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2.7 GHz 50 Ω Multiplexer and SPDT Relay Switches

NI PXI-254x *NEW!*

- 2.7 GHz bandwidth
- 50 Ω characteristic impedance
- 30 V max switching voltage
- 0.5 A max switching current
- 10 W max switching power
- SMA direct connectivity
- Fully software programmable
- Single-slot 3U PXI modules

Operating Systems

- Windows Vista/XP/2000
- Linux®

Recommended Software

- NI Switch Executive
- LabVIEW
- LabWindows™/CVI
- Measurement Studio
- NI TestStand

Other Compatible Software

- Visual Basic
- C/C++

Driver Software (included)

- NI-SWITCH
- NI-DAQmx



Module	Configuration	Insertion Loss		VSWR		Isolation	
		0 to 1 GHz	1 to 2.7 GHz	0 to 1 GHz	1 to 2.7 GHz	0 to 1 GHz	1 to 2.7 GHz
PXI-2545	4x1 terminated multiplexer	0.7 dB	1.7 dB	1.2	1.3	50 dB	40 dB
PXI-2546	Dual 4x1 multiplexer	0.5 dB	0.9 dB	1.1	1.4	47 dB	40 dB
PXI-2547	8x1 multiplexer	0.7 dB	1.6 dB	1.1	1.2	48 dB	36 dB
PXI-2548	Quad SPDT relays	0.4 dB[1]	0.6 dB	1.15[1]	1.35	58 dB[1]	39 dB
PXI-2549	Dual-terminated SPDT relays	0.7 dB[1]	1.3 dB	1.15[1]	1.3	55 dB[1]	45 dB

[1]These specifications extend to 1.5 GHz. Specifications listed are typical. For more detailed specifications and performance curves, refer to the individual product specifications at **ni.com/switches**.

Table 1. PXI-254x Configurations and Typical Specifications

Overview

The National Instruments PXI-254x 2.7 GHz multiplexers and SPDT relay switch modules are ideal for routing RF signals in automated test applications. All modules are designed to have minimum insertion loss and voltage standing-wave ratio (VSWR) specifications to reduce signal reflections and losses in the transmission line, thereby maintaining signal integrity (see page 5). The NI PXI-2545 multiplexer and PXI-2549 SPDT relay modules provide 50 Ω terminations for applications where high-power signal reflections could damage the source. The PXI-2546, PXI-2547, and PXI-2548 are high-channel-count multiplexers and SPDT relay switch modules ideal for building dense switch networks in a single PXI chassis. All modules are well-suited for use with RF upconverters and downconverters such as the NI PXI-5671 2.7 GHz vector signal generator and the NI PXI-5661 2.7 GHz RF signal analyzer.

Relay Count Tracking

All modules count relay closures on each RF relay. You can programmatically retrieve the counts, which are stored on board the module itself, and use them for predictive maintenance to reduce unexpected system downtime.

Software

National Instruments ships all PXI switch modules with NI-SWITCH, an IVI-compliant driver offering complete functionality for all switch modules. For additional assistance in configuring, programming, and managing higher-channel-count switching systems, NI Switch Executive software offers an easy-to-use, intelligent switch management and visual routing environment. Use the NI-SWITCH Soft Front Panel for simple relay operations or debugging switch code/execution.

Using the PXI Platform for RF Applications

National Instruments manufactures 18 RF switch modules for the PXI platform. You can use these modules to switch signals from DC to 26.5 GHz in 50 Ω RF applications and DC to 2.7 GHz in 75 Ω RF applications. The modules come in a variety of topologies with different connectivity options (SMA and mini-SMB) that provide you greater flexibility in designing your PXI RF test systems. In a single chassis, you can use these switches to route signals between RF signal analyzers and generators or build a multichannel video signal generator using one of six 75 Ω RF switches. Make configurations of complex switch networks easy on a system level using NI Switch Executive, which offers visual route configurations, per-path calibration, and compatibility with Microsoft Excel.

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Example Application – Stimulus Response Testing with NI PXI RF Modules

Many RF applications involve measuring or analyzing the response of a device under test (DUT) when it is supplied with a high-frequency signal. Consider an example of such a device that has 16 inputs and 16 outputs. To test the device, a 2 GHz signal needs to be supplied to all 16 pins using an RF signal generator and a 16x1 multiplexer. Next, the response from all 16 pins must be measured using an RF analyzer through a similar switching setup. When building such an application, keep in mind that you must choose a modular, flexible platform to ensure that the system is cost-effective and upgradable so it can sustain long-term change. Next, you must select quality RF instrumentation to take accurate measurements on the output of the DUT. To extend the channel count of these instruments, you must use an efficient switch system that minimizes signal degradation by offering low VSWR and insertion loss specifications. It is also important to design the switch framework so that paths between the analyzer, generator, and DUT are of equal length to minimize inconsistencies in measurements between channels. Finally, you must use powerful software tools that minimize deployment time and maximize code reuse to program the hardware.

Figure 1 shows an example setup of a PXI system that meets these needs. The low VSWR and insertion loss of the PXI-2547 8x1 multiplexer minimizes attenuation and losses in the transmission lines while the PXI-2548 quad SPDT relay module ensures that path lengths between the input and output pins of the DUT and the RF instruments are the same. You can configure the entire switch system using a system-level software management tool such as NI Switch Executive, which provides storage of per-path calibration data and offers code reuse capability when system components change. Once configured, you can deploy your RF switch network in NI LabVIEW, a graphical programming language with enhanced features for development of test and measurement applications.

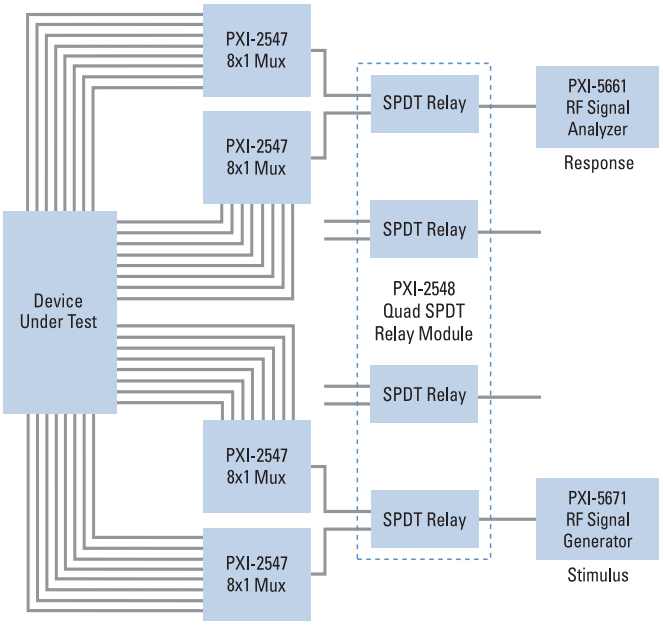


Figure 1. 16x1 Stimulus-Response Test Using PXI RF Switches

Ordering Information

NI PXI-2545	778572-45
NI PXI-2546	778572-46
NI PXI-2547	778572-47
NI PXI-2548	778572-48
NI PXI-2549	778572-49

Includes NI-SWITCH and NI-DAQmx driver software.

Related Products and Accessories

NI PXI-2594 (2.5 GHz, 4x1 mux)	778572-94
NI PXI-2595 (5.0 GHz, 4x1 mux)	778572-95
SMA male-male cable (semirigid)	
0.15 cm	763443-01
0.45 cm	763444-01
NI Switch Executive	778546-09

BUY NOW!

For complete product specifications, pricing, and accessory information, call 800 813 3693 (U.S.) or go to **ni.com/switches**.

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Insertion Loss

Think of a switch or relay as a lowpass filter. Every switch in the real world causes some attenuation and power loss on the signal routed. Insertion loss is a measure of this attenuation and power loss. An insertion loss graph for a switch module is analogous to a 3 dB graph (Bode plot) for a lowpass filter. To choose the best switch for a particular RF application, it is important to know the insertion loss of the switch at the frequency of the signal being routed. Consider a 50 Ω RF application where you need to route eight 3 GHz signals to a channel on a vector network analyzer with less than 30 percent attenuation. This means that the switch you use to route the signals needs to have an insertion loss specification of less than 3 dB at 3 GHz.

At first it may seem that a module such as the PXI-2547 is unsuitable for this application given that its bandwidth is less than the frequency of concern (2.7 versus 3 GHz). However, upon reviewing the insertion loss specifications, it appears that the attenuation caused by the module is less than 18 percent at 3 GHz, which is well under the 30 percent requirement (typical insertion loss of the PXI-2547 at 3 GHz is 1.75 dB). Therefore, in the case of this application, a 2.7 GHz switch such as the PXI-2547 is more than sufficient for routing a 3 GHz signal. The most important thing to remember from this example is that the bandwidth specification of an RF switch is not necessarily its -3 dB point. Rather it is the highest-frequency signal that the vendor of the product believes can be routed with acceptable performance. Because the definition of "acceptable" may vary from one vendor to another, it is important to check the insertion loss specification of a switch in conjunction with the bandwidth specification to determine whether it meets your application needs.

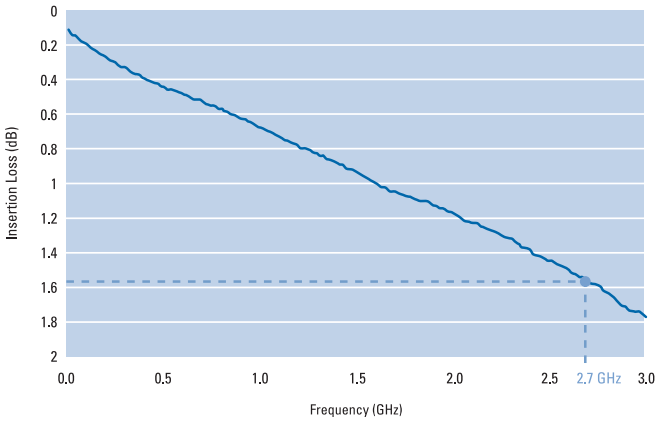


Figure 2. The insertion loss of the PXI-2547 8x1 multiplexer at its bandwidth (2.7 GHz) is only about 1.6 dB.

Voltage Standing-Wave Ratio (VSWR)

VSWR is the ratio of reflected to transmitted waves. At higher frequencies, signals take the form and shape of a wave when passing through a transmission line. For this reason, just as in the case of sound and light waves, reflections occur when the signal travels between varying mediums. In the case of RF applications, this happens when a signal is made to propagate between components with unmatched impedances. Such mismatches occur in switch modules because of slight variations in impedances of the connectors on the module, PCB traces, and the actual relay itself. Because VSWR is a measure of the power of the reflected wave, it also contributes to the amount of power loss in the transmission line. VSWR is especially important in RF applications where signal reflections can damage the source. An ideal switch has a VSWR equal to 1. But in most cases, a switch that has a VSWR specification of 1.8 or less at the frequency of the signal being routed is sufficient to prevent the source from being damaged. Again, a switch bandwidth is not related to its VSWR specification, which is why it is important to ensure that the VSWR performance of the product at the frequency of concern of your application meets system needs.

When determining the best switch to use in an RF application, topology and bandwidth are naturally important considerations. Even so, they are not enough to make a decision. For more information on choosing the right RF switch for your application, review the "Guide to Selecting an RF Switch" at **ni.com/switches**.

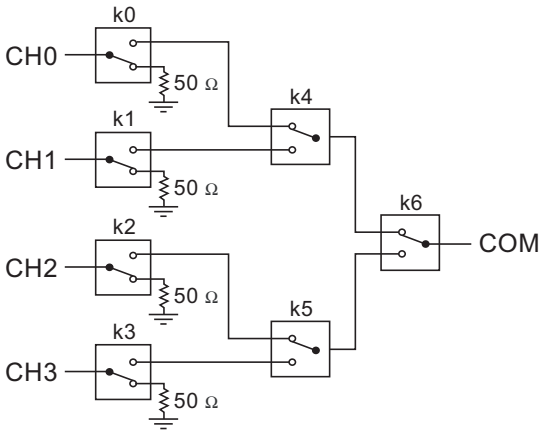
Three Tips for Optimizing Your RF Switch Network

1. Check whether insertion loss and VSWR specifications of a particular RF switch at the frequency of your application are in line with the requirements of your system.
2. Avoid cascading multiplexers whenever possible by using products that provide inherent topologies (for example, use the PXI-2547 to build an 8x1 multiplexer instead of two PXI-2594 4x1 multiplexers). When inherent topologies are unavailable, use SPDT relays and multiplexers to ensure that the signal path length for all channels in your system is the same to avoid discrepancies in measurements between channels.
3. Note that RF switches from certain vendors (such as NI) have a bandwidth specification that is not the -3 dB point of the product. If -3 dB is your system requirement, you can cut costs by using an RF switch module with lower bandwidth than your system frequency of concern.

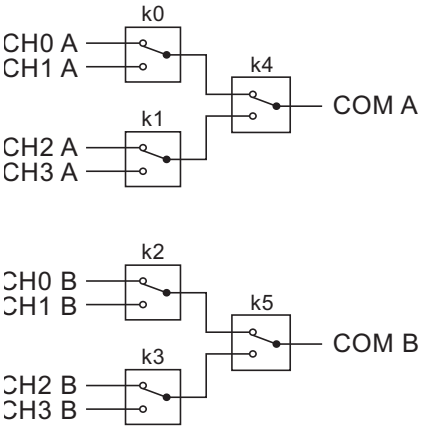
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Topology Diagrams

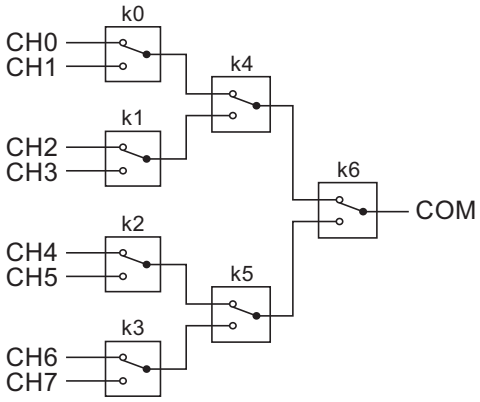
PXI-2545 – 4x1 Terminated Multiplexer



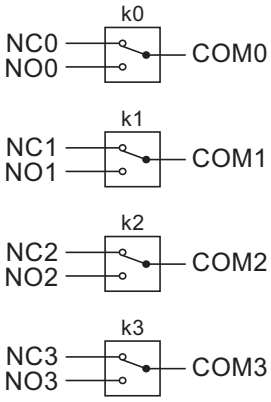
PXI-2546 – Dual 4x1 Multiplexer



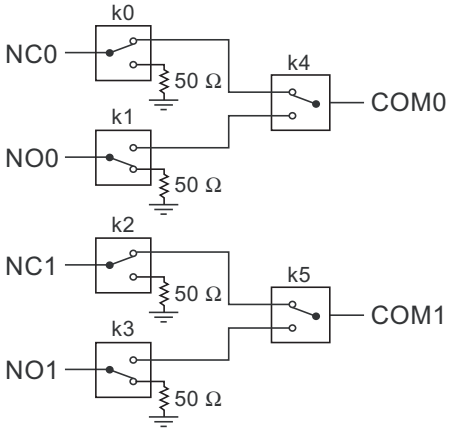
PXI-2547 – 8x1 Multiplexer



PXI-2548 – Quad SPDT Relays



PXI-2549 – Dual-Terminated SPDT Relays



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Specifications

Input Characteristics

All input characteristics are V_{rms}, unless otherwise specified.

Maximum switching voltage ..... 30 V
Maximum switching current..... 0.5 A (per channel)
Maximum carry current..... 0.5 A (per channel)
Maximum RF power
  Channel to common..... 10 W
Termination (PXI-2545 and PXI-2548 only)
  (≤25 °C ambient)..... 1.5 W
DC path resistance
  Initial..... <0.25 Ω
  End of life ..... ≤1.0 Ω

RF Performance Characteristics

Characteristic impedance (Z_0) ..... 50 Ω nominal

Insertion Loss

Module	Insertion Loss	
	0 to 1 GHz	1 to 2.7 GHz
PXI-2545	1.0 dB (0.7 dB)	2.1 dB (1.7 dB)
PXI-2546	0.7 dB (0.5 dB)	1.3 dB (0.9 dB)
PXI-2547	1.0 dB (0.7 dB)	2.0 dB (1.6 dB)
PXI-2548	0.7 dB (0.4 dB)[1]	0.9 dB (0.6 dB)[1]
PXI-2549	0.9 dB (0.7 dB)[1]	1.7 dB (1.3 dB)[1]

Voltage Standing-Wave Ratio (VSWR)

Module	VSWR	
	0 to 1 GHz	1 to 2.7 GHz
PXI-2545	1.3 (1.2)	1.5 (1.3)
PXI-2546	1.25 (1.1)	1.6 (1.4)
PXI-2547	1.3 (1.1)	1.5 (1.2)
PXI-2548	1.25 (1.15)[1]	1.5 (1.35)[1]
PXI-2549	1.3 (1.15)[1]	1.5 (1.3)[1]

Isolation

Module	Isolation	
	0 to 1 GHz	1 to 2.7 GHz
PXI-2545	50 dB	40 dB
PXI-2546	47 dB	40 dB
PXI-2547	48 dB	36 dB
PXI-2548	58 dB[1]	39 dB[1]
PXI-2549	55 dB[1]	45 dB[1]

[1]This specification extends to 1.5 GHz. Values in parentheses are typical.

For more detailed specifications and performance curves, refer to the individual product specifications at **ni.com/switches**.

Dynamic Characteristics

Maximum relay operate time ..... 10.4 ms

Note: Certain applications may require additional time for proper settling. For information about including additional settling time, refer to the *NI Switches Help*.

Maximum scan rate ..... 45 channels/s
Expected relay life
  Mechanical ..... $1x10^6$ cycles
  Electrical ..... $3x10^5$ cycles
  (30 V, 10 mA, DC resistive)

Physical Characteristics

Relay type ..... Electromechanical, latching
I/O connectors..... SMA jacks, gold plated
Power requirements
  5 V..... 3.7 W
  3.3 V..... 0.3 W
Dimensions (L by W by H)..... 3U, 1 slot, PXI/cPCI module
  21.6 by 2.0 by 13.0 cm
  (8.5 by 0.8 by 5.1 in.)
Weight..... 255 g (9 oz)

Environment

Operating temperature ..... 0 to 55 °C
Storage temperature..... -20 to 70 °C
Relative humidity ..... 5 to 85%, noncondensing
Pollution degree..... 2
Maximum altitude..... 2,000 m
Indoor use only

Compliance and Certifications

Safety

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1

Note: For UL and other safety certifications, refer to the product label or visit **ni.com/certification**, search by model number or product line, and click the appropriate link in the Certification column.

Electromagnetic Compatibility

This product is designed to meet the requirements of the following standards of EMC for electrical equipment for measurement, control, and laboratory use:

- EN 61326 EMC requirements; minimum immunity
- EN 55011 Emissions; Group 1, Class A
- CE, C-Tick, ICES, and FCC Part 15 Emissions; Class A

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

- 73/23/EEC; Low-Directive (safety)
- 89/336/EEC; Electromagnetic Compatibility Directive (EMC)

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Hardware Services

NI Factory Installation Services

NI Factory Installation Services (FIS) is the fastest and easiest way to use your PXI or PXI/SCXI combination systems right out of the box. Trained NI technicians install the software and hardware and configure the system to your specifications. NI extends the standard warranty by one year on hardware components (controllers, chassis, modules) purchased with FIS. To use FIS, simply configure your system online with **ni.com/pxiadvisor**.

Calibration Services

NI recognizes the need to maintain properly calibrated devices for high-accuracy measurements. We provide manual calibration procedures, services to recalibrate your products, and automated calibration software specifically designed for use by metrology laboratories. Visit **ni.com/calibration**.

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NI provides complete repair services for our products. Express repair and advance replacement services are also available. We offer extended warranties to help you meet project life-cycle requirements. Visit **ni.com/services**.

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351464A-01 2006-8234-101-D

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