

# **Model 7158 Low Current Scanner Card**

---

Instruction Manual

Contains Operating and Servicing Information

**KEITHLEY**

## WARRANTY

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

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

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

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

## LIMITATION OF WARRANTY

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

**THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE. THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES.**

NEITHER KEITHLEY INSTRUMENTS, INC. NOR ANY OF ITS EMPLOYEES SHALL BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OF ITS INSTRUMENTS AND SOFTWARE EVEN IF KEITHLEY INSTRUMENTS, INC., HAS BEEN ADVISED IN ADVANCE OF THE POSSIBILITY OF SUCH DAMAGES. SUCH EXCLUDED DAMAGES SHALL INCLUDE, BUT ARE NOT LIMITED TO: COSTS OF REMOVAL AND INSTALLATION, LOSSES SUSTAINED AS THE RESULT OF INJURY TO ANY PERSON, OR DAMAGE TO PROPERTY.

## KEITHLEY

Keithley Instruments, Inc. • 28775 Aurora Road • Cleveland, OH 44139 • 216-248-0400 • Fax: 216-248-6168 • <http://www.keithley.com>

CHINA: Keithley Instruments China • Yuan Chen Xin Building, Room 705 • No. 12 Yumin Road, Dewai, Madian • Beijing, China 100029 • 8610-2022886 • Fax: 8610-2022892  
FRANCE: Keithley Instruments SARL • BP 60 • 3 allée des Girays • 91122 Palaiseau Cédex • 31-6-0115155 • Fax: 31-6-0117726  
GERMANY: Keithley Instruments GmbH • Landsberger Straße 65 • 82110 Germering • 49-89-849307-0 • Fax: 49-89-84930759  
GREAT BRITAIN: Keithley Instruments, Ltd. • The Minster • 58 Portman Road • Reading, Berkshire RG30 1EA • 44-01734-575666 • Fax: 44-01734-596469  
ITALY: Keithley Instruments SRL • Viale S. Cimignano 38 • 20146 Milano • 39-2-48303008 • Fax: 39-2-48302274  
JAPAN: Keithley KK • Aibido Bldg. • 7-20-2 Nishitshinjuku • Shinjuku-ku, Tokyo 160 • 81-3-5389-1964 • Fax: 81-3-5389-2068  
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 • 1, Ming-Yu First Street • Hsinchu, Taiwan, R.O.C. • 886-35-778462 • Fax: 886-35-778455

# Model 7158 Low Current Scanner Card Instruction Manual

© 1987, Keithley Instruments, Inc.  
Test Instrumentation Group  
All rights reserved.  
Cleveland, Ohio, U.S.A.  
June 1990, Second Printing  
Document Number: 7158-901-01 Rev. B

## SAFETY PRECAUTIONS

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

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

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. **A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.**

Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. **ALWAYS** remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.


Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture rear panel, or switching card.


Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance limited sources. **NEVER** connect switching cards directly to AC main. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

When fuses are used in a product, replace with same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

If a  screw is present on the test fixture, connect it to safety earth ground using #18 AWG or larger wire.

The  symbol on an instrument or accessory indicates that 1000V or more may be present on the terminals. Refer to the product manual for detailed operating information.

Instrumentation and accessories should not be connected to humans.

Maintenance should be performed by qualified service personnel. Before performing any maintenance, disconnect the line cord and all test cables.

# SPECIFICATIONS

## MODEL 7158 LOW CURRENT SCANNER CARD

**CHANNELS PER CARD:** 10

**CONTACT CONFIGURATION:** Single pole. When a channel is open, signal HI is connected to signal LO. Signal LO is common for all 10 channels and output.

**CONNECTOR TYPE:** BNC

**RELAY DRIVE CURRENT:** 100mA per card typical.

**MAXIMUM SIGNAL LEVEL:** 100mA, 30V, peak (resistive load)

**3dB BANDWIDTH:** 1MHz typical.

**CONTACT LIFE:** 10<sup>7</sup> closures (cold switching); 10<sup>6</sup> closures (at maximum signal level)

**CONTACT RESISTANCE:** <1 $\Omega$  to rated life

**CONTACT POTENTIAL:** <200 $\mu$ V

**ACTUATION TIME:** <1ms, exclusive of mainframe

**OFFSET CURRENT:** <10<sup>-13</sup>A (<3  $\times$  10<sup>-14</sup>A typical)

**COMMON MODE VOLTAGE:** 30V peak

### GENERAL

#### ENVIRONMENT,

**Operating:** 0° to 50°C, up to 35°C at 70% RH

**Storage:** -25° to 65°C

**DIMENSIONS, WEIGHT:** 32mm high  $\times$  114mm wide  $\times$  272mm long (1 $\frac{1}{4}$ "  $\times$  4 $\frac{1}{2}$ "  $\times$  10 $\frac{3}{4}$ "). Net weight 0.58kg (20.5 oz.)

**ACCESSORY SUPPLIED:** Model 4801 Low Noise Cable

**ACCESSORY AVAILABLE:** Model 4804 triax female to BNC male adapter

Specifications subject to change without notice.

# TABLE OF CONTENTS

## SECTION 1 - GENERAL INFORMATION

|     |                                |   |
|-----|--------------------------------|---|
| 1.1 | Introduction .....             | 1 |
| 1.2 | Warranty Information .....     | 1 |
| 1.3 | Manual Addenda .....           | 2 |
| 1.4 | Safety Symbols and Terms ..... | 2 |
| 1.5 | Unpacking and Inspection ..... | 2 |
| 1.6 | Specifications .....           | 3 |

## SECTION 2 - OPERATION

|       |                                       |    |
|-------|---------------------------------------|----|
| 2.1   | Introduction .....                    | 5  |
| 2.2   | Safety Precautions .....              | 5  |
| 2.2.1 | High Impedance Considerations .....   | 5  |
| 2.2.2 | Static Precautions .....              | 6  |
| 2.3   | Connections and Cabling .....         | 6  |
| 2.4   | Installation and Removal .....        | 8  |
| 2.5   | Operation .....                       | 10 |
| 2.5.1 | Scanner Control of the Channels ..... | 11 |
| 2.5.2 | Operation Notes .....                 | 18 |
| 2.6   | Applications .....                    | 18 |

## SECTION 3 - SERVICING INFORMATION

|     |                                  |    |
|-----|----------------------------------|----|
| 3.1 | Introduction .....               | 25 |
| 3.2 | Handling and Cleaning .....      | 25 |
| 3.3 | Relay Replacement .....          | 26 |
| 3.4 | Recommended Test Equipment ..... | 27 |
| 3.5 | Offset Current Test .....        | 27 |
| 3.6 | Contact Resistance Test .....    | 29 |

## SECTION 4 - REPLACEABLE PARTS

|     |  |    |
|-----|--|----|
| 4.1 | Introduction .....                           | 33 |
| 4.2 | Parts Lists .....                            | 33 |
| 4.3 | Ordering Information .....                   | 33 |
| 4.4 | Factory Service .....                        | 35 |
| 4.5 | Component Layout and Schematic Diagram ..... | 35 |

# LIST OF TABLES

## SECTION 2 - OPERATION

|     |   |    |
|-----|---|----|
| 2-1 | Example Channel Assignments in 2-Pole Mode . . . . .          | 12 |
| 2-2 | Example Channel Assignments in 1-Pole Mode . . . . .          | 13 |
| 2-3 | Example Channel Assignments in Matrix (0-Pole) Mode . . . . . | 14 |
| 2-4 | Scanner Control of Model 7158 4-Pole Mode . . . . .           | 15 |
| 2-5 | Scanner Control of Model 7158 2-Pole Mode . . . . .           | 15 |
| 2-6 | Scanner Control of Model 7158 1-Pole Mode . . . . .           | 16 |
| 2-7 | Scanner Control of Model 7158 Matrix (0-Pole) Mode . . . . .  | 17 |

## SECTION 3 - SERVICING INFORMATION

|     |                                      |    |
|-----|--------------------------------------|----|
| 3-1 | Recommended Test Equipment . . . . . | 27 |
|-----|--------------------------------------|----|

## SECTION 4 - REPLACEABLE PARTS

|     |                                       |    |
|-----|---------------------------------------|----|
| 4-1 | Model 7158 Electrical Parts . . . . . | 34 |
| 4-2 | Model 7158 Mechanical Parts . . . . . | 35 |



# LIST OF ILLUSTRATIONS

## SECTION 2 - OPERATION

|     |  |    |
|-----|--|----|
| 2-1 | Multi-Card Connection . . . . .              | 7  |
| 2-2 | Installing Card in Model 705 . . . . .       | 9  |
| 2-3 | Installing Card in Model 706 . . . . .       | 10 |
| 2-4 | Model 7158 Simplified Schematic . . . . .    | 11 |
| 2-5 | Capacitor Leakage Schematic . . . . .        | 20 |
| 2-6 | Capacitor Leakage Instrument Setup . . . . . | 21 |
| 2-7 | Measuring Leakages with One Card . . . . .   | 23 |

## SECTION 3 - SERVICING INFORMATION

|     |                                    |    |
|-----|------------------------------------|----|
| 3-1 | Offset Current . . . . .           | 28 |
| 3-2 | Coax Pigtail Preparation . . . . . | 30 |
| 3-3 | Contact Resistance . . . . .       | 31 |

## SECTION 4 - REPLACEABLE PARTS

|     |  |    |
|-----|--|----|
| 4-1 | Model 7158 Component Layout . . . . .  | 36 |
| 4-2 | Model 7158 Schematic Diagram . . . . . | 37 |

# SECTION 1

## GENERAL INFORMATION

### 1.1 INTRODUCTION

The Model 7158 Low Current Scanner Card has ten channels of paired single-pole single-throw (SPST), normally open (NO) relays. The card will switch any one of ten signals to one output, or switch one signal to any one of ten outputs.

Signal HI is connected to signal LO (analog ground) when the scanner mainframe channel is open, and to output HI when the channel is closed. Signal LO is common to all ten channels and the output. An additional relay isolates all circuitry on the card from the output when no channel is closed.

Features of the scanner card include:

- Low offset current error ( $< 1\text{pA}$  specified,  $< 30\text{fA}$  typical).
- Switching of AC or DC signals up to 100mA.
- BNC input and output connectors.
- Two outputs for daisy-chaining of Model 7158 cards.
- Configurable for low current or low voltage switching.

The Model 7158 is field-installable in the Models 705 and 706 scanner mainframes.

### 1.2 WARRANTY INFORMATION


Warranty information is stated on the inside front cover of this manual. If there is a need for service, contact the Keithley representative or authorized repair facility in your area. Check the back cover for addresses. The service form supplied at the end of the manual should be used to provide the service facility with information concerning any difficulty.

## 1.3 MANUAL ADDENDA

Product improvements or changes to this manual will be explained on an addendum included with the manual. It is recommended that this information be incorporated immediately into the appropriate places in the manual.

If an additional instruction manual is required, order the manual package (Keithley Part Number 7158-901-00). The manual package includes an instruction manual and all pertinent addenda.

## 1.4 SAFETY SYMBOLS AND TERMS

The symbol  on the card denotes that the user should refer to the operating instructions.

The **WARNING** used in this manual explains dangers that could result in personal injury or death.

The **CAUTION** used in this manual explains hazards that could damage the card.

## 1.5 UNPACKING AND INSPECTION

The Model 7158 was inspected both electrically and mechanically before shipment. Upon receiving the Model 7158, unpack all items from the shipping carton and check for any obvious damage that may have occurred during transit. Report any damage to the shipping agent. Retain and use the original packaging materials in case reshipment is necessary. The following items are shipped with every Model 7158:

Model 7158 Low Current Scanner Card

Model 7158 Instruction Manual

Model 4801 Low Noise Coax Cable (48 in., supplied accessory)

The following item is an optional accessory:

Model 4804 Triax (F) to BNC (M) Adapter

## **1.6 SPECIFICATIONS**

Detailed specifications of the Model 7158 precede the Table of Contents of this manual.

# SECTION 2 OPERATION

## 2.1 INTRODUCTION

This section contains an operation overview, safety information, connections and cabling information, an installation procedure, operating instructions, and an application for the card.

## 2.2 SAFETY PRECAUTIONS

### WARNING

**Maintain inputs and outputs within 30V peak of earth ground. Turn off all power and discharge stored energy in external circuitry before making or breaking connections.**

1. The maximum signal level is 100mA peak (30V compliance).
2. Make sure the scanner mainframes are grounded through an earth grounded receptacle before operation.
3. Inspect all connections for wear and defects such as cracks and exposed wires.

### 2.2.1 High Impedance Considerations

Because of the high impedance circuits on the card, be careful when handling it to avoid contamination from such foreign materials as body oils. Such contamination can substantially lower leakage resistance, degrading performance.

Handle the card only by the edges. If you remove the relay covers, be careful not to touch board surfaces or exposed parts.

To avoid dirt build-up over a period of time, operate the scanner and scanner card only in a clean environment. If contamination is suspected, the card should be carefully cleaned using the procedure given in paragraph 3.2.

### **2.2.2 Static Precautions**

The card's IC chips are static-sensitive and can be damaged by static discharge, rendering the card partially or completely inoperative. For that reason, be careful not to touch exposed areas of the circuit board if static is thought to be a problem.

#### **CAUTION**

**Static discharge to exposed circuits can damage the card and might invalidate the warranty.**

## **2.3 CONNECTIONS AND CABLING**

Signal input and output connections are made with BNC connectors on the card. The locations for each channel input and the outputs are indicated on the relay covers. The two output connectors permit multiple Model 7158 cards to be connected together. For example, a 20-channel scanner system can be connected as shown in Figure 2-1.

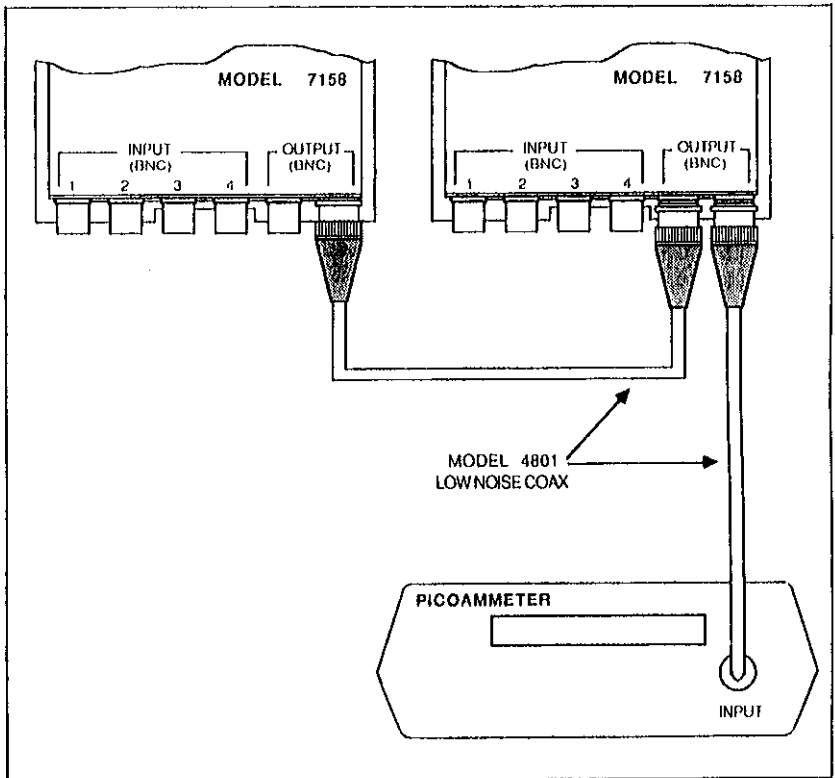
In addition to card-to-card connections, the Model 4801 low noise cable can be used for scanner-to-scanner connections when daisy-chaining up to five scanner mainframes.

#### **CAUTION**

**Keithley's Model 7058 low current scanner card has triax connectors. Be careful not to interchange triax and BNC connectors to avoid damaging them.**

Caps are provided for all connectors. Unused connectors should be capped to prevent contamination of the insulators, which could degrade performance.

The supplied low noise coax cable has a conductive lubricant (graphite) to minimize the error current caused by friction between cable insulators and conductors. This becomes a consideration when measuring current levels in the picoamp range. Since cable flexing due to vibration and cable expansion and contraction due to temperature fluctuation cause friction, the signal cables should be fastened to a rigid surface and not subject to temperature changes. (The temperature changes normally experienced in laboratory environments are not a problem).



**Figure 2-1. Multi-Card Connection**

## **2.4 INSTALLATION AND REMOVAL**

The procedures to install the Model 7158 in the Model 705 or 706 Scanners are similar except for the card orientation. See Figure 2-2 for a Model 705 and Figure 2-3 for a Model 706.

### **WARNING**

**Turn off the scanner mainframe and disconnect the power cord before installing or removing scanner cards.**

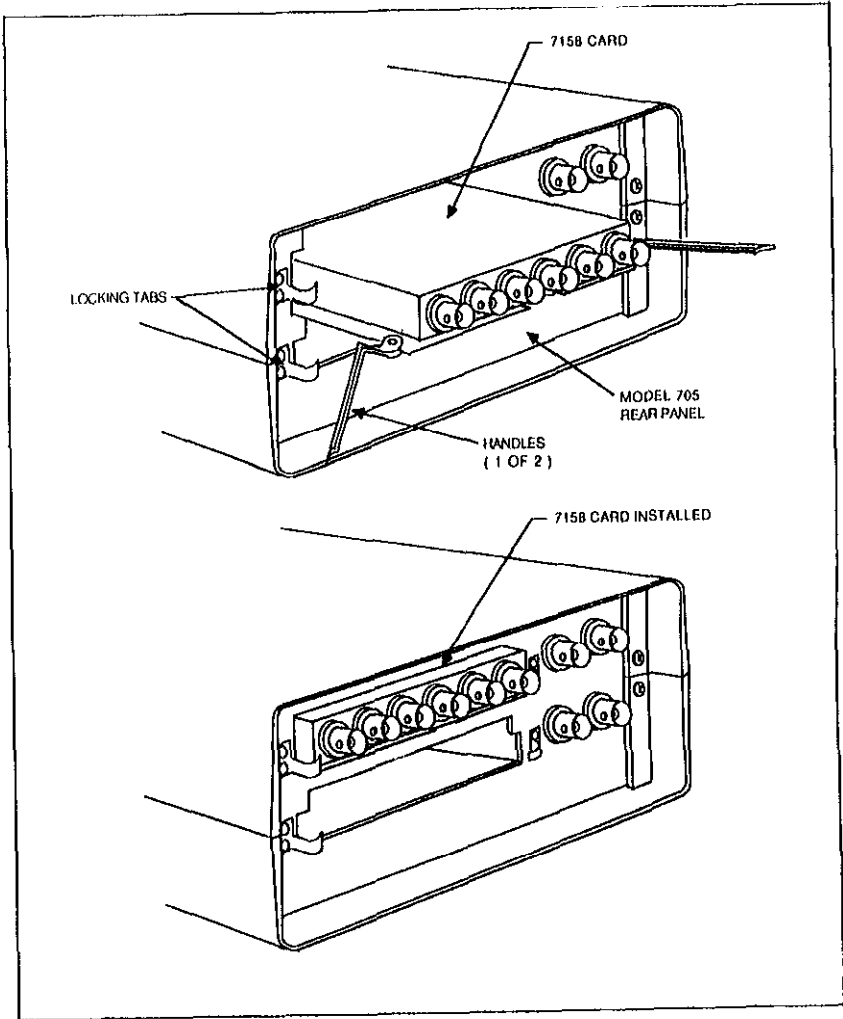
### **CAUTION**

**Leave the Model 7158 in its anti-static bag until ready for cabling and installing to avoid possible static damage.**

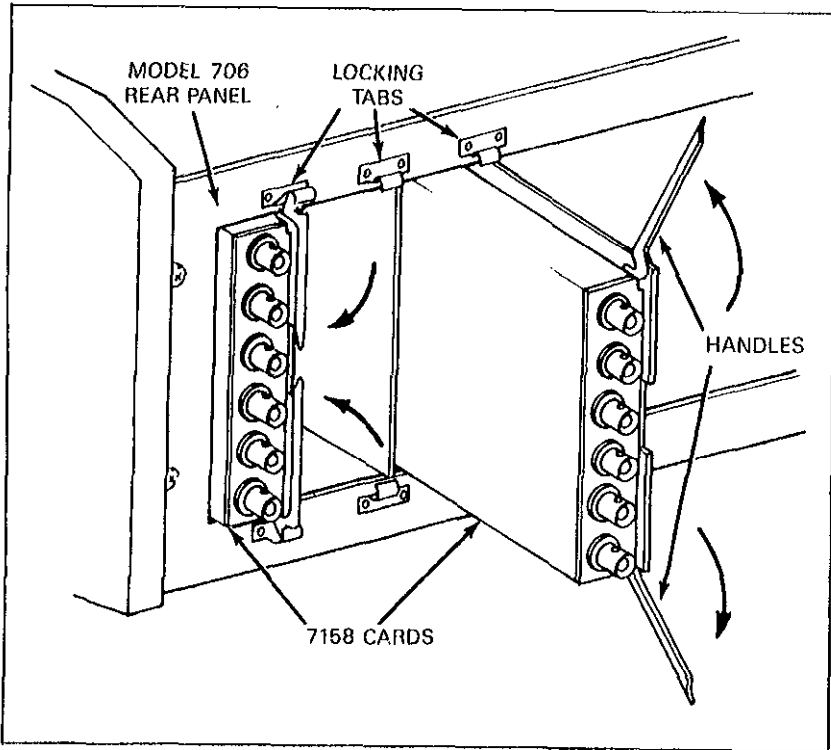
Once the card is cabled, insert it card edge first into the scanner mainframe by aligning it with the grooves in the appropriate slot. Make sure it is properly seated into the mainframe connector. Push the locking tabs forward to the center of the card to lock it in.

To remove a card, first turn off the mainframe and all other equipment connected to the card. Unfasten the locking tabs on the card by pulling the tabs outward. Grasp the end of the card and carefully pull it out of the mainframe.





**Figure 2-2. Installing Card in Model 705**



**Figure 2-3. Installing Card in Model 706**

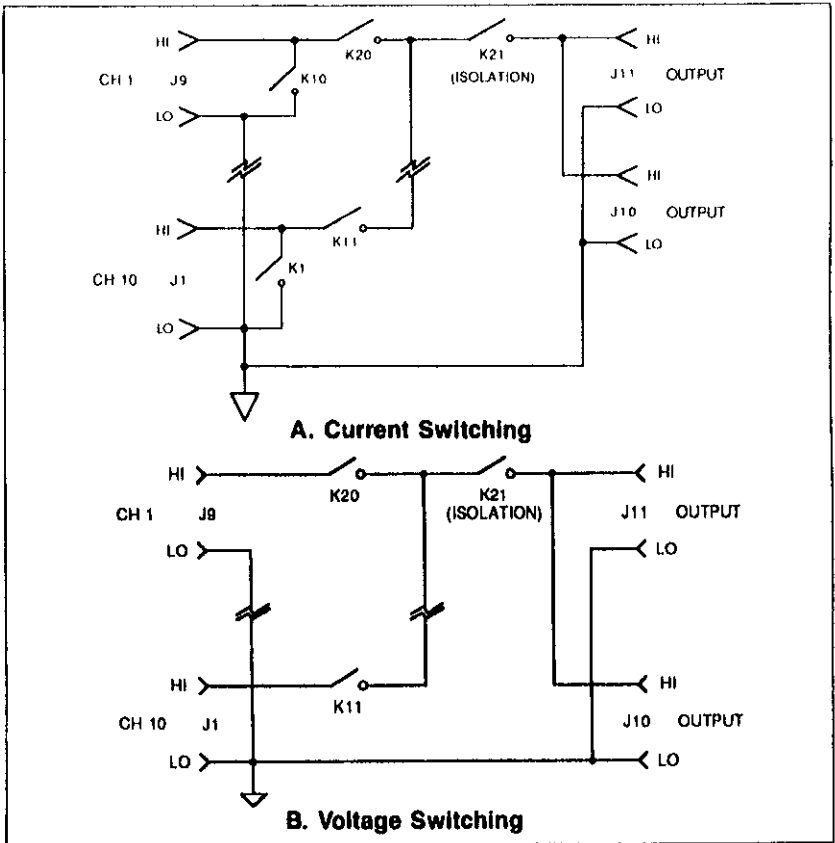
## **2.5 OPERATION**

As shown in Figure 2-4A for current switching, each channel on the Model 7158 has a pair of single-pole single-throw (SPST), normally open (NO) relays. The relay pair switches signal HI between signal LO (analog ground) and output HI. Signal LO (outside shell of the BNC) is common to all channels and outputs in the system.

*An additional relay isolates all circuitry on the card from the outputs when no channel is closed. That is, the isolation relay is open when all channels are open, and it is closed when any channel is closed.*

The card is designed for scanning current sources: when a channel is not selected, a current path is maintained through its signal HI to LO relay. This protects sensitive devices under test from spikes when switching an ammeter in and out of each circuit.

The Model 7158 can also be configured for voltage switching (schematic shown in Figure 2-4B). This configuration is made possible by removing the socketed driver chips (U1 and U2) for the channel HI to LO relay coils. (These chips are static sensitive. See paragraph 3.2 for handling precautions).



**Figure 2-4. Model 7158 Simplified Schematic**

## 2.5.1 Scanner Control of the Channels

Since the Model 7158 is a 10-channel card, set the scanner to the 2-pole mode when using the Model 7158 by itself or when intermixing with other 10-channel cards (such as Models 7056, 7058, 7059, 7066, and 7067). In the 2-pole mode, each scanner channel controls one channel on one 10-channel card.

As an example, consider the combination of a Model 7158 and Model 7059. Table 2-1 shows the scanner and card channel assignments for a master scanner.

**Table 2-1. Example Channel Assignments in 2-Pole Mode**

| Card 1 - Model 7158<br>10 channels |                 | Card 2 - Model 7059<br>10 channels |                 |
|------------------------------------|-----------------|------------------------------------|-----------------|
| Scanner<br>Ch. No.                 | 7158<br>Ch. No. | Scanner<br>Ch. No.                 | 7059<br>Ch. No. |
| 001                                | 1               | 011                                | 1               |
| 002                                | 2               | 012                                | 2               |
| 003                                | 3               | 013                                | 3               |
| 004                                | 4               | 014                                | 4               |
| 005                                | 5               | 015                                | 5               |
| 006                                | 6               | 016                                | 6               |
| 007                                | 7               | 017                                | 7               |
| 008                                | 8               | 018                                | 8               |
| 009                                | 9               | 019                                | 9               |
| 010                                | 10              | 020                                | 10              |

The Model 7158 can be mixed with cards other than 10-channel cards, but there are complications when changing the pole mode to support a mix of card types. When using a Model 7158 in combination with a 20-channel card, such as the Model 7064, set the scanner to 1-pole mode. In this mode, each scanner channel controls one channel on one 20-channel card. The effect on the Model 7158 channel assignments is shown in Table 2-2.

### NOTE

In the 1-pole scanner mode, close one channel at a time when using the Model 7158. Otherwise, other channels are closed on the card and show up on the mainframe display. For example, close channels 2 and 5, channels 1 and 6 also close.

**Table 2-2. Example Channel Assignments in 1-Pole Mode**

| Card 1 - Model 7158<br>10 channels |                 | Card 2 - Model 7064<br>20 channels |                 |
|------------------------------------|-----------------|------------------------------------|-----------------|
| Scanner<br>Ch. No.                 | 7158<br>Ch. No. | Scanner<br>Ch. No.                 | 7064<br>Ch. No. |
| 001                                | 1               | 021                                | 1               |
| 002                                | 1               | 022                                | 2               |
| 003                                | 2               | 023                                | 3               |
| 004                                | 2               | 024                                | 4               |
| 005                                | 3               | 025                                | 5               |
| 006                                | 3               | 026                                | 6               |
| 007                                | 4               | 027                                | 7               |
| 008                                | 4               | 028                                | 8               |
| 009                                | 5               | 029                                | 9               |
| 010                                | 5               | 030                                | 10              |
| 011                                | 6               | 031                                | 11              |
| 012                                | 6               | 032                                | 12              |
| 013                                | 7               | 033                                | 13              |
| 014                                | 7               | 034                                | 14              |
| 015                                | 8               | 035                                | 15              |
| 016                                | 8               | 036                                | 16              |
| 017                                | 9               | 037                                | 17              |
| 018                                | 9               | 038                                | 18              |
| 019                                | 10              | 039                                | 19              |
| 020                                | 10              | 040                                | 20              |

Next, consider a mix of a 10-channel card (Model 7158), a 20-channel card (Model 7064), and a matrix card (Model 7052) in a Model 706 scanner mainframe. Since a matrix card is present, the scanner is set to matrix (0-pole) mode. The scanner crosspoints and card channel assignments for a master scanner are shown in Table 2-3.

**Table 2-3. Example Channel Assignments in Matrix (0-Pole Mode)**

| Card 1 - Model 7158<br>10 channels |                 | Card 2 - Model 7064<br>20 channels |                 | Card 3 - Model 7052<br>5 Columns by 4 rows |                        |
|------------------------------------|-----------------|------------------------------------|-----------------|--|------------------------|
| 706<br>Crosspoint                  | 7158<br>Ch. No. | 706<br>Crosspoints                 | 7064<br>Ch. No. | 706<br>Crosspoint                          | 7052<br>Column,<br>Row |
| 001,1                              | 1               | 006,1 007,3                        | 1               | 011,1                                      | 1,1                    |
| 002,1                              | 2               | 006,1 006,3                        | 2               | 011,2                                      | 1,2                    |
| 003,1                              | 3               | 007,1 007,3                        | 3               | 011,3                                      | 1,3                    |
| 004,1                              | 4               | 007,1 006,3                        | 4               | 011,4                                      | 1,4                    |
| 005,1                              | 5               | 008,1 007,3                        | 5               | 012,1                                      | 2,1                    |
| 001,2                              | 6               | 008,1 006,3                        | 6               | 012,2                                      | 2,2                    |
| 002,2                              | 7               | 009,1 007,3                        | 7               | 012,3                                      | 2,3                    |
| 003,2                              | 8               | 009,1 006,3                        | 8               | 012,4                                      | 2,4                    |
| 004,2                              | 9               | 010,1 007,3                        | 9               | 013,1                                      | 3,1                    |
| 005,2                              | 10              | 010,1 006,3                        | 10              | 013,2                                      | 3,2                    |
|                                    |                 | 006,2 007,3                        | 11              | 013,3                                      | 3,3                    |
|                                    |                 | 006,2 006,3                        | 12              | 013,4                                      | 3,4                    |
|                                    |                 | 007,2 007,3                        | 13              | 014,1                                      | 4,1                    |
|                                    |                 | 007,2 006,3                        | 14              | 014,2                                      | 4,2                    |
|                                    |                 | 008,2 007,3                        | 15              | 014,3                                      | 4,3                    |
|                                    |                 | 008,2 006,3                        | 16              | 014,4                                      | 4,4                    |
|                                    |                 | 009,2 007,3                        | 17              | 015,1                                      | 5,1                    |
|                                    |                 | 009,2 006,3                        | 18              | 015,2                                      | 5,2                    |
|                                    |                 | 010,2 007,3                        | 19              | 015,3                                      | 5,3                    |
|                                    |                 | 010,2 006,3                        | 20              | 015,4                                      | 5,4                    |

When using 20-channel cards in matrix mode, two crosspoints must be closed for each of the card channels.

In general, the rules for choosing different scanner pole modes are:

matrix (0-pole) - If a matrix card is present.

1-pole - If a 20-channel card is present, but no matrix card.

2-pole - If a 10-channel card is present, but no 20-channel or matrix cards.

4-pole - If 4-pole switching is desired with two 2-pole, 10-channel cards.

Tables 2-4 through 2-7 list the scanner channels that control Model 7158 channels for all scanner pole configurations.

**Table 2-4. Scanner Control of Model 7158 4-Pole Mode**

| Card No. | Scanner Channel No. | 7158 Channel No. | Scanner  |
|----------|---------------------|------------------|----------|
| 1        | 01-10               | 1-10             | 705, 706 |
| 2        | 01-10               | 1-10             | 705, 706 |
| 3        | 11-20               | 1-10             | 706      |
| 4        | 11-20               | 1-10             | 706      |
| 5        | 21-30               | 1-10             | 706      |
| 6        | 21-30               | 1-10             | 706      |
| 7        | 31-40               | 1-10             | 706      |
| 8        | 31-40               | 1-10             | 706      |
| 9        | 41-50               | 1-10             | 706      |
| 10       | 41-50               | 1-10             | 706      |

**Table 2-5. Scanner Control of Model 7158 2-Pole Mode**

| Card No. | Scanner Channel No. | 7158 Channel No. | Scanner  |
|----------|---------------------|------------------|----------|
| 1        | 01-10               | 1-10             | 705, 706 |
| 2        | 11-20               | 1-10             | 705, 706 |
| 3        | 21-30               | 1-10             | 706      |
| 4        | 31-40               | 1-10             | 706      |
| 5        | 41-50               | 1-10             | 706      |
| 6        | 51-60               | 1-10             | 706      |
| 7        | 61-70               | 1-10             | 706      |
| 8        | 71-80               | 1-10             | 706      |
| 9        | 81-90               | 1-10             | 706      |
| 10       | 91-100              | 1-10             | 706      |

**Table 2-6. Scanner Control of Model 7158 1-Pole Mode**

| Card 1             | Card 2             | Card 3             | Card 4             | Card 5             | 7158<br>Ch. No. |
|--------------------|--------------------|--------------------|--------------------|--------------------|-----------------|
| Scanner<br>Ch. No. | Scanner<br>Ch. No. | Scanner<br>Ch. No. | Scanner<br>Ch. No. | Scanner<br>Ch. No. |                 |
| 01, 02             | 21, 22             | 41, 42             | 61, 62             | 81, 82             | 1               |
| 03, 04             | 23, 24             | 43, 44             | 63, 64             | 83, 84             | 2               |
| 05, 06             | 25, 26             | 45, 46             | 65, 66             | 85, 86             | 3               |
| 07, 08             | 27, 28             | 47, 48             | 67, 68             | 87, 88             | 4               |
| 09, 10             | 29, 30             | 49, 50             | 69, 70             | 89, 90             | 5               |
| 11, 12             | 31, 32             | 51, 52             | 71, 72             | 91, 92             | 6               |
| 13, 14             | 33, 34             | 53, 54             | 73, 74             | 93, 94             | 7               |
| 15, 16             | 35, 36             | 55, 56             | 75, 76             | 95, 96             | 8               |
| 17, 18             | 37, 38             | 57, 58             | 77, 78             | 97, 98             | 9               |
| 19, 20             | 39, 40             | 59, 60             | 79, 80             | 99, 100            | 10              |
| 705, 706           | 705, 706           | 706                | 706                | 706                |                 |

| Card 6             | Card 7             | Card 8             | Card 9             | Card 10            | 7158<br>Ch. No. |
|--------------------|--------------------|--------------------|--------------------|--------------------|-----------------|
| Scanner<br>Ch. No. | Scanner<br>Ch. No. | Scanner<br>Ch. No. | Scanner<br>Ch. No. | Scanner<br>Ch. No. |                 |
| 101, 102           | 121, 122           | 141, 142           | 161, 162           | 181, 182           | 1               |
| 103, 104           | 123, 124           | 143, 144           | 163, 164           | 183, 184           | 2               |
| 105, 106           | 125, 126           | 145, 146           | 165, 166           | 185, 186           | 3               |
| 107, 108           | 127, 128           | 147, 148           | 167, 168           | 187, 188           | 4               |
| 109, 110           | 129, 130           | 149, 150           | 169, 170           | 189, 190           | 5               |
| 111, 112           | 131, 132           | 151, 152           | 171, 172           | 191, 192           | 6               |
| 113, 114           | 133, 134           | 153, 154           | 173, 174           | 193, 194           | 7               |
| 115, 116           | 135, 136           | 155, 156           | 175, 176           | 195, 196           | 8               |
| 117, 118           | 137, 138           | 157, 158           | 177, 178           | 197, 198           | 9               |
| 119, 120           | 139, 140           | 159, 160           | 179, 180           | 199, 200           | 10              |
| 706                | 706                | 706                | 706                | 706                |                 |



**Table 2-7. Scanner Control of Model 7158 Matrix (0-Pole) Mode**

| Card 1             | Card 2             | Card 3             | Card 4             | Card 5             | 7158<br>Ch. No. |
|--------------------|--------------------|--------------------|--------------------|--------------------|-----------------|
| Scanner<br>Ch. No. | Scanner<br>Ch. No. | Scanner<br>Ch. No. | Scanner<br>Ch. No. | Scanner<br>Ch. No. |                 |
| 01, 1              | 06, 1              | 11, 1              | 16, 1              | 21, 1              | 1               |
| 02, 1              | 07, 1              | 12, 1              | 17, 1              | 22, 1              | 2               |
| 03, 1              | 08, 1              | 13, 1              | 18, 1              | 23, 1              | 3               |
| 04, 1              | 09, 1              | 14, 1              | 19, 1              | 24, 1              | 4               |
| 05, 1              | 10, 1              | 15, 1              | 20, 1              | 25, 1              | 5               |
| 01, 2              | 06, 2              | 11, 2              | 16, 2              | 21, 2              | 6               |
| 02, 2              | 07, 2              | 12, 2              | 17, 2              | 22, 2              | 7               |
| 03, 2              | 08, 2              | 13, 2              | 18, 2              | 23, 2              | 8               |
| 04, 2              | 09, 2              | 14, 2              | 19, 2              | 24, 2              | 9               |
| 05, 2              | 10, 2              | 15, 2              | 20, 2              | 25, 2              | 10              |
| 705, 706           | 705, 706           | 706                | 706                | 706                |                 |

| Card 6             | Card 7             | Card 8             | Card 9             | Card 10            | 7158<br>Ch. No. |
|--------------------|--------------------|--------------------|--------------------|--------------------|-----------------|
| Scanner<br>Ch. No. | Scanner<br>Ch. No. | Scanner<br>Ch. No. | Scanner<br>Ch. No. | Scanner<br>Ch. No. |                 |
| 26, 1              | 31, 1              | 36, 1              | 41, 1              | 46, 1              | 1               |
| 27, 1              | 32, 1              | 37, 1              | 42, 1              | 47, 1              | 2               |
| 28, 1              | 33, 1              | 38, 1              | 43, 1              | 48, 1              | 3               |
| 29, 1              | 34, 1              | 39, 1              | 44, 1              | 49, 1              | 4               |
| 30, 1              | 35, 1              | 40, 1              | 45, 1              | 50, 1              | 5               |
| 26, 2              | 31, 2              | 36, 2              | 41, 2              | 46, 2              | 6               |
| 27, 2              | 32, 2              | 37, 2              | 42, 2              | 47, 2              | 7               |
| 28, 2              | 33, 2              | 38, 2              | 43, 2              | 48, 2              | 8               |
| 29, 2              | 34, 2              | 39, 2              | 44, 2              | 49, 2              | 9               |
| 30, 2              | 35, 2              | 40, 2              | 45, 2              | 50, 2              | 10              |
| 706                | 706                | 706                | 706                | 706                |                 |

## 2.5.2 Operation Notes

1. Extreme environmental conditions can cause the offset current to exceed the 1pA specification. If the card has been exposed to high humidity and/or temperature (for example during shipping), stabilize the board within the specified environmental limits for 24 hours.
2. When a channel is opened or closed, there is a charge transfer in the picocoulomb range. This is because of the mechanical release or closure of the contacts, the contact to coil capacitance, and the stray capacitance between signal and relay drive lines. The charge transfer causes a current pulse. The effect on the signal depends on the magnitude of the source being measured.
3. Each relay on the Model 7158 draws 10mA. For current switching, there are either ten or eleven relays energized with any combination of open and closed channels. The maximum current draw of one card from the mainframe power supply is 110mA. (For voltage switching, there are between zero and eleven relays energized for any open/closed channel combination.) There are no restrictions on the maximum number of simultaneous channel closures unless relays from other card types are energized at the same time.
4. System response is affected by cable capacitance. This should be considered when the sources are connected to the scanner. Use of a feedback ammeter (or an electrometer in the FAST mode) for currents below  $10^{-9}$ A is recommended to increase measurement speed and decrease the effects of cable capacitance.
5. Power Limits - To prevent overheating or damage to the relay contacts, never exceed the signal level specifications of the card. Maximum switched and carry current and voltage levels are 100mA, 30V. The card can switch low power AC (typical bandwidth up to 1MHz). Maximum switched and carry current and voltage levels are 100mA, 30V, peak (resistive loads).
6. Switching Speed - Relay actuation time is 1msec maximum plus the mainframe programming time. Maximum relay switching rate is 100 cycles per second (10msec). This is the maximum rate of the scanner mainframe. For extended relay life, use low power or cold switching (turn on sources after the channel is closed).

## 2.6 APPLICATIONS

The Model 7158 can be used in a variety of applications to switch low

current levels. Typical applications include those where sourcing voltage and measuring current are required, such as:

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

Voltage applications include those where the Model 7158 can be used to switch a single-pole of low voltage sources. (Refer to the application example that follows.)

When measuring low currents, the following sources of noise current should be considered:

- Triboelectric currents are caused by friction between a conductor and insulator when a coax cable flexes due to vibration or temperature fluctuation. To minimize, use low noise cables and tie down to a rigid surface.
- Piezoelectric currents are caused by mechanical stress to the insulating materials of connectors. Remove the stress from the insulators and use material with low piezoelectric effects to minimize.
- Electrochemical effects generate current between PCB conductors due to contamination of the card surface. To minimize, handle the card by the edges only and follow the cleaning instructions in paragraph 3.2.

For a specific application, consider measuring capacitor leakage current to calculate insulation resistance. The amount of leakage current depends on the capacitor dielectric material as well as the applied voltage. The schematic of Figure 2-5 shows a Model 7055/7056 card on the source side, but a Model 7158 could be used in its voltage configuration when the test voltage does not exceed 30V.

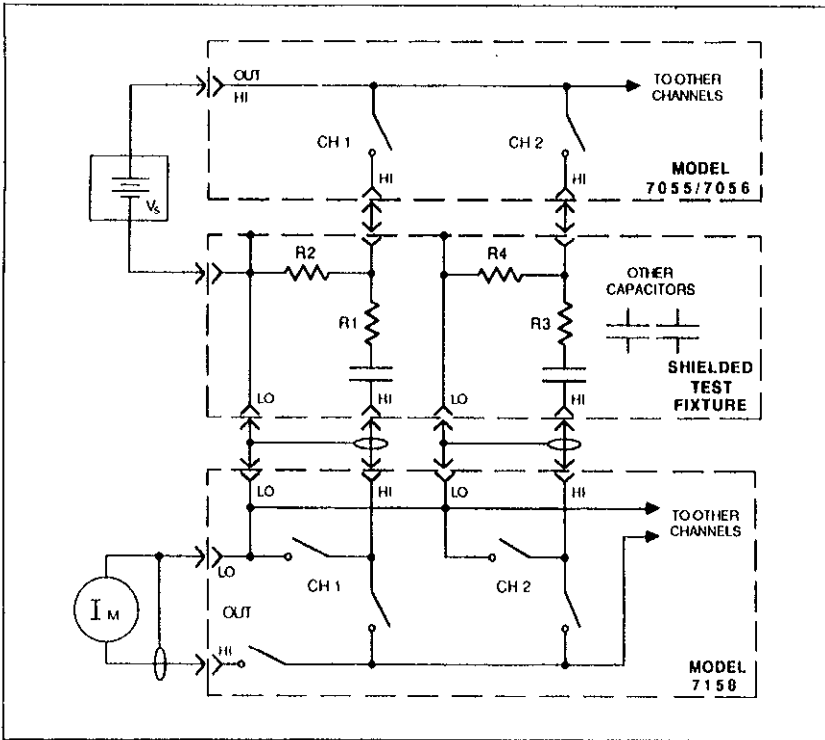
The configuration shown is the direct method of measuring leakage currents: a feedback type picoammeter in series with the capacitor under test. This test is fully explained (including controlling software

and test fixture construction) in Application Note #120, "Capacitor Leakage Measurements".

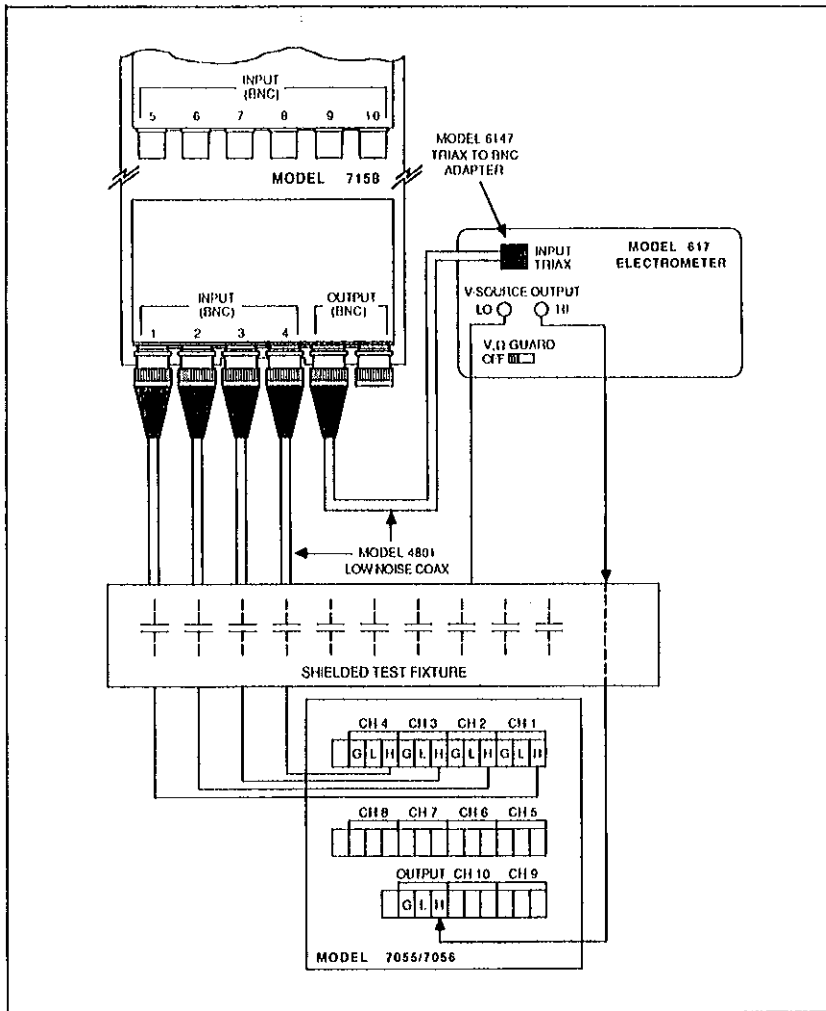
**NOTE**

The indirect method, with a voltmeter reading the voltage drop across a resistor in series with the capacitor, is recommended for capacitor values above  $1\mu\text{F}$  to maintain stability and noise performance.

The instrument setup is shown in Figure 2-6. For clarity, only four channels are shown. Obviously, all ten channels are available for testing purposes.



**Figure 2-5. Capacitor Leakage Schematic**



**Figure 2-6. Capacitor Leakage Instrument Setup**

The internal voltage source of a Model 617 electrometer stagger charges the capacitors when the corresponding channels are closed on a Model 7056 general purpose card. (At this time, the signal HI to LO relay on

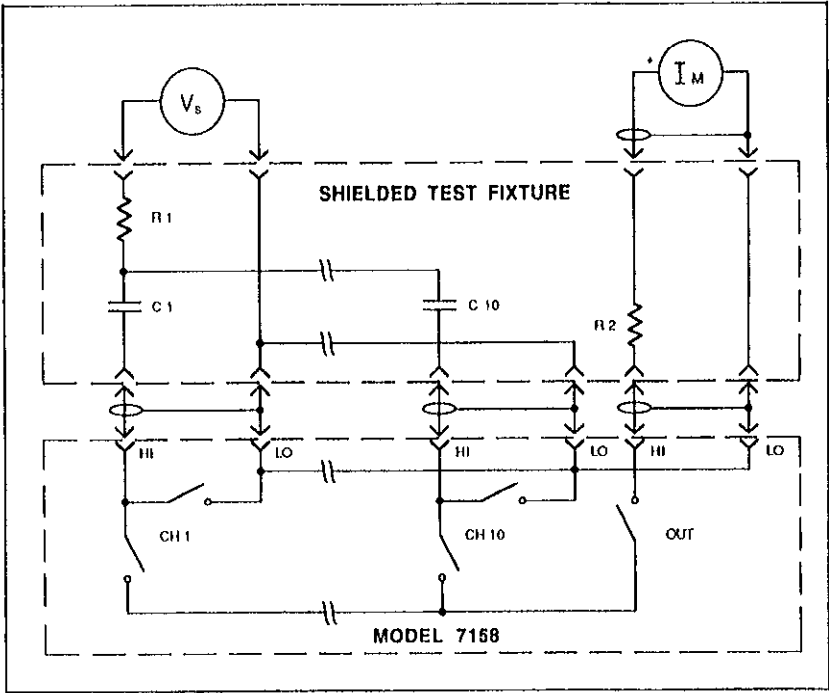
the Model 7158 is closed, completing the circuit.) Resistor R1 is needed to limit current in case the capacitor is shorted and it also helps reduce noise.

After each capacitor is fully charged (usually 10 times  $R1C$ ), the Model 7158 channel is programmed to close. This switches in the Model 617 for reading current or resistance (V/I mode).

Once the Model 617 has settled and the measurement is taken, the Model 7158 channel is opened and the signal HI to LO relay closes to shunt the current to ground. Then the Model 7056 channel is opened to avoid a current surge through the electrometer and resistors R1 and R2 bleed off the capacitor charge.

With this two-card configuration, the capacitors have equal soak times. This is important when comparing low leakage levels (picoamps).

Having equivalent soak times is not as critical at higher leakage levels (e.g. the nanoamp range of tantalum capacitors). In this case, the one-card configuration shown in Figure 2-7 is sufficient. Since the settling time of the Model 617 is less when measuring higher currents, the channels can be switched faster.



**Figure 2-7. Measuring Leakages with One Card**

# SECTION 3

## SERVICING INFORMATION

### 3.1 INTRODUCTION

This section describes tests for verifying the performance of the Model 7158. Perform these tests in an environment of 18°C to 28°C up to 70% RH.

Because of the low signal levels measured in these tests, the test cables should be kept as still as possible to help minimize noise.

Recommended maintenance includes inspection of the card and the card edge connector to ensure good electrical contact.

### 3.2 HANDLING AND CLEANING

*Because of the high impedance of the board, take special care when handling and using to prevent degradation of performance. Handle the board by the edges to avoid contaminating it with dirt, body oil, etc.*

CMOS and other high-impedance devices are subject to possible static discharge damage because of the high impedance levels involved. When handling such devices (indicated by \* in the parts list), use the following precautions:

1. Such devices should be transported and handled only in containers specially designed to prevent or dissipate static build-up. Typically, these devices will be received in anti-static containers of plastic or foam. Keep these parts in their original containers until ready for installation.
2. Remove the devices from their protective containers only at a properly grounded work station. Also, ground yourself with a suitable wrist strap.



3. Handle the devices only by the body; do not touch the pins.
4. Any printed circuit board into which the device is to be inserted must also be grounded to the bench or table.
5. Use only anti-static de-soldering tools and grounded-tip soldering irons.

Before cleaning the board, remove the front and rear relay covers. Clean the board with cotton swabs or a soft brush saturated with an uncontaminated solvent, such as Freon® TMS or TE. After the solvent has been applied and is still liquid, blow-dry the board with dry-pumped nitrogen gas.

### **3.3 RELAY REPLACEMENT**

If you have determined that a relay is defective, use the following procedure to replace it:

1. Remove the screws that secure the appropriate relay cover and remove the cover.
2. Unsolder the defective relay and clean the card holes with a desoldering tool or wick. Solder in a replacement relay.
3. Clean the card according to the method given in paragraph 3.2 using localized cleaning only, then reinstall relay covers.

### 3.4 RECOMMENDED TEST EQUIPMENT

Table 3-1 lists recommended test equipment for performance verification. Other test equipment may be substituted if specifications equal or exceed those stated.

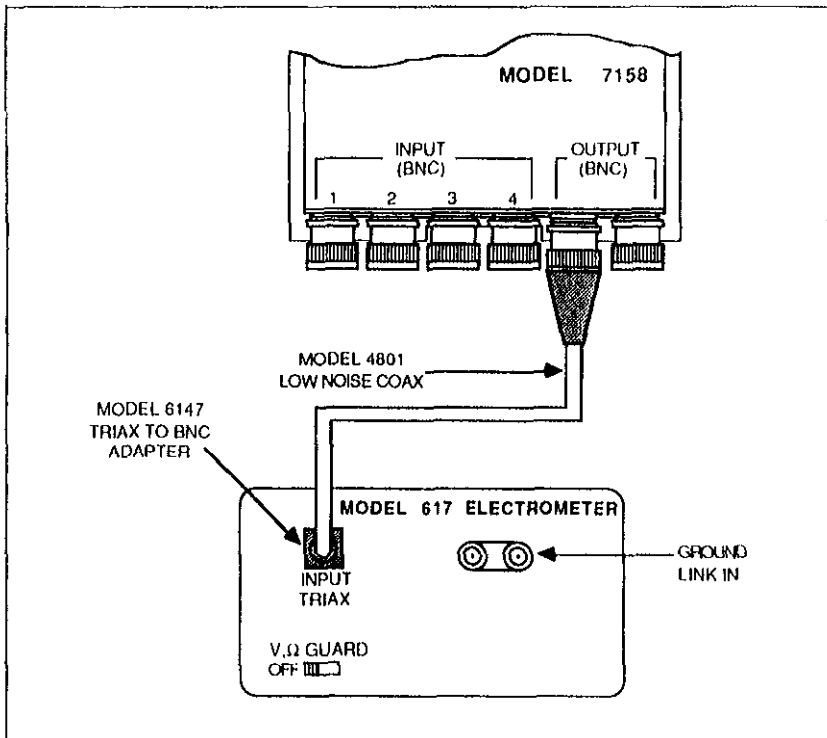
**Table 3-1. Recommended Test Equipment**

| Description          | Specification            | Mfr.     | Model         |
|----------------------|--------------------------|----------|---------------|
| Scanner Mainframe    | —                        | Keithley | 705 or<br>706 |
| Extender Card        | —                        | Keithley | 7061          |
| Low Noise Coax Cable | 4 feet long              | Keithley | 4801          |
| Electrometer         | $10^{-12}$ A sensitivity | Keithley | 617           |
| Triax to BNC Adapter | —                        | Keithley | 6147          |
| Ohmmeter-DMM         | $< 1\Omega$ sensitivity  | Keithley | 196           |
| Kelvin Test Leads    | —                        | Keithley | 5806          |

### 3.5 OFFSET CURRENT TEST

This test verifies that the offset current for each channel is within specification.

1. Set up the equipment as shown in Figure 3-1 with caps on all inputs and the unused output.
2. Insert the card into the mainframe.
3. Set the electrometer to the 2pA range and zero check.
4. Turn on the mainframe and close channel 1.
5. Zero correct the Model 617 and release its zero check. Note the offset current long enough to allow the switching transients to decay and the current to stabilize. The current indicated by the electrometer should be less than 1pA, exclusive of noise. Open the channel after taking the reading.
6. Close the remaining channels one at a time and repeat step 5.



**Figure 3-1. Offset Current**

## 3.6 CONTACT RESISTANCE TEST

This test verifies that the contact resistance of the relays does not exceed the specification. The procedure is in three parts:

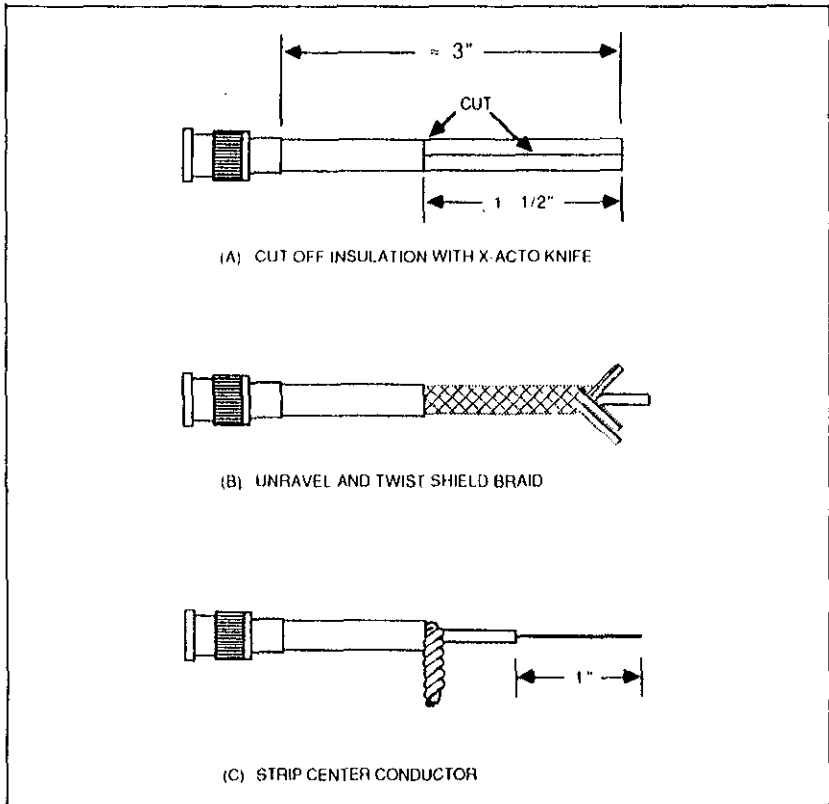
- Setting up equipment.
- Checking contacts of signal HI to LO relays (when channel is open).
- Checking contacts of signal HI to output HI relays in combination with the isolation relay (when channel is closed).

### Setting Up Equipment

1. Turn on the Model 196 DMM and let it warm up (two hours if from cold-start).
2. Using the following procedure, prepare two BNC male connectors with coax pigtails as shown in Figure 3-2.
  - Use an X-acto® knife to cut and strip 1½ inches of outer insulation without cutting the shield.
  - With the knife point, unravel the braided shield and twist it off to the side.
  - Strip one inch of insulation off the center conductor.
3. Connect the Model 7158 to the scanner through the Model 7061 Universal Adapter Card, which is used as an extender to allow access to all connectors.
4. Select the 300Ω range on the Model 196. Temporarily short the test leads and zero the instrument. Leave zero enabled for the duration of the test.

### Checking Signal HI to LO Relays

5. Connect one of the BNC plugs to an input connector on the card. Connect the Kelvin leads to the coax pigtail as shown in Figure 3-3A.
6. With all channels open, verify that the contact resistance is less than 1Ω.
7. Verify the resistance of the remaining signal HI to LO relays by just moving the BNC plug and Kelvin leads to the remaining input connectors and taking readings.

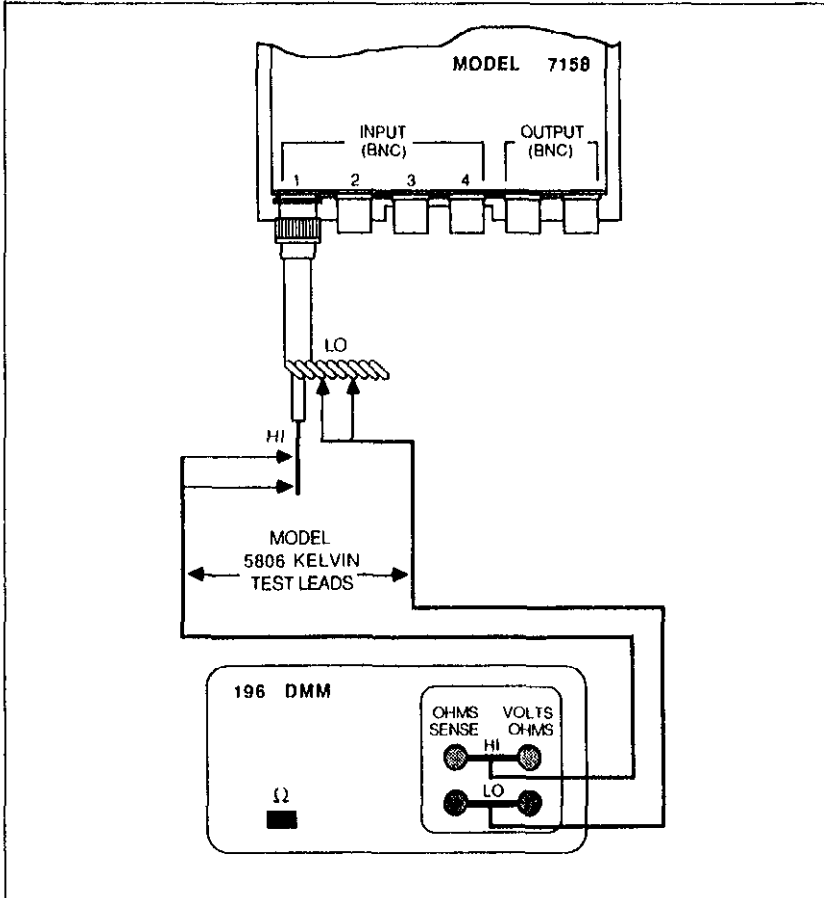


**Figure 3-2. Coax Pigtail Preparation**

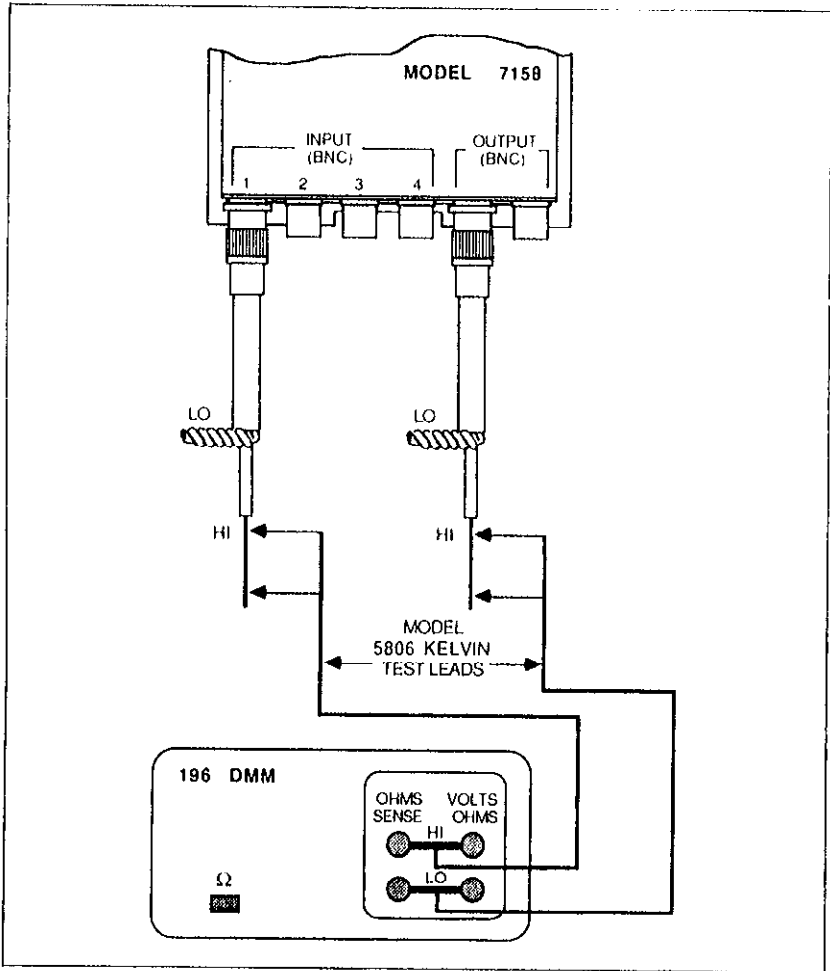
### Checking Signal HI to Output HI Relays and Isolation Relay

8. Connect one of the BNC plugs to an input connector and the other BNC plug to an output connector. Connect the Kelvin leads to the coax pigtails as shown in Figure 3-3B.
9. Program the scanner to close the channel being tested. This closes both the signal HI to output HI relay and the isolation relay for measuring.
10. Verify that the contact resistance of the relay combination (signal HI to LO relay and isolation relay) is less than  $1\Omega$ . Open the channel after taking the reading.

11. Continue with the remaining channels by leaving one BNC plug on the output connector and moving the other BNC plug and Kelvin leads to the remaining input connectors. Take readings with the appropriate channel closed.



**Figure 3-3A. Contact Resistance (Signal HI to LO Relays)**



**Figure 3-3B. Contact Resistance (Signal HI to Output HI Relays)**

# **SECTION 4 REPLACEABLE PARTS**

## **4.1 INTRODUCTION**

This section contains replacement parts information, a component layout, and a schematic diagram for the Model 7158.

## **4.2 PARTS LISTS**

Electrical parts are listed in order of circuit designation in Table 4-1. Table 4-2 summarizes mechanical parts.

## **4.3 ORDERING INFORMATION**

To place a parts order or to obtain information about replacement parts, contact your Keithley representative or the factory. See the back cover for addresses. When ordering parts, be sure to include the following information:

- Scanner card model number (7158)
- Card serial number
- Part description
- Circuit description (if applicable)
- Keithley part number



**Table 4-1. Model 7158 Electrical Parts**

| <b>Circuit Desig.</b>          | <b>Description</b>   | <b>Sch Loc</b> | <b>Keithley Part No.</b> |
|--------------------------------|--|----------------|--------------------------|
| C1                             | Capacitor, 10 $\mu$ F, 25V, Aluminum Electrolytic  | A1             | C-314-10                 |
| C2-C5                          | Capacitor, 0.1 $\mu$ F, 50V, Ceramic Film  | sev            | C-237-1                  |
| J1-J12                         | Connector, Coaxial Female  | sev            | CS-249                   |
| K1-K21                         | Relay, SPST  | sev            | RL-70                    |
| R1-R10                         | Resistor, 330k $\Omega$ , 5%, 1/4W, Carbon Composition   | sev            | R-76-330k                |
| R11                            | Not used   |                |                          |
| R12, R13                       | Resistor, 10k $\Omega$ , 5%, 1/4W, Carbon Composition  | B2             | R-76-10k                 |
| R14                            | Resistor Network, 10k $\Omega$ , 2%, 1.5W, Thick Film  | sev            | TF-39                    |
| TE3, TE4, TE6, TE7, TE11, TE12 | Terminal, Teflon <sup>®</sup>  | sev            | TE-105-1                 |
| U1, U2*                        | IC, Buffer/Line Driver and Receiver, 74HC241   | sev            | IC-520                   |
| U3, U4*                        | IC, Hex Inverter, 74HC04   | sev            | IC-354                   |
| U5*                            | IC, 13-input NAND Gate, 74HC133  | B1             | IC-547                   |
| W1                             | Cable Assembly<br>Sockets (2)<br>#18 AWG Bare Buss Wire<br>#22 AWG Bare Buss Wire<br>#22 AWG Natural Thinwall Teflon <sup>®</sup> Tubing | C4             | 7158-070<br>SO-84-20     |

\*These parts are static sensitive. See paragraph 3.2 for handling precautions.

**Table 4-2. Model 7158 Mechanical Parts**

| <b>Qty.</b> | <b>Description</b>   | <b>Keithley Part No.</b> |
|-------------|--|--------------------------|
| 1           | Bracket, Front Connector Mounting (CH5-CH10)                     | 7158-303                 |
| 1           | Bracket, Rear Connector Mounting (CH1-CH4, OUTPUT)               | 7158-302                 |
| 1           | Cable Clamp  | CC-38-4                  |
| 1           | Cover, Front Relay (CH5-CH10)                                    | 7158-307                 |
| 1           | Cover, Rear Relay (CH1-CH4, OUTPUT)                              | 7158-304                 |
| 12          | Protective Cap (for BNC jacks)                                   | CAP-18                   |
| 5           | #4-40 × 3/16 Phillips pan head sems screw (for bracket mounting) |                          |
| 6           | #6-32 × 1/4 Phillips pan head sems screw (for cover mounting)    |                          |

#### **4.4 FACTORY SERVICE**

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

1. Photocopy and 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.

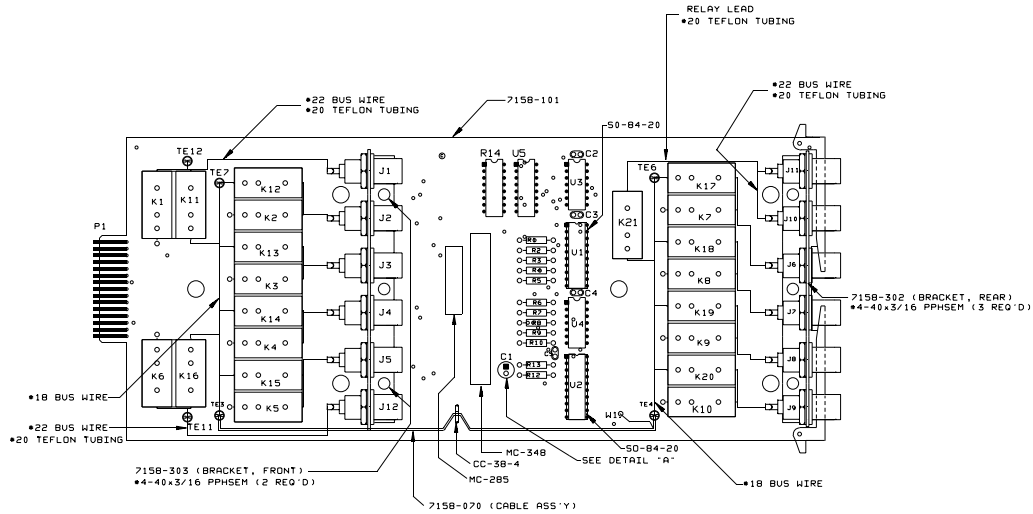
Note that it is not necessary to return the scanner mainframe with the card.

#### **4.5 COMPONENT LAYOUT and SCHEMATIC DIAGRAM**

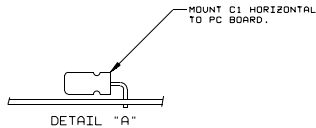
Figure 4-1 shows a component layout of the Model 7158. Figure 4-2 shows a schematic diagram of the Model 7158.

001-BS1Z "DN"

| LTR. | ECD NO. | REVISION                  | ENG. | DATE    |
|------|---------|---------------------------|------|---------|
| A    | 11855   | RELEASED                  | MS   | 2-24-86 |
| B    | 11952   | CHANGED REV FROM A TO B   | MS   | 3-10-87 |
| B1   | 12376   | ADDED DETAIL FOR TP-10    | SZ   | 4-2-87  |
| B3   | 12393   | DELETED DETAIL "B"        | SZ   | 2-11-87 |
| B4   | 12511   | ADDED 50-B4-20 TO U1 & U2 | SZ   | 2-28-87 |

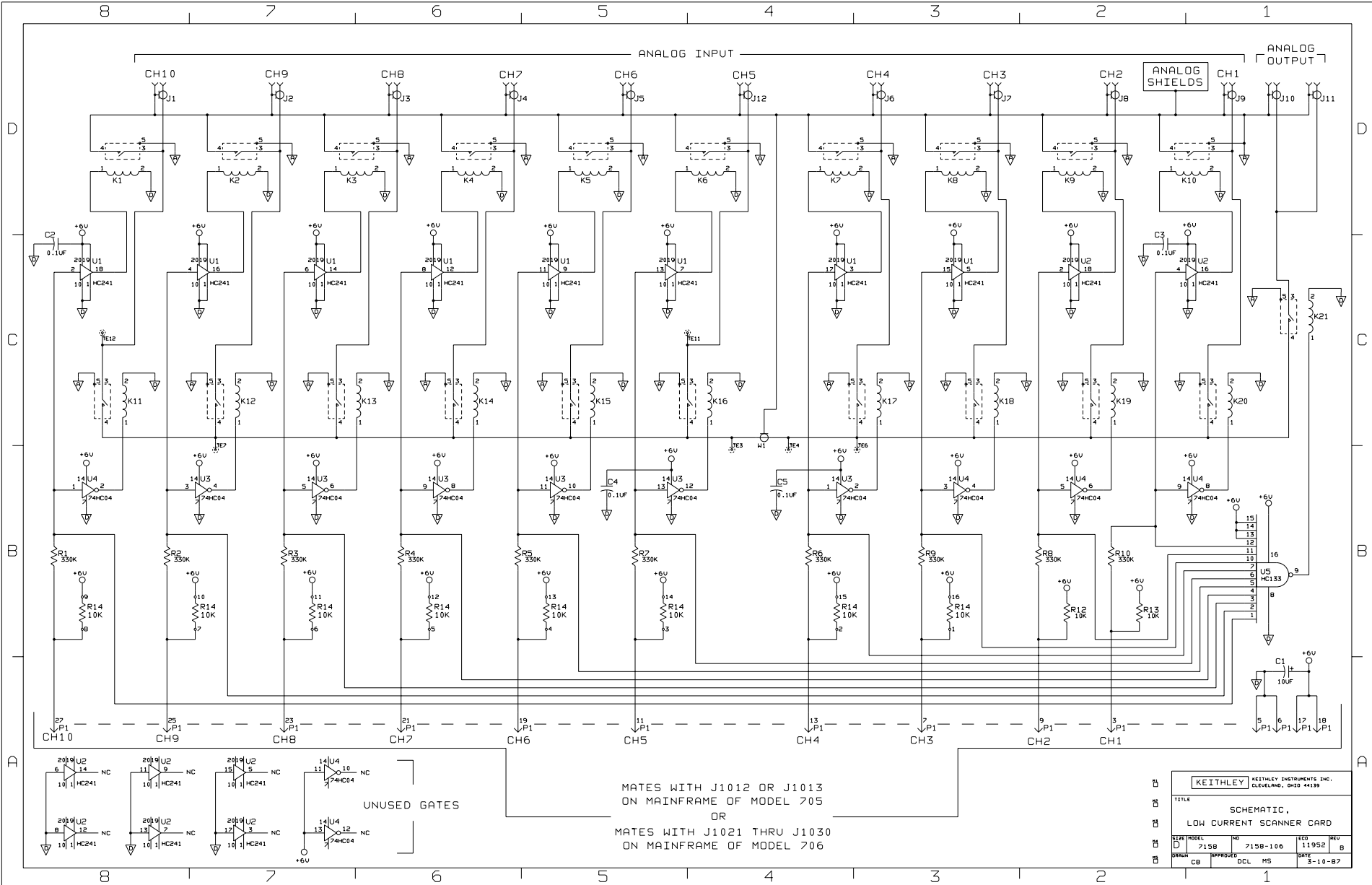


NOTE:  
FOR COMPONENT INFORMATION  
REFER TO BILL OF MATERIAL  
7158-000-00.



| 7158 | MODEL | NEXT ASSEMBLY | QTY. |
|------|-------|---------------|------|
|      |       |               |      |
|      |       |               |      |
|      |       |               |      |

|                           |  |   |             |              |           |  |
|---------------------------|--|---|-------------|--------------|-----------|--|
| DO NOT SCALE THIS DRAWING |  | DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED |             | DATE 2/11/87 | SCALE 1:1 | TITLE COMPONENT LAYOUT, LOW CURRENT SCANNER CARD |
| XXX±.015                  | ANG. ±.1°  | DRN. MM   | ENG. DCL    |              |           |  |
| KEITHLEY                  | KEITHLEY INSTRUMENTS INC.<br>CLEVELAND, OHIO 44139 | XXX±.005  | FAC. ±.1/64 | MATERIAL     |           | NO. 7158-100                                     |
|                           |  | SURFACE MAX. 0.3                                  | FINISH      |              |           |  |



MATES WITH J1012 OR J1013  
ON MAINFRAME OF MODEL 705  
OR  
MATES WITH J1021 THRU J1030  
ON MAINFRAME OF MODEL 706

|   |  |     |         |
|---|--|-----|---------|
| KEITHLEY KEITHLEY INSTRUMENTS INC.<br>CLEVELAND, OHIO 44139 |  |     |         |
| TITLE   | SCHEMATIC,<br>LOW CURRENT SCANNER CARD |     |         |
| DATE  | 7158                                   | REV | 11952   |
| DR  | 7158-106                               | ED  | B       |
| CB  | APP                                    | MS  | 5-10-67 |



# 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.

**KEITHLEY**

**Keithley Instruments, Inc.**  
**Test Instrumentation Group**  
28775 Aurora Road  
Cleveland, Ohio 44139

Printed in the U.S.A.