



Model 7709

User's Guide

PA-771 Rev. B / 8-03

A GREATER MEASURE OF CONFIDENCE

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The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information carefully before using the product. Refer to the manual for complete product specifications.

If the product is used in a manner not specified, the protection provided by the product may be impaired.

The types of product users are:

Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

Maintenance personnel perform routine procedures on the product to keep it operating properly, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the manual. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

Service personnel are trained to work on live circuits, and perform safe installations and repairs of products. Only properly trained service personnel may perform installation and service procedures.

Keithley products are designed for use with electrical signals that are rated Measurement Category I and Measurement Category II, as described in the International Electrotechnical Commission (IEC) Standard IEC 60664. Most measurement, control, and data I/O signals are Measurement Category I and must not be directly connected to mains voltage or to voltage sources with high transient over-voltages. Measurement Category II connections require protection for high transient over-voltages often associated with local AC mains connections. Assume all measurement, control, and data I/O connections are for connection to Category I sources unless otherwise marked or described in the Manual.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. **A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.**

Operators of this product must be protected from electric shock at all times. The responsible body must ensure that operators are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product operators in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 volts, **no conductive part of the circuit may be exposed.**

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

When installing equipment where access to the main power cord is restricted, such as rack mounting, a separate main input power disconnect device must be provided, in close proximity to the equipment and within easy reach of the operator.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

The instrument and accessories must be used in accordance with its specifications and operating instructions or the safety of the equipment may be impaired.

Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.

When fuses are used in a product, replace with same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

If a  screw is present, connect it to safety earth ground using the wire recommended in the user documentation.

The  symbol on an instrument indicates that the user should refer to the operating instructions located in the manual.

The  symbol on an instrument shows that it can source or measure 1000 volts or more, including the combined effect of normal and common mode voltages. Use standard safety precautions to avoid personal contact with these voltages.

The  symbol indicates a connection terminal to the equipment frame.

The **WARNING** heading in a manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in a manual explains hazards that could damage the instrument. Such damage may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits, including the power transformer, test leads, and input jacks, must be purchased from Keithley Instruments. Standard fuses, with applicable national safety approvals, may be used if the rating and type are the same. Other components that are not safety related may be purchased from other suppliers as long as they are equivalent to the original component. (Note that selected parts should be purchased only through Keithley Instruments to maintain accuracy and functionality of the product.) If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

To clean an instrument, use a damp cloth or mild, water based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument. Products that consist of a circuit board with no case or chassis (e.g., data acquisition board for installation into a computer) should never require cleaning if handled according to instructions. If the board becomes contaminated and operation is affected, the board should be returned to the factory for proper cleaning/servicing.

The information in this section is organized as follows:

- Card configuration – schematic on page 2.
 - Rows 1 and 2 on page 4.
 - Rows 3 through 6 on page 5.
- Matrix expansion on page 6.
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Introduction

The Model 7709 is a 2-pole, 6×8 matrix card with the following features:

- Two rows (1 and 2) connected to the backplane of the Model 27xx for 2-wire or 4-wire Ω measurements (automatically pairs switches for four wire measurements).
- 50-pin female D-shell connector (DB-50) for matrix rows and columns.
- 25-pin female D-shell connector (DB-25) for matrix expansion. Used to “daisy-chain” matrix rows to the rows of a second Model 7709.
- Temperature applications (RTD or thermistor).

NOTE The 7709 module can be used with Keithley Models 2700, 2701, and 2750. All references to the Model 27xx apply to the Models 2700, 2701, and 2750.

WARNING Before operating the Model 27xx with an accessory card, verify that the card is properly installed and the mounting screws are tightly fastened. If the mounting screws are not properly connected, an electrical shock hazard may be present.

Card configuration – schematic

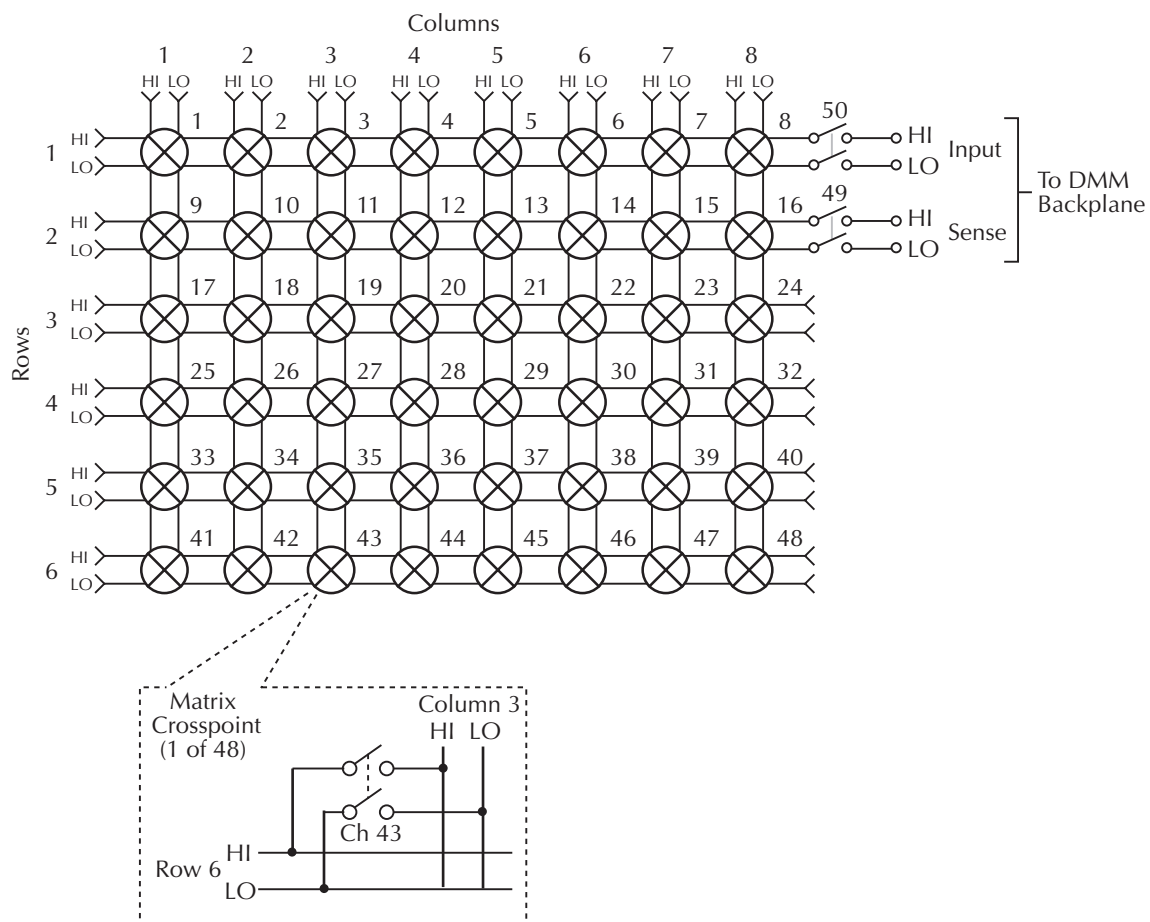
Figure 1 shows a simplified diagram of the Model 7709 matrix module. The matrix consists of 48 crosspoints. Each crosspoint channel is a 2-pole switch that, when closed, connects a row to a column. As shown in Figure 1, closing channel 43 connects Row 6 to Column 3.

Two switches (channels 49 and 50) are used to connect Rows 1 and 2 to the backplane of the Model 27xx multimeter. When channel 50 is closed, Row 1 is connected to the INPUT of the DMM. When channel 49 is closed, Row 2 is connected to SENSE of the DMM.

Devices under test (DUT) are to be connected to the matrix columns. Using 2-wire connections, up to eight DUT can be tested. For 4-wire connections, up to four DUT can be tested. Rows 3 through 6 can be used to add one or more external sources to the test system.

Although the Model 7709 relays are the latching type (relays hold their state even after power has been removed), all relay states are set to open a few seconds after either a power cycle or an *RST command is issued.

Figure 1
Simplified schematic for Model 7709



Rows 1 and 2

System channel operation (ROUT : CLOS command) is used to close Rows 1 and 2 channels to connect a DUT to the DMM. With a 2-wire function selected (i.e., DCV), system channels 1 through 8 can be closed. When one of these channels is closed, channel 50 automatically closes to connect Row 1 to the DMM Input. [Figure 2](#) shows a DUT connected to column 3 of the matrix. Closing system channel 3 connects the DUT to the DMM.

With a 4-wire function selected (i.e., $\Omega 4$), system channels 1 through 4 can be closed. These four channels are paired to channels 13 through 16 (channel 1 paired to channel 13, channel 2 paired to channel 14, and so on). When one of these system channels is closed, its paired channel, and channels 49 and 50 also close to connect the DUT to the DMM. As shown in [Figure 3](#), closing system channel 3 also closes channels 15, 49, and 50 to connect the DUT to the DMM.

Figure 2
2-wire DUT measurements using Model 27xx DMM

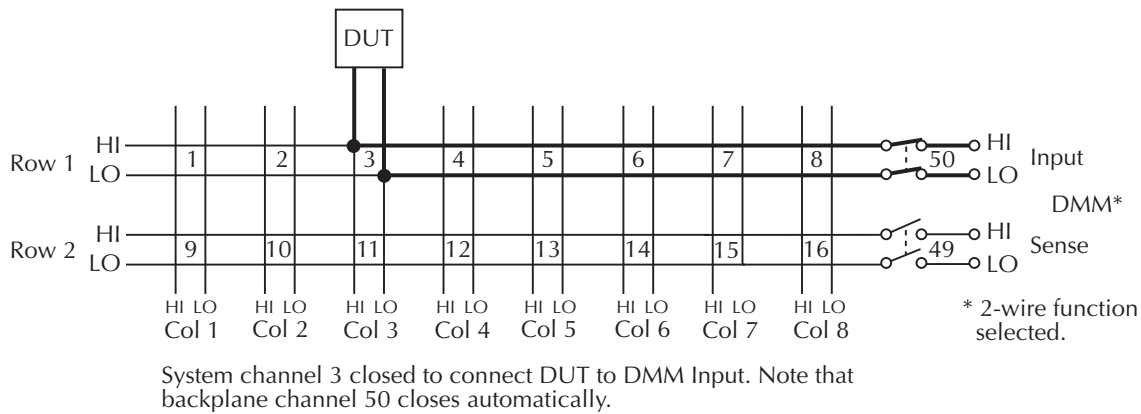
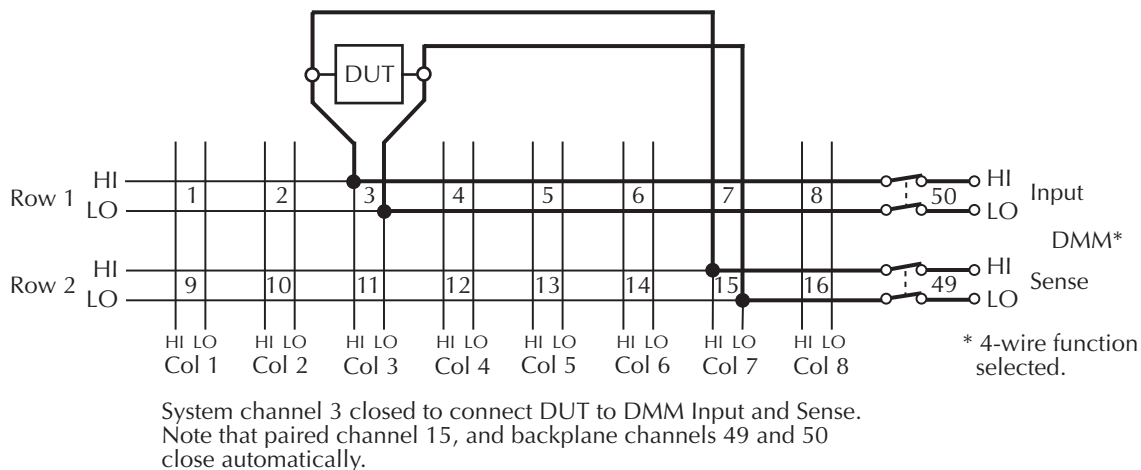


Figure 3
4-wire DUT measurements using Model 27xx DMM



Rows 3 through 6

As shown in Figure 1, channels 17 through 48 are the channels for Rows 3 through 6. These channels can only be closed using multiple channel operation (ROUT :MULT :CLOS command). For system channel operation, these channels are invalid (cannot be closed).

WARNING Multiple channel operation should only be performed by experienced test engineers who recognize the dangers associated with multiple channel closures.

CAUTION When closing multiple channels, it is possible to connect incompatible test equipment and/or DUTs causing high currents to flow. This can cause serious damage to test equipment and DUTs.

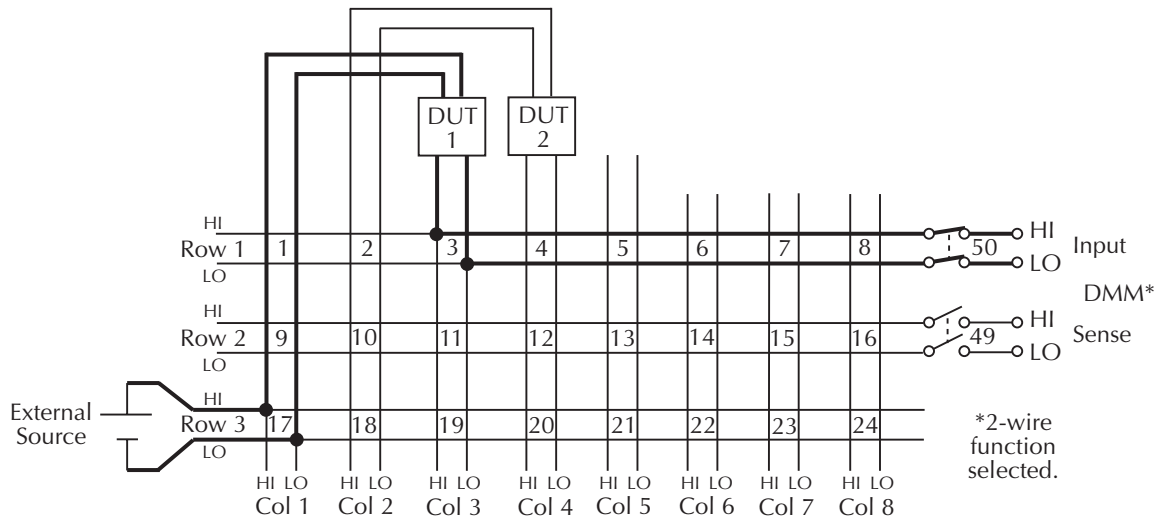
Rows 3 through 6 are used to connect one or more external sources to the test system. An external source is typically used to power DUT. To prevent overloading of the external source, each DUT can be powered separately. An example of this is shown in Figure 4. The external source is connected to Row 3 and the power cables for the two DUTs are connected to Columns 1 and 2.

As shown in Figure 4, DUT 1 is tested by closing system channel 3 and multiple channel 17. To test DUT 2, the following sequence would be used:

1. Open multiple channel 17 to remove power from DUT 1.
2. Close multiple channel 18 to apply power to DUT 2.
3. Close system channel 4 to connect DUT 2 to the DMM (channel 3 opens automatically).

Figure 4

Adding an external source to the test system



Multiple channel 17 closed to power DUT 1.
System channel 3 closed to connect DUT 1 to DMM Input.

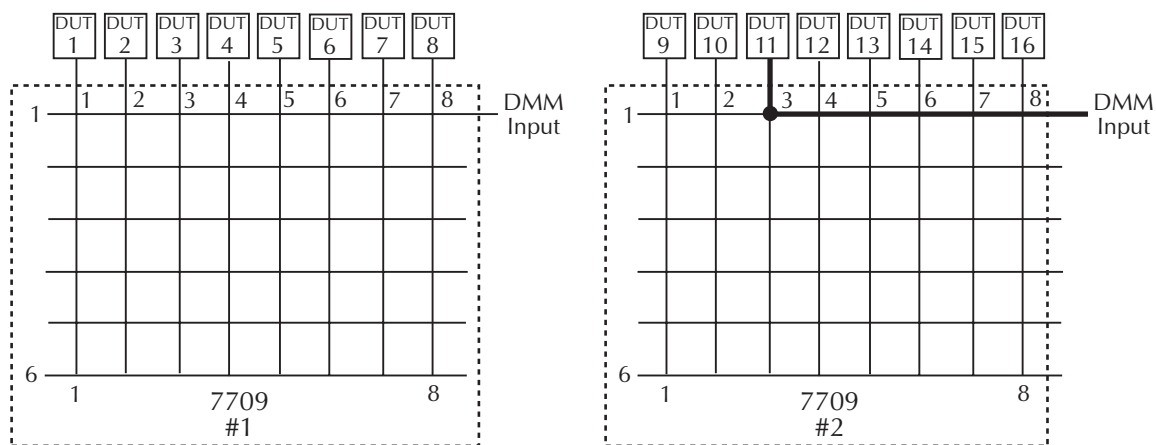
Matrix expansion

Basic matrix column expansion

The number of columns in a matrix test system can be increased by simply installing another Model 7709 in the mainframe. For the Model 2700/2701 mainframe, adding a second Model 7709 increases the total number of columns to 16. For the Model 2750, five installed Model 7709s provide 40 columns for DUT.

Figure 5 shows a two matrix module system to test 16 DUT. It is similar to the one in Figure 2 except that the second card allows eight more DUT to be tested. As shown, system channel 3 of the second module is closed to connect DUT 11 to the DMM Input.

Figure 5
Two matrix module test system



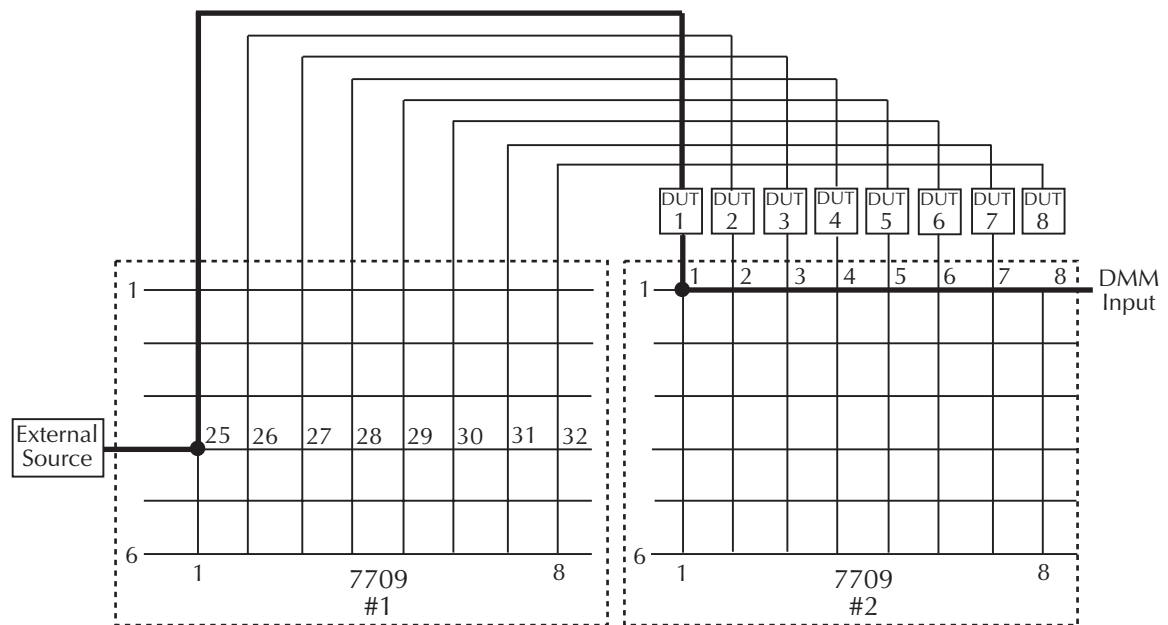
System channel 3 of module #2 closed to connect DUT 11 to DMM Input.

Note: Each signal path shown in this illustration is actually a two conductor path pair (HI and LO).

Figure 6 shows a two matrix module system that uses an external source. It is similar to the one in Figure 4 except that it allows more DUT to be tested. The first matrix module is used to route the external source to the DUT, while the second module is used to measure the DUT.

As shown in Figure 6, DUT 1 is tested by closing multiple channel 25 and system channel 1 of the two respective modules. The other DUT is tested in a similar manner. DUT 2 is tested with channels 26 and 2 closed, DUT 3 is tested with channels 27 and 3 closed, and so on.

Figure 6
Two matrix module test system using an external source



Multiple channel 25 of module #1 closed to power DUT 1.
 System channel 1 of module #2 closed to connect DUT 1 to DMM Input.

Note: Each signal path shown in this illustration is actually a two conductor path pair (HI and LO).

Daisy-chaining matrix rows

In order to route one or more external sources to other matrix modules, the rows of the modules must be daisy-chained. External cabling is used to connect the rows of the matrix modules together.

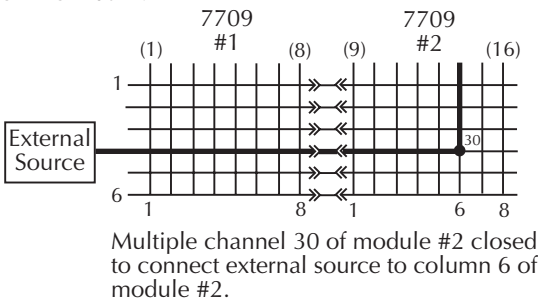
Figure 7 shows examples of row daisy-chained matrix systems. For the 6×16 matrix, daisy-chaining the two matrix modules allows the external source to be routed to the second module. For the 6×40 matrix, daisy-chaining the five matrix modules allows the external source to be routed to any of the 40 columns in the system.

NOTE Techniques to daisy-chain rows are explained in “Connections and wiring.”

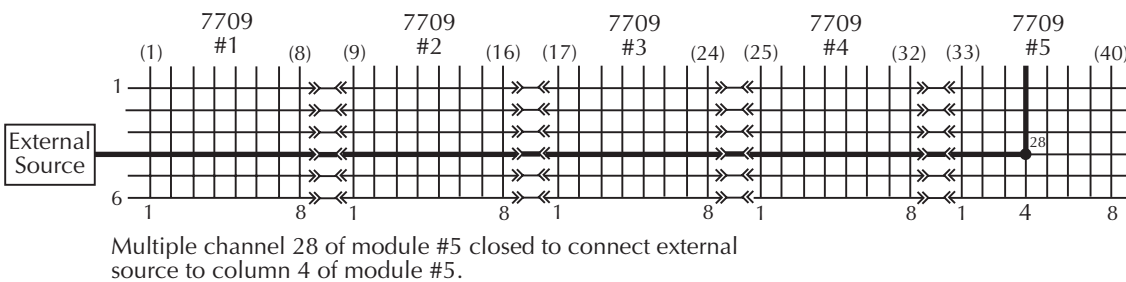
Figure 7

Daisy-chained matrix modules

6×16 Matrix:



6×40 Matrix (Model 2750):



Notes:

The matrices in this illustration are simplified to show external source connections to other matrix modules. Connections to the DMM are not shown.

Each signal path shown in this illustration is actually a two conductor path pair (HI and LO).

Connections and wiring

WARNING The following information is intended for qualified service personnel. Do not make matrix module connections unless qualified to do so.

To prevent electric shock that could result in serious injury or death, adhere to following safety precautions:

- Before removing or installing a matrix module in the mainframe, make sure the mainframe is turned off and disconnected from line power.
- Before making or breaking connections, make sure power is removed from all external circuitry.
- Do not connect signals that may exceed the maximum specifications of the Model 7709 or external wiring. Specifications for the Model 7709 are provided at the end of this section.

WARNING A connector cover must be installed on unused connectors. This includes unused connectors on the Model 7709s and unused row daisy-chain cable connectors. Use two #4-40 screws and nuts to secure a connector cover to a cable connector.

D-shell connectors

Figure 8 shows the pin numbers for the Model 7709 rear panel connectors. The 50-pin D-shell is used for DUT and external source connections. The 25-pin D-shell is used to daisy-chain the matrix rows of two or more Model 7709s. Terminal identification for the female connector pins are contained in Table 1.

Figure 8
Rear view – Model 7709 D-shell pinouts

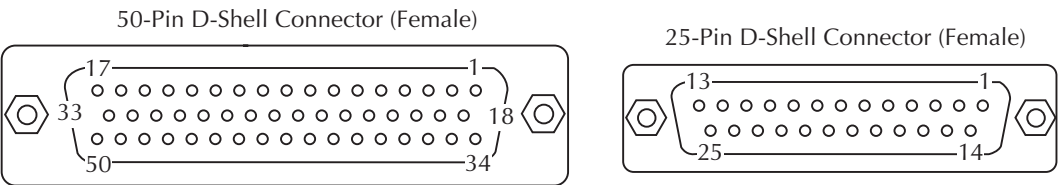


Table 1
D-shell pin identification

50-pin D-shell (DB-50)				25-pin D-shell (DB-25)	
Pin	Matrix terminal	Pin	Matrix terminal	Pin	Matrix terminal
1	Row 1 Hi	25	Col 2 Lo	1	Row 1 Hi
2	Row 2 Lo	26	Col 3 Hi	2	Row 2 Hi
3	—	27	Col 4 Lo	3	Row 3 Hi
4	Row 4 Lo	28	Col 5 Hi	4	—
5	—	29	Col 6 Lo	5	Row 4 Hi
6	Row 6 Lo	30	Col 7 Hi	6	Row 5 Hi
7	—	31	Col 8 Lo	7	—
8	Col 1 Lo	32, 33	—	8	Row 6 Hi
9	—	34	Row 1 Lo	9-13	—
10	Col 3 Lo	35	Row 3 Hi	14	Row 1 Lo
11	—	36	—	15	Row 2 Lo
12	Col 5 Lo	37	Row 5 Hi	16	Row 3 Lo
13	—	38-40	—	17	—
14	Col 7 Lo	41	Col 2 Hi	18	Row 4 Lo
15-17	—	42	—	19	Row 5 Lo
18	Row 2 Hi	43	Col 4 Hi	20	—
19	Row 3 Lo	44	—	21	Row 6 Lo
20	Row 4 Hi	45	Col 6 Hi	22-25	—
21	Row 5 Lo	46	—		
22	Row 6 Hi	47	Col 8 Hi		
23	—	48-50	—		
24	Col 1 Hi				

Wiring

NOTE *The Model 7709 is shipped with plastic connector covers installed on the D-shell connectors. Each cover is secured to the connector by two screws. After removing a connector cover, retain it and the screws for future use. Any unused D-shell connector must have the connector cover installed.*

The Model 7709 is supplied with one 50-pin male IDC ribbon cable connector, and one 25-pin male IDC ribbon cable connector. These ribbon cable connectors mate to the D-shell connectors of the switching module.

WARNING When using IDC ribbon cable connections, **DO NOT** exceed 42V anywhere in the test system or at the front panel inputs of the Model 27xx. For higher voltage applications, use larger wire (up to #20 AWG) and solder cup D-shell connectors.

There are two connector kits that have connectors that can be used with the Model 7709:

- **Model 7790 ribbon cable adapter kit** — Contains one female DB-50, one male DB-50, and one male DB-25 IDC ribbon cable connectors. The two male IDC connectors mate to the female connectors on the Model 7709.
- **Model 7789 50/25-pin solder cup connector kit** — Contains one male DB-50 and one male DB-25 solder cup connectors. These connectors mate to the female connectors on the Model 7709.

DUT and external source connections

DUT and external sources are to be wired to a 50-pin male D-shell connector. An IDC D-shell ribbon cable connector or a D-shell solder cup connector can be used.

IDC ribbon cable connections

WARNING When using IDC ribbon cable connections, DO NOT exceed 42V anywhere in the test system or to the front panel inputs of the Model 27xx.

Connect an appropriate length of 50-conductor IDC ribbon cable to a 50-pin male D-shell IDC connector. Table 2 and Figure 9 provide terminal identification for the 50-pin ribbon cable connections.

The connector of the prepared ribbon cable assembly mates to the 50-pin D-shell connector of the Model 7790 as shown in Figure 10. Make sure the connector cover for the 25-pin D-shell connector is installed if it is not going to be used.

Table 2

Terminal identification for 50-conductor IDC ribbon cable and 7709 DB-50 connector

Ribbon Cable*:		Matrix Terminal	DB-50 Pin #	Ribbon Cable*:		Matrix Terminal	DB-50 Pin #
Conductor	Color			Conductor	Color		
1	Brown	Row 1 Hi	1	26	Blue	—	—
2	Red	Row 1 Lo	34	27	Violet	Col 3 Hi	26
3	Orange	Row 2 Hi	18	28	Grey	Col 3 Lo	10
4	Yellow	Row 2 Lo	2	29	White	Col 4 Hi	43
5	Green	Row 3 Hi	35	30	Black	Col 4 Lo	27
6	Blue	Row 3 Lo	19	31	Brown	—	—
7	Violet	—	—	32	Red	—	—
8	Grey	—	—	33	Orange	Col 5 Hi	28
9	White	Row 4 Hi	20	34	Yellow	Col 5 Lo	12
10	Black	Row 4 Lo	4	35	Green	Col 6 Hi	45
11	Brown	Row 5 Hi	37	36	Blue	Col 6 Lo	29
12	Red	Row 5 Lo	21	37	Violet	—	—
13	Orange	—	—	38	Grey	—	—
14	Yellow	—	—	39	White	Col 7 Hi	30
15	Green	Row 6 Hi	22	40	Black	Col 7 Lo	14
16	Blue	Row 6 Lo	6	41	Brown	Col 8 Hi	47
17	Violet	—	—	42	Red	Col 8 Lo	31
18	Grey	—	—	43	Orange	—	—
19	White	—	—	44	Yellow	—	—
20	Black	—	—	45	Green	—	—
21	Brown	Col 1 Hi	24	46	Blue	—	—
22	Red	Col 1 Lo	8	47	Violet	—	—
23	Orange	Col 2 Hi	41	48	Grey	—	—
24	Yellow	Col 2 Lo	25	49	White	—	—
25	Green	—	—	50	Black	—	—

* 50-conductor IDC ribbon cable is available from Keithley.

Figure 9
Ribbon cable terminal identification

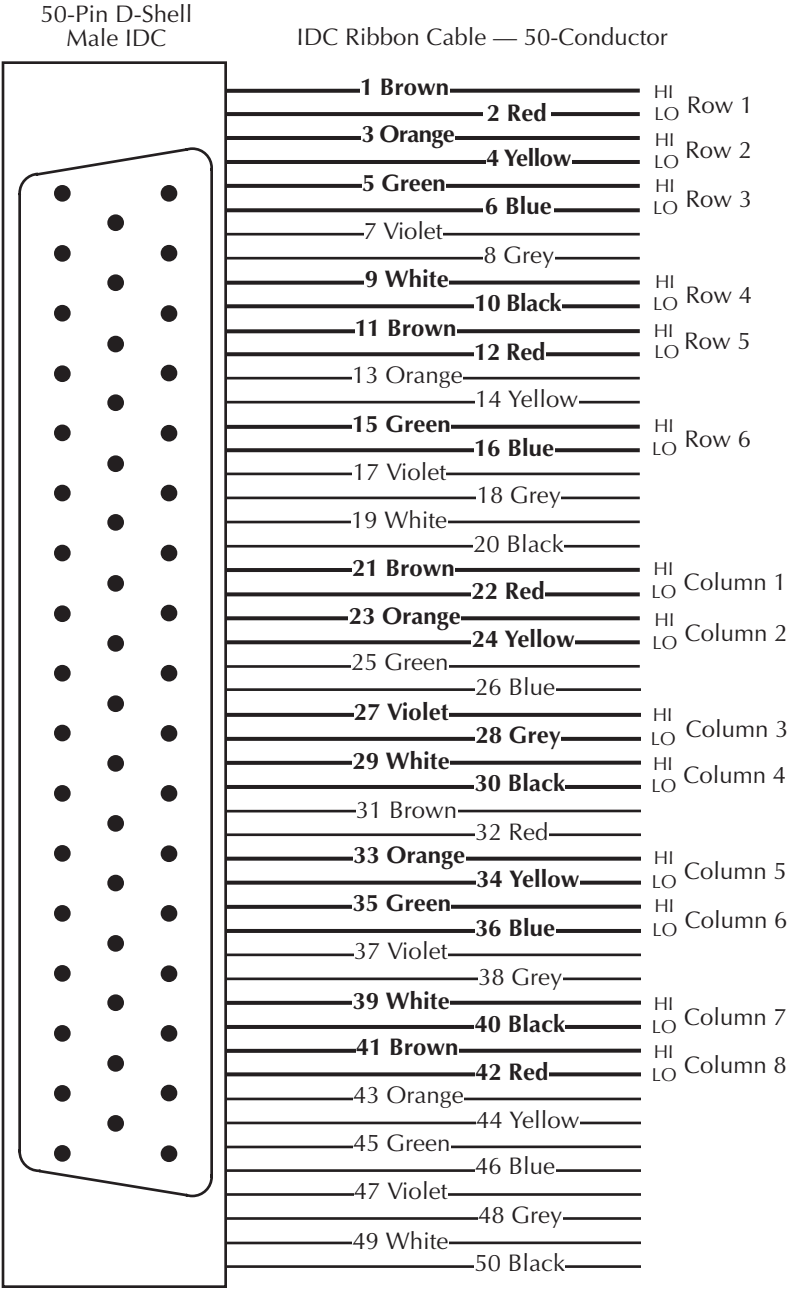
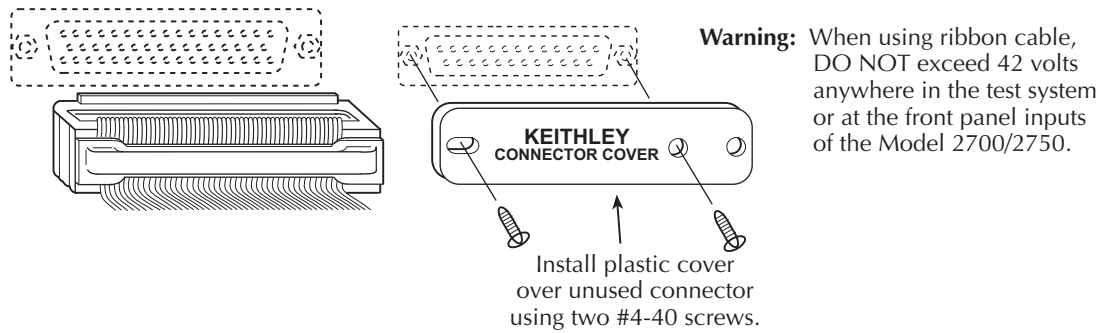


Figure 10

Connecting ribbon cable assembly



Solder cup cable connections

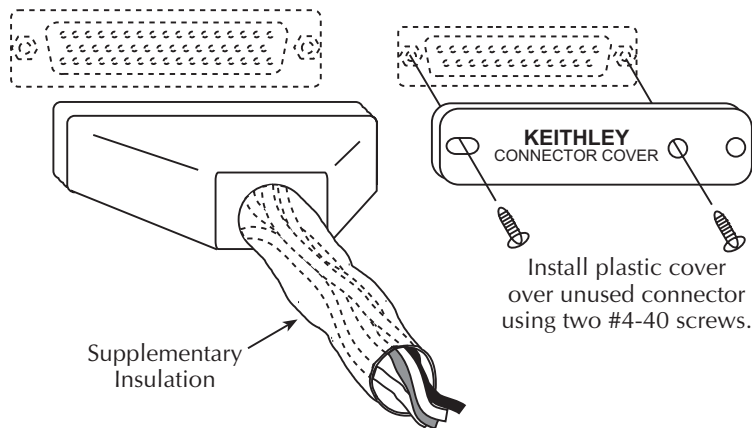
Make all connections to a 50-pin D-shell male solder cup connector using the correct wire size up to 20 AWG. Terminal identification for the 50-pin D-shell connector is provided in [Table 1](#) and [Table 2](#). Make sure to add supplementary insulation around the harness for voltages above 42V peak ([Figure 11](#)).

WARNING All solder cup wiring must be rated for the maximum voltage in the system. For example, if 1000V is applied to the front terminals of the DMM, all matrix module wiring must be rated for 1000V.

The connector cover for the 25-pin D-shell connector on the Model 7709 must be installed if it is not going to be used. If the connector is left open, an electrical shock hazard may be present.

Figure 11

Connecting solder cup cable assembly



Row daisy-chain connections

Row daisy-chain ribbon cable assembly

WARNING When using IDC ribbon cable, DO NOT exceed 42V anywhere in the test system or to the front panel inputs of the Model 27xx.

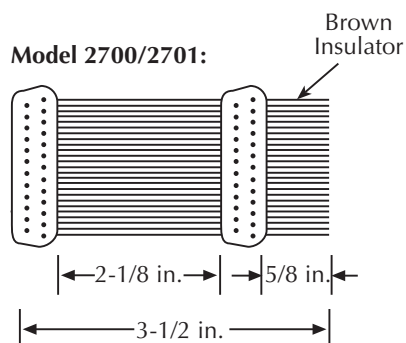
A convenient method to daisy-chain the rows of two or more Model 7709s, is to use a 25-conductor ribbon cable assembly with IDC ribbon cable connectors attached to it. For the Model 2700/2701, a two-connector ribbon cable assembly will daisy-chain two matrix modules. For the Model 2750, a five-connector ribbon cable will daisy-chain five matrix modules.

Refer to [Figure 12](#) and perform the following steps to build a row of daisy-chain cable:

1. Start with an appropriate length of 25-conductor IDC ribbon cable. For the Model 2700/2701, a 3½" length of cable is needed. For the Model 2750, a 20¼" length is needed.
2. Mark the locations for the IDC connectors on the ribbon cable.
3. Starting at the left end of the cable, attach an IDC connector.

Figure 12

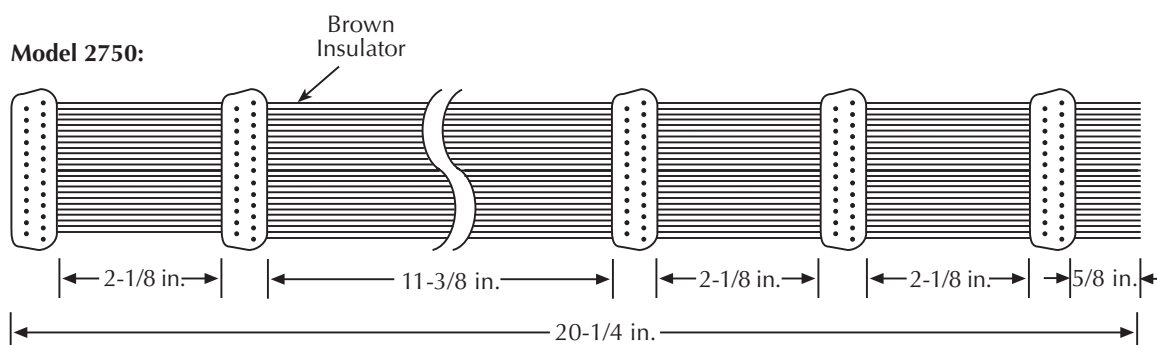
Row daisy-chain ribbon cable assembly



Required Parts:

25 Conductor IDC Ribbon Cable (KI part #15025):
Model 2700/2701 – 3.5 inch length required.
Model 2750 – 20.25 length required.

25-pin Male D-shell IDC Connector:
Model 2700/2701 – Two connectors required.
Model 2750 – Five connectors required.



4. Route the cable over the back side of the connector and install the strain relief for the connector. Make sure the cable is firmly clamped to the connector body. [Figure 13](#) shows how the cable is routed through the strain reliefs of the connectors.
5. Repeat steps 3 and 4 to attach the rest of the IDC connectors at the marked locations.

[Figure 14](#) shows the row of daisy-chain ribbon cables connected to the 25-pin D-shell connectors of the Model 7709s. Matrix terminal identification for the 25-conductor ribbon cable is provided in [Table 3](#).

WARNING A connector cover must be installed on unused connectors. This includes unused connectors on the Model 7709s and unused row daisy-chain cable connectors. Use two #4-40 screws and nuts to secure a connector cover to a cable connector.

Figure 13

Row daisy-chain ribbon cable routing

Side View of Cable Assemblies:

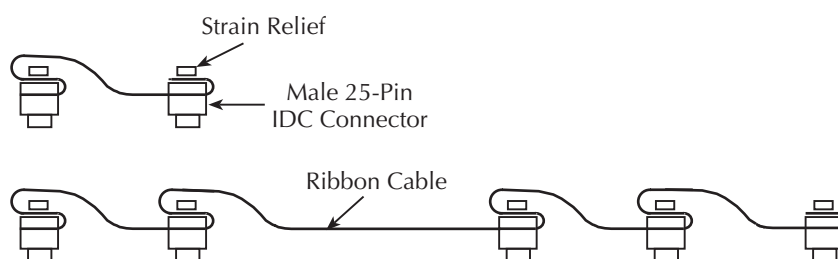


Figure 14
Connecting row daisy-chain cables

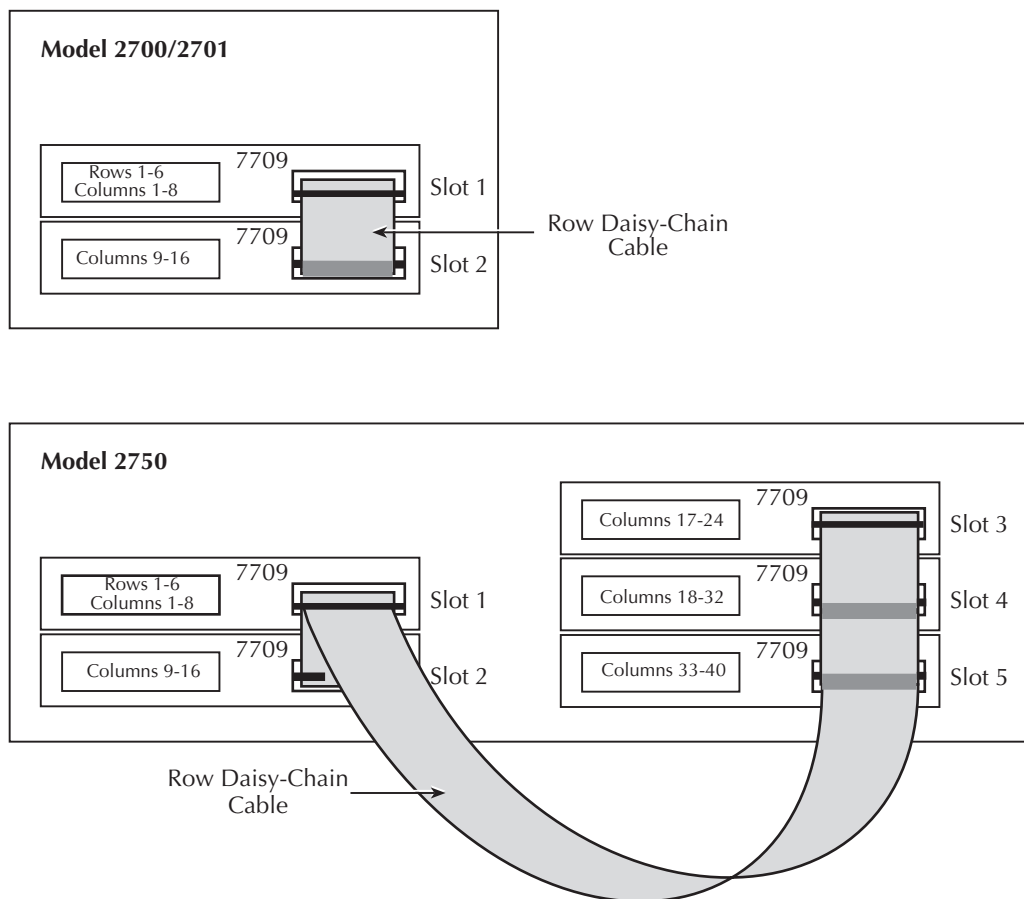


Table 3
Terminal identification for 25-conductor IDC ribbon cable and 7709 DB-25 connector

Ribbon Cable*:		Matrix	DB-25	Ribbon Cable*:		Matrix	DB-25
Conductor	Color	Terminal	Pin #	Conductor	Color	Terminal	Pin #
1	Brown	Row 1 Hi	1	14	Yellow	—	—
2	Red	Row 1 Lo	14	15	Green	Row 6 Hi	8
3	Orange	Row 2 Hi	2	16	Blue	Row 6 Lo	21
4	Yellow	Row 2 Lo	15	17	Violet	—	—
5	Green	Row 3 Hi	3	18	Grey	—	—
6	Blue	Row 3 Lo	16	19	White	—	—
7	Violet	—	—	20	Black	—	—
8	Grey	—	—	21	Brown	—	—
9	White	Row 4 Hi	5	22	Red	—	—
10	Black	Row 4 Lo	18	23	Orange	—	—
11	Brown	Row 5 Hi	6	24	Yellow	—	—
12	Red	Row 5 Lo	19	25	Green	—	—
13	Orange	—	—				

*25-conductor IDC ribbon cable is available from Keithley, Part #15025.

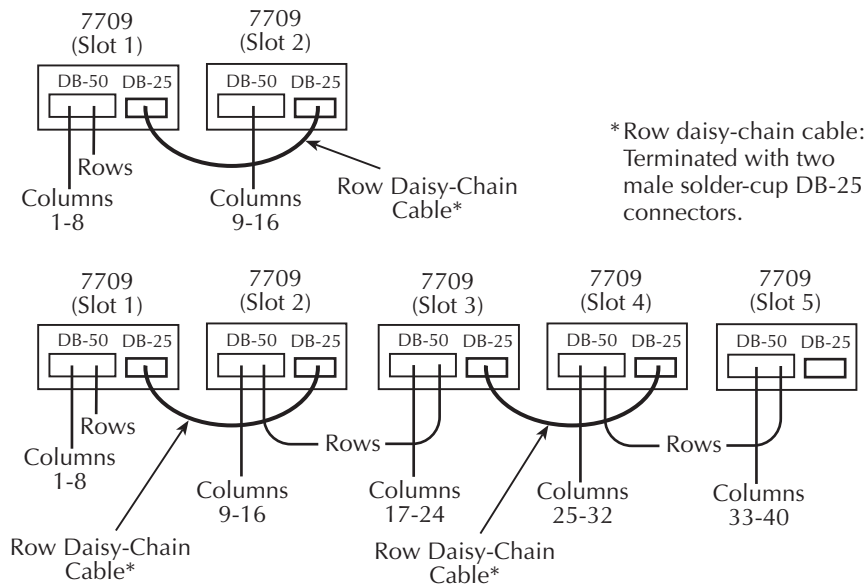
Row daisy-chaining using solder cup connectors

Figure 15 shows how to daisy-chain rows using solder cup connectors. Notice that not all row-to-row connections can be accessed from the DB-25 connectors. For the Model 2750, daisy-chaining to the third and fifth matrix modules require that rows be accessed at the DB-50 connectors. Table 1 and Table 2 provide terminal identification for DB-50 connectors. Table 3 provides terminal identification for DB-25 connectors.

WARNING All solder cup wiring must be rated for the maximum voltage in the system. For example, if 1000V is applied to the front terminals of the DMM, all matrix module wiring must be rated for 1000V.

Figure 15

Row daisy-chaining using solder cup connectors



Typical DUT connections

The following examples show typical wiring connections for the following types of measurements:

- Ω 2-Wire and thermistor connections, Figure 16.
- Ω 4-Wire and RTD connections, Figure 17.
- Voltage connections (AC or DC), Figure 18.

Figure 16
 Ω 2-Wire and thermistor connections

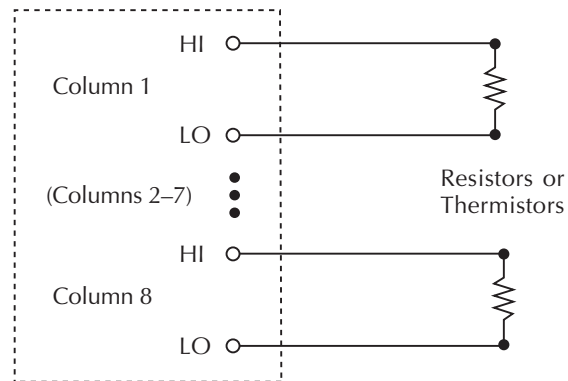


Figure 17
 Ω 4-Wire and RTD connections

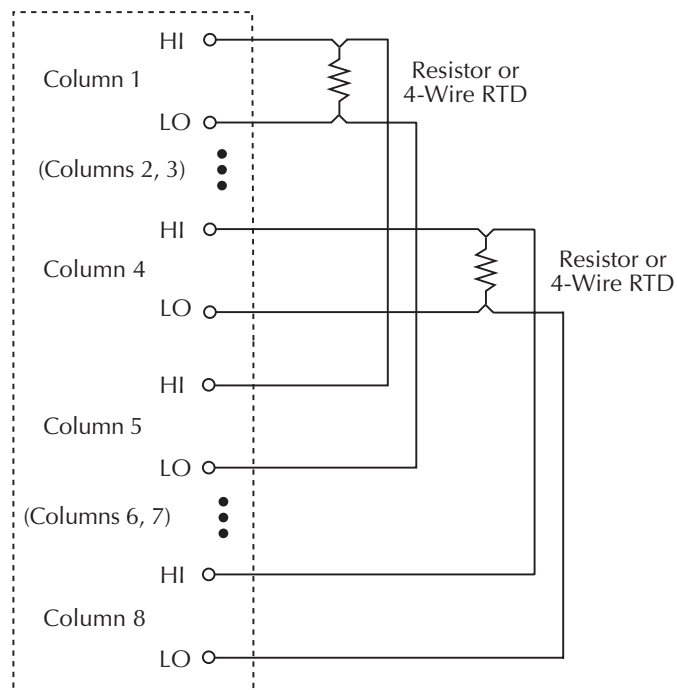
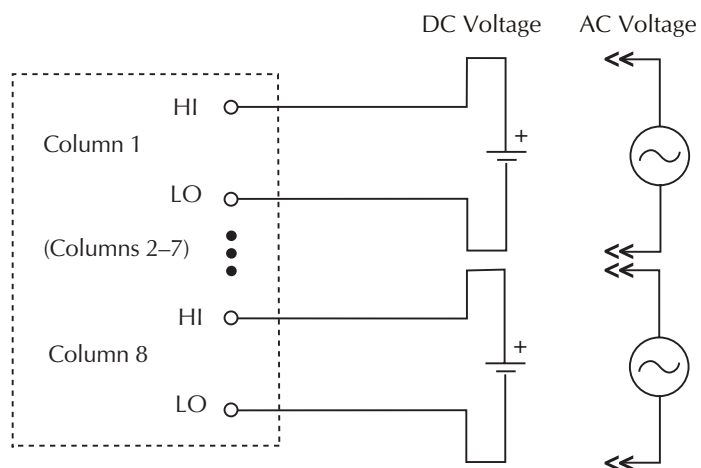


Figure 18
Voltage connections (DC or AC)



Connection log

Make a copy of [Table 4](#) and affix it to the cover of Model 7709. Use this to record connection information and channel descriptions as needed.

Table 4
Connection log Model 7709

Column/Row		Color	Description
Col 1	H		
	L		
Col 2	H		
	L		
Col 3	H		
	L		
Col 4	H		
	L		
Col 5	H		
	L		
Col 6	H		
	L		
Col 7	H		
	L		
Col 8	H		
	L		
Row 1	H		
	L		
Row 2	H		
	L		
Row 3	H		
	L		
Row 4	H		
	L		
Row 5	H		
	L		
Row 6	H		
	L		

Operation

Detailed information to close and open switching module channels are provided in Section 2 of the Model 27xx User's Manual. The following summarizes basic operation, and provides operating information specific to the Model 7709.

Channel assignments

The Model 2700/2701 has two slots for switching modules and the Model 2750 has five slots. To control the appropriate matrix module, the slot number must be included with the matrix module channel number when you specify a channel. The channel assignment is formatted as follows:

SCH where: S is the slot number
 CH is the channel number

Examples:

101 = Slot 1, Channel 1

210 = Slot 2, Channel 10

506 = Slot 5, Channel 6 (Model 2750)

NOTE *For remote operation, the 3-digit channel assignment is included in the channel list parameter for the commands.*

System channel operation

System channel operation is used to connect matrix columns to the Model 27xx DMM. With 2-wire function selected, system channels 1 through 8 can be closed. When one of these channels is closed, channel 50 automatically closes to connect Row 1 to the DMM. [Figure 2](#) shows channel 3 closed to connect column 3 to the DMM.

NOTE *With a 2-wire function selected, channels 9 through 48 cannot be closed using system channel operation.*

With a 4-wire function selected, system channels 1 through 4 can be closed. When one of these channels is closed, its paired channel also closes, and the backplane relays for sense and input (channels 49 and 50) also close.

For a 4-wire function, channels are paired as follows:

CH1 and CH13

CH2 and CH14

CH3 and CH15

CH4 and CH16

[Figure 3](#) shows system channel 3 closed to connect the DUT to DMM Input and Sense.

NOTE *With a 4-wire function selected, channels 5 through 12, and channels 17 through 48 cannot be closed using system channel operation.*

System channel operation for the Model 7709 is summarized as follows:

- The ◀/▶ keys on the Model 27xx DMM can be used to close a system channel.
- The CLOSE key can be used to close a system channel. For the Model 2701/2750 and later versions of the Model 2700, use the SINGLE option of the CLOSE key.
- Use the OPEN key to open all channels in the test system. For the Model 2701/2750 and later versions of the Model 2700, use the ALL option of the OPEN key.
- For remote operation, the following commands are used for system channel operation:

ROUT:CLOS <clist>	Close specified system channel.
ROUT:CLOS?	Returns the closed system channel.
ROUT:CLOS:STAT? <clist>	Query closed channels in list (1 = closed).
ROUT:OPEN:ALL	Open all channels.

Amps measurements

The 7709 module does not support amps measurements. System channel operation cannot be used to close channels while an amps function (DCI or ICI) is selected.

If an amps function (DCI or ACI) is selected and you attempt to close a system channel, the message “NO AMPS CHAN” will be displayed briefly. For remote programming, error -222 (Parameter data out of range) is generated. Example:

SYST:PRES	‘ Restores system preset defaults.
SENS:FUNC ‘CURR:DC’	‘ Selects DCI function.
ROUT:CLOS (@101)	‘ Attempts to close system channel 101 – Generates error -222.

If a system channel is already closed and you attempt to select the DCI or ACI function, the message “INVALID FUNC” will be displayed briefly. For remote programming, error -221 (Settings conflict) is generated. Example:

SYST:PRES	‘ Restores system preset defaults.
ROUT:CLOS (@101)	‘ Close system channel 101.
SENS:FUNC ‘CURR:DC’	‘ Attempts to select DCI function – Generates error -221.

Making amps measurements – In order to perform amps measurements, you must use the front panel inputs of the 27xx mainframe. You can still use the 7709 module for other aspects of the test (such as controlling a bias supply for DUT), but you must use multiple channel operation to close channels. Example:

NOTE In order to use the front panel inputs, make sure the INPUT switch is in the out (F) position.

SYST:PRES	‘ Restores system preset defaults.
ROUT:MULT:CLOS (@101)	‘ Closes channel 101.
SENS:FUNC ‘CURR:DC’	‘ Selects DCI function – Legal operation.

Multiple channel operation

WARNING Multiple channel operation should only be performed by experienced test engineers who recognize the dangers associated with multiple channel closures.

For the Model 7709, multiple channel operation provides independent control of channels 17 through 48 (Rows 3 through 6). When you close multiple channel, only the specified channel (or channels) will close. Other closed channels are not affected.

Rows 3 through 6 are used to add one or more external sources to the test system. As shown in [Figure 4](#), closing channel 17 connects the external source to DUT 1.

Multiple channel operation for the Model 7709 is summarized as follows:

- For earlier versions of the Model 2700, multiple channel operation is not available from the front panel (remote operation only).
- For the Model 2701/2750 and later versions of the Model 2700, the MULTI option of the CLOSE key can be used to close a channel.
- For the Model 2701/2750 and later versions of the Model 2700, the MULTI option of the OPEN key can be used to open a channel. The ALL option of the OPEN key opens all channels.

ROUT:MULT:CLOS <clist>	Close specified channels (unlisted channels not affected).
ROUT:MULT:OPEN <clist>	Open specified channels (unlisted channels not affected).
ROUT:MULT:CLOS?	Returns list of all closed channels.
ROUT:MULT:CLOS:STAT? <clist>	Query closed channels in list (1 = closed).

You can also use the following command to open all channels:

ROUT:OPEN:ALL	Open all channels.
---------------	--------------------

Service

WARNING All service information is intended only for qualified service personnel. Do not attempt to service the Model 7709 unless you are qualified to do so.

Performance verification

Performance verification can be performed on Rows A and B signal paths to the Model 27xx DMM. Use the performance verification procedure for the Model 7700, which is provided in Section 1 of this manual.

When using the performance verification procedure, connect the voltage, resistance, thermistor or 4-wire RTD to matrix columns, and close the appropriate system channel to make the measurement.

Replaceable parts

This section contains replacement parts information and the component layout drawing for the Model 7709.

Parts list

Replaceable parts for the Model 7709 are listed in [Table 5](#).

Ordering information

To place an order, or to obtain information concerning replacement parts, contact your Keithley representative or the factory (see back cover for addresses). When ordering parts, be sure to include the following information:

- Card model number (Model 7709).
- Card serial number.
- Part description.
- Component designation (if applicable).
- Keithley part number.

Factory service

If the instrument is to be returned to Keithley Instruments for repair, perform the following:

- Call the Repair Department at 1-888-KEITHLEY for a Return Material Authorization (RMA) number.
- Carefully pack the instrument in the original packing carton.
- Write ATTENTION REPAIR DEPARTMENT and the RMA number on the shipping label.

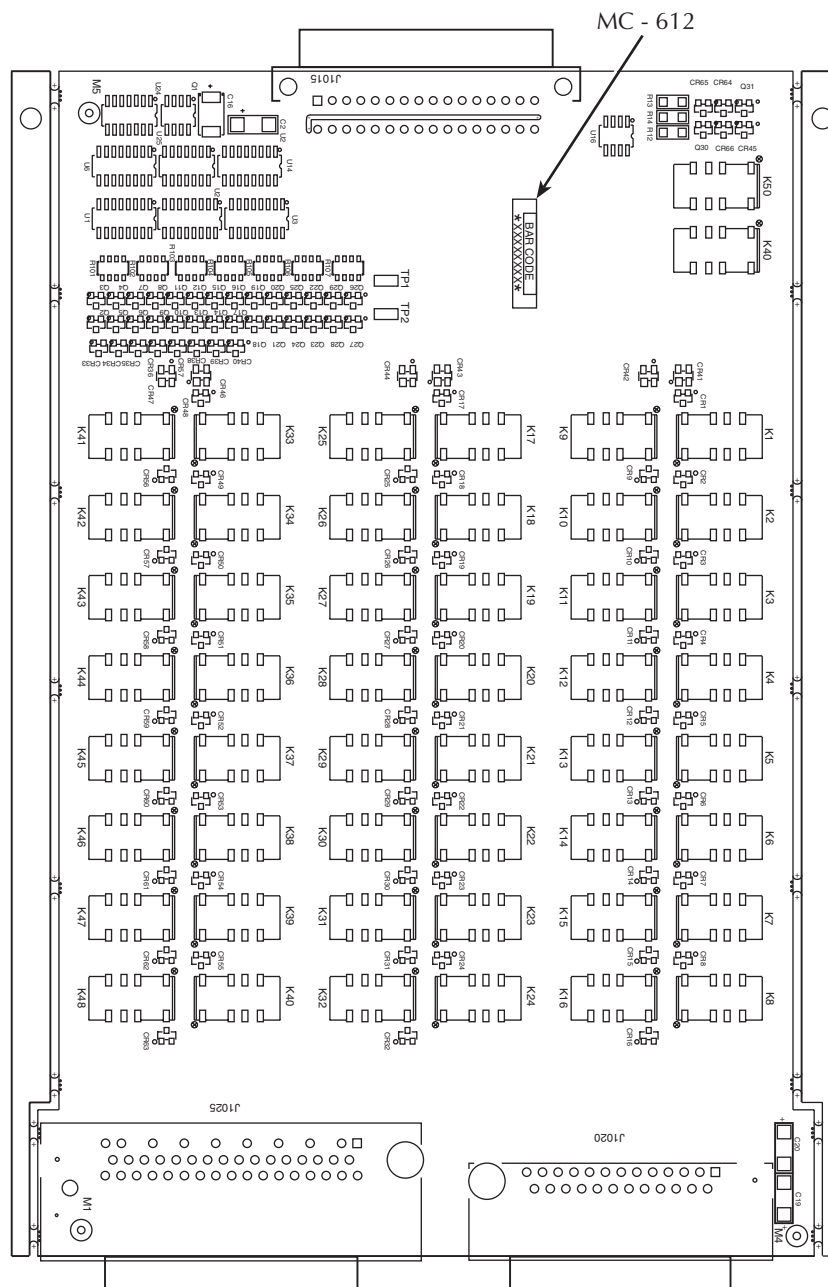
Component layout

The component layout for Model 7709 is provided in [Figure 19](#) and [Figure 20](#).

Table 5
Model 7709 parts list

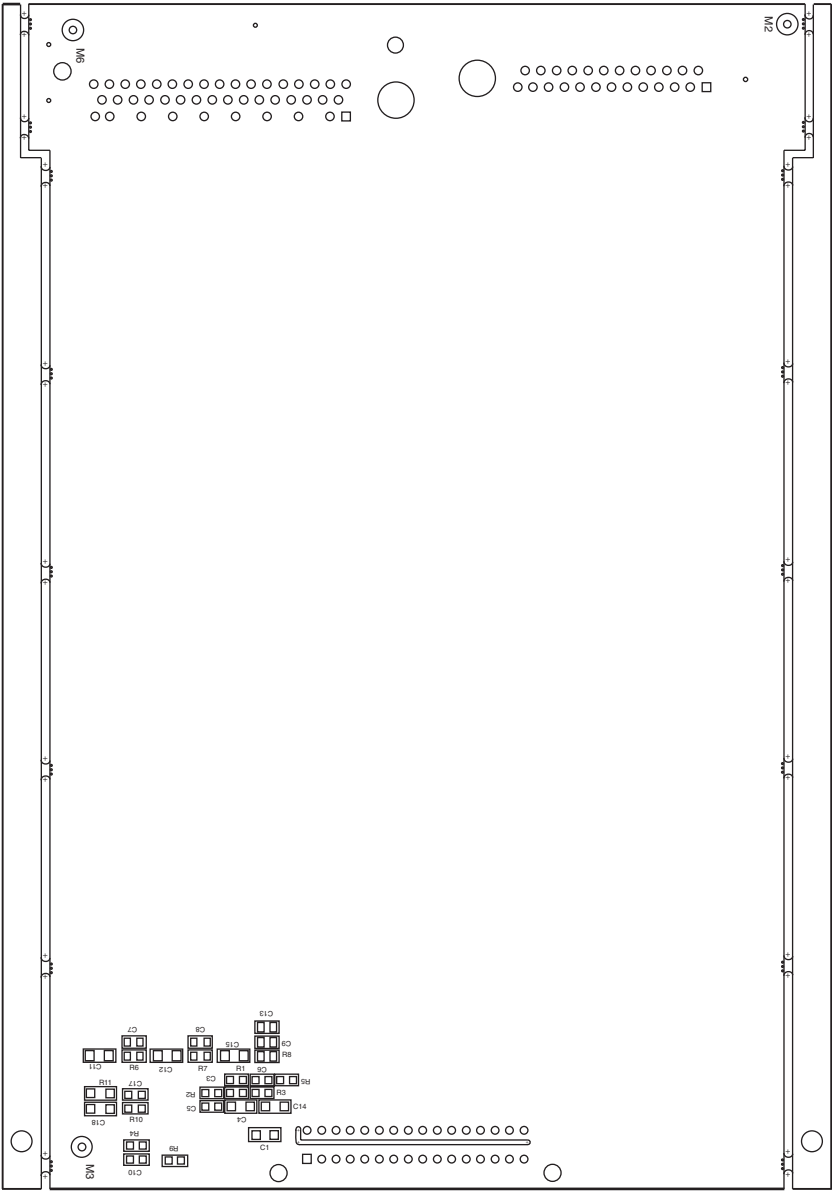
Circuit Designation	Description	Keithley Part No.
C1, C4, C11, C12, C14, C15, C18	CAP, .1UF, 20%, 50V, CERAMIC (1206)	C-418-1
C16	CAP, 220UF, 20%, 10V, TANTALUM	C-558-220
C2, C19, C20	CAP, 4.7UF, 10%, 35V, TANTALUM	C-476-4.7
C3, C5, C6, C7, C8, C9, C10, C13, C17	CAP, 47PF, 5%, 100V, CERAMIC (0805)	C-465-47P
CR1-CR40, CR48-CR63	DIODE, DUAL SWITCHING, BAV99L (SOT-23)	RF-82
CR41, CR42, CR43, CR44, CR46, CR47	DUAL HIGH SPEED DIODE	RF-147
CR45, CR64, CR65, CR66	DIODE, SWITCHING, MMBD914 (SOT-23)	RF-83
J1015	CONN, RT ANGLE DUAL ROW RECEPT	CS-1065-1
J1020	CONN, FEMALE, 25-PIN	CS-484
J1025	CONN, RT ANGLE SEL CS-1061-1	CS-1062
K1-K48	SINGLE COIL LATCH RELAY	RL-225
K49, K50	NON LATCHING RELAY	RL-242
Q1	N-CHANNEL/P-CHANNEL POWER MOSFET	TG-360
Q2, Q4, Q6, Q8, Q10, Q12, Q14, Q16, Q18, Q20, Q22	TRANS, PNP SILICON	TG-388
Q24, Q26, Q28	TRANS, PNP SILICON	TG-388
Q25, Q27, Q29, Q30, Q31	TRANS, NPN SILICON	TG-389
Q3, Q5, Q7, Q9, Q11, Q13, Q15, Q17, Q19, Q21, Q23	TRANS, NPN SILICON	TG-389
R1, R3, R4, R6, R7, R8, R9, R10	RES, 1K, 1%, 100MW, THICK FILM (0805)	R-418-1K
R101, R102, R103, R104	RES, ARRAY 4X4.3K, 5%, .125W	TF-276-4.3K
R105, R106, R107	RES, ARRAY 4X1K, 5%, .125W	TF-276-1K
R11	RES, 4.99K, 1%, 1/4W, METAL FILM (1206)	R-391-4.99K
R12, R14	RES, 49.9, 1%, 1/4W, METAL FILM (1206)	R-391-49.9
R13	RES, 4.99K, 1%, 1/4W, METAL FILM (1206)	R-391-4.99K
R2	RES, 10K, 1%, 100MW, THICK FILM (0805)	R-418-10K
R5	RES, 140K, 1%, 100MW, THICK FILM (0805)	R-418-140K
U1, U2, U3, U6	IC, 8 STAGE SHIFT/STORE, MC14094BD (SOIC)	IC-772
U14	IC, RETRIG., MULTIVIB, 74HC123AM (SOIC)	IC-788
U16	IC, 2.5V CASCADABLE SERIAL EEPROM	LSI-212
U24	IC, QUAD 2 IN AND, 74HCT08 (SOIC)	IC-837
U25	IC, POS NAND GATES/INVERT, 74HCT14 (SOIC)	IC-656
	25 D-SHELL MALE	7709-307A
	2700 SUPPORT SOFTWARE	2700-850B03
	4-40 X 1/4 LG. PHIL. FLAT HD. SCREW	4-40X1/4PFH
	4-40 X 1/4 PHILLIPS PAN HD.	4-40X1/4PPH
	BAR CODE S/N LABEL	MC-612A
	BOTTOM CARD COVER	7703-301B
	CHIPLOC BAG STATIC SHIELDING	PO-13-1
	D-SUB CABLE KIT	7709-306A
	DUAL CONN COVER	7709-312A
	FINAL INSPECTION	7709-FIN-51
	HOLE SIZE	7709-102B
	MASS TERM BRACKET	7709-303-1A
	MECHANICAL ASSEMBLY	7709-SCAN-MECH-3
	PACKING LIST	PA-771A
	PACKING LIST	PA-774A
	SCANNER BOARD SURFACE MOUNT BOTTOM	7709-SCAN-1B
	SCANNER BOARD SURFACE MOUNT TOP	7709-SCAN-1T
	SCANNER BOARD THRU HOLE	7709-SCAN-1H
	SCANNER PC BOARD ASSEMBLY	7709-100B
	SCREWLOCK, FEMALE	CS-725
	SERIAL NUMBER LABEL	MC-285
	SHIPPING KIT	7709-SHI-41
	STANDOFF, BRASS HEXAGON	ST-166-1
	SURFACE MOUNT PCB TEST POINT	CS-1026
	TOP CARD COVER	7703-302C

Figure 19
Model 7709 component layout (Side - 06)



Primary Side Components (Side - 06)
For component information, see product structure.

Figure 20
Model 7709 component layout (Side - 01)



Secondary Side Components (Side - 01)
For component information, see product structure.

7709 6×8 Matrix Module

GENERAL

MATRIX CONFIGURATION: 6 rows × 8 columns.

CONTACT CONFIGURATION: 2 pole Form A.

FIRMWARE: Specified for Model 2700 rev. B03 and Model 2750 rev. A01.

RELAY TYPE: Latching electromechanical.

ACTUATION TIME: <3ms.

CAPABILITIES

DMM CONNECTION:

2-Wire Functions

Row 1, channels 1–8, through channel 50.

4-Wire Functions

Row 1, channels 1–4 (Input) through channel 50 and Row 2, channels 13–16 (Sense), through channel 49.

CLOSE CHANNEL: CLOSE command connects channels 1–8 to DMM.

For 4-wire, channels 1–4 are automatically paired with channels 13–16.

ROUTE: MULTIPLE allows any combination of rows and columns to be connected at the same time.

INPUTS

MAXIMUM SIGNAL LEVEL: Any Channel to Any Channel (1–48):

300VDC or 300Vrms (425V peak) for AC waveforms, 1A switched, 60W, 125VA maximum.

SAFETY: Conforms to European Union Directive 73/23/EEC EN61010-1, CAT I.

CONTACT LIFE (typ): >10⁵ operations at max signal level.

>10⁸ operations cold switching.

CONTACT RESISTANCE: <1Ω any path and additional 1Ω at end of contact life.

CONTACT POTENTIAL: <3μV per contact pair.

OFFSET CURRENT: <100pA.

CONNECTOR TYPE: 50-pin female D-shell for rows and columns.

25-pin female D-shell for “daisy-chain” rows.

Supplied with male IDC ribbon cable connectors.

ISOLATION BETWEEN ANY TWO TERMINALS: >10⁹Ω, <200pF.

ISOLATION BETWEEN ANY TERMINAL AND EARTH: >10⁹Ω, <400pF.

CROSS TALK (1MHz, 50Ω Load): <–35dB.

INSERTION LOSS (50Ω Source, 50Ω Load): <0.35dB below 1MHz.

<3dB below 2MHz.

COMMON MODE VOLTAGE: 300VDC or 300Vrms (425V peak) for AC waveforms between any terminal and chassis.

ENVIRONMENTAL:

OPERATING ENVIRONMENT: Specified for 0°C to 50°C.

Specified to 50% R.H. at 35°C.

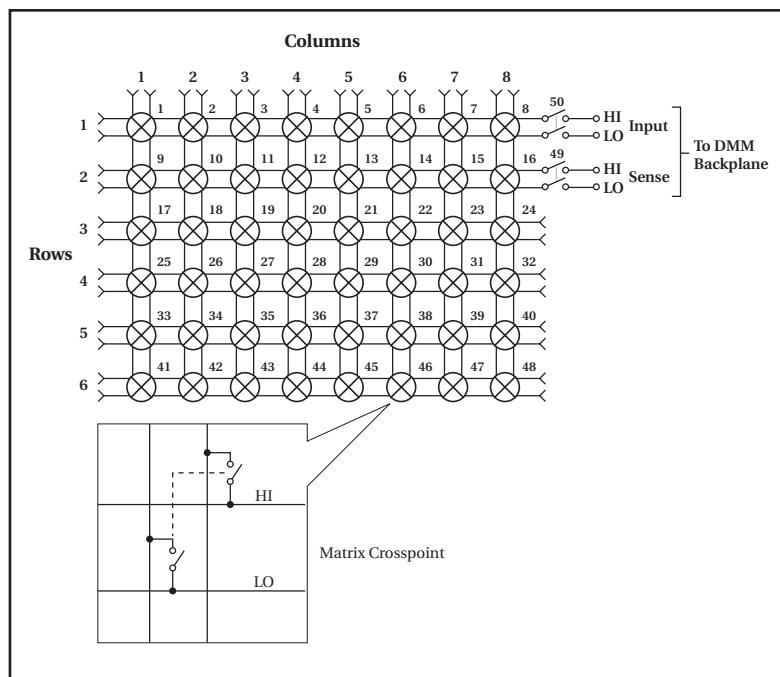
STORAGE ENVIRONMENT: –25°C to 65°C.

WEIGHT: <0.52kg (1.16 lb).

ACCESSORIES AVAILABLE:

Model 7789 50/25 Pin Male D-Shell Solder Cup Connectors

Model 7790 50/50/25 Pin Female/Male D-Shell IDC Connectors



Specifications are subject to change without notice.

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