

# Agilent 87606B

## Coaxial Matrix Switch

### dc to 20 GHz

#### Product Overview

#### High performance matrix switch for RF and microwave test systems

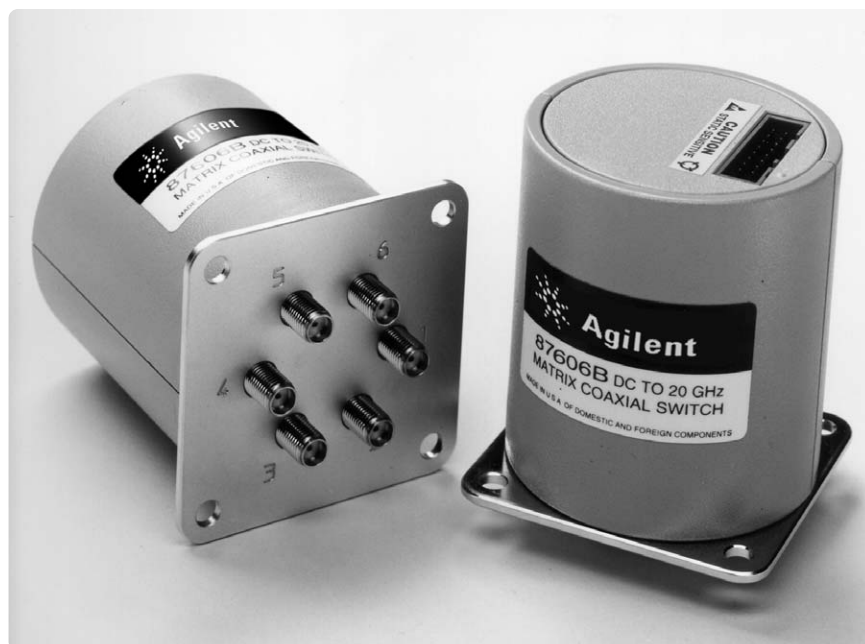
- 3 x 3, 2 x 4, and 1 x 5 blocking matrix configurations
- Magnetic latching
- Make-before-break or break-before-make operation
- Exceptional repeatability for more than 5 million cycles
- Excellent isolation, typically >100 dB at 20 GHz
- Terminated ports
- Self-interrupting drive circuit
- Fully compatible with Agilent 87130A/70611A switch drivers

Modern automated test systems demand higher accuracy and performance than ever before. The Agilent Technologies 87606B matrix switch offers improvements in insertion loss repeatability and isolation necessary to achieve higher test system performance. Long life, excellent repeatability, and high reliability lowers the cost of ownership by reducing calibration cycles and increasing test system uptime and are vital to ATS measurement system integrity.

#### Description

The 87606B matrix switch provides the life and reliability required for automated test and measurement, signal monitoring, and routing applications. Innovative design and careful process control creates a switch that meets the requirements for highly repeatable switching elements in test instruments and switching interfaces. The switch is designed to operate for more than 10 million cycles and will meet all electrical specifications for at least 5 million cycles.

The switch exhibits exceptional insertion loss repeatability. 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 the switch increases system uptime, and lowers the cost of ownership by reducing calibration cycles and switch maintenance.



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Operating to 20 GHz, this switch exhibits the exceptional isolation performance required to maintain measurement integrity. Isolation between ports is typically >100 dB to 20 GHz. This reduces the influence of signals from other channels, sustains the integrity of the measured signal, and reduces system measurement uncertainties. This switch also minimizes measurement uncertainty with low insertion loss and reflection, which makes it an ideal element in large, multi-tiered switching systems.

The 87606B is designed to fall within most popular industry footprints. The 2 $\frac{1}{4}$  inch square flange provides

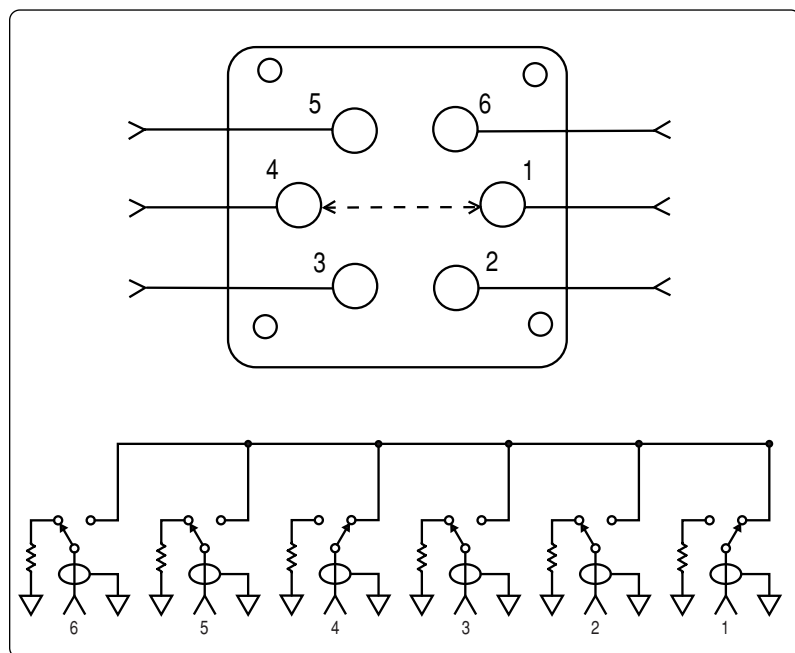
mounting holes, while the rest of the 2 $\frac{1}{2}$  inch long by 2 $\frac{1}{4}$  inch diameter body will easily fit into most systems. Ribbon cable or optional solder terminal connections accommodate the need for secure and efficient control cable attachment.

Option 100 provides solder terminal connections in place of the 16-pin ribbon drive cable. Option 100 does not incorporate the “open all ports” feature.

Each port is individually controlled by its corresponding “close” and “open” control lines. A port is closed or open when its corresponding “close” or “open” pin is connected to ground.

At this point, the current to the solenoids is shut off by the opto-electronic interrupts. This improves reliability and extends the life of the switch by eliminating dc circuit contact failures characteristic of conventional electro-mechanical switches. Full position sensing capability is assured when used with the Agilent 87130A/70611A switch drivers.

All unselected RF ports are terminated with 50 ohm loads.



**Figure 1. Agilent 87606B connection diagram and simplified schematic (RF path 4 to 1 shown)**

## Applications

### Matrix signal routing

Figures 2 and 3 show the 87606B configured for blocking 2 x 4 and 3 x 3 applications. With outstanding repeatability and life greater than 5 million cycles, these switches enhance measurement confidence and reduce cost of ownership. In addition, the matrix switch has the versatility to provide single pole multiple throw signal routing up to 1 x 5 (SP5T). For applications requiring only single pole multithrow signal routing, the 87204 and 87206 series high performance switches are recommended.

Information on switch drivers can be found on page 8 of this document. For additional information, request publication number 5963-2038E, *Agilent 70611A, 87130A, and 11713A Switch and Attenuator Driver Configuration Guide*.

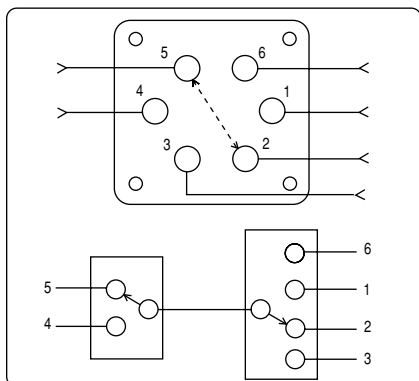
### General operation

The 87606B matrix switch consists of 6 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

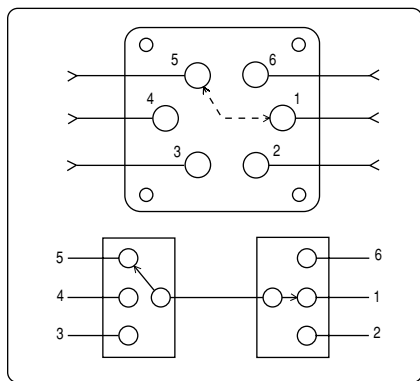
requires 200 mA @ 24 VDC nominal for 15 ms. The solenoid current is interrupted once the switching solenoids are magnetically latched. The supply current then returns to the standby level that is required by the opto-electronic components.

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 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).

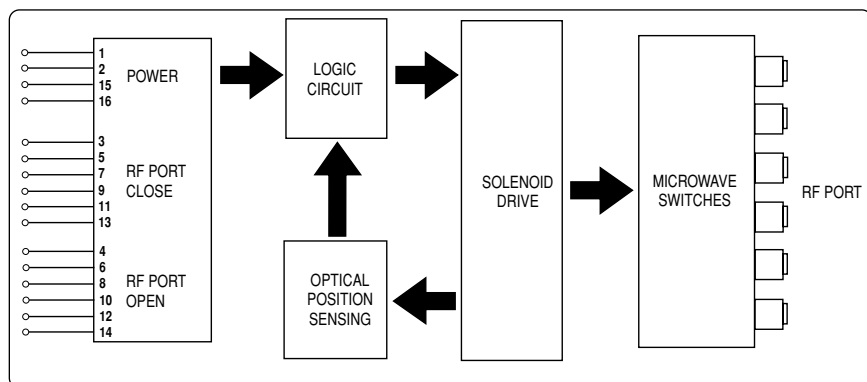
**Simultaneously selecting the "RF port close" pin and the "RF port open" pin for the same port will cause rapid cycling and premature failure of the switch.**



**Figure 2. Matrix switch configured for a 2 x 4 blocking application (RF Path 5 to 2 shown)**



**Figure 3. Matrix switch configured for a 3 x 3 blocking application (RF Path 5 to 1 shown)**



**Figure 4. Agilent 87606B block diagram**

### General operation (cont.)

All of the “RF port open” solenoids are connected to pin 16 via logic circuitry. Grounding of pin 16 will open all RF ports (this feature is not available with Option 100, solder terminals).

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

### 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.

**WARNING: DAMAGE TO SWITCH WILL OCCUR IF PIN 15 IS NOT GROUNDED.**

### RF Path Selection

#### Close an RF Port

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

**Table 1. Agilent 87606B “Close” RF Port Control Data (See Figure 7 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 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. Agilent 87606B “Open” RF Port Control Data (See Figure 7 for drive connection diagrams.)**

RF Port	1	2	3	4	5	6
Drive Pin	3	5	7	9	11	13

Using Table 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 Tables 1 and 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.

RF port	1		2		3		4		5		6	
Drive pin	3	4	5	6	7	8	9	10	11	12	13	14
Standard, Option 100	U	G	G	U	U	G	U	G	G	U	U	G

U=Ungrounded, G=Grounded

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

## Specifications

**Specifications** describe the instrument's warranted performance. **Supplemental** and **typical characteristics** are intended to provide information useful in applying the instrument by giving typical, but not warranted, performance parameters.

<b>Maximum power rating:</b>	1 W average into 50 ohm internal loads
Switching:	1 W average
Non-switching:	50 W Peak (10 $\mu$ s max, not to exceed 1 watt average)
<b>Life:</b>	5,000,000 cycles minimum
<b>Switching speed:</b>	15 ms maximum

#### Switch drive specifications

Parameter	Conditions	Min	Nom	Max	Units
<b>Supply voltage, Vcc</b>		20	24	32	V
<b>Switching current</b>	Vcc=24 VDC		200 <sup>1</sup>		mA
<b>Standby current (quiescent)</b>		25		50	mA

1. 200 mA is required for each RF port closed or open. Using “open all ports” (pin 16) will require up to 1200 mA (6 ports times 200 mA each). See General Operation, page 3.

## Specifications (cont.)

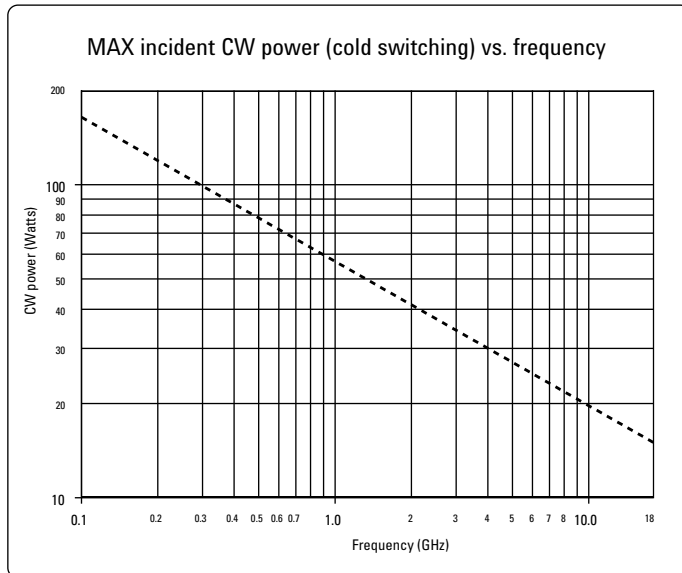
Frequency range	dc to 20 GHz
Insertion loss	$0.34 \text{ dB} + 0.033 \times \text{frequency (GHz)}$ maximum
Isolation	100 dB minimum to 12 GHz 80 dB minimum from 12 to 15 GHz 70 dB minimum from 15 to 20 GHz
SWR	1.21 maximum from dc to 4 GHz 1.35 maximum from 4 to 10 GHz 1.5 maximum from 10 to 15 GHz 1.7 maximum from 15 to 18 GHz 1.9 maximum from 18 to 20 GHz

## Supplemental characteristics<sup>2</sup>

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

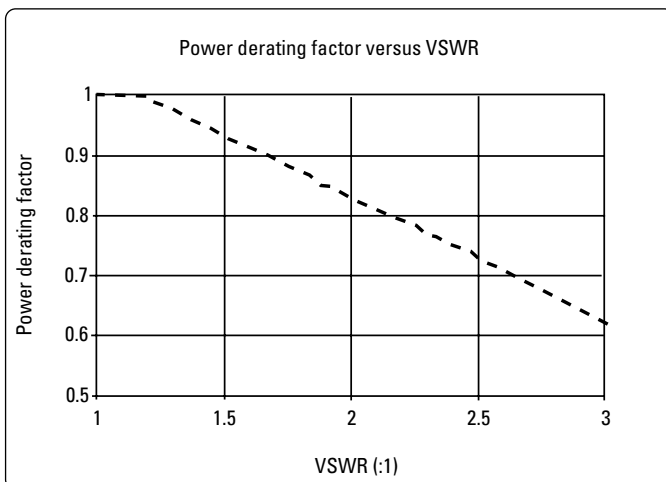
2. **Supplemental** and **typical characteristics** are intended to provide information useful in applying the instrument by giving typical, but not warranted, performance parameters.

## Supplemental characteristic



### Reference conditions:

- Cold switching only (NO Hot switching)
- Ambient temperature of 75°C or less
- Sea level (0.88 derating @ 15,000ft.)
- Load VSWR < 1.2 (see graph for derating above 1.2 VSWR)



## Environmental specifications

Operating temperature:	–25 to 75 °C
Storage temperature:	–55 to 85 °C
Temperature cycling:	–55 to 85 °C, 10 cycles per MIL-STD-202F, Method 107D, Condition A (modified)
Vibration	
Operating:	7 g: 5 to 2000 Hz at 0.25 in p-p
Survival:	20 g: 20 to 2000 Hz at 0.06 in p-p, 4 min/cycle, 4 cycles/axis
Random:	2.41 g (rms) 10 min/axis
Shock	
Half-sine:	500 g at 0.5 ms, 3 drops/direction, 8 total
Operating:	50 g at 6 ms, 6 directions
Moisture resistance:	65 °C, 95% RH, 10 days per MIL-STD-202F, Method 106E
Altitude storage:	50,000 feet (15,240 meters) per MIL-STD-202F, Method 105C, Condition B
RFI:	Per MIL-STD-461C, RE02, Part 4
Magnetic field:	<5 gauss 1/4 inch from surface

## Physical Specifications

Dimensions:	Per Figure 6
Weight:	229 gm (0.50 lb)

Dimensions  
in millimeters  
and (inches)

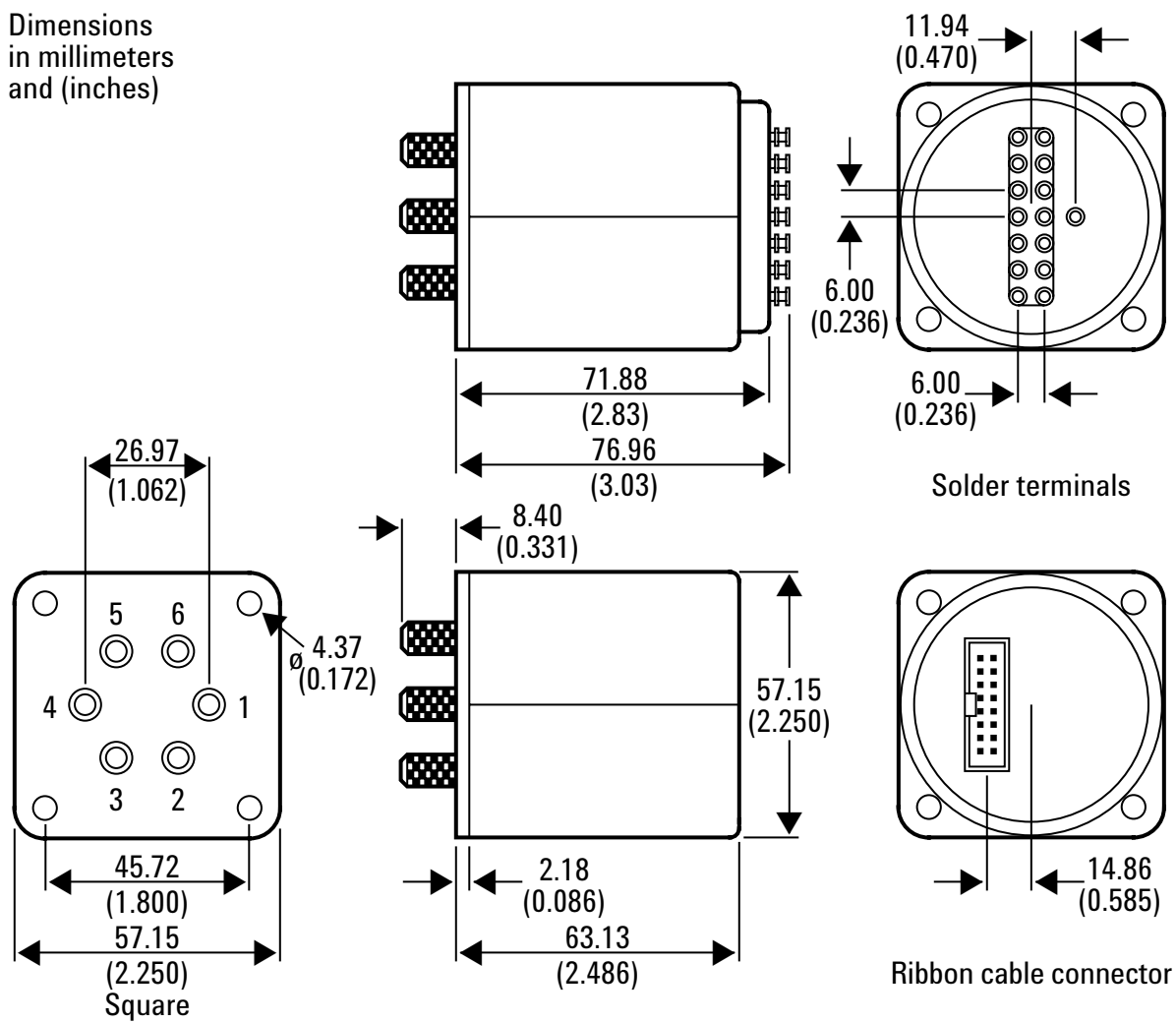


Figure 6. Product outline

## Troubleshooting

Symptom	Probable cause
1. Will not switch	<ul style="list-style-type: none"> <li>• Not connected to supply</li> <li>• Supply &lt;20 V</li> <li>• Insufficient supply current</li> <li>• Pin 15 not connected to ground</li> <li>• Select line not at ground</li> </ul>
2. Switch buzzes	<ul style="list-style-type: none"> <li>• "Open" and "close" pins on same RF port selected simultaneously</li> <li>• Pin 16 and any "close" pins selected simultaneously</li> </ul>

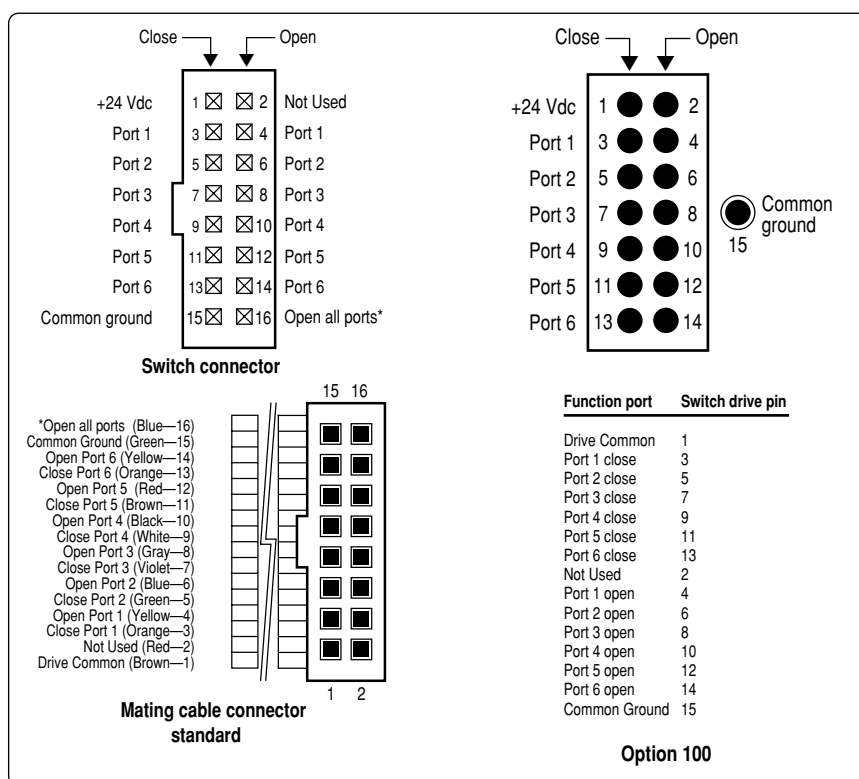


Figure 7. Drive connection diagrams

\* Open all ports pin is not available with Option 100.

## Ordering information

### Switch

**87606B** Coaxial matrix switch,  
dc to 20 GHz

**Option 100** Solder terminals to  
replace ribbon cable

**Option UK6** Commercial calibration  
test data with certificate

**Option UKS** Commercial calibration  
certificate

### Drivers

#### **11713A Attenuator switch driver**

Drives up to 10 sections of switches  
or attenuators.

##### **5061-0969 Accessory cable**

Viking connector to bare tinned  
wires (60 inches long). Use two  
(2) to connect the 11713A to one  
87606B, Option 100 switch.

#### **70611A Attenuator/switch driver**

When expanded with up to 8 external  
(standard only) 84940A driver cards,  
the 70611A will drive up to 248 switch  
or attenuator sections. See below for  
accessories.

#### **87130A Attenuator/switch driver**

Drives up to 31 sections of switches  
or attenuators. When expanded with  
up to 7 external 84940A driver cards,  
the 87130A will drive up to 248 switch  
or attenuator sections. See below for  
accessories.

### Accessories

#### **84940A Switch driver card**

Will drive up to 31 switch or attenua-  
tor sections. For use with 87130A and  
70611A.

#### **84941A Switch interface kit**

Includes a signal distribution card  
and 70611-60008 accessory cable. For  
use with 87606B Option 100.

#### **11764-60008 Accessory cable**

##### **(use with 87606B)**

16-pin DIP to (6) 4-pin berg connec-  
tors (30 inches long).

#### **70611-60008 Accessory cable**

##### **(use with 87606B Option 100)**

(31) 52 inch cables, 4-pin berg con-  
nector to bare tinned wire.

### Configuration guide

See publication 5963-2038E.



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