KEITHLEY

Model 7169A 20-Channel Form C Switch Card
Instruction Manual

A GREATER MEASURE OF CONFIDENCE

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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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Model 7169A
20-Channel Form C Switch Card
Instruction Manual

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Safety Precautions

The following safety precautions should be observed before using the Model 7169A and the associated instruments.

This card is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read over this manual carefully before using the card.

Exercise extreme caution when a shock hazard is present at the test circuit. User-supplied lethal voltages may be present on the PC board. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS or 42.4V peak are present. A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.

Do not exceed 500V peak between any two pins or between any pin and earth ground.

Inspect the connecting cables and test leads for possible wear, cracks, or breaks before each use.

For maximum safety, do not touch the test cables or any instruments while power is applied to the circuit under test. Turn off the power and discharge any capacitors before connecting or disconnecting cables from the card.

Do not touch any object which 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.

Do not exceed the maximum signal levels of the card, as defined in the specifications and operation section of this manual.

Instrumentation and accessories should not be connected to humans.

Model 7169A 20 Form C Switch Card for the Models 7002 and 706 Mainframes only

CHANNELS PER CARD: 20 independent Form C. All poles available at connectors. Replacement of factory installed jumper allows current limit resistor in series with common of each channel. On-card bus allows for addition of jumper to change configuration from switch to multiplex. Bus also allows channel interconnection.

RELAY TYPE: Position sensitive mercury wetted reed relay. Card is only for use inside the Model 706 mainframe, and must be used within 30° of vertical for relay to work properly.

CONNECTOR TYPE: Three 20 pin mass termination connectors.

RELAY DRIVE CURRENT: 30mA per relay typical.

MAXIMUM SIGNAL LEVEL: 500V peak, 1.0A peak switched, 2A peak carry, 50W (resistive load only).

CONTACT LIFE: $>10^9$ closures cold switching; $>10^7$ closures at maximum signal levels.

CONTACT RESISTANCE: <2Ω to rated life.

CONTACT POTENTIAL: <35μV, C to NO or NC.

ACTUATION TIME: <3msec, exclusive of mainframe.

CHANNEL ISOLATION: $>10^9\Omega$, <50pF.

INPUT ISOLATION: $>10^9\Omega$, <50pF.

COMMON MODE VOLTAGE: 500V peak.

OPERATING ENVIRONMENT: 0° to 50°C, up to 35°C at 70% RH.

STORAGE ENVIRONMENT: –25° to 65°C.

DIMENSIONS, WEIGHT: 32mm high × 114mm wide × 272mm long (1.25 in. × 4.5 in. × 10.75 in.). Shipping weight 0.91kg (2 lbs.).

Specifications subject to change without notice.

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SECTION 1
General Information

1.1 INTRODUCTION

This section contains general information about the Model 7169A 20-Channel Form C Switch Card.

1.2 Warranty Information

1.3 Manual Addenda

1.4 Safety Symbols and Terms

1.5 Specifications

1.6 Unpacking and Inspection

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1.2 WARRANTY INFORMATION

Warranty information is located on the inside front cover of this instruction manual. Should your Model 7169A require warranty service, contact the Keithley representative or authorized repair facility in your area for further information. When returning the switch 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.

1.3 MANUAL ADDENDA

Any improvements or changes concerning the switch card or manual will be explained in an addendum included with the unit. Be sure to note these changes and incorporate them into the manual.

1.4 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 high voltage 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 switch card. Such damage may invalidate the warranty.

1.5 SPECIFICATIONS

Model 7169A specifications may be found at the front of this manual. These specifications are exclusive of the Model 706 mainframe specifications.

1.6 UNPACKING AND INSPECTION

1.6.1 Inspection for Damage

The Model 7169A is packaged in a resealable bag to protect it from contamination that could degrade performance. Before removing the card from the bag, observe the following precautions on handling.

1. Always grasp the card by the side edges. Do not touch the edge connector, board surfaces or components.
2. When not installed in the mainframe, keep the card in the bag and store in the original packing carton. After removing the card from the bag, inspect if for any obvious signs of physical damage. Report any such damage to the shipping agent immediately. Save the original packing carton for possible future reshipment.

1.6.2 Shipping Contents

The following items are included with every Model 7169A order:

- Model 7169A Switch Card
- Model 7169A Instruction Manual
- Additional accessories as ordered

1.6.3 Instruction Manual

If an additional instruction manual is required, order the manual package, Keithley part number 7169A-901-00. The manual package includes an instruction manual and any pertinent addenda.

1.7 REPACKING FOR SHIPMENT

Should it become necessary to return the Model 7169A 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 switch 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 from Keithley for use with the Model 7169A:

Model 7169-MTC-10 — The Model 7169-MTC-10 is a 10-foot, cable that allows connection between the 7169A and the supplied mating connectors (7169-KIT).

Model 7169-KIT — The Model 7169-KIT consists of a 20-pin connector body and 20 contacts for assembly of custom cables to mate with the Model 7169A switch card connectors. It requires the use of crimping pliers, such as the Model 7078-HCT, for assembly. Also useful is the Model 7078-CIT contact insertion and extraction tool kit.

Model 7169-MTR — The Model 7169-MTR consists of a 20-pin female receptacle body and 20 contacts for assembly of bulkhead connectors that mate to the Model 7169-MTC-10 cable. Assembly requires the use of crimping pliers (Model 7078-HCT) and a contact insertion/extractor tool kit (Model 7078-CIT).

SECTION 2
Operation

2.1 INTRODUCTION

This section contains information on aspects of switch card operation and is arranged as follows:

2.3 Mainframe Precautions: Lists precautions about the mercury wetted reed relays of the Model 7169A

2.3 Handling Precautions: Details precautions that should be observed when handling the switch card to ensure that its performance is not degraded due to contamination.

2.4 Equivalent Circuit: Provides the simplified switch card circuit for the Model 7169A.

2.5 Multi-Card Configurations: Explains two basic methods for using multiple cards; common OUTPUT and separate OUTPUTs.

2.6 Connections: Explains the various methods and techniques that can be used to make connections to the switch card.

2.7 Mainframe Control of Switch Card: Covers operating aspects specific to the Model 7169A.

2.2 MAINFRAME PRECAUTIONS

The mercury wetted reed relays of the Model 7169A are position sensitive. The switch card must be oriented within 30° of vertical. If it is not vertical, the normally-open contact may short to the common or to the normally-closed contact.

The Model 7169A can only be used in the Model 706 mainframe. The Model 706 cannot be used on its side.

The top of every relay on the Model 7169A has an arrow showing the direction of "UP".

To prevent possible shorting of relay contacts (and causing unintended operation of external circuitry), all cables must be disconnected from the Model 7169A before removing it from the Model 706.

2.3 HANDLING PRECAUTIONS

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

To avoid possible contamination, always grasp the card by the side edges. Do not touch the edge connectors of the card and do not touch board surfaces or components. When not installed in a Model 706 mainframe, keep the card in the bag and store in the original packing carton.

Dirt build-up over a period of time is another possible source of contamination. To avoid this problem, operate the mainframe and switch card only in a clean environment.

If the card should become contaminated, it should be thoroughly cleaned as explained in paragraph 4.2.

2.4 EQUIVALENT CIRCUIT

Figure 2-1 shows the equivalent circuit of the Model 7169A.

Each channel is a single-pole, double throw (1-Form C) isolated switch. The factory-installed jumper in series with the COMMON terminal can be removed if a limiting resistor is required. Two undedicated on-card buses are available for intracard connections.

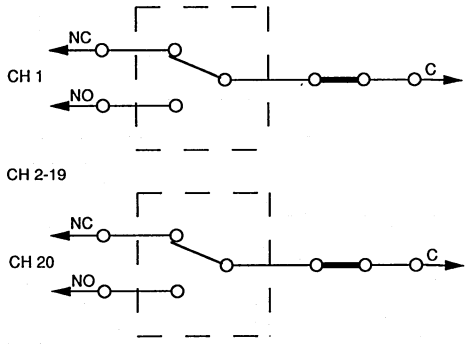


Figure 2-1. Model 7169A Simplified Schematic

2.5 MULTI-CARD CONFIGURATIONS

Typically, multi-card systems are configured by connecting one or more of the terminal blocks of all the cards together. An example of this type of configuration is shown in Figure 2-2, which connects the common and normally closed pins of a three-card system together. This common output system allows a single piece of equipment to operate all 60 channels.

Another possible way to configure a multi-channel system is with separate outputs. Figure 2-3 shows a two-card system with separate outputs. With this type of configuration, more than one test system can be controlled by the master mainframe.

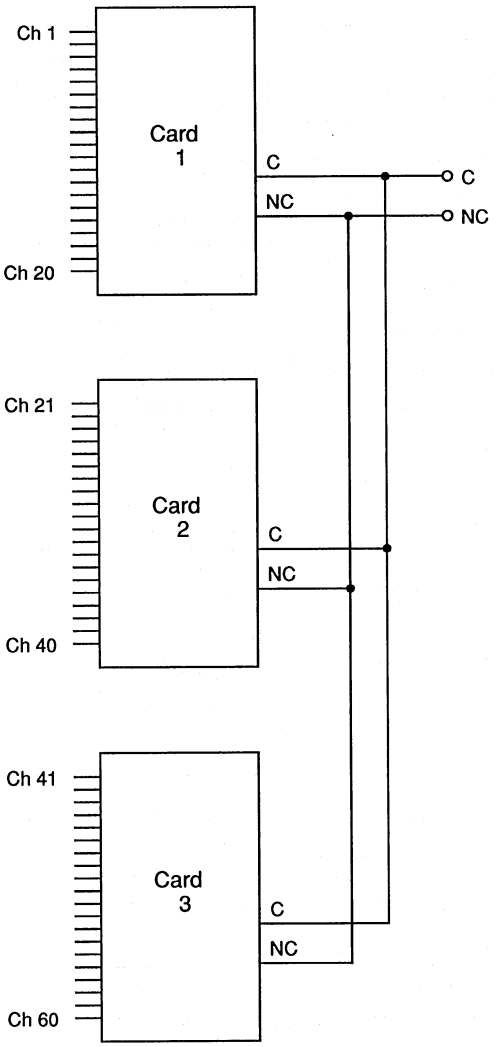


Figure 2-2. Multi-Card Configuration

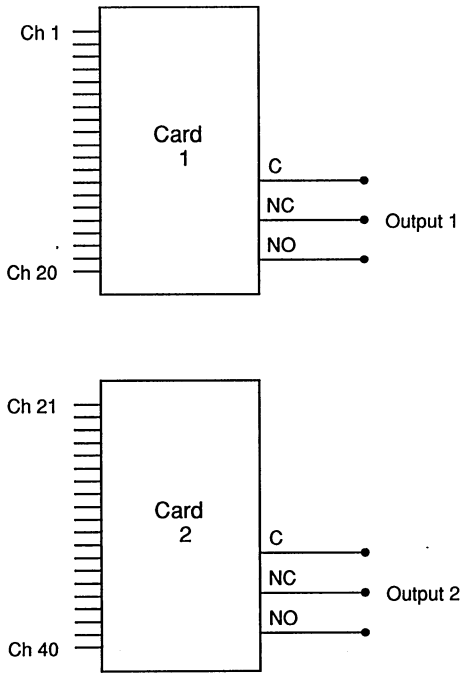


Figure 2-3. Separate Outputs Configuration

2.6 CONNECTIONS

WARNING

User-supplied lethal voltage may be present on PC board and connectors.

CAUTION

To prevent possible shorting of relay contacts (and causing unintended operation of external circuitry), make cable connections to the Model 7169A only when it is installed in a Model 706 mainframe.

Figure 2-4 shows the connectors on the switch card. Table 2-1 references switch card terminals to connector pins and channel numbers. For example, Channel 1 common is connected to pin A of J102, Channel 1 normally-open is connected to pin B of J103, and Channel 1 normally-closed is connected to pin A of J103.

NOTE

The Model 7169A is connector pin compatible with the Model 7169. The Model 7169A works in all Model 706 mainframe applications that the Model 7169 does.

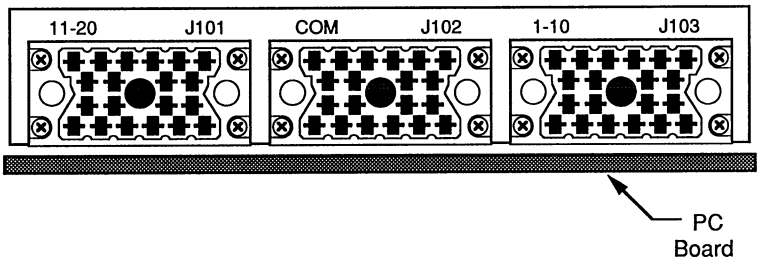


Figure 2-4. Connectors on Switch Card (Pin Side Shown)

The connector on the switch card will mate to either a connector (Model 7169-KIT) or to an optional mass terminated cable (Model 7169-MTC-10).

The following procedure explains how to mate the connector to the Model 7169A.

1. Mate the female connector to the male connector on the PC board.
2. Tighten the jackscrew finger tight. This is the locked position and secures the connectors together.

2.6.1 Connections Using Model 7169-KIT

The Model 7169-KIT is a connector that mates to the connector on the back panel of the Model 7169A. Cabling from instrumentation and DUTs can be crimped directly to the pins that fit into the 7169-KIT connector. The terminals of this connector will accommodate up to #18 AWG wire. Figure 2-5 shows the pinout of the male connector for all three terminals blocks. Table 2-1 can be used to identify switch card terminals.

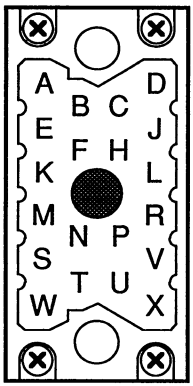


Figure 2-5. Female Connector Pin Identification (Terminal Crimp Side Shown)

Table 2-1. Connector Pin Identification

Channel	Matrix Location	Contact	Connector	Pin
1	1,1	C	J102	A
		NC	J103	A
		NO	J103	B
2	1,2	C	J102	B
		NC	J103	C
		NO	J103	D
3	1,3	C	J102	C
		NC	J103	E
		NO	J103	F
4	1,4	C	J102	D
		NC	J103	H
		NO	J103	J
5	2,1	C	J102	E
		NC	J103	K
		NO	J103	L
6	2,2	C	J102	F
		NC	J103	M
		NO	J103	N
7	2,3	C	J102	H
		NC	J103	P
		NO	J103	R
8	2,4	C	J102	J
		NC	J103	S
		NO	J103	T
9	3,1	C	J102	K
		NC	J103	U
		NO	J103	V
10	3,2	C	J102	L
		NC	J103	W
		NO	J103	X

Table 2-1. Connector Pin Identification (Cont.)

Channel	Matrix Location	Contact	Connector	Pin
11	3,3	C	J102	M
		NC	J101	A
		NO	J101	B
12	3,4	C	J102	N
		NC	J101	C
		NO	J101	D
13	4,1	C	J102	P
		NC	J101	E
		NO	J101	F
14	4,2	C	J102	R
		NC	J101	H
		NO	J101	J
15	4,3	C	J102	S
		NC	J101	K
		NO	J101	L
16	4,4	C	J102	T
		NC	J101	M
		NO	J101	N
17	5,1	C	J102	U
		NC	J101	P
		NO	J101	R
18	5,2	C	J102	V
		NC	J101	S
		NO	J101	T
19	5,3	C	J102	W
		NC	J101	U
		NO	J101	V
20	5,4	C	J102	X
		NC	J101	W
		NO	J101	X

2.6.2 Connections Using Model 7169-MTC Cable

The Keithley Model 7169-MTC-10 (see Figure 2-6) is a 20-conductor, 10-foot cable terminated with male connectors on both ends.

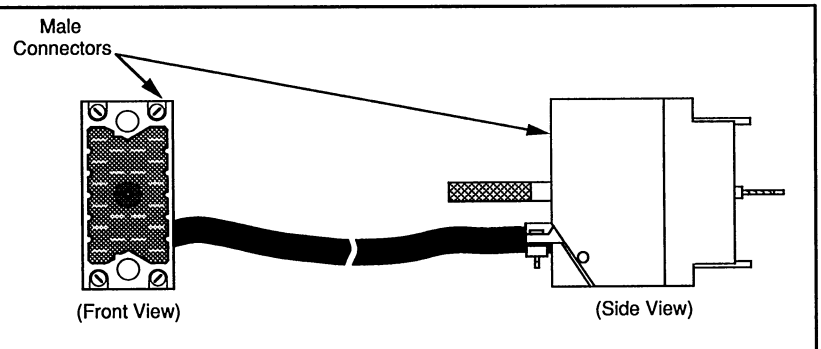


Figure 2-6. Model 7169-MTC-10

If the cable is to be used, a 7169-MTR becomes part of the user's test fixture with instrumentation and DUTs crimped directly to its terminal pins. The Model 7169-MTR is the same connector that is used on the panel of the Model 7169A. Its pins will accommodate up to #18 AWG wire.

Another way to use the cable is to remove one of the connectors (by cutting the cable). In this situation, the opposite end of the cable is mated to the switch card, while the unterminated end is hard-wired to instrumentation and DUT. Table 2-2 provides terminal identification for the cable.

When used as is, each conductor of the 10-foot Model 7169-MTC-10 cable adds approximately 700mΩ to the "contact resistance" specification of the switch card.

Table 2-2. Model 7169-MTC Conductor Identification

Pin	Conductor	Color
A	1	Black
B	2	White
C	3	Red
D	4	Green
E	5	Orange
F	6	Blue
H	7	White/Black
J	8	Red/Black
K	9	Green/Black
L	10	Orange/Black
M	11	Blue/Black
N	12	Black/White
P	13	Red/White
R	14	Green/White
S	15	Blue/White
T	16	Black/Red
U	17	White/Red
V	18	Orange/Red
W	19	Blue/Red
X	20	Red/Green

2.6.3 Shielded Cables

RFI can be generated when high voltages are switched. Shielded cables are one way to reduce the amplitude of the emissions. If a shielded cable is used along with a Model 7169-KIT to connect to the Model 7169A, the shield should be connected to earth at one end of the cable. There are no unused pins on J101, J102, and J103, so the shield must be connected externally to the connectors.

Any cabling used with the Model 7169A should have a working voltage specification of at least 500V.

2.7 MAINFRAME CONTROL OF SWITCH CARD

The information in the following paragraphs deals with programming a Model 706 mainframe to control Model 7169A switch cards. Refer to the Model 706 Instruction Manual for operation details of the mainframe.

CAUTION
The Model 7169A card can only be used in the Model 706 mainframe because the mercury wetted reed relays of the card are position sensitive. The switch card must be oriented within 30° of vertical or the pool of mercury shorts the relay contacts.

2.7.1 Selection of Matrix Mode

Using the Model 7169A switching card requires that the matrix mode be selected. To place the Model 706 in the matrix mode from the front panel, perform the following steps:

1. Select Program 6 by pressing the PRGM key and then the number 6 key.
2. Press the 0 key and then the ENTER key.

After the ENTER key is pressed, the mainframe is placed in the matrix mode of operation. With the mainframe in the matrix mode, the display format is as follows:

mmm n x

where: "mmm n" is the crosspoint assignment number.

mmm = Three-digit ID number from 001 to 250. This number identifies the mainframe and slot that the card is located in and also indicates the matrix column number.

n = Matrix row from 1 to 4.

x = Status of the relay controlled by the crosspoint assignment number. An O indicates that the relay is open, while a C indicates that the relay is closed.

Selection of matrix mode over the IEEE-488 bus is done by the following HP BASIC 4.0 statements:

```
REMOTE 718
OUTPUT 718;"A0X"
```

The first statement places a Model 706 mainframe, with an address of 18, in remote. The second statement places the mainframe in the matrix mode.

2.7.2 Crosspoint Assignments

In general, controlling the Model 7169A consists of determining the desired crosspoint assignment number and closing (or opening) the corresponding relay. Table 2-3 lists the crosspoint assignment numbers (column, row) for a card installed in the first slot of a Model 706 mainframe.

Table 2-3. Crosspoint Assignments for Card 1 in Master Mainframe

Relay Number	Channel	Column, Row
K101	1	001,1
K102	2	001,2
K103	3	001,3
K104	4	001,4
K105	5	002,1
K106	6	002,2
K107	7	002,3
K108	8	002,4
K109	9	003,1
K110	10	003,2
K111	11	003,3
K112	12	003,4
K113	13	004,1
K114	14	004,2
K115	15	004,3
K116	16	004,4
K117	17	005,1
K118	18	005,2
K119	19	005,3
K120	20	005,4

Crosspoint assignments for the remaining slots and any slave mainframes are determined by using a look-up table for the channel number and then calculating the column and row. Table 2-4 lists the channels for five Model 706 mainframes. The formulas for calculating the corresponding column and row follow:

$$\text{Column} = \text{INT}((\text{Channel} - 1) / 4) + 1$$

where: "INT" is the integer portion of the divide by four operation and "Channel" is the relay to control (see Table 2-4).

$$\text{Row} = ((\text{Channel} - 1) / \text{MOD } 4) + 1$$

where: "MOD 4" is the remainder of a divide by four operation (a modulo function) and "Channel" is the relay to control.

Table 2-4. Model 706 Channel Numbers in Matrix Mode

Card #	Master	Slave #1	Slave #2	Slave #3	Slave #4
1	01 - 20	201 - 220	401 - 420	601 - 620	801 - 820
2	21 - 40	221 - 240	421 - 440	621 - 640	821 - 840
3	41 - 60	241 - 260	441 - 460	641 - 660	841 - 860
4	61 - 80	261 - 280	461 - 480	661 - 680	861 - 880
5	81 - 100	281 - 300	481 - 500	681 - 700	881 - 900
6	101 - 120	301 - 320	501 - 520	701 - 720	901 - 920
7	121 - 140	321 - 340	521 - 540	721 - 740	921 - 940
8	141 - 160	341 - 360	541 - 560	741 - 760	941 - 960
9	161 - 180	361 - 380	561 - 580	761 - 780	961 - 980
10	181 - 200	381 - 400	581 - 600	781 - 800	981 - 1000

Example 1 — In a single mainframe system, program the Model 706 to close K120 of the card installed in slot 4.

1. From Table 2-4, it can be determined that the required channel number is 80.

2. From the channel number, calculate the column assignment:

   Column = INT ((80 – 1) / 4) + 1
   = INT (79 / 4) + 1
   = 19 + 1
   = 20

3. Also from the channel number, calculate the row assignment:

   Row = ((80 – 1) / MOD 4) + 1
   = (79 / MOD 4) + 1
   = 3 + 1
   = 4

4. Therefore, the crosspoint assignment number would be 020, 4.

From the front panel of the Model 706, use the CHANNEL key to display the crosspoint assignment number (020 4). Close the relay by pressing the CLOSE key on the mainframe.

From the IEEE-488 bus, close the relay by sending the following command:

OUTPUT 718;"C204X"

Example 2 — In a multiple mainframe system, program the Slave #2 mainframe to close K110 of the card installed in slot 8.

1. From Table 2-4, it can be determined that the required channel number is 550.
2. From the channel number, calculate the column assignment:

   Column = INT ((550 – 1) / 4) + 1
   = INT (549 / 4) + 1
   = 137 + 1
   = 138

3. Also from the channel number, calculate the row assignment:

   Row = ((550 – 1) / MOD 4) + 1
   = (549 / MOD 4) + 1

= 1 + 1
= 2

4. From the front panel of the Slave #2 mainframe, use the CHANNEL key to display the number 138 2. Close the relay by pressing the CLOSE key on the Slave #2 mainframe.

From the IEEE-488 bus, close the relay by sending the following command to the master mainframe:

OUTPUT 718;"C1382X"

2.8 REACTIVE LOADS

Since reactive loads can cause excessive currents and voltages, current surge limiting (for capacitive loads) and voltage clamping (for inductive loads) are required to prevent damage to relays and external circuitry.

2.8.1 Capacitive Loads

The surge current from a capacitive load must be <1A for the Model 7169A to protect the relays and circuit board. Figure 2-7 shows typical circuits to limit current surges. Also, consider the maximum load of 50W for the Model 7169A when determining the current limit. For example, when switching 100V with the Model 7169A, the current must be limited to:

$$I = VA/V = 50VA/100V = 500mA$$

The current limiting resistor as used in Figure 2-7A would be:

$$R = V/I = 100V/500mA = 200\Omega \text{ @ } 50W$$

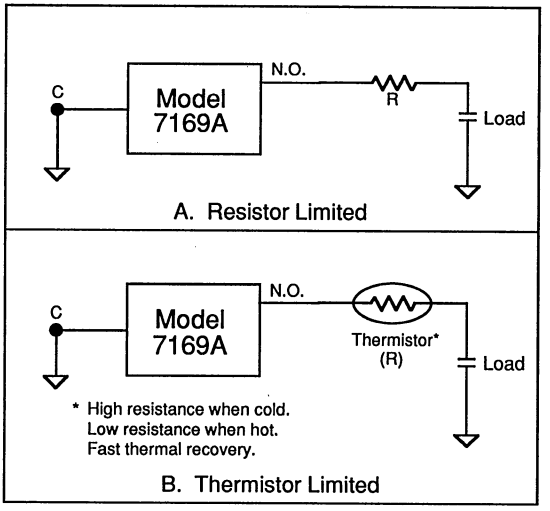


Figure 2-7. Limiting Capacitive Reaction Current

2.8.2 Inductive Loads

Inductive reaction voltage, L × (di/dt), must be less than 500V. Typical clamping circuits are shown in Figure 2-8. Also, consider the maximum load of 50W for the Model 7169A when determining the voltage limit. For example, when switching 200mA with the Model 7169A, the voltage must be limited to:

$$V = VA/I = 50W/200mA = 250V$$

The value of the voltage clamping resistor used in Figure 2-8A would be:

$$R = V/I = 250V/200mA = 1.25k\Omega \text{ @ } 50W$$

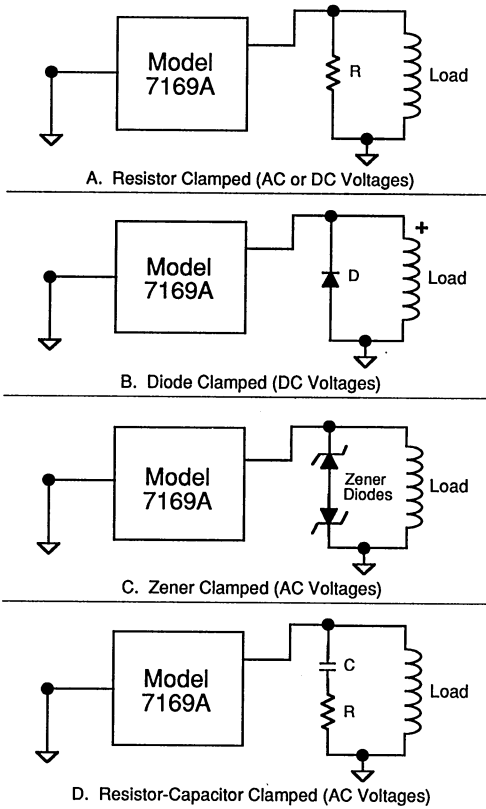


Figure 2-8. Limiting Inductive Reaction Voltage

SECTION 3
Applications

3.1 INTRODUCTION

This section provides some possible applications for the Model 7169A Switch Card and is arranged as follows:

3.2 Surface Insulation Resistance Testing: This application uses the Form C relays and on-card bus to simplify wiring for high voltage PC board insulation resistance testing.

3.3 Cable Insulation Resistance Testing: This application uses bank switching and the on-card bus to simplify insulation resistance testing of multi-conductor cables.

NOTE
The Model 7169A is connector pin compatible with the Model 7169. The Model 7169A works in all Model 706 mainframe applications that the Model 7169 does.

3.2 SURFACE INSULATION RESISTANCE TESTING

Standard test procedures for printed circuit board surface resistance testing often call for biasing and testing at a different high voltage levels. Figure 3-1 shows pairs of two relays configured for different bias and test voltage sources as well as provision for shorting the DUT to reference after testing for safety.

With both channels open, a bias voltage is applied through current limit resistor R1. Note that the factory installed jumper can be removed and replaced with R1. To apply the test voltage, channel 1 is closed and then

channel 2 is closed. After taking the test reading, channel 2 can be opened to discharge the capacitance of the DUT and cabling. Then channel 1 is opened to return to the bias condition.

Each Model 7169A allows ten DUTs to be tested using this set-up. The two on-card buses can also be used to bus the bias and test voltages so that only two external connections are needed for each source instead of two for each channel.

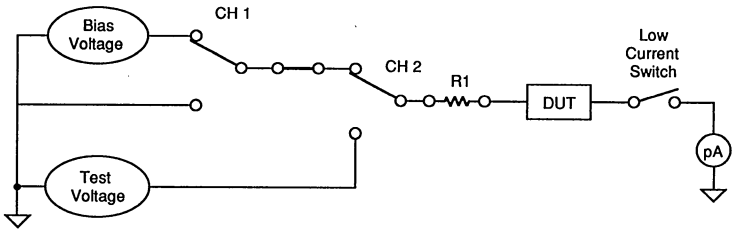


Figure 3-1. Surface Insulation Resistance Testing

3.3 CABLE INSULATION RESISTANCE TESTING

The insulation resistance of multiple conductor cables can efficiently be measured using the Model 7169A. Up to 180 conductors or pins may be tested using a Model 706 mainframe with nine Model 7169A cards and one Model 7158 low current card.

Closing a given channel will measure the insulation resistance from all other channels to that channel. Bias voltage is controlled by the V-source output. Bias time is set by the delay time from one channel closure to the next. Another programmable V-source would allow for automated changes in test voltage. This would not be necessary if the bias and test voltages are the same.

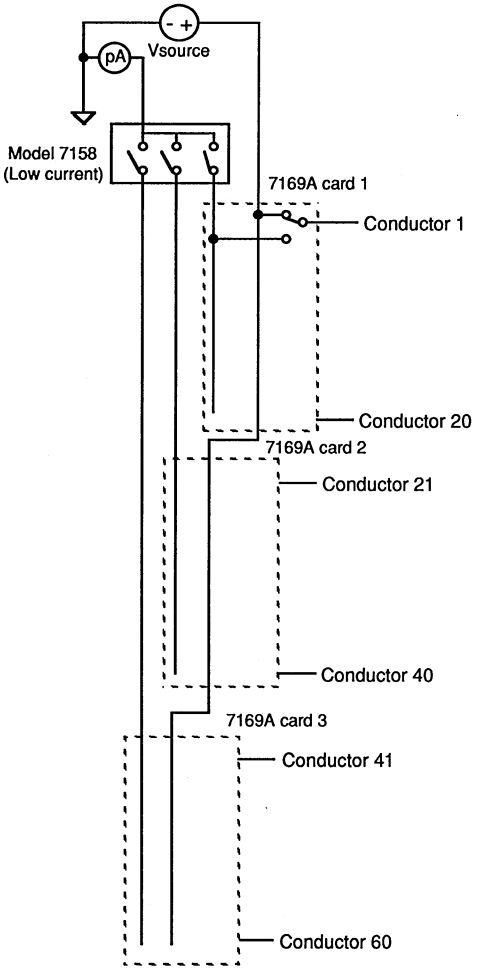


Figure 3-2. Cable Insulation Resistance Testing

SECTION 4
Service Information

4.1 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.

This section contains information necessary to service the Model 7169A and is arranged as follows:

4.2 **Handling and Cleaning Precautions:** Discusses handling procedures and cleaning methods for the switch card.

4.3 **Card Installation and Removal:** Describes the installation and removal of the card in a Model 706 mainframe.

4.4 **Performance Verification:** Covers the procedures necessary to determine if the card is operating properly.

4.2 HANDLING AND CLEANING PRECAUTIONS

Because of the high impedance circuits on the Model 7169A, care should be taken when handling or servicing the card to prevent possible contamination, which could degrade performance. The following precautions should be taken when handling and cleaning the switch card.

1. 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 card if necessary.

2. Handle the card only by the side edges. Do not touch any board surfaces or components associated with the repair. When servicing the card, wear clean, cotton gloves.
3. When making repairs on the circuit board, use aqua core solder and OA-based (organic activated) flux. Use warm 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, blow dry the board with dry nitrogen gas.
4. After cleaning, the card should be placed in a 50°C low humidity environment for several hours.

4.3 CARD INSTALLATION AND REMOVAL

The following procedures explain how to install and remove the Model 7169A switch card with the Model 706 mainframe.

WARNING
To prevent electrical shock which could result in injury or death, turn off the mainframe power and disconnect the line cord before installing or removing cards. Also ensure no voltage is applied from user circuits.

CAUTION
Contamination will degrade the performance of the switch card. To avoid contamination, always grasp the card by the side edges. Do not touch the board surfaces or components.

CAUTION
The mercury wetted reed relays of the Model 7169A are position sensitive. The switch card must be oriented within 30° of vertical or the pool of mercury shorts the relay contacts. The Model 7169A card can only be used in the Model 706 mainframe. The Model 706 cannot be used on its side.

CAUTION
To prevent possible shorting of relay contacts (and causing unintended operation of external circuitry), make cable

connections to the Model 7169A only when it is installed in a Model 706 mainframe.

4.3.1 Switch Card Installation

Perform the following procedure to install the Model 7169A switch card in the Model 706 mainframe. Refer to Figure 4-1.

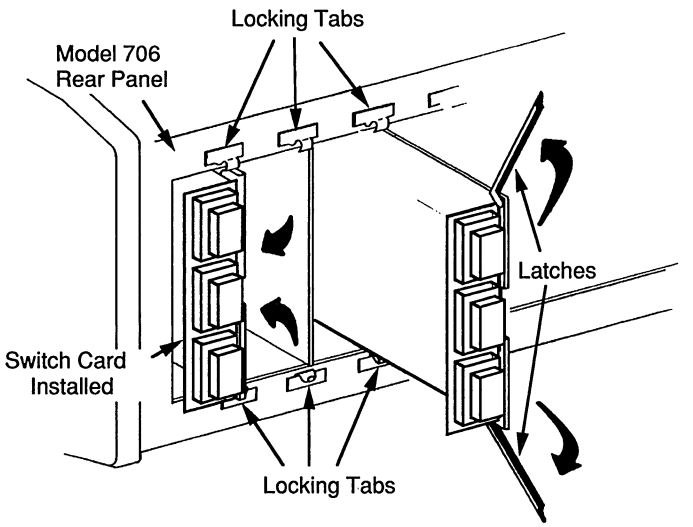


Figure 4-1. Card Installation in Model 706

1. Slide the card into the desired slot as shown in the appropriate illustration. Make sure the card edges of the board are properly aligned with the grooves in the receptacle.
2. Once the card is almost all the way in the slot, and you encounter resistance, push firmly on the edge of the card to seat it in the edge connector.
3. Once the card is fully seated, lock the card in place by placing the latches in the locked position.

WARNING

The latches must be firmly locked to ensure a proper chassis ground connection between the card and mainframe. Failure to secure this connection may result in personal injury or death due to electric shock.

4.3.2 Switch Card Removal

To remove the switch card, first remove all cables. Then unlock the card by pulling the latches outward, grasping the end of the card at the edges, and pulling the card out of the scanner mainframe.

4.4 PERFORMANCE VERIFICATION

The following paragraphs discuss performance verification procedures for the Model 7169A, including isolation and path resistance. The performance verification procedures should be performed with the switch card installed in the Model 706 mainframe to protect it from contamination and allow it to operate in its normal environment.

CAUTION

Contamination will degrade the performance of the scanner card. To avoid contamination, always grasp the card by the side edges. Do not touch the board surfaces or components.

NOTE

Failure of any performance verification test may indicate that the switch card is contaminated. See paragraph 4.2 to clean the card.

4.4.1 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%.

4.4.2 Recommended Equipment

Table 4-1 summarizes the equipment necessary for performance verification, along with an application for each unit.

Table 4-1. Verification Equipment

Description	Model	Specifications	Application
Electrometer	Keithley 617	100nA; 0.25% 100V Source; 0.2%	Isolation
DMM	Keithley 196	300Ω; 0.01%	Path resistance
Male Connector	Keithley 7169-KIT	—	Connections to card

4.4.3 Connector Preparation

For the test procedures, a connector (7169-KIT) is used to make circuit connections to the switch card. These connectors are available as an accessory.

Prepare three 7169-KIT connectors as follows:

1. Using clean #18-24 AWG copper wire, crimp wires to all of the terminals. Each wire should be approximately six inches long.
2. Insert each terminal into a connector, LABELING the wire with the pin location letter.
3. Assemble the connector body.
4. Mate the three connectors to J101, J102 and J103 on the Model 7169A.

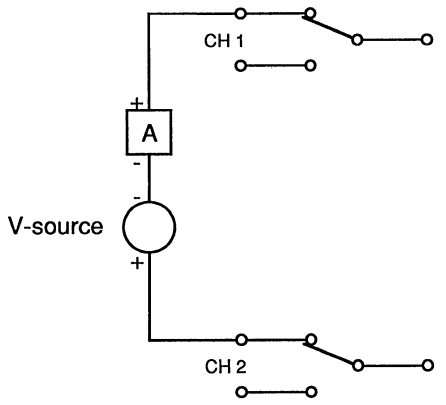
4.4.4 Channel Isolation Tests

These tests check the resistance (isolation) between two channels. In general, the test is performed by applying a voltage (+100V) across two channels, 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 both a voltage source and a picoammeter. In the V/I function, the Model 617 internally calculates the resistance from the known voltage and measured current levels and displays the resistance value.

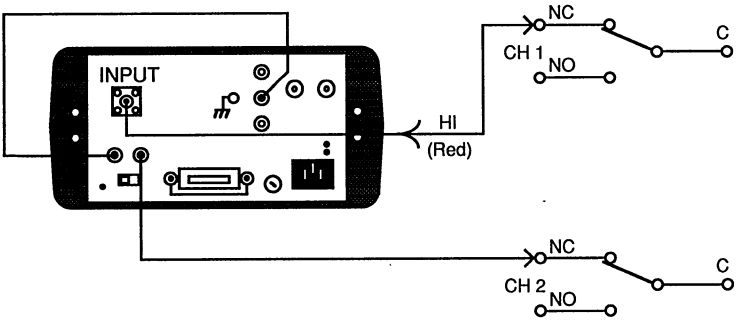
Referring to Figure 4-2, perform the following procedure to check channel isolation:

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

1. Using Table 4-2 to identify switch card terminals, connect the Model 617 to the card as shown in Figure 4-2.
2. 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.
3. 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.
4. Place the Model 617 in the V/I measurement function by pressing SHIFT OHMS.
5. On the Model 617, press OPERATE to source 100V and then disable zero check.
6. After allowing the reading on the Model 617 to settle, verify that it is >1GΩ.
7. Enable zero check on the Model 617 and then place it in standby.
8. Connect the electrometer input HI lead to channel 3 of the switch card.
9. Repeat steps 5 through 8.
10. Repeat the basic procedure in steps 8 and 9 for channels 4 through 20.



Equivalent Circuit



NOTE : Setup shown is configured to test isolation between channels 1 and 2.

Figure 4-2. Channel Isolation

Table 4-2. Connector Pin Identification

Channel	Contact	Connector	Pin
1	C	J102	A
	NC	J103	A
	NO	J103	B
2	C	J102	B
	NC	J103	C
	NO	J103	D
3	C	J102	C
	NC	J103	E
	NO	J103	F
4	C	J102	D
	NC	J103	H
	NO	J103	J
5	C	J102	E
	NC	J103	K
	NO	J103	L
6	C	J102	F
	NC	J103	M
	NO	J103	N
7	C	J102	H
	NC	J103	P
	NO	J103	R
8	C	J102	J
	NC	J103	S
	NO	J103	T
9	C	J102	K
	NC	J103	U
	NO	J103	V
10	C	J102	L
	NC	J103	W
	NO	J103	X
11	C	J102	M
	NC	J101	A
	NO	J101	B
12	C	J102	N
	NC	J101	C
	NO	J101	D

Table 4-2. Connector Pin Identification (Cont.)

Channel	Contact	Connector	Pin
13	C	J102	P
	NC	J101	E
	NO	J101	F
14	C	J102	R
	NC	J101	H
	NO	J101	J
15	C	J102	S
	NC	J101	K
	NO	J101	L
16	C	J102	T
	NC	J101	M
	NO	J101	N
17	C	J102	U
	NC	J101	P
	NO	J101	R
18	C	J102	V
	NC	J101	S
	NO	J101	T
19	C	J102	W
	NC	J101	U
	NO	J101	V
20	C	J102	X
	NC	J101	W
	NO	J101	X

4.4.5 Input Isolation Tests

These tests check the resistance (isolation) between the N.C. and N.O. terminals of every switch card 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 measured current levels and displays the resistance value.

Referring to Figure 4-3, perform the following procedure to check differential input isolation:

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

1. Using Table 4-2 to identify switch card terminals, connect the Model 617 to the switch card as shown in Figure 4-3.
2. 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.
3. 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.
4. Place the Model 617 in the V/I measurement function by pressing SHIFT OHMS.
5. On the Model 617, press OPERATE to source 100V and then disable zero check.
6. After allowing the reading on the Model 617 to settle, verify that it is >1GΩ.
7. Enable zero check on the Model 617 and then place it in standby.
8. Connect the electrometer Input HI lead to channel 1 N.O. of the switch card, and connect V-Source HI channel 1 COMMON.
9. Repeat the basic procedure in steps 5 through 8 for channels 2 through 20.

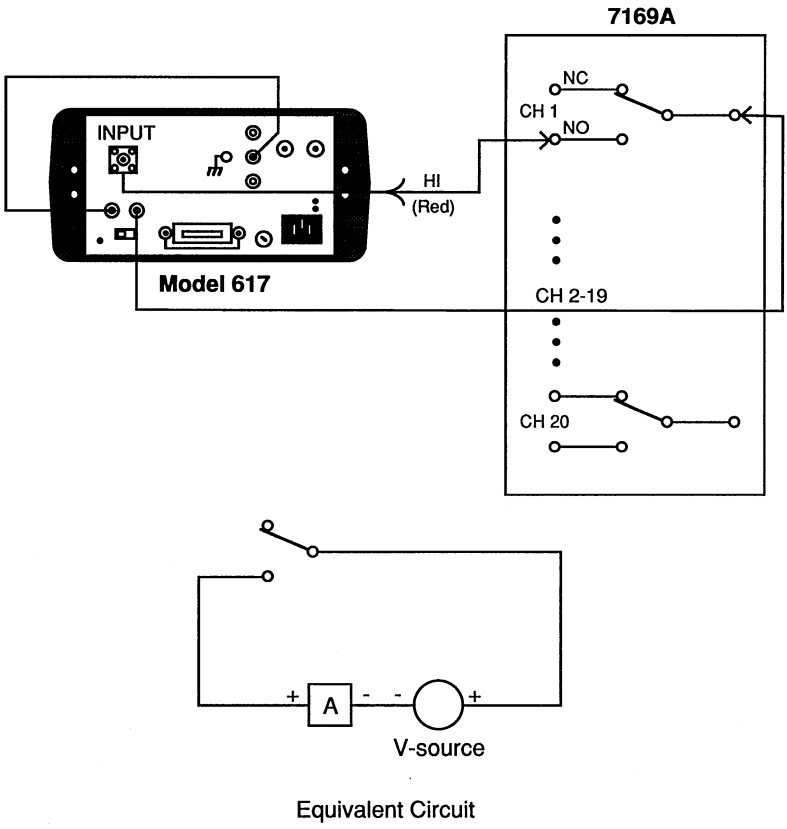


Figure 4-3. Input Isolation

4.4.6 Path Resistance Tests

Referring to Figure 4-4, perform the following steps to verify that the contacts of each relay are closing properly and the resistance is within specification.

1. Connect the Kelvin clip leads to the input of the Model 196 as shown in Figure 4-4 and select the 300Ω range.
2. Short the Kelvin clip leads together and zero the Model 196. Leave zero enabled for the entire test.
3. Using Table 4-2 to identify switch card terminals, connect the Model 196 to the switch card.
4. With the scanner in the step mode, close channel 1 (0,1). The reading on the Model 196 should be <2Ω (0.2Ω typical).
5. Open channel 1 and verify that the Model 196 indicates an open circuit (> 300MΩ).
6. Move one lead from N.O to N.C. The reading on the 196 should be <2Ω (0.2Ω typical).
7. Repeat the basic procedure of steps 3 through 6 to test path resistance of N.O. and N.C. of channels 2 through 10.

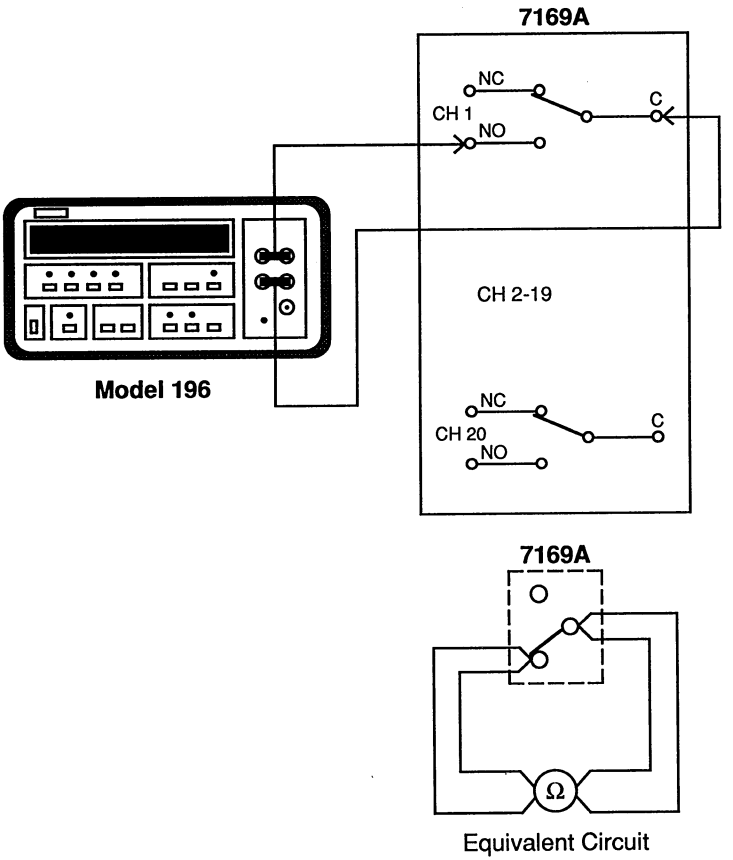


Figure 4-4. Path Resistance

SECTION 5
Replaceable Parts

5.1 INTRODUCTION

This section contains a list of replaceable electrical and mechanical parts for the Model 7169A, as well as a component layout drawing and schematic diagram of the card.

5.2 PARTS LISTS

Electrical parts are listed in order of circuit designation in Table 5-1. Table 5-2 summarizes miscellaneous parts.

5.3 ORDERING INFORMATION

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

1. Switch card model number (7169A)
2. Card serial number
3. Part description
4. Circuit description, if applicable
5. Keithley part number

5.4 FACTORY SERVICE

If the switch 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 DEPARTMENT on the shipping label.

NOTE
Do not return the scanner mainframe with the card.

5.5 COMPONENT LAYOUT AND SCHEMATIC DIAGRAM

Figure 5-1 shows a component layout of the Model 7169A, while Figure 5-2 shows a schematic diagram.

Table 5-1. Model 7169A, Part List

Circuit Desig.	Description	Keithley Part No.
C101,102,104	CAP,.1UF,20%,50V,CERAMIC	C-365-.1
C103	CAP,22UF,-20+100%,25V,ALUM ELEC	C-314-22
C105	CAP, 10UF,-20+100%,25V,ALUM ELEC	C-314-10
CR101-113	DIODE,SILICON,IN4148 (DO-35)	RF-28
E101	BEAD, FERRITE	CT-9
K101-120	RELAY, REED	RL-161
R101	RES, 40.2K, 1%, 1/8W, METAL FILM	R-88-40.2K
U101	IC, 8 STAGE SHIFT/STORE UCN5841	IC-536
U102	IC,DUAL D-TYPE FLIP FLOP,74HC74	IC-337
W101-120	JUMPER	J-15

Table 5-2. Model 7169 Miscellaneous, Part List

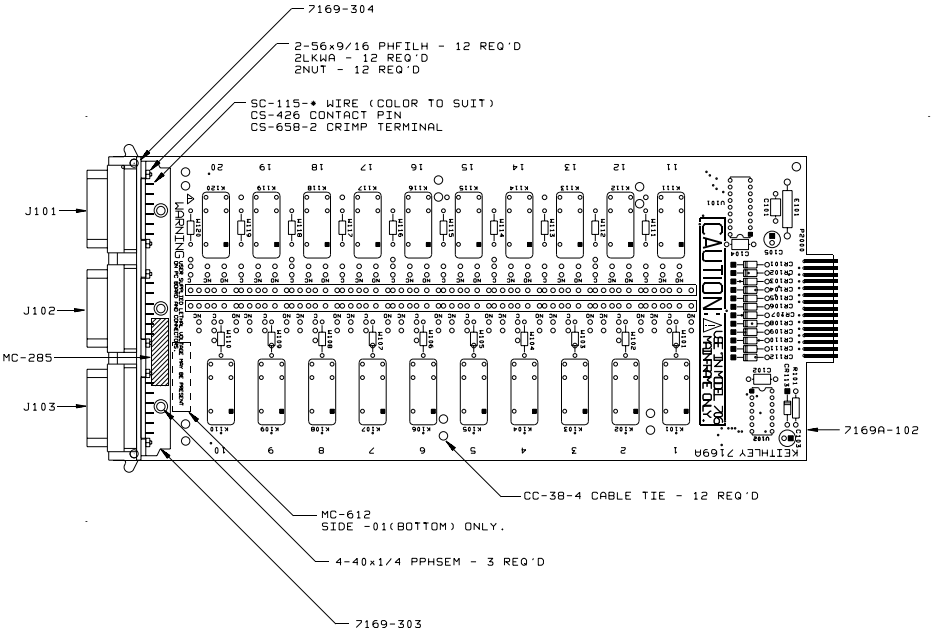
Quantity	Description	Keithley Part No.
1	BRACKET, REAR PANEL	7169-303
14	CABLE CLAMP	CC-38-4
3	CONNECTOR	CS-425
60	CONNECTOR	CS-658-2
	CONTACT PIN	CS-426-1
2	HANDLE	FA-119
1	PANEL, REAR	7169-304
2	RIVET	FA-121

NO. 7169A-100

LTR.	ECO NO.	REVISION	ENG.	DATE
A	911202	RELEASED	MS	12/2/91
B	15029	REVISED	MS	1/8/92
B1	15083	CHG'D SILK	SZ	1/30/99

7169A PANEL PIN-OUT

RELAY # (KXXX)	"CHANNEL"	MATRIX LOCATION	CONTACT	CONNECTOR	PIN
1	1	1,1	C NC NO	J102 J103 J103	A A B
2	2	1,2	C NC NO	J102 J103 J103	B C D
3	3	1,3	C NC NO	J102 J103 J103	C E F
4	4	1,4	C NC NO	J102 J103 J103	D H J
5	5	2,1	C NC NO	J102 J103 J103	E K L
6	6	2,2	C NC NO	J102 J103 J103	F M N
7	7	2,3	C NC NO	J102 J103 J103	H P R
8	8	2,4	C NC NO	J102 J103 J103	J S T
9	9	3,1	C NC NO	J102 J103 J103	K U V
10	10	3,2	C NC NO	J102 J103 J103	L W X
11	11	3,3	C NC NO	J102 J101 J101	M A B
12	12	3,4	C NC NO	J102 J101 J101	N C D
13	13	4,1	C NC NO	J102 J101 J101	P E F
14	14	4,2	C NC NO	J102 J101 J101	R H J
15	15	4,3	C NC NO	J102 J101 J101	S K L
16	16	4,4	C NC NO	J102 J101 J101	T M N
17	17	5,1	C NC NO	J102 J101 J101	U P R
18	18	5,2	C NC NO	J102 J101 J101	V S T
19	19	5,3	C NC NO	J102 J101 J101	W U V
20	20	5,4	C NC NO	J102 J101 J101	X W X



NOTE:
FOR COMPONENT INFORMATION
REFER TO PRODUCT STRUCTURE.

MODEL	NEXT ASSEMBLY	QTY.
USED ON		

DO NOT SCALE THIS DRAWING

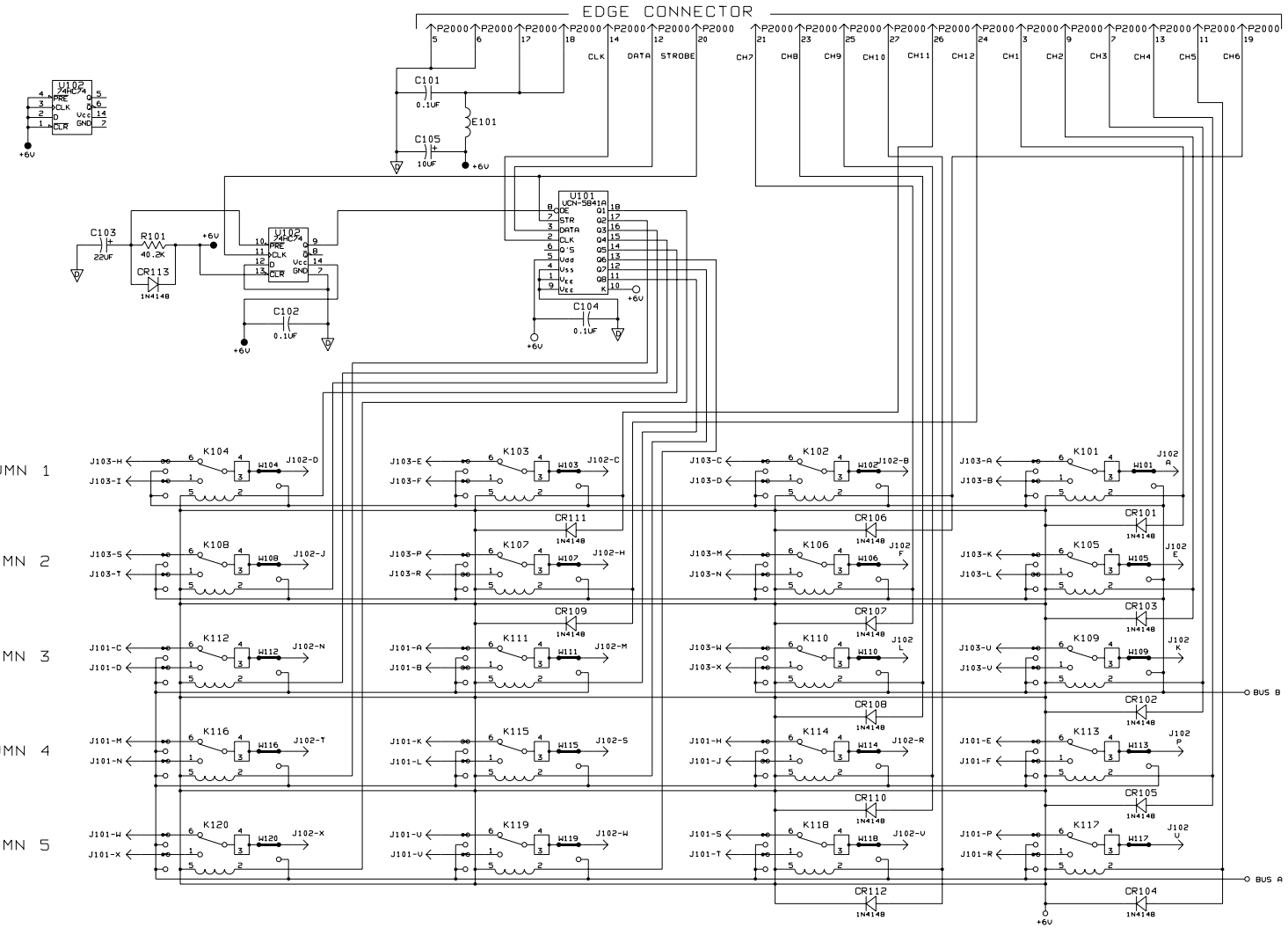
DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED
XX=±.015 ANG.=±1°
XXX=±.005 FRAC.=±1/64
SURFACE MAX. 63

DATE 11/20/91 SCALE 1:1
DRN. MAH ENG. APPR. P.S.
MATERIAL
FINISH

TITLE COMPONENT LAYOUT, 20 FORM-C SWITCH CARD

KEITHLEY INSTRUMENTS INC.
CLEVELAND, OHIO 44139

C NO. 7169A-100



KEITHLEY

KEITHLEY INSTRUMENTS INC.
CLEVELAND,OHIO 44139

TITLE

SCHEMATIC
20 FORM-C SWITCH CARD

SIZE	MODEL	NO	ECO	REV
D	7169A	7169A-106	15029	B

DRAWN	APPROVED	DATE
MAH	JSD 1/6/92 MS	1/2/92

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
- ❑ IEEE failure
- ❑ Front panel operational
- ❑ Analog output follows display
- ❑ Obvious problem on power-up
- ❑ All ranges or functions are bad
- ❑ Particular range or function bad; specify _____
- ❑ Batteries and fuses are OK
- ❑ Checked all cables

Display or output (check one)

- ❑ Drifts
- ❑ Unstable
- ❑ Overload
- ❑ Unable to zero
- ❑ Will not read applied input

- ❑ Calibration only
- ❑ Data required
- ❑ Certificate of calibration 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.

Specifications are subject to change without notice.

KEITHLEY

Keithley Instruments, Inc. 28775 Aurora Road • Cleveland, Ohio 44139
440-248-0400 • Fax: 440-248-6168
1-888-KEITHLEY (534-8453) www.keithley.com

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