect the Channel A oscilloscope probe to the HIGH common test points on the test fixture.

7. Connect the Channel B oscilloscope probe to the OPENING test connection on the service module.

8. Apply power to the HP 3852A. Wait for the wake-up sequence to complete.

9. Set up the following subroutine in HP 3852A memory. When the first statement is entered the SUB ENTRY annunciator should be on in the left display. This annunciator should remain on until the SUBEND statement is entered.

```
SUB A
TRG
SCAN ES00-ES19   (where E = extender number, S = slot number)
SUBEND
```

The subroutine will scan all channels on the FET multiplexer. Do not reset or cycle power to the HP 3852A or the subroutine will be erased from memory. The front panel CLEAR key may be used without disturbing the subroutine.

9-28 Opening Time Test

This test checks the time it takes for the FET to open after receiving an OPENING pulse from the FET multiplexer.

1. Repetitively call the entered subroutine 10000 times by executing:

```
CALL A,10000
```

This statement will call the subroutine 10000 times.

2. Observe the waveform displayed on the Channel B trace and make sure all 20 channels are present. It may also be necessary to adjust the TRIGGER LEVEL and TRIGGER HOLD controls, and to select the negative trigger pulse position on the scope to synchronize the signal on the scope.

3. Rotate the DELAY SWEEP dial to the minimum position. Select the DELAYED sweep mode on the scope. Slowly rotate the DELAY SWEEP dial clockwise while observing the displayed waveforms. The Channel B waveform is the OPENING pulse. The Channel A waveform is the +5V supply as switched by the relays. As the DELAY SWEEP dial is rotated, each channel switch and the associated OPENING pulse will come into view. The FET opening time is the time from the falling edge of the OPENING pulse to the falling edge of the Channel A waveform. This time must be less than 1.2 µseconds. The opening time is illustrated in Figure 9-14.

NOTE

The +5 V power supply waveform on Channel A will show an amplitude difference between the Bank A and Bank B FET switches. This is due to impedance differences in the Bank A common and Bank B common measurements paths on the multiplexer.

Continue rotating the DELAY Sweep dial until all 20 FET channels have been checked. A failing channel indicates a failing FET switch.

To stop the test at any time, press the front panel CLEAR key. The test time may be extended by by increasing the number of times the subroutine is called, as specified in step 1.

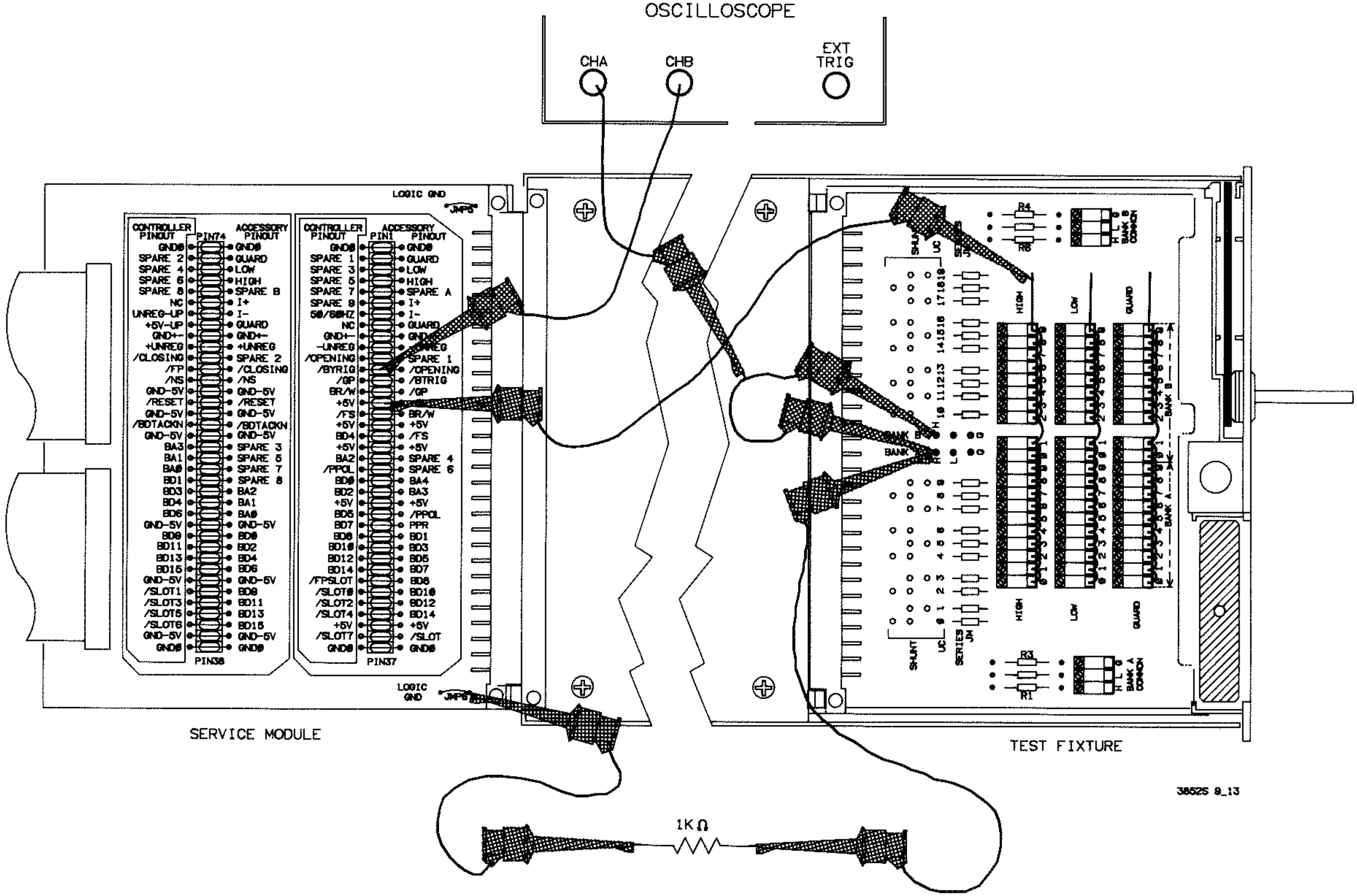


Figure 9-13 HP 44709A/44710A Opening Time Set-Up

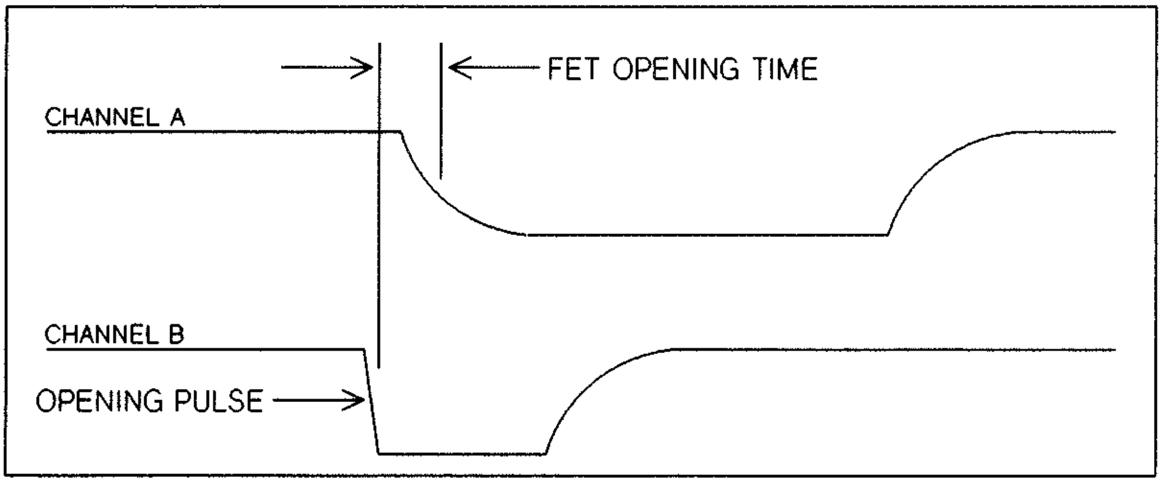


Figure 9-14 HP 44709A/44710A Opening Time

The waveform will exhibit a small amount of jitter due to the overhead requirements of the HP 3852A operating system.

9-29 Closing Time Test

This test checks the time it takes for the FET to close after receiving a CLOSING pulse from the FET multiplexer.

1. Move the channel B oscilloscope probe to the CLOSING connection on the service module. The Closing Time test set-up is shown in Figure 9-15.

2. Repetitively call the entered subroutine by executing:

   CALL A,10000

3. Rotate the DELAY SWEEP dial on the oscilloscope to the minimum position. Slowly rotate the dial clockwise until the first closing is displayed. The Channel B trace is the closing pulse output from the multiplexer. The Channel A waveform is the +5V supply, as switched by the FET channel switches. As the DELAY SWEEP dial is rotated, each channel switch and the associated CLOSING pulse will come into view. The FET closing time is the time from the falling edge of the CLOSING pulse to the rising edge of the Channel A waveform. This time must be less than 2.25 µseconds. The closing time is illustrated in Figure 9-16.

Continue rotating the DELAY Sweep dial until all 20 FET channels have been checked. A failing channel indicates a failing FET switch.

To stop the test at any time, press the front panel CLEAR key. The test time may be extended by by increasing the number of times the subroutine is called, as specified in step 2.

The waveform will exhibit a small amount of jitter due to the overhead requirements of the HP 3852A operating system.

9-30 Leakage/Bias Current Test

The leakage current test checks the FET switches for excessive leakage/bias current. Leakage/bias current is sourced by the multiplexer from HIGH, LOW, or GUARD to chassis ground.

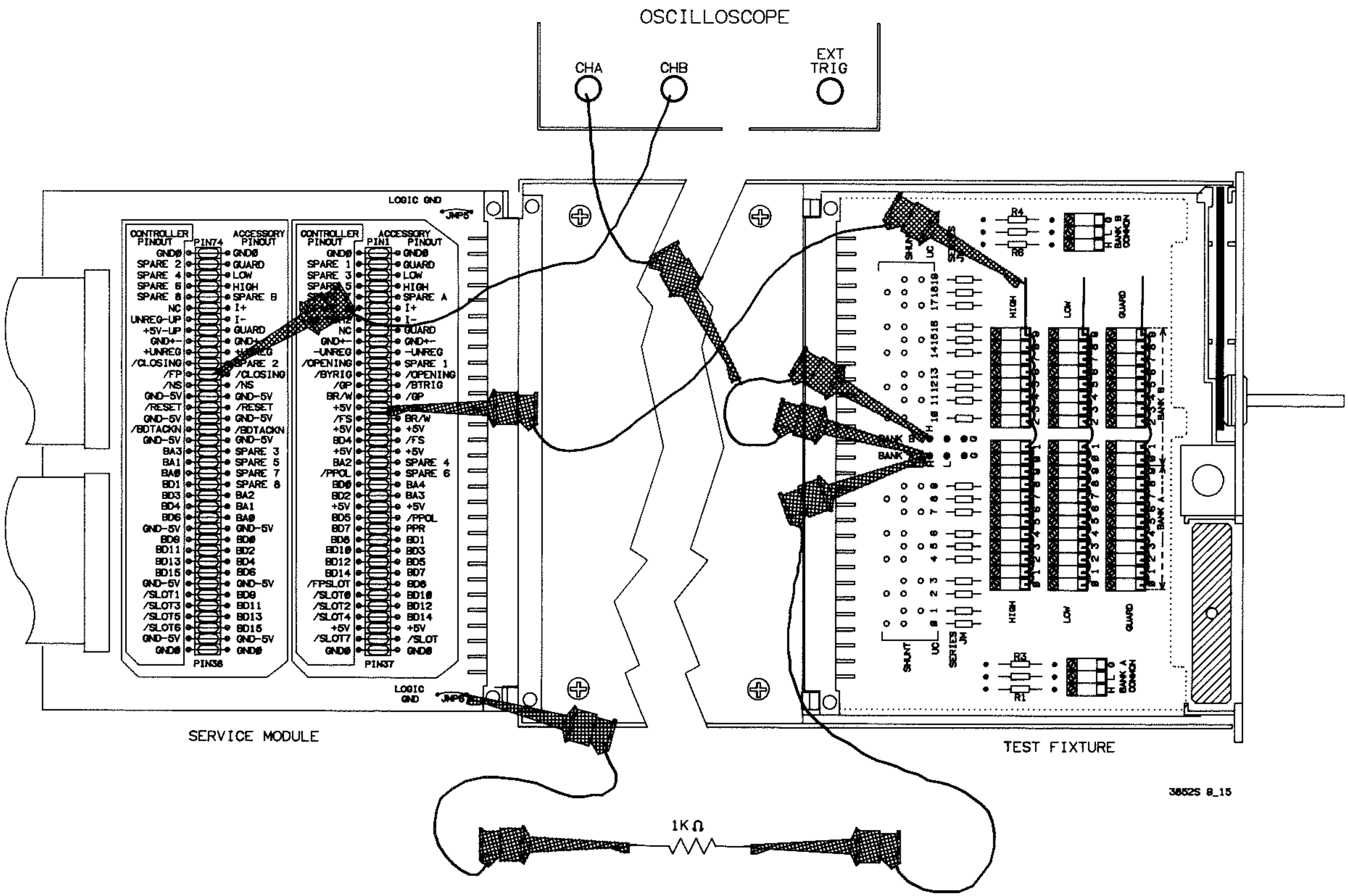


Figure 9-15 HP 44709A/44710A Closing Time Set-Up

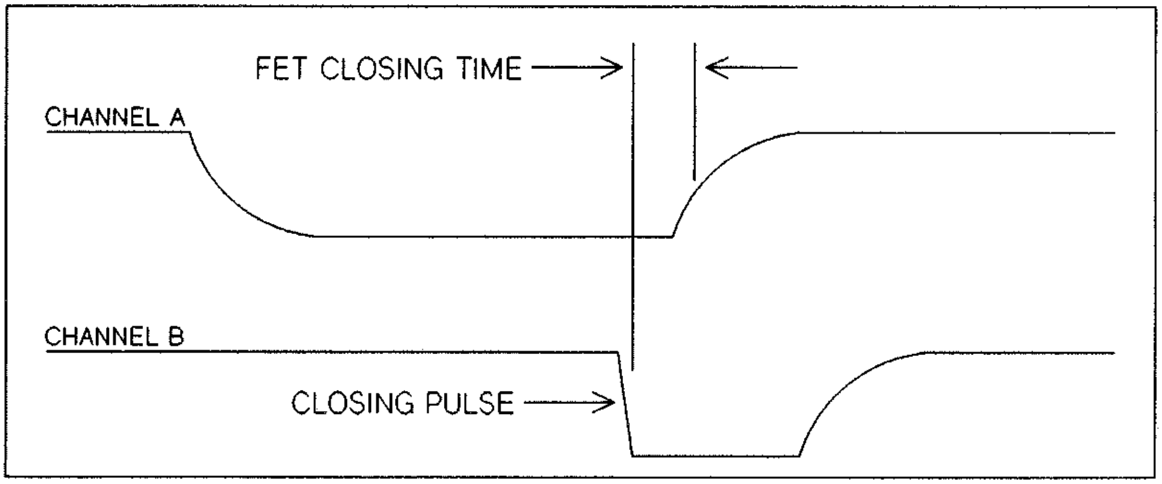


Figure 9-16 HP 44709A/44710A Closing Time

NOTE

The input resistance of the test digital multimeter could affect the value of R1 in the following tests, if using other than the recommended digital multimeter. The value of R1 should be determined by the 10 Mohm resistor in parallel with the input reistance of the digital multimeter.

1. OPEN CHANNELS LEAKAGE/BIAS CURRENT TEST. This test checks the leakage current with all channels open. A simplified schematic of the setup is shown in Figure 9-17 and the test setup for the HIGH lines is shown in Figure 9-18.

2. Perform the Set-Up procedure in Section 9-23.

3. Set the negative power supply to 10 Vdc and connect the negative lead to the shorted HIGH lines on the test fixure. Connect the negative power supply common lead to the chassis.

NOTE

Connections to chassis ground can be accomplished by connecting to any sheet metal part. Chassis ground is also available at a connector on the rear panel of the HP 3852A power supply.

4. Set the positive power supply output to 10 Vdc and connect the positive lead to the multimeter common. Connect the positive power supply common to the chassis.

5. Connect the 10 Mohm resistor (**R1**) across the multimeter input terminals. Connect the multimeter DCV input terminal to the Bank A HIGH common test point. Short the Bank A and Bank B HIGH common test points together.

6. Open all switches on the multiplexer by executing:

RESET ES00 (where E = extender number, S = slot number)

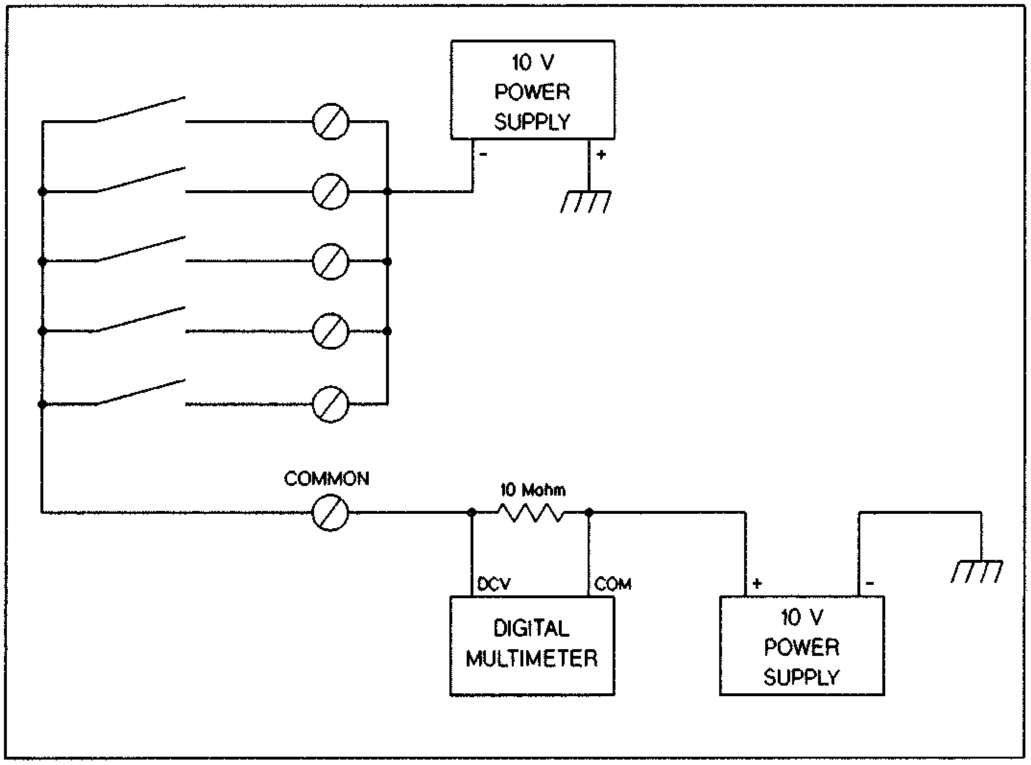


Figure 9-17 Open Channel Leakage Test

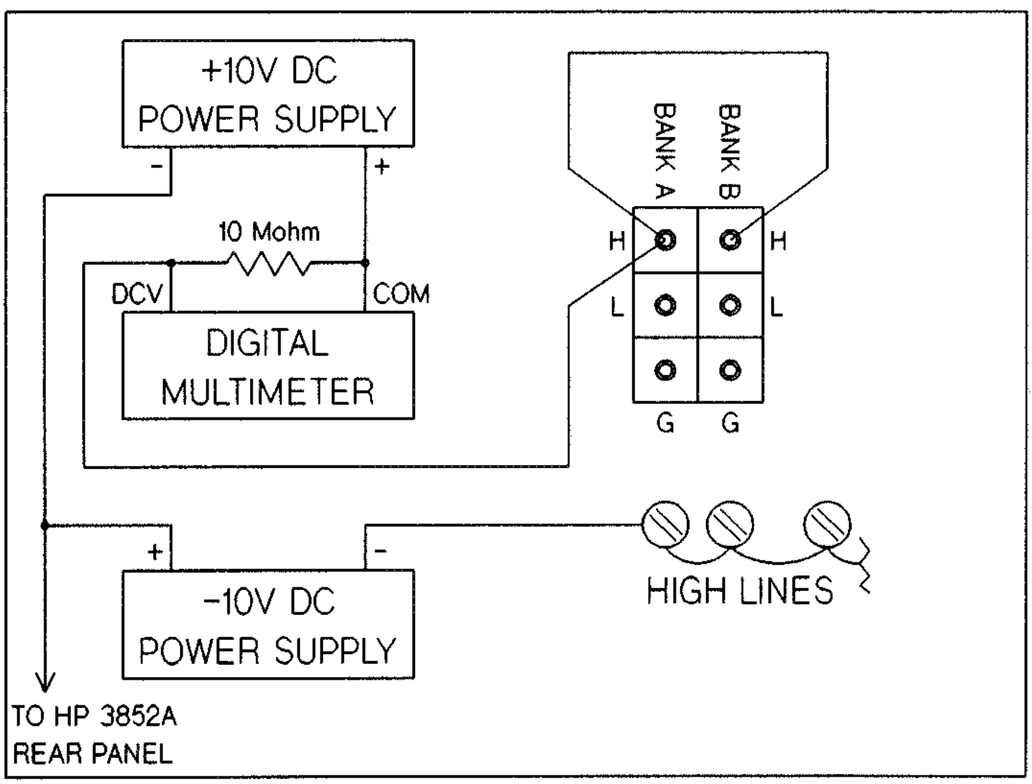


Figure 9-18 HP 44709A/44710A Open HIGH Channel Test Set-Up

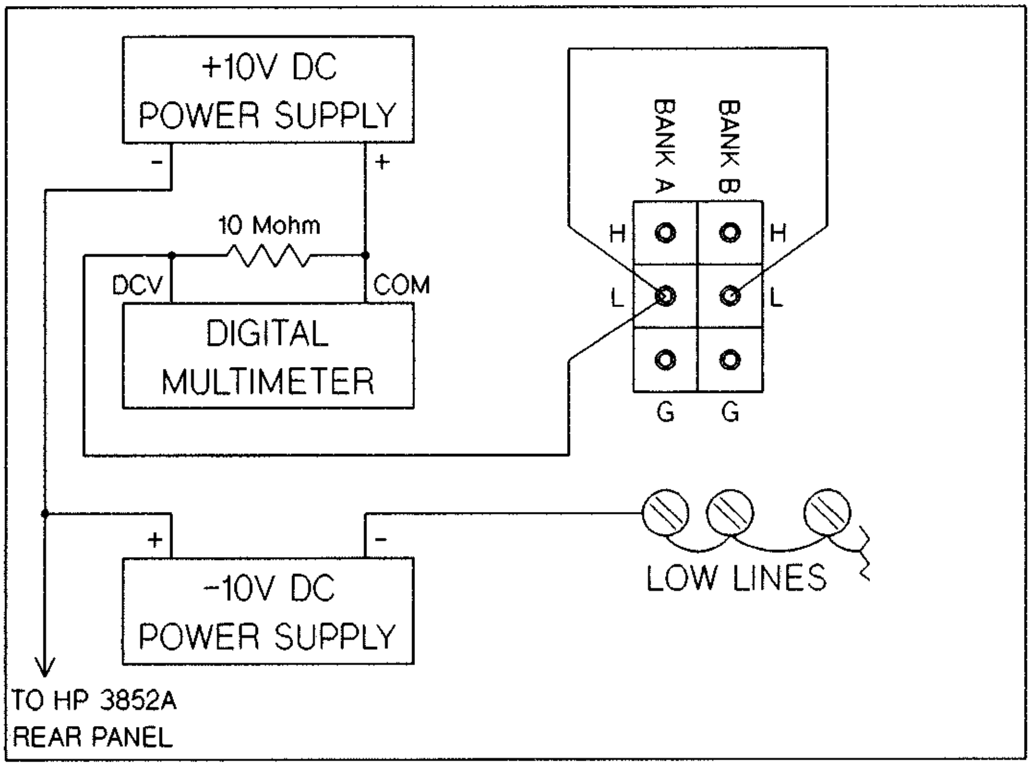


Figure 9-19 HP 44709A/44710A Open LOW Channel Test-Setup

7. Close the isolation relay and a tree switch by executing:

   CLOSE ES90,ES91 (where E = extender number, S = slot number)

8. Observe the reading on the multimeter. This reading is referred to as **V1** in the following steps.

9. Calculate the leakage current (I) from the formula:

$$\mathbf{I} = \frac{\mathbf{V1}}{\mathbf{R1}}$$

The calculated open channel leakage current for the HIGH lines should be less than 2 nA for a room temperature between 0° and 28° C (for temperatures in the range of 0° to 55° C the leakage current should be less than 11 nA).

10. Refer to Figure 9-19. Connect the negative power supply's negative lead to the shorted LOW lines on the test fixure. Connect the negative power supply common lead to the chassis.

11. Connect the multimeter DCV lead to the Bank A common LOW test point. Short the Bank A and Bank B LOW common test points together.

12. Observe the reading on the multimeter. This reading is referred to as **V1** in the following step.

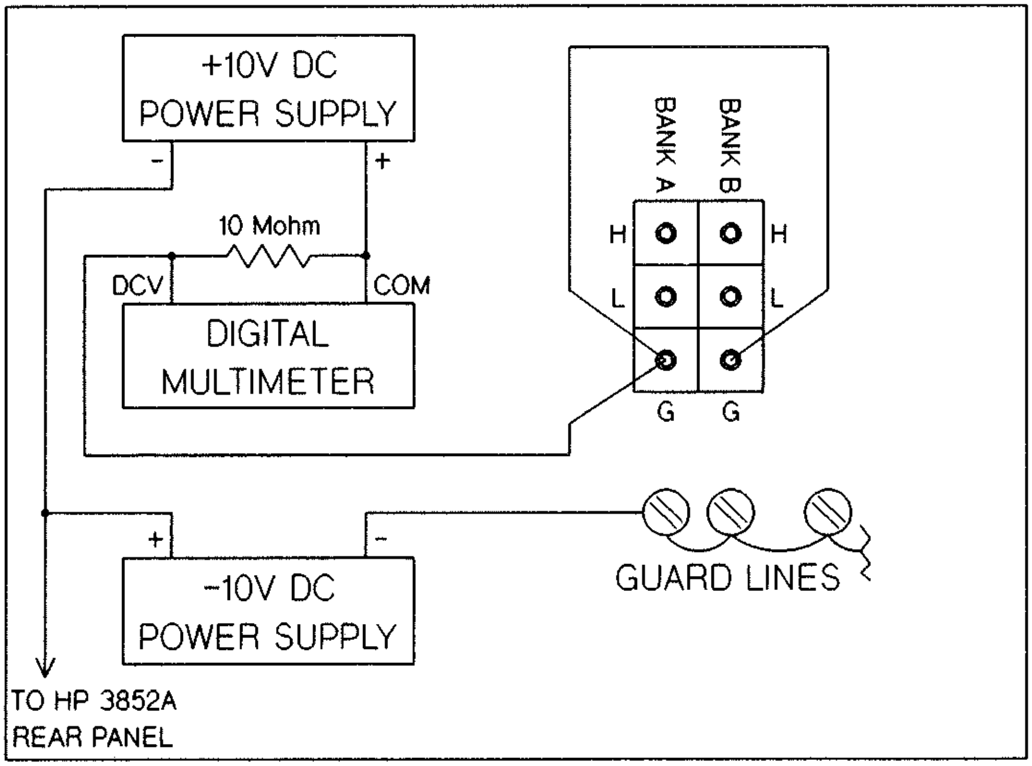


Figure 9-20 HP 44709A/44710A Open GUARD Channel Test-Setup

13. Calculate the leakage current (I) from the formula:

$$I = \frac{V1}{R1}$$

The calculated open channel leakage current for the LOW lines should be less than 2 nA for a room temperature between 0° and 28° C (for temperatures in the range of 0° to 55° C the leakage current should be less than 11 nA).

14. Refer to Figure 9-20. Connect the negative power supply's negative lead to the shorted GUARD lines on the test fixure. Connect the negative power supply common lead to the chassis.

15. Connect the multimeter DCV lead to the Bank A common GUARD test point. Short the Bank A and Bank B GUARD common test points together.

16. Observe the reading on the multimeter. This reading is referred to as **V1** in the following step.

17. Calculate the leakage current (I) from the formula:

$$I = \frac{V1}{R1}$$

The calculated open channel leakage current for the GUARD lines should be less than 6 nA for a room temperature between 0° and 28° C (for temperatures in the range of 0° to 55° C the leakage current should be less than 110 nA).

18. CLOSED CHANNEL LEAKAGE/BIAS CURRENT TEST. This test checks each channel HIGH, LOW, and GUARD for leakage current when a channel is closed. A simplified schematic of the setup is shown in Figure 9-21 and the test setup for the HIGH lines is shown in Figure 9-22.

19. Remove the negative power supply from the test fixture.

20. On the test fixture, connect the shorted HIGH lines to the Bank A HIGH common test point. Short the Bank A and Bank B common HIGH test points together.

21. Connect the +10 V power supply common to chassis ground. Connect the power supply positive lead to the common input of the multimeter.

22. Connect the 10 Mohm resistor across the multimeter input terminals. Connect the multimeter DCV input terminal to the shorted HIGH lines on the test fixture.

23. Close the isolation relay by executing:

CLOSE ES90 (where E = mainframe number, S = slot number)

24. Close the first channel in Bank A and the associated tree switch by executing:

CLOSE ES91,ES00 (where E = mainframe number, S = slot number)

25. Observe the voltage reading on the multimeter. This voltage is referred to as **V1** in the following step.

26. Calculate the leakage current (I) from the formula:

$$I = \frac{V1}{R1}$$

The leakage current should be less than 5.0 nA for room temperatures in the range of 0° to 28° C (leakage current should be less than 15 nA for a temperature range of 28° to 55° C).

27. Repeat steps 24, 25, and 26 for channels 01 through 09. In step 21, the channel under test is specified in the second term of the CLOSE command (i.e., CLOSE ES91,ES01 for channel 01).

28. Close the first channel in Bank B and the associated tree switch by executing:

CLOSE ES92,ES10 (where E = mainframe number, S = slot number)

29. Observe the voltage reading on the multimeter. This voltage is referred to as **V1** in the following step.

30. Calculate the leakage current (I) from the formula:

$$I = \frac{V1}{R1}$$

The leakage current should be less than 5.0 nA for room temperatures in the range of 0° to 28° C (leakage current should be less than 15 nA for a temperature range of 28° to 55° C).

31. Repeat steps 28, 29, and 30 for channels 11 through 19. In step 28, the channel under test is specified in the second term of the CLOSE command (i.e., CLOSE ES92,ES11 for channel 11).

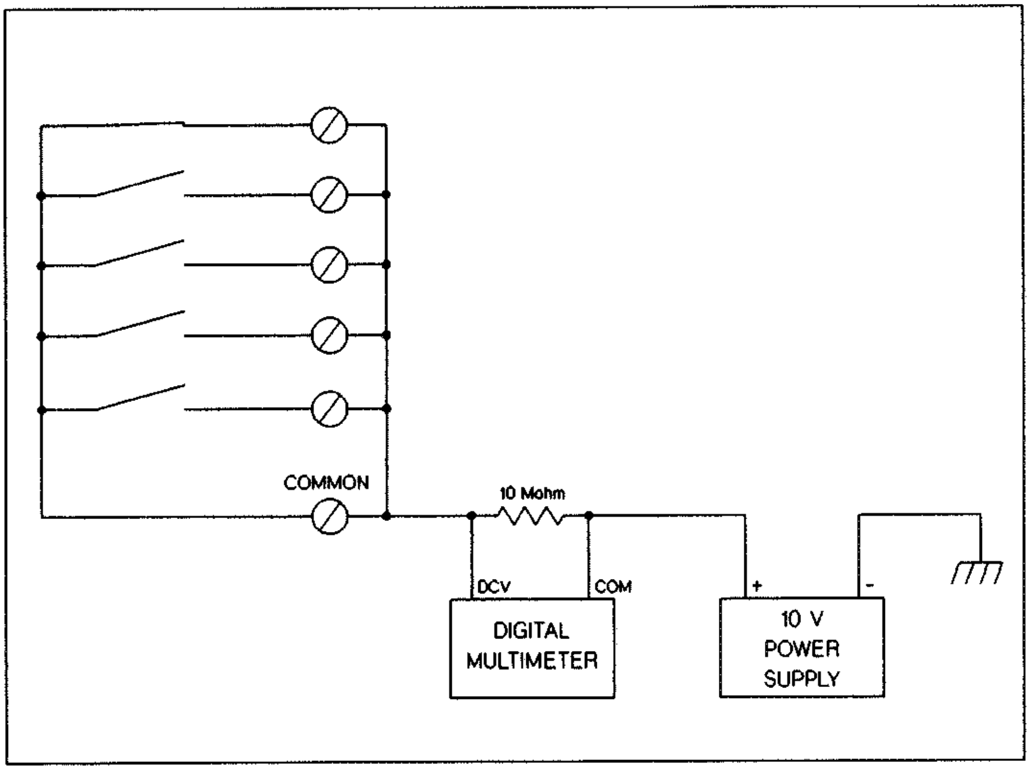


Figure 9-21 Closed Channel Leakage Test

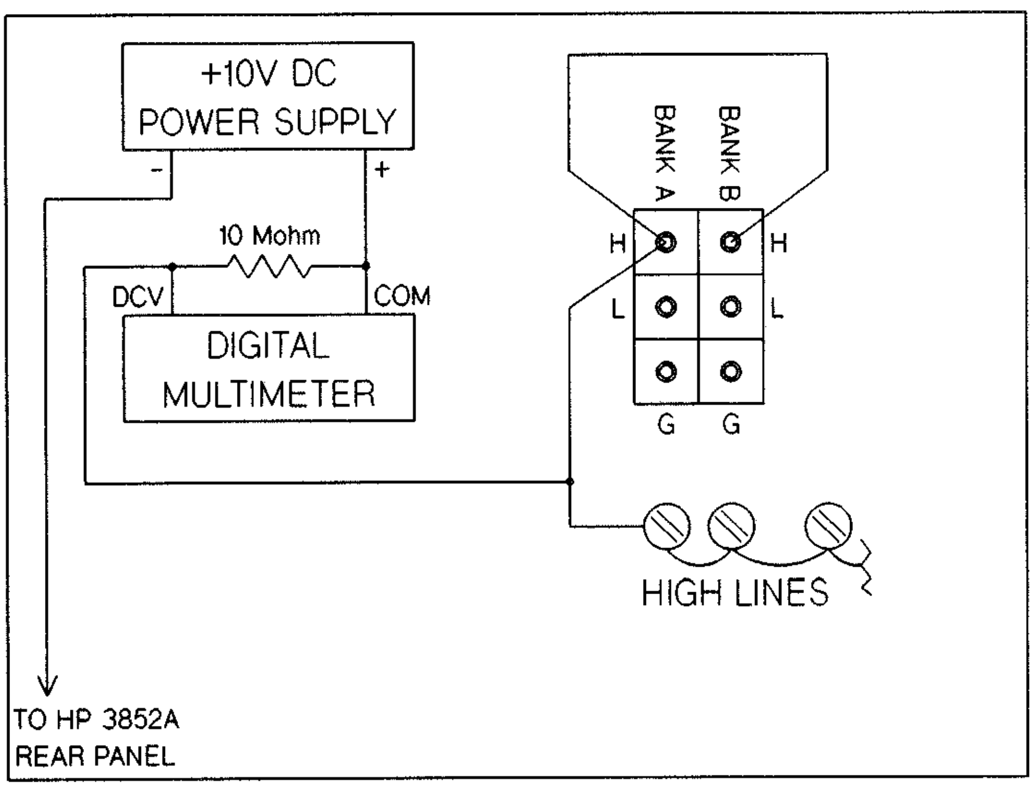


Figure 9-22 HP 44709A/44710A Closed HIGH Channel Test Set-Up

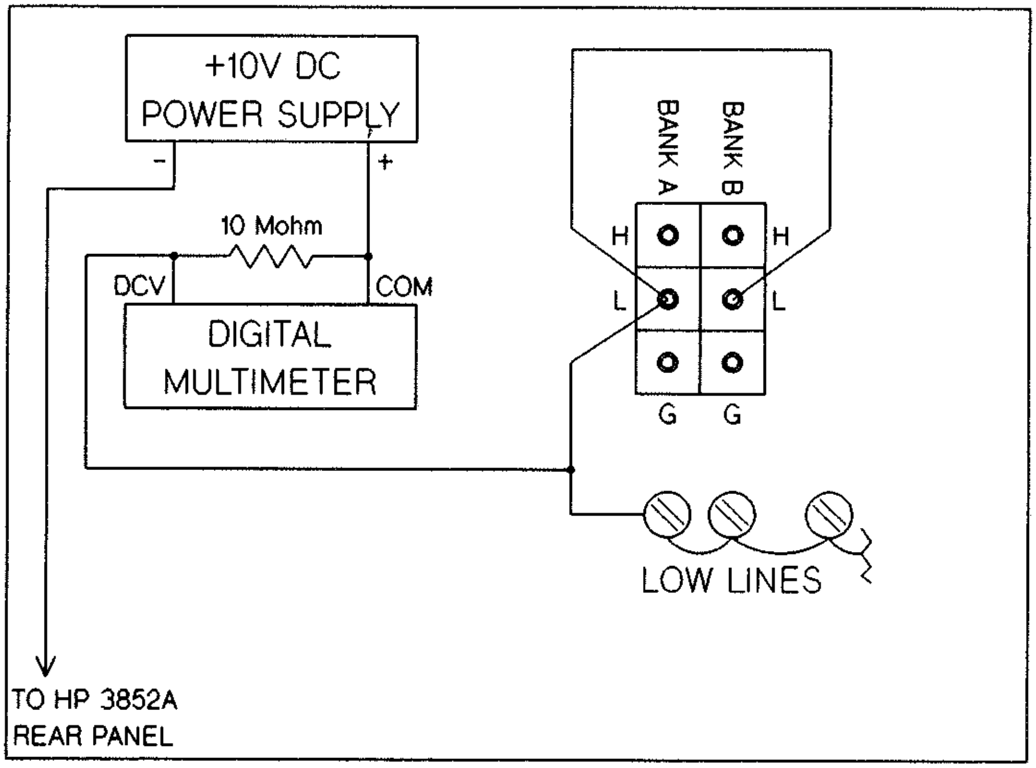


Figure 9-23 HP 44709A/44710A Closed LOW Channel Test Set-Up

32. Refer to Figure 9-23. On the test fixture, connect the shorted LOW lines to the Bank A common LOW test point. Short the Bank A and Bank B LOW common test points together.

33. Connect the multimeter DCV input terminal to the shorted LOW lines on the test fixture.

34. Close the first channel in Bank A and the associated tree switch by executing:

CLOSE ES91,ES00 (where E = mainframe number, S = slot number)

35. Observe the voltage reading on the multimeter. This voltage is referred to as **V1** in the following step.

36. Calculate the leakage current (I) from the formula:

$$I = \frac{V1}{R1}$$

The leakage current should be less than 5.0 nA for room temperatures in the range of 0° to 28° C (leakage current should be less than 15 nA for a temperature range of 28° to 55° C).

37. Repeat steps 34, 35, and 36 for channels 01 through 09. In step 34, the channel under test is specified in the second term of the CLOSE command (i.e., CLOSE ES91,ES01 for channel 01).

38. Close the first channel in Bank B and the associated tree switch by executing:

CLOSE ES92,ES10 (where E = mainframe number, S = slot number)

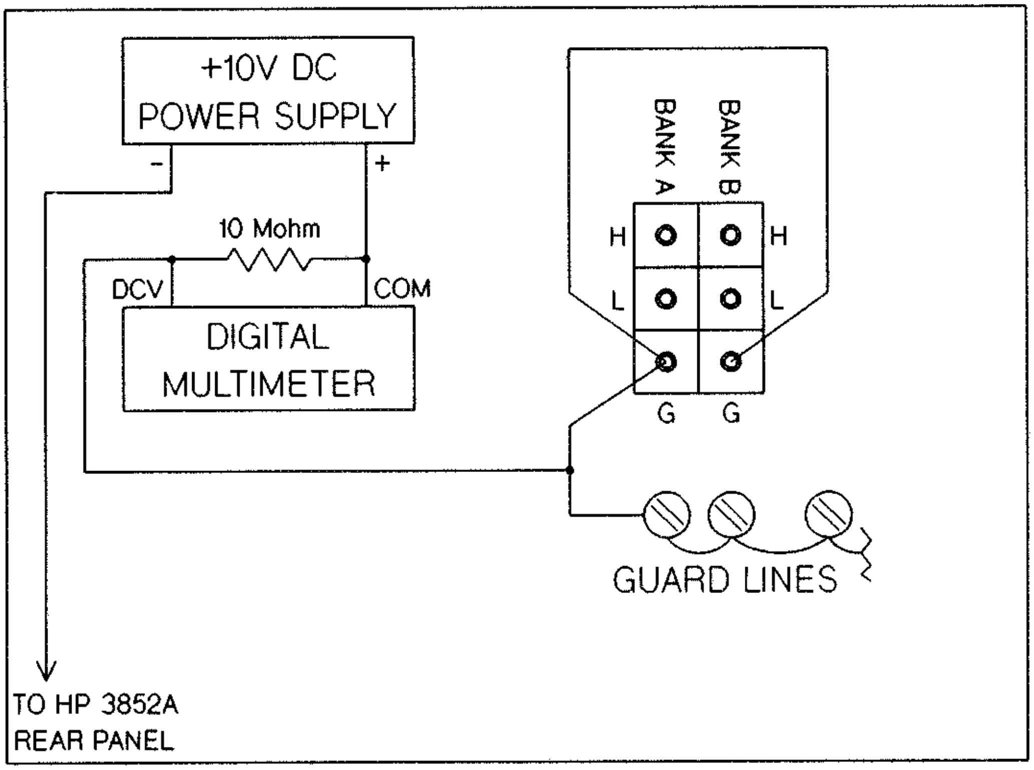


Figure 9-24 HP 44709A/44710A Closed GUARD Channel Test Set-Up

39. Observe the voltage reading on the multimeter. This voltage is referred to as **V1** in the following step.

40. Calculate the leakage current (I) from the formula:

$$I = \frac{V1}{R1}$$

The leakage current should be less than 5.0 nA for room temperatures in the range of 0° to 28° C (leakage current should be less than 15 nA for a temperature range of 28° to 55° C).

41. Repeat steps 38, 39, and 40 for channels 11 through 19. In step 38, the channel under test is specified in the second term of the CLOSE command (i.e., CLOSE ES92,ES11 for channel 11).

42. Refer to Figure 9-24. On the test fixture, connect the shorted GUARD lines to the Bank A common GUARD test point. Short the Bank A and Bank B common GUARD test points together.

43. Connect the multimeter DCV input terminal to the shorted GUARD lines on the test fixture.

44. Close the first channel in Bank A and the associated tree switch by executing:

CLOSE ES91,ES00 (where E = mainframe number, S = slot number)

45. Observe the voltage reading on the multimeter. This voltage is referred to as **V1** in the following step.

46. Calculate the leakage current (I) from the formula:

$$I = \frac{V1}{R1}$$

The leakage current should be less than 65 nA for room temperatures in the range of 0° to 28° C (leakage current should be less than 770 *n*A for a temperature range of 28° to 55° C).

47. Repeat steps 44, 45, and 46 for channels 01 through 09. In step 44, the channel under test is specified in the second term of the CLOSE command (i.e., CLOSE ES91,ES01 for channel 01).

48. Close the first channel in Bank B and the associated tree switch by executing:

CLOSE ES92,ES10 (where E = mainframe number, S = slot number)

49. Observe the voltage reading on the multimeter. This voltage is referred to as **V1** in the following step.

50. Calculate the leakage current (I) from the formula:

$$I = \frac{V1}{R1}$$

The leakage current should be less than 65 nA for room temperatures in the range of 0° to 28° C (leakage current should be less than 770 nA for a temperature range of 28° to 55° C).

51. Repeat steps 48, 49, and 50 for channels 11 through 19. In step 48, the channel under test is specified in the second term of the CLOSE command (i.e., CLOSE ES92,ES11 for channel 11).

9-31 REPLACEABLE PARTS

Figure 9-25 shows the mechanical breakdown of the HP 44709A and HP 44710A. This figure also provides assembly or disassembly information. The parts shown in Figure 9-25 are keyed to the parts list in Table 9-4.

To order a part listed in Table 9-4, quote the Hewlett-Packard part number, the quantity desired, the HP system description, and the check digit (abbreviated CD in Table 9-4). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board for the FET multiplexers is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

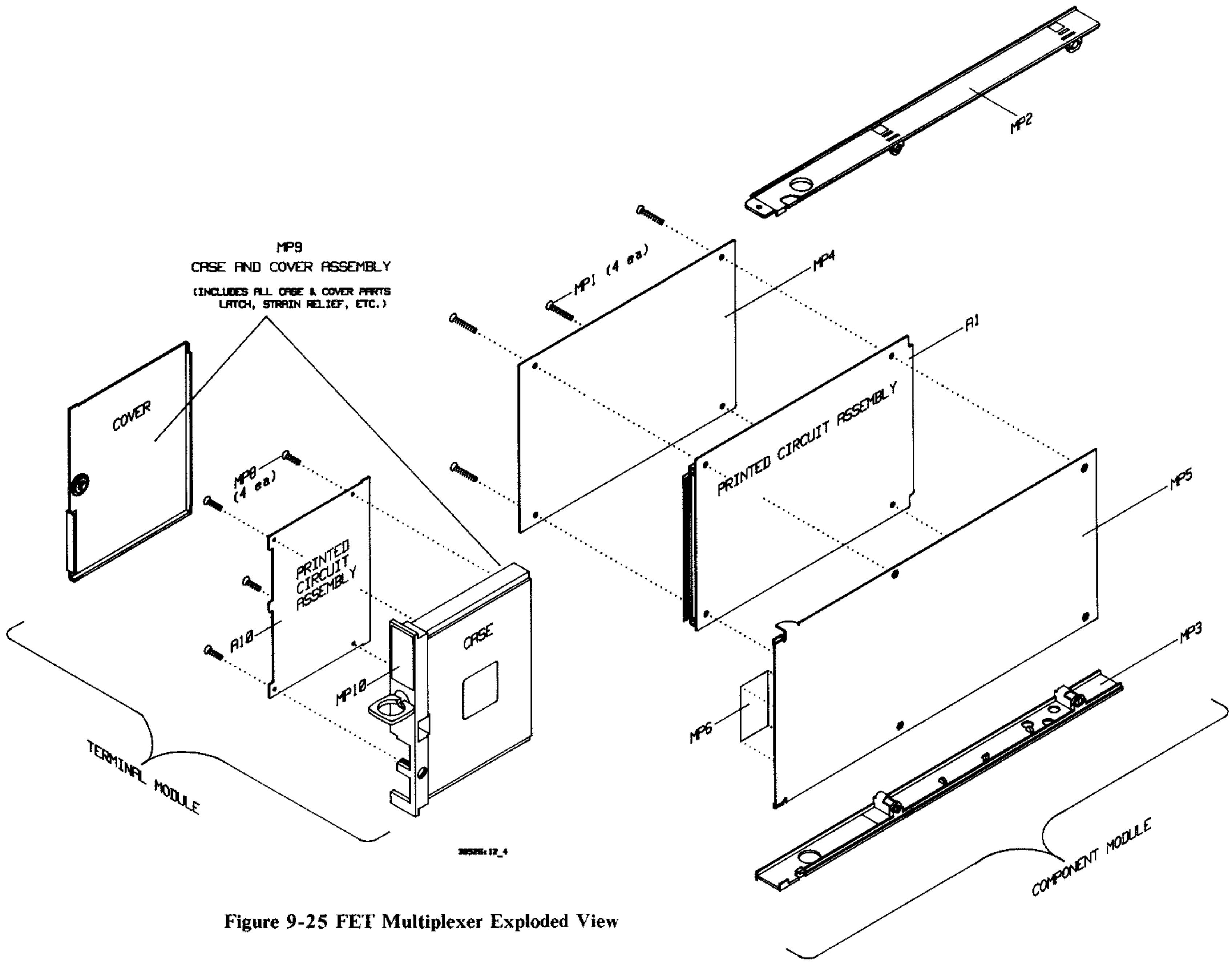


Figure 9-25 FET Multiplexer Exploded View

Table 9-4a HP 44709A 20 Channel FET Multiplexer

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44709A	Module; 20 channel FET mux component	1	44709-66201	5	MOD-20CH FET MUX
A1	PCA; 20 channel FET mux component	1	44709-66501	8	PCA-20CH GP F/MU
A10	PCA; 20 channel mux terminal	1	44705-66510	5	PCA-20CH MX TERM
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44709/44710 component module	1	44709-84320	7	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44709A	1	44709-84325	2	LBL-ID,TERM ASSY

Completely assembled HP 44709A terminal modules can be ordered from your local HP Office by ordering Number 44709AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44709A	Module; 20 channel FET mux component		44709-69201	1	RBLT-44709-66201

Table 9-4b HP 44710A 20 Channel FET Mux with Thermocouple Compensation

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44710A	Module; 20 channel FET mux component	1	44709-66201	5	MOD-20CH FET MUX
A1	PCA; 20 channel FET mux component	1	44709-66501	8	PCA-20CH GP F/MU
A10	PCA; 20 chan mux term w/TC reference	1	44708-66510	8	PCA-20CH TERM/TC
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44709/44710 component module	1	44709-84320	7	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN'
MP10	Label; rear panel of term mod 44710A	1	44710-84325	5	LBL-ID,TERM ASSY

Completely assembled HP 44710A terminal modules can be ordered from your local HP Office by ordering Number 44710AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44710A	Module; 20 channel FET mux component		44709-69201	1	RBLT-44709-66201

Table 9-4c HP 44719A 10 Bridge 120 ohm Strain Gage FET Multiplexer

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44719A	Module; 20 channel FET mux component	1	44709-66201	5	MOD-20CH FET MUX
A1	PCA; 20 channel FET mux component	1	44709-66501	8	PCA-20CH GP F/MU
A10	PCA; 10 chan 120 ohm str. gage term	1	44717-66510	9	PCA-10CH 120 OHM
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44709/44710/44719/44720 mod	1	44709-84320	7	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44719A	1	44719-84325	5	LBL-ID,TERM ASSY

Completely assembled HP 44719A terminal modules can be ordered from your local HP Office by ordering Number 44719AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44709A	Module; 20 channel FET mux component		44709-69201	1	RBLT-44709-66201

Table 9-4d HP 44720A 10 Bridge 350 ohm Strain Gage FET Multiplexer

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44720A	Module; 20 channel FET mux component	1	44709-66201	5	MOD-20CH FET MUX
A1	PCA; 20 channel FET mux component	1	44709-66501	8	PCA-20CH GP F/MU
A10	PCA; 10 chan 120 ohm str. gage term	1	44718-66510	0	PCA-10CH 350 OHM
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44709/44710/44719/44720 mod	1	44709-84320	7	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44719A	1	44720-84325	7	LBL-ID,TERM ASSY

Completely assembled HP 44720A terminal modules can be ordered from your local HP Office by ordering Number 44720AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44709A	Module; 20 channel FET mux component		44709-69201	1	RBLT-44709-66201

Chapter 18
HP 44711A/12A/13A High-Speed
FET Multiplexers

CHAPTER 10
HP 44711A/44712A/44713A
HIGH SPEED FET MULTIPLEXER

CHAPTER 10

HP 44711A/44712A/44713A HIGH-SPEED FET MULTIPLEXERS

10-1 INTRODUCTION

This chapter provides a technical description, performance test procedures, and replaceable parts lists for the HP 44711A 24 Channel High-Speed FET Multiplexer, HP 47712A 48 Channel Single Ended High-Speed FET Multiplexer, and HP 44713A 24 Channel High-Speed FET Multiplexer with Thermocouple Compensation. All three FET multiplexers use the same component module and are made unique by the addition of the terminal modules.

10-2 HP 44711A Technical Description

The HP 44711A 24 Channel High-Speed FET Multiplexer has two main assemblies: the component module and the terminal module. The component module contains the backplane interface electronics, the ribbon cable interface electronics, the switching FETs, the FET control logic, and the isolation relay control logic. The terminal module contains terminal strips for connection to external wiring and provides mounting holes for user installed parts such as one pole low pass filters or voltage dividers. The printed circuit board used in the component module is also used in the HP 44712A and HP 44713A component modules.

Figure 10-1 shows a simplified schematic of the HP 44711A. In the component module the FET switches are arranged into channel switches and tree switches. There are 48 channel switches arranged and switched in pairs. Each channel switch pair switches a high line and a low line. The channel switches are arranged into two banks, referred to as Bank A and Bank B. There are 12 channels in each bank and each bank has its own set of common terminals. Only one channel in each bank can be closed at the same time.

The tree switches allow the multiplexer channels to be connected to either the backplane analog bus or the high-speed voltmeter ribbon cable. There are eight tree switches arranged and switched in pairs. Each tree switch pair switches a high line and a low line. Two of the tree switch pairs connect to the sense bus and two connect to the source bus. The sense bus is used for measurements. The source bus provides a current source for resistance measurements. The current on the source bus is provided by either an HP 44701A through the backplane analog bus or an HP 44702A/B through either the backplane analog bus or the ribbon cable.

The tree switches are controlled independently of the channel switches in the high level commands. The tree switches are controlled by the use of channel numbers 91, 92, 93, and 94. Channel 91 controls the source bus tree switch, channel 92 controls the sense bus tree switch, channel 93 configures the HP 44711A for two-wire ohms measurements, and channel 94 configures the HP 44711A for four-wire ohms measurements.

The HP 44711A is specifically designed to connect to an HP 44702A/B High-Speed Voltmeter. The ribbon cable is provided for this purpose. The HP 44702A/B is able to control the multiplexer switches and take measurements through the ribbon cable. This control can be established independently of the HP 3852A backplane. The connection of one or more high-speed FET multiplexers with the HP 44702A/B through the ribbon cable creates a separate subsystem within the HP 3852A system.

Isolation relays are provided on the HP 44711A. These relays allow the FET multiplexer to be completely isolated from the backplane analog bus. The state of these relays are controlled by assigning them channel number 90. Once the isolation relays have been closed, they will remain closed until specifically instructed to open or a reset occurs. The isolation relays can be opened to reduce the leakage current on the backplane analog bus for critical measurements. Also, since the backplane analog sense bus can have up to 42 V peak (with an HP 44711A installed), the isolation relays provide protection for the FET switches. If, for example, an application requires that the backplane analog sense bus voltage is greater than 12 V peak, the isolation relays should be opened to prevent damage to the FET switches. In addition, the FETs are protected from voltages above 16 Vdc by the overvoltage protection circuit on the multiplexer assembly (the input impedance to the FETs, however, decreases above 12 V peak). The overvoltage protection circuit automatically opens the isolation relays, if the backplane analog bus voltage exceeds 16 Vdc.

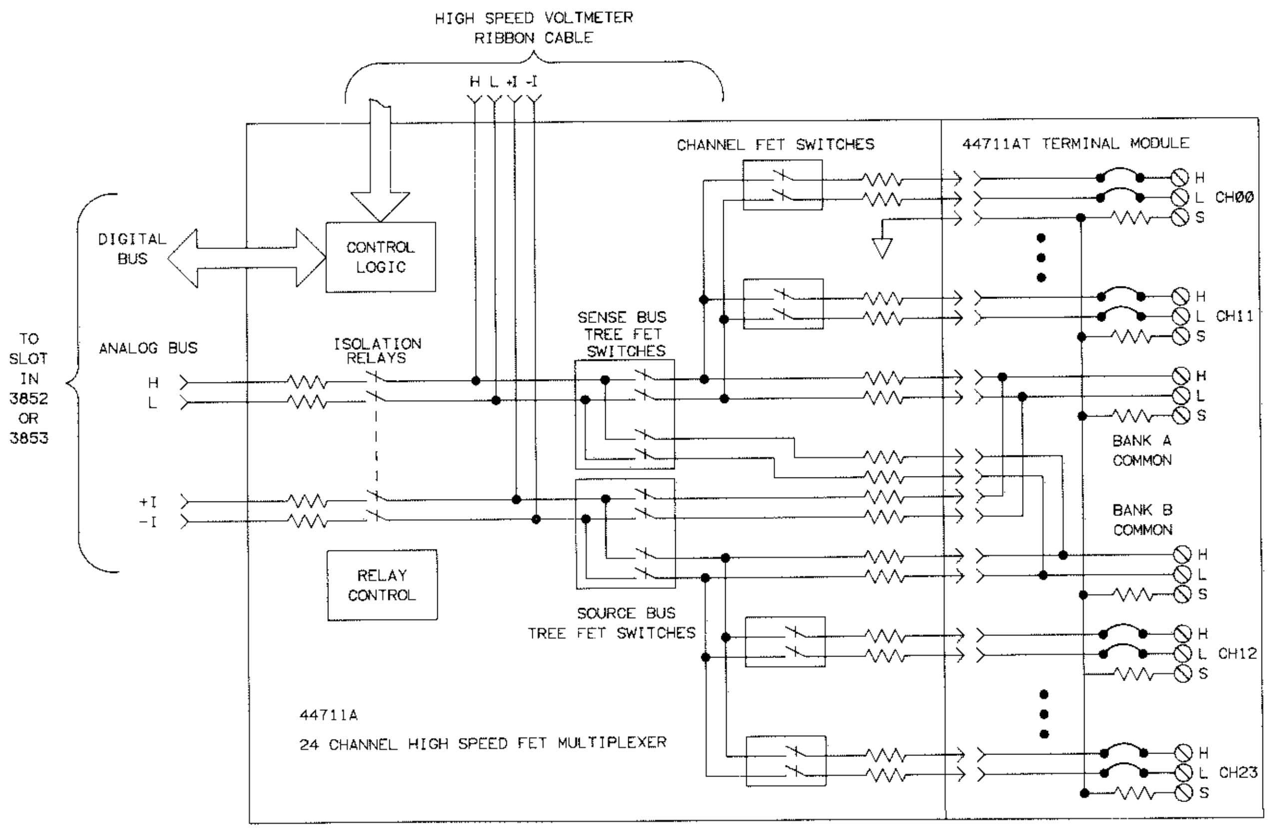


Figure 10-1 HP 44711A Simplified Schematic

10-3 HP 44712A Technical Description

The HP 44712A 48 Channel Single Ended High-Speed FET Multiplexer has two main assemblies: a component module and a terminal module. The component module contains the backplane interface electronics, the ribbon cable interface electronics, the FET control logic, and the isolation relay control logic. The terminal module contains terminal strips for connection to external wiring. The printed circuit board used in the component module is also used in the HP 44711A and HP 44713A component modules. The terminal module is unique.

Figure 10-2 shows a simplified schematic of the HP 44712A. In the component module the FET switches are arranged into channel switches and tree switches. There are 48 channel switches arranged and switched in pairs. Each channel switch pair switches two channel high lines into the tree switches. The low lines for all channels are common on the terminal module and are connected to the component module circuit ground through a 100 ohm resistor.

The tree switches connect the multiplexer channels to either the backplane analog bus or the high-speed voltmeter ribbon cable. There are eight tree switches arranged and switched in pairs. Each tree switch pair switches a channel high line and circuit ground. The tree switches allow selection of a single channel from the paired channel switches. Two of the tree switch pairs are connected to the sense bus and two are connected to the source bus. The sense bus is used for measurements. The source bus provides a current source for resistance measurements. The current on the source bus is provided by either an HP 44701A through the backplane analog bus or by an HP 44702A/B through either the backplane analog bus or the ribbon cable.

The tree switches are controlled independently of the channel switches in the high level commands. The tree switches are controlled by use of channel numbers 91, 92, and 93. Channel 91 connects the source bus, channel 92 connects the sense bus, and channel 93 configures the HP 44712A for two-wire ohms measurements.

The HP 44712A is specifically designed to connect to an HP 44702A/B High-Speed Voltmeter. The ribbon cable is provided for this purpose. The HP 44702A/B is able to control the multiplexer switches and take measurements through the ribbon cable. This control can be established independently of the HP 3852A backplane. The connection of one or more high-speed FET multiplexers with the HP 44702A/B through the ribbon cable creates a separate subsystem within the HP 3852A system.

Isolation relays are provided on the HP 44712A. These relays allow the FET multiplexer to be completely isolated from the backplane analog bus. The state of these relays are controlled by assigning them channel number 90. Once the isolation relays have been closed, they will remain closed until specifically instructed to open or a reset occurs. The isolation relays can be opened to reduce the leakage current on the backplane analog bus for critical measurements. Also, since the backplane analog sense bus can have up to 42 V peak (with an HP 44712A installed), the isolation relays provide protection for the FET switches. If, for example, an application requires that the backplane analog sense bus voltage is greater than 12 V peak, the isolation relays should be opened to prevent damage to the FET switches. In addition, the FETs are protected from voltages above 16 Vdc by the overvoltage protection circuit on the multiplexer assembly (the input impedance to the FETs, however, decreases above 12 V peak). The overvoltage protection circuit automatically opens the isolation relays, if the backplane analog bus voltage exceeds 16 Vdc.

10-4 HP 44713A Technical Description

The HP 44713A has two main assemblies: a component module and a terminal module. The component module contains the backplane interface electronics, the ribbon cable interface electronics, the FET control logic and the isolation relays control logic. The terminal module contains terminal strips for connection to external wiring, a thermistor in an isothermal block, and provides mounting holes for user installed parts such as one pole low pass filters or voltage dividers. The printed circuit board used in the component module is also used the HP 44711A and HP 44712A component modules. The terminal module is unique.

Figure 10-3 shows a simplified schematic of the HP 44713A. In the component module the FET switches are arranged into channel switches and tree switches. There are 48 channel switches arranged and switched in pairs. Each channel switch pair switches a high line and a low line. One set of multiplexer common terminals is provided on the terminal module.

The tree switches allow the multiplexer channels to be connected to either the backplane analog bus or the high-speed voltmeter ribbon cable. There are eight tree switches arranged and switched in pairs. Each tree switch pair switches a high line and a low line. Two of the tree switch pairs connect to the sense bus and two connect to the source bus. The sense bus is used for measurements. The source bus provides a current source for resistance measurements. The current on the source bus is provided by either an HP 44701A through the backplane analog bus or an HP 44702A/B through either the backplane analog bus or the ribbon cable.

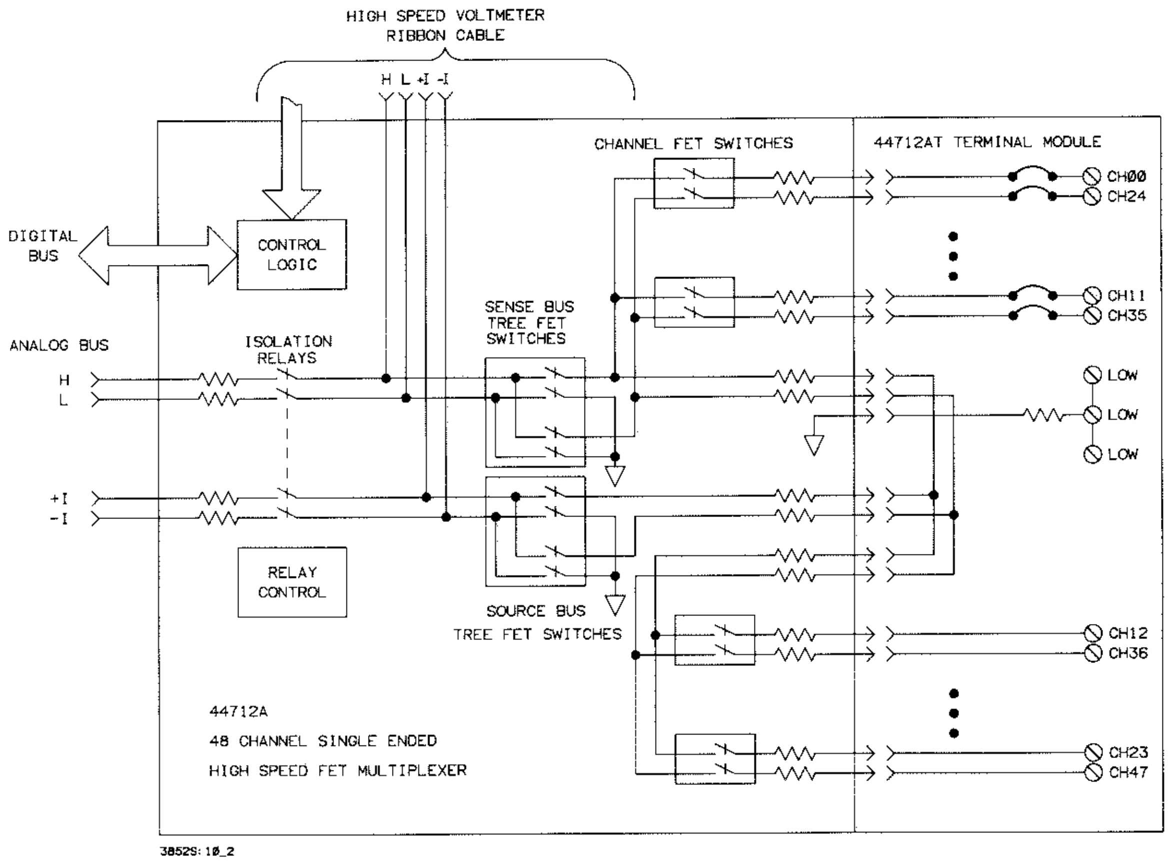


Figure 10-2 HP 44712A Simplified Schematic

The tree switches are controlled independently of the channel switches in the high level commands. The tree switches are controlled by the use of channel numbers 91, 92, 93, and 94. Channel 91 controls the source bus tree switch, channel 92 controls the sense bus tree switch, channel 93 configures the HP 44713A for two-wire ohms measurements and channel 94 configures the HP 44713A to measure the thermistor.

The HP 44713A is specifically designed to connect to an HP 44702A/B High-Speed Voltmeter. The ribbon cable is provided for this purpose. The HP 44702A/B is able to control the multiplexer switches and take measurements through the ribbon cable. This control can be established independently of the HP 3852A backplane. The connection of one or more high-speed FET multiplexers with the HP 44702A/B through the ribbon cable creates a separate subsystem within the HP 3852A system.

Isolation relays are provided on the HP 44713A. These relays allow the FET multiplexer to be completely isolated from the backplane analog bus. The state of these relays are controlled by assigning them channel number 90. Once the isolation relays have been closed, they will remain closed until specifically instructed to open or a reset occurs. The isolation relays can be opened to reduce the leakage current on the backplane analog bus for critical measurements. Also, since the backplane analog sense bus can have up to 42 V peak (with an HP 44713A installed), the isolation relays provide protection for the FET switches. If, for example, an application requires that the backplane analog sense bus voltage is greater than 12 V peak, the isolation relays should be opened to prevent damage to the FET switches. In addition, the FETs are protected from voltages above 16 Vdc by the overvoltage protection circuit on the multiplexer assembly (the input impedance to the FETs, however, decreases above 12 V peak). The overvoltage protection circuit automatically opens the isolation relays, if the backplane analog bus voltage exceeds 16 Vdc.

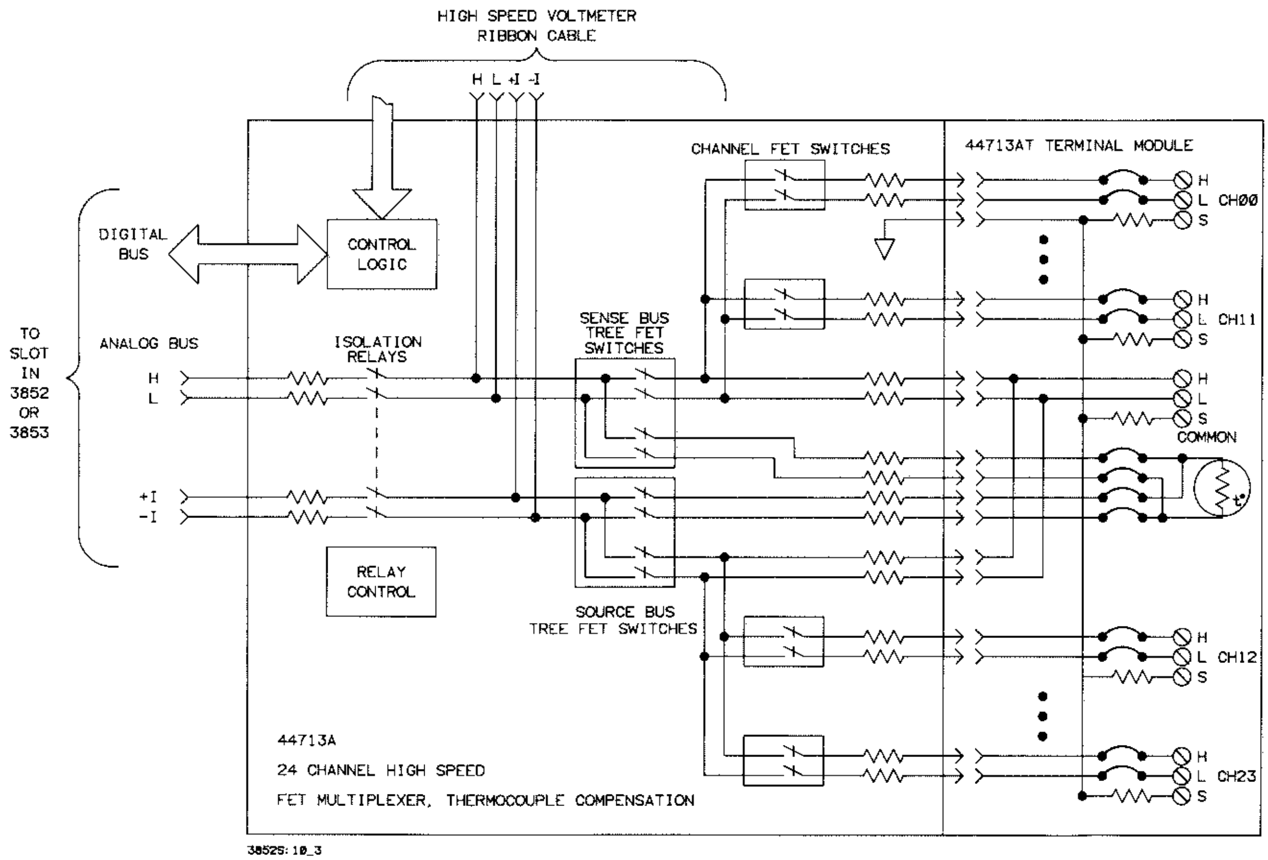


Figure 10-3 HP 44713A Simplified Schematic

10-5 Read and Write Registers

The HP 3852A communicates with each plug-in accessory by using read and write registers. High level commands are translated into appropriate register commands. The SREAD and SWRITE commands can be used to directly control each register.

SREAD and SWRITE are described in Chapter 2 of this manual. Table 10-1 shows the registers used by the HP 44711A, HP 44712A, and HP 44713A.

CAUTION

Using the primitive commands (SREAD and SWRITE) may cause unexpected and undesirable effects on the plug-in accessories. It is possible to program some plug-in accessories into illegal and potentially damaging states with these commands. The commands are documented here for service purposes only.

10-6 Read Registers

NOTE

The decimal number returned after the execution of an SREAD command represents the two's compliment of the status word.

Table 10-1 High-Speed FET Multiplexer Read and Write Registers

Register #	READ Registers	WRITE Registers
0	Accessory Identification	Accessory Reset
1	Accessory Status	Accessory Address
2	FET Switch Status	Not used
3	Not Used	FET Opening
4	Not Used	Isolation Relays Opening
5	Not Used	Isolation Relays Closing
6	Not used	FET Closing
7	Not Used	Not Used

10-7 Register 0. Read Register 0 contains the accessory identification. Eight bits are used to uniquely identify the accessory. The eight bits are output on the lower eight bits of the backplane data bus.

The eight bit identification is in two parts. The five most significant bits identify the component module installed. The least significant three bits identify the type of terminal module installed. If the terminal module is not present, the lower three bits are set high by the component module. If a terminal module is installed, the type of terminal module is also identified.

Table 10-2 lists the decimal equivalent codes returned in response to an SREAD of Register 0 for all combinations of the modules. Note that all three FET multiplexers use the same component module, identified as an HP 44711A in Table 10-2.

Table 10-2 HP 44711A, HP 44712A, and HP 44713A Identification Codes

Module Combinations	Codes
HP 44711A Component Module (no terminal module installed)	-137
HP 44711A Component Module, HP 44711AT Terminal Module installed	-141
HP 44711A Component Module, HP 44712AT Terminal Module installed	-139
HP 44711A Component Module, HP 44713AT Terminal Module installed	-144

10-8 Register 1. Read Register 1 is the accessory status register. This register uses backplane data bits 0 through 7 to indicate the current operating status of the accessory to the HP 3852A local controller. The following paragraphs describe the meaning of each bit in the status word.

Bit 7 indicates the status of the isolation relays. Bit 7 is set high when the isolation relays have been instructed to open and low when instructed to close. It is possible that the status bit will not correctly indicate the status of the isolation relays if the register is read too soon after the close or open command has been sent. The period of uncertainty is 1 millisecond after a close command and 0.5 millisecond after an open command.

Bit 6 is used to indicate the connection status of the ribbon cable. When the ribbon cable is connected to an HP 44702A/B bit 6 is pulled low.

Bit 5 is used to indicate the active bus for switch control. A high level indicates that the accessory control has been assigned to the HP 44702A/B High-Speed Voltmeter. A low level indicates that the accessory control is assigned to the HP 3852A backplane bus.

Bit 4 is set low when a HP 44702A/B High-Speed Voltmeter scan is in progress. The bit returns high when the scan is completed. A scan operation also sets bit 1 high so bits 4 and 1 can be used to determine if the accessory is currently scanning or is busy processing a command.

Bit 3 indicates the current status of the HP 3852A backplane OPENING line. When the OPENING pulse on the backplane is asserted, bit 3 is set high.

Bit 2 is the local opening signal. Bit 2 is set high while the multiplexer is opening a switch.

Bit 1 indicates the busy/ready status of the multiplexer. When bit 1 is set high the multiplexer is processing the last command or is involved in a scan operation. When bit 1 is high no write operations should be made to the multiplexer. Bit 1 is set low to indicate that the multiplexer is ready to accept a new command.

Bit 0 is fixed low.

10-9 Register 2. Read Register 2 is the switch status register. Figure 10-4 shows the eight bits returned from the switch status register.

```
7 6 5 4 3 2 1 0
0 0 0 0 C C C C
```

Figure 10-4 Read Register 2

The most significant four bits, D4 through D7, are an operation code that provides an indication of the tree switch states and the channel bank that is currently enabled. Bits D0 through D3 provides an indication of the channel number that is being used with the operation codes. Table 10-3 gives the operation codes for the HP 44711A. Table 10-4 gives the operation codes for the HP 44712A and Table 10-5 gives the operation codes for the HP 44713A. The channel number codes for the HP 44711A and HP 44713A are given in Table 10-6. Channel codes for the HP 44712A are given in Table 10-7.

10-10 Write Registers

10-11 Register 0. Write Register 0 is the accessory reset register. Any data written to this register will open any FET switches closed, open the isolation relays, and stop opening and closing coordination on the backplane. A write to register 0 produces the same results as a system reset (backplane reset).

10-12 Register 1. Write Register 1 is the accessory address register. The address register is used to assign each FET multiplexer a unique address on the ribbon cable. The address is used when the FET Multiplexers are being controlled by the HP 44702A/B over the ribbon cable. Additionally the address register uses one bit to set the control of the FET multiplexer to either the HP 3852A backplane or the HP 44702A/B. Figure 10-5 shows the accessory address word.

Table 10-3 HP 44711A Operation Codes

Code	Tree Switches	Bank Enabled
0000	None	Bank B
0001	None	Bank B
0010	None	Bank A
0011	None	Bank A
0100	Bank A source bus	Bank B
0101	Bank B source bus	Bank B
0110	Bank A source bus	Bank A
0111	Bank B source bus	Bank A
1000	Bank A sense bus	Bank B
1001	Bank B sense bus	Bank B
1010	Bank A sense bus	Bank A
1011	Bank B sense bus	Bank A
1100	Bank A sense, Bank B source	Bank A, Bank B
1101	Bank B sense, Bank B source	Bank B
1110	Bank A sense, Bank A source	Bank A
1111	Bank B sense, Bank A source	Bank A, Bank B

Table 10-4 HP 44712A Operation Codes

Code	Tree Switches	Channels Enabled
0000	None	12-23, 36-47
0001	None	12-23, 36-47
0010	None	00-11, 24-35
0011	None	00-11, 24-35
0100	Ch 24-47 source bus	12-23, 36-47
0101	Ch 0-23 source bus	12-23, 36-47
0110	Ch 24-47 source bus	00-11, 24-35
0111	Ch 0-23 source bus	00-11, 24-35
1000	Ch 24-47 sense bus	12-23, 36-47
1001	Ch 0-23 sense bus	12-23, 36-47
1010	Ch 24-47 sense bus	00-11, 24-35
1011	Ch 0-23 sense bus	00-11, 24-35
1100	Ch 24-47 sense and source	12-23, 36-47
1101	Ch 0-23 sense and source	12-23, 36-47
1110	Ch 24-47 sense and source	00-11, 24-35
1111	Ch 0-23 sense and source	00-11, 24-35

Table 10-5 HP 44713A Operation Codes

Code	Tree Switches	Channels Enabled
0000	None	Ch 12-23
0001	None	Ch 12-23
0010	None	Ch 00-11
0011	None	Ch 00-11
0100	Source to common	Ch 12-23
0101	Source to thermistor	Ch 12-23
0110	Source to common	Ch 00-11
0111	Source to thermistor	Ch 00-11
1000	Sense to common	Ch 12-23
1001	Sense to thermistor	Ch 12-23
1010	Sense to common	Ch 00-11
1011	Sense to thermistor	Ch 00-11
1100	Sense and source to common	Ch 12-23
1101	Sense and source to thermistor	Ch 12-23
1110	Sense and source to common	Ch 00-11
1111	Sense and source to thermistor	Ch 00-11

Table 10-6 HP 44711A and HP 44713A Channel Codes

Code	Channel	Code	Channel
0000	None	1000	7 (19)
0001	None	1001	6 (18)
0010	None	1010	5 (17)
0011	None	1011	4 (16)
0100	11 (23)	1100	3 (15)
0101	10 (22)	1101	2 (14)
0110	9 (21)	1110	1 (13)
0111	8 (20)	1111	0 (12)

Table 10-7 HP 44712A Channel Codes

Code	Channel	Code	Channel
0000	None	1000	7 & 31 (19 & 43)
0001	None	1001	6 & 30 (18 & 42)
0010	None	1010	5 & 29 (17 & 41)
0011	None	1011	4 & 28 (16 & 40)
0100	11 & 35 (23 & 47)	1100	3 & 27 (15 & 39)
0101	10 & 34 (22 & 46)	1101	2 & 26 (14 & 38)
0110	9 & 33 (21 & 45)	1110	1 & 25 (13 & 37)
0111	8 & 32 (20 & 44)	1111	0 & 24 (12 & 36)

7	6	5	4	3	2	1	0
X	X	X	X	B	A	A	A

Figure 10-5 Write Register 1 Accessory Address Word

In the accessory address word, bits 4 through 7 are not used. Bit 3 is the bus control bit. When this bit is set high, the control of the FET Multiplexer is given to the HP 44702A/B. When set low, control returns to the HP 3852A backplane. Bits 0 through 2 are the address bits. Typically, the addresses assigned correspond to the slot number where the FET Multiplexer is installed.

10-13 Register 3. Write Register 3 is the Opening register. A write to this register opens the FET switches indicated in the command word. The command word is described in Section 10-17. When the command word is sent to register 3, the backplane OPENING line is pulsed to coordinate the break-before-make feature.

10-14 Register 4. Write Register 4 opens the isolation relays. Any data sent to this register causes the isolation relays to open and pulses the HP 3852A backplane OPENING line.

10-15 Register 5. Write Register 5 closes the isolation relays. Any data written to this register initiates the closing of the isolation relays. Before the relay closes, the HP 3852A backplane OPENING line is examined. If the OPENING line is low the relays closure is delayed until the line returns high. When the isolation relays are closing the HP 3852A backplane CLOSING line is pulsed.

10-16 Register 6. Write Register 6 is the is the FET switch closing register. A write to this register will close the FET switches indicated in the command word. The command word is described in Section 10-17. When the command word is sent to this register the HP 3852A backplane CLOSING line is pulsed.

10-17 Command Word

The command word uses 15 bits. The bits are arranged into isolation relays control, tree switch operation code bits, and channel bits. The command word is shown in Figure 10-6. The command word is used for both opening and closing functions. The function is determined by the register receiving the command word.

Bits:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Use:	C	X	X	X	X	X	X	X	O	O	O	O	C	C	C	C

Figure 10-6 Command Word

Bit 15 controls the isolation relays. Bits 8 through 14 are not used and will be ignored. Bits 4 through 7 are the tree switch operation codes bits. The operation codes for the FET Multiplexers are shown in Tables 10-3, 10-4 and 10-5. Bits 0 through 3 are the channel control bits. The actual channels that these bits control is determined by the operation code in bits 4 through 7. The channel codes for the FET multiplexers are given in Tables 10-6 and 10-7. The decimal number sent by an SWRITE command represents the two's compliment of the command word.

10-18 SPECIFICATIONS

Specifications for the HP 44711A, HP 44712A and HP 44713A are given in Table 10-8. Specifications are the performance standards or limits against which the FET multiplexers may be tested.

CAUTION

The installation of the HP 44711A, HP 44712A, or HP 44713A reduces the maximum allowable backplane voltages to 42 V peak.

Table 10-8 HP 44711A/44712A/44713A Specifications

HP 44711A 24 Channel High Speed FET Multiplexer

Maximum Switch Rates: 5500 channels/second (from back-plane)*
100000 channels/second (from ribbon cable)

Maximum Input Voltage: Rear and back-plane inputs protected to 16 V peak (input impedance decreases above 12 V due to internal protection circuitry). With analog back-plane disconnected from multiplexer, the back-plane voltage can go up to 42 V peak.

Maximum Input Current: 1 mA non-inductive per channel

Input Impedance:

Impedance	Terminals: High to Low	Terminals: High or Low to Chassis
Power On Resistance (Ω)	$>10^8$	$>10^8$
Power Off Resistance (Ω) Vin 10 V	>1000	>1000
Power Off Resistance (Ω) Vin >10 V	>200	>200
Max. Capacitance (pf) at 1MHz	200	200

Closed Channel Path Resistance: 3.1 kΩ for either High or Low Inputs considered separately

Bandwidth: 1.0% flatness at 20 kHz, -3 dB Bandwidth at 200 kHz (50 Ω source, 1 MΩ termination)

Crosstalk: -50 dB at 10 kHz, -35 dB at 100 kHz (channel-to-channel, 50 Ω source, 1 MΩ termination)

Maximum Offset Voltage: 15 µV at 0 to 28 °C
185 µV at 28 to 55 °C
(offset voltage between High and Low)

Maximum Bias Current: ±5 nA DC at 0 to 28 °C
±15 nA DC at 28 to 55 °C
(Current sourced by High or Low to Chassis into Input Terminals or back-plane, with isolation relays closed)

±1 nA DC at 0 to 55 °C
(Current sourced by High or Low to Chassis into back-plane, with isolation relays open)

Maximum Wire Size: 16 AWG

Table 10-8 HP 44711A/44712A/44713A Specifications (Cont.)

HP 44712A 48 Channel Single Ended High Speed FET Multiplexer	
Maximum Switch Rates:	5500 channels/second (from back-plane)* 100000 channels/second (from ribbon cable)
Maximum Input Voltage:	Rear and back-plane inputs protected to 16 V peak (input impedance decreases above 12 V due to internal protection circuitry). With analog back-plane disconnected from multiplexer, the back-plane voltage can go up to 42 V peak.
Maximum Input Current:	1 mA non-inductive per channel
Input Impedance:	High to Low, $>10^8\ \Omega$, <=200 pF (at 1 MHz) Power Off Resistance, >1000 Ω (Vin <=10 V) Power Off Resistance, >200 Ω (Vin >10 V)
Closed Channel Path Resistance:	3.1 kΩ for either High or Low Inputs considered separately
Bandwidth:	1.0% flatness at 20 kHz, -3 dB Bandwidth at 200 kHz (50 Ω source, 1 MΩ termination)
Crosstalk:	-50 dB at 10 kHz, -35 dB at 100 kHz (channel-to-channel, 50 Ω source, 1 MΩ termination)
Maximum Offset Voltage:	15 µV at 0 to 28 °C 185 µV at 28 to 55 °C (offset voltage between High and Low)
Maximum Bias Current:	±5 nA DC at 0 to 28 °C ±15 nA DC at 28 to 55 °C (Current sourced by High or Low to Chassis into Input Terminals or back-plane, with isolation relays closed) ±1 nA DC at 0 to 55 °C (Current sourced by High or Low to Chassis into back-plane, with isolation relays open)
Maximum Wire Size:	16 AWG
HP 44713A 24 Channel High Speed FET Mux with Thermocouple Compensation	
Maximum Switch Rates:	5500 channels/second (from back-plane)* 100000 channels/second (from ribbon cable)

Maximum Input Voltage: Rear and back-plane inputs protected to 16 V peak (input impedance decreases above 12 V due to internal protection circuitry). With analog back-plane disconnected from multiplexer, the back-plane voltage can go up to 42 V peak.

Maximum Input Current: 1 mA non-inductive per channel

Input Impedance:

Impedance	Terminals: High to Low	Terminals: High or Low to Chassis
Power On Resistance (Ω)	$>10^8$	$>10^8$
Power Off Resistance (Ω) Vin 10 V	>1000	>1000
Power Off Resistance (Ω) Vin >10 V	>200	>200
Max. Capacitance (pf) at 1MHz	200	200

Closed Channel Path Resistance: 3.1 kΩ for either High or Low Inputs considered separately

Bandwidth: 1.0% flatness at 20 kHz, -3 dB Bandwidth at 200 kHz (50 Ω source, 1 MΩ termination)

Crosstalk: -50 dB at 10 kHz, -35 dB at 100 kHz (channel-to-channel, 50 Ω source, 1 MΩ termination)

Maximum Offset Voltage: 15 µV at 0 to 28 °C
185 µV at 28 to 55 °C
(offset voltage between High and Low)

Maximum Bias Current: ±5 nA DC at 0 to 28 °C
±45 nA DC at 28 to 55 °C
(Current sourced by High or Low to Chassis into Input Terminals or back-plane, with isolation relays closed)

±1 nA DC at 0 to 55 °C
(Current sourced by High or Low to Chassis into back-plane, with isolation relays open)

Maximum Wire Size: 16 AWG

Ref. Junction Compensation Accuracy: 0.1 °C (over 18 to 28 °C operating temperature)

Max Temperature Difference Across Isothermal Module: 0.2 °C

*Applies to HP 3852As with firmware revision 2.0 or above.

10-19 HP 44711A AND HP 44713A PERFORMANCE TESTS

10-20 Introduction

The following Performance Tests check the operation of the HP 44711A and HP 44713A component module. Performance Tests are not given for the terminal modules. Successful completion of all tests in this chapter provides a high confidence level that the FET Multiplexer is meeting its listed specifications.

The Performance Tests should be performed in the order they are presented. The completion of each test increases the confidence level in FET Multiplexer operation. A minimum set of tests is given as Operational Verification Tests. These tests are described in Section 10-21.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence that the FET Multiplexer is operating normally, it is not recommended that all the Performance Tests be performed unless one of the tested specifications is in question.

10-21 Operational Verification

The first tests given in this section are the minimum set of tests recommended for the FET Multiplexer. These tests are designed to test the functionality and the on resistance of the FET switches. A ribbon cable test is included to verify that the HP 44711A or HP 44713A can communicate and transmit data over the ribbon cable to an HP 44702A/B. Successful completion of the Operational Verification Tests provides a 90% confidence level that the FET Multiplexer is operating normally and is within specification.

The Operational Verification Tests consist of the following:

Section 10-25 - Set-Up Procedure
Section 10-26 - Channel Switches Test
Section 10-27 - Tree Switch and Isolation Relay Test
Section 10-28 - Ribbon Cable Test

10-22 Equipment Required

The following test equipment is required to run the Performance Tests. Only the first four items in the list are required for the Operational Verification Tests.

1. Test Fixture (as described in Section 10-23)

2. Digital Multimeter -- HP 3456A or equivalent

3. HP 44702A/B High-Speed Voltmeter (for Ribbon Cable Test only)

4. Test Leads and Jumpers

5. Service Module -- HP 44743A

6. Resistor -- 10 Mohm

7. Resistor -- 1 kohm

8. Oscilloscope -- HP 1740A or equivalent (dual trace with delayed sweep)

9. +10 V Power Supply -- HP 6234 or equivalent

10. -10 V Power Supply -- HP 6234 or equivalent

NOTE

Except for the Ribbon Cable Test (it requires the HP 44702A/B), either of the accessory plug-in voltmeters (HP 44701A or HP 44702A/B) may be used for this test. This test does not describe the specific steps required to use the plug-in voltmeters. A description of the plug-in voltmeters can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

10-23 Test Fixture

A test fixture is required to run the Performance Tests. A schematic of the required test fixture is shown in Figure 10-7a. A test fixture can be manufactured using an HP 44711AT terminal module (see Figure 10-7b). Because wiring the test fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

If the test fixture is to be fabricated from other than an HP 44711AT terminal module, it is important that the terminal ID lines, shown in Figure 10-7a, be correctly wired. The HP 3852A local controller will not allow the execution of some commands with an incorrect terminal ID.

The test fixture consists of a short circuit between all channel HIGH lines and a short circuit between all channel LOW lines. The use of the test fixture minimizes the number of test lead connections required for the tests.

10-24 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

10-25 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the FET multiplexer. Disconnect the ribbon cable if it is connected to either an HP 44702A/B or another FET multiplexer. Install the test fixture on the multiplexer. Note the slot number where the multiplexer under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

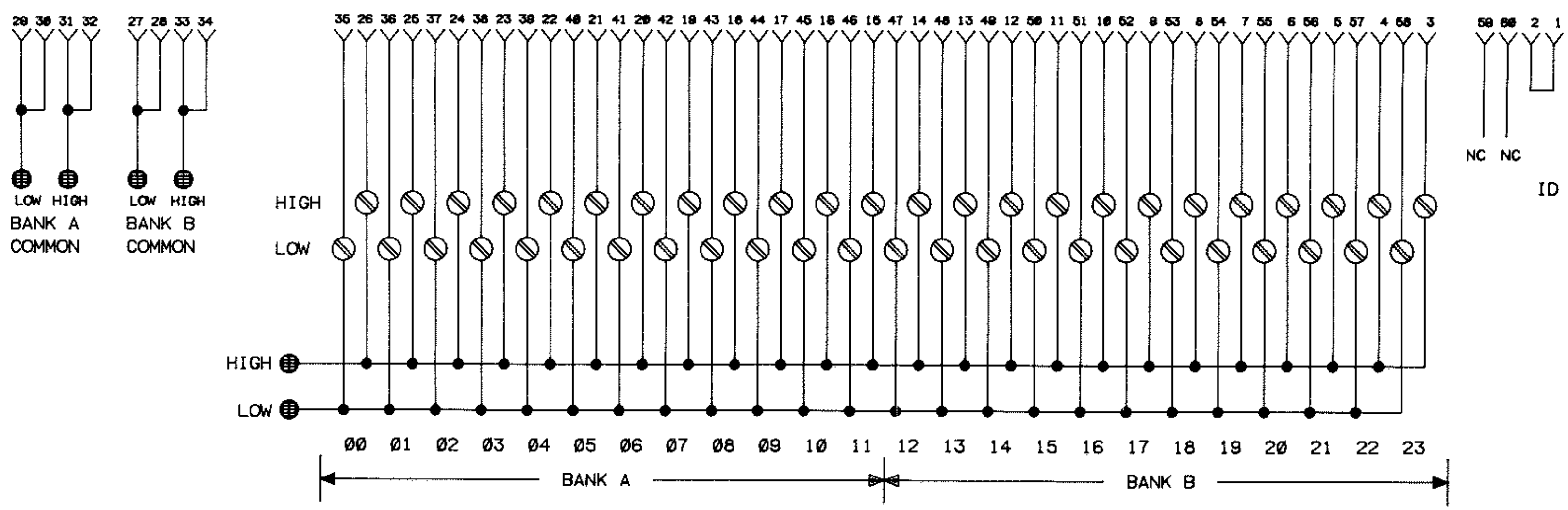


Figure 10-7a HP 44711A Test Fixure Schematic

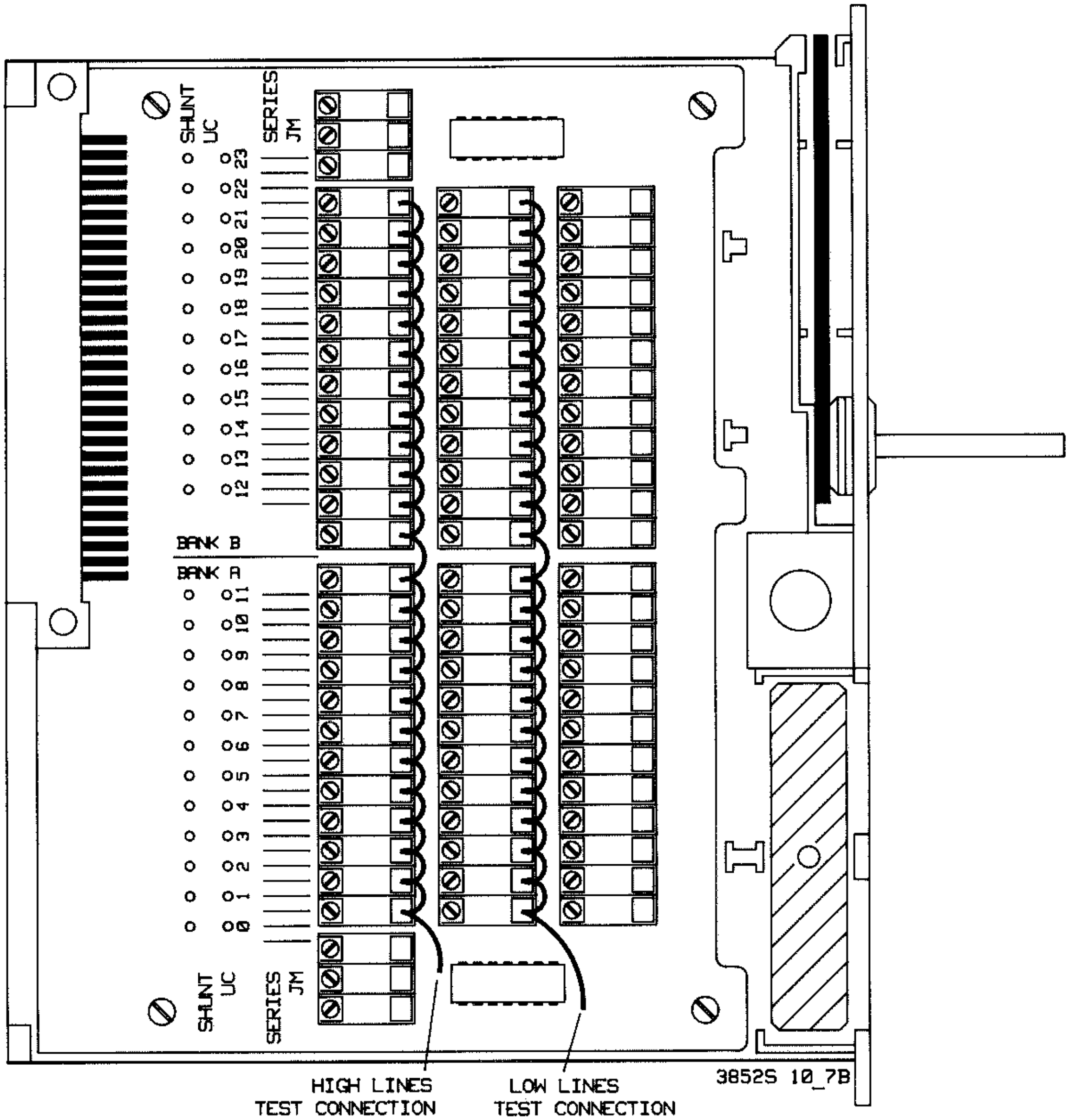


Figure 10-7b HP 44711A Test Fixture

c. Verify that the HP 3852A right display shows:

44711A

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

10-26 Channel Switches Test

This test checks the on resistance for the HIGH and LOW FET switches in both Banks A and B.

1. Set the HP 44711A to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

This opens all switches on the HP 44711A.

2. On the test fixture, connect the multimeter DCV lead to the Bank A HIGH common test point. Connect the multimeter COM lead to the shorted HIGH connections of the channels. Short the Bank A and Bank B HIGH common test points together. Set the multimeter to measure two-wire ohms. The connections are shown in Figure 10-8.

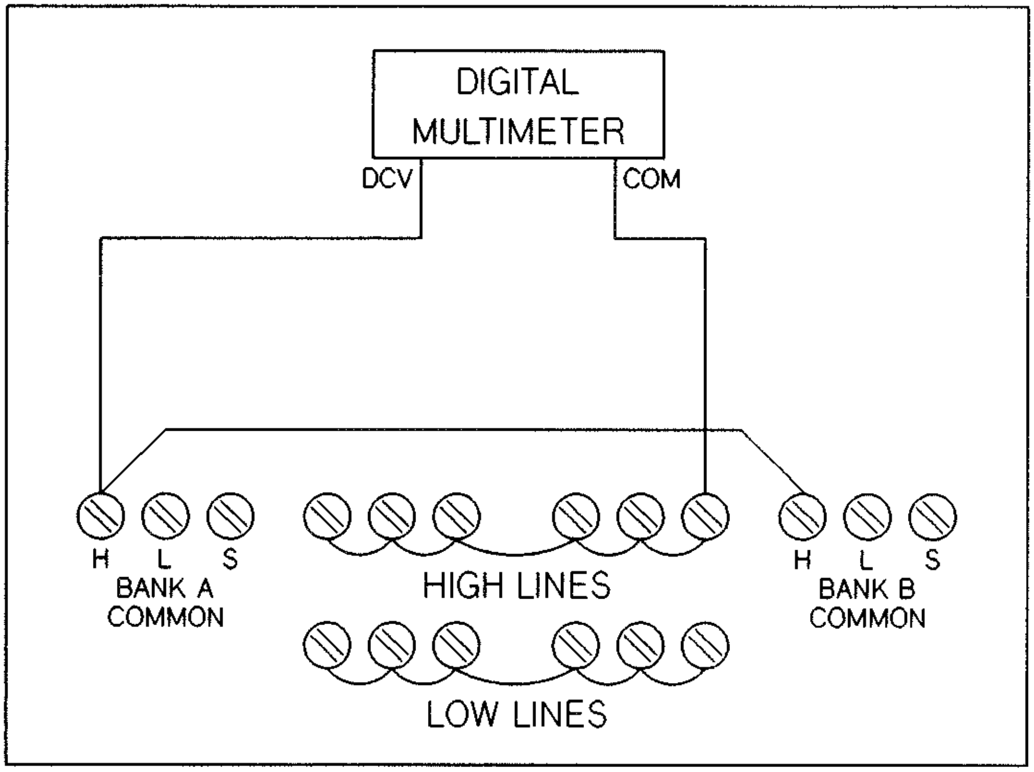


Figure 10-8 HP 44711A HIGH Channel Test Set-Up

3. Close the first channel by executing:

CLOSE ES00 (where E = extender number, S = slot number)

4. Observe the reading on the multimeter. The multimeter should indicate <1.6 kohms resistance. If the reading is greater than 1.6 kohms, the channel FET switch may be faulty.

5. Open the channel by executing:

OPEN ES00 (where E = extender number, S = slot number)

6. Observe the reading on the multimeter. The multimeter should indicate a resistance greater than 100 Mohm. It is important to perform this step to ensure that none of the FET switches are stuck on or leaking.

7. Repeat steps 4, 5, 6, and 7 for channels 01 through 23. In the CLOSE and OPEN commands the last two digits indicate the channel number. For example, CLOSE ES01 closes channel 01 in extender E at slot S.

8. Connect the multimeter DCV lead to the Bank A LOW common test point on the test fixture. Connect the multimeter COM lead to the shorted LOW connections of the channels. Short the Bank A and Bank B LOW common test points together. The connections are shown in Figure 10-9.

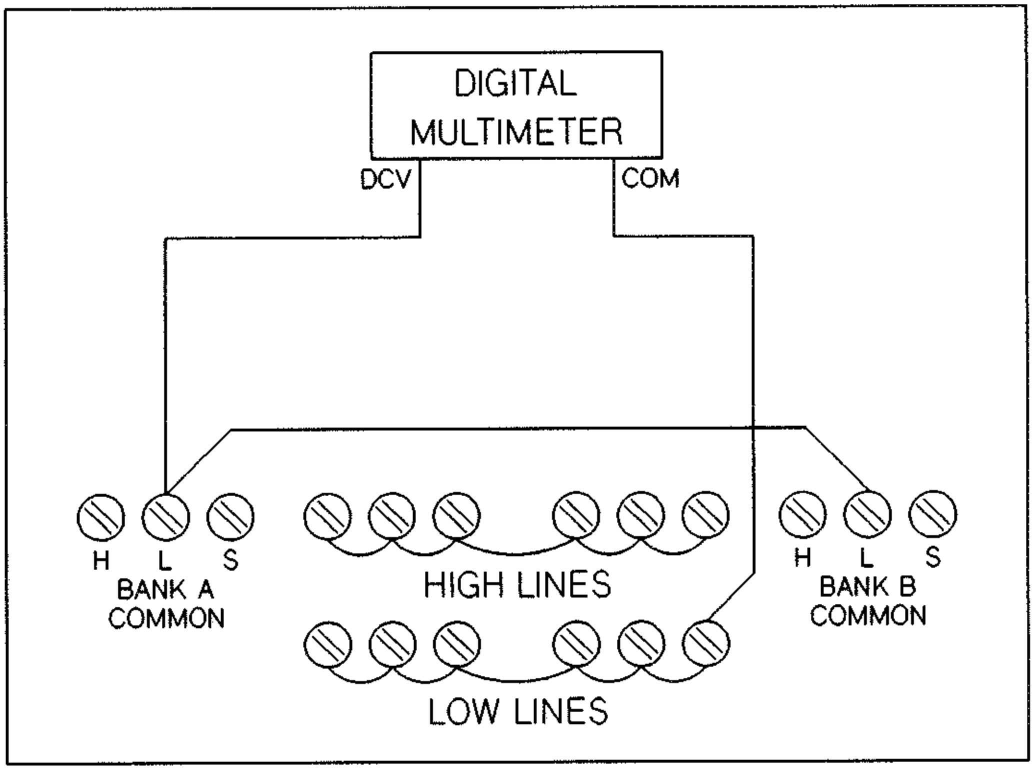


Figure 10-9 HP 44711A LOW Channel Test Set-Up

9. Repeat steps 3, 4, 5, 6, and 7. This checks the LOW path through the FET switches.

10-27 Tree Switch and Isolation Relay Test

1. SENSE BUS TREE SWITCH AND ISOLATION RELAY TEST: This test checks the measurement path from the backplane analog sense bus through the isolation relay and tree switches.

2. Connect a jumper between the Bank A common HIGH and Bank A common LOW connections on the test fixture.

3. Set the multimeter to measure two-wire ohms. Connect the multimeter test leads to the backplane analog bus sense HIGH and LOW lines.

NOTE

The backplane analog bus can be tested in one of two ways: 1) By connecting an external multimeter to the analog bus connector on the rear panel of the power supply module as shown in Figure 10-10, or 2) By connecting an external multimeter to the backplane analog bus line jumpers provided on the 44743A service module as shown in Figure 10-11.

4. Close Bank A sense tree switch and isolation relay by executing:

   SWRITE ES00,6,-32608 (where E = extender number, S = slot number)

5. Observe the indication on the multimeter. The multimeter should indicate less than 3.2 kohm.

6. Open the tree switch and isolation relay by executing:

   RESET ES00 (where E= extender number, S= slot number)

7. Observe the indication on the multimeter. The multimeter should indicate greater than 100 Mohm.

8. Disconnect the jumper between the Bank A common HIGH and the Bank A common low connection on the test fixure. Connect a jumper between the Bank B common HIGH and the Bank B common LOW connections on the test fixture.

9. Close the Bank B sense tree switch and isolation relay by executing:

   SWRITE ES00,6,-32624 (where E = extender number, S = slot number)

10. Observe the indication on the multimeter. The multimeter should indicate less than 3.2 kohm.

11. Open the Bank B sense tree switch and isolation relay by executing:

    RESET ES00 (where E= extender number, S= slot number)

12. Observe the indication on the multimeter. The multimeter should indicate greater than 100 Mohm.

13. SOURCE BUS TREE SWITCH AND ISOLATION RELAY TEST: This test checks the measurement path from the backplane analog source bus through the isolation relay and tree switches.

14. Set the multimeter to measure two-wire ohms. Connect the multimeter test leads to the backplane analog source bus HIGH and LOW lines.

15. Disconnect the jumper between the Bank B common HIGH and the Bank B common low connection on the test fixure. Connect a jumper between the Bank A common HIGH and the Bank A common LOW connections on the test fixture.

16. Close Bank A source tree switch and isolation relay by executing:

    SWRITE ES00,6,-32672 (where E = extender number, S = slot number)

17. Observe the indication on the multimeter. The multimeter should indicate less than 3.2 kohm.

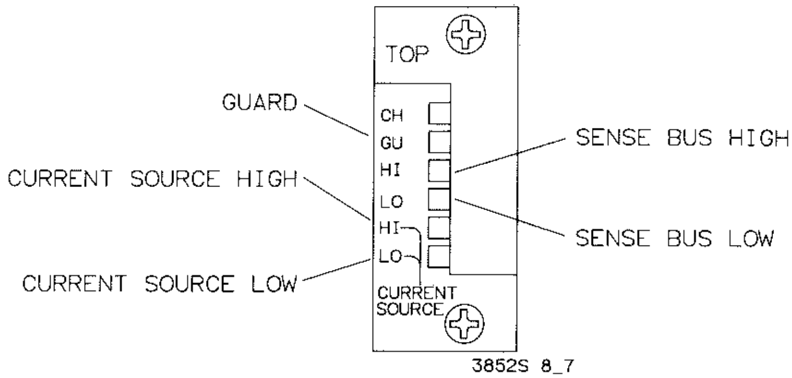


Figure 10-10 Analog Bus Connector

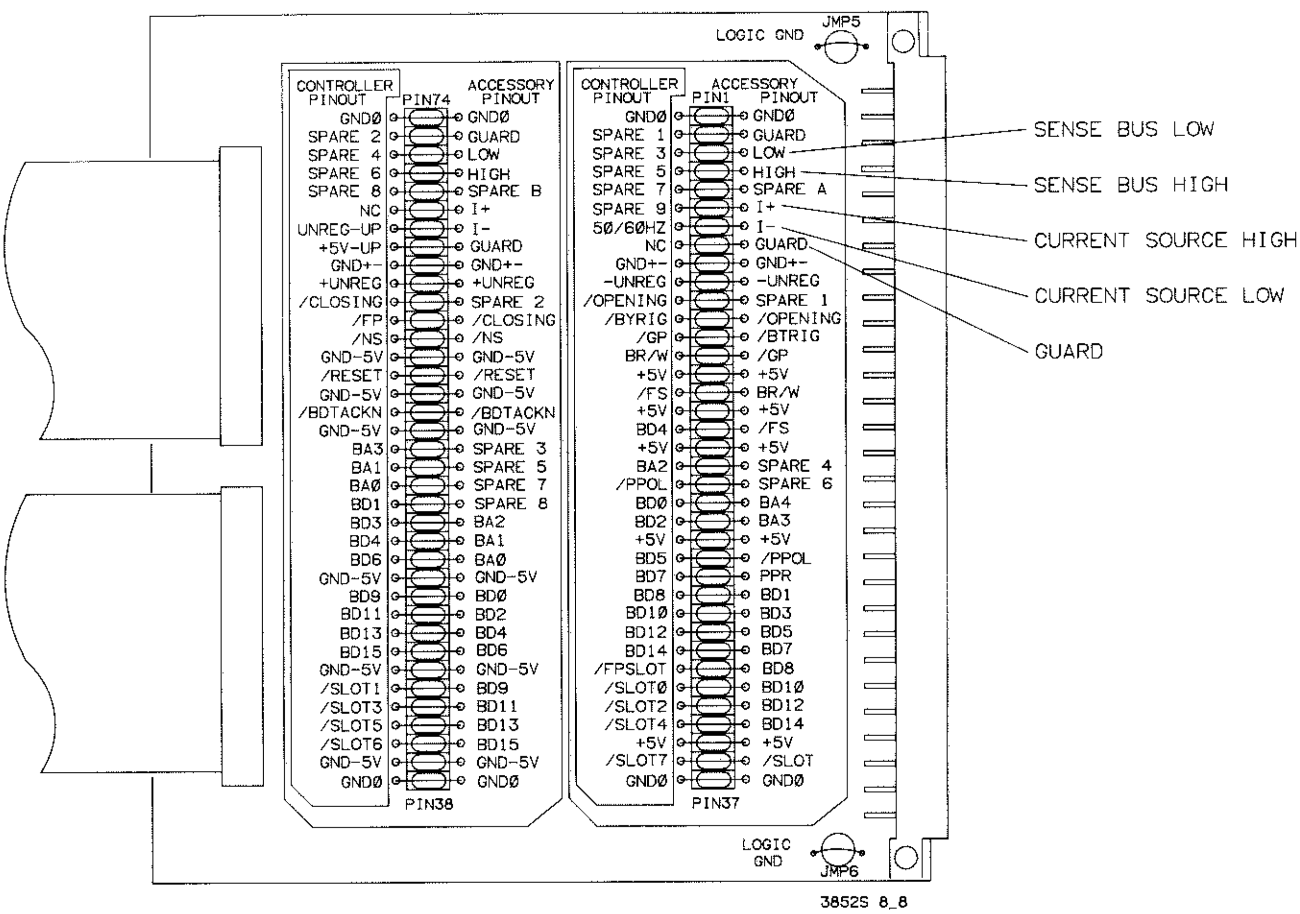


Figure 10-11 HP 44743A Service Module

18. Open the tree switch and isolation relay by executing:

RESET ES00 (where E = extender number, S = slot number)

19. Observe the indication on the multimeter. The multimeter should indicate greater than 100 Mohm.

20. Disconnect the jumper between the Bank A common HIGH and the Bank A common LOW connection on the test fixure. Connect a jumper between the Bank B common HIGH and the Bank B common LOW connections on the test fixture.

21. Close the Bank B source tree switch and isolation relay by executing:

SWRITE ES00,6,-32688 (where E = extender number, S = slot number)

22. Observe the indication on the multimeter. The multimeter should indicate less than 3.2 kohm.

23. Open the Bank B source tree switch and isolation relay by executing:

RESET ES00 (where E = extender number, S = slot number)

24. Observe the indication on the multimeter. The multimeter should indicate greater than 100 Mohm.

10-28 Ribbon Cable Test

This test verifies that the FET multiplexer can be controlled by the HP 44702A/B High-Speed Voltmeter. It also verifies that measurement results can be transferred to the voltmeter over the ribbon cable.

1. Remove power from the HP 3852A.

2. Install the HP 44711A component module in the mainframe next to an HP 44702A/B. Connect the ribbon cable between the FET multiplexer and the HP 44702A/B. Note the slot number where the FET under test is installed and the slot number where the HP 44702A/B is installed.

3. Install the test fixture on the FET multiplexer.

4. Apply power to the HP 3852A.

5. Set up the tests by executing the following commands:

USE ES00 (where E = extender number, S = slot number for High Speed Voltmeter)
FASTDISP OFF
SCANMODE ON
TERM RIBBON

6. On the test fixture, connect a jumper between the shorted HIGH lines and the shorted LOW lines.

7. Enter, but do not execute, the following command:

CONFMEAS OHM ES00-ES23 (where E = extender number, S = FET mux. slot number)

8. When the command entered in step 7 is executed, the HP 44702A/B will perform a resistance measurement on all channels on the HP 44711A. With the FASTDISP OFF, each measurement will appear in the HP 3852A right display. The HP 3852A left display will indicate each channel as it is scanned. Observe the HP 3852A displays and press execute. The resistance indicated in the right display, for all channels, should

be less than 6.2 kohms (the number in the display will be in exponential format). The resistance indicated includes the on-resistance of the channel FET switch, the on-resistance of the tree FET switch, and the resistance of the series protection resistors. The scan list can be repeated, if desired, by pressing the RECALL ENTRY key and then the ENTER key.

9. Remove the jumper from the test fixture.

10. Press the RECALL ENTRY key to retrieve the scan list command. Press the ENTER key and observe the displays. The resistance indicated in the HP 3852A right display should be infinite (the HP 44702A/B indicates an infinite resistance by the display: 1.000000E+38).

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44711A/44713A PERFORMANCE TESTS.

10-29 DC Offset Test

1. Perform the Set-Up Procedure given in Section 10-25. The DC Offset test set-up is shown in Figure 10-12.

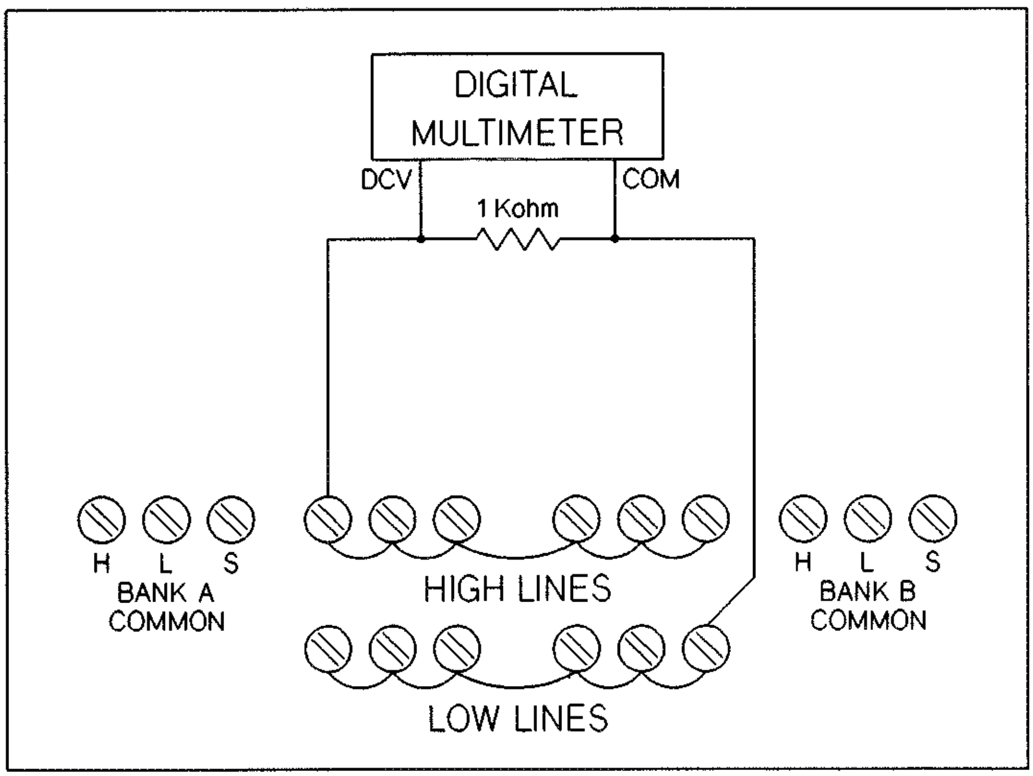


Figure 10-12 HP 44711A DC Offset Test Set-Up

2. Set the multimeter to measure DC volts, on a range with at least 10 μV resolution. Connect the multimeter DCV lead to the shorted HIGH lines of the test fixture. Connect the multimeter COM lead to the shorted LOW lines of the test fixture.

3. Connect the 1 kohm resistor across the multimeter input leads.

NOTE

The offset voltage is specified with a resistance of 1 kohm or less. A smaller value resistor may be used for this test.

4. Close the first channel in the multiplexer by executing:

   CLOSE ES00 (where E = extender number, S = slot number)

5. Observe the indication on the multimeter. The voltage indicated should be less than 15 µV (0 to 28 °C) or less than 185 µV (28 to 55 °C). A failure of the DC Offset test indicates a failing channel FET switch.

6. Repeat steps 4 and 5 for channels 01 through 23. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES01 would close channel 01 in extender E at slot S).

10-30 Opening and Closing Time Set-Up Procedure

The Opening and Closing Time test verifies that the channel FETs will switch on and off and that the multiplexer can scan the channels at the specified speed.

1. Remove power from the HP 3852A and unplug the multiplexer to be tested. Install the Service Module in a convenient slot in the HP 3852A. Note the slot number where the Service Module is installed. Install the multiplexer on the service module. Install the test fixture on the multiplexer. The Set-Up Procedure is depicted in Figure 10-13.

2. On an oscilloscope, connect probes to the Channel A INPUT and the Channel B INPUT. Set up the oscilloscope to the following:

   Dual Trace
   Channel A -- DC, 0.2 Volts/Div (if using 10:1 probes)
   Channel B -- DC, 0.5 Volts/Div (if using 10:1 probes)
   Trigger -- Internal, triggered on Channel B
   Vertical Display -- Alternate
   Time -- 0.5 mses/Div
   Delayed Sweep -- 0.1 µsec/Div
   Delayed Sweep Dial -- Minimum

3. Connect a jumper from the +5V test connection on the service module to the shorted HIGH connections on the test fixture.

4. Connect a jumper between the Bank A HIGH common test point and the Bank B HIGH common test point on the test fixure.

5. Connect the 1 kohm resistor between the HIGH common test points on the test fixture and the logic ground test connection on the service module.

6. Connect the Channel A oscilloscope probe to the HIGH common test points on the test fixture.

7. Connect the Channel B oscilloscope probe to the OPENING test connection on the service module.

8. Apply power to the HP 3852A. Wait for the wake-up sequence to complete.

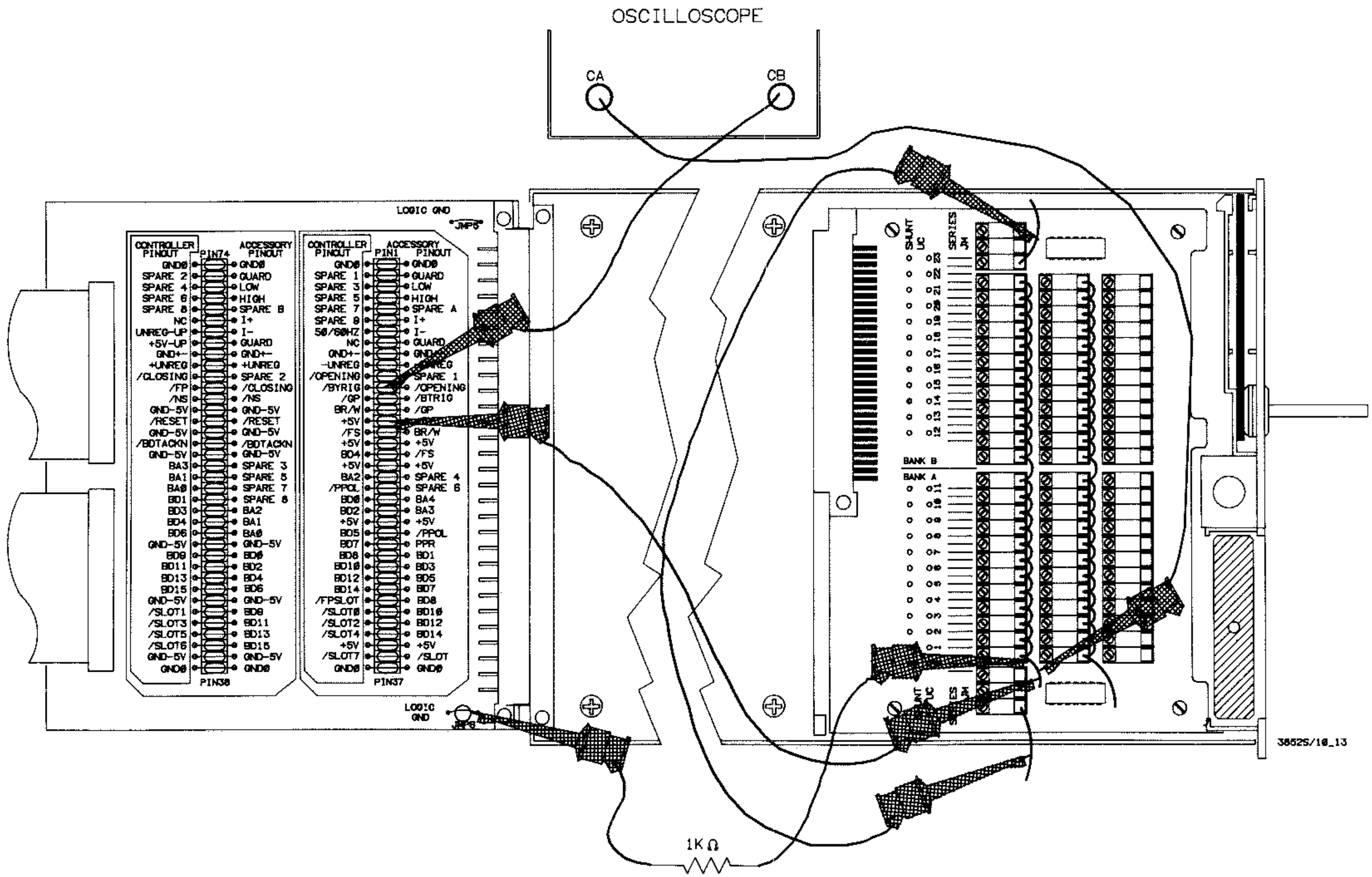


Figure 10-13 HP 44711A Opening Time Set-Up

9. Set up the following subroutine in HP 3852A memory. When the first statement is entered the SUB ENTRY annunciator should be on in the left display. This annunciator should remain on until the SUBEND statement is entered.

```
SUB A
TRG
SCAN ES00-ES23   (where E = extender number, S = slot number)
SUBEND
```

The subroutine will scan all channels on the FET multiplexer. Do not reset or cycle power to the HP 3852A or the subroutine will be erased from memory. The front panel CLEAR key may be used without disturbing the subroutine.

10-31 Opening Time Test

This test checks the time it takes for the FET to open after receiving an OPENING pulse from the FET multiplexer.

1. Repetitively call the entered subroutine 10000 times by executing:

```
CALL A,10000
```

This statement will call the subroutine 10000 times.

2. Observe the waveform displayed on the Channel B trace and make sure all 24 channels are present. It may also be necessary to adjust the TRIGGER LEVEL and TRIGGER HOLD controls, and to select the negative trigger pulse position on the scope to synchronize the signal on the scope.

3. Rotate the DELAY SWEEP dial to the minimum position. Select the DELAYED sweep mode on the scope. Slowly rotate the DELAY SWEEP dial clockwise while observing the displayed waveforms. The Channel B waveform is the OPENING pulse. The Channel A waveform is the +5V supply as switched by the relays. As the DELAY SWEEP dial is rotated, each channel switch and the associated OPENING pulse will come into view. The FET opening time is the time from the falling edge of the OPENING pulse to the falling edge of the Channel A waveform. This time must be less than 1.2 μseconds. The opening time is illustrated in Figure 10-14.

NOTE

The +5 V power supply waveform on Channel A will show an amplitude difference between the Bank A and Bank B FET switches. This is due to impedance differences in the Bank A common and Bank B common measurements paths on the multiplexer.

Continue rotating the DELAY Sweep dial until all 24 FET channels have been checked. A failing channel indicates a failing FET switch.

To stop the test at any time, press the front panel CLEAR key. The test time may be extended by increasing the number of times the subroutine is called, as specified in step 1.

The waveform will exhibit a small amount of jitter due to the overhead requirements of the HP 3852A operating system.

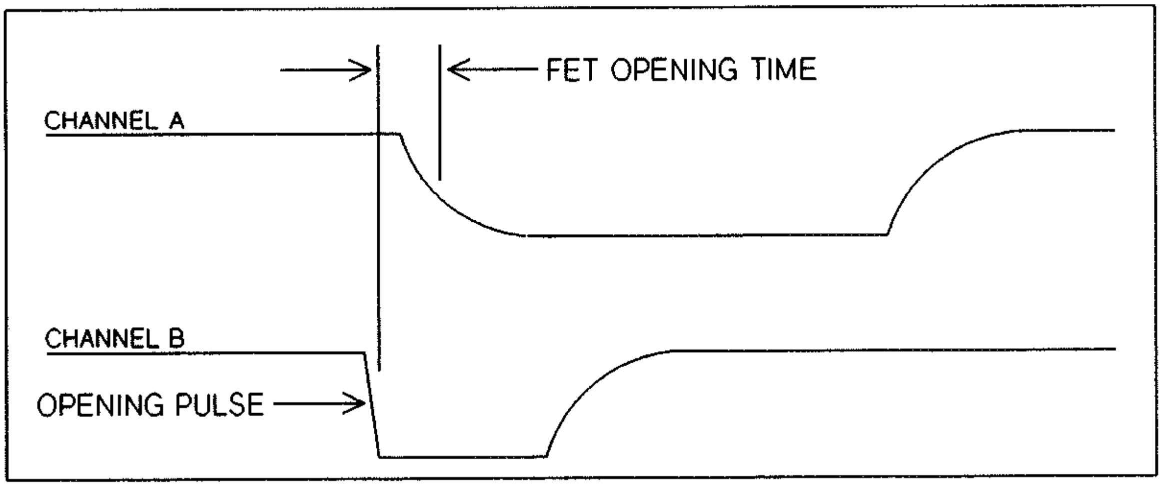


Figure 10-14 HP 44711A Opening Time

10-32 Closing Time Test

This test checks the time it takes for the FET to close after receiving a CLOSING pulse from the FET multiplexer.

1. Move the channel B oscilloscope probe to the CLOSING connection on the service module. The Closing Time test set-up is shown in Figure 10-15.

2. Repetitively call the entered subroutine by executing:

CALL A,10000

3. Rotate the DELAY SWEEP dial on the oscilloscope to the minimum position. Slowly rotate the dial clockwise until the first closing is displayed. The Channel B trace is the closing pulse output from the multiplexer. The Channel A waveform is the +5V supply, as switched by the FET channel switches. As the DELAY SWEEP dial is rotated, each channel switch and the associated CLOSING pulse will come into view. The FET closing time is the time from the falling edge of the CLOSING pulse to the rising edge of the Channel A waveform. This time must be less than 2.25 μseconds. The closing time is illustrated in Figure 10-16.

Continue rotating the DELAY Sweep dial until all 24 FET channels have been checked. A failing channel indicates a failing FET switch.

To stop the test at any time, press the front panel CLEAR key. The test time may be extended by by increasing the number of times the subroutine is called, as specified in step 2.

The waveform will exhibit a small amount of jitter due to the overhead requirements of the HP 3852A operating system.

10-33 Leakage/Bias Current Test

The leakage current test checks the FET switches for excessive leakage/bias current. Leakage/bias current is sourced by the multiplexer from HIGH or LOW to chassis ground.

1. OPEN CHANNELS LEAKAGE/BIAS CURRENT TEST. This test checks the leakage current with all channels open. A simplified schematic of the setup is shown in Figure 10-17 and the test setup for the HIGH lines is shown in Figure 10-18.

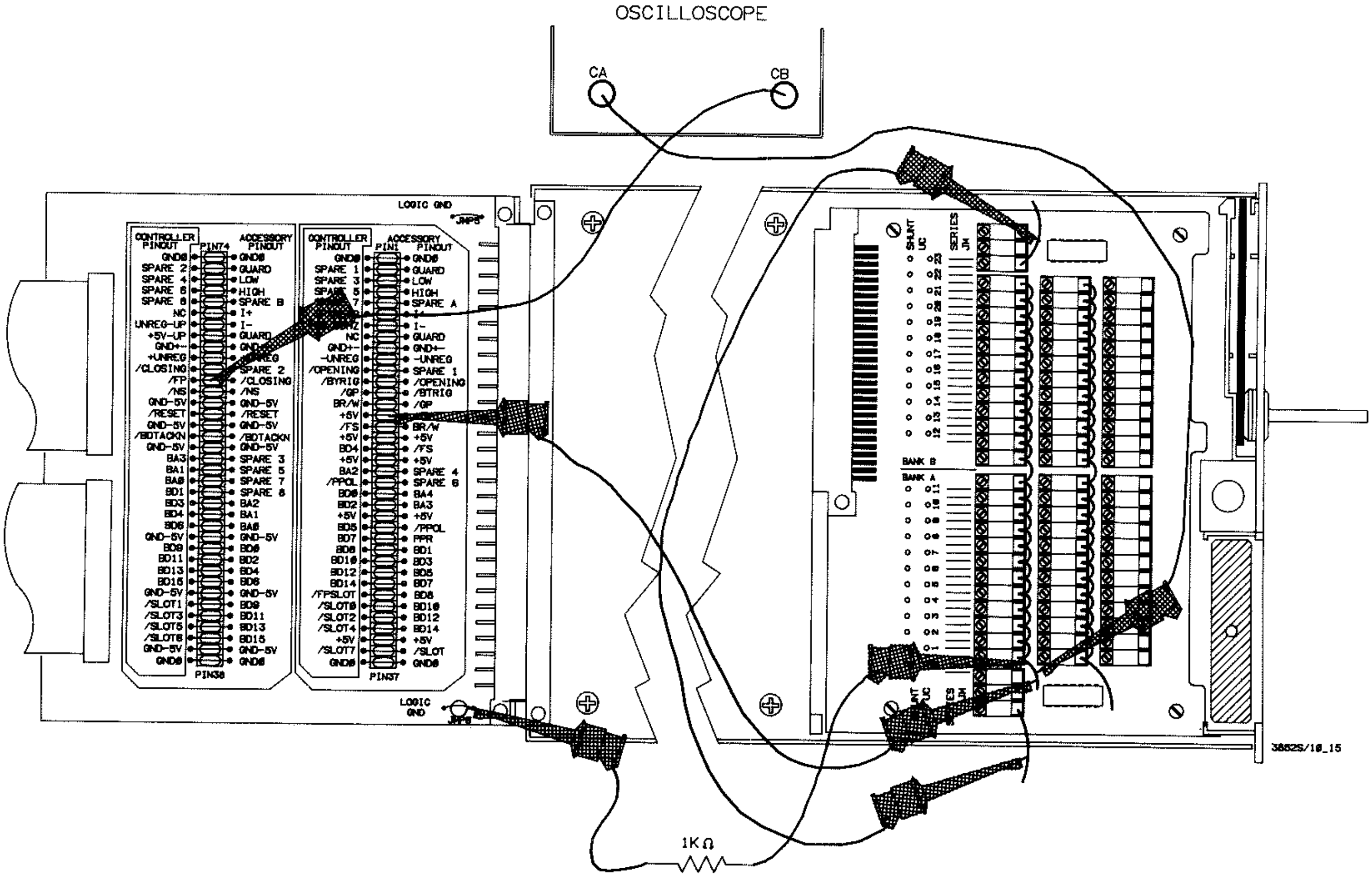


Figure 10-15 HP 44711A Closing Time Set-Up

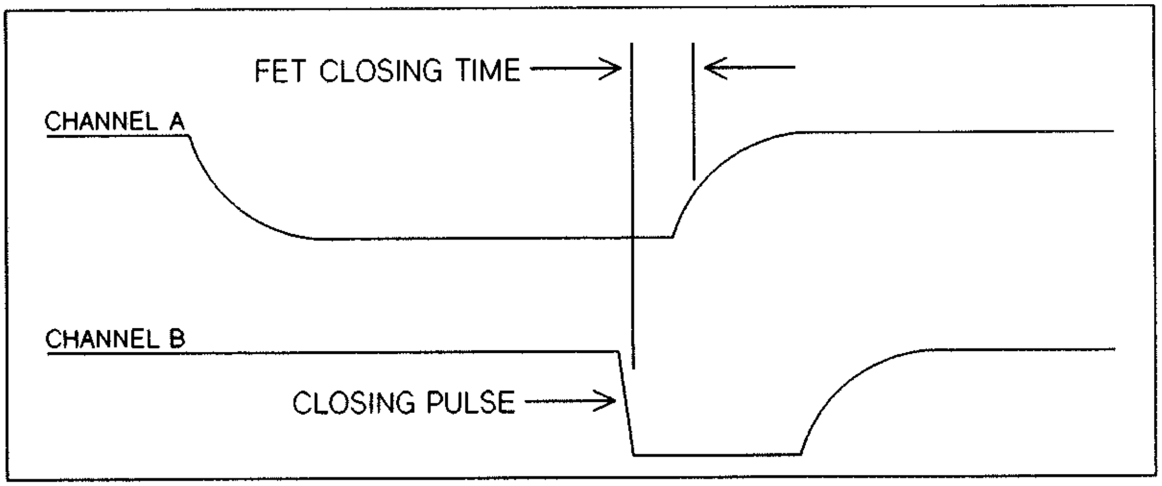


Figure 10-16 HP 44711A Closing Time

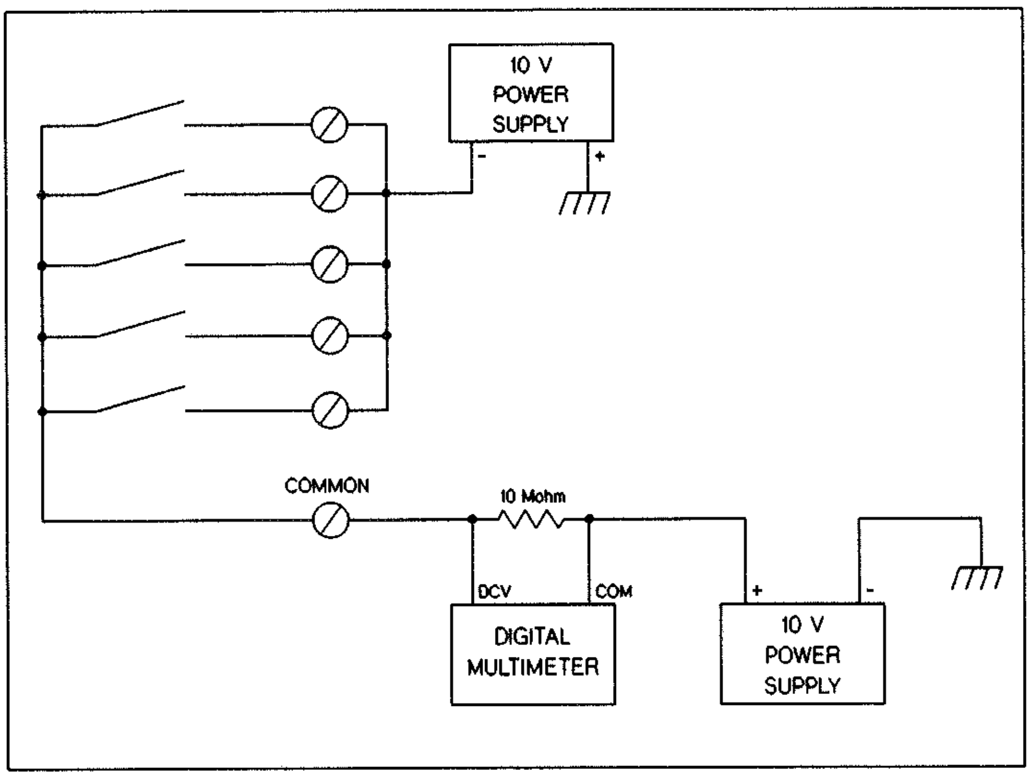


Figure 10-17 Open Channel Leakage Test

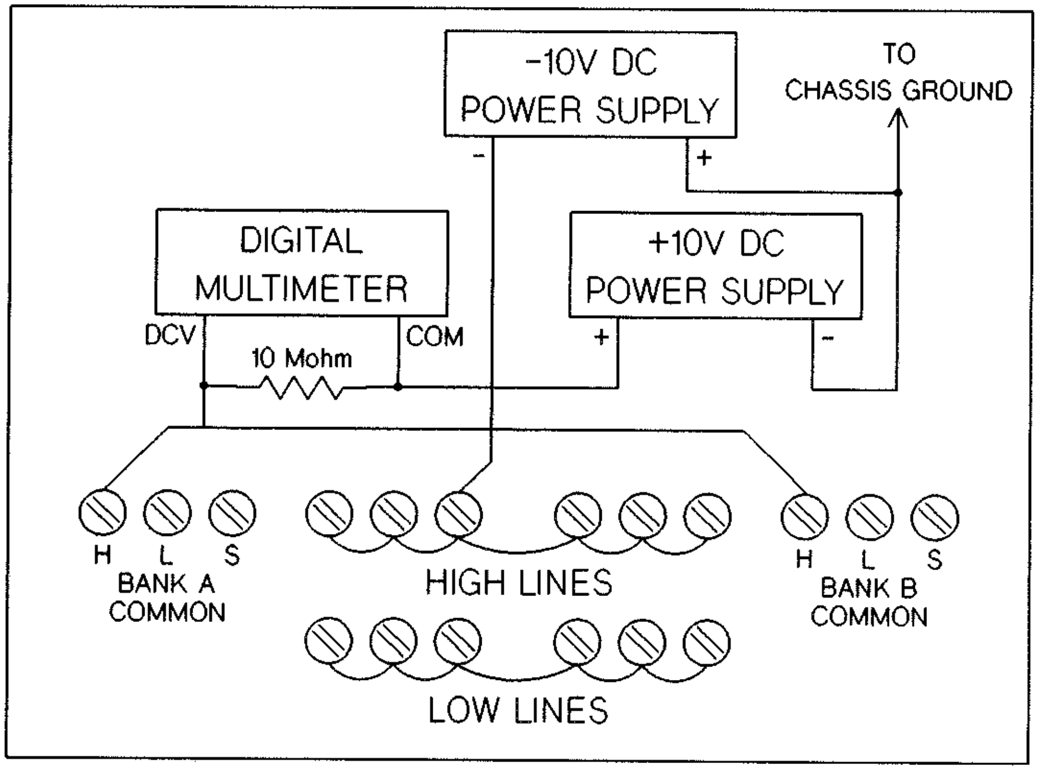


Figure 10-18 HP 44711A Open HIGH Channel Test Set-Up

2. Perform the Set-Up procedure in Section 10-23.

3. Set the negative power supply to 10 Vdc and connect the negative lead to the shorted HIGH lines on the test fixure. Connect the negative power supply common lead to the chassis.

NOTE

Connections to chassis ground can be accomplished by connecting to any sheet metal part. Chassis ground is also available at a connector on the rear panel of the HP 3852A power supply.

4. Set the positive power supply output to 10 Vdc and connect the positive lead to the multimeter common. Connect the positive power supply common to the chassis.

5. Connect the 10 Mohm resistor (**R1**) across the multimeter input terminals. Connect the multimeter DCV input terminal to the Bank A HIGH common test point. Short the Bank A and Bank B HIGH common test points together.

6. Open all switches on the multiplexer by executing:

RESET ES00 (where E = extender number, S = slot number)

7. Close the isolation relay and a tree switch by executing:

CLOSE ES90,ES94 (where E = extender number, S = slot number)

8. Observe the reading on the multimeter. This reading is referred to as **V1** in the following steps.

9. Calculate the leakage current (**I**) from the formula:

$$I = \frac{V1}{R1}$$

The calculated open channel leakage current for the HIGH lines should be less than 2 nA for a room temperature between 0° and 28° C (for temperatures in the range of 0° to 55° C the leakage current should be less than 11 nA).

10. Refer to Figure 10-19. Connect the negative power supply's negative lead to the shorted LOW lines on the test fixure. Connect the negative power supply common lead to the chassis.

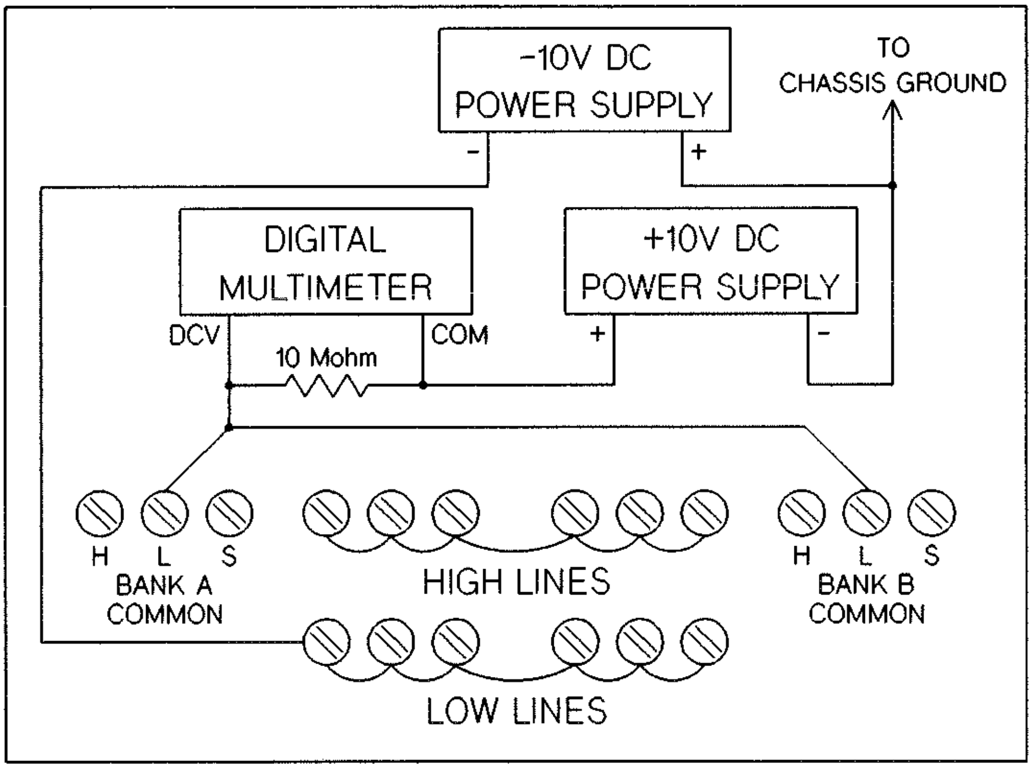


Figure 10-19 HP 44711A Open LOW Channel Test-Setup

11. Connect the multimeter DCV lead to the Bank A common LOW test point. Short the Bank A and Bank B LOW common test points together.

12. Observe the reading on the multimeter. This reading is referred to as **V1** in the following step.

13. Calculate the leakage current (I) from the formula:

$$I = \frac{V1}{R1}$$

The calculated open channel leakage current for the LOW lines should be less than 2 nA for a room temperature between 0° and 28° C (for temperatures in the range of 0° to 55° C the leakage current should be less than 11 nA).

14. CLOSED CHANNEL LEAKAGE/BIAS CURRENT TEST. This test checks each channel HIGH and LOW for leakage current when a channel is closed. A simplified schematic of the setup is shown in Figure 10-20 and the test setup for the HIGH lines is shown in Figure 10-21.

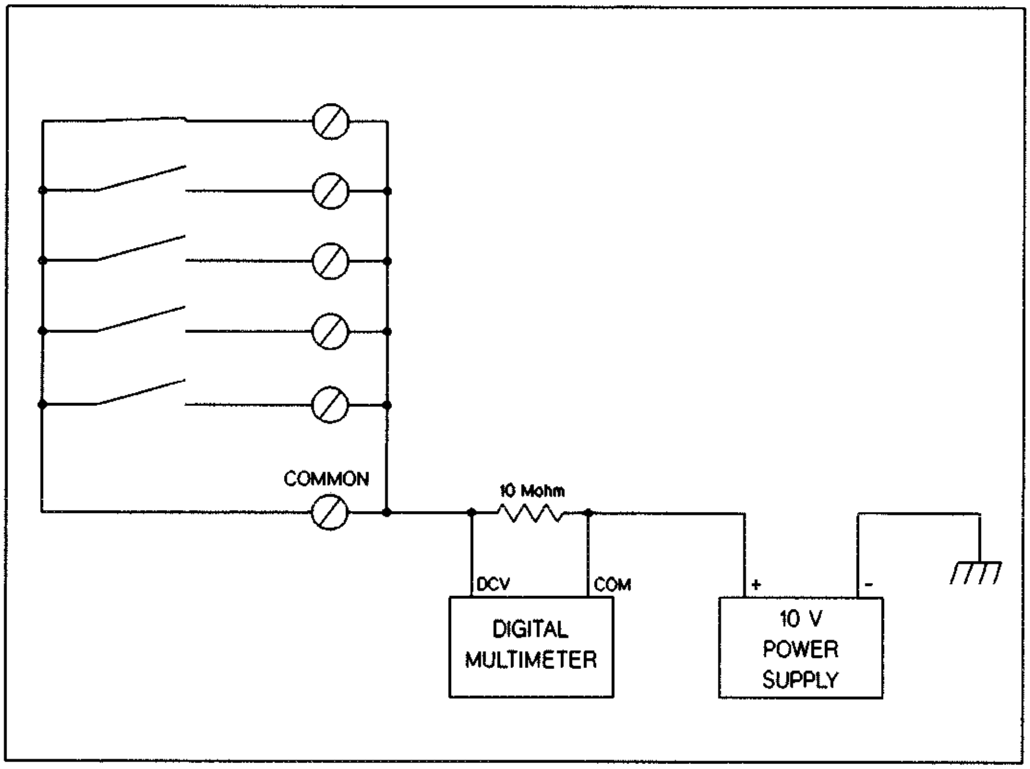


Figure 10-20 Closed Channel Leakage Test

15. Remove the negative power supply from the test fixure.

16. On the test fixture, connect the shorted HIGH lines to the Bank A HIGH common test point. Short the Bank A and Bank B common HIGH test points together.

17. Connect the +10 V power supply common to chassis ground. Connect the power supply positive lead to the common input of the multimeter.

18. Connect the 10 Mohm resistor across the multimeter input terminals. Connect the multimeter DCV input terminal to the shorted HIGH lines on the test fixture.

19. Close the isolation relay by executing:

CLOSE ES90 (where E = mainframe number, S = slot number)

20. Close the first channel in Bank A and the switch by executing:

CLOSE ES94,ES00 (where E = mainframe number, S = slot number)

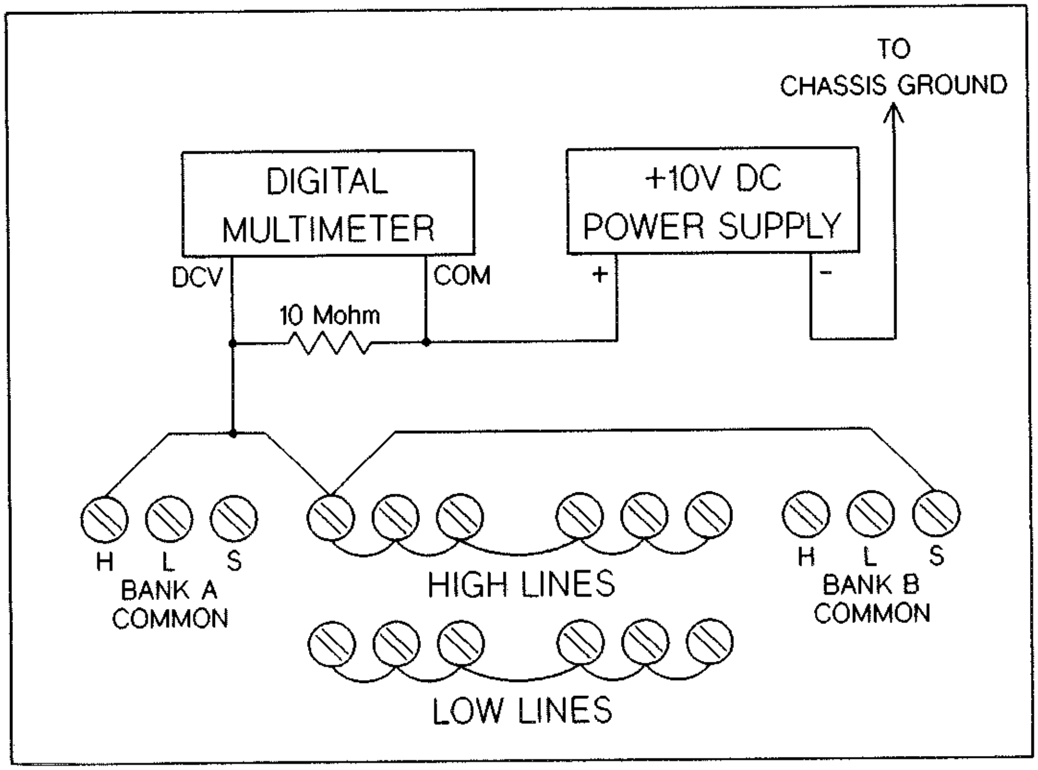


Figure 10-21 HP 44711A Closed HIGH Channel Test Set-Up

21. Observe the voltage reading on the multimeter. This voltage is referred to as **V1** in the following step.

22. Calculate the leakage current (I) from the formula:

$$I = \frac{V1}{R1}$$

The leakage current should be less than 5.0 nA for room temperatures in the range of 0° to 28° C (leakage current should be less than 15 nA for a temperature range of 28° to 55° C).

23. Repeat steps 24, 25, and 26 for channels 01 through 11. In step 21, the channel under test is specified in the second term of the CLOSE command (i.e., CLOSE ES94,ES01 for channel 01).

24. Close the first channel in Bank B and the tree switch by executing:

    CLOSE ES94,ES12 (where E = mainframe number, S = slot number)

25. Observe the voltage reading on the multimeter. This voltage is referred to as **V1** in the following step.

26. Calculate the leakage current (I) from the formula:

$$I = \frac{V1}{R1}$$

The leakage current should be less than 5.0 nA for room temperatures in the range of 0° to 28° C (leakage current should be less than 15 nA for a temperature range of 28° to 55° C).

27. Repeat steps 24, 25, and 26 for channels 12 through 23. In step 24, the channel under test is specified in the second term of the CLOSE command (i.e., CLOSE ES92,ES11 for channel 11).

28. Refer to Figure 10-22. On the test fixture, connect the shorted LOW lines to the Bank A common LOW test point. Short the Bank A and Bank B LOW common test points together.

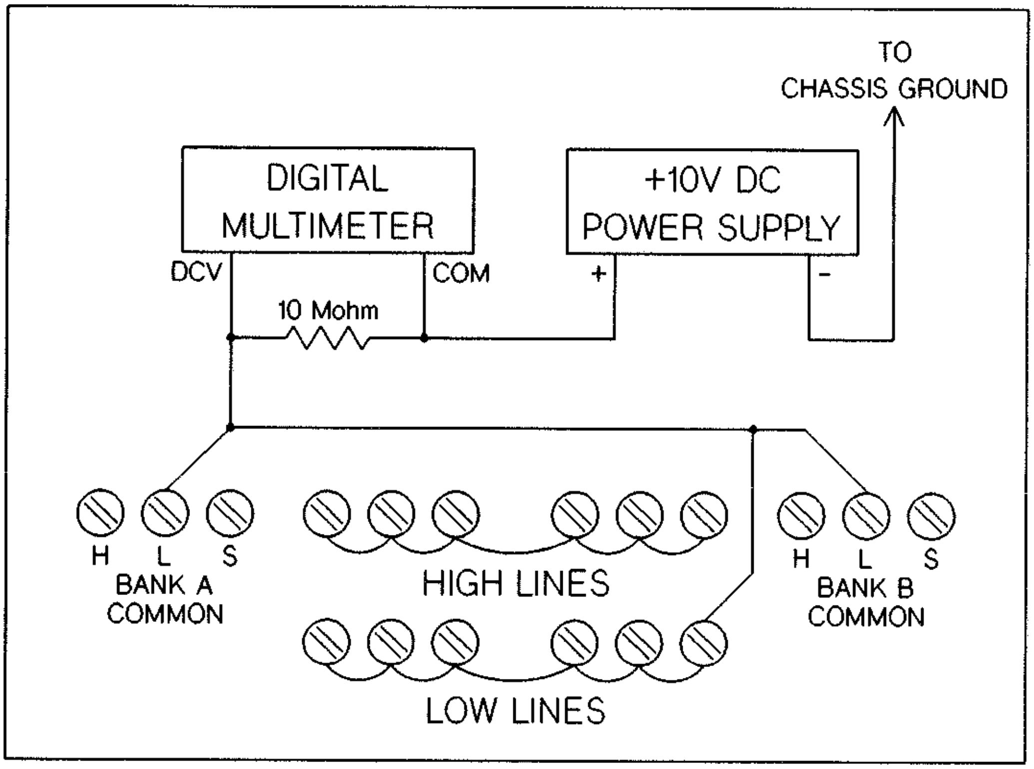


Figure 10-22 HP 44711A Closed LOW Channel Test Set-Up

29. Connect the multimeter DCV input terminal to the shorted LOW lines on the test fixture.

30. Close the first channel in Bank A and the tree switch by executing:

CLOSE ES94,ES00 (where E = mainframe number, S = slot number)

31. Observe the voltage reading on the multimeter. This voltage is referred to as **V1** in the following step.

32. Calculate the leakage current (I) from the formula:

$$I = \frac{V1}{R1}$$

The leakage current should be less than 5.0 nA for room temperatures in the range of 0° to 28° C (leakage current should be less than 15 nA for a temperature range of 28° to 55° C).

33. Repeat steps 30, 31, and 32 for channels 01 through 11. In step 30, the channel under test is specified in the second term of the CLOSE command (i.e., CLOSE ES94,ES01 for channel 01).

34. Close the first channel in Bank B and the associated tree switch by executing:

CLOSE ES94,ES10 (where E = mainframe number, S = slot number)

35. Observe the voltage reading on the multimeter. This voltage is referred to as **V1** in the following step.

36. Calculate the leakage current (I) from the formula:

$$I = \frac{V1}{R1}$$

The leakage current should be less than 5.0 nA for room temperatures in the range of 0° to 28° C (leakage current should be less than 15 nA for a temperature range of 28° to 55° C).

37. Repeat steps 34, 35, and 36 for channels 12 through 23. In step 34, the channel under test is specified in the second term of the CLOSE command (i.e., CLOSE ES94,ES12 for channel 12).

10-34 HP 44712A PERFORMANCE TESTS

10-35 Introduction

The following Performance Tests check the operation of the HP 44712A component module. Performance Tests are not given for the terminal modules. Successful completion of all tests in this chapter provides a high confidence level that the FET Multiplexer is meeting its listed specifications.

The Performance Tests should be performed in the order they are presented. The completion of each test increases the confidence level in FET Multiplexer operation. A minimum set of tests is given as Operational Verification Tests. These tests are described in Section 10-36.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence that the FET Multiplexer is operating normally, it is not recommended that all the Performance Tests be performed unless one of the tested specifications is in question.

10-36 Operational Verification

The first tests given in this section are the minimum set of tests recommended for the FET Multiplexer. These tests are designed to test the functionality and the on resistance of the FET switches. A ribbon cable test is included to verify that the HP 44712A can communicate and transmit data over the ribbon cable to an HP 44702A/B. Successful completion of the Operational Verification Tests provides a 90% confidence level that the FET Multiplexer is operating normally and is within specification.

The Operational Verification Tests consist of the following:

Section 10-40 - Set-Up Procedure
Section 10-40 - Channel Switches Test
Section 10-42 - Tree Switch and Isolation Relay Test
Section 10-43 - Ribbon Cable Test

10-37 Equipment Required

The following test equipment is required to run the Performance Tests. Only the first four items in the list are required for the Operational Verification Tests.

1. Test Fixture (as described in Section 10-38)

2. Digital Multimeter -- HP 3456A or equivalent

3. HP 44702A/B High-Speed Voltmeter (for Ribbon Cable Test only)

4. Test Leads and Jumpers

5. Service Module -- HP 44743A

6. Resistor -- 10 Mohm

7. Resistor -- 1 kohm

8. Oscilloscope -- HP 1740A or equivalent (dual trace with delayed sweep)

9. +10 V Power Supply -- HP 6234 or equivalent

10. -10 V Power Supply -- HP 6234 or equivalent

NOTE

Except for the Ribbon Cable Test (it requires the HP 44702A/B), either of the accessory plug-in voltmeters (HP 44701A or HP 44702A/B) may be used for this test. This test does not describe the specific steps required to use the plug-in voltmeters. A description of the plug-in voltmeters can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

10-38 Test Fixture

A test fixture is required to run the Performance Tests. A schematic of the required test fixture is shown in Figure 10-23a. A test fixture can be manufactured using an HP 44712AT terminal module (see Figure 10-23b). Because wiring the test fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

If the test fixture is to be fabricated from other than an HP 44712AT terminal module, it is important that the terminal ID lines, shown in Figure 10-23a, be correctly wired. The HP 3852A local controller will not allow the execution of some commands with an incorrect terminal ID.

The test fixture consists of a short circuit between all channel HIGH lines and test connections for the LOW line. The use of the test fixture minimizes the number of test lead connections required for the tests.

10-39 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

10-40 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the FET multiplexer. Disconnect the ribbon cable if it is connected to either an HP 44702A/B or another FET multiplexer. Install the test fixture on the multiplexer. Note the slot number where the multiplexer under test is installed.

3. Verify the correct connections and slot numbers:

    a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

    b. Execute:

        ID? ES00 (where E = extender number, S = slot number)

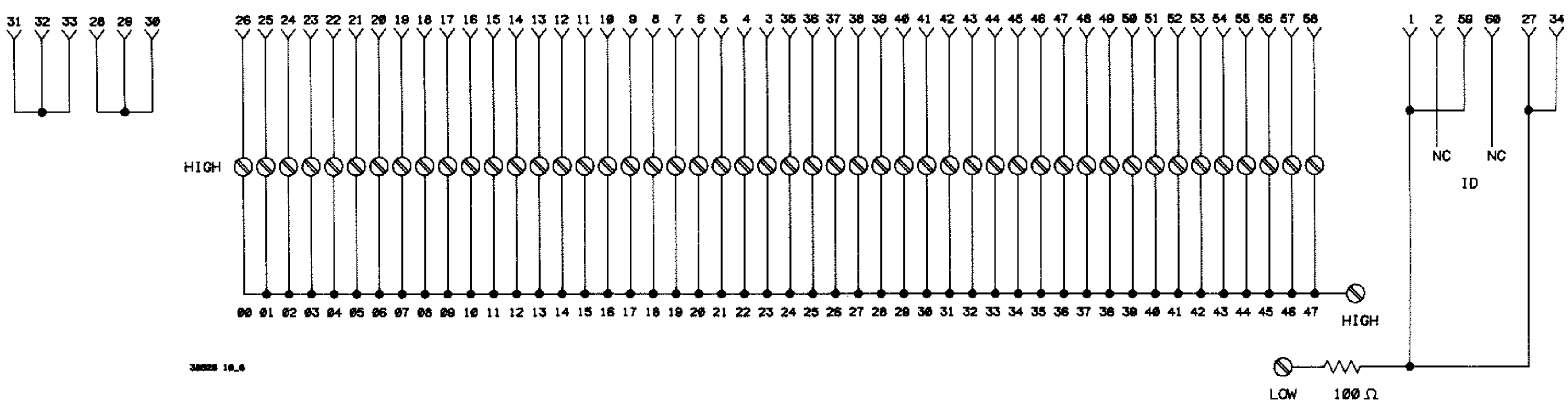


Figure 10-23a HP 44712A Test Fixure Schematic

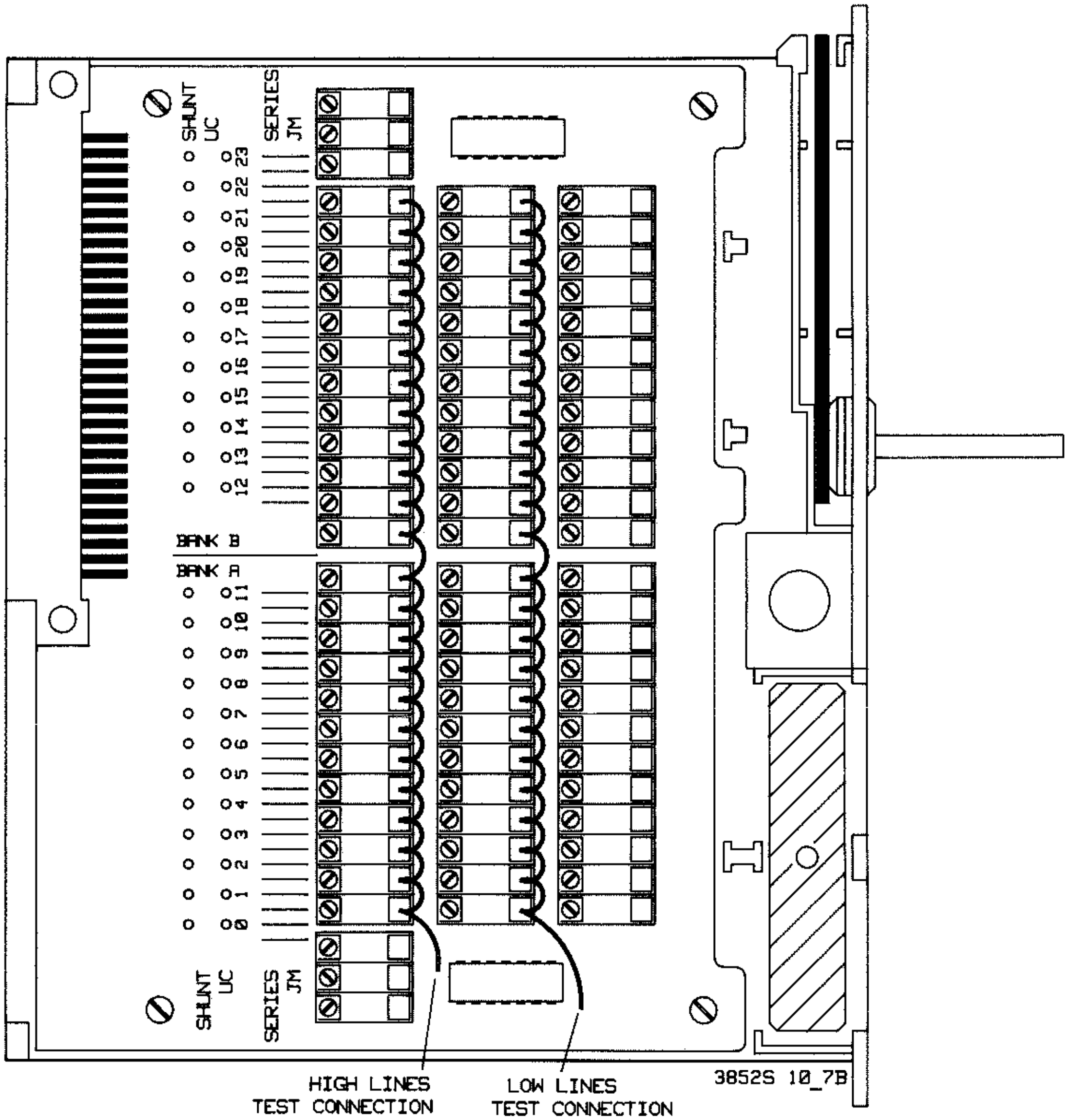


Figure 10-23b HP 44712A Test Fixure

c. Verify that the HP 3852A right display shows:

44712A

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

10-41 Channel and Sense Bus Tree Switches, and Isolation Relay Test

This test checks the measurement path from each channel input to the HP 3852A backplane analog sense bus.

1. Set the HP 44712A to a known state by executing:

   RESET ES00 (where E = extender number, S = slot number)

This opens all switches on the HP 44712A.

2. Set the multimeter to measure two-wire ohms. Connect the multimeter DCV lead to the backplane analog bus sense HIGH line. Connect the multimeter COM lead to the backplane analog bus sense LOW line.

NOTE

The backplane analog bus can be tested in one of two ways: 1) By connecting an external multimeter to the analog bus connector on the rear panel of the power supply module as shown in Figure 10-24, or 2) By connecting an external multimeter to the backplane analog bus line jumpers provided on the 44743A service module as shown in Figure 10-25.

3. Connect a jumper between the shorted HIGH lines and the shorted LOW lines on the test fixure.

4. Close the first channel by executing:

   CLOSE ES90,ES92,ES00 (where E = extender number, S = slot number)

5. Observe the reading on the multimeter. The multimeter should indicate <4.6 kohms resistance. If the reading is greater than 4.6 kohms, the channel FET switch or sense bus tree switch FET, or isolation relay may be faulty.

6. Open the channel by executing:

   OPEN ES90,ES92,ES00 (where E = extender number, S = slot number)

7. Observe the reading on the multimeter. The multimeter should indicate greater than 100 Mohm.

8. Repeat steps 4, 5, 6, and 7 for channels 01 through 47. In the CLOSE and OPEN commands the last two digits indicate the channel number. For example, CLOSE ES01 closes channel 01 in extender E at slot S. Note that in steps 3 and 5 the isolation relays and tree FET switches are controlled by using channel numbers 90 and 92, respectively. These two channels must remain the same for all channels tested in this test.

10-42 Source Bus Tree Switches Test

This test checks the measurement path from the backplane analog source bus through the isolation relay and tree switches. Only two channels are used for the test since all channel switches should be tested by the previous test in Section 10-41.

1. Set the multimeter to measure two-wire ohms. Connect the multimeter DCV lead to the backplane analog bus source HIGH line. Connect the multimeter COM lead to the backplane analog bus source LOW line.

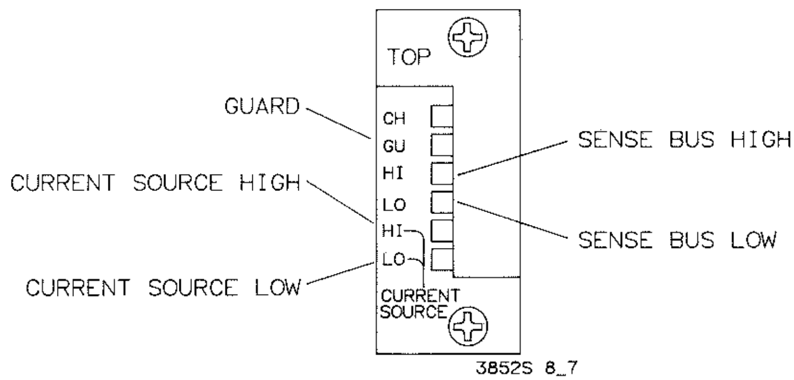


Figure 10-24 Analog Bus Connector

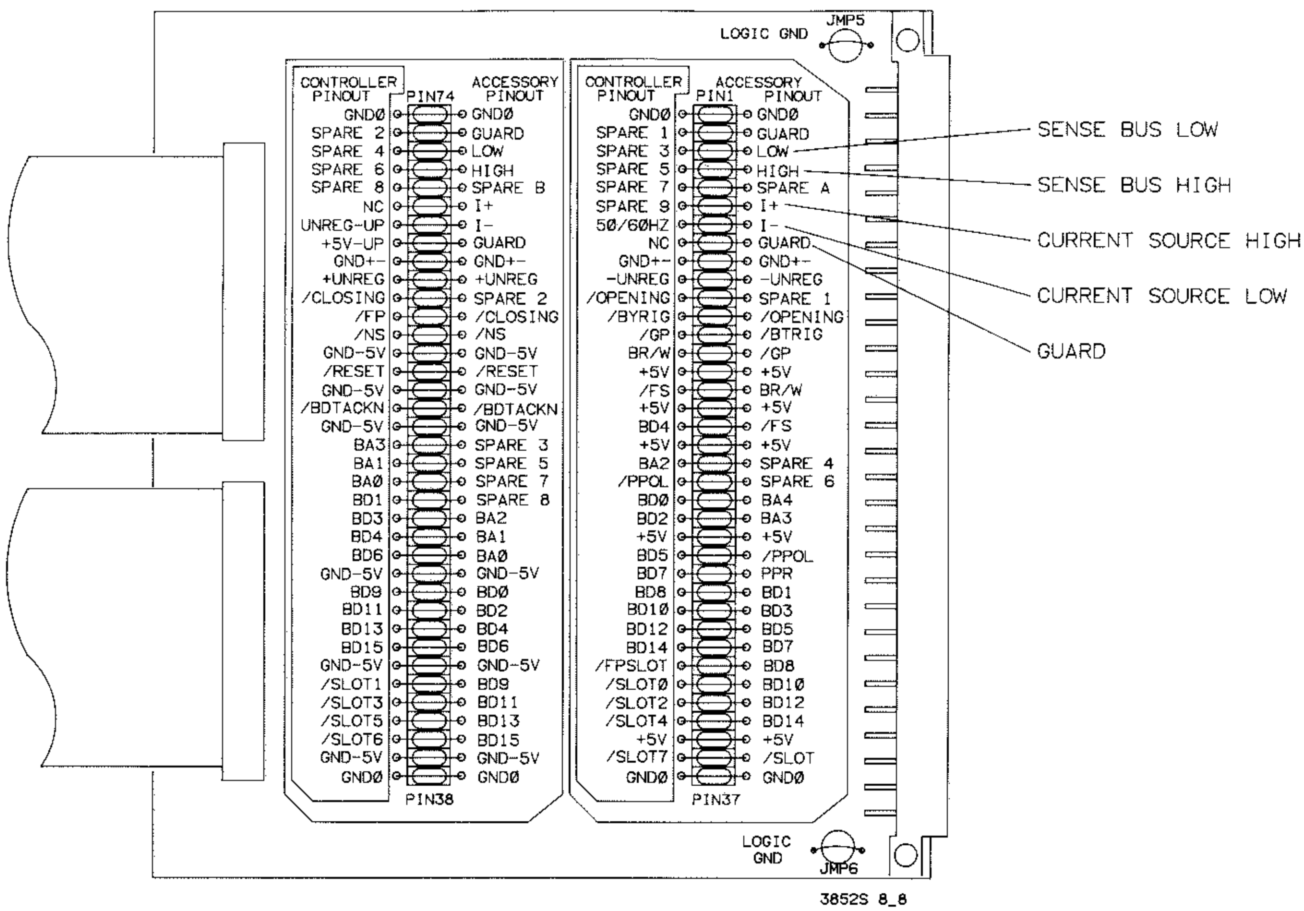


Figure 10-25 HP 44743A Service Module

2. Connect a jumper between the shorted HIGH lines and the shorted LOW lines on the test fixure.

3. Close the first channel by executing:

CLOSE ES90,ES91,ES00 (where E = extender number, S = slot number)

4. Observe the reading on the multimeter. The multimeter should indicate <4.6 kohms resistance. If the reading is greater than 4.6 kohms, the source bus tree switch FET may be faulty.

5. Open the channel by executing:

OPEN ES90,ES91,ES00 (where E = extender number, S = slot number)

6. Observe the reading on the multimeter. The multimeter should indicate greater than 100 Mohm.

7. Close channel 24 by executing:

CLOSE ES90,ES91,ES24 (where E = extender number, S = slot number)

8. Observe the reading on the multimeter. The multimeter should indicate <4.6 kohms resistance.

9. Open the channel by executing:

OPEN ES90,ES91,ES00 (where E= extender number, S= slot number)

10. Observe the reading on the multimeter. The multimeter should indicate greater than 100 Mohm.

10-43 Ribbon Cable Test

This test verifies that the FET multiplexer can be controlled by the HP 44702A/B High-Speed Voltmeter. It also verifies that measurement results can be transferred to the voltmeter over the ribbon cable.

1. Remove power from the HP 3852A.

2. Install the HP 44712A component module in the mainframe next to an HP 44702A/B. Connect the ribbon cable between the FET multiplexer and the HP 44702A/B. Note the slot number where the FET under test is installed and the slot number where the HP 44702A/B is installed.

3. Install the test fixture on the FET multiplexer.

4. Apply power to the HP 3852A.

5. Set up the tests by executing the following commands:

USE ES00 (where E = extender number, S = slot number for High Speed Voltmeter)
FASTDISP OFF
SCANMODE ON
TERM RIBBON

6. On the test fixture, connect a jumper between the shorted HIGH lines and the shorted LOW lines.

7. Enter, but do not execute, the following command:

CONFMEAS OHM ES00-ES23 (where E = extender number, S = FET mux. slot number)

8. When the command entered in step 7 is executed, the HP 44702A/B will perform a resistance measurement on all channels on the HP 44712A. With the FASTDISP OFF, each measurement will appear in the HP 3852A right display. The HP 3852A left display will indicate each channel as it is scanned. Observe the HP 3852A displays and press execute. The resistance indicated in the right display, for all channels, should be less than 4.6 kohms (the number in the display will be in exponential format). The resistance indicated includes the on-resistance of the channel FET switch, the on-resistance of the tree FET switch, and the resistance of the series protection resistor. The scan list can be repeated, if desired, by pressing the RECALL ENTRY key and then the ENTER key.

9. Remove the jumper from the test fixture.

10. Press the RECALL ENTRY key to retrieve the scan list command. Press the ENTER key and observe the displays. The resistance indicated in the HP 3852A right display should be infinite (the HP 44702A/B indicates an infinite resistance by the display: 1.000000E+38).

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44712A PERFORMANCE TESTS.

10-44 DC Offset Test

1. Perform the Set-Up Procedure given in Section 10-40. The DC Offset test set-up is shown in Figure 10-26.

2. Set the multimeter to measure DC volts, on a range with at least 10 µV resolution. Connect the multimeter DCV lead to the shorted HIGH lines of the test fixture. Connect the multimeter COM lead to the LOW lines of the test fixture.

3. Connect the 1 kohm resistor across the multimeter input leads.

NOTE

The offset voltage is specified with a resistance of 1 kohm or less. A smaller value resistor may be used for this test.

4. Close the first channel in the multiplexer by executing:

CLOSE ES00 (where E = extender number, S = slot number)

5. Observe the indication on the multimeter. The voltage indicated should be less than 15 µV (0 to 28 °C) or less than 185 µV (28 to 55 °C). A failure of the DC Offset test indicates a failing channel FET switch.

6. Repeat steps 4 and 5 for channels 01 through 47. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES01 would close channel 01 in extender E at slot S).

10-45 Opening and Closing Time Set-Up Procedure

The Opening and Closing Time test verifies that the channel FETs will switch on and off and that the multiplexer can scan the channels at the specified speed.

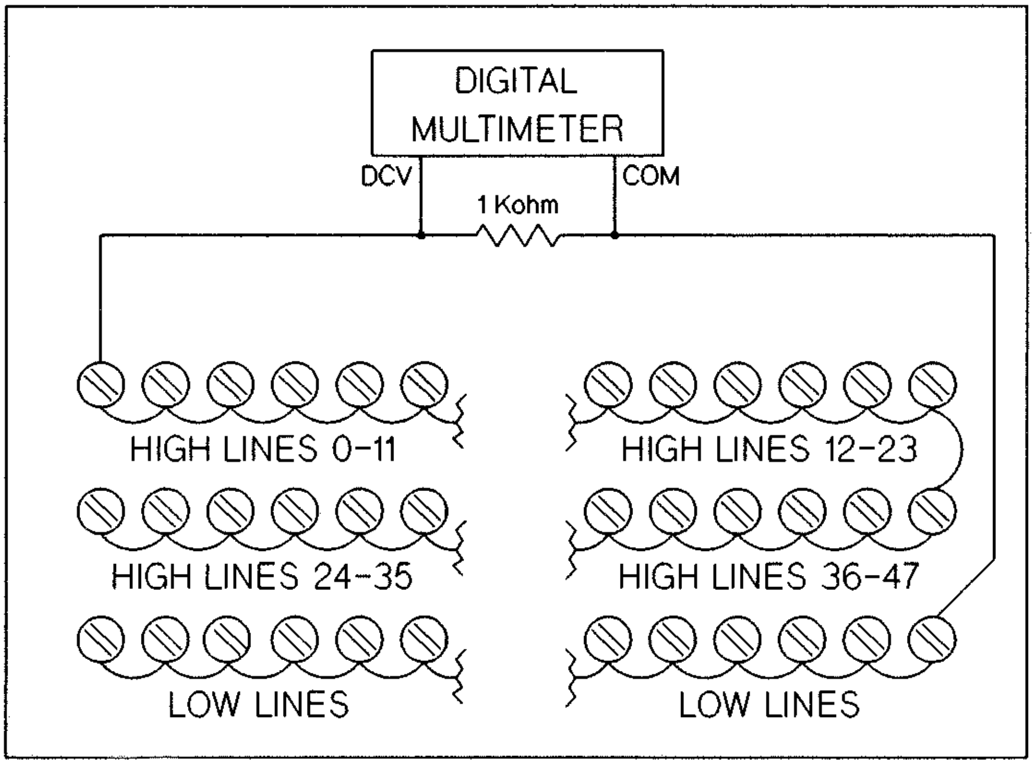


Figure 10-26 HP 44712A DC Offset Test Set-Up

1. Remove power from the HP 3852A and unplug the multiplexer to be tested. Install the Service Module in a convenient slot in the HP 3852A. Note the slot number where the Service Module is installed. Install the multiplexer on the service module. Install the test fixture on the multiplexer. The Set-Up Procedure is depicted in Figure 10-27.

2. On an oscilloscope, connect probes to the Channel A INPUT and the Channel B INPUT. Set up the oscilloscope to the following:

Dual Trace
Channel A -- DC, 0.2 Volts/Div (if using 10:1 probes)
Channel B -- DC, 0.5 Volts/Div (if using 10:1 probes)
Trigger -- Internal, triggered on Channel B
Vertical Display -- Alternate
Time -- 0.5 mses/Div
Delayed Sweep -- 0.1 µsec/Div
Delayed Sweep Dial -- Minimum

3. Connect the 1 kohm resistor between the analog bus sense HIGH connection and the +5 V connection on the service module.

4. Connect a jumper between the analog bus sense LOW connection and the logic ground test point on the service module.

5. Connect the shorted HIGH lines to the shorted LOW lines on the test fixure.

6. Connect the Channel A oscilloscope probe to the analog bus sense HIGH connection on the service module.

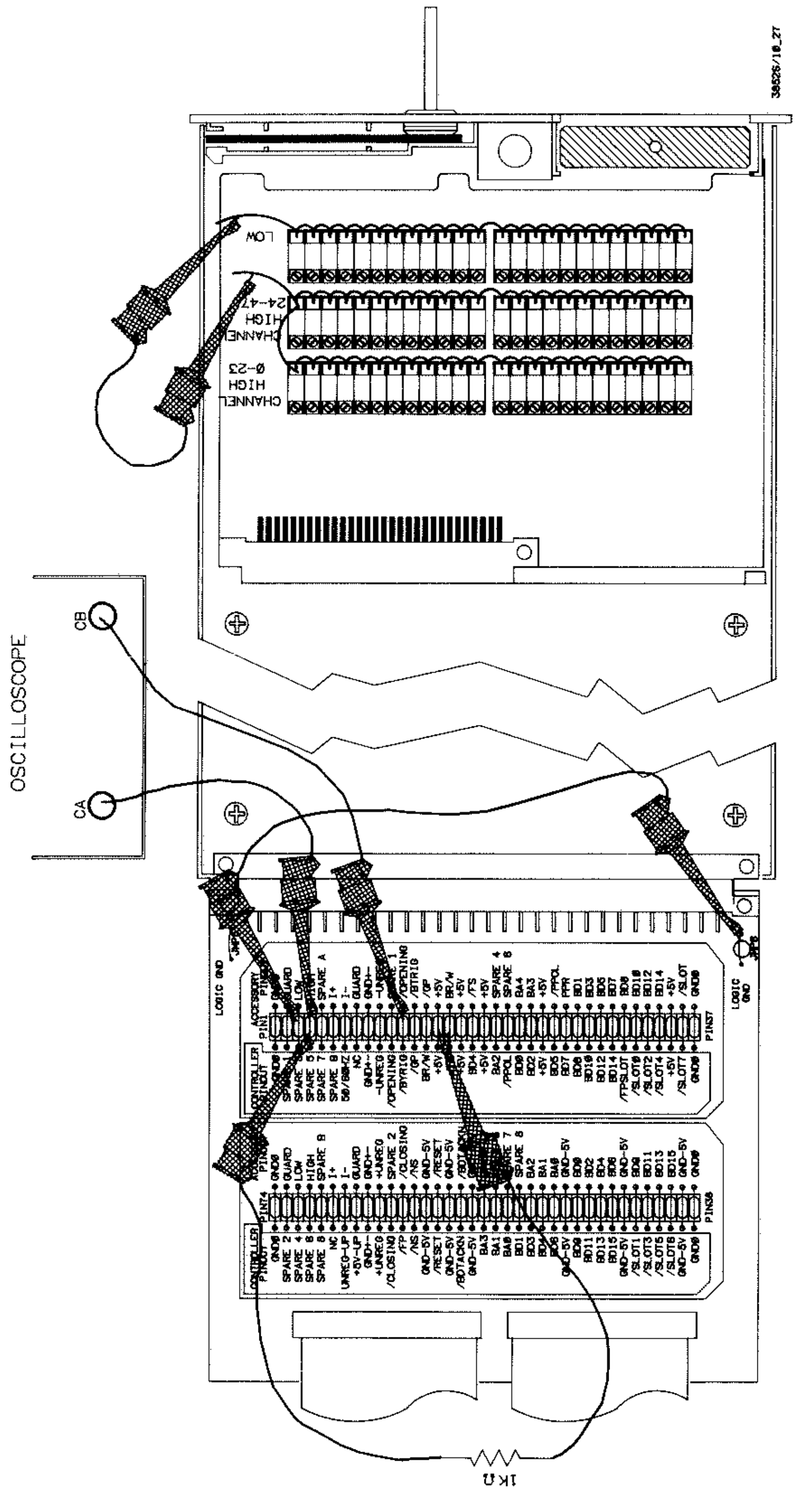


Figure 10-27 HP 44712A Opening Time Set-Up

7. Connect the Channel B oscilloscope probe to the OPENING test connection on the service module.

8. Apply power to the HP 3852A. Wait for the wake-up sequence to complete.

9. Set up the following subroutine in HP 3852A memory. When the first statement is entered the SUB ENTRY annunciator should be on in the left display. This annunciator should remain on until the SUBEND statement is entered.

```
SUB A
TRG
SCAN ES00-ES47   (where E = extender number, S = slot number)
SUBEND
```

The subroutine will scan all channels on the FET multiplexer. Do not reset or cycle power to the HP 3852A or the subroutine will be erased from memory. The front panel CLEAR key may be used without disturbing the subroutine.

10-46 Opening Time Test

This test checks the time it takes for the FET to open after receiving an OPENING pulse from the FET multiplexer.

1. Repetitively call the entered subroutine 10000 times by executing:

```
CALL A,10000
```

This statement will call the subroutine 10000 times.

2. Observe the waveform displayed on the Channel B trace and make sure all 48 channels are present. It may also be necessary to adjust the TRIGGER LEVEL and TRIGGER HOLD controls, and to select the negative trigger pulse position on the scope to synchronize the signal on the scope.

3. Rotate the DELAY SWEEP dial to the minimum position. Select the DELAYED sweep mode on the scope. Slowly rotate the DELAY SWEEP dial clockwise while observing the displayed waveforms. The Channel B waveform is the OPENING pulse. The Channel A waveform is the +5V supply as switched by the relays. As the DELAY SWEEP dial is rotated, each channel switch and the associated OPENING pulse will come into view. The FET opening time is the time from the falling edge of the OPENING pulse to the rising edge of the Channel A waveform. This time must be less than 1.2 µseconds. The opening time is illustrated in Figure 10-28.

Continue rotating the DELAY Sweep dial until all 48 FET channels have been checked. A failing channel indicates a failing FET switch.

To stop the test at any time, press the front panel CLEAR key. The test time may be extended by by increasing the number of times the subroutine is called, as specified in step 1.

The waveform will exhibit a small amount of jitter due to the overhead requirements of the HP 3852A operating system.

10-47 Closing Time Test

This test checks the time it takes for the FET to close after receiving a CLOSING pulse from the FET multiplexer.

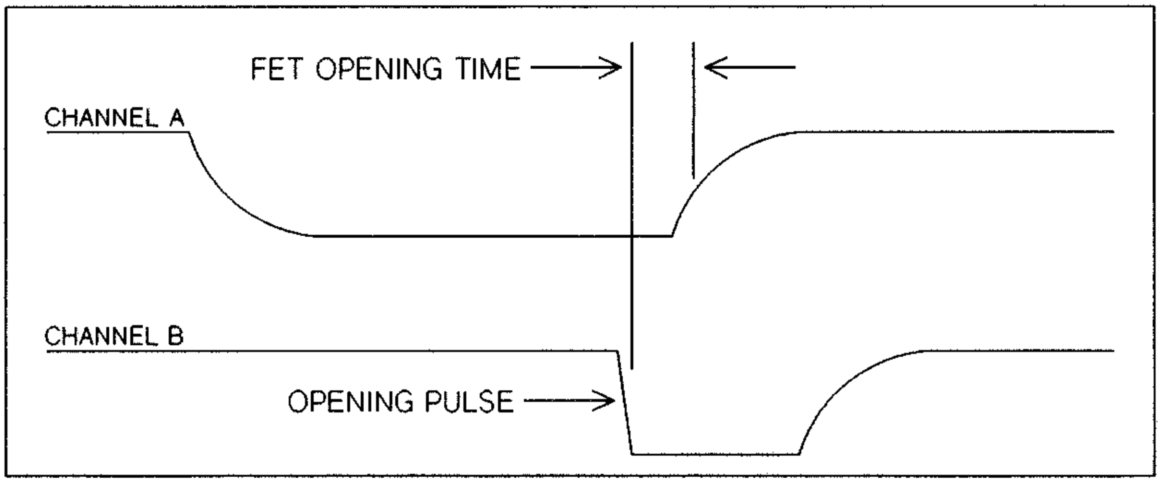


Figure 10-28 HP 44712A Opening Time

1. Move the channel B oscilloscope probe to the CLOSING connection on the service module. The Closing Time test set-up is shown in Figure 10-29.

2. Repetitively call the entered subroutine by executing:

CALL A,10000

3. Rotate the DELAY SWEEP dial on the oscilloscope to the minimum position. Slowly rotate the dial clockwise until the first closing is displayed. The Channel B trace is the closing pulse output from the multiplexer. The Channel A waveform is the +5V supply, as switched by the FET channel switches. As the DELAY SWEEP dial is rotated, each channel switch and the associated CLOSING pulse will come into view. The FET closing time is the time from the falling edge of the CLOSING pulse to the falling edge of the Channel A waveform. This time must be less than 2.25 µseconds. The closing time is illustrated in Figure 10-30.

Continue rotating the DELAY Sweep dial until all 48 FET channels have been checked. A failing channel indicates a failing FET switch.

To stop the test at any time, press the front panel CLEAR key. The test time may be extended by by increasing the number of times the subroutine is called, as specified in step 2.

The waveform will exhibit a small amount of jitter due to the overhead requirements of the HP 3852A operating system.

10-48 Leakage/Bias Current Test

The leakage current test checks the FET switches for excessive leakage/bias current. Leakage/bias current is sourced by the multiplexer from HIGH or LOW to chassis ground.

1. OPEN CHANNELS LEAKAGE/BIAS CURRENT TEST. This test checks the leakage current with all channels open. A simplified schematic of the setup is shown in Figure 10-31 and the test setup is shown in Figure 10-32.

2. Perform the Set-Up procedure in Section 10-40.

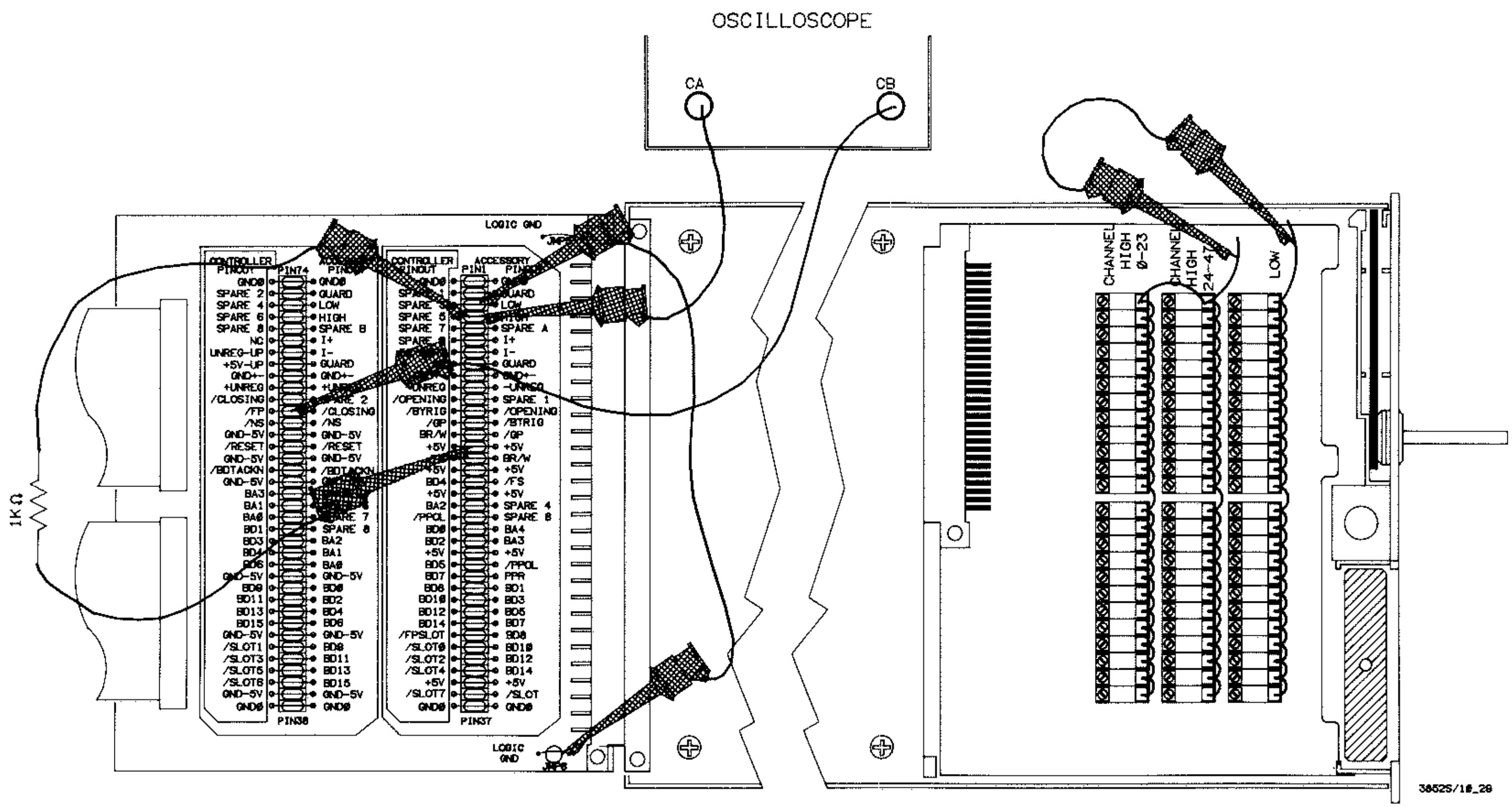


Figure 10-29 HP 44712A Closing Time Set-Up

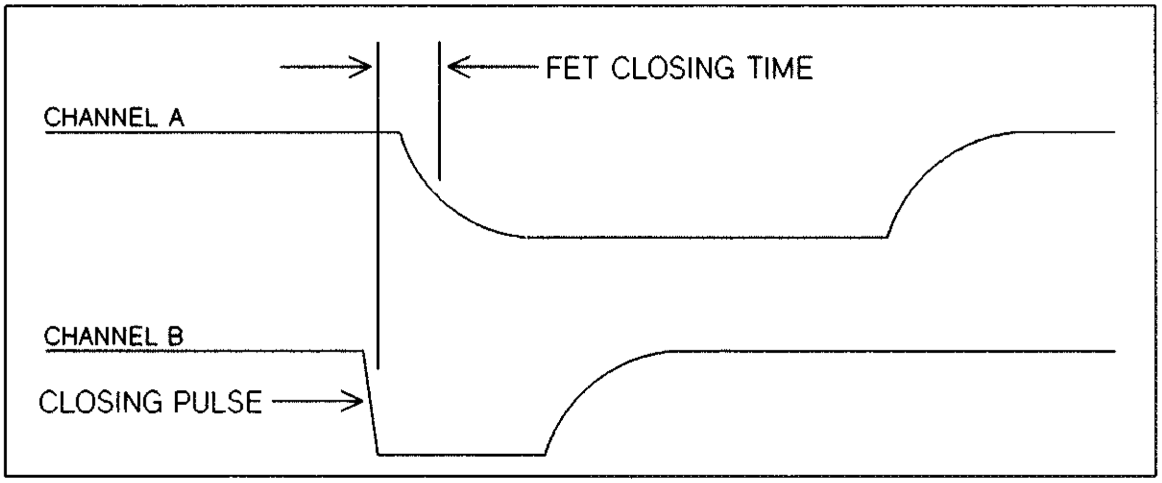


Figure 10-30 HP 44712A Closing Time

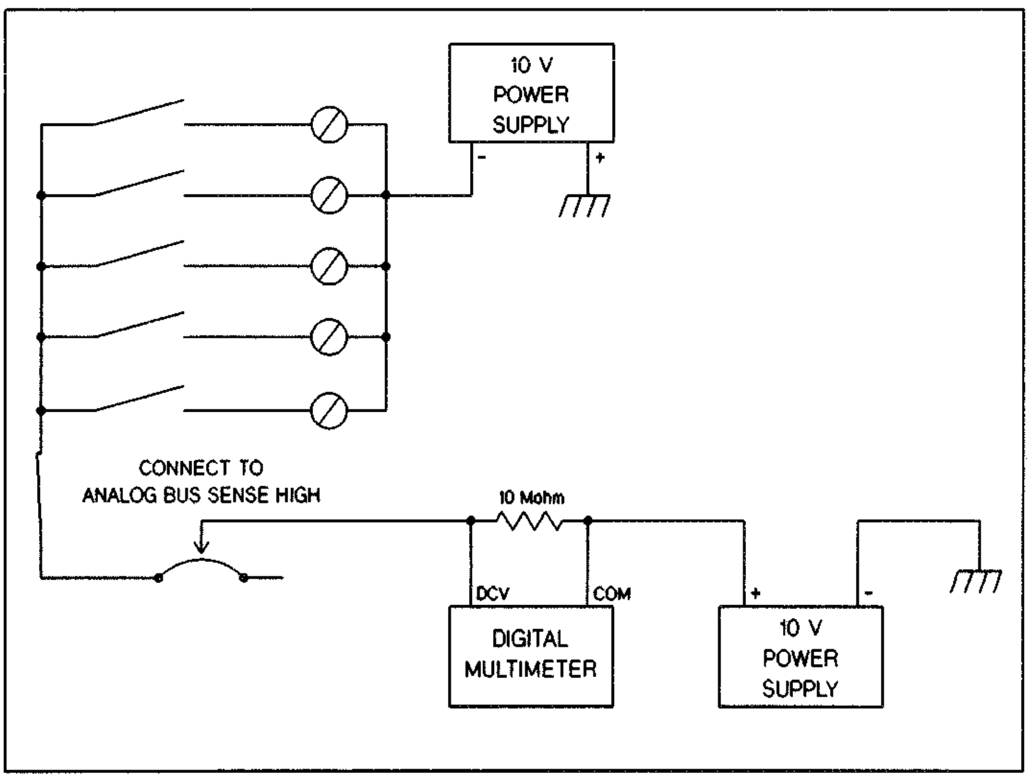


Figure 10-31 Open Channel Leakage Test

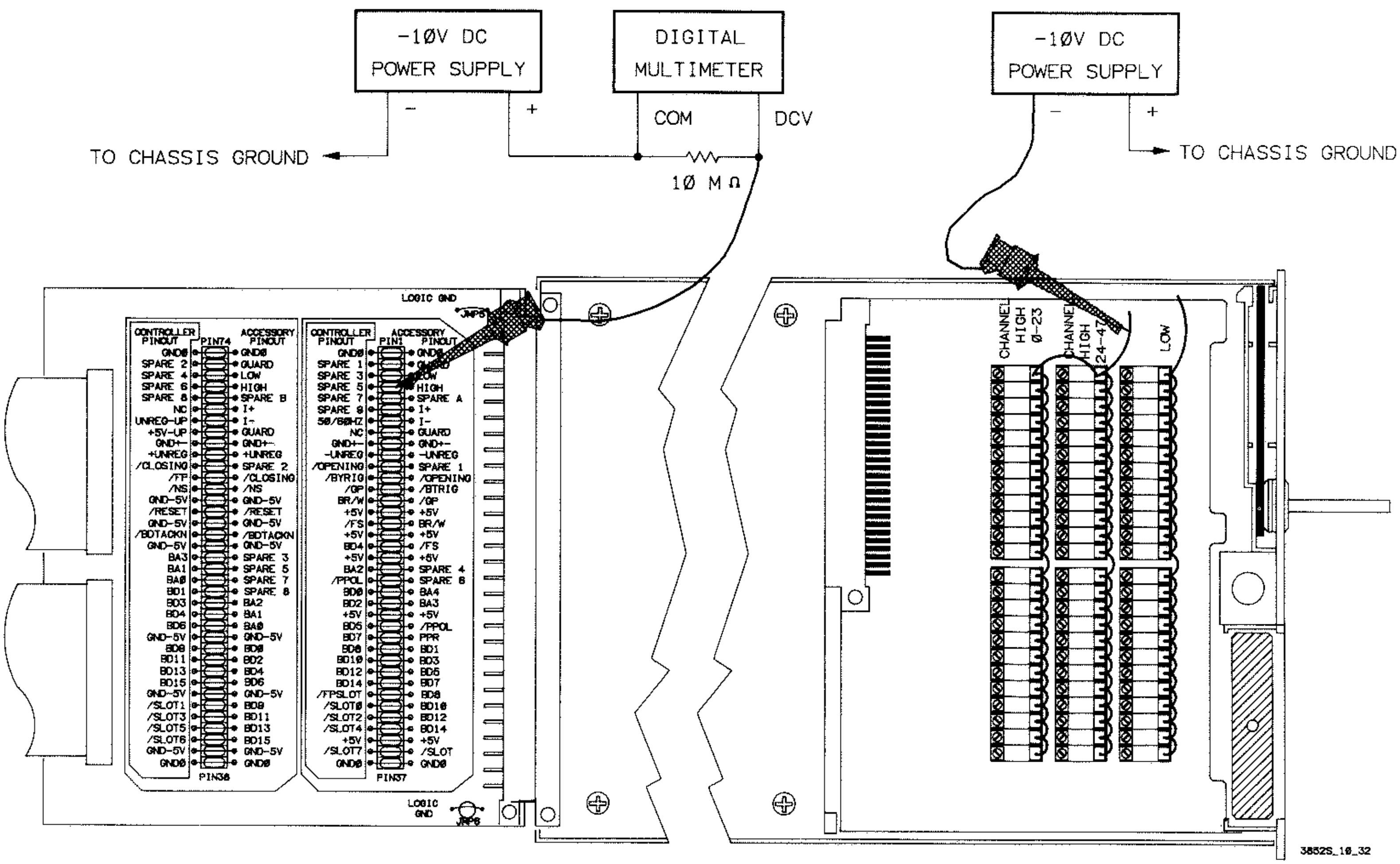


Figure 10-32 HP 44712A Open Channel Test Set-Up

3. Set the negative power supply output to 10 Vdc and connect the negative lead to the shorted HIGH lines on the test fixture. Connect the negative power supply common lead to the chassis.

NOTE

Connections to chassis ground can be accomplished by connecting to any sheet metal part. Chassis ground is also available at a connector on the rear panel of the HP 3852A power supply.

4. Set the positive power supply output to 10 Vdc and connect the positive lead to the multimeter common. Connect the positive power supply common to the chassis.

5. Connect the 10 Mohm resistor (**R1**) across the multimeter input terminals. Connect the multimeter DCV input terminal to the analog bus sense HIGH connection on the service module.

6. Open all switches on the multiplexer by executing:

RESET ES00 (where E = extender number, S = slot number)

7. Close the isolation relay and tree switches by executing:

CLOSE ES90,ES94 (where E = extender number, S = slot number)

8. Observe the reading on the multimeter. This reading is referred to as **V1** in the following steps.

9. Calculate the leakage current (**I**) from the formula:

$$I = \frac{V1}{R1}$$

The calculated open channel leakage current for the HIGH lines should be less than 2 nA for a room temperature between 0° and 28° C (for temperatures in the range of 0° to 55° C the leakage current should be less than 11 nA).

10. CLOSED CHANNEL LEAKAGE/BIAS CURRENT TEST. This test checks each channel HIGH lines for leakage current when a channel is closed. A simplified schematic of the setup is shown in Figure 10-31 and the test setup is shown in Figure 10-32.

11. Remove the negative power supply from the shorted HIGH lines on the test fixure.

12. Connect the shorted HIGH lines on the test fixure to the analog bus sense HIGH connection on the service module.

13. Connect the +10 V power supply common to chassis ground. Connect the power supply positive lead to the common lead of the multimeter.

14. Connect the 10 Mohm resistor across the multimeter input terminals. Connect the multimeter DCV input terminal to the shorted HIGH lines on the test fixture.

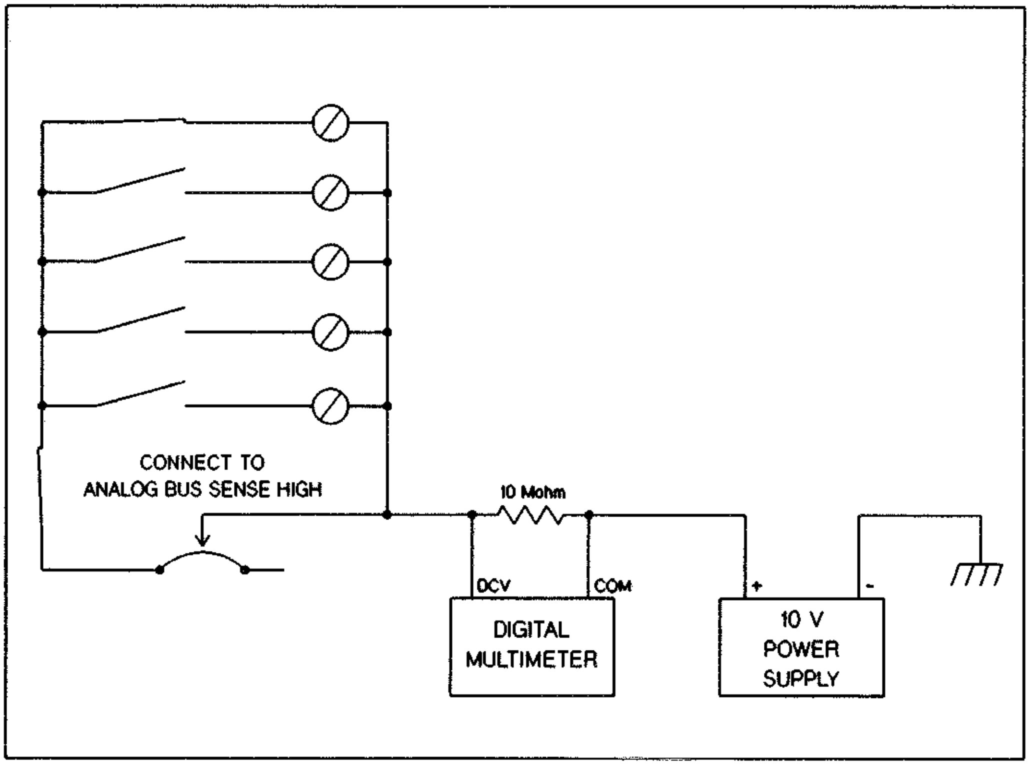


Figure 10-33 Closed Channel Leakage Test

15. Close the isolation relay by executing:

    CLOSE ES90 (where E = mainframe number, S = slot number)

16. Close the first channel in Bank A and the tree switches by executing:

    CLOSE ES94,ES00 (where E = mainframe number, S = slot number)

17. Observe the voltage reading on the multimeter. This voltage is referred to as **V1** in the following step.

18. Calculate the leakage current (I) from the formula:

$$I = \frac{V1}{R1}$$

The leakage current should be less than 5.0 nA for room temperatures in the range of 0° to 28° C (leakage current should be less than 15 nA for a temperature range of 28° to 55° C).

19. Repeat steps 16, 17, and 18 for channels 01 through 47. In step 16, the channel under test is specified in the second term of the CLOSE command (i.e., CLOSE ES94,ES01 for channel 01).

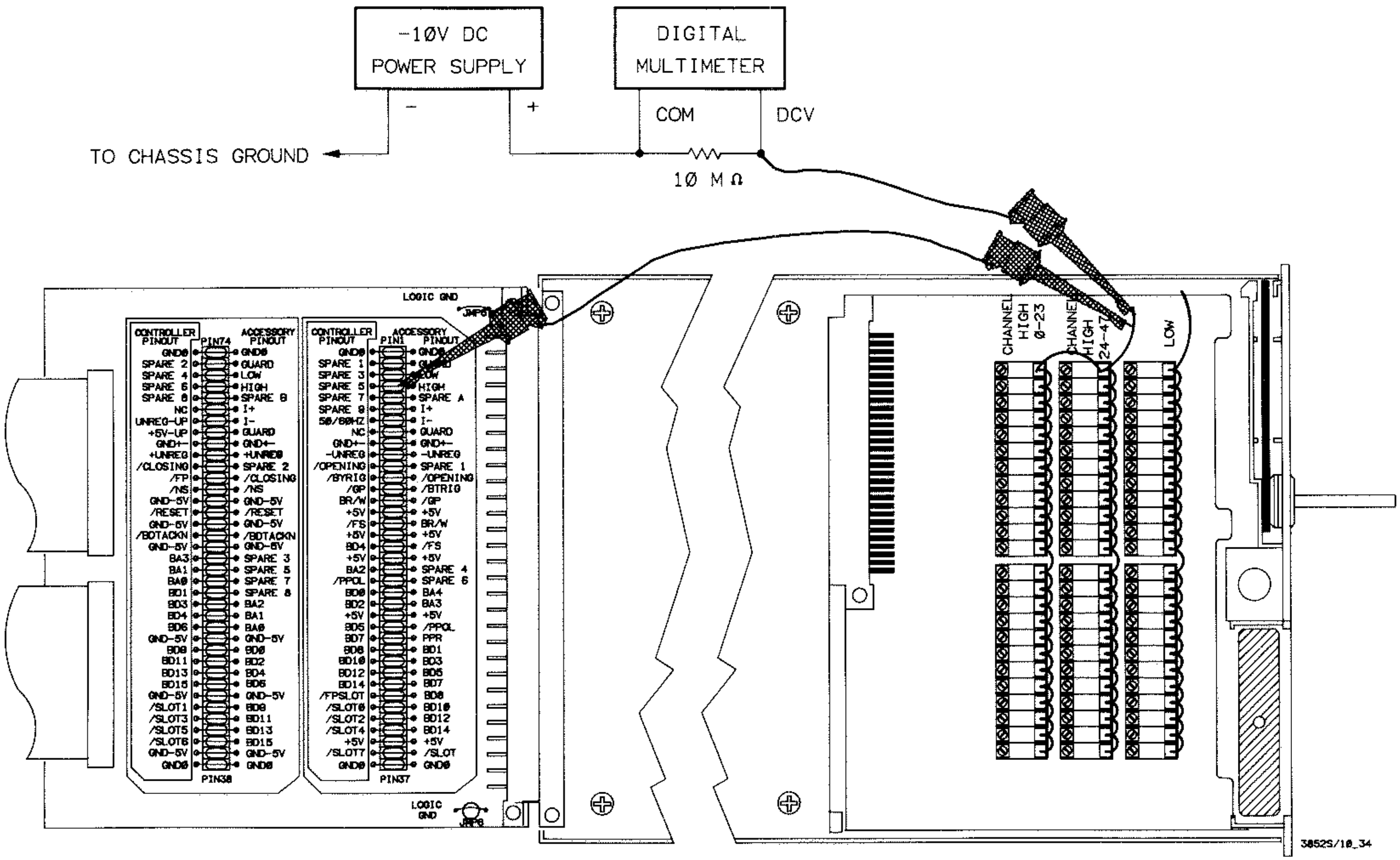


Figure 10-34 HP 44712A Closed Channel Test Set-Up

10-49 REPLACEABLE PARTS

Figure 10-35 shows the mechanical breakdown of the HP 44711A, HP 44712A and HP 44713A. The figure also provides assembly and disassembly information. The parts shown in Figure 10-35 are keyed to the parts lists in Table 10-9.

To order a part listed in Table 10-9, quote the Hewlett-Packard part number, the quantity desired, the HP system description, and the check digit (abbreviated CD in Table 10-9). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board for the FET multiplexers is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

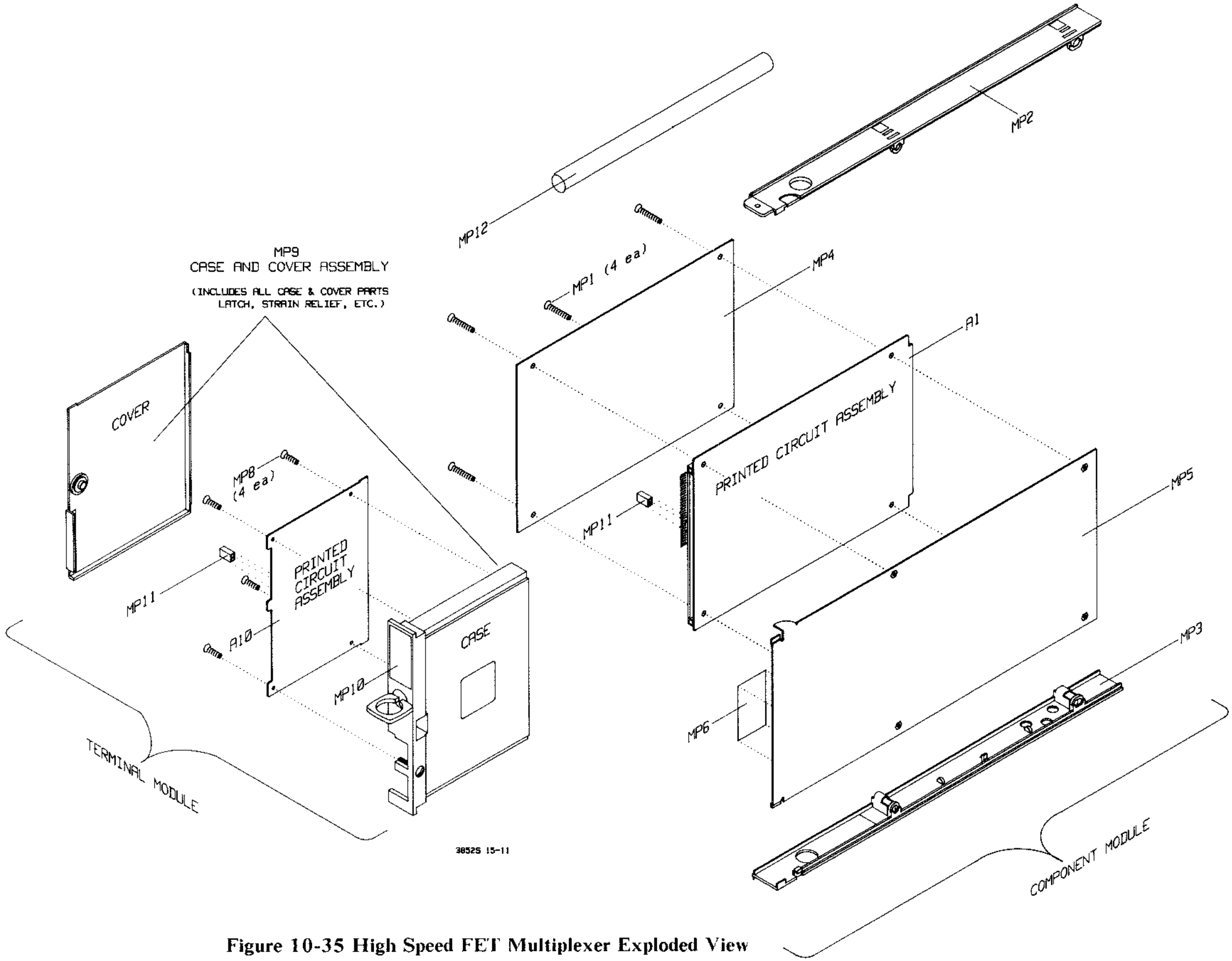


Figure 10-35 High Speed FET Multiplexer Exploded View

Table 10-9a HP 44711A 24 Channel High Speed FET Multiplexer

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44711A	Module; 24/48ch HS FET mux component	1	44711-66201	9	MOD-24/48CH FMUX
A1	PCA; 24/48 chan HS FET mux component	1	44711-66501	2	PCA-24/48CH FMUX
A10	PCA; 24 channel mux terminal	1	44711-66510	3	PCA-24CH GP TERM
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (alum) w/ribbon-c access	1	44711-04101	8	0601 COV LEFT
MP5	Cover; right (alum) w/ribbn-c access	1	44711-04102	9	0601 COV RIGHT
MP6	Label; 44711/44712/44713 compont mod	1	44711-84320	1	LBL-I/O OPTIONS
MP7	Label; "STOP" internal cable warning	1	44711-84321	2	LBL-CAUTION-STOP
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84411	5	ASSY-TERM-SM OPN
MP10	Label; rear panel of term mod 44711A	1	44711-84325	6	LBL-ID,TERM ASSY

Completely assembled HP 44711A terminal modules can be ordered from your local HP Office by ordering Number 44711AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44711A	Module; 24/48ch HS FET mux component		44711-69201	5	RBLT-44711-66201

Table 10-9b HP 44712A 48 Channel High Speed Single Ended FET Multiplexer

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44712A	Module; 24/48ch HS FET mux component	1	44711-66201	9	MOD-24/48CH FMUX
A1	PCA; 24/48 chan HS FET mux component	1	44711-66501	2	PCA-24/48CH FMUX
A10	PCA; 48 chan single-end mux terminal	1	44712-66510	4	PCA-48CH,SE TERM
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (alum) w/ribbon-c access	1	44711-04101	8	0601 COV LEFT
MP5	Cover; right (alum) w/ribbn-c access	1	44711-04102	9	0601 COV RIGHT
MP6	Label; 44711/44712/44713 compont mod	1	44711-84320	1	LBL-I/O OPTIONS
MP7	Label; "STOP" internal cable warning	1	44711-84321	2	LBL-CAUTION-STOP
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84411	5	ASSY-TERM-SM OPN
MP10	Label; rear panel of term mod 44712A	1	44712-84325	7	LBL-ID,TERM ASSY

Completely assembled HP 44712A terminal modules can be ordered from your local HP Office by ordering Number 44712AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44712A	Module; 24/48ch HS FET mux component		44711-69201	5	RBLT-44711-66201

Table 10-9c HP 44713A 24 Channel High Speed FET Mux with Thermocouple Compensation

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44713A	Module; 24/48ch HS FET mux component	1	44711-66201	9	MOD-24/48CH FMUX
A1	PCA; 24/48 chan HS FET mux component	1	44711-66501	2	PCA-24/48CH FMUX
A10	PCA; 24 chan mux term w/TC reference	1	44713-66510	5	PCA-24CH TC COMP
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (alum) w/ribbon-c access	1	44711-04101	8	0601 COV LEFT
MP5	Cover; right (alum) w/ribbn-c access	1	44711-04102	9	0601 COV RIGHT
MP6	Label; 44711/44712/44713 compont mod	1	44711-84320	1	LBL-I/O OPTIONS
MP7	Label; "STOP" internal cable warning	1	44711-84321	2	LBL-CAUTION-STOP
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84411	5	ASSY-TERM-SM OPN
MP10	Label; rear panel of term mod 44713A	1	44713-84325	8	LBL-ID,TERM ASSY

Completely assembled HP 44713A terminal modules can be ordered from your local HP Office by ordering Number 44713AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44713A	Module; 24/48ch HS FET mux component		44711-69201	5	RBLT-44711-66201

Chapter 11
HP 44715A 5-Channel Counter

CHAPTER 11

HP 44715A 5 CHANNEL COUNTER/TOTALIZER

CHAPTER 11

HP 44715A

5 CHANNEL COUNTER/TOTALIZER

11-1 INTRODUCTION

This chapter contains a technical description, performance test procedures, and a replaceable parts list for the HP 44715A 5 Channel Counter/Totalizer.

11-2 Technical Description

The HP 44715A is a twelve function counter/totalizer which can operate at frequencies of up to 200 kHz. It has five independent input channels, each of which can be isolated or referenced to ground. The non-isolated inputs can either be TTL levels or AC signals with amplitudes as low as 25 mV RMS.

Up to five independent inputs can be measured for frequency or totalized using the HP 44715A. The other functions require two input channels per function. The reference timebase is generated internally in the counter, and is stable to 0.01% (100 ppm).

Figure 11-1 shows a simplified block diagram of the HP 44715A. Only two of the five input channels are shown on the block diagram. Each channel has two input paths that can be individually selected by the source select circuitry. The isolated input path is opto-isolated. The non-isolated path has signal conditioning which can be selected for 5, 12, or 24 volts DC inputs. AC signals can also be measured using the non-isolated inputs. Amplitudes as low as 25 mV RMS can be measured at frequencies up to 10 kHz. AC signals with amplitudes as low as 50 mV RMS can be measured at frequencies up to 200 kHz. Provisions are also made on the board for an optional low-pass filter capacitor on each channel.

Transition selection is made for each of the five input channels after the source, isolated or non-isolated, has been selected. Transition selection allows the user to select whether the counter should respond to low to high transitions, or high to low transitions. An external trigger input is also provided.

The heart of the HP 44715A is an LSI chip used in conjunction with the on card microprocessor. These two chips handle all the signal routing and count acquisition and computation. Commands to the HP 44715A come from the HP 3852A mainframe via the backplane interface. The local controller in the HP 44715A interprets these commands, executes them, and returns data to the mainframe processor via the backplane interface.

The HP 44715A is a very powerful counter with an extensive command set. To learn more about the set up and use of the HP 44715A, refer to the HP 3852A Data Acquisition and Control Unit Plug-In Accessories Configuration and Programming Manual, Chapter 12.

11-3 SPECIFICATIONS

Specifications for the HP 44715A are given in Table 11-1. Specifications are the performance standards or limits against which the counter may be tested.

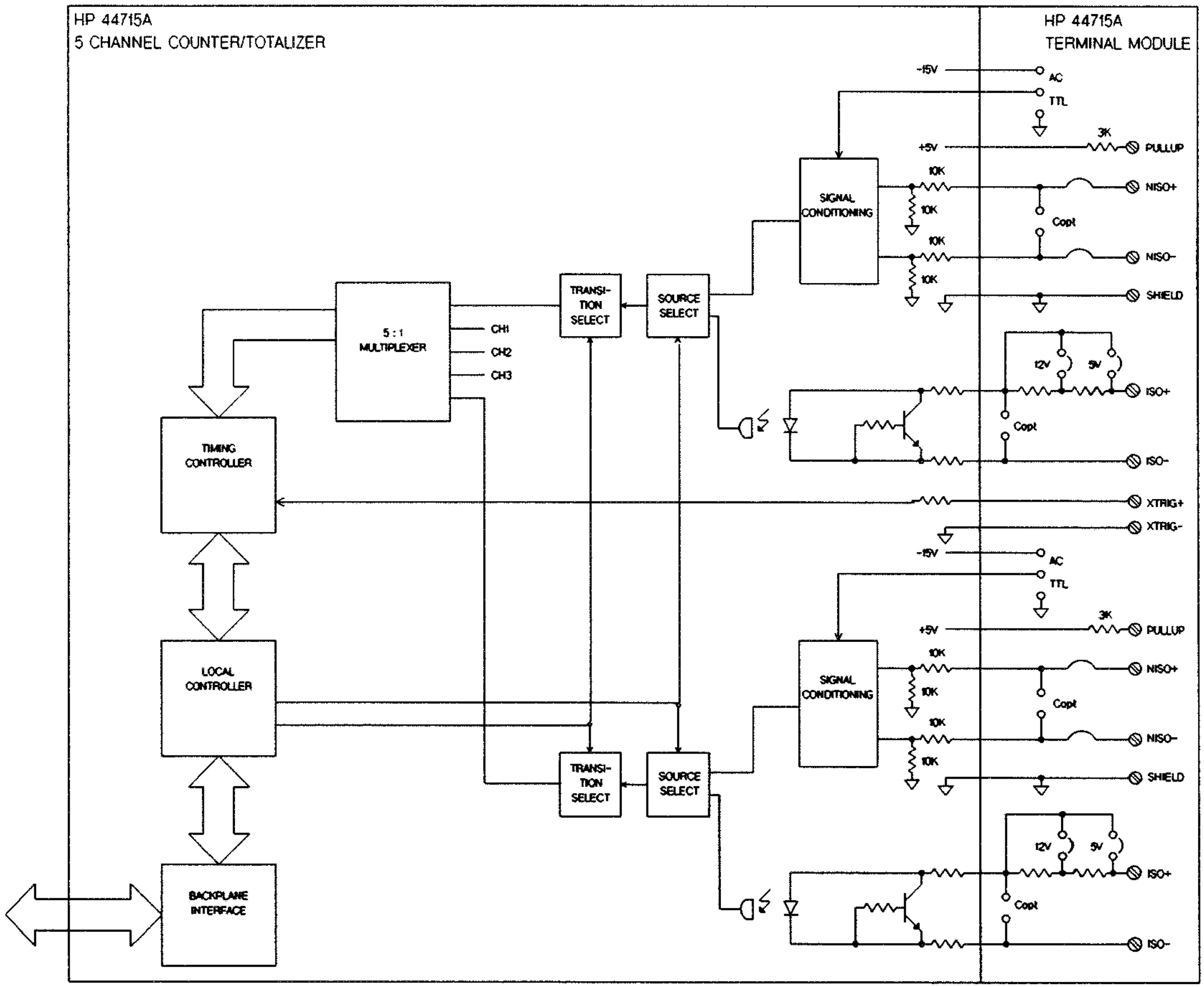


Figure 11-1 HP 44715A Simplified Block Diagram

Table 11-1 HP 44715A Specifications

Totalize and Totalize Modulo:

Counts number of transitions. Counting starts from zero to a programmable preset value (totalize only). Counting up to a programmable N limit (totalize modulo) or a count transition from -1 to 0 (totalize) can cause an interrupt if enabled. Normally one-channel functions, these functions use two channels when gating is desired.

Accuracy: ±1 count

Range: -2^{31} to $+2^{31} - 1$ (32 bits, 2's complement)

Range of Modulo N: 2 to 65,535

Up/Down (A-B) and Up/Down Count Modulo:

Counts A transitions and B transitions, starting from zero. Subtracts (A-B) when asked for reading. No interrupt is generated. Two-channel functions.

Accuracy: ±2 counts

Range: -2^{31} to $+2^{31} - 1$ (32 bits, 2's complement)

Range of Modulo N: 2 to 65,535

Count with Direction Control and Count Modulo with Direction Control:

Counter A increments or decrements according to level of B. No interrupt can overflow or underflow. B must hold its level for greater than 2 µsec before the count signal changes and greater than 1 µsec after the signal changes. Two-channel function.

Accuracy: ±1 count + # reversals/2

Range: -2^{31} to $+2^{31} - 1$ (32 bits, 2's complement)

Range of Modulo N: 2 to 65,535

Quadrature Count and Quadrature Count Modulo:

Similar to Count with Direction Control except **every** transition of A is counted according to level B as indicated above. Two-channel function.

Accuracy: ±1 count + # reversals/2

Range: -2^{31} to $+2^{31} - 1$ (32 bits, 2's complement)

Range of Modulo N: 2 to 65,535

Ratio Count (A/B):

Counts A transitions during N periods of B. The count is divided by N to get average number of A counts per B period. Two-channel function.

Accuracy: ±1/N count

Max Counts on A or B inputs: 65,535

Range of N or B Input: 1 to 65,535

Period:

Averages N periods of A. Minimum period for A is 5 µsec (maximum period is 655.35 seconds). Resolution of reading can be increased by increasing N. The timer base for each measurement is faster than the period (reciprocal counter). When selected, auto-ranging for the input period is independently determined for each input. Function requires two channel even though B is not used directly.

Accuracy:

±0.01% of reading ±1 count of resolution + trigger error, where trigger error = maximum time for input voltage to change from low to high or high to low.

Resolution:

	Time Base				
	1 µsec	10 µsec	100 µsec	1 msec	10 msec
Resolution	1/N µsec	10/N µsec	100/N µsec	1/N msec	10/N msec

Range of N: 1 to 65,535

Period After Delay:

Time for one period of A after N edges of A. Valid edges are gated by B. Measures the Nth gated period of A.

Accuracy:

±0.01% of reading ±1 count of resolution + trigger error, where trigger error = maximum time for input voltage to change from low to high or high to low.

Table 11-1 HP 44715A Specifications (Cont.)

Resolution:

	Time Base 1 µsec	10 µsec	100 µsec	1 msec	10 msec
Resolution	1/N µsec	10/N µsec	100/N µsec	1/N msec	10/N msec

Range of N: 1 to 65,535

Frequency:

Counts number of transitions over the time base. Provides average frequency. Time base adjusts from 10 msec to 1 sec. The time base (gate time) is the same for all channels, and frequency auto-ranging, when selected, is determined by the channel that has the highest frequency input. (The period function resolution is better than this function and hence more accurate for determining frequency.) One-channel function.

Accuracy:

±0.01% of reading ±1 count of resolution + trigger error, where trigger error = maximum time for input voltage to change from low to high or high to low.

Range/Resolution:

Gate Time	Range	Resolution
1 sec	1 Hz to 65,535 kHz	1 Hz
100 msec	10 Hz to 200 kHz	10 Hz
10 msec	100 Hz to 200 kHz	100 Hz

Minimum Pulse Width: 2.5 µsec

Minimum Period: **5.0** µsec

Operating Range:

Isolated:

Accessory Input		Nominal Voltage (Vdc) 5	12	24
Threshold Voltage (V):	Vlow(max)	1	1.2	1.5
	Vhigh(min)	4	10	16
Threshold Current (mA):	Ilow(max)	0.05	0.05	0.05
	Ihigh(min)	1.8	1.8	1.8

Table 11-1 HP 44715A Specifications (Cont.)

Non-Isolated:

For 5 V DC (TTL) nominal voltage,
Vlow(max) is 0.8 V
Vhigh(min) is 2.25 V

For RMS signals (zero-crossing detector is used),
25 mV RMS sensitivity (DC to 10 kHz)
50 mV RMS sensitivity (10 kHz to 200 kHz)

Maximum Input Voltage:

Isolated:

Between high and low terminals of each channel,
24 V DC (5 V, 12 V nominal voltage)
42 V DC (42 V nominal voltage)

Between any terminal and chassis (DC to 60 Hz),
170 V peak

Between channels (DC to 60 Hz),
340 V peak

Non-Isolated:

All inputs (rear and back-plane) are protected to 16 V peak. Input impedance, however, decreases above 12 V due to internal protection circuitry.

Noise Rejection:

Rejected common mode voltages are prevented from triggering false counts.

60 dB minimum effective common mode noise rejection with 1 kΩ in low lead (DC to 120 Hz).

Non-Isolated Input Resistance (balance differential input):

High to Low: 20 MΩ ±10%

High or Low to Chassis: 10 MΩ ±5%

Maximum Wire Size: 16 AWG

Pull-Up Connection:

Output Voltage: 4.7 V to 5.25 V DC

Maximum Output Current: 1.67 mA per pull-up connection

11-4 HP 44715A PERFORMANCE TESTS

11-5 Introduction

The following Performance Tests check the operation of the HP 44715A Component Module. Performance Tests are not given for the terminal modules. Successful completion of all tests in this chapter provides a high confidence level that the Counter is meeting its listed specifications.

The Performance Tests should be performed in the order they are presented. The completion of each test increases the confidence level in Counter operation. A minimum set of tests is given as Operational Verification Tests. These tests are described in Section 11-6.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence that the Counter is operating normally, it is not recommended that all the Performance Tests be performed unless one of the tested specifications is in question.

11-6 Operational Verification

The first tests given in this section are the minimum set of tests recommended for the Counter. These tests are designed to test the input circuitry operation and the functionality of the counter. Successful completion of the Operational Verification Tests provides a 90% confidence level that the Counter is operating normally and is within specification.

The Operational Verification Tests consist of the following:

Section 11-10 - Self-Test Procedure
Section 11-11 - Input Signal Conditioning Test

11-7 Equipment Required

The following test equipment is required to run the Performance Tests.

1. Test Fixture (as described in Section 11-8)

2. Test Leads

3. Function Generator -- HP Model 3325A

If the recommended function generator is not available, use one that is capable of meeting the following critical specifications and requirements.

a. Sinewave output with the following specifications:

   25 mV RMS (±0.2 dB) from 1 Hz to 10 kHz
   50 mV RMS (±0.6 dB) from 10 kHz to 200 kHz

b. Squarewave output with the following specification:

   0.8 V DC to 4.0 V DC (±1%) from 1 Hz to 200 kHz

c. Frequency accuracy within 0.001%

11-8 Test Fixture

A test fixture is required to run the Performance Tests. A schematic of the required test fixture is shown in Figure 11-2a. A test fixture can be manufactured using an HP 44715AT terminal module (see Figure 11-2b). Because wiring the test fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

If the test fixture is to be fabricated from other than an HP 44715AT terminal module, it is important that the correct Card Configuration is selected, as shown in Figure 11-2a. For the Totalizer mode, connect pin 40 to pin 34 on the terminal module connector. For the Frequency mode, connect pin 40 to pin 35 on the terminal module connector.

The test fixture consists of a short circuit between all channel Isolated and Non-Isolated "+" lines and a short circuit between all channel Isolated and Non-Isolated "-" lines. The use of the test fixture minimizes the number of test lead connections required for the tests.

11-9 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

11-10 Self-Test Procedure

1. Apply power to the HP 3852A.

2. Press the RESET button on the HP 3852A front panel. Perform the HP 44715A 5 Channel Counter/Totalizer self-test by executing:

   TEST ES00 (where E = extender number, S = slot number)

3. The HP 3852A right display should show:

   SELF TEST OK

4. If the display shows a different message, or if the ERR annunciator is on, the HP 44715A may be failing its self test. Test the counter again by executing the command in step 2. If the counter still fails, repair of the unit may be necessary.

11-11 Input Signal Conditioning Tests

The following tests the Isolated Inputs and Non-Isolated Inputs of all channels, and the Trigger operation.

1. ISOLATED INPUTS. The following tests the Isolated Inputs of all channels.

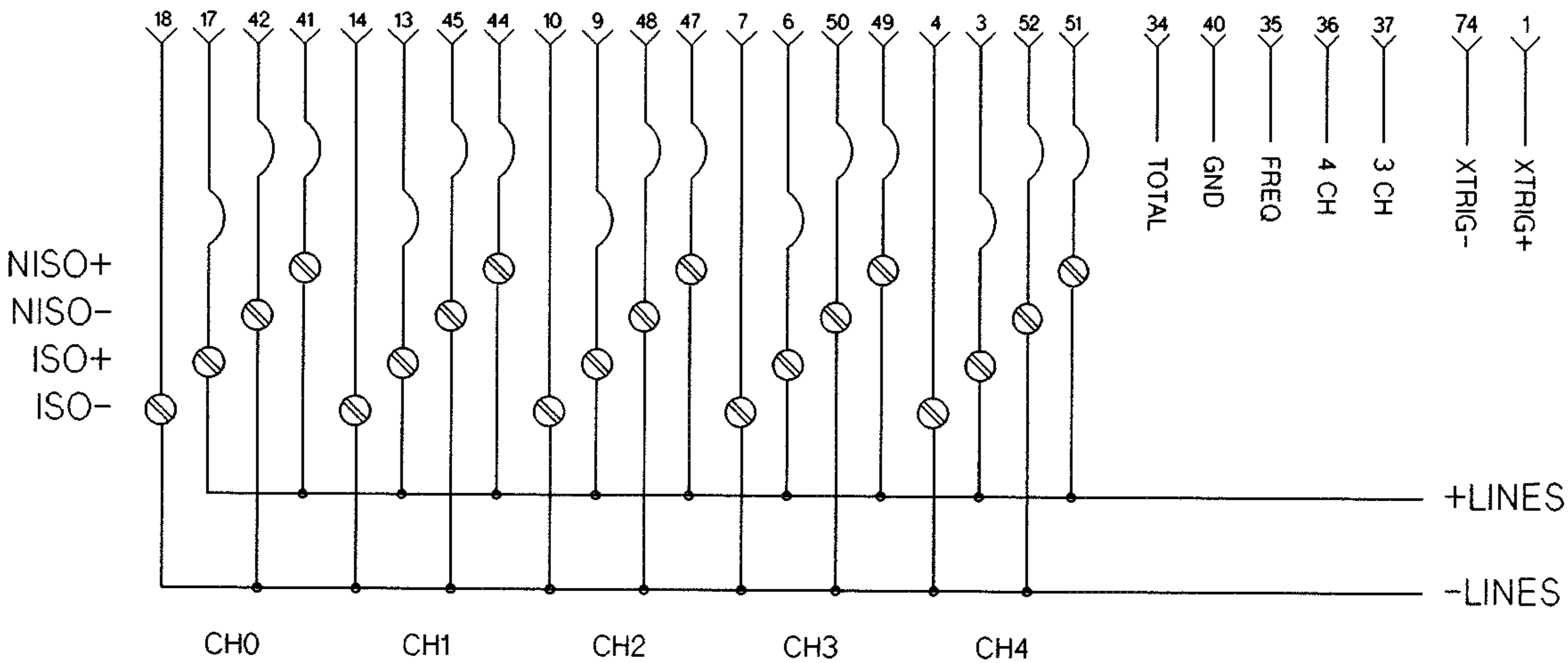


Figure 11-2a HP 44715A Test Fixure Schematic

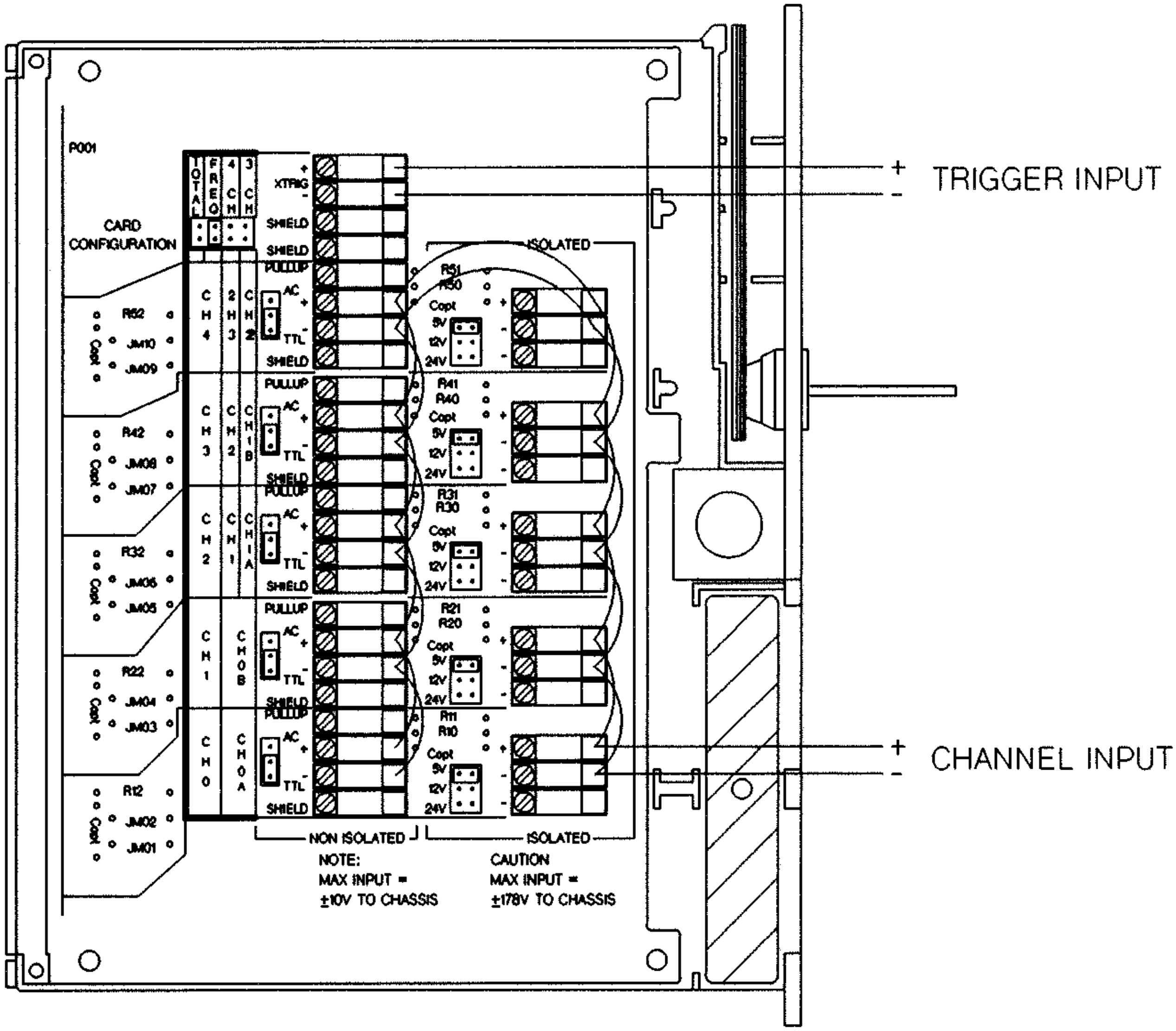


Figure 11-2b HP 44715A Test Fixure

2. Set the function generator to output a +1 V to +4 V peak-to-peak, 200 kHz square wave. The signal is represented in Figure 11-3. If using the recommended function generator, set it up as follows (a 50 Ω output impedance is assumed):

Function -- Square Wave
Frequency -- 200 kHz
Amplitude -- 3 V p-p
DC Offset -- 2.5 V

3. Connect the function generator to the shorted "+" and "-" inputs of the Isolated and Non-Isolated channels. The connections are shown in Figure 11-4.

4. Refer to Figure 11-4. Set the Isolated Input range jumpers to 5 V and set the Card Configuration jumper to FREQ.

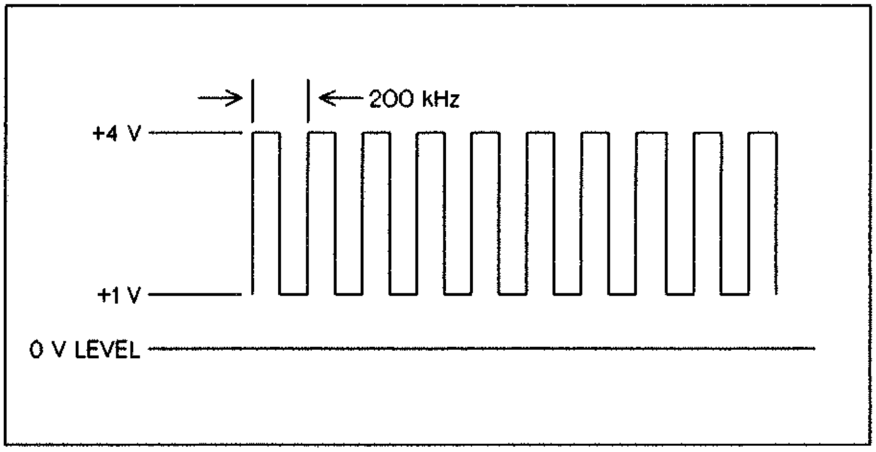


Figure 11-3 Isolated Input Test Signal

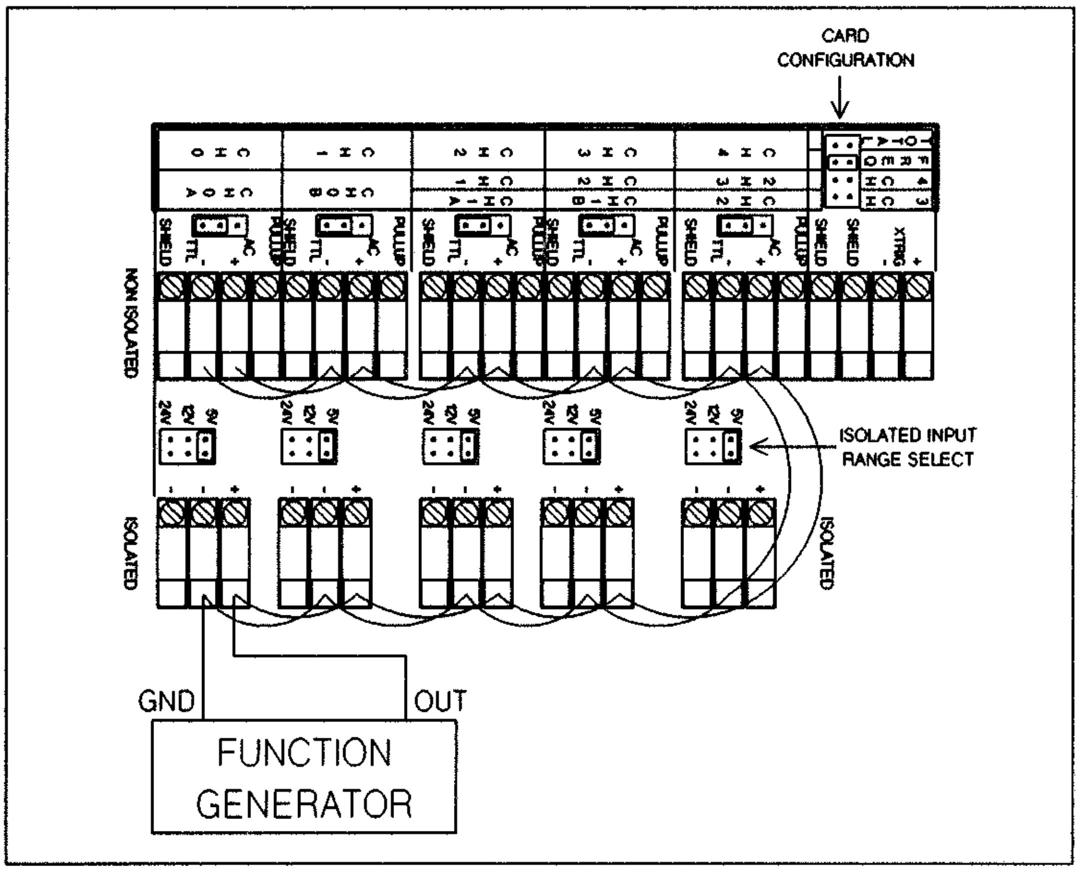


Figure 11-4 Isolated/Non-Isolated TTL Tests

5. Setup the HP 44715A by executing:

```
TRIG AUTO
TBASE 0.1
```

6. Setup channel 0 by executing:

USE ES00 (where E = extender number, S = slot number)
TERM ISO

7. Read channel 0 by executing:

CHREAD ES00 (where E = extender number, S = slot number)

8. Verify that the HP 3852A right display shows:

1.999880E+05 to 2.000120E+05

9. Repeat steps 6, 7, and 8 for channels 1, 2, 3, and 4. In the USE command in step 6 and the CHREAD command in step 7, the last two digits indicate the channel number. For example, USE ES02 and CHREAD ES02 would be for channel 2.

10. Leave the function generator connected for the next test.

11. NON-ISOLATED TTL INPUTS. The following tests the Non-Isolated Inputs of all channels in the TTL mode.

12. Set the Non-Isolated Input jumpers to TTL, as shown in Figure 11-4.

13. Set the function generator to output a +0.8 V to +2.25 V peak-to-peak, 200 kHz square wave. The signal is represented in Figure 11-5. If using the recommended function generator, set it up as follows (a 50 Ω output impedance is assumed):

Function -- Square Wave
Frequency -- 200 kHz
Amplitude -- 1.45 V p-p
DC Offset -- 1.525 V

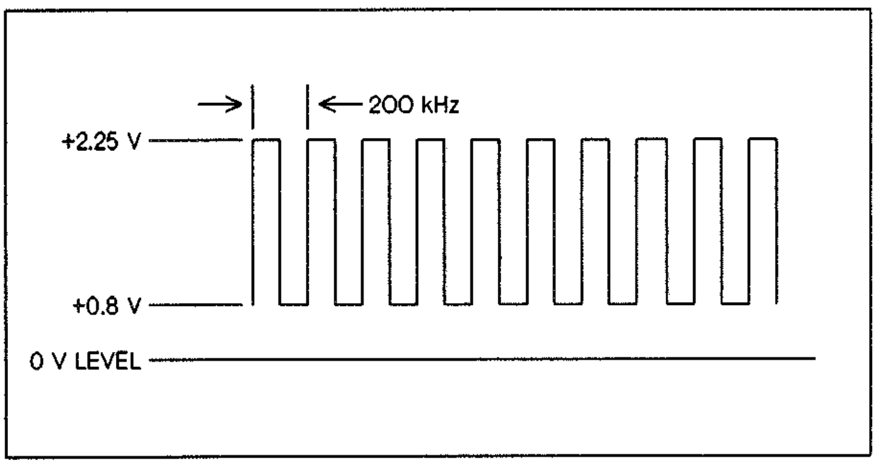


Figure 11-5 Non-Isolated TTL Input Test Signal

14. Setup channel 0 by executing:

USE ES00 (where E = extender number, S = slot number)
TERM NON

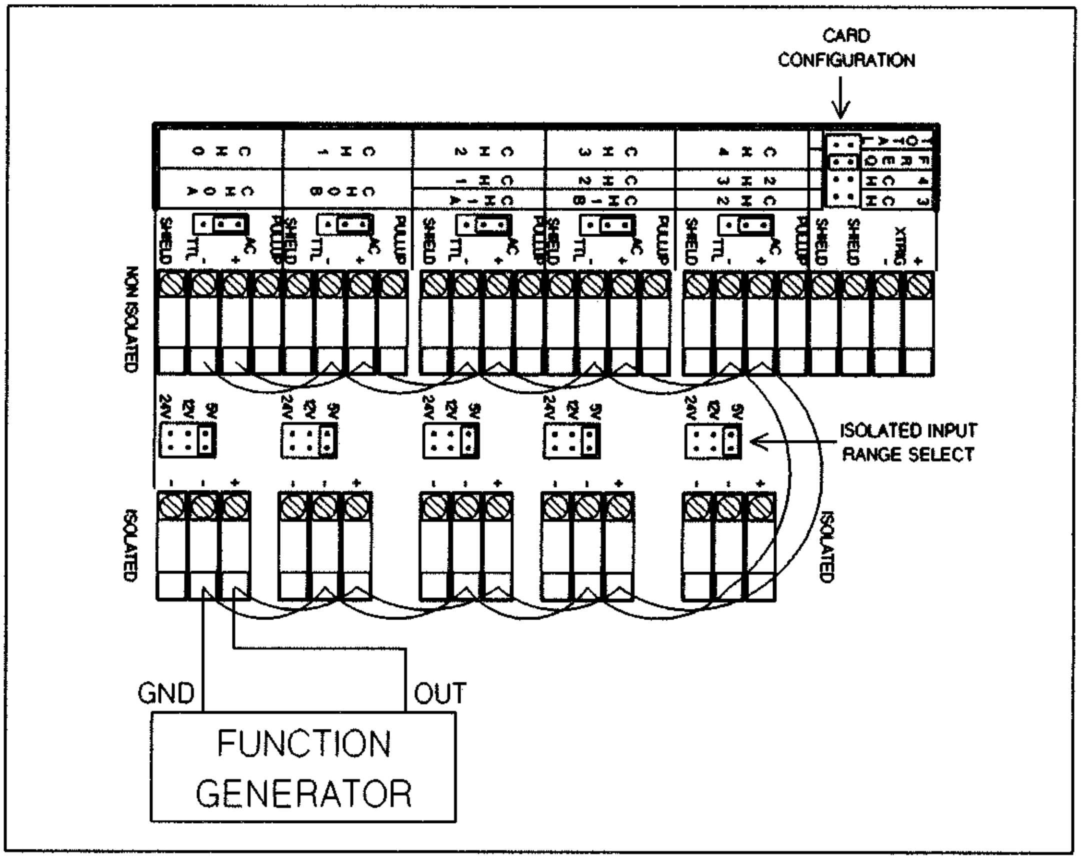


Figure 11-6 Non-Isolated AC Input Test

15. Read channel 0 by executing:

    CHREAD ES00 (where E = extender number, S = slot number)

16. Verify that the HP 3852A right display shows:

    1.999880E+05 to 2.000120E+05

17. Repeat steps 14, 15, and 16 for channels 1, 2, 3, and 4. In the USE command in step 14 and the CHREAD command in step 15, the last two digits indicate the channel number. For example, USE ES02 and CHREAD ES02 would be for channel 2.

18. Leave the function generator connected for the next test.

19. NON-ISOLATED AC INPUTS. The following tests the Non-Isolated Inputs of all channels in the AC input mode.

20. Set the Non-Isolated Input jumpers to AC, as shown in Figure 11-6.

21. Set the function generator to output a 50 mV RMS, 200 kHz sine wave (DC Offset to 0 V). If using the recommended function generator, set it up as follows (a 50Ω output impedance is assumed):

    Function -- Sine Wave
    Frequency -- 200 kHz
    Amplitude -- 50 mV RMS
    Offset -- 0 V

22. Setup the HP 44715A by executing:

    TRIG AUTO
    TBASE 0.1

23. Setup channel 0 by executing:

    USE ES00 (where E = extender number, S = slot number)
    TERM NON

24. Transfer 10000 readings from channel 0 by executing:

    XRDGS ES00,10000 (where E = extender number, S = slot number)

25. Verify that the HP 3852A right display shows:

    1.999880E+05 to 2.000120E+05

26. Change the function generator output to 25 mV RMS at 10 kHz.

27. Verify that the HP 3852A right display changes to:

    1.001100E+04 to 9.989000E+03

28. Change the function generator output to 25 mV RMS at 100 Hz.

29. Verify that the HP 3852A right display changes to:

    8.999000E+01 to 1.100100E+02

30. Press the HP 3852A front panel CLEAR key to stop transferring readings to the display.

31. Repeat steps 22 through 30 for channels 1, 2, 3, and 4. In the USE command in step 23 and the XRDGS command in step 24, the last two digits indicate the channel number. For example, USE ES02 and XRDGS ES02,10000 would be for channel 2.

32. Leave the function generator connected for the next test.

33. TRIGGER INPUT. The following tests the Trigger operation.

34. Change the function generator output to 25 mV RMS at 10 Hz.

35. Setup the HP 44715A by executing:

    TRIG EXT
    TBASE 1
    CHREAD ES00 (where E = extender number, S = slot number)

36. Short the two wires connected to the trigger input, as shown in Figure 11-7.

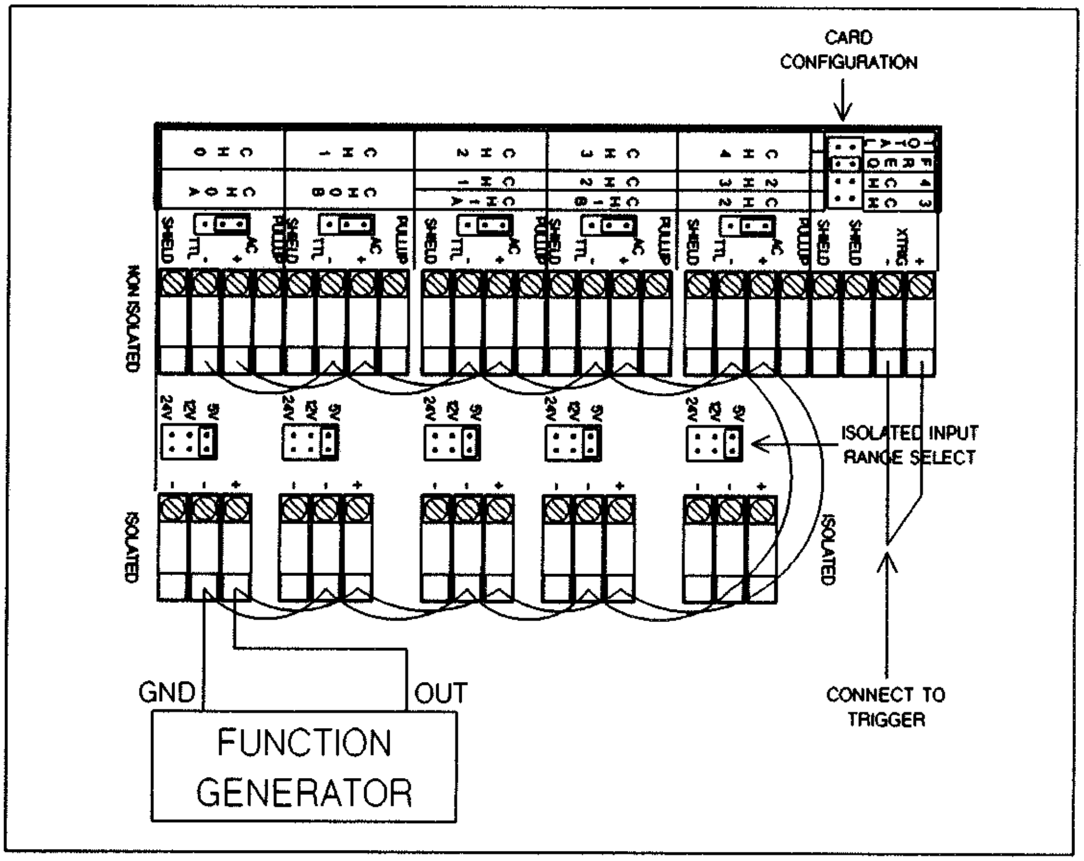


Figure 11-7 Trigger Input Test

37. After triggering the HP 44715A, the HP 3852A right display should be blank for approximately 1 second. Then the display should show:

8.999000E+00 to 1.100100E+01

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44715A PERFORMANCE TESTS.

11-12 Functional Tests

The following tests checks the Frequency, Totalize/Interrupt, Period, and Ratio functions of the Counter.

1. FREQUENCY TEST. The following tests the Frequency function.

2. Set the function generator to output a 25 mV RMS, 10 kHz sine wave. If using the recommended function generator, set it up as follows (a 50 Ω output impedance is assumed):

Function -- Sine Wave
Frequency -- 10 kHz
Amplitude -- 25 mV RMS
DC Offset -- 0 V

3. Connect the function generator to the shorted "+" and "-" inputs of the Isolated and Non-Isolated channels. The connections are shown in Figure 11-8.

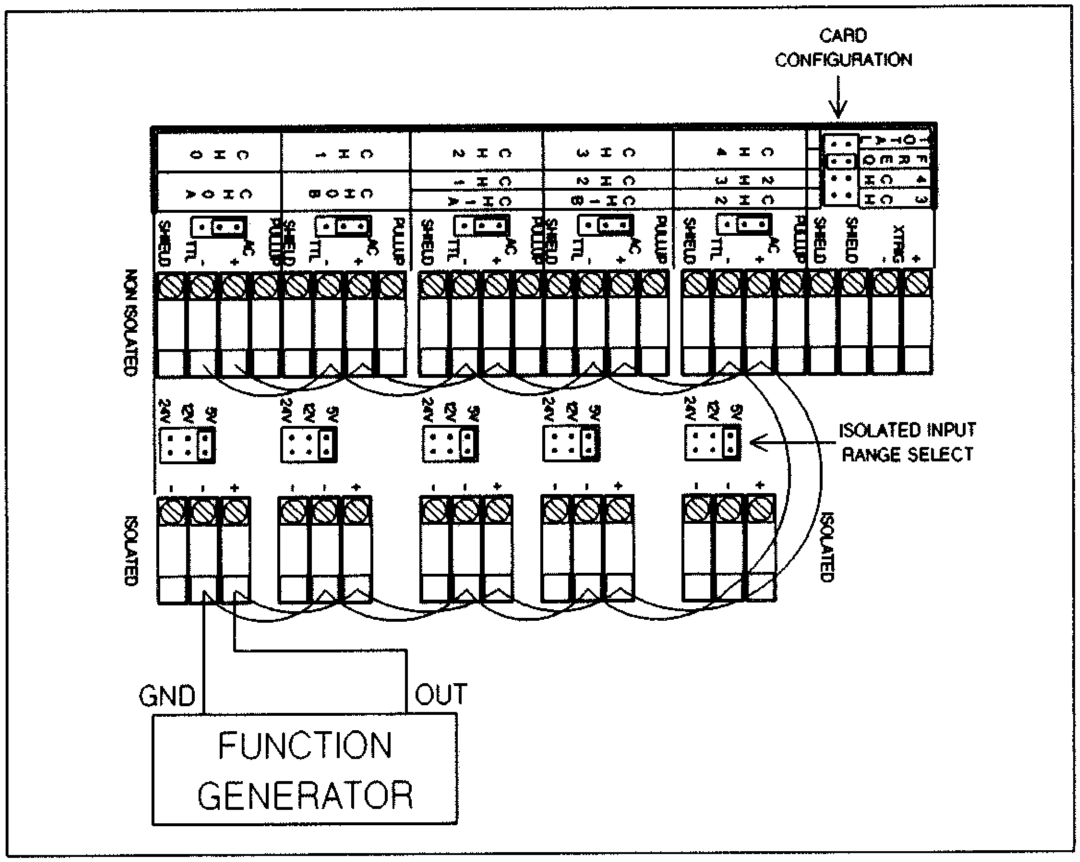


Figure 11-8 Frequency Test

4. Refer to Figure 11-8. Set the Non-Isolated Input jumpers to AC and set the Card Configuration jumper to FREQ.

5. Setup the HP 44715A by executing:

```
USE ES00  (where E = extender number, S = slot number)
TRIG AUTO
TERM NON
```

6. Set the counter time base to .01 by executing:

```
TBASE .01
```

7. Read channel 0 by executing:

```
CHREAD ES00  (where E = extender number, S = slot number)
```

8. Note the reading on the HP 3852A right display. Make sure it is within the specified limits in Table 11-2.

9. Repeat steps 6, 7, and 8 for time base 0.1 and 1.0. In the TBASE command in step 6, use TBASE 0.1 for time base 0.1, and TBASE 1 for time base 1.0.

10. Leave the function generator connected for the next test.

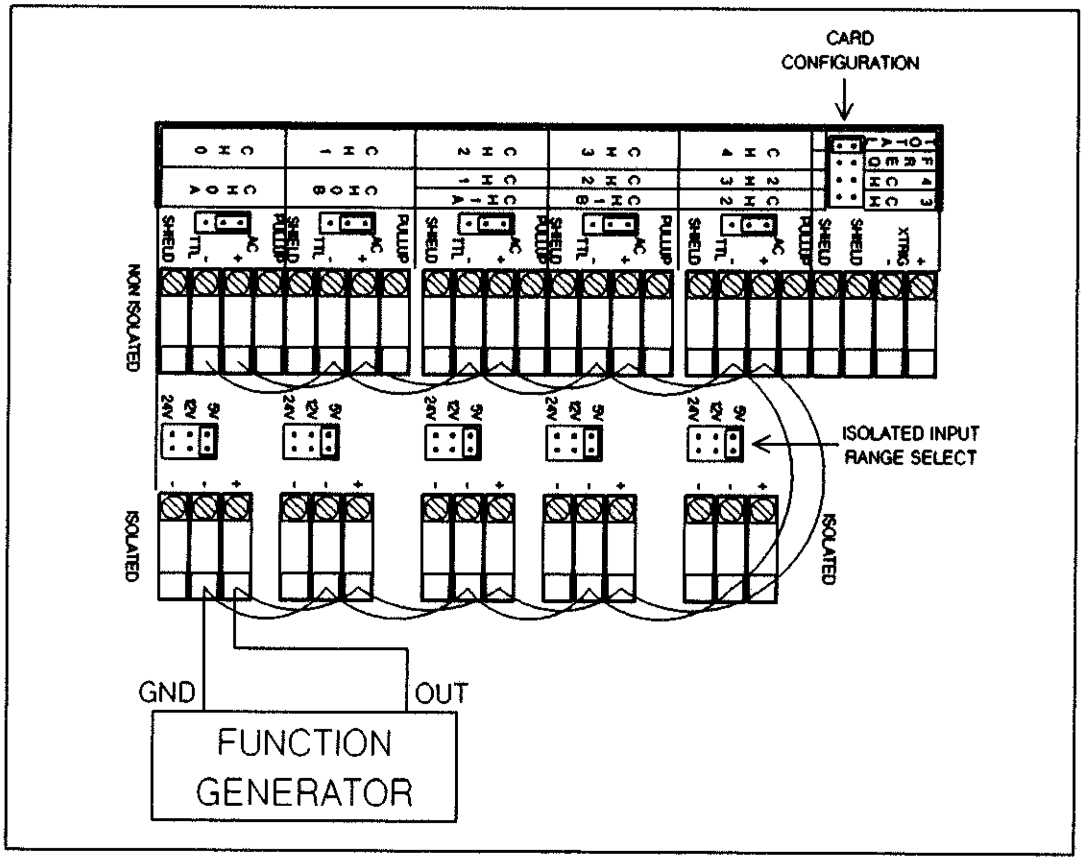


Figure 11-9 Totalize/Interrupt Tests

Table 11-2 Frequency Test limits

44715A Input	44715A Set-Up	44715A TBASE	Test Limits High	Test Limits Low
10 kHz	FREQ	.01	1.010100E+04	9.899000E+03
10 kHz	FREQ	0.1	1.001100E+04	9.989000E+03
10 kHz	FREQ	1	1.000200E+04	9.998000E+03

11. TOTALIZE/INTERRUPT TEST. The following tests the Totalize/Interrupt functions.

12. Turn the function generator output off. If using other than the recommended function generator without an output switch, it may have to be disconnected from the counter accessory.

13. Set the function generator to output a 25 mV RMS, 1 Hz sine wave. If using the recommended function generator, set it up as follows (a 50 Ω output impedance is assumed):

Function -- Sine Wave
Frequency -- 1 Hz
Amplitude -- 25 mV RMS
DC Offset -- 0 V

14. Set the Card Configuration jumper to TOTAL, as shown in Figure 11-9.

15. Setup the HP 44715A by executing:

FUNC TOTAL
ENABLE INTR
CNTSET -10

16. Transfer 10000 readings from channel 0 by executing:

XRDGS ES00,10000 (where E = extender number, S = slot number)

17. Verify that the HP 3852A right display shows:

-1.000000E+01

18. Turn the function generator output on (or connect it to the counter accessory).

19. The reading in the display should increase towards zero, at a 1 Hz rate. When the reading changes from "-1.000000E+00" to "0.000000E+00", the interrupt annunciator in the HP 3852A right display should turn on.

20. Press the HP 3852A front panel CLEAR key to stop transferring readings to the display.

21. Re-configure the HP 44715A by executing:

FUNC TOTALM
NPER 8
XRDGS ES00,1000 (where E = extender number, S = slot number)

22. The reading in the display should increase from "0.000000E+00" to "7.000000E+00" at a 1 Hz rate. After the reading reaches "7.000000E+00" it should then change to "0.000000E+00".

23. Press the HP 3852A front panel CLEAR key to stop transferring readings to the display.

24. Leave the function generator connected for the next test.

25. PERIOD TEST. The following tests the Period function.

26. Set the function generator to output a 25 mV RMS, 200 Hz sine wave. If using the recommended function generator, set it up as follows (a 50 Ω output impedance is assumed):

Function -- Sine Wave
Frequency -- 200 Hz
Amplitude -- 25 mV RMS
DC Offset -- 0 V

27. Set the Card Configuration jumper to 3 CH, as shown in Figure 11-10.

28. Setup the HP 44715A by executing:

FUNC PER
TBASE .000001
NPER 1

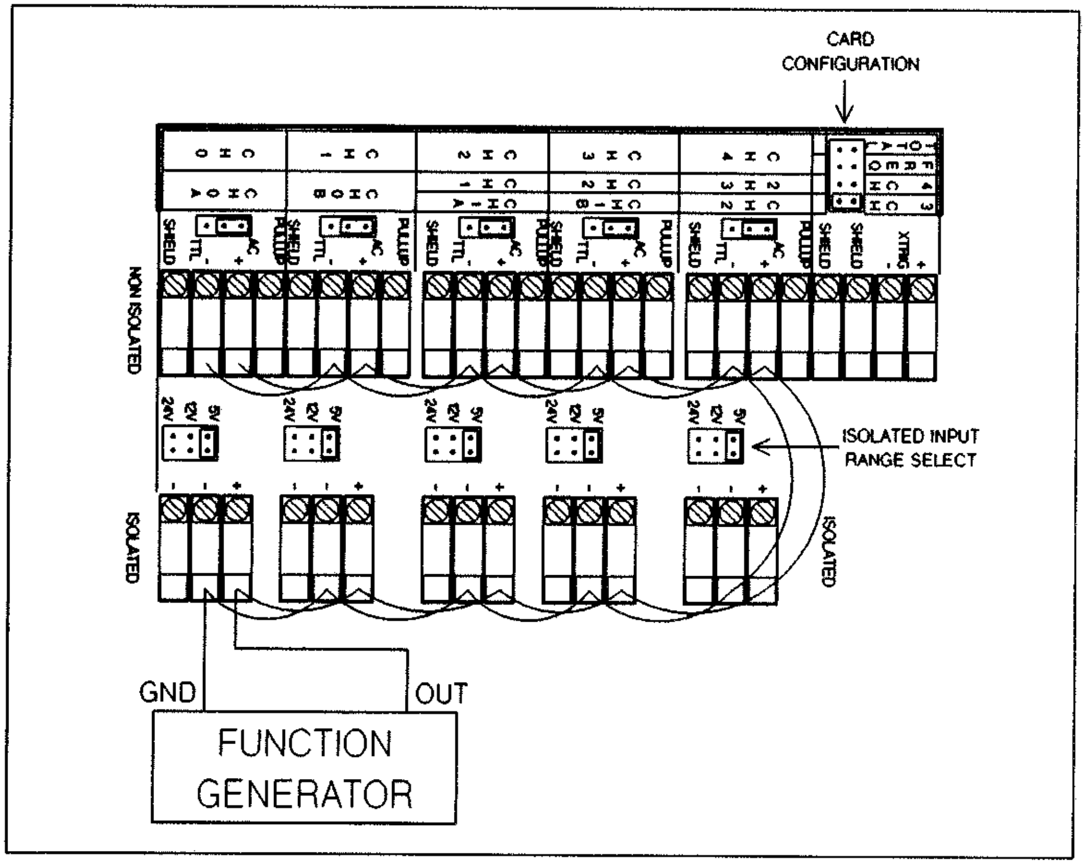


Figure 11-10 Period/Ratio Tests

29. read channel 0 by executing:

CHREAD ES00 (where E = extender number, S = slot number)

30. Note the reading on the HP 3852A right display. Make sure it is within the specified limits in Table 11-3. This reading is for a .000001 time base and 1 period counter configuration.

Table 11-3 Period Test limits

44715A Input	44715A NPER	44715A TBASE	Test Limits High	Test Limits Low
200 Hz	1	.000001	5.001500E-03	4.998500E-03
200 Hz	1	.00001	5.010500E-03	4.989500E-03
200 Hz	10	.00001	5.001500E-03	4.998500E-03
200 Hz	100	.00001	5.000700E-03	4.999300E-03

31. Change the time base to .00001 by executing:

TBASE .00001

32. Read channel 0 by executing:

CHREAD ES00 (where E = extender number, S = slot number)

33. Note the reading on the HP 3852A right display. Make sure it is within the specified limits in Table 11-3. This reading is for a .00001 time base and 1 period counter configuration.

34. Change the period to 10 by executing:

NPER 10

35. read channel 0 by executing:

CHREAD ES00 (where E = extender number, S = slot number)

36. Note the reading on the HP 3852A right display. Make sure it is within the specified limits in Table 11-3. This reading is for a .00001 time base and 10 period counter configuration.

37. Change the period to 100 by executing:

NPER 100

38. read channel 0 by executing:

CHREAD ES00 (where E = extender number, S = slot number)

39. Note the reading on the HP 3852A right display. Make sure it is within the specified limits in Table 11-3. This reading is for a .00001 time base and 100 period counter configuration.

40. Leave the function generator connected for the next test.

41. RATIO TEST. The following tests the Ratio function.

42. Set the function generator to output a 50 mV RMS, 200 kHz sine wave. If using the recommended function generator, set it up as follows (a 50 Ω output impedance is assumed):

Function -- Sine Wave
Frequency -- 200 kHz
Amplitude -- 50 mV RMS
DC Offset -- 0 V

43. Setup the HP 44715A by executing:

FUNC RATIO
NPER 1000

44. read channel 0 by executing:

CHREAD ES00 (where E = extender number, S = slot number)

45. Verify that the HP 3852A right display shows:

1.000000E+00

11-13 REPLACEABLE PARTS

Figure 11-11 shows the mechanical breakdown of the HP 44715A. The figure also provides assembly and disassembly information. The parts shown in Figure 11-11 are keyed to the parts lists in Table 11-4.

To order a part listed in Table 11-4, quote the Hewlett-Packard part number, the quantity desired, the HP factory reference, and the check digit (abbreviated CD in Table 11-4). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

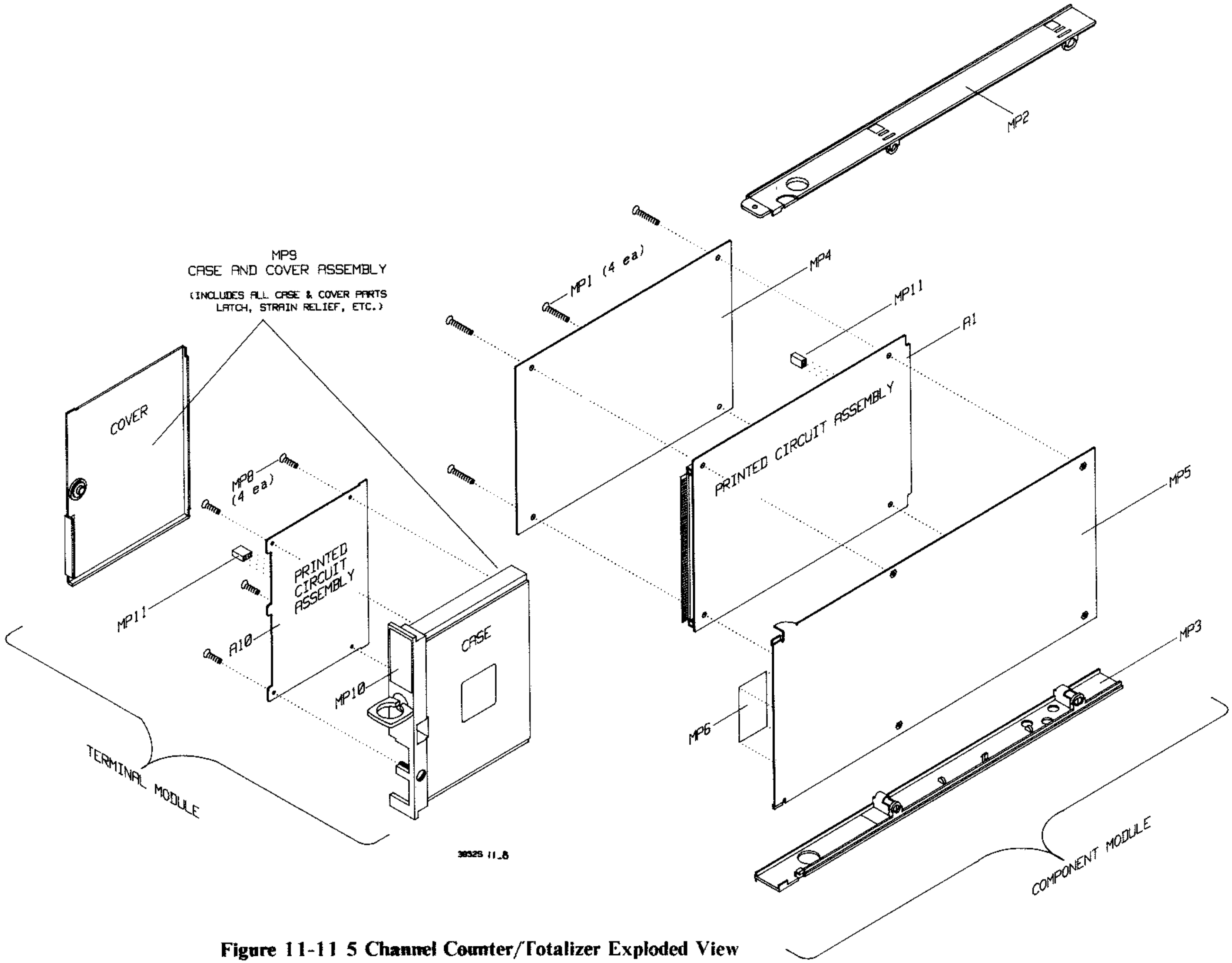


Figure 11-11 5 Channel Counter/Totalizer Exploded View

Table 11-4 HP 44715A 5 Channel Counter/Totalizer (200 kHz)

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44715A	Module; 5 ch counter/total component	1	44715-66201	3	MOD-5CH COUNTER
A1	PCA; 5 ch counter/totalizr component	1	44715-66501	6	PCA-5CH COUNTER
A10	PCA; 5 ch counter/totalizr terminal	1	44715-66510	7	PCA-TERM,5CH CNT
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44715 component module	1	44715-84320	5	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44715A	1	44715-84325	0	LBL-ID,TERM ASSY
MP11	Jumper; removable, A1/A10 PCAs	15	1258-0141	8	JMPR-REM.025P

Completely assembled HP 44715A terminal modules can be ordered from your local HP Office by ordering Number 44715AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44715A	Module; 5 ch counter/total component		44715-69201	9	RBLT-44715-66201

Chapter 12
HP 44721A/22A Digital Inputs

CHAPTER 12
HP 44721A/44722A DIGITAL INPUTS

CHAPTER 12

HP 44721A/44722A DIGITAL INPUTS

12-1 INTRODUCTION

This chapter contains a technical description, performance tests, and replaceable parts for the HP 44721A 16 Channel Digital Input and the HP 44722A 8 Channel AC Digital Input.

12-2 HP 44721A Technical Description

The HP 44721A 16 Channel Digital Input Accessory can read the state of any or all of the 16 digital channels. Each of the channels can also be programmed as a low frequency counter.

The HP 44721A has the capability to interrupt the HP 3852A local controller. Each of the 16 channels can be programmed to generate an HP 3852A interrupt on either an event or a count. An event for a channel is a high-to-low or low-to-high transition (selected by program codes). A count interrupt can be programmed to occur on a specified count or when the counter reaches roll-over.

A simplified block diagram of the HP 44721A is given in Figure 12-1. The HP 44721A has two main assemblies: a component module and a terminal module. The component module contains the backplane interface electronics, the debounce oscillator, and the channel opto-isolators. The terminal module contains terminal blocks for connection to external wiring, the debounce oscillator capacitor (selected by a jumper) and a jumper selected input attenuator. The printed circuit board used in the component module is also used in the HP 44722A component module.

The control logic interfaces the HP 44721A with the HP 3852A backplane. The control logic contains the read and write registers used by the digital bus to communicate with the accessory. The control logic uses a microprocessor to control the registers, set-up the desired functions on each channel, monitor the conditions of each channel and generate the appropriate interrupts to the HP 3852A local controller. The counter function is also implemented in the microprocessor.

The input from each channel is optically isolated on the component module. In parallel with each opto-isolator is a reverse polarity protection diode.

After the opto-isolator, the input is sent to the digital debounce circuit. This circuit prevents erroneous readings. The digital debounce circuit is a four bit shift register, clocked by the debounce oscillator. The input to the shift register and the output from the shift register are combined in an exclusive or (EXOR) gate that controls the shift register. If the output of the EXOR gate is set true, the shift register is reset. An input signal must remain at a constant level for at least four oscillator clock cycles for the output of the digital debounce circuit to be true.

The debounce oscillator controls the digital debounce circuit for each channel by setting the rate at which the input is shifted through the four bit shift register. The debounce oscillator is designed to operate at one of three frequencies and the frequency of operation is determined by a jumper selected capacitor on the terminal module. The debounce oscillator frequency selected applies to all 16 channels. The frequency is user selected based upon the minimum pulse width required to sense and the maximum bounce time of the input signal.

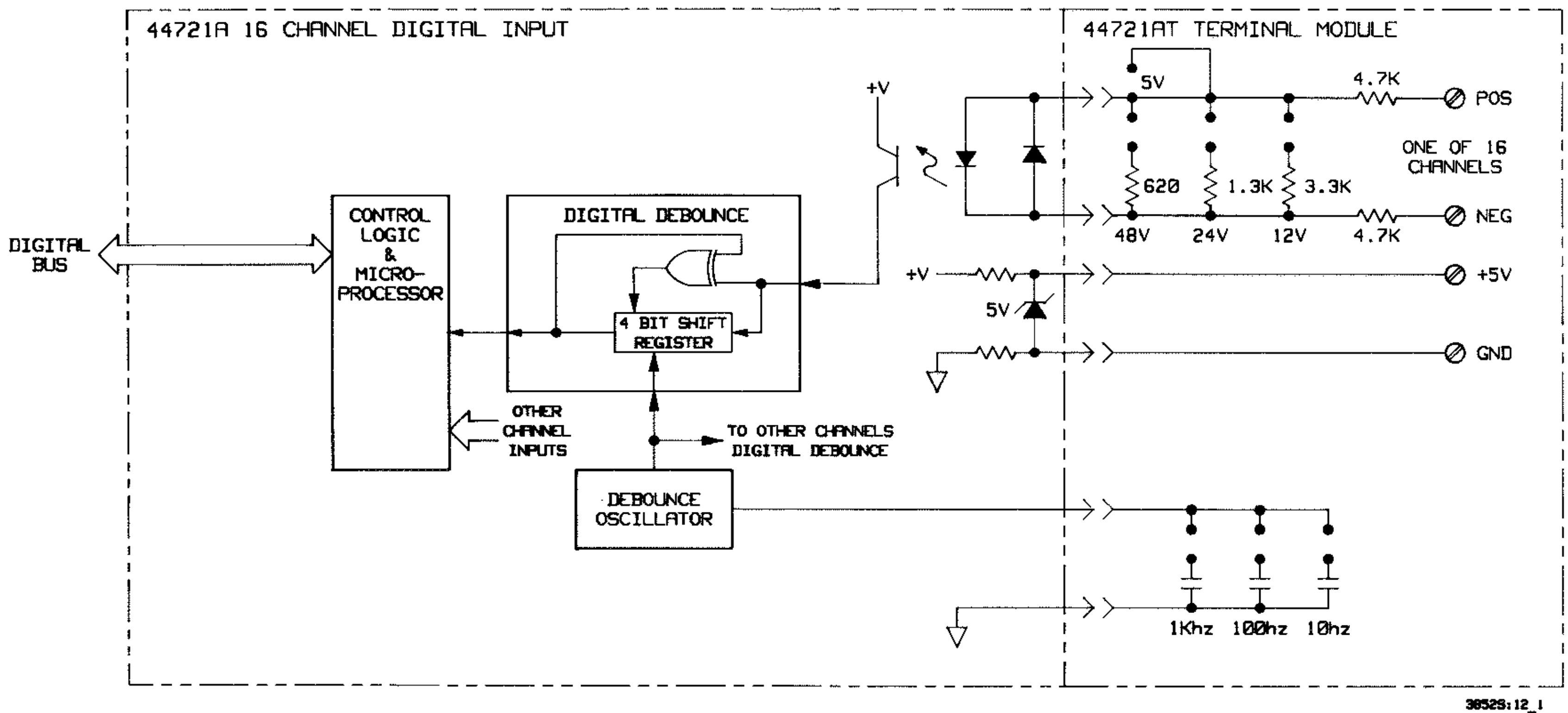


Figure 12-1 HP 44721A Simplified Block Diagram

On the terminal module, in addition to the terminal blocks for external wiring, is a jumper selected input attenuator. With no jumper installed (or with the jumper installed in a dummy position), the input is set for 5 V. Other input voltage ranges as set by the jumper are: 12 V, 24V, and 48 V.

Also provided on the terminal module are +5 VDC and ground. These terminals can be used to measure dry contact inputs. If the +5 VDC terminal is used, the channel connected is no longer isolated from the HP 3852A.

12-3 HP 44722A Technical Description

A simplified block diagram of the HP 44722A is given in Figure 12-2. The HP 44722A has two main assemblies: a component module and a terminal module. The component module is identical to the HP 44721A component module. The accessory is made unique by the addition of the terminal module. The functions and features of the HP 44722A are the same as the HP 44721A. Because of the physical size of the components and the higher rated input voltages for the HP 44722A, only every other input channel is used on the component module.

The debounce oscillator is fixed at a frequency that will allow the accessory to read 47 Hz to 470 Hz AC line voltage interrupted at a 10 Hz rate. The 44722AT terminal module also allows higher input voltages than the HP 44721AT. The jumper selected input voltage ranges are: 24 V, 120 V, and 240 V. The accessory can accept either AC or DC voltage inputs.

12-4 Read and Write Registers

The HP 3852A local controller communicates with each plug-in accessory by using read and write registers. High level commands are translated into appropriate register commands. The SREAD and SWRITE commands can be used to directly control each register.

SREAD and SWRITE are described in Chapter 2 of this manual. Table 12-1 shows the registers used by the HP 44721A/ and HP 44722A accessories.

Table 12-1 Digital Input Read and Write Registers

Register #	READ Registers	WRITE Registers
0	Accessory Identification	Accessory Control
1	Status	Processor Command
2	Not Used	Not Used
3	Processor Data	Processor Data
4	Not Used	Not Used
5	Input Data	Not Used

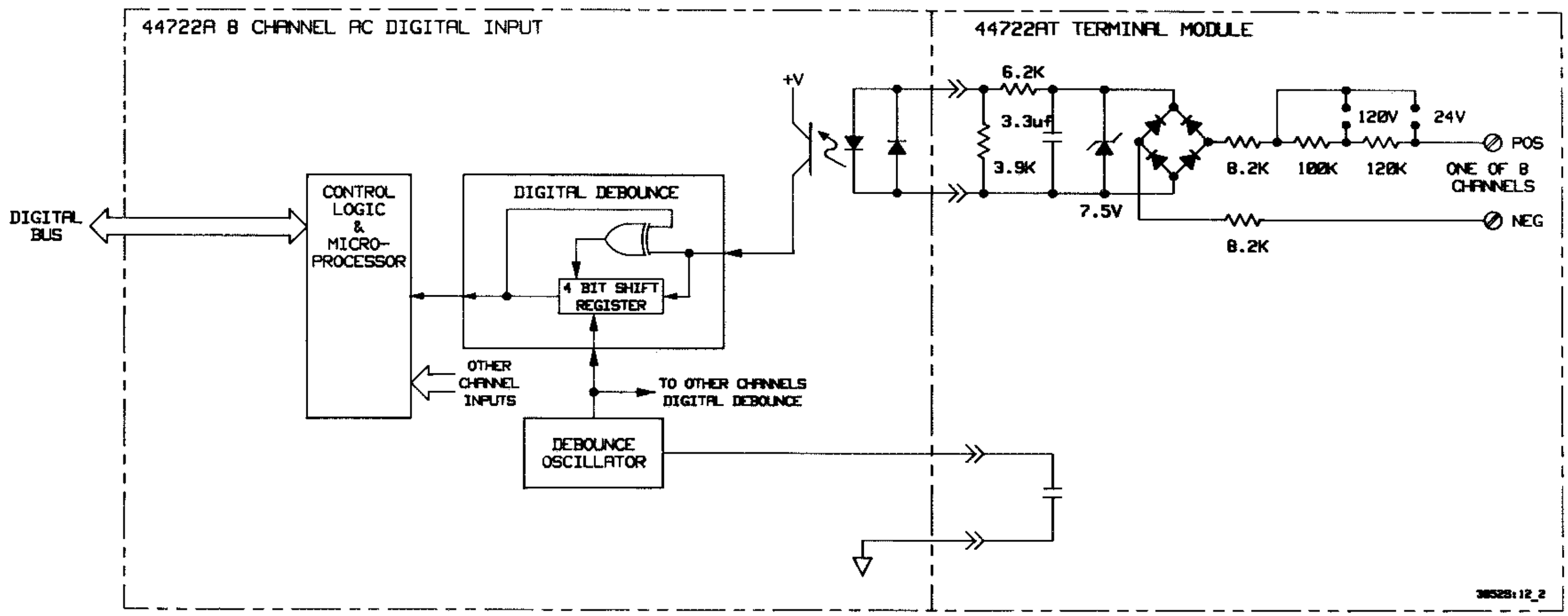


Figure 12-2 HP 44722A Simplified Block Diagram

CAUTION

Using the primitive commands (SREAD and SWRITE) may cause unexpected and undesirable effects on the plug-in accessories. It is possible to program some plug-in accessories into illegal and potentially damaging states with these commands. The commands are documented here for service purposes only.

12-5 Read Registers

12-6 Register 0. Read Register 0 contains the accessory identification. Eight bits are used to uniquely identify the accessory. The eight bits are output on the lower eight bits of the backplane data lines.

The eight bit identification is in two parts. The five most significant bits identify the component module and the three least significant bits identify the type of terminal module installed. If a terminal module is not present, the lower three bits are set high by the component module. The HP 3852A local controller can thus identify the type of plug-in accessory installed and determine if a terminal module is installed.

Table 12-2 lists the decimal equivalent codes returned in response to an SREAD of Register 0 for all combinations of the accessory.

Table 12-2 HP 44721A and HP 44722A Identification Codes

Module Combinations	Codes
HP 44721A Component Module (no terminal module installed)	-241
HP 44721A Component Module, HP 44721AT Terminal Module installed	-248
HP 44721A Component Module, HP 44722AT Terminal Module installed	-240

12-7 Register 1. Read Register 1 is the status register. The register shows the present status of the accessory. The definitions of the bits are in Table 12-3.

Table 12-3 Read Status Register

Bit #	Definitions
0	Data Ready (Output Buffer Full)
1	Busy (Input Buffer Full)
2	Not Used
3	Not Used
4	Done (Ready for Next Command)

12-8 Register 3. Read Registers 3 reads the data register of the microprocessor on the component module. This data serves no useful purpose for troubleshooting.

12-9 Register 5. Read Registers 5 reads the input data to the component module. This data serves no useful purpose for troubleshooting.

12-10 Write Registers

12-11 Register 0. Write Registers 0 is the accessory control register. The purpose of the register is to enable interrupt and enable interrupt acknowledge and clear the interrupt of the accessory. The register can also reset the accessory. The definitions of the bits are in Table 12-4.

Table 12-4 Write Control Register

Bit #	Definitions
0	Interrupt Enable
1	Reset Accessory
2	Interrupt Acknowledge/Clear

12-12 Register 1. Write Register 1 is the microprocessor command register. This register serves no useful purpose for troubleshooting.

12-13 Register 2. Write Register 2 is the microprocessor data register. This register serves no useful purpose for troubleshooting.

12-14 SPECIFICATIONS

Specifications for the HP 44721A and HP 44722A are given in Table 12-5. Specifications are the performance standards or limits against which the Digital Input Accessories may be tested.

Table 12-5 HP 44721A/44722A Specifications

HP 44721A

Operating Range:

Accessory Input	Nominal Voltage (Vdc) 5	12	24	48
Threshold Voltage (V): Vlow (max)	1	2.5	7	14
Vhigh (min)	4	9.5	17	31
Input Current (ma) at Nominal Voltage	0.5	1.3	2.8	5.8

Maximum Input Voltage: 80 V peak (between High and Low Terminal of each Channel)
354 V peak or 250 V DC (between channels or between any Terminal and Chassis)

Totalize and Totalize Modulo:

Accuracy: ±1 count

Range: -2^{31} to $+2^{31} - 1$ (32 bits, 2's complement)

Range of Modulo N: 2 to 65,535

Maximum On/Off Frequency: 500 cycles per second

5 Volt Power Supply: 4.5 V to 5.5 V DC
8 mA maximum output current

Maximum Wire Size: 16 AWG

Table 12-5 HP 44721A/44722A Specifications (Cont.)

HP 44722A

Operating Range: For sine wave frequencies between 47 to 470 Hz

Accessory Input	Nominal Voltage (Vdc) 24	120	240
Threshold Voltage (V): Vlow (max)	5.5	30	65
Vhigh (min)	16.5	90	185
Input Current (ma) at Nominal Voltage	1.7	1.1	1.1

Maximum Input Voltage: 354 V peak or 250 V DC between High and Low Terminal of Each Channel)
354 V peak or 250 V dc (between channels or between any Terminal and Chassis)

Totalize and Totalize Modulo:

Accuracy: ±1 count

Range: -2^{31} to $+2^{31} - 1$ (32 bits, 2's complement)

Range of Modulo N: 2 to 65,535

Maximum On/Off Frequency: 10 cycles per second

Maximum Wire Size: 14 AWG

12-15 PERFORMANCE TESTS

12-16 Introduction

The following Performance Tests check the operation of the HP 44721A and HP 44722A component module. Performance Tests are not given for the terminal modules. Successful completion of all tests in this chapter provides a high confidence level that the Digital Input Accessory is meeting its listed specifications.

The Performance Tests should be performed in the order they are presented. The completion of each test increases the confidence level in the Digital Input Accessory operation. A minimum set of tests is given as Operational Verification Tests. These tests are described in Section 12-17.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence that the Digital Input Accessory is operating normally, it is not recommended that all the Performance Tests be performed unless one of the tested specifications is in question.

12-17 Operational Verification

The first tests given in this section are the minimum set of tests recommended for the Digital Input Accessory. These tests are designed to test the functionality of the accessory. Successful completion of the Operational Verification Tests provides a 90% confidence level that the Digital Input Accessory is operating normally and is within specification.

The Operational Verification Tests consist of the following:

Section 12-21 - Set-Up Procedure
Section 12-22 - +5 V Supply Test
Section 12-23 - Pattern Test
Section 12-24 - Counter Test
Section 12-25 - Interrupt Test

12-18 Equipment Required

The following test equipment is required to run the Performance Tests. Only the first three items in the list are required for the Operational Verification Tests.

1. Test Fixture (as described in Section 12-19)

2. Test Leads and Jumpers

3. Voltmeter -- Any DC Voltmeter able to read +5 V at ±10%

4. Function Generator -- HP 8116A or equivalent

NOTE

Either of the accessory plug-in voltmeters (HP 44701A or HP 44702A/B) may be used for the +5 V Supply Test. This test does not describe the specific steps required to use the plug-in voltmeters. A description of the plug-in voltmeters can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

12-19 Test Fixture

A test fixture is required to run the Performance Tests. A schematic of the required test fixture is shown in Figure 12-3a. A test fixture can be manufactured using an HP 44721AT terminal module, (see Figure 12-3b). Make sure only the HP 44721AT module is used; an HP 44722AT module cannot be used. Because wiring the fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

If the test fixture is to be fabricated from other than an HP 44721AT terminal module, it is important that the terminal ID lines, shown in Figure 12-3a, be correctly wired. The HP 3852A local controller will not allow the execution of some commands with an incorrect terminal ID.

The test fixture consists of the following:

1. A short circuit between all odd numbered channels POS (positive) connections.

2. A short circuit between all even numbered channels POS connections.

3. A short circuit between all channels NEG (negative) and GND (ground) connections.

4. A connection to the +5 V supply.

On the test fixure, set the input attenuator jumpers of all channels to the 5 V position.

12-20 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

12-21 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the Digital Input Accessory component module and install the test fixture. Note the slot number where the Digital Input Accessory under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

   c. Verify that the HP 3852A right display shows:

      44721A

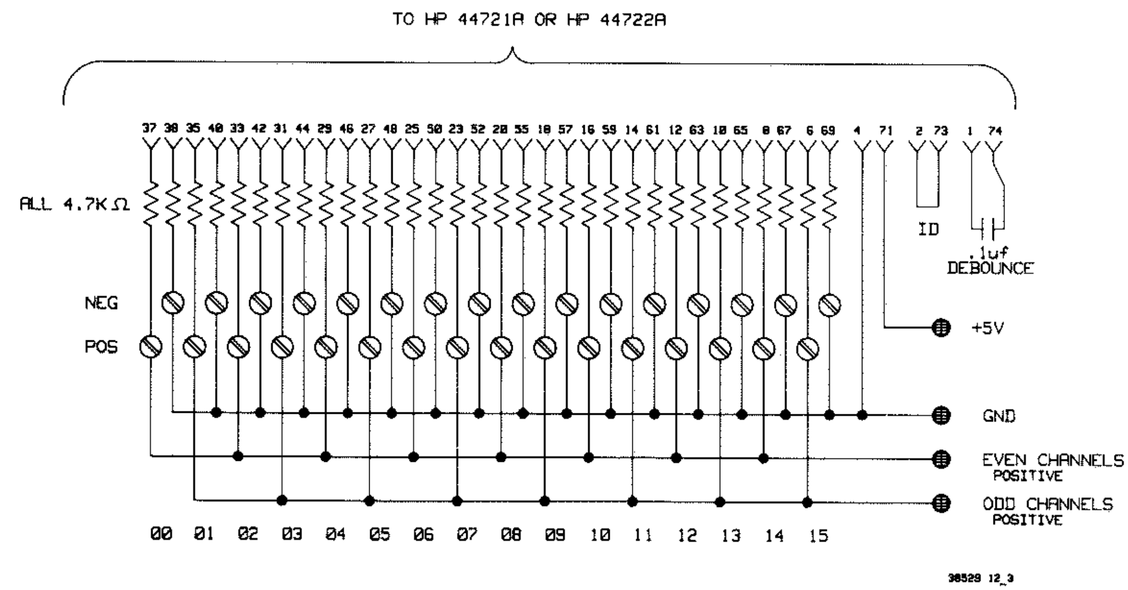


Figure 12-3a HP 44721A Test Fixure Schematic

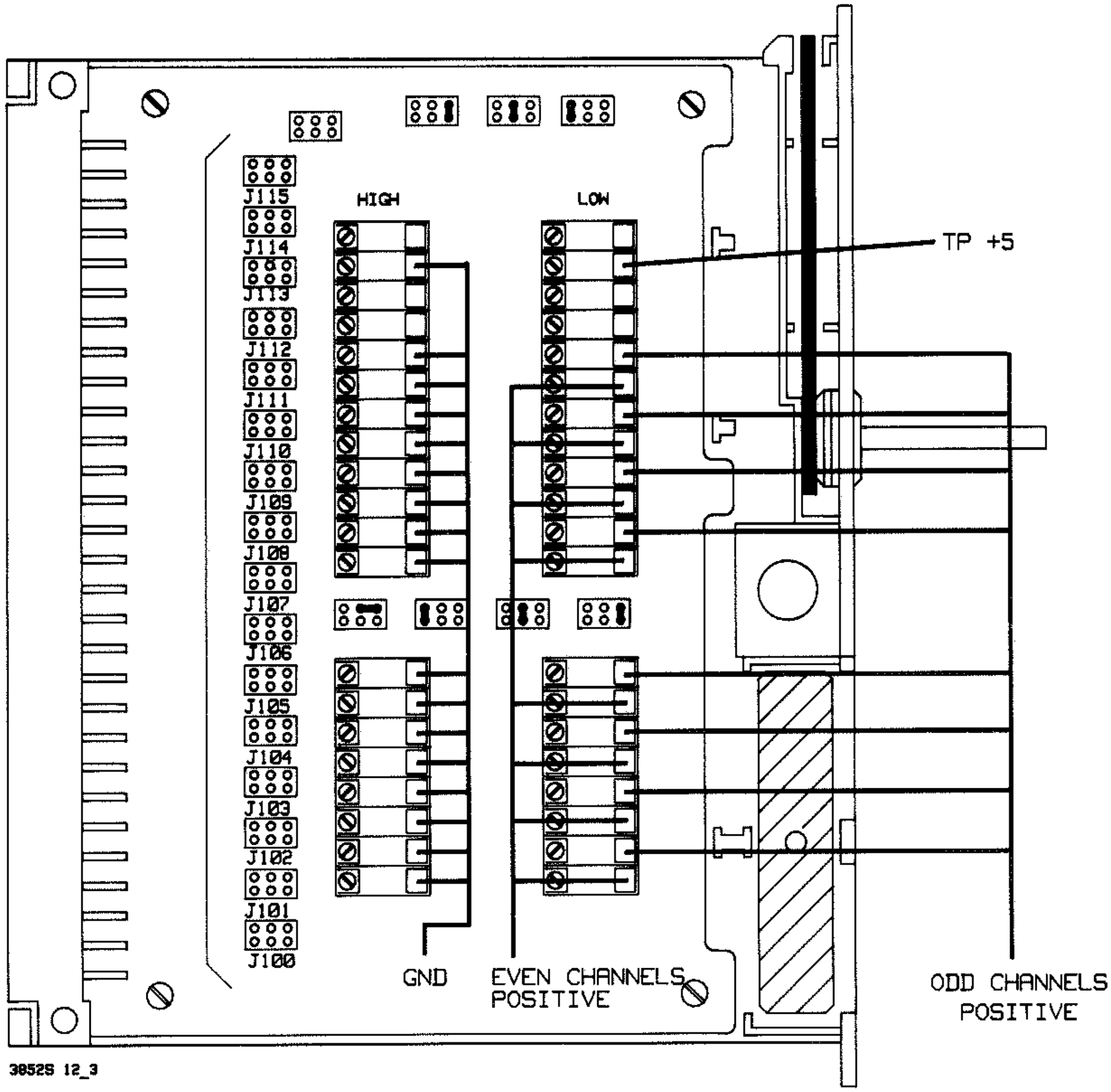


Figure 12-3b HP 44721A Test Fixure

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

12-22 +5 V Supply Test

This test checks the component module's +5 V Supply.

1. Set the voltmeter to measure 5 Vdc. Connect the voltmeter to the +5 supply and ground connections on the test fixure. The connections are shown in Figure 12-4.

2. Observe the indication on the voltmeter. The voltmeter should indicate +5 V ±0.5 V.

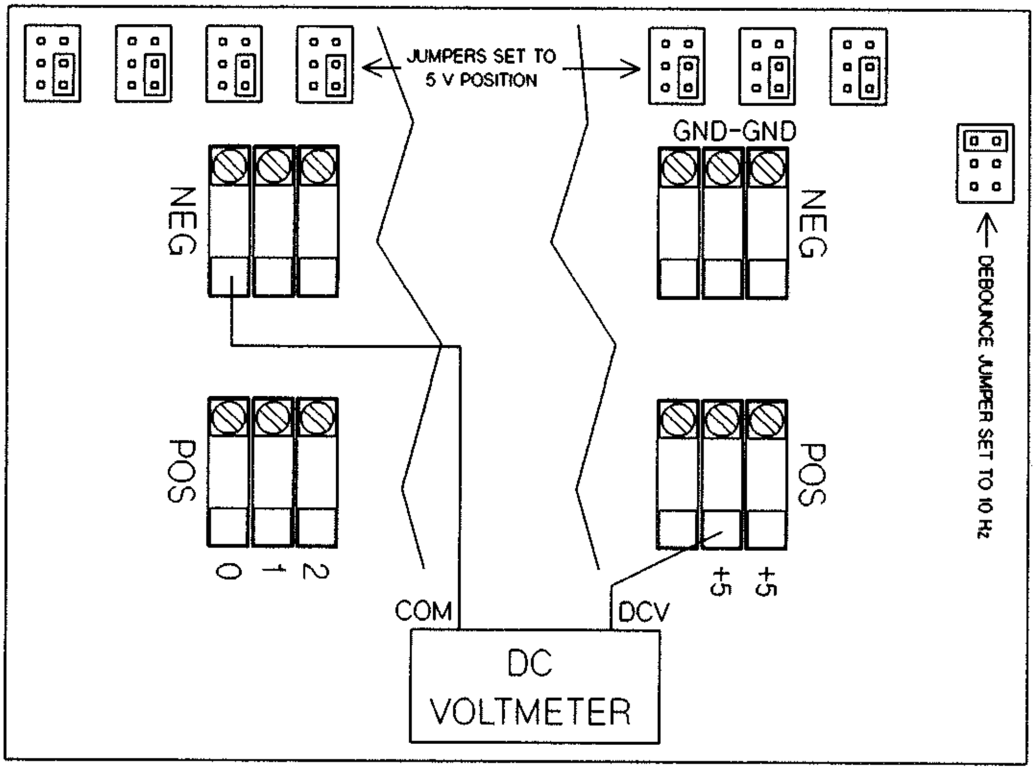


Figure 12-4 +5 V Supply Test

12-23 Pattern Test

1. EVEN NUMBERED CHANNELS PATTERN TEST. This test verifies the accessory can detect and correctly report a pattern of inputs on even numbered channels.

2. Set all HP 44721A channels to a known state by executing:

   RESET ES00 (where E = extender number, S = slot number)

3. Set all even numbered channel inputs high by installing a jumper between the shorted even channel POS (positive) connections and the +5 V connection. The connections are shown in Figure 12-5.

4. Read the channels by executing:

   READ ES00 (where E = extender number, S = slot number)

5. Verify that the HP 3852A right display shows:

   21845

The number in the display is a decimal equivalent of a two's compliment binary representation of the 16 channel inputs. A number other than "21845" shows a failing channel. The displayed number can be decoded as a binary number to determine a failing channel(s).

6. Set all channels low by removing the jumper from the POS and +5 V connections.

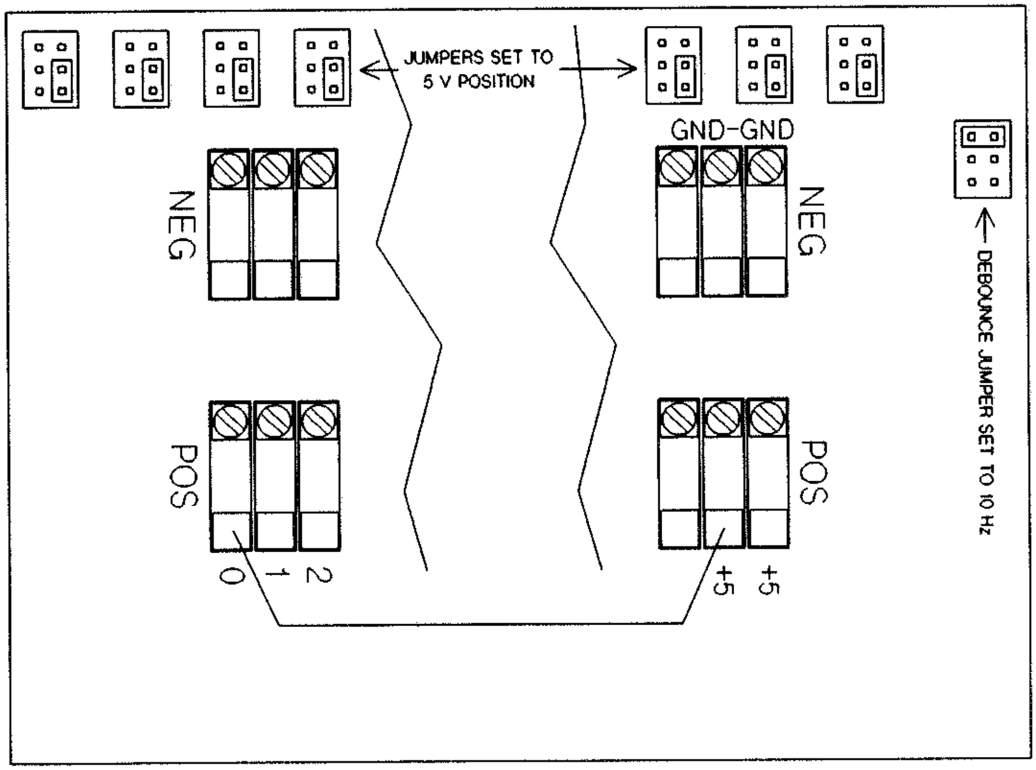


Figure 12-5 Even Channel Pattern Test

7. Read the channels by executing:

   READ ES00 (where E = extender number, S = <slot number)

8. Verify that the HP 3852A right display shows:

   0

9. ODD NUMBERED CHANNELS PATTERN TEST. This test verifies the the accessory can detect and correctly report a pattern of inputs on odd numbered channels.

10. Set all odd numbered channel inputs high by installing a jumper between the shorted odd channel POS (positive) connections and the +5 V connection. The connections are in Figure 12-6.

11. Read the channels by executing:

    READ ES00 (where E = extender number, S = slot number)

12. Verify that the HP 3852A right display shows:

    -21846

The number in the display is a decimal equivalent of a two's compliment binary representation of the 16 channel inputs. A number other than "-21846" shows a failing channel. The displayed number can be decoded as a binary number to determine a failing channel(s).

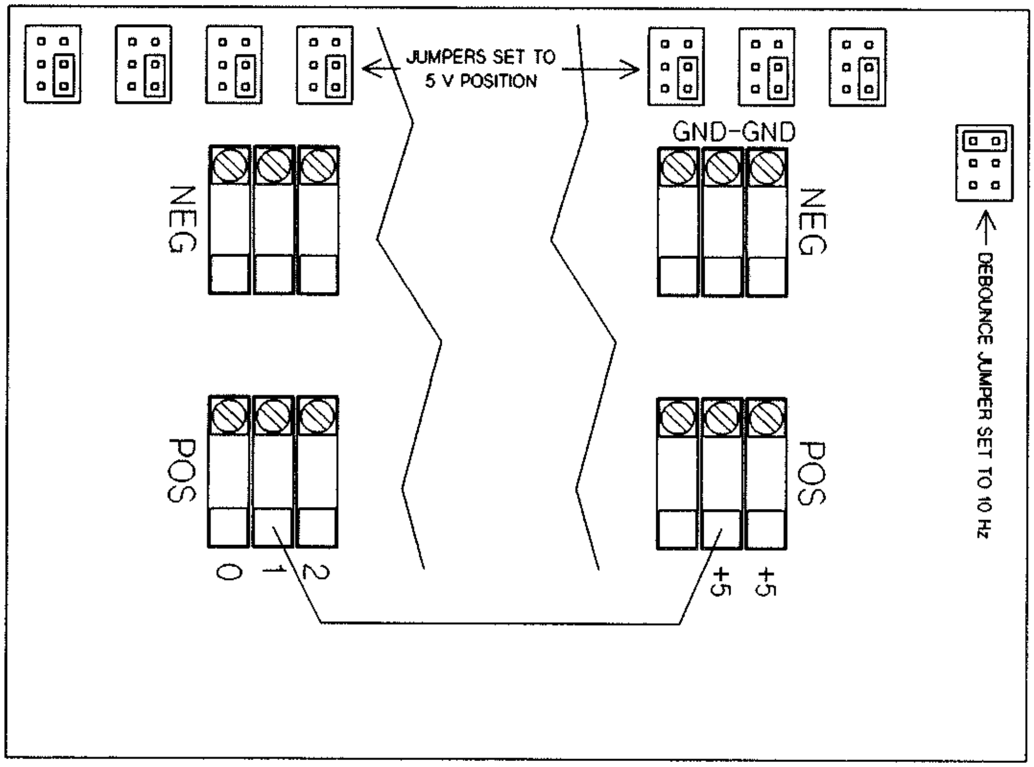


Figure 12-6 Odd Channel Pattern Test

13. ALL CHANNELS HIGH TEST. This test verifies that the accessory can detect and correctly report the results of all channels set to a high input.

14. Set all channel inputs high by installing a jumper between the shorted even channel POS (positive) connections and the +5 V connection, and installing a jumper between the shorted odd channel POS (positive) connections and the +5 V connection. The connections are shown in Figure 12-7.

15. Read the channels by executing:

READ ES00 (where E = extender number, S = slot number)

16. Verify that the HP 3852A right display shows:

-1

17. Return the HP 44721A to a known state by removing all jumpers and executing:

RESET ES00 (where E = extender number, S = slot number)

12-24 Counter Test

1. EVEN NUMBERED CHANNELS COUNTER TEST. This test verifies that even numbered channels can count transitions on the channel inputs and correctly report the number of counts.

2. Refer to Figure 12-8. On the test fixure, set the debounce jumper to the 10 Hz position.

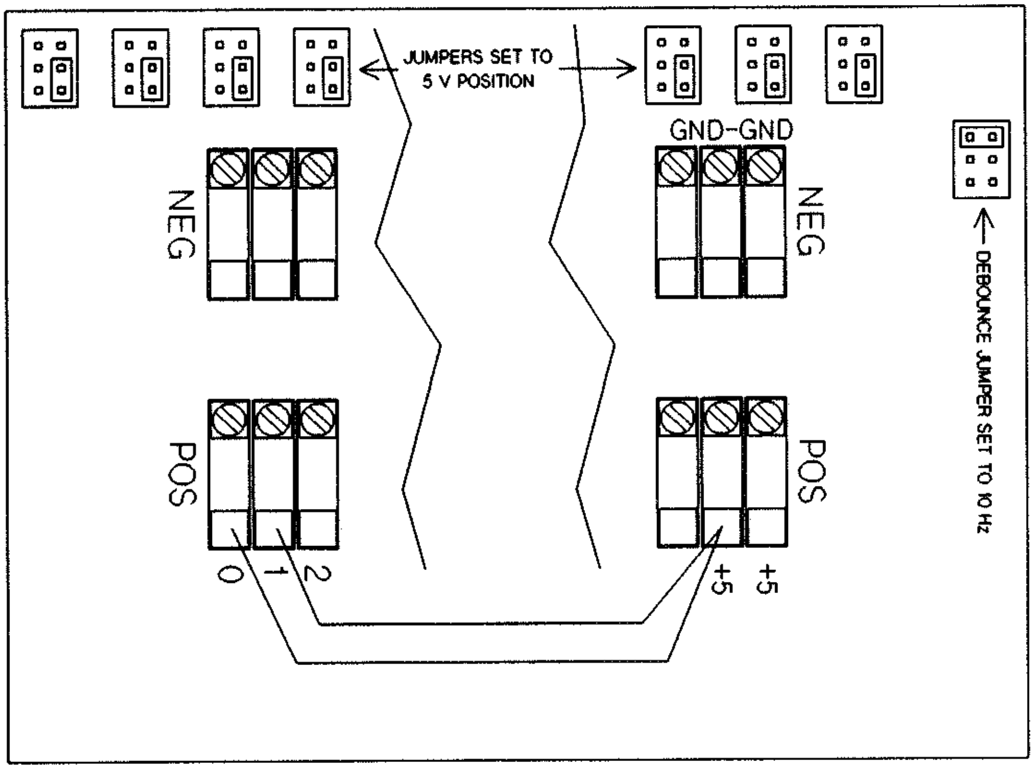


Figure 12-7 All Channel Pattern Test

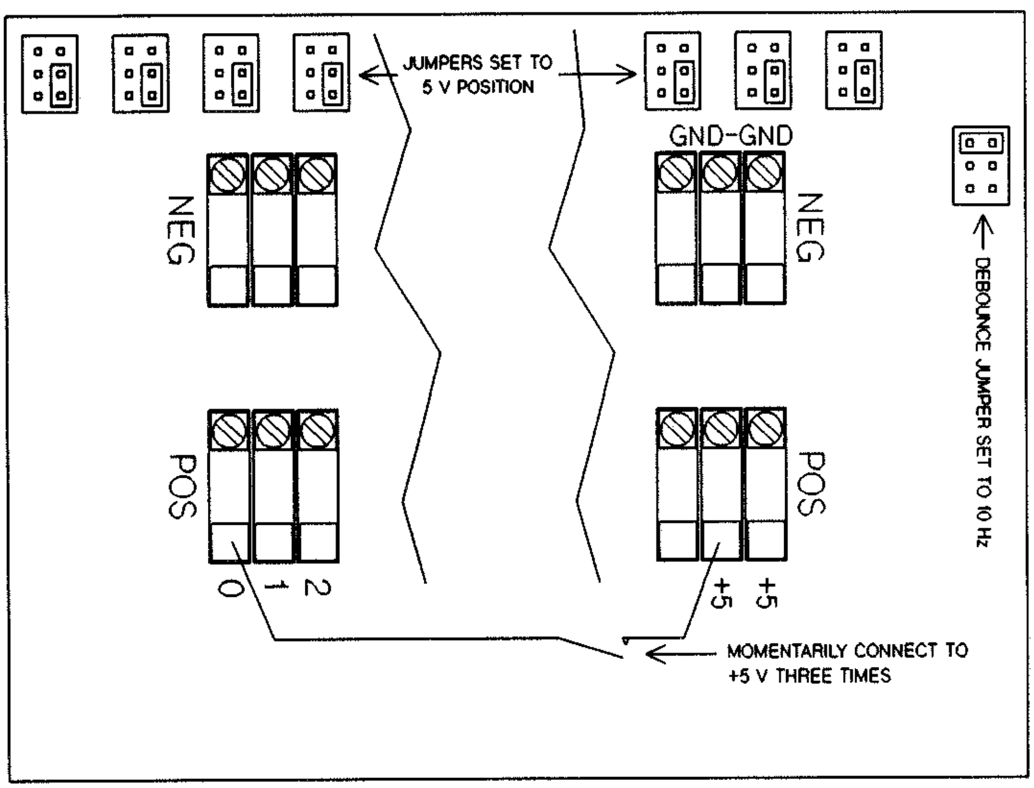


Figure 12-8 Even Channel Counter Test

3. Setup counter measurement by executing:

EDGE LH,USE ES00 (where E = extender number, S = slot number)

4. Refer to Figure 12-8. With a jumper, momentarily connect the shorted even numbered channel POS (positive) connections to the +5 V connection three times.

5. Read the counter input of the even numbered channels by executing:

CHREAD ES00 (where E = extender number, S = slot number)

6. Verify that the counter counted the transitions on the even numbered channels. The HP 3852A right display should show:

3.000000E+00

7. Read the counter input of the odd numbered channels by executing:

CHREAD ES01 (where E = extender number, S = slot number)

8. Verify that the counter counted no transitions on the odd numbered channels. The HP 3852A right display should show:

0.000000E+00

9. ODD NUMBERED CHANNELS COUNTER TEST. This test verifies that odd numbered channels can count transitions on the channel inputs and correctly report the number of counts.

10. Setup counter measurement by executing:

EDGE LH,USE ES01 (where E = extender number, S = slot number)

11. Refer to Figure 12-9. With a jumper, momentarily connect the shorted odd numbered channel POS (positive) connections to the +5 V connection three times.

12. Read the counter input of the odd numbered channels by executing:

CHREAD ES01 (where E = extender number, S = slot number)

13. Verify that the counter counted the transitions on the odd numbered channels. The HP 3852A right display should show:

3.000000E+00

14. Read the counter input of the even numbered channels by executing:

CHREAD ES00 (where E = extender number, S = slot number)

15. Verify that the counter counted no transitions on the even numbered channels. Since in step 4 the counter incremented three times, the HP 3852A right display should show:

3.000000E+00

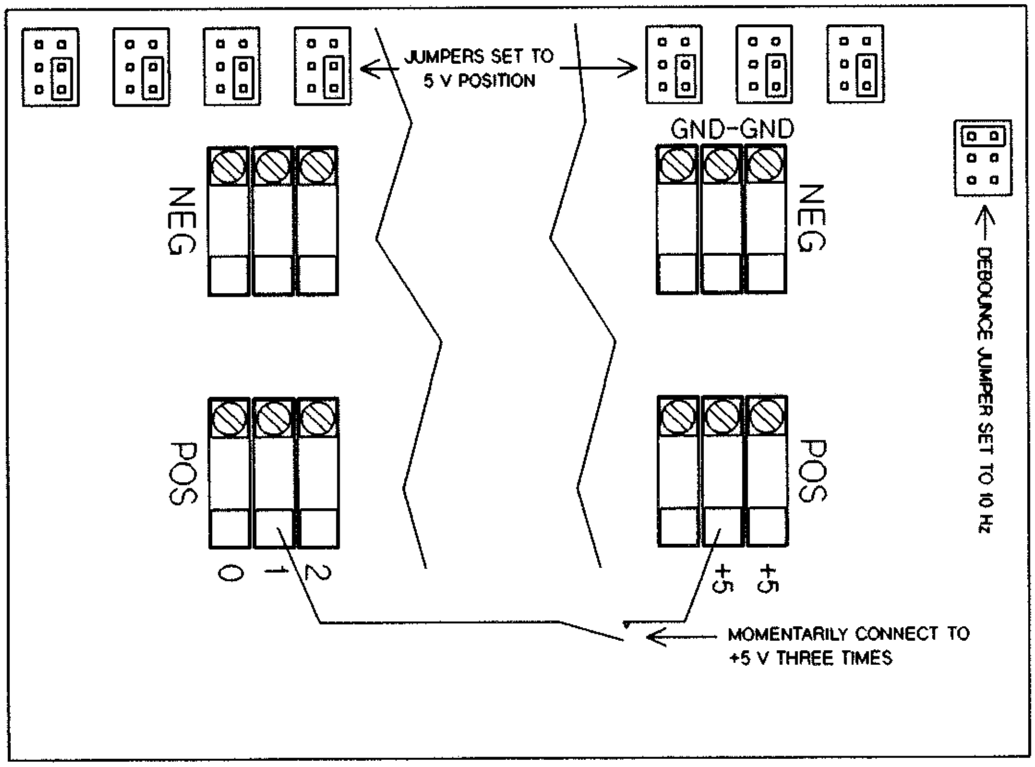


Figure 12-9 Odd Channel Counter Test

12-25 Interrupt Test

This test verifies that the accessory can detect and report an interrupt.

1. Setup the interrupt by executing:

    USE ES16 (where E = extender number, S = slot number)

2. Setup the counter by executing:

    EDGE LH

3. Enable the interrupt by executing:

    ENABLE INTR

4. Refer to Figure 12-10. With a jumper, momentarily connect the shorted even numbered channels POS (positive) connections to the +5 V connection.

5. Verify that the INTR annunciator (second annunciator from right) below the HP 3852A left display is on.

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44721A/44722A PERFORMANCE TESTS.

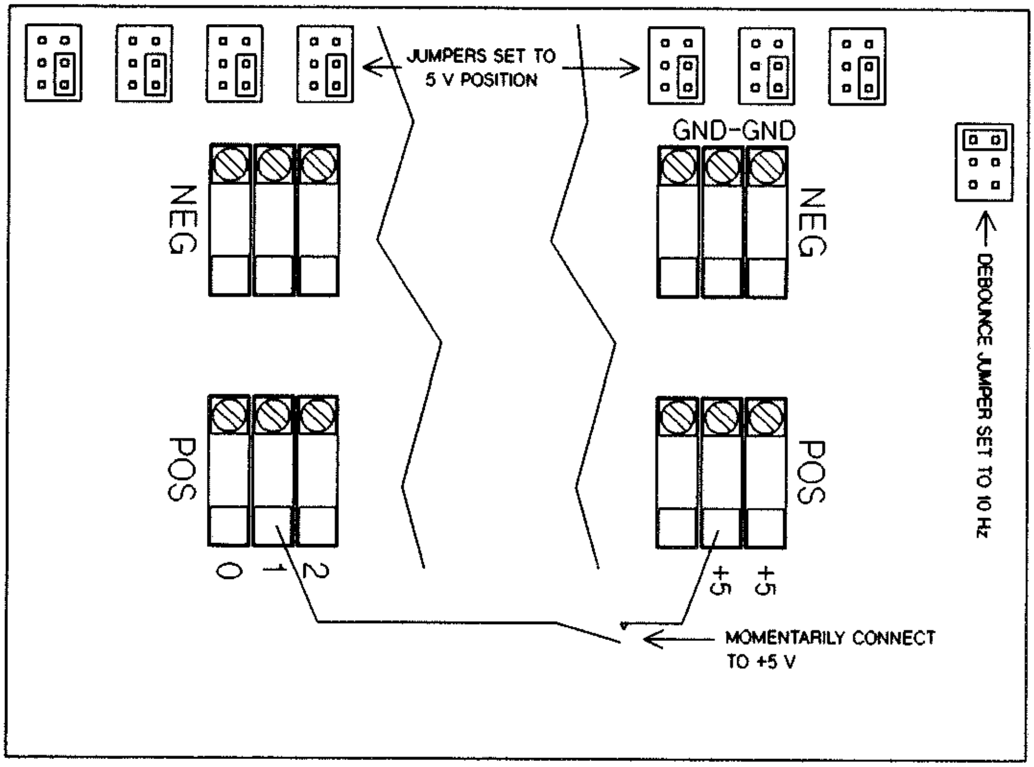


Figure 12-10 Interrupt Test

12-26 Input, Totalize, and Debounce Tests

This test verifies that the accessory detects inputs within the specified threshold voltage limits. The test also tests the counter's totalizing operation and the debounce operation.

In the following tests, a function generator outputs a burst of ten +1 V to +4 V peak-to-peak 500 Hz square waves, after being triggered (see Figure 12-11). The Digital Input Accessory then counts those ten cycles. A +1 V to +4 V square wave is used to check the upper and lower limits of the accessory's threshold voltage. A frequency of 500 Hz is used since that is the maximum frequency the accessory is able to count transitions accurately.

1. EVEN CHANNEL INPUT/TOTALIZING TEST. This test verifies the operation of all even channels.

2. Set all HP 44721A channels to a known state by executing:

   RESET ES00 (where E = extender number, S = slot number)

3. Set the function generator to output a ten cycle burst of +1 V to +4 V peak-to-peak 500 Hz square waves. The square waves are represented in Figure 12-11. If using the recommended function generator, set it up as follows:

   Mode -- External Burst (E.BURST)
   Function -- Square Wave
   Frequency (FRQ) -- 500 Hz
   Amplitude (AMP) -- 1.5 V RMS
   Offset (OFS) -- +1.25 V
   Duty Cycle (DTY) -- 50%
   Burst Cycles (BUR) -- 10

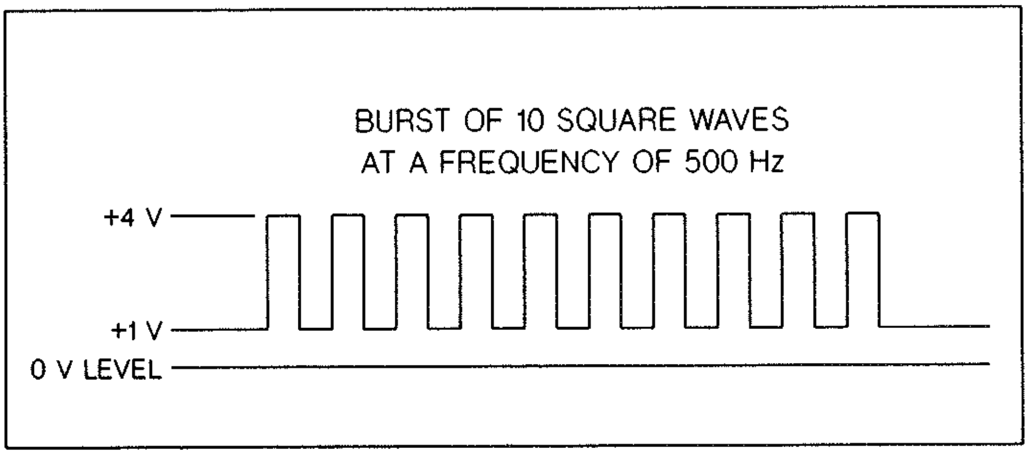


Figure 12-11 Input/Totalize Test Signal

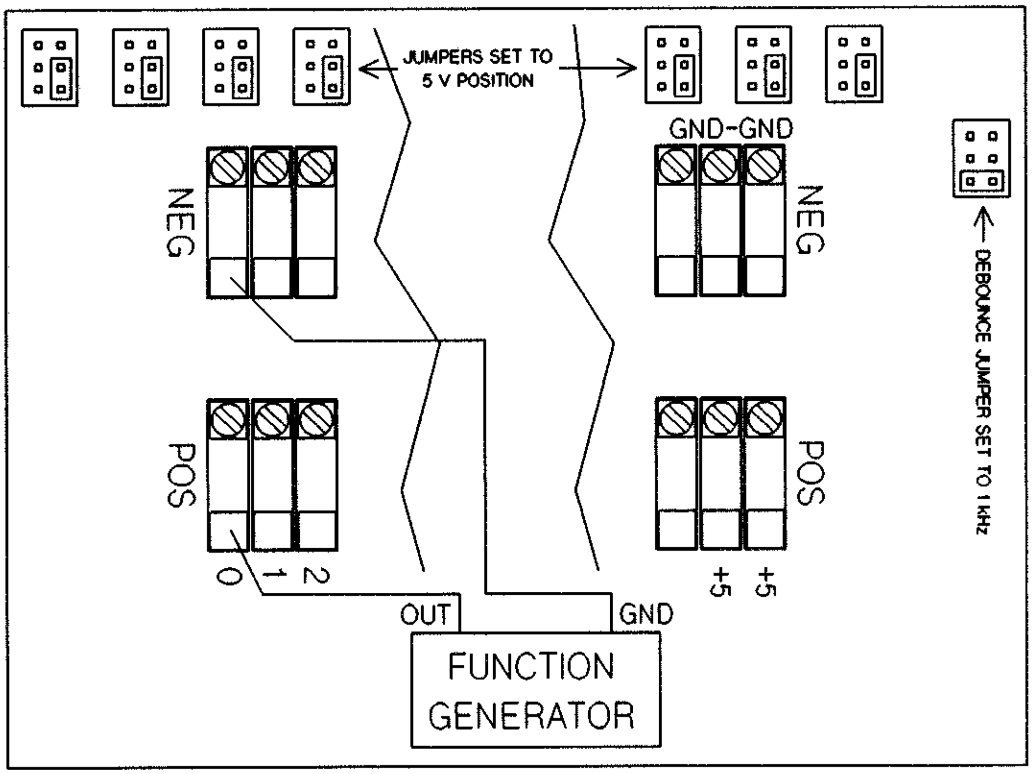


Figure 12-12 Even Channel Input/Totalize Test

4. Connect the function generator to the shorted even channel POS (positive) connections and the GND (ground) connections. The connections are shown in Figure 12-12.

5. On the test fixure, set the debounce jumper to the 1 kHz position, as shown in Figure 12-12.

6. Set the Digital Input Accessory to count positive transitions on Channel 0 by executing:

   EDGE LH,USE ES00 (where E = extender number, S = slot number)

7. Trigger the function generator to output the ten cycle burst. If using the recommended function generator, press the MAN button.

8. After the accessory has read all ten cycles, read channel 0 by executing:

CHREAD ES00 (E = extender number, S = slot number)

9. Verify that the HP 3852A right display shows:

1.000000E+01 ±1 count (i.e., 9.000000E+00 to 1.100000E+01)

Note this reading for the negative transition test in the next step.

10. Set the Digital Input Accessory to count negative transitions on Channel 0 by executing:

EDGE HL,USE ES00 (where E = extender number, S = slot number)

11. Trigger the function generator to output the ten cycle burst.

12. After the accessory has read all ten cycles, read channel 0 by executing:

CHREAD ES00 (where E = extender number, S = slot number)

13. Add the reading on the the HP 3852A right display to the reading in step 9. If the reading in step 9 was 1.000000E+01, the reading in the display should be as follows:

2.000000E+01 ±1 count (i.e., 1.900000E+1 to 2.100000E+1)

14. Repeat steps 6 through 13 for channels 2, 4, 6, 8, 10, 12, and 14. In the USE and CHREAD commands, the last two digits indicate the channel number. For example, CHREAD ES02 would read channel 2.

15. ODD CHANNEL INPUT/TOTALIZE TEST. This test verifies the operation of all odd channels.

16. Connect the function generator to the shorted odd channel POS (positive) connections and the GND (ground) connections. The connections are shown in Figure 12-13.

17. Set the Digital Input Accessory to count positive transitions on Channel 1 by executing:

EDGE LH,USE ES01 (where E = extender number, S = slot number)

18. Trigger the function generator to output the ten cycle burst.

19. After the accessory has read all ten cycles, read channel 1 by executing:

CHREAD ES01 (where E = extender number, S = slot number)

20. Verify that the HP 3852A right display shows:

1.000000E+01 ±1 count (i.e., 9.000000E+00 to 1.100000E+01)

Note this reading for the negative transition test in the next step.

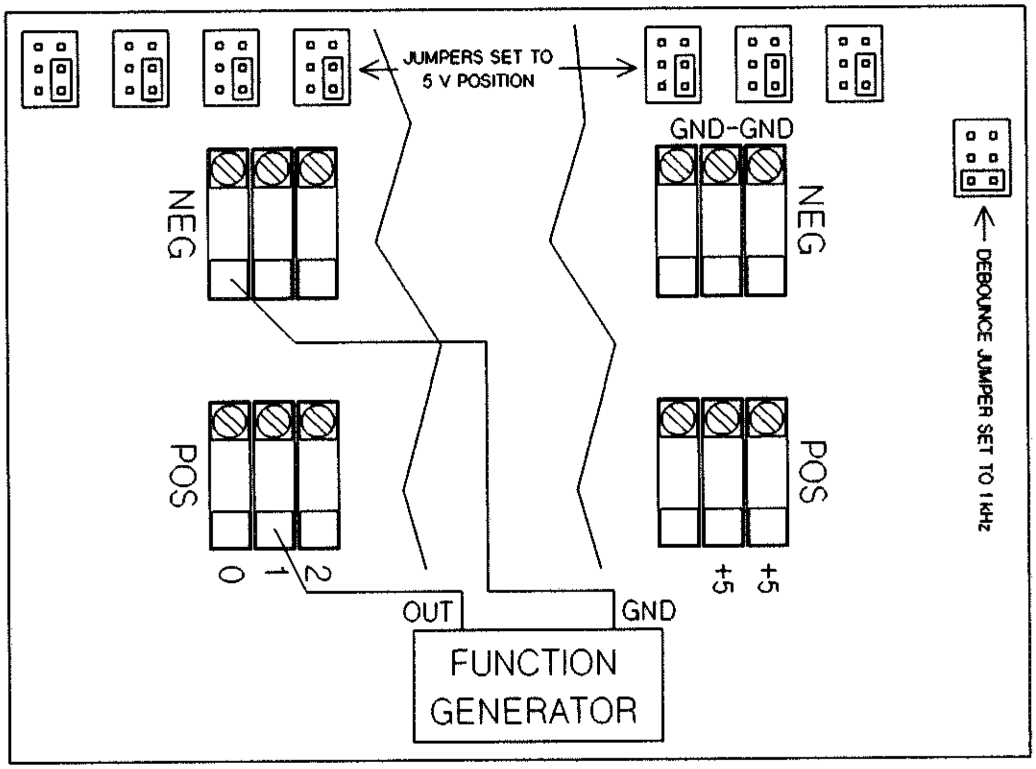


Figure 12-13 Odd Channel Input/Totalize Test

21. Set the Digital Input Accessory to count negative transitions on Channel 1 by executing:

    EDGE HL,USE ES01 (where E = extender number, S = slot number)

22. Trigger the function generator to output the ten cycle burst.

23. After the accessory has read all ten cycles, read channel 1 by executing:

    CHREAD ES01 (where E = extender number, S = slot number)

24. Add the reading on the the HP 3852A right display to the reading in step 9. If the reading in step 20 was 1.000000E+01, the reading in the display should be as follows:

    2.000000E+01 ±1 count (i.e., 1.900000E+01 to 2.100000E+01)

25. Repeat steps 17 through 24 for channels 3, 5, 7, 9, 11, 13, and 15. In the USE and CHREAD commands, the last two digits indicate the channel number. For example, CHREAD ES03 would read channel 3.

26. Leave the function generator connected to the test fixure for the next test.

27. DEBOUNCE TEST. This checks the operation of the debounce circuitry.

28. On the test fixure, set the debounce jumper to the 10 Hz position.

29. Read channel 1 by executing:

    CHREAD ES01 (where E = extender number, S = slot number)

30. Note and record the reading on the HP 3852A right display.

32. Set the Digital Input Accessory to count positive transitions on Channel 1 by executing:

    EDGE LH,USE ES01 (where E = extender number, S = slot number)

31. Trigger the function generator to output the ten cycle burst.

32. Read channel 1 by executing:

    CHREAD ES01 (where E = extender number, S = slot number)

33. Verify that the HP 3852A right display shows the same as in step 30.

12-27 REPLACEABLE PARTS

Figure 12-14 shows the mechanical breakdown of the HP 44721A and HP 44722A. The figure also provides assembly and disassembly information. The parts shown in Figure 12-14 are keyed to the parts lists in Table 12-6.

To order a part listed in Table 12-6, quote the Hewlett-Packard part number, the quantity desired, the HP factory reference, and the check digit (abbreviated CD in Table 12-6). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board for the digital input accessory is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

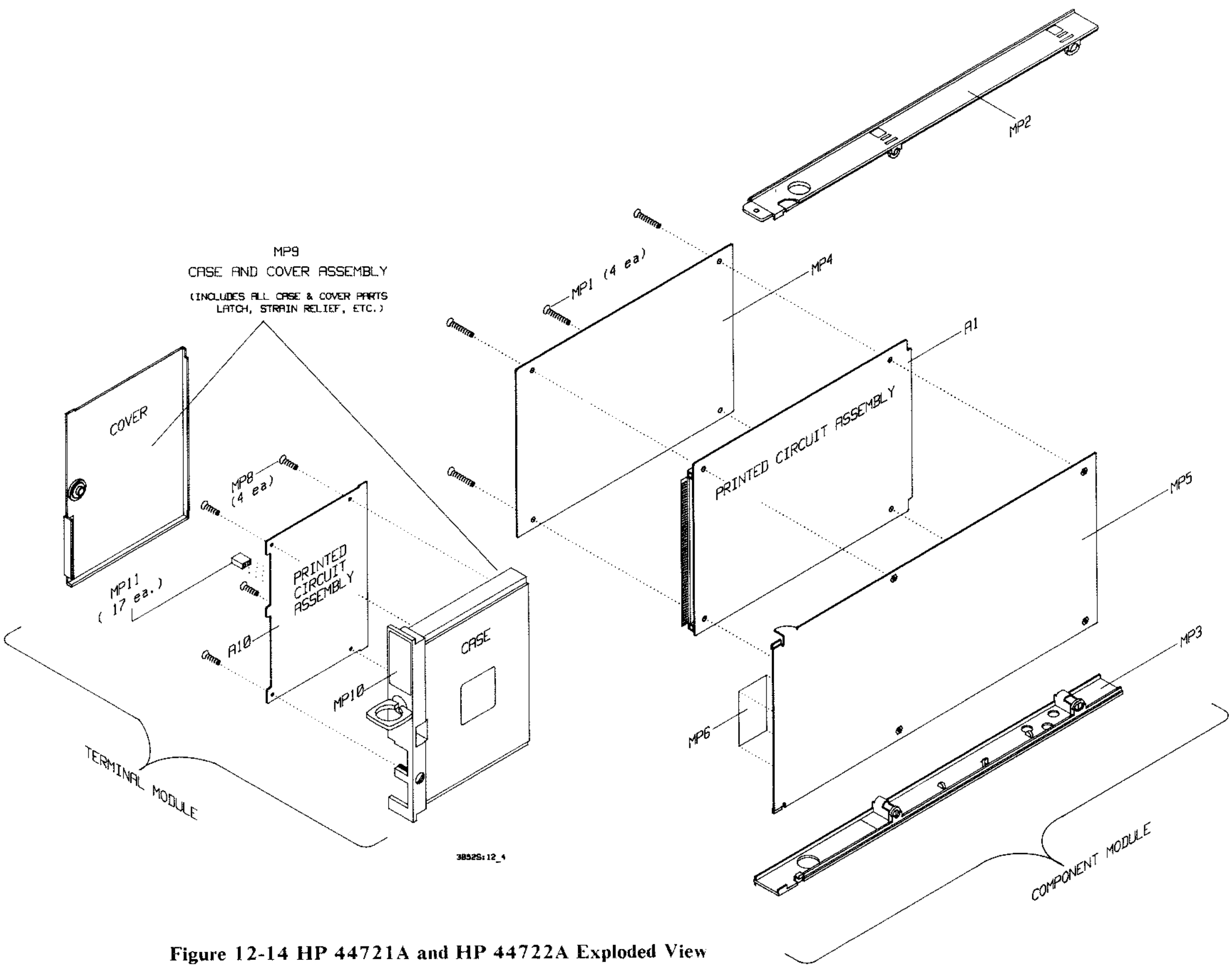


Figure 12-14 HP 44721A and HP 44722A Exploded View

Table 12-6a HP 44721A 16 Channel Digital Input with Totalize and Interrupt

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44721A	Module; 16ch DC/8ch AC dig-in compon	1	44721-66201	1	MOD-DC/AC DIG IN
A1	PCA; 16ch DC/8ch AC dig-in component	1	44721-66501	4	PCA-DC/AC DIG IN
A10	PCA; 16 ch DC digital input terminal	1	44721-66510	5	PCA-DC D-IN TERM
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44721/44722A component module	1	44721-84320	3	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44721A	1	44721-84325	8	LBL-ID,TERM ASSY
MP11	Jumper; removable, A10 PCA	17	1258-0141	8	JMPR-REM.025P

Completely assembled HP 44721A terminal modules can be ordered from your local HP Office by ordering Number 44721AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44721A	Module; 16ch DC/8ch AC dig-in compon		44721-69201	7	RBLT-44721-66201

Table 12-6b HP 44722A 8 Channel AC Digital Input with Totalize and Interrupt

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44722A	Module; 16ch DC/8ch AC dig-in compon	1	44721-66201	1	MOD-DC/AC DIG IN
A1	PCA; 16ch DC/8ch AC dig-in component	1	44721-66501	4	PCA-DC/AC DIG IN
A10	PCA; 8 ch AC digital input terminal	1	44722-66510	6	PCA-AC D-IN TERM
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44721/44722A component module	1	44721-84320	3	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44722A	1	44722-84325	9	LBL-ID,TERM ASSY
MP11	Jumper; removable, A10 PCA	8	1258-0141	8	JMPR-REM.025P

Completely assembled HP 44722A terminal modules can be ordered from your local HP Office by ordering Number 44722AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44722A	Module; 16ch DC/8ch AC dig-in compon		44721-69201	7	RBLT-44721-66201

Chapter 13
HP 44724A Digital Output

CHAPTER 13
HP 44724A DIGITAL OUTPUT

CHAPTER 13
HP 44724A
16 CHANNEL DIGITAL OUTPUT

13-1 INTRODUCTION

This chapter provides a technical description, operational verification procedures, and replaceable parts lists for the HP 44724A 16 Channel Digital Output accessory.

13-2 Technical Description

The HP 44724A can be used to control low level DC devices or to drive logic levels. In either case, an external power supply and pull-up resistors are needed. When a channel is turned on, a low impedance path is created between the HIGH and LOW inputs of the terminal module.

The HP 44724A has two main assemblies: a component module and a terminal module. The component module contains the backplane interface electronics, the channel driver control logic, the channel drivers, and the channel output MOSFET switches. The terminal module contains terminal blocks for connection to external wiring and fuses for the protection of the component module.

A simplified block diagram of the HP 44724A is shown in Figure 13-1. The control logic interfaces the HP 44724A with the HP 3852A or HP 3853A backplane. The control logic accepts commands from the HP 3852A and controls the desired channel driver. The channel drivers turn the output MOSFET on or off as indicated in the command received.

There are two protection diodes on the output of each MOSFET. One diode, external to the MOSFET, provides overvoltage protection. The other diode is an integral part of the MOSFET. This diode provides reverse polarity protection. If a reverse polarity voltage is applied to the HIGH and LOW terminals on the terminal module, this diode is forward biased. Any channel wired with reverse polarity will always appear to be on.

On the terminal module each channel HIGH line is fused to provide further protection for the output MOSFET. The fuses are rated at 1 Amp.

13-3 Read and Write Registers

The HP 3852A local controller communicates with each plug-in accessory by using read and write registers. High level commands are translated into appropriate register commands. The SREAD and SWRITE commands can be used to directly control each register.

SREAD and SWRITE are described in Chapter 2 of this manual. Table 13-1 shows the registers used by the HP 44724A.

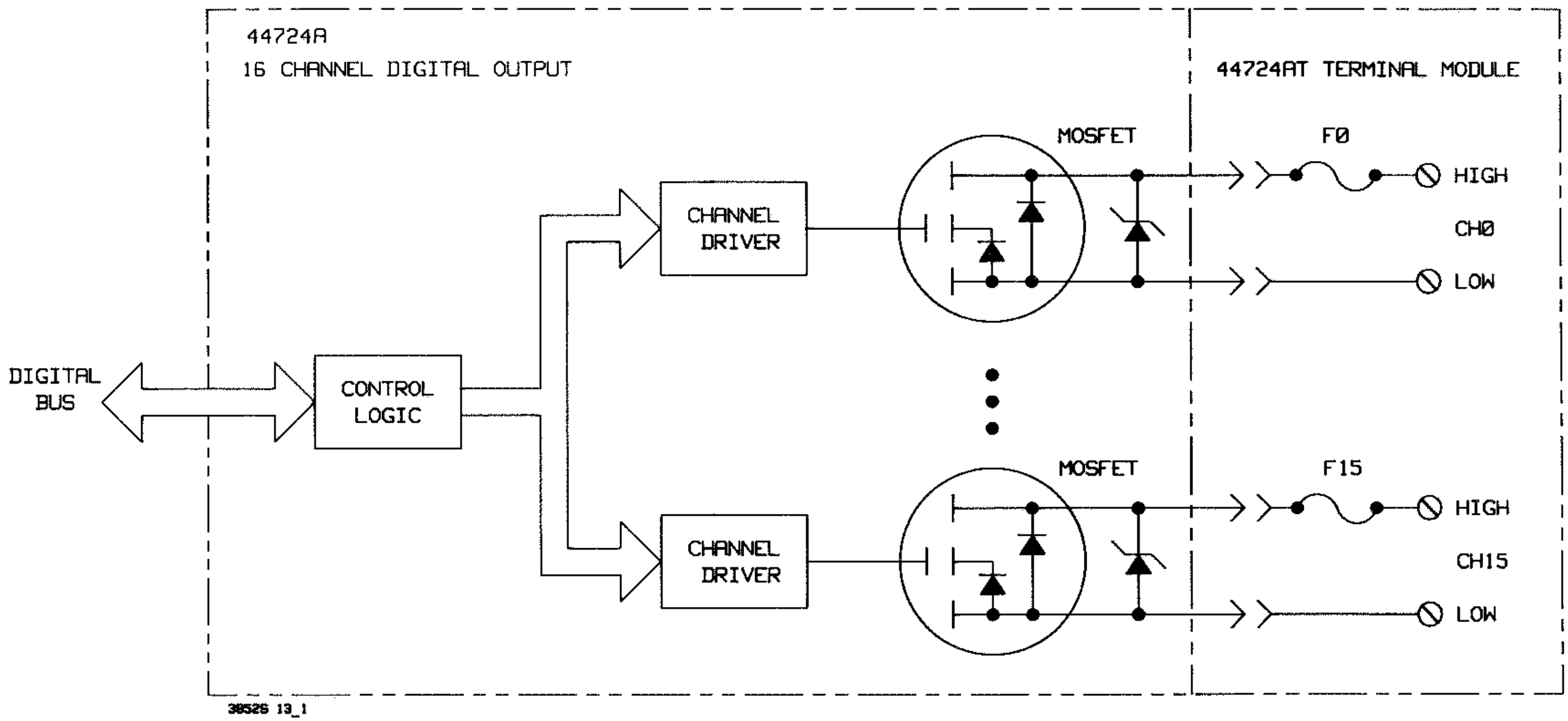


Figure 13-1 HP 44724A Simplified Block Diagram

CAUTION

Using the primitive commands (SREAD and SWRITE) may cause unexpected and undesirable effects on the plug-in accessories. It is possible to program some plug-in accessories into illegal and potentially damaging states with these commands. The commands are documented here for service purposes only.

Table 13-1 Digital Output Read and Write Registers

Register #	READ Registers	WRITE Registers
0	Accessory Identification	Accessory Control
1	Always -240	Not Used
2	Channels 8 through 15	Channels 8 through 15
3	Channels 0 through 7	Channels 0 through 7

13-4 Read Registers

13-5 Register 0. Read Register 0 contains the accessory identification. Eight bits are used to uniquely identify the accessory. The eight bits are output on the lower eight bits of the backplane data lines.

The eight bit identification is in two parts. The five most significant bits identify the component module and the three least significant bits identify the type of terminal module installed. If a terminal module is not present, the lower three bits are set high by the component module. The HP 3852A local controller can thus identify the type of plug-in accessory installed and determine if a terminal module is installed.

Table 13-2 lists the decimal equivalent codes returned in response to an SREAD of Register 0 for all combinations of the accessory.

Table 13-2 HP 44724A Identification Codes

Module Combinations	Codes
HP 44724A Component Module (no terminal module installed)	-89
HP 44724A Component Module, HP 44724AT Terminal Module installed	-95

13-6 Register 1. Read Register 1 is a hardwired register and will always return a decimal value of -240 in response to an SREAD.

13-7 Register 2. Read Register 2 is the upper channel condition register. The eight bit register contains a binary representation of the last state programmed for channels 8 through 15. Note that the register latches the last state programmed, not the actual state of the MOSFET switches. Figure 13-2 is an example of the word in the register. In the figure, it is presumed that channel 7 was programmed to be closed.

13-8 Register 3. Read Register 3 is the lower channel condition register. The eight bit register contains a binary representation of the last state programmed for channels 0 through 7. Note that the register latches the last state programmed, not the actual state of the MOSFET switches. Figure 13-2 is an example of the word in the register. In the figure, it is presumed that channel 15 was programmed to be closed.

```
Bits:       7  6  5  4  3  2  1  0
Bit Value:  1  0  0  0  0  0  0  0
```

Figure 13-2 Read Registers 2 and 3

NOTE

The decimal number returned after the execution of an SREAD command represents the two's compliment of the status word.

13-9 Write Registers

13-10 Register 0. Write Register 0 is the accessory reset register. Any data written to this register will cause a reset of the accessory and force all the channel switches open. A write to Register 0 has the same effect as a backplane reset.

13-11 Register 2. Write Register 2 is a control register for channels 8 through 15. An eight bit word is used to control the status of the channels. The bits in the command word corresponds one-to-one to the channel numbers (i.e., setting bit 9 closes channel 9). Figure 13-3 is an example of the command word. In the figure, it is presumed that channel 9 is to be closed.

13-12 Register 3. Write Register 3 is a control register for channels 0 through 7. An eight bit word is used to control the status of the channels. The bits in the command word corresponds one-to-one to the channel numbers (i.e., setting bit 7 closes channel 15). Figure 13-3 is an example of the command word. In the figure, it is presumed that channel 15 is to be closed.

```
Bits:       7  6  5  4  3  2  1  0
Bit Value:  1  0  0  0  0  0  0  0
```

Figure 13-3 Command Word

13-13 SPECIFICATIONS

Specifications for the HP 44724A are given in Table 13-3. Specifications are the performance standards or limits against which the accessory may be tested tested.

Table 13-3 HP 44724A Specifications

Maximum Input Voltage:	55 V DC Between High and Low Terminal (of each channel) 350 V peak or 250 V DC (between channels or between any Terminal and Chassis)
Maximum Sink Current:	500 mA DC per channel (1 A fuse protected)
Maximum Reverse Polarity Current:	500 mA DC per channel
TTL Compatibility:	200 mA per channel with Vout =<0.4 volts
Closed Channel Path Resistance:	1.5 Ω
Maximum Off Leakage:	0.25 mA per channel at 55 V DC
Maximum Wire Size:	16 AWG

13-14 PERFORMANCE TESTS

13-15 Introduction

The following Performance Tests check the operation of the HP 44724A component module. Performance Tests are not given for the terminal modules. Successful completion of all tests in this chapter provides a high confidence level that the Digital Output Accessory is meeting its listed specifications.

The Performance Tests should be performed in the order they are presented. The completion of each test increases the confidence level in the Digital Output Accessory operation. A minimum set of tests is given as Operational Verification Tests. These tests are described in Section 13-16.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence that the Digital Output Accessory is operating normally, it is not recommended that all the Performance Tests be performed unless one of the tested specifications is in question.

13-16 Operational Verification

The first tests given in this section are the minimum set of tests recommended for the Digital Output Accessory. These tests are designed to test the functionality of the accessory. Successful completion of the Operational Verification Tests provides a 90% confidence level that the Digital Output Accessory is operating normally and is within specification.

The Operational Verification Tests consist of the following:

Section 13-20 - Set-Up Procedure
Section 13-21 - Channels On-Resistance Test

13-17 Equipment Required

The following test equipment is required to run the Performance Tests. Only the first three items in the list are required for the Operational Verification Tests.

1. Test Fixture (as described in Section 13-18)
2. Test Leads and Jumpers
3. Digital Multimeter -- HP 3456A or equivalent
4. +5 V Power Supply -- HP 6214 or equivalent
5. Resistor -- 10 ohms (5 W, 10% or better)

NOTE

Either of the accessory plug-in voltmeters (HP 44701A or HP 44702A/B) may be used for the +5 V Supply Test. This test does not describe the specific steps required to use the plug-in voltmeters. A description of the plug-in voltmeters can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

13-18 Test Fixture

A test fixture is required to run the Performance Tests. A schematic of the required test fixture is shown in Figure 13-4a. A test fixture can be manufactured using an HP 44724AT terminal module (see Figure 13-4b). Because wiring the test fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

If the test fixture is to be fabricated from other than an HP 44724AT terminal module, it is important that the terminal ID lines, shown in Figure 13-4a, be correctly wired. The HP 3852A local controller will not allow the execution of some commands with an incorrect terminal ID.

The test fixture consists of a short circuit between the odd numbered channels HIGH connections, a short circuit between all even numbered HIGH connections, and a short circuit between all channels LOW connections.

13-19 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

13-20 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the Digital Output Accessory component module and install the test fixture. Note the slot number where the Digital Output Accessory under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

   c. Verify that the HP 3852A right display shows:

      44724A

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

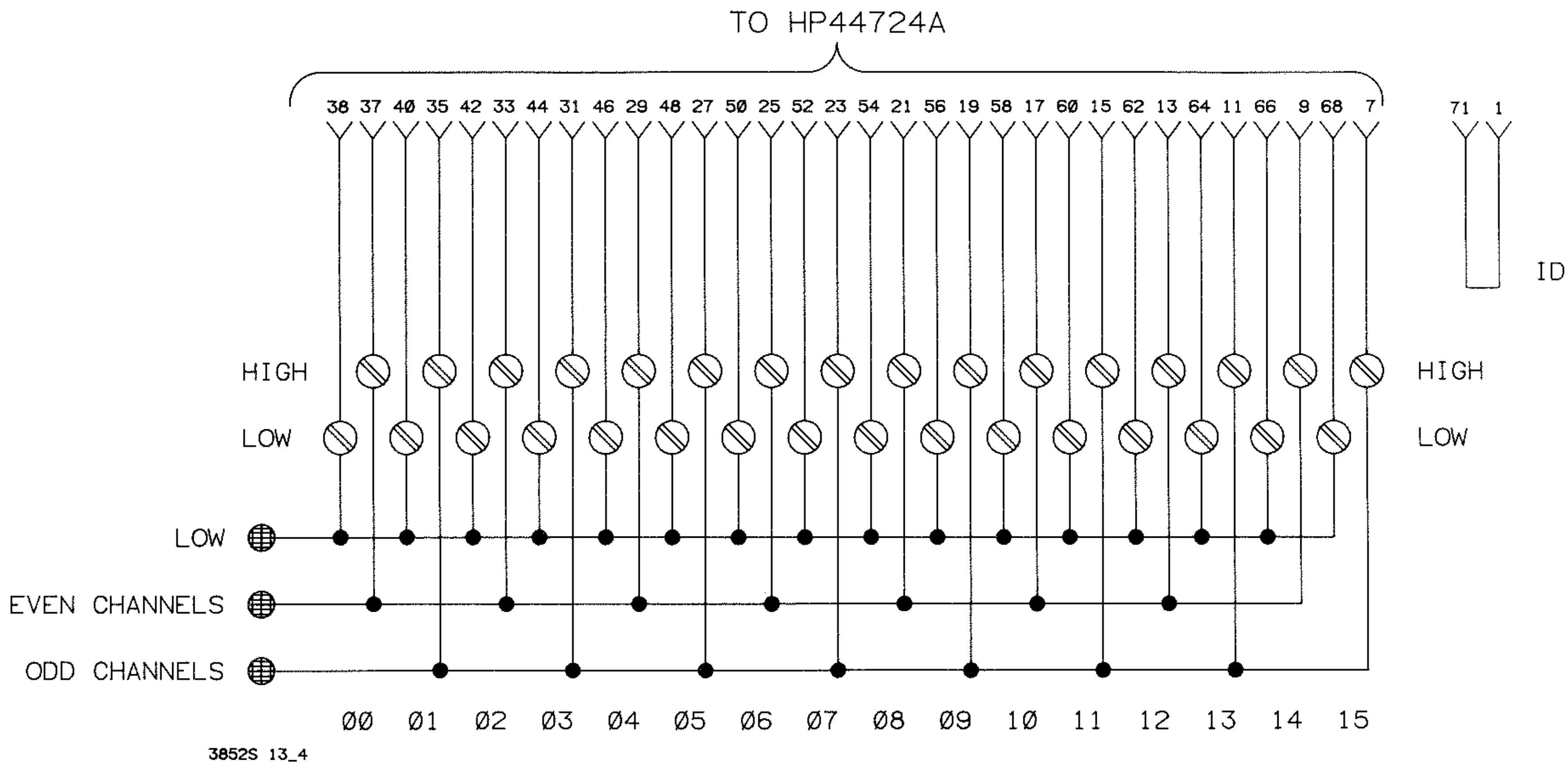


Figure 13-4a HP 44724A Test Fixure Schematic

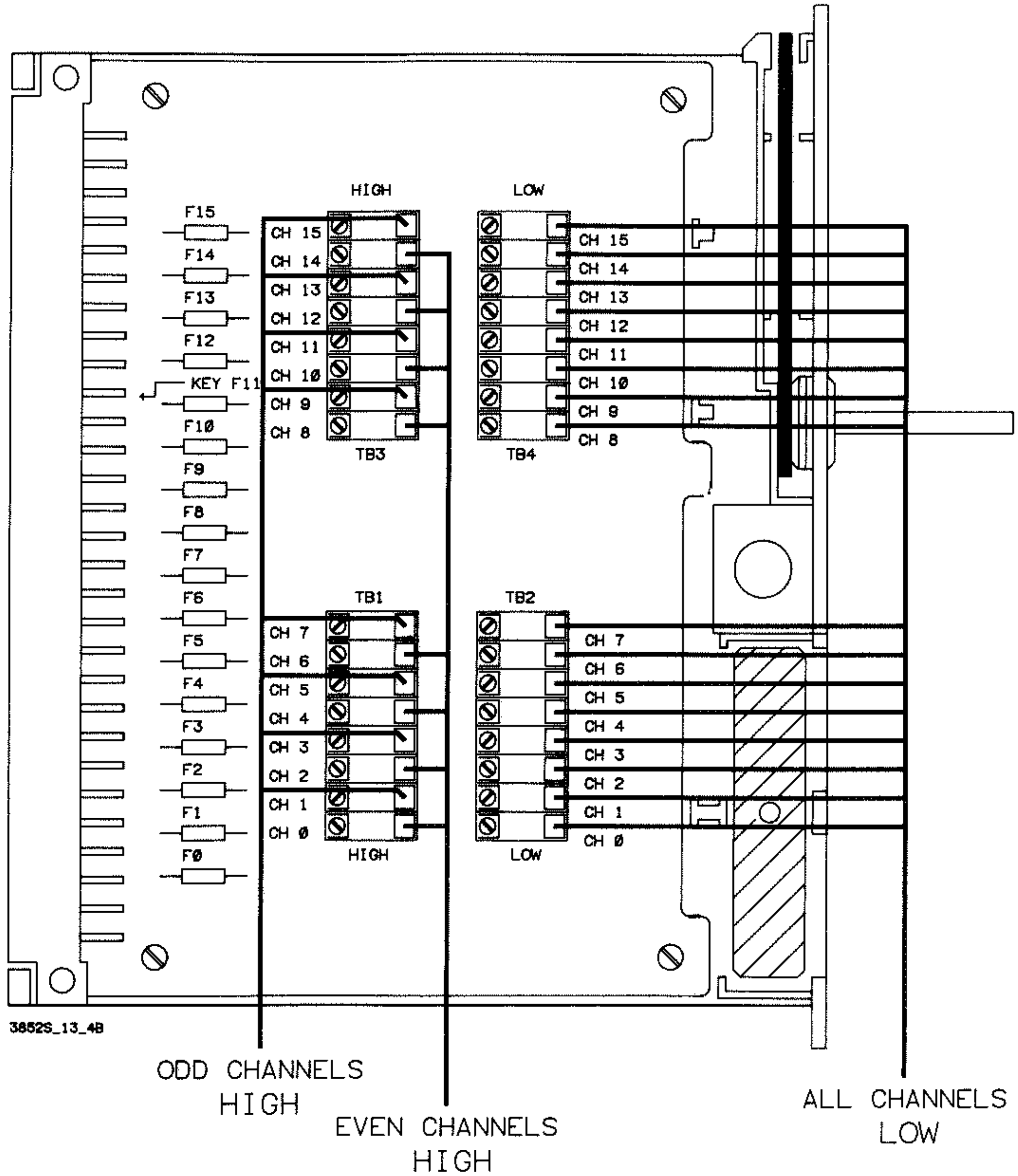


Figure 13-4b HP 44724A Test Fixure

13-21 Channels On-Resistance Test

The following tests check the on-resistance of the channel switches for the both the even and odd numbered channels.

1. EVEN CHANNEL ON-RESISTANCE TEST: This test checks the on-resistance of the channel switches for the even numbered channels.

2. Set all HP 44724A channel relays to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

3. Set the multimeter to measure two-wire ohms. If using the recommended multimeter (i.e., HP 3456A), connect the DCV (HI) input of the multimeter to the shorted LOW connections on the test fixure. Connect the multimeter COM (LO) input to the even channels HIGH connections on the test fixure. The connections are shown in Figure 13-5.

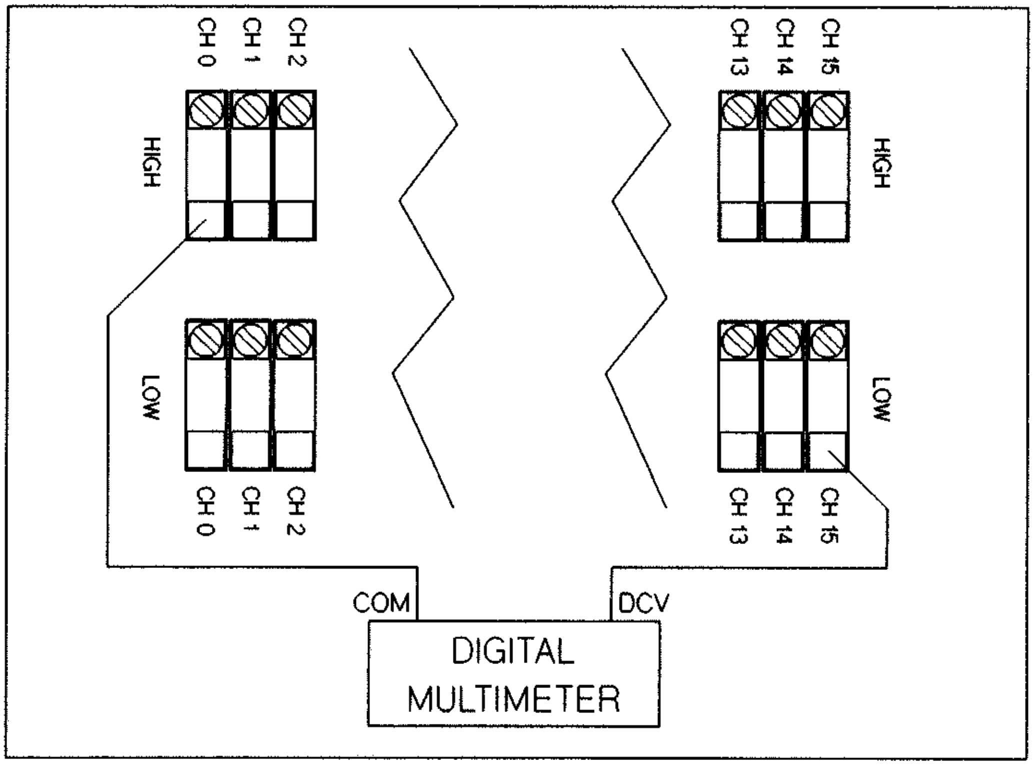


Figure 13-5 Even Channels Tests

If using a different multimeter/voltmeter than the recommended model, the multimeter/voltmeter current source polarity must be determined. For negative polarity current sources, like the recommended multimeter, make the connections as stated above and as shown in Figure 13-5. For positive polarity current sources, like the HP 44701A plug-in voltmeter, connect the multimeter/voltmeter High lead to the HIGH connections on the test fixure and the Low lead to the LOW connections on the test fixure. Incorrect connections may cause the reverse bias protection diode of the output MOSFET to be forward biased by the current source. This can result in incorrect readings.

4. Close channel 0 by executing:

CLOSE ES00 (where E = extender number, S = slot number)

5. Observe the indication on the multimeter. The multimeter should indicate a resistance less than 1.5 ohms.

6. Open channel 0 by executing:

OPEN ES00 (where E = extender number, S = slot number)

7. Observe the indication on the multimeter. The multimeter should indicate greater than 10 Mohms.

8. Repeat Steps 3, 4, 5, and 6 for channels 2, 4, 6, 8, 10, 12, and 14. In the CLOSE and OPEN commands the last two digits are the channel number (i.e., CLOSE ES02 for channel 2).

9. ODD CHANNEL ON-RESISTANCE TEST: This test checks the on-resistance of the odd numbered channels.

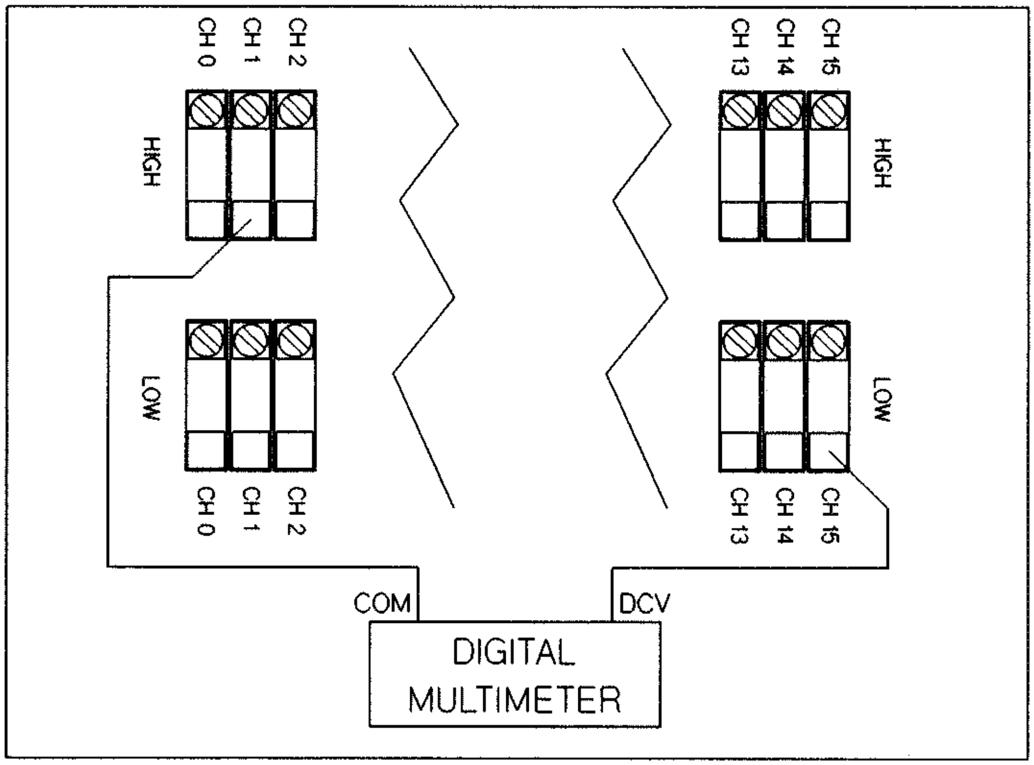


Figure 13-6 Odd Channels Tests

10. If using the recommended multimeter (i.e., HP 3456A), connect the DCV (HI) input of the multimeter to the shorted LOW connections on the test fixure. Connect the multimeter COM (LO) input to the odd channels HIGH connections on the test fixure. The connections are shown in Figure 13-6. See step 3 above if using other than the recommended multimeter.

11. Close channel 1 by executing:

CLOSE ES01 (where E = extender number, S = slot number)

12. Observe the indication on the multimeter. The multimeter should indicate a resistance less than 1.5 ohms.

13. Open channel 1 by executing:

OPEN ES01 (where E = extender number, S = slot number)

14. Observe the indication on the multimeter. The multimeter should indicate greater than 10 Mohms.

15. Repeat Steps 11, 12, 13, and 14 for channels 3, 5, 7, 9, 11, 13 and 15. In the CLOSE and OPEN commands the last two digits are the channel number (i.e., CLOSE ES03 for channel 3).

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44724A PERFORMANCE TESTS.

13-22 Adjacent Channels Test

This test checks the isolation between adjacent channels.

1. Set the multimeter to measure two-wire ohms. If using the recommended multimeter (i.e., HP 3456A), connect the DCV (HI) input of the multimeter to the shorted LOW connections on the test fixure. Connect the multimeter COM (LO) input to the odd channels HIGH connections on the test fixure. The connections are shown in Figure 13-6. See paragraph 13-19 step 3 if using other than the recommended multimeter.

2. Close all the odd channels by executing:

WRITE ES00,43690 (where E = extender number, S = slot number)

3. Verify that the channels have closed by observing the indication on the multimeter. The resistance reading indicated should be less than 1.5 ohms.

4. Connect the COM (LO) input of the multimeter to the even channels shorted HIGH connections. Leave the DCV (HI) input connected to the shorted LOW connections. The connections are shown in Figure 13-5.

5. Observe the indication on the multimeter. The multimeter should indicate greater than 10 Mohms, verifying that all even numbered channels are open. If the multimeter indicates that a channel is closed, two adjacent channels are closing at the same time.

6. Open the odd numbered channels by executing:

WRITE ES00,0 (where E = extender number, S = slot number)

7. Close the even numbered channels by executing:

WRITE ES00,21845 (where E = extender number, S = slot number)

8. Verify that the channels have closed by observing the indication on the multimeter. The resistance reading indicated should be less than 1.5 ohms.

9. Connect the COM (LO) input of the multimeter to the odd channels shorted HIGH connections. Leave the DCV (HI) input connected to the shorted LOW connections (see Figure 13-6).

10. Observe the indication on the multimeter. The multimeter should indicate greater than 10 Mohms, verifying that all odd numbered channels are open. If the multimeter indicates that a channel is closed, two adjacent channels are closing at the same time.

11. Open the even numbered channels by executing:

WRITE ES00,0 (where E = extender number, S = slot number)

13-23 Maximum Sink Current Test

The maximum sink current test ensures that each channel output MOSFET is able to sink 500 mA of current. The test also checks the MOSFET's on-resistance at the specified maximum sink current. The test uses a 10 ohm resistor and a dc power supply to develop the 500 mA of sink current.

1. SET-UP PROCEDURE. Using the multimeter, measure the exact resistance of the 10 ohm resistor. This resistance is referred to as **R** in the following step.

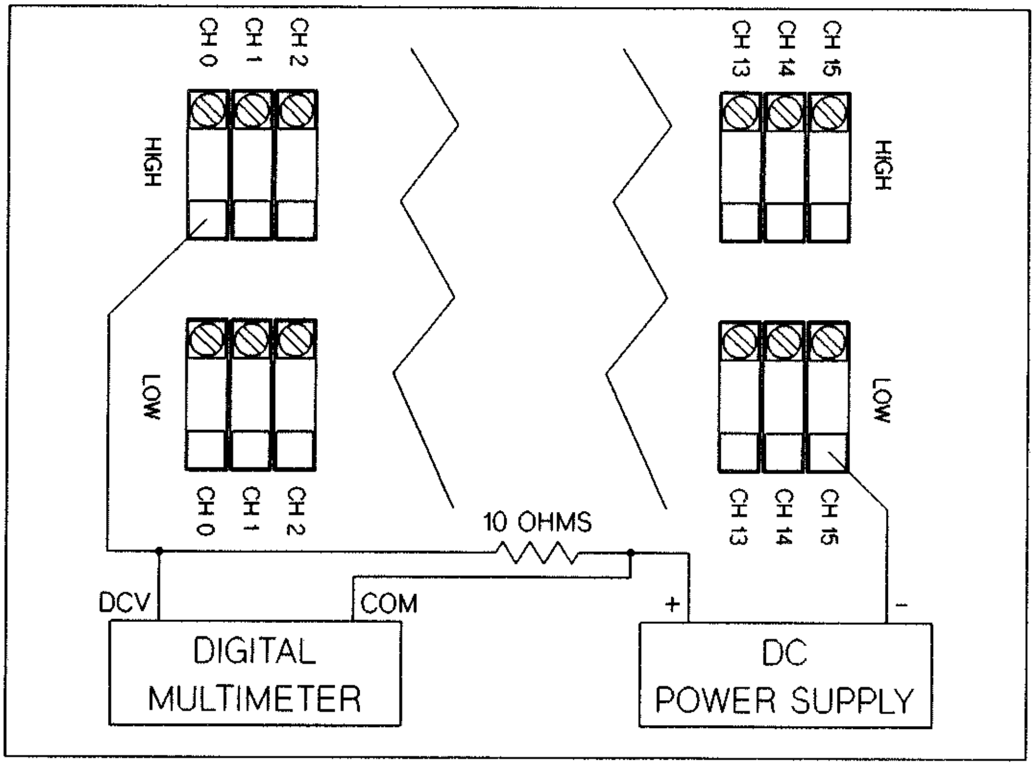


Figure 13-7 Even Channel Sink Current Test Set-Up

2. Calculate the voltage necessary to develop 500 mA of current by the formula:

$$V = 0.5 \cdot R$$

3. EVEN CHANNEL SINK CURRENT TEST. The following test checks the sink current capability of even channel output MOSFETs.

4. Set the power supply to output approximately +5 V dc. Connect the 10 ohm resistor (**R**) between the power supply + output and the even channel HIGH connections on the test fixure. Connect the power supply's - output to the shorted LOW connections on the test fixure. The connections are shown in Figure 13-7.

5. Set the multimeter to measure dc volts. Connect the DCV (HI) input of the multimeter to the shorted even channel HIGH connections on the test fixure. Connect the multimeter COM (LO) input to the + output on the power supply. The connections are shown in Figure 13-7.

6. Close channel 0 by executing:

CLOSE ES00 (where E = extender number, S = slot number)

7. Adjust the power supply until the voltage reading on the multimeter is at the same value as voltage **V** noted in step 2 (approximately -4.5 V). This should develop a sink current of 500 mA.

8. Connect the COM (LO) input of the multimeter to the shorted LOW connections on the test fixure. the connections are shown in Figure 13-8.

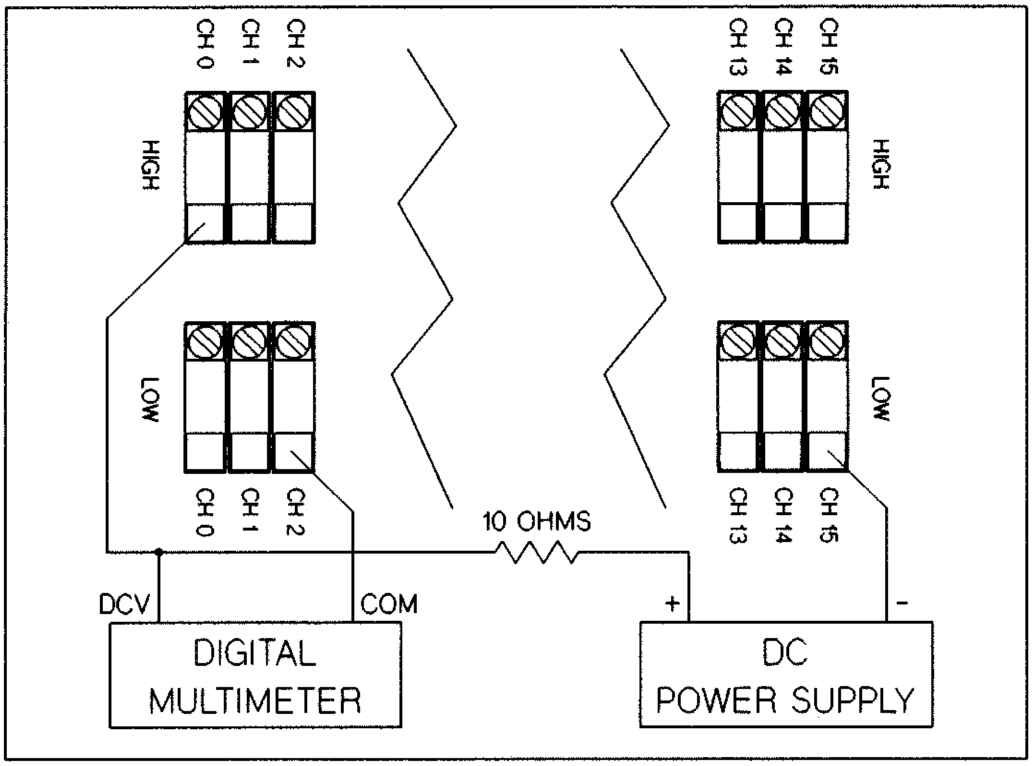


Figure 13-8 Even Channel Sink Current Test

9. Verify that the reading on the multimeter is 0.75 volts or less. This indicates an on-resistance of 1.5 ohms or less at a sink current of 500 mA.

10. Open channel 0 by executing:

OPEN ES00 (where E = extender number, S = slot number)

11. Repeat steps 5, 6, 7, 8, 9, and 10 for channels 2, 4, 6, 8, 10, 12, and 14. In the CLOSE and OPEN commands, the last two digits are the channel numbers (i.e., CLOSE ES02 for channel 2).

12. ODD CHANNEL SINK CURRENT TEST. The following test checks the sink current capability of odd channel output MOSFETs.

13. Connect the 10 ohm resistor (**R**) between the power supply + output and the odd channel HIGH connections on the test fixure. Connect the DCV (HI) input of the multimeter to the shorted odd channel HIGH connections on the test fixure. Connect the multimeter COM (LO) input to the + output on the power supply. The connections are shown in Figure 13-9.

14. Close channel 1 by executing:

CLOSE ES01 (where E = extender number, S = slot number)

15. Adjust the power supply until the voltage reading on the multimeter is the same as voltage **V** noted in step 2 (ignore polarity). This should develop a sink current of 500 mA.

16. Connect the COM (LO) input of the multimeter to the shorted LOW connections on the test fixure. the connections are shown in Figure 13-10.

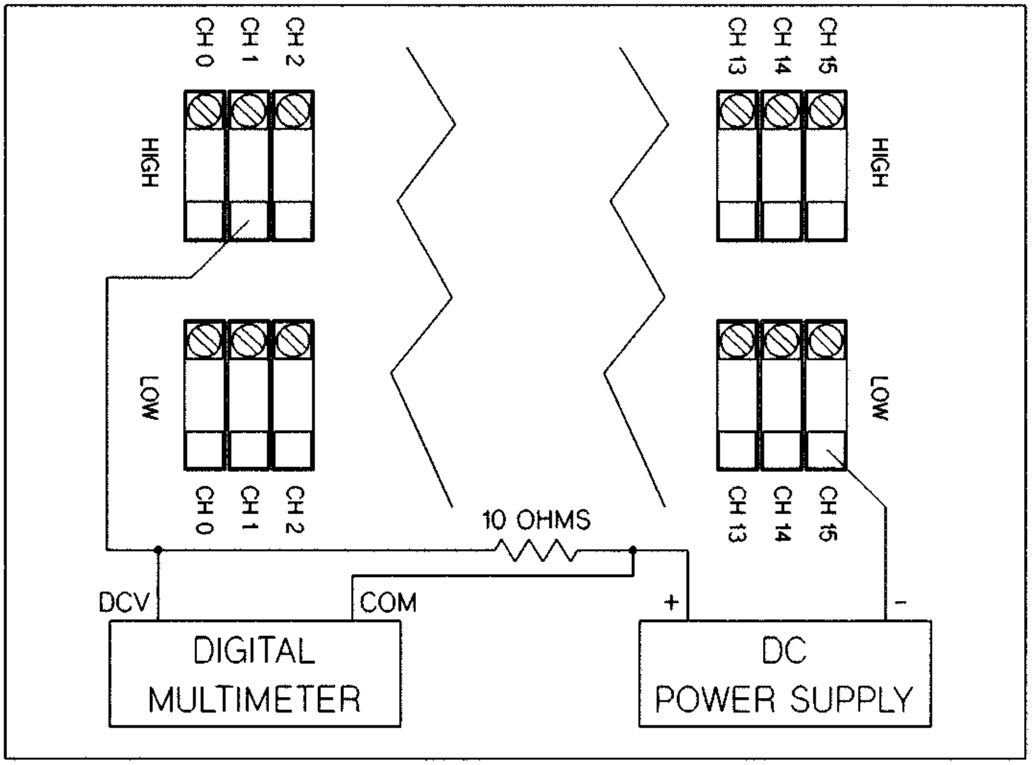


Figure 13-9 Odd Channel Sink Current Test Set-Up

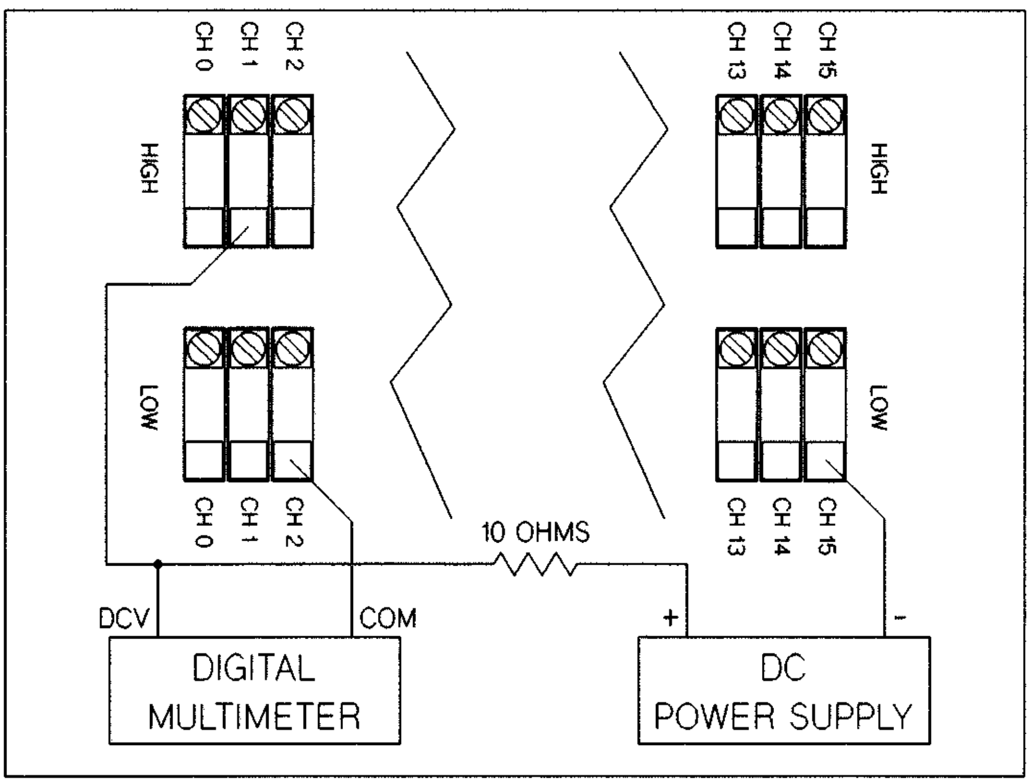


Figure 13-10 Odd Channel Sink Current Test

17. Verify that the reading on the multimeter is 0.75 volts or less. This indicates an on-resistance of 1.5 ohms or less at a sink current of 500 mA.

18. Open channel 1 by executing:

OPEN ES01 (where E = extender number, S = slot number)

19. Repeat steps 13, 14, 15, 16, 17, and 18 for channels 3, 5, 7, 9, 11, 13, and 15. In the CLOSE and OPEN commands, the last two digits are the channel numbers (i.e., CLOSE ES03 for channel 3).

13-24 REPLACEABLE PARTS

Figure 13-11 shows the mechanical breakdown of the HP 44724A. The figure also provides assembly and disassembly information. The parts shown in Figure 13-11 are keyed to the parts lists in Table 13-4.

To order a part listed in Table 13-4, quote the Hewlett-Packard part number, the quantity desired, the HP factory reference, and the check digit (abbreviated CD in Table 13-4). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

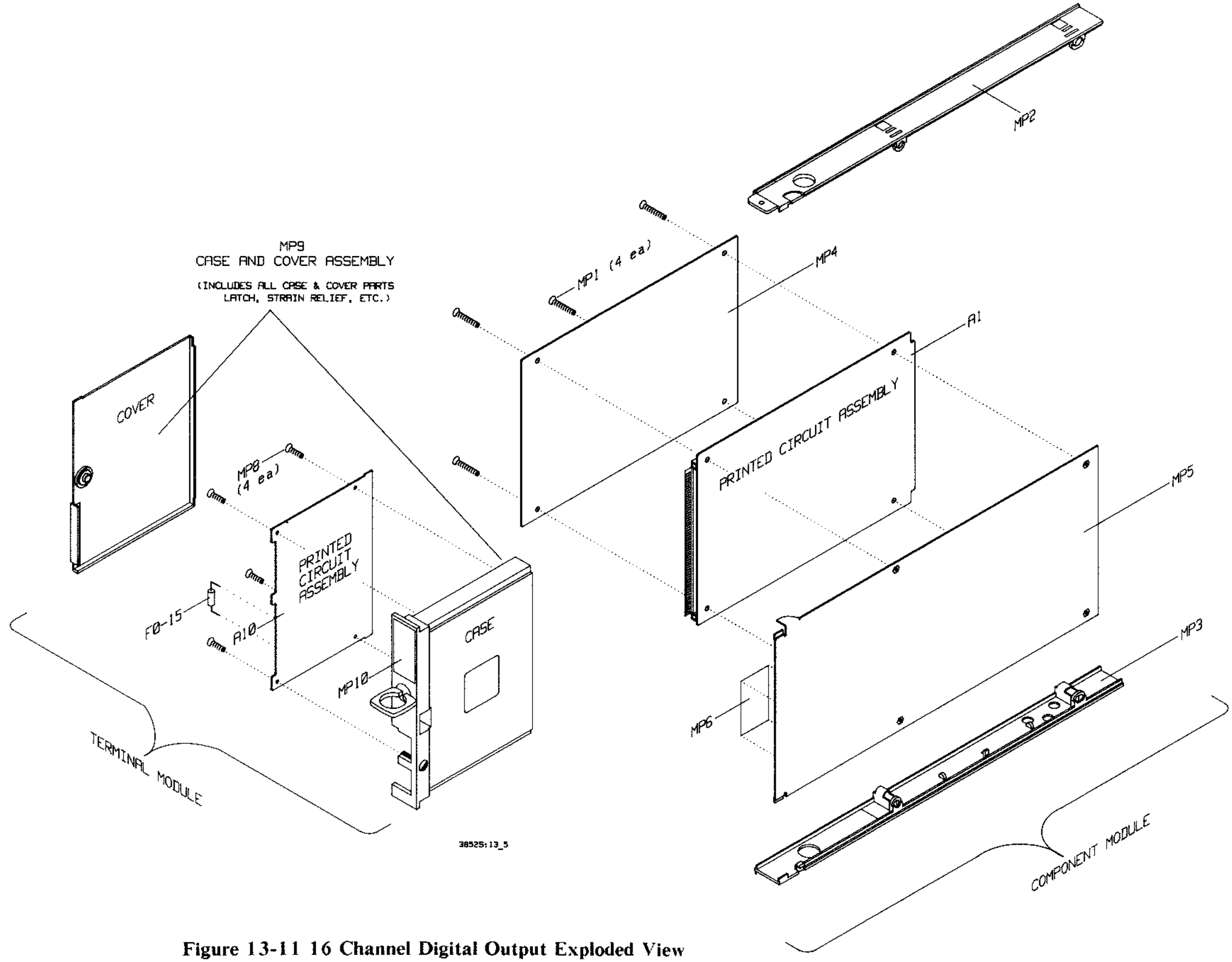


Figure 13-11 16 Channel Digital Output Exploded View

Table 13-4 HP 44724A 16 Channel Digital Output

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44724A	Module; 16 ch digtl output component	1	44724-66201	4	MOD-16CH DIG OUT
A1	PCA; 16 ch digital output component	1	44724-66501	7	PCA-DGTL OUT,DC
A10	PCA; 16 chan digital output terminal	1	44724-66510	8	PCA-DIG OUT TERM
F0-15	Fuse; subminiature 1A 125V, A10 PCA	16	2110-0099	4	FUSE-1A 125V
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44724A component module	1	44724-84320	6	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44724A	1	44724-84325	1	LBL-ID,TERM ASSY

Completely assembled HP 44724A terminal modules can be ordered from your local HP Office by ordering Number 44724AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44724A	Module; 16 ch digtl output component		44724-69201	0	RBLT-44724-66201

Chapter 14
HP 44725A General Purpose Switch

CHAPTER 14
HP 44725A 16 CHANNEL GENERAL PURPOSE SWITCH

CHAPTER 14
HP 44725A
16 CHANNEL
GENERAL PURPOSE SWITCH

14-1 INTRODUCTION

This chapter contains a technical description, performance test procedures, relay troubleshooting procedures, and replaceable parts for the HP 44725A 16 Channel General Purpose Switch.

14-2 Technical Description

The HP 44725A 16 Channel General Purpose Switch is designed to switch low and moderate levels of voltage and current. The switches are low noise, break-before-make single pole, double throw (SPDT) form C relays with normally open and normally closed contacts. The relays are not latching relays and return to the normally closed position after a reset, if power is removed, or following an OPEN command.

A block diagram of the HP 44725A is shown in Figure 14-1. On the schematic only two of the 16 channels are shown. The HP 44725A is made up of two main assemblies: a component module and a terminal module. The component module contains the backplane interface electronics, the relay drive control logic, the relay drivers and the channel relays. The component module contains terminal blocks for connection to external wiring.

14-3 Read and Write Registers

The HP 3852A communicates with each plug-in accessory by using read and write registers. High level commands are translated into appropriate register commands. The SREAD and SWRITE commands can be used to directly control each register.

SREAD and SWRITE are described in Chapter 2 of this manual. Table 14-1 shows the registers used by the HP 44725A accessory.

CAUTION

Using the primitive commands (SREAD and SWRITE) may cause unexpected and undesirable effects on the plug-in accessory. It is possible to program some plug-in accessories into illegal ant potentially damaging states with these commands. The commands are documented here for service purposes only.

14-4 Read Registers

14-5 Register 0. Read Register 0 contains the accessory identification. Eight bits are used to uniquely identify the accessory. The eight bits are output on the lower eight bits of the backplane data bus.

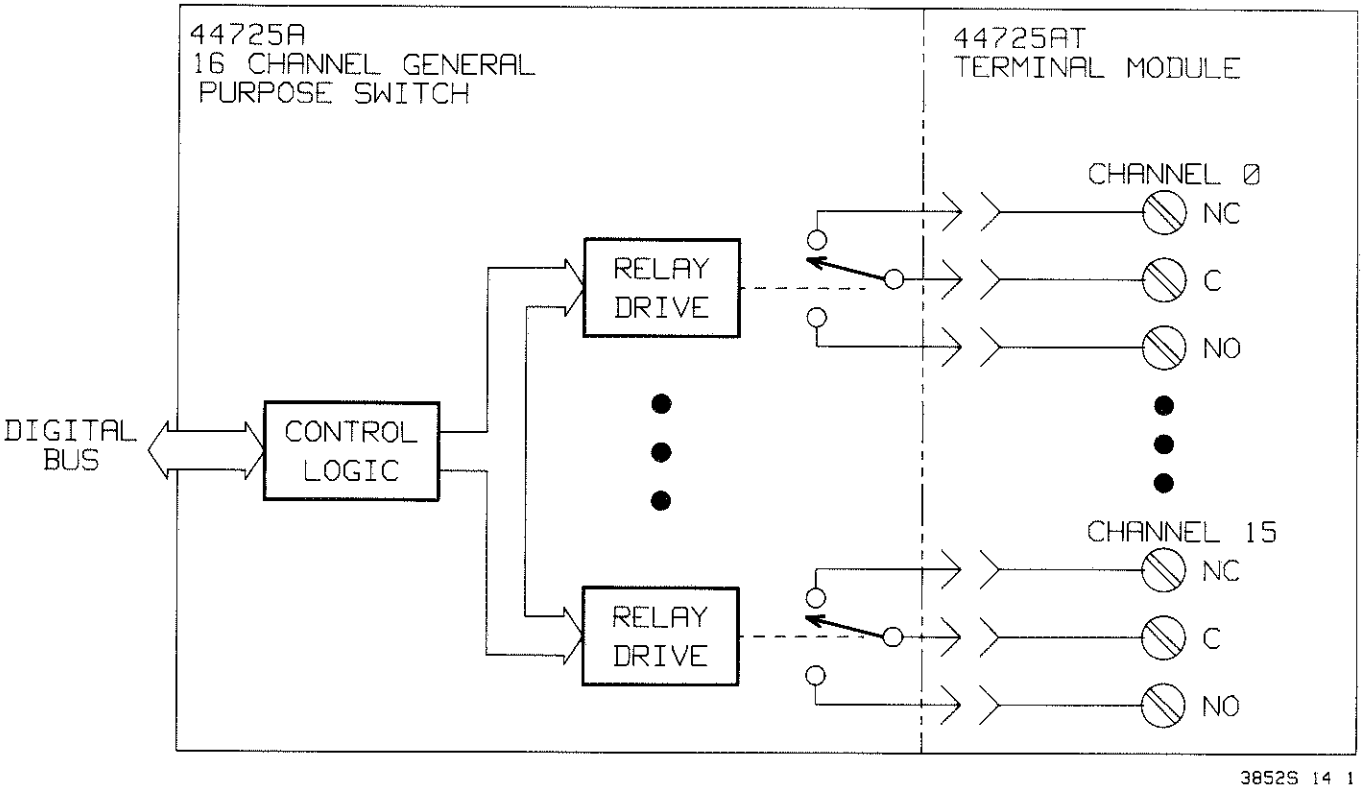


Figure 14-1 HP 44725A Block Diagram

Table 14-1 General Purpose Switch Read and Write Registers

Register #	READ Registers	WRITE Registers
0	Accessory Identification	Accessory Reset
1	Always -239	Not Used
2	Not Used	Not used
3	Channels 0 through 15	Channels 0 through 15

The eight bit identification is in two parts. The five most significant bits identify the component module and the three least significant bits identify the type of terminal module installed. If a terminal module is not present, the lower three bits are set high by the component module. The HP 3852A local controller can thus identify the type of plug-in accessory installed and determine if a terminal module is installed.

Table 14-2 lists the decimal equivalent codes returned in response to an SREAD of Register 0.

14-6 Register 1. Read Register 1 is a hardwired register and will always return a decimal value of -239 in response to an SREAD.

Table 14-2 HP 44725A Identification Codes

Module Combinations	Codes
HP 44725A Component Module (no terminal module installed)	-217
HP 44725A Component Module, HP 44725AT Terminal Module installed	-222

14-7 Register 3. Read Register 3 is the status register. The register contains a sixteen bit stấtus word, representing the last programmed state of the channel switches. The bits in the status word correspond one-to-one with the channel numbers (i.e., bit 15 represents channel 15). Figure 14-2 is an example of the status word. In the figure, it is presumed that channel 15 is closed.

Bits:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Bit Value:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 14-2 Read Register 3

NOTE

The decimal number returned after the execution of an SREAD command represents the two's compliment of the status word.

14-8 Write Registers

14-9 Register 0. Write Register 0 is the accessory reset register. Any data written to this register will cause a reset of the accessory and force all the channel switches open. A write to Register 0 has the same effect as a backplane accessory reset.

14-10 Register 3. Register 3 is the control register. A sixteen bit word is used to control the status of the channel switches. The bits in the command word correspond one-to-one to the channel number (i.e., setting bit 15 closes channel 15). Figure 14-3 is an example of the command word. In the figure, it is presumed that channel 15 to be closed.

Bits:	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Bit Value:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 14-3 Command Word

NOTE

The decimal number sent by an SWRITE command represents the two's compliment of the command word in the write register.

14-11 SPECIFICATIONS

Specifications for the HP 44725A are given in Table 14-3. Specifications are the performance standards or limits against which the General Purpose Switch may be tested.

Table 14-3 HP 44725A Specifications

Maximum Input Voltage (Vmax) per channel: 30 V DC or RMS
42 V peak

Maximum Input Current: 1.5 A DC, 1.5 A RMS per channel

Maximum Sum of the Squared RMS Currents in Each Channel (per module; for any type load): 24 A^2

Closed Channel Path Resistance: 175 mΩ

Switch Life: At Full Load, 10^5 (<=2 switches per second)
At Minimum Load, 10^8 (<=2 switches per second)

Input Impedance:

Impedance	Terminals: Open Contacts	Terminals: Channel to Channel	Terminals: Channel to Earth
Resistance (Ω)	$>10^9$	$>10^9$	$>10^9$
Max. Capacitance (pf) at 1MHz	10	5	30

Crosstalk: -73 dB at 100 kHz (channel-to-channel, 50 Ω source, 1 MΩ termination)

Maximum Offset Voltage: 5 µV

Maximum Bias Current: ±5 nA DC

Minimum Load: 100 mV minimum DC voltage and 100 µA minimum DC current is needed to avoid excessive buildup of contact resistance

Maximum Wire Size: 16 AWG

14-12 PERFORMANCE TESTS

14-13 Introduction

The following Performance Tests check the operation of the HP 44725A component module. Performance Tests are not given for the terminal modules. Successful completion of all tests in this chapter provides a high confidence level that the General Purpose Switch is meeting its listed specifications.

The Performance Tests should be performed in the order they are presented. The completion of each test increases the confidence level in the General Purpose Switch operation. A minimum set of tests is given as Operational Verification Tests. These tests are described in Section 14-14.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence that the General Purpose Switch is operating normally, it is not recommended that all the Performance Tests be performed unless one of the tested specifications is in question.

14-14 Operational Verification

The first tests given in this section are the minimum set of tests recommended for the General Purpose Switch. These tests are designed to test the functionality and the contact resistance of the relays. Successful completion of the Operational Verification Tests provides a 90% confidence level that the General Purpose Switch is operating normally and is within specification.

The Operational Verification Tests consist of the following:

Section 14-15 - Set-Up Procedure
Section 14-19 - Contact Resistance Test

14-15 Equipment Required

The following test equipment is required to run the Performance Tests. Only the first three items in the list are required for the Operational Verification Tests.

1. Test Fixture (as described in Section 14-16)

2. Digital Multimeter -- HP 3456A or equivalent

3. Test Leads and Jumpers

4. Service Module -- HP 44743A

5. Resistor -- 10 Mohm

6. +20 V Power Supply -- HP 6212 or equivalent

NOTE

Either of the accessory plug-in voltmeters (HP 44701A or HP 44702A/B) may be used for this test. This test does not describe the specific steps required to use the plug-in voltmeters. A description of the plug-in voltmeters can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

14-16 Test Fixture

A test fixture is required to run the Performance Tests. A schematic of the required test fixture is shown in Figure 14-4a. A test fixture can be manufactured using an HP 44725AT terminal module (see Figure 14-4b). Because wiring the test fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

If the test fixture is to be fabricated from other than an HP 44725AT terminal module, it is important that the terminal ID lines, shown in Figure 14-4a, be correctly wired. The HP 3852A local controller will not allow the execution of some commands with an incorrect terminal ID.

The test fixture consists of: a short circuit between all channel NC (Normally Closed) lines, a short circuit between all channel NO (Normally Open) lines, and a short circuit between all channel C (Common) lines. The use of the test fixture minimizes the number of test lead connections required for the tests.

14-17 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

14-18 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the General Purpose Switch component module and install the test fixture. Note the slot number where the General Purpose Switch under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

   c. Verify that the HP 3852A right display shows:

      44725

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

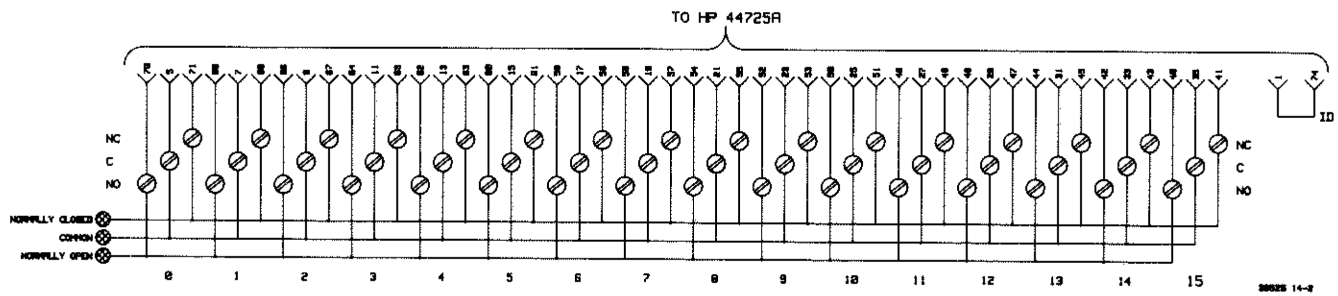


Figure 14-4a HP 44725A Test Fixure Schematic

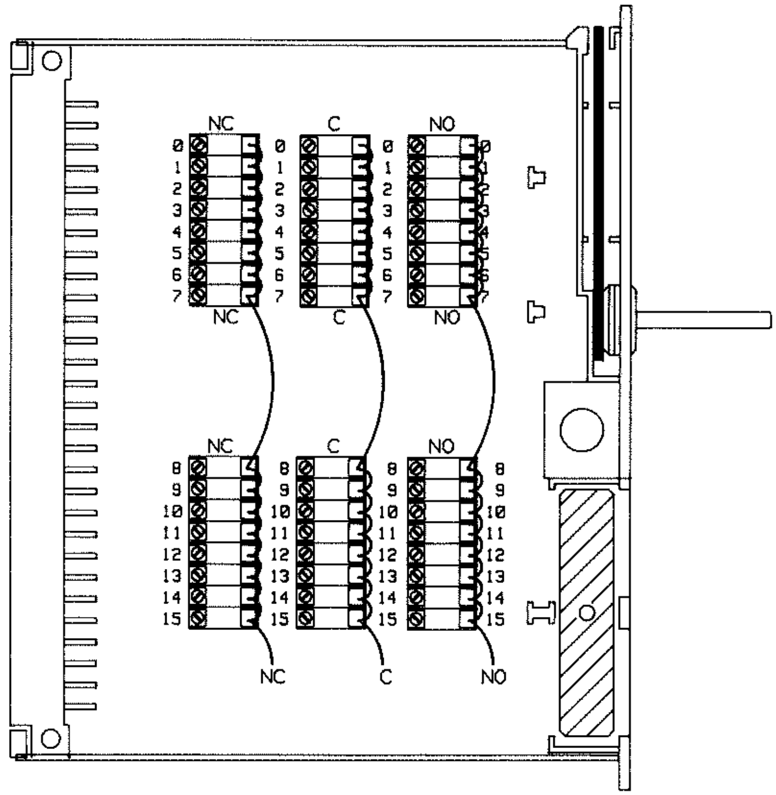


Figure 14-4b HP 44725A Test Fixture

14-19 Contact Resistance Test

1. NORMALLY OPEN CONTACT RESISTANCE TEST: This test checks the contact resistance of the normally open relay contacts. Since these contacts are normally open, a CLOSE command closes the contacts and an OPEN command opens the contacts.

2. Set all HP 44725A channel relays to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

3. Set the multimeter to measure four-wire ohms. Connect the multimeter DCV input and high SENSE leads to the NO (Normally Open) connection on the test fixture. Connect the multimeter COM input and COM SENSE leads to the C (Common) connection on the test fixture. The connections are shown in Figure 14-5.

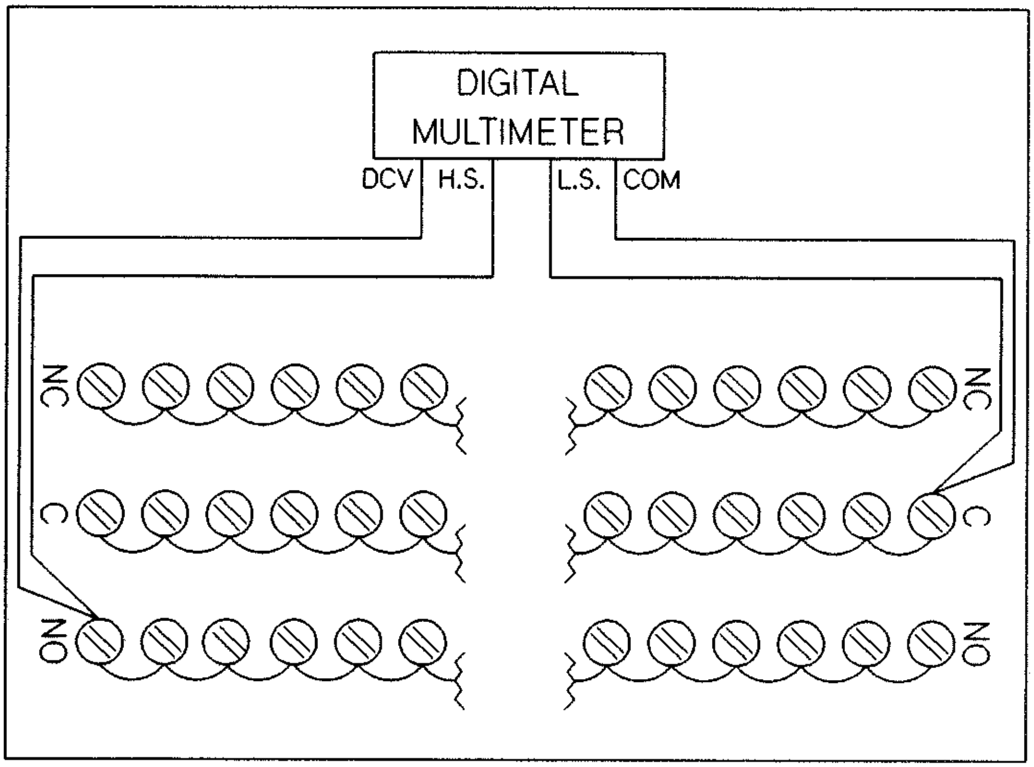


Figure 14-5 HP 44725A NO Channels Contact Resistance Test

4. Close channel 00 by executing:

CLOSE ES00 (where E = extender number, S = slot number)

5. Observe the indication on the multimeter. The multimeter should indicate a resistance less than 0.175 ohms.

6. Open channel 00 by executing:

OPEN ES00 (where E = extender number, S = slot number)

7. Observe the indication on the multimeter. The multimeter should indicate an open circuit (>=10^9 ohm). It is important to perform this step to ensure that none of the relays are stuck closed. If the multimeter does not indicate an open, troubleshooting will be necessary to locate the stuck relay. Section 14-23 describes locating a stuck relay.

8. Repeat steps 4, 5, 6, and 7 for channels 01 through 15. In the CLOSE and OPEN command the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

9. NORMALLY CLOSED CONTACT RESISTANCE TEST: This test checks the contact resistance of the normally closed relay contacts. Since these contacts are normally closed, a CLOSE command opens the contacts and an OPEN command closes the contacts.

10. Connect the multimeter DCV input and high SENSE leads to the NC (Normally Closed) connection on the test fixture. Connect the multimeter COM input and low SENSE leads to the C (Common) connection on the test fixture. The connections are shown in Figure 14-6.

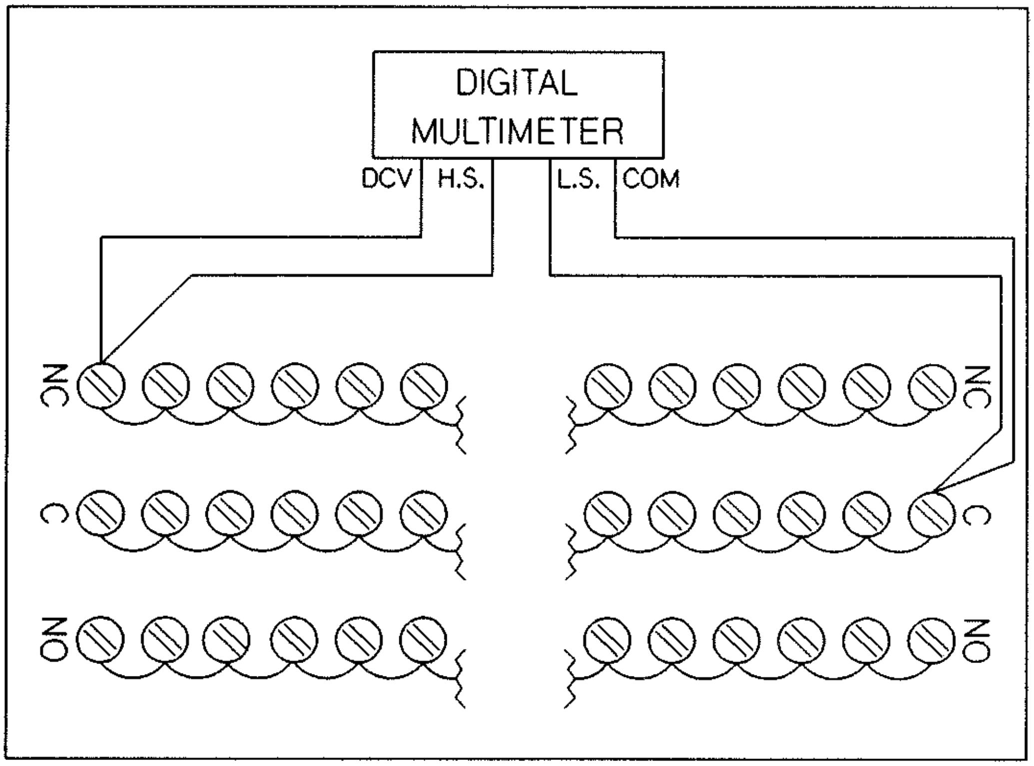


Figure 14-6 HP 44725A NC Channels Contact Resistance Test

11. Open all channels by executing:

    CLOSE ES00-ES15 (where E = extender number, S = slot number)

The multimeter should indicate an open circuit.

12. Close channel 00 by executing:

    OPEN ES00 (where E = extender number, S = slot number)

13. Observe the indication on the multimeter. The multimeter should indicate a resistance of less than 0.175 ohms.

14. Open channel 00 by executing:

    CLOSE ES00 (where E = extender number, S = slot number)

15. Observe the indication on the multimeter. The multimeter should indicate an open circuit (>=10^9 ohm) It is important to perform this step to ensure that none of the relays are stuck closed. If the multimeter does not indicate an open, troubleshooting will be necessary to locate the stuck relay. Section 14-23 describes locating a stuck relay.

16. Repeat steps 12, 13, 14, and 15 for channels 01 through 15. In the CLOSE and OPEN commands the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44725A PERFORMANCE TESTS.

14-20 Thermal Offset Test

1. NORMALLY OPEN THERMAL OFFSET TEST: This test checks the thermal offset of the normally open relay contacts. Since these relays are normally open, a CLOSE command closes the relays.

2. Set all HP 44725A channel relays to a known state by executing:

   RESET ES00 (where E= extender number, S= slot number)

3. Perform the Set-Up Procedure given in Section 14-18. The NO Thermal Offset test set-up is shown in Figure 14-7.

4. Set the multimeter to measure DC volts, on a range with at least 1 µV resolution. Connect the multimeter DCV lead to the shorted NO (Normally Open) lines of the test fixture. Connect the multimeter COM lead to the shorted C (Common) lines of the test fixture.

5. Close channel 00 by executing:

   CLOSE ES00 (where E = extender number, S = slot number)

6. Observe the indication on the multimeter. The voltage indicated should be less than 5 µV.

7. Repeat steps 5 and 6 for channels 01 through 15. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES01 would close channel 01 in extender E at slot S).

8. NORMALLY CLOSED THERMAL OFFSET TEST: This test checks the thermal offset of the normally closed relay contacts. Since these relays are normally closed, a CLOSE command opens the relays and an OPEN command closes the relays.

9. Refer to Figure 14-8 for the test set-up. Connect the multimeter DCV lead to the shorted NC (Normally Closed) lines of the test fixture. Connect the multimeter COM lead to the shorted C (Common) lines of the test fixture.

10. Open all channels by executing the following:

    CLOSE ES00-ES15 (where E = extender number, S = slot number)

11. Close channel 00 by executing:

    OPEN ES00 (where E = extender number, S = slot number)

12. Observe the indication on the multimeter. The voltage indicated should be less than 5 µV.

13. Repeat steps 11 and 12 for channels 01 through 15. In the OPEN and CLOSE commands, the last two digits are the channel number (i.e., OPEN ES01 would close channel 01 in extender E at slot S).

14-21 DC Isolation Tests

The DC Isolation tests use a power supply, a resistor and the voltmeter to form a voltage divider. The channel being tested is then connected in parallel with this divider and the isolation resistance computed from the measured voltage across the divider. The best test results will be obtained when the resistor value used is the same value as the internal resistance of the voltmeter. The recommended 10 Mohm resistor was selected to match the input impedance of an HP 3456A multimeter set to the 100 Vdc range.

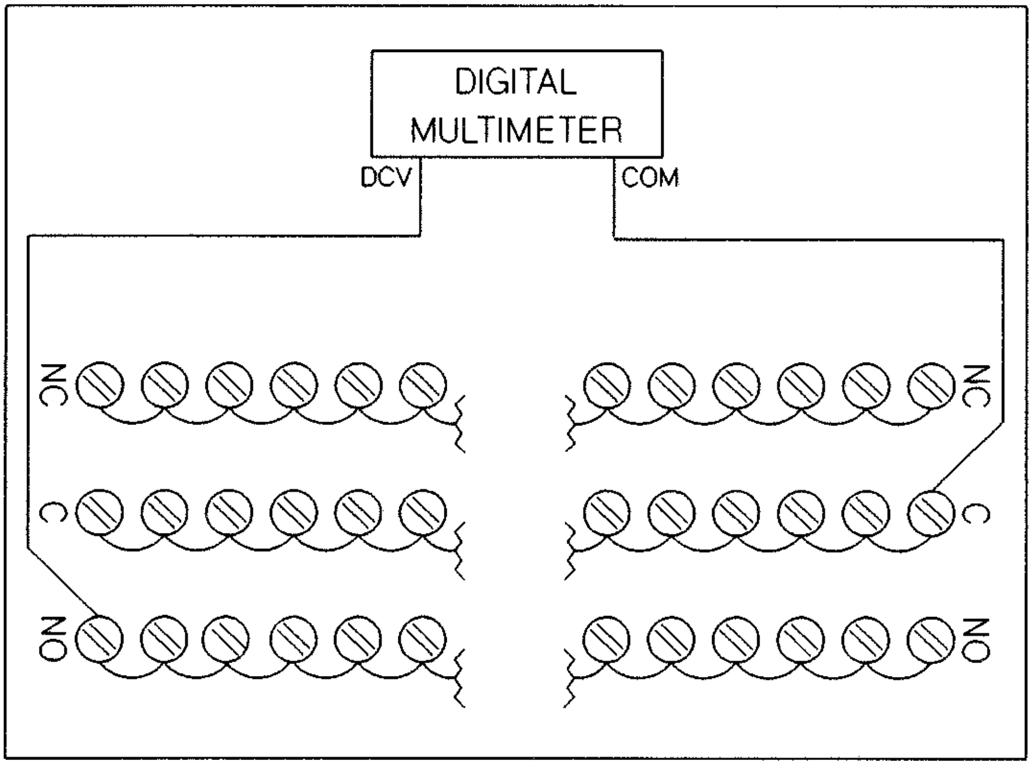


Figure 14-7 HP 44725A NO Channels Thermal Offset Test Set-Up

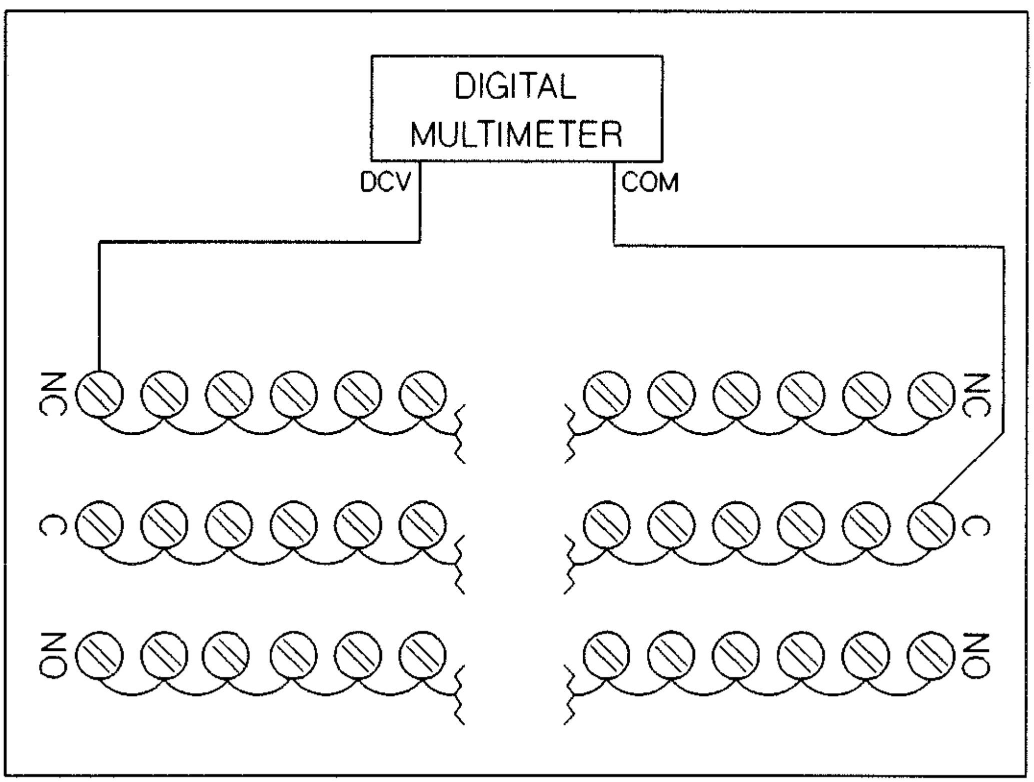


Figure 14-8 HP 44725A NC Channels Thermal Offset Test Set-Up

1. SET-UP PROCEDURE. Using the multimeter, measure the exact resistance of the 10 Mohm resistor. This resistance will be referred to as **R1** in the following steps.

2. Set the multimeter to measure DC volts and connect the multimeter to the DC power supply. Adjust the DC power supply output to +20 Vdc ±0.01 Vdc. This voltage will be referred to as **V1** in the following steps.

3. Connect the resistor, power supply and multimeter as shown in Figure 14-9.

4. Set the multimeter to the 100 Vdc range. Measure the exact voltage displayed on the multimeter. This voltage will be referred to as **V2** in the following steps.

5. Calculate the internal resistance of the multimeter (**Rm**) using the following equation:

$$Rm = R1 \bullet V2/(V1-V2)$$

NOTE

In most cases, the internal resistance of the multimeter is dependent upon the range selected. For this reason, do not change the multimeter range setting in the following procedure.

6. NORMALLY OPEN CHANNELS TO COMMON ISOLATION TEST. This test checks the open channel DC isolation across the NO (Normally Open) relay contacts.

7. Set the General Purpose Switch to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

8. Refer to Figure 14-10. Connect test lead A of the test circuit to the shorted NO lines on the test fixure. Connect test lead B of the test circuit to the shorted C (Common) lines on the test fixture.

9. Record the multimeter voltage measurement. This reading will be referred to as **V3**.

10. Calculate the DC isolation (**Rc**) using the following equation:

$$Rc = \frac{V3 \bullet R1 \bullet Rm}{Rm \bullet (V1 - V3) - (R1 \bullet V3)}$$

The open channel DC isolation should be greater than 65 Mohms. If the isolation is less than 65 Mohms, one or more of the Normally Open channel relays may be defective.

11. NORMALLY CLOSED CHANNELS TO COMMON ISOLATION TEST. This test checks the open channel DC isolation across the NC (Normally Closed) relay contacts.

12. Open the NC channels by executing:

CLOSE ES00-ES15 (where E = extender number, S = slot number)

13. Refer to Figure 14-11. Connect test lead A of the test circuit to the shorted NC lines on the test fixure. Connect test lead B of the test circuit to the shorted C (Common) lines on the test fixture.

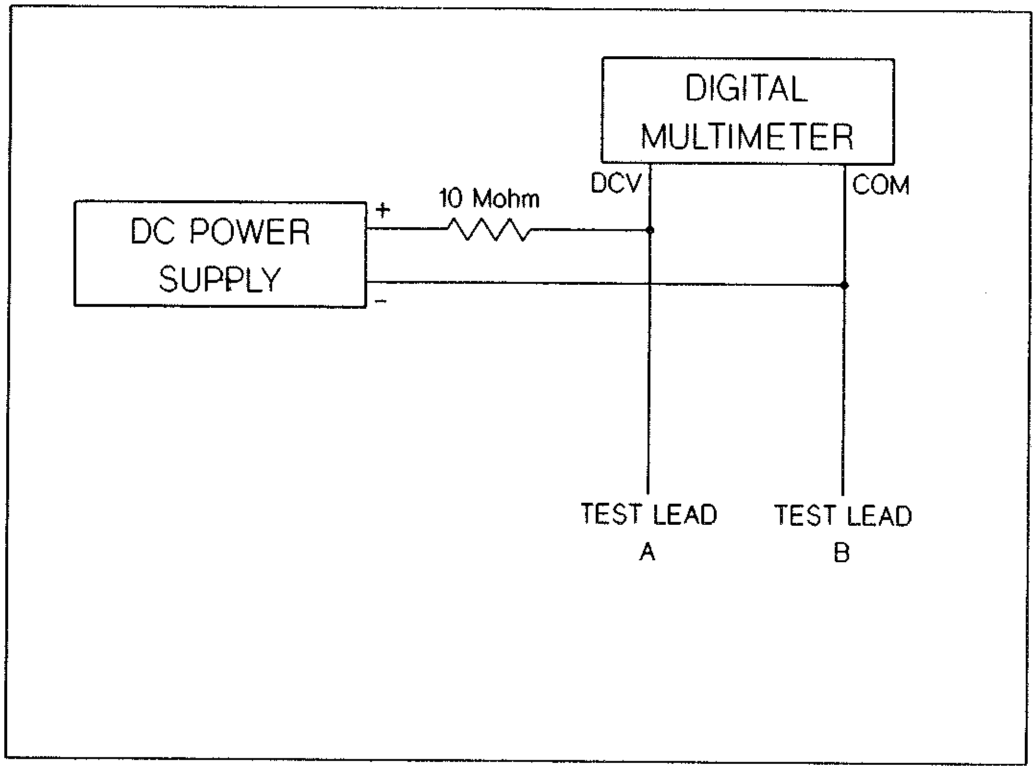


Figure 14-9 HP 44725A DC Isolation Test Set-Up

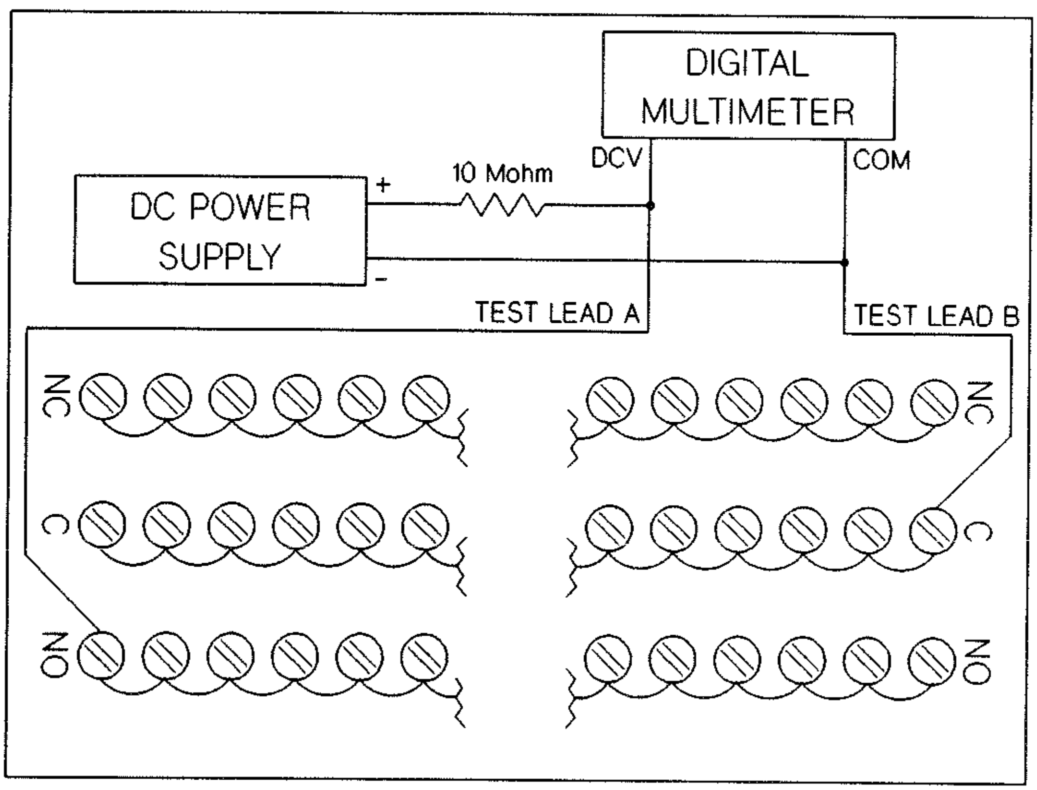


Figure 14-10 HP 44725A NO Channels to Common DC Isolation Test

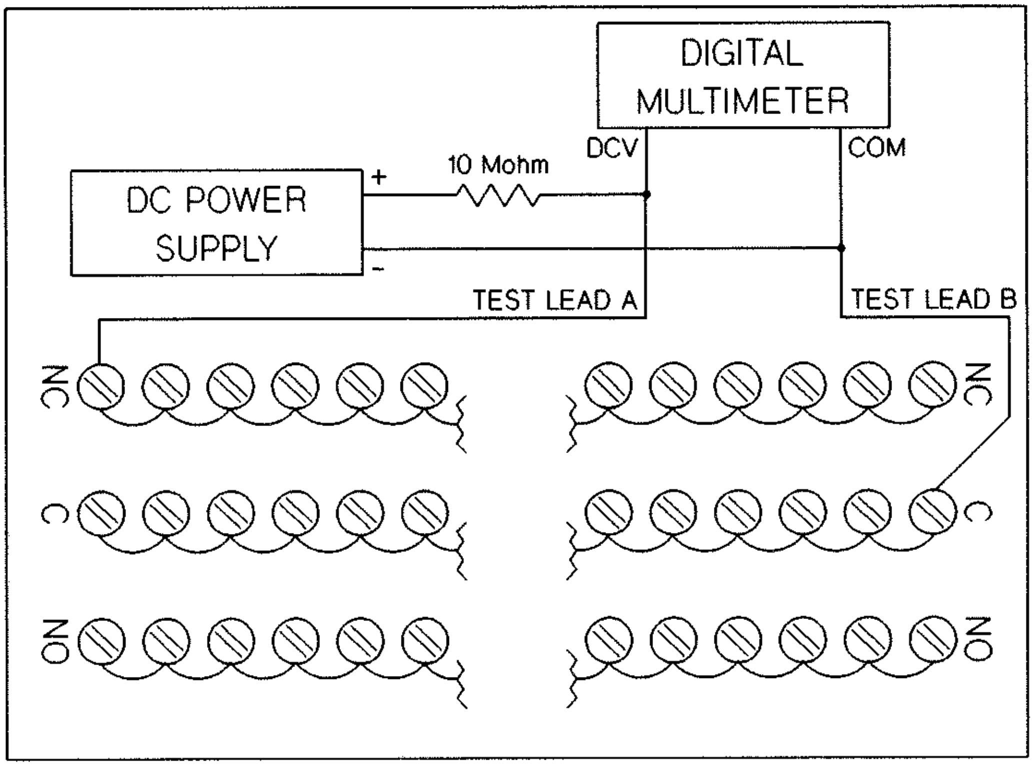


Figure 14-11 HP 44725A NC Channels to Common DC Isolation Test

14. Record the multimeter voltage measurement. This reading will be referred to as **V4**.

15. Calculate the DC isolation (**Rc**) using the following equation:

$$Rc = \frac{V4 \cdot R1 \cdot Rm}{Rm \cdot (V1 - V4) - (R1 \cdot V4)}$$

The open channel DC isolation should be greater than 65 Mohms. If the isolation is less than 65 Mohms, one or more of the Normally Closed channel relays may be defective.

16. NORMALLY OPEN CHANNELS TO EARTH GROUND ISOLATION TEST. This test checks the NO (Normally Open) channels to earth ground DC isolation.

17. Close the NO channels by executing:

CLOSE ES00-ES15 (where E = extender number, S = slot number)

18. Refer to Figure 14-12. Connect test lead A of the test circuit to the shorted C (Common) lines on the test fixture. Connect test lead B of the test circuit to the chassis.

NOTE

Connections to chassis ground can be accomplished by connecting to any sheet metal part. Chassis ground is also available at a connector on the rear panel of the HP 3852A power supply.

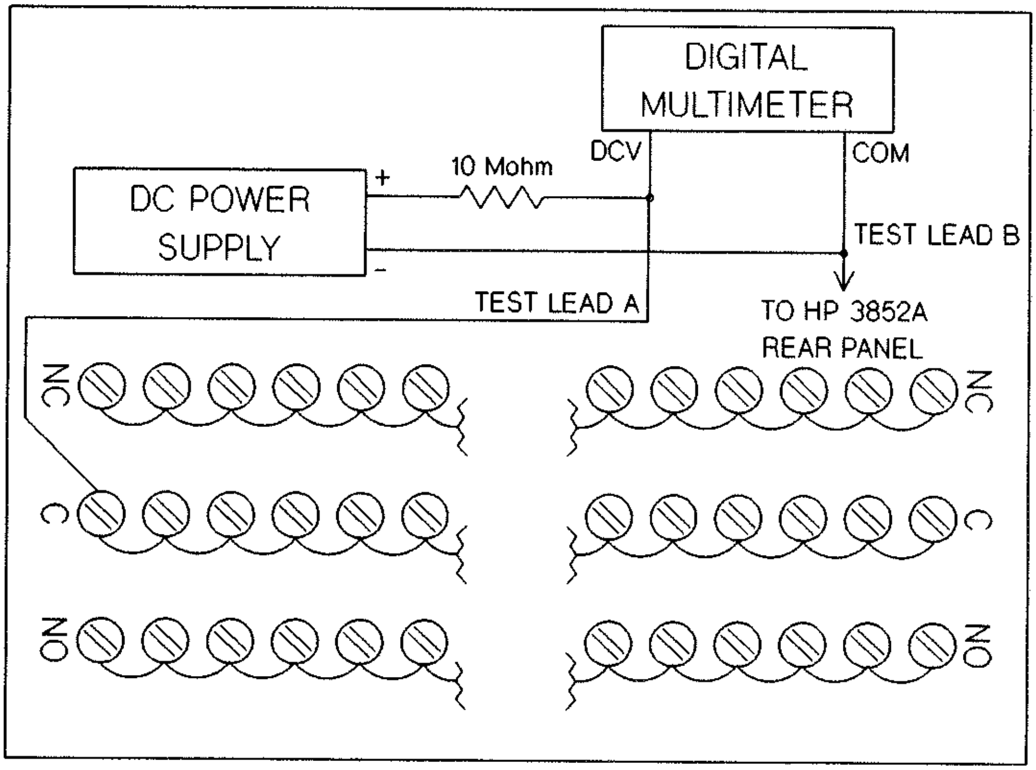


Figure 14-12 HP 44725A Channels to Earth Ground DC Isolation Test

19. Record the multimeter voltage measurement. This reading will be referred to as **V5**.

20. Calculate the DC isolation (**Rc**) using the following equation:

$$Rc = \frac{V5 \bullet R1 \bullet Rm}{Rm \bullet (V1 - V5) - (R1 \bullet V5)}$$

The NO channels to earth ground DC isolation should be greater than 10^9 ohms.

21. NORMALLY CLOSED CHANNELS TO EARTH GROUND ISOLATION TEST. This test checks the NC (Normally Closed) channels to earth ground DC isolation.

22. Close the NC channels by executing:

OPEN ES00-ES15 (where E = extender number, S = slot number)

23. Refer to Figure 14-12. Connect test lead A of the test circuit to the shorted C (Common) lines on the test fixture. Connect test lead B of the test circuit to the chassis.

24. Record the multimeter voltage measurement. This reading will be referred to as **V6**.

25. Calculate the DC isolation (**Rc**) using the following equation:

$$Rc = \frac{V6 \bullet R1 \bullet Rm}{Rm \bullet (V1 - V6) - (R1 \bullet V6)}$$

The NC channels to earth ground DC isolation should be greater than 10^9 ohms.

14-22 Injected Current Test

This test measures the amount of current injected into the NO (Normally Open) and NC (Normally Closed) contacts of each channel relay. The amount of injected current is deduced by measuring the voltage drop across a known value resistor. A 10 Mohm resistor is recommended.

1. NO LINES INJECTED CURRENT TEST. Set the multimeter to the DC volts function on a range with at least 10 µV of resolution. Install the 10 Mohm resistor across the input terminals of the multimeter. This resistance will be referred to as **R1** in the following steps.

2. Refer to Figure 14-13. Connect the multimeter DCV lead to the shorted NO lines of the test fixture. Connect the multimeter COM lead to the shorted C (Common) lines of the test fixure.

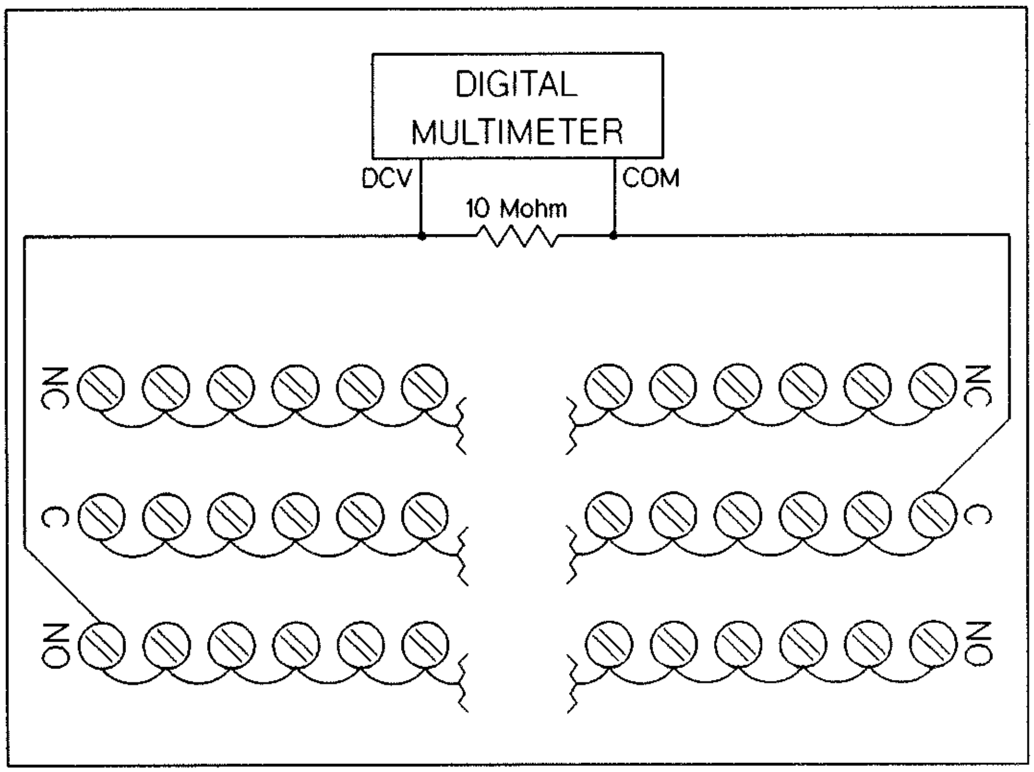


Figure 14-13 HP 44725A NO Channels Injected Current Test

3. Set the General Purpose Switch to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

4. Close the first NO channel in the General Purpose Switch by executing:

CLOSE ES00 (where E = extender number, S = slot number)

5. Record the voltage indicated on the multimeter. This voltage will be referred to as **V1**.

6. Calculate the injected current (I) from the formula:

$$I = \frac{V1}{R1}$$

The injected current must be less than 5 nA.

Once the value of the resistor used is known, the specification can be checked by simply measuring the voltage. For example, using the recommended 10 Mohm resistor, the voltage indicated on the multimeter must be less than 0.05 VDC.

7. Open the first NO channel by executing:

OPEN ES00 (where E = extender number, S = slot number)

8. Repeat steps 4, 5, 6, and 7 for channels 01 through 15. In the CLOSE and OPEN commands, the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

9. NC LINES INJECTED CURRENT TEST. Set the multimeter to the DC volts function on a range with at least 10 µV of resolution. Install the 10 Mohm resistor across the input terminals of the multimeter. This resistance will be referred to as **R1** in the following steps.

10. Refer to Figure 14-14. Connect the multimeter DCV lead to the shorted NC lines of the test fixture. Connect the multimeter COM lead to the shorted C (Common) lines of the test fixure.

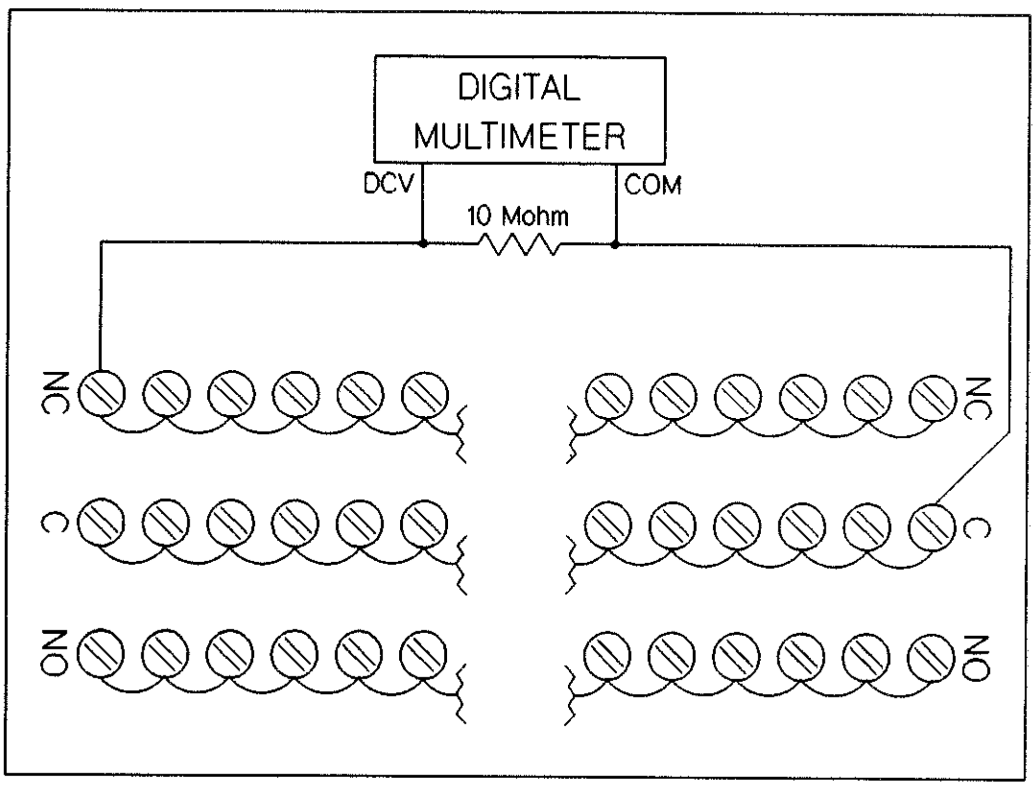


Figure 14-14 HP 44725A NC Channels Injected Current Test

11. Open all NC channel by executing:

CLOSE ES00-ES15 (where E = extender number, S = slot number)

12. Close the first NC channel in the General Purpose Switch by executing:

OPEN ES00 (where E = extender number, S = slot number)

13. Record the voltage indicated on the multimeter. This voltage will be referred to as **V1**.

14. Calculate the injected current (I) from the formula:

$$I = \frac{V1}{R1}$$

The injected current must be less than 5 nA.

15. Open the first NC channel by executing:

CLOSE ES00 (where E = extender number, S = slot number)

16. Repeat steps 12, 13, 14, and 15 for channels 01 through 15. In the OPEN and CLOSE commands, the last two digits are the channel number (i.e., OPEN ES01 for channel 01).

14-23 RELAY TROUBLESHOOTING

This section describes relay troubleshooting. The troubleshooting procedures first determine if the problem is located in the relays, or in the control logic. If the problem is determined to be in the control logic, complete replacement of the printed circuit board is required. Individual relays may be replaced.

The Operational Verification tests provide a starting point for problem isolation. Operational Verification tests are described in Section 14-14.

A single failing channel indicates a failing channel relay. Table 14-4 is the relay cross reference table showing the relationship between channel numbers, relay numbers, and relay drivers and their corresponding input/output pin numbers. The table also shows the NC, NO, and C pin numbers on the component module connector.

Figure 14-15 shows the location of the relays on the component module board. Figure 14-16 shows a simplified schematic of one relay and associated circuitry. Since all the relay circuitry is the same, only one relay circuit is shown in the figure. Also shown in Figure 14-16 is a package outline and pinout diagram of the type of relay used. Use both Figures 14-13 and 14-14, and Table 14-4 for the following troubleshooting procedures.

CAUTION

To prevent equipment circuit damage always set the line power switch to off before removing or replacing any assembly. To prevent static zap of ICs always observe anti-static handling techniques when assemblies are handled or stored.

Table 14-4 HP 44725A Relay Cross Reference Table

Channel Number	Relay Number	Relay Driver Input/Output Input	Output	Component Module Connector Pins NC	NO	C
0	K1	U13 pin 1	U13 pin 18	71	70	5
1	K2	U13 pin 2	U13 pin 17	69	68	7
2	K3	U13 pin 3	U13 pin 16	67	66	9
3	K4	U13 pin 4	U13 pin 15	65	64	11
4	K5	U13 pin 5	U13 pin 14	63	62	13
5	K6	U13 pin 6	U13 pin 13	61	60	15
6	K7	U13 pin 7	U13 pin 12	59	58	17
7	K8	U13 pin 8	U13 pin 11	57	56	19
8	K9	U14 pin 1	U14 pin 18	55	54	21
9	K10	U14 pin 2	U14 pin 17	53	52	23
10	K11	U14 pin 3	U14 pin 16	51	50	25
11	K12	U14 pin 4	U14 pin 15	49	48	27
12	K13	U14 pin 5	U14 pin 14	47	46	29
13	K14	U14 pin 6	U14 pin 13	45	44	31
14	K15	U14 pin 7	U14 pin 12	43	42	33
15	K16	U14 pin 8	U14 pin 11	41	40	35

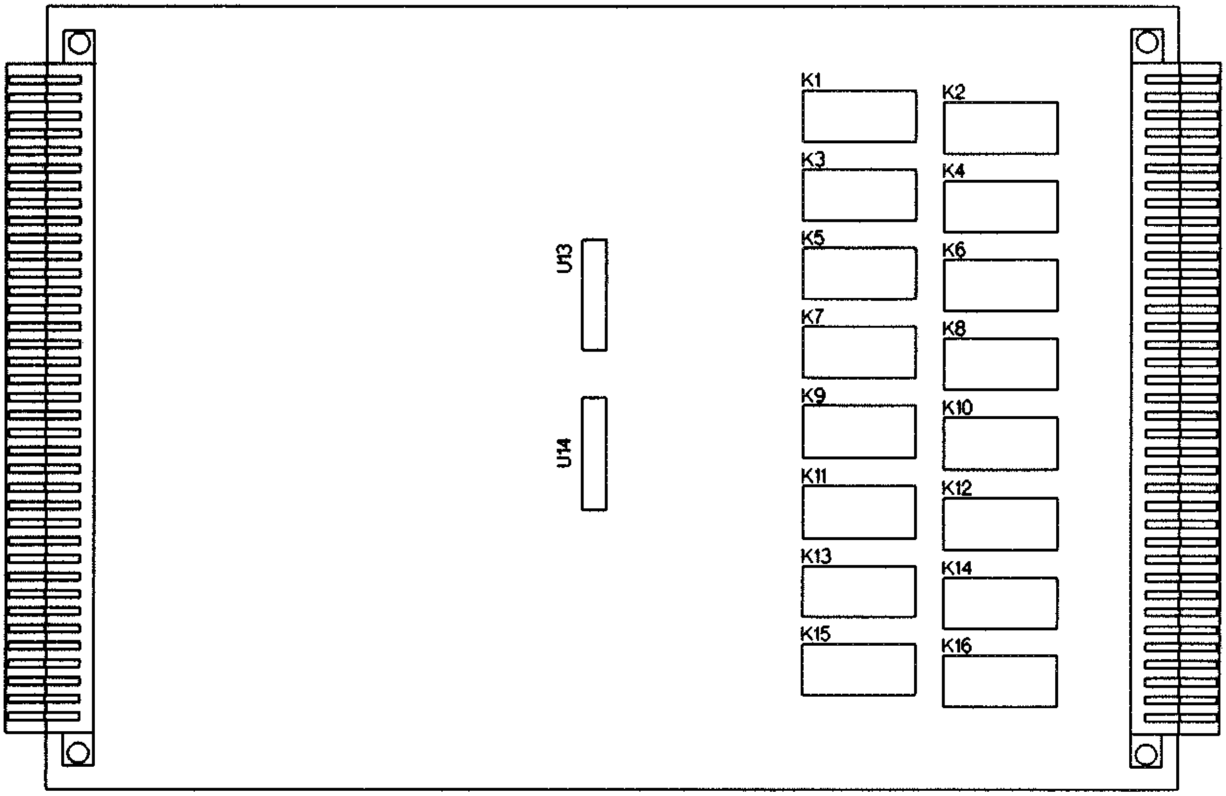


Figure 14-15 Relay Component Locator

14-24 Control Logic Problem Isolation

The following control logic test writes relay closing patterns to the General Purpose Switch and then checks for an indication of the relay state in the status register (Read Register 3). Electrically, this test checks that the correct relay drive lines were enabled. It does not actually check the drive lines. The test does provide an indication that the control logic is performing as required and can communicate with the HP 3852A local controller.

NOTE

If using an HP 9000 Series 300 or Series 300 computer to perform this test, it may be necessary to program a delay between the SWRITE and SREAD commands (steps 2, 4, and 5) to allow time for the relay states to be latched into the status register.

1. Reset the HP 44725A General Purpose Switch by executing:

   RESET ES00 (where E = extender number, S = slot number)

2. Read the status register by executing:

   SREAD ES00 (where E = extender number, S = slot number)

3. Verify that the right display shows:

   0

If the display shows 0 (all channels open), the HP 44725A has been reset. Proceed to Step 4. If a number other than 0 is displayed, cycle power on the HP 3852A and perform steps 2 and 3 again. If the number is still incorrect, a failure exists with the HP 44725A control logic or with the HP 3852A. If the HP 3852A seems to operate normally (see Chapter 5 for HP 3852A problem isolation), the fault most likely exists in the HP 44725A switch control logic.

4. Close all relays by executing:

   SWRITE ES00,3,-1 (where E = extender number, S = slot number)

5. Read the status register by executing:

   SREAD ES00,3 (where E = extender number, S = slot number)

6. Verify that the right display shows:

   -1

7. Reset the HP 44725A General Purpose Switch by executing:

   RESET ES00 (where E = extender number, S = slot number)

CAUTION

This procedure sets illegal and potentially damaging states on the HP 44725A General Purpose Switch. Be sure to execute the RESET command in Step 7 to clear these states.

If the control logic test passed and a relay is not closing or opening, relay replacement is indicated. Since the control logic test is unable to check the actual relay drive lines, an additional test can be performed. With a digital multimeter, check the voltage across the faulty relay coil. The multimeter should indicate a steady state voltage of approximately 4.0 Vdc when the relay is open. The multimeter should indicate less than 0.2 Vdc when the relay is closed. The resistance across the relay coil should be approximately 130 Ω.

14-25 Stuck Relay Troubleshooting

When a relay contact is stuck in the closed position it cannot be isolated with the test fixture installed. The test fixture parallels all the relays together. However, the test fixture, or a terminal module, must be installed to allow the HP 3852A to normally communicate with the component module.

There are two ways to isolate the stuck relay. The first, and easiest means is to install a regular terminal module on the failing component module. Each channel of the multiplexer can then be checked with an ohmmeter. Measure between the faulty NO or NC terminal (depending on which contact is stuck) and the corresponding C terminal on the terminal module. Once the stuck channel is isolated, Table 14-4 identifies the stuck relay.

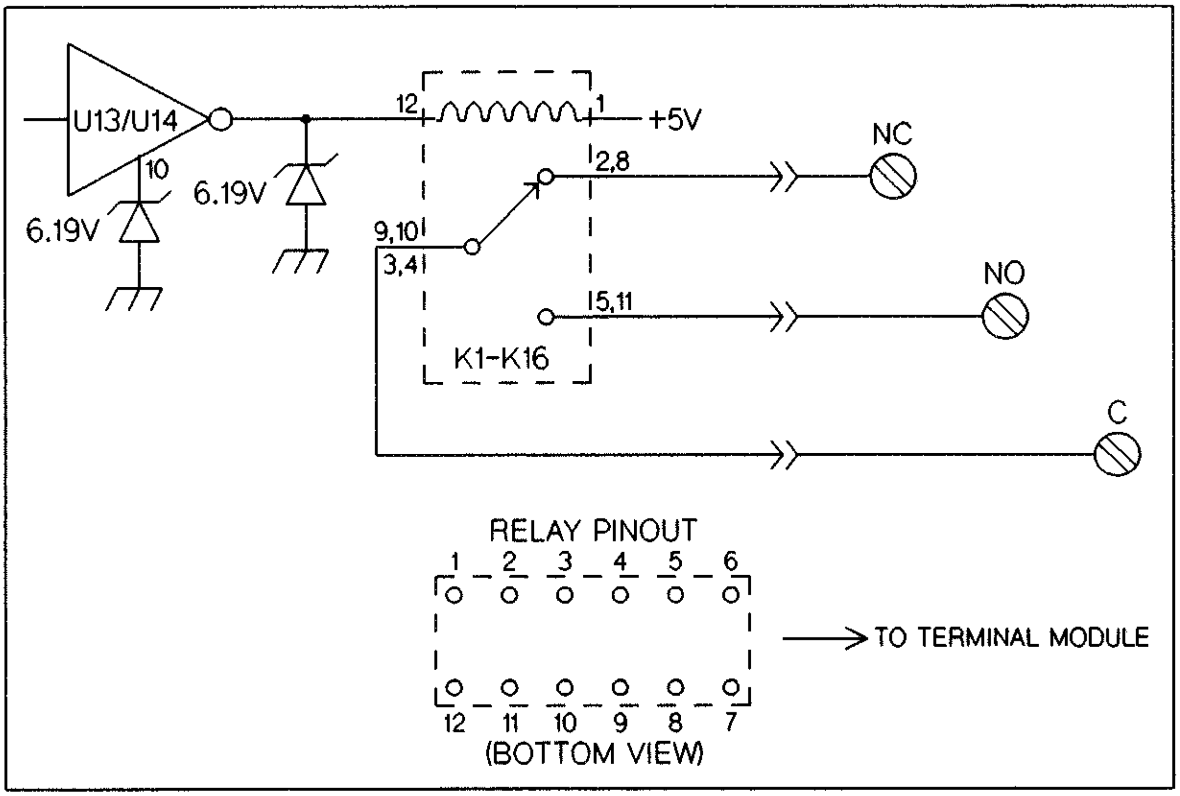


Figure 14-16 Relay Simplified Schematic

The second means to isolate a stuck relay involves checking for the stuck contacts on the component module connector. This method is not recommended for general use. To use this method, the test fixture or a terminal module must be installed and the HP 3852A power applied. When the wake-up sequence has completed, the test fixture or terminal module is removed. Removing the module after the wake-up sequence will allow commands to be processed since the local controller only queries the slots for accessory identification after power-on or reset.

It is recommended that the entire component module be replaced if the relays are at or near the relay maximum specified life cycle (shown in Table 14-3) and the relays are sticking or the contact resistance is out of specification.

14-26 REPLACEABLE PARTS

Figure 14-17 shows the mechanical breakdown of the HP 44725A. This figure also provides assembly and disassembly information. The parts shown in Figure 14-17 are keyed to the parts list in Table 14-5.

To order a part listed in Table 14-5, quote the Hewlett-Packard part number, the check digit (abbreviated CD in Table 14-4), and the quantity desired. Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

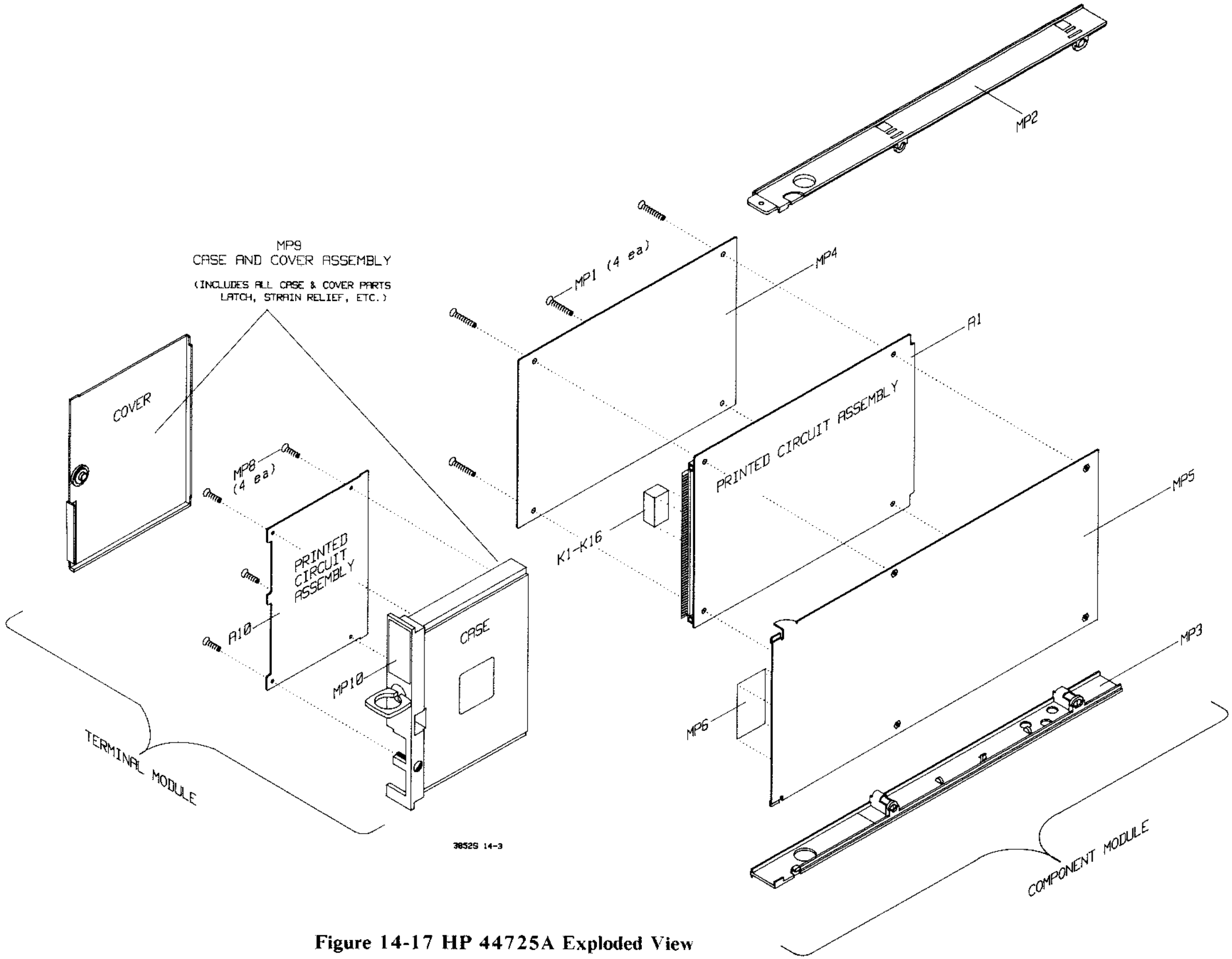


Figure 14-17 HP 44725A Exploded View

Table 14-5 HP 44725A 16 Channel General Purpose Switch

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44725A	Module; 16 chan GP switch component	1	44725-66201	5	MOD-16CH GP SWCH
A1	PCA; 16 channel GP switch component	1	44725-66501	8	PCA-16CH GP SWCH
A10	PCA; 16 channel GP switch terminal	1	44725-66510	9	PCA-GP SWCH TERM
K1-16	Relay; A1 PCA	16	0490-1512	0	RLY-S2EB-5V
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44725A component module	1	44725-84320	7	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44725A	1	44725-84325	2	LBL-ID,TERM ASSY

Completely assembled HP 44725A terminal modules can be ordered from your local HP Office by ordering Number 44725AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Chapter 18
HP 44727A/B/C 4-Channel DACs

CHAPTER 15

HP 44727A/B/C 4 CHANNEL VOLTAGE/CURRENT DACs

CHAPTER 15
HP 44727A/B/C
4 CHANNEL VOLTAGE/CURRENT DACs

15-1 INTRODUCTION

This chapter provides a technical description, performance test procedures, calibration procedures, and replaceable parts lists for the HP 44727A/B/C 4 Channel Voltage/Current DAC.

15-2 Technical Description

The HP 44727A/B/C 4 Channel Voltage/Current DACs are designed to output analog voltages or currents that can be used to test and control devices. The HP 44727A/B/C are identical products, but configured for different applications. The HP 44727A has all 4 channels configured for voltage outputs. The HP 44727B has all 4 channels configured for current outputs. The HP 44727C has two channels configured for voltage and two channels configured for current. Each channel can be configured for one of four modes by movable jumpers and switch settings. The modes are 0 to +10.235 volts, -10.235 to +10.235 volts, 0 to +20.16 mA, and +4 mA to +20.16 mA. Each channel of the HP 44727A/B/C has remote sense capability for accurate outputs at the test point. The channels can float up to 170 volts peak above ground.

A simplified block diagram of HP 44727A/B/C is shown in Figure 15-1. The accessory is made up of two main assemblies: a component module and a terminal module. The component module contains both analog and digital sections. The digital section consists of a local controller to interface with the backplane and channel drivers. The analog section is identical for each channel and consists of error amplifiers, sense amplifiers, output buffers, and potentiometers for calibration. The terminal module contains jumpers to configure and calibrate the output channels. The module also contains terminal strips for user connections and calibration resistors for current.

NOTE

Since the HP 44727A/B/C accessories consume a relatively large amount of power, only a limited number of accessories can be installed in the HP 3852A and HP 3853A. Consult the HP 44727A/B/C and HP 3852A Operating and Programming Manual for more information.

15-3 Read and Write Registers

The HP 3852A local controller communicates with each plug-in accessory by using read and write registers. High level commands are translated into appropriate register commands. The SREAD and SWRITE commands can be used to directly control each register.

SREAD and SWRITE are described in Chapter 2 of this manual. Table 15-1 shows the registers used by the HP 44727/B/C.

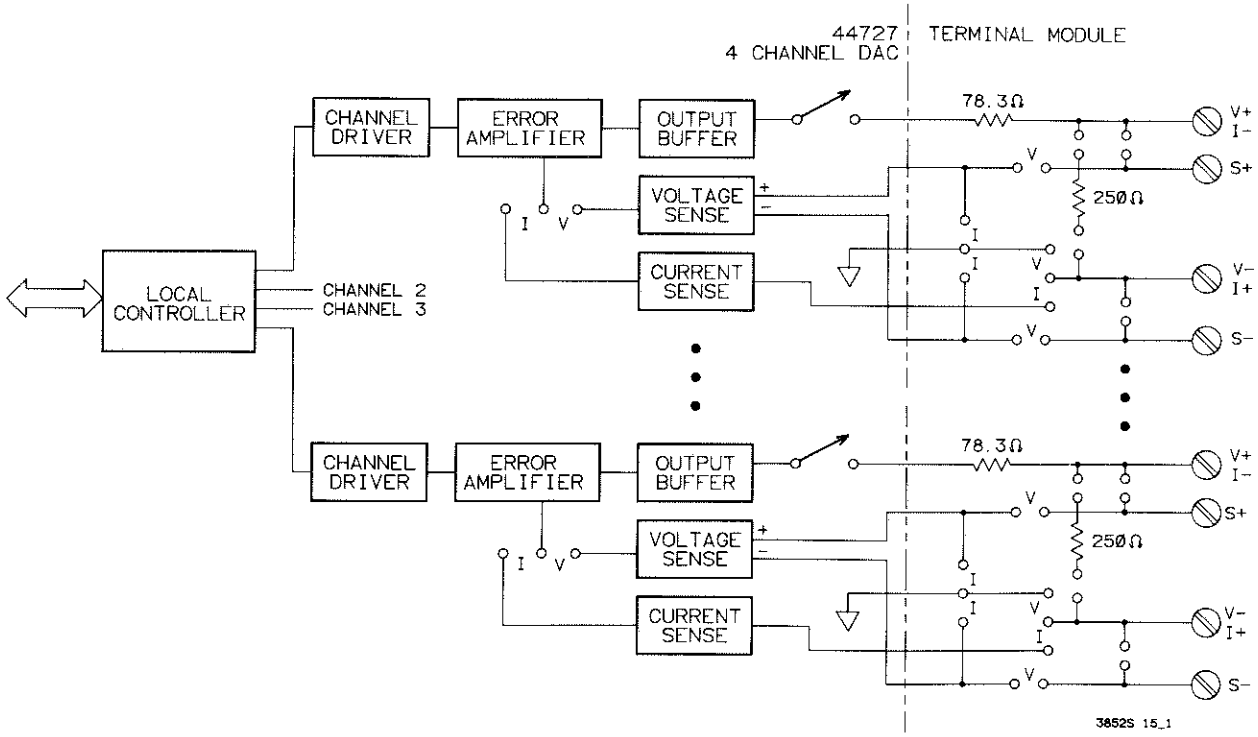


Figure 15-1 HP 44727A/B/C Simplified Block Diagram

CAUTION

Using the primitive commands (SREAD and SWRITE) may cause unexpected and undesirable effects on the plug-in accessories. It is possible to program some plug-in accessories into illegal and potentially damaging states with these commands. The commands are documented here for service purposes only.

15-4 Read Registers

15-5 Registers 0 and 4. Read Registers 0 and 4 contain the accessory identification. The registers are identical. Eight bits are used to uniquely identify the accessory. The eight bits are output on the lower eight bits of the backplane data lines.

The eight bit identification is in two parts. The five most significant bits identify the component module and the three least significant bits identify the type of terminal module installed. If a terminal module is not present, the lower three bits are set high by the component module. The HP 3852A local controller can thus identify the type of plug-in accessory installed and determine if a terminal module is installed.

Table 15-2 lists the decimal equivalent codes returned in response to an SREAD of Registers 0 and 4 for all combinations of the accessory.

Table 15-1 DAC Read and Write Registers

Register #	READ Registers	WRITE Registers
0	Accessory Identification	Accessory Reset
1	Status	Not Used
2	Read Control	Write Control
3	External Identification	Output Enable
4	Accessory Identification	Accessory Reset
5	Status	Not Used
6	Read Data	Write Data
7	External Identification	Output Enable

Table 15-2 HP 44727A/B/C Identification Codes

Module Combinations	Codes
HP 44727A/B/C Component Module (no terminal module installed)	-226
HP 44729A/B/C Component Module, HP 44727AT Terminal Module installed	-225

15-6 Registers 1 and 5. Read Registers 1 and 5 are status registers. The registers are identical. Eight bits are used to determine if the HP 44727A/B/C needs initialization or if it has been done. A decimal value of -248 shows that initialization is needed and a decimal value of -240 shows that it has been done. Initialization is needed after a power-up or reset is performed. However, initialization is normally done when the HP 44727A/B/C is setup to output voltage/current using higher level commands (i.e., the APPLY command).

15-7 Register 2. Read Register 2 is the read control register. It determines the last control data sent to various circuitry on the component module, after the Write Control command was sent.

15-8 Registers 3 and 7. Read Registers 3 and 7 are the external identification registers. The registers are identical. They contain an eight bit word, representing the output modes of the four channels on the HP 44727A/B/C. Figure 15-2 is an example of the word and Table 15-3 lists the different output modes of the HP 44727A/B/C. You can use Registers 3 and 7, and Table 15-3 to determine the output configuration of the channels. It is presumed in Figure 15-2 that the channels are configured as follows:

Channel 0: 0 to +10.235 V
Channel 1: -10.235 V to +10.235 V
Channel 2: 0 to +20.16 mA
Channel 3: +4 mA to +20.16 mA

Table 15-3 Channel Output Modes

Mode	M1	M2
0 to +10.235 V	0	0
-10.235 V to +10.235 V	0	1
0 to +20.16 mA	1	0
+4 mA to +20.16 mA	1	1

Bits:	7	6	5	4	3	2	1	0
Channels:	CH0	CH0	CH1	CH1	CH2	CH2	CH3	CH3
Output Mode:	M2	M1	M2	M1	M2	M1	M2	M1
Bit Value:	0	0	1	0	0	1	1	1

Figure 15-2 Read Registers 3 and 7

15-9 Register 6. Read Registers 6 is the read data register. It determines the last configuration data sent to various circuitry on the component module, after the Write Data command was sent.

NOTE

The decimal number returned after the execution of an SREAD command represents the two's compliment of the status word.

15-10 Write Registers

15-11 Registers 0 and 4. Write Registers 0 and 4 are the accessory reset registers. The registers are identical. Any data written to these registers will cause a reset of the accessory and forces the accessory's output relays to open. A write to Register 0 or 4 has the same effect as a backplane reset.

15-12 Register 2. Write Register 2 is the write control register. It is used to send control data to various circuitry on the component module.

15-13 Registers 3 and 7. Write Registers 3 and 7 are the output enable registers. The registers are identical. Any data written to these registers will cause the accessory's output relays to close.

15-14 Register 6. Write Register 6 is the write data register. It is used to send configuration data to various circuitry on the component module.

15-15 SPECIFICATIONS

Specifications for the HP 44727A/B/C are given in Table 15-4. Specifications are the performance standards or limits against which the accessory may be tested tested.

Table 15-4 HP 44727A/B/C Specifications

DC Voltage
Ranges: 0 to +10.235 V or -10.325 to +10.325 V
Resolution: 2.5 mV (12 bits plus a sign bit for bipolar range)
Protection: 170 V peak or 120 V DC channel to channel or channel to chassis
DC Accuracy: Specified over load and operating temperature for 90 days since last calibration. Rload is load used for calibration (open circuit at the factory). Using remote sense where resistance of each SENSE lead is less than 2.5 Ω, and max IR drop in SOURCE leads is 1.5 V.
Rload, 18 to 28°C: ±(0.05% of programmed output + 2.5 mV)
Load Regulation: If actual load used is different than Rload, the maximum additional error for loads as small as 500 Ω is 0.6 mV.
Temperature Coefficient: Adds as an additional accuracy error using ±(% of programmed output + volts) per °C change outside 18 to 28°C, as long as the operating temperature is maintained between 0 to 18 or 28 to 55°C. 0.002% + 0.035 mV.
Maximum Output Current: 20 mA
Ripple and Noise: 2.5 mV RMS (20 Hz to 250 kHz)
Maximum Wire Size: 16 AWG

Table 15-4 HP 44727A/B/C Specifications (Cont.)

DC Current

Ranges: 0 to +20.16 mA or +4 to +20.16 mA

Resolution: 2.5 µA (13 bits)

Protection: 170 V peak or 120 V DC channel to channel or channel to chassis

DC Accuracy: Specified over load and operating temperature for 90 days since last calibration. Rload is load used for calibration (250 Ω circuit at the factory).

Rload, 18 to 28°C: ±(0.05% of programmed output + 5 µA)

Load Regulation: If actual load used is different than Rload, the maximum additional error for loads as large as 600 Ω is 2 µA.

Temperature Coefficient: Adds as an additional accuracy error using ±(% of programmed output + volts) per °C change outside 18 to 28°C, as long as the operating temperature is maintained between 0 to 18 or 28 to 55°C. 0.003% + 0.3 µA.

Compliance: 12 V

Ripple and Noise: 7.5 µA RMS (20 Hz to 250 kHz)

Maximum Wire Size: 16 AWG

15-16 PERFORMANCE TESTS

15-17 Introduction

The following Performance Tests checks the operation of the HP 44727A/B/C component module. Performance Tests are not given for the terminal modules. Successful completion of the tests in this chapter provides a high confidence level that the HP 44727A/B/C is meeting its listed specifications.

The Performance Tests should be performed in the order they are presented. The completion of each test increases the confidence level in the HP 44727A/B/C operation. A minimum set of tests is given as Operational Verification Tests. These tests are described in Section 15-18.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence level that the HP 44727A/B/C is operating normally, it is not recommended that the Performance Tests be performed unless one of the tested specifications is in question.

15-18 Operational Verification Test

The first tests given in this section are the minimum set of tests recommended for the HP 44727A/B/C. These tests are designed to test the functionality of the DACs. Successful completion of the Operational Verification Tests provides a 90% confidence level that the DACs are operating normally and are within specifications.

The Operational Verification Tests consist of the following:

Section 15-22 - Set-Up Procedure
Section 15-23 - Voltage Channel Output Test
Section 15-24 - Current Channel Output Test

15-19 Equipment Required

The following test equipment is required to run the Performance Test. Only the first two items in the list are required for the Operational Verification Tests.

1. Test Fixture (as described in Section 15-20)
2. Digital Multimeter -- HP 3456A or equivalent
3. Service Module -- HP 44743A
4. Resistor -- 500 ohms (.25 W, 5% or better)
5. Resistor -- 600 to 630 ohms (.5 W, 5% or better, low TC)
6. Resistor -- 125 ohms (5 W, 5% or better, low TC)

NOTE

The integrating plug-in voltmeter (HP 44701A) may be used for this test. This test does not describe the specific steps required to use the plug-in voltmeter. A description of the plug-in voltmeter can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

15-20 Test Fixture

A test fixure is required to run the Performance Test. The fixure is shown in Figure 15-3. This test fixture is made from an HP 44727AT terminal module. To prevent any disconnections from your terminal module, it may be to your advantage to order an additional terminal module for service purposes.

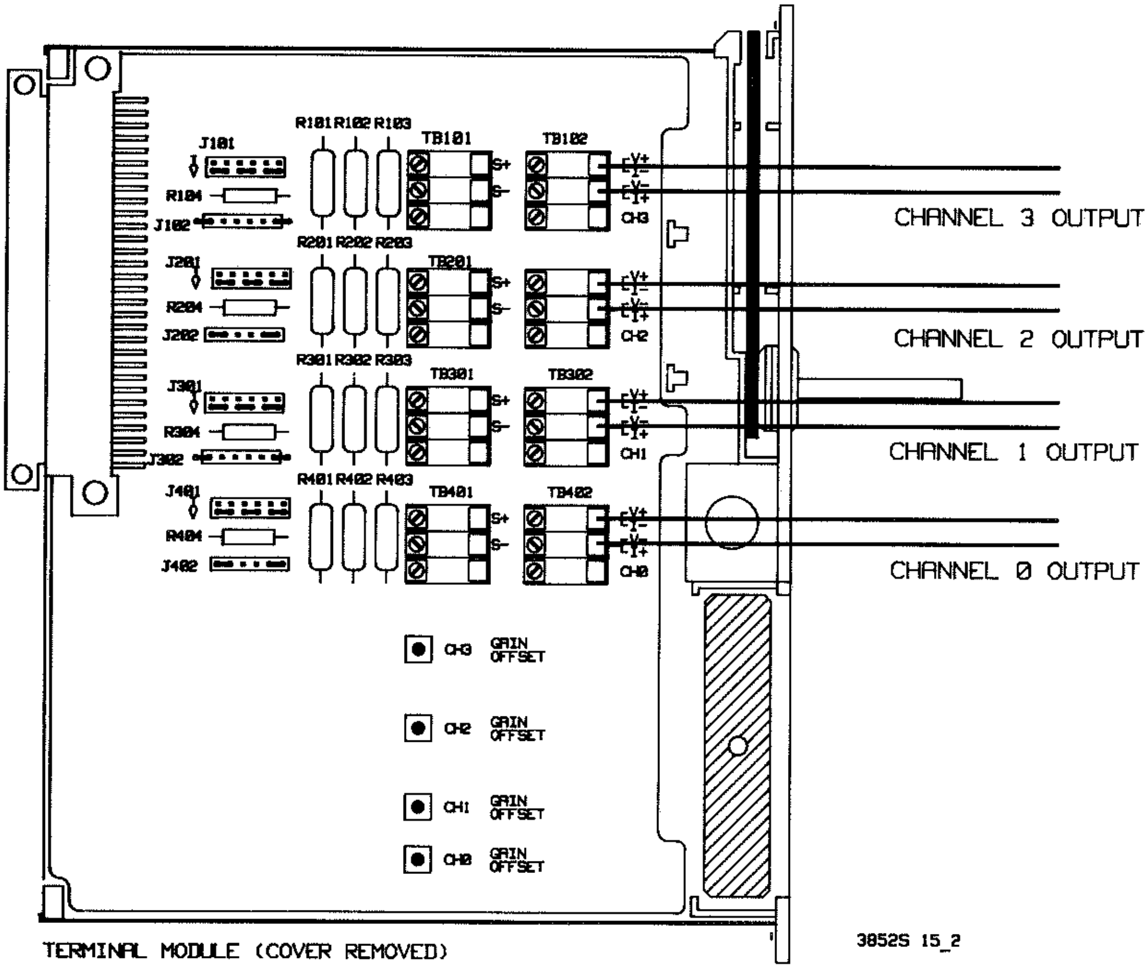


Figure 15-3 HP 44727A/B/C Test Fixure

15-21 Test Procedure

The following procedures test both the voltage and current channels of the HP 44727A/B/C. For voltage channels perform only the voltage test procedures. Likewise, for current channels perform only the current test procedures. The procedures test both the 0 to +10.235 V or -10.235 V to +10.235 V voltage output modes, and both the 0 to +20.16 mA or +4 mA to +20.16 mA current output modes.

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

15-22 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the HP 44727A/B/C component module.

3. Configure the test fixure for the correct voltage and/or current channels. Use the terminal module removed in step 2 to determine the correct channel configuration. Configure the test fixure as follows:

   a. Remove the window from the test fixure.

   b. Refer to Figure 15-4 and locate the Voltage/Current configuration jumpers and the Sense Jumpers on the test fixure.

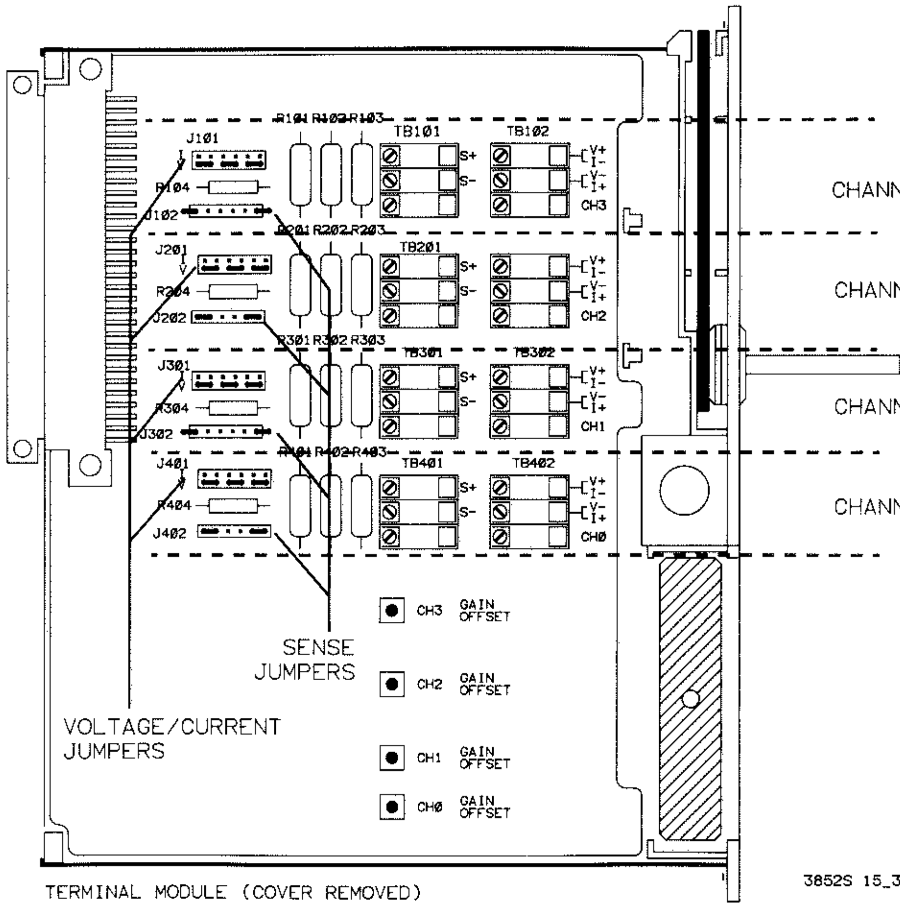


Figure 15-4 Terminal Module Jumpers

   b. Configure the test fixture for each voltage channel by moving the configuration jumpers on the test fixture to the positions shown in Figure 15-5. Make sure the Sense jumpers are in the LOCAL position (and not the CAL position) as shown in the figure.

   c. Configure the test fixture for each current channel by moving the configuration jumpers on the test fixture to the positions shown in Figure 15-6. Make sure the Sense jumpers are in the CAL position (and not the LOCAL position) as shown in the figure.

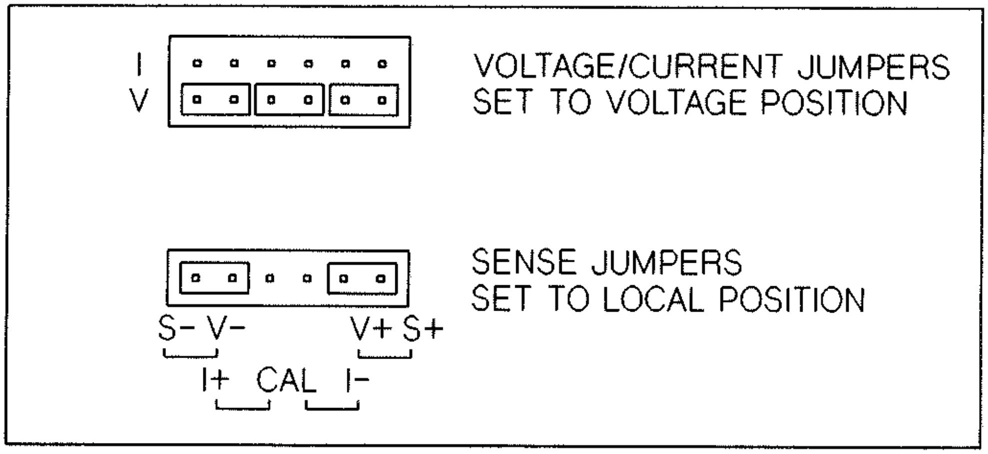


Figure 15-5 Configuration Jumpers set to Voltage/Local Positions

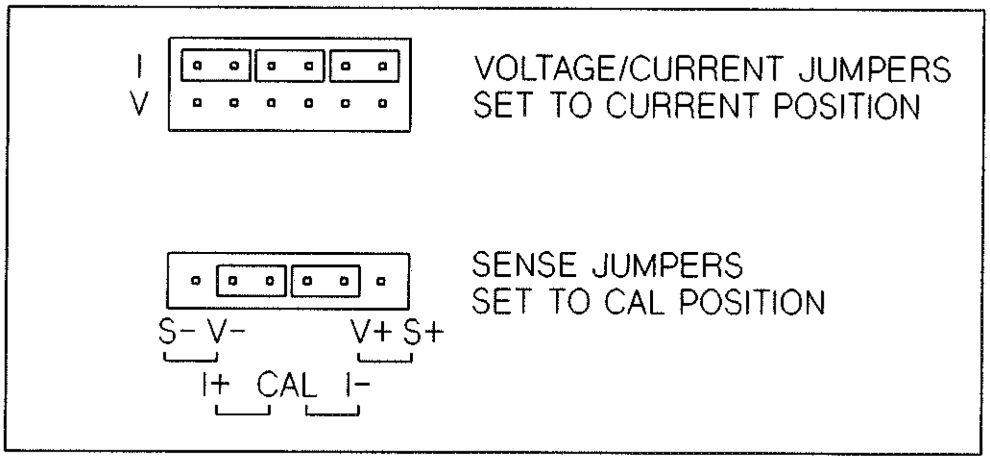


Figure 15-6 Configuration Jumpers set to Current/Cal Positions

d. Reinstall the window on the test fixture.

4. Install the test fixture on the component module. Note the slot number where the HP 44727A/B/C under test is installed.

5. Verify the slot number:

a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

b. Execute:

ID? ES00 (where E = extender number, S = slot number)

c. Verify that the HP 3852A right display shows:

44727X

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

15-23 Voltage Channel Output Test

Steps 1 through 9 in this test check both the 0 to +10.235 V and -10.235 V to +10.235 V output modes. Steps 10 through 13 includes an additional test that checks the -10.235 V to +10.235 V output mode only. Perform the following procedure only for channels configured for voltage.

NOTE

If attempting to perform voltage channel tests on channels configured for current, the HP 3852A will display an "Invalid Command for Accessory" error.

1. 0 TO +10.235 V AND -10.235 V TO +10.235 V TEST. This test checks both the 0 to +10.235 V and -10.235 V to +10.235 V output modes.

2. Set the HP 44727A/B/C channels to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

3. Set the multimeter to measure dc volts. On the test fixure, connect the multimeter DCV input to the V+ connection and connect the COM input to the V- connection of the channel to be tested. The connections are shown in Figure 15-7.

4. On the test fixure, make sure the Sense jumpers are set to the LOCAL position as shown in Figure 15-5 or 15-7.

5. Output 0 V by executing:

APPLY DCV ESXX,0 (where E = extender number, S = slot number, XX = channel)

6. Observe the indication on the multimeter. The multimeter should indicate 0.00000 ±.0025 volts.

7. Output +10 V by executing:

APPLY DCV ESXX,10 (where E = extender number, S = slot number, XX = channel)

8. Observe the indication on the multimeter. The multimeter should indicate +10.00000 ±.0075 volts.

9. Repeat steps 5, 6, 7, and 8 for other channels configured for voltage. If any reading in steps 6 and 8 are out of tolerance, calibration of the channel may be necessary. The calibration procedures are in Section 15-32.

10. -10.235 V TO +10.235 V TEST. Steps 9 through 12 is for the -10.235 V to +10.235 V output mode only.

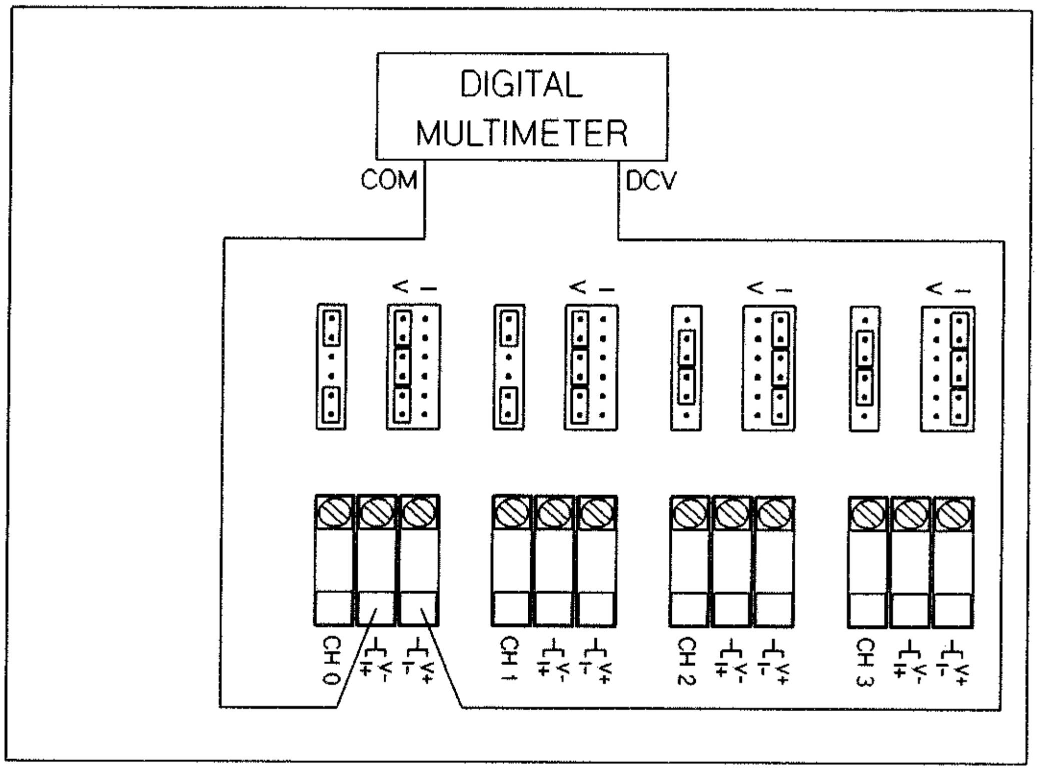


Figure 15-7 HP 44727A/B/C Voltage Channel Test

11. Output -10 V by executing:

APPLY DCV ESXX,-10 (where E = extender number, S = slot number, XX = channel)

12. Observe the indication on the multimeter. The multimeter should indicate -10.00000 ±.0075 volts.

13. Repeat steps 11 and 12 for other channels configured for voltage. If any reading in step 12 is out of tolerance, calibration of the channel may be necessary. The calibration procedures are in Section 15-32.

15-24 Current Channel Output Test

This test checks both the 0 to +20.16 mA and +4 mA to +20.16 mA output modes. Perform the following procedure only for channels configured for current.

NOTE

If attempting to perform current channel tests on channels configured for voltage, the HP 3852A will display an "Invalid Command for Accessory" error.

1. Set the HP 44727A/B/C channels to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

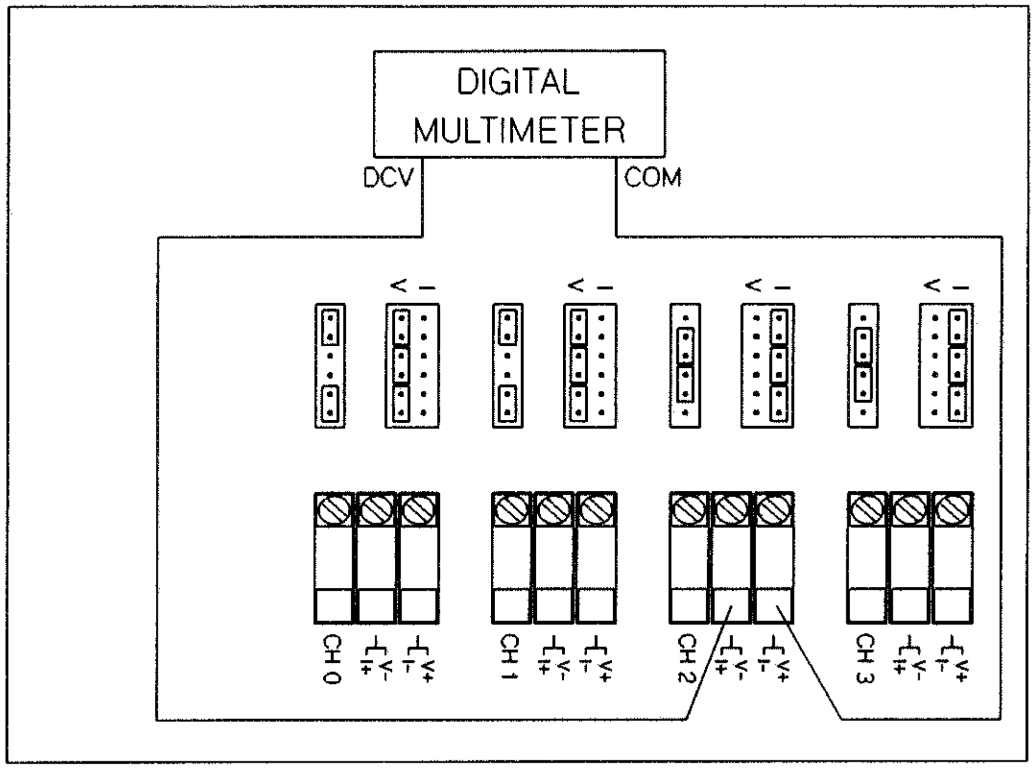


Figure 15-8 HP 44727A/B/C Current Channel Test

2. Set the multimeter to measure dc volts. On the test fixure, connect the multimeter DCV input to the I+ connection and connect the COM input to the I- connection of the channel to be tested. The connections are shown in Figure 15-8.

3. On the test fixure, make sure the Sense jumpers are set to the CAL position as shown in Figure 15-6 or 15-8.

4. Output 4 mA by executing:

APPLY DCI ESXX,.004 (where E = extender number, S = slot number, XX = channel)

5. Observe the indication on the multimeter. The multimeter is reading the voltage across the 250 ohm calibration resistor. It should be +1.00000 ±.002 volts.

6. Output +20 mA by executing:

APPLY DCI ESXX,.02 (where E = extender number, S = slot number, XX = channel)

7. Observe the indication on the multimeter. The multimeter should indicate +5.00000 ±.004 volts.

8. Repeat steps 4, 5, 6, and 7 for other channels configured for current. If any reading in steps 5 and 7 are out of tolerance, calibration of the channel may be necessary. The calibration procedures are in Section 15-32.

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44727A/B/C PERFORMANCE TESTS.

15-25 Voltage Channel Tests

Perform the following test procedures only for channels configured for voltage.

NOTE

If attempting to perform voltage channel tests on channels configured for current, the HP 3852A will display an "Invalid Command for Accessory" error.

15-26 Maximum Current and Full Load Test. This test checks the maximum output current and full load capabilities of channels configured for voltage.

1. Perform the setup procedure in Section 15-22.

2. Set the multimeter to measure dc volts. On the test fixure, connect the multimeter DCV input to the V+ connection and connect the COM input to the V- connection of the channel to be tested. Connect a 500 ohm resistor across the channel's V+ and V- connections. The connections are shown in Figure 15-9.

3. Output +10 V by executing:

   APPLY DCV ESXX,10 (where E = extender number, S = slot number, XX = channel)

4. Observe the indication on the multimeter. The reading should be +10.00000 ±.0081 volts. Note the reading on the multimeter.

5. Remove the 500 ohm resistor from the test fixure.

6. Observe the indication on the multimeter. The reading should not change more than±.0006 volts from the reading noted in step 4.

7. Repeat steps 1 through 6 for other channels configured for voltage.

8. Remove the resistor and multimeter from the test fixure.

15-27 RMS Noise Test. This test checks the output noise for channels configured for voltage.

1. Set the multimeter to measure ac volts. On the test fixure, connect the multimeter ACV input to the V+ connection and connect the COM input to the V- connection of the channel to be tested. The connections are shown in Figure 15-10.

2. Output +10 V by executing:

   APPLY DCV ESXX,10 (where E = extender number, S = slot number, XX = channel)

3. Observe the indication on the multimeter. It should be less than .0025 volts ac.

4. Repeat steps 1 through 3 for other channels configured for voltage.

5. Remove the multimeter from the test fixure.

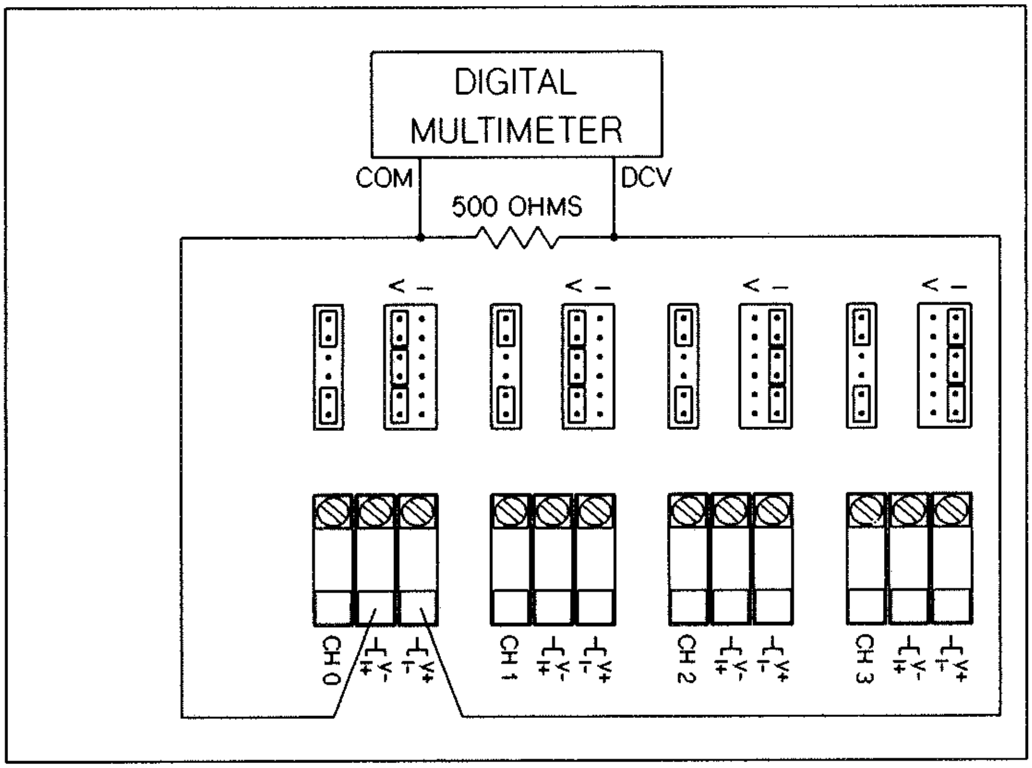


Figure 15-9 HP 44727A/B/C Maximum Current/Load Tests

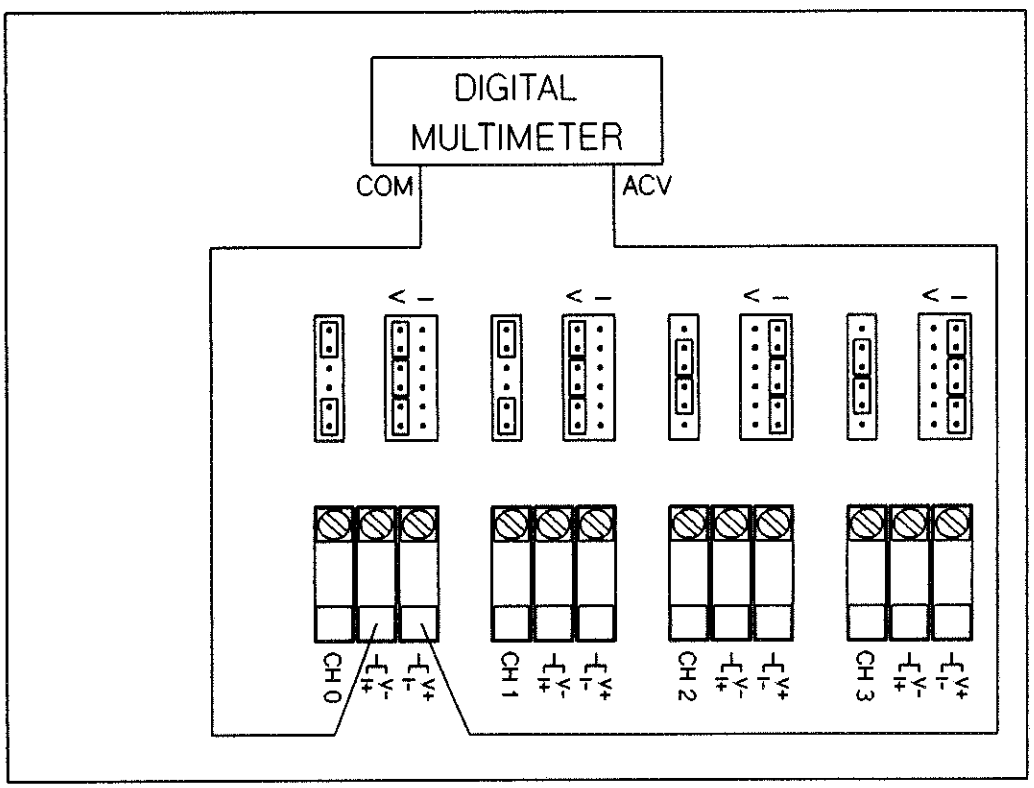


Figure 15-10 HP 44727A/B/C Voltage Noise Test

15-28 Current Channel Tests

Perform the following test procedures only for channels configured for current.

NOTE

If attempting to perform current channel tests on channels configured for voltage, the HP 3852A will display an "Invalid Command for Accessory" error.

15-29 Compliance Test. This test checks the compliance of channels configured for current.

1. Perform the setup procedure in Section 15-22, except place the Sense jumpers in the LOCAL position (and not the CAL position) as shown in Figure 15-11.

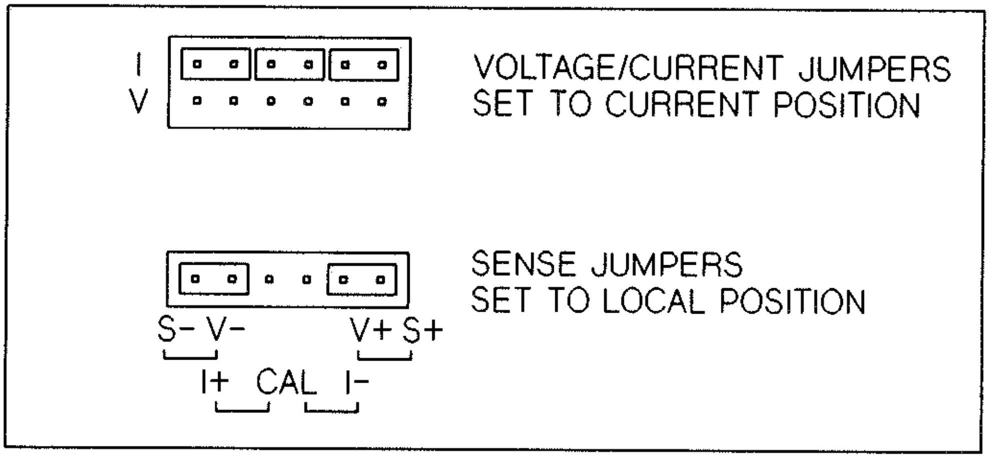


Figure 15-11 Configuration Jumpers set to Current/Local Positions

2. Set the multimeter to measure 4-wire ohms. Measure the value of a 600 to 630 ohm resistor with the multimeter. Record the value as R1.

3. Set the multimeter to measure dc volts. On the test fixture, connect the multimeter DCV input to the I+ connection and connect the COM input to the I- connection of the channel to be tested. Connect the 600 to 630 ohm resistor across the channel's I+ and I- connections. The connections are shown in Figure 15-12.

4. Set the channel to output an appropriate current value (I1) for a 12 V compliance level. Calculate the I1 current value using the following formula. (For example, for a 600 Ω resistor value, the I1 current is 0.02 A.)

$$I1 = \frac{12}{R1}$$

5. Output the I1 current by executing:

```
APPLY DCI ESXX,I1
```

(where E = extender number, S = slot number, XX = channel, I1 = current value)

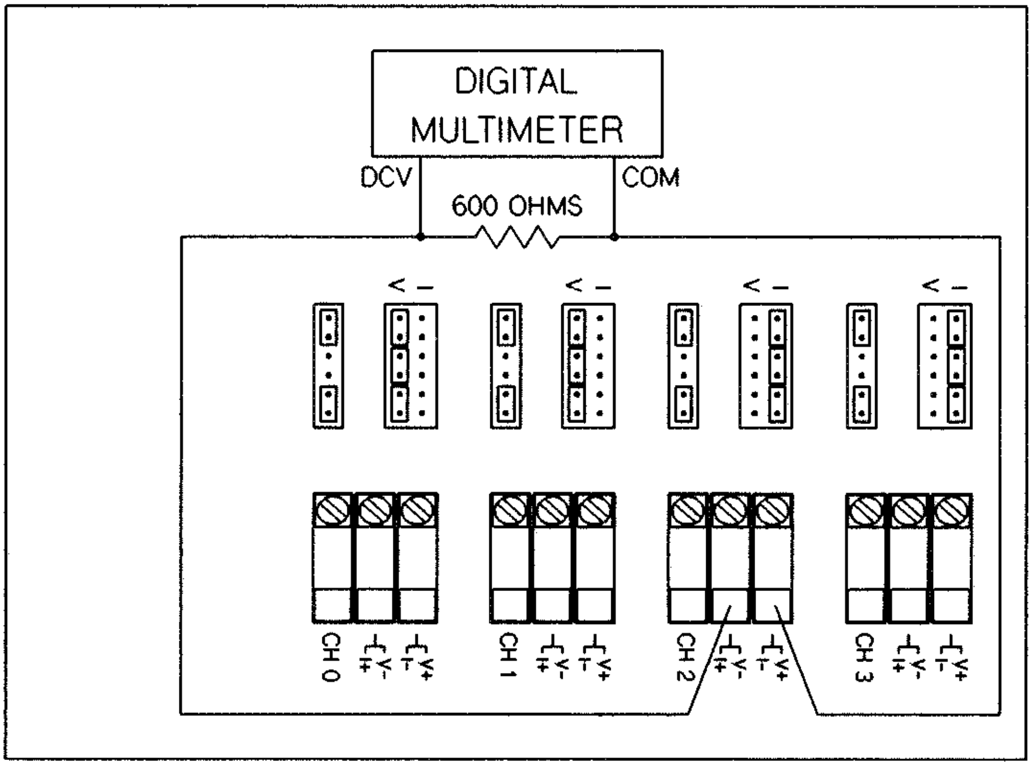


Figure 15-12 HP 44727A/B/C Current Compliance Test

6. Observe the indication on the multimeter. It should be +12.00000 ±.010 volts.

7. Repeat steps 5 and 6 for other channels configured for current.

15-30 RMS Noise Test. This test checks the output noise of channels configured for current.

1. Set the multimeter to measure ac volts. On the test fixure, connect the multimeter ACV input to the I+ connection and connect the COM input to the I- connection of the channel to be tested. Connect a 600 to 630 ohm resistor across the channel's I+ and I- connections. The connections are shown in Figure 15-13.

2. Output +20 mA by executing:

APPLY DCI ESXX,.02 (where E = extender number, S = slot number, XX = channel)

3. Observe the indication on the multimeter. It should be less than .0045 volts ac.

4. Repeat steps 1 through 3 for other channels configured for current.

5. Remove the 600 to 630 ohm resistor from the test fixure.

15-31 Load Regulation Test. This test checks the load regulation of the channels configured for current.

1. Set the multimeter to measure 4-wire ohms. Measure the value of a 125 ohm resistor with the multimeter. Record the value as R-Low.

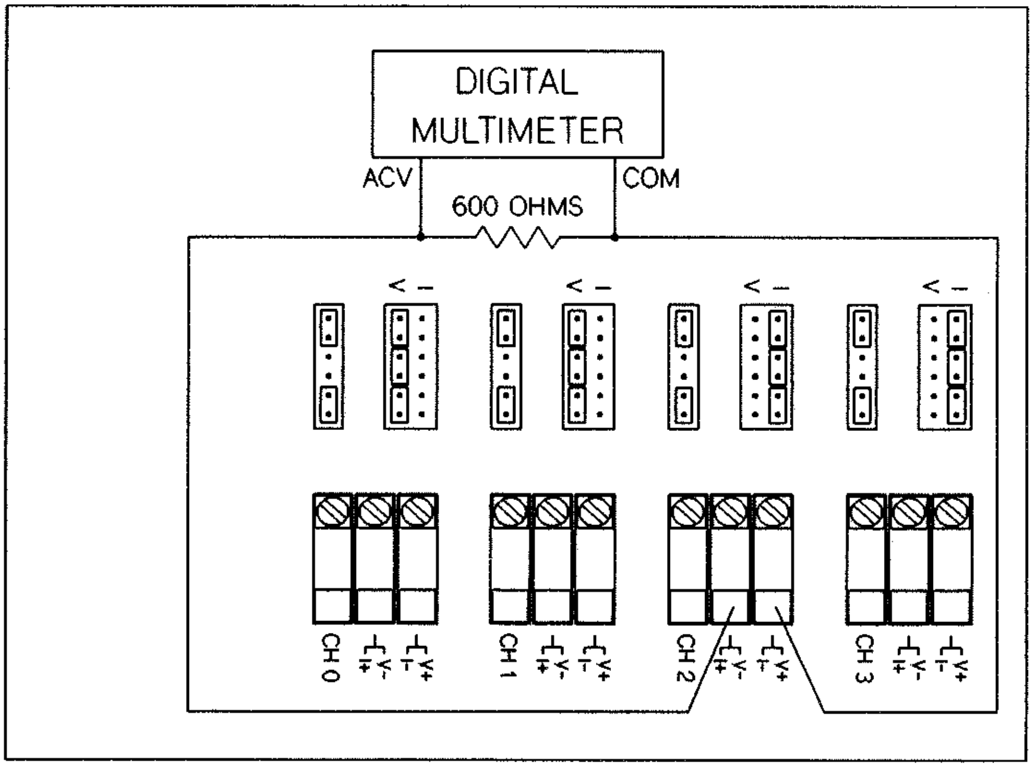


Figure 15-13 HP 44727A/B/C Current Noise Test

2. Set the multimeter to measure dc volts. On the test fixure, connect the multimeter DCV input to the I+ connection and connect the COM input to the I- connection of the channel to be tested. Connect the 125 ohm resistor across the channel's I+ and I- connections. The connections are shown in Figure 15-14.

3. Output +20 mA by executing:

APPLY DCI ESXX,.02 (where E = extender number, S = slot number, XX = channel)

4. Observe the indication on the multimeter. The reading should be approximately +2.5 volts (i.e., 20 mA * R-Low). Record the reading as V-Low.

5. Calculate the actual I-Low current by the following formula:

$$\text{I-Low} = \frac{\text{V-Low}}{\text{R-Low}}$$

6. Remove the multimeter and the 125 ohm resistor from the test fixure. Leave the channel output current at +20 mA.

7. Set the multimeter to measure 4-wire ohms. Measure the value of a 500 ohm resistor with the multimeter. Record the value as R-High.

8. Set the multimeter to measure dc volts. On the test fixure, connect the multimeter DCV input to the I+ connection and connect the COM input to the I- connection of the channel to be tested. Connect the 500 ohm resistor across the channel's I+ and I- connections. The connections are shown in Figure 15-15.

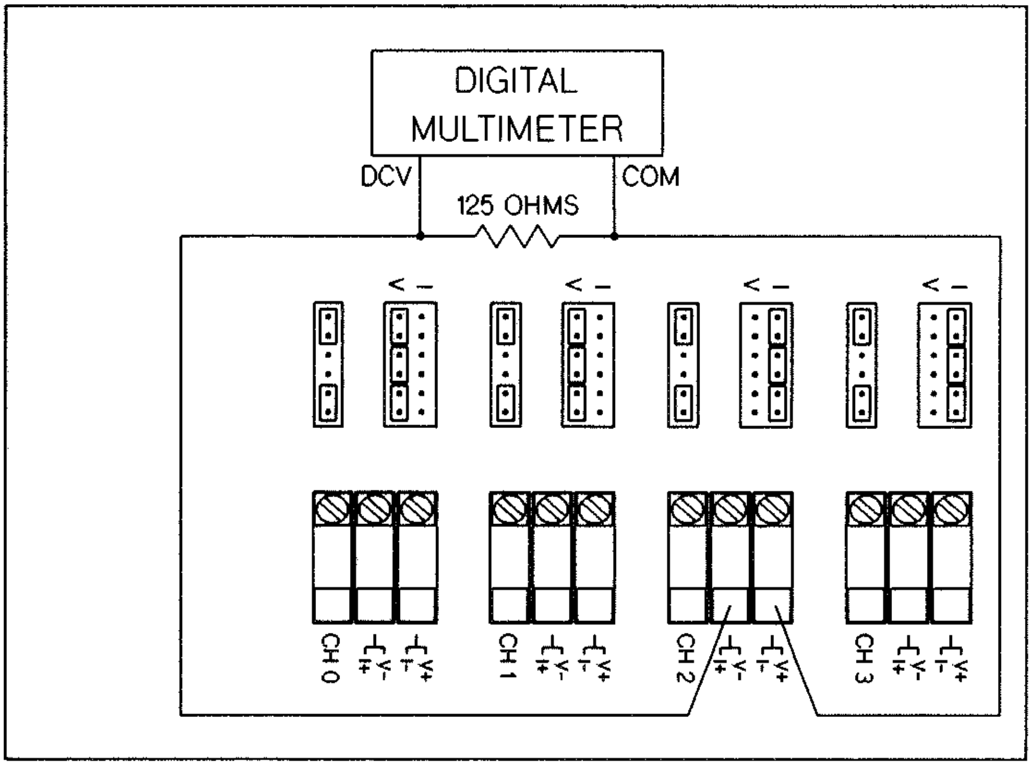


Figure 15-14 HP 44727A/B/C Load Regulation Low Connection

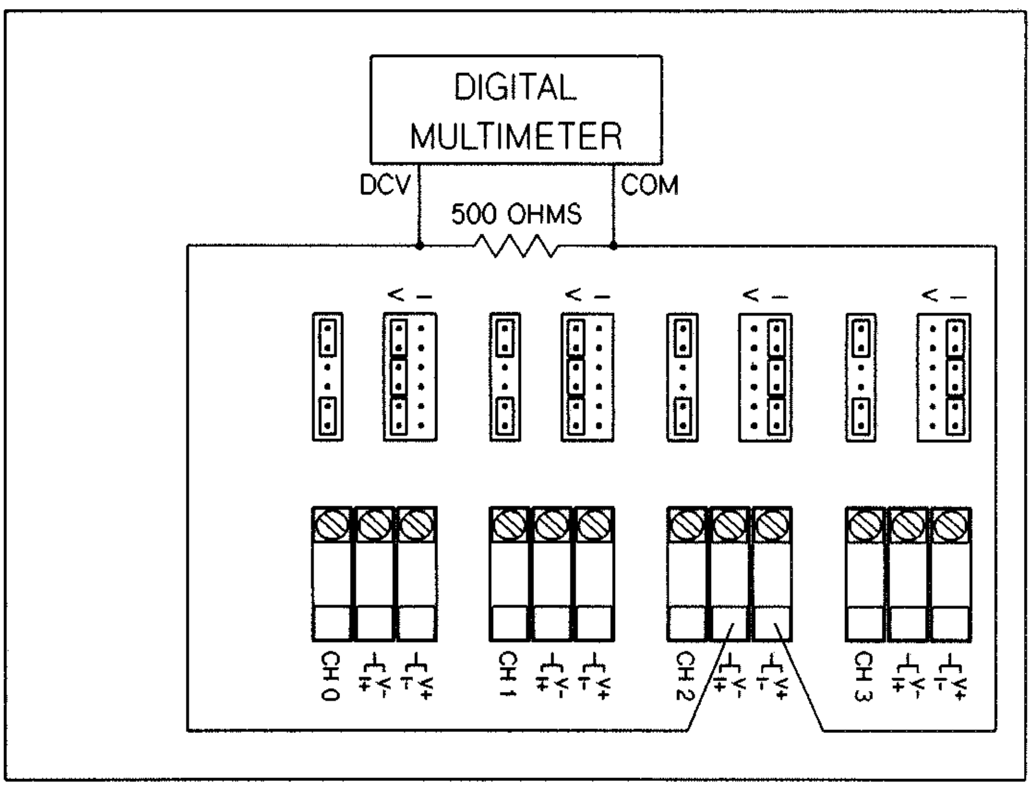


Figure 15-15 HP 44727A/B/C Load Regulation High Connection

9. Observe the indication on the multimeter. The reading should be approximately +10 volts (i.e., 20 mA * R-High). Record the reading as V-High.

10. Calculate the actual I-High current by the following formula:

$$\text{I-High} = \frac{\text{V-High}}{\text{R-High}}$$

11. The I-High current should not deviate more than ±2 μA from the I-Low current measured in step 5.

12. Repeat steps 2 through 11 for other channels configured for current.

13. Remove the resistor and multimeter from the test fixture.

15-32 HP 44727A/B/C CALIBRATION

Each channel of the HP 44727A/B/C can be calibrated for either voltage or current. To calibrate voltage channels, use the Voltage DAC Calibration procedure. To calibrate current channels, use the Current DAC Calibration procedure. The voltage channels can be calibrated in either the 0 to +10.235 V mode or the -10.235 V to +10.235 V mode. The current channels must be calibrated in the 0 to +20.16 mA mode. However, the channel can be reconfigured for the +4 mA to +20.16 mA mode after calibration, if necessary.

15-33 Equipment Required

The only test equipment required for calibration is a digital multimeter. The recommended model is the HP 3456A or equivalent.

15-34 HP 44727A/B/C Channel Configuration

The following procedures show how to determine channel configuration and how to reconfigure a channel for calibration or other uses.

Before calibrating a channel, the configuration of the channel needs to be determined. This is necessary to select the appropriate calibration procedure and to perform any needed reconfiguration of the channels.

15-35 Determining Channel Configuration

The channel configuration depends on the settings of various jumpers and switches on BOTH the terminal module and component module. It is important that both modules are configured to the same mode (i.e., voltage or current) for a particular channel. Use the following procedure to determine the configuration of the channels.

1. Remove power from the HP 3852A.

2. Remove the HP 44727A/B/C Accessory from the HP 3852A. Remove both the component module and the terminal module.

3. Remove the window on the terminal module.

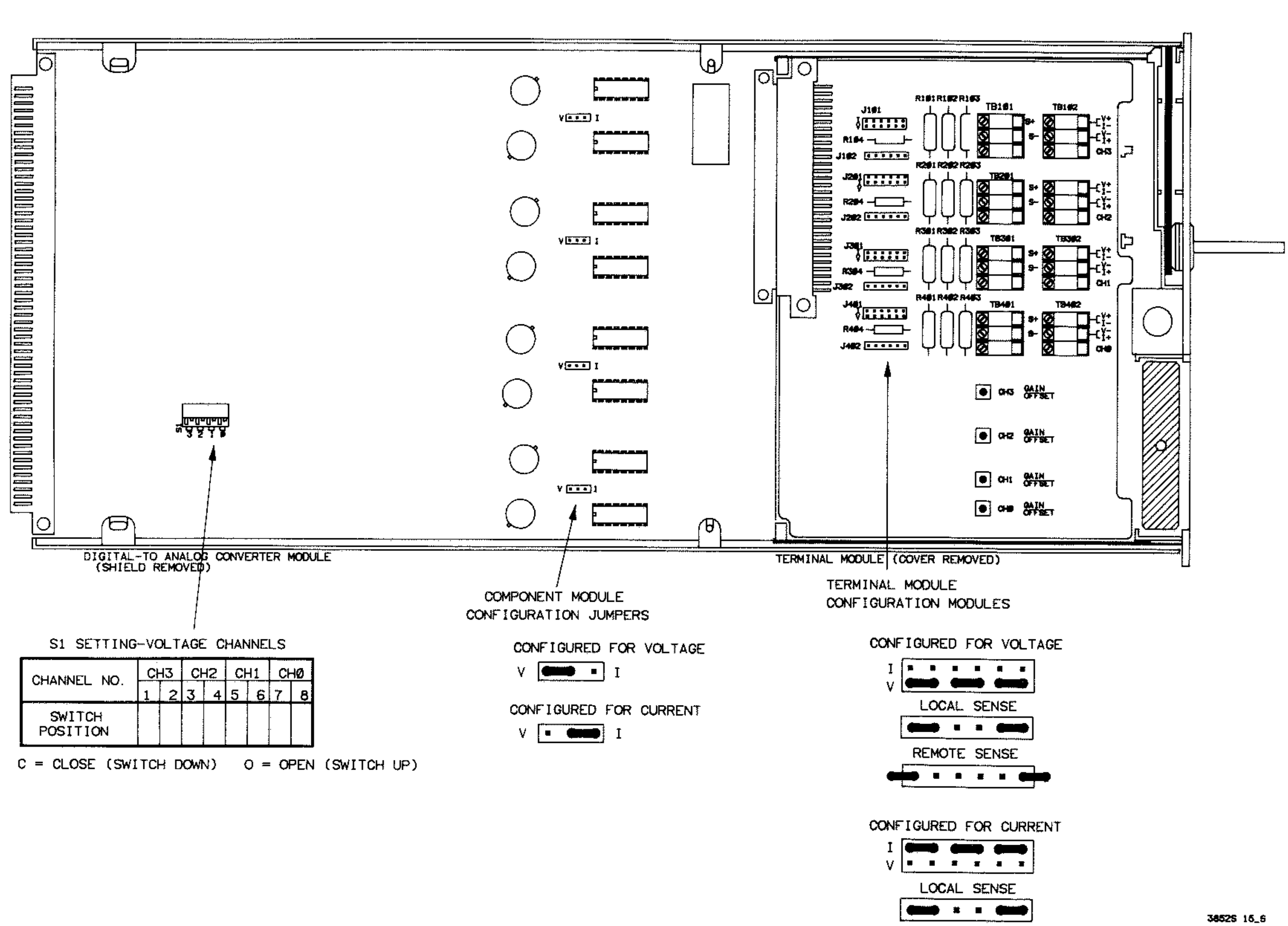
4. Remove the cover from the component module. Cover removal is accomplished by placing the module on its back and removing the four screws holding the cover in place.

5. Using Figure 15-16 as a guide, locate the configuration jumpers and switches on both the terminal module and component module. Note the settings of these jumpers and switches. This is important since the configuration jumpers and switches are normally returned to their original settings after calibration.

6. Figure 15-16 also shows the channel configurations for the different output modes. This is useful if a channel reconfiguration is desired other than for calibration. Use Table 15-5 to determine how to set the configuration switch to the four different output modes of all channels.

15-36 Setup Accessory for Calibration

The following shows how to setup the DAC accessory for calibration. Keep in mind that the +4 mA to +20.16 mA current channels need to be reconfigured to the 0 to +20.16 mA mode. The voltage channels do not need reconfiguration.



CHANNEL NO.	CH3		CH2		CH1		CHØ	
	1	2	3	4	5	6	7	8
SWITCH POSITION								

Figure 15-16 Original Switch and Jumper Configuration

Table 15-5 Configuration Switch Settings

Channel Output Modes	Switch Position Channel 3		Channel 2		Channel 1		Channel 0	
	1	2	3	4	5	6	7	8
Voltage: 0 to +10.235 V	C	C	C	C	C	C	C	C
Voltage: -10.235 V to +10.235 V	C	O	C	O	C	O	C	O
Current: 0 to +20.16 mA	O	C	O	C	O	C	O	C
Current +4 mA to +20.16 mA	O	O	O	O	O	O	O	O
C = Close (switch down) O = Open (swtich up)								

1. To calibrate a channel in the voltage mode, the jumper and switch configurations must be as shown in Figure 15-17. Reconfigure the component module/terminal module jumpers and component module switch if necessary.

2. To calibrate a channel in the current mode, the jumper and switch configurations must be as shown in Figure 15-18. Reconfigure the component module/terminal module jumpers and component module switch if necessary.

3. If calibration is to be performed outside the mainframe, continue with step 4. If calibration of the accessory is to be performed inside the mainframe, do the following:

   a. Remove power from the 3852A.

   b. Replace the cover back on the component module.

   c. Install the terminal module on the component module.

   d. Install the component module in a convenient slot in the HP 3852A mainframe. Note the slot number where the module is installed for future reference.

   e. Apply power to the 3852A. Wait long enough for the temperature on the HP 44277A/B/C accessory to stabilize.

   f. Go to the appropriate calibration procedure for calibration.

4. If calibration of the accessory is to be performed outside the mainframe, do the following:

   a. Remove power from the 3852A.

   b. Install the HP 44743A Service Module in an convenient slot in the HP 3852A mainframe. Note the slot number where the module is installed for future reference.

   c. Replace the cover back on the component module.

   d. Install the terminal module on the component module.

   e. Install the component/terminal module combination on the Service Module.

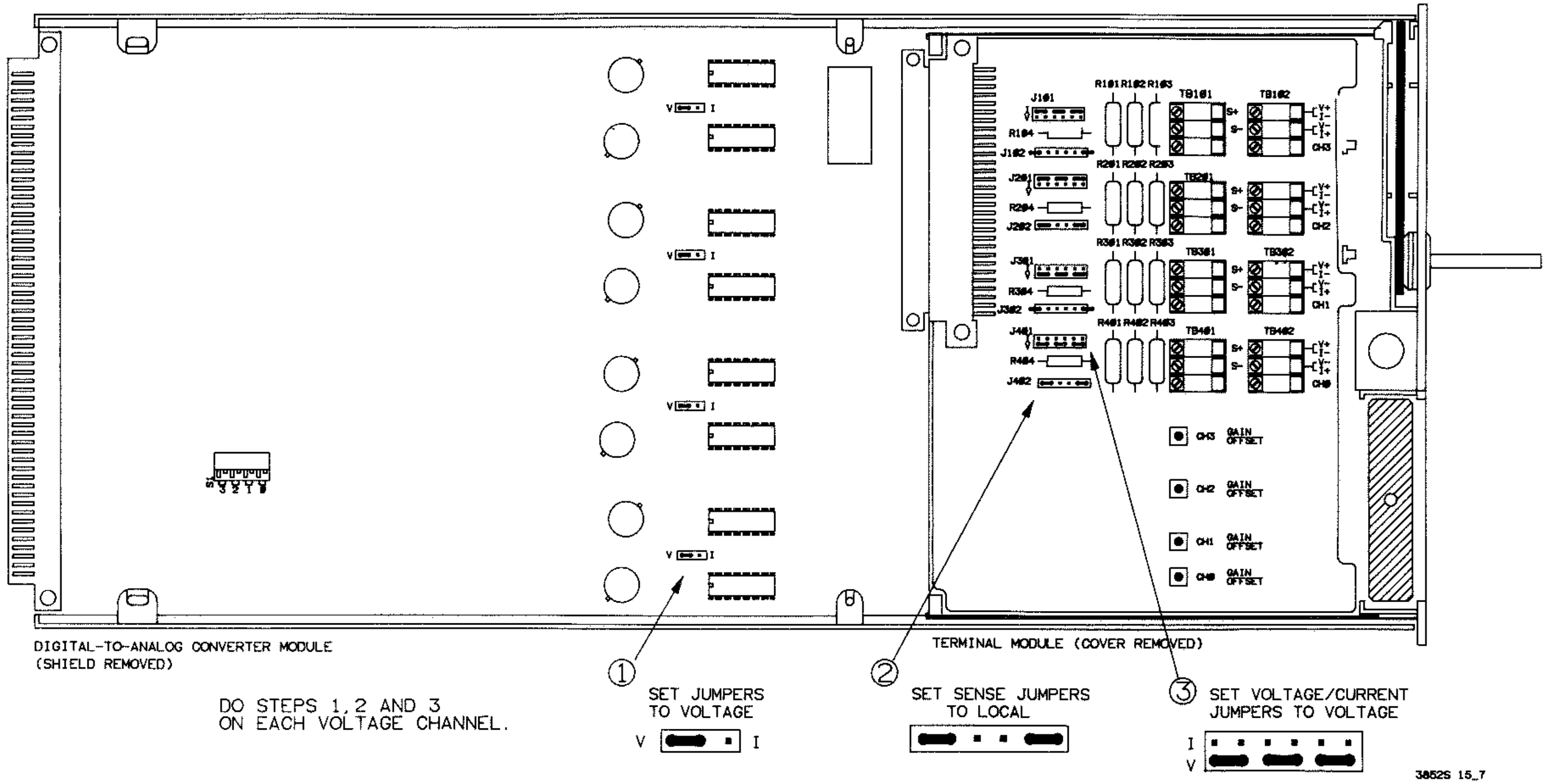


Figure 15-17 Voltage Calibration Configuration

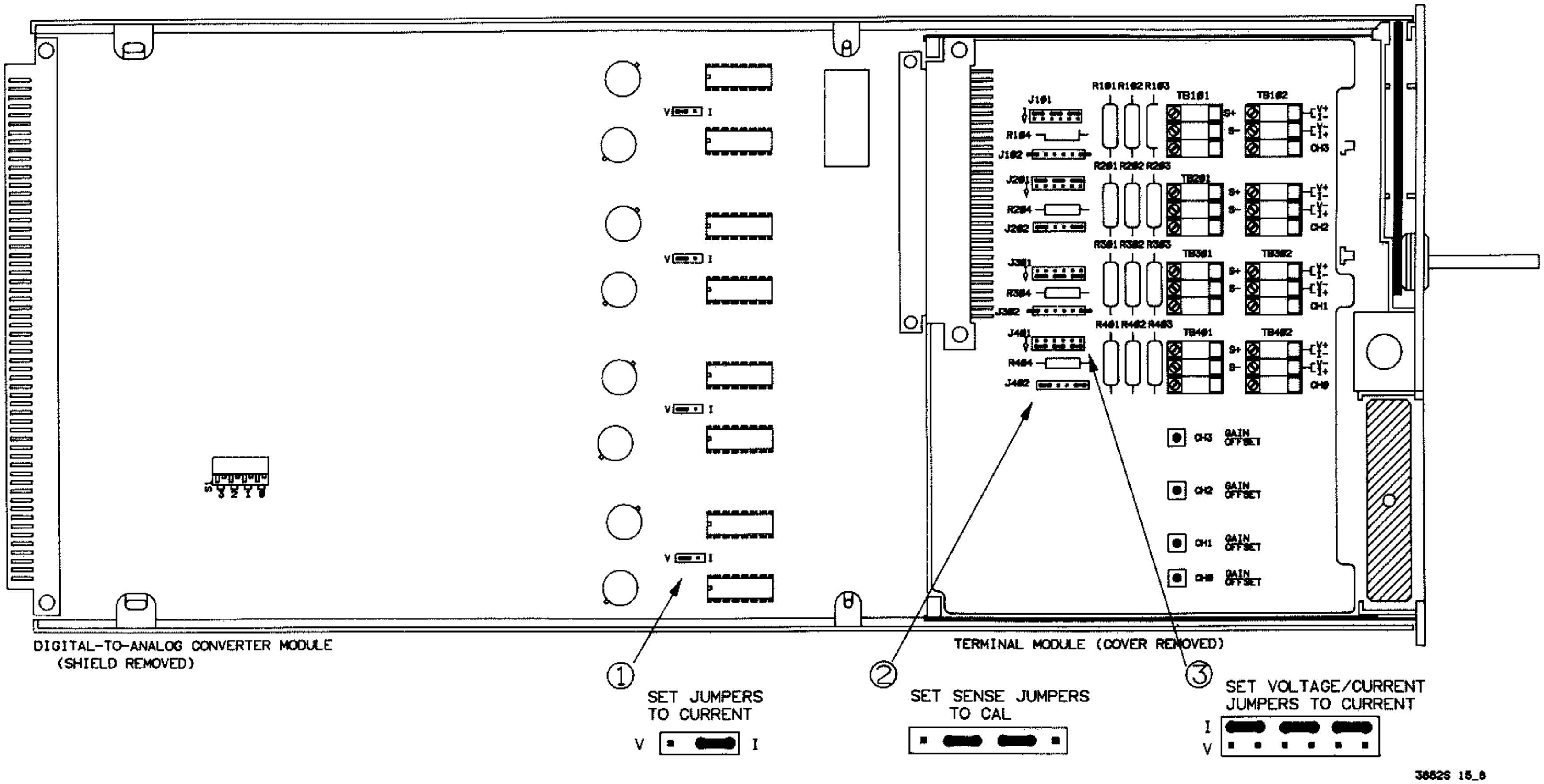


Figure 15-18 Current Calibration Configuration

f. Apply power to the 3852A. Wait long enough for the temperature on the HP 44277A/B/C accessory to stabilize.

g. Go to the appropriate calibration procedure for calibration.

15-37 Voltage DAC Calibration

Perform the following procedure only for channels configured for voltage.

NOTE

If attempting to perform voltage channel calibration on channels configured for current, the HP 3852A will display an "Invalid Command for Accessory" error.

NOTE

Make sure no external connections, other than the test equipment, is made to the channel to be calibrated or invalid calibration results may be obtained.

1. Set the HP 44727A/B/C channels to a known state by executing:

   RESET ES00 (where E = extender number, S = slot number)

2. Set the multimeter to measure dc volts. On the terminal module, connect the multimeter DCV input to the V+ connection and connect the COM input to the V- connection of the channel to be calibrated. The connections are shown in Figure 15-19.

NOTE

In Figure 15-19, Channels 0 and 1 are configured for voltage, and Channels 2 and 3 are configured for current. Use Channels 0 and 1 jumper configuration for voltage calibration

3. Output 0 V by executing:

   APPLY DCV ESXX,0 (where E = extender number, S = slot number, XX = channel)

4. Adjust the OFFSET potentiometer on the channel being calibrated for a 0.00000 volts reading on the multimeter. A special tool is provided to easily access the potentiometer from the terminal module. Guide the adjustment tool on top of the test point in the terminal module for the specific channel being calibrated. The OFFSET potentiometer is the lower of the two potentiometers as shown in Figure 15-20.

5. Output +10 V by executing:

   APPLY DCV ESXX,10 (where E = extender number, S = slot number, XX = channel)

6. Adjust the GAIN potentiometer on the channel being calibrated for a +10.00000 volts reading on the multimeter. The GAIN potentiometer is the upper of the two potentiometers as shown in Figure 15-20.

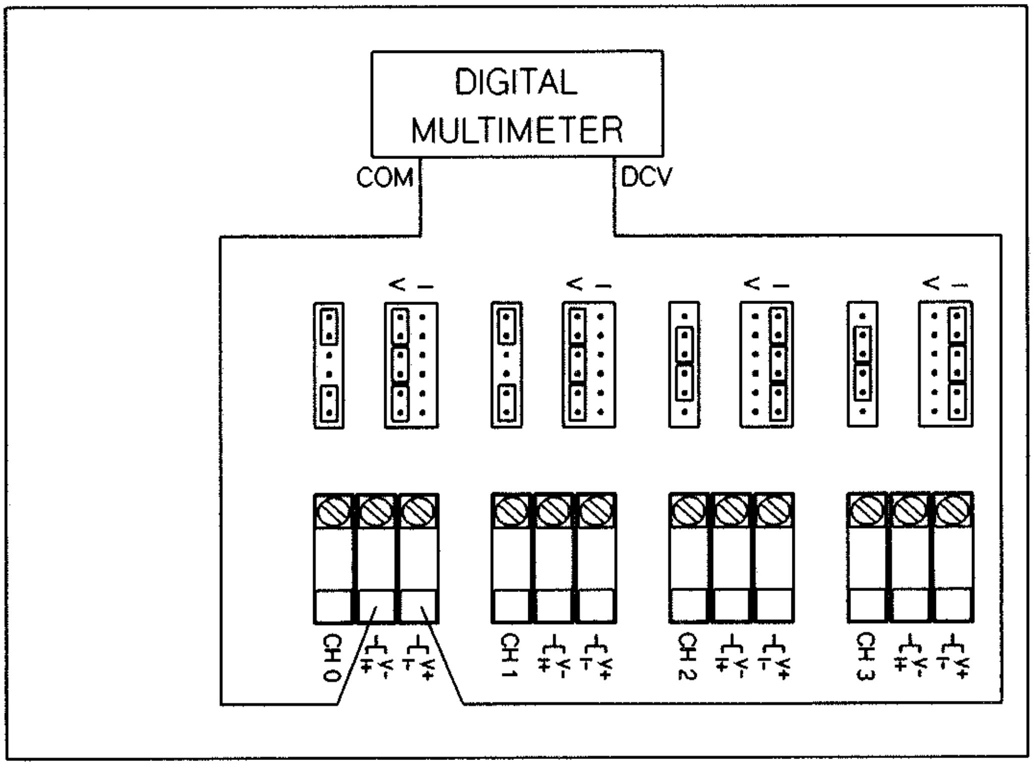


Figure 15-19 Voltage Calibration Connections

7. Repeat steps 2 through 6 for other channels configured for voltage.

8. Return the voltage channels to the original configuration noted in Figure 15-16, if necessary.

15-38 Current DAC Calibration

Perform the following procedure only for channels configured for Current.

NOTE

If attempting to perform current channel calibration on channels configured for voltage, the HP 3852A will display an "Invalid Command for Accessory" error.

NOTE

Make sure no external connections, other than the test equipment, is made to the channel to be calibrated or invalid calibration results may be obtained.

1. Set the HP 44727A/B/C channels to a known state by executing:

   RESET ES00 (where E = extender number, S = slot number)

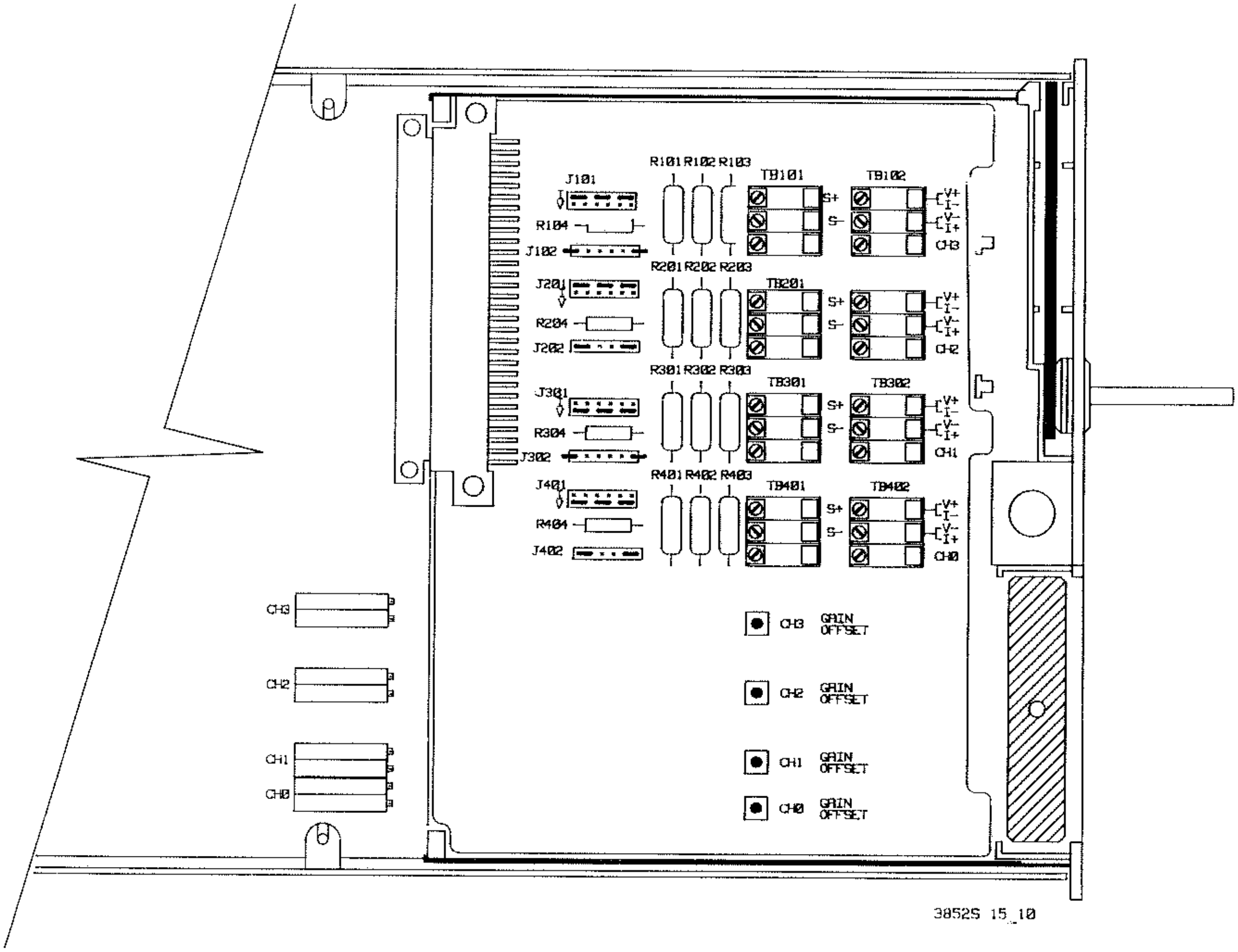


Figure 15-20 Calibration Potentiometer Locations

2. Set the multimeter to measure dc volts. On the terminal module, connect the multimeter DCV input to the I+ connection and connect the COM input to the I- connection of the channel to be calibrated. With these connections and the Sense jumpers on the terminal module set in the CAL position, the multimeter measures across a 250 ohm calibration resistor. The resistor is used in conjunction with the multimeter to calibrate the current output. The connections are shown in Figure 15-21.

NOTE

In Figure 15-21, Channels 2 and 3 are configured for current, and Channels 0 and 2 are configured for voltage. Use Channels 2 and 3 jumper configuration for current calibration

3. Output 0 mA by executing:

APPLY DCI ESXX,0 (where E = extender number, S = slot number, XX = channel)

4. Adjust the OFFSET potentiometer on the channel being calibrated for a 0.00000 volts reading on the multimeter. A special tool is provided to easily access the potentiometer from the terminal module. Guide the adjustment tool on top of the test point in the terminal module for the specific channel being calibrated. The OFFSET potentiometer is the lower of the two potentiometers as shown in Figure 15-20.

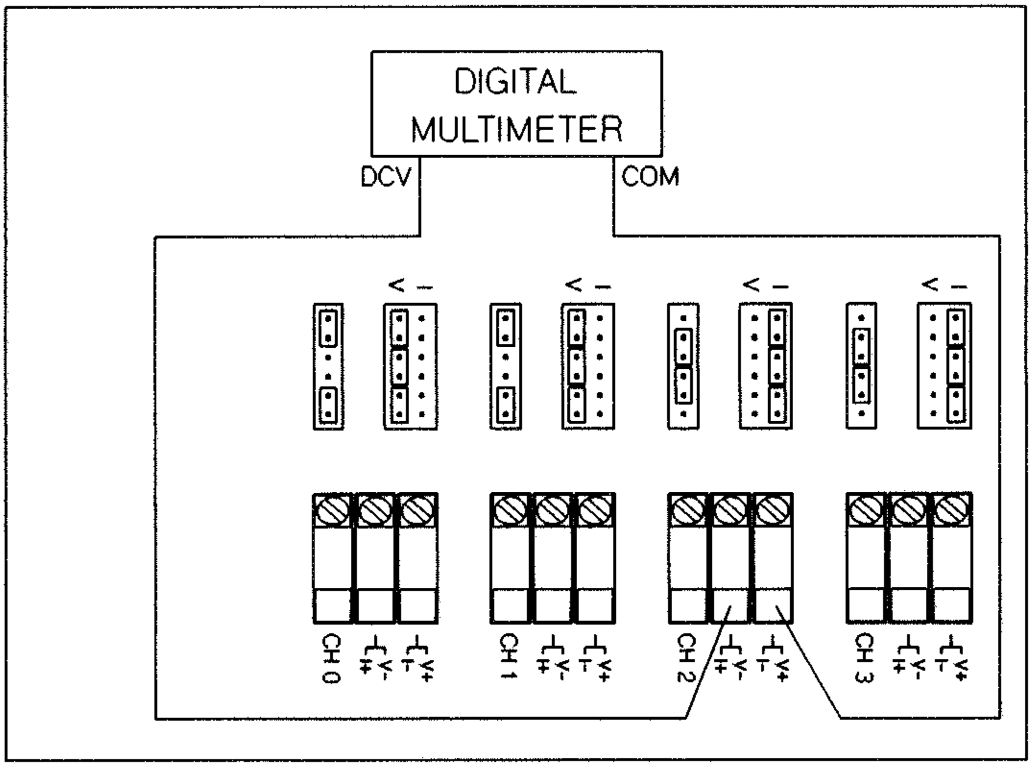


Figure 15-21 Current Calibration Connections

5. Output +20 mA by executing:

   APPLY DCI ESXX,.02 (where E = extender number, S = slot number, XX = channel)

6. Adjust the GAIN potentiometer on the channel being calibrated for a +5.00000 volts reading on the multimeter. The GAIN potentiometer is the upper of the two potentiometers as shown in Figure 15-20.

7. Repeat steps 2 through 6 for other channels configured for current.

8. Return the current channels to the original configuration noted in Figure 15-16, if necessary.

15-39 REPLACEABLE PARTS

Figure 15-22 shows the mechanical breakdown of the HP44727A/B/C. The figure also provides the disassembly information. The parts shown in Figure 15-22 are keyed to the parts lists in Table 15-6.

To order a part listed in Table 15-6, quote the Hewlett-Packard part number, the quantity desired, the HP factory reference, and the check digit (abbreviated CD). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board for the HP 44727A/B/C is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

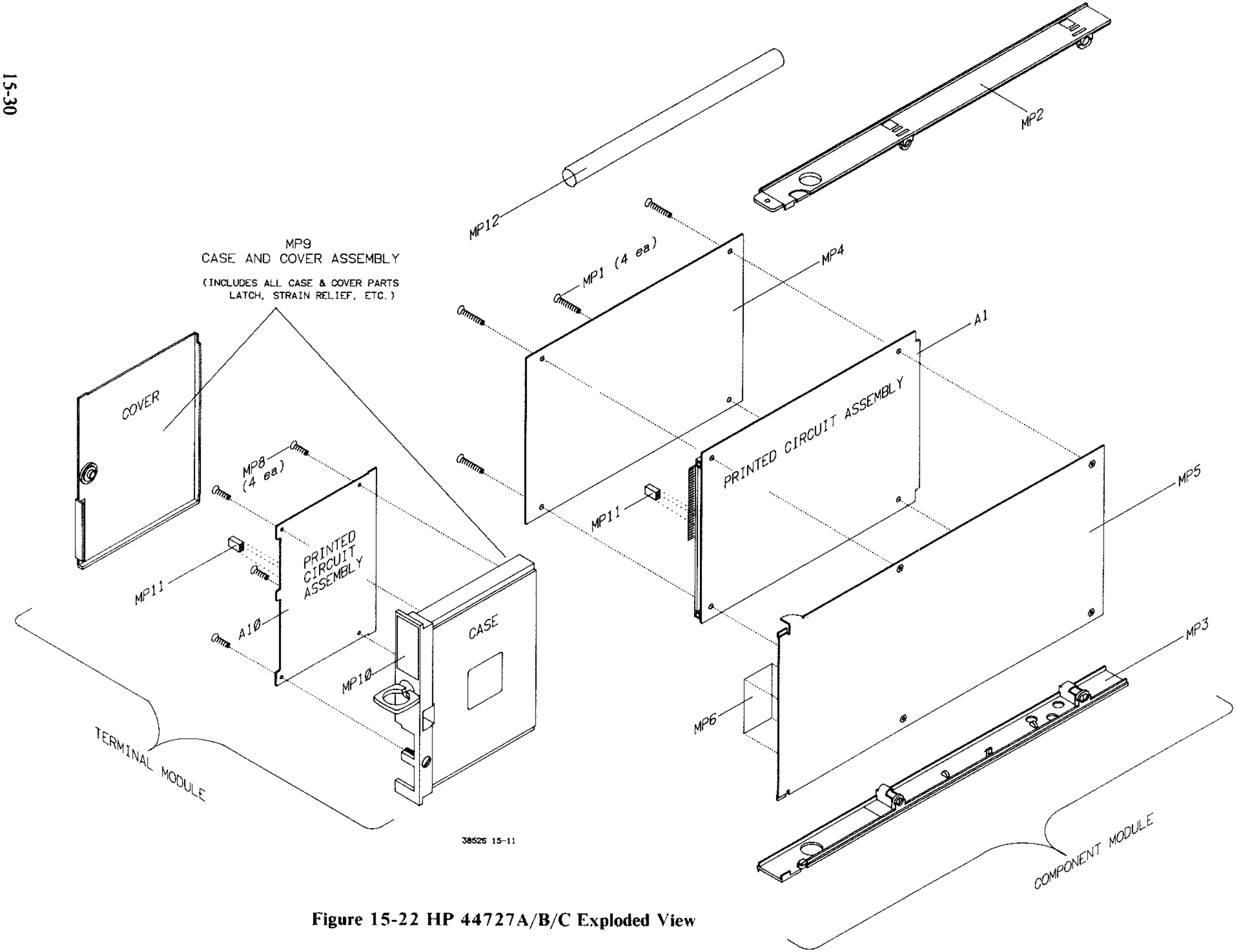


Figure 15-22 HP 44727A/B/C Exploded View

Table 15-6 HP 44727A/B/C 4 Channel Voltage/Current DAC

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44727A	Module; 4ch V/I DAC (configured: 4V)	1	44727-66201	7	MOD-DAC:4CH-VOLT
44727B	Module; 4ch V/I DAC (configured: 4I)	1	44727-66202	8	MOD-DAC:4CH-CURR
44727C	Module; 4ch V/I DAC (configrd:2V&2I)	1	44727-66203	9	MOD-DAC:2-V;2-I
A1	PCA; 4ch V/I DAC compnt (confgrd:4V)	1	44727-66501	1	PCA-DAC:4CH-VOLT
	PCA; 4ch V/I DAC compnt (confgrd:4I)	1	44727-66502	0	PCA-DAC:4CH-CURR
	PCA; 4ch V/I DAC cmp (confgrd:2V&2I)	1	44727-66503	2	PCA-DAC:2-V;2-I
A10	PCA; 4ch V/I DAC term (configrd: 4V)	1	44727-66510	1	PCA-DAC TERM:4-V
	PCA; 4ch V/I DAC term (configrd: 4I)	1	44727-66511	1	PCA-DAC TERM:4-I
	PCA; 4ch V/I DAC trm (confgrd:2V&2I)	1	44727-66512	1	PCA-DACTERM:2V2I
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44727A/B/C component module	1	44727-84320	9	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear pnl of term mod 44727ABC	1	44727-84325	4	LBL-ID,TERM ASSY
MP11	Jumper; removable, A1/A10 PCA	24	1258-0141	8	JMPR-REM .025P
MP12	Tool; calibration	1	8730-0011	0	TOOL-TUNING

Completely assembled HP 44727A, B, or C terminal modules can be ordered from your local HP Office by ordering Number 44727AT, 44727BT, or 44727CT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44727A	Module; 4ch V/I DAC (configured: 4V)		44727-69201	3	RBLT-44727-66201
44727B	(use reconfigured & recal'd 44727A)		44727-69201	3	RBLT-44727-66201
44727C	(use reconfigured & recal'd 44727A)		44727-69201	3	RBLT-44727-66201

Chapter 16
HP 44728A 8 Channel Relay
Actuator

CHAPTER 16
HP 44728A 8 CHANNEL RELAY ACTUATOR

CHAPTER 16
HP 44728A
8 CHANNEL RELAY ACTUATOR

16-1 INTRODUCTION

This chapter provides a technical description, a performance test procedure, relay troubleshooting procedures, and a replaceable parts list for the HP 44728A 8 Channel Relay Actuator.

16-2 Technical Description

The HP 44728A 8 Channel Relay Actuator is designed to switch moderate to high levels of voltage and current. The relays used are single-pole double-throw (SPDT) form C relays with normally open and normally closed contacts. The relays are not latching relays and return to the normally closed position after a reset, if power is removed, or following an OPEN command.

A block diagram of the HP 44728A is shown in Figure 16-1. Only two of the eight channels are shown in the diagram. The HP 44728A is made up of two main assemblies: a component module and a terminal module. The component module contains the backplane interface electronics, the channel relay drivers, the channel relays, and protection circuitry. The terminal module contains terminal blocks for connection to external wiring.

A varistor and a capacitor are used to protect each set of relay contacts from transients during switching. Each common connection of the relay is fused.

16-3 Read and Write Registers

The HP 3852A communicates with each plug-in accessory by using read and write registers. High level commands are translated into appropriate register commands. The SREAD and SWRITE commands can be used to directly control each register.

SREAD and SWRITE are described in Chapter 2 of this manual. Table 16-1 shows the registers used by the HP 44728A accessory.

CAUTION

Using the primitive commands (SREAD and SWRITE) may cause unexpected and undesirable effects on the plug-in accessory. It is possible to program some plug-in accessories into illegal ant potentially damaging states with these commands. The commands are documented here for service purposes only.

16-4 Read Registers

16-5 Register 0. Read Register 0 contains the accessory identification. Eight bits are used to uniquely identify the accessory. The eight bits are output on the lower eight bits of the backplane data bus.

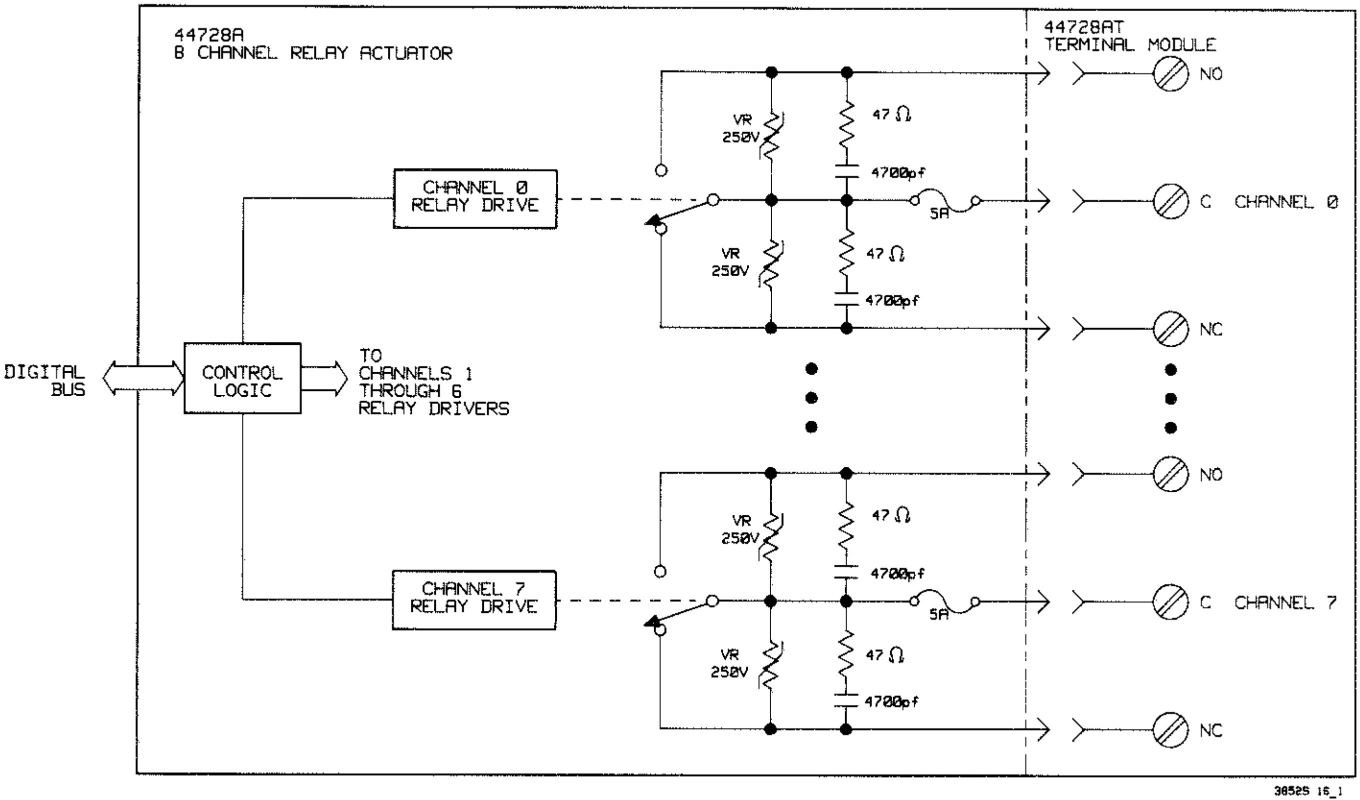


Figure 16-1 HP 44728A Block Diagram

Table 16-1 8 Channel Relay Actuator Read and Write Registers

Register #	READ Registers	WRITE Registers
0	Accessory Identification	Accessory Reset
1	Always -239	Not Used
2	Not Used	Not used
3	Channels 0 through 7	Channels 0 through 7

The eight bit identification is in two parts. The five most significant bits identify the component module and the three least significant bits identify the type of terminal module installed. If a terminal module is not present, the lower three bits are set high by the component module. The HP 3852A local controller can thus identify the type of plug-in accessory installed and determine if a terminal module is installed.

Table 16-2 lists the decimal equivalent codes returned in response to an SREAD of Register 0.

16-6 Register 1. Read Register 1 is a hardwired register and will always return a decimal value of -239 in response to an SREAD.

Table 16-2 HP 44728A Identification Codes

Module Combinations	Codes
HP 44728A Component Module (no terminal module installed)	-209
HP 44728A Component Module, HP 44728AT Terminal Module installed	-214

16-7 Register 3. Read Register 3 is the status register. The register contains an eight bit status word, representing the last programmed state of the channel switches. The bits in the status word correspond one-to-one with the channel numbers (i.e., bit 7 represents channel 7). Figure 16-2 is an example of the status word. In the figure, it is presumed that channel 7 is closed.

```
Bits:       7  6  5  4  3  2  1  0
Bit Value:  1  0  0  0  0  0  0  0
```

Figure 16-2 Read Register 3

NOTE

The decimal number returned after the execution of an SREAD command represents the two's compliment of the status word.

16-8 Write Registers

16-9 Register 0. Write Register 0 is the accessory reset register. Any data written to this register will cause a reset of the accessory and force all the channel switches open. A write to Register 0 has the same effect as a backplane accessory reset.

16-10 Register 3. Register 3 is the control register. An eight bit word is used to control the status of the channel switches. The bits in the command word correspond one-to-one to the channel number (i.e., setting bit 7 closes channel 7). Figure 16-3 is an example of the command word. In the figure, it is presumed that channel 7 is to be closed.

```
Bits:       7  6  5  4  3  2  1  0
Bit Value:  1  0  0  0  0  0  0  0
```

Figure 16-3 Command Word

16-11 SPECIFICATIONS

Specifications for the HP 44728A are given in Table 16-3. Specifications are the performance standards or limits against which the accessory may be tested.

Table 16-3 HP 44728A Specifications

Maximum Input Voltage (Vmax) per channel: 300 V DC or
250 V RMS

Maximum Input Current: 2 A DC, 3 A RMS per channel
(5 A fuse protection)

Maximum Sum of the Squared RMS Currents in Each Channel (per module; for any type load): 26 A^2

Closed Channel Path Resistance: 500 mΩ

Switch Life: At Full Load, 10^5

Maximum Input Power per channel: 60 W DC (Vmax <=30 V DC)
45 W DC (Vmax >30 V DC)
750 VA RMS

Maximum Snubber Circuit Leakage: 1 mA per channel @ 250 V RMS

Maximum Wire Size: 14 AWG

16-12 PERFORMANCE TEST

16-13 Introduction

The following Performance Test checks the operation of the HP 44728A component module. Performance Tests are not given for the terminal modules. Successful completion of the test in this chapter provides a high confidence level that the Relay Actuator is meeting its listed specifications.

16-14 Equipment Required

The following test equipment is required to run the Performance Test.

1. Test Fixture (as described in Section 16-15)

2. Digital Multimeter -- HP 3456A or equivalent

3. Test Leads and Jumpers

4. Service Module -- HP 44743A

NOTE

Either of the accessory plug-in voltmeters (HP 44701A or HP 44702A/B) may be used for this test. This test does not describe the specific steps required to use the plug-in voltmeters. A description of the plug-in voltmeters can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

16-15 Test Fixture

A test fixture is required to run the Performance Test. A schematic of the required test fixture is shown in Figure 16-4a. A test fixture can be manufactured using an HP 44728AT terminal module (see Figure 16-4b). Because wiring the test fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

If the test fixture is to be fabricated from other than an HP 44728AT terminal module, it is important that the terminal ID lines, shown in Figure 16-4a, be correctly wired. The HP 3852A local controller will not allow the execution of some commands with an incorrect terminal ID.

The test fixture consists of: a short circuit between all channel NC (Normally Closed) lines, a short circuit between all channel NO (Normally Open) lines, and a short circuit between all channel C (Common) lines. The use of the test fixture minimizes the number of test lead connections required for the tests.

16-16 Test Procedure

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

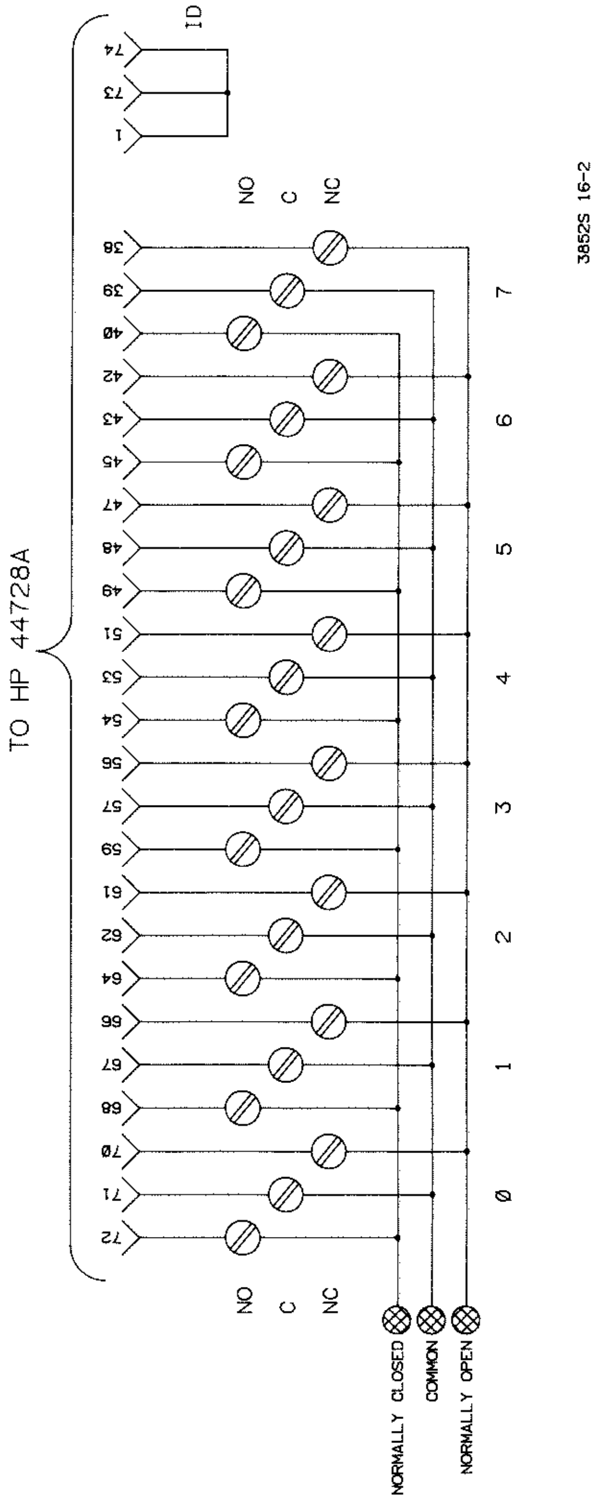


Figure 16-4a HP 44728A Test Fixture Schematic

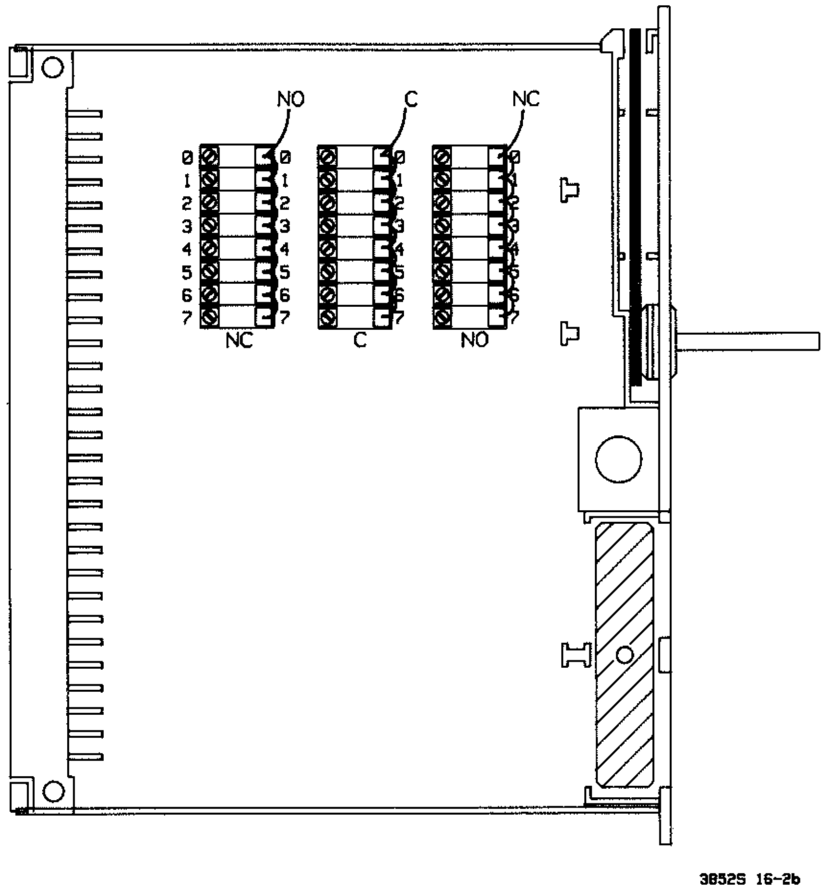


Figure 16-4b HP 44728A Test Fixure

16-17 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the Relay Actuator component module and install the test fixture. Note the slot number where the Relay Actuator under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

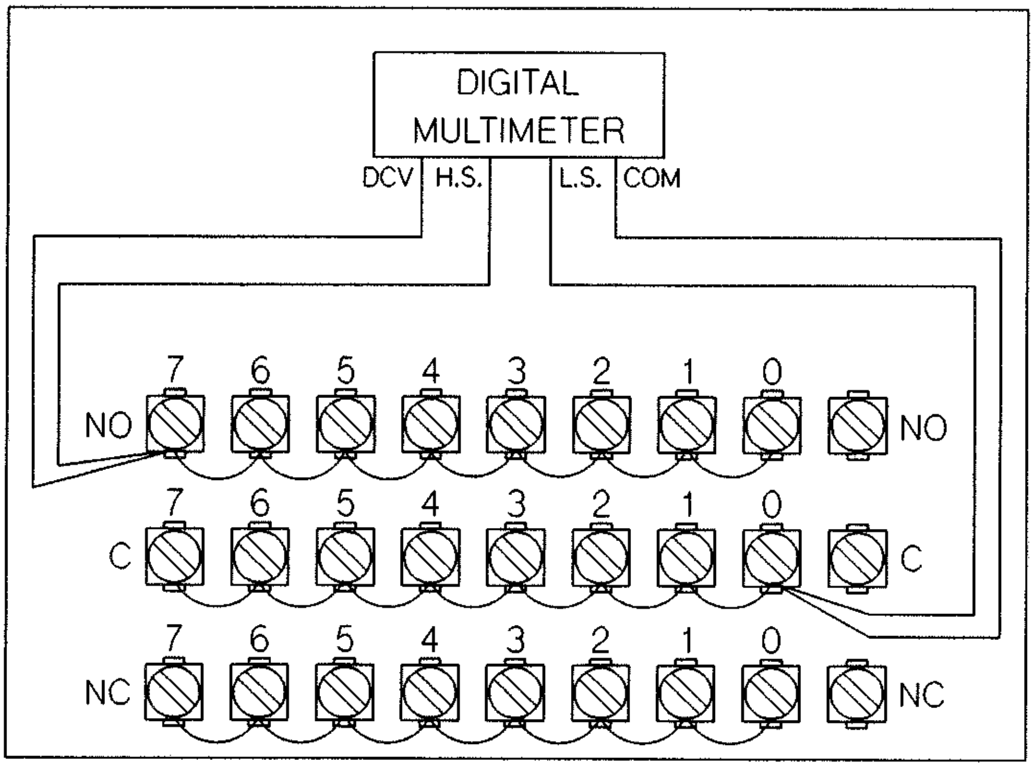


Figure 16-5 HP 44728A NO Channels Contact Resistance Test

c. Verify that the HP 3852A right display shows:

44728

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

16-18 Contact Resistance Test

1. NORMALLY OPEN CONTACT RESISTANCE TEST: This test checks the contact resistance of the normally open relay contacts. Since these contacts are normally open, a CLOSE command closes the contacts and an OPEN command opens the contacts.

2. Set all HP 44728A channel relays to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

3. Set the multimeter to measure four-wire ohms. Connect the multimeter DCV input and high SENSE leads to the NO (Normally Open) connection on the test fixture. Connect the multimeter COM input and low SENSE leads to the C (Common) connection on the test fixture. The connections are shown in Figure 16-5.

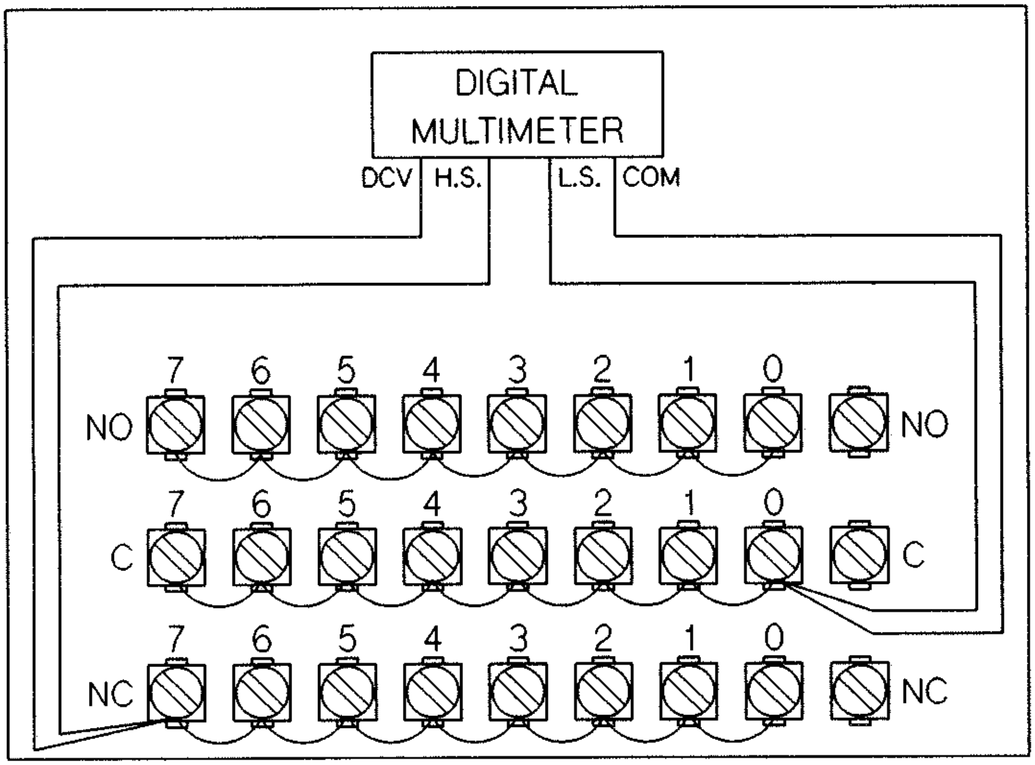


Figure 16-6 HP 44728A NC Channels Contact Resistance Test

4. Close channel 00 by executing:

   CLOSE ES00 (where E = extender number, S = slot number)

5. Observe the indication on the multimeter. The multimeter should indicate a resistance less than 0.5 ohms. If the contact resistance is above 0.5 ohms, check and make sure the protection fuse in the C (Common) path is not causing the failure.

6. Open channel 00 by executing:

   OPEN ES00 (where E = extender number, S = slot number)

7. Observe the indication on the multimeter. The multimeter should indicate an open circuit (>10^7 ohms). It is important to perform this step to ensure that none of the relays are stuck closed. If the multimeter does not indicate an open, troubleshooting will be necessary to locate the stuck relay. Section 16-19 describes locating a stuck relay.

8. Repeat steps 4, 5, 6, and 7 for channels 01 through 07. In the CLOSE and OPEN command the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

9. NORMALLY CLOSED CONTACT RESISTANCE TEST: This test checks the contact resistance of the normally closed relay contacts. Since these contacts are normally closed, a CLOSE command opens the contacts and an OPEN command closes the contacts.

10. Connect the multimeter DCV input and high SENSE leads to the NC (Normally Closed) connection on the test fixture. Connect the multimeter COM input and low SENSE leads to the C (Common) connection on the test fixture. The connections are shown in Figure 16-6.

11. Open all channels by executing:

CLOSE ES00-ES07 (where E = extender number, S = slot number)

The multimeter should indicate an open circuit (>10^7 ohms).

12. Close channel 00 by executing:

OPEN ES00 (where E = extender number, S = slot number)

13. Observe the indication on the multimeter. The multimeter should indicate a resistance of less than 0.5 ohms.

14. Open channel 00 by executing:

CLOSE ES00 (where E = extender number, S = slot number)

15. Observe the indication on the multimeter. The multimeter should indicate an open circuit (>10^7 ohms). It is important to perform this step to ensure that none of the relays are stuck closed. If the multimeter does not indicate an open, troubleshooting will be necessary to locate the stuck relay. Section 16-19 describes locating a stuck relay.

16. Repeat steps 12, 13, 14, and 15 for channels 01 through 07. In the CLOSE and OPEN commands the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

16-19 RELAY TROUBLESHOOTING

This section describes relay troubleshooting. The troubleshooting procedures first determine if the problem is located in the relays, or in the control logic. If the problem is determined to be in the control logic, complete replacement of the printed circuit board is required. Individual relays may be replaced.

The Performance Test provides a starting point for problem isolation. The Performance Test is described in Section 16-12.

A single failing channel indicates a failing channel relay. Table 16-4 is the relay cross reference table showing the relationship between channel numbers, relay numbers, and relay drivers and their corresponding input/output pin numbers. The table also shows the NC, NO, and C pin numbers on the component module connector.

Figure 16-7 shows the location of the relays on the component module board. Figure 16-8 shows a simplified schematic of one relay and associated circuitry. Since all the relay circuitry is the same, only one relay circuit is shown in the figure. Also shown in Figure 16-8 is a package outline and pinout diagram of the type of relay used. Use both Figures 16-7 and 16-8, and Table 16-4 for the following troubleshooting procedures.

CAUTION

To prevent equipment circuit damage always set the line power switch to off before removing or replacing any assembly. To prevent static zap of ICs always observe anti-static handling techniques when assemblies are handled or stored.

Table 16-4 HP 44728A Relay Cross Reference Table

Channel Number	Relay Number	Relay Driver Input/Output		Component Module Connector Pins		
		Input	Output	NC	NO	C
0	K1	U10 pin 1	U10 pin 18	72	70	71
1	K2	U10 pin 2	U10 pin 17	68	66	67
2	K3	U10 pin 3	U10 pin 16	64	61	62
3	K4	U10 pin 4	U10 pin 15	59	56	57
4	K5	U10 pin 5	U10 pin 14	54	51	53
5	K6	U10 pin 6	U10 pin 13	49	47	48
6	K7	U10 pin 7	U10 pin 12	45	42	43
7	K8	U10 pin 8	U10 pin 11	40	38	39

16-20 Control Logic Problem Isolation

The following control logic test writes relay closing patterns to the Relay Actuator and then checks for an indication of the relay state in the status register (Read Register 3). Electrically, this test checks that the correct relay drive lines were enabled. It does not actually check the drive lines. The test does provide an indication that the control logic is performing as required and can communicate with the HP 3852A local controller.

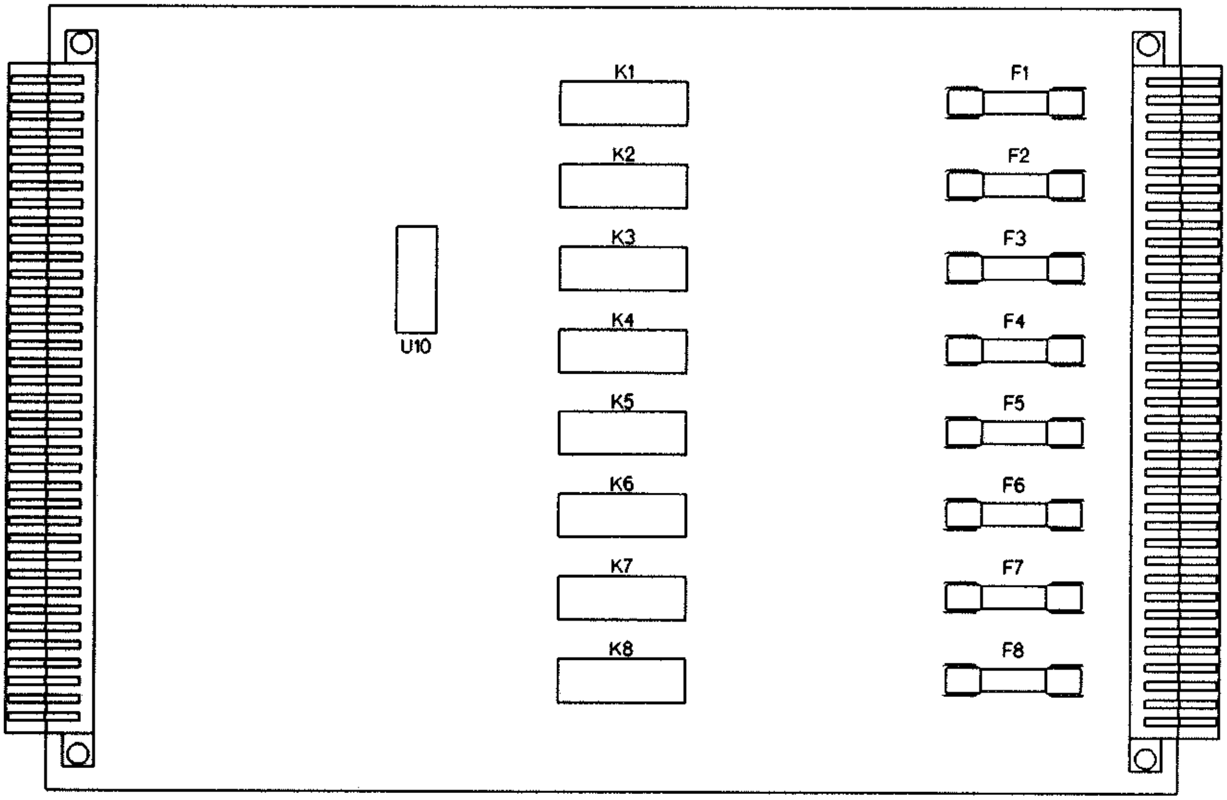


Figure 16-7 Relay Component Locator

NOTE

If using an HP 9000 Series 300 or Series 300 computer to perform this test, it may be necessary to program a delay between the SWRITE and SREAD commands (steps 2, 4, and 5) to allow time for the relay states to be latched into the status register.

1. Reset the HP 44728A Relay Actuator by executing:

   RESET ES00 (where E = extender number, S = slot number)

2. Read the status register by executing:

   SREAD ES00 (where E = extender number, S = slot number)

3. Verify that the right display shows:

   -256

If the display shows -256 (all channels open), the HP 44728A has been reset. Proceed to Step 4. If a number other than -256 is displayed, cycle power on the HP 3852A and perform steps 2 and 3 again. If the number is still incorrect, a failure exists with the HP 44728A control logic or with the HP 3852A. If the HP 3852A seems to operate normally (see Chapter 5 for HP 3852A problem isolation), the fault most likely exists in the HP 44728A switch control logic.

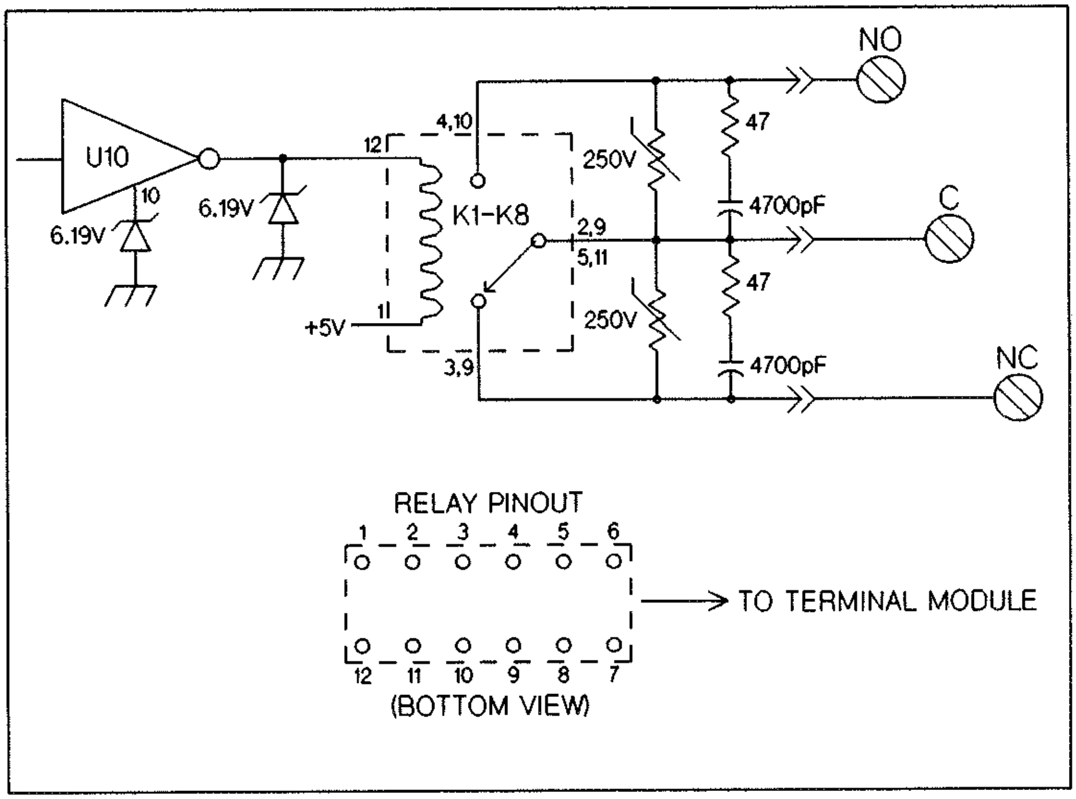


Figure 16-8 Relay Simplified Schematic

4. Close all relays by executing:

   SWRITE ES00,3,-1 (where E = extender number, S = slot number)

5. Read the status register by executing:

   SREAD ES00,3 (where E = extender number, S = slot number)

6. Verify that the right display shows:

   -1

7. Reset the HP 44728A Relay Actuator by executing:

   RESET ES00 (where E = extender number, S = slot number)

CAUTION

This procedure sets illegal and potentially damaging states on the HP 44728A Relay Actuator. Be sure to execute the RESET command in Step 7 to clear these states.

If the control logic test passed and a relay is not closing or opening, relay replacement is indicated. Since the control logic test is unable to check the actual relay drive lines, an additional test can be performed. With a digital multimeter, check the voltage across the faulty relay coil. The multimeter should indicate a steady state voltage of approximately 4.0 Vdc when the relay is open. The multimeter should indicate less than 0.2 Vdc when the relay is closed. The resistance across the relay coil should be approximately 130 Ω.

16-21 Stuck Relay Troubleshooting

When a relay contact is stuck in the closed position it cannot be isolated with the test fixture installed. The test fixture parallels all the relays together. However, the test fixture, or a terminal module, must be installed to allow the HP 3852A to normally communicate with the component module.

There are two ways to isolate the stuck relay. The first, and easiest means is to install a regular terminal module on the failing component module. Each channel of the multiplexer can then be checked with an ohmmeter. Measure between the faulty NO or NC terminal (depending on which contact is stuck) and the corresponding C terminal on the terminal module. Once the stuck channel is isolated, Table 16-4 identifies the stuck relay.

The second means to isolate a stuck relay involves checking for the stuck contacts on the component module connector. This method is not recommended for general use. To use this method, the test fixture or a terminal module must be installed and the HP 3852A power applied. When the wake-up sequence has completed, the test fixture or terminal module is removed. Removing the module after the wake-up sequence will allow commands to be processed since the local controller only queries the slots for accessory identification after power-on or reset.

It is recommended that the entire component module be replaced if the relays are at or near the relay maximum specified life cycle (shown in Table 16-3) and the relays are sticking or the contact resistance is out of specification.

16-22 REPLACEABLE PARTS

Figure 16-9 shows the mechanical breakdown of the HP 44728A. This figure also provides assembly and disassembly information. The parts shown in Figure 16-9 are keyed to the parts list in Table 16-5.

To order a part listed in Table 16-5, quote the Hewlett-Packard part number, the check digit (abbreviated CD in Table 16-5), and the quantity desired. Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

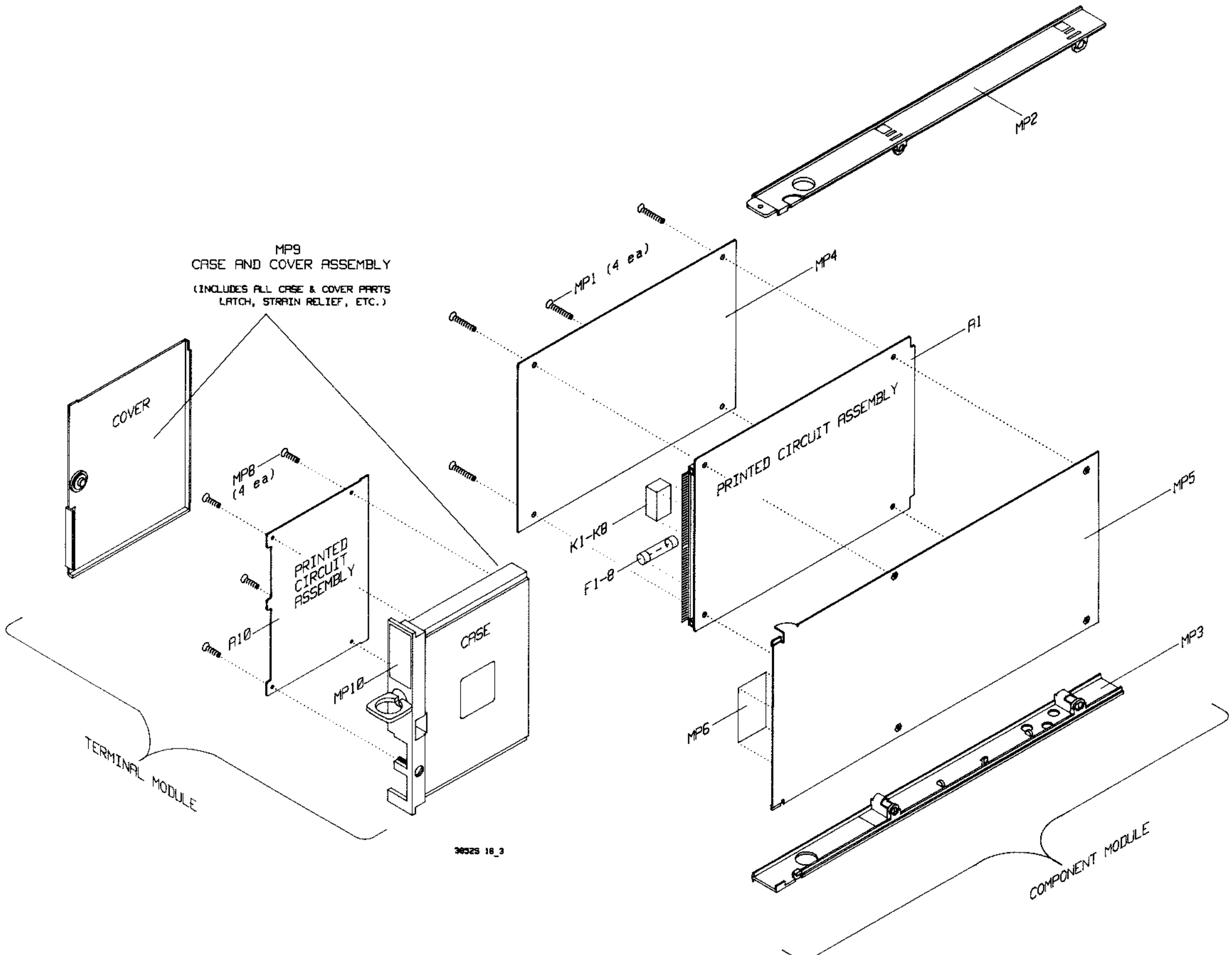


Figure 16-9 HP 44728A Exploded View

Table 16-5 HP 44728A 8 Channel Relay Actuator

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44728A	Module; 8ch relay actuator component	1	44728-66201	8	MOD-8CH RLY ACTR
A1	PCA; 8 chan relay actuator component	1	44728-6650	1	PCA-8CH RLY ACTR
A10	PCA; 8 chan relay actuator terminal	1	44728-66510	2	PCA-8CH ACT TERM
K1-8	Relay; A1 PCA	8	0490-1512	0	RLY-S2EB-5V
F1-8	Fuse; 5A, 250V fast blow, A1 PCA	8	2110-0010	9	FUSE-5AMPS NB
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44728A component module	1	44728-84320	0	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44728A	1	44728-84325	5	LBL-ID,TERM ASSY

Completely assembled HP 44728A terminal modules can be ordered from your local HP Office by ordering Number 44728AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Chapter 17
HP 44729A 8 Channel Power
Controller

CHAPTER 17
HP 44729A 8 CHANNEL POWER CONTROLLER

CHAPTER 17

HP 44729A

8 CHANNEL POWER CONTROLLER

17-1 INTRODUCTION

This chapter provides a technical description, a performance test procedure, and replaceable parts lists for the HP 44729A 8 Channel Power Controller.

17-2 Technical Description

The HP 44729A has two main assemblies; a component module and a terminal module. The component module contains the backplane interface electronics, the channel drivers, the channel switches, protection circuitry, and noise reduction circuitry. The terminal module contains an AC line filter, output protection fuses, and terminals for connection to external wiring.

A simplified schematic of the HP 44729A is shown in Figure 17-1. Only two of the eight channels are shown. The control logic interfaces the HP 3852A or HP 3853A digital bus with the individual channel switches. The control logic decodes the commands received on the digital bus and turns on or off the appropriate channel drivers. Each channel driver has two outputs; a thyristor gate drive line and a relay coil drive line.

The channel drivers are further controlled by the phase control circuit. This circuit synchronizes the channel drivers so that output switching occurs at the points of the AC line input cycle which minimizes arcing across the relay contacts and minimizes RFI generation.

The output switching is accomplished by an SCR and a relay in parallel. This parallel arrangement provides extended relay contact life with low transient generation. In operation, when a channel is commanded to turn on, the SCR is turned on slightly before the relay is closed. The SCR is gated on when the AC input voltage crosses zero (going positive). The SCR then conducts all the current in the channel. The relay closure occurs and the relay contacts begin to conduct. The relay contacts may bounce when first closed and the SCR conducts the channel current during this bounce period. When the AC line voltage again crosses zero (going negative), the SCR is turned off and all the channel current is conducted through the relay contacts.

When a channel is commanded to turn off, the SCR is again gated on and takes up the channel current while the relay contacts open. The channel is turned off at the zero current crossing of the AC line input voltage.

Short circuit protection is provided by a fuse in each channel on the terminal module. Voltage transient protection is provided on each channel by a pair of inductors, Metal Oxide Varistors (MOV's) and capacitors that limit the amplitude and rise time of the transients.

17-3 Read and Write Registers

The HP 3852A local controller communicates with each plug-in accessory by using read and write registers. High level commands are translated into appropriate register commands. The SREAD and SWRITE commands can be used to directly control each register.

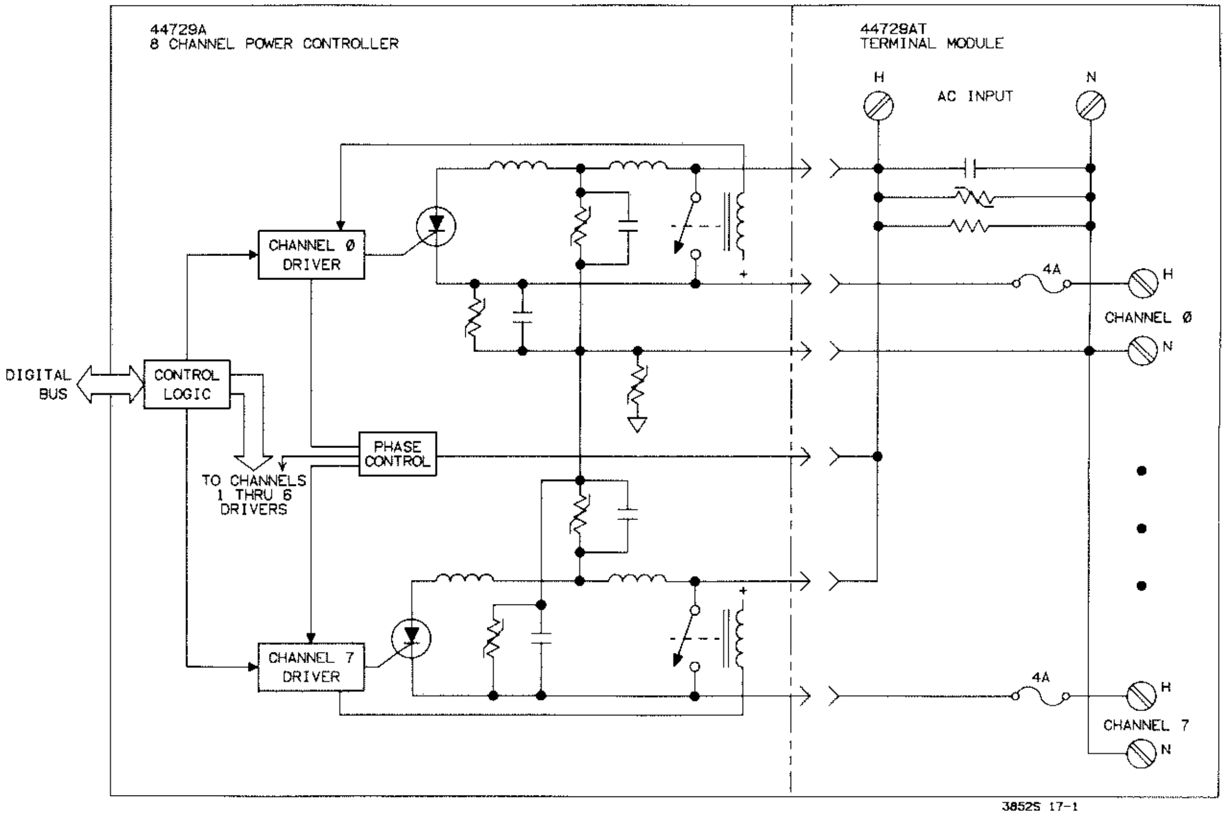


Figure 17-1 HP 44729A Block Diagram

SREAD and SWRITE are described in Chapter 2 of this manual. Table 17-1 shows the registers used by the HP 44729A.

CAUTION

Using the primitive commands (SREAD and SWRITE) may cause unexpected and undesirable effects on the plug-in accessories. It is possible to program some plug-in accessories into illegal and potentially damaging states with these commands. The commands are documented here for service purposes only.

Table 17-1 Power Controller Read and Write Registers

Register #	READ Registers	WRITE Registers
0	Accessory Identification	Accessory Reset
1	Always -240	Not Used
2	Channels 0 through 7	Channels 0 through 7
3	Channels 0 through 7	Channels 0 through 7

17-4 Read Registers

17-5 Register 0. Read Register 0 contains the accessory identification. Eight bits are used to uniquely identify the accessory. The eight bits are output on the lower eight bits of the backplane data lines.

The eight bit identification is in two parts. The five most significant bits identify the component module and the three least significant bits identify the type of terminal module installed. If a terminal module is not present, the lower three bits are set high by the component module. The HP 3852A local controller can thus identify the type of plug-in accessory installed and determine if a terminal module is installed.

Table 17-2 lists the decimal equivalent codes returned in response to an SREAD of Register 0 for all combinations of the accessory.

Table 17-2 HP 44729A Identification Codes

Module Combinations	Codes
HP 44729A Component Module (no terminal module installed)	-81
HP 44729A Component Module, HP 44729AT Terminal Module installed	-88

17-6 Register 1. Read Register 1 is a hardwired register and will always return a decimal value of -240 in response to an SREAD.

17-7 Registers 2 and 3. Read Registers 2 and 3 are status registers. The two registers are identical. The registers contain an eight bit status word, representing the last programmed state of the channel switches. The bits in the status word correspond one-to-one with the channel numbers (i.e., bit 7 represents channel 7). Figure 17-2 is an example of the status word. In the figure, it is presumed that channel 7 is closed.

```
Bits:       7  6  5  4  3  2  1  0
Bit Value:  1  0  0  0  0  0  0  0
```

Figure 17-2 Read Register 3

17-8 Write Registers

17-9 Register 0. Write Register 0 is the accessory reset register. Any data written to this register will cause a reset of the accessory and force all the channel switches open. The opening of the channel switches may be delayed until the zero current crossing of the AC line input occurs. A write to Register 0 has the same effect as a backplane reset.

17-10 Registers 2 and 3. Write Registers 2 and 3 are control registers. The two registers are identical. An eight bit word is used to control the status of the channel switches. The bits in the command word correspond one-to-one to the channel numbers (i.e., setting bit 7 closes channel 7). Figure 17-3 is an example of the command word. In the figure, it is presumed that channel 7 is to be closed.

```
Bits:       7  6  5  4  3  2  1  0
Bit Value:  1  0  0  0  0  0  0  0
```

Figure 17-3 Command Word

17-11 SPECIFICATIONS

Specifications for the HP 44729A are given in Table 17-3. Specifications are the performance standards or limits against which the accessory may be tested.

Table 17-3 HP 44729A Specifications

Maximum Input Voltage per channel:	250 V RMS 350 V peak
Maximum Input Current:	2.5 A RMS per channel (3 A RMS is module is limited to 16 A RMS total; 4 A fuse fuse protection per channel)
Closed Channel Path Resistance:	125 mΩ @ 3 A RMS 200 mΩ @ 100 mA RMS
Switch Life:	At Full Load, $5*10^6$
Minimum Voltage:	12 V RMS for proper operation
Surge Current:	50 A non-repetetive
Maximum Off Leakage:	0.5 mA per channel
Maximum Wire Size:	12 AWG

17-12 PERFORMANCE TEST

17-13 Introduction

The following Performance Test checks the operation of the HP 44729A component module. Performance Tests are not given for the terminal modules. Successful completion of the test in this chapter provides a high confidence level that the Power Controller is meeting its listed specifications.

The Performance Test makes use of a function generator to provide an AC line input voltage. The use of a function generator allows the test to be performed with a less than lethal AC line input voltage.

17-14 Equipment Required

The following test equipment is required to run the Performance Test.

1. Test Fixture (as described in Section 17-15)
2. Digital Multimeter -- HP 3456A or equivalent.
3. Function Generator -- HP 8116A or equivalent
4. Test Leads and Jumpers
5. Service Module -- HP 44743A

NOTE

The integrating plug-in voltmeter (HP 44701A) may be used for this test. This test does not describe the specific steps required to use the plug-in voltmeter. A description of the plug-in voltmeter can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

17-15 Test Fixture

A test fixture is required to perform the Performance Test. A schematic of the required test fixture is shown in Figure 17-4a. A test fixture can be made using an HP 44729AT Terminal Module (see Figure 17-4b). Because wiring the fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

If the test fixture is to be fabricated from other than an HP 44729AT Terminal Module, it is important that the terminal ID lines, shown in Figure 17-4a, be correctly wired. The HP 3852A local controller will not allow the execution of some commands with an incorrect terminal ID.

On the test fixture, in addition to a line input, all channel outputs are connected together (all channels share a common neutral connection).

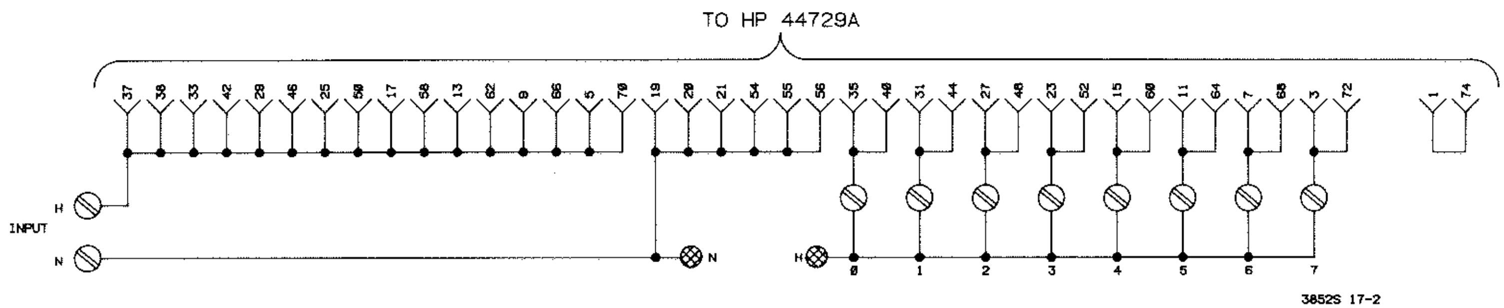


Figure 17-4a HP 44729A Test Fixure Schematic

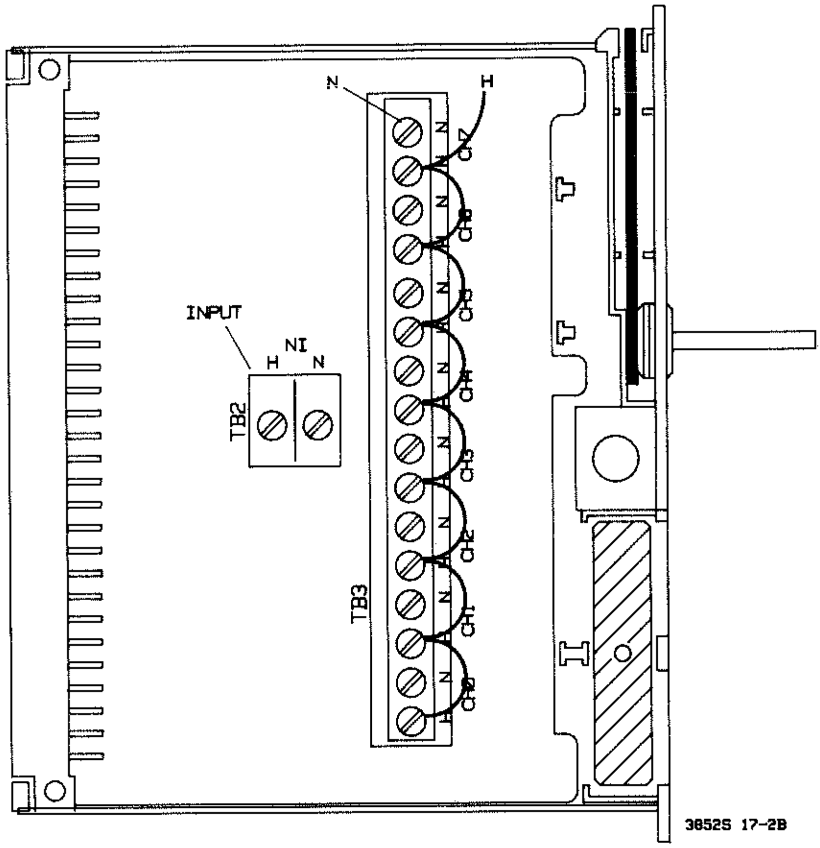


Figure 17-4b HP 44729A Test Fixure

17-16 Test Procedure

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

17-17 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the HP 44729A component module and install the test fixture. Note the slot number where the HP 44729A under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

   c. Verify that the HP 3852A right display shows:

      44729A

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

17-18 Channel Functional Test

1. Set the HP 44729A to a known state by executing:

   RESET ES00 (where E = extender number, S = slot number)

2. Set the function generator to output a 14.14 V peak (28.28 V peak-to-peak) sine wave at a 60 Hz rate. Connect the function generator output to the H and N AC input terminals on the test fixture. The connections are shown in Figure 17-5.

3. Set the multimeter to measure AC Volts (RMS). Connect the multimeter DCV input to the shorted HIGH channel connections. Connect the multimeter COM input to any channel neutral connection, as shown in Figure 17-5.

4. Close channel 00 by executing:

   CLOSE ES00 (where E = extender number, S = slot number)

5. Observe the indication on the multimeter. The multimeter should indicate 10 VAC (RMS).

6. Open channel 00 by executing:

   OPEN ES00 (where E = extender number, S = slot number)

7. Observe the indication on the multimeter. The multimeter should indicate less than 0.5 VAC (RMS).

8. Repeat steps 4, 5, 6, and 7 for channels 01 through 07. In the CLOSE and OPEN commands the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

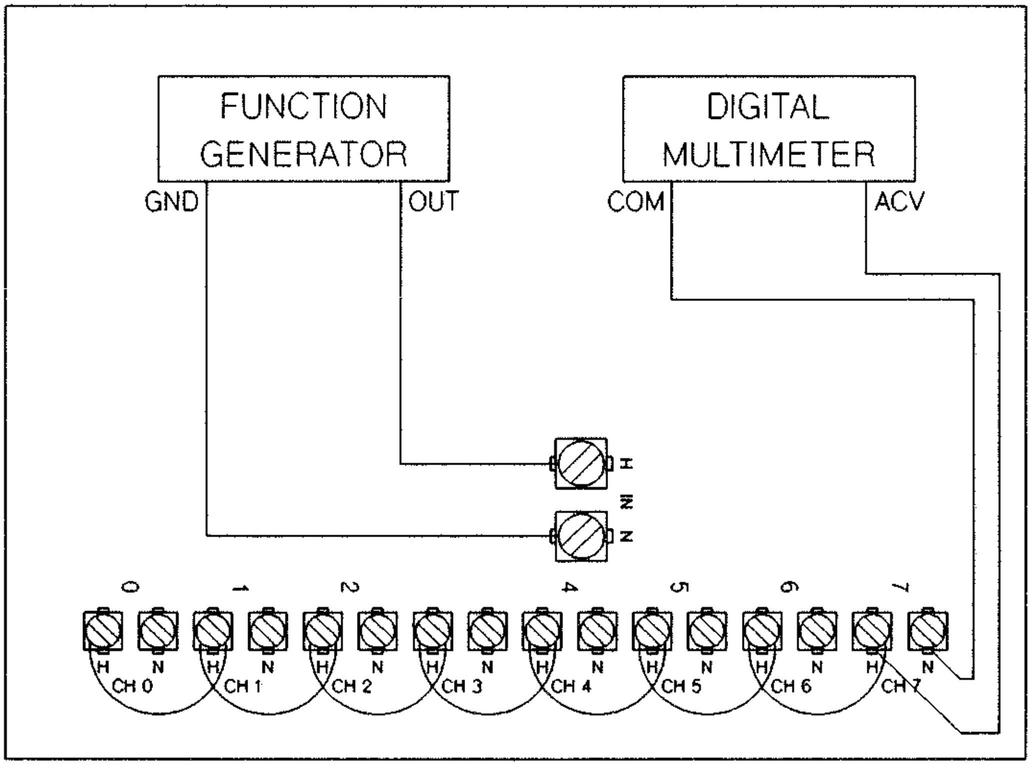


Figure 17-5 HP 44729A Channel Functional Test

17-19 REPLACEABLE PARTS

Figure 17-6 shows the mechanical breakdown of the HP 44729A. The figure also provides assembly and disassembly information. The parts shown in Figure 17-6 are keyed to the parts list in Table 17-4.

To order a part listed in Table 17-4, quote the Hewlett-packard part number, the quantity desired, the HP system description, and the check digit (abbreviated CD in Table 17-4). Address the order to the nearest Hewlett-packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

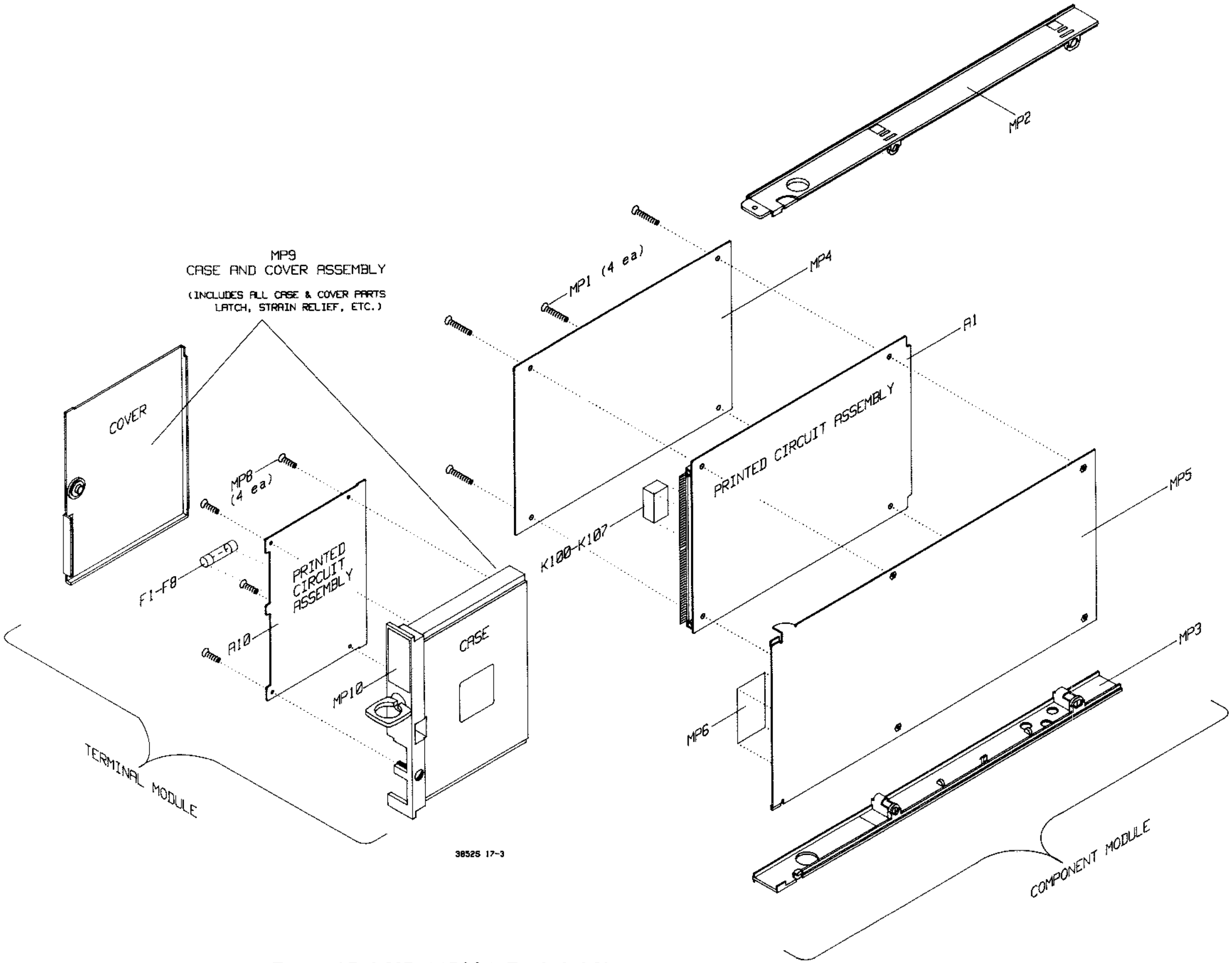


Figure 17-6 HP 44729A Exploded View

Table 17-4 HP 44729A 8 Channel Power Controller

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44729A	Module; 8ch pwr controller component	1	44729-66201	9	MOD-8CH PWR CTRL
A1	PCA; 8 ch power controller component	1	44729-66501	2	PCA-8CH PWR CTRL
A10	PCA; 8 ch power controller terminal	1	44729-66510	3	PCA-PWRCTRL TERM
K100-107	Relay; A1 PCA	8	0490-1517	5	RLY-ST1E-DC12V
F1-8	Fuse; 4A, 250V fast blow, A10 PCA	8	2110-0055	2	FUSE-4AMPS NB
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44729A component module	1	44729-84320	1	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44729A	1	44729-84325	6	LBL-ID,TERM ASSY

Completely assembled HP 44729A terminal modules can be ordered from your local HP Office by ordering Number 44729AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44729A	Module; 8ch pwr controller component		44729-69201	5	RBLT-44729-66201

Chapter 18
HP 44714A Stepper Motor Controller

CHAPTER 18
HP 44714A 3-CHANNEL STEPPER MOTOR CONTROLLER/PULSE OUTPUT

CHAPTER 18
HP 44714A
3-CHANNEL
STEPPER MOTOR CONTROLLER
PULSE OUTPUT

18-1 INTRODUCTION

This chapter provides a technical description, performance test procedures, and replaceable parts lists for the HP 44714A Stepper Motor Controller/Pulse Output Accessory.

NOTE

The Stepper Motor Controller/Pulse Output Accessory can only be used with instruments having a firmware revision of 3.0 or above. Determine the firmware revision by sending the **IDN?"** *command.*

18-2 Technical Description

The HP 44714A Stepper Motor Controller/Pulse Output Accessory has three channels that provide: isolated and non-isolated pulse outputs, halt/limit switches inputs, and quadrature counter inputs. The isolated outputs are isolated from chassis ground using opto-isolators. The inputs are not isolated. All channels operate independent from each other.

The width and frequency of the output pulses are selected by the user. The quadrature counter can be reset programmatically or by an index pulse on the stepper motor's shaft encoder. Triggering of the channels to initiate output pulses is done by software commands or the backplane trigger input.

The PVCC input is used to bias the opto-isolator; it is also located on the terminal module. The bias voltage can either be supplied by an internal power supply (PVCC jumper on terminal module in NON ISOLATED position) or by the user (jumper in ISOLATED position). If supplied by the user, the voltage must range from at least +5 V to no greater than +20 V.

Refer to Figure 18-1. The HP 44714A has two main assemblies; a component module and a terminal module. The component module includes the backplane interface electronics, a master clock, and various registers. The component module also has for each channel circuitry to develop the pulse outputs, to read the limit switches, and a quadrature counter. The terminal module contains the terminal blocks for connecting external wring to the accessory.

Each channel on the accessory has its own microprocessor, delay circuitry, pulse width circuitry, and output drivers to develop and output the stepper motor pulses. The microprocessor receives commands and data from the command and data registers to output pulses with the pulse width and frequency set by the user.

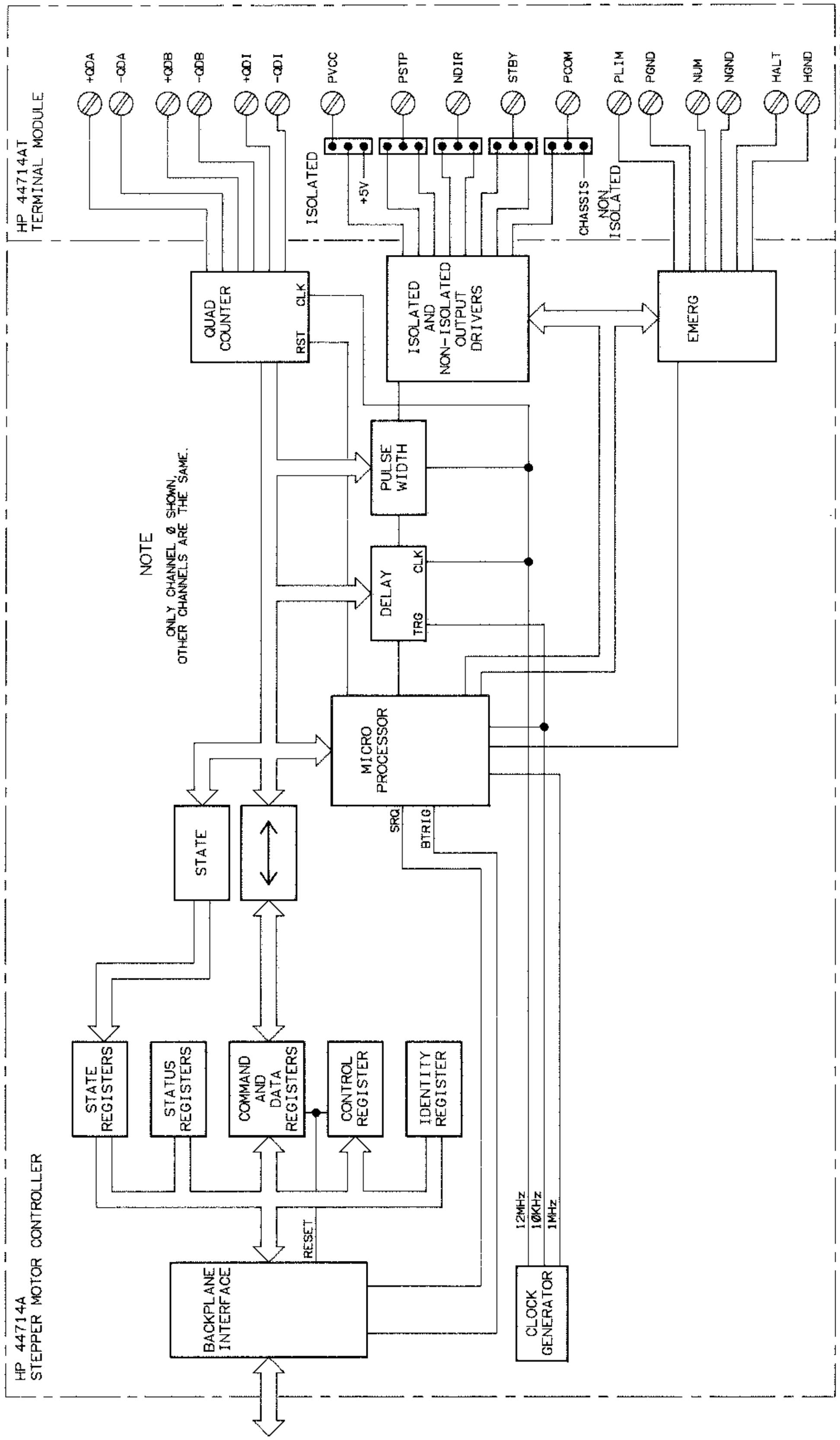


Figure 18-1 HP 44714A Simplified Block Diagram

The pulses are developed using the delay and pulse width circuitry and output by the output drivers. Data is transferred between the microprocessor and the command and data registers using a transceiver. The registers receive their instructions from the backplane logic which receives its instructions from the mainframe.

The microprocessor can be triggered using the BTRIG line from the mainframe via the backplane logic. The microprocessor can also interrupt the mainframe, using the SRQ line, if instructed to do so by the user. An interrupt can be developed when a stepper motor move is completed.

The isolated and non-isolated outputs are selected by jumpers on the terminal module. Each of the channel's outputs can be configured for two different modes. In one mode, the pulses appear on the PSTP output while the NDIR output controls direction. In the other mode, the pulses appearing on PSTP is one direction and the pulses on NDIR is for the other direction.

The halt/limit switch input circuitry (EMERG) consist of two limit switch inputs (one for each direction) and a halt switch input. The microprocessor constantly queries this circuitry to determine if a halt/limit condition exists.

The quadrature counter is always active but its contents are not used until requested by the mainframe. The data is then transferred to the command and data registers through the transceiver. The counter can be reset via the microprocessor by the user.

The pulse width and frequency accuracy, and stability is determined by the clock generator. The clock generator generates three clock frequencies: 12 MHz, 1 MHz, and 10 kHz. The 12 MHz clock is used to run the processor and to develop the other frequencies. The 10 kHz clock is used to synchronize the delay circuitry with the processor. The 1 MHz clock is used to clock the delay and pulse width circuitry, and the quadrature counter.

Other circuitry on the component module are the state, status, control, and identity registers. All these registers receive and transfer data to the backplane interface logic.

The state register is used to determine the specific state of a channel. This data is latched from the channel's microprocessor to the state register via the STATE latch.

The status register is used by the mainframe to determine what a channel is doing and what it has done. These instructions come from the microprocessor using various control lines.

The control register is used by the mainframe to perform certain overriding functions on the accessory. These include reset and selecting channels.

The identity register is used by the mainframe to identify the accessory and to determine its location (i.e., the slot).

Included on the component module is also the QPWR power supply. The supply is rated at 5 Vdc and is used to power the shaft encoders in a stepper motor system. The power supply return is QGND.

The test jumper on the terminal module configures the accessory for a complete self-test. To perform the test, the module should also be wired according to the instructions given in paragraph 18-8. When the jumper is in the TEST position, a complete test is performed. When the jumper is in the NORM position, only a partial test is performed. Since the output and other lines are toggled during a complete self-test, no external connections should be made to the terminal module. Damage or personal injury may result if these instructions are not followed.

18-3 SPECIFICATIONS

Specifications for the HP 44714A are given in Table 18-1. Specifications are the performance standards or limits against which the accessory may be tested.

Table 18-1 HP 44714A Specifications

OUTPUT CHARACTERISTICS

Trapezoidal Motion Profile:

Pulse Output Terminals:

Terminals Terminals	Description
PVCC	+5 V to +42 V relative to PCOM*
PSTP	Positive/Step Output Channel
NDIR	Negative/Direction Output Channel
STBY	Removes Power when No Output
PCOM	Common Return

* = supplied by the user (isolated operation) or supplied by the module (non-isolated operation). +42 V is the absolute maximum voltage that can be applied; +30 V is the recommended maximum voltage.

Isolation: Channels are isolated from each other. PVCC, PSTP, NDIR, and STBY outputs on each channel have a common return.

Between outputs (PSTP, NDIR, STBY) and common (PCOM): 15 V
Between channels: 42 V
Between channel and ground: 42 V

Stepper Motor Configuration:

Two outputs per channel - PSTP & NDIR. These outputs can be configured in one of two modes

(1) PSTP - outputs pulses
NDIR - determines direction

(2) PSTP - pulses for one direction (e.g. CW)
NDIR - pulses for other direction (e.g. CCW)

	Maximum	Resolution
Pulse Rate	10 kHz	2.5 µHz**
Pulse Rate of Change	1 MHz/sec	25 mHz/sec
Pulse Width	65.535 msec	1 µsec
Pulse Width Rate of Change	1 sec/sec	1 µsec/sec

** = An average pulse rate can be selected to this resolution, but period elements will be based on a 1 µsec time base.

Table 18-1 HP 44714A Specifications (Cont.)

	Jitter	Accuracy
Pulse Rate	1 µsec	0.01%
Pulse Width	1 µsec	0.01% ±200 nsec***

*** = Applies to non-isolated outputs (otherwise 0.01% ±1 µsec). Must be properly terminated.

Total number of output pulses per channel in burst mode is ±2,147,483,647.

INPUT CHARACTERISTICS

Quadrature Counter:

(1) TTL Compatible
(2) +5 V (180 mA) or 0 to 15 V with an external power supply available.
(3) Differential inputs (0 to 15 V) are filtered for noisy environment.

The minimum time interval between any pulse edge on channel QDA to any pulse edge on channel QDB of a particular channel is 2 µsec.

Limit Switch Inputs:

(1) Schmitt trigger inputs filter noise and sense input state
(2) Causes an immediate halt of output pulses

Limit Switch Characteristics:

The limit switch inputs are TTL compatible and require a >50 µsec pulse width. The accessory supplies a +5 V and a 10 kohm pull-up resistor for switch closure sensing.

	Counter	Limit Switches
Maximum Input Voltage	15 V	5 V
Maximum Input Current	3.5 mA	-1 mA
Thresholds:		
Vlow (max)	0.5 V	1.0 V
Vhigh (min)	2.5 V	3.85 V
Number of Counts	±2,147,483,647	N/A
Counter Accuracy	±0.5 counts	N/A

Table 18-1 HP 44714A Specifications (Cont.)

SUPPLEMENTAL CHARACTERISTICS

This section contains characteristics that are intended to provide information useful in applying the system by giving typical or nominal, but non-warranted performance parameters.

Response Time:

Command over HP-IB to start/stop pulses:	35 msec
Command from a subroutine to start/stop pulses:	10 msec
Backplane Trigger to start pulses:	150 µsec
Limit Switch to stop pulses:	100 µsec

MISCELLANEOUS CHARACTERISTICS

Relative Power Consumption: 1.0

For multiple modules, check that the sum of relative power used does not exceed 8 for the HP 3852A or 10 for the HP 3853A.

18-4 PERFORMANCE TESTS

18-5 Introduction

The following Performance Tests check the operation of the HP 44714A component module. Performance Tests are not given for the terminal modules. Successful completion of the tests in this chapter provides a high confidence level that the Stepper Motor Controller/Pulse Output Accessory is meeting its listed specifications.

The performance tests should be performed in the order they are presented. The completion of each test increases the confidence level in the accessory. A minimum set of tests is given as the Operational Verification Test. This test is described in Section 18-6.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Test yields a 90% confidence level that the accessory is operating normally, it is not recommended that all the Performance Tests be performed unless one of the tested specifications is in question.

18-6 Operational Verification

The first test in this section is the minimum test recommended for the HP 44714A Accessory. This test is designed to test the functionality of the accessory. Successful completion of the Operational Verification Test provides a 90% confidence level that the HP 44714A Accessory is operating normally and is within specifications.

The Operational Verification Test consists of the following:

Section 18-10 - Set-Up Procedure
Section 18-11 - Self-Test

18-7 Equipment Required

The following test equipment is required to run the Performance Tests. Only the first item is required for the Operational Verification Test.

1. Test Fixture (as described in Section 18-8)

2. Test Leads and Jumpers

3. Digital Multimeter -- HP 3456A

4. Resistor -- 28 ohms, 1 W

5. Counter -- HP 5316A

NOTE

The integrating plug-in voltmeter (HP 44701A) may be used for the Voltage Output Test in the Performance Test Procedures. This test does not describe the specific steps required to use the plug-in voltmeter. A description of the plug-in voltmeter can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

18-8 Test Fixture

A test fixture is required to run the Performance Tests. The test fixture can be manufactured using an HP 44714AT terminal module (see Figure 19-2). Because wiring the fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

The connections on the test fixure are as follows. The same connections are used for each channel.

1. +QDI connects to HALT and STBY.

2. +QDA connects to NLIM and NDIR.

3. +QDB connects to PLIM and PSTP.

4. QPWR connects to PVCC.

5. PCOM connects to GND

6. NORM/TEST jumper in Test position.

18-9 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

18-10 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the Stepper Motor Controller/Pulse Output Accessory component module and install the test fixture. Note the slot number where the accessory under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

   c. Verify that the HP 3852A right display shows:

      44714A

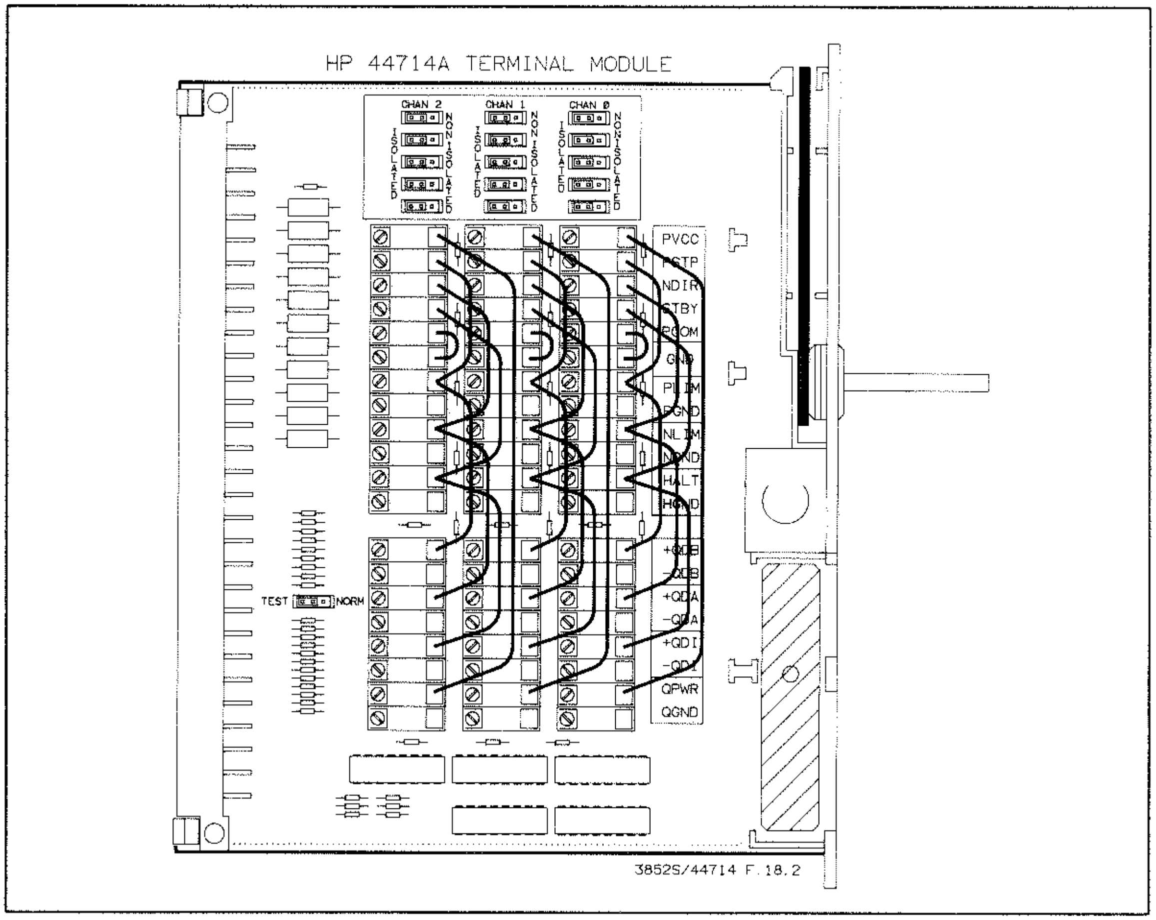


Figure 18-2 HP 44714A Test Fixure

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

18-11 Self-Test

This test checks most of the circuitry on the component module.

1. Use the wired test fixure shown in Figure 18-2 for the self-test. Make sure the NORM/TEST jumper is in the test position.

WARNING

The **NORM/TEST** *jumper is only used to test the accessory.* **DO NOT** *place the jumper in the test position if the accessory has any external connections, other than the test connections, or personal injury and/or damage to equipment may result.*

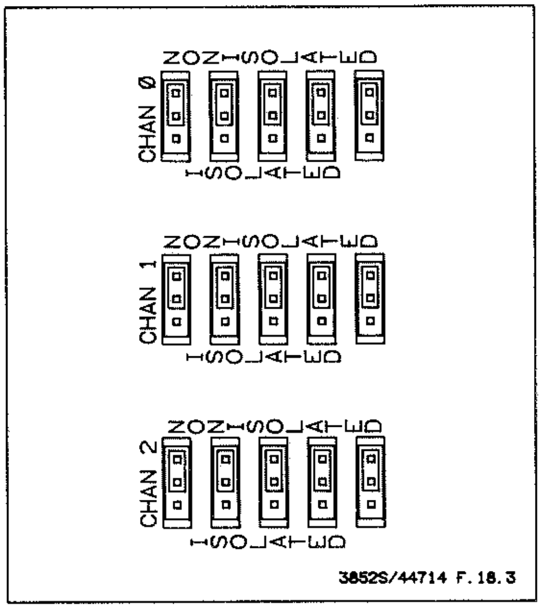


Figure 18-3 Non Isolated Output Self Test Setup

2. Locate the ISOLATED/NON ISOLATED jumpers on the terminal module (see Figure 18-2). If ONLY the Operational Verification Test is to be performed, place the jumpers in the position in which the accessory is to be used (e.g., NON ISOLATED for non isolated output, etc.). If the complete performance test is to be performed, place the jumpers in the ISOLATED position as shown in Figure 18-2.

3. Perform the HP 44714A self-test by executing:

TEST ES00 (where E = extender number, S = slot number)

4. After the test routine is completed, the HP 3852A right display should show:

SELF TEST OK

If the display shows a different message, or if the ERR annunciator is on, the HP 44714A Accessory may be failing its self-test. Test the accessory again by executing the command in step 3.

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE PERFORMANCE TESTS.

18-12 Non Isolated Output Self Test

1. Make sure the NORM/TEST jumper is in the test position as shown in Figure 18-2.

2. Place the ISOLATED/NON ISOLATED jumpers on the terminal module in the NON ISOLATED position as shown in Figure 18-3.

3. Perform the HP 44714A self-test by executing:

TEST ES00 (where E = extender number, S = slot number)

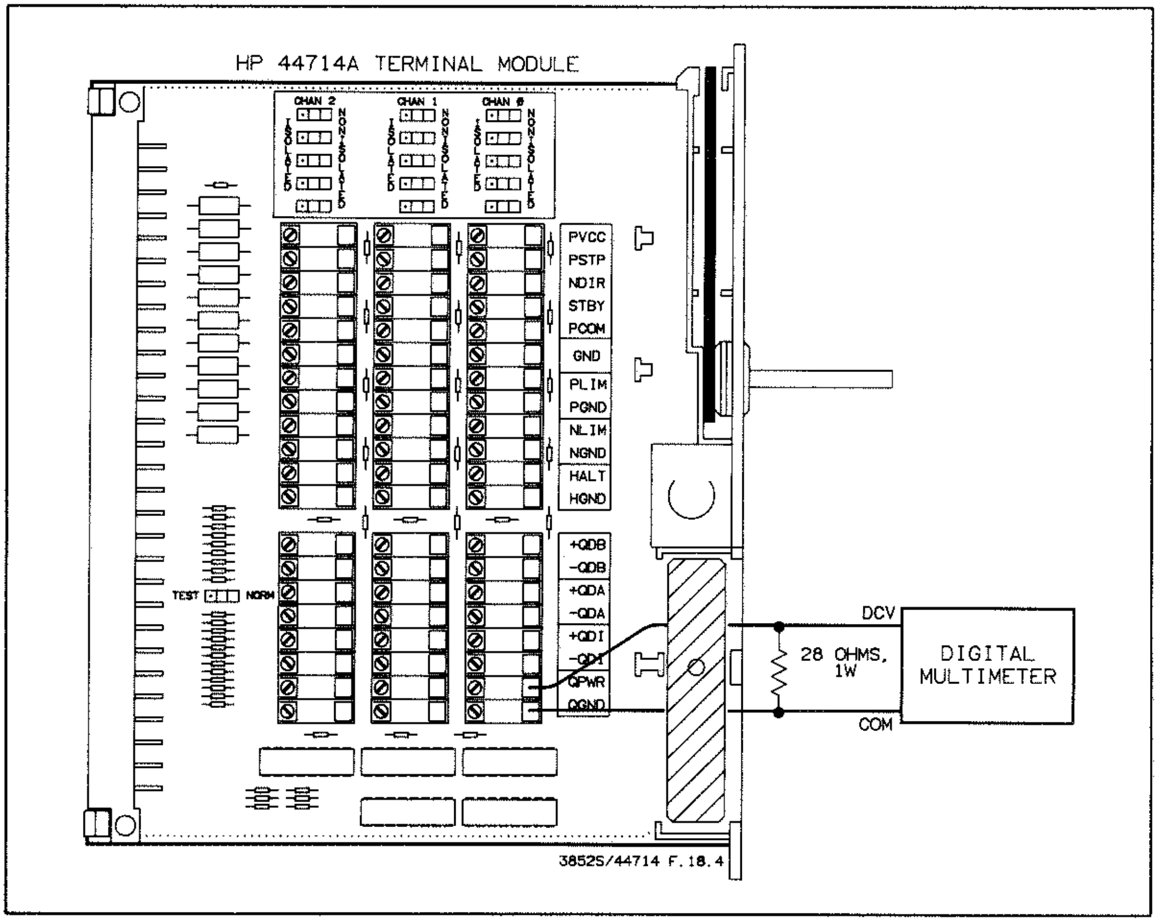


Figure 18-4 QPWR Power Supply Test Connection

4. After the test routine is completed, the HP 3852A right display should show:

SELF TEST OK

18-13 QPWR Power Supply Test

This test checks the output voltages of the QPWR power supplies under full load.

1. Setup a digital multimeter to measure dc volts in autorange.

2. Refer to Figure 18-4. Connect a 28Ω, 1 W resistor between the DCV (HI) and COM (LO) terminals of a digital multimeter. Connect the DCV input of the multimeter to the QPWR connection and the COM (LO) input to the QGND connection on the terminal module.

3. Make sure the dc volts reading on the digital multimeter is +5 V ±0.50 V.

4. Remove the digital multimeter from the terminal module. Remove the resistor from the digital multimeter.

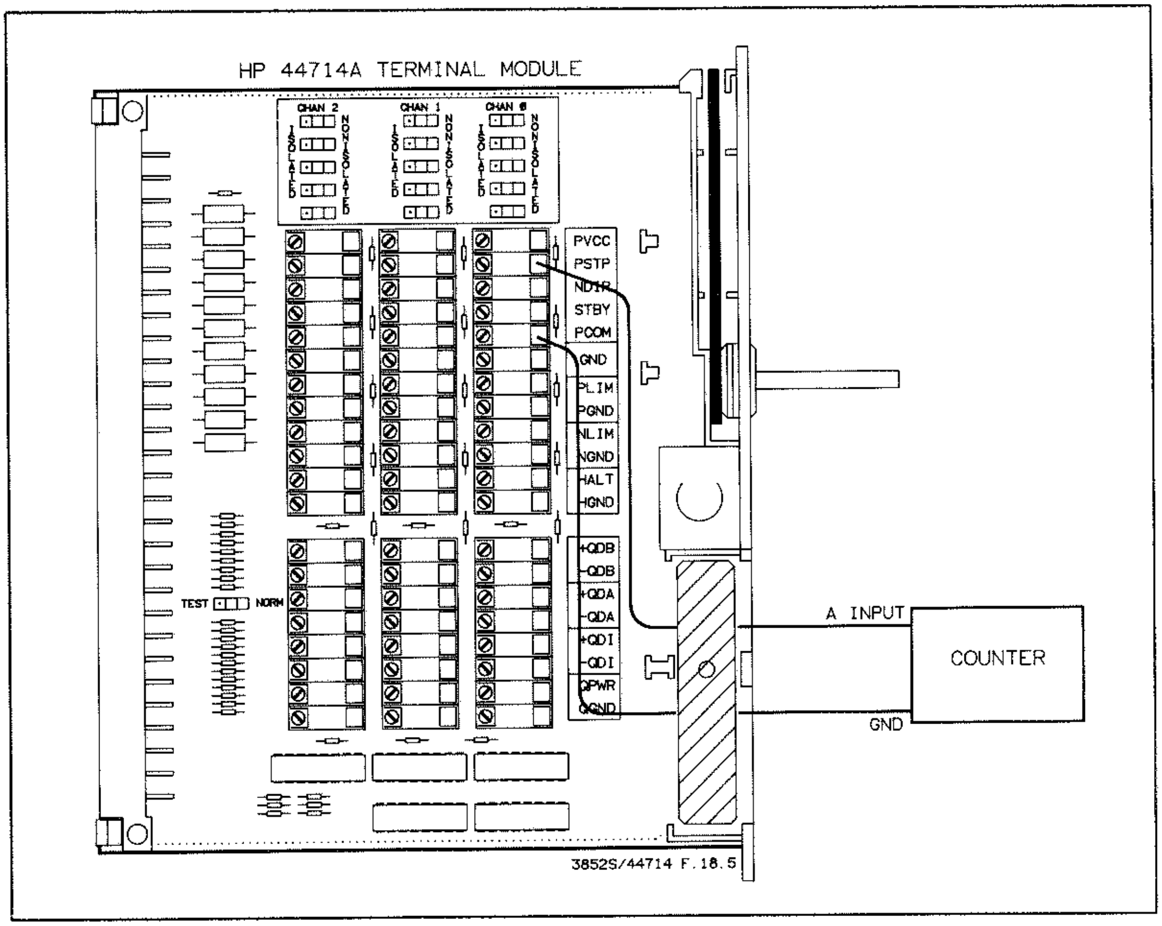


Figure 18-5 Frequency and Pulse Accuracy Test Connection

18-14 Frequency and Pulse Width Accuracy Test

This test checks the accuracy of the pulse outputs. Since the pulse accuracy depends on the accessory's internal clock accuracy, used by all channels, only one channel is tested.

1. Place the NORM/TEST jumper into the norm position, as shown in Figure 18-5.

2. On the terminal module, remove the wire on the PSTP terminal for channel 0. (This wire was connected to perform the accessory's self-test.)

3. Refer To Figure 18-5. Connect the High input (A input if using the recommended counter) of a counter to the PSTP terminal that is for channel 0 and the Low (Gnd) input to the PCOM terminal on the terminal module.

4. Set the HP 44714A to continually output pulses at a frequency of 10 kHz by executing:

```
USE ES00 (where E = extender number, S = slot number)
TRIG AUTO
PROFILE FREQ 0 10E3 10E3 1E-6
SUSTAIN 10E3
```

5. If using the recommended counter, set it up as follows:

> Function Switch -- FREQ A
> Channel A Slope Switch -- Position IN ( )
> Trigger Level Switch -- Position IN (Sensitivity)
> *Level/Sensitivity Control -- Position CENTER
> Rest of Switches -- Position OUT

*The Level/Sensitivity Control may need adjustment for a stable reading on the counter.

6. Make sure the frequency reading of the counter is within the following range:

> 9.99900E3 to 10.00100E3

7. Stop outputting pulses by executing:

> HALT

8. Set the HP 44714A to continually output pulses at a width of 65 mS by executing:

> PROFILE WIDTH 0 65E-3 65E-3 10 100E-3
> SUSTAIN 65E-3

9. Setup the counter to the following:

> Function -- T1 A->B
> Channel A Input Slope Switch -- Position IN ( )
> Channel B Input Slope Switch -- Position OUT ( )
> Trigger Level Switches -- Both Chan. A and B Position IN (Sensitivity)
> Level/Sensitivity Controls -- Both Chan. A and B Position CENTER
> Sep/Com A Switch -- Position IN (COM A)
> **Attenuator Switches -- Both Chan. A and B Position IN (X20)
> Rest of Switches -- Position OUT

** A 10:1 oscilloscope probe can be used for the counter input instead of placing the attenuator switches in the X20 position. Either one is necessary for a stable reading on the counter. The Level/Sensitivity Controls may also need adjustment.

10. Make sure the pulse width reading on the counter is within the following range:

> 64.9925E3 to 65.0075E3

11. Stop outputting pulses by executing:

> HALT

12. Remove the counter from the terminal module. This completes the performance test of the HP 44714A.

18-15 REPLACEABLE PARTS

Figure 18-6 shows the mechanical breakdown of the HP 44714A. The figure also provides assembly and disassembly information. The parts shown in Figure 18-6 are keyed to the parts list in Table 18-2.

To order a part listed in Table 18-2, quote the Hewlett-Packard part number, the quantity desired, the HP system description, and the check digit (abbreviated CD in Table 18-2). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

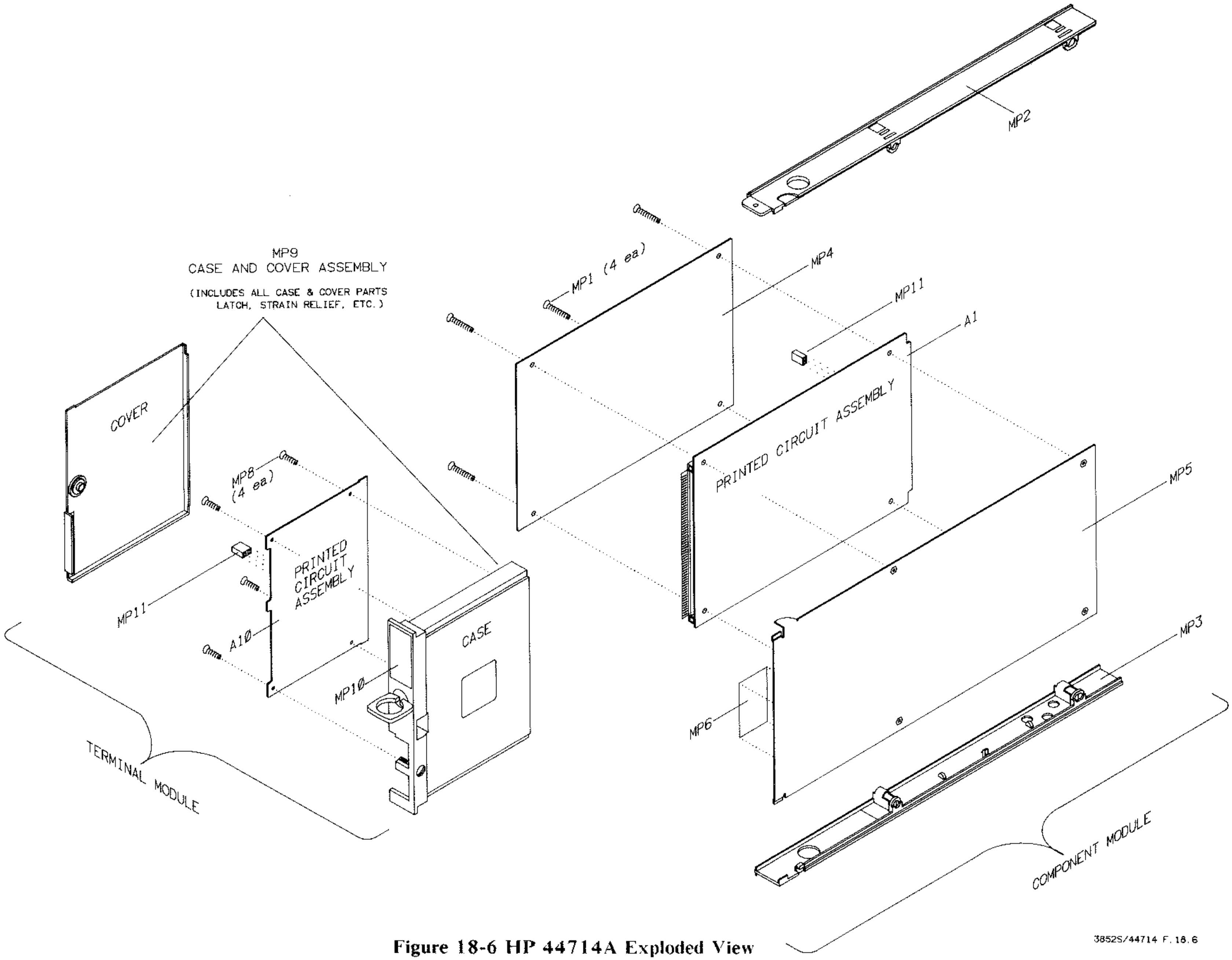


Figure 18-6 HP 44714A Exploded View

Table 18-2 HP 44714A Stepper Motor Controller/Pulse Output

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44714A	Module; Stepper Motor Controller	1	44714-66201	2	MOD-STEPPER
A1	PCA; 3ch Stepper Motor component	1	44714-66501	5	PCA-STPR MOT
A10	PCA; 3ch Stepper Motor terminal	1	44714-66510	6	PCA-STPR TERM
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44714A component module	1	44714-84320	4	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear pnl of term mod 44714A	1	44714-84325	9	LBL-ID,TERM ASSY
MP11	Jumper; removable, A10 PCA	16	1258-0141	8	JMPR-REM .025P

Completely assembled HP 44714A terminal modules can be ordered from your local HP office by ordering Number 44714AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program. For details see Section 4-9.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44714A	Module; 3ch Stepper Motor Controller		44714-69201	8	RBLT-44714-66201

Chapter 19

HP 44723A Fast Digital I/O

CHAPTER 19
HP 44723A FAST DIGITAL I/O

CHAPTER 19
HP 44723A
FAST DIGITAL I/O

19-1 INTRODUCTION

This chapter provides a technical description, performance test procedures, and replaceable parts lists for the HP 44723A Fast Digital I/O Accessory.

NOTE

The Fast Digital I/O Accessory can only be used with instruments having a firmware revision of 3.0 or above. Determine the firmware revision by sending the mainframe command: **IDN?**.

19-2 Technical Description

The HP 44723A Fast Digital I/O Accessory has 16 output channels, 16 input channels, and three trigger inputs/outputs. The outputs (excluding the trigger outputs) are jumper selectable for 5 V TTL or 30 V, 40 mA open collector outputs. The inputs (including trigger inputs) are jumper selectable for 5 V, 12 V, and 24 V input levels. All output/input channels are non-isolated.

Refer to Figure 19-1. The HP 44723A has two main assemblies: a component module and a terminal module. The component module includes the backplane interface electronics, the input/output registers, output drivers, trigger circuitry, and interrupt circuitry. The terminal module contains the terminal blocks for connecting external wiring, the selection jumpers, and trigger input/output terminals.

The backplane circuitry interfaces with the the HP 3852A or HP 3853A backplane. The circuitry accepts commands from the HP 3852A mainframe to turn the output drivers on or off as indicated in the commands. The circuitry also transfers digital input signals to the mainframe.

The HP 44723A uses a two-rank design to output data. Data from the backplane logic is transferred to the first rank register after a 2nd rank output trigger occurs. The data is then latched to the second rank register which latches it to the TTL and open collector output circuitry. The two rank design allows the most recent data to be output.

The HP 44723A also uses a two-rank design for the input circuitry. The input data from the terminal module is latched into the first rank register after this register is triggered. No data is latched into the register before the trigger occurs. This data is then latched into the second rank register after this register is triggered. The data is then transferred to the backplane logic.

The HP 44723A has five user selectable trigger modes: backplane, internal, single, external, and hold. Except for hold, all of the trigger modes can be used to trigger the first rank input register, second rank input register, and second rank output register. The backplane trigger is generated from an input at the "System Trigger In" port on the rear panel of the HP 3852A mainframe. The internal and single triggers, and hold are generated on the accessory's component module. The external triggers are generated from inputs on the the trigger input terminals on the terminal module.

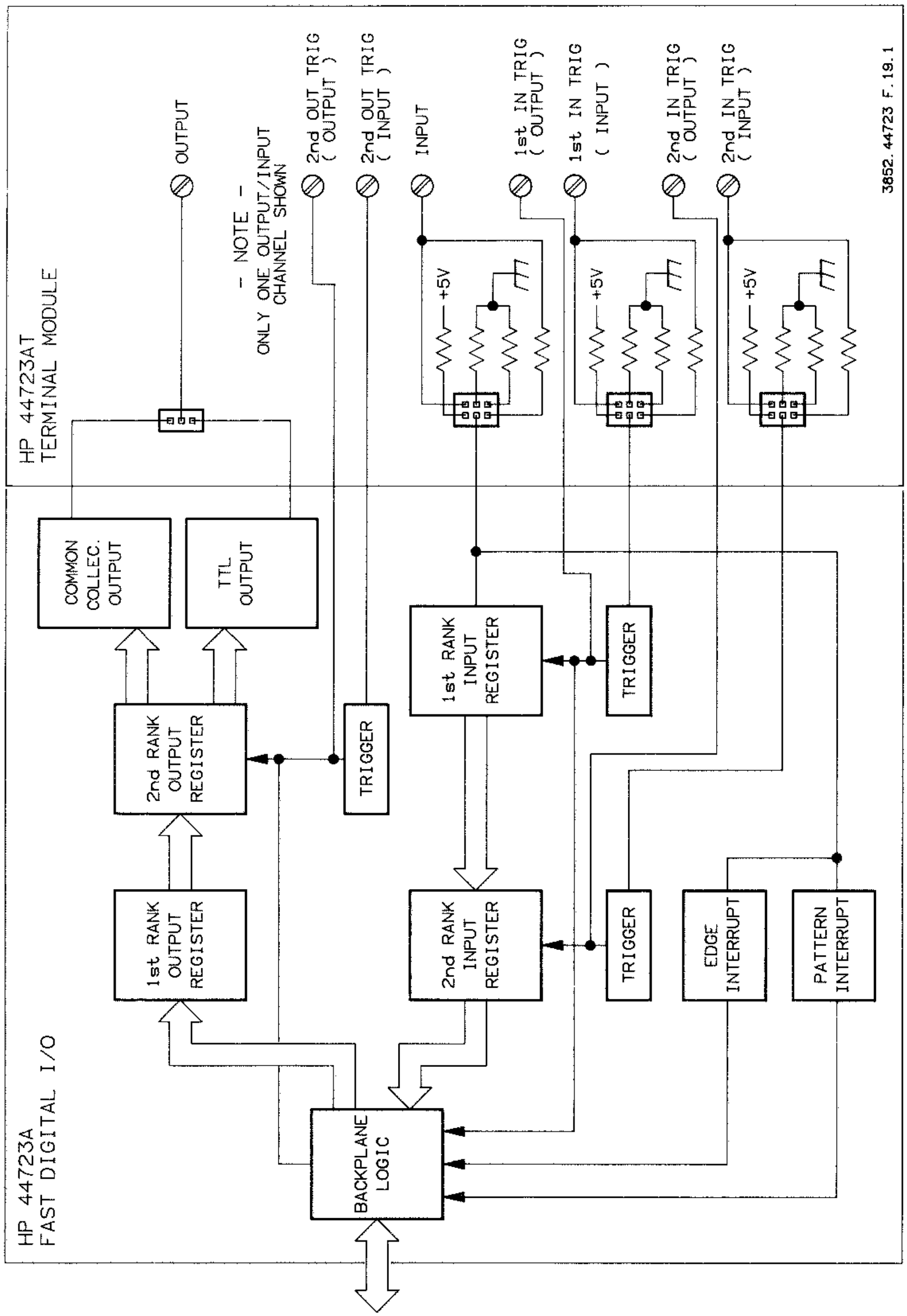


Figure 19-1 HP 44723A Simplified Block Diagram

The trigger pulses for external triggers are applied at the input terminals on the 1ST IN TRIG, 2ND IN TRIG, and 2ND OUT TRIG terminal blocks. The trigger pulses are used to trigger the first rank input register (1ST IN TRIG), second rank input register (2ND IN TRIG), and/or second rank output register (2ND OUT TRIG), respectively. When a register is triggered, either internally or externally, 2 µS output trigger pulses for that register are generated by the accessory. These pulses are output at the corresponding trigger output (OUT) terminals on the terminal module. The trigger outputs for the first rank input, second rank input, and second rank output registers are output on the terminasls of the 1ST IN TRIG, 2ND IN TRIG, and 2ND OUT TRIG terminal blocks, respectively.

Four types of interrupts are generated by the HP 44723A: input, output, input edge, and input pattern. Input interrupts are generated by a valid first rank input trigger. Output interrupts are developed by a valid second rank output trigger.

The input edge and input pattern interrupts are generated from the input applied at the terminal module. Input edge interrupts can be selected for positive, negative, or both edges. Input pattern interrupt can be programmed for arbitrary patterns on any set of bits and for either equal or non-equal conditions. The input edge and input pattern interrupts are user-selectable and are generated by the Interrupt Edge and Interrupt Pattern circuitry on the component module.

19-3 SPECIFICATIONS

Specifications for the HP 44723A are given in Table 19-1. Specifications are the performance standards or limits against which the accessory may be tested.

Table 19-1 HP 44723A Specifications

SPECIFICATIONS

Operating Range:

	Nominal Voltage (Vdc) 5*	12	24
Threshold Voltage (V): Vlow (max)	0.79	1.89	3.80
Vhigh (min)	2.06	4.92	9.90
Input Current (mA) at Nominal Voltage	0.001	1.39	3.77
Minimum Pulse Width (nS)	600	420	355

* = Also Includes PULLUP position

Maximum Input Voltage: ±24 Vdc (between any terminal and chassis)

Maximum Voltage/Current: (Open Collector Output) ±24 Vdc (max) @ 600 Ω. Low-level voltage/current = 0.4 Vdc @ 40 mA

Maximum Voltage/Current: (TTL Output) 5.5 Vdc (max) @ 5.2 mA. Low level voltage/current = 0.4 Vdc @ 48 mA

Trigger Terminals Outputs:

With TRIGMODE FIRST: 5 Vdc (CMOS) negative (HL) edge (Does not apply to Second Rank Input Trigger Output)

With TRIGMODE ALL: 5 Vdc negative TTL pulse. Nominal value = 2 µS. Range = 1.70 µS to 2.80 µS.

Maximum Wire Size: 16 AWG

Relative Power Consumption: 0.7 W**

** = For multiple accessories, ensure that the sum of the relative power consumption does not exceed 8 for the HP 3852A or 10 for an HP 3853A

SPEED CHARACTERISTICS

This part provides supplemental characteristics which show TYPICAL or NOMINAL, but Non-Warranted performance parameters.

Input Speeds: Rates (reading/sec) to program and execute reads of digital inputs and to transfer readings.

Table 19-1 HP 44723A Specifications (Cont.)

Readings to Mainframe Memory (rdgs/sec):

Packed Format:	176,000
IN16 Format:	176,000

Readings to Controller via HP-IB (rdgs/sec):

Packed Format:	2550
IN16 Format:	2550
IASC Format:	625

Output Speeds: Times to program and execute digital writes (16 channels at one time).

	Commands from Downloaded Subroutine	Commands from HP Series 200/ 300 Controller via HP-IB
Response Time (mS)	0.5	4.0
Continuous Operation (transition/second)	189,000	110

Interrupts: Time (mS) between event occurance and resulting action for a single interrupt and the maximum continuous interrupt rate (interrupt occurs, is serviced and reenabled, and the sequence repeats)

Interrupt Condition	Resulting Action		
	Max time for single call to interrupt subroutine (mS)	Max time to enable SRQ line once (mS)	Max continuous Max continuous (interrupt/sec)
Digital Input:			
Edge Occurance	2.6	0.4	400
Bit Pattern	2.6	0.4	400
Input Trigger	2.6	0.4	320

Table 19-1 HP 44723A Specifications (Cont.)

Set-Up and Hold Times: Time (nS) from occurance of digital input to generation of first rank input trigger

Source	LOW (0)	HIGH (1)	Setup Time (nS)	Hold Time (nS)
5 V	0 V	3 V	500	700
12 V	0 V	7 V	300	500
24 V	0 V	14 V	225	425

Input Trigger Timing: Minimum time (nS) between first and second rank input trigger.

5 V:	590 nS
12 V:	390 nS
24 V:	320 nS

Trigger Output Delays:

Delay time from reception of an external trigger into the IN trigger terminal to generation of a trigger output from the OUT trigger terminal or to generation of valid output data.

1ST IN TRIG IN to 1ST IN TRIG OUT
2ND IN TRIG IN to 2ND IN TRIG OUT [1]
2ND OUT TRIG IN to 2ND OUT TRIG OUT
2ND OUT TRIG OUT to valid data output [2]

[1] = add 600 nS if a "collision" occurs between the first and second rank input triggers (i.e., the second rank input trigger occurs too soon after the first rank input trigger). See "Input Trigger Timing" for minimum times.

[2] = add 600 nS if a "collision" occurs between the write to the first rank output register and generation of a second rank output trigger.

5 V:	800 nS
12 V:	600 nS
24 V:	530 nS

19-4 PERFORMANCE TESTS

19-5 Introduction

The following Performance Tests check the operation of the HP 44723A component module. Performance Tests are not given for the terminal modules. Successful completion of the tests in this chapter provides a high confidence level that the Fast Digital I/O is meeting its listed specifications.

The performance tests should be performed in the order they are presented. The completion of each test increases the confidence level in the Fast Digital I/O Accessory. A minimum set of tests is given as the Operational Verification Tests. These tests are described in Section 19-6.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence level that the Fast Digital I/O Accessory is operating normally, it is not recommended that all the Performance Tests be performed unless one of the tested specifications is in question.

19-6 Operational Verification

The first tests in this section are the minimum set of tests recommended for the Fast Digital I/O Accessory. These tests are designed to test the functionality of the accessory. Successful completion of the Operational Verification Tests provide a 90% confidence level that the Fast Digital I/O Accessory is operating normally and is within specifications.

The Operational Verification Tests consist of the following:

Section 19-10 - Set-Up Procedure
Section 19-11 - Self-Test
Section 19-12 - Input/Output Pattern Test
Section 19-13 - Trigger Test

19-7 Equipment Required

The following test equipment is required to run the Performance Testa. Only the first three items are required for the Operational Verification Tests.

1. Test Fixture (as described in Section 19-8)

2. Test Leads and Jumpers (including 2 ea BNC-to-cliplead cables)

3. Digital Multimeter -- HP 3456A

4. Service Module -- HP 44743-66203

5. 0 to 10 V Power Supply -- HP 6214B

6. 500 ohm 5%, 1/4 W Resistor

7. 100 ohm 5%, 1/4 W Resistor

19-8 Test Fixture

A test fixture is required to run the Performance Tests. The test fixture can be manufactured using an HP 44723AT terminal module. The test fixure is shown in Figure 19-2.

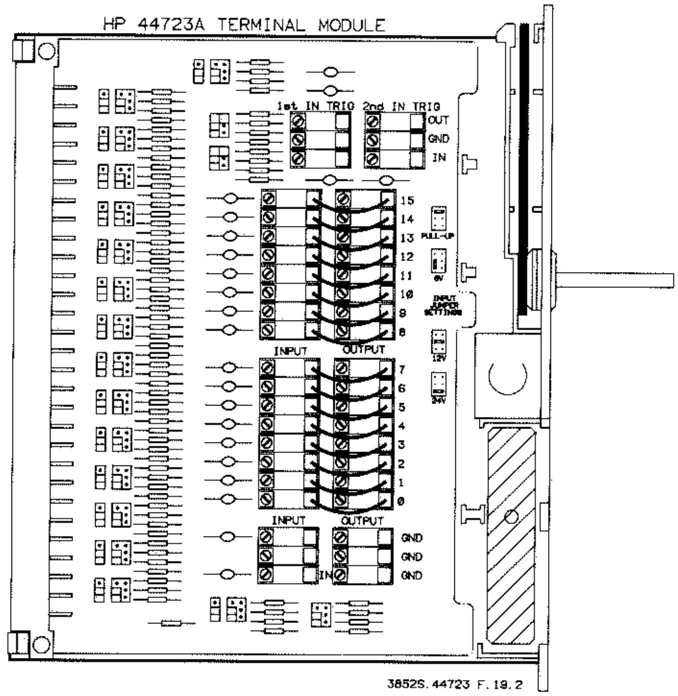


Figure 19-2 HP 44723A Test Fixure

On the test fixture, the output of each channel is connected to the corresponding input of the channel. All Input Jumpers are set to the 5 V position. The test fixure configuration is shown in Figure 19-2.

19-9 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

19-10 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the Fast Digital I/O Accessory component module and install the test fixture. Note the slot number where the accessory under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

b. Execute:

ID? ES00 (where E = extender number, S = slot number)

c. Verify that the HP 3852A right display shows:

44723A

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture may not be installed.

19-11 Self-Test

This test checks most of the circuitry on the component module.

1. Perform the HP 44723A self-test by executing:

TEST ES00 (where E = extender number, S = slot number)

2. The HP 3852A right display should show:

SELF TEST OK

If the display shows a different message, or if the ERR annunciator is on, the HP 44723A accessory may be failing its self-test. Test the accessory again by executing the command in step 1. If the accessory still fails, exchange it with a working one.

19-12 Input/Output Pattern Test

This test verifies that all the accessory's channels can correctly output and input TTL level patterns. A pattern that alternately sets the output channels high and low (i.e., from channel 0 to 15) is selected and then read. A pattern that alternately sets the output channels Low and High is next output and then read.

1. HIGH/LOW PATTERN. This test uses a High/Low pattern to test the channels.

2. Make sure the output of each output channel is connected to its corresponding input channel, as shown in Figure 19-2. Make sure that all output and input jumpers are selected for +5 V TTL, as shown in the figure. It is important that the jumpers are in the correct positions, or the test will fail.

3. Set all HP 44723A channels to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

4. Output a pattern that alternately sets the channels high (1) and low (0) by executing:

WRITE ES00,21845 (where E = extender number, S = slot number)

5. Trigger and read all channels by executing:

READ ES00 (where E = extender number, S = slot number)

6. Verify that the HP 3852A right display shows:

   21845

7. LOW/HIGH PATTERN. This test uses a Low/High pattern to test the channels.

8. Output a pattern that alternately sets the channels low (0) and high (1) by executing:

   WRITE ES00,-21846 (where E = extender number, S = slot number)

9. Trigger and read all channels by executing:

   READ ES00 (where E = extender number, S = slot number)

10. Verify that the HP 3852A right display shows:

   -21846

19-13 Trigger Test

This test checks all trigger operations of the accessory. A subroutine is set up to output certain pulses at the Pacer Output that are used as trigger pulses for the Digital I/O Accessory. The subroutine also sets up the mainframe to wait for an event to occur. The test routine is as follows:

•Pulses from the mainframe's PACER OUT is applied to the Input Terminal of the 1ST IN TRIG block on the terminal module.

•The trigger pulse generated at the Output Terminal of the 1ST IN TRIG block is applied to the Input Terminal of the 2ND IN TRIG block.

•The trigger pulse generated at the Output Terminal of the 2ND IN TRIG block is applied to the Input Terminal of the 2ND OUT TRIG block.

•The trigger pulse generated at the Output Terminal of the 2ND OUT TRIG block is applied to mainframe's EVENT IN input. When this pulse is detected, the subroutine is completed.

1. Refer to Figure 19-3 and make the following connections.

   a. Using a BNC-to-cliplead cable, connect the PACER OUT on the mainframe's rear panel to the Input Terminal of the terminal module's 1ST IN TRIG terminal block.

   b. Using another BNC-to-cliplead cable, connect EVENT IN on the mainframe's rear panel to the Output Terminal of the terminal module's 2ND OUT TRIG terminal block.

   c. On the terminal module, connect the Output Terminal of 1ST IN TRIG block to the Input Terminal of 2ND TIN TRIG block.

   d. Connect the Output Terminal of 2ND OUT TRIG block to the Input Terminal of 2ND OUT TRIG block.

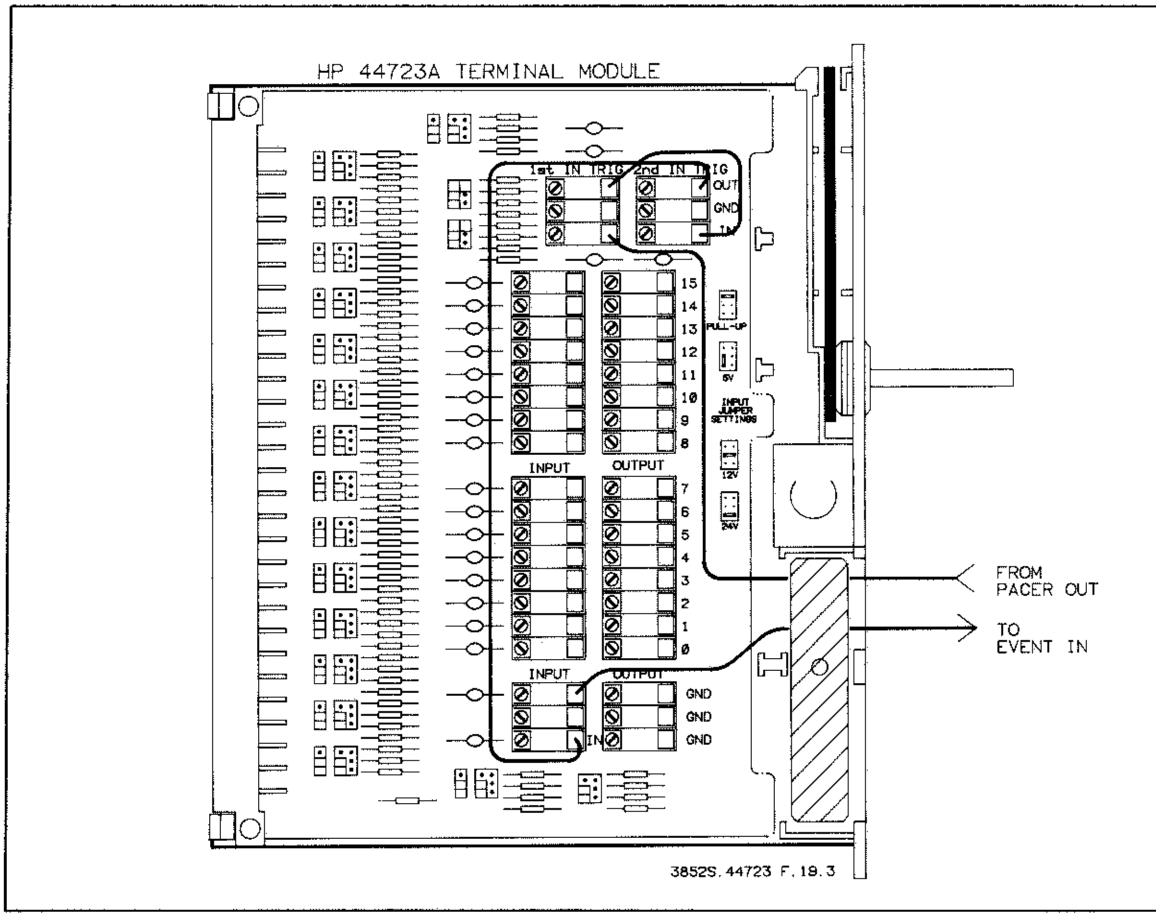


Figure 19-3 HP 44723A Trigger Test

2. Setup the accessory by executing:

   USE ES00 (where E = extender number, S = slot number)
   TRIGMODE ALL
   TRIG EXT
   SRTRIG EXT
   SRTRIG EXT USE ES16 (where E = extender number, S = slot number)

With this setup, each of the accessory's trigger inputs and outputs are set to receive an external trigger and output a trigger pulse.

3. Setup the following subroutine in the HP 3852A memory.

   SUB A
   PACER 1E-6, 1
   PDELAY .1
   PTRIG SGL
   WAITFOR EVENT
   BEEP
   SUBEND

The subroutine sets up the mainframe to output certain pulses at the pacer output and wait for an event to occur. When the event occurs, the mainframe beeps and displays the message SUBEND.

4. Call the entered subroutine by executing:

```
CALL A
```

5. After executing the subroutine, the HP 3852A should "beep" and the message SUBEND should be displayed on the front panel's left display.

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE PERFORMANCE TESTS.

19-14 Input Voltage Test

This test checks the ability of the accessory to detect the correct High (1) and Low (0) input levels.

1. Use the recommended service module to perform the following tests.

2. Remove power from the HP 3852A and unplug the HP 44723A Digital I/O Accessory to be tested. Install the service module in a convenient slot in the HP 3852A. Note the slot number where the service module is installed. Install the HP 44723A accessory on the service module. If not installed, install the terminal module on the HP 44723A accessory.

3. Make sure the input jumpers on the terminal module are selected for +5 V TTL levels on all channels (see Figure 19-4). Also be sure to remove any connections between the output and input terminals.

4. Setup the accessory to trigger internally by executing:

```
USE ES00   (where E = extender number, S = slot number)
TRIG INT
SRTRIG INT
```

5. Setup a power supply to output 0.79 Vdc.

6. Refer to Figure 19-4. Connect the DCV (HI) and COM (LO) inputs of a digital multimeter to the positive (+) and negative (-) outputs of the power supply.

7. Adjust the power supply for a 0.79 Vdc reading on the digital multimeter.

8. Connect the + output of the power supply to the High input of channel 0 on the terminal module. Connect the negative (-) output of the power supply to Gnd on the terminal module.

9. Read all channels by executing:

```
READ ES00   (where E = extender number, S = slot number)
```

10. Verify that the HP 3852A right display shows:

```
0
```

11. Repeat steps 8, 9, and 10 for channels 1 through 15. Be sure to connect the power supply to the correct input terminals on the terminal module.

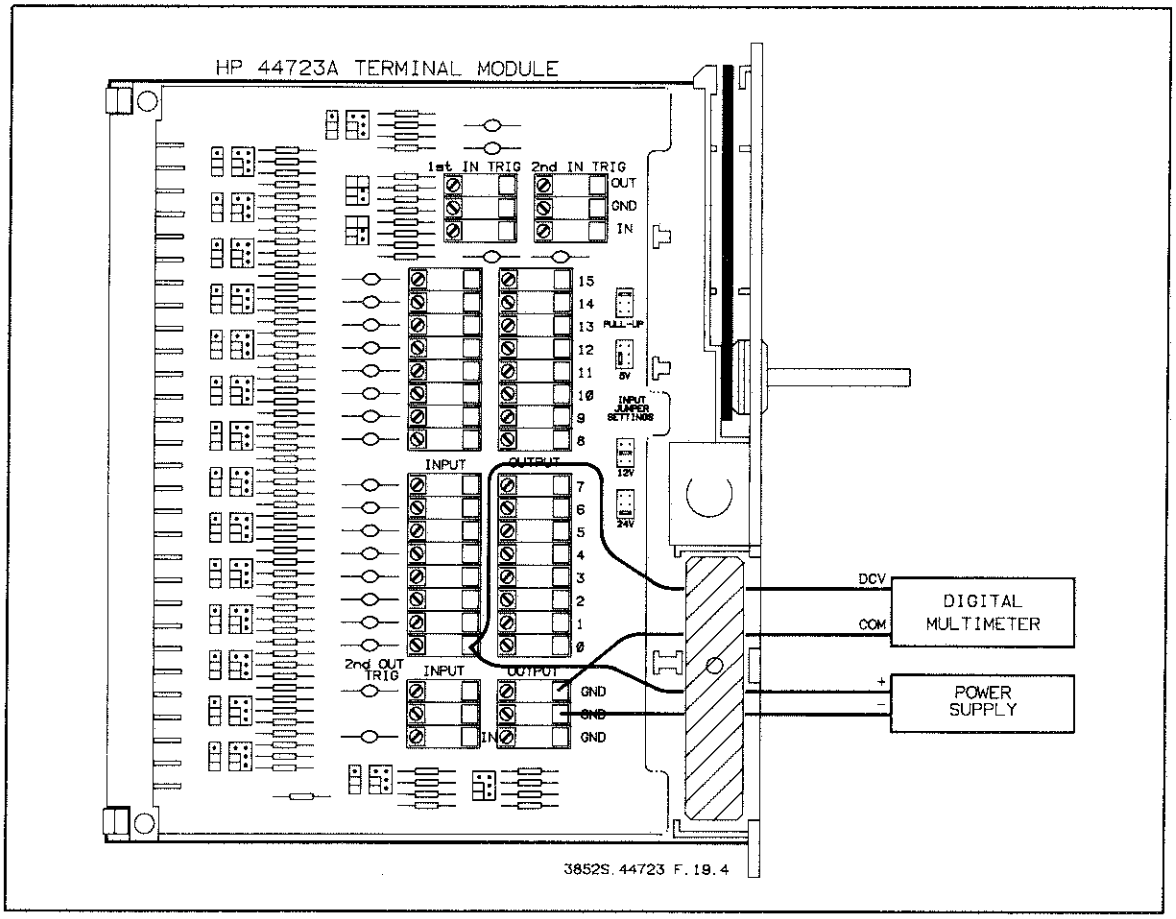


Figure 19-4 Input Voltage Test

12. After all channels are tested, remove the power supply from channel 15.

13. Adjust the power supply for a 2.6 Vdc reading on the digital multimeter.

14. Connect the power supply to the channel 0 input terminals.

15. Read channel 0 by executing:

    READ ES00 (where E = extender number, S = slot number)

16. Verify that the HP 3852A right display shows:

    1

17. Repeat steps 14 and 15 for channels 1 through 15 Be sure to connect the power supply to the correct input terminals on the terminal module. The reading on the display for channels 1 through 15 should be as follows:

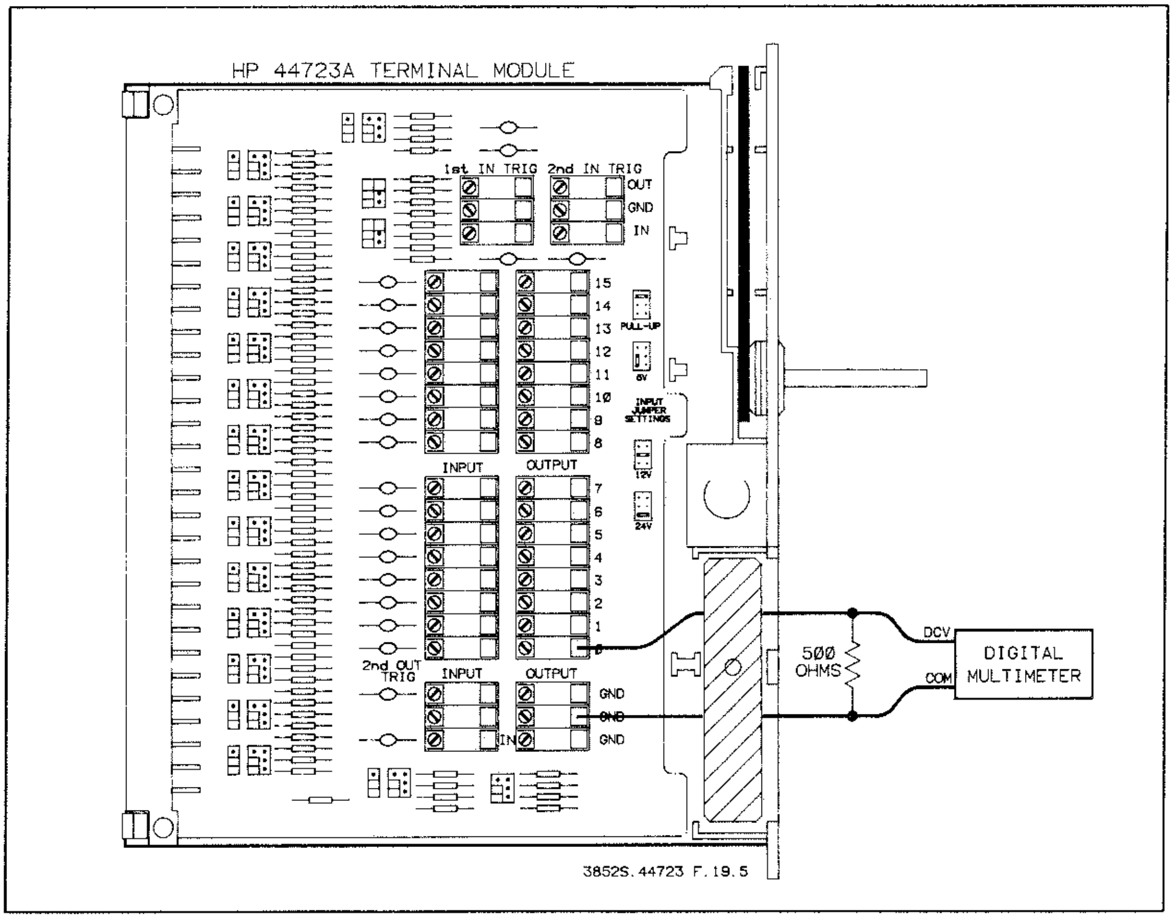


Figure 19-5 Output Driver Test

Channel No.	Reading	Channel No.	Reading
1	2	8	256
2	4	9	512
3	8	10	1024
4	16	11	2048
5	32	12	4096
6	64	13	8192
7	128	14	16384
		15	-32768

17. Leave the service module connected to the accessory. Disconnect the power supply from the accessory. Disconnect the digital multimeter from the power supply.

19-15 Output Driver Test

This test checks the current output and sink capability of the TTL output, the current sink capability of the open collector output drivers, and the input leakage of the open collector drivers.

1. TTL OUTPUT HIGH LEVEL DRIVE TEST. This test checks the output current capabilities of the TTL output drivers.

2. Make sure the output jumpers on the terminal module are selected for TTL outputs on all channels (see Figure 19-5).

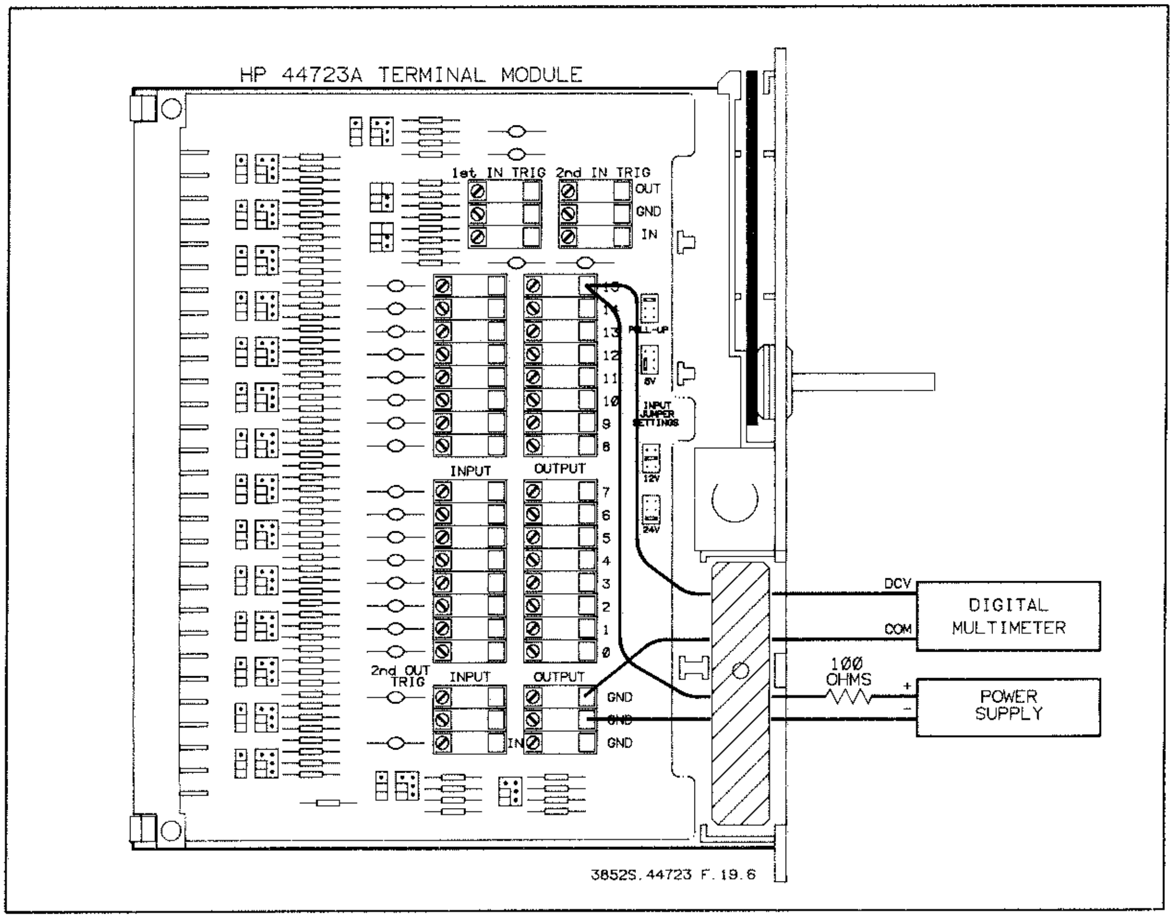


Figure 19-6 TTL Sink Current Test

3. Set all channels high (1) by executing:

WRITE ES00,-1 (where E = extender number, S = slot number)

4. Refer to Figure 19-5. Connect a 500 Ω, 1/4 W resistor across the digital multimeter's DCV (HI) and COM (LO) input terminals. Setup the digital multimeter for dc volts and autorange.

5. Connect the digital multimeter's DCV input to the HIGH output terminal of channel 0 on the terminal module. Connect the COM input to GND on the terminal module. The setup is shown in Figure 19-5.

6. Verify that the digital multimeter displays greater than or equal to 2.4 Vdc.

7. Repeat steps 5 and 6 for channels 1 through 15. Be sure to connect the multimeter to the appropriate output terminals on the terminal module.

8. At the conclusion of this test, remove the resistor from the digital multimeter. Leave the multimeter connected for the next test (it should be connected to the output terminals of channel 15).

9. TTL OUTPUT SINK CURRENT TEST. This test checks the sink current capability of the TTL output drivers.

10. Set all channels low (0) by executing:

WRITE ES00,0 (where E = extender number, S = slot number)

11. Refer to Figure 19-6. Set a power supply to output +5 V. Connect the negative (-) output to GND on the terminal module. Connect the positive (+) output of the power supply to a 100 Ω, 1/4 W resistor.

12. Connect the other end of the resistor to the high output terminal of channel 15 on the terminal module. The setup is shown in Figure 19-6.

13. Verify that the digital multimeter displays less than or equal 0.4 V.

14. Repeat steps 12 and 13 for channels 14 through 0. Be sure to connect the multimeter and resistor to the appropriate output terminals on the terminal module.

15. Leave the digital multimeter, power supply, and resistor connected to the terminal module (on output terminal of channel 0).

16. OPEN COLLECTOR OUTPUT SINK CURRENT TEST. This test checks the sink current capability of the open collector output drivers.

17. Change the power supply output to 4 V.

18. Change ALL output jumpers on the terminal module to open collector outputs as shown in Figure 19-7.

19. Verify that the digital multimeter displays less than or equal to 0.4 V.

20. Repeat steps 18 and 19 for channels 1 through 15. Be sure to connect the multimeter to the appropriate output terminals on the terminal module.

21. At the completion of this test, remove the multimeter, power supply, and resistor from the terminal module.

19-16 REPLACEABLE PARTS

Figure 19-8 shows the mechanical breakdown of the HP 44723A. The figure also provides assembly and disassembly information. The parts shown in Figure 19-8 are keyed to the parts list in Table 19-2.

To order a part listed in Table 19-2, quote the Hewlett-Packard part number, the quantity desired, the HP system description, and the check digit (abbreviated CD in Table 19-2). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

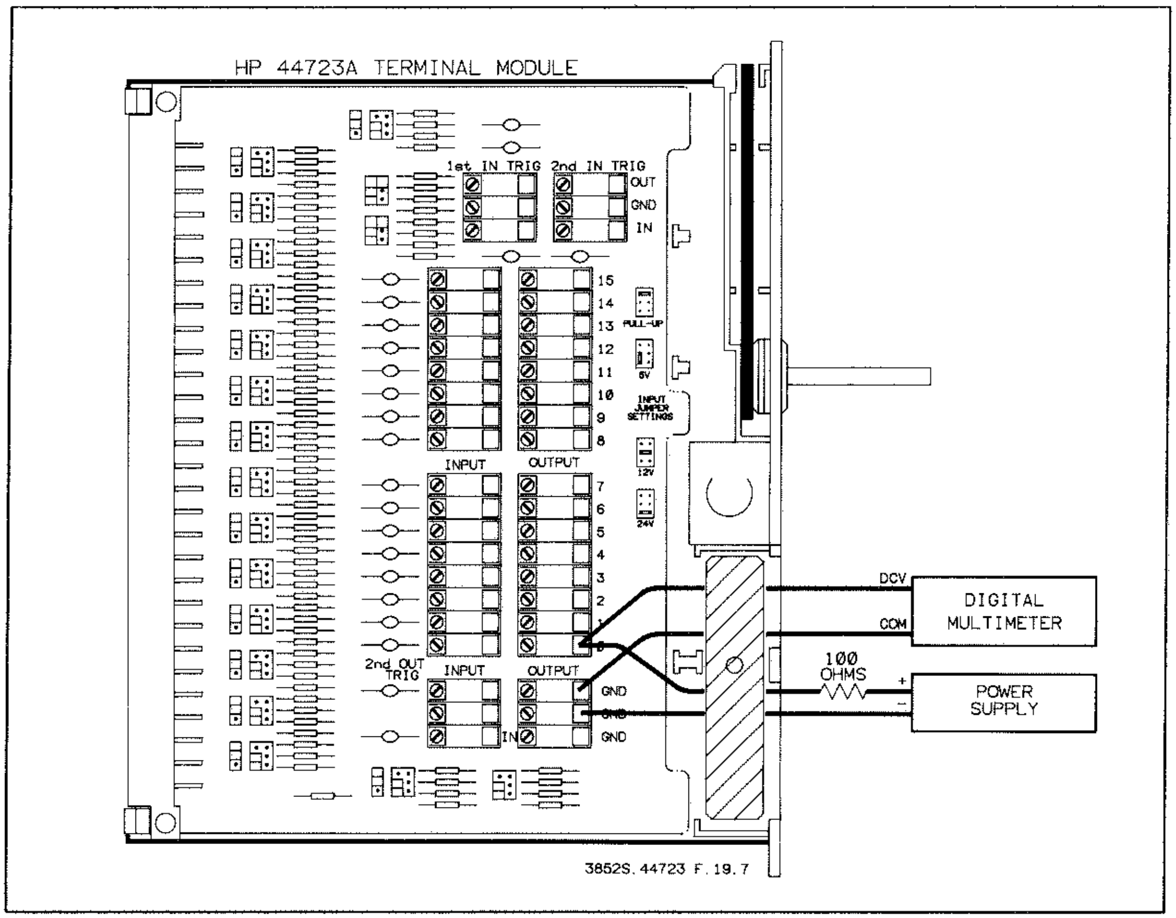


Figure 19-7 Open Collector Sink Current Test

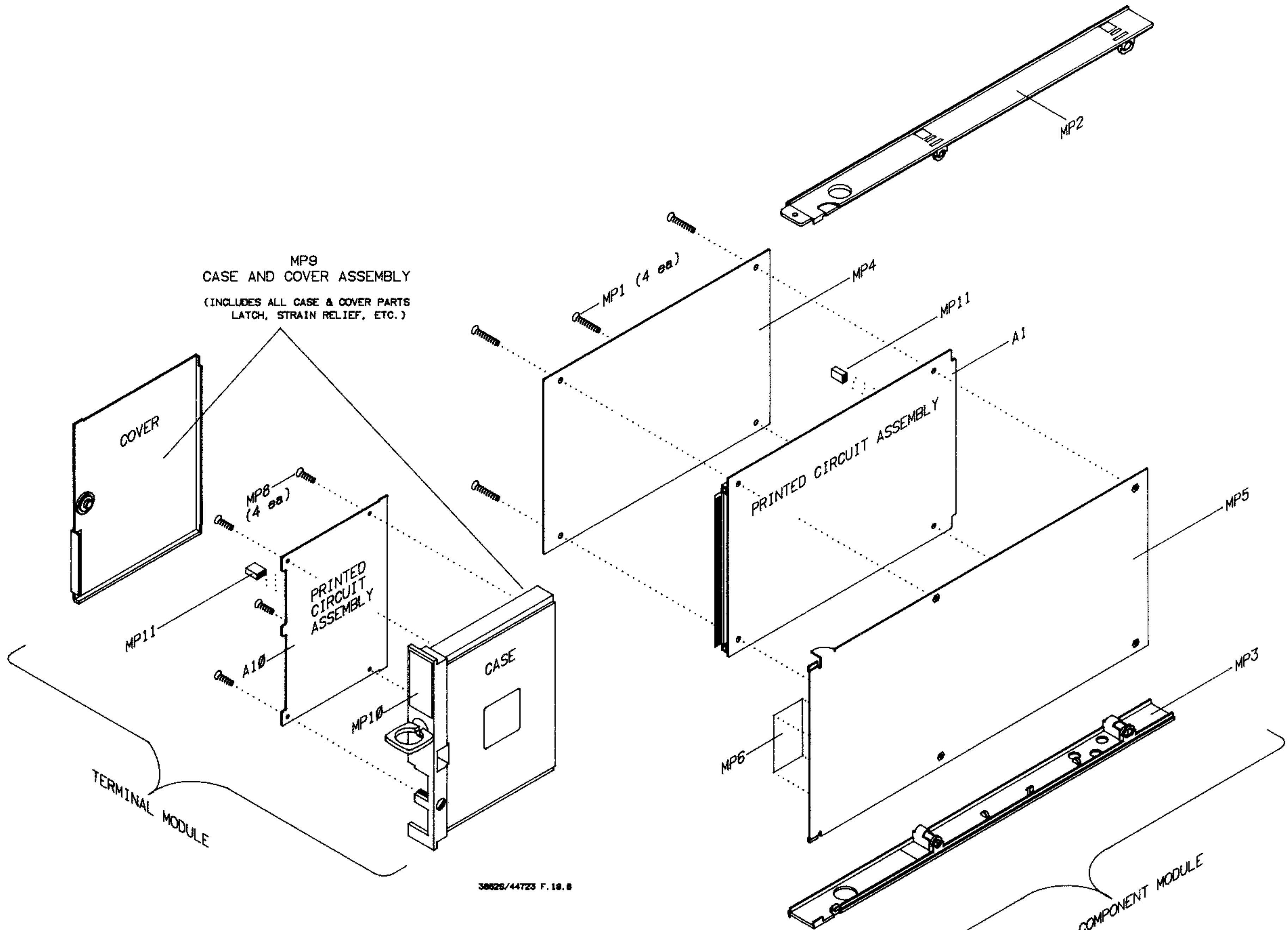


Figure 19-8 HP 44723A Exploded View

Table 19-2 HP 44723A Fast Digital I/O

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44723A	Module; 16ch Fast Digital I/O	1	44723-66201	3	MOD-DIG.SEN CONT
A1	PCA; 16ch Fast Digital I/O component	1	44723-66501	6	PCA-FST DGTL I/O
A10	PCA; 16ch Fast Digital I/O terminal	1	44723-66510	7	PCA-FST DGTL TERM
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44723A component module	1	44723-84320	5	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear pnl of term mod 44723A	1	44723-84325	0	LBL-ID,TERM ASSY
MP11	Jumper; removable, A10 PCA	35	1258-0141	8	JMPR-REM .025P

Completely assembled HP 44723A terminal modules can be ordered from your local HP office by ordering Number 44723AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program. For details see Section 4-9.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44723A	Module; 16ch Fast Digital I/O		44723-69201	9	RBLT-44723-66201

Chapter 20
HP 44730A/32A/33A
Track/Hold

CHAPTER 20

HP 44730A 4 CHANNEL TRACK/HOLD WITH SIGNAL CONDITIONING
HP 44732A/44733A 4 BRIDGE DYNAMIC STRAIN GAGE

CHAPTER 20
HP 44730A
TRACK/HOLD WITH
SIGNAL CONDITIONING
HP 44732A/44733A
STRAIN GAGE

20-1 INTRODUCTION

This chapter provides a technical description, performance test procedures, calibration procedures, and a replaceable parts list for the HP 44732A Track/Hold with Signal Conditioning Accessory (called the Signal Conditioning Accessory). Also included are the replaceable parts lists of the HP 44732A 120 ohm and HP 44733A 350 ohm Dynamic Strain Gages.

NOTE

The Signal Conditioning Accessory can only be used with instruments having a firmware revision of 3.5 or above. Determine the firmware revision by sending the mainframe command: **IDN?**.

20-2 HP 44730A Technical Description

The HP 44730A Track/Hold with Signal Conditioning Accessory has four channels for signal conditioning and four channels for measuring transducer exitation supply voltages. The accessory also has four +4.6 V power supplies that can be used for transducer exitation voltages.

Included on the accessory are trigger input terminals for triggering the track/hold or peak detection circuitry. Also supplied are output terminals for making measurements with an externally connected device (e.g., a voltmeter) and calibration terminals for connecting calibration signals.

The accessory can be connected via a ribbon cable to an HP 44702A High Speed Voltmeter for high speed measurements. The High Speed Voltmeter can also be used to trigger the accessory and to transfer measurement data to the voltmeter.

Refer to Figure 20-1. The HP 44730A has two main assemblies: a component module and a terminal module. The component module includes the input amplifier and associated circuitry, various multiplexers, track/hold and peak detection circuitry, backplane control logic, ribbon cable control logic, and the +4.6 V power supplies. The terminal module has the terminal blocks for connecting external wiring to the accessory.

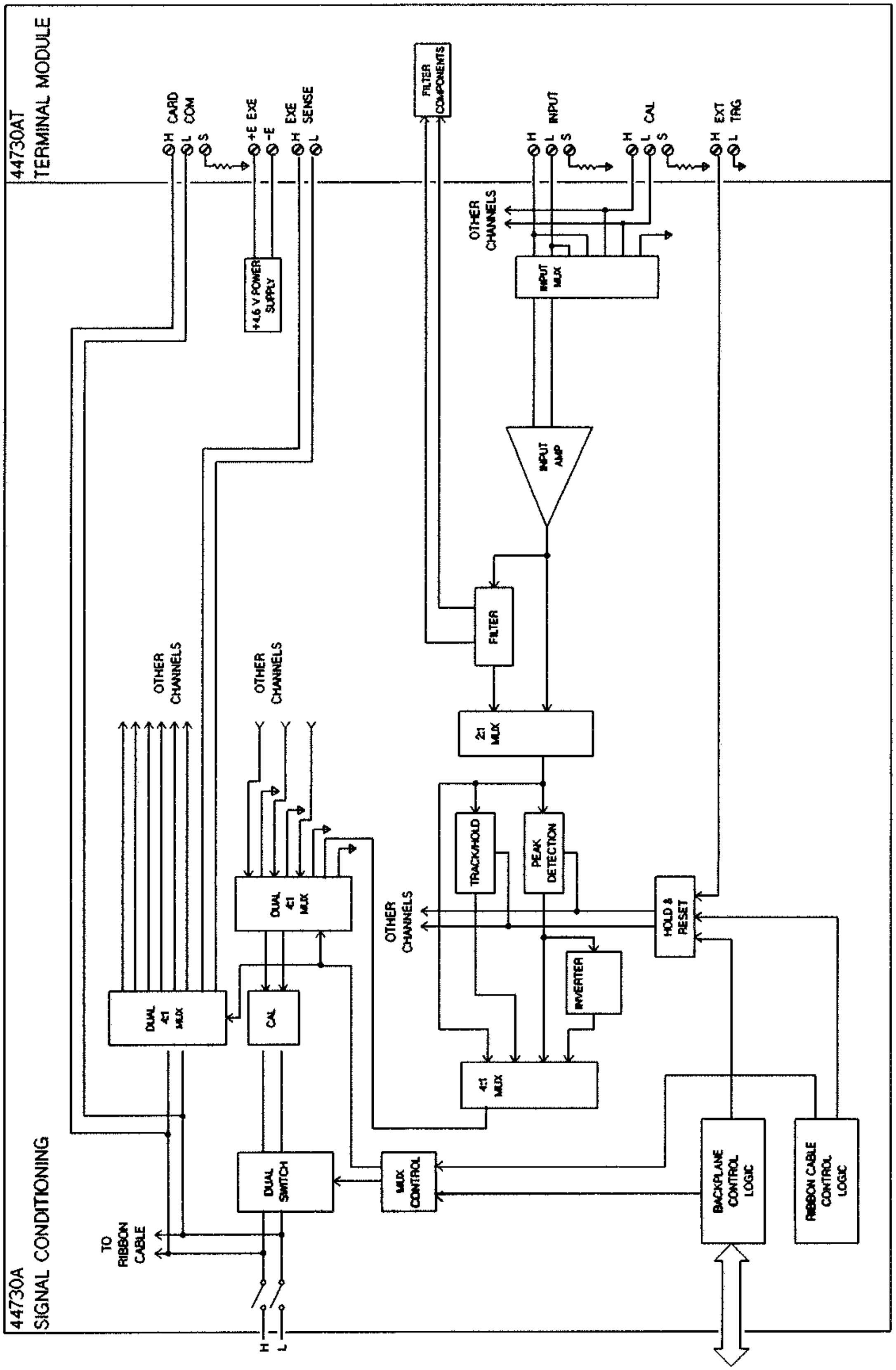


Figure 20-1 HP 44730A Simplified Block Diagram

The following paragraphs explain the operation of the accessory. Except where noted, only one channel is explained since the operation is the same for all channels.

The input signal is applied to the High (H) and Low (L) input terminals on the terminal module. (The Shield (S) terminal is used as a termination for a shielded cable that also serves as a bias current return path.) The input signal is then applied to the input multiplexer which connects it to the input amplifier. The multiplexer also performs other functions. It connects the input signal to an inverter for negative peak detection measurements only. It also connects the amplifier inputs to ground for an autozero measurement and connects the calibration signal to the input amplifier for calibration.

The input amplifier consists of a differential amplifier with three selectable gains: 1, 10, and 100. The amplifier's input voltage levels are ±10.24 V. The amplifier is calibrated programatically by applying a calibration signal to the input amplifier and then adjusting the amplifier's offset and gain with digital-to-analog converters (DACs). Calibration constants are then calculated and stored in an EEPROM.

The output of the amplifier is applied either directly to the track/hold amplifier, positive and negative peak detection circuitry, and the output multiplexer, or to the same circuitry through a filter. A 2:1 multiplexer is used to connect the filter between the amplifier and the different circuitry. The output of the amplifier (either direct or through the filter), or the output of the track/hold amplifier and the peak detection circuitry is connected to the output multiplexer circuitry via a 4:1 multiplexer. The output of the output multiplexer circuitry becomes the actual output of the accessory, after signal conditioning. The output multiplexer circuitry consists of a dual 4:1 multiplexer, the calibration circuitry, and a dual switch switch.

The filter is resistor programmable with its response determined by user selectable passive components on the terminal module.

The track/hold amplifier provides simultaneous sampling of all channels. The hold state is triggered either by the backplane trigger (on the mainframe), by the HP 44702A High Speed Voltmeter via the ribbon cable, or from the trigger input on the terminal module. The different triggers are user selectable.

The peak detection circuitry can perform both positive and negative peak detection. The same circuitry is used for both operations. To perform positive peak detection, the accessory's input signal is inverted before it is applied to the input amplifier. The input amplifier inverts the signal again. This applies a non-inverted signal to the peak detection circuitry. The output signal of the amplifier then in effect becomes a positive output signal. This signal is then inverted following the peak detection stage and inverted again in the calibration stage. This restores the final signal to the original polarity.

For negative peak detection, the signal is inverted in the input amplifier, peak detected, and re-inverted in the calibration stage.

The output multiplexer circuitry scans all four signal conditioning channels and the four channels used to measure the transducer exitation voltages. This makes the output of all channels available to the backplane through isolation relays, the High Speed Voltmeter via the ribbon cable, and the output terminals on the terminal module. The scanning of the channels is controlled by either the backplane control logic (i.e., the mainframe) or the ribbon cable control logic (i.e., HP 44702A High Speed Voltmeter).

The +4.6 V powers supplies are regulated supplies that are capable of supplying 45 mA each.

The backplane control logic interfaces the mainframe with the accessory. It is used to select the gain of the input amplifier, enables/disables the filter, selects the track/hold and peak detection circuitry, and controls the calibration of the accessory.

20-3 HP 44732A and HP 44733A Technical Description

The HP 44732A and HP 44733A Strain Gage terminal modules work in conjunction with the HP 44730A Signal Conditioning Accessory to make strain gage measurements. The HP 44732A is used for 120 Ω strain gage measurements and the HP 44733A is for 350 Ω measurements. The modules have terminal strips for making external connections for quarter, half, and/or full bridge configurations.

Figure 20-2 shows a simplified schematic of the HP 44732A and 44733A strain gage modules, and also shows the different strain gage configurations. The actual strain gage measurements are made by a voltmeter via the HP 44730A Signal Conditioning Accessory. Either the HP 44702A High Speed Voltmeter (via the ribbon cable), or the HP 44701A DC Voltmeter or an externally connected voltmeter connected to either the analog bus or the CARD COM terminals (on the strain gage module) can be used for measurements. The exitation voltage for the strain gage bridge is supplied by +4.6 V power supplies (one for each channel) on the HP 44730A component module. The +4.6 V supplies are measured by connecting the +E and -E2 EXC terminals to the corresponding H and L EXC SENSE terminals on the strain gage module. Like the strain gage measurements, the +4.6 V supplies are measured using the HP 44702A High Speed Voltmeter, the HP 44701A DC Voltmeter, or an externally connected voltmeter.

20-4 SPECIFICATIONS

Specifications for the HP 44730A are given in Table 20-1. Specifications are the performance standards or limits against which the accessory may be tested.

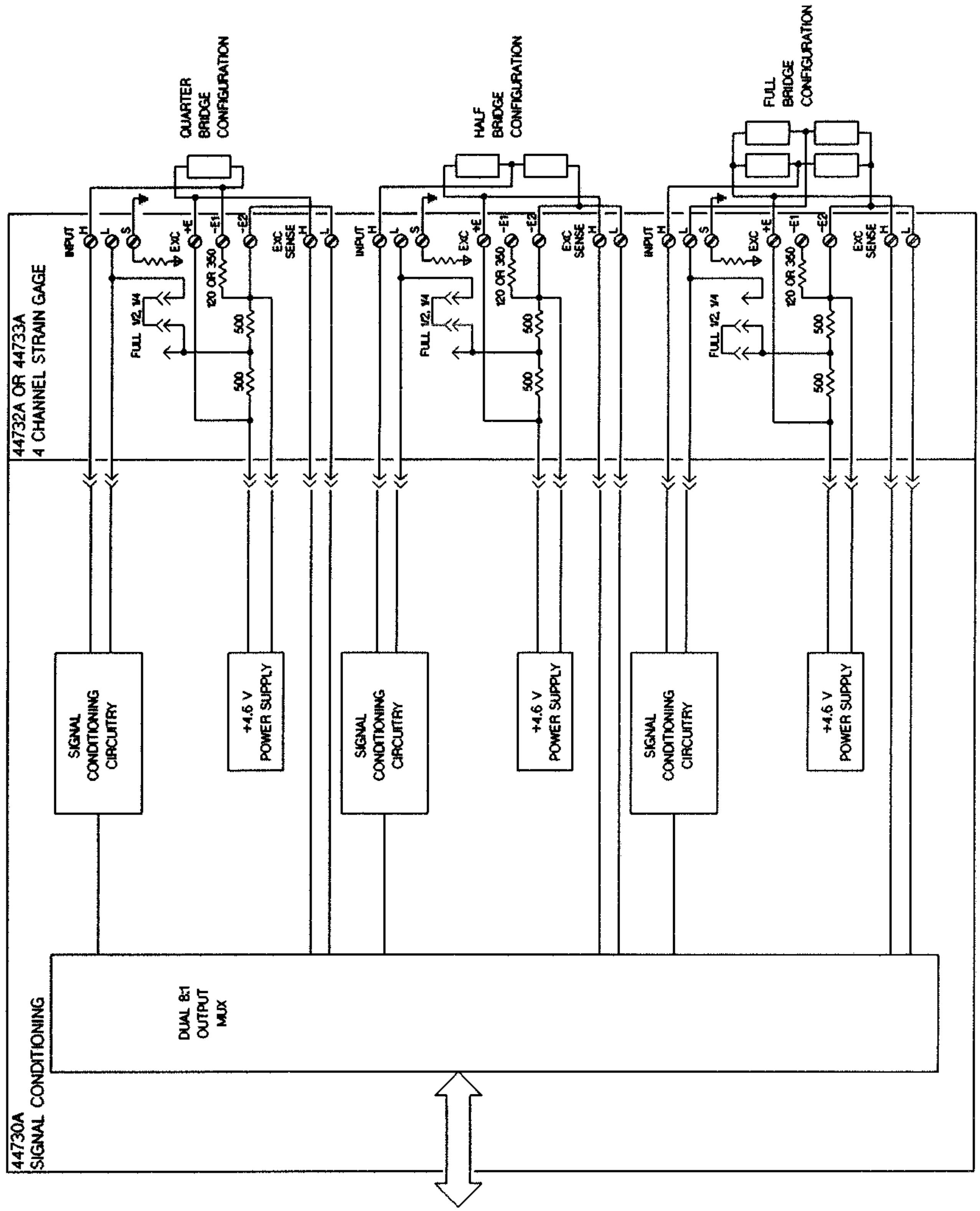


Figure 20-2 HP 44732A/44733A Simplified Schematic

Table 20-1 HP 44730A/44732A/44733A Specifications

Channel Inputs:

Maximum Sample Rate: 100 kHz (using HP 44702A/B Voltmeter)
Maximum Input Voltage: ±12 V
Maximum Input Current: 15 mA

Input Impedance:

Impedance	Terminals: High to Low	Terminals: High or Low to Chassis
Power On Resistance (Ω)	$>10^8$	$>10^8$
Power Off Resistance (Ω)	>1000	>1000
Max. Capacitance (pF) at 1MHz	50	50

DC Accuracy: ±(% of reading + offset) referred to the input. Specified with autozero (nulling for strain) performed within one minute of measurement.

90 days, 18° to 28°C

	Gain 1	Gain 10	Gain 100
Multiplexer only	0.02% + 1mV	0.02% + 0.1mV	0.03% + 20µV

Add an additional error for each of the following functions:

	Gain 1	Gain 10	Gain 100
Filter	0.005% + .3mV	0.005% + 0.03mV	0.005% + 3µV
Track/Hold	0.005% + 5mV	0.005% + 0.5mV	0.005% + 50µV
Peak Detect	0.005% + 20mV	0.005% + 2mV	0.005% + 200µV
Strain (all type)*	0% + 0.5mV	0% + 0.05mV	0% + 5µV

Temperature Coefficient: Add as an additional accuracy error per °C for an operating temperature outside of 18° to 28°C but within 0 to 55°C for all configurations.

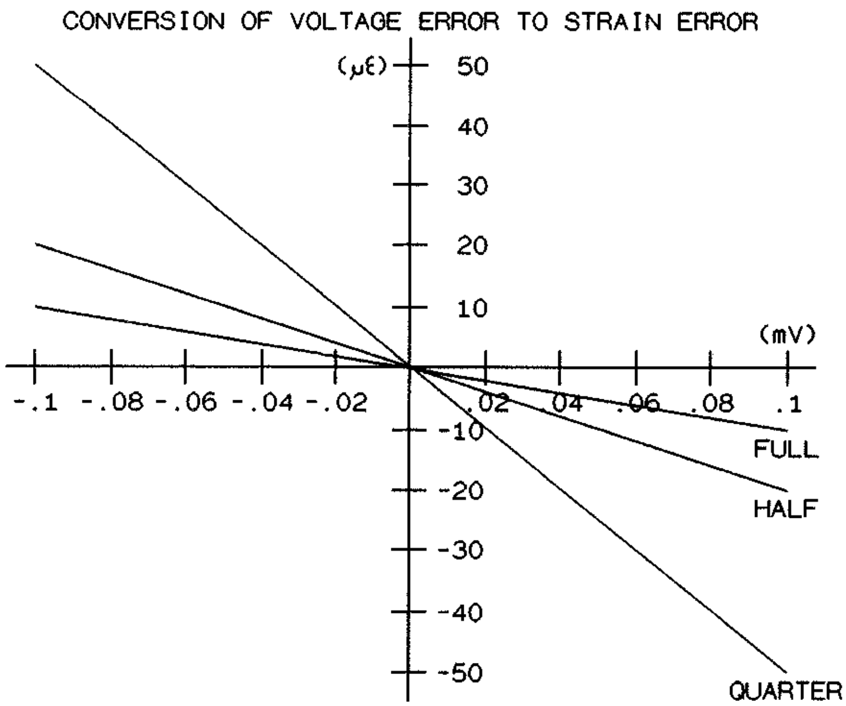
Table 20-1 HP 44730A/44732A/44733A Specifications (Cont.)

Gain 1	Gain 10	Gain 100
0.002% + 0.01mV	0.002% + 0.001mV	0.004% + 0.1µV

* All strain specifications are made using internal power supplied on the plug-in module.

Voltage To Strain Error Conversion:

The following figure shows conversion of voltage error (mV) to equivalent strain error (µε) for 1/4 (QUARTER), 1/2 (HALF), and full (FULL) bridge measurements for a gage factor (GF) of 2.



Gain:

Using the HP 44702A/B High Speed Voltmeter. Cross-talk specified for channel-to-channel with 50 Ω source and 1 MΩ termination @ 10 kHz.

Table 20-1 HP 44730A/44732A/44733A Specifications (Cont.)

	Gain 1	10	100
Bandwidth (3dB point)	1.0 MHz	500 kHz	250 kHz
Cross-talk (dB)	-50	-70	-80
CMRR (dB, 1 kohm unbalance):			
@ DC	70	85	100
@ 60 Hz	60	80	90
@ 10 kHz	30	40	45

Filter:

The accessory is shipped with a four-pole Bessel filter with default bandwidth of 10 kHz. Filter characteristics can be changed by changing component values on the terminal module. Default bandwidth = 10 kHz.

Track/Hold:

	Trigger Internal	External
Acquisition time (µS)**	2	2
Aperture time (nS)	25	25
Aperture delay time (nS)	105	60
Aperture jitter (nS)	0.5	0.5
Time skew between channels (nS)	1.2	1.6
Time skew between cards (nS)	1.5	2.5
Droop rate @ 25°C (V/S)***	0.5	0.5

** Acquisition time to within 0.01% of full-scale. Refer to Appendix B in HP 3852A Configuration and Programming Manual for parameter definitions.

*** Doubles every 6.5°C above 25°C.

Peak Detect: Minimum duration (µS) of a square wave (without the filter) to attain system accuracies listed above OR to attain an accuracy of 1% of full-scale.

	Gain 1	10	100
System accuracies	50	50	70
Accuracies at full scale	5	5	10

Table 20-1 HP 44730A/44732A/44733A Specifications (Cont.)

Strain Gage: Resolution (με) using the internal 4.6 V supply, a gain of 100, and the HP 44702A/B High Speed Voltmeter on the 2.56 V range.

	Bridge		
	1/4	1/2	Full
Resolution (με)	2.7	1.4	0.7

Relative Power Consumption: 3.0 using power supplies with HP part number 03852-66202. 1.0 using power supplies with HP part number 03852-66212.

Maximum Wire Size: 16 AWG

20-5 PERFORMANCE TESTS

20-6 Introduction

The following Performance Tests check the operation of the HP 44730A component module. Performance Tests are not given for the terminal modules. Successful completion of the tests in this chapter provides a high confidence level that the Signal Conditioning Accessory is meeting its listed specifications.

The performance tests should be performed in the order they are presented. The completion of each test increases the confidence level in the Signal Conditioning Accessory. A minimum set of tests is given as the Operational Verification Tests. These tests are described in Section 20-7.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence level that the Signal Conditioning Accessory is operating normally, it is not recommended that all the Performance Tests be performed unless one of the tested specifications is in question.

20-7 Operational Verification

The first tests in this section are the minimum set of tests recommended for the Signal Conditioning Accessory. These tests are designed to test the functionality of the accessory. Successful completion of the Operational Verification Tests provide a 90% confidence level that the Signal Conditioning Accessory is operating normally and is within specifications.

The Operational Verification Tests consist of the following:

Section 20-11 - Set-Up Procedure
Section 20-12 - Self-Test
Section 20-13 - DCV Test
Section 20-14 - Nulling Functionality Test
Section 20-15 - Peak Detection Functionality Test
Section 20-16 - Ribbon Cable Test

20-8 Equipment Required

The following test equipment is required to run the Performance Tests.

1. Test Fixure (as described in Section 20-9).

2. Test Leads and Jumpers.

3. Digital Multimeter -- HP 3456A.

4. Stable DC Voltage Source -- Any stable dc voltage source that can output 0.1 V, 1.0 V, 4.9 V, and 10 V.

In the dc volts test procedures, the dc voltages applied to the HP 44730A must be accurate and stable. Good accuracy and stability are needed to meet the accessory's accuracy requirements.

With the above in mind, there are two ways of performing the test procedures.

a. Use the recommended digital multimeter to adjust the dc voltage source output to the correct accessory input. Do this by connecting the dc voltage source to the digital multimeter and then adjust the voltage source to the appropriate accessory input voltage. Use the reading on the digital multimeter to adjust for the correct voltage. Then connect the dc voltage source to the accessory for testing.

The test procedures are written using the above procedure. If you plan to use this procedure, keep the following in mind.

The dc voltage source must have good short term stability. This is needed since it takes time to manually perform the test procedures. Any drift in the dc source may make the tests invalid.

The dc source must be adjustable so you can adjust it to the correct input voltage, as read on the digital multimeter.

b. Use an accurate and stable dc voltage standard, like the Datron Model 4000/4000A. You can directly connect one of these standards to the HP 44730A input without adjusting the standard's output voltage on the digital multimeter. It has sufficient accuracy and short term stability to test the HP 44730A.

5. Function Generator -- HP 3325A.

6. HP 44702A/B High Speed Voltmeter (only required for full performance test or if the Ribbon Cable Test in Section 20-16 is to be performed).

NOTE

The integrating plug-in voltmeter (HP 44701A) may be used for the Performance/Operational Verification Test Procedures. The tests do not describe specific steps required to use the plug-in voltmeter. A description of the plug-in voltmeter can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

20-9 Test Fixure

A test fixure is recommended to run the Performance Tests. The test fixure can be manufactured using an HP 44730AT terminal module. Make sure the filter components on the terminal module are the ones installed by the factory. Any changes made to the filter components invalidates the following filter tests. The use of the fixure minimizes the number of test connections required for the tests.

On the test fixure, the H (High) and L (Low) inputs of each channel are connected to each other. The test fixure configuration is shown in Figure 20-3.

20-10 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

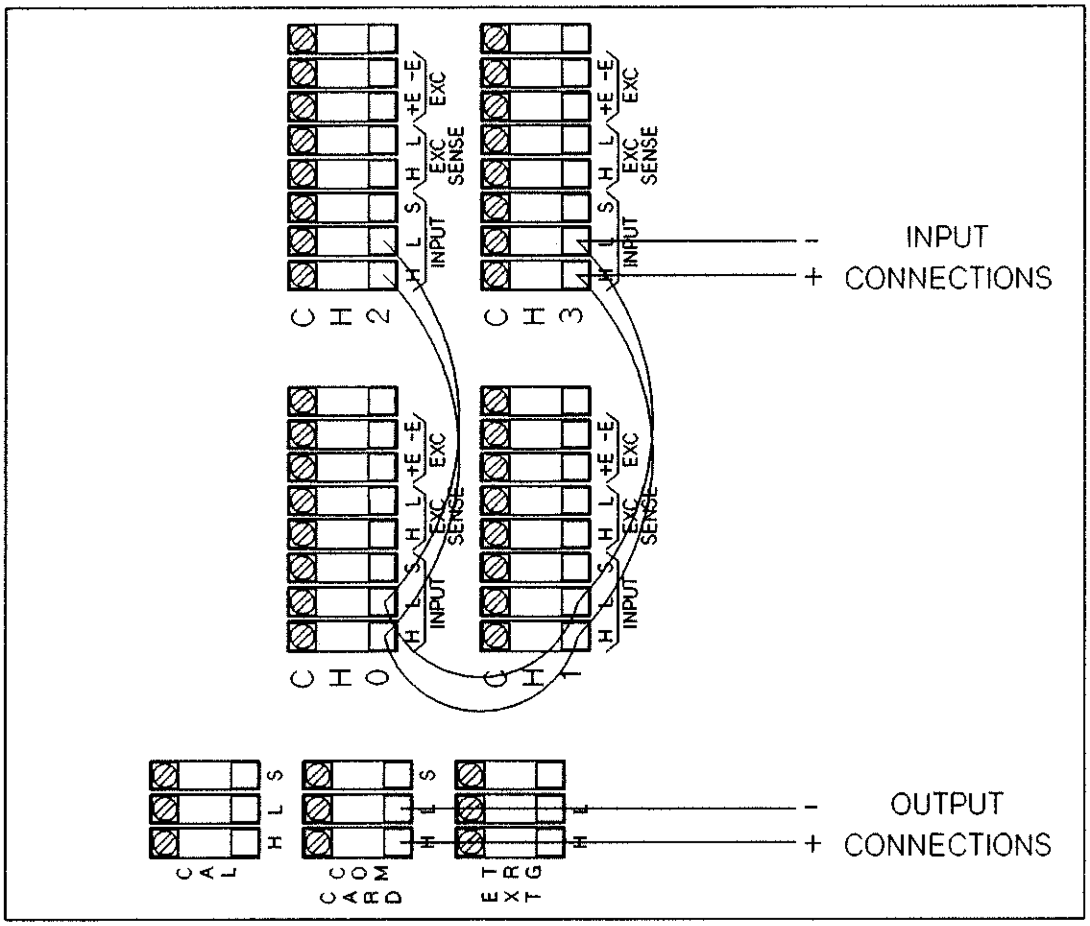


Figure 20-3 HP 44730A Test Fixure

20-11 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Make sure a terminal module is installed in the accessory. Note the slot number where the accessory under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

   c. Verify that the HP 3852A right display shows the following:

      44730A

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture may not be installed.

20-12 Self-Test

This test checks most of the accessory's digital circuitry.

1. Perform the HP 44730A self-test by executing:

   TEST ES00 (where E = extender number, S = slot number)

2. The HP 3852A right display should show:

   SELF TEST OK

If the display shows a different message, or if the ERR annunciator is on, the HP 44730A accessory may be failing its self-test. Test the accessory again by executing the command in step 1. If the accessory still fails, exchange it with a working one.

20-13 DCV Test

This test is in three parts. One part checks the full scale dc volts accuracy of the accessory. Another part checks the filter. The last part checks the isolation relays.

1. Set the HP 44730A accessory to a known state by executing:

   RESET ES00 (where E = extender number, S = slot number)

2. Set the digital multimeter to dc volts and autorange. Then connect it to the dc voltage source.

3. Set the dc voltage source for a 10.0000 V output, as shown on the digital multimeter.

4. Refer to Figure 20-4. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the dc voltage source to the H and L Input Connections on the test fixure.

5. Set the channel 0 gain to "1" and turn on autozero by executing:

   FUNC AMPLIFY,1 USE ES00 (where E = extender number, S = slot number)
   AZERO ONCE, USE ES00 (where E = extender number, S = slot number)

6. Close channel 0 by executing:

   CLOSE ES00 (where E = extender number, S = slot number)

7. Observe the indication on the multimeter. It should indicate 10.0000 V ± 0.003 V.

8. Enable the filter and autozero by executing:

   FILTER ON, USE ES00 (where E = extender number, S = slot number)
   AZERO ONCE, USE ES00 (where E = extender number, S = slot number)

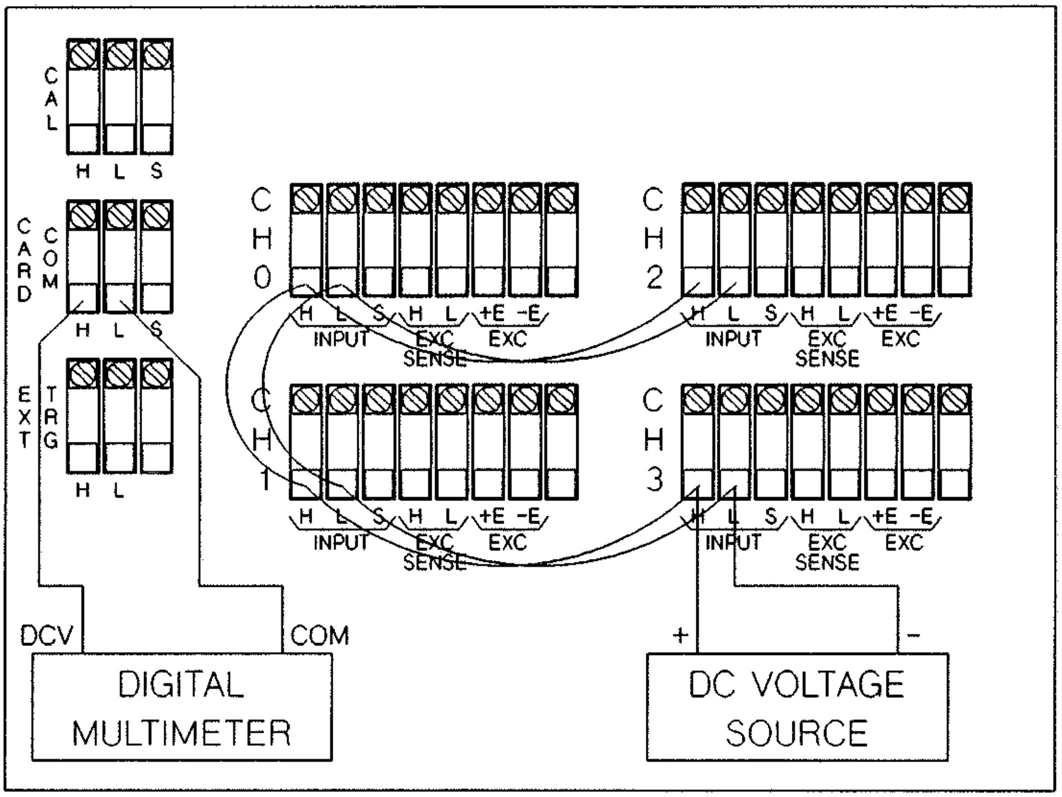


Figure 20-4 DC Voltage Source Connections

9. Observe the indication on the multimeter. It should indicate 10.0 V ± 0.0038 V.

10. Turn the filter off by executing:

FILTER OFF, USE ES00 (where E = Extender number, S = slot number)

11. Repeat steps 5 through 10 for channels 1, 2, and 3. In the USE, CLOSE, and FILTER commands in steps 5, 6, 8, and 10, the last two digits are the channel number (e.g., USE ES02 for channel 2).

12. Remove the dc voltage source from the test fixure. Connect the digital multimeter to the dc voltage source.

13. Set the dc voltage source for a 1.0000 V output, as shown on the digital multimeter.

14. Refer to Figure 20-4. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the dc voltage source to the H and L Input Connections on the test fixure.

15. Set the channel 0 gain to "10" and turn on autozero by executing:

FUNC AMPLIFY, 10 USE ES00 (where E = extender number, S = slot number)
AZERO ONCE, USE ES00 (where E = extender number, S = slot number)

16. Close channel 0 by executing:

CLOSE ES00 (where E = extender number, S = slot number)

17. Observe the indication on the multimeter. It should indicate 10.0000 V ± 0.003 V.

18. Repeat steps 15, 16, and 17 for channels 1, 2, and 3. In the USE and CLOSE commands in steps 15 and 16, the last two digits are the channel number (e.g., USE ES02 for channel 2).

19. Remove the dc voltage source from the test fixure. Connect the digital multimeter to the dc voltage source.

20. Set the dc voltage source for a 0.10000 V output, as shown on the digital multimeter.

21. Refer to Figure 20-4. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the dc voltage source to the H and L Input Connection on the test fixure.

22. Set the channel 0 gain to "100" and turn on autozero by executing:

FUNC AMPLIFY, 100 USE ES00 (where E = extender number, S = slot number)
AZERO ONCE, USE ES00 (where E = extender number, S = slot number)

23. Close channel 0 by executing:

CLOSE ES00 (where E = extender number, S = slot number)

24. Observe the indication on the multimeter. It should indicate 10.0000 V ± 0.005 V.

25. Repeat steps 22, 23, and 24 for channels 1, 2, and 3. In the USE and CLOSE commands in steps 22 and 23, the last two digits are the channel number (e.g., USE ES02 for channel 2).

26. Note the last reading taken on the digital multimeter.

27. Refer to Figure 20-5. Remove the digital multimeter from the test fixure and connect its to the Analog Bus Connector. Connect the DCV input to the Analog Bus Connector's SENSE BUS HIGH terminal and the COM input to the SENSE BUS LOW terminal.

28. Close the isolation relay by executing:

CLOSE ES90 (where E = extender number, S = slot number)

29. Observe the reading on the digital multimeter. It should be the same noted in step 26.

30. Remove the digital multimeter from the Analog Bus Connector.

20-14 Nulling Functionality Test

This test checks the nulling capability of the accessory.

1. Make sure the digital multimeter is set to dc volts and autorange.

2. Refer to Figure 20-4. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the dc voltage source to the H and L Input Connections on the test fixure.

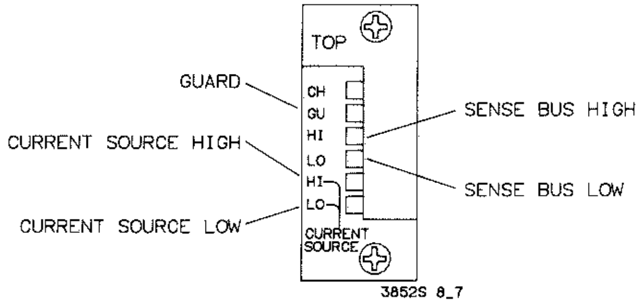


Figure 20-5 Analog Bus Connector

3. Set the dc voltage source for a +4.9 V output.

4. Set the channel 0 gain to "1" by executing:

   FUNC AMPLIFY, 1 USE ES00 (where E = extender number, S = slot number)

5. Null channel 0 by executing:

   NULL, USE ES00 (where E = extender number, S = slot number)

6. Close channel 0 by executing:

   CLOSE ES00 (where E = extender number, S = slot number)

7. Observe the indication on the multimeter. It should indicate 0 V ± 0.001 V.

8. Set the dc voltage source for a -4.9 V output.

9. Null channel 0 by executing:

   NULL, USE ES00 (where E = extender number, S = slot number)

10. Observe the indication on the multimeter. It should indicate 0 V ± 0.001 V.

11. Repeat steps 3 through 10 for channels 1, 2, and 3. In the USE, NULL, and CLOSE commands in steps 4, 5, 6, and 9 the last two digits are the channel number (e.g., USE ES02 for channel 2).

12. Disconnect the digital multimeter and dc voltage source from the test fixure.

20-15 Peak Detection Functionality Test

This test verifies the peak detection capability of the accessory.

Do not perform this test if you plan to do the complete Performance Test procedures. A more extensive Peak Detection test is given later in the Performance Test procedures.

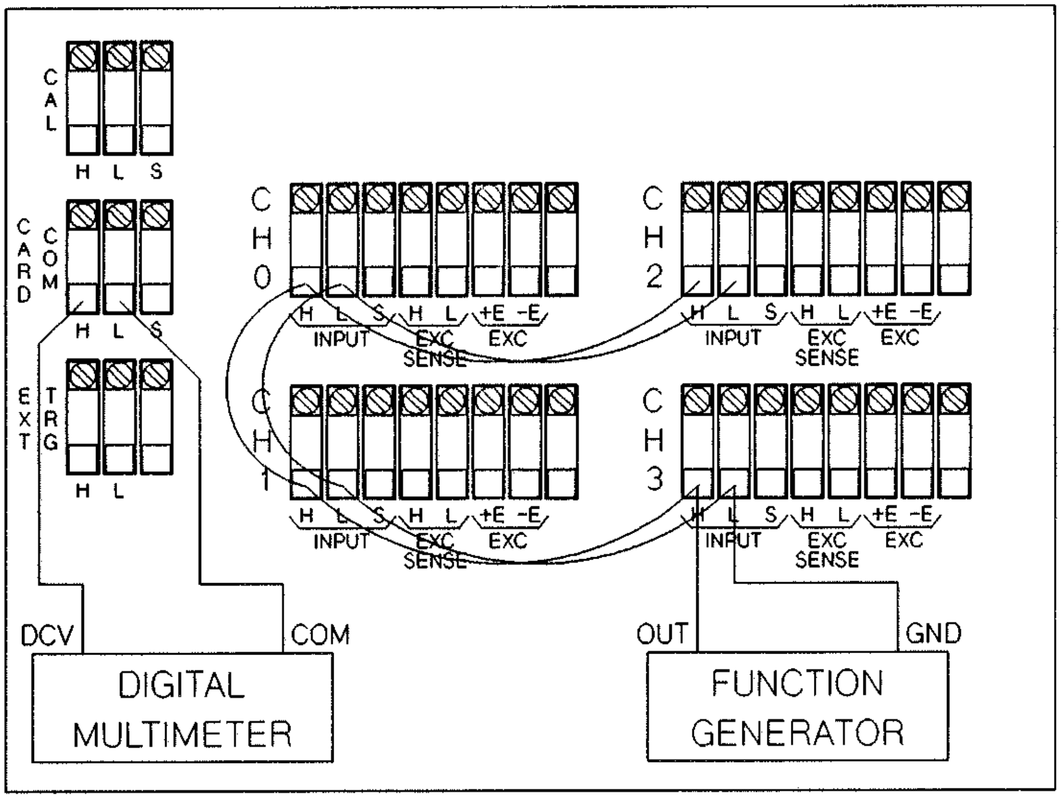


Figure 20-6 Function Generator Test Connections

1. Setup a function generator for a 100 Hz 1 V peak-to-peak sine wave. If using the recommended function generator, set it up as follows:

Function -- Sine Wave
Frequency -- 100 Hz
Amplitude -- 1.0 V p-p
DC Offset -- 0 V

2. Refer to Figure 20-6. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the function generator to the H and L Input Connections on the test fixure.

3. Set channel 0 gain to "1" and to positive peak detection and turn on autozero by executing:

FUNC POSPEAK, 1 USE ES00 (where E = extender number, S = slot number)
AZERO ONCE, USE ES00 (where E = extender number, S = slot number)

4. Close channel 0 by executing:

CLOSE ES00 (where E = extender number, S = slot number)

5. Observe the indication on the multimeter. It should indicate approximately 1.0 V.

6. Set channel 0 to negative peak detection and turn on autozero by executing:

FUNC NEGPEAK, 1 USE ES00 (where E = extender number, S = slot number)
AZERO ONCE, USE ES00 (where E = extender number, S = slot number)

7. Observe the indication on the multimeter. It should indicate approximately -1.0 V.

8. Repeat steps 3, 4, 5, 6, and 7 for channels 1, 2, and 3. In the USE and CLOSE commands in steps 3, 4, and 6, the last two digits are the channel number (e.g., USE ES02 for channel 2).

9. Disconnect the function generator from the test fixure.

20-16 Ribbon Cable Test

This test verifies that the HP 44730A accessory can be controlled by an HP 44702A/B. It also verifies that measurement results can be transferred to the voltmeter over the ribbon cable.

Do not perform this test if you plan to perform the complete Performance Test procedures. Ribbon cable operation will automatically be checked in some of the following Performance Test procedures. Also, if the HP 44730A accessory is not used with an HP 44702A/B High Speed Voltmeter, this test may not be necessary.

1. Remove power from the HP 3852A.

2. Set the HP 44730A component module next to an HP 44702A/B High Speed Voltmeter accessory to enable connection between the two accessories. Connect the ribbon cable between the accessory and the HP 44702A/B. Then install both accessories into the mainframe. Note the slot number where the HP 44730A under test is installed and the slot number where the HP 44702A/B is installed.

3. Install the test fixure on the HP 44730A.

4. Apply power to the HP 3852A.

5. Set up the mainframe and HP 44702A/B by executing:

FASTDISP OFF
USE ES00 (where E = extender number, S = slot number of High Speed Voltmeter)
SCANMODE ON
TERM RIBBON

6. Set the dc voltage source for 1.0 V output. Connect the dc voltage source to the H and L input connection on the test fixure.

7. Setup the HP 44730A accessory to the RIBBON trigger mode by executing:

TRIG RIBBON, USE ES00 (where E = extender number, S = HP 44730A slot number)

8. Enter, but do not execute, the following command:

CONFMEAS DCV ES00-ES03 (where E = extender number, S = HP 44730A slot number)

9. When the command entered in step 8 is executed, the HP 44702A/B performs a dc voltage measurement the HP 44730A's channels (i.e., all). With the FASTDISP off, each measurement will appear in the HP 3852A's right display. The HP 3852A left display will indicate each channel as it is scanned. Observe the HP 3852A display and press execute. The voltage indicated in the right display, for all channels, should be approximately 1.0 V dc. The scan list can be repeated, if desired, by pressing the RECALL ENTRY key and ENTER key.

10. Remove the dc voltage source from the HP 44730A. If you wish to continue with the Performance Test Procedures, leave the HP 44702A/B High Speed Voltmeter connected.

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE PERFORMANCE TESTS.

20-17 Linearity Test

This test checks the linearity of the signal conditioning amplifiers on the HP 44730A accessory.

1. Set the HP 44730A accessory to a known state by executing:

    RESET ES00 (where E = extender number, S = slot number)

2. Set the digital multimeter to dc volts and autorange.

3. Connect the digital multimeter to the dc voltage source.

4. Set the dc voltage source for a 1.0 V output, as shown on the digital multimeter. This is the accessory's input voltage.

5. Refer to Figure 20-4. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the dc voltage source to the H and L Input Connection

6. Close channel 0 by executing:

    AZERO ES00 (where E = extender number, S = slot number)
    CLOSE ES00 (where E = extender number, S = slot number)

7. Observe the indication on the multimeter. It should indicate 1.0 V ±0.0012 V, as listed in Table 20-2.

8. Remove both the digital multimeter and dc voltage source from the test fixure.

9. Repeat steps 3, 4, 5, 7, and 8 for input voltages of 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, and 9.0, volts. Make sure the dc voltage source in step 4 is set to the correct voltage (i.e., the accessory's input voltage). Use Table 20-2 for the correct voltage settings and multimeter readings.

9. Connect the digital multimeter to the dc voltage source.

10. Set the dc voltage source for a 0.1 V output, as shown on the digital multimeter. This is the accessory's input voltage.

Table 20-2 HP 44730A Linearity Test Limits

Input Voltage	Gain of Channel	Multimeter Reading		Input Voltage	Gain of Channel	Multimeter Reading	
		High	Low			High	Low
1.0	1	1.0012	0.9988	0.6	10	6.0022	5.9978
2.0	1	2.0014	1.9986	0.7	10	7.0024	6.9976
3.0	1	3.0016	2.9984	0.8	10	8.0026	7.9974
4.0	1	4.0018	3.9982	0.9	10	9.0028	8.9972
5.0	1	5.0020	4.9980	0.01	100	1.0023	0.9977
6.0	1	6.0022	5.9978	0.02	100	2.0026	1.9974
7.0	1	7.0024	6.9976	0.03	100	3.0029	2.9971
8.0	1	8.0026	7.9974	0.04	100	4.0032	3.9968
9.0	1	9.0028	8.9972	0.05	100	5.0035	4.9965
0.1	10	1.0012	0.9988	0.06	100	6.0038	5.9962
0.2	10	2.0014	2.9986	0.07	100	7.0041	6.9959
0.3	10	3.0016	2.9984	0.08	100	8.0044	7.9956
0.4	10	4.0018	3.9982	0.09	100	9.0047	8.9953
0.5	10	5.0020	4.9980				

11. Set the channel 0 gain to "10" by executing:

    AZERO USE ES00 (where E = extender number, S = slot number)
    FUNC AMPLIFY, 10 USE ES00 (where E = extender number, S = slot number)

12. Refer to Figure 20-4. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the dc voltage source to the H and L Input Connection

13. Observe the indication on the multimeter. It should indicate 1.0 V ±0.0012 V, as shown in Table 20-2.

14. Repeat steps 9, 10, 12, and 13 for input voltages of 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, and 0.9, volts. Make sure the dc voltage source in step 10 is set to the correct voltage (i.e., the accessory's input voltage). Use Table 20-2 for the correct voltage settings and multimeter readings.

15. Connect the digital multimeter to the dc voltage source.

16. Set the dc voltage source for a 0.01 V output, as shown on the digital multimeter. This is the accessory's input voltage.

17. Set the channel 0 gain to "100" by executing:

    AZERO USE ES00 (where E = extender number, S = slot number)
    FUNC AMPLIFY, 100 USE ES00 (where E = extender number, S = slot number)

18. Refer to Figure 20-4. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the dc voltage source to the H and L Input Connection

19. Observe the indication on the multimeter. It should indicate 1.0 V ±0.0023 V, as shown in Table 20-2.

20. Repeat steps 15, 16, 18, and 19 for input voltages of 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, and 0.09, volts. Make sure the dc voltage source in step 16 is set to the correct voltage (i.e., the accessory's input voltage). Use Table 20-2 for the correct voltage settings and multimeter readings.

21. Repeat steps 1 through 20 for channels 1, 2, and 3. In the USE and CLOSE commands in steps 6, 11, and 17, the last two digits are the channel number (e.g., USE ES02 for channel 2).

22. Disconnect the digital multimeter and dc voltage source from the test fixure.

20-18 Filter Test At 10 kHz

This test checks the operation of the switchable filter. Be sure to use the test fixure to run this test. Any filter component changes on the terminal module makes the test results unusable.

1. Set the HP 44730A accessory to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

2. Setup a function generator for a 100 Hz 1 V peak-to-peak sine wave. If using the recommended function generator, set it up as follows:

Function -- Sine Wave
Frequency -- 100 Hz
Amplitude -- 1.0 V p-p
DC Offset -- 0 V

3. Setup the digital multimeter to ac volts and autorange.

4. Refer to Figure 20-6. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the function generator to the H and L Input Connection

4. Close channel 0 by executing:

CLOSE ES00 (where E = extender number, S = slot number)

5. Turn the filter on by executing:

FILTER ON, USE ES00 (where E = extender number, S = slot number)

6. Observe the indication on the multimeter. It should indicate approximately 0.707 V ac.

7. Change the function generator output to a 50 kHz 1 V peak-to-peak sine wave. If using the recommended function generator, set it up as follows:

Function -- Sine Wave
Frequency -- 50 kHz
Amplitude -- 1.0 V p-p
DC Offset -- 0 V

8. Observe the indication on the multimeter. It should indicate approximately 5.61 mV ac.

9. Repeat steps 2, 4, 5, 6, 7, and 8 for channels 1, 2, and 3. In the USE, CLOSE, and FILTER commands in steps 4 and 5, the last two digits are the channel number (e.g., USE ES02 for channel 2).

10. Disconnect the function generator and digital multimeter from the test fixure.

20-19 Track/Hold Droop Test

In this test, the HP 44702A/B is used to trigger the HP 44730A accessory and take a reading. The accessory is triggered again after a 100 mS delay and another reading is taken. The droop is then calculated from this data.

1. Remove power from the HP 3852A.

2. Set the HP 44730A component module next to an HP 44702A/B High Speed Voltmeter accessory to enable connection between the two accessories. Connect the ribbon cable between the accessory and the HP 44702A/B. Then install both accessories into the mainframe. Note the slot number where the HP 44730A under test is installed and the slot number where the HP 44702A/B is installed.

3. Install the test fixure on the HP 44730A.

4. Apply power to the HP 3852A.

5. Set the dc voltage source for 10.0 V output. Connect the dc voltage source to the H and L input connection on the test fixure.

6. Dimension variable A to store two readings by executing:

   DIM A(1)

7. Setup the accessory for track/hold bye executing:

   FUNC SAMPLE, 1 USE ES00 (where E = extender number, S = HP 44730A slot number)

8. Setup the HP 44730A accessory for RIBBON trigger by executing:

   TRIG RIBBON USE ES00 (where E = extender number, S = HP 44730A slot number)

9. Setup the HP 44702A/B High Speed Voltmeter to scan the HP 44730A accessory and to take two readings with a 100 mS delay by executing:

   USE ES00 (where E = extender number, S = HP 44702A/B slot number)
   SCANMODE ON
   CONF DCV
   PRESCAN 2
   SPER 0.1

10. Set channel 0 to be scanned by executing:

    CLWRITE ES00 (where E = extender number, S = HP 44730A slot number)

11. Trigger the HP 44702A/B by executing:

    SCTRIG INT

12. The HP 44702A now takes the two readings. Transfer the readings into variable A by executing:

    XRDGS ES00 INTO A (where E = extender number, S = HP 44702A/B slot number)

13. Determine the first reading by executing:

```
VREAD A(0)
```

The first reading is displayed on the HP 3852A right display. Note this reading.

14. Determine the second reading by executing:

```
VREAD A(1)
```

The second reading is displayed next on the HP 3852A right display. Note this reading.

15. Calculate the droop using the A(0) and A(1) readings noted in steps 13 and 14 using this formula:

$$\frac{A(0) - A(1)}{0.100}$$

16. Make sure the droop is less than 0.5 (with an ambient temperature greater than or equal to 25°C).

17. Repeat steps 6, 7, 10, 11, 12, 13, 14, 15, and 16 for channels 1, 2, and 3. In the CLWRITE command in step 9 and the USE command in step 7, the last two digits indicate the channel number (e.g., USE ES02 is for channel 2).

18. Remove the dc voltage source from the HP 44730A accessory.

20-20 Peak Detection Test

This test verifies the operation of the Peak Detection circuitry for all channels.

1. Reset the HP 3852A and its accessories by pressing the RESET button on the HP 3852A front panel.

2. Setup a function generator for a 100 Hz 1 V peak-to-peak sine wave. If using the recommended function generator, set it up as follows:

Function -- Sine Wave
Frequency -- 100 Hz
Amplitude -- 1.0 V p-p
DC Offset -- 0 V

3. Refer to Figure 20-6. Connect the digital multimeter to the H and L CARD COM Output Connections. Connect the function generator to the HP 44730A's H and L Input Connections.

4. Define variable A and dimension the variable for 2000 readings by executing:

```
REAL MIN,MAX,MEAN,STDD
DIM A(1999)
```

5. Setup the HP 44730A accessory by executing:

```
FUNC AMPLIFY,1 USE ES00   (where = extender number, S = slot number)
AZERO ONCE USE ES00   (where E = extender number, S = slot number)
```

6. Setup the HP 44730A accessory for RIBBON trigger by executing:

TRIG RIBBON, USE ES00 (where E = extender number, S = HP 44730A slot number)

7. Setup the HP 44702A/B High Speed Voltmeter to scan the HP 44730A accessory and take 2000 readings by executing:

USE ES00 (where E = extender number, S = HP 44702A/B slot number)
SCANMODE ON
CONF DCV
NRDGS 2000

8. Set channel 0 to be scanned by executing:

CLWRITE ES00 (where E = extender number, S = HP 44730A slot number)

9. Trigger the HP 44702A/B by executing:

SCTRIG INT

10. The HP 44702A now takes the 2000 readings. Transfer the readings into variable A by executing:

XRDGS ES00 INTO A (where E = extender number, S = HP 44702A/B slot number)

11. Determine the highest and lowest readings in variable A by executing:

STAT MIN,MAX,MEAN,STDD,A

12. Display the highest reading by executing:

VREAD MAX

The highest reading is displayed on the HP 3852A right display. Note this reading.

13. Display the lowest reading by executing:

VREAD MIN

The lowest reading is displayed next on the HP 3852A right display. Note this reading.

14. Setup channel 0 of the HP 44730A for positive peak detection by executing:

FUNC POSPEAK, 1 USE ES00 (where E = extender number, S = slot number)
AZERO ONCE, USE ES00 (where E = extender number, S = slot number)

15. Close channel 0 by executing:

CLOSE ES00 (where E = extender number, S = slot number)

16. The digital multimeter reading should be the high reading in step 12 ± 0.02005 V.

17. Setup channel 0 of the HP 44730A for negative peak detection by executing:

    FUNC NEGPEAK, 1 USE ES00   (where E = extender number, S = slot number)
    AZERO ONCE, USE ES00   (where E = extender number, S = slot number)

18. The digital multimeter reading should be the low reading in step 13 ±0.02005 V.

19. Repeat steps 4 and 5, and 8 through 18 for channels 1, 2, and 3. In the USE, CLWRITE, and CLOSE commands in steps 5, 8, 14, 15, and 17, the last two digits are the channels numbers (e.g., USE ES02 for channel 2).

20. Remove the digital multimeter and function generator from the accessory.

20-21 CALIBRATION

20-22 Introduction

The calibration procedure in this section calibrates the accessory's input amplifiers of all channels.

The HP 44730A is calibrated programatically; no external adjustments are performed. Calibration is performed as follows:

1. A known calibration signal is applied to the HP 44730A's CAL inputs.
2. The channel's gain is set to its lowest calibration value by using FUNC CALLO command.
3. This voltage is read by the digital multimeter connected to the CARD COM output terminals.
4. The channel's gain is set to its highest calibration value by using FUNC CALHI command.
5. This voltage is read by the digital multimeter connected to the CARD COM output terminals.
6. Using the values in steps 1, 3, and 5, the accessory is then calibrated.

20-23 Calibration Cycle

Periodic calibration should be performed to ensure that the accessory is meeting its accuracy specifications. The accessory should be calibrated every 90 days. Calibration should also be performed if determined by the Performance Test procedures that calibration is needed.

20-24 Calibration Environment

The HP 44730A accessory may be calibrated in a "bench" environment or system cabinet. For best accuracy, the temperature of the calibration environment should be within $\pm 5°$ C of the actual operating environment. The HP 44730A was calibrated at the factory at an environment temperature of 23° C.

20-25 Equipment Required

The following test equipment is required to calibrate the HP 44730A.

1. Test leads.
2. Digital Multimeter -- HP Model 3456A.
3. Stable DC Voltage Source -- Any stable dc voltage source that can output 0.1 V, 1.0 V, and 10 V.

In the following calibration procedures, the dc voltages applied to the HP 44730A must be accurate and stable. Good accuracy and stability are needed to meet the accessory's accuracy requirements.

With the above in mind, there are two ways of performing the calibration procedures.

a. Use the recommended digital multimeter to adjust the dc voltage source output to the correct accessory input. Do this by connecting the dc voltage source to the digital multimeter and then adjust the voltage source to the appropriate accessory input voltage. Use the reading on the digital multimeter to adjust for the correct voltage. Then connect the dc voltage source to the accessory for calibration.

The calibration procedures are written using the above procedure. If you plan to use this procedure, keep the following in mind.

The dc voltage source must have good short term stability. This is needed since it takes time to manually perform the calibratopn procedures. Any drift in the dc source may make calibration invalid.

The dc source must be adjustable so you can adjust it to the correct input voltage, as read on the digital multimeter.

b. Use an accurate and stable dc voltage standard, like the Datron Model 4000/4000A. You can directly connect one of these standards to the HP 44730A input without adjusting the standard's output voltage on the digital multimeter. It has sufficient accuracy and short term stability to calibrate the HP 44730A.

NOTE

The integrating plug-in voltmeter (HP 44701A) may be used for the Calibration Procedure. The procedure does not describe specific steps required to use the plug-in voltmeter. A description of the plug-in voltmeter can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

20-26 Calibration Procedure

20-27 Set-Up Procedure

1. Apply power to the HP 3852A and allow the HP 44730A accessory a 15 minute warm-up period inside the mainframe.

2. Press the RESET button on the HP 3852A front panel. Perform the HP 44730A self-test by executing:

   TEST ES00 (where E = extender number, S = slot number)

3. The HP 3852A right display should show:

   SELF TEST OK

If the display shows a different message, or if the ERR annunciator is on, the HP 44730A accessory may be failing its self-test. Test the accessory again by executing the command in step 1. If the accessory still fails, exchange it with a working one.

20-28 DCV Calibration

All gains of each channel will be calibrated individually.

1. Set the digital multimeter to dc volts and autorange. Then connect it to the dc voltage source.

2. Set the dc voltage source for a 9.0 V to 10.0 V output, as shown on the digital multimeter. Note this reading. This is the *true* reading.

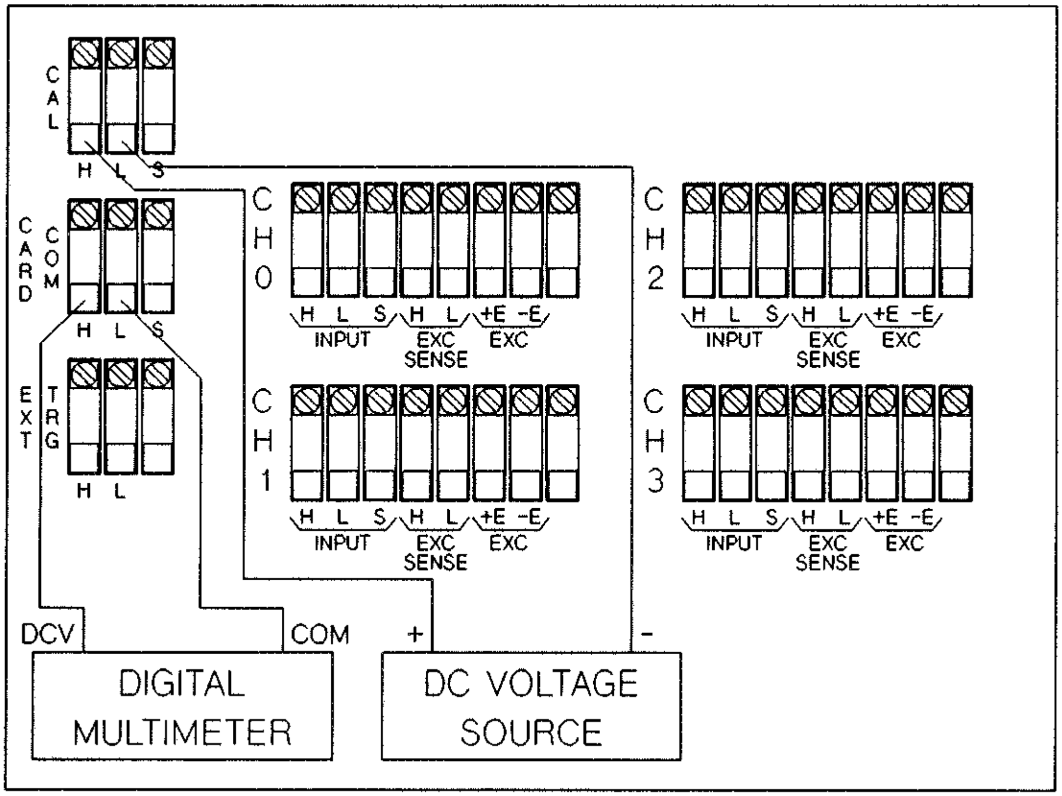


Figure 20-7 Calibration Connections

3. Refer to Figure 20-7. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the dc voltage source to the H and L CAL Terminals.

4. Perform the channel 0 offset calibration by executing:

```
USE ES00  (where E = extender number, S = slot number)
FUNC AMPLIFY, 1
CAL 0
```

5. Make a "low" measurement by executing:

```
FUNC CALLO, 1
```

6. Note the reading on the digital multimeter. This is the *low* reading.

7. Make a "high" measurement by executing:

```
FUNC CALHI, 1
```

8. Note the reading on the digital multimeter. This is the *high* reading.

9. Using the values of the *true*, *low*, and *high* readings noted in steps 2, 6, and 8, respectively, calibrate the HP 44730A gain by executing:

CAL *true*, LO *low*, HI *high*

10. Repeat steps 4, 5, 6, 7, 8, and 9 for channels 1, 2, and 3. In the USE command in step 4, the last two digits are the channel number (e.g., ES02 for channel 2).

11. Connect the digital multimeter to the dc voltage source.

12. Set the dc voltage source for a 0.9 V to 1.0 V output, as shown on the digital multimeter. Note this reading. This is the *true* reading.

13. Refer to Figure 20-7. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the dc voltage source to the H and L CAL Terminals.

14. Set channel 0 to a gain of "10" and perform an offset calibration by executing:

USE ES00 (where E = extender number, S = slot number)
FUNC AMPLIFY, 10
CAL 0

15. Make a "low" measurement by executing:

FUNC CALLO

16. Note the reading on the digital multimeter. This is the *low* reading.

17. Make a "high" measurement by executing:

FUNC CALHI

18. Note the reading on the digital multimeter. This is the *high* reading.

19. Using the values of the *true*, *low*, and *high* readings noted in steps 12, 16, and 18, respectively, calibrate the HP 44730A gain by executing:

CAL *true*, LO *low*, HI *high*

20. Repeat steps 14, 15, 16, 17, 18, and 19 for channels 1, 2, and 3. In the USE command in step 14, the last two digits are the channel number (e.g., ES02 for channel 2).

21. Connect the digital multimeter to the dc voltage source.

22. Set the dc voltage source for a 0.09 V to 0.1 V output, as shown on the digital multimeter. Note this reading. This is the *true* reading.

23. Refer to Figure 20-7. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the dc voltage source to the H and L CAL Terminals.

24. Set channel 0 to a gain of "100" and perform an offset calibration by executing:

USE ES00 (where E = extender number, S = slot number)
FUNC AMPLIFY, 100
CAL 0

25. Make a "low" measurement by executing:

    FUNC CALLO

26. Note the reading on the digital multimeter. This is the *low* reading.

27. Make a "high" measurement by executing:

    FUNC CALHI

28. Note the reading on the digital multimeter. This is the *high* reading.

29. Using the values of the *true*, *low*, and *high* readings noted in steps 12, 16, and 18, respectively, calibrate the HP 44730A gain by executing:

    CAL *true*, LO *low*, HI *high*

30. Repeat steps 24, 25, 26, 27, 28, and 29 for channels 1, 2, and 3. In the USE command in step 24, the last two digits are the channel number (e.g., ES02 for channel 2).

31. Remove the digital multimeter and dc voltage source from the accessory.

20-29 REPLACEABLE PARTS

Figure 20-8 shows the mechanical breakdown of the HP 44730A. The figure also provides assembly and disassembly information. The parts shown in Figure 20-8 are keyed to the parts list in Table 20-3.

To order a part listed in Table 20-3, quote the Hewlett-Packard part number, the quantity desired, the HP system description, and the check digit (abbreviated CD in Table 20-3). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

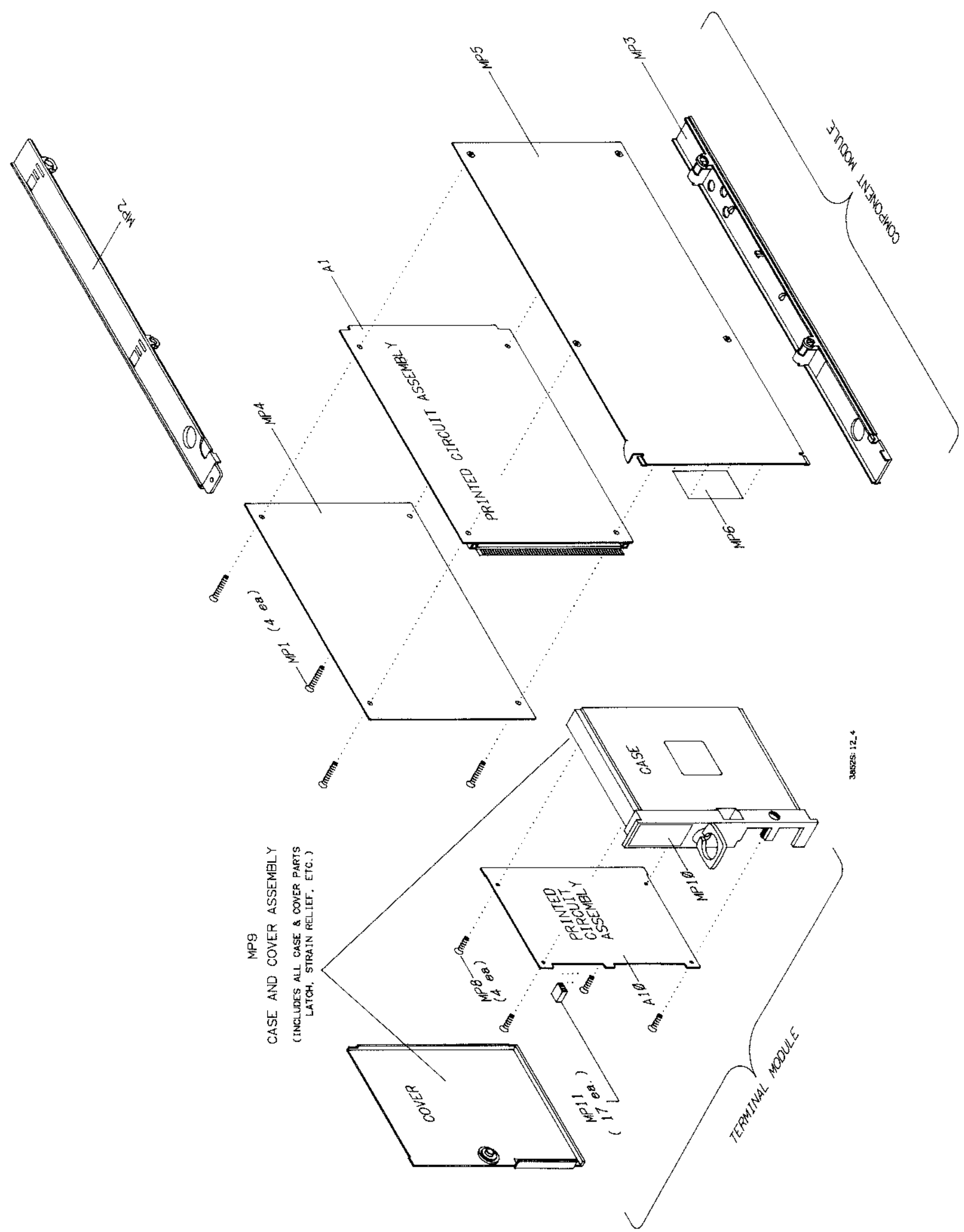


Figure 20-8 HP 44730A Exploded View

Table 20-3a HP 44730A 4 Channel Track/Hold with Signal Conditioning

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44730A	Module; 4 chan. sig. cond. component	1	44730-66201	2	MOD-SMPLE/HLD SIG
A1	PCA; 4 channel sig. cond. component	1	44730-66501	5	PCA-SIG COND
A10	PCA; 4 channel sig. cond. terminal	1	44730-66510	6	PCA-TERM CD
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44730A component module	1	44730-84320	4	LBL-I/O SIG COND
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44730A	1	44730-84325	9	LBL-ID,SIG COND

Completely assembled HP 44730A terminal modules can be ordered from your local HP Office by ordering Number 44730AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program. For details, see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44730A	Module; 4 chan. sig. cond. component		44730-69201	8	RBLT-44730-66201

Table 20-3b HP 44732A 4 Bridge 120 ohm Strain Gage Track/Hold

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44730A	Module; 4 chan. sig. cond. component	1	44730-66201	2	MOD-SMPLE/HLD SIG
A1	PCA; 4 channel sig. cond. component	1	44730-66501	5	PCA-SIG COND
A10	PCA; 4 channel 120 ohm str. gage term	1	44732-66510	6	PCA-TERM CD
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44730A component module	1	44730-84320	4	LBL-I/O SIG COND
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44732A	1	44730-84325	9	LBL-ID,SIG COND

Completely assembled HP 44732A terminal modules can be ordered from your local HP Office by ordering Number 44732AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program. For details, see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44730A	Module; 4 chan. sig. cond. component		44730-69201	8	RBLT-44730-66201

Table 20-3c HP 44733A 4 Bridge 350 ohm Strain Gage Track/Hold

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44730A	Module; 4 chan. sig. cond. component	1	44730-66201	2	MOD-SMPLE/HLD SIG
A1	PCA; 4 channel sig. cond. component	1	44730-66501	5	PCA-SIG COND
A10	PCA; 4 channel 350 ohm str. gage term	1	44733-66510	8	PCA-TERM CD
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44730A component module	1	44730-84320	4	LBL-I/O SIG COND
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44733A	1	44730-84325	9	LBL-ID,SIG COND

Completely assembled HP 44733A terminal modules can be ordered from your local HP Office by ordering Number 44733AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program. For details, see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44730A	Module; 4 chan. sig. cond. component		44730-69201	8	RBLT-44730-66201

Chapter 11
HP [illegible]
Arbitrary Waveform Gen

CHAPTER 21

HP 44726A 2 CHANNEL ARBITRARY WAVEFORM DAC

CHAPTER 21
HP 44726A
2 CHANNEL ARBITRARY WAVEFORM DAC

21-1 INTRODUCTION

This chapter provides a technical description, performance test procedures, calibration procedures, and a replaceable parts list for the HP 44726A 2 Channel Arbitrary Waveform DAC Accessory (also called the Arbitrary Waveform DAC Accessory).

NOTE

The Arbitrary Waveform DAC Accessory can only be used with instruments having a firmware revision of 3.5 or above. Determine the firmware revision by sending the mainframe command: **IDN?**.

21-2 HP 44726A Technical Description

The HP 44726A Arbitrary Waveform DAC Accessory is used to generate and output arbitrary waveforms that are generated from user supplied data. The data can be a maximum of 32,400 points on a waveform. The channels can be programmed for one cycle or for a continuous output.

The waveforms are generated using voltage outputs from a 16 bit digital-to-analog converter. The maximum specified voltage output of the converter is ±10.235 V with .3125 mV resolution. By specifying the different voltages (i.e., the points on the waveform) and the time the voltages are output, almost any type waveform is possible. These include sine waves, square waves, ramps, pulses, etc.

The accessory can also store data to generate single or multiple waveforms. A maximum of 32,400 data points can be stored. This data is lost whenever the mainframe is turned off or reset, the accessory is reset, or a self-test is performed on the accessory.

Refer to Figure 21-1. Since both channels of the HP 44726A accessory are the same, the figure shows one channel. The HP 44726A accessory has 2 channels with each channel having DAC OUT, SYNC OUT, and EXT IN connectors. The waveforms are output by the DAC OUT connector, the sync signals are output by the SYNC OUT connector, and the external trigger signal are input to the EXT IN connector. The connectors are all BNC that are referenced to chassis ground.

Each channel of the HP 44726A has two main circuits. One circuit consists of analog circuitry and the other of digital circuitry. The analog circuitry includes the digital-to-analog converter (DAC), a filter, and output buffers. The digital circuitry controls the DAC outputs, stores user entered data to generate waveforms, generates the clock signal to output the waveforms, and interfaces with the mainframe.

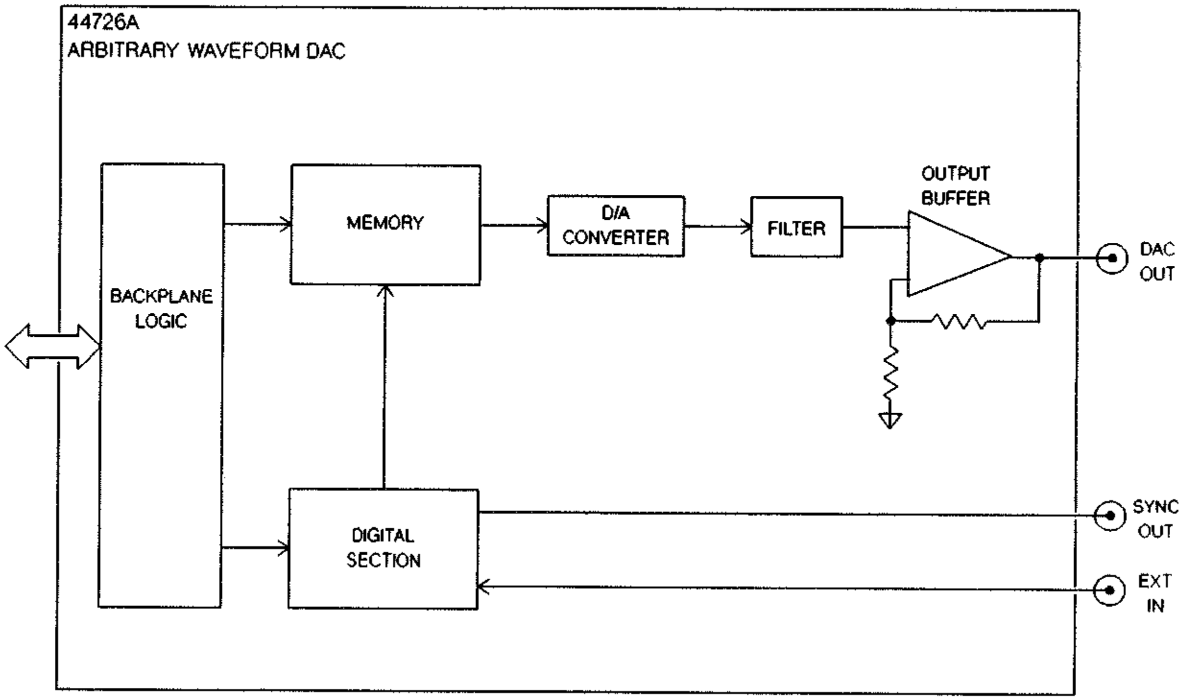


Figure 21-1 HP 44730A Simplified Block Diagram

The data that generates the waveforms comes from the mainframe via the backplane logic. This data is stored into memory which in turn outputs the data to the DAC to generate the actual waveform.

The digital section controls the timing of the waveform using internally and externally (i.e., EXT IN) applied trigger signals. It also generates the different sync signals.

21-3 SPECIFICATIONS

Specifications for the HP 44726A are given in Table 21-1. specifications are the performance standards or limits against which the accessory may be tested.

Table 21-1 HP 44726A Specifications

Maximum Step Rate: 800 kHz

Settling Time (resistive load):

8 µS (12 bits- 5 mV). Typically 10 µS (14 bits - 1.25 mV)

Range: ±10.235 V

Resolution: 15 bits plus sign, 0.3215 mV (Uses a 16-bit DAC that is monotonic to 14 bits - 1.25 mV)

Memory (per channel):

Points: 32,400
Maximum # of waveforms: 64 (Up to a total of 32,400 points)

DC Accuracy:

90 days - using a resistive load after a one-hour warm-up (18° to 28° C): 0.026% %3.6 mV
Outside of 18° to 28° C but between 0 to 18° C or 28° to 55° C, add the following accuracy error: (.0017% ±0.21 mV)/C

Max Output Current: 5 mA

Programmable Time Base:

Range: 1.25 µS to 16.384 mS
Resolution: 0.25 µS
Accuracy: 0.01%

Trigger Characteristics:

Trigger inputs are TTL compatible and require pulse widths of >0.4 µS.

The Sync Outputs can drive CMOS/HCMOS, one TTL load, or two LSTTL loads.

Relative Power Consumption: 2.0 using power supplies with HP part number 03852-66202.

21-4 PERFORMANCE TESTS

21-5 Introduction

The following Performance Tests check the operation of the HP 44726A. Successful completion of the tests in this chapter provides a high confidence level that the Arbitrary Waveform DAC Accessory is meeting its listed specifications.

The performance tests should be performed in the order they are presented. The completion of each test increases the confidence level in the accessory. A minimum set of tests is given as the Operational Verification Tests. These tests are described in Section 21-6.

The Operational Verification Tests yield a 90% confidence level that the accessory is operating normally. These tests are very extensive and, in most instances, will be more than sufficient. The two additional tests included in the Performance Tests should only be performed if the monotonicity and/or dc accuracy under full load specifications are in question.

21-6 Operational Verification

The first tests in this section are the minimum set of tests recommended for the HP 44726A accessory. These tests are designed to test the functionality of the accessory. Successful completion of the Operational Verification Tests provide a 90% confidence level that the accessory is operating normally and is within specifications.

The Operational Verification Tests consist of the following:

Section 21-9 - Set-Up Procedure
Section 21-10 - Self-Test
Section 21-11 - SYNC Output and TRIG Input Functionality Tests
Section 21-12 - DC Volts Accuracy Test

21-7 Equipment Required

The following test equipment is required to run the Performance Tests. Only the first three items are required for the Operational Verification Tests.

1. Test Leads and Jumpers (includes a BNC-to-Banana and BNC-to-cliplead cables).

2. Digital Multimeter -- HP 3456A or equivalent.

3. Oscilloscope -- HP 1740A or equivalent (dual trace with 1µS resolution).

4. Resistor -- 2.1 kohm, .5 W, ±5%.

NOTE

The integrating voltmeter (HP 44701A) may be used for the Performance Test Procedures. The procedures do not describe specific steps required to use the plug-in voltmeter. A description of the plug-in voltmeter can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

21-8 Test Procedure

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

21-9 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Note the slot number where the accessory under test is installed.

3. Verify the correct slot number:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence. Verify that the READY annunciator is on and the ERR annunciator is off.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

   c. Verify that the HP 3852A right display shows:

      44726A

NOTE

If the HP 3852A right display shows a different number, the slot number used may not be correct.

21-10 Self-Test

This test checks most of the accessory's digital circuitry.

CAUTION

Executing the self-test will destroy all waveform data loaded into memory.

1. Perform the HP 44726A self-test by executing:

   TEST ES00 (where E = extender number, S = slot number)

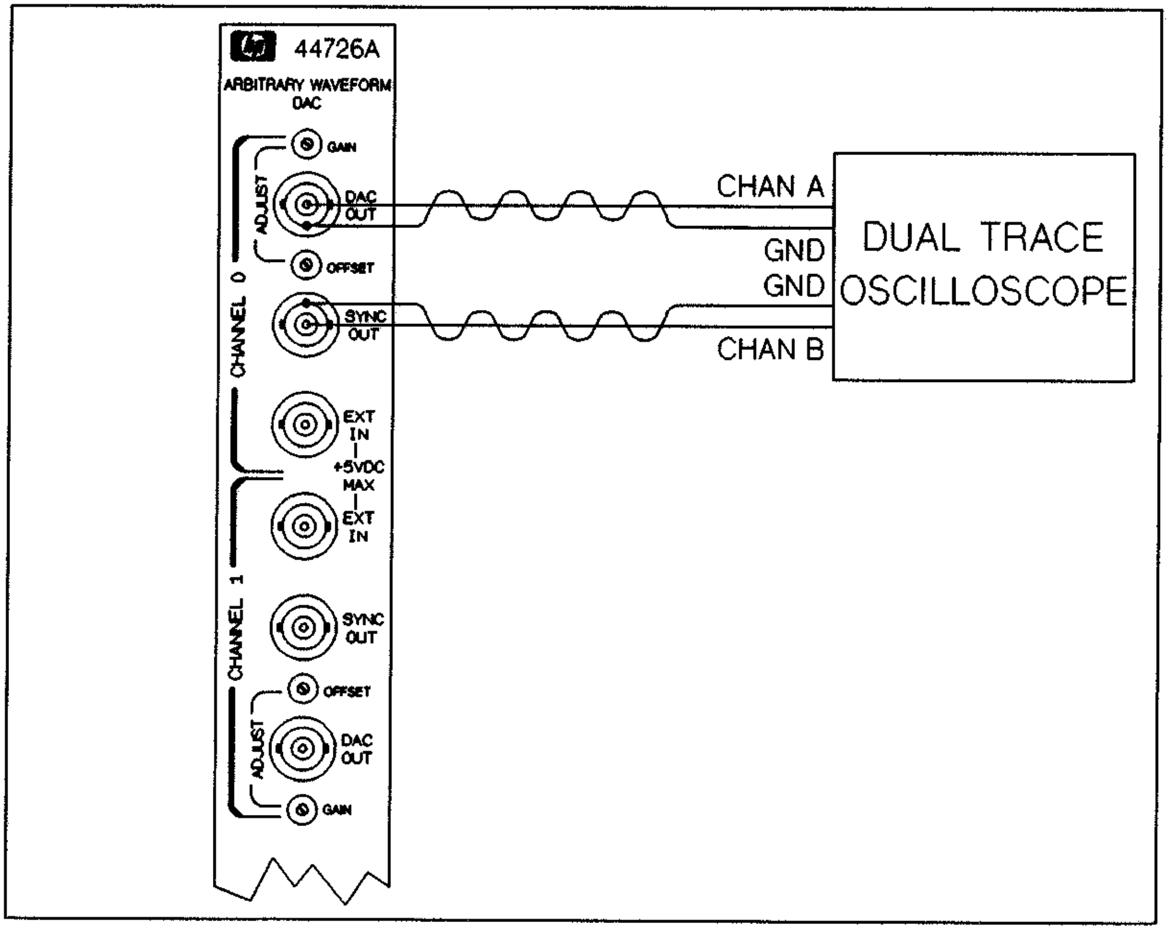


Figure 21-2 Channel 0 Sync Output Test Setup

2. The HP 3852A right display should show:

   SELF TEST OK

If the display shows a different message, or if the ERR annunciator is on, the HP 44726A accessory may be failing its self-test. Test the accessory again by executing the command in step 1. If the accessory still fails, exchange it with a working one.

21-11 SYNC Output and TRIG Input Functionality Tests

This test verifies that the accessory can output all the correct sync signals and that it can accept an external trigger input.

1. CHANNEL 0 SYNC OUTPUT TEST. This test verifies that channel 0 can output all sync signals.

2. Set the HP 44726A to a known state by executing:

   RESET ES00 (where E = extender number, S = slot number)

3. Refer to Figure 21-2. Connect channel A of the oscilloscope to the accessory's DAC OUT connector on channel 0. Connect channel B of the oscilloscope to the accessory's SYNC OUT connector on channel 0.

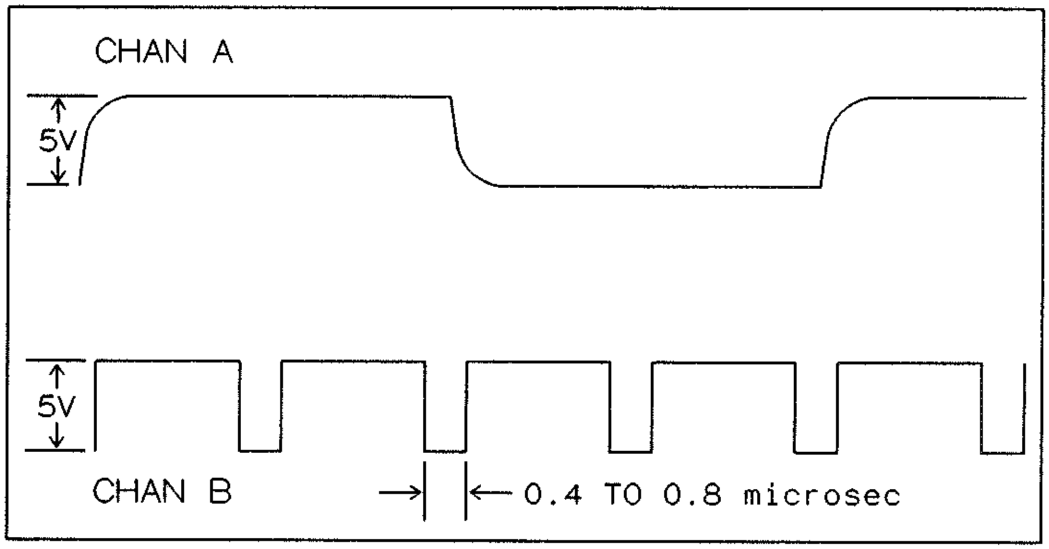


Figure 21-3 SYNC TRIG Waveforms

4. Setup the oscilloscope as follows:

Dual Trace
Channel A -- DC, 0.5 Volts/Div (if using 10:1 probes)
Channel B -- DC, 0.5 Volts/Div (if using 10:1 probes)
Trigger -- Internal
Trig Comp -- Channel A
Vertical Display -- Alternate
Time -- 1 µS/Div

5. Output a 5 V peak-to-peak, 8 µS square wave from channel 0 of the accessory by executing:

USE ES00 (where E = extender number, S = slot number)
WFWRITE SQV, 1, 5, TBASE 2E-6
APPLY WFV, ES00, 1 (where E = extender number, S = slot number)
TRIG INT
TARM AUTO
SYNC TRIG

6. Verify that the waveform displayed on the oscilloscope is as shown in Figure 21-3. The sync pulse shown on channel B of the oscilloscope is between 0.4 µS and 0.8 µS.

7. Setup channel 0 for SYNC WF by executing:

SYNC WF

8. Verify that the waveform displayed on the oscilloscope is as shown in Figure 21-4. The sync pulse on channel B of the oscilloscope should go low approximately 4 µS before the output pulse goes high.

9. Setup channel 0 for SYNC DAC by executing:

SYNC DAC

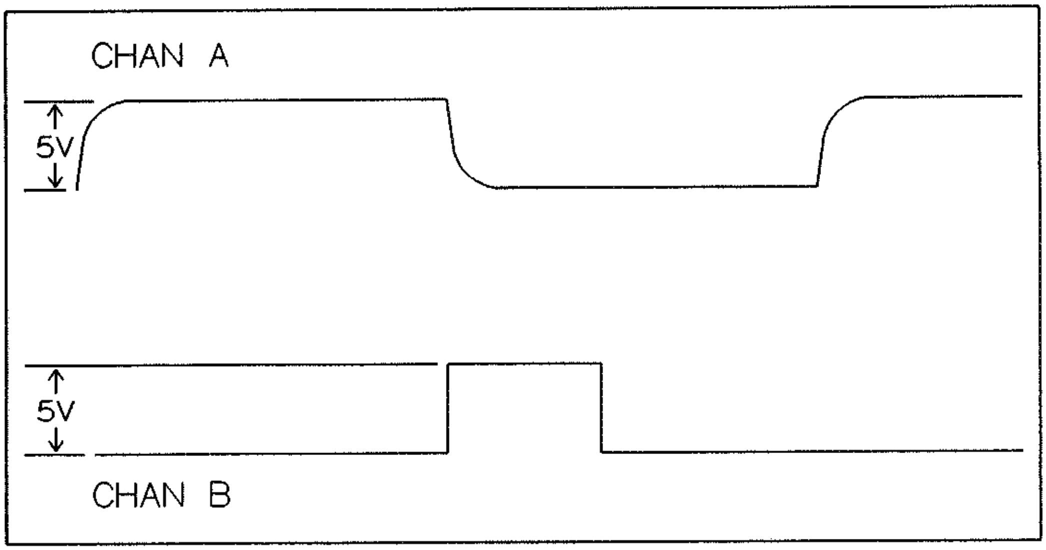


Figure 21-4 SYNC WF Waveforms

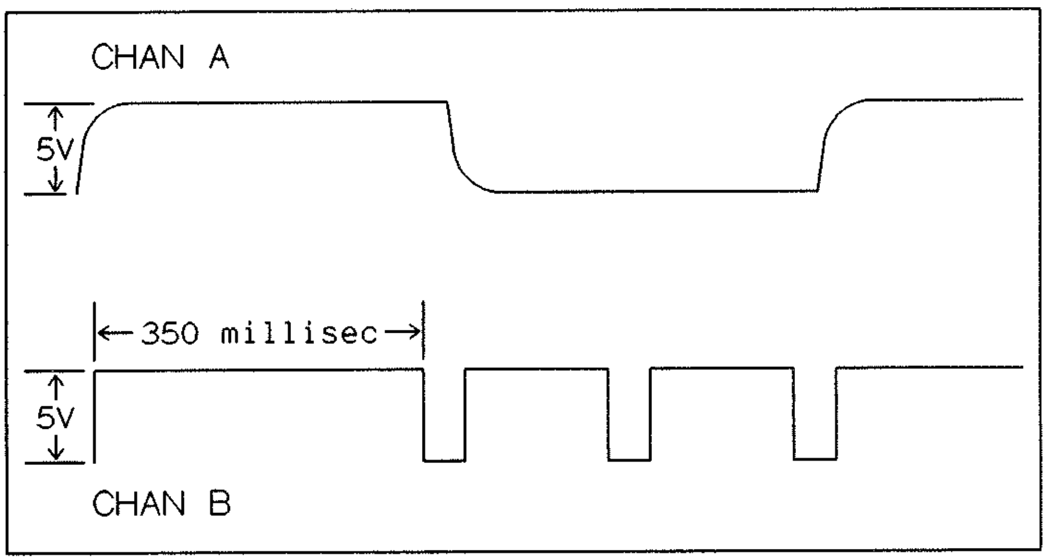


Figure 21-5 SYNC DAC Waveforms

10. Verify that the waveform displayed on the oscilloscope is as shown in Figure 21-5. The sync pulse on channel B of the oscilloscope should consist of three pulses for every output pulse. The uneven spaced pulses should be approximately 350 nS wide.

11. Setup channel 0 for SYNC HOLD by executing:

    SYNC HOLD

12. Verify that the waveform displayed on the oscilloscope is as shown in Figure 21-6. Channel B of the oscilloscope should display a constant +5 V level.

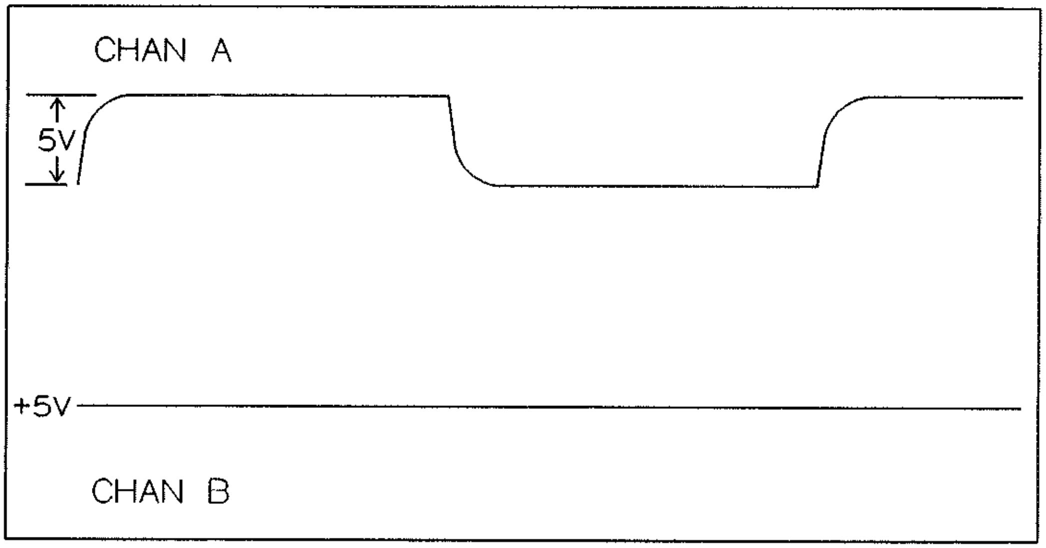


Figure 21-6 SYNC HOLD Waveforms

13. CHANNEL 0 TRIG INPUT TEST. This test verifies that channel 0 can execute an external trigger input.

14. Refer to Figure 21-7. Connect channel A of the oscilloscope to the accessory's DAC OUT connector on channel 0. Connect channel B of the oscilloscope to the accessory's EXT IN connector on channel 0. Also connect the accessory's DAC OUT connector on channel 1 to the EXT IN connector on channel 0.

15. Set channel 0 of the accessory for external trigger by executing:

    TRIG EXT

16. Output a 5 V peak-to-peak, 8 µS square wave from channel 1 of the accessory by executing:

    WFWRITE SQV, 1, 5, TBASE 2E-6, USE ES01
    APPLY WFV ES01, 1 (where E = extender number, S = slot number)
    TARM AUTO, USE ES01
    SYNC WF, USE ES01

Note: In the USE commands above, E = extender number, S = slot number.

17. Change the oscilloscope Time setting to 2 µS/Div. Verify that the waveform displayed on the oscilloscope is as shown in Figure 21-8.

18. Change the oscilloscope Time setting back to 1 µS/Div. Remove the oscilloscope from the HP 44726A accessory. Also remove the connection between DAC OUT of channel 1 and EXT IN of channel 0.

19. CHANNEL 1 SYNC OUTPUT TEST. This test verifies that channel 1 can output all sync signals.

20. Set the HP 44726A to a known state by executing:

    RESET ES00 (where E = extender number, S = slot number)

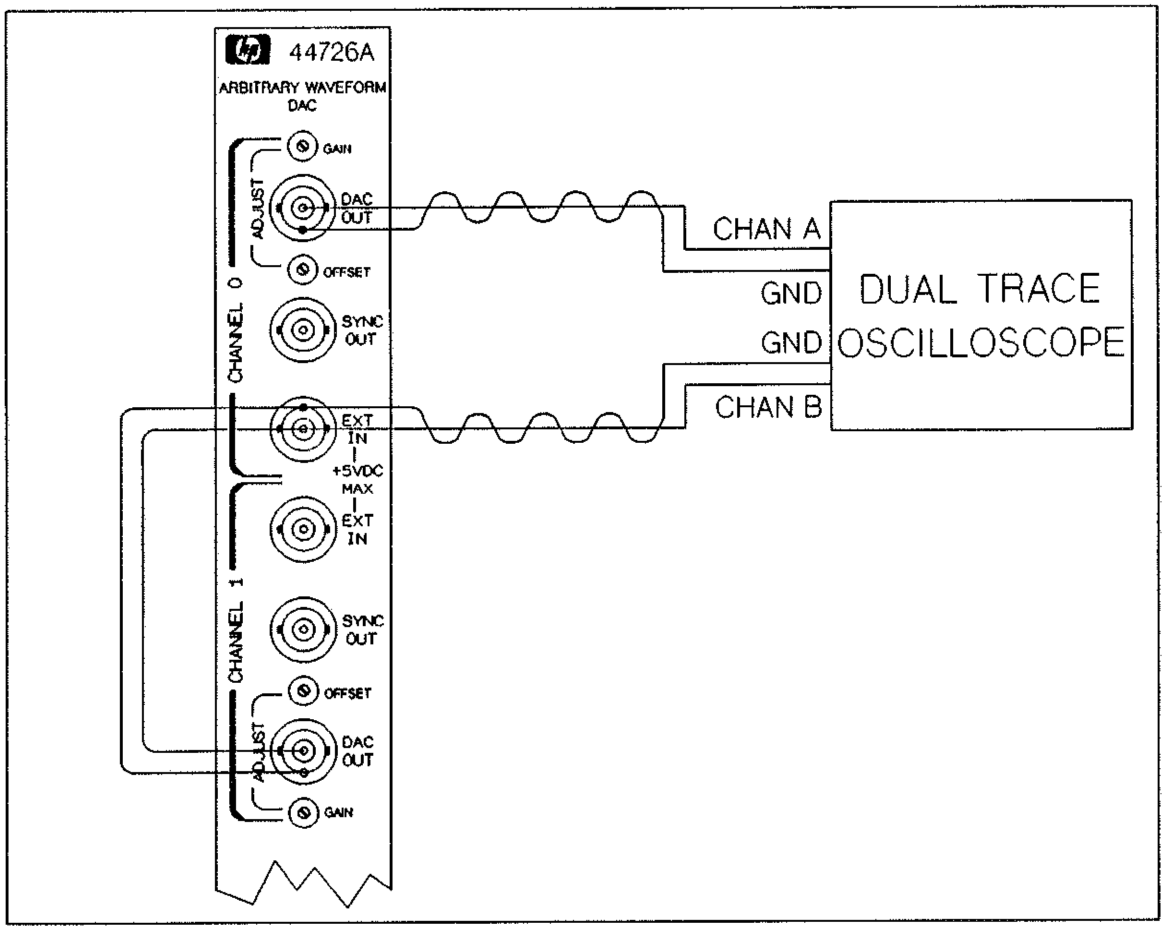


Figure 21-7 Channel 0 Trig Input Test Setup

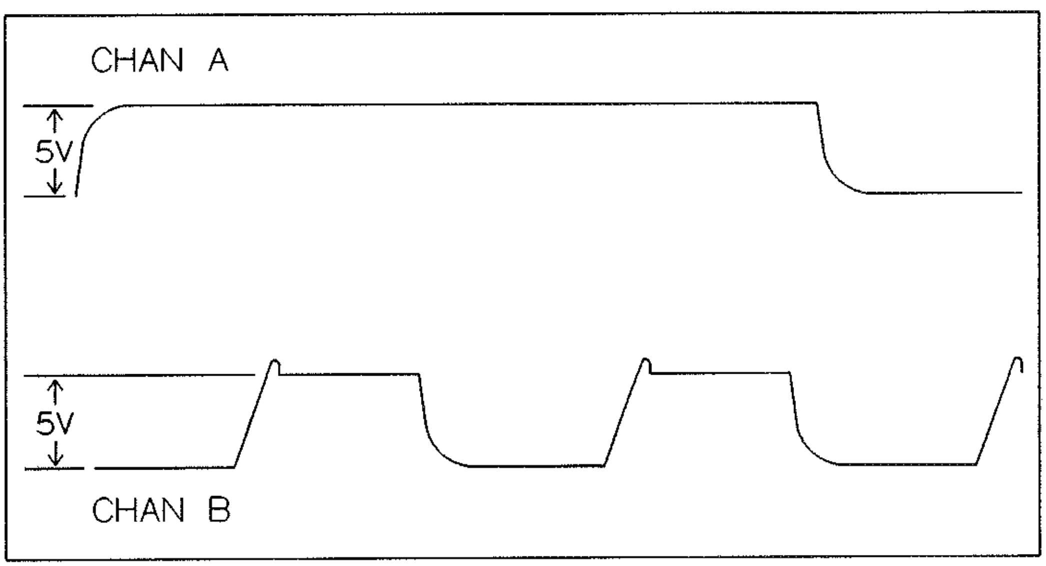


Figure 21-8 Trigger Input Test Waveforms

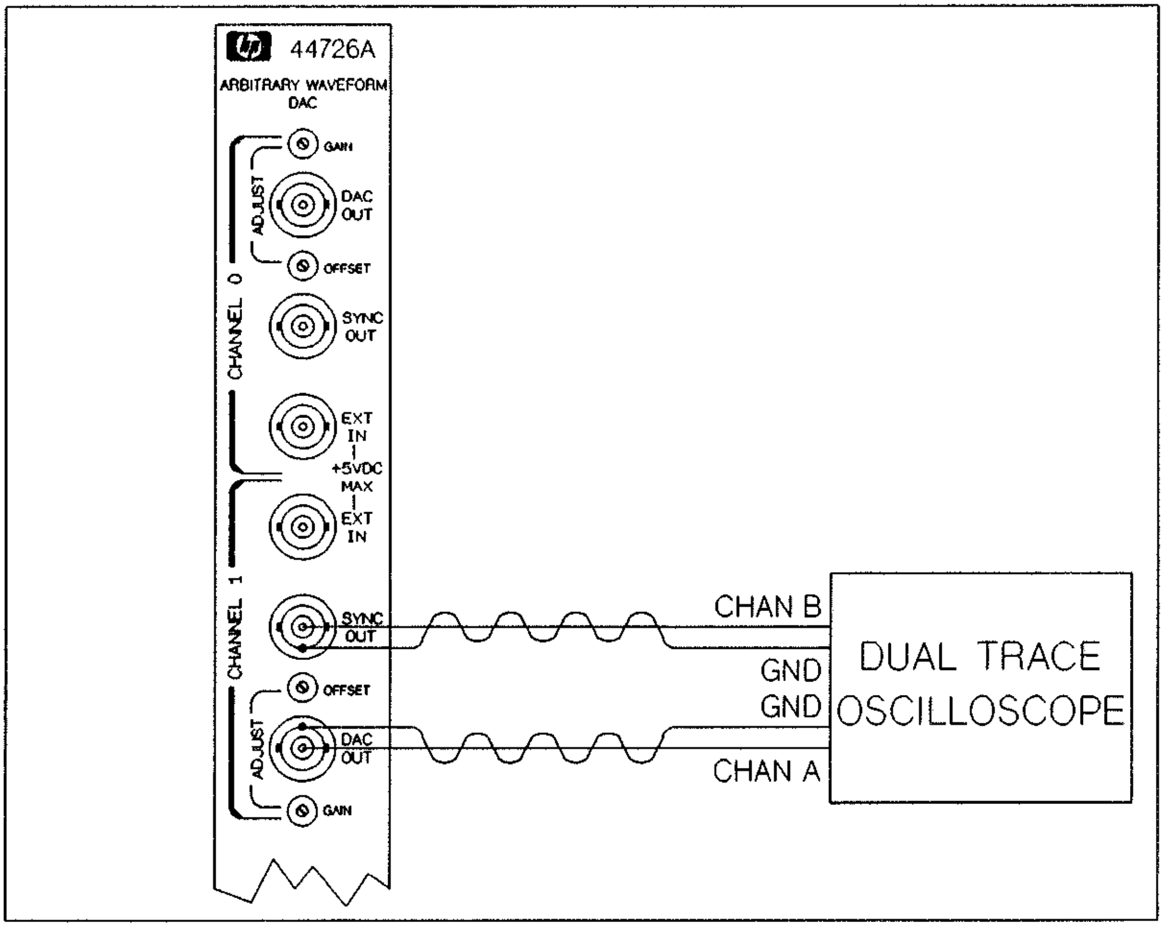


Figure 21-9 Channel 1 Sync Output Test Setup

21. Refer to Figure 21-9. Connect channel A of the oscilloscope to the accessory's DAC OUT connector on channel 1. Connect channel B of the oscilloscope to the accessory's SYNC OUT connector on channel 1.

22. Output a 5 V peak-to-peak, 8 µS square wave from channel 1 of the accessory by executing:

```
USE ES01   (where E = extender number, S = slot number)
WFWRITE SQV, 1, 5, TBASE 2E-6
APPLY WFV, ES01, 1   (where E = extender number, S = slot number)
TRIG INT
TARM AUTO
SYNC TRIG
```

23. Verify that the waveform displayed on the oscilloscope is as shown in Figure 21-3. The sync pulse shown on channel B of the oscilloscope is between 0.4 µS and 0.8 µS.

24. Setup channel 1 for SYNC WF by executing:

```
SYNC WF
```

25. Verify that the waveform displayed on the oscilloscope is as shown in Figure 21-4. The sync pulse on channel B of the oscilloscope should go low before the output pulse goes high.

26. Setup channel 1 for SYNC DAC by executing:

SYNC DAC

27. Verify that the waveform displayed on the oscilloscope is as shown in Figure 21-5. The sync pulse on channel B of the oscilloscope should consist of three pulses for every output pulse. The uneven spaced pulses should be approximately 350 nS wide.

28. Setup channel 1 for SYNC HOLD by executing:

SYNC HOLD

29. Verify that the waveform displayed on the oscilloscope is as shown in Figure 21-6. channel B of the oscilloscope should display a constant high level (+5.0 V).

30. CHANNEL 1 TRIG INPUT TEST. This test verifies that channel 1 can execute an external trigger input.

31. Refer to Figure 21-10. Connect channel A of the oscilloscope to the accessory's DAC OUT connector on channel 1. Connect channel B of the oscilloscope to the accessory's EXT IN connector on channel 0. Also connect the accessory's DAC OUT connector on channel 0 to the EXT IN connector on channel 1.

32. Set channel 1 of the accessory for external trigger by executing:

TRIG EXT

33. Output a 5 V peak-to-peak, 8 µS square wave from channel 0 of the accessory by executing:

WFWRITE SQV, 1, 5, TBASE 2E-6, USE ES00
APPLY WFV ES00, 1 (where E = extender number, S = slot number)
TARM AUTO, USE ES00
SYNC WF, USE ES00

Note: In the USE commands above, E = extender number, S = slot number.

34. Change the oscilloscope Time setting to 2 µS/Div. Verify that the waveform displayed on the oscilloscope is as shown in Figure 21-8.

35. Remove the oscilloscope from the HP 44726A accessory. Also remove the connection between DAC OUT of channel 0 and EXT IN of channel 1.

21-12 DC Volts Accuracy Test

This test checks the dc offset voltage and full scale accuracy of both channels. A one hour warm-up of the accessory is required to perform the test. If any portion of the test fails, perform the calibration procedure in Section 21-15.

1. CHANNEL 0 DC VOLTS TEST. This test checks the offset and full scale accuracy of channel 0.

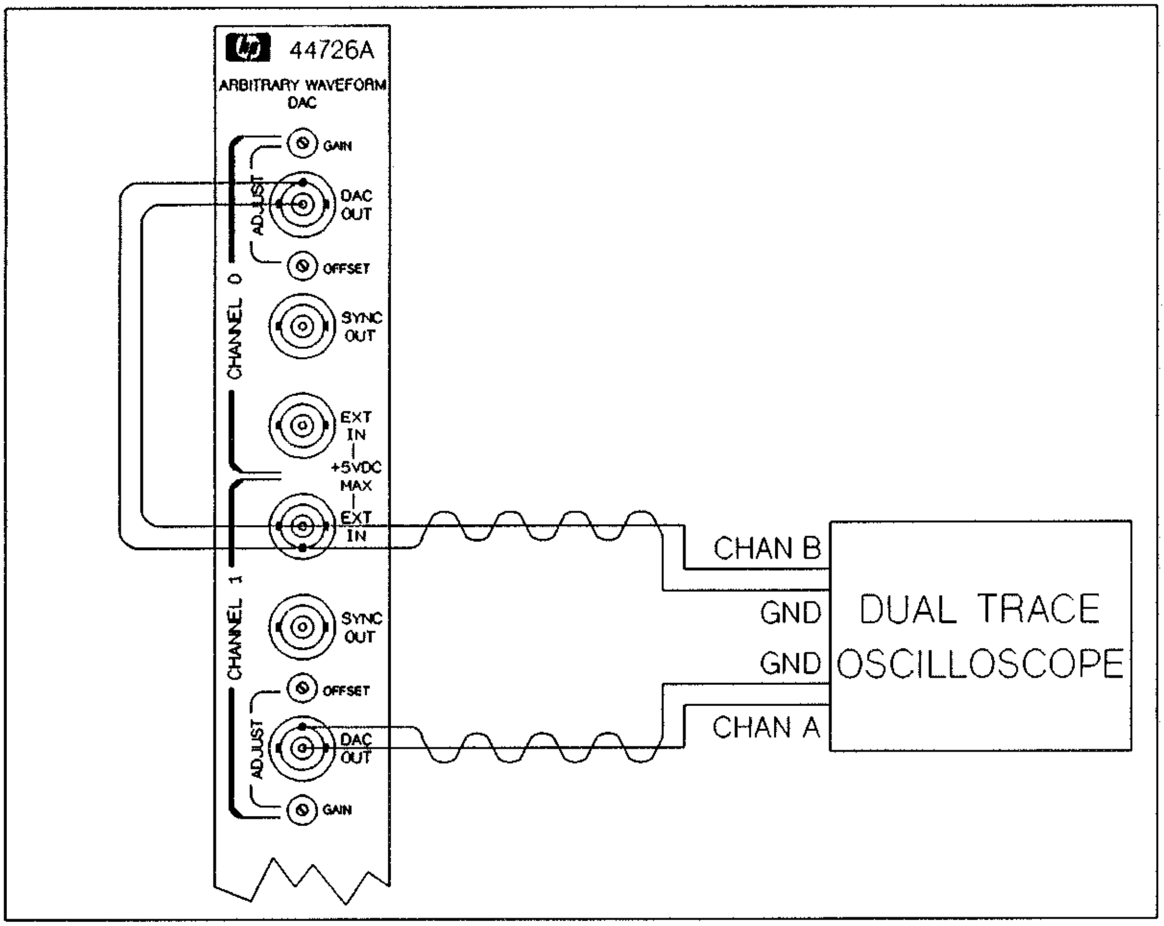


Figure 21-10 Channel 1 Trig Input Test Setup

2. Set the HP 44726A to a known state by executing:

   RESET ES00 (where E = extender number, S = slot number)

3. Set the digital multimeter for dc volts and autorange.

4. Refer to Figure 21-11. Connect the digital multimeter to the accessory's DAC OUT connector on channel 0.

5. Set channel 0 to output 0 V by executing:

   APPLY DCV ES00, 0 (where E = extender number, S = slot number)

6. Observe the reading on the digital multimeter. It should indicate 0 V ±3.6 mV.

7. Set channel 0 to output -10.235 V by executing:

   APPLY DCV ES00, -10.235 (where E = extender number, S = slot number)

8. Observe the reading on the digital multimeter. It should indicate between -10.2287 V and -10.2413 V.

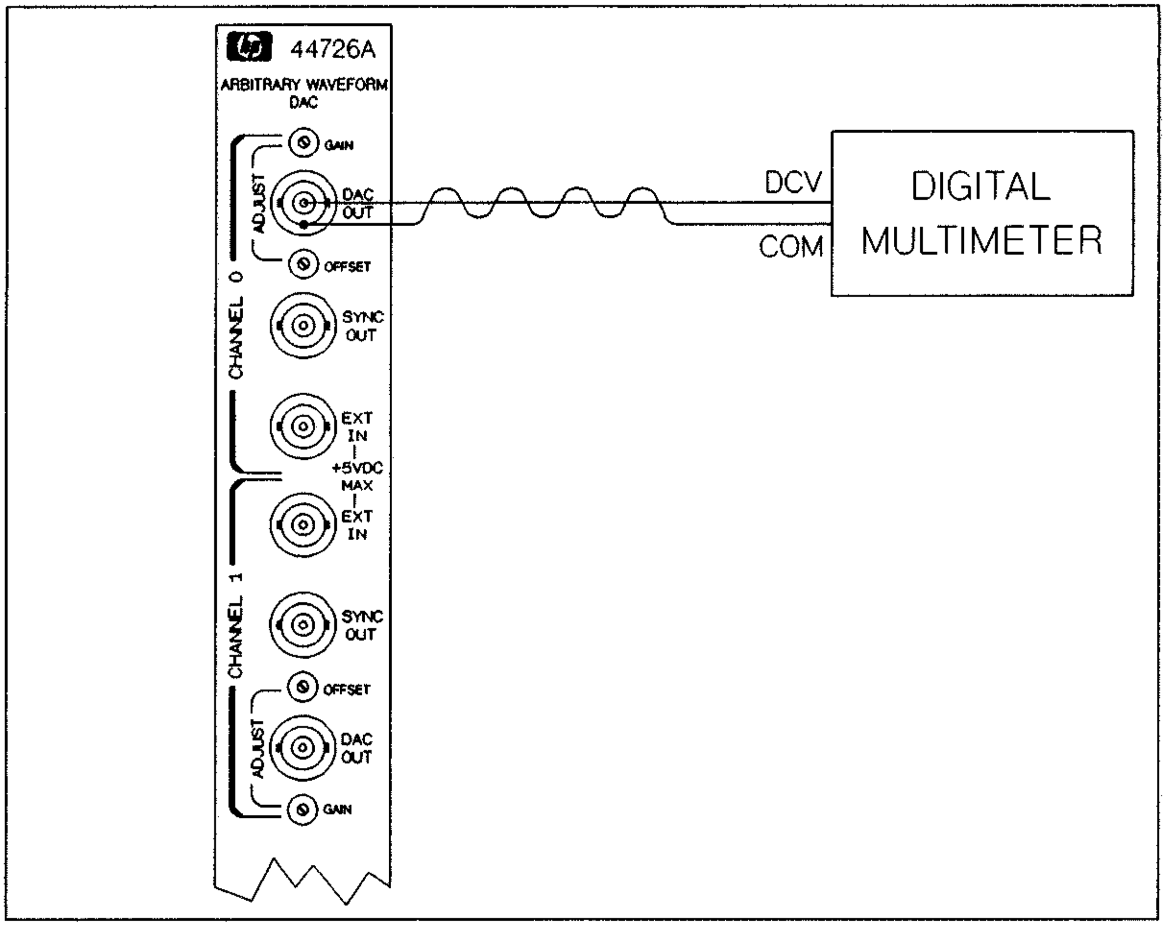


Figure 21-11 Channel 0 DC Volts Test Connection

9. Set channel 0 to output +10.235 V by executing:

    APPLY DCV ES00, 10.235 (where E = extender number, S = slot number)

10. Observe the reading on the digital multimeter. It should indicate between +10.2287 V and +10.2413 V.

11. CHANNEL 1 DC VOLTS TEST. This test checks the offset and full scale accuracy of channel 1.

12. Refer to Figure 21-12. Remove the digital multimeter from channel 0 and connect it to the accessory's DAC OUT connector on channel 1.

13. Set channel 1 to output 0 V by executing:

    APPLY DCV ES01, 0 (where E = extender number, S = slot number)

14. Observe the reading on the digital multimeter. It should indicate 0 V ±3.6 mV.

15. Set channel 1 to output -10.235 V by executing:

    APPLY DCV ES01, -10.235 (where E = extender number, S = slot number)

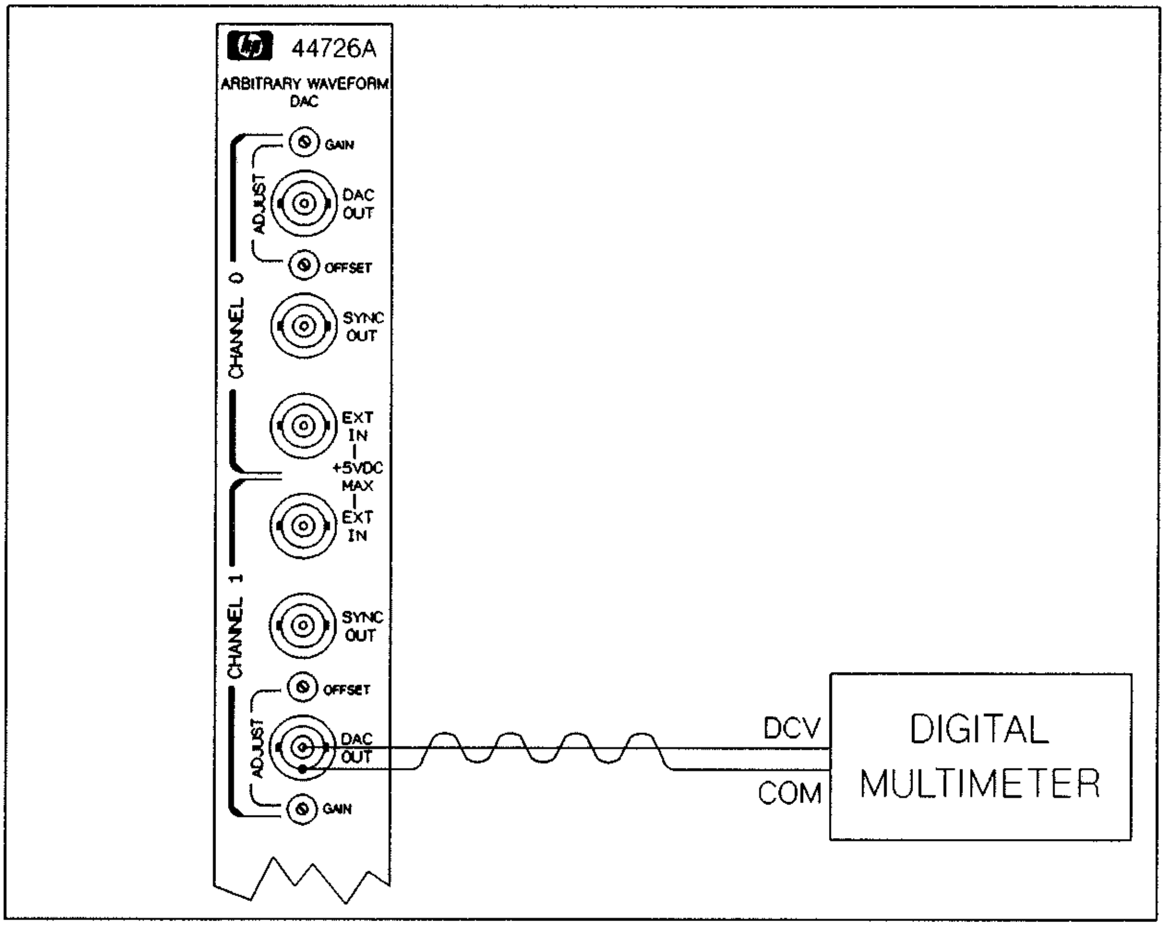


Figure 21-12 Channel 1 DC Volts Test Connection

16. Observe the reading on the digital multimeter. It should indicate between -10.2287 V and -10.2413 V.

17. Set channel 1 to output 10.235 V by executing:

    APPLY DCV ES01, 10.235 (where E = extender number, S = slot number)

18. Observe the reading on the digital multimeter. It should indicate between +10.2287 V and +10.2413 V.

19. If you wish to do the rest of the performance test, leave the digital multimeter connected and continue with section 21-13. Otherwise remove the digital multimeter from the HP 44726A accessory. This completes the DC Volts Accuracy Test.

THIS COMPLETES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44726A PERFORMANCE TESTS.

21-13 DC Volts Accuracy Test Under Full Load

This test checks the dc full scale accuracy under full load of both channels. If any portion of the test fails, perform the calibration procedure in Section 21-15.

1. CHANNEL 1 DC VOLTS TEST. This test checks the full scale accuracy under full load of channel 1.

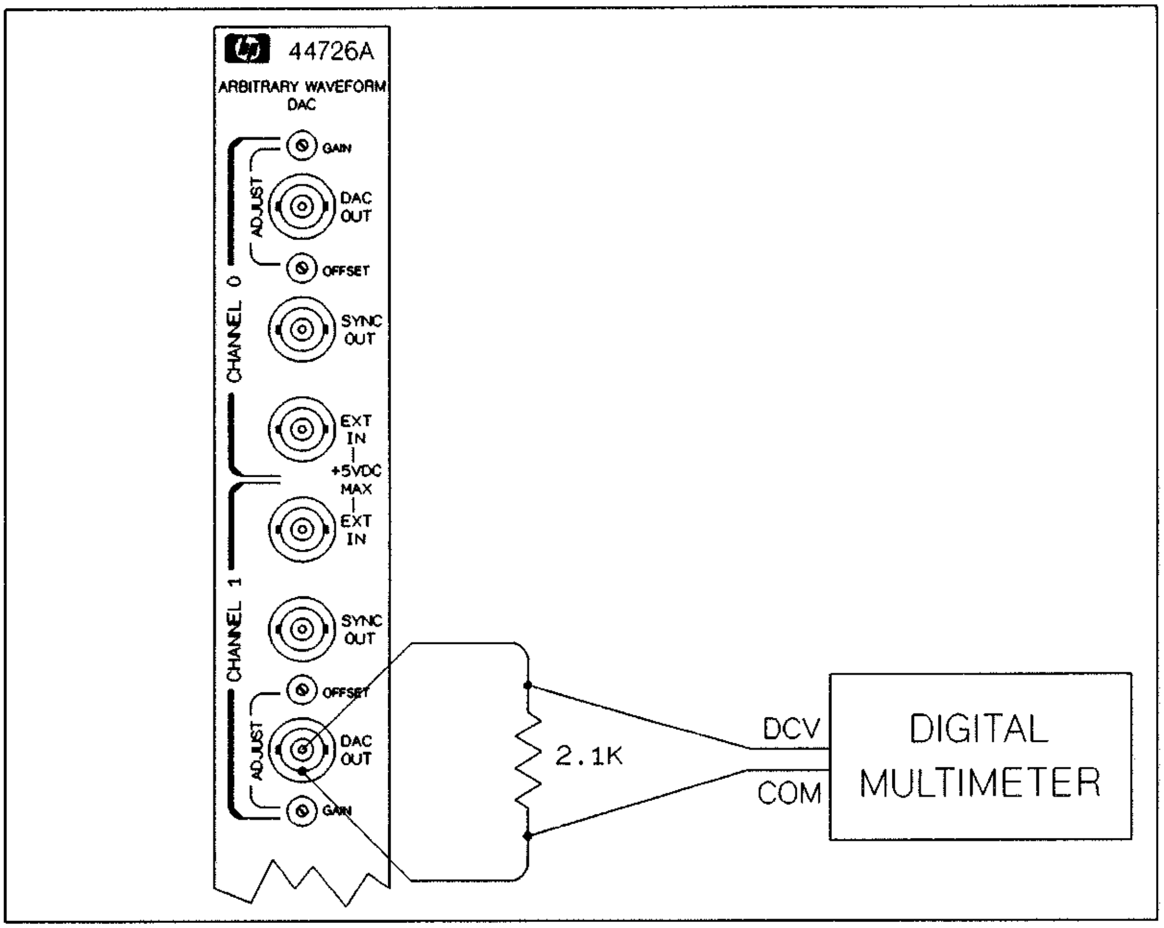


Figure 21-13 Channel 1 Full Load DC Volts Test Connection

2. If the DC Volts Accuracy test in Section 21-12 has not been previously performed, do the following:

   a. Set the HP 44726A to a known state by executing:

      RESET ES00 (where E = extender number, S = slot number)

   b. Set the digital multimeter for dc volts and autorange.

   c. Refer to Figure 21-13. Connect the digital multimeter to the accessory's DAC OUT connector on channel 1.

3. Connect a 2.1 kohm resistor across the channel 1 DAC OUT connector, as shown in Figure 21-13.

4. If the DC Volts Accuracy test in Section 21-12 has not been performed previously, execute the following. Otherwise, continue with step 5.

   APPLY DCV ES01, 10.235 (where E = extender number, S = slot number)

5. Observe the reading on the digital multimeter. It should indicate between +10.2287 V and +10.2413 V.

6. Set channel 1 to output -10.235 V by executing:

APPLY DCV ES01, -10.235 (where E = extender number, S = slot number)

7. Observe the reading on the digital multimeter. It should indicate between -10.2287 V and -10.2413 V.

8. CHANNEL 0 DC VOLTS TEST. This test checks the full scale accuracy under full load of channel 0.

9. Refer to Figure 21-14. Connect the digital multimeter to the accessory's DAC OUT connector on channel 1.

10. Connect a 2.1 kohm resistor across the channel 0 DAC OUT connector, as shown in Figure 21-14.

11. Set channel 0 to output -10.235 V by executing:

APPLY DCV ES00, -10.235 (where E = extender number, S = slot number)

12. Observe the reading on the digital multimeter. It should indicate between -10.2287 V and -10.2413 V.

13. Set channel 0 to output 10.235 V by executing:

APPLY DCV ES00, 10.235 (where E = extender number, S = slot number)

14. Observe the reading on the digital multimeter. It should indicate between +10.2208 V and +10.2492 V.

15. Remove the digital multimeter and resistor from the HP 44726A accessory. This completes the DC Volts Accuracy Test under Full Load.

21-14 Monotonicity Test

This test verifies that both channels meet the monotonicity specifications.

Monotonicity guarantees that with a voltage increase of 0.00125 V, the output voltage may only have a 0.0 V or above change. If it is negative or zero, it is increased by .000125 V. The Monotonicity Test is illustrated as follows:

a. If the output voltage is presently at +10.235000 V, the HP 44726A accessory is next setup to output +10.236250 V (i.e., +10.235000 + .00125 = +10.236250).

b. The new output voltage must then be equal to or above +10.235000 V (the original voltage). If the voltage would go below +10.235000 V, the monotonicity test would fail.

Do the following:

1. Set the digital multimeter for dc volts and autorange.

2. Refer to Figure 21-11. Connect the digital multimeter to the accessory's DAC OUT connector on channel 0.

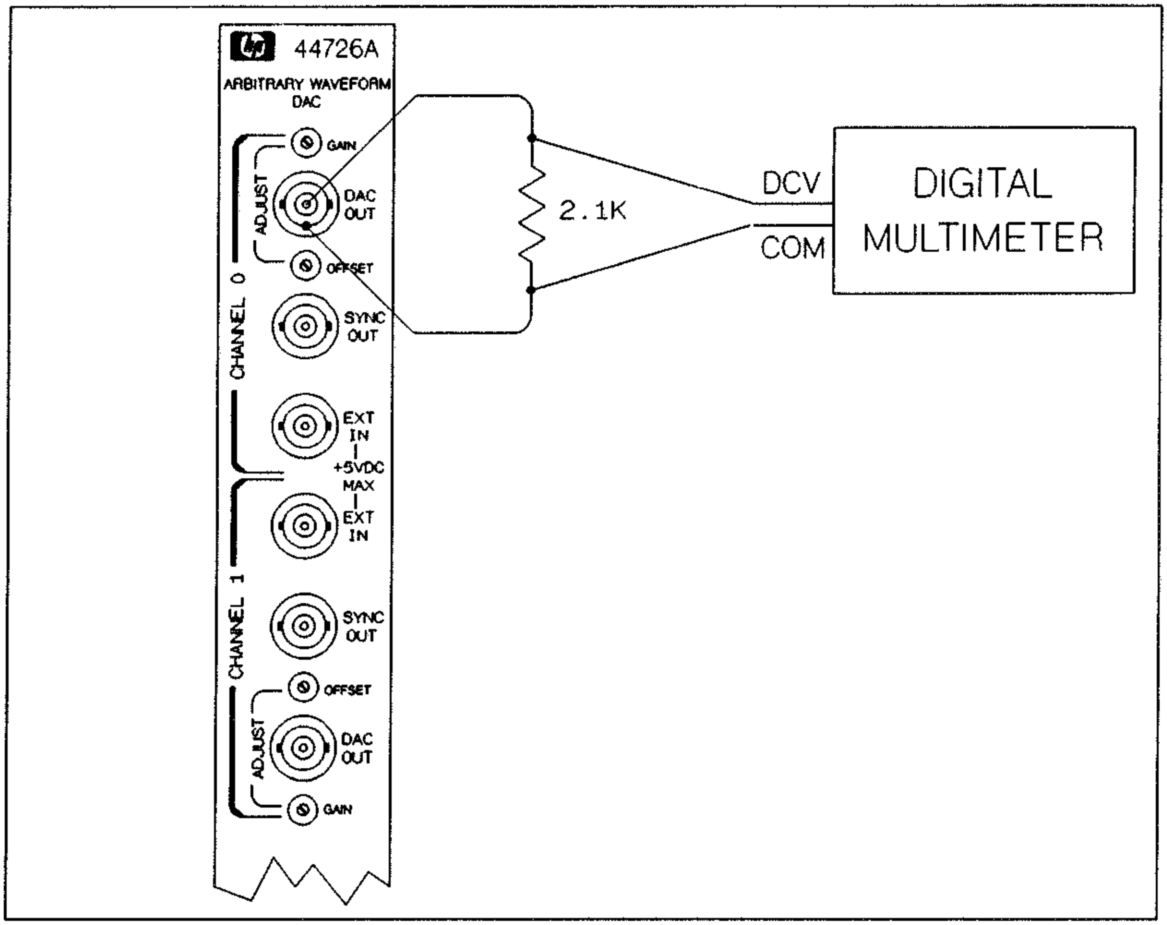


Figure 21-14 Channel 0 Full Load DC Volts Test Connection

3. Using the data in Table 21-2, set channel 0 to output the voltage from the "Output Voltage" column in Table 21-2. Output the voltage by executing:

APPLY DCV ES00, DD (where E = extender number, S = slot number, DD = input voltage)

4. Note the reading on the digital multimeter.

5. Using the command in step 3, set channel 0 to output the voltage from the "Step Voltage" column that corresponds to the "Output Voltage" column in step 3. Output the voltage by executing:

APPLY DCV ES00, DD (where E = extender number, S = slot number, DD = input voltage)

6. Verify that the new reading on the digital multimeter is within the reading noted in step 4 plus 0.003125 V. Use the "Error" column in Table 21-2 to determine the change in output voltage.

Note, monotonicity only guarantees that the output will not go lower with a 0.00125 V increase. This in effect makes the "High" Error column in Table 21-2 unnecessary. However, if the high limits in the column are exceeded, it may indicate a failure in the digital-to-analog converter.

7. Repeat steps 3, 4, 5, and 6 for the rest of the voltages in the "Output Voltage" column of Table 21-2. In the APPLY DCV ES00 DD command in steps 3 and 5, be sure to change the "DD" digits to the appropriate values listed in the "Output Voltage" and "Step Voltage" columns of Table 21-2.

8. Refer to Figure 21-12. Connect the digital multimeter to the accessory's DAC OUT connector on channel 1.

9. Repeat steps 3, 4, 5, 6, and 7 for channel 1. In the APPLY DCV ES00 command in steps 3 and 5, be sure to change the last two digits to ES01 for channel 1.

Table 21-2 Monotonicity Test Limits

Output Voltage	Step Voltage	Error Low	Error High
10.235000	10.236250	0.0	0.003125
10.230000	10.231250	0.0	0.003125
10.220000	10.221250	0.0	0.003125
10.200000	10.201250	0.0	0.003125
10.160000	10.161250	0.0	0.003125
10.080000	10.081250	0.0	0.003125
9.920000	9.921250	0.0	0.003125
9.600000	9.601250	0.0	0.003125
8.960000	8.961250	0.0	0.003125
7.680000	7.681250	0.0	0.003125
5.120000	5.121250	0.0	0.003125
2.560000	2.561250	0.0	0.003125
0.000000	0.001250	0.0	0.003125
-0.000312	0.001562	0.0	0.003125
-0.000625	0.000625	0.0	0.003125
-0.001250	0.000000	0.0	0.003125
-0.002500	-0.001250	0.0	0.003125
-2.560000	-2.558750	0.0	0.003125
-5.120000	-5.118750	0.0	0.003125
-7.680000	-7.678750	0.0	0.003125

21-15 CALIBRATION

21-16 Introduction

The calibration procedure in this section calibrates the accessory's output amplifiers of both channels.

Calibration is performed by adjusting two potentiometers for each channel. One potentiometer adjusts the offset voltage and the other the full scale voltage.

21-17 Calibration Cycle

Periodic calibration should be performed to ensure that the accessory is meeting its accuracy specifications. The accessory should be calibrated every 90 days. Calibration should also be performed if determined by the Performance Test procedures that calibration is needed.

21-18 Calibration Environment

The HP 44726A accessory may be calibrated is a "bench" environment or system cabinet. For best accuracy, the temperature of the calibration environment should be within ±5° C of the actual operating environment. The HP 44726A was calibrated at the factory at an environment temperature of 23± C.

21-19 Equipment Required

The following test equipment is required to calibrate the HP 44726A.

1. Test Leads and Jumpers (includes a BNC-to-Banana cable).

2. Digital Multimeter -- HP 3456A or equivalent.

NOTE

The integrating voltmeter (HP 44701A) may be used for the Calibration Procedure. The procedure does not describe specific steps required to use the plug-in voltmeter. A description of the plug-in voltmeter can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

21-20 Calibration Procedure

21-21 Set-Up Procedure

1. Apply power to the HP 3852A and allow the HP 44726A accessory a one hour warm-up period inside the mainframe.

2. Press the RESET button on the HP 3852A front panel. Perform the HP 44726A self-test by executing:

   TEST ES00 (where E = extender number, S = slot number)

3. The HP 3852A right display should show:

   SELF TEST OK

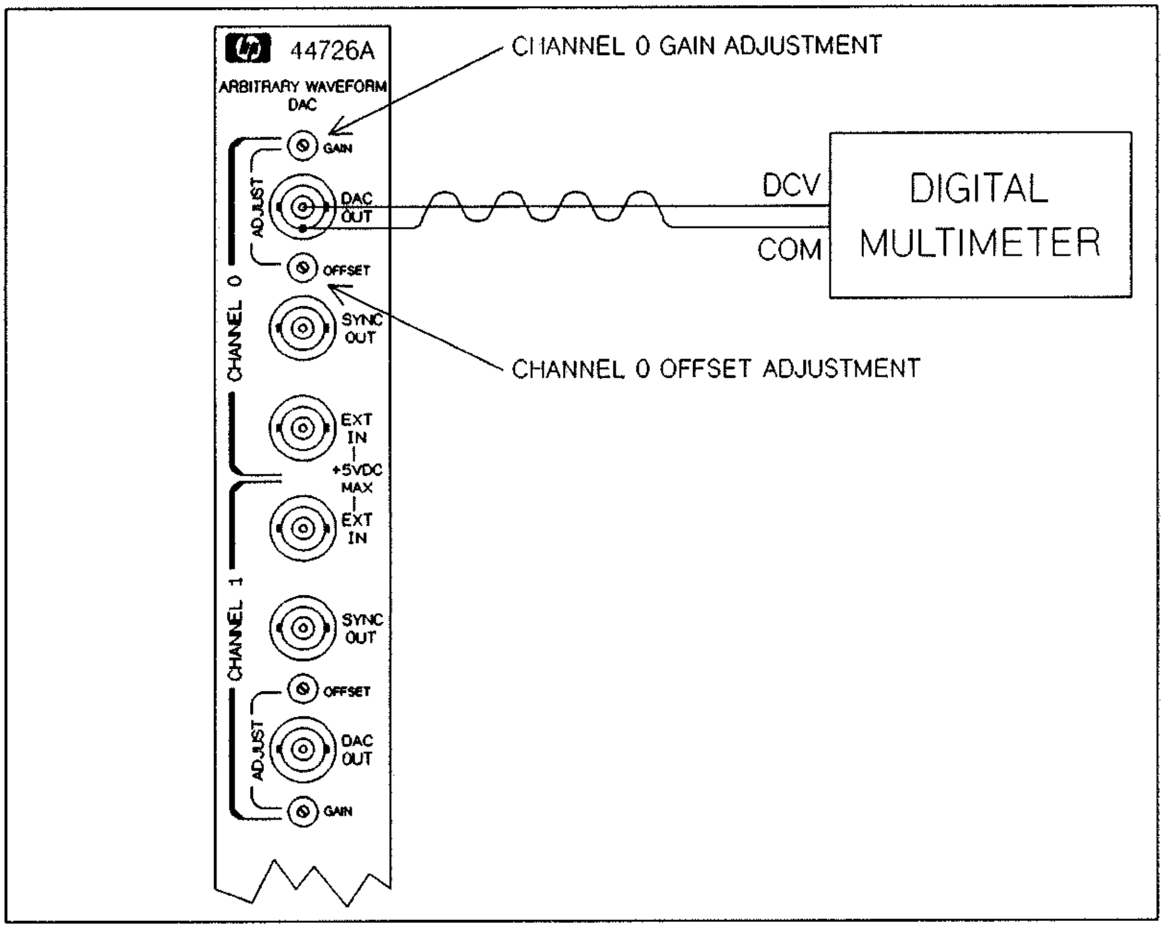


Figure 21-15 Channel 0 Calibration

If the display shows a different message, or the ERR annunciator is on, the HP 44726A accessory may be failing its self-test. Test the accessory again by executing the command in step 1. If the accessory still fails, exchange it with a working one.

21-22 Offset/Gain Calibration

Both of the accessory's channels are calibrated individually.

1. Set the digital multimeter to dc volts and autorange.

2. Refer to Figure 21-15. Connect the digital multimeter to the accessory's DAC OUT connector on channel 0.

3. Set channel 0 to output 0 V by executing:

APPLY DCV ES00, 0 (where E = extender number, S = slot number)

4. Refer to Figure 21-15 to locate the "OFFSET" potentiometer. Using a small flat blade screwdriver, adjust the potentiometer for a 0 V reading on the digital multimeter.

5. Set channel 0 to output +10.235 V by executing:

APPLY DCV ES00, 10.235 (where E = extender number, S = slot number)

6. Refer to Figure 21-15 to locate the "GAIN" potentiometer. Using a small flat blade screwdriver, adjust the potentiometer for a +10.235 V reading on the digital multimeter.

7. Set channel 0 to output -10.235 V by executing:

APPLY DCV ES00, -10.235 (where E = extender number, S = slot number)

8. Note the reading on the digital multimeter. Determine the calibration error by subtracting the reading from -10.235 V. Then adjust the "GAIN" potentiometer to correct for one half of the error between the ideal voltage (-10.235 V) and the actual voltage. This is illustrated in the following example:

a. If the reading on the digital multimeter is -10.236 V, the error voltage will be:

(-10.235) - (-10.236) = 0.001

b. Adjust the "GAIN" potentiometer for a reading on the digital multimeter that equals the ideal voltage minus one half the error voltage. In this example, the reading would be:

(-10.235) - (0.001/2) = (-10.235) - (0.0005) = -10.2355

9. Set channel 0 to output +10.235 V by executing:

APPLY DCV ES00, 10.235

10. Make sure the reading on the digital multimeter is the ideal reading (+10.235 V) ±0.5 mV. In the example in step 8, the reading would be +10.2355 V. If the reading is wrong, perform the channel 0 calibration procedure again.

11. Using the previous procedure (steps 1 through 10), calibrate channel 1. Refer to Figure 21-16 for the calibration connections and gain/offset adjustment locations. The APPLY DCV commands in steps 3, 5, 7, and 9 should reflect channel 1 (e.g., APPLY DCV ES01, -10.235).

12. Remove the digital multimeter from the accessory.

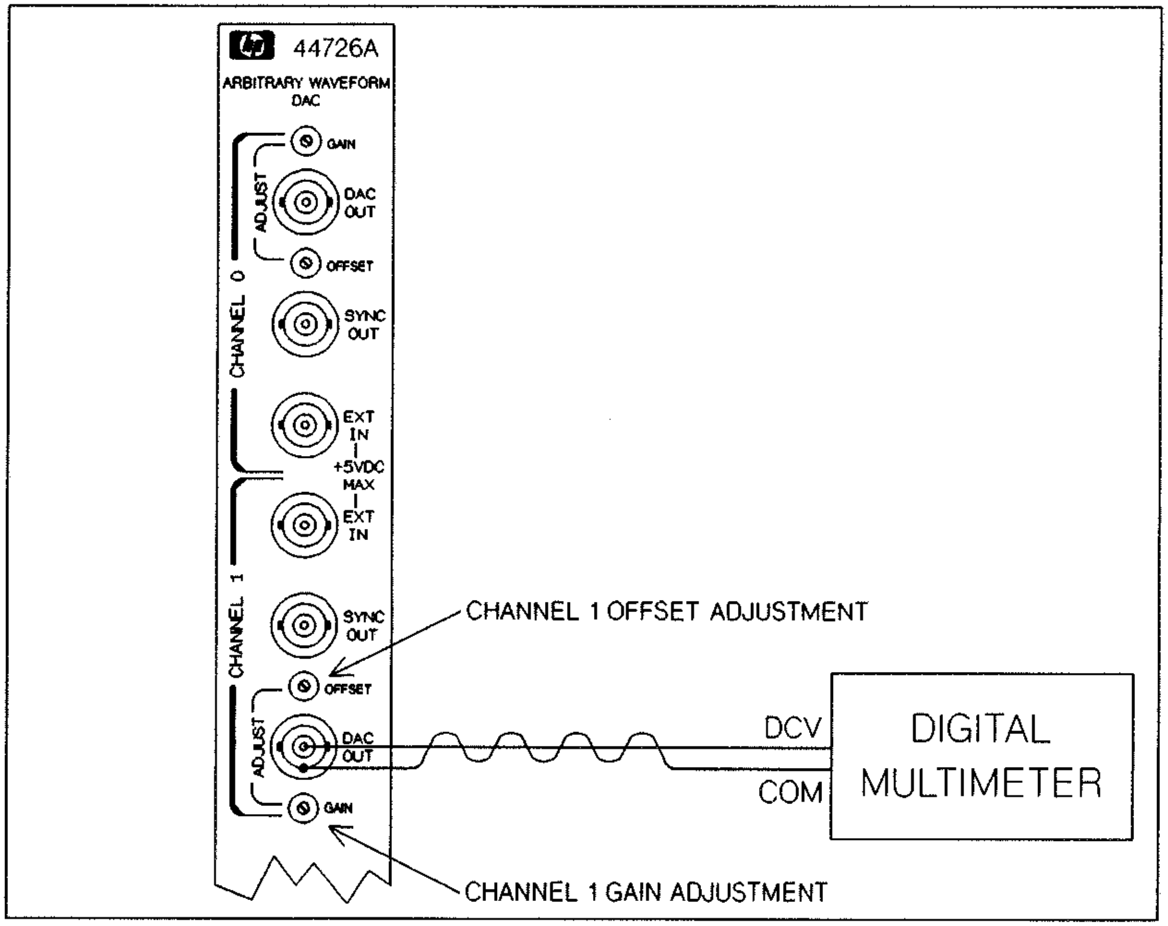


Figure 21-16 Channel 1 Calibration

21-23 REPLACEABLE PARTS

Figure 21-17 shows the mechanical breakdown of the HP 44726A. The figure also provides assembly and disassembly information. The parts shown in Figure 21-17 are keyed to the parts list in Table 21-3.

To order a part listed in Table 21-3, quote the Hewlett-Packard part number, the quantity desired, the HP system description, and the check digit (abbreviated CD in Table 21-3). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

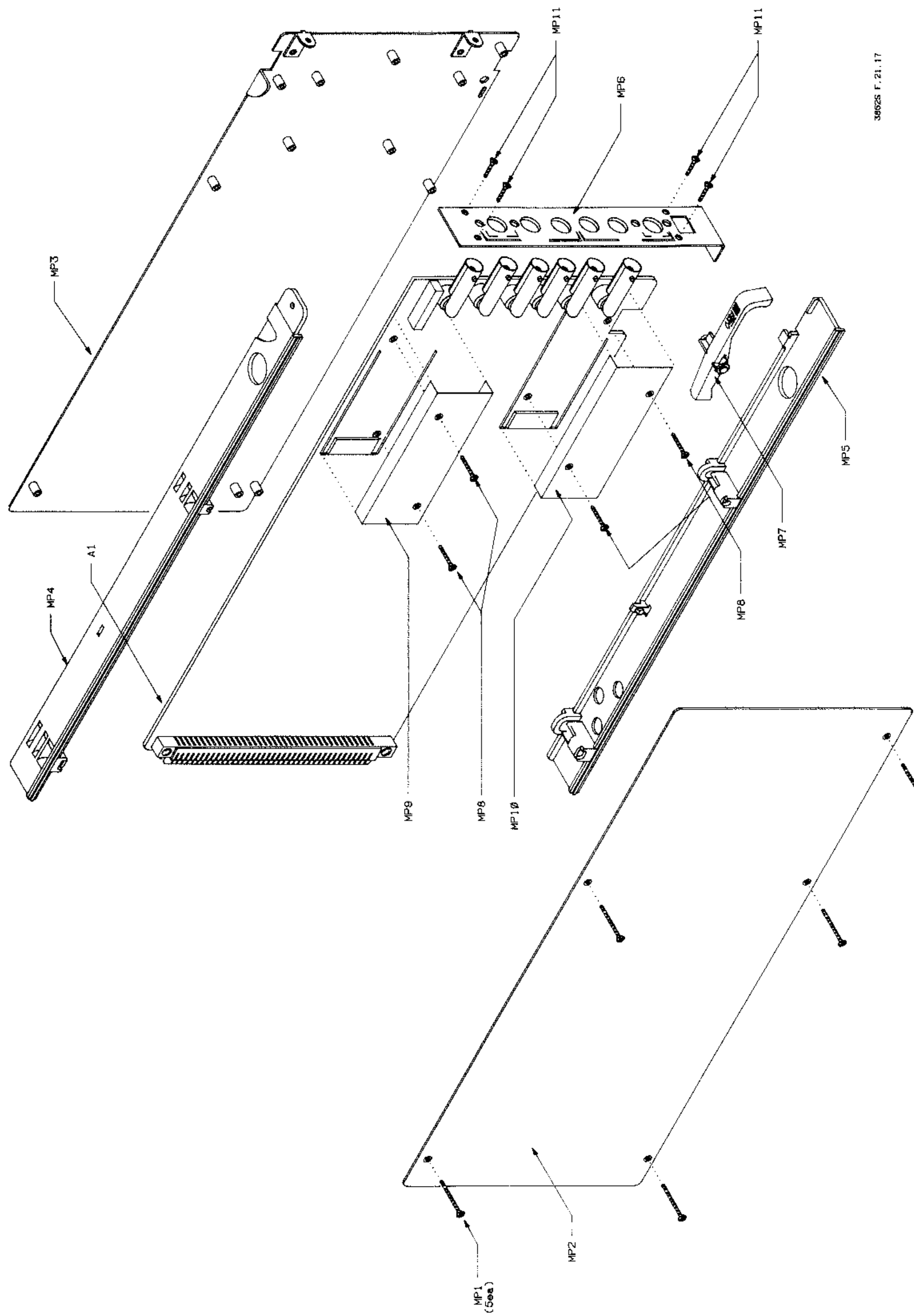


Figure 21-17 HP 44726A Exploded View

Table 21-3 HP 44726A Arbitrary Waveform DAC

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44726A	Arbitrary waveform DAC	1	44726A	7	FAST DAC
A1	PCA; arbitrary waveform DAC	1	44726-66501	9	PCA-FAST DAC
MP1	Screw; cover	5	0515-1322	4	SCR-FH M3.0X30LK
MP2	Cover; left (aluminum)	1	44726-04101	5	CVR-DAC LT
MP3	Cover; right (aluminum)	1	44726-04102	6	CVR-DAC RT
MP4	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP5	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP6	Panel; rear (molded)	1	44726-60201	4	PNL-RR,FAST DAC
MP7	Pull lever; (molded)	1	03852-45002	8	MLD-PULL LEVER
MP8	Screw; shield (top & bottom)	4	0515-1441	8	SCR-PH M3.0X20LK
MP9	Shield (top)	1	44726-00601	2	SHLD-TP
MP10	Shield (bottom)	1	44726-00602	3	SHLD-BT
MP11	Screw; rear panel	4	0515-0886	3	SCR-PH M3.0X6LK

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44726A	Arbitrary waveform DAC		44726-69201	2	RBLT-44726A

CHAPTER 22

HP 44788A 2 HP-IB CONTROLLER

CHAPTER 22
HP 44788A
HP-IB CONTROLLER

22-1 INTRODUCTION

This chapter provides a description, operational check, and a replaceable parts list for the HP 44788A HP-IB Controller Accessory.

NOTE

The HP-IB Controller Accessory can only be used with instruments having a firmware revision of 3.5 or above. Determine the firmware revision by sending the mainframe command: **IDN?**.

22-2 HP 44788A Description

The HP-IB accessory may be used as a stand-alone HP-IB controller for disc drive, printer, and instrument control through a local HP-IB port without the need of a system controller. The accessory normally receives programming instructions from an externally connected disc drive. It can also receive instructions from the mainframe using data entered from the front panel.

The accessory can not be used in slot 0 of the HP 3852A mainframe. It must be used in slots 1 through 7. However, it can be used in any slot of an HP 3853A Extender.

22-3 OPERATIONAL CHECK

22-4 Introduction

Only an operational check is performed on the accessory. A performance test is not needed. Successful completion of the check provides a high confidence level that the HP-IB Controller Accessory is operating properly.

22-5 Equipment Required

A short HP-IB cable (e.g., HP 10833D). It needs to be long enough to connect the HP 44788A accessory to the mainframe HP-IB connector.

22-6 Procedure

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

1. Remove power from the HP 3852A.

2. Install the HP 44788A accessory into any slot, except slot 0 of the HP 3852A.

3. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

4. Once the wake-up sequence is completed, the HP 3852A will normally display an error message. The reason for the message is that the HP 44788A is looking for an autostart program on a disc drive. Since no drive is connected to it, the above message will be displayed. This is normal.

5. Connect the HP-IB cable between the HP-IB connector of the accessory and the HP-IB connector on the mainframe.

6. Be sure the HP 3852A HP-IB address is set to "9". If different, change ES09 in step 7 to reflect the address (e.g., for an address of "11", ES09 becomes ES11).

7. Execute the following:

   INTEGER I
   OUTPUT ES09 "VREAD 12345" (where E = extender number, S = slot number)*
   LOCAL (i.e., the LOCAL key on the HP 3852A front panel)

*The quotation marks are entered into the display by pressing the "E" key on the right number keyboard several times until the quotation mark is displayed.

8. Read the mainframe by executing:

   ENTER ES09 I (where E = extender number, S = slot number)

9. Display the value of variable I on the HP 3852A display by executing:

   VREAD I

10. Variable I should now be displayed on the right display of the HP 3852A. It should be shown as:

    1.234500E+4

11. This completes the operational check.

22-7 REPLACEABLE PARTS

Figure 22-1 shows the mechanical breakdown of the HP 44788A. The figure also provides assembly and disassembly information. The parts shown in Figure 22-1 are keyed to the parts list in Table 22-1.

To order a part listed in Table 22-1, quote the Hewlett-Packard part number, the quantity desired, the HP system description, and the check digit (abbreviated CD in Table 22-1). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The accessory printed circuit board is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

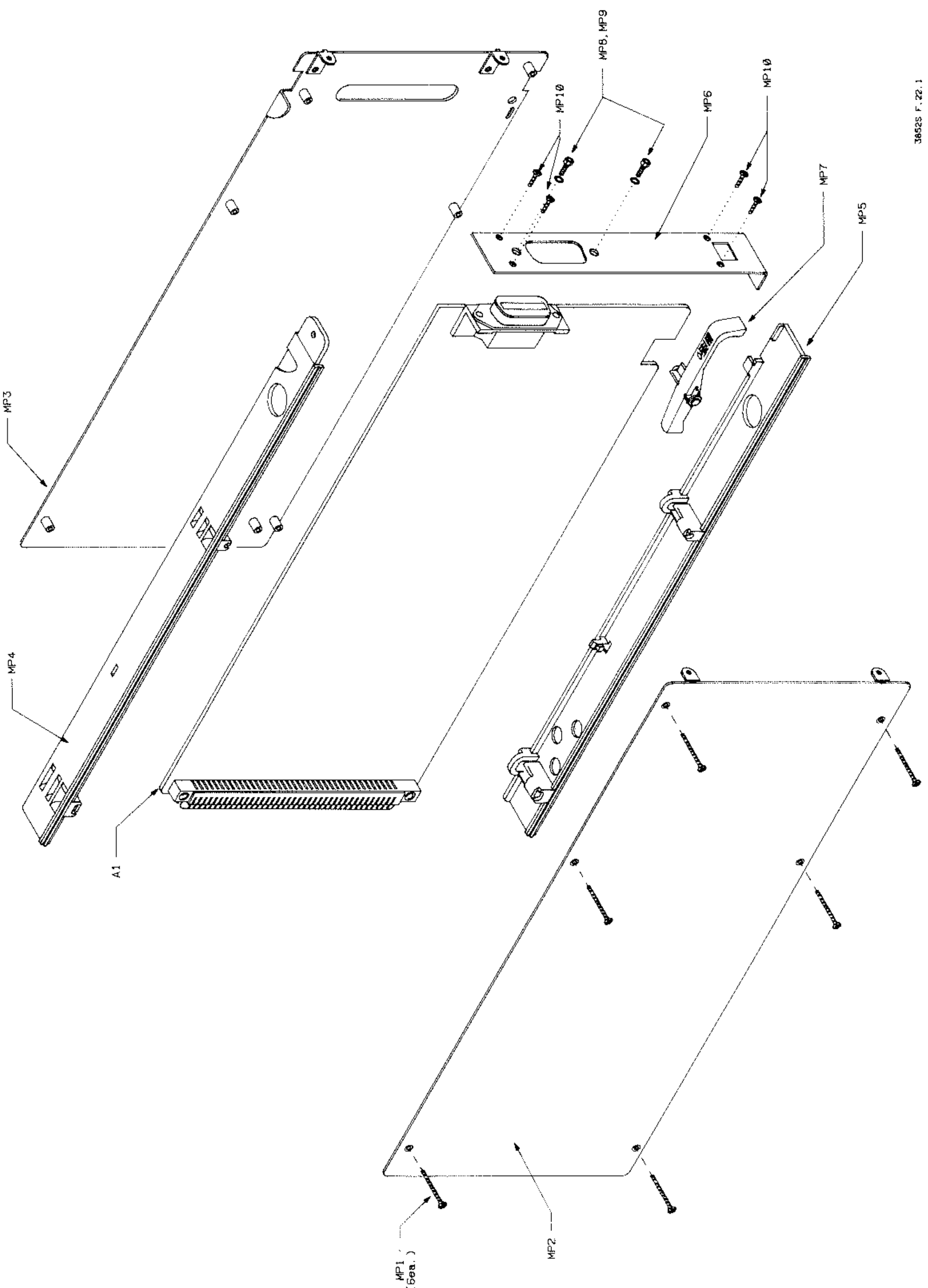


Figure 22-1 HP 44788A Exploded View

Table 22-1 HP 44788 HP-IB Controller

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44788A	HP-IB controller	1	44788A	1	HP-IB CONT
A1	PCA; HP-IB controller	1	44788-66501	3	PCA-HP-IB CONT
MP1	Screw; cover	6	0515-1322	4	SCR-FH M3.0X30LK
MP2	Cover; left (aluminum)	1	44750-04101	5	CVR-MOD LT
MP3	Cover; right (aluminum)	1	44750-04102	6	CVR-MOD RT
MP4	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP5	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP6	Panel; rear (molded)	1	44788-60201	8	PNL-RR,HP-IB CONT
MP7	Pull lever; (molded)	1	03852-45002	8	MLD-PULL LEVER
MP8	Standoff; HP-IB connector	2	5180-6650	5	STANDOFF-HEX
MP9	Washer; HP-IB connector	2	2190-0577	1	WSHR-LK SCR-10
MP10	Screw; rear panel	4	0515-0886	3	SCR-PH M3.0X6LK

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44788A	HP-IB controller		44788-69201	6	RBLT-44788A