HP 3488A Switch/Control Unit

HP 44476A/B
Microwave Switch Module

Operating, Programming, and
Configuration Manual

HEWLETT PACKARD

Copyright © Hewlett-Packard Company, 1986

RESTRICTED RIGHTS LEGEND

HEWLETT PACKARD

Herstellerbescheinigung

Hiermit wird bescheinigt, daβ das Gerät/System _____ HP 44476A/B _____
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 Meβ- und Testgeräte

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

Manufacturer's declaration

This is to certify that the equipment _____ HP 44476A/B _____
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 [,except that in the case of certain components listed in Section I of this manual, the warranty shall be for the specified period]. 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 CONSE-QUENTIAL 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.

A   3/11/83

www.valuetronics.com

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.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

A

HEWLETT PACKARD

Operating and Safety Symbols
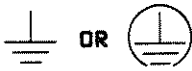
Symbols Used On Products And In Manuals

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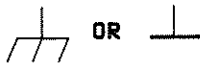
Frame or chassis ground. Indicates equipment chassis ground terminal – normally connects to equipment frame and all metal parts.

ATTENTION
Static Sensitive
Devices

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.

Contents

HP 44476A/B Microwave Switch Module

HP 44476A/B
Microwave Switch Module

Introduction

This manual contains a description of the HP 44476A and 44476B Microwave Switch Modules. You will also find information on configuring, installing, and programming the modules. Additionally, there is a section which gives several application examples for the modules. Brief definitions of the "A" and "B" versions follow.

- The HP 44476A is a 3-channel, single-pole, double-throw coaxial switch module. The coaxial switches have excellent electrical characteristics for 50-ohm transmission systems operating from dc to 18 GHz. The HP 44476A is Option 016 for the HP 3488A Switch/Control Unit.

- The HP 44476B is like the "A" version but does not have coaxial switches installed. The module panel has two 53.8 X 9.6 mm cutouts for multi-port coaxial switches with mounting holes that allow you to install two 3-, 4-, or 5-port +5V coaxial switches. The HP 44476B is Option 018 for the HP 3488A Switch/Control Unit.

Module Description

HP 44476A Description

The HP 44476A module contains three HP 33311B Option 011 Microwave Switches designated as channels 00, 01, and 02 (See Figure 1). These switches have the following features:

- Broad bandwidth (dc - 18 GHz, useable to 24 GHz)
- High isolation (>90 dB to 18 GHz)
- Excellent repeatibility (typically 0.03 dB after 1,000,000 switchings)
- Internal 50 ohm terminations

The HP 33311B Option 011 allows +5V coil voltage (drive voltage) operation instead of the standard +24V. This is necessary since the HP 44476 only provides +5V for driving microwave switches. Switch operation is controlled by form C relays K901, K902, and K903.

The HP 33311B is a break-before-make switch controlled by a latching solenoid. Once switched, coil voltage can be removed and the switch remains in the switched position. Internal coil contacts open and remove coil voltage after a switching operation to minimize the amount of heat dissipated near the switch contacts.

HP 33311B Pivot Armature

When a coil is energized and a switching operation occurs, a pivot armature in the microwave switch also operates the other set of contacts. For example, in Figure 1, when a ground is applied to the top switch coil, the solenoid connects port 1 to the common port of the channel (ports described here are as silkscreened on

Figure 1. HP 44476A Simplified Schematic.
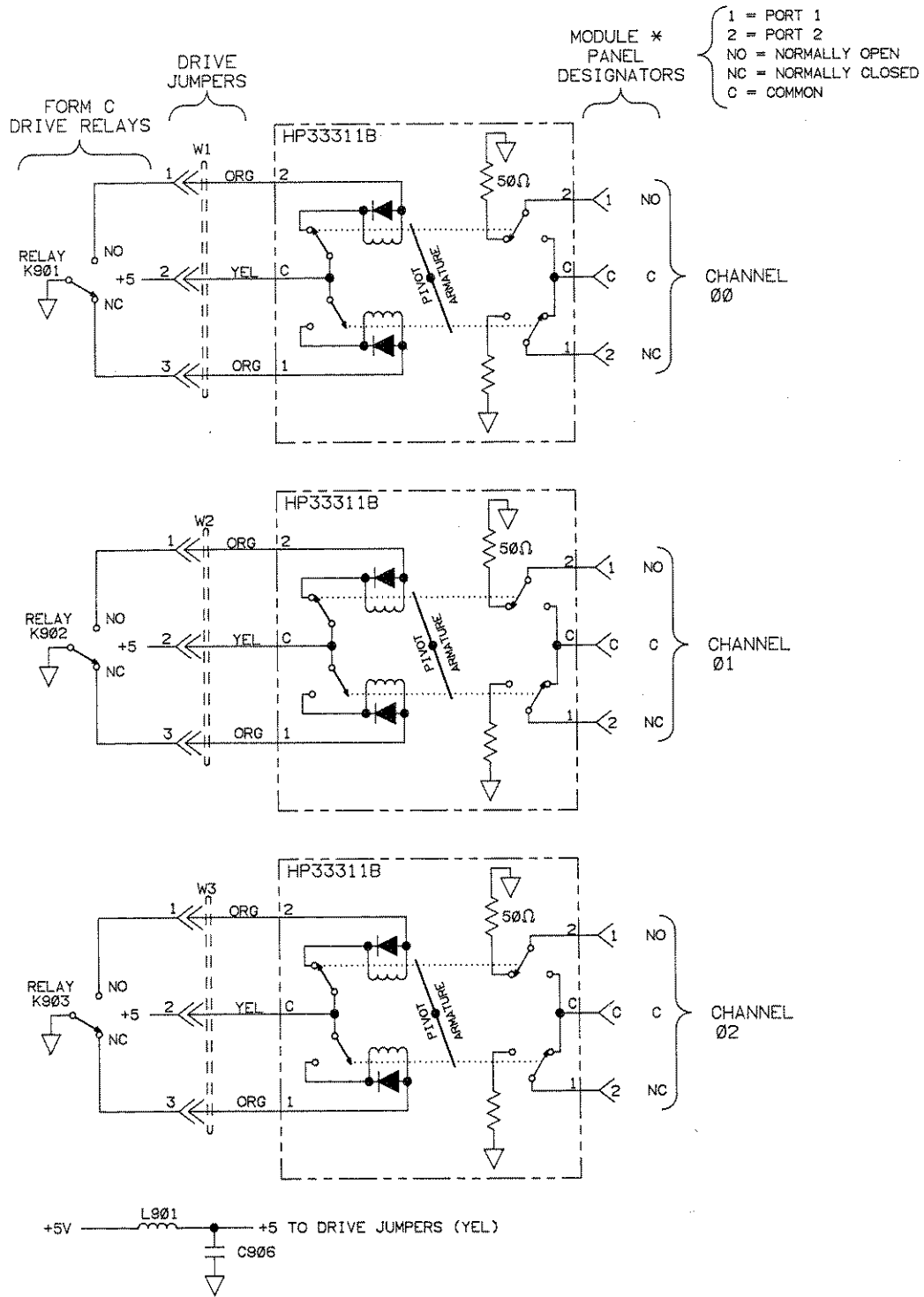
* NOTE :
TERMINAL DESIGNATIONS INSIDE THE DASHED BOXES REFER TO THE HP33311B
ONLY. MODULE PANEL DESIGNATORS OUTSIDE THE DASHED BOXES ARE THOSE
SILKSCREENED ON THE HP44476A PANEL. ANY REFERENCE IN THIS MANUAL
TO A PORT REFERS TO THE MODULE PANEL DESIGNATORS.

444760P F.1

Microwave Switch Module

2

the module panel and referred to in the Figure 1 note). The top coil circuit is then opened due to the switching operation. The pivot armature also operates with the switch operation and disconnects port 2 from the common port of the channel and connects it to a 50 ohm termination. At the same time, the bottom coil contact is closed making the bottom coil circuit ready for a switch operation in the opposite direction when a ground is applied.

HP 44476B Description

The HP 44476B differs from the "A" version in two ways: 1) It is not supplied with microwave switches (but does have the form C relays). You provide your own microwave switches, mount them on the assembly, and connect one of the module's form C relay drive circuits to each switch. 2) Instead of three cutouts, the HP 44476B panel has two 53.8 X 9.6 mm cutouts for HP 33313B Option 011 5-port +5V microwave switches supplied by the user. The panel will also allow mounting of the HP 33311B Option 011 (18 GHz) 3-port, HP 33311C Option 011 (26.5 GHz) 3-port, or HP 33312B Option 011 4-port microwave switches. Figure 2 is a simplified schematic of the HP 44476B. Figure 3 illustrates both the "A" and "B" modules for comparison.
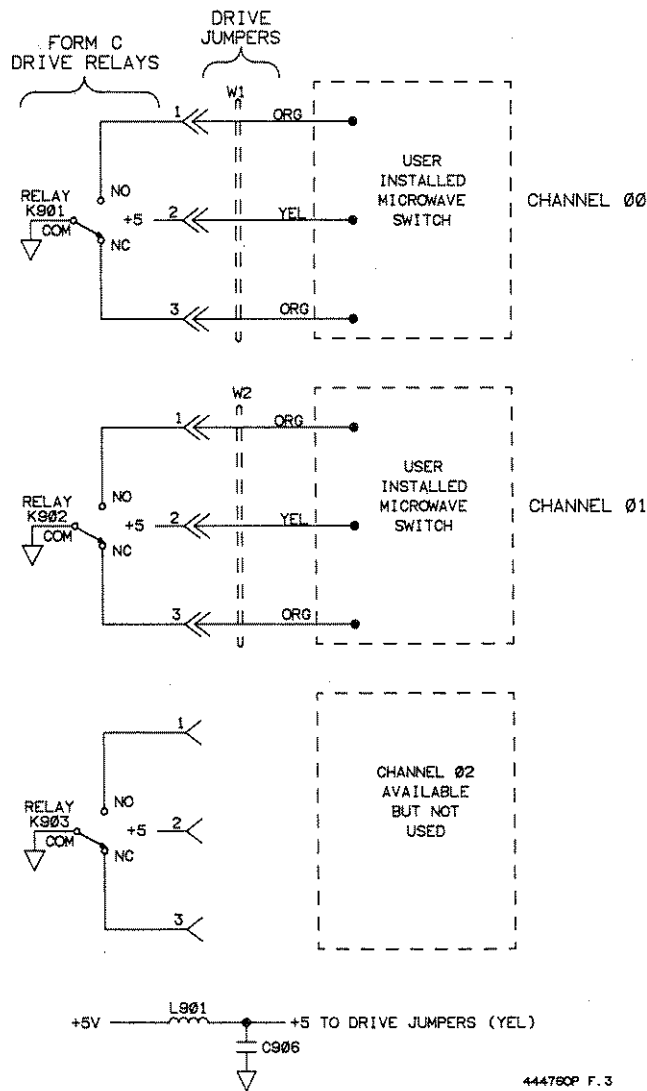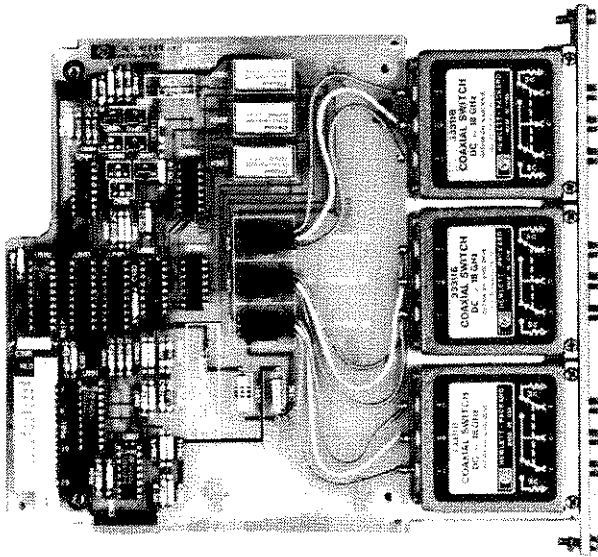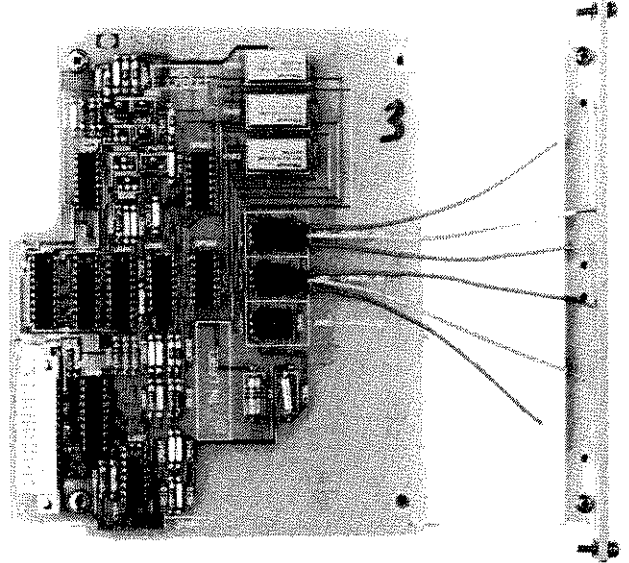

Figure 2. HP 44476B Simplified Schematic.
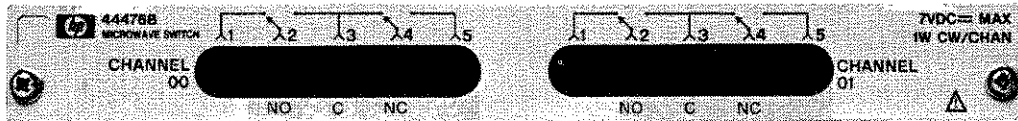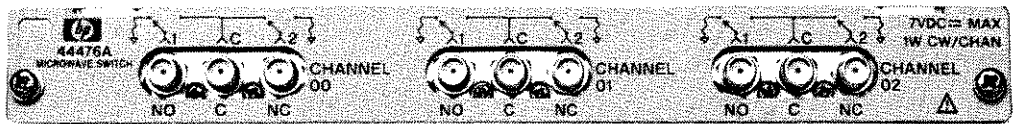
HP 44476A   HP 44476B

Figure 3. HP 44476A/B Microwave Switch Modules.

Channels

A channel refers to one of the three HP 33311B microwave switches mounted on the HP 44476A or one of the two you supply on the HP 44476B. The channels are numbered 00, 01, and 02 on the "A" version and 00 and 01 on the "B" version. The outer panel of each module indicates the channel number of each switch.

You switch a channel by using a complete channel address. The channel address is determined by which slot the HP 44476 is installed in. Channel addresses are three digit numbers of the form snn where the first number "s" specifies the particular slot (1 through 5) of the 3488A where the HP 44476 is installed. The last two digits "nn" (00, 01, or 02) are the channel number. For example, channel address 102 means slot 1, channel 02.

The following table shows all possible channel addresses.

Channel number as shown on the module panel	Channel address if HP 44476 module is in slot number:				
	1	2	3	4	5
00	100	200	300	400	500
01	101	201	301	401	501
02	102	202	302	402	502

Table 1. Possible Channel Addresses.

Internal +5V Power Supply

The HP 44476B allows you to install your own +5V microwave switches and operate them from the HP 3488A +5V power supply. You must consider the switching current requirement of your switches so that the current limit is not exceeded. For HP 44476B use, the +5V power supply, provided for connection to your switches, can supply a maximum of 0.5A total (all slots) and continuously before being current limited. The HP 33311B/C, 33312B, and 33313B Option 011 Microwave Switches are controlled by latching solenoids and automatically disconnect from the power supply after a switching operation. The +5V power supply current is sufficient to switch the HP latching-type microwave switches. If non-HP switches are used, latching-types are recommended. The total current requirement of switches you use should not exceed the power supply current limit.

Installing the HP 44476 ————————————————————

This section gives you information on how to install the HP 44476. There is no configuration required of the "A" module prior to installation in the HP 3488A Switch/Control Unit. The "B" module requires mounting of your microwave switches and connection of the form C relay drive circuits to these switches before installation in the HP 3488A.

WARNING

Only qualified service-trained personnel should remove, configure, or install the HP 44476A/B modules. Disconnect the HP 3488A power cord from the back of the instrument prior to installing a module.

CAUTION

Use anti-static procedures when removing, configuring, and installing a module. The module, as well as the HP 3488A, contains CMOS devices which are susceptible to static discharges.

To install an HP 44476 Microwave Switch Module in the HP 3488A, you perform the following steps.

1. Remove the ac power cord from the HP 3488A before installing the module.

2. Face the HP 3488A rear panel toward you.

3. Determine the slot in which you will install the module. Figure 4 illustrates the five slots that are available for installing modules. You can install the HP 44476 in any one of the five slots.

4. Hold the module by the metal shields, component side down. Insert the module into the slot guides and slide the module toward the front of the instrument. Push firmly until the assembly "snaps" into place. Secure the module in the slot by tightening the panel's two captive screws.

NOTE

To remove the module, simply loosen the screws at each end of the panel. Then pull the module out of the mainframe by holding on to the captive screws at each end of the panel.
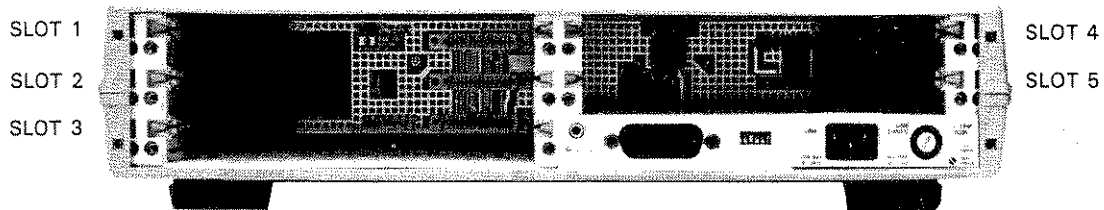
---

www.valuetronics.com

Figure 4. HP 3488A Rear Panel; Available Module Slots.

HP 44476B Configuration

The "B" version is not supplied with microwave switches. You mount user-supplied microwave switches on the module after connecting the channel 00 and 01 drive jumpers (W1 and W2). The following procedure gives you instructions for orienting and connecting the drive jumpers to your microwave switches and then mounting these switches on the HP 44476B module.

1. Orient the drive jumpers W1 and W2 with the corresponding microwave switch as shown in Figure 5. This orientation will make the switch operation agree with the silkscreen on the module panel. Solder the drive jumpers to your microwave switches.

2. Figure 6 shows an HP 33313B Option 011 5-port switch mounted on the module. Two panhead M2.5 x 18 mm long screws through the switch and into the module panel mount the switch. The tapped holes in the panel accomodate HP 3331X type microwave switches. The illustrated portion of Figure 6 identifies which mounting holes go with which type of microwave switch. Also shown are the maximum switch dimensions that can be accomodated by the HP 44476B if non-HP switches are used.

3. Plug the drive jumpers into the module connectors (do not install unused jumpers). The channel number is silkscreened on the module PC board next to the connector. The drive jumper plug is keyed to fit into the module connector one way only. After drive jumpers are installed, lay them flat against the PC board so they stay beneath the component-side shield when installed. See Figures 5 and 6.

NOTE

Do not leave an unused drive jumper plugged into the module during operation. If left installed, the yellow wire connected to the +5V supply can contact the orange wire routed to ground through the drive relay and short the +5V power supply. This causes the HP 3488A to reset (all modules also reset).
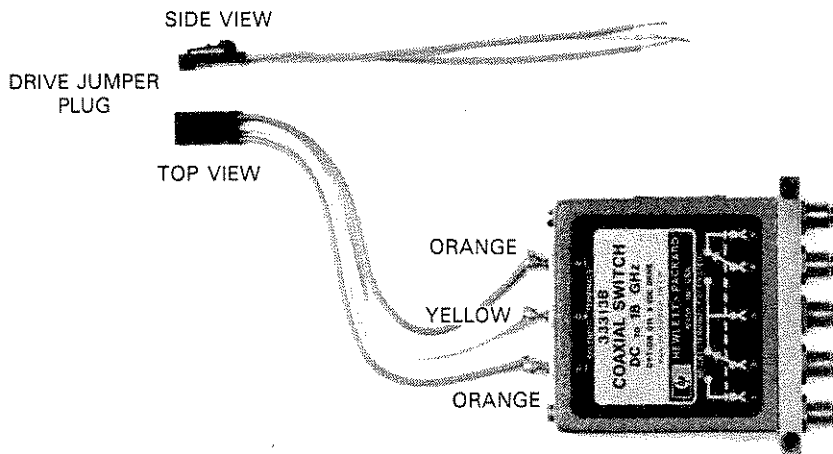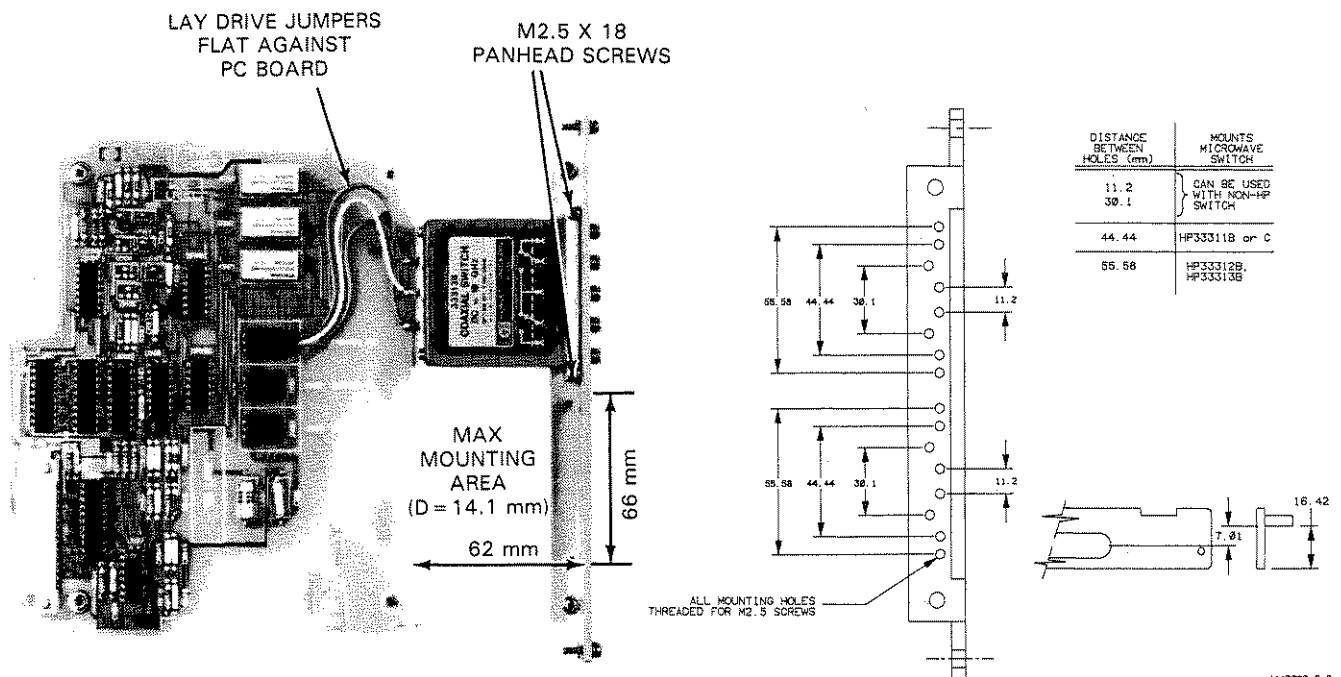

Figure 5. Drive Jumper Orientation.

Figure 6. Mounting the Microwave Switch.

Using the HP 44476

This section provides you information on how to close and open channels, what the power-on state of the module is, and what the reset state of the module is. A full description of the commands used in this section can be found in the "Command Summary" section along with the syntax for each command.

⚠ WARNING

POSSIBLE OPERATOR INJURY. *The HP 44476A (HP 3488A Option 016) and the HP 44476B (HP 3488A Option 018) contain latching drive relays. HP 3331X Microwave Switches also have latching solenoids. The state of the drive relays (and HP 33311B Microwave Switches on the HP 44476A) can only be altered by program control. In case of a power or equipment failure, the relays will remain in whatever state they were last programmed to. Any application requiring a failsafe method of insuring that the circuits under control are in a known state after a power or equipment failure, must be provided for by the installer. When power is reinstated, relays go to the power-on state.*

NOTE

Any reference to port 1 or port 2 of the HP 44476 modules refers to the ports as designated on the module panel. The microwave switch SMA connectors protrude through this panel.

NOTE

The examples used in this manual are intended for Hewlett-Packard Series 80, Series 200, or Series 300 computers using HP BASIC language. They assume an HP-IB* interface select code of 7 and a device address of 09 (factory address setting) resulting in a combined HP-IB address of 709. We recommend you retain this address to simplify programming.

HP-IB Commands

Some HP 3488A commands are abbreviated when used as HP-IB commands. The "Command Summary" section of this manual lists the HP 3488A syntax for each command. For those commands where the HP-IB language syntax is different, a line labeled "HP-IB Syntax:" follows the HP 3488A syntax line showing the difference. Complete information is contained in the "Command Directory" section of the HP 3488A Operating, Programming, and Configuration Manual.

Power-On and Reset States

When you apply power to the HP 3488A, the form C drive relays on the HP 44476 have their normally open (NO) contacts open and normally closed (NC) contacts closed. These relays drive the microwave switches on

---

*HP-IB (Hewlett-Packard Interface Bus) is Hewlett-Packard's implementation of IEEE Standard 488-1978 and ANSI MC1.1.

Microwave Switch Module

9

the HP 44476A so that port 2 is connected to the common port and port 1 is connected to a 50 ohm termination to ground. For microwave switches you supply for the HP 44476B, you must determine the state in which the form C drive relays set these switches. This state is called the power-on state and can be reached by pressing the 3488A **RESET** button or giving a **CARD RESET** command to the slot in which you have the module installed.

Power Failure State

If a power failure occurs, the latching form C drive relays and microwave switches retain the state they were last programmed to. See the **WARNING** which follows the heading "Using the HP 44476". When power is reinstated, the HP 3488A resets all modules and the relays (and microwave switches on the HP 44476A) are set to the power-on state.

Using Channels

The HP 44476 microwave switches are controlled by the HP 3488A **CLOSE, OPEN, CARD RESET, CHAN,** and **STEP** commands. In the following paragraphs you will find example programs or program segments containing these commands. A description of the effect these commands have on the switches is also given.

| **NOTE** |

When using channels, all switching activity must be directed to channels 00, 01, and 02 only. Attempting to close a channel greater than 02 will result in either a logic or execution error.

Closing Channels

The **CLOSE** command is used to close the normally open port and open the normally closed port of one or more channels (normally open = NO = port 1; normally closed = NC = port 2). Port 2 is normally closed to the common port (C). For example, the following statement closes the NO port 1 (and opens the NC port 2) of channels 00 and 01 on a module in slot 5 of the HP 3488A:

```
OUTPUT 709; "CLOSE 500,501"
```

For the HP 44476A, only channels 00, 01, and 02 are valid. Attempting to close channels 03-09 will result in a logic error since those channels are not present. Attempting to close channels greater than 09 will result in an execution error. The HP 44476B has the same valid channels as the "A" version but you may not be using all of the channels depending on how many microwave switches you mount.

Opening Channels

You use an **OPEN** command to open a previously closed switch. This will connect the normally closed port (port 2) to the common port (port C). When more than one channel is specified in the **OPEN** command, channels are opened in the order listed. For example, the following statement opens channel 00 then channel 01 in slot 5.

```
OUTPUT 709; "OPEN 500,501"
```

If all channels on a module are to be opened, you can use the **CARD RESET** command instead of listing all the channels in an **OPEN** command. Opening channels not present (03-09) with an **OPEN** command will not result in a logic error and will not cause a change in the module.

Scanning Channels

You can declare a sequence of channels, called a scan list, and step through these channels break-before-make. The **SCAN LIST** and **STEP** commands are used to establish and execute a scan through the channels in the order listed in the scan list. When the last channel in the list is closed, the next **STEP** command begins scanning the scan list again. The following example scans through channels 500, 501, 502, and 501 two times. The scan will be channels 500, 501, 502, 501, 500, 501, 502, 501.

```
10 OUTPUT 709; "SLIST 500-502,501"   !SLIST = SCAN LIST
20 FOR I = 1 TO 8
30 OUTPUT 709; "STEP"
40 NEXT I
```

You can use the **CHAN** command to open the last channel closed by a **STEP** command (or another **CHAN** command) before closing the channel specified in the **CHAN** statement. If no channel is specified in the **CHAN** command, the HP 3488A will respond with the last channel closed by either **STEP** or **CHAN**. If no channel has been closed since the last reset, then **CHAN** returns the number 0.

If a scan list is in effect and **CHAN** is executed specifying a channel within the list, the HP 3488A will search through the list and position the scan list pointer to the channel specified. The next **STEP** command will advance the scan from the channel specified by **CHAN**. If **CHAN** closes a channel that is not in the scan list and **STEP** is executed, the HP 3488A will open the channel closed by **CHAN** and then go to the beginning of the scan list.

Pairing Cards

You use the **CARD PAIR** to pair two HP 44476 modules together. Additionally, you can pair the HP 44476A and B modules with the HP 44471A General Purpose Relay Module or the HP 44477A Form C Relay Module. Any combination of HP 44471A, 44476A, 44476B, and 44477A can be paired. When different module types are paired, you must be aware of which channels are present on each module because this command causes identically numbered channels in each module to operate together. Executing a command to close or open one channel causes the same channel on the paired module to close or open. Additionally, you can use paired slots in a scan list. Commands used with the **CARD PAIR** function are: **OPEN, CLOSE, CARD RESET, CHAN,** and **STEP**.

Executing a **CARD PAIR** command cancels a **CARD PAIR** command that previously paired one of the slots specified by the new **CARD PAIR** command. For example if slots 1 and 2 are paired, pairing slots 2 and 4 cancels the slot 1 and 2 pair. You can have more than one pair of slots; slot 1 paired with slot 2 and slot 3 paired with slot 4 establishes two pairs.

The following example closes a pair of channels.

```
10 OUTPUT 709; "CPAIR 1,3"   !Pairs slots 1 and 3. CPAIR = CARD PAIR
20 OUTPUT 709; "CLOSE 101"   !Closes channels 101 and 301 simultaneously
```

Executing the **CARD PAIR** command without specifying slot numbers allows you to determine if any slots are paired together. Four numbers are returned to the HP 3488A display separated by commas. The first two numbers specify the slots of the first pair; the last two numbers specify the slots of the last pair. A display of 0,0 indicates there is no pair established.

If the HP-IB **CPAIR** command is executed, the HP 3488A loads the response in the output buffer and the system controller must retrieve the information as shown in the following example.

```
10 OUTPUT 709; "CPAIR"
20 ENTER 709; A$
30 DISP A$              !Controller displays active pairs.
```

Other Commands

You can use three commands to query the HP 44476 to determine card type and to determine status of the channels. These commands are **CARD TYPE, VIEW,** and **CARD MON**.

CARD TYPE Command

This command causes the HP 3488A to display the slot number, module name, and model number of the module installed in the slot specified. The HP 44476 is an exception; it will not display "44476" but will respond with "GP RELAY 44471" since the HP 44471 relay drive circuit is used in the HP 44476 (and HP 44477A). To determine if the module is truly an HP 44471, try to close channels 04 and 09 with separate **CLOSE** commands. If an HP 44471 is present, both channels 04 and 09 will close. If an HP 44476 is present, you will receive a logic error message on the display for both channels since only channels 00, 01, or 02 are valid on the microwave switch module. If an HP 44477A is present, only channel 09 will result in a logic error since channels 00 through 06 are valid. This summary of errors is tabulated in Table 2.

MODULE	NO. OF CHANNELS	VALID CHANNEL NOS.	ERROR SUMMARY	
			CLOSE S04	CLOSE S09
44471	10	00 - 09	VALID	VALID
44477	7	00 - 06	VALID	LOGIC ERROR
44476	3	00 - 02	LOGIC ERROR	LOGIC ERROR

Notes: 1. CLOSE S04 = CLOSE <slot>04
2. Execute CLOSE S04 and CLOSE S09 separately.

Table 2. **CARD TYPE** Command Error Summary.

VIEW Command

You use the **VIEW** command to look at the state (open or closed) of a particular channel. The HP 3488A responds with the string "OPEN 1" if the specified channel is open. If the specified channel is closed, the HP 3488A responds with the string "CLOSED 0". In the HP 3488A display, the channel address is displayed followed by a colon and the appropriate string. If **VIEW** is sent via the HP-IB, the controller must read the HP 3488A response ("1" or "0") as done for **CPAIR**.

CARD MON Command

The **CARD MON** command (card monitor) is used to display the state of all the channels on a module at once. You specify the slot (1-5) of the module you want to monitor. Specifying slot 0 in the command will cancel the card monitor function. Specifying a negative slot number causes the HP 3488A to go into the "MONITOR TRACKING" mode. In this mode, the HP 3488A display shows the slot of the negative slot number (ignoring the negative sign) but tracks to subsequent slots where channels are opened or closed. When used to monitor the HP 44476 modules, the display shows the slot number, a channel number that is closed, and commas that separate channel numbers. An open channel is represented by a blank. See Figure 7.

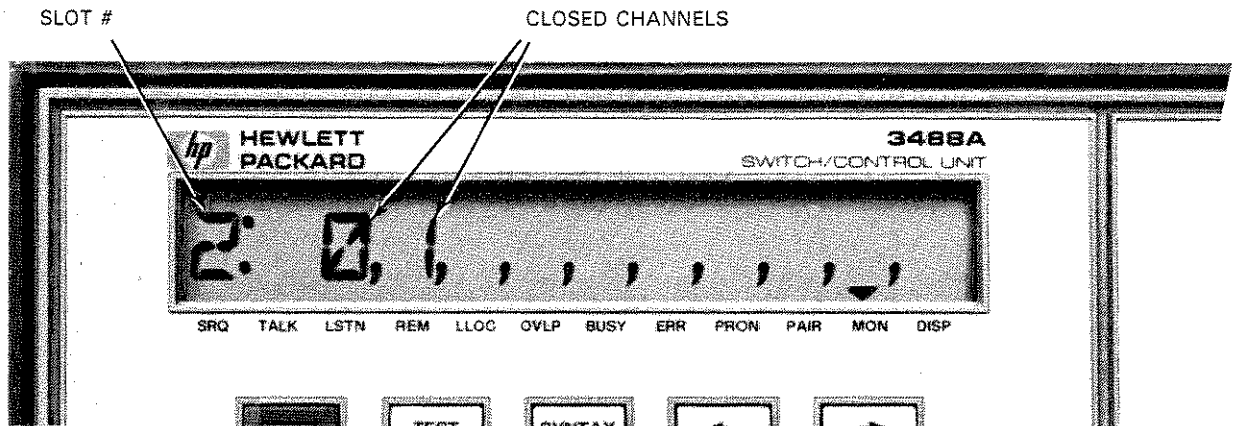Figure 7. HP 44476 **CARD MON** Display.

The format of the display is

```
S: N,N,N, , , , , , ,
```

where S represents the slot number being monitored and N is a channel number. Channel numbers 0, 1, and 2 are the only numbers valid for the HP 44476. Whether **CARD MON** is executed from the HP 3488A front panel or via the HP-IB (**CMON**), the response is displayed on the HP 3488A front panel.

Application Examples

This section gives several application examples for the HP 44476A/B Microwave Switch Module.

General Purpose Switch Application

The HP 44476A is shown in Figure 8 with one channel used to switch separate signal sources for a multiband receiver testing application. When not switched to the receiver, the "unused" signal source is terminated in 50Ω by the HP 33311B switch.
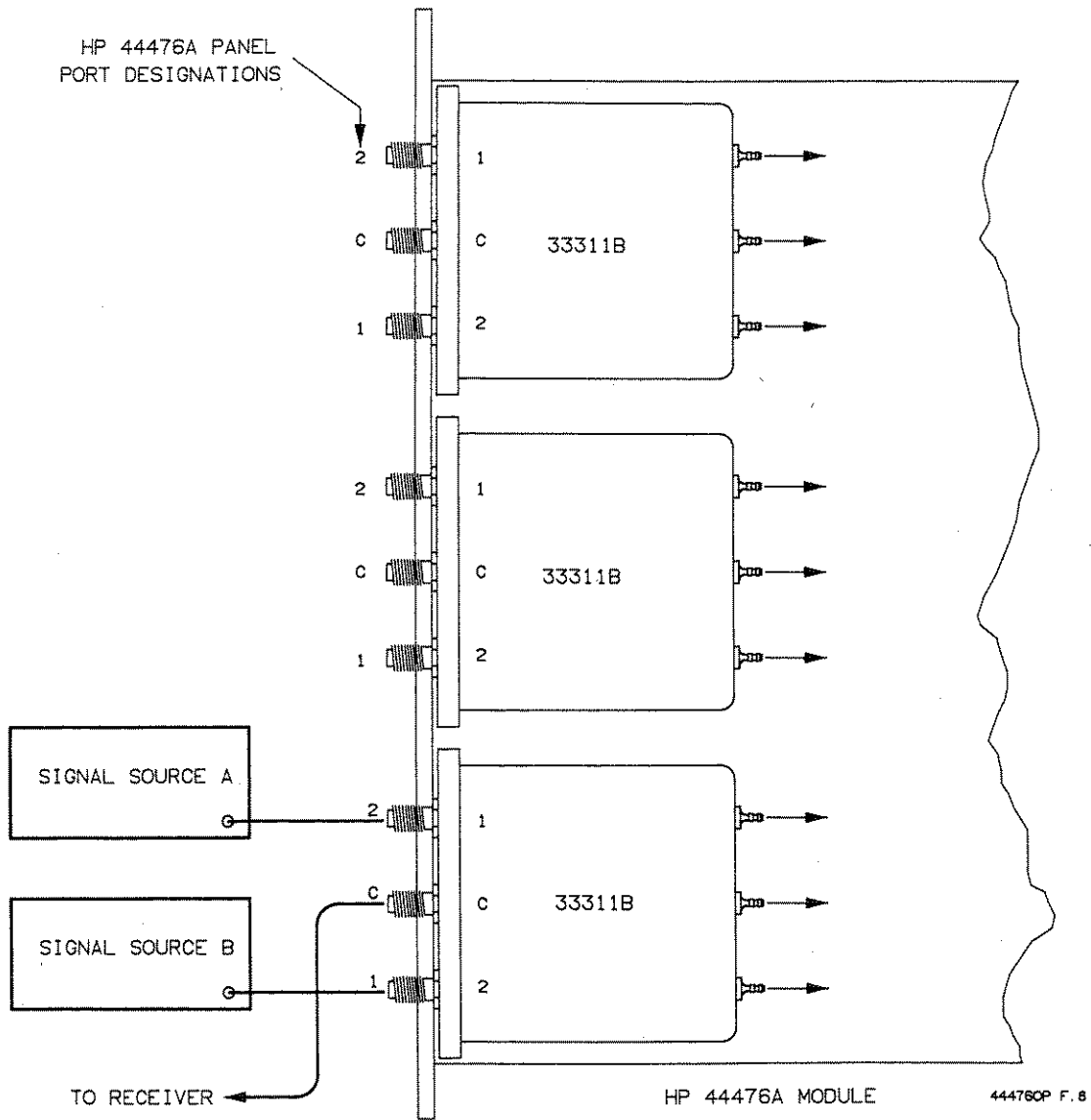

Figure 8. General Purpose Switch Application.

Transfer Switch Application

Transfer switching is used to insert a component or device in or out of a signal path. It can also be used in a test setup to switch in a device-under-test after a calibration. Transfer switching can be accomplished with two 3-port microwave switches supplied on the HP 44476A or one 4- or 5-port microwave switch you supply on the HP 44476B. Figure 9 shows a transfer switching example using both the HP 44476A and 44476B modules. Refer to Figure 1 for the simplified schematic of the HP 44476A. The 4-port example of Figure 9 shows the equivalent circuit of the HP 33312B being used as a transfer switch. The HP 33312B's internal 50-ohm load can terminate the device-under-test when the device is out of the signal path. The 5-port HP 33313B can be used in this application (mounted on the HP 44476B) where the fifth port is used to externally terminate the DUT with a resistor other than 50 ohms.
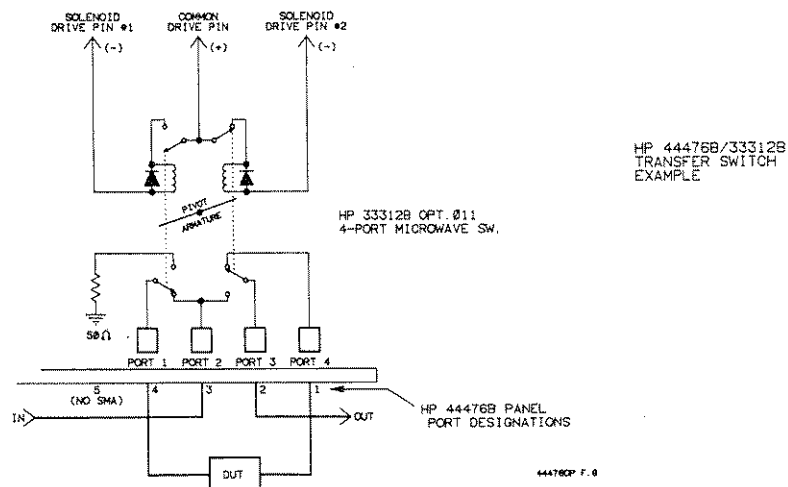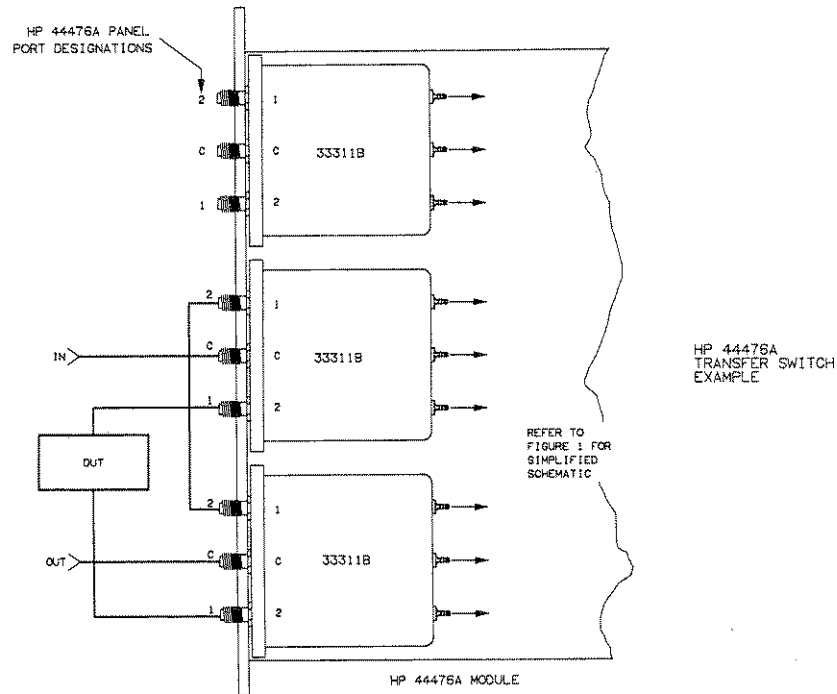
Figure 9. Transfer Switch Application.

Matrix Application

Figure 10 shows a 3 X 4 matrix application using two HP 44476A modules and three HP 44476B modules that have HP 33312B Option 011 4-port microwave switches installed by the user. Figure 10 is illustrated with connections between row 4 and column A, row 3 and column B, and row 2 and column C. The switches are used to provide the through-connection and cross-connection functions in the 3 X 4 matrix. Typically, this matrix could be used to route signals from three different units-under-test to four different pieces of test equipment such as a power meter, spectrum analyzer, counter, and modulation analyzer. The microwave switches' internal 50-ohm loads serve to terminate unused rows to prevent resonances.
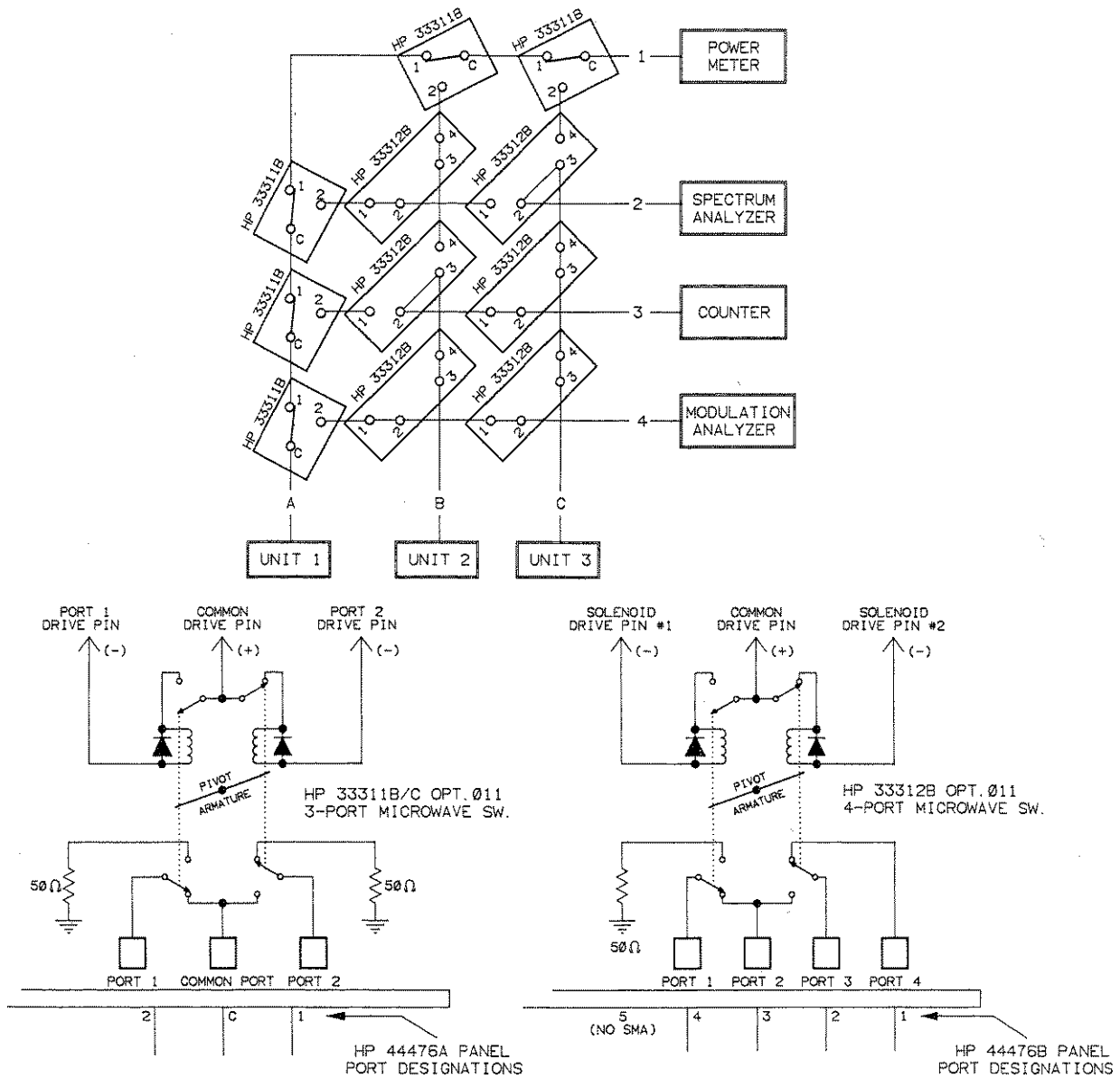
Figure 10. Matrix Application.

Command Summary ————————————————————————————————————

This section gives you a summary of the HP 3488A commands that control the HP 44476. Following each command is a description of the command and the command syntax. In addition to the HP 3488A commands, the HP-IB interface commands **TRIGGER** and **CLEAR** affect the HP 44476 and are discussed in this section. For more information on commands for these modules, refer to the Command Directory section in the HP 3488A Operating, Programming, and Configuration Manual.

CLOSE

The **CLOSE** command is used to close the normally open contact (connect port 1 to the common port) after opening the normally closed contact (port 2). The **CLOSE** command does not open any channels that were previously closed. You can close more than one channel with the same **CLOSE** command by separating the channel addresses with a comma; channels are closed in the order listed in the command.

Syntax: CLOSE <*ch. address*>[,<*ch. address*>,<*ch. address*>,...]

OPEN

You use the **OPEN** command to disconnect the normally open contact from the common port (and connect the normally closed contact to the common port). If more than one channel is specified in the **OPEN** list, channels are opened in the order listed. Use the **CARD RESET** command to open all channels on a module.

Syntax: OPEN <*ch. address*>[,<*ch. address*>,<*ch. address*>,...]

SCAN LIST

SCAN LIST allows you to specify a sequence of channels to be scanned. The sequence is specified as a list of up to 85 channel addresses or items (relays, Digital I/O lines, or stored setups) separated by commas. Contiguous channels may be specified by entering the first and last channel addresses separated by a hyphen. The **STEP** command is used to sequentially close channels in the list.

Syntax: SCAN LIST [<*ch. address*>(,or-)<*ch. address*> ...<*ch. address*>]

HP-IB Syntax: SLIST[<*ch. address*>(,or-)<*ch. address*> ...<*ch. address*>]

STEP

STEP is used to open the previously closed channel and close the next channel in the scan list. If **STEP** is executed and no scan list exists, the HP 3488A will generate an error.

The HP 3488A uses a pointer to keep track of which channel in the scan list is currently closed. When **STEP** is executed, that channel is opened and the next item in the list is checked. If the next item in the list is a relay or Digital I/O line, that channel is closed. If the next item in the list is a stored setup, that setup is recalled. Channels that are closed as part of a stored setup will remain closed; that is, they are not opened by the next execution of the **STEP** command unless the next item is the recall of a stored setup.

Syntax: STEP

www.valuetronics.com

CHAN

You use **CHAN** to open the last channel closed by either **STEP** or **CHAN** (the most recent command) and close the specified channel. If no channel is specified with **CHAN**, the HP 3488A will respond with the last channel closed by either **STEP** or **CHAN**. If no channel has been closed since the last reset, then **CHAN** returns the number 0.

If a scan list is in effect when **CHAN** is executed, the HP 3488A will search through the list and position the scan list pointer to the channel specified by **CHAN**. If **CHAN** specifies a channel that is not in the scan list, and the **STEP** is executed, the HP 3488A will open the channel closed by **CHAN** and then go to the beginning of the scan list.

Syntax: CHAN [<*ch. address*>]

CARD RESET

CARD RESET is used to set all channels on the HP 44476A/B to their power on state. You specify the slot number for the card you want to reset.

Syntax: CARD RESET <*slot*>[,<*slot*>,...]

HP-IB Syntax: CRESET <*slot*>[,<*slot*>,...]

CARD TYPE

The **CARD TYPE** command is used to query an HP 3488A slot and determine what type of module is intalled in that slot. The HP 3488A responds to this command by displaying the slot number, module name, and module model number. The response must be read over the HP-IB if the HP-IB **CTYPE** command was given. Possible responses are shown in the table below. You use the ← key to shift the display and see the model number.

CARD TYPE	MODEL NO.	DISPLAY	
Slot is empty		NO CARD	00000
Relay Multiplexer Module	44470A	RELAY MUX	44470
General Purpose Relay Module	44471A	GP RELAY	44471 **
VHF Switch Module	44472A	VHF SW	44472
Matrix Module	44473A	MATRIX SW	44473
Digital I/O Module	44474A	DIGITAL IO	44474
Breadboard Module	44475A	BREADBOARD	44475
Microwave Switch Module	44476A/B	GP RELAY	44471 **
Form C Relay Module	44477A	GP RELAY	44471 **

** The HP 44476A/B and the 44477A modules also display "GP RELAY 44471". To determine if the module is an HP 44471, 44476, or 44477, try to close channel 04 and channel 09 with separate commands. If you get a logic error on channels 04 and 09, the module is an HP 44476 (you cannot determine whether it is A or B without looking at the module's panel). If channel 04 closes and you get a logic error on channel 09, the module is an HP 44477A. If both channels close (no logic error) the module is an HP 44471A.

Syntax: CARD TYPE <*slot*>

HP-IB Syntax: CTYPE <*slot*>

CARD PAIR

You use the **CARD PAIR** command to pair two modules of the same type (e.g. two HP 44471As). You can pair HP 44476s and 44477s with 44471s. This command assigns both modules to both slot numbers, and a command to close or open a channel on one module closes or opens the same channel on the other module.

Commands used with **CARD PAIR** are: **OPEN, CLOSE, CARD RESET, CHAN,** and **STEP.** You can also use paired channels in a **SCAN LIST.**

Executing a **CARD PAIR** command cancels any previous **CARD PAIR** command that involved either of the two slots listed. This allows you to have a maximum of two sets of card pairs at one time.

Syntax: CARD PAIR *<slot>,<slot>*

HP-IB Syntax: CPAIR *<slot>,<slot>*

CARD MON

The **CARD MON** command (card monitor) is used to look at the state of a module in the slot you specify. Specifying slot 0 will cause the monitor mode to be cancelled. If a negative number is used, the HP 3488A goes to the "MONITOR TRACKING" mode. First, the slot number (ignoring the negative sign) is monitored. The monitor will display the next slot having an open or close command executed and track any subsequent openings or closures. The format of the monitor mode display is

$$s: n,n,n, , , , , , ,$$

where s represents the slot number being monitored and n is a channel number. Only the first three n's are valid for the HP 44476A/B (channels 00, 01, and 02). The HP 44476B does not use one of the three channels since only two microwave switches can be mounted. You can close the unused channel and the card monitor display will show it closed, but no channel activity actually takes place.

Syntax: CARD MON *<slot>*

HP-IB SYNTAX: CMON *<slot>*

HP-IB Interface Commands

Only two interface commands, other than those listed in the previous summary, affect the state of the HP 44476A/B channels: **TRIGGER** (Group Execute Trigger) and **CLEAR** (Device Clear or Selected Device Clear).

TRIGGER

TRIGGER performs the same function as the HP 3488A **STEP** command; it opens the last channel closed and closes the next channel in the scan list.

CLEAR

The **CLEAR** command (either a Device Clear or Selected Device Clear) resets the HP 3488A and all modules installed. The HP 44476A/B goes to its power-on state.

HP 44476A Specifications
HP 3488A Option 016

Switch Type	Single-pole double-throw, break before make, Latching Solenoid, Internal 50 Ω terminations, automatic coil disconnect.
Frequency Range	DC - 18 GHz
Insertion Loss	DC - 2 GHz: <0.25 dB DC - 18 GHz: <0.50 dB
Isolation	DC - 18 GHz: >90 dB
Characteristic Impedance	50 Ω
SWR 3 mm (SMA)	DC - 2 GHz: <1.15 DC - 12.4 GHz: <1.25 DC - 18.0 GHz: <1.40
50 Ω Load	DC - 2 GHz: <1.15 DC - 12.4 GHZ: <1.25 DC - 18.0 GHz: <1.40
Input Power Rating	1 watt average, 100 watts peak (Also less than ±7 Vdc)
Repeatability (Typical)	0.03 dB after 1,000,000 switchings

HP 44476B Specifications
HP 3488A Option 018

The HP 44476B Switching Speeds are identical to those of the HP 44476A. The HP 44476B Specifications are a function of which HP microwave switch is installed into the module. For more information on the switch characteristics, refer to the HP 33311B, HP 33311C, HP 33312B/HP 33313B Data Sheets (HP Part Numbers 5952-8153, 5952-8171, and 5954-6384 respectively).

Environmental

Operating: 0 - 55 °C (32 - 130 °F);
Storage: -40 - 75 °C (-40 - 165 °F);
Humidity: 95%, 0 - 40 °C (32 - 104 °F)

Weight

	Net		Shipping	
	kg.	lbs.	kg.	lbs.
HP 3488A Mainframe—	5.0	11.0	8.5	19.0
Modules (ea.)—	0.7	1.5	1.5	3.5
Maximum Total—	8.5	18.5	16	36.5

General

Relays: All channels use magnetically latching relays. When power is removed from the HP 3488A, all channels remain in their previously programmed state. Power-on or RESET command opens all channels.

HP 44476A Average Switch Life: 10^6 operations.

Connectors:

HP 44476A/B Microwave Switch: SMA Connector.

Switching Speeds

Time for the command OUTPUT 709; "Switch Operation/Command" to be executed (in msec) via HP-IB, using HP Model 85 or Series 300 computers. Includes computer output execution time, and time for HP 3488A to execute command (default conditions) or to release interface (maximum speed conditions with overlap on).

It is important to note that the times listed below in the tables are computer/ HP 3488A/HP 44476A (or HP 44476B) command execution times. The actual time required for any of the HP 3331XX switches to change state OPEN to CLOSE, or from CLOSE to OPEN takes a maximum time of 30 milliseconds in addition to the times in the table.

Switch Operation/ Command	HP 3488 Opt/ HP Module	HP Series 300 Controller		HP Model 85 Controller Default (Turn-on) Conditions[2]
		Default (Turn-on) Conditions	Maximum Speed (Overlap on) Conditions[1]	
CLOSE 101 or OPEN 101	016/44476A 018/44476B	23	9	46
CLOSE 101, 201 or OPEN 101, 201	016/44476A 018/44476B	34	10	58
OPEN 102; CLOSE 203	016/44476A 018/44476B	33	13	57
CLOSE 100, 203, 301, 402, 501 or OPEN 100, 203, 301, 402, 501	016/44476A 018/44476B	69	15	92
CLOSE (all channels on module)	016/44476A 018/44476B	40	14	64
CHAN 102 or STEP (used with scan list)	016/44476A 018/44476B	36	9	65
CARD RESET	016/44476A 018/44476B	116	10	145
RECALL	016/44476A 018/44476B	113	8	138

[1]Maximum speed conditions = overlap mode on. Time listed is time from beginning of execution of output command by controller until HP 3488A releases interface for one OUTPUT statement. In Overlap mode, HP 3488A may release interface before complete execution of command. See Product Note 3488A-1 for more information.

[2]Overlap mode provides negligible speed improvement for Model 85 controller.

Maximum Scan Rate (Chans./sec); Using HP 3488A
External Increment & Channel Closed, with Opt. 014; display off.

HP 3488A only:

Option/ Accessory	016/018 HP 44476A/B
Rate	43/sec