Keysight Technologies
P9400A/C
Solid State PIN Diode Transfer Switches

P9400A 100 MHz to 8 GHz PIN transfer switch
P9400C 100 MHz to 18 GHz PIN transfer switch

Technical Overview

Key Features

- Minimize crosstalk with exceptionally high port-to-port isolation of > 80 dB
- Increase test setup flexibility with a broad operating frequency range
- Increase throughput effectively with high-speed switching time of < 200 ns
- Optimize system dynamic range with low insertion loss
- Eliminate the need for external drivers with integrated TTL-compatible driver

Description

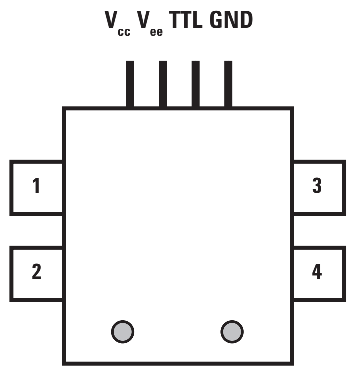
The Keysight Technologies, Inc. P9400A/C solid state PIN diode transfer switches offer outstanding performance in isolation, insertion loss and return loss across a broad operating frequency range. Based on PIN diode technology, P9400A/C fit exceptionally well into ultra-fast RF and microwave switching applications in instrumentation, communications, radar, switch matrices and various other test systems where speed and lifetime of a switch are critical.

A PIN diode switch IC and multiple shunt PIN diodes on the RF path of the P9400A/C ensure unmatched isolation performance between ports. Keysight's careful selection of the PIN diodes provides accurate low frequency measurements down to 100 MHz, while maintaining superb performance up to 8 GHz (P9400A) and 18 GHz (P9400C).

P9400A/C have an integrated TTL-compatible driver for easy operation. These transfer switches increase system flexibility and are useful in systems where superior RF performance switches is critical.

Applications

Keysight P9400A/C solid state transfer switches can be utilized in numerous ways to enhance system flexibility and simplicity. The following are five examples of how the P9400A/C switches can be used: as a drop-out switch, as an SPDT switch, for signal reversal, to bypass an active device, and to switch between multiple equipment to multiple DUTs.



Logic Control	Port 1 to Port 2 Port 3 to Port 4	Port 1 to Port 3 Port 2 to Port 4
TTL HIGH	Low Loss	High Isolation
TTL LOW	High Isolation	Low Loss

Figure 1. **Driving the switch**

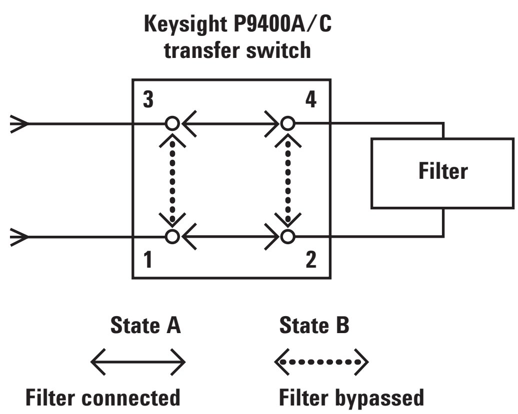


Figure 2. The Keysight P9400A/C as a drop-out switch

The P9400A/C can be used as a simple drop-out switch where a signal is either run through the device or straight through the switch bypassing the device.

By attaching an external termination, you can use the P9400A/C in an SPDT terminated switch configuration.

In the signal reversal configuration, a device can be connected across two diagonal ports of the P9400A/C transfer switch. This will allow the signal direction through the device to be reversed.

In Figure 5, an active device, such as an amplifier, is inserted into a signal path. This presents a unique problem. A single transfer switch has the undesirable characteristic of shorting the output of the amplifier to its input when the signal is bypassing the amplifier. Two transfer switches

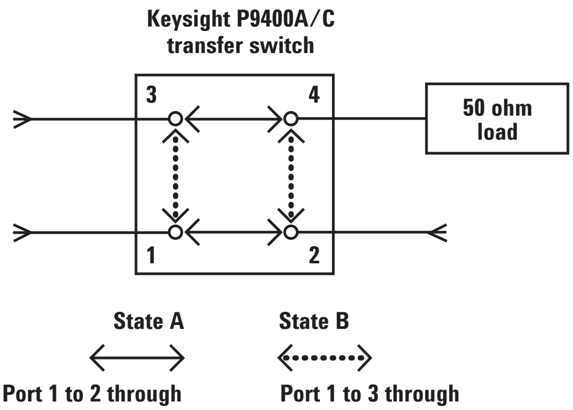


Figure 3. The Keysight P9400A/C configured as an SPDT switch

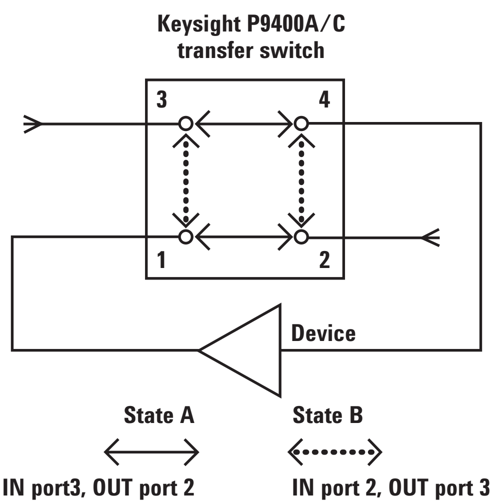


Figure 4. The Keysight P9400A/C in a signal reversal application

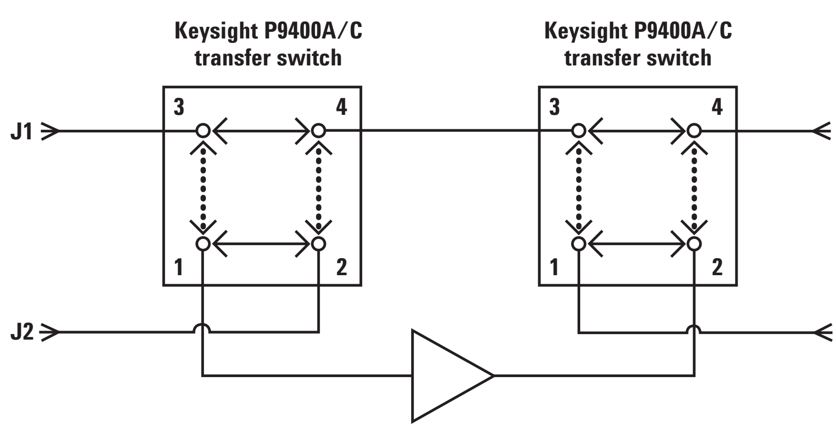


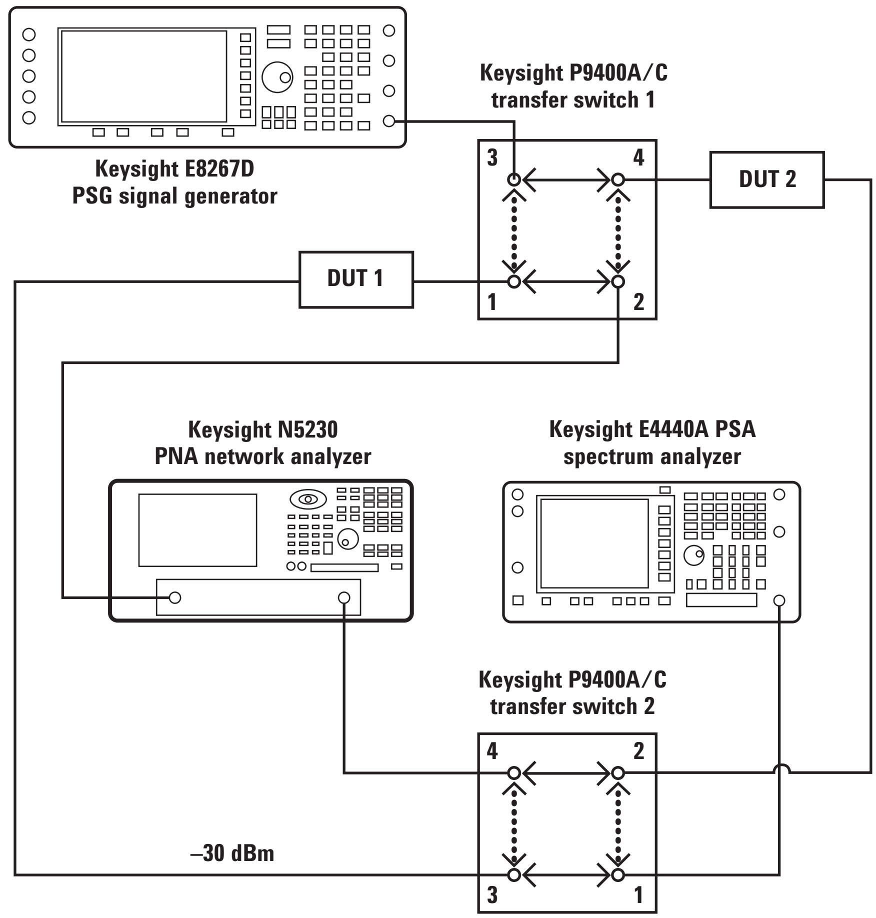
Figure 5. The Keysight P9400A/C used to bypass an active device

are used in this example instead of two SPDT switches, which can serve the similar purpose. However by using two transfer switches, an additional signal path is always simultaneously available.

Figure 6 shows an example of a configuration of transfer switches that tests two DUTs simultaneously, each through different sets of equipment targeting distinctive measurement parameters.

DUT 1 is tested for S-parameters using a network analyzer, while DUT 2 is tested on harmonics and spurious signals using a signal generator and spectrum analyzer. Examples of devices that can be conveniently tested this way include: amplifiers, mixers and receivers. With only one TTL control input that controls both switches' control pin, both tests can be run simultaneously and efficiently on both DUTs. This type of usage will increase throughput and simplify your test system.

Besides being versatile, P9400A/C switch's outstanding isolation is evidently portrayed in this application example. Assume that the transmitted power coming out from DUT 1 is –30 dBm. At the same time, DUT 2 is tested on spurious signal, which might be measured to a value as low as –100 dBm or more. This requires switch #2 to have an isolation of more than –100 dBm – (–30 dBm) = –70 dB, which is fulfilled by the isolation performance of P9400A/C.
This is only one of the countless measurement uncertainties that need careful attention. You do not want your system's accuracy to be impaired by switches with low or even moderate isolation performance. Nor do you want to waste extra time calculating for the uncertainties which always lead to even more complexities due to the precise timing required in the ever-increasing speed of switching and testing.



Control input	State	DUT 1 connected to	DUT 2 connected to	Tests
High	⟷	Network analyzer	Network analyzer	S-parameter
Low	⇠⋯⇢	Spectrum analyzer and signal generator	Spectrum analyzer and signal generator	Spurious signal, harmonics

Figure 6. Switching and testing two DUTs between two different test sets of equipment simultaneously

Specifications

Specifications refer to the performance standards or limits against which the solid state switches are tested.

Typical characteristics are included for additional information only and they are not specifications. These are denoted as “typical”, “nominal” or “approximate” and are printed in italic.

RF Specifications

Model	P9400A	P9400C
Frequency range	100 MHz to 8 GHz	100 MHz to 18 GHz
Insertion loss	< 3 dB (100 MHz to 4 GHz) < 3.5 dB (4 GHz to 8 GHz)	< 3.5 dB (100 MHz to 8 GHz) < 4.2 dB (8 to 18 GHz)
Isolation	> 80 dB	> 80 dB
Return loss (ON Ports)	> 15 dB	> 10 dB
Switching speed 1	< 200 ns (typical)	< 200 ns (typical)
Video leakage	0.6 Vpp (typical)	0.6 Vpp (typical)
Characteristic impedance	50 Ω (nominal)	50 Ω (nominal)
Connectors	SMA (f)	SMA (f)

1. Switching speed is based on 50% TTL to 90% RF (ON time) or 50%TTL to 10%RF (OFF time)

Absolute Maximum Ratings [2]

Parameters	P9400A/C	
	MIN	MAX
RF input power (average)	–	+23 dBm
V_{cc}	–0.5 V	6 V
V_{ee}	–6 V	0 V
TTL Control Input	–0.5 V	(V_{cc}+0.5) V

2. Operation in excess of any one of these may result in permanent damage to the products.

DC Operating Range [3]

Parameters	P9400A/C	
	MIN	MAX
V_{cc}	4.5 V	5.5 V
V_{ee}	–5.5 V	–4.5 V
Control Input (TTL) HIGH	2.4 V	Vcc
Control Input (TTL) LOW	–0.5 V	0.8 V

3. Recommended parameters for optimum RF performance

Typical DC Power Consumption

	MIN	TYPICAL	MAX
Vcc	0.24 W	0.30 W	0.38 W
Vee	0.15 W	0.19 W	0.23 W

Environmental Specifications

The P9400A/C solid state switches are designed to fully comply with Keysight Technologies' product operating environment specifications. The following summarizes the environmental specifications for these products.

Temperature	
Operating	–40 °C to +85 °C
Storage	–65 °C to +125 °C
Cycling	–65 °C to +150 °C, 10 cycles @ 20 °C per minute ramp rate, 20 minutes dwell time per MIL-STD-833F, Method 1010.8, Condition C (modified)
Humidity	
Operating	50% to 95% RH @ 40 °C, one 24 hour cycle, repeated 5 times
Storage	< 90% RH @ 65 °C, 24 hours
Shock	
Half-sine, smoothed	1000 G @ 0.5 ms, 3 shock pulses per orientation, 18 total per MIL-STD-833F, Method 2002.4, Condition B (modified)
Vibration	
Broadband random	50 to 2000 Hz, 7.0 G rms, 15 minutes, per MIL-STD-833F, Method 2026-1 (modified)
Altitude	
Storage	< 15,300 meters (50,000 feet)
ESD Immunity	
Direct discharge	2 KV per IEC 61000-4-2
Air discharge	4 KV per IEC 61000-4-2

Mechanical Dimensions

Dimensions are in mm (inches) nominal, unless otherwise specified.

	P9400A	P9400C
Length, mm (inches)	46.2 (1.82)	46.2 (1.82)
Width, mm (inches)	43.4 (1.71)	43.4 (1.71)
Net weight, kg (lb)	0.07 (0.154)	0.07 (0.154)

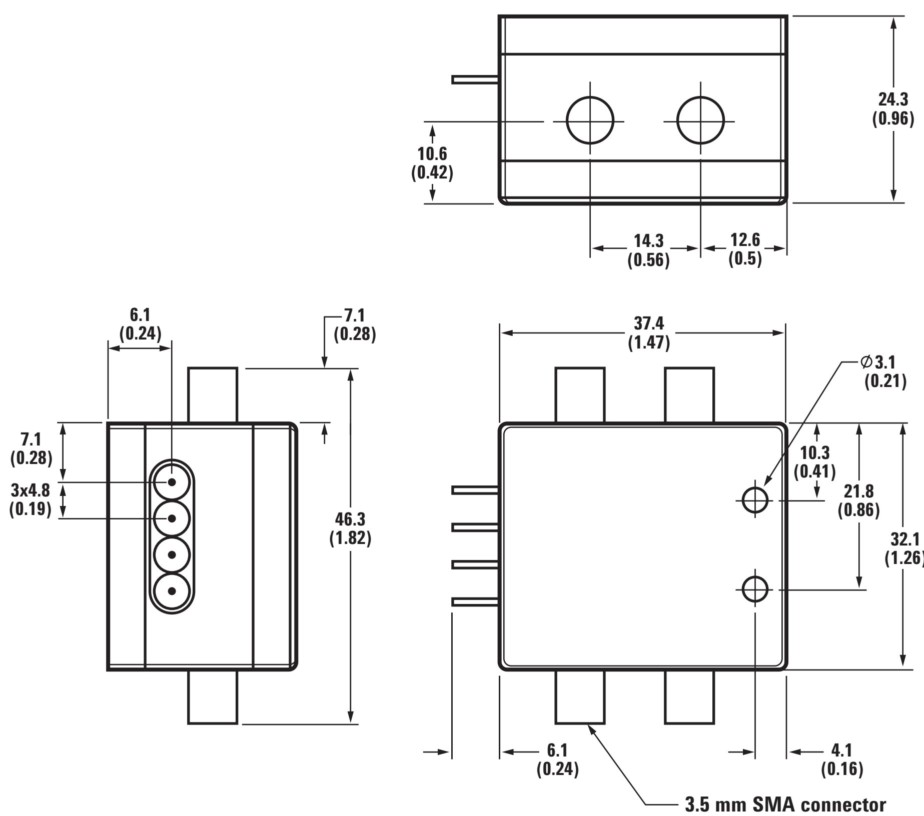


Figure 7. P9400A/C mechanical dimensions

Typical Performance

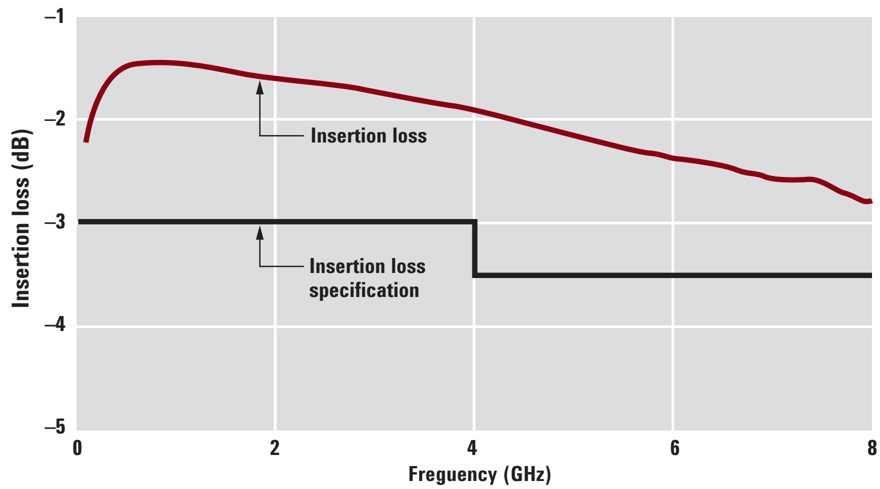


Figure 8. P9400A insertion loss versus frequency (typical)

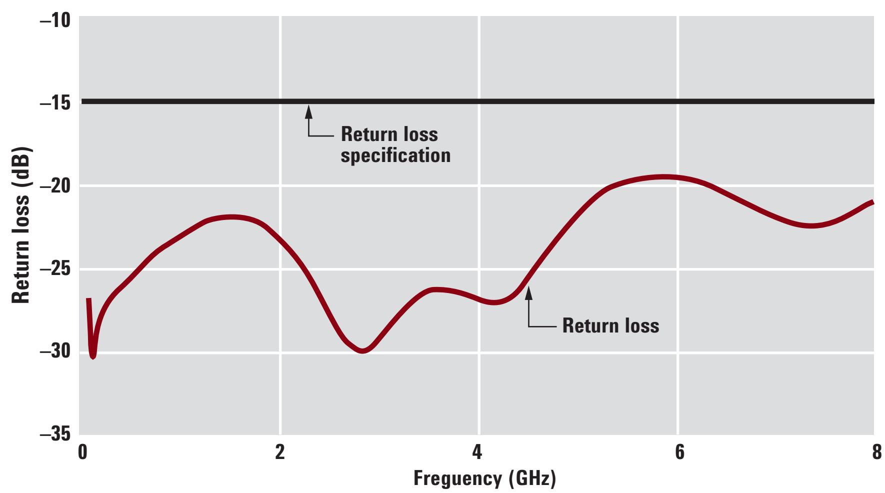


Figure 9. P9400A return loss versus frequency (typical)

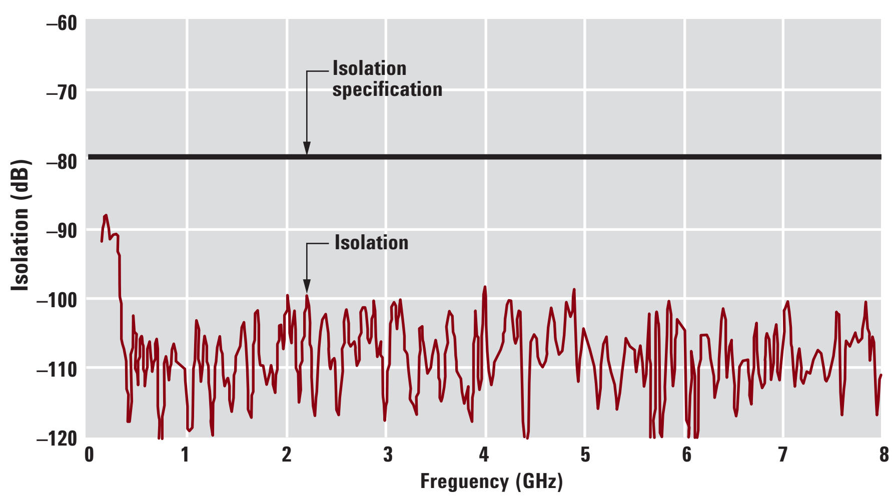


Figure 10. P9400A isolation versus frequency (typical)

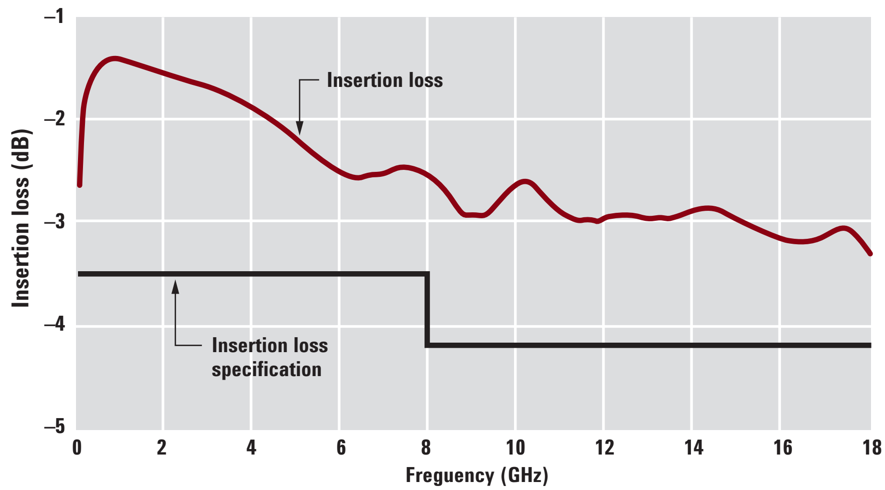


Figure 11. P9400C insertion loss versus frequency (typical)

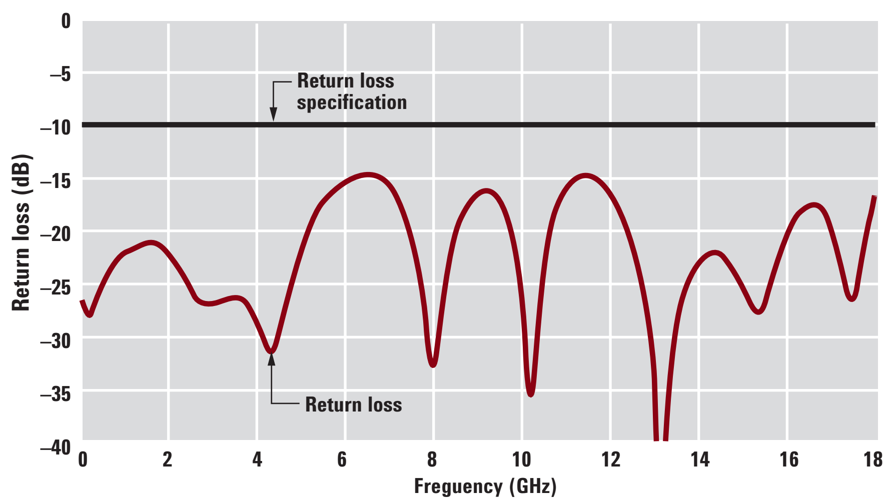


Figure 12. P9400C return loss versus frequency (typical)

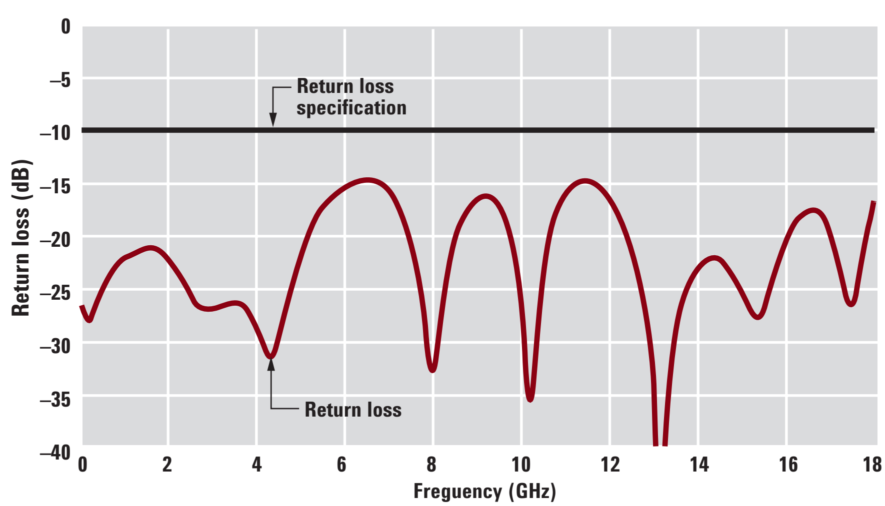


Figure 13. P9400C isolation versus frequency (typical)

Ordering Information

P9400A	8 GHz Solid State PIN Transfer Switch
P9400C	18 GHz Solid State PIN Transfer Switch

Related Literature

1. *Selecting the right switch technology for your application*, 5989-5189EN
2. *Video Leakage Application Note*, 5989-6086EN

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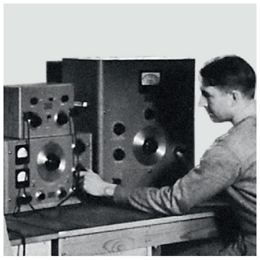

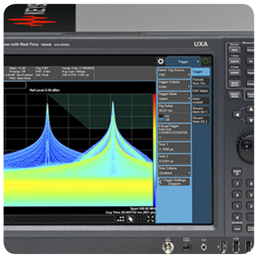

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