Keysight 8710x Low PIM Coaxial Multiport Switches

Operating and Service Manual

KEYSIGHT TECHNOLOGIES

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Notices

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Contents

1
Introduction

This chapter provides you the overview of Keysight 8710x low PIM coaxial multiport switches.

General Information

Keysight 87104P/Q/R SP4T and 87106P/Q/R SP6T terminated switches provide the life and reliability required for automated test and measurement and signal monitoring and routing applications. These switches can be used in various applications as they are available in multiple frequency ranges, up to 26.5 GHz.

Figure 1-1 Keysight 8710x Low PIM Coaxial Multiport Switches

Innovative design and careful process control create switches that meet the requirements for highly repeatable switching elements in test instruments and switching interfaces. The exceptional 0.03 dB insertion loss repeatability is warranted for 3 million cycles at 25 °C. This reduces sources of random errors in the measurement path and improves measurement uncertainty. Switch life is a critical consideration in production test systems, satellite and antenna monitoring systems, and test instrumentation. The longevity of these switches increases system uptime and lowers the cost of ownership by reducing calibration cycles and switch maintenance.

Table 1-1 List of Keysight 8710x Low PIM Coaxial Multiport Switches

Model number	Frequency range	Configuration
87104P	DC to 4 GHz	SP4T
87104Q	DC to 20 GHz	SP4T
87104R	DC to 26.5 GHz	SP4T
87106P	DC to 4 GHz	SP6T
87106Q	DC to 20 GHz	SP6T
87106R	DC to 26.5 GHz	SP6T

Key Features

- SP4T and SP6T configurations
- Magnetic latching
- Guaranteed repeatability of 0.03 dB up to 3 million cycles, ensuring accurate system measurements and reducing calibration intervals
- Excellent isolation, typically > 90 dB at 26.5 GHz
- PIM level (typical) of –165 dBc
- Opto-electronic indicators and interrupts
- Terminated ports

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2
Switch Configuration

This chapter provides you information on how to drive the switches using standard drive and TTL drive. Also included is the configuration to utilize the function of the position indicator.

Driving the Switch

Each RF path can be closed by applying ground (TTL “High” for Option T24) to the corresponding “drive” pin. In general, all other RF paths are simultaneously opened by internal logic. See Figure 2-1 for drive connection diagrams.

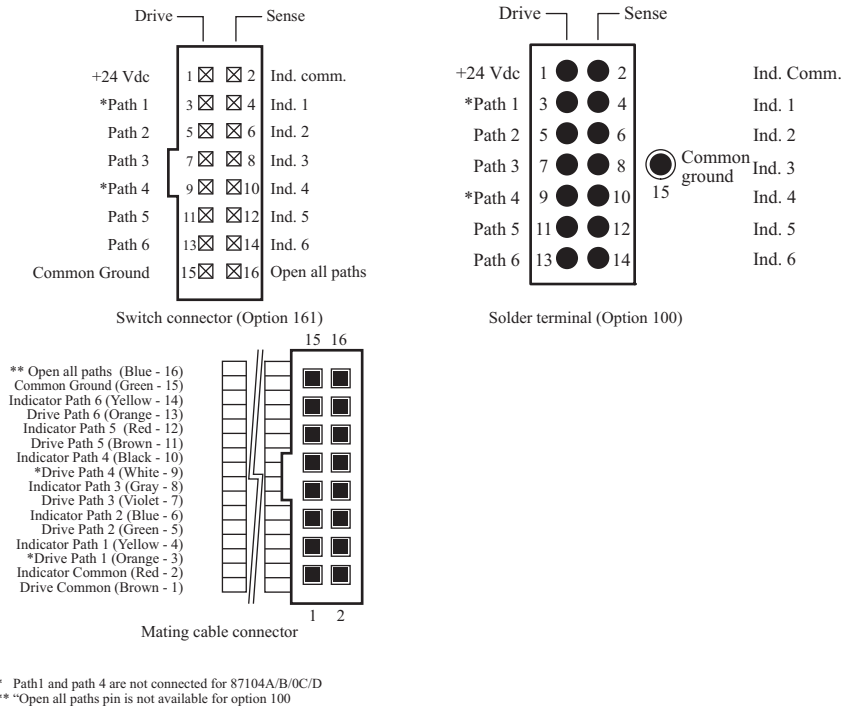


Figure 2-1 Drive connection diagrams for Option 161 and Option 100

The default operation of the switches is break-before-make. Make-before-break switching can be accomplished by simultaneously selecting the “drive” pins for old RF path and new RF path. Once the new RF path is closed (15 ms), de-select the old RF path “drive” pin while leaving the new RF path “drive” pin selected. The switch circuitry will automatically open the old RF path while leaving the new RF path engaged.

Standard Drive

1 Connect pin 1 to supply voltage (+20 Vdc to +32 Vdc) and pin 15 to ground.

NOTE Pin 15 must always be connected to ground to enable the electronic position-indicating circuitry and drive logic circuitry.

CAUTION If pin 15 is not connected to power supply ground, catastrophic failure will occur.

2 Select (close) desired RF path by applying ground to the corresponding “drive” pin; for example ground pin 3 to close RF path 1.

NOTE 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 the switch is fully latched.

3 To select another RF path, ensure that all unwanted RF path “drive” pins are disconnected from ground (to prevent multiple RF path engagement). Ground the “drive” pin which corresponds to the desired RF path.

4 To open all RF paths, ensure that all RF path “drive” pins are disconnected from ground. Then, connect pin 16 to ground. This feature is not available in option 100.

TTL Drive (Option T24)

1 Connect pin 1 to supply voltage (+20 Vdc to +32 Vdc) and pin 15 to ground.

NOTE

Pin 15 must always be connected to ground to enable the electronic position-indicating circuitry and drive logic circuitry.

In addition to the quiescent current supplying the electronic position-sensing circuitry, the drive current flows out of pin 15 (during switching) on TTL drive switches (option T24).

CAUTION

If pin 15 is not connected to power supply ground, catastrophic failure will occur.

2 Select (close) desired RF path by applying TTL “High” to the corresponding “drive” pin; for example apply TTL “High” to pin 3 to close RF path 1.

NOTE

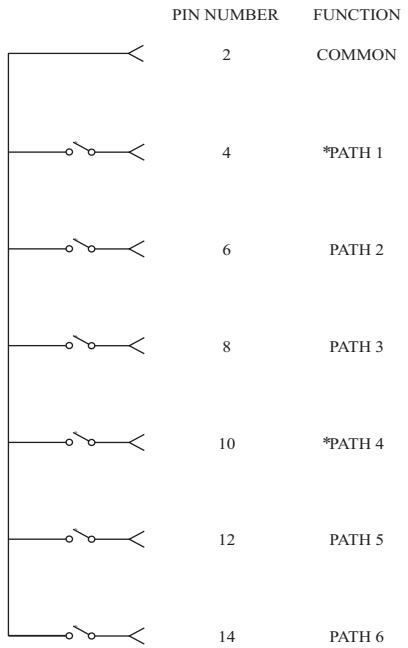
After the RF path is switched and latched, the drive current is interrupted by the electronic position-sensing circuitry. Pulsed control is not necessary, but if implemented, the pulse width must be 15 ms minimum to ensure the switch is fully latched.

3 To select another RF path, ensure that all unwanted RF path “drive” pins are at TTL “Low” (to prevent multiple RF path engagement). Apply TTL “High” to the “drive” pin which corresponds to the desired RF path.

4 To open all RF paths, ensure that all RF path “drive” pins are at TTL “Low”. Then, apply TTL “High” to pin. This feature is not available in option 100.

Electronic Position Indicators

The 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 2-2). The circuitry consists of a common which can be connected to an output corresponding to each RF path. If multiple RF paths are engaged, the position indicator corresponding to each closed RF path will be connected to common. 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 to 32 VDC) be connected to pin 1 and ground connected to pin 15.



* Path 1 and 4 are not connected for 87104A/B/C/D
* Paths 1 and 4 are not connected for 87104P/Q/R

Figure 2-2 Pin configuration for indicator function

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3
Specifications

This chapter provides the specifications of the switches.

Specifications refer to the performance standards or limits against which the coaxial multiport 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 italics.

General Specifications

Keysight model number	87104P/Q/R and 87106P/Q/R
Maximum power rating	1 watt average into 50 Ω internal loads
Hot switching	1 watt CW 50 W peak, 10 µs max pulse width, not to exceed 1 W average.
Cold switching	See "Supplemental specifications (cold switching)"
Life	3,000,000 cycles minimum
Switching speed	15 ms maximum

Supplemental specifications (cold switching)

Figure 3-3 illustrates the maximum incident CW power (cold switching) from 100 MHz to 26.5 GHz. The reference conditions are as below:

- Cold switching only (NO hot switching)
- Ambient temperature of 75 °C or less
- Sea level (0.88 derating at 15,000 feet)
- Low VSWR < 1.2 (See Figure 3-4 for derating above 1.2 VSWR)

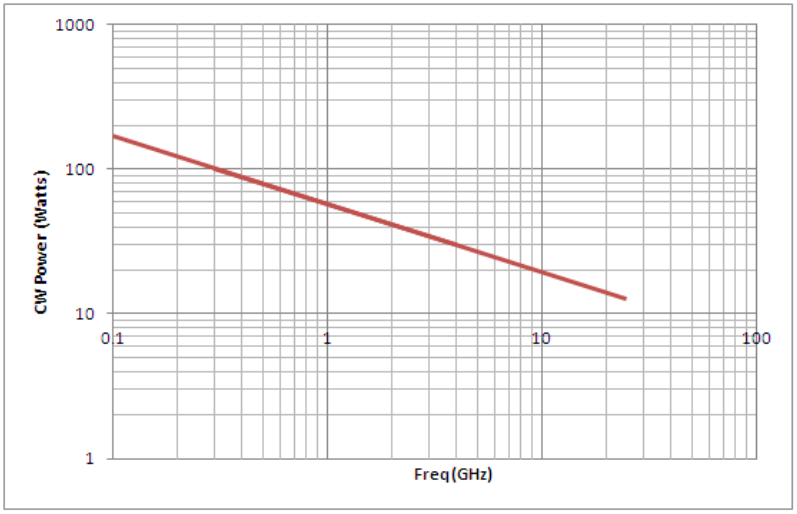

Figure 3-3 Maximum incident power (cold switching) vs. frequency

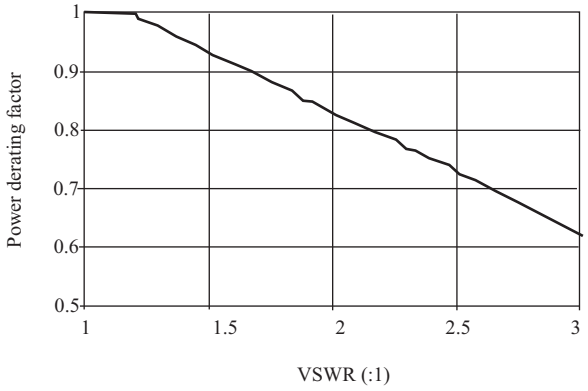

Figure 3-4 Power derating factor vs. VSWR

RF Specifications

Keysight model number	87104P and 87106P	87104Q and 87106Q
Frequency range	DC to 4 GHz	DC to 20 GHz
Insertion loss (dB)	0.015f* + 0.3	0.015f* + 0.3
Isolation (dB)	> 100	> 100 (DC to 12 GHz) > 80 (12 to 15 GHz) > 70 (15 to 20 GHz)
SWR	< 1.20	< 1.20 (DC to 4 GHz) < 1.35 (4 to 12.4 GHz) < 1.45 (12.4 to 20 GHz)
Repeatability† (dB)	< 0.03	< 0.03
Characteristics	50 Ω, terminated	50 Ω, terminated
Connectors	SMA (f)	SMA (f)

* f = frequency in GHz

† Up to 3 million cycles, measured at 25 °C

Keysight model number	87104R and 87106R
Frequency range	DC to 26.5 GHz
Insertion loss (dB)	0.015f* + 0.3
Isolation (dB)	> 100 (DC to 12 GHz) > 80 (12 to 15 GHz) > 70 (15 to 20 GHz) > 65 (20 to 26.5 GHz)
SWR	< 1.20 (DC to 4 GHz) < 1.35 (4 to 12.4 GHz) < 1.45 (12.4 to 20 GHz) < 1.70 (20 to 26.5 GHz)
Repeatability† (dB)	< 0.03
Characteristics	50 Ω, terminated
Connectors	SMA (f)

* f = frequency in GHz

† Up to 5 million cycles, measured at 25 °C

Indicator Specifications

Keysight model number	87104P/Q/R and 87106P/Q/R
Maximum withstand voltage	60 V
Maximum current capacity	150 mA
Maximum “ON” resistance	2.5 Ω
Maximum “OFF” resistance	10 GΩ

Switch Drive Specifications

Parameter	Min	Nom	Max	Unit
Supply voltage, Vcc	20	24	32	V
Supply current, Icc*		200†		mA
Supply current (quiescent)	25		50	mA

* Switching condition: pulse width ≥ 15 ms (Vcc = 24 VDC).

† Closing one RF path requires 200 mA. Add 200 mA for each additional RF path closed or opened. Using all RF paths open (selecting pin 16) requires 200 mA per RF path reset with Vcc = 24 VDC.

TTL drive (option T24)

Parameter	Min	Nom	Max	Unit
High level input	3		7	V
Low level input			0.8	V
Max high input current*		1	1.4	mA

* Vcc = Max. Vinput = 3.85 VDC.

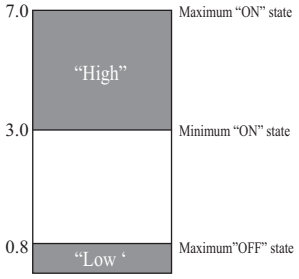

Figure 3-5 TTL control voltage states (Option T24)

Environmental Specifications

The Keysight 8710x low PIM coaxial multiport 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

Physical Specifications

Parameter	Specification
Dimensions	Figure 3-6
Net weight, kg (lb)	0.370 (0.82)

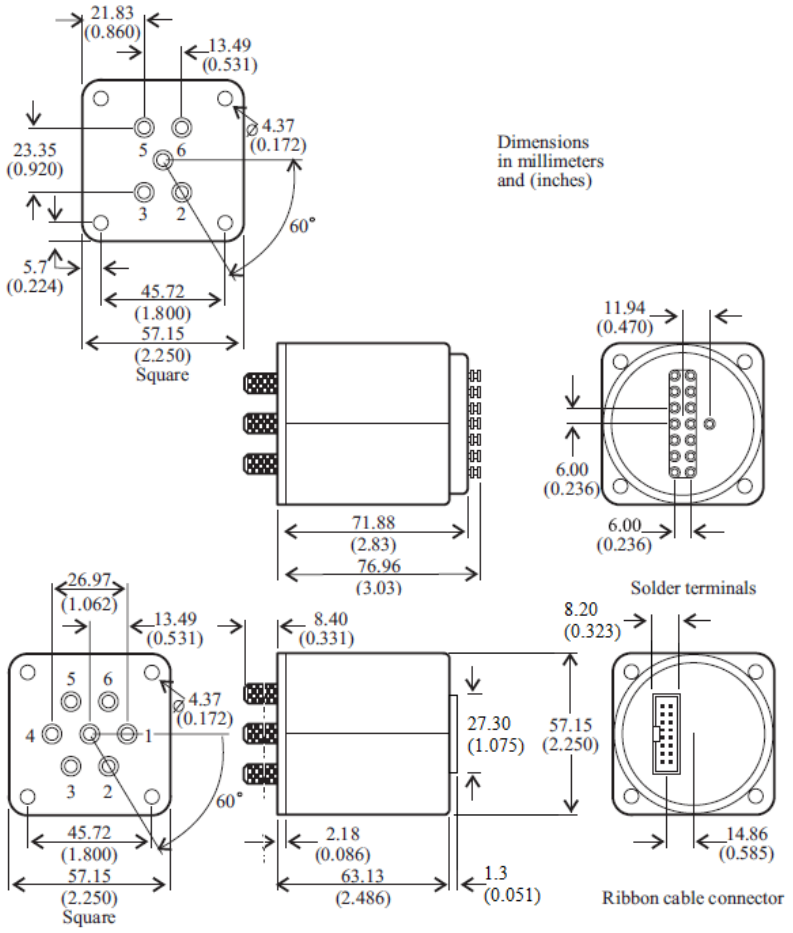

Figure 3-6 Dimensions of Keysight 8710x Low PIM Coaxial Multiport Switches

4
Installation and Verification

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

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 27 or "Performance test" on page 28.
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 Instructions

Operator's check

The operator's check is supplied to allow the operator to make a quick check on the coaxial multiport switches 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 "General Specifications" may cause permanent damage to the device.

Description

The coaxial multiport 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.

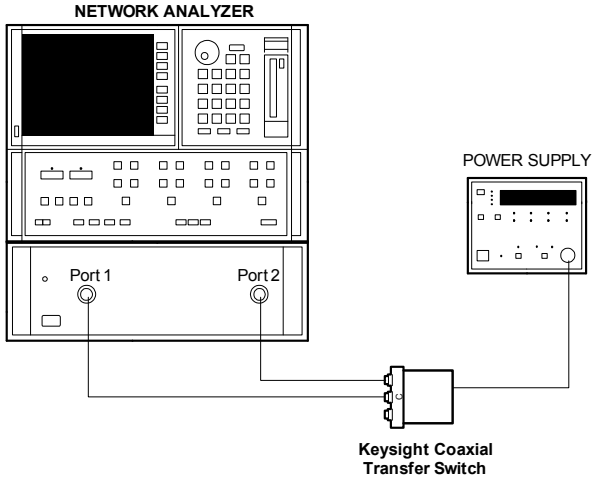

Figure 4-7 Connection to perform quick check

Quick check procedure

1. Connect the common port of the switch to Port 1 of the network analyzer and one of the outer RF ports to Port 2 of the network analyzer as illustrated in Figure 4-7.
2. For standard drive, apply ground to the corresponding “drive” pin to close the selected path. Refer to “Standard Drive” on page 13.
3. For TTL drive (option T24), apply “High” to the corresponding “drive” pin to close the selected path. Refer to “TTL Drive (Option T24)” on page 14.
4. Perform the S-parameter measurement and verify against “Supplemental specifications (cold switching)” on page 18.
5. Repeat steps 1 to 4 until all paths are measured and verified.

Performance test

The coaxial multiport switches 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 8710x low PIM coaxial multiport switches do not require internal adjustments and are not recommended for repair.

NOTE If any of the low PIM coaxial multiport switches fails within the warranty period, a new unit will be replaced. Refer to “Replacement units” on page 29 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, SP4T, DC - 4 GHz, terminated with Option 100, 024	87104-60066
Low PIM switch, SP4T, DC - 4 GHz, terminated with Option 100, T24	87104-60067
Low PIM switch, SP4T, DC - 4 GHz, terminated with Option 161, 024	87104-60068
Low PIM switch, SP4T, DC - 4 GHz, terminated with Option 161, T24	87104-60069
Low PIM switch, SP4T, DC - 20 GHz, terminated with Option 100, 024	87104-60070
Low PIM switch, SP4T, DC - 20 GHz, terminated with Option 100, T24	87104-60071
Low PIM switch, SP4T, DC - 20 GHz, terminated with Option 161, 024	87104-60072
Low PIM switch, SP4T, DC - 20 GHz, terminated with Option 161, T24	87104-60073
Low PIM switch, SP4T, DC - 26.5 GHz, terminated with Option 100, 024	87104-60074
Low PIM switch, SP4T, DC - 26.5 GHz, terminated with Option 100, T24	87104-60075
Low PIM switch, SP4T, DC - 26.5 GHz, terminated with Option 161, 024	87104-60076
Low PIM switch, SP4T, DC - 26.5 GHz, terminated with Option 161, T24	87104-60077
Low PIM switch, SP6T, DC - 4 GHz, terminated with Option 100, 024	87106-60094
Low PIM switch, SP6T, DC - 4 GHz, terminated with Option 100, T24	87106-60095
Low PIM switch, SP6T, DC - 4 GHz, terminated with Option 161, 024	87106-60096
Low PIM switch, SP6T, DC - 4 GHz, terminated with Option 161, T24	87106-60097
Low PIM switch, SP6T, DC - 20 GHz, terminated with Option 100, 024	87106-60098
Low PIM switch, SP6T, DC - 20 GHz, terminated with Option 100, T24	87106-60099
Low PIM switch, SP6T, DC - 20 GHz, terminated with Option 161, 024	87106-60100
Low PIM switch, SP6T, DC - 20 GHz, terminated with Option 161, T24	87106-60101

Replacement unit	Part number
Low PIM switch, SP6T, DC - 26.5 GHz, terminated with Option 100, 024	87106-60102
Low PIM switch, SP6T, DC - 26.5 GHz, terminated with Option 100, T24	87106-60103
Low PIM switch, SP6T, DC - 26.5 GHz, terminated with Option 161, 024	87106-60104
Low PIM switch, SP6T, DC - 26.5 GHz, terminated with Option 161, T24	87106-60105

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

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