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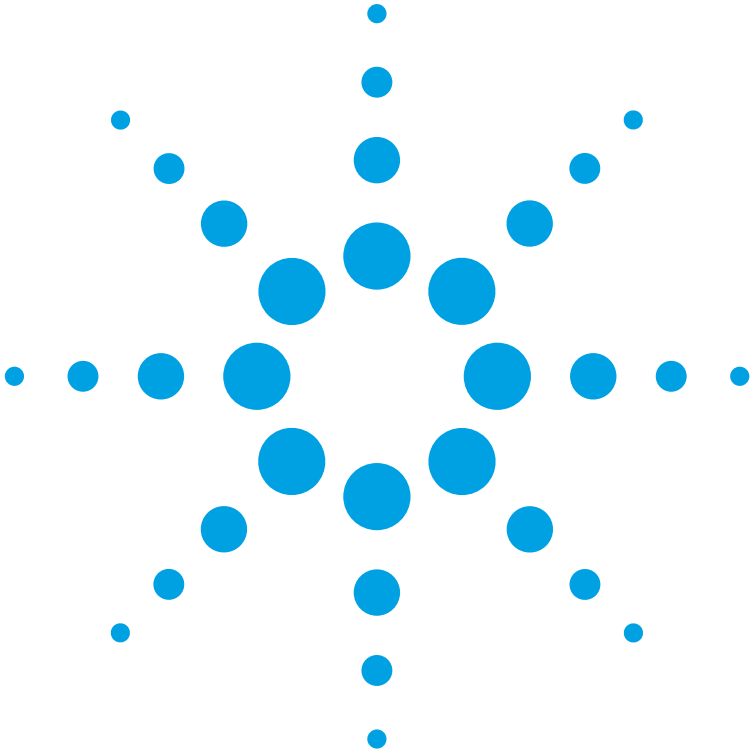
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Agilent 3499A/B/C
Switch / Control System



Service Manual

Agilent Technologies

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KEYSIGHT TECHNOLOGIES

Legal and Safety Information

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Agilent Technologies

Agilent 3499A/B/C Switch/Control System Service Manual
Rev. F
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Documentation History

All Editions and Updates of this manual and their creation date are listed below. The first Edition of the manual is Edition 1. The Edition number increments by 1 whenever the manual is revised. Updates, which are issued between Editions, contain replacement pages to correct or add additional information to the current Edition of the manual. Whenever a new Edition is created, it will contain all of the Update information for the previous Edition. Each new Edition or Update also includes a revised copy of this documentation history page.

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Rev. C . . . . . April 2002

Rev. D . . . . . March 2003

Rev. E . . . . . March 2009

Rev. F. . . . . October 2012

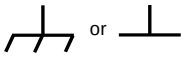
Safety Symbols



Instruction manual symbol affixed to product. Indicates that the user must refer to the manual for specific WARNING or CAUTION information to avoid personal injury or damage to the product.



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



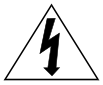
Frame or chassis ground terminal—typically connects to the equipment's metal frame.



Alternating current (AC)



Direct current (DC).



Indicates hazardous voltages.

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

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

WARNINGS

The following general safety precautions must be observed during all phases of operation, service, and repair of this product. 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 product. Agilent Technologies Company assumes no liability for the customer's failure to comply with these requirements.

Ground the equipment: For Safety Class 1 equipment (equipment having a protective earth terminal), an uninterruptible safety earth ground must be provided from the mains power source to the product input wiring terminals or supplied power cable.

DO NOT operate the product in an explosive atmosphere or in the presence of flammable gases or fumes.

For continued protection against fire, replace the line fuse(s) only with fuse(s) of the same voltage and current rating and type. DO NOT use repaired fuses or short-circuited fuse holders.

Keep away from live circuits: Operating personnel must not remove equipment covers or shields. Procedures involving the removal of covers or shields are for use by service-trained personnel only. Under certain conditions, dangerous voltages may exist even with the equipment switched off. To avoid dangerous electrical shock, DO NOT perform procedures involving cover or shield removal unless you are qualified to do so.

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

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 equipment: Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the product. Return the product to an Agilent Technologies Sales and Service Office for service and repair to ensure that safety features are maintained.

Operating Location: Sheltered location where air temperature and humidity are controlled within this product's specifications and the product is protected against direct exposure to climatic conditions such as direct sunlight, wind, rain, snow, sleet, and icing, water spray or splash, hoarfrost or dew. Pollution environment for which this product may be operated is IEC 664 Pollution degree 2.

WARNINGS (Cont.)

The Agilent 3499A/B/C can have modules that are capable of switching voltages up to 250V maximum. Voltage levels above the levels specified for accessible connectors or cable ends could cause bodily injury or death to an operator. Special precautions must be adhered to (discussed below) when applying voltages in excess of 60 Vdc, 30 Vac rms or 42.4 Vac peak.

Module connectors and test signal cables connected to them cannot be operator accessible. Cables and connectors are considered inaccessible if a tool (e.g., screwdriver, wrench, socket, etc.) or a key (equipment in a locked cabinet) is required to gain access to them. Additionally, the operator cannot have access to a conductive surface connected to any cable conductor (High, Low or Guard).

Assure the equipment under test has adequate insulation between the cable connections and any operator-accessible parts (doors, covers, panels, shields, cases, cabinets, etc.). Verify there are multiple and sufficient protective means (rated for the voltages you are applying) to assure the operator will NOT come into contact with any energized conductor even if one of the protective means fails to work as intended. For example, the inner side of a case, cabinet, door, cover or panel can be covered with an insulating material as well as routing the test cables to the module's front panel connectors through non-conductive, flexible conduit such as that used in electrical power distribution.

This ISM device complies with Canadian CES-001
Cet appareil ISM est conforme à la norme NMB-001 du Canada

CLEANING INFORMATION

The instrument should only be cleaned by wiping it with a soft damp cloth.

Declaration of Conformity

Declarations of Conformity for this product and for other Agilent products may be downloaded from the Internet. There are two methods to obtain the Declaration of Conformity:

- Go to http://regulations.corporate.agilent.com/DoC/search.htm . You can then search by product number to find the latest Declaration of Conformity.

- Alternately, you can go to the product web page (www.agilent.com/find/3499A), click on the Document Library tab then scroll down until you find the Declaration of Conformity link.

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Chapter 1
Specifications

General Information

The Agilent 3499A/B/C Switch/Control System is composed of three mainframes and a set of plug-in modules. This chapter lists the specifications of the three Agilent 3499A/B/C mainframes and all the plug-in modules. These include:

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- Multiplexer (MUX) Modules Specifications . . . . . Page 3
- GP Relay Modules Specifications. . . . . Page 7
- Matrix Modules Specifications . . . . . Page 10
- Digital I/O Modules Specifications. . . . . Page 11
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- Agilent 44477A Form-C Relay Module Specifications . . . . Page 16
- Agilent 44478A/B 1.3 GHz MUX Modules Specifications . Page 17
- Agilent N2280A/81A/82A Modules Specifications . . . . . Page 18

Agilent 3499A/B/C Mainframe's Specifications

ITEMS	SPECIFICATIONS
General	
Power Supply:	3499A/B: ~100 to 127 Vac 50 Hz to 400 Hz ~200 to 240 Vac 50 Hz to 60 Hz 90 VA; 3499C: 100 to 240 VAC universal input; 47 Hz to 63 Hz; 140 VA.
Operating Environment:	0 to 55^{o}C (32 to 131^{o}F); < 80% RH, 0 to 40^{o}C (32 to 104^{o}F).
Storage Environment:	-40 to +70^{o}C (-40 to 158^{o}F)
Net Weight:	Agilent 3499A: 3.8 kg (8.4 lbs); Agilent 3499B: 2.5 kg (5.5 lbs). Agilent 3499C: 7.4 kg (16.4 lbs).
Dimensions:	Agilent 3499A (H x W x L): 89mm x 426mm x 348mm (3.5" x 16.8" x 13.7"); Agilent 3499B (H x W x L): 89mm x 213mm x 348mm (3.5" x 8.4" x 13.7"); Agilent 3499C (H x W x L):221.5mm x 426mm x 353.5mm (8.7" x 16.8" x 13.9").
Operating Altitude	3000 meters (10,000 ft)
IEC 61010-1 Operating Pollution Degree	2
IEC 61010-1 Installation Category	II
System	
Capacity:	5 Slots (Agilent 3499A) or 2 Slots (Agilent 3499B) or 9 slots (Agilent 3499C).
Display:	Vacuum fluorescent, 13 characters can be displayed simultaneously.
Rear Panel Connectors:	GPIB (IEEE-488); RS-232; 8-pin Mini DIN connector (4-bit Digital I/O, external triggers).
Switch Setting Time:	Automatically selected by the mainframe for individual modules; Additional time from 0 to 99999.999 seconds can be added in 1 ms steps.
Arm Source:	External trigger (from the rear panel Mini DIN connector); IEEE-488 bus (GET, *TRG, or pressing **Step** from the front-panel); Software (TRIGger:IMM); Internal timer (programmable as 0 to 99999.999 seconds in 1 ms steps).
Trigger Source:	External trigger (from the rear panel Mini DIN connector); IEEE-488 bus (GET, *TRG, or pressing **Step** from the front-panel); Software (Trigger:IMM); Internal timer (programmable as 0 to 99999.999 seconds in 1 ms steps).
External Trigger Input:	Level: TTL compatible; Minimum trigger pulse width: 2 μs; Maximum external trigger delay[a]: 2 ms.
External Trigger Output:	Level: Normally pull up to 5 V; Sink current: 10 mA @ V_o(Low) ≤ 0.4V; 80 mA @ V_o(Low) ≤ 0.8V; Low going pulse width: 10 μs typical.
Built-in 4-bit Digital I/O:	Input: TTL compatible; Output: V_o(high) ≥ 2.4V @ I_o = 1 mA; V_o(Low) ≤ 0.8V @ I_o = –100 mA; Maximum V_o = 42V, with external pull-up.
System Speed[b]	
Scan Speed:	350 chans/sec (N2266A)
Parser Time[c]:	Open (@100): 3 ms; Close (@100): 3 ms; Open (@100:139): 4 ms
Switching Speed:	Channels / Time (ms) Open/Close: 1 / 7.1 (N2266A) Open/Close: 10 / 22.0 (N2266A, in the same group) Open/Close: 40 / 28.9 (N2266A)
Digital I/O Block Transfer Rate:	20K bytes/sec (long word)

a. Maximum time from activation of external trigger pulse to start of switch open or close.

b. Just for reference. The system speed specification may vary in a small range due to the speed of the remote PC, the GPIB module, the version of VISA and the version of 3499A/B/C's firmware used.

c. Measured from the time at which the command terminator is taken from the bus to the time at which the relay begins to open or close.

Plug-in Modules Specifications

Multiplexer (MUX) Modules

The MUX modules available with Agilent 3499A/B/C include: Agilent N2260A, 44470A/D, N2266A, N2268A and N2270A. Specifications of these MUX modules are listed in the following tables.

ITEMS		SPECIFICATIONS		
		Agilent N2260A	Agilent 44470A	Agilent 44470D
INPUT CHARACTERISTICS				
Total Channels:		80 1-wire; or 40 2-wire; or dual 20 2-wire; or 20 4-wire	10 (2-wire)	20 (2-wire)
Maximum Voltage	Terminal-Terminal or Terminal-Chassis:	200 V, dc or ac rms	250 V, dc or ac rms	250 V, dc or ac rms
Maximum Current	Per Channel:	1 A, dc or ac rms	2 A, dc or ac rms	2 A, dc or ac rms
	Per Module:	2A, dc or ac rms	2 A, dc or ac rms	2 A, dc or ac rms
Maximum Power	Per Channel:	60 W dc; 62.5 VA ac	60 W dc; 500 VA ac	60 W dc; 125 VA ac
	Per Module:	120 W dc; 125 VA ac	60 W dc; 500 VA ac	60 W dc; 125 VA ac
Maximum Overvoltage Transients:		N/A	1400 V_{pk}	1400 V_{pk}
Thermal Offset:		< 3 μV	< 3 μV differential or single-ended	< 3 μV differential or single-ended
Initial Closed Channel Resistance:		< 1 Ω	< 1 Ω	< 1 Ω
Relay Life:		Mechanical: 10^8 (at 36000 operations/hour) Electrical: 5 x 10^5 (1A load)	10^8 (dry load of < 300 mA & < 10 V) 10^5 (maximum rated load)	
Maximum Scan Rate:		80 Chans/sec	43 Chans/sec	43 Chans/sec
DC ISOLATION (with terminal block)				
Open Channel, Channel-Channel (with 1 channel closed)		< (40°C, 50% RH): > 10^{10} Ω < (40°C, 80% RH): > 10^9 Ω	< (40°C, 60% RH): > 10^{11} Ω < (40°C, 95% RH): > 10^9 Ω	< (40°C, 60% RH): > 10^{11} Ω < (40°C, 95% RH): > 5x10^9 Ω
HI-LO (with 1 channel closed)		< (40°C, 50% RH): > 10^{10} Ω < (40°C, 80% RH): > 10^9 Ω	< (40°C, 60% RH): > 10^{10} Ω < (40°C, 95% RH): > 10^8 Ω	< (40°C, 60% RH): > 5x10^{10} Ω < (40°C, 95% RH): > 10^9 Ω
Channel-Chassis (with 1 channel closed)		< (40°C, 50% RH): > 10^{10} Ω < (40°C, 80% RH): > 10^9 Ω	< (40°C, 60% RH): > 10^{10} Ω < (40°C, 95% RH): > 5x10^8 Ω	< (40°C, 60% RH): > 5x10^{10} Ω < (40°C, 95% RH): > 10^9 Ω
AC ISOLATION / PERFORMANCE[a] (without terminal block)				
Capacitance (with 1 channel closed)	Open Channel, Channel-Channel: HI-LO: Channel-Chassis:	< 7 pF (2-wire) < 7 pF (dual 2-wire) < 75 pF (2-wire) < 45 pF (dual 2-wire) < 150 pF (2-wire) < 90 pF (dual 2-wire)	< 5 pF < 27 pF < 80 pF	< 7 pF < 27 pF < 80 pF
Insertion Loss (with 50Ω termination)	100 kHz: 1 MHz: 10 MHz:	< 0.10 dB < 0.20 dB < 1.50 dB	< 0.20 dB < 0.25 dB < 0.50 dB	< 0.20 dB < 0.25 dB < 1.20 dB
Crosstalk (with 50Ω termination)	100 kHz: 1 MHz: 10 MHz:	< -70 dB (2-wire) < -40 dB (1-wire) < -50 dB (2-wire) < -25 dB (1-wire) < -30 dB (2-wire) N/A (1-wire)	< -73 dB < -53 dB < -33 dB	< -73 dB < -53 dB < -31 dB

a. With chassis of all instruments connected, and with the Low Terminal of the input connected to the Low Terminal of the output (either directly or via Agilent 3499A/B/C switching channels).

ITEMS		SPECIFICATIONS		
		Agilent N2266A	Agilent N2268A	Agilent N2270A
INPUT CHARACTERISTICS				
Total Channels		80 1-wire; or 40 2-wire; or dual 20 2-wire; or 20 4-wire	Dual 1-to-4 Chans	10 (2-wire)
Maximum Voltage	Terminal-Terminal or Terminal-Chassis	200 V, dc or peak AC Resist.	30 V, dc or peak AC Resist.	1000 V peak (per IEC1010 for Pollution Degree I)
Maximum Current	Per Channel	0.5 A, dc or peak AC Resist.	0.5 A, dc or peak AC	1 A
	Per Module	1 A, dc or peak AC Resist.	1 A, dc or peak AC	1 A
Maximum Power	Per Channel	10 W dc or peak AC Resist.	10 W	10 W
	Per Module	20 W dc or peak AC Resist.	20 W	10 W
Thermal Offset	Per Channel	50 μV differential or single-ended	3 μV	200 μV
Initial Closed Channel Resistance		< 1 Ω	< 1 Ω	< 1 Ω
Relay Life		10^9 (at 1V/1mA)	mechanical: $5X10^6$ 10mA/24VDC resist. load:$3X10^5$ 10W 2.5G 50W: 10^5	Signal Load (1 V 10 mA): 10^8
Maximum Scan Rate		350 Chans/sec	20 Chans/sec	43 Chans/sec
DC CHARACTERISTICS				
Open Channel, Channel-Channel (with 1 channel closed)		< (40^oC, 50% RH): > 10^{10} Ω < (40^oC, 80% RH): > 10^9 Ω	< (40^oC, 50% RH): > 10^{10} Ω < (40^oC, 80% RH): > 10^9 Ω	< (40^oC, 50% RH): > 10^{10} Ω < (40^oC, 80% RH): > 10^9 Ω
HI-LO (with 1 channel closed)		< (40^oC, 50% RH): > 10^{10} Ω < (40^oC, 80% RH): > 10^9 Ω	< (40^oC, 50% RH): > 10^{10} Ω < (40^oC, 80% RH): > 10^9 Ω	
Channel-Chassis (with 1 channel closed)		< (40^oC, 50% RH): > 10^{10} Ω < (40^oC, 80% RH): > 10^9 Ω	< (40^oC, 50% RH): > 10^{10} Ω < (40^oC, 80% RH): > 10^9 Ω	< (40^oC, 50% RH): > 10^{10} Ω < (40^oC, 80% RH): > 10^9 Ω
AC CHARACTERISTICS[a]				
Bandwidth (-3dB)		40 MHz	3.0 GHz (50Ω source, 50Ω termination)	
Capacitance (with 1 channel closed)	Open Channel, Channel-Channel: HI-LO: Channel-Chassis:	< 7 pF < 50 pF < 140 pF	20 pF (Center-Shield) 0.06 pF (Center-Center)	< 7 pF < 7 pF < 50 pF
Insertion Loss (with 50Ω termination)		100 kHz < 0.2 dB 1 MHz < 0.3 dB 10 MHz < 2.0 dB 40MHz < 3.0 dB	1 GHz: 0.9 dB 2 GHz: 1.2 dB 3 GHz: 1.4 dB	100 kHz: 0.1 dB 1 MHz: 0.2 dB
Crosstalk (with 50Ω termination)		100 kHz < -75 dB 1 MHz < -55 dB 10 MHz < -33 dB	DC-2GHz: -64 dB 2GHz-3.0GHz: -50 dB	100 kHz: -70 dB 1 MHz: -50 dB
VSWR			1 GHz: 1.20 2 GHz: 1.35 3.0 GHz: 1.35	
Rise Time			< 150 ps	
Signal Delay			< 1.5 ns	

ITEMS	SPECIFICATIONS		
	Agilent N2266A	Agilent N2268A	Agilent N2270A
Environmental Conditions			
Operating Pollution Degree			2
Operating Altitude			3000 meters (10,000 ft)
Measurement Category I			I, 1500 Vpk transient, 500 V over voltage transient
Operating Temperature			0-55^{o}C
Operating Humidity			<80% RH (0^{o}C-40^{o}C), non-condensing

a. With chassis of all instruments connected, and with the Low Terminal of the input connected to the Low Terminal of the output (either directly or via Agilent 3499A/B/C switching channels).

Agilent N2272A 1-to-9 RF MUX Module

The following table lists the specifications of Agilent N2272A.

ITEMS		SPECIFICATIONS
INPUT CHARACTERISTICS		
Total Channels		1-to-9
Relay Type		Latching
Connector Type		BNC
Maximum Switching Voltage		24VDC
Maximum Switching Current		1A
Maximum Switching Power		24W
Characteristic Impedance		50Ω
Relay Life	Mechanical Electrical@1A24VDC	$5X10^6$ 10^5
DC CHARACTERISTICS		
Offset Voltage (mV)		8.0
Initial Closed Channel Resistance (W)		0.8
Insulation Resistance (W)	@(25°C, 40%RH) (Open Ch, Ch-Ch) (Ch-Chassis, Ch-Center) @(40°C, 80%RH) (Open Ch, Ch-Ch) (Ch-Chassis, Ch-Center)	10^{10} 10^{10} 10^9 10^9
AC CHARACTERISTICS		
Bandwidth (-3dB)		1GHz
Insertion Loss (dB) **@(25°C, 40%RH)**	100MHz 300MHz 500MHz 800MHz 1GHz	0.5 0.8 1.0 1.8 2.5
Ch-Ch Cross Talk (dB) **@(25°C, 40%RH)**	100MHz 300MHz 500MHz 800MHz 1GHz	-75 -65 -65 -55 -50
VSWR **@(25°C, 40%RH)**	100MHz 300MHz 500MHz 800MHz 1GHz	1.20 1.30 1.35 1.35 1.55
Capacitance (pF)	Center-Shield Center-Center	60 pF 0.006 pF
Rise Time		500 ps
Signal Delay		2.5 ns

GP Relay Modules

The General Purpose (GP) relay modules include: Agilent N2261A, Agilent 44471A/D, Agilent N2264A and Agilent N2267A. Specifications of them are listed in the following tables.

ITEMS		SPECIFICATIONS		
		Agilent N2261A	Agilent 44471A	Agilent 44471D
INPUT CHARACTERISTICS				
Total Channels:		40	10	20
Maximum Voltage	Terminal-Terminal or Terminal-Chassis:	200 V, dc or ac rms	250 V, dc or ac rms	250 V, dc or ac rms
Maximum Current	Per Channel: Per Module:	1 A, dc or ac rms 20 A, dc or ac rms	2 A, dc or ac rms 20 A, dc or ac rms	1A, dc or ac rms 20 A, dc or ac rms
Maximum Power	Per Channel: Per Module:	60 W dc; 62.5 VA ac 1200 W dc; 1250 VA ac	60 W dc; 500 VA ac 600 W dc; 5000 VA ac	60 W dc; 125 VA ac 1200 W dc; 2500 VA ac
Maximum Overvoltage Transients:		N/A	1400 V_{pk}	1400 V_{pk}
Thermal Offset	Per Channel:	< 3 μV	< 3 μV different or single-ended	< 3 μV different or single-ended
Initial Closed Channel Resistance:		< 0.5 Ω	< 1 Ω	< 1 Ω
Relay Life		Mechanical: 10^8 (at 36000 operations/hour) Electrical: 5 x 10^5 (1A load)	10^8 operations/chan (dry load of < 300 mA & < 10 V) 10^5 operations/chan (maximum rated load)	10^8 operations/chan (dry load of < 300 mA & < 10 V) 10^5 operations/chan (maximum rated load)
Maximum Scan Rate:		80 Chans/sec	43 Chans/sec	43 Chans/sec
DC ISOLATION (with terminal block)				
Open Channel, Channel-Channel (with 1 channel closed)		< (40°C, 50% RH): > 10^{10} Ω < (40°C, 80% RH): > 10^9 Ω	< (40°C, 60% RH): > 10^{11} Ω < (40°C, 95% RH): > 10^9 Ω	< (40°C, 60% RH): > 10^{11} Ω < (40°C, 95% RH): > 10^9 Ω
Channel-Chassis (with 1 channel closed)		< (40°C, 50% RH): > 10^{10} Ω < (40°C, 80% RH): > 10^9 Ω	< (40°C, 60% RH): > 5x10^{11} Ω < (40°C, 95% RH): > 10^{10} Ω	< (40°C, 60% RH): > 5x10^{11} Ω < (40°C, 95% RH): > 10^{10} Ω
AC ISOLATION / PERFORMANCE[a] (without terminal block)				
Capacitance (with 1 channel closed)	Open Channel: Channel-Channel: Channel-Chassis:	< 10 pF < 10 pF < 20 pF	< 7 pF < 10 pF < 25 pF	< 7 pF < 10 pF < 25 pF
Insertion Loss (with 50Ω termination)	100 kHz: 1 MHz: 10 MHz:	< 0.10 dB < 0.20 dB < 0.50 dB	< 0.20 dB < 0.25 dB < 0.50 dB	< 0.20 dB < 0.25 dB < 1.00 dB
Crosstalk (with 50Ω termination)	100 kHz: 1 MHz: 10 MHz:	< -70 dB < -50 dB < -30 dB	< -73 dB < -53 dB < -33 dB	< -71 dB < -51 dB < -31 dB

a. With chassis of all instruments connected, and with Low Terminal of the input connected to Low Terminal of the output (either directly or via Agilent 3499A/B/C switching channels)

Agilent N2264A GP Relay Module

The specifications of the GP relays on an Agilent N2264A are listed in the table below.

ITEMS		SPECIFICATIONS	
		Agilent N2264A[a] (12-Channel GP function)	Agilent N2264A (3-Channel High-current GP function)
INPUT CHARACTERISTICS			
Total Channels:		12	3
Maximum Voltage	Terminal-Terminal or Terminal-Chassis:	200 V, dc or ac rms	125 V dc or 200 V ac rms
Maximum Current	Per Channel:	1 A, dc or ac rms	5A, dc or ac rms
Maximum Power	Per Channel:	60 W dc; 62.5 VA ac	150 W dc; 1250 VA ac
Thermal Offset	Per Channel:	< 3 μV	< 3 μV
Initial Closed Channel Resistance:		< 0.5 Ω	< 0.1 Ω
Relay Life		10^8 (at 36000 operations/hour) 5 x 10^5 (1A load)	5 x 10^7 (at 180 cycles/minute) 10^5 (at rated load)
Maximum Scan Rate:		80 Chans/sec	N/A
Time to Close One Channel:		N/A	16 ms
DC ISOLATION (with terminal block)			
Open Channel, Channel-Channel (with 1 channel closed)		< (40°C, 50% RH): > 10^{10} Ω < (40°C, 80% RH): > 10^9 Ω	< (40°C, 50% RH): > 10^{10} Ω < (40°C, 80% RH): > 10^9 Ω
Channel-Chassis (with 1 channel closed)		< (40°C, 50% RH): > 10^{10} Ω < (40°C, 80% RH): > 10^9 Ω	< (40°C, 50% RH): > 10^{10} Ω < (40°C, 80% RH): > 10^9 Ω
AC ISOLATION / PERFORMANCE[b] (without terminal block)			
Capacitance (with 1 channel closed)	Open Channel: Channel-Channel: Channel-Chassis:	< 10 pF < 10 pF < 20 pF	< 10 pF < 10 pF < 20 pF
Insertion Loss (with 50Ω termination)	100 kHz: 1 MHz: 10 MHz:	< 0.10 dB < 0.20 dB < 0.50 dB	< 0.10 dB < 0.20 dB < 0.50 dB
Crosstalk (with 50Ω termination)	100 kHz: 1 MHz: 10 MHz:	< -70 dB < -50 dB < -30 dB	< -70 dB < -50 dB < -30 dB

a. Agilent N2264A combines a 12-channel GP, a 3-channel high-current GP and a 16-bit digital I/O into one module. It can be operated as three separate modules.

b. With chassis of all instruments connected, and with Low Terminal of the input connected to Low Terminal of the output (either directly or via Agilent 3499A/B/C switching channels)

Agilent N2267A GP Module

The specifications of Agilent N2267A are listed in the table below.

ITEMS		SPECIFICATIONS
INPUT CHARACTERISTICS		
Total Channels		8
Maximum Switching Voltage	Terminal-Terminal or Terminal-Chassis	250 VAC, 125 VDC
Maximum Switching Current	Per Channel 0 - 30 Vdc 30 - 125 Vdc 0 - 250 Vac Per Module	 5 A 0.24 A 8 A 64 A
Maximum Switching Power	Per Channel Per Module	2000 VA, 150 W 16000 VA, 1200 W
Thermal Offset	Per Channel	3 mV
Initial Closed Channel Resistance		< 0.08 W
Relay Life	Mechanical Electrical	5 x 10^7 (at 180 cpm) 10^5
Maximum Scan Rate		20 Channs/sec
DC CHARACTERISTICS		
Open ChannelL (with 1 channel closed)	< (40°C, 50% RH) < (40°C, 80% RH)	>10^{10} W >10^9 W
Channel-Chassis (with 1 channel closed)	< (40°C, 50% RH) < (40°C, 80% RH)	>10^{10} W >10^9 W
AC CHARACTERISTICS[a]		
Capacitance (with 1 channel closeed)	Open Channel, Channel-Channel Channel-Chassis	< 10 pF < 10 pF
Insertion Loss (with 50W termination)	100 kHz 1 MHz	0.10 dB 0.20 dB
Crosstalk (with 50W termination)	100 kHz 1 MHz	-75 dB -55 dB
Environmental Conditions		
Operating Pollution Degree		2
Operating Altitude		3000 meters (10,000 ft)
Measurement Category	I	I, 1500 Vpk transient, 500 V over voltage transient
Operating Temperature		0-55°C
Operating Humidity		<80% RH (0°C to 40°C) non-condensing

a. With chassis of all instruments connected, and with Low Terminal of the input connected to Low Terminal of the output (either directly or via the 3499A/B/C switching channels)

Matrix Modules

The matrix modules include: Agilent N2262A 4 x 8 2-wire matrix, Agilent 44473A 4 x 4 2-wire matrix and the 4 x 4 2-wire matrix on an Agilent N2265A. The specifications are listed in the table below.

ITEMS		SPECIFICATIONS		
		Agilent N2262A	Agilent N2265A[a] (4 x 4 Matrix)	Agilent 44473A
INPUT CHARACTERISTICS				
Total Channels:		4 x 8	4 x 4	4 x 4
Maximum Voltage	Terminal-Terminal or Terminal-Chassis:	200 V, dc or ac rms	200 V, dc or ac rms	250 V, dc or ac rms
Maximum Current	Per Channel: Per Module:	1 A, dc or ac rms 4 A, dc or ac rms	1 A, dc or ac rms 4 A, dc or ac rms	2 A, dc or ac rms 8 A, dc or ac rms
Maximum Power	Per Channel: Per Module:	60 W dc; 62.5 VA ac 240 W dc; 250 VA ac	60 W dc; 62.5 VA ac 240 W dc; 250 VA ac	60 W dc; 500 VA ac 240 W dc; 2000 VA ac
Maximum Overvoltage Transients		N/A	N/A	1400 V_{pk}
Thermal Offset:		< 3 μV differential	< 3 μV differential	< 3 μV differential
Initial Closed Channel Resistance:		< 1 Ω	< 1 Ω	< 1 Ω
Relay Life		Mechanical: 10^8 (at 36000 operations/hour) Electrical: 5 x 10^5 (1A load)	Mechanical: 10^8 (at 36000 operations/hour) Electrical: 5 x 10^5 (1A load)	10^8 operations/chan (dry load of < 300 mA & < 10 V) 10^5 operations/chan (maximum rated load)
Maximum Scan Rate:		80 Chans/sec	80 Chans/sec	43 Chans/sec
DC ISOLATION (with terminal block)				
Open Channel, Channel-Channel (with 1 channel closed)		< (40°C, 50% RH): > 10^{10} Ω < (40°C, 80% RH): > 10^9 Ω	< (40°C, 50% RH): > 10^{10} Ω < (40°C, 80% RH): > 10^9 Ω	< (40°C, 60% RH): > 10^{11} Ω < (40°C, 95% RH): > 10^9 Ω
HI-LO (with 1 channel closed)		< (40°C, 50% RH): > 10^{10} Ω < (40°C, 80% RH): > 10^9 Ω	< (40°C, 50% RH): > 10^{10} Ω < (40°C, 80% RH): > 10^9 Ω	< (40°C, 60% RH): > 10^{10} Ω < (40°C, 95% RH): > 10^8 Ω
Channel-Chassis (with 1 channel closed)		< (40°C, 50% RH): > 10^{10} Ω < (40°C, 80% RH): > 10^9 Ω	< (40°C, 50% RH): > 10^{10} Ω < (40°C, 80% RH): > 10^9 Ω	< (40°C, 60% RH): > 10^{10} Ω < (40°C, 95% RH): > 5x10^8 Ω
AC ISOLATION / PERFORMANCE[b] (without terminal block)				
Capacitance (with 1 channel closed)	Open Channel, Channel-Channel: HI-LO: Channel-Chassis:	 < 7 pF < 30 pF < 50 pF	 < 7 pF < 25 pF < 40 pF	 < 5 pF < 40 pF < 70 pF
Insertion Loss (with 50Ω termination)	100 kHz: 1 MHz: 10 MHz:	< 0.10 dB < 0.20 dB < 0.60 dB	< 0.10 dB < 0.20 dB < 0.60 dB	< 0.30 dB < 0.35 dB < 0.90 dB
Crosstalk (with 50Ω termination)	100 kHz: 1 MHz: 10 MHz:	< -73 dB < -53 dB < -28 dB	< -76 dB < -56 dB < -33 dB	< -76 dB < -56 dB < -36 dB

a. Agilent N2265A combines a 4 x 4 matrix and a 16-bit digital I/O into one module. It can be operated as two separate modules.

b. With chassis of all instruments connected, and with Low Terminal of the input connected to Low Terminal of the output (either directly or via Agilent 3499A/B/C switching channels).

Digital I/O Modules

The digital I/O modules available with Agilent 3499A/B/C include: Agilent N2263A 32-bit digital I/O, Agilent 44474A 16-bit digital I/O module and the 16-bit digital I/O on both the Agilent N2264A/65A multifunction modules. The specifications are listed in the table below.

ITEMS		SPECIFICATIONS	
		Agilent N2263A/64A/65A[a]	Agilent 44474A
I/O LINES			
Bit Number:		32/16/16	16
Maximum Voltage	Line-Chassis:	+ 42 V dc	+ 30 V dc
Maximum Sink Current	Per Bit:	600 mA	125 mA
Output Characteristics	Vout (high): Vout (low): I (low):	≥ 2.4 V @ I ≤ 10 mA output ≤ 0.8 V @ I ≤ 600 mA input N/A	≥ 2.4 V @ I ≤ 8 mA output ≤ 0.4 V @ I ≤ 16 mA input = 125 mA @ Vout (low) ≤ 1.25 V I (low) is fused at 250 mA
Input Characteristics	Vin (high): Vin (low):	≥ 2.0 V ≤ 0.8 V	≥ 2.0 V ≤ 0.8 V
HANDSHAKE LINES			
Maximum Voltage	Line-Chassis:	+ 5 V dc	+ 5 V dc
Output Characteristics	Vout (high): Vout (low): Iout (low):	≥ 2.4 V @ I ≤ 400 μA output ≤ 0.5 V @ I ≤ 1 mA input < 25 mA (when shorted to +5 V)	≥ 2.4 V @ I ≤ 400 μA output ≤ 0.5 V @ I ≤ 2 mA input N/A
Input Characteristics	Vin (high): Vin (low):	≥ 2.0 V ≤ 0.8 V	≥ 2.0 V ≤ 0.8 V
External Increment (EI)[b]:		N/A	Advance Agilent 3499A to next programmed configuration on falling edge of TTL pulse, 0.25 μsec minimum width.
Channel Closed (CC)[c]:		N/A	Indicates completion of new configuration; TTL pulse, 10 μsec minimum width.

a. Both the Agilent N2264A and N2265A are multifunction modules, the specifications listed in this table are for the 16-bit digital I/O function on the Agilent N2264A and N2265A.

b. Both EI and CC lines are used for external controlled scanning. This item is for Agilent 44474A only.

c. When the next channel closes, the Agilent 44474A outputs a CC pulse to trigger the voltmeter. This item is for Agilent 44474A only.

Agilent N2269A Multifunction Module

The following table lists Agilent N2269A module's specifications.

ITEMS		SPECIFICATIONS
DIGITAL I/O LINES		
maximum Voltage (line-to-chassis)		+5.25 VDC
Maximum Sink Current (per bit)		16 mA
Maximum Block Transfer Rate		Up to 3.57 M by 16 bit/s
Output Characteristics	Vout (high) Vout (low)	>=2.4 V @|<=10 mA output <=0.8 V @|<=16 mA input
Input Characteristics	Vin (high) Vin (low)	>=2.0 V <=0.8 V
Isolation Voltage		350 VDC
HANDSHAKE LINES		
Maximum Voltage (line-to-chassis)		+5 VDC
Output Characteristics	Vout (high) Vout (low) Iout (low)	>=2.4 V @|<=400 mA output <=0.5 V @|<=1 mA input <=25 mA (when shorted to +5V)
Input Characteristics	Vin (high) Vin (low)	>=2.0 V <=0.8 V
DAC LINES		
Analog Output Range		+12 V, non-isolated
Resolution		1 mV
Maximum Output Current	Iout	10 mA
Setting Time		1 ms to 0.01% of Output
Accuracy		0.04% of Output + 4mV @24hour$\pm$1^{o}C
Temp Coefficient		$\pm$(0.015% of Output + 1mV)
Data Update Rate		781.25 KHz

Agilent 44472A VHF Switch Module

Agilent 44472A VHF Switch module contains 14 latching relays, which provides dual independent 4-to-1 coaxial MUXs. The specifications are listed in the table below.

ITEMS		SPECIFICATIONS
INPUT CHARACTERISTICS		
Total Channels:		dual 4
Connector Type:		BNC (x10)
Maximum Voltage	Center-Center or Center-Low: Low-Chassis or Low-Low:	250 V dc, 30 V ac rms or 42 V ac peak 42 V dc
Maximum Current	Per Channel:	30 mA dc, 300 mA ac rms
Thermal Offset	Per Channel:	< 15 μV
Characteristic Impedance:		50 Ω
Initial Closed Channel Resistance:		< 1 Ω
Relay Life	Dry Load of < 300 mA & < 10 V: Maximum Rated Load:	10^8 10^5
Maximum Scan Rate[a]:		43 Chans/sec
DC ISOLATION		
Between Any Two Points	< (40°C, 95% RH):	> 10^7 Ω
AC ISOLATION / PERFORMANCE[b]		
Capacitance	Center-Center, Center-Common: Center-Low: Low-Chassis:	< 0.002 pF < 70 pF < 0.20 μF
Rise Time:		< 0.7 ns
Signal Delay:		< 2.5 ns (channel match < 90 ps)
Insertion Loss (with 50Ω termination)	30 MHz: 100 MHz: 300 MHz:	< 0.50 dB < 0.75 dB < 1.25 dB
Crosstalk Within a Group (Channel-Channel or Channel-Common, with 50Ω termination)	30 MHz: 100 MHz: 300 MHz:	< -100 dB < -85 dB < -65 dB
Crosstalk Group to Group (with 50Ω termination)	30 MHz: 100 MHz: 300 MHz:	< -85 dB < -85 dB < -50 dB
VSWR (with 50 Ω termination)	30 MHz: 100 MHz: 300 MHz:	< 1.06 < 1.12 < 1.43

a. Using Agilent 44474A external increment & channel closed, display off.
b. When all channels in a group are opened, the last channel opened (or channel 00 or 13 following a group RESET) has channel-common isolation of > 80 dB @ 30 MHz, > 60 dB @ 100 MHz, and > 40 dB @ 300 MHz.

Agilent 44475A Breadboard Module

Agilent 44475A is a breadboard module, and the specifications are listed in the table below.

ITEMS	SPECIFICATIONS
MODULE DIMENTIONS	
Component Area Available:	104mm x 74mm and 79mm x 74mm (4.1" x 2.9" and 3.1" x 2.9")
Grid Hole Spacing (center-center):	2.54mm x 2.54 mm (0.1" x 0.1")
Grid Hole Size (inside diameter):	1.17mm (0.046")
Maximum Component Height (above board):	12.7mm (0.5")
Maximum lead Length (below board):	3.2mm (0.125")
INPUT CHARACTERISTICS	
Maximum Voltage:	42 V dc, 30 V ac rms, 42 V ac peak (on Breadboard area) 5.5 V (on Digital Input port lines)
Maximum Power Dissipation (per module):	2 Watt

Agilent 44476A Microwave Switch Module

Agilent 44476A is a microwave switch module, the specifications of it are listed in the table below:

ITEMS		SPECIFICATIONS
INPUT CHARACTERISTICS		
Frequency Range:		DC to 18 GHz
Characteristic Impedance:		50 Ω
Input Power Rating:		1 Watt average, 100 Watts peak (Also less than ±7 V dc)
Average Switch Life:		10^6 operations per channel
Repeatability (typical):		0.03 dB after 10^6 switchings
Maximum Scan Rate[a]:		43 Chans/sec
Connector:		SMA
AC ISOLATION / PERFORMANCE		
Isolation	DC - 18 GHz:	> 90 dB
Insertion Loss	DC - 2 GHz: DC - 18 GHz:	< 0.25 dB < 0.50 dB
VSWR (3 mm SMA)	DC - 2 GHz: DC - 12.4 GHz: DC - 18.0 GHz:	< 1.15 < 1.25 < 1.40

a. Using Agilent 44474A External Increment & Channel Closed, display off.

Agilent N2276A/B Microwave Switch Module

Agilent N2276A's specifications are listed in the table below. Since the switching and attenuation characteristics of the N2276B are determined by the switches and attenuators installed in it, please refer to the switch's and/or attenuator's data sheet for the specifications of your customized N2276B module.

ITEMS	SPECIFICATIONS
Total Channels	Dual 1-to-6 (Dual 1-to-4 when with option 204)
Connector Type	SMA (female)
Frequency Range	DC to 20 GHz
Insertion Loss	0.3 dB + 0.015*Frequency (GHz)
Isolation	100 dB min. DC to 12GHz 80 dB min. 12GHz to 15GHz 70 dB min. 15GHz to 20GHz
SWR	1.2 max DC to 4GHz 1.35 max 4 to 12.4GHz 1.45 max 12.4 to 18GHz 1.7 max 18 to 20 GHz
Repeatability (5 million cycles at 25^{o}C)	0.03dB maximum
Switch Speed	25ms
Switch Life	5 million cycles

Agilent 44477A Form-C Relay Module

Agilent 44477A module provides seven independent, break-before-make, SPDT Form-C latching relays, the specifications of it are listed in the table below.

ITEMS		SPECIFICATIONS
INPUT CHARACTERISTICS		
Total Channels:		7
Maximum Voltage	Terminal-Terminal or Terminal-Chassis:	250 V dc or ac rms, 350 V ac peak
Maximum Current	Per Channel: Per Module:	2 A, dc or ac rms 14 A, dc or ac rms
Maximum Power	Per Channel: Per Module:	60 W dc; 500 VA ac 420 W dc; 3500 VA ac
Maximum Overvoltage Transients:		1400 V_{pk}
Thermal Offset:		< 3 μV per channel
Initial Closed Channel Resistance:		< 1 Ω
Relay Life	Dry Load of < 300 mA & < 10 V: Maximum Rated Load:	10^8 operations/chan 10^5 operations/chan
Maximum Scan Rate[a]:		43 Chans/sec
DC ISOLATION		
Open Channel, Channel-Channel (with 1 channel closed)	≤ (40°C, 60% RH): ≤ (40°C, 95% RH):	> 10^{11} Ω > 10^9 Ω
Channel-Chassis (with 1 channel closed)	≤ (40°C, 60% RH): ≤ (40°C, 95% RH):	> 5 x 10^{11} Ω > 10^{10} Ω
AC ISOLATION/PERFORMANCE[b]		
Capacitance (with 1 channel closed)	Open Channel, Channel-Channel: Channel-Chassis:	< 10 pF < 25 pF
Insertion Loss (with 50Ω termination)	100 kHz: 1 MHz: 10 MHz:	< 0.20 dB < 0.25 dB < 0.50 dB
Crosstalk (with 50Ω termination)	100 kHz: 1 MHz: 10 MHz:	< -73 dB < -53 dB < -33 dB

a. Using Agilent 44474A external increment & channel closed, display off.
b. With chassis of all instruments connected, and with the Low of input lines connected to the Low of output lines (either directly or via Agilent 3499A/B/C switched channels)

Agilent 44478A/B 1.3GHz MUX Modules

The specifications of the Agilent 44478A/B are listed in the table below. Specifications in the table describe the modules' warranted performance over the temperature range 0 to 55°C. Information marked by the "*Typical*" designation is helpful in applying the modules, but is non-warranted information.

ITEMS		SPECIFICATIONS
INPUT CHARACTERISTICS		
Total Channels:		dual 4
Maximum Voltage (any center/shield to any other center/shield/chassis)**:**		42 V dc + ac peak
Maximum Current (per channel or common):		1 A dc, or ac rms
Maximum Power	Per Channel or Common: Each Resistive Termination:	24 W, 24 VA or 44 dBm 0.25 W, 0.25 VA or 24 dBm
Characteristic Impedance	Agilent 44478A: Agilent 44478B:	50 Ω 75 Ω
Relay Life (*Typical*)	With no load: At maximum rated power:	5×10^6 operations 10^5 operations
Maximum Scan Rate[a]:		43 Chans/sec
DC PERFORMANCE		
Thermal Offset (per channel):		< 6 μV (< 2 μV, *Typical*)
Initial Closed Channel Resistance:		< 1 Ω
Insulation Resistance (any terminal to any terminal)	≤ (40°C, 95% RH): ≤ (25°C, 40% RH):	$> 10^8$ Ω $> 10^{10}$ Ω (*Typical*)
AC ISOLATION / PERFORMANCE ($Z_L = Z_S$ = 50Ω or 75Ω)[b]		
Insertion Loss		
≤ **40°C, 95% RH**	≤ 10 MHz: ≤ 100 MHz: ≤ 500 MHz: ≤ 1.3 GHz:	< 0.3 dB < 0.7 dB < 1.5 dB < 3.0 dB
≤ **25°C, 40% RH** (*Typical*)	≤ 10 MHz: ≤ 100 MHz: ≤ 500 MHz: ≤ 1.3 GHz:	< 0.2 dB < 0.5 dB < 1.1 dB < 1.9 dB
Crosstalk[c]		
Channel-Channel, Channel-Common (with 1 channel closed)	≤ 10 MHz: ≤ 100 MHz: ≤ 500 MHz: ≤ 1.3 GHz:	< -90 dB < -80 dB < -65 dB < -55 dB
Group-Group, Module-Module	≤ 10 MHz: ≤ 100 MHz: ≤ 500 MHz: ≤ 1.3 GHz:	< -90 dB < -80 dB < -70 dB < -60 dB
VSWR	≤ 10 MHz: ≤ 100 MHz: ≤ 500 MHz: ≤ 1.3 GHz:	< 1.20 < 1.25 < 1.35 < 1.55
Capacitance	Center-Center: Center-Shield:	< 0.006 pF < 60 pF
Rise Time:		< 300 ps
Signal Delay:		< 3 ns (channel matched to ± 50 ps)

a. Using Agilent 44474A external increment & channel closed, display off.
b. $Z_L = Z_S = 50$ Ω applies for Agilent 44478A and $Z_L = Z_S = 75$ Ω applies for Agilent 44478B.
c. The CrossTalk specifications assume 50 Ω termination for 44478A and 75 Ω termination for 44478B. If all channels unterminated, derate specification by 6 dB.

Agilent N2280A/N2281A Optical Switch Modules

The specifications of the Agilent N2280A/N2281A are listed in the table below. Information in the column "*Typical*" is helpful in applying the modules.

ITEMS	SPECIFICATIONS			
	Agilent N2280A		Agilent N2281A	
	Typical	Maximum	Typical	Maximum
Insertion Loss: Single-mode (SM)[a]	0.5 dB	0.8 dB	0.5 dB	0.8 dB
Return Loss: SM[b]	50 dB	45 dB (min.)	50 dB	45 dB (min.)
Polarization Dependent Loss: SM	0.02 dB	0.07 dB	0.02 dB	0.07 dB
Insertion Loss Stability[c]	±0.03 dB	±0.05 dB	±0.03 dB	±0.05 dB
Repeatability	±0.003 dB	±0.005 dB	±0.003 dB	±0.005 dB
Crosstalk	-70 dB	-60 dB	-70 dB	-60 dB
Optical Input Power		300 mW		300 mW
Switching Time	15 ms	20 ms	20 ms	25 ms
Cycle Rate		5 c/s		5 c/s
Relay Life		10M cycles (min.)		10M cycles (min.)
Operating Temperature		-25 to 65°C		-25 to 65°C
Storage Temperature		-40 to 80°C		-40 to 80°C
Humidity (non-condensing)		95%		95%
Power	5±5 %VDC/45mA	5±5 %VDC/70mA	5±5 %VDC/45mA	5±5 %VDC/70mA

a. Excluding connectors. Include 0.2dB (typical insertion loss) for each connector.

b. Excluding connectors.

c. Drift of any channel relative to one assigned reference channel at +/- 5°C deviation of ambient temperature over a seven-day period.

Agilent N2282A Optical Switch Module

The specifications of Agilent N2282A is listed in the table below.

ITEMS	SPECIFICATIONS		
	Minimum	**Typical**	**Maximum**
Channel Count		1-to-8	
Switch Type		Latching	
Return Loss (SM)[a]		-62 dB	-57 dB
Insertion Loss (SM)[b]		0.5 dB	0.7 dB
Insertion Loss Stability[c]		±0.02 dB	±0.025 dB
Polarization Dependent Loss (PDL)		0.02 dB	0.04 dB
Insertion Repeatability[d]			
Sequential Switching		±0.005 dB	±0.01 dB
Random Switching		±0.01 dB	±0.05 dB
Crosstalk		-90 dB	-80 dB
Input Power (Optical)		300 mW Continuous	
Switching Time		250 ms	
Wavelength (SM)	1270nm		1670nm
Relay Life	10M cycles		
Operating Temperature	0^oC		55^oC
Humidity (non-condensing)		<80%RH (0^oC~55^oC)	

a. Excluding connector.
b. Excluding Connectors, 0.2dB typical connector insertion loss.
c. Measured after one hour's warm-up.
d. Measured after temperature has been stablized for one hour.

Chapter 2
Getting Started

About This Chapter

This chapter describes the procedure to install the plug-in modules into a mainframe and mount the mainframe onto a system rack, followed by the basic front panel operations of an Agilent 3499A/B/C Switch/Control System. The chapter contents include:

- To Prepare the Instrument for Use . . . . . Page 21
- Module Installation . . . . . Page 22
- Operating the Instrument . . . . . Page 24
- To Rack Mount the Agilent 3499A/B/C . . . . . Page 28

To Prepare the Instrument for Use

Check the List of Supplied Items

Verify that you have received the following items with each one of your 3499A/B/C mainframe. If anything is missing, contact your nearest Agilent Technologies Sales Office.

-- One power cord;
-- One ***User's Manual*** (if ordered);
-- One Tie Down Clip 03499-21002 (for Agilent 3499B only);
-- Any plug-in modules you ordered, which were delivered in separate shipping containers.

This ***Service Manual*** must be ordered separately.

Initial Inspection

The Agilent 3499A/B/C was carefully inspected, both mechanically and electrically, before shipment. It should be free of any scratches and in perfect electrical order upon receipt. You should inspect the Unit for any damage that may have occurred in transit.

WARNING **To avoid potentially hazardous electrical shock, do not perform electrical tests when there are signs of damage to any portion of the outer enclosure.**

If the shipping container or packing material shows any signs of damage or stress, you should notify both carrier and the nearest Agilent Technologies Sales Office.

Power on the Instrument

Make sure no mechanical damages on the instrument, then you can perform the following procedure to verify that the instrument is in proper working order.

1. Connect the instrument to an AC power source with the supplied power cord.
2. Push the **Power** switch to power on the instrument.
3. On power-up, every segment in the display should light up briefly. The internal self-test will begin following this “starburst” display.
4. If the self-test passes, the default system mode and the GPIB address are displayed, together with a “beep” sound. Then the display shows the instrument model number.

Note If the instrument failed the self-test, contact your nearest Agilent Technologies Sales Office.

If the Instrument Does Not Turn On

1. Verify that the power cord is firmly plugged into the power receptacle on the rear panel of the instrument.
2. Make sure that the power source the instrument is plugged into is energized.
3. Verify that the instrument is turned on.

Note If the instrument DOES NOT turn on after you perform the above procedure, contact your nearest Agilent Technologies Sales Office.

Module Installation

WARNING **Only qualified personnel should install or remove the plug-in modules into or from an Agilent 3499A/B/C mainframe. Make sure to disconnect the power cord from the back of the mainframe prior to installing or removing any modules.**

Caution **Use anti-static procedures when configuring, installing or removing any plug-in modules. To prevent contamination to the modules that could degrade performance, handle the modules by the side edges or shields only. Do not touch the board surfaces or components.**

Module Installation

Upon receipt of an Agilent 3499A/B/C mainframe, the plug-in modules you ordered were not installed in the mainframe. In addition, the terminal block(s) and/or the cables ordered for wiring external test circuits are also separated from your modules.

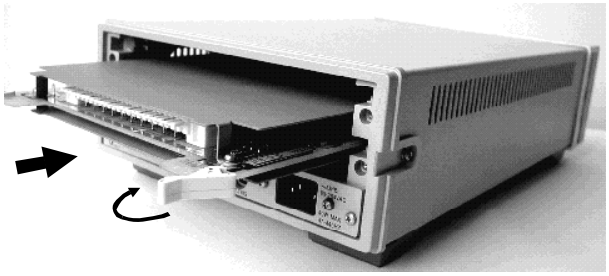
Figure 2-1 on Page 23 shows the procedure to install a plug-in module into the mainframe 3499B, as well as to attach a screw terminal block onto the module. For 3499A, the installation procedure is the same as in 3499B. For the details about screw terminal blocks, crimp-and-insert terminal blocks and/or DIN-to-D cables wiring, see “Plug-in Modules Wiring Information” on Page 110.

STEP 1



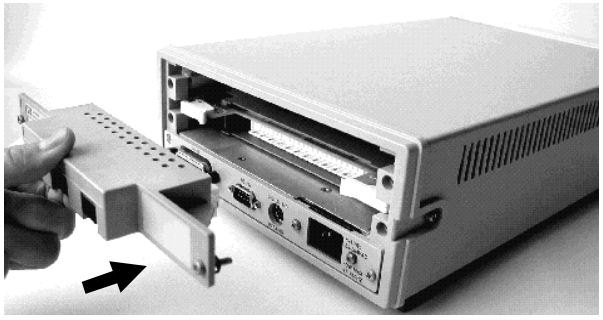
1. Face the mainframe rear panel towards you;
2. Select a slot in which the module is to be installed.

STEP 2



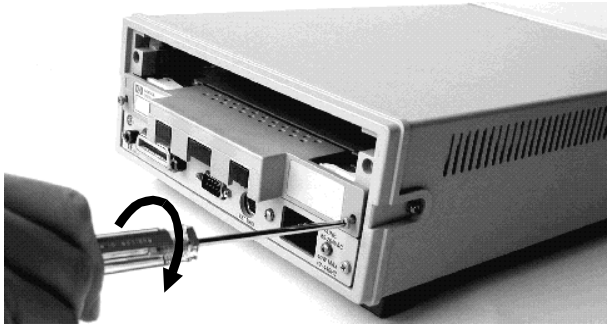
1. Hold the sides of the module, component side down, by the metal shields;
2. Insert the module into the slot guides and slide the module towards the front of the instrument;
3. Push firmly until the module “snaps” into place.
4. Push both plastic levers inward to lock the module.

STEP 3 (Optional)



1. Wire the screw terminal block (module dependent).
2. Attach the screw terminal block onto the plug-in module.

STEP 4 (Optional)



1. Push firmly until the terminal block “snaps” into place;
2. Lock the screw terminal block with the two screws (Torque < 8 in-lbs).

Figure 2-1. Module installation

Module Removal

To remove a plug-in module from an Agilent 3499A/B/C mainframe, reverse the procedures above.

Operating the Instrument

An Agilent 3499A/B/C Switch/Control System can be easily operated from the front-panel, or programmed with SCPI (in SCPI mode) or 3488A (in 3488A mode) commands over the remote interface.

The following sections are only intended to show some basic front-panel operation. For more information about the front panel operation, refer to Chapter 3 “Front-Panel Operation” starting from Page 31.

Channel Addressing

In Agilent 3499A/B/C Switch/Control System, a channel refers to an individual relay on a switching module, or an individual bit/port on a digital I/O module. The channel address is in the form of *snn*, where *s* represents slot number. Slot 0 refers to the mainframe controller board, s = 1-2 (for an Agilent 3499B), s = 1-5 (for an Agilent 3499A) or s = 1-9 (for an Agilent 3499C); *nn* represents channel number (module dependent, see Table 2-1).

Table 2-1. Plug-in Modules Channel Addressing

Agilent P/N Descriptions	**Channel Addressing** (*snn*, *s* = Slot Number[a]; *nn* = Channel Number)	
	SCPI Mode	**3488A Mode**
Agilent 44470A 10-Channel MUX Module	*s00, s01, s02, s03... s08, s09*	*Same as in SCPI mode.*
Agilent 44470D 20-Channel MUX Module	*s00, s01, s02, s03... s18, s19*	*Same as in SCPI mode.*
Agilent 44471A 10-Channel GP Relay Module	*s00, s01, s02, s03... s08, s09*	*Same as in SCPI mode.*
Agilent 44471D 20-Channel GP Relay Module	*s00, s01, s02, s03... s18, s19*	*Same as in SCPI mode.*
Agilent 44472A Dual 4-Channel VHF Module	Group 0: *s00, s01, s02, s03*; Group 1: *s10, s11, s12, s13*	*Same as in SCPI mode.*
Agilent 44473A 4 x 4 Matrix Module	Row: 0, 1, 2, 3; Column: 0, 1, 2, 3 (*s00, s01, s02, s03; s10, s11, s12, s13; s20, s21, s22, s23; s30, s31, s32, s33)*[b]	*Same as in SCPI mode.*
Agilent 44474A 16-Bit Digital I/O Module	Individual Bits: *s00, s01, s02... s14, s15* 8-Bit Ports: *s00, s01* 16-Bit Port: *s00*	Individual Bits: *s00, s01, s02... s14, s15* 8-Bit Ports: *s00, s01* 16-Bit Port: *s02*
Agilent 44475A Breadboard Module	N/A	N/A
Agilent 44476A 3-Channel 13 GHz Microwave Switch Module	*s00, s01, s02*	*Same as in SCPI mode.*
Agilent 44476B 2-Channel 26 GHz Microwave Switch Module	*s00, s01*	*Same as in SCPI mode.*
Agilent 44477A 7-Channel Form-C Relay Module	*s00, s01, s02, s03, s04, s05, s06*	*Same as in SCPI mode.*

Table 2-1. Plug-in Modules Channel Addressing

Agilent P/N Descriptions	**Channel Addressing** (*snn*, *s* = Slot Number[a]; *nn* = Channel Number)	
	SCPI Mode	**3488A Mode**
Agilent 44478A/B 50/75 Ω 1.3 GHz MUX Module	Group 0: *s00, s01, s02, s03* Group 1: *s10, s11, s12, s13*	*Same as in SCPI mode.*
Agilent N2260A 40-Channel MUX Module[c]	1-Wire Mode: *s00, s01... s78, s79*[d] 2-Wire Mode: *s00, s01...s38, s39* Dual 2-Wire Mode: *s00, s01...s38, s39* 4-Wire Mode: *s00, s01...s18, s19*[e]	*s00, s01...s38, s39*[f]
Agilent N2261A 40-Channel GP Relay Module	*s00, s01, s02, s03... s37, s38, s39*	*Same as in SCPI mode.*
Agilent N2262A 4X8 Matrix Module	Row 0, 1, 2, 3; Column 0, 1, 2, 3... 6, 7 *(s00, s01, s02... s07; s10, s11, s12... s17; s20, s21, s22... s27; s30, s31, s32... s37)*	*Same as in SCPI mode.*
Agilent N2263A 32-Bit Digital I/O Module	Individual Bits: *s00, s01, s02... s30, s31;* 8-Bit Ports: *s00, s01, s02, s03;* 16-Bit Ports: *s00, s02;* 32-Bit Port: *s00.*	Individual Bits: *s00, s01, s02... s30, s31;* 8-Bit Ports: *s00, s01, s02, s03;* 16-Bit Ports: *s04, s05;* 32-Bit Port: *s06.*
Agilent N2264A 12-Channel GP Relay + 3-Channel High-current GP Relay + 16-Bit Digital I/O Module	12 GP Relays: *s00, s01, s02... s10, s11;* 3 High-current GP Relays: *s20, s21, s22;* **16-Bit Digital I/O:** Individual Bits: *s30, s31, s32... s44, s45;* 8-Bit Ports: *s30, s31;* 16-Bit Port: *s30.*	12 GP Relays: *s00, s01, s02... s10, s11;* 3 High-current GP Relays: *s20, s21, s22;* **16-Bit Digital I/O:** Individual Bits: *s30, s31, s32... s44, s45;* 8-Bit Ports: *s30, s31;* 16-Bit Port: *s32.*
Agilent N2265A 4X4 Matrix + 16-Bit Digital I/O Module	4X4 Matrix: Row 0, 1, 2, 3; Column 0, 1, 2, 3 *(s00, s01, s02, s03; s10, s11, s12, s13; s20, s21, s22, s23; s30, s31, s32, s33)* **16-Bit Digital I/O:** Individual Bits: *s40, s41, s42... s54, s55;* 8-Bit Ports: *s40, s41;* 16-Bit Port: *s40.*	4X4 Matrix: *Same as in SCPI mode.* **16-Bit Digital I/O:** Individual Bits: *s40, s41, s42... s54, s55;* 8-Bit Ports: *s40, s41;* 16-Bit Port: *s42.*
Agilent N2266A 40-Channel MUX Module	1-Wire Mode: *s00, s01... s78, s79* 2-Wire Mode: *s00, s01...s38, s39* Dual 2-Wire Mode: *s00, s01...s38, s39* 4-Wire Mode: *s00, s01...s18, s19*	*s00, s01...s38, s39*
Agilent N2267A 8-Channel High Current GP Module	s00, s01,..., s06, s07	s00, s01,..., s06, s07
Agilent N2268A 50Ω 3.0 GHz Dual 1-to-4 MUX Module	Group 0: *s00, s01, s02, s03* Group 1: *s10, s11, s12, s13*	*Same as in SCPI mode.*

Table 2-1. Plug-in Modules Channel Addressing

Agilent P/N Descriptions	**Channel Addressing** *(snn, s* = Slot Number[a]; *nn* = Channel Number)	
	SCPI Mode	**3488A Mode**
Agilent N2269A Multifunction Module	**16-Bit D/A Port:** s40, s42 **16-Bit Memory Access Port:** S50 **Digital I/O:** individual Bits: s00, s01,..., s30, s31 8-Bit Port: s00, s01, s02, s03 16-Bit Port: s00, s02	**16-Bit D/A Port:** s44, s45 **16-Bit Memory Access Port:** S58 **Digital I/O:** individual Bits: s00, s01,..., s30, s31 8-Bit Port: s00, s01, s02, s03 16-Bit Port: s04, s05
Agilent N2270A 10-Channel High Voltage MUX Module	s00, s01,..., s08, s09	s00, s01,..., s08, s09
Agilent N2272A 1GHz RF 1-to-9 MUX Module	s00, s01,..., s07, s08	Not supported.
Agilent N2276A/B Dual 1-to-6(4) Microwave MUX/Atttenuator Module	**Two 1-to-4(6) Microwave Switch:** *s00, s01, s02, s03(, s04, s05);* *s10, s11, s12, s13(, s14, s15).* **Two Attenuator:** *s20; s30.*	Not supported.
Agilent N2280A Quadruple 1-to-2 Optical Switch Module	Group0: s00, s01 Group1: s10, s11 Group2: s20, s21 Group3: s30, s31	Group0: s00, s01 Group1: s10, s11 Group2: s20, s21 Group3: s30, s31
Agilent N2281A Dual 1-to-4 Optical Switch Module	Group0: s00, s01, s02, s03 Group1: s10, s11, s12, s13	Group0: s00, s01, s02, s03 Group1: s10, s11, s12, s13
Agilent N2282A 1-to-8 Optical Switch MUX Module	*s00, s01, s02... s07.*	Not supported.
4-Bit Built-in Digital I/O	Individual Bits: *091, 092, 093, 094;* 4-Bit Port: *090.*	*Same as in SCPI mode.*

a. For an Agilent 3499A, the Slot Number = 1-5; for an Agilent 3499B, the Slot Number = 1-2; for an Agilent 3499C, the Slot Number = 1-9.
b. A channel number on a matrix module is formed in Slot-Row-Column format, i.e., channel address s23 means row 2, column 3 in Slot s.
c. Agilent N2260A can be used as an 80-channel 1-wire MUX module, a 40-channel 2-wire MUX module, two 20-channel 2-wire MUX modules, or a 20-channel 4-wire MUX module in SCPI mode.
d. The Low (L) terminals of the 40 2-wire channels form the first 40 1-wire channels (Channels 00-39), and the High (H) terminals of the 40 2-wire channels form the second 40 1-wire channels (Channels 40-79).
e. The first channels (CH00 & CH20) of either banks (BANK 0 and BANK 1) form Channel 00, the second channels (CH01 & CH21) of either banks form Channel 01, and so on.
f. In 3488A mode, Agilent N2260A is used as a 40-channel 2-wire MUX module.

Basic Front-Panel Operation

The following examples demonstrate some basic operation to operated the Agilent 3499A/B/C. Assuming that an Agilent N2260A module is installed in slot 1 of the Agilent 3499A and configured as a 40-channel 2-wire MUX (default setting), the channels on the Agilent N2260A can be addressed as 100 through 139.

To Open/Close a Channel

Turn the knob to the desired channel (i.e. 102), the channel specified is shown on the channel display area.

MUX	OPEN	102

Press **Open/Close**[1] to open/close the selected channel.

Only one channel can be opened/closed each time, repeat the procedure above to open/close other channels.

Note To open all channels on a module, press **Card Reset**. To open all channels on the plug-in modules in an Agilent 3499A/B/C, press **Shift + Card Reset**[2], or cycle power the instrument.

To Change the Instrument System Mode

The Agilent 3499A/B/C can be operated in either one of the two system modes: SCPI mode and 3488A mode. The instrument is set to SCPI mode (factory default).

To change the system mode, press **Menu** first, turn the knob until the "SYSTEM MODE" is displayed, press **Enter**; then turn the knob to the specific system mode, press **Enter** again to change the instrument system mode.

Note Switching between SCPI mode and 3488A mode will reset the instrument to the factory default settings (except the GPIB address).

To View Relay Cycles

The relay cycle counts for the switching relays on some Agilent modules can be read out. These modules include:

1. Agilent N2260A 40-Channel 2-Wire MUX Module;
2. Agilent N2261A 40-Channel GP Relay Module;
3. Agilent N2262A 4 x 8 2-Wire Matrix Switch Module;
4. Agilent N2264A Multifunction Module;

[1]. Press **Close** means to press the key **Close** on the front panel of the Agilent 3499A/B/C.
[2]. Press **Shift + Card Reset** means to press the key **Shift** first, then press the key **Card Reset**.

5. Agilent N2265A Multifunction Module;
6. Agilent N2266A 40-channel 2-Wire MUX Module;
7. Agilent N2267A 8-channel High Current GP Module;
8. Agilent N2268A 50Ω 3.0GHz Dual 1-to-4 MUX Module;
9. Agilent N2270A 10-Channel High Voltage MUX Module;
10. Agilent N2272A 1GHz RF 1-to-9 MUX Module;
11. Agilent N2276A/B Dual 1-to-6(4) Microwave MUX/Atttenuator Module (not include Attenuators);
12. Agilent N2280A/81A/82A Optical Switch Modules.

To read out the relay cycles, press **View**, turn the knob until the "RELAY CYCLES" is displayed, press **Enter** to view the relay cycles of the switching relays. Turn the knob to view all the relay cycles on the plug-in modules.

Note "N/A" will be displayed a little while if the module does not support relay cycle count feature.

To View the Errors

The Agilent 3499A/B/C can store up to 10 errors in the error queue. Once an error occurs, the ERROR annunciator turns on.

To view the errors, press **View**, turn the knob until "ERROR" is displayed, press **Enter** to view the error. Refer to Appendix B "Error Messages" starting from Page 122 for more error messages.

Note In SCPI mode, the instrument will display "NO ERROR" for a little while, then return to the upper menu if the error queue is empty. In 3488A mode, the instrument will display "0000" if no error occurs.

To Rack Mount the Agilent 3499A/B/C

You can mount the Agilent 3499A/B/C mainframes on a standard 19-inch rack cabinet with the optional rack-mounting kits. The instructions and mounting hardware are included with each rack-mounting kit.

To Mount an Agilent 3499A

To rack mount an Agilent 3499A, the full-rack-width mainframe, order either:

- Rack-mount kit with handles, part number 5183-7170, or
- Rack-mount kit without handles, part number 5183-7171.

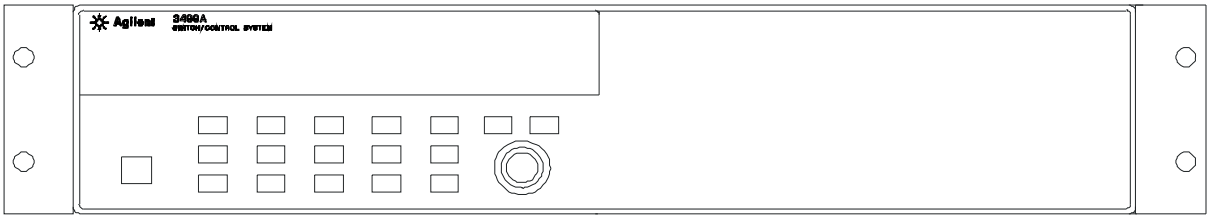


Figure 2-2. Rack Mount an Agilent 3499A

To Mount an Agilent 3499B

To rack mount a single Agilent 3499B, the half-rack-width mainframe, order an adapter kit 5183-7172 (Figure 2-3). This kit includes the flange and filler panel.

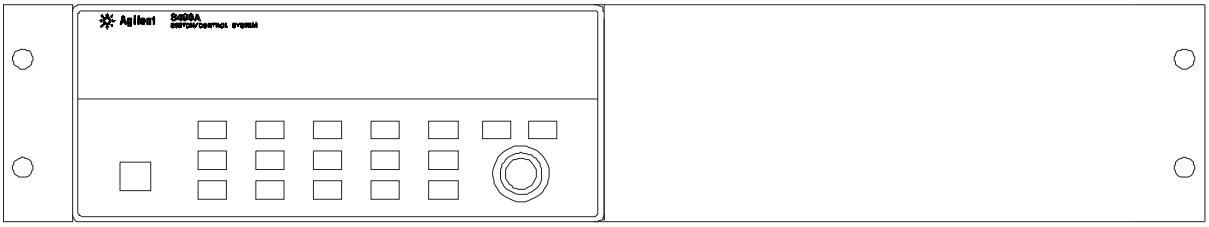


Figure 2-3. Rack Mount a Single Agilent 3499B with Adapter Kit 5183-7172

Or, you can order a Support Shelf 5063-9255, a slide kit 1494-0015, and a filler panel 5002-3999 (Figure 2-4).

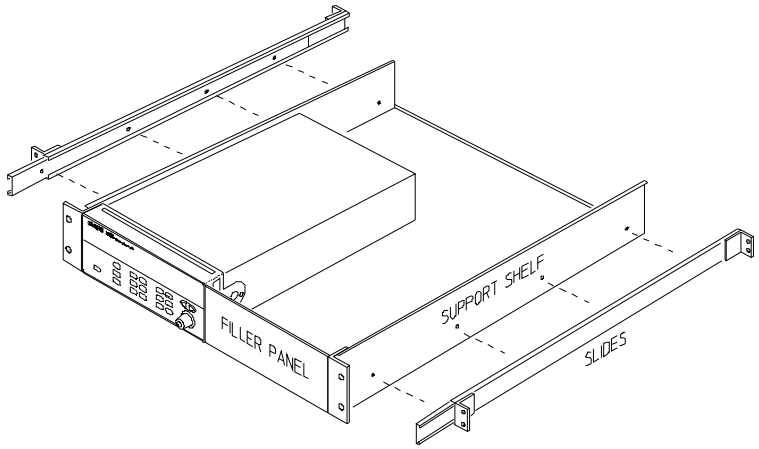


Figure 2-4. Rack Mount a Single Agilent 3499B on a Support Shelf

To rack mount two Agilent 3499B's side-by-side (or any System II instrument next to an Agilent 3499B), order a Support Shelf 5063-9255 and a slide kit 1494-0015 (Figure 2-5).

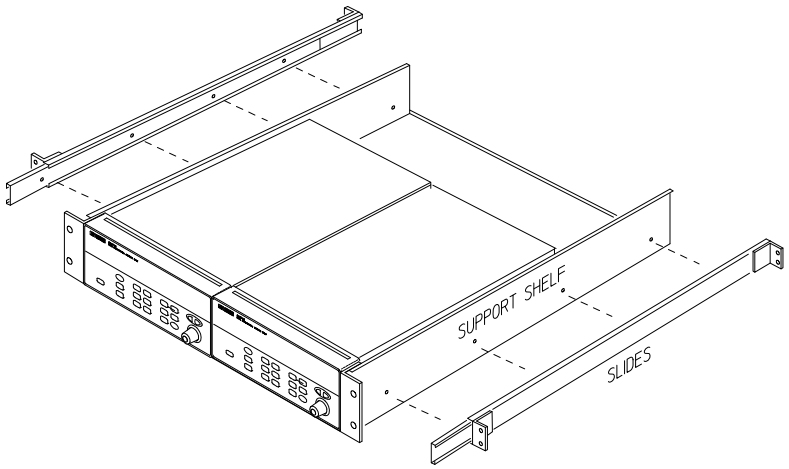


Figure 2-5. Rack Mount Two Agilent 3499B's Side-by-Side

To Mount an Agilent 3499C

To rack mount an Agilent 3499C, order either an adapter kit 5063-9216 (without handles, see Figure below) or 5063-9223 (with handles).

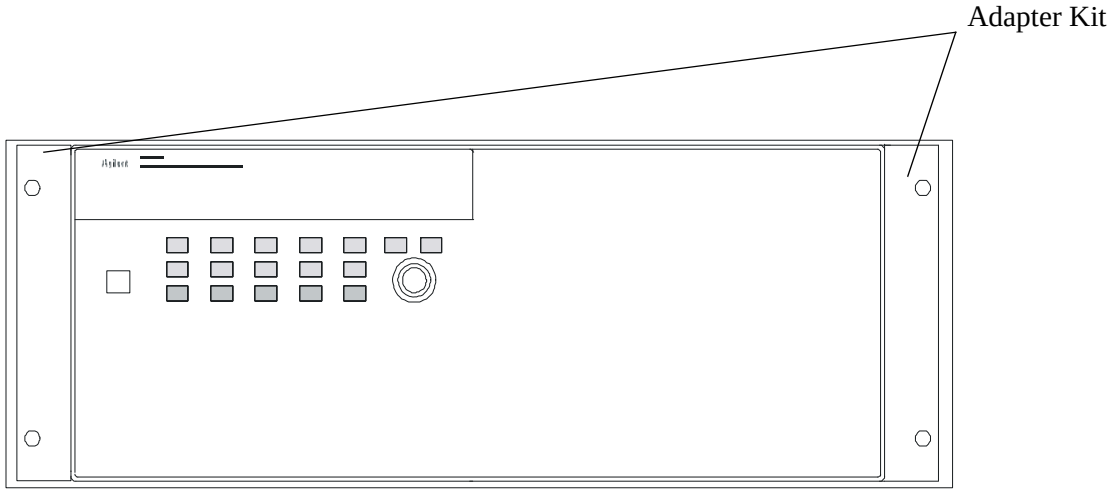


Figure 2-6. Rack Mount an Agilent 3499C

Filler Panels

Order filler panels to cover any unused slots in an Agilent 3499A/B/C.

- 1-slot filler panel, part number 03499-00023 (option FP1)
- 2-slot filler panel, part number 03499-00024 (option FP2).

Chapter 3
Front-Panel Operation

About This Chapter

This chapter introduces you to each front-panel menu, it covers all aspects of front-panel operation. Chapter contents include:

- Front-Panel Overview . . . . . Page 32
- Local/Remote Control . . . . . Page 34
- To Monitor a Channel or a Slot. . . . . Page 34
- To Close or Open a Channel . . . . . Page 36
- To Read from a Digital I/O Port . . . . . Page 36
- To Write to a Digital I/O Port . . . . . Page 36
- To Store an Instrument State . . . . . Page 37
- To Recall an Instrument State . . . . . Page 38
- View Key Operation . . . . . Page 38
- Mode Key Operation. . . . . Page 40
- Scanning Operation. . . . . Page 43
- Menu Key Operation. . . . . Page 48
- To Reset a Module . . . . . Page 57
- To Reset the Instrument . . . . . Page 57

The following conventions are used for the front-panel operation.

- The keys on the front-panel keyboard are expressed in bold font and normally associated with a “press”. For example, press **Mon**.
- The front panel display annunciators are expressed in bold font followed by an “annunciator”. For example, **MON** annunciator.
- The information shown on the front panel display is enclosed within a pair of quotation marks.
- **Shift + Recall**[1] indicates the sequential operation: first press **Shift**, then press **Recall**.

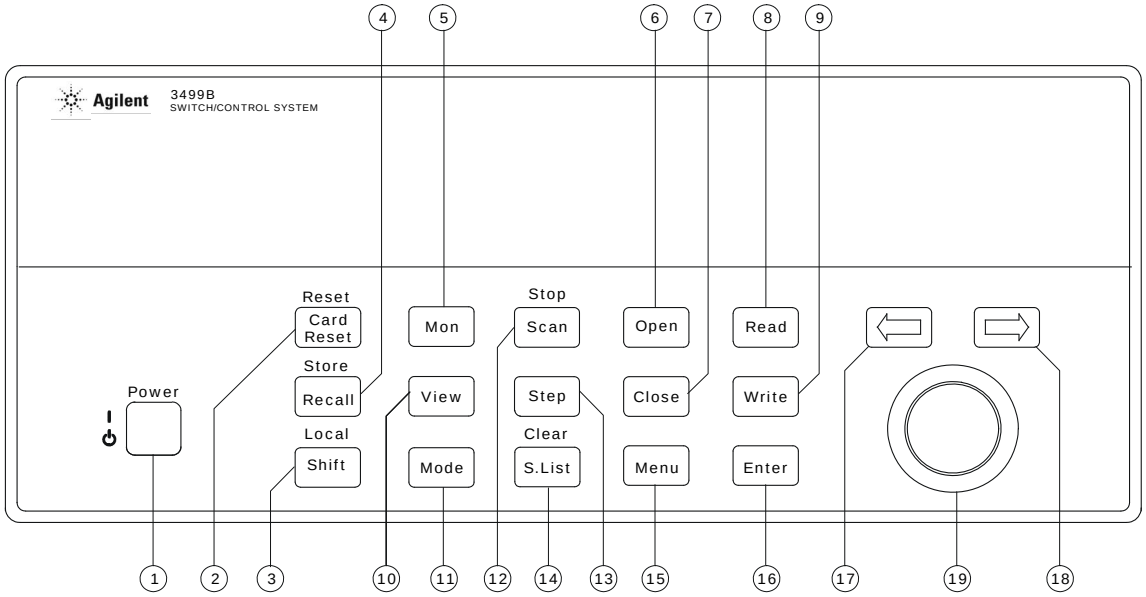
Note If no key is pressed within 5 seconds or an invalid key is pressed after the key **Shift** has been pressed, the **SHIFT** annunciator will turn off.

Note During a menu operation, if no key is pressed within 30 seconds or an invalid key is pressed, the instrument will exit the operation.

[1]. Also applicable to keys **Card Reset**, **Scan**, and **S.List**.

Front-Panel Overview

The Agilent 3499A/B/C can be operated in either SCPI mode or 3488A mode. All the operations demonstrated in this chapter apply to both modes, unless specifically indicated.



Note: 1. The keys Labelled with (10), (11), (14), and (15) guide you through menus to configure various parameters of the instrument. The details on these menus operation are demonstrated later in this chapter.

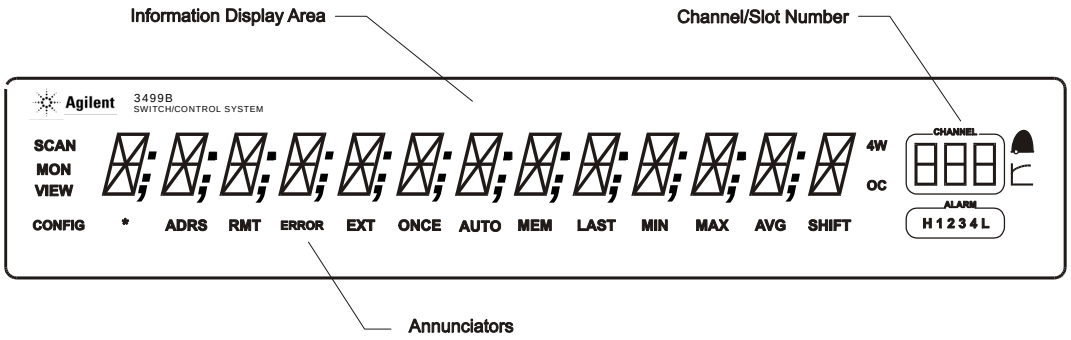
2. The keys Labelled with (2), (3), (4), (12) and (14) are double-function keys. See the next page for the rules of their operation.

---

1. Power on/standby
2. **a.** Reset a module
   b. Reset instrument
3. Shift/Local key
4. **a.** Recall instrument state
   b. Store instrument state
5. Monitor a channel/port/module
6. Open relay channel
7. Close relay channel
8. Read from DIO port
9. Write to DIO port
10. Enable View menu to:
    View errors
    View scan list
    View relay cycle counts
11. Enable Mode menu to:
    Configure MUX module
    Configure DIO module
12. **a.** Initiate scan
    b. Stop scan
13. Step through scan list
14. **a.** Enable S.List menu to:
    Create scan list
    Select arm source
    Select arm count
    Select trigger source
    Set channel delay time
    b. Clear scan list
15. Enable Menu menu to:
    Pair two modules together
    Enable/disable trigger out pulse
    Set instrument power-on state
    Configure GPIB/RS-232 interface
    Perform self-test
    Select SCPI/3488A mode
    Query firmware revision
    Query serial number
16. Confirm the selection
17. Left arrow key
18. Right arrow key
19. Knob

Figure 3-1. Agilent 3499B Front Panel

Display



As shown in above figure, the display is divided into three areas. Channel area displays the channel/port/slot number. The main display area displays the channel status (open/closed), or other information messages. Around the main display area are the annunciators, as listed in Table 3-1.

Table 3-1. Annunciators Summary

Annunciator	Indication
SCAN	Scan is initiated.
MON	Instrument is in monitor mode.
VIEW	Scan list, errors or relay cycle counts are being viewed.
CONFIG	Any configuration key has been pressed.
*****	Instrument is advancing a scan step.
ADRS	Instrument is addressed to listen or talk over the remote interface.
RMT	Instrument is in remote mode.
ERROR	Error queue is not empty.
EXT	Scan is waiting for external trigger source.
SHIFT	Shift key has been pressed.

Channel Addressing

Many of the front-panel operations require you specify one or more channels. A channel refers to an individual relay on a switching module, or an individual bit/port on a digital I/O module. The channel address is in the form of *snn*, where *s* is the Slot Number (1-5 for an Agilent 3499A, 1-2 for an Agilent 3499B, 1-9 for an Agilent 3499C and Slot 0 reserves for the 4-bit built-in digital I/O), and *nn* represents channel number on the plug-in modules (module dependent). Refer to Table 2-1 on Page 24 for more details about the channel addressing.

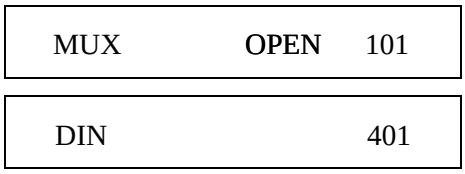
Channel/Slot Selection

The two arrow keys (<= and =>) together with the knob are used to select slots and channels. The following procedure shows you how to do that.

1. **Select a slot.** Press the two arrow keys to select a desired slot directly, or turn the knob to select the desired slot number.



2. **Select a channel**. Turn the knob to select a channel (3 digital number). As shown below, the top display indicates the current channel 101 is a MUX channel and in OPEN state, and the lower indicates that the current bit 401 is a digital input port.



Note **Open**, **Close**, **Read** and **Write** keys are invalid if a slot, instead of a channel, is selected.

To demonstrate the following operations more easily and clearly, we assume five modules have been installed in an Agilent 3499A mainframe. The configuration is:

Slot 1	Agilent N2260A MUX module
Slot 2	Agilent N2261A GP Relay module
Slot 3	Agilent N2262A Matrix module
Slot 4	Agilent N2263A Digital I/O module
Slot 5	Agilent N2260A MUX module

Local/Remote Control

When power-up, the instrument is in local mode. All keys on the front panel are fully functional. When receiving any command from the remote interface, the instrument automatically switches to remote mode (**ADRS** and **RMT** annunciators light up), all front-panel keys are locked, except the keys **Local, Mon, View, Enter,** the two arrow keys and the knob.

Local and **Shift** use the same key. While in local mode, it is used as **Shift** key. While in remote mode (the **RMT** annunciator turns on), it is used as **Local** key.

To Monitor a Channel or a Slot

In a switch/control system, it is necessary to acquire, confirm and continuously monitor the current status of a particular switching channel, a

digital I/O port, or an entire plug-in module. Agilent 3499A/B/C provides you the ability to achieve the above.

1. Press **Mon**, the **MON** annunciator lights up;
2. Select the slot or the channel/port to be monitored;
3. Press **Enter** to display the next part if necessary;
4. Press **Mon** again to exit the monitoring state, the **MON** annunciator turns off.

Table 3-2. Display on Monitoring Mode

Display	Description
1:0, , , , , ,6, , ,9, 2	The display for a multiplexer or a GP relay module. This display indicates that the monitored module is in Slot 2 and channels 10, 16, and 19 are closed.
ROW 3: ,1, ,3, , ,6,7 3 0; , ,3,COL 3, 3	The display for a matrix module. The top is the row information, indicating that the relays on Row 3, Columns 1, 3, 6 and 7 of the module (in Slot 3) are closed. The lower display is the column information, indicating that relays on column 3, row 0 and 3 are closed.
00:H255 L254. 4	The display for a digital I/O module. The first 2 digits on the left (“00” in this case) represents the “L” 8-bit port address. Adding one to this value, the “H” 8-bit port address is obtained. Data with a trailing decimal point indicates that the last operation on that port was a WRITE, data without a trailing decimal point indicates that the last operation on that port was a READ. This display shows that the data last read from Port 401 is 255 and the data last written to Port 400 is 254.
DIO 12 090 DOUT 0 091	The top display is for the built-in digital I/O Port *090* and the data from the last operation. The lower display indicates that data last written to the bit channel 091 is 0.
ROW 0: ,1, ,3, 5 00:H255 L254. 5	For a multifunction module, the first function on the module is displayed, then the next. This display is an example of a multifunction module with matrix and DIO functions.

Note The built-in digital I/O can be monitored either as individual bit channels (*091-094*) or as a 4-bit port (*090*).

Note For MUX modules and GP Relay modules, 10 channels can be displayed at one time; for matrix modules, one ROW or one Column can be displayed at one time; for digital I/O modules, two 8-bit ports can be displayed at one time. For multifunction modules, the first function on the module is displayed, then the next.

To Close or Open a Channel

To close/open a channel, you need to:

1. Select the channel to be closed or opened;
2. Press **Close/Open** to close/open the channel.

Repeat steps 1 & 2 to close or open other channels.

To Read from a Digital I/O Port

To read data from the built-in digital I/O port/bits (*090-094*), or any one of the 8-bit ports on a digital I/O, you need to:

1. Select a digital I/O port;
2. Press **Read** to read data from the selected port.

   For example, the display below shows the data read from Port 401.

DIN 255 401	Decimal format
DIN 11111111 401	Binary format

Note Data display format of individual 8-bit ports can be specified either in binary or decimal. Once specified, the format applies to all input and output operations on the same port (refer to “Mode Key Operation” on Page 40).

To Write to a Digital I/O Port

To write data to the built-in digital I/O port/bits (*090-094*), or any one of the 8-bit ports on a digital I/O, you need to:

1. Select a digital I/O port to be written to (“DIN” indicates that the last operation on the port is a READ, and “DOUT”, a WRITE);

   DIN 401

2. Press **Write**, the data from the last operation (READ or WRITE) on the selected port will be displayed and “DOUT” is displayed to indicate the port is now an output port;

   DOUT 255 401

3. Edit the value. Press the two arrow keys to select the to-be-edited bit (in dim), turn the knob to modify the value;



4. Press **Enter** to output the data to the selected port, or press **Write** again to cancel the current write operation.

To Store an Instrument State

The Controller board in Agilent 3499A/B mainframe has two types: Controller board Version 1.0 and Version 2.0. Agilent 3499C always has a Controller board of Version 2.0.

Firmware of Agilent 3499A/B/C mainframe currently has 4 revisions: REV 1.0, REV 2.0, REV 3.0 and REV 4.0. Firmware REV 1.0/2.0/3.0 runs under Controller board Version 1.0 and REV 4.0 runs under Controller board Version 2.0.

The current instrument setup can be stored for future convenience. The stored setups can be recalled directly, or included in a scan list. However, the stored instrument setup in SCPI mode is different from that in 3488A mode. Table 3-3 lists these differences.

Table 3-3. The Differences Between Two Modes

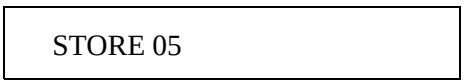
SCPI Mode	3488A Mode
Stored information: 1. Status of relay channels (open/close); 2. Status of digital I/O ports (input/output) on digital I/O modules in either static Mode #1 or Mode #2; 3. Module configurations: card pair, 1/2/4-wire function mode, baud rate, flow control, etc.; 4. Scanning setups: scan list, arm count, arm source, etc.	Stored information: 1. Status of relay channels (open/close); 2. Status of digital I/O ports (input/output) on digital I/O modules in either static mode1 or mode2.
For Firmware REV 4.0: Up to 50 instrument setups can be stored (numbered 1-50); For Firmware REV 1.0/2.0/3.0: Up to 10 instrument setups can be stored (numbered 1-10).	Up to 40 instrument states can be stored (numbered 1-40).

To store a instrument setup:

1. Press **Shift** + **Recall,** the display would be:



2. Turn the knob to change the memory location number (i.e. 05);



3. Press **Enter** to store the current instrument setup (to location 5).

Note An instrument reset does not affect the stored instrument setup information. Once a setup is stored, it remains until overwritten or specially deleted with a SCPI command SYSTem:STATe:DELete.

Note All the stored instrument setups will be cleared automatically whenever the system mode is changed.

To Recall an Instrument State

A previously stored instrument setup can be recalled. Before recalling a stored setup, the instrument verifies that all module type and slot assignment match the setup. If a mismatch is detected, the recall operation will stop and a string “RECALL FAILED” will be returned (no error occurs).

To recall an instrument setup:

1. Press **Recall,** turn the knob to a previously stored setup (i.e. 05);

   RECALL 05

2. Press **Enter** to recall the setup (i.e. 05); press **Recall** again to cancel the current recall operation.

View Key Operation

The instrument can store up to 10 errors[1] in the error queue, up to 200 channels in the scan list, as well as the relay cycle counts on the newer plug-in modules. The **View** key provides you an intuitive way to query these information. Table 3-4 lists the **View** key structure.

Table 3-4. View Key Structure

1st level Items	Description
ERROR	Query the errors recorded in the error queue.
SCAN LIST	Query the channels included in the scan list.
RELAY CYCLES	Query the relay cycle counts on some modules.

To View an Error

To view an error:

1. Press **View** (the **VIEW** annunciator turns on), turn the knob to “ERROR”, then press **Enter**;
2. If no error is in the error queue (the **ERROR** annunciator is off), the instrument displays “NO ERROR”, and then returns to the first level

[1]. In 3488A mode, only the sum of the values of the possible error conditions, as defined in Table 6-20 on Page 128, is recorded in the error queue and shown on the front panel.

of the View menu automatically.

NO ERROR	108

If there are errors (the **ERROR** annunciator is on), the first error in the error queue is displayed. Press the arrow key to scroll the display to show the whole error message;

01:ERR -109

MISSING PARAMETER

3. Turn the knob to view other errors in the error queue, or press **Enter** to return to the first level of the View menu, the **ERROR** annunciator turns off;
4. Press **View** again to exit the View menu operation, the **VIEW** annunciator turns off.

Note All errors are cleared once the error queue is viewed, and the **ERROR** annunciator turns off. Refer to Appendix B starting from Page 122 for details about the instrument errors.

To View a Scan List

To view the channels included in a scan list (assuming channels 103-107 are included in the scan list):

1. Press **View** (**VIEW** annunciator lights up). Turn the knob until "SCAN LIST" is displayed, then press **Enter**;

SCAN LIST	101

2. The first channel in the scan list is displayed on the channel area. Continuously turn the knob to view other channels in the scan list;

001 OF 005	103

3. Press **Enter** to return to the first level of the View menu;

SCAN LIST	107

4. Press **View** again to end this operation, the **VIEW** annunciator turns off.

To View the Relay Cycles

To view the relay cycle counts:

1. Press **View**, the **VIEW** annunciator lights up. Turn the knob until "RELAY CYCLES" is displayed, then press **Enter**;



2. If no module with the relay cycle count feature[1] is present, "N/A" will be displayed, then the display automatically returns to the first level of the View menu;



   If the selected channel is a relay without the cycle counts feature, the instrument will display the cycle counts of the first relay with the feature;



   If the selected channel (i.e. 109) is a relay with the cycle counts feature, the cycle counts of the relay will be displayed;



3. Turn the knob to read other relays cycle counts, or press **Enter** to return to the first level of the View menu;



4. Press **View** again to exit the View menu operation, the **VIEW** annunciator turns off.

Mode Key Operation

A digital I/O and the digital I/O ports can be configured from the instrument front panel. In SCPI mode, Agilent N2260A can be configured as different MUX modules. The Mode key is designed for these configurations.

- Agilent N2260A can be configured in SCPI mode. Table 3-5 shows the **Mode** key structure in this case.

[1]. Relay cycle count feature is supported by the switching relays on the Agilent N2260A/61A/62A/64A/65A modules.

Table 3-5. Agilent N2260A Configuration (Mode)

1st level Items	2nd Level Items	Description
CONFIG MUX	**WIRE1** **WIRE2** **WIRE4** **DUAL WIRE2**	Configure Agilent N2260A Multiplexer module to work as: 80-channel 1-wire, 40-channel 2-wire, 20-channel 4-wire, or two independent groups of 20-channel 2-wire module.

- The digital I/O modules can be configured in either SCPI mode or 3488A mode. Table 3-6 on Page 41 shows the **Mode** key structure.

Note The 4-bit built-in digital I/O in Slot 0 cannot be configured.

- The **Mode** key shows a completely different structure (Table 3-7) when it is used to configure a digital I/O port.

Table 3-6. Digital I/O Configuration (Mode)

1st level Items	2nd Level Items	3rd Level Items	4th Level Items	5th Level Items	Description
CONFIG DIO	**MODE 1** **MODE 2** **MODE 3** **MODE 4** **MODE 5**	**CONT POL POS** **CONT POL NEG**	**FLAG POL POS** **FLAG POL NEG**	**I/O POL POS** **I/O POL NEG**	Configure DIO module, including the handshake mode, the control line and flag line polarities, and the polarity of the I/O direction line.

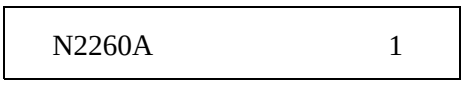
Table 3-7. Digital I/O Port Configuration (Mode)

1st Level Items	2nd Level Items	Description
DATA POLARITY	**POS POLARITY** **NEG POLARITY**	Set the polarity of the data lines for the port.
DISP FORMAT	**DECIMAL** **BINARY**	Set data display format for the port.

Agilent N2260A Configuration

To configure an Agilent N2260A MUX module:

1. Select a slot in which an Agilent N2260A module is installed;



2. Press **Mode**, the **CONFIG** annunciator lights up and “CONFIG MUX” is displayed;



3. Press **Enter**, turn the knob to select one mode (i.e. WIRE1);



4. Press **Enter** to return to "CONFIG MUX", press **Mode** again to exit the configuration, the **CONFIG** annunciator turns off accordingly.

DIO Module Configuration

A digital I/O module can be configured, which include the flow control mode, the control line polarity, the flag line polarity, and the I/O direction line polarity.

To configure a digital I/O module:

1. Select a slot in which a digital I/O is installed;



2. Press **Mode**, the **CONFIG** annunciator lights up and "CONFIG DIO" is displayed, then press **Enter**;



3. Turn the knob to select the flow control mode (i.e. MODE 2), then press **Enter**;



4. Turn the knob to select the control line polarity (i.e. CONT POL POS), then press **Enter**;



5. Turn the knob to select the flag line polarity (i.e. FLAG POL POS), then press **Enter**;



6. Turn the knob to select the I/O line polarity (i.e. I/O POL POS), then press **Enter**;



7. The instrument returns to “CONFIG DIO”, press **Mode** again to exit the configuration, the **CONFIG** annunciator turns off accordingly.

DIO Port Configuration

To configure the data line polarity and data display format for an individual digital I/O port:

1. Select a digital I/O port (i.e. Port 401), press **Mode** (the **CONFIG** annunciator lights up). Turn the knob to select one item (i.e. DATA POLARITY);

DATA POLARITY	401

2. Press **Enter**, turn the knob to select the polarity (i.e. NEG POLARITY);

NEG POLARITY	401

3. If another item “DISP FORMAT” is selected, press **Enter**, then turn the knob to select the data display format (i.e. BINARY);

BINARY	401

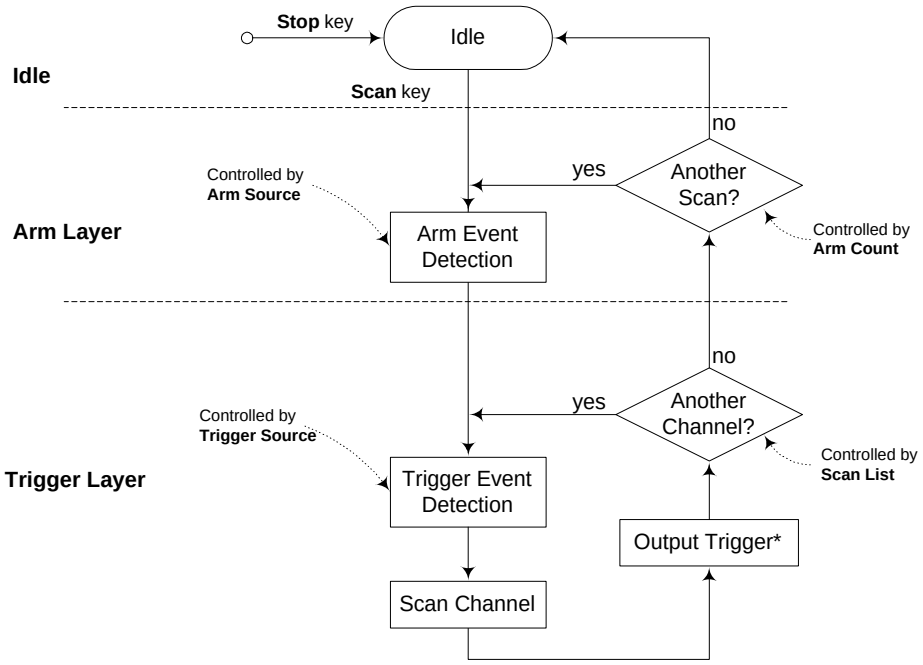
4. Press **Enter** to select the data display format and return to “DISP FORMAT”, press **Mode** again to exit the configuration, the **CONFIG** annunciator turns off accordingly.

To configure other digital I/O ports, repeat Steps 1 through 4.

Note Once you have selected the data display format for a port, it applies to all input and output operations on that port.

Scanning Operation

The scan operation in SCPI mode is different from that in 3488A mode. In 3488A mode, you only need to create a scan list, then step through the scan list by repeatedly pressing **Step**. However, scanning in SCPI mode has more features (refer to Figure 3-2).



* Note: The trigger out pulse will occur at the specified trig-out line only if you have configured to enable the slot to output.

Figure 3-2. The Process of Scanning Operation (in SCPI mode)

Overview

Before initiating a scan, a scan list must be set up. You can also specify an arm source, a trigger source, and the number of sweeps (a sweep is one pass through the scan list) to control the scan process. All these can be done from the **S.List** key. The **S.List** key structure in SCPI mode (Table 3-8) is different from that in 3488A mode (Table 3-9 on Page 45).

Table 3-8. S.List Key Structure in SCPI Mode

1st Level Items	2nd Level Items	3rd Level Items	4th Level Items	Description
ADD TO SCAN	**SELECT** nnn			Create a scan list to include all the desired switch channels, DIO bit channels, and/or the previously stored setups.
CONFIG SCAN	**ARM: TIMER** **ARM: IMM** **ARM: BUS** **ARM: EXT** **ARM: MIX** **ARM: HOLD**	**COUNT:** 00001	**TRIG: TIMER** **TRIG: IMM** **TRIG: BUS** **TRIG: EXT** **TRIG: MIX** **TRIG: HOLD**	Configure the scan operation, such as an arm source, an arm count, and a trigger source.
DELAY TIME	**SET ALL**	nnnnn.nnn **SECS**		Set delay time for all channels or for individual channels.
	SET CH	**SELECT** nnn	nnnnn.nnn **SECS**	

Table 3-9. S.List Key Structure in 3488A Mode

1st Level Items	2nd Level Items	Description
ADD TO SCAN	**SELECT** nnn	Create a scan list to include all the desired switch channels, DIO bit channels, and/or the previously stored setups.
DELAY TIME	nnnnn.nnn **SECS**	Set a delay time for all scanned channels.

To Create a Scan List

To create a scan list, you can:

1. Press **S.List,** the **CONFIG** annunciator lights up, and "ADD TO SCAN" is displayed;

   ADD TO SCAN 101

2. Press **Enter**, then turn the knob to select a previously stored channel setup (i.e. 001). Press **Enter** to add it into the scan list;

   SELECT * 001

3. To add other switch channels, digital I/O bits, and/or other stored channel setups, repeat Step 2;

4. Press **S.List** again to return to "ADD TO SCAN", press **S.List** once more to exit this operation, the **CONFIG** annunciator turns off accordingly.

Note To view a scan list, press **View**. To clear a scan list, press **Shift** + **S.List**.

To Configure a Scan

The Arm Source, Arm Count and the Trigger Source can be set to configure a scan:

1. Press **S.List**, the **CONFIG** annunciator lights up. Turn the knob until "CONFIG SCAN" is displayed, then press **Enter**;

   CONFIG SCAN

2. Turn the knob to set the arm source, then press **Enter**;

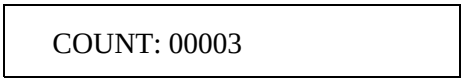
   ARM: BUS

   If "ARM:TIMER" is specified, the instrument will guide you to set the time interval (default is 0) after pressing **Enter**. Use the two arrow keys and the knob to edit or modify the value. Press **Enter** to set this

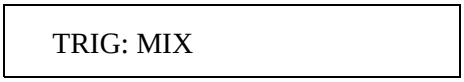
value (ranging from 0 to 99999.999 seconds);



3. Use the arrow keys and the knob to set the arm source, press **Enter**;



4. Turn the knob to set the trigger source, then press **Enter** to return to "CONFIG TO SCAN";



   If "TRIG:TIMER" is specified, the instrument will guide you to set the time interval (default is 0) after pressing **Enter**. Use the two arrow keys and the knob to edit or modify the value. Press **Enter** to set this value (ranging from 0 to 99999.999 seconds) and return to "CONFIG TO SCAN";



5. Press **S.List** again to exit this operation, the **CONFIG** annunciator turns off accordingly.

To Set a Delay Time

1. Press **S.List**, the **CONFIG** annunciator lights up. Turn the knob until "DELAY TIME" is displayed, press **Enter**;



2. To set a uniform delay time for all channels, select "SET ALL", then press **Enter**. Use the arrow keys and the knob to modify the value (between 0 and 99999.999 seconds). Press **Enter** to set the delay time and return to "DELAY TIME";







3. To set a different delay time for individual channel, select "SET CH", then press **Enter**. Turn the knob to select the channel to be set (i.e. 103), then press **Enter** again and use the arrow keys and the knob to

set its delay time (between 0 and 99999.999 seconds). Press **Enter** once more to set the delay time and return to “SET CH” item;

SET CH	107
SELECT CH	103
00000.005 SECS	103
SELECT CH	103
DELAY TIME	103

4. To set a delay time for other channel, repeat the procedure above. Press **S.List** again to return to “DELAY TIME”;
5. Press **S.List** once more to exit this operation, the **CONFIG** annunciator turns off accordingly.

To Start a Scan

To start a scan[1]:

1. Press **Scan**, the **SCAN** annunciator lights up;
2. Then the instrument will continue scanning according to the configuration. The arm source is used to control the onset of each scan sweep. The trigger source is used to advance one channel in the scan list (open the previous channel and close the next channel in the list, the ***** annunciator lights up);
3. When the scanning is finished, the instrument returns to the idle state and the **SCAN** annunciator turns off. To stop the scanning in progress press **Shift + Scan**.

Note Once a scan list exists, simply press **Step** repeatedly to step through the scan list. In this case, the **SCAN** and the ***** annunciators turn off.

Note Card Pair is functional during a scan, which means that both the channels included in the scan list and the paired channels will be scanned.

[1]. The scan cannot be performed and “CANNOT INIT” will be displayed if any of the following conditions occurs:
a. The scan list contains a non-existing channel, such as N2260A module changes from WIRE1 to WIRE2.
b. The scan list contains a channel on a digital I/O module that does not work in Mode #1 or Mode #2.
c. A stored channel setup in the scan list does not match the current hardware configuration.

Menu Key Operation

Configuring system-related instrument parameters can be done from the **Menu** key. However, the **Menu** key structure in 3488A mode (Table 3-10) is different from that in SCPI mode (Table 3-11 on Page 49). Since SCPI mode can do whatever 3488A mode can, only the **Menu** key operation in SCPI mode will be demonstrated.

Table 3-10. Menu Key Structure in 3488A Mode

1st Level Items	2nd Level Items	3rd Level Items	4th Level Items	Description
CARD PAIR	**FIRST SLOT** 1	**SECOND SLOT** -		Pair the same (type) cards.
CONF EXT TRIG	**TRIG OF SLOT** 0	**ENABLE** **DISABLE**		Select a pair of external trigger lines and enable/disable the Agilent 3499 to output a trigger pulse.
INTERFACE	**GPIB/488**	**ADDRESS** 09	**SRQ ON** **SRQ OFF**	Set GPIB address (0-30) and enable/disable Power-on SRQ.
SELFTEST				Perform a selftest.
SYSTEM MODE	**SCPI MODE**			Select a system mode for the instrument.[1]
	3488A MODE			
REVISION INFO				Query the current firmware revision.
SERIAL NO				Query Agilent 3499A/B/C serial number.

[1].For Firmware REV 3.0, the two system modes can not be switched to each other since they are realized in two independent firmwares: SCPI mode Firmware REV 3.0 and 3488A mode Firmware REV 3.0.

Table 3-11. Menu Key Structure in SCPI Mode

1st Level Items	2nd Level Items	3rd level Items	4th level Items	Description
CARD PAIR	**FIRST SLOT** 1	**SECOND SLOT** -		Select the cards to be paired together.
CONF EXT TRIG	**TRIG SLOT** 0	**ENABLE** **DISABLE**		Select a pair of external trigger lines and enable/disable Agilent 3499 to output a trigger pulse.
POWER ON SET[1]	**PWR ON RESET**			Set instrument power-on to the reset state or a state stored in memory location nn.
	USER SET UP	**POWER ON** nn		
INTERFACE	**GPIB/488**	**ADDRESS** 09	**SRQ ON** **SRQ OFF**	Select GPIB interface, then set its address (0-30) and enable/disable Power-on SRQ.
	RS-232	**2400 BAUD; 4800 BAUD; 9600 BAUD; 19200 BAUD; 38400 BAUD; 57600 BAUD**		Select RS-232 interface and configure its baud rate, data bits, parity, and flow control mode. The defaults are 9600 BAUD, NONE, 8 BITS, and FLOW NONE.
		ODD, 7 BITS; EVEN, 7 BITS; NONE, 8 BITS		
		FLOW NONE; FLOW XON/XOFF; FLOW DTR/DSR; FLOW RTS/CTS		
SELFTEST				Perform a selftest.
SYSTEM MODE	**SCPI MODE**			Select a system mode for operation.[2]
	3488A MODE			
REVISION INFO				Query the current firmware revision.
SERIAL NO				Query Agilent 3499A/B/C serial number.

[1].This menu item is only effective in Agilent 3499A/B/C with Firmware REV 4.0 or later.

[2].For Firmware REV 3.0, the two system modes can not be switched to each other since they are realized in two independent firmwares: SCPI mode Firmware REV 3.0 and 3488A mode Firmware REV 3.0.

The following operations can be done with the **Menu** key in SCPI mode:

- To pair two cards;
- To configure the external trigger;
- To configure the power-on state;
- To configure the remote interface;
- To perform a self-test;
- To select a system mode;
- To query the firmware revision;
- To query the serial number.

Note In 3488A mode, the Agilent 3499A/B/C does not support configuring RS-232 interface and the instrument power-on state.

To Pair Two Cards

Two same type plug-in modules (cards) can be paired. Once paired, any operation on a channel of one module will be duplicated on the corresponding channel of the paired module. To pair two same type cards:

1. Press **Menu**, the **CONFIG** annunciator lights up. Turn the knob to select “CARD PAIR”, press **Enter**;

   CARD PAIR

2. When “FIRST SLOT 1” is displayed, turn the knob to select the first paired slot (i.e. Slot 1), then press **Enter**[1];

   FIRST SLOT 1

3. When “SECOND SLOT -” is displayed, turn the knob to select the second slot (i.e. 5) to be paired with the first;

   SECOND SLOT 5

4. Press **Enter** to return to “CARD PAIR”, press **Menu** again to exit this operation, the **CONFIG** annunciator turns off accordingly.

To Configure the External Trigger

Agilent 3499A/B/C provides two pairs of trigger lines for externally-controlled scanning. The first pair (TRIG IN & TRIG OUT) is on the rear panel of the mainframes, the second pair of EI (External Increment) & CC (Channel Closed) is on the Agilent 44474A. You can use only one pair of the trigger lines each time, and specify whether a trigger out pulse can be sent out when a relay is closed during a scan.

To configure the external trigger:

1. Press **Menu**, the **CONFIG** annunciator lights up. Turn the knob to select “CONF EXT TRIG”, then press **Enter**;

   CONF EXT TRIG

2. Select either Slot 0 (Agilent 3499A/B/C) or the slot in which an Agilent 44474A is installed, then press **Enter**;

   TRIG SLOT 0

[1]. In case there are no matching cards installed in the mainframe, the display will show “NO MATCH”, then automatically returns to the first level of the Menu menu.

3. To enable a trigger pulse output from the selected line, turn the knob to select “ENABLE”; or select “DISABLE”;



4. Press **Enter**, the instrument returns to “CONF EXT TRIG”. Press **Menu** again to exit this operation, the **CONFIG** annunciator turns off accordingly.

Note

In SCPI mode, once a new pair of control lines is selected, the newly selected trigger-in line is immediately ready to accept the trigger signal from an external instrument. However, in 3488A mode, only after the newly selected pair is enabled, will the previously enabled pair be disabled. Otherwise, the previously enabled pair is still in effect.

To Configure the Power-on State[1]

The power-on state of the Agilent 3499A/B/C with Firmware REV 4.0 or later can be set to the reset state, or to a stored state. The instrument will return to the specified state the next time it is turned on. To configure the power-on state:

1. Press **Menu**, the **CONFIG** annunciator lights up. Turn the knob to select “POWER ON SET”, then press **Enter**;



2. To set the instrument power-on to reset state, turn the knob to select “PWR ON RESET”, then press **Enter**, the instrument will return to “POWER ON SET”;



To set the instrument power-on to a stored state, turn the knob to select “USER SET UP”, then press **Enter**[2]. Turn the knob to specify a memory location (i.e. 05), press **Enter** again to return to “POWER ON SET”;





[1]. This section is only intended for 3499A/B/C with Firmware REV 4.0 or later.

[2]. “NO DATA” will be displayed if no state had ever been stored, then the instrument automatically returns to the first level of the Menu menu.

3. Press **Menu** again to exit this operation, the **CONFIG** annunciator turns off accordingly.

Note Please note that the content in this section is only effective for Agilent 3499A/B/C mainframe with Firmware REV 4.0 or later. for Agilent 3499A/B with Firmware REV1.0/2.0/3.0, please ignore this section.

Note If the power-on state of the instrument is set to a previously stored setup that is no longer valid, the power-on state will automatically set to the reset state, in this case the instrument displays “RECALL FAILED”.

To Configure the Remote Interface

The instrument can communicate with a computer over GPIB or RS-232 interface. Perform the following procedure to configure the interface.

Note Only one interface can be used at a time. When shipped from the factory, the GPIB interface is selected and its address is set to "9".

Note RS-232 interface can be configured and used only in SCPI mode.

GPIB Interface

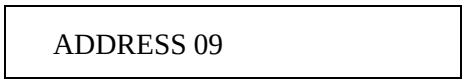
1. Press **Menu**, the **CONFIG** annunciator lights up. Turn the knob to select "INTERFACE", then press **Enter**;



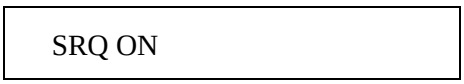
2. Turn the knob to select "GPIB/488", then press **Enter**;



3. Turn the knob to set a valid GPIB address (0-30), then press **Enter**;



4. When "SRQ ON" is displayed, press **Enter**, the Agilent 3499A/B/C will interrupt the system computer when powered up. To disable this feature, select "SRQ OFF", then press **Enter**;



5. The instrument returns to "INTERFACE", press **Menu** again to exit this operation, the **CONFIG** annunciator turns off.

RS-232 Interface

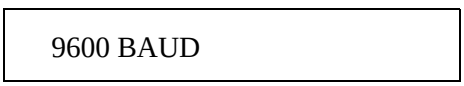
1. Press **Menu**, the **CONFIG** annunciator lights up. Turn the knob to select "INTERFACE", then press **Enter**;



2. Turn the knob to select "RS-232", then press **Enter**;



3. Turn the knob to select the baud rate (default: 9600), then press **Enter**;



4. Turn the knob to select the parity and data bits (default: NONE, 8 BITS), then press **Enter**;



5. Turn the knob to select the mode (default: FLOW NONE), then press **Enter** to return to “INTERFACE”;



6. Press **Menu** again to exit this operation, the **CONFIG** annunciator turns off accordingly.

To Perform a Self-test

The self-test feature of the instrument can be used to verify proper instrument operation. To perform a self-test:

1. Press **Menu**, the **CONFIG** annunciator lights up. Turn the knob to select “SELFTEST”, then press **Enter**;



2. If all the tests have passed, “PASSED” will be displayed. Otherwise, the reason of the failure will be displayed;



Note For more about the self-test errors, refer to Appendix B starting from Page 122.

3. Press **Enter** to return to “SELFTEST”, press **Menu** again to exit this operation, the **CONFIG** annunciator turns off accordingly.

To Select a System Mode

The instrument can be operated in either SCPI mode or 3488A mode. To select a system mode[1]:

1. Press **Menu**, the **CONFIG** annunciator lights up. Turn the knob to select “SYSTEM MODE”, then press **Enter**;



[1]. For an instrument with Firmware REV 3.0, the two system modes (SCPI and 3488A) can not be switched to each other.

2. Turn the knob to select the system mode, press **Enter**;



3. The instrument will be reset if the system mode has been switched; or it will display “SYSTEM MODE”. In later case, press **Menu** again to exit this operation.

To Query the Firmware Revision

To query the Agilent 3499A/B/C firmware revision:

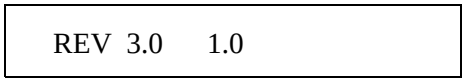
1. Press **Menu**, the **CONFIG** annunciator lights up. Turn the knob to select “REVISION INFO”, then press **Enter**;

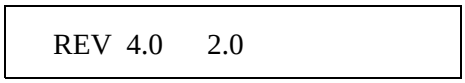


2. The system firmware revision number will be displayed as one of the four formats in the following. Please note that for Firmware REV 3.0/4.0, the displayed Firmware Revision information also indicates the Controller board version: for “REV 3.0 1.0”, ‘1.0’ indicates the Controller board is 1.0; for “REV 4.0 2.0”, ‘2.0’ indicates the Controller board is 2.0. Firmware REV 1.0/2.0 always runs under Controller board 1.0.









3. Press **Enter** to return to “REVISION INFO”, press **Menu** again to exit this operation, the **CONFIG** annunciator turns off accordingly.

To Query the Serial Number

To query the Agilent 3499A/B/C serial number:

1. Press **Menu**, the **CONFIG** annunciator lights up. Turn the knob to select “SERIAL NO”;

   SERIAL NO

2. Press **Enter**, Agilent 3499A/B/C serial number is displayed;

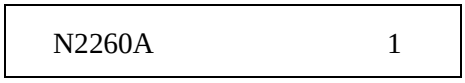
   CN12345678

3. Press **Enter** to return to “SERIAL NO”, press **Menu** again to exit this operation, the **CONFIG** annunciator turns off accordingly.

To Reset a Module

To reset a plug-in module:

1. Turn the knob to select the slot to be reset;



2. Hold down **Card Reset** until the display changes from “HOLD TO RESET” to “RESET CARD”, then release the key to end this operation.







Note **Card Reset** will open all channels on the switching module and make all ports on the specific digital I/O module as input ports.

To Reset the Instrument

To reset the instrument:

1. Press **Shift,** then hold down **Card Reset**, the display would be:



2. Hold the key until the display message changes, then release the key;



3. When the instrument finishes resetting, the default display appears.



Note The instrument will also be reset if any plug-in module is installed or removed while the instrument is on.

Chapter 4
Verification Tests

About This Chapter

This Chapter contains procedures for operating verification of the Agilent 3499A/B/C mainframes and the plug-in modules. This Chapter contains the following sections:

- General Information . . . . . Page 59
- Mainframe Self-Test . . . . . Page 60
- Mainframe Verification Tests . . . . . Page 61
- Relay Cycle Count . . . . . Page 62
- MUX Modules Verification Tests . . . . . Page 62
- GP Relay Modules Verification Tests . . . . . Page 64
- Matrix Modules Verification Tests . . . . . Page 65
- Digital I/O Modules Verification Tests . . . . . Page 67
- Agilent 44472A Verification Tests . . . . . Page 70
- Agilent 44476A/B Verification Tests . . . . . Page 70
- Agilent N2276A/B Verification Tests . . . . . Page 72
- Agilent 44477A Verification Tests . . . . . Page 72
- Agilent 44478A/B Verification Tests . . . . . Page 74
- Agilent N2280A/81A/82A Verification Tests . . . . . Page 76

General Information

The Operation Verification Tests should be performed whenever it is desired to determine whether the Agilent 3499A/B/C and its plug-in modules are actually operating. For example, these tests can be used as an “incoming inspection procedure” when an Agilent 3499A/B/C Switch/Control System is initially received, or they can be used to verify a suspected failure after the system has been installed into a test system. Additionally, after a failure has been detected and repaired, these tests can be used to confirm that the repairs have accomplished their purpose.

A “test fixture” is required for several plug-in modules to simplify testing and act as an interface between the module and a multimeter. A test fixture can be made for a plug-in module by configuring a removable wiring (screw) terminal block.

The following instruments can be used to perform the Verification Tests:

- Agilent 34401A Digital Multimeter, or equivalent;
- Test Fixture (configured from the related wiring terminal block);
- PC (IBM compatible, with the RS-232 default);
- GPIB Interface.

WARNING **Hazardous voltages may exist on the wiring and connectors of the Agilent 3499A/B/C plug-in modules. Only service trained personnel should make repairs to the Agilent 3499A/B/C mainframes and/or the plug-in modules.**

WARNING **Make sure to disconnect all the wiring from the Agilent 3499A/B/C plug-in modules to the external devices in order to execute the Verification Tests. This presents two potential safety hazardous:**

a: It is possible for the user to come in contact with high voltage (if high voltage exists in the test system).

b: Equipment damage may occur if the wrong lines become accidentally connected or disconnected.

Caution **Use anti-static handling techniques during the Verification Tests.**

Mainframes Self-Test

The Agilent 3499A/B/C mainframe's self-test verifies the operation of the front panel circuitry, and a part of the micro-processor related circuitry (ROM, etc.) on the Controller board. In addition, GPIB & RS-232 circuitry on the Controller board can also be verified with self-test.

The self-test does not, however, assess the operability of the backplane or the drivers contained in the mainframe. The operability of the backplane or the drivers will not be tested until the individual plug-in modules tests are performed.

It is important to remember that if the self-test passes, it does not, in itself, ensure proper instrument operation. A self-test failure, however, does indicate an instrument malfunction.

Self-Test

To perform a self-test: Press **Menu**, turn the knob to "SELFTEST", then press **Enter**. The self-test should start by turning on all display segments. Following the display test, the internal tests are performed. If all internal tests pass, "PASSED" will be displayed. Otherwise, the reason of the failure will be displayed (see the Table below).

Table 4-1.

Error Number	Description
+1	ROM test failed.
+2	GPIB test failed.

Table 4-1.

Error Number	Description
+3	RS-232 test failed.
+4	Front-panel test failed.

Correction

If, during the display test, a segment or segments malfunctioned, a problem exists on the Controller board or the Display assembly. Refer to “Agilent 3499A/B/C Problem Isolation” on Page 80 for problem isolation information.

If the front-panel test failed, a problem exists on the front panel circuitry; if any of the other internal tests failed, the Controller board is malfunctioned. To replace or repair the front panel circuitry and /or the Controller board, the mainframe must be disassembled. Refer to “Replaceable Parts” on Page 85 for Agilent 3499A/B/C mainframes disassembly information.

Mainframe Verification Tests

The mainframe self-test does not assess the operability of the driver circuitry and the connectivity, more operation verification tests are required. These include the GPIB test, the RS-232 test and the keyboard test.

GPIB Test

To test the GPIB on an Agilent 3499A/B/C mainframe:

1. Make sure the GPIB interface card and the Agilent I/O Library is installed in your PC, and the Agilent 3499A/B/C interface is set to GPIB;
2. Make sure one or more plug-in modules are installed (i.e. Agilent N2260A, etc.);
3. Make sure the GPIB address is correct and the GPIB cable is operational;
4. Connect the GPIB interface from your PC to an Agilent 3499A/B/C;
5. Set the Agilent 3499A/B/C to SCPI mode. Send a SCPI command DIAG:DISP “GPIB test” from you PC.

If “GPIB TEST” is displayed on the front panel of the Agilent 3499A/B/C, the GPIB test passed. Otherwise, the GPIB test failed.

RS-232 Test

To test the RS-232 on an Agilent 3499A/B/C:

1. Make sure one or more plug-in modules are installed (i.e. Agilent N2260A, etc.);
2. Set the Agilent 3499A/B/C to SCPI mode and the Agilent 3499A/B/C interface is set to RS-232;
3. Connect the RS-232 cable from your PC to an Agilent 3499A/B/C;
4. Send a SCPI command DIAG:DISP “RS232 test” from you PC.

If “RS232 TEST” is displayed on the front panel of the Agilent 3499A/B/C, the RS-232 test passed. Otherwise, the RS-232 test failed.

Keyboard Test

All the keys on the front panel of an Agilent 3499A/B/C can be tested easily by pressing the keys. If one or more keys has no response, a problem exists in either the Keyboard Assembly, or the Controller board. Refer to “Agilent 3499A/B/C Problem Isolation” on Page 80 for problem isolation information.

Correction

If GPIB test and/or RS-232 test failed, the Controller board malfunctioned. To replace or repair the Controller board, it is necessary to disassemble the Agilent 3499A/B/C mainframe. Refer to “Replaceable Parts” on Page 85 for the mainframes disassembly information.

Relay Cycle Count

For the plug-in modules Agilent N2260A, N2261A, N2262A, N2266A, N2267A, N2268A, N2270A, N2272A, N2276A/B (except attenuators), N2280A/81A/82A, and the switching function on the multifunction modules Agilent N2264A/65A, the relay cycle count can be queried from the front panel (refer to “Front-Panel Operation” on Page 31 for the operation).

It is recommended that the switching module can be replaced with a new one, if the relay cycles of the switching relay(s) on this module exceed the relay life. Refer to “Specifications” on Page 1 for more information.

MUX Modules Verification Tests

The following MUX modules can be tested in a similar way:

- Agilent N2260A 40-channel MUX module;
- Agilent 44470A 10-channel MUX module;
- Agilent 44470D 20-channel MUX module;
- Agilent N2266A 40-channel MUX module;
- Agilent N2268A 50W 3.0 GHz Dual 1-to-4 MUX module;
- Agilent N2270A 10-channel High Voltage MUX module;
- Agilent N2272A 1
- GHz RF 1-to-9 MUX module.

Test Fixture

In order to perform the Operation Verification Tests for a MUX module, a test fixture is required and it can be constructed by configuring the related

MUX module's removable wiring terminal block as shown in Figure 4-1.

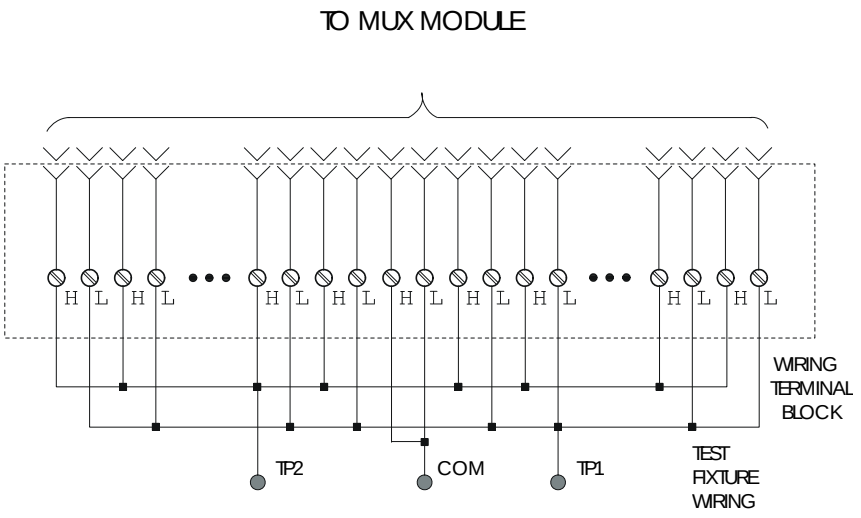


Figure 4-1. MUX Modules Test Fixture

The fixture contains:

- A short circuit between all of the low (L) lines (TP1);
- A short circuit between all of the high (H) lines (TP2);
- A short circuit between the shorted common lines (COM).

With the test fixture installed, and a Multimeter (i.e. an Agilent 34401A) connected between the shorted common lines (COM) and either the shorted low lines (TP1) or the shorted high lines (TP2), the MUX module is tested by successively closing each relay while checking for an indication of the closure on the Multimeter.

Tests Procedure

To perform the Operation Verification Tests:

1. Remove the wiring terminal block from the MUX module;
2. Install the related test fixture onto the MUX module;
3. Set the Multimeter to measure resistance. "Zero" the Multimeter;
4. Press **Mon** and specify the slot occupied by the MUX module;
5. Press **S.LIST** and specify all channels on the MUX to be scanned;
6. Connect the Multimeter between COM & TP1 (or COM & TP2) on the test fixture (Figure 4-1 on Page 63);
7. Press **Card Reset** to reset the MUX module, the Multimeter should indicate that all relays are open (very high resistance or overload indication);

Note If the Multimeter is indicating a very low resistance, one or more of the relays is remaining closed. You need to do more tests to isolate the clumsy damaged relay(s).

8. Successively press **Step** while observing the displays on the Agilent

3499A/B/C and the Multimeter. The Agilent 3499A/B/C's display should show a number corresponding to the closed relay. The clumsy damaged relay(s) can be isolated in this way.

Correction

If during Step 8, one or more relays did not close as described, a problem exists either in the Controller board or the related MUX module. Replace this MUX with another same one and perform the tests as described above to isolate the problem.

If during step 8, the appropriate relays closed, but one or more of the resistances were higher than 1Ω, the corresponding relay(s) are defective.

If a MUX module is defective, replace it with a new one (the relays are not replaceable parts, refer to Chapter 6 on Page 85 for more information).

GP Relay Modules Verification Tests

The GP Relay modules available with an Agilent 3499A/B/C include:

- Agilent N2261A 40-channel GP Relay module;
- Agilent 44471A 10-channel GP Relay module;
- Agilent 44471D 20-channel GP Relay module;
- Agilent N2264A Multifunction (GP function);
- Agilent N2267A 8-channel High Current GP module.

Test Fixture

The test fixture can be constructed by configuring the related GP Relay module's removable wiring terminal block as shown in Figure 4-2.

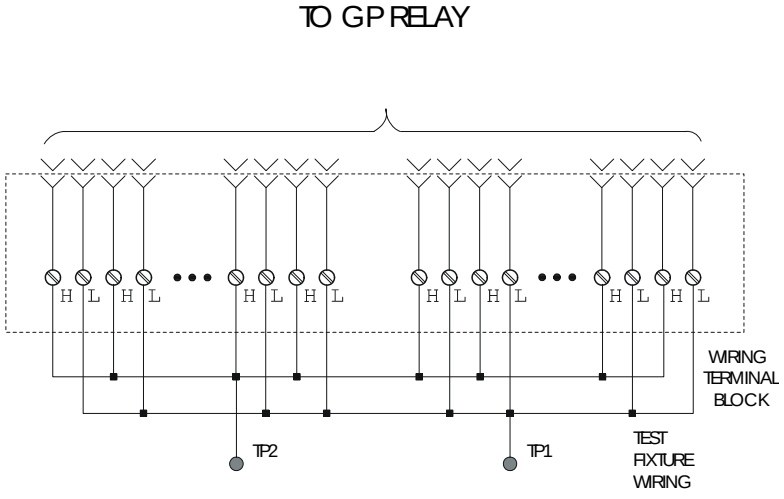


Figure 4-2. GP Relay Modules Test Fixture

The fixture contains:

- A short circuit between all of the low (L) lines (TP1);
- A short circuit between all of the high (H) lines (TP2).

With the test fixture installed, and a Multimeter (i.e. an Agilent 34401A) connected between the shorted low lines (TP1) and the shorted high lines (TP2), the GP Relay module is tested by successively closing each relay while checking for an indication of the closure on the Multimeter.

Tests Procedure

To perform the Operation Verification Tests:

1. Remove the wiring terminal block from the GP Relay module;
2. Install the related test fixture onto the GP Relay module;
3. Set the Multimeter to measure resistance. “Zero” the Multimeter;
4. Press **Mon** and specify the slot occupied by the GP Relay module;
5. Press **S.LIST** and specify all channels to be scanned;
6. Connect the Multimeter between TP1 & TP2 on the test fixture (Figure 4-2);.
7. Press **Card Reset** to reset the GP Relay module, the Multimeter should indicate that all relays are open (very high resistance or overload indication);

Note If the Multimeter is indicating a very low resistance, one or more of the relays is remaining closed. You need to do more tests to isolate the clumsy damaged relay(s).

8. Successively press **Step** while observing the displays on the Agilent 3499A/B/C and the Multimeter. The Agilent 3499A/B/C’s display should show a number corresponding to the closed relay. The clumsy damaged relay(s) can be isolated in this way.

Correction

If during Step 8, one or more relays did not close as described, a problem exists either in the Controller board or the related GP Relay module. Replace this GP Relay with another same one and perform the tests as described above to isolate the problem.

If during step 8, the appropriate relays closed, but one or more of the resistances were higher than the Initial Closed Channel Resistance (refer to Chapter 1 on Page 1), the corresponding relay is defective.

If the GP Relay module is defective, replace it with a new one (the relays are not replaceable parts, refer to Chapter 6 on Page 85 for more information).

Matrix Modules Verification Tests

The Matrix modules available with the Agilent 3499A/B/C include:

- Agilent N2262A 4 x 8 2-wire Matrix module;
- Agilent 44473A 4 x 4 2-wire Matrix module;
- Agilent N2265A Multifunction module (4 x 4 2-wire Matrix).

Test Fixture

The test fixture can be constructed by configuring the related Matrix

module's removable wiring terminal block as shown in Figure 4-3.

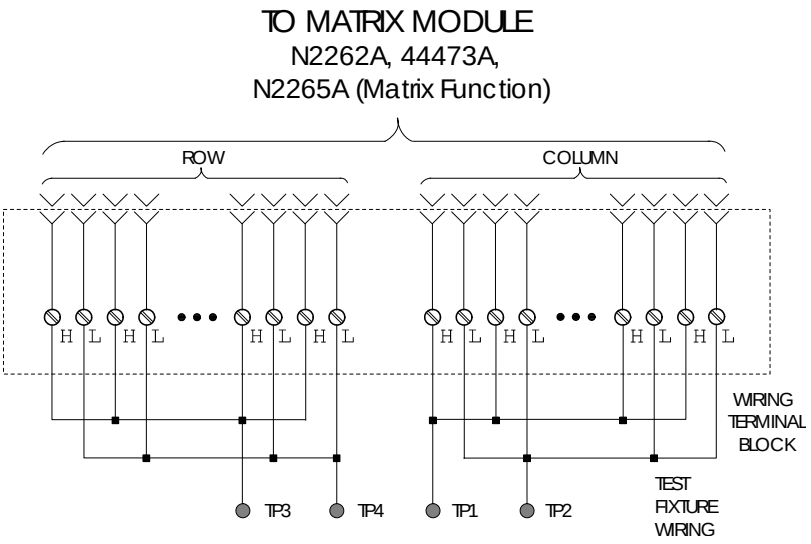


Figure 4-3. Matrix Modules Test Fixture

The fixture contains:

- A short circuit between all of the high lines in the Columns (TP1);
- A short circuit between all of the low lines in the Columns (TP2);
- A short circuit between all of the high lines in the Rows (TP3);
- A short circuit between all of the low lines in the Rows (TP4).

With the test fixture installed, and a Multimeter (i.e. an Agilent 34401A) connected between the Columns and the Rows, the related Matrix module is tested by successively closing each relay while checking for an indication of the closure on the Multimeter.

Tests Procedure

To perform the Operation Verification Tests:

1. Remove the wiring terminal block from the Matrix module;
2. Install the related test fixture onto the Matrix module;
3. Set the Multimeter to measure resistance. "Zero" the Multimeter;
4. Press **Mon** and specify the slot occupied by the Matrix module;
5. Press **S.LIST** and specify all channels to be scanned;
6. Connect the Multimeter between TP1& TP3 (or TP2 & TP4) on the test fixture (Figure 4-3 on Page 66);
7. Press **Card Reset** to reset the Matrix module, the Multimeter should indicate that all relays are open (very high resistance or overload indication);

Note If the Multimeter is indicating a very low resistance, one or more of the relays is remaining closed. You need to do more tests to isolate the clumsy damaged relay(s).

8. Successively press **Step** while observing the displays on the Agilent 3499A/B/C and the Multimeter. The Agilent 3499A/B/C's display should show a number corresponding to the closed relay. The clumsy damaged relay(s) can be isolated in this way.

Correction

If during Step 8, one or more relays did not close as described, a problem exists either in the Controller board or the related Matrix module. Replace this Matrix with another same one and perform the tests as described above to isolate the problem.

If during Step 8, the appropriate relays closed, but one or more of the resistances were higher than 1Ω, the corresponding relay is defective.

If the Matrix module(s) is defective, replace it with a new one (the relays are not replaceable parts, refer to Chapter 6 on Page 85 for more information).

Digital I/O Modules Verification Tests

Four digital I/O (DIO) modules are available with the Agilent 3499A/B/C:

- Agilent 44474A 16-bit DIO module;
- Agilent N2263A 32-bit DIO module;
- Agilent N2264A Multifunction module (16-bit DIO Function);
- Agilent N2265A Multifunction module (16-bit DIO Function);
- Agilent N2269A Multifunction module (16-bit DIO Function).

Test Fixture

The test fixture can be constructed by configuring the related DIO module's removable wiring terminal block as shown in Figure 4-4.

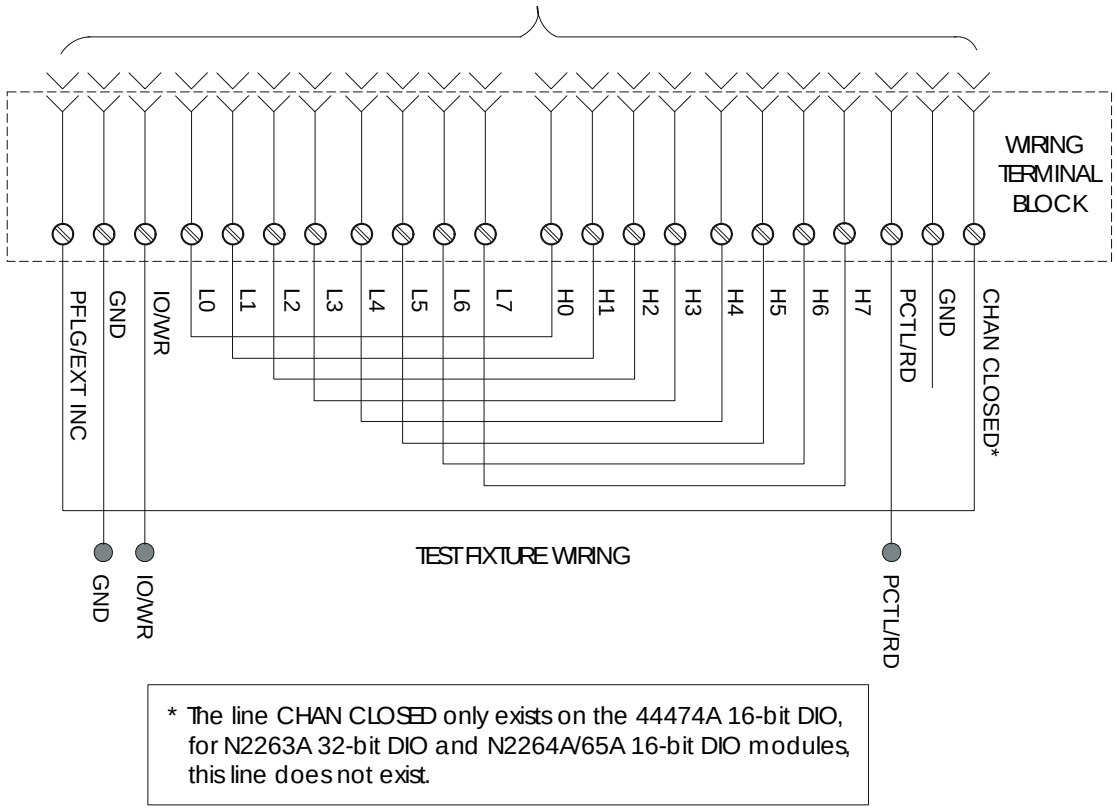


Figure 4-4. DIO Modules Test Fixture

This fixture is applicable for the Agilent 44474A 16-bit DIO. For Agilent N2263A/64A/65A, the line CHAN CLOSED does not exist. For Agilent N2263A 32-bit DIO, the related data lines (i.e. the first bit in ports s00, s01, s02 and s03, and so on) in each of the four 8-bit ports are connected together to simplify the data lines testing.

Tests Procedure

The Verification Tests for a DIO module consist of:

a. Data lines input/output tests;
b. The CHAN CLOSED[1] and PFLG/EXT INC tests;
c. The IO/WR and PCTL/RD tests.

Data Lines Input/Output Tests Procedure:

1. Remove the wiring terminal block from the DIO module and install the related test fixture onto it;
2. Press **Card Reset** to reset the DIO module, all the ports in this

[1]. The line Channel Closed is for the Agilent 44474A 16-bit DIO only.

module should be input (DIN). Press **Mon**, the display should be "DIN 11111111 snn" or "DIN 255 snn", where s = slot number, and nn is the related port number;

3. Write a binary 10101010 to any one of the 8-bit ports (in order to open every other line) and verify the data has been transferred to all the other ports.

   Take an Agilent N2263A for example, if a data (10101010) has been written to the port s02, this data should be transferred to other ports s00, s01 and s03. When these ports (s00, s01 & s03) are monitored, the display should be 10101010 (binary) or 170 (decimal). If it does not, a problem exists on this DIO module.

Note

You can write any other data to one port to verify the data lines.

Chan Closed and PFLG/EXT INC Tests Procedure

1. Reset the DIO module and create a scan list including all the bits on this module;
2. Press **Step**. If the CHAN CLOSED (Agilent 44474A only) and/or PFLG/EXT INC lines are functioning, the Agilent 3499A/B/C will begin stepping through the scan list, opening each data line as it closes the previous line. This will be shown on the Agilent 3499A/B/C's display as the first 8-bit port being successively decreased by the binary weighted value of each data line. In other words, the display will start with the value of 255, step to 254 (binary 1), step to 253 (binary 2), step to 251 (binary 4), step to 247 (binary 8), step to 239 (binary 16), step to 223 (binary 32), step to 191 (binary 64) and finally, step to 127 (binary 128). When all eight data lines in this port have been stepped through, the port will reset to 255 and the process will repeat with the second 8-bit port, and so on.

If the scan list will not automatically advance as described above, the CHAN CLOSED line, the PFLG/EXT INC line, or both are malfunctioning.

IO/WR and PCTL/RD Tests Procedure

1. Reset the DIO module;
2. Connect the Multimeter between the GND and the PCTL/RD (or IO/WR) terminals on the test fixture (Figure 4-4 on Page 68) to measure dc voltage. The PCTL/RD (or IO/WR) line should be in the high state (between +2.4 V dc and +5 Vdc);
3. Change the polarities of the IO/WR and PCTL/RD to negative (NEG), and write a data to any one of the 8-bit ports on the DIO module (for more instructions, refer to "Front-Panel Operation" on Page 31);
4. Measure the voltage between the GND and the IO/WR (or PCTL/RD) terminals. The IO/WR (or PCTL/RD) line should be in the low state (between 0 Vdc and +0.4 V dc).

If either or both control lines failed to achieve either or both states, a problem exists in either the mainframe Controller board or the plug-in DIO module. You can isolate the problem by testing the same items described above with another (same type) functional DIO module.

Correction

Replace the DIO module with a new one if it is failed.

Agilent 44472A Verification Tests

The VHF Switch module consists of two 4-to-1 MUXs with BNC connections. Only the center conductor of each channel is switched. The outer conductors (shield) of all channels in a particular MUX are connected together and unswitched.

Tests Procedure

To test a channel:

1. Remove any external wiring from the rear of the 44472A. Reset the 44472A and press **Mon**;
2. Set the Multimeter to measure resistance, “Zero” the Multimeter;
3. Create a scan list including all the channels of 44472A;
4. **MUX #0 TESTS:** Connect a Multimeter between the center conductor of the common connector (common #0) and the center conductor of the channel under test (channel 00 to start). The Multimeter should indicate that the channel is open (very high resistance or an overload indication);
5. Press **Step**, the Multimeter should display a resistance reading of less than 1Ω;
6. Repeat Steps 4 and 5 for channels 01, 02 and 03;
7. **MUX #1 TESTS:** Reset the 44472A and connect the Multimeter between the center conductor of the common connector (common #1) and the center conductor of the channel under test (channel 10 to start). The Multimeter should indicate that the channel is open (very high resistance or an overload indication);
8. Press **Step** until the channel under test appears in the Agilent 3499A/B/C’s display. The Multimeter should display a resistance reading of less than 1Ω;
9. Repeat Steps 7 and 8 for channels 11, 12 and 13.

Correction

a. If during Steps 5 or 8, one or more channels does not close as described, a problem exists in either the mainframe Controller board or the 44472A. You can use a functional 44472A to isolate the problem.

b. If during Steps 5 or 8, the channels closed but one or more of the resistances was greater than 1Ω, the relays in the corresponding channel(s) are failing.

Note Replace the 44472A with a new one if it is failing.

Agilent 44476A/B Verification Tests

The Agilent 44476A has three independent SPDT 50 Ω coaxial switches (Figure 4-5). The Agilent 44476B allows you to mount any two 3331XX

Coaxial Switches; these coaxial switches come in 3/4/5-port configurations. To verify that the 33311B Coaxial Switches on the Agilent 44476A (or the switches you provide on the Agilent 44476B) are functioning, verify continuity between the common port and the port connected to it. Also, verify there is no continuity between the common port and any unconnected ports.

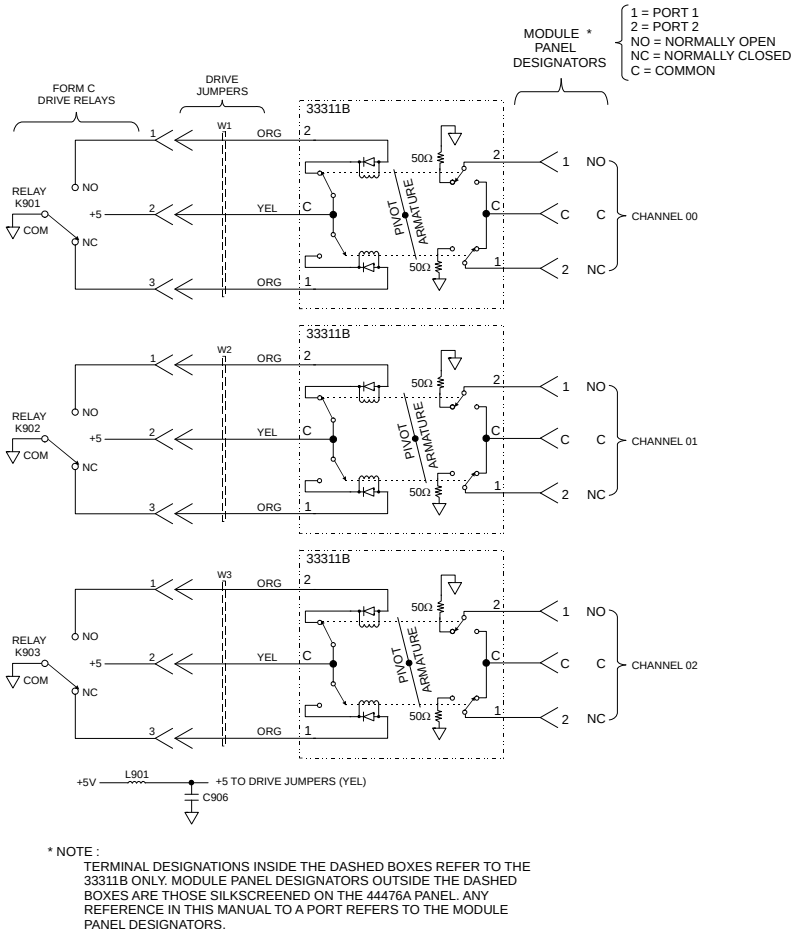


Figure 4-5. Agilent 44476A Simplified Schematic

Note The Agilent 44476B simplified schematic is the same as the Agilent 44476A's, with the exception of that the three Microwave modules (33311B) are not installed.

Tests Procedure

To perform the Verification Tests for an Agilent 44476A/B:

1. Reset the module (Agilent 44476A/B) and press **Mon**;
2. Using the Multimeter, verify continuity between the Channel 00 center conductor of the common port (C) and center conductor port 1 (1). For an Agilent 44476B, you must determine which ports should have continuity for Channel 00 and verify it;
3. Verify there is no continuity between the common port and ports that should not be connected to the common port;

4. Repeat Steps 2 & 3 to verify the other channels;
5. Close all the channels on the Agilent 4476A/B;
6. Verify continuity between the Channel 00 center conductor of the common port and center conductor of port 2. For an Agilent 44476B, you must determine which ports should have continuity for Channel 00 and verify it;
7. Verify there is no continuity between the common port and port 1 of channel 00. For the Agilent 44476B, you must determine which ports should not have continuity and verify they do not;
8. Repeat Steps 6 & 7 to verify other channels.

Correction

If a Microwave Switch does not function properly, you must determine if the problem is caused by the drive circuity or drive relays K901, K902, or K903. Use another same functional Microwave Switch and perform the same tests as described above to isolate the problem.

The three Microwave Switches are replaceable parts, if any one of them is defective, replace it with a new one. If the drive circuity or drive relays are defective, replace the Agilent 44476A/B with a new one (with the exception of the Microwave Switches if they are functioning).

Agilent N2276A/B Verification Tests

Since Agilent N2276A/B has similar style with 44476A/B, please refer to Agilent 44476A/B's Verification Tests.

Agilent 44477A Verification Tests

Agilent 44477A contains seven independent, single-pole double-throw (SPDT) Form C relays. When a channel is open, the normally closed (NC) will connect to the common (C). When a channel is closed, the normally open (NO) will connect to the common (C).

Test Fixture

A test fixture can be configured by connecting all relay commons (C) together at TP1, all normally open (NO) contacts at TP2 and all normally closed (NC) contacts together at TP3, with an Agilent 44487A screw terminal block.

Tests Procedure

To verify that all relays are functioning properly, you must:

a. Verify that each relay can close the normally open (NO) contact;
b. Verify that each relay's normally closed (NC) contact operates

properly.

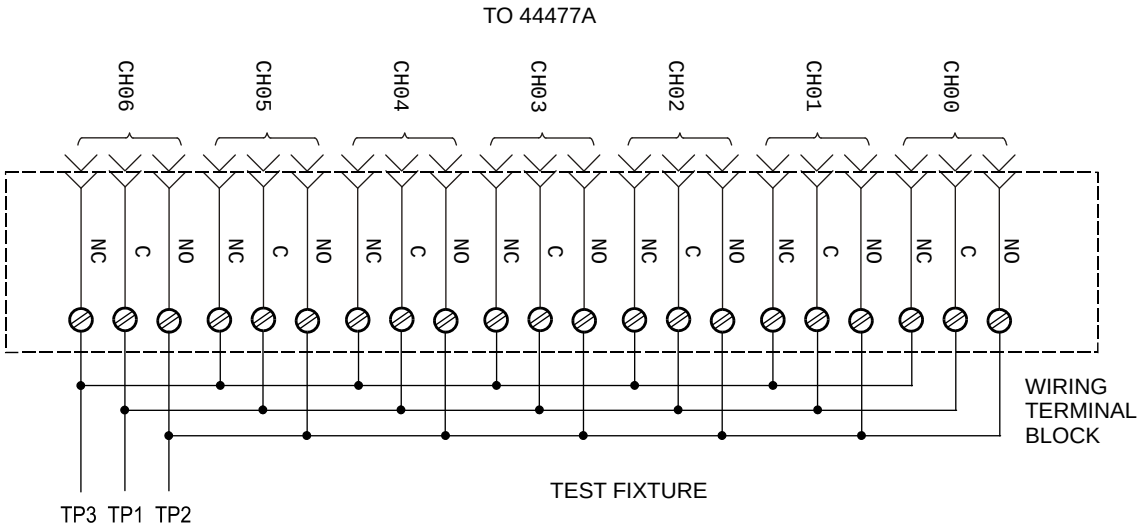


Figure 4-6. Agilent 44477A Test Fixture

To Verify the NO Contacts:

1. Connect a Multimeter between TP1 (C) & TP2 (NO), reset the Agilent 44477A. The Multimeter should show an open circuit;
2. Close Channel 00 and check the Multimeter for an indication of closure. This reading will be the closed channel resistance of the NO contact and should be less than 1Ω;
3. Open Channel 00 and close Channel 01, check for an open circuit when Channel 00 is opened, and an indication of closure when Channel 01 is closed;
4. Repeat Steps 2 & 3 to check the remaining Channels 02-06.

To Verify the NC Contacts:

5. Connect the Multimeter between TP1 (C) & TP3 (NC), reset the Agilent 44477A. The Multimeter should show an open circuit;
6. Repeat Steps 2 through 4 to verify the NC contacts (the “NO” in Steps 2-4 should be replaced with “NC”, respectively).

Correction

If during Steps 1 & 5, one or more relays does not function properly, a problem exists either in the Controller board or in the Agilent 44477A, use a functional Agilent 44477A and perform the same tests to isolate the problem.

If during Steps 3 & 6, the Agilent 44477A is functioning but the contact resistance is more than 1Ω, the Agilent 44477A is defective. Replace the Agilent 44477A with a new one in this case.

Agilent 44478A/B Verification Tests

Agilent 44478A/B consists of two 4-to-1 MUXs (Group 00 & Group 10) that can switch signals bidirectionally. Each group has a separate ground for isolation between groups and this ground is unswitched (Figure 4-7).

To verify that the relays in each group are functioning, verify continuity between the center conductor of the common BNC and each channel's BNC center conductor when that channel is closed. If no continuity exists, verify that a relay is stuck open and continuity exists from the channel's BNC center conductor and the channel's associated SMB (J101-J110) center conductor when the channel is open.

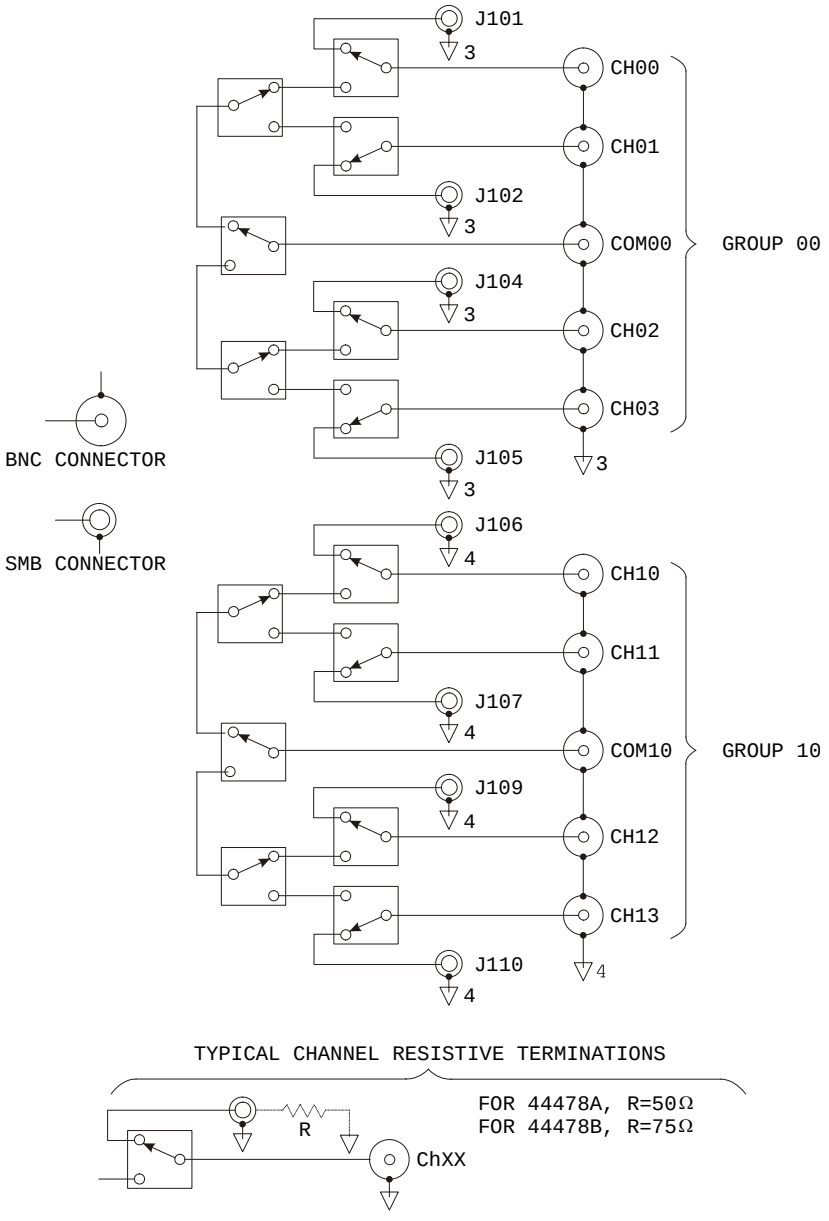


Figure 4-7. Agilent 44478A/B Simplified Schematic

Tests Procedure

To verify that the relays in each group are functioning:

1. Remove any external wiring from the Agilent 44478A/B connectors;
2. Reset the Agilent 44478A/B and press **Mon**;
3. Create a scan list including all the channels on an Agilent 44478A/B;
4. Connect the Multimeter between the center conductor of the COM 00 connector and the center conductor of the channel under test (start with CH 00). The Multimeter should indicate the channel is open (very high resistance or an overload indication);
5. Press **Step**, the Multimeter should display a resistance of less than 1Ω;
6. Repeat Steps 4 & 5 for Channels 01, 02 and 03;
7. Connect the Multimeter between the center conductor of the COMM 00 connector and the center conductor of the channel under test (start with CH 10. The Multimeter should indicate the channel is open;
8. Press **Step**, the Multimeter should display a resistance of less than 1Ω;
9. Repeat Steps 7 & 8 for Channels 11, 12 and 13.

Correction

If during Steps 4 & 7, one or more relays does not function, a problem exists either in the Controller board or in the Agilent 44478A/B. Use a functional Agilent 44478A/B and perform the same tests to isolate the problem.

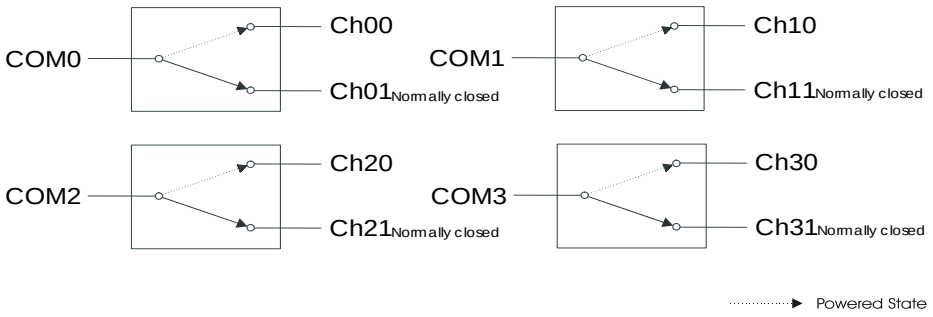
If during Steps 5 & 8, the resistance when the channel is closed is more than 1Ω, one or more relays on this channel is defective. Replace the Agilent 44478A/B with a new one in this case.

Agilent N2280A/81A/82A Verification Tests

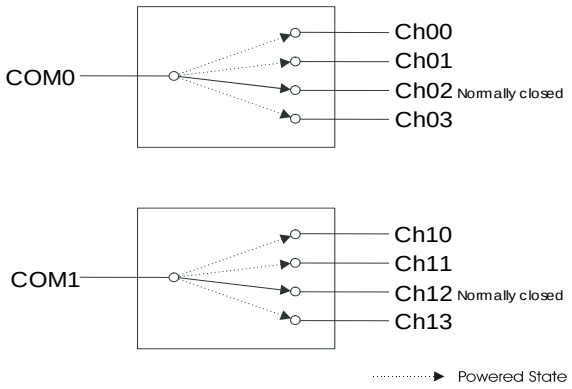
Agilent N2280A consists of four 1-to-2 Optical Switches, each 1-to-2 Optical Switch should be tested independently.

Agilent N2281A consists of two 1-to-4 Optical Switches, each 1-to-4 Optical Switch should be tested independently.

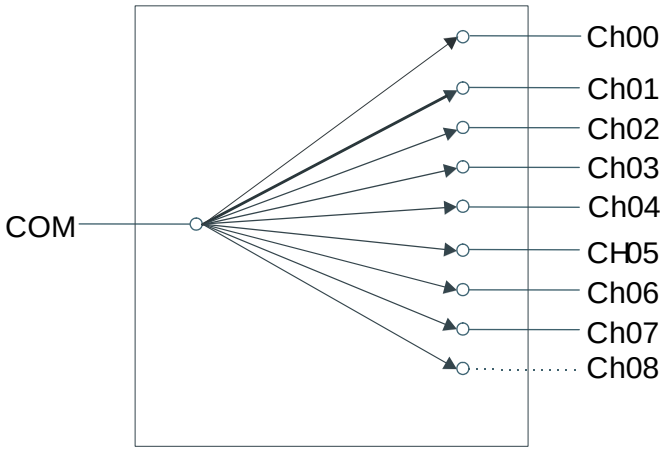
Agilent N2282A consists of one 1-to-8 Optical Switch.



Agilent N2280A



Agilent N2281A



Agilent N2282A

Figure 4-8. Agilent N2280A/81A/82A Simplified Schematic

Test Procedure

Before testing the Agilent N2280A/81A/82A Optical Switch Module, the user should have an Optical Multimeter in hand. When testing, the two Optical probes of the Optical Multimeter should be connected to the two end-connectors of one channel of the specific Optical Switch, then execute closing and opening commands on it , you can find whether this channel is normal or not via the optical multimeter's display.

To verify that the optical switches in each group are functioning:

1. Plug the Optical Module into a 3499A/B/C mainframe.

2. Connect the Optical Multimeter's two optical probes to the COMx and CHxn ('x' is the Optical Switch number in the same module, and 'n' is the channel number in the same Optical Switch) of the Optical Switch which is under testing.

3. Power on the 3499A/B/C mainframe, and execute Opening and closing command on this channel to see if it is operated correctly.

4. Perform step 2 and 3 on next channel of the same Optical Switch until all channels of it is tested.

5. Perform step 2, 3, and 4 on next Optical Switch in the same module.

Correction

If the channel under testing does not function in the step 3 above, a problem exists either in the Optical Switch or in the Controller board of this module. Using a normal Optical Switch to substitute the current one, then perform the steps listed above. If the problem still exists, this demonstrates the Controller board is malfunctioning. If the problem disappeared, this demonstrates the Optical Switch is malfunctioning. Thus the problem is solved by substituting the Controller board or the Optical Switch.

Chapter 5
Service

Introduction

This Chapter provides general service related information about the Agilent 3499A/B/C Switch/Control System. This includes safety considerations, static-handling procedures, and problem isolation processes. Chapter contents include:

- Safety Considerations . . . . . Page 79
- Static Handing. . . . . Page 79
- Agilent 3499A/B/C Problem Isolation . . . . . Page 80
- Mainframe Problem Isolation . . . . . Page 81

Safety Considerations

Only service trained personnel should attempt to repair the Agilent 3499A/B/C. There are two places in the Agilent 3499A/B/C where dangerous voltages may exist. The ac line voltage exists in the Agilent 3499A/B/C mainframe around the areas of the line input filter, line power switch and the power supply assembly. This potentially lethal voltage can only be contacted if the covers are removed.

The other potentially lethal voltage may exist at the plug-in module wiring terminal block. This voltage is generated externally to the Agilent 3499A/B/C. Consult the system installer before attempting to remove the Agilent 3499A/B/C and its plug-in modules from the system.

WARNING **Only personnel with a knowledge of electronic circuitry and an awareness of the hazards involved could install, reconfigure, or make any repairs to the Agilent 3499A/B/C mainframe or its plug-in modules.**

Static Handing

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 electrostatics discharge (ESD) is a major cause of component failure. In many cases, the component damaged may not immediately fail, causing low instrument reliability and unnecessary repairs at a later time. ESD damage can occur at static levels too low for human perception. Additionally, it has been shown that ESD can affect both passive and active devices.

Any assembly or subassembly removed from the mainframe MUST be handled in accordance with anti-static handing procedures.

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

- The work bench should be equipped with a conductive table mat. The mat should be grounded to earth ground through a 1 MΩ resistor. The mat should be equipped with at least one swivel connected to the 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 MΩ resistor.
- All metal equipment at a work station must be grounded. This includes soldering irons, solder suckers, shelving, and equipment stands.
- Only one common ground should be provided at a workstation.
- The workstation must 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 and transporting assemblies.

Caution **To prevent equipment circuit damage, always set the line power switch to off before removing or replacing any assembly.**

Caution **Always use anti-static techniques when assemblies are handled or serviced.**

Agilent 3499A/B/C Problem Isolation

An Agilent 3499A/B/C Switch/Control System consists of three mainframes and a set of plug-in modules. Once the Agilent 3499A/B/C is suspected of a failure, a problem should be existing either in the mainframe or in the plug-in modules or in both of them. More tests must be performed to isolate the problem.

Preliminary Tests

Once the Agilent 3499A/B/C is suspected of a failure:

1. Power off the Agilent 3499A/B/C and remove all the plug-in modules;
2. Cycle power on the Agilent 3499A/B/C. If the same problem exists,

the problem is mostly on the mainframe; if the problem is solved, the problem may be caused by one or more plug-in module.

Plug-in Module Substitution

The easiest and fastest method to isolate a failure to a particular assembly is the board substitution technique. The technique calls for the suspected bad board to be replaced with a known good board. If the problem is solved, the replaced board or assembly had the problem.

A limited substitution may be performed to isolate a faulty plug-in module. To use this method:

1. Determine which plug-in module is suspected of the failure;
2. Try the failing module in another mainframe slot.

If the module functions normally in other slot, a mainframe failure is indicated; if the module still fails, try a known good module. If the known good module does not function properly, a mainframe failure is indicated; if the module does function properly, a failure in the suspected module is indicated.

Mainframe Problem Isolation

Once an Agilent 3499A/B/C mainframe is suspected of a failure, the problem may be further isolated within the mainframe to a particular assembly. Isolating a problem within a mainframe requires that the Agilent 3499A/B/C mainframe be disassembled. A disassembly procedure is given in the next Chapter (refer to “Replaceable Parts” on Page 85).

There are four main electronic assemblies within an Agilent 3499A/B/C mainframe. These include:

1. The Power Supply;
2. The Controller;
3. The Keyboard & Display;
4. The Backplane.

Power Supply

The Power Supply assembly is located behind the keyboard. There are three connectors on it: J1 through J3. J1 is connected to the ac power line and J3 is the safety ground terminal. J2 is connected to the mainframe’s backplane, which provides a set of voltages (dc) to the Controller board and the plug-in modules.

To determine if the power supply is functioning properly:

1. Make sure the ac power line are connected properly and the fuse (3.15 A @ 250 V ac) on the pc board is well;
2. Power on the instrument and measure the voltage between Pin 4 (or Pin 5) and Pin 1 (or 2, 3, 6);
3. If the voltages are correct, the power supply does function; if the voltage is not correct, a problem exists in this assembly.
4. If the voltages on the J2 are correct, but the voltages on the backplane

are incorrect, check the cable (03499-61004) and the plug-in modules. You can perform more tests to further isolate the problem to the cable, or the particular plug-in module.

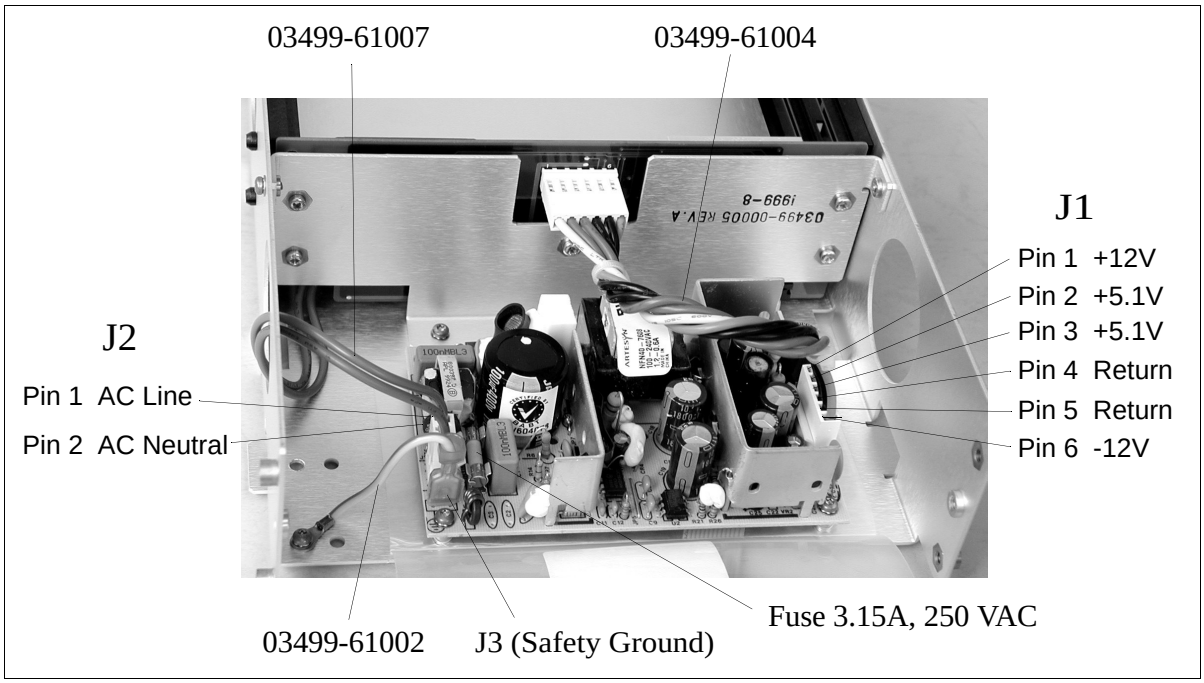


Figure 5-1. Power Supply on the Agilent 3499A/B

Controller

Isolating a problem to the Controller board is best accomplished by substituting a known good board. The Controller is not repairable and should be replaced if it fails.

Keyboard & Display

Problems in the keyboard can be isolated by performing the keyboard test. No response to a key closure is the typical failure mode of the keyboard. No response to any key closure would indicate a Controller board failure.

Problems in the display can usually be detected by performing the display test (i.e. self-test). Typically, a failing display will exhibit missing segments. Display removal is described in the next Chapter (refer to “Replaceable

Parts” on Page 85).

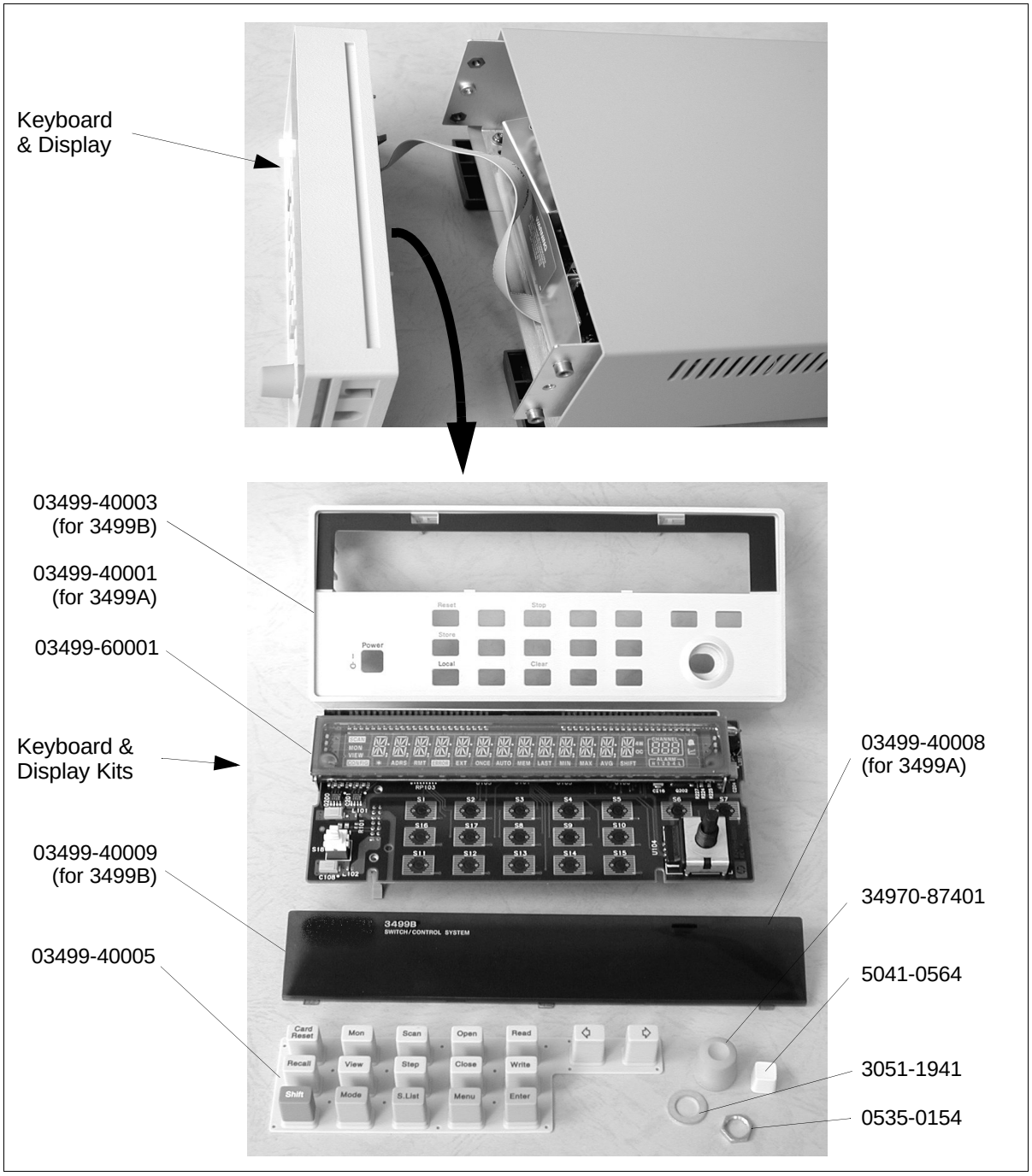


Figure 5-2. Keyboard & Display on an Agilent 3499B

Backplane

If a plug-in module will not function in only one slot, the backplane board should be suspected. Connector failure on the backplane board will be the most common form of backplane failures (for there are few components on the backplane). Because the plug-in module slots are all parallel on the backplane, a shorted connector on the backplane board may appear to be a

Controller board failure.

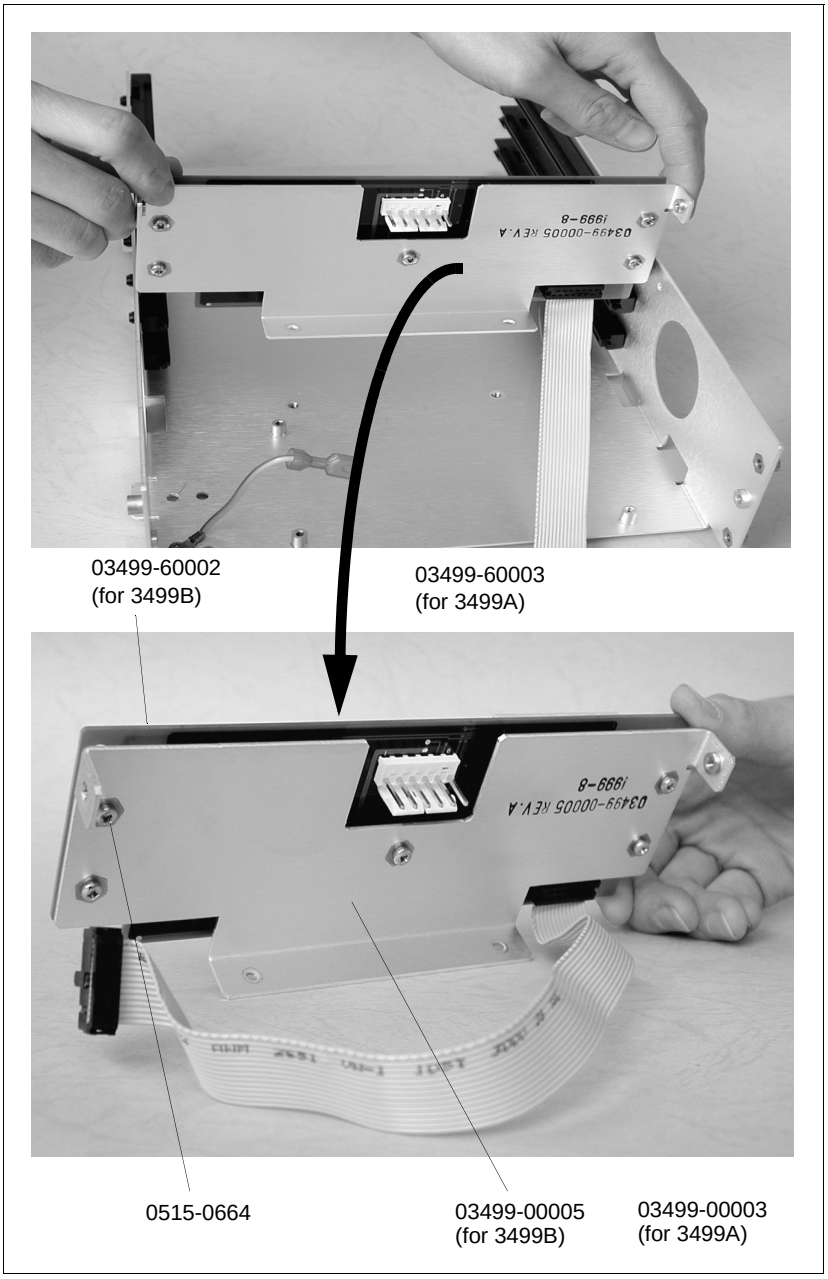


Figure 5-3. Backplane Assembly

Chapter 6
Replaceable Parts

Introduction

This Chapter contains the disassembly/assembly procedures for an Agilent 3499A/B/C mainframe, followed by the mechanical and electrical replaceable parts for the Agilent 3499A/B/C mainframe, and its plug-in modules. This Chapter contains the following sections:

- Agilent 3499A/B/C Disassembly/Assembly Procedures . . . Page 85
- Agilent 3499A/B Mainframe Replaceable Parts. . . . . page 92
- Agilent 34399C Mainframe Replaceable Parts. . . . . page 94
- Plug-in Modules Replaceable Parts . . . . . Page 95

Agilent 3499A/B/C Disassembly/Assembly Procedures

WARNING **The line power cord and all other interconnections must be removed before performing any disassembly or assembly procedures.**

Caution **The Agilent 3499A/B/C mainframe, as well as the plug-in modules, are susceptible to static discharges. Use the anti-static techniques when assemblies are handled or serviced.**

3499A/B Disassembly Procedures

To disassemble an Agilent 3499B half-rack-width mainframe, perform the following procedures (STEP 1 through STEP 6). For an Agilent 3499A full-rack width mainframe, the disassembly procedures are the same with exception of some different replaceable parts, i.e. the Backplane, the Front-Panel (part), the Rear Bezel, etc.

Figure 6-1 through Figure 6-6 demonstrate the disassembly procedures for an Agilent 3499A/B mainframe. The replaceable parts on it are identified with a number and listed in Table 6-1 on page 92.

Note The replaceable parts for the Agilent 3499A/B/C plug-in modules are listed in Table 6-3 on page 95.

STEP 1: Front-Panel Removal

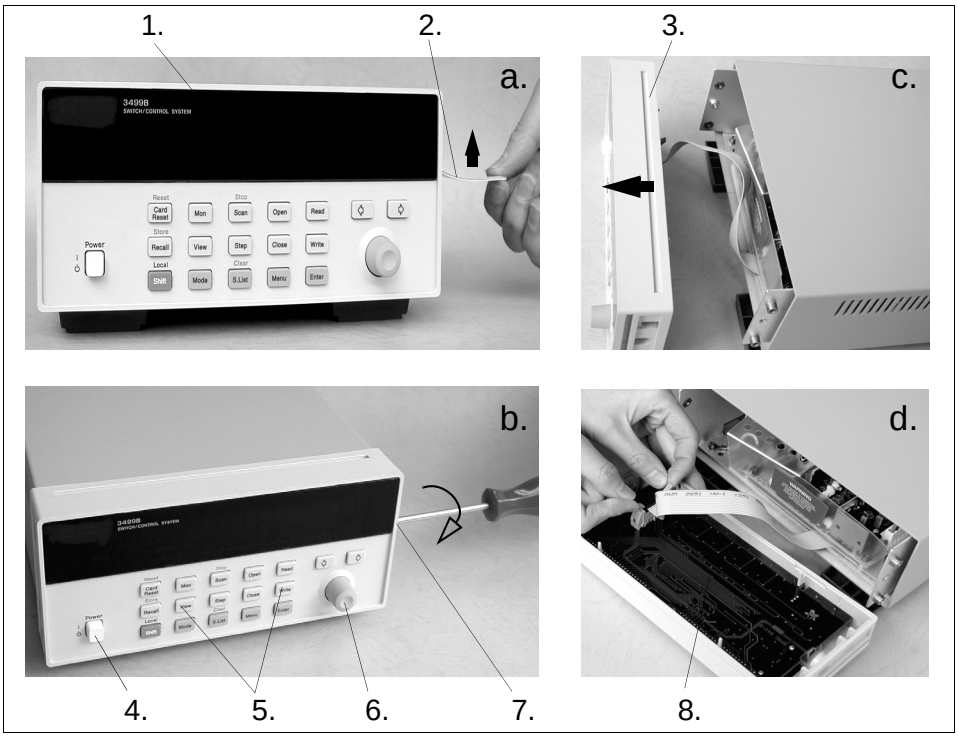


Figure 6-1. Front-Panel Removal

Figure 6-2 shows the Front-Panel disassembling procedures.

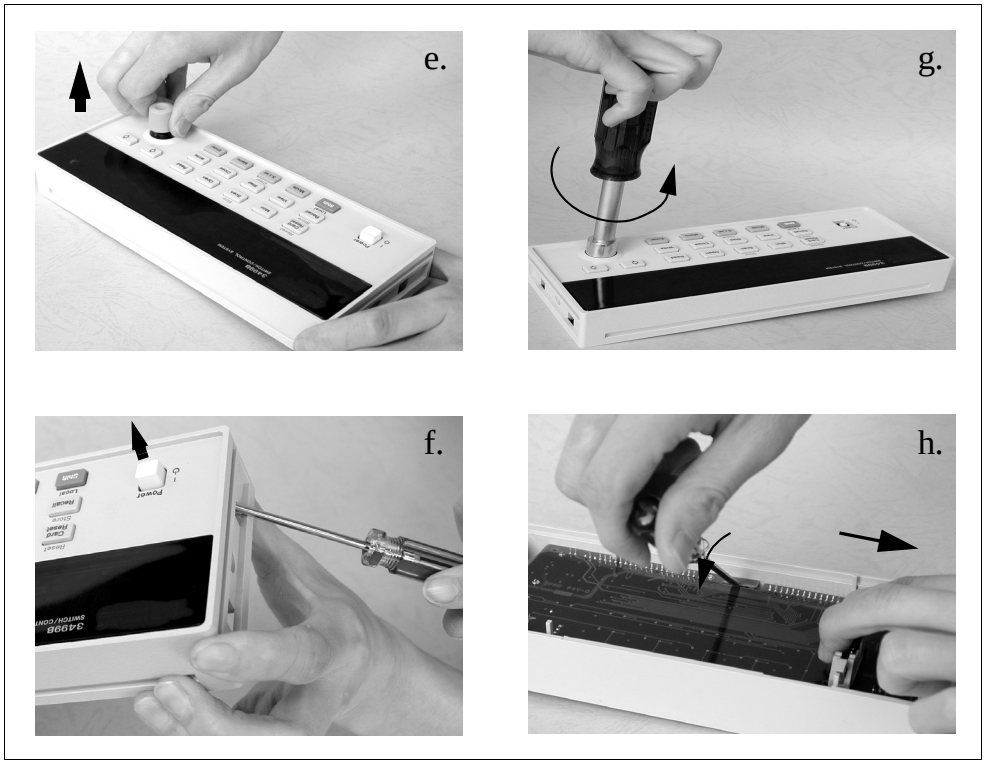


Figure 6-2. Front-Panel Disassembly

STEP 2: Cover Removal

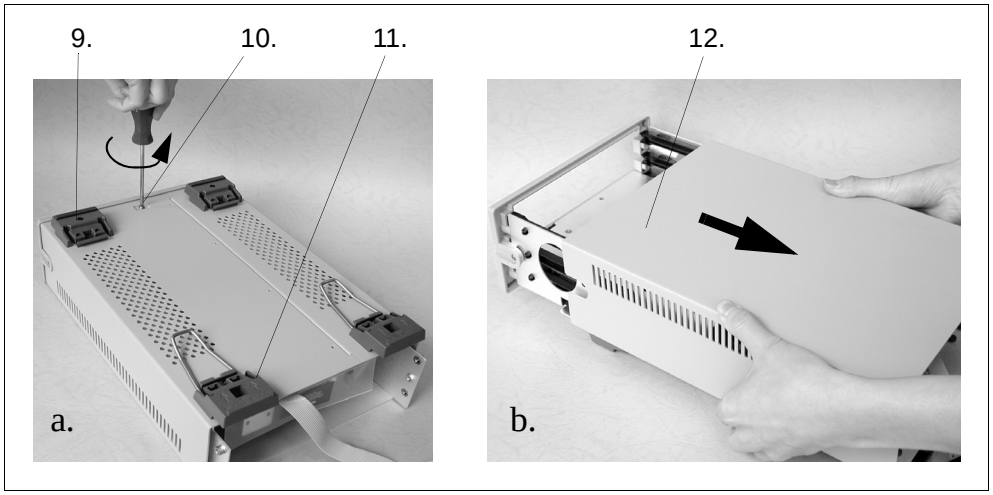


Figure 6-3. Cover Removal

STEP 3: Power Supply Removal

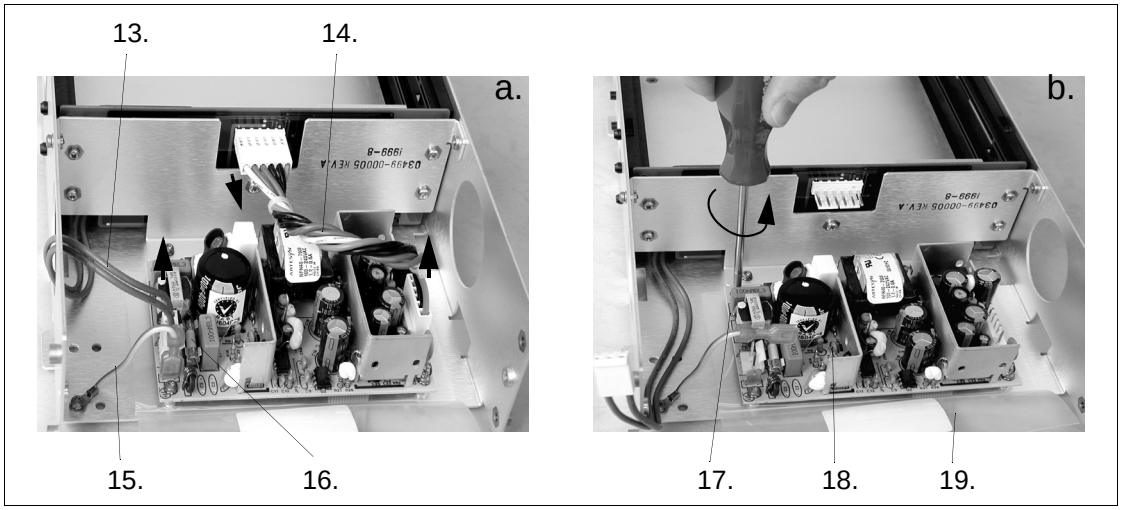


Figure 6-4. Power Supply Removal

STEP 4: Controller board Removal

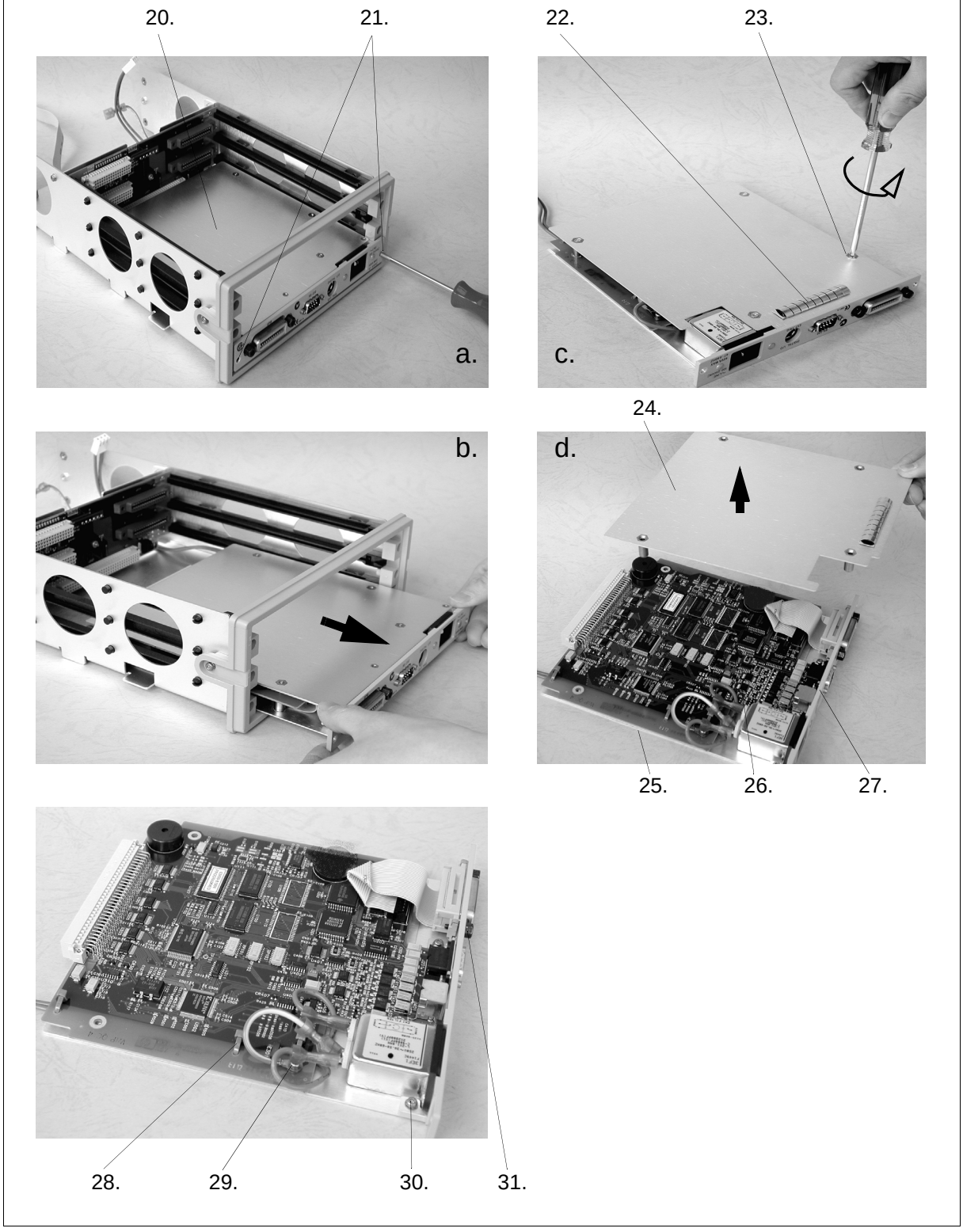


Figure 6-5. Controller board Removal

STEP 5: Rear Bezel Removal

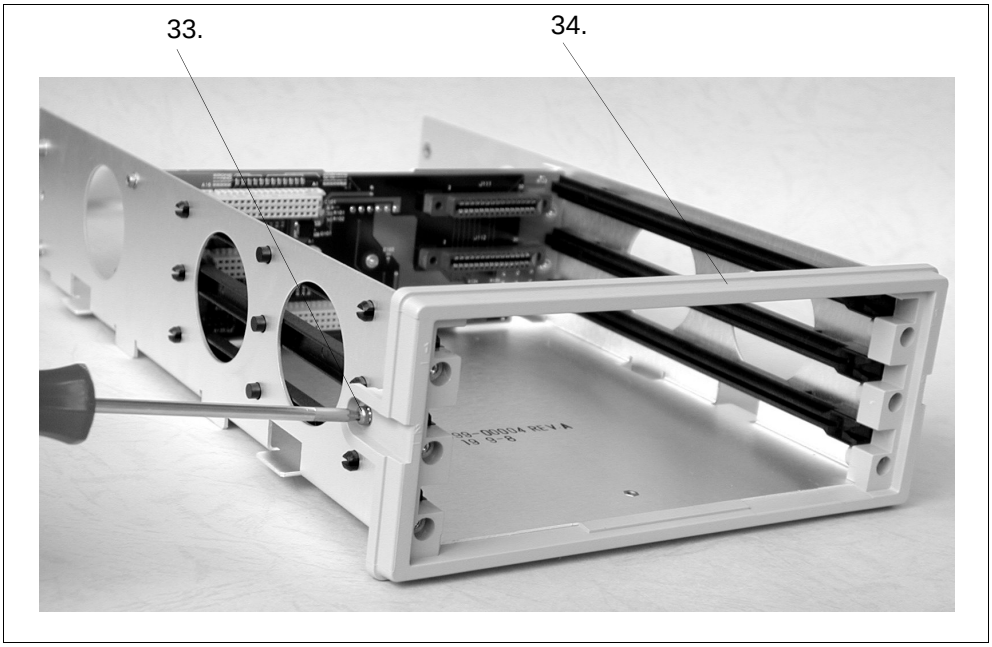


Figure 6-6. Rear Bezel Removal

STEP 6: Backplane Removal

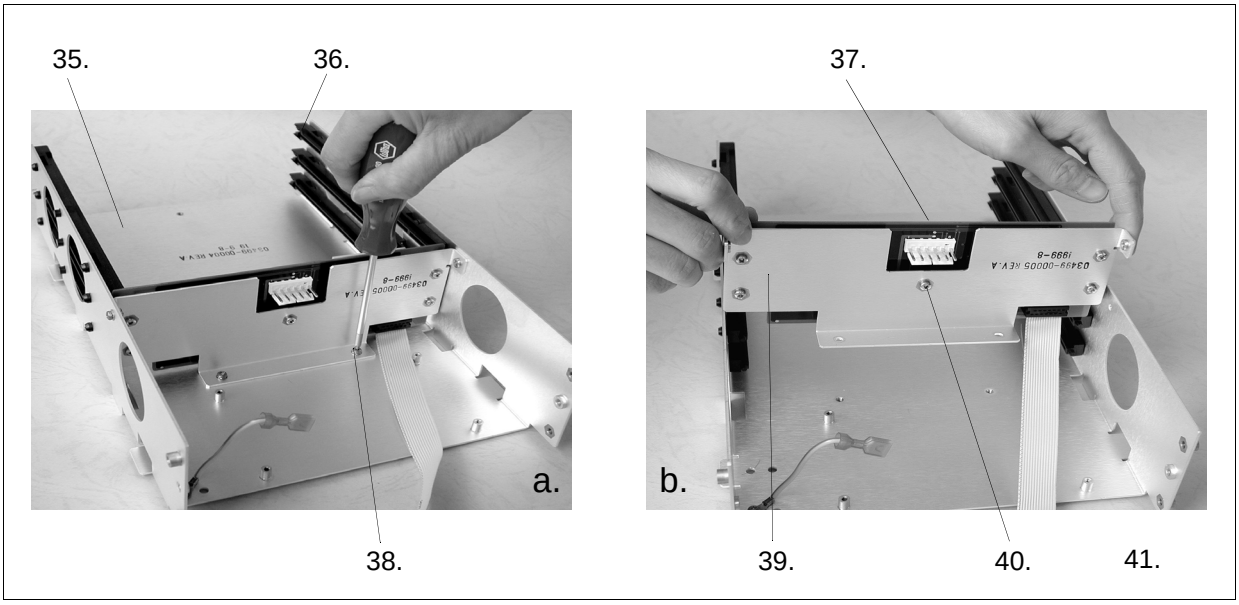


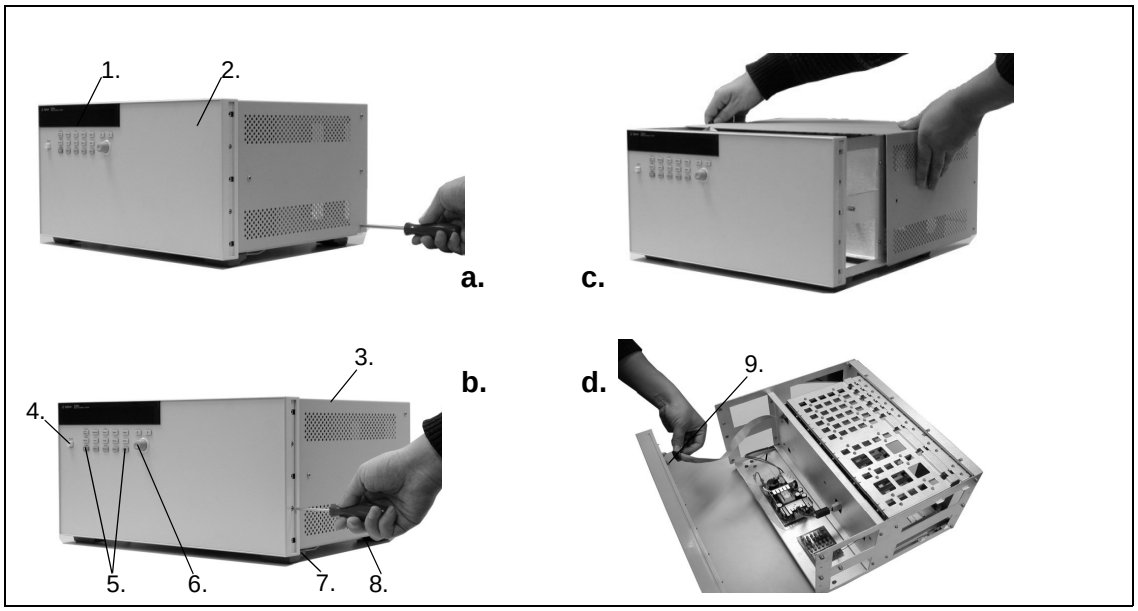
Figure 6-7. Backplane Removal

3499A/B Assembly Procedures

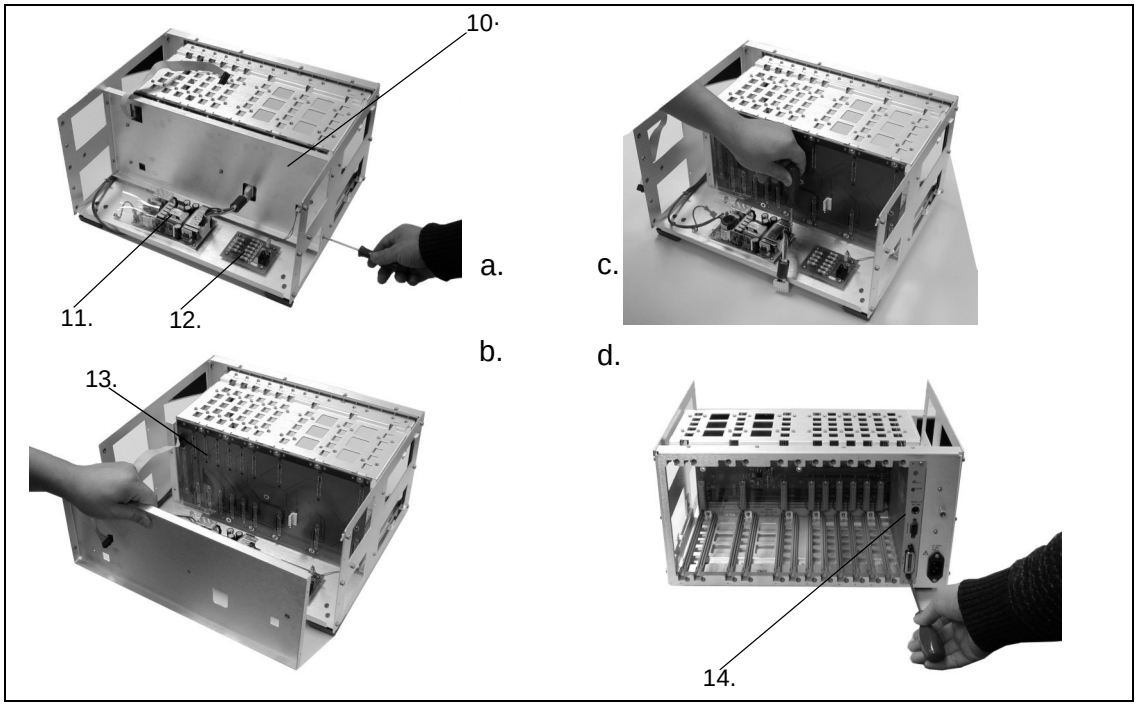
To assemble an Agilent 3499A/B mainframe, reverse the procedures above.

3499C Disassembly Procedures

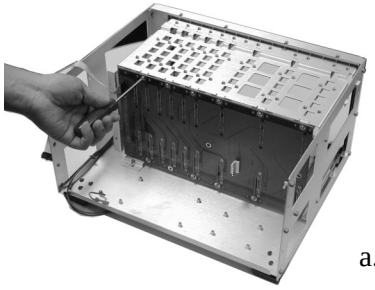
STEP 1: Top Cover and Front Panel Removal



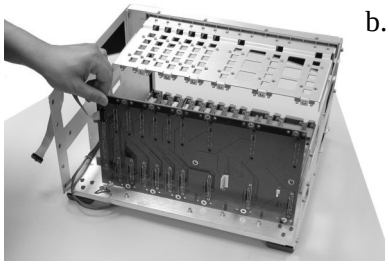
STEP 2: Backplane Shield, Power Module, Power Protection Module and Controller Board Removal.



STEP 3: Backplane Removal.



a.



b.

3499C Assembly Procedures

To assemble an Agilent 3499C mainframe, reverse the procedures above.

Agilent 3499A/B Mainframe Replaceable Parts

Table 6-1. Agilent 3499A/B Mainframe Replaceable Parts

ITEM #	Part Number		Qty.	DESCRIPTION
	3499A	3499B		
1	03499-40008	03499-40009	1	WINDOW DISPLAY-FULL/HALF RACK
2	5041-9170		2	TRIM, SIDE
3	03499-40001	03499-40003	1	FRONT PANEL-FULL/HALF RACK
4	5041-0564		1	QUARTER KEY
5	03499-40005		1	KEYPAD
6	34970-87401		1	KNOB
7	0515-0430		2	SCR-MACHINE
8	03499-60001		1	PCA-KEY&VFD CONT UNIT
9	5041-8822		2	FOOT-NON SKID
10	0515-0430		1	SCR-MACHINE
11	5041-8801 1460-1345		2 2	FOOT-MOLD TILT STAND
12	03499-00001	03499-00006	1	COVER-FULL/HALF RACK
13	03499-61007		1	CABLE ASSY LINE
14	03499-61004		1	CBL ASSY-POWER MODULE
15	03499-61002		1	CBL ASSY-GROUND
16			1	Fuse 3.15A, 250 VAC
17	0515-0430		4	SCR-MACHINE
18	0950-2649		1	POWER SUPPLY MODULE
19	03499-40007		1	SAFETY SHIELD POWER SUPPLY
20	03499-61008		1	CONTROL MODULE ASSY
21	5180-8269		2	SCREW M3.0
22	8160-0686		1	RFI STRP-FINGERS
23	0515-0844		4	SCR-MACHINE
24	03499-00008		1	CONTROL CARD-SHIELD COMP
25	03499-00007		1	CONTROL CARD-SHIELD CIRCUIT
26	03499-60004		1	PCA-CONTROL MODULE
27	03499-61009		1	CONTROL PANEL ASSY
28	1400-0249		3	CABLE TIE
29	0515-1934		1	SCR-MACHINE

Table 6-1. Agilent 3499A/B Mainframe Replaceable Parts

ITEM #	Part Number		Qty.	DESCRIPTION
	3499A	3499B		
30	0515-0367		2	SCR-MACHINE
31	0380-0643		2	STDF-HEX .255-IN
33	1390-0793	0515-0430	2	CAPTIVE SCR/SCR MACHINE
34	03499-40002	03499-40004	1	REAR BEZEL-FULL/HALF RACK
35	03499-00002	03499-00004	1	CHASSIS-FULL/HALF RACK
36	03499-40006		6	PCB CARD GUIDE
37	03499-60003	03499-60002	1	PCA-BACK PLN-FULL/HALF RACK
38	0515-0430		4	SCR-MACHINE
39	03499-00003	03499-00005	1	BACK PLN BRACKET-FULL/HALF RACK
40	0515-0664		5	SCR-MACHINE
41	5041-5209	N/A	1	GUIDE-PC BD
42	3050-1941		1	WSHR-FL NM
43	0535-0154		1	NUT-HEX SGL-CHAM

Agilent 3499C Mainframe Replaceable Parts

Table 6-2. Agilent 3499C Mainframe Replaceable Parts

ITEM #	Part Number	Qty.	DESCRIPTION
1	03499-40012	1	WINDOW DISPLAY-3499C
2	03499-40014	1	FRONT PANEL
3	03499-00013	1	COVER-3499C
4	5041-0564	1	QUARTER KEY
5	03499-40005	1	KEY PAD
6	34970-87401	1	KNOB
7	5041-8801	2	FOOT, MOLD
8	5041-8822	2	FOOT-NON SKID
9	03499-60001	1	PCA-KEY&VFD CONT UNIT
10	03499-00020	1	SHIELD BACKPLANE
11	0950-4321	1	POWER SUPPLY MODULE
12	03499-60007	1	POWER PROTECTION LOAD
13	03499-60006	1	BACKPLANE PCA
14	03499-60005	1	CONTROL BOARD MODULE

Plug-in Modules Replaceable Parts

Table 6-3 lists the replaceable parts for the existing Agilent 3499A/B/C plug-in modules. Kits 1 through Kits 6 are used to refer to the different sets of mechanical kits as described in the follow-up sections.

Table 6-3. Plug-in Modules Replaceable Parts

Product Number	PCA (P/N)	Mechanical Kits	Microwave Module
Agilent 44470A	44470-66511	Kits 1	None
Agilent 44470D	44470-66521		
Agilent 44471A	44471-66511		
Agilent 44471D	44471-66521		
Agilent 44473A	44473-66511		
Agilent 44474A	44474-66501		
Agilent 44477A	44477-66501		
Agilent N2260A	N2260-60001	Kits 2	
Agilent N2261A	N2261-60001		
Agilent N2262A	N2262-60001		
Agilent N2263A	N2263-60001		
Agilent N2264A	N2264-60001		
Agilent N2265A	N2265-60001		
Agilent N2266A	N2266-60001		
Agilent N2269A	N2269-60001		
Agilent 44472A	44472-66511	Kits 3	
Agilent 44476A	44476-66501	Kits 4	33311B (x3)
Agilent 44476B		Kits 5	876XX (x2)[a]
Agilent 44478A	44478-66501	Kits 6	None
Agilent 44478B	44478-66502		
Agilent N2267A	N2267-60001	Kits 7	None
Agilent N2268A	N2268-60001	Kits 8	None
Agilent N2270A	N2270-60001	Kits 9	None
Agilent N2272A	N2272-60001	Kits 10	None
Agilent N2276A/B	N2276-60001	Kits 11	8710XX
Agilent N2280A	N2280-60001	Kits 12	None

Table 6-3. Plug-in Modules Replaceable Parts

Product Number	PCA (P/N)	Mechanical Kits	Microwave Module
Agilent N2281A	N2281-60001	Kits 13	None
Agilent N2282A	N2282-60001	Kits 14	None

a. The microwave modules used with an Agilent 44476B can be the 3-, 4- or 5-port modules (8762A/B/C/F, 8763B/C, 8764B/C), from DC to 26.5 GHz, and must be ordered separately.

Mechanical Kits 1 & 2

Figure 6-8 shows the replaceable mechanical parts for Kits 1 & 2 as listed in Table 6-4.

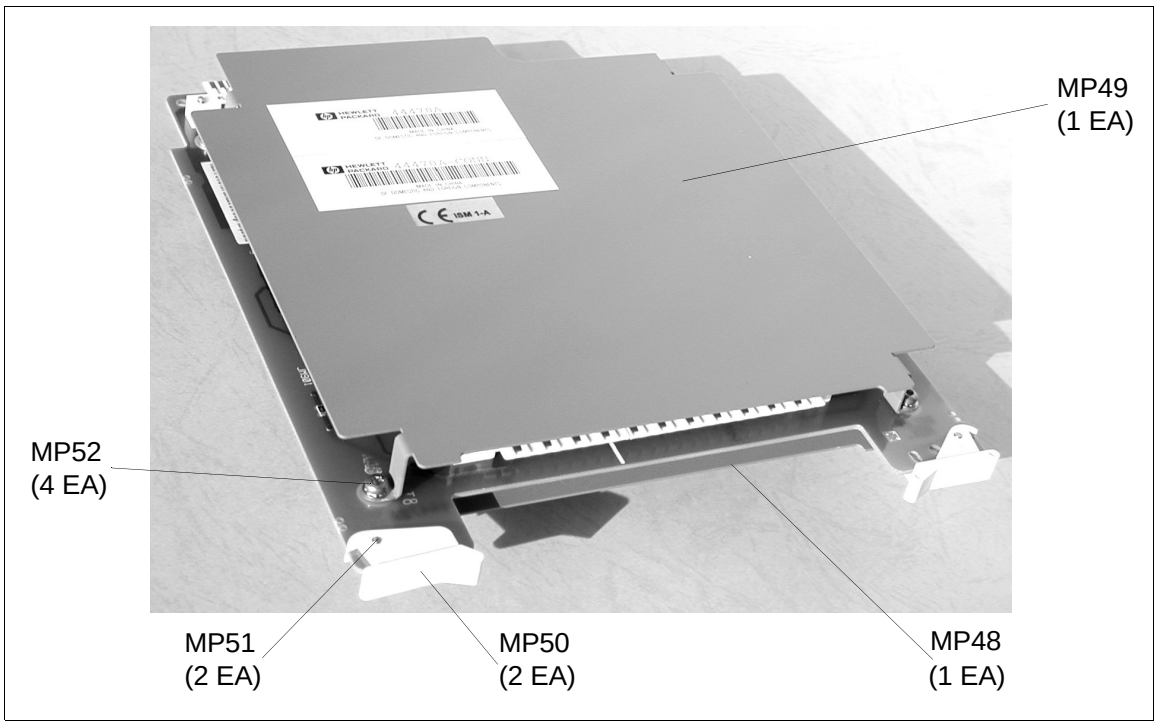


Figure 6-8. Mechanical Kits 1 & 2

Table 6-4. Mechanical Kits 1 & 2

Ref. Designation	Qty.	Description	Kits 1 (P/N)	Kits 2 (P/N)
MP48	1	SHIELD CIRCUIT	03488-00612	5184-0501
MP49	1	SHIELD COMP	03488-00613	5184-0502
MP50	2	PC EXTRACTOR WHT	0403-0464	
MP51	2	PIN-GRV 3/32 X 1/4	1480-0625	
MP52	4	SCREW M3.0 X 06TXSC	0515-0430	

Mechanical Kits 3

Figure 6-9 shows the replaceable mechanical parts (Kits 3) as listed in Table 6-5.

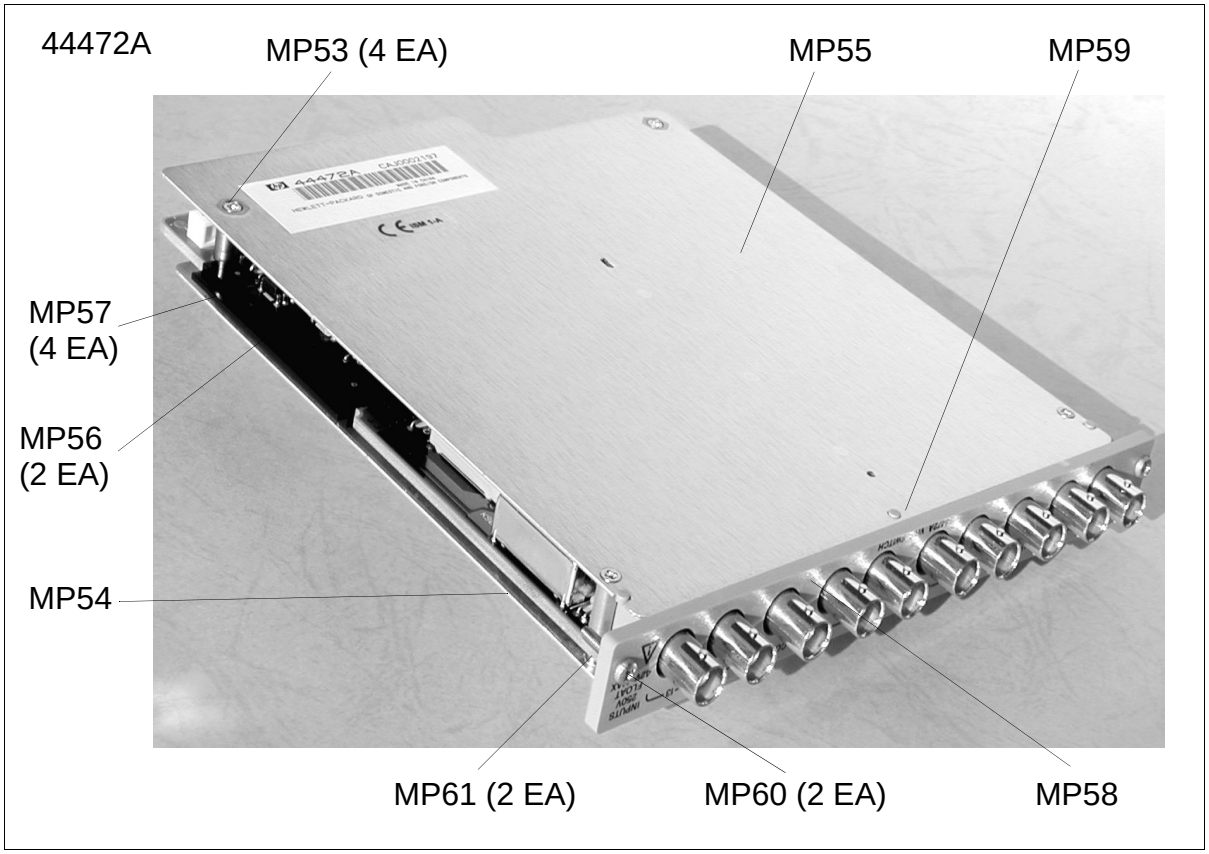


Figure 6-9. Mechanical Kits 3

Table 6-5. Mechanical Kits 3

Ref. Designation	Qty.	Description	Part Number (Kits 3)
MP53	4	SCREW M2.5 X 20 LK	0515-0843
MP54	1	SHIELD-VHF CIRCUIT	44472-00601
MP55	1	SHIELD-VHF COMP	44472-00602
MP56	2	GLIDE PC BOARD	5041-5213
MP57	4	PIN-GRV 3/32 X 1/4	1480-0625
MP58	1	PANEL-REAR VHF	44472-40201
MP59	1	SCREW M2.5 X 8 LK	0515-0403
MP60	2	SCREW, CAPTIVE	5180-8269
MP61	2	RING, RETATINER 3.58	0510-0043

Mechanical Kits 4 & 5

Figure 6-10 shows the replaceable mechanical parts (Kits 4 & 5) as listed in Table 6-6 on page 100.

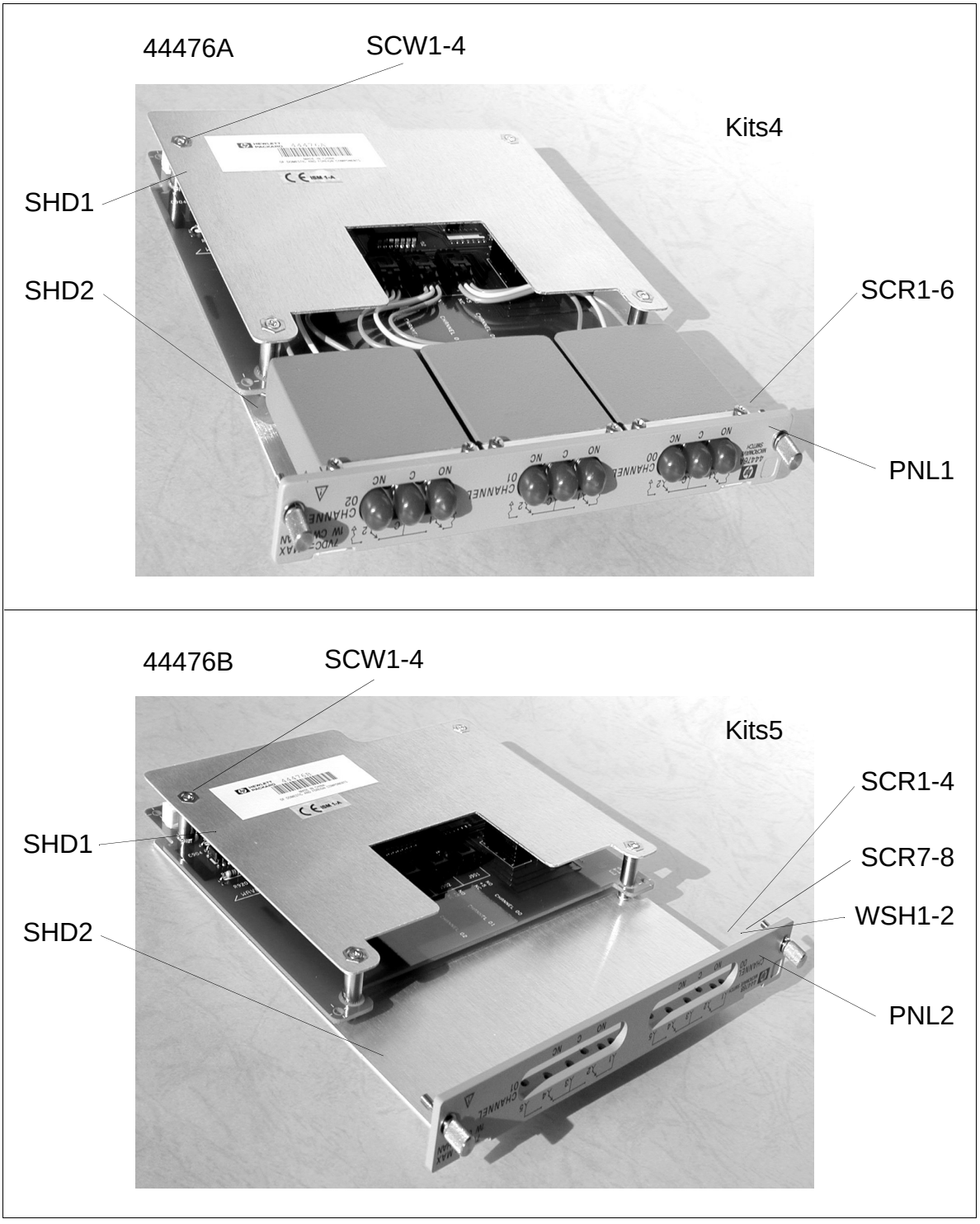


Figure 6-10. Mechanical Kits 4 & 5

Table 6-6. Mechanical Kits 4 & 5

Ref. Designation	Qty.	Description	Part Number	Application
SW1	1	33311B MICORWAVE SW 5V	33311	For 44476A only.
SW2	1			
SW3	1			
SCR1	1	SCREW-PANHEAD M2.5 X 18 LK	0515-1057	For 44476A/B.
SCR2	1			
SCR3	1			
SCR4	1			
SCR5	1			For 44476A only.
SCR6	1			
SCW1	1	SCREW-FLATHEAD M2.5 X 20 LK	0515-0843	For 44476A/B.
SCW2	1			
SCW3	1			
SCW4	1			
SHD1	1	SHIELD - CIRCUIT SIDE	44476-00601	
SHD2	1	SHIELD - COMPONENT SIDE	44476-00602	
PNL1	1	PANEL - Agilent 44476A	44476-00201	For 44476A only.
PNL2	1	PANEL - Agilent 44476B	44476-00202	For 44476B only.
SCR7	1	SCREW-PANHEAD M2.5 X 6mm LONG	0515-0905	
SCR8	1			
WSH1	1	WASHER-LOCK HLCL 2.5 MM 2.6 - MM - ID	2190-2583	
WSH2	1			

Mechanical Kits 6

Figure 6-11 shows the replaceable mechanical parts (Kits 6) as listed in Table 6-7.

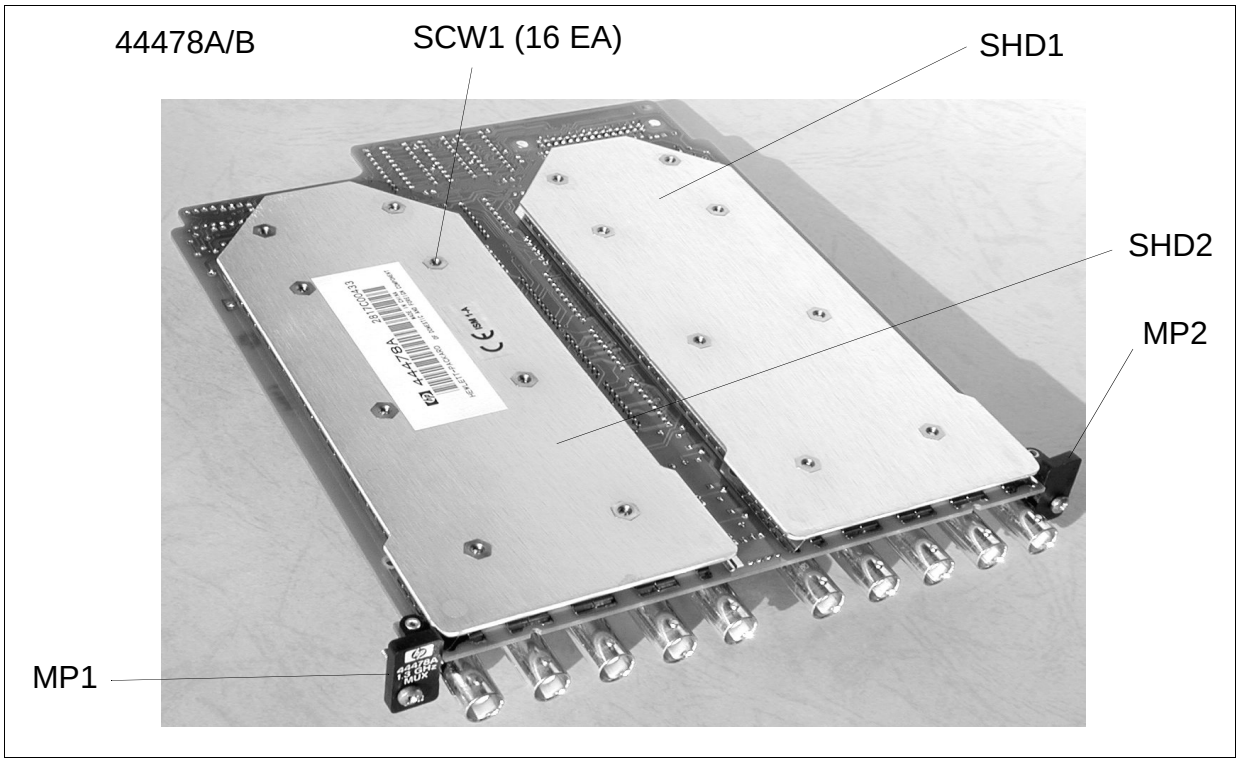


Figure 6-11. Mechanical Kits 6

Table 6-7. Mechanical Kits 6

Ref. Designation	Qty.	Description	Part Number (Kits 6)
MP1	1	BRACKET - LEFT	44478-41201
MP2	1	BRACKET - RIGHT	44478-41203
SCW1-16	16	SCREW-MACH M3.0 X 0.5 6MM-LG PAN-HD	0515-0211
SHD1	1	SHIELD - CIRCUIT SIDE	34505-00601
SHD2	1		

Mechanical Kits 7

Figure 6-12 shows the replaceable mechanical parts (Kits 7) as listed in Table 6-8.

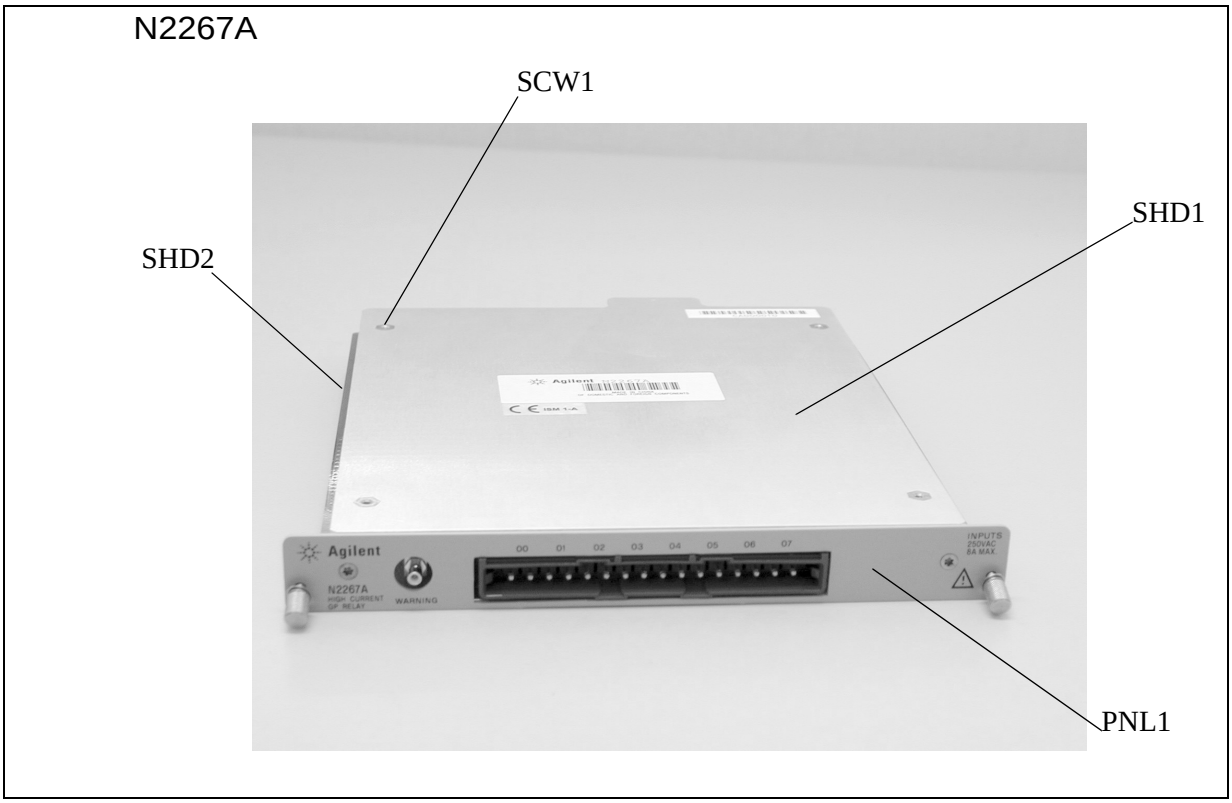


Figure 6-12. Mechanical Kits 7

Table 6-8. Mechanical Kits 7

Ref. Designation	Qty.	Description	Part Number
PNL1	1	FRONT-PANEL	N2267-00001
SCW1	4	SCRFHM2.5x20PZLK (SHEET METAL)	0515-0843
SHD1	1	TOP-SHIELD	N2267-00003
SHD2	1	BOTTOM-SHIELD	N2267-00002

Mechanical Kits 8

Figure 6-13 shows the replaceable mechanical parts (Kits 8) as listed in Table 6-9.

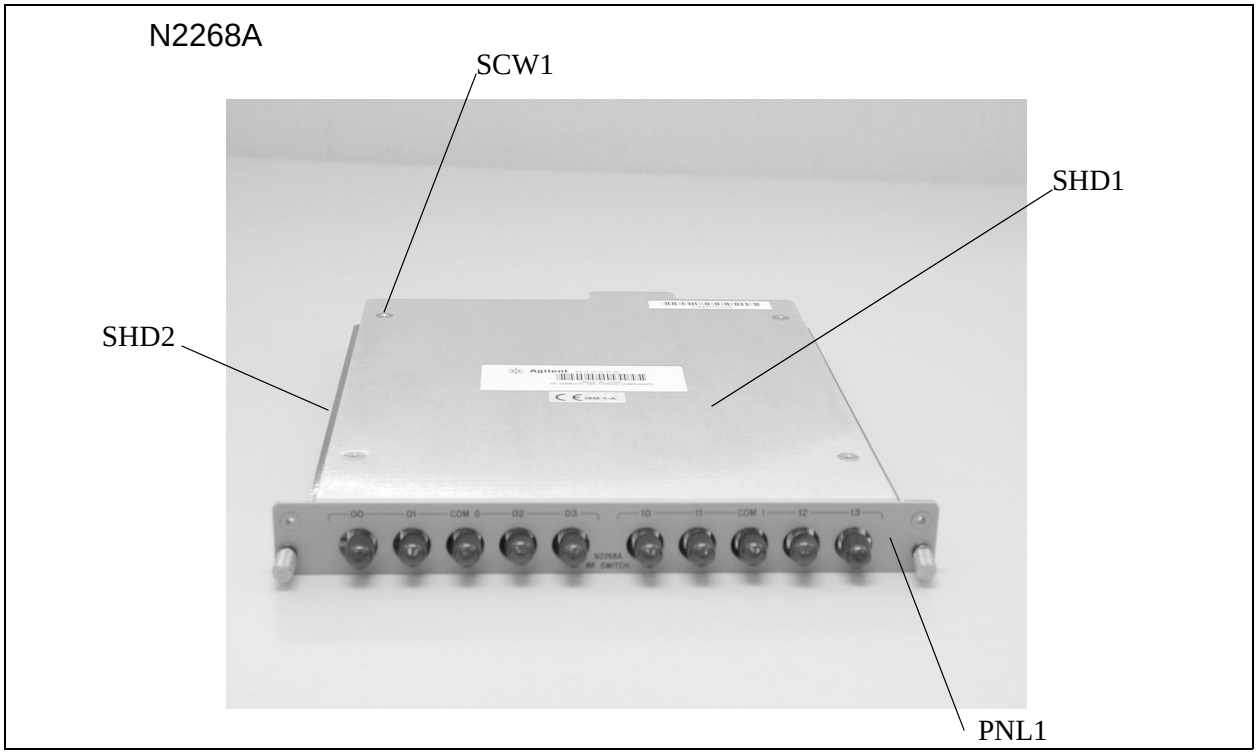


Figure 6-13. Mechanical Kits 8

Table 6-9. Mechanical Kits 8

Ref. Designation	Qty.	Description	Part Number
PNL1	1	FRONT-PANEL	N2268-00003
SCW1	1	SCREW M3.0-FLAT (SHEET METAL)	0515-1946
	2	SCRFHM2.5X20PZLK (SHEET METAL)	0515-0843
SHD1	1	TOP-SHIELD	N2268-00002
SHD2	1	BOTTOM-SHIELD	N2268-00001

Mechanical Kits 9

Figure 6-14 shows the replaceable mechanical parts (Kits 9) as listed in Table 6-10.

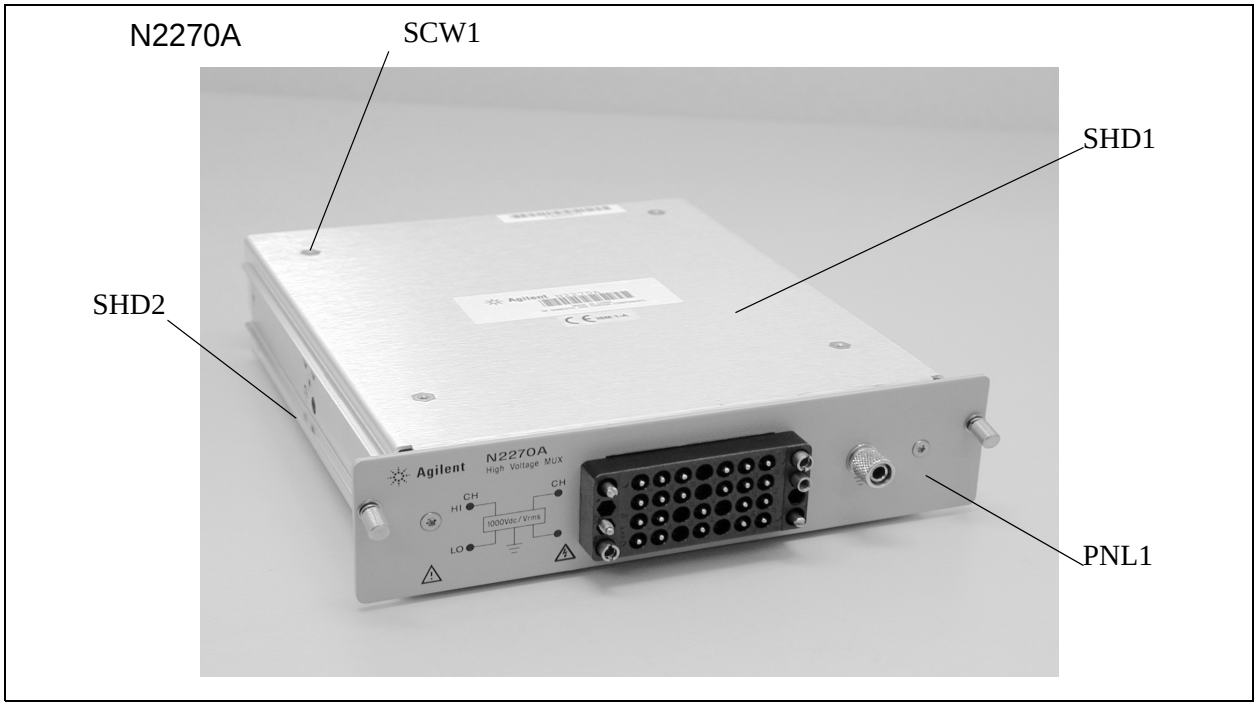


Figure 6-14. Mechanical Kits 9

Table 6-10. Mechanical Kits 9

Ref. Designation	Qty.	Description	Part Number
PNL1	1	FRONT-PANEL	N2270-00002
SCW1	8	SCREW M3.0-FLAT (AROUND)	0515-1946
SHD1	1	TOP-SHIELD	N2280-00004
SHD2	1	BOTTOM-SHIELD	N2270-00001

Mechanical Kits 10

Figure 6-15 shows the replaceable mechanical parts (Kits 10) as listed in Table 6-11.

N2272A



Figure 6-15. Mechanical Kits 10

Table 6-11. Mechanical Kits 10

Ref. Designation	Qty.	Description	Part Number
PNL1	1	FRONT-PANEL	N2272-40001
SHD1	1	TOP-SHIELD	N2272-00004
SHD2	1	SHIELD-COMP	N2272-00003

Mechanical Kits 11

Figure 6-16 shows the replaceable mechanical parts (Kits 10) as listed in Table 6-12.

N2276A/B



Figure 6-16. Mechanical Kits 11

Table 6-12. Mechanical Kits 11

Ref. Designation	Qty.	Description	Part Number
PNL1	1	FRONT-PANEL	N2276-00003
SHD1	1	TOP-COVER	N2276-00001
SHD2	1	BOTTOM-SHIELD	N2270-00002

Mechanical Kits 12

Figure 6-17 shows the replaceable mechanical parts (Kits 10) as listed in Table 6-13.

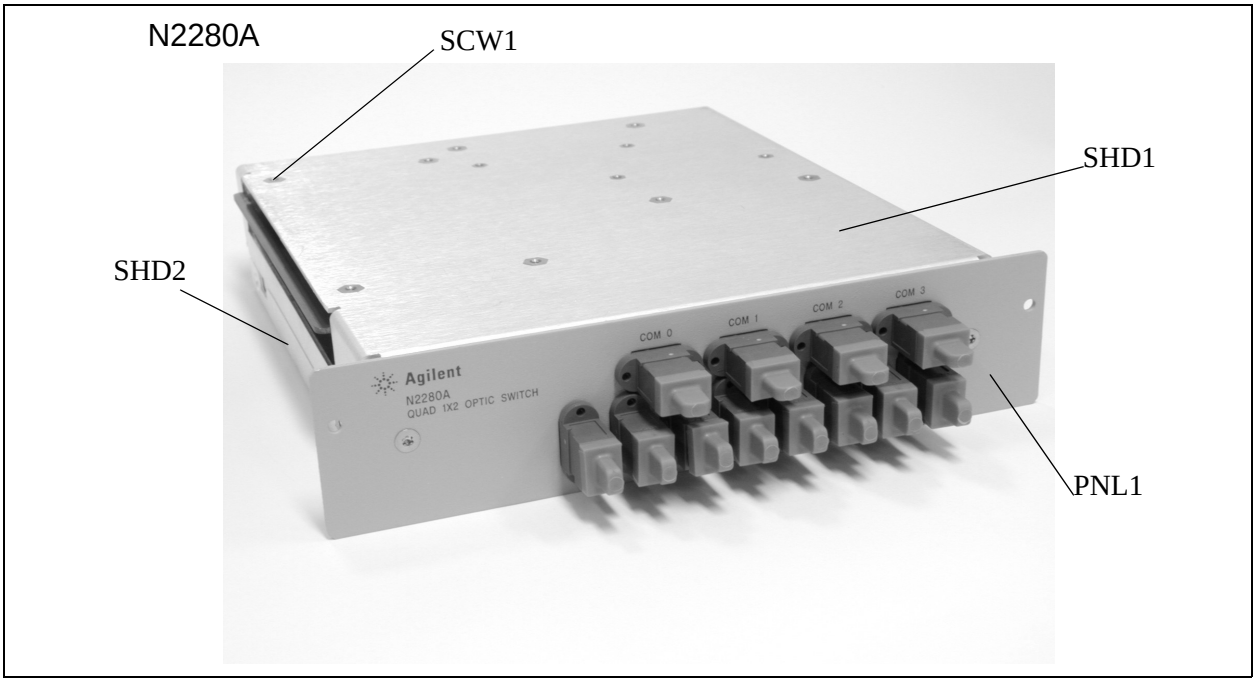


Figure 6-17. Mechanical Kits 12

Table 6-13. Mechanical Kits 12

Ref. Designation	Qty.	Description	Part Number
PNL1	1	FRONT-PANEL	N2280-00001
SCW1	8	SCREW M3.0-FLAT (AROUND)	0515-1946
SHD1	1	TOP-SHIELD	N2280-00004
SHD2	1	BOTTOM-SHIELD	N2280-00002

Mechanical Kits 13

Figure 6-18 shows the replaceable mechanical parts (Kits 11) as listed in Table 6-14.

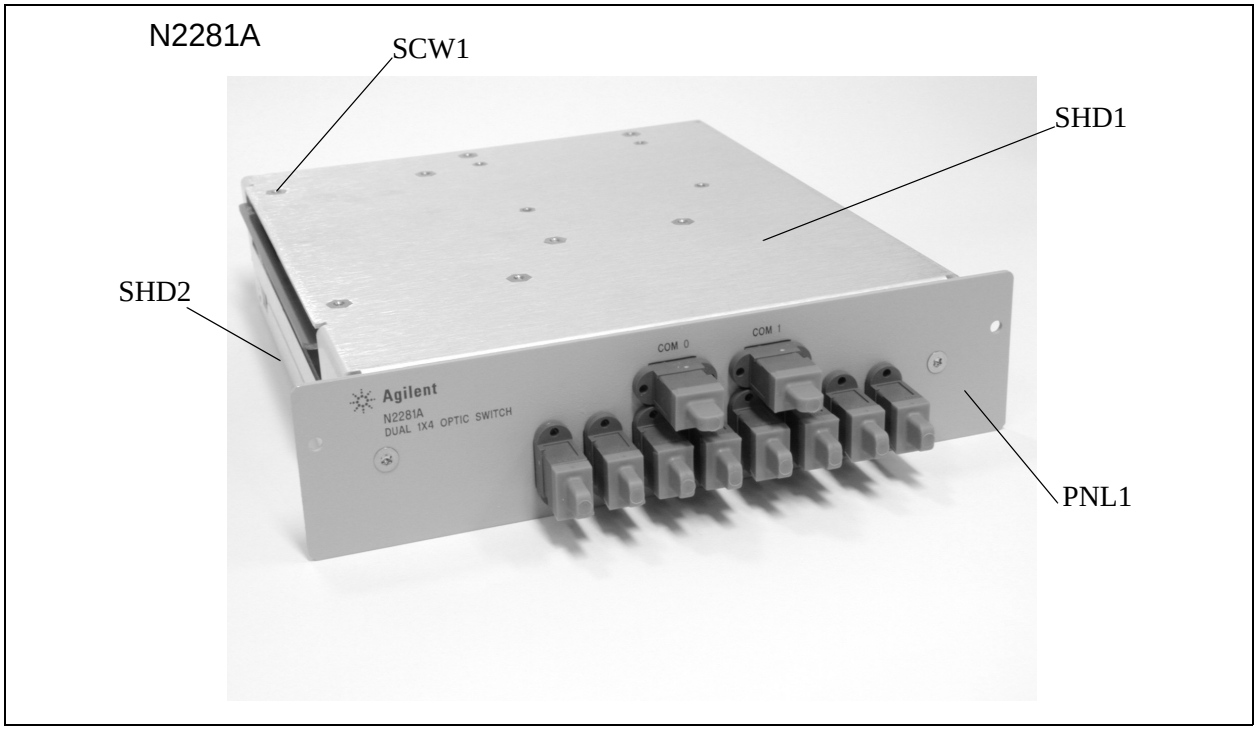


Figure 6-18. Mechanical Kits 13

Table 6-14. Mechanical Kits 13

Ref. Designation	Qty.	Description	Part Number
PNL1	1	FRONT-PANEL	N2281-00001
SCW1	8	SCREW M3.0-FLAT (AROUND)	0515-1946
SHD1	1	TOP-SHIELD	N2280-00004
SHD2	1	BOTTOM-SHIELD	N2281-00002

Mechanical Kits 14

Figure 6-19 shows the replaceable mechanical parts (Kits 14) as listed in Table 6-15.

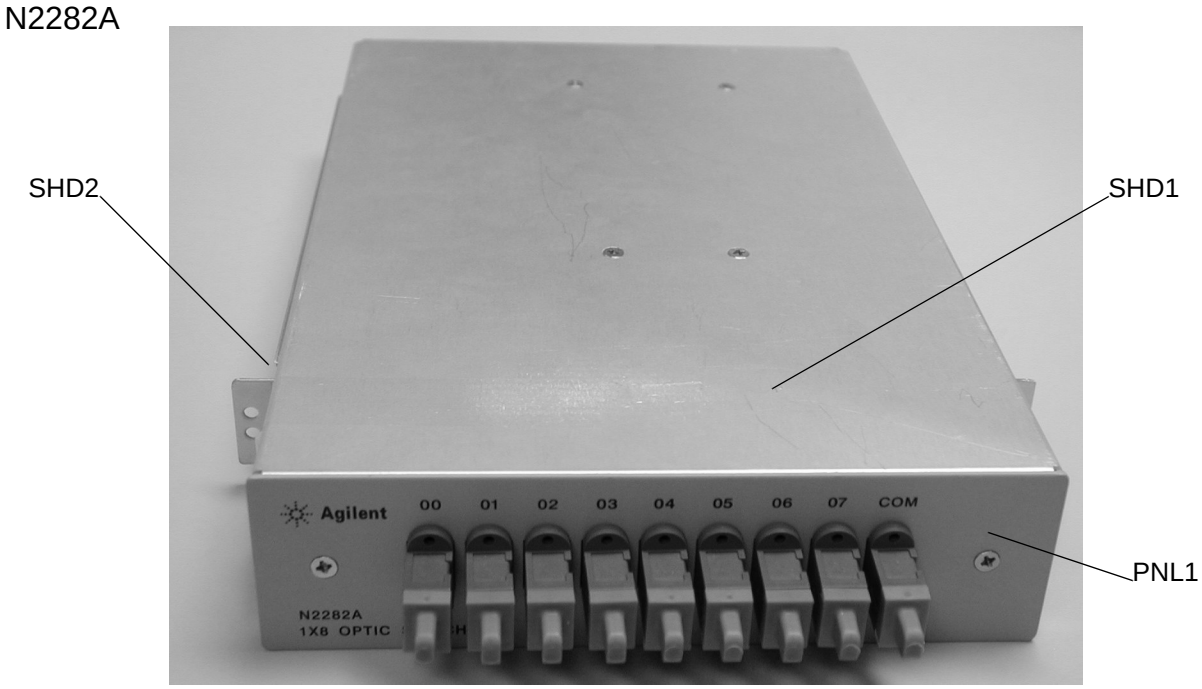


Figure 6-19. Mechanical Kits 14

Table 6-15. Mechanical Kits 14

Ref. Designation	Qty.	Description	Part Number
PNL1	1	FRONT-PANEL	N2282-00002
SHD1	1	TOP-SHIELD	N2282-00001
SHD2	1	BOTTOM-SHIELD	N2282-00003

Appendix A
Plug-in Modules Wiring Information

BNC and SMA Connection

The modules listed in Table 6-16 provide BNC or SMA connections to external devices.

Table 6-16. BNC & SMA Connection

Connection Type	Quantity	Module Description
BNC Connector	10	Agilent 44472A Dual 4-Channel VHF Switch Module
	10	Agilent 44478A 50Ω 1.3 GHz MUX Module
	10	Agilent 44478B 75Ω 1.3 GHz MUX Module
	10	Agilent N2272A 1GHz RF 1-to-9 MUX Module
SMA Connector	9	Agilent 44476A 3-Channel 18 GHz Switch Module
	6[1]	Agilent 44476B 2-Channel Microwave Switch Module
	10	Agilent N2268A 50Ω 3.0 GHz Dual 1-to-4 MUX Module

[1]. The number of SMA connectors depends on the specified microwave modules installed. If the two modules are 5-port, the number of SMA connectors is 10, and so on.

Screw Terminal Blocks

A set of screw terminal blocks are available for wiring conveniences, as listed in Table 6-17. Figure 6-20 through Figure 6-23 illuminate wiring for the three screw terminal block types.

Table 6-17. Screw Terminal Blocks

Screw Terminal Block (Wiring Inf.)	Agilent P/N	Application
Type A[1] (Figure 6-20 on Page 112 & Figure 6-21 on Page 113)	Agilent 44480A	For Agilent 44470A module only (default).
	Agilent 44481A	For Agilent 44471A module only (default).
	Agilent 44483A	For Agilent 44473A module only (default).
	Agilent 44484A	For Agilent 44474A module only (default).
	Agilent 44485A	For Agilent 44475A module only (default).
	Agilent 44487A	For Agilent 44477A module only (default).
Type B (Figure 6-22 on Page 114)	Agilent 44480B	For Agilent 44470D module only (default).
	Agilent 44481B	For Agilent 44471D module only (default).

Table 6-17. Screw Terminal Blocks

Screw Terminal Block (Wiring Inf.)	Agilent P/N	Application
Type C[2] (Figure 6-23 on Page 115)	Agilent N2290A	For Agilent N2260A module only.
	Agilent N2291A	For Agilent N2261A module only.
	Agilent N2292A	For Agilent N2262A module only.
	Agilent N2293A	For Agilent N2263A module only.
	Agilent N2294A	For Agilent N2264A module only.
	Agilent N2295A	For Agilent N2265A module only.
	Agilent N2329A	For Agilent N2269A module only.

[1]. Types A & B of the screw terminal blocks are provided with the ordered modules.
[2]. Type C of the screw terminal blocks must be ordered separately.

Screw Terminal Block Wiring (Type A)

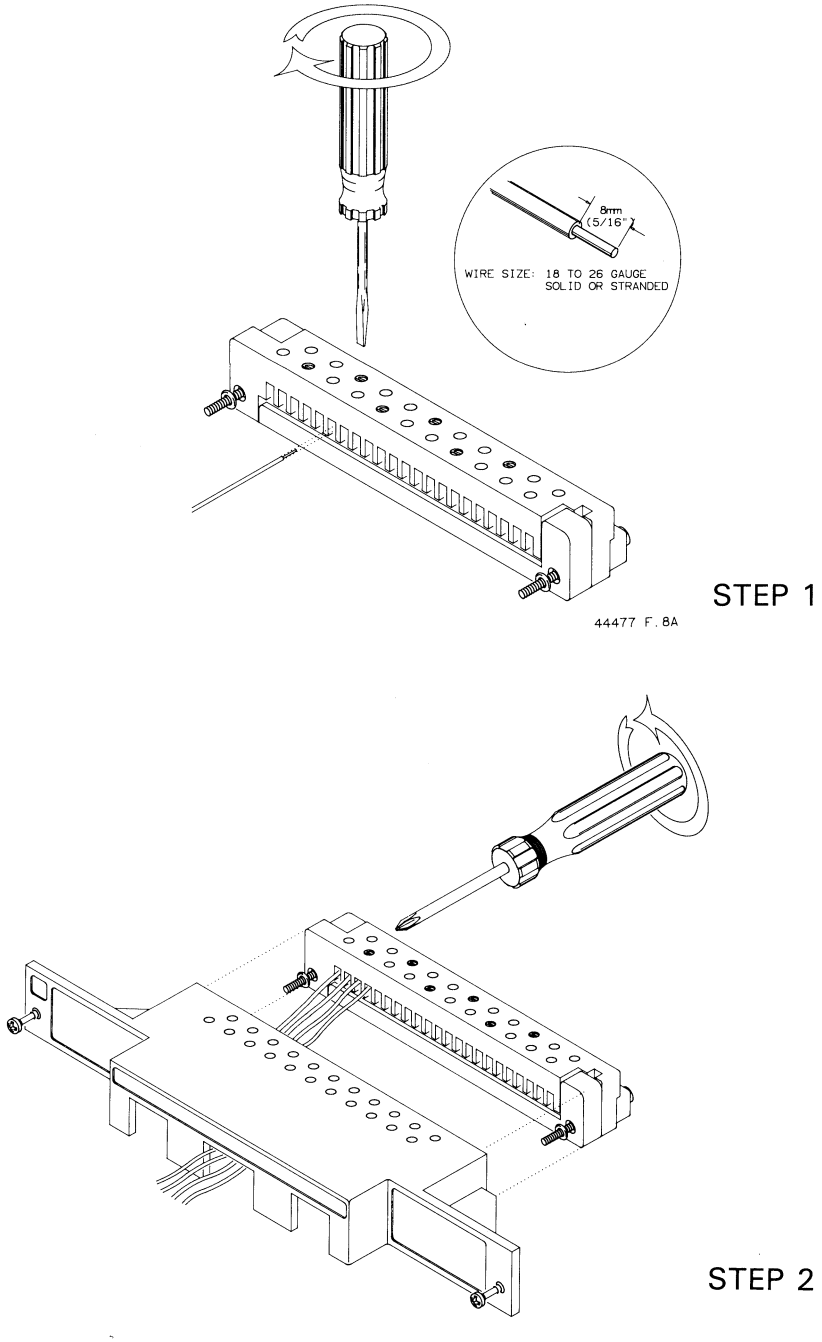


Figure 6-20. Type A Screw Terminal Block Wiring

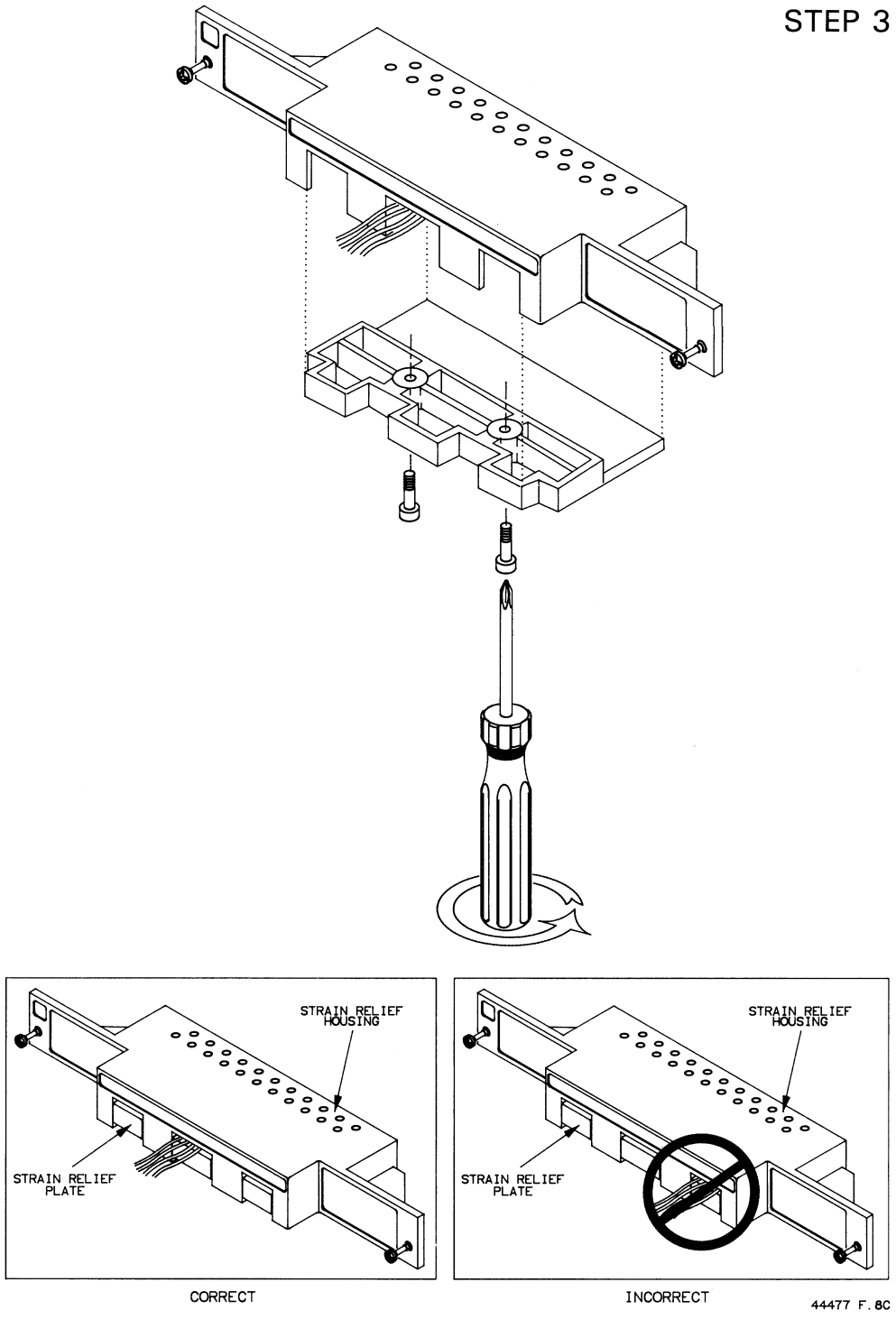


Figure 6-21. Type A Screw Terminal Block Wiring (Cont'd)

Screw Terminal Block Wiring (Type B)

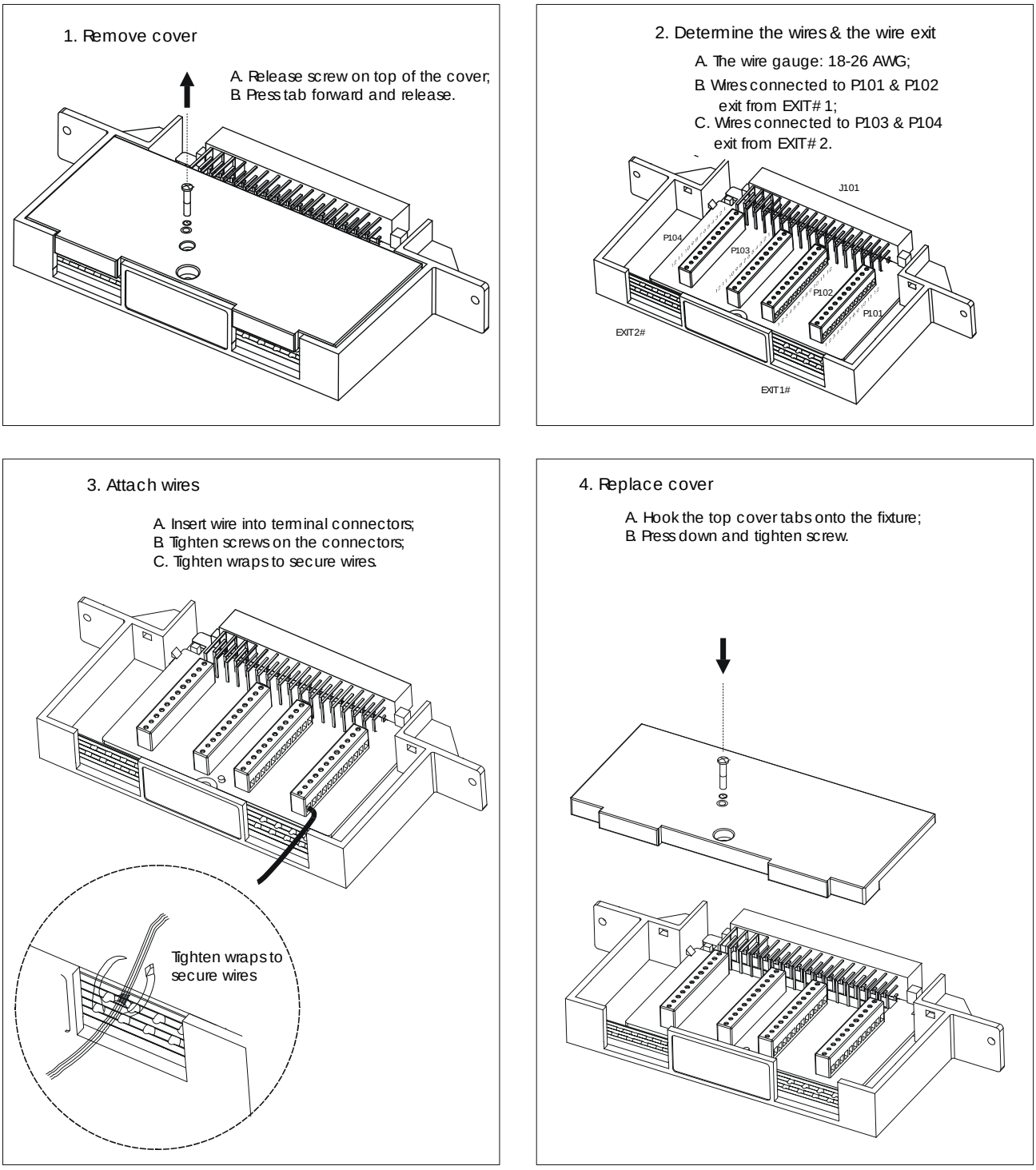


Figure 6-22. Type B Screw Terminal Block Wiring

Screw Terminal Block Wiring (Type C)

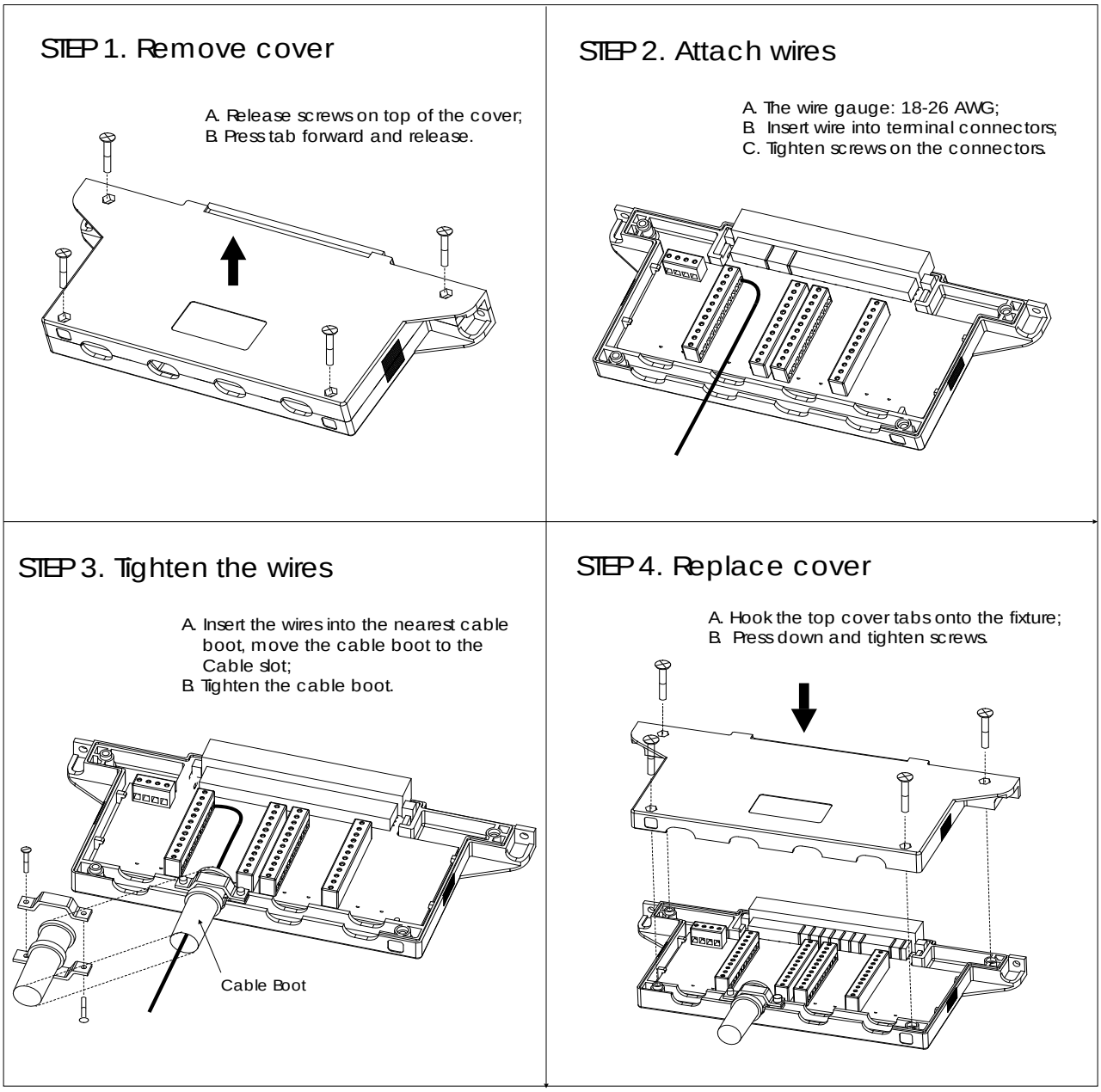


Figure 6-23. Type C Screw Terminal Block Wiring

Crimp-and-insert Terminal Block

Agilent N2296A is a crimp-and-insert terminal block for Agilent N2260A, N2261A, N2262A, N2263A, N2264A and N2265A. It provides a flexibility for connecting the above modules to external devices. The wiring procedure for the Agilent N2296A is shown in Figure 6-24.

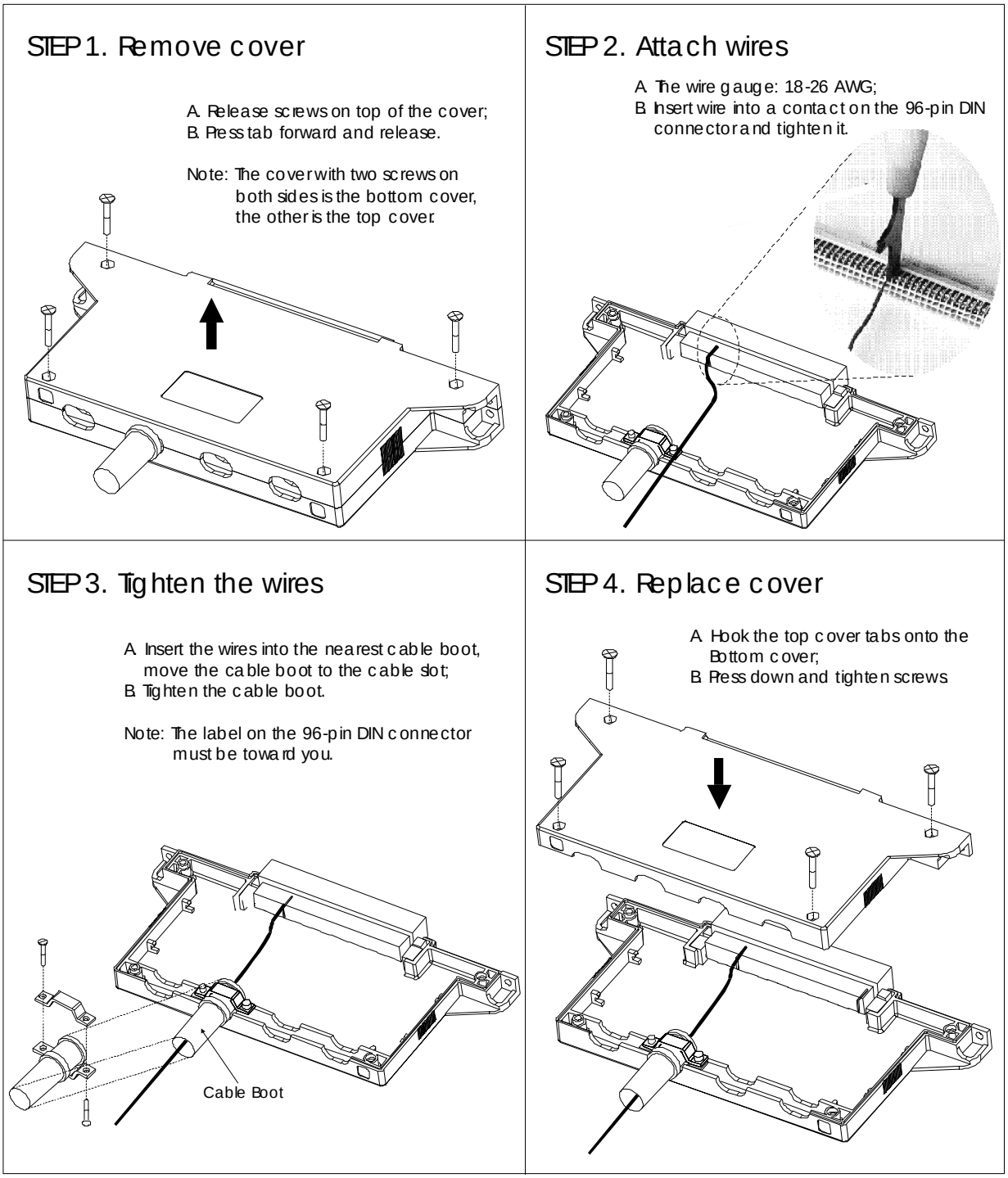


Figure 6-24. Crimp-and-Insert Terminal Block Wiring

Connector Kits

Agilent N2327A is a Connector Kit used for Agilent N2267A High Current GP module and Agilent N2320A is for Agilent N2270A High Voltage MUX module. The Wiring Sequence of the two Connector Kits are illustrated below.

Agilent N2327A Wiring Sequence

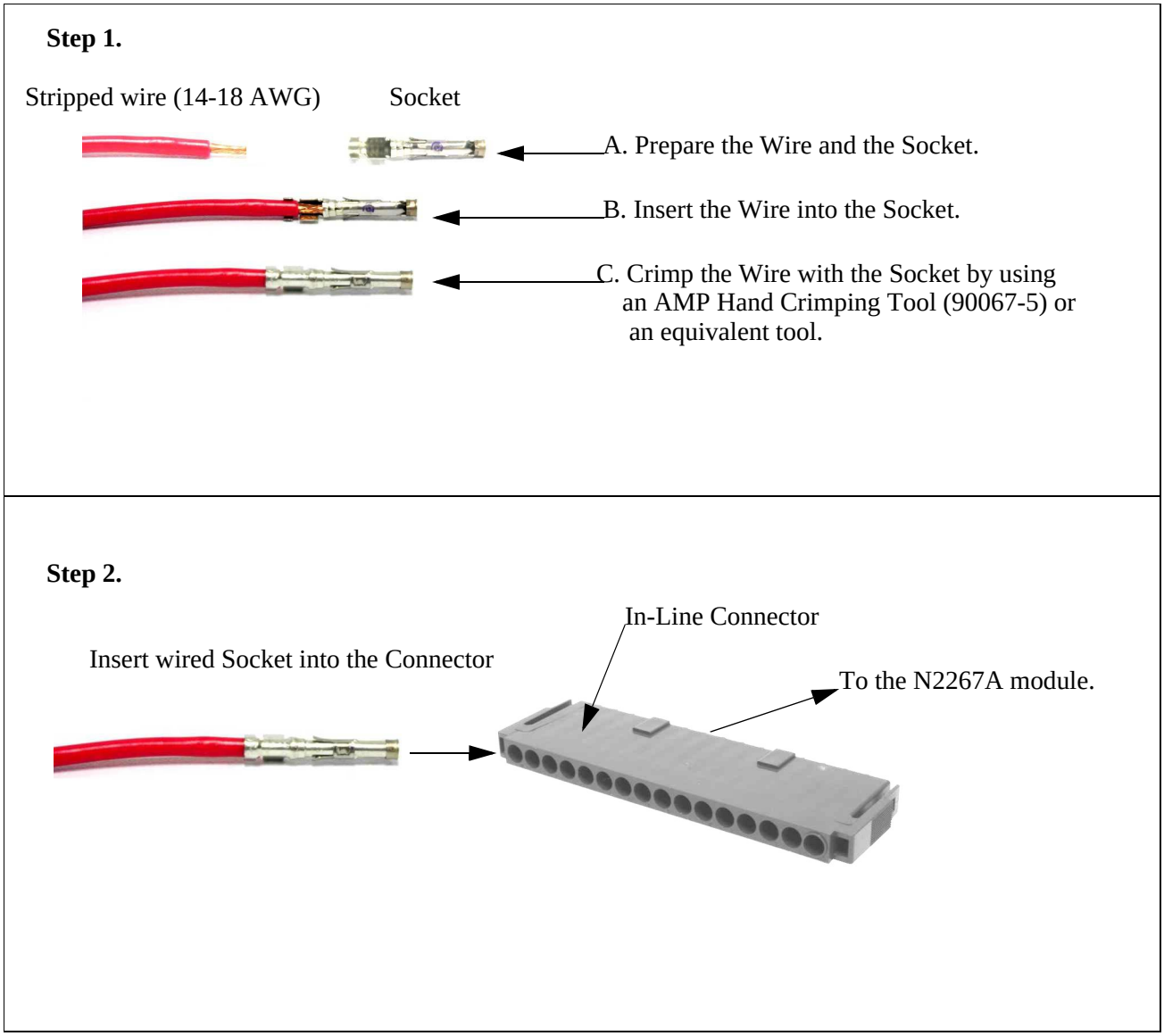
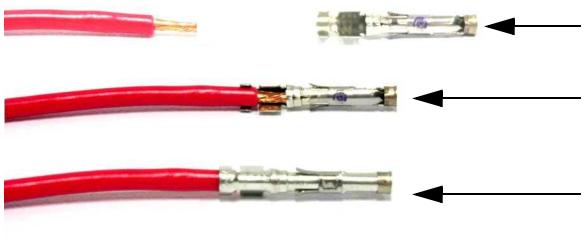


Figure 6-25. Agilent N2327A Connector Kit Wiring Sequence

Agilent N2320A
Wiring Sequence

Step 1.

Stripped wire (20-24 AWG) Socket



A. Prepare the Wire and the Socket.

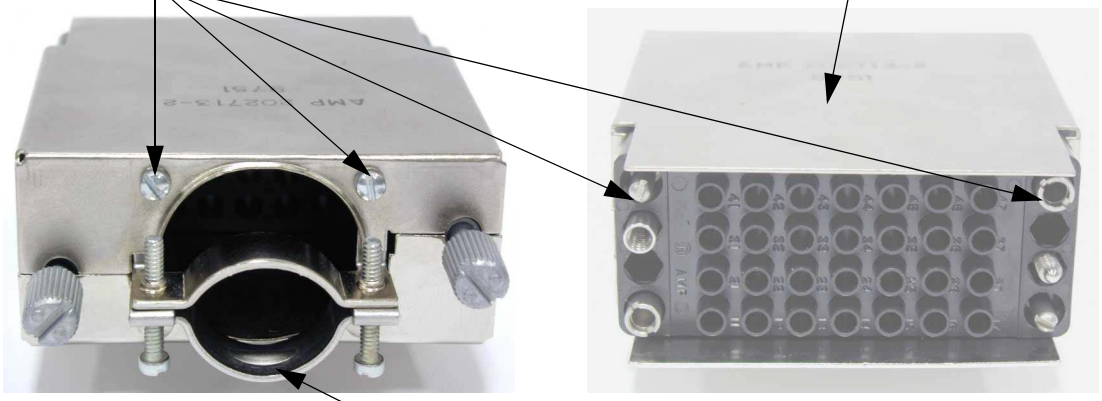
B. Insert the Wire into the Socket.

C. Crimp the Wire with the Socket by using an AMP Hand Crimping Tool (90067-5) or an equivalent tool.

Step 2.

Release the four screws and uncover the upper metal shield

Upper metal shield



Rear view

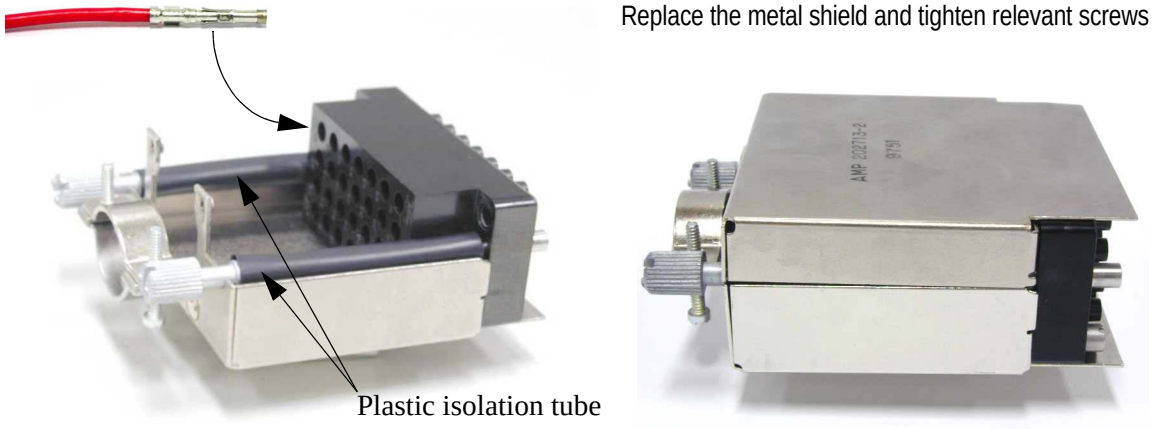
Metal strain relief clamp

Front view

Step 3.

Insert wired Socket into the Receptacle

Replace the metal shield and tighten relevant screws



Plastic isolation tube

The strain relief clamp can be used to tighten wires with additional insulation around them. Additional insulation should be used around the wires to prevent possible damage caused by the strain relief clamp.

Figure 6-26. Agilent N2320A Connector Wiring Sequence

DIN-TO-D Cables

Three DIN-to-D cables are available for the Agilent N22XX series modules. The 96-pin female DIN connectors at one end of the cables are used to connect the plug-in modules, and the other ends are either 50-pin or 25-pin female sub-D connectors, as listed in Table 6-18.

Table 6-18. DIN-TO-D Cables

Agilent P/N	Description	Application
Agilent N2297A	**DIN96-TO-TWIN-D50 CABLE:** 1.5-meter round cable terminated with a 96-pin female DIN connector at one end, two 50-pin male sub-D connectors at another end	For Agilent N2260A/61A/62A/63A/64A/65A.
Agilent N2298A	**DIN96-TO-D25 CABLE:** 1.5-meter round cable terminated with a 96-pin female DIN connector at one end, a 25-pin male sub-D connector at another end.	For Agilent N2262A only.
Agilent N2299A	**DIN96-TO-QUAD-D25 CABLE:** 1.5-meter round cable terminated with a 96-pin female DIN connector at one end, four 25-pin male sub-D connectors at another end	For Agilent N2260A/61A/62A/63A/64A/65A.

Agilent N2297A

Figure 6-27 shows an Agilent N2297A. The wire gauge is 26 AWG (which meets UL AWM: 2464), the maximum voltage is 200 volts per wire. The connection between the 96-pin female DIN connector and the two 50-pin sub-D male connectors is also listed.

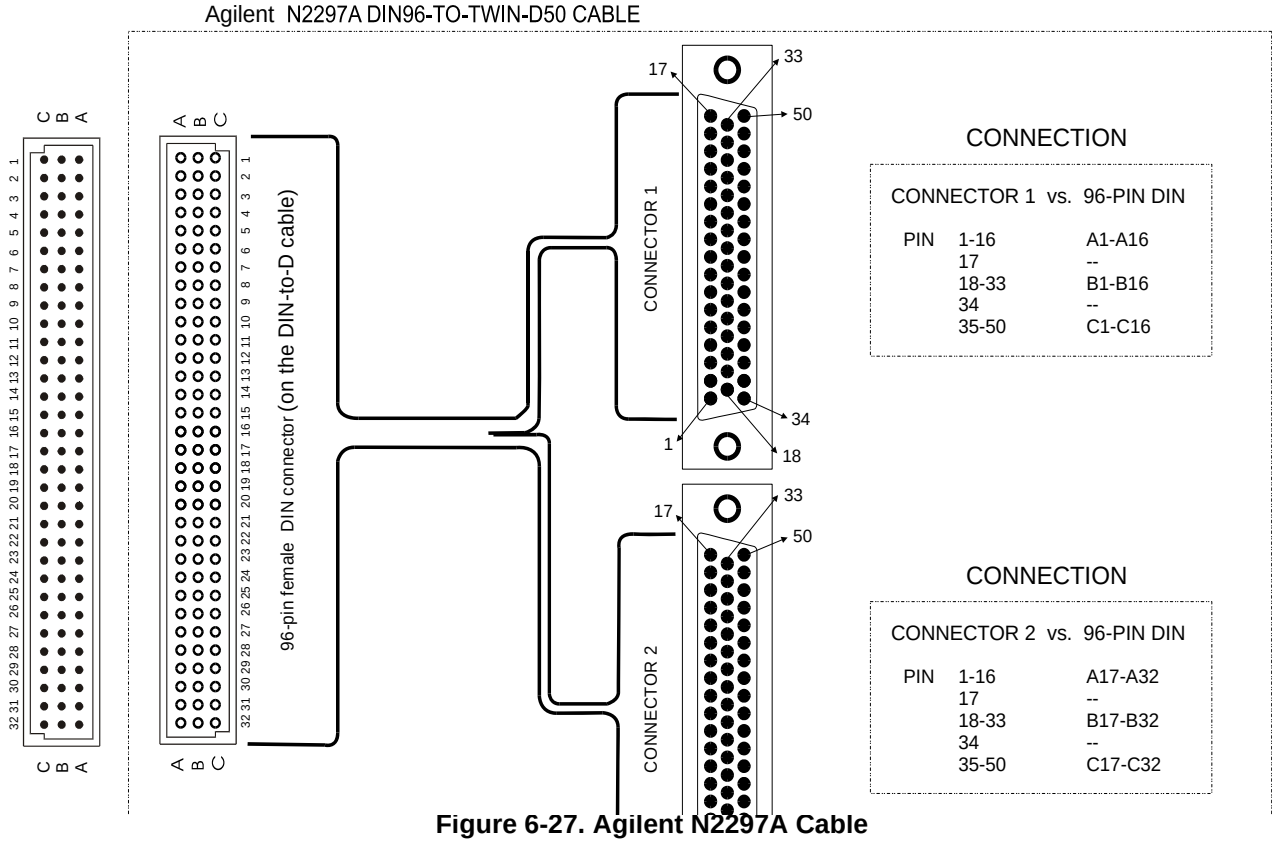


Figure 6-27. Agilent N2297A Cable

Agilent N2298A

Figure 6-28 shows an Agilent N2298A. The wire gauge is 24 AWG (which meets UL AWM: 2464), the maximum voltage is 200 volts per wire. The connection between the 96-pin female DIN connector and the 25-pin sub-D male connector is also listed.

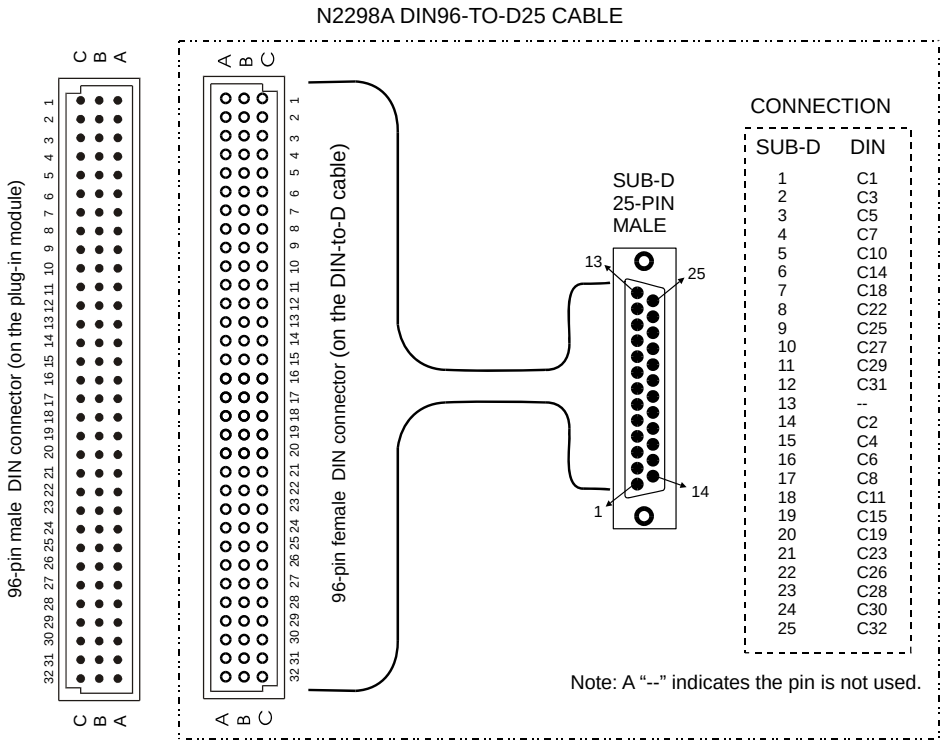
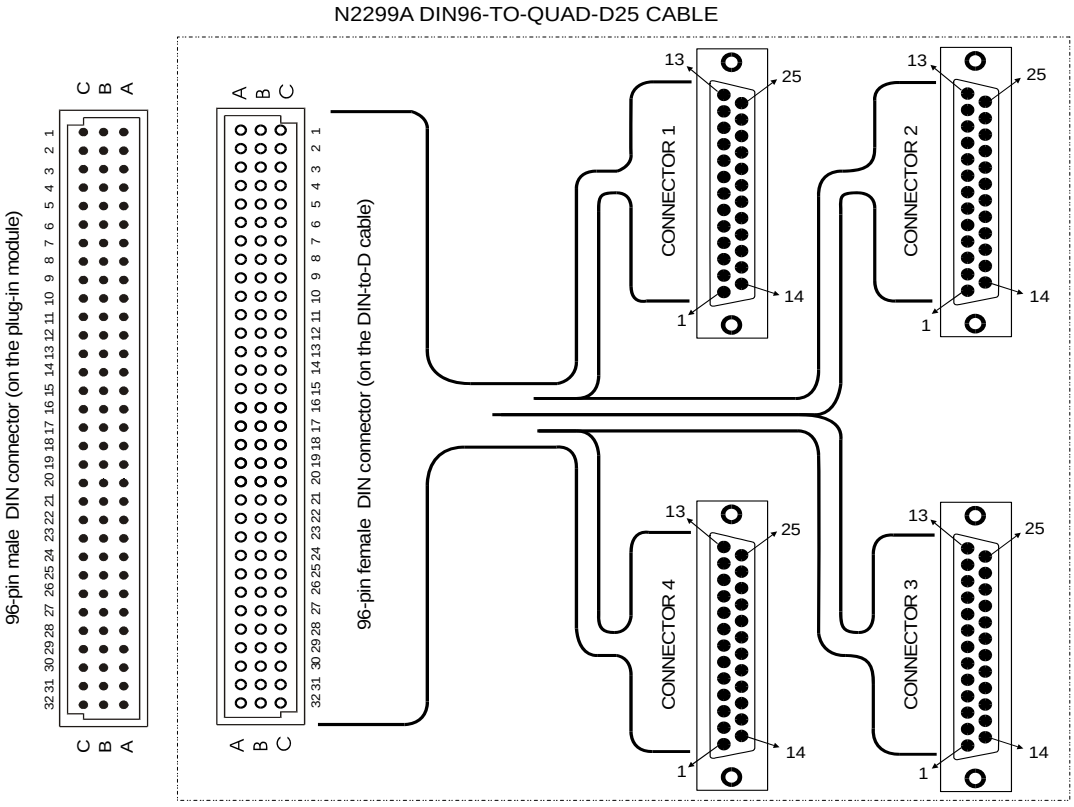


Figure 6-28. Agilent N2298A Cable

Agilent N2299A

Figure 6-29 on Page 121 shows an Agilent N2299A. The wire gauge is 24 AWG (which meets UL AWM: 2464), the maximum voltage is 200 volts per wire. The connection between the 96-pin female DIN connector and the four 25-pin sub-D male connectors is also listed.



CONNECTOR 1 vs. 96-PIN DIN

SUB-D	DIN
1	A1
2	B1
3	C1
4	A3
5	B3
6	C3
7	A5
8	B5
9	C5
10	A7
11	B7
12	C7
13	--
14	A2
15	B2
16	C2
17	A4
18	B4
19	C4
20	A6
21	B6
22	C6
23	A8
24	B8
25	C8

CONNECTOR 2 vs. 96-PIN DIN

SUB-D	DIN
1	A9
2	B9
3	C9
4	A11
5	B11
6	C11
7	A13
8	B13
9	C13
10	A15
11	B15
12	C15
13	--
14	A10
15	B10
16	C10
17	A12
18	B12
19	C12
20	A14
21	B14
22	C14
23	A16
24	B16
25	C16

CONNECTOR 3 vs. 96-PIN DIN

SUB-D	DIN
1	A17
2	B17
3	C17
4	A19
5	B19
6	C19
7	A21
8	B21
9	C21
10	A23
11	B23
12	C23
13	--
14	A18
15	B18
16	C18
17	A20
18	B20
19	C20
20	A22
21	B22
22	C22
23	A24
24	B24
25	C24

CONNECTOR 4 vs. 96-PIN DIN

SUB-D	DIN
1	A25
2	B25
3	C25
4	A27
5	B27
6	C27
7	A29
8	B29
9	C29
10	A31
11	B31
12	C31
13	--
14	A26
15	B26
16	C26
17	A28
18	B28
19	C28
20	A30
21	B30
22	C30
23	A32
24	B32
25	C32

Note: A "--" indicates the pin is not used.

Figure 6-29. Agilent N2299A Cable

Appendix B
Error Messages

Agilent 3499A/B/C Switch/Control System can be operated in either SCPI mode or 3488A mode. The error messages are different in different system modes. This Appendix lists all these error messages.

In SCPI Mode

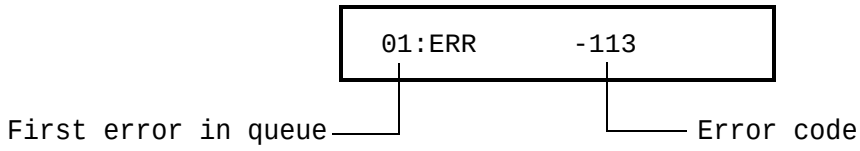
- Errors are retrieved in first-in-first-out (FIFO) order. The first error returned is the first error that was stored. Errors are cleared as you read them. When you have read all errors from the queue, the ERROR annunciator turns off and the errors are cleared. The instrument beeps once each time an error is generated.

- If more than 10 errors have occurred, the last error stored in the queue (the most recent error) is replaced with -350, "Queue overflow". No additional errors are stored until you remove errors from the queue. If no errors have occurred when you read the error queue, the instrument responds with +0, "No error".

- The error queue is cleared by the *CLS (clear status) command or when power is cycled. The errors are also cleared when you read the queue. The error queue is not cleared by an instrument reset (*RST command) or a card/module reset (SYSTem:CPON command).

- ***Front-Panel Operation:***

  If the ERROR annunciator is on, press **View** to view the errors stored in the queue. Use the knob to scroll through the error numbers. Press the arrow key (right) to view the text of the error message. All errors are cleared when you exit the menu.



- ***Remote Interface Operation:***

  SYSTem:ERRor? Read and clear one error from the error queue

  Errors have the following format (the error string may contain up to 80 characters):

  -113, "Undefined header".

Execution Errors

-101 **Invalid character**

An invalid character was found in the command string. You may have used an invalid character such as #, {, $, or % in the command header or within a parameter.
Example: *OPEN {@101)*

-102 **Syntax error**

Invalid syntax was found in the command string. You may have inserted a blank space before or after a colon in the command header, or before a comma. Or you may have omitted the ‘‘@’’ character in the channel list syntax.
Examples: *ROUT:CHAN: DEL 1 or ROUT:OPEN (101:102)*

-103 **Invalid separator**

An invalid separator was found in the command string. You may have used a comma instead of a colon, semicolon, or blank space -- or you may have used a blank space instead of a comma.
Example: *TRIG:COUNT,1*

-105 **GET not allowed**

A Group Execute Trigger (GET) is not allowed within a command string.

-108 **Parameter not allowed**

More parameters were received than expected for this command. You may have entered an extra parameter or added a parameter to a command that does not require a parameter.
Example: *ROUT:CLOS:STAT? 2*

-109 **Missing parameter**

Fewer parameters were received than were expected for this command. You have omitted one or more parameters that are required for this command.
Example: *ROUT:CHAN:DEL 10,*

-112 **Program mnemonic too long**

A command header was received which contained more than the maximum 12 characters allowed.
Example: *CONFIGURE:EXTERNAL:TRIGGER:SOURCE 2*

-113 **Undefined header**

A command was received that is not valid for this instrument. You may have misspelled the command or it may not be a valid command. If you are using the short form of this command, remember that it may contain up to four letters.
Examples: *TRIGG:SOUR TIM*

-121 **Invalid character in number**

An invalid character was found in the number specified for a parameter.
Example: *TRIG:TIMER 12..34*

-123 **Exponent too large**

A numeric parameter was found whose exponent was large than 32,000.

-124 **Too many digits**

A numeric parameter was found whose mantissa contained more than 255 digits, excluding leading zeros.

-128 **Numeric data not allowed**

The wrong parameter type was found in the command string. You may have specified a number where a string or expression was expected, or vice versa.
Examples: *DISP:TEXT 5.0 or ROUT:CLOSE 101*

-131 Invalid suffix

A suffix was incorrectly specified for a numeric parameter. You may have misspelled the suffix.

-134 Suffix too long

A header suffix is the number that can be appended to the end of some command headers. This error is generated if the header suffix contains more than 12 characters.

-138 Suffix not allowed

A suffix was received following a numeric parameter. You may have misspelled the suffix.

-148 Character data not allowed

A discrete parameter was received but a character string or a numeric parameter was expected. Check the list of parameters to verify that you have used a valid parameter type.
Examples: *ROUTE:CLOSE CH101 or DIAG:DISP TEXT123 (the string must be enclosed in quotes)*

-151 Invalid string data

An invalid character string was received. Check to see if you have enclosed the character string in quotation marks and verify that the string contains valid ASCII characters.
Example: *DIAG:DISP 'TESTING (the ending quote is missing)*

-158 String data not allowed

A character string was received but is not allowed for this command. Check the list of parameters to verify that you have used a valid parameter type.

-161 Invalid block data

For a definite-length block, the number of types of data sent does not match the number of bytes that you specified in the block header

-168 Block data not allowed

Data was sent to the instrument in SCPI definite length block format but this command does not accept this format.

-178 Expression data not allowed

A channel list was received but is not allowed for this command.
Example: *SYST:CTYPE? (@100)*

-222 Data out of range

A numeric parameter value is outside the valid range for this command.
Example: *ARM:COUNT -3*

-223 Too much data

A character string was received but could not be executed because the string length was more than 12 characters. This error can be generated by the DIAGnostic:DISPlay command.

-224 Illegal parameter value

A discrete parameter was received which was not a valid choice for this command. You may have used an invalid parameter choice.
Example: *TRIG:SOURCE ALARM (ALARM is not a valid choice)*

-310 System error

A firmware defect has been found. This is not a fatal error but you should contact your nearest Agilent Technologies Service Center if this error is reported.

-350 Queue overflow

The error queue is full because more than 10 errors have occurred. No additional errors are stored until you remove errors from the queue. The error queue is cleared by the *CLS

(clear status) command or when power is cycled. The errors are also cleared when you read the queue.

-410 **Query INTERRUPTED**

A command was received which sends data to the output buffer, but the output buffer contained data from a previous command (the previous data is not overwritten). The output buffer is cleared when power has been off or after a bus Device Clear.

-420 **Query UNTERMINATED**

The instrument was addressed to talk (i.e., send data over the interface) but a command has not been received which sends data to the output buffer. For example, you may have executed a CONFigure command (which does not generate data) and then attempted to read data from the remote interface.

-430 **Query DEADLOCKED**

A command was received which generates too much data to fit in the output buffer and the input buffer is also full. Command execution continues but all data is lost.

-440 **Query UNTERMINATED after indefinite response**

The *IDN? command must be the last query command within a command string. The *IDN? command returns an indefinite length string which cannot be combined with any other query command.
Example: **IDN?;*STB?*

Instrument Errors

100[1] **Number of SAV/RCL out of range**

Up to 50/10 channel setups (1-50/10) can be stored and recalled. This error will occur if a number included in *SAV/*RCL is not between 1 and 50/10.
Examples: **SAV 52 or *RCL 0*

101 **Unable to recall - scan is running**

102 **Unable to recall - memory is empty**

103 **Unable to recall - modules were changed**

Before recalling a stored channel setup, the instrument verifies the same module types are installed in each slot. This error indicates that the instrument has detected one or multiple modules in the specific slots have been replaced with other types or removed from the instrument.

104 **Unable to store - scan is running**

110 **Slot number out of range**

The specified slot number is invalid. The channel number has the form (@snn), where s is the slot number and nn is the channel number.
Example: *OPEN (@604)*

111 **Data out of range**

The data for some commands is invalid.
Example: *SOUR:DIG:DATA:BYTE:VAL 266 (valid data should be 0-255)*

1. Up to 50 instrument setups can be stored under Firmware REV 4.0 or later and 10 setups under Firmware REV 1.0/2.0/3.0.

112 **Not able to perform requested operation**

The requested operation is not valid for the instrument.
Example: *FUNC 3,BIWIRE2 (the module in Slot 3 is not an Agilent N2260A).*

113 **Block name not exist**

In an Agilent 3499A/B/C, maximum two blocks can be defined. The two defined blocks can be read and written, etc. If you read or write a block that has not been previously defined, this error occurs.

114 **Block name already exist**

The instrument has detected a defined block name, while you are to define it once more.

115 **Two Blocks already exist**

The instrument has detected two defined block names while you are to define them once more.

116 **Channel number out of range**

The specified channel number is invalid for the module in the selected slot. The channel number has the form (@snn), where s is the slot number and nn is the channel number.
Example: *ROUT:CLOSE (@156)*

201 **Scan list is empty**

202 **Scan initiated**

203 **Scan init ignored**

204 **Trig ignored**

205 **Hardware trigger too fast**

206 **Too many channels**

207 **Card in use.**

208 **N2282A execution error.**

300 **Unable to execute this command in local mode**

501 **RS232 data receiving error**

502 **Internal command error**

503 **RS232 only - unable to execute on GPIB**

There are three commands which are allowd only with the RS-232 interface: SYSTem:LOCal, SYSTem:REMote, SYSTem:RWLock.

Self-Test Errors

The errors listed in Table 6-19 indicate failures that may occur during a self-test (in SCPI mode).

Table 6-19. Self -Test Errors

Error Number	Description
+1	ROM test failed.
+2	GPIB test failed.
+3	RS-232 test failed.
+4	Front-panel test failed.

Note A string “+0” read back (with command *TST) indicates that all the tests have passed. In this case, a string “PASSED” displays on the front panel of the instrument.

In 3488A Mode

Error Conditions

In 3488A mode, you can also query the error queue when the ERROR annuciator is on. The returned decimal value is equal to the sum of the values of the possible error conditions, as defined in Table 6-20.

Table 6-20. Error Conditions in 3488A Mode

Weighted Value	Error Condition
1	Syntax Error
2	Execution Error which include: a. Parameter out of range; b. Module type mismatch; c. Attempt to access a nonexistent stored state or scan list.
4	Hardware Trigger too fast
8	Logical Failure
16	Power Supply Failure

Note A string "+00000" read back (with the command ERROR**)** indicates that the error queue is empty. In this case, a string "0000" displays on the front panel of the instrument.

Self Test Errors

The errors listed in Table 6-21 indicate failures that may occur during a self-test (in 3488A mode).

Table 6-21. Self -Test Errors

Error Number	Description
+1	ROM test failed.
+2	GPIB test failed.
+3	RS-232 test failed.
+4	Front-panel test failed.

Note A string "+0" read back (with the command TEST) indicates that all the tests have passed. In this case, a string "PASSED" displays on the front panel of the instrument.

Note: Due to the large file size, this on-line version of the 3499A/B/C Service Manual does not include schematics.

Appendix C
Schematics

This chapter contains the schematics for the Agilent 3499A/B/C mainframes and the plug-in modules designed for Agilent 3499A/B/C Switch/Control System. For the schematics of the existing 3488A plug-in modules, you can refer to *Agilent 3488A Switch/Control System Service Manual*.

The schematics in this chapter include:

- Agilent 3499A/B/C Controller Board 1.0 Components Locator . . . . . Page 131
- Agilent 3499A/B/C Controller Board 1.0 Schematics . . . . . Page 132
- Agilent 3499A/B/C Controller Board 2.0 Components Locator . . . . . Page 137
- Agilent 3499A/B/C Controller Board 2.0 Schematics . . . . . Page 138
- Agilent 3499A/B/C Keyboard and Display Components Locator & Schematics . . . Page 143
- Agilent 3499A/B/C Backplane Components Locator & Schematics . . . . . Page 146
- Agilent N2260A Components Locator . . . . . Page 149
- Agilent N2260A Schematics . . . . . Page 150
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- Agilent N2280A/N2281A Schematics . . . . . Page 223
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- Agilent N2282A Schematics . . . . . Page 225
- Agilent 44470D Components Locator . . . . . Page 227
- Agilent 44470D Schematics . . . . . Page 228
- Agilent 44480B Components Locator & Schematics. . . . . Page 232
- Agilent 44471D Components Locator . . . . . Page 233
- Agilent 44471D Schematics . . . . . Page 234
- Agilent 44481B Components Locator & Schematics. . . . . Page 238

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