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Model 7166 Mercury Wetted Relay 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 7166 Mercury Wetted Relay Card
Instruction Manual

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Safety Precautions

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

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

The types of product users are:

Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

Maintenance personnel perform routine procedures on the product to keep it operating, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the manual. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

Service personnel are trained to work on live circuits, and perform safe installations and repairs of products. Only properly trained service personnel may perform installation and service procedures.

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

Users of this product must be protected from electric shock at all times. The responsible body must ensure that users are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product users in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 volts, **no conductive part of the circuit may be exposed.**

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

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

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

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

removing switching cards, or making internal changes, such as installing or removing jumpers.

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

The instrument and accessories must be used in accordance with its specifications and operating instructions or the safety of the equipment may be impaired.

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

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

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

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

If a  screw is present, connect it to safety earth ground using the wire recommended in the user documentation.

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

The  symbol on an instrument shows that it can source or measure 1000 volts or more, including the combined effect of normal and common mode voltages. Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading in a manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in a manual explains hazards that could damage the instrument. Such damage may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits, including the power transformer, test leads, and input jacks, must be purchased from Keithley Instruments. Standard fuses, with applicable national safety approvals, may be used if the rating and type are the same. Other components that are not safety related may be purchased from other suppliers as long as they are equivalent to the original component. (Note that selected parts should be purchased only through Keithley Instruments to maintain accuracy and functionality of the product.) If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

To clean an instrument, use a damp cloth or mild, water based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument. Products that consist of a circuit board with no case or chassis (e.g., data acquisition board for installation into a computer) should never require cleaning if handled according to instructions. If the board becomes contaminated and operation is affected, the board should be returned to the factory for proper cleaning/servicing.

SPECIFICATIONS

MODEL 7166 MERCURY WETTED RELAY CARD

CHANNELS PER CARD: 10

CONTACT CONFIGURATION: 2-pole, Form A; 1 of 10 selectable or 10 isolated channels, jumper selectable.

CONNECTOR TYPE: Quick disconnect screw terminals, No. 14 AWG maximum wire size.

RELAY DRIVE CURRENT: 75mA per relay typical.

MAXIMUM SIGNAL LEVEL: 300V peak. 0.75A DC or RMS switched, 2A DC or RMS carry. 30VA.

CONTACT LIFE: $>4 \times 10^8$ closures (cold switching); $>5 \times 10^7$ closures (at maximum signal level).

CONTACT RESISTANCE:

Channel IN to Channel OUT: $<125m\Omega$ to rated life.

Channel IN to Card OUTPUT: $<225m\Omega$ to rated life.

CONTACT POTENTIAL: $<75\mu V$ per contact pair with copper leads typical.

ACTUATION TIME: <3ms, exclusive of mainframe.

CHANNEL ISOLATION: $10^{10}\Omega$, <10pF.

INPUT ISOLATION

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

Common Mode: $>10^9\Omega$, <150pF.

COMMON MODE VOLTAGE: 300V peak.

ENVIRONMENT,

Operating: 0° to 50°C, up to 35°C at 70% R.H.

Storage: −25° to 65°C.

DIMENSIONS, WEIGHT: 32mm high × 114mm wide × 272mm long (1¼" × 4½" × 10¾"). Net weight 0.28kg (10 oz.).

Specifications subject to change without notice.

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SECTION 1
GENERAL INFORMATION

1.1 INTRODUCTION

1.1.1 Product Description

The Model 7166 Mercury Wetted Relay Card provides either 10 separate switches using 10 two-pole relays or, with all jumpers installed, 10 inputs to one output or one input to 10 outputs switched. Cards are shipped with all jumpers installed. Features of the mercury wetted relay card include:

- Quick disconnect terminal blocks for each channel.
- Removeable jumpers to configure any switch to be a separate, isolated IN/OUT circuit.
- Long switch life with low, stable contact resistance.
- Bounce-free switching.

1.1.2 Manual Overview

The instruction manual is organized in the following manner:

- Section 1 General Information—Includes a product description and an overview of the manual, information on warranty, manual addenda, safety symbols and terms, unpacking and inspection, and specifications.
- Section 2 Operation—Includes safety information, wiring and installation, operating instructions, and some typical applications.
- Section 3 Performance Verification—Provides the procedure to check proper operation of the card.
- Section 4 Replaceable Parts—Includes a parts list, schematic diagram and a component layout.

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 7166-901-00). The manual package includes an instruction manual and all pertinent addenda.

1.4 SAFETY SYMBOLS AND TERMS

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

The symbol  denotes that a high voltage may be present on the terminal(s).

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 instrument.

1.5 UNPACKING AND INSPECTION

The Model 7166 is inspected both electrically and mechanically before shipment. Upon receiving the Model 7166, 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 7166:

Model 7166 Mercury Wetted Relay Card
Model 7166 Instruction Manual

1.6 SPECIFICATIONS

Detailed specifications of the Model 7166 precede the table of contents of this manual.

SECTION 2
OPERATION

2.1 INTRODUCTION

This section contains safety information, wiring instructions for the various relay configurations, an installation procedure of the card in a scanner, operating instructions, and some typical applications for the card.

2.2 SAFETY PRECAUTIONS

1. Make sure the scanner mainframe is grounded through a properly earth grounded receptacle before operation.
2. Inspect all test lead connections for wear and defects such as cracks, exposed wires, (etc). Correct any defect found before operating the relay card with the mainframe.
3. Do not exceed the Model 7166's maximum allowable voltages as defined in the specifications.
4. Turn off all power supplies and discharge any residual power before installing or removing the Model 7166 from the scanner mainframe.
5. Turn off all power supplies and discharge any residual power before connecting or disconnecting wires and jumpers from the Model 7166.
6. The Model 7166 is not intended to directly switch high power mains circuitry. Switching low power mains circuitry is explained in paragraph 2.5.

2.3 WIRING

Each channel on the Model 7166 consists of a two-pole relay that has a quick disconnect terminal block. As shipped, each channel is also connected through jumpers to the output terminal block. The relay card can be wired for different switch configurations as explained in this section.

WARNING

To avoid electrical shock that could result in severe injury or death, always remove all power from external sources before making or breaking connections to the relay card.

CAUTION

When switching a circuit that approaches the current limit (¾A) or a circuit with high fault current capability (such as AC mains), it is required that a (¾A) fuse be wired in series with the input to protect the card.

Peak transients must be clamped to <300V. See paragraph 2.5 for clamping information.

Notes:

1. To maintain $>10^9\Omega$ input isolation, keep the card and terminal blocks clean. Body oil and dirt from handling can degrade the insulation resistance.
2. To prevent overheating, do not place loads on the card. All loads should be outside of the scanner.
3. Shielding—Shielded cables should be used when switching above 100V or high current. The shield should preferably be connected to a guard circuit or to earth ground. This helps prevent excessive radiation from the cables from interfering with any equipment. The cable rating must exceed the maximum allowable signal levels as defined in the specifications.
4. RFI Filtering—RFI on inputs or outputs may cause problems with other cards installed in the scanner and with low level measurements. RFI filtering on these lines may be required in order to operate the cards to their full specifications. The guard terminal at the output block is tied to the ground plane on the board. Connecting this point to a guard circuit or to earth ground will also help to keep conducted and radiated noise from interfering with equipment.
5. Reactive loads require voltage clamping (for inductive loads) and current limiting (for capacitive loads). See paragraph 2.5 for more information.

2.3.1 Jumpers

At the factory, both poles of each relay are connected to the output terminal. That is, each input is connected to its own output as well as the output terminal when the relay is energized (Figure 2-1A).

A pole of any relay channel can be configured as an isolated switch by removing the jumper (Figure 2-1B).

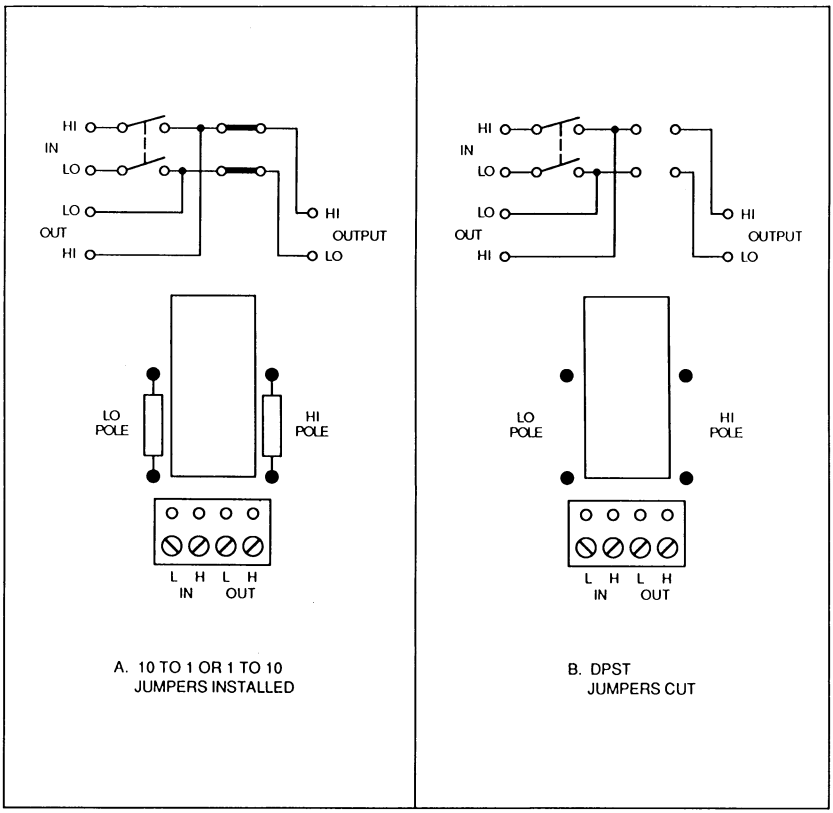


Figure 2-1. Jumper Positions for 10 to 1 and Isolated DPST Switching

2.3.2 DPST Configuration

To use a channel in the double-pole single-throw (DPST) configuration, simply remove the jumpers (P/N J-15) by cutting or desoldering, then connect the source to the IN terminals of the terminal block and the load across the OUT terminals as shown in Figure 2-2. The procedure to make connections to the terminal block is provided in the next paragraph.

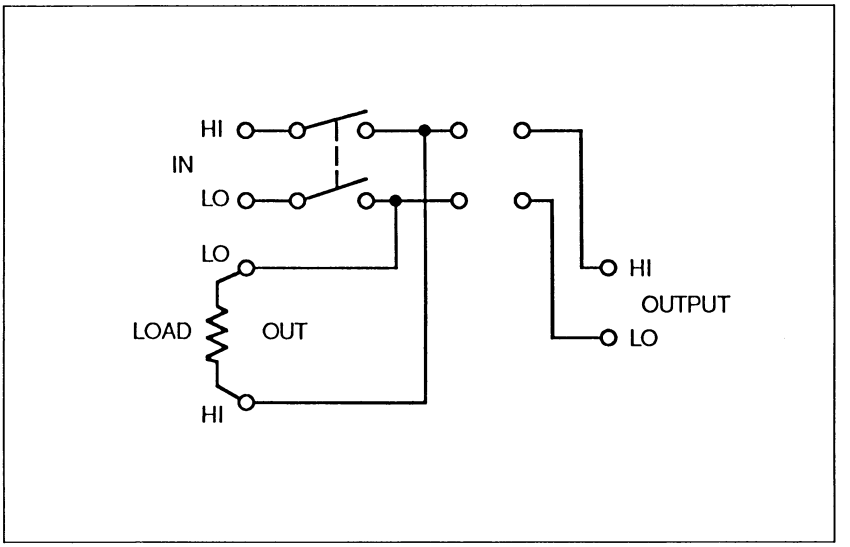


Figure 2-2. DPST Configuration

2.3.3 Terminal Block Connections

Perform the following procedure to wire circuitry to the terminal blocks of the Model 7166:

WARNING

Make sure all power is off and stored energy in external circuitry is discharged.

1. Remove the terminal block, for the appropriate channel, from the relay card by simply pulling it off the PC board.
2. Using an insulated screwdriver, connect the circuitry to the terminal block as shown in Figure 2-3. The screw terminals accept #14 to #26 AWG wire.
3. Reinstall the terminal block on the relay card. Make sure the pins on the card are properly mated to the terminal block.
4. Repeat steps 1 through 3 if it is desired to wire additional terminal blocks.
5. Referring to Figure 2-4, remove one screw from the cable clamp of the relay card and route the terminal block wires as shown.
6. Reassemble and tighten the cable clamp. The clamp serves as a strain relief for the terminal block wires.

NOTE

To order extra terminal blocks, order Keithley part number CS-521-3 for the channel terminals, and CS-521-1 for the output terminal. See paragraph 4.3 for ordering information.

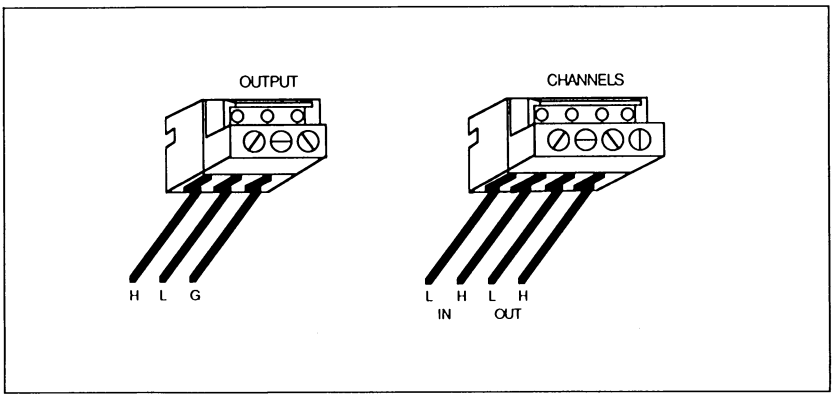


Figure 2-3. Quick Disconnect Terminal Block

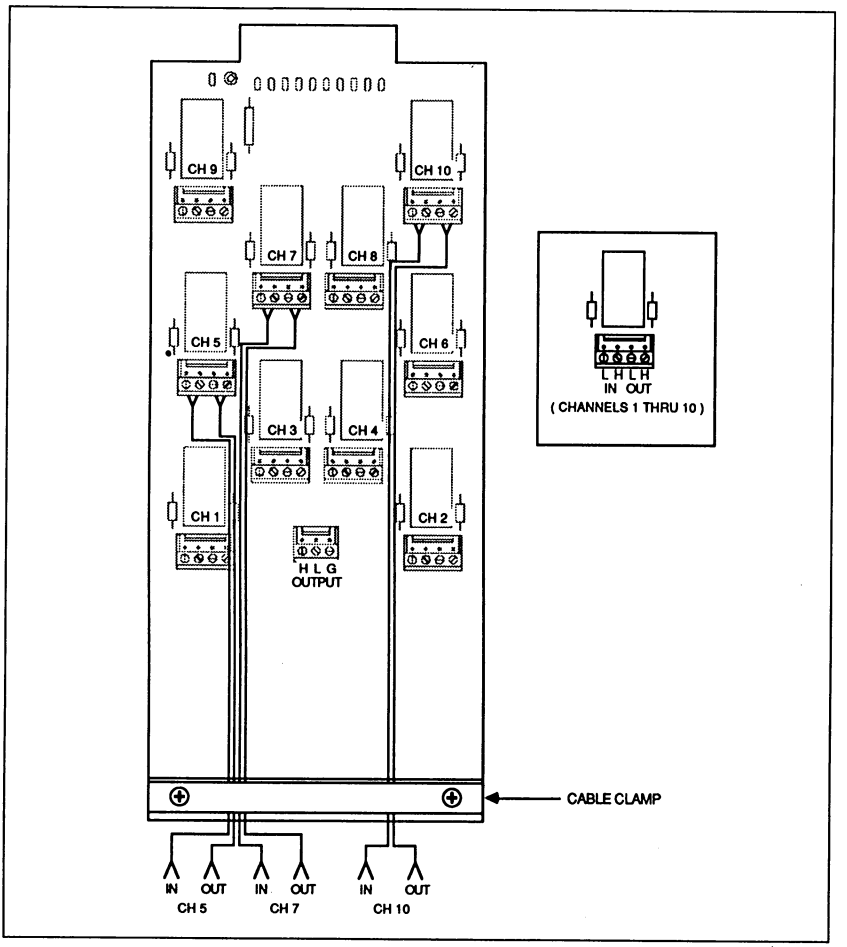


Figure 2-4. Typical Wire Routing

2.3.4 Other Configurations

A variety of different relay configurations can be set up.

Isolated Poles—In this configuration, the relay serves as a single-pole switch between the DUT and the output in addition to operating as

a SPST switch for the DUT Referring to Figure 2-5, wire the relay card as follows:

1. Set up the relay card jumpers so that one pole is isolated from the output.
2. Connect the DUT switch using the isolated pole, and the load or source using the connected channel.

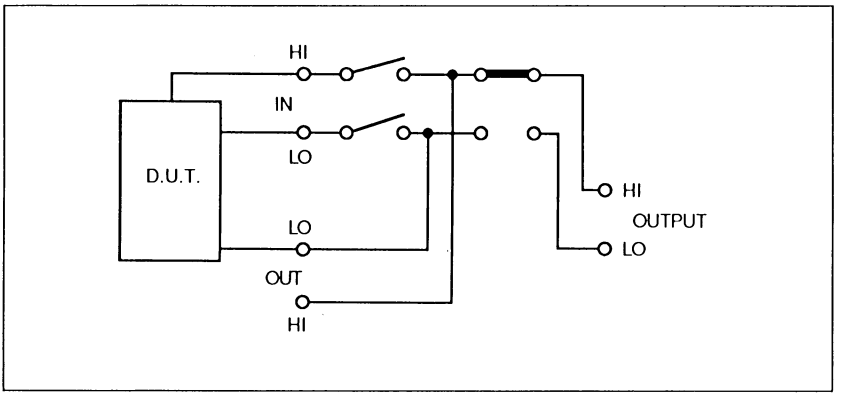


Figure 2-5. Isolated Poles Configuration

NOTE

Many versions of Figure 2-5 are possible, as any desired combination of jumpers may be installed or removed.

Four-Pole Configurations—In this configuration, two relays are energized at the same time to control two separate circuits. The relay jumpers must be removed. Figure 2-6 shows the 4PST-NO configuration. Wire the relay card as follows:

1. Remove the relay card jumpers.
2. Connect the circuits to the two channels.

NOTE

6PST and 8PST configurations are possible by adding a third and fourth channel respectively.

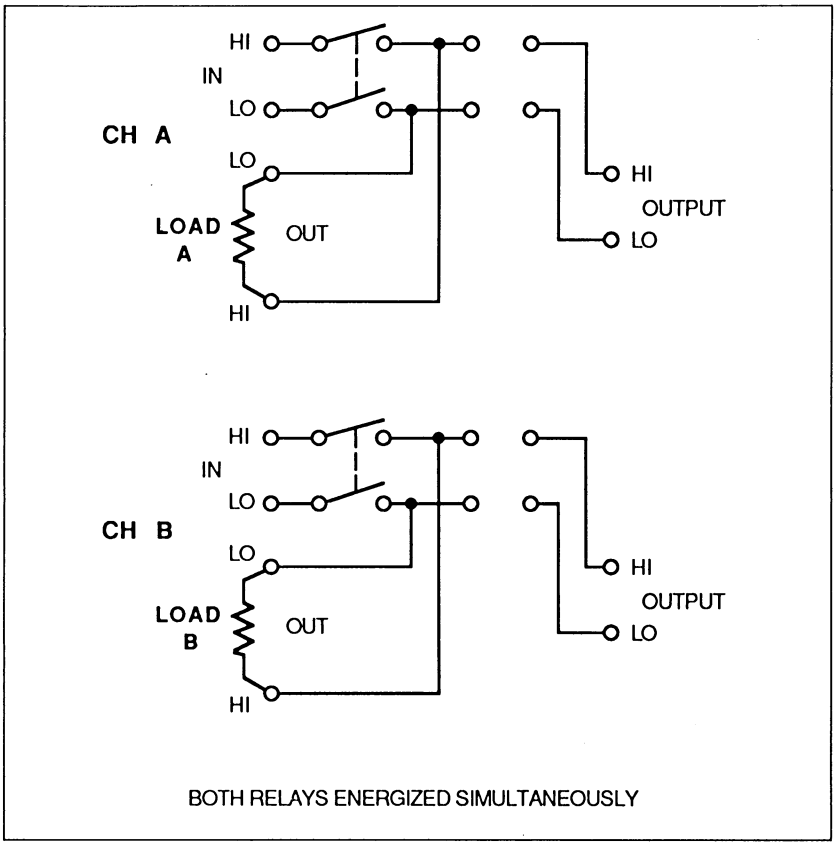


Figure 2-6. 4PST Configuration

2.4 INSTALLATION AND REMOVAL

WARNING

Make sure all power is off and stored energy in external circuitry is discharged.

2.4.1 Relay Card Installation

Before installing the Model 7166 into the scanner mainframe, it must be wired with the desired configuration as explained in paragraph 2.3. Once the card is configured, plug it into the appropriate slot in the rear panel of the scanner mainframe. In the Model 705, the relay card is placed horizontally into the unit. In the Model 706, the relay card is placed vertically in the unit. Since this card may be used in either the Model 705 or the Model 706, position-insensitive mercury wetted relays are used on the card. The relay card is placed in the mainframe with the card edge connector first. Align the card with the grooves in the slot and insert the card to its full depth into the mainframe. Make sure the card is properly seated into the connector in the mainframe. With the card fully inserted, push the locking tabs forward to the center of the card to lock it in the mainframe.

NOTE

Refer to the scanner mainframe's instruction manual for complete details.

2.4.2 Relay Card Removal

To remove a relay 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.

2.5 OPERATION

WARNING

User supplied lethal voltage may be present on the PC board or the connectors. Maximum voltage terminal to terminal is 300V peak. Maximum voltage terminal to chassis is 300V peak.

Model 7166 operation consists of three parts:

1. Wiring the Model 7166 for the desired configuration.
2. Installing the Model 7166 in a scanner mainframe.
3. Controlling the channels from the scanner.

Refer to paragraph 2.3 for wiring information, paragraph 2.4 for card installation information and the scanner instruction manual for information concerning control of the channels.

When the Model 7166(s) is the only card(s) in the scanner being used, it is recommended that the scanner be used in the 2-pole or 4-pole mode. The Model 7166 can be used with other scanner cards in any scanner pole configuration. Tables 2-1 through 2-4 list the scanner channels that control relay switch card channels for all the pole configurations of the scanner. The card numbers refer to the designated slots in the scanner where a Model 7166 may be physically located. Each table includes data for the 10 card locations in the Model 706. Since the Model 705 can only accommodate two cards, only the data for cards 1 and 2 is relevant.

Table 2-1. Scanner Control of Model 7166 4-Pole Mode

Card#	Scanner Channel Numbers	7166 Relays Controlled
1, 2	01-10	1-10
3, 4	11-20	1-10
5, 6	21-30	1-10
7, 8	31-40	1-10
9, 10	41-50	1-10

NOTE: Model 705 can accomodate 2 cards; Model 706 can accomodate 10 cards.

Table 2-2. Scanner Control of Model 7166 2-Pole Mode

Card#	Scanner Channel Numbers	7166 Relays Controlled
1	01-10	1-10
2	11-20	1-10
3	21-30	1-10
4	31-40	1-10
5	41-50	1-10
6	51-60	1-10
7	61-70	1-10
8	71-80	1-10
9	81-90	1-10
10	91-100	1-10

NOTE: Model 705 can accomodate 2 cards; Model 706 can accomodate 10 cards

Table 2-3. Scanner Control of Model 7166 1-Pole Mode

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

Table 2-3. Scanner Control of Model 7166 1-Pole Mode (Cont.)

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

NOTE: Model 705 can accomodate 2 cards; Model 706 can accomodate 10 cards.

Table 2-4. Scanner Control of Model 7166 Matrix Mode (0-Pole)

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

Table 2-4. Scanner Control of Model 7166 Matrix Mode (0-Pole) (Cont.)

CARD 6		CARD 7		CARD 8		CARD 9		CARD 10	
Scanner Ch. No.	Relay Controlled	Scanner Ch. No.	Relay Controlled	Scanner Ch. No.	Relay Controlled	Scanner Ch. No	Relay Controlled	Scanner Ch. No.	Relay Controlled
26, 1	1	31, 1	1	36, 1	1	41, 1	1	46, 1	1
26, 2	6	31, 2	6	36, 2	6	41, 2	6	46, 2	6
27, 1	2	32, 1	2	37, 1	2	42, 1	2	47, 1	2
27, 2	7	32, 2	7	37, 2	7	42, 2	7	47, 2	7
28, 1	3	33, 1	3	38, 1	3	43, 1	3	48, 1	3
28, 2	8	33, 2	8	38, 2	8	43, 2	8	48, 2	8
29, 1	4	34, 1	4	39, 1	4	44, 1	4	49, 1	4
29, 2	9	34, 2	9	39, 2	9	44, 2	9	49, 2	9
30, 1	5	35, 1	5	40, 1	5	45, 1	5	50, 1	5
30, 2	10	35, 2	10	40, 2	10	45, 2	10	50, 2	10

NOTE: Model 705 can accomodate 2 cards; Model 706 can accomodate 10 cards.

Operation Notes:

1. To ensure reliable relay performance, do not energize more than four channels at the same time when using the Model 705 Scanner. In the Model 706, the number of channels that can be energized simultaneously depends on factors such as temperature and ventilation. Refer to Table 2-5. The quantities given in this table assume that only Model 7166 cards are installed. If relays from other cards are energized at the same time, their drive currents will reduce these quantities.

Table 2-5. Maximum Number of Simultaneous Channel Closures of Model 7166 in Model 706 Scanner

Temp.	Using Louvers and Letting 706 Stand Free	Using Louvers and "1" Space Between Scanners in Rack	706 Closed in Rack	Max. No. of Channels in the 706
23°C	57	57	57	100
50°C	44	30	17	100

2. Power Limits—To prevent overheating or damage to the relay contacts, never exceed the signal level specifications of the relay. Maximum switched voltage and current levels are 300V peak, 0.75A DC or RMS. The maximum carry current is 2A DC or RMS. The power limit is 30VA. Reactive loads may require clamping and surge limiting.
3. Reactive Loads—Operation is specified for resistive loads. Reactive loads require voltage clamping (for inductive loads) and current surge limiting (for capacitive loads) to prevent damage to the relays and to external circuitry.
   A. Inductive Loads—Inductive reaction voltage, $L\frac{di}{dt}$, must be limited to less than 300V in DC circuits or 300V peak in AC circuits. Also, consider the load when determining the voltage limit. Clamping circuits that can be used are shown in Figure 2-7.

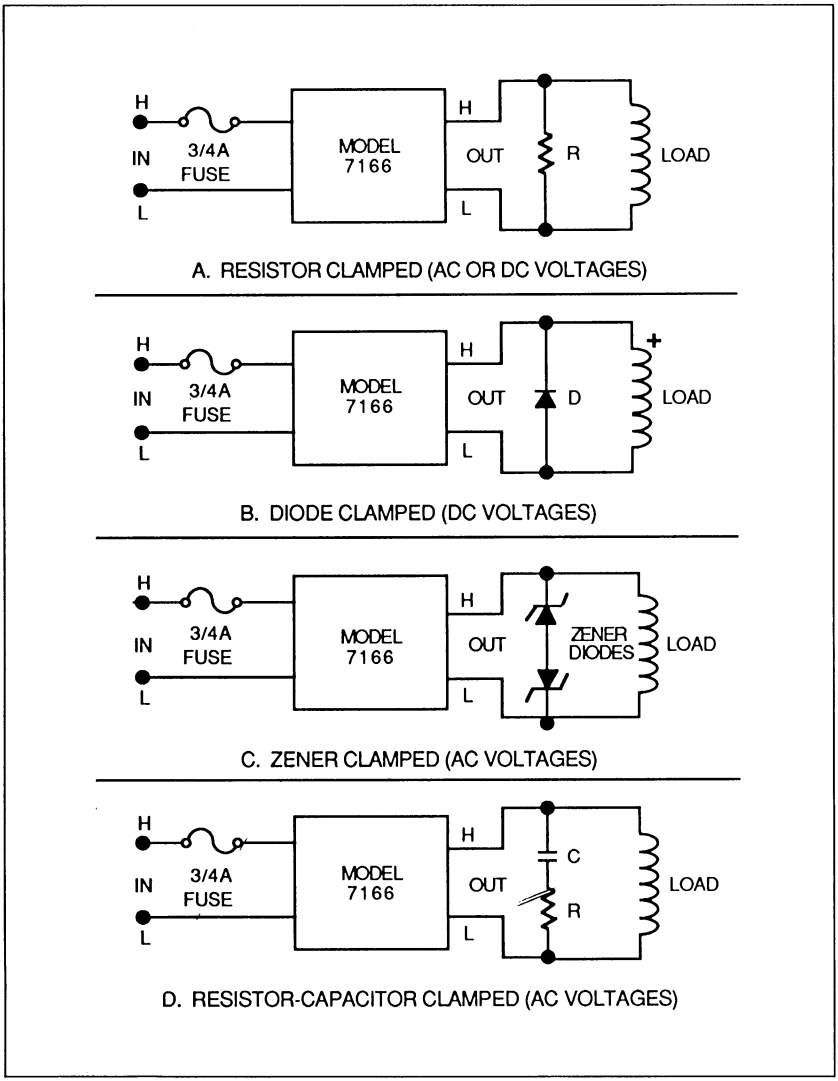


Figure 2-7. Limiting Inductive Reaction Voltage

B. Capacitive Loads—The initial surge current from a capacitive reactive load must be limited. Figure 2-8 shows circuits that can be used to limit current surges. Use a 0.75A fuse for hot switching (contacts make or break current) and a 2A fuse for cold switching (contacts do not make or break current). Also consider the load when determining the current surge limit.

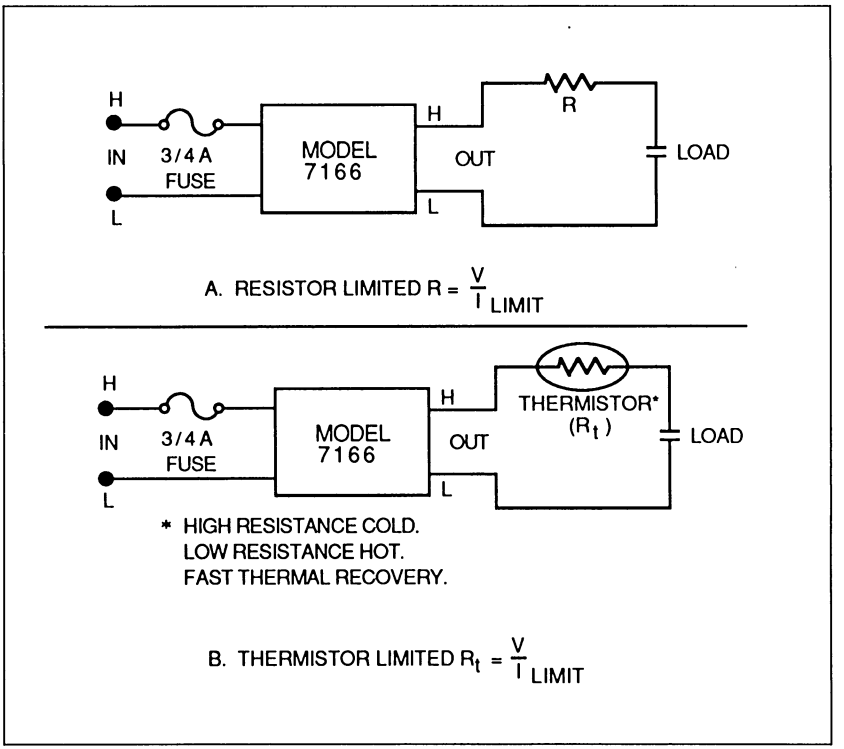


Figure 2-8. Limiting Capacitive Reaction Current

4. AC Mains Switching—The Model 7166 may be used to switch low power AC mains as long as the following restrictions are adhered to:
   A. Do not exceed the signal level specifications of the card.
   B. Use a 0.75A fuse for hot switching and a 2A fuse for cold switching.

C. Line filtering must be used to limit voltage transients and RF noise. A clamping circuit to protect the card from AC mains transients is shown in Figure 2-9.

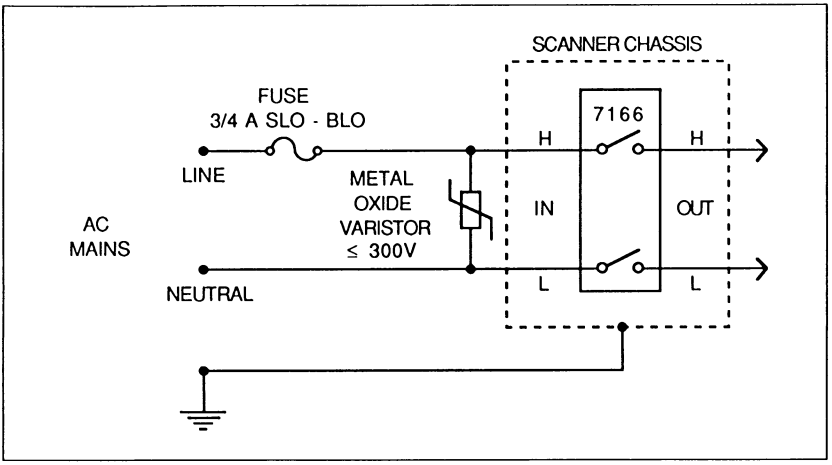


Figure 2-9. Clamping AC Mains Transients

5. Switching Speed—Relay actuation time is 3msec maximum, plus mainframe programming time. Maximum relay speed is 100 cycles per second at low level loads. For maximum relay life, operating speed should be limited to 60 cycles per minute at full rated load to avoid overheating of relay contacts.

2.6 TYPICAL APPLICATIONS

Independent IN/OUT circuits for each channel, the flexibility of individually selecting connection to the common output block, and the advantages of mercury wetted relays provide the means to configure the Model 7166 for particular setups. This section describes some typical examples on how the mercury wetted relay card can be used.

2.6.1 Switching with Shielded Cables

The circuit shown in Figure 2-10 will switch a load or a DUT connected via a length of shielded cable to the output or out of the channel. Limiting is not needed as long as the voltage specification of the card is met.

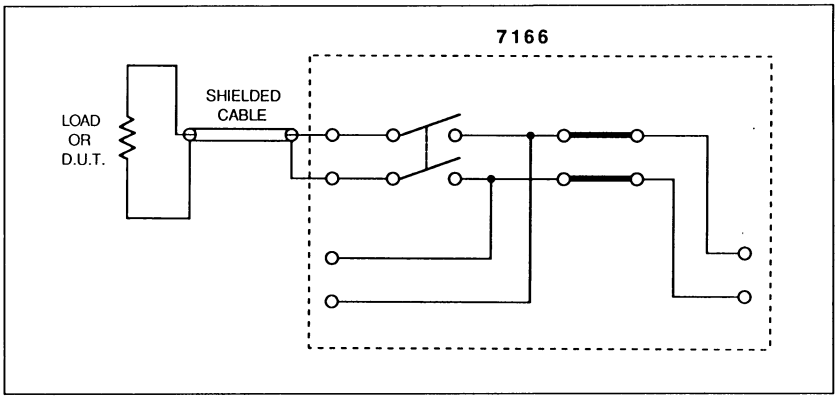


Figure 2-10. Switching with Shielded Cables

2.6.2 Switching Inductive Loads

The circuit shown in Figure 2-11 uses the Model 7166 to control a small motor or other inductive load. As long as the current specifications of the card are met, no limiting is needed.

2.6.3 Testing Devices Under Load

Figure 2-12 shows the Model 7166 configured to test a device under a given load. The load could be passive or active.

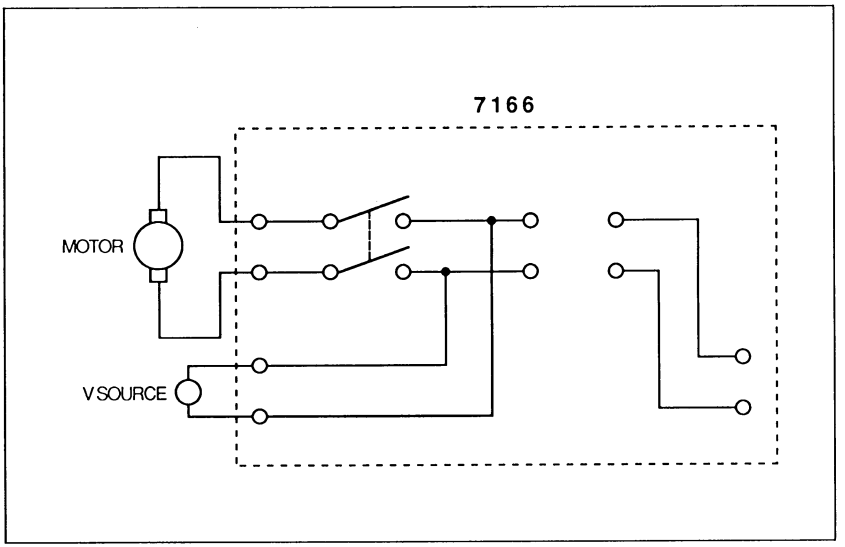


Figure 2-11. Switching Inductive Loads

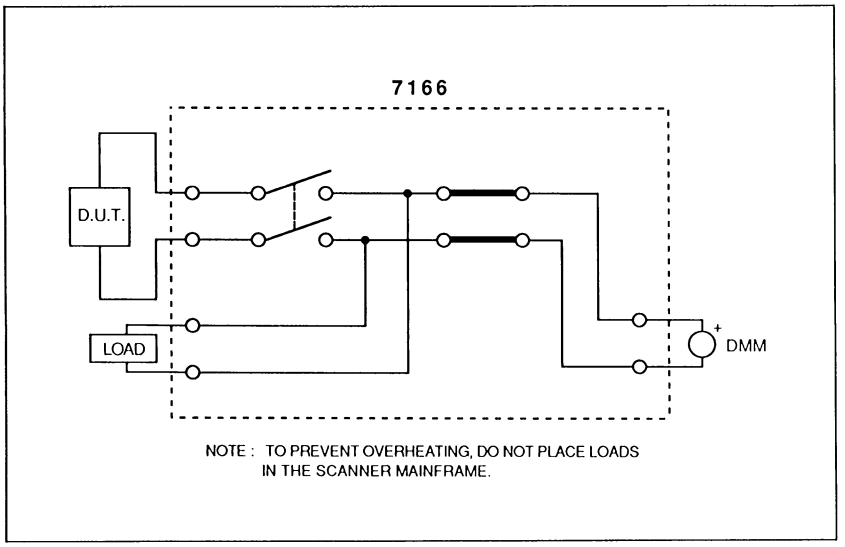


Figure 2-12. Testing DUT Under Load

2.6.4 Switching Requiring Bounce-free Operation

The Model 7166 is shown set up in Figure 2-13 for testing components such as electromechanical relays that require bounce-free switching to evaluate the component. This application also shows how the Model 7166 can be used with other scanner cards.

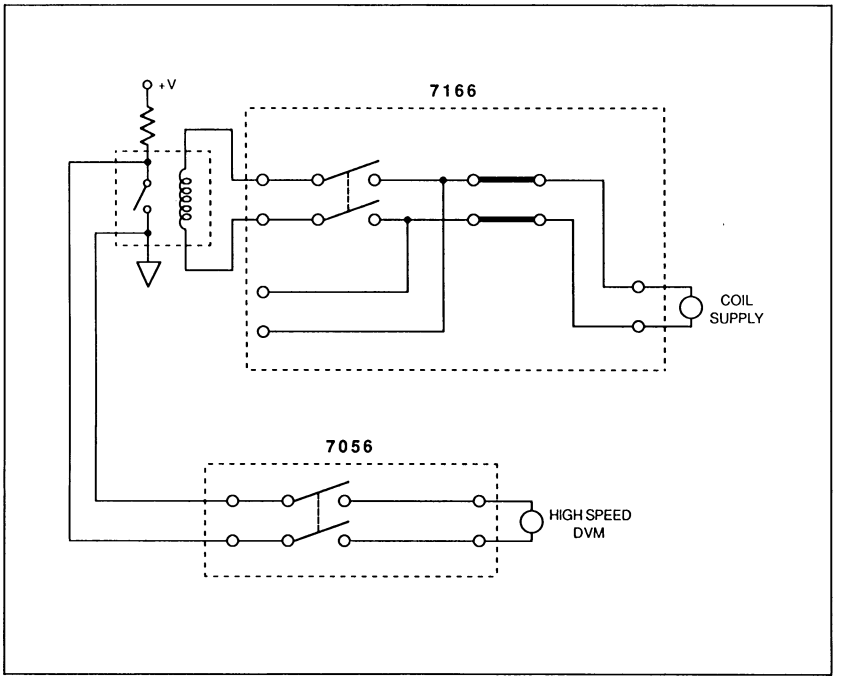


Figure 2-13. Bounce Free Switching

2.6.5 Two-wire Resistance Measurements

A simple scanning example is a switching system measuring resistances with the 2-wire method. With a DMM on the Model 7166 card output, the channel inputs can be scanned to connect one DUT at a time. This setup is shown in Figure 2-14.

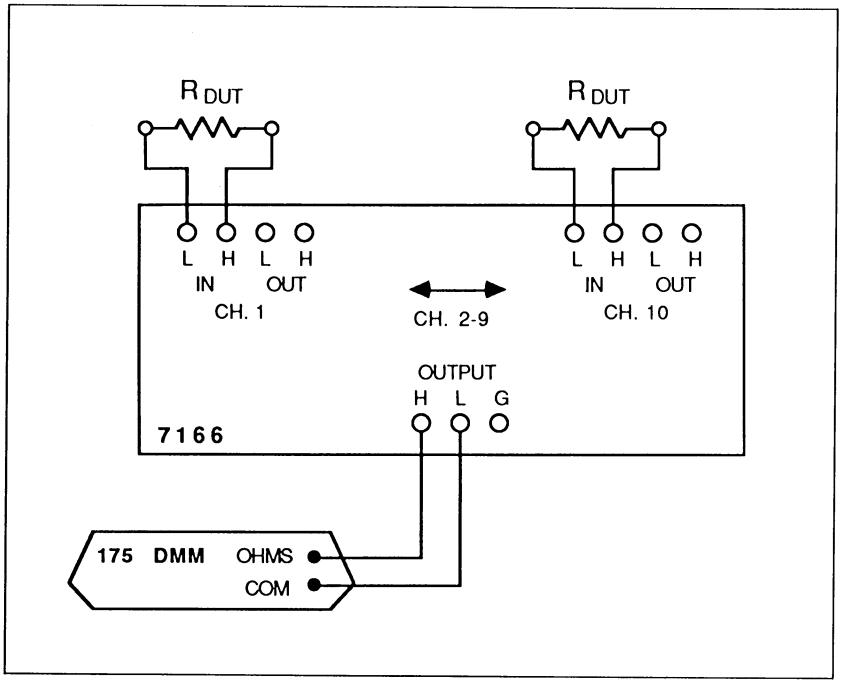


Figure 2-14. Two-Wire Resistance

2.6.6 High Current Sourcing

Since the Model 7166 has a carry current specification of 2A, it can be used in high current sourcing applications with cold switching (turn on sources after channel is closed).

As an example, consider the instrument setup of Figure 2-15 to calculate the gains (I_C/I_B) of several power transistors. The high and low poles of each Model 7166 channel are used to switch in a Model 228 current source for the collector and a Model 220 current source for the base. (Set a current limit of 2A on the Model 228.)

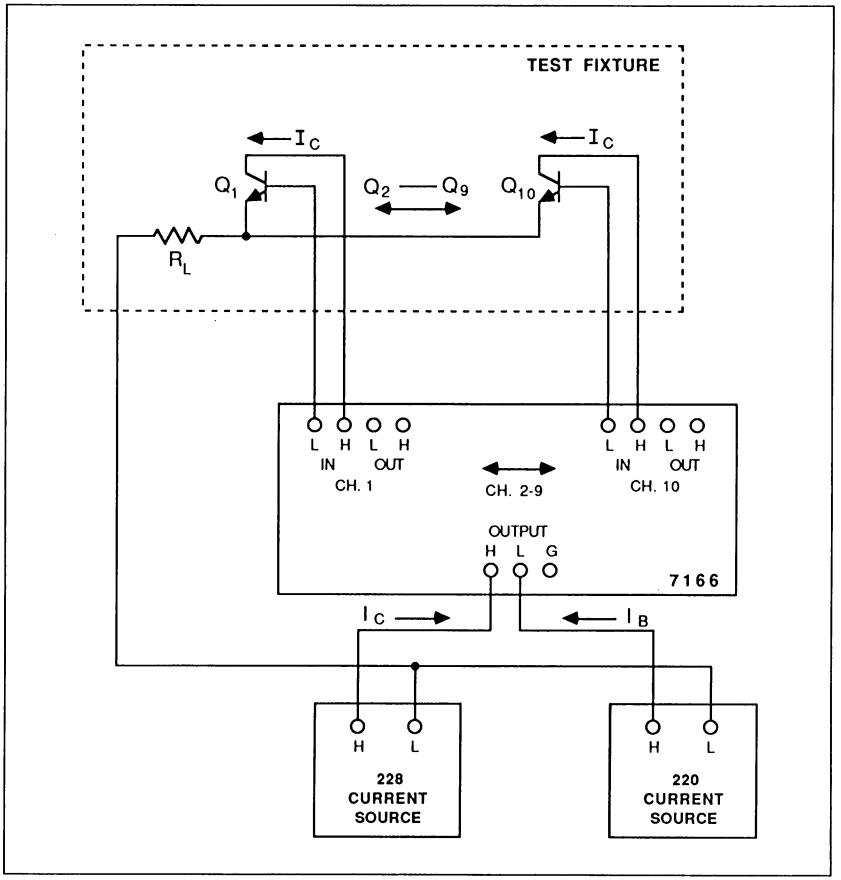


Figure 2-15. High Current Source

2.6.7. Other Applications

The Model 7166 can also be used to activate indicators, alarms and control circuitry.

SECTION 3
SERVICING INFORMATION

3.1 INTRODUCTION

This section contains a performance verification procedure. Recommended maintenance includes inspection of the relay card and the card edge connector to ensure good electrical contact, and the verification of the input isolation and contact resistance specifications. The Model 7166 does not require calibration.

3.2 REQUIRED TEST EQUIPMENT

Recommended test equipment for performance verification is provided in Table 3-1. Test equipment other than the recommended equipment may be substituted if specifications equal or exceed the stated specifications in Table 3-1.

Table 3-1. Recommended Test Equipment

Description	Specification	Mfg.	Model
Scanner Mainframe	—	Keithley	705 or 706
Extender Card	—	Keithley	7061
DMM	300MΩ full scale 100μΩ resolution	Keithley	196
Kelvin Test Leads	—	Keithley	5806

3.3 ENVIRONMENTAL CONDITIONS

Performance verification should be done in an environment that is within the specified operating temperature range of the relay card.

3.4 VERIFICATION PROCEDURE

In general, verification consists of measuring the resistance of each relay switch in an open and closed state. Perform the following procedures to verify the input isolation and contact resistance specifications of the Model 7166:

1. Wire up a channel terminal block and the Output terminal block with two copper wires on each terminal. See Figure 3-1. Use wires long enough to be clamped on the card and exit the scanner if an extender card is not available.
2. Zero the Model 196 with the Kelvin test leads shorted together. (The Model 196 must be warmed up two hours if from cold-start.)
3. If the Model 7061 extender is not available, insert the Model 7166 into the mainframe. Turn on the mainframe and select the channel to be tested.
4. If the jumper is present for the channel HI pole, connect the Kelvin test leads across the card's Output High and the channel's Input High. Figure 3-1 shows these connections for Channel 1.

   If the jumper is removed, connect the leads across the channel's In High and Out High.
5. From the front panel of the mainframe, open and close the channel. Verify that the resistance is >300MΩ when open and <225mΩ (if jumper present) or <125mΩ (if no jumper) when closed.
6. Zero the Model 196, then connect the Kelvin test leads for the same channel's LO pole. This is across the card's Output Low and the channel's Input Low if the jumper is present on the channel LO pole.

   If the jumper is removed, connect between the channel's In Low and Out Low.
7. Take readings for an opened and closed channel. The readings should be >300MΩ when open and <225mΩ (if jumper present) or <125mΩ (if no jumper) when closed.
8 If the Model 7166 is not on an extender, turn off the mainframe and remove the card. Move the wired-up channel terminal block to the next channel to be tested.
9. Repeat steps 3 through 8 to check the remaining channels.

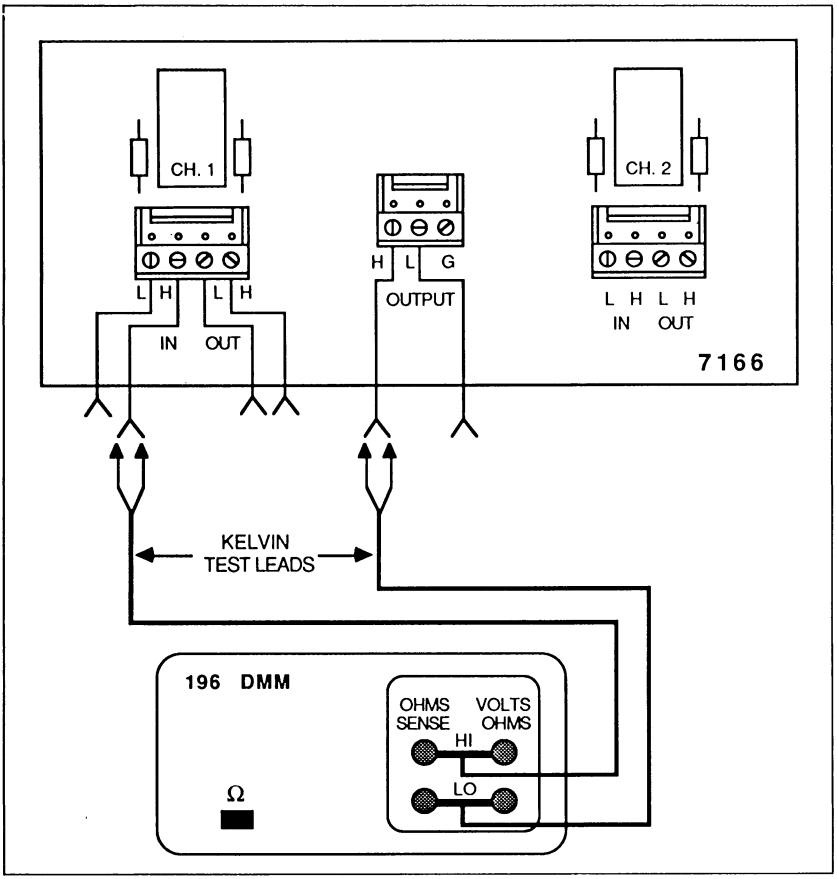


Figure 3-1. Performance Verification Setup

SECTION 4
REPLACEABLE PARTS

4.1 INTRODUCTION

This section contains replacement parts information, a schematic diagram and a component layout for the Model 7166.

4.2 REPLACEABLE PARTS

Parts are listed alpha-numerically in the order of their circuit designations.

4.3 ORDERING INFORMATION

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

1. Model Number (7166)
2. Serial Number
3. Part Description
4. Circuit Description (if applicable)
5. Keithley Part Number

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

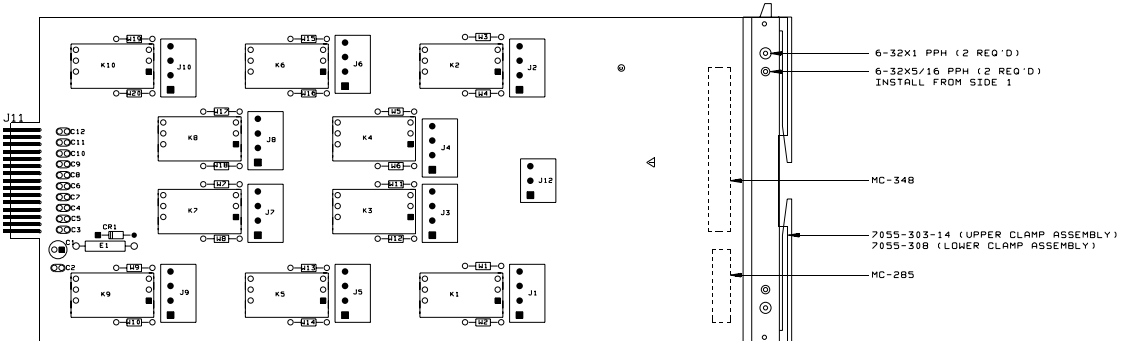
Figure 4-1 contains a component layout of the Model 7166. Figure 4-2 contains a schematic diagram of the Model 7166.

Table 4-1. Model 7166, Parts List

Circuit Desig.	Description	Sch. Loc.	Keithley Part No.
C1	Capacitor, 10μF	D8	C-314-10
C2-C12	Capacitor, 0.1μF	sev.	C-237-.1
CR1	Rectifier, 1A, 1N4006	C8	RF-38
J1-J10	Terminal Block	sev.	CS-521-3
J12	Terminal Block	D1	CS-521-1
W1-W20	Jumper	sev.	J-15
E1	Ferrite Bead	D8	CT-9
K1-K10	Relay	sev.	RL-108
	Cable Clamp Assembly, Upper		7055-303-14
	Cable Clamp Assembly, Lower		705-308

NO. 7166-100

LTR.	ECO NO.	REVISION	ENG.	DATE
C	12081	RELEASED	MS	5-18-89
C1	13260	REVISED	SZ	6-22-89
D	15680	CHG'D ARTWORK FROM REV C TO D.	AS	4-22-93

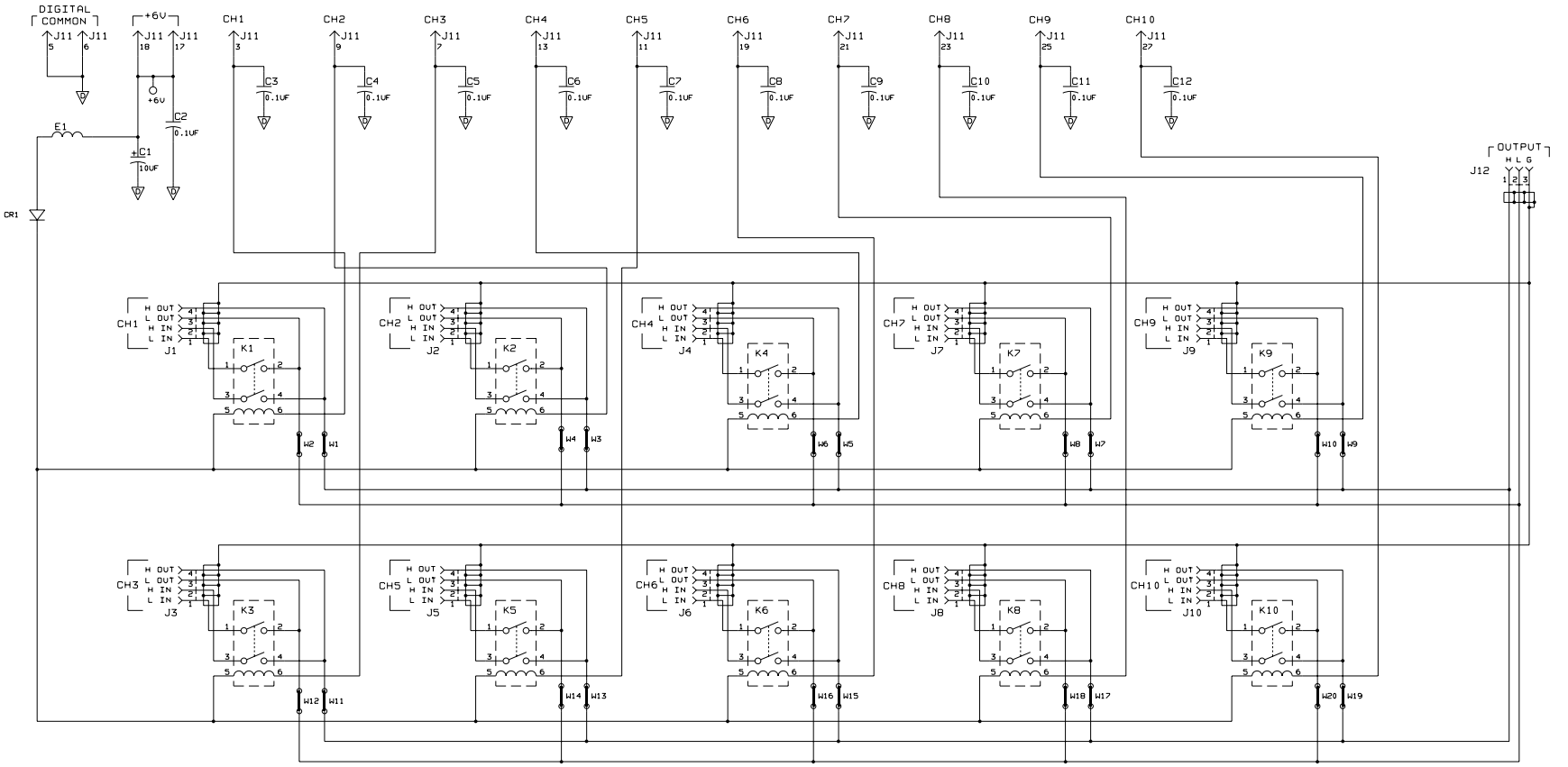


NOTES:

FOR COMPONENT INFORMATION
REFER TO BILL OF MATERIAL
7166-000-00

7166		1
MODEL	NEXT ASSEMBLY	QTY.
USED ON		

DO NOT SCALE THIS DRAWING	DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED	DATE 4/20/87	SCALE 1:1	TITLE COMPONENT LAYOUT, MERCURY CARD
	XX=±.015 ANG.=±1°	DRN. MH	ENG. APPR. DK	
KEITHLEY KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139	XXX=±.005 FRAC.=±1/64	MATERIAL		C NO. 7166-100
	SURFACE MAX. 63	FINISH		



KEITHLEY

KEITHLEY INSTRUMENTS INC.
CLEVELAND, OHIO 44139

TITLE

SCHEMATIC, MERCURY CARD

SIZE	MODEL	NO	ECO	REV
D	7166	7166-106	15680	D

DRAWN	APPROVED	DATE
PB	DK	4/20/93

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
❑ Data required
❑ Certificate of calibration required

(attach any additional sheets as necessary)

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

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

_____

_____

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

Relative humidity? _____ Other? _____

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

_____

_____

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

KEITHLEY

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