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Instruction Manual

Model 7037
Single-Pole Relay-Digital I/O Card

Contains Operating and Servicing Information

KEITHLEY

7037-901-01 Rev. A / 5-97

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

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

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

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Model 7037 Single-Pole Relay-Digital I/O Card
Instruction Manual

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Manual Print History

The print history shown below lists the printing dates of all Revisions and Addenda created for this manual. The Revision Level letter increases alphabetically as the manual undergoes subsequent updates. Addenda, which are released between Revisions, contain important change information that the user should incorporate immediately into the manual. Addenda are numbered sequentially. When a new Revision is created, all Addenda associated with the previous Revision of the manual are incorporated into the new Revision of the manual. Each new Revision includes a revised copy of this print history page.

Revision A (Document Number 7037-901-01)..... May 1997

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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, 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) measuring circuits 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.

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 the 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.

RELAY SWITCH SPECIFICATIONS

RELAY SWITCH CONFIGURATION: 30 independent channels of 1-pole switching.

CONTACT CONFIGURATION: 1 pole Form A.

CONNECTOR TYPE: 96-pin male DIN card connector.

MAXIMUM SIGNAL: 110V DC, 110V rms, 155V peak betwen any two inputs or chassis, 1A switched, 30VA (resistive load).

CONTACT LIFE:
Cold Switching: 10^8 closures.
At Maximum Signal Levels: 10^5 closures.

CHANNEL RESISTANCE (per conductor): <1.25Ω.

CONTACT POTENTIAL: <4µV per contact.

OFFSET CURRENT: <100pA.

ACTUATION TIME: 3ms.

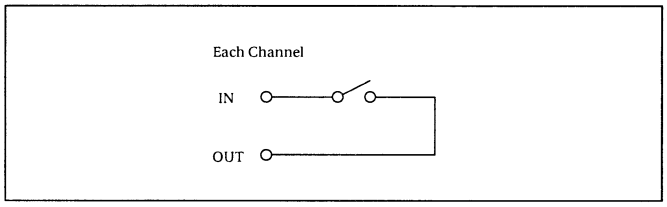
ISOLATION:
Channel to Channel: $>10^9\Omega$, <25pF.
Common Mode: $>10^9\Omega$, <100pF.

CROSSTALK (1MHz, 50Ω Load): <–40dB.

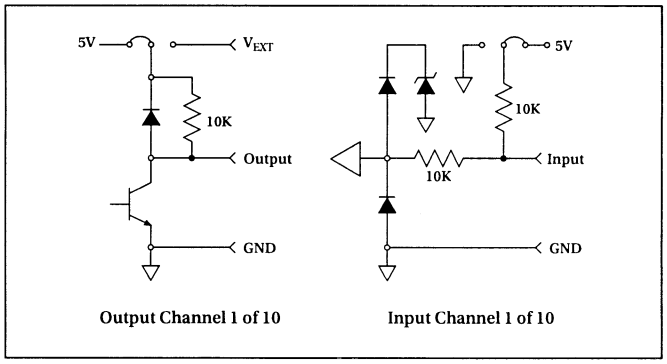
INSERTION LOSS (50Ω Source, 50Ω Load): <0.25dB below 1MHz, <3dB below 10MHz.

RELAY DRIVE CURRENT (per relay): 16mA.

Relay Switch Configuration



Digital I/O Configuration



DIGITAL I/O SPECIFICATIONS

DIGITAL I/O CAPABILITY: 10 independent inputs.
10 independent outputs.

OUTPUT:

Configuration: 10 open collector drivers with factory installed 10kΩ pull-up resistors. Each driver has an internal flyback diode.

Pull-Up Voltage: 5V internally supplied, external connection provided for user supplied voltage up to 42V max. Outputs short circuit protected up to 25V.

Maximum Sink Current: **Per Channel:** 250mA.
Per Card: 1A.

Logic: Hardware user configurable for negative or positive true logic levels.

INPUT:

Configuration: 10 inputs with internal 10kΩ pull-up resistors provided. Input resistors can be set for pull-up or pull-down configuration.

MAXIMUM VOLTAGE LEVEL: 42V peak.

LOGIC: Positive true.

GENERAL

CONNECTOR TYPE: 96-pin male DIN connector.

ENVIRONMENT: **Operating:** 0° to 50°C, up to 35°C <80% RH.
Storage: –25° to 65°C.

EMC: Conforms with European Union Directive 89/336/EEC EN 55011, EN 50082-1, EN 61000-3-2 and 61000-3-3, FCC part 15 class B.

SAFETY: Conforms with European Union Directive 73/23/EEC EN 61010-1, UL 3111-1.

Specifications subject to change without notice.

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1
General Information

Introduction

This section contains general information about the Model 7037 single-pole relay-digital I/O card.

The Model 7037 consists of a multi-pin (mass termination) connector card and a relay card. External test circuit connections are made via the 96-pin male DIN connector on the connector card. Keithley offers a variety of optional accessories that can be used to make connections to the connector card. (See the available accessories at the end of this section.)

The rest of Section 1 is arranged in the following manner:

- **Features**
- **Warranty information**
- **Manual addenda**
- **Safety symbols and terms**
- **Specifications**
- **Unpacking and inspection**
- **Repacking for shipment**
- **Optional accessories**

Features

The Model 7037 has 30 independent channels of single-pole switching. It also has ten independent inputs and outputs for digital I/O capabilities. Some of the key features include:

- Low contact potential and offset current for minimal effects on low-level signals.
- High density switching and control.
- High capacity digital output sink of 250mA.
- 1A pathway current carrying capacity.
- High isolation resistance >1GΩ for minimal load effects.
- Model 7011-KIT-R connector kit that includes a 96-pin female DIN connector that will mate directly to the connector on the Model 7037 or to a standard 96-pin male DIN bulkhead connector (see Model 7011-MTR). This connector uses solder cups for connections to external circuitry and includes an adapter for a round cable and the housing.

Warranty information

Warranty information is located at the front of this instruction manual. Should your Model 7037 require warranty service, contact the Keithley representative or authorized repair facility in your area for further information. When returning the 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.

Manual addenda

Any improvements or changes concerning the card or manual will be explained in an addendum included with the card. Addenda are provided in a page replacement format. Replace the obsolete pages with the new pages.

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 card. Such damage may invalidate the warranty.

Specifications

Model 7037 specifications are found at the front of this manual. These specifications are exclusive of the mainframe specifications

Unpacking and inspection

Inspection for damage

The Model 7037 is packaged in a resealable, anti-static bag to protect it from damage due to static discharge and from contamination that could degrade its performance. Before removing the card from the bag, observe the following precautions on handling.

Handling precautions

1. Always grasp the card by the side edges and shields. Do not touch the board surfaces or components.
2. When not installed in a Model 7001/7002 mainframe, keep the card in the anti-static bag and store it in the original packing carton.

After removing the card from its anti-static bag, inspect it for any obvious signs of physical damage. Report any such damage to the shipping agent immediately.

Shipping contents

The following items are included with every Model 7037 order:

- Model 7037 Single-Pole Relay-Digital I/O Card
- Model 7011-KIT-R 96-pin Female DIN Connector Kit
- Model 7037 Instruction Manual
- Additional accessories as ordered

Instruction manual

The Model 7037 Instruction Manual is three-hole drilled so it can be added to the three-ring binder of the Model 7001 or 7002 Instruction Manual. After removing the plastic wrapping, place the manual in the binder following the mainframe instruction manual. Note that a manual identification tab is included and should precede the Model 7037 Instruction Manual.

If an additional instruction manual is required, order the manual package, Keithley part number 7037-901-00. The manual package includes an instruction manual and any pertinent addenda.

Repacking for shipment

Should it become necessary to return the Model 7037 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 card.
- Write ATTENTION REPAIR DEPARTMENT on the shipping label.
- Fill out and include the service form located at the back of this manual.

Optional accessories

The following accessories are available for use with the Model 7037:

Model 7011-MTC-2 — This two-meter round cable assembly is terminated with a 96-pin female DIN connector on each end. It will mate directly to the connector on the Model 7037 and to a standard 96-pin male DIN bulkhead connector (see Model 7011-MTR).

Model 7011-MTR — This 96-pin male DIN bulkhead connector uses solder cups for connections to external circuitry. It will mate to the Model 7011-KIT-R connector and Model 7011-MTC-2 cable assembly.

2

Relay Switch Configuration

Introduction

This section covers the basic single-pole, single-throw (SPST) switch configuration

Basic switch configuration (SPST)

A simplified schematic of the Model 7037 relay switch configuration is shown in Figure 2-1. The card has 30 independent channels. Each channel is made up of a single-pole, single-throw (SPST), normally open (NO) switch.

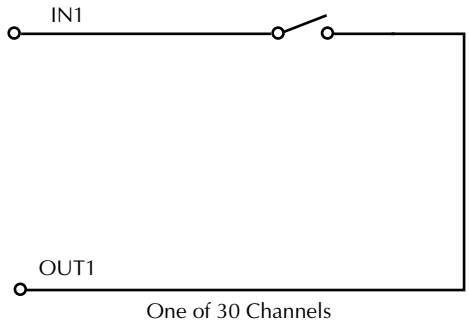


Figure 2-1
Model 7037 relay switch configu ation (simplified s hematic)

3

Digital I/O Configuration

Introduction

This section covers the basic digital input and output config urations for the Model 7037. Connection information for these configurations is provided in Section 4 of this manual, while operation (front panel and IEEE-488 bus) is explained in Section 5.

Digital outputs

Output channels are user configurable for negative (low) or positive (high) true logic. That is, the output can be high or low when the channel is turned on (closed) depending upon user configuration. Conversely, the output can be high or low when the channel is turned off (open). Refer to Section 4 to configure the logic to your requirement

Controlling pull-up devices

Typically, the digital outputs are used to provide drive for relatively high current devices such as solenoids, relays, and small motors. The configurations for these applications are shown in Figure 3-1. Figure 3-1 allows you to use an external voltage source (V) for devices that require a higher voltage (42V maximum). An internal jumper is used to select the internal pull-up voltage. At the factory, the internal 5V source is selected.

Each output channel uses a fly-back diode for protection when switching an inductive device, such as a solenoid coil. This diode diverts the potentially damaging fly-back voltage away from the driver.

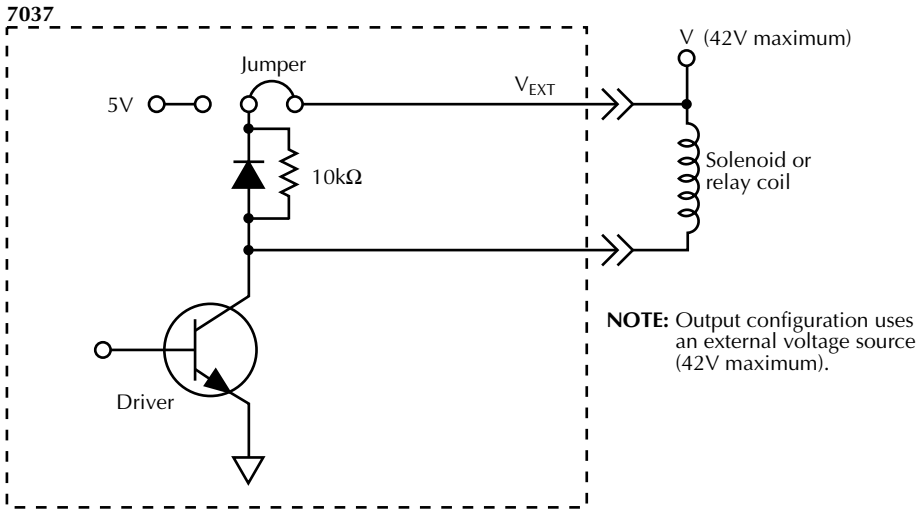


Figure 3-1
Output configu ation for pull-up devices

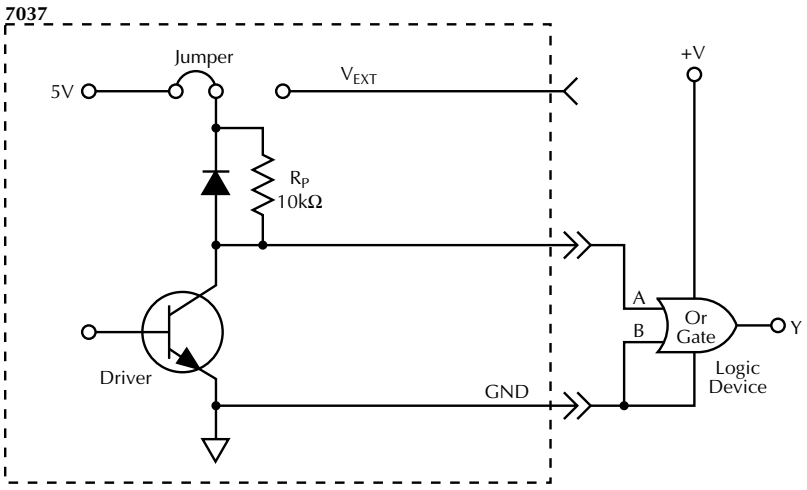


Figure 3-2
Output configu ation using pull-up resistance

Controlling devices using pull-up resistors

CAUTION

Failure to set J201 to the Vext position when using external pull-up voltages may result in damage to the output drivers.

When interfacing outputs to high-impedance devices (i.e., logic devices), internal pull-up resistors are used to achieve the appropriate logic level. Figure 3-2 shows the output configuration using the 10 Ω pull-up resistor (Rp).

The configuration in Figure 3-2 uses the internal 5V source as the high logic level. If you need a higher logic level, you can place the jumper in the alternate position and apply an external voltage (via V_{EXT}).

Digital inputs

Input channels use positive true logic but can be pulled up or pulled down based on the configuration of the pull-up resistor. Each channel uses a 10kΩ pull-up resistor (R_1). The pull-up resistors can be pulled up to 5V or pulled down to ground depending on the positioning of the jumper on the input logic bank. Refer to Section 4 for more information. Figure 3-3 shows the resistor being pulled up to 5V.

When the resistor is connected to 5V, the channel is pulled high. Thus, with nothing connected to the channel, the input is pulled high to 5V which displays the channel as on.

When the resistor is connected to ground, the channel is pulled low. Thus, with nothing connected to the channel, the input is pulled low to ground which displays the channel as off.

The digital input is compatible with external TTL logic. Each built-in pull-up resistor provides level shifting so devices such as micro-switches can be monitored. Each input has a protection network that clamps the input at 5.7V. This allows logic levels up to 42V peak to be monitored.

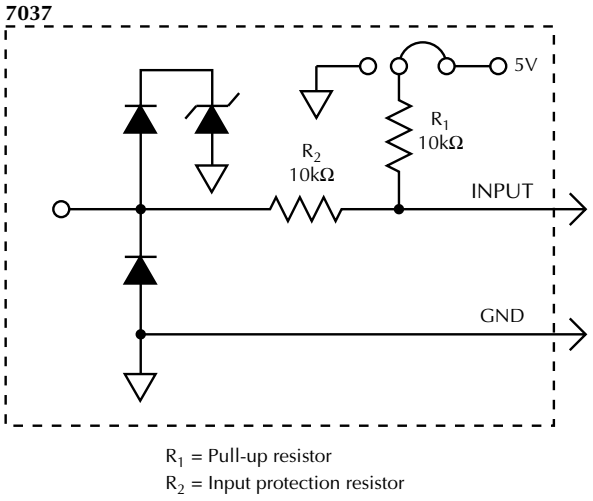


Figure 3-3
Input configu ation

4

Card Connections and Installation

Introduction

WARNING

The procedures in this section are intended only for qualified service personnel. Do not perform these procedures unless qualified to do so. Failure to recognize and observe normal safety precautions could result in personal injury or death.

The information in this section is arranged as follows:

- **Handling precaution —** Explains precautions that must be followed to prevent contamination to the card. Contamination could degrade the performance of the card.
- **Digital I/O connections —** Explains the voltage source jumpers, pull-up resistors, output logic, and input resistance and how to configure them.
- **Multi-pin (mass termination) connector card —** Covers the basic connections to the 96-pin DIN male connector and identifies each terminal.
- **Typical relay switch connection scheme —** Provides a typical connection scheme for a relay switch configuration
- **Typical digital I/O connection schemes —** Provides some typical connection schemes for output solenoid, relay, motor, and logic device control and for input micro-switch monitoring.
- **Model 7037 installation and removal —** Provides the procedures to install and remove the card from the Model 7001/7002 mainframe.

Handling precautions

To maintain high impedance isolation, care should be taken when handling the relay and connector cards to avoid contamination from such foreign materials as body oils. Such contamination can substantially lower leakage resistances, thus degrading performance.

To avoid possible contamination, always grasp the relay and connector cards by the side edges or shields. Do not touch the board surfaces or components. On connectors, do not touch areas adjacent to the electrical contacts. Dirt buildup over a period of time is another possible source of contamination. To avoid this problem, operate the mainframe and card in a clean environment.

If a card becomes contaminated, it should be thoroughly cleaned as explained in Section 6.

Digital I/O connections

Voltage source jumper

Digital output high uses the internal +5V source as the high logic level. If higher voltages are required, a user-supplied voltage can be used (42V maximum). At the factory, the internal jumper is set to use the internal +5V source.

CAUTION

Failure to set J201 to the Vext position when using external pull-up voltages may result in damage to the output drivers.

A plug-in jumper for the bank allows you to select the internal +5V source or an external source. In Figure 4-1, the banks are using the external voltage source.

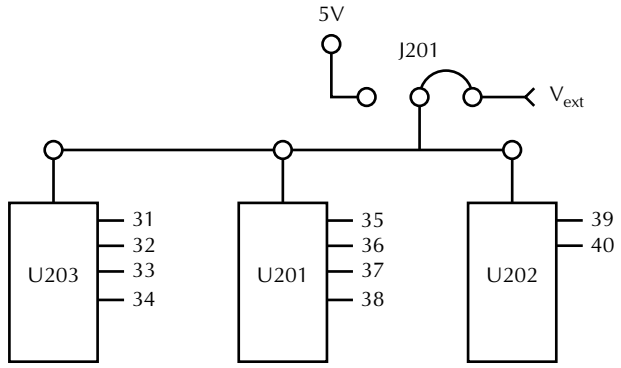


Figure 4-1
Voltage source jumper for output channels

The voltage source jumper is located on the connector board as shown in Figure 4-2. Figure 4-3 shows how the plug-in jumper is installed on J201.

Pull-up resistors

When interfacing outputs to high-impedance devices (i.e., logic devices), pull-up resistors are used to achieve the appropriate logic level. These resistors are installed at the factory.

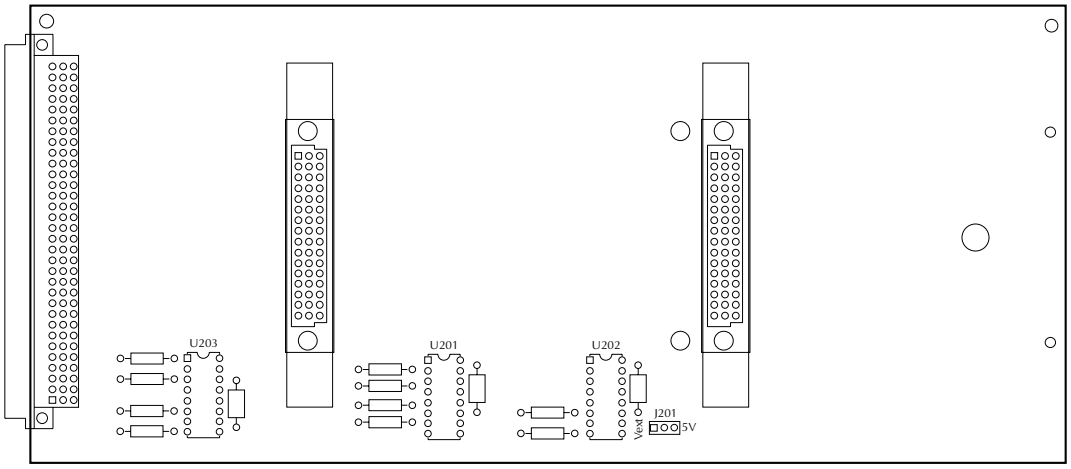


Figure 4-2
Component locations — connector board

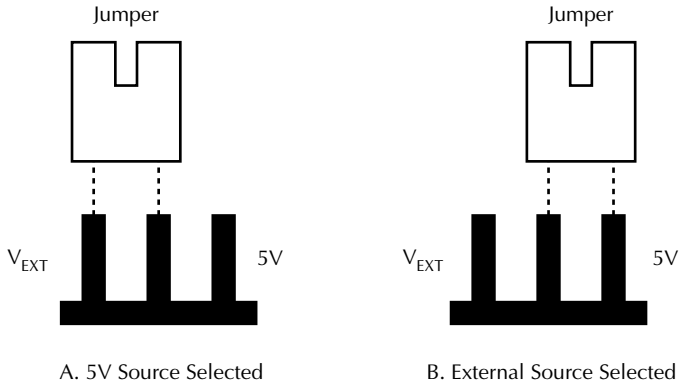


Figure 4-3
Voltage source jumper installation

Configuring digital I/O output logic

Referring to Figure 4-4 for the digital I/O output logic location, perform the following steps to configure J101

1. If mated together, separate the relay card from the connector card by removing the mounting screw and then pulling the two cards away from each other. Remember to only handle the cards by the edges and shields to avoid contamination.
2. Locate J101 on the relay board. Refer to Figure 4-4.
3. Determine if you require positive (high) or negative (low) logic.
4. Install the plug-in jumper in the appropriate position as shown in Figure 4-5.

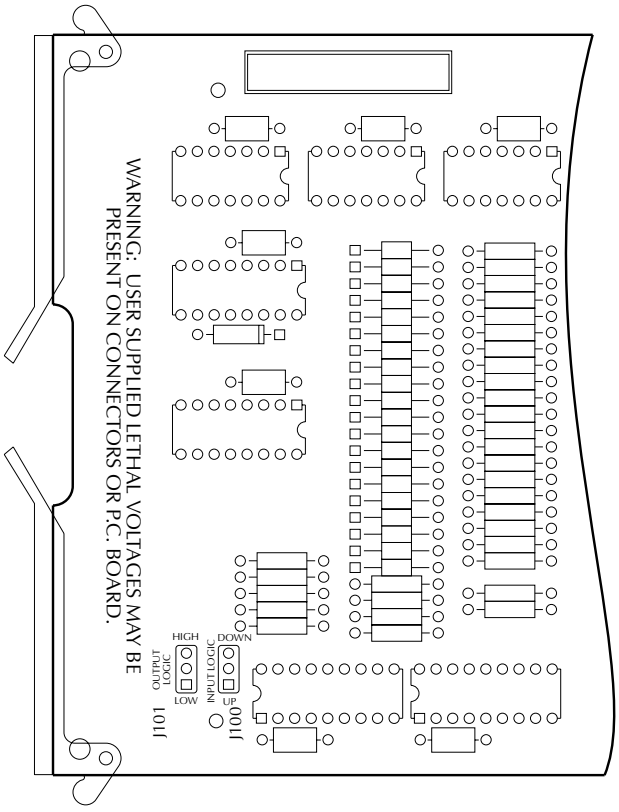


Figure 4-4
Digital I/O output logic location

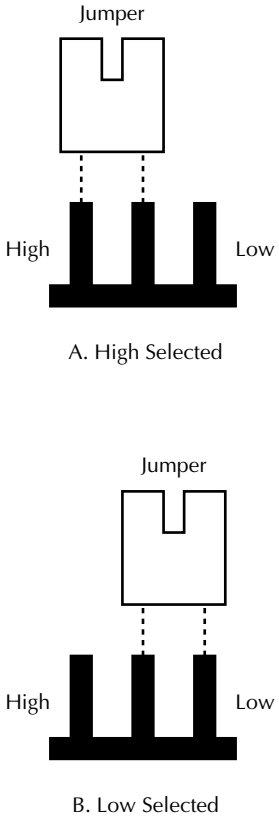


Figure 4-5
Digital I/O output logic selection

Configuring digital I/O input pull-up resistance

Referring to Figure 4-4 for digital I/O input pull-up resistance location, perform the following steps to configur J100:

1. If mated together, separate the relay card from the connector card by removing the mounting screw and then pulling the two cards away from each other. Remember to only handle the cards by the edges and shields to avoid contamination.
2. Locate J100 on the relay board. Refer to Figure 4-4.
3. Determine if you require pull-up (5V) or pull-down (ground) input logic.
4. Install the plug-in jumper in the appropriate position as shown in Figure 4-6.

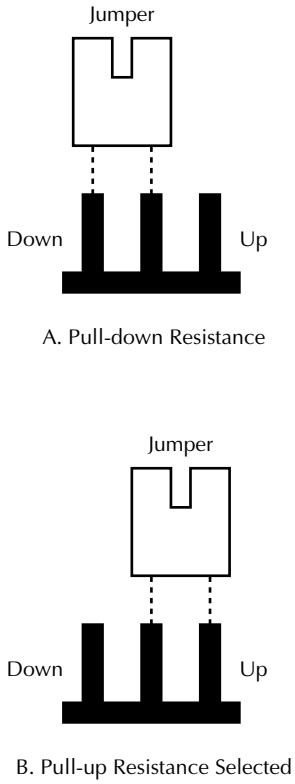


Figure 4-6
Digital I/O input pull-up resistance selection

Multi-pin (mass termination) connector card

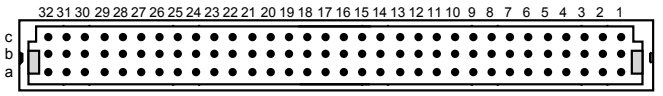
Since connections to external circuitry are made at the 96-pin male DIN bulkhead connector, there is no need to separate the connector card from the relay card. If the connector card is separated from the relay card, carefully mate them together. Make sure to handle the cards by the edges and shields to avoid contamination.

Keithley has a variety of cable and connector accessories available to accommodate connections from the connector card to test instrumentation and DUTs (devices under test). In general, these accessories, which are summarized in Table 4-1, utilize a round cable assembly for connections.

Table 4-1
Mass termination accessories

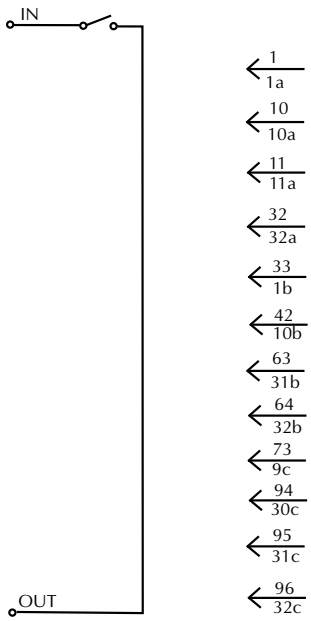
Model	Description
7011-KIT-R	96-pin female DIN connector and housing for round cable (provided with the Model 7037 card).
7011-MTC-2	Two-meter round cable assembly terminated with a 96-pin female DIN connector on each end.
7011-MTR	96-pin male DIN bulkhead connector.

Terminal identification for the DIN connector of the multi-pin connector card is provided by Table 4-2 and Figure 4-7. This connector will mate to a 96-pin female DIN connector.

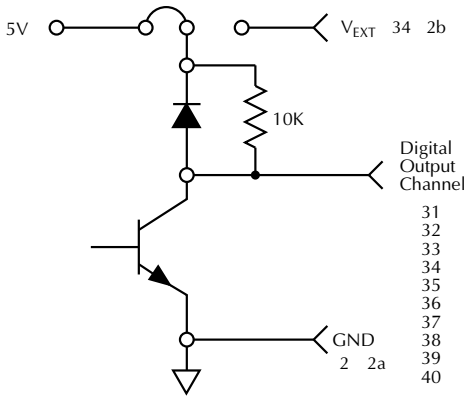


View from pin side of connector

Relay Channel	Schematic Designator IN	Schematic Designator OUT	Schematic Connector IN	Schematic Connector OUT
1	75	43	11c	11b
2	74	13	10c	13a
3	44	12	12b	12a
4	77	45	13c	13b
5	76	15	12c	15a
6	46	14	14b	14a
7	79	47	15c	15b
8	78	17	14c	17a
9	48	16	16b	16a
10	81	49	17c	17b
11	80	19	16c	19a
12	50	18	18b	18a
13	83	51	19c	19b
14	82	21	18c	21a
15	52	20	20b	20a
16	85	53	21c	21b
17	84	23	20c	23a
18	54	22	22b	22a
19	87	55	23c	23b
20	86	25	22c	25a
21	56	24	24b	24a
22	89	57	25c	25b
23	88	27	24c	27a
24	58	26	26b	26a
25	91	59	27c	27b
26	90	29	26c	29a
27	60	28	28b	28a
28	93	61	29c	29b
29	92	31	28c	31a
30	62	30	30b	30a



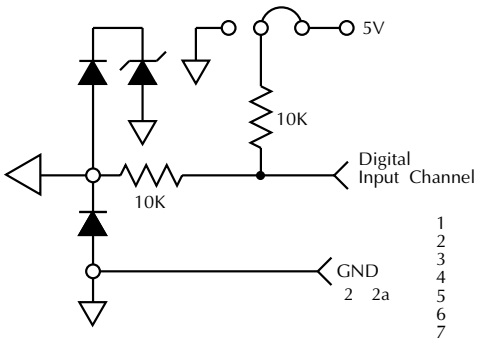
1 (1a)
10 (10a)
11 (11a)
32 (32a)
33 (1b)
42 (10b)
63 (31b)
64 (32b)
73 (9c)
94 (30c)
95 (31c)
96 (32c)



Digital Output Channel	Schematic Designator	Connector Designator
31	4	4a
32	6	6a
33	8	8a
34	36	4b
35	38	6b
36	40	8b
37	66	2c
38	68	4c
39	70	6c
40	72	8c

Pins of the Model 7037 mass termination connector can be identified in one of three ways:

- Relay switch or digital I/O channels.
- Connector designation, consisting of rows a-c and columns 1-32.
- Schematic and component layout designation (1-96).



Digital Input Channel	Schematic Designator	Connector Designator
1	3	3a
2	5	5a
3	7	7a
4	35	3b
5	37	5b
6	39	7b
7	65	1c
8	67	3c
9	69	5c
10	71	7c

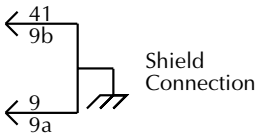


Figure 4-7
Multi-pin connector card terminal identificatio

Table 4-2
Multi-pin connector card terminal designation cross-reference

Switch terminal		**Conn. desig. 1a-32c**	**Schem. desig. 1-96**	**Switch terminal**		**Conn. desig. 1a-32c**	**Schem. desig. 1-96**	**Switch terminal**	**Conn. desig. 1a-32c**	**Schem. desig. 1-96**
Chan 1	IN	11c	75	Chan 17	IN	20c	84	DIG OUT 35	6b	38
	OUT	11b	43		OUT	23a	23	DIG OUT 36	8b	40
Chan 2	IN	10c	74	Chan 18	IN	22b	54	DIG OUT 37	2c	66
	OUT	13a	13		OUT	22a	22	DIG OUT 38	4c	68
Chan 3	IN	12b	44	Chan 19	IN	23c	87	DIG OUT 39	6c	70
	OUT	12a	12		OUT	23b	55	DIG OUT 40	8c	72
Chan 4	IN	13c	77	Chan 20	IN	22c	86	DIG IN 1	3a	3
	OUT	13b	45		OUT	25a	25	DIG IN 2	5a	5
Chan 5	IN	12c	76	Chan 21	IN	24b	56	DIG IN 3	7a	7
	OUT	15a	15		OUT	24a	24	DIG IN 4	3b	35
Chan 6	IN	14b	46	Chan 22	IN	25c	89	DIG IN 5	5b	37
	OUT	14a	14		OUT	25b	57	DIG IN 6	7b	39
Chan 7	IN	15c	79	Chan 23	IN	24c	88	DIG IN 7	1c	65
	OUT	15b	47		OUT	27a	27	DIG IN 8	3c	67
Chan 8	IN	14c	78	Chan 24	IN	26b	58	DIG IN 9	5c	69
	OUT	17a	17		OUT	26a	26	DIG IN 10	7c	71
Chan 9	IN	16b	48	Chan 25	IN	27c	91	Vext	2b	34
	OUT	16a	16		OUT	27b	59	gnd	2a	2
Chan 10	IN	17c	81	Chan 26	IN	26c	90	Shield	9a	9
	OUT	17b	49		OUT	29a	29	Shield	9b	41
Chan 11	IN	16c	80	Chan 27	IN	28b	60	nc	1a	1
	OUT	19a	19		OUT	28a	28	nc	10a	10
Chan 12	IN	18b	50	Chan 28	IN	29c	93	nc	11a	11
	OUT	18a	18		OUT	29b	61	nc	32a	32
Chan 13	IN	19c	83	Chan 29	IN	28c	92	nc	1b	33
	OUT	19b	51		OUT	31a	31	nc	10b	42
Chan 14	IN	18c	82	Chan 30	IN	30b	62	nc	31b	63
	OUT	21a	21		OUT	30a	30	nc	32b	64
Chan 15	IN	20b	52	DIG OUT 31		4a	4	nc	9c	73
	OUT	20a	20	DIG OUT 32		6a	6	nc	30c	94
Chan 16	IN	21c	85	DIG OUT 33		8a	8	nc	31c	95
	OUT	21b	53	DIG OUT 34		4b	36	nc	32c	96

Typical connection techniques

All external circuitry, such as instrumentation and DUTs, that you want to connect to the card must be terminated with a single 96-pin female DIN connector. The following connection techniques provide some guidelines and suggestions for wiring your circuitry.

WARNING

Before beginning any wiring procedures, make sure all power is off and any stored energy in external circuitry is discharged.

WARNING

When wiring a connector, do not leave any exposed wires. No conductive part of the circuit shall be exposed. Properly cover the conductive parts, or death by electric shock may occur.

NOTE

It is recommended that external circuitry be connected (plugged in) after the Model 7037 is installed in the Model 7001/7002 mainframe and with the mainframe power off. Installation is covered at the end of this section.

Round cable assemblies — Figure 4-8 shows typical round cable connection techniques using accessories available from Keithley.

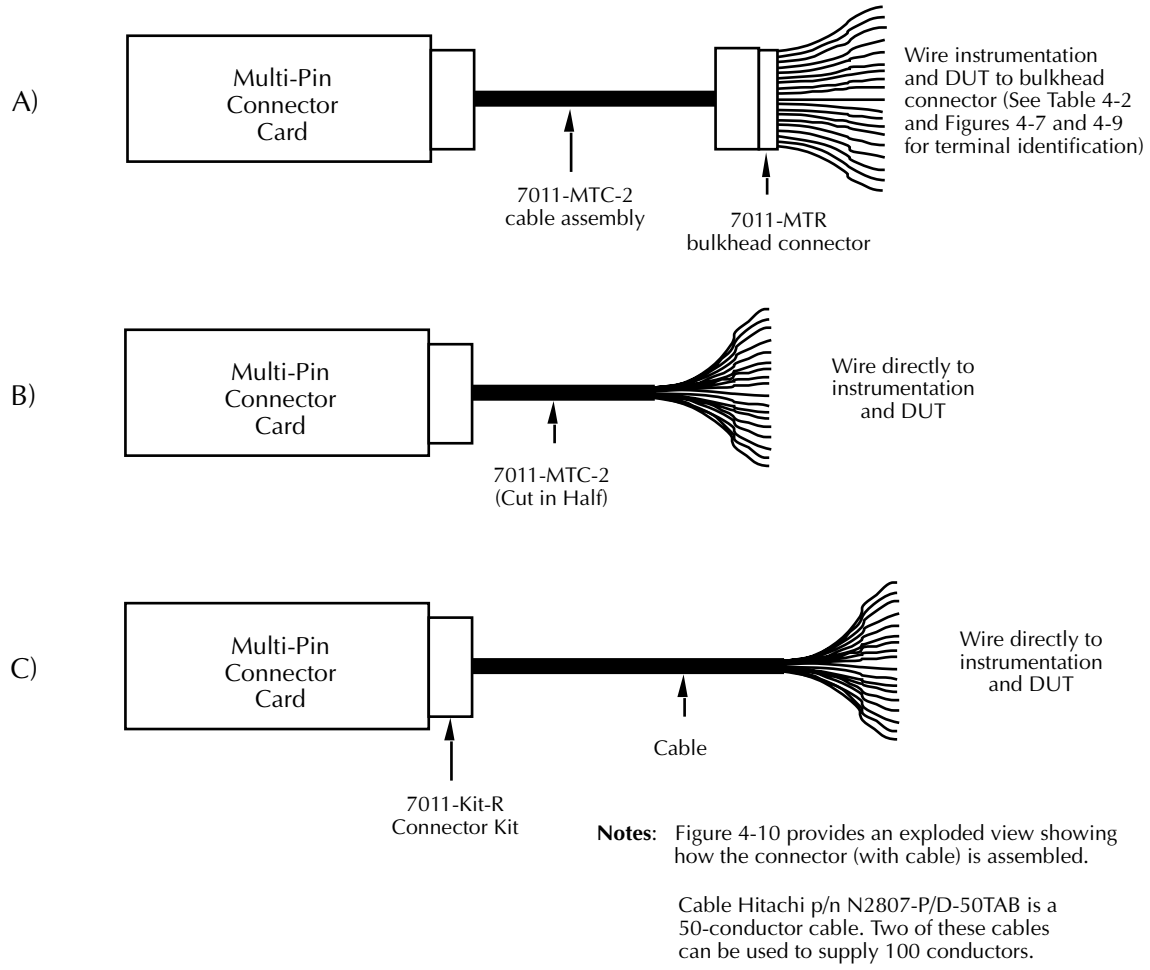
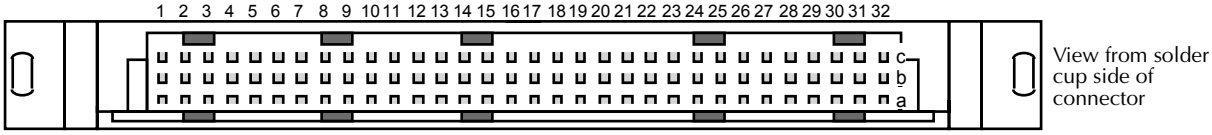


Figure 4-8
Typical round cable connection techniques

In Figure 4-8A, connections are accomplished using a Model 7011-MTC-2 cable and a Model 7011-MTR bulkhead connector. The two-meter round cable is terminated with a 96-pin female DIN connector at each end. This cable mates directly to the multi-pin connector card and to the bulkhead connector. The bulkhead connector has solder cups to allow direct connection to instrumentation and DUT. Figure 4-9 provides pinout for the bulkhead connector. The view shown is from the solder cup end of the connector.

In Figure 4-8B, connections are accomplished using a Model 7011-MTC-2 cable assembly that is cut in half. The 96-pin female DIN connector on one end of the cable mates directly to the multi-pin connector card. The unterminated end of the cable is wired directly to instrumentation and DUT. The other half of the cable assembly could be used for a second card.

In Figure 4-8C, connections are accomplished using a custom-built cable assembly that consists of a Model 7011-KIT-R connector and a suitable round cable. Hitachi cable part number N2807-P/D-50TAB is a 50-conductor round cable. Two of these cables can be used to provide 100 conductors. The connector has solder cups to accommodate the individual wires of the unterminated cable. Figure 4-10 provides an exploded view of the connector assembly and shows how the cable is connected. For further Model 7011-KIT-R assembly information, refer to the packing list provided with the kit. The connector end of the resultant cable assembly mates directly to the multi-pin connector card. The unterminated end of the cable assembly is wired directly to instrumentation and DUT.



Note: See Figure 4-7 for terminal identification.

Figure 4-9
Model 7011-MTR connector pinout

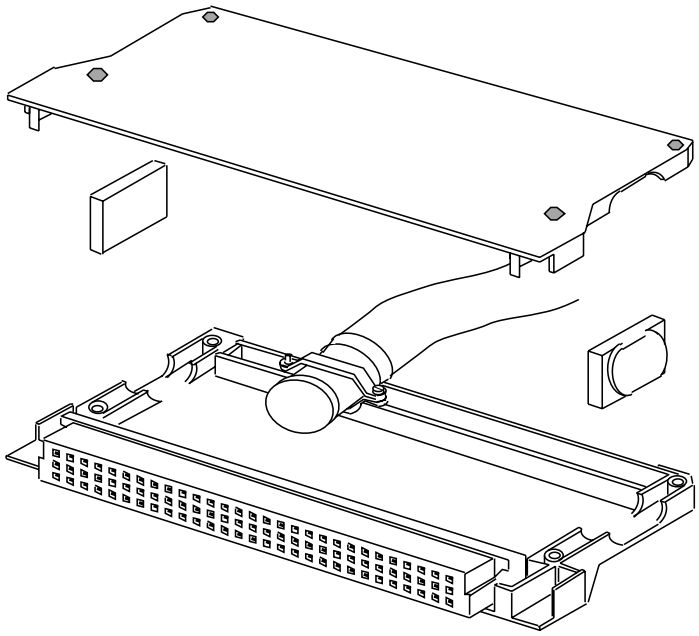


Figure 4-10
Model 7011-KIT-R (with cable) assembly

Typical relay switch connection scheme

The following paragraphs show how the Model 7037 could be connected to a system that activates external devices and circuits.

Figure 4-11 shows how external connections can be made to the system using the Model 7011-MTC-2 cable that is unterminated at one end. The unterminated end of the cable can be hard-wired directly to the external devices and power supplies.

The other end will mate to the Model 7037 card. Connection details are provided in the Multi-pin (mass termination) connections paragraph.

If adding more Model 7037 cards to a system, simply wire them in the same manner as the first. Remember that Model 7037 cards installed in the same mainframe are electrically isolated from each other.

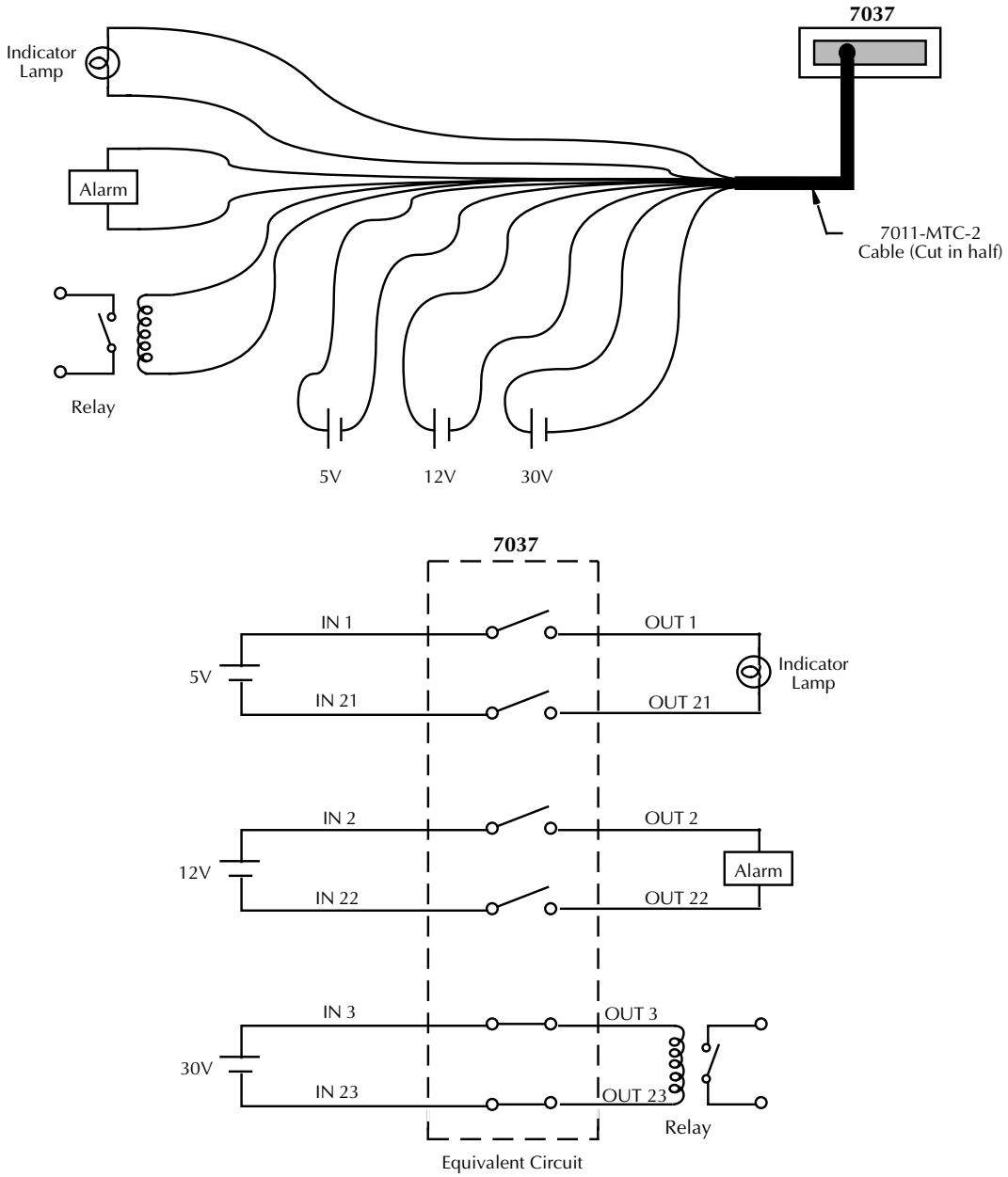


Figure 4-11
Typical connection scheme for Model 7037

Typical digital I/O connection schemes

Output connection schemes

The following examples show output connections from the card to external circuitry and summarize the required internal connections on the card. Each example assumes negative true logic is used. To conf gure for positive true logic, refer to the Conf guring digital I/O output logic paragraph.

Solenoid control — Figure 4-12 shows a digital output connection scheme to control solenoids. This example assumes that an external 24V source is being used. A solenoid is energized when the corresponding output channel is turned on (closed).

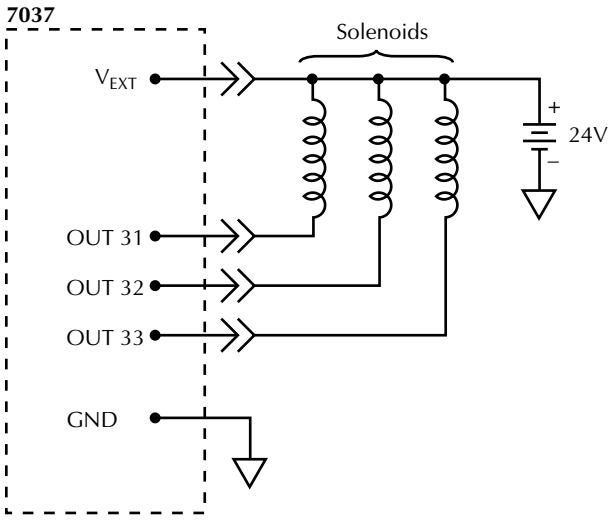


Figure 4-12
Digital output, solenoid control

Motor control — Figure 4-13 shows a digital output connection scheme to control small 12V dc motors. An external 12V source is used to provide the necessary voltage level. A motor is turned on when the corresponding output channel is turned on (closed).

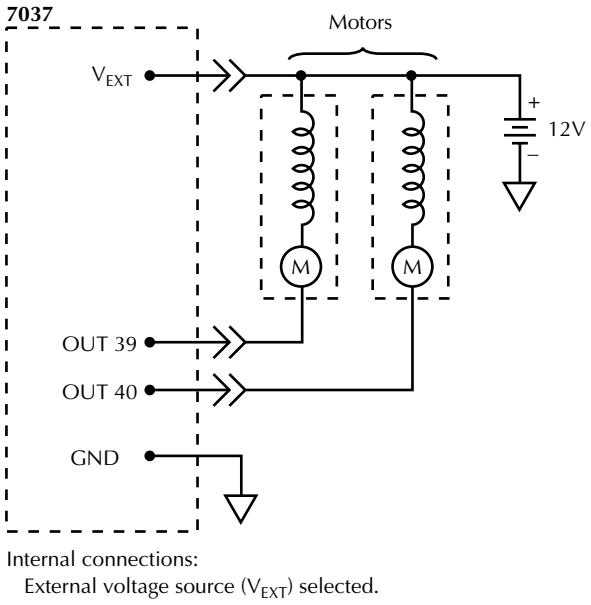


Figure 4-13
Digital output, motor control

Logic device control — Figure 4-14 shows a digital output connection scheme to control a logic device. This example assumes that an internal +5V voltage source is being used.

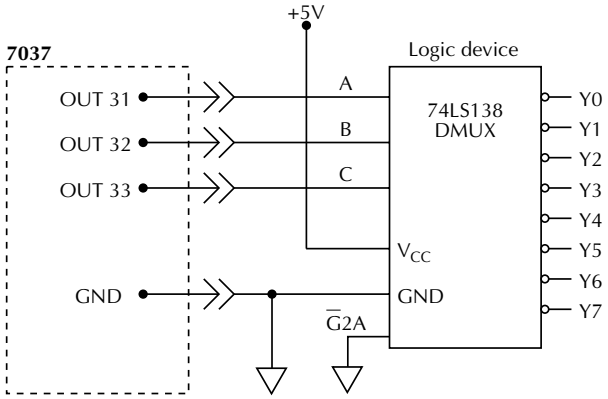


Figure 4-14
Digital output, logic device control

The logic device is a demultiplexer (DMUX). The binary pattern (value) seen at the input of the DMUX (lines A, B, and C) determines which DMUX output line (Y0 through Y7) is selected (pulled low). For example, with channels 1, 2, and 3 off (open), lines A, B and C are high. The binary 7 at the DMUX input (A = 1, B = 1 and C = 1) selects (pulls low) output Y7. If channel 32 is turned on (closed), line B goes low. The binary 5 seen at the DMUX input (1, 0, 1) selects (pulls low) Y5.

Input connection scheme

Figure 4-15 shows a digital input connection scheme to monitor the state of micro-switches. With a switch open and the input resistor conf gured for pull up as shown in Figure 4-15a, the corresponding input channel is pulled high by the internal input resistor. As a result, the input channel is high (appears as a bar on the Model 7001 display or a lit LED on the Model 7002). When a switch is closed, the corresponding input channel is pulled low to ground. As a result, the input channel is low (appears as a single dot on the Model 7001 display or an unlit LED on the Model 7002).

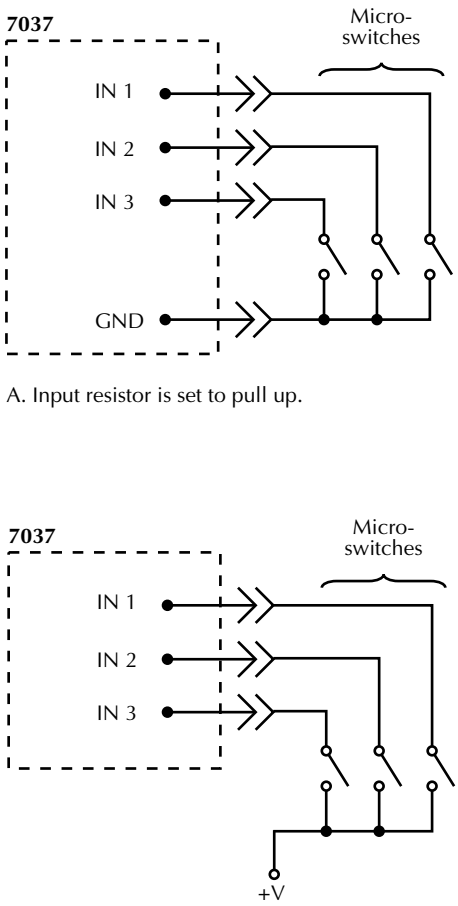


Figure 4-15
Digital input, monitoring micro-switches

With a switch open and the input resistance conf guration set to pull down as shown in Figure 4-15b, the corresponding input channel is pulled low by the internal input resistor. As a result, the input channel is low. When a switch is closed, the corresponding input channel is pulled high. As a result, the input channel is high.

For more information on conf guring pull-up resistance, refer to the Conf guring digital I/O input pull-up resistance paragraph.

Model 7037 installation and removal

The following paragraphs explain how to install and remove the Model 7037 card from the Model 7001/7002 mainframe.

WARNING

Installation or removal of the Model 7037 is to be performed by qualified service personnel. Failure to recognize and observe standard safety precautions could result in personal injury or death.

CAUTION

To prevent contamination to the Model 7037 card that could degrade performance, only handle the card by the edges and shields.

Card installation

Perform the following steps to install the Model 7037 card in the Model 7001/7002 mainframe:

WARNING

Turn off power from all instrumentation (including the Model 7001/7002 mainframe) and disconnect their line cords. Make sure all power is removed and stored energy in external circuitry is discharged.

1. Mate the connector card to the relay card if they are separated. Install the supplied 4-40 screw at the end of the card to secure the assembly. Make sure to handle the cards by the edges and shields to prevent contamination.
2. Facing the rear panel of the mainframe, select the slot (CARD 1 or CARD 2) that you want to install the Model 7037 card in.
3. Referring to Figure 4-16, feed the Model 7037 card into the desired slot so the edges of the relay card ride in the rails.
4. With the ejector arms in the unlocked position, push the Model 7037 card all the way into the mainframe until the arms engage into the ejector cups. Then push both arms inward to lock the card into the mainframe.

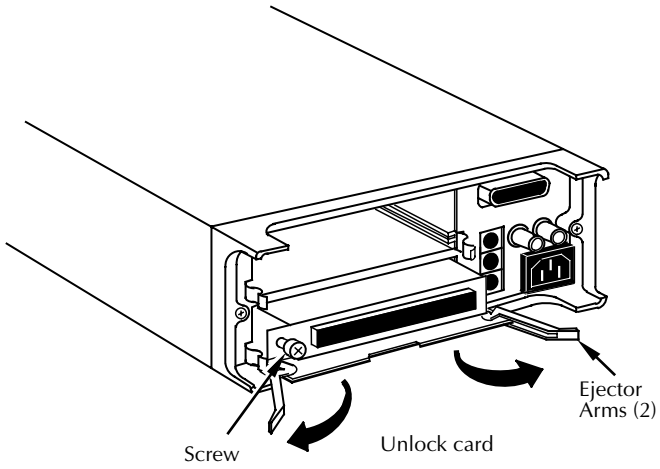
WARNING

To avoid electric shock that could result in injury or death, make sure to properly install and tighten the safety ground screw shown in Figure 4-16.

5. Install the screw shown in Figure 4-16.

Card removal

To remove the Model 7037 card, first unloosen the safety ground screw, unlock the card by pulling the latches outward, and then pull the card out of the mainframe. Remember to handle the card by the edges and shields to avoid contamination that could degrade performance.



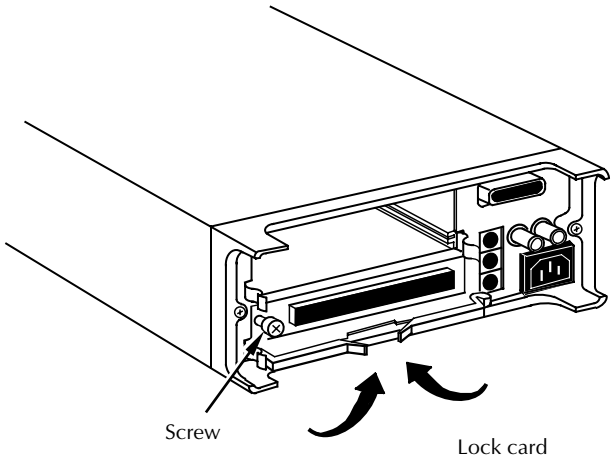


Figure 4-16
Model 7037 card installation in Model 7001

5
Operation

Introduction

The information in this section is formatted as follows:

- **Power limits** — Summarizes the maximum power limits of the Model 7037 card assembly.
- **Mainframe control of the card** — Summarizes programming steps to control the card from the Model 7001/7002 Switch System mainframe.
- **Measurement considerations** — Reviews a number of considerations when using the Model 7037 to make measurements.

Power limits

CAUTION

To prevent damage to the card, do not exceed the maximum signal level specifications of the card. For reactive loads, be sure to use voltage clamping and current limiting as explained in the Reactive loads paragraph.

Digital I/O maximum signal levels

Output channels

Maximum user-supplied pull-up voltage: 42V
Maximum sink current:
Per channel: 250mA
Per card: 1A

Input channels

Maximum voltage level: 42V peak

Relay switch maximum signal levels

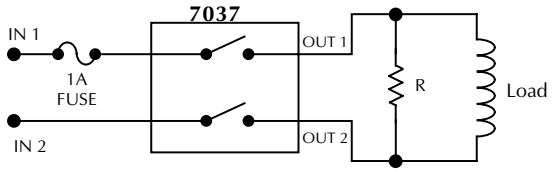
To prevent overheating or damage to the relays, never exceed the following maximum signal levels: 110V DC, 110V rms, 155V peak between any two inputs or chassis, 1A switched, 30VA (resistive load).

Reactive loads

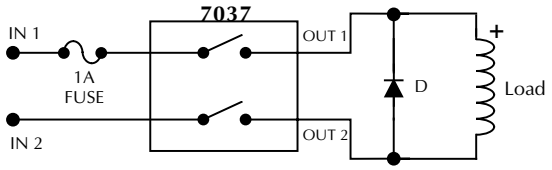
Operation is specified for resistive loads. Reactive loads require voltage clamping (for inductive loads) and current surge limiting (for capacitive loads) to prevent damage to the relays and to external circuitry.

Inductive loads — Inductive reaction voltage must be limited to less than 110V in DC circuits or 110V rms, 155V peak in AC circuits. Also consider the load when determining the voltage limit. Clamping circuits that can be used are shown in Figure 5-1.

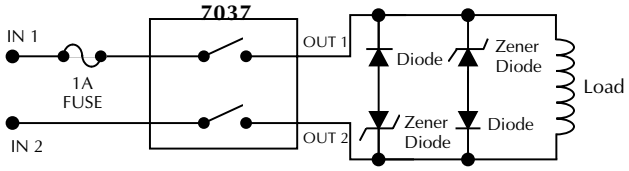
Capacitive loads — The initial surge current from a capacitive reactive load must be limited. Figure 5-2 shows circuits that can be used to limit current surges. To protect the relay, limit current to 1A. Also consider the load when determining the current surge limit.



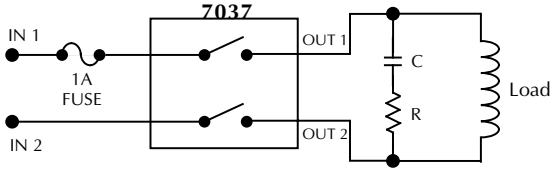
A. Resistor Clamped (AC or DC Voltages)



B. Diode Clamped (DC Voltages)

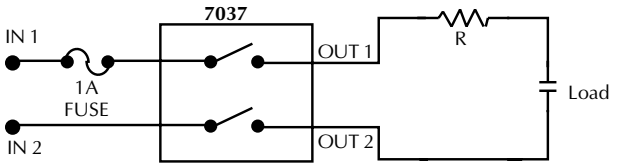


C. Zener Clamped (AC Voltages)

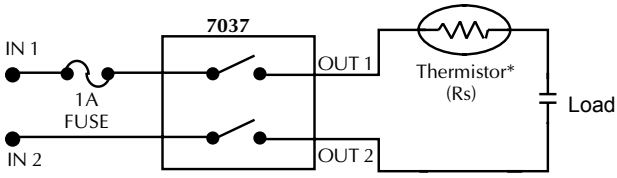


D. Resistor-Capacitor Clamped (AC Voltages)

Figure 5-1
Limiting inductive reaction voltage



A. Resistor Limited R = $\frac{V}{I}$ Limit



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

B. Thermistor Limited Rs = $\frac{V}{I}$ Limit

Figure 5-2
Limiting capacitive reaction current

Mainframe control of the card

The following information pertains to the Model 7037 card. It assumes you are familiar with the operation of the Model 7001/7002 mainframe.

If you are not familiar with the operation of the mainframe, it is recommended that you proceed to Getting Started (Section 3) in the Model 7001 or Model 7002 Instruction Manual after reading the following information.

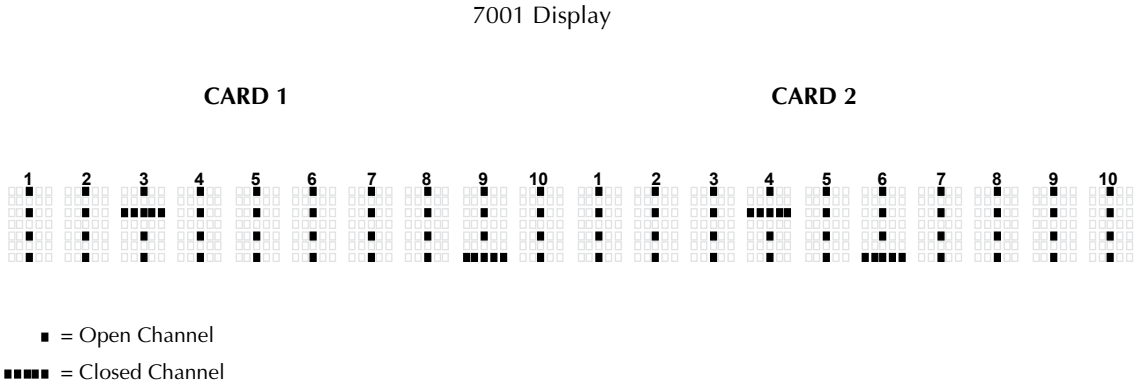


Figure 5-3
Model 7001 channel status display

Channel assignments

The Model 7001 has a channel status display (Figure 5-3) that provides the real-time state of each available channel. The left portion of the display is for slot 1 (card 1), and the right portion is for slot 2 (card 2). With two Model 7037 cards installed in the mainframe, the 40 channels of each card will be displayed as shown in Figure 5-3. For the Model 7002, channel status LED grids are used for the ten slots. The LED grid for slot 1 is shown in Figure 5-4.

Organization of the channel status display for each slot is shown in Figure 5-5. The card contains 40 channels and is made up of 30 independent channels of one-pole switching and ten digital output channels.

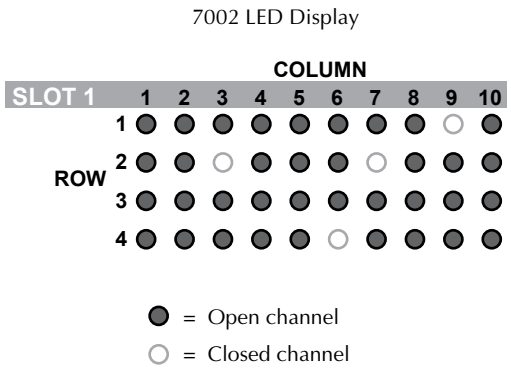


Figure 5-4
Model 7002 channel status display (slot 1)

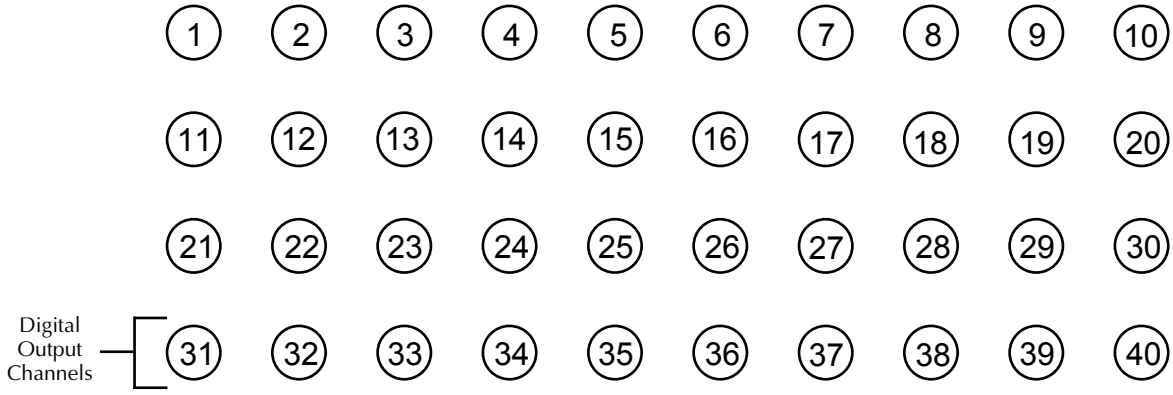


Figure 5-5
Channel display organization

All digital input and output channels are isolated from the backplane of the mainframe. With the mainframe in the normal display state, the status (on or off) of the output and relay channels is displayed. When the mainframe is in the read input channels mode, the status (on or off) of the input channels is displayed.

The hardware for the digital output channels is user config urable for negative or positive true logic. That is, depending on the user configuration, the output can go high or be pulled low when the channel is turned on (closed) or off (open). To configure output logic, refer to Section 4

Input channels use positive true logic but can be configure to pull up or pull down. Thus, a channel can be pulled high or pulled low when the input is open depending on the jumper configuration. Input channels will be displayed as high (on) when the input has a high logic level applied. Conversely, an input channel will be displayed as low (off) when a low logic level is applied.

To control the card from the mainframe, each relay and digital output must have a unique channel assignment. The channel assignments for the card are provided in Figure 5-6. Each channel assignment is made up of the slot designator (1 or 2) and the relay or digital output channel. For the Model 7002, the slot designator can be from 1 to 10 since there are ten slots. To be consistent with Model 7001/ 7002 operation, the slot designator and channel are separated by exclamation points (!). Some examples of channel assignments are as follows:

CHANNEL 1!1 = Slot 1, Channel 1
CHANNEL 1!40 = Slot 1, Channel 40 (Output 40 of Digital I/O)
CHANNEL 2!2 = Slot 2, Channel 2
CHANNEL 2!34 = Slot 2, Channel 34 (Output 34 of Digital I/O)

These channels are displayed and controlled from the normal display state of the mainframe. If currently in the menu structure, return to the normal display state by pressing EXIT.

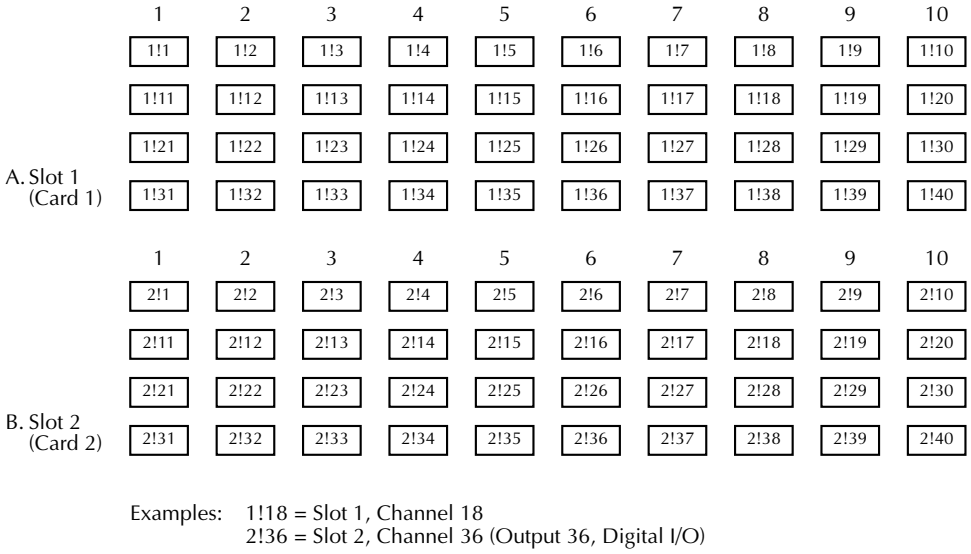


Figure 5-6
Model 7037 programming channel assignments

Closing and opening channels

NOTE

This procedure applies to relay channels (channels 1!1 through 1!30) and digital I/O output channels (1!31 through 1!40). Digital input channels are read only.

A channel is closed (turned on) from the front panel by simply keying in the channel assignment and pressing CLOSE. For example, to close channel 18 of a card installed in slot 2, key in the following channel list and press CLOSE:

SELECT CHANNELS 2!18

The above closed channel can be opened (turned off) by pressing OPEN or OPEN ALL. The OPEN key opens only the channels specified in the channel list, and OPEN ALL opens all channels.

NOTE

For the Model 7002, you can use the light pen to open and close channels.

The following display is an example of a channel list that consists of several channels:

SELECT CHANNELS 2!1, 2!3, 2!22-2!25

Notice that channel entries are separated by commas (,). A comma is inserted by pressing ENTER or the right cursor key (▶). The channel range is specified by using the hyphen (-) key to separate the range limits. Pressing CLOSE will close all the channels specified in the channel list. Pressing OPEN (or OPEN ALL) will open the channels.

Channel patterns can also be used in a channel list. This allows you to control specific bit patterns for logic circuits. Example:

SELECT CHANNELS 2!1, M1

Pressing CLOSE will turn on channel 2!1 and the channels that make up channel pattern M1. Refer to the instruction manual for the mainframe and for information on definin channel patterns.

Scanning channels

Channels are scanned by creating a scan list and configurin the Model 7001/7002 to perform a scan. The scan list is created in the same manner as a channel list. (See the previous Closing and opening channels paragraph.) However, the scan list is specified from the SCAN CHANNELS display mode. (The SCAN LIST key toggles between the channel list and scan list.) The following shows an example of a scan list:

SCAN CHANNELS 2!1, 2!3, 2!1-2!5

When a scan is performed, the channels specified in the scan list will be scanned in the order that they are presented in the scan list.

Channel patterns can also be used in a scan list. This allows you to control specific bit patterns for logic circuits. Example:

SCAN CHANNELS M1, M2, M3, M4

When M1 is scanned, the channels that make up channel pattern M1 will turn on. When M2 is scanned, the M1 channels will turn off and the channels that make up M2 will turn on. M3 and M4 are scanned in a similar manner. Refer to the instruction manual for the mainframe for information on defining channel patterns

A manual scan can be performed by using the RESET default conditions of the Model 7001/7002. RESET is selected from the SAVESETUP menu of the main MENU. When RESET is performed, the mainframe is configured for an infinite number of manual scans. The first press of STEP takes the mainframe out of the idle state. The next press of STEP will close the first channel specified in the scan list. Each subsequent press of STEP will select the next channel in the scan list.

Reading input channels

Input channels are read from the READ-I/O-CARD option of the CARD CONFIG MENU of the mainframe. This menu is accessed by pressing the CARD key. In this "read input channels" display mode, the mainframe displays the real-time state of each input channel.

Input channels use positive true logic but can be configure to pull up or pull down. Open inputs will read high (on) if inputs are configured for pull up. Conversely, open inputs will read low (off) when configured for pull down. To config ure pull-up resistance, refer to Section 4.

Perform the following steps to configure the mainframe to display the digital input channels.

1. Press the CARD CONFIGURATION key to display the CARD CONFIG MENU.
2. Use the ◀ and ▶ keys to place the cursor on READ-I/O-CARD and press ENTER.

   Model 7001 mainframe — The real-time state (on or off) of each input channel is provided on the first row of the display. Only digital I/O input channels are displayed.

   Model 7002 mainframe — The real-time state (on or off) of each input channel is provided on the first row of the appropriate LED display grid. Use the TYPE option of the CARD CONFIG MENU if you do not know which slot the card is installed in.

3. Use the EXIT key to exit from the "read input channels" display mode.

NOTE

With input channels displayed, you can turn off (open) all other channels by pressing OPEN ALL.

IEEE-488 bus operation

Bus operation is demonstrated using Microsoft QuickBASIC 4.5, the Keithley KPC-488.2 (or Capital Equipment Corporation) IEEE interface and the HP-style Universal Language Driver (CECHP). Refer to "QuickBASIC 4.5 Programming" in the mainframe manual for details on installing the Universal Language Driver, opening driver files, and setting the input terminal. Program statements assume that the primary address of the mainframe is 07.

Closing and opening channels

The following SCPI commands are used to open and close relay and digital I/O output channels:

`:CLOSe <list>`	Closes specified channels
`:OPEN <list>|ALL`	Opens specified (or all) channels.

The following program statement turns on channels 1!1, 1!4 through 1!6, and the channels that make up channel pattern M1.

```
PRINT #1, "output 07; clos (@ 1!1, 1!4:1!6, M1)"
```

Notice that the colon (:) is used to separate the range limits.

Either of the following statements turns off channels 1!1, 1!4 through 1!6, and the channels of M1:

```
PRINT #1, "output 07; open (@ 1!1, 1!4:1!6, M1)"
PRINT #1, "output 07; open all"
```

Scanning output channels

There are many commands associated with scanning. However, it is possible to configure a scan using as little as four commands. These commands are listed as follows:

```
*RST
:TRIGger:COUNt:AUTo ON
:ROUTe:SCAN <list>
:INIT
```

The first command resets the mainframe to a default scan configuration. The second command automatically sets the channel count to the number of channels in the scan list, the third command defines the scan list, and the fourth command takes the Model 7001/7002 out of the idle state.

The following program fragment will perform a single scan of channels 1 through 4 of slot 1 and the channels that make up channel pattern M1:

```
PRINT #1, "output 07; *rst"
PRINT #1, "output 07; trig:coun:auto on"
PRINT #1, "output 07; scan (@ 1!1:1!4, M1)"
PRINT #1, "output 07; init"
```

The first statement selects the *RST default configuration for the scan. The second statement sets channel count to the scan-list-length (5). The third statement defines the scan list, and the last statement takes the mainframe out of the idle state. The scan is configured to start as soon as the :INIT command is executed.

When the above program fragment is run, the scan will be completed in approximately 240msec (3msec delay for channel closures and 3msec delay for each open), which is too fast to view from the front panel. An additional relay delay can be added to the program to slow down the scan for viewing. The program is modified by adding a statement to slow down the scan. Also, a statement is added to the beginning of the program to ensure that all channels are open before the scan is started. The two additional statements are indicated in bold typeface.

```
PRINT #1, "output 07; open all"
PRINT #1, "output 07; *rst"
PRINT #1, "output 07; trig:coun:auto on"
PRINT #1, "output 07; trig:del 0.5"
PRINT #1, "output 07; scan (@ 1!1:1!4, M1)"
PRINT #1, "output 07; init"
```

The first statement opens all channels, and the fourth statement sets a 1/2 second delay after each channel closes.

Reading digital I/O input channels

The following SCPI commands are used to read the status of digital I/O input channels:

`:SENSe2:DATA? <list>`	Read input channels; slot 1
`:SENSe3:DATA? <list>`	Read input channels; slot 2
`:SENSe4:DATA? <list>`	Read input channels; slot 3
`:SENSe5:DATA? <list>`	Read input channels; slot 4
`:SENSe6:DATA? <list>`	Read input channels; slot 5
`:SENSe7:DATA? <list>`	Read input channels; slot 6
`:SENSe8:DATA? <list>`	Read input channels; slot 7
`:SENSe9:DATA? <list>`	Read input channels; slot 8
`:SENSe10:DATA? <list>`	Read input channels; slot 9
`:SENSe11:DATA? <list>`	Read input channels; slot 10

The conventional form for the <list> parameter includes the slot and input channel number. However, for these commands you do not need to include the slot number. For example, you can send either of the following two commands to read input channel 2 in slot 6:

`:SENSe7:DATA? (@6!2)` or `:SENSe7:DATA? (@2)`

After the mainframe is addressed to talk, the response message will indicate the state of each listed input channel. A returned “0” indicates that the channel is off (open), and a returned “1” indicates that the channel is on (closed).

The following program fragment reads channel 3 of a digital I/O card installed in slot 1:

```
PRINT #1, "output 07; sens2:data? (@3)"
PRINT #1, "enter 07"
LINE INPUT #2, A$
PRINT A$
```

The first statement reads input channel 3 (slot 1). The second statement addresses the mainframe to talk (sends response message to computer). The third statement reads the response message, and the last statement displays the message (0 or 1) on the computer CRT.

The above program fragment is modified to read all ten digital I/O input channels in slot 1 as follows. The modifie statement is shown in bold typeface.

```
PRINT #1, "output 07; sens2:data? (@1:10)"
PRINT #1, "enter 07"
LINE INPUT #2, A$
PRINT A$
```

The response message will include a “0” (off) or “1” (on) for each of the ten input channels (i.e. “0, 0, 0, 1, 0..... 0, 1”).

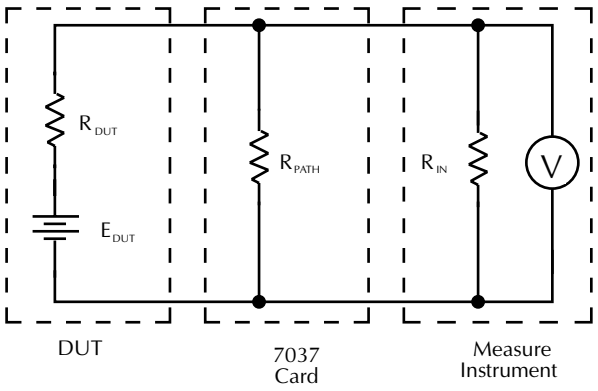
Measurement considerations

Many measurements made with the Model 7037 are subject to various effects that can seriously affect low-level measurement accuracy. The following paragraphs discuss these effects and ways to minimize them.

Path isolation

The path isolation is simply the equivalent impedance between any two test paths in a measurement system. Ideally, the path isolation should be infinite, but the actual resistance and distributed capacitance of cables and connectors results in less than infinite path isolation alues for these devices.

Path isolation resistance forms a signal path that is in parallel with the equivalent resistance of the DUT, as shown in Figure 5-7. For low-to-medium device resistance values, path isolation resistance is seldom a consideration; however, it can seriously degrade measurement accuracy when testing high-impedance devices. The voltage measured across such a device, for example, can be substantially attenuated by the voltage divider action of the device source resistance and path isolation resistance, as shown in Figure 5-8. Also, leakage currents can be generated through these resistances by voltage sources in the system.



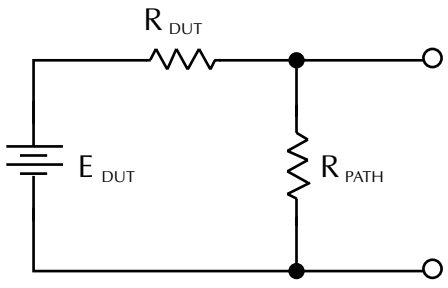
R_{DUT} = Source Resistance of DUT

E_{DUT} = Source EMF of DUT

R_{PATH} = Path Isolation Resistance

R_{IN} = Input Resistance of Measuring Instrument

Figure 5-7
Path isolation resistance



$$E_{OUT} = \frac{E_{DUT} \; R_{PATH}}{R_{DUT} + R_{PATH}}$$

Figure 5-8
Voltage attenuation by path isolation resistance

Any differential isolation capacitance affects DC measurement settling time as well as AC measurement accuracy. Thus, it is often important that such capacitance be kept as low as possible. Although the distributed capacitance of the card is generally fi ed by design, there is one area where you do have control over the capacitance in your system: the connecting cables. To minimize capacitance, keep all cables as short as possible.

Magnetic fields

When a conductor cuts through magnetic lines of force, a very small current is generated. This phenomenon will frequently cause unwanted signals to occur in the test leads of a relay switching system. If the conductorhas sufficient length, even weak magnetic fields like those of the earth can create sufficient signals to a fect low-level measurements.

Two ways to reduce these effects are: (1) reduce the lengths of the test leads, and (2) minimize the exposed circuit area. In extreme cases, magnetic shielding may be required. Special metal with high permeability at low flux densities (such as mu metal) is effective at reducing these effects.

Even when the conductor is stationary, magnetically induced signals may still be a problem. Fields can be produced by various signals such as the AC power line voltage. Large inductors such as power transformers can generate substantial magnetic fields, so care must be taken to keep the switching and measuring circuits a good distance away from these potential noise sources.

At high current levels, even a single conductor can generate significant fields. These effects can be minimized by using twisted pairs, which will cancel out most of the resulting fields

Radio frequency interference

Radio Frequency Interference (RFI) is a general term used to describe electromagnetic interference over a wide range of frequencies across the spectrum. Such RFI can be particularly troublesome at low signal levels, but it can also affect measurements at high levels if the problem is of sufficien severity.

RFI can be caused by steady-state sources such as radio or TV signals or some types of electronic equipment (microprocessors, high speed digital circuits, etc.), or it can result from impulse sources, as in the case of arcing in high-voltage environments. In either case, the effect on the measurement can be considerable if enough of the unwanted signal is present.

RFI can be minimized in several ways. The most obvious method is to keep the equipment and signal leads as far away from the RFI source as possible. Shielding the Model 7037 relay-digital I/O card, signal leads, sources, and measuring instruments will often reduce RFI to an acceptable level. In extreme cases, a specially constructed screen room may be required to sufficiently attenuate the troublesome signal

Many instruments incorporate internal filtering that may help to reduce RFI effects in some situations. In some cases, additional external filtering may also be required. Keep in mind, however, that filtering may have detrimental effects on the desired signal.

Ground loops

When two or more instruments are connected together, care must be taken to avoid unwanted signals caused by ground loops. Ground loops usually occur when sensitive instrumentation is connected to other instrumentation with more than one signal return path such as power line ground. As shown in Figure 5-9, the resulting ground loop causes current to fl w through the instrument LO signal leads and then back through power line ground. This circulating current develops a small, but undesirable, voltage between the LO terminals of the two instruments. This voltage will be added to the source voltage, affecting the accuracy of the measurement.

Figure 5-10 shows how to connect several instruments together to eliminate this type of ground loop problem. Here, only one instrument is connected to power line ground.

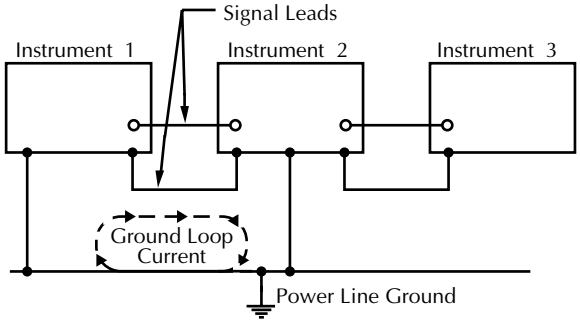


Figure 5-9
Power line ground loops

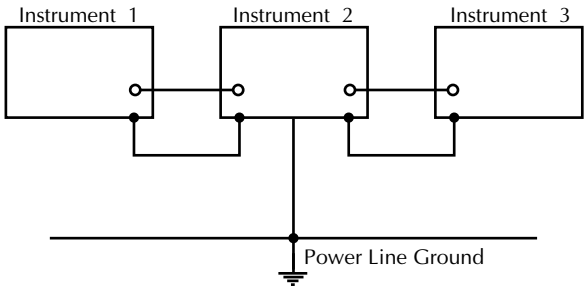


Figure 5-10
Eliminating ground loops

Ground loops are not normally a problem with instruments having isolated LO terminals. However, all instruments in the test setup may not be designed in this manner. When in doubt, consult the manual for all instrumentation in the test setup.

Keeping connectors clean

As is the case with any high-resistance device, the integrity of connectors can be damaged if they are not handled properly. If connector insulation becomes contaminated, the insulation resistance will be substantially reduced, affecting high-impedance measurement paths.

Oils and salts from the skin can contaminate connector insulators, reducing their resistance. Also, contaminants present in the air can be deposited on the insulator surface. To avoid these problems, never touch the connector insulating material. In addition, the Model 7037 card should be used only in clean, dry environments to avoid contamination.

If the connector insulators should become contaminated, either by inadvertent touching or from airborne deposits, they can be cleaned with a cotton swab dipped in clean methanol. After thorough cleaning, they should be allowed to dry for several hours in a low-humidity environment before use, or they can be dried more quickly using dry nitrogen.

AC frequency response

The AC frequency response of the Model 7037 is important in test systems that switch AC signals. Refer to the specifica tions at the front of this manual.

6
Service Information

WARNING

The information in this section is intended only for qualified service personnel. Some of the procedures may expose you to hazardous voltages that could result in personal injury or death. Do not attempt to perform these procedures unless you are qualified to do so.

Introduction

This section contains information necessary to service the Model 7037 relay-digital I/O card and is arranged as follows:

- **Handling and cleaning precautions** — Discusses handling procedures and cleaning methods for the card.
- **Performance verificatio** — Covers the procedures necessary to determine if the card is operating properly.
- **Channel functionality test** — Provides a test procedure to determine if a digital I/O input or output channel is functioning properly.
- **Special handling of static-sensitive devices** — Reviews precautions necessary when handling static-sensitive devices.
- **Principles of operation** — Briefly discusses circuit operation.
- **Troubleshooting** — Presents some troubleshooting tips for the card.

Handling and cleaning precautions

Because of the high impedance circuits on the Model 7037, care should be taken when handling or servicing the card to prevent possible contamination that could degrade performance. The following precautions should be taken when handling the card.

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.

Handle the card only by the side edges and shields. Do not touch any board surfaces, components, or connectors. Do not touch areas adjacent to electrical contacts. When servicing the card, wear clean cotton gloves.

If making solder repairs on the circuit board, use an OA-based (organic activated) flux. Remove the flux from these areas when the repair is complete. Use pure water 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 blowdry the board with dry nitrogen gas.

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

Performance verification

The following paragraphs discuss performance verificatio procedures for the Model 7037, including channel resistance, offset current, contact potential, and isolation.

CAUTION

Contamination will degrade the performance of the card. To avoid contamination, always grasp the card by the side edges and shields. Do not touch the connectors and do not touch the board surfaces or components. On plugs and receptacles, do not touch areas adjacent to the electrical contacts.

NOTE

Failure of any performance verification test may indicate that the switch card is contaminated. See the Handling and cleaning precautions paragraph to clean the card.

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%.

Recommended equipment

Table 6-1 summarizes the equipment necessary for performance verification, along with an application for each unit.

Card connections

The following information summarizes methods that can be used to connect test instrumentation to the connector card. Detailed connection information is provided in Section 4.

Table 6-1
Verification equipmen

Description	Model	Specifications	Applications
DMM	Keithley Model 2000	100Ω; 0.01%	Path resistance
Electrometer w/voltage source	Keithley Model 6517A	20pA, 200pA; 1% 100V source; 0.15%	Offset current, path isolation
Sensitive Digital Voltmeter	Keithley Model 182	3mV; 60ppm	Contact potential
Triax cable (unterminated)	Keithley Model 7025	—	Offset current
Low thermal cable (unterminated)	Keithley Model 1484	—	Contact potential

One method to make instrument connections to the card is to hard-wire a 96-pin female DIN connector and then mate it to the connector on the Model 7037. Shorting connections can also be done at the connector. The connector in the Model 7011-KIT-R connection kit (see Table 4-1) can be used for this purpose. Pin identification for the multi-pin connector for the connector card is provided by Figure 4-7 and Table 4-2.

WARNING

When wiring a connector, do not leave any exposed wires. No conductive part of the circuit may be exposed. Properly cover the conductive parts, or death by electric shock may occur.

CAUTION

After making solder connections to a connector, remove solder flux as explained at the beginning of this section. Failure to clean the solder connections could result in degraded performance, preventing the card from passing verification tests.

Before pre-wiring any connector plugs, study the following test procedures to fully understand the connection requirements.

Channel resistance tests

Referring to Figure 6-1, perform the following steps to verify that each contact of every relay is closing properly and that the resistance is within specification

1. Turn off the Model 7001/7002 if it is on.
2. Set the Model 2000 to the 100Ω range and connect four test leads to the INPUT and SENSE Ω 4 WIRE input.
3. Short the four test leads together and zero the Model 2000. Leave zero enabled for the entire test.
4. Connect INPUT HI and SENSE Ω 4 WIRE HI of the Model 2000 to the input (IN) terminal of channel 1 as shown in Figure 6-1.
5. Connect INPUT LO and SENSE Ω 4 WIRE LO to the output (OUT) terminal of channel 1.
6. With the card installed in slot 1 (CARD 1) of the mainframe, turn on the Model 7001/7002 and program it to close channel 1!1 (slot 1, channel 1). Verify that the resistance of this channel is <1.25Ω.
7. Repeat the basic procedure of steps 1 through 6 to test the rest of the channels of the Model 7037 card. Remember to close the channel that the Model 2000 is connected to.

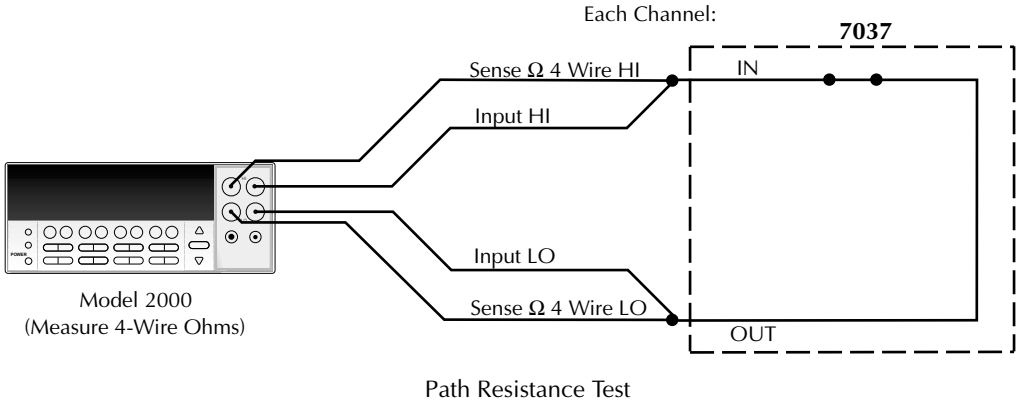


Figure 6-1
Channel resistance testing

Offset current tests

These tests check leakage current from input (IN) and output (OUT) to chassis (common mode) for each channel. In general, these tests are performed by simply measuring the leakage current with an electrometer. In the following procedure, the Model 6517A is used to measure leakage current.

Referring to Figure 6-2, perform the following procedure to check offset current:

1. Turn off the Model 7001/7002 if it is on.
2. Connect the Model 6517A electrometer to channel 1 as shown in Figure 6-2. Note that electrometer HI is connected to input (IN) of channel 1. Electrometer LO is connected to chassis ground, which is accessible at the rear panel of the mainframe.
3. Install the Model 7037 card in slot 1 (CARD 1) of the Model 7001/7002 if it is not already installed.
4. On the Model 6517A, select the 200pA range and enable zero check and zero correct the instrument. Leave zero correct enabled for the entire procedure.
5. Turn on the Model 7001/7002.
6. Program the Model 7001/7002 to close channel 1!1.
7. On the Model 6517A, disable zero check and verify that it is <100pA. This measurement is the common-mode leakage current of the channel.
8. On the Model 6517A, enable zero check.
9. Repeat the basic procedure in steps 1 through 8 to check the other channels. Remember to close the channel that the electrometer is connected to.

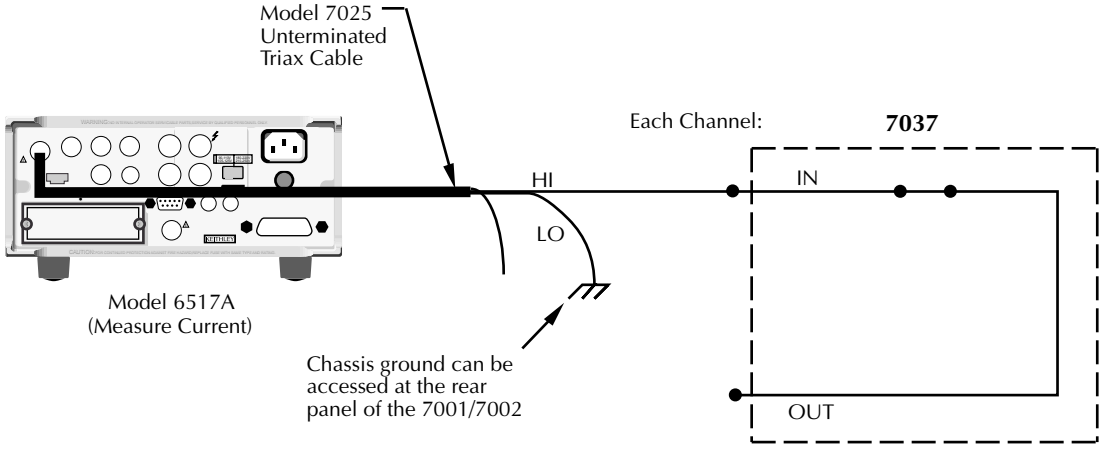


Figure 6-2
Offset current testing

Contact potential tests

These tests check the EMF generated by each relay contact for each channel. The tests simply consist of using a sensitive DVM (Model 182) to measure the contact potential.

Perform the following procedure to check contact potential of each path:

1. Turn off the Model 7001/7002 if it is on.
2. Set the Model 182 to the 3mV range, short the input leads, and press REL READING to null out internal offset. Leave REL enabled for the entire procedure.
3. Connect the Model 182 to channel 1 as shown in Figure 6-3.
4. Install the Model 7037 card in slot 1 (CARD 1) of the Model 7001/7002 if it is not already installed.
5. Turn on the Model 7001/7002.
6. Program the Model 7001/7002 to close channel 1!1.
7. Verify that the reading on the Model 182 is <4µV. This measurement is the contact potential of the channel.
8. Repeat the basic procedure in steps 1 through 7 to test the rest of the channels of the Model 7037.

Channel to channel isolation tests

These tests check the leakage resistance (isolation) between adjacent channels. A channel is the circuit from the input (IN) to the output (OUT) that results by closing the channel relay.

In general, the test is performed by applying a voltage (+100V) across two adjacent channels and then measuring the leakage current across the channels. The isolation resistance is then calculated as R = V/I. In the following procedure, the Model 6517A functions as both a voltage source and an ammeter. In the R function, the Model 6517A internally calculates the resistance from the known voltage and current levels and displays the resistance value.

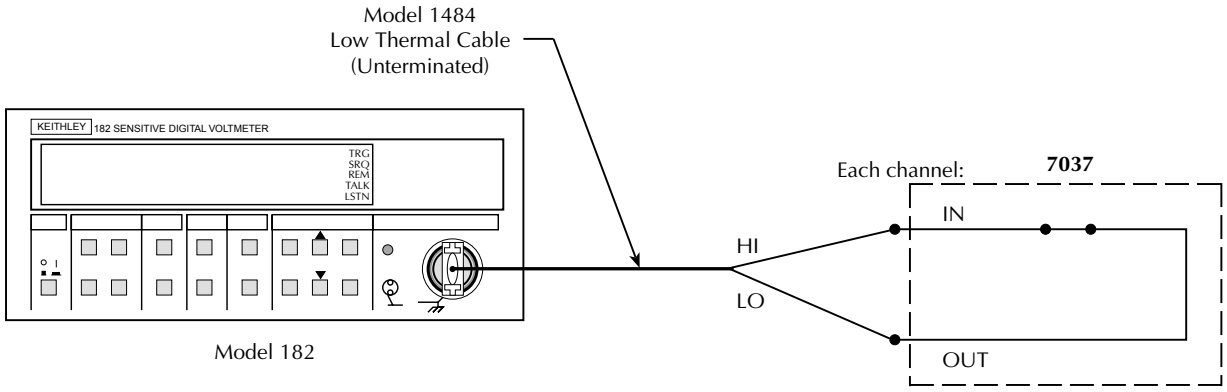


Figure 6-3
Contact potential testing

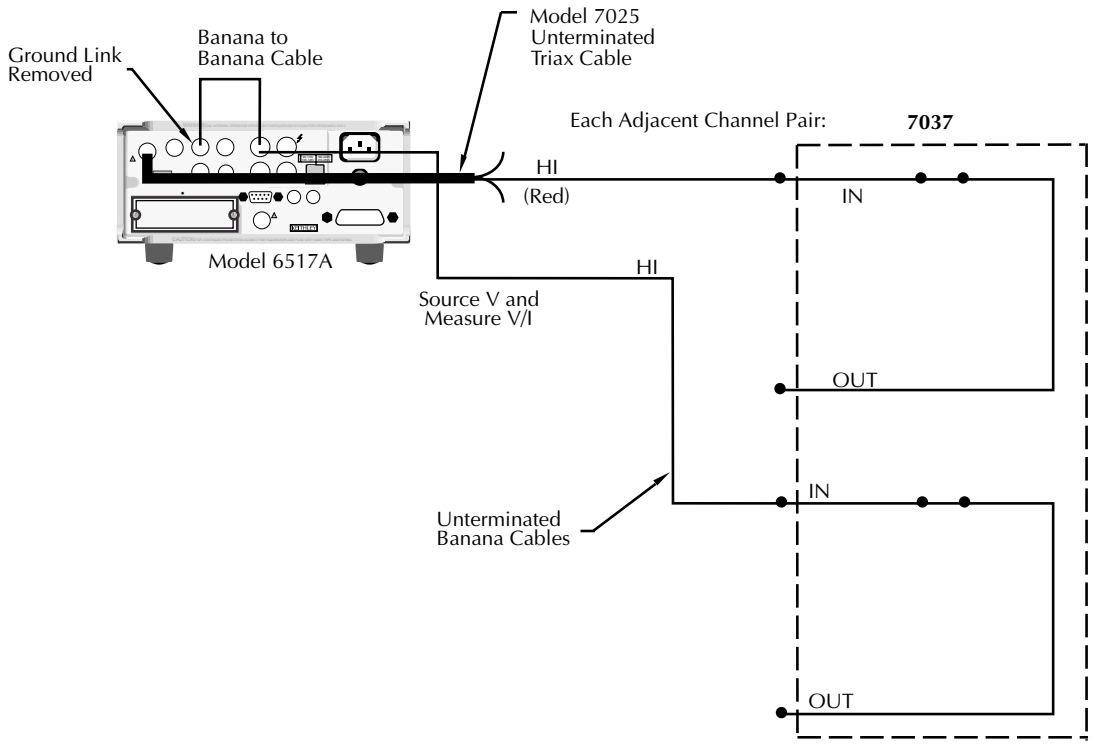


Figure 6-4
Channel to channel testing

Refer to Figure 6-4 and perform the following steps to test channel to channel isolation:

1. Turn off the Model 7001/7002 if it is on.
2. Connect the Model 6517A to channels 1 and 2 as shown in Figure 6-4. Make sure the voltage source is off.
3. Install the Model 7037 in slot 1 (CARD 1) of the Model 7001/7002 if it is not already installed.

WARNING

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

4. On the Model 6517A, select the ohms function and choose the 2GΩ range.
5. On the Model 6517A, set the voltage source for +100V. Make sure the voltage source is off.
6. Place the Model 6517A in the R measurement function.
7. Turn on the Model 7001/7002, and program it to close channels 1!1 and 1!2 (channels 1 and 2).
8. On the Model 6517A, turn on the output of the voltage source.
9. After allowing the reading on the Model 6517A to settle, verify that it is >1GΩ. This measurement is the channel to channel leakage resistance (isolation) between channels 1 and 2.
10. Turn off the Model 6517A voltage source.
11. Turn off the Model 7001/7002.
12. Disconnect the Model 6517A from channels 1 and 2, and, in a similar manner, reconnect it to channels 2 and 3 (electrometer high to channel 2, and voltage source high to channel 3).
13. Install the card in slot 1 (CARD 1) of the Model 7001/7002 if it is not already installed.
14. Turn on the Model 7001/7002 and program it to close channels 1!2 and 1!3.
15. On the Model 6517A, turn on the voltage source.
16. After allowing the reading on the Model 6517A to settle, verify that it is >1GΩ. This is the isolation between channels 2 and 3.
17. Using Table 6-2 as a guide, repeat the basic procedure of steps 11 through 16 for the rest of the path pairs (starting with test 3).

Table 6-2
Channel to channel isolation tests

Test no.	Isolation test	Test equipment location	Channels closed
1	Channel 1 to Channel 2	Channels 1 and 2	1!1 and 1!2
2	Channel 2 to Channel 3	Channels 2 and 3	1!2 and 1!3
3	Channel 3 to Channel 4	Channels 3 and 4	1!3 and 1!4
4	Channel 4 to Channel 5	Channels 4 and 5	1!4 and 1!5
5	Channel 5 to Channel 6	Channels 5 and 6	1!5 and 1!6
6	Channel 6 to Channel 7	Channels 6 and 7	1!6 and 1!7
7	Channel 7 to Channel 8	Channels 7 and 8	1!7 and 1!8
8	Channel 8 to Channel 9	Channels 8 and 9	1!8 and 1!9
9	Channel 9 to Channel 10	Channels 9 and 10	1!9 and 1!10
10	Channel 10 to Channel 11	Channels 10 and 11	1!10 and 1!11
11	Channel 11 to Channel 12	Channels 11 and 12	1!11 and 1!12
12	Channel 12 to Channel 13	Channels 12 and 13	1!12 and 1!13
13	Channel 13 to Channel 14	Channels 13 and 14	1!13 and 1!14
14	Channel 14 to Channel 15	Channels 14 and 15	1!14 and 1!15
15	Channel 15 to Channel 16	Channels 15 and 16	1!15 and 1!16
16	Channel 16 to Channel 17	Channels 16 and 17	1!16 and 1!17
17	Channel 17 to Channel 18	Channels 17 and 18	1!17 and 1!18
18	Channel 18 to Channel 19	Channels 18 and 19	1!18 and 1!19
19	Channel 19 to Channel 20	Channels 19 and 20	1!19 and 1!20
20	Channel 20 to Channel 21	Channels 20 and 21	1!20 and 1!21
21	Channel 21 to Channel 22	Channels 21 and 22	1!21 and 1!22
22	Channel 22 to Channel 23	Channels 22 and 23	1!22 and 1!23
23	Channel 23 to Channel 24	Channels 23 and 24	1!23 and 1!24
24	Channel 24 to Channel 25	Channels 24 and 25	1!24 and 1!25
25	Channel 25 to Channel 26	Channels 25 and 26	1!25 and 1!26
26	Channel 26 to Channel 27	Channels 26 and 27	1!26 and 1!27
27	Channel 27 to Channel 28	Channels 27 and 28	1!27 and 1!28
28	Channel 28 to Channel 29	Channels 28 and 29	1!28 and 1!29
29	Channel 29 to Channel 30	Channels 29 and 30	1!29 and 1!30

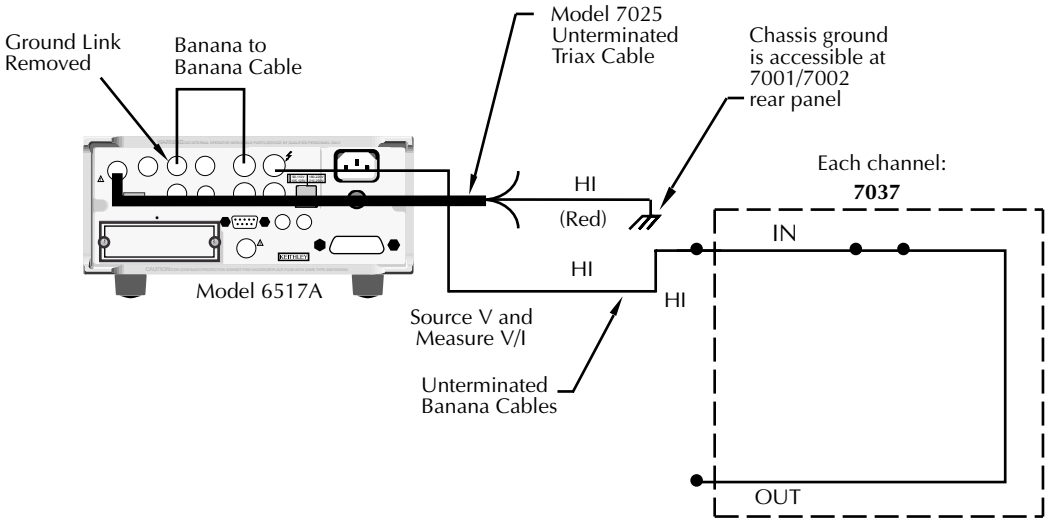


Figure 6-5
Common-mode isolation testing

Common-mode isolation tests

These tests check the common-mode isolation (leakage resistance) between the input (IN) and chassis ground of every channel.

In general, the test is performed by applying a voltage (+100V) and then measuring the leakage current. The isolation resistance is then calculated as R = V/I. In the following procedure, the Model 6517A functions as a voltage source and an ammeter. In the R function, the Model 6517A internally calculates the resistance from the known voltage and current levels and displays the resistance value.

Refer to Figure 6-5 and perform the following steps to test common-mode isolation.

1. Turn off the Model 7001/7002 if it is on.
2. Connect the Model 6517A to channel 1 as shown in Figure 6-5. Make sure the voltage source is off. Note that the voltage source HI is connected to the input (IN). Electrometer HI can be connected to chassis ground at the rear panel of the Model 7001/7002.
3. Install the Model 7037 in slot 1 (CARD 1) of the Model 7001/7002 if it is not already installed.

WARNING

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

4. On the Model 6517A, select the ohms function and choose the 2GΩ range.
5. On the Model 6517A, set the voltage source for +100V. Make sure the voltage source is still off.
6. Place the Model 6517A in the R measurement function.
7. Turn on the Model 7001/7002 and program the mainframe to close channel 1!1 (slot 1, channel 1).
8. On the Model 6517A, turn on the voltage source.
9. After allowing the reading on the Model 6517A to settle, verify that it is >1GΩ. This measurement checks the common-mode isolation of channel 1.
10. Turn off the Model 6517A voltage source.
11. Repeat the basic procedure in steps 1 through 10 to check differential isolation of the other Model 7037 channels. Remember to close the relay of the channel being checked.
12. Turn off the Model 6517A voltage source and the Model 7001/7002.

Channel functionality test

1. As shown in Figure 6-6, connect the suspect input or output channel to an output or input channel that is known to be functioning properly. The internal 5V supply must be used.
2. From the front panel of the mainframe, turn on (close) the output channel. Verify that the display indicates that the output channel is on (closed). Keep in mind that the output can be high (positive) or low (negative) when the channel is turned on, depending on the logic configuration
3. Place the mainframe in the "read input channels" display mode. Verify on the display that the input channel is off (open).
4. On the mainframe, turn off (open) the output channel and verify on the display that the input channel turns on (closes).
5. On the mainframe, return the instrument to the normal display mode and verify on the display that the output channel is off (open).

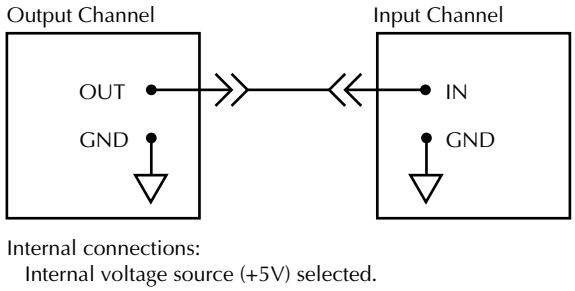


Figure 6-6
Testing an input or output channel

Special handling of static-sensitive devices

CMOS and other high-impedance devices are subject to possible static discharge damage because of the high-impedance levels involved. The following precautions pertain specifi cally to static-sensitive devices. However, since many devices in the Model 7037 are static-sensitive, it is recommended that they all be treated as static-sensitive.

1. Such devices should be transported and handled only in containers specially designed to prevent or dissipate static buildup. Typically, these devices will be received in anti-static containers made of plastic or foam. Keep these parts in their original containers until ready for installation.
2. Remove the devices from their protective containers only at a properly grounded work station. Also, ground yourself with a suitable wrist strap while working with these devices.
3. Handle the devices only by the body; do not touch the pins or terminals.
4. Any printed circuit board into which the device is to be inserted must first be grounded to the bench or table.
5. Use only anti-static type de-soldering tools and grounded-tip soldering irons.

Principles of operation

The following paragraphs discuss the basic operating principles for the Model 7037 and can be used as an aid in troubleshooting the card. The schematic drawings of the card are shown on drawing numbers 7037-106 and 7021-172 located in Section 7.

Block diagram

Figure 6-7 shows a simplified block diagram of the Model 7037. Key elements include the ROM, which contains card ID and configuration information, relay drivers and relays, digital I/O output channel drivers, and digital I/O input channel registers. These various elements are discussed in the following paragraphs.

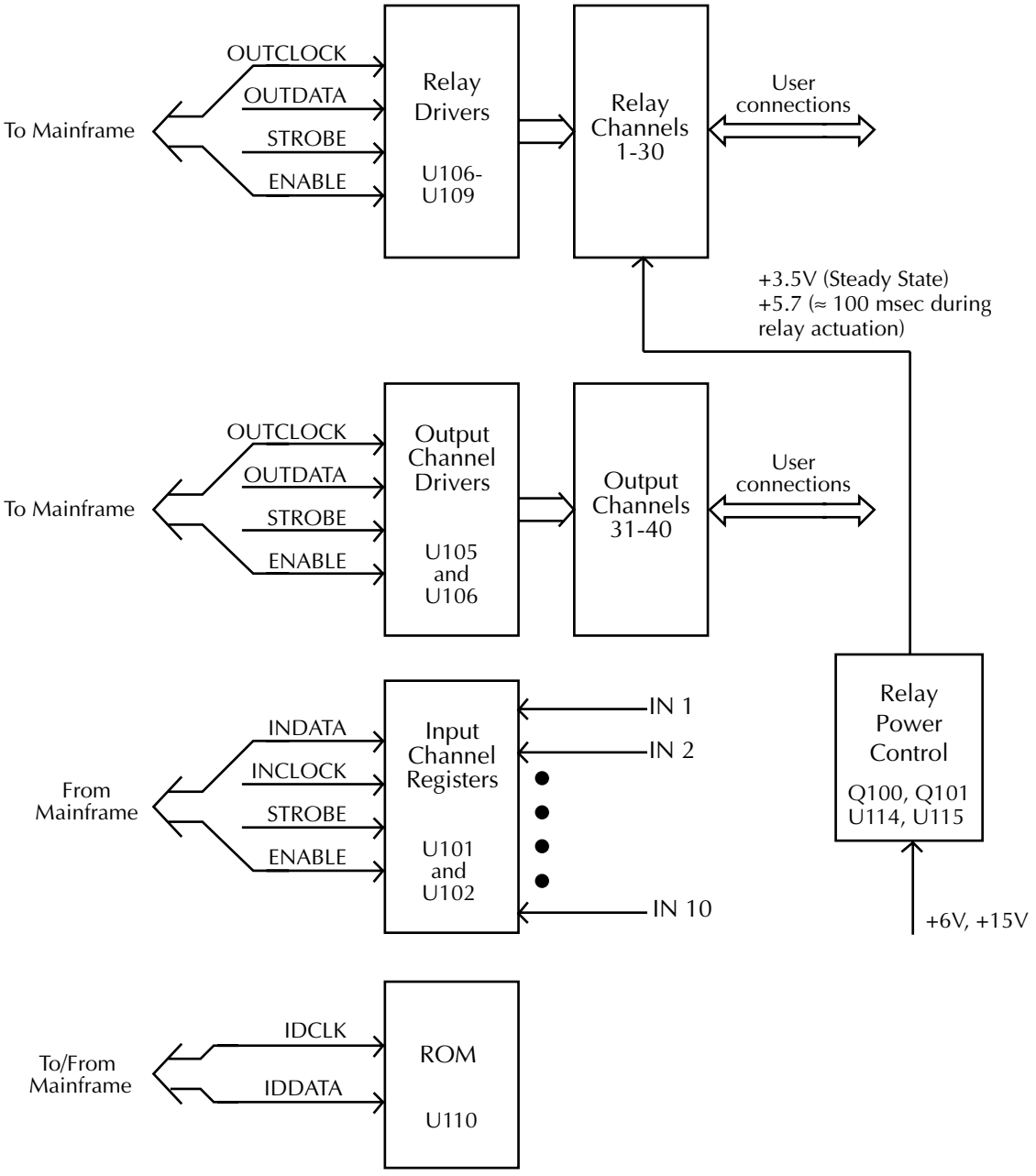


Figure 6-7
Model 7037 block diagram

ID data circuits

Upon power-up, card identification information from each card is read by the mainframe. This ID data includes such information as card ID, hardware settling time, and relay and channel configuration information.

ID data is contained within an on-card EEPROM (U110). In order to read this information, the sequence described below is performed on power-up.

1. The IDDATA line (pin 5 of U110) is set from high to low while the IDCLK line (pin 6 of U110) is held high. This action initiates a start command to the ROM to transmit data serially to the mainframe (Figure 6-8).
2. The mainframe sends the ROM address location to be read over the IDDATA line. The ROM then transmits an acknowledge signal back to the mainframe, and it then transmits data at that location back to the mainframe (Figure 6-9).
3. The mainframe then transmits an acknowledge signal, indicating that it requires more data. The ROM will then sequentially transmit data after each acknowledge signal it receives.
4. Once all data is received, the mainframe sends a stop command, which is a low-to-high transition of the IDDATA line with the IDCLK line held high (Figure 6-8).

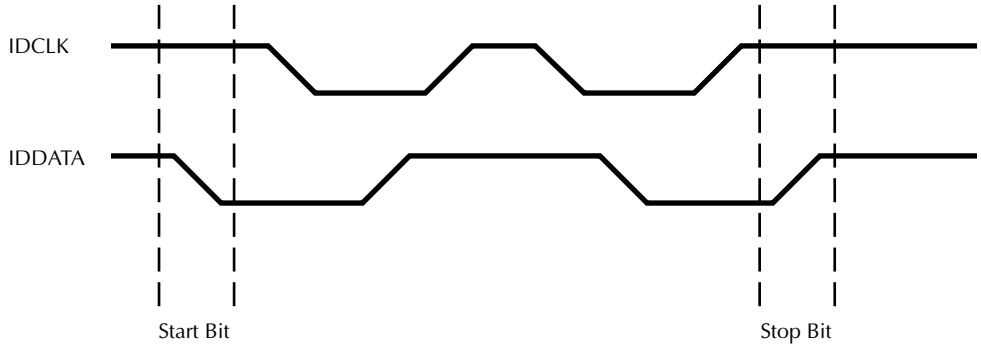


Figure 6-8
Start and stop sequences

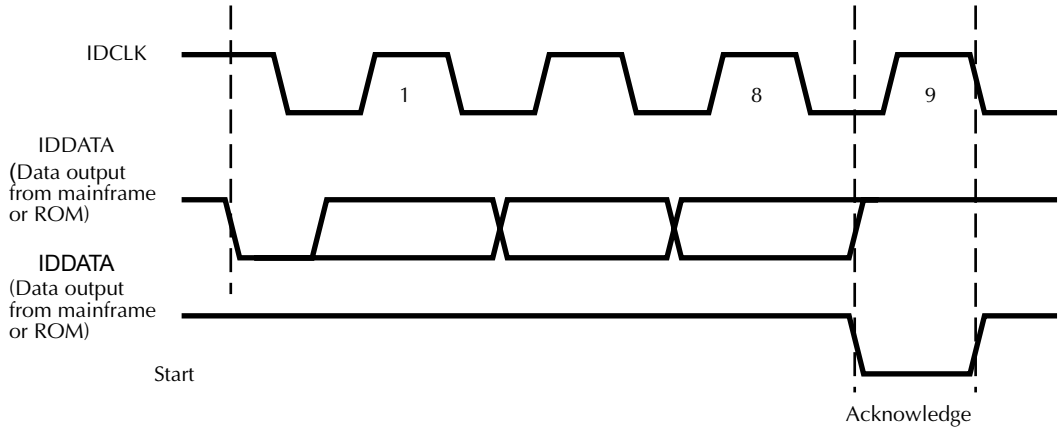


Figure 6-9
Transmit and acknowledge sequence

Relay control

Card relays are controlled by serial data transmitted via the relay OUTDATA line. A total of fi e bytes for each card are shifted in serial fashion into latches located in the card relay driver ICs. The serial data is clocked in by the OUTCLOCK line. As data overfl ws one register, it is fed out the Q's line of the register down the chain.

Once all fi e bytes have shifted into the card, the STROBE line is set high to latch the relay information into the Q outputs of the relay drivers, and the appropriate relays are energized (assuming the driver outputs are enabled, as discussed below). Note that a relay driver output goes low to energize the corresponding relay.

Relay power control

A relay power control circuit, made up of U114, U115, Q100, Q101, and associated components, keeps power dissipated in relay coils at a minimum, thus reducing possible problems caused by thermal EMFs.

During steady-state operation, the relay supply voltage, +V, is regulated to +3.5V to minimize coil power dissipation. When a relay is first closed, the STROBE pulse applied to U114 changes the parameters of the relay supply voltage regulator, Q100, allowing the relay supply voltage, +V, to rise to +5.7V for about 100msec. This brief voltage rise ensures that relays close as quickly as possible. After the 100msec period has elapsed, the relay supply voltage (+V) drops back down to its nominal steady-state value of +3.5V.

Digital I/O output channel control

Digital output channels are controlled by serial data transmitted from the mainframe to the card via the OUTDATA line. A total of two bytes are shifted in a serial fashion into latches located in the output channel driver ICs. The serial data is clocked in by the OUTCLK line. As data overfl ws one register, it is fed out the Q's line of the register down the chain.

Once all bytes have shifted into the card, the STROBE line is set high to latch the output channel information into the Q outputs of the output channel drivers. Note that a channel driver output can go low or high when it is turned on (closed) depending on its logic configuration

Digital I/O input channel control

The mainframe reads digital input channels of the I/O card from a serial, two-byte data stream (via INDATA line).

Digital inputs are applied in a parallel fashion to the two input channel registers (U102 contains eight channels and U101 contains two channels). When the digital inputs are read, the STROBE line goes high to latch the input channel information. The INCLOCK line then clocks out the information as a serial, two-byte data stream (via INDATA line) to the mainframe. As data empties from the lead register (U102), it is replaced by data via the Q7 line of the registers down the chain.

Power-on safeguard

NOTE

The power-on safeguard circuit discussed below is actually located on the digital board in the mainframe.

A power-on safeguard circuit, made up of a D-type flip-fl and associated components, ensures that relays and digital I/O output channels do not randomly energize on power-up and power-down. This circuit disables all relays and output channels (all relays and output channels are open) during power-up and power-down periods.

The PRESET line on the D-type flip-flo is controlled by the 68302 microprocessor, while the CLK line of the D-type flip-flo is controlled by a VIA port line on the 68302 processor. The Q output of the flip-flo drives each switch card relay/output channel driver IC enable pin (U105-U109, pin 8).

When the 68302 microprocessor is in the reset mode, the flip-flo PRESET line is held low, and Q out immediately goes high, disabling all relays and output channels (driver IC enable pins are high). After the reset condition elapses (≈200msec), PRESET goes high while Q out stays high. When the first valid STROBE pulse occurs, a low logic level is clocked into the D-type flip-flop setting Q out low and enabling all relay drivers and output channel drivers simultaneously. Note that Q out stays low, (enabling relay drivers and output channels) until the 68302 processor goes into a reset condition.

Troubleshooting

WARNING

Lethal voltages are present within the Model 7001/7002 mainframe. Some of the procedures may expose you to hazardous voltages. Observe standard safety precautions for dealing with live circuits. Failure to do so could result in personal injury or death.

CAUTION

Observe the following precautions when troubleshooting or repairing the card.

To avoid contamination, which could degrade card performance, always handle the card only by the handle and side edges. Do not touch edge connectors, board surfaces, or components on the card. Also, do not touch areas adjacent to electrical contacts on connectors.

Use care when removing relays from the PC board to avoid pulling traces away from the circuit board. Before attempting to remove a relay, use an appropriate de-soldering tool, such as a solder sucker, to clear each mounting hole completely free of solder. Each relay pin must be free to move in its mounting hole before removal. Also, make certain that no burrs are present on the ends of the relay pins.

Troubleshooting equipment

Table 6-3 summarizes recommended equipment for troubleshooting the Model 7037.

Table 6-3
Recommended troubleshooting equipment

Description	Manufacturer and model	Application
Multimeter	Keithley 2000	Measure DC voltages
Oscilloscope	TEK 2243	View logic waveforms

Troubleshooting access

In order to gain access to the relay card top surface to measure voltages under actual operation conditions, perform the following steps:

1. Disconnect the connector card from the relay card.
2. Remove the Model 7001/7002 cover.
3. Install the relay card in the CARD 1 slot location.
4. Turn on Model 7001/7002 power to measure voltages (see following paragraph).

Troubleshooting procedure

Table 6-4 summarizes relay-digital I/O card troubleshooting.

Table 6-4
Troubleshooting procedure

Step	Item/Component	Required Condition	Comments
1	GND pad		All voltages referenced to digital ground (GND pad).
2	Q100, pin 2	+6VDC	Relay voltage.
3	U101, pin 16	+5VDC	Logic voltage.
4	R135	+15VDC	Relay bias voltage.
5	Q100, pin 3	+3.5VDC*	Regulated relay voltage.
6	U110, pin 6	IDCLK pulses	During power-up only.
7	U110, pin 5	IDDATA pulses	During power-up only.
8	U106, pin 7	STROBE pulse	End of relay update sequence.
9	U106, pin 2	CLK pulses	During relay update sequence only.
10	U106, pin 3	DATA pulses	During relay update sequence only.
11	U105-U109, pins 10-18	Low with relay energized; high with relay de-energized.	Relay driver outputs.

*+3.5VDC present at +V pad under steady-state conditions. This voltage rises to +5.7VDC for about 100msec when relay configurat on is changed.

7
Replaceable Parts

Introduction

This section contains replacement parts information, schematic diagrams, and component layout drawings for the Model 7037.

Parts lists

Parts lists for the various circuit boards are included in tables integrated with schematic diagrams and component layout drawings for the boards. Parts are listed alphabetically in order of circuit designation.

Ordering information

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

1. Card model number 7037
2. Card serial number
3. Part description
4. Circuit description, if applicable
5. Keithley part number

Factory service

If the 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 or the equivalent.
3. Write ATTENTION REPAIR DEPT on the shipping label.

NOTE

It is not necessary to return the mainframe with the card.

Component layouts and schematic diagrams

Component layout drawings and schematic diagrams are included on the following pages after the parts lists:

Table 7-1 — Parts List, Relay Card for 7037.
Table 7-2 — Parts List, Mass Terminated Connector Card for 7037.
Table 7-3 — Parts List, Model 7011-KIT-R 96-pin Female DIN Connector Kit.
7037-100 — Component Layout, Relay Card for 7037.
7037-106 — Schematic, Relay Card for 7037.

7021-170 — Component Layout, Mass Terminated Connector Card for 7037.
7021-176 — Schematic, Mass Terminated Connector Card for 7037.

Table 7-1
Relay card for Model 7037 parts list

Circuit designation	Description	Keithley part no.
	2-56X3/16 PHILLIPS PAN HEAD SCREW (BOARD TO SHIELD)	3-56X3/16PPH
	2-56X5/16 PHILLIPS PAN HEAD SEMS SCREW (BOARD TO SHIELD)	2-56X5/16PPHSEM
	2-56X5/8 PHILLIPS PAN HEAD FASTENER (FOR P2001 TO STAND-OFF AND SHIELD)	FA-245-1
	4-40X3/16 PHILLIPS PAN HEAD SEMS SCREW (FOR Q100)	4-40X3/16PPHSEM
	4-40 PEM NUT	FA-131
	CONNECTOR, JUMPER	CS-476
	EJECTOR ARM	7011-301B
	IC, SERIAL EPROM, 24C01P	IC-737
	ROLL PIN (FOR EJECTOR ARMS)	DP-6-1
	SHIELD	7011-305C
	STANDOFF, 2 CLEARANCE	ST-204-1
C100-112,114,115, 118,121,122, 125	CAP, 0.1µF, 20%, 50V, CERAMIC	C-365-.1
C116,117,126	CAP, 150PF, 10%, 1000V, CERAMIC	C-64-150P
C119,127	CAP, 1µF, 20%, 50V, CERAMIC	C-237-1
C120	CAP, 0.001µF, 20%, 500V, CERAMIC	C-22-.001
C123,124	CAP, 10µF, -20+100%, 25V, ALUM ELEC	C-314-10
CR100-119	DIODE, SILICON, IN4148 (D0-35)	RF-28
J100,101	CONN, BERG	CS-339
J1002,1003	CONN, 48-PIN, 3-ROW	CS-736-2
K100-129	RELAY, ULTRA-SMALL POLARIZED TF2E-5V	RL-149
P2001	CONN, 32-PIN, 2-ROW	CS-775-1
Q100	TRANS, NPN PWR, TIP31 (T0-220AB)	TG-253
Q101	TRANS, N CHAN MOSPOW FET, 2N7000 (T0-92)	TG-195
R100-130,132	RES, 10K, 5%, 1/4W, COMPOSITION OR FILM	R-76-10K
R131	RES, 1K, 5%, 1/4W, COMPOSITION OR FILM	R-76-1K
R133	RES, 220K, 5%, 1/4W, COMPOSITION OR FILM	R-76-220K
R134,135	RES, 560, 10%, 1/2W, COMPOSITION	R-1-560
R136	RES, 2.49K, 1%, 1/8W, METAL FILM	R-88-2.49K
R137	RES, 1.15K, 1%, 1/8W, METAL FILM	R-88-1.15K
R138	RES, 1K, 1%, 1/8W, METAL FILM	R-88-1K
S110	SOCKET	S0-72
ST1	STANDOFF, 4-40X0.812LG	ST-137-20
U100,103,104	IC, QUAD 2-INPUT EXCLUSIVE OR 74HCT86	IC-707
U101,102	IC, 8-BIT PARALLEL TO SERIAL, 74HCT165	IC-548
U105-109	IC, 8-BIT, SERIAL-IN LATCH DRIVER, 5841A	IC-536
U110	PROGRAM	7037-800A01
U111	IC, HEX INVERTER, 74HCT04	IC-444
U112	IC, QUAD 2 INPUT OR 74HCT32	IC-443
U113	IC, HIGH SPEED BUFFER, 74HC125	IC-451
U114	IC, RETRIG MONO MULTIVIB, 74HC123	IC-492
U115	IC, AJD SHUNT REGULATOR, TL431CLP	IC-677
VR100	DIODE, ZENER, 5.1V, IN751 (D0-7)	DZ-59

Table 7-2
Mass terminated connector card for Model 7037 parts list

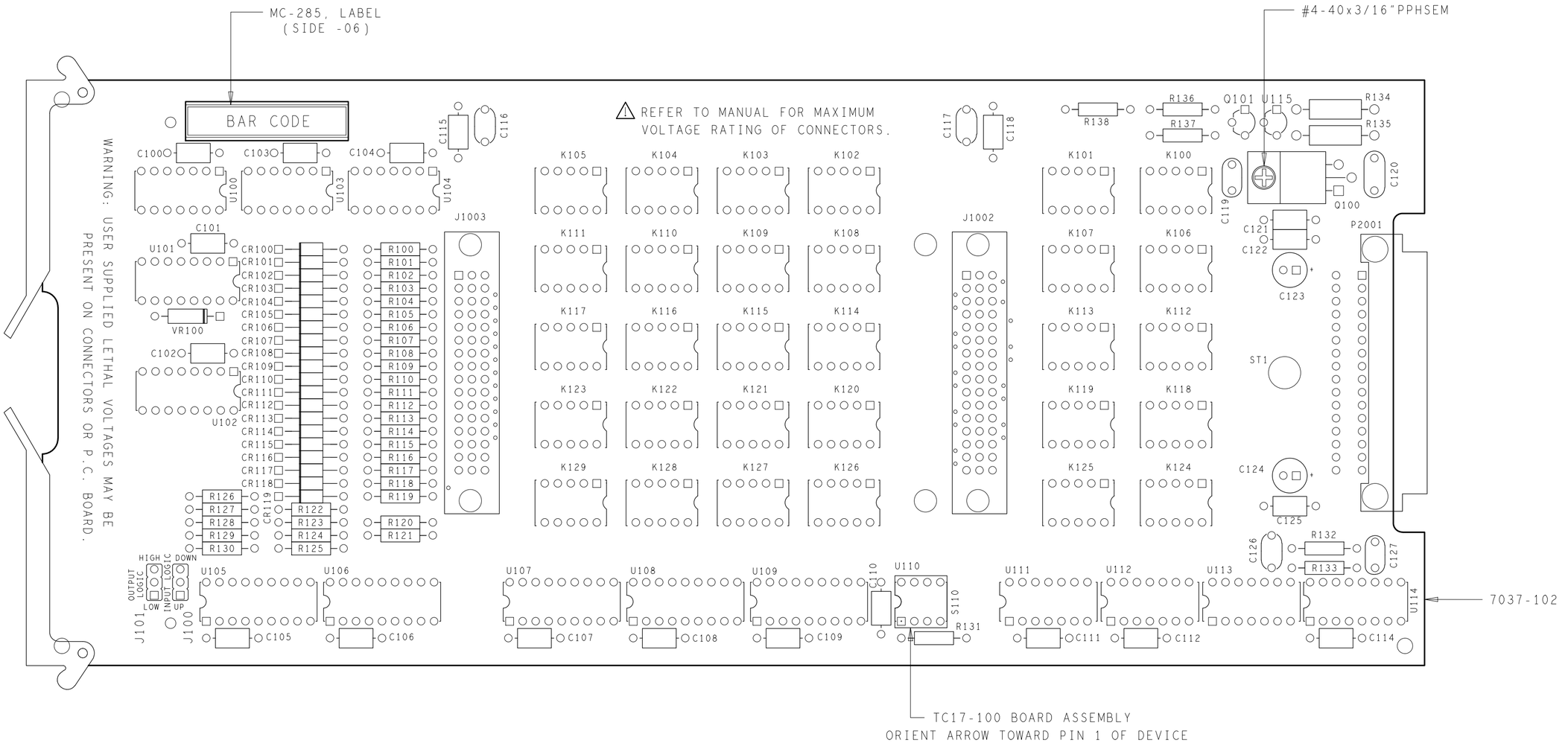
Circuit designation	Description	Keithley part no.
	2-56X3/16 PHILLIPS PAN HEAD SCREW (FOR SHIELD)	2-56X3/16PPH
	2-56X3/8 PHILLIPS PAN HEAD SCREW (FOR BRACKET)	2-56X3/8PPH
	2-56X7/16 PHILLIPS PAN HEAD SCREW	2-56X7/16PPH
	4-40X1/4 PHILLIPS PAN HEAD SEMS SCREW (CONNECTS RELAY BOARD TO CONNECTOR BOARD)	4-40X1/4PPHSEM
	BRACKET	7011-307
	CONN, JUMPER (FOR J201)	CS-476
	SHIELD	7011-311A
	STANDOFF	ST-203-1
C201-203	CAP, 0.1µF, 20%, 50V, CERAMIC	C-365-.1
J201	CONN, BERG	CS-339
J202,203	CONNECTOR SHIM	7011-309A
J1004	CONN, 96-PIN, 3-ROW	CS-514
P1002,1003	CONNECTOR, 48-PIN, 3-ROW	CS-748-3
R201-205,207-210,212	RES, 10K, 5%, 1/4W, COMPOSITION OR FILM	R-76-10K
U201-203	IC, 4-CHANNEL PWR DRIVER, 2549B	IC-1044

Table 7-3
Model 7011-KIT-R 96-pin female DIN connector kit parts list

Description	Keithley part no.
96-PIN FEMALE DIN CONNECTOR	CS-787-1
BUSHING, STRAIN RELIEF	BU-27
CABLE ADAPTER, REAR EXIT (INCLUDES TWO CABLE CLAMPS)	CC-64
CONNECTOR HOUSING	CS-788

NO. 7037-100

LTR.	ECA NO.	REVISION	ENG.	DATE
A		PRELIMINARY		
B	19791	RELEASED	SZ	3/31/97
B1	25918	CHANGED U110 TO TC17-100	ELS	6/21/01

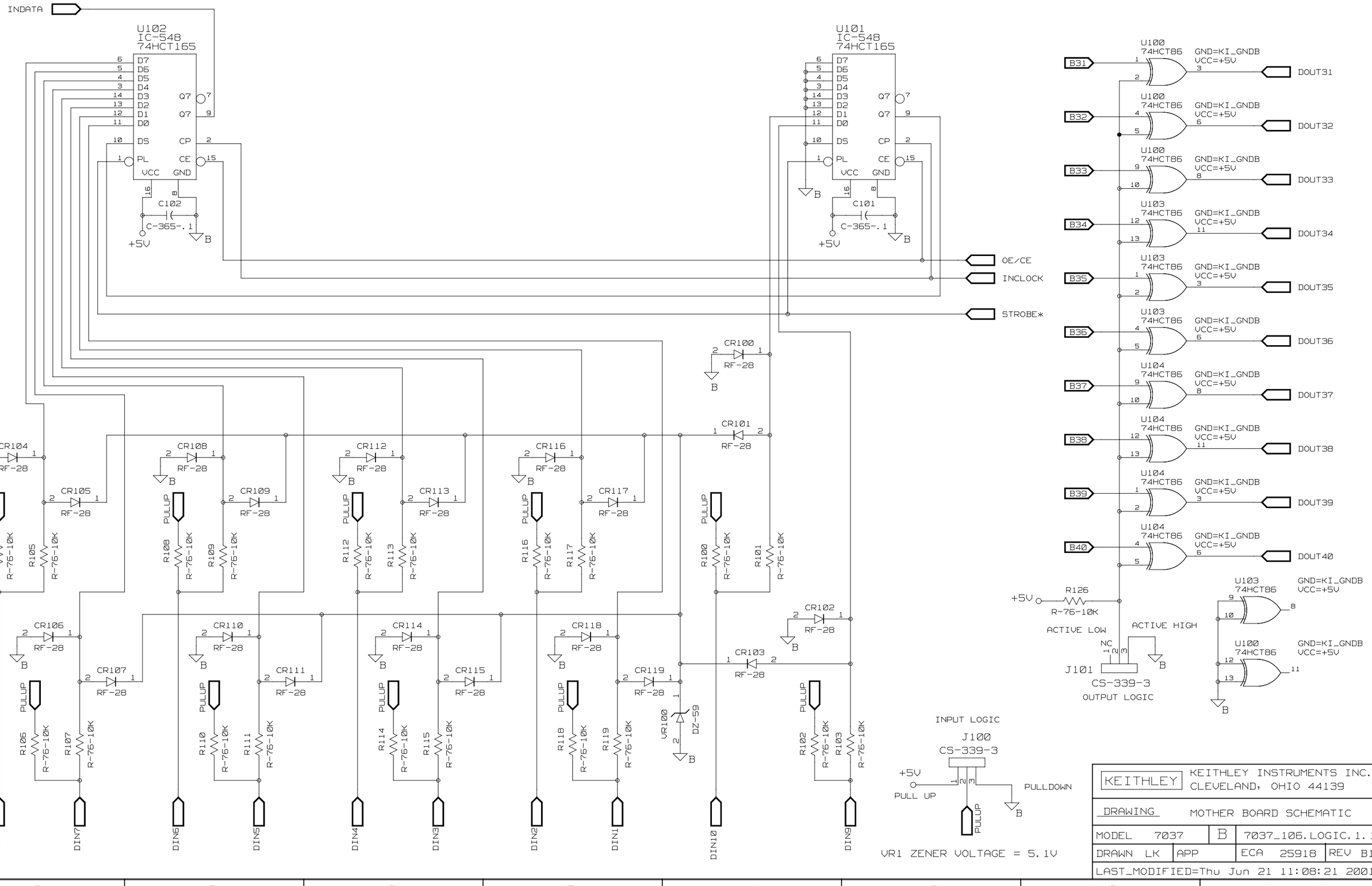


NOTE: FOR COMPONENT INFORMATION,
REFER TO 7037 PRODUCT STRUCTURE.

MODEL	NEXT ASSEMBLY	QTY.
USED ON		

KEITHLEY
KEITHLEY INSTRUMENTS INC.
CLEVELAND, OHIO 44139

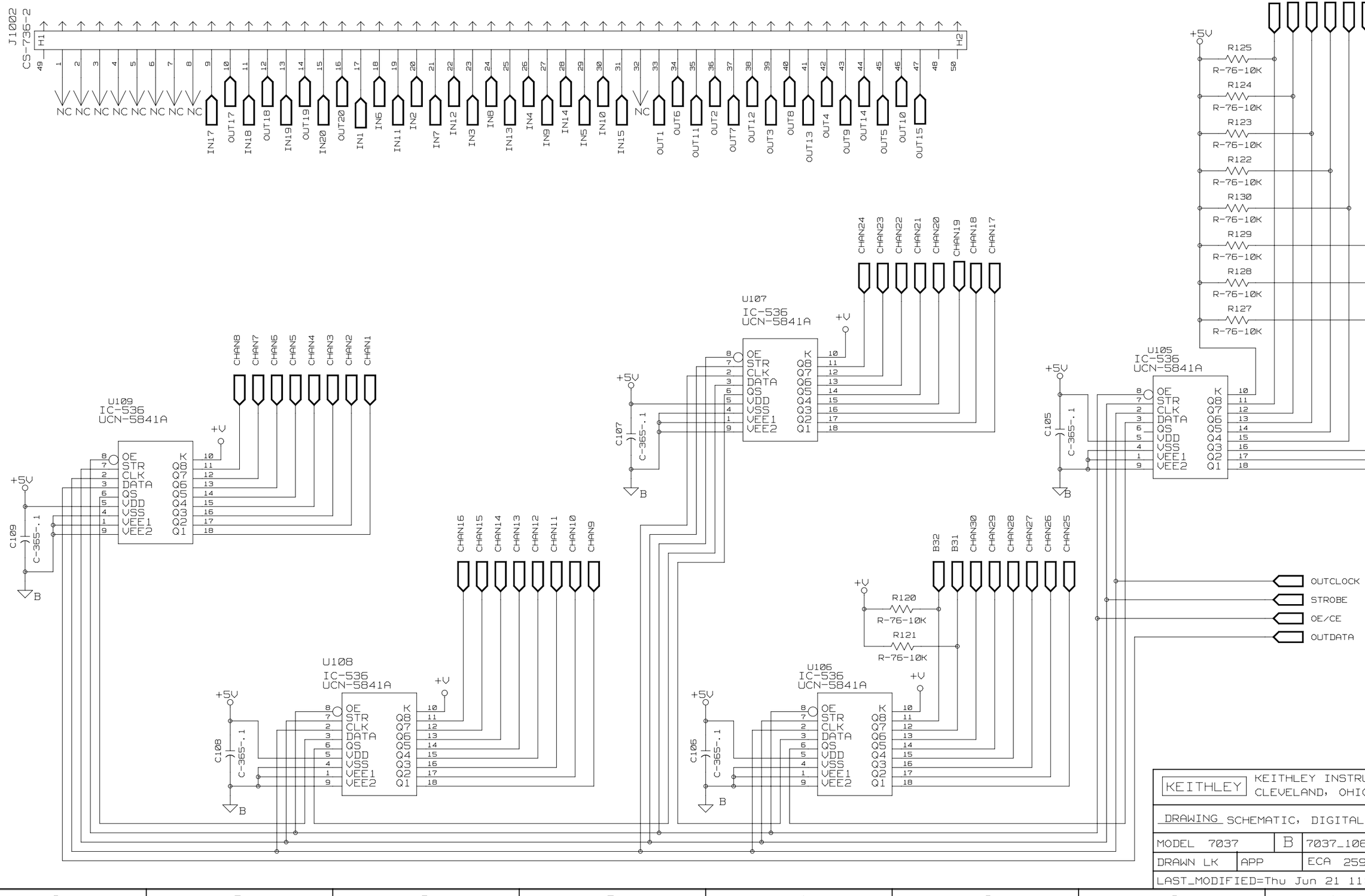
DIM ARE IN IN. UNLESS OTHERWISE NOTED	DATE 3/5/97	SCALE 3:2	TITLE COMPONENT LAYOUT, RELAY BOARD
DIM. TOL. UNLESS OTHERWISE SPECIFIED	DRN MAH	APPR. P.S.	
XX=+.01 ANG.=+1 XXX=+.005 FRAC.=+1/64	DO NOT SCALE THIS DRAWING	C	NO. 7037-100



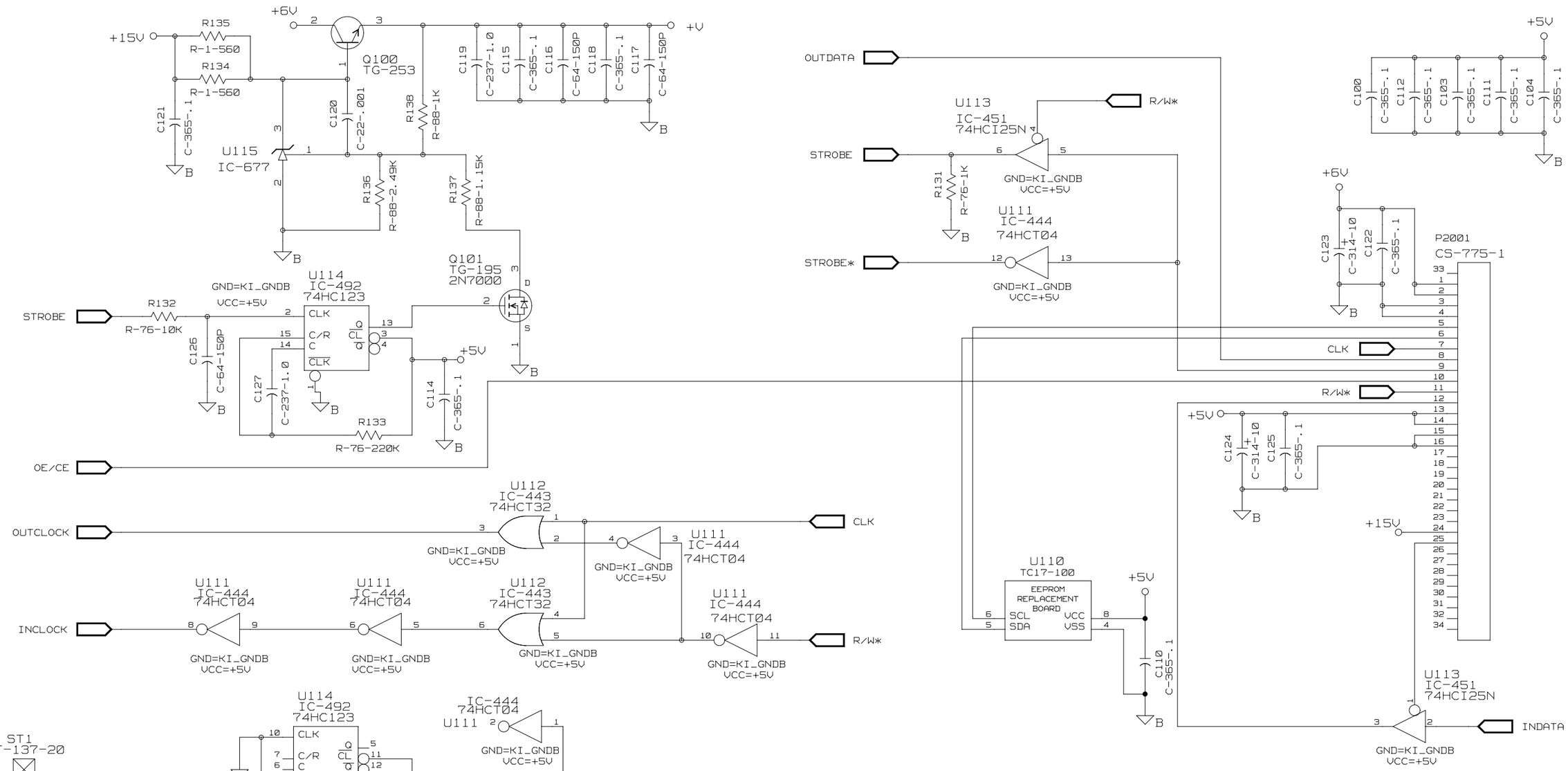
KEITHLEY	KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139
DRAWING	MOTHER BOARD SCHEMATIC
MODEL 7037	B 7037_106.LOGIC.1.1
DRAWN LK	APP ECA 25918 REV B1
LAST_MODIFIED=Thu Jun 21 11:08:21 2001	



KEITHLEY	KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139		
DRAWING	SCHEMATIC MOTHER BOARD		
MODEL 7037	B	7037_106.LOGIC.1.2	
DRAWN LK	APP	ECA 25918	REV B1
LAST_MODIFIED=Thu Jun 21 11:11:20 2001			



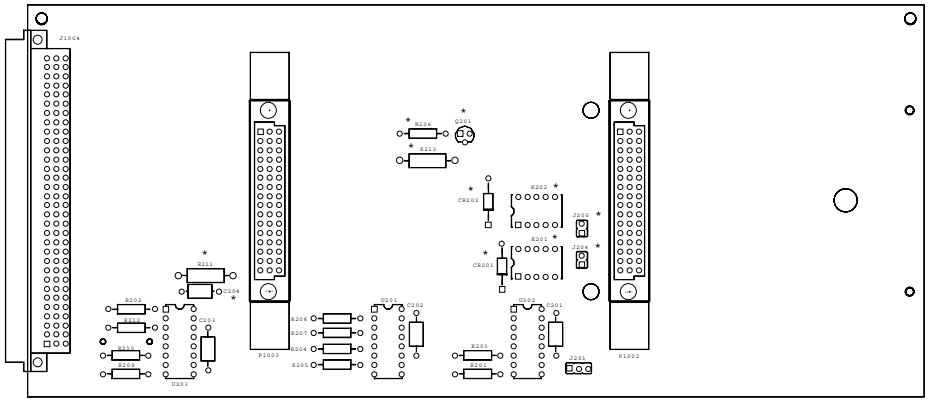
KEITHLEY	KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139		
DRAWING SCHEMATIC, DIGITAL I/O CARD			
MODEL 7037	B	7037_106.LOGIC.1.3	
DRAWN LK	APP	ECA 25918	REV B1
LAST_MODIFIED=Thu Jun 21 11:08:43 2001			



KEITHLEY	KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139							
DRAWING	MOTHER BOARD							
MODEL 7037		B	7037_106.LOGIC.1.4					
DRAWN LK	APP		ECA 25918	REV B1				
LAST_MODIFIED=Thu Jun 21 11:11:59 2001								

LTR.	ECA NO.	REVISION	ENG.	DATE
A	19587	RELEASED	SZ	2/11/97
A1		ADDED NO POP NOTE FOR MODEL 7037,K201,K202 CR202,CR201,J204,J205,C204,R211,R206,R213,Q201		

TOP SIDE COMPONENTS (SIDE -06)



NOTE: FOR COMPONENT INFORMATION, SEE PRODUCT STRUCTURE.
*DO NOT POPULATE THESE PARTS FOR MODEL 7037;
R211,C204,K202,CR202,Q201,R213,R206,CR201,K201,J204,J205.

MODEL	NEXT ASSEMBLY	QTY.
USED ON		

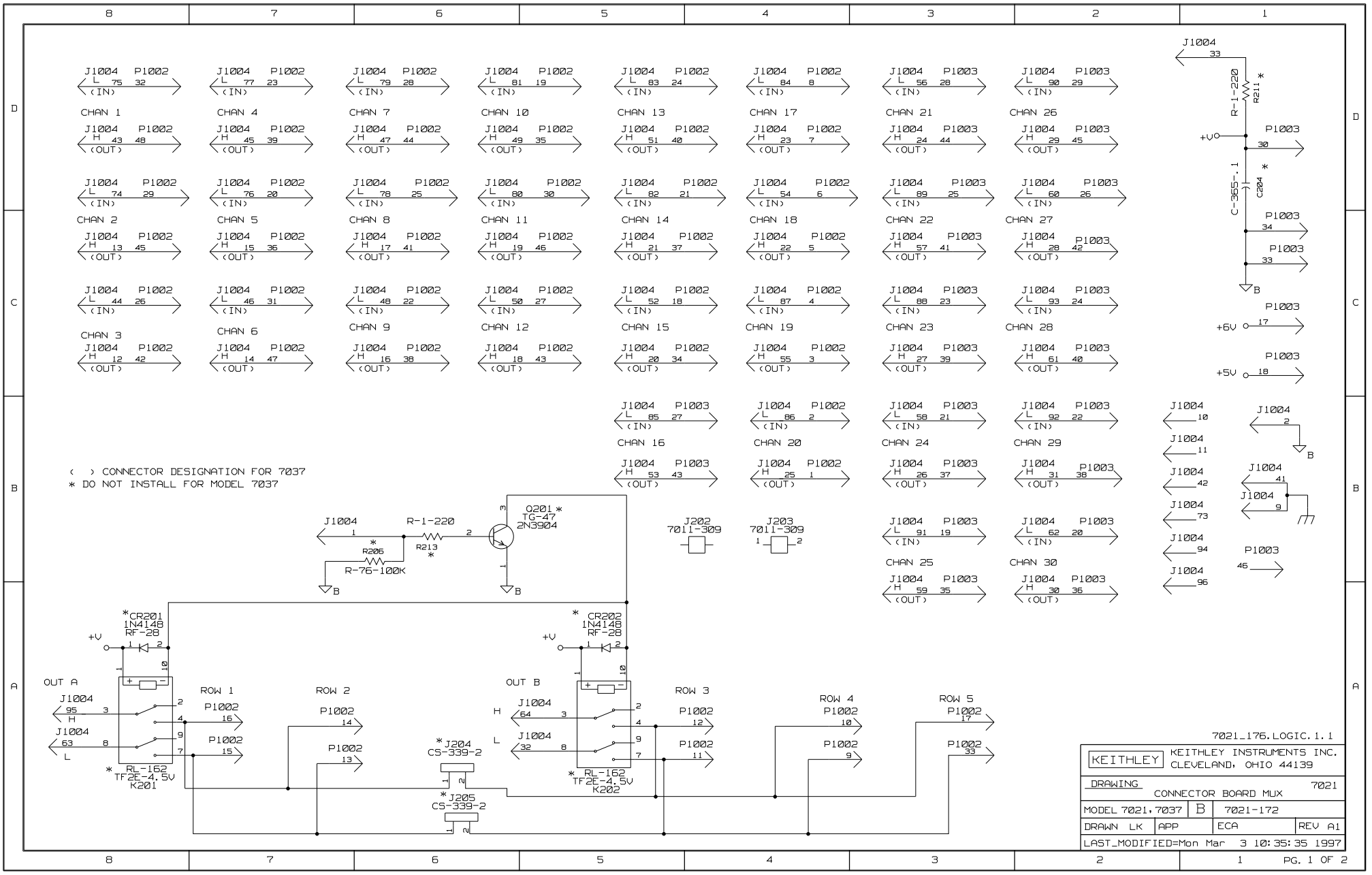
KEITHLEY
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CLEVELAND, OHIO 44139

DIM ARE IN IN. UNLESS OTHERWISE NOTED
DIM. TOL. UNLESS OTHERWISE SPECIFIED
XX=+.01 ANG.=+1
XXX=+.005 FRAC.=+1/64
DO NOT SCALE THIS DRAWING

DATE 1/6/97 SCALE 1:1
DRN CAB APPR.

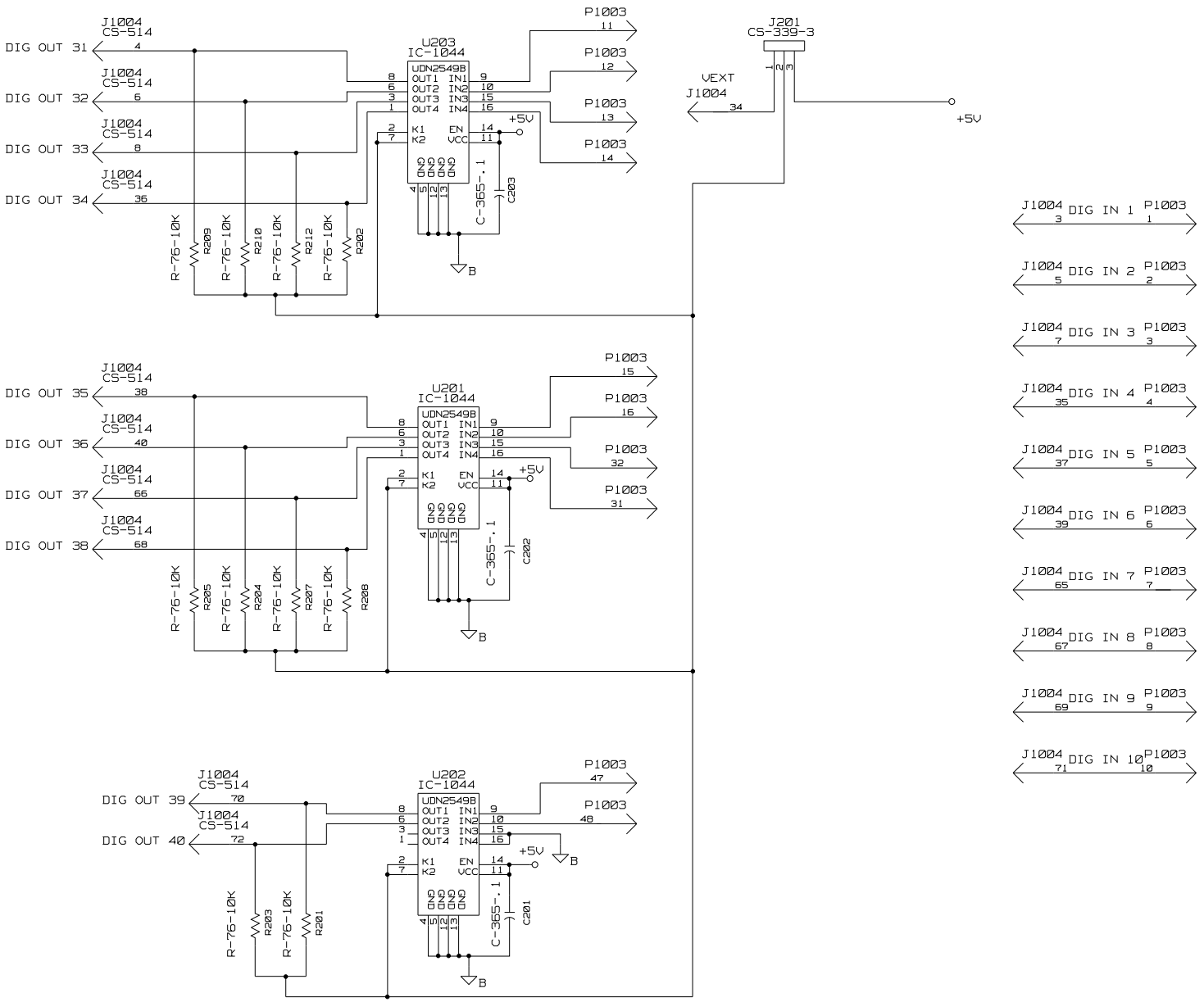
TITLE COMPONENT LAYOUT, CONNECTOR BOARD

C NO. 7021-170



7021_176.LOGIC.1.1

KEITHLEY	KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139		
DRAWING	CONNECTOR BOARD MUX		7021
MODEL 7021, 7037	B	7021-172	
DRAWN LK	APP	ECA	REV A1
LAST_MODIFIED=Mon Mar 3 10:35:35 1997			



7021_176.LOGIC.1.2

KEITHLEY INSTRUMENTS INC.
CLEVELAND, OHIO 44139

DRAWING 7021
CONNECTOR BOARD

MODEL 7021,7037 | B | 7021-176

DRAWN LK | APP | ECA | REV A1

LAST_MODIFIED=Fri Feb 28 15:12:06 1997

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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	Unable to zero
Unstable	Will not read applied input
Overload	

Calibration only	Certificate of calibration require
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 h ve 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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28775 Aurora Road
Cleveland, Ohio 44139

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