

# Model 3761 10-Channel Low Current Multiplexer Card

## User's Manual

3761-900-01 Rev. A / July 2017



3761-900-01A

# **Model 3761**

## **10-Channel Low Current Multiplexer Card**

### **User's Manual**

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The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with 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 Instruments 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 Instruments 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 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 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 Instruments. 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 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.

Unless otherwise noted in product-specific literature, Keithley Instruments 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.

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## Introduction

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## Your multiplexer card

Thank you for choosing a Keithley Instruments product. The Model 3761 10-channel Low Current Multiplexer Card is a single-pole, single-throw, low-leakage multiplexer designed for use in the Model 3706A System Switch/Multimeter. The 3761 is ideal for switching either current or voltage into a picoammeter or an electrometer voltmeter.

**Figure 1: Model 3761 10-channel Low Current Multiplexer Card**



The 3761 has two output connectors which allow you to add additional cards. Each additional card increases the capacity of the multiplexer by ten channels. High-speed, low-leakage reed relays with actuation times as low as 1 ms let you use the 3761 to make accurate, low-current measurements. The 3706A supports up to six 3761 cards, for a maximum of 60 low-current channels in a single mainframe system.

An automatically-configured software relay isolates all circuitry on the card from the outputs when all channels are open, and it closes when any channel closes. You will use this relay when configuring multiple 3761 cards. See the [Typical applications](#) (on page 5-1) topic for more information.

## ⚠ WARNING

When an interlock is required for safety, a separate circuit should be provided that meets the requirements of the application to reliably protect the operator from exposed voltages. The digital I/O port of the 3761 is not suitable for control of safety circuits and should not be used to control a safety interlock. Bypassing the interlock can result in personal injury or death from electric shock.

## System switch / multimeter card compatibility

The following table lists the cards that are compatible with the 3706 and 3706A.

Mainframe System Switch / Multimeter	Compatible plug-in cards
Model 3706	3720, 3721, 3722, 3723, 3724, 3730, 3731, 3732, 3740, 3750
Model 3706A	3760, 3761, 3762, 3765

## NOTE

The 3761 is designed for use only with the Model 3706A System Switch / Multimeter. Using the 3761 with the Model 3706 mainframe can cause unpredictable behavior.

## Extended warranty

Additional years of warranty coverage are available on many products. These valuable contracts protect you from unbudgeted service expenses and provide additional years of protection at a fraction of the price of a repair. Extended warranties are available on new and existing products. Contact your local Keithley Instruments office, sales partner, or distributor for details.

## Series 3700A documentation

Complete documentation for the Series 3700A System Switch/Multimeter instruments is available at the [Keithley Instruments website](http://www.tek.com/keithley) (<http://www.tek.com/keithley>). The following is a list of available documentation.

Document number	Document name	Content description
3700AS-903-01	Series 3700A System Switch/Multimeter Quick Start Guide	Hardware and software requirements, switching card installation instructions, and a brief description of front-panel and remote interface operation
3700AS-900-01	Series 3700A System Switch/Multimeter User's Manual	Information about scanning, reading, writing, and controlling channels
3700AS-901-01	Series 3700A System Switch/Multimeter Reference Manual	Information about controlling the Series 3700A from a remote interface

## Contact information

If you have any questions after you review the information in this documentation, please contact your local Keithley Instruments office, sales partner, or distributor. You can also call the corporate headquarters of Keithley Instruments (toll-free inside the U.S. and Canada only) at 1-800-935-5595, or from outside the U.S. at +1-440-248-0400. For worldwide contact numbers, visit the [Keithley Instruments website](http://www.tek.com/keithley) (<http://www.tek.com/keithley>).

## General information

General ratings for the 3761 are listed in the following table.

Category	Specification
Voltage rating*	30 V
Current rating	100 mA
Input and output connections	Current source input female triaxial cables Sample inputs for female triaxial cables Current monitor female BNC Measurement output spring loaded terminals
Environmental conditions	<b>Indoor use only</b> <b>Operating:</b> 0 °C to 50 °C (32 °F to 122 °F), 70% relative humidity up to 35 °C (95 °F); derate 3% relative humidity per °C, 35 °C to 50 °C, noncondensing <b>Storage:</b> -25 °C to 65 °C (-13 °F to 149 °F) <b>Altitude:</b> 0 to 2000 m (0 to 6562 ft) above sea level <b>Pollution degree:</b> 2

\*Input voltage operating range  $\pm 8$  V

## Specifications

For the most recent instrument specifications, search for the 3761 on the [Keithley Instruments website](http://www.tek.com/keithley) (<http://www.tek.com/keithley>).

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# Installation and connections

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## Handling precautions

Make sure to handle the 3761 carefully. Always grasp the multiplexer card by the side edges or covers. Do not touch board surfaces, components, or areas adjacent to electrical contacts. Contamination from foreign materials such as dirt, dust, and body oils can substantially lower leakage resistances, degrading card performance.

### **WARNING**

The information in this section is intended only for qualified personnel. Do not perform these procedures unless you are qualified. Failure to recognize and observe standard safety precautions could result in personal injury or death due to electric shock.

## Unpack and inspect

### *To unpack and inspect your instrument:*

1. Inspect the box for damage.
2. Open the top of the box.
3. Remove the contents accessories and verify that all items are included. You should have received:
  - One 3761 card
  - One Model 3761-BNC-SMA 1.2 m (4 ft) Low Noise SMA Male to BNC SMU cable
  - 12 CAP-47 SMA male protective caps
  - One CS-573 BNC to triaxial adapter (optional)
4. Inspect the 3761 card for any obvious signs of physical damage.
5. Report any damage to the shipping agent immediately.

## Card connectors

You can make signal input and output connections with the SMA connectors on the card. The locations for each channel input and its outputs are located on the front of the card.

**Figure 2: Model 3761 card connectors**



While SMA connectors are not typically used in low-current applications, the connectors on the 3761 are compact, Teflon-insulated, and exhibit low-leakage characteristics.

## 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.

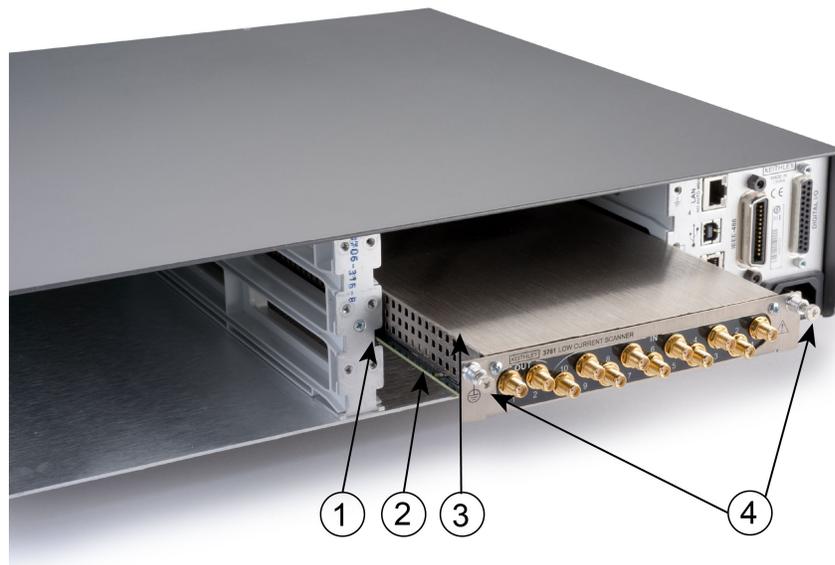
Perform the following steps to install a switching card into the instrument mainframe:

1. Turn the instrument off and disconnect the power line cord and any other cables connected to the rear panel.
2. Position the instrument so that you are facing the rear panel.
3. Remove the slot cover plate from the desired mainframe slot. Retain the plate and screws for future use.
4. With the top cover of the switching card facing up, align the card's edge into the slot's card guide and slide in the card. For the last ¼ inch or so, press in firmly to mate the card connector to the mainframe connector.
5. On each side of the card, there is a mounting screw. Tighten these two screws to secure the card to the mainframe. Do not overtighten.
6. Reconnect the power line cable and any other cables to the rear panel, then turn the instrument on.
7. Press the **SLOT** key to see the model numbers, description, and the firmware revision of the installed switching cards, along with the mainframe firmware and DMM (if present).

**NOTE**

Item shipped may vary from model pictured here.

**Figure 3: 3761 card installation**



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

## **Web browser support**

Web browser support for the 3761 10-Channel Low Current Multiplexer Card is not supported with the 3706A Switch System/DMM.

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## General operation

### In this section:

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## General operation

This section provides information needed to use the 3761 Model 3706A system switch mainframe. Once the card is installed in the mainframe, refer to the *Series 3700A System Switch/Multimeter Reference Manual* for complete operating instructions.

## Safety hazards

### WARNING

To prevent electrical shock that could cause injury or death, never make or break connections while the equipment is powered on. User supplied lethal voltages may be present on the PC board or the connections. Turn off the equipment from the front panel, disconnect the main power cord, and discharge stored energy in external circuitry before making or breaking cable connections. Putting the mainframe equipment into an output-off state does not guarantee that the outputs are powered off if a hardware or software fault occurs. Precautions must be taken to prevent a shock hazard by surrounding the test device and any unprotected leads (wiring) with double insulation for 500 volts, Category I.

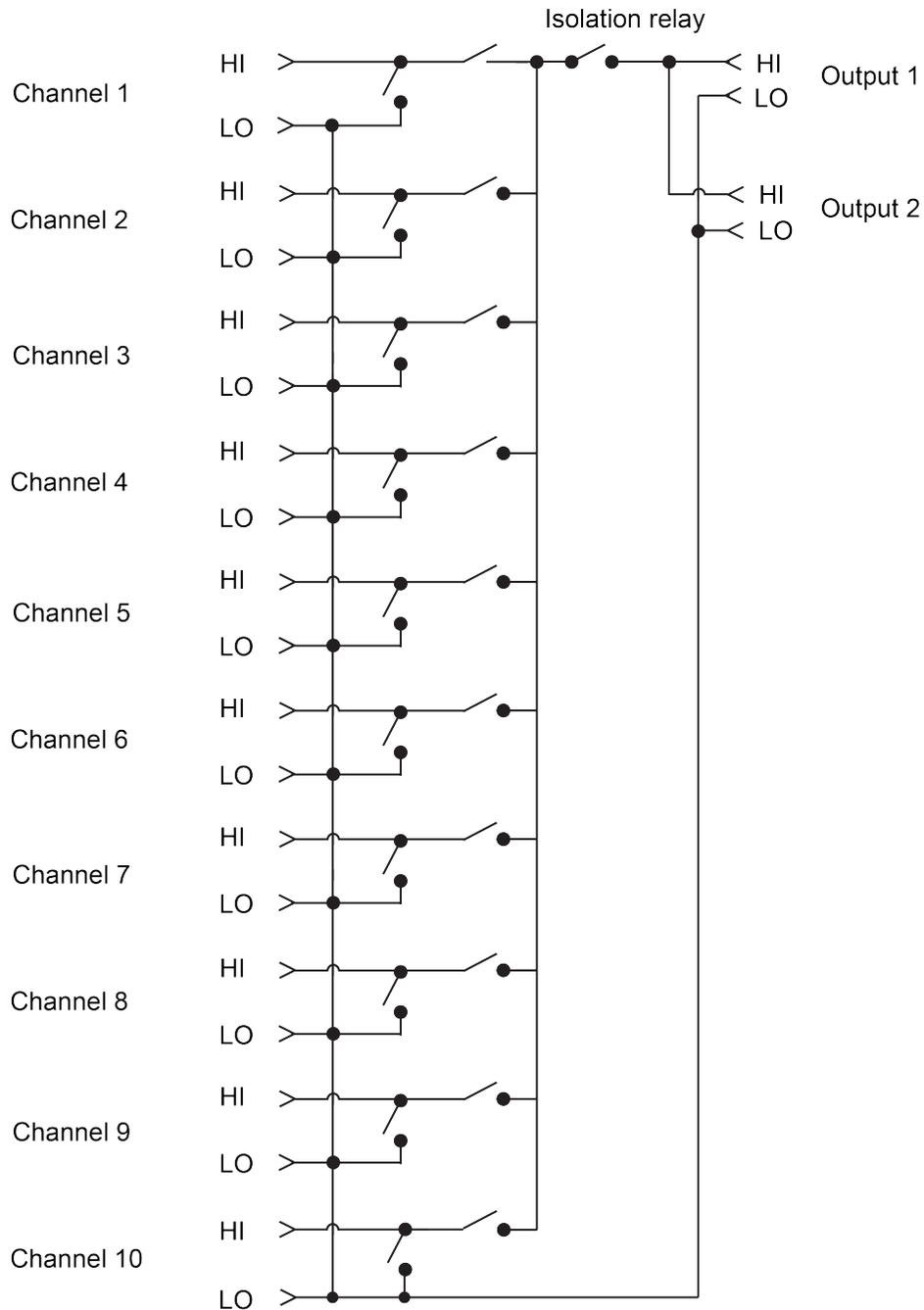
Follow these recommendations before and after applying power to the equipment:

1. Do not exceed the 3761 maximum allowable signal level as defined in the specifications.
2. Do not exceed the 3761 maximum common mode voltage of 30 V as defined in the specifications.
3. Make sure the system switch mainframe is grounded through an earth grounded receptacle before operation.
4. Turn off all power supplies and discharge any residual energy before installing or removing the 3761 from the system switch mainframe or changing the 3761 SMA connections.
5. Inspect all cables for wear and defects such as cracks and exposed wires. Make sure that you correct any defects found before operating the instrument.
6. Use only low noise coaxial cables.
7. Ensure that the mounting screws for the card are securely connected to the system switch mainframe chassis in order to provide the proper chassis protective grounding.
8. Read this manual carefully and adhere to all of the safety precautions listed before operating the instrument.

## Current and voltage switching applications

For current switching applications, each channel on the 3761 has a pair of single-pole single-throw (SPST), normally open (NO) relays. The relay pair switches signal HI between signal LO (analog ground) and output HI. Signal LO (the outside shell of the SMA connector) is common to all channels and outputs in the test system.

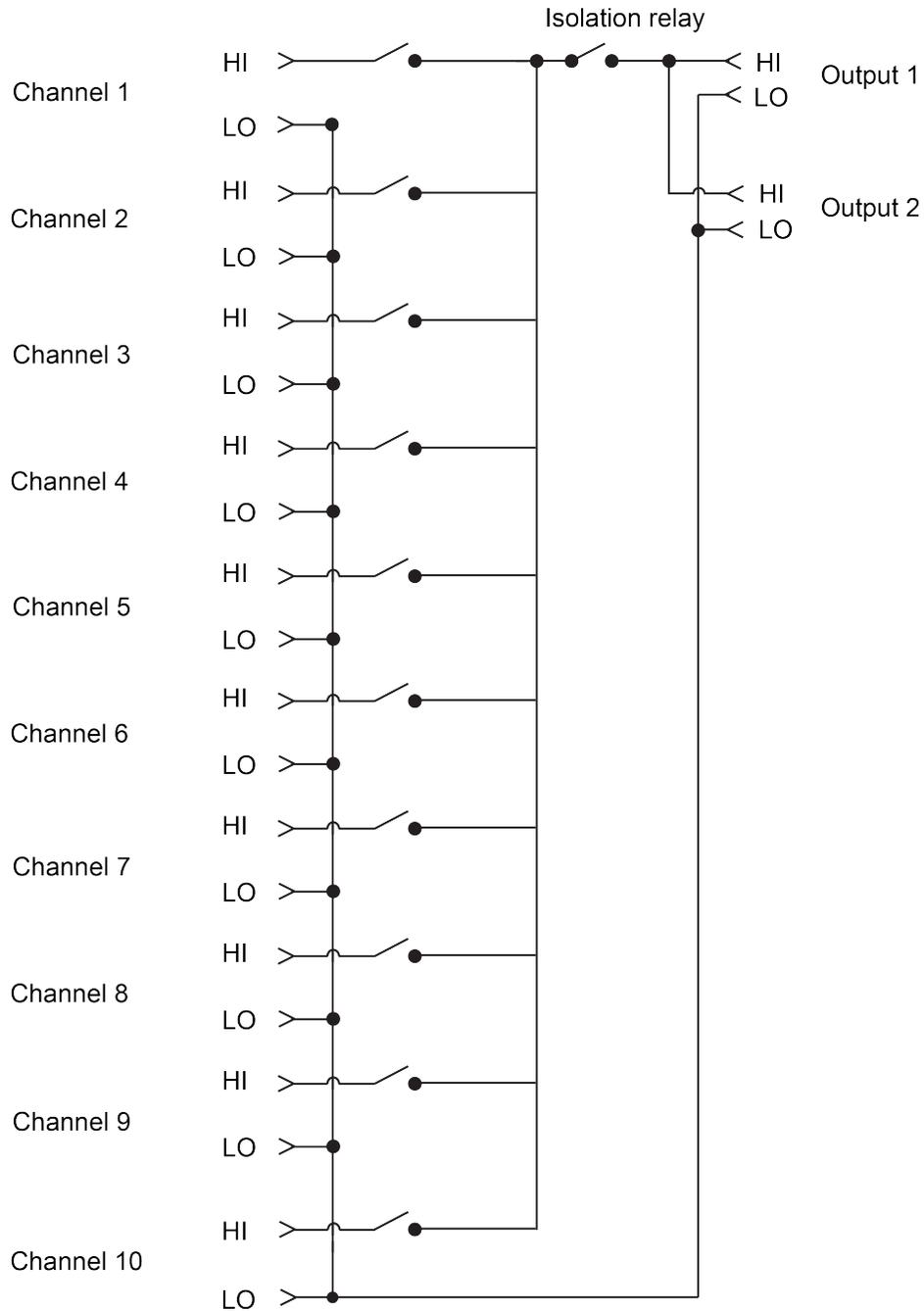
**Figure 4: 3761 current switching schematic**



The 3761 is designed for scanning low-ampere currents into a low-impedance picoammeter. When a channel is not selected for measurement, the current path is maintained through that channel's analog grounding relay, which is automatically updated with the channel selection.

You can also configure the 3761 for voltage switching. See the next figure for a schematic of the 3761 card configured for voltage mode.

**Figure 5: 3761 voltage switching schematic**



You can use the following 3706A commands with the 3761 card for voltage and current mode applications.

```
-- set slot numbers
slot_3761 = 1
slot_not_3761 = 2
slot_empty = 3
-- 0=Amps-mode=default; 1=Volts-mode
-- get the present mode of a 3761 card
print(slot[slot_3761].voltsampsmode)
-- set the mode of a 3761 card to Amps-mode
slot[slot_3761].voltsampsmode = 1
-- set the mode of a 3761 card to Volts-mode
slot[slot_3761].voltsampsmode = 0
-- setting voltsampsmode to any value other than 0 or 1 will result in the
  following error
-- "-222, Parameter data out of range"
slot[slot_3761].voltsampsmode = 2
-- setting voltsampsmode on a card that does not support it will result in the
  following error
-- "1114, Settings conflict with VoltAmps-mode not supported for this slot"
slot[slot_not_3761].voltsampsmode = 1
-- setting voltsampsmode on an empty slot will result in the following error
-- "1114, Settings conflict with VoltAmps-mode not supported for empty slot"
slot[slot_empty].voltsampsmode = 1
```

## NOTE

The isolation impedance of the 3761 in voltage mode is high enough to use with an electrometer voltmeter to switch devices with impedances greater than  $10^9 \Omega$ . This configuration minimizes voltage loading on the device under test.

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## Operation considerations

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### Cables

Shielded cables should be used with the 3761. The shield should be connected to circuit guard, analog LO. This helps prevent excessive radiation from the cables from interfering with any equipment. The cable rating must not exceed the maximum allowable signal levels as defined in the 3761 card specifications. For more information on cable requirements, go to the [Keithley Instruments website](http://www.tek.com/keithley) (<http://www.tek.com/keithley>) and search for *Switching Handbook* or *Low Current Measurements Application Note*.

The test system response is affected by cable capacitance. This should be considered when the sources are connected to the 3761. Use a feedback ammeter for currents below  $10^{-5}$  A to increase measurement speed and decrease the effects of cable capacitance measurement.

### External factors

The 3761 is specified for a resistive load. However, external circuit capacitances and inductances can cause excessive currents and voltages across the relay contacts. The currents and voltages must be limited to within the maximum allowable signal levels.

- **Capacitance:** Charged capacitances in the circuit can cause excessive currents (surge currents) to flow through the relay contacts if the source is shorted out or if the output is switched to capacitive loads. This excessive current can weld the relay contacts together. Therefore, use series resistors, where needed, to limit the maximum current to within the contact ratings. The maximum signal levels are stated in the specifications.
- **Inductance:** The inductance of cables can produce high voltage and arcing across relay contacts when switching. The peak transients must be limited to within the maximum signal levels as defined in the 3761 specifications.

When a channel is opened or closed, there is a charge transfer in the picocoulomb range. This is due to the mechanical release or closure of the contacts, the contact-to-coil capacitance, and the stray capacitance between the signal and relay drive lines. The charge transfer causes a current pulse, and the effect on the signal depends on the magnitude of the source being measured.

Extreme environmental conditions can cause the offset current to exceed the 1 pA specification. If the card has been exposed to high humidity or temperature (for example, during shipping), stabilize the board within the specified environmental limits for 24 hours.

## High impedance measurements

### CAUTION

Because of the high impedance circuits on the 3761, this card contains no user-serviceable components and should only be opened by a Tektronix factory service technician.

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## Typical applications

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## Introduction

The 3761 card has ten channels of paired, single-pole, single-throw (SPST), normally open (NO) relays. The card will switch one or more of ten signals to one output or signal LO.

Signal HI is connected to signal LO (analog ground) when the scanner mainframe channel is open (current mode), and to output HI when the channel is closed. Signal LO is common to all ten channels and the output. An additional relay isolates all circuitry on the card from the output when none of the channels are closed.

Features of the scanner card include:

- Low offset current error (< 1 pA specified, < 30 fA typical)
- Switching of AC or DC signals up to 100 mA
- SMA input and output connectors
- Two outputs for connecting multiple 3761 cards
- Low current or low voltage switching

The 3761 is field-installable in the 3706A scanner mainframe, and can be used in a variety of applications to switch low current levels. Typical applications include those where sourcing voltage and measuring current are required, such as:

- Leakage currents (e.g. capacitor, FET gate)
- PCB test coupons
- Materials research and characterization
- Semiconductor sub-threshold current

The following applications focus on:

- Capacitor leakage / insulation resistance measurements using the direct and indirect methods of measurement using the Model 3761 and 3762 cards, and a Model 6517B Electrometer.
- Connecting multiple 3761 cards to expand your multiplexer system.

## Application considerations

Voltage applications include those where the 3761 can be used to switch a single pole of low voltage sources. When measuring low currents, consider the following sources of noise:

- **Triboelectric currents** are caused by friction between a conductor and insulator when a coax cable flexes due to vibration or temperature fluctuation. To minimize noise, use cables such as the Keithley Instruments Model 3761-BNC-SMA. This low-noise cable is ideal for low-level measurements of voltage and current.
- **Piezoelectric currents** are caused by mechanical stress to the insulating materials of connectors. Minimize stress on the insulators and use a connecting cable such as the 3761-BNC-SMA. This cable features BNC and SMA connectors with low piezoelectric effects.
- **Electrochemical effects** generate current between PCB conductors due to contamination of the card surface. To minimize card contamination, handle the card by the edges only.

### CAUTION

To prevent overheating or damage to the relay contacts, do not exceed the signal level specifications of the 3761 card. Maximum switched and carry current and voltage levels are 100 mA and 30 V in voltage mode. The card can switch low power AC (typical bandwidth up to 1 MHz). Maximum switched and carry current and voltage levels are 100 mA and 30 V peak using resistive loads.

## Direct measurement of capacitor leakage or insulation resistance

If you want to measure the leakage current or insulation resistance of a capacitor, the direct method of measurement lets you apply almost any test voltage to the capacitor under test. The direct method uses the 3761 in current mode, operating the card at zero volts even though the capacitor test voltage is large.

The leakage current measurement depends on the capacitor dielectric and the applied voltage. A direct measurement of the insulation resistance is shown in the next figure for three channels of the 3761. In this test configuration, a picoammeter (IM) is connected to one of the two output connectors of the 3761 card, a shielded test fixture is used to contain the capacitors under test, and a 3762 is used to route the test and soak voltages for the capacitors under test.

**NOTE**

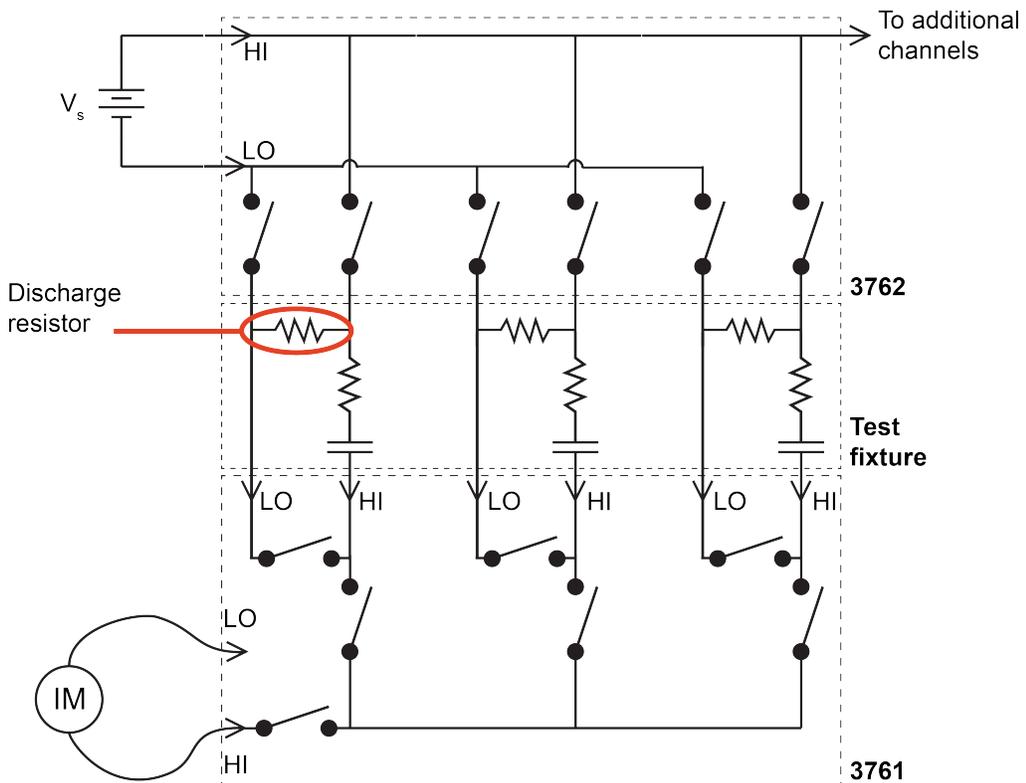
To avoid inaccurate capacitor leakage measurements, do not enable the 3761 channels until you verify that the capacitors under test are fully charged.

Make sure that each capacitor under test has a series resistance and an individual discharge resistor. The discharge resistors are used to drain the electric charge on the capacitors when the test completes.

**NOTE**

If you are making measurements with capacitor values greater than 1  $\mu\text{F}$ , use the [indirect method](#) (on page 5-5) with a voltmeter measuring the voltage drop across a resistor connected in series with the capacitor under test.

**Figure 6: Direct capacitor insulation leakage measurement**



***To make a measurement using the direct method:***

1. Make sure that your Model 3761 is in ampere mode.
2. Close the correct channels on the 3762 to charge the capacitor under test.
3. When the capacitor is charged, close the applicable channel of the 3761 to start the measurement.

**NOTE**

The current is measured at IM, as shown in the previous figure. To maintain the voltage applied to the capacitor under test, be sure to keep the applicable channel of the 3762 closed when making the measurement.

4. When the test is complete, open the channels on the 3761 and 3762. The charge on the capacitor under test is released automatically through the discharge resistor.
5. Repeat the previous steps for each capacitor under test.

## Indirect measurement of capacitor leakage or insulation resistance

You can also make an indirect measurement of the capacitor's insulation resistance by using the 3761 in voltage mode (VM). Use this method if you are making measurements with capacitor values greater than 1  $\mu\text{F}$ . This configuration maintains stability and improves noise performance for large capacitor values.

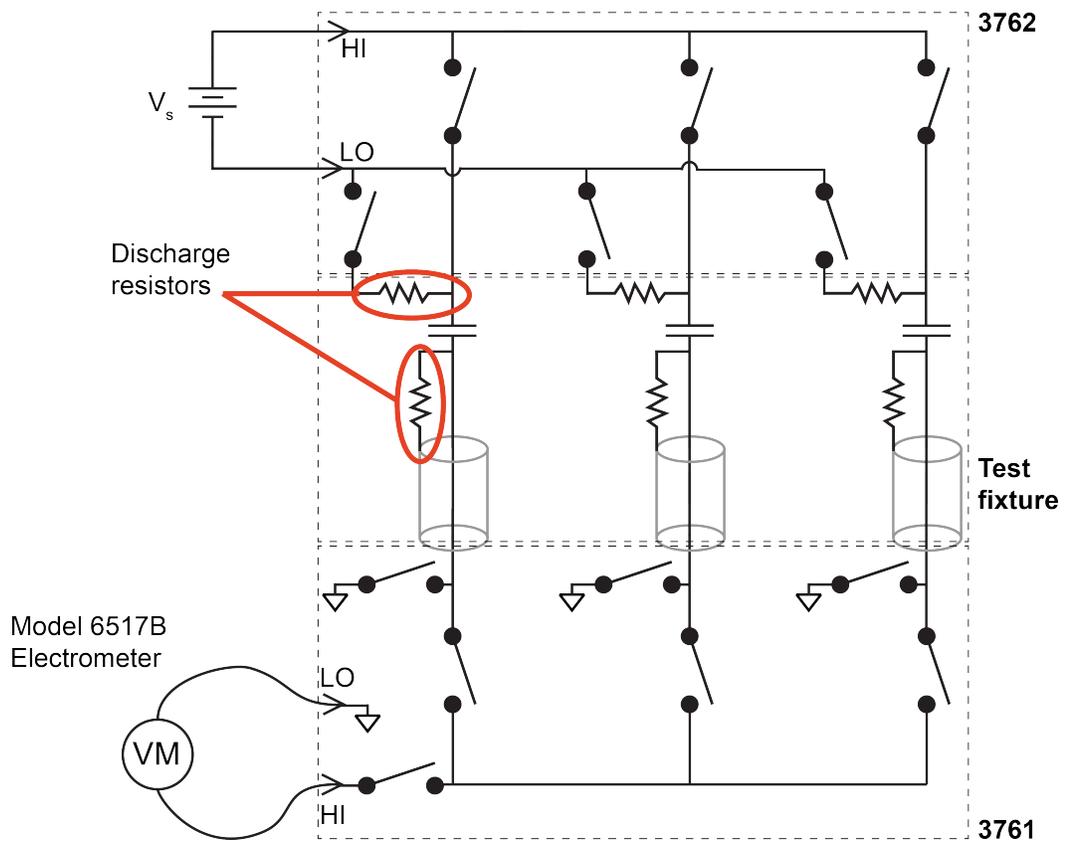
Make sure that each capacitor under test has a series resistance and an individual discharge resistor. The discharge resistors are used to drain the electric charge from the capacitors when the test completes.

Using the indirect method, the Model 3762 can be used to switch the soak voltage to each capacitor under test for specific capacitor soak times with the 3761 in current mode. When the capacitors are charged and settled, the 3761 is switched to voltage mode and a new source voltage ( $V_{\text{TEST}}$  equal to  $V_{\text{SOAK}} + V_{\text{EQ}}$ ) is applied to the capacitors through the 3762. A Model 6517B is used to make the measurement.

NOTE

To avoid inaccurate capacitor leakage measurements, do not enable the 3761 channels until you verify that the capacitors under test are fully charged.

**Figure 7: Indirect capacitor insulation leakage measurement**



The capacitor insulation resistance is calculated using the following formula:

$$R_{\text{INSL}} = \frac{(V_{\text{TEST}} - V_{\text{MEAS}}) \times R_{\text{DCHG}}}{V_{\text{MEAS}}}$$

Where:

- $R_{\text{INSL}}$  = Insulation resistance of the capacitor under test
- $V_{\text{TEST}}$  = The test voltage
- $V_{\text{MEAS}}$  = Voltage measurement at the output of the 3761
- $R_{\text{DCHG}}$  = Value of the discharge resistor

## NOTE

Be sure to select a series resistor value that maintains the 3761 test voltage specifications, and select a  $V_{\text{EQ}}$  value that minimizes the settling time of the indirect measurement.

## Connecting multiple 3761 cards

Two output connectors on each 3761 card let you add multiple cards to expand the size of the multiplexer by ten for each additional 3761. An additional relay isolates all circuitry on the card from the outputs when all channels are open and closes when any channel closes. This isolation relay configures itself automatically when assembling a test system using multiple 3761 cards.

The 3706A supports up to six 3761 cards, for a maximum of 60 low-current channels in a single mainframe system. Up to sixty-four 3706A systems can be configured to provide 3,840 low-current channels. See the *Series 3706A System Switch/Multimeter Reference Manual*, available on the [Keithley Instruments website](http://www.tek.com/keithley) (<http://www.tek.com/keithley>), for multiple 3706A system configurations.

NOTE

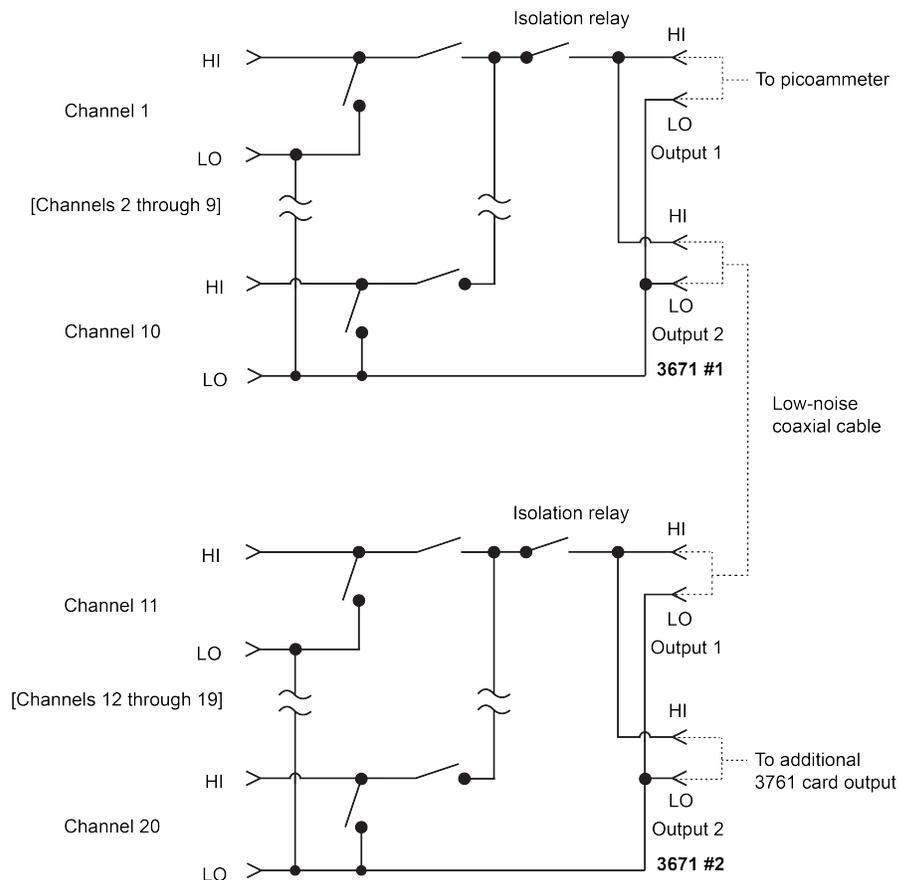
Leakage current specifications increase for each additional card enabled in a test system.

A 20-channel scanner system is shown in the next figure. In this configuration, you will connect one output connector of the 3761 to a picoammeter, and the second output connector to an output connector of a second 3761 card.

NOTE

Use a SMA-male to SMA-male cable to connect the cards, such as a Cinch Connectors part number 415-0038-012.

**Figure 8: 20-channel scanner system with two 3761 cards in ampere mode**



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Keithley Instruments  
Corporate Headquarters • 28775 Aurora Road • Cleveland, Ohio 44139 • 440-248-0400 • Fax: 440-248-6168 • 1-800-935-5595 • [www.tek.com/keithley](http://www.tek.com/keithley)

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