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Agilent 8710x Series Coaxial Multiport Switches

Operating and Service Manual



Agilent Technologies

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This chapter provides you the overview of Agilent 8710x series coaxial multiport swtiches.

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General Information

Agilent 87104A/B/C/D SP4T and 87106A/B/C/D SP6T terminated switches provide the life and reliability required for automated test and measurement, signal monitoring and routing applications. These switches can be used in various applications as they are available in multiple frequency ranges, up to 40 GHz.



Figure 1 Agilent 87106D (left) and 87104D (right) 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 switches are designed to operate for more than 10,000,000 cycles. The exceptional 0.03 dB insertion loss repeatability is warranted for 5 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.

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Table 1 List of Agilent 8710x Series Coaxial Multiport Switches

Model Number	Frequency Range	Configuration
87104A	DC to 4 GHz	SP4T
87104B	DC to 20 GHz	SP4T
87104C	DC to 26.5 GHz	SP4T
87104D	DC to 40 GHz	SP4T
87106A	DC to 4 GHz	SP6T
87106B	DC to 20 GHz	SP6T
87106C	DC to 26.5 GHz	SP6T
87106D	DC to 40 GHz	SP6T

Key Features

- SP4T and SP6T configurations
- Magnetic latching
- Operating life of 10 million cycles, typical
- Guaranteed repeatability of 0.03 dB up to 5 million cycles ensure accurate system measurements and reduces calibration intervals
- Excellent isolation, typically > 65 dB at 40 GHz
- Opto-electronic indicators and interrupts
- Terminated ports
- TTL/5 V CMOS compatible (optional)

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

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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 for drive connection diagrams.

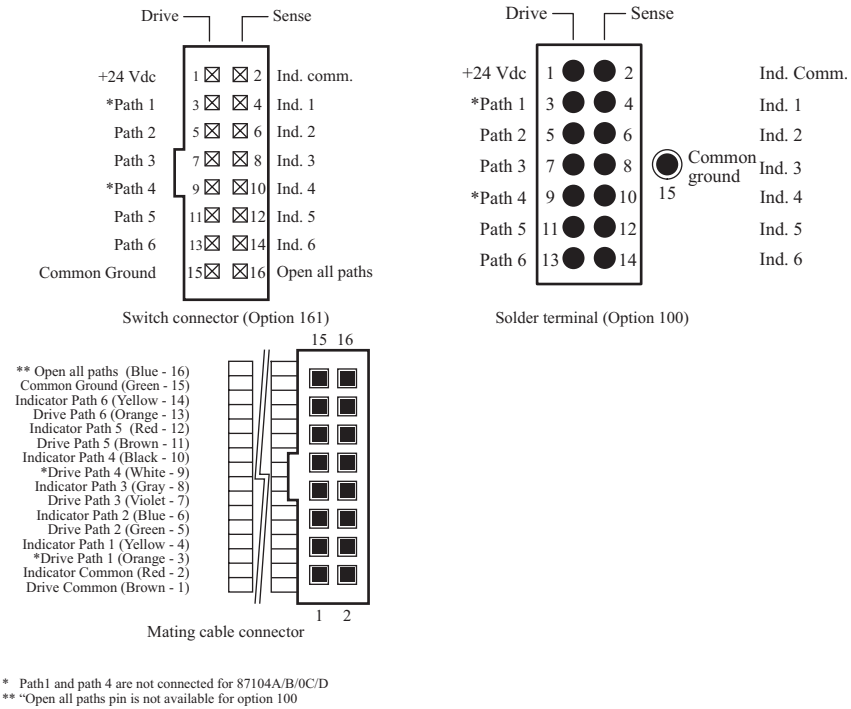


Figure 2 Drive Connection Diagram for Option 161 and Option 100

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.

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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 interupted 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.

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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 interupted 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.

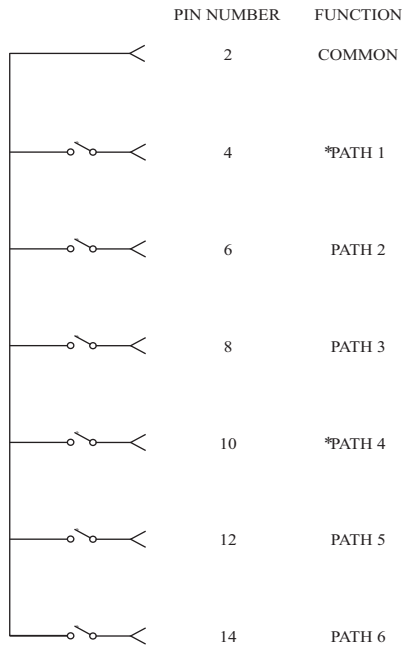
3 To select another RF path, ensure that all unwanted RF path “drive” pins are at TTL “Low” (to prevent multiple RF path engagement). Apply TTL “High” to the “drive” pin which corresponds to the desired RF path.

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.

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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 3). The circuitry consists of a common which can be connected to an output corresponding to each RF path. If multiple RF paths 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 page 21 for "Indicator Specifications". 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

Figure 3 Pin Configuration for Indicator Function

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This chapter provides you 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.

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General Specifications

Agilent Model Number	87104A/B/C/D & 87106A/B/C/D
Maximum power rating	1 watt average into 50 Ω internal loads
Hot Switching	1 watt CW 50 watt Pk (not to exceed 1 watt average)
Cold Switching	See "Supplement Specifications (Cold Switching)"
Life	5,000,000 cycles minimum
Switching Speed	15 ms maximum

Supplement Specifications (Cold Switching)

Figure 4 illustrates the maximum incident CW power (cold switching) from 100 MHz to 40 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 5 for derating above 1.2 VSWR)

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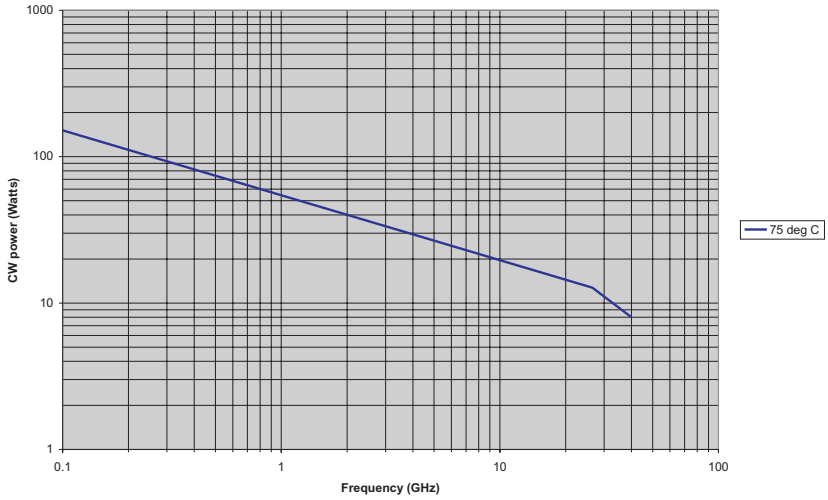


Figure 4 Maximum Incident Power (Cold Switching) vs. Frequency

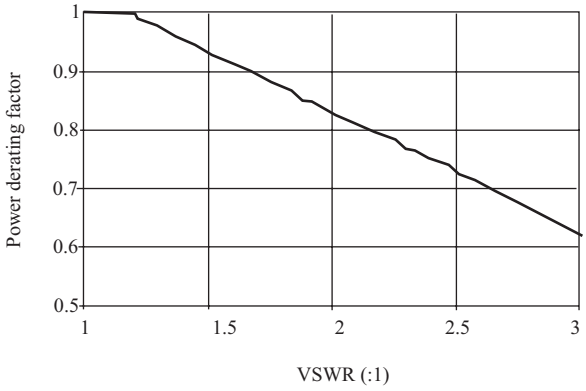


Figure 5 Power Derating Factor vs. VSWR

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RF Specifications

Agilent Model Number	87104A & 87106A	87104B & 87106B
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 18 GHz) < 1.70 (18 to 20 GHz)
Repeatability† (dB)	< 0.03	< 0.03
Characteristics	50Ω, terminated	50Ω, terminated
Connectors	SMA (f)	SMA (f)

* f = frequency in GHz

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

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Agilent Model Number	87104C & 87106C	87104D & 87106D
Frequency Range	DC to 26.5 GHz	DC to 40 GHz
Insertion Loss (dB)	0.015f* + 0.3	0.015f* + 0.3 (DC to 26.5 GHz) 0.030f* - 0.1 (26.5 to 40 GHz)
Isolation (dB)	> 100 (DC to 12 GHz) > 80 (12 to 15 GHz) > 70 (15 to 20 GHz) > 65 (20 to 26.5 GHz)	> 100 (DC to 12 GHz) > 80 (12 to 15 GHz) > 70 (15 to 20 GHz) > 65 (20 to 40 GHz)
SWR	< 1.20 (DC to 4 GHz) < 1.35 (4 to 12.4 GHz) < 1.45 (12.4 to 18 GHz) < 1.70 (18 to 26.5 GHz)	< 1.20 (DC to 4 GHz) < 1.35 (4 to 12.4 GHz) < 1.45 (12.4 to 18 GHz) < 1.70 (18 to 26.5 GHz) < 1.95 (26.5 to 40 GHz)
Repeatability† (dB)	< 0.03	< 0.03
Characteristics	50Ω, terminated	50Ω, terminated
Connectors	SMA (f)	2.92 mm (f)

* f = frequency in GHz

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

Indicator Specifications

Agilent Model Number	87104A/B/C/D & 87106A/B/C/D
Maximum withstand voltage	60 V
Maximum current capacity	150 mA
Maximum “ON” resistance	2.5 Ω
Maximum “OFF” resistance	10 GΩ

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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.

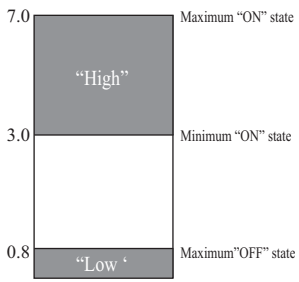


Figure 6 TTL Control Voltage States (Option T24)

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Environmental Specifications

The 8710x series coaxial multiport switches are designed to fully comply with Agilent Technologies' product operating environmental specifications.

Parameter	Specification
Temperature	
• Operating	-25°C to +75°C
• Storage	-55°C to +85°C
• Cycling	-55°C to +85°C, 10 cycles per MIL-STD-202F, Method 107D, Condition A (modified)
Humidity	
• Operating	95% RH at 65°C, 10 days per MIL-STD-202F, Method 106E
Shock	
• Half-sine	500 G @ 0.5 ms, 3 drops/direction, 18 total
• Operating	50 G @ 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	2.41 G rms, 10 minutes/axis
Altitude	
• Storage	< 15,240 meters (50,000 feet) per MIL-STD-202F, Method 105C, Condition B
ESD immunity	
• Direct discharge	4 kV (to outer conductor) per IEC 61000-4-2
• Air discharge	8 kV (to center conductor) per IEC 61000-4-2
RFI	Radiated emission per CISPR 11
Magnetic field	< 5 gauss 1/4 inch from surface

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Physical Specifications

Parameter	Specification
Dimensions	Figure 7
Net weight, kg (lb)	0.229 (0.5)

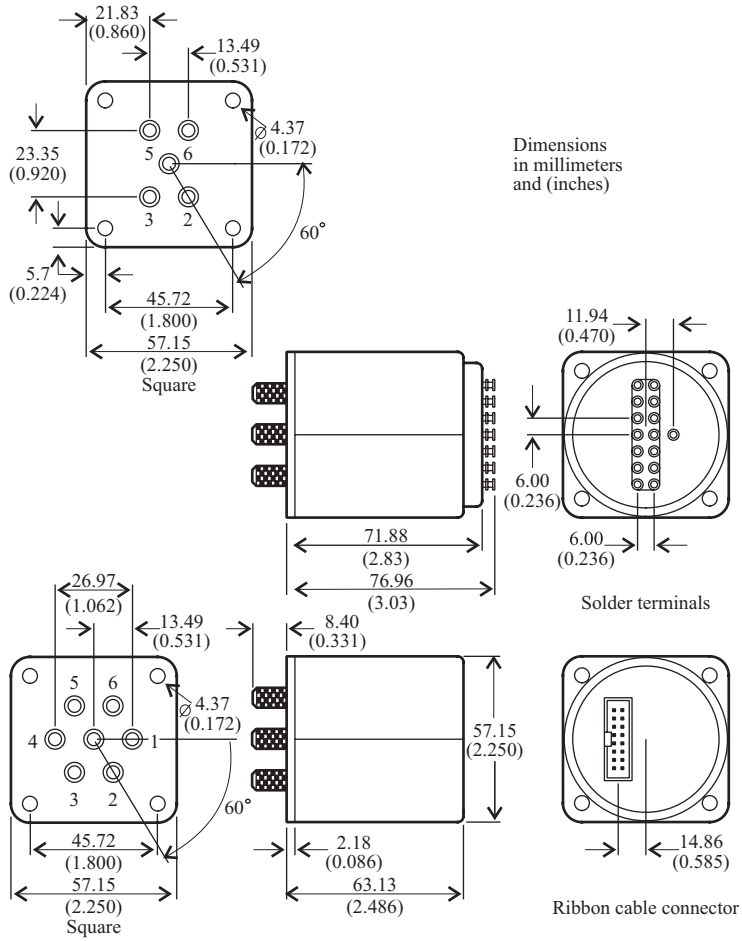


Figure 7 Dimensions of 8710x coaxial multiport switches

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Installation and Verification

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Operating and Service Instruction 27
"Operator's Check"
"Performance Test"
"Service Instructions"

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

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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” or “Performance Tests’.
2. If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the electrical performance test, contact the nearest Agilent Technologies Sales and Service office. Refer to the Service and Support information in the front matter of this manual. Agilent Technologies 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. Agilent Technologies can provide packaging materials identical to the original materials. Refer to Service and Support information in the front matter of this manual for the Agilent Technologies nearest 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 model number and serial number.

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Operating and Service Instruction

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-parameters measurement is the best way to determine if the switch is working properly.

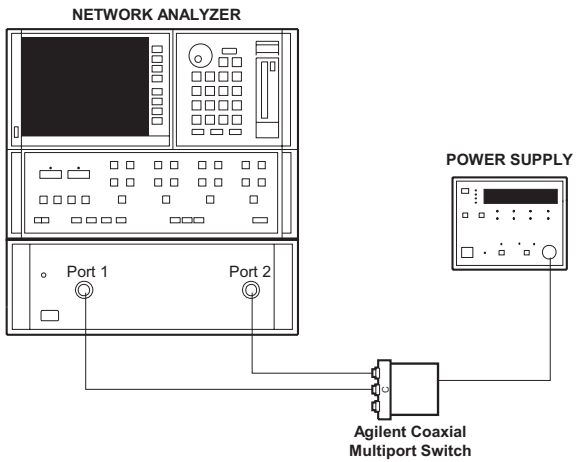


Figure 8 Connection to Perform Quick Check

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Quick Check Procedure

1. Connect common port of switch to Port 1 of the network analyzer and one of the outer RF ports to Port 2 of network analyzer as illustrated in Figure 8.
2. For standard drive, apply ground to the corresponding “drive” pin to close the selected path. Refer to “Standard Drive” 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 s-parameters measurement and verify against “Supplement Specifications (Cold Switching)” on page 13 and page 14.
5. Repeat from step 1 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

Agilent 8710x series coaxial multiport switches do not require internal adjustments and are not recommended for repair.

Maintenance

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

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