

The Core of Test Systems— RF/Microwave Signal Routing without Compromise

Custom and standard off-the-shelf solutions

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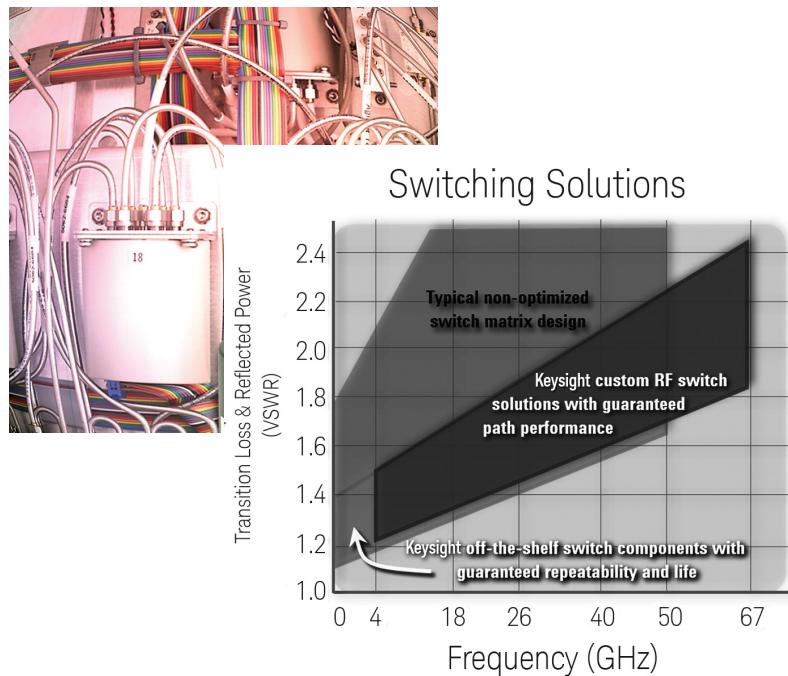
Breadth of RF/Microwave Switching Knowledge

Keysight Technologies, Inc. has been providing RF/Microwave switch solutions for over 20 years. Our engineering talent has a deep understanding of customers' applications at the technology, business, process, and system levels. We have offerings from simple switch control to fully integrated solutions that are tested and documented. Keysight is in the unique position of supplying the highest quality RF and Microwave components, and the expertise to guarantee world-class path performance in a switching solution.

Keysight has a large family of solutions for R&D and manufacturing engineers who develop design validation or functional test systems. We offer RF/Microwave solutions with the broad range of supported switches and custom solutions from DC to 110 GHz. Our solutions are designed for test applications in many areas including military radios, radar communications or satellites in Aerospace/Defense or handsets, base stations, and radio components in wireless applications.

There are issues to consider when designing an RF switch matrix, which makes it a challenging task. Some of these issues include:

- Electrical and mechanical constraints
- Switch control architecture.
- Signal integrity and reliability.
- Cost effectiveness
- Documentation and support



RF/Microwave Switching Solutions

This brochure describes how Keysight provides the right switching solutions giving you confidence in your measurements. It is an overview of RF/Microwave switching solutions as well as how to best choose among several different types of approaches to RF switching and/or switch control.

Many of Keysight's switching products come standard with these key features:

- LXI Class C with standard LAN, USB and GPIB interfaces
- Web interface for remote monitoring and control
- Relay counter to track switch closures.
- Switch sequencer for faster switch setup and execution.
- Switch verification to ensure closures.
- SCPI code generator for ease of programming
- Software drivers for most common development environments including Python, IVI.NET and IVI-C



Product

Electromechanical Switches
Multiport Switches, SPDT Switches,
Bypass Switches, Transfer Switches,
Matrix Switches and Low-Cost L-
Series Switches



Benefit

High accuracy and repeatability
for automated test and
measurement – all with a wide
variety in configurations to meet
all your switching requirements

Modular Switch Solutions



Switch, Coupler, Programmable
attenuator modules enabling field
reconfiguration via built in
software.

Custom Switch Solutions
For more information see
www.keysight.com/find/switchmatrix



Just the right custom switch
solutions; as well as world-class
path performance solutions up to
110 GHz

Switch & Control Units
34980A Multifunction
Switch/Measure Unit, 34970A Data
Acquisition Switch Unit



Mixed signal system can cost up
to 40% less than VXI or PXI –
Get low frequency and
high frequency switching in a
single box

RF/Microwave switching considerations

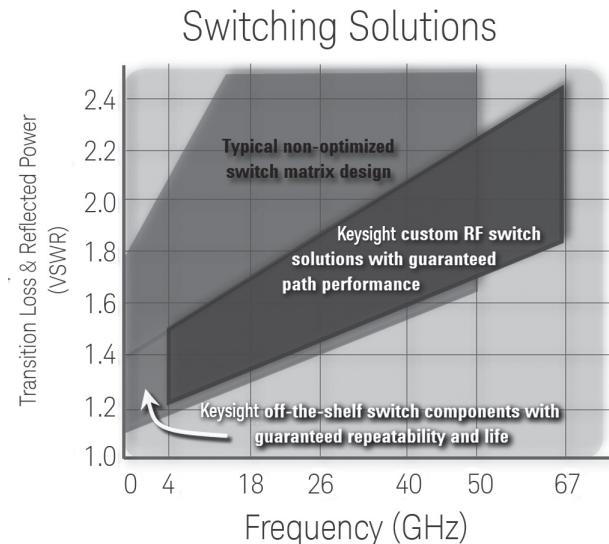
The choice of cables, connectors, and switches can significantly impact overall system performance and reliability. The cables, connectors, and switches create the signal path from the DUT to the measurement instruments. Ideally, there would be no signal degradation when routing from one point to another. For actual test systems, there is always some degradation of the signal in passing through these components. Signal degradation is directly related to signal frequency and the quality of signal routing components. To ensure good signal integrity choose cables, connectors, and switches where the insertion loss, VSWR, and isolation at the desired frequencies do not compromise the measurement.

Key factors in selecting RF/Microwave switches

When selecting RF/Microwave switches, be aware that the most common and readily available switches often present a minimum viable solution. The cost of the minimum solution may seem attractive; however, when using these products, the test system can give varying results over time and can often be difficult to troubleshoot. By adding a few switching options and features, you can significantly improve the repeatability, performance, and usability of your switching solution.

Be sure to include the following when selecting your RF/Microwave switches:

- Use high quality switches so the insertion loss, VSWR and isolation at the desired frequencies do not compromise your measurements.
- Select switches with long life and high repeatability between switch cycles to improve test system integrity.
- Use switches that provide position feedback so you can determine the actual position of the signal instead of the programmed state.
- Use switches with latching relays for less heat rise resulting in better measurement uncertainty.
- Use switches with D-sub or ribbon cable socket connectors for ease of wiring.

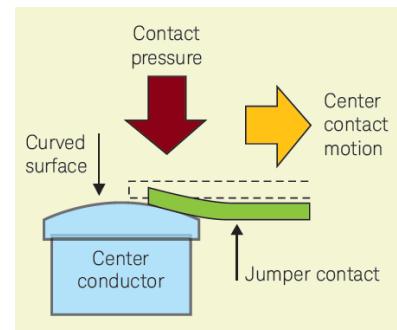


Keysight RF/Microwave Switches

Keysight switches are designed with high accuracy and repeatability for automated test and measurement, signal monitoring and routing applications. These switches provide excellent performance with a wide variety of configurations to meet all your switching requirements.

- **Bypass** switches insert or remove a test component from a signal path.
- **SPDT** switches route signals from an input to two output paths.
- **Multiport** switches allow a single input and multiple (three or more) output paths.
- **Transfer** switches can be used to switch between two inputs and two outputs, as a drop-out switch, for signal reversal, as a SPDT switch, or to bypass a test component.
- **Matrix** switches can be connected individually via internal microwave switches to form an RF path. They can be configured for blocking 1x5, 2x4, or 3x3 switching applications.

Electromechanical switches are widely used in both basic signal routing and application-specific switch matrices such as tree matrix, full access matrix, bypassing an active device, multi-source/multi-DUT switching, etc.



Electromechanical switches

Keysight electromechanical switches are available in many different configurations with operating life up to 10 million cycles. With a guaranteed insertion loss repeatability of 0.03 dB up to 5 million cycles, these switches ensure accurate system measurements and reduce calibration intervals. Unmatched isolation, typically > 90 dB at 4 GHz, reduces sources of random errors. TTL drive option is available for most switches.

Keysight electromechanical switches offer:

- A typical switching life that is two times the guaranteed specifications. For example, the specified switching life for 87106A is 5 million cycles, but in actuality the 87106A can typically work up to more than 10 million cycles.
- Guaranteed insertion loss repeatability of 0.03 dB up to 5 million cycles. This is made possible in Keysight switches with a unique "wiping action" mechanism in the contact area. The wiping action removes debris to ensure the insertion loss repeatability.
- Maximum input power of 100 W at 0.3 GHz at 25 °C under cold switching conditions, which means the RF signal is removed before switching is performed. Cold switching results in lower contact stress and longer life.



87104/6 Series DC to 40 GHz Multiport Switches

The Keysight 87104/6 A/B/C/D latching coaxial switch combines unmatched flexibility of configuration with excellent repeatability, long life, and reliability.



N1810 Series SPDT Coaxial Switches

The Keysight N1810TL/UL SPDT latching coaxial switch combines unmatched flexibility of configuration with excellent repeatability, long life, and reliability. These SPDT switches can be used to route signals from input to two output paths.



Bypass Switches

These bypass switches can be used to automatically insert or remove a test component from a signal path. The switches allow the user to “bypass” an active device. The Keysight N1811/2TL latching coaxial switch combines unmatched flexibility of configuration with excellent repeatability, long life, and reliability.



87222 Series DC to 50 GHz Coaxial Transfer Switches

Flexibility is essential in signal routing applications, and the Keysight 87222C/D/E 4-port coaxial transfer switch offers just that. It provides exceptional repeatability, low insertion loss, and high isolation. These switches provide simplification of design in signal routing and conditioning applications.



87404/06 Series Matrix Switches

The Keysight 87406B and 87606B matrix switches provide the life and reliability required for automated test and measurement, signal monitoring and routing applications. The switches are designed to operate for more than 10 million cycles and will meet all electrical specifications for at least 5 million cycles.



Keysight's L-Series Electro-Mechanical Switches

Reduce measurement uncertainty for 2 million cycles with a guaranteed 0.03 dB insertion loss repeatability and unmatched isolation. These economically priced, high-performance switches offer a full selection of switch configurations from DC up to 26.5 GHz. The L-Series switches are a lower cost alternative with many of the same specifications as previous generations but with lower life expectancy.

Electromechanical Switch Selection Table

Keysight model number	Frequency	Terminated (T)/Unterminated (U)	Guaranteed operating life (n million cycle)	Repeatability (dB)	Min isolation (dB)	Max insertion (dB) loss	Max SWR	RF connectors
Bypass switch (4-port)								
8763A	DC to 4 GHz	T	1	0.03	100	0.25	1.20	SMA (f)
8763B	DC to 18 GHz	T	1	0.03	90	0.50	1.30	SMA (f)
8763C	DC to 26.5 GHz	T	1	0.50	50	1.25	1.80	3.5 mm (f)
N1811TL	DC to 26.5 GHz	T	5	0.03	60	0.80	1.60	SMA (f)
Bypass switch (5-port)								
8764A	DC to 4 GHz	U	1	0.03	100	0.25	1.20	SMA (f)
8764B	DC to 18 GHz	U	1	0.03	90	0.50	1.30	SMA (f)
8764C	DC to 26.5 GHz	U	1	0.50	50	1.25	1.80	3.5 mm (f)
N1812UL	DC to 26.5 GHz	U	5	0.03	60	0.80	1.60	SMA (f)
Single-pole double-throw (SPDT) switch								
8762A	DC to 4 GHz	T	1	0.03	100	0.25	1.20	SMA (f)
8762F1	DC to 4 GHz	T	1	0.03	100	0.40	1.30	Mini SMB (m)
8765A	DC to 4 GHz	U	5	0.03	101	0.30	1.20	SMA (f)
8765F1	DC to 4 GHz	U	5	0.03	90	0.40	1.20	Mini SMB (m)
8761A	DC to 18 GHz	U	1	0.03	45	0.80	1.35	SMA (f)2
8761B	DC to 18 GHz	U	1	0.03	45	0.80	1.35	SMA (f)2
8762B	DC to 18 GHz	T	1	0.03	90	0.50	1.30	SMA (f)
8765B	DC to 20 GHz	U	5	0.03	65	0.70	1.70	SMA (f)
8762C	DC to 26.5 GHz	T	1	0.50	50	1.25	1.80	3.5 mm (f)
8765C	DC to 26.5 GHz	U	5	0.03	50	0.97	1.70	3.5 mm (f)
N1810UL	DC to 26.5 GHz	U	5	0.03	60	0.80	1.60	SMA (f)
N1810TL	DC to 26.5 GHz	T	5	0.03	60	0.80	1.60	SMA (f)
8765D	DC to 40 GHz	U	5	0.03	50	1.67	1.50	2.4 mm (f)
Single-pole triple-throw (SP3T) switch								
8766K	DC to 26.5 GHz	U	5	0.05	Isolation3	3.43	1.80	3.5 mm (f)
Single-pole four-throw (SP4T) switch								
87104A	DC to 4 GHz	T	5	0.03	100	0.36	1.20	SMA (f)
87204A	DC to 4 GHz	T	5	0.03	100	0.36	1.20	SMA (f)
L7104A	DC to 4 GHz	T	2	0.03	90	0.36	1.20	SMA (f)
L7204A	DC to 4 GHz	U	2	0.03	90	0.36	1.20	SMA (f)
87104B	DC to 20 GHz	T	5	0.03	70	0.60	1.70	SMA (f)
87204B	DC to 20 GHz	T	5	0.03	70	0.60	1.70	SMA (f)
L7104B	DC to 20 GHz	T	2	0.03	65	0.60	1.70	SMA (f)
L7204B	DC to 20 GHz	U	2	0.03	65	0.60	1.70	SMA (f)
87104C	DC to 26.5 GHz	T	5	0.03	65	0.70	1.70	SMA (f)
87204C	DC to 26.5 GHz	T	5	0.03	65	0.70	1.70	SMA (f)
L7104C	DC to 26.5 GHz	T	2	0.03	60	0.70	1.70	SMA (f)
L7204C	DC to 26.5 GHz	U	2	0.03	60	0.70	1.70	SMA (f)
8767K4	DC to 26.5 GHz	U	5	0.05	Isolation3	3.43	1.80	3.5 mm (f)
87104D	DC to 40 GHz	T	5	0.03	65	0.70	1.95	2.92 (f)
8767M4	DC to 50 GHz	U	5	0.03	45	2.60	2.30	2.4 mm (f/m)
Single-pole five-throw (SP5T) switch								
8768K4	DC to 26.5 GHz	U	5	0.05	Isolation3	3.43	1.80	3.5 mm (f)
8768M4	DC to 50 GHz	U	5	0.05	45	2.60	2.30	2.4 mm (f/m)
Single-pole six-throw (SP6T) switch								
87106A	DC to 4 GHz	T	5	0.03	100	0.36	1.20	SMA (f)
87206A	DC to 4 GHz	T	5	0.03	100	0.36	1.20	SMA (f)
L7106A	DC to 4 GHz	T	2	0.03	90	0.36	1.20	SMA (f)
L7206A	DC to 4 GHz	U	2	0.03	90	0.36	1.20	SMA (f)
87106B	DC to 20 GHz	T	5	0.03	70	0.60	1.70	SMA (f)
87206B	DC to 20 GHz	T	5	0.03	70	0.60	1.70	SMA (f)

Keysight model number	Frequency	Terminated (T)/Unterminated (U)	Guaranteed operating life (n million cycle)	Repeatability (dB)	Min isolation (dB)	Max insertion (dB) loss	Max SWR	RF connectors
L7106B	DC to 20 GHz	T	2	0.03	65	0.60	1.70	SMA (f)
L7206B	DC to 20 GHz	U	2	0.03	65	0.60	1.70	SMA (f)
87106C	DC to 26.5 GHz	T	5	0.03	65	0.70	1.70	SMA (f)
87206C	DC to 26.5 GHz	T	5	0.03	65	0.70	1.70	SMA (f)
L7106C	DC to 26.5 GHz	T	2	0.03	60	0.70	1.70	SMA (f)
L7206C	DC to 26.5 GHz	U	2	0.03	60	0.70	1.70	SMA (f)
8769K4	DC to 26.5 GHz	U	5	0.05	Isolation3	3.43	2.05	3.5 mm (f)
87106D	DC to 40 GHz	T	5	0.03	65	0.70	1.95	2.92 (f)
8769M4	DC to 50 GHz	U	5	0.03	45	2.60	2.30	2.4 mm (f/m)
Double-pole double-throw (transfer) switch								
87222C	DC to 26.5 GHz	U	5	0.03	67	0.86	1.65	SMA (f)
L7222C	DC to 26.5 GHz	U	2	0.03	57	0.86	1.65	SMA (f)
87222D	DC to 40 GHz	U	5	0.03	60	1.20	1.70	2.92 mm (f)
87222E	DC to 50 GHz	U	5	0.05	60	1.15	1.70	2.4 mm (f)
Matrix switch (3x3, 2x4 & 1x5								
87406B	DC to 20 GHz	T	5	0.03	70	1.00	1.90	SMA (f)
87606B	DC to 20 GHz	T	5	0.03	70	1.00	1.90	SMA (f)

1. 75-ohm impedance

2. Only applicable when all ports have the same connector type. Connector options available: Type-N (m/f)/APC-7/UT-250 Coax/SMA (m/f)/50-ohm termination

3. Varies with frequency and port selected.

4. Insertion loss stated is from common port to the furthest port.

For more information on 8 and 10 port switches:

<https://www.keysight.com/us/en/assets/3120-1472/technical-overviews/U7108ABC-and-U7110ABC-Multiport-Electromechanical-Coaxial-Switches.pdf>

For information on higher frequency switches:

<https://www.keysight.com/us/en/assets/3120-1534/technical-overviews/U7104-6E-N-F-Multiport-Electromechanical-Coaxial-Switches.pdf>

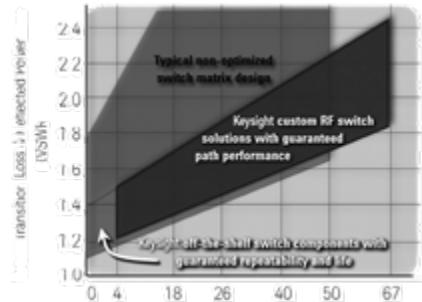
Custom Switch Solutions

Keysight Technologies provides integrated, high performance RF test systems and system components to the aerospace/defense and wireless industries. We deliver significant numbers of systems per year and a custom system purchased from Keysight brings confidence in a highly accurate and repeatable solution. The system team also designs and provides system components for our customers. The heart of an RF test system is the switch matrix. Keysight has been providing exceptional switch matrices for many years and continues to do so as part of our system business.

To complete custom switching and signal conditioning units, our switch matrix designs range from a simple 1 x 12 fanout to a 10 x 10 non-blocking full access matrix, to complete custom switching and signal conditioning units. The keys to Keysight's exceptional switch matrix performance are our unmatched design experience, our no-compromise manufacturing processes for switches and semi-rigid cables, and our well-established methods for matrix assembly and testing.

The Customs team uses Keysight's standard commercial manufacturing process, except for one difference, you are involved in the design phase. Then after your matrix is built, we will measure the S-parameters of every signal path with a Keysight Performance Series Network Analyzer to make sure that your specifications are met. The test data is included in the documentation you receive with the matrix.

Various frequency span and connector type options are available. For more information on custom solutions, go to: www.keysight.com/find/switchmatrix



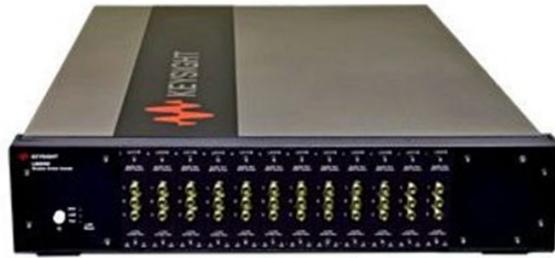
Recommended Electronic Calibration (ECal) modules

The software supports the use of Keysight Electronic Calibration (ECal) modules for reducing calibration time and increasing ease-of-use. <https://www.keysight.com/us/en/products/accessories/calibration-modules-kits.html>

RF/Microwave Switch Platforms

Keysight's L8990M modular switch matrix provides a cost-effective and quick-ship solution with a simple and flexible platform for basic RF switching. The L8990M can support up to 30 switch channels in a 2U rack-mountable enclosure with signal frequencies up to 67 GHz. It can support up to 66 switch channels in a 4U high enclosure. This provides the capability to test a wide range of RF and telecommunication products and devices.

- excellent RF performance
- user-defined configurations
- automated and manual control
- specified for low loss and high repeatability.
- internal controller and power supply
- custom modules and other RF components



Each L8990M Modular Signal Routing Solution is delivered fully integrated according to the user-specified configuration.

- The Modular Signal Routing Solution includes:
- Rack-mountable enclosure, 2U,3U, 4U or 5U in height.
- Modules installed in front panel slots - each module consists of a switch or another RF.
- Switches, couplers, and dividers secured to a 1-3 slot wide sub-panel.
- Filler panels in unused slots
- Internal controller and power supply
- Internal driver boards and cables necessary to support chosen modules.
- User manual, customized for the specified configuration.
- Flexible and Semi Rigid RF cables available

To request pricing and delivery, simply send an email to; quotes.adsys@keysight.com, or fill out the configuration form available here:

<https://www.keysight.com/us/en/assets/7018-05692/technical-overviews/5992-2227.pdf>

Low Frequency and RF/Microwave Switch and Control Unit – 34980A

Keysight has standard switching systems that offer either RF/Microwave switching on a card or RF/Microwave switch drivers.

These modules can be used in high frequency systems or in mixed systems that require both high and low frequency switching in a single box.



34980A Multifunction Switch/Measure Unit

Number of available slots	8
Number of available modules	21
Front panel	Yes
Integrated DMM	
Max scan speed	6½ digit
Max 2-wire Mux channels	1000 ch/s
Max voltage	560
Max frequency	300 V
Max matrix cross points	26.5 GHz
IO interfaces	4,096
Microwave switch driver	LAN, USB 2.0, GPIB
	Yes

34980A Multifunction Switch/Measurement Unit

The Keysight 34980A is an eight-slot mainframe that includes an optional built-in 6½ digit DMM. Choose from more than 20 optional plug-in modules that offer a broad range of functionality which includes DC to 26.5 GHz switching, counter/totalizer, digital I/O with pattern capabilities, and D/A converters in one compact, high-performance modular platform. The 34980A is easily integrated into automated test or data acquisition applications with a graphical Web interface, standard connectors, standard I/O to the computer, and standard software drivers.

- Front panel or software controlled.
- Graphical Web interface for quick setup and troubleshooting
- Easy connections with standard D-sub cables or screw terminal blocks
- Use RF/Microwave Switches on a card or control switches external to the mainframe with switch driver.
- Define and execute up to 500 switch sequences stored in non-volatile memory.
- Relay cycle counter to predict end of switch life.
- LXI Class C compliant with standard LAN, USB and GPIB interfaces

BenchLink Data Logger for 34980A

The 34980A also include FREE BenchLink Data Logger software for a convenient way to collect and analyze your data. The New BenchLink Data Logger Pro adds real-time limit checking, decision making and conditional branching with no programming required.

For more information go to:
www.keysight.com/find/3483xA.

For more information on the Keysight 34980A, go to: www.keysight.com/find/34980A.

34980A Multifunction Switch/Measure Mainframe and Modules

Low frequency modules

Module	Description	Max volts	Switch/ carry current	BW (MHz)	Scan ch/sec	Thermal offset	Comments
Multiplexers							
34921A	40-channel armature multiplexer w/ low thermal offset	±300 V	1 A / 2 A	45 MHz	100	< 3 µV	
.	4 current channels						
.	Config as 2- or 4-wire						
34922A	70-channel armature multiplexer	±300 V	1 A / 2 A	25 MHz	100	< 3 µV	Config as 2- or 4-wire
34923A	40/80-channel reed multiplexer	±150 V peak	0.5 A / 1.5 A	45 MHz	500	< 50 µV	Config as 1-, 2- or 4-wire
Matrices							
34931A	Dual 4x8 armature matrix	±300 V	1 A / 2 A	30 MHz	100	< 3 µV	Backplane expandable
34932A	Dual 4x16 armature matrix	±300 V	1 A / 2 A	30 MHz	100	< 3 µV	Backplane expandable
34933A	Dual/quad 4x8 reed matrix	±150 V peak	0.5 A / 1.5 A	30 MHz	500	< 50 µV	Backplane expandable Config as 1- or 2-wire
34934A	Quad 4x32 reed matrix	±100 V	0.5 A / 0.5 A	20 MHz	500	< 50 µV	
General purpose							
34937A	28-channel Form C and 4-channel Form A	300 V	1 A / 2 A 5 A / 8 A	10 MHz	N/A	3 µV	
34938A	20-channel 5-amp Form A	30 VDC/250 VAC	5 A / 8 A	1 MHz	N/A	3 µV	
34939A	64-channel Form A	±100 V	1 A / 2 A	10 MHz	N/A	3 µV	
RF and microwave modules							
34941A	Quad 1x4 50-ohm 3 GHz RF multiplexer	< 0.6 dB	> 58 dB	3 GHz	< 1.25	50 ohm	Specs @ 1 GHz
34942A	Quad 1x4 75-ohm 1.5 GHz RF multiplexer	< 0.6 dB	> 60 dB	1.5 GHz	< 1.35	75 ohm	Specs @ 1 GHz
34945A	Microwave switch/attenuator driver						
34946A	Dual 1x2 SPDT terminated microwave	< 0.42 dB	> 85 dB	4 GHz or	< 1.15	50 ohm	@ 4 GHz
	switch	< 0.69 dB	> 67 dB	20 GHz	< 1.30		@ 20 GHz
		< 0.8 dB	< 60 dB	26.5 GHz	< 1.6		@ 26.5 GHz
34947A	Triple 1x2 SPDT unterminated microwave	< 0.42 dB	> 85 dB	4 GHz or	< 1.15	50 ohm	@ 4 GHz
	switch	< 0.69 dB	> 67 dB	20 GHz	< 1.30		@ 20 GHz
		< 0.8 dB	< 60 dB	26.5 GHz	< 1.6		@ 26.5 GHz

System control modules

Module	Description	Comments
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, 7 handshaking protocols and pattern memory. Two 10 MHz frequency counter/totalizers.
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 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 32 drive lines.

RF/Microwave Switch Drivers

Switch drivers are good for controlling RF/Microwave switches and attenuators anywhere in a test system. They can control switches on a bench, in a test fixture or on a tray in your rack.



34945A

Number of Control Lines	64 to 512
Front Panel	Yes
IO Interfaces	LAN, USB, GPIB

34980A Switch/Measurement Unit with the 34945A Switch Driver

The Keysight 34980A switch/measure mainframe with the 34945A switch driver is an ideal solution for systems requiring both low and high frequency switching. This offers a low-cost solution for mixed signal switching applications.



- Control of most popular microwave switches and attenuators
- Expandable with 34945EXT Remote Module
- Distribution boards for ease of wiring
- Switch readback capabilities.
- External power option for simultaneous switching
- Create and execute up to 500 switching sequences from nonvolatile memory.

The Keysight 34945A switch/attenuator driver module for the 34980A Multifunction Switch/Measure Unit allows you to control switches and attenuators external to the 34980A Mainframe. This module provides power and control signals for many of the most popular microwave switches and attenuators. Distribution boards offer ease of wiring to the external switches. One 34945A and 34945EXT can drive up to 64 switch coils, equaling 32 SPDT switches. Extend up to 8 additional 34945EXT's to drive up to 512 switch coils.

Keysight enables innovators to push the boundaries of engineering by quickly solving design, emulation, and test challenges to create the best product experiences. Start your innovation journey at www.keysight.com.



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