

# **Model 7169 General Purpose Scanner Card**

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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. 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 instrument, transportation prepaid, to the indicated service facility. Repairs will be made and the instrument returned, transportation prepaid. Repaired products are warranted for the balance of the original warranty period, or at least 90 days.

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This warranty is in lieu of all other warranties, expressed or implied, including any implied warranty of merchantability or fitness for a particular use. Keithley Instruments, Inc. shall not be liable for any indirect, special or consequential damages.

## STATEMENT OF CALIBRATION

This instrument has been inspected and tested in accordance with specifications published by Keithley Instruments, Inc.

The accuracy and calibration of this instrument are traceable to the National Bureau of Standards through equipment which is calibrated at planned intervals by comparison to certified standards maintained in the Laboratories of Keithley Instruments, Inc.



Keithley Instruments, Inc. • 28775 Aurora Road • Cleveland, OH 44139 • 440-248-0400 • Fax: 440-248-6168 • <http://www.keithley.com>

**CHINA:** Keithley Instruments China • Yuan Chen Xin Building, Room 705 • 12 Yumin Road, Dewai, Madian • Beijing 100029 • 8610-62022886 • Fax: 8610-62022892  
**FRANCE:** Keithley Instruments SAREL • BP 60 • 3 Allée des Garays • 91122 Palaiseau Cédex • 33-1-60-11-51-55 • Fax: 33-1-60-11-77-26  
**GERMANY:** Keithley Instruments GmbH • Landsberger Strasse 65 • D-82110 Germering, Munich • 49-89-8493070 • Fax: 49-89-84930759  
**GREAT BRITAIN:** Keithley Instruments, Ltd. • The Minster • 58 Portman Road • Reading, Berkshire, England RG3 1EA • 44-1189-596469 • Fax: 44-1189-575666  
**ITALY:** Keithley Instruments SRL • Viale S. Gimignano 38 • 20146 Milano • 39-2-48303003 • Fax: 39-2-48302274  
**NETHERLANDS:** Keithley Instruments BV • Avelingen West 49 • 4202 MS Gorinchem • 31-(0)183-635333 • Fax: 31-(0)183-630821  
**SWITZERLAND:** Keithley Instruments SA • Kriesbachstrasse 4 • 8600 Dübendorf • 41-1-8219444 • Fax: 41-1-8203081  
**TAIWAN:** Keithley Instruments Taiwan • IFL, 85 Po Ai Street • Hsinchu, Taiwan • 886-3-572-9077 • Fax: 886-3-572-9011

Model 7169  
General Purpose Scanner Card  
Instruction Manual

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# SAFETY PRECAUTIONS

The following safety precautions should be observed before using the Model 7169 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.

## Model 7169 20 Form C Switch Card

**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.

**CONNECTOR TYPE:** 3 × 20 pin mass termination.

**RELAY DRIVE CURRENT:** 30mA per relay typical.

**MAXIMUM SIGNAL LEVEL:** 500V peak, 0.5A rms switched, 1A rms carry, 10W (resistive load only).

**CONTACT LIFE:**  $>10^8$  closures cold switching;  $>10^7$  closures at maximum signal levels.

**CONTACT RESISTANCE:**  $<2\Omega$  to rated life.

**CONTACT POTENTIAL:**  $<30\mu\text{V}$ , C to NO or NC.

**ACTUATION TIME:**  $<1\text{msec.}$ , exclusive of mainframe.

**CHANNEL ISOLATION:**  $>10^9\Omega$ ,  $<150\text{pF}$ .

**INPUT ISOLATION:**  $>10^9\Omega$ ,  $<150\text{pF}$ .

**COMMON MODE VOLTAGE:** 500V peak.

**OPERATING ENVIRONMENT:**  $0^\circ$  to  $55^\circ\text{C}$ , up to  $35^\circ\text{C}$  at 70% RH.

**STORAGE ENVIRONMENT:**  $-25^\circ$  to  $65^\circ\text{C}$ .

**DIMENSIONS, WEIGHT:** 32mm high × 114mm wide × 272mm long (1.25 in. × 4.5 in. × 10.75 in.). Net weight 0.54 kg (19 oz.).

Specifications subject to change without notice.

# Table of Contents

---

## SECTION 1 — General Information

|       |                                    |     |
|-------|------------------------------------|-----|
| 1.1   | INTRODUCTION . . . . .             | 1-1 |
| 1.2   | WARRANTY INFORMATION . . . . .     | 1-1 |
| 1.3   | MANUAL ADDENDA . . . . .           | 1-1 |
| 1.4   | SAFETY SYMBOLS AND TERMS . . . . . | 1-2 |
| 1.5   | SPECIFICATIONS . . . . .           | 1-2 |
| 1.6   | UNPACKING AND INSPECTION . . . . . | 1-2 |
| 1.6.1 | Inspection for Damage . . . . .    | 1-2 |
| 1.6.2 | Shipping Contents . . . . .        | 1-3 |
| 1.6.3 | Instruction Manual . . . . .       | 1-3 |
| 1.7   | REPACKING FOR SHIPMENT . . . . .   | 1-3 |
| 1.8   | OPTIONAL ACCESSORIES . . . . .     | 1-3 |

## SECTION 2 — Operation

|       |  |      |
|-------|--|------|
| 2.1   | INTRODUCTION . . . . .                           | 2-1  |
| 2.2   | HANDLING PRECAUTIONS . . . . .                   | 2-1  |
| 2.3   | EQUIVALENT CIRCUIT . . . . .                     | 2-2  |
| 2.4   | MULTI-CARD CONFIGURATIONS . . . . .              | 2-2  |
| 2.5   | CONNECTIONS . . . . .                            | 2-6  |
| 2.5.1 | Connections Using Model 7169-KIT . . . . .       | 2-6  |
| 2.5.2 | Connections Using Model 7169-MTC Cable . . . . . | 2-10 |
| 2.5.3 | Shielded Cables . . . . .                        | 2-12 |
| 2.6   | CARD INSTALLATION AND REMOVAL . . . . .          | 2-12 |
| 2.6.1 | Scanner Card Installation . . . . .              | 2-12 |
| 2.6.2 | Scanner Card Removal . . . . .                   | 2-14 |
| 2.7   | MAINFRAME CONTROL OF SCANNER CARD . . . . .      | 2-14 |
| 2.7.1 | Matrix Mode . . . . .                            | 2-14 |
| 2.7.2 | Multi-Channel Systems . . . . .                  | 2-18 |
| 2.7.3 | Scanner Switching Control . . . . .              | 2-18 |
| 2.7.4 | Reactive Loads . . . . .                         | 2-19 |

## **SECTION 3 — Applications**

|     |                                  |     |
|-----|----------------------------------|-----|
| 3.1 | INTRODUCTION .....               | 3-1 |
| 3.2 | COUPON TESTING .....             | 3-1 |
| 3.3 | CABLING INSULATION TESTING ..... | 3-2 |

## **SECTION 4 — Service Information**

|       |                                      |      |
|-------|--------------------------------------|------|
| 4.1   | INTRODUCTION .....                   | 4-1  |
| 4.2   | HANDLING AND CLEANING PRECAUTIONS .. | 4-1  |
| 4.3   | PERFORMANCE VERIFICATION .....       | 4-2  |
| 4.3.1 | Environmental Conditions .....       | 4-2  |
| 4.3.2 | Recommended Equipment .....          | 4-2  |
| 4.3.3 | Connector Preparation .....          | 4-2  |
| 4.3.4 | Channel Isolation Tests .....        | 4-3  |
| 4.3.5 | Input Isolation Tests .....          | 4-8  |
| 4.3.6 | Path Resistance Tests .....          | 4-10 |

## **SECTION 5 — Replaceable Parts**

|     |   |     |
|-----|---|-----|
| 5.1 | INTRODUCTION .....                              | 5-1 |
| 5.2 | PARTS LISTS .....                               | 5-1 |
| 5.3 | ORDERING INFORMATION .....                      | 5-1 |
| 5.4 | FACTORY SERVICE .....                           | 5-1 |
| 5.5 | COMPONENT LAYOUT AND SCHEMATIC<br>DIAGRAM ..... | 5-2 |



# List of Illustrations

---

## SECTION 2 — Operation

|             |  |      |
|-------------|--|------|
| Figure 2-1  | Model 7169 Simplified Schematic . . . . .                                    | 2-2  |
| Figure 2-2  | Multi-Card Configuration . . . . .   | 2-4  |
| Figure 2-3  | Separate Outputs Configuration . . . . .                                     | 2-5  |
| Figure 2-4  | Connectors on Scanner Card<br>(Pin Side Shown) . . . . .                     | 2-6  |
| Figure 2-5  | Female Connector Pin Identification<br>(Terminal Crimp Side Shown) . . . . . | 2-7  |
| Figure 2-6  | Model 7169-MTC-10 . . . . .  | 2-10 |
| Figure 2-7  | Card Installation in Model 705 . . . . .                                     | 2-13 |
| Figure 2-8  | Card Installation in Model 706 . . . . .                                     | 2-14 |
| Figure 2-9  | Limiting Capacitive Reaction Current . . . . .                               | 2-19 |
| Figure 2-10 | Limiting Inductive Reaction Voltage . . . . .                                | 2-21 |

## SECTION 3 — Applications

|            |  |     |
|------------|--|-----|
| Figure 3-1 | Coupon Insulation Resistance Testing . . . . . | 3-2 |
| Figure 3-2 | Cabling Insulation Testing . . . . .           | 3-3 |

## SECTION 4 — Service Information

|            |                             |      |
|------------|-----------------------------|------|
| Figure 4-1 | Channel Isolation . . . . . | 4-5  |
| Figure 4-2 | Input Isolation . . . . .   | 4-9  |
| Figure 4-3 | Path Resistance . . . . .   | 4-11 |

# List of Tables

---

## SECTION 2 — Operation

|           |   |      |
|-----------|---|------|
| Table 2-1 | Connector Pin Identification . . . . .                          | 2-8  |
| Table 2-2 | Model 7169-MTC Conductor Identification                         | 2-11 |
| Table 2-3 | Scanner Control of Model 7169 Matrix<br>Mode (0-Pole) . . . . . | 2-16 |
| Table 2-4 | Model 705 Channel Assignments in 0-Pole<br>Mode . . . . .       | 2-18 |

## SECTION 4 — Service Information

|           |  |     |
|-----------|--|-----|
| Table 4-1 | Verification Equipment . . . . .       | 4-3 |
| Table 4-2 | Connector Pin Identification . . . . . | 4-6 |

# **SECTION 1**

## **General Information**

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### **1.1 INTRODUCTION**

This section contains general information about the Model 7169 General Purpose Scanner Card.

#### **1.2 Warranty Information**

#### **1.3 Manual Addenda**

#### **1.4 Safety Symbols and Terms**

#### **1.5 Specifications**

#### **1.6 Unpacking and Inspection**

#### **1.7 Repacking for Shipment**

#### **1.8 Optional Accessories**

### **1.2 WARRANTY INFORMATION**


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

## **1.5 SPECIFICATIONS**

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

## **1.6 UNPACKING AND INSPECTION**

### **1.6.1 Inspection for Damage**

The Model 7169 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 7169 order:

- Model 7169 Scanner Card
- Model 7169 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 7169-901-00. The manual package includes an instruction manual and any pertinent addenda.

## **1.7 REPACKING FOR SHIPMENT**

Should it become necessary to return the Model 7169 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 scanner 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 7169:

**SECTION 1**  
*General Information*

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

**Model 7169-KIT** — The Model 7169-KIT mates to the scanner card connectors.

**Model 7169-MTR** — The Model 7169-MTR is a bulkhead mount connector that mates to the Model 7169-MTC-10.

# SECTION 2

## Operation

---

### 2.1 INTRODUCTION

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

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

**2.3 Equivalent Circuit:** Provides the simplified scanner card circuit for the Model 7169.

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

**2.5 Connections:** Explains the various methods and techniques that can be used to make connections to the scanner card.

**2.6 Card Installation and Removal:** Covers the basic procedure for installing and removing the card from the scanner mainframe.

**2.7 Mainframe Control of Scanner Card:** Covers operating aspects specific to the Model 7169.

### 2.2 HANDLING PRECAUTIONS

To maintain high impedance isolation, care should be taken when handling the scanner 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 mainframe, keep the card in the bag and store in the original packing carton.

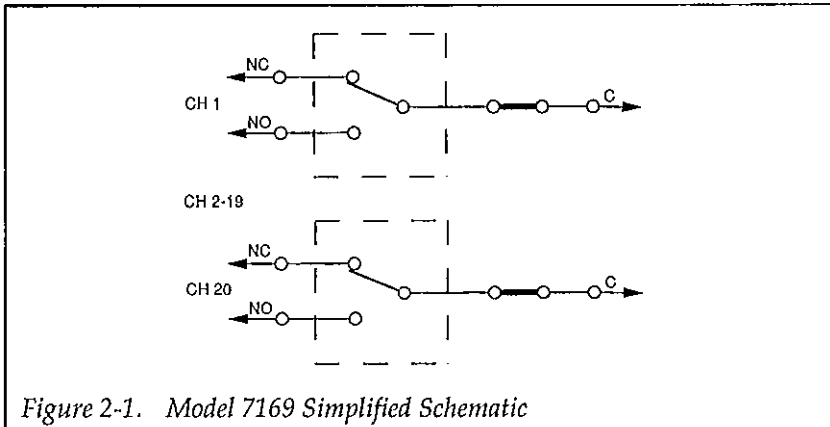
Dirt build-up over a period of time is another possible source of contamination. To avoid this problem, operate the mainframe and scanner card only in a clean environment.

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

### **2.3 EQUIVALENT CIRCUIT**

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

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 7169 Simplified Schematic*

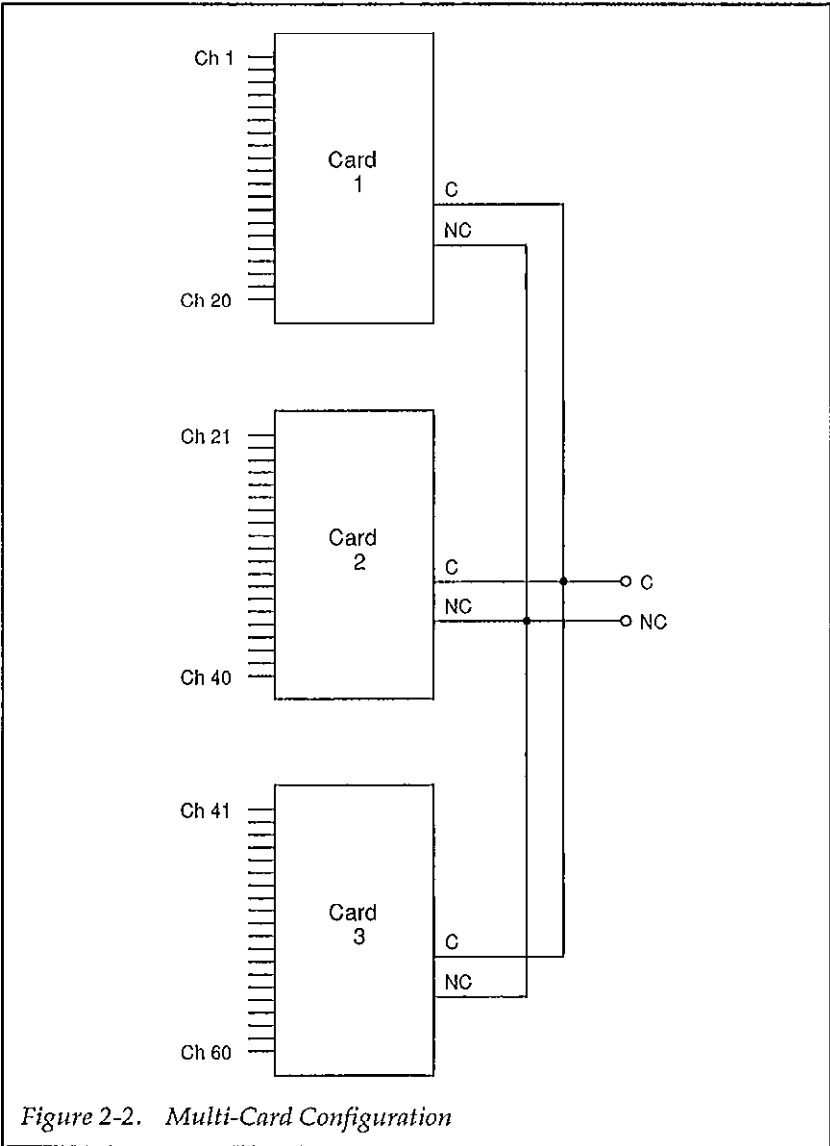
### **2.4 MULTI-CARD CONFIGURATIONS**

Typically, multi-card systems are configured by connecting one or more of the terminal blocks of all the scanner 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*

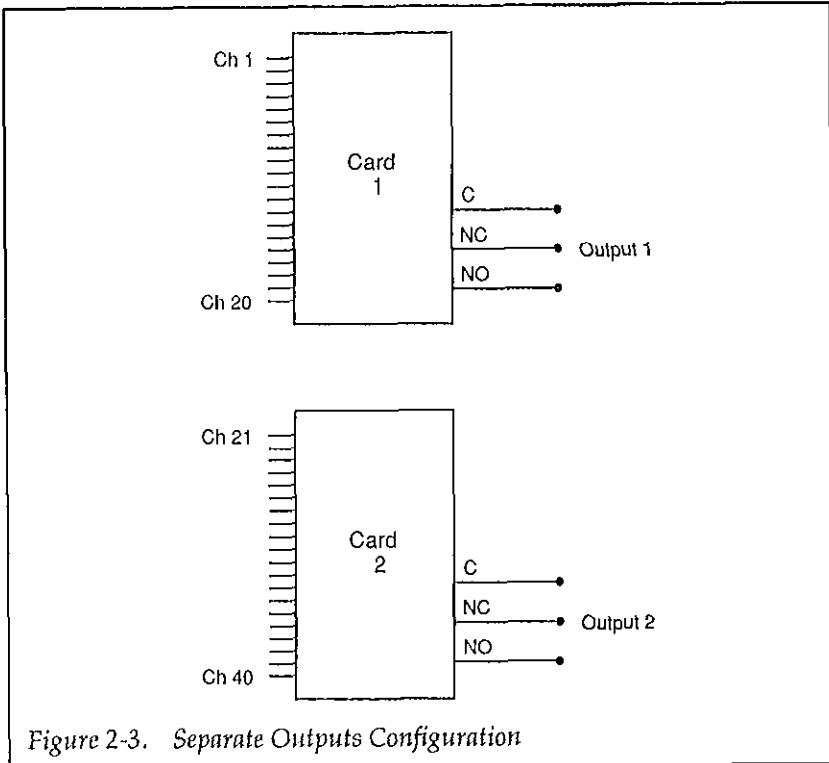


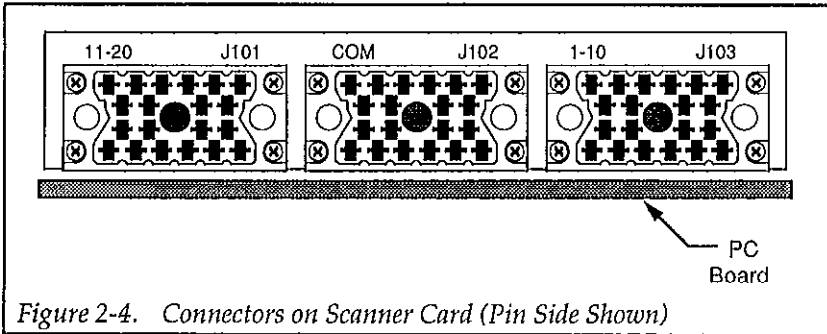
Figure 2-3. Separate Outputs Configuration

## 2.5 CONNECTIONS

### 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.

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



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

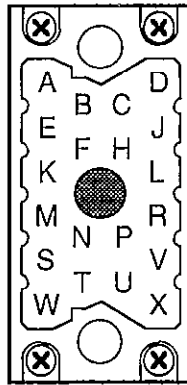
The following procedure explains how to mate the connector to the Model 7169.

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.

### 2.5.1 Connections Using Model 7169-KIT

The Model 7169-KIT is a connector that mates to the connector on the back panel of the Model 7169. 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 scanner card terminals.



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

**Table 2-1. Connector Pin Identification**

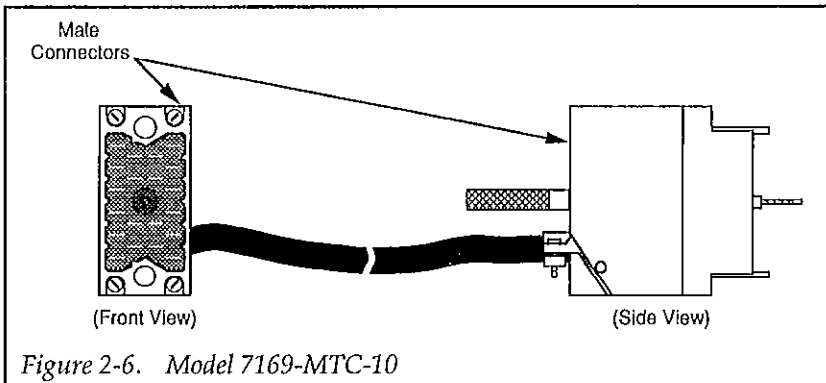
| Channel | Matrix Location | Contact | Connector | Pin |
|---------|-----------------|---------|-----------|-----|
| 1       | 1,1             | C       | J102      | A   |
|         |                 | NC      | J103      | A   |
|         |                 | NO      | J103      | B   |
| 2       | 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   |
| 11      | 3,3             | C       | J102      | M   |
|         |                 | NC      | J101      | A   |
|         |                 | NO      | J101      | B   |
| 12      | 3,4             | C       | J102      | N   |
|         |                 | NC      | J101      | C   |
|         |                 | NO      | J101      | D   |

**Connector Pin Identification**

| Channel | Matrix Location | Contact | Connector | Pin |
|---------|-----------------|---------|-----------|-----|
| 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   |

## 2.5.2 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.



If the cable is going 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 7169. 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 scanner 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 700m $\Omega$  to the "contact resistance" specification of the scanner card.



**Table 2-2. Model 7169-MTC Conductor Identification**

| <b>Pin</b> | <b>Conductor</b> | <b>Color</b> |
|------------|------------------|--------------|
| 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    |

### **2.5.3 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 7169, 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 external to the connectors.

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

## **2.6 CARD INSTALLATION AND REMOVAL**

The following procedures explain how to install and remove the Model 7169 scanner card with the Models 705 and 706 scanner mainframes.

### **WARNING**

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

### **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.**

### **2.6.1 Scanner Card Installation**

Perform the following procedure to install the Model 7169 scanner card in either the Model 705 or 706 mainframe. Refer to Figure 2-7 to install the card in the Model 705 and refer to Figure 2-8 to install the card in the Model 706.

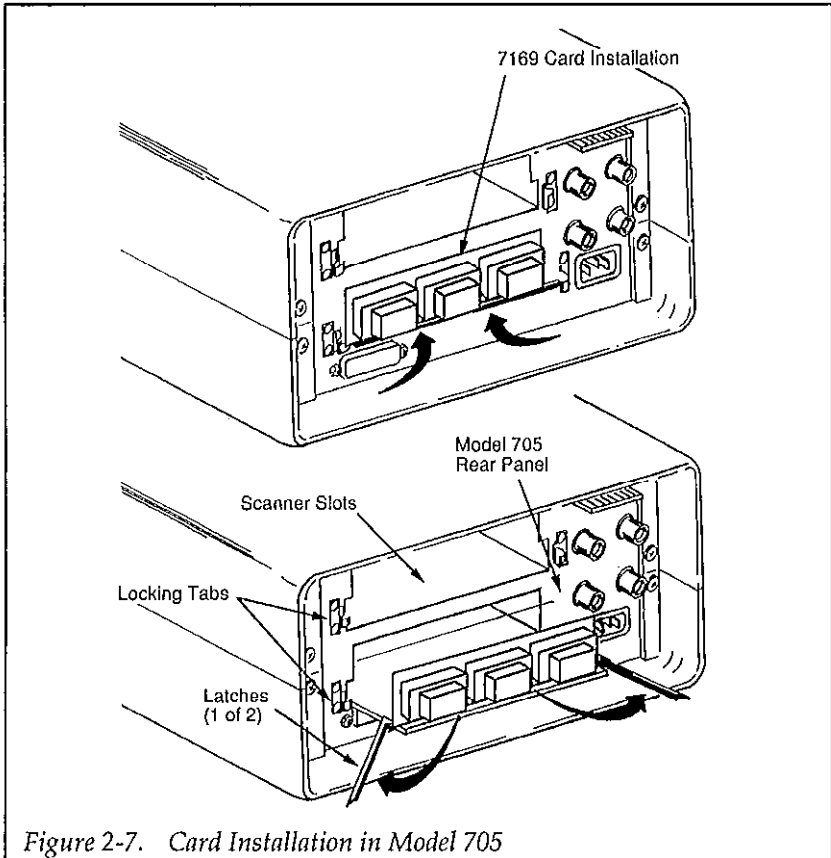
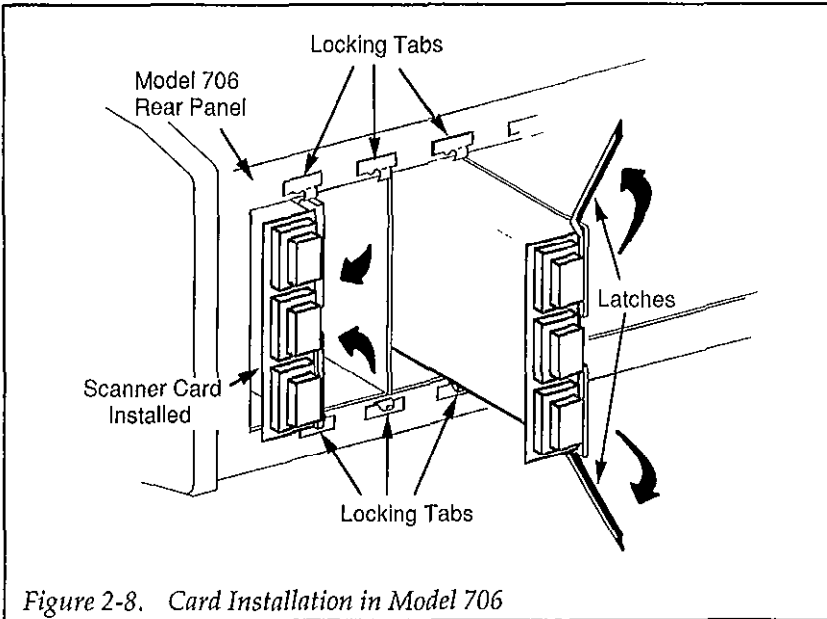


Figure 2-7. Card Installation in Model 705

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.



*Figure 2-8. Card Installation in Model 706*

## **2.6.2 Scanner Card Removal**

To remove the scanner card, first unlock it by pulling the latches outward, then grasp the end of the card at the edges, and pull the card out of the scanner mainframe.

## **2.7 MAINFRAME CONTROL OF SCANNER CARD**

Detailed information to program the Model 705 or 706 scanners is contained in their respective instruction manuals. The following paragraphs provide the information specific to the Model 7169.

The Model 7169 is designed to operate in the matrix mode of the scanner mainframe.

### **2.7.1 Matrix Mode**

The mainframe scanner must be placed in matrix (0-Pole) mode to operate the Model 7169. Keep in mind that scanner card channel numbers are

determined by the slot in which the card is installed. For example, with a Model 7169 installed in the bottom slot (Card 2) of a Model 705, the 20 scanner card channels are assigned channel numbers 21 through 40.

Table 2-3 lists the matrix mode crosspoints that must be closed in order to close the channels of a scanner card installed in a Model 705 or 706. Since the Model 705 has only two slots, only the first two card slots are relevant.

**Table 2-3. Scanner Control of Model 7169 Matrix Mode (0-Pole)**

|        | <b>Scanner<br/>Ch. No.</b> | <b>Relay<br/>Controlled</b> |
|--------|----------------------------|-----------------------------|
| CARD 1 | 01, 1                      | 1                           |
|        | 01, 2                      | 2                           |
|        | 01, 3                      | 3                           |
|        | 01, 4                      | 4                           |
|        | 02, 1                      | 5                           |
|        | 02, 2                      | 6                           |
|        | 02, 3                      | 7                           |
|        | 02, 4                      | 8                           |
|        | 03, 1                      | 9                           |
|        | 03, 2                      | 10                          |
|        | 03, 3                      | 11                          |
|        | 03, 4                      | 12                          |
|        | 04, 1                      | 13                          |
|        | 04, 2                      | 14                          |
|        | 04, 3                      | 15                          |
|        | 04, 4                      | 16                          |
|        | 05, 1                      | 17                          |
|        | 05, 2                      | 18                          |
|        | 05, 3                      | 19                          |
|        | 05, 4                      | 20                          |

Scanner Control of Model 7169 Matrix Mode (0-Pole) (Cont.)

|        | Scanner<br>Ch. No. | Relay<br>Controlled |
|--------|--------------------|---------------------|
| CARD 2 | 01, 1              | 21                  |
|        | 01, 2              | 22                  |
|        | 01, 3              | 23                  |
|        | 01, 4              | 24                  |
|        | 02, 1              | 25                  |
|        | 02, 2              | 26                  |
|        | 02, 3              | 27                  |
|        | 02, 4              | 28                  |
|        | 03, 1              | 29                  |
|        | 03, 2              | 30                  |
|        | 03, 3              | 31                  |
|        | 03, 4              | 32                  |
|        | 04, 1              | 33                  |
|        | 04, 2              | 34                  |
|        | 04, 3              | 35                  |
|        | 04, 4              | 36                  |
|        | 05, 1              | 37                  |
|        | etc.               | etc.                |

## **2.7.2 Multi-Channel Systems**

Additional channels are available using additional scanner cards. The Model 705 has two card slots. Thus, using one Model 705, 40 channels could be configured. With the maximum of five Model 705s daisy chained, 200 channels could be configured.

### **NOTE**

Refer to the mainframe's instruction manual for information concerning daisy chain operation.

Scanner card channel assignments for up to five mainframes are shown in Table 2-4.

**Table 2-4. Model 705 Channel Assignments in 0-Pole Mode**

| <b>Card #</b> | <b>Master</b> | <b>Slave #1</b> | <b>Slave #2</b> | <b>Slave #3</b> | <b>Slave #4</b> |
|---------------|---------------|-----------------|-----------------|-----------------|-----------------|
| 1             | 01 - 20       | 41 - 60         | 81 - 100        | 121 - 140       | 161 - 180       |
| 2             | 21 - 40       | 61 - 80         | 101 - 120       | 141 - 160       | 181 - 200       |

The Model 706 has 10 card slots. Thus, using one Model 706, 200 channels could be configured. With the maximum of five Model 706s daisy chained, 1000 channels could be configured.

## **2.7.3 Scanner Switching Control**

The Models 705 and 706 operate on a "break-before-make" basis when scanning. A delay of 1msec occurs between the time the current channel opens until the next channel closes to ensure that no two channels are connected together.

When switching channels manually, however, it is possible to have two or more channels on simultaneously. In this situation, it is important that the potential between channels does not exceed the maximum signal level of the Model 7169.



## 2.7.4 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.

### Capacitive Loads

The surge current from a capacitive load must be  $< 0.5A$  for the Model 7169 to protect the relays and circuit board. Figure 2-9 shows typical circuits to limit current surges. Also, consider the maximum load of 10W for the Model 7169 when determining the current limit. For example, when switching 100V with the Model 7169, the current must be limited to:

$$I = VA/V = 10VA/100V = 100mA$$

The current limiting resistor as used in Figure 2-9A would be:

$$R = V/I = 100V/100mA = 1k\Omega @ 10W$$

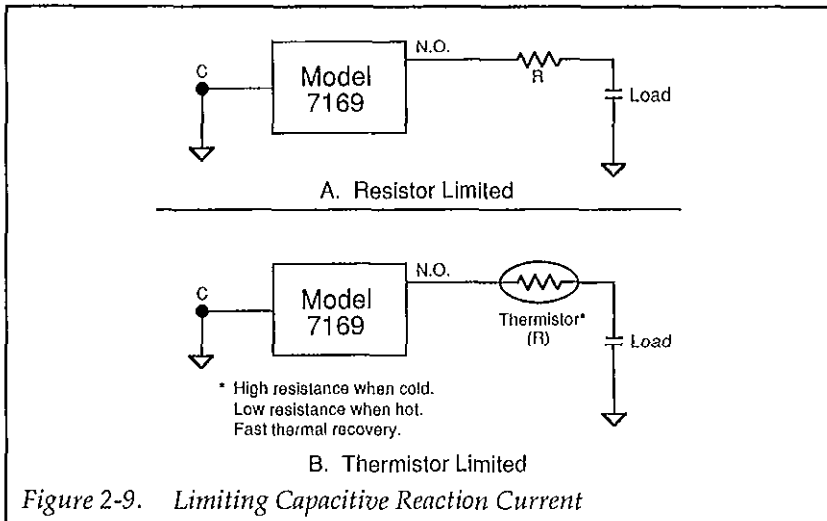


Figure 2-9. Limiting Capacitive Reaction Current

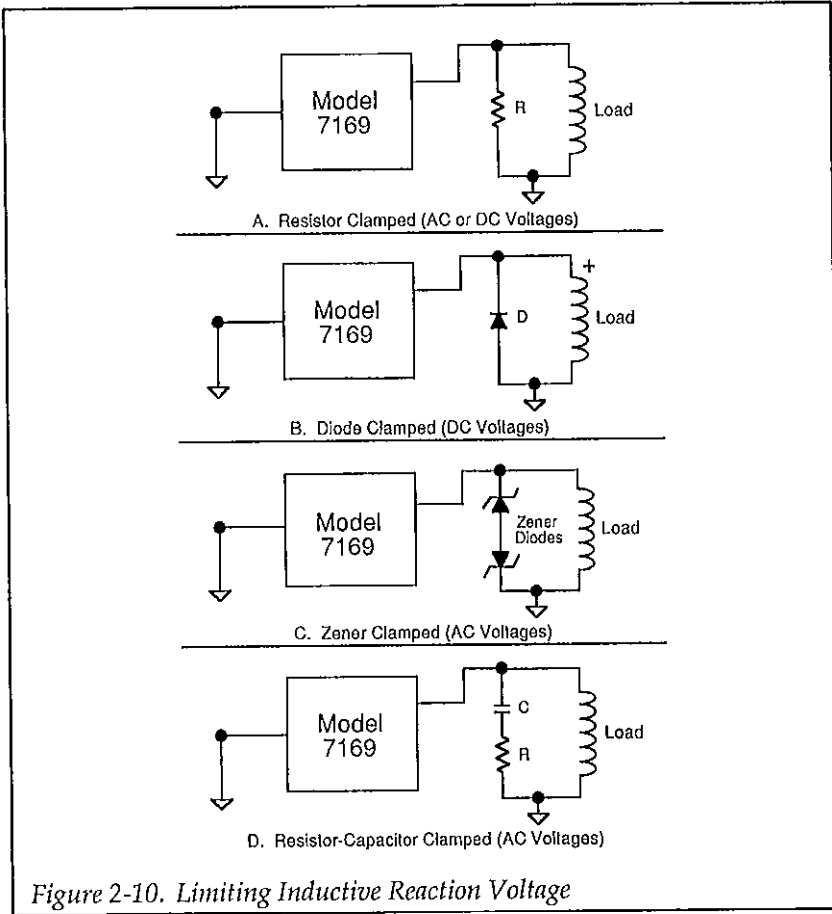
### **Inductive Loads**

Inductive reaction voltage,  $L (di/dt)$ , must be less than 500V. Typical clamping circuits are shown in Figure 2-10. Also, consider the maximum load of 10W for the Model 7169 when determining the voltage limit. For example, when switching 200mA with the Model 7169, the voltage must be limited to:

$$V = VA/I = 10W/200mA = 50V$$

The value of the voltage clamping resistor used in Figure 2-10A would be:

$$R = V/I = 50V/200mA = 250\Omega @ 10W$$



# SECTION 3

## Applications

---

### 3.1 INTRODUCTION

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

**3.2 Coupon 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 Testing:** This application uses bank switching and the on-card bus to simplify insulation resistance testing of multi-conductor cables.

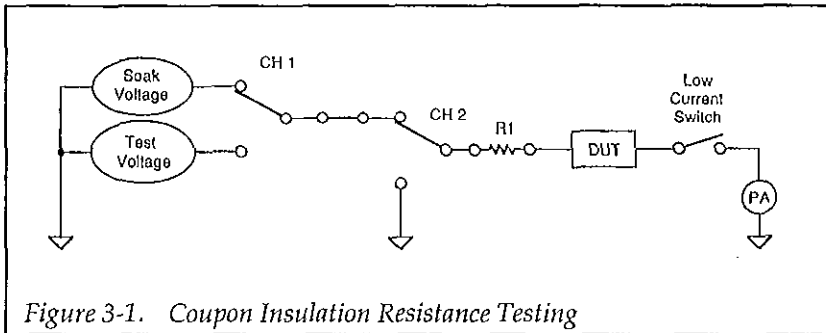
### 3.2 COUPON TESTING

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

With both channels open, a soak 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. After taking the test reading, channel 2 can be closed to discharge the capacitance of the DUT and cabling.

Each Model 7169 allows 10 DUT to be tested using this set-up. The two on-card buses can also be used to bus the soak and test voltages so that

only two external connections are needed for each source instead of two for each channel.



*Figure 3-1. Coupon Insulation Resistance Testing*

### **3.3 CABLING INSULATION TESTING**

The insulation resistance of multiple conductor cables can efficiently be measured using the Model 7169. Up to 180 conductors or pins may be tested using the Model 7169 in a Model 706 mainframe scanner.

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

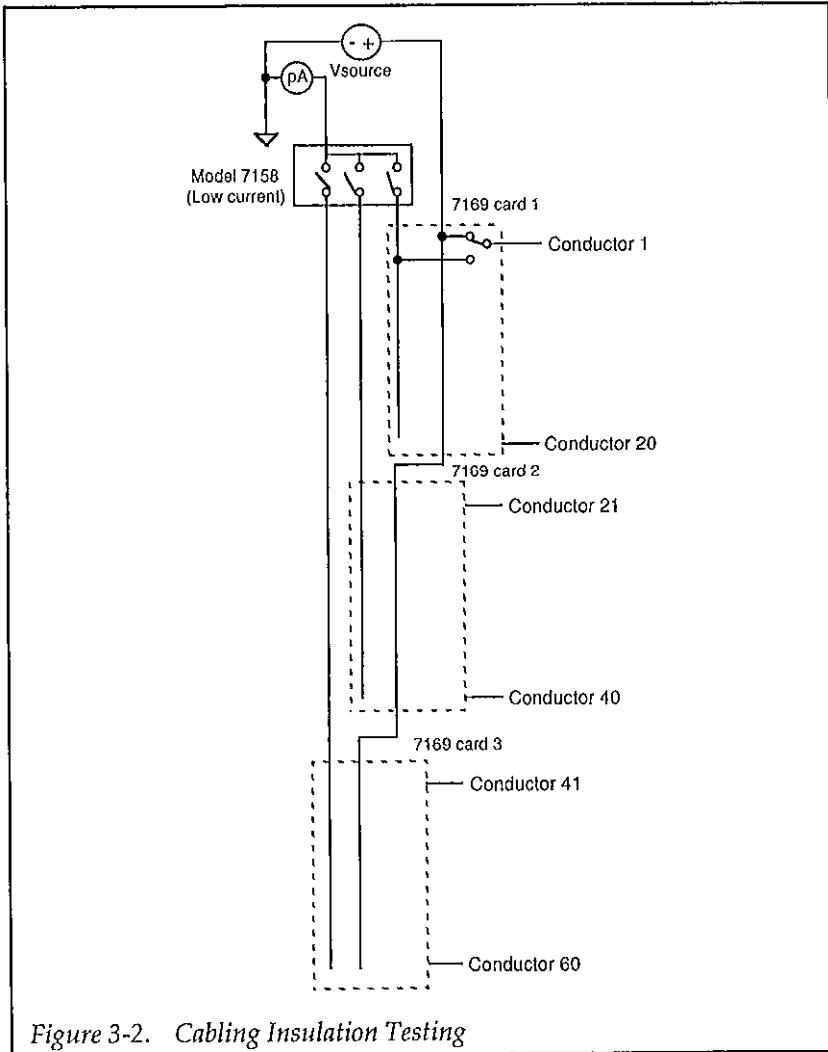


Figure 3-2. Cabling Insulation Testing

# SECTION 4

## Service Information

---

### 4.1 INTRODUCTION

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

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

**4.3 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 7169, 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 scanner 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. If making solder repairs on the circuit board, use a flux that is rosin RMA based. Remove the flux from these areas when the repair is complete. Use Freon® TMS or TE, or the equivalent along with plenty of clean cotton swabs 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.

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

### **4.3 PERFORMANCE VERIFICATION**

The following paragraphs discuss performance verification procedures for the Model 7169, including isolation and path resistance. The performance verification procedures should be performed with the scanner card installed in the Model 705 or 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 scanner card is contaminated. See paragraph 4.2 to clean the card.

#### **4.3.1 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%.

#### **4.3.2 Recommended Equipment**

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

#### **4.3.3 Connector Preparation**

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



**Table 4-1. Verification Equipment**

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

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 7169.

### 4.3.4 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 4-1, 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.

**SECTION 4**  
*Service Information*

---

1. Using Table 4-2 to identify scanner card terminals, connect the Model 617 to the scanner card as shown in Figure 4-1.
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, disable zero check and press OPERATE to source 100V.
6. After allowing the reading on the Model 617 to settle, verify that it is  $>1G\Omega$ .
7. Place the Model 617 in standby and enable zero check.
8. Connect the electrometer input HI lead to channel 3 of the scanner card.
9. Repeat steps 5 through 8.
10. Repeat the basic procedure in steps 8 and 9 for channels 4 through 20.

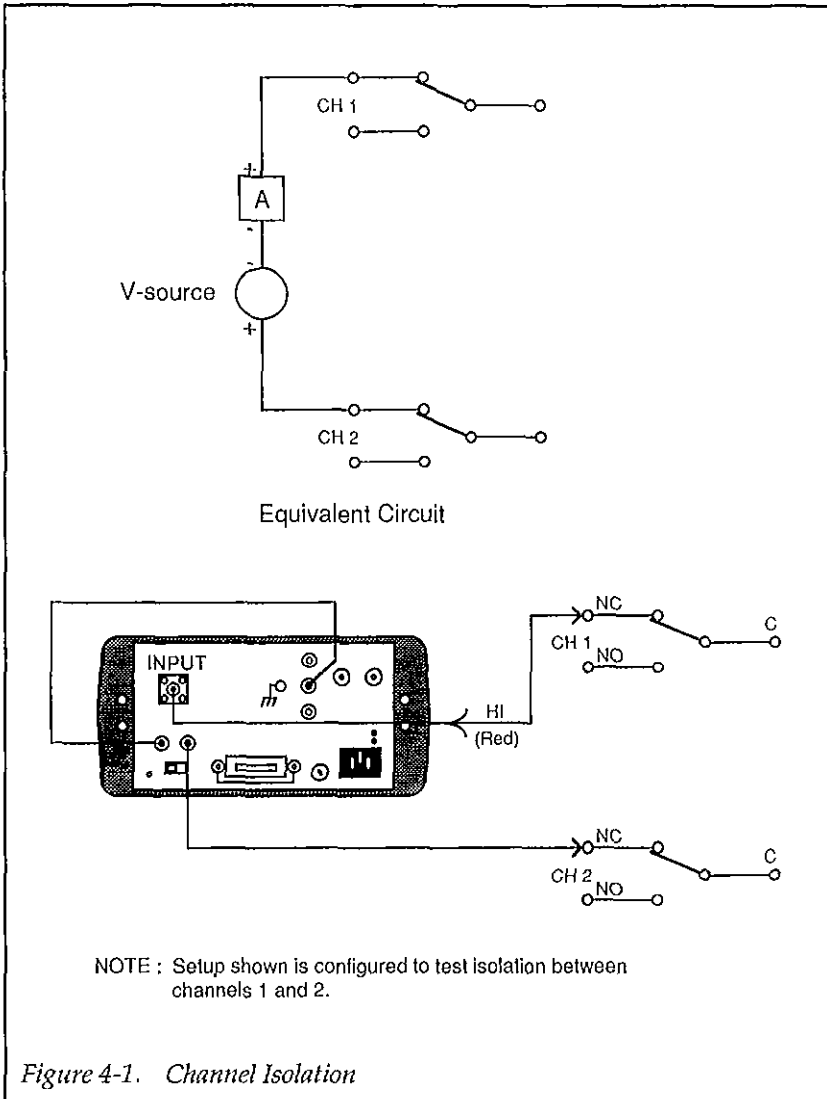


Figure 4-1. Channel Isolation

**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   |

**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   |

### **4.3.5 Input Isolation Tests**

These tests check the resistance (isolation) between the N.C. and N.O. terminals of every scanner 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 4-2, 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 scanner card terminals, connect the Model 617 to the scanner 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, disable zero check and press OPERATE to, source 100V.
6. After allowing the reading on the Model 617 to settle, verify that it is  $>1G\Omega$ .
7. Place the Model 617 in standby and enable zero check.
8. Connect the electrometer Input HI lead to channel 1 N.O. of the scanner card, and connect V-Source HI channel 1 COMMON.
9. Repeat the basic procedure in steps 5 through 8 for channels 2 through 20.

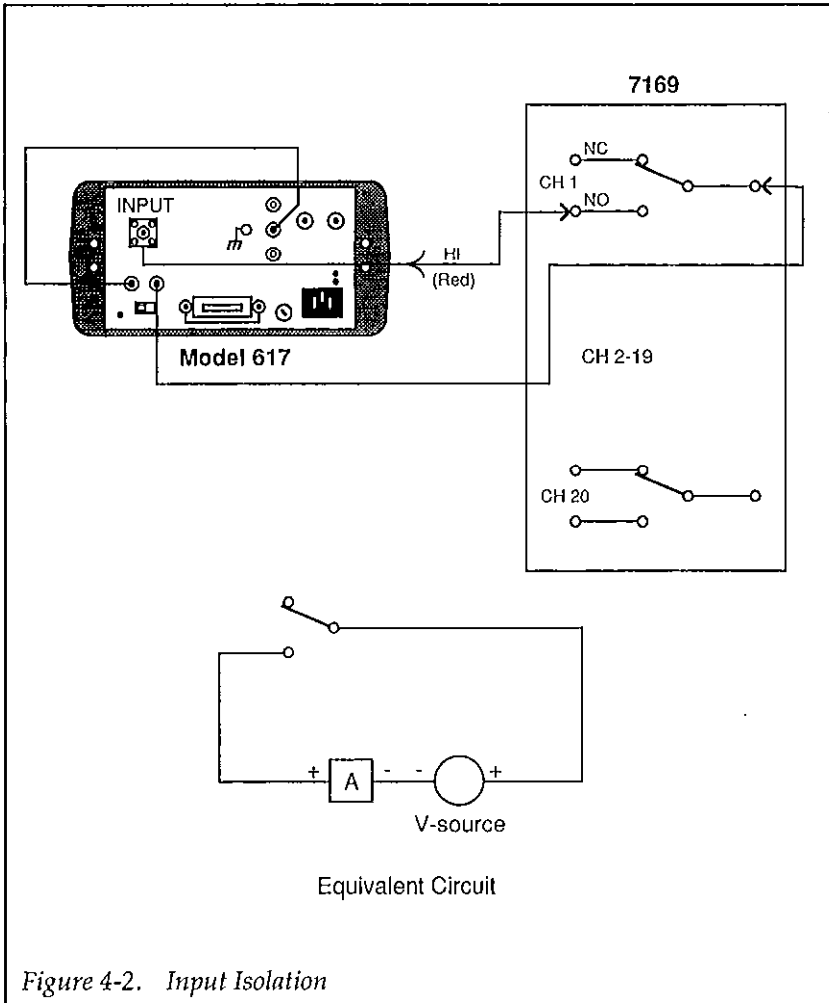


Figure 4-2. Input Isolation

### **4.3.6 Path Resistance Tests**

Referring to Figure 4-3, 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 4-3 and select the  $300\Omega$  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 scanner card terminals, connect the Model 196 to the scanner card.
4. With the scanner in the step mode, close channel 1 (0,1). The reading on the Model 196 should be  $<2\Omega$  ( $0.3\Omega$  typical).
5. Open channel 1 and verify that the Model 196 indicates an open circuit ( $> 300M\Omega$ ).
6. Move one lead from N.O to N.C. The reading on the 196 should be  $<2\Omega$  ( $0.3\Omega$  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.



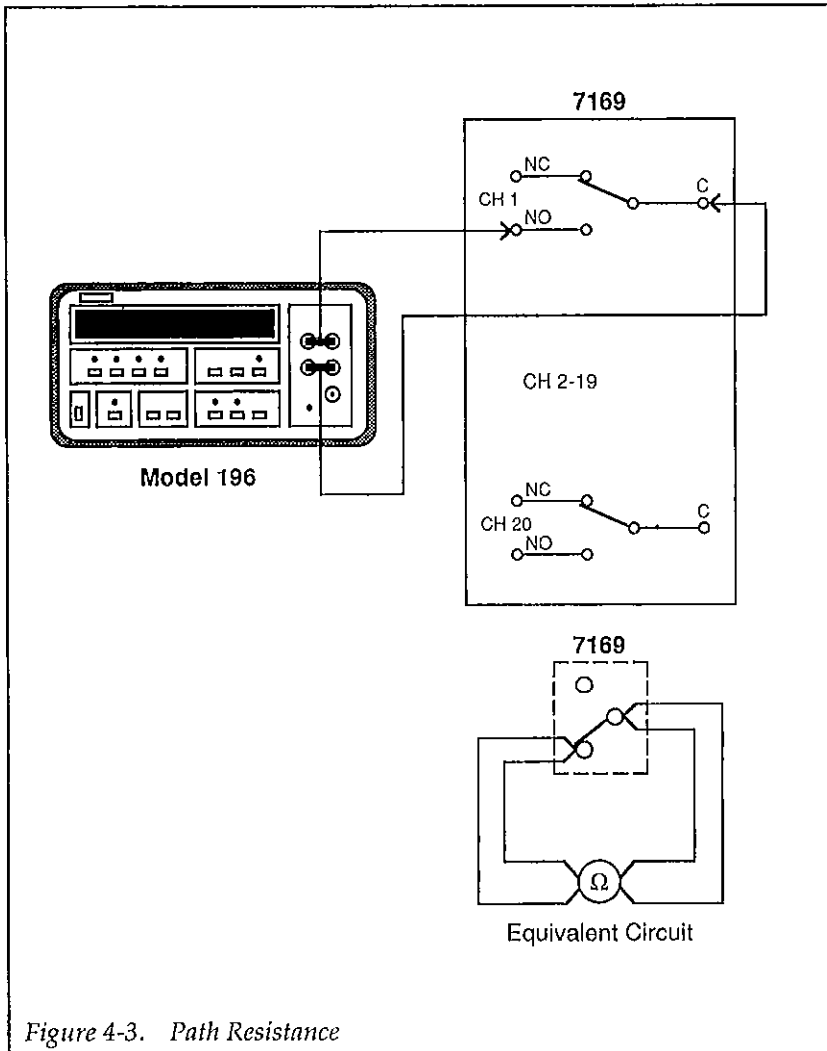


Figure 4-3. Path Resistance

# SECTION 5

## Replaceable Parts

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### 5.1 INTRODUCTION

This section contains a list of replaceable electrical and mechanical parts for the Model 7169, 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. Scanner card model number (7169)
2. Card serial number
3. Part description
4. Circuit description, if applicable
5. Keithley part number

### 5.4 FACTORY SERVICE

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

**SECTION 5**  
*Replaceable Parts*

---

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 7169, while Figure 5-2 shows a schematic diagram.

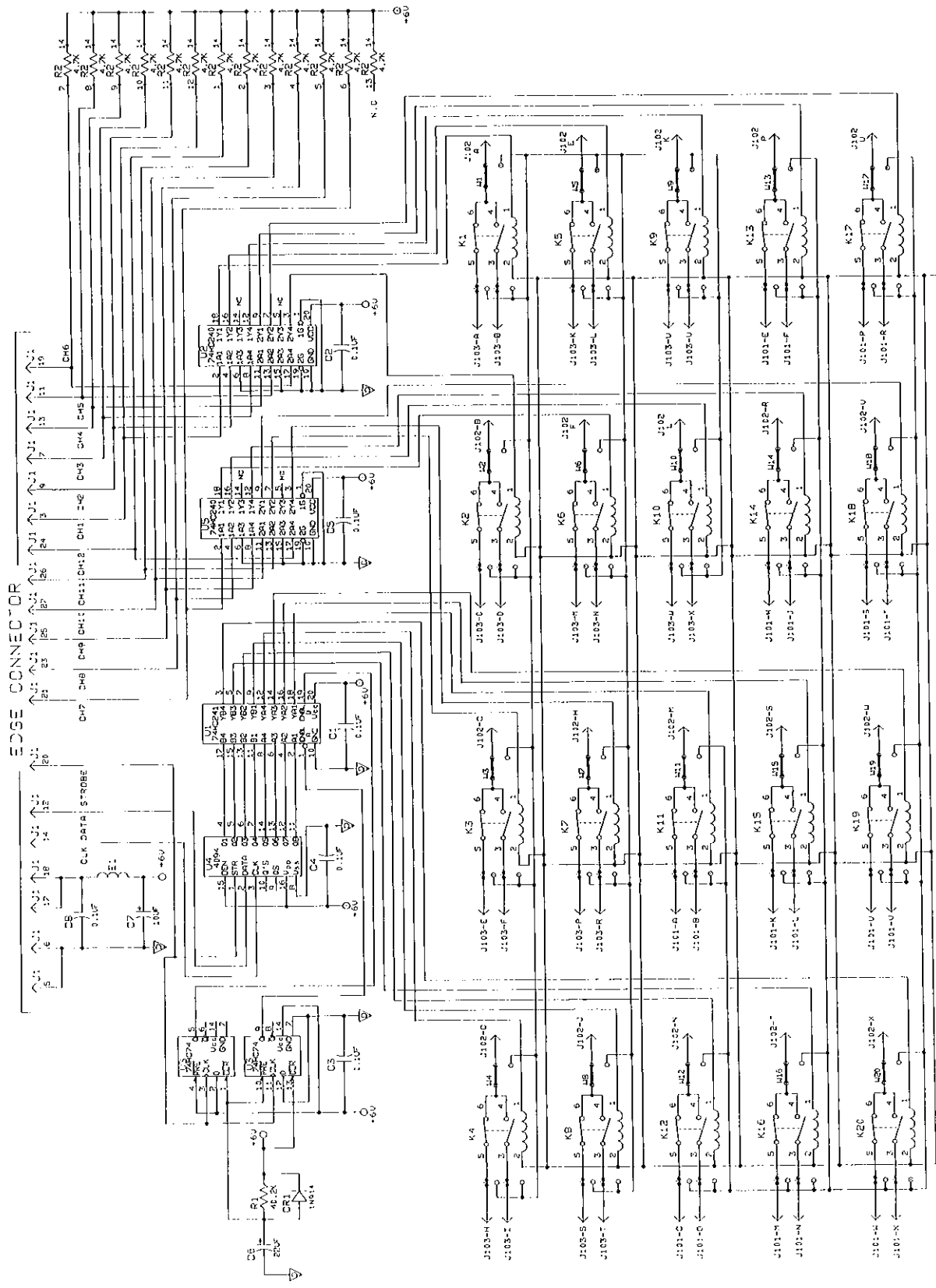
**TABLE 5-1. MODEL 7169, PARTS LIST**

| <b>CIRCUIT<br/>DESIG.</b> | <b>DESCRIPTION</b>                           | <b>KEITHLEY<br/>PART NO.</b> |
|---------------------------|--|------------------------------|
| C1-C5                     | CAP,.1uF,20%,50V,CERAMIC                     | C-365-.1                     |
| C6                        | CAP,22uF,-20+100%,25V<br>ALUM ELEC           | C-314-22                     |
| C7                        | CAP,10uF,-20+100%,25V,<br>ALUM BLEC          | C-314-10                     |
| E1                        | BEAD,FERRITE                                 | CT-9                         |
| K1..K20                   | RELAY (SPDT)                                 | RL-133                       |
| R1                        | RES,40.2K,1%,1/8W,METAL FILM                 | R-88-40.2                    |
| R2                        | RES NET,4.7K,2%,1.5W                         | TF-19-4.7K                   |
| U1                        | IC,BUF/LINE DRIVER & RECEIVER,<br>MC74HC241N | IC-520                       |
| U2,U5                     | IC,OCTAL TRI-STATE BUFFER,<br>MM74HC240      | IC-617                       |
| U3                        | IC,DUAL D-TYPE FLIP FLOP,<br>74HC74          | IC-337                       |
| U4                        | IC, 8 STAGE SHIFT/STORE<br>REGISTER,4094     | IC-251                       |
| W1...W20                  | JUMPERS                                      | J-15                         |

**TABLE 5-2. MODEL 7169, MISCELLANEOUS PARTS LIST**

| <b>QTY.</b> | <b>DESCRIPTION</b> | <b>KEITHLEY<br/>PART NO.</b> |
|-------------|--------------------|------------------------------|
| 1           | BACK PANEL         | 7169-301                     |
| 2           | HANDLE             | FA-119                       |
| 1           | HANDLING LABEL     | MC-348                       |
| 2           | RIVET              | FA-121                       |

EDGE CONNECTOR



|           |           |      |          |
|-----------|-----------|------|----------|
| REVISIONS |           | DATE |          |
| 1         | RECTIFIER | 2169 | 2169-106 |
| 2         | REVISION  | 2169 | 2169-106 |
| 3         | REVISION  | 2169 | 2169-106 |
| 4         | REVISION  | 2169 | 2169-106 |
| 5         | REVISION  | 2169 | 2169-106 |
| 6         | REVISION  | 2169 | 2169-106 |
| 7         | REVISION  | 2169 | 2169-106 |
| 8         | REVISION  | 2169 | 2169-106 |
| 9         | REVISION  | 2169 | 2169-106 |
| 10        | REVISION  | 2169 | 2169-106 |
| 11        | REVISION  | 2169 | 2169-106 |
| 12        | REVISION  | 2169 | 2169-106 |
| 13        | REVISION  | 2169 | 2169-106 |
| 14        | REVISION  | 2169 | 2169-106 |
| 15        | REVISION  | 2169 | 2169-106 |
| 16        | REVISION  | 2169 | 2169-106 |
| 17        | REVISION  | 2169 | 2169-106 |
| 18        | REVISION  | 2169 | 2169-106 |
| 19        | REVISION  | 2169 | 2169-106 |
| 20        | REVISION  | 2169 | 2169-106 |

SCHEMATIC  
20 FORM-C SWITCH CARD  
DATE: 2169  
REVISED: 2169-106  
BY: 10/10/90

ROW 1  
ROW 2  
ROW 3  
ROW 4

N 1  
N 2  
N 3  
N 4  
N 5

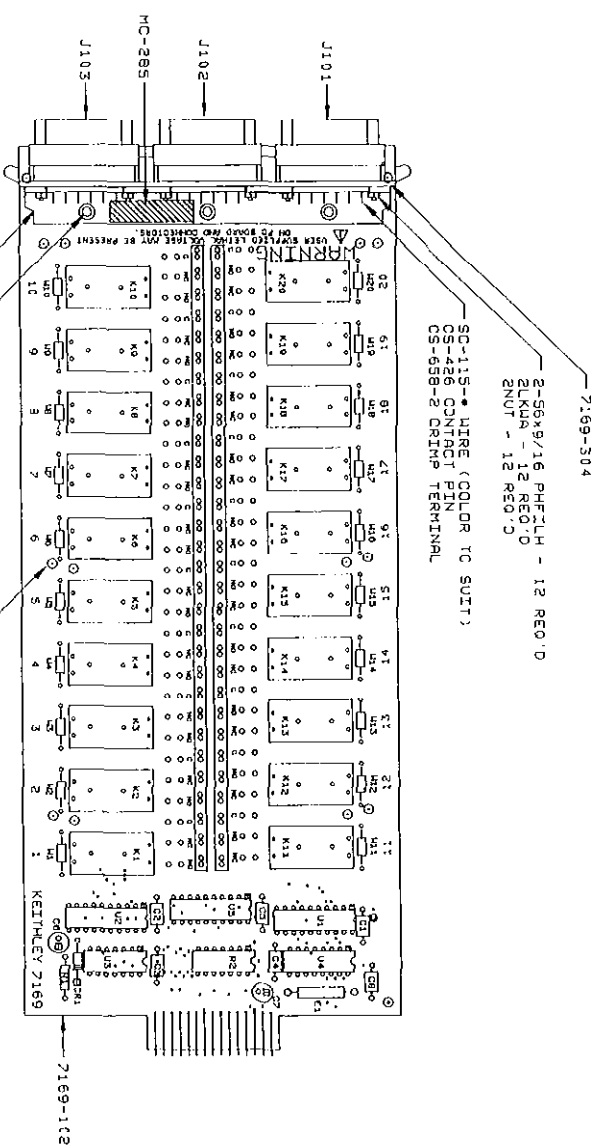
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

001-6917

| LT# | ECO NO. | REVISION | ENG. | DATE    |
|-----|---------|----------|------|---------|
| B   | 1382    | RELEASED | FS   | 3/29/99 |
| C   | 14160   | REVISED  | AA   | 4/24/00 |

7169 PANEL PIN-OUT

| RELAY + (XXXX) | CHANNEL | MATRIX LOCATION | CONTACT | CONNECTOR | PIN |
|----------------|---------|-----------------|---------|-----------|-----|
| 1              | 1       | 1.1             | C       | J102      | A   |
| 1              | 1       | 1.1             | NC      | J103      | A   |
| 1              | 1       | 1.1             | NO      | J103      | B   |
| 2              | 2       | 2.2             | C       | J102      | B   |
| 2              | 2       | 2.2             | NC      | J103      | C   |
| 2              | 2       | 2.2             | NO      | J103      | D   |
| 3              | 3       | 3.3             | C       | J102      | E   |
| 3              | 3       | 3.3             | NC      | J103      | F   |
| 3              | 3       | 3.3             | NO      | J103      | G   |
| 4              | 4       | 4.4             | C       | J102      | H   |
| 4              | 4       | 4.4             | NC      | J103      | I   |
| 4              | 4       | 4.4             | NO      | J103      | J   |
| 5              | 5       | 5.1             | C       | J102      | K   |
| 5              | 5       | 5.1             | NC      | J103      | L   |
| 5              | 5       | 5.1             | NO      | J103      | M   |
| 6              | 6       | 6.2             | C       | J102      | N   |
| 6              | 6       | 6.2             | NC      | J103      | O   |
| 6              | 6       | 6.2             | NO      | J103      | P   |
| 7              | 7       | 7.3             | C       | J102      | Q   |
| 7              | 7       | 7.3             | NC      | J103      | R   |
| 7              | 7       | 7.3             | NO      | J103      | S   |
| 8              | 8       | 8.4             | C       | J102      | T   |
| 8              | 8       | 8.4             | NC      | J103      | U   |
| 8              | 8       | 8.4             | NO      | J103      | V   |
| 9              | 9       | 9.1             | C       | J102      | W   |
| 9              | 9       | 9.1             | NC      | J103      | X   |
| 9              | 9       | 9.1             | NO      | J103      | Y   |
| 10             | 10      | 10.2            | C       | J102      | Z   |
| 10             | 10      | 10.2            | NC      | J103      | AA  |
| 10             | 10      | 10.2            | NO      | J103      | AB  |
| 11             | 11      | 11.3            | C       | J102      | AC  |
| 11             | 11      | 11.3            | NC      | J103      | AD  |
| 11             | 11      | 11.3            | NO      | J103      | AE  |
| 12             | 12      | 12.4            | C       | J102      | AF  |
| 12             | 12      | 12.4            | NC      | J103      | AG  |
| 12             | 12      | 12.4            | NO      | J103      | AH  |
| 13             | 13      | 13.1            | C       | J102      | AI  |
| 13             | 13      | 13.1            | NC      | J103      | AJ  |
| 13             | 13      | 13.1            | NO      | J103      | AK  |
| 14             | 14      | 14.2            | C       | J102      | AL  |
| 14             | 14      | 14.2            | NC      | J103      | AM  |
| 14             | 14      | 14.2            | NO      | J103      | AN  |
| 15             | 15      | 15.3            | C       | J102      | AO  |
| 15             | 15      | 15.3            | NC      | J103      | AP  |
| 15             | 15      | 15.3            | NO      | J103      | AQ  |
| 16             | 16      | 16.4            | C       | J102      | AR  |
| 16             | 16      | 16.4            | NC      | J103      | AS  |
| 16             | 16      | 16.4            | NO      | J103      | AT  |
| 17             | 17      | 17.1            | C       | J102      | AV  |
| 17             | 17      | 17.1            | NC      | J103      | AW  |
| 17             | 17      | 17.1            | NO      | J103      | AX  |
| 18             | 18      | 18.2            | C       | J102      | AY  |
| 18             | 18      | 18.2            | NC      | J103      | AZ  |
| 18             | 18      | 18.2            | NO      | J103      | BA  |
| 19             | 19      | 19.3            | C       | J102      | BB  |
| 19             | 19      | 19.3            | NC      | J103      | BC  |
| 19             | 19      | 19.3            | NO      | J103      | BD  |
| 20             | 20      | 20.4            | C       | J102      | BE  |
| 20             | 20      | 20.4            | NC      | J103      | BF  |
| 20             | 20      | 20.4            | NO      | J103      | BG  |



NOTE:  
FOR COMPONENT INFORMATION  
REFER TO PRODUCT STRUCTURE  
(7169-000-00).

DO NOT SCALE THIS DRAWING  
UNLESS OTHERWISE SPECIFIED  
DATE 3/7/99 SCALE 1:1 TITLE COMPONENT LAYOUT,  
20 FORM-C SWITCH CARD  
KEITHLEY INSTRUMENTS, INC.  
SURFACE FIN. FINISH

|         |                    |
|---------|--------------------|
| 7169    | NEXT ASSEMBLY DIV. |
| NO.     | 7169-100           |
| USEG DN |                    |

## **KEITHLEY**

Keithley Instruments, Inc. • 28775 Aurora Road • Cleveland, OH 44139 • 410-248-0400 • Fax: 440-248-6168 • <http://www.keithley.com>

**CHINA:** Keithley Instruments China • Yuan Chen Xin Building, Room 705 • 12 Yunlin Road, Xiwai, Mianlan • Beijing 100029 • 8610-62022886 • Fax: 8610-62022892  
**FRANCE:** Keithley Instruments SARI • BP 60 • 3 Allée des Garays • 91122 Palaiseau Cédex • 33-1-60-11-51-55 • Fax: 33-1-60-11-77-26  
**GERMANY:** Keithley Instruments GmbH • Landsberger Strasse 65 • D-82110 Gernering, Munich • 49-89-8493070 • Fax: 49-89-84930759  
**GREAT BRITAIN:** Keithley Instruments, Ltd. • The Minister • 58 Portman Road • Reading, Berkshire, England RG3 1EA • 44-1189-596469 • Fax: 44-1189-575666  
**ITALY:** Keithley Instruments SRI • Viale S. Gimignano 38 • 20146 Milano • 39-2-48303008 • Fax: 39-2-48302274  
**NETHERLANDS:** Keithley Instruments BV • Avelingen West 49 • 4202 MS Gorinchem • 31 (0)183-635333 • Fax: 31 (0)183-630821  
**SWITZERLAND:** Keithley Instruments SA • Kriesbachstrasse 4 • 8600 Dübendorf • 41-1-8219444 • Fax: 41-1-8203081  
**TAIWAN:** Keithley Instruments Taiwan • 11F., 85 Po Ai Street • Hsinchu, Taiwan • 886-3-572-9077 • Fax: 886-3-572-9031





# 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. \_\_\_\_\_

- |  |  |  |
|--|--|--|
| <input type="checkbox"/> Intermittent            | <input type="checkbox"/> Analog output follows display   | <input type="checkbox"/> Particular range or function bad; specify _____ |
| <input type="checkbox"/> IEEE failure            | <input type="checkbox"/> Obvious problem on power-up     | <input type="checkbox"/> Batteries and fuses are OK                      |
| <input type="checkbox"/> Front panel operational | <input type="checkbox"/> All ranges or functions are bad | <input type="checkbox"/> Checked all cables                              |

Display or output (check one)

- |   |  |
|---|--|
| <input type="checkbox"/> Drifts           | <input type="checkbox"/> Unable to zero                      |
| <input type="checkbox"/> Unstable         | <input type="checkbox"/> Will not read applied input         |
| <input type="checkbox"/> Overload         |  |
| <input type="checkbox"/> Calibration only | <input type="checkbox"/> Certificate of calibration required |
| <input type="checkbox"/> 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.