

Keithley Instruments

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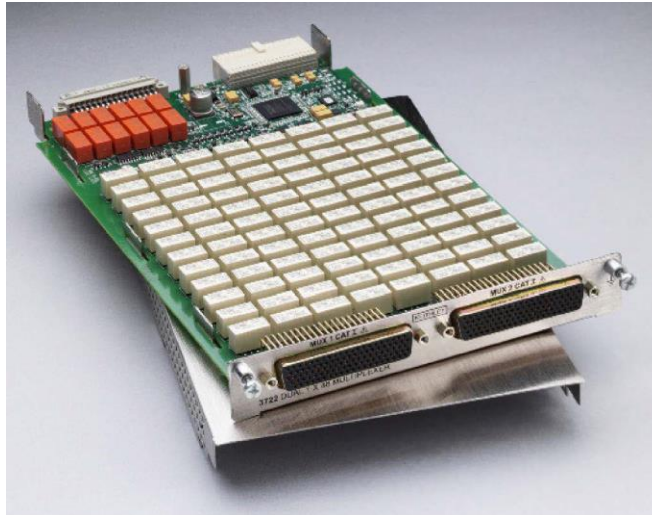
Introduction

The Model 3722 offers two independent banks of 1x48 two-pole multiplexers that are ideal for applications that require a high channel count. The two banks can be automatically connected to the Series 3700A mainframe backplane and optional DMM through the analog backplane connection relays. This connection allows the mainframe to reconfigure the 3722 as a single 1x96 two-pole multiplexer or to enable card-to-card expansion for even larger configurations. The latching electromechanical relays of this card can accommodate 300 V, 1 A switched signal levels.

The 3722 uses two 104-pin D-sub connectors for signal connections. A solder style connector kit (3722-MTC-1.5-KIT) and pre-assembled cable (3722-MTC-1.5/MM) are available for card connections. For more information regarding available cards and accessories, refer to the *Series 3700A System Switch/Multimeter and Plug-in Cards* datasheet, available at tek.com/keithley.

The 3722 card is shown in the following figure.

Figure 1: Model 3722 Two-Pole Multiplexer Card



Item shipped may vary from model pictured here.

This document describes how to install the plug-in card and make connections to it. For information on scanning, and on reading, writing, and controlling channels, refer to the *Series 3700A System Switch/Multimeter Reference Manual*, available at tek.com/keithley.



Safety precautions for connections

WARNING

Shock hazard. To prevent electric shock that could result in serious injury or death, comply with these safety precautions.

Connection information for plug-in cards is intended for qualified service personnel. Do not attempt to connect devices under test (DUTs) or external circuitry to a plug-in card unless you are qualified.

As described in the International Electrotechnical Commission (IEC) Standard IEC 60664, the Series 3700A is Installation Category O and signal lines must not be directly connected to AC mains.

Before making or breaking any connections to the plug-in card, make sure the Series 3700A instrument power is turned off and power is removed from all external circuitry.

Do not connect signals that will exceed the maximum specifications of any installed plug-in card. If the rear analog backplane connector of the instrument and the plug-in card terminals are connected at the same time, the test lead insulation must be rated to the highest voltage that is connected. For example, if 300 V is connected to the analog backplane connector, the test lead insulation for the plug-in card must also be rated for 300 V.

Dangerous arcs of an explosive nature in a high-energy circuit can cause severe personal injury or death if contacted. If the multimeter is connected to a high-energy circuit when set to a current range, low-resistance range, or any other low-impedance range, the circuit is virtually shorted. Dangerous arcing can result, even when the multimeter is set to a voltage range, if the minimum voltage spacing is reduced in the external connections.

Use test leads that are fully insulated. Use only test leads that can be connected to the circuit (for example, alligator clips and spade lugs) for hands-off measurements. Do not use test leads that decrease voltage spacing. These diminish arc protection and create a hazardous condition.

Card installation

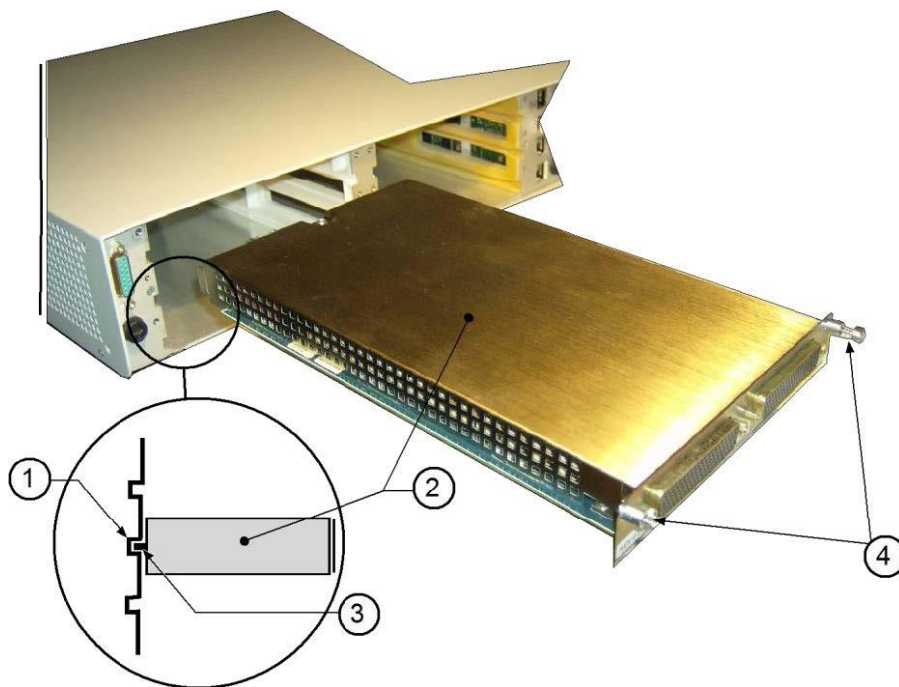
WARNING

Slot covers must be installed on unused slots to prevent personal contact with high-voltage circuits. Failure to recognize and observe standard safety precautions could result in personal injury or death due to electric shock.

To install a switching card into the instrument mainframe:

1. Turn the instrument off.
2. Position the instrument so that you are facing the rear panel.
3. Disconnect the power line cord and any other cables connected to the rear panel.
4. Remove the slot cover plate from the mainframe slot. Retain the plate and screws for future use.
5. With the top cover of the switching card facing up, align the card edge into the card guide of the slot, as shown in the following figure.
6. Slide in the card. For approximately the last ¼ inch, press in firmly to seat the card connector to the mainframe connector.
7. On each side of the card, there is a mounting screw. Use a flat-bladed screwdriver to tighten the two mounting screws to secure the card to the mainframe. Do not overtighten.
8. Reconnect the power line cable and any other cables to the rear panel.
9. Turn the instrument on.

Figure 2: Module installation



Item shipped may vary from model pictured here.

Item	Description
1	Card guide (part of mainframe)
2	Card
3	Card edge (part of card)
4	Mounting screw (part of card)

Verify card installation

To verify that the card was properly installed:

1. If the 3700A is controlled remotely (REM is displayed), press **EXIT** to switch control to local.
2. On the 3700A front panel, press **SLOT**. The name and firmware version of the instrument is displayed.
3. Press **SLOT** again. The name and firmware version of the card in slot 1 is displayed.
4. If you have more than one card installed, continue to press **SLOT** until the slot you installed is displayed.
5. Confirm the name and firmware version.
6. Press **EXIT** to return to the operating display.

Pseudocards

You can perform open, close, and scan operations and configure your system without having a switch card installed in your instrument. If you are connected to a remote interface, you can assign a pseudocard to an empty switch card slot.

You cannot set up a pseudocard from the front panel. However, once pseudocard configuration is complete, you can take the instrument out of remote mode and use the front panel to control the pseudocard. Press the **EXIT** key to take the instrument out of remote mode. The model number of a pseudocard is the same as the model number of an actual card (except for 3732 cards).

When the instrument is turned off, the pseudocard settings are lost and the pseudocard is no longer assigned to the slot. To preserve the pseudocard setting through a power cycle, use a saved setup or a configuration script. The setup or script retains the model number of the card installed in each slot, including pseudocards.

For additional information on pseudocards, refer to the *Series 3700A System Switch/Multimeter Reference Manual* at [tek.com/keithley](https://www.tek.com/keithley).

Set up a 3722 pseudocard

You can install a pseudocard in any empty slot. With the 3722 pseudocard installed, the instrument operates as if a 3722 card is installed in the slot. This allows you to configure a scan and exercise its operation before the switching module is installed in the 3700A instrument.

In the following code examples, replace `slot` with the slot number (1 to 6).

To set a slot to use a pseudocard, send:

```
slot[slot].pseudocard = 3722
```

To query the pseudocard, send:

```
print(slot[slot].pseudocard)
```

To set a slot to stop using a pseudocard, send:

```
slot[slot].pseudocard = slot.PSEUDO_NONE
```

NOTE

The revision level of a pseudocard is always returned as 00.00 a.

You can query the slot attributes to determine the capabilities of the installed switching modules. For example, send the following query to determine if slot 1 supports 4-wire commonside ohms channels:

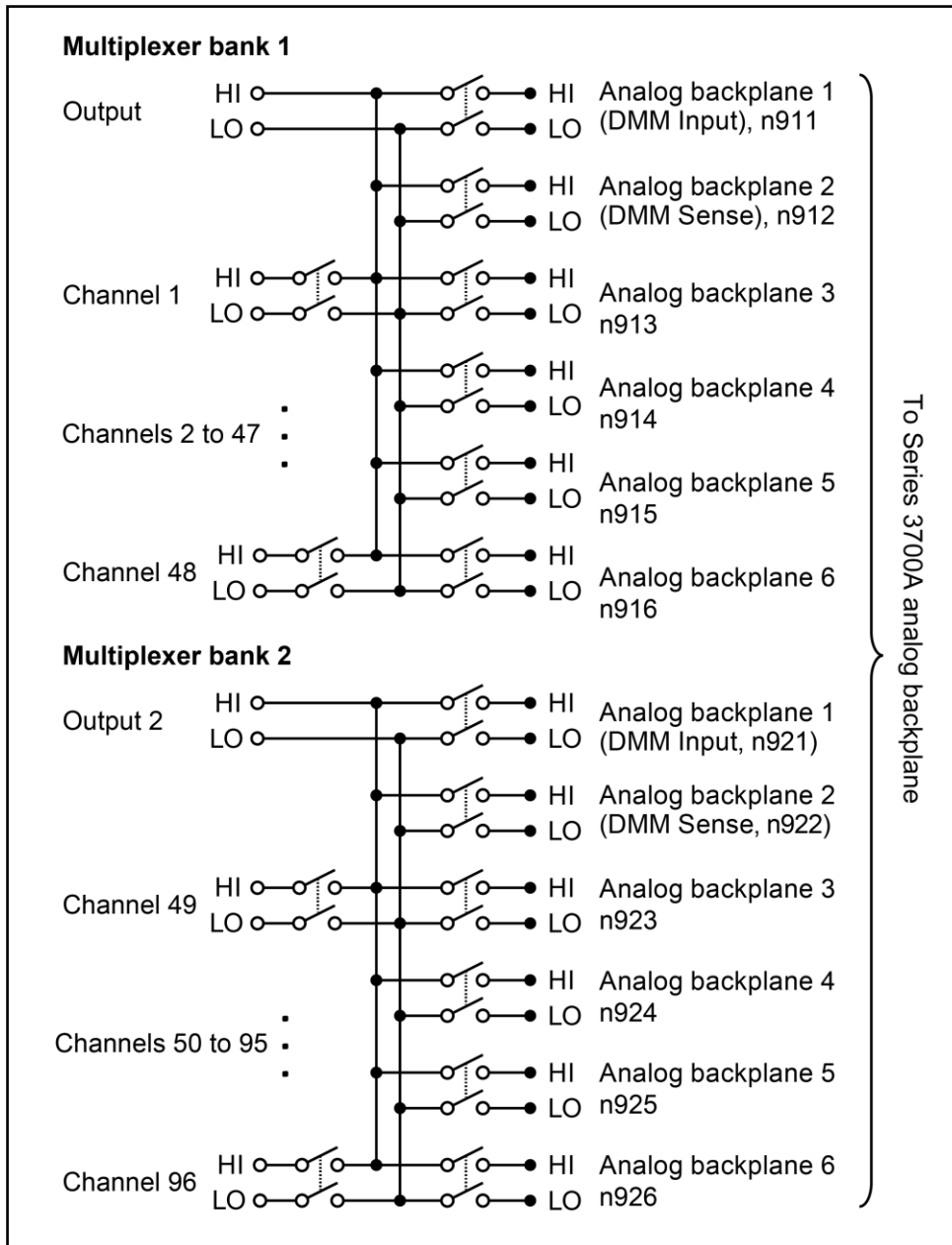
```
print(slot[1].commonsideohms)
```

Refer to the *Series 3700A System Switch/Multimeter Reference Manual* for more information about using queries at tek.com/keithley.

Schematic

The switching schematic for the 3722 is shown in the following figure.

Figure 3: Model 3722 schematic



Connection information

The 3722 uses two 104-pin D-sub connectors for signal connections, as shown in the following figure.

A solder-style connector kit (3722-MTC-1.5-KIT) and pre-assembled cable (3722-MTC-1.5/MM) are available for card connections.

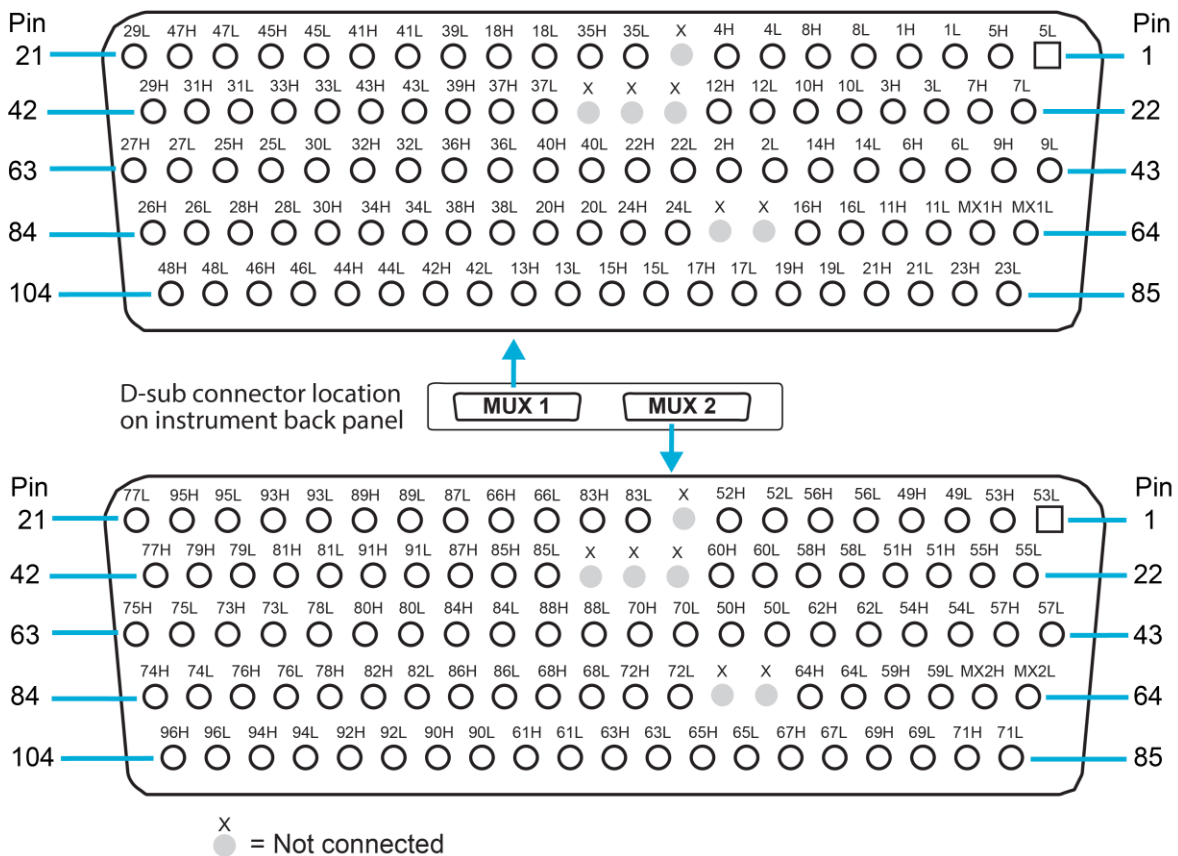
The 3722 D-sub connection information:

- MUX1H and MUX1L = Output 1HI and 1LO
- MUX2H and MUX2L = Output 2HI and 2LO

NOTE

The 3722 does not contain interlocks on the switch card.

Figure 4: Model 3722 D-sub pin connections



Cables and cable kits for the 3722

The following topics contain assembly instructions and characteristics for the Keithley Series 3700A System Switch/Multimeter cables and connector kits.

⚠ WARNING

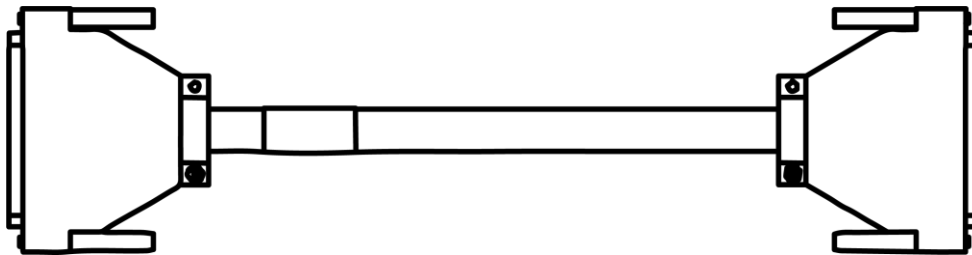
To prevent electrical shock, observe the following safety precautions:

- Connect both ends of the cable before applying any power to the system.
 - Remove all power in the system before connecting the cable to a switching module or external circuitry.
 - Connect both D-sub connector shells of this cable to a safety earth ground. A shock hazard exists when voltage levels greater than 30 V_{RMS}, 42.4 V_{PEAK}, or 60 V DC are present.
-

3722-MTC-1.5/MM cable

The Model 3722-MTC-1.5/MM cable is 1.5 m (5 ft) long and terminated with a 104-pin D-sub plug on each end.

Figure 5: Model 3722-MTC-1.5/MM cable



Characteristics

Maximum signal levels: 300 V DC or 300 V_{RMS}

Maximum current rating:

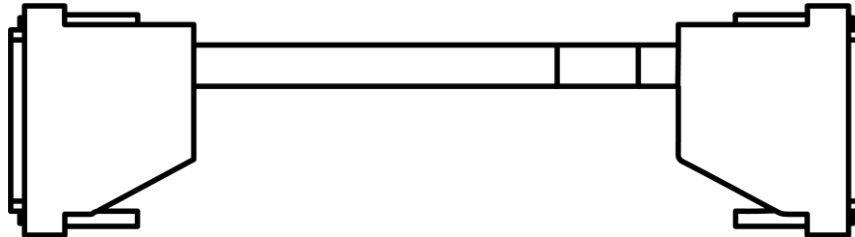
- **Single conductor:** 4.4 A
- **Multiple conductors:** 2.2 A per wire

Conductor gauge: 24 AWG

Model 3722-MTC-1.5-KIT

The Model 3722-MTC-1.5-KIT is a cable and connector kit that includes a 104-pin cable assembly. The cable assembly is 1.5 m (5 ft) long and is terminated with a D-sub plug on one end and a D-sub jack on the other end.

Figure 6: 3722-MTC-1.5-KIT cable



This kit contains the following items:

- 104-pin plug to jack cable assembly, 1.5 m (10 ft)
- 104-pin D-sub plug solder-cup kit
- 104-pin D-sub jack solder-cup kit

NOTE

This kit replaces the cable assemblies 3722-MTC-1.5, 3792-KIT104-R/F, and 3792-KIT104-R.

Cable maximum signal levels

Maximum signal level: 300 V DC or 300 V_{RMS}

Maximum current ratings:

- **Single conductor:** 4.4 A
- **Multiple conductors:** 2.2 A per wire
- **Conductor gauge:** 24 AWG

Solder-cup kit ratings:

- **Maximum signal level:** 300 V_{RMS}
- **Maximum current rating:** 5.0 A
- **Contacts:** 22 AWG maximum.

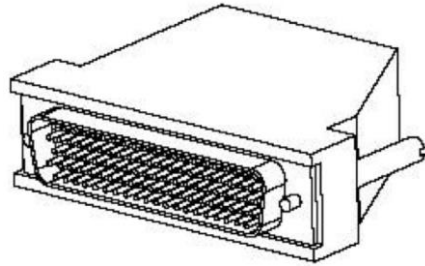
NOTE

An insertion and extraction tool for circular contacts size 22D (not included) is required.

3722-MTC-1.5-KIT D-sub plug kit

The Model 3722-MTC-1.5-KIT includes a 104-pin solder-cup connector kit terminated with a D-sub plug.

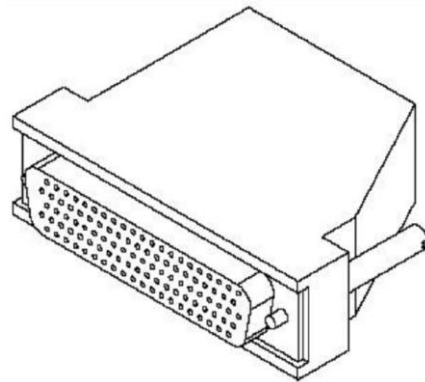
Figure 7: Model 3722-MTC-1.5-KIT plug



3722-MTC-1.5-KIT D-sub jack kit

The Model 3722-MTC-1.5-KIT includes a 104-pin solder-cup connector kit terminated with a D-sub jack.

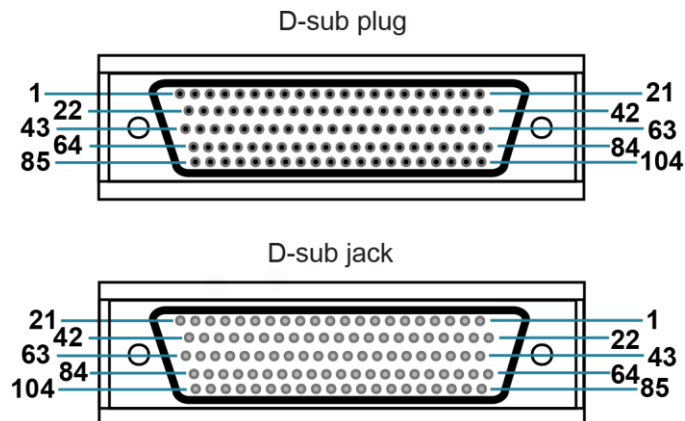
Figure 8: Model 3722-MTC-1.5-KIT jack



Pin number identification

Pin number identification for the Model 3722-MTC-1.5-KIT and Model 3722-MTC-1.5/MM D-sub connectors are shown in the following figure and table.

Figure 9: Model 3722-MTC-1.5-KIT and Model 3722-MTC-1.5/MM D-sub connectors



NOTE

Connect drain wire to shield at both ends.

Pins 9, 30, 31, and 32 are not connected.

CONN 1		Paired wire colors	CONN 2	
First color pin	Second color pin		First color pin	Second color pin
1	2	Blue paired with white	1	2
3	4	Orange paired with white	3	4
5	6	Green paired with white	5	6
7	8	Brown paired with white	7	8
10	11	Slate paired with white	10	11
12	13	Blue/white striped paired with white	12	13
14	35	Blue/orange striped paired with white	14	35
15	16	Blue/green striped paired with white	15	16
17	18	Blue/brown striped paired with white (spare)	17	18
19	20	Blue/slate striped paired with white	19	20
21	42	Orange/white striped paired with white	21	42
22	23	Orange/green striped paired with white	22	23
24	25	Orange/brown striped paired with white	24	25
26	27	Orange/slate striped paired with white	26	27
28	29	Green/white striped paired with white	28	29
33	34	Green/brown striped paired with white	33	34
36	37	Green/slate striped paired with white	36	37
38	39	Brown/white striped paired with white	38	39
40	41	Brown/slate striped paired with white	40	41
43	44	Slate/white striped paired with white	43	44
45	46	Blue paired with red	45	46
47	48	Orange paired with red	47	48
49	50	Green paired with red	49	50
51	52	Brown paired with red	51	52
53	54	Slate paired with red	53	54
55	56	Blue/white striped paired with red	55	56
57	58	Blue/orange striped paired with red	57	58
59	80	Blue/green striped paired with red	59	80
60	61	Blue/brown striped paired with red	60	61
62	63	Blue/slate striped paired with red	62	63
64	65	Orange/white striped paired with red	64	65
66	67	Orange/green striped paired with red	66	67
68	69	Orange/brown striped paired with Red	68	69
70	71	Orange/slate striped paired with red	70	71
72	73	Green/white striped paired with red	72	73
74	75	Green/brown striped paired with red	74	75
76	77	Green/slate striped paired with red	76	77
78	79	Brown/white striped paired with red	78	79
81	82	Brown/slate striped paired with red	81	82
83	84	Slate/white striped paired with red	83	84

CONN 1		Paired wire colors	CONN 2	
First color pin	Second color pin		First color pin	Second color pin
85	86	Blue paired with black	85	86
87	88	Orange paired with black	87	88
89	90	Green paired with black	89	90
91	92	Brown paired with black	91	92
93	94	Slate paired with black	93	94
95	96	Blue/white striped paired with black	95	96
97	98	Blue/orange striped paired with black	97	98
99	100	Blue/green striped paired with black	99	100
101	102	Blue/brown striped paired with black	101	102
103	104	Blue/slate striped paired with black	103	104

Maximum power usage with 3700A cards

The 3700A plug-in cards can switch many relays at once, which can take a substantial amount of system power. The maximum power available in the 3700A is limited on a per-slot and per-bank basis, as shown in the following table.

Bank 1	Bank 2
Slot 1	Slot 4
Slot 2	Slot 5
Slot 3	Slot 6
12,300 mW (maximum)	12,300 mW (maximum)

The maximum slot power limit is 10,500 mW.

If the power levels are exceeded, the system performs as many of the operations as possible until the power limits are reached. When the power limits are reached, an error message is generated and the remaining operations are not performed.

Power budgeting and calculation

Individual relay power consumption generally depends on the type of relay. Latching relays consume power briefly to open or close and are not a concern when budgeting power. Nonlatching relays continuously consume power to maintain their state, so they must be considered when budgeting for power consumption.

Each switch card also uses system power to operate. This continuous power draw is known as quiescent power. Quiescent power takes away power that is available to operate relays, so it must also be considered when budgeting for power consumption.

The following table shows the power consumption of channel and backplane relays for the 3700A switch cards. The quiescent power is also shown.

Model	Quiescent power (P _Q) (milliwatts)	Channel relay power (P _{CR}) consumption each (milliwatts)	Backplane relay power (P _{BR}) consumption each (milliwatts)
3720	975	Not applicable	100
3721	1350	Not applicable	100
3722	475	Not applicable	100
3723	700	100 (2-pole)	100
		50 (1-pole)	100
3724	1150	20	100
3730	780	Not applicable	100
3731	780	67	100
3732	780	17	100
3740	1000	Not applicable (independent)	100
		200 (high current)	100

To determine how many relay operations can be performed, use the previous table to calculate the total power required by applying the following equation:

$$P_{TS} = P_Q + (N_{CC} \times P_{CR}) + (N_{BC} \times P_{BR})$$

Where:

- P_{TS} is the total slot power
- P_Q is the quiescent power
- N_{CC} is the number of closed channels
- P_{CR} is the power per channel relay
- N_{BC} is the number of closed backplane channels
- P_{BR} is the power per backplane relay

To calculate the total slot power, you must calculate the power for each bank of slots:

$$\text{Bank 1 Power} = \text{Slot 1 } P_{TS} + \text{Slot 2 } P_{TS} + \text{Slot 3 } P_{TS}$$

$$\text{Bank 2 Power} = \text{Slot 4 } P_{TS} + \text{Slot 5 } P_{TS} + \text{Slot 6 } P_{TS}$$

The results are called bank powers and should be compared with the maximum limits. Example calculations are shown in the following topics.

Power budgeting example for six 3722 cards

This example is for a fully loaded 3706A-S with all 3722 switch cards.

Slot	Card	Channel relays closed	Backplane relays closed
1	3722	15 (2-pole)	4
2	3722	15 (2-pole)	4
3	3722	15 (2-pole)	4
4	3722	15 (2-pole)	4
5	3722	15 (2-pole)	4
6	3722	15 (2-pole)	4

This produces the following power consumption:

	P_Q		$N_{CC} \times P_{CR}$		$N_{BC} \times P_{BR}$		P_{TS}
Slot 1 power consumed =	475	+	0	+	4×100	=	875
Slot 2 power consumed =	475	+	0	+	4×100	=	875
Slot 3 power consumed =	475	+	0	+	4×100	=	875
Slot 4 power consumed =	475	+	0	+	4×100	=	875
Slot 5 power consumed =	475	+	0	+	4×100	=	875
Slot 6 power consumed =	475	+	0	+	4×100	=	875

Totals for each bank are calculated as follows:

	Slot 1		Slot 2		Slot 3		Total
Bank 1 power consumed =	875	+	875	+	875	=	2625

	Slot 4		Slot 5		Slot 6		Total
Bank 2 power consumed =	875	+	875	+	875	=	2625

Since each bank did not exceed the maximum power, the power budget is within the limits.

Power budgeting example with multiple cards

This example is for a fully loaded 3706A-S with a mix of switch cards.

Slot	Card	Channel relays closed	Backplane relays closed
1	3720	20	2
2	3721	20	2
3	3722	15	4
4	3723	25 (2-pole)	2
5	3730	10	4
6	3740	2 (high current)	4

This produces the following power consumption:

	P_Q		$N_{CC} \times P_{CR}$		$N_{BC} \times P_{BR}$		P_{TS}
Slot 1 power consumed =	975	+	0	+	2×100	=	1175
Slot 2 power consumed =	1350	+	0	+	2×100	=	1550
Slot 3 power consumed =	475	+	0	+	4×100	=	875
Slot 4 power consumed =	700	+	25×100	+	2×100	=	3400
Slot 5 power consumed =	780	+	0	+	4×100	=	1180
Slot 6 power consumed =	1000	+	2×200	+	4×100	=	1800

Totals for each bank are calculated:

	Slot 1		Slot 2		Slot 3		Total
Bank 1 power consumed =	1175	+	1550	+	875	=	3600

	Slot 4		Slot 5		Slot 6		Total
Bank 2 power consumed =	3400	+	1180	+	1800	=	6380

Since each bank did not exceed the maximum power, the power budget is within the limits.

Model 3722 connection log

Use this table to record your 3722 connection information.

Channel		Color	Description
OUTPUT 1	H		
	L		
CH1	H		
	L		
CH2	H		
	L		
CH3	H		
	L		
CH4	H		
	L		
CH5	H		
	L		

Channel		Color	Description
CH6	H		
	L		
CH7	H		
	L		
CH8	H		
	L		
CH9	H		
	L		
CH10	H		
	L		
CH11	H		
	L		
CH12	H		
	L		
CH13	H		
	L		
CH14	H		
	L		
CH15	H		
	L		
CH16	H		
	L		
CH17	H		
	L		
CH18	H		
	L		
CH19	H		
	L		
CH20	H		
	L		
CH21	H		
	L		
CH22	H		
	L		
CH23	H		
	L		
CH24	H		
	L		
CH25	H		
	L		
CH26	H		
	L		
CH27	H		
	L		
CH28	H		
	L		
CH29	H		

Model 3722 Dual 1x48 Multiplexer Card Instructions

Channel		Color	Description
CH30	L		
	H		
CH31	L		
	H		
CH32	L		
	H		
CH33	L		
	H		
CH34	L		
	H		
CH35	L		
	H		
CH36	L		
	H		
CH37	L		
	H		
CH38	L		
	H		
CH39	L		
	H		
CH40	L		
	H		
CH41	L		
	H		
CH42	L		
	H		
CH43	L		
	H		
CH44	L		
	H		
CH45	L		
	H		
CH46	L		
	H		
CH47	L		
	H		
CH48	L		
	H		
OUTPUT 2	L		
	H		
CH49	L		
	H		
CH50	L		
	H		
CH51	L		
	H		

Channel		Color	Description
CH52	H		
	L		
CH53	H		
	L		
CH54	H		
	L		
CH55	H		
	L		
CH56	H		
	L		
CH57	H		
	L		
CH58	H		
	L		
CH59	H		
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CH60	H		
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CH61	H		
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CH64	H		
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CH65	H		
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CH66	H		
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CH67	H		
	L		
CH68	H		
	L		
CH69	H		
	L		
CH70	H		
	L		
CH71	H		
	L		
CH72	H		
	L		
CH73	H		
	L		
CH74	H		
	L		
CH75	H		

Model 3722 Dual 1x48 Multiplexer Card Instructions

Channel		Color	Description
	L		
CH76	H		
	L		
CH77	H		
	L		
CH78	H		
	L		
CH79	H		
	L		
CH80	H		
	L		
CH81	H		
	L		
CH82	H		
	L		
CH83	H		
	L		
CH84	H		
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CH85	H		
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CH86	H		
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CH87	H		
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CH88	H		
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CH89	H		
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CH90	H		
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CH91	H		
	L		
CH92	H		
	L		
CH93	H		
	L		
CH94	H		
	L		
CH95	H		
	L		
CH96	H		
	L		

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 2018.