KEITHLEY

Model 7701

User's Guide

PA-769 Rev. B / 8-03

The Model 7701 can be used with Keithley Models 2700, 2701, and 2750. All references to the Model 27xx apply to the Models 2700, 2701, and 2750.

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Safety Precautions

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.

KEITHLEY
Keithley Instruments, Inc.
28775 Aurora Road
Cleveland, Ohio 44139
(440) 248-0400
Fax: (440) 248-6168
www.keithley.com

Model 7701
User's Guide

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Introduction

NOTE *The 7701 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.*

The Model 7701 is a 32-channel high speed differential multiplexer module and has the following features:

- Voltage measurements (DC and AC).
- Frequency and period measurements.
- Normal ohms measurements:
  - 2-wire ohms to test up to 32 DUT.
  - 4-wire ohms to test up to 16 DUT. Normal Ω4 automatically pairs switches for four wire measurements — $n + 16$.
- Common-side 4-wire ohms measurements – Configures the module to allow use of a common bus to perform 4-wire ohms measurements on up to 32 DUT.
- Temperature applications (RTD or thermistor).
- 50-pin female D-Shell connector (DB-50) for channels 1 through 24.
- 25-pin female D-Shell connector (DB-25) for channels 25 through 32.
- Screw terminals and supplied jumpers to access the DMM of the Model 27xx mainframe.

WARNING **The Model 7701 is configurable to be connected to the internal DMM via the supplied jumpers and the screw terminals. When connected to the internal DMM, all other modules must be derated to 150VDC or 150Vrms (212V peak) for AC waveforms.**

NOTE *The Model 7701 is shipped from the factory with the screw terminal jumpers NOT installed. See "Screw terminals" to install the jumpers.*

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 schematic diagram of the Model 7701 module. As shown, the Model 7701 has input channels that are grouped into two banks of sixteen channels (thirty-two channels total). A backplane isolation relay is provided for each bank. The first bank contains channels 1 through 16 while the second bank contains channels 17 through 32. Each input channel of the 32-channel multiplexer card is wired with separate inputs for HI/LO providing fully isolated inputs.

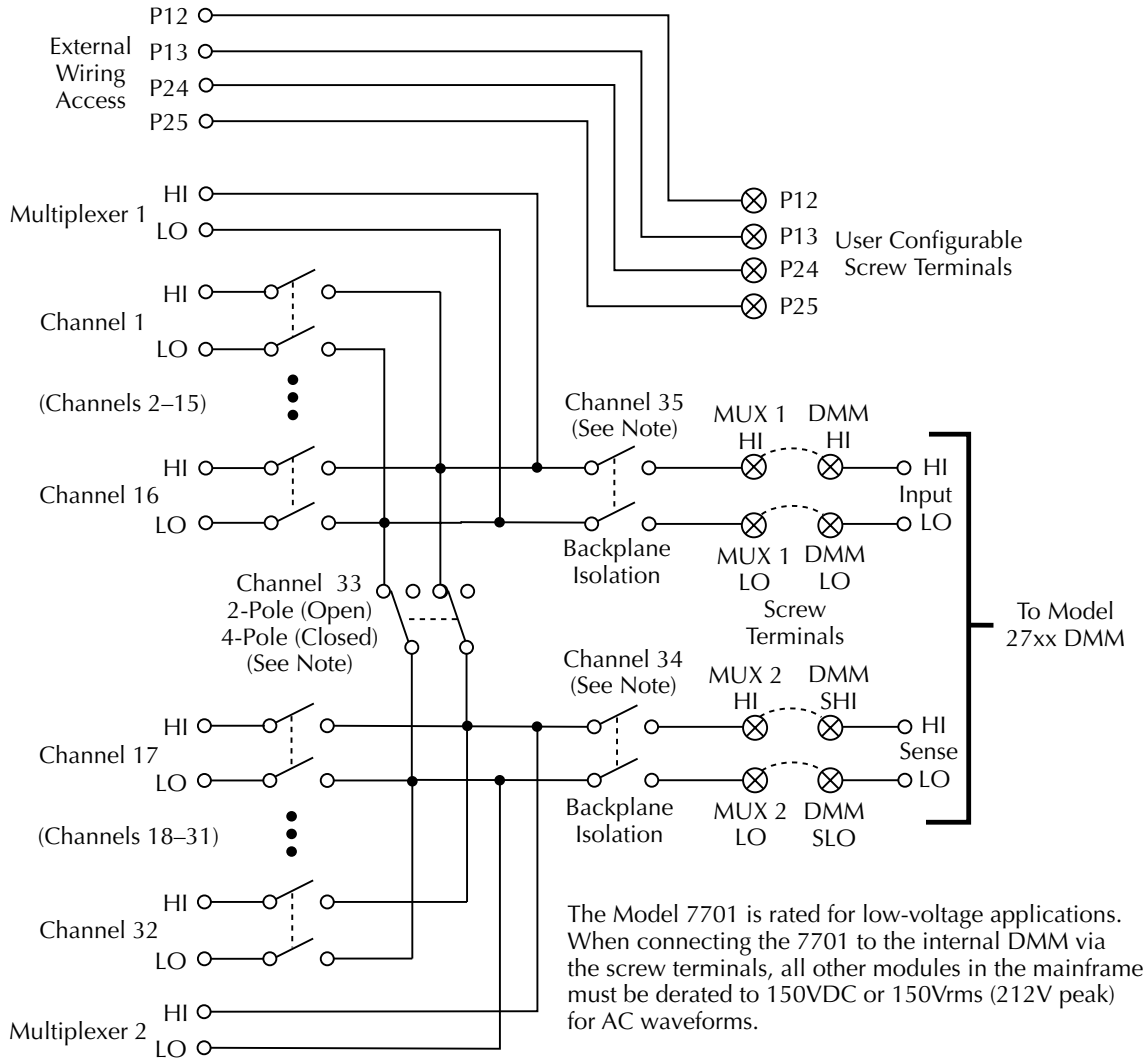
As shown in Figure 1, all Model 7701 channels are isolated from the DMM of the Model 27xx by screw terminals. Supplied jumpers must be installed in the screw terminals to connect switching module channels to the DMM.

For added flexibility, the Model 7701 is equipped with four extra screw terminals. These user-configurable screw terminals are hard-wired to the female DB-25 connector of the switching module. These screw terminals allow external input to bypass the switching module channels.

Although the Model 7701 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.

System channel operation (`ROUT:CLOS` command) is used to close measurement channels to connect a DUT to the DMM. With a 2-wire function selected (i.e., DCV), system channels 1 through 32 can be closed. When one of these channels is closed, channel 35 automatically closes to connect the channel to the DMM Input.

Figure 1
Simplified schematic for Model 7701



= Jumper to be installed by user to connect 7701 channels to DMM (Figure 3).

Notes:

Channels 33–35 in this schematic refer to the designations used for control and not actual available channels.

Channels 33, 34, and 35 can be individually controlled using multiple channel operation (ROUT:MULT commands). For more information, see Section 2 of the Model 27xx User's Manual.

With a normal 4-wire function selected (i.e., Ω4), system channels 1 through 16 can be closed. These 16 channels are paired to channels 17 through 32 (channel 1 paired to channel 17, channel 2 paired to channel 18, and so on). When one of these system channels is closed, its paired channel, and channels 33 and 34 also close to connect the DUT to the DMM.

With common-side (CSID) 4-wire ohms selected, system channels 1 through 32 can be measured by the DMM. For this ohms mode, the module is to be configured as shown in Figure 12. With CSID ohms selected, channel 33 remains open and channel 35 remains closed. In Figure 12, the bold lines show the signal path to test DUT1.

Dual independent multiplexers

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

Multiple channel operation (`ROUT:MULT:CLOS` command) allows individual control of switching module channels. Multiple channel operation allows the switching module to be configured as two independent multiplexers. The Model 7701 is normally used as a single 1×32 multiplexer, but it can also be configured as two 1×16 multiplexers.

In Figure 1, the open position of channel 33 is shown. When channel 33 is closed, Multiplexer 1 (channels 1 through 16) are isolated from Multiplexer 2 (channels 16 through 32).

For the dual multiplexer configuration, only Multiplexer 1 channels can be internally connected to the DMM of the Model 27xx. Closing channel 35 allows channels 1 through 16 to be measured by the DMM.

When using the dual multiplexer configuration, Multiplexer 2 must be isolated from the sense terminals of the DMM. This can be done by keeping channel 34 open, or by not installing the screw terminal jumpers to DMM Sense.

Connections and wiring

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

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

- **Before removing or installing the switching 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 7701. Specifications are provided at the end of this section.**

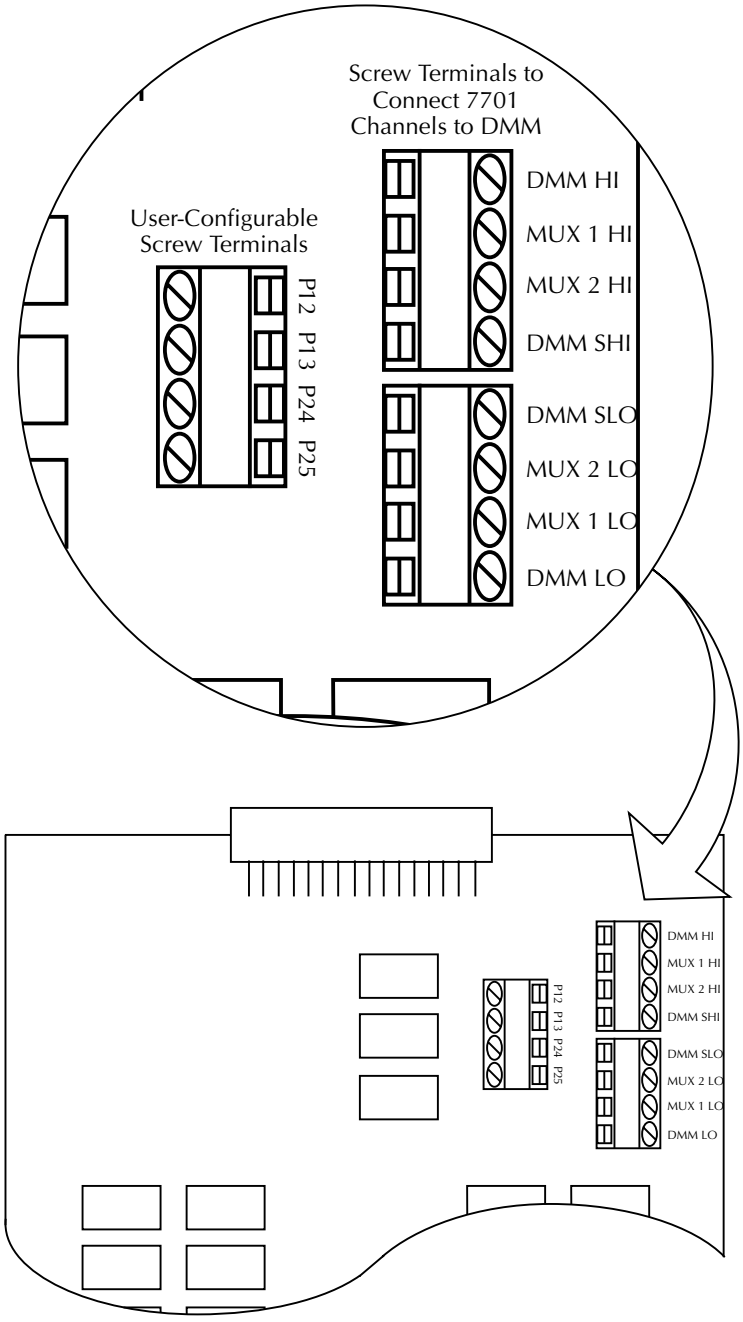
WARNING **The Model 7701 is configurable to be connected to the internal DMM via the supplied jumpers and the screw terminals. When connected to the internal DMM, all other modules must be derated to 150VDC or 150Vrms (212V peak) for AC waveforms.**

Screw terminals

The screw terminals of the Model 7701 are shown in Figure 2. As shown, screw terminals are provided to connect the switching module channels to the DMM. User-configurable screw terminals are also provided to allow external input to bypass the switching module channels.

Four jumpers are supplied with the Model 7701 for use with the screw terminals. As shown in Figure 2, the Model 7701 is shipped with the jumpers not installed. With the jumpers not installed, all input to the Model 7701 is electrically isolated from the DMM.

Figure 2
Model 7701 screw terminals

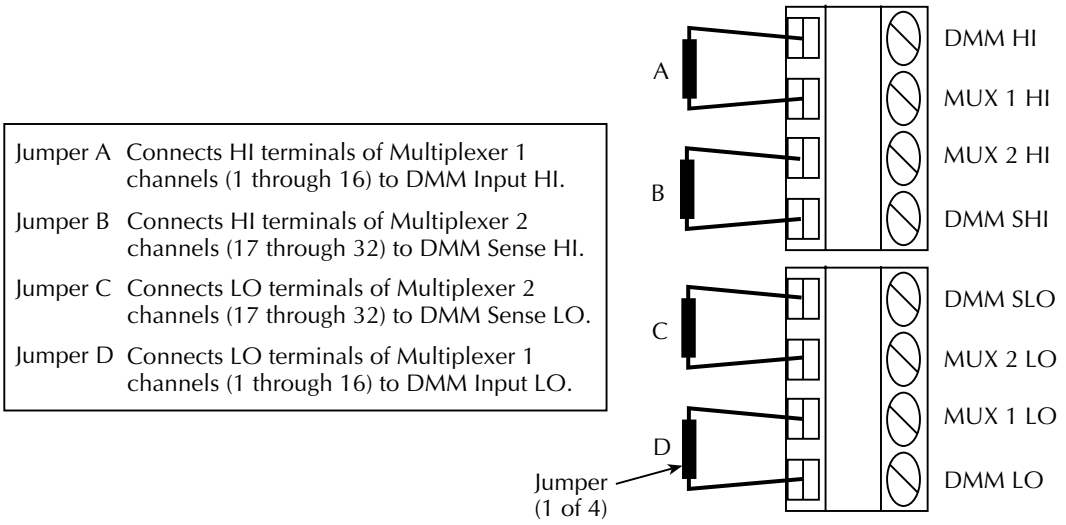


Connecting Model 7701 channels to DMM

Perform the following steps to internally connect the channels of the Model 7701 to the DMM of the Model 27xx:

1. Remove the top cover of the Model 7701. It is secured to the module case by a single screw.
2. Install the four supplied #22 AWG jumpers in the screw terminals as shown in Figure 3. Position the jumpers to allow clearance for the top cover and make sure the jumper wires do not come in contact with each other or other electrical conductors.
3. Replace the top cover.

Figure 3
Jumper installation to connect 7701 channels to DMM



D-shell connectors

Figure 4 shows the pin numbers for the Model 7701 rear panel connectors. The 50-pin D-shell is used to access channels 1 through 24, and Multiplexer 1 terminals. The 25-pin D-shell is used to access channels 25 through 32, and Multiplexer 2 terminals. The user-configurable screw terminals are also accessed at the 25-pin D-shell. Terminal identification for the female connector pins is provided in Table 1.

Figure 4
Rear view – Model 7701 pinouts

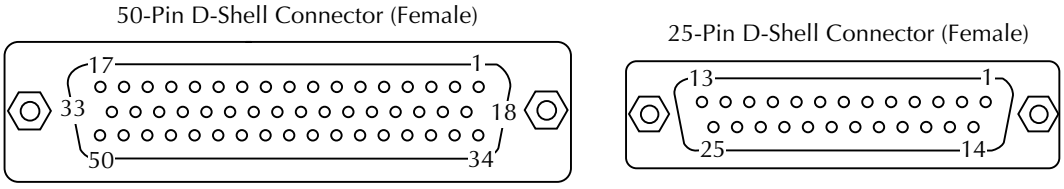


Table 1
D-shell pin identification

50-pin D-shell (DB-50)									
Pin	**7701 Terminal**	**Pin**	**7701 Terminal**	**Pin**	**7701 Terminal**	**Pin**	**7701 Terminal**	**Pin**	**7701 Terminal**
1	Ch 1 Hi	11	Ch 16 Hi	21	Ch 6 Lo	31	Ch 21 Lo	41	Ch 12 Hi
2	Ch 2 Lo	12	Ch 17 Lo	22	Ch 8 Hi	32	Ch 23 Hi	42	Ch 13 Lo
3	Ch 4 Hi	13	Ch 19 Hi	23	Ch 9 Lo	33	Ch 24 Lo	43	Ch 15 Hi
4	Ch 5 Lo	14	Ch 20 Lo	24	Ch 11 Hi	34	Ch 1 Lo	44	Ch 16 Lo
5	Ch 7 Hi	15	Ch 22 Hi	25	Ch 12 Lo	35	Ch 3 Hi	45	Ch 18 Hi
6	Ch 8 Lo	16	Ch 23 Lo	26	Ch 14 Hi	36	Ch 4 Lo	46	Ch 19 Lo
7	Ch 10 Hi	17	Mux 1 Hi	27	Ch 15 Lo	37	Ch 6 Hi	47	Ch 21 Hi
8	Ch 11 Lo	18	Ch 2 Hi	28	Ch 17 Hi	38	Ch 7 Lo	48	Ch 22 Lo
9	Ch 13 Hi	19	Ch 3 Lo	29	Ch 18 Lo	39	Ch 9 Hi	49	Ch 24 Hi
10	Ch 14 Lo	20	Ch 5 Hi	30	Ch 20 Hi	40	Ch 10 Lo	50	Mux 1 Lo

25-pin D-shell (DB-25)							
Pin	**7701 Terminal**	**Pin**	**7701 Terminal**	**Pin**	**7701 Terminal**	**Pin**	**7701 Terminal**
1	Ch 25 Hi	7	Ch 31 Hi	14	Ch 25 Lo	20	Ch 31 Lo
2	Ch 26 Hi	8	Ch 32 Hi	15	Ch 26 Lo	21	Ch 32 Lo
3	Ch 27 Hi	9	Mux 2 Hi	16	Ch 27 Lo	22	Mux 2 Lo
4	Ch 28 Hi	10, 11	—	17	Ch 28 Lo	23	—
5	Ch 29 Hi	12	P12	18	Ch 29 Lo	24	P24
6	Ch 30 Hi	13	P13	19	Ch 30 Lo	25	P25

Wiring

NOTE *The Model 7701 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 7701 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 7701:

- **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 D-shell connectors on the Model 7701.
- **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 D-shell connectors on the Model 7701.

IDC ribbon cable connections

Connect an appropriate length of 50-conductor IDC ribbon cable to a 50-pin male D-shell IDC connector, and connect an appropriate length of 25-conductor IDC ribbon cable to a 25-pin male D-shell IDC connector. Table 2 and Figure 5 provides terminal identification for the 50-pin ribbon cable connections. Table 3 and Figure 6 provides terminal identification for the 25-pin ribbon cable connections.

The connectors of the prepared ribbon cable assemblies mate to the 50- and 25-pin D-shell connectors of the Model 7701 (Figure 7). Make sure an unused D-shell connector has the connector cover installed.

Table 2
Terminal identification for 50-conductor IDC ribbon cable and 7701 DB-50 connector

Ribbon Cable*: Conductor	Color	7701 Terminal	DB-50 Pin #	Ribbon Cable*: Conductor	Color	7701 Terminal	DB-50 Pin #
1	Brown	Ch 1 Hi	1	26	Blue	Ch 13 Lo	42
2	Red	Ch 1 Lo	34	27	Violet	Ch 14 Hi	26
3	Orange	Ch 2 Hi	18	28	Grey	Ch 14 Lo	10
4	Yellow	Ch 2 Lo	2	29	White	Ch 15 Hi	43
5	Green	Ch 3 Hi	35	30	Black	Ch 15 Lo	27
6	Blue	Ch 3 Lo	19	31	Brown	Ch 16 Hi	11
7	Violet	Ch 4 Hi	3	32	Red	Ch 16 Lo	44
8	Grey	Ch 4 Lo	36	33	Orange	Ch 17 Hi	28
9	White	Ch 5 Hi	20	34	Yellow	Ch 17 Lo	12
10	Black	Ch 5 Lo	4	35	Green	Ch 18 Hi	45
11	Brown	Ch 6 Hi	37	36	Blue	Ch 18 Lo	29
12	Red	Ch 6 Lo	21	37	Violet	Ch 19 Hi	13
13	Orange	Ch 7 Hi	5	38	Grey	Ch 19 Lo	46
14	Yellow	Ch 7 Lo	38	39	White	Ch 20 Hi	30
15	Green	Ch 8 Hi	22	40	Black	Ch 20 Lo	14
16	Blue	Ch 8 Lo	6	41	Brown	Ch 21 Hi	47
17	Violet	Ch 9 Hi	39	42	Red	Ch 21 Lo	31
18	Grey	Ch 9 Lo	23	43	Orange	Ch 22 Hi	15
19	White	Ch 10 Hi	7	44	Yellow	Ch 22 Lo	48
20	Black	Ch 10 Lo	40	45	Green	Ch 23 Hi	32
21	Brown	Ch 11 Hi	24	46	Blue	Ch 23 Lo	16
22	Red	Ch 11 Lo	8	47	Violet	Ch 24 Hi	49
23	Orange	Ch 12 Hi	41	48	Grey	Ch 24 Lo	33
24	Yellow	Ch 12 Lo	25	49	White	Mux 1 Hi	17
25	Green	Ch 13 Hi	9	50	Black	Mux 1 Lo	50

*50-conductor IDC ribbon cable is available from Keithley, Part #15020.

Figure 5
50-conductor ribbon cable terminal identification

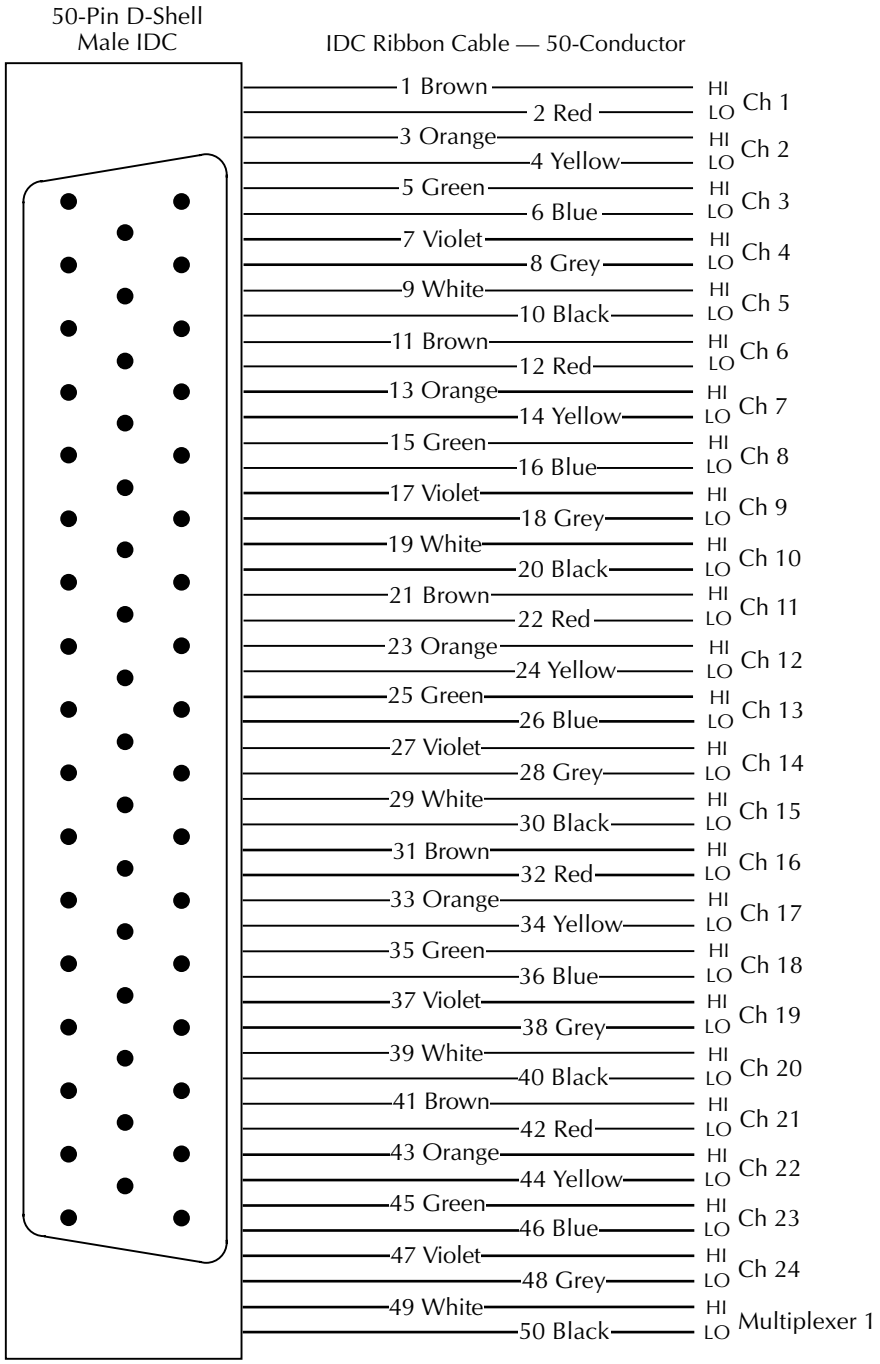


Table 3
Terminal identification for 25-conductor IDC ribbon cable and 7701 DB-25 connector

Ribbon Cable*: Conductor	Color	7701 Terminal	DB-25 Pin #	Ribbon Cable*: Conductor	Color	7701 Terminal	DB-25 Pin #
1	Brown	Ch 25 Hi	1	14	Yellow	Ch 31 Lo	20
2	Red	Ch 25 Lo	14	15	Green	Ch 32 Hi	8
3	Orange	Ch 26 Hi	2	16	Blue	Ch 32 Lo	21
4	Yellow	Ch 26 Lo	15	17	Violet	Mux 2 Hi	9
5	Green	Ch 27 Hi	3	18	Grey	Mux 2 Lo	22
6	Blue	Ch 27 Lo	16	19	White	—	—
7	Violet	Ch 28 Hi	4	20	Black	—	—
8	Grey	Ch 28 Lo	17	21	Brown	—	—
9	White	Ch 29 Hi	5	22	Red	P24	24
10	Black	Ch 29 Lo	18	23	Orange	P12	12
11	Brown	Ch 30 Hi	6	24	Yellow	P25	25
12	Red	Ch 30 Lo	19	25	Green	P13	13
13	Orange	Ch 31 Hi	7				

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

Figure 6
25-conductor ribbon cable terminal identification

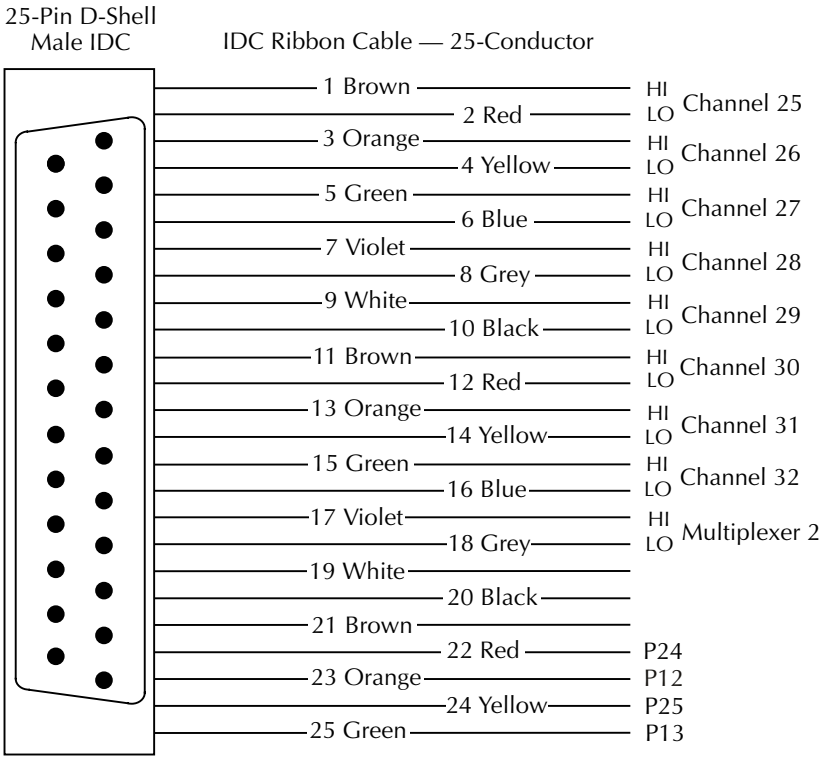
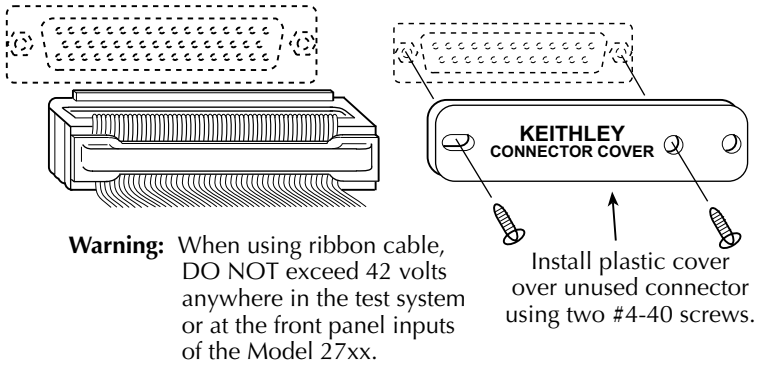


Figure 7
Connecting ribbon cable assembly



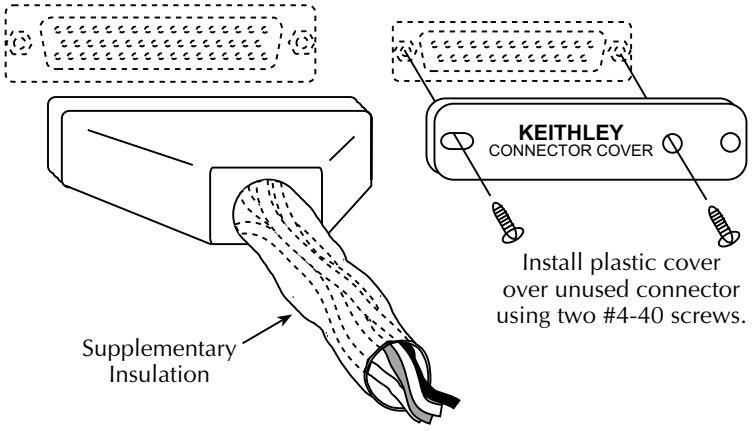
Solder cup cable connections

Make all connections to D-shell male solder cup connectors 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. Terminal identification for the 25-pin D-shell connector is provided in Table 1 and Table 3. Make sure to add supplementary insulation around the harness for voltages above 42V peak (Figure 8).

WARNING **All solder cup wiring must be rated for the maximum voltage in the system. For example, if 150V is applied to the front terminals of the DMM, All matrix module wiring must be rated for 150V.**

A connector cover must be installed on an unused D-shell connector. If the connector is left open, an electrical shock hazard may be present.

Figure 8
Connecting solder cup cable assembly



Typical connections

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

- Ω2-Wire and thermistor connections, Figure 9.
- Ω4-Wire and RTD connections, Figure 10.
- Voltage connections (AC or DC), Figure 11.

Figure 9
Ω2-Wire and thermistor connections

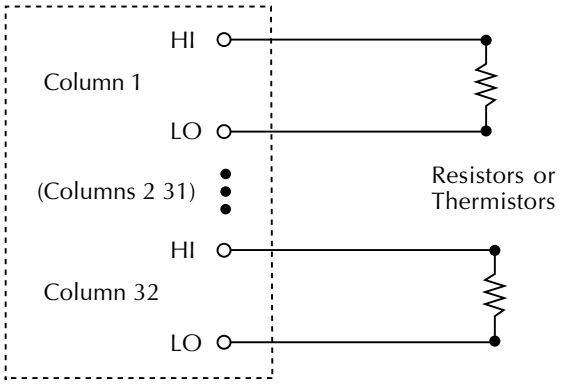


Figure 10
Ω4-Wire and RTD connections

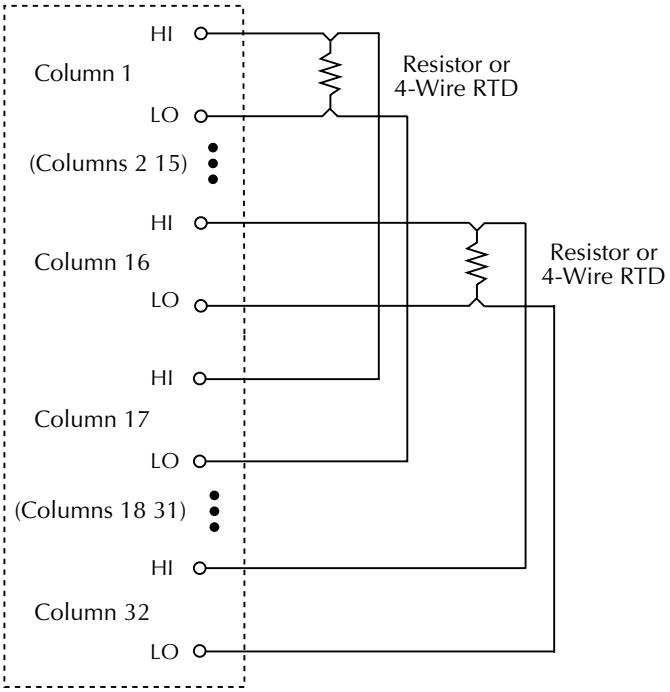
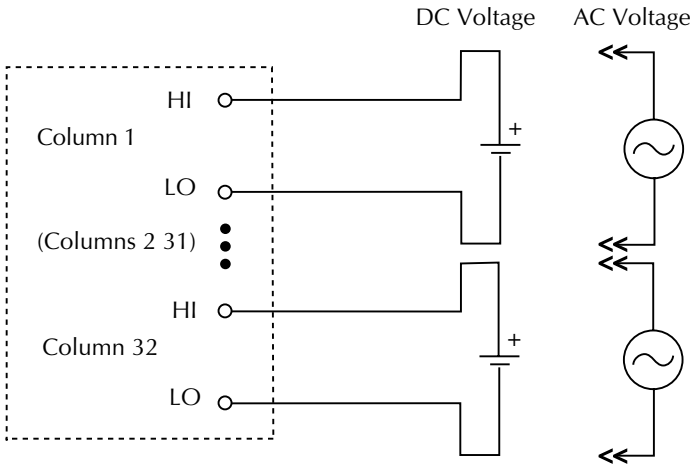


Figure 11
Voltage connections (DC or AC)



Connection log

Make a copy of Table 4 and affix it to the cover of the Model 7701. Use this to record connection information and channel descriptions as needed.

Table 4
Connection log Model 7701

Channel		Color	Description	Description	Color	Channel	
MUX 1	H					P12	
	L					P13	
MUX 2	H					P24	
	L					P25	
CH1	H					H	CH17
	L					L	
CH2	H					H	CH18
	L					L	
CH3	H					H	CH19
	L					L	
CH4	H					H	CH20
	L					L	
CH5	H					H	CH21
	L					L	
CH6	H					H	CH22
	L					L	
CH7	H					H	CH23
	L					L	
CH8	H					H	CH24
	L					L	
CH9	H					H	CH25
	L					L	
CH10	H					H	CH26
	L					L	
CH11	H					H	CH27
	L					L	
CH12	H					H	CH28
	L					L	
CH13	H					H	CH29
	L					L	
CH14	H					H	CH30
	L					L	
CH15	H					H	CH31
	L					L	
CH16	H					H	CH32
	L					L	

Operation

Detailed information to close and open switching module channels are provided in Section 2 of the Model 2700 or 2750 User's Manual. The following summarizes basic operation, and provides operating information specific to the Model 7701.

Channel assignments

The Model 2700 has two slots for switching modules and the Model 2750 has five slots. To control the appropriate switching module, the slot number must be included with the switching 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 measurement channels to the Model 27xx DMM. With 2-wire function selected, system channels 1 through 32 can be closed. When one of these channels is closed, channel 35 automatically closes to connect the measurement channel to the DMM Input.

With a 4-wire function selected, system channels 1 through 16 can be closed. When one of these channels is closed, its paired channel closes, and the backplane relays for sense and input (channels 34 and 35) also close.

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

CH1 and CH17	CH5 and CH21	CH9 and CH25	CH13 and CH29
CH2 and CH18	CH6 and CH22	CH10 and CH26	CH14 and CH30
CH3 and CH19	CH7 and CH23	CH11 and CH27	CH15 and CH31
CH4 and CH20	CH8 and CH24	CH12 and CH28	CH16 and CH32

System channel operation for the Model 7701 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.

Common-side (CSID) 4-wire ohms

The Model 7701 can be configured to use a common bus to perform 4-wire ohms measurements on up to 32 DUT. Details of CSID operation is provided in the application for Common-side 4-wire ohms measurements on page 17.

Amps measurements

The 7701 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 7701 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.**

Multiple channel operation provides independent control of switching module channels (1 through 35). When you close or open a multiple channel, only the specified channel (or channels) will close or open. Other closed or open channels are not affected.

Multiple channel operation for the Model 7701 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.
```

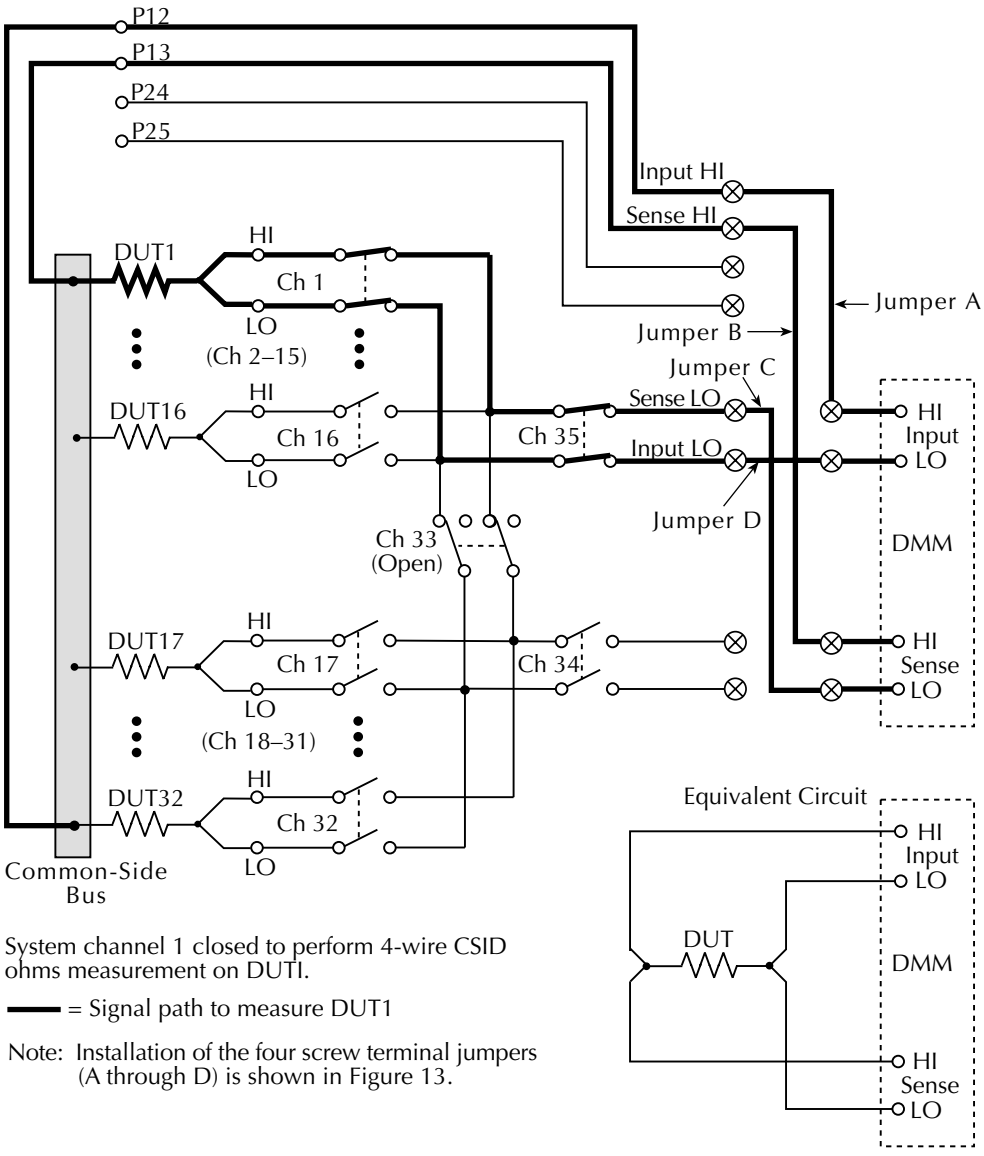
Applications

Common-side 4-wire ohms measurements

When using 4-wire ohms measurements and system channel operation, up to 16 DUT can be tested by the DMM. By using common-side (CSID) 4-wire ohms mode and the user configurable screw terminals, up to 32 DUT can be measured using 4-wire ohms. Such a test system is shown in Figure 12.

As shown in Figure 12, all 32 DUT are connected to a common metal bus. The bus is connected directly to Input HI and Sense HI of the DMM via the user-configurable screw terminals. The 32 measurement channels can then be used to connect the other side of each DUT to Input LO and Sense LO of the DMM. Jumper installation for this test system is shown in Figure 13.

Figure 12
Common-side 4-wire test system (common-side 4-wire ohms mode)



With the 4-wire common-side ohms mode selected, channels 33 and 35 are automatically controlled as follows when a system input channel (1 through 32) is closed.

- Channel 33 is forced open to connect Multiplexer 1 (channels 1 through 16) to Multiplexer 2 (channels 17 through 32).
- Channel 35 is forced closed to connect an input channel (1 through 32) to the DMM Input.

Closing input channel 1 also closes channel 35 to connect DUT1 to the DMM input. All other input channels will open (see Figure 12). Closing channel 2 also closes channel 35 to connect DUT2 to the DMM. Again, all other channels will open. The other 30 input channels are controlled in a similar manner. Closing an input channel also closes channel 35 to connect the DUT to the DMM. All other channels will open.

Selecting 4-wire ohms mode

There are two 4-wire ohms modes: NORM (normal) and CSID (common-side). For this application use the following procedure to select the CSID mode.

The 4-wire ohms mode can be selected using the following key-press sequence:

1. Press SHIFT and then press CARD.
2. Select CONFIG.
3. Select slot that has the 7701 (i.e., SLOT1: 7701).
4. Select 4W MODE: NORM (normal) or CSID (common-side).

NOTE *Changing the 4-wire ohms mode opens all channels for all modules in the mainframe.*

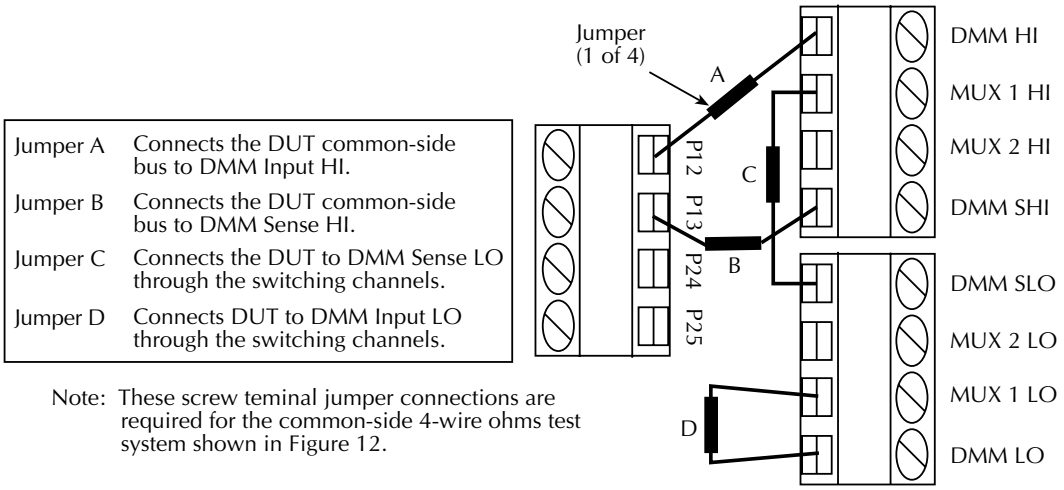
For remote programming, the following commands are valid with a 7701 module installed:

```
SYSTem:FRESistance:TYPEx, NORMal        ‘ Select normal 4W mode.
SYSTem:FRESistance:TYPEx, CSIDe         ‘ Select common-side 4W mode.
SYSTem:FRESistance:TYPEx?               ‘ Query 4W mode.
```

Where the x in TYPEx is the slot number for the 7701 module.

NOTE *For the Model 2700, the SYST:FRES:TYPEx command is only supported in units with firmware revision B03.1 or later. The command is supported for all Model 2701 and 2750 units.*

Figure 13
Jumper installation for common-side 4-wire ohms test system



Test procedure:

NOTE *The following test procedure assumes a Model 7701 switching module installed in slot 1 of the mainframe.*

1. Open all channels.

   Front panel operation: *Press OPEN > Display ALL > Press OPEN*
   Remote programming: `ROUT:OPEN:ALL`

2. Select Ω4 function.

   Front panel operation: *Press Ω4 key*
   Remote programming: `SENS:FUNC 'FRES'`

3. Select the common-side (CSID) 4-wire ohms mode.

   Front panel operation: *Press SHIFT > Press CARD > Select CONFIG > Select SLOT1: 7701 > Select 4W MODE: CSID*
   Remote programming: `SYST:FRES:TYPE1 CSID`

4. Close channel 1 to test DUT1.

   Front panel operation: *Press the ▶ key to close the first channel (Ch. 1)*
   Remote programming: `ROUT:CLOS (@101)`

5. Measure DUT #1.

   Front panel operation: *Take reading from display*
   Remote programming: `DATA? (for continuous triggering mode)`
   `READ? (for one-shot triggering mode)`

6. Close next channel to test DUT.

   Front panel operation: *Press the ▶ key to close the next channel (Ch. 2)*
   Remote programming: `ROUT:CLOS (@102)`

7. Measure DUT.

   Front panel operation: *Take reading from display*
   Remote programming: `DATA? (for continuous triggering mode)`
   `READ? (for one-shot triggering mode)`

8. In general, repeat steps 6 and 7 to test DUT3 through DUT32. That is, close the DUT input channel and take a measurement.

9. After all DUT is tested, repeat step 1 to open all channels.

10. Return the Model 27xx to the normal ohms mode.

    Front panel operation: *Press SHIFT > Press CARD > Select CONFIG > Select SLOT1: 7701 > Select 4W MODE: NORM*
    Remote programming: `SYST:FRES:TYPE1 NORM`

Multiple module system

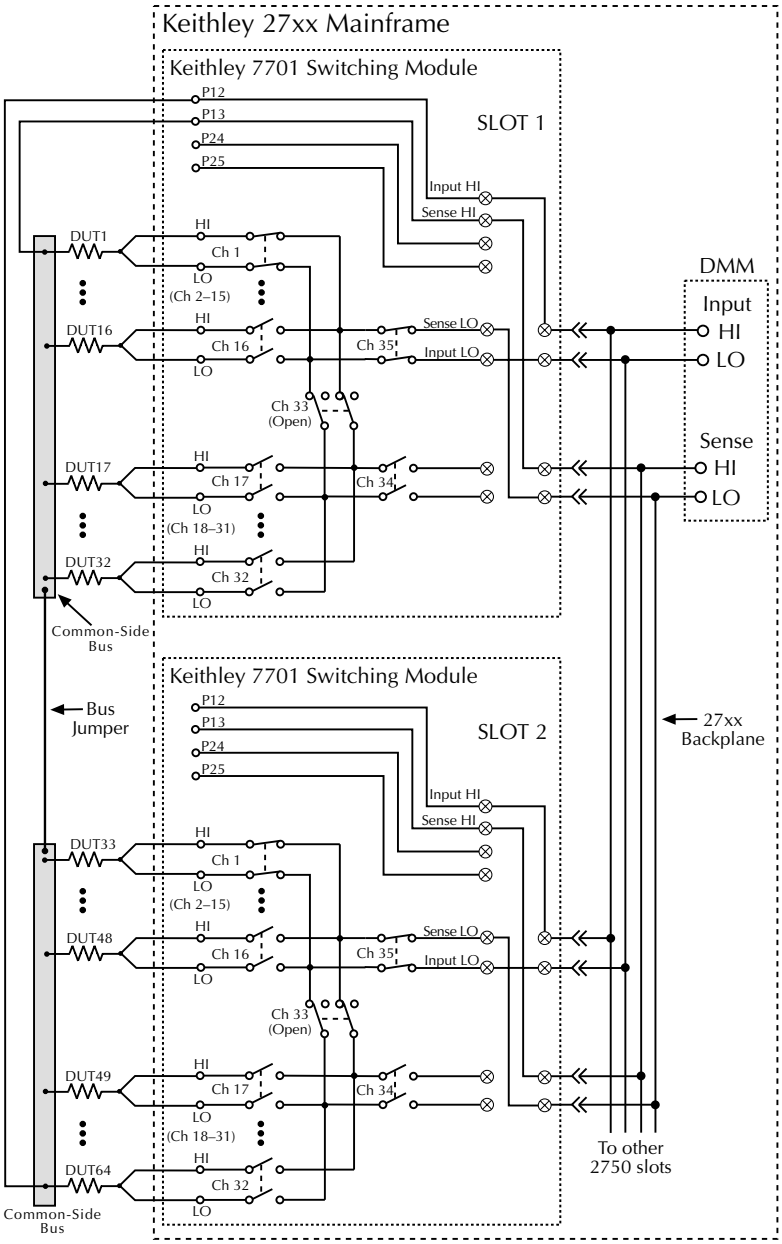
Figure 12 shows a one-card test system to perform common-side ohms measurements on up to 32 DUT. The test system can be expanded to test more DUT by adding one or more modules:

- Models 2700 and 2701 – Adding a second Model 7701 to the test system allows up to 64 DUT to be tested.
- Model 2750 – Use up to five Model 7701s to test up to 160 DUT.

When adding a Model 7701 module to a common-side ohms test system, you must wire the card properly to minimize path resistance, especially for low-ohms measurements. Figure 14 shows how to properly wire a multiple card system for common-side ohms measurements. This connection scheme will minimize signal path resistance through the backplane connections of the modules.

Notice that for the second module (slot 2), the P12 and P13 terminals are not used. Only the P12 and P13 terminals of the first module are to be connected. It is best to use one common-side bus for all DUT. However, if more than one bus must be used, connect them together using a bus jumper (as shown in Figure 14).

Figure 14
Multiple module test system (common-side ohms)



Biasing and measuring DUT (dual multiplexing)

WARNING **Multiple channel operation is required for the following application. Multiple channel operation should only be performed by experienced test engineers who recognize the dangers associated with multiple channel closures.**

This application demonstrates how to use the Model 7701 as a dual multiplexer to bias and measure 16 DUT. An external source powers DUT, while the DMM of the Model 27xx measures the output of the DUT. To prevent overloading of the external source, each DUT is powered (and measured) separately.

Figure 15 shows the connections for this application. The external source is connected to the Multiplexer 2 terminals of the switching module, and DUT is connected to channels 1 through 16. Channels 17 through 32 are used to connect external power to each DUT.

For this application, channels 33, 34, and 35 are to be controlled as follows:

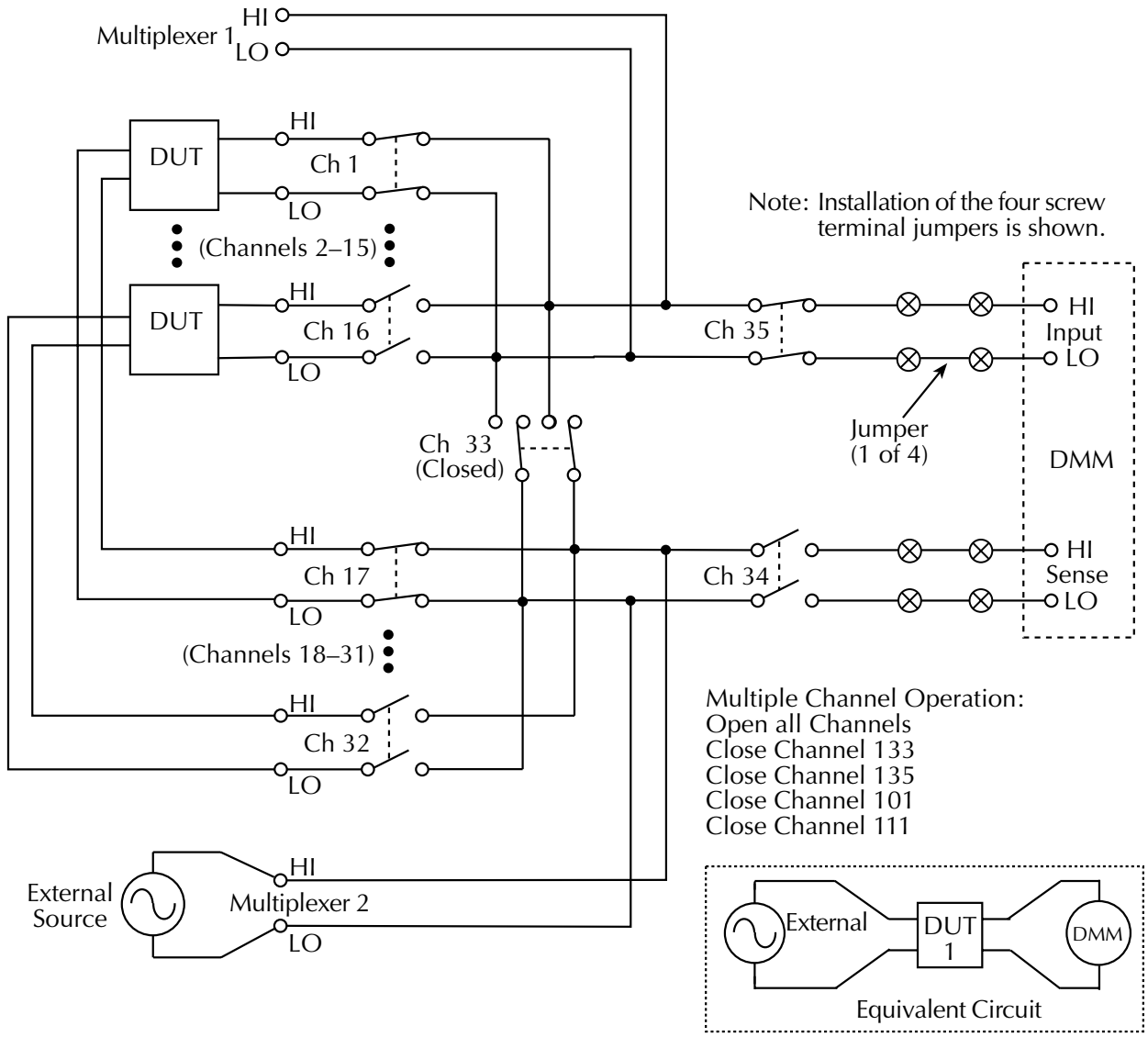
- Closing channel 33 isolates the input measurement channels 1 through 16 (Multiplexer 1) from the external source channels 11 through 20 (Multiplexer 2). It also connects the DUT to the external source. This channel must remain closed while testing DUT.
- Opening channel 34 isolates the external source from the backplane of the Model 2750. This channel must remain open while testing DUT.
- Closing channel 35 connects an input channel (1 through 16) to the DMM. This channel must remain closed while testing DUT.

In Figure 15, channels 1 and 17 are closed to test DUT 1. The test for the other DUTs is similar except that different source and measure channels are closed. Closed channels for each DUT test are listed as follows:

Tested Device	Closed Channels
DUT 1	1, 17, 33, and 35
DUT 2	2, 18, 33, and 35
DUT 3	3, 19, 33, and 35
DUT 4	4, 20, 33, and 35
DUT 5	5, 21, 33, and 35
DUT 6	6, 22, 33, and 35
DUT 7	7, 23, 33, and 35
DUT 8	8, 24, 33, and 35

Tested Device	Closed Channels
DUT 9	9, 25, 33, and 35
DUT 10	10, 26, 33, and 35
DUT 11	11, 27, 33, and 35
DUT 12	12, 28, 33, and 35
DUT 13	13, 29, 33, and 35
DUT 14	14, 30, 33, and 35
DUT 15	15, 31, 33, and 35
DUT 16	16, 32, 33, and 35

Figure 15
Biasing and measuring DUT test system (multiple channel operation)



Test procedure:

NOTE *The following test procedure assumes a Model 7701 switching module installed in slot 1 of the mainframe.*

Multiple channel operation from the front panel is not available for early versions of the Model 2700.

1. Open all channels.

   Front panel operation: *Press OPEN > Display ALL > Press OPEN*
   Remote programming: `ROUT:OPEN:ALL`

2. Close channel 33 to isolate measure channels (1 through 16) from source channels (17 through 32).

   Front panel operation: *Press CLOSE > Select MULTI > Key in 133 > Press ENTER*
   Remote programming: `ROUT:MULT:CLOS (@133)`

3. Close channel 35 to connect measure channels (1 through 16) to DMM Input.

   Front panel operation: *Press CLOSE > Select MULTI > Key in 135 > Press ENTER*
   Remote programming: `ROUT:MULT:CLOS (@135)`

4. Close channel 1 to connect DUT 1 to the DMM.

   Front panel operation: *Press CLOSE > Select MULTI > Key in 101 > Press ENTER*
   Remote programming: `ROUT:MULT:CLOS (@101)`

5. Close channel 17 to connect DUT 1 to the external source.

   Front panel operation: *Press CLOSE > Select MULTI > Key in 117 > Press ENTER*
   Remote programming: `ROUT:MULT:CLOS (@117)`

6. Measure DUT 1.

   Front panel operation: *Take reading from display*
   Remote programming: `DATA? (for continuous triggering mode)`
   `READ? (for one-shot triggering mode)`

7. Open channels 1 and 17 to disconnect the DMM and external source from DUT 1.

   Front panel operation: *Press OPEN > Select MULTI > Key in 101 > Press ENTER*
   Press OPEN > Select MULTI > Key in 117 > Press ENTER
   Remote programming: `ROUT:MULT:OPEN (@101,117)`

8. In general, repeat steps 4 through 7 to test DUT 2 through DUT 16. That is, close the channels to connect the DUT to the DMM and external source, take a measurement, and then open the channels to disconnect the DUT from the DMM and external source.

9. After all DUT is tested, repeat step 1 to open all channels.

Service

Service for the Model 7701 includes a procedure to verify performance, and provides replaceable parts information.

WARNING **All service information is intended only for qualified service personnel. Do not attempt to service the Model 7701 unless you are qualified to do so.**

Performance verification

Use the performance verification procedure for the Model 7701. This procedure is provided in PA-775 of this manual.

Replaceable parts

This section contains replacement parts information and the component layout drawing for the Model 7701.

Parts list

Replaceable parts for the Model 7701 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 7701).
- 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 the Model 7701 is provided in Figure 16.

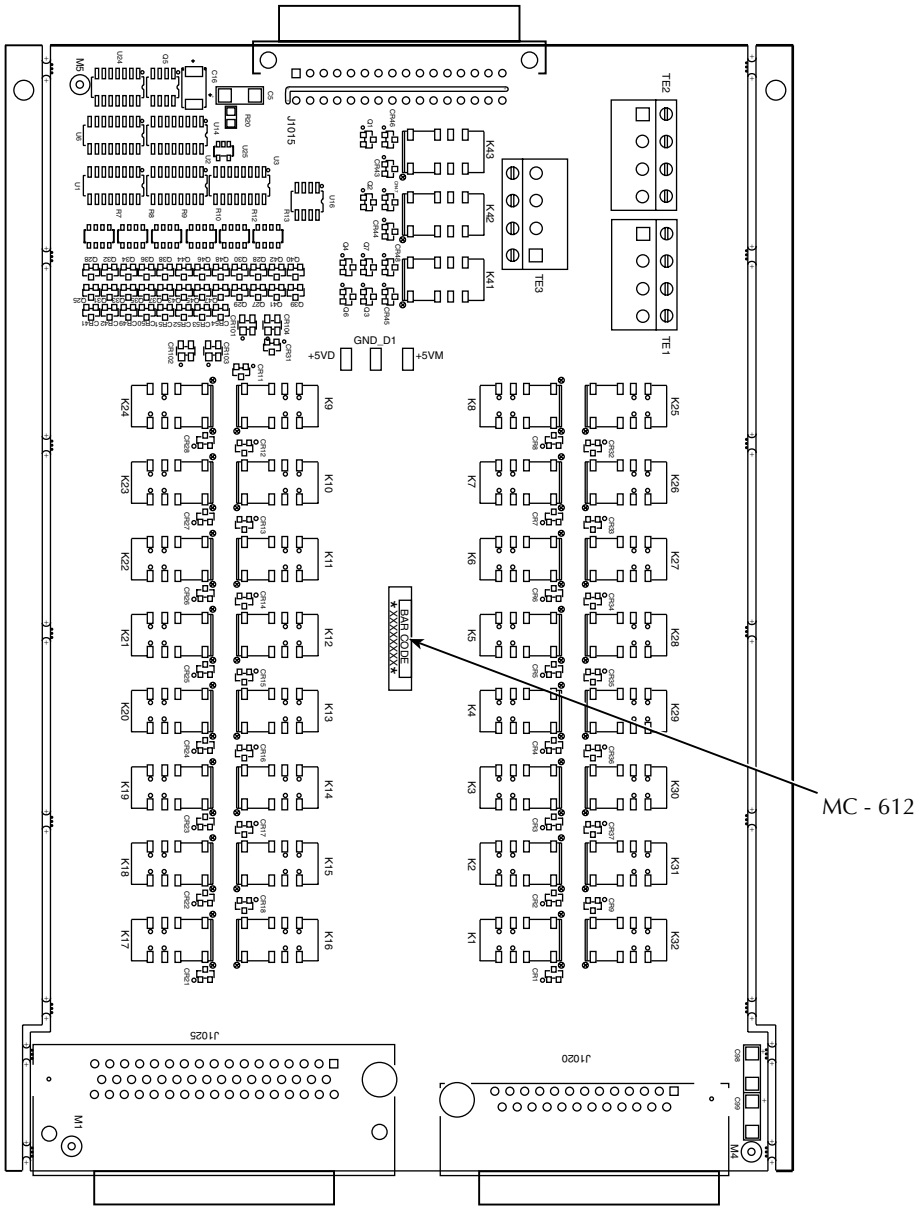
Table 5
Model 7701 parts list

Circuit Designation	Description	Keithley Part No.
C1, C3, C4, C9, C10, C11, C14	CAP, .1UF, 20%, 50V, CERAMIC (1206)	C-418-.1
C2, C6, C17, C18, C19, C20, C23, C24, C25	CAP, 47PF, 5%, 100V, CERAMIC (0805)	C-465-47P
C5, C98, C99	CAP, 4.7UF, 10%, 35V, TANTALUM	C-476-4.7
C16	CAP, 220UF, 20%, 10V, TANTALUM	C-558-220
CR1-CR9,CR11-CR18, CR21-CR28, CR31-CR37	DIODE, DUAL SWITCHING, BAV99L (SOT-23)	RF-82
CR41, CR42, CR45, CR48-CR54	DIODE, DUAL SWITCHING, BAV99L (SOT-23)	RF-82
CR43, CR44, CR46, CR47	DIODE, SWITCHING, MMBD914 (SOT-23)	RF-83
CR101, CR102, CR103, CR104	DUAL HIGH SPEED DIODE	RF-147
J1015	CONN, RT ANGLE DUAL ROW RECEPT	CS-1065-1
J1020	CONN, FEMALE, 25-PINS	CS-484
J1025	CONN, RT ANGLE 50-PINS	CS-1061-1
K1-K32, K41	SINGLE COIL LATCH RELAY	RL-225
K42, K43	NON LATCHING RELAY	RL-242
Q1-Q4, Q26, Q34, Q36, Q38, Q40, Q42, Q44, Q46	TRANS, NPN SILICON	TG-389
Q5	N-CHANNEL/P-CHANNEL POWER MOSFET	TG-360
Q6, Q7, Q25, Q27, Q29, Q31, Q33, Q35, Q37, Q39	TRANS, PNP SILICON	TG-388
Q41, Q43, Q45, Q47	TRANS, PNP SILICON	TG-388
Q48	TRANS, NPN SILICON	TG-389
R1	RES, 69.8K, 1%, 1W, THICK FILM	R-418-69.8K
R2, R3, R5, R6, R108, R109, R110, R112	RES, 1K, 1%, 100MW, THICK FILM (0805)	R-418-1K
R4	RES, 10K, 1%, 100MW, THICK FILM (0805)	R-418-10K
R7, R8, R9, R10	RES ARRAY 4X4.3K, 5%, .125W	TF-276-4.3K
R11, R15, R16, R17, R18, R19	RES, 2.21K, 1%, 1/4W, METAL FILM (1206)	R-391-2.21K
R12, R13	RES, ARRAY 4X1K, 5%, .125W	TF-276-1K
R14, R55	RES, 49.9, 1%, 1/4W, METAL FILM (1206)	R-391-49.9
R20	RES, 4.75K, 1%, 100MW, THICK FILM (0805)	R-418-4.75K
TE1, TE2, TE3	CONN, 4-PIN, JOLO BB-125-04	TE-115-4
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, HEX SCHMITT INVERT TRIGGER	IC-1397
	25 D-SHELL MALE	7709-307A

Table 5 (cont.)
Model 7701 parts list

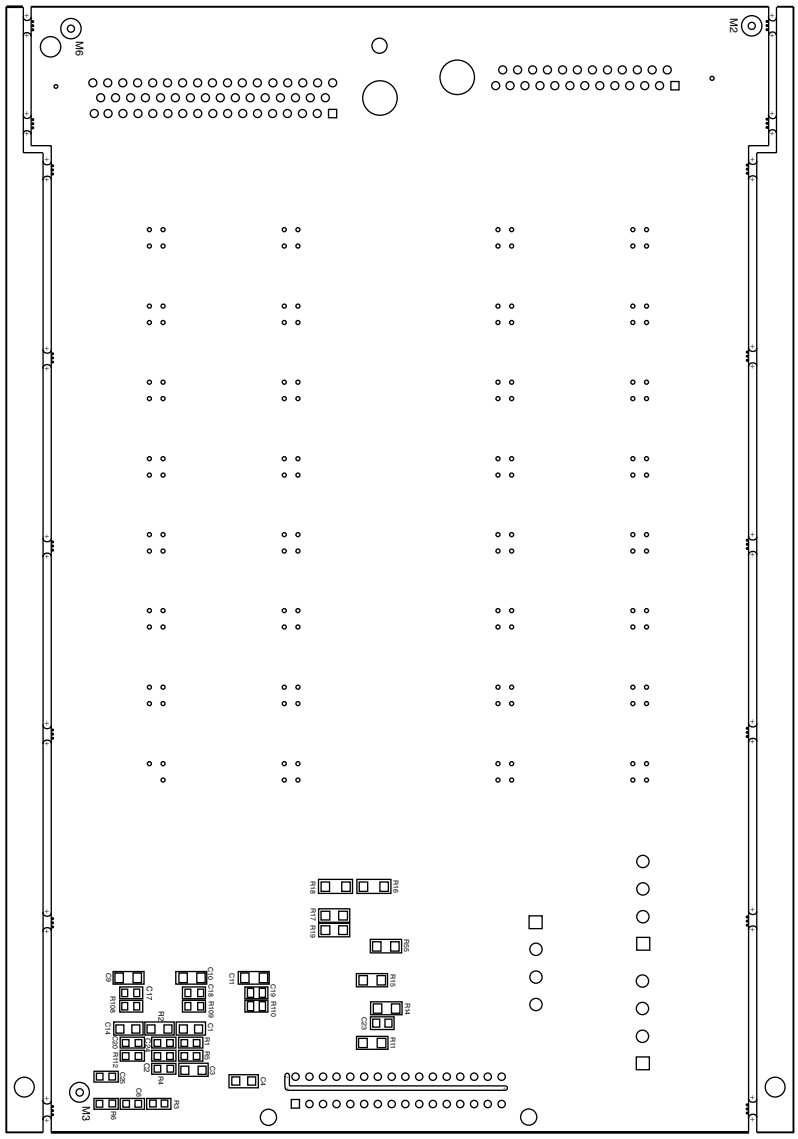
Circuit Designation	Description	Keithley Part No.
	4-40 X 1/4 LG. PHIL. FLAT HD. SCREW	4-40X1/4PFH
FOR 7709-312A	4-40 X 1/4 PHILLIPS PAN HD.	4-40X1/4PPH
	4-40 X 7/16 STANDOFF	ST-166-18
	BOTTOM CARD COVER	7703-301B
	CHIPLOC BAG STATIC SHIELDING	PO-13-1
	D-SUB CABLE KIT	7709-306A
	DUAL CONN COVER	7709-312A
	FINAL INSPECTION	7701-FIN-51
	HOLE SIZE	7701-102B
	MULTIPLEXER 0 U	32 CHANNE
	JUMPER	J-15
	MASS TERM BRACKET	7709-303-2A
	MECHANICAL ASSEMBLY	7701-SCAN-MECH-3
	SCANNER PC BOARD ASSEMBLY	7701-100B
	SCANNER BOARD SURFACE MOUNT BOTTOM	7701-SCAN-1B
	SCANNER BOARD THRU HOLE	7701-SCAN-1H
	SCANNER BOARD SURFACE MOUNT TOP	7701-SCAN-1T
	SERIAL NUMBER LABEL	MC-285
	SURFACE MOUNT PCB TEST POINT	CS-1026
	TOP CARD COVER	7703-302C

Figure 16
Model 7701 component layout (Side-06)



Primary Side Components (Side - 06)
Note: For component information, see 7701 Product Structure.

Figure 17
Model 7701 component layout (Side-01)



Secondary Side Components (Side - 01)
Note: For component information, see 7701 Product Structure.

7701 150V 32-Channel Differential Multiplexer

GENERAL

32 CHANNELS: 32 channels of 2-pole relay input. All channels configurable to 4-pole.

RELAY TYPE: Latching electromechanical.

ACTUATION TIME: <3ms.

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

DMM CONNECTIONS: Screw terminals provide internal DMM connections to channels 34 and 35 and connections to external wiring access.

CAPABILITIES

CHANNELS 1–32: Multiplex one of 32 2-pole or one of 16 4-pole signals into DMM. Configuration supports dual 1×16 independent multiplexers.

INPUTS

MAXIMUM SIGNAL LEVEL: Any channel to Any Channel (1–32): 150V DC or 150Vrms (212V 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): $>10^5$ operations at max signal level.
$>10^8$ operations cold switching.

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

CONTACT POTENTIAL: <6µV per contact pair.

OFFSET CURRENT: <100pA.

CONNECTOR TYPE: 50-pin female D-shell, Channels 1–24.
25-pin female D-shell, Channels 25–32.
Supplied with male IDC ribbon cable connectors.

ISOLATION BETWEEN ANY TWO TERMINALS: $>10^9$Ω, <200pF.

ISOLATION BETWEEN ANY TERMINAL AND EARTH: $>10^9$Ω, <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.

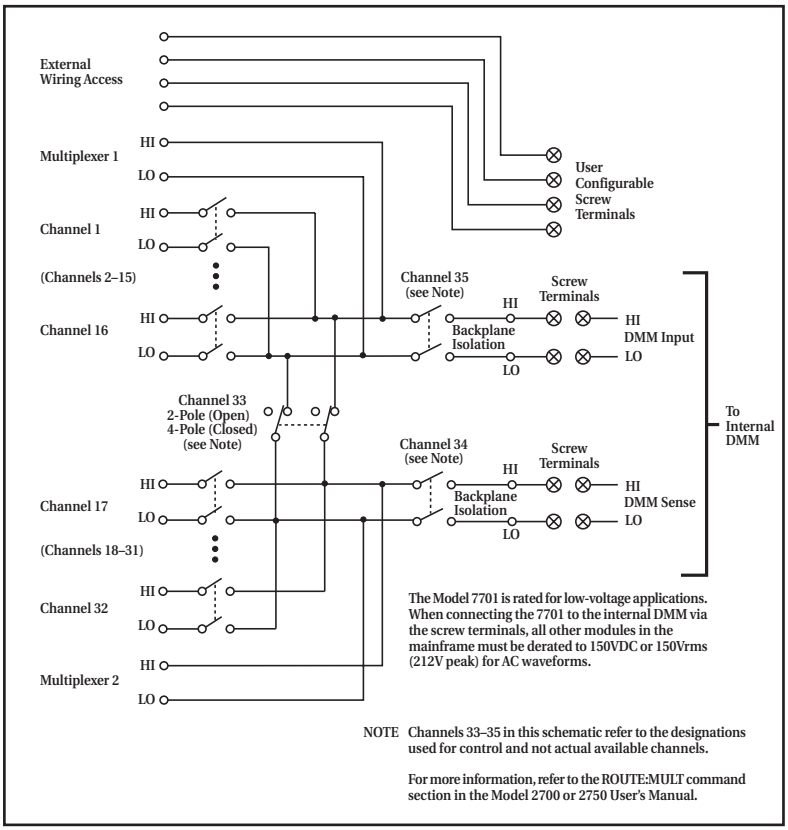
ENVIRONMENTAL:

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



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Keithley Instruments, Inc. 28775 Aurora Road • Cleveland, Ohio 44139 • 440-248-0400 • Fax: 440-248-6168
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Sales Offices:

BELGIUM:	Bergensesteenweg 709 • B-1600 Sint-Pieters-Leeuw • 02-363 00 40 • Fax: 02/363 00 64
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JAPAN:	New Pier Takeshiba North Tower 13F • 11-1, Kaigan 1-chome • Minato-ku, Tokyo 105-0022 • 81-3-5733-7555 • Fax: 81-3-5733-7556
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1/03