Agilent 34980A
Multifunction Switch/Measure Unit

Data Sheet

CONFIGURE, CONNECT, GO

- **8-slot mainframe with 19 mix-and-match plug-in modules so you can create your own custom configuration**
- **High-performance switching: Up to 560 2-wire multiplexer channels or 1024 matrix cross-points in one mainframe**
- **Optional built-in 6 ½-digit DMM lets you make 11 measurements with over 3000 readings/sec**
- **Easy to integrate: Built-in Ethernet, USB 2.0, and GPIB connectivity, standard connectors and software drivers for most common programming environments**

Agilent Technologies

High-performance unit provides low-cost alternative to PXI and VXI switch and measurement platforms

If you use automated test equipment for design validation or manufacturing, you now have a cost-effective alternative to PXI and VXI test-system platforms. The 34980A multifunction switch/measure unit provides comparable functionality that is much easier to use than PXI and VXI and costs less. The 34980A helps you lower your cost of test and accelerate your test-system integration and development.

The 34980A handles system switching up to 20 GHz and provides basic measurements and system control. It also offers DMM measurements, counter/totalizer functionality, digital I/O with pattern capabilities, and analog outputs with basic waveforms— all in one low-cost, compact box. And with its standard connectors and software drivers, computer-standard I/O, and Web browser interface, the 34980A easily integrates into electronic functional test and data acquisition systems.

Flexible switching, measurements, and system control

The 34980A accommodates up to 8 plug-in modules to give you the flexibility you need. Choose from 19 different modules to define your own configuration. You can buy what you need now and add to it or reconfigure it as your requirements change.

Whether you are measuring temperature, AC or DC voltage, resistance, frequency, current, or custom measurements, the 34980A offers the functionality you need in a single box. Switch in different measurements with high-performance signal switching with no external signal conditioning required. Choose between different switch types and topologies with frequency ranges from DC to 20 GHz. The 34980A offers high-density multiplexers for scanning multiple channels, matrices for connecting multiple points at one time, and general purpose switches for simple control and high power needs.

Use the 34980A to route individual signals or monitor multiple signals over a specified period of time— monitor a single channel or multiple channels, set alarms, and identify irregularities.

The 34980A offers flexible choices for system control. You can control external devices such as microwave switches, attenuators, solenoids, and power relays. Or use the digital inputs to sense limit-switch and digital-bus status.

Optimized for test systems

The 34980A has the performance you need for medium- to high-density switching/measurement applications such as design verification, functional test and data acquisition. Your signals are switched to the right measurement device without compromising signal integrity. Switch your signals to the optional internal DMM and achieve optimal throughput on switch closure time. Or, if you prefer, you can easily connect to external instruments such as DMMs, scopes, power supplies, and more. What's more, with the built-in Ethernet interface, you can control the 34980A and collect data from remote locations.

The rugged instrument comes with a variety of system-ready features:

- Web browser interface shows settings at a glance and provides remote access and control
- Self-guiding front panel to configure, troubleshoot or view data
- Low EMI and efficient system cooling
- Heavy-duty cabling and connection options
- Rack mount options
- Relay counters help predict end-of-life
- In-rack calibration for reduced maintenance time
- DMM measurement accuracies include the switch for simple calculations

Make system connections easily and quickly with simple, reliable connection options:

- Built-in Ethernet, USB 2.0, and GPIB connectivity
- Low-cost, standard 50- or 78-pin Dsub connectors and cables
- Detachable terminal blocks with strain relief
- Mass interconnect solutions

In addition, the 34980A comes with Agilent E2094N IO Libraries Suite 14. Quickly establish an error-free connection between your PC and instruments—regardless of vendor. The IO Libraries provide robust instrument control and work with the software development environment you choose.

Easier signal routing with four 2-wire internal analog buses. You can route your measurements directly to the internal DMM, or you can connect to external instruments through the analog bus connector on the rear of the mainframe. And since you have four 2-wire buses, you can dedicate one bus for use with the internal DMM and use the other three buses for module extensions or additional signal routing between modules, reducing your wiring needs.

You can define switch sequences to control complex signal routing and the order of switch closures. Assign a sequence, give it a name and then execute it with the name you created.

External trigger capabilities make it easy for you to time and synchronize measurements and other events. This can help you determine when to begin or end an acquisition.

Measurements you can trust

Get proven performance from Agilent instruments, with the resolution, repeatability, speed, and accuracy you've come to expect.

The 34980A offers built-in signal conditioning and modular flexibility. When you use it with the internal DMM, you can configure each channel independently for the measurements you choose. It includes a variety of features that give you confidence in your measurements:

- 6½ digits of resolution with .004% of accuracy with DC voltage measurements
- Alarms per channel—high limit, low limit, or both
- Math functions—use Mx+B for custom linear conversions and converting raw inputs
- Built-in thermocouple reference for temperature measurements (34921T)
- Time-stamped readings

The integrated DMM is mounted inside the mainframe and does not consume any of the eight user-available slots. You can access the DMM through any switch module that connects to the analog bus, or directly from the analog bus connector on the rear of the mainframe. The internal DMM gives you the flexibility to measure 11 types of inputs:

- Temperature with thermocouples, RTDs, or thermistors (with 34921A)
- DC and AC voltage
- 2- and 4-wire resistance
- Frequency and period
- DC and AC current

You can control the DMM directly, or configure it to work in conjunction with the switches. Each switch channel can be configured independently for measurement functions, scale factors and alarm limits. Advanced measurement features such as offset compensation, variable integration time, and delay are also selectable on a per-channel basis.

The DMM inputs are shielded and optically isolated from the 34980A's earth-referenced circuitry and computer interface, and as a result, you get up to 300 V of input isolation. This is important for reducing ground-loops and common-mode voltage errors associated with long wiring runs and floating sources.

Simple DMM calibration is accomplished with just the analog bus connection on the rear panel of the mainframe. You don't need to remove the mainframe from the rack or dedicate a channel for calibration.

Modules provide flexible system stimulus and control

System control—with analog outputs, open-collector digital outputs, clock generation, and isolated Form-C relays for controlling external devices. Additionally, with the microwave switch/attenuator driver, high-frequency switches and attenuators can be efficiently controlled external to the 34980A mainframe.

Analog sources—output either voltage or current. You can configure the 4-channel isolated D/A converter as a point-to-point arbitrary waveform generator that lets you define up to 500,000 points per waveform.

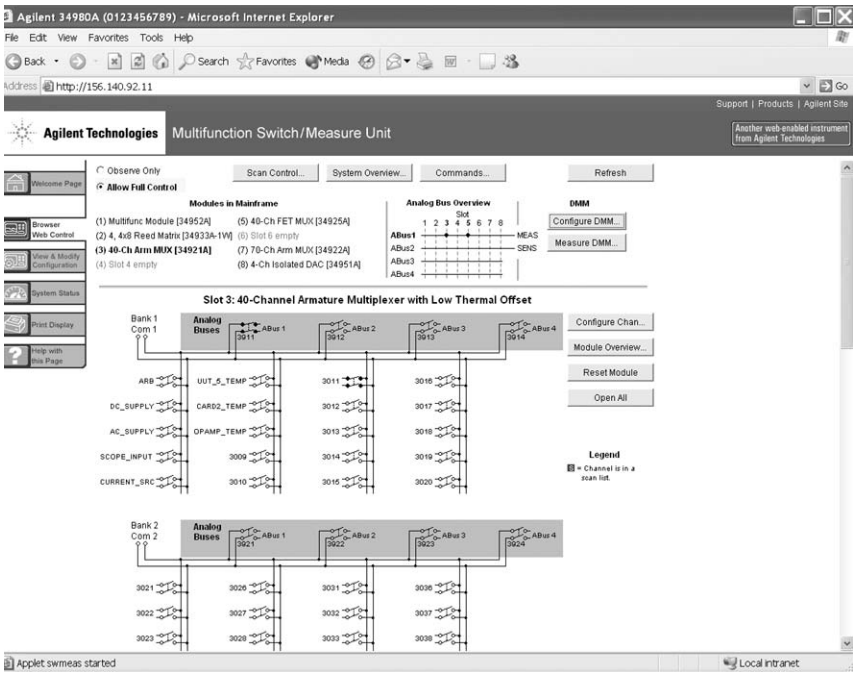
Digital patterns—send or receive digital data from your device under test. With on-board memory you can output communication protocols and bit streams or monitor digital input patterns and interrupt when a user-defined pattern is detected.

Standard interfaces take the hassle out of connecting to your PC

Standard Ethernet, USB and GPIB interfaces are included in every mainframe. Use one of the built-in interfaces that is already available in your computer, or if you prefer, GPIB is still available.

- USB offers the quickest and easiest connection scheme–it's perfect for small systems and bench connections.
- Ethernet offers high-speed connections that allow for remote access and control. Choose a local area network to filter out unwanted LAN traffic and speed up the I/O throughput. Or take advantage of the remote capabilities and distribute your tests worldwide. Monitor, troubleshoot, or debug your application remotely.
- GPIB has many years of proven reliability for instrument communication and can be used in existing GPIB based test systems.

Figure 1 The Web interface makes it easy to set up, troubleshoot and maintain your system remotely.



Remote access and control

The built-in Web browser interface provides remote access and control of the instrument via a Java-enabled browser such as Internet Explorer. Using the Web interface, you can set up, troubleshoot, and maintain your system remotely.

- View and modify instrument setup
- Open, close, or monitor switches
- Send SCPI commands
- Define and execute switch sequences
- View error queue
- Get status reports on relay counts, firmware revisions, and more

Additionally, since the Web interface is built into the instrument, you can access it on any operating system that supports the Web browser without having to install any special software. Password protection and LAN lock-out are also provided to limit access.

The Web interface makes it easy to set up, troubleshoot and maintain your system remotely.

Works with your choice of software so you can save time and preserve your software and hardware investments. Program directly with SCPI, or use IVI or LabVIEW software drivers that provide compatibility with the most popular development environments and tools:

- Agilent VEE Pro, Agilent T&M Toolkit (requires Microsoft® Visual Studio®.NET)
- National Instruments LabVIEW, LabWindows/CVI, TestStand, and Switch Executive
- Microsoft Visual Studio.NET, C/C++ and Visual Basic 6

Power and flexibility to get your job done

Intuitive front panel with self-guiding menus

See results on bright, multiline display

6 1/2 digit DMM measurements with 11 functions

Use keypad to enter channel number or knob to scroll

Scan multiple channels, close specified channel list, or monitor results on a single channel

Configure measurements by channel

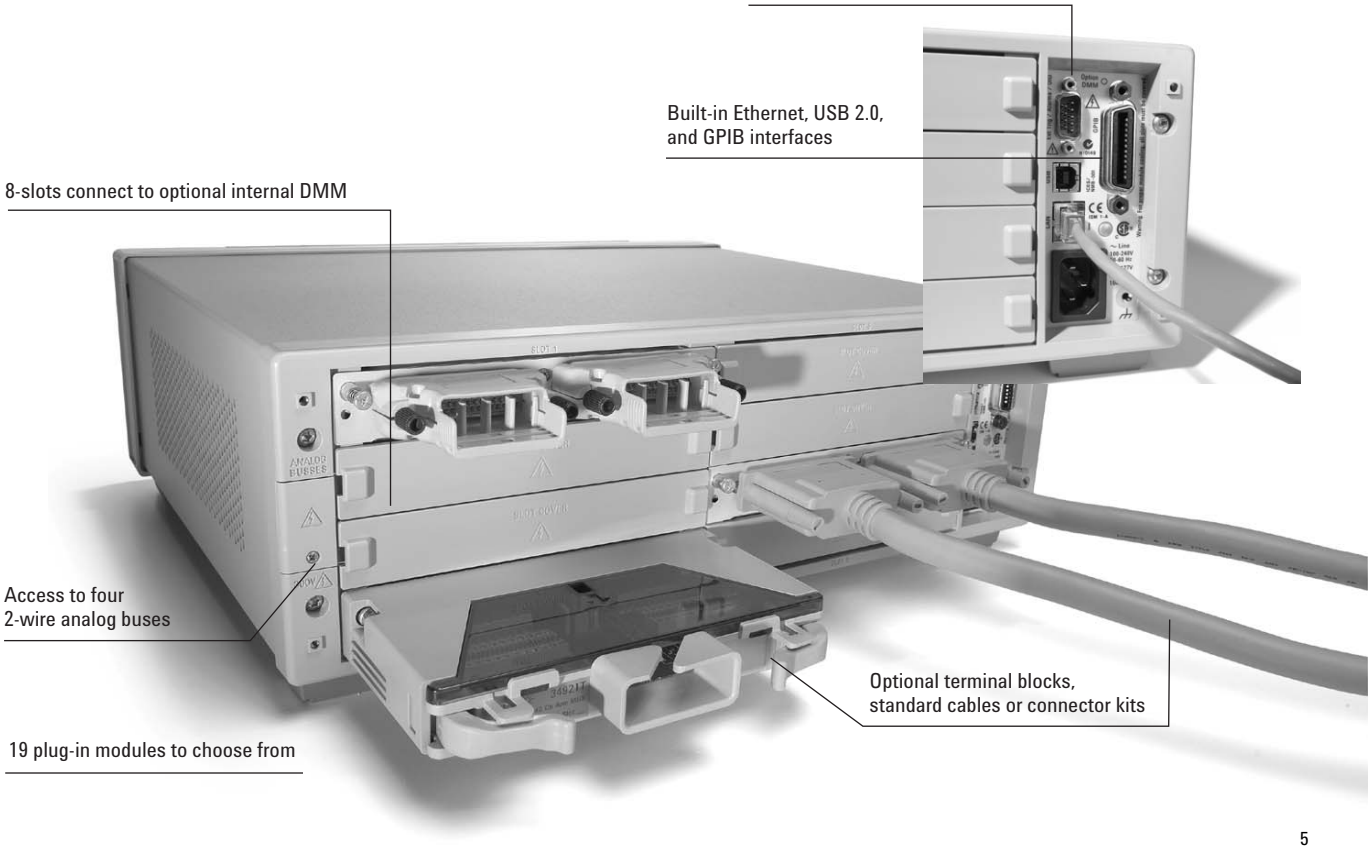
Set up scan lists

Store up to 500,000 readings with timestamp

External trigger to synchronize events

Built-in Ethernet, USB 2.0, and GPIB interfaces

8-slots connect to optional internal DMM



Access to four 2-wire analog buses

Optional terminal blocks, standard cables or connector kits

19 plug-in modules to choose from

Mix and match 34980A modules to create your own custom configuration

The 34980A mainframe holds up to eight plug-in modules. Mix and match them to create a custom system to meet your switching and system control needs. You can easily add or replace modules as your needs change.

Table 1. 34980A modules at a glance

Module	Description	Max volts	Max current	BW (MHz)	Scan ch/sec	Thermal offset	Comments
Multiplexer modules							
34921A	40-channel armature multiplexer w/ low thermal offset	± 300 V	1 A	45 MHz	100	< 3 uV	Temperature reference 4 current channels Config as 2- or 4-wire
34922A	70-channel armature multiplexer	± 300 V	1 A	25 MHz	100	< 3 uV	Config as 2- or 4-wire
34923A	40/80-channel reed multiplexer	± 150 V	0.5 A	45 MHz	500	< 50 uV	Config as 1-, 2- or 4-wire
34924A	70-channel reed multiplexer	± 150 V	0.5 A	25 MHz	500	< 50 uV	Config as 2- or 4-wire
34925A	40/80-channel optically isolated FET multiplexer	± 80 V	0.05 A	1 MHz	1000	< 3 uV	Config as 1-, 2- or 4-wire
Matrix modules							
34931A	Dual 4x8 armature matrix	± 300 V	1 A	30 MHz	100	< 3 uV	Backplane expandable
34932A	Dual 4x16 armature matrix	± 300 V	1 A	30 MHz	100	< 3 uV	Backplane expandable
34933A	Dual/Quad 4x8 reed matrix	± 150 V	0.5 A	30 MHz	500	< 50 uV	Backplane expandable Config as 1- or 2-wire
General-purpose modules							
34937A	28-channel Form C and 4-channel Form A	300 V 250 VAC	1 A 5 A	10 MHz	N/A	< 3 uV < 3 uV	
34938A	20-channel 5-amp Form A	250 VAC	5 A	1 MHz	N/A	< 3 uV	

RF and microwave modules

Module	Description	Insertion loss	Isolation	Freq range	VSWR	Input impedence	Comments
34941A	Quad 1x4 50 ohm 3 GHz RF multiplexer	0.6 dB	> 58 dB	3 GHz	< 1.25	50 Ω	@ 1 GHz
34942A	Quad 1x4 75 ohm 1.5 GHz RF multiplexer	0.6 dB	> 60 dB	1.5 GHz	< 1.35	75 Ω	@ 1 GHz
34945A/ 34945EXT	Microwave switch/attenuator driver	Can drive up to 64 external switch coils; 32 SPDT switches,8 multiport switches, 8 attenuators, or your own combination. Expand with additional 34945EXTs.					
34946A	Dual 1x2 SPDT terminated microwave switch	< 0.42 dB < 0.69 dB	> 85 dB > 67 dB	4 GHz or 20 GHz	< 1.15 < 1.30	50 Ω	@ 4 GHz @ 20 GHz
34947A	Triple 1x2 SPDT unterminated microwave switch	< 0.42 dB < 0.69 dB	> 85 dB > 67 dB	4 GHz or 20 GHz	< 1.15 < 1.30	50 Ω	@ 4 GHz @ 20 GHz

System control modules		Description
34950A	64-bit digital I/O with memory and counter	Eight 8-bit digital I/O channels with programmable polarity, thresholds up to 5 V, with handshaking protocols and pattern memory. Two 10 MHz frequency counter and programmable clock output to 20 MHz.
34951A	4-channel isolated D/A converter with waveform memory	Output DC voltage up to ± 16 V or DC current up to ± 20 mA. Output waveforms with a 200 kHz update rate and 16 bits of resolution. Use on-board memory to create point-to-point waveforms with more than 500,000 points.
34952A	Multifunction module with 32-bit DIO, 2-ch D/A and totalizer	Four 8-bit digital I/O channels, two ± 12-V analog outputs, and a 100 kHz gated totalizer.
34959A	Breadboard module	Create your own custom designs with access to the +12 V and +5 V supplies, 16 GPIO ports and 28 relay drive lines.

34980A multiplexer switch modules

The 34980A multiplexer modules can be used to connect one of many different points to a single point. You can connect to an external instrument, or scan multiple analog signals to the internal DMM.

Choose from the following features:

- 1-wire, 2-wire, or 4-wire configurations
- High voltage—up to 300 V, 1 A
- High density—70 2-wire or 80 1-wire channels
- Bandwidths up to 45 MHz
- Temperature measurements with built-in thermocouple reference junction (34921T)
- AC or DC current measurements without external shunts
- Connections via standard 50- or 78-pin Dsub cables or detachable terminal block

Figure 2. 34921A 40-channel armature multiplexer with low thermal offset (bank 2)

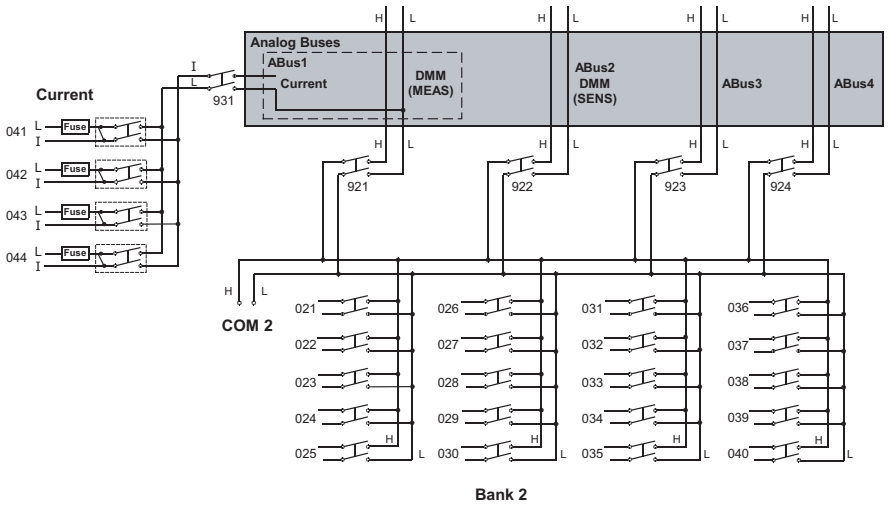


Table 2. Multiplexer measurement functions

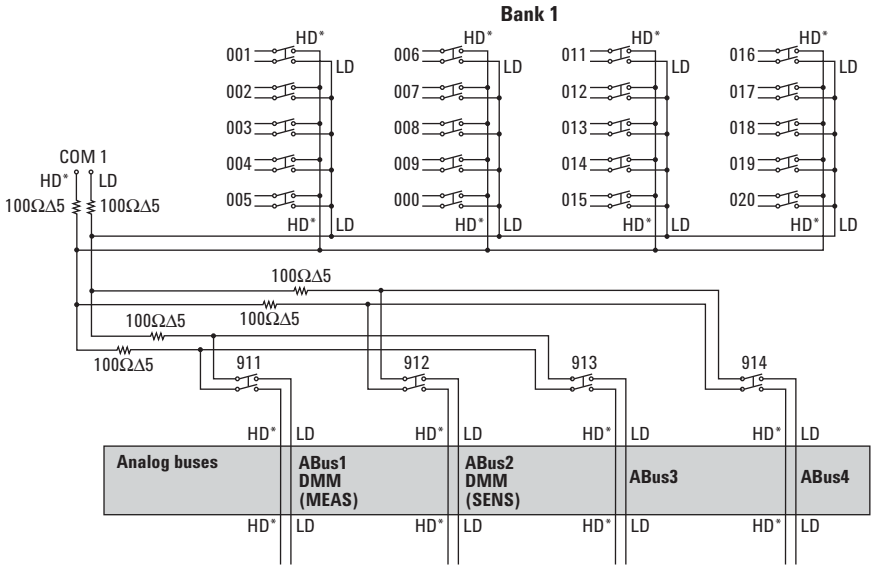
	Voltage AC/DC	Current AC/DC	Freq/ Period	Ω 2-Wire	Ω 4-Wire	Thermo-couple	RTD 2-Wire	RTD 4-Wire	Thermistor
34921A Armature Multiplexer	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
34922A Armature Multiplexer	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
34923A Reed Multiplexer (2-wire)	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
34923A Reed Multiplexer (1-wire)	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
34924A Reed Multiplexer	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
34925A FET Multiplexer (2-wire)	Yes	No	Yes	Yes	Yes	Yes	No	Yes	No
34925A FET Multiplexer (1-wire)	Yes	No	Yes	Yes	No	Yes	No	No	No

Note: See User's Guide for additional information.

Multiple multiplexers can connect to the built-in analog buses, allowing you to scan up to 560 2-wire channels or 640 1-wire channels in a single mainframe. The 34921A also offers 4 channels for directly measuring current. Or if you need more current channels, shunts can be added to the terminal block for easy current measurements.

The multiplexer modules feature break-before-make connections to ensure that no two signals are connected to each other during a scan. Or, if you prefer, you can control switching manually to create your own switch configuration. All the multiplexer switches have a relay counter to help predict when relays need to be replaced.

Figure 3. 34923A 40-channel reed multiplexer (bank 1 shown)



Note: The 34923A and 34924A have 100 ohm input protection resistors that limit current and protect the reed relays.

Figure 4. 34925A 40/80-channel optically isolated FET mux (shown in 1-wire mode bank 2)

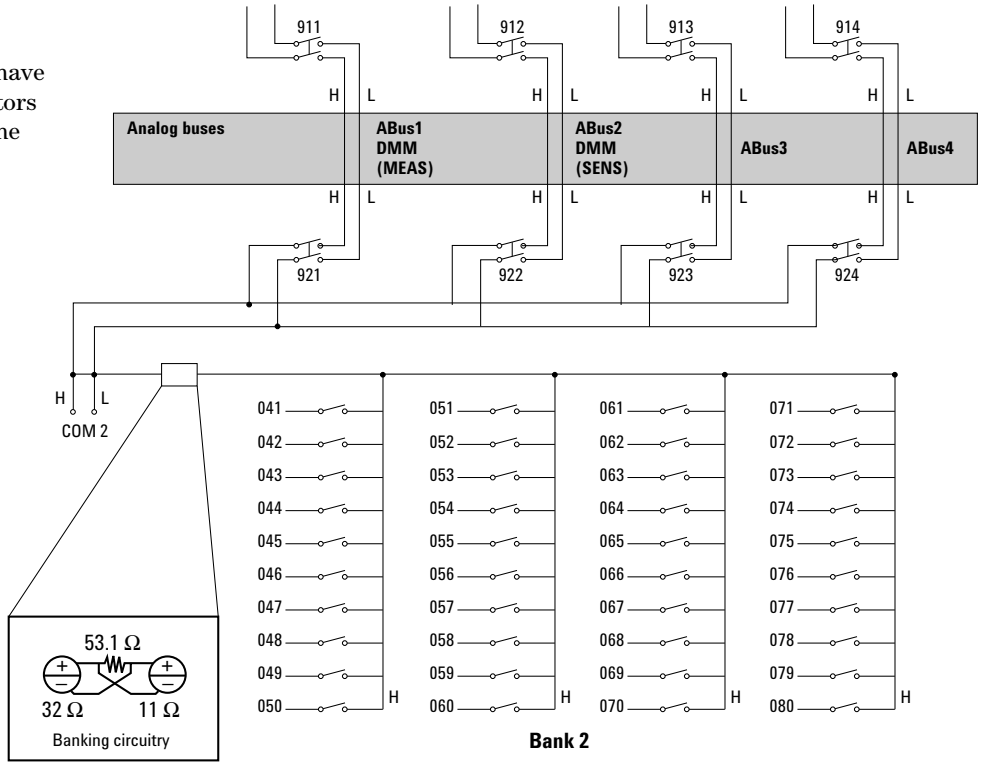


Table 3. Multiplexer selection table—specifications and characteristics

	34921A	34922A	34923A	34924A	34925A
Channels/configurations	40 2-wire 20 4-wire 4-current 1.5 A Fused	70 2-wire 35 4-wire	80 1-wire 40 2-wire 20 4-wire	70 2-wire 35 4-wire	80 1-wire 40 2-wire 20 4-wire
Switch type	Armature latching	Armature latching	Reed	Reed	Optically isolated FET
Input characteristics (per channel)					
Max volts	± 300 V [1]	± 300 V [1]	± 150 V peak [2]	± 150 V peak [2]	± 80 V peak [2]
Max current (DC, AC RMS)					
Switch current	1 A	1 A	0.5 A [5]/ 0.05 A [11]	0.5 A [5]/ 0.05 A [11]	0.02 A[8]
Carry current	2 A	2 A	1.5 A [5]/ 0.05 A [11]	1.5 A [5]/ 0.05 A [11]	
Power (W, VA) [6]	60 W	60 W	10 W	10 W	1.6 W
Volt-Hertz limit	10^8	10^8	10^8	10^8	10^7
General specifications					
Offset voltage [3]	< 3 uV	< 3 uV	< 50 uV < 100 uV 1-wire	< 50 uV	< 3 uV
Initial closed channel res [3]	< 1.5 Ω	< 1.5 Ω	< 1.5 Ω [5]/200 Ω[11]	< 1.5 Ω[5]/200 Ω[11]	< 700 Ω
DC Isolation (ch-ch, ch-earth)	>10 GΩ	>10 GΩ	>10 GΩ	>10 GΩ	>10 GΩ
Leakage current [3]	N/A	N/A	N/A	N/A	20 nA [9]
T/C cold junction accuracy [3, 10]	< 1°C	N/A	N/A	N/A	N/A
AC characteristics					
Bandwidth at terminal block [4]	45 MHz	25 MHz	45 MHz[5]/4 MHz 10 MHz 1-wire	25 MHz[5]/4 MHz[11]	1 MHz
Crosstalk at terminal block (ch-ch) [4]					
300 kHz	-75 dB	-75 dB	-75 dB	-75 dB	N/A
1 MHz	-75 dB	-75 dB	-75 dB	-70 dB	
20 MHz	-50 dB	-50 dB	-50 dB	-45 dB	
45 MHz	-40 dB		-40 dB		
Capacitance at terminal block					
HI-LO	150 pF	250 pF	130 pF	200 pF	100 pF
LO – earth	150 pF	200 pF	120 pF	170 pF	300 pF (600 pF 1-wire)
General characteristics					
Relay life, typical					
No load	100 M	100 M	1000 M	1000 M	unlimited
10 V, 100 ma	10 M	10 M	10 M	10 M	unlimited
Rated load	100 k	100 k	10 k	10 k	unlimited
Scanning speeds [7]	100 ch/sec	100 ch/sec	500 ch/sec	500 ch/sec	1000 ch/sec
Open/ close time, typical	4 ms/4 ms	4 ms/4 ms	0.5 ms/0.5 ms	0.5 ms/0.5 ms	0.25 ms/0.25 ms
Analog bus backplane connection	Yes	Yes	Yes	Yes	Yes

[1] DC or AC RMS voltage, channel-to-channel or channel-to-earth

[2] Peak voltage, channel-to-channel or channel-to-earth

[3] Into analog bus. System errors are included in the internal DMM measurement accuracy specifications

[4] 50 Ω source, 50 Ω load, differential measurements verified with 4-port network analyzer (Sdd21)

[5] With input resistors bypassed. Bypassing resistors will reduce lifetime of relays. See the rated load relay life characteristics.

[6] Limited to 6 W of channel resistance power loss per module

[7] Speeds are for 4-1/2 digits, delay 0, display off, autozero off, and within bank

[8] DC or peak AC current

[9] Ambient temperature < 30°C

[10] Includes 0.5°C temperature reference sensor and 0.5°C terminal block isothermal gradient error. Measured under worst case loading of the mainframe. See User's Guide for information on supported external reference sensors.

[11] With 100 Ω input protection resistors.

34980A matrix switch modules

The 34980A matrix modules are full cross-point matrices that allow you to connect any row to any column. This is a convenient way to connect multiple test instruments to multiple points on a device under test.

Choose from the following features:

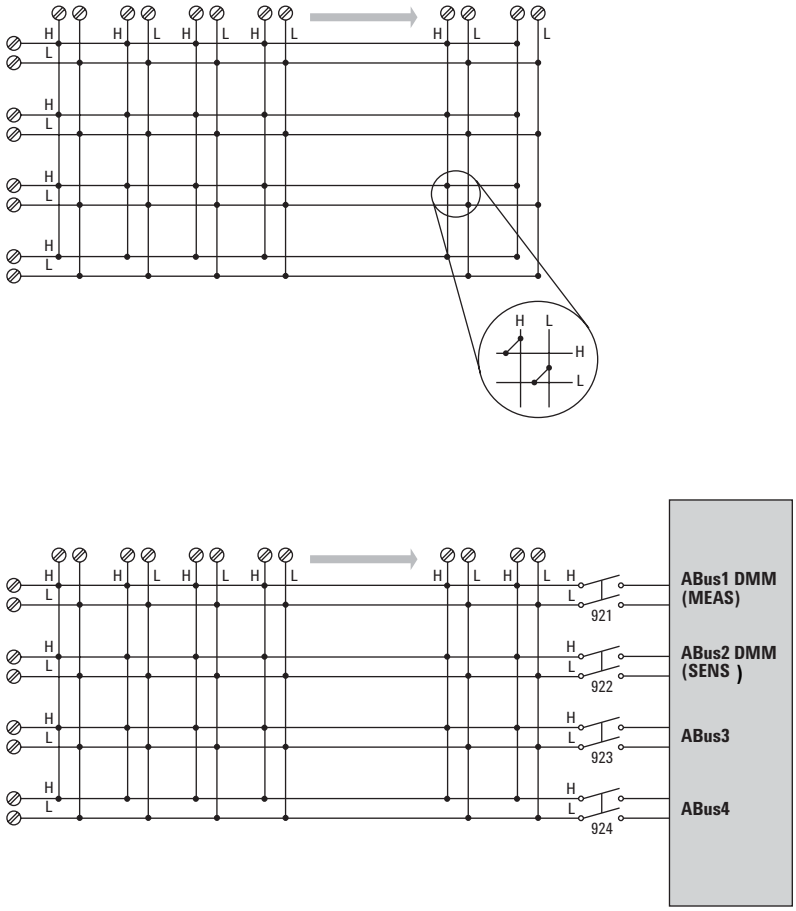
- Latching armature relays—300 V, 1 A
- High-speed reed relays—150 V, 0.5 A
- Configurable dual 4x8 or dual 4x16 modules
- Single-wire configuration (34933A)
- Analog bus expandable rows to create larger matrices
- Connections via standard 50-pin Dsub cables or detachable terminal block

Each cross-point in the matrix switch has two wires—a high and a low for the measurement. Or, if you prefer, the 34933A can be configured as a single-wire matrix, increasing the number of channels. The 34933A also has in-rush resistors on each column for added protection.

Combine multiple matrix modules through the 34980A analog buses to create a larger matrix. Two matrix rows also can be connected to the internal DMM for easy measurements.

Combine your matrix with a multiplexer switch to achieve the desired switching topology and get a lower-cost solution with better specifications. All the matrix switches include a relay counter to help predict when relays need to be replaced. Use the sequencing feature to easily change between different cross-point setups.

Figure 5. 34932A dual 4x16 armature matrix



Note: The 34933A has 100 ohm input protection resistors to limit current and protect the reed relays.

Table 4. Matrix selection table—specifications and characteristics

	34931A	34932A	34933A
Channels/configurations	dual 4x8 8x8 4x16	dual 4x16 8x16 4x32	dual 4x8 8x8 4x16 quad 4x8, 1-wire
Switch type	Armature latching	Armature latching	Reed non-latching
Input characteristics (per channel)			
Max volts	± 300 V [1]	± 300 V [1]	± 150 V peak [2]
Max current (DC, AC RMS) Switch current Carry current	 1 A 2 A	 1 A 2 A	 0.5 A [5]/0.05 A [8] 1.5 A [5]/0.05 A [8]
Power (W, VA) [2, 6]	60 W	60 W	10 W[7]
Volt-Hertz limit	10^8	10^8	10^8
General Specifications			
Offset voltage [3]	< 3 uV	< 3 uV	< 50 uV < 100 uV 1-wire
Initial closed channel res [3]	< 1.5 Ω	< 1.5 Ω	< 1.5 Ω [5]/200 Ω[8]
DC Isolation (ch-ch, ch-earth)	> 10G Ω	> 10G Ω	> 10G Ω
AC characteristics			
Bandwidth at terminal block [4]	30 MHz	30 MHz	30 MHz[5]/4 MHz [8] 2 MHz 1-wire
Crosstalk at terminal block (ch-ch) [4] 300 kHz 1 MHz 20 MHz	 -65 dB -55 dB -30 dB	 -65 dB -55 dB -30 dB	 -65 dB -55 dB -40 dB
Capacitance at terminal block HI-LO LO – earth	 50 pF 80 pF	 50 pF 80 pF	 80 pF 75 pF
General characteristics			
Relay life, typical No load 10 V, 100 ma Rated load	 100 M 10 M 100 k	 100 M 10 M 100 k	 1000 M 10 M 10 k
Open/close time	4 ms/4 ms	4 ms/4 ms	0.5 ms/0.5 ms
Analog bus backplane connection	Bank 2	Bank 2	Bank 2

[1] DC or AC RMS voltage, channel-to-channel or channel-to-earth

[2] Peak voltage, channel-to-channel or channel-to-earth

[3] Into analog bus. System errors are included in the internal DMM measurement accuracy specifications

[4] 50 Ω source, 50 Ω load, differential measurements verified (Sdd21)

[5] With input resistors bypassed. Bypassing resistors will reduce lifetime of relays. See the rated load relay life characteristics.

[6] Limited to 6 W channel resistance power loss per module

[7] Power restrictions allow only 20 channels to be closed at one time

[8] With 100 Ω inpout protection resistors.

34980A general-purpose switch modules

The 34980A general-purpose switches can be used to route signals or to control other system devices. These switches are ideal for device actuation and switching loads or power supplies.

Choose from the following features:

- Form C channels up to 1 A, 50 W
- Form A channels up to 5 A, 150 W
- Armature latching relays
- Simultaneous channel switching
- Temperature sensor to detect overheating conditions
- Connections via standard 50-pin Dsub cables or detachable terminal block

The 34937A is the most versatile general-purpose switch with 28 Form C channels that can switch up to 1 A of current. In addition, this module has four Form A channels that can switch up to 5 A of current. For power switching applications, the 34938A has 20 5-amp channels in a Form A topology. Each Form A general-purpose switch can handle up to 150 W, enough for many power line-switching applications.

The 34937A and 34938A contain latching armature relays where multiple channels can be closed at the same time. Additionally, for switching reactive loads, the optional terminal blocks have pads for snubbing circuits.

The built-in relay counter helps predict when relays need to be replaced.

Figure 6. 34937A 32-channel Form A/ Form C switch

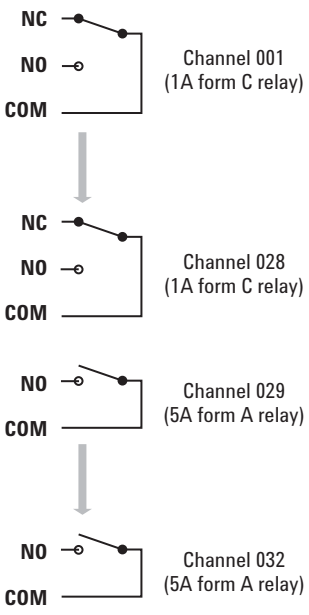


Table 5. GP actuator selection table—specifications and characteristics

	34937A	34938A
Channels/configurations	28 Form C 4 Form A	20 Form A
Switch type	Armature, latching	Armature, latching
Input characteristics (per channel)		
Max volts (DC, AC RMS) [1]	Form C – 300 V Form A – 30 VDC/250 VAC	30 VDC/250 VAC
Max current (DC, AC RMS)	Form C – 1 A (2 A carry) Form A – 5 A switch (8 A carry)	5 A switch (8 A carry)
Power (W, VA) [2]	Form C – 60 W Form A – 150 W	150 W
Volt-Hertz limit	10^8	10^8
General specifications		
Offset voltage	3 uV	3 uV
Initial closed channel res	Form C – 125 mΩ Form A – 50 mΩ	< 60 mΩ
DC Isolation (ch-ch, ch-earth)	> 10G Ω	> 10G Ω
AC characteristics		
Bandwidth at terminal block [3]	10 MHz	1 MHz
Channel Isolation at terminal block [3] 100 kHz 1 MHz 10 MHz	 55 dB 35 dB 15 dB	 60 dB 40 dB
Capacitance at terminal block CH – CH CH – earth	 Form C 12 pF/ Form A 10 pF Form C 21 pF/Form A 18 pF	 65 pF 105 pF
General characteristics		
Relay life no load/rated	Form C – 100 M/100 k Form A – 50 M/30 k	50 M/30 k
Open/close time	Form C – 4 ms/4 ms Form A – 10 ms/10 ms	10 ms/10 ms
Initial/reset relay state	Form C – maintain state Form A – user configurable	user configurable
Analog bus backplane connection	No	No

[1] DC or AC RMS voltage, channel-to-channel or channel-to-earth

[2] Limited to 6 W of channel resistance power loss per module

[3] 50 Ω source, 50 Ω load, differential measurements verified (S21)

34980A RF and microwave switch modules

The 34980A offers a variety of RF and microwave switch modules—RF multiplexers, SPDT switching from DC to 20 GHz, or a switch/attenuator driver module that allows you to control switches or attenuators external to the 34980A mainframe.

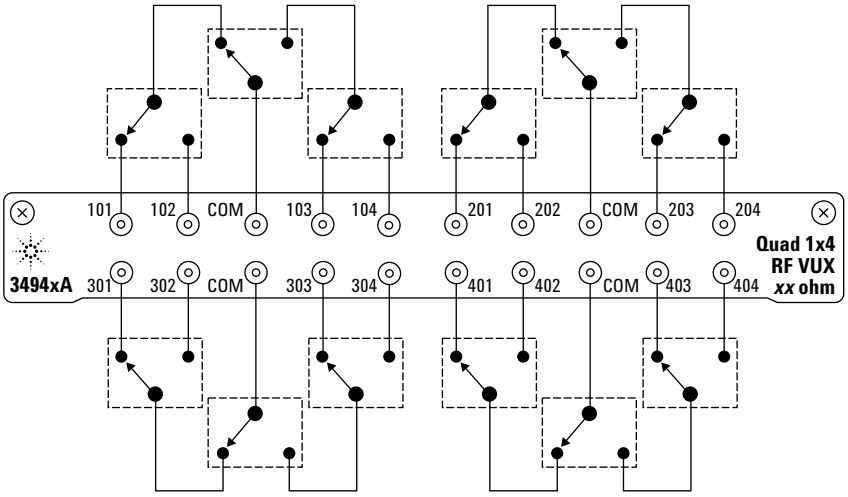
34941A/42A—from DC to 3 GHz
The RF switch modules can be used to switch signals from DC to 3 GHz and above. This can be useful for switching signals between oscilloscopes, spectrum analyzers, network analyzers, and other RF test equipment.

Choose from the following features:

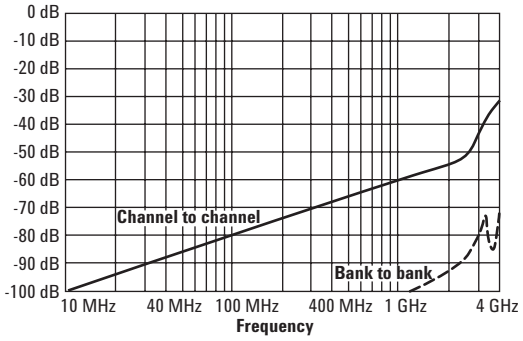
- 50- or 75-ohm Quad 4-channel multiplexers
- DC to 3 GHz
- 30 V, 0.5 A, 10 W

The 34941A and 34942A are configured as four independent 1x4 RF multiplexers on a single module. Multiple banks can be connected together to create a larger multiplexer. To prevent ground loops, individual multiplexers are isolated from each other and from the mainframe's chassis. However, the multiplexer channels can be chassis grounded with a simple change. Both 50-ohm and 75-ohm versions are available.

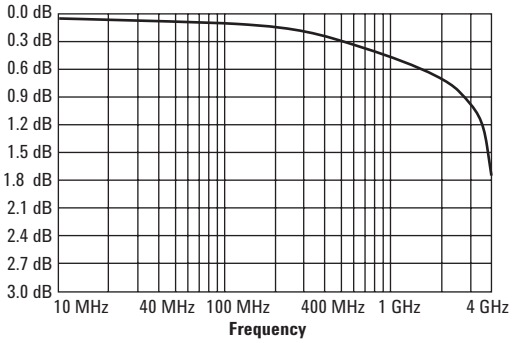
Figure 7. 34941A Quad 1x4 50 ohm 3 GHz multiplexer



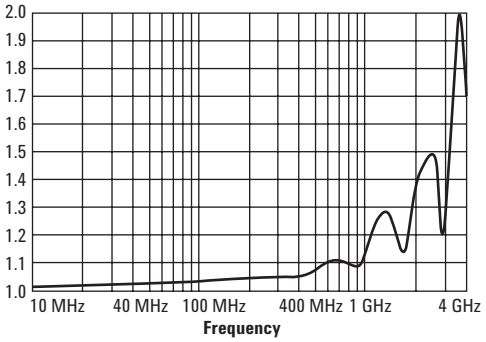
34941A Typical crosstalk



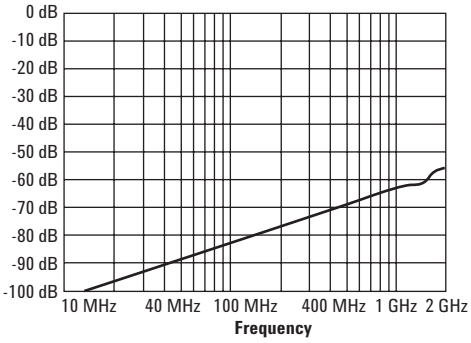
34941A Typical insertion loss



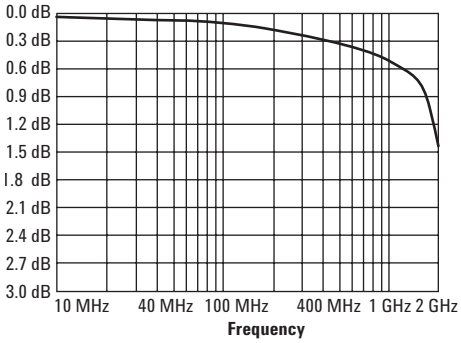
34941A Typical VSRW



34942A Typical crosstalk



34942A Typical insertion loss



34942A Typical VSRW

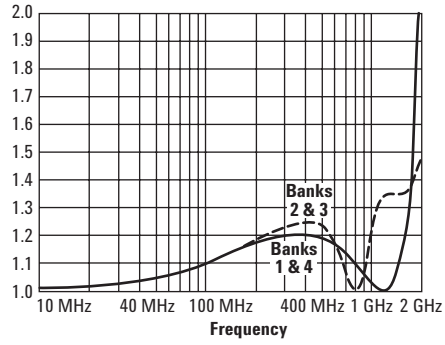
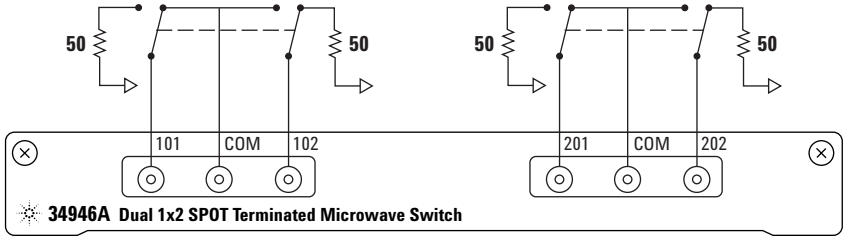


Figure 8. 34946A dual 1x2 SPDT terminated microwave switch



34946A/47A—from DC to 20 GHz

For applications where you need only a few high-frequency switches, the 34946A and 34947A offer single-pole, double-throw switches in either 4-GHz or 20-GHz options. These modules internally mount two or three independent Agilent N1810 series coaxial switches. These switches are well known for their excellent insertion loss, isolation and VSWR specifications. Switch read back capabilities allow you to query the position of the switch. You can choose higher density with the unterminated switches, or select the terminated switches to maintain impedance match.

Table 6. RF and microwave selection table—specifications and characteristics

	DC to 3 GHz		DC to 20 GHz [3]	
	34941A	**34942A**	**34946A**	**34947A**
Channels	quad 1x4	quad 1x4	2 SPDT	3 SPDT
Switch type	50 Ω unterminated, latching relays	75 Ω unterminated, latching relays	50 Ω terminated	50 Ω unterminated
RF characteristics				
Frequency range [2]	DC to 3 GHz	DC to 1.5 GHz	DC to 4 GHz OR DC to 20 GHz	DC to 4 GHz OR DC to 20 GHz
Insertion loss [2] (< 40 C/ 80% RH)			DC to 4 GHz < 0.42 dB @ 20 GHz < 0.69 dB	DC to 4 GHz < 0.42 dB @ 20 GHz < 0.69 dB
100 MHz	0.15 dB	0.15 dB		
1 GHz	0.60 dB	0.60 dB		
3 GHz	1.40 dB	N/A		
VSWR			DC to 4 GHz < 1.15 @ 20 GHz < 1.30	DC to 4 GHz < 1.15 @ 20 GHz < 1.30
100 MHz	1.03	1.15		
1 GHz	1.25	1.35		
3 GHz	1.55	N/A		
Isolation (dB) [2]	Contact factory	Contact factory	DC to 4 GHz > 85 dB at 20 GHz > 67 dB	DC to 4 GHz > 85 dB at 20 GHz > 67 dB
100 MHz	80 dB	80 dB		
1 GHz	58 dB	60 dB		
3 GHz	40 dB	N/A		
Spurious noise below 1.3 GHz	-140 dBm	-140 dBm	80 dB	80 dB
Risetime	< 80 ps	< 160 ps	N/A	N/A
Signal delay	< 1 ns	< 1 ns	N/A	N/A
Capacitance	< 30 pF	< 30 pf	N/A	N/A
Switching characteristics				
Max volts [1]	30 V	30 V	7 VDC	7 VDC
Max current	0.5 A	0.5 A	N/A	N/A
Max power (W)	10 W [5]	10 W [5]	1 W @ 7 VDC, 50 W peak [4]	1 W @ 7 VDC, 50 W peak [4]
Offset voltage	10 uV	10 uV	N/A	N/A
Initial channel resistance	1 Ω	1 Ω	N/A	N/A
Volt-Hertz limit	2×10^{10}	2×10^{10}		
General characteristics				
Relay life	300,000 at 30 V/10 mA load; 100,000 at 10 W load RF SAmeas	300,000 at 30 V/10 mA load 100,000 at 10 W load RF SAmeas	> 5 M cycles, 1 M w/drive 28-32 VDC	> 5 M cycles, 1 M w/drive 28-32 VDC
Open/close time	18 ms/18 ms	18 ms/18 ms	< 15 ms/15 ms	< 15 ms/15 ms
Connector type	SMA	Mini 75 Ω SMB	SMA	SMA
Analog bus backplane connection	No	No	No	No

[1] Channel-to-earth

[2] 50 Ω source, 50 Ω load (75 Ω for 34942A)

[3] For more detailed specifications, see the N1810TL for the 34946A and N1810UL for the 34947A

[4] 10 usec maximum duration

[5] Max power is 1 W between 30 MHz and 1 GHz for CISPR 11 compliance

34945A/34945EXT microwave switch/attenuator driver

This module allows you to control switches attenuators, and other devices external to the 34980A. The 34945A/34945EXT provides the power and control signals for many of the most popular microwave switches and attenuators. One 34945A/34945EXT combination can drive up to 64 switch coils—that's 32 standard SPDT switches. The 34945A/EXT can be extended by adding additional 34945EXT boards. The first 34945EXT is powered by the mainframe. You can add up to seven additional 34945EXT boards with user supplied power. Multiple switch operations are performed in sequential order, or for faster, simultaneous switching, you can connect an external power supply to the 34945EXT.

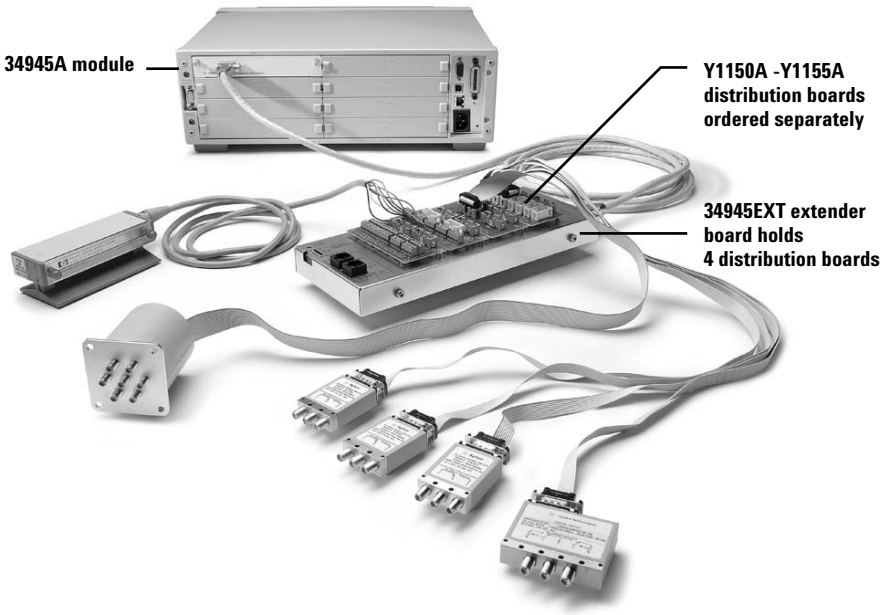
The Y1150A-Y1155A distribution boards enable simple connections to the external switches. The distribution boards plug onto the 34945EXT and are used to route the power and control signals from the driver module to the switches using standard cables.

The 34945A/34945EXT also has sensing capabilities that allows read back of the actual position of the switch or attenuator. Drive signals for LED indicators are also provided to give a visual indication of the switch position.

The following microwave switches and attenuators are supported with the Y1150A-Y1155A distribution boards:

- N181x series SPDT switches
- 8762/3/4 series SPDT switches (screw terminals)
- 87104x/106x multiport switches
- 87406x series matrix switches
- 87204x/206x series multiport switches
- 87606x series matrix switches
- 87222x transfer switches
- 849x series attenuators
- 8490x series attenuators
- Screw terminal connections

Figure 9. 34945A/34945EXT microwave switch/attenuator driver



General specifications

34945EXT switch drive (64 channels, low side drive mode)

Driver off voltage (max)	30 V
Driver off leakage current	500 uA
Driver on current (max)	600 mA
Driver on voltage (max)	0.5 V @ 600 mA

34945EXT switch drive (64 channels, TTL drive mode)

Hi output voltage	3 V @ I_{out} = 2 mA
Lo output voltage	0.4 V @ I_{in} = 20 mA
Lo input Current	20 mA

34945EXT position indicator sense inputs

Channels	64
Lo input voltage (max)	0.8 V
Hi input voltage (min)	2.5 V
Input resistance	>100 kΩ @ $V_{in} \leq 5$ V >20 kΩ @ $V_{in} > 5$ V
Maximum input voltage	30 V

34945EXT switch drive power supply (34945EXT powered by 34945A)

Voltage	24 V nominal (external power supply required for switches needing more than 24 V)
Current	100 mA continuous + 200 mA (15 msec pulse, 25% duty cycle)

34945EXT external power connection

Voltage range	4.75 V to 30 V
Current limit	2 A

LED indicator (Current mode divers)

Channels	64
Supply voltage	5 V nominal
LED drive current	5 mA nominal (prog 1-20 mA)
Driver compliance voltage	0.8 V

34945EXT dimensions

11.2″ x 4.5″ x 1.5″ high with distribution boards installed

Maximum 8 34945 Ext's per mainframe

Note: See the Application note: Configuring an RF1 Microwave Switch System (5989-2272EN) for configuration details.

34950A 64-bit digital I/O with memory and counter

This module can be used to simulate or detect digital patterns. It has eight 8-bit digital I/O channels with handshaking, pattern memory, two 10 MHz counters with gate functions, and a programmable clock output.

Digital input/output

The digital I/O bits are organized into two banks of 32-bits. The I/O bits can be configured and programmed as inputs or outputs in 8-bit channels. The digital outputs can be configured as active drive or open drain outputs with a 10 kΩ pull up. User supplied pull up resistors for up to 5 V outputs are also acceptable. The digital inputs have programmable thresholds up to 5 V for compatibility with most digital logic standards.

The onboard pattern memory can be used to select and output digital stimulus or bitstream patterns, or to capture external digital data. Each bank has independent memory and directional control so that one bank can output data while the other captures data. The memory can be divided up to 64 Kbytes per 8-bit channel.

Specifically, the digital I/O channels also have:

- Variable active high drive output from 1.65 V to 5 V or open drain
- Variable input thresholds from 0 V to 5 V
- Configurable handshaking protocols including synchronous, and strobe
- Programmable polarity
- Source or sink up to 24 mA with a I_{max} of 400 mA per module.
- Internal alarming for maskable pattern match
- 1 hardware pattern interrupt per bank
- Connections via standard 78-pin Dsub cables or detachable terminal block

Frequency counter/totalizer

The two channels can be used to count digital events, frequency, period, duty cycle, totalize, and pulse width. The counter/totalizer also includes

- Programmable gate functionality
- Programmable input thresholds levels 0 V to 3 V

Digital input/output characteristics

Eight 8-bit channels: 8 bits wide, input or output, non-isolated	
Vin	0 V – 5 V [1]
Vout	1.65 V – 5V [1, 2]
Iout (max)	24 mA [2]
Frequency (max)	10 MHz [3]
I_{Load} (max)	400 mA
$t_r + t_f$ (typ)	6 ns [5]

Handshake lines

Vin	0 – 5 V [4]
Vout	1.65 – 5 V [2, 4]
I out (max)	24 mA [2]
Frequency (max)	10 MHz

Counter function characteristics

Maximum freq	10 MHz (max) 50% duty cycle
Vin	0 V – 5 V

Totalizer function characteristics

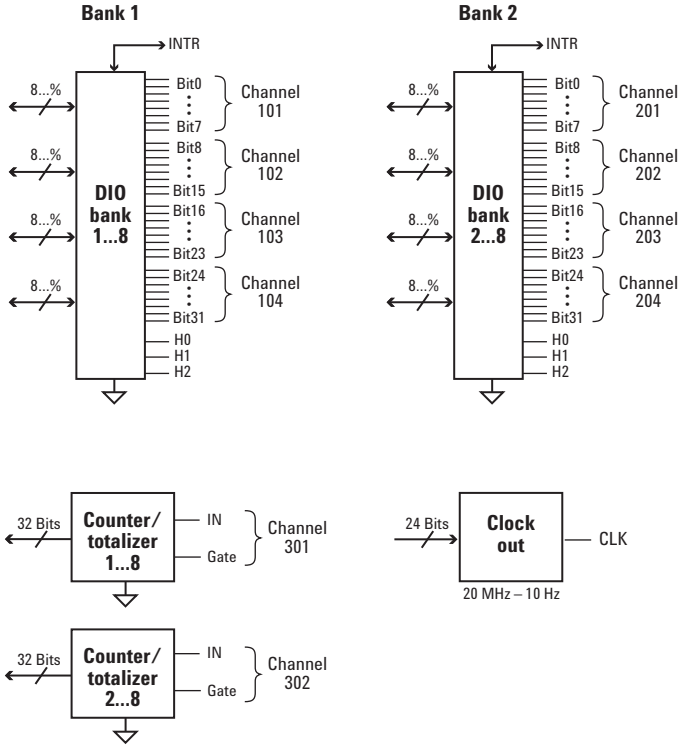
Maximum count	2^32 – 1 (4,294,967,296)
Max input freq	10 MHz (max), rising or falling edge programmable
Vin	0 V – 5 V
Gate input	0 V – 5 V

System clock generator characteristics

Frequency	20 MHz – 10 Hz configurable divide-by-n 24-bits, programmable on/off
Vout	1.65 V – 5 V [2]
Accuracy:	100 ppm

[1] Configurable by 8-bit channel
[2] Lower current drive at lower voltages
[3] From memory with handshaking
[4] Configurable by bank
[5] 5 V, 50 pF load

Figure 10. 34950A 64-channel digital I/O



34951A 4-channel isolated D/A converter with waveform memory

This module has four independent, isolated channels that output DC voltage up to ± 16 V or DC current up to ± 20 mA. The gain and offset can be adjusted on-the-fly. Each channel can be controlled manually, or use the onboard memory to download a waveform. The 500k of memory is global and can store up to 32 waveforms. Any waveform can be dynamically allocated among one or more channels and output as a point-to-point arbitrary waveform generator at up to 200k points/sec. You can use the standard sine, square or ramp wave shapes provided or define your own wave shape using over 500,000 points and output to a device under test. There is also a single CLK that can be divided down for each channel independently.

The calibration command connects the D/A converters to the internal DMM to be automatically calibrated. Connections to the module can be made via standard 50-pin Dsub cables or a detachable terminal block.

General specifications

Maximum update rate:	200 kHz point-to-point
Monotonic :	to 16-bits
Isolation:	> 80 VDC/AC peak (chan-to-chassis or chan-to-chan)
Synchronization:	Software commands or external trigger
Internal/external CLK accuracy:	100 ppm
AC accuracy:	Not specified

DC voltage

Amplitude:	± 16 V up to 10 mA
Resolution:	16-bits = 500 uV
Amplitude accuracy (DC):	± (0.05% + 3.0 mV (90 days, Tcal ± 5°C or Cal:MOD?: ± 5°C)
Ripple and noise:	< 2 mVrms, 20 Hz to 250 kHz into 10 kΩ load
Settling time:	40 uS (-full scale to +full scale step, single channel, to rated accuracy)
Output impedance:	< 1 Ω with the load sensed

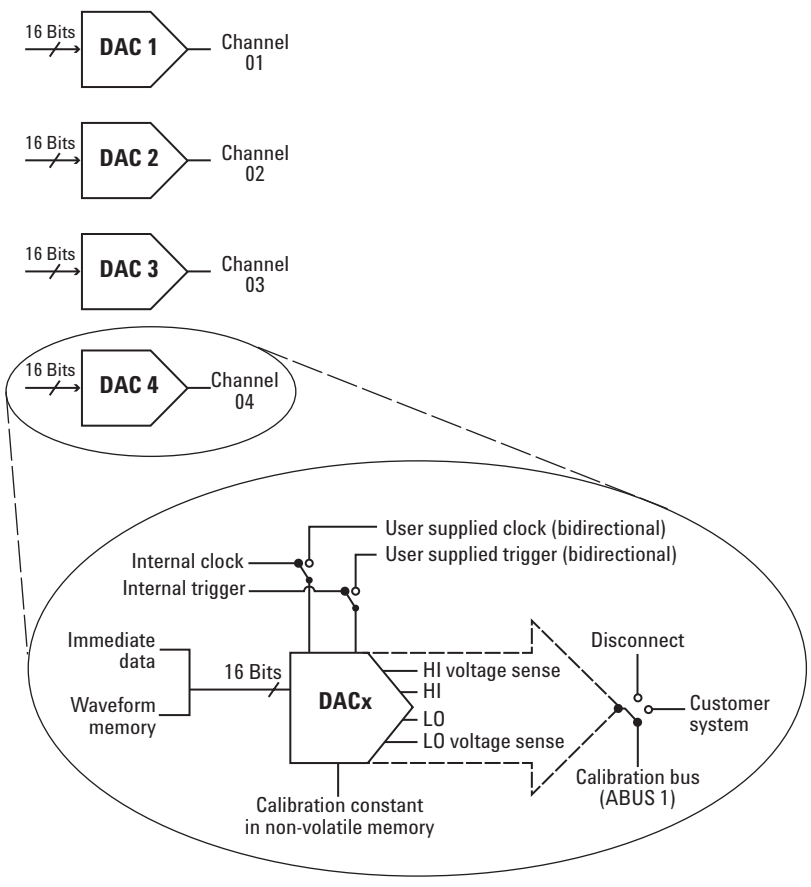
DC current

Range:	± 20 mA
Resolution:	16-bit = 630 nA
Accuracy:	± (% value + amps) (temperature within ± 5°C of Tcal or *Cal?) 90-day: ± (0.09% + 5.0 uA)
Ripple and noise:	< 2 uArms, 20 Hz to 250 kHz into 250 Ω
Compliance voltage:	± 12 V
Max open circuit voltage:	< ± 22 V

Phase-locking I/O trigger characteristics

Trigger input	
Input level:	TTL compatible (3.3 V logic, 5 V tolerant)
Slope:	Rising or falling, selectable
Pulse width:	> 100 nS
Input impedance:	> 10 kΩ, DC coupled
Trigger output	
Level:	TTL compatible into 1 kΩ (3.3 V logic)
Output impedance:	50 Ω typical
Clock input	
Input level:	TTL compatible (3.3 V logic, 5 V tolerant)
Input impedance:	> 10 kΩ, DC
Maximum rate:	10 MHz
Clock output	
Level:	TTL compatible into 1k Ω (3.3 V logic)
Output impedance:	50 Ω typical
Maximum rate:	10 MHz
Accuracy:	± 100 ppm

Figure 11. 34951A 4-channel isolated D/A converter



34952A multifunction module with 32-bit DIO, 2-channel D/A and totalizer

The multifunction module offers the flexibility you need for system control. The 34952A has four 8-bit digital I/O channels, a 100-kHz gated totalizer, and two ± 12 V analog outputs—all on a single earth-referenced module. The digital inputs and totalizer input may be included in a scan list. Alarm limits for the digital and totalizer inputs are evaluated continuously, capturing and logging alarm conditions even between scans. Connections can be made via standard 50-pin Dsub cables or detachable terminal block. The 34952T terminal block has a pinout for connection to an external opto 22 board.

Digital input/output characteristics

Four 8-bits channels, 8 bits wide, input or output, non-isolated	
Vin(L)	< 0.8 V (TTL)
Vin(H)	> 2.0 V (TTL)
Vout(L)	< 0.8 V @ Iout = -400 mA
Vout(H)	> 2.4 V @ Iout = 1 mA
Vin(H) max	< 42 V with external open drain pull-up
Alarm	Maskable pattern match or state change
Speed sampling	4 ms (max) alarm sam-
Latency	5 ms (typical) to 34980A alarm output
Read/write speed	95/s

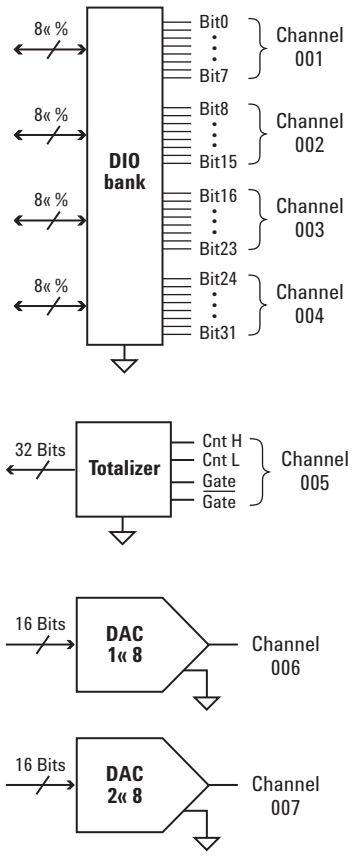
Totalize input characteristics

Max count	$2^{26} - 1$
Totalize input	100 kHz (max) rising or falling edge, programmable
Signal level	1 Vp-p (min) 42 Vpk (max)
Threshold	0 V or TTL
Gate input	TTL-Hi, TTL-Lo, or none
Count reset	Manual or read + reset
Read speed	85 rds/s

Analog output characteristics

DAC 1, 2	± 12 V, non-isolated
Resolution	1 mV
IOUT	10 mA max
Settling time	1 ms to 0.01% of output
Accuracy 1 year	± (% of output + mV) (0.25% + 20 mV)
Temp. coefficient	± (0.015% + 1mV)/°C

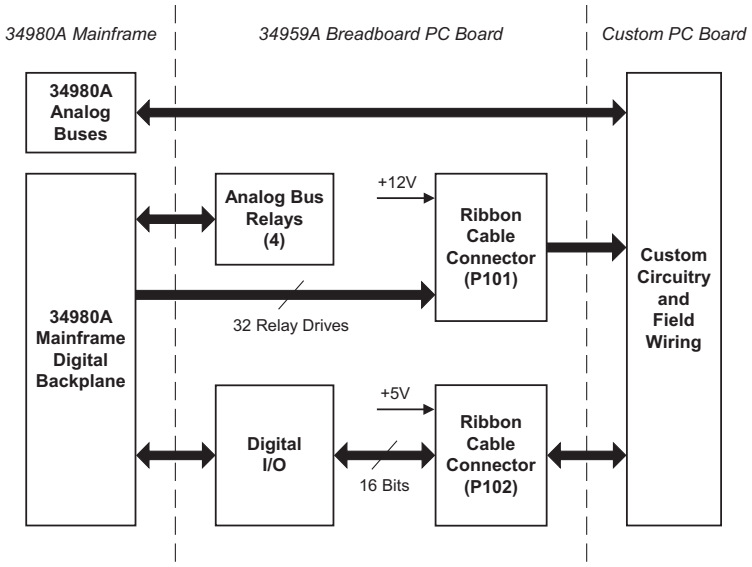
Figure 12. 34952A multifunction module



34959A breadboard module

Use this module to create your own custom designs inside the 34980A mainframe. You can control your custom circuits with access to both the +12 V and +5 V supplies, 28 relay drive lines and two 8-bit GPIO ports. Your design can be isolated from the analog buses or connected by loading the backplane switches. Simply mount your custom PC board or other components into the space provided and connect via the two ribbon connectors provided. The module is provided with two 50- or 78-pin Dsub connector openings. For custom connections, use the detachable flat faceplates for easy modification. You can program your circuitry using standard read and write commands in SCPI.

Figure 13. 34959A breadboard module



General specifications

Max module power dissipation	6 W
Power available	
12 V regulation no load to full load	10%
5 V regulation no load to full load	5%
Max power from 12 V	6 W
Max power from 5 V	1 W
Relay drives	28, sink up to 100 mA
GPIO ports	
Chan 1 and Chan 2:	8 configure bits as input or output
Chan 3:	3 output bits

Available board dimensions:
5.4 x 7.5 x either 0.9 inches height without PC board, or 0.7 inches high with PC board.

34980A system specifications and characteristics

DMM accuracy ± (% of reading + % of range)

Includes measurement error, switching error, and transducer conversion error

			Measurement including switch error [1]			
Function	**Range [4]**	**Frequency, etc.**	**24 hour [2,3] Tcal ± 1°C**	**90 days Tcal ± 5°C**	**1 year Tcal ± 5°C**	**Temperature coefficient >Tcal ± 5°C**
DC voltage (with 34921A/22A/ 31A/32A) [10]	100.0000 mV		0.0030 + 0.0035	0.0040 + 0.0040	0.0050 + 0.0040	0.0005 + 0.0005
	1.000000 V		0.0020 + 0.0006	0.0030 + 0.0007	0.0040 + 0.0007	0.0005 + 0.0001
	10.00000 V		**0.0015 + 0.0004**	**0.0020 + 0.0005**	**0.0035 + 0.0005**	**0.0005 + 0.0001**
	100.0000 V		0.0020 + 0.0006	0.0035 + 0.0006	0.0045 + 0.0006	0.0005 + 0.0001
	300.0000 V		0.0020 + 0.0020	0.0035 + 0.0030	0.0045 + 0.0030	0.0005 + 0.0003
True RMS AC voltage [5]	100.0000 mV to 100.0000 V	3 Hz-5 Hz	1.00 + 0.03	1.00 + 0.04	1.00 + 0.04	0.100 + 0.004
		5 Hz-10 Hz	0.35 + 0.03	0.35 + 0.04	0.35 + 0.04	0.035 + 0.004
		10 Hz-20 kHz	**0.04 + 0.03**	**0.05 + 0.04**	**0.06 + 0.04**	**0.005 + 0.004**
		20 kHz-50 kHz	0.10 + 0.05	0.11 + 0.05	0.12 + 0.05	0.011 + 0.005
		50 kHz-100 kHz	0.55 + 0.08	0.60 + 0.08	0.60 + 0.08	0.060 + 0.008
		100 kHz-300 kHz [6]	4.00 + 0.50	4.00 + 0.50	4.00 + 0.50	0.20 + 0.02
	300.0000 V	3 Hz-5 Hz	1.00 + 0.05	1.00 + 0.08	1.00 + 0.08	0.100 + 0.008
		5 Hz-10 Hz	0.35 + 0.05	0.35 + 0.08	0.35 + 0.08	0.035 + 0.008
		10 Hz-20 kHz	0.04 + 0.05	0.05 + 0.08	0.06 + 0.08	0.005 + 0.008
		20 kHz-50 kHz	0.10 + 0.10	0.11 + 0.12	0.12 + 0.12	0.011 + 0.012
		50 kHz-100 kHz	0.55 + 0.20	0.60 + 0.20	0.60 + 0.20	0.060 + 0.020
		100 kHz-300 kHz[6]	4.00 + 1.25	4.00 + 1.25	4.00 + 1.25	0.20 + 0.05
Resistance [7]	100.0000 Ω	1 mA	0.0030 + 0.0035	0.008 + 0.004	0.010 + 0.004	0.0006 + 0.0005
	1.000000 kΩ	1 mA	0.0020 + 0.0006	0.008 + 0.001	0.010 + 0.001	0.0006 + 0.0001
	10.00000 kΩ	100 uA	**0.0020 + 0.0005**	**0.008 + 0.001**	**0.010 + 0.001**	**0.0006 + 0.0001**
	100.0000 kΩ	10 uA	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	0.0006 + 0.0001
	1.000000 MΩ	5.0 uA	0.002 + 0.001	0.008 + 0.001	0.010 + 0.001	0.0010 + 0.0002
	10.00000 MΩ	500 nA	0.015 + 0.001	0.020 + 0.001	0.040 + 0.001	0.0030 + 0.0004
	100.0000 MΩ	500 nA/10 MΩ	0.300 + 0.010	0.800 + 0.010	0.800 + 0.010	0.1500 + 0.0002
Frequency and period [8]	100 mV to 300 V	3 Hz-5 Hz	0.10	0.10	0.10	0.005
		5 Hz-10 Hz	0.05	0.05	0.05	0.005
		10 Hz-40 Hz	0.03	0.03	0.03	0.001
		40 Hz-300 kHz	**0.006**	**0.01**	**0.01**	**0.001**
DC current (34921 only)	10.00000 mA	< 0.1 V burden	0.005 + 0.010	0.030 + 0.020	0.050 + 0.020	0.002 + 0.0020
	100.0000 mA	**< 0.6 V**	**0.010 + 0.004**	**0.030 + 0.005**	**0.050 + 0.005**	**0.002 + 0.0005**
	1.000000 A	< 2 V	0.050 + 0.006	0.080 + 0.010	0.100 + 0.010	0.005 + 0.0010
True RMS AC current (34921A only)	10.00000 mA and [5]	3 Hz-5 Hz	1.00 + 0.04	1.00 + 0.04	1.00 + 0.04	0.100 + 0.006
		5 Hz-10 Hz	0.30 + 0.04	0.30 + 0.04	0.30 + 0.04	0.035 + 0.006
	1.0 A	**10 Hz-5 kHz**	**0.10 + 0.04**	**0.10 + 0.04**	**0.10 + 0.04**	**0.015 + 0.006**
	100.0000 mA [9]	3 Hz-5 Hz	1.00 + 0.5	1.00 + 0.5	1.00 + 0.5	0.100 + 0.006
		5 Hz-10 Hz	0.30 + 0.5	0.30 + 0.5	0.30 + 0.5	0.035 + 0.006
		10 Hz-5 kHz	0.10 + 0.5	0.10 + 0.5	0.10 + 0.5	0.015 + 0.006

[1] One hour warm-up and a fixed configuration with slow AC filter, sine wave input, and 6 1⁄2 digits. Temperature within ± 5°C of temperature at calibration (Tcal between 18-28°C).

[2] 90 minute warm-up and a fixed configuration and 6 1⁄2 digits. Temperature within ± 1°C of temperature at calibration (Tcal between 18-28°C).

[3] Relative to calibration standards

[4] 20% over range on all ranges except 300VDC and AC ranges and 1 ADC and AC current ranges

[5] For singe wave input > 5% of range. For inputs from 1% to 5% of range and < 50 kHz add 0.1% of range additional error. For AC filter slow.

[6] Typically 30% of reading error at 1 MHz, limited to 1 x 108 volt-hertz

[7] For 4-wire ohms or 2-wire ohms using scaling to remove offset. Add 4 ohms additional error to 2-wire ohms function without scaling. 34923/24/25/33 have series resistance that may limit low 2-wire ohm measurements.

[8] Input > 100 mV. For 10 mV inputs multiply % of reading error x 10. For 1 sec aperture (6 1/2 digits).

[9] Specified only for inputs > 10 mA. For AC filter slow.

[10] Add 50 uV error for 34923/24/33.

Additional Low Frequency Error for ACV, ACI (% of reading)

Frequency	AC Filter Slow	AC Filter Medium	AC Filter Fast
10 Hz- 20 Hz	0	0.74	–
20 Hz - 40 Hz	0	0.22	–
40 Hz - 100 Hz	0	0.06	0.73
100 Hz - 200 Hz	0	0.01	0.22
200 Hz - 1 kHz	0	0	0.18
> 1 kHz	0	0	0

Additional Error for Frequency, Period (% of reading)

Frequency	Aperature (Digits) 1 second (6½ digits)	0.1 seconds (5½ digits)	0.01 seconds (4½ digits)
3 Hz- 5 Hz	0	0.12	0.12
5 Hz - 10 Hz	0	0.17	0.17
10 Hz - 40 Hz	0	0.2	0.2
40 Hz - 100 Hz	0	0.06	0.21
100 Hz - 300 Hz	0	0.03	0.21
300 Hz - 1 kHz	0	0.01	0.07
> 1 kHz	0	0	0.02

Temperature measurement accuracy ± (% of reading + % of range)

Temperature 1-year accuracy	Type	Best range [1]	Extended range [1]		Temp Coefficient	
Thermocouple (34921A only, includes cold junction accuracy on terminal block)	B	1100°C to 1820°C	1.2°C	400°C to 1100°C	1.8°C	0.03°C
	E	-150°C to 1000°C	1.0°C	-200°C to -150°C	1.5°C	0.03°C
	J	**-150°C to 1200°C**	**1.0°C**	**-210°C to -150°C**	**1.2°C**	0.03°C
	K	-100°C to 1200°C	1.0°C	-200°C to -100°C	1.5°C	0.03°C
	N	-100°C to 1300°C	1.0°C	-200°C to -100°C	1.5°C	0.03°C
	R	300°C to 1760°C	1.2°C	-50°C to 300°C	1.8°C	0.03°C
	S	400°C to 1760°C	1.2°C	-50°C to 400°C	1.8°C	0.03°C
	T	-100°C to 400°C	1.0°C	-200°C to -100°C	1.5°C	0.03°C
RTD	R_0 from 49 Ω to 2.1 K Ω	-200°C to 600°C	0.06°C			0.003°C
Thermistor	2.2 k, 5 k, 10 k	-80°C to 150°C	0.08°C			0.002°C

[1] For total measurement accuracy, add temperature probe error

Typical system speeds (Measurements made on a 3.2GHz PC running VB6 in Windows XP Pro)

Single Channel Reading times in msec	Direct measurements – direct to I/O (includes switch, measure time and I/O time)			Direct Measurement to Memory(GPIB)
Single channel [1] [2]	GPIB msec	USB 2.0 msec	LAN (w/ VXI 11) msec	Measurement into memory msec
Single channel, DCV	2.83	3.14	4.57	1.9
Single channel, ACV	5.00	5.35	5.75	4
Single channel, ohms	2.91	3.14	4.65	1.9
Single channel while changing scale (eg MEAS DCV 10 / MEAS DCV 1)	9.52	10.64	11.76	8.4
Single channel while changing function (eg. MEAS ACV / MEAS DCV)	128	120	120	120
Command execution time [3]				
34925A	Open or Close	0.7	0.9	1.6
	Read?	2.9	3.3	4.7
	Close/Read/Open	4.8	5.3	6.5
	Init/*WAI	1.9	2.1	3
	Close/Init/Open	3.7	4.1	4.7
34923A	Open or Close	0.9	1.2	1.8
	Read?	2.9	3.3	4.7
	Close/Read/Open	5.3	5.8	6.5
	Init/*WAI	1.9	2.1	3
	Close/Init/Open	4.2	4.7	5.2
34921A	Open or Close	4.7	5	5.3
	Read?	2.9	3. 3	4.7
	Close/Read/Open	14	15	15
	Init/*WAI	1.9	2.1	3
	Close/Init/Open	12.4	14	14

[1] Readings were made with minimum NPLC, delay 0, display off, autozero off.

[2] All times include the issue of "READ?" and the retrieval of data.

[3] CLOSE or OPEN bus transfer times allowed to overlap previous command. Command parse times overlap current activity until IO latency dominant.

Single channel measurement rates—DMM reading rates [1] [2]

Function	Resolution	Rds/s
DCV	4-1/2 digits (0.02 plc)	3000
	5-1/2 digits (1 plc)	59
	6-1/2 digits (10 plc)	6
2-wire resistance	4-1/2 digits (0.02 plc)	2000
	5-1/2 digits (1 plc)	58
	6-1/2 digits (10 plc)	6
Thermocouple	(0.02 plc)	2000
	0.1°C (1 plc)	59
RTD/Thermistor	1°C (0.02 plc)	1900
	0.1°C (1 plc)	58
	0.01°C (10 plc)	6
ACV	6-1/2 fast (200 Hz)	350
	6-1/2 Med (20 Hz)	350
	6-1/2 slow (3 Hz)	300
Frequency, period	4-1/2 digits (10 ms)	70
	5-1/2 digits (100 ms)	9
	6-1/2 digits (1 s gate)	1

[1] Reading speeds for 60Hz; autozero OFF

[2] For fixed function and range, readings to memory, scaling and alarms off, autozero OFF

Scanning measurement rates to bus or memory

	Direct measurements – direct to I/O (includes switch, measure time and I/O time)			Measurement into memory
Scanning channels [1]	**GPIB ch/sec**	**USB 2.0 ch/sec**	**LAN (w/ VXI 11) ch/sec**	**Into memory ch/sec**
Scanning DCV or Ohms				
34925A	920	860	980	1000
34923A/24A	588	572	605	625
34921A/22A	109	109	109	109
Scanning ACV [2]				
34925A	318	315	323	318
34923A/24A	260	260	260	260
34921A/22A	88	88	88	88
Scanning temperature				
34921A	109	109	109	109
Scanning digital in				
34950A	660	592	815	1038

[1] Speeds are for 4 ½ digits, delay 0, display off, autozero off.
Scanning is within bank on the same module. Add 10ms for between banks or modules.

[2] Add additional time for filter setting on ACV.

Data out of memory to LAN, USB, or GPIB (data transfer rate with 1000 channel blocks)

	GPIB rds/sec	USB 2.0 rds/sec	LAN (w/ VXI 11) [1] rds/sec
Readings	2560	2400	3542
readings with timestamp	1304	1230	1826
readings with all format options ON	980	926	1361

[1] LAN large block throughput rate is increased by approximately 30% using LAN sockets

Measurement characteristics with optional internal DMM

DC voltage

Measurement method	Continuously integrating multi-slope III A-D converter
A-D linearity	0.0002% of reading + 0.0001% of range on 10 V range
Input resistance 100 mV, 1 V, 10 V ranges 100 V, 300 V ranges	 Selectable 10 M Ω or > 10,000 M Ω 10 M Ω ± 1%
Input bias current	< 50 pA at 25°C
Input protection	300 V all ranges

True RMS AC voltage

Measurement method	AC coupled True RMS—measures the AC component of the input with up to 300 VDC of bias on any range
Crest factor	Maximum of 5:1 at full scale
Additional crest factor errors (non-sinewave)	Crest factor 1-2 0.05% of reading Crest factor 2-3 0.15% of reading Crest factor 3-4 0.30% of reading Crest factor 4-5 0.40% of reading
AC Filter Bandwidth: Slow Medium Fast	 3 Hz - 300 kHz 20 Hz - 300 kHz 200 Hz - 300 kHz
Input impedance	1 M Ω ± 2% in parallel with 150 pF
Input protection	300 Vrms all ranges

Resistance

Measurement method	Selectable 4-wire or 2-wire ohms
Current source	referenced to LO input
Offset compensation	Selectable on 100 Ω, 1k Ω, 10k Ω ranges
Maximum lead resistance	10% of range per lead for 100 Ω and 1k Ω ranges. 1k Ω on all other ranges
Input protection	300 V on all ranges

Frequency and period

Measurement method	Reciprocal counting technique
Voltage ranges	Same as AC voltage function
Gate time	1s, 100 ms, or 10 ms
Measurement timeout	Selectable 3 Hz, 20 Hz, 200 Hz LF limit

Measurement Consideration (Frequency and Period)

All frequency counters are susceptible to error when measuring low-voltage, low-frequency signals. Shielding inputs from external noise pickup is critical for minimizing measurement errors.

DC current

Shunt resistance	5 Ω for 10 mA, 100 mA; 0.1 Ω for 1 A
Input protection	1A 250 V fuse on 34921A module

True RMS AC current

Measurement method	Direct coupled to the fuse and shunt. AC coupled True RMS measurement (measures the ac component only)
Shunt resistance	5 Ω for 10 mA; 0.1 Ω for 100 mA, 1 A
Input protection	1A 250 V fuse on 34921A module

Measurement characteristics with optional internal DMM (Continued)

Thermocouple

Conversion	ITS-90 software compensation
Reference junction type	Internal, fixed, or external
Open thermocouple check	Selectable per channel. Open > 5 k Ω
Thermistor	44004, 44007, 44006 series
RTD	a = 0.00385 (DIN) and a = 0.00392

Measurement noise rejection 60 (50) Hz [1]

DC CMRR	140 dB
AC CMRR	70 dB

Integration time	**Normal mode rejection [2]**
200 plc/3.33 s (4 s)	105 dB [3]
100 plc/1.67 s (2 s)	100 dB [3]
20 plc/333 ms (400 ms)	95 dB [3]
10 plc/167 ms (200 ms)	90 dB [3]
2 plc/33.3 ms (40 ms)	85 dB
1 plc/16.7 ms (20 ms)	60 dB
< 1 plc	0 dB

DC Operating Characteristics [4]

Function	**Digits[5]**	**Readings**	**Additional RMS Noise Error**
DCV[7], DCI, and	6½	0.6 (0.5)	0% of range
Reistance (≤10 kΩ)	6½	6 (5)	0% of range
	5½	60 (50)	0.001% of range
	5½	300	0.001% of range[6]
	4½	600	0.01% of range[6]

Autozero OFF Operation

Following instrument warm-up at calibration temerature ±1°C and <10 minutes, add 0.0002% range additional error +5 µV. (For 300 VDC, instead of .0002% of range, need .00066% of range)

Settling Considerations

Reading settling times are affected by source impedance, low dielectric absorptin characteristics, and input signal changes.

AC Operating Characteristics[8]

Function	**Digits[9]**	**Readings/s**	**AC Filter**
ACV, ACI:	6½	7 sec/reading	Slow (3 Hz)
	6½	1	Medium (20 Hz)
	6½	8[10]	Fast (200 Hz)
	6½	10	Fast (200 Hz)
	6½ üxç31ç33 Çä 32é	100[11]	Fast (200 Hz)

[1] For 1 KΩ unbalance in LO lead

[2] For power line frequency ± 0.08%

[3] For power line frequency ± 1% use 75 dB or ± 2.5% use 60 dB

[4] Reading speeds for 60 Hz and (50 Hz) operation; autozero OFF

[5] 6½ digits = 22 bits; 5½ digits = 18 bits; 4½ digits = 15 bits

[6] Add 20 µV for DCV, 4 µA for DCI, or 20 mΩ for resistance

[7] For 300 VDC, multiply the additional noise error by 3.3.

[8] Maximum reading rates for 0.01% of AC step additional error. Additional settling delay required when input DC level varies.

[9] 6½ digits = 22 bits; 5½ digits = 18 bits; 4½ digits = 15 bits

[10] For external trigger or remote operation using default settling delay (Delay Auto)

[11] Maximum limit with default settling delays defeated

System specifications

Scanning inputs

Analog:	34921A, 34922A, 34923A, 34924A, and 34925A multiplexer channels
Digital:	34950A/52A digital in and totalize

Scan triggering

Source	Interval, external, button press, software, or on monitor channel alarm
Scan count	1 to 50,000 or continuous
Scan interval	0 to 99 hours; 1ms step size
Channel delay	0 to 60 seconds per channel; 1 ms step size
External trig delay	< 2 ms. With monitor on < 200 ms
External trig jitter	< 2 ms

Alarms

Analog inputs	Hi, Lo, or Hi + Lo evaluated each scan
Digital inputs	34950A/52A digital in maskable pattern match or state change
	34950A/52A frequency and totalize: Hi limit only
Monitor channel	Alarm evaluated each reading
Alarm outputs	4 TTL compatible Selectable TTL logic Hi or Lo on fail
Latency	5 ms (typical)

Memory

Type	Volatile
Readings	500,000 with timestamp, readable during scan
States	5 instrument states with user label
Alarm queue	Up to 20 events with channel number, reading, and timestamp

System features

Per-channel math Min/max/average	Individual Mx+B scaling and calculated real time
Power fail recovery	Save switch states
Relay maintenance	Counts each relay closure and stores on module User resettable
Real-time clock	Battery-backed, 20-year typical life

General specifications

Power supply	Universal 100 V to 240 V ± 10%
Power line frequency	50 – 60 Hz ± 10% automatically sensed
Power consumption	150 VA
Operating environment	Full accuracy for 0°C to 55°C Full accuracy to 80% R.H. at 40°C IEC 60664-1 pollution degree 1
Storage environment	-40°C to 70°C [1]
Mainframe dimensions	133 H x 426 W x 341 D mm (5.25″ x 16.8″ x 14″) Full rack, 3 units high
Mainframe weight:	8.8 kg (19.6 lbs)
Module dimensions	280 x 170 x 27 mm (11″ x 6.7″ x 1″)
Safety conforms to	CSA, UL/IEC/EN 61010-1
EMC conforms to	IEC/EN 61326-1, CISPR 11
Warranty	1 year

Software

Agilent connectivity software included	
Agilent IO Libraries Suite 14 or greater (E2094N)	
Minimum system requirements (IO libraries and drivers)	
PC hardware	Intel Pentium 100 MHz, 64 Mbyte RAM, 210 Mbyte disk space Display 800 x 600, 256 colors, CD-Rom drive
Operating system [2]	Windows® 98 SE/NT/2000/XP
Computer interfaces	Standard LAN 10BaseT/100BaseTx Standard USB 2.0 IEEE 488.2 GPIB
Software driver support for programming languages	
Software drivers:	IVI-C and IVI COM for Windows NT/2000/XP LabVIEW
Compatible with programming tools and environments:	Agilent VEE Pro, Agilent T&M Toolkit (requires Visual Studio.NET) National Instruments Test Stand, Measurement Studio, LabWindows/CVI, LabVIEW, Switch Executive Microsoft Visual Studio.NET, C/C++, Visual Basic 6

[1] Storage at temperatures above 40°C will decrease battery life

[2] Load IO Libraries Version M for Windows NT support or version 14.0 for window 98 SE support,

Ordering instructions

Mainframe – holds up to 8 plug-in modules			
34980A	Multifunction switch/measure mainframe	Comes standard with "DMM" option	
	Description	**Module connectors**	**Optional terminal blocks, cables, connector kits**
Multiplexer modules			
34921A	40-channel armature multiplexer w/low thermal offset (order 34921T for temp reference)	2 – 50-pin Dsub, Male	3492xT Terminal block with screw connectors
34923A	40/80-channel reed multiplexer		Y1135A – 1.5 m 50-pin M/F Dsub cable
34925A	40/80-channel optically isolated FET multiplexer		Y1136A – 3 m 50-pin M/F Dsub cable
			Y1139A – 50-pin female solder cup connector kit
34922A	70-channel armature multiplexer	2 – 78-pin Dsub, Male	3492xT Terminal block with solder connections
34924A	70-channel reed multiplexer		Y1137A – 1.5 m 78-pin M/F Dsub cable
			Y1138A – 3 m 78-pin M/F Dsub cable
			Y1140A – 78-pin female solder cup connector kit
Matrix modules			
34931A	Dual 4x8 armature matrix	2 – 50-pin Dsub, Male	3493xT Terminal block with screw connectors
34932A	Dual 4x16 armature matrix		Y1135A – 1.5 m 50-pin M/F Dsub cable
34933A	Dual/quad 4x8 reed matrix		Y1136A – 3 m 50-pin M/F Dsub cable
			Y1139A – 50-pin female solder cup connector kit
General purpose/actuator modules			
34937A	32-channel Form C/Form A general-purpose switch	2 – 50-pin Dsub, Male	3493xT Terminal block with screw connectors
34938A	20-channel 5-amp Form A switch		Y1135A – 1.5 m 50-pin M/F Dsub cable
			Y1136A – 3 m 50-pin M/F Dsub cable
			Y1139A – 50-pin female solder cup connector kit
RF and microwave modules			
34941A	Quad 1x4 50-ohm 3-GHz RF multiplexer	10 – SMA	Requires standard 50 ohm SMA RF cables, adapters
34942A	Quad 1x4 75-ohm 1.5 GHz RF multiplexer	10 – Mini SMB	Requires mini 75 ohm SMB RF cables, adapters
34945A	Microwave switch/attenuator driver	N/A	Requires 34945EXT and optional Y1150A-Y1155A distribution boards
34946A	Dual 1x2 SPDT terminated microwave switch **Option 004:** 4 GHZ switches installed **Option 020:** 20 GHz switches installed	SMA	Requires standard 50 ohm SMA cables and adapters
34947A	Triple 1x2 SPDT unterminated microwave switch **Option 004:** 4 GHZ switches installed **Option 020:** 20 GHz switches installed	SMA	Requires standard 50 ohm SMA cables and adapters
System measurement & control modules			
34950A	64-bit digital I/O with memory and counter	2 – 78-pin Dsub, Female	3495xT Terminal block with screw connectors
			Y1137A – 1.5 m 78-pin M/F Dsub cable
			Y1138A – 3 m 78-pin M/F Dsub cable
			Y1142A – 78-pin male solder cup connector kit
34951A	4-channel isolated D/A converter with waveform memory (DMM option required for calibration)	1 – 50-pin Dsub, Female	3495xT Terminal block with screw connectors
			Y1135A – 1.5 m 50-pin M/F Dsub cable
			Y1136A – 3 m 50-pin M/F Dsub cable
			Y1141A – 50-pin male solder cup connector kit
34952A	Multifunction module with 32-bit DIO, 2-ch D/A and totalizer		
34959A	Breadboard module	26- & 40-pin internal ribbon cable connectors	Any terminal block can be used assuming 50- or 78-pin Dsub is used

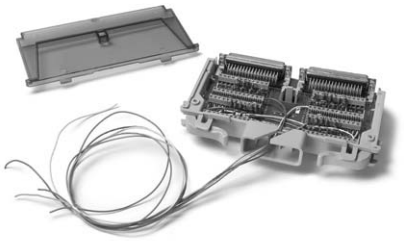
Accessories	
Y1130A	Rackmount kit for 34980A, forward or reverse mount (must order either E3663AC rail kit for forward rack mounting or E3664AC rail kit for reverse rack mounting)
Y1131A	Verification and diagnostic tools for 34980A mainframe and modules (select option for specific module support)
Y1132A	Module extender for 34980A
Terminal blocks	used for discrete wiring. Fully loaded terminal blocks supports up to 20 AWG wire
3492xT	Multiplexer terminal blocks
3493xT	Matrix and GP terminal blocks
3495xT	Measurement and control terminal blocks
Cables [1]	used for direct cable connection to module. some modules require 2 cables
Y1135A	1.5 m 50-pin Dsub, M/F twisted pair with outer shield cable – 300 V
Y1136A	3 m 50-pin Dsub, M/F twisted pair with outer shield cable – 300 V
Y1137A	1.5 m 78-pin Dsub, M/F twisted pair with outer shield cable – 300 V
Y1138A	3 m 78-pin Dsub, M/F twisted pair with outer shield cable – 300 V
Connector kits [1]	used to build custom cables
Y1139A	Solder cup connector kit for 34921/23/25/31/32/33/37/38 –50-pin Dsub female – 125 V
Y1140A	Solder cup connector kit for 34922, 34924 – 78-pin Dsub female – 60 V
Y1141A	Solder cup connector kit for 34951, 34952 – 50-pin Dsub male – 125 V
Y1142A	Solder cup connector kit for the 34950A – 78-pin Dsub male – 60 V
34945A accessories	– distribution boards required for control of external switch
34945EXT	External driver for 34945A, one required for each 64 coils – holds 4 distribution boards
Y1150A	34945EXT distribution board for 8 N181x SPDT switches
Y1151A	34945EXT distribution board for two 87104x/106x multiport or 87406B matrix switches
Y1152A	34945EXT distribution board for one 87204x/206x or 87606B switch and two N181x switches
Y1153A	34945EXT distribution board for two 84904/5/6/7/8 or 8494/5/6 step attenuators
Y1154A	34945EXT distribution board for two 87222 transfer switches and six N181x SPDT switches
Y1155A	34945A distribution board w/ generic screw terminals for driving 16 switch coils
Thermocouples/thermistors	
34307A	10 pack of J type thermocouples
34308A	5 pack of 10 k thermistors

For additional information please visit: **http://www.agilent.com/find/34980a**

[1] Module specifications include terminal block. Performance may be degraded when using cables or connector kits.

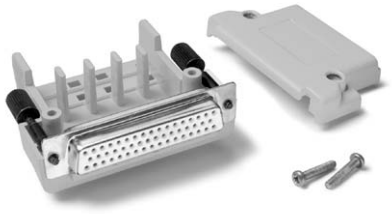
Rack kit

Terminal block



Cable

Connector kit



Related Agilent literature

Publication title	Publication type	Publication number
Agilent VEE Pro	Data sheet	5988-6302EN
Agilent W1140A-TKT T&M Toolkit 2.0 with Test Automation	Data sheet	5989-1441EN
Agilent E2094N IO Libraries Suite 14	Data sheet	5989-1439EN
Agilent 34980A Configuring an RF/Microwave Switch System	Application Note	5989-2272EN