Keysight 87222R Low PIM Coaxial Transfer Switch

Operating and Service Manual

KEYSIGHT TECHNOLOGIES

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Notices

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Contents

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1
Introduction

This chapter provides you an overview of the Keysight 87222R Low PIM Coaxial Transfer Switch.

General Information

The Keysight 87222R low PIM coaxial transfer switch offers the flexibility essential in signal routing applications. The switch provides exceptional repeatability, low insertion loss, high isolation, and simplification of design in signal routing and conditioning applications.

The 87222R can be used in a variety of applications, such as a drop-out switch, switching two inputs and two outputs, or signal reversal switching.

Figure 1-1 Keysight 87222R Low PIM Coaxial Transfer Switch

Innovative design and careful process control mean the 87222R meets the requirements for highly repeatable switching elements in test instruments and switching interfaces. The switch offers exceptional insertion loss repeatability, reducing sources of random errors in the measurement path and improving measurement uncertainty.

Switch life is a critical consideration in production test systems, satellite and antenna monitoring systems, and test instrumentation. The longevity of the switch increases system uptime and lowers the cost of ownership by reducing calibration cycles and switch maintenance.

Operating from DC to 26.5 GHz, the switch exhibits exceptional isolation performance required to maintain measurement integrity. Isolation between ports is typically > 100 dB to 12 GHz and > 90 dB to 26.5 GHz, reducing the influence of signals from other channels and system measurement uncertainties. Hence, the 87222R is an ideal element in large, multitiered switching systems.

The Keysight 87222R is designed to fall within most popular industry footprints. The 1¼ inch square flange provides tapped mounting holes, while the rest of the 2¾ inch long by 1¼ inch square body will easily fit into most systems. The standard 10-pin ribbon drive cable or optional solder terminal connections accommodate the need for secure and efficient control cable attachment.

Opto-electronic interrupts and indicators improve reliability and extend the life of the switch by eliminating DC circuit contact failures characteristic of conventional electromechanical switches. The 87222R has circuits that interrupt the current to all the solenoids once switching is complete and offers independent indicators that are controlled by optical interrupts. These indicators provide a closed path between the indicator common pin and the corresponding sense pin of the selected path.

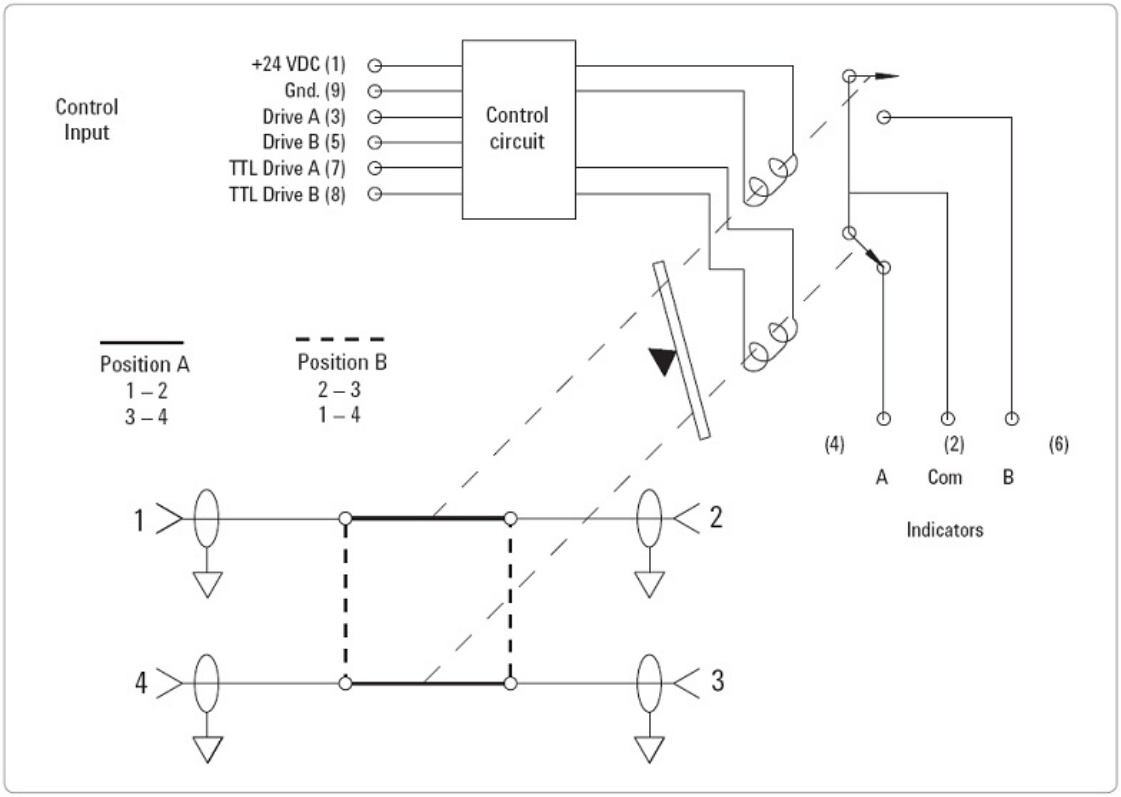

Figure 1-2 Keysight 87222R schematic

Key Features

- Excellent isolation, typically >90 dB at 26.5 GHz
- Opto-electronic indicators and interrupts
- Magnetic latching
- TTL/5 V CMOS compatible
- PIM level (typical) of –165 dBc

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2
Switch Configuration

This chapter provides you information on driving the switch and the configuration to utilize the function of the position indicators.

Driving the Switch

There are two positions for the 87222R switch (see Table 2-1). Position A has RF Port 1 connected to RF Port 2 and RF Port 3 connected to RF Port 4. Position B has RF Port 2 connected to RF Port 3 and RF Port 1 connected to RF Port 4. Either switch can be driven with a standard grounding drive control with or without a separate ground. Single line or dual line TTL control are also available. The switch operates in a break-before-make mode. See Figure 2-1.

(I) Standard drive:

See Figure 2-2 for drive connection diagrams.

- Connect pin 1 to supply (+20 VDC to +32 VDC).
- Connect pin 9 to ground (see Note 1).
- Select position A by applying ground to pin 3 (see Note 3).
- Select position B by applying ground to pin 5 (see Note 3).

(II) Single line TTL drive:

See Figure 2-2 for drive connection diagrams.

See Figure 2-3 for TTL voltage states.

- Connect pin 1 to supply (+20 VDC to +32 VDC).
- Connect pin 9 to ground (see Notes 2, 4).
- Connect pin 8 to TTL “High.”
- Select position A by applying TTL “High” to pin 7 (see Note 3).
- Select position B by applying TTL “Low” to pin 7 (see Note 3).

(III) Dual line TTL drive:

See Figure 2-2 for drive connection diagrams.

See Figure 2-3 for TTL voltage states.

- Connect pin 1 to supply (+20 VDC to +32 VDC).
- Connect pin 9 to ground (see Notes 2, 4).

- Select position A by applying TTL “High” to pin 7 and TTL “Low” to pin 8 (see Note 3).
- Select position B by applying TTL “Low” to pin 7 and TTL “High” to pin 8 (see Note 3).

Notes:

1 *Pin 9 does not need to be grounded for the switch to operate in standard drive mode. If pin 9 is not grounded, the position indicators will only function while the appropriate drive has ground applied. Therefore, if a pulse drive is used and continuous indicator operation is required, pin 9 must be grounded.*

2 *For TTL drive, pin 9 must be grounded.*

3 *After the RF path is switched and latched, the drive current is interrupted by the electronic position- sensing circuitry. Pulsed control is not necessary, but if implemented, the pulse width must be 15 ms minimum to ensure that the switch is fully latched.*

4 *In addition to the quiescent current supplying the electronic position sensing circuitry, the drive current flows out of pin 9 (during switching) when using TTL drive.*

CAUTION

FOR USERS OF THE KEYSIGHT 11713B/C SWITCH DRIVER:

Do not drive the 87222R using the S9 or SO outputs from either the banana plugs or from pins 3 or 4 within the Atten X and Atten Y Viking sockets located on the rear panel of the 11713B/C.

Table 2-1 Drive control alternatives

RF path	(I) Standard drive voltage		(II) Single line TTL/5 V CMOS drive voltage		(II) Dual line TTL/5 V CMOS drive voltage	
	Drive A Pin 3	Drive B Pin 5	TTL Drive A Pin 7	TTL Drive B Pin 8	TTL Drive A Pin 7	TTL Drive B Pin 8
Position A 1 to 2, 3 to 4	Ground	Open	High	High	High	Low
Position B 2 to 3, 1 to 4	Open	Ground	Low	High	Low	High

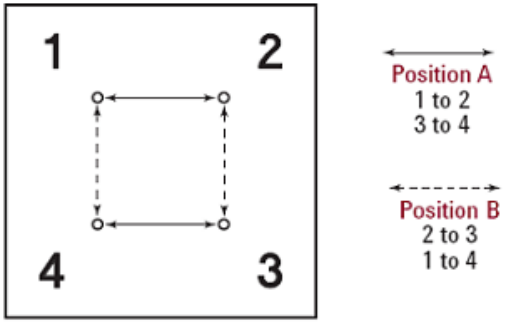


Figure 2-1 RF port connections

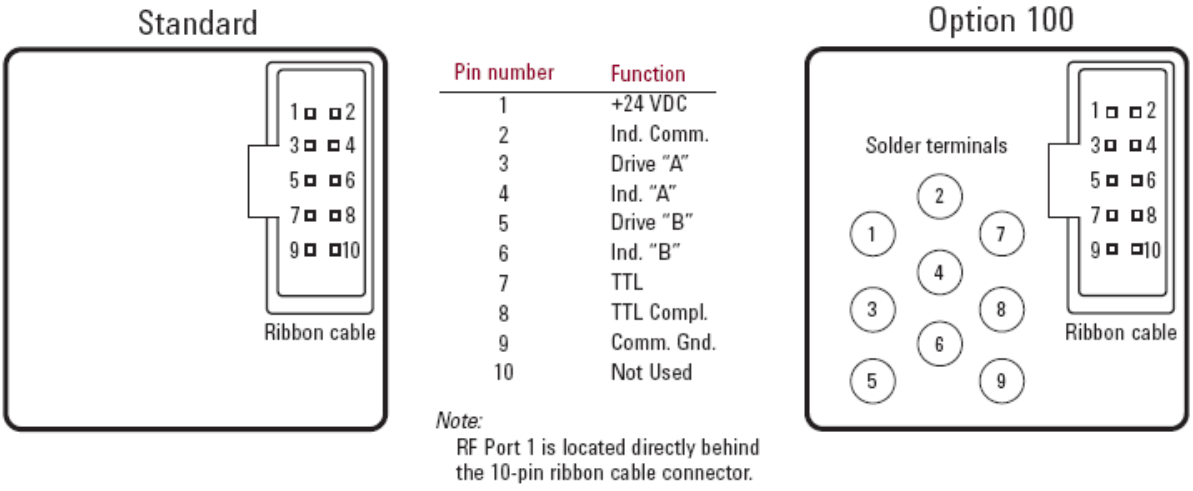


Figure 2-2 Drive connections

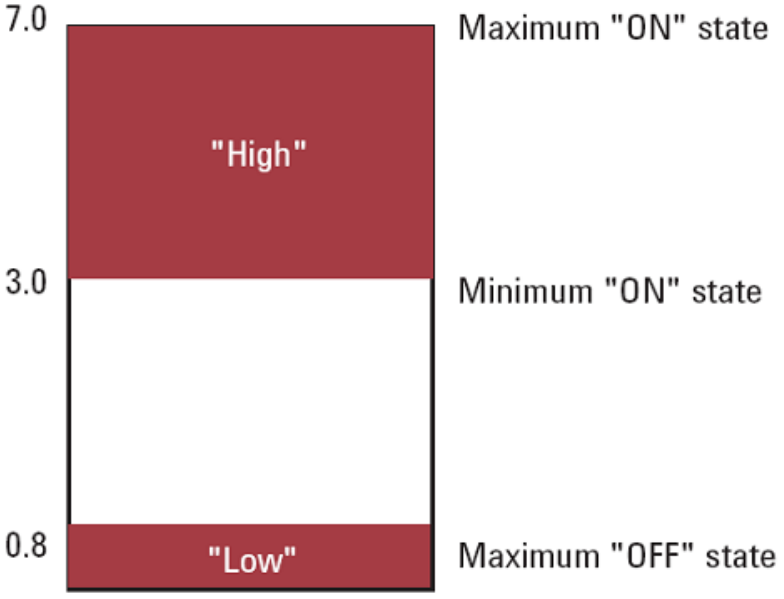


Figure 2-3 TTL control voltage states

Electronic Position Indicators

The independent electronic position indicators consist of optically isolated, solid-state relays, which are driven by photo-electric sensors coupled to the mechanical position of the RF path's moving elements. See Figure 2-4. The circuitry consists of a common which can be connected to an output corresponding to either position A or position B. The solid state relays are configured for AC and/or DC operation (see "Indicator specifications" on page 21). The electronic position indicators require that the supply (+20 VDC to +32 VDC) be connected to pin 1 but require that pin 9 be grounded if pulse drive is used and continuous indicators operation is desired. If pin 9 is not grounded, the position indicators will function while the appropriate drive has ground applied.

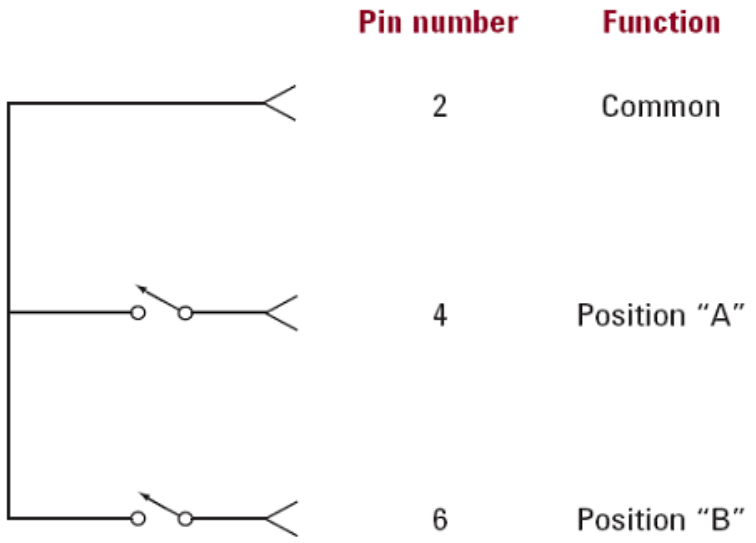


Figure 2-4 Indicator function diagram

3
Specifications

This chapter provides the specifications of the switch.

Specifications describe the warranted performance of the switch.

Supplemental and typical characteristics are intended to provide information useful in applying the switch by giving typical, but not warranted performance parameters.

Specifications

Specifications refer to the performance standards or limits against which the switch is 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 italics.

Table 3-1 Standard switch drive specifications

Parameter	Condition	Minimum	Nominal	Maximum	Unit
Supply voltage		20	24	32	V
Supply current, Icc	Switching: Pulse width >15 ms: Vcc = 24 VDC		200		mA
Supply current (quiescent)		25		50	mA

Table 3-2 TTL-specific drive specifications

Parameter	Condition	Minimum	Nominal	Maximum	Unit
High level input		3		7	V
Low level input				0.8	V
Maximum high input current	Vcc = Max Vinput = 3.85 VDC		1	1.4	mA

General operating data

Parameter	Specification
Nominal/Impedance	50 Ω
Maximum power rating	
Hot switching	1 W CW 50 W peak, 10 μs max pulse width, not to exceed 1 W average
Cold switching	150 W CW at 3 GHz, 25 °C 120 W CW at 4.2 GHz, 25 °C
Life	3,000,000 cycles minimum
Switching speed	15 ms maximum

Indicator specifications

Parameter	Specification
Maximum withstand voltage	60 V
Maximum current capacity	100 mA
Maximum “ON” resistance	50 Ω
Minimum “OFF” resistance	1 G Ω

RF specifications

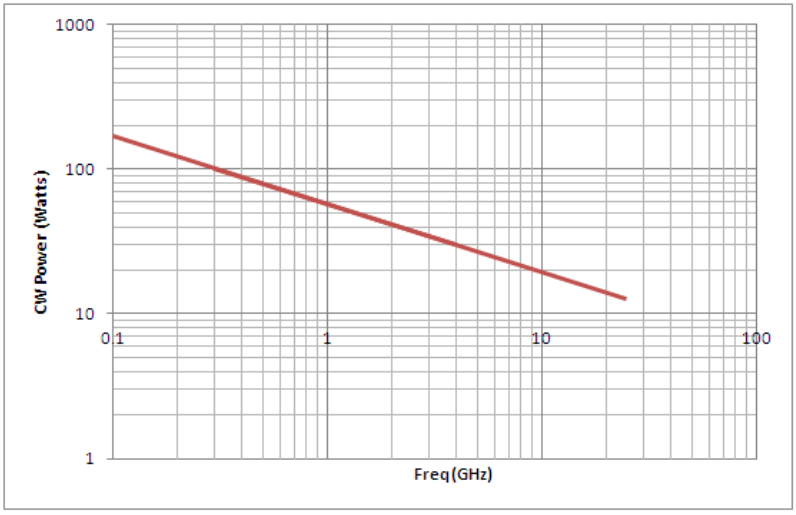
Parameter	Specification
Frequency range	DC to 26.5 GHz
Insertion loss	0.2 dB + 0.025 x frequency (GHz)
Isolation	120 dB – 2.0 x frequency (GHz)
SWR	1.1 maximum DC to 2 GHz 1.15 maximum 2 to 4 GHz 1.25 maximum 4 to 12.4 GHz 1.4 maximum 12.4 to 20 GHz 1.65 maximum 20 to 26.5 GHz
Insertion loss repeatability	< 0.03 dB typical
Connectors	SMA (f)

Environmental specifications

The low PIM switches are designed to fully comply with Keysight's product operating environmental specifications.

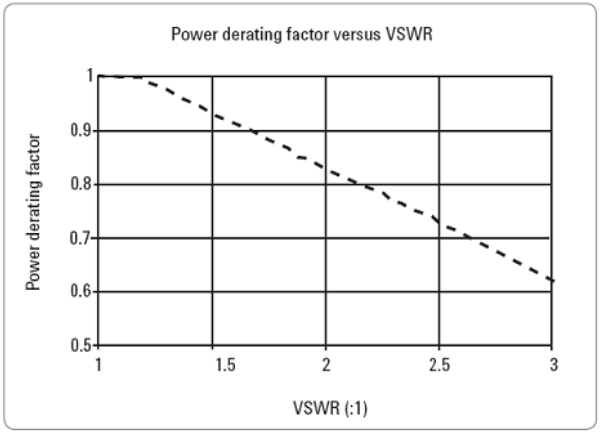
Parameter	Specification
Temperature	
• Operating	–25 °C to 75 °C
• Storage	–55 °C to 85 °C
• Cycling	–50 °C to 150 °C, 10 cycles
Humidity	
• Operating	40 °C/95% RH, 5 days
• Storage	65 °C/90% RH, 24 hours
• Condensation	40 °C/95% RH
Shock	
• Non-operating:	
◦ Half-sine	500 G at 0.5 ms, 3 drops/direction
◦ Transportation	50 G Vibration: 8 m/s ±10%
• Operating	50 G at 6 ms, 6 directions
Vibration	
• Operating	7 G rms, 5 to 2000 Hz at 0.25 in p-p
• Survival	20 G rms, 20 to 2000 Hz at 0.06 in p-p, 4 min/cycle, 4 cycles/axis
• Random	7 G rms, 50 to 2000 Hz, 15 min/axis
ESD immunity	
• Direct discharge	6 kV (to outer conductor)
• Air discharge	15 kV (to outer conductor)
RFI	Radiated emission per CISPR 11
Magnetic field	
• Operating emission	AC magnetic emission (1.88 G rms)
	DC magnetic emission (5 G)
• Operating immunity	30 A/M rms at 47 Hz, 50 Hz, 60 Hz, and 189 Hz
	150 A/M rms at 47 Hz and 189 Hz

Supplemental Characteristics



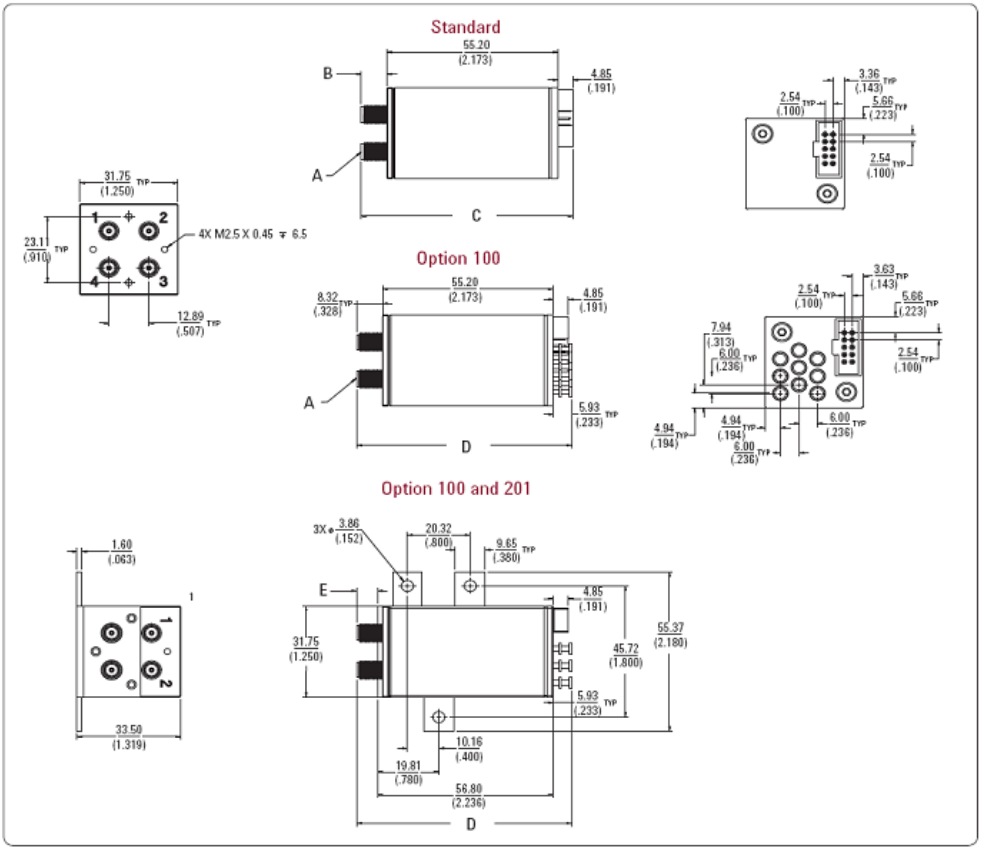
Reference conditions:

- Cold switching only (NO hot switching)
- Ambient temperature of 75 °C or less
- Sea level (0.88 derating @ 15000 ft.)
- Load VSWR < 1.2 (see graph for derating above 1.2 VSWR)



Physical Specifications

Parameter	Specification
Dimensions	Per Figure 3-5
Weight	150 gm (0.33 lb)



Note: Dimensions are in millimeters and (inches) nominal unless otherwise specified.

1. *One of four bracket configurations shown.*

Figure 3-5 Product outline

Keysight model number		A	B	C	D	E
87222R milimeter (inches)	SMA (f)	8.32 (0.328) TYP	REF 6.72 (0.265)	REF 69.46 (2.735)	REF 68.37 (2.692)	REF 6.322 (0.249)

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4
Installation and Verification

This chapter provides you installation information and simple verification steps of the switch.

Installation

Initial inspection

1. Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked both mechanically and electrically.
   - Check for mechanical damage such as scratches or dents.
   - Procedures for checking electrical performance are given under "Operator's check" on page 29 or "Performance test" on page 30.
2. If the contents are incomplete, there is mechanical damage or defect, or the instrument does not pass the electrical performance test, contact the nearest Keysight Sales and Service office (refer to "Contacting Keysight" on page 4). Keysight will arrange for repair or replacement of the damaged or defective equipment. Keep the shipping materials for the carrier's inspection.
3. If you are returning the instrument under warranty or for service, repackaging the instrument requires original shipping containers and materials or their equivalents. Keysight can provide packaging materials identical to the original materials. Refer to "Contacting Keysight" on page 4 for the Keysight office nearest to you. Attach a tag indicating the type of service required, return address, model number, and serial number. Mark the container ***FRAGILE*** to insure careful handling. In any correspondence, refer to the instrument by its model number and serial number.

Operating and Service Instruction

Operator's check

The operator's check is supplied to allow the operator to make a quick check on the switch prior to use or if a failure is suspected.

CAUTION ESD exceeding the level specified in "Environmental specifications" or RF power applied is greater than the maximum specified as in "Specifications" may cause permanent damage to the device.

Description

The coaxial transfer switch is connected to a network analyzer configured for the S-parameter measurement. The network analyzer may be set to sweep over the whole or selected frequency range of the switch to be verified. The S-parameter measurement is the best way to determine if the switch is working properly.

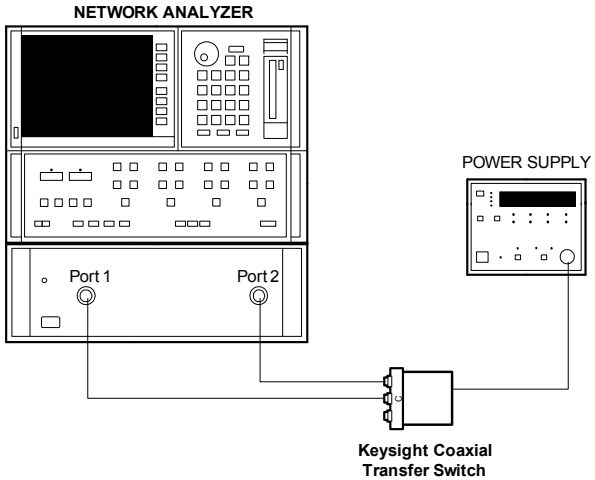

Figure 4-1 Connection to perform quick check

Quick check procedure

1. Drive the switch as in Position A (Port 1 to Port 2 and Port 3 to Port 4). Connect the switch's Port 1 to Port 1 of the network analyzer and Port 2 to Port 2 of the network analyzer as illustrated in Figure 4-1.
2. For standard drive, apply ground to the corresponding "drive" pin to close the selected path. Refer to "Driving the Switch" on page 14.
3. For TTL drive (option T24), apply "High" to the corresponding "drive" pin to close the selected path. Refer to "Driving the Switch" on page 14.
4. Perform the S-parameter measurement and verify against "Supplemental Characteristics" on page 24.
5. Repeat steps 1 to 4 until all paths are measured and verified.

Performance test

The coaxial transfer switch can be tested to the accuracy of the specifications with a network analyzer or equivalent equipment of suitable accuracy. If a network analyzer is available, test the instrument using the procedure in the analyzer's operating manual.

Service instructions

Adjustment and repair

Keysight 87222R low PIM coaxial transfer switch does not require internal adjustments and is not recommended for repair.

NOTE If any low PIM coaxial transfer switch fails within the warranty period, a new unit will be replaced. Refer to "Replacement units" on page 31 for more details.

Maintenance

The connectors, particularly the connector faces, must be kept clean. For instructions on connecting and care of your connectors, refer to the Microwave Connector Care Quick Reference Card (08510-90360).

Replacement units

Replacement unit	Part number
Low PIM switch, transfer, DC - 26.5 GHz with Option 100	87222-60037
Low PIM switch, transfer, DC - 26.5 GHz with Option 161	87222-60038
Low PIM switch, transfer, DC - 26.5 GHz with Option 161, 201	87222-60039
Low PIM switch, transfer, DC - 26.5 GHz with Option 100, 201	87222-60040

NOTE The above list of replacement units is not applicable as customer-orderable units. The list only applies for any low PIM coaxial transfer switch which fails within the warranty period.

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