

Agilent Technologies 87050A Option K24

User's and Service Guide

Multiport Test Set

Use this manual with the following documents:

PNA Series Network Analyzer On-line Help System and Application Note 1408-12

8719D/20D/22D Network Analyzer User's Guide, Part Number 08720-90288

8753D Network Analyzer User's Guide, Part Number 08753-90257

8753E Network Analyzer User's Guide, Part Number 08753-90367

8719D/20D/22D Network Analyzer Service Guide, Part Number: 08720-90292

8753D Network Analyzer Service Guide, Part Number: 08753-90261

8753E Network Analyzer Service Guide, Part Number: 08753-90374



Agilent Technologies

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WARNING	Warning denotes a hazard. It calls attention to a procedure which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a warning note until the indicated conditions are fully understood and met.
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CAUTION	Caution denotes a hazard. It calls attention to a procedure that, if not correctly performed or adhered to, could result in damage to or destruction of the instrument. Do not proceed beyond a caution sign until the indicated conditions are fully understood and met.
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Definitions

- *Specifications* describe the performance of parameters covered by the product warranty (temperature –0 to 55 °C, unless otherwise noted.)
- *Typical* describes additional product performance information that is not covered by the product warranty. It is performance beyond specification that 80% of the units exhibit with a 95% confidence level over the temperature range 20 to 30 °C. Typical performance does not include measurement uncertainty.
- *Nominal* values indicate expected performance or describe product performance that is useful in the application of the product, but is not covered by the product warranty.
- *Characteristic Performance* describes performance parameter that the product is expected to meet before it leaves the factory, but is not verified in the field and is not covered by the product warranty. A characteristic includes the same guard bands as a specification.

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87050A Option K24

Description

The Agilent 87050A Option K24 Multiport Mechanical Switching Test Set is designed for use with 50 Ω network analyzers such as the Agilent PNA E8362B, PNA-L N5230A, 8719D/E, 8720D/E, 8722D/E and 8753D/E.

The Test Set provides the ability to make single connection, multiple measurements of multiport devices with up to 24 ports, such as distribution amplifiers, taps, switches and couplers. Throughput is increased by reducing the number of device reconnects the operator must perform. Switching is performed with mechanical switches.

The test set can be controlled by using an external GPIB controller, or parallel control

NOTE This User's and Service Guide documents the use of the test set with an Agilent 8720D or the PNA E8362B.

87050A Option K24 Options

UK6

Option UK6 provides a commercial calibration certificate including actual test data. Data includes test results of 95 tests including reflection, transmission, and isolation from all test ports.

Rack Ear Mounts

Option 908 (5062-3974) provides rack mounts that make it quick and easy to install or remove the test set from a mainframe.

For further information on these options please contact Agilent Technologies. Refer to "[Contacting Agilent](#)" on page 57.

Verifying the Shipment

After the test set has been unpacked, keep the original packaging materials so they can be used if you need to transport the instrument. Inspect the test set and all accessories for any signs of damage that may have occurred during shipment. If your test set or any accessories appear to be damaged or missing refer to ["Contacting Agilent" on page 57](#).

Table 1 **87050A Option K24 Accessories Supplied**

Description	Agilent Part Number	Quantity
Power Cord	See Figure 7 on page 14	1
Adapter, 3.5 mm to APC-7	1250-1747	2
RF Cable (SMA to SMA)	5062-6682	2
Front Handle Kit	5063-9228	1
Rack Mount Kit	5063-9235	1
Parallel Port Interface Cable	8120-6818	1
RF Cable (Connect Option K24 trans and refl ports to the analyzer)	08720-20245	2
3.5 mm Connector	85052-60012	2
User's and Service Guide	87050-90022	1

General Specifications

Table 2 Agilent 87050A Option K24 Specifications

Parameter	Specification
Frequency Range	50 MHz to 20 GHz
Isolation	
0.50 GHz to 1.3 GHz	≥ 85 dB
1.3 GHz to 3.0 GHz	≥ 100 dB
3.0 GHz to 6.0 GHz	≥ 95 dB
Return Loss	
0.50 GHz to 1.3 GHz	≥ 24 dB
1.3 GHz to 3.0 GHz	≥ 20 dB
3.0 GHz to 6.0 GHz	≥ 14 dB
6.0 GHz to 12.4 GHz	≥ 12 dB
12.4 GHz to 20 GHz	≥ 8 dB
Insertion Loss	
0.5 GHz to 6.0 GHz	≤ 2.5 dB
6.0 GHz to 12.4 GHz	≤ 3.5 dB
12.4 GHz to 20 GHz	≤ 4.5 dB
Phase Deviation	
Reflection Port to Ports 1–24 (0.5 GHz to 6.0 GHz)	± 10°
Transmission Port to Ports 1–24 (0.5 GHz to 6.0 GHz)	± 10°
Reflection Port to Ports 1–24 (6.0 GHz to 20 GHz)	± 35°
Transmission Port to Ports 1–24 (6.0 GHz to 20 GHz)	± 35°
Input Power Damage Level	> 1 Watt (RF +dc)

Power Requirements

NOTE Refer to your network analyzer documentation for specifications and power requirements.

Verify that the required ac power is available at all necessary locations before installing the Test Set to the PNA.

- Air conditioning equipment (or other motor-operated equipment) should not be placed on the same ac line that powers the Test Set and PNA.
- The line power module on your test set is an autoranging input.
- Ensure that the available ac power source meets the following requirements:
 - 100/120/220/240 Vac
 - 50/60 Hz
 - 40 Watts

Specifications for the 87050A Mechanical Switching Multiport Test Set are characteristics for the system performance of the PNA and test set. Actual performance of the system is based on the customers PNA that is used with the test set.

WARNING **This is a Safety Class I product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall be inserted only into a socket outlet provided with a protective earth contact. Any interruption of the protective conductor, inside or outside the instrument, is likely to make the instrument dangerous. Intentional interruption is prohibited.**

CAUTION This product has an autoranging line voltage input. Be sure the supply voltage is within the specified range. If the ac line voltage does not fall within these ranges, an autotransformer that provides third wire continuity to earth ground should be used.

Environmental Requirements

Operating Environment

Indoor use only

Operating Temperature: 0 to 55 °C (32 °F to 104 °F)

Storage Temperature: -40 °C to +70 °C (-40 °F to +158 °F)

Altitude: 10,000 feet (3,000 meters)

Enclosure Protection IP 2 0

Environmental Tests

The 87050A Option K24 complies with all applicable safety and regulatory requirements for the intended location of use and have been evaluated to assure that they are consistent with Agilent quality and reliability goals.

Equipment Heating and Cooling

If necessary, install air conditioning and heating to maintain the ambient temperature within the appropriate range. Air conditioning capacity must be consistent with the power ratings given on [Page 5](#).

Required Conditions for Accuracy Enhanced Measurement

Accuracy-enhanced (error-corrected) measurements require the ambient temperature of the PNA and Test Set to be maintained within ± 1 °C of the ambient temperature at calibration.

CAUTION This product is designed for use in Installation Category II, and Pollution Degree 2.

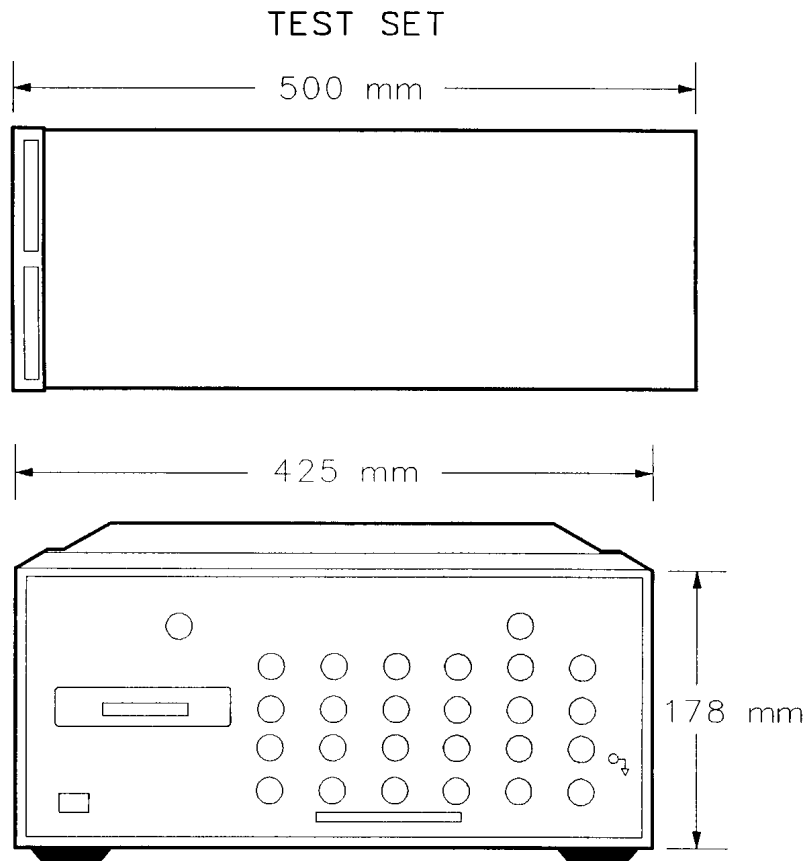
Dimensions and Space Requirements

Standard installation of the 87050A Option K24 and PNA includes configuration and installation on a customer provided lab bench or table top of adequate size and strength.

Table 3 Instrument Dimensions

Model	Weight	Height	Width	Depth
E8362B	29 kg (64 lb)	26.7 cm (10.5 in)	42.5 cm (16.7 in)	42.6 cm (16.8 in)
N5230A	24.9 kg (55 lb, ±0.5 lb)	26.7 cm (10.5 in)	42.5 cm (16.7 in)	42.6 cm (16.8 in)
87050A Opt K24	9 kg (19.8 lb)	17.8 cm (7 in)	42.5 cm (16.7 in)	50 cm (19.7 in)

Figure 1 Agilent 87050A Option K24 Physical Dimensions



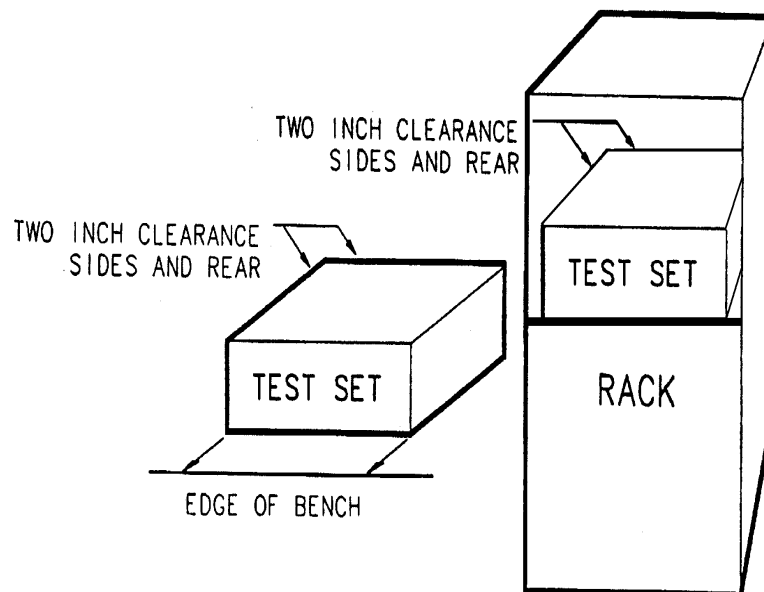
Ventilation Requirements

ESD (electrostatic discharge) must be eliminated by use of static-safe work procedures and an anti-static bench mat. Refer to “[Electrostatic Discharge Protection](#)” on page 56.

The 87050A Option K24 and the PNA are listed in “[Environmental Requirements](#)” are listed on [Page 6](#). Note that these requirements are the same as those of the E8362B and N5230A PNA-L. The E8362B and N5230A PNA-L provides front panel access to the source outputs, receiver inputs and couplers for use with the multiport test sets.

CAUTION Ventilation Requirements: When installing the instrument in a cabinet, the convection into and out of the instrument must not be restricted. The ambient temperature (outside the cabinet) must be less than the maximum operating temperature of the instrument by 4 °C for every 100 watts dissipated in the cabinet. If the total power dissipated in the cabinet is greater than 800 watts, forced convection must be used.

Figure 2 Ventilation Clearance Requirements

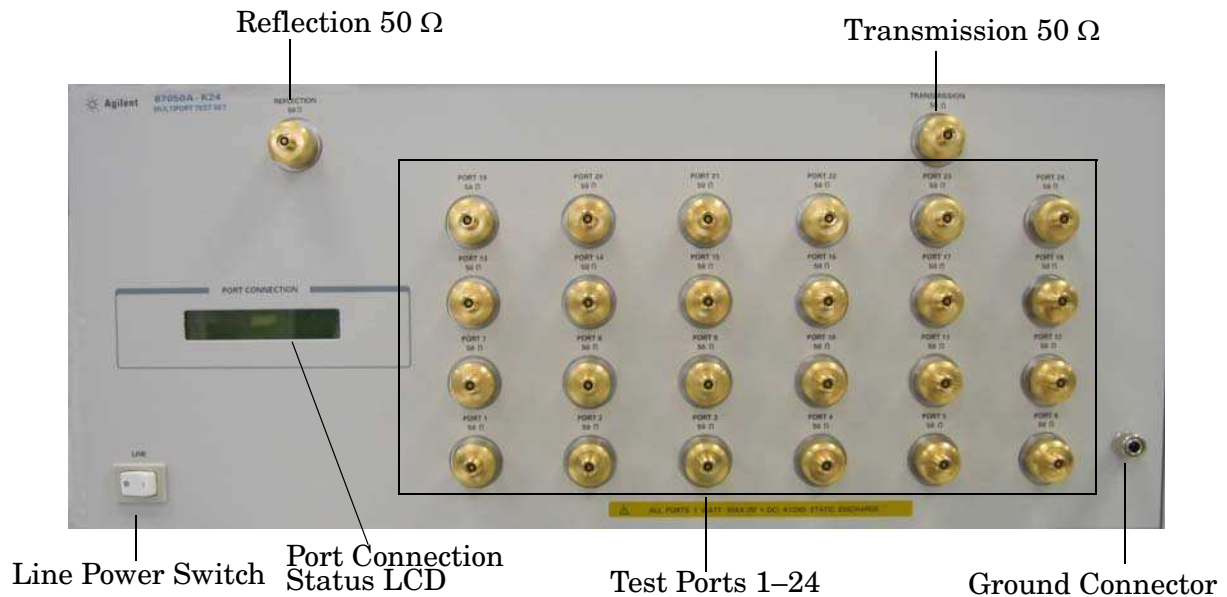


CAUTION If the total power dissipated in the cabinet is greater than 800 watts, forced convection must be used.

Front and Rear Panel Features

This chapter contains information on the ports and switches found on the front and rear panels of the test set.

Figure 3 Front Panel



Line Power Switch

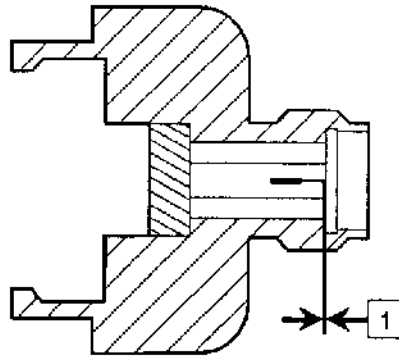
The Test Set line power switch is located at the bottom left corner of the front panel. See [Figure 3](#). The line power switch turns the power to the test set on or off.

The front panel line switch disconnects the mains circuits from the mains supply after the EMC filters and before other parts of the instrument.

Ports 1-24

Ports 1 through 24 are 50 Ω , 3.5 mm connectors that are used to connect to the device under test.

CAUTION Do not input more than 1 watt, RF and DC combined, to these ports or damage to the internal RF switches or the analyzer may occur.

Figure 4 Physical Characteristics of the 3.5 mm Connector**NOTE:**

1	Pin Depth: 0.0050 mm to 0.0381 mm (.0002 in. to .0012 in.)
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Transmission and Reflection Ports

The Transmission and Reflection Ports are female 3.5 mm 50 Ω connectors. A 50 Ω cable connects directly to the Port 1/Port 2 or Reflection/Transmission port of the network analyzer using the cable (08720-20245) that was shipped with your Test Set.

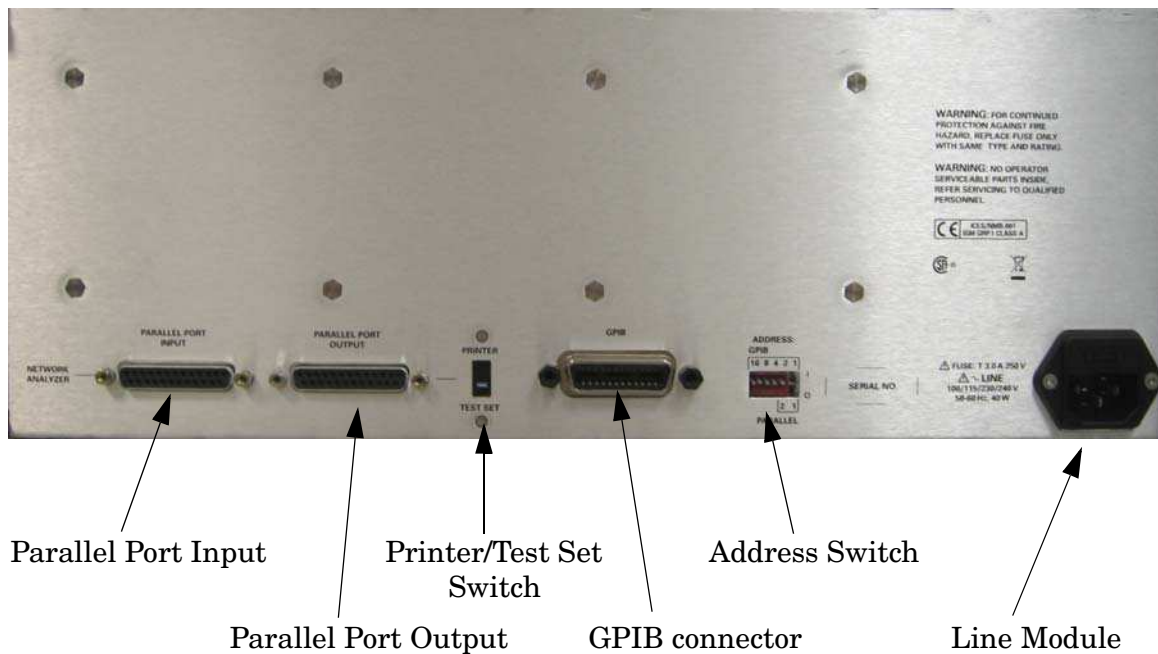
CAUTION Refer to your analyzer documentation for damage limits to the RF OUT port. Verify that your test setup will not cause those limits to be exceeded.

Ground Connector

The Ground connector provides a convenient front panel ground connection for a standard banana plug.

Port Connection Status LCD

The Port Connection Status LCD provides visual feedback of which port(s) are connected to the Transmission and Reflection ports of the test set. When the LCD displays a path connection, all other corresponding test ports are internally terminated in 50 Ω .

Figure 5 Rear Panel

Parallel Port Input Connector

This input is connected to the network analyzer. The analyzer provides control signals that drive the switches inside the test set. In pass-through mode, it also accepts signals required to drive a printer.

Parallel Port Output Connector

The output from this connector is used either to control another test set, or to control a printer, depending upon how the Printer/Test Set switch is set.

Printer/Test Set Switch

This switch determines the function of the Parallel Port Output connector. When switched to Printer, the Parallel Port Output will pass through printer driver signals. When switched to Test Set, an additional test set can be controlled from the Parallel Port Output connector.

GPIB Connector

This connector allows the test set to be connected directly to a controller, as shown in [Figure 5](#).

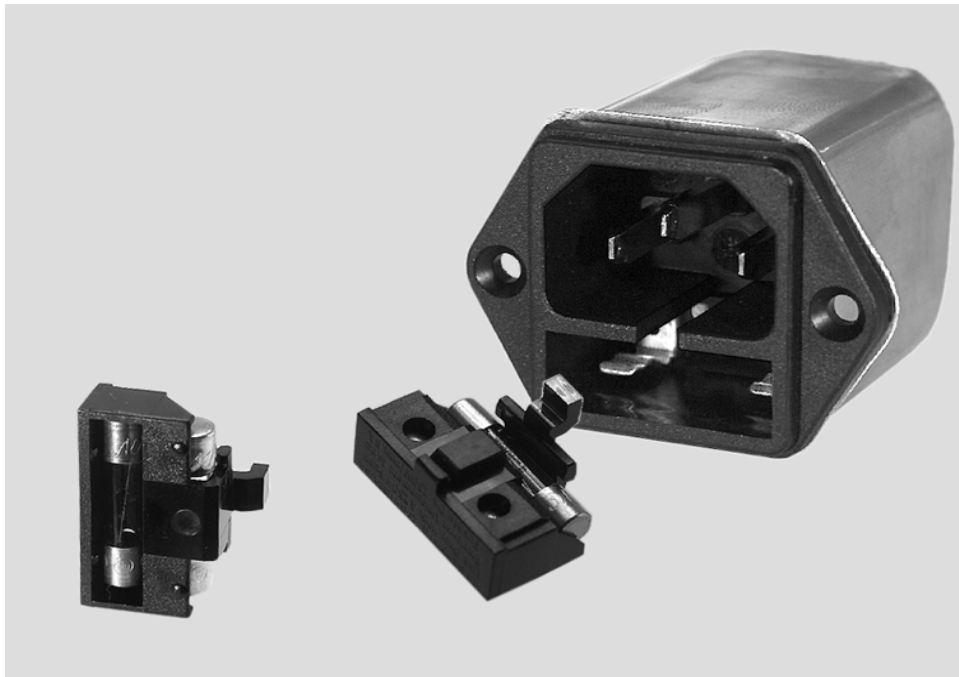
Address Switch

The address switch sets the GPIB or parallel address of the test set. See “[Setting the Test Set Address Switch](#)” on page 16 for information.

Line Module

The line fuse and a spare reside within the line module. [Figure 6](#) illustrates where the fuses are and how to access them.

Figure 6 Line Module



Available Fuse

- Fuse (F 3 A/250 V, part number 2110-0780) UL listed and CSA certified.

Power Cables

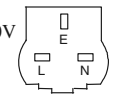
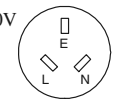
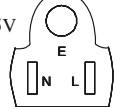
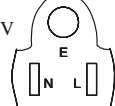
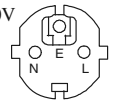
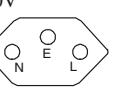

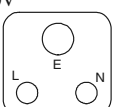
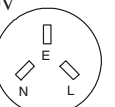
The line power cable is supplied in one of several configurations, depending on the destination of the original shipment.

Each instrument is equipped with a three-wire power cable. When connected to an appropriate ac power receptacle, this cable grounds the instrument chassis. The type of power cable shipped with each instrument depends on the country of destination. See [Figure 7 on page 14](#) for the part numbers of these power cables. Cables are available in different lengths. See "[Contacting Agilent](#)" on [page 57](#) for descriptions and part numbers of cables other than those described in [Figure 7](#).

CAUTION Always use the three-prong ac power cord supplied with this product. Failure to ensure adequate grounding by not using this cord may cause damage to the product.

WARNING **This is a Safety Class I product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. Any interruption of the protective conductor, inside or outside the instrument, is likely to make the instrument dangerous. Intentional interruption is prohibited.**

Figure 7 Power Cable and Line (Mains) Plug Part Numbers

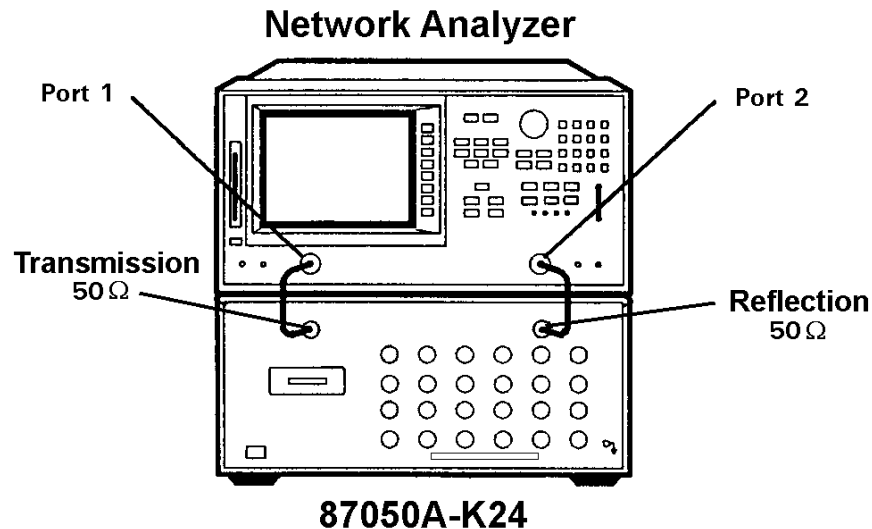
Plug Type ^a	Cable Part Number	Plug ^b Description	Length cm (in.)	Cable Color	For Use in Country
250V 	8120-8705	Straight BS 1363A	229 (90)	Mint Gray	Option 900 United Kingdom, Hong Kong, Cyprus, Nigeria, Singapore, Zimbabwe
	8120-8709	90°	229 (90)	Mint Gray	
250V 	8120-1369	Straight AS 3112	210 (79)	Gray	Option 901 Argentina, Australia, New Zealand, Mainland China
	8120-0696	90°	200 (78)	Gray	
125V 	8120-1378	Straight NEMA 5-15P	203 (80)	Jade Gray	Option 903 United States, Canada, Brazil, Colombia, Mexico, Philippines, Saudi Arabia, Taiwan
	8120-1521	90°	203 (80)	Jade Gray	
125V 	8120-4753	Straight NEMA 5-15P	229 (90)	Gray	Option 918 Japan
	8120-4754	90°	229 (90)	Gray	
250V 	8120-1689	Straight CEE 7/VII	200 (78)	Mint Gray	Option 902 Continental Europe, Central African Republic, United Arab Republic
	8120-1692	90°	200 (78)	Mint Gray	
230V 	8120-2104	Straight SEV Type 12	200 (78)	Gray	Option 906 Switzerland
	8120-2296	90°	200 (78)	Gray	
220V 	8120-2956	Straight SR 107-2-D	200 (78)	Gray	Option 912 Denmark
	8120-2957	90°	200 (78)	Gray	
250V 	8120-4211	Straight IEC 83-B1	200 (78)	Mint Gray	Option 917 South Africa, India
	8120-4600	90°	200 (78)	Mint Gray	
250V 	8120-5182	Straight SI 32	200 (78)	Jade Gray	Option 919 Israel
	8120-5181	90°	200 (78)	Jade Gray	

a. E =earth ground, L = line, and N = neutral.
b. Plug identifier numbers describe the plug only. The Agilent Technologies part number is for the complete cable assembly.

System Setup

The test set is designed to be placed underneath the network analyzer in a rack system and connected as shown in [Figure 8](#). Use the two SMA 50 Ω jumper cables (08720-20245) included in the shipment. See [Table 1 on page 3](#).

Figure 8 Connecting the Test Set to the Network Analyzer



After all the proper connections have been made, turn on the test set using the front panel line switch. The front panel line switch disconnects the mains circuits from the mains supply after the EMC filters and before other parts of the instrument.

NOTE Allow the test set warm up for at least 2 hours for accurate, repeatable measurements. For the most stable and accurate measurements, leave the test set turned on at all times.

Setting the Test Set Address Switch

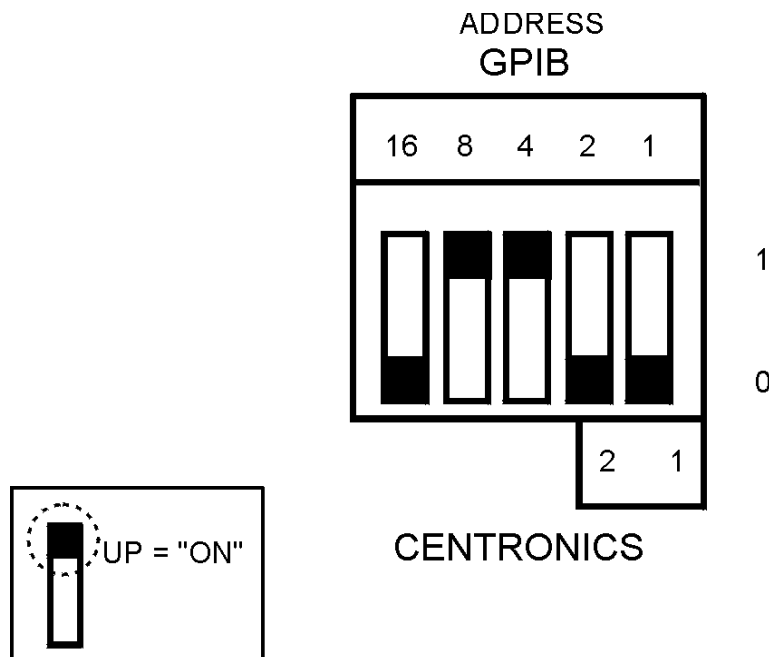
The test set is shipped with the GPIB (HP-IB) address set to 12, which sets the parallel address to 0 as in [Figure 9](#). Refer to [“Operation” on page 18](#) for the definition of the parallel address.

To set the GPIB address, set all five switches so that the sum of the switches in the On or “1” position equal the desired address. In the example below, the two switches in the “On” position are 8 and 4, therefore the GPIB address is 12.

To set the parallel address, use only the number 1 switch. Therefore the possibilities for parallel port addressing are an address of 0 or 1.

When GPIB is used, the parallel address is ignored.

Figure 9 The Test Set Address Switch



Performance Verification

For information on how to control the test set, refer to [“Operation” on page 18](#).

The following performance verification is designed to provide you with a high degree of confidence that your test set is working properly. It is not designed to verify specifications. To verify specifications, refer to [“Performance Tests” on page 30](#).

Equipment Required

- Network Analyzer, 50 Ω impedance (Agilent 8720D)
- Cable, 50 Ω 3.5 mm (85131-60012 or equivalent)
- Calibration Kit, 50 Ω (Agilent 85052B)

Procedure

This procedure is for performing a simple performance verification using a network analyzer of the proper frequency range and impedance.

NOTE This is an 80% confidence test only. A unit could pass this simple test and yet still not function properly. For more complete testing, see [“Performance Tests” on page 30](#).

- Step 1.** Perform a one-port reflection calibration at the end of a 50 Ω cable over a frequency range of 50 MHz to 20 GHz on the analyzer. Verify the calibration is active and that a cable terminated with a short displays a return loss of 0 (± 0.2 dB).
- Step 2.** Connect the cable (already connected to the reflection port of the analyzer) to the reflection port of the 87050A Option K24 Test Set.
- Step 3.** Measure the return loss of each section of the test set by selecting each port individually (ports 1 thru 24), using the network analyzer. Terminate each port being tested with a known good 50 Ω load (greater than -30 dB). The resulting return loss should be greater than -10 dB (the absolute value should be greater than 10).

Operation

The Agilent 87050A Option K24 is a “slave” instrument: a controller must be used to control the test set. There are three ways in which the test set can be controlled:

- The controller can talk to the network analyzer GPIB, which then controls the test set via the parallel connection
- The controller can control the test set directly via GPIB
- A network analyzer equipped with a parallel connection can control the test set directly

Typeface Key Conventions

The following key conventions are used throughout this document.

- **[HARDKEYS]** are labeled front panel keys
- **SOFTKEYS** are unlabeled key whose function is indicated on the instrument display

Commands

As mentioned earlier, the test set can be controlled in three ways. The first two involve the use of a separate computer. The third way uses the network analyzer manually. These methods of control are detailed below and on the following page.

Computer Control

The first way to control the test set is to write GPIB commands to the network analyzer which then writes to the test set by way of the parallel port. See [Figure 10 on page 19](#) for a diagram of connections for this type of control. The following examples use the variable [D] which is defined in [Table 4 on page 20](#).

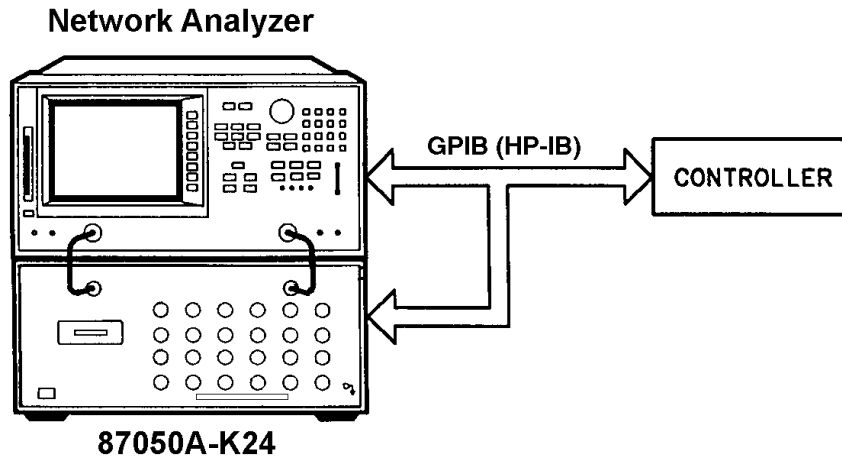
To use a parallel port connection with the 8720D, use a GPIB command to write bits on the parallel port. The following example assumes that the address of the network analyzer is 16.

OUTPUT 716; "PARALGPIO; "	<i>Sets the parallel port for GP-IO function</i>
OUTPUT 716; "PARAOUT [D] ; "	<i>Programs all GP-IO output bits (0 to 256) at once</i>

NOTE Be sure to use the ending semi-colon.

The second way to control the test set is to address the 87050A Option K24 test set directly over GPIB, using a controller to write directly to the test set GPIB port. The following example assumes that the address of the test set is 12.

OUTPUT 712; "STRING\$"

Figure 10 Controlling the Test Set Over GPIB

NOTE Connection to the network analyzer is not required when controlling the test set over GPIB.

Network Analyzer Control

The third method of sending commands uses the network analyzer to control the test set directly. This method is performed with the standard setup of the network analyzer working with the test set. A parallel cable is connected from the network analyzer output to the test set input on both rear panels.

Press: **[SEQ]**

TTL → I/O → PARALLEL ALL OUT

Use the arrow keys, \uparrow or \downarrow , to scroll to the desired test port address, or input the number directly using the hard keys **[D] → [x1]**, where **D** represents the decimal value of the test port address, see [Table 4 on page 20](#).

Table 4 Test Port Addresses

Connection Path	GPIB Command	Decimal [D]	Binary Equivalent
Transmission to Port 1	tran_01	0	00000000
Transmission to Port 2	tran_02	1	00000001
Transmission to Port 3	tran_03	2	00000010
Transmission to Port 4	tran_04	3	00000011
Transmission to Port 5	tran_05	4	00000100
Transmission to Port 6	tran_06	5	00000101
Transmission to Port 7	tran_07	6	00000110
Transmission to Port 8	tran_08	7	00000111
Transmission to Port 9	tran_09	8	00001000
Transmission to Port 10	tran_10	9	00001001
Transmission to Port 11	tran_11	10	00001010
Transmission to Port 12	tran_12	11	00001011
Transmission to Port 13	tran_13	12	00001100
Transmission to Port 14	tran_14	13	00001101
Transmission to Port 15	tran_15	14	00001110
Transmission to Port 16	tran_16	15	00001111
Transmission to Port 17	tran_17	16	00010000
Transmission to Port 18	tran_18	17	00010001
Transmission to Port 19	tran_19	18	00010010
Transmission to Port 20	tran_20	19	00010011
Transmission to Port 21	tran_21	20	00010100
Transmission to Port 22	tran_22	21	00010101
Transmission to Port 23	tran_23	22	00010110
Transmission to Port 24	tran_24	23	00010111
Transmission Terminated	*t_term	24	00011000
Reflection to Port 1	refl_01	25	00011001
Reflection to Port 2	refl_02	26	00011010
Reflection to Port 3	refl_03	27	00011011
Reflection to Port 4	refl_04	28	00011100

Table 4 Test Port Addresses

Connection Path	GPIB Command	Decimal [D]	Binary Equivalent
Reflection to Port 5	refl_05	29	00011101
Reflection to Port 6	refl_06	30	00011110
Reflection to Port 7	refl_07	31	00011111
Reflection to Port 8	refl_08	32	00100000
Reflection to Port 9	refl_09	33	00100001
Reflection to Port 10	refl_10	34	00100010
Reflection to Port 11	refl_11	35	00100011
Reflection to Port 12	refl_12	36	00100100
Reflection to Port 13	refl_13	37	00100101
Reflection to Port 14	refl_14	38	00100110
Reflection to Port 15	refl_15	39	00100111
Reflection to Port 16	refl_16	40	00101000
Reflection to Port 17	refl_17	41	00101001
Reflection to Port 18	refl_18	42	00101010
Reflection to Port 19	refl_19	43	00101011
Reflection to Port 20	refl_20	44	00101100
Reflection to Port 21	refl_21	45	00101101
Reflection to Port 22	refl_22	46	00101110
Reflection to Port 23	refl_23	47	00101111
Reflection to Port 24	refl_24	48	00110000
Reflection Terminated	*r term	49	00110001
Box Identity	idn?		
Reset	*rst	50	00110010
Serial Number	sn?		

To connect all ports to their internal 50 Ω loads, send the following two commands:

```
OUTPUT
716;"PARAOUT24;"
```

```
OUTPUT 716;"PARAOUT49;"
```

or

```
OUTPUT 712;"*t_term"
```

```
OUTPUT 712;"*r_term"
```

NOTE When a test set port is not in use, it is terminated in 50 Ω

If the 87050A Option K24 is being controlled by GPIB, you can read the serial number of the test set by sending the following commands:

```
OUTPUT 712;"sn?"
```

```
ENTER 712;Sn$
```

```
DISP Sn$
```

Reset Command:

When the Reset (*rst) command is sent, the box is set to a known state where all ports are terminated.

Switch Count Commands

To read the individual switch count, send the following two commands:

```
OUTPUT 712;"SW10?"
```

```
OUTPUT 712;J10$
```

The previous example illustrates the J10 command only. To enter additional commands use [Table 5 on page 23](#).

Table 5 Switch Count Commands

Switch Number	GPIB Command
J10	SW10?
J11	SW11?
J12	SW12?
J13	SW13?
J14	SW14?
J15	SW15?
J16	SW16?
J17	SW17?
J18	SW18?
J19	SW19?
J50	SW50?
J51	SW51?
J52	SW52?
J53	SW53?
J54	SW54?
J55	SW55?
J56	SW56?
J57	SW57?
J58	SW58?
J59	SW59?
J60	SW60?
J61	SW61?
J62	SW62?
J63	SW63?
J64	SW64?
J65	SW65?
J66	SW66?
J67	SW67?
J68	SW68?
J69	SW69?

Table 5 Switch Count Commands

J70	SW70?
J71	SW71?
J72	SW72?
J73	SW73?

Calibrating the Test System

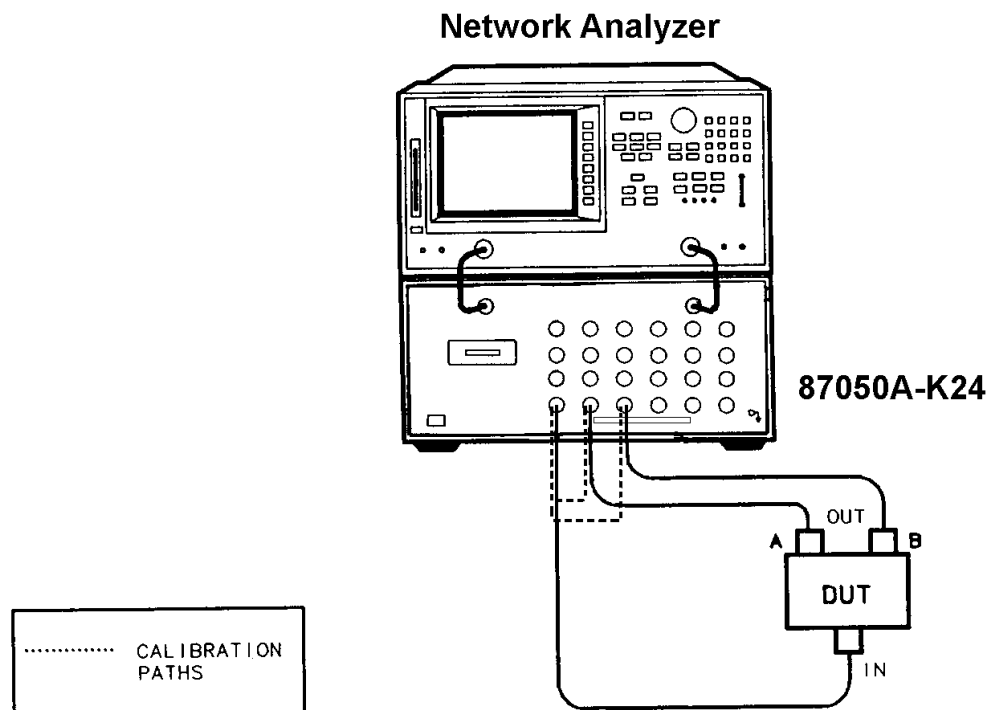
After the test set has warmed up for at least two hours, you should calibrate before making any measurements. Refer to your network analyzer user's guide to determine the type of calibration appropriate for the measurements you will be making.

You must calibrate each measurement path separately and store the calibration as an instrument state in the network analyzer. Refer to your network analyzer user's guide for information on how to calibrate and store instrument states.

Refer to [Figure 11](#). In this example setup the following tests will be made:

- Return loss on the DUT input and 2 output ports (A and B)
- Insertion loss (or gain) between the DUT input and port A
- Insertion loss (or gain) between the DUT input and port B

Figure 11 Calibrating the Test System



For the best accuracy, you should perform a full two-port calibration between test set ports 1 and 2, and again between ports 1 and 3. As mentioned before, you must save the calibrations as instrument states. See your analyzer user's guide for information on calibrations and saving instrument states.

CAUTION When performing a full two-port calibration and making subsequent measurements, you must use the transfer switch internal to the 8720D to change the RF signal path direction. Do not use the test set to change the RF signal path direction when you are using a full two-port calibration. Doing so will render the calibration invalid.

Making Measurements

The following examples assume that you are using a parallel port connection with an 8720D, with the test set's parallel address set to "0". See [“Setting the Test Set Address Switch” on page 16](#) for information on setting the test set address.

Measuring Reflection

By leaving the DUT connected, as shown in [Figure 12](#), and setting the network analyzer to measure S11, you can measure reflection or return loss.

Measuring Transmission

Refer to [Figure 12 on page 27](#) for the following discussion. With the 8720D set to measure forward transmission (S_{21}), the analyzer RF source is output through the analyzer PORT 1, and PORT 2 is set to receive the RF signal.

By using the following commands, you will connect PORT 20 of the test set to the Transmission port, and you will connect PORT 21 of the test set to the Reflection port. You will, therefore; be measuring forward transmission through the device under test when measuring S_{21} . This will provide you with gain or insertion loss information.

```
OUTPUT 716;"PARALGPIO;"
```

```
OUTPUT 716;"PARAOUT19;"
```

```
OUTPUT 716;"PARALGPIO;"
```

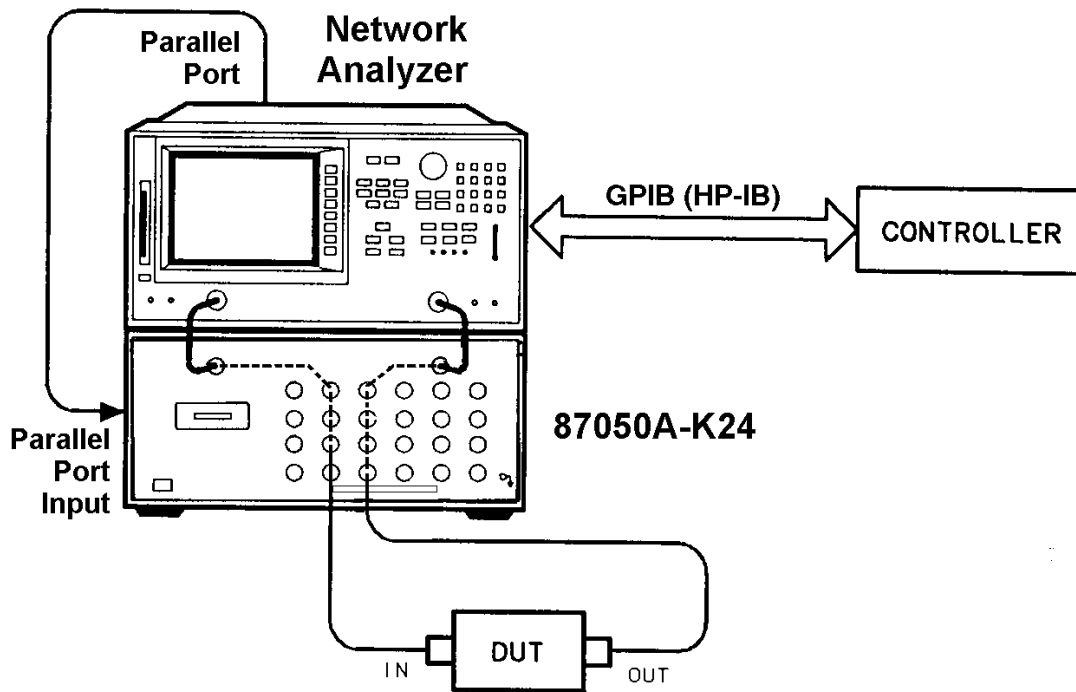
```
OUTPUT 716;"PARAOUT45;"
```

If directly controlling the 87050A Option K24, use the following GPIB commands:

```
OUTPUT 712;"tran_20"
```

```
OUTPUT 712;"refl_21"
```


Figure 12 Controlling the Test Set



Theory of Operation

The theory of operation begins with a general description of the 87050A Option K24 Multiport Test Set. This is followed by more detailed operating theory. The operation of each group is described briefly, to the assembly level only. Detailed component level circuit theory is not provided.

System Theory

The test set consists of three main components: a power supply, a front panel display and a controller interface mother board. The purpose of the power supply is to provide power to both the front panel display and the main switch board. The front panel display serves to indicate the switching paths to the user. The controller interface mother board does the actual switching between the different ports.

A1 Power Supply

The switching power supply provides regulated dc voltages to power all assemblies in the test set. A dc cable provides power to the main switch board. A connector from the main switch board to the front panel display provides dc power and control signals to the front panel. The power supply provides the following voltages: +24V, +12V, and +5V.

The power LED on the front panel indicates that the instrument is on and that the power supply is providing power.

A2 Front Panel Display

The front panel display consists of an LCD. The LCD is divided into two lines, forward and reverse. The first line indicates which of the 24 ports is connected to the forward path. The second line indicates which of the 24 ports is connected to the reverse path. Control signals and dc power are provided by a cable connected to the main switch board.

A3 Controller Board (Mother Board) and Switch Driver Board (Daughter Board)

Refer to [Figure 13 on page 50](#) for the following discussion. The mother and daughter board provide the bias to switch the paths of the various ports to the Transmission and Reflection ports. The front panel display contains an LCD that indicates the switched ports. A particular test port (1 thru 24) can be in one of the following three states:

- Switched to the forward path
- Switched to the reverse path
- Terminated in 50 Ω

When a port is not connected, it is automatically terminated in 50 Ω

The test set consists of twenty four 1×2 switches, eight 1×6 switches, and two 1×4 switches. The 1×2 switches divide each of the input ports (1 thru 24) into two separate paths, the Transmission path or the Reflection path.

Each path is routed to a bank of four 1×6 switches, for a total of eight 1×6 switches. Each bank of switches is routed to a single 1×4 switch where it becomes either the Transmission or Reflection port.

All switches are mechanical, biased according to the necessary switching path. A user interface through the GPIB and parallel ports converts the necessary input signals from the user to the necessary control signals to control the switching paths.

Performance Tests

Performance testing consists of measuring insertion loss, return loss and isolation between all ports. For the most accurate measurements, the use of an Agilent 8720D 50 Ω Network Analyzer is recommended and its use is recommended in this document. Familiarity with RF/microwave measurements is assumed. The use of adapters may be required and their effects should be accounted for. Performance tests will require the following equipment:

- Agilent 8720D Network Analyzer
- Test Port Extension Cables (85131-60012)
- Agilent 85052B Cal Kit
- Agilent 909D Option 040 or 50 Ω Termination (00909-60007)

NOTE Make a photocopy of the performance test record (later in this chapter) to record the results of the performance tests.

There are no adjustments required for the 87050A Option K24 test set.

Perform a full two-port calibration over a frequency range of 50 MHz to 20 GHz at the ends of two cables attached to the two test ports of the 8720D. Verify that the calibration is active. Save the results to a disk, as they will be used again.

Set up the 8720D with the following:

1. Set the number of points to “201”.
2. Set the Bandwidth to “300 Hz”.
3. Set the 8720D to “Step Sweep”.

NOTE The Isolation Cal Routine is done with 16 averages.

Insertion Loss

Step 1. Recall the full two-port calibration.

Step 2. Connect the cable that is attached to Port 1 of the 8720D to the Transmission port of the 87050A Option K24.

Step 3. Connect the cable from Port 2 of the analyzer to Port 1 of the 87050A Option K24. Select Transmission Port 1 using the 8720D. Record the results in the Performance Test Record, [Table 6](#) beginning on [Page 33](#).

Step 4. Repeat step 3 for each of the remaining test ports 2 through 24.

Step 5. Repeat steps 2 through 4, but connect the cable in step 2 to the Reflection port of the 87050A Option K24. In step 3, select the Reflection port instead of the Transmission port.

Return Loss

This test will verify the internal termination load of each port and the through match when the appropriate input port is terminated with a load.

- Step 1.** Perform a one-port reflection calibration at the end of a 50 Ω cable over the frequency range of 50 MHz to 20 GHz on the analyzer. Verify the calibration is active and that the terminated cable displays a return loss of 0 (± 0.2 dB).
- Step 2.** Connect the cable (already connected to the Reflection measurement port of the analyzer) to Port 1 of the 87050A Option K24. Connect a high-quality 50 Ω load to the Transmission port of the 87050A Option K24. Measure the return loss of Port 1 by selecting Port 1. Record the results in the Performance Test Record, [Table 9](#) beginning on [Page 36](#).
- Step 3.** Repeat this measurement, but this time select no active port. The display should indicate “Transmission-Terminated, Reflection-Terminated”.
- Step 4.** Move the cable to Port 2 and repeat steps 2 and 3, selecting Port 2. Repeat steps 2 and 3 for the remaining ports.

Isolation

Isolation must be measured only on adjacent ports. Two 50 Ω loads are required for this test.

- Step 1.** Recall the full two-port calibration. Make sure the calibration is active and that averaging is *On* when making measurements.
- Step 2.** Connect a 50 Ω load to the Transmission and Reflection ports of the 87050A Option K24.
- Step 3.** Connect the two cables from the network analyzer to Ports 1 and 2 of the 87050A Option K24. The exact order does not matter.
- Step 4.** Select Reflection Port 1 and Transmission Port 2. Set the 8720D to measure Transmission. Record the results in the Performance Test Record, [Table 14](#) beginning on [Page 41](#).
- Step 5.** Repeat steps 3 and 4 for the next two adjacent ports; 2 and 3. Repeat again for ports 3 and 4, then 4 and 5, and so on, ending with ports 23 and 24.

Performance Test Record

NOTE The following pages (Performance Test Record) are designed to be duplicated and used as a template for either of the Transmission or Reflection ports during each of the performance tests (Insertion Loss, Return Loss, and Isolation). At the top of each page, circle the appropriate input port (Transmission or Reflection), and write in the test date.

Agilent 87050A Option K24 Test Record

Test Facility _____	Report Number _____
_____	Date _____
_____	Date of Last System Calibration _____
_____	_____
Tested by _____	Customer _____
Model _____	Serial Number _____
Ambient Temperature _____ °C	Relative Humidity _____ %

Test Equipment Used	Model Number	Trace Number	Cal Due Date
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Special Notes:

Table 6 Insertion Loss Test Record

Transmission/Reflection		Date _____		
Test Description	Port	Minimum Specifications	Measured Results	Measured Uncertainty
Insertion Loss to Band 1 0.5 GHz to 6.0 GHz	Port 1	≤2.5 dB	_____	±0.3 dB
	Port 2	≤2.5 dB	_____	±0.3 dB
	Port 3	≤2.5 dB	_____	±0.3 dB
	Port 4	≤2.5 dB	_____	±0.3 dB
	Port 5	≤2.5 dB	_____	±0.3 dB
	Port 6	≤2.5 dB	_____	±0.3 dB
	Port 7	≤2.5 dB	_____	±0.3 dB
	Port 8	≤2.5 dB	_____	±0.3 dB
	Port 9	≤2.5 dB	_____	±0.3 dB
	Port 10	≤2.5 dB	_____	±0.3 dB
	Port 11	≤2.5 dB	_____	±0.3 dB
	Port 12	≤2.5 dB	_____	±0.3 dB
	Port 13	≤2.5 dB	_____	±0.3 dB
	Port 14	≤2.5 dB	_____	±0.3 dB
	Port 15	≤2.5 dB	_____	±0.3 dB
	Port 16	≤2.5 dB	_____	±0.3 dB
	Port 17	≤2.5 dB	_____	±0.3 dB
	Port 18	≤2.5 dB	_____	±0.3 dB
	Port 19	≤2.5 dB	_____	±0.3 dB
	Port 20	≤2.5 dB	_____	±0.3 dB
	Port 21	≤2.5 dB	_____	±0.3 dB
	Port 22	≤2.5 dB	_____	±0.3 dB
	Port 23	≤2.5 dB	_____	±0.3 dB
	Port 24	≤2.5 dB	_____	±0.3 dB

Table 7 Insertion Loss Test Record

Transmission/Reflection			Date _____	
Test Description	Port	Minimum Specifications	Measured Results	Measured Uncertainty
Insertion Loss to Band 2 6.0 GHz to 12.4 GHz	Port 1	≤ 3.5 dB	_____	± 0.3 dB
	Port 2	≤ 3.5 dB	_____	± 0.3 dB
	Port 3	≤ 3.5 dB	_____	± 0.3 dB
	Port 4	≤ 3.5 dB	_____	± 0.3 dB
	Port 5	≤ 3.5 dB	_____	± 0.3 dB
	Port 6	≤ 3.5 dB	_____	± 0.3 dB
	Port 7	≤ 3.5 dB	_____	± 0.3 dB
	Port 8	≤ 3.5 dB	_____	± 0.3 dB
	Port 9	≤ 3.5 dB	_____	± 0.3 dB
	Port 10	≤ 3.5 dB	_____	± 0.3 dB
	Port 11	≤ 3.5 dB	_____	± 0.3 dB
	Port 12	≤ 3.5 dB	_____	± 0.3 dB
	Port 13	≤ 3.5 dB	_____	± 0.3 dB
	Port 14	≤ 3.5 dB	_____	± 0.3 dB
	Port 15	≤ 3.5 dB	_____	± 0.3 dB
	Port 16	≤ 3.5 dB	_____	± 0.3 dB
	Port 17	≤ 3.5 dB	_____	± 0.3 dB
	Port 18	≤ 3.5 dB	_____	± 0.3 dB
	Port 19	≤ 3.5 dB	_____	± 0.3 dB
	Port 20	≤ 3.5 dB	_____	± 0.3 dB
	Port 21	≤ 3.5 dB	_____	± 0.3 dB
	Port 22	≤ 3.5 dB	_____	± 0.3 dB
	Port 23	≤ 3.5 dB	_____	± 0.3 dB
	Port 24	≤ 3.5 dB	_____	± 0.3 dB

Table 8 Insertion Loss Record

Transmission/Reflection		Date _____		
Test Description	Port	Minimum Specifications	Measured Results	Measured Uncertainty
Insertion Loss to Band 3 12.4 GHz to 20 GHz	Port 1	≤4.5 dB	_____	±0.3 dB
	Port 2	≤4.5 dB	_____	±0.3 dB
	Port 3	≤4.5 dB	_____	±0.3 dB
	Port 4	≤4.5 dB	_____	±0.3 dB
	Port 5	≤4.5 dB	_____	±0.3 dB
	Port 6	≤4.5 dB	_____	±0.3 dB
	Port 7	≤4.5 dB	_____	±0.3 dB
	Port 8	≤4.5 dB	_____	±0.3 dB
	Port 9	≤4.5 dB	_____	±0.3 dB
	Port 10	≤4.5 dB	_____	±0.3 dB
	Port 11	≤4.5 dB	_____	±0.3 dB
	Port 12	≤4.5 dB	_____	±0.3 dB
	Port 13	≤4.5 dB	_____	±0.3 dB
	Port 14	≤4.5 dB	_____	±0.3 dB
	Port 15	≤4.5 dB	_____	±0.3 dB
	Port 16	≤4.5 dB	_____	±0.3 dB
	Port 17	≤4.5 dB	_____	±0.3 dB
	Port 18	≤4.5 dB	_____	±0.3 dB
	Port 19	≤4.5 dB	_____	±0.3 dB
	Port 20	≤4.5 dB	_____	±0.3 dB
	Port 21	≤4.5 dB	_____	±0.3 dB
	Port 22	≤4.5 dB	_____	±0.3 dB
	Port 23	≤4.5 dB	_____	±0.3 dB
	Port 24	≤4.5 dB	_____	±0.3 dB

Table 9 Return Loss Test Record

Transmission/Reflection			Date _____	
Test Description	Port	Minimum Specifications	Measured Results	Measured Uncertainty
Return Loss Band 1 0.5 GHz to 1.3 GHz	Port 1	≥24 dB	_____	±1.5 dB
	Port 2	≥24 dB	_____	±1.5 dB
	Port 3	≥24 dB	_____	±1.5 dB
	Port 4	≥24 dB	_____	±1.5 dB
	Port 5	≥24 dB	_____	±1.5 dB
	Port 6	≥24 dB	_____	±1.5 dB
	Port 7	≥24 dB	_____	±1.5 dB
	Port 8	≥24 dB	_____	±1.5 dB
	Port 9	≥24 dB	_____	±1.5 dB
	Port 10	≥24 dB	_____	±1.5 dB
	Port 11	≥24 dB	_____	±1.5 dB
	Port 12	≥24 dB	_____	±1.5 dB
	Port 13	≥24 dB	_____	±1.5 dB
	Port 14	≥24 dB	_____	±1.5 dB
	Port 15	≥24 dB	_____	±1.5 dB
	Port 16	≥24 dB	_____	±1.5 dB
	Port 17	≥24 dB	_____	±1.5 dB
	Port 18	≥24 dB	_____	±1.5 dB
	Port 19	≥24 dB	_____	±1.5 dB
	Port 20	≥24 dB	_____	±1.5 dB
	Port 21	≥24 dB	_____	±1.5 dB
	Port 22	≥24 dB	_____	±1.5 dB
	Port 23	≥24 dB	_____	±1.5 dB
	Port 24	≥24 dB	_____	±1.5 dB

Table 10 Return Loss Test Record

Transmission/Reflection			Date _____	
Test Description	Port	Minimum Specifications	Measured Results	Measured Uncertainty
Return Loss Band 2 1.3 GHz to 3.0 GHz	Port 1	≥20 dB	_____	±1.5 dB
	Port 2	≥20 dB	_____	±1.5 dB
	Port 3	≥20 dB	_____	±1.5 dB
	Port 4	≥20 dB	_____	±1.5 dB
	Port 5	≥20 dB	_____	±1.5 dB
	Port 6	≥20 dB	_____	±1.5 dB
	Port 7	≥20 dB	_____	±1.5 dB
	Port 8	≥20 dB	_____	±1.5 dB
	Port 9	≥20 dB	_____	±1.5 dB
	Port 10	≥20 dB	_____	±1.5 dB
	Port 11	≥20 dB	_____	±1.5 dB
	Port 12	≥20 dB	_____	±1.5 dB
	Port 13	≥20 dB	_____	±1.5 dB
	Port 14	≥20 dB	_____	±1.5 dB
	Port 15	≥20 dB	_____	±1.5 dB
	Port 16	≥20 dB	_____	±1.5 dB
	Port 17	≥20 dB	_____	±1.5 dB
	Port 18	≥20 dB	_____	±1.5 dB
	Port 19	≥20 dB	_____	±1.5 dB
	Port 20	≥20 dB	_____	±1.5 dB
	Port 21	≥20 dB	_____	±1.5 dB
	Port 22	≥20 dB	_____	±1.5 dB
	Port 23	≥20 dB	_____	±1.5 dB
	Port 24	≥20 dB	_____	±1.5 dB

Table 11 Return Loss Test Record

Transmission/Reflection		Date _____		
Test Description	Port	Minimum Specifications	Measured Results	Measured Uncertainty
Return Loss Band 3 3.0 GHz to 6.0 GHz	Port 1	≥14 dB	_____	±0.6 dB
	Port 2	≥14 dB	_____	±0.6 dB
	Port 3	≥14 dB	_____	±0.6 dB
	Port 4	≥14 dB	_____	±0.6 dB
	Port 5	≥14 dB	_____	±0.6 dB
	Port 6	≥14 dB	_____	±0.6 dB
	Port 7	≥14 dB	_____	±0.6 dB
	Port 8	≥14 dB	_____	±0.6 dB
	Port 9	≥14 dB	_____	±0.6 dB
	Port 10	≥14 dB	_____	±0.6 dB
	Port 11	≥14 dB	_____	±0.6 dB
	Port 12	≥14 dB	_____	±0.6 dB
	Port 13	≥14 dB	_____	±0.6 dB
	Port 14	≥14 dB	_____	±0.6 dB
	Port 15	≥14 dB	_____	±0.6 dB
	Port 16	≥14 dB	_____	±0.6 dB
	Port 17	≥14 dB	_____	±0.6 dB
	Port 18	≥14 dB	_____	±0.6 dB
	Port 19	≥14 dB	_____	±0.6 dB
	Port 20	≥14 dB	_____	±0.6 dB
	Port 21	≥14 dB	_____	±0.6 dB
	Port 22	≥14 dB	_____	±0.6 dB
	Port 23	≥14 dB	_____	±0.6 dB
	Port 24	≥14 dB	_____	±0.6 dB

Table 12 Return Loss Test Record

Transmission/Reflection		Date _____		
Test Description	Port	Minimum Specifications	Measured Results	Measured Uncertainty
Return Loss Band 4 6.0 GHz to 12.4 GHz	Port 1	≥12 dB	_____	±0.5 dB
	Port 2	≥12 dB	_____	±0.5 dB
	Port 3	≥12 dB	_____	±0.5 dB
	Port 4	≥12 dB	_____	±0.5 dB
	Port 5	≥12 dB	_____	±0.5 dB
	Port 6	≥12 dB	_____	±0.5 dB
	Port 7	≥12 dB	_____	±0.5 dB
	Port 8	≥12 dB	_____	±0.5 dB
	Port 9	≥12 dB	_____	±0.5 dB
	Port 10	≥12 dB	_____	±0.5 dB
	Port 11	≥12 dB	_____	±0.5 dB
	Port 12	≥12 dB	_____	±0.5 dB
	Port 13	≥12 dB	_____	±0.5 dB
	Port 14	≥12 dB	_____	±0.5 dB
	Port 15	≥12 dB	_____	±0.5 dB
	Port 16	≥12 dB	_____	±0.5 dB
	Port 17	≥12 dB	_____	±0.5 dB
	Port 18	≥12 dB	_____	±0.5 dB
	Port 19	≥12 dB	_____	±0.5 dB
	Port 20	≥12 dB	_____	±0.5 dB
	Port 21	≥12 dB	_____	±0.5 dB
	Port 22	≥12 dB	_____	±0.5 dB
	Port 23	≥12 dB	_____	±0.5 dB
	Port 24	≥12 dB	_____	±0.5 dB

Table 13 Return Loss Record

Transmission/Reflection			Date _____	
Test Description	Port	Minimum Specifications	Measured Results	Measured Uncertainty
Return Loss Band 5 12.4 GHz to 20 GHz	Port 1	≥8 dB	_____	±0.5 dB
	Port 2	≥8 dB	_____	±0.5 dB
	Port 3	≥8 dB	_____	±0.5 dB
	Port 4	≥8 dB	_____	±0.5 dB
	Port 5	≥8 dB	_____	±0.5 dB
	Port 6	≥8 dB	_____	±0.5 dB
	Port 7	≥8 dB	_____	±0.5 dB
	Port 8	≥8 dB	_____	±0.5 dB
	Port 9	≥8 dB	_____	±0.5 dB
	Port 10	≥8 dB	_____	±0.5 dB
	Port 11	≥8 dB	_____	±0.5 dB
	Port 12	≥8 dB	_____	±0.5 dB
	Port 13	≥8 dB	_____	±0.5 dB
	Port 14	≥8 dB	_____	±0.5 dB
	Port 15	≥8 dB	_____	±0.5 dB
	Port 16	≥8 dB	_____	±0.5 dB
	Port 17	≥8 dB	_____	±0.5 dB
	Port 18	≥8 dB	_____	±0.5 dB
	Port 19	≥8 dB	_____	±0.5 dB
	Port 20	≥8 dB	_____	±0.5 dB
	Port 21	≥8 dB	_____	±0.5 dB
	Port 22	≥8 dB	_____	±0.5 dB
	Port 23	≥8 dB	_____	±0.5 dB
	Port 24	≥8 dB	_____	±0.5 dB

Table 14 Isolation Test Record

Transmission/Reflection			Date _____	
Test Description	Port	Minimum Specifications	Measured Results	Measured Uncertainty
Isolation Band 1 0.5 GHz to 1.3 GHz	Port 1	≥85 dB	_____	±5 dB
	Port 2	≥85 dB	_____	±5 dB
	Port 3	≥85 dB	_____	±5 dB
	Port 4	≥85 dB	_____	±5 dB
	Port 5	≥85 dB	_____	±5 dB
	Port 6	≥85 dB	_____	±5 dB
	Port 7	≥85 dB	_____	±5 dB
	Port 8	≥85 dB	_____	±5 dB
	Port 9	≥85 dB	_____	±5 dB
	Port 10	≥85 dB	_____	±5 dB
	Port 11	≥85 dB	_____	±5 dB
	Port 12	≥85 dB	_____	±5 dB
	Port 13	≥85 dB	_____	±5 dB
	Port 14	≥85 dB	_____	±5 dB
	Port 15	≥85 dB	_____	±5 dB
	Port 16	≥85 dB	_____	±5 dB
	Port 17	≥85 dB	_____	±5 dB
	Port 18	≥85 dB	_____	±5 dB
	Port 19	≥85 dB	_____	±5 dB
	Port 20	≥85 dB	_____	±5 dB
	Port 21	≥85 dB	_____	±5 dB
	Port 22	≥85 dB	_____	±5 dB
	Port 23	≥85 dB	_____	±5 dB
	Port 24	≥85 dB	_____	±5 dB

Table 15 Agilent 87050A Option K24 Isolation Test Record

Transmission/Reflection			Date _____	
Test Description	Port	Minimum Specifications	Measured Results	Measured Uncertainty
Isolation Band 2 1.3 GHz to 3.0 GHz	Port 1	≥100 dB	_____	±5 dB
	Port 2	≥100 dB	_____	±5 dB
	Port 3	≥100 dB	_____	±5 dB
	Port 4	≥100 dB	_____	±5 dB
	Port 5	≥100 dB	_____	±5 dB
	Port 6	≥100 dB	_____	±5 dB
	Port 7	≥100 dB	_____	±5 dB
	Port 8	≥100 dB	_____	±5 dB
	Port 9	≥100 dB	_____	±5 dB
	Port 10	≥100 dB	_____	±5 dB
	Port 11	≥100 dB	_____	±5 dB
	Port 12	≥100 dB	_____	±5 dB
	Port 13	≥100 dB	_____	±5 dB
	Port 14	≥100 dB	_____	±5 dB
	Port 15	≥100 dB	_____	±5 dB
	Port 16	≥100 dB	_____	±5 dB
	Port 17	≥100 dB	_____	±5 dB
	Port 18	≥100 dB	_____	±5 dB
	Port 19	≥100 dB	_____	±5 dB
	Port 20	≥100 dB	_____	±5 dB
	Port 21	≥100 dB	_____	±5 dB
	Port 22	≥100 dB	_____	±5 dB
	Port 23	≥100 dB	_____	±5 dB
	Port 24	≥100 dB	_____	±5 dB

Table 16 Isolation Test Record

Transmission/Reflection			Date _____	
Test Description	Port	Minimum Specifications	Measured Results	Measured Uncertainty
Isolation Band 3 3.0 GHz to 6.0 GHz	Port 1	≥95 dB	_____	±5 dB
	Port 2	≥95 dB	_____	±5 dB
	Port 3	≥95 dB	_____	±5 dB
	Port 4	≥95 dB	_____	±5 dB
	Port 5	≥95 dB	_____	±5 dB
	Port 6	≥95 dB	_____	±5 dB
	Port 7	≥95 dB	_____	±5 dB
	Port 8	≥95 dB	_____	±5 dB
	Port 9	≥95 dB	_____	±5 dB
	Port 10	≥95 dB	_____	±5 dB
	Port 11	≥95 dB	_____	±5 dB
	Port 12	≥95 dB	_____	±5 dB
	Port 1	≥95 dB	_____	±5 dB
	Port 2	≥95 dB	_____	±5 dB
	Port 3	≥95 dB	_____	±5 dB
	Port 4	≥95 dB	_____	±5 dB
	Port 5	≥95 dB	_____	±5 dB
	Port 6	≥95 dB	_____	±5 dB
	Port 7	≥95 dB	_____	±5 dB
	Port 8	≥95 dB	_____	±5 dB
	Port 9	≥95 dB	_____	±5 dB
	Port 10	≥95 dB	_____	±5 dB
	Port 11	≥95 dB	_____	±5 dB
	Port 12	≥95 dB	_____	±5 dB

Table 17 Isolation Test Record

Transmission/Reflection			Date _____	
Test Description	Port	Minimum Specifications	Measured Results	Measured Uncertainty
Isolation Band 4 6.0 GHz to 20.0 GHz	Port 1	≥90 dB	_____	±7 dB
	Port 2	≥90 dB	_____	±7 dB
	Port 3	≥90 dB	_____	±7 dB
	Port 4	≥90 dB	_____	±7 dB
	Port 5	≥90 dB	_____	±7 dB
	Port 6	≥90 dB	_____	±7 dB
	Port 7	≥90 dB	_____	±7 dB
	Port 8	≥90 dB	_____	±7 dB
	Port 9	≥90 dB	_____	±7 dB
	Port 10	≥90 dB	_____	±7 dB
	Port 11	≥90 dB	_____	±7 dB
	Port 12	≥90 dB	_____	±7 dB
	Port 13	≥90 dB	_____	±7 dB
	Port 14	≥90 dB	_____	±7 dB
	Port 15	≥90 dB	_____	±7 dB
	Port 16	≥90 dB	_____	±7 dB
	Port 17	≥90 dB	_____	±7 dB
	Port 18	≥90 dB	_____	±7 dB
	Port 19	≥90 dB	_____	±7 dB
	Port 20	≥90 dB	_____	±7 dB
	Port 21	≥90 dB	_____	±7 dB
	Port 22	≥90 dB	_____	±7 dB
	Port 23	≥90 dB	_____	±7 dB
	Port 24	≥90 dB	_____	±7 dB

Assembly Replacement and Post-Repair Procedures

The following table contains the list of replaceable parts for the Agilent 87050A Option K24 test set. If any of these parts or assemblies is replaced, you must run all performance tests to verify conformance to specifications.

NOTE Special options are built to order, therefore long lead times may be encountered when ordering replacement parts. Refer to [“Contacting Agilent” on page 57](#).

Table 18 Agilent 87050A Option K24 Replaceable Parts

Replacement Part	Part Number	Quantity
Power Supply	0950-2252	1
Rear Panel	08720-00102	1
Switch Bracket	08720-00103	4
RF Cable (Option K24 to 8720D)	08720-20245	2
Wire Harness, Multiport-short	08720-60191	1
Display Subassembly	08720-60193	1
Switch Support (12sw)	87050-00020	1
Deck	87050-00021	1
RF Cable-Refl	87050-20070	1
RF Cable-Trans	87050-20071	1
RF Cable-Port 1/6	87050-20072	1
RF Cable-Port 6/12	87050-20073	1
RF Cable-Port 13/18	87050-20074	1
RF Cable-Port 19/24	87050-20075	1
RF Cable-Sw A1-1	87050-20076	1
RF Cable-Sw A2-1	87050-20077	1
RF Cable- Sw A3-1	87050-20078	1
RF Cable- Sw A7-1	87050-20079	1
RF Cable- Sw A8-1	87050-20080	1
RF Cable- Sw A9-1	87050-20081	1
RF Cable- Sw A13-1	87050-20082	1
RF Cable- Sw A14-1	87050-20083	1

Table 18 Agilent 87050A Option K24 Replaceable Parts

Replacement Part	Part Number	Quantity
RF Cable- Sw A15-1	87050-20084	1
RF Cable- Sw A19-1	87050-20085	1
RF Cable- Sw A20-1	87050-20086	1
RF Cable- Sw A21-1	87050-20087	1
RF Cable- Sw A1-2	87050-20088	1
RF Cable- Sw A2-2	87050-20089	1
RF Cable- Sw A3-2	87050-20090	1
RF Cable- Sw A7-2	87050-20091	1
RF Cable- Sw A8-2	87050-20092	1
RF Cable- Sw A9-2	87050-20093	1
RF Cable- Sw A13-2	87050-20094	1
RF Cable- Sw A14-2	87050-20095	1
RF Cable- Sw A15-2	87050-20096	1
RF Cable- Sw A19-2	87050-20097	1
RF Cable- Sw A20-2	87050-20098	1
RF Cable- Sw A21-2	87050-20099	1
RF Cable-Sw B1-C	87050-20100	1
RF Cable- Sw B2-C	87050-20101	1
RF Cable- Sw B3-C	87050-20102	1
RF Cable- Sw B4-C	87050-20103	1
RF Cable- Sw C1-C	87050-20104	1
RF Cable- Sw C2-C	87050-20105	1
RF Cable- Sw C3-C	87050-20106	1
RF Cable- Sw C4-C	87050-20107	1
Wire Harness, Multiport-long	87050-60070	1
Controller Mother Board	87050-60149	1
Front Panel Subassembly	87050-60153	1
User's and Service Guide	87050-90022	1

Connector Replacement

The 50 Ω , 3.5 mm connectors are available separately as (5062-6618). It is possible to replace them in the field. An alternative to replacing a damaged connector would be to replace just the center pin components. The components for the assembly are:

Component	Part Number
3.5 mm Connector, RF (complete)	5062-6618
3.5 mm Pin and Bead Assembly (only)	5061-5394

When replacing just the pin and bead, a liquid thread-locking adhesive such as part number 0470-1590 will be needed. Re-use any shims and spacers from the connector being replaced. For best results, use a connector gauge to verify pin depth. See [Figure 4 on page 10](#) for proper pin-depth. Add or subtract spacers as required. Spacers and shims are also available from Agilent Technologies.

WARNING **The opening of covers or removal of parts is likely to expose the user to dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened.**

Troubleshooting and Block Diagram

This section contains information on troubleshooting the test set to the assembly level only. By following these procedures you should be able to determine whether the power supply, front panel, or main switch board needs replacing. Refer to [Figure 13, “Agilent 87050A Option K24 Block Diagram,”](#) as an aid in troubleshooting.

Theory of operation information can be found [Page 28](#) of this manual.

General Troubleshooting Notes

WARNING **The opening of covers or removal of parts is likely to expose the user to dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened.**

CAUTION If you need to disassemble the instrument, be sure to work at an antistatic workstation and use a grounded wrist strap to prevent damage from electrostatic discharge (ESD). See [“Electrostatic Discharge Protection” on page 56.](#)

Troubleshooting Power Supply Problems

Turn the instrument on. Verify the condition of the LCD on the front panel:

- Step 1.** If the LCD is off, inspect the main fuse located in the power supply filter at the rear of the instrument and replace if necessary.
- Step 2.** If the LCD is still off, there is still a possibility that the power supply is not supplying the necessary +24V, +12V, and +5V to the main board.
- Step 3.** If the LCD is still off, check the cable between the main board and front panel board.
- Step 4.** Finally, disconnect the DC power cable from the power supply to the main switch board and measure the voltages. They should be +24V, +12V, and +5V. If not, replace the power supply.

Troubleshooting the Front Panel Board

Turn the instrument power on and confirm the following:

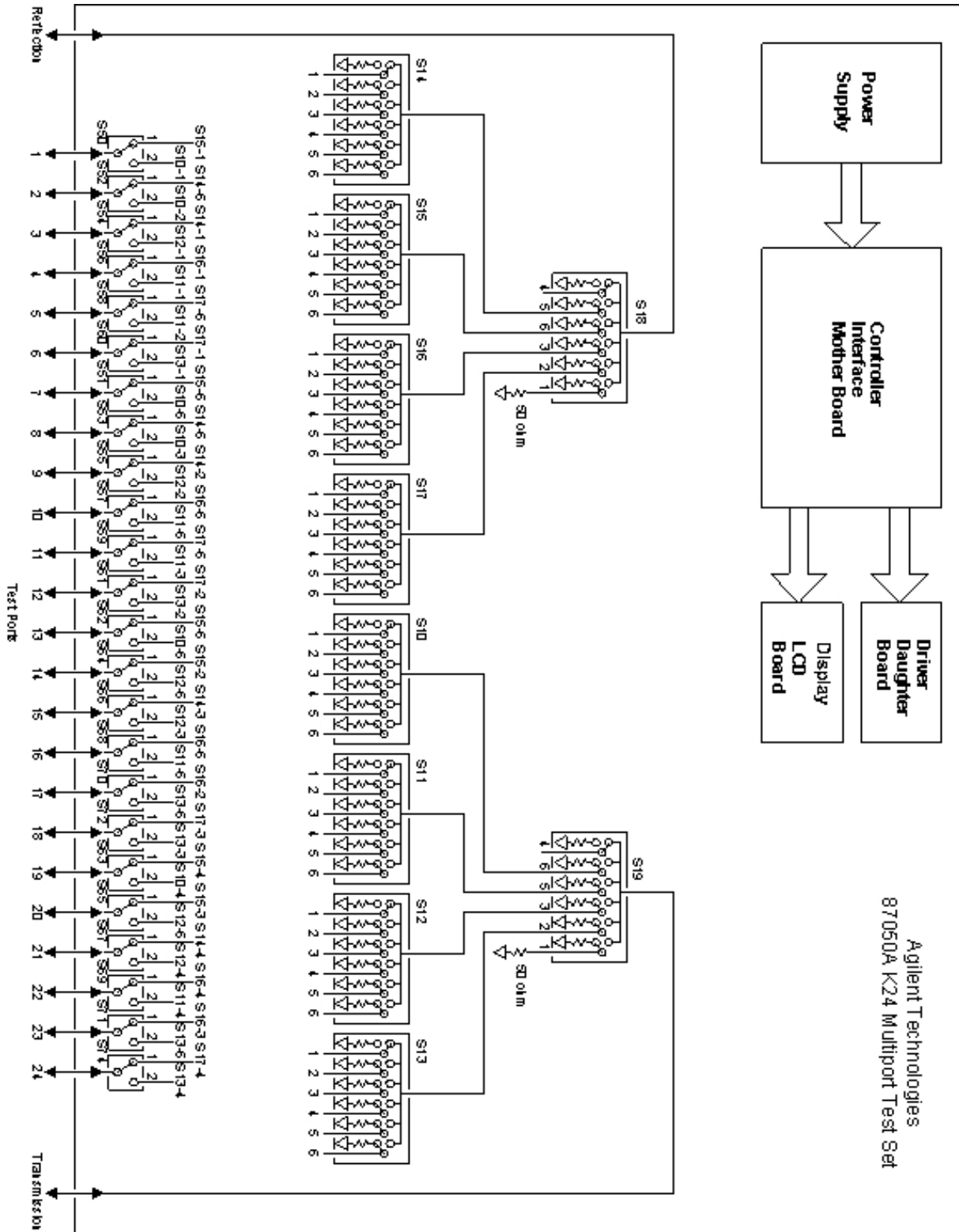
- Step 1.** Verify the condition of each of the switching paths by issuing commands to switch each of the paths to either the transmission or reflection path. Ensure that the LCD indicates the appropriate path.
- Step 2.** If the LCD indicates a wrong path, the problem can lie either with the front panel board or with the main switch board. Measure the RF path to determine where the problem is.
- Step 3.** If the LCD does not display the proper path, confirm if the RF path has indeed been switched. If the problem lies with the front panel board, replace it

Troubleshooting the Controller and Switch Driver Boards

Turn the instrument power on.

- Step 1.** Confirm the condition of each of the switching paths by issuing commands to switch each of the paths to either the Transmission or Reflection path.
- Step 2.** Verify each of the RF paths for connection.
- Step 3.** If an RF path is not connected to the necessary port or terminated in 50 Ω , replace the controller and switch driver board.

Figure 13 Agilent 87050A Option K24 Block Diagram



Safety and Regulatory Information

Introduction

Review this product and related documentation to familiarize yourself with safety markings and instructions before you operate the instrument. The documentation contains information and warnings that must be followed by the user to ensure safe operation and to maintain the product in a safe condition.

Before Applying Power

Verify that the premises electrical supply is within the range of the instrument. The instrument has an autoranging power supply.

WARNING To prevent electrical shock, disconnect the **Agilent Technologies 87050A Option K24** from mains electrical supply before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.

Connector Care and Cleaning

If alcohol is used to clean the connectors, the power cord to the instrument must be removed. All cleaning should take place in a well ventilated area. Allow adequate time for the fumes to disperse and moist alcohol to evaporate prior to energizing the instrument.

WARNING Keep isopropyl alcohol away from heat, sparks, and flame. Store in a tightly closed container. It is extremely flammable. In case of fire, use alcohol foam, dry chemical, or carbon dioxide; water may be ineffective.

Declaration of Conformity

A copy of the Declaration of Conformity is available upon request, or a copy is available on the Agilent Technologies web site at <http://regulations.corporate.agilent.com/DoC/search.htm>

Statement of Compliance

This instrument has been designed and tested in accordance with CAN/CSA 22.2 No. 61010-1-04, UL Std No. 61010-1 (Second Edition), and IEC 61010-1 (Second Edition).

General Safety Considerations

Cautions

Cautions applicable to this instrument.

CAUTION The Mains wiring and connectors shall be compatible with the connector used in the premise electrical system. Failure, to ensure adequate earth grounding by not using the correct components may cause product damage, and serious injury.

CAUTION Always use the three prong AC power cord supplied with this product. Failure to ensure adequate earth grounding by not using this cord may cause product damage and the risk of electrical shock.

CAUTION This product is designed for use in Installation Category II and Pollution Degree 2.

CAUTION Verify that the premise electrical voltage supply is within the range specified on the instrument.

CAUTION Ventilation Requirements: When installing the instrument in a cabinet, the convection into and out of the instrument must not be restricted. The ambient temperature (outside the cabinet) must be less than the maximum operating temperature of the instrument by 4 °C for every 100 watts dissipated in the cabinet. If the total power dissipated in the cabinet is greater than 800 watts, forced convection must be used.

Warnings

Warnings applicable to this instrument.

-
- | | |
|----------------|--|
| WARNING | Danger of explosion if battery is incorrectly replaced. Replace only with the same or equivalent type recommended. Discard used batteries according to manufacturer's instructions. |
|----------------|--|
-
- | | |
|----------------|--|
| WARNING | This is a Safety Class I product (provided with a protective earthing ground incorporated in the power cord). The mains plug shall be inserted only into a socket outlet provided with a protective earth contact. Any interruption of the protective conductor, inside or outside the product is likely to make the product dangerous. Intentional interruption is prohibited. |
|----------------|--|
-
- | | |
|----------------|---|
| WARNING | For continued protection against fire hazard replace line fuse only with same type and rating. The use of other fuses or material is prohibited. |
|----------------|---|
-
- | | |
|----------------|---|
| WARNING | These servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing unless you are qualified to do so. |
|----------------|---|
-
- | | |
|----------------|---|
| WARNING | The opening of covers or removal of parts is likely to expose the user to dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened. |
|----------------|---|
-
- | | |
|----------------|---|
| WARNING | This product is designed for use in Installation Category II and Pollution Degree 2. |
|----------------|---|
-
- | | |
|----------------|--|
| WARNING | No operator serviceable parts inside. Refer servicing to qualified personnel. |
|----------------|--|
-
- | | |
|----------------|---|
| WARNING | If this product is not used as specified, the protection provided by the equipment could be impaired. This product must be used in a normal condition (in which all means for protection are intact) only. |
|----------------|---|
-

Regulatory Information

This section contains information that is required by various government regulatory agencies.

Instrument Markings



The instruction documentation symbol. The product is marked with this symbol when it is necessary for the user to refer to the instructions in the documentation.



This symbol indicates that the instrument requires alternating current (ac) input.



This symbol indicates separate collection for electrical and electronic equipment, mandated under EU law as of August 13, 2005. All electric and electronic equipment are required to be separated from normal waste for disposal (Reference WEEE Directive, 2002/96/EC).



This symbol indicates that the power line switch is ON.



This symbol indicates that the power line switch is in the STANDBY position.



This symbol indicates that the power line switch is in the OFF position.



This symbol is used to identify a terminal which is internally connected to the product frame or chassis.



The CE mark is a registered trademark of the European Community. (If accompanied by a year, it is when the design was proven.)



The CSA mark is a registered trademark of the CSA International. This instrument complies with Canada: CSA 22.2 No. 61010-1-04.



This is a symbol of an Industrial Scientific and Medical Group 1 Class A product.



This is a marking to indicate product compliance with the Canadian Interference-Causing Equipment Standard (ICES-001).



Direct Current.



The instrument has been designed to meet the requirements of IP 2 0 for ingress and operational environment.



This is a required mark signifying compliance with an EMC requirement. The C-Tick mark is a registered trademark of the Australian Spectrum Management Agency.



China RoHS regulations include requirements related to packaging, and require compliance to China standard GB18455-2001.



This symbol indicates compliance with the China RoHS regulations for paper/fiberboard packaging.

Battery Collection

Do not throw batteries away but collect as small chemical waste, or in accordance with your country's requirements. You may return the battery to Agilent Technologies for disposal. Refer to “[Contacting Agilent](#)” on page 57 for assistance.

Compliance with German Noise Requirements

This is to declare that this instrument is in conformance with the German Regulation on Noise Declaration for Machines (Laermangabe nach der Maschinenlaermrerordnung-3. GSGV Deutschland).

Acoustic Noise Emission/Geraeuschemission	
LpA<70 dB	Lpa<70 dB
Operator Position	am Arbeitsplatz
Normal Operation	normaler Betrieb
per ISO 7779	nach DIN 45635 t. 19

EMC Information

Complies with European EMC Directive 2004/108/EC

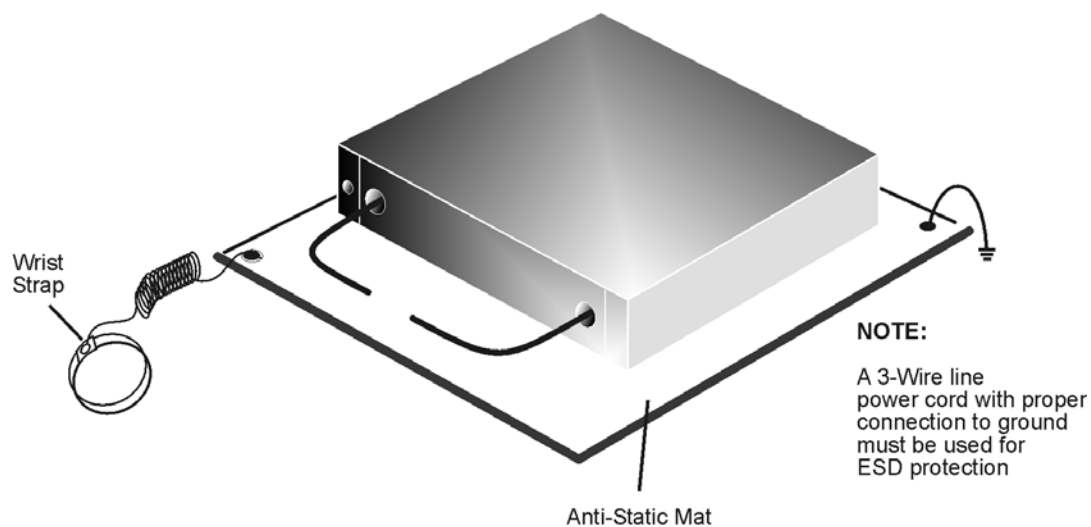
- IEC/EN 61326-1
- CISPR Pub 11 Group 1, class A
- AS/NZS CISPR 11
- This ISM device complies with Canadian ICES-001.
Cet appareil ISM est conforme a la norme NMB du Canada.

Electrostatic Discharge Protection

Protection against electrostatic discharge (ESD) is essential while removing assemblies from or connecting cables to the network analyzer. Static electricity can build up on your body and can easily damage sensitive internal circuit elements when discharged. Static discharges too small to be felt can cause permanent damage. To prevent damage to the instrument:

- *always* have a grounded, conductive table mat (9300-0797) in front of your test equipment.
- *always* wear a grounded wrist strap (9300-1367) with grounding cord (9300-0980), connected to a grounded conductive table mat, having a 1 M Ω resistor in series with it, when handling components and assemblies or when making connections.
- *always* wear a heel strap (9300-1126) when working in an area with a conductive floor. If you are uncertain about the conductivity of your floor, wear a heel strap.
- *always* ground yourself before you clean, inspect, or make a connection to a static-sensitive device or test port. You can, for example, grasp the grounded outer shell of the test port or cable connector briefly.
- *always* ground the center conductor of a test cable before making a connection to the analyzer test port or other static-sensitive device. This can be done as follows:
 1. Connect a short (from your calibration kit) to one end of the cable to short the center conductor to the outer conductor.
 2. While wearing a grounded wrist strap, grasp the outer shell of the cable connector.
 3. Connect the other end of the cable to the test port and remove the short from the cable.

Figure 19 ESD Protection Setup



ku310b

Agilent Support, Services, and Assistance

Service and Support Options

The analyzer's standard warranty is a one-year return to Agilent Technologies service warranty.

NOTE There are many other repair and calibration options available from the Agilent Technologies support organization. These options cover a range of service agreements with varying response times. Contact Agilent for additional information on available service agreements for this product.

Contacting Agilent

Assistance with test and measurements needs and information or finding a local Agilent office are available on the Web at:

<http://www.agilent.com/find/assist>

You can also purchase accessories or documentation items on the Internet at:

<http://www.agilent.com/find>

If you do not have access to the Internet, contact your field engineer.

NOTE In any correspondence or telephone conversation, refer to the Agilent product by its model number and full serial number. With this information, the Agilent representative can determine the warranty status of your unit.

Shipping Your Analyzer to Agilent for Service or Repair

IMPORTANT Agilent Technologies reserves the right to reformat or replace the internal hard disk drive in your analyzer as part of its repair. This will erase all user information stored on the hard disk. It is imperative, therefore, that you make a backup copy of your critical test data located on the analyzer's hard disk before shipping it to Agilent for repair.

If you wish to send your instrument to Agilent Technologies for service or repair:

- Include a complete description of the service requested or of the failure and a description of any failed test and any error message.
- Ship the analyzer using the original or comparable antistatic packaging materials.
- Contact Agilent for instructions on where to ship your analyzer.

