

**KEITHLEY**

# Model 7020 Digital I/O Interface Card

## Instruction Manual

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**Keithley Instruments, Inc.** • 28775 Aurora Road • Cleveland, OH 44139 • 440-248-0400 • Fax: 440-248-6168 • <http://www.keithley.com>

<b>BELGIUM:</b>	<b>Keithley Instruments B.V.</b>	Bergensesteenweg 709 • B-1600 Sint-Pieters-Leeuw • 02/363 00 40 • Fax: 02/363 00 64
<b>CHINA:</b>	<b>Keithley Instruments China</b>	Yuan Chen Xin Building, Room 705 • 12 Yumin Road, Dewai, Madian • Beijing 100029 • 8610-62022886 • Fax: 8610-62022892
<b>FRANCE:</b>	<b>Keithley Instruments Sarl</b>	3, allée des Garays • 91127 Palaiseau Cedex • 01-64 53 20 20 • Fax: 01-60 11 77 26
<b>GERMANY:</b>	<b>Keithley Instruments GmbH</b>	Landsberger Strasse 65 • 82110 Germering • 089/84 93 07-40 • Fax: 089/84 93 07-34
<b>GREAT BRITAIN:</b>	<b>Keithley Instruments Ltd</b>	Unit 2 Commerce Park, Brunel Road • Theale • Reading • Berkshire RG7 4AB • 0118 929 7500 • Fax: 0118 929 7519
<b>INDIA:</b>	<b>Keithley Instruments GmbH</b>	Flat 2B, WILOCRISSA • 14, Rest House Crescent • Bangalore 560 001 • 91-80-509-1320/21 • Fax: 91-80-509-1322
<b>ITALY:</b>	<b>Keithley Instruments s.r.l.</b>	Viale S. Gimignano, 38 • 20146 Milano • 02-48 39 16 01 • Fax: 02-48 30 22 74
<b>NETHERLANDS:</b>	<b>Keithley Instruments B.V.</b>	Postbus 559 • 4200 AN Gorinchem • 0183-635333 • Fax: 0183-630821
<b>SWITZERLAND:</b>	<b>Keithley Instruments SA</b>	Kriesbachstrasse 4 • 8600 Dübendorf • 01-821 94 44 • Fax: 01-820 30 81
<b>TAIWAN:</b>	<b>Keithley Instruments Taiwan</b>	1 Fl. 85 Po Ai Street • Hsinchu, Taiwan, R.O.C. • 886-3572-9077 • Fax: 886-3572-903

# Model 7020 Digital I/O Interface 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.

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# Safety Precautions

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

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

The types of product users are:

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

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

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

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

Keithley products are designed for use with electrical signals that are rated Installation Category I and Installation Category II, as described in the International Electrotechnical Commission (IEC) Standard IEC 60664. Most measurement, control, and data I/O signals are Installation Category I and must not be directly connected to mains voltage or to voltage sources with high transient over-voltages. Installation Category II connections require protection for high transient over-voltages often associated with local AC mains connections. The user should assume all measurement, control, and data I/O connections are for connection to Category I sources unless otherwise marked or described in the Manual.

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.**

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.

When installing equipment where access to the main power cord is restricted, such as rack mounting, a separate main input power disconnect device must be provided, in close proximity to the equipment and within easy reach of the operator.

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

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


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


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


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

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

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

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

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

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

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

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

Instrumentation and accessories shall not be connected to humans.

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

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

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

# 7020 and 7020-D Digital I/O Interface Cards

**DIGITAL I/O CAPABILITY:** Forty independent inputs.  
Forty independent outputs.

**OUTPUT SPECIFICATIONS:**

**Configuration:** 40 open collector drivers with factory installed 10kΩ pull up resistors. Pull-up resistors can be removed when driving external pull-up devices. Each driver has an internal fly-back diode.

**Pull up Voltage:** 5.3V Internally supplied, external connection provided for user supplied voltage 25V max. Removal of internal jumper allows user to use two different pull-up voltages.

**Maximum Sink Current:** Per Channel: 65mA.  
Per Bank (8 bits): 500mA.  
Per Card: 1A.

**Current Limit:** Positive Temperature Coefficient circuit protector in series with each output. Output protection resistance <18Ω.

**Collector-Emitter Saturation Voltage:** <0.75V @ 1mA.  
<1V @ 65mA.

**Logic:** Negative True.

**INPUT SPECIFICATIONS:**

**Configuration:** 40 inputs with internal 10kΩ pull-up resistors provided.

**Characteristics:**

Input logic low voltage: 0.8V max.  
Input logic high voltage: 2V min.  
Input logic low current: -600μA max. @ 0V  
Input logic high current: 50μA max. @ 5V

**Maximum Voltage Level:** 42V pk.

**Logic:** Positive True.

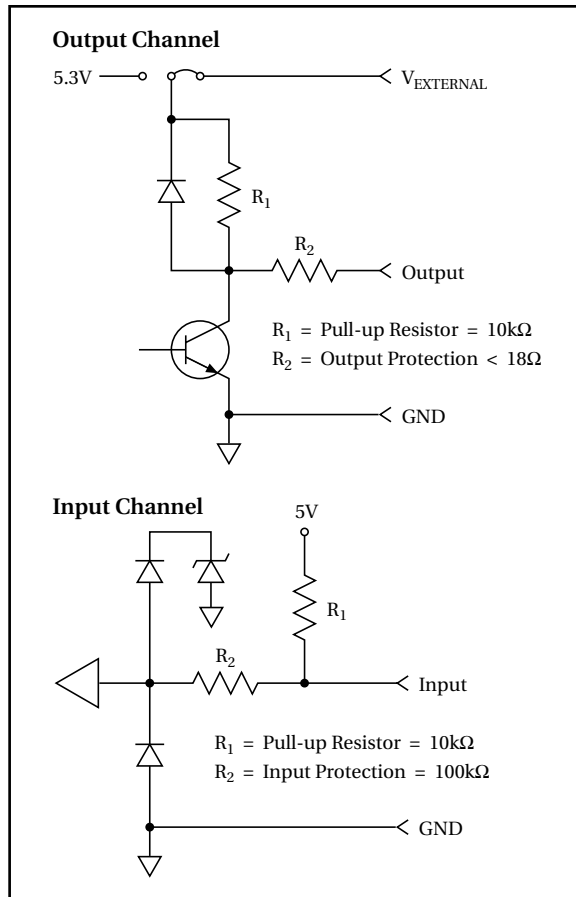
**7020/7020-D General Specifications**

**CONNECTOR:**

**7020:** 96-pin male DIN connector.

**7020-D:** Cables with 50-pin male and female D-sub connectors.

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



Specifications are subject to change without notice.





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# Digital I/O Configuration

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## 1.1 Introduction

This section covers the basic digital input and output configurations for the Model 7020. Connection information for these configurations is provided in Section 2 of this manual, while operation (front panel and IEEE-488 bus) is explained in Section 3.

## 1.2 Digital outputs

Output channels use negative true logic. That is, the output is pulled low when the channel is turned on (closed). Conversely, the output goes high when the channel is turned off (open).

## 1.3 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 1-1. Figure 1-1A uses the internal voltage source (5.3V), while Figure 1-1B allows you to use an external voltage source (V) for devices that require a higher voltage (25V maximum). Internal jumpers are used to select the voltage source. At the factory, the internal 5.3V source is selected.

As shown in Figure 1-1, each output channel has a resettable fuse (F) that is used to protect the output driver from excessive current. During normal operation, the resettable fuse is in a low resistance state like a regular fuse. When output current reaches the trip level (around 180mA at 23°C, 130mA at 50°C), the fuse goes to a high resistance state that interrupts the damaging high current. The fuse will automatically reset to the low resistance state when the fault condition is removed.

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.

## 1.4 Controlling devices using pull-up resistors

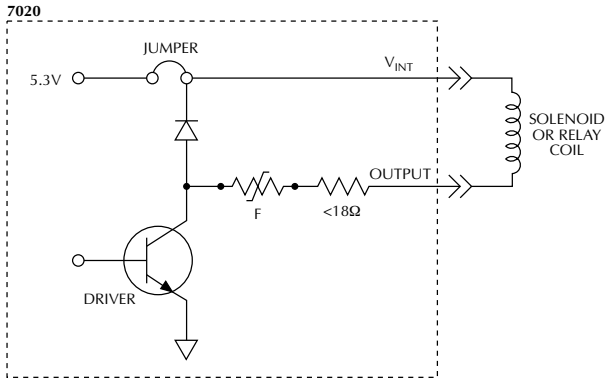
When interfacing outputs to high-impedance devices (i.e. logic devices), pull-up resistors are used to achieve the appropriate logic level. Figure 1-2 shows the output configuration using the 10k $\Omega$  pull-up resistor ( $R_P$ ).

The configuration in Figure 1-2 uses the internal 5.3V source as the high logic level. Notice that the 5.3V source is also used to power the device. If you need a higher logic level, you can place the jumper in the alternate position and apply an external voltage (via  $V_{EXT1}$  or  $V_{EXT2}$ ).

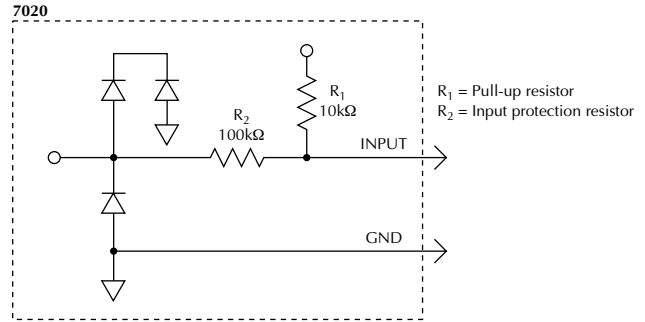
## 1.5 Digital inputs

Input channels use positive true logic. A channel is on (closed) when the input is high (up to 42V peak). Conversely, a channel is off (open) when the input is pulled low. As shown in Figure 1-3, each channel uses a 10k $\Omega$  pull-up resistor ( $R_I$ ) that is connected to 5V. Thus, with nothing connected to the channel, the input is pulled high to 5V which turns the channel on (closed).

The digital input is compatible with external TTL logic. Each built-in pull-up resistor provides level shifting so that 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.

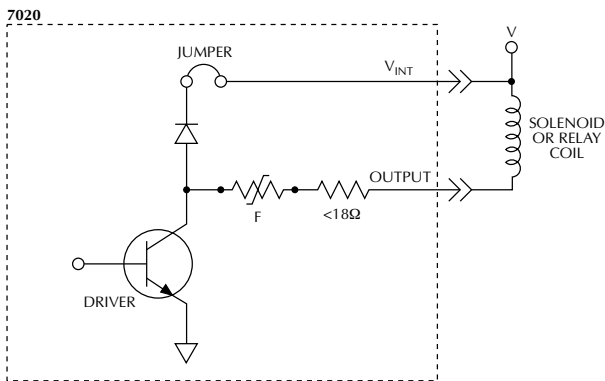


A. Using Internal Voltage Source (5.3V)



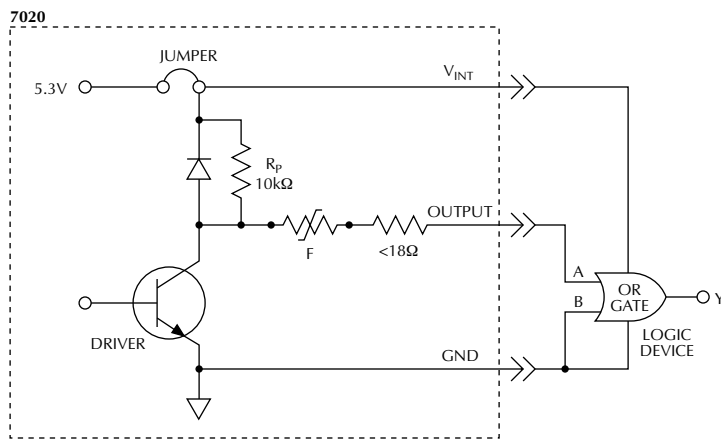
**Figure 1-3**  
Input configuration

$R_1$  = Pull-up resistor  
 $R_2$  = Input protection resistor



B. Using External Voltage Source (25V maximum)

**Figure 1-1**  
Output configurations for pull-up devices



Note: Pull-up resistor ( $R_p$ ) installed

**Figure 1-2**  
Output configuration using pull-up resistance



# 2

## Card Connections and Installation

---

### 2.1 Introduction

#### WARNING

**The following connection and installation procedures are to be performed by qualified service personnel. Failure to recognize and observe standard safety precautions could result in personal injury or death.**

#### NOTE

All input and output channels are electrically isolated from the backplane of the mainframe.

### 2.2 Internal connections

#### NOTE

All internal connections are for the digital outputs. No internal connections are required for reading digital input channels.

The Model 7020 is made up of two PC-boards that plug together and are secured together by a 4-40 screw. To gain access to internal connections, remove the screw and carefully separate the two boards. The board with the 96-pin DIN connector is called the mass terminal board, and the board with the majority of components is called the scanner board.

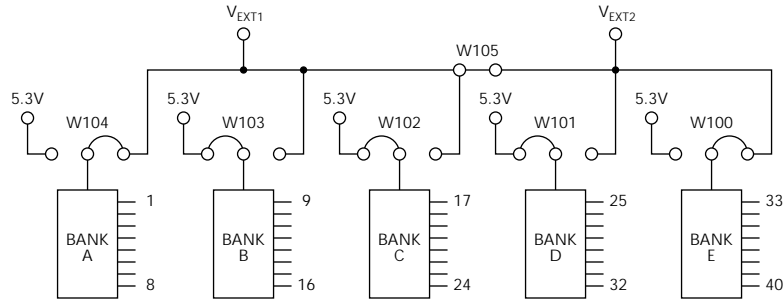
### 2.3 Voltage source jumpers

Digital output high can be supplied by the internal 5.3V voltage source, or by a user supplied voltage. At the factory, internal jumpers are set to use the internal 5.3V source.

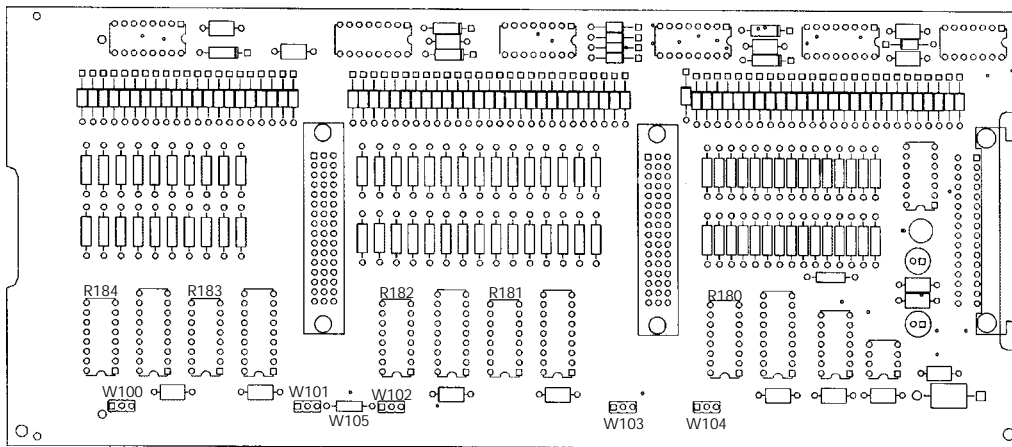
The 40 output channels are divided up into five banks (eight output channels per bank) as shown in Figure 2-1. For each bank, there is a plug-in jumper that allows you to select the internal 5.3V source or an external source. In Figure 2-1, Banks B, C and D use the 5.3V source, while Banks A and E use an external source.

The I/O card can accommodate two different external voltage sources ( $V_{EXT1}$  and  $V_{EXT2}$ ) by removing (cutting) jumper W105 (see Figure 2-1). With W105 removed, the external voltage source ( $V_{EXT1}$ ) for Banks A, B and C is electrically isolated from the external voltage source ( $V_{EXT2}$ ) for Banks D and E.

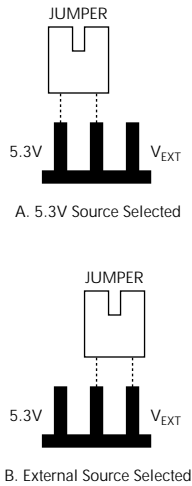
The voltage source jumpers are located on the scanner board as shown in Figure 2-2. Figure 2-3 shows how the plug-in jumpers (W100 through W104) are installed.



**Figure 2-1**  
Voltage source jumpers for output channels



**Figure 2-2**  
Component locations — scanner board



**Figure 2-3**  
Voltage source jumper installation

## 2.4 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. When interfacing digital output channels to pull-up devices, such as solenoid coils and motors, the pull-up resistors for those channels have to be removed.

The 40 output channels are divided up into five banks (eight output channels per bank). Each output bank has a 16-pin DIP socket that is used for a thick film resistor network. Each thick film resistor network has eight resistors to accommodate the eight output channels. Thus, when you remove a resistor network, you remove the pull-up resistors for eight output channels.

Table 2-1 indicates the resistor network for each bank of output channels.

**Table 2-1**  
Pull-up resistors identification

Bank	Output channels	Resistor network
A	1 - 8	R180
B	9 - 16	R181
C	17 - 24	R182
D	25 - 32	R183
E	33 - 40	R184

The resistor networks (R180 through R181) are located on the scanner board (see Figure 2-2). To remove a resistor network, use a thin-bladed screwdriver and carefully pry the chip out of the socket. Pull-up resistors should be replaced with same value and wattage only.

## 2.5 Card installation

Perform the following steps to install the card assembly in the Model 7001 or 7002 mainframe:

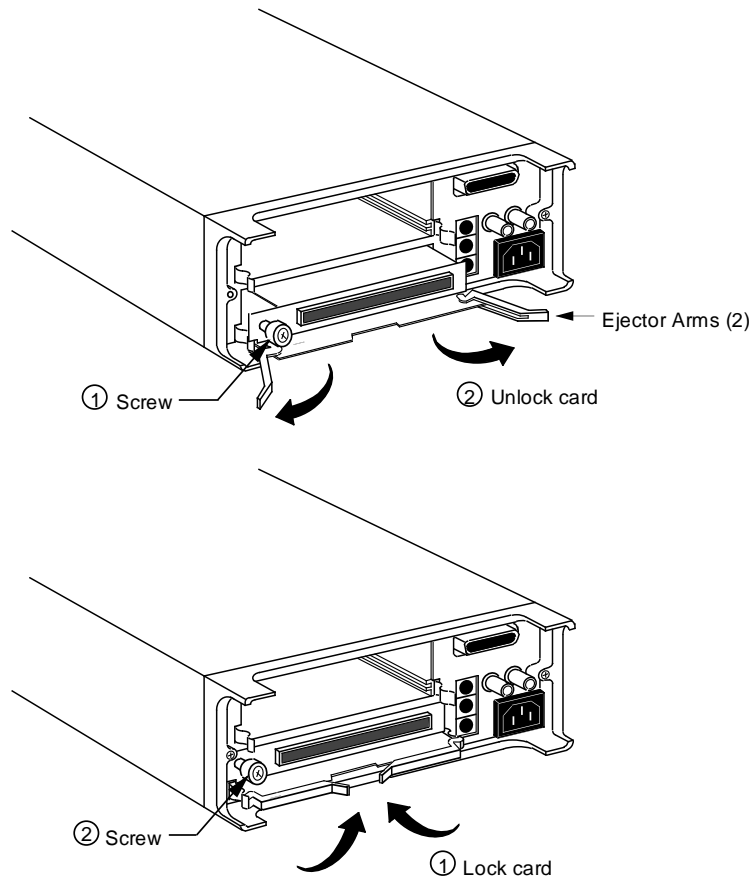
### WARNING

**Turn off power from all instrumentation (including the Model 7001 or 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 mass terminal board to the scanner board 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 that you wish to install the card in.
3. Feed the I/O card assembly into the desired slot such that the edges of the relay card ride in the rails.
4. With the ejector arms in the unlocked position, push the card assembly 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. Figure 2-4 shows how the card installs in the Model 7001.
5. Install and tighten the safety ground screw shown in Figure 2-4.

### 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 2-4.**



**Figure 2-4**  
*Model 7020 card installation in Model 7001*

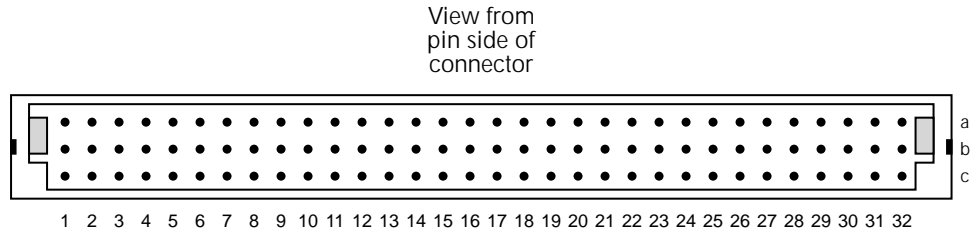
## 2.6 Card removal

To remove the card assembly, loosen the safety ground screw, unlock it by pulling the latches outward, then pull the card assembly out of the mainframe. Remember to handle the card assembly by the edges and shields.

## 2.7 Input/output connections

Connections to external circuitry are made at the 96-pin male DIN bulkhead connector. The pinout for this connector is shown in Figure 2-5. This connector will mate to a 96-pin female DIN connector.

Terminal identification for the DIN connector is provided by Tables 2-2, 2-3 and 2-4. Table 2-2 provides terminal identification for digital output channels, Table 2-3 provides terminal identification for digital input channels and Table 2-4 provides identification for the rest of the I/O card terminals.



**Figure 2-5**  
96-pin DIN connector pinout

**Table 2-2**  
Output channel terminal identification

Output channel	Bank	Connector pin no.	Output channel	Bank	Connector pin no.
OUT1	A	2a	OUT21	C	10b
OUT2	A	4a	OUT22	C	12b
OUT3	A	6a	OUT23	C	14b
OUT4	A	8a	OUT24	C	16b
OUT5	A	10a	OUT25	D	18b
OUT6	A	12a	OUT26	D	20b
OUT7	A	14a	OUT27	D	22b
OUT8	A	16a	OUT28	D	24b
OUT9	B	18a	OUT29	D	26b
OUT10	B	20a	OUT30	D	28b
OUT11	B	22a	OUT31	D	30b
OUT12	B	24a	OUT32	D	32b
OUT13	B	26a	OUT33	E	2c
OUT14	B	28a	OUT34	E	4c
OUT15	B	30a	OUT35	E	6c
OUT16	B	32a	OUT36	E	8c
OUT17	C	2b	OUT37	E	10c
OUT18	C	4b	OUT38	E	12c
OUT19	C	6b	OUT39	E	14c
OUT20	C	8b	OUT40	E	16c

**Table 2-3**  
Input channel terminal identification

Input channel	Bank	Connector pin no.	Input channel	Bank	Connector pin no.
IN1	A	1a	IN21	C	9b
IN2	A	3a	IN22	C	11b
IN3	A	5a	IN23	C	13b
IN4	A	7a	IN24	C	15b
IN5	A	9a	IN25	D	17b
IN6	A	11a	IN26	D	19b
IN7	A	13a	IN27	D	21b
IN8	A	15a	IN28	D	23b
IN9	B	17a	IN29	D	25b
IN10	B	19a	IN30	D	27b
IN11	B	21a	IN31	D	29b
IN12	B	23a	IN32	D	31b
IN13	B	25a	IN33	E	1c
IN14	B	27a	IN34	E	3c
IN15	B	29a	IN35	E	5c
IN16	B	31a	IN36	E	7c
IN17	C	1b	IN37	E	9c
IN18	C	3b	IN38	E	11c
IN19	C	5b	IN39	E	13c
IN20	C	7b	IN40	E	15c

**Table 2-4**  
Miscellaneous terminal identification

Terminal	Connector pin no.
GND	17c
5.3V	18c
5.3V	19c
GND	20c
VEXT1	21c
VEXT1	22c
GND	23c
GND	24c
VEXT2	25c
VEXT2	26c
NC	27c
NC	28c
NC	29c
NC	30c
NC	31c
NC	32c

## 2.8 Typical connection techniques

Keithley has two connector accessories available to accommodate connections from the DIN connector of the card to external circuitry. These accessories are summarized in Table 2-5.

**Table 2-5**  
I/O connection accessories

Model	Description
7011-KIT-R	96-pin female DIN connector and housing for round cable.
7011-MTR	96-pin male DIN bulkhead connector.

### CAUTION

**Do not use the Model 7011-MTC-2 cable with the Model 7020. Damage to the card could result.**

All input and/or output circuitry that you wish 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.

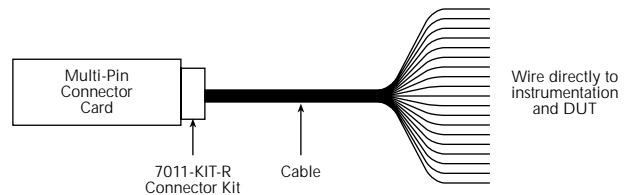
### WARNING

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

### NOTE

External circuitry should be connected (plugged in) only with the mainframe power off. Power should only be turned on after the Model 7020 is installed in the mainframe.

**Round cable assemblies** — Figure 2-6 shows a typical round cable connection technique using accessories available from Keithley.



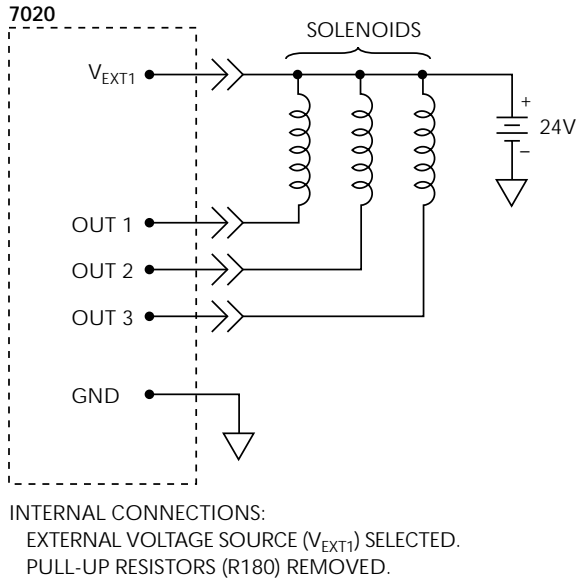
**Notes:** Figure 2-7 provides an exploded view showing how the connector (with cable) is assembled. Cable Hitachi p/n N2807-P/D-50TAB is a 50-conductor round cable. Two of these cables can be used to supply 100 conductors.

**Figure 2-6**  
Typical round cable connection techniques

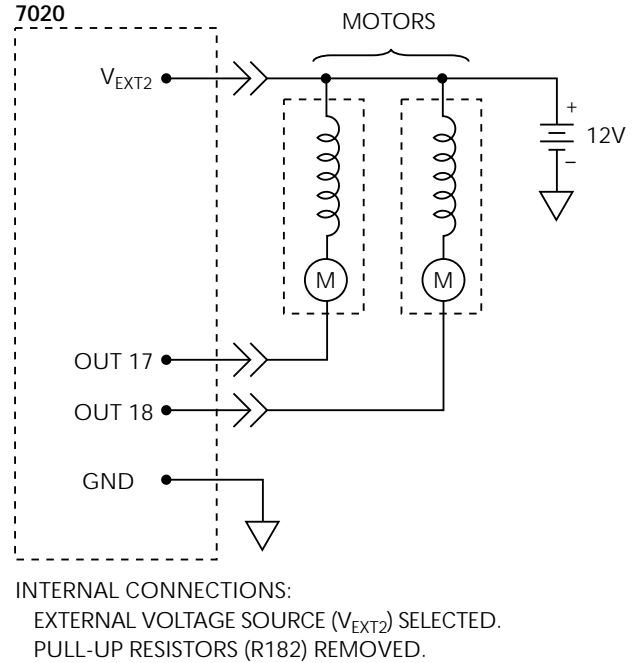
Connections are accomplished using a custom-built cable assembly that consists of a Model 7011-KIT-R connector and a suitable round cable. Hitachi cable part number N2807-P/D-50TAB is a 50-conductor cable. Two of these cables can be used to supply 100 conductors. The connector has solder cups to accommodate the individual wires of the unterminated cable. Figure 2-7 provides an exploded view of the connector assembly and shows how the cable is connected. The connector end of the resultant cable assembly mates directly to the connector on the digital I/O card. The unterminated end of the cable assembly can be wired directly to external circuitry.

Also included in Table 2-5 is a male DIN bulkhead connector (Model 7011-MTR). This connector has solder cups to allow direct connection to external circuitry. The bulkhead connector can then be connected to the digital I/O card via a custom-built cable assembly using two Model 7011-KIT-R connectors. Figure 2-8 provides the pinout for the bulkhead connector.

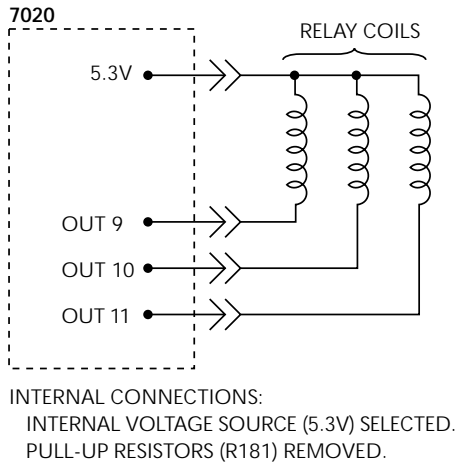




**Figure 2-9**  
Digital output, solenoid control



**Figure 2-11**  
Digital output, motor control

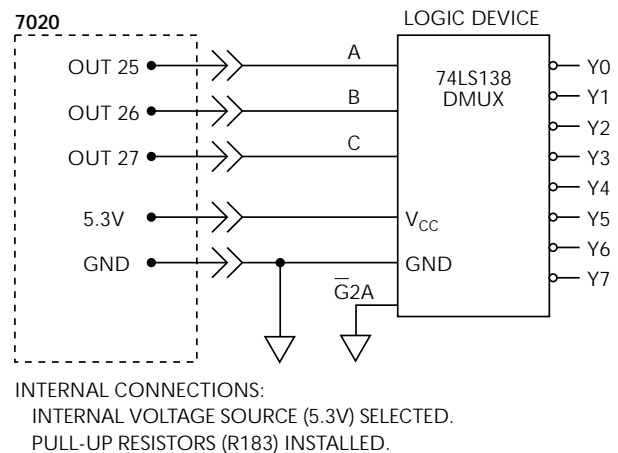


**Figure 2-10**  
Digital output, relay control

**Motor control** — Figure 2-11 shows a digital output connection scheme to control small 12V dc motors. An external 12V voltage source is used to provide the necessary voltage level. This example assumes that the pull-up resistors for channels 17 and 18 (R182) are removed.

A motor is turned on when the corresponding output channel is turned on (closed).

**Logic device control** — Figure 2-12 shows a digital output connection scheme to control a logic device. This example assumes that the internal 5.3V voltage source is being used, and the pull-up resistors for channels 25, 26 and 27 (R183) are installed.



**Figure 2-12**  
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 25, 26 and 27 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 26 is turned on (closed), line B goes low. The binary 5 seen at the DMUX input (1, 0, 1) selects (pulls low) Y5.

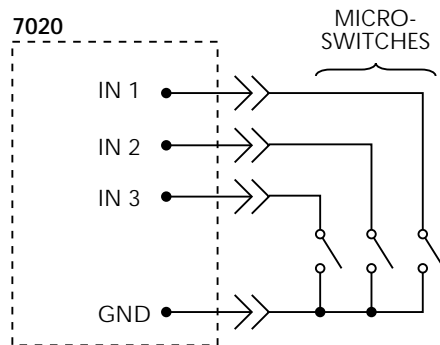
**NOTE**

With jumper W105 removed, all of the above output connection schemes could be used at the same time (assuming that current sink limits are not exceeded). Removing jumper W105 allows you to use two different external voltage sources ( $V_{EXT1}$  and  $V_{EXT2}$ ).

**2.10 Typical input connection scheme**

Figure 2-13 shows a digital input connection scheme to monitor the state of micro-switches. With a switch open, the corresponding input channel is pulled high by the internal pull-up resistor. As a result, the input channel is on (closed).

When a switch is closed, the corresponding input channel is pulled low to ground. As a result, the input channel is off (open).



**Figure 2-13**  
Digital input, monitoring micro-switches

**2.11 Models 7020-D and 7020-DT**

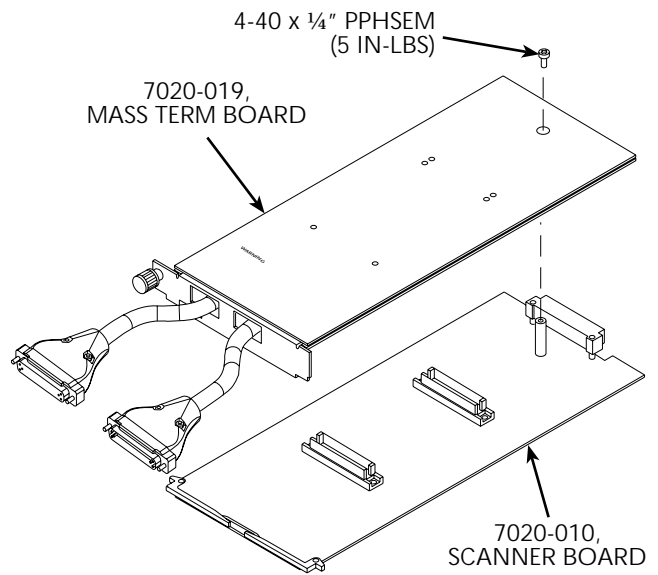
The Models 7020-D and 7020-DT are alternate configurations of the Model 7020 Digital I/O Interface Card. The Model 7020 consists of a scanner card and a connector card in a sandwich. The configurations are as follows:

- Model 7020 — Scanner card and mass-terminated card with 96-pin male DIN connector.
- Model 7020-D — Scanner card and mass-terminated card/cable with 50-pin male and female D-Sub connectors.
- Model 7020-DT — Spare mass-terminated card/cable with 50-pin male and female D-Sub connectors.

This section describes additional information for the Models 7020-D and 7020-DT

**Internal connections**

The two PC-boards that plug together are secured by a 4-40 screw (see Figure 2-14).



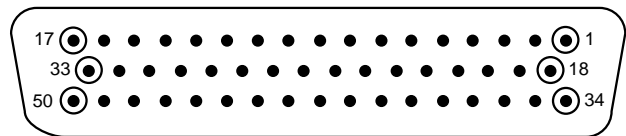
**Figure 2-14**  
Mating the PC-boards

**Input/output connections**

**WARNING**

**Connection and installation procedures are to be performed by qualified service personnel. Failure to recognize and observe standard safety precautions could result in personal injury or death.**

Connections to external circuitry are made at the 50-pin D-Sub connectors. Connector pinouts are shown in Table 2-6. Figure 2-15 shows the solder-side view of a mating connector.



**Figure 2-15**  
Mating connector (solder-side view)

**Table 2-6**  
Terminal identification

Male D-Sub (Digital In)				Female D-Sub (Digital Out)			
Signal	Pin	Signal	Pin	Signal	Pin	Signal	Pin
IN14	1	IN21	25	VEXT1	1	OUT24	25
IN13	2	IN22	24	VEXT1	2	OUT25	24
IN12	3	IN23	23	OUT14	3	OUT26	23
IN11	4	IN24	22	OUT13	4	OUT27	22
IN10	5	IN25	21	OUT12	5	+5.3V	21
IN9	6	IN26	20	OUT11	6	DIG GND	20
IN8	7	IN27	19	OUT10	7	VEXT2	19
IN7	8	IN40	18	OUT9	8	+5.3V	18
IN6	9	IN39	34	OUT8	9	VEXT2	34
IN5	10	IN38	35	OUT7	10	DIG GND	35
IN4	11	IN37	36	OUT6	11	OUT40	36
IN3	12	IN36	37	OUT5	12	OUT39	37
IN2	13	IN35	38	OUT4	13	OUT38	38
IN1	14	IN34	39	OUT3	14	OUT37	39
N/C	15	IN33	40	OUT2	15	OUT36	40
N/C	16	IN32	41	OUT1	16	OUT35	41
N/C	17	IN31	42	OUT15	17	OUT34	42
DIG GND	33	IN30	43	OUT16	33	OUT33	43
N/C	32	IN29	44	OUT17	32	OUT32	44
IN15	31	IN28	45	OUT18	31	OUT31	45
IN16	30	DIG GND	46	OUT19	30	OUT30	46
IN17	29	N/C	47	OUT20	29	OUT29	47
IN18	28	N/C	48	OUT21	28	OUT28	48
IN19	27	N/C	49	OUT22	27	N/C	49
IN20	26	N/C	50	OUT23	26	N/C	50

# 3

## Operation

---

### 3.1 Introduction

The information in this section is organized as follows:

- Power limits — Covers the maximum power limits of the Model 7020 Digital I/O Interface Card.
- Channel status display — Summarizes how the mainframe display is used to provide status of input and output channels.
- Channel assignments — Reviews how I/O card channels and mainframe slots are designated for channel and scan lists.
- Controlling output channels — Explains how to open/close and scan output channels from the front panel.
- Reading input channels — Explains how to read input channels from the front panel.
- IEEE-488 bus operation — Summarizes the commands used to control output channels and read input channels from over the IEEE-488 bus.

The following information pertains to the Model 7020 Digital I/O Interface 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, refer to the Model 7001 or 7002 Instruction Manual after reading the following information.

### 3.2 Power limits

To ensure proper operation and prevent damage to the card, never exceed the following power limits.

#### Output channels:

Maximum User Supplied Pull-Up Voltage: 25V.

Maximum Sink Current:

Per channel: 65mA

Per bank: 500mA (see note).

Per card: 1A.

#### NOTE

A bank refers to the internal IC that is used to drive eight output channels. The card uses five driver ICs (banks) to accommodate the 40 output channels. The channels are grouped as follows for each bank:

Bank 1 = Channels 1 through 8

Bank 2 = Channels 9 through 16

Bank 3 = Channels 17 through 24

Bank 4 = Channels 25 through 32

Bank 5 = Channels 33 through 40

As specified, the maximum output current for each 8-bit bank (i.e. channels 1 through 8) is 500mA.

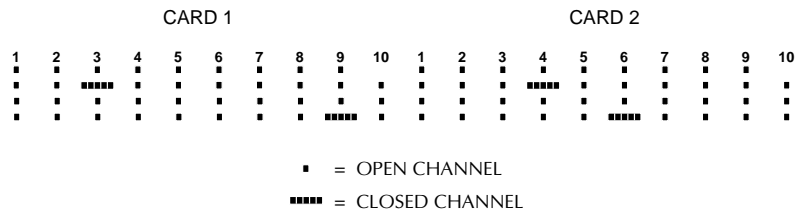
#### Input channels:

Maximum Voltage Level: 42V peak.

### 3.3 Channel status display

The Model 7001 has a channel status display (Figure 3-1) that provides the real-time state of each input or output channel. The left portion of the display is for slot 1 (Card 1), and

7001 DISPLAY



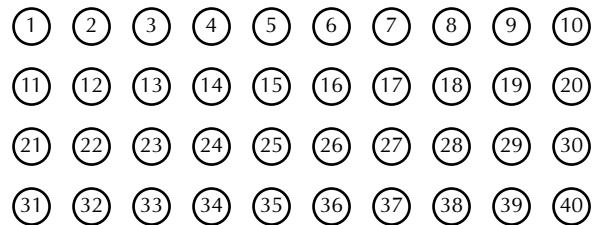
**Figure 3-1**  
Model 7001 channel status display

the right portion is for slot 2 (Card 2). For the Model 7002, channel status LED grids are used for the 10 slots. The LED grid for slot 1 is shown in Figure 3-2.

Input/output channel organization of the channel status display for each slot is shown in Figure 3-3. The card contains 40 independent input channels and 40 independent output channels. All 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 channels is displayed. When the mainframe is in the read input channels mode, the status (on or off) of the input channels is displayed.

Output channels use negative true logic. That is, the output is pulled low when the channel is turned on (closed). Conversely, the output goes high when the channel is turned off (open).

Input channels use positive true logic. A channel is on (closed) when the input is high. Keep in mind that an open input is pulled high by the internal pull-up resistor. Conversely, a channel is off (open) when the input is pulled low to ground.



**Figure 3-3**  
Display organization for input and output channels

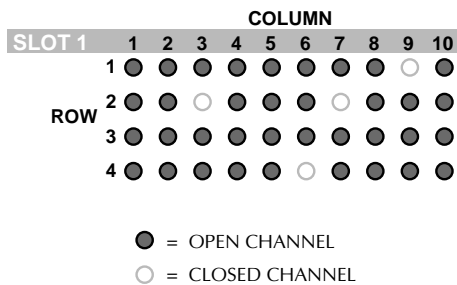
### 3.4 Channel assignments

Each input and output channel has a CHANNEL assignment, which includes the slot number that the card is installed in. Figure 3-4 shows the CHANNEL assignments for slots 1 and 2. Each CHANNEL assignment is made up of the slot designator (1 or 2) and the channel (1 to 40). For the Model 7002, the slot designator can be from 1 to 10 since there are 10 slots.

To be consistent with Model 7001/7002 operation, the slot designator and channel are separated by an exclamation point (!). Some examples of CHANNEL assignments are as follows:

- CHANNEL 1!1 = Slot 1, Channel 1
- CHANNEL 2!40 = Slot 2, Channel 40
- CHANNEL 6!23 = Slot 6, Channel 23
- CHANNEL 10!36 = Slot 10, Channel 36

7002 LED DISPLAY



**Figure 3-2**  
Model 7002 channel status display (slot 1)

	1	2	3	4	5	6	7	8	9	10
A. SLOT 1 (CARD 1)	1!1	1!2	1!3	1!4	1!5	1!6	1!7	1!8	1!9	1!10
	1!11	1!12	1!13	1!14	1!15	1!16	2!17	1!18	1!19	1!20
	1!21	1!22	1!23	1!24	1!25	1!26	1!27	1!28	1!29	1!30
	1!31	1!32	1!33	1!34	1!35	1!36	1!37	1!38	1!39	1!40
B. SLOT 2 (CARD 2)	2!1	2!2	2!3	2!4	2!5	2!6	2!7	2!8	2!9	2!10
	2!11	2!12	2!13	2!14	2!15	2!16	2!17	2!18	2!19	2!20
	2!21	2!22	2!23	2!24	2!25	2!26	2!27	2!28	2!29	2!30
	2!31	2!32	2!33	2!34	2!35	2!36	2!37	2!38	2!39	2!40

EXAMPLES: 1!18 = SLOT 1, CHANNEL 18  
2!36 = SLOT 2, CHANNEL 36

**Figure 3-4**  
Model 7020 programming channel assignments

### 3.5 Controlling output channels

Output channels are displayed and controlled from the normal display state of the Model 7001 or 7002. If currently in a menu structure, use the EXIT key to return to the normal display state.

### 3.6 Turning output channels On and Off

An output channel is turned on by simply keying in the CHANNEL assignment and pressing CLOSE. When a channel is on (closed), ~0V is seen at the output (negative true logic). For example, to turn on output channel 36 of an I/O card installed in slot 2, key in the following channel list and press CLOSE:

```
SELECT CHANNELS 2!36
```

The above channel can be turned off by pressing OPEN or OPEN ALL. The OPEN key turns off only the channels specified in the channel list, and OPEN ALL turns off all channels.

Note that for the Model 7002 mainframe, you can use the light pen to turn output channels on and off.

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 turn on all the channels specified in the channel list. Pressing OPEN (or OPEN ALL) will turn off the channels.

Channel patterns can also be used in a channel list. This allows you 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 for information on defining channel patterns.

### 3.7 Scanning output channels

Output 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 Turning Output Channels On and Off). 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!21-2!25
```

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 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.

### 3.8 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. A channel is on (closed) when the input is high. Keep in mind that an open input is pulled high by the internal pull-up resistor. Conversely, a channel is off (open) when the input is pulled low to ground.

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 display. Only I/O card channels are displayed.

Model 7002 Mainframe — The real-time state (on or off) of each channel is provided by the appropriate LED display grid. Use the TYPE option of the CARD CONFIG MENU if you don't know which slot the I/O 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 output channels by pressing OPEN ALL.

### 3.9 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.

### 3.10 Turning output channels On and Off

The following SCPI commands are used to turn output channels on and off:

```
:CLOSe <list>          Turn on specified channels
:OPEN <list>|ALL       Turn off 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"
```

### 3.11 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 output 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 30 milliseconds (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.

### 3.12 Reading input channels

The following SCPI commands are used to read the status of 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 23 in slot 6:

```
:SENSe7:DATA? (@6!23) or :SENSe7:DATA? (@23)
```

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 40 input channels in slot 1 as follows. The modified statement is shown in bold typeface.

## *Operation*

---

```
PRINT #1, "output 07; sens2:data? (@1:40)"
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 40 input channels (i.e. "0, 0, 0, 1, 0..... 0, 1").



# 4

## Service Information

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### 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.

### 4.1 Introduction

This section contains information necessary to service the Model 7020 card and is arranged as follows:

- Handling and cleaning: Discusses handling precautions and methods to clean the card should it become contaminated.
- Functionality test: Provides a test procedure to determine if an 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 Model 7020.

### 4.2 Handling and cleaning

Care should be taken when handling or servicing the card to prevent possible contamination. The following precautions should be taken when servicing the card.

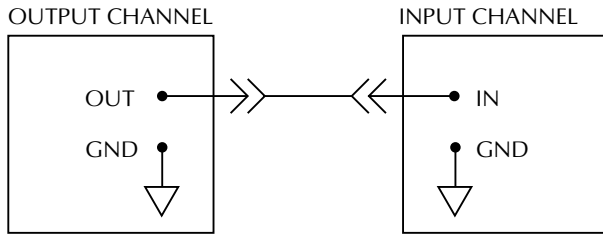
Handle the card only by the edges and shields. Do not touch any board surfaces or components not associated with the repair. Do not touch areas adjacent to electrical contacts.

Should it become necessary to use solder on the circuit board, use an OA-based (organic activated) flux. Remove the flux from the work areas when the repair has been completed. Use pure water along with clean cotton swabs or a clean soft brush to remove the flux. Take care not to spread the flux to other areas of the circuit board. Once the flux has been removed, swab only the repaired area with methanol, then blow dry the board with dry nitrogen gas.

### 4.3 Channel functionality test

An input or output channel can be tested without the use of test equipment.

1. As shown in Figure 4-1, connect the suspect input or output channel to an output or input channel that is known to be functioning properly. Note that for the output channel, the pull-up resistor must be installed, and the internal 5.3V 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 is low when the channel is turned on.



INTERNAL CONNECTIONS:  
 INTERNAL VOLTAGE SOURCE (5.3V) SELECTED.  
 PULL-UP RESISTOR INSTALLED.

**Figure 4-1**  
 Testing an input or output channel

3. Place the mainframe in the “read input channels” display mode by selecting the READ-I/O-CARD option of the CARD COFIGURATION MENU. Verify on the display that the input channel is off (open).
4. On the mainframe, press OPEN ALL to turn off (open) the output channel and verify on the display that the input channel turns on (closes).
5. On the mainframe, use the EXIT key to return the instrument to the normal display mode and verify on the display that the output channel is off (open).

#### 4.4 Static-sensitive devices

CMOS and other high-impedance devices are subject to possible static discharge damage because of the high-impedance levels involved. When handling such devices, use the precautions listed below.

In order to prevent damage, assume that all parts are static-sensitive.

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

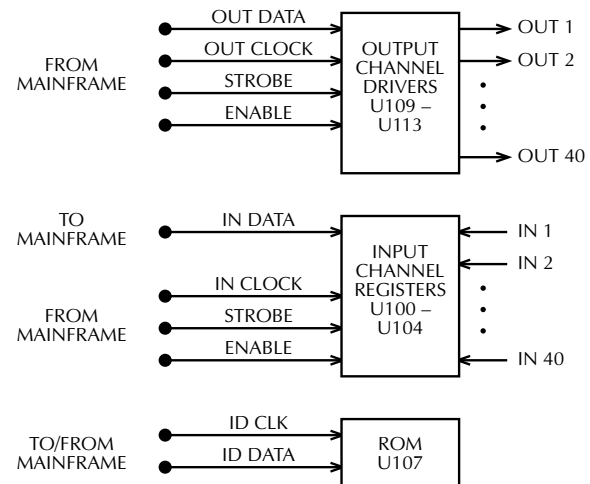
5. Use only anti-static type de-soldering tools and grounded-tip soldering irons.

#### 4.5 Principles of operation

The following paragraphs discuss the basic operating principles for the Model 7020, and can be used as an aid in troubleshooting the card. The schematic drawing of the Scanner card is shown on drawing number 7020-106, located at the end of this Section 5.

#### 4.6 Block diagram

Figure 4-2 shows a simplified block diagram of the Model 7020. Key elements include the output channel drivers and the input channel registers, as well as the ROM, which contains card ID and configuration information. These various elements are discussed in the following paragraphs.



**Figure 4-2**  
 Model 7020 block diagram

#### 4.7 ID data circuits

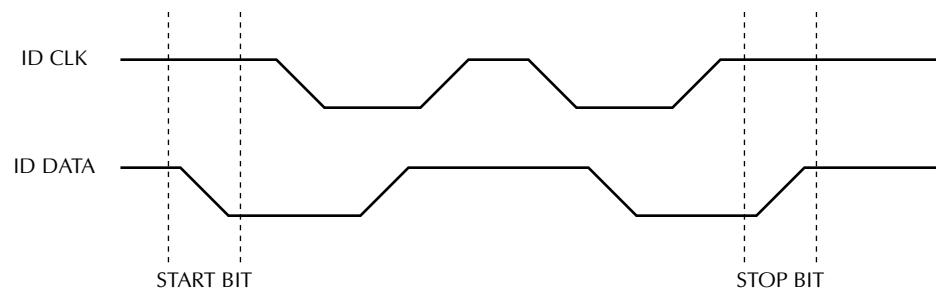
Upon power-up, card identification information from each card is read by the mainframe. This ID data includes such information as card ID, settling time, and channel configuration information. ID data is contained within an on-card EEPROM (U107). In order to read this information, the sequence described below is performed on power-up.

1. The ID DATA line (pin 5 of U107) is set from high to low while the ID CLK 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 4-3).
2. The mainframe sends the ROM address location to be read over the ID DATA 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 4-4).
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 ID DATA line with the ID CLK line held high (see Figure 4-3).

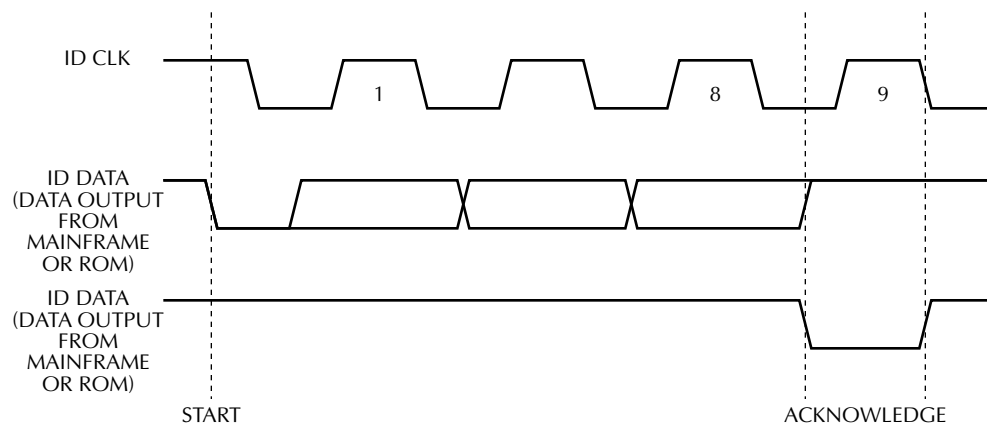
## 4.8 Output channel control

Digital output channels are controlled by serial data transmitted from the mainframe to the I/O card via the OUTDATA line. A total of five bytes (40-bits) 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 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 output channel information into the Q outputs of the output channel drivers. Note that a channel driver output goes low when it is turned on (closed).



**Figure 4-3**  
Start and stop sequences



**Figure 4-4**  
Transmit and acknowledge sequence

## 4.9 Input channel control

The mainframe reads digital input channels of the I/O card from a serial, five-byte (40-bits) data stream (via INDATA line).

Digital inputs are applied in a parallel fashion to the five input channel registers (8 channels per register). 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, five-byte (40-bits) data stream (via INDATA line) to the mainframe. As data empties from the lead register (U100), it is replaced by data via the Q7 line of the registers down the chain.

Note that a channel is on (closed) when the input is high.

## 4.10 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-flop and associated components ensures that output channels do not randomly turn on (close) when power is cycled. This circuit disables all output channels 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 VIA port line on the 68302 processor. The Q output of the flip-flop drives each I/O card output channel driver IC enable pin (U109-U113, 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 output channels (output channel 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 output channel drivers simultaneously. Note that Q out stays low, (enabling output channel drivers) until the 68302 processor goes into a reset condition.

## 4.11 Troubleshooting

### Troubleshooting equipment

Table 4-1 summarizes recommended equipment for troubleshooting the Model 7020.

*Table 4-1  
Recommended troubleshooting equipment*

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

## 4.12 Troubleshooting access

In order to gain access to the scanner board top surface to measure voltages under actual operating conditions, perform the following steps:

1. Disconnect the mass terminal card from the scanner board card.
2. Remove the mainframe cover.
3. Install the scanner board card in slot 1.
4. Turn on mainframe power to measure voltages (see following paragraph).

## 4.13 Troubleshooting procedure

Table 4-2 summarizes I/O card troubleshooting.

### WARNING

**Lethal voltages are present within 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

**To avoid contamination, 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.**

**Table 4-2**  
*Troubleshooting procedure*

Step	Item/component	Required condition	Comments
1	GND pad		All voltages referenced to digital ground (GND pad).
2	+5V pad	+5.3VDC	Logic voltage.
3	U107, pin 6	ID CLK pulses	During power-up only.
4	U107, pin 5	ID DATA pulses	During power-up only.
5	U113, pin 7 and U104, pin 1	STROBE pulse	End of update sequence.
6	U113 and U104, pin 2	CLK pulses	During update sequence only.
7	U113, pin 3 and U104, pin 9	DATA pulses	During update sequence only.
8	U109-U113, pins 11-18	Low with output channel on; high with output channel off.	Output channel driver outputs.



# 5

## Replaceable Parts

---

### 5.1 Introduction

This section contains replacement parts information, schematic diagrams and component layout drawings for the Model 7020.

### 5.2 Parts lists

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

### 5.3 Ordering information

To place an order, or to obtain information concerning replacement parts, contact your Keithley representative or the factory. When ordering parts, be sure to include the following information:

1. Card model number 7020
2. Card serial number
3. Part description
4. Circuit designation (if applicable)
5. Keithley part number

### 5.4 Factory service

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

- Call the Repair Department at 1-800-552-1115 for a Return Material Authorization (RMA) number.
- Complete the service form at the back of this manual and include it with the card.
- Carefully pack the card in the original packing carton.
- Write ATTENTION REPAIR DEPT and the RMA number on the shipping label.

#### NOTE

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

### 5.5 Component layouts and schematic diagrams

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

Mass terminal board component layout: 7020-170

Mass terminal board schematic: 7020-176

Scanner board component layout: 7020-100

Scanner board schematic: 7020-106

**Table 5-1**

Model 7020 mass terminal board, parts list

Circuit Desig.	Description	Keithley Part Number
	BRACKET SILKSCREENING CONNECTOR SHIM SHIELD	7011-318-6A 7011-309A 7011-311A
C401-404	CAP., 1UF,20%,50V,CERAMIC	C-365-.1
J1004	CONN, 96-PIN, 3 ROWS	CS-514
P1002,1003	CONNECTOR, 48-PIN, 3 ROWS	CS-748-3
R401-440	RES,10,5%,1/2W,COMPOSITION OR FILM	R-448-10
RT401-440	POLYSWITCH, PTC RESISTOR	RT-17

**Table 5-2**

Model 7020 scanner board, parts list

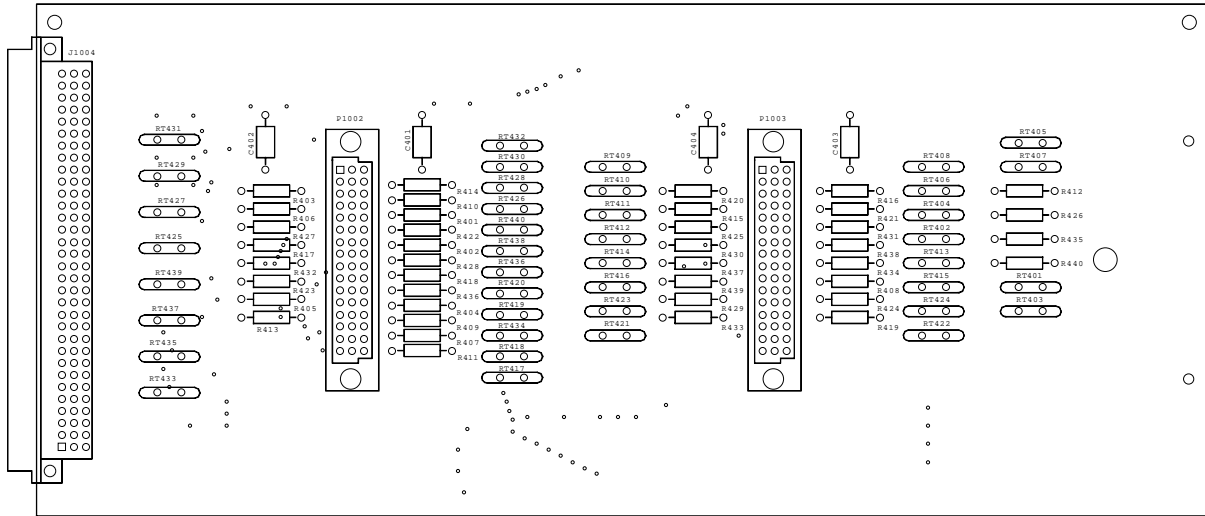
Circuit Desig.	Description	Keithley Part Number
	16-PIN SOCKET FOR TF-117 CONNECTOR, JUMPER FOR CS-339 SHIELD	SO-65 CS-476 7011-305C
C100-105,107,108,110-117	CAP.,1UF,20%,50V,CERAMIC	C-365-.1
C106,109	CAP, 10UF,-20+100%,25V,ALUM ELEC	C-314-10
CR100-179	DIODE,SILICON,IN4148 (D0-35)	RF-28
CR180	DIODE, 1N5404	RF-74
J1002,1003	CONN, 48-PIN, 3-ROWS	CS-736-2
P2001	CONNECTOR, 32-PIN, 2-ROWS	CS-775-1
R100-109,120-134,150-164	RES,10K,5%,1/4W,COMPOSITION OR FILM	R-76-10K
R110-119,135-149,165-179	RES,100K,5%,1/4W,COMPOSITION OR FILM	R-76-100K
R180-184	RES NET, 10K, .5%, 7W	TF-117
R185	RES,1K,5%,1/4W,COMPOSITION OR FILM	R-76-1K
U100-104	IC, 8-BIT PARALLEL TO SERIAL, 74HCT165	IC-548
U105	IC, QUAD 2 INPUT OR, 74HCT32	IC-443
U106	IC, HEX INVERTER, 74HCT04	IC-444
U107	ID ROM	7020-800-**
U108	IC, HIGH SPEED BUFFER, 74HC125	IC-451
U109-113	IC, 8-BIT SERIAL-IN-LATCH DRIVER, 5841A	IC-536
VR100-104	DIODE, ZENER 5.1V,IN751(D0-7)	DZ-59
W100-104	CONN, 3 PIN	CS-339-3
W105	JUMPER	J-15

\*\* Order firmware revision of present ROM.



7020-170 ON

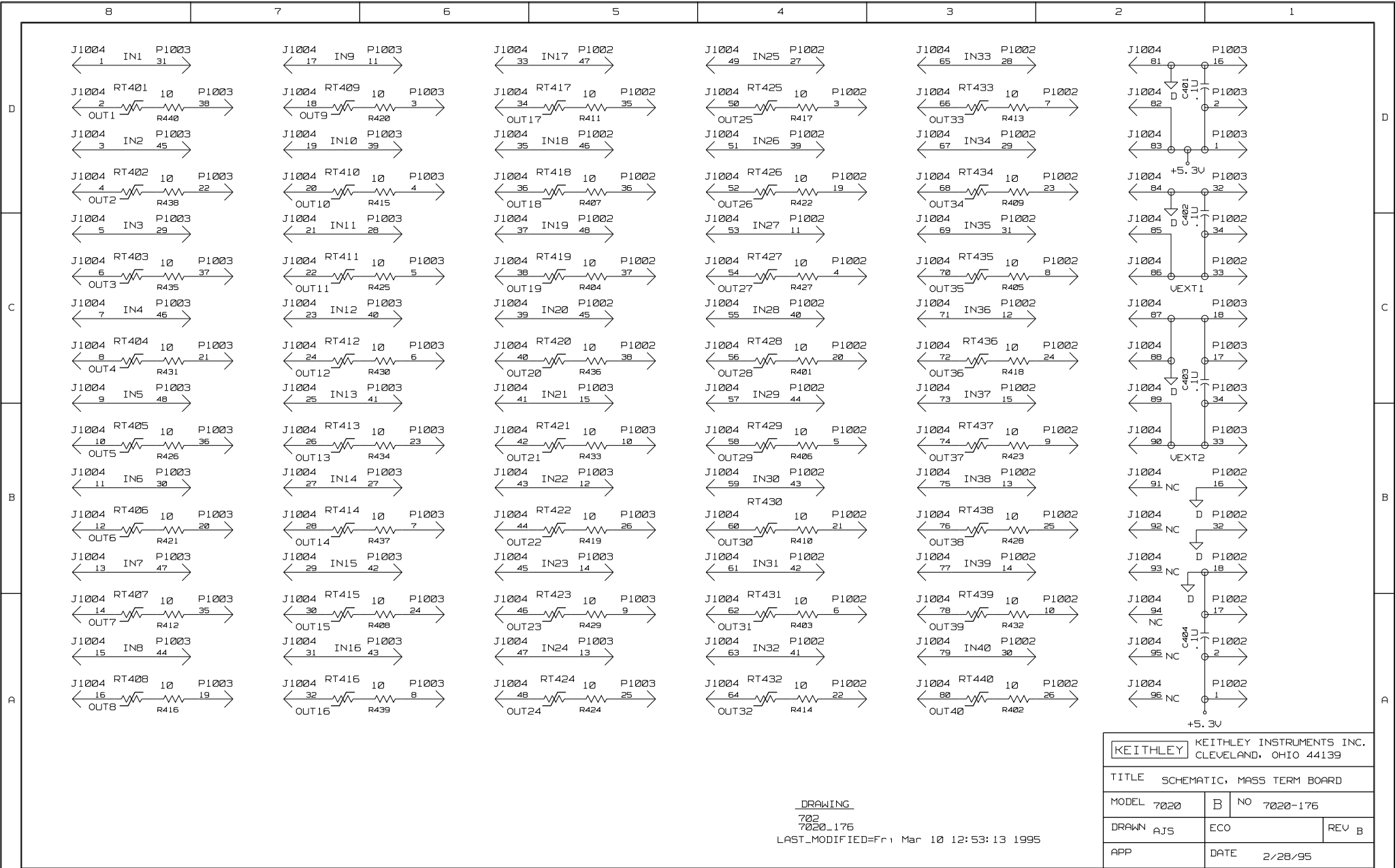
LTR.	ECA NO.	REVISION	ENG.	DATE
A		PRELIMINARY		
B				



NOTE: FOR COMPONENT INFORMATION, SEE PRODUCT STRUCTURE.

MODEL	NEXT ASSEMBLY	QTY.
USED ON		

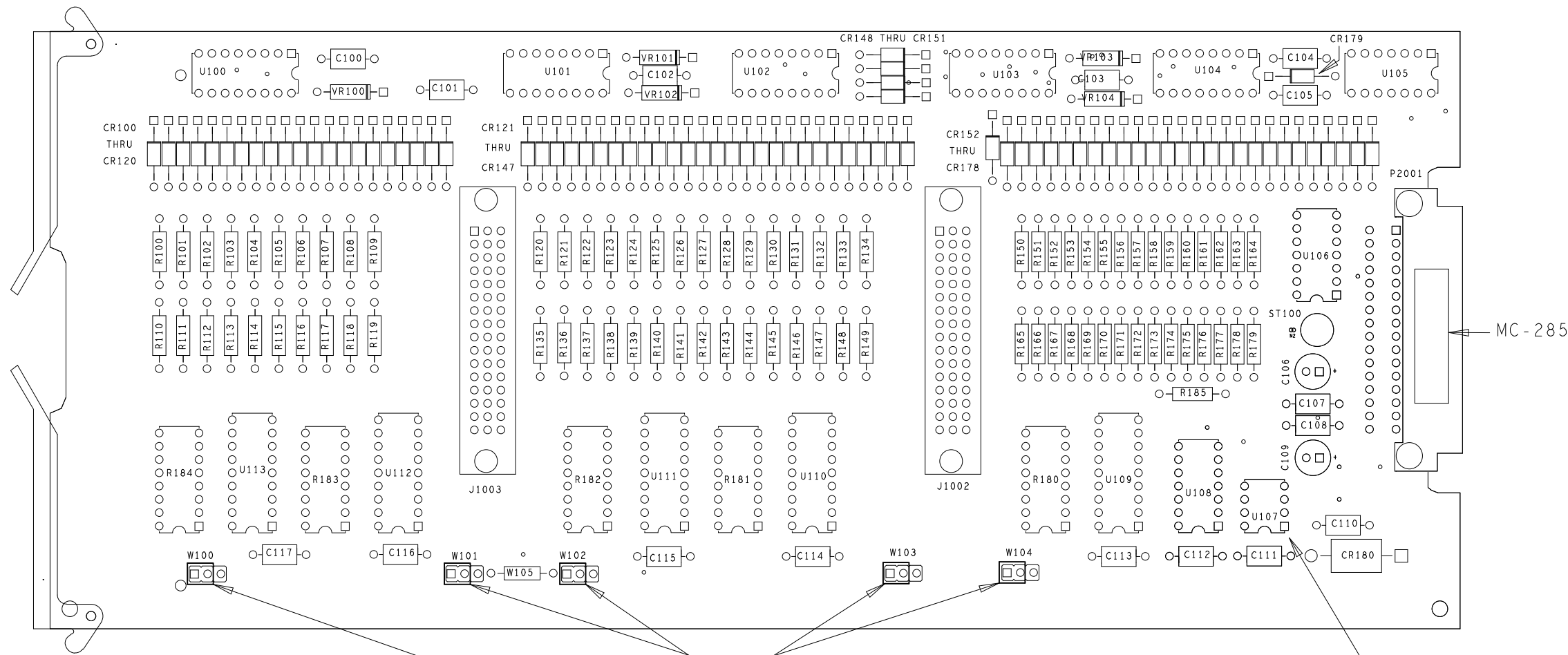
<b>KEITHLEY</b> KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139	DIM ARE IN IN. UNLESS OTHERWISE NOTED	DATE 3/6/95	SCALE 1:1	TITLE COMPONENT LAYOUT, MASS TERMINATED CARD
	DIM. TOL. UNLESS OTHERWISE SPECIFIED	DRN CAB	APPR.	
	XX=+.01 ANG.=+1 XXX=+.005 FRAC.=+1/64	DO NOT SCALE THIS DRAWING		B NO. 7020-170



KEITHLEY		KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139	
TITLE SCHEMATIC, MASS TERM BOARD			
MODEL 7020	B	NO 7020-176	
DRAWN AJ5	ECO	REV B	
APP	DATE	2/28/95	

DRAWING  
7020  
7020\_176  
LAST\_MODIFIED=Fri Mar 10 12:53:13 1995

LTR.	ECA NO.	REVISION	ENG.	DATE
A		PRELIMINARY		
B	17236	RELEASED	SZ	3-2-95
B1	25918	CHANGED U107 TO TC17-100	ELS	6/20/01

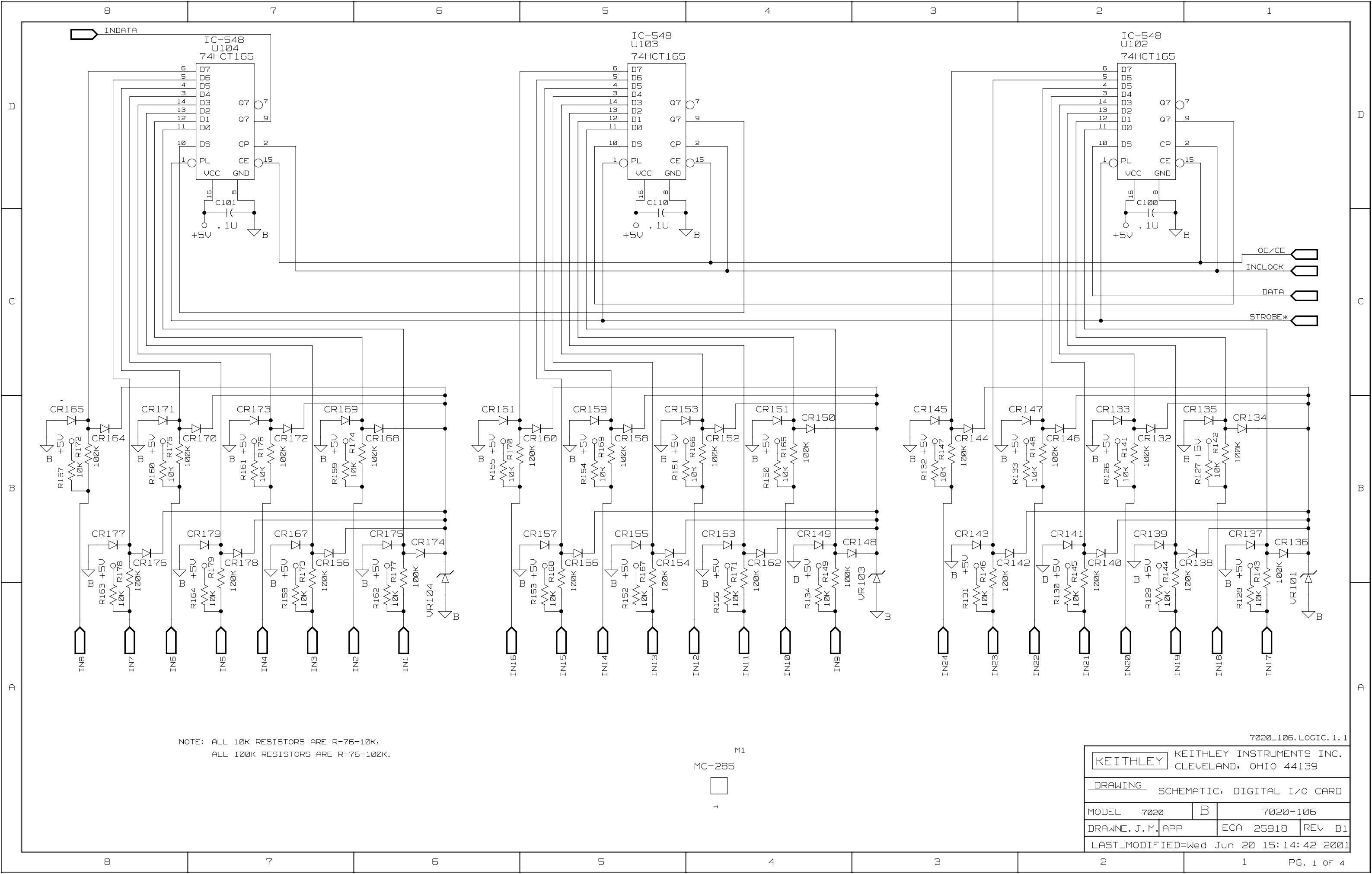


NOTE: FOR COMPONENT INFORMATION, SEE PRODUCT STRUCTURE.

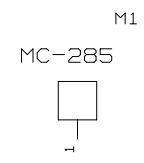
TC17-100 BOARD ASSEMBLY  
ORIENT ARROW TOWARD  
PIN 1 OF DEVICE

MODEL	NEXT ASSEMBLY	QTY.
USED ON		

<b>KEITHLEY</b> KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139	DIM ARE IN IN. UNLESS OTHERWISE NOTED	DATE 2/22/95	SCALE 1:1	TITLE COMPONENT LAYOUT, DIGITAL IO CARD NO. 7020-100
	DIM. TOL. UNLESS OTHERWISE SPECIFIED	DRN CB	APPR.	
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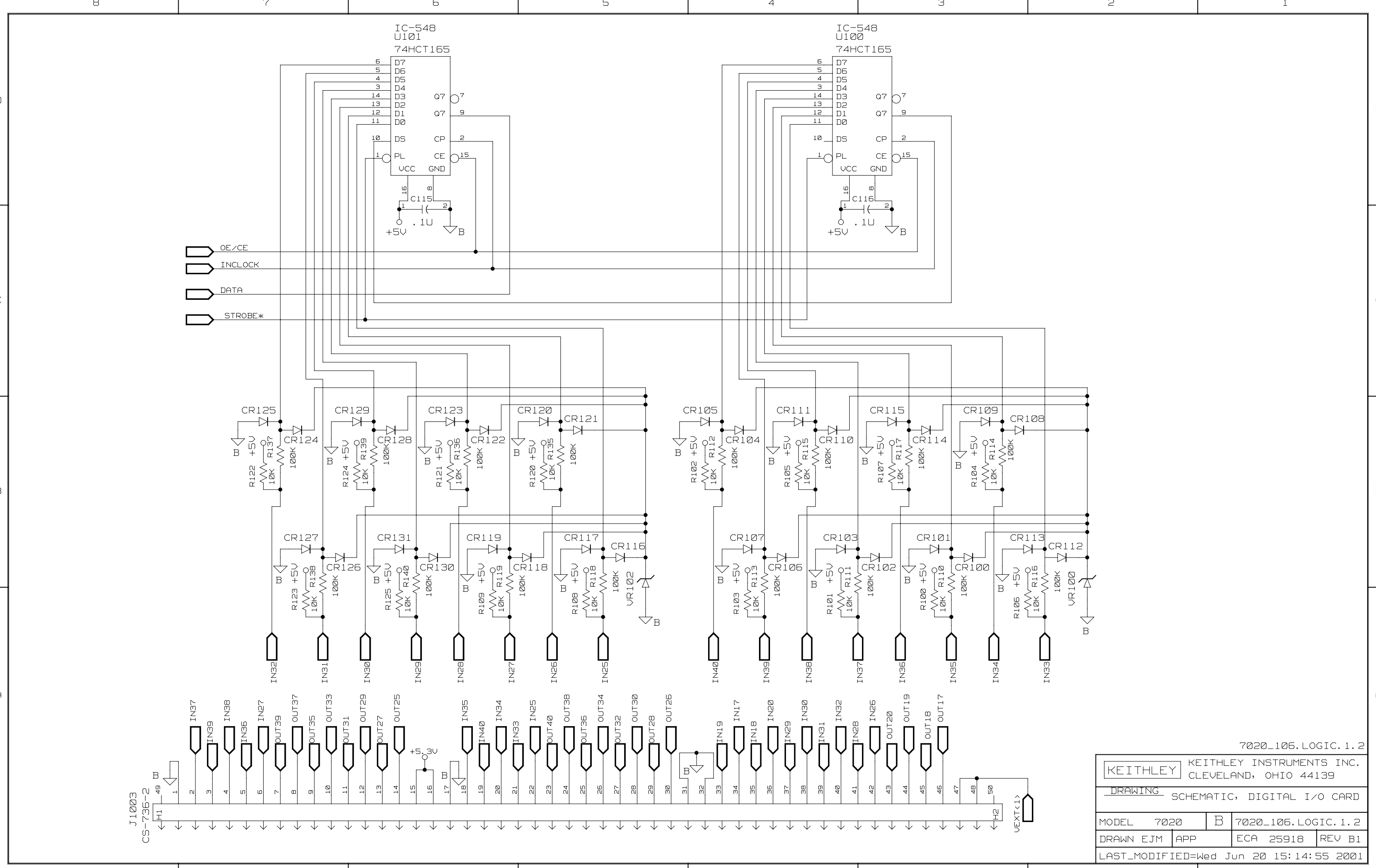


NOTE: ALL 10K RESISTORS ARE R-76-10K,  
ALL 100K RESISTORS ARE R-76-100K.



7020\_106.LOGIC.1.1

KEITHLEY		KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139	
DRAWING SCHEMATIC, DIGITAL I/O CARD			
MODEL	7020	B	7020-106
DRAWN	J. M. APP	ECA 25918	REV B1
LAST_MODIFIED=Wed Jun 20 15:14:42 2001			



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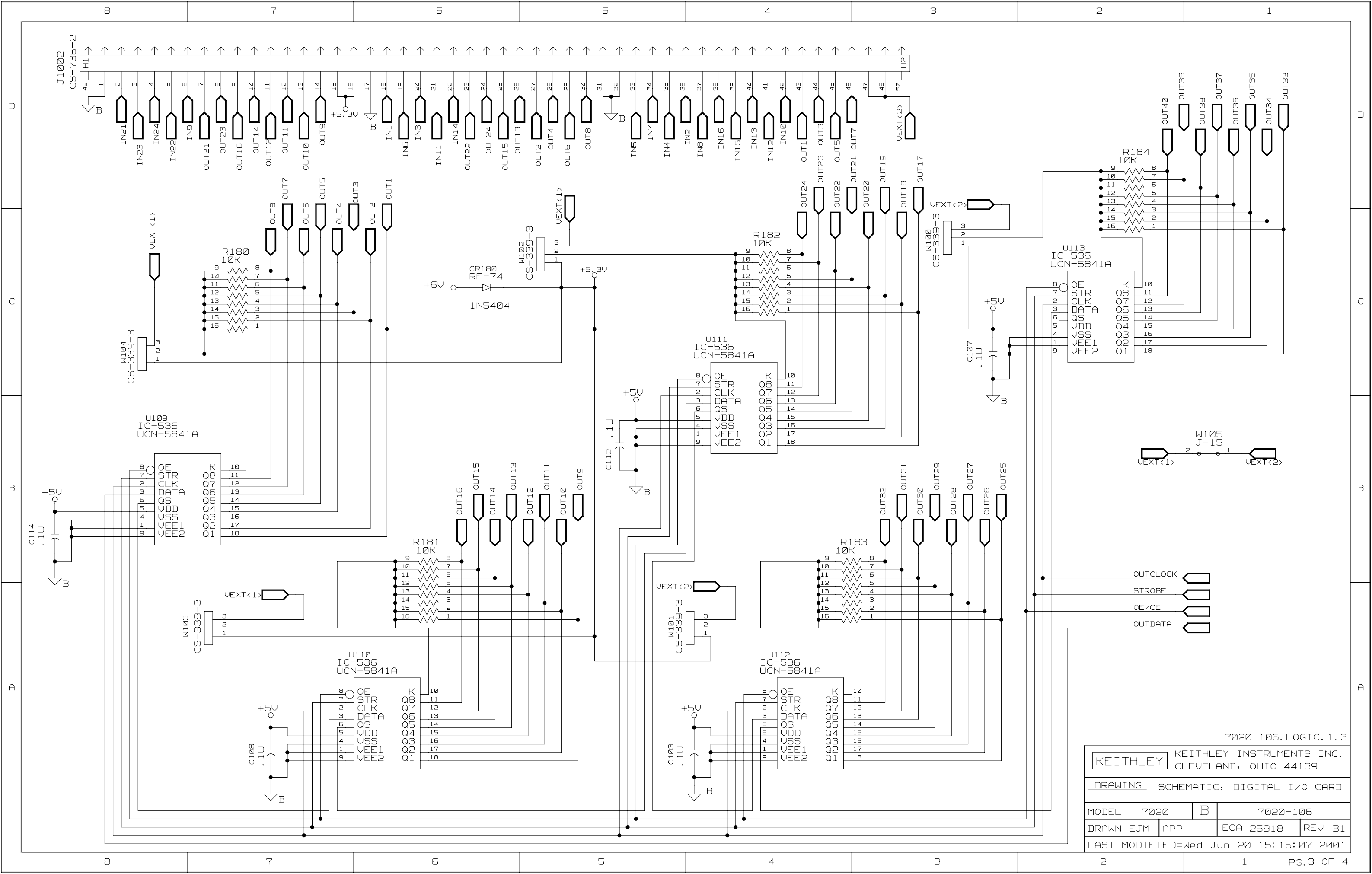
KEITHLEY KEITHLEY INSTRUMENTS INC.  
CLEVELAND, OHIO 44139

DRAWING SCHEMATIC, DIGITAL I/O CARD

MODEL	7020	B	7020_106.LOGIC.1.2
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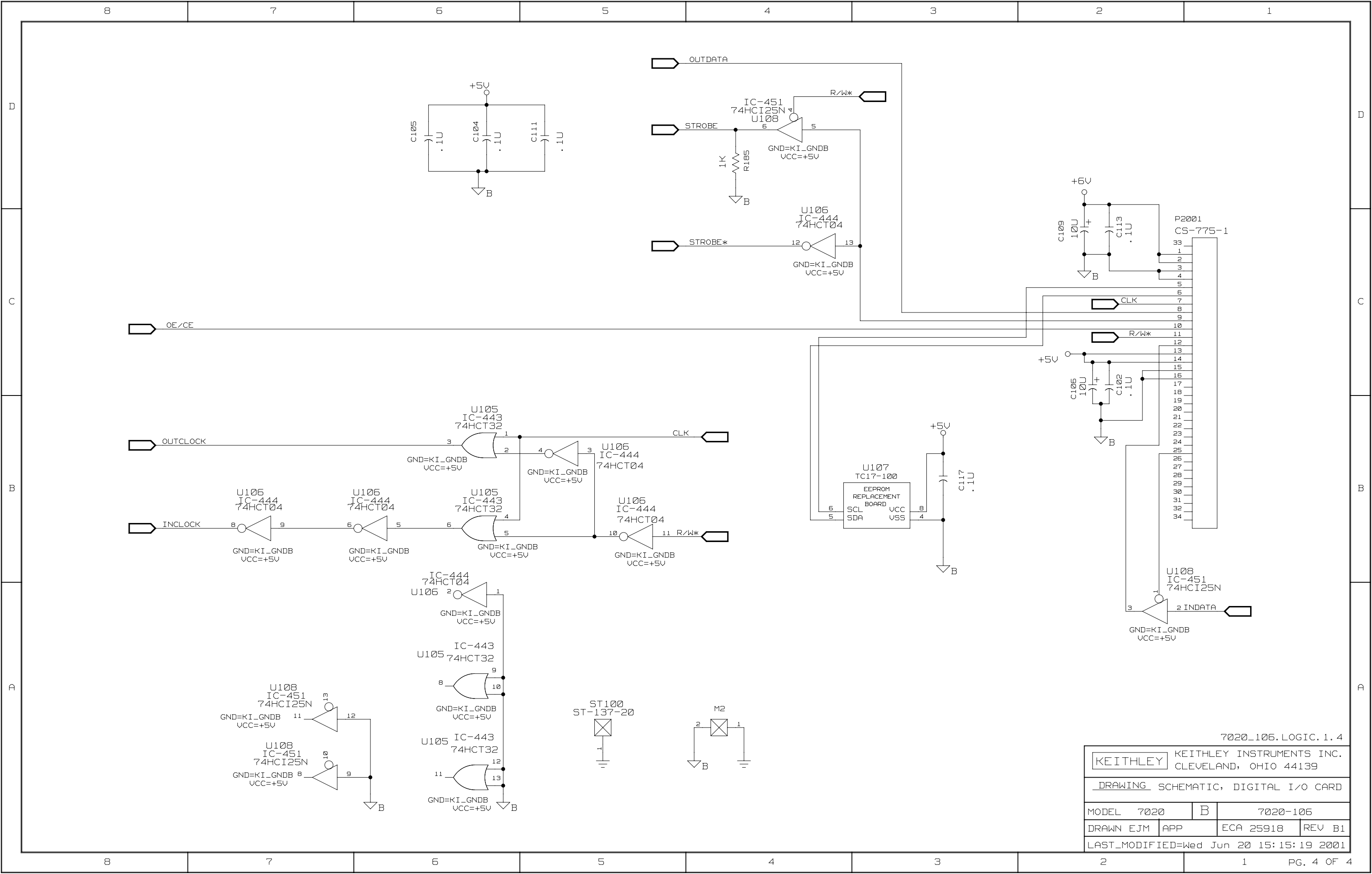
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DRAWING SCHEMATIC, DIGITAL I/O CARD			
MODEL 7020	B	7020-106	
DRAWN EJM	APP	ECA 25918	REV B1
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7020\_106.LOGIC.1.4

KEITHLEY				KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139			
DRAWING SCHEMATIC, DIGITAL I/O CARD							
MODEL	7020	B	7020-106				
DRAWN	EJM	APP	ECA 25918	REV	B1		
LAST_MODIFIED=Wed Jun 20 15:15:19 2001							

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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. \_\_\_\_\_

- |  |  |  |
|--|--|--|
| <input type="checkbox"/> Intermittent            | <input type="checkbox"/> Analog output follows display   | <input type="checkbox"/> Particular range or function bad; specify _____ |
| <input type="checkbox"/> IEEE failure            | <input type="checkbox"/> Obvious problem on power-up     | <input type="checkbox"/> Batteries and fuses are OK                      |
| <input type="checkbox"/> Front panel operational | <input type="checkbox"/> All ranges or functions are bad | <input type="checkbox"/> Checked all cables                              |

Display or output (check one)

- |                                   |  |
|-----------------------------------|--|
| <input type="checkbox"/> Drifts   | <input type="checkbox"/> Unable to zero              |
| <input type="checkbox"/> Unstable | <input type="checkbox"/> Will not read applied input |
| <input type="checkbox"/> Overload |  |

- |   |  |
|---|--|
| <input type="checkbox"/> Calibration only | <input type="checkbox"/> Certificate of calibration required |
| <input type="checkbox"/> Data required    |  |

(attach any additional sheets as necessary)

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

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

What power line voltage is used? \_\_\_\_\_ Ambient temperature? \_\_\_\_\_ °F

Relative humidity? \_\_\_\_\_ Other? \_\_\_\_\_

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

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





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28775 Aurora Road • Cleveland, Ohio 44139 • 440-248-0400 • Fax: 440-248-6168  
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