
Instruction Manual

Model 7077
Isolated Coaxial Matrix Card

Contains Operating and Servicing Information

KEITHLEY

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Model 7077 Isolated Coaxial Matrix 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

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 main. 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.

Specifications

MATRIX CONFIGURATION: 8 rows by 12 columns.

CROSSPOINT CONFIGURATION: 2-pole Form A (HI, LO).

CONNECTOR TYPE: BNC (HI, LO).

MAXIMUM SIGNAL LEVEL:

Any center or shield to any other center or shield: 42V peak, 1A switched.

DC SIGNALS: 30VA resistive load.

AC SIGNALS: 42VA resistive load.

COMMON MODE VOLTAGE: 42V peak, any terminal to chassis

CONTACT LIFE:

Cold Switching: 10^8 closures.

At Maximum Signal Level: 10^5 closures.

PATH RESISTANCE (per conductor): $< 0.5\Omega$, $< 1.5\Omega$ at end of contact life.

CONTACT POTENTIAL: $< 5\mu\text{V}$ per crosspoint (HI to LO).

OFFSET CURRENT: $< 100\text{pA}$.

AC PERFORMANCE:

$(Z_L = Z_S = 50\Omega)$ $< 100\text{ kHz}$ $< 1\text{ MHz}$

Insertion Loss¹ 0.05 dB 0.1 dB

Crosstalk -65 dB -45 dB

¹Excludes loss caused by DC path resistance.

ISOLATION:

Path: $> 10^{10}\Omega$, $< 75\text{pF}$.

Differential: $> 10^9\Omega$, $< 120\text{pF}$.

Common Mode: $> 10^9\Omega$, $< 200\text{pF}$.

RELAY DRIVE CURRENT (per crosspoint): 28mA

RELAY SETTling TIME: $< 3\text{ms}$.

ENVIRONMENT:

Operating: 0° – 50°C , up to 35°C at 70% RH.

Storage: -25° to 65°C .

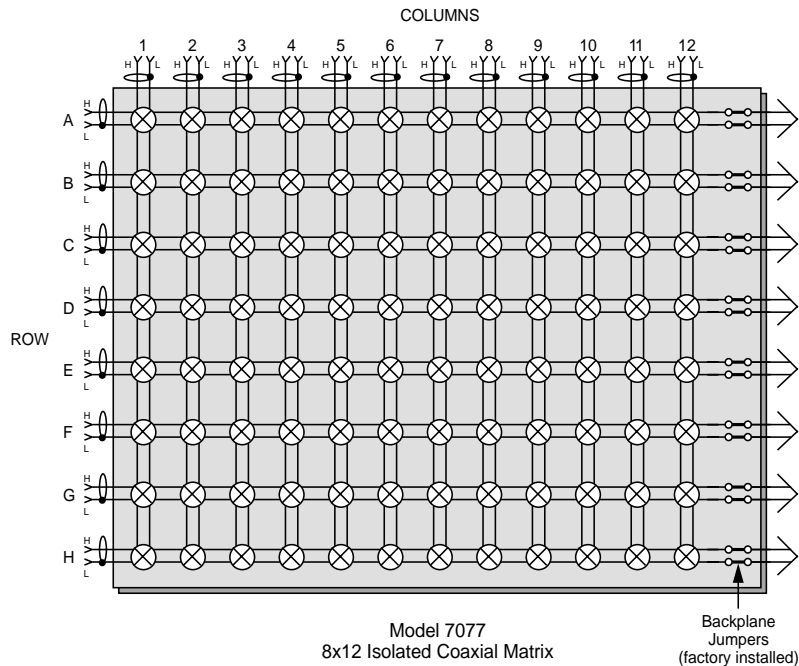


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General Information

1.1 Introduction

This section contains general information about the Model 7077 Isolated Coaxial 8 × 12 Matrix Card.

1.2 Features

The Model 7077 is a general purpose, two-pole, 8 × 12 (eight rows by twelve columns) matrix card. Some of the key features include:

- Low contact potential and offset current for minimal effects on low level signals.
- BNC connectors to device under test (DUT) and instrumentation.
- Row backplane jumpers that isolate or connect matrix rows from the Models 707 and 708 backplanes.

1.3 Warranty information


Warranty information is located on the inside front cover of this manual. Should your Model 7077 require warranty service, contact your Keithley representative or an authorized repair facility in your area for further information.


1.4 Manual addenda

Any improvements or changes concerning the matrix card or manual will be explained on an addendum. Addenda are provided in a page replacement format. Simply replace the obsolete pages with the new pages where indicated.

1.5 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 indicates 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 matrix card. Such damage may invalidate the warranty.

The **COLUMN**, **COLUMNS**, **ROW**, and **ROWS** terms used in this manual reference the rear panel receptacles of the Model 7077 Matrix Card.

The **Mainframe** term used in this manual references the Model 707 or Model 708 Switching Matrix.

1.6 Specifications

Model 7077 specifications are located at the front of this manual. These specifications are exclusive of the switching matrix specifications.

1.7 Unpacking and inspection

1.7.1 Inspection for damage

The Model 7077 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.

- Always grasp the card by the handle and side edges. Do not touch edge connectors, board surfaces, or components.
- When not installed in a switching matrix, keep the card in the anti-static bag and store 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 damage to the shipping agent immediately.

If installing the card in a switching matrix at this time, be sure to follow the additional handling precautions explained in paragraph 4.2.

1.7.2 Shipping contents

The following items are included with every Model 7077 order:

- Model 7077 Isolated Coaxial 8 × 12 Matrix Card.
- Model 7077 Instruction Manual.
- Additional accessories (as ordered). Note that the cables may be shipped in a separate packing carton.

1.7.3 Instruction manual

If an additional Model 7077 Instruction Manual is required, order the manual package, Keithley part number 7077-901-00. The manual package includes an instruction manual and any applicable addenda.

1.8 Optional accessories

The following optional accessories are available from Keithley for use with the Model 7077:

Low noise triax cable

Model 237-ALG-2 — Low noise triax cable. A 2m (6.6ft.) cable with a 3-slot male triax connector on one end and three alligator clips on the other.

Low noise coaxial cable/cable kit

Model 4801 — Low noise coaxial cable. A 1.2m (48in.) cable with male BNC connectors on both ends.

Model 4802-10 — Low noise coaxial cable. A 3m (10ft.) cable with a male BNC connector end and an unterminated end.

Model 4803 — Low noise coaxial cable kit. Includes 50ft. of low noise coaxial cable, ten male BNC connectors, and five female BNC chassis-mount connectors.

BNC adapter/shorting plug

Model 4804 — Male BNC to female triax adapter.

Model 4851 — BNC shorting plug.

Model 6147 — Male triax to female BNC adapter.

BNC Interconnect cables

The BNC interconnect cables, 50Ω BNC to BNC (RG-58C), are available in the lengths listed in Table 1-1:

*Table 1-1
BNC cable lengths*

Model number	Length
7051-2	0.6m (2ft.)
7051-5	1.5m (5ft.)
7051-10	3.0m (10ft.)

Miscellaneous

Model 7754-3 BNC to alligator cable — 0.9m (3ft.) 50Ω cable (RG-58C) terminated with a BNC plug on one end and two alligator clips on the other end.

Model 7755 50Ω feed-through terminator — BNC to BNC adapter terminated with a 50Ω resistor.

2

Operation

2.1 Introduction

WARNING

The matrix configuration procedures in this section should only be performed by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Review the safety precautions found at the front of this manual.

This section contains detailed information on matrix card operation.

2.2 Basic matrix configurations

A simplified schematic of the Model 7077 matrix card is shown in Figure 2-1 (View A). Each of the 96 crosspoints is made up of a two-pole switch. By closing the appropriate crosspoint switch, any row can be connected to any column in the same matrix. The columns of every Model 7077 matrix card are referred to as columns 1 through 12, except where noted.

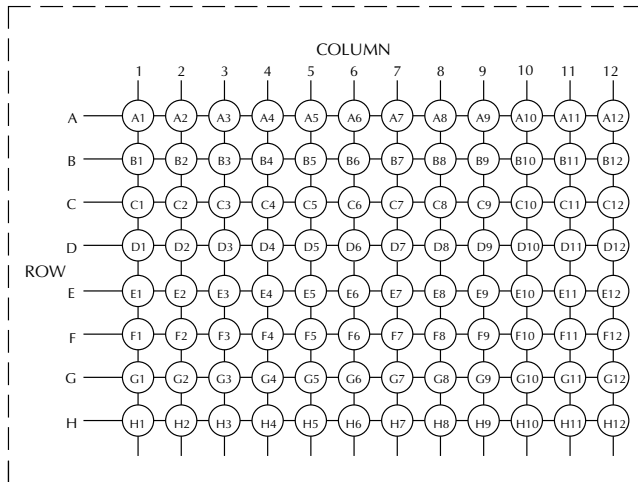
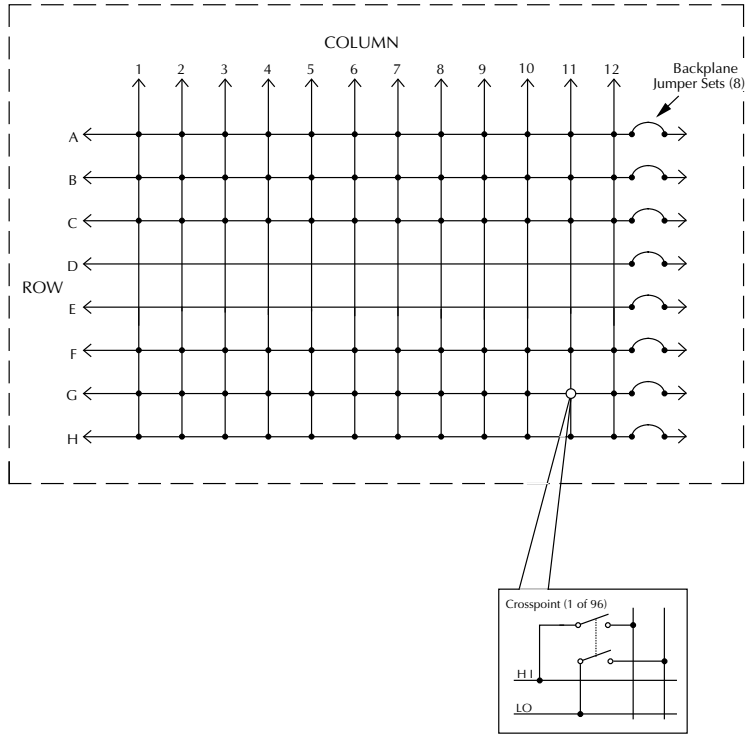
The Model 707 or 708 recognizes 12 columns for programming purposes. The crosspoint assignments for the matrix card are shown in Figure 2-1 (View B). To connect ROW A to COLUMN 10, the Model 707 or 708 must be programmed to close crosspoint A10 (ROW A, COLUMN 10). To connect ROW E to COLUMN 10, crosspoint E10 must be closed. The crosspoint assignments in Figure 2-1 (View B) are valid regardless of how the card is configured.

When installed in a multiple card switching matrix (Model 707), the column number assignments for programming the Model 707 are determined by the switching matrix slot the matrix card is installed in. For example, the column number assignments of a matrix card installed in slot 4 of the switching matrix are numbered 37 through 48. Column number assignments for all six switching matrix slots are listed in Table 2-1.

*Table 2-1
Model 7077 column number assignments*

Card location	Matrix column numbers
Slot 1	1 through 12
Slot 2	13 through 24
Slot 3	25 through 36
Slot 4	37 through 48
Slot 5	49 through 60
Slot 6	61 through 72

In Figure 2-1 (View A), there are backplane jumpers located on the matrix card. With the jumpers installed, the matrix card is connected to the backplane of the Model 707 or 708 for matrix expansion (see paragraph 2.5). With the jumpers removed, the matrix card is isolated from other cards or switching matrices. The physical location on the board of these jumpers is shown in Figure 2-2.



Note : Crosspoint assignments of Model 7077 Matrix Card shown above apply when installed in:
 Model 708 Switching Matrix - Stand-alone or master of multi-unit configuration or
 Model 707 Switching Matrix - Slot one of stand-alone or master of multi-unit configuration.

Figure 2-1
 Model 7077 simplified schematic and crosspoint assignments

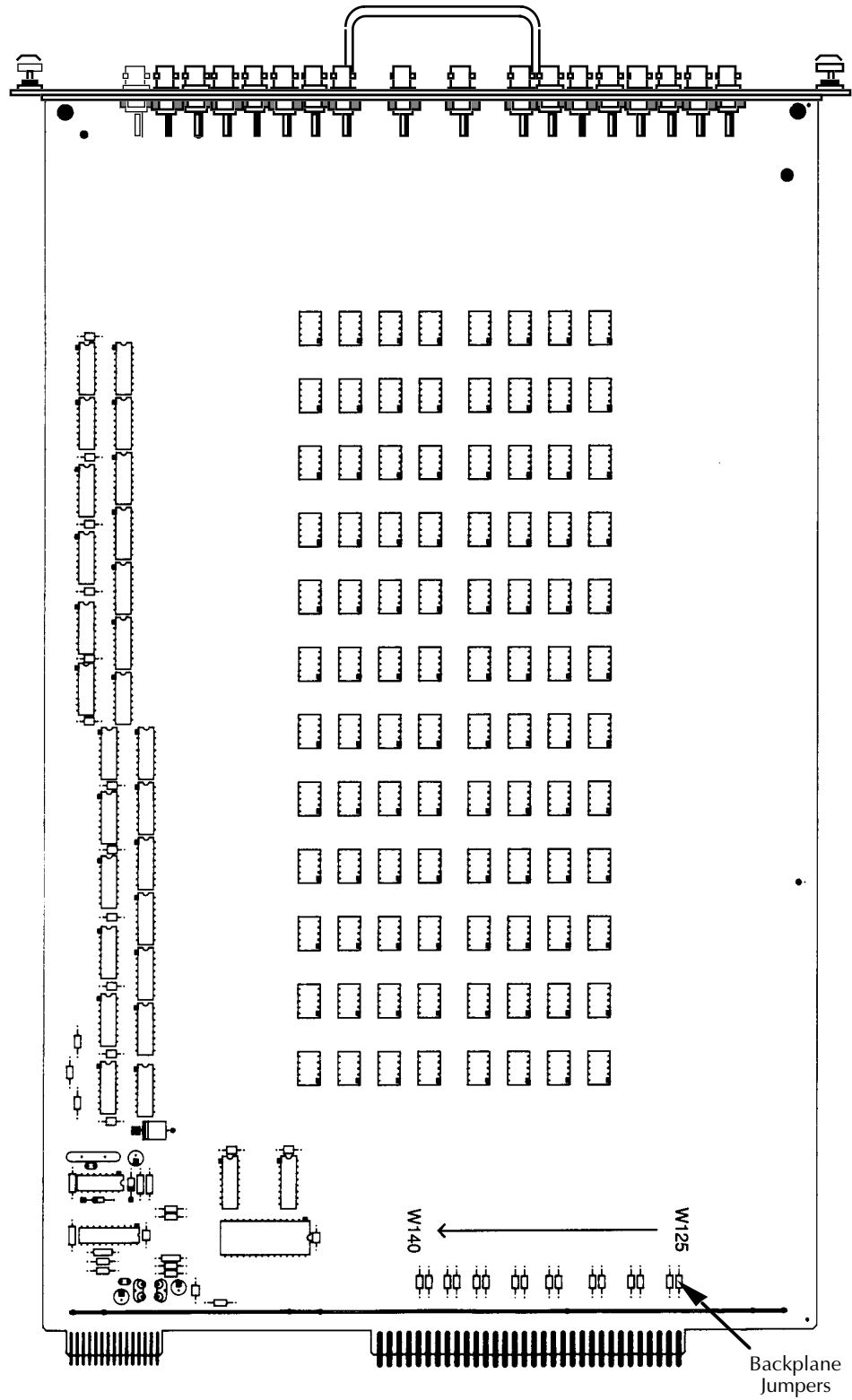


Figure 2-2
Simplified component layout

2.3 Typical matrix switching schemes

The following paragraphs describe basic switching schemes that are possible with a two-pole switching matrix.

2.3.1 Single-ended switching

In the single-ended switching configuration, the source or measure instrument is connected to the DUT through a single pathway as shown in Figure 2-3. The closure of a single crosspoint will connect an instrument to a DUT.

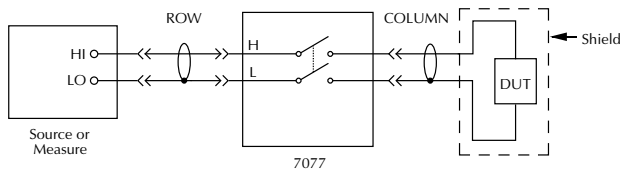


Figure 2-3
Single-ended switching example (using 4801 coaxial cable)

2.3.2 Differential switching

The differential or floating switching configuration is shown in Figure 2-4. The advantage of using this configuration is that the terminals of the source or measure instrument are not

confined to the same matrix crosspoint. Each terminal of the instrument can be connected to any matrix crosspoint. The LO terminals of the matrix card are used as a shield. The closure of a single crosspoint will not connect an instrument to a DUT.

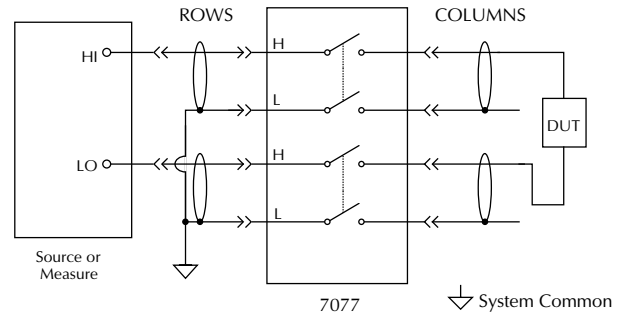


Figure 2-4
Differential switching example

2.3.3 Sensing

Figure 2-5 shows how the matrix card can be configured to use instruments that have remote sensing capability. Sensing is used to cancel the effects of matrix card path resistance (<math><1.5\Omega</math>) and the resistance of external cabling. Remote sensing should be used when path resistance needs to be considered.

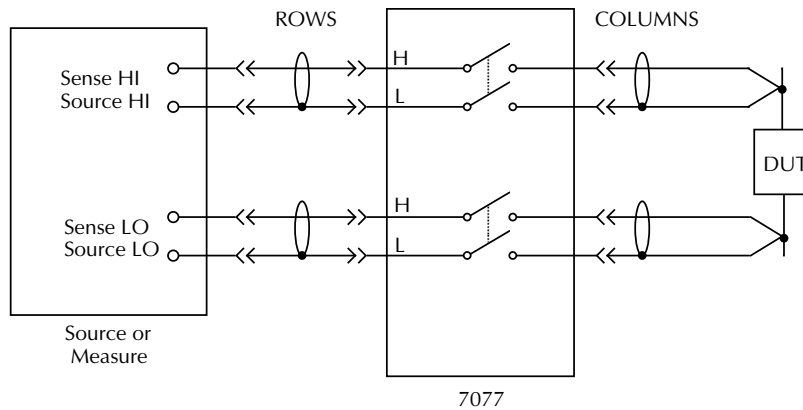


Figure 2-5
Sensing example

2.4 Connections

CAUTION

To prevent damage (not covered by the warranty), do not exceed the maximum allowable limits of the Model 7077. Maximum signal levels are listed in the specifications located at the front of the manual.

All rows and columns of the Model 7077 Matrix Card are connected to the BNC connectors mounted on the rear panel of the matrix card when shipped. One receptacle is provided for each row connection (rows A through H) and one for each column connection (columns 1 through 12).

BNC connector identification is provided in Figure 2-6. Each BNC connector is internally connected to the adjacent corresponding row or column.

Cable connections

Available Keithley cables and connectors for customized user supplied terminations are summarized in Table 2-2.

WARNING

To avoid electrical shock that could result in injury or death, ALWAYS remove power from the entire system (Model 707 or 708, test instruments, DUT, etc.) and discharge any capacitors before connecting or disconnecting cables from the matrix card.

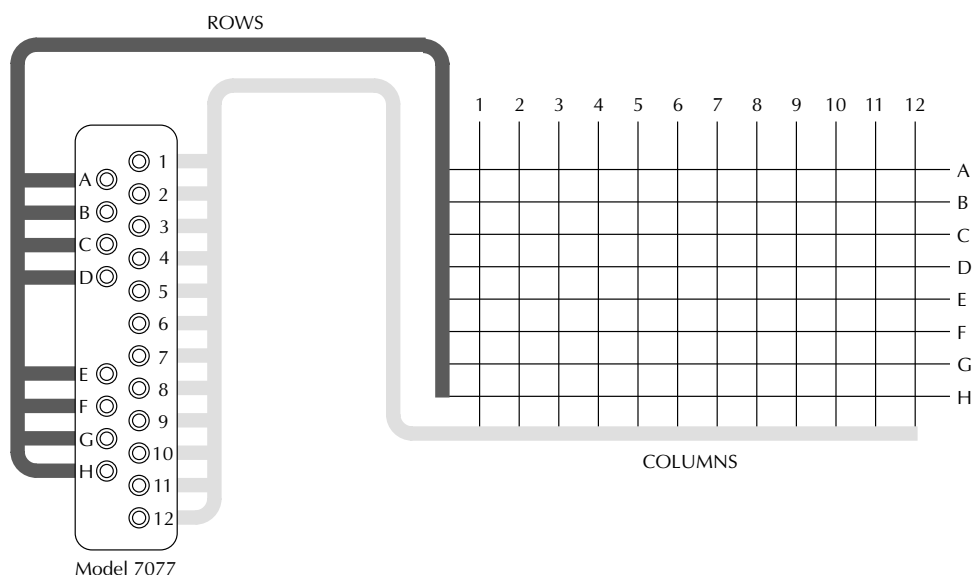


Figure 2-6
BNC connector identification

Table 2-2
Available Keithley cables and connectors

Model or part number	Description
237-ALG-2	Low noise triax cable 2m (6.6ft.) in length with a 3-slot male triax connector on one end and three alligator clips on the other.
4801	Low noise coaxial cable 1.2m (48in.) in length with male BNC connectors on both ends.
4802-10	Low noise coaxial cable 3m (10ft.) in length with a male BNC connector at one end and unterminated at the other end.
4803	Low noise cable kit. Includes 50ft. of low noise coaxial cable, 10 male BNC connectors, and 5 female BNC chassis-mount connectors.
4804	Male BNC to female triax adapter.
4851	BNC shorting plug.
6147	Male triax to female BNC adapter.
7051-2 BNC to BNC cable	The Model 7051-2 is a 50Ω BNC to BNC cable (RG-58C) 1.5m (5ft.) in length.
7051-5 BNC to BNC cable	The Model 7051-5 is a 50Ω BNC to BNC cable (RG-58C) 1.5m (5ft.) in length.
7051-10 BNC to BNC cable	The Model 7051-10 is a 50Ω BNC to BNC cable (RG-58C) 3.0m (10ft.) in length.
7754-3 BNC to alligator cable	The Model 7754-3 is a 0.9m (3ft.) 50Ω cable (RG-58C) terminated with a BNC plug on one end and two alligator clips on the other end.
7755 50Ω feed-through terminator	The Model 7755 is a BNC to BNC adapter terminated with a 50Ω resistor.

Use the following procedure to connect a BNC cable to the matrix card:

1. Install the matrix card in the Model 707 or 708 Switching Matrix (see paragraph 4.3).
2. Push the cables onto the appropriate receptacle of the matrix card.
3. Tighten the BNC connector to secure it to the panel. The same procedure can be used for connecting the cable plug to a test fixture receptacle.

Modifying BNC terminated

A common way to use the standard cable is to cut it at a convenient length. The result is two cables that are both unterminated at one end. The unterminated ends of the cables can then be connected to instrumentation and the DUT, and the other ends can mate to the ROW and COLUMN BNC connectors of the matrix card.

WARNING

Due to the large amount of wiring that switching systems contain, check that both ends of the coaxial cable to be cut are disconnected from instruments or DUTs prior to performing this procedure. Cutting a connected cable may cause severe injury or death due to electric shock.

2.5 Matrix expansion

By using additional matrix cards in the Model 707 or additional switching matrices in the Model 708, larger matrices can be configured through the backplane of the Model 707 or 708. Therefore, unless otherwise noted, the examples provided in the following paragraphs assume the Model 7077 backplane jumpers are installed.

2.5.1 Backplane row jumpers

Matrix row expansion can be done through the backplane of the Model 707 or 708 Switching Matrix. As explained in paragraph 2.2, the Model 7077 has eight sets of backplane jumpers that connect the rows of the matrix card to the switching matrix backplane.

Model 707 switching matrix

The set of backplane jumpers located in the Model 707 Switching Matrix must be considered when building larger matrices through rows. With the switching matrix backplane jumpers installed, the rows of all switching matrix slots are connected together. With these jumpers removed, the rows of Model 707 Switching Matrix slots 1, 2, and 3 are isolated from the rows of slots 4, 5, and 6.

NOTE

- The Model 707 Switching Matrix is shipped with its backplane row jumpers installed. Some configurations require these backplane row jumpers to be removed. The procedure for removing these jumpers is in the Model 707 Instruction Manual.
- The Model 708 Switching Matrix does not have backplane row jumpers. It is a one-slot switching matrix.

Backplane compatibility considerations

The Model 7077 may be incompatible with other card types when expansion is through the backplane. For example, in some test systems it may be necessary to connect LO of the Model 7077 (which is a two-pole card) to LO of a three-pole card. As shipped, the Model 7077 backplane row jumpers connect the LO signal paths to the GUARD terminals of the three-pole general purpose backplane of the Model 707 or 708 switching matrix. The LO signal paths of the other card are connected to the LO backplane terminals of the Model 707 or 708. With this configuration, LO of the Model 7077 cannot be routed to LO of the other card.

The Model 7077 provides flexibility by allowing the backplane route of the guard signal paths to be altered. The backplane row jumpers are shown in Figure 2-7. They have circuit designations W125 through W140. The odd circuit designations (W125, W127, W129, W131, W133, W135, W137 and W139) identify the LO jumpers of the card. These jumpers connect the LO signal paths of the card to the GUARD backplane terminals of the Model 707 or 708. Adjacent to each HI jumper (identified by the even circuit designations) are holes in the pc-board to accommodate a jumper. By moving the guard jumpers to these locations, the matrix card LO paths will connect to the low backplane terminals of the Model 707 or 708.

WARNING

Internal modifications to the matrix card should only be performed by qualified service personnel familiar with standard safety precautions.

CAUTION

Solder operations require that the pc-board be cleaned. Refer to the precautions contained in paragraph 4.2.

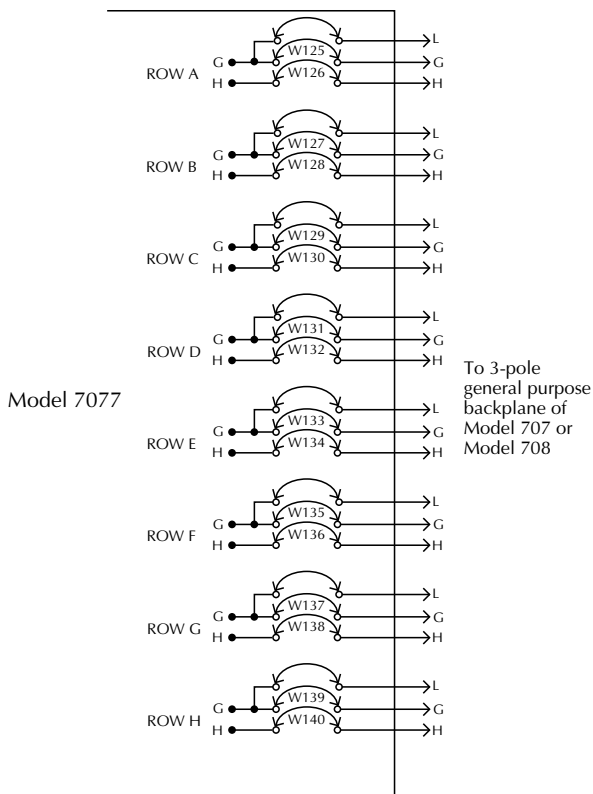


Figure 2-7
Backplane jumper configuration (factory default)

A simplified schematic diagram of the Model 707 backplane is shown in Figure 2-8. The segmented line represents backplane connections for one matrix row. Each empty slot is isolated by the open backplane connections. Row connections from one slot to an adjacent slot are accomplished through the jumpers on the Model 7077 Matrix Cards.

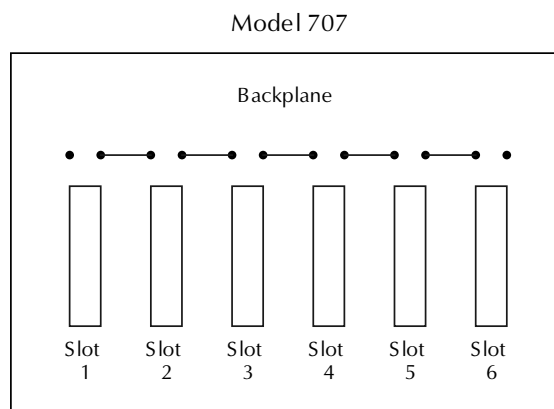


Figure 2-8
Model 707 backplane configured for row expansion

As shown in Figure 2-7, the backplane disconnect jumper is positioned to connect the matrix row to the next higher and lower switching matrix slot. To isolate the matrix row from the backplane, remove the jumper. Refer to the Model 707 Switching Matrix Instruction Manual for more information on configuring the Model 707 Switching Matrix backplane disconnect jumpers.

NOTE

The backplane used in the Model 707 and 708 Switching Matrices for the Model 7073 Matrix Cards is not used by any other switching matrix cards. This isolates any Model 7077 Matrix Cards connected through the backplane of a Model 707/708 Switching Matrix from Model 7073 Matrix Cards.

2.5.2 Narrow matrix expansion

When shipped from the factory, the jumpers on the card are positioned to connect the rows into the backplane of a Model 707 or 708 Switching Matrix. Therefore, each Model 7077 card installed next to another Model 7077 in the switching matrix extends the matrix by 12 columns (see Table 2-3). For example, three cards installed in slots 1, 2, and 3 of the Model 707 will result in an 8 × 36 matrix. Figure 2-9 shows three matrix cards installed in slots 1, 2, and 3. Cards must be installed in adjacent slots for the rows to be connected together. Similarly, if a Model 708 Switching Matrix is externally expanded (three Model 708s connected through the backplane), installing the Model 7077 Matrix Card in each would result in an 8 × 36 matrix. Refer to paragraph 2.5.5 for information on external mainframe matrix expansion for the Model 708 Switching Matrix.

Table 2-3
*Narrow matrix expansion**

Installed matrix cards	Resulting matrix
1 card	8 × 12
2 cards	8 × 24
3 cards	8 × 36
4 cards	8 × 48
5 cards	8 × 60
6 cards**	8 × 72

* For the Model 707 Switching Matrix, backplane jumpers must be in position 1 (refer to Model 707 Switching Matrix Instruction Manual), and cards must be installed with no empty slots between them. This will keep the circuit through the backplane serial link closed.

**Not applicable to the Model 708 Switching Matrix due to the master/slave configuration having a maximum of five cards.

2.5.3 Wide matrix expansion

Configure wide matrices by connecting the columns of one Model 7077 card to the columns of another Model 7077 card. An example of a wide matrix (16 × 12) is shown in Figure 2-10. Note that the rows of the two cards are isolated from each other. Isolate each matrix card's rows by removing jumpers to isolate each card.

The most convenient method for connecting columns of two cards together is to use 12 BNC to BNC cables (Keithley Model 7051) and 12 BNC “T” female, male, female adapters (Pomona Model 3285). Connect the “T” adapters to the 12 columns of one card, and then connect the BNC cables from the adapters to the columns of the other card. The extra BNC connector on each adapter will then allow column connection to instrumentation or DUTs.

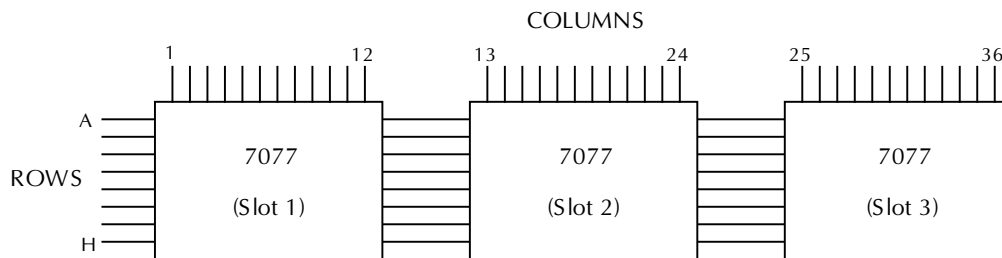


Figure 2-9
Narrow matrix expansion (8 × 36)

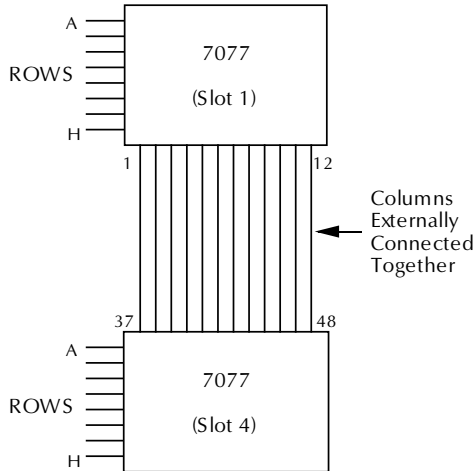


Figure 2-10
Wide matrix expansion (16 × 12)

2.5.4 Partial matrix implementation

A fully implemented matrix provides a relay at each potential crosspoint. For example, a fully implemented 16 × 24 matrix utilizing four Model 7077s contains 384 crosspoints. A partially implemented matrix is obtained by removing one Model 7077 from the switching matrix (Figure 2-11). The partial matrix is still 16 × 24, but contains only 288 crosspoints. An advantage of a partial matrix is that fewer matrix cards are needed. Also, by incorporating a partial matrix into the design of the matrix, specific devices can be isolated avoiding direct connection with an accidental crosspoint closure. For example, a source in Figure 2-11 cannot be connected to DUT #2 with one “accidental” crosspoint closure. Three specific crosspoints must be closed in order to connect a source to DUT #2. Partial matrix expansion of a Model 708 Switching Matrix can be accomplished by externally expanding the matrix (three Model 708s, two connected through the backplane, one connected externally through the matrix columns). Refer to paragraph 2.5.5 for information on external mainframe matrix expansion for the Model 708 Switching Matrix.

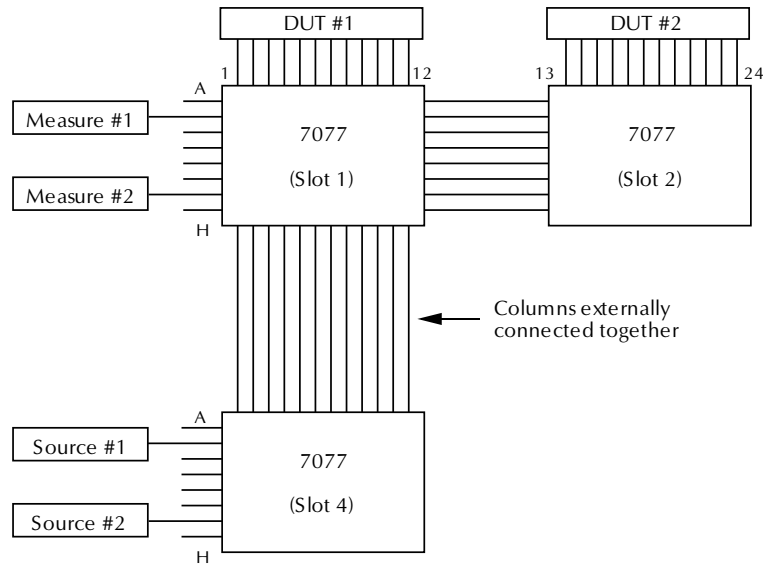


Figure 2-11
Partial matrix example (16 × 24)

2.5.5 Mainframe matrix expansion

Model 707

Systems containing up to 30 matrix cards can be built by daisy-chaining five Model 707 switching matrices together. Using 30 Model 7077 matrix cards provides 2880 crosspoints.

Assuming all backplane jumpers are installed, connecting the rows of a card in one mainframe to the rows of a card in a second mainframe increases the number of columns in the matrix. For example, if the rows of a 4×120 matrix in one mainframe are connected to the rows of a 4×72 matrix in a second mainframe, the resulting matrix would be 4×192 . See the Model 707 Instruction Manual for detailed information on daisy-chaining Model 707 mainframes. Table 2-4 summarizes possibilities for mainframe matrix expansion for one Model 707 Switching Matrix. A maximum of 576 crosspoints can be contained in each Model 707 Switching Matrix.

Table 2-4
Mainframe matrix expansion — Model 707

Number of installed matrix cards per mainframe	Resulting matrix per Model 707 Switching Matrix
1	8×12
2	8×24
3	8×36
4	8×48
5	8×60
6	8×72

Model 708

Systems containing up to five Model 7077 Matrix Cards are possible by daisy-chaining five Model 708 Switching Matrices together. Using five Model 7077 Matrix Cards provides a maximum of 480 crosspoints (96 per switching matrix/matrix card).

The number of columns in the matrix can be increased by connecting the rows of the card in one switching matrix to the rows of the card in the second switching matrix, assuming all backplane jumpers are installed. For example, if the rows of an 8×12 card in one switching matrix are connected to the rows of an 8×12 card in a second switching matrix, the result would be an 8×24 matrix. See the Model 708 In-

struction Manual for detailed information on daisy-chaining Model 708 Switching Matrices. Table 2-5 summarizes the possibilities for mainframe matrix expansion for the Model 708 Switching Matrix.

Table 2-5
Mainframe matrix expansion — Model 708

Number of mainframe	Resulting matrix
1	8×12
2	8×24
3	8×36
4	8×48
5	8×60

2.6 Typical connection schemes

The following paragraphs provide typical connection schemes for single card, multiple card, and multiple switching matrix configurations. A system using the matrix card with a multiplexer card (Keithley Model 7075) is illustrated to demonstrate versatility and compatibility.

All examples show BNC cables. In many cases, these cables are best used by cutting them in half, which provides twice as many cables and allows direct connection to instrumentation and the DUT. Cables could be custom built to better suit a particular application.

2.6.1 Single card system

External connections for a single card system are made by connecting instrumentation to matrix card rows using a BNC cable for general purpose testing. Cutting one of these cables in half provides two column cables that will connect directly to the DUT. Figure 2-12 shows the connections of an example single card system. Instruments are connected to the Model 7077 rows, and DUTs are connected to the Model 7077 columns and four of the rows (E through H).

2.6.2 Multiple card system

Figure 2-13 shows a system using two matrix cards. In this configuration, the instrumentation and the DUT are both connected to the columns of the matrix. In this example, the instruments are connected to the rows (they only require six pathways), and the DUTs are connected to the columns.

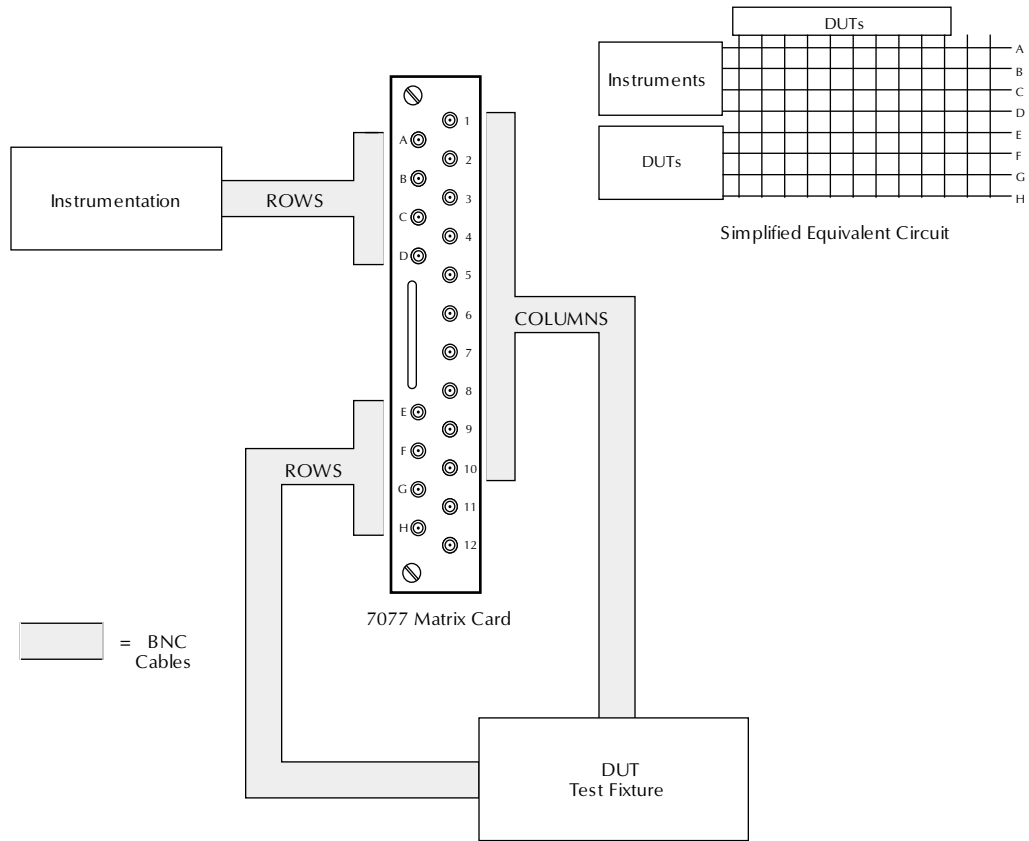


Figure 2-12
Single card example

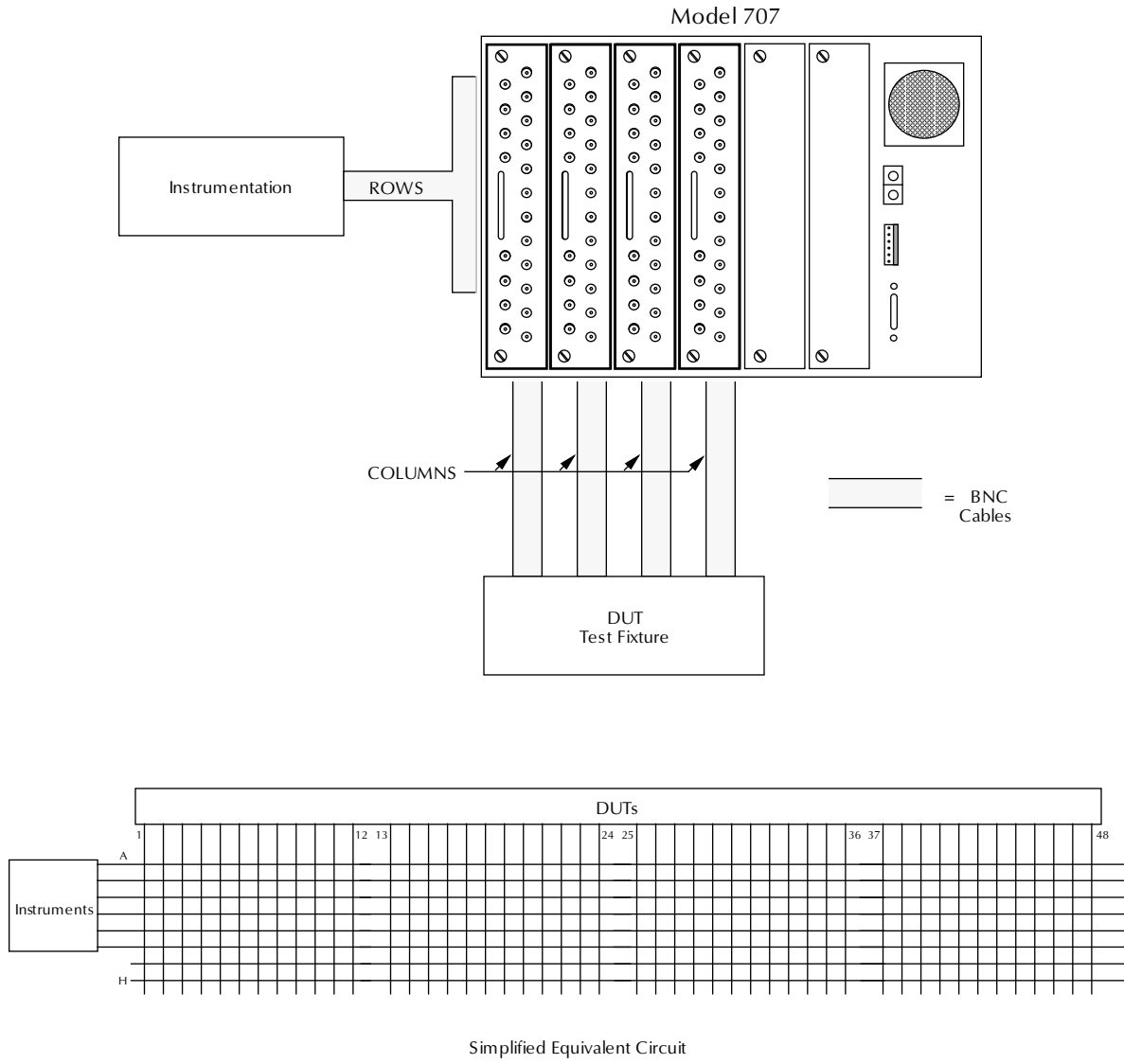


Figure 2-13
Multiple card system example

2.6.3 Multiple switching matrix system

Figure 2-14 shows a system using eight matrix cards, requiring two Model 707s daisy-chained together. In this configuration, instrumentation and DUTs are connected to matrix card columns. A single cable is used to connect each row of the master Model 707 Switching Matrix to the corresponding row of the slave. Use a modified or custom cable as short as possible especially if path resistance is a critical factor. Similarly in Figure 2-15, two Model 708 Switching Matrices are daisy-chained together.

2.6.4 Matrix/multiplexer system

Figure 2-16 shows an example of how the Model 7077 is used with a multiplexer card (Keithley Model 7075) in the same test system. In this example, the Model 7077 is configured as an 8×12 matrix and the Model 7075 is configured as a quad 1×24 multiplexer. In this test system, the matrix card provides 24 columns for the DUT or additional instrumentation. By using the multiplexer card in the system, 96 additional test lines become available. Different multiplexer card bank jumper/backplane jumper combinations in the Model 7075 can provide different pin outs for the same quad 1×24 multiplexer configuration. Different multiplexer configurations are easily accomplished. For example (refer to Figure 2-16), removing backplane jumpers for rows C and F, and installing bank jumpers B to C and F to G will configure the card as a dual 1×48 multiplexer.

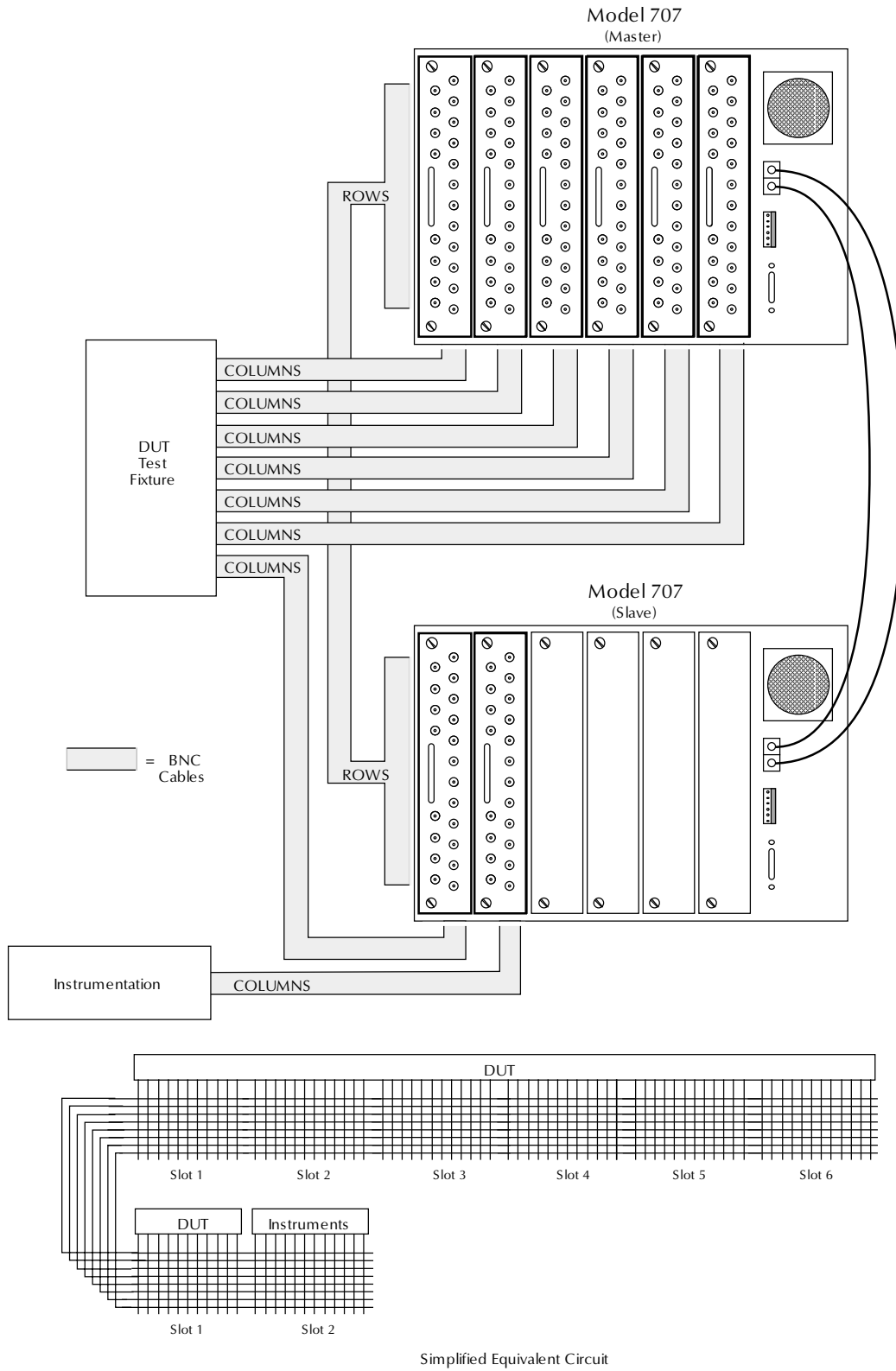


Figure 2-14
Multiple switching matrix example — Model 707

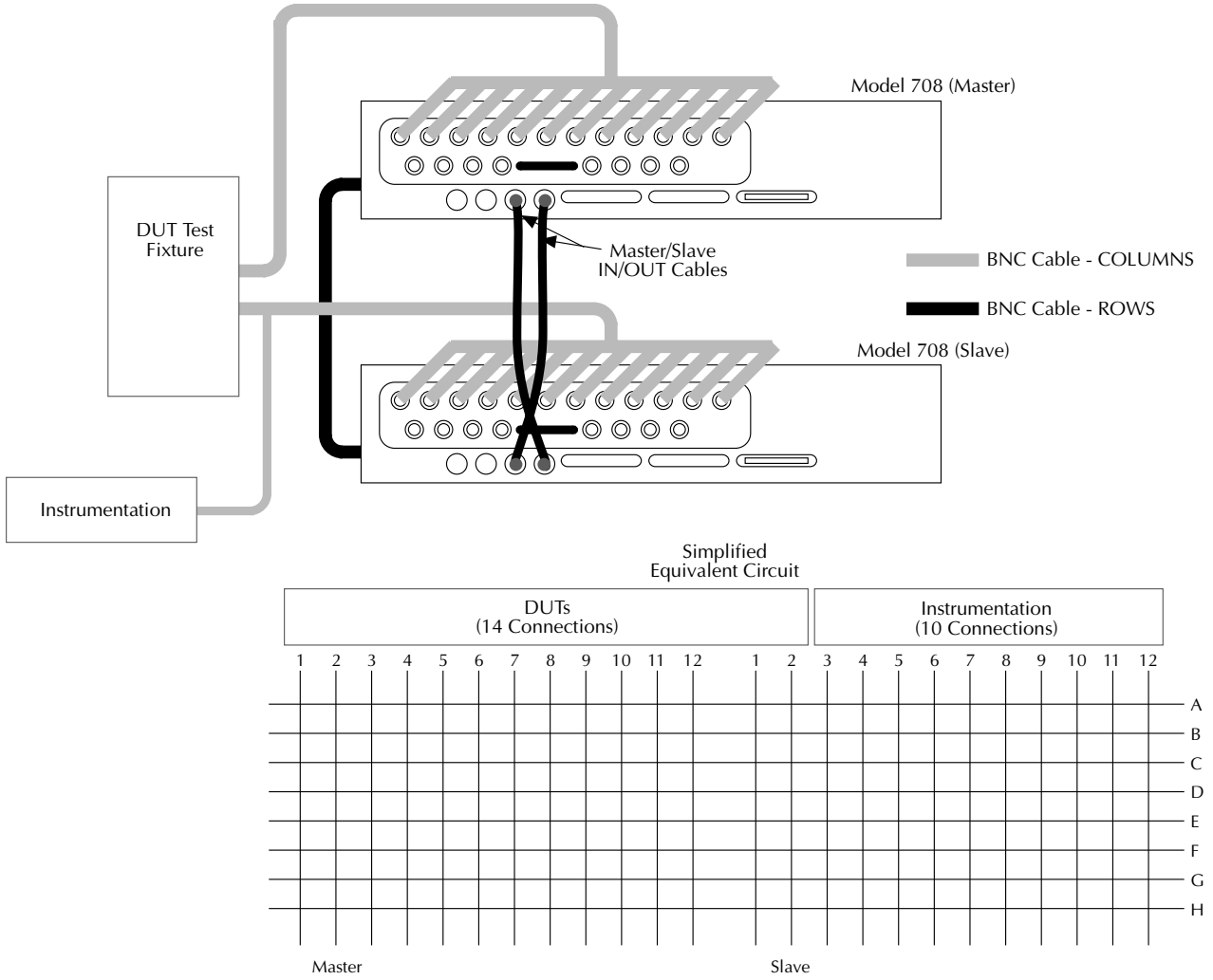


Figure 2-15
Multiple switching matrix example – Model 708

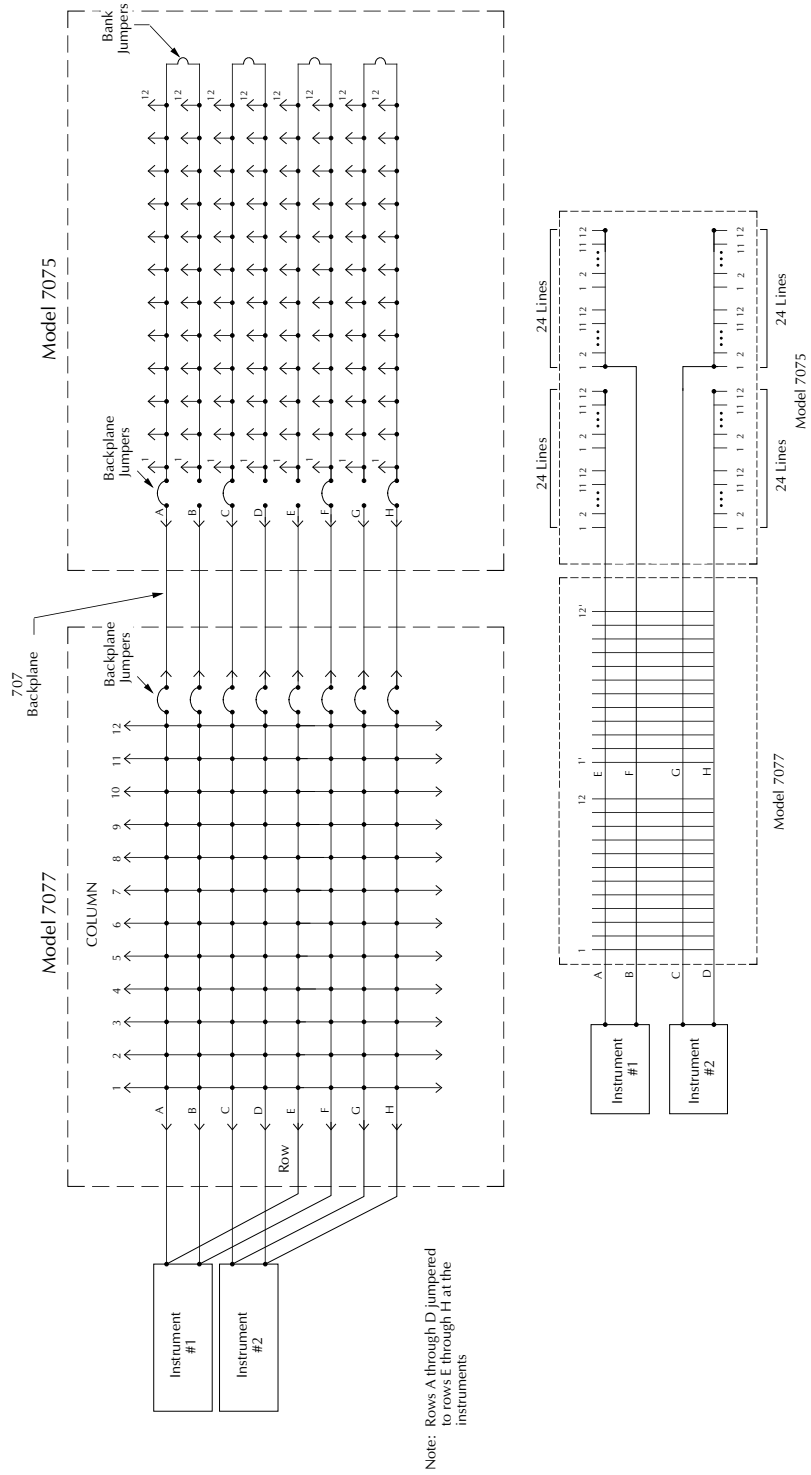


Figure 2-16
Matrix/multiplexer system

3

Applications

3.1 Introduction

General applications to test thick film resistor networks and transistors are provided in this section. These applications are intended to demonstrate the versatility of using the matrix card in test systems.

3.2 Thick film resistor network testing

A dedicated matrix system for testing thick film resistor networks is shown in Figure 3-1. This system provides two different methods for checking thick films: four-wire resistance measurement and voltage measurements using an applied voltage. The Model 7077 used in this system is configured as an 8×12 matrix.

The system shown in Figure 3-1 tests three 3-element thick films, but can be expanded to test more using additional Model 7077 matrix cards. The Model 707 Switching Matrix will accommodate six matrix cards, allowing up to 18 three-element thick films to be tested. Daisy-chaining five Model 707s expands the system to 30 matrix cards allowing 90 three-element thick films to be tested. The Model 708

Switching Matrix accommodates one Model 7077 Matrix Card. Daisy-chaining five Model 708s expands the system to five matrix cards allowing up to 15 thick films to be tested.

3.2.1 Four-terminal ohms measurements

For general purpose testing, the Keithley Model 2000 can be used to make 4-terminal resistance measurements of each thick film. As shown in Figure 3-2, Ohms HI and Ohms Sense HI are connected to one matrix row, and Ohms LO and Ohms Sense LO are connected to another matrix row. With this configuration, the resistance of each resistor element and/or combined elements can be measured by closing the appropriate crosspoints. In Figure 3-2, crosspoints A1 and B3 are closed to measure the combined resistance of R1 and R2.

The effects of thermal EMFs generated by relay contacts and connections can be canceled using the offset compensated ohms feature of the Model 2000. To compensate for thermal EMFs, close two crosspoints (such as A1 and B1). This will short the input of the Model 2000, enabling zero to cancel internal offset, and then enabling offset compensated ohms.

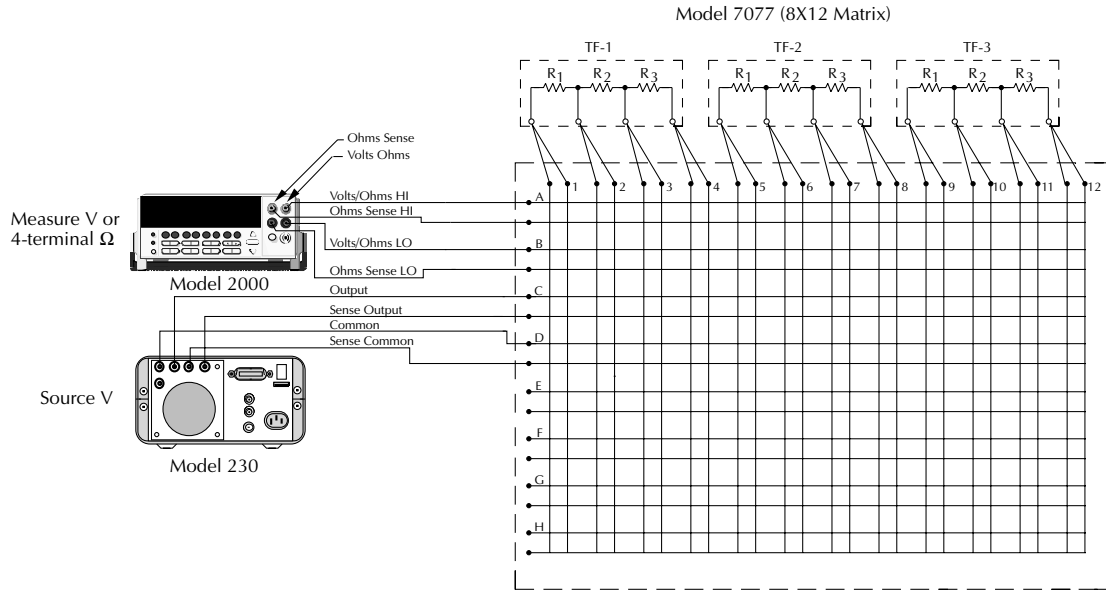


Figure 3-1
Thick film resistor network testing

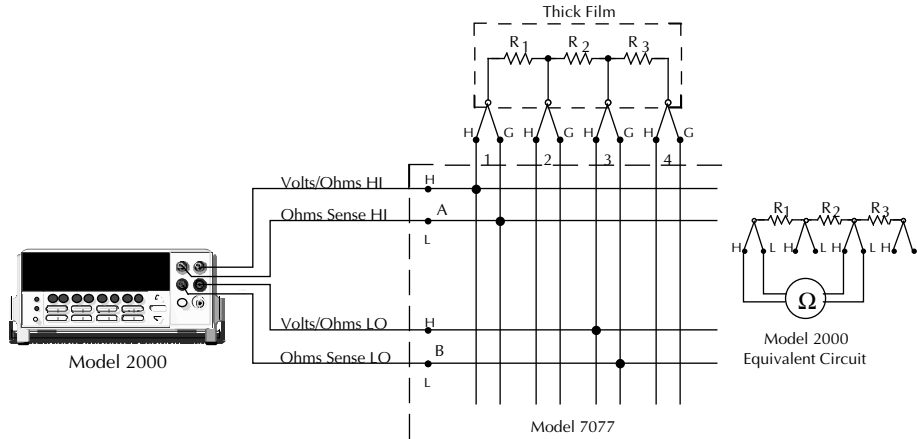


Figure 3-2
Four-terminal Ω measurement

3.2.2 Voltage divider checks

Thick film resistor networks that are going to be used as voltage dividers may be tested using voltages that simulate actual operating conditions. This is a particularly useful test for resistor networks that have a voltage coefficient specification. The test system in Figure 3-1 uses the Keithley Model 230 to source voltage and the Keithley Model 2000 to measure voltage.

A consideration in these checks is the Model 2000 input impedance on voltage measurements. The input impedance is diverted across the resistor being measured. The resultant divider resistance is the parallel combination of the resistor under test and the input impedance. As long as the input impedance is much larger than the resistor being tested, the error introduced into the measurement will be minimal. Minimum input impedance requirements are determined by the accuracy needed in the measurement. The input impedances of the Model 2000 are listed in Table 3-1. For better input impedance requirements, the Keithley Model 6517 Electrometer can be incorporated into the test system to measure voltage.

Another factor considered when checking low voltage dividers is thermal EMFs generated by the matrix card. A matrix card crosspoint can generate up to $+5\mu\text{V}$ of thermal EMFs. When making low voltage measurements be sure to account for this additional error.

Table 3-1
Minimum input impedance — Model 2000 DMM

DC voltage range	Minimum input resistance
100mV	>10G Ω
1.0V	>10G Ω
10V	>10G Ω
100V	10M Ω
1000V	10M Ω

Even though four-terminal connections are made at the Model 2000 and the resistor networks, the sense leads are internally disconnected from the input of the DMM when the volts function is selected. The simplified test system is shown in Figure 3-3.

The thick film is tested by applying a voltage across the resistor network and measuring the voltage across each resistor element and/or across combined elements. In Figure 3-3, crosspoints C1 and D4 are closed to apply voltage across the network, and crosspoints A3 and B4 are closed to measure the voltage drop across R3.

3.3 Transistor testing

A matrix system for testing dc parameters of transistors is shown in Figure 3-4. This system uses a current source (Keithley Model 224), a voltage source (Keithley Model 230) and a DMM (Keithley Model 2000) to measure current and/or voltage. This system tests three transistors, but can be expanded to test more by using additional Model 7077 Matrix Cards. The Model 707 backplane will accommodate six matrix cards. Daisy-chaining five Model 707s expands the system to 30 matrix cards allowing 90 transistors to be tested. Using a Model 708 Switching Matrix for this application, three transistors can be tested. Expanding a system based on the Model 708 Switching Matrix requires an additional Model 708 Switching Matrix for each additional Model 7077 Matrix Card. This expansion allows up to five Model 708 Switching Matrices to be daisy-chained, which allows 15 transistors to be tested.

NOTE

To check FETs or transistors that have high gain or low power, equipment that has lower offset current and higher impedance must be used. To check these devices, the Keithley Model 7072 Semiconductor Matrix Card and the Keithley Model 6517 Electrometer can be used.

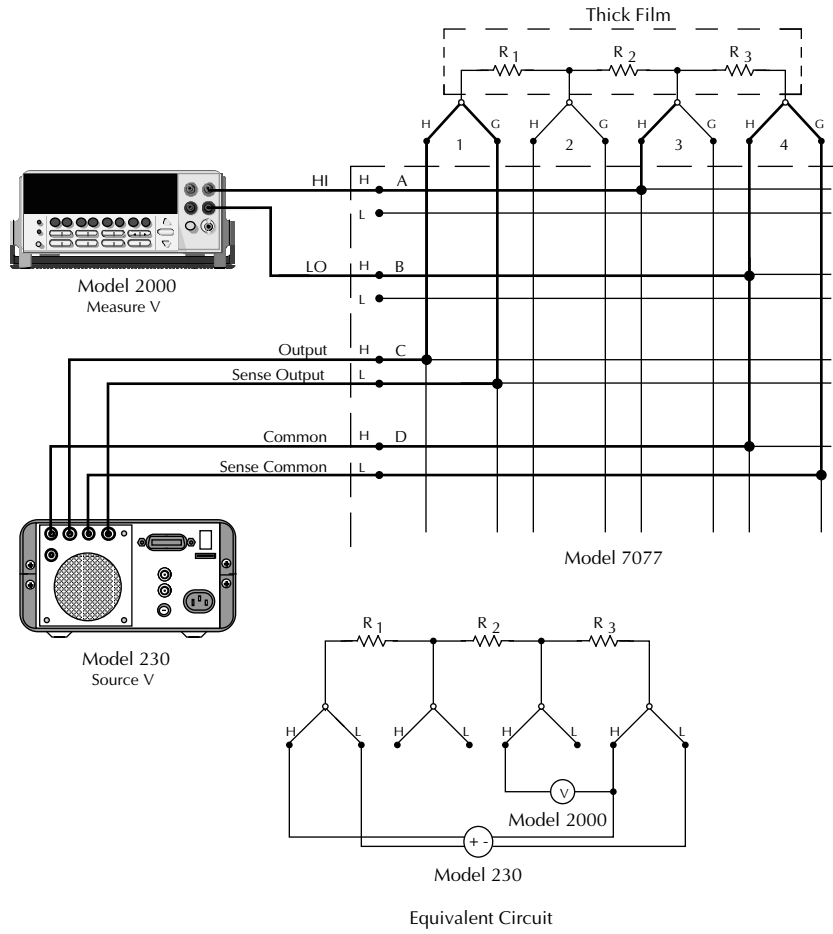


Figure 3-3
Voltage divider checks

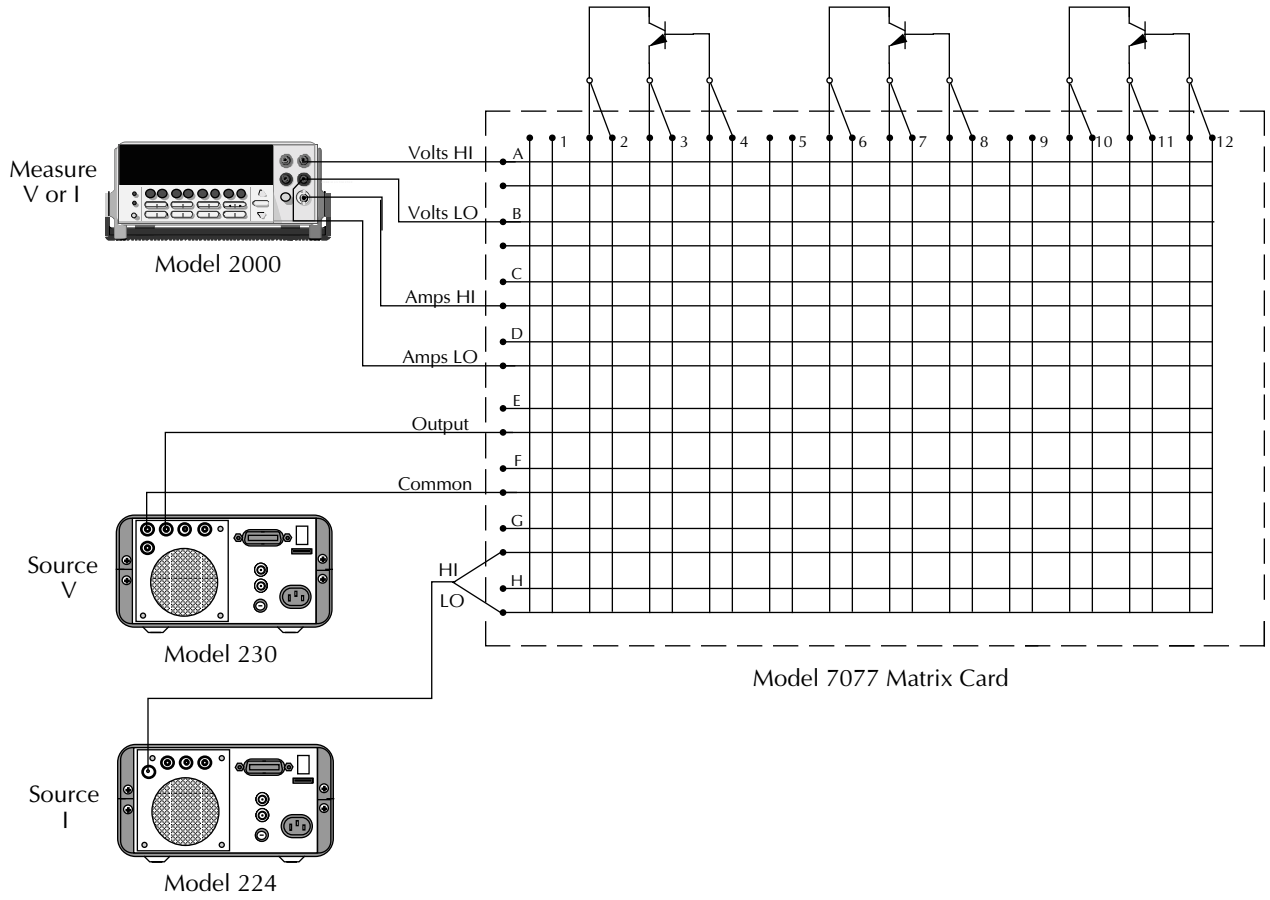


Figure 3-4
Transistor checking

3.3.1 Current gain checks

The dc current gain of a general purpose transistor can be checked by configuring the transistor as a common emitter amplifier. Figure 3-5 shows which crosspoints to close to configure the amplifier circuit. In this circuit, gain is calculated by dividing collector current (measured by the Model

2000) by base current (sourced by the Model 224). A profile of the transistor operating characteristics can be obtained by measuring the collector current over a specified voltage range (V) for different base bias currents. For example, Figure 3-6 shows the characteristics of a typical NPN silicon transistor at base bias currents (I) of 20µA, 40µA, 60µA and 80µA.

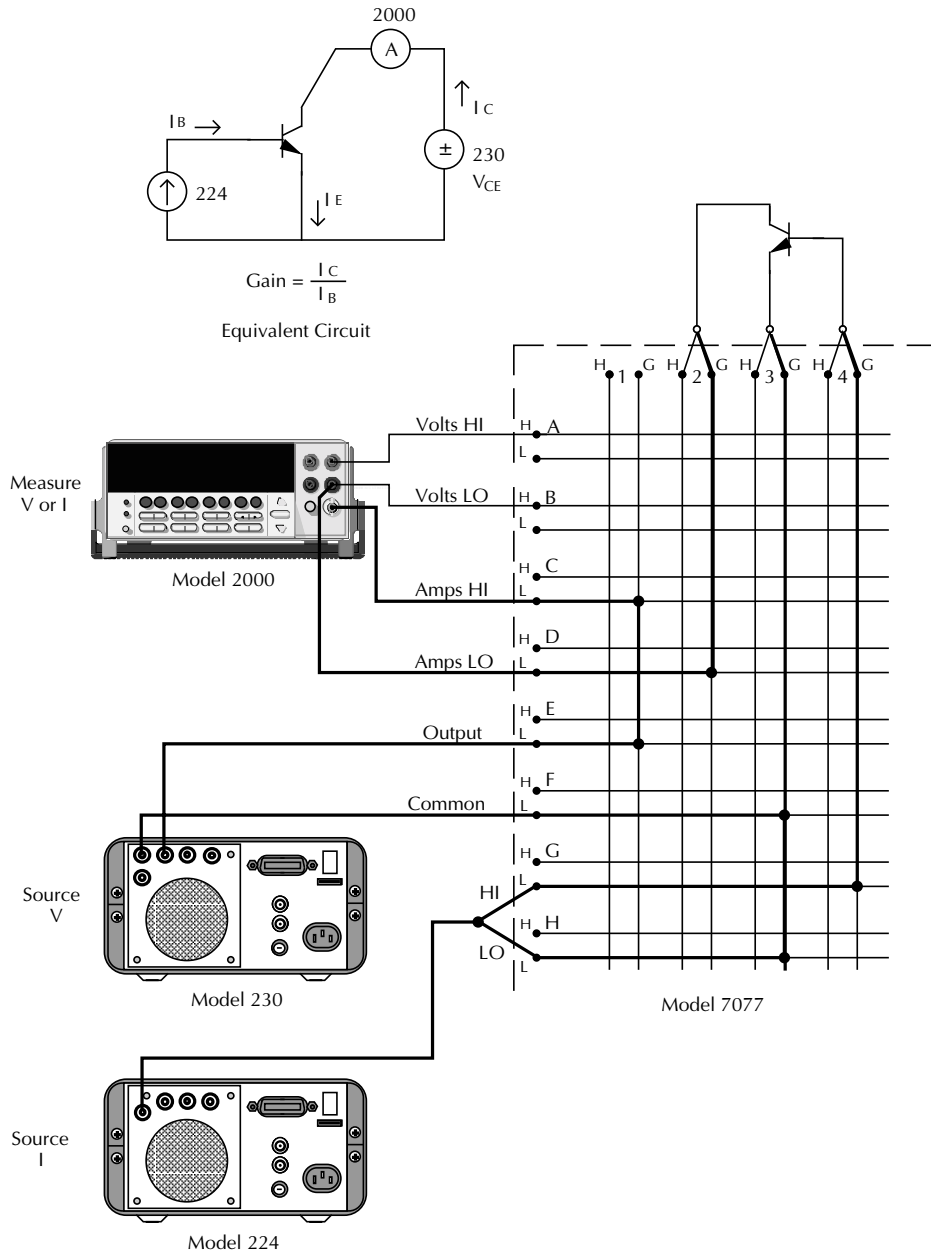


Figure 3-5
Transistor current gain checks

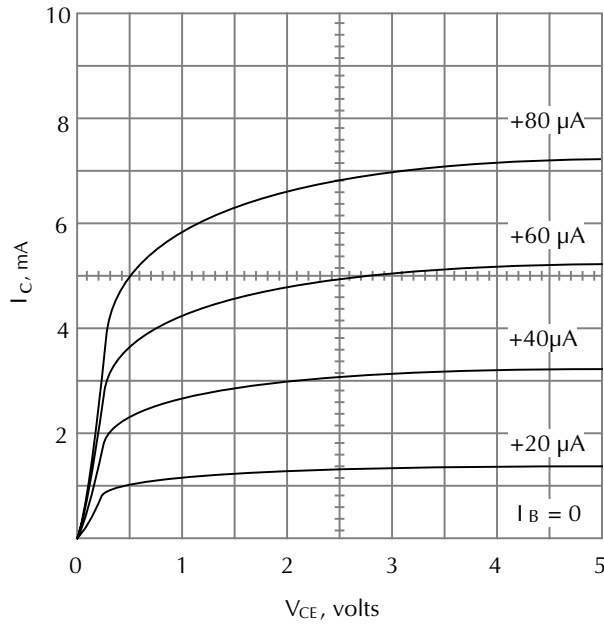


Figure 3-6
Common emitter characteristics of an NPN silicon transistor

3.3.2 I_E and V_{BE} measurements

Matrix versatility is demonstrated in Figure 3-7 and Figure 3-8. The transistor is still configured as a common-emitter amplifier, but the Model 2000 is removed from the collector circuit and used to measure emitter current and base-to-emitter voltage. Notice that external connection changes are not required. All connection changes are accomplished by control of matrix crosspoints. Care must be taken to prevent crosspoints of rows B and D from being closed at the same time.

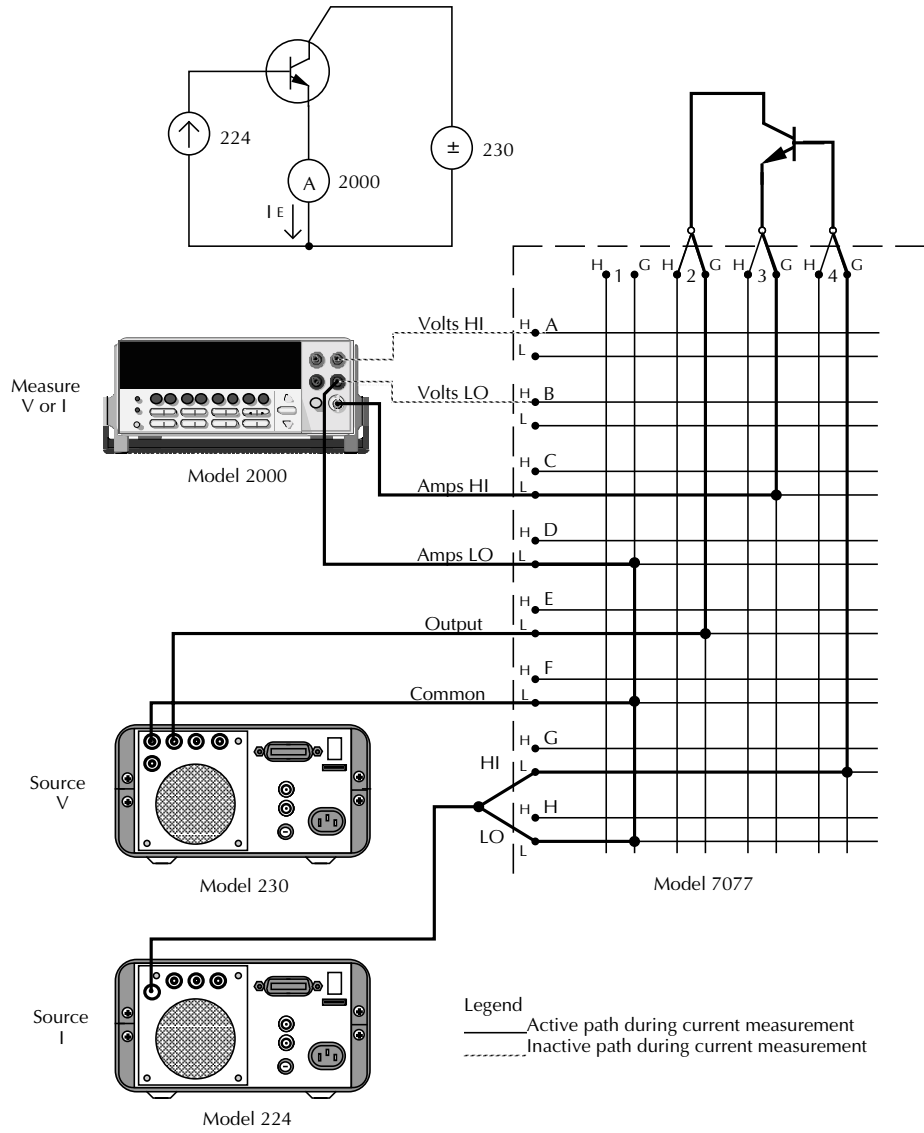


Figure 3-7
Transistor I_E measurements

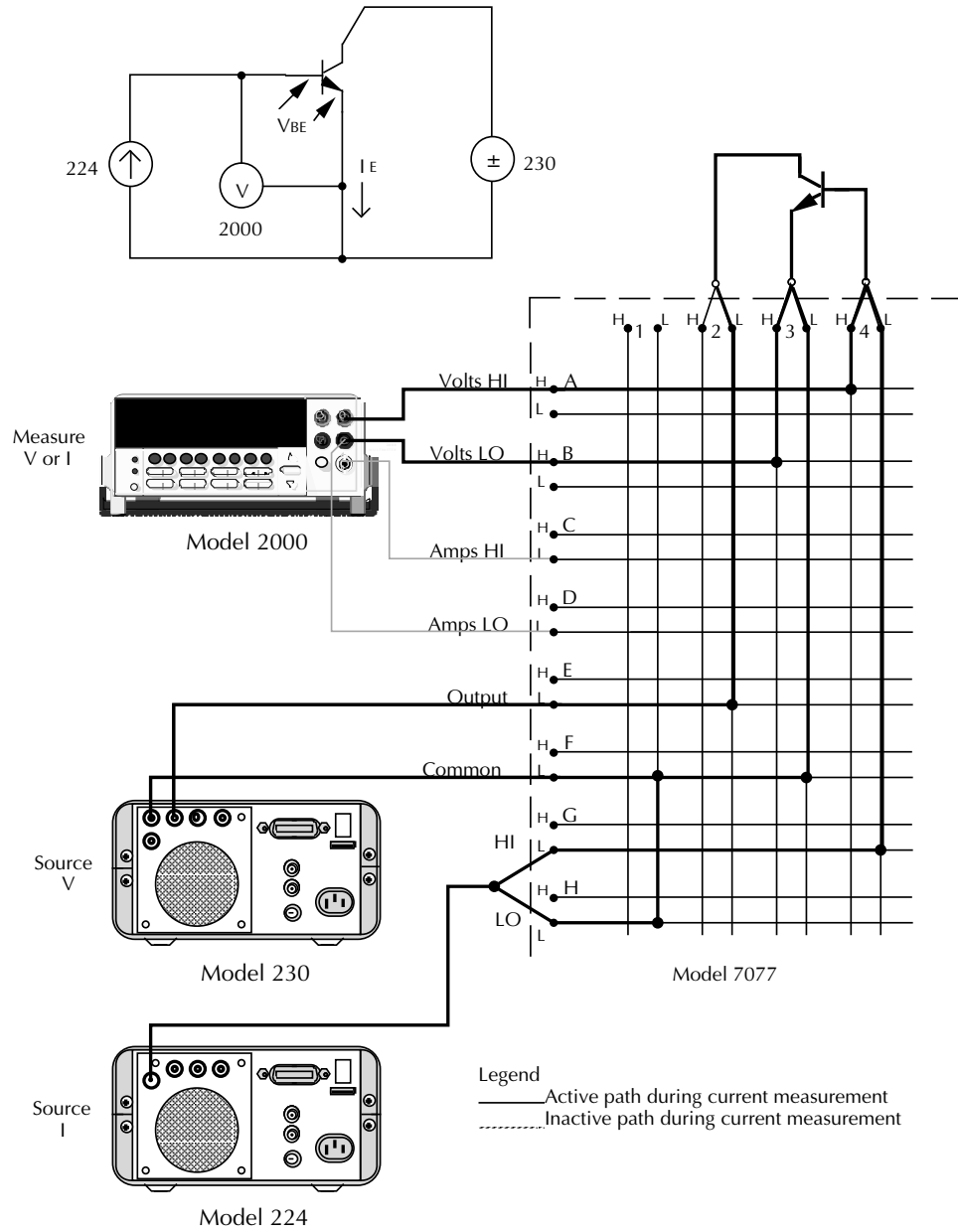


Figure 3-8
 Transistor V_{BE} measurements

4

Service Information

4.1 Introduction

This section contains information on servicing the Model 7077.

WARNING

The matrix configuration procedures and installation in this section should only be performed by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Review the safety precautions found at the front panel this manual.

4.2 Handling and cleaning precautions

Because of the high impedance circuits on the Model 7077, care should be taken when handling or servicing the card to prevent possible contamination, which could degrade performance. The following precautions should be taken when handling the matrix 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 of the card if necessary.
- Handle the card only by the handle and side edges. Do not touch any board surfaces, components, or edge 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 a flux that is rosin RMA based. Remove the flux from these

areas when the repair is complete using Genesolve or the equivalent and clean cotton swabs. 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, and then blow-dry the board with dry nitrogen gas.

- To avoid dirt build-up, operate the switching matrix and matrix card in a clean environment. If the card becomes contaminated, it should be thoroughly cleaned.
- After cleaning, the card should be placed in a 50°C low humidity environment for several hours.

CAUTION

Do not store the card by leaning it against an object (such as a wall) with its edge connectors in contact with a contaminated surface (such as the floor). The edge connectors will become contaminated, and tapes and solder connections on the pc board may break as the card bends. ALWAYS store the card (in its anti-static bag) in the original shipping carton.

4.3 Card installation and removal

WARNING

To avoid electrical shock that could result in injury or death, ALWAYS remove power from the entire system (Model 707 or 708, test instruments, DUT, etc.) and make sure stored energy in external circuitry is discharged before performing any of the following:

1. Installing or removing the matrix cards from the switching matrix.
2. Connecting or disconnecting cables from the matrix card. The pins of the cable connectors are easily accessible, which makes them extremely hazardous to handle while power is applied.
3. Making internal changes to the card (such as removing or installing jumpers).

Cable connections to the matrix card make it difficult to install or remove the card from the switching matrix. Therefore, it is advisable to install the card and then make the cable connections. Cables should also be disconnected before removing the card from the switching matrix.

Referring to Figure 4-1, perform the following procedure to install the Model 7077 Matrix Card in the Model 707 or 708 Switching Matrices.

CAUTION

Contamination will degrade the performance of the matrix card. To avoid contamination, always grasp the card by the handle and side edges. Do not touch the card edge connectors, board surfaces, or components. Do not touch areas adjacent to the electrical contacts on the connectors.

Card installation

WARNING

Turn off system power before installing or removing matrix cards.

1. Turn the switching matrix off.
2. Select a slot in the switching matrix and remove cover plate and mounting screws (Figure 4-1).
3. Install the Matrix Card.

WARNING

Both spring loaded panel fasteners must be secured to ensure a proper chassis ground connection between the matrix card and the switching matrix. Failure to properly secure this ground connection may result in personal injury or death due to electric shock.

Model 707 — With the relay side of the matrix card facing the fan and the card's top and bottom edges seated in the switching matrix card edge guides, feed the card completely into the switching matrix (Figure 4-1, View A). Secure the matrix card in the switching matrix by tightening both spring loaded mounting screws.

Model 708 — With the relay side of the matrix card facing upwards and the card's top and bottom edges seated in the switching matrix card edge guides, feed the card completely into the switching matrix (Figure 4-1, View B). Secure the matrix card in the switching matrix by tightening both spring loaded mounting screws.

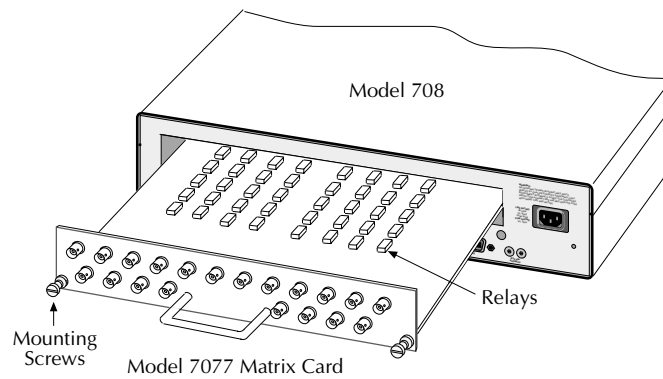
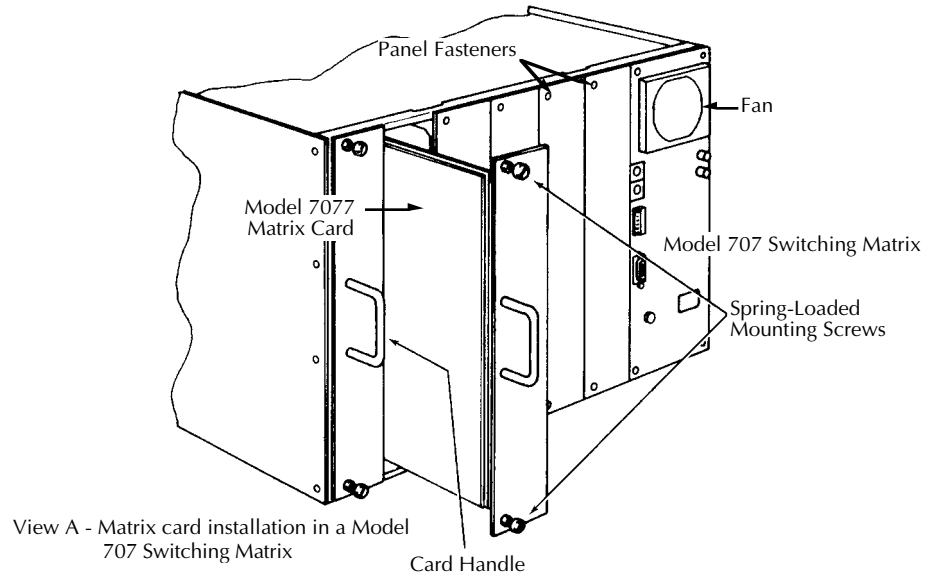
4. Connect cables to the matrix card as required. Refer to Section 3 for sample applications.

Card removal

WARNING

Turn off all system power before installing or removing matrix cards.

1. Turn the switching matrix(es) off.
2. Remove all cables from the matrix card.
3. Remove the matrix card from the switching matrix by loosening both spring loaded panel fasteners and sliding matrix card out of the switching matrix.
4. Install cover plate with mounting screws (Figure 4-1).



Note: Rear panel installation into Model 708, is shown. Front panel installation is similar.

Figure 4-1
Matrix card installation

4.4 Performance verification

The following paragraphs discuss performance verification procedures for the Model 7077, including path resistance, offset current, contact potential, and isolation.

WARNING

The performance verification procedures contained in this section are intended for use by experienced 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 procedures described in this section are lengthy due to the large number of row and column combinations checked. As an alternative to this extensive testing, it may be desirable to check only those paths that are going to be used, or those that are suspected of being faulty.

With the Model 7077's backplane jumpers installed, the performance verification procedures must be performed with only one matrix card (the one being checked) installed in a Model 707/708 Switching Matrix. The switching matrix must not be daisy-chained to another switching matrix. These conditions do not apply if the Model 7077's backplane jumpers have been removed.

CAUTION

Contamination will degrade the performance of the matrix card. To avoid con-

tamination, always grasp the card by the handle and side edges. Do not touch the card edge connectors, 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 matrix card is contaminated. See paragraph 4.2 for card cleaning instructions. If the test still fails after cleaning, clean the backplane (see the Switching Matrix Instruction Manual).

4.4.1 Environmental conditions

All verification measurements should be made at an ambient temperature between 18° and 28°C and at a relative humidity of less than 70%.

4.4.2 Recommended equipment

Table 4-1 summarizes the equipment necessary for performance verification and an application for each unit.

NOTE

Do not use the Model 7070 Universal Adapter Card as an extender card to verify performance of the Model 7077. The Model 7077 must be installed in the switching matrix.

Table 4-1
Verification equipment

Description	Keithley model or part number	Specifications	Applications
DMM Electrometer with voltage source	Model 2000 Model 6517	100Ω, .008% 20pA-200pA, 1% 100V source, .15%	Path resistance Offset current path isolation
Nanovoltmeter	Model 182	2mV, 0.015%	Contact potential
Triax cable (unterminated)	Model 7025	—	Offset current
Low thermal cable (unterminated)	Model 1484	—	Contact potential

4.4.3 Path resistance tests

NOTE

Refer to the performance verification overview (paragraph 4.4) prior to performing this procedure.

1. Remove all power from the switching matrix and switching matrix cards.
2. Install the Model 7077 Matrix Card in the switching matrix.

NOTE

Install the Model 7077 Matrix Card in slot one of the Model 707/708 Switching Matrix.

3. Connect all column terminals (columns 1 through 12) of the Model 7077 together (Figure 4-2) forming one common terminal.
4. Set the Model 2000 to the 100 Ω range for Ω 4 measurements.
5. Connect the four test leads to the INPUT and SENSE Ω 4 WIRE inputs of the Model 2000. Make sure the Model 2000 is set appropriately for front panel or rear panel inputs.
6. Short the four test leads together and zero the Model 2000. Leave zero enabled for the entire test.

7. Connect the Ohms HI and Ohms Sense HI leads from the Model 2000 to the common terminal (refer to step 3). Make the physical connections at columns 1 through 12 as shown in Figure 4-2.
8. Connect the Ohms LO and Ohms Sense LO leads from the Model 2000 to the high terminal (marked H in Figure 4-2) of ROW A.
9. Turn on the switching matrix and check the high terminals' path resistance.
 - A. Program the switching matrix to close crosspoint A1. Verify that the resistance of this path is <1.5 Ω .
 - B. Open crosspoint A1, and close crosspoint A2. Verify that the resistance of this path is <1.5 Ω . Repeat this procedure for the remainder of row A's high terminal column paths (columns 3 through 12).
10. Turn off the switching matrix and connect the Ohms LO and Ohms Sense LO leads from the Model 2000 to the low terminal (marked L in Figure 4-2) of ROW A.
11. Turn on the switching matrix and check the low terminals' path resistance.
 - A. Program the switching matrix to close crosspoint A1. Verify that the resistance of this path is <1.5 Ω .
 - B. Open crosspoint A1, and close crosspoint A2. Verify that the resistance of this path is <1.5 Ω . Repeat this procedure for the remainder of row A's low terminal column paths (columns 3 through 12).
12. Repeat steps 8 through 11 for the remainder of the matrix card's rows (rows B through H).

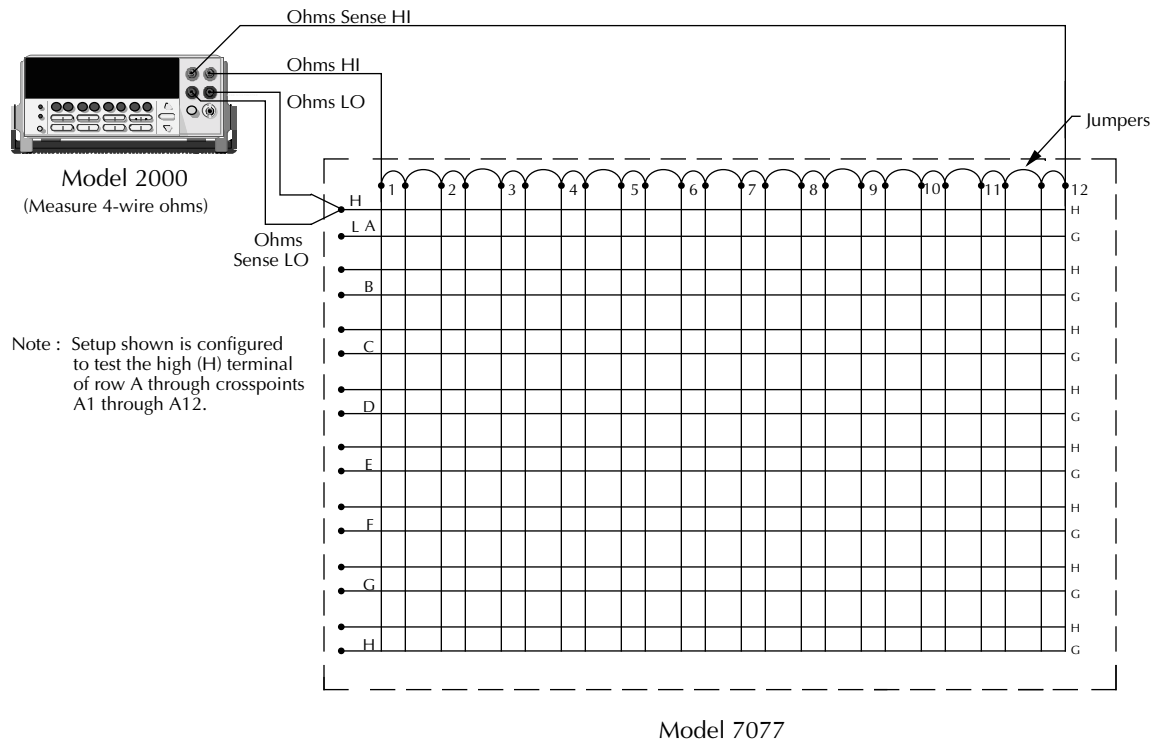


Figure 4-2
Path resistance testing

4.4.4 Offset current tests

Offset current tests check leakage current from high (HI) to guard (L) chassis (common mode) and from high (HI) and guard (L) (differential) for each pathway. These tests are performed by measuring the leakage current with an electrometer. In the following procedure, the Model 6517 is used to measure leakage current.

Referring to Figure 4-3, perform the following procedure to check offset current:

1. Remove all power from the switching matrix and switching matrix cards.
2. Install the matrix card in the Model 708 or in slot 1 if using the Model 707.
3. Connect the Model 6517 to ROW A of the matrix card as shown in Figure 4-2.
4. On the Model 6517, select the 200pA range, and enable zero check and then zero correct. Leave zero correct enabled for the entire procedure.
5. Turn on the Model 707/708 Switching Matrix.
6. Program the Model 707/708 to close crosspoint A1.
7. On the Model 6517, disable zero check and verify that it is <100pA. This measurement is the leakage current of the pathway.
8. On the Model 6517, enable zero check. On the Model 707/708, open crosspoint A1.
9. Repeat steps 6 through 8 to check the remaining pathways (crosspoints A2 through A12) of the row.
10. Connect the Model 6517 to ROW B and repeat steps 6 through 9 to check crosspoints B1 through B12.
11. Repeat step 10 to check ROWS C through G.
12. To check differential offset current, connect the Model 6517 to ROW A as shown in Figure 4-4 and repeat steps 5 through 12.

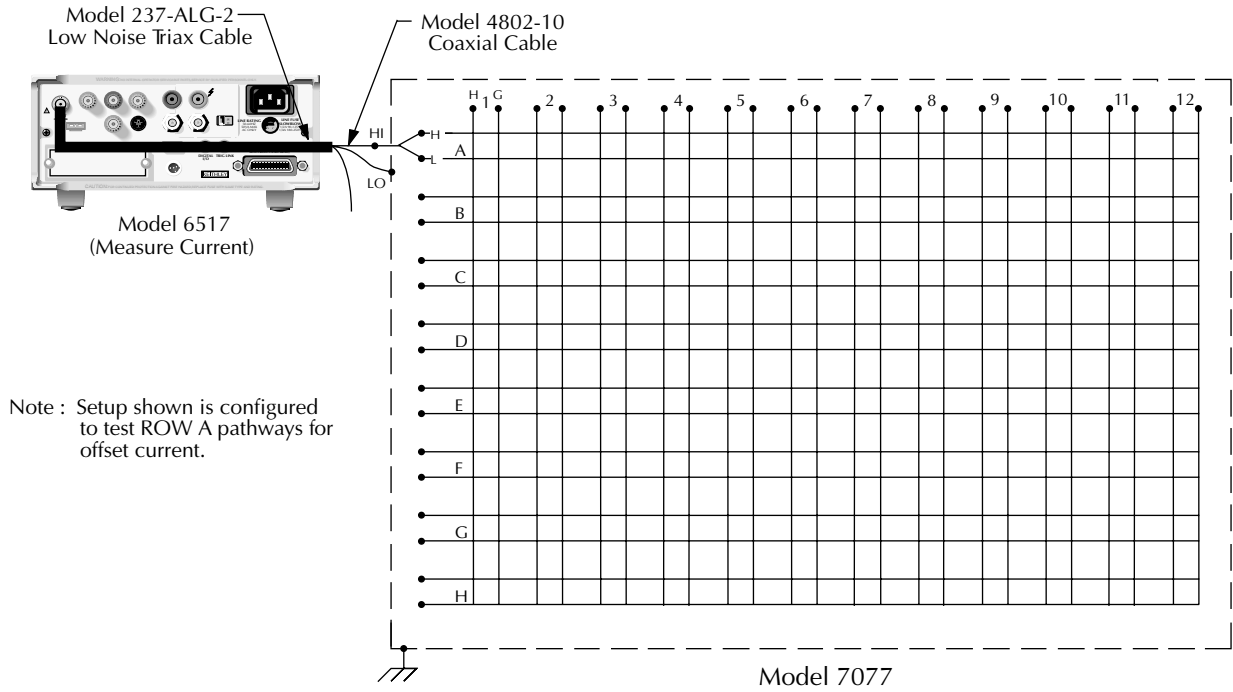


Figure 4-3
Common mode offset current testing

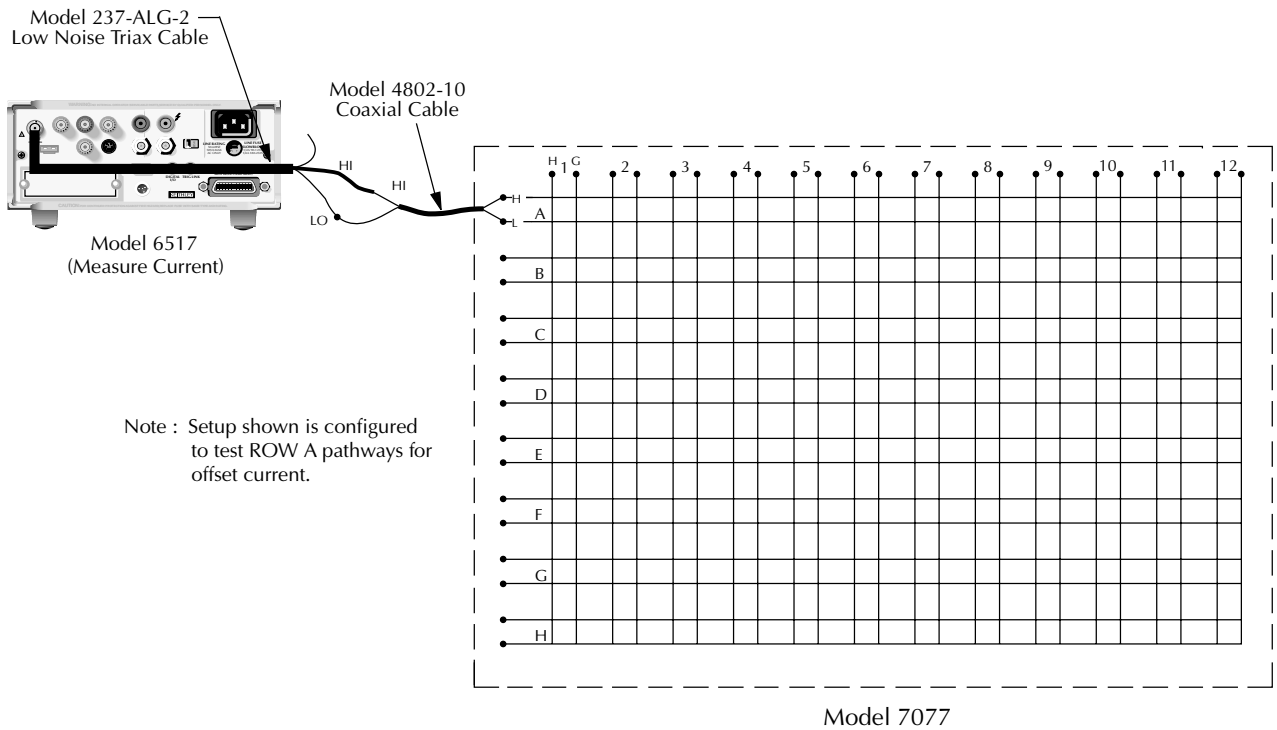


Figure 4-4
Differential offset current testing

4.4.5 Path isolation tests

Path isolation tests check the leakage resistance (isolation) between adjacent paths. A path is defined as the HIGH (H) and LO (L) circuit from a row to a column that results from closing a particular crosspoint. The test is performed by applying a voltage (+42V) across two adjacent paths and then measuring the leakage current across the paths. The isolation resistance is then calculated as $R = V/I$. In the following procedure, the Model 6517 functions as both a voltage source and an ammeter. In the V/I function, the Model 6517 internally calculates the resistance from the known voltage and current levels and displays the resistance value.

1. Remove all power from the switching matrix and switching matrix cards.
2. Install the Model 7077 in the Model 708 or in slot 1 of the Model 707.
3. Connect the Model 6517 to ROWS A and B as shown in Figure 4-5. Make sure the voltage source is in standby and there are no other connections to the card.
4. On the Model 6517, select the 20pA range, and enable zero check and then zero correct. Leave zero correct enabled for the entire procedure.
5. On the Model 6517, select the 200pA range, and release zero check.
6. On the Model 6517, press suppress to cancel offset current, and then enable zero check.
7. On the Model 6517, set the voltage source for +42V, and select the 20nA current range. Make sure the voltage source is in standby.
8. Place the Model 6517 in the V/I measurement function.
9. Turn on the Model 707/708, and program it to close crosspoints A1 and B2.
10. On the Model 6517, disable zero check, and press OPERATE to source +42V.
11. After allowing the reading on the Model 6517 to settle, verify that it is $>10G\Omega$. This measurement is the leakage resistance (isolation) between ROW A, COLUMN 1 and ROW B, COLUMN 2.
12. Enable zero check, and then place the Model 6517 in standby.
13. Turn off the Model 707/708, and make sure all power is removed from the circuit.
14. Disconnect the Model 6517 from ROWS A and B. In a similar manner, reconnect it to ROWS B and C (picoammeter high and voltage source low to ROW B and voltage source high and low to ROW C).
15. Turn on the Model 707/708, and program it to close crosspoints B2 and C3.
16. On the Model 6517, disable zero check, and press OPERATE to source +42V.
17. After allowing the reading on the Model 6517 to settle, verify that it is $>10G\Omega$.
18. Using Table 4-2, repeat steps 13 through 18 for the rest of the path pairs starting with test number 3.

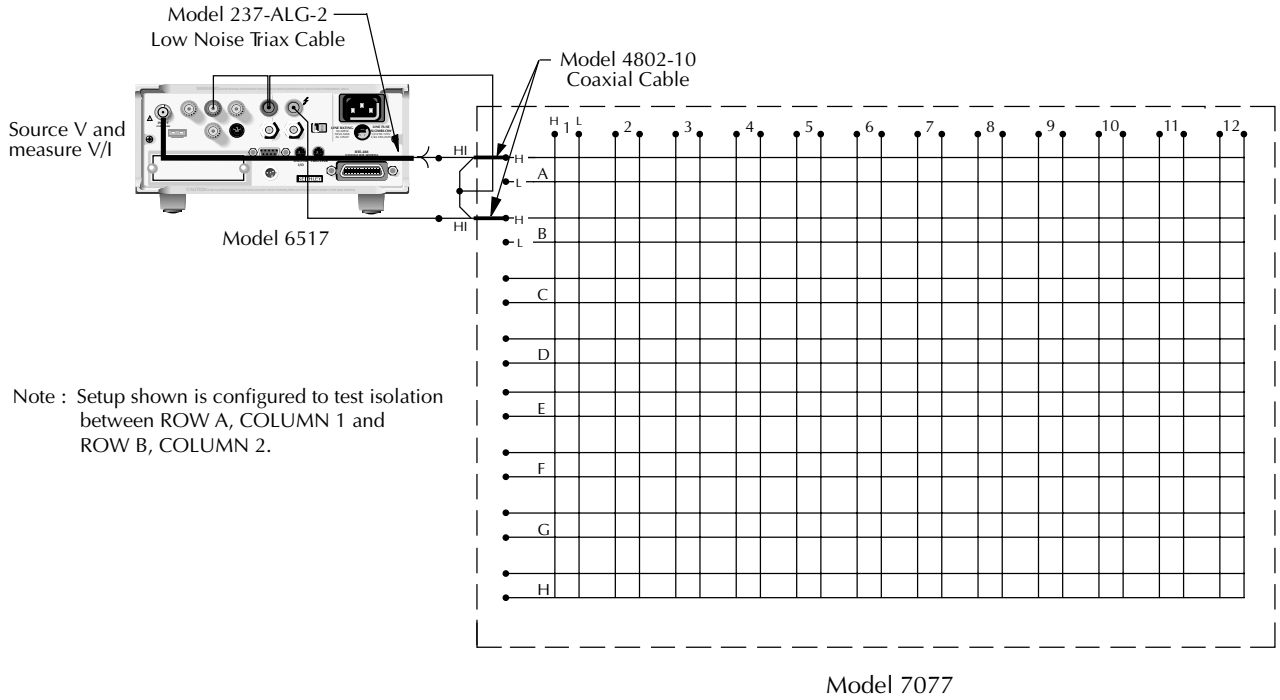


Figure 4-5
Path isolation testing (guarded)

Table 4-2
Path isolation tests

Test no.	Path isolation	Test equipment locations	Crosspoints closed
1	Row A, Col 1 to Row B, Col 2	Row A and Row B	A1 and B2
2	Row B, Col 2 to Row C, Col 3	Row B and Row C	B2 and C3
3	Row C, Col 3 to Row D, Col 4	Row C and Row D	C3 and D4
4	Row D, Col 4 to Row E, Col 5	Row D and Row E	D4 and E5
5	Row E, Col 5 to Row F, Col 6	Row E and Row F	E5 and F6
6	Row F, Col 6 to Row G, Col 7	Row F and Row G	F6 and G7
7	Row G, Col 7 to Row H, Col 8	Row G and Row H	G7 and H8
8	Row G, Col 8 to Row H, Col 9	Row G and Row H	G8 and H9
9	Row G, Col 9 to Row H, Col 10	Row G and Row H	G9 and H10
10	Row G, Col 10 to Row H, Col 11	Row G and Row H	G10 and H11
11	Row G, Col 11 to Row H, Col 12	Row G and Row H	G11 and H12

4.4.6 Differential and common model isolation tests

Differential and common mode isolation tests check the leakage resistance (isolation) between high (H) and guard (G) (differential), and from high and guard to chassis (common mode) of every row and column. The tests are performed by applying a voltage (42V) across the terminals and then measuring the leakage current. The isolation resistance is then calculated as $R = V/I$. In the following procedure, the Model 6517 functions as a voltage source and an ammeter. In the V/I function, the Model 6517 internally calculates the resistance from the known voltage and current levels and displays the resistance value.

1. Remove all power from the switching matrix and switching matrix cards.
2. Install the Model 7077 in the Model 708 or in slot 1 of the Model 707.
3. Connect the Model 6517 to ROW A as shown in Figure 4-6 to measure differential isolation. Make sure the voltage source is in standby and there are no other connections to the card.
4. On the Model 6517, select the 20pA range, and enable zero check and then zero correct. Leave zero correct enabled for the entire procedure.
5. On the Model 6517, set the voltage source for +42V, and select the 200nA current range. Make sure the voltage source is still in standby.
6. Place the Model 6517 in the V/I measurement function by pressing SHIFT OHMS.
7. Turn on the Model 707/708, but do not program any crosspoints to close. All crosspoints must be open.
8. On the Model 6517, disable zero check, and press OPERATE to source 42V.
9. After allowing the reading on the Model 6517 to settle, verify that it is $>1G\Omega$. This measurement is the leakage resistance (isolation) of ROW A.
10. Place the Model 6517 in standby and enable zero check.
11. Program the Model 707/708 to close crosspoint A1.
12. On the Model 6517, disable zero check and press OPERATE to source +42V.
13. After allowing the reading on the Model 6517 to settle, verify that it is also $>1G\Omega$. This measurement checks the isolation of COLUMN 1.
14. Using Table 4-3 as a guide, repeat the basic procedure of steps 11 through 14 for the rest of the columns and rows (test numbers 3 through 32 of the table).
15. Place the Model 6517 in standby, and turn the Model 707/708 off.
16. Connect the Model 6517 to ROW A as shown in Figure 4-7, and repeat steps 8 through 16 to check common mode isolation.

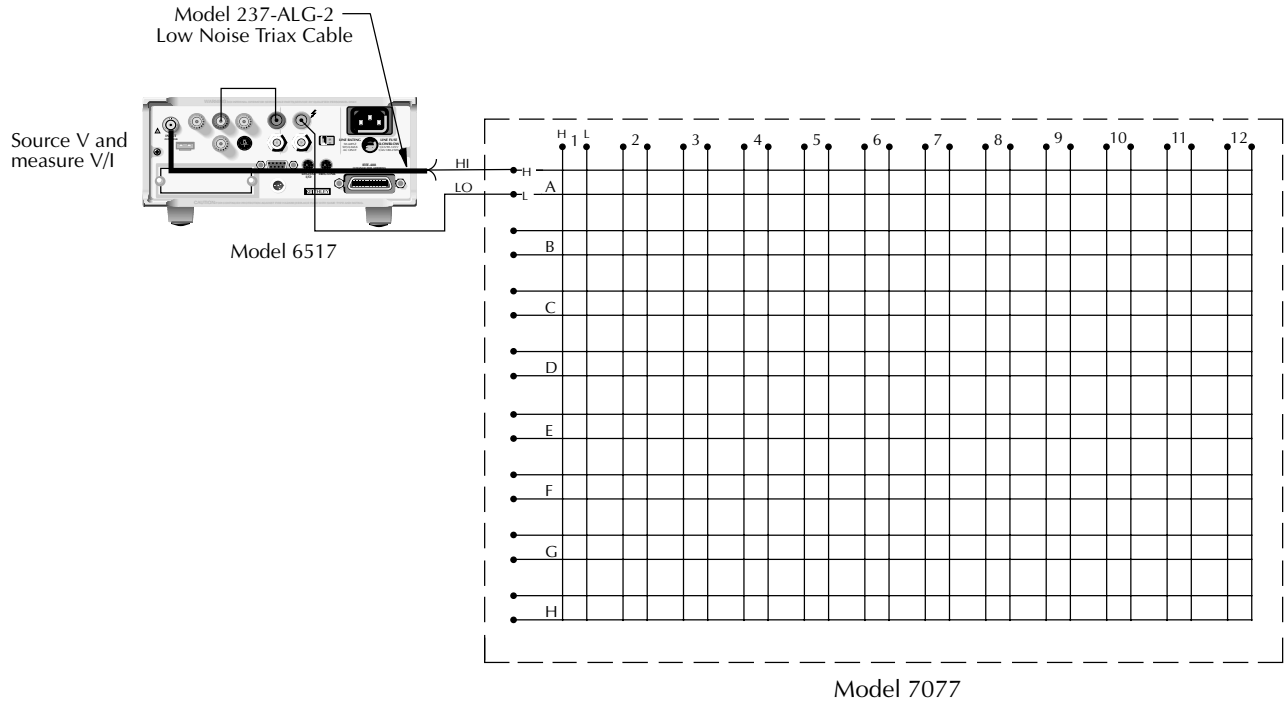


Figure 4-6
Differential isolation testing

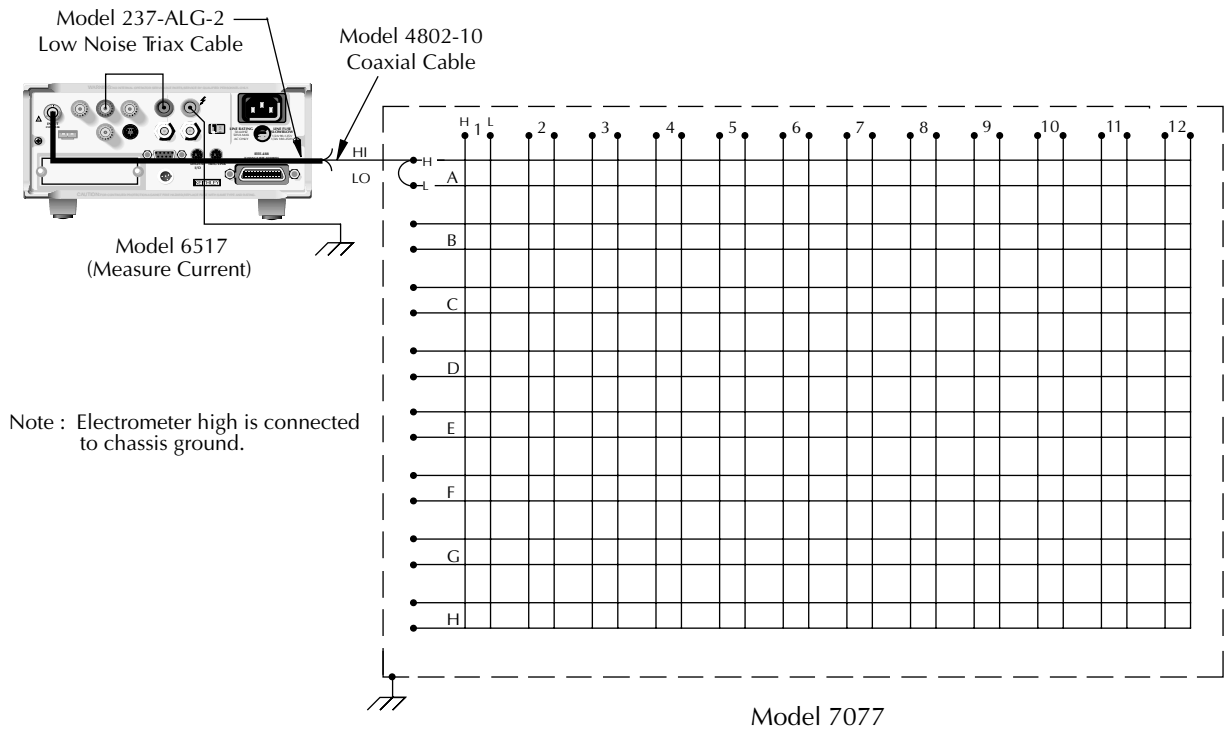


Figure 4-7
Common mode isolation testing

Table 4-3
Differential and common mode isolation test

Test no.	Differential or common mode test	Crosspoints closed
1	ROW A	None
2	COLUMN 1	A1
3	COLUMN 2	A2
4	COLUMN 3	A3
5	COLUMN 4	A4
6	COLUMN 5	A5
7	COLUMN 6	A6
8	COLUMN 7	A7
9	COLUMN 8	A8
10	COLUMN 9	A9
11	COLUMN 10	A10
12	COLUMN 11	A11
13	COLUMN 12	A12
14	ROW B	A1 and B1
15	ROW C	A1 and C1
16	ROW D	A1 and D1
17	ROW E	A1 and E1
30	ROW F	A1 and F1
31	ROW G	A1 and G1
32	ROW H	A1 and H1

4.5 Principles of operation

The following paragraphs discuss the basic operating principles for the Model 7077 and can be used when troubleshooting the matrix card. The schematic drawing of the matrix card is shown in drawing 7077-106, located at the end of Section 5.

4.5.1 Card identification

Identification coding and a matrix configuration table are stored in erasable programmable read only memory (EPROM). This information is sent to the Model 707/708 so the switching matrix can determine which type of matrix card is installed in a particular slot. This lets the Model 707/708 send valid configuration data to the matrix card.

On power up, control line CARDSEL goes low turning on the EPROM (U128). This control line and other control lines from the Model 707/708 are buffered by U130. Lines CLK, NEXT ADDR, and CLR ADDR along with counter U126 control the task of loading data from the EPROM into the parallel to serial shift register (U127). Data sent from U130 to the Model 707/708 through the IDDATA line is strobed by the CLK control line. The timing diagram in Figure 4-8 shows the first byte of identification data during the transfer sequence. For subsequent bytes, the CLRADDR line stays low.

4.5.2 Switching circuitry

Matrix configuration data is sent from the Model 707/708 through the RELAY DATA control line and is serially loaded into the 12 shift registers (U114 through U125). The matrix card relays configure when the registers receive the STROBE signal from the Model 707/708. A relay is energized when a relay driver output (U100 through U113) is low (connected to digital common). A driver output is low when a "high" data bit is clocked (i.e., inverting drivers).

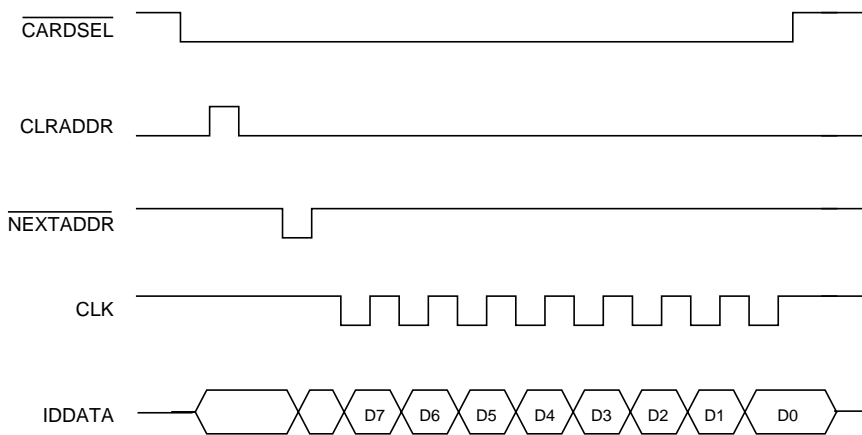


Figure 4-8
ID data timing diagram

4.5.3 Power up safeguard

To prevent relays from accidentally energizing and causing possible damage during power up, a safeguard circuit has been incorporated into the design. The protection circuit is comprised of a dual NAND gate (U129) configured as a SET or RESET flip-flop and an RC network (R102, C122 and CR101). The time constant of the RC network keeps the output of the NAND gate low during the power up sequence. This low signal is applied to the OE input of the shift registers keeping the relays de-energized. After the capacitor of the RC network charges, a STROBE signal will then force the output of the NAND gate high, allowing configured relays to energize.

4.6 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 7077 are static-sensitive, it is recommended that they are all treated as static-sensitive.

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

4.7 Troubleshooting

The Keithley Model 7070 Universal Adapter Card is an extender card that allows access to circuit components of the Model 7077 during troubleshooting.

4.7.1 Recommended equipment

Table 4-4 summarizes the equipment necessary for general troubleshooting.

Table 4-4
Recommended troubleshooting equipment

Description	Application
DMM (Keithley 2000)	Measure dc voltage
Dual-trace, triggered sweep oscilloscope, dc to 50MHz	Check clock and logic pulses
Extender card (Keithley 7070)	Allow circuit access

4.7.2 Troubleshooting procedure

In order to service the matrix card, it may be necessary to remove the bottom shield. The bottom shield is secured to the matrix card by eight screws. Remove these screws and separate the shield from the pc-board. When reinstalling the shield, make sure it is oriented such that the standoffs (staked onto the shield) are positioned between the pc-board and the shield.

Table 4-5 outlines troubleshooting procedures for the matrix card.

CAUTION

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

If removing relays from the pc-board, care must be taken to prevent traces from breaking off the board. Using a solder sucker, make sure all solder is removed. Each relay pin must move freely in the feed-through hole. Make sure there are no burrs on the ends of the relay pins.

Table 4-5
Troubleshooting summary*

Step	Items/component**	Comment	Required condition
1	W152	+6V supply	+6V dc
2	W155	+5V supply	+5V dc
3	W150	CLR ADDR line***	High logic pulse at the beginning of each card identification byte transfer sequence (upon power up).
4	W151	NEXT ADDR line	Low logic pulse before each byte transfer.
5	W149	Clk line	1.79MHz clock
6	W154	ID Data line***	Card identification logic pulse train (on power up).
7	W156	Power up safeguard	Remains low during power up.
8	W157	RELAY DATA line	Logic pulse train to load relay configuration registers.
9	W158	STROBE line	High logic pulse to strobe relay configuration registers.
10	U100 through U113	Relay drivers	+6V for open crosspoints 0V for closed crosspoints. Note that pins 10 through 16, pin 10 on U100 and U107 is not connected.

*All measurements referenced to digital common (W153)

**W149 through W158 are jumpers located on the pc-board. See component location drawing (at end of Section 5) for jumper locations.

***See Figure 4-8.

5

Replaceable Parts

5.1 Introduction

This section contains replacement parts information, schematic diagrams, and component layout drawings for the Model 7077.

5.2 Parts list

The parts list for the Model 7077 is included in tables integrated with the schematic diagram and component layout drawing. 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 (see the inside front cover for addresses). When ordering parts, be sure to include the following information:

- Card model number (7077)
- Card serial number
- Part description
- Circuit description, if applicable
- 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 DEPARTMENT and the RMA number on the shipping label.

NOTE

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

5.5 Component layout and schematic diagram

A component layout drawing and schematic diagram are included on the following pages integrated with the parts list.

Table 5-1
Model 7077 electrical parts list

Circuit designation	Description	Keithley part no.
C100-116	CAP,.1UF,20%,50V,CERAMIC	C-365-.1
C117,118	CAP,.01UF,20%,50V,CERAMIC	C-237-.01
C119	CAP,.01UF,10%,1000V,CERAMIC	C-64-.01
C120,121	CAP,270PF,20%,100V,CERAMIC/FERRITE	C-386-270P
C122	CAP, 47UF,10%,16V,ALUM ELEC	C-321-47
C123,124	CAP, 10UF,-20+100%,25V,ALUM ELEC	C-314-10
CR100	DIODE,SILICON, 5400 (267-01)	RF-34
CR101	DIODE,SILICON,IN4148 (DO-35)	RF-28
CR102	DIODE,SCHOTTKY, IN5711	RF-69
J1001-1020	CONNECTOR	CS-681-3
K100-195	RELAY, MINI SIGNAL REL	RL-163
R100	RES,10K,5%,1/4W,COMPOSITION OR FILM	R-76-10K
R101	RES,200,5%,1/4W,COMPOSITION OR FILM	R-76-200
R102	RES,47K,5%,1/4W,COMPOSITION OR FILM	R-76-47K
R103	RES,11K,5%,1/4W,COMPOSITION OR FILM	R-76-11K
R104	RES,5.1K,5%,1/4W,COMPOSITION OR FILM	R-76-5.1K
R105	RES,120K,5%,1/4W,COMPOSITION OR FILM	R-76-120K
U100-113	IC,DARLINGTON ARRAY,2003	IC-206
U114-125	IC, 8 BIT SHIFT LAT REG,74HC4094	IC-713
U126	IC, 12 STAGE BINARY COUNTER,74HCT4040	IC-545
U127	IC,8-BIT PARALLEL TO SERIAL,74HCT165	IC-548
U128	EPROM PROGRAM	7077-800**
U129	IC, QUAD 2 INPUT NAND, 74HCT00	IC-399
U130	IC, OCTAL BUFFER/LINE DRIVER, 74HC244	IC-489
W100	STIFFENER, BOARD	J-16
W125-148, 151-155	JUMPER	J-15
W149,150, 156-158	JUMPER	J-15

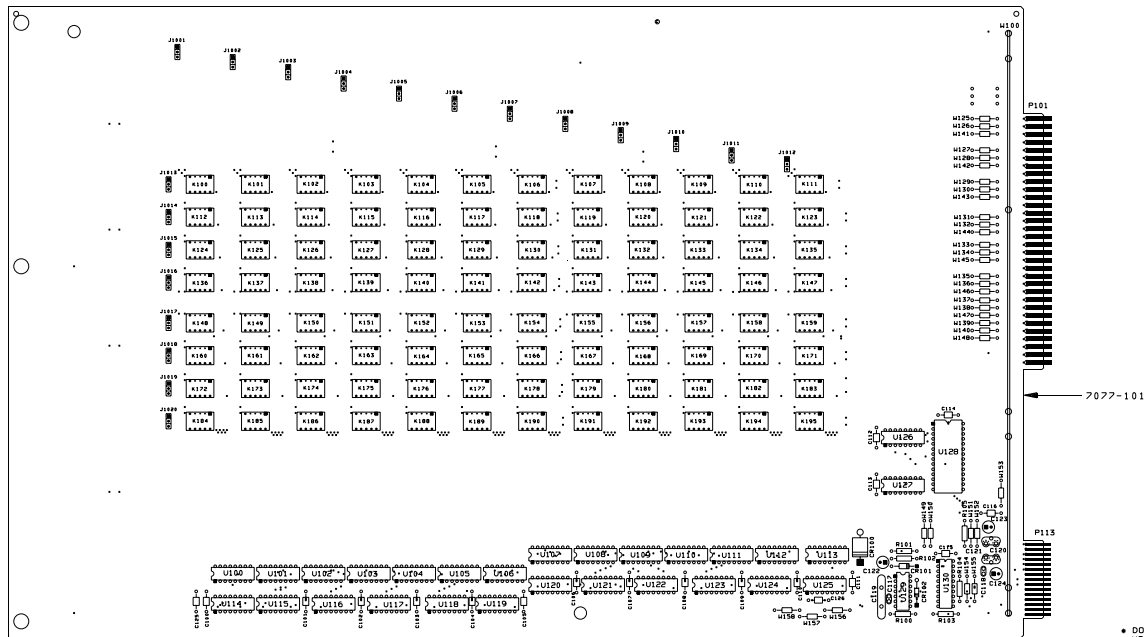
**Order firmware revision of present ROM.

Table 5-2
Model 7077 mechanical parts list

Description	Keithley part no.
4-40X1/4 PHILLIPS PAN HD SEMS SCREW (SHIELD TO PCB)	4-40X1/4PPHSEM
6-32X3/8LG. PHIL FLAT HD SCR (FOR MOUNTING HANDLE)	6-32X3/8PFH
6-32X5/16PHIL PAN HD SEMS SCR (PANEL TO PCB)	6-32X5/16PPHSEM
6-32 PEM NUT	FA-135
CONNECTOR	CS-236
CONNECTOR, BNC	CS-520
CONNECTOR HOUSING	CS-270
HANDLE	HH-33-1
REAR PANEL ASSEMBLY	7077-303A
SHIELD, BOTTOM	7075-306A
SOCKET,I.C. 28 PIN (FOR U128)	SO-69

001-2202-DN

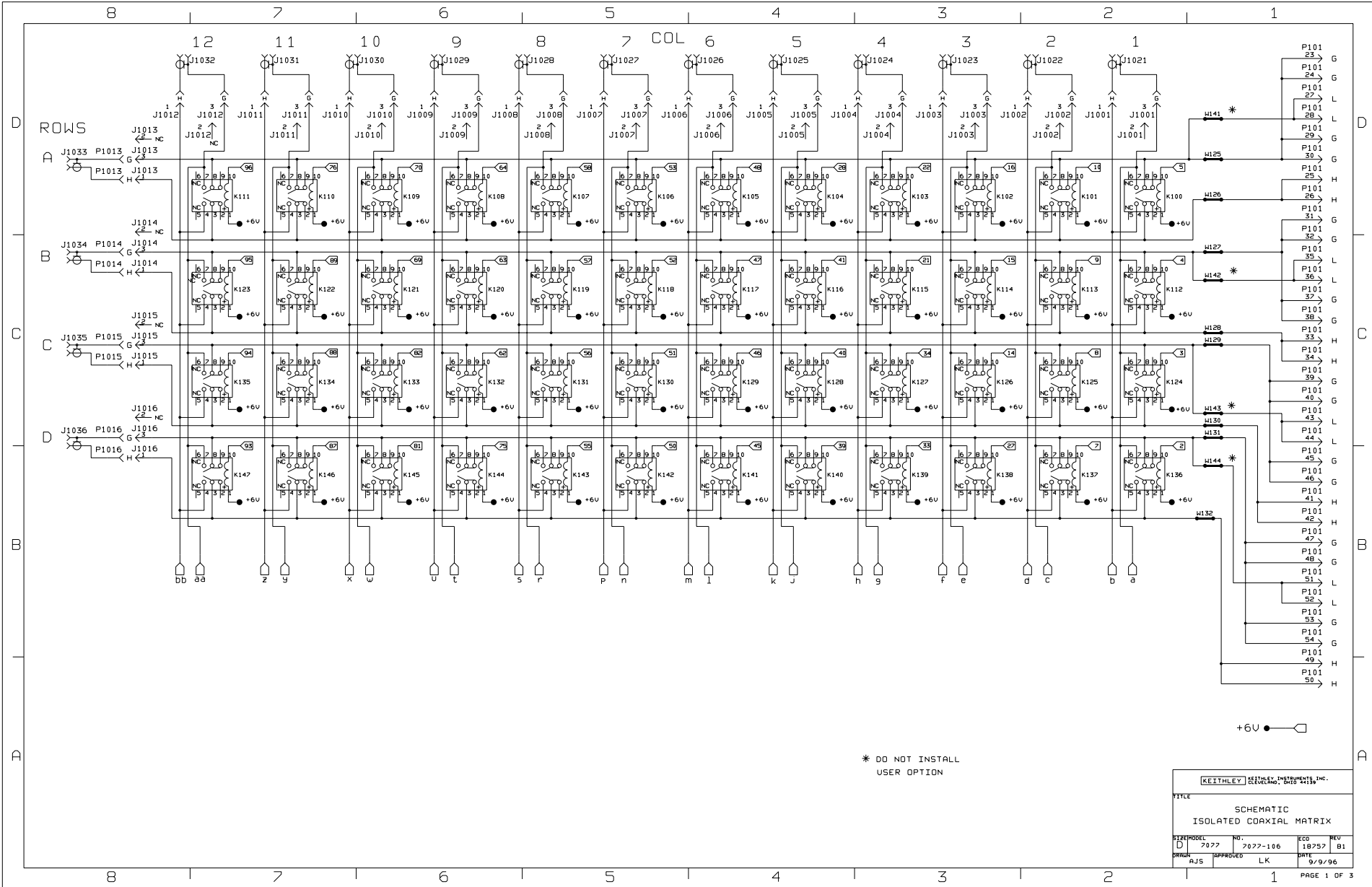
LTR	ECO NO.	REVISION	ENG.	DATE
A	17622	RELEASED	SZ	8-8-95
B	17992	TEST POINT INITIAL ONLY	SZ	1/26/96
B	18254	ISSUE 817001667, 16.0	SZ	8/1/96



NOTE:
FOR COMPONENT INFORMATION
REFER TO PRODUCT STRUCTURE.

* DO NOT INSTALL
USER OPTION

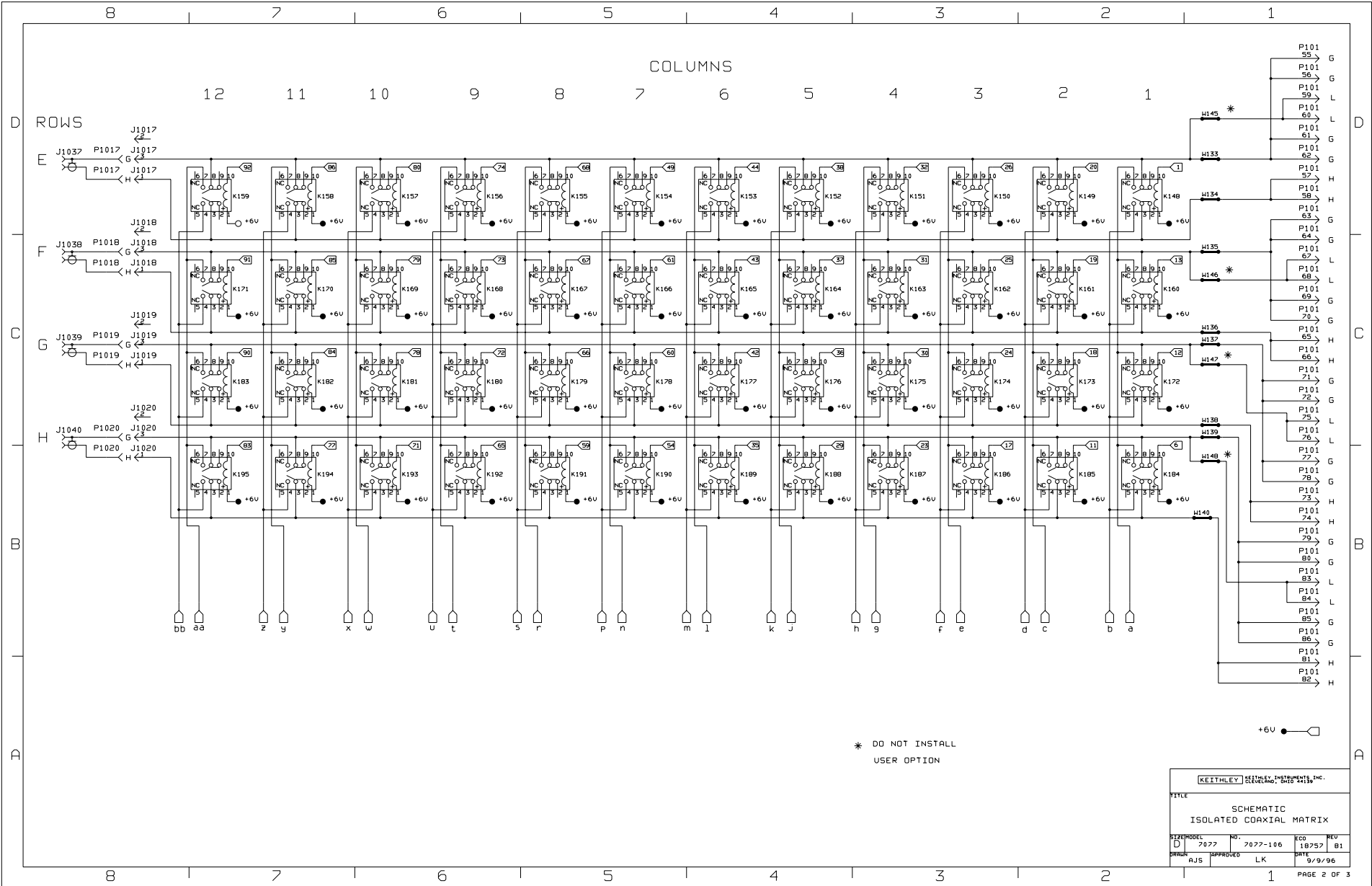
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REV. 1	DATE 8-11-95	DATE 8-11-95	SCALE 1:1	COMPONENT LAYOUT
REV. 2	DATE 8-11-95	DATE 8-11-95	SCALE 1:1	ISOLATED CORNICAL MATRIX
REV. 3	DATE 8-11-95	DATE 8-11-95	SCALE 1:1	
KETTLEBY INSTRUMENTS INC.			NO. 7077-100	
114100, 014100			FINISH	
SURFACE MAX. 0.0125				



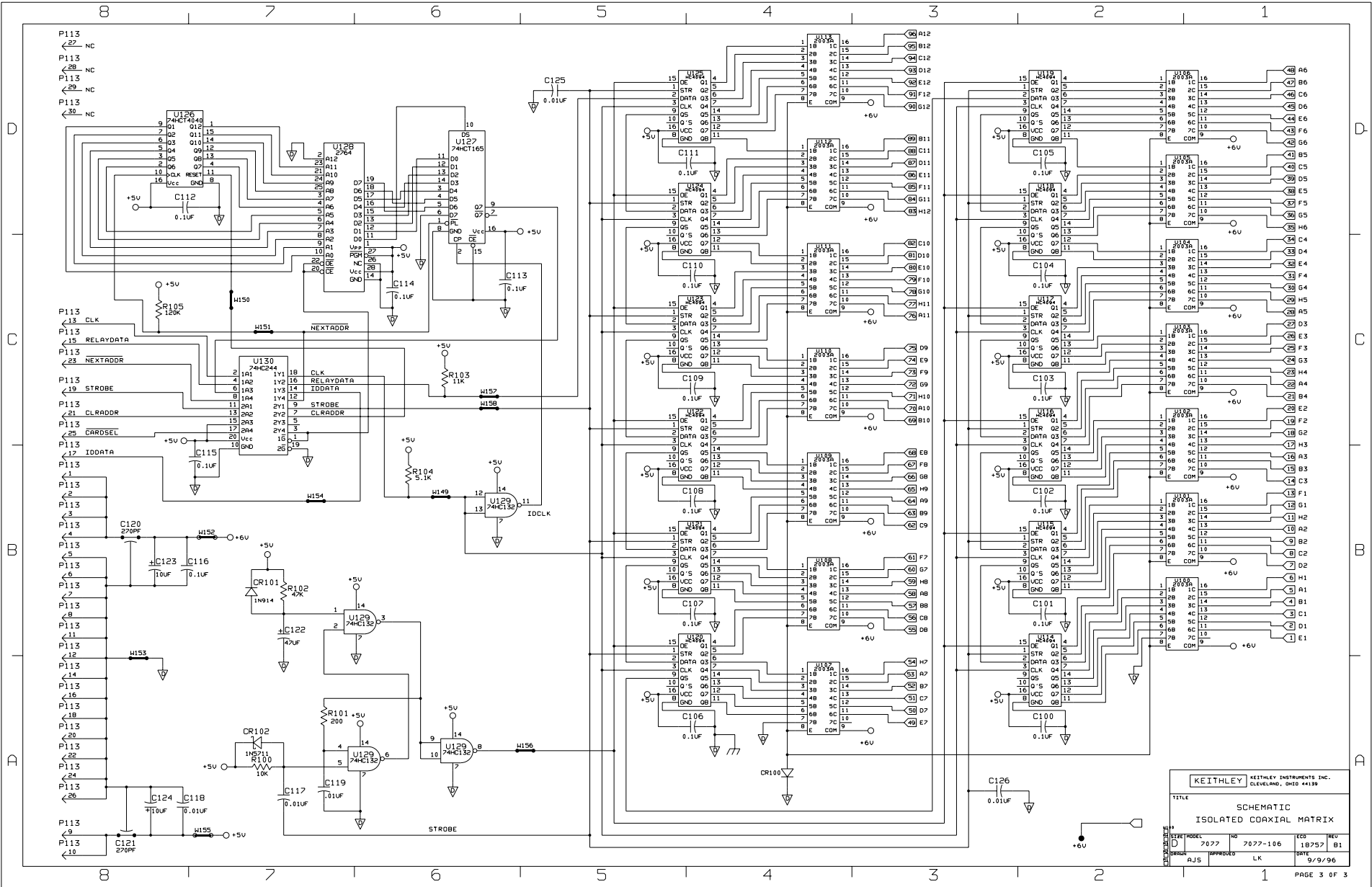
+6V

* DO NOT INSTALL
USER OPTION

KEITHLEY KEITHLEY INSTRUMENTS, INC. Cleveland, Ohio 44139				
TITLE SCHEMATIC ISOLATED COAXIAL MATRIX				
SIZE	MODEL	NO.	ECC	REV
D	7077	2077-106	18757	B1
DR	RJS	APPROVED	LK	DATE 9/9/96



KEITHLEY KEITHLEY INSTRUMENTS INC. RECEIVED: 0110 0419			
TITLE			
SCHEMATIC ISOLATED COAXIAL MATRIX			
SIZE/MODEL	NO.	ECO	REV
D 7077	7077-106	18757	B1
DR	APPROVED	DATE	
AJS	LK	9/9/96	



KEITHLEY KEITHLEY INSTRUMENTS INC.
 CLEVELAND, OHIO 44139
 TITLE SCHEMATIC
 ISOLATED COAXIAL MATRIX
 REV 18757
 NO 7077
 DATE 9/9/96
 APPROVED LK
 DESIGNED RJS
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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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