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Instruction Manual

Model 7036
40-Channel Single-Pole Relay Switch Card

Contains Operating and Servicing Information

KEITHLEY

7036-901-01 Rev. A / 4-97

WARRANTY

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

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

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

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

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

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Model 7036 40-Channel Single-Pole Relay Switch 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 7036-901-01)..... April 1997

All Keithley product names are trademarks or registered trademarks of Keithley Instruments, Inc.

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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.

MODEL 7036 SPECIFICATIONS

RELAY SWITCH CONFIGURATION: 40 independent channels of 1-pole switching.

CONTACT CONFIGURATION: 1 pole Form A.

CONNECTOR TYPE: 96-pin male DIN card connector.

MAXIMUM SIGNAL LEVEL: 60VDC, 30V rms, 42V 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): <1Ω.

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): <0.3dB below 1MHz, <3dB below 10MHz.

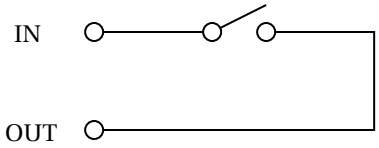
RELAY DRIVE CURRENT (per relay): 16mA.

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.

ENVIRONMENT: Operating: 0° to 50°C, up to 35°C at <80% R.H.
Storage: –25°C to 65°C.

Each Channel



Specifications are subject to change without notice.

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1
General Information

Introduction

This section contains general information about the Model 7036 40-Channel Single-Pole Relay Switch Card.

The Model 7036 switch card consists of a multi-pin (mass termination) connector card and a relay card. External test circuit connections to the Model 7036 are made via the 96-pin male DIN connector on the connector card. Keithley offers an optional Model 7011-MTR bulkhead connector that can be used to make connections to the connector card. (See the optional accessories paragraph 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 7036 is a general purpose switch card with 40 independent channels for greater programming flexibility. Some of the key features include:

- Low contact potential and offset current for minimal effects on low-level signals.
- 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 7036 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 on the inside front cover of this instruction manual. Should your Model 7036 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 switch 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 switch card. Such damage may invalidate the warranty.

Specifications

Model 7036 specifications may be found at the front of this manual. These specifications are exclusive of the Model 7001/7002 mainframe specifications.

Unpacking and inspection

Inspection for damage

The Model 7036 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 handling precautions.

Handling pr ecautions

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 7036 order:

- Model 7036 40-Channel Single-Pole Relay Switch Card
- Model 7036 Instruction Manual
- Model 7011-KIT-R 96-pin Female DIN Connector Kit
- Additional accessories as ordered

Instruction manual

The Model 7036 Instruction Manual is three-hole drilled so that it can be added to the three-ring binder of the Model 7001 or Model 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 switch card instruction manual.

If an additional instruction manual is required, order the manual package, Keithley part number 7036-901-00. The manual package includes an instruction manual and any pertinent addenda.

Repacking for shipment

Should it become necessary to return the Model 7036 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 switch 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 accessory is available for use with the Model 7036:

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.

2

Relay Switching Basics

Introduction

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

Basic switch configuration (SPST)

A simplified schematic of the Model 7036 switch card is shown in Figure 2-1. The card consists of 40 independent channels. Each channel is made up of a single-pole, single-throw (SPST), normally open (NO) switch.

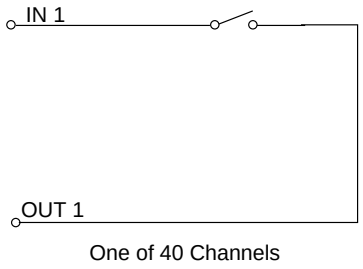


Figure 2-1
Model 7036 40-channel switch card (simplified schematic)

3

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 precautions** — Explains precautions that must be followed to prevent contamination to the switch card. Contamination could degrade the performance of the card.
- **Multi-pin (mass termination) connections** — Covers the basics for connecting external circuitry to the connector card.
- **Model 7036 installation and removal** — Provides the procedures to install and remove the Model 7036 switch card from the Model 7001/7002 mainframe.

Handling precautions

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

To avoid possible contamination, always grasp the relay card and the connector card 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 switch card in a clean environment.

If a card becomes contaminated, it should be thoroughly cleaned as explained in Section 5.

WARNING

The following connection information is intended to be used by qualified service personnel. Failure to recognize and observe standard safety precautions could result in personal injury or death.

Multi-pin (mass termination) connections

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 and install the supplied 4-40 screw to secure the cards. Make sure to handle the cards by the edges and shields to avoid contamination.

Terminal identification for the DIN connector of the multi-pin connector card is provided by Figure 3-1 and Table 3-1. This connector will mate to a 96-pin female DIN connector.

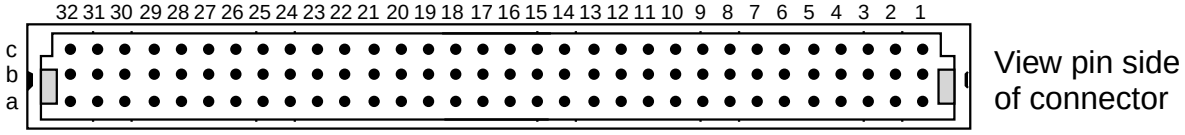


Figure 3-1
Multi-pin connector card terminal identification

Table 3-1
Multi-pin connector card terminal designation cross-reference

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

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 3-2, utilize a custom-built cable assembly for connections.

Table 3-2
Mass termination accessories

Model	Description
7011-KIT-R	96-pin female DIN connector and housing for round cable (provided with the Model 7036 card).
7011-MTR	96-pin male DIN bulkhead connector.

Typical connection technique

All external circuitry, such as instrumentation and DUTs, that you want to connect to the switch 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 stored energy in external circuitry is discharged.

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.

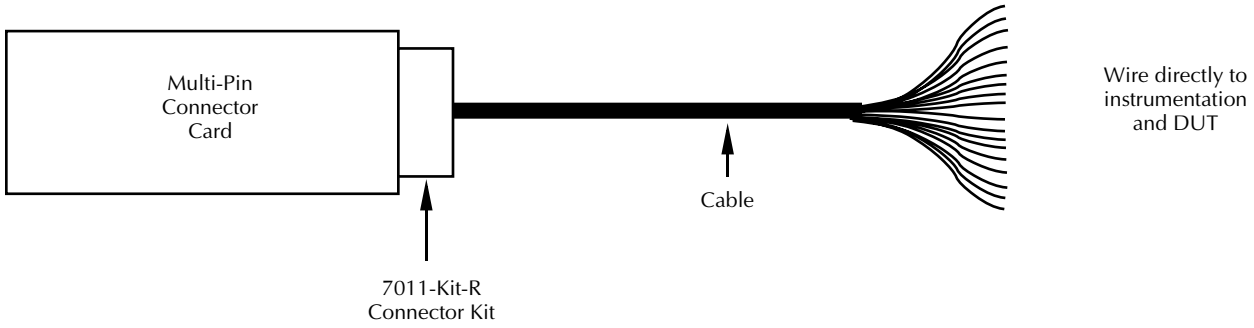
CAUTION

The 7011-MTC-2 cable is not intended to be used with the Model 7036. Pins 1 and 33 in the cable are internally shorted, but the Model 7036 uses these pins for signaling. Using the 7011-MTC-2 cable with the Model 7036 will short out the system and cause equipment damage.

NOTE

It is recommended that external circuitry be connected (plugged in) after the Model 7036 is installed in the Model 7001/7002 mainframe. Installation is covered at the end of this section.

In Figure 3-2, connections are accomplished using a custom-built cable assembly that consists of a Model 7011-KIT-R connector and a suitable round cable. Hitachi part number N2807-P/D-50TAB is a round, 50-conductor cable. Two cables can be used to provide 100 conductors. The connector has solder cups to accommodate the individual wires of the unterminated cable. Figure 3-3 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.



Notes : Figure 3-3 provides an exploded view showing how the connector (with cable) is assembled.

Cable Hitachi p/n N2807-P/D-50TAB is a 50-conductor round cable. Two of these cables can be used to supply 100 conductors.

Figure 3-2
Typical cable connection technique

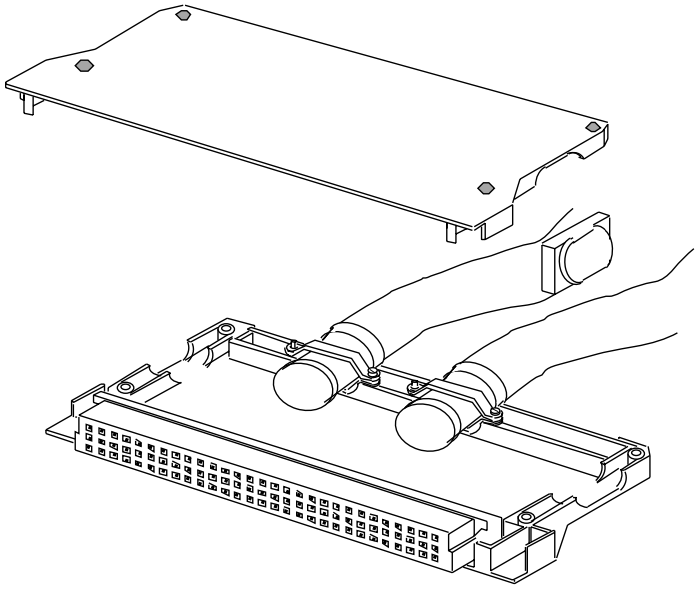


Figure 3-3
Model 7011-KIT-R (cable) assembly

Typical connection scheme

This paragraph shows how the Model 7036 could be connected to a system that activates external devices and circuits.

Figure 3-4 shows how external connections can be made to the system using a custom-built 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 7036 switch card. Connection details are provided in the Multi-pin (mass termination) connections paragraph.

If adding more Model 7036 cards to a system, simply wire them in the same manner as the first. Remember that Model 7036 cards installed in the same mainframe are electrically isolated from each other.

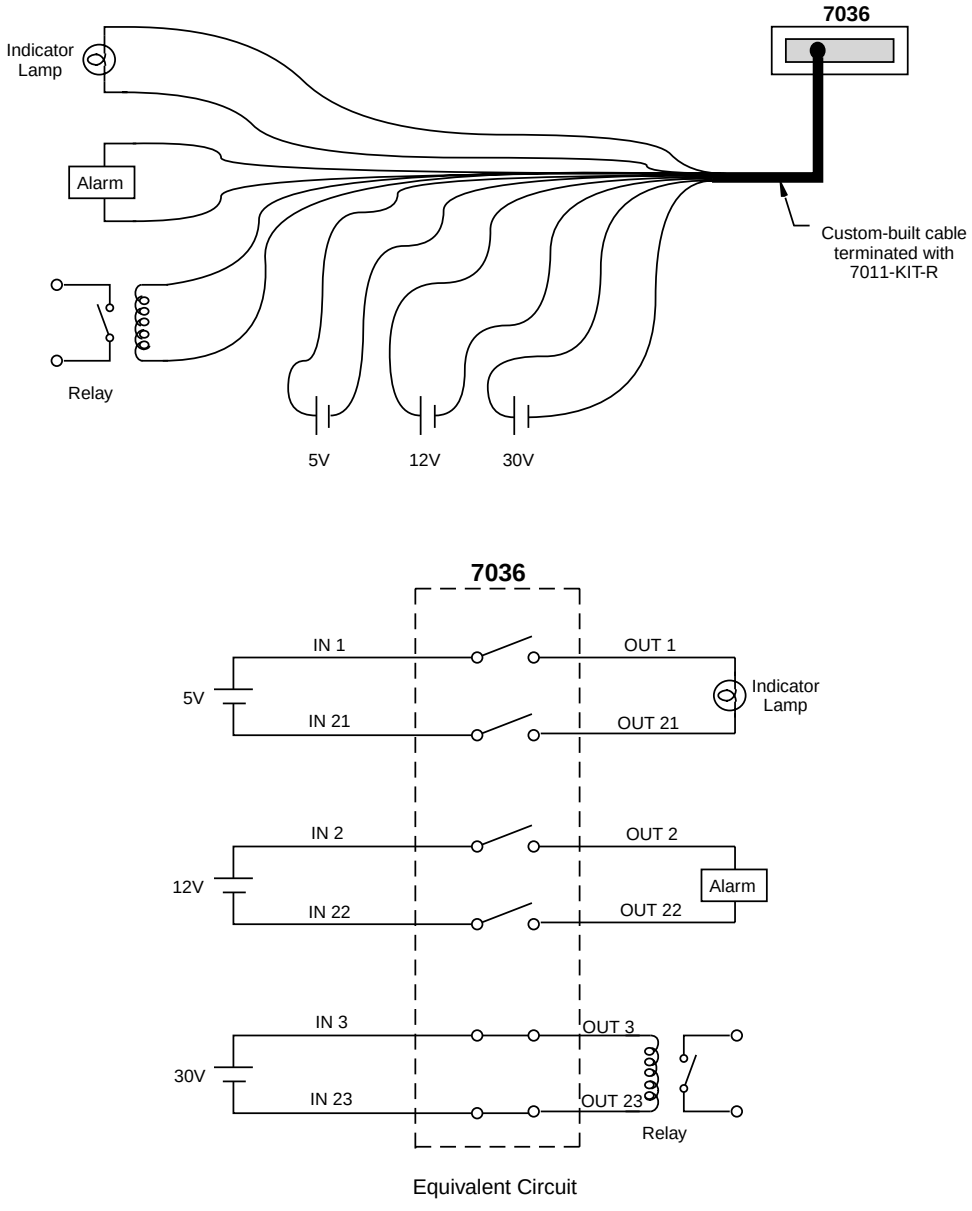


Figure 3-4
Typical connection scheme for Model 7036

Model 7036 installation and removal

The following paragraphs explain how to install and remove the Model 7036 switch card from the Model 7001/7002 mainframe.

WARNING

Installation or removal of the Model 7036 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 switch card that could degrade performance, only handle the card by the edges and shields.

Switch card installation

Perform the following steps to install the switch 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 any 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 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 Model 7001/7002, select the slot that you wish to install the card in.
3. Referring to Figure 3-5, feed the switch 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 switch card all the way into the mainframe until the arms engage into the ejector cups. Then push both arms inward to lock the switch 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 3-5.

5. Install the screw shown in Figure 3-5.

Switch card removal

To remove the switch card, first unloosen the safety ground screw, unlock the card by pulling the latches outward, and pull the card out of the mainframe. Remember to handle the

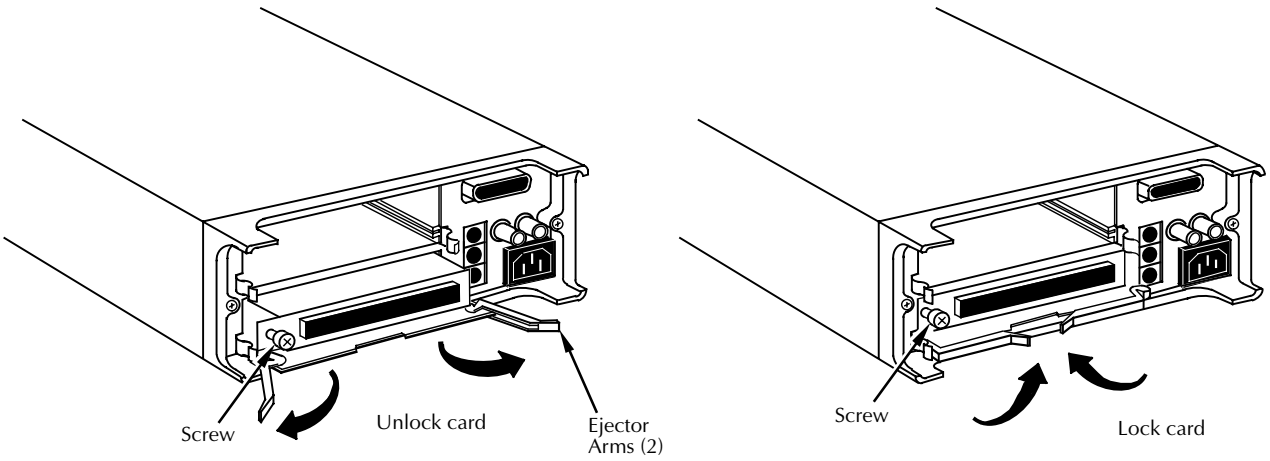


Figure 3-5
Model 7036 card installation in Model 7001

4
Operation

Introduction

The information in this section is formatted as follows:

- **Power limits** — Summarizes the maximum power limits of the Model 7036 switch card.
- **Mainframe control of relay card** — Summarizes programming steps to control the relay card from the Model 7001/7002 Switch System mainframe.
- **Measurement considerations** — Reviews a number of considerations when using the Model 7036 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.

Maximum signal levels

To prevent overheating or damage to the relays, never exceed the following maximum signal levels: 60VDC, 30V rms, 42V 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 60V in DC circuits or 30V rms, 42V peak in AC circuits. Also consider the load when determining the voltage limit. Clamping circuits that can be used are shown in Figure 4-1.

Capacitive loads — The initial surge current from a capacitive reactive load must be limited. Figure 4-2 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.

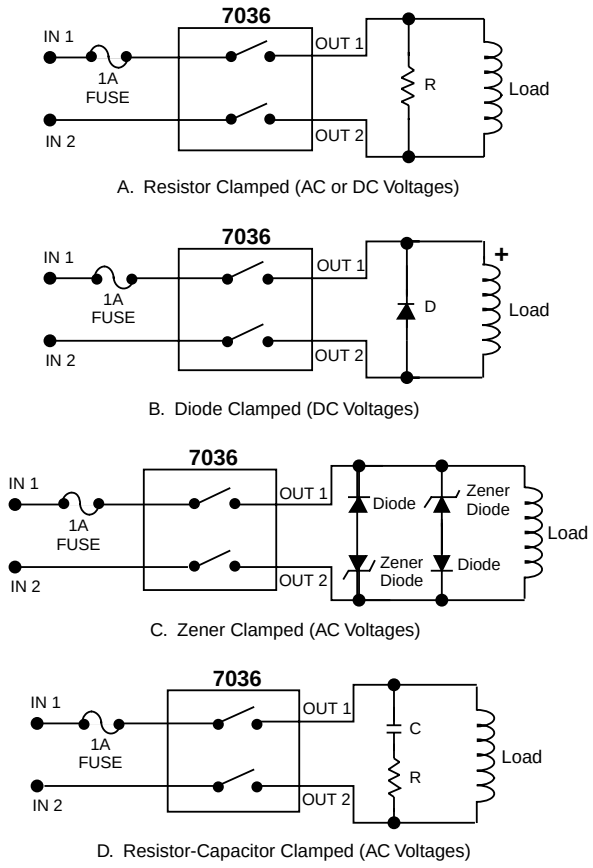


Figure 4-1
Limiting inductive reaction voltage

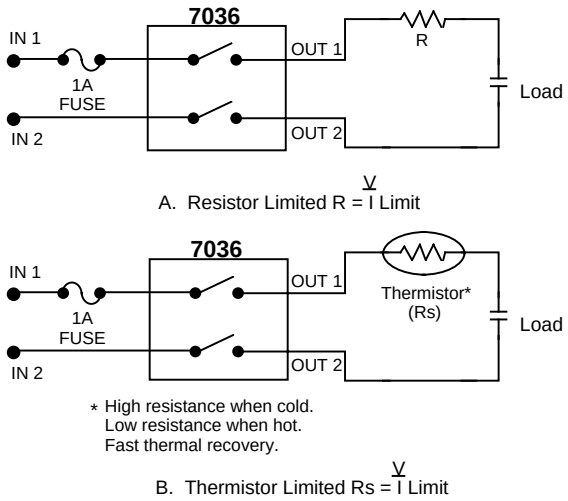


Figure 4-2
Limiting capacitive reaction current

Mainframe control of relay card

The following information pertains to the Model 7036 relay card. It assumes that 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.

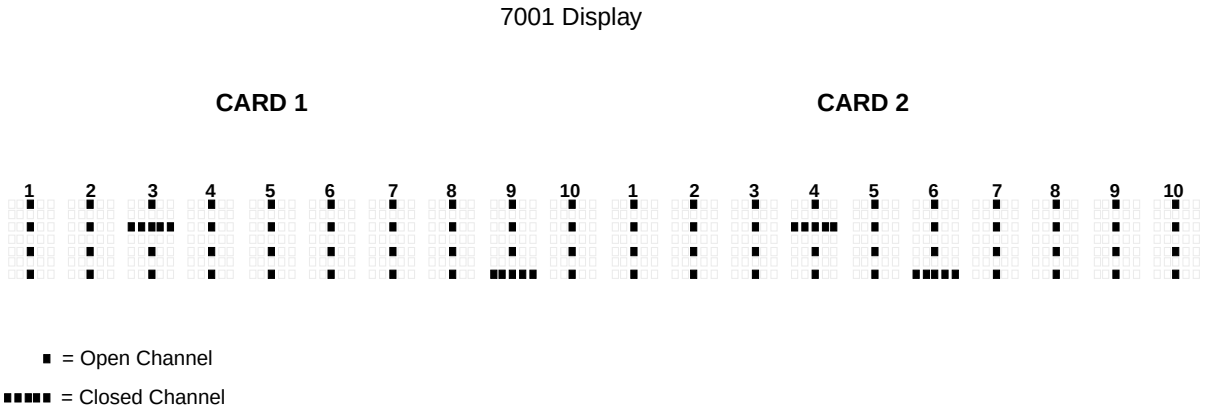


Figure 4-3
Model 7001 channel status display (two cards installed)

Channel assignments

The Model 7001 has a channel status display (Figure 4-3) 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 7036 cards installed in the mainframe, the 40 channels of each card will be displayed as shown in Figure 4-3. For the Model 7002, channel status LED grids are used for the ten slots. The LED grid for slot 1 is shown in Figure 4-4.

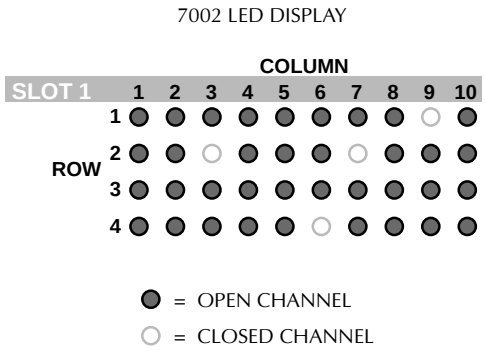


Figure 4-4
Model 7002 channel status display (slot 1)

Relay organization of the channel status display for each slot is shown in Figure 4-5. The relay card contains 40 channels as shown in the illustration.

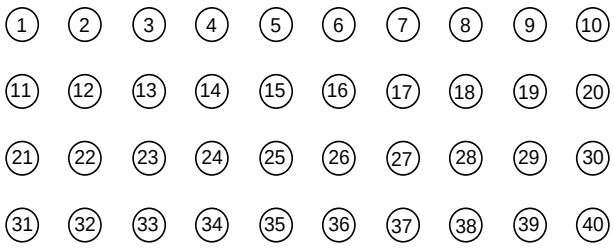


Figure 4-5
Display organization for relay card channels

To control the relay card from the mainframe, each relay must have a unique channel assignment, which includes the slot number that the card is installed in. The channel assignments for the relay card are provided in Figure 4-6. Each channel assignment is made up of the slot designator (1 or 2) and the relay card 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 relay card channel are separated by an exclamation point (!). Some examples of CHANNEL assignments are as follows:

CHANNEL 1!1 = Slot 1, Channel 1
CHANNEL 1!20 = Slot 1, Channel 20
CHANNEL 2!2 = Slot 2, Channel 2
CHANNEL 2!6 = Slot 2, Channel 6

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.

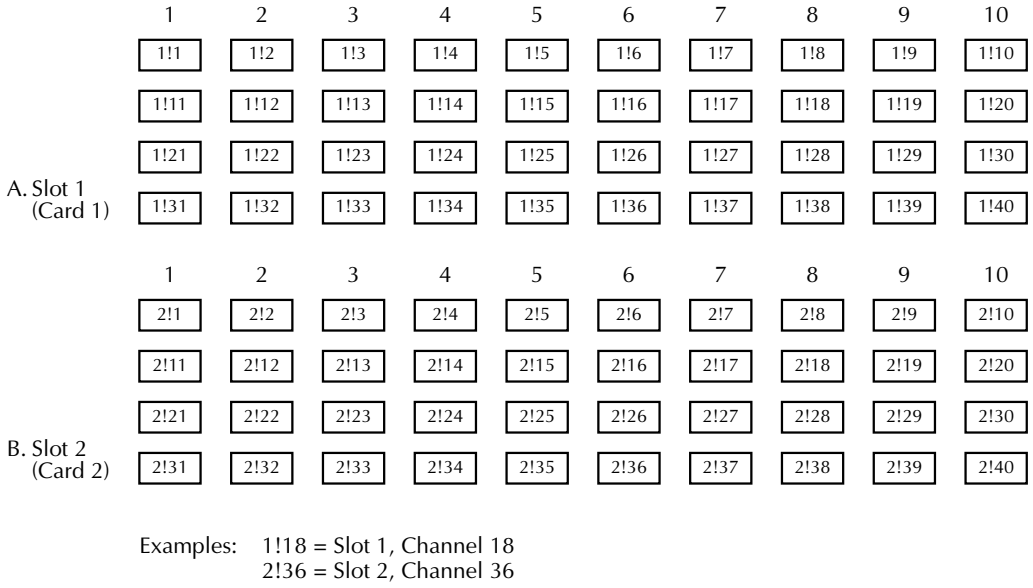


Figure 4-6
Channel assignments

Front panel control

NOTE

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

Closing and opening channels

A channel is closed from the front panel by simply keying in the channel assignment and then pressing CLOSE. For example, to close channel 16 of a relay card installed in slot 2, key in the following channel list and press CLOSE:

SELECT CHANNELS 2!16

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

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

SELECT CHANNELS 2!1, 2!3, 2!12-2!15

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 mainframe instruction manual for information on defining channel patterns.

Scanning channels

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

SCAN CHANNELS 2!1, 2!3, 2!11-2!15

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.

A manual scan can be performed 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.

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 close and open channels:

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

The following program statement closes 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 opens 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 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 previous 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.

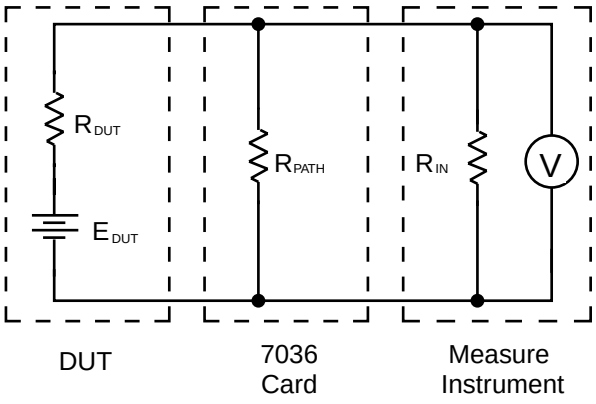
Measurement considerations

Many measurements made with the Model 7036 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 values 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 4-7. 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 4-8. 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 4-7
Path isolation resistance

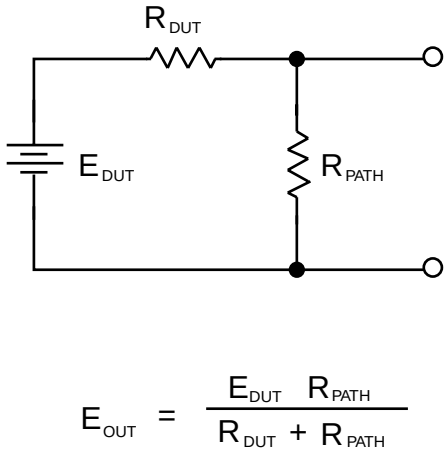


Figure 4-8
Voltage attenuation by path isolation resistance

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 switch card is generally fixed 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 conductor has sufficient length, even weak magnetic fields like those of the earth can create sufficient signals to affect 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 sufficient 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 7036 switch 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 4-9, the resulting ground loop causes current to flow 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 4-10 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.

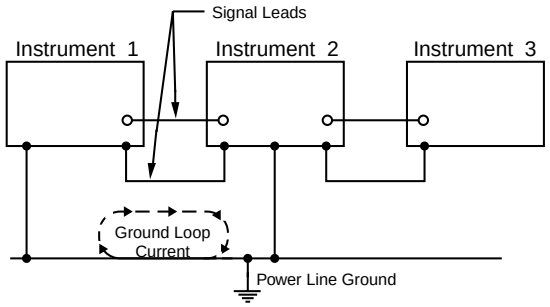


Figure 4-9
Power line ground loops

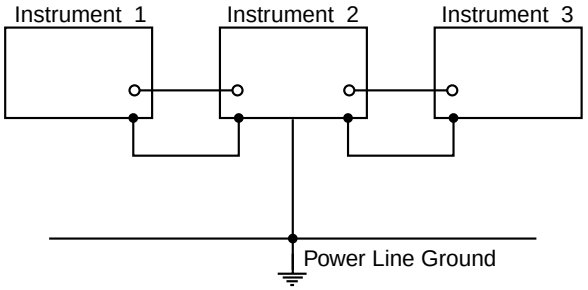


Figure 4-10
Eliminating ground loops

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 7036 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 7036 is important in test systems that switch AC signals. Refer to the specifications at the front of this manual.

5
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 7036 switch card and is arranged as follows:

- **Handling and cleaning precautions** — Discusses handling procedures and cleaning methods for the switch card.
- **Performance verification** — Covers the procedures necessary to determine if the card is operating 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 switch card.

Handling and cleaning precautions

Because of the high impedance circuits on the Model 7036, 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 switch 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 verification procedures for the Model 7036, including channel resistance, offset current, contact potential, and isolation.

CAUTION

Contamination will degrade the performance of the switch 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 5-1 summarizes the equipment necessary for performance verification, along with an application for each unit.

Switch 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 3.

Table 5-1
Verification equipment

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 switch card is to hard-wire a 96-pin female DIN connector and then mate it to the connector on the Model 7036. Shorting connections can also be done at the connector. The connector in the Model 7011-KIT-R connection kit (see Table 3-2) can be used for this purpose. Pin identification for the multi-pin connector for the relay card is provided by Figure 3-1 and Table 3-1.

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 5-1, perform the following steps to verify that each contact of every relay is closing properly and that the resistance is within specification.

1. Turn the Model 7001/7002 off 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 5-1.
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 <1Ω.
7. Repeat the basic procedure of steps 1 through 6 to test the rest of the channels of the Model 7036 relay switch card. Remember to close the channel that the Model 2000 is connected to.

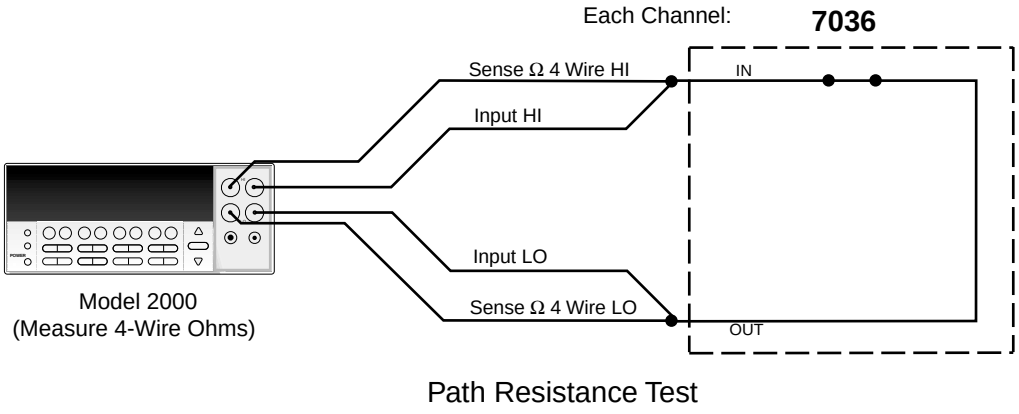


Figure 5-1
Channel resistance testing

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 5-2, 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 5-2. 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 switch 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.

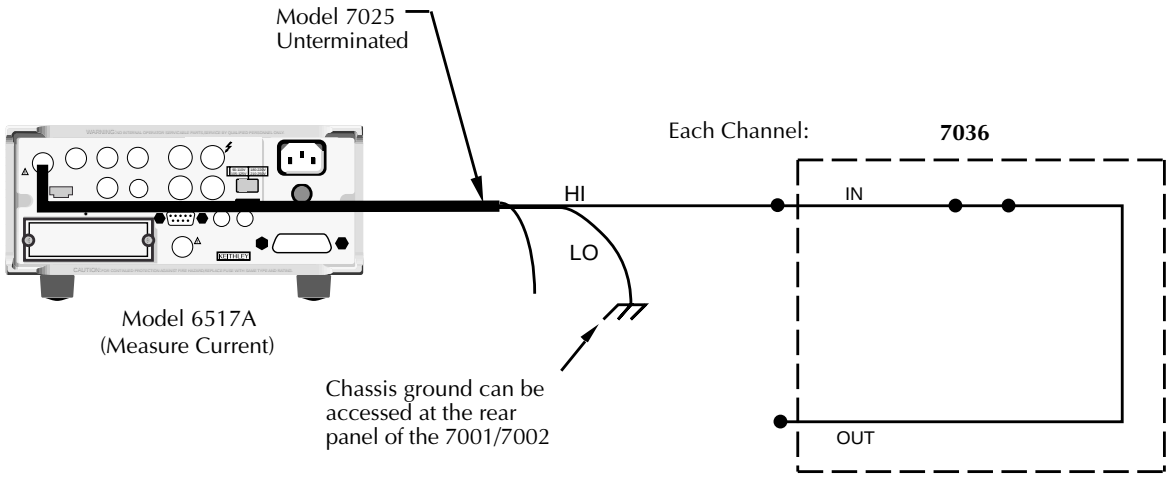


Figure 5-2
Offset current testing

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 5-3.
4. Install the switch 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 7036.

Channel to channel isolation tests

These tests check the leakage resistance (isolation) between adjacent channels. A channel is simply 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 (+42V) 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.

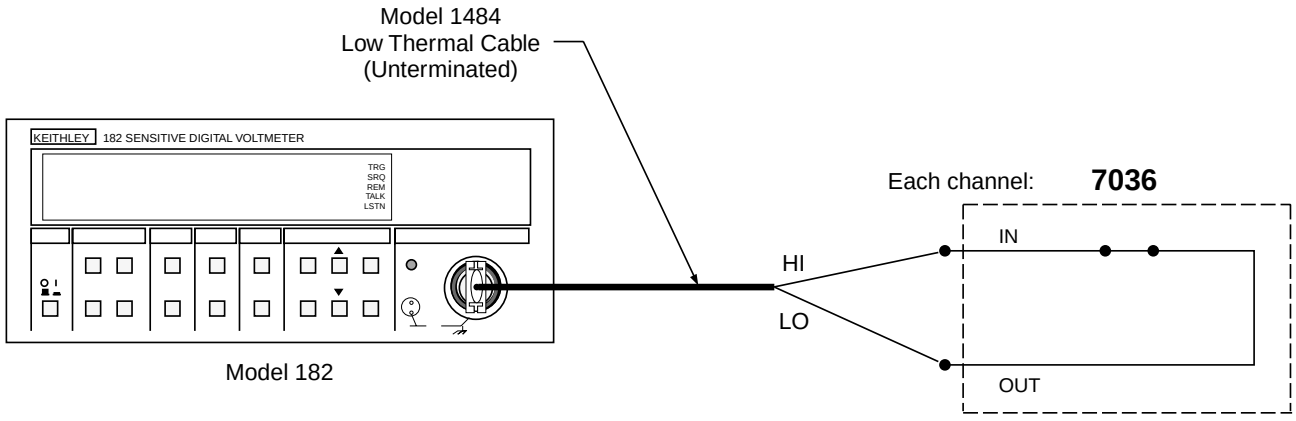


Figure 5-3
Contact potential testing

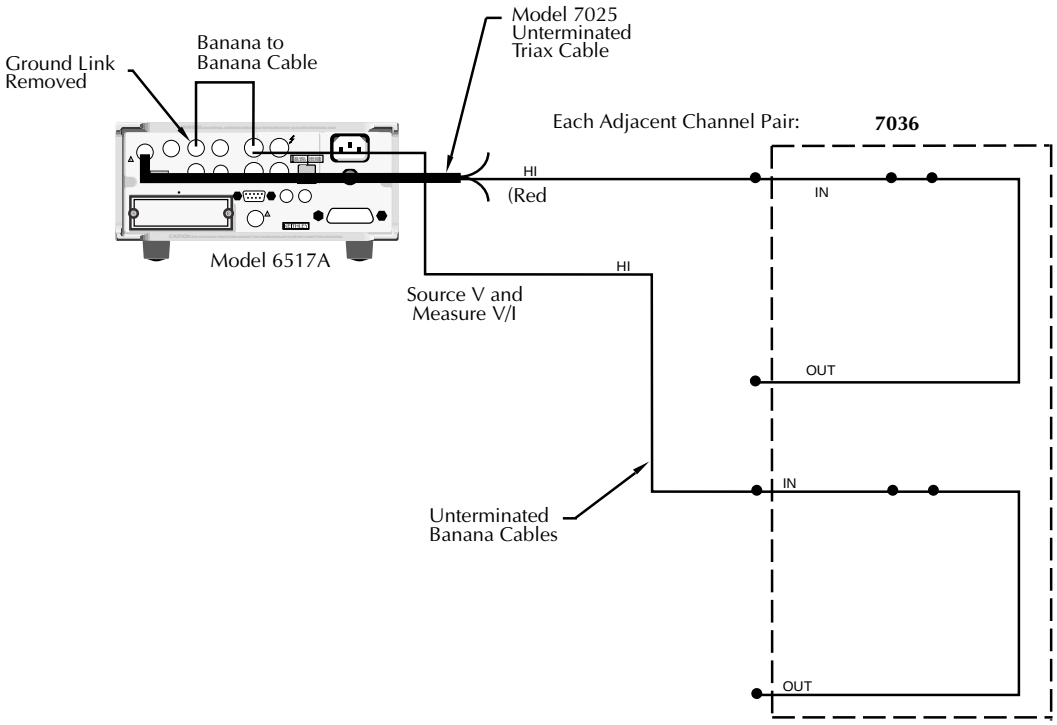


Figure 5-4
Channel to channel testing

Refer to Figure 5-4 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 5-4. Make sure the voltage source is off.
3. Install the Model 7036 in slot 1 (CARD 1) of the Model 7001/7002 if it is not already installed.
4. On the Model 6517A, select the ohms function and choose the 2GΩ range.
5. On the Model 6517A, set the voltage source for +42V. 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 5-2 as a guide, repeat the basic procedure of steps 11 through 16 for the rest of the path pairs (starting with test 3).

Table 5-2
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
30	Channel 30 to Channel 31	Channels 30 and 31	1!30 and 1!31
31	Channel 31 to Channel 32	Channels 31 and 32	1!31 and 1!32
32	Channel 32 to Channel 33	Channels 32 and 33	1!32 and 1!33
33	Channel 33 to Channel 34	Channels 33 and 34	1!33 and 1!34
34	Channel 34 to Channel 35	Channels 34 and 35	1!34 and 1!35
35	Channel 35 to Channel 36	Channels 35 and 36	1!35 and 1!36
36	Channel 36 to Channel 37	Channels 36 and 37	1!36 and 1!37
37	Channel 37 to Channel 38	Channels 37 and 38	1!37 and 1!38
38	Channel 38 to Channel 39	Channels 38 and 39	1!38 and 1!39
39	Channel 39 to Channel 40	Channels 39 and 40	1!39 and 1!40

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 (42V) 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 5-5 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 5-5. 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 7036 in slot 1 (CARD 1) of the Model 7001/7002 if it is not already installed.
4. On the Model 6517A, select the ohms function and choose the 2GΩ range.
5. On the Model 6517A, set the voltage source for +42V. 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 7036 channels. Remember to close the relay of the channel being checked.
12. Turn off the Model 6517A voltage source and the Model 7001/7002.

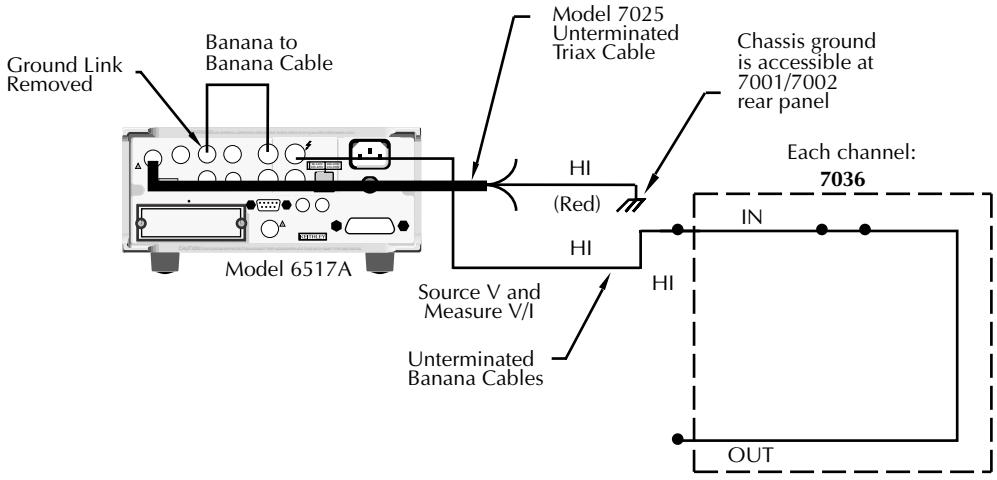


Figure 5-5
Common-mode isolation testing

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 specifically to static-sensitive devices. However, since many devices in the Model 7036 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.
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 paragraphs below discuss the basic operating principles for the Model 7036 and can be used as an aid in troubleshooting the switch card. The schematic drawings of the switch card are shown on drawing numbers 7036-106 and 7036-176 located at the end of Section 6.

Block diagram

Figure 5-6 shows a simplified block diagram of the Model 7036. Key elements include the relay drivers and relays, as well as the ROM, which contains card ID and configuration information. These various elements are discussed in the following paragraphs.

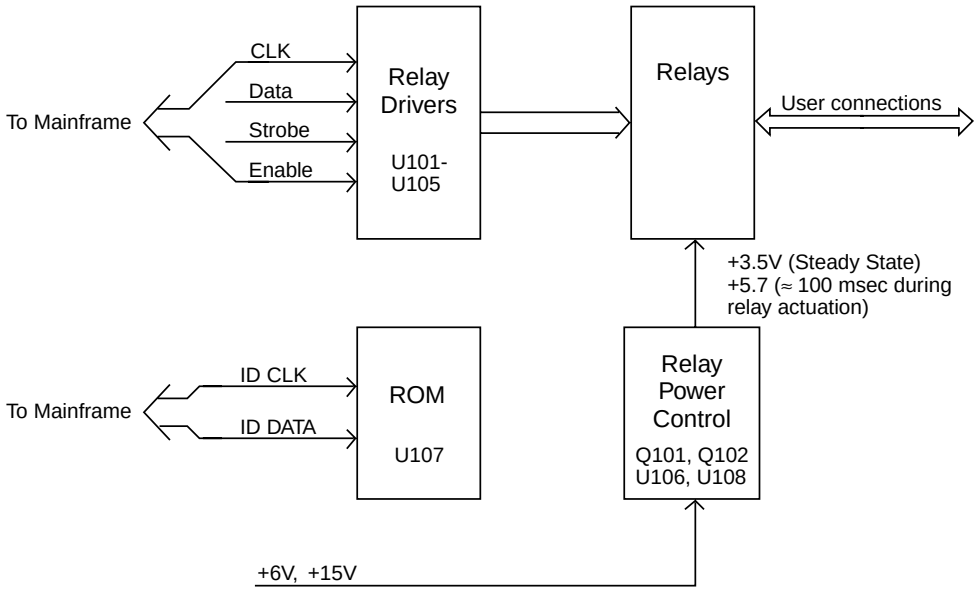


Figure 5-6
Model 7036 block diagram

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 configuration information.

ID data is contained within an on-card EEPROM (U107). In order to read this information, the sequence described below is performed on power-up.

1. The IDDATA line (pin 5 of U107) is set from high to low while the IDCLK line (pin 6 of U107) is held high. This action initiates a start command to the ROM to transmit data serially to the mainframe (Figure 5-7).

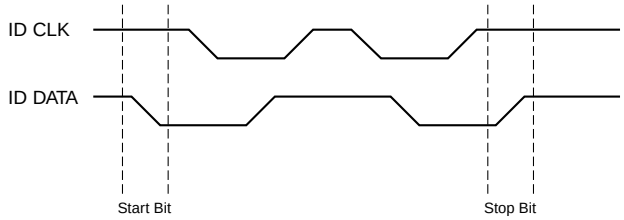


Figure 5-7
Start and stop sequences

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 5-8).
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 5-7).

Relay control

Card relays are controlled by serial data transmitted via the relay DATA line. A total of five 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 CLK line. As data overflows one register, it is fed out the Q's line of the register down the chain.

Once all five 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 Q101, Q102, U106, U108, 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 U106 changes the parameters of the relay supply voltage regulator, Q101, 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.

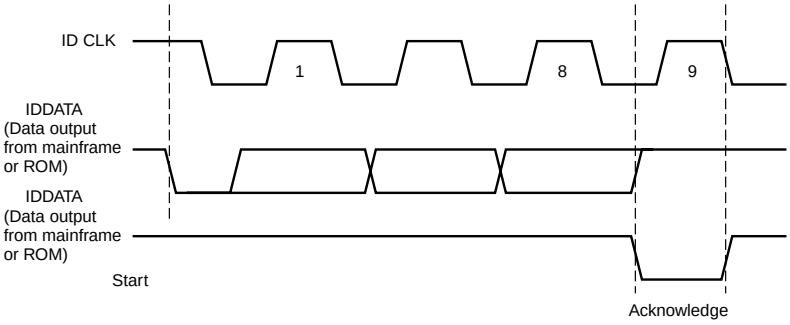


Figure 5-8
Transmit and acknowledge sequence

Power-on safeguard

NOTE

The power-on safeguard circuit discussed below is actually located on the digital board in the Model 7001/7002 mainframe.

A power-on safeguard circuit, made up of U114 (a D-type flip-flop) and associated components, ensures that relays do not randomly energize on power-up and power-down. This circuit disables all relays (all relays are open) during power-up and power-down periods.

The PRESET line on the D-type flip-flop is controlled by the 68302 microprocessor, while the CLK line of the D-type flip-flop is controlled by a port line on the 68302 processor. The Q output of the flip-flop drives each switch card relay driver IC enable pin (U101-U105, pin 8).

When the 68302 microprocessor is in the reset mode, the flip-flop PRESET line is held low, and Q out immediately goes high, disabling all relays (relay driver IC enable pins are high, disabling the relays.) 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 simultaneously. Note that Q out stays low, (enabling relay drivers) until the 68302 processor goes into a reset condition.

Troubleshooting

Troubleshooting equipment

Table 5-3 summarizes recommended equipment for troubleshooting the Model 7036.

Table 5-3
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 5-4 summarizes switch card 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 switch 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.

Table 5-4
Troubleshooting procedure

Step	Item/component	Required condition	Comments
1	GND test point (C114)		All voltages referenced to digital ground (GND pad).
2	+6V pad (Q101, pin 2)	+6VDC	Relay voltage.
3	+5V pad (C103)	+5VDC	Logic voltage.
4	+15V pad (R101)	+15VDC	Relay bias voltage.
5	+V pad (C114)	+3.5VDC*	Regulated relay voltage.
6	U107, pin 6	ID CLK pulses	During power-up only.
7	U107, pin 5	ID DATA pulses	During power-up only.
8	U101, pin 7	STROBE pulse	End of relay update sequence.
9	U101, pin 2	CLK pulses	During relay update sequence only.
10	U101, pin 3	DATA pulses	During relay update sequence only.
11	U101-U105, 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 configuration is changed.

6
Replaceable Parts

Introduction

This section contains replacement parts information, schematic diagrams, and component layout drawings for the Model 7036.

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 7036
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 integrated with the parts lists:

Table 6-1 — Parts List, Relay Card for Model 7036.
7036-100 — Component Layout, Relay Card for Model 7036.
7036-106 — Schematic, Relay Card for Model 7036.
Table 6-2 — Parts List, Mass-Terminated Connector Card for Model 7036.
7035-170 — Component Layout, Mass-Terminated Connector Card for Model 7036.
7036-176 — Schematic, Mass-Terminated Connector Card for Model 7036.
Table 6-3 — Parts List, Model 7011-KIT-R 96-pin Female DIN Connector Kit.

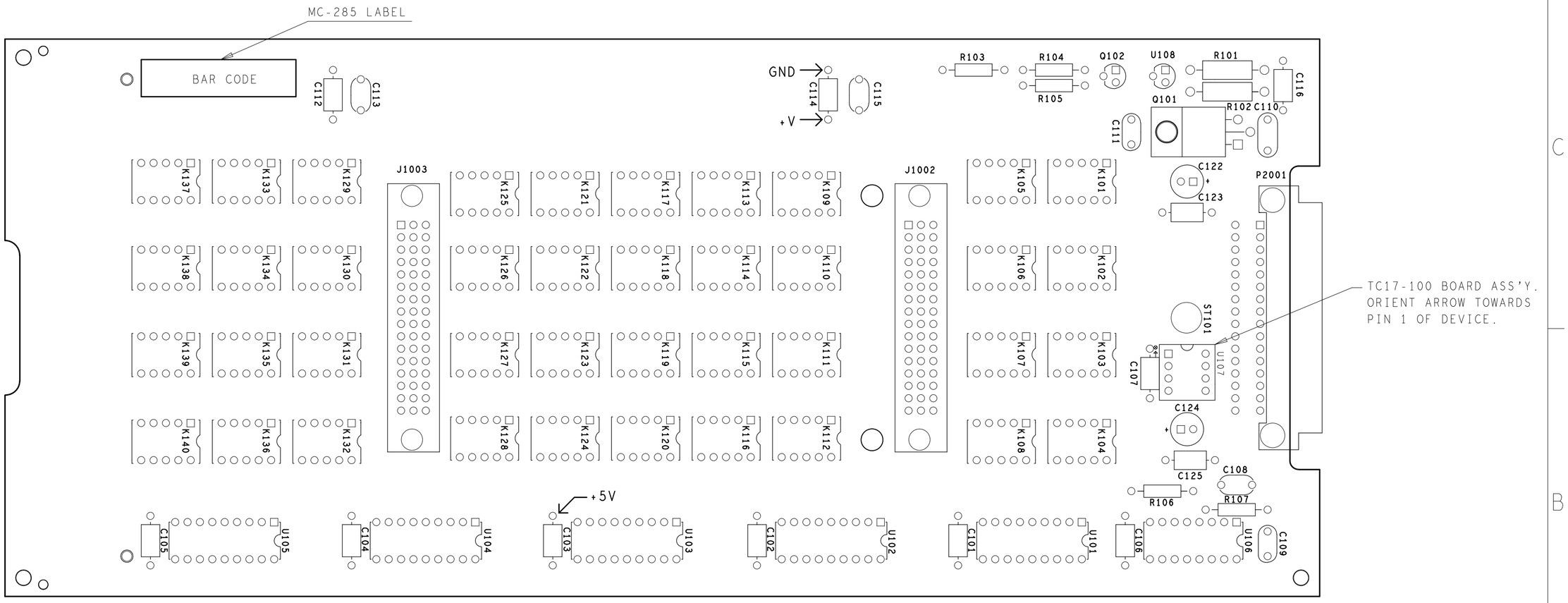
Table 6-1
Relay card for Model 7036, parts list

Circuit designation	Description	Keithley part no.
	2-56X3/16 PHILLIPS PAN HEAD SCREW (RELAY BOARD TO SHIELD)	2-56X3/16PPH
	2-56X5/8 PHILLIPS PAN HEAD FASTENER	FA-245-1
	2-56X5/8 PHILLIPS PAN HEAD SCREW	2-56X5/8PPH
	2-56X5/16 PHILLIPS PAN HEAD SEMS SCREW (CONNECTOR TO SHIELD)	2-56X5/16PPHSEM
	4-40X3/16 PHILLIPS PAN HEAD SEMS SCREW	4-40X3/16PPHSEM
	4-40 PEM NUT	FA-131
	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
C101-107, 112, 114,116,123,125	CAP, 1µF, 20% 50V, CERAMIC	C-365-.1
C108,113,115	CAP, 150pF, 10%, 1000V, CERAMIC	C-64-150P
C109,111	CAP, 1µF, 20% 50V, CERAMIC	C-237-1
C110	CAP, 0.001µF, 20%, 500V, CERAMIC	C-22-.001
C122,124	CAP, 10µF, -20+100% 25V, ALUM ELEC	C-314-10
J1002,1003	CONN, 48-PIN, 3-ROW	CS-736-2
K101-140	RELAY, ULTRA-SMALL POLARIZED, TF2E-5V	RL-149
P2001	CONN, 32-PIN, 2-ROW	CS-775-1
Q101	TRANS, NPN PWR, TIP31 (T0-220AB)	TG-253
Q102	TRANS, N CHAN MOSPOW FET, 2N7000 (T0-92)	TG-195
R101,102	RES, 560, 10%, 1/2W, COMPOSITION	R-1-560
R103	RES, 1K, 1%, 1/8W, METAL FILM	R-88-1K
R104	RES, 2.49K, 1%, 1/8W, METAL FILM	R-88-2.49K
R105	RES, 1.15K, 1%, 1/8W, METAL FILM	R-88-1.15K
R106	RES, 10K, 5%, 1/4W, COMPOSITION OR FILM	R-76-10K
R107	RES, 220K, 5%, 1/4W, COMPOSITION OR FILM	R-76-220K
S107	SOCKET	S0-72
ST101	4-40X0.812 STANDOFF	ST-137-20
U101-105	IC, 8-BIT SERIAL-IN LATCH DRIVER, 5841A	IC-536
U106	IC, RETRIG MONO MULTIVIB, 74HC123	IC-492
U107	PROGRAM	7036-800A01
U108	IC, AJD SHUNT REGULATOR, TL431CLP	IC-677

NO. 7036-100

LTR.	ECA NO.	REVISION	ENG.	DATE
B	19790	RELEASED	SZ	3/25/97
C	20065	REFER TO ECA	ELS	4/9/99
C1	25917	CHG'D U107 FROM IC-737 TO TC17-100. DELETED S107 (SO-72).	KK	6/21/01

TOP COMPONENT LAYOUT

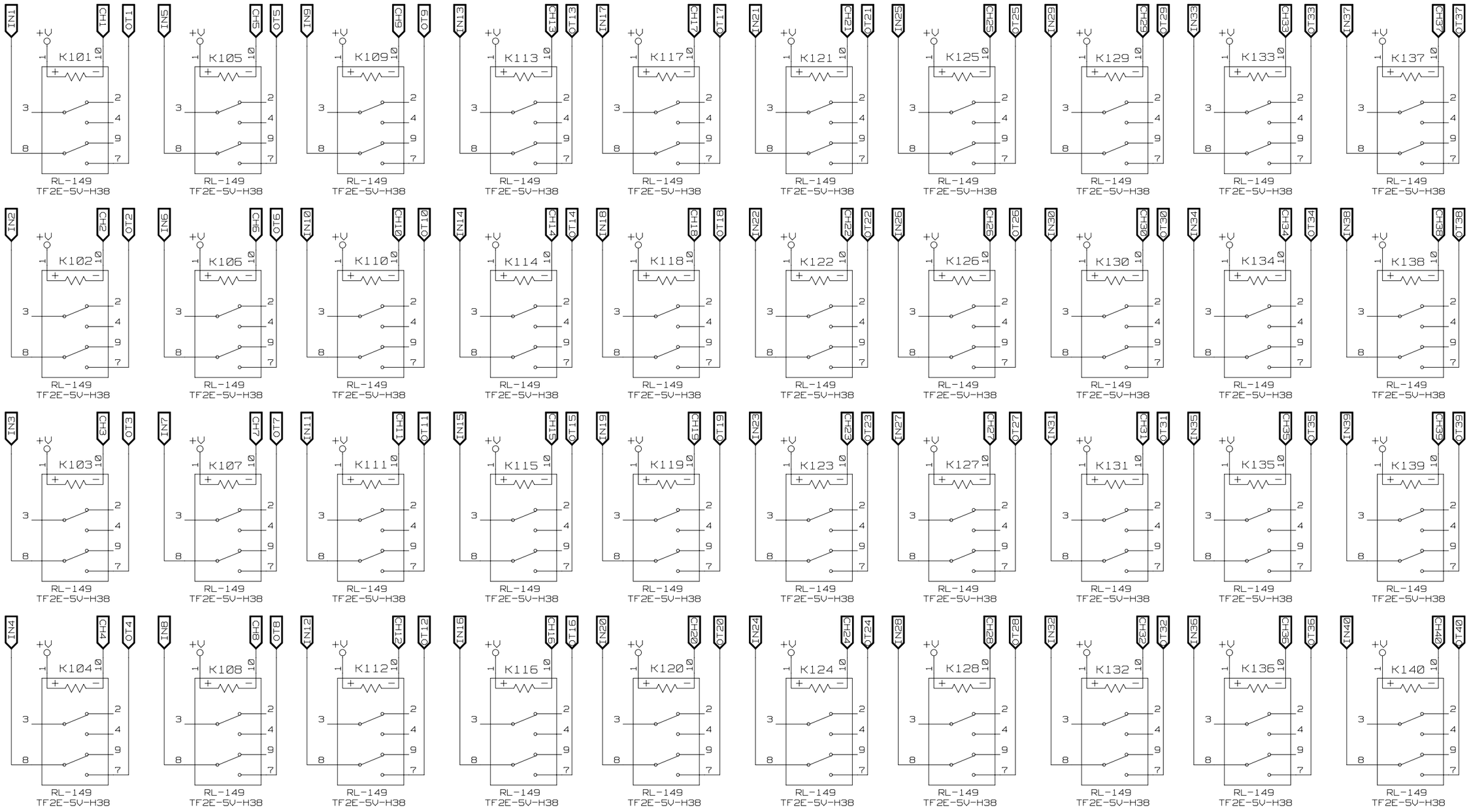


FOR COMPONENT LAYOUT SEE PRODUCT STRUCTURE

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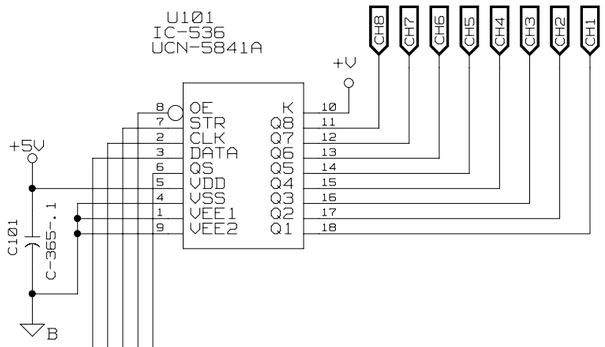
KEITHLEY
KEITHLEY INSTRUMENTS INC.
CLEVELAND, OHIO 44139

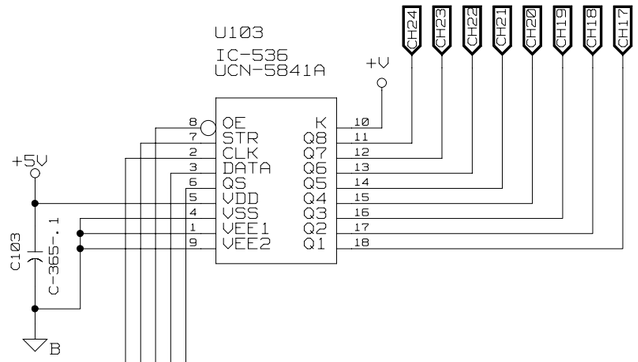
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DIM. TOL. UNLESS OTHERWISE SPECIFIED	DRN MRS	APPR. PS	
XX=±.01 ANG.=±1 XXX=±.005 FRAC.=±1/64	DO NOT SCALE THIS DRAWING	C	NO. 7036-100

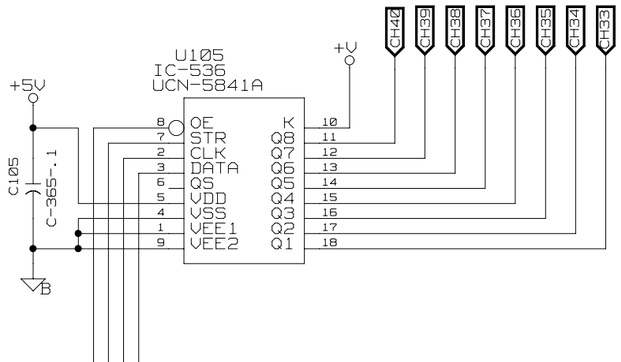


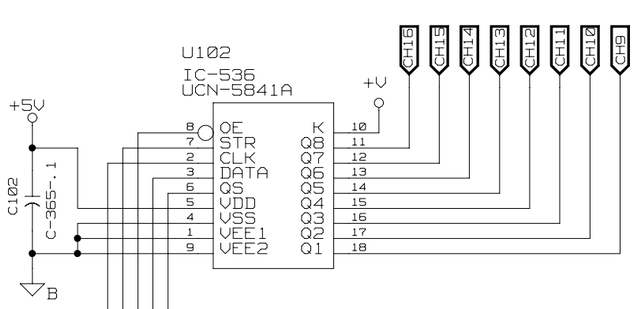
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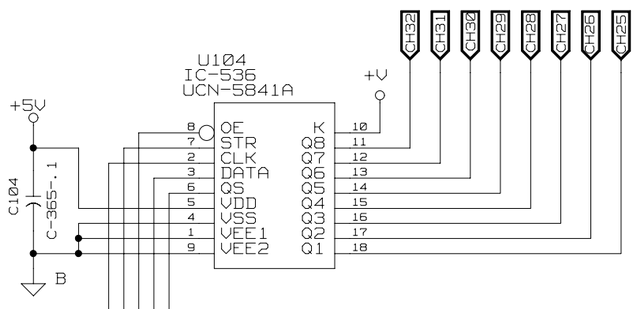
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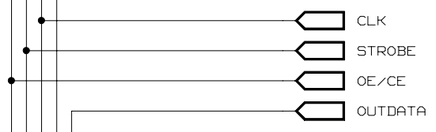






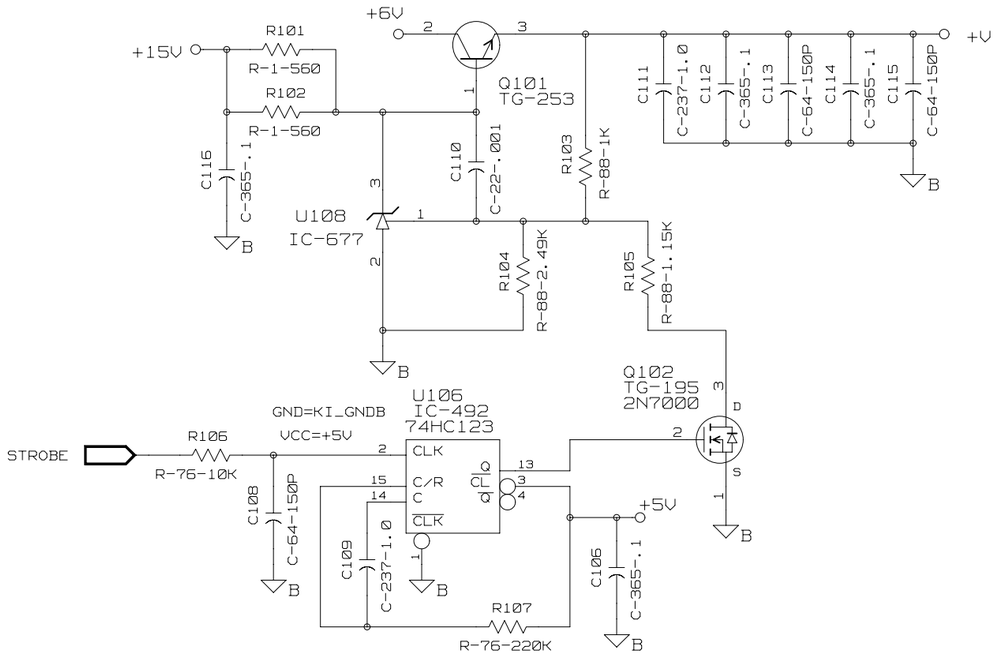


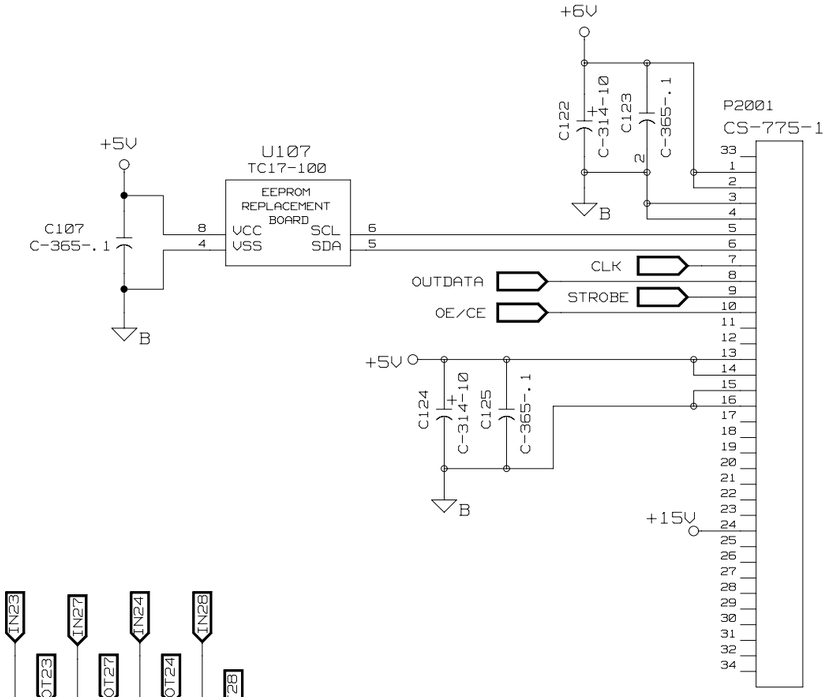


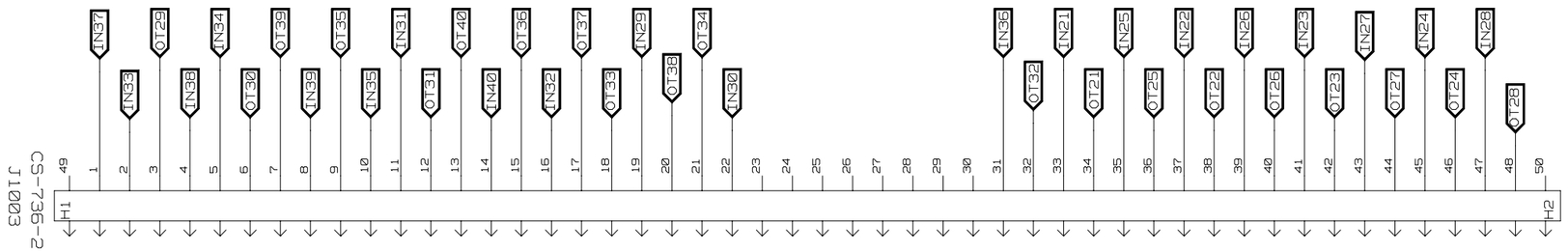


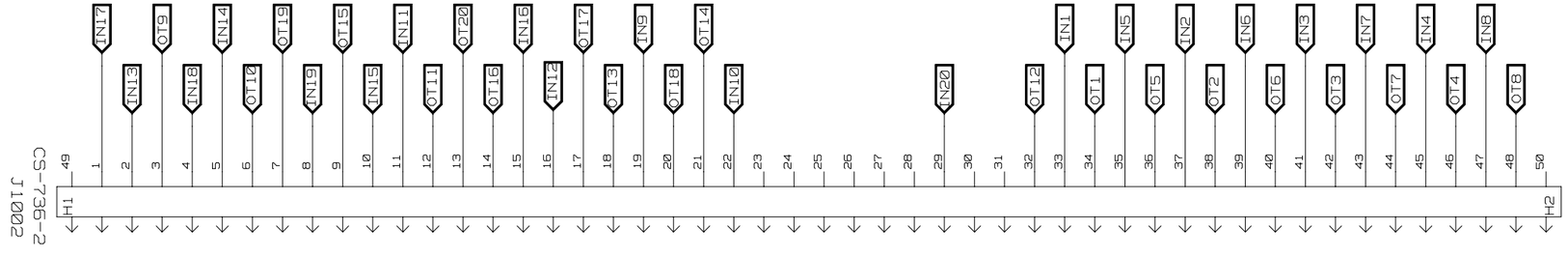
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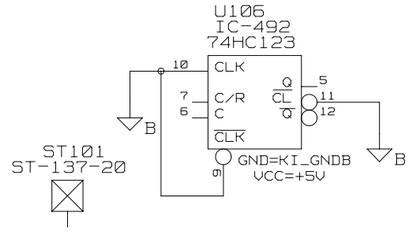
KEITHLEY	KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139		
DRAWING	RELAY BOARD SCHEMATIC		
MODEL 7036	B	7036-106	
DRAWN ELS	APP LK	ECA 25917	REV C1
LAST_MODIFIED=Thu Jun 21 15:57:33 2001			











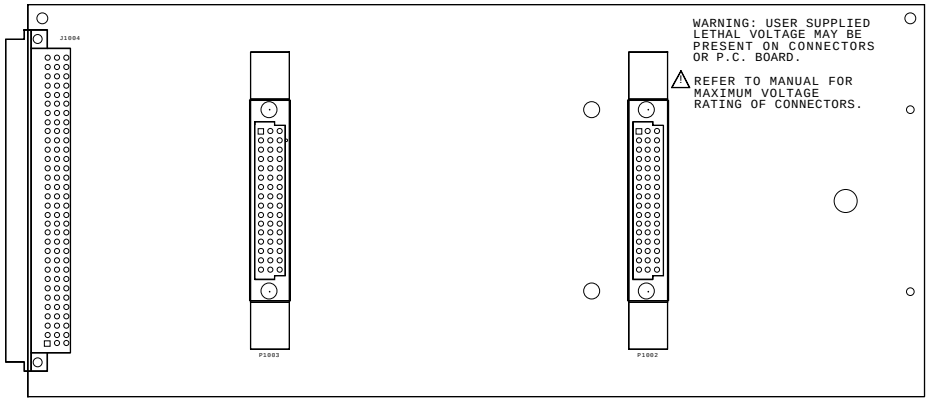
7036_106.SCH.1.3

KEITHLEY	KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139		
DRAWING	RELAY BOARD SCHEMATIC		
MODEL 7036	B	7036-106	
DRAWN ELS	APP LK	ECA 25917	REV C1
LAST_MODIFIED=Thu Jun 21 15:57:38 2001			

Table 6-2
Mass-terminated connector card for Model 7036, 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 (FOR SHIELD AND SHIMS)	2-56X7/16PPH
	4-40X1/4 PHILLIPS PAN HEAD SEMS SCREW (RELAY BOARD TO CONNECTOR BOARD)	4-40X1/4PPHSEM
	BRACKET	7011-307
	CONNECTOR SHIM	7011-309A
	SHIELD	7011-311A
	STANDOFF	ST-203-1
J1004	CONN, 96-PIN, 3-ROW	CS-514
P1002,1003	CONN, 48-PIN, 3-ROW	CS-748-3

LTR.	ECA NO.	REVISION	ENG.	DATE
A				



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

MODEL	NEXT ASSEMBLY	QTY.
USED ON		

KEITHLEY

KEITHLEY INSTRUMENTS INC.
CLEVELAND, OHIO 44139

DIM ARE IN IN. UNLESS OTHERWISE NOTED	DATE 2/18/97	SCALE 1:1	TITLE COMPONENT LAYOUT CONNECTOR BOARD
DIM. TOL. UNLESS OTHERWISE SPECIFIED	DRN CAB	APPR.	
XX=+.01 ANG.=+1 XXX=+.005 FRAC.=+1/64	DO NOT SCALE THIS DRAWING	C	NO. 7035-170

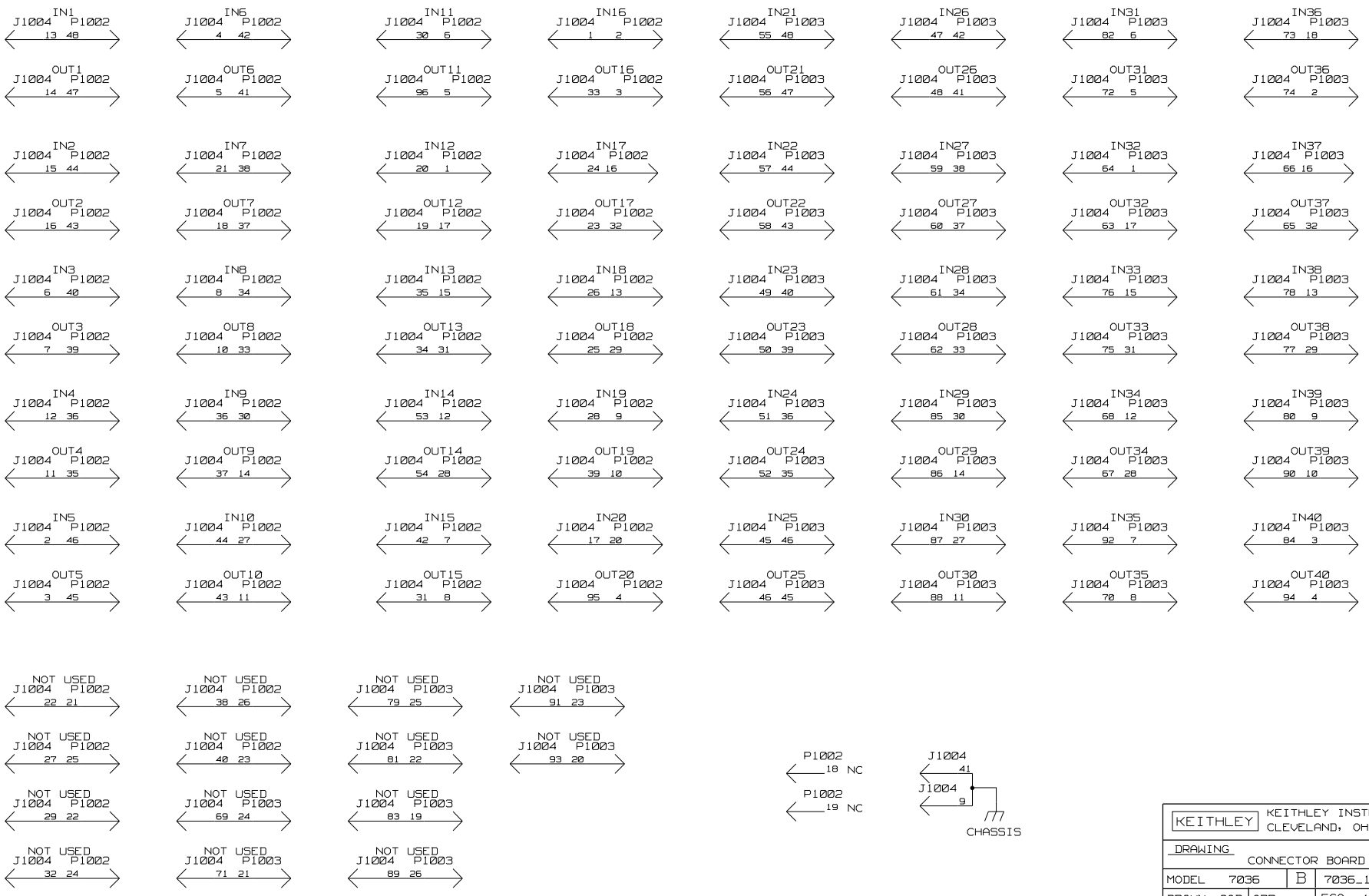

IN1 J1004 P1002 13 48
IN6 J1004 P1002 4 42
IN11 J1004 P1002 30 6
IN16 J1004 P1002 1 2
IN21 J1004 P1003 55 48
IN26 J1004 P1003 47 42
IN31 J1004 P1003 82 6
IN36 J1004 P1003 73 18
OUT1 J1004 P1002 14 47
OUT6 J1004 P1002 5 41
OUT11 J1004 P1002 96 5
OUT16 J1004 P1002 33 3
OUT21 J1004 P1003 56 47
OUT26 J1004 P1003 48 41
OUT31 J1004 P1003 72 5
OUT36 J1004 P1003 74 2
IN2 J1004 P1002 15 44
IN7 J1004 P1002 21 38
IN12 J1004 P1002 20 1
IN17 J1004 P1002 24 16
IN22 J1004 P1003 57 44
IN27 J1004 P1003 59 38
IN32 J1004 P1003 64 1
IN37 J1004 P1003 66 16
OUT2 J1004 P1002 16 43
OUT7 J1004 P1002 18 37
OUT12 J1004 P1002 19 17
OUT17 J1004 P1002 23 32
OUT22 J1004 P1003 58 43
OUT27 J1004 P1003 60 37
OUT32 J1004 P1003 63 17
OUT37 J1004 P1003 65 32
IN3 J1004 P1002 6 40
IN8 J1004 P1002 8 34
IN13 J1004 P1002 35 15
IN18 J1004 P1002 26 13
IN23 J1004 P1003 49 40
IN28 J1004 P1003 61 34
IN33 J1004 P1003 76 15
IN38 J1004 P1003 78 13
OUT3 J1004 P1002 7 39
OUT8 J1004 P1002 10 33
OUT13 J1004 P1002 34 31
OUT18 J1004 P1002 25 29
OUT23 J1004 P1003 50 39
OUT28 J1004 P1003 62 33
OUT33 J1004 P1003 75 31
OUT38 J1004 P1003 77 29
IN4 J1004 P1002 12 36
IN9 J1004 P1002 36 30
IN14 J1004 P1002 53 12
IN19 J1004 P1002 28 9
IN24 J1004 P1003 51 36
IN29 J1004 P1003 85 30
IN34 J1004 P1003 68 12
IN39 J1004 P1003 80 9
OUT4 J1004 P1002 11 35
OUT9 J1004 P1002 37 14
OUT14 J1004 P1002 54 28
OUT19 J1004 P1002 39 10
OUT24 J1004 P1003 52 35
OUT29 J1004 P1003 86 14
OUT34 J1004 P1003 67 28
OUT39 J1004 P1003 90 10
IN5 J1004 P1002 2 46
IN10 J1004 P1002 44 27
IN15 J1004 P1002 42 7
IN20 J1004 P1002 17 20
IN25 J1004 P1003 45 46
IN30 J1004 P1003 87 27
IN35 J1004 P1003 92 7
IN40 J1004 P1003 84 3
OUT5 J1004 P1002 3 45
OUT10 J1004 P1002 43 11
OUT15 J1004 P1002 31 8
OUT20 J1004 P1002 95 4
OUT25 J1004 P1003 46 45
OUT30 J1004 P1003 88 11
OUT35 J1004 P1003 70 8
OUT40 J1004 P1003 94 4
NOT USED J1004 P1002 22 21
NOT USED J1004 P1002 38 26
NOT USED J1004 P1003 79 25
NOT USED J1004 P1003 91 23
NOT USED J1004 P1002 27 25
NOT USED J1004 P1002 40 23
NOT USED J1004 P1003 81 22
NOT USED J1004 P1003 93 20
NOT USED J1004 P1002 29 22
NOT USED J1004 P1003 69 24
NOT USED J1004 P1003 83 19
NOT USED J1004 P1002 32 24
NOT USED J1004 P1003 71 21
NOT USED J1004 P1003 89 26
P1002 18 NC
P1002 19 NC
J1004 41
J1004 9
CHASSIS
KEITHLEY
KEITHLEY INSTRUMENTS INC.
CLEVELAND, OHIO 44139
DRAWING
CONNECTOR BOARD
MODEL 7036
B
7036_176.LOGIC.1.1
DRAWN CAB
APP
ECA 19858
REV A
LAST_MODIFIED=Wed Apr 9 14:28:16 1997
PG. 1 OF 1

Table 6-3
Model 7011-KIT-R 96-pin Female DIN connector kit

Circuit designation	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

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KEITHLEY

Service Form

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

Name and Telephone No. _____

Company _____

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

_____

_____

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

Display or output (check one)

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

❑ Calibration only
❑ Data required
❑ Certificate of calibration required

(attach any additional sheets as necessary)

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

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

_____

_____

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

Relative humidity? _____ Other? _____

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

_____

_____

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

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28775 Aurora Road
Cleveland, Ohio 44139

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