Models 7018-S and 7018-C
28-Channel 3-Pole Multiplexer Cards
Instruction Manual

Contains Operating and Servicing Information

KEITHLEY

WARRANTY

Keithley Instruments, Inc. warrants this product to be free from defects in material and workmanship for a period of 1 year from date of shipment.

Keithley Instruments, Inc. warrants the following items for 90 days from the date of shipment: probes, cables, rechargeable batteries, diskettes, and documentation.

During the warranty period, we will, at our option, either repair or replace any product that proves to be defective.

To exercise this warranty, write or call your local Keithley representative, or contact Keithley headquarters in Cleveland, Ohio. You will be given prompt assistance and return instructions. Send the product, transportation prepaid, to the indicated service facility. Repairs will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days.

LIMITATION OF WARRANTY

This warranty does not apply to defects resulting from product modification without Keithley's express written consent, or misuse of any product or part. This warranty also does not apply to fuses, software, non-rechargeable batteries, damage from battery leakage, or problems arising from normal wear or failure to follow instructions.

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Models 7018-S and 7018-C
Instruction Manual

Manual Print History

The print history shown below lists the printing dates of all Revisions and Addenda created for this manual. The Revision Level letter increases alphabetically as the manual undergoes subsequent updates. Addenda, which are released between Revisions, contain important change information that the user should incorporate immediately into the manual. Addenda are numbered sequentially. When a new Revision is created, all Addenda associated with the previous Revision of the manual are incorporated into the new Revision of the manual. Each new Revision includes a revised copy of this print history page.

Revision A (Document Number 7018-901-01) ....October 1993

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 the operating information carefully before using the product.

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, 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.

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.**

Users of this product must be protected from electric shock at all times. The responsible body must ensure that users are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product users 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.**

As described in the International Electrotechnical Commission (IEC) Standard IEC 664, digital multimeter measuring circuits (e.g., Keithley Models 175A, 199, 2000, 2001, 2002, and 2010) are Installation Category II. All other instruments' signal terminals are Installation Category I and must not be connected to mains.

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.

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 **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.

MODEL 7018-C, 7018-S
28-CHANNEL 3-POLE MULTIPLEXER

MULTIPLEX CONFIGURATION: Two independent 1×14 3-pole multiplex banks or one 1×14 6-pole multiplexer. Jumpers can be removed to isolate any bank from the backplane.

CONTACT CONFIGURATION: 3-pole Form A.

CONNECTOR TYPE:

7018-C: 96-pin male DIN connector.

7018-S: Screw terminal, #16AWG maximum wire size, with .092 inch O.D. 28 conductors per card maximum. #22AWG typical wire size with .062 inch O.D. 90 conductors per card maximum.

MAXIMUM SIGNAL LEVEL:

DC Signals: 110V DC between any two pins, 1A switched, 30VA (resistive load).

AC Signals: 125V RMS or 175V AC peak, between any two pins, 1A switched, 60VA (resistive load).

COMMON MODE VOLTAGE: 175V peak, any pin to chassis.

CONTACT LIFE:

Cold Switching: 10^8 closures.

At Maximum Signal Levels: 10^5 closures.

CHANNEL RESISTANCE (per conductor): $< 1.5\Omega$.

CONTACT POTENTIAL: $< 5\mu V$ per single contact.

OFFSET CURRENT: $< 100pA$.

ACTUATION TIME: 3ms.

ISOLATION:

Bank: $>10^9\Omega$, $< 25pF$.

Channel to Channel: $>10^9\Omega$, < 50 pF.

Differential: Configured as 1×14 $>10^9\Omega$, $< 100pF$ Configured as 1×28 $>10^9\Omega$, < 200 pF.

Common Mode: Configured as 1×14 $>10^9\Omega$, < 400 pF Configured as 1×28 $>10^9\Omega$, $< 650pF$

CROSS TALK (1MHz, 50Ω Load):

Bank: < -40 dB.

Channel: < -40 dB.

INSERTION LOSS (50Ω Source, 50 Load): $< 0.2dB$ below 1 MHz, $< 3dB$ below 2 MHz.

RELAY DRIVE CURRENT (per channel): 59 mA (Maximum of 11 channels on at same time).

ENVIRONMENT:

Operation: 0°C to 50°C, up to 35°C at 80% RH.

Storage: –25°C to 65°C.

Specifications subject to change without notice.

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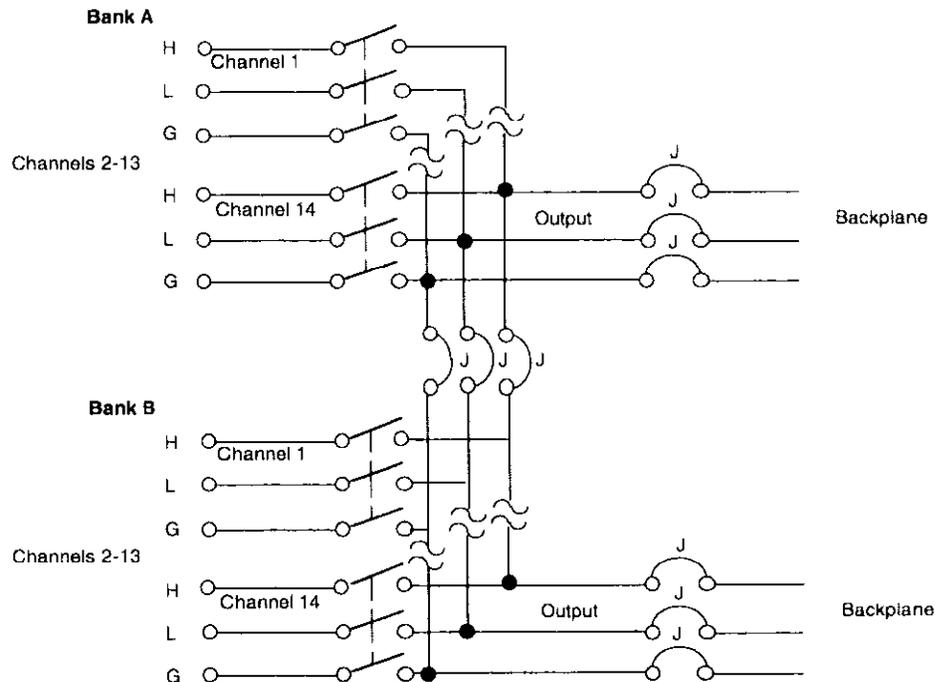
List of Tables

1

General Information

1.1 Introduction

This section contains general information about the Model 7018 28-Channel 3-Pole Multiplexer Card.

There are two basic versions of this multiplexer card; the Model 7018-S and the Model 7018-C. The Model 7018-S assembly consists of a screw terminal connector card and a relay card. External test circuits are wired directly to the screw terminals of the connector card. Also available from Keithley is the Model 7018-ST. This accessory is an extra screw terminal connector card. With an extra connector card, you can wire a second test system without disturbing the wiring configuration of the first test system.

The Model 7018-C assembly consists of a multi-pin (mass termination) connector card and the relay card. External test circuit connections to the multiplexer are made via the 96-pin male DIN connector on the connector card. Keithley offers a variety of optional accessories that can be used to make connections to the connector card (see paragraph 1.8).

The rest of Section 1 is arranged in the following manner:

1.2 Features

1.3 Warranty information

1.4 Manual addenda

1.5 Safety symbols and terms

1.6 Specifications

1.7 Unpacking and inspection

1.8 Optional accessories

1.2 Features

The Model 7018 is a three-pole, 28-channel multiplexer card. Some of the key features include:

- Low contact potential and offset current for minimal effects on low-level signals.

- The connector board detaches from the relay board allowing easy access to the screw terminals (Model 7018-S) and jumpers.

- Easy jumper configuration of one or two multiplexer banks (1×28 or 2×14).

- Backplane jumpers. Cutting jumpers disconnects multiplexer bank outputs from the Model 7001/7002 analog backplane.

- 3-pole or 6-pole operation.

1.3 Warranty information

Warranty information is located on the inside front cover of this instruction manual. Should your Model 7018 require warranty service, contact the Keithley representative or authorized repair facility in your area for further information. When returning the multiplexer card for repair, be sure to fill out and include the service form at the back of this manual in order to provide the repair facility with the necessary information.

1.4   Manual addenda

Any improvements or changes concerning the multiplexer card or manual will be explained in an addendum included with the card. Addenda are provided in a page replacement format. Simply replace the obsolete pages with the new pages.

1.5   Safety symbols and terms

The following symbols and terms may be found on an instrument or used in this manual.

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

The ⚡ symbol on an instrument shows that 1000V or more may be present on the terminal(s). Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading used in this 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 used in this manual explains hazards that could damage the multiplexer card. Such damage may invalidate the warranty.

1.6   Specifications

Model 7018 specifications are found at the front of this manual. These specifications are exclusive of the switching mainframe specifications.

1.7   Unpacking and inspection

1.7.1   Inspection for damage

The Model 7018 is packaged in a re-sealable, anti-static bag to protect it from damage due to static discharge and from contamination that could degrade its performance. Before removing the card from the bag, observe the following precautions on handling.

Handling Precautions:

1. Always grasp the card by the side edges and shields. Do not touch the board surfaces or components.

2. When not installed in a Model 7001/7002 mainframe, keep the card in the anti-static bag, and store it in the original packing carton.

After removing the card from its anti-static bag, inspect it for any obvious signs of physical damage. Report any such damage to the shipping agent immediately.

1.7.2   Shipping contents

The following items are included with every Model 7018 order:

- Model 7018 28-channel 3-pole Multiplexer Card
- Model 7018 Instruction Manual
- Additional accessories as ordered

1.7.3   Instruction manual

The Model 7018 Instruction Manual is three-hole drilled so that it can be added to the three-ring binder of the Model 7001/7002 Instruction Manual. After removing the plastic wrapping, place the manual in the binder following the mainframe instruction manual. Note that a manual identification tab is included and should precede the multiplexer card instruction manual.

If an additional instruction manual is required, order the manual package, Keithley part number 7018-901-00. The manual package includes an instruction manual and any pertinent addenda.

1.7.4   Repacking for shipment

Should it become necessary to return the Model 7018 for repair, carefully pack the unit in its original packing carton or the equivalent, and include the following information:

- Advise as to the warranty status of the multiplexer card.
- Write ATTENTION REPAIR DEPARTMENT on the shipping label.
- Fill out and include the service form located at the back of this manual.

1.8   Optional accessories

The following accessories are available for use with the Model 7018:

Model 7018-ST — This screw terminal connector card is identical to the one provided with the Model 7018-S assembly. An extra screw terminal connector card allows you to wire a second test system without disturbing the wiring configuration of the first connector card.

Model 7011-KIT-R — This connection kit includes a 96-pin female DIN connector that will mate directly to the connector on the Model 7018-C or to a standard 96-pin male DIN bulkhead connector (see Model 7011-MTR). This connector uses solder cups for connections to external circuitry. It includes an adapter for a round cable and the housing.

Model 7011-MTC-2 — This 2-meter round cable assembly is terminated with a 96-pin female DIN connector on each end. It will mate directly to the connector on the Model 7018-C and to a standard 96-pin male DIN bulkhead connector (see Model 7011-MTR).

Model 7011-MTR — This 96-pin male DIN bulkhead connector uses solder cups for connections to external circuitry. It will mate to the Model 7011-KIT-R connector, and Model 7011-MTC-2 cable assembly.

2

Multiplexing Basics

2.1 Introduction

This section covers the basics for multiplex switching and is arranged as follows:

2.2 **Basic multiplex configurations:** Covers the basic multiplex configurations: dual 1 × 14 configuration and single 1 × 28 configuration. The backplane jumpers are also covered here.

2.3 **Typical multiplexer switching schemes:** Explains some of the basic ways a multiplexer can be used for switching. Covers single-ended switching, differential (floating) switching, sensing, and 3-pole/6-pole operation.

2.4 **System expansion:** Discusses the various configurations that are possible by using multiple cards.

2.2 Basic multiplexer configurations

A simplified schematic of the Model 7018 multiplexer card is shown in Figure 2-1. It is organized as two 1 × 14 multiplexer banks. Each bank has 14 inputs and one output. Three-pole switching is provided for each multiplexer input, with HI, LO, and guard switched. The banks can be jumpered together to expand multiplexer inputs, and backplane jumpers provide bank connections to other card(s) installed in a Model 7001/7002 mainframe.

Note : Factory Configuration shown
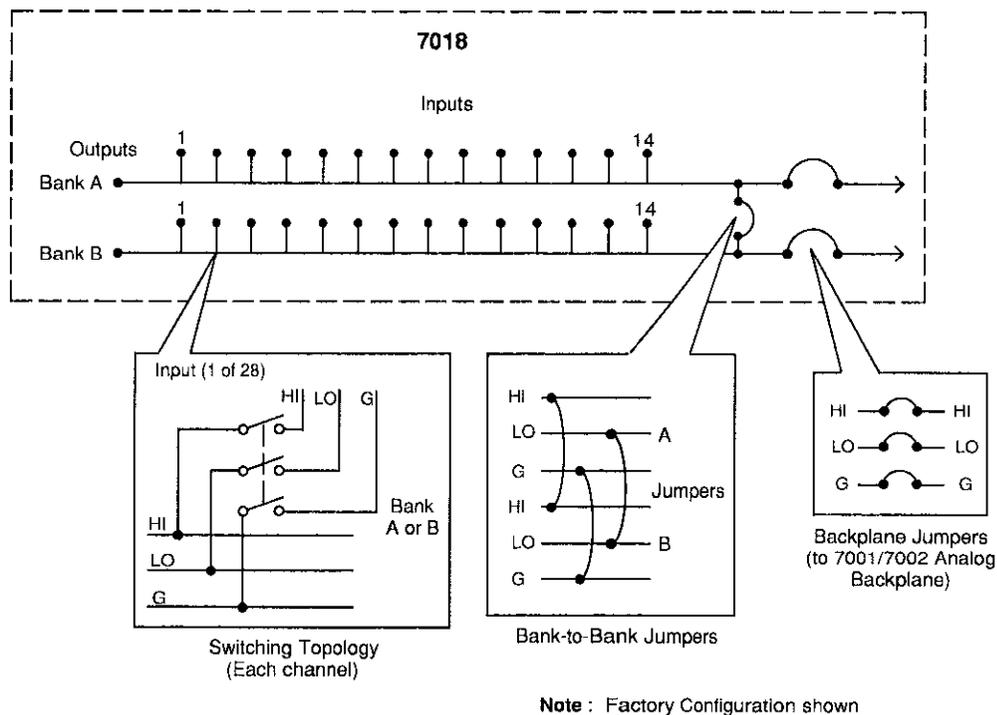
Figure 2-1
Model 7018 simplified schematic

2.2.1 Multiplexer bank-to-bank jumpers

Jumpers are installed on the connector card to connect the two multiplexer banks together to form a 1 × 28 multiplexer. These jumper sets are included with the Model 7018 and are installed as shipped from the factory.

The bank-to-bank jumpers allow you to configure the multiplexer card in two ways:

• Two 1 × 14 multiplexers; no jumpers installed (Figure 2-2).

• One 1 × 28 multiplexer; all three bank-to-bank jumpers installed (Figure 2-3).

Refer to Section 3 for information on removing or installing bank-to-bank jumpers.
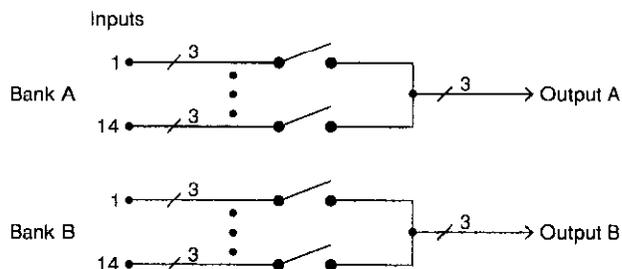
Figure 2-2
Dual 1 × 14 multiplexer configuration (jumpers not installed)
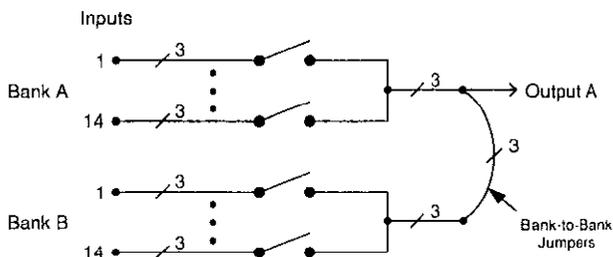
Figure 2-3
Single1 × 28 multiplexer configuration (jumpers installed)

2.2.2 Backplane jumpers

There are six backplane jumpers located on the relay card (three for each bank). With the jumpers installed, the banks of the multiplexer card are connected to the analog backplane of the Model 7001/7002, allowing expansion with other 7001/7002 card(s) installed in the mainframe. With the jumpers removed (cut), the multiplexer card is isolated from other card(s) installed in the mainframe.

The three-pole analog backplane of the Model 7001/7002 mainframe is shown in Figure 2-4. Through this analog backplane, the banks of a Model 7018 multiplexer card, installed in one slot, can be connected to the banks (or rows) of a compatible card installed in another slot of the mainframe.

NOTE

When the backplane jumpers are installed, connecting the banks together on one card will automatically connect the banks of cards in other slots together.

Figure 2-5 shows how each bank of the Model 7018 is connected to the backplane. The Model 7018 is shipped from the factory with the backplane jumpers installed.

Removing (cutting) the backplane jumpers isolates the card from the backplane, and subsequently, any card installed in the other slot. For information on removing the jumpers, refer to Section 3.

NOTE

The Model 7001/7002 does not provide an analog backplane for the non-701X series cards. As a result, any of these cards installed in one slot in the mainframe is electrically isolated from any card installed in another slot. The only way to connect a Model 7018 to one of these cards is to wire them together externally.

Figure 2-4
Model 7001/7002 analog backplane
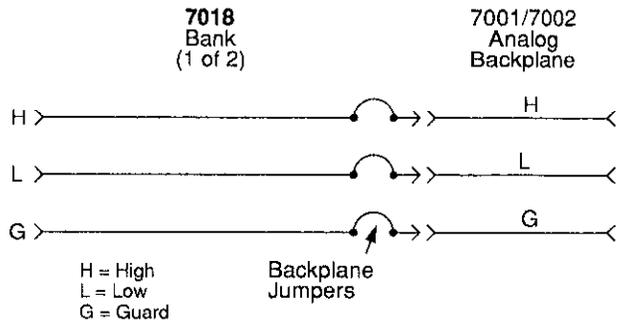
Figure 2-5
Bank connections to backplane

Figure 2-6
Single-ended switching example

2.3   Typical multiplexer switching schemes

The following paragraphs describe some basic switching schemes that are possible with a three-pole switching multiplexer. These switching schemes include some various shielding configurations to help minimize noise pickup in sensitive measurement applications. These shields are shown connected to chassis ground. For some test configurations, shielding may prove to be more effective connected to circuit low or common. Chassis ground is accessible at the rear panel of the Model 7001/7002.

2.3.1   Single-ended switching

In the single-ended switching configuration, the source or measure instrument is connected to the DUT through a single pathway, as shown in Figure 2-6. The instrument is connected to the output of one of the banks, and the DUT is shown connected to one of the inputs for that bank.

2.3.2   Differential switching

The differential or floating switching configuration is shown in Figure 2-7. The advantage of using this configuration is that the terminals of the source or measure instrument are not confined to the same pathway. Each terminal of the instrument can be switched to any available input in the test system.

2.3.3   Sensing

Figure 2-8 shows how the multiplexer card can be configured to use instruments that have sensing capability. The main advantage of using sensing is to minimize the effects of switch card path resistance ($<1.5\Omega$) and the resistance of external cabling. Whenever path resistance is a consideration, sensing should be used.
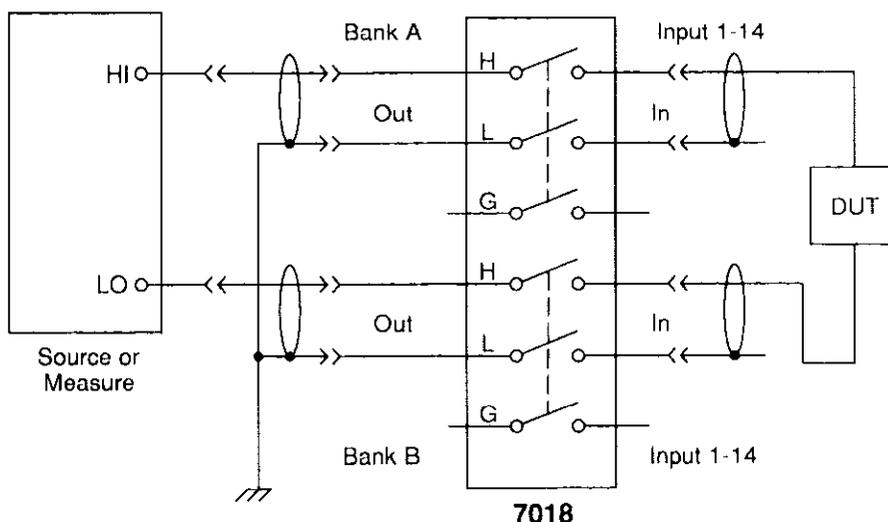
Figure 2-7
Differential switching example
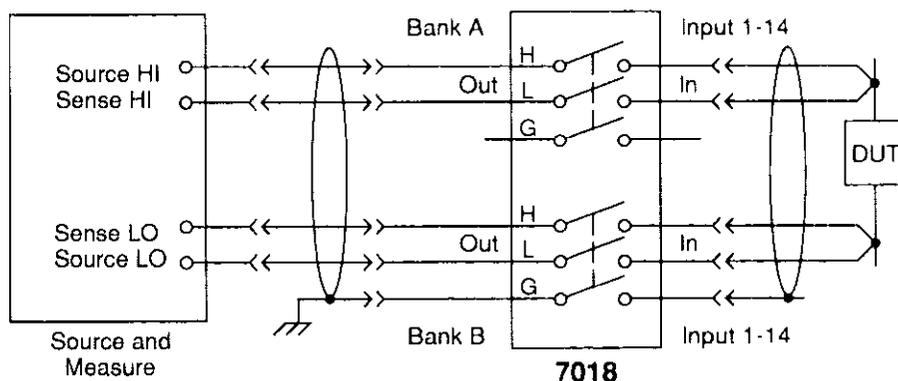
Figure 2-8
Sensing example

2.3.4 3-pole connections

Figure 2-9 shows typical 3-pole connections using a single channel to switch both source and measure instruments to the DUT. In this example, source HI and measure HI are routed separately to the DUT, while the LO terminals are connected together externally.

2.3.5 6-pole connections

The Model 7018 can also be used for 6-pole switching for testing more complex DUTs. Figure 2-10 shows typical 6-pole connections. In order to use 6-pole switching, the like-numbered channels of Banks A and B must be paired together (Bank A, Input 1 with Bank B, Input 1, etc.). See paragraph 4.3.4 for information on setting up the switching mainframe for 6-pole operation.
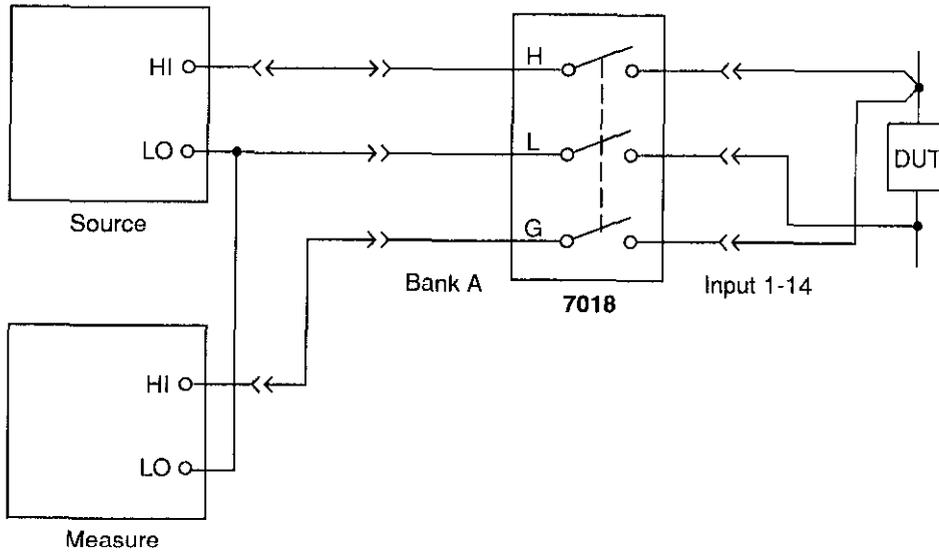
Figure 2-9
3-pole connections

Note : Like-numbered inputs of Banks A and B must be paired together for 6-pole operation.
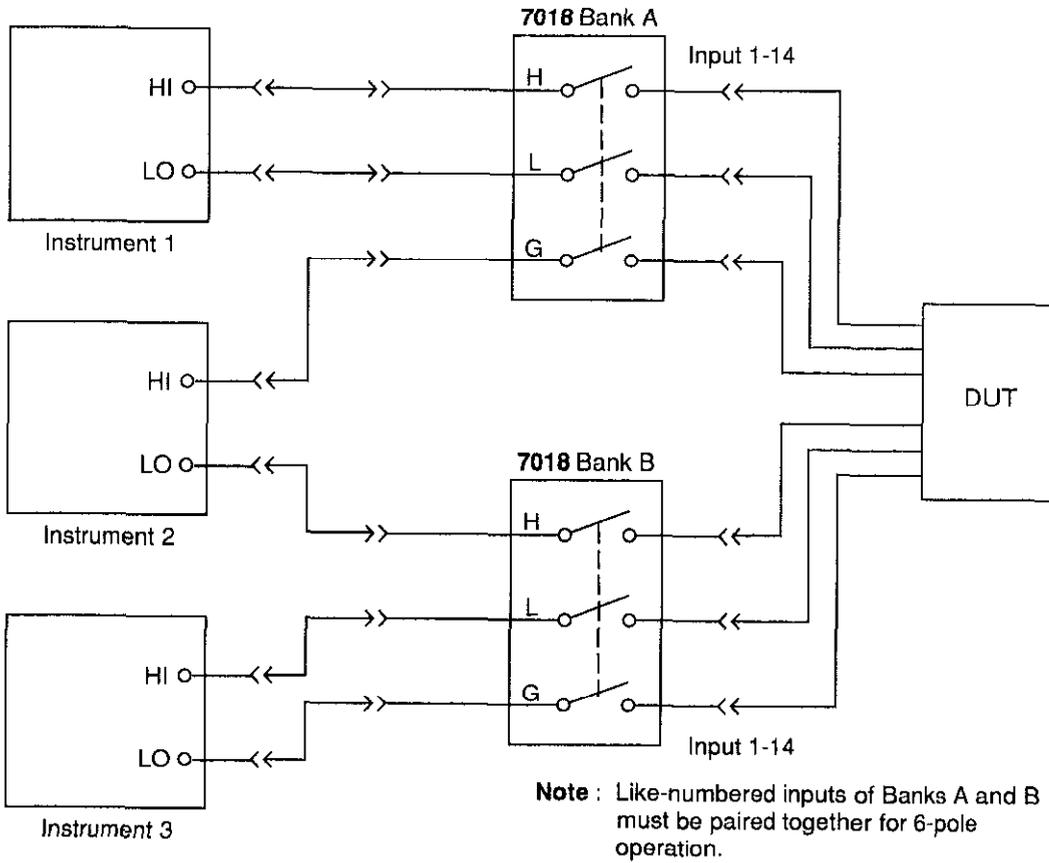
Figure 2-10
6-pole connections

2.4 Multiplexer expansion

With the use of additional switching cards and mainframes, larger systems can be configured. Each Model 7001 Switch System mainframe will accommodate up to two cards, and each Model 7002 Switch System can hold up to 10 cards.

2.4.1 Multiple-card switching systems

Separate switching systems

Multiple single-card systems can be configured by removing the backplane jumpers from each card. The cards will be controlled by the same mainframe, but they will be electrically isolated from each other. Figure 2-11 shows an example using two Model 7018 multiplexer cards.

Multiplexer input expansion

You can increase the number of multiplexer inputs simply by installing additional "as shipped" Model 7018 cards in the mainframe. By leaving the backplane jumpers installed, the banks of the multiplexer card installed in slot 1 (CARD 1) are automatically connected to the banks of the multiplexer card installed in slot 2 (CARD 2) through the analog backplane (and to any additional cards in the Model 7002).

Figure 2-12 shows an example of input expansion. Each Model 7018 card is configured as two 1 × 14 multiplexers. By connecting the banks together (via the Model 7001/7002 analog backplane), the resultant multiplexer system has 28 inputs for each of the two banks. Notice that if the bank-to-

bank jumpers for either card were installed, the result would be a single 1 × 56 multiplexer.

Mixing card types

Different types of cards can be used together to create some versatile switching systems. For example, you could have a Model 7018 multiplexer card installed in one slot and a Model 7012 matrix card installed in another slot.

Figure 2-13 shows a possible switching system using a matrix card and a multiplexer card. The backplane jumpers for both the matrix and multiplexer cards must be installed. This setup allows matrix rows to be connected to multiplexer banks. On the multiplexer card, the bank-to-bank jumpers must be removed to maintain isolation between matrix rows. See the instruction manual for the Model 7012 for complete information on the matrix card.

Note that Banks A and B of the Model 7018 are connected to Banks A and C of quad 1 × 10 mux cards or Rows 1 and 3 of matrix cards through the backplane.

2.4.2 Mainframe multiplexer expansion

Multiplexer systems using additional multiplexer cards are possible by using a number of Model 7001/7002 mainframes together. Each Model 7018 added to the system provides 28 additional inputs. Paragraph 3.4.3 explains how to connect a test system using two mainframes.
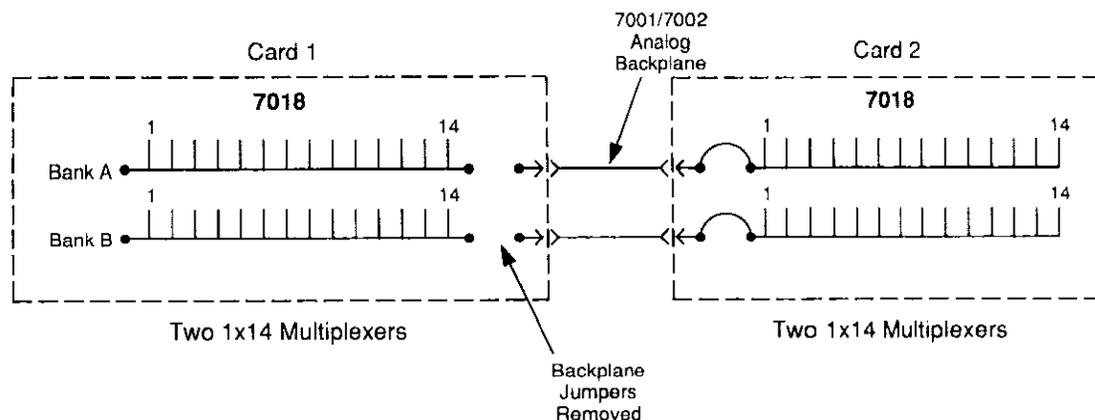
Figure 2-11
Two separate multiplexer systems

Dual 1 x 28 Multiplexer
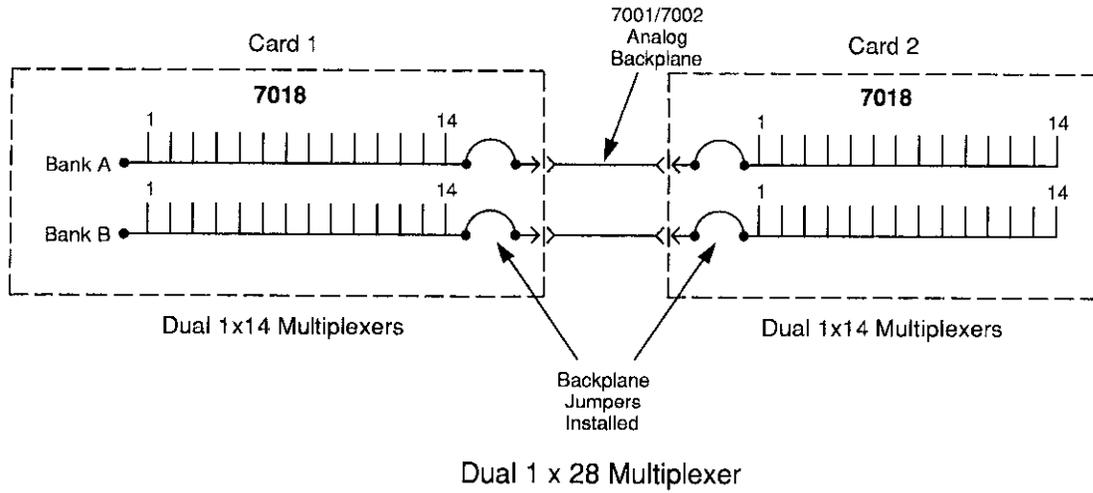
Figure 2-12
Multiplexer input expansion example

4 x 10 Matrix
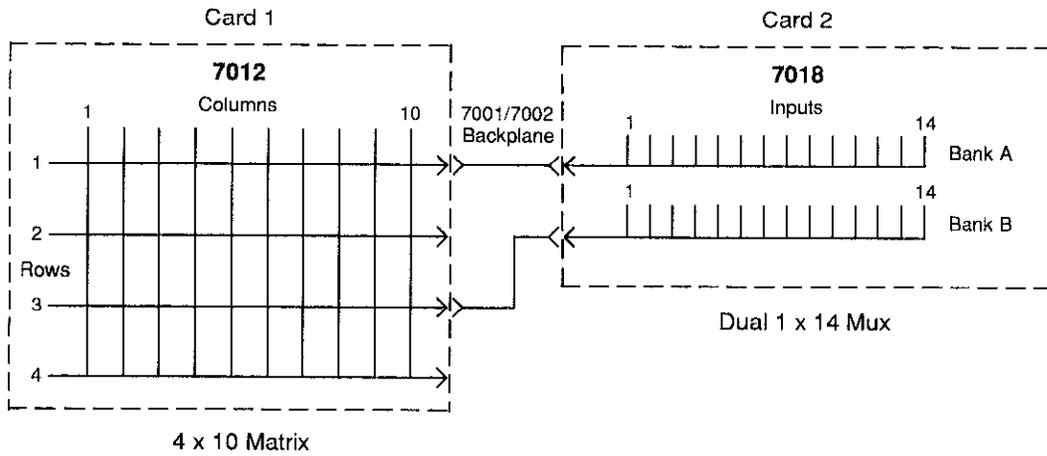
Notes : 1. Models 7018 and 7012 backplane jumpers must be installed.
2. Model 7018 bank-to-bank jumpers must be removed.
3. Model 7012 is a 2-pole card and switches only HI and LO.

Figure 2-13
Mixed card type example

3

Card Connections & Installation

3.1 Introduction

WARNING

The procedures in this section are intended only for qualified service personnel. Do not perform these procedures unless qualified to do so. Failure to recognize and observe normal safety precautions could result in personal injury or death.

The information in this section is arranged as follows:

3.2 Handling precautions: Explains precautions that must be followed to prevent contamination to the multiplexer card assembly. Contamination could degrade the performance of the multiplexer card.

3.3 Connections: Covers the basics for connecting external circuitry to the two available connector cards for the multiplexer; the screw terminal connector card and the multi-pin connector card.

3.4 Typical connection schemes: Provides some typical connection schemes for single card, two-card, and two-mainframe system configurations.

3.5 Model 7018 installation: Provides a procedure to install the multiplexer card assembly in the Model 7001/7002 mainframe.

3.2 Handling precautions

To maintain high impedance isolation, care should be taken when handling the card to avoid contamination from such foreign materials as body oils. Such contamination can substantially lower leakage resistances, thus degrading performance.

To avoid possible contamination, always grasp the relay and connector cards by the side edges or shields. Do not touch the board surfaces or components. On connectors, do not touch areas adjacent to the electrical contacts. Dirt build-up over a period of time is another possible source of contamination. To avoid this problem, operate the mainframe and multiplexer card in a clean environment.

If a card becomes contaminated, it should be thoroughly cleaned as explained in paragraph 5.2.

3.3 Connections

This paragraph provides the basic information needed to connect your external test circuitry to the multiplexer card. It includes the installation of the bank-to-bank jumpers on the connector card, installation/removal of backplane jumpers on the relay card, and detailed information on making external connections to the two available connector cards.

WARNING

The following connection information is intended to be used by qualified service personnel. Failure to recognize and observe standard safety precautions could result in personal injury or death.

3.3.1 Bank-to-bank jumpers

As explained in paragraph 2.2.1, the two banks of the multiplexer card can be connected together (using plug-in jumpers) to form a larger multiplexer. The locations of the bank-to-bank jumper terminals for both connector cards are shown in Figure 3-1. The Model 7018 is shipped from the factory with the bank-to-bank jumpers installed.

Terminal identification is provided by Figure 3-2. On the drawing, the three terminal pairs are labeled W101 through W103.

Table 3-1
Bank-to-bank jumpers (on connector cards)

Installed jumper*	Connection
W101	Connect Bank A G to Bank B G
W102	Connect Bank A HI to Bank B HI
W103	Connect Bank A LO to Bank B LO

* See Figure 3-1 and Figure 3-2.
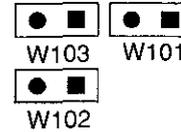
Figure 3-2
Bank-to-bank jumper terminal identification

Referring to Figure 3-1 for jumper locations, perform the following steps to remove or install bank-to-bank jumpers:

1. If mated together, separate the relay card from the connector card by removing the mounting screw and pulling the two cards away from each other. Remember to handle the cards only by the edges and shields to avoid contamination.
2. Refer to Figure 3-2 to determine jumper location.
3. Using Figure 3-3 as a guide, install or remove the jumpers on all three terminal pairs.
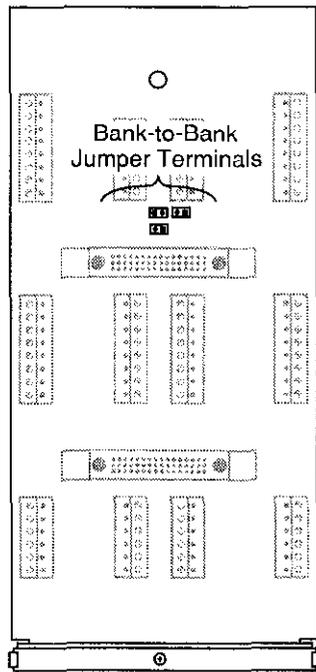
A. Screw Terminal Connector
   Card (Model 7018-S)
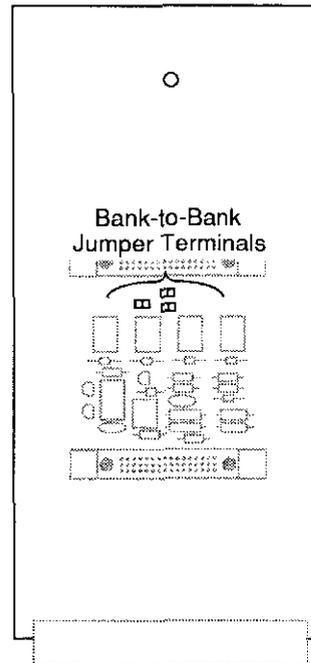
B. Multi-pin Connector Card
   (Model 7018-C)

Figure 3-1
Bank-to-bank jumper locations
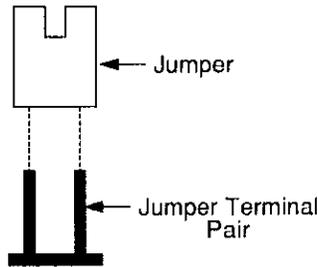
Figure 3-3
Bank-to-bank jumper installation

3.3.2 Backplane jumpers

The Model 7001/7002 mainframe has an analog backplane that allows the banks of a Model 7018 multiplexer to be internally connected to a compatible switching card installed in another slot (see paragraph 2.4.1 for details).

The backplane jumpers for the multiplexer card assembly are located on the relay card as shown in Figure 3-4. The card is shipped from the factory with the jumpers installed.
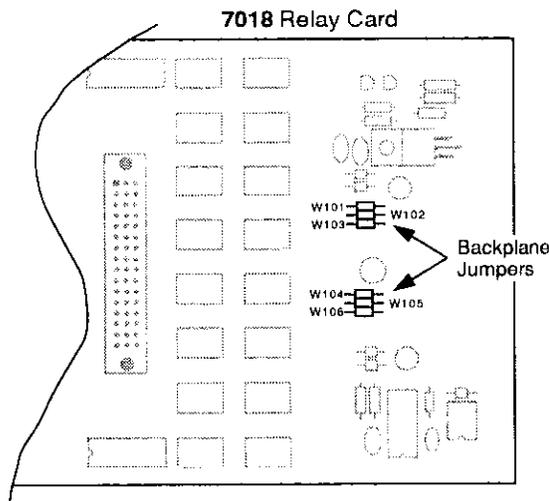
Figure 3-4
Backplane jumpers

Jumper removal

Perform the following steps to remove backplane jumpers:

1. If mated together, separate the relay card from the connector card by removing the mounting screw and pulling the two cards away from each other. Remember to handle the cards only by the edges and shields to avoid contamination.

2. Use Figure 3-4 and Table 3-2 to locate the jumper(s) that are to be removed.

3. It is not necessary to unsolder the jumpers from the PC board. Using a pair of wire cutters, cut both ends of each jumper, then remove the cut jumper segment completely.

Table 3-2
Backplane jumpers (on relay cards)

Jumper*	Connection
W101	Bank A HI
W102	Bank A LO
W103	Bank A G
W104	Bank B HI
W105	Bank B LO
W106	Bank B G

*See Figure 3-4 for location.

Jumper installation

Referring to Figure 3-4 for jumper locations, perform the following steps to install backplane row jumpers:

1. If mated together, separate the relay card from the connector card by removing the mounting screw and pulling the two cards away from each other. Remember to handle the cards only by the edges and shields to avoid contamination.

2. Physically remove cut jumper ends by unsoldering them from the PC board.

3. Install a new #22 AWG jumper wire (Keithley P/N J-15), and solder it to the PC board.

4. Remove the solder flux from the PC board The cleaning procedure is explained in paragraph 5.2.

3.3.3 Screw terminal connector card

The screw terminal connector card is shown in Figure 3-5. Connections are made directly to the screw terminals of the twelve terminal blocks. Each screw terminal will accommodate #16-22 AWG wire. Note that the inputs for channels 1-14 of both Bank A and Bank B are labelled IN1 through IN14 respectively.

Each input and output has three terminals labelled H, L and G for HI, LO and guard respectively.

NOTE

Although the G terminal is called guard, it is not a guard terminal and should not be considered a guard in the usual sense. All

three pathways for each input have the same electrical characteristics. Chassis ground is available at the rear panel of the mainframe.
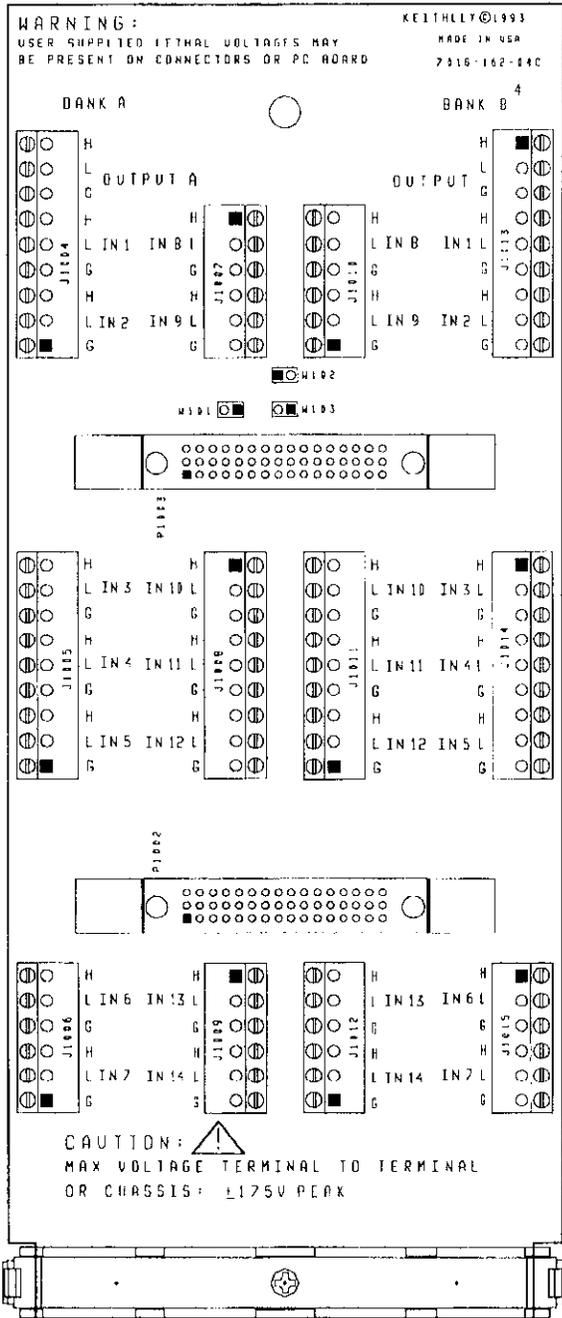
Figure 3-5
Model 7018 screw terminal connector card

Wiring procedure

Perform the following procedure to wire circuitry to the screw terminal connector card:

WARNING

Make sure all power is off and any stored energy in external circuitry is discharged. All DUT connections must be insulated to prevent electric shock. The recommended minimum wire insulation rating is 175V RMS.

1. If mated together, separate the connector card from the relay card by removing the mounting screw and pulling the two cards away from each other. Remember to only handle the cards only by the edges and shields to avoid contamination.

2. Using an insulated screwdriver, connect the circuitry to the appropriate terminals. Figure 3-6 shows how the output of Bank A would be connected to a DMM.
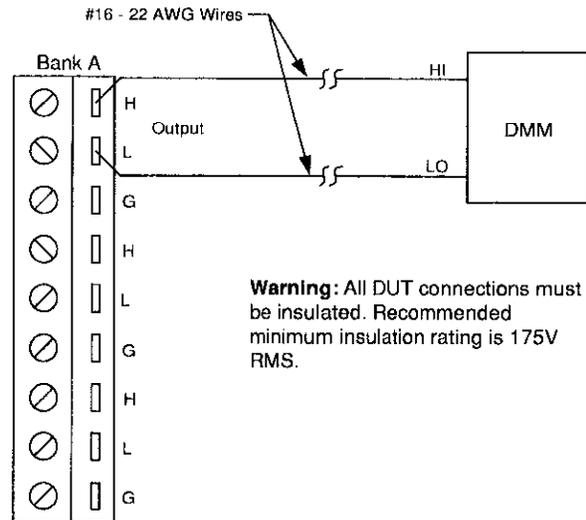
Figure 3-6
Typical screw terminal connections

3. Referring to Figure 3-7, remove the top half of the cable clamp as follows:
   A. Loosen the cable clamp screw enough to disengage it from the bottom half of the cable clamp.
   B. Using your thumb and forefinger, press the retaining clips inward, and, with your other hand, remove the top half of the clamp.

4. Route wires under the wire guide/connector shim.

5. Route the wires through the bottom half of the cable clamp.
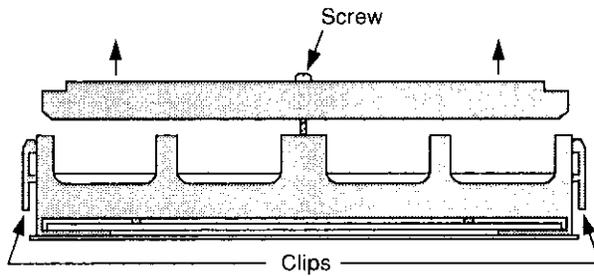
Caution: External strain relief should be used with large wire bundles

Figure 3-7
Cable clamp for screw terminal connector card

6. Replace the top half of the clamp. It simply snaps onto the bottom half of the clamp. Tighten the cable clamp screw. The clamp serves as a strain relief for terminal block wires.

CAUTION

An external strain relief should be used with large wire bundles to prevent damage to the card.

7. Mate the connector card to the relay card. The Model 7018 is now ready to be installed in the Model 7001/ 7002 mainframe. See paragraph 3.5 for details.

3.3.4 Multi-pin (mass termination) connector card

Since connections to external circuitry are made at the 96-pin male DIN bulkhead connector, there is no need to separate the connector card from the relay card. If the connector card is separated from the relay card, carefully mate them together, and install the supplied 4-40 mounting screw. Make sure to handle the cards by the edges and shields to avoid contamination.

Terminal identification for the DIN connector of the multi-pin connector card is provided by Figure 3-8. This connector will mate to a 96-pin female DIN connector. Each input and output has three terminals, HI, LO and G (guard).

NOTE

Although the G terminal is called guard, it is not a guard in the usual sense. All three pathways of each input have the same electrical characteristics, and they can be used interchangeably.

Keithley has a variety of cable and connector accessories available to accommodate connections from the connector card to test instrumentation and DUT (devices under test). In general, these accessories, which are summarized in Table 3-3, utilize a round cable assembly for connections.

WARNING

All DUT connections must be insulated to prevent electric shock. The recommended minimum wire insulation rating is 175V RMS.

CAUTION

An external strain relief should be used with large wire bundles to prevent damage to the card.

Table 3-3
Mass termination accessories

Model	Description
7011-KIT-R	96-pin female DIN connector and housing for round cable.
7011-MTC-2	Two-meter round cable assembly terminated with a 96-pin female DIN connector on each end.
7011-MTR	96-pin male DIN bulkhead connector.

Typical connection techniques

All external circuitry, such as instrumentation and DUTs, that you wish to connect to the multiplexer card must be terminated with a single 96-pin female DIN connector. The following connection techniques provide some guidelines and suggestions for wiring your circuitry.

WARNING

Before beginning any wiring procedures, make sure all power is off and any stored energy in external circuitry is discharged.

NOTE

External circuitry should be connected (plugged in) only with the mainframe power off, after the Model 7018 assembly is installed in the Model 7001/7002 mainframe. Installation is covered in paragraph 3.5.

Output relays— The multi-pin connector card uses a relay for each of the two output banks. These output relays are normally open to prevent any hazardous voltages (via the mainframe backplane) from appearing on the pins of the male DIN connector. The output relays will only close when the Model 7011-MTC-2 cable assembly is connected to card. If building you own cable assembly, you must make sure that it shorts pins 1a to 1b of the card connector (Figure 3-8) when it is mated to the card. Shorting pins 1a to 1b allows the output relays to close.

Round cable assemblies — Figure 3-9 shows typical round cable connection techniques using accessories available from Keithley.

In Figure 3-9A, connections are accomplished using a Model 7011-MTC-2 cable and a Model 7011-MTR bulkhead connector. The two-meter round cable is terminated with a 96-pin female DIN connector at each end. This cable mates directly to the multi-pin connector card and to the bulkhead connector. The bulkhead connector has solder cups to allow direct connection to instrumentation and DUT. Figure 3-10 provides the pinout for the bulkhead connector.

In Figure 3-9B, connections are accomplished using a Model 7011-MTC-2 cable assembly that is cut in half. The 96-pin female DIN connector on one end of the cable mates directly to the multi-pin connector card. The unterminated end of the cable is wired directly to instrumentation and DUT. The other half of the cable assembly could be used for a second switching card.

In Figure 3-9C, connections are accomplished using a custom-built cable assembly that consists of a Model 7011-KIT-R connector and a suitable round cable. Hitachi cable part number N2807-P/D-50TAB is a 50-conductor cable. Two of these cables can be used to supply 100 conductors. The connector has solder cups to accommodate the individual wires of the unterminated cable. Figure 3-11 provides an exploded view of the connector assembly and shows how the cable is connected. The connector end of the resultant cable assembly mates directly to the multi-pin connector card. The unterminated end of the cable assembly is wired directly to instrumentation and DUT.

Pins of the Model 7018-C mass termination connector can be identified in one of three ways:

1. Mux terminal, consisting of banks A-B and inputs 1-14.
2. Connector description, consisting of rows a-c and columns 1-32.
3. Schematic and component layout designation (1-96).

The following pinout diagrams show the correspondence between these arrangements:
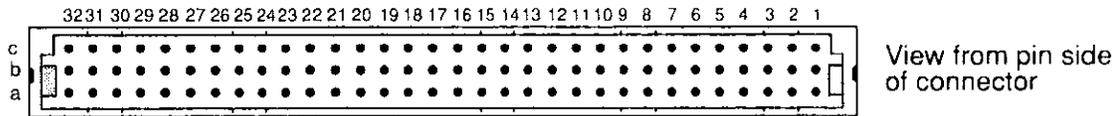
View from pin side
of connector

Mux Terminal	Connector Desig. 1a-32c	Schem. Desig. 1-96	Mux Terminal	Connector Desig. 1a-32c	Schem. Desig. 1-96	Mux Terminal	Connector Desig. 1a-32c	Schem. Desig. 1-96	Mux Terminal	Connector Desig. 1a-32c	Schem. Desig. 1-96
Bank A			Bank A			Bank B			Bank B		
Input 1 HI	2a	2	Input 8 HI	10a	10	Input 1 HI	17a	17	Input 8 HI	24a	24
LO	2c	66	LO	10c	74	LO	17c	81	LO	24c	88
G	2b	34	G	10b	42	G	17b	49	G	24b	56
Input 2 HI	3a	3	Input 9 HI	11a	11	Input 2 HI	18a	18	Input 9 HI	25a	25
LO	3c	67	LO	11c	75	LO	18c	82	LO	25c	89
G	3b	35	G	11b	43	G	18b	50	G	25b	57
Input 3 HI	4a	4	Input 10 HI	12a	12	Input 3 HI	19a	19	Input 10 HI	26a	26
LO	4c	68	LO	12c	76	LO	19c	83	LO	26c	90
G	4b	36	G	12b	44	G	19b	51	G	26b	58
Input 4 HI	5a	5	Input 11 HI	13a	13	Input 4 HI	20a	20	Input 11 HI	27a	27
LO	5c	69	LO	13c	77	LO	20c	84	LO	27c	91
G	5b	37	G	13b	45	G	20b	52	G	27b	59
Input 5 HI	6a	6	Input 12 HI	14a	14	Input 5 HI	21a	21	Input 12 HI	28a	28
LO	6c	70	LO	14c	78	LO	21c	85	LO	28c	92
G	6b	38	G	14b	46	G	21b	53	G	28b	60
Input 6 HI	7a	7	Input 13 HI	15a	15	Input 6 HI	22a	22	Input 13 HI	29a	29
LO	7c	71	LO	15c	79	LO	22c	86	LO	29c	93
G	7b	39	G	15b	47	G	22b	54	G	29b	61
Input 7 HI	8a	8	Input 14 HI	16a	16	Input 7 HI	23a	23	Input 14 HI	30a	30
LO	8c	72	LO	16c	80	LO	23c	87	LO	30c	94
G	8b	40	G	16b	48	G	23b	55	G	30b	62
			Output HI	31a	31				Output HI	32a	32
			LO	31c	95				LO	32c	96
			G	31b	63				G	32b	64

Notes:
1. Pins 9a and 9b (pins 9 and 41 on schematic) are shield.
2. Short pins 1a to 1b on the mating connector (pins 1 and 33 on schematic) to allow the output relays on the connector card to close.

WARNING

All DUT connections must be insulated. Recommended minimum insulation rating is 175V RMS.

CAUTION

External strain relief should be used for large wire bundles.

Figure 3-8
Multi-pin card terminal identification

A) Multi-Pin Connector Card

7011-MTC-2 cable assembly

7011-MTR bulkhead connector

Wire instrumentation and DUT to bulkhead connector (See Figures 3-8 and 3-10 for terminal identification)

B) Multi-Pin Connector Card

7011-MTC-2 (Cut in Half)

Wire directly to instrumentation and DUT

C) Multi-Pin Connector Card

7011-Kit-R Connector Kit

Cable

Wire directly to instrumentation and DUT

Notes : Figure 3-11 provides an exploded view showing how the connector (with cable) is assembled.

Cable Hitachi p/n N2807-P/D-50TAB is a 50-conductor round cable. Two of these cables can be used to supply 100 conductors.

Figure 3-9
Typical round cable connection techniques

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32

View from solder cup side of connector
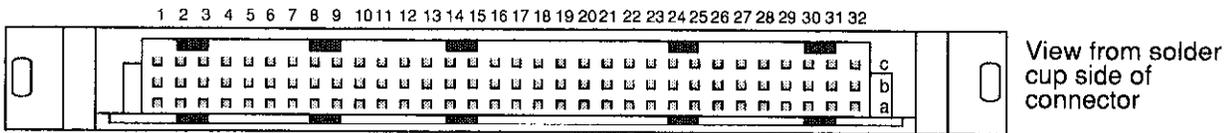
Note : See Figure 3-8 for terminal identification.

Figure 3-10
Model 7011-MTR connector pinout
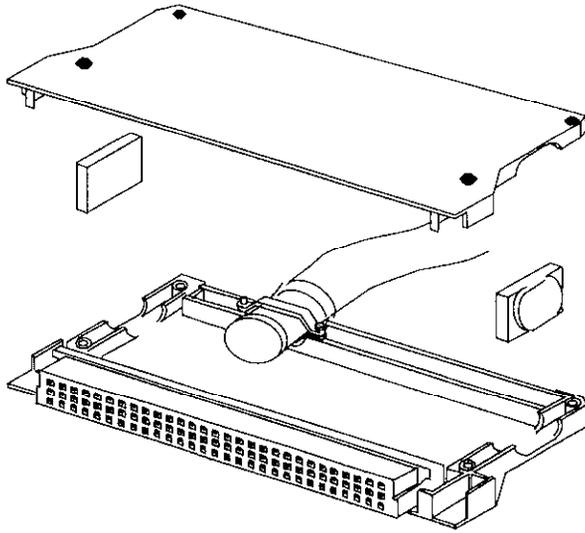
Figure 3-11
Model 7011-KIT-R (with/cable) assembly

3.4 Typical connection schemes

The following information provides some typical connection schemes for single-card, two-card and two-mainframe system configurations. Connection schemes for the multi-pin connector card use some of the techniques presented in paragraph 3.3.2. Keep in mind that these are only examples to demonstrate various ways to wire a test system. Connection details for both connector cards (multi-pin and screw terminal connector cards) are provided in paragraph 3.3.

3.4.1 Single-card system

Figure 3-12 shows how external connections can be made to a single-card system that uses the multi-pin connector card

(Model 7018-C). This single-card system is configured as two 1 × 14 multiplexers. To accomplish this, the bank-to-bank jumpers must be removed.

Instrumentation and DUTs are hard-wired to the Model 7011-MTR male bulkhead connector. This connector has solder cups that will accept wire size up to #24 AWG. The test system is connected to the multiplexer using the Model 7011-MTC-2 round cable assembly. This cable mates directly to both the external bulkhead connector and the Model 7018-C multiplexer card assembly. Notice that the bulkhead connector is shown mounted to a fixture to help keep the cabling stable during the test.

The single-card system in Figure 3-13 is identical to the system in the previous illustration, except for the connection scheme. The system in Figure 3-13 uses the screw terminal connector card (Model 7018-S). With this card, single-conductor connections are made directly from the terminal blocks of the connector card to instrumentation and DUTs.

When using a single-card system, make sure that the card remains electrically isolated from any other switching cards. There are several ways to ensure isolation for a single card in the Model 7001/7002 mainframe:

1. Vacate other mainframe slot(s). If there is a Model 701X card installed in another slot, remove it.
2. Remove the backplane jumpers on the multiplexer card. Doing so will disconnect the card from the analog backplane of the mainframe.
3. Remove the backplane jumpers from switching card(s) installed in other slot(s).
4. Remove backplane jumpers from the Model 7002 backplane.
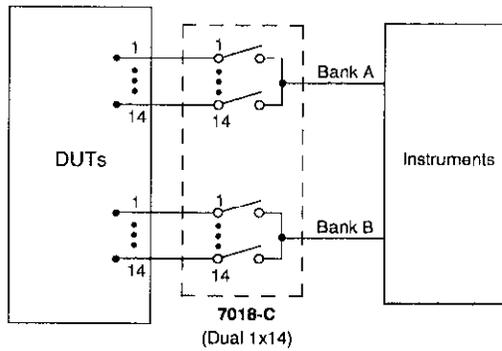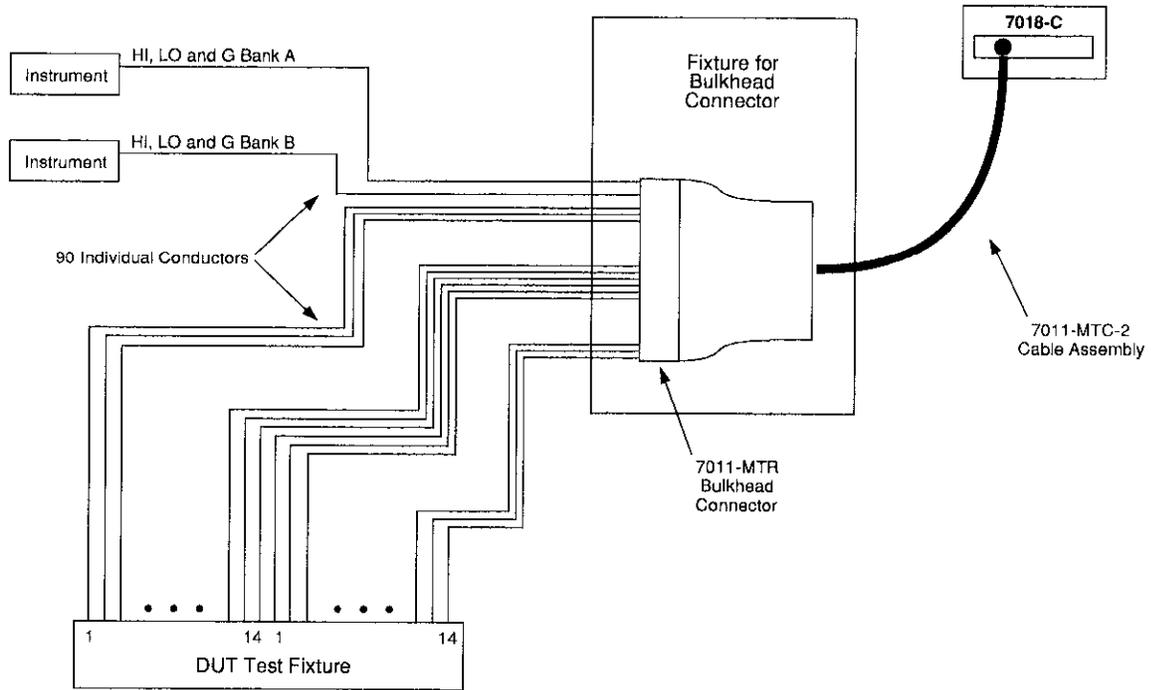
Figure 3-12
Single-card system example (multi-pin connector card)
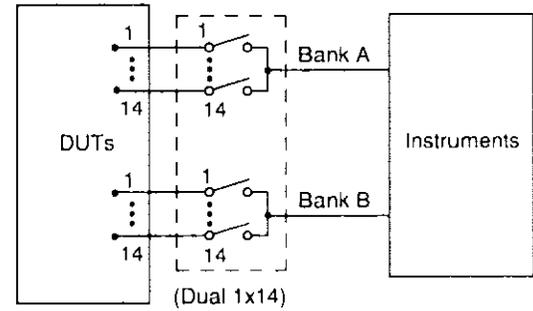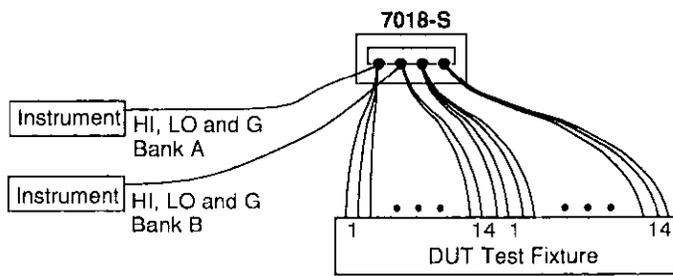
Figure 3-13
Single-card system example (screw terminal connector card)
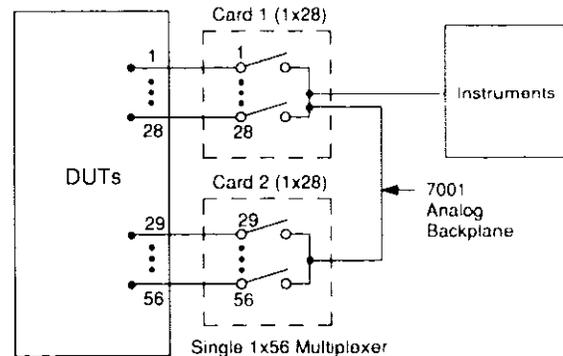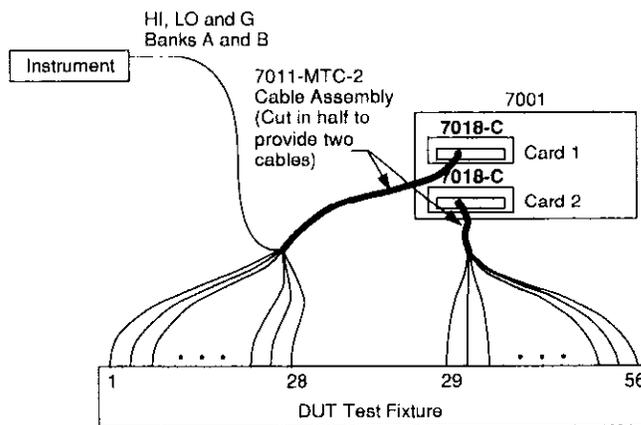
Figure 3-14
Two-card system example (multi-pin connector card)

3.4.2 Two-card system

Both Figure 3-14 and Figure 3-15 show a system using two multiplexer cards installed in one Model 7001 mainframe to configure a single 1 × 56 multiplexer system. Each card is configured as a single 1 × 28 multiplexer. To accomplish this, bank-to-bank jumpers are installed to connect Banks A and B together. By leaving the backplane jumpers of both cards installed, the banks of Card 1 are connected to the banks of Card 2 through the analog backplane of the Model 7001 mainframe resulting in the 1 × 56 configuration.

Figure 3-14 shows how external connections can be made for the multi-pin connector cards. In this example, a single Model 7011-MTC-2 round cable assembly is cut in half to provide two cables, each of which is unterminated at one end. The unterminated ends of the two cables are hard-wired to the instrument and DUT as shown in the drawing. The other ends of these cables mate directly to the Model 7018-C multiplexer card assemblies.

Figure 3-15 shows how external connections can be made for the screw terminal connector card. Single conductor connections are made directly from the screw terminals of the connector card to the instrument and DUT.

Figure 3-15
Two-card system example (screw terminal connector card)

3.4.3 Two-mainframe system
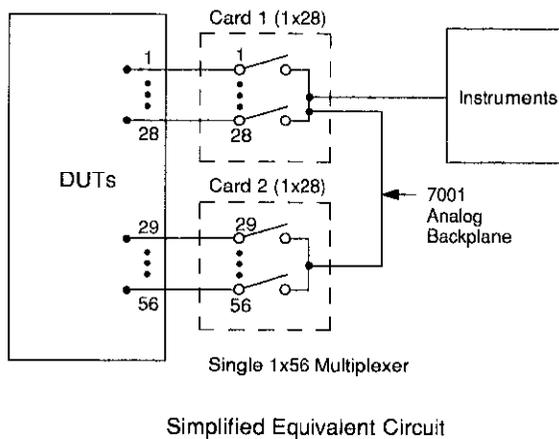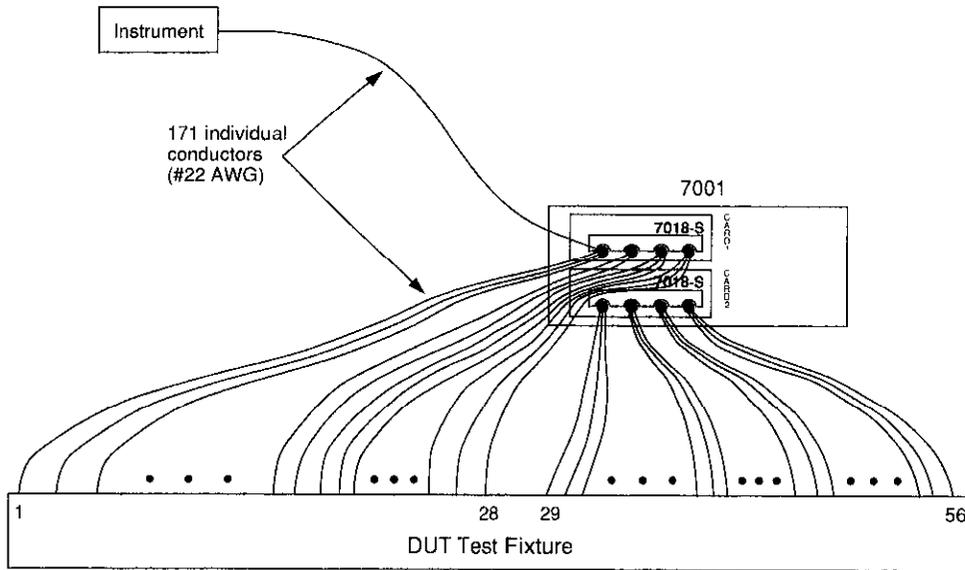
Both Figure 3-16 and Figure 3-17 show a system using three multiplexer cards installed in two Model 7001 mainframes to configure a single 1 × 84 multiplexer system. Each card is configured as a single 1 × 28 multiplexer. To accomplish this, bank-to-bank jumpers of all at least one card must be installed to connect Banks A and B together.

By leaving the backplane jumpers of the cards in mainframe #1 installed, the banks of Card 1 are connected to the banks of Card 2 through the analog backplane of the Model 7001

mainframe resulting in a 1 × 56 configuration. External bank connections from the instrument to the card in the second mainframe connect the banks of all three cards together to form the 1 × 84 multiplexer system. This system is similar to the Two-card System (see previous paragraph) except that a third multiplexer card (installed in a second mainframe) is added.

Figure 3-16 shows the connection scheme for the multi-pin connector cards. External circuit connections to the Model 7001 #1 mainframe are identical to the ones used for the

Two-card System. The third multiplexer card (installed in Model 7001 #2 mainframe) shows how a custom-built cable can be used to make connections to external circuitry. A suitable round cable can be constructed using a 96-pin female DIN connector (Model 7011-KIT-R) with two lengths of Hitachi cable P/N N2807-P/D-50TAB. This cable contains 50 conductors; two lengths provide 100 conductors. This cable will mate to the Model 7011-C multiplexer card assembly.

The unterminated end of the cable is connected directly to the instrument and DUT. Notice that the bank connections for the third multiplexer card are made at the instruments.

Figure 3-17 shows connections for the screw terminal connector card. Single conductor connections are made directly from the screw terminals of the connector card to the instrument and DUT.
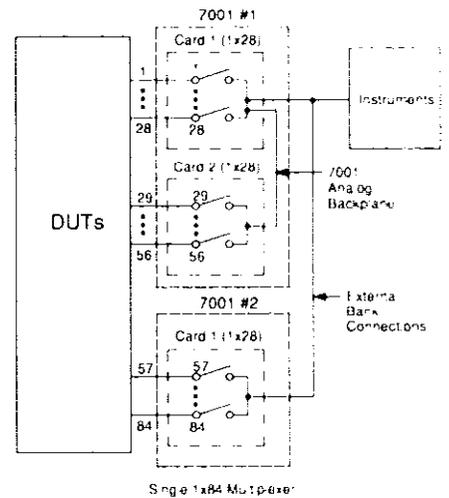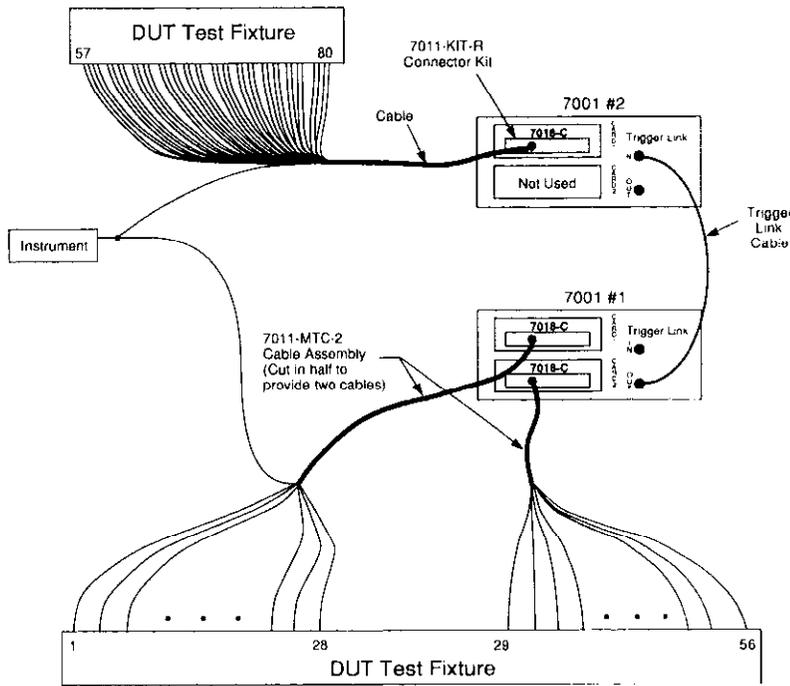
Figure 3-16
Two-mainframe system example (multi-pin connector card)
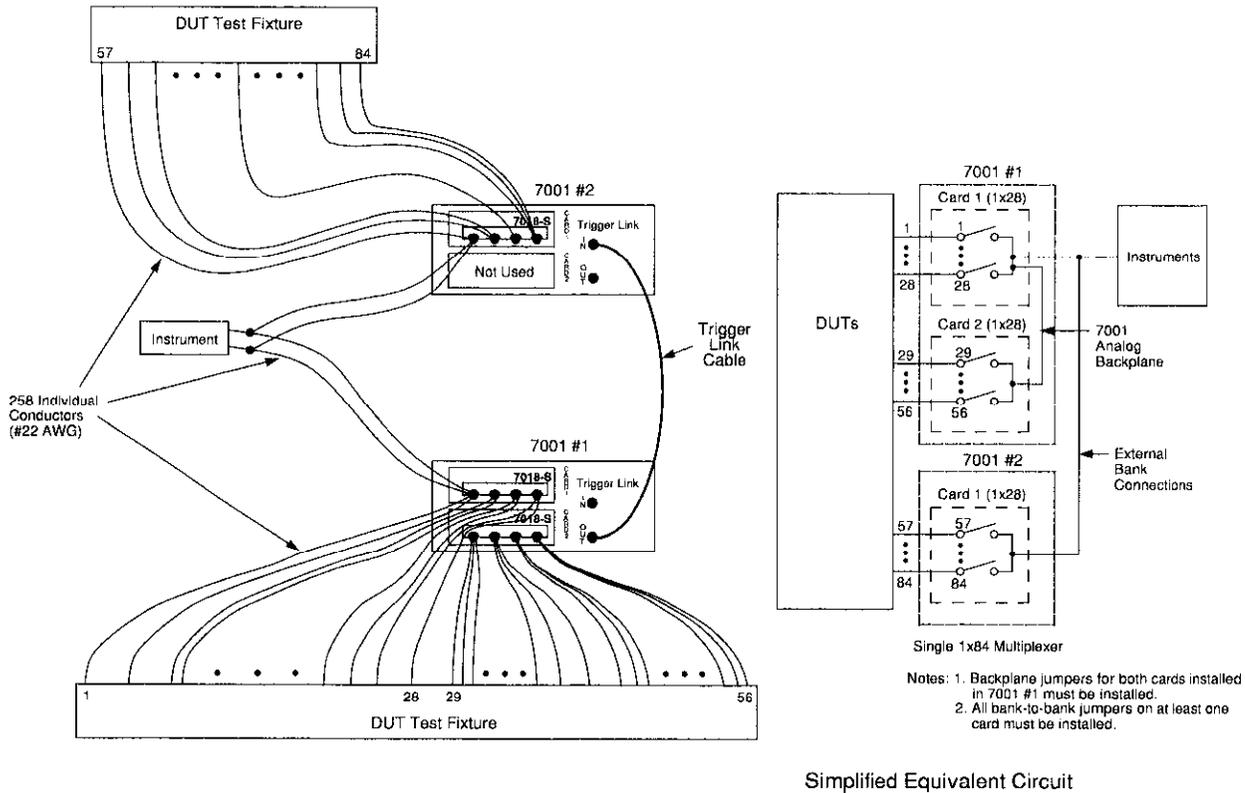
Figure 3-17
Two-mainframe system example (screw terminal connector card)

3.5 Model 7018 installation and removal

This paragraph explains how to install and remove the Model 7018 multiplexer card assembly from the Model 7001 or 7002 mainframe.

WARNING

Installation or removal of the Model 7018 is to be performed by qualified service personnel. Failure to recognize and observe standard safety precautions could result in personal injury or death.

NOTE

If using the screw terminal connector card, make sure your external circuitry is wired to the card (as explained in paragraph 3.3.1) before installing the card assembly in the Model 7001 or Model 7002 mainframe.

CAUTION

To prevent contamination to the multiplexer card that could degrade performance, handle the card assembly only by the edges and shields.

3.5.1 Ground screw

The Model 7018-C is equipped with a ground screw, which is identified with this symbol: $\textcircled{\frac{\perp}{=}}$ (The Model 7018-S does not require a ground screw because there are no exposed metal parts.)

The Model 7018-C ground screw must be securely tightened after installation and remain secure during use of the multiplexer card. This ground screw provides a proper safety ground for the Model 7018-C when in use.

WARNING

Securely tighten the ground screw after installing the Model 7018-C. Failure to do so may result in personal injury or death.

3.5.2 Multiplexer card installation

Perform the following steps to install the multiplexer card assembly in the Model 7001 or Model 7002 mainframe:

WARNING

Turn off all instrumentation power (including the Model 7001 or Model 7002 mainframe), and disconnect their line cords. Make sure all power is removed and that any stored energy in external circuitry is discharged.

1. Mate the connector card to the relay card if they are separated. Install the supplied 4-40 screw at the end of the card to secure the assembly. Make sure to handle the cards by the edges and shields to prevent contamination.

2. Facing the rear panel of the mainframe, select the slot in which you wish to install the card.

3. Referring to Figure 3-17 or Figure 3-18, feed the multiplexer card assembly into the desired slot such that the edges of the relay card ride in the rails.

4. With the ejector arms in the unlocked position, push the card assembly all the way into the mainframe until the arms engage into the ejector cups, then push both arms inward to lock the card into the mainframe.

5. For the Model 7018-C only, tighten the ground screw shown in Figure 3-17 and Figure 3-18.

WARNING

Securely tighten the ground screw. Failure to tighten the ground screw may result in a shock hazard.

3.5.3 Multiplexer card removal

To remove the multiplexer card assembly, first loosen the ground screw (Model 7018-C only), unlock the card by pulling the latches outward, then pull the card assembly out of the mainframe. Remember to handle the card assembly by the edges and shields to avoid contamination that could degrade performance.

Figure 3-18
Model 7018 card installation in Model 7001

Ejector Arms
(locked position)

Ejector Arms
(open position)

Warning: Tighten Ground Screw
After installation (Model 7018-C)
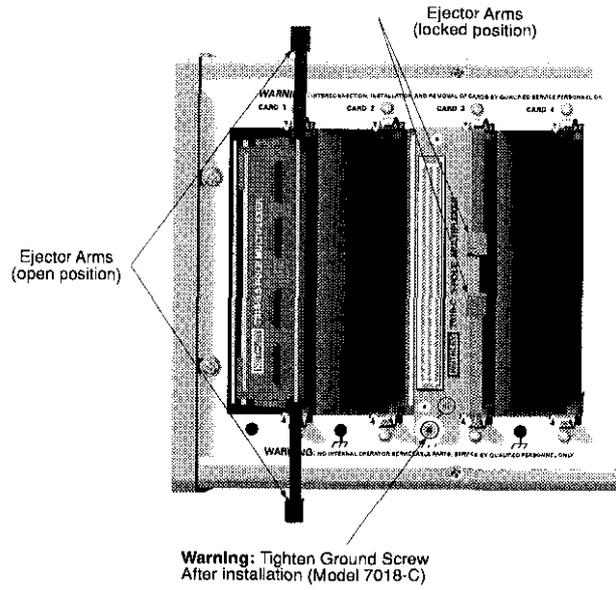
Figure 3-19
7018 card installation in Model 7002

4

Operation

4.1 Introduction

The information in this section is formatted as follows:

4.2 Operational constraints: Summarizes the maximum signal limits of the Model 7018 multiplexer card assembly, and the maximum number of relays that can be turned on simultaneously.

4.3 Mainframe control of multiplexer card: Summarizes programming steps to control the multiplexer card from the Model 7001/7002 Switch System mainframe.

4.4 Multiplexer applications: Provides some typical applications for using the Model 7018.

4.5 Measurement considerations: Reviews a number of considerations when using the Model 7018 to make measurements.

4.2 Operational constraints

4.2.1 Maximum signal levels

CAUTION

To prevent damage to the card, do not exceed the maximum signal level specifications of the card.

To prevent overheating or damage to the relays, never exceed the following maximum signal levels:

DC signals: 110V between any two pins (terminals), 1A switched, 30VA (resistive load).

AC signals: 125V rms or 175V AC peak between any two pins (terminals), 1A switched, 60VA (resistive load).

4.2.2 Channel limitations

A maximum of 11 channels can be turned on simultaneously because of relay power control circuit limitations.

4.3 Mainframe control of multiplexer card

The following information pertains to the Model 7018 multiplexer card. It assumes that you are familiar with the operation of the Model 7001/7002 mainframes.

If you are not familiar with the operation of the mainframes, it is recommended that you proceed to Getting Started (Section 3) of the Model 7001/7002 Instruction Manuals after reading the following information.

4.3.1 Channel assignments

The Model 7001 has a channel status display (Figure 4-1) that provides the real-time state of each available channel. The left portion of the display is for slot 1 (Card 1), and the right portion is for slot 2 (Card 2).

The Model 7002 has a similar display organized into a 4-row by 10-column matrix for each of the 10 cards in the system.

Multiplexer organization of the channel status display for each slot is shown in Figure 4-2. The card contains 28 channels and is made up of two banks (Banks A and B), of 14 multiplexer inputs as shown in the illustration.

To control the multiplexer card from the mainframe, each multiplexer input must have a unique CHANNEL assignment which includes the slot number in which the card is installed. The CHANNEL assignments for the multiplexer card in slots 1 and 2 are provided in Figure 4-3. Each CHANNEL assignment is made up of the slot designator and the

multiplexer channel. To be consistent with Model 7001/7002 operation, the slot designator and mux input are separated by exclamation points (!). Some examples of CHANNEL assignments are as follows:

CHANNEL 1!1 = Slot 1, Channel 1 (Input 1 of Bank A)

CHANNEL 1!28 = Slot 1, Channel 28 (Input 14 of Bank B)

CHANNEL 2!3 = Slot 2, Channel 3 (Input 3 of Bank A)

CHANNEL 4!16 = Slot 4, Channel 16 (Input 2 of Bank B), Model 7002 only
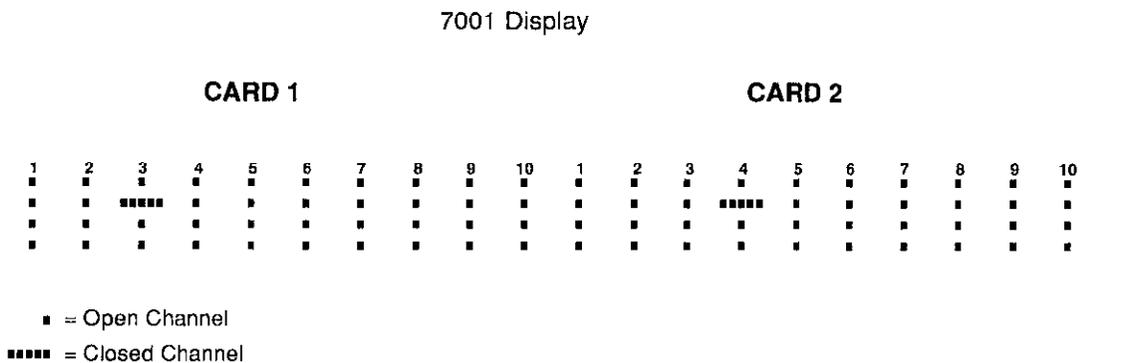
Figure 4-1
Channel status display

Numbers within circles identify inputs
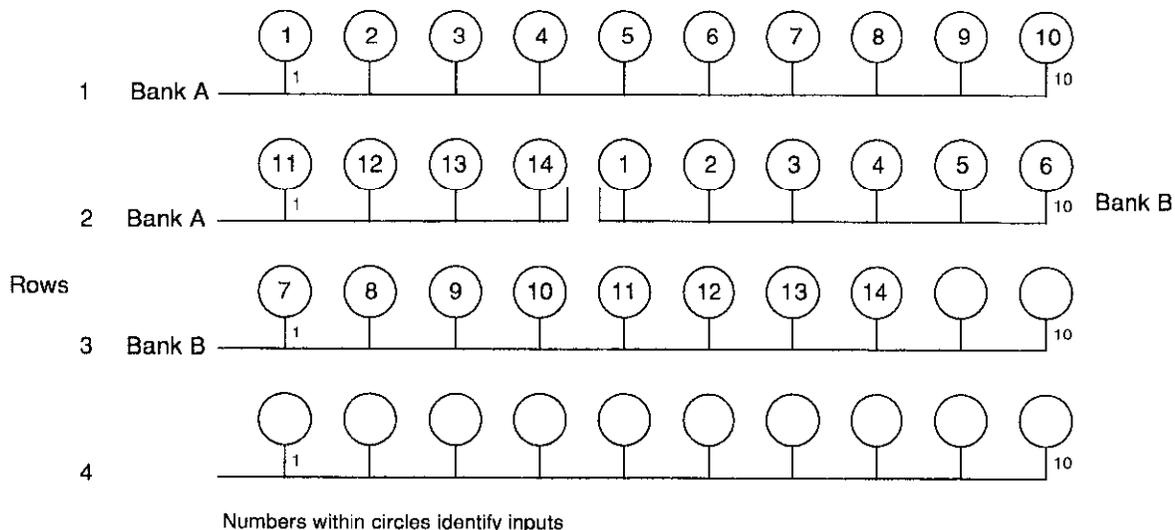
Figure 4-2
Display organization for Model 7018 multiplexer inputs

	1	2	3	4	5	6	7	8	9	10
	1!1	1!2	1!3	1!4	1!5	1!6	1!7	1!8	1!9	1!10
	1!11	1!12	1!13	1!14	1!15	1!16	1!17	1!18	1!19	1!20
	1!21	1!22	1!23	1!24	1!25	1!26	1!27	1!28		
A. Slot 1 (Card 1)										

	1	2	3	4	5	6	7	8	9	10
	2!1	2!2	2!3	2!4	2!5	2!6	2!7	2!8	2!9	2!10
	2!11	2!12	2!13	2!14	2!15	2!16	2!17	2!18	2!19	2!20
	2!21	2!22	2!23	2!24	2!25	2!26	2!27	2!28		
B. Slot 2 (Card 2)										
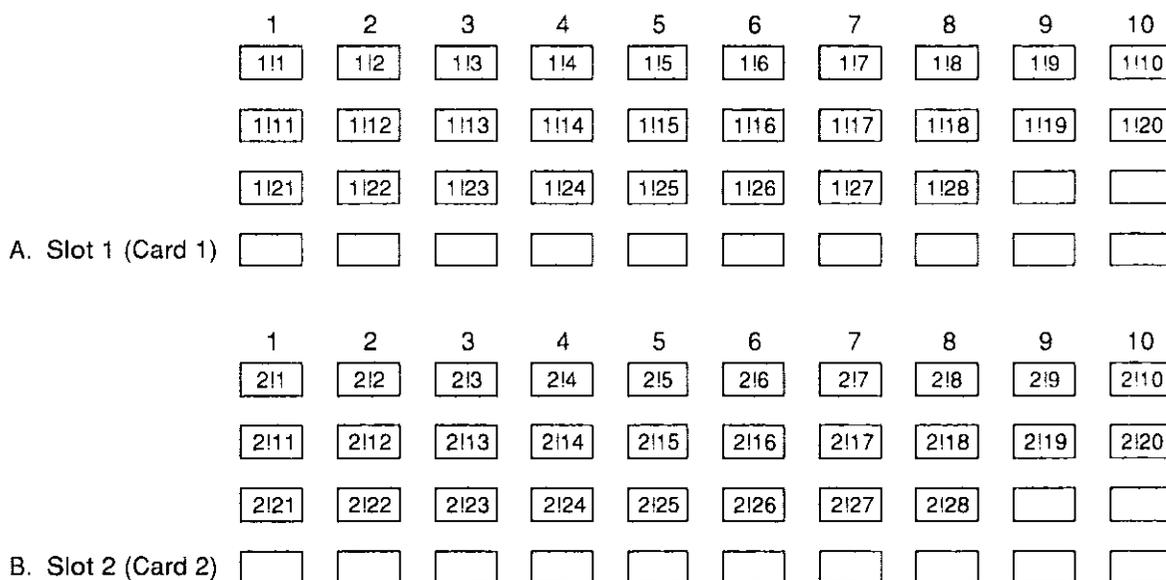
Examples : 1!18 = Slot 1, Channel 18 (Input 4, Bank B)
2!6 = Slot 2, Channel 6 (Input 6, Bank A)

Note : For Model 7002 slots 3-10, substitute appropriate slot number in channel assignments.

Figure 4-3
Model 7018 programming channel assignments

4.3.2   Front panel control

Closing and opening channels

A multiplexer channel is closed from the front panel by sim-ply keying in the CHANNEL assignment and pressing CLOSE. For example, to close channel 2!6 (Input 6 of Bank A) of a multiplexer card installed in slot 2, key in the follow-ing channel list and press CLOSE:

SELECT CHANNELS 2!6

The above closed channel can be opened by pressing OPEN or OPEN ALL. The OPEN key opens only the channels spec-ified in the channel list, and OPEN ALL opens all channels.

The following display is an example of a channel list that consists of several channels:

SELECT CHANNELS 2!1, 2!3, 2!22-2!25

Notice that channel entries are separated by commas (,). A comma is inserted by pressing ENTER or the right cursor key ▶). The channel range is specified by using the hyphen (-) key to separate the range limits. Pressing CLOSE will

close all the channels specified in the channel list. Pressing OPEN (or OPEN ALL) will open the channels.

CAUTION

Use care when closing more than one channel at a time, or the card may be damaged.

Scanning channels

Multiplexer channels are scanned by creating a scan list and configuring the Model 7001/7002 to perform a scan. The scan list is created in the same manner as a channel list (see Closing and Opening Channels). However, the scan list is specified from the "SCAN CHANNEL" display mode. The SCAN LIST key toggles between the channel list and the scan list.) The following shows an example of a scan list:

SCAN CHANNELS 2!1, 2!3, 2!21-2!25

When a scan is performed, the channels specified in the scan list will be scanned in the order that they are presented in the scan list.

A manual scan can be performed by using the RESET default conditions of the Model 7001/7002. RESET is selected from the SAVESETUP menu of the main MENU. When RESET is performed, the mainframe is configured for an infinite number of manual scans. The first press of STEP takes the mainframe out of the idle state. The next press of STEP will close the first channel specified in the scan list. Each subsequent press of STEP will select the next channel in the scan list.

4.3.3 IEEE-488 bus operation

Bus operation is demonstrated below using HP BASIC 4.0. The programming statements assume that the primary address of the mainframe is 7.

Closing and opening channels

The following SCPI commands are used to close and open channels:

```
:CLOSe <list>
:OPEN <list>|ALL
```

The following statement closes channels 1!1, and 1!3 through 1!11:

```
OUTPUT 707; ":clos (@1!1, 1!3:1!11)"
```

Notice that the colon (:) is used to separate the range limits.

Either of the following statements will open channels 1!1, and 1!3 through 1!11:

```
OUTPUT 707; ":open (@1!1, 1!3:1!11)"
OUTPUT 707; ":open all"
```

Scanning channels

There are many commands associated with scanning. However, it is possible to configure a scan using as little as four commands. These commands are listed as follows:

```
*RST
:TRIGger:SEQuence:COUNt:AUTo ON
:ROUTe:SCAN <list>
:INIT
```

The first command resets the mainframe to a default scan configuration. The second command automatically sets the channel count to the number of channels in the Scan List, the third command defines the Scan List and the fourth command takes the Model 7001/7002 out of the idle state.

The following program will perform a single scan through all 28 channels of a Model 7018 multiplexer card installed in slot 1:

```
10  OUTPUT 707; "*RST"
20  OUTPUT 707; ":trig:seq:coun:auto on"
30  OUTPUT 707; ":scan (@1!1:1!28)"
40  OUTPUT 707; ":init"
50  END
```

Line 10   Selects a default configuration for the scan.

Line 20   Sets channel count to the scan-list-length.

Line 30   Defines the scan list.

Line 40   Takes the Model 7001/7002 out of the idle state. The scan is configured to start as soon as this command is executed.

When the above program is run, the scan will be completed in approximately 240 milliseconds (3msec delay for each relay close and a 3msec delay for each open), which is too fast to view from the front panel. An additional relay delay can be added to the program to slow down the scan for viewing. The program is modified by adding line 25 to slow down the scan. Also, Line 5 is added to the beginning of the program to ensure that all channels are open before the scan is started.

```
5   OUTPUT 707; ":open all"
10  OUTPUT 707; "*RST"
20  OUTPUT 707; ":trig:seq:coun:auto on"
25  OUTPUT 707; ":trig:del 0.25"
30  OUTPUT 707; ":scan (@1!1:1!28)"
40  OUTPUT 707; ":INIT"
50  END
```

Line 5   Opens all channels.

Line 25   Sets a 1/4 second delay after each channel closes.

4.3.4 Selecting 3-pole/6-pole operation

The Model 7018 may be used in either the 3-pole mode or the 6-pole mode. In the 6-pole mode, the inputs of Bank A are paired with the corresponding inputs of Bank B (Input 1, Bank A with Input 1, Bank B, etc.).

To select 3-pole or 6-pole operation, press the CARD CONFIGURATION key, then choose the #-OF-POLES selection in the card configuration menu. Use the 2-POLE selection to operate the card in the 3-pole mode, or select 4-POLE to use the multiplexer card in the 6-pole mode.

4.4   Multiplexer applications

The following paragraphs discuss some typical applications for the Model 7018. These applications include various forms of resistor testing, transistor testing, as well as a discussion of how to combine the Model 7018 with a matrix card to increase switching versatility.

4.4.1   Resistor testing

The Model 7018 can be used to test a number of resistors using only one test instrument or group of instruments. Such tests include four-wire resistance measurements using a DMM, and low-resistance measurements using a separate current source and sensitive digital voltmeter.

Four-wire resistance tests

Although many resistance tests are made using the two-wire method, more precise measurements over a wider range of system and DUT conditions can be obtained by using the four-wire measurement scheme shown in Figure 4-4. Here, separate sense leads from the Model 2001 Multimeter are routed through the multiplexer card to the resistor under test. The extra set of sense leads minimizes the effects of voltage drops across the card contacts that supply the test current to the DUT. (The current through the sense leads is negligible, resulting in virtually no voltage drop across the sense lead relay contacts.) Note, however, that four poles of switching per device are required for four-wire resistance measurements. (Although the Model 7018 can switch up to six poles, only four poles are needed in this application.) For this reason, only 14 resistors per card can be tested using this configuration.

The Model 7018 can be configured for 14 channels of 4-pole or 6-pole operation by isolating Bank A from B, and by programming the Model 7001/7002 mainframe for 4-pole mode. (See paragraph 4.3.4.) Bank jumper removal is described in paragraph 3.3.1. To configure the connector card for 4-pole or 6-pole operation, remove the jumpers between Banks A and B. The resulting paired channels are shown in Table 4-1.

Table 4-1
Paired Channels in 4-pole Operation

7001 CHANNEL assignment	Channel pair in 4-pole*	Connection designations
1	1 and 15	Bank A, In 1 and Bank B, In 1
2	2 and 16	Bank A, In 2 and Bank B, In 2
3	3 and 17	Bank A, In 3 and Bank B, In 3
4	4 and 18	Bank A, In 4 and Bank B, In 4
5	5 and 19	Bank A, In 5 and Bank B, In 5
6	6 and 20	Bank A, In 6 and Bank B, In 6
7	7 and 21	Bank A, In 7 and Bank B, In 7
8	8 and 22	Bank A, In 8 and Bank B, In 8
9	9 and 23	Bank A, In 9 and Bank B, In 9
10	10 and 24	Bank A, In 10 and Bank B, In 10
11	11 and 25	Bank A, In 11 and Bank B, In 11
12	12 and 26	Bank A, In 12 and Bank B, In 12
13	13 and 27	Bank A, In 13 and Bank B, In 13
14	14 and 28	Bank A, In 14 and Bank B, In 14

*Card actually operated in 6-pole mode, but two poles are unused.
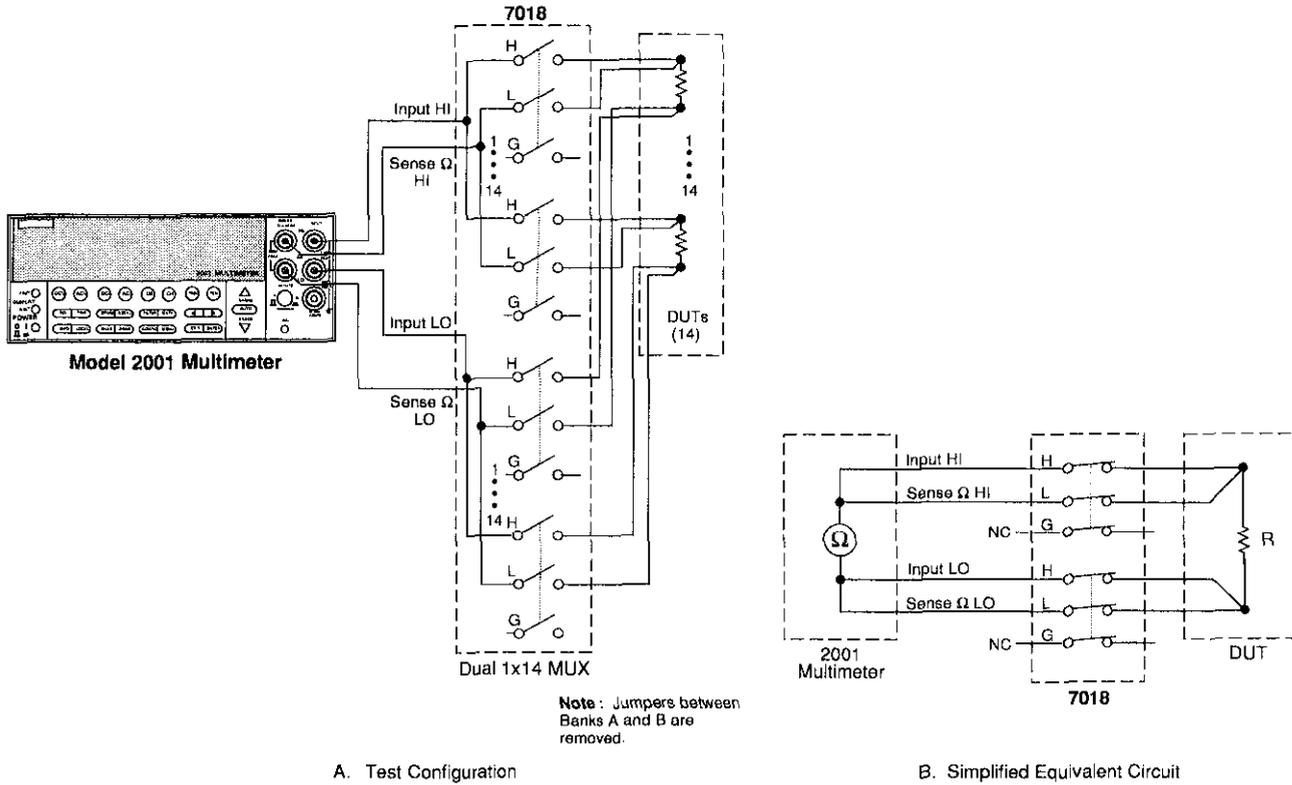
Figure 4-4
Four-wire resistance testing

Low-level resistance measurements

Many times, it is necessary to make resistance measurements with either lower voltage sensitivity or higher currents than are available with ordinary DMMs. Examples of cases where low-level resistance measurements may be necessary include the testing of PC board traces, contacts, bus bars, and low resistance shunts.

Figure 4-5 shows a typical test configuration for a switching system capable of testing a number of low-resistance devices. Again, the Model 7018 is operated in the 6-pole mode (although only four poles are used). The Model 220 Current Source forces current through the device under test, while the Model 182 Sensitive Digital Voltmeter measures the resulting voltage across the device.

Since low voltage levels are being measured, thermal EMF offsets generated by relay and connector contacts will have a detrimental effect on measurement accuracy unless steps are taken to avoid them (the Model 7018 has been designed to keep relay EMF at a minimal level). Thermal EMF effects

can be virtually eliminated by taking two voltage measurements, E_1 and E_2, the first with the current, I, flowing in one direction, and the second with a current, I, of the same magnitude flowing in the opposite direction. The resistance can then be calculated as follows:

$$R = \frac{E_2 - E_1}{2I}$$

4.4.2 Transistor current gain testing

The DC or static common-emitter current gain of a transistor can be determined by biasing the transistor for a specific value of base current, I_B, and then measuring the collector current, I_C. The DC common-emitter current gain, β, of the transistor is then determined as follows:

$$\beta = \frac{I_C}{I_B}$$
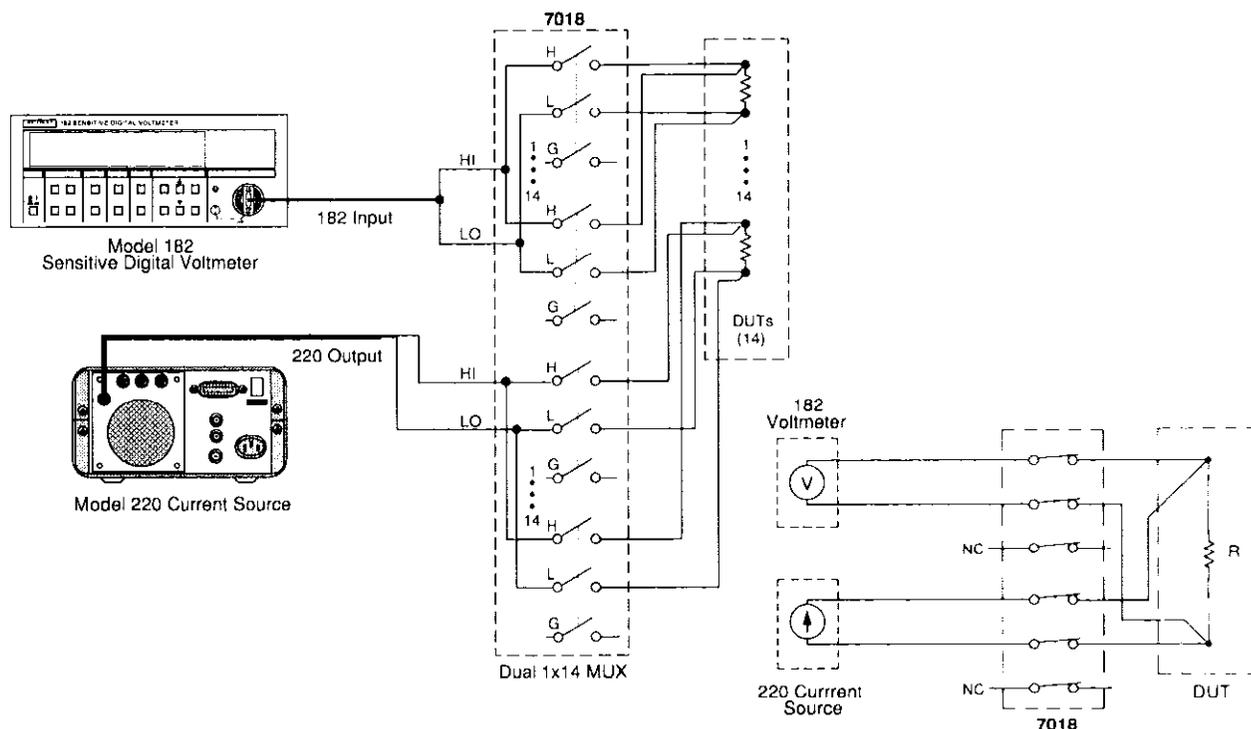
Figure 4-5
Low resistance testing

Figure 4-6 shows the test configuration and equivalent circuit for the current gain test. The Model 224 Current Source is used to source the base current, I_B. The Model 230 Voltage Source supplies the collector-emitter voltage, V_{CE}, and the collector current, I_C, is measured by the Model 2001 Mutlimeter. Switching among the transistors being tested is, of course, performed by the Model 7018 multiplexer card. The Model 7018 is especially suited to this application because of its 3-pole switching configuration.

In order to perform the current gain test, the voltage source is first set to the desired value of V_{CE}. The current source is then set to a base current value that will result in the desired value of I_C as measured by the DMM. The current gain can then be calculated as outlined above.

4.4.3 Testing with matrix cards

The Model 7018 can be added to a matrix switching system to enhance the test capabilities of that system. The following paragraphs discuss an overall multiplexer/matrix switching system.

Multiplexer and matrix card connections

Figure 4-7 shows a typical system using Model 7012 and 7018 cards together. In this instance, the multiplexer card is configured as two 1 × 14 multiplexers. Note that rows of the matrix card are connected to the banks of the multiplexer card through the analog backplane of the mainframe; no external wiring is necessary to connect the two cards together. Note, however, that the Model 7012 switches only HI and LO as it is a 2-pole card.

In this application, the DUTs are connected to the bank inputs on the multiplexer card, allowing a large number of DUTs to be switched through the matrix card. Also, the instruments are connected to the columns on the matrix card. This particular configuration is best suited for applications requiring a large number of DUTs to be connected to several instruments. In other cases, the test configuration may call for a large number of instruments and few DUTs. In those situations, the instruments would be connected to the multiplexer inputs, and the DUTs would be connected to the columns.
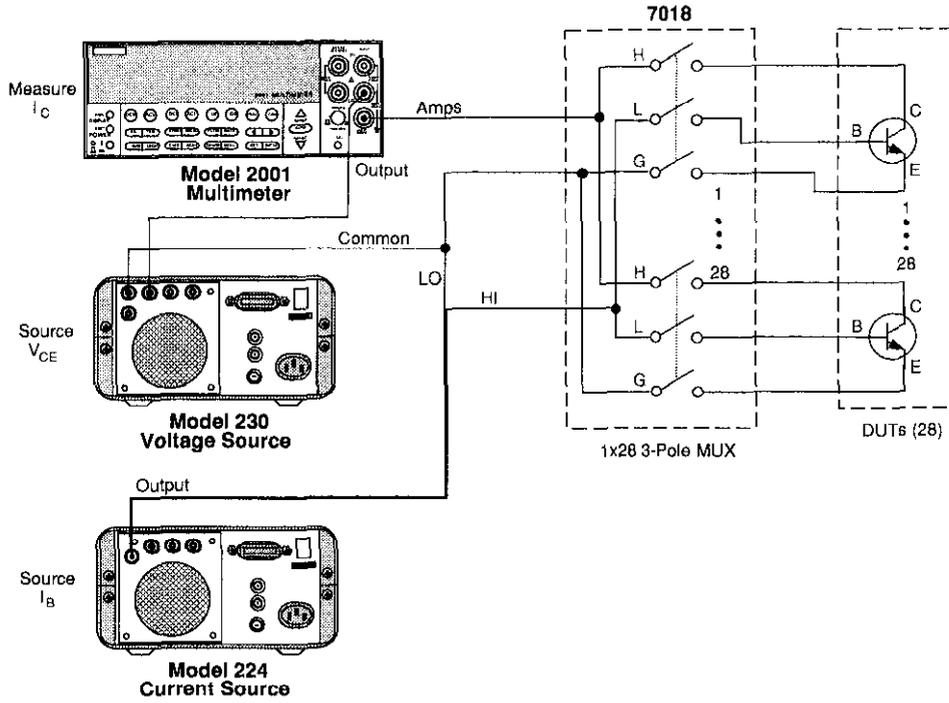
A. Test Configuration

$$\beta = \frac{I_C}{I_B}$$
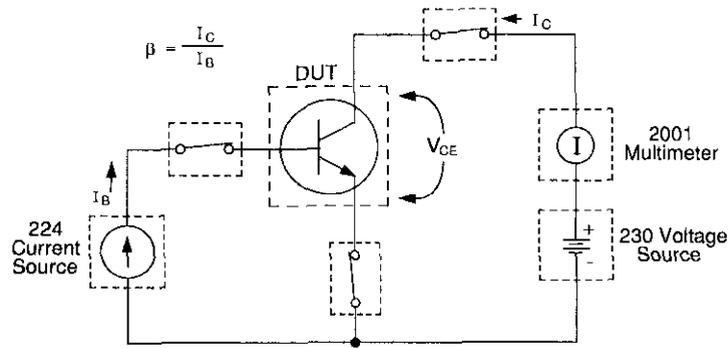
B. Simplified Equivalent Circuit

Figure 4-6
Configuration for current gain test
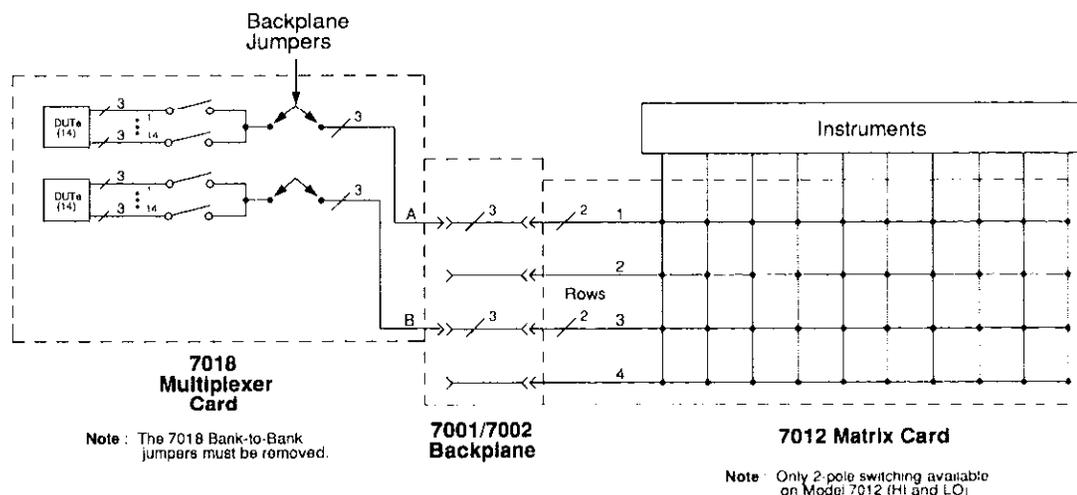
Figure 4-7
Connecting multiplexer and matrix cards together

4.5 Measurement considerations

Many measurements made with the Model 7018 are subject to various effects that can seriously affect low-level measurement accuracy. The following paragraphs discuss these effects and ways to minimize them.

4.5.1 Path isolation

The path isolation is simply the equivalent impedance between any two test paths in a measurement system. Ideally, the path isolation should be infinite, but the actual resistance and distributed capacitance of the card, cables, and connectors results in less than infinite path isolation values for these devices.

Path isolation resistance forms a signal path that is in parallel with the equivalent resistance of the DUT, as shown in Figure 4-8. For low-to-medium device resistance values, path isolation resistance is seldom a consideration; however, it can seriously degrade measurement accuracy when testing high-impedance devices. The voltage measured across such a device, for example, can be substantially attenuated by the voltage divider action of the device source resistance and path isolation resistance, as shown in Figure 4-9. Also, leakage currents can be generated through these resistances by voltage sources in the system.
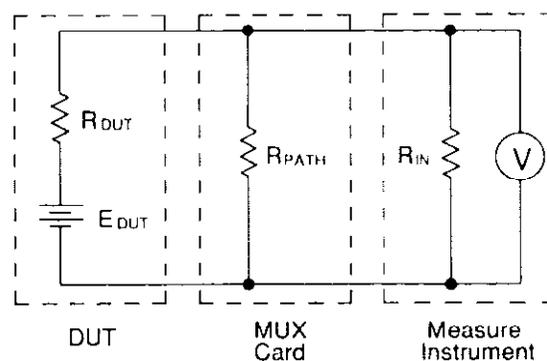
R_{DUT} = Source Resistance of DUT

E_{DUT} = Source EMF of DUT

R_{PATH} = Path Isolation Resistance

R_{IN} = Input Resistance of Measuring Instrument

Figure 4-8
Path isolation resistance

Any differential isolation capacitance affects DC measurement settling time as well as AC measurement accuracy. Thus, it is often important that such capacitance be kept as low as possible. Although the distributed capacitance of the card is generally fixed by design, there is one area where you do have control over the capacitance in your system — the connecting cables. To minimize capacitance, keep all cables as short as possible.
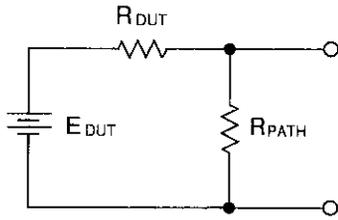
$$E_{OUT} = \frac{E_{DUT} \; R_{PATH}}{R_{DUT} + R_{PATH}}$$

Figure 4-9
Voltage attenuation by path isolation resistance

4.5.2 Magnetic fields

When a conductor cuts through magnetic lines of force, a very small current is generated. This phenomenon will frequently cause unwanted signals to occur in the test leads of a switching matrix system. If the conductor has sufficient length, even weak magnetic fields like those of the earth can create sufficient signals to affect low-level measurements.

Two ways to reduce these effects are: (1) reduce the lengths of the test leads, and (2) minimize the exposed circuit area. In extreme cases, magnetic shielding may be required. Special metal with high permeability at low flux densities (such as mu metal) is effective at reducing these effects.

Even when the conductor is stationary, magnetically-induced signals may still be a problem. Fields can be produced by various signals such as the AC power line voltage. Large inductors such as power transformers can generate substantial magnetic fields, so care must be taken to keep the switching and measuring circuits a good distance away from these potential noise sources.

At high current levels, even a single conductor can generate significant fields. These effects can be minimized by using twisted pairs, which will cancel out most of the resulting fields.

4.5.3 Radio frequency interference

RFI (Radio Frequency Interference) is a general term used to describe electromagnetic interference over a wide range of frequencies across the spectrum. Such RFI can be particularly troublesome at low signal levels, but it can also affect measurements at high levels if the problem is of sufficient severity.

RFI can be caused by steady-state sources such as radio or TV signals, or some types of electronic equipment (microprocessors, high-speed digital circuits, etc.), or it can result from impulse sources, as in the case of arcing in high-voltage environments. In either case, the effect on the measurement can be considerable if enough of the unwanted signal is present.

RFI can be minimized in several ways. The most obvious method is to keep the equipment and signal leads as far away from the RFI source as possible. Shielding the switching card, signal leads, sources, and measuring instruments will often reduce RFI to an acceptable level. In extreme cases, a specially-constructed screen room may be required to sufficiently attenuate the troublesome signal.

Many instruments incorporate internal filtering that may help to reduce RFI effects in some situations. In some cases, additional external filtering may also be required. Keep in mind, however, that filtering may have detrimental effects on the desired signal.

4.5.4 Ground loops

When two or more instruments are connected together, care must be taken to avoid unwanted signals caused by ground loops. Ground loops usually occur when sensitive instrumentation is connected to other instrumentation with more than one signal return path such as power line ground. As shown in Figure 4-10, the resulting ground loop causes current to flow through the instrument LO signal leads and then back through power line ground. This circulating current develops a small but undesirable voltage between the LO terminals of the two instruments. This voltage will be added to the source voltage, affecting the accuracy of the measurement.
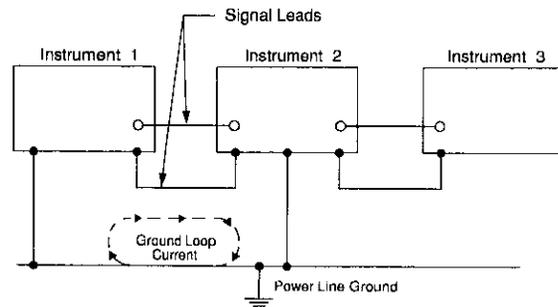
Figure 4-10
Power line ground loops

Figure 4-11 shows how to connect several instruments together to eliminate this type of ground loop problem. Here, only one instrument is connected to power line ground.
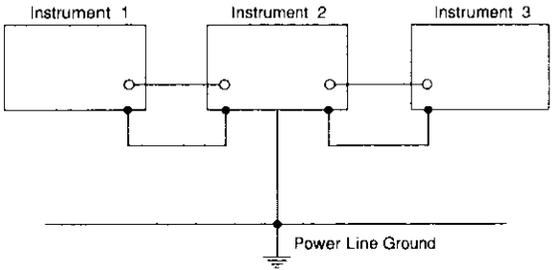
Figure 4-11
Eliminating ground loops

Ground loops are not normally a problem with instruments having isolated LO terminals. However, all instruments in the test setup may not be designed in this manner. When in doubt, consult the manual for all instrumentation in the test setup.

4.5.5 Keeping connectors clean

As is the case with any high-resistance device, the integrity of connectors can be damaged if they are not handled properly. If connector insulation becomes contaminated, the insulation resistance will be substantially reduced, affecting high-impedance measurement paths.

Oils and salts from the skin can contaminate connector insulators, reducing their resistance. Also, contaminants present in the air can be deposited on the insulator surface. To avoid these problems, never touch the connector insulating material. In addition, the multiplexer card should be used only in clean, dry environments to avoid contamination.

If the connector insulators should become contaminated, either by inadvertent touching, or from air-borne deposits, they can be cleaned with a cotton swab dipped in clean methanol. After thorough cleaning, they should be allowed to dry for several hours in a low-humidity environment before use, or they can be dried more quickly using dry nitrogen.

4.5.6 AC frequency response

The AC frequency response of the Model 7018 is important in test systems that switch AC signals. Refer to the specifications at the front of this manual.

4.5.7 Thermoelectric potentials

Thermoelectric potentials (thermal EMFs) are small electric potentials generated by differences in temperature at circuit connecting points such as multiplexer relay contacts, card terminals, and connectors.

Thermoelectric generation

Figure 4-12 shows a representation of how thermal EMFs are generated. The test leads are made of the A material, while the source under test is the B material. The temperatures between the junctions are T1 and T2. To determine the thermal EMF generated, the relationship shown may be used.

In the unlikely event that the two junction temperatures are identical, the thermal EMFs will exactly cancel because the generated potentials oppose one another. More often, the two junction temperatures will differ, and considerable thermal EMFs will be generated.
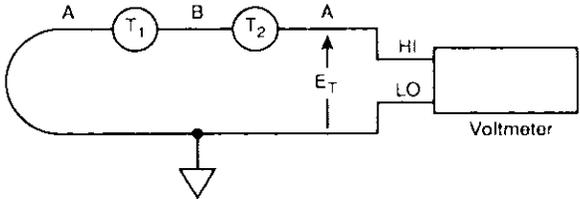
The thermal EMF developed by dissimilar metals A and B in a series circuit is:

$$E_T = Q_{AB} (T_1 - T_2)$$

Temperature of the A to B junction in °C

Temperature of the B to A junction in °C

Thermoelectric voltage coefficient of material A with respect to B, μV/°C

Figure 4-12
Thermoelectric generation

Nulling residual thermal offsets

Even if all reasonable precautions are taken, some residual thermal offsets may still be present. These offsets can be minimized by using the measuring instrument's offset-compensated ohms feature if available. Also, the zero or relative feature can be used to null them out. To do so, place the instrument on the range to be used for the measurement, close the multiplexer card channel to be used for the measurement, and short the end of the connecting cable nearest the measured source (first disconnect the cable from the source to avoid shorting out the source). After allowing the reading to settle, press the zero or rel button to null the offset, then make your measurement as usual. Note that it may be necessary to re-zero often to counteract thermal drifts, and the rel process should be repeated whenever the range is changed or when a different channel is used for best accuracy.

5

Service Information

5.1 Introduction

This section contains information necessary to service the Model 7018 multiplexer card and is arranged as follows:

5.2 Handling and cleaning precautions: Discusses handling precautions and methods to clean the card should it become contaminated.

5.3 Performance verification: Covers the procedures necessary to determine if the card meets stated specifications.

5.4 Special handling of static-sensitive devices: Reviews precautions necessary when handling static-sensitive devices.

5.5 Principles of operation: Briefly discusses circuit operation.

5.6 Troubleshooting: Presents some troubleshooting tips for the Model 7018 including relay replacement precautions.

5.2 Handling and cleaning precautions

Because of the high-impedance areas on the Model 7018, care should be taken when handling or servicing the card to prevent possible contamination. The following precautions should be taken when servicing the card.

- Handle the card only by the edges and shields.

- Do not touch any board surfaces or components not associated with the repair.

- Do not touch areas adjacent to electrical contacts.

- When servicing the card, wear clean cotton gloves.

- Do not store or operate the card in an environment where dust could settle on the circuit board. Use dry nitrogen gas to clean dust off the board if necessary.

- Should it become necessary to use solder on the circuit board, use an OA-based (organic activated) flux. Remove the flux from the work areas when the repair has been completed. Use pure water along with clean cotton swabs or a clean, soft brush to remove the flux. Take care not to spread the flux to other areas of the circuit board. Once the flux has been removed, swab only the repaired area with methanol, then blow dry the board with dry nitrogen gas.

- After cleaning, the card should be placed in a 50°C low humidity environment for several hours before use.

5.3 Performance verification

The following paragraphs discuss performance verification procedures for the Model 7018, including path resistance, offset current, contact potential, and isolation.

With the Model 7018's backplane jumpers installed, the performance verification procedures must be performed with only one multiplexer card (the one being checked) installed in the Model 7001/7002 mainframe. These conditions do not apply if the backplane jumpers are removed.

CAUTION

Contamination will degrade the performance of the card. To avoid contamination, always grasp the card by the side edges. Do not touch the connectors, and do not touch the board surfaces or components. On plugs and receptacles, do not touch areas adjacent to the electrical contacts.

NOTE

Failure of any performance verification test may indicate that the multiplexer card is contaminated. See paragraph 5.2 for procedures to clean the card.

5.3.1 Environmental conditions

All verification measurements should be made at an ambient temperature between 18° and 28°C, and at a relative humidity of less than 70%.

5.3.2 Recommended equipment

Table 5-1 summarizes the equipment necessary for performance verification, along with the application for each unit.

5.3.3 Multiplexer card connections

The following information summarizes methods that can be used to connect test instrumentation to the two connector cards. Detailed connection information is provided in Section 3.

Model 7018-S — Instrumentation can simply be hard-wired directly to the screw terminals of the connector card. Jumper wires should be kept as short as possible.

Model 7018-C — One method to make instrument connections to the multiplexer card is by hard-wiring a 96-pin female DIN connector then mating it to the connector on the Model 7018-C. Input and output shorting connections can also be done at the connector. The connector in the Model 7011-KIT-R connection kit (see Table 3-2) can be used for this purpose. Pin identification for the connector is provided by Figure 3-8.

CAUTION

After making solder connections to a connector, remove solder flux as explained in paragraph 5.2. Failure to clean the solder connections could result in degraded performance preventing the card from passing verification tests.

Before pre-wiring any connectors or plugs, study the following test procedures to fully understand the connection requirements.

Table 5-1
Verification equipment

Description	Model or part	Specifications	Applications
DMM	Keithley Model 2001	20Ω; 72ppm	Path resistance
Electrometer w/voltage source	Keithley Model 617	10pA, 100pA; 1.6% 100V source; 0.2%	Offset current, path isolation
Sensitive Digital Voltmeter	Keithley Model 182	3mV; 60ppm	Contact potential
Triax cable (unterminated)	Keithley Model 7025	—	Offset current
Low thermal cable (unterminated)	Keithley Model 1484	—	Contact potential

5.3.4 Channel resistance tests

Perform the following steps to verify that each contact of every relay is closing properly and that the resistance is within specification.

1. Turn off the Model 7001/7002 if it is on.

2. Turn on the Model 2001, and allow it to warm up for one hour before making measurements.

3. Connect all input terminals of Bank A together to form one common terminal, as shown in Figure 5-1.

4. Set the Model 2001 to the 20Ω range, and connect the four test leads to the INPUT and SENSE jacks.

5. Short the four test leads together, and press REL on the Model 2001. Leave REL enabled for the entire test.

6. Connect INPUT HI and SENSE HI of the Model 2001 to the common terminal (jumper on Bank A inputs). It is recommended that the physical connections be made at inputs 1 and 14 of Bank A, as shown in Figure 5-1.

7. Connect INPUT LO and SENSE LO to the HI (H) terminal of Bank A output.

8. Install the Model 7018 in slot 1 (CARD 1) of the Model 7001/7002.

9. Turn on the Model 7001/7002, and program it to close Channel 1!1 (Bank A, Input 1). Verify that the resistance of this path is <1.5Ω.

10. Open Channel 1!1, and close Channel 1!2 (Bank A, Input 2). Verify that the resistance of this path is <1.5Ω.

11. Using the basic procedure in steps 9 and 10, check the resistance of Bank A HI (H) terminal paths for Inputs 3 through 14 (Channels 1!3 through 1!14).

12. Turn off the Model 7001/7002, and move the INPUT LO and SENSE LO test leads to the LO (L) terminal of Bank A output.

13. Repeat steps 9 through 11 to check the LO (L) terminal paths of Bank A (Channels 1!1 through 1!14).

14. Turn off the Model 7001/7002, and move the INPUT LO and SENSE LO test leads to the G terminal of Bank A output.

15. Repeat steps 9 through 11 to check the G terminal paths of Bank A (channels 1!1 to 1!14).

16. Repeat the basic procedure in steps 1 through 15 for Bank B (Channels 1!15 through 1!28). Make sure the resistance of each path is <1.5Ω.

5.3.5 Offset current tests

These tests check leakage current between HI (H), LO (L), and G (differential offset current) and from HI (H), LO (L), and G to chassis (common-mode offset current) of each pathway. In general, these tests are performed by simply measuring the leakage current with an electrometer. In the following procedure, the Model 617 is used to measure the leakage current. Test connections are shown in Figure 5-2.
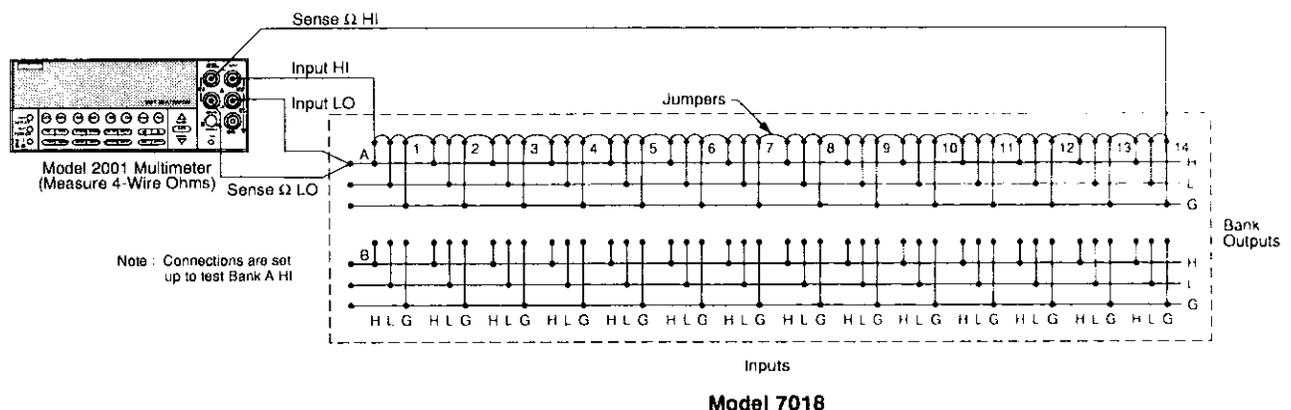
Figure 5-1
Path resistance test connections
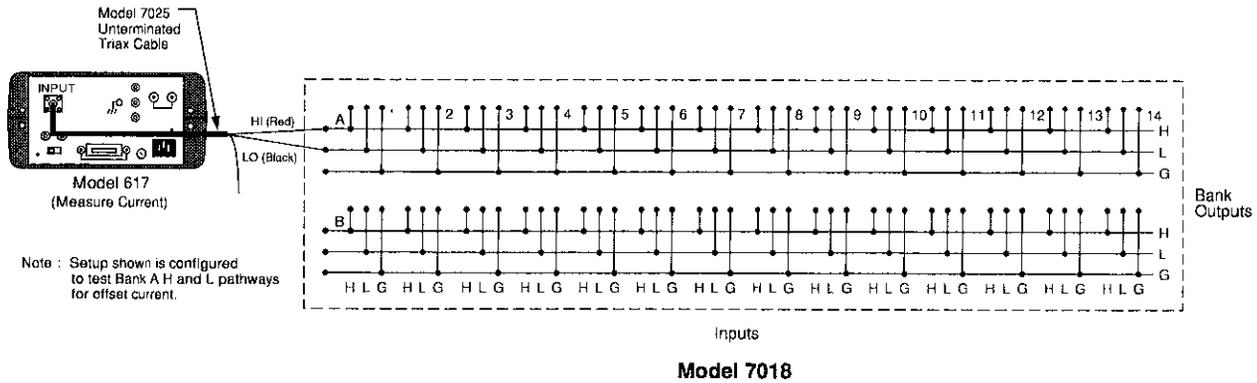
A) Differential
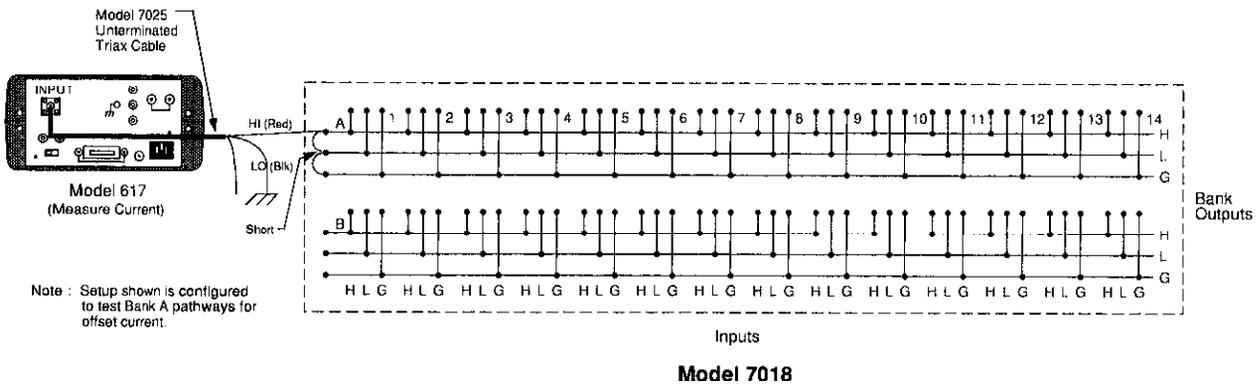
B) Common Mode

Figure 5-2
Offset current test connections

Perform the following procedure to check offset current:

1. Turn off the Model 7001/7002 if it is on, and remove any jumpers or wires connected to the multiplexer card.

2. Connect the triax cable to the Model 617, but do not connect it to the multiplexer card at this time.

3. Turn on the Model 617, and allow the unit to warm up for two hours before testing. After warmup, select the 200pA range, and enable zero check and zero correct in that order. Leave zero correct enabled for the entire procedure. Also, be certain that V-Ω, GUARD is OFF and that the ground strap is connected to LO.

4. Connect the triax cable to Bank A output HI and LO, as shown in Figure 5-2A.

5. Install the Model 7018 in slot 1 (CARD 1) of the Model 7001/7002.

6. Turn on the Model 7001/7002, and program the unit to close Channel 1!1 (Bank A, Input 1).

7. On the Model 617, disable zero check, and allow the reading to settle. Verify that the reading is <100pA. This specification is the offset (leakage) current of the pathway.

8. Enable zero check on the Model 617, and open Channel 1!1 from the front panel of the Model 7001/7002.

9. Repeat steps 6 through 8 with the electrometer connected to the HI and G output terminals.

10. Repeat steps 6 through 8 with the electrometer connected to the LO and G output terminals.

11. Repeat the basic procedure in steps 6 through 10 to check the rest of the pathways (Inputs 2 through 14) of Bank A (Channels 1!2 through 1!14).

12. Turn off the Model 7001/7002 and change the electrometer connections to Bank B.

13. Repeat the basic procedure in steps 6 through 11 to check Bank B, Inputs 1 through 14 (Channels 1!15 through 1!28).

14. Turn off the Model 7001/7002, and change the electrometer connections, as shown in Figure 5-2B. Note that electrometer HI is connected to HI, LO, and G of the Bank A output, which are jumpered together. Electrometer LO is connected to chassis.

15. Repeat ateps 6 through 11, and check that the Bank A common-mode offset current is <100pA.

16. Repeat step 15 for Bank B to check that the common-mode offset current is <100pA.

5.3.6 Contact potential tests

These tests check the thermal EMF generated by the relay contact for each pathway (HI, LO, and G). The tests use a sensitive digital voltmeter (Model 182) to measure the contact potential.

Perform the following procedure to check contact potential of each contact:

1. Turn off the Model 7001/7002 if it is on.

2. Turn on the Model 182, and allow the unit to warm up for two hours to achieve rated accuracy.

3. Connect the Model 182 input leads to Bank A output HI and input 1 HI (see Figure 5-3).

4. Temporarily connect a clean, high-purity copper short between Bank A output HI and Bank A input 1 HI.

5. Install the Model 7018 in the Model 7001/7002 slot 1, and turn on the Model 7001/7002.

6. Allow Models 7001/7002, 7018, and 182 to warm up for two hours.

7. Select the 3mV range on the Model 182.

8. Press REL READING (on the Model 182) to null out internal offsets. Leave REL READING enabled for the entire procedure.

9. Turn off the Model 7001/7002, and remove the Model 7018 from slot 1. Remove the short between Input HI and Bank A output HI.

10. Install the Model 7018 in Model 7001/7002 slot 1, and turn on the power.

11. Wait 15 minutes.

12. Program the Model 7001/7002 to close Channel 1!1.

13. After settling, verify that reading on the Model 182 is <5μV. This measurement represents the contact potential of the pathway.

14. From the Model 7001/7002, open Channel 1!1.

15. Repeat steps 7 through 14 for the LO and G terminals. (Be sure to connect the voltmeter HI and LO terminals to the path being tested.)

16. Repeat steps 7 through 15 for the remaining channels of Bank A (1!2 to 1!14) and all channels of Bank B (1!15 to 1!28).
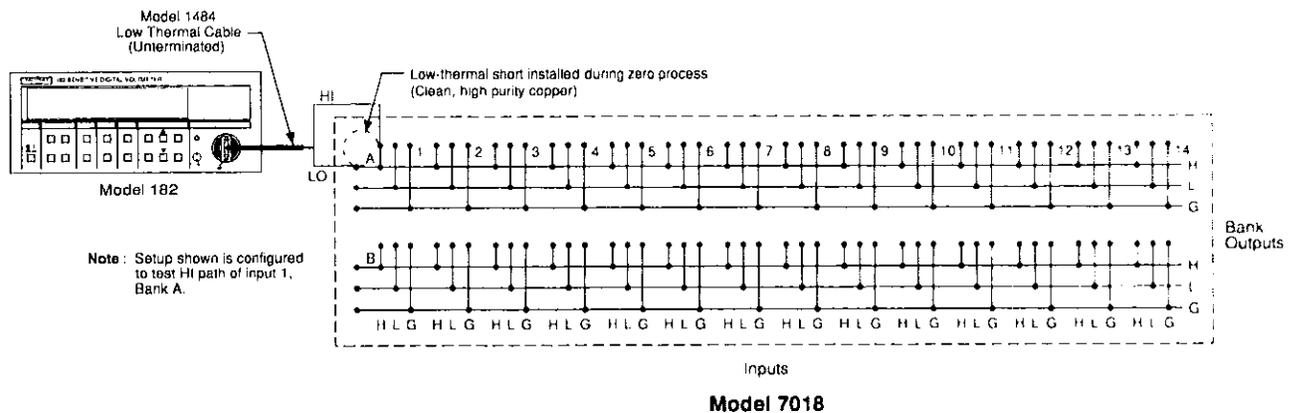

Figure 5-3
Contact potential test connections

5.3.7 Bank and channel-to-channel isolation tests

Bank isolation tests check the leakage resistance between adjacent banks. Channel-to-channel isolation tests check the leakage resistance between a Bank Output connection and a Bank Input connection with an adjacent Bank Input relay closed. In general, the tests are performed by applying a voltage (100V) across the leakage resistance and then measuring the current. The isolation resistance is then calculated as R = V/I. In the following procedure, the Model 617 functions as both a voltage source and an ammeter. In the V/I function, the Model 617 internally calculates the resistance from the known voltage and current levels and displays the resistance value.

Perform the following steps to check bank and channel-to-channel isolation:

1. Turn off the Model 7001/7002 if it is on, and remove any jumpers or test leads connected to the multiplexer card.

2. Turn on the Model 617, and allow the unit to warm up for two hours before testing.

3. On the Model 617, select the 2pA range, and enable zero check and zero correct in that order. Leave zero correct enabled for the entire procedure.

4. Connect the electrometer to the Model 7018, as shown in Figure 5-4.

5. Install the Model 7018 in slot 1 (CARD 1) of the Model 7001/7002, and turn on the mainframe.

6. On the Model 617, select the 20pA range, and release zero check.

7. On the Model 617, press SUPPRESS to cancel offset current, then enable zero check.

WARNING

The following steps use high voltage (100V). Be sure to remove power from the circuit before making connection changes.

8. On the Model 617, set the voltage source for +100V, and select the 20nA current range. Make sure the voltage source is in standby.

9. Place the Model 617 in the V/I measurement function by pressing SHIFT OHMS.

10. Program the Model 7001/7002 to close Channels 1!1 and 1!16 (Bank A, Input 1 and Bank B, Input 2).

11. On the Model 617, disable zero check and press OPERATE to source +100V.

12. After allowing the reading on the Model 617 to settle, verify that it is >1GΩ (10^9Ω). This measurement is the leakage resistance (bank isolation) between Bank A, Input 1 and Bank B, Input 2.

13. Using Table 5-2 as a guide, repeat the basic procedure of steps 10 through 12 for the rest of the path pairs (test numbers 2 through 7 in the table).

14. Place the Model 617 voltage source in standby, and enable zero check.

15. Repeat the entire test with the electrometer connected to the Bank A and B G terminals instead of the HI terminals.

16. Turn off the Model 7001/7002, and connect the Model 617 to the card as shown in Figure 5-5.

17. Install the Model 7018 in slot 1 of the Model 7001/7002, and turn on the mainframe.

18. Program the Model 7001/7002 to close Channel 1!2 (Bank A, Input 2). Make sure all other channels are open.

19. On the Model 617, disable zero check, and press OPERATE to source 100V.

20. After allowing the reading on the Model 617 to settle, verify that it is >1GΩ (10^9Ω).

21. Place the Model 617 voltage source in standby, and enable zero check.

22. Using Table 5-3 as a guide, perform tests 2 through 13 for the remaining Bank A Inputs. Remember to move Bank Input connections as indicated in the table.

23. Use Table 5-3 (test numbers 14 through 26) and the above procedure to test Bank B.

24. Repeat steps 16 through 22 with the electrometer connected to the G terminals instead of the HI terminals.
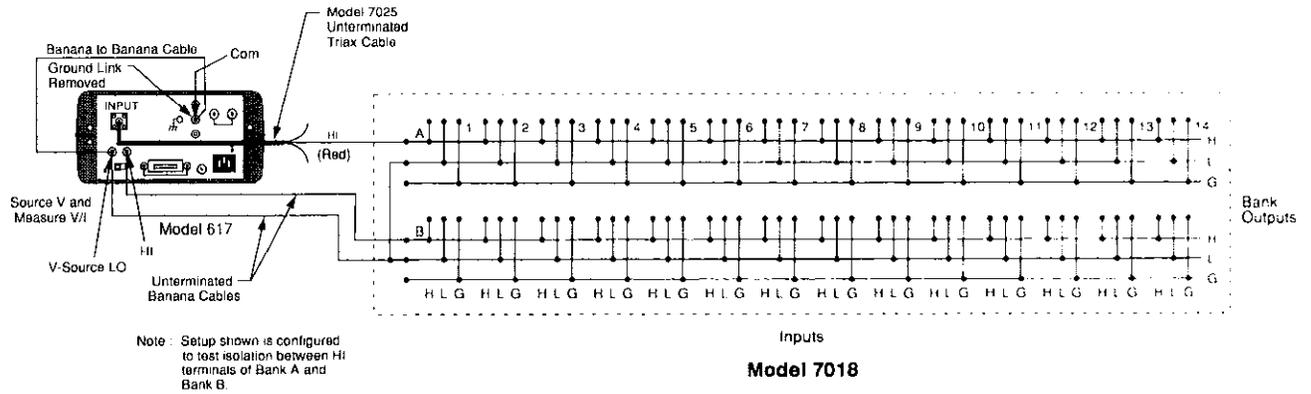
Figure 5-4
Bank isolation test connections

Table 5-2
Bank isolation test summary

Test number	Bank isolation	Channels closed*
1	Bank A, Input 1 to Bank B, Input 2	1!1 and 1!16
2	Bank A, Input 3 to Bank B, Input 4	1!3 and 1!18
3	Bank A, Input 5 to Bank B, Input 6	1!5 and 1!20
4	Bank A, Input 7 to Bank B, Input 8	1!7 and 1!22
5	Bank A, Input 9 to Bank B, Input 10	1!9 and 1!24
6	Bank A, Input 11 to Bank B, Input 12	1!11 and 1!26
7	Bank A, Input 13 to Bank B, Input 14	1!13 and 1!28

*Assumes Model 7018 installed in slot 1 of mainframe. Programmed as slot (1) and channel.
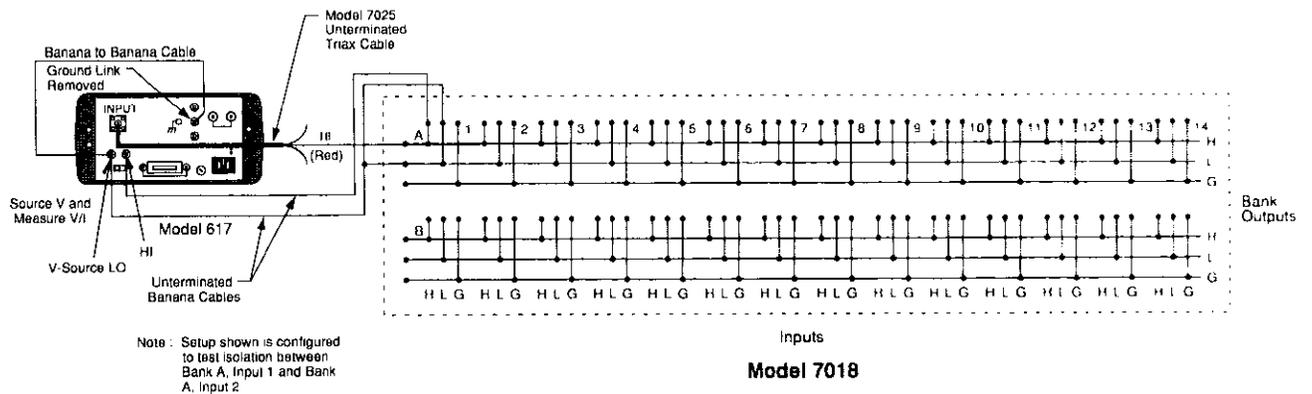
Figure 5-5
Channel-to-channel isolation test connections

Table 5-3
Channel-to-channel isolation test summary

Test number	Channel-to-channel isolation	Test equipment location	Channel closed*
1	Bank A, Input 1 to Bank A, Input 2	Bank A and Input 1	1!2
2	Bank A, Input 2 to Bank A, Input 3	Bank A and Input 2	1!3
3	Bank A, Input 3 to Bank A, Input 4	Bank A and Input 3	1!4
4	Bank A, Input 4 to Bank A, Input 5	Bank A and Input 4	1!5
5	Bank A, Input 5 to Bank A, Input 6	Bank A and Input 5	1!6
6	Bank A, Input 6 to Bank A, Input 7	Bank A and Input 6	1!7
7	Bank A, Input 7 to Bank A, Input 8	Bank A and Input 7	1!8
8	Bank A, Input 8 to Bank A, Input 9	Bank A and Input 8	1!9
9	Bank A, Input 9 to Bank A, Input 10	Bank A and Input 9	1!10
10	Bank A, Input 10 to Bank A, Input 11	Bank A and Input 10	1!11
11	Bank A, Input 11 to Bank A, Input 12	Bank A and Input 11	1!12
12	Bank A, Input 12 to Bank A, Input 13	Bank A and Input 12	1!13
13	Bank A, Input 13 to Bank A, Input 14	Bank A and Input 13	1!14
14	Bank B, Input 1 to Bank B, Input 2	Bank B and Input 1	1!16
15	Bank B, Input 2 to Bank B, Input 3	Bank B and Input 2	1!17
16	Bank B, Input 3 to Bank B, Input 4	Bank B and Input 3	1!18
17	Bank B, Input 4 to Bank B, Input 5	Bank B and Input 4	1!19
18	Bank B, Input 5 to Bank B, Input 6	Bank B and Input 5	1!20
19	Bank B, Input 6 to Bank B, Input 7	Bank B and Input 6	1!21
20	Bank B, Input 7 to Bank B, Input 8	Bank B and Input 7	1!22
21	Bank B, Input 8 to Bank B, Input 9	Bank B and Input 8	1!23
22	Bank B, Input 9 to Bank B, Input 10	Bank B and Input 9	1!24
23	Bank B, Input 10 to Bank B, Input 11	Bank B and Input 10	1!25
24	Bank B, Input 11 to Bank B, Input 12	Bank B and Input 11	1!26
25	Bank B, Input 12 to Bank B, Input 13	Bank B and Input 12	1!27
26	Bank B, Input 13 to Bank B, Input 14	Bank B and Input 13	1!28

*Assumes Model 7018 installed in slot 1 of mainframe. Programmed as slot (1) and channel.

5.3.8 Differential and common-mode isolation tests

These tests check the leakage resistance (isolation) between HI (H), LO (L) and G (differential), and from HI (H), LO (L), and G to chassis (common-mode) of every bank and channel. In general, the test is performed by applying a voltage (100V) across the terminals and then measuring the leakage current. The isolation resistance is then calculated as $R = V/I$. In the following procedure, the Model 617 functions as a voltage source and an ammeter. In the V/I function, the Model 617 internally calculates the resistance from the known voltage and current levels, and displays the resistance value.

Perform the following steps to check differential and common mode isolation:

1. Turn off the Model 7001/7002 if it is on, and remove any jumpers and test leads connected to the multiplexer card.
2. Turn on the Model 617, and allow the unit to warm up for two hours for rated accuracy.
3. On the Model 617, select the 2pA range, and enable zero check and zero correct in that order. Leave zero correct enabled for the entire procedure.

WARNING

The following steps use high voltage (100V). Be sure to remove power from the circuit before making connection changes.

4. On the Model 617, set the voltage source for +100V, and select the 200nA current range. Make sure the voltage source is still in standby.

5. Place the Model 617 in the V/I measurement function by pressing SHIFT OHMS.

6. With the Model 617 in standby, connect the electrometer to Bank A of the multiplexer card, as shown in Figure 5-6.

7. Install the Model 7018 in slot 1 (CARD 1) of the main-frame, and turn on the Model 7001/7002 on.

8. Make sure all the relays are open. (Press OPEN ALL on the Model 7001/7002.)

9. On the Model 617, disable zero check, and press OPER-ATE to source 100V.

10. After allowing the reading on the Model 617 to settle, verify that it is >1GΩ ($10^9\Omega$). This measurement is the differential leakage resistance (isolation) of Bank A.

11. Place the Model 617 in standby and enable zero check.

12. Program the Model 7001/7002 to close Channel 1!1 (Bank A, Input 1).

13. On the Model 617, disable zero check, and press OPER-ATE to source +100V.

14. After allowing the reading on the Model 617 to settle, verify that it is also >1GΩ ($10^9\Omega$). This measurement checks the differential isolation of Input 1.

15. Using Table 5-4 as a guide, repeat the basic procedure in steps 12 through 14 to test Inputs 2 through 14 of Bank A (test numbers 3 through 15 of the table).

16. Use Table 5-4 (test numbers 16 through 32) and the above procedure to test Bank B.

17. Repeat steps 12 through 14 for the H and G, and the L and G terminals. (The electrometer should be connected between H and G, and L and G respectively.)

18. Place the Model 617 voltage source in standby, and en-able zero check.

NOTE

Refer to Figure 5-7 for the following pro-cedure to check common mode isolation.

19. Turn off the Model 7001/7002, and connect the elec-trometer to the Model 7018 as shown in Figure 5-7.

20. Repeat steps 4 through 16 to check common-mode iso-lation. Verify that each reading is >1GΩ ($10^9\Omega$).

Table 5-4

Differential and common-mode isolation testing

Test number	Differential or common mode isolation	Channel closed*
1	Bank A	None
2	Bank A, Input 1	1!1
3	Bank A, Input 2	1!2
4	Bank A, Input 3	1!3
5	Bank A, Input 4	1!4
6	Bank A, Input 5	1!5
7	Bank A, Input 6	1!6
8	Bank A, Input 7	1!7
9	Bank A, Input 8	1!8
10	Bank A, Input 9	1!9
11	Bank A, Input 10	1!10
12	Bank A, Input 11	1!11
13	Bank A, Input 12	1!12
14	Bank A, Input 13	1!13
15	Bank A, Input 14	1!14
16	Bank B	
18	Bank B, Input 1	1!15
19	Bank B, Input 2	1!16
20	Bank B, Input 3	1!17
21	Bank B, Input 4	1!18
22	Bank B, Input 5	1!19
24	Bank B, Input 6	1!20
25	Bank B, Input 7	1!21
26	Bank B, Input 8	1!22
27	Bank B, Input 9	1!23
28	Bank B, Input 10	1!24
29	Bank B, Input 11	1!25
30	Bank B, Input 12	1!26
31	Bank B, Input 13	1!27
32	Bank B, Input 14	1!28

*Assumes Model 7018 installed in slot 1 of mainframe. Pro-grammed as slot (1) and channel.
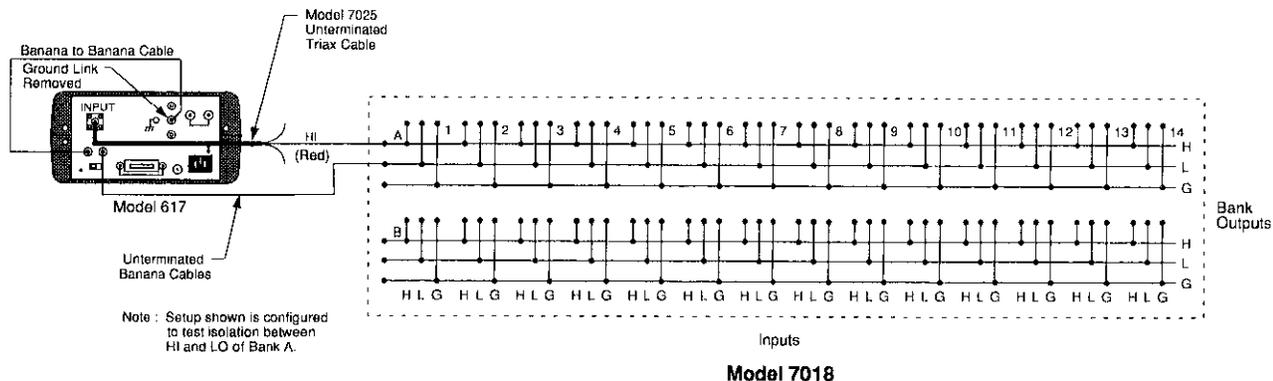
Figure 5-6
Differential isolation test connections
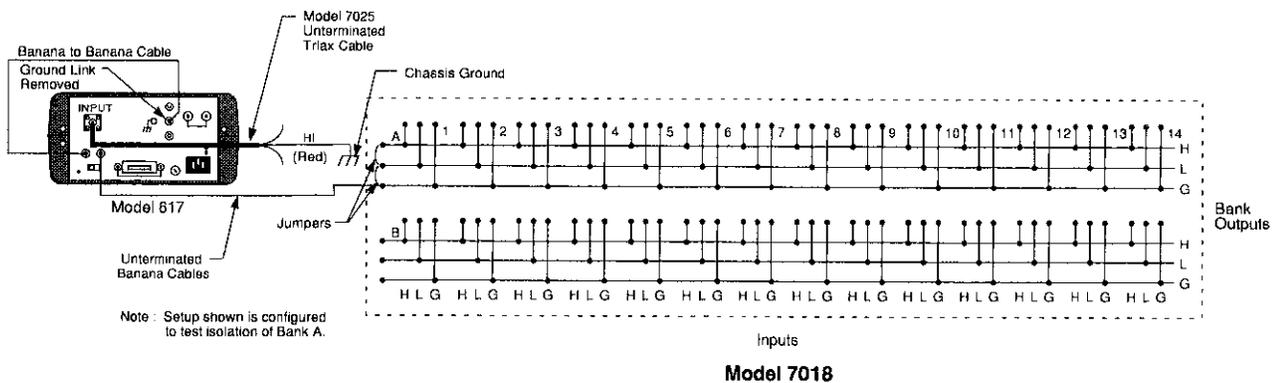
Figure 5-7
Common-mode isolation test connections

5.4 Special handling of static-sensitive devices

CMOS and other high-impedance devices are subject to possible static discharge damage because of the high-impedance levels involved.

CAUTION

Follow the precautions below when handling static-sensitive parts.

1. Static-sensitive devices should be transported and handled only in containers specially designed to prevent or dissipate static build-up. Typically, these devices will be received in anti-static containers made of plastic or foam. Keep these parts in their original containers until ready for installation or use.

2. Remove the devices from their protective containers only at a properly-grounded workstation. Also, ground yourself with an appropriate wrist strap while working with these devices.

3. Handle the devices only by the body; do not touch the pins or terminals.

4. Any printed circuit board into which the device is to be inserted must first be grounded to the bench or table.

5. Use only anti-static type de-soldering tools and grounded-tip soldering irons.

5.5   Principles of operation

The following paragraphs discuss the basic operating principles for the Model 7018, and can be used as an aid in troubleshooting the card. The schematic drawing of the relay card is shown on drawing number 7018-106, located at the end of Section 6.

5.5.1   Block diagram

Figure 5-8 shows a simplified block diagram of the Model 7018. Key elements include the relay drivers and relays, as well as the ROM, which contains card ID and configuration information. These various elements are discussed in the following paragraphs.
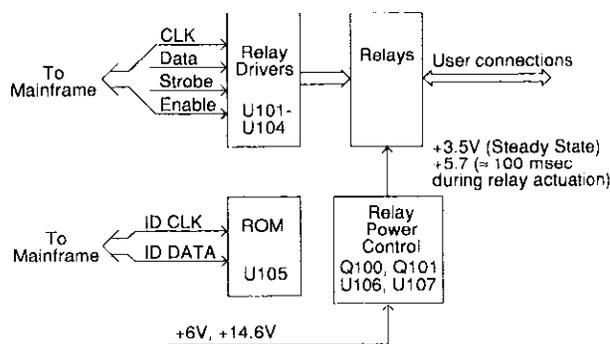
Figure 5-8
Model 7018 block diagram

5.5.2   ID data circuits

Upon power-up, card identification information from each card is read by the mainframe. This ID data includes such information as card ID, hardware settling time, and relay configuration information.

ID data is contained within an on-card EEPROM (U105). In order to read this information, the sequence described below is performed on power-up.

1. The IDDATA line (pin 6 of U105) is set from high to low while the IDCLK line (pin 5 of U105) is held high. This action initiates a start command to the ROM to transmit data serially to the mainframe (Figure 5-9).

2. The mainframe sends the ROM address location to be read over the IDDATA line. The ROM then transmits an acknowledge signal back to the mainframe, and it then transmits data at that location back to the mainframe (Figure 5-10).
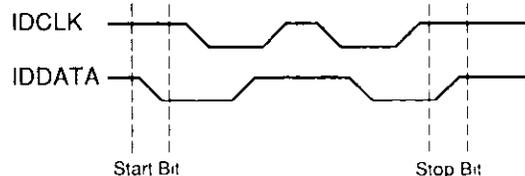
Figure 5-9
Start and stop sequences

3. The mainframe then transmits an acknowledge signal, indicating that it requires more data. The ROM will then sequentially transmit data after each acknowledge signal it receives.

4. Once all data is received, the mainframe sends a stop command, which is a low-to-high transition of the IDDATA line with the IDCLK line held high (see Figure 5-9).
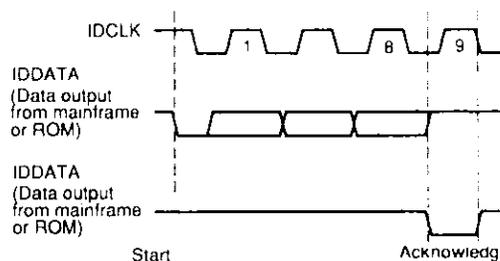
Figure 5-10
Transmit and acknowledge sequence

5.5.3   Relay control

Card relays are controlled by serial data transmitted via the relay DATA line. A total of four bytes for each card are shifted in serial fashion into latches located in the card relay driver ICs. The serial data is clocked in by the CLK line. As data overflows one register, it is fed out the Q'S line of the register down the chain.

Once all four bytes have shifted into the card, the STROBE line is set high to latch the relay information into the Q outputs of the relay drivers, and the appropriate relays are energized. Note that a relay driver output goes low to energize the corresponding relay.

5.5.4 Relay power control

A relay power control circuit, made up of U106, U107, Q100, Q101, and associated components, keeps power dissipated in relay coils at a minimum, thus reducing possible problems caused by thermal EMFs.

During steady-state operation, the relay supply voltage, +V, is regulated to +3.5V to minimize coil power dissipation. When a relay is first closed, the STROBE pulse applied to U106 changes the parameters of the relay supply voltage regulator, Q100, allowing the relay supply voltage, +V, to rise to +5.7V for about 100msec. This brief voltage rise ensures that relays close as quickly as possible. After the 100msec period has elapsed, the relay supply voltage (+V) drops back down to its nominal steady-state value of +3.5V.

5.6 Troubleshooting

5.6.1 Troubleshooting equipment

Table 5-5 summarizes recommended equipment for troubleshooting the Model 7018.

Table 5-5
Recommended troubleshooting equipment

Description	Manufacturer and model	Application
Multimeter	Keithley 2001	Measure DC voltages
Oscilloscope	TEK 2243	View logic waveforms

5.6.2 Troubleshooting access

The Model 7018 can be tested while installed in the Model 7001 only. The circuit board cannot be accessed while installed in a Model 7002.

In order to gain access to the relay card top surface to measure voltages under actual operation conditions, perform the following steps:

1. Disconnect the connector card from the relay card.

2. Remove the Model 7001 cover.

3. Install the relay card in the CARD 1 slot location.

4. Turn on Model 7001 power to measure voltages (see following paragraph).

5.6.3 Troubleshooting procedure

Table 5-6 summarizes switch card troubleshooting.

WARNING

Be careful not to touch AC mains or other high-voltage circuits while working on low-voltage circuits. Failure to observe these precautions may result in personal injury or death because of electric shock.

CAUTION

Observe the following precautions when troubleshooting or repairing the switch card:

To avoid contamination, which could degrade card performance, always handle the card only by the handle and side edges. Do not touch edge connectors, board surfaces, or components on the card. Also, do not touch areas adjacent to electrical contacts on connectors.

Use care when removing relays from the PC board to avoid pulling traces away from the circuit board. Before attempting to remove a relay, use an appropriate de-soldering tool, such as a solder sucker, to clear each mounting hole completely free of solder. Each relay pin must be free to move in its mounting hole before removal. Also, make certain that no burrs are present on the ends of the relay pins.

Table 5-6
Troubleshooting procedure

Step	Item/component	Required condition	Comments
1	U105, pin 4	GND	All voltages referenced to digital ground (U105, pin 4).
2	Q100 collector	+6VDC	Relay voltage.
3	U105, pin 8	+5VDC	Logic voltage.
4	Junction of R102 and C109	+14.6VDC	Relay bias voltage.
5	Q100 emitter	+3.5VDC*	Regulated relay voltage.
6	U105, pin 5	ID CLK pulses	During power-up only.
7	U105, pin 6	ID DATA pulses	During power-up only.
8	U101, pin 7	STROBE pulse	End of relay update sequence.
9	U101, pin 2	CLK pulses	During relay update sequence only.
10	U101, pin 3	DATA pulses	During relay update sequence only.
11	U101-U104, pins 10-18	Low with relay energized; high with relay de-energized.	Relay driver outputs.

*+3.5VDC present at +V pad under steady-state conditions. This voltage rises to +5.7VDC for about 100msec when relay configuration is changed.

6

Replaceable Parts

6.1 Introduction

This section contains replacement parts information, schematic diagrams, and component layout drawings for the Model 7018.

6.2 Parts lists

Parts lists for the various circuit boards are included in tables integrated with schematic diagrams and component layout drawings for the boards. Parts are listed alphabetically in order of circuit designation.

6.3 Ordering information

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

1. Card model number (7018)
2. Card serial number
3. Part description
4. Circuit description, if applicable
5. Keithley part number

6.4 Factory service

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

1. Complete the service form at the back of this manual, and include it with the card.
2. Carefully pack the card in the original packing carton.
3. Write ATTENTION REPAIR DEPT on the shipping label.

Note: It is not necessary to return the switching mainframe with the card.

6.5 Component layouts and schematic diagrams

Component layout drawings and schematic diagrams are included on the following pages integrated with the parts lists:

Table 6-1, Parts List, 3-pole Scanner Card for 7018-S and 7018-C.

7018-100, Component Layout, 3-pole Scanner Card for 7018-S and 7018-C.

7018-106, Schematic, 3-pole Scanner Card for 7018-S and 7018-C.

Table 6-2, Parts List, Screw Terminal Connector Board for 7018-S.

7018-160, Component Layout, Screw Terminal Connector Board for 7018-S.

7018-166, Schematic, Screw Terminal Connector Board for 7018-S.

Table 6-3, Parts List, Mass Termination Card for 7018-C.

7018-170, Component Layout, Mass Termination Card for 7018-C.

7018-176, Schematic, Mass Termination Card for 7018-C.

Table 6-1

Parts List, 3-pole Scanner Card for 7018-S and 7018-C

Circuit Designation	Description	Keithley Part No.
	SHIELD	7011-305C
	EJECTOR ARM	7011-301B
C101-109	CAP,.1UF,20%,50V,CERAMIC	C-365-.1
C110,111	CAP,1UF,20%,50V, CERAMIC	C-237-1
C112	CAP, 0.001uF, 20%, 500V, CERAMI	C-22-.001
C113,114	CAP, 10UF,-20+100%,25V,ALUM ELEC	C-314-10
C115-119	CAP,150PF,10%,1000V,CERAMIC	C-64-150P
J1002,1003	CONN, 48-PIN, 3-ROWS	CS-736-2
K101-156	RELAY, MINI SIGNAL REL	RL-163
P2001	CONNECTOR, 32-PIN, 2-ROWS	CS-775-1
Q100	TRANS, NPN PWR, TIP31, (TO-220AB)	TG-253
Q101	TRANS,N CHAN MOSPOW FET,2N7000 (TO-92)	TG-195
R100	RES, 2.49K, 1%, 1/8W, METAL FILM	R-88-2.49K
R101	RES, 1.15K, 1%, 1/8W, METAL FILM	R-88-1.15K
R102,103	RES, 560, 10%, 1/2W, COMPOSITION	R-1-560
R104	RES,1K,1%,1/8W,METAL FILM	R-88-1K
R105	RES,220K,5%,1/4W,COMPOSITION OR FILM	R-76-220K
R106,107	RES,10K,5%,1/4W,COMPOSITION OR FILM	R-76-10K
U101-104	IC, 8-BIT SERIAL-IN LATCH DRIVER,5841A	IC-536
U105	EPROM PROGRAM	7018-800A01
U106	IC,RETRIG MONO MULTIVIB,74HC123	IC-492
U107	IC,AJD SHUNT REGULATOR,TL431CLP	IC-677
W101-106	JUMPER	J-15

LTR.	ECO NO.	REVISION	ENG.	DATE
A		PRELIMINARY		
B	931028	RELEASED		10/28/93

MC-612 (SIDE-01)

WARNING: USER LETHAL VOLTAGES MAY BE PRESENT ON CONNECTORS OR PC BOARD

CAUTION: MAX VOLTAGE TERMINAL TO TERMINAL OR CHASSIS: 110 VDC OR ±175 VAC PEAK
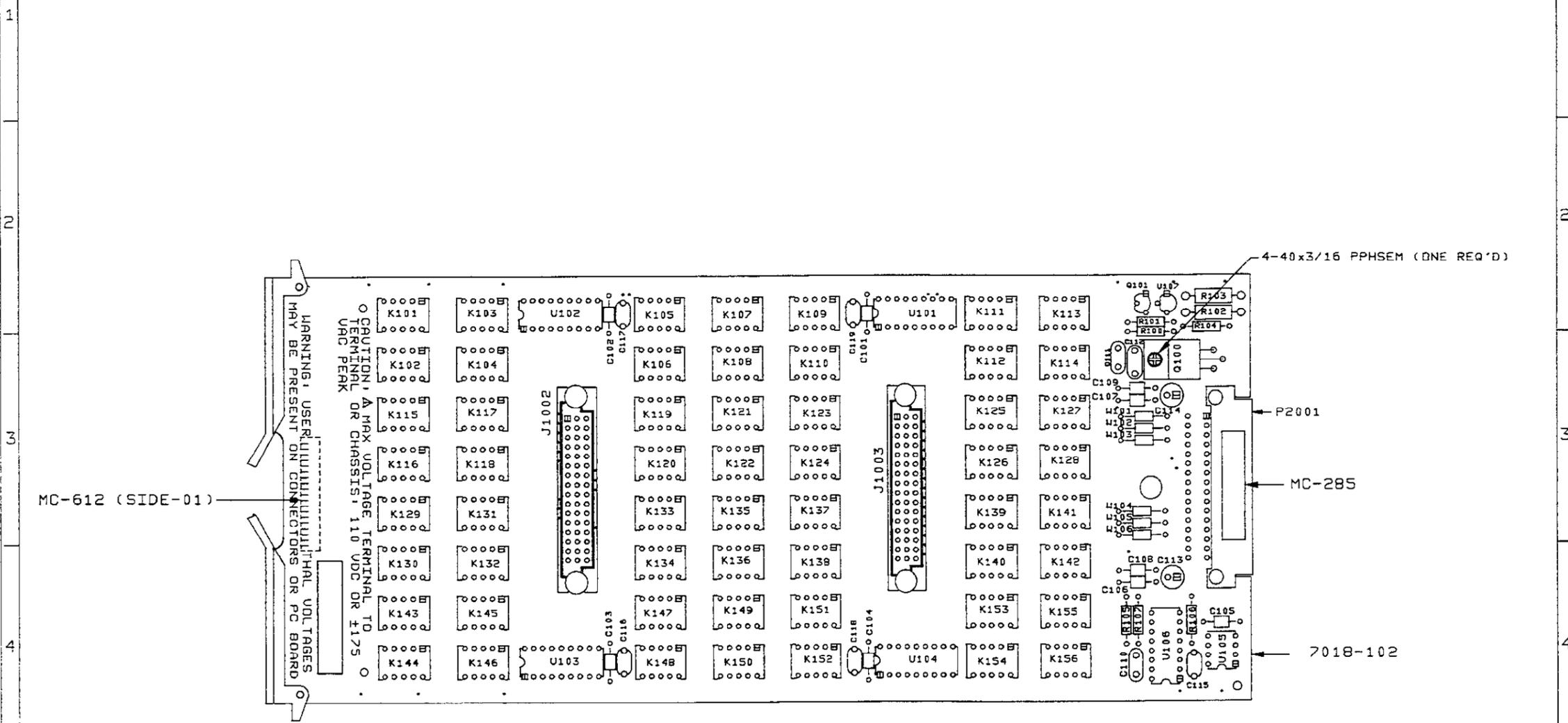
4-40x3/16 PPHSEM (ONE REQ'D)

P2001

MC-285

7018-102

K101 K103 U102 K105 K107 K109 U101 K111 K113
K102 K104 K106 K108 K110 K112 K114
K115 K117 J1002 K119 K121 K123 K125 K127
K116 K118 K120 K122 K124 J1003 K126 K128
K129 K131 K133 K135 K137 K139 K141
K130 K132 K134 K136 K138 K140 K142
K143 K145 K147 K149 K151 K153 K155
K144 K146 U103 K148 K150 K152 U104 K154 K156

Q101 U107 R103 R102 R104
R101
R100
C109 C107
C108 C113
C106
C105
U106 U105
C115

NOTE: FOR COMPONENT INFORMATION, REFER TO PRODUCT STRUCTURE FOR 7018.

DO NOT SCALE THIS DRAWING	DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED	DATE 08/05/93	SCALE 5:4	TITLE
	XX=±.015 ANG.=±1°	DRN. KEK	ENG. APPR.	COMPONENT LAYOUT 3-POLE SCANNER CARD
KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139	XXX=±.005 FRAC.=±1/64	MATERIAL		
	SURFACE MAX. 63	FINISH	C	NO. 7018-100

SCHEMATIC
3-POLE SCANNER CARD
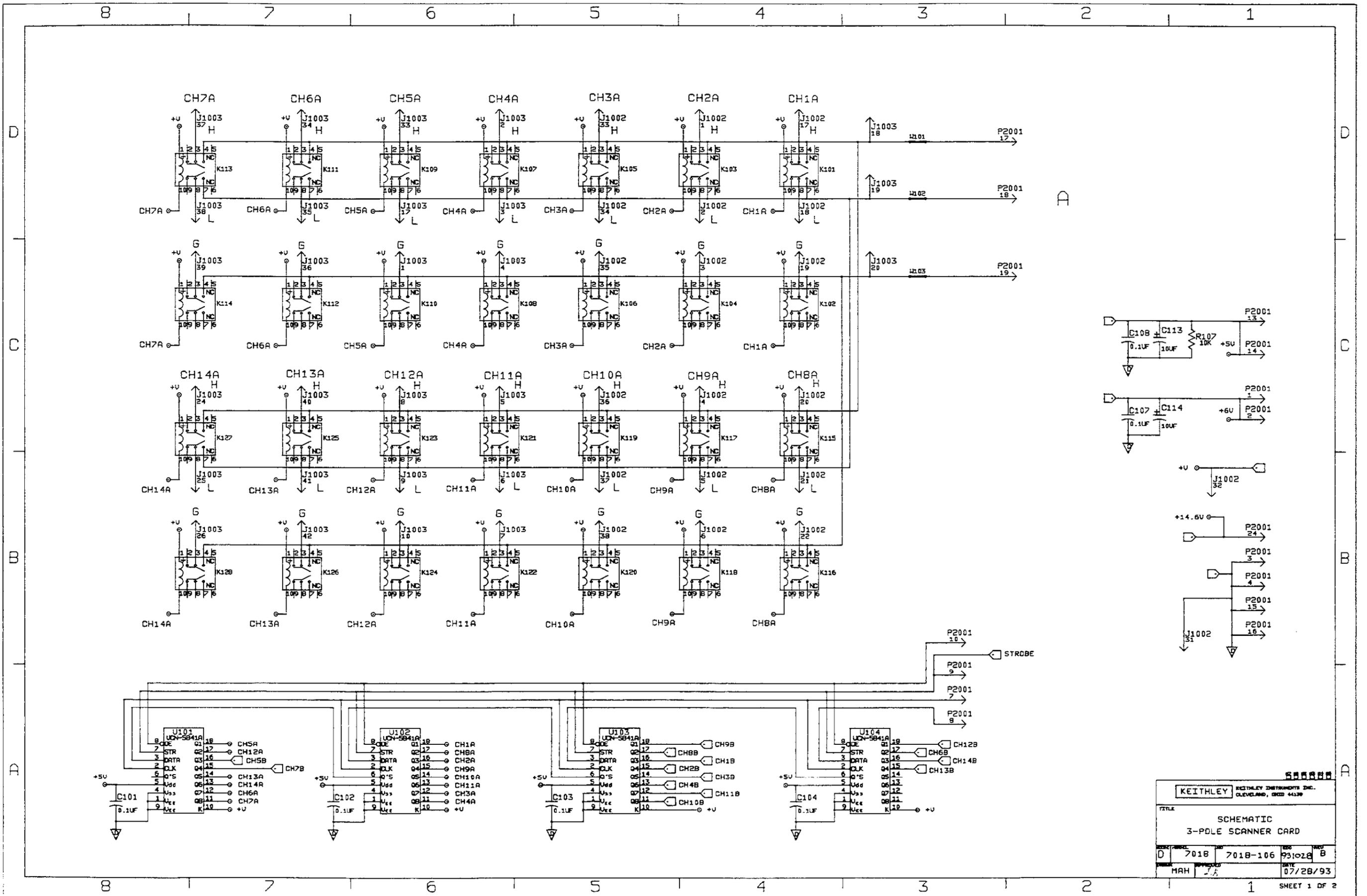
KEITHLEY KEITHLEY INSTRUMENTS INC.
CLEVELAND, OHIO 44139

| D | 7018 | 7018-106 | 931028 | B |

MAH

DATE 07/28/93

SHEET 1 OF 2

Table 6-2
Parts List, Screw Terminal Connector Board for 7018-S

Circuit Designation	Description	Keithley Part No.
	BOTTOM CLAMP, RAW	7011-303B
	SHIELD	7011-305C
	TOP CLAMP	7011-302B
	TERMINAL BLOCK	TE-115-9
	CONN, 6 PIN	TE-115-6
	CONN,BERG	CS-339
P1002,1003	CONNECTOR, 48-PIN, 3 ROWS	CS-748-3
W100-105	CONN,BERG,2 PIN	CS-339-2

WARNING:
USER SUPPLIED LETHAL VOLTAGES MAY
BE PRESENT ON CONNECTORS OR PC BOARD

7018-162

BANK B   BANK A

J1004   J1013
H   H
L OUTB   OUTA L
G   J1007   J1010   G
H   IN7 L   H L IN14
L IN14   G   G   IN7 L
G   H   H
H   IN6 L   L IN13   H
L IN13   G   G   IN6 L
G   G

P1003

J1005   J1008   J1011   J1014
H L IN12 IN5 L   H L IN12 IN5 L
L IN12 IN5 L   G
G   H   H
H L IN11 IN4 L   L IN11 IN4 L
L IN11 IN4 L   G
G   H   H
H L IN10 IN3 L   L IN10 IN3 L
L IN10 IN3 L   G
G   G   G   G

P1002

J1006   J1009   J1012   J1015
H   H
L IN9 IN2 L   L IN9 IN2 L
G   G   G
H   H
L IN8 IN1 L   L IN8 IN1 L
G   G   G   G

CAUTION: /!\ MAX VOLTAGE
TERMINAL TO TERMINAL OR CHASSIS:
±110 VDC OR 175 VAC PEAK

MC-285 (COMPONENT SIDE -04)
MC-612 (SOLDER SIDE -01)

7011-309 (CONNECTOR SHIM)
(2 REQ'D)

7011-302 (TOP CLAMP)
7018-304-6 (CLAMP SILKSCREEN)
2001-345-1 (POLYURETHANE STRIP)
FA-243-1 (CAPTIVE PANEL SCREW)

NOTE: FOR MORE COMPONENT INFORMATION REFER
TO THE 7018 PRODUCT STRUCTURE.

DO NOT SCALE THIS DRAWING

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED
XX ±.015
XXX ±.005
SURFACE MAX 63

DATE 9/29/93 SCALE 1:1
DWN MAH
ENG APPR

TITLE COMPONENT LAYOUT,
SCREW TERMINAL CONNECT CARD

NO. 7018-160

REVISION

LTR ECO NO   DATE   ENG
A 28014 RELEASED

MODEL NEXT ASSEMBLY QTY
USED ON

BANK A

IN1	HI	J1015 4 → P1002 32
	LO	J1015 5 → P1002 31
	GD	J1015 6 → P1002 30
IN2	HI	J1015 1 → P1002 16
	LO	J1015 2 → P1002 15
	GD	J1015 3 → P1002 14
IN3	HI	J1014 7 → P1002 48
	LO	J1014 8 → P1002 47
	GD	J1014 9 → P1002 46
IN4	HI	J1014 4 → P1003 15
	LO	J1014 5 → P1003 14
	GD	J1014 6 → P1003 13
IN5	HI	J1014 1 → P1003 48
	LO	J1014 2 → P1003 32
	GD	J1014 3 → P1003 16
IN6	HI	J1013 7 → P1003 47
	LO	J1013 8 → P1003 46
	GD	J1013 9 → P1003 45
IN7	HI	J1013 4 → P1003 44
	LO	J1013 5 → P1003 43
	GD	J1013 6 → P1003 42

IN8	HI	J1012 3 → P1002 29
	LO	J1012 2 → P1002 28
	GD	J1012 1 → P1002 27
IN9	HI	J1012 6 → P1002 13
	LO	J1012 5 → P1002 12
	GD	J1012 4 → P1002 11
IN10	HI	J1011 3 → P1002 45
	LO	J1011 2 → P1002 44
	GD	J1011 1 → P1002 43
IN11	HI	J1011 6 → P1003 12
	LO	J1011 5 → P1003 11
	GD	J1011 4 → P1003 10
IN12	HI	J1011 9 → P1003 9
	LO	J1011 8 → P1003 8
	GD	J1011 7 → P1003 7
IN13	HI	J1010 3 → P1003 41
	LO	J1010 2 → P1003 40
	GD	J1010 1 → P1003 39
IN14	HI	J1010 6 → P1003 25
	LO	J1010 5 → P1003 24
	GD	J1010 4 → P1003 23

BANK B

IN1	HI	J1009 4 → P1002 23
	LO	J1009 5 → P1002 22
	GD	J1009 6 → P1002 21
IN2	HI	J1009 1 → P1002 10
	LO	J1009 2 → P1002 9
	GD	J1009 3 → P1002 8
IN3	HI	J1008 7 → P1002 42
	LO	J1008 8 → P1002 41
	GD	J1008 9 → P1002 40
IN4	HI	J1008 4 → P1002 26
	LO	J1008 5 → P1002 25
	GD	J1008 6 → P1002 24
IN5	HI	J1008 1 → P1003 6
	LO	J1008 2 → P1003 5
	GD	J1008 3 → P1003 4
IN6	HI	J1007 4 → P1003 38
	LO	J1007 5 → P1003 37
	GD	J1007 6 → P1003 36
IN7	HI	J1007 1 → P1003 22
	LO	J1007 2 → P1003 21
	GD	J1007 3 → P1003 20

IN8	HI	J1006 3 → P1002 7
	LO	J1006 2 → P1002 6
	GD	J1006 1 → P1002 5
IN9	HI	J1006 6 → P1002 4
	LO	J1006 5 → P1002 3
	GD	J1006 4 → P1002 2
IN10	HI	J1005 3 → P1002 39
	LO	J1005 2 → P1002 38
	GD	J1005 1 → P1002 37
IN11	HI	J1005 6 → P1002 20
	LO	J1005 5 → P1002 36
	GD	J1005 4 → P1002 35
IN12	HI	J1005 9 → P1003 3
	LO	J1005 8 → P1003 2
	GD	J1005 7 → P1003 1
IN13	HI	J1004 3 → P1003 35
	LO	J1004 2 → P1003 34
	GD	J1004 1 → P1003 33
IN14	HI	J1004 6 → P1003 19
	LO	J1004 5 → P1003 18
	GD	J1004 4 → P1003 17

N.C.
P1002 1 →
P1002 17 →
P1002 18 →
P1002 19 →
P1002 33 →
P1002 34 →

OUT A
HI	J1013 1 → P1003 31	W102 1—2	P1003 26 → J1004 9	HI
LO	J1013 2 → P1003 30	W103 1—2	P1003 27 → J1004 8	LO
GD	J1013 3 → P1003 29	W101 1—2	P1003 28 → J1004 7	GD
OUT B

Table 6-3
Parts List, Mass Termination Card for 7018-C

Circuit Designation	Description	Keithley Part No.
	BRACKET	7011-307
	SHIELD	7011-311A
C101,102	CAP,1UF,20%,50V, CERAMIC	C-237-1
C103	CAP,.1UF,20%,50V,CERAMIC	C-365-.1
CR101-105	DIODE,SILICON,IN4148 (DO-35)	RF-28
E101,102	FERRITE BEAD	CT-8
J1004	CONN, 96-PIN, 3 ROWS	CS-514
	JUMPER FOR W101-103 CONNECTOR, JUMPER	CS-476
K101-104	RELAY, ULTRA-SMALL POLARIZED TF2E-4.5V	RL-162
P1002,1003	CONNECTOR, 48-PIN, 3 ROWS	CS-748-3
Q101-103	TRANS,N CHAN MOSPOW FET,2N7000 (TO-92)	TG-195
R103,104	RES, 1M, 10%, 1/2W, COMPOSITION	R-1-1M
R105	RES, 39, 5%, 1/4W, COMPOSITION OR FILM	R-76-39
R106	RES,10,5%,1/4W,COMPOSITION OR FILM	R-76-10
R107	RES,4.99K,1%,1/8W,METAL FILM	R-88-4.99K
R108,110	RES,10K,5%,1/4W,COMPOSITION OR FILM	R-76-10K
R109	RES,100K,5%,1/4W,COMPOSITION OR FILM	R-76-100K
R111	RES,10K,1%,1/8W,METAL FILM	R-88-10K
U101	IC,QUAD 2 INPUT NOR,74HC02	IC-412
U102	IC, DUAL, VOLTAGE COMPARATOR, LM393	IC-343
W101-103	CONN,BERG,2 PIN	S-339-2

NOTE: FOR COMPONENT INFORMATION, REFER TO PRODUCT STRUCTURE.

MC-612 1 REQ'D

7018-172

7011-309
CONNECTOR SHIM
(2 REQ'D)

BAR CODE

P1003

P1002

J1004

K101 K102 K103 K104

7018-B-170 NO.

SCHEMATIC
MASS TERMINATION CARD

KEITHLEY INSTRUMENTS INC.
CLEVELAND, OHIO 44139

UNUSED GATES

BANK A

BANK B

Index

KEITHLEY

Service Form

Model No. _____ Serial No. _____ Date _____

Name and Telephone No. _____

Company _____

List all control settings, describe problem and check boxes that apply to problem. _____

_____

❏ Intermittent   ❏ Analog output follows display   ❏ Particular range or function bad; specify

❏ IEEE failure   ❏ Obvious problem on power-up   ❏ Batteries and fuses are OK

❏ Front panel operational   ❏ All ranges or functions are bad   ❏ Checked all cables

Display or output (check one)

❏ Drifts   ❏ Unable to zero

❏ Unstable   ❏ Will not read applied input

❏ Overload

❏ Calibration only   ❏ Certificate of calibration required

❏ Data required

(attach any additional sheets as necessary)

Show a block diagram of your measurement system including all instruments connected (whether power is turned on or not).
Also, describe signal source.

Where is the measurement being performed? (factory, controlled laboratory, out-of-doors, etc.)

_____

What power line voltage is used? _____ Ambient temperature? _____ °F

Relative humidity? _____ Other? _____

Any additional information. (If special modifications have been made by the user, please describe.)

_____

Be sure to include your name and phone number on this service form.

KEITHLEY