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Model 7709 6 × 8 Matrix Module

Instructions for use with DAQ6510

Introduction

The 7709 switching module is a two-pole, 6 × 8 matrix switching module. It can connect any combination of six differential channels of instrumentation to any combination of eight differential device-under-test channels. The instrumentation can be AC and DC sources, such as internal or external meters or oscilloscopes. This matrix configuration allows wide flexibility for complex test systems.

Figure 1: Model 7709



Item shipped may vary from model pictured here.

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

- Automatic 2-wire or 4-wire connection to DMM
- 6 row × 8 column matrix
- Expandable to larger switch configurations by daisy-chaining or cascading multiple modules
- Two female D-sub connectors are standard for secure hook-up and quick teardown
- 300 V, 1 A capacity
- Relay closures stored in onboard memory

NOTE

If you are using this switching module with the 2700, 2701, or 2750, please see *Model 7709 Multiplexer Card User's Guide*, Keithley Instruments PA-771.



Schematic information

⚠ WARNING

Connection and wiring procedures in this document are intended for use by qualified personnel only, as described by the types of product users in the [Safety precautions](#) (on page 19). Do not perform these procedures unless qualified to do so. Failure to recognize and observe normal safety precautions could result in personal injury or death.

The following figure shows a simplified diagram of the 7709 switching module. The matrix consists of 48 crosspoints. Each crosspoint channel is a 2-pole switch that, when closed, connects a row to a column. For example, closing channel 43 connects row 6 to column 3.

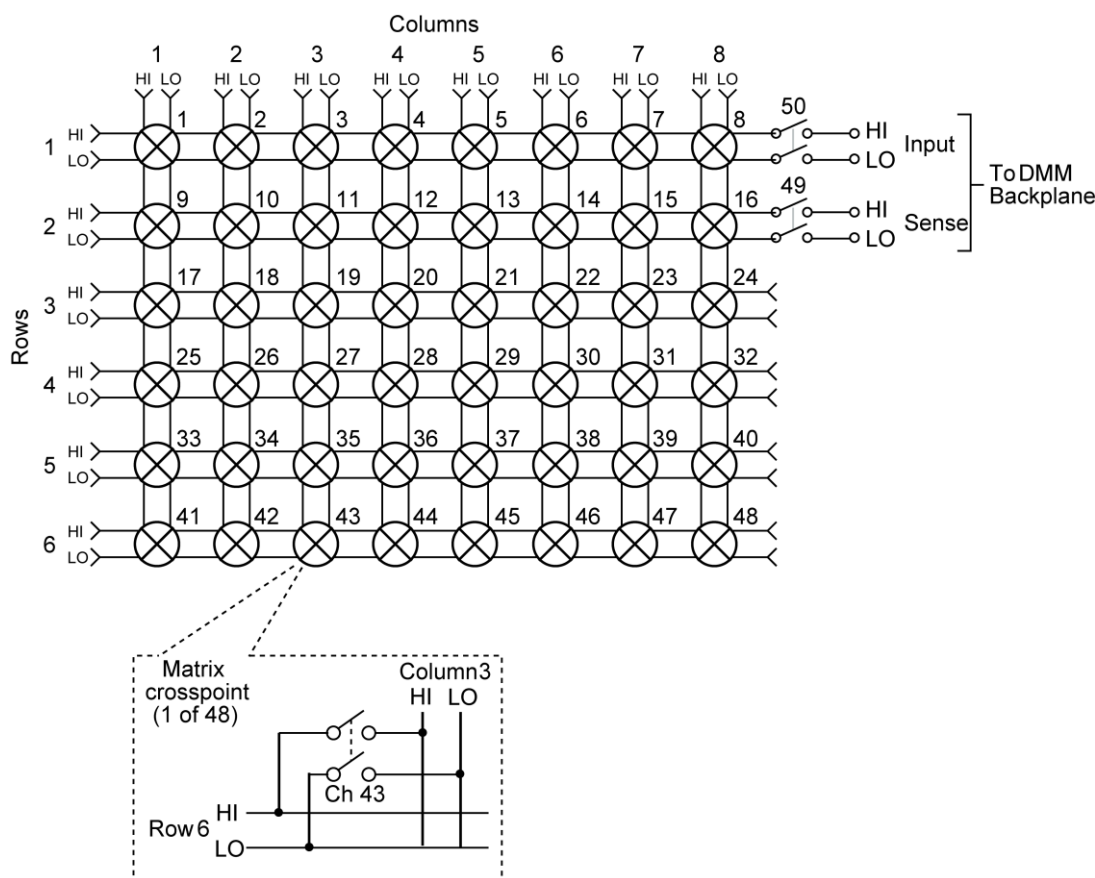
Two switches (channels 49 and 50) are used to connect rows 1 and 2 to the backplane of the DAQ6510. When channel 50 is closed, row 1 is connected to the INPUT of the DMM. When channel 49 is closed, row 2 is connected to SENSE of the DMM.

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

NOTE

Although the 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 a *RST or reset () command is issued.

Figure 2: Simplified schematic for Model 7709



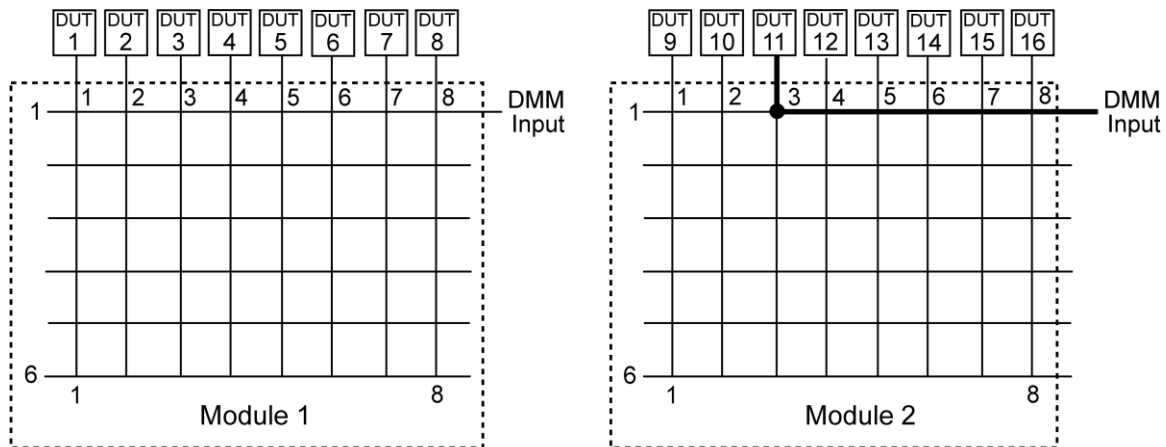
Matrix expansion

Basic matrix column expansion

The number of columns in a matrix test system can be increased by installing another 7709 in the DAQ6510. Adding a second 7709 increases the total number of columns to 16.

The following figure shows a two matrix module system to test 16 DUTs. It is similar to a 2-wire DUT measurement except that the second card allows eight more DUTs to be tested. As shown, channel 3 of the second module is closed to connect DUT 11 to the DMM Input.

Figure 3: Two matrix module test system



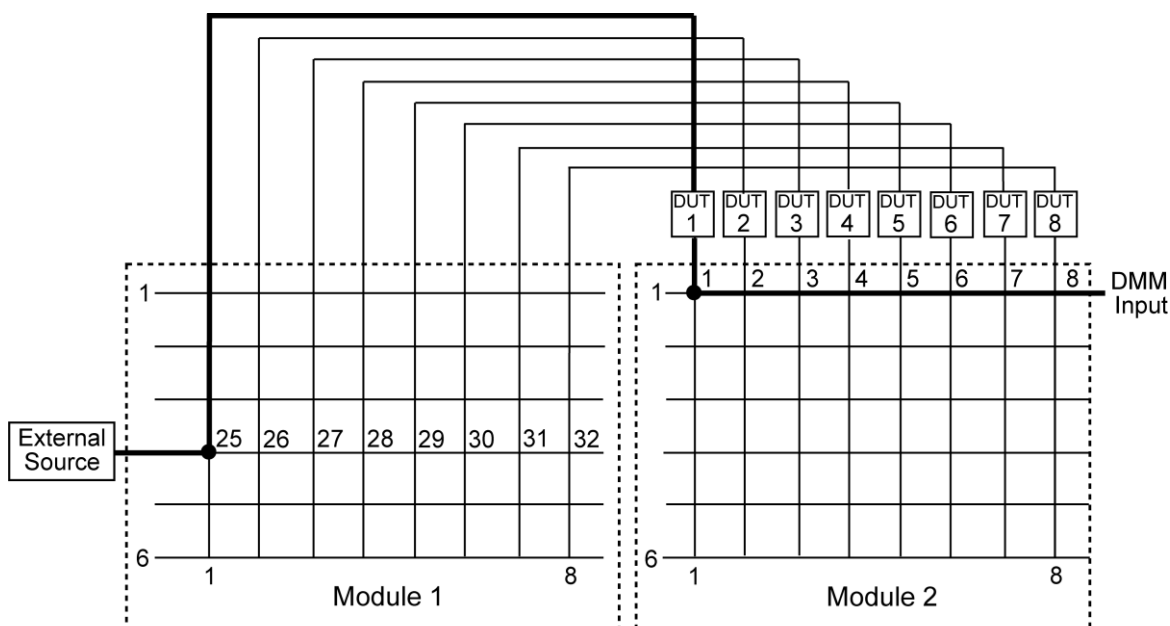
Channel 3 of module 2 closed to connect DUT 11 to DMM Input.

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

The following figure shows a two matrix module system that uses an external source. It is similar to the one in the previous figure except that it allows more DUTs 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 the following figure, DUT 1 is tested by closing multiple channel 25 and 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 4: Two matrix module test system with an external source

Multiple channel 25 of module 1 closed to power DUT 1.
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).

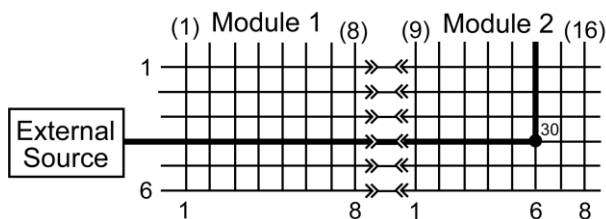
Daisy-chaining matrix rows

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.

The following figure 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.

NOTE

The matrix in this illustration is 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 a two conductor path pair (HI and LO).

Figure 5: Daisy-chained matrix modules

Multiple channel 30 of module 2 closed to connect external source to column 6 of module 2.

Installation

WARNING

Before operating an instrument with a switching module, verify that the switching module 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.

If you are installing two switching modules, it is easier to install one switching module into slot 2 first, then install the second switching module into slot 1.

NOTE

If you have a Keithley Instruments Model 2700, 2701, or 2750 instrument, you can use your existing switching module in the DAQ6510. Follow the instructions in your original equipment documentation to remove the module from the instrument, then use the following instructions to install it in the DAQ6510. You do not need to remove wiring to the module.

NOTE

For inexperienced users, it is recommended that you do not connect a device under test (DUT) and external circuitry to the switching module. This allows you to exercise close and open operations without the dangers associated with live test circuits. You can also set up pseudocards to experiment with switching. Refer to "Pseudocards" in the *Model DAQ6510 Data Acquisition and Multimeter System Reference Manual* for information on setting up pseudocards.

WARNING

To prevent electric shock that could result in injury or death, never handle a switching module that has power applied to it. Before installing or removing a switching module, make sure the DAQ6510 is turned off and disconnected from line power. If the switching module is connected to a DUT, make sure power is removed from all external circuitry.

WARNING

If a card slot is unused, you must install slot covers to prevent personal contact with high voltage circuits. Failure to install slot covers could result in personal exposure to hazardous voltages, which could cause personal injury or death if contacted.

CAUTION

Before installing or removing a switching module, make sure the DAQ6510 power is turned off and disconnected from line power. Failure to comply may result in incorrect operation and loss of data in the memory.

Required equipment:

- Medium flat-blade screwdriver
- Medium Phillips screwdriver

To install a switching module into the DAQ6510:

1. Turn off the DAQ6510.
2. Disconnect the power cord from the power source.
3. Disconnect the power cord and any other cables that are connected to the rear panel.
4. Position the DAQ6510 so you are facing the rear panel.
5. Use the screwdriver to remove the slot cover screws and the cover plate. Retain the plate and screws for future use.
6. With the top cover of the switching module facing up, slide the switching module into the slot.
7. Press the switching module in firmly to make sure the switching module connector is connected to the DAQ6510 connector.
8. Use the screwdriver to tighten the two mounting screws to secure the switching module to the mainframe. Do not overtighten.
9. Reconnect the power cord and any other cables.

Remove a switching module

NOTE

Before you remove a switching module or begin any testing, make sure that all the relays are open. Since some relays may be latched closed, you must open all the relays before removing the switching module to make connections. Additionally, if you drop your switching module, it is possible for some relays to latch closed.

To open all channel relays, go to the CHANNEL swipe screen. Select **Open All**.

WARNING

To prevent electric shock that could result in injury or death, never handle a switching module that has power applied to it. Before installing or removing a switching module, make sure the DAQ6510 is turned off and disconnected from line power. If the switching module is connected to a DUT, make sure power is removed from all external circuitry.

WARNING

If a card slot is unused, you must install slot covers to prevent personal contact with high voltage circuits. Failure to install slot covers could result in personal exposure to hazardous voltages, which could cause personal injury or death if contacted.

CAUTION

Before installing or removing a switching module, make sure the DAQ6510 power is turned off and disconnected from line power. Failure to comply may result in incorrect operation and loss of data in the memory.

Required equipment:

- Medium flat-blade screwdriver
- Medium Phillips screwdriver

To remove a switching module from the DAQ6510:

1. Turn off the DAQ6510.
2. Disconnect the power cord from the power source.
3. Disconnect the power cord and any other cables that are connected to the rear panel.
4. Position the DAQ6510 so you are facing the rear panel.
5. Use the screwdriver to loosen the mounting screws that secure the switching module to the instrument.
6. Carefully remove the switching module.
7. Install a slot plate or another switching module in the empty slot.
8. Reconnect the power cord and any other cables.

Wiring

The 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 42 V anywhere in the test system or at the front-panel inputs. For higher voltage applications, use larger wire (up to #20 AWG) and solder cup D-shell connectors.

NOTE

The 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.

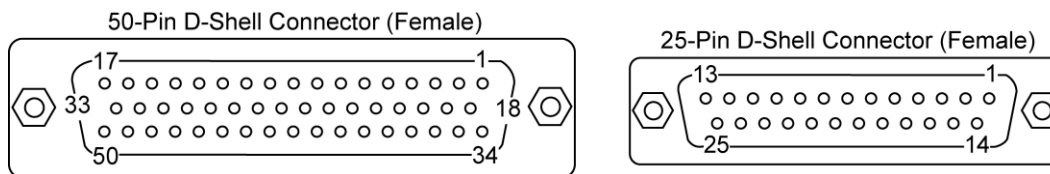
There are two connector kits that have connectors that can be used with the 7709:

- 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 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 7709.

D-shell connectors

The following figure shows the pin numbers for the 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 7709 switching modules. Terminal identification for the female connector pins are in the following table.

Figure 6: Model 7709 D-shell pinouts



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	26	Col 3 HI	1	Row 1 HI
2	Row 2 Lo	27	Col 4 Lo	2	Row 2 HI
3	—	28	Col 5 HI	3	Row 3 HI
4	Row 4 Lo	29	Col 6 Lo	4	—
5	—	30	Col 7 HI	5	Row 4 HI
6	Row 6 Lo	31	Col 8 Lo	6	Row 5 HI
7	—	32	—	7	—
8	Col 1 Lo	33	—	8	Row 6 HI
9	—	34	Row 1 Lo	9	—
10	Col 3 Lo	35	Row 3 HI	10	—
11	—	36	—	11	—
12	Col 5 Lo	37	Row 5 HI	12	—
13	—	38	—	13	—
14	Col 7 Lo	39	—	14	Row 1 Lo
15	—	40	—	15	Row 2 Lo
16	—	41	Col 2 HI	16	Row 3 Lo
17	—	42	—	17	—
18	Row 2 HI	43	Col 4 HI	18	Row 4 Lo
19	Row 3 Lo	44	—	19	Row 5 Lo
20	Row 4 HI	45	Col 6 HI	20	—
21	Row 5 Lo	46	—	21	Row 6 Lo
22	Row 6 HI	47	Col 8 HI	22	—
23	—	48	—	23	—
24	Col 1 HI	49	—	24	—
25	Col 2 Lo	50	—	25	—

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.

WARNING

When using IDC ribbon cable connections, do not exceed 42 V anywhere in the test system or to the front-panel inputs.

WARNING

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

IDC ribbon cable connections

Connect an appropriate length of 50-conductor IDC ribbon cable to a 50-pin male D-shell IDC connector. The following table provides terminal identification for the 50-pin ribbon cable connections.

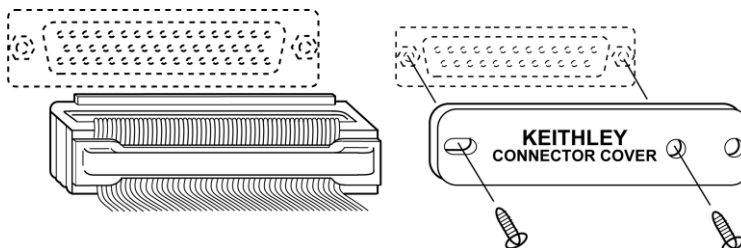
Ribbon Cable*		Matrix	DB-50		Ribbon Cable		Matrix	DB-50
Conductor	Color	Terminal	Pin #		Conductor	Color	Terminal	Pin #
1	Brown	Row 1 Hi	1		26	Blue	—	—
2	Red	Row 1 Lo	34		27	Violet	Col 3 Hi	26
3	Orange	Row 2 Hi	18		28	Gray	Col 3 Lo	10
4	Yellow	Row 2 Lo	2		29	White	Col 4 Hi	43
5	Green	Row 3 Hi	35		30	Black	Col 4 Lo	27
6	Blue	Row 3 Lo	19		31	Brown	—	—
7	Violet	—	—		32	Red	—	—
8	Gray	—	—		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 6 Lo	21		37	Violet	—	—
13	Orange	—	—		38	Gray	—	—
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	Gray	—	—		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	Gray	—	—
24	Yellow	Col 2 Lo	25		49	White	—	—
25	Green	—	—		50	Black	—	—

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

Connecting ribbon cable assembly

The following figure shows the connector of the prepared ribbon cable assembly mates to the 50-pin D-shell connector of the Model 7790. Make sure the connector cover for the 25-pin D-shell connector is installed if it is not going to be used.

Figure 7: Connecting ribbon cable assembly



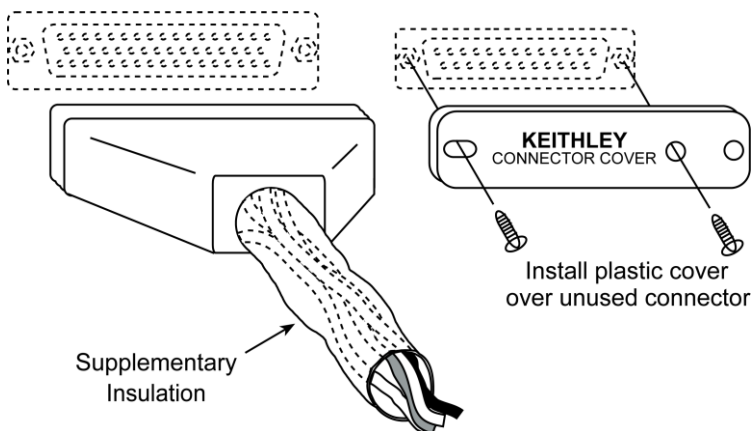
Solder cup cable connections

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 [D-shell connectors](#) (on page 7) and [DUT and external source connections](#) (on page 8). Make sure to add supplementary insulation around the harness for voltages above 42 V_{PEAK}.

⚠ WARNING

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

Figure 8: Solder cup cable connections



Row daisy-chain connections

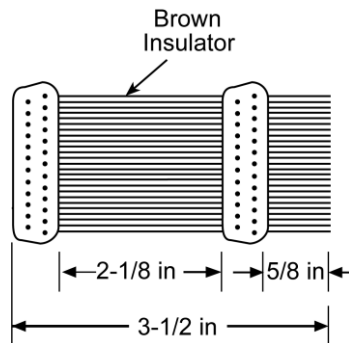
Row daisy-chain ribbon cable assembly

A convenient method to daisy-chain the two 7709s is to use a 25-conductor ribbon cable assembly with IDC ribbon cable connectors attached to it. For the DAQ6510, a two-connector ribbon cable assembly will daisy-chain two matrix modules.

To build a row of daisy-chain cable:

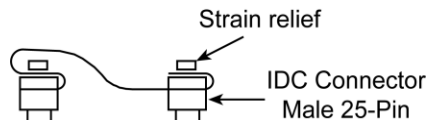
1. Start with an appropriate length of 25-conductor IDC ribbon cable. A 3½" length of cable is needed, as shown in the following figure.

Figure 9: Row daisy-chain ribbon cable assembly



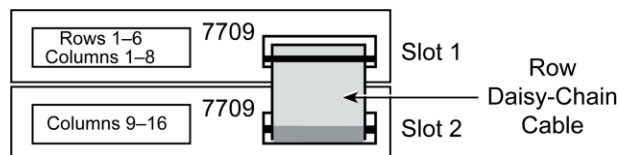
2. Route the cable over the back side of the connector and install the strain relief for the connector. Make sure the cable is firmly clamped to the connector body. The following figure shows how the cable is routed through the strain reliefs of the connectors.

Figure 10: Daisy-chain ribbon cable routing side view



The following figure shows the row of daisy-chain ribbon cables connected to the 25-pin D-shell connectors of the 7709s. Matrix terminal identification for the 25-conductor ribbon cable is provided in the following table.

Figure 11: Connecting row daisy-chain cables



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	Gray	——	——
6	Blue	Row 3 Lo	16		19	White	——	——
7	Violet	——	——		20	Black	——	——
8	Gray	——	——		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 Instruments, part number 15025.

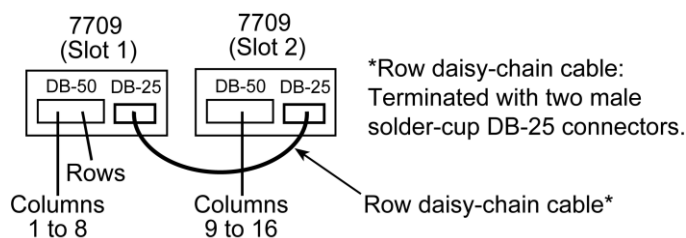
Row daisy-chaining using solder cup connectors

The following figure shows how to daisy-chain rows using solder cup connectors.

⚠ WARNING

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

Figure 12: Row daisy-chaining using solder cup connectors



Typical connections

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

- Two-wire resistance and thermistor
- Four-wire resistance and RTD
- DC or AC voltage

Figure 13: Two-wire resistor or thermistor connections

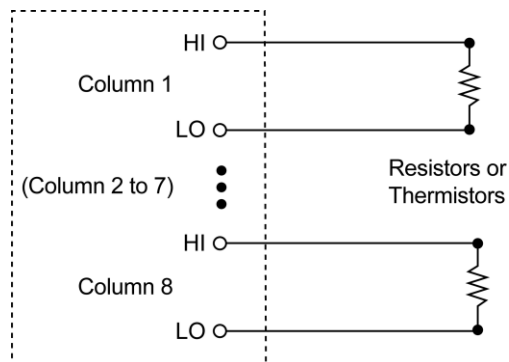


Figure 14: Four-wire resistance or RTD connections

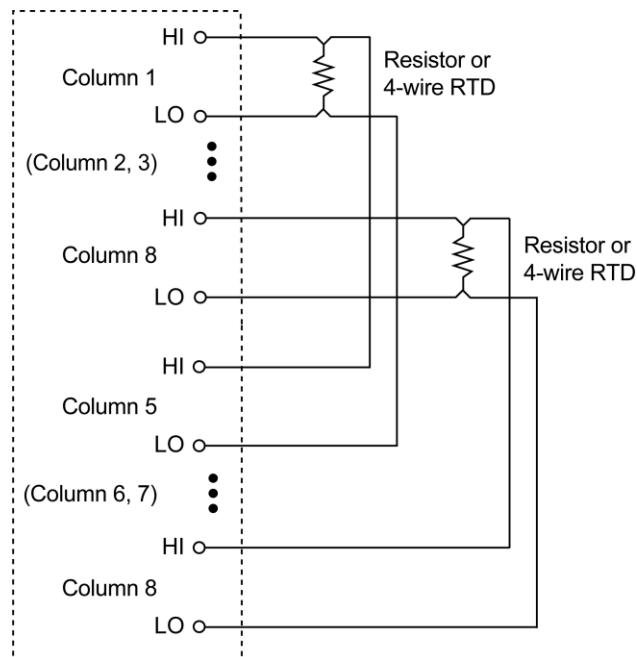
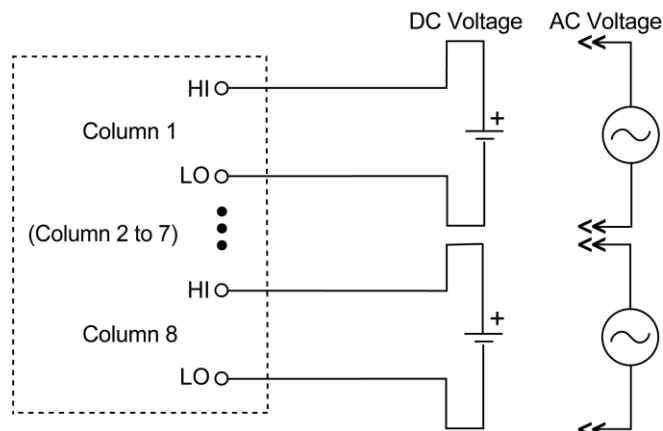


Figure 15: AC or DC voltage connections



Connection log

You can use the following table to record connection information and channel descriptions as needed.

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

The following summarizes basic operation and provides operating information specific to the 7709.

Channel operation

Channel operation is used to connect matrix columns to the DAQ6510. With a 2-wire function selected, channels 1 to 8 can be closed. When one of these channels is closed, channel 50 automatically closes to connect row 1 to the DAQ6510. The following figure shows channel 3 closed to connect column 3 to the DAQ6510.

NOTE

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

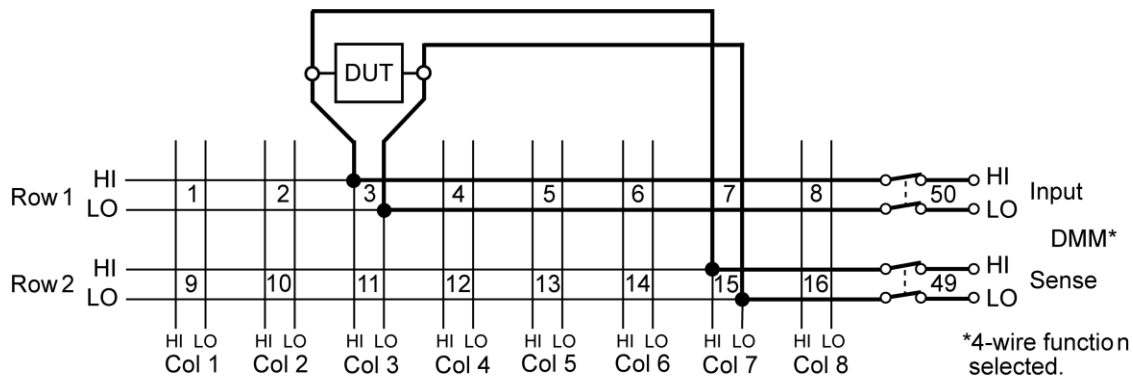
With a 4-wire function selected, channels 1 to 4 can be closed. When one of these channels is closed, its paired channel also closes, and the backplane relays for sense and input (channels 49 and 50) also close.

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

- CH1 and CH13
- CH2 and CH14
- CH3 and CH15
- CH4 and CH16

The following figure shows channel 3 closed to connect the DUT to the DAQ6510 Input and Sense.

Figure 16: Four-wire DUT measurements



Channel 3 closed to connect DUT to DMM Input and Sense.
Note that the DAQ6510 closes paired channel 15 and backplane channels 49 and 50 automatically.

NOTE

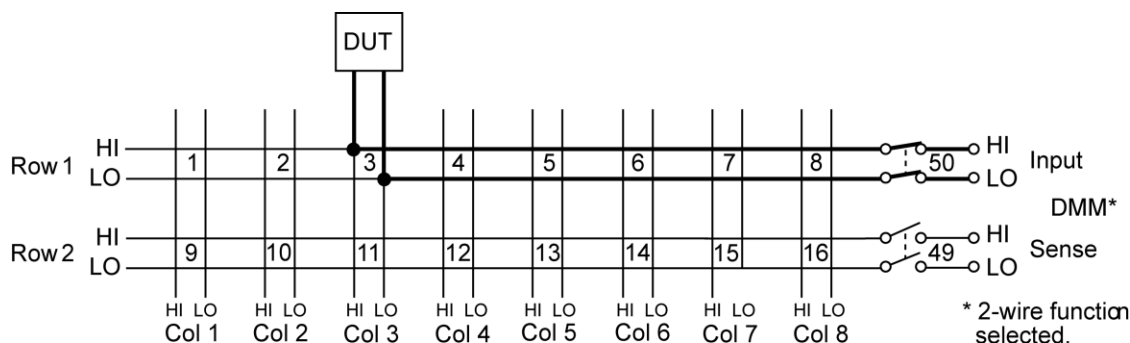
With a 4-wire function selected, channels 5 to 12 and channels 17 to 48 cannot be closed using normal channel operation.

Additional information on controlling channels is available in the *Model DAQ6510 Data Acquisition and Multimeter System Reference Manual*.

Rows 1 and 2

Normal DAQ6510 operation is used to close rows 1 and 2 channels to connect a DUT to the DMM. With a 2-wire function selected, such as DC voltage, channels 1 to 8 can be closed. When one of these channels is closed, channel 50 automatically closes to connect row 1 to the DMM Input. The following figure shows a DUT connected to column 3 of the matrix. Closing channel 3 connects the DUT to the DMM.

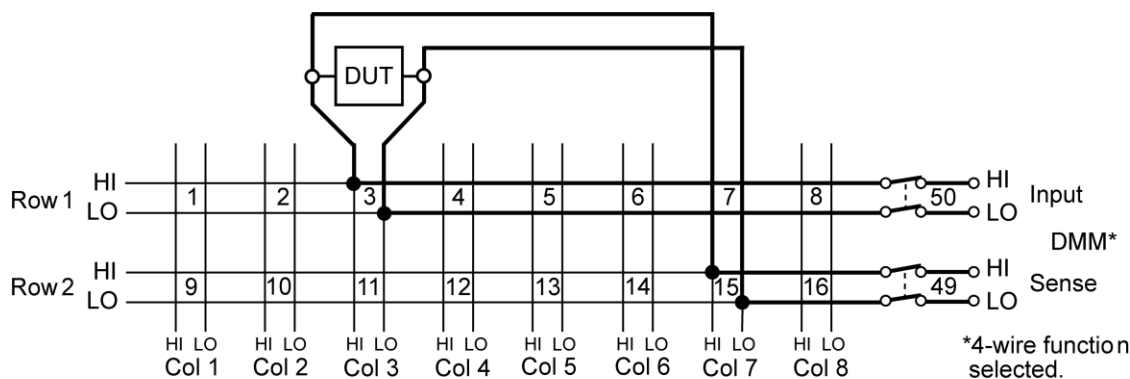
Figure 17: Two-wire DUT measurements



Channel 3 closed to connect DUT to DMM Input. Note that the DAQ6510 closes the backplane channel 50 automatically.

With a 4-wire function selected, such as 4-wire resistance, channels 1 to 4 can be closed. These four channels are paired to channels 13 to 16 (channel 1 paired to channel 13, channel 2 paired to channel 14, and so on). When one of these channels is closed, its paired channel, and channels 49 and 50 also close to connect the DUT to the DMM. As shown in the following figure, closing channel 3 also closes channels 15, 49, and 50 to connect the DUT to the DMM.

Figure 18: Four-wire DUT measurements



Channel 3 closed to connect DUT to DMM Input and Sense. Note that the DAQ6510 closes paired channel 15 and backplane channels 49 and 50 automatically.

Rows 3 to 6

As shown in figure 1, channels 17 to 48 are the channels for rows 3 to 6. These channels can only be closed using multiple channel operation (SCPI :ROUTE:MULTiple:CLOSe or TSP channel.multiple.close). When you close multiple channels, only the specified channels close. Other channels are not affected. Using normal channel operation, the channels for rows 3 to 6 cannot be closed.

WARNING

Careless multiple channel operation could create an electric shock hazard that could result in severe injury or death. Improper operation can also cause damage to the switching modules and external circuitry. Operating channels independently should be restricted to experienced test engineers who recognize the dangers associated with multiple independent channel closures. Do not attempt to perform this procedure unless you are qualified, as described by the types of product users in the [Safety precautions](#) (on page 19). Do not perform these procedures unless qualified to do so. Failure to recognize and observe normal safety precautions could result in personal injury or death.

CAUTION

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

For more information, refer to "Multiple channel operation" in the *Model DAQ6510 Data Acquisition and Multimeter System Reference Manual*.

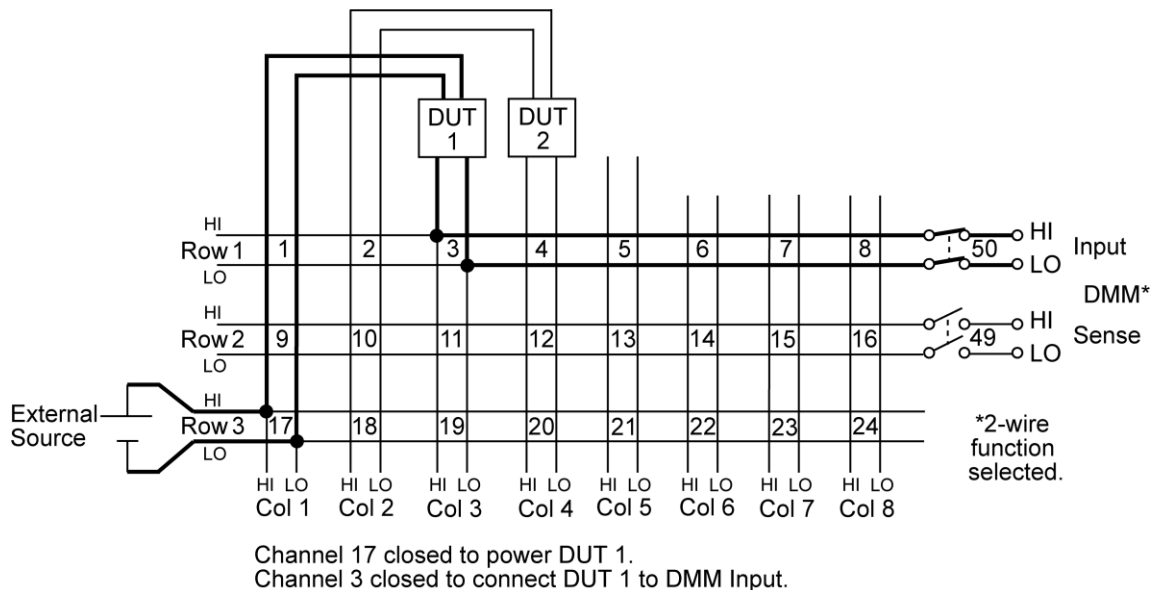
Rows 3 to 6 are used to connect one or more external sources to the test system. An external source is typically used to power a DUT. To prevent overloading of the external source, each DUT can be powered separately.

As shown in the following figure, DUT 1 is tested by closing channel 3 and channel 17. The external source is connected to row 3 and the power cables for the two DUTs are connected to columns 1 and 2.

To test DUT 2, use the following sequence:

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

Figure 19: Adding external source to the test system



Current measurements

This switching module does not support current measurements. If the instrument has the TERMINALS switch set to REAR and you are working with the slot that contains this switching module, the AC, DC, and digitize current functions are not available. You can measure current using the front panel or using another slot that contains a switching module that supports the AC, DC, and digitize current measurements.

If you use remote commands to attempt to measure current when configuring a channel, an error is returned.

Factory service

To return the switching module to Keithley Instruments for repair:

- Call the Repair Department at 1-800-833-9200 or send an email to RMAREQUEST@tektronix.com 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.

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 nonhazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by 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 user documentation for complete product specifications.

If the product is used in a manner not specified, the protection provided by the product warranty 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 user documentation. 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, perform safe installations, and repair products. Only properly trained service personnel may perform installation and service procedures.

Keithley products are designed for use with electrical signals that are measurement, control, and data I/O connections, with low transient overvoltages, and must not be directly connected to mains voltage or to voltage sources with high transient overvoltages. Measurement Category II (as referenced in IEC 60664) connections require protection for high transient overvoltages often associated with local AC mains connections. Certain Keithley measuring instruments may be connected to mains. These instruments will be marked as category II or higher.

Unless explicitly allowed in the specifications, operating manual, and instrument labels, do not connect any instrument to mains.

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 30 V RMS, 42.4 V peak, or 60 VDC 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 V, 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, ensure that 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.


For safety, instruments and accessories must be used in accordance with the operating instructions. If the instruments or accessories are used in a manner not specified in the operating instructions, the protection provided by the equipment may be impaired.


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


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

Chassis connections must only be used as shield connections for measuring circuits, NOT as protective earth (safety 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 protective earth (safety ground) using the wire recommended in the user documentation.

The  symbol on an instrument means caution, risk of hazard. The user must refer to the operating instructions located in the user documentation in all cases where the symbol is marked on the instrument.

The  symbol on an instrument means warning, risk of electric shock. Use standard safety precautions to avoid personal contact with these voltages.


The  symbol on an instrument shows that the surface may be hot. Avoid personal contact to prevent burns.

The  symbol indicates a connection terminal to the equipment frame.

If this  symbol is on a product, it indicates that mercury is present in the display lamp. Please note that the lamp must be properly disposed of according to federal, state, and local laws.

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

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

The **CAUTION** heading with the  symbol in the user documentation explains hazards that could result in moderate or minor injury or damage the instrument. Always read the associated information very carefully before performing the indicated procedure. Damage to the instrument 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. Standard fuses with applicable national safety approvals may be used if the rating and type are the same. The detachable mains power cord provided with the instrument may only be replaced with a similarly rated power cord. 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 to maintain accuracy and functionality of the product). If you are unsure about the applicability of a replacement component, call a Keithley office for information.

Unless otherwise noted in product-specific literature, Keithley instruments are designed to operate indoors only, in the following environment: Altitude at or below 2,000 m (6,562 ft); temperature 0 °C to 50 °C (32 °F to 122 °F); and pollution degree 1 or 2.

To clean an instrument, use a cloth dampened with deionized water 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., a 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.

Safety precaution revision as of June 2017.