

# Keysight 87606Q Low PIM Coaxial Matrix Switch



Operating and  
Service Manual

# Notices

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This instrument complies with the WEEE Directive (2002/96/EC) marking requirement. This affixed product label indicates that you must not discard this electrical or electronic product in domestic household waste.

### Product Category

With reference to the equipment types in the WEEE directive Annex 1, this instrument is classified as a “Monitoring and Control Instrument” product.

The affixed product label is as shown below.



Do not dispose in domestic household waste.

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## Sales and Technical Support

To contact Keysight for sales and technical support, refer to the support links on the following Keysight websites:

- [www.keysight.com/find/lowPIM](http://www.keysight.com/find/lowPIM)  
(product-specific information and support, software and documentation updates)
- [www.keysight.com/find/assist](http://www.keysight.com/find/assist)  
(worldwide contact information for repair and service)

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# 1 Introduction

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This chapter provides you an overview of the Keysight 87606Q Coaxial Matrix Switch.

## General Information

The Keysight 87606Q terminated switch provides the life and reliability required for automated test and measurement and signal monitoring and routing applications. The switch can be used in various applications as it is available in multiple frequency ranges, up to 20 GHz.



**Figure 1-1** Keysight 87606Q Coaxial Matrix Switch

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.



## Key Features

- 3 x 3, 2 x 4, and 1 x 5 blocking matrix 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 > 100 dB at 20 GHz
- PIM level (typical) of -165 dBc
- Opto-electronic indicators and interrupts
- Terminated ports
- Make-before-break or break-before-make operation

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## 2 Switch Configuration

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Driving the Switch 14

This chapter provides you information on how to drive the switch.

## General Operation

The 87606Q matrix switch consists of six ports which can be individually connected via internal microwave switches to form an RF path. When control inputs are sent to the switch, the internal logic and position sensing circuitry routes current to the appropriate solenoids to open or close the microwave switches based on the input state. The position sensing circuitry utilizes opto-electronic components to determine the position of the individual internal microwave switches.

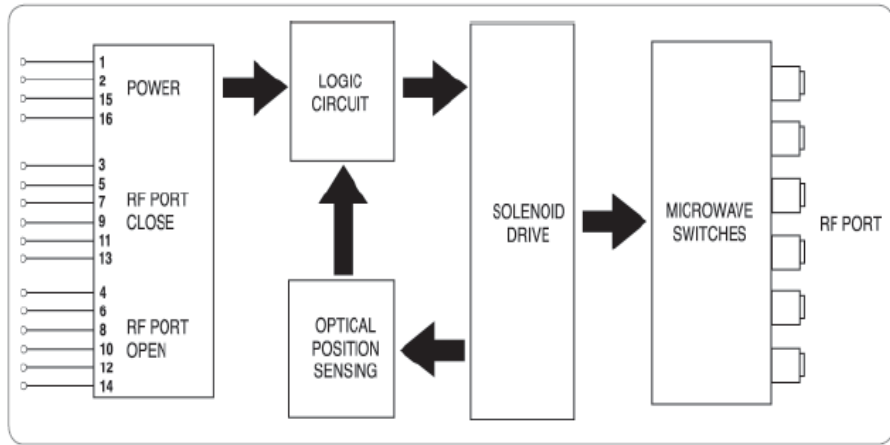
Each internal microwave switch has two solenoids: one to select the RF port, and one to unselect the RF port. The position sensing circuits serve two purposes: to enable solenoids that need to be switched, and to interrupt the solenoid current once the individual internal microwave switch is closed or opened. Each solenoid requires 200 mA at 24 VDC nominal for 15 ms.

The solenoid current is interrupted once the switching solenoids are magnetically latched. The supply current then returns to the standby level that is required by the opto-electronic components.

To configure a desired RF path, two ports must be closed. The ports are closed by grounding the “RF port close” pin that corresponds to the RF port (see [Table 2-1](#)). RF ports that are already closed must be opened if they are not part of the desired RF path. RF ports may be opened by grounding the “RF port open” pin that corresponds to the desired port (see [Table 2-2](#)).

### CAUTION

- Simultaneously selecting the “RF port close” pin and the “RF port open” pin for the same port will cause rapid cycling and premature failure of the switch.
  - If pin 15 is not grounded, the logic circuit will not operate as expected, and damage to the switch will occur.
-



**Figure 2-2** Keysight 87606Q block diagram

## Driving the Switch

### DC Power Connection

- Connect pin 1 to supply (+20 VDC to +32 VDC)
- Connect pin 15 to chassis ground to enable the electronic position indicating circuitry and drive logic circuitry.

#### 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.
- 

#### 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.
- 

### RF Path Selection

To connect any two RF ports, apply control signal to the corresponding drive pins as shown below.

**Table 2-1** Keysight 87606Q RF port drive pin control data (see [Figure 3-5](#) for drive connection diagrams)

RF port	6	5	4	3	2
1	3, 13	3, 11	3, 9	3, 7	3, 5
2	5, 13	5, 11	5, 9	5, 7	
3	7, 13	7, 11	7, 9		
4	9, 13	9, 11			
5	11, 13				

Using [Table 2-1](#), select (close) the desired RF path by connecting ground to the corresponding "drive" pins.

### Open an RF port

To open RF ports, apply control signal to the corresponding drive pins as shown below.

**Table 2-2** Keysight 87606Q "Open" RF port control data (see [Figure 3-5](#) for drive connection diagrams)

RF port	1	2	3	4	5	6
Drive pin	3	5	7	9	11	13

Using [Table 2-2](#), unselect (open) the desired RF path by connecting ground to the corresponding "drive" pins.

### Example: Configure the RF path from port 2 to port 5

Using the data in [Table 2-1](#) and [Table 2-2](#), close ports 2 and 5 while opening all other ports (1, 3, 4, 6); ground pins 4, 5, 8, 10, 11, 14; all other drive pins must be removed from ground. Another method is to first apply ground to pin 16; with all other drive pins (3-14) ungrounded, for 15 milliseconds to open all paths, then apply ground to pins 5 and 11, to close ports 2 and 5.

## 2 Switch Configuration

RF port	1		2		3		4		5		6	
Drive pin	3	4	5	6	7	8	9	10	11	12	13	14
Standard drive	U	G	G	U	U	G	U	G	G	U	U	G
U = Ungrounded, G = Grounded												

Removing all drive pins (3 to 14) from ground and grounding pin 16 will open all RF paths.

### CAUTION

Simultaneously grounding any "RF port close" pin and pin 16 will cause rapid cycling and premature failure of the switch.

#### Break-before-make

Open the undesired RF path. After 15 ms (minimum), close the new RF port(s).

#### Make-before-break

Close the new RF port(s). After 15 ms (minimum), open the undesired RF port(s).



# 3 Specifications

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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.

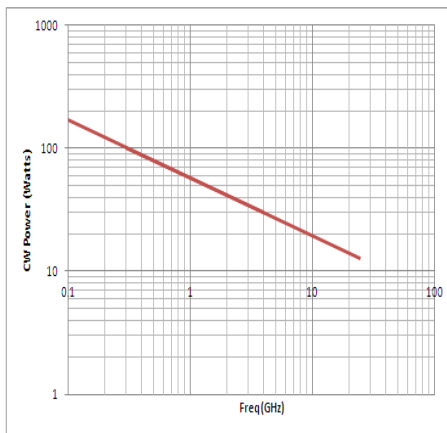
## General Specifications

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.*

Maximum power rating	1 W CW
Into internal termination	50 W peak, 10 $\mu$ s max pulse width, not to exceed 1 W average
Into thru path	2 W CW
Hot switching	100 W peak, 10 $\mu$ s max pulse width, not to exceed 2 W average
Cold switching	See <a href="#">"Supplemental Specifications (Cold Switching)"</a>
Switching time	15 ms maximum

## Supplemental Specifications (Cold Switching)

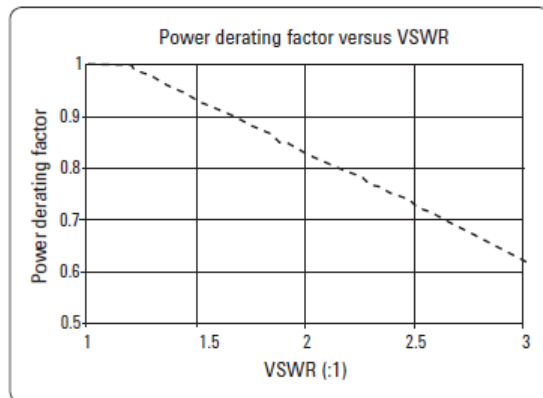


## Supplemental Characteristics

Insertion loss repeatability (measured at 25 °C)	0.03 dB
Characteristic impedance	50 $\Omega$
RF connectors	SMA (f)

### Reference Conditions

- Cold switching only (NO hot switching)
- Ambient temperature of 75 °C or less
- Sea level (0.88 derating at 15000 feet)
- Load VSWR < 1.2 (see [Figure 3-3](#) for derating above 1.2 VSWR)
- Power handling at 25 °C is 100 W at 4 GHz



**Figure 3-3** Power derating factor vs. VSWR

## Specifications

### Switch Drive Specifications

Parameter	Condition	Minimum	Nominal	Maximum	Unit
Supply voltage, Vcc		20	24	32	V
Switching current	Vcc = 24 VDC		200 <sup>[1]</sup>		mA
Standby current (quiescent)		25		50	mA

[1] 200 mA is required for each RF port closed or opened. Using “open all ports” (pin 16) will require up to 1200 mA (six ports times 200 mA each). See [“General Operation” on page 12](#).

### RF Specifications

Parameter	Characteristic
Frequency range	DC to 20 GHz
Insertion loss	0.34 dB + 0.033 x frequency (GHz) maximum
Isolation	100 dB minimum to 12 GHz 80 dB minimum from 12 to 15 GHz 70 dB minimum from 15 to 20 GHz
SWR	1.21 maximum from DC to 4 GHz 1.35 maximum from 4 to 10 GHz 1.5 maximum from 10 to 15 GHz 1.7 maximum from 15 to 18 GHz 1.9 maximum from 18 to 20 GHz

## 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<sup>[1]</sup>

Parameter	Characteristic
Insertion loss repeatability (measured at 25 °C)	0.03 dB
Characteristic impedance	50 $\Omega$
RF connectors	SMA (f)

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

## Physical Specifications

Parameter	Specification
Dimensions	Figure 3-4
Weight	229 gm (0.50 lb)

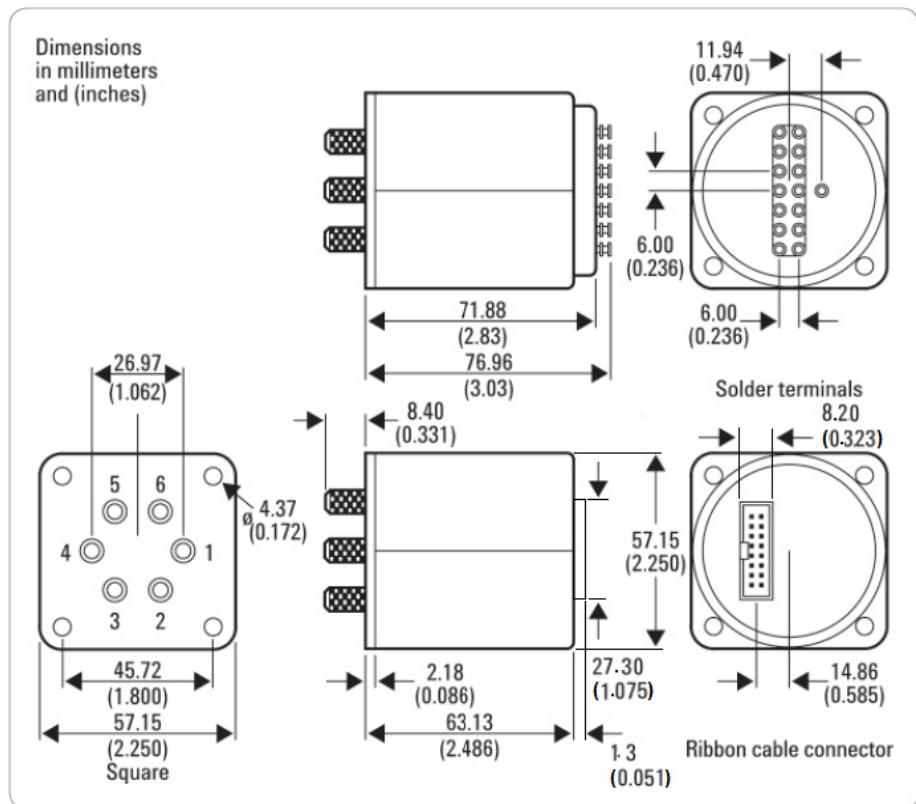
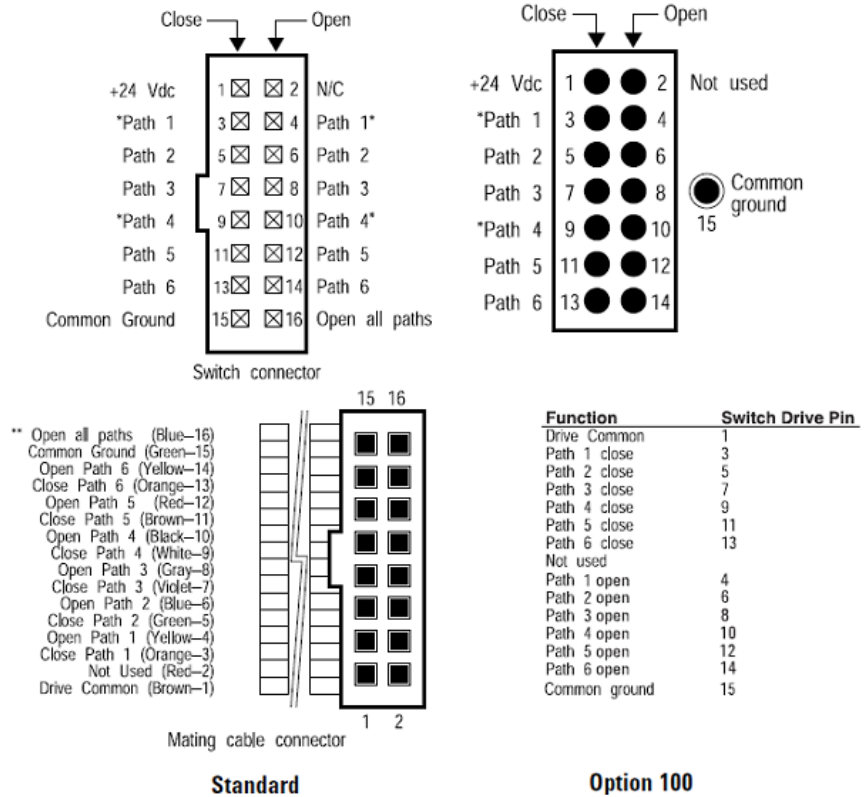


Figure 3-4 Product Outline



**Figure 3-5** Drive Connection Diagram

**NOTE**

The “Open all paths” pin is not available for Option 100.



## Troubleshooting

Symptom	Probable Cause
Will not switch	<ul style="list-style-type: none"><li>- Not connected to supply</li><li>- Supply &lt; 20 V</li><li>- Supply current too low</li><li>- Not connected to ground</li><li>- Select line not at ground (std)</li></ul>

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# 4 Installation and Verification

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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 “[Sales and Technical Support](#)” on page 3). 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 “[Sales and Technical Support](#)” on page 3 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

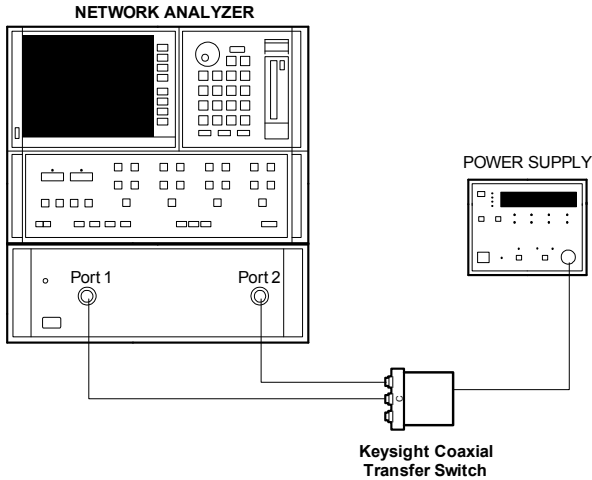
The operator's check is supplied to allow the operator to make a quick check on the switch prior to use or if a failure is suspected.

**CAUTION**

ESD exceeding the level specified in “” or RF power applied is greater than the maximum specified as in “General Specifications” may cause permanent damage to the device.

### Description

The coaxial matrix 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 4-6** Connection to perform quick check

### Quick Check Procedure

- 1 Connect one port of the switch to Port 1 of the network analyzer and another port of the switch to Port 2 of the network analyzer as illustrated in [Figure 4-6](#).
- 2 Apply ground to the corresponding “drive” pin to close the selected path. Refer to [“Driving the Switch” on page 14](#).
- 3 Perform the S-parameter measurement and verify against [“Supplemental Specifications \(Cold Switching\)” on page 18](#).
- 4 Repeat steps 1 to 4 until all paths are measured and verified.

### Performance Test

The coaxial matrix 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 87606Q low PIM coaxial matrix switch does not require internal adjustments and are not recommended for repair.

#### NOTE

If any of the low PIM coaxial matrix switches 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, matrix, DC - 20 GHz, terminated, 24 VDC with Option 100	87606-60009
Low PIM switch, matrix, DC - 20 GHz, terminated, 24 VDC with Option 161	87606-60010

**NOTE**

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

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