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Model 7156 General Purpose Scanner Card

Instruction Manual

Contains Operating and Servicing Information

KEITHLEY

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

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

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Model 7156 General Purpose Scanner Card Instruction Manual

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SAFETY PRECAUTIONS

The following safety precautions should be observed before using the Model 7156 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 150V 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 7156-D, 7156-M
General Purpose Scanner Cards

CHANNELS PER CARD: 10 in 2-pole mode, 20 in 1-pole mode.
CONTACT CONFIGURATION: 2-pole Form A. HI or LO switched to a separate output for 1-pole mode. Removal of factory installed jumper creates a SPST isolated switch at each channel.
CONNECTOR TYPE: 37 pin D-sub.
RELAY DRIVE CURRENT:
7156-D: 30mA per relay typical.
7156-M: 50mA per relay typical.
MAXIMUM SIGNAL LEVEL:
7156-D: 150V peak, 0.5A rms switched, 1A rms carry, 10VA (resistive load only).
7156-M: 150V peak, 0.75A rms switched, 1A rms carry, 30VA.
CONTACT LIFE:
7156-D: $>10^8$ closures cold switching; $>10^7$ closures at maximum signal levels
7156-M: $>10^9$ closures cold switching; $>10^8$ closures at maximum signal levels.
CONTACT RESISTANCE: <2Ω to rated life.
CONTACT POTENTIAL:
7156-D: <100μV per contact pair, <50μV typical.
7156-M: <100μV per contact pair, <75μV typical.
ACTUATION TIME:
7156-D: <2msec., exclusive of mainframe.
7156-M: <3msec., exclusive of mainframe.
CHANNEL ISOLATION: $>10^9\Omega$, <150pF.
INPUT ISOLATION:
Differential Mode: $>10^9\Omega$, <50pF.
Common Mode: $>10^9\Omega$, <150pF.
COMMON MODE VOLTAGE: 150V peak.
OPERATING ENVIRONMENT: 0° to 55°C, up to 35°C at 70% RH.
STORAGE ENVIRONMENT: –25° to 65°C.
DIMENSIONS, WEIGHT: 32mm high x 114mm wide x 272 mm long (1.25 in. x 4.5 x 10.75 in.). Net weight: **7156-D**, 0.22kg. (7.5 oz.); **7156-M**, 0.23kg (8 oz.).

Specifications subject to change without notice.

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SECTION 1
General Information

1.1 INTRODUCTION

This section contains general information about the Model 7156 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 7156 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 7156 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 7156 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 7156 order:

- Model 7156 Scanner Card
- Model 7156 Instruction Manual
- Model 7156-MTR Connector
- Additional accessories as ordered

1.6.3 Instruction Manual

If an additional instruction manual is required, order the manual package, Keithley part number 7156-901-00. The manual package includes an instruction manual and any pertinent addenda.

1.7 REPACKING FOR SHIPMENT

Should it become necessary to return the Model 7156 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 7156:

Model 7156-MTC-10 — The Model 7156-MTC-10 is a 10-foot, twisted pair ribbon cable, that is terminated with a male and female 50-pin "D" connector.

Model 7156-MTR — The Model 7156-MTR is a female bulkhead "D" type connector with solder cups. It mates to the scanner card connector or the Model 7156-MTC-10, and includes a slide lock.

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 circuits for both the Models 7156-D and 7156-M.

2.4 Guard/Shield: Explains the significance of this scanner card terminal and provides examples for making shielded measurements and non-driven guarded measurements.

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

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

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

2.8 Mainframe Control of Scanner Card: Covers operating aspects specific to the Model 7156. Includes using the card in the 1-pole mode and the matrix mode of operation.

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 and Figure 2-2 show the equivalent circuits of the Model 7156-D and 7156-M. Notice that the only difference between the two circuits is the shielding of the relay switches. The dry reed relays of the Model 7156-D have a shield built into them while the mercury wetted relays of the Model 7156-M do not.

For both models, the high (H) and low (L) terminals of each channel are routed through a two-pole, Form A (normally open) relay switch. When a relay is energized, the signal connected to that channel is routed to the output.

Each channel can also be used as a single-pole, normally open (1-Form A) isolated switch. This is done by removing the factory installed jumper and using H as the input and H_{OUT} as the output, or other side, of the switch.

High and low can also be used as separate, isolated inputs if the card is used in single-pole mode. In this mode, the 1-pole output is used instead of the H and L outputs.

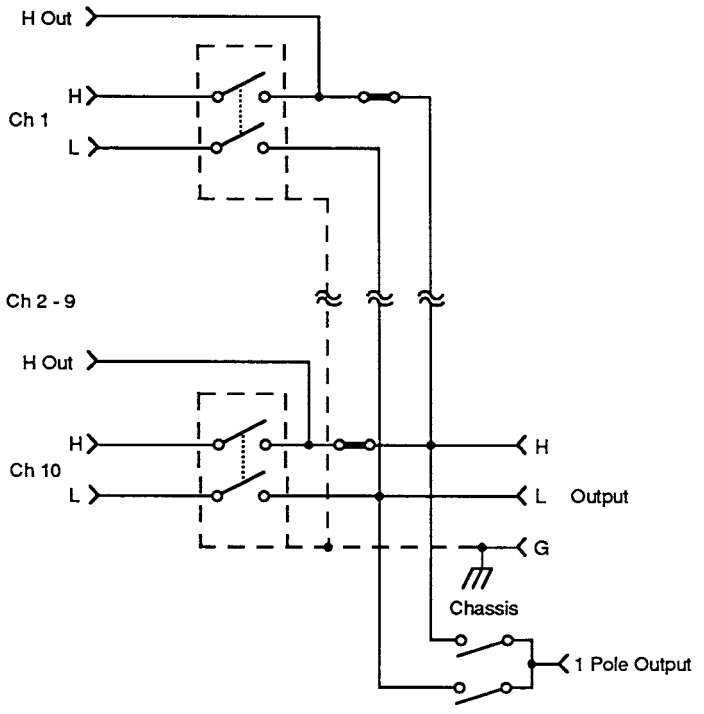


Figure 2-1. Model 7156-D Simplified Schematic

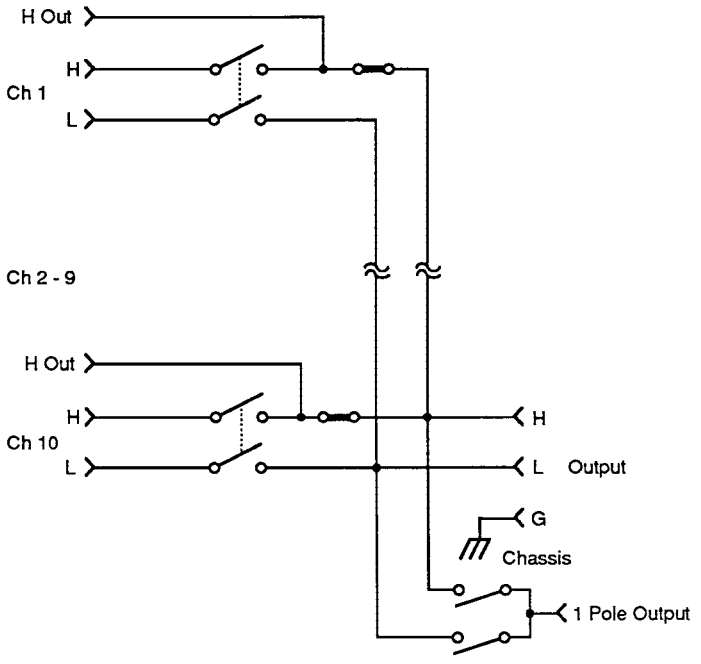


Figure 2-2. Model 7156-M Simplified Schematic

2.4 SHIELD (G)

When installed in a Model 705 or 706 mainframe, the shield of the scanner card is electrically connected to chassis. Figure 2-3 shows an example of a shielded measurement configuration. The shield is connected to signal low and extends to the DUT and the voltmeter to help eliminate interference from nearby electric fields. Notice that the DUT end of the shield is not connected to low in order to avoid a ground loop. Figure 2-4 shows an example of a measurement configuration using a floating shield. Circuit low is not connected to chassis. Notice that in both Figure 2-3 and Figure 2-4, the shield is connected to chassis at only one point in order to avoid ground loops.

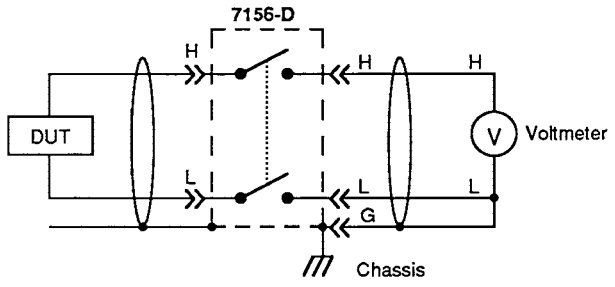


Figure 2-3. Shielded Measurement

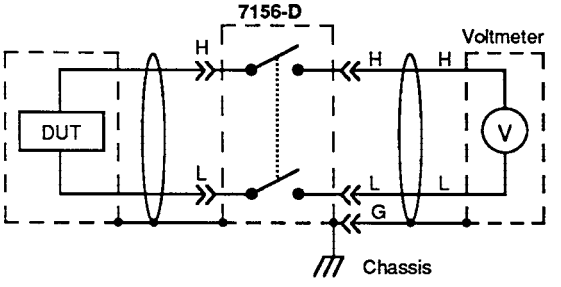


Figure 2-4. Shielded Measurement (Floating)

2.5 MULTI-CARD CONFIGURATIONS

Typically, multi-card systems are configured by connecting the OUTPUTs of all the scanner cards together. An example of this type of configuration is shown in Figure 2-5, which connects the OUTPUTs of a three-card system together. This common output system allows a single piece of equipment to source or measure all 30 channels.

Another possible way to configure a multi-channel system is with separate outputs. Figure 2-6 shows a two-card system with separate out puts. With this type of configuration, more than one test system can be controlled by the master mainframe.

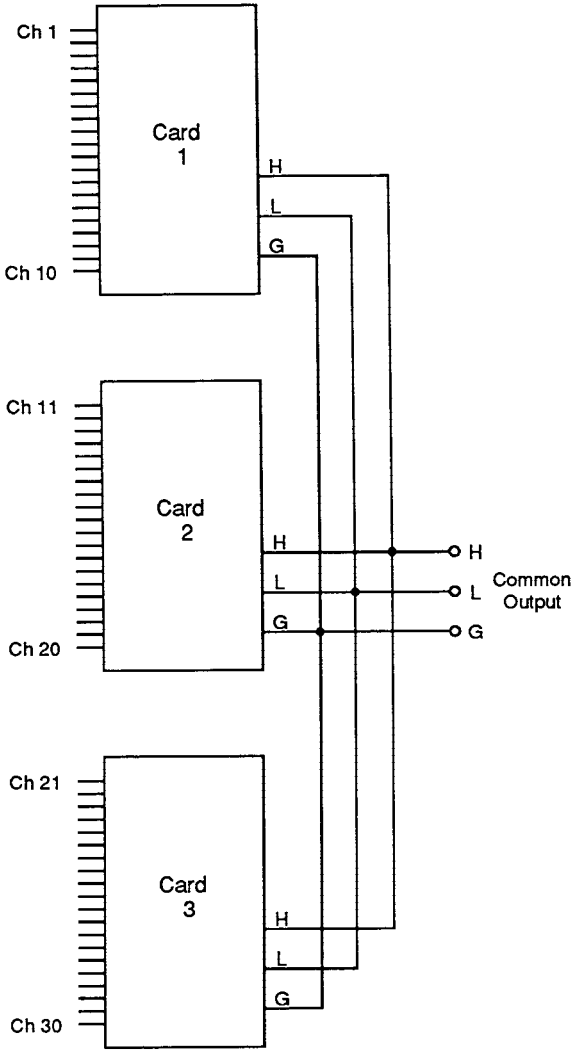


Figure 2-5. Common Output Configuration

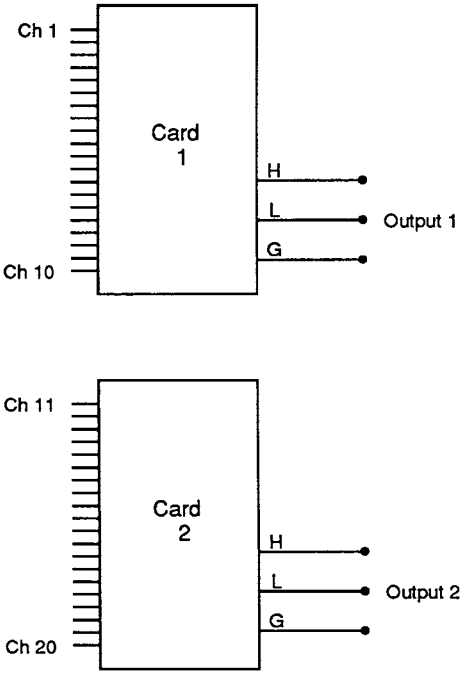


Figure 2-6. Separate Outputs Configuration

2.6 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 2-7 shows the male "D" connector of the scanner card. Table 2-1 references scanner card terminals to connector pins. For example, Channel 1 high is connected to pin 1 and Channel 1 low is connected to pin 20, and Channel 1 H_{OUT} is connected to pin 2.

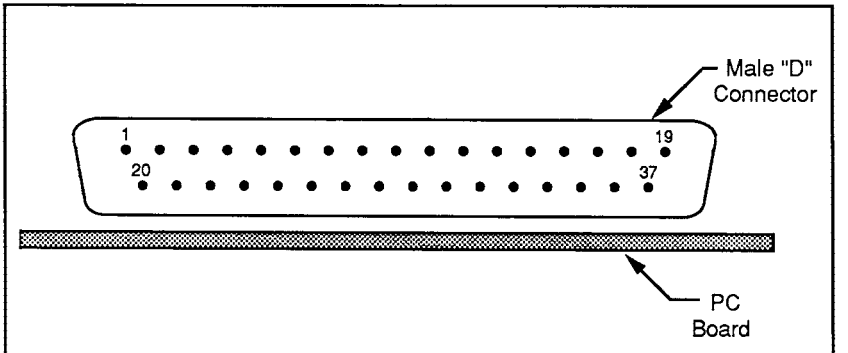


Figure 2-7. Male "D" Connector on Scanner Card (Pin Side Shown)

The connector on the scanner card will mate to either the supplied female "D" connector (Model 7156-MTR) or to an optional mass terminated cable (Model 7156-MTC).

The following procedure explains how to mate the female "D" connector to the Model 7156.

1. Viewing the female connector from the rear, (cable side), move the locking slide all the way to the right. This is the unlocked position.

2. Mate the female connector to the male connector on the PC board.
3. Move the locking slide all the way to the left. This is the locked position and secures the connectors together.

2.6.1 Connections Using Supplied "D" Connector

As shipped, the Model 7156 has a female "D" connector mated to the scanner card connector. Cabling from instrumentation and DUTs can be soldered directly to this connector. The solder cups of this connector will accommodate up to #18 AWG wire. Figure 2-8 shows the pinout of the female "D" connector and identifies the scanner card terminals. For example, Channel 7 uses pins 10 (high) and 29 (low). Table 2-1 can also be used to identify scanner card terminals.

CAUTION

After soldering wires to the female "D" connector, flux will be present on the connector insulator. This contamination will degrade the isolation qualities of the scanner card and must be cleaned off as explained in paragraph 4.2.

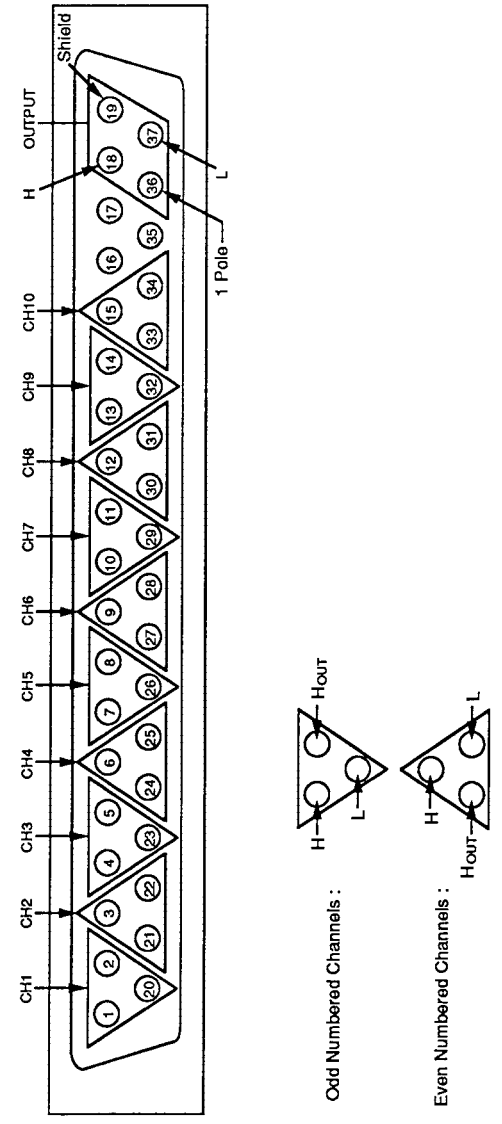


Figure 2-8. Female "D" Connector Pin Identification (Solder Cup Side Shown)

Table 2-1."D" Connector Pin Identification

Scanner Card Channel	Terminal	Connector Pin No.	Scanner Card Channel	Terminal	Connector Pin No.
CH1	H	1	CH7	H	10
	L	20		L	29
	H_{OUT}	2		H_{OUT}	11
CH2	H	3	CH8	H	12
	L	22		L	31
	H_{OUT}	21		H_{OUT}	30
CH3	H	4	CH9	H	13
	L	23		L	32
	H_{OUT}	5		H_{OUT}	14
CH4	H	6	CH10	H	15
	L	25		L	34
	H_{OUT}	24		H_{OUT}	33
CH5	H	7	Output	H	18
	L	26		L	37
	H_{OUT}	8		1P	36
CH6	H	9		G	19
	L	28			
	H_{OUT}	27			

Note: Connector pins not used; 16, 17, and 35

2.6.2 Connections Using Model 7156-MTC Cable

The Keithley Model 7156-MTC-10 (see Figure 2-9) is a 40-conductor, 10-foot, twisted-pair ribbon cable terminated with a female "D" connector on one end and a male "D" connector on the other end.

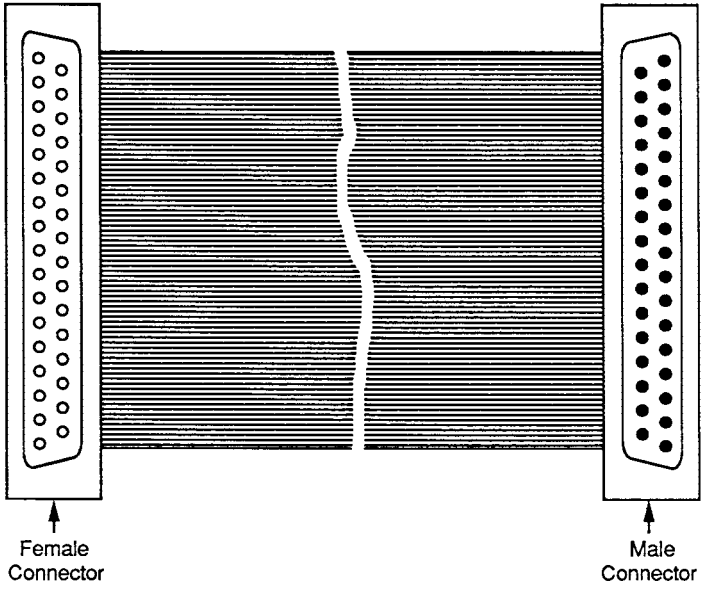


Figure 2-9. Model 7156-MTC

If the cable is going to be used as is, the female end of the cable will mate to the "D" connector on the scanner card, and the male end will mate to the supplied female "D" connector. In this situation, the supplied female "D" connector becomes part of the user's test fixture with instrumentation and DUTs soldered directly to it. Figure 2-8 identifies the scanner card terminals. Remember, the supplied connector must be cleaned after making solder connections to it (see paragraph 4.2).

Another way to use the cable is to remove the male connector (by cutting the cable). In this situation, the female end of the cable is mated to the scanner card, while the unterminated end is hard-wired to instrumentation and DUT. Note that every 18" the cable is flat for 2". It is at one of these flats that the cable should be cut in order to make scanner card terminal identification easier. Figure 2-10 shows how the conductors are numbered at the flat sections of the cable. Table 2-2 provides scanner card terminal identification for the cable. For example, low (L) and high (H) of Channel 7 are located at conductors 29 and 10 of the cable respectively. When the destination of the output is located away from the destination of the channels, the output portion of the cable can be peeled away from the rest of the cable as shown in Figure 2-11.

The crimp type connectors of the Model 7156-MTC make it relatively easy to shorten the cable or make several smaller cables using additional connectors. One vendor source for these connectors is T&B Ansley. The Ansley part number for the male connector is 609-37PM and for the female connector is 609-37SM. To shorten the exisiting cable, the male connector can be removed and re-attached to the shortened cable. Shorter cables may be necessary in applications where path resistance is critical. When used as is, each conductor of the 10-foot Model 7156-MTC-10 cable adds approximately 675mΩ to the "contact resistance" specification of the scanner card.

The following procedure explains how to attach a "D" connector, male or female, to the cable. Make sure the finished cable is terminated with a female connector that will mate to the scanner card and a male connector that will mate with the supplied female connector. Correct orientation of the connectors is shown in Figure 2-10.

1. Cut the cable to an appropriate length. The cut must be made at the middle of one of the flat portions of the cable.
2. Figure 2-12 shows how a connector is attached to the ribbon cable. Position the ribbon cable on the connector body such that the crimping pins align with 37 of the cable conductors (conductors 38-40 are not used).
3. By hand, firmly press the ribbon cable on to the connector body just enough to keep the cable from moving.
4. Install the connector cap on to the connector body.

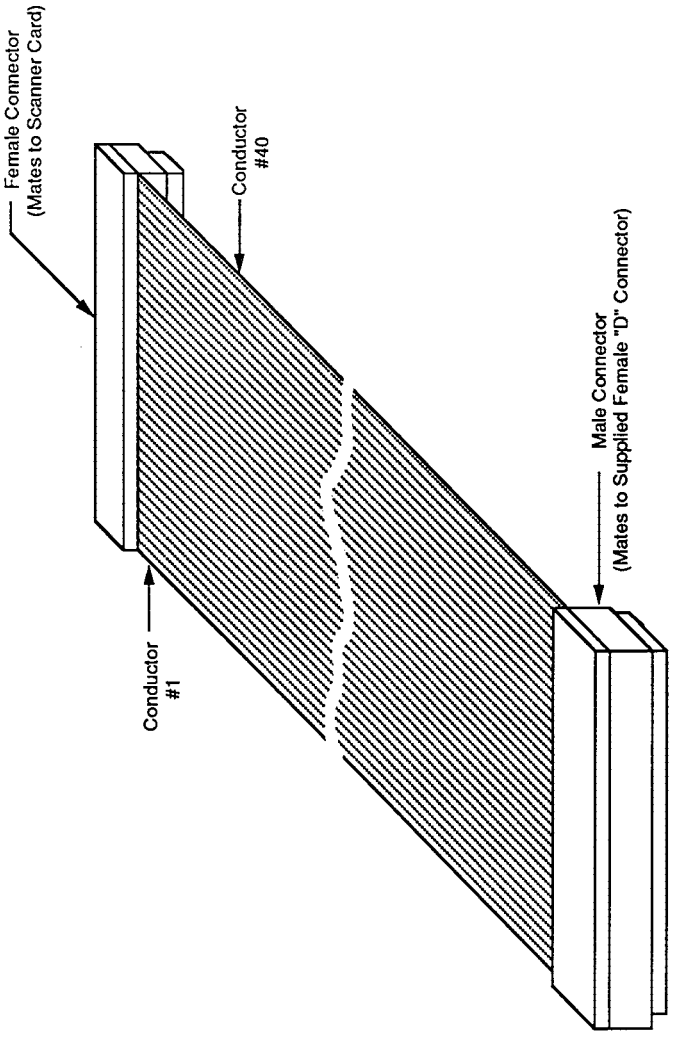


Figure 2-10. Model 7156-MTC Cable

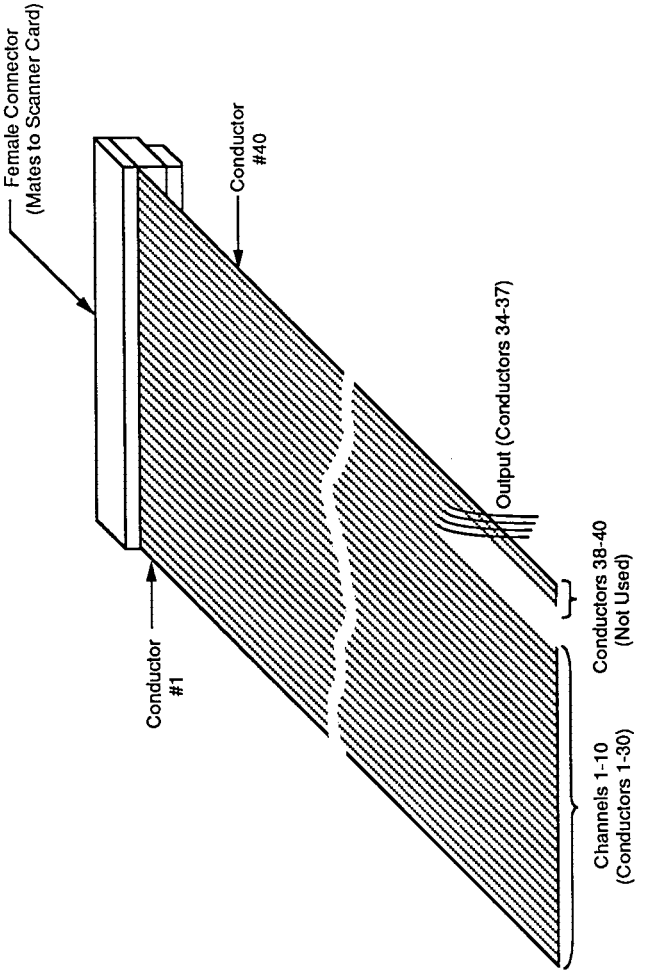


Figure 2-11. Model 7156-MTC Cable

5. Using a vise or press, squeeze the entire assembly together until the connector cap "snaps" onto the connector body.

Table 2-2. Model 7156-MTC Conductor Identification

Scanner Card Channel	Terminal	Cable Conductor Number	Scanner Card Channel	Terminal	Cable Conductor Number
CH1	H	1	CH7	H	19
	L	2		L	20
	H_{OUT}	3		H_{OUT}	21
CH2	H_{OUT}	4	CH8	H_{OUT}	22
	H	5		H	23
	L	6		L	24
CH3	H	7	CH9	H	25
	L	8		L	26
	H_{OUT}	9		H_{OUT}	27
CH4	H_{OUT}	10	CH10	H_{OUT}	28
	H	11		H	29
	L	12		L	30
CH5	H	13	Output	1P	34
	L	14		H	35
	H_{OUT}	15		L	36
CH6	H_{OUT}	16		G	37
	H	17			
	L	18			

Note: Connector pins not used; 31, 32, 33, 38, 39, 40

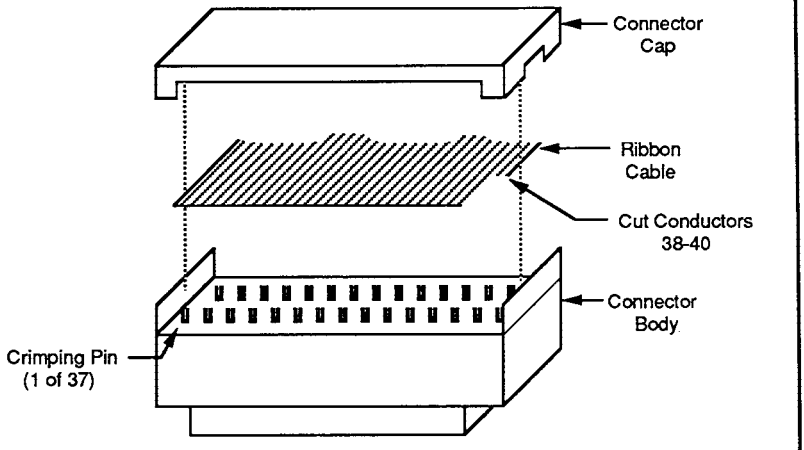


Figure 2-12. Attaching "D" Connector to Ribbon Cable

2.6.3 Shielded Cables

There are several shielded, unterminated cables available from Spectra-Strip that can be used in applications where maximum shielding is necessary. Male and female "D" type connectors can be attached to these cables in the same manner that they are attached to the Model 7156-MTC. Two of these available cables are described as follows:

Twist "N" Flat jacketed cable with aluminum/mylar shield (Spectra-Strip P/N 843-152-2831-040) — This cable is similar to the Model 7156-MTC cable except that the ribbon cable is surrounded by a shield that has two drain wires, and is encased in an insulated jacket.

Round Twist "N" Flat jacketed shielded cable (Spectra-Strip P/N 843-159-2832-040) — This cable combines the features of a round cable and the mass termination capabilities of a flat cable which allows "D" type connectors to be easily attached. This cable uses a foil/braid shield and is encased in an insulated jacket.

2.7 CARD INSTALLATION AND REMOVAL

The following procedures explain how to install and remove the Model 7156 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.

2.7.1 Scanner Card Installation

Perform the following procedure to install the Model 7156 scanner card in either the Model 705 or 706 mainframe. Refer to Figure 2-13 to install the card in the Model 705 and refer to Figure 2-14 to install the card in the Model 706.

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

2.7.2 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.

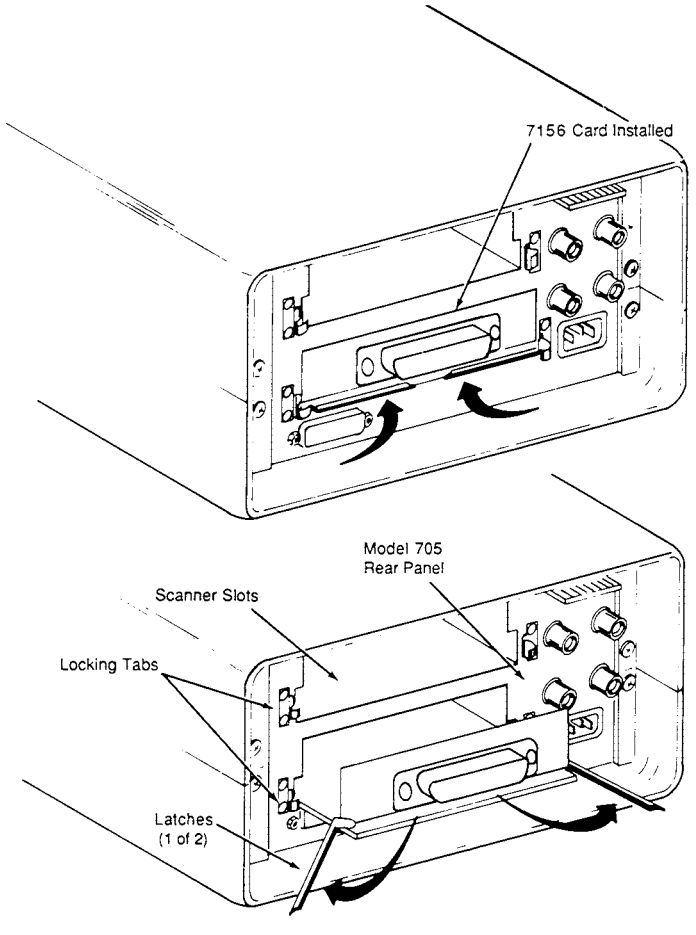


Figure 2-13. Card Installation in Model 705

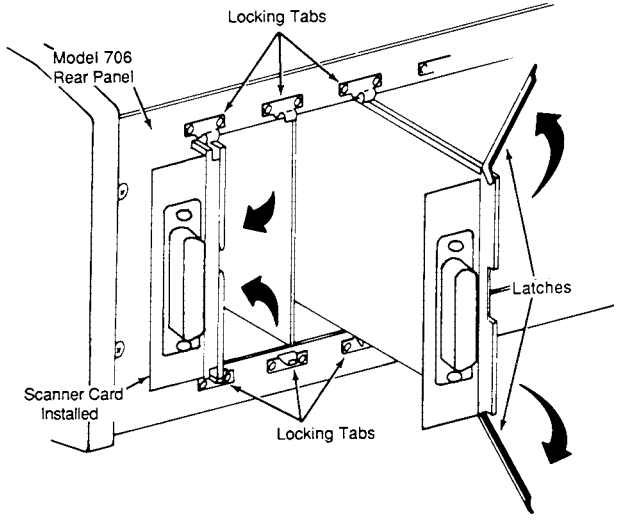


Figure 2-14. Card Installation in Model 706

2.8 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 7156.

The Model 7156 is designed to operate in the 1- or 2-pole mode of the scanner mainframe. It will also operate in the matrix mode, but two crosspoints must be closed to close one Model 7156 channel.

2.8.1 2-Pole Mode

The easiest way to control the scanner card is with the mainframe scanner in the 2-pole mode. In this mode, the displayed channel number on the mainframe display corresponds to the scanner card channel under control. Keep in mind that scanner card channel numbers are determined by the slot that the card is installed. For example, with a Model 7156 installed in the bottom slot (Card 2) of a Model 705, the 10 scanner card channels are assigned channel numbers 11 through 20.

2.8.2 1-Pole Mode

When used in 1-pole mode, the Model 7156 has 20 isolated inputs and one output. The inputs are high and low of the 10 channels, and the output is the 1-pole output. Table 2-3 summarizes 1-pole mode channel assignments for a Model 7156 in slot 1.

2.8.3 Matrix Mode

Scanner card channels can be manually controlled with the scanner mainframe in the matrix mode of operation. In this mode, two matrix crosspoints must be accessed (closed) from the mainframe in order to close a scanner card channel. The major disadvantages of this mode are

that the scanner cannot scan and the channel under control is not obvious from the mainframe display.

Table 2-4 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. 1-Pole Channel Assignments

7156 Channel		1-Pole Mode 705	1-Pole Mode 706	7156 Channel		1-Pole Mode 705	1-Pole Mode 706
CH1	H	01	001	CH6	H	11	011
	L	02	002		L	12	012
CH2	H	03	003	CH7	H	13	013
	L	04	004		L	14	014
CH3	H	05	005	CH8	H	15	015
	L	06	006		L	16	016
CH4	H	07	007	CH9	H	17	017
	L	08	008		L	18	018
CH5	H	09	009	CH10	H	19	019
	L	10	010		L	20	020

Table 2-4. Scanner Control of Model 7156 Matrix Mode (0-Pole)

	Scanner Ch. No.	Relay Con-trolled		Scanner Ch. No.	Relay Con-trolled
CARD 1	01, 1	1	CARD 2	06, 1	1
	01, 2	6		06, 2	6
	02, 1	2		07, 1	2
	02, 2	7		07, 2	7
	03, 1	3		08, 1	3
	03, 2	8		08, 2	8
	04, 1	4		09, 1	4
	04, 2	9		09, 2	9
	05, 1	5		10, 1	5
	05, 2	10		10, 2	10
CARD 3	11, 1	1	CARD 4	16, 1	1
	11, 2	6		16, 2	6
	12, 1	2		17, 1	2
	12, 2	7		17, 2	7
	13, 1	3		18, 1	3
	13, 2	8		18, 2	8
	14, 1	4		19, 1	4
	14, 2	9		19, 2	9
	15, 1	5		20, 1	5
	15, 2	10		20, 2	10
CARD 5	21, 1	1	CARD 6	26, 1	1
	21, 2	6		26, 2	6
	22, 1	2		27, 1	2
	22, 2	7		27, 2	7
	23, 1	3		28, 1	3
	23, 2	8		28, 2	8
	24, 1	4		29, 1	4
	24, 2	9		29, 2	9
	25, 1	5		30, 1	5
	25, 2	10		30, 2	10

Scanner Control of Model 7156 Matrix Mode (0-Pole) (Cont.)

	Scanner Ch. No.	Relay Controlled		Scanner Ch. No.	Relay Controlled
CARD 7	31, 1	1	CARD 8	36, 1	1
	31, 2	6		36, 2	6
	32, 1	2		37, 1	2
	32, 2	7		37, 2	7
	33, 1	3		38, 1	3
	33, 2	8		38, 2	8
	34, 1	4		39, 1	4
	34, 2	9		39, 2	9
	35, 1	5		40, 1	5
	35, 2	10		40, 2	10
CARD 9	41, 1	1	CARD 10	46, 1	1
	41, 2	6		46, 2	6
	42, 1	2		47, 1	2
	42, 2	7		47, 2	7
	43, 1	3		48, 1	3
	43, 2	8		48, 2	8
	44, 1	4		49, 1	4
	44, 2	9		49, 2	9
	45, 1	5		50, 1	5
	45, 2	10		50, 2	10

2.8.4 Multi-Channel Systems

Additional channels are available using additional scanner cards. The Model 705 has two card slots. Thus, using one Model 705, 20 two-pole or 40 single-pole channels could be configured. With the maximum of five Model 705s daisy chained, 100 two-pole or 200 single-pole 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 2-5.

Table 2-5. Model 705 Channel Assignments in 2-Pole Mode

Card #	Master	Slave #1	Slave #2	Slave #3	Slave #4
1	01 - 10	21 - 30	41 - 50	61 - 70	81 - 90
2	11 - 20	31 - 40	51 - 60	71 - 80	91 - 100

The Model 706 has 10 card slots. Thus, using one Model 706, 100 two-pole channels could be configured. With the maximum of five Model 706s daisy chained, 500 two-pole or 1000 single-pole channels could be configured.

2.8.5 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 7156.

2.8.6 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 7156-D and < 0.75A for the Model 7156-M to protect the relays and circuit board. Figure 2-15 shows typical circuits to limit current surges. Also, consider the maximum load of 10VA for the Model 7156-D and 30VA for the Model 7156-M when determining the current limit. For example, when switching 100V with the Model 7156-D, the current must be limited to:

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

The current limiting resistor as used in Figure 2-15A would be:

$$R = V/I = 100V/100mA = 1k\Omega \text{ @ } 10VA$$

Inductive Loads

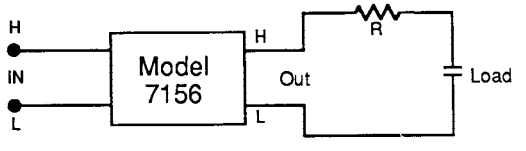
Inductive reaction voltage, L (di/dt), must be less than 100V. Typical clamping circuits are shown in Figure 2-16. Also, consider the maximum load of 10VA for the Model 7156-D and 30VA for the Model

7156-M when determining the voltage limit. For example, when switching 200mA with the Model 7156-D, the voltage must be limited to:

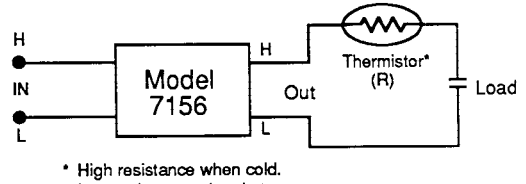
$$V = VA/I = 10VA/200mA = 50V$$

The value of the voltage clamping resistor used in Figure 2-16A would be:

$$R = V/I = 50V/200mA = 250\Omega \text{ @ } 10VA$$



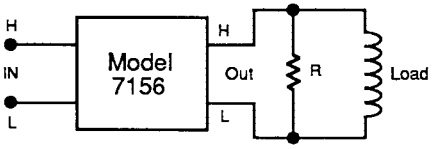
A. Resistor Limited



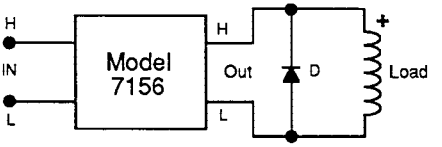
* High resistance when cold.
Low resistance when hot.
Fast thermal recovery.

B. Thermistor Limited

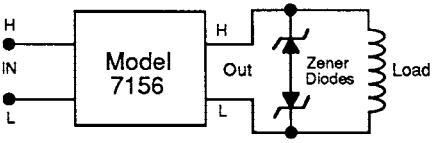
Figure 2-15. Limiting Capacitive Reaction Current



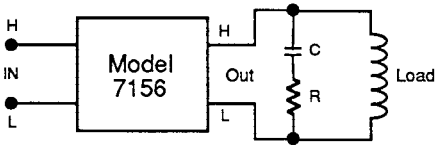
A. Resistor Clamped (AC or DC Voltages)



B. Diode Clamped (DC Voltages)



C. Zener Clamped (AC Voltages)



D. Resistor-Capacitor Clamped (AC Voltages)

Figure 2-16. Limiting Inductive Reaction Voltage

SECTION 3
Applications

3.1 INTRODUCTION

This section provides some possible applications for the Model 7156 Scanner Card and is arranged as follows:

3.2 Relay Bounce Testing: This application takes advantage of the bounce free switching of the Model 7156-M.

3.3 Battery Self Discharge Testing: This application uses the Model 7156-D in 1-pole mode to monitor 20 DUT per card.

3.4 Motor Control: This application uses the single-pole switch capability of the Model 7156-M to control small motors.

3.5 Other Applications

3.2 RELAY BOUNCE TESTING

The mercury wetted relays used in the Model 7156-M make it ideal for testing components such as relays. There is no bounce when the relays on the Model 7156-M are closed, so only the bounce of the relay under test (RUT) is seen.

Figure 3-1 shows a configuration for testing relays. It shows two Model 7156-M cards, one to energize the coil of the relay and one to connect the measuring instrument. If the channel on card #2 is closed and allowed to settle before the corresponding channel on card #1, any card with appropriate specifications for the signal to be measured could be used. If

configured as shown, the test would run faster since the corresponding channel on card #1 could be closed immediately after the channel on card #2.

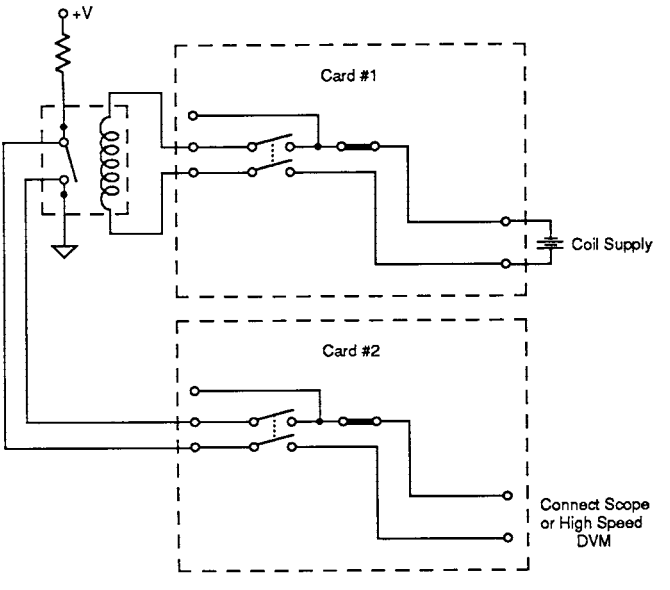


Figure 3-1. Relay Bounce Testing

3.3 BATTERY SELF DISCHARGE TESTING

By placing the Model 705 or 706 in 1-pole mode, 20 isolated inputs can be switched to the 1-pole output of the Model 7156. (Refer to Table 2-3 for input channel numbers in this mode.)

An application using this mode is shown in Figure 3-2. Here, 20 batteries are being monitored using one voltmeter. This is possible because the batteries and meter all have a common low. Almost any DUT can be substituted for the batteries as long as a common low is used.

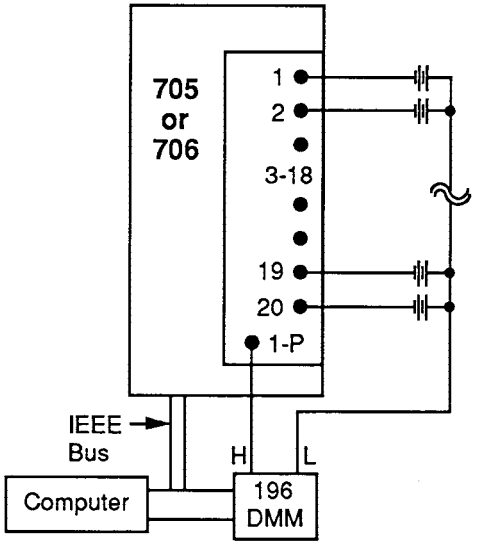


Figure 3-2. Battery Self Discharge Testing

3.4 MOTOR CONTROL

When the factory installed jumper for a given channel is cut, H and Hout are the ends of a single-pole, normally open switch. This switch can be used to control any external circuit as long as its voltage, current, and power ratings do not exceed those of the Model 7156.

The example in Figure 3-3 shows the Model 7156-M controlling a small motor. The relays on the Model 7156-M can switch inductive (or capacitive) loads as long as the current (or voltage) surge does not exceed the specifications of the card.

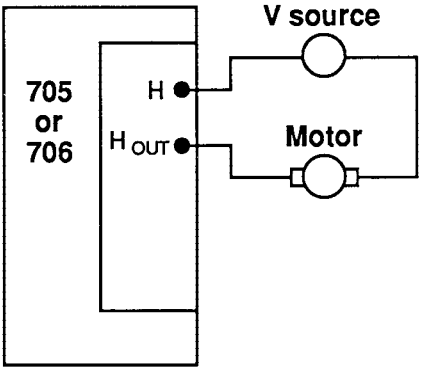


Figure 3-3. Small Motor Control

3.5 OTHER APPLICATIONS

Combinations of the above applications are also possible. One example would be to monitor or control nine DUT's, and control an alarm or signal device with channel 10.

SECTION 4
Service Information

4.1 INTRODUCTION

This section contains information necessary to service the Model 7156 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.

4.4 Relay Interchangeability: Discusses the interchangeability of the relays between the Models 7156-D and 7156-M.

4.2 HANDLING AND CLEANING PRECAUTIONS

Because of the high impedance circuits on the Model 7156, 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. If solder connections are made to the female "D" connector, clean the flux off the insulator in the same manner.

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 Models 7156-D and 7156-M, 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 indictate 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.

Table 4-1. Verification Equipment

Description	Model	Specifications	Application
Electrometer	Keithley 617	100nA; 0.25% 100V Source; 0.2%	Isolation
DMM	Keithley 196	300Ω; 0.01%	Path resistance
Female "D" Connector*	Keithley 7156-MTR	—	Connections to card

*One of these connectors is supplied with the Model 7156.

4.3.3 Connector Preparation

For the test procedures, a female "D" connector is used to make circuit connections to the scanner card. One of these connectors is supplied with the Model 7156. One end of the connector mates to the "D" connector on the scanner card and the other end has solder cups for external circuit connections.

Prepare a female "D" connector as follows:

1. Using clean #18-24 AWG copper wire, solder in 11 jumpers at the locations shown in Figure 4-1. Each jumper wire should be approximately one inch long.
2. Solder a 1/2" length of copper wire to pin 37 of the connector.
3. Clean the connector as described in paragraph 4.2 to remove solder flux and other contaminants.

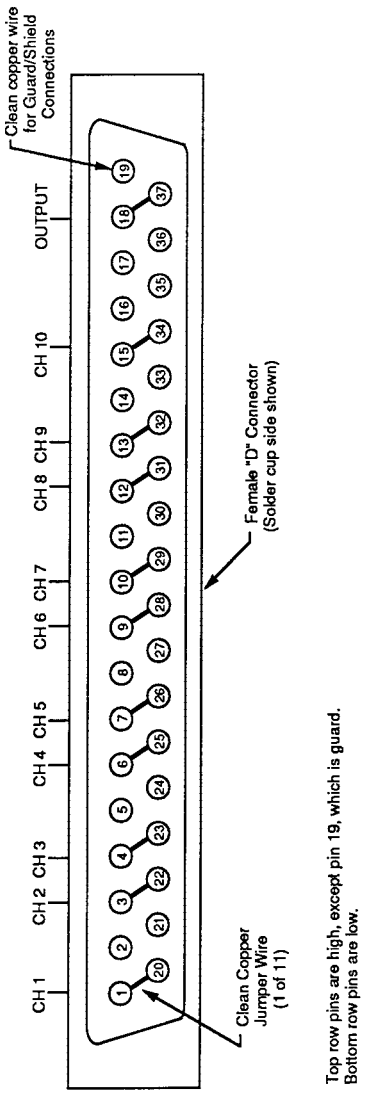


Figure 4-1. Female Connector Preparation for Performance Verification

4. Separate the soldered wires to prevent them from shorting to one another.
5. Mate the prepared "D" connector to the male "D" connector of the scanner card.

NOTE

The order that performance verification tests are presented is such that additional soldering to the connector (and subsequent cleaning) is not required. Required connector modifications are accomplished by simply cutting appropriate jumper wires in half.

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 the open channel and the output, and then measuring the leakage current. The isolation resistance is then calculated as R = V/I. In the following procedure, the Model 617 functions as both a voltage source and a picoammeter. In the V/I function, the Model 617 internally calculates the resistance from the known voltage and measured current levels and displays the resistance value.

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

WARNING

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

1. Using Figure 4-1 to identify scanner card terminals, connect the Model 617 to the scanner card as shown in Figure 4-2.
2. With the scanner in the step mode, open channel 1 and close the rest of the scanner card channels.
3. On the Model 617, select the 2pA range, and enable zero check and zero correct in that order. Leave zero correct enabled for the entire procedure.

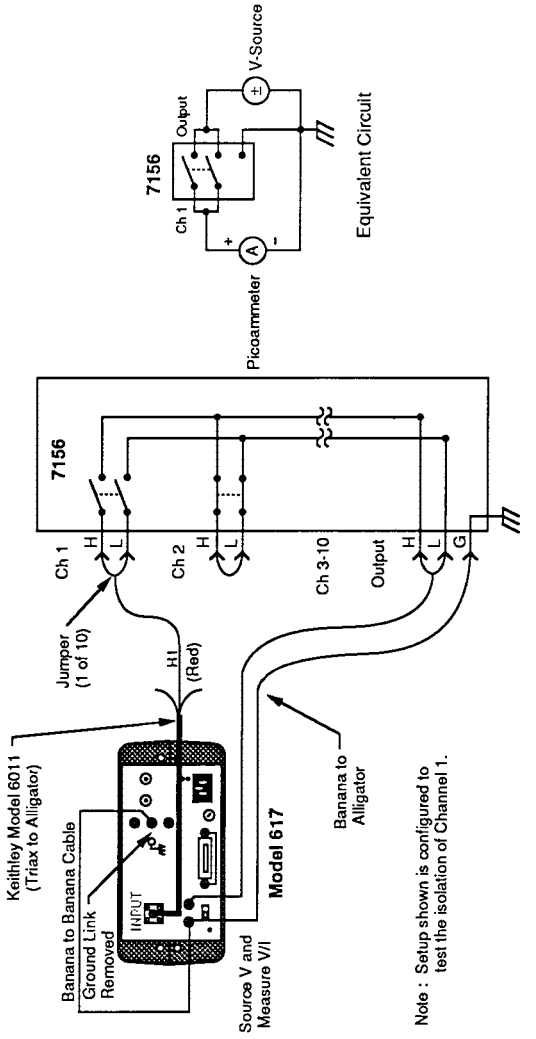


Figure 4-2. Channel Isolation

4. On the Model 617, set the voltage source for +100V, and select the 200nA current range. Make sure the voltage source is still in standby.
5. Place the Model 617 in the V/I measurement function by pressing SHIFT OHMS.
6. On the Model 617, disable zero check and press OPERATE to source 100V.
7. After allowing the reading on the Model 617 to settle, verify that it is >1GΩ.
8. Place the Model 617 in standby and enable zero check.
9. Connect the electrometer input HI lead to channel 2 of the scanner card.
10. On the scanner, open channel 2 and close the rest of the scanner card channels.
11. Repeat steps 6 through 8.
12. Repeat the basic procedure in steps 9 through 11 for channels 3 through 10.

4.3.5 Common Mode Input Isolation Tests

These tests check the resistance (isolation) between high/low of every channel and shield. In general, the test is performed by applying a voltage (100V) across the terminals and then measuring the leakage current. The isolation resistance is then calculated as R = V/I. In the following procedure, the Model 617 functions as a voltage source and an ammeter. In the V/I function, the Model 617 internally calculates the resistance from the known voltage and measured current levels and displays the resistance value.

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

WARNING

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

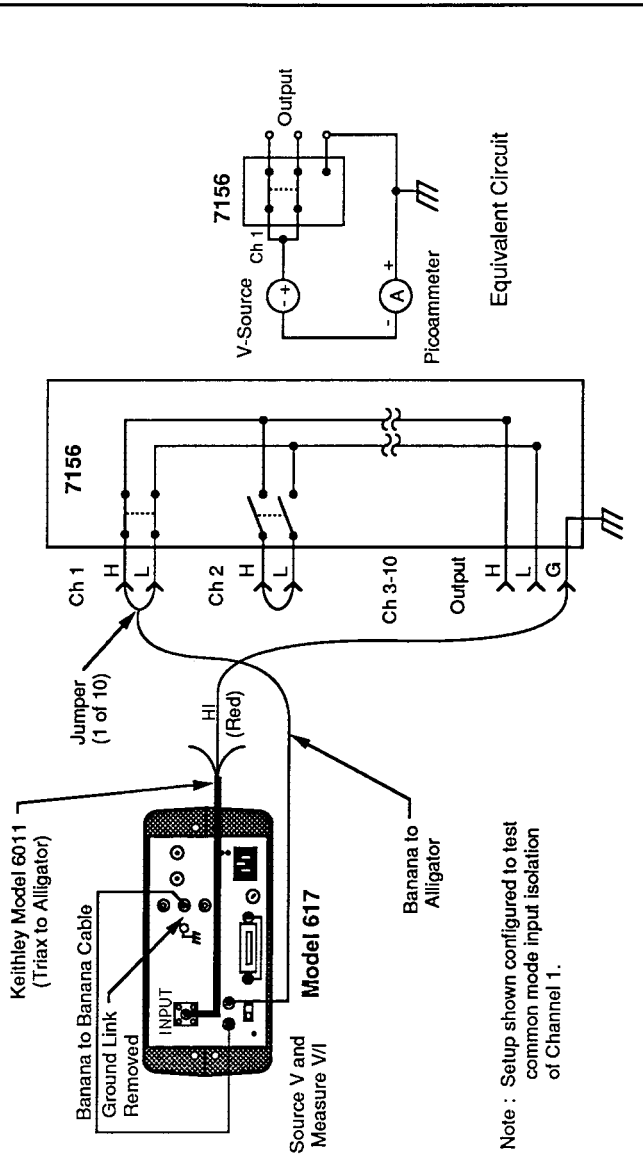


Figure 4-3. Input Isolation (Common Mode)

1. Referring to Figure 4-1, cut the jumper connecting pins 18 to 37 in half.
2. Using Figure 4-1 to identify scanner card terminals, connect the Model 617 to the scanner card as shown in Figure 4-3.
3. With the scanner in the step mode, close channel 1 and open the rest of the scanner card channels.
4. 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.
5. 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.
6. Place the Model 617 in the V/I measurement function by pressing SHIFT OHMS.
7. On the Model 617, disable zero check and press OPERATE to source 100V.
8. After allowing the reading on the Model 617 to settle, verify that it is >1GΩ.
9. Place the Model 617 in standby and enable zero check.
10. Connect the voltage source output HI lead to channel 2 of the scanner card.
11. On the scanner, close channel 2 and open the rest of the scanner card channels.
12. Repeat steps 7 through 9.
13. Repeat the basic procedure in steps 10 through 12 for channels 3 through 10.

4.3.6 Path Resistance Tests

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

1. Cut all the remaining jumper wires in half. Position each wire such that they do not short to one another.
2. Connect the Kelvin clip leads to the input of the Model 196 as shown in Figure 4-4 and select the 300Ω range.
3. Short the Kelvin clip leads together and zero the Model 196. Leave zero enabled for the entire test.

4. Using Figure 4-1 to identify scanner card terminals, connect the Model 196 to the scanner card.
5. With the scanner in the step mode, close channel 1. The reading on the Model 196 should be as follows:
   A. For the Model 7156-D, < 2Ω (0.6Ω typical).
   B. For the Model 7156-M, < 2Ω (0.5Ω typical).
6. Open channel 1 and verify that the Model 196 indicates an open circuit (> 300MΩ).
7. Connect the Model 196 to channel 1 low (L) and output low (L), and repeat steps 5 and 6.
8. Repeat the basic procedure of steps 4 through 7 to test path resistance of high and low of channels 2 through 10.

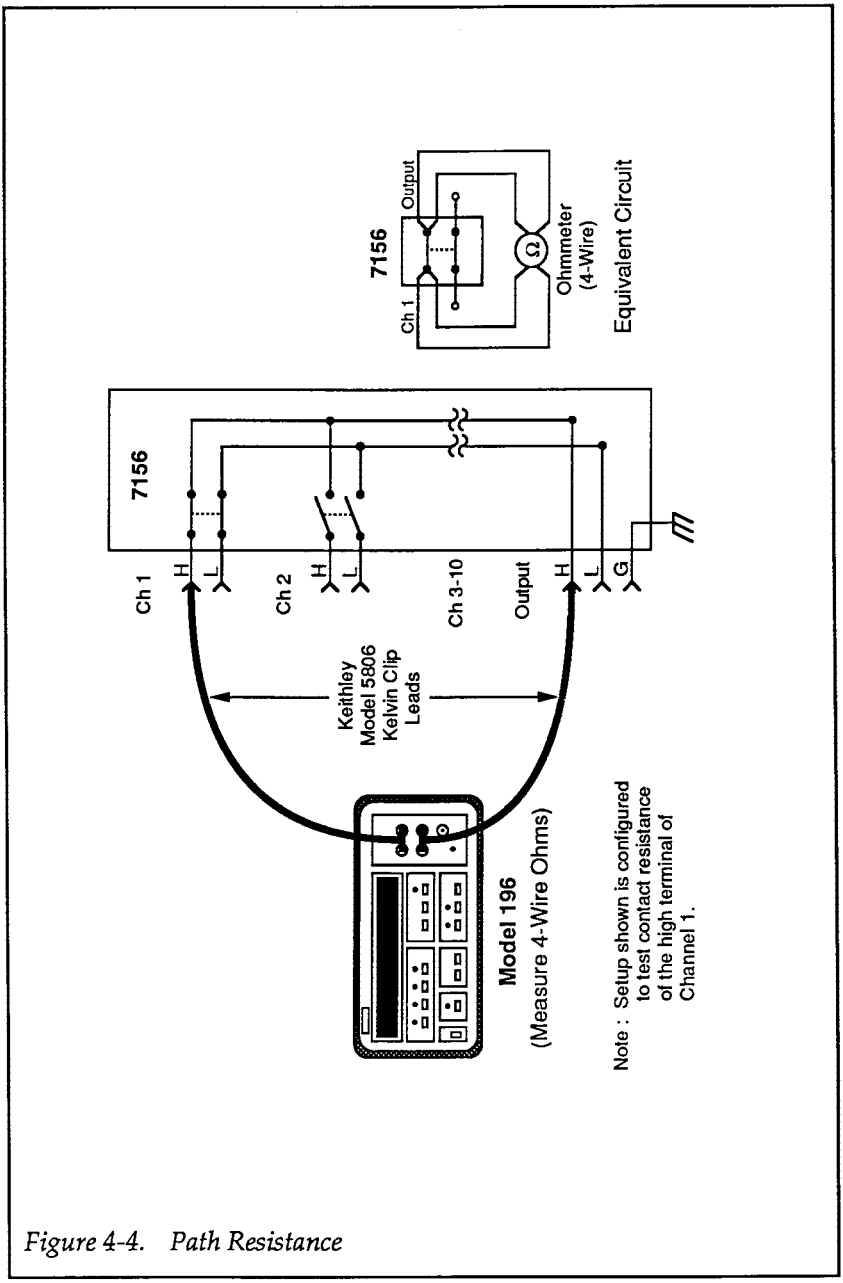


Figure 4-4. Path Resistance

4.3.7 Differential Input Isolation Tests

These tests check the resistance (isolation) between the high and low 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 4-5, 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 Figure 4-1 to identify scanner card terminals, connect the Model 617 to the scanner card as shown in Figure 4-5.
2. With the scanner in the step mode, close channel 1 and open the rest of the scanner card channels.
3. On the Model 617, select the 2pA range, and enable zero check and zero correct in that order. Leave zero correct enabled for the entire procedure.
4. On the Model 617, set the voltage source for +100V, and select the 200nA current range. Make sure the voltage source is still in standby.
5. Place the Model 617 in the V/I measurement function by pressing SHIFT OHMS.
6. On the Model 617, disable zero check and press OPERATE to, source 100V.
7. After allowing the reading on the Model 617 to settle, verify that it is >1GΩ.
8. Place the Model 617 in standby and enable zero check.
9. Connect the electrometer Input HI lead to channel 2 low (L) of the scanner card, and connect V-Source HI channel 2 high (H).

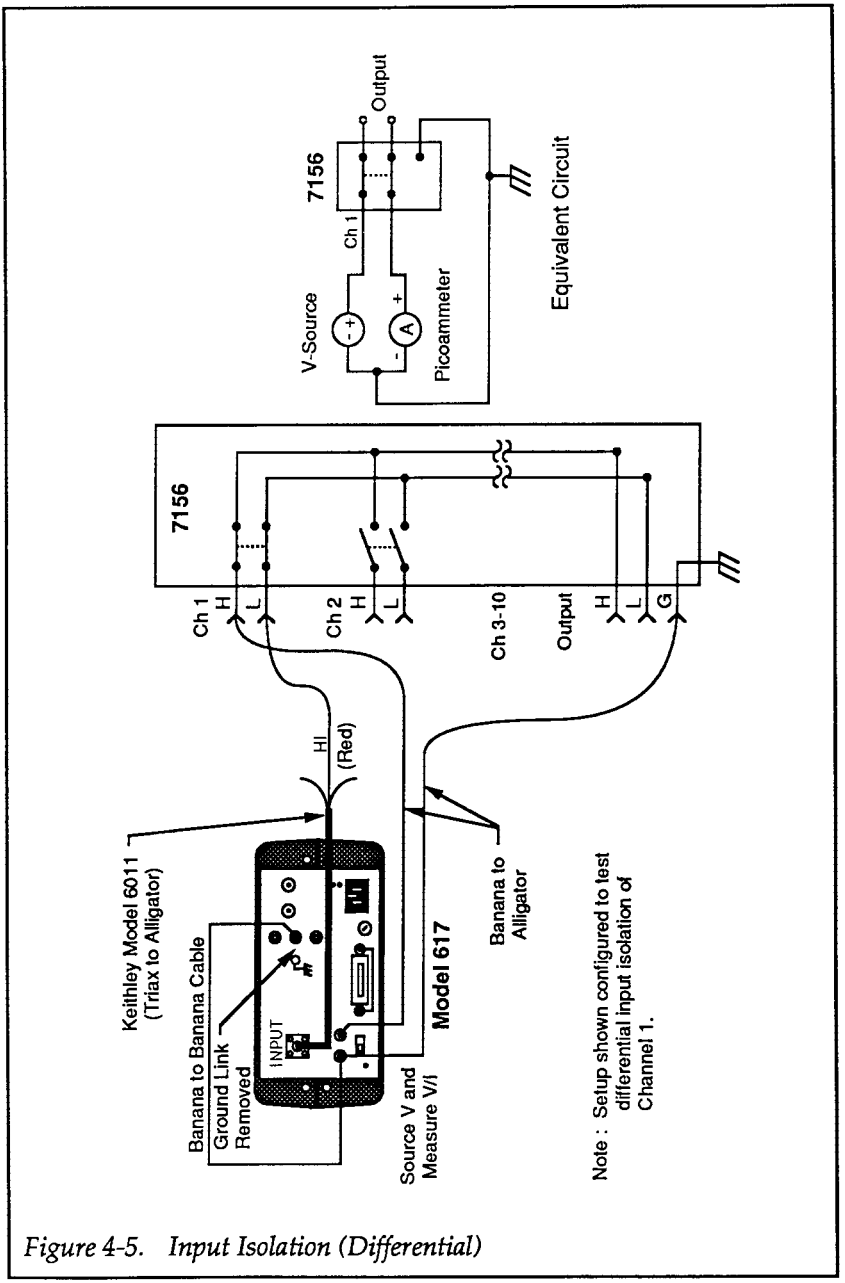


Figure 4-5. Input Isolation (Differential)

10. On the scanner, close channel 2 and open the rest of the scanner card channels.
11. Repeat steps 6 through 8.
12. Repeat the basic procedure in steps 9 through 11 for channels 3 through 10.

4.4 RELAY INTERCHANGEABILITY

The only difference between the Model 7156-D and the Model 7156-M is the relays. The Model 7156-D uses dry reed relays while the Model 7156-M uses mercury wetted relays. Mercury wetted relays used on the Model 7156-M can be used as replacement relays on the Model 7156-D and conversely, reed relays used by the Model 7156-D can be used on the Model 7156-M. Table 4-2 lists the specification differences between the two relay types. If a different type relay is installed on the card, it is recommended that a tag be strategically placed to indicate the change.

Table 4-2. Relay Specification Comparison

Specification	Model 7156-D	Model 7156-M
Relay Drive Current	30mA typical	50mA typical
Maximum Signal Level	10VA	30VA
Contact Life (Closures)	1×10^8 (cold) 1×10^7 (max signal)	2×10^8 (cold) 2×10^7 (max signal)

SECTION 5
Replaceable Parts

5.1 INTRODUCTION

This section contains a list of replaceable electrical and mechanical parts for the Model 7156, 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 (7156-D or 7156-M)
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:

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 7156, while Figure 5-2 shows a schematic diagram.

MODEL 7156, MISCELLANEOUS PARTS LIST

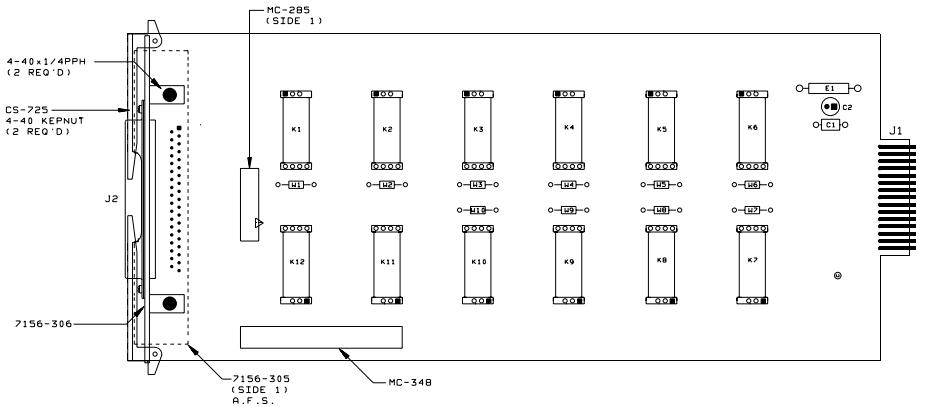
QTY.	DESCRIPTION	KEITHLEY PART NO.
1	BACK PANEL	7156-301
2	HANDLE	FA-119
1	HANDLING LABEL	MC-348
1	INSULATOR, BOTTOM	7156-305
1	MATING CONNECTOR	CS-640-2
2	PEM NUT	FA-131
2	RIVET	FA-121
1	SLIDE LOCK KIT	CS-682
1	SLIDE LOCK POST	CS-653
4	#4-40 KEPNUTS	4-40 KEPNUT
2	#4-40 X 5/16" PHILLIPS PAN HEAD	4-40X5/16PPH

MODEL 7156, PARTS LIST

CIRCUIT DESIG.	DESCRIPTION	KEITHLEY PART NO.
C1	CAP,.1uF,20%,50V,CERAMIC	C-365-.1
C2	CAP,10uF,-20+100%,25V, ALUM ELEC	C-314-10
E1	BEAD,FERRITE	CT-9
J2	CONN,MALE,37-PIN	CS-306
K1..K12	RELAY (DPST) (MODEL 7156-M)	RL-122
	RELAY (DPST) (MODEL 7156-D)	RL-130
W1...W10	JUMPERS	J-15

NO. 7156-100

LTR.	ECO NO.	REVISION	ENG.	DATE
A	13012	RELEASED	SZ	9/16/88
B	13030	REVISED	SZ	10/6/88
B1	13100	REVISED	SZ	12/5/88
B2	13260	ADDED MC-348	SZ	6/22/89
C	15490	ARTWORK WAS REV B, CHG'D BACK PANEL 7156-301 TO 7156-306. DELETED (2) 7164-303 MTG BRKT'S	SZ	7/14/93



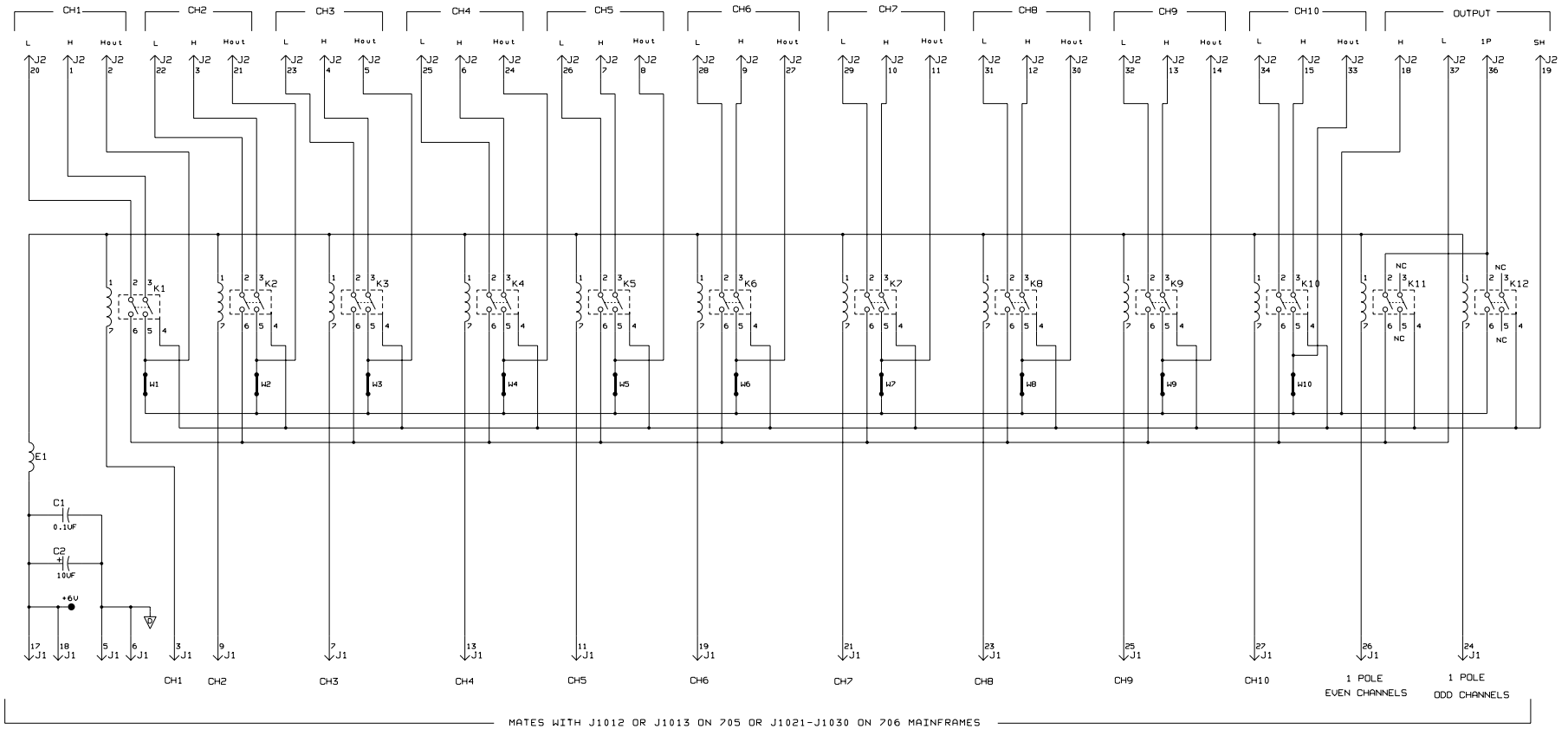
NOTE: FOR MORE COMPONENT INFORMATION SEE BILL OF MATERIAL 7156-D-000-00 OR 7156-M-000-00.

7156-M		1
7156-D		1
MODEL	NEXT ASSEMBLY	QTY.
USED ON		

DO NOT SCALE THIS DRAWING	DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED	DATE 8/9/88	SCALE 1:1
	XX=±.015 ANG.=±1°	DRN. SAZ	ENG. APPR.
KEITHLEY KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139	XXX=±.005 FRAC.=±1/64	MATERIAL	
	SURFACE MAX. 63	FINISH	

TITLE: COMPONENT LAYOUT, GENERAL PURPOSE CARD

C NO. 7156-100



KEITHLEY

KEITHLEY INSTRUMENTS INC.
CLEVELAND,OHIO 44139

TITLE

SCHEMATIC,
GENERAL PURPOSE CARD

SIZE	MODEL	NO	ECO	REV
D	7156	7156-106	15490	C

DRAWN	APPROVED	DATE
SZ		7/7/93

KEITHLEY

Service Form

Model No. _____ **Serial No.** _____ **Date** _____

Name and Telephone No. _____

Company _____

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

_____

_____

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

Display or output (check one)

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

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

(attach any additional sheets as necessary)

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

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

_____

_____

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

Relative humidity? _____ Other? _____

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

_____

_____

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



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