KEITHLEY

Model 7073 Coaxial Matrix Card Instruction Manual

Contains Operating and Servicing Information

Publication Date: October 1992
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WARRANTY

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

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

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

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

LIMITATION OF WARRANTY

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

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Model 7073 Coaxial Matrix Card
Instruction Manual

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Safety Precautions

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

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

The types of product users are:

Responsible body is the individual or group responsible for the use and maintenance of equipment, and for ensuring that operators are adequately trained.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Instrumentation and accessories shall not be connected to humans.

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

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

To clean the instrument, use a damp cloth or mild, water based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument.

SPECIFICATIONS

MATRIX CONFIGURATION:
8 rows by 12 columns.

CROSSPOINT CONFIGURATION:
1-pole Form A.

CONNECTOR TYPE: BNC (HI, Chassis).

MAXIMUM SIGNAL LEVEL: 200V, 1A, 30VA peak (resistive load). 200V maximum between any 2 pins or chassis.

CONTACT LIFE:
Cold Switching: 10^7 closures.
At Maximum Signal Level: 10^5 closures.

PATH RESISTANCE (per conductor): <0.5Ω initial, <1Ω at end of contact life.

CONTACT POTENTIAL: <2μV per contact.

OFFSET CURRENT: <200pA, 10pA typical.

PATH ISOLATION*: $>10^{10}$Ω, <0.3pF.
1MHz, 50Ω load: >80dB.
10MHz, 50Ω load: >65dB.
1MHz, 1MΩ load: >55dB.
*Path isolation specified with backplane disconnect jumpers removed.

INPUT ISOLATION: 10^9Ω, 220pF nominal.

INSERTION LOSS (50Ω source),
50Ω load, 10MHz: <0.5dB
1MΩ load, 1MHz: <0.2dB.

3dB BANDWIDTH, 50Ω load: 30MHz typical.

RELAY DRIVE CURRENT (per crosspoint): 20mA.

RELAY SETTLING TIME: <15ms.

ENVIRONMENT:
Operating: 0° to 50°C, up to 35°C at 70% R.H.
Storage: −25 to +65°C.

ACCESSORY SUPPLIED: Instruction manual.

ACCESSORIES AVAILABLE:
Model 7051-2: BNC to BNC Cable, 0.6m (2 ft.)
Model 7051-5: BNC to BNC Cable, 1.5m (5 ft.)
Model 7754-3: BNC to Alligator Cable, 0.9m (3 ft.)
Model 7755: 50Ω Feed-Through Terminator

Specifications subject to change without notice.

Contains information on Model 7073 features, specifications, and accessories.

SECTION 1
General Information

Details installation of the Model 7073 into the Model 707 Switching Matrix, basic matrix configurations, card connections, and also discusses operating considerations.

SECTION 2
Operation

Provides two applications for the Model 7073, including a test system for analog and/or digital devices and a test system for resistor networks.

SECTION 3
Applications

Contains performance verification procedures, principles of operation and troubleshooting information for the matrix card.

SECTION 4
Service Information

Lists replacement parts, and also includes component layout and schematic diagrams for the Model 7073.

SECTION 5
Replaceable Parts

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SECTION 1
General Information

1.1 INTRODUCTION

This section contains general information about the Model 7073 Coaxial Matrix Card and is arranged in the following manner:

1.2 Features
1.3 Warranty Information
1.4 Manual Addenda
1.5 Safety Symbols and Terms
1.6 Specifications
1.7 Unpacking and Inspection
1.8 Repacking for Shipment
1.9 Optional Accessories

1.2 FEATURES

The Model 7073 is a coaxial, one-pole 8 row × 12 column matrix card. Some of the key features include:

- Low contact potential and offset current for minimal effects on low-level signals.
- Quick-disconnect BNC connections to DUT and instrumentation.
- Backplane disconnect jumpers to isolate or connect matrix rows to the backplane of the Model 707.

1.3 WARRANTY INFORMATION

Warranty information is located on the inside front cover of this instruction manual. Should your Model 7073 require warranty service, contact the Keithley representative or authorized repair facility in your area for further information. When returning the matrix card for repair, be sure to fill out and include the service form at the back of this manual in order to provide the repair facility with the necessary information.

1.4 MANUAL ADDENDA

Any improvements or changes concerning the matrix card or manual will be explained in an addendum included with the the unit. Be sure to note these changes and incorporate them into the manual.

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 shows that high voltage may be present on the terminal(s). Use standard safety precautions to avoid personal contact with these voltages.

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

The **CAUTION** heading used in this manual explains hazards that could damage the matrix card. Such damage may invalidate the warranty.

1.6 SPECIFICATIONS

Model 7073 specifications may be found at the front of this manual. These specifications are exclusive of the matrix mainframe specifications.

1.7 UNPACKING and INSPECTION

1.7.1 Inspection for Damage

The Model 7073 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 to the following precautions on handling.

Handling Precautions:

1. Always grasp the card by the handle and side edges. Do not touch the edge connectors and do not touch board surfaces or components.
2. When not installed in a Model 707 mainframe, 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 such damage to the shipping agent immediately. Save the origianl packing carton for possible reshipment.

If you are going to install the card in the Model 707 mainframe at this time, be sure to follow the additional handling precautions explained in paragraph 2.2

1.7.2 Shipping Contents

The following items are included with every Model 7073 order:

- Model 7073 Coaxial Matrix Card
- Model 7073 Instruction Manual
- Additional accessories as ordered.

1.7.3 Instruction Manual

The Model 7073 Instruction Manual is three-hole drilled so that it can be added to the three-ring binder of the Model 707 Switching Matrix Instruction Manual. After removing the plastic wrapping, place the manual in the binder after the mainframe instruction manual. Note that a manual identification tab is included and should precede the matrix card instruction manual.

If an additional instruction manual is required, order the manual package, Keithley part number 7073-901-00. The manual package includes an instruction manual and any pertinent addenda.

1.8 REPACKING FOR SHIPMENT

Should it become necessary to return the Model 7073 for repair, carefully pack the unit in its original packing carton or the equivalent, and include the following information:

- Advise as to the warranty status of the matrix card.
- Write ATTENTION REPAIR DEPARTMENT on the shipping label.
- Fill out and include the service form located at the back of this manual.

1.9 OPTIONAL ACCESSORIES

The following accessories are available for use with the Model 7073:

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

Model 4802-10—Low noise coaxial cable, 10ft. (3m) in length, with a male BNC connector at one end and unterminated at the other end.

Model 4803—Low noise cable kit. Includes 50ft. of low noise coaxial cable, 10 male BNC connectors, and 5 female BNC chassis-mount connectors.

Model 4804—Male BNC to female triax adapter.

Model 4851—BNC shorting plug.

Model 6147—Male triax to female BNC adapter.

Model 7051-2 BNC to BNC Cable—The Model 7051-2 is a 50Ω BNC to BNC cable (RG-58C) 2ft. (0.6m) in length.

Model 7071-5 BNC to BNC Cable—The Model 7051-5 is a 50Ω BNC to BNC cable (RG-58C) 5ft. (1.5m) in length.

Model 7754-3 BNC to Alligator Cable—The Model 7754-3 is a 3ft. (0.9m) 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—The Model 7755 is a BNC to BNC adapter that is teminated with a 50Ω resistor. VSWR < 1.1, dc to 250MHz.

Mode CS-115—Male UHF to female BNC adapter.

SECTION 2
Operation

2.1 INTRODUCTION

This section contains information on aspects of matrix card operation and is arranged as follows:

2.2 **Handling Precautions:** Details precautions that should be observed when handling the matrix card to ensure that its performance is not degraded due to contamination.

2.3 **Card Installation and Removal:** Covers the basic procedure for installing and removing the card from the Model 707 Switching Matrix.

2.4 **Basic Matrix Configurations:** Explains some of the basic ways that a matrix can be used to source or measure. Covers single-ended switching, differential (floating) switching, sensing, and shielding.

2.5 **Connections:** Discusses methods used to connect external DUT and instrumentation to the matrix card.

2.6 **Matrix Expansion:** Discusses the various matrix configurations that are possible by using multiple cards. The significance of the backplane disconnect jumpers is covered here.

2.7 **Typical Connection Schemes:** Provides examples of external connections for single card, multiple card and multiple mainframe systems.

2.8 **Operating Considerations:** Covers key characteristics and limitations of the matrix card. Also provides recommendations for optimizing performance.

2.2 HANDLING PRECAUTIONS

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

To avoid possible contamination, always grasp the card by the handle and side edges. Do not touch the edge connectors of the card and do not touch board surfaces or components.

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. ALWAYS store the card (in its anti-static bag) in the original shipping carton.

Dirt build-up over a period of time is another possible source of contamination. To avoid this problem, operate the mainframe and matrix card only in a clean environment.

If the card should become contaminated, it should be thoroughly cleaned as explained in paragraph 4.2.

2.3 CARD INSTALLATION AND REMOVAL

Cables connected to the matrix card make it awkward to install or remove the card. Thus, it is advisable to first install the card in the Model 707 mainframe and then make connections to it. Conversely, cables should be disconnected before removing the card from the mainframe.

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 edge connectors of the card, and do not touch the board surfaces or components.

Referring to Figure 2-1, perform the following procedure to install the Model 7073 matrix card in the Model 707:

1. Turn the Model 707 off.
2. Select a slot in the mainframe and remove the cover plate. The cover plate is fastened to the mainframe chassis with two screws. Retain the cover plate and screws for future use.
3. With the relay side of the matrix card facing towards the fan, feed the card into the slot such that the top and bottom card edges seat into the the card edge guides of the mainframe.
4. Slide the matrix card all the way into the mainframe and tighten the two spring loaded panel fastenters.
5. To remove the card from the mainframe make sure the Model 707 is off and power is removed from external circuitry. Then reverse the above procedure.

WARNING

The mounting screws must be secured to ensure a proper chassis ground connection between the card and mainframe. Failure to properly secure this ground connection may result in personal injury or death due to electric shock.

NOTE

If using the terminal blocks, leave enough slack in the external cabling so that the card can slide out far enough to gain access to the connections.

6. To remove the card from the mainframe make sure the Model 707 is off, power is removed from external circuitry, and then reverse the above procedure.

2.4 BASIC MATRIX CONFIGURATIONS

A simplified schematic of the Model 7073 8 × 12 matrix card is shown in Figure 2-2. Each of the 96 crosspoints is made up of a one-pole switch. In this simple configuration, any row can be connected to any column by closing the appropriate crosspoint switch. The columns of every Model 7073 matrix card are numbered 1 through 12. However, the actual column numbers of the matrix are determined by which mainframe slot the card is installed. For example, the columns of a matrix card installed in slot 4 of the mainframe are numbered 37 through 48. Column number assignments for all six mainframe slots are listed in Table 2-1.

Table 2-1. Column Number Assignments

7071 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

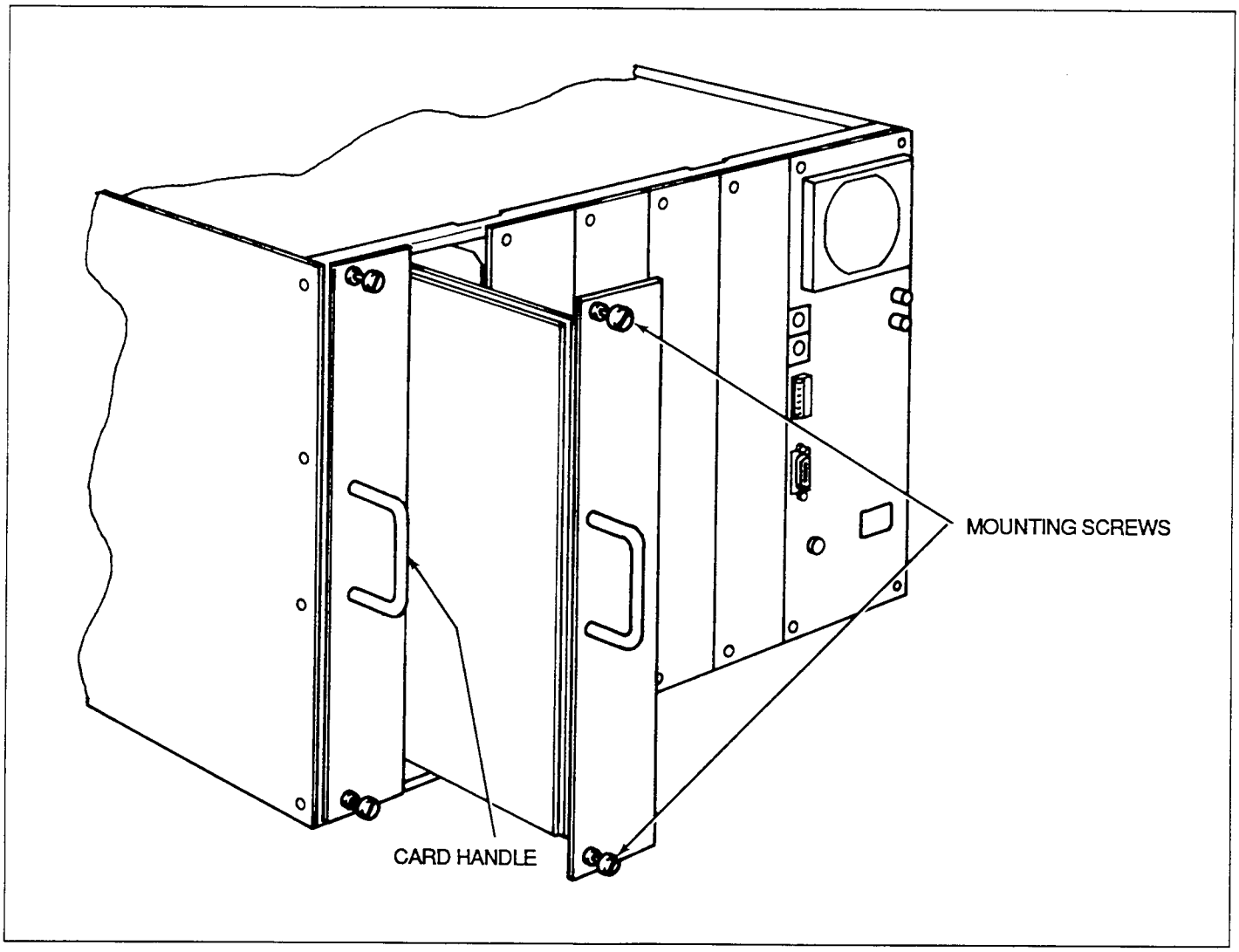


Figure 2-1. Model 7073 Installation

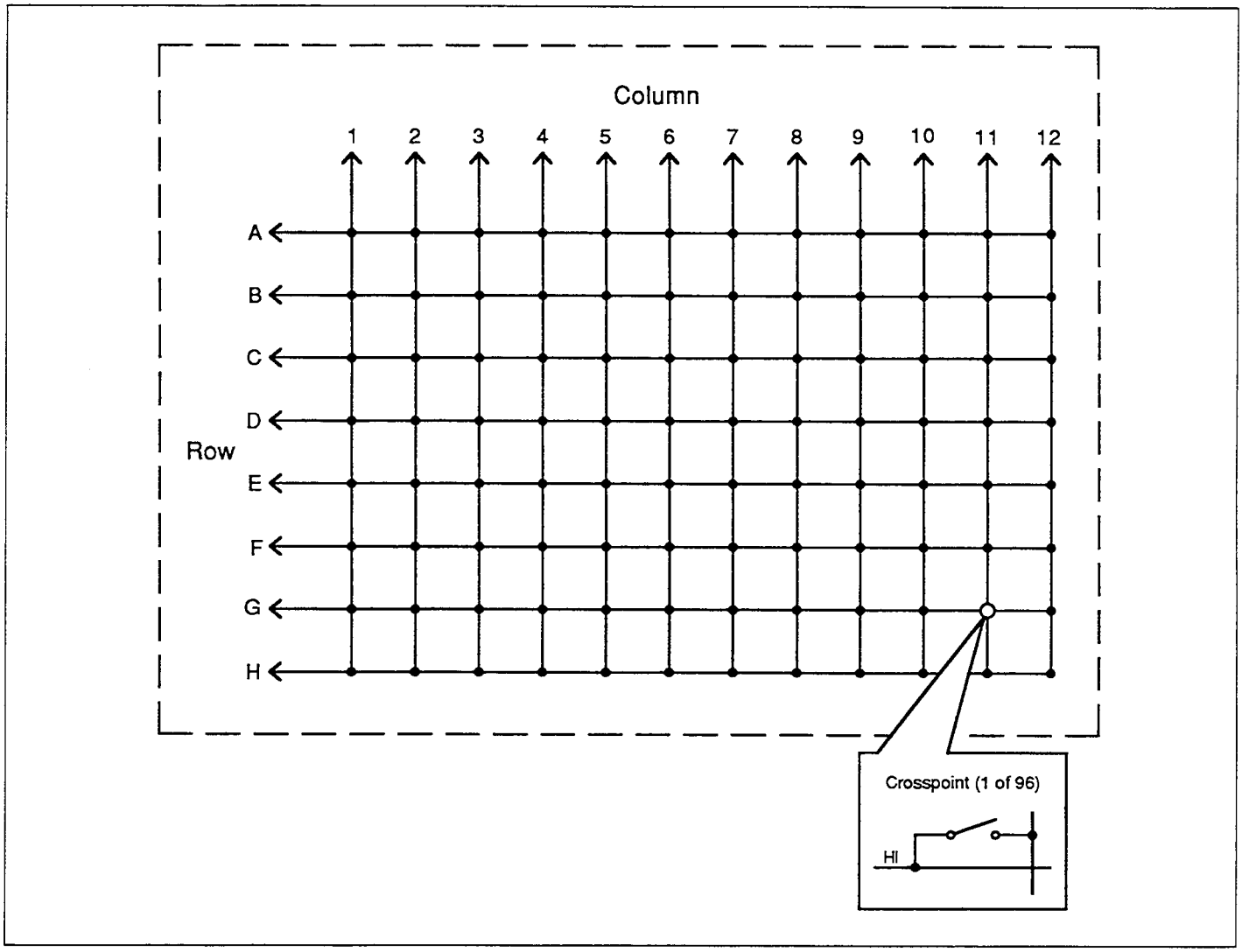


Figure 2-2. Simplified Schematic of Model 7073

2.4.1 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.

2.4.2 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 of the 96 matrix crosspoints. In the illustration, matrix card low (L) is also used as a shield.

2.4.3 Sensing

Figure 2-5 shows how the matrix card can be configured to use instrumentation that have sensing capability. The main advantage of using sensing is to cancel the effects of matrix card path resistance ($<1\Omega$) and the resistance of external cabling. Whenever path resistance is a consideration, sensing should be used. In the illustration, matrix card low is again used as a shield.

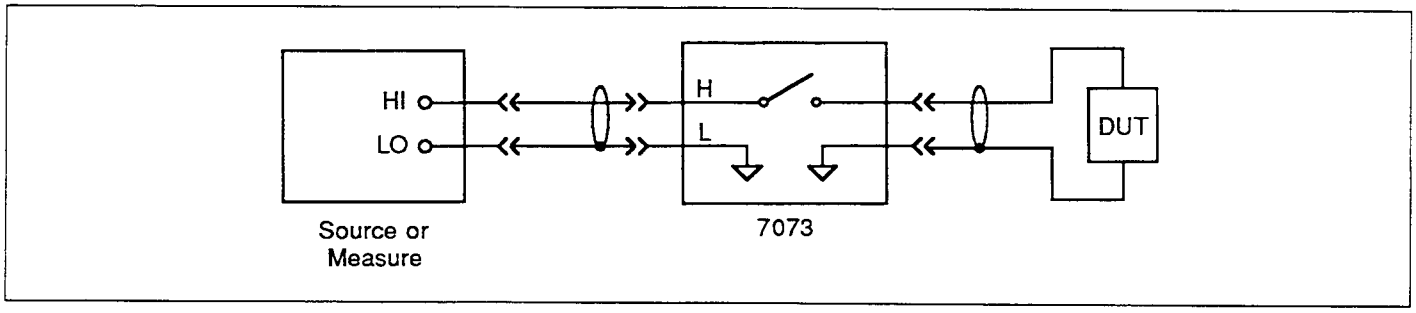


Figure 2-3. Single Ended

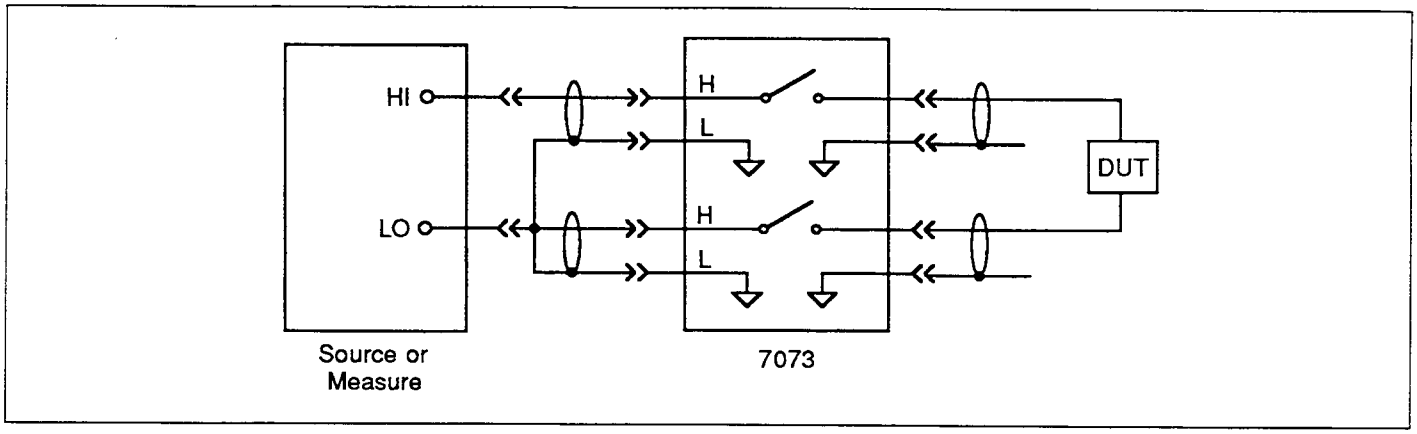


Figure 2-4. Differential (Shielded)

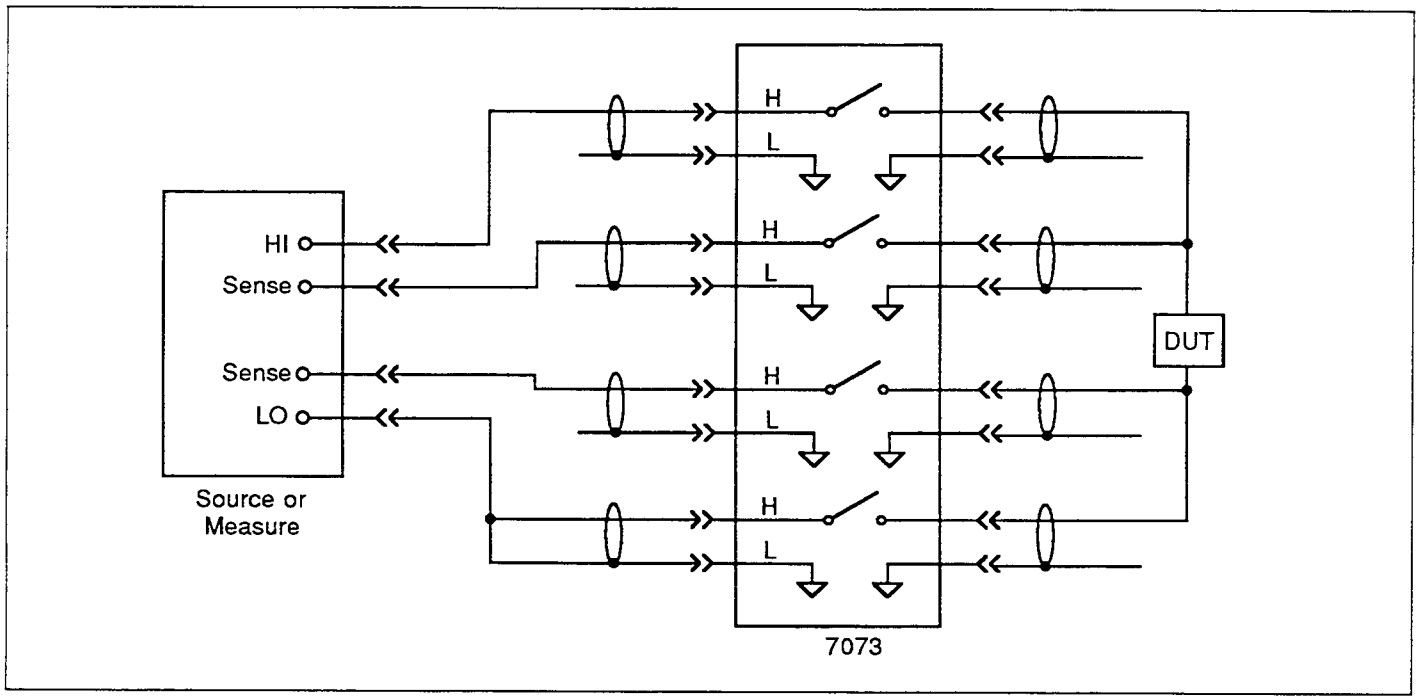


Figure 2-5. Sensing

2.5 CONNECTIONS

WARNING
To avoid injury or death, make sure all power is off and stored energy in external circuitry is discharged before making any connections to the matrix card.

External connections to the matrix card should be made after it is installed in the Model 707 mainframe. Rows and columns of the matrix card are terminated with 2-lug, female BNC connectors. Matrix card connections to instrumentation and test circuits terminated with similar type BNC connectors are easily made using BNC to BNC cables such as the ones described in paragraph 1.9. Special cables and adapters for making connections to instrumentation using different types of connectors (such as banana, triax, UHF, etc.) are available from various manufacturers. For DUTs, it may be desirable to terminate them with BNC connectors so that BNC cables can be used to connect them to the matrix card.

2.6 MATRIX CONFIGURATIONS

CAUTION
Contamination will degrade the performance (isolation properties) of the matrix card. To avoid contamination, always grasp the card by the handle and side edges. Do not touch the edge connectors of the card, and do not touch the board surfaces or components.

With the use of additional Model 7073 matrix cards and proper configuration of backplane disconnect jumpers, larger matricies can be configured. The following paragraph explains how to use the on-card backplane jumpers to configure a variety of matrices.

2.6.1 Backplane Disconnect Jumpers

As shipped, the Model 7073 is configured to connect its rows to the backplane of the Model 707. This allows the rows of cards installed in adjacent slots to be connected together eliminating the need for external row connections.

Each row of the Model 7073 matrix card has a moveable jumper whose position determines how (or if) that row is connected to the Model 707 backplane. The location of these jumpers on the card is shown in Figure 2-6. A simplified diagram of the Model 707 backplane is shown in Figure 2-7. The segmented line represents the backplane connections for one matrix row. As can be seen in the illustration, each slot in the empty mainframe is isolated by the open backplane connections. Row connections from one slot to an adjacent slot are accomplished through the jumpers on the Model 7073 matrix cards.

A schematic diagram showing how each row of the Model 7073 matrix card connects to the Model 707 backplane is shown in Figure 2-8. As shown, the backplane disconnect jumper is positioned to connect the matrix row to the next higher and lower mainframe slot. Positioning the jumper such that only terminals A and B are shorted, would connect the matrix row only to the next lower slot. Positioning the jumper such that only terminals B and C are shorted, would connect the matrix row only to the next higher slot. Removing the jumper would isolate the matrix row from the backplane.

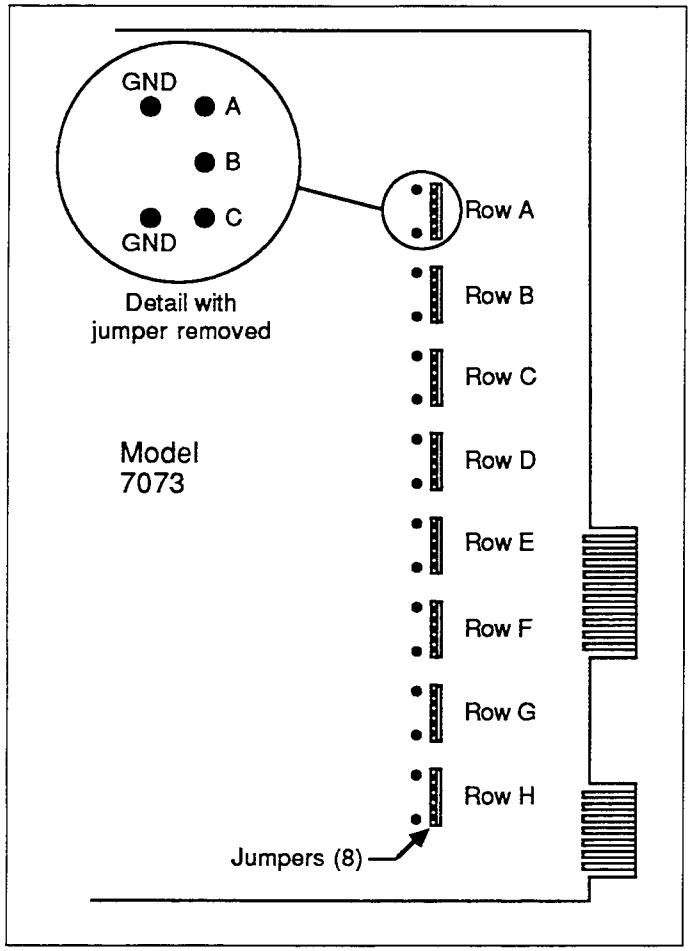


Figure 2-6. Backplane Jumper Locations (Shield Removed)

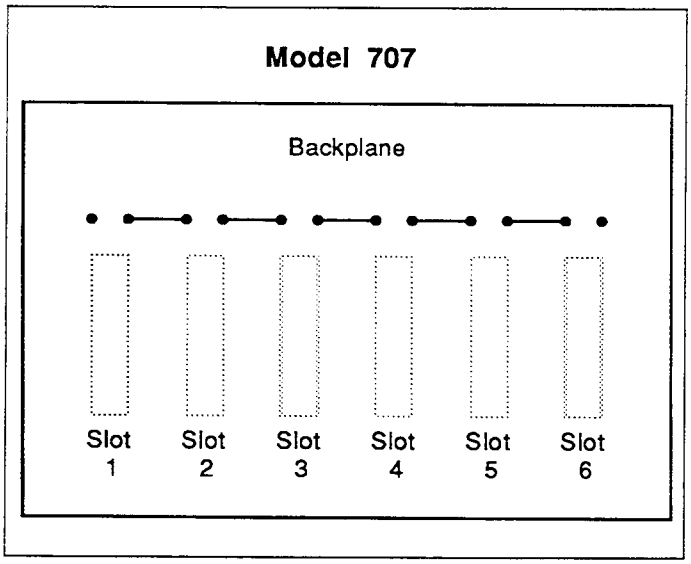


Figure 2-7. Model 707 Backplane Configuration for Model 7073 Cards

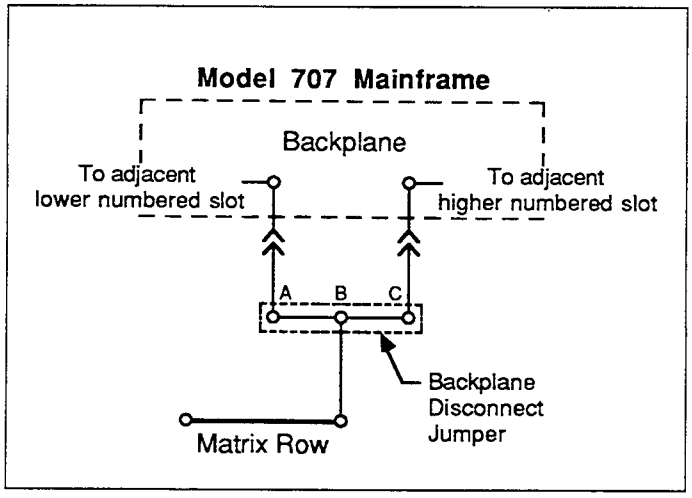


Figure 2-8. Backplane Connection Circuit (one of eight)

Each of the eight jumpers on the Model 7073 can be placed in one of four positions as shown in Figure 2-9A. With the jumper in Position 1, the matrix row makes a two-point backplane connection to adjacent slots (see Slot 2 of Figure 2-9B). The Model 7073 is shipped with the jumpers in this position. In Position 2, the matrix row makes a one-point backplane connection to the next higher numbered slot (see Slot 1 of Figure 2-9B). In Position 3, the matrix row makes a one-point backplane connection to the next lower numbered slot (see Slot 3 of Figure 2-9B). In Position 4, no connections are made to the backplane (see Slot 6 in Figure 2-9B).

In Figure 2-9B, the rows of the Model 7073s installed in slots 1, 2 and 3 are connected together, and isolated from the other slots. The rows of the Model 7073 installed in slot 6 are not connected to the backplane. Note that the cards must be installed in adjacent slots for the rows to be connected together. For example, a card installed in slot 4 will be isolated from cards in slots 1 and 2 if slot 3 is vacant or occupied by a different type card. Remember, removing a Model 7073 card from the mainframe breaks the backplane serial link.

NOTE

The Model 707 backplane used by the Model 7073 matrix card is not used by any other matrix card type (such as the Models 7071 and 7072 matrix cards). Thus, any other card types installed in the mainframe will always be isolated from Model 7073 cards.

To gain access to the backplane disconnect jumpers, remove the shield as explained in paragraph 4.7.2.

WARNING

To avoid injury (cut fingers) and contamination to the card, do not attempt to pull the jumpers off the board by hand. Instead, use a small bladed screwdriver to pry the jumpers off the board.

2.6.2 Narrow Matrix Expansion

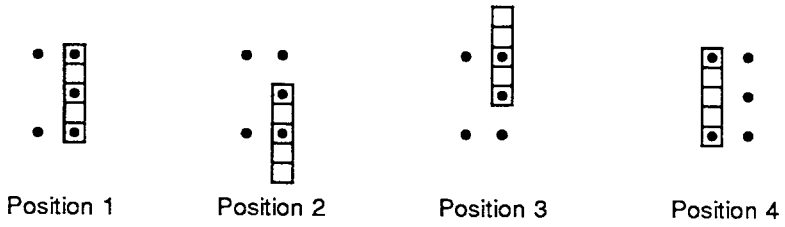
As shipped from the factory, the jumpers on the card are positioned to connect the rows into the backplane of the Model 707 (see Figure 2-9A, Position 1). Thus, each Model 7073 card installed next to another Model 7073 in the mainframe extends the matrix by 12 columns (see Table 2-2). For example, three cards installed in slots 1, 2, and 3 of the Model 707 will result in an 8 × 36 matrix. Figure 2-10 shows three matrix cards installed in slots 1, 2, and 3. Again, cards must be installed in adjacent slots for the rows to be connected together.

Table 2-2. 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

*Jumpers must be in position 1 (see Figure 2-9A), and cards must be installed with no empty slots between them.

As previously mentioned, another way to break the backplane serial link is to place the matrix backplane jumpers in Positions 2, 3, or 4. With jumpers set to isolate the cards from the backplane (Position 4), six Model 7073s in the mainframe will result in six separate 8 × 12 matrices.



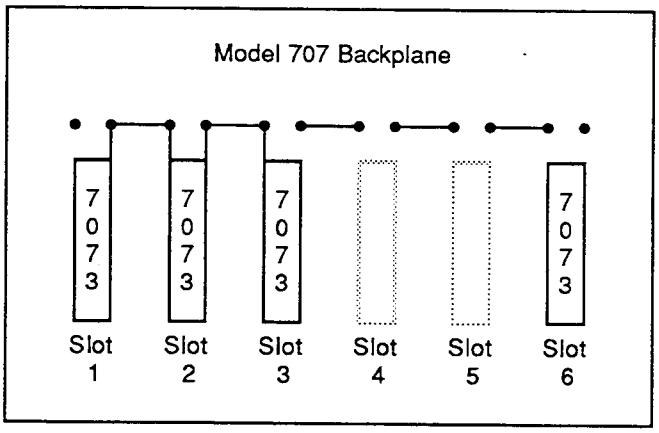
Position 1 : Makes a two point connection into the backplane. (See slot 2) Provides Backplane continuity to adjacent slots.

Position 2 : Makes a one-point backplane connection to the next higher numbered slot (See slot 1).

Position 3 : Makes a one-point backplane connection to the next lower numbered slot (See slot 3).

Position 4 : No connections made to the backplane (See slot 6). Backplane interrupted at this slot.

A.) Backplane Disconnect Jumper Positions



Jumper Positions :

Slot 1 - Card jumpers in Position 2
Slot 2 - Card jumpers in Position 1
Slot 3 - Card jumpers in Position 3
Slot 6 - Card jumpers in Position 4

B.) Example Backplane Connections

Figure 2-9. Backplane Jumpers

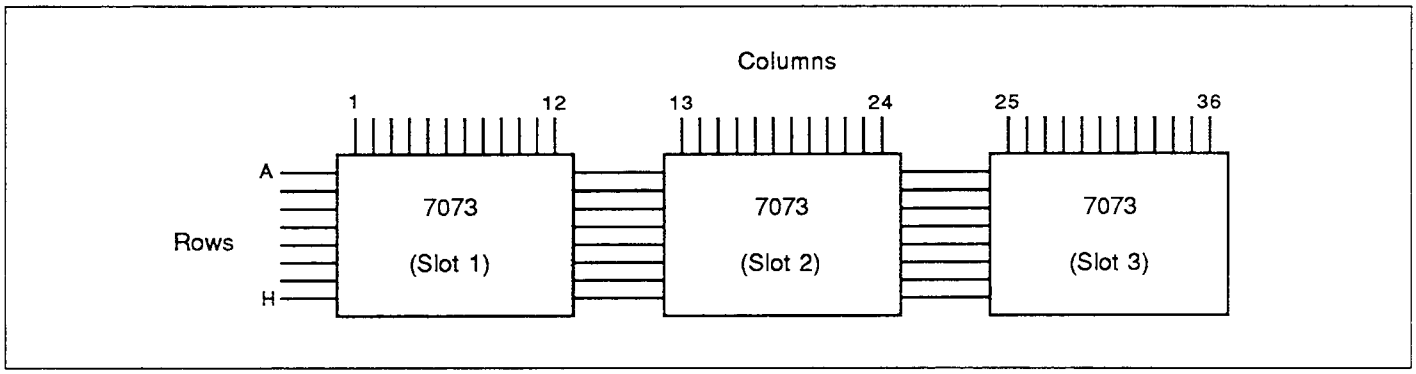


Figure 2-10. Narrow Matrix Example (8 × 36)

2.6.3 Wide Matrix Expansion

In general, wide matrices can be configured by connecting the columns of one Model 7073 card to the columns of another Model 7073 card. An example of a wide matrix (16 × 12) is shown in Figure 2-11. Note that the rows of the two cards are isolated from each other. This can be accomplished by maintaining an open slot between the two cards or by positioning their jumpers so that they are isolated from each other.

The most convenient method to connect 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.

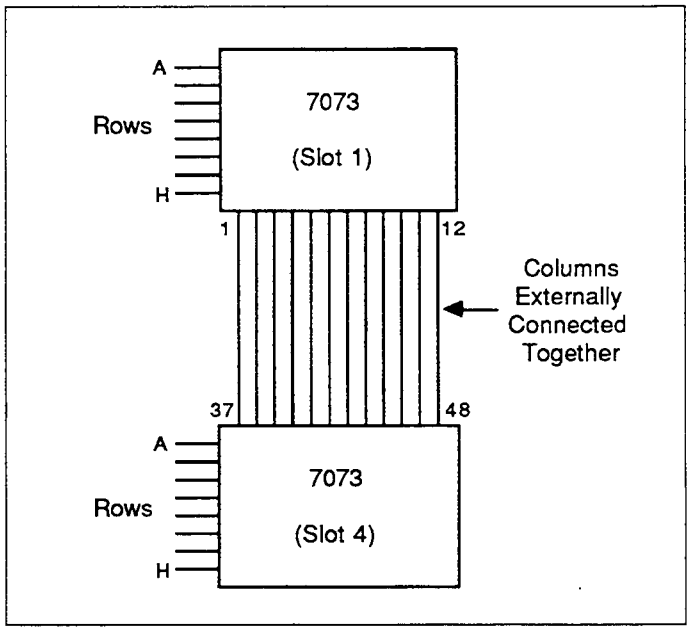


Figure 2-11. Wide Matrix Example (16 × 12)

2.6.4 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 7073s contains 384 crosspoints. A partially implemented matrix can be obtained by removing one Model 7073 from the mainframe (see Figure 2-12). The partial matrix is still 16 × 24, but contains only 288 crosspoints. An obvious advantage of a partial matrix is that less matrix cards are needed. Another reason to use a partial matrix is to keep certain devices from being connected directly to other certain devices. For example, a source in Figure 2-12 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.

2.6.5 Mainframe Matrix Expansion

Matricies using up to 30 Model 7073 matrix cards are possible by daisy-chaining five Model 707 mainframes together. Using 30 Model 7073 matrix cards provides 2880 crosspoints.

In general, connecting columns of a card in one mainframe to the columns of a card in another mainframe increases the the row numbers of the matrix. Connecting rows of any card in one mainframe to the rows of any other card in a second mainframe increases the column numbers of the matrix. See the Model 707 Instruction Manual for detailed information on daisy-chaining Model 707 mainframes.

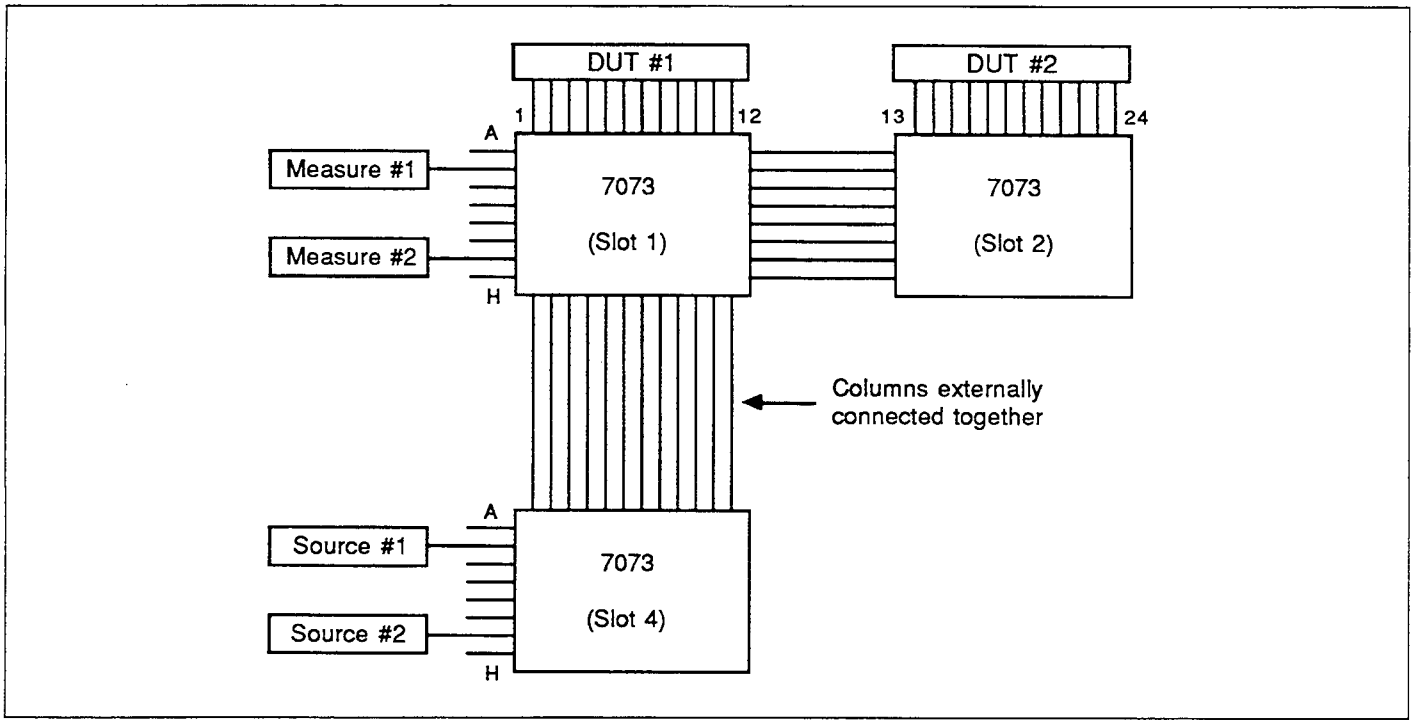


Figure 2-12. Partial Matrix Example (16 × 24)

2.7 TYPICAL CONNECTION SCHEMES

The information in this paragraph provides a typical connection scheme for single card, multiple card and multiple mainframe configurations. The examples in Figures 2-14 and 2-15 assume that the backplane disconnect jumpers of all cards are in Position 1 (rows of all cards connected together).

Figure 2-13 shows an example of how a single card system might be connected. Instruments are connected to matrix rows, and DUTs are connected to matrix columns. Note however, that since instrumentation only uses four rows in this example, the remaining four rows are used for DUTs.

Figure 2-14 shows how a multiple card system might be connected. Instruments are connected to the rows of the matrix card in slot 1, while the columns of each card are connected to the DUTs.

Figure 2-15 shows an example of how a multiple mainframe system might be connected. In this system, instrumentation and DUTs are connected to matrix card columns. Note that external cabling is needed to connect matrix rows of the master Model 707 to the matrix rows of the slave Model 707.

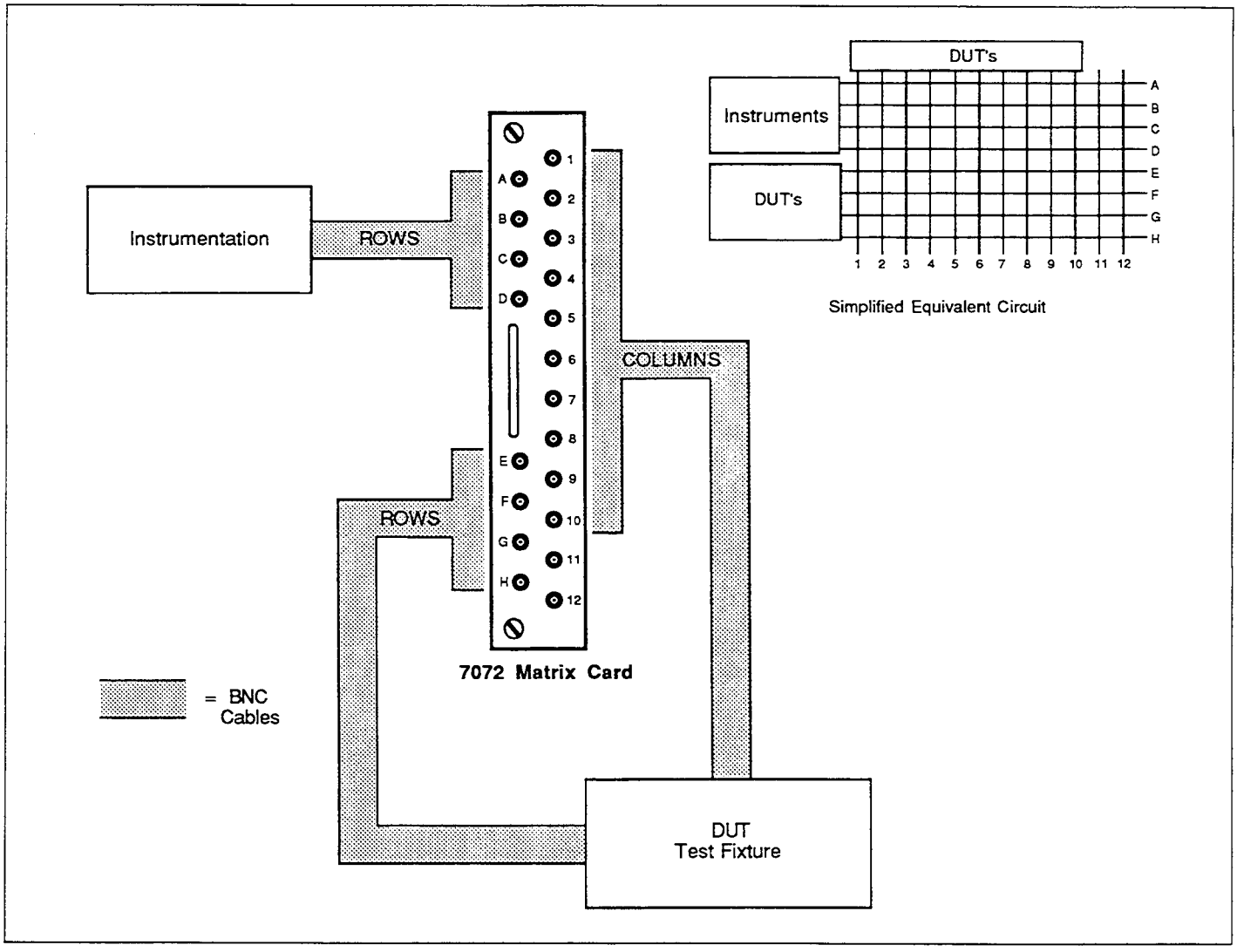


Figure 2-13. Single Card Example

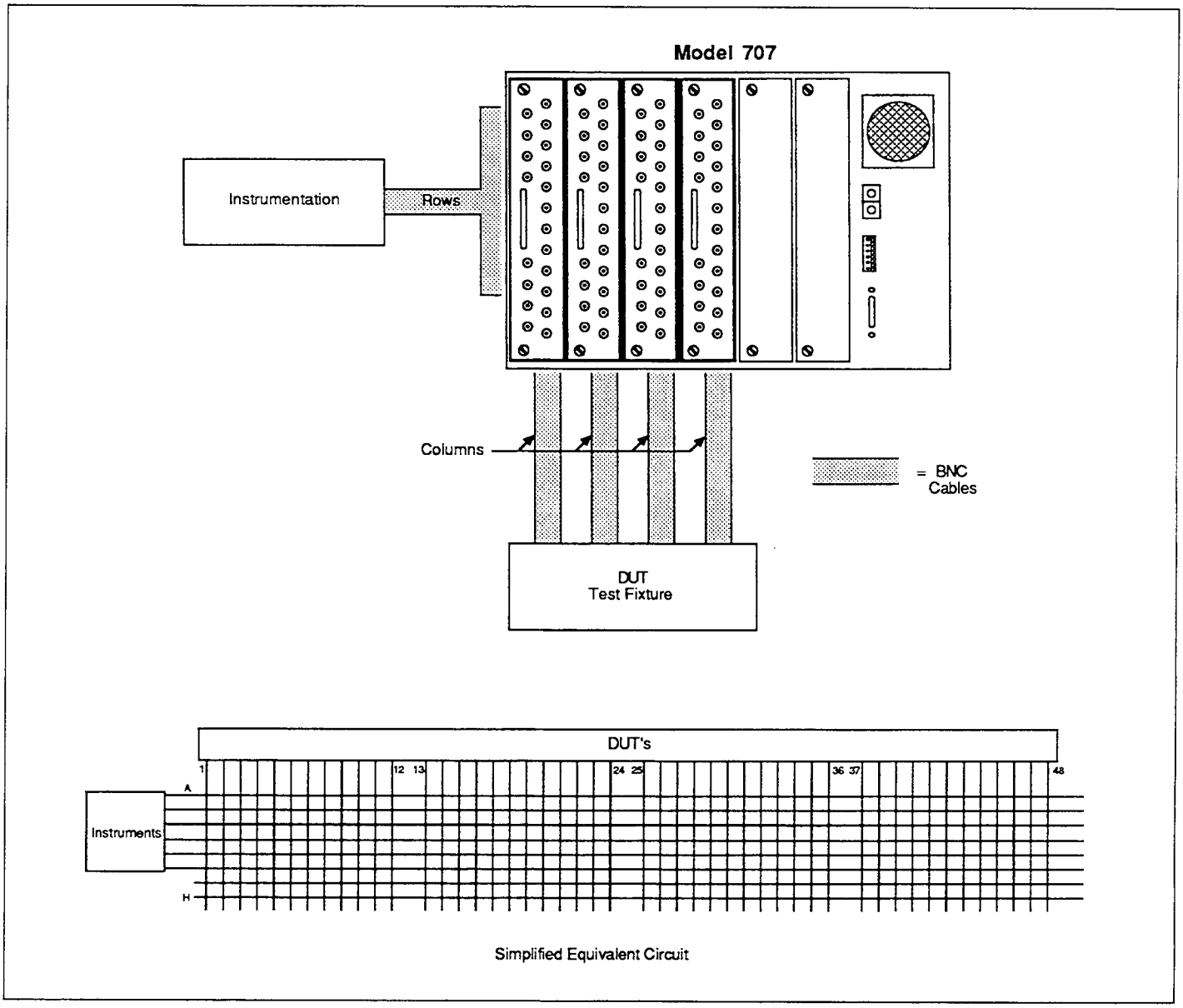


Figure 2-14. Multiple Card System Example

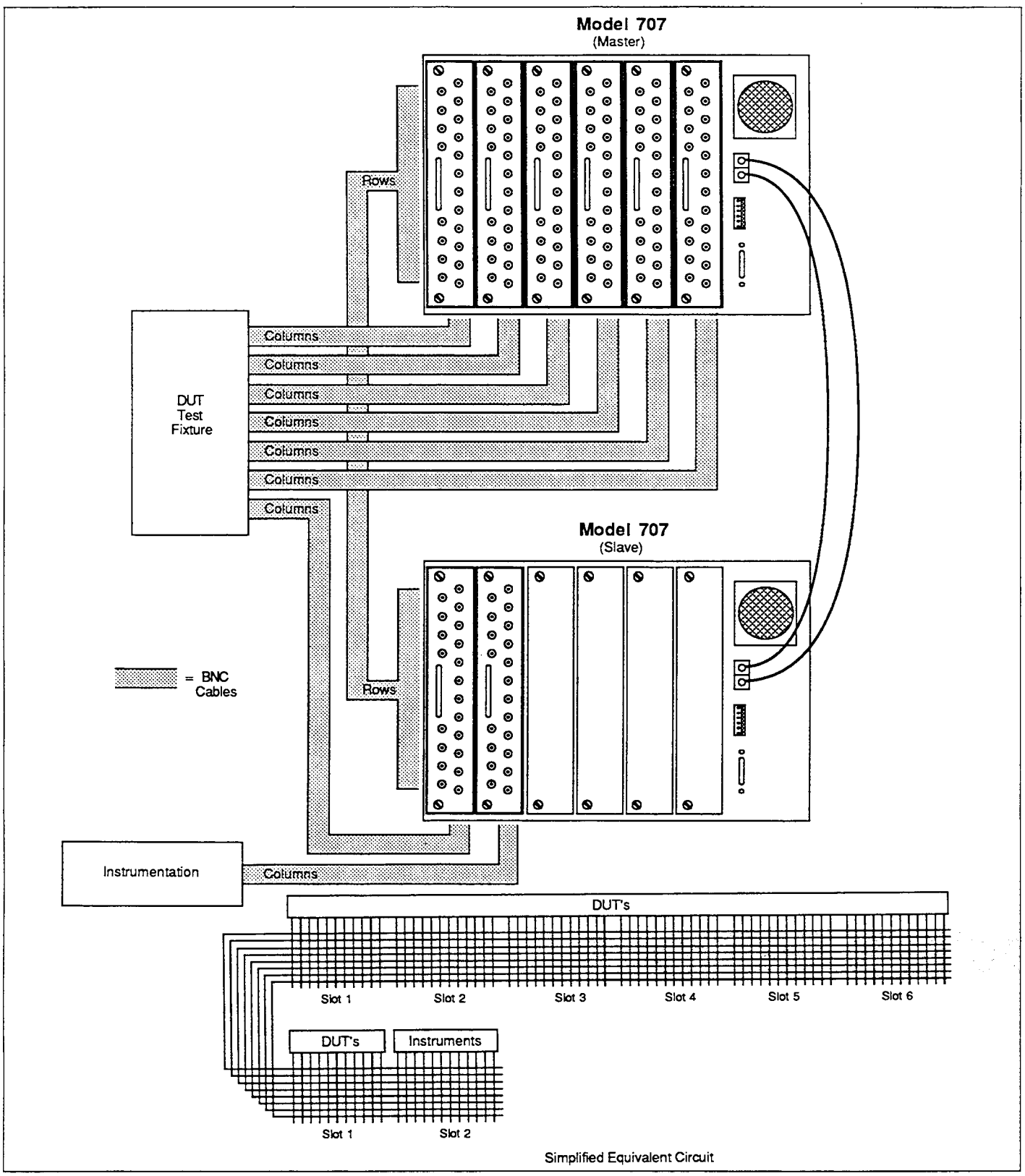


Figure 2-15. Multiple Mainframe System Example

2.8 OPERATING CONSIDERATIONS

This paragraph explains electrical characteristics and limitations of the Model 7073 matrix card. Also included are some recommendations on how to maximize the performance of the card.

Path Resistance—A matrix path is defined as the route a signal follows from row to column (or column to row) through a single crosspoint. The resistance of each matrix path is specified to be $<1\Omega$. In systems where path resistance is critical, use instrumentation that have sensing capabilites, or connect source leads and measurement leads through different pathways (4-wire Kelvin connections). If sensing cannot be done, keep external cabling as short as possible and minimize the number of connections to keep resistance to a minimum.

Contact Potential and Offset Current—Each crosspoint relay generates $<2\mu V$ of thermal EMF and must be considered in systems where low signal levels are used. Thermal EMFs can be minimized by using two adjacent paths to carry signals. Two adjacent relays (such as A1 and B2) will be at practically the same temperature resulting with the same thermal EMF level. The signal through the two crosspoints will be opposite in direction causing thermal EMFs of the two relays to cancel. Thermal EMFs caused by external circuitry can be minimized by using conductors that are made out of the same material. For example, an excellent low thermal junction is a clean, crimped copper-to-copper connection. In general, use high quality cables and connections. Finally, the thermal EMF can be measured and subtracted from the measurement. The matrix card can generate <200pA of offset current (typically 10pA) and must also be considered in a system where low signal levels are used. A common source of excessive offset current is "battery affect" caused by contamination of connectors or cables.

Isolation—Matrix card path isolation is specified at $>10^{10}\Omega$ with the card disconnected from the Model 707 backplane. Each additional Model 7073 card connected through the backplane further decreases isolation. For example, two cards connected together through the backplane have better isolation than three cards connected together. Input isolation is specified at $>10^{9}\Omega$. Note that the more cards that are connected through the backplane the more this isolation specification will degrade. Thus, for maximum isolation requirements, only one Model 7073 should be used in a system. Also, note that to maintain isolation, external cables and test fixture connectors must have excellent insulators, such as Teflon® .

Insertion Loss—In a 50Ω system (source and load), sinusodial signals up to 30MHz (3dB point), and digital (squarewave) signals up to 3MHz can be effectively routed through the card. In non-50Ω systems, sinusodial signals up to 1MHz and digital signals up to 100kHz can be effectively routed through the card. For sinusodial signals in a non-50Ω system, the 3dB point can be calculated as follows:

$$f_{3dB} = \frac{1}{2\pi RC}$$

where: R = Series source resistance
C = Capacitance of the card and cables

SECTION 3
Applications

3.1 INTRODUCTION

The following applications demonstrate the versatility of using the matrix card in a test system.

3.2 ANALOG/DIGITAL DEVICE TESTING

This application demonstrates how a variety of equipment configured in a matrix can be used to perform multiple tests on analog and digital DUTs. This is a single-ended system which has all signal lows connected together (system common).

3.2.1 Test Setup

An example of a test system is shown in Figure 3-1. The DUTs shown in this system are input/output devices. For high volume testing, a fixture that uses quick-disconnect sockets for the DUT will speed up the testing process. Also, BNC connectors can be mounted on the test fixture so that BNC to BNC cables (Keithley Model 7051) can be used to connect the DUT to the matrix card.

Most of the instruments used in the system use BNC connectors making it simple to connect them to the matrix card using BNC to BNC cables. For instrumentation that uses other type of connectors, there are adapters available (some from Keithley) to convert to BNC female.

3.2.2 Test Configurations

Because of the versatility of a matrix, any instrument can be connected to any port of any DUT by simply closing the appropriate crosspoint. However, in the test system shown in Figure 3-1, the instruments are most likely to be configured as follows:

Precision Source—The Keithley Model 263 is used to source voltage or current, as needed, to the DUT. When testing DUT #1, crosspoint A1 is closed to supply a test signal to it. When testing DUTs #2, 3, and 4, crosspoints A4, A7, and A10 are closed respectively. It is recommended that a signal be delivered to each DUT only when it is being tested so as not to exceed the maximum power output of the Model 263.

Measure Voltage—In this test system, the Model 196 DMM serves as a versatile measurement tool in that it can measure the DC component at any port of any DUT, or at a source. The DMM is connected to DUT by simply closing the appropriate crosspoint of ROW B (crosspoints B1 through B12). Only one crosspoint should be closed at any one time to avoid shorting DUT ports. The DMM can be connected directly to a sourcing instrument by closing two crosspoint. For example, to connect the DMM to the Model 263, close crosspoints A1 and B1.

Source Signal—A function generator and a pulse generator will provide a wide range of AC signals needed to test DUT. While the function generator will provide the standard analog type signals (sine, square, triangle and ramp) for analog circuits, the higher speed pulse generator can be used to test both analog and digital circuits. A signal gnerator is connected to the IN port of the DUT by closing the appropriate crosspoint. For example, to connect the pulse generator to DUT #1, close crosspoint E2.

Analyze Output—The Keithley Model 775A Programmable Counter/Timer, spectrum analyzer and Keithley Model 194 High Resolution Digitizer are used to analyze the output of the DUT. These instruments are connected to the OUT port of the DUT by closing the appropriate crosspoints. For example, to connect Card 1 input of the Model 194 to DUT #1, close crosspoint G3.

Notes:

1. The Model 7073 is specified for an offset current of <200pA, but is typically much less. Unless the actual value of offset current is known, this value should be used to calculate the minimum current that can be sourced accurately. For example, if 1% error is acceptable, the lowest current that the Model 263 should source is 20nA.
2. The system is shown in a single-ended configuration (all signals referenced to system common). By using two rows to switch both signal high and low, differential (or floating) measurements can be made. A differential system is used in the next application.

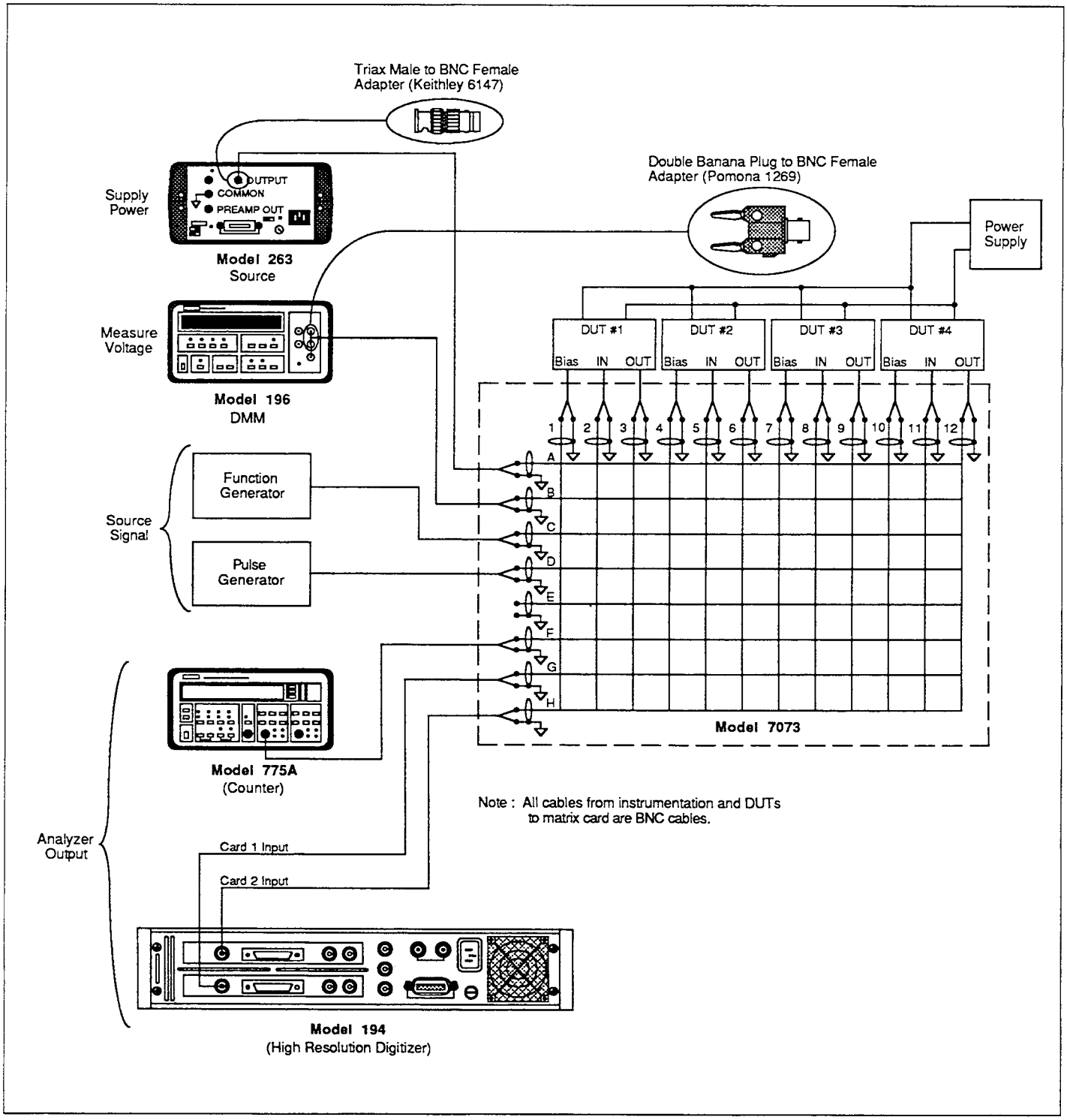


Figure 3-1. Parametric Test System

3.3 RESISTOR NETWORK TESTING

This application shows a differential (or floating) matrix system that can be used to perform a variety of tests on resistor networks. Tests include resistance measurements, capacitance or inductance measurements, and AC and DC voltage divider measurements. The test system is shown in Figure 3-2.

3.3.1 Resistance Measurements

In the ohms function, the Model 196 DMM is configured to make 2-wire ohms measurements of any or all elements of a resistor network. For example, closing crosspoints A1 and B3 will measure the resistance of R_1 and R_2 of DUT #1.

The effects of thermal EMFs generated by relay contacts and connections can be cancelled by using the offset compensated ohms feature of the Model 196. To compensate for thermal EMFs, close two crosspoints (such as A1 and B1) that will short the input of the Model 196, enable zero to cancel internal offset, and then enable offset compensation.

A consideration in 2-wire ohms measurements is the path resistance (<1Ω) and input isolation (<1GΩ) of the matrix card. The matrix card may contribute up to 0.1% error for measurements between 1kΩ and 1MΩ. For measurements between 10kΩ and 100kΩ, up to 0.01% error may be contributed by the matrix card.

To eliminate the effects of path resistance, the Model 196 can be reconfigured to make 4-terminal ohms measurements of low resistance DUTs. To do this, the matrix would have to be expanded since four pathways would be needed by the Model 196 (two paths to source and two paths to sense).

To make guarded high resistance measurements, a matrix card and ohmmeter with guard capabilities (such as the Keithley Models 7071 General Purpose Matrix Card and the Model 617 Electrometer) will be required. For guarded resistance measurements greater than 1GΩ, a matrix card with better isolation capabilities (such as the Model 7072 Semiconductor Matrix Card) should be used.

3.3.2 Voltage Divider Checks

For resistor networks that are going to be used as voltage dividers, it may be desirable to test them using AC or DC voltages that simulate actual operating conditions. This is a particularly useful test for resistor networks that have a voltage coefficient. The system in Figure 3-2 uses a Keithley Model 230 to source DC volts and a general purpose function generator to source AC volts. The Model 196 DMM is used to measure both AC (up to 100kHz) and DC volts. Note that the function generator is connected to only one path (Row F). Row E (shorted to common) is used as the return path for the generator making it a differential (floating) source.

A consideration in these checks is the affect of Model 196 input impedance on voltage measurements. The input impedance is shunted across the resistor being measured. The resultant divider resistance is the parallel combination of the resistor under test and the input impedance of the measurement instrument. As long as the input impedance is much larger than the resistor being measured, the error introduced into the measurement will be minimal.

The resistor network is tested by applying a voltage across it and measuring the voltage across each resistor element and/or across combined elements.

3.3.3 Capacitance/Inductance Measurements

In applications where capacitance or inductance is a factor, the Keithley Model 590 CV Analyzer can be used as a C-meter to measure the capacitance or inductance (-C) across each resistor element and/or across combined elements.

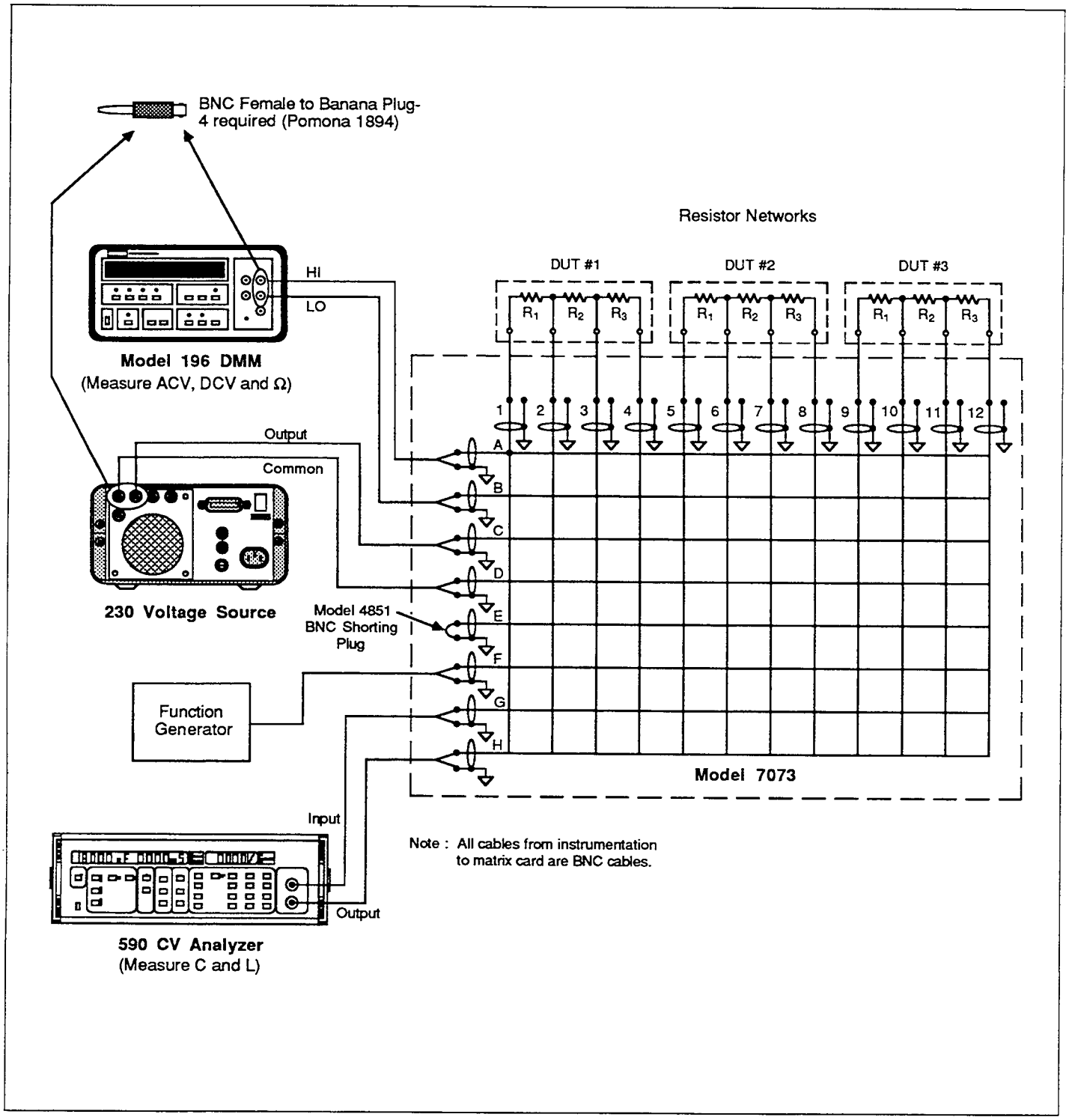


Figure 3-2. Resistor Network Testing

SECTION 4
Service Information

4.1 INTRODUCTION

This section contains information necessary to service the Model 7073 General Purpose Matrix Card and is arranged as follows:

4.2 Handling and Cleaning Precautions: Discusses handling procedures and cleaning methods for the matrix card.

4.3 Relay Test Program: Explains how to connect the matrix card to the Model 707 mainframe for the relay test program.

4.4 Performance Verification: Covers the procedures necessary to determine if the card is operating properly.

4.5 Principles of Operation: Briefly discusses circuit operation.

4.6 Special Handling of Static-Sensitive Devices: Reviews precautions necessary when handling static-sensitive devices.

4.7 Troubleshooting: Presents some troubleshooting tips for the matrix card.

4.2 HANDLING AND CLEANING PRECAUTIONS

Because of the high impedance circuits on the Model 7073, 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.

1. Do not store or operate the card in an environment where dust could settle on the circuit board. Use dry nitrogen gas to clean dust off the card if necessary.
2. Handle the card only by the handle and side edges. Do not touch any board surfaces or components associated with the repair. When servicing the card, wear clean, white cotton gloves.
3. 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. Use Freon® TMS or TE, or the equivalent along with plenty of clean cotton swabs to remove the flux. Take care not to spread the flux to other areas of the circuit board. Once the flux has been removed, swab only the repaired area with methanol, then blow dry the board with dry nitrogen gas.
4. After cleaning, the card should be placed in a 50°C low humidity environment for several hours.

4.3 RELAY TEST PROGRAM SETUP

The Model 707 comes equipped with a test program on disk that will test all relays of Model 7073s installed in the mainframe. The test program will flag any relay that fails to close when energized or open when de-energized. Instructions for using the test program with an IBM PC or XT, or HP 300 series computer are contained in the Model 707 Instruction Manual.

Perform the following steps to configure the Model 7073 for relay testing:

1. Remove the relay test terminal block from the rear panel of the Model 707. This is a quick-disconnect terminal block and simply pulls off the rear panel terminal strip.
2. Connect the relay test terminal block to rows A and B of any Model 7073 card installed in the mainframe as shown in Figure 4-1. Note that terminals 5 and 6 of the relay test terminal block must be shorted together.
3. Re-install the relay test terminal block into the rear panel of the Model 707 mainframe.

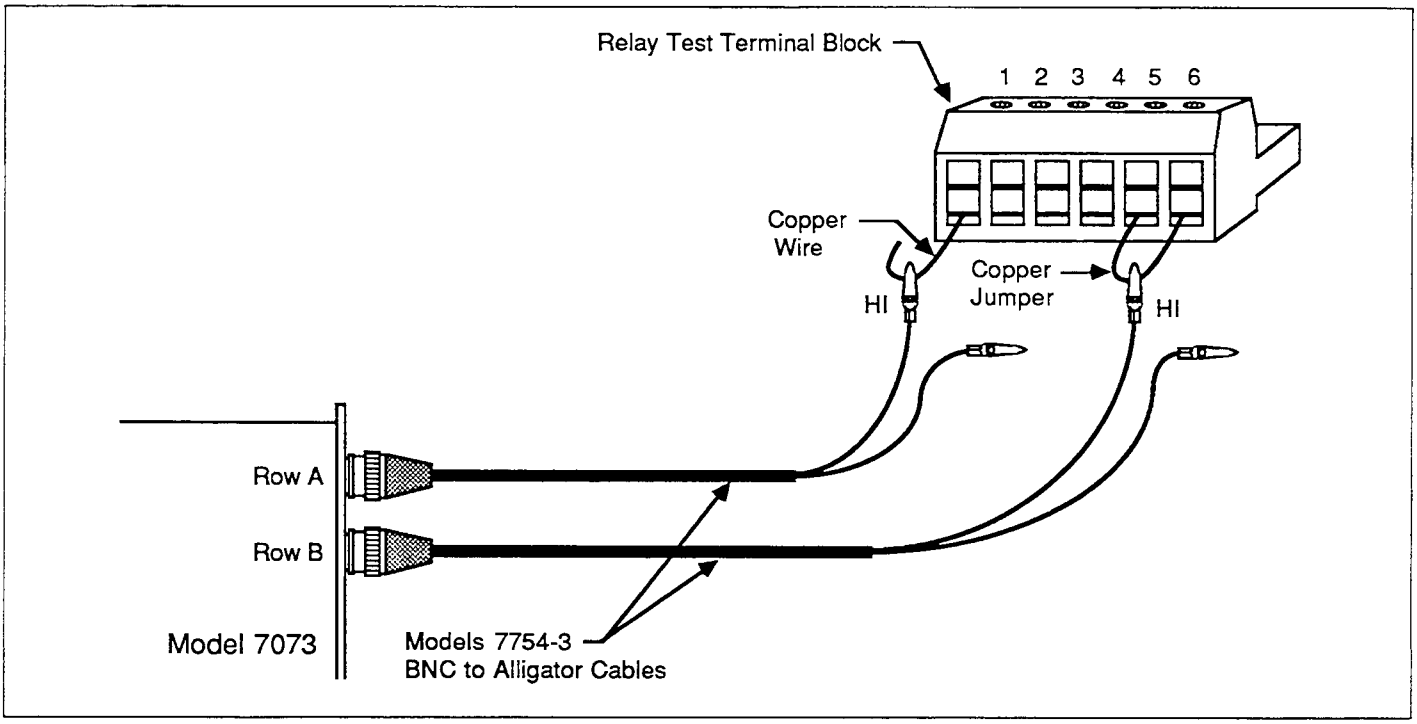


Figure 4-1. Relay Test Setup

4.4 PERFORMANCE VERIFICATION

The following paragraphs discuss performance verification procedures for the Model 7073, including path resistance, offset current, contact potential, and isolation.

The procedures in this section are rather lengthy due to the large number of row and column combinations that are 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.

The performance verification procedures must be performed with only one matrix card (the one being checked) installed in the Model 707 mainframe. Also, the Model 707 must not be daisy-chained to another Model 707.

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 edge connectors of the card, and do not touch the board surfaces or components.

NOTE

Failure of any performance verification test may indictate that the matrix card is contaminated. See paragraph 4.2 to clean the card. If the test still fails after cleaning, then try cleaning the backplane (see the Model 707 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, along with the application for each unit.

NOTE

Do not use the Model 7070 Universal Adapter Card as an extender card to verify performance of the Model 7073. The Model 7073 must be installed in the Model 707 mainframe.

Table 4-1. Verification Equipment

Description	Model	Specifications	Application
DMM	Keithley 196	300Ω; 0.01%	Path resistance
Electrometer w/voltage source	Keithley 617	10pA, 100pA; 1.6% 100V source; 0.2%	Offset current isolation
Nanovoltmeter	Keithley 181	2mV; 0.015%	Contact potential
Triax cable (unterminated)	Keithley 7025	—	Offset current isolation
Binding post to BNC male adapters (2)	Pomona 3430	—	Path resistance isolation
Female triax to male BNC adapter	Keithley 4804	—	Offset current path isolation
BNC female to triax male adapter	Keithley 6147	—	Input isolation
Double binding posts to BNC male adapter	Pomona 1296	—	Input isolation

4.4.3 Path Resistance Tests

Referring to Figure 4-2, perform the following steps to verify that the contact of each relay is closing properly and that the resistance is within specification.

1. Turn the Model 707 off if it is on.
2. Install the Model 7073 in slot 1 of the Model 707.
3. Set the Model 196 to the 300Ω range and connect four test leads to the OHMS and OHMS SENSE input.
4. Short the four test leads together and zero the Model 196. Leave zero enabled for the entire test.
5. Connect the Model 196 to the matrix card as shown in Figure 4-2 and turn on the Model 707.
6. Program the Model 707 to close crosspoint A1 (ROW A, COLUMN 1), and verify that the resistance of this path is <1Ω.
7. Open crosspoint A1, and connect the OHMS LO and OHMS SENSE LO test leads to ROW B.
8. Close crosspoint B1 and verify that the resistance of this path is <1Ω.
9. Repeat the basic procedure of steps 7 and 8 to check the path resistance through crosspoints C1, D1, E1, F1, G1 and H1.
10. Connect the OHMS SENSE HI and OHMS HI test leads to COLUMN 2 and check that the path resistance through crosspoints A2 through H2 is <1Ω.
11. Repeat the basic procedure of connecting the test leads to the appropriate row and column, and check the rest of the matrix crosspoints.

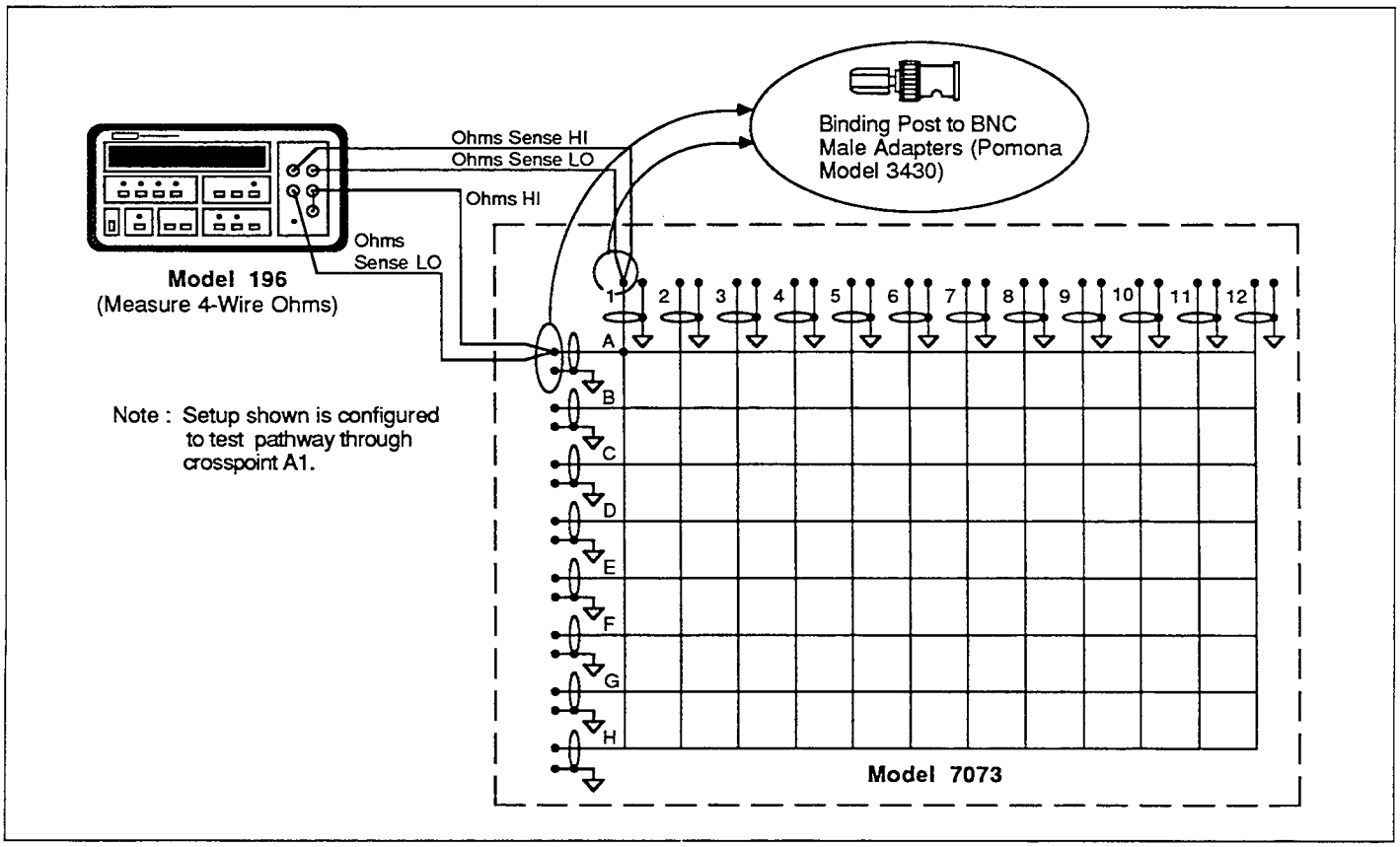


Figure 4-2. Path Resistance Testing

4.4.4 Offset Current Tests

These tests check leakage current between HI (signal high) and chassis (signal low). In general, these tests are performed by simply measuring the leakage current with a picoammeter. In the following procedure, the Keithley Model 617 is used to measure leakage current.

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

1. Turn the Model 707 off if it is on.
2. Install the matrix card in slot 1 of the Model 707.
3. On the Model 617, select the 200pA range, and enable zero check and zero correct in that order. Leave zero correct enabled for the entire procedure.
4. Connect the Model 617 to ROW A of the Model 7073 matrix card as shown in Figure 4-3.
5. Turn on the Model 707.
6. Program the Model 707 to close crosspoint A1.
7. On the Model 617, disable zero check and verify that it is <200pA. This measurement is the leakage current of the pathway.
8. On the Model 617, enable zero check and on the Model 707, open crosspoint A1.
9. Repeat the basic procedure in steps 6 through 8 to check the rest of the pathways (crosspoints A2 through A12) of the row.
10. Connect the Model 617 to ROW B of the matrix card and repeat the basic procedure in steps 6 through 8 to check crosspoints B1 through B12.
11. Repeat the above basic procedure for the remaining rows (ROWS C through H).

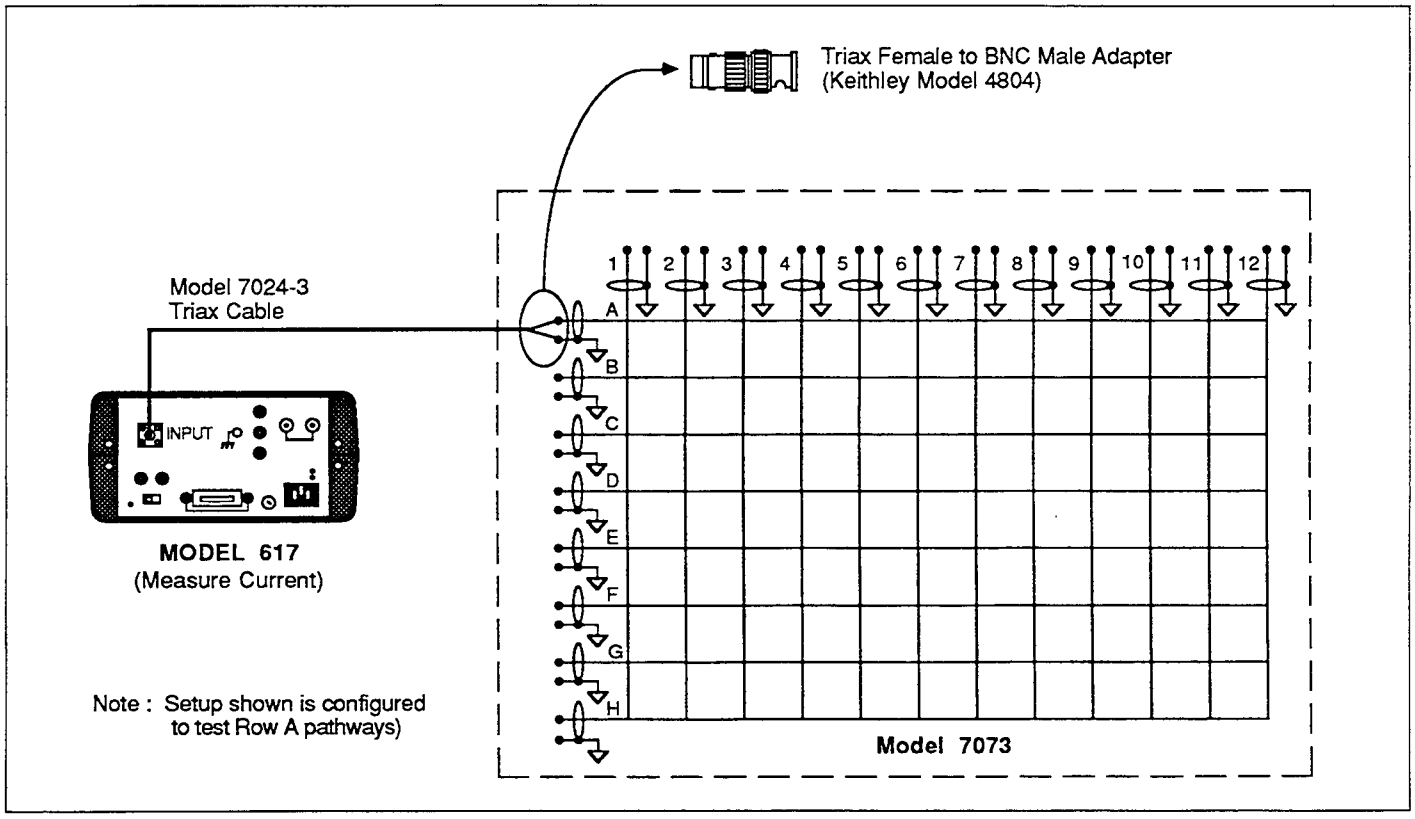


Figure 4-3. Offset Current Testing

4.4.5 Contact Potential Tests

These tests check the EMF generated by each relay contact pair (H and L) for each pathway. The tests simply consist of using a nanovoltmeter (Model 181) to measure the contact potential.

Referring to Figure 4-4, perform the following procedure to check contact potential of each path:

1. Turn the Model 707 off if it is on.
2. Install the Model 7073 in slot 1 of the Model 707.
3. Set the Model 181 to the 2mV range, short the input leads and press ZERO to null out internal offset. Leave zero enabled for the entire procedure.
4. Connect the Model 181 to the matrix card as shown in Figure 4-4 and turn on the Model 707. Notice that the copper wire is inserted into the BNC connector center conductor.

CAUTION

To prevent damage to the BNC connectors on the matrix card, do not insert a wire larger than #17 gage into the center conductors.

5. Program the Model 707 to close crosspoint A1 (ROW A, COLUMN 1), and verify that the contact potential of this path is $<2\mu V$.
6. Open crosspoint A1, and connect the LO of the Model 181 to ROW B.
7. Close crosspoint B1 and verify that the contact potential of this path is $<2\mu V$.
8. Repeat the basic procedure of steps 6 and 7 to check contact potential through crosspoints C1, D1, E1, F1, G1 and H1.
9. Connect HI of the Model 181 to COLUMN 2 and check that contact potential through crosspoints A2 through H2 is $<2\mu V$.
10. Repeat the basic procedure of connecting the test leads to the appropriate row and column and check the rest of the matrix crosspoints.

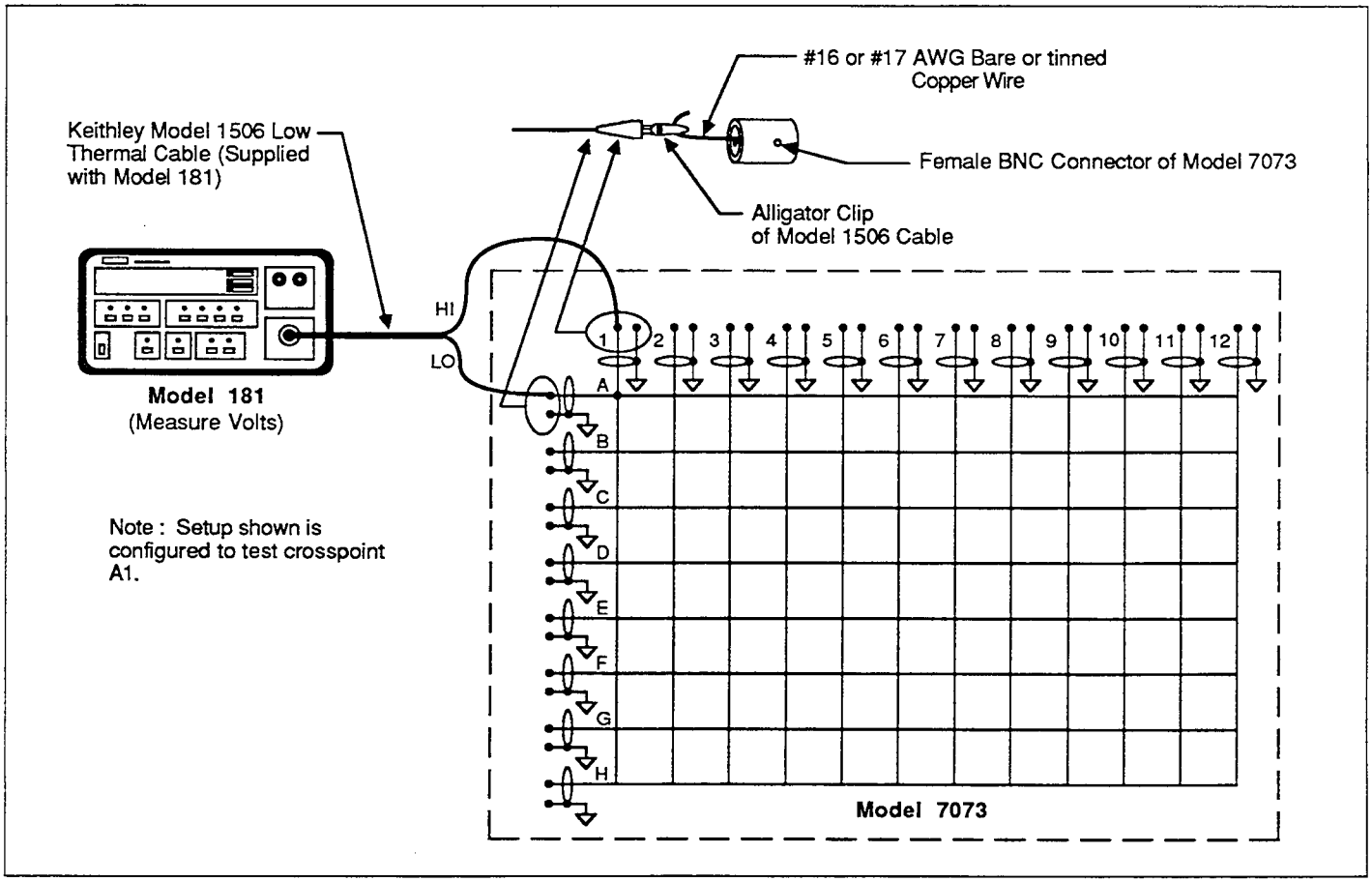


Figure 4-4. Contact Potential Testings

4.4.6 Path Isolation Tests

These tests check the leakage resistance (isolation) between adjacent paths. A path is defined as the circuit from a row to a column that results by closing a particular crosspoint.

Referring to Figure 4-5, perform the following procedure to check path isolation:

1. Turn the Model 707 off if it is on.
2. On the matrix card, remove all eight backplane disconnect jumpers in order to isolate the card from the backplane of the Model 707.
3. Install the matrix card in slot 1 of the Model 707.
4. On the Model 617, select the 2kΩ range, and enable zero check and zero correct in that order. Leave zero correct enabled for the entire procedure.
5. Connect the Model 617 to the matrix card as shown in Figure 4-5.
6. On the Model 617, select the 20GΩ range.
7. Turn on the Model 707, and program it to close crosspoints A1 (ROW A, COLUMN 1) and B2 (ROW B, COLUMN 2).
8. On the Model 617, disable zero check.
9. After allowing the reading on the Model 617 to settle, verify that it is >10GΩ. This measurement is the leakage resistance (isolation) between ROW A, COLUMN 1 and ROW B, COLUMN 2.
10. On the Model 617, enable zero check.
11. Move both leads of the Model 617 down one row such that they are connected to ROWs B and C.
12. Program the Model 707 to close crosspoints B2 and C3.
13. On the Model 617, disable zero check.
14. After allowing the reading on the Model 617 to settle, verify that it is >10GΩ.
15. Using Table 4-2 as a guide, repeat the basic procedure of steps 10 through 14 for the rest of the path pairs (test numbers 3 through 11 in the table).
16. Turn off the Model 707, remove the matrix card, and re-install the backplane disconnect jumpers.

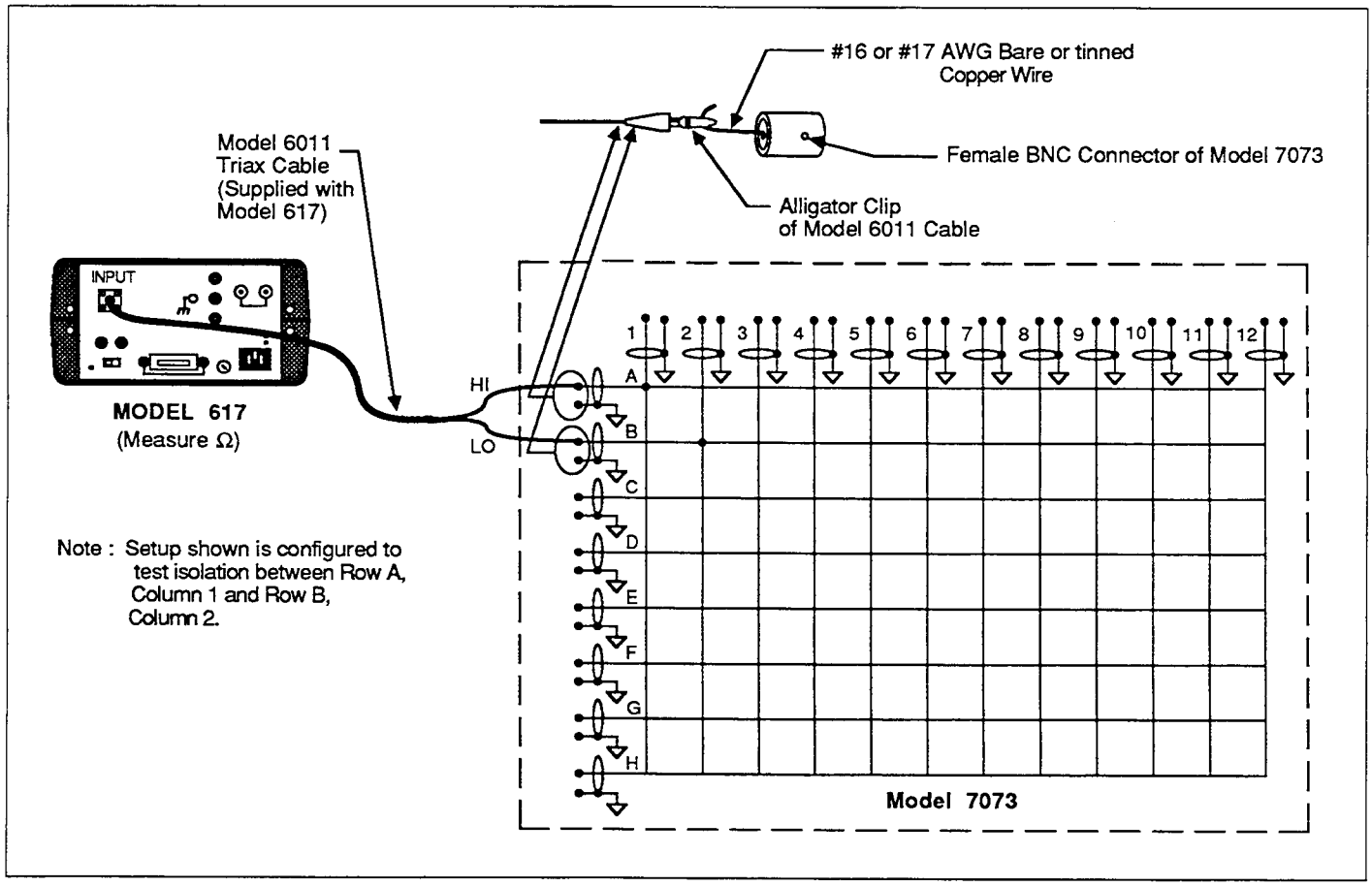


Figure 4-5. Path Isolation Testing

Table 4-2. Path Isolation Tests

Test No.	Path Isolation	Test Equipment Location	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

4.4.7 Input Isolation Tests

These tests check the leakage resistance (isolation) between high (HI) and low (Chassis) of every row and column.

Referring to Figure 4-6, perform the following procedure to check input isolation:

1. Turn the Model 707 off if it is on.
2. Install the matrix card in slot 1 of the Model 707.
3. On the Model 617, select the 2kΩ range, and enable zero check and zero correct in that order. Leave zero correct enabled for the entire procedure.
4. Connect the Model 617 to the matrix card as shown in Figure 4-6.
5. On the Model 617, select the 1GΩ range.
6. Turn on the Model 707, but do not program any crosspoints to close. All crosspoints must be open.
7. On the Model 617, disable zero check.
8. After allowing the reading on the Model 617 to settle, verify that it is >1GΩ. This measurement is the leakage resistance (isolation) of ROW A.
9. Place the Model 617 in zero check.
10. Program the Model 707 to close crosspoint A1.
11. On the Model 617, disable zero check.
12. After allowing the reading on the Model 617 to settle, verify that it is also >1GΩ. This measurement checks the isolation of COLUMN 1.
13. Using Table 4-3 as a guide, repeat the basic procedure of steps 9 through 12 for the rest of the columns and rows (test numbers 3 through 20 of the table).

Table 4-3. Input Isolation Test

Test No.	Input Isolation	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
18	ROW F	A1 and F1
19	ROW G	A1 and G1
20	ROW H	A1 and H1

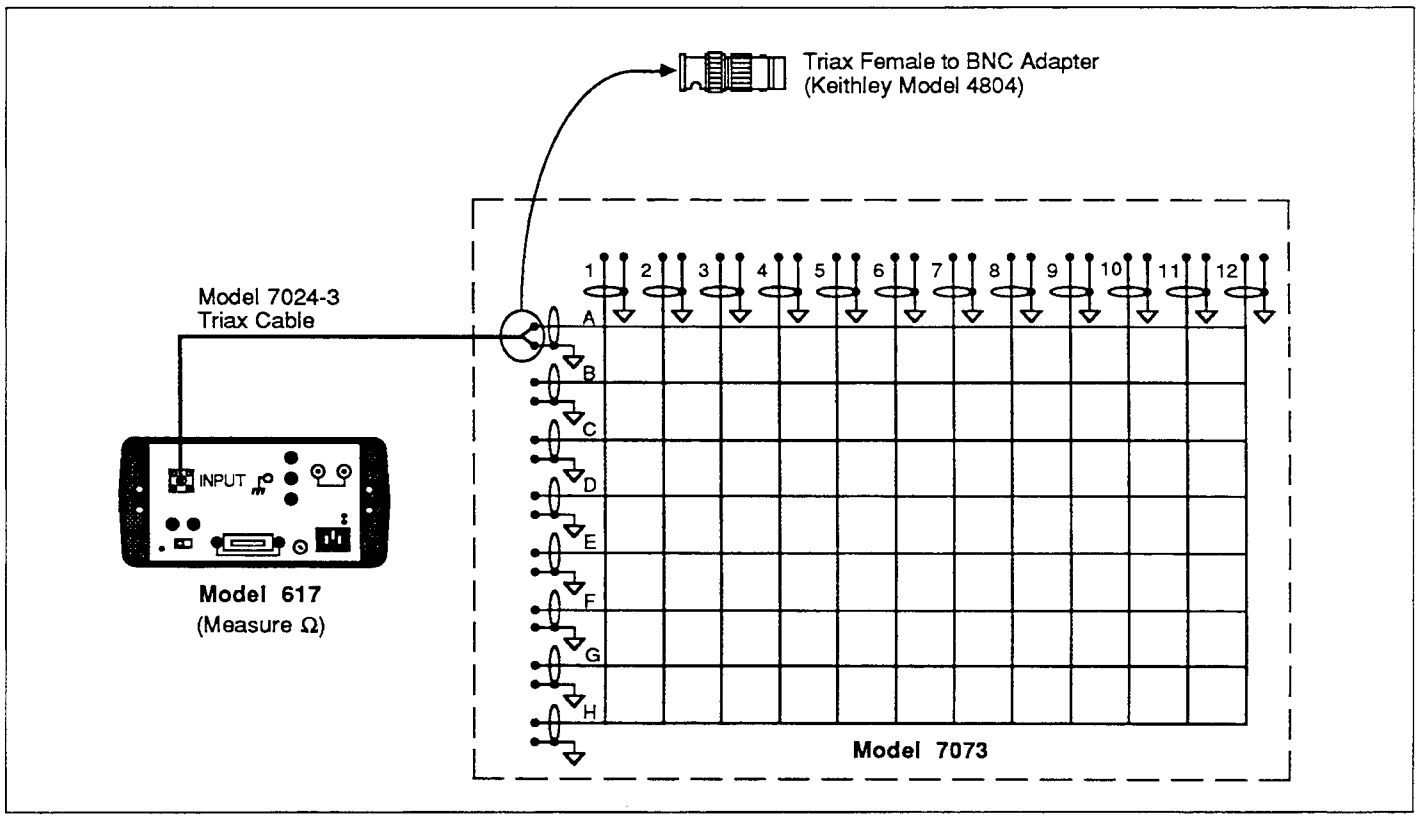


Figure 4-6. Input Isolation Testing

4.5 PRINCIPLES OF OPERATION

The paragraphs below discuss the basic operating principles for the Model 7073 and can be used as an aid in troubleshooting the matrix card. The schematic drawing of the matrix card is shown on drawing number 7073-106, located at the end of Section 5.

4.5.1 Card Identification

Identification coding and a matrix configuration table is stored in an erasable programmable read-only memory (EPROM). This information is sent to the Model 707 so that it "knows" which type of matrix card is installed in that particular mainframe slot. This enables the Model 707 to send valid configuration data to the matrix card.

On power-up, control line $\overline{\text{CARDSEL}}$ goes low turning on the EPROM (U114). That control line, as well as the other control lines from the Model 707, is buffered by U113. Lines CLK, $\overline{\text{NEXT ADDR}}$ and CLR ADDR along with counter U116 control the task of loading data from the EPROM into the parallel to serial shift register (U115). Data is clocked from U114 to the Model 707 via the IDDATA line by the CLK control line. A timing diagram for the transfer sequence of each byte of identification data is shown in Figure 4-7.

4.5.2 Switching Circuitry

Matrix configuration data is sent from the Model 707 via the RELAY DATA control line and serially loaded into the 12 shift registers (U101 through U112). The matrix card relays configure accordingly when the registers receive the STROBE signal from the Model 707. A relay is energized when a register output is low (connected to digital common).

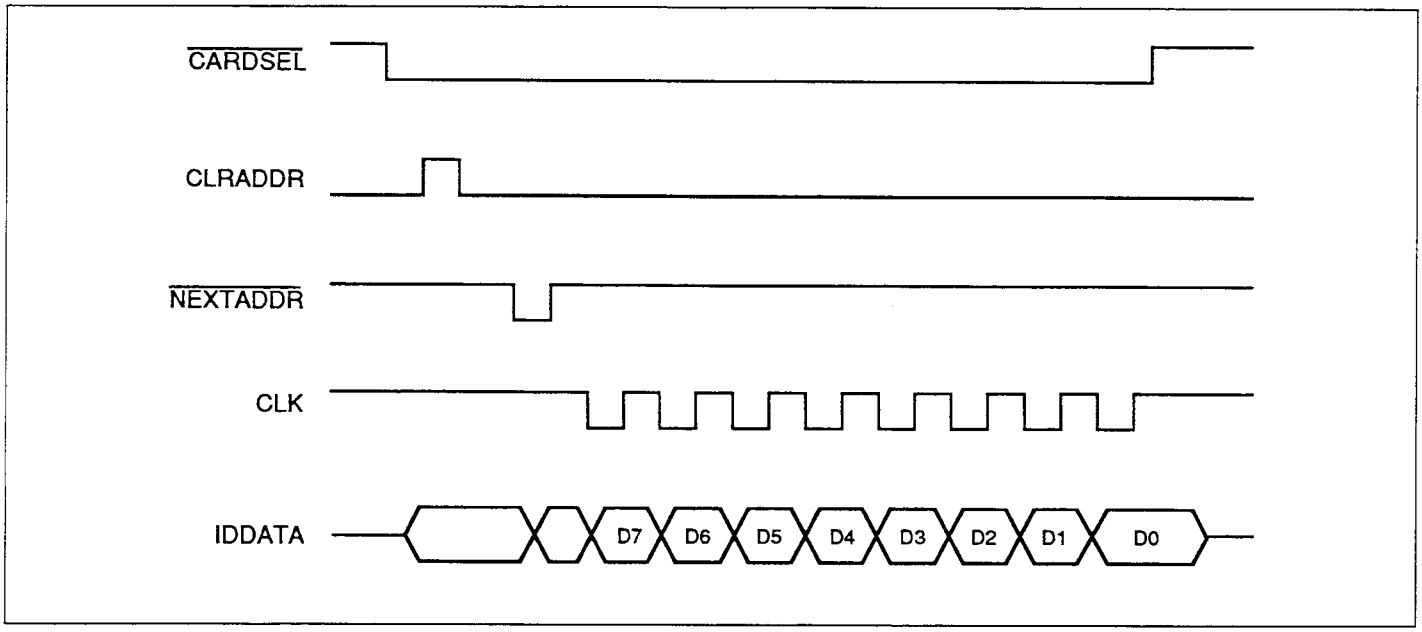


Figure 4-7. IDDATA Timing Diagram

4.5.3 Power-Up Safeguard

To prevent relays from inadvertently 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 (U117) and an RC network (R105, C125 and CR101). The time constant of the RC network keeps the output of the NAND gate high during the power-up sequence. This high signal is applied to the $\overline{OE}$ input of the shift registers keeping the relays de-energized. After the capacitor of the RC network charges, the falling edge of the first STROBE signal will then force the output of the NAND gate low 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 7073 are static-sensitive, it is recommended that they all be treated as static-sensitive.

1. Such devices should be transported and handled only in containers specially designed to prevent or dissipate static 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.
2. Revove the devices from their protective containers only at a properly grounded work station. Also ground yourself with a suitable wrist strap while working with these devices.
3. Handle the devices only by the body; do not touch the pins.
4. Any printed circuit board into which the device is to be inserted must first be grounded to the bench or table.
5. Use only anti-static type de-soldering tools and grounded-tip soldering irons.

4.7 TROUBLESHOOTING

The Keithley Model 7070 Universal Adapter card is an extender card that allows the card to operate outside of the Model 707 so that it can be troubleshooted.

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 196)	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

To gain access to individual circuit components, remove the circuit board shield. The shield is secured to the board with seven screws.

Table 4-5 outlines the troubleshooting procedure 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 edge connectors of the card, and do not touch the board surfaces or components.

Table 4-5. Troubleshooting Summary*

Step	Item/Component	Comment	Required Condition
1	TP101	+6V supply	+6VDC
2	TP103	+5V supply	+5VDC
3	TP105	CLR ADDR line**	High logic pulse at beginning of each card identification byte transfer
5	TP104	$\overline{\text{NEXT ADDR}}$ line**	Low logic pulse after CLR ADDR pulse.
6	TP109	CLK line	Hz clock
7	TP106	IDDATA line**	Card identification logic pulse train (on power-up).
8	TP110	Power-up safeguard	Remains high during power-up
9	TP108	RELAY DATA line	Logic pulse train to load relay configuration resistors
10	TP107	STROBE line	High logic pulse to strobe relay configuration registers.
11	U101 thru U112 pins 11 thru 18	Relay Drivers	+5.3V for open crosspoints ≈ 0V for closed crosspoints

*All measurements referenced to digital common (TP102)

**See Figure 4-9

Copper cladding has been added to the rear shield of the matrix card in order to provide increased protection from static discharge. The copper shield is electrically connected to chassis ground of the matrix card by a jumper wire.

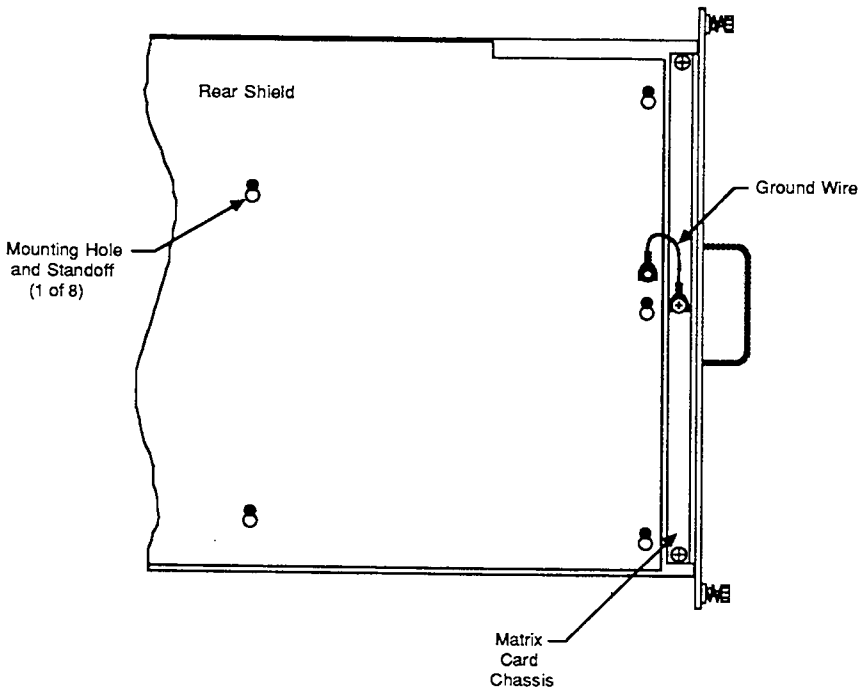
In order to service the matrix card, it may be necessary to remove the rear shield. Referring to the illustration, perform the following procedure to remove and reinstall the rear shield:

1. Disconnect the jumper wire from the matrix card chassis. The wire is secured to the matrix card chassis with a screw.
2. The rear shield is secured to the matrix card by eight standoffs. Carefully slide the rear shield upward until the eight standoffs align with the large clearance holes in the shield and remove the shield.
3. To reinstall the shield, reverse the above procedure. make sure the metal side of the shield is facing outward.

CAUTION

Failure to observe the following precautions could result in damage not covered by the warranty:

1. **The shield must be installed such that the metal side facing away from the matrix card. Backward installation will cause PC board connections to short out against the metal shield.**
2. **The jumper wire must be connected as shown in order to provide circuit protection from static discharge.**



SECTION 5
Replaceable Parts

5.1 INTRODUCTION

This section contains a list of replaceable electrical and mechanical parts for the Model 7073, as well as a component layout drawing and schematic diagram of the matrix card.

5.2 PARTS LISTS

Electrical parts are listed in order of circuit designation in Table 5-1. Table 5-2 summarizes miscellaneous parts.

5.3 ORDERING INFORMATION

To place a parts 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:

1. Matrix card model number (7073)
2. Card serial number
3. Part description
4. Circuit description, if applicable
5. Keithley part number

5.4 FACTORY SERVICE

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

1. Complete the service form at the back of this manual and include it with the card.
2. Carefully pack the card in the original packing carton.
3. Write ATTENTION REPAIR DEPT on the shipping label.

Note: It is not necessary to return the matrix mainframe with the card.

5.5 COMPONENT LAYOUT AND SCHEMATIC DIAGRAM

Figure 5-1 shows a component layout of the Model 7073, while Figure 5-2 shows a schematic diagram.

Table 5-1
Model 7073, Parts List

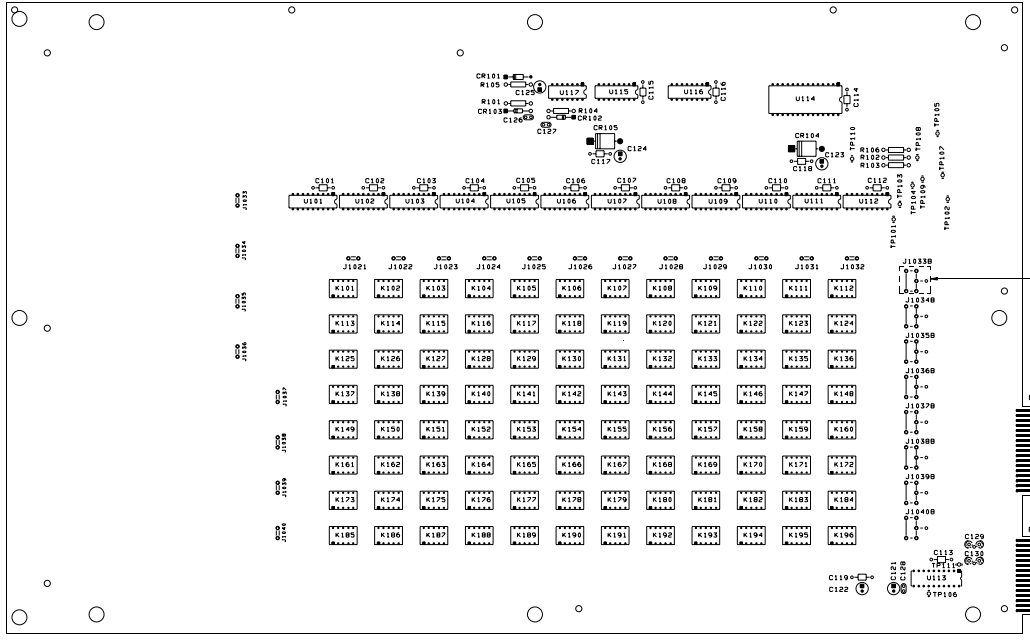
Circuit Desig.	Description	Keithley Part No.
C101-119	CAP, .1µF, 20%, 50V, ALUM ELEC	C-365-.1
C121-124	CAP, 10µF, -20 +100%, 25V, ALUM ELEC	C-314-10
C125	CAP, 47µF, 10%, 16V, ALUM ELEC	C-321-47
C126-128	CAP, .01µF, 20%, 50V, CERAMIC	C-237-.01
C129, 130	CAP, 270pF, 20%, 100V	C-386-270p
CR101	DIODE, SILICON, 1N4148 (D0-35)	RF-28
CR102, 103	DIODE, SCHOTTKY BARRIER, IN5711	RF-69
CR104, 105	DIODE, SILICON, 5400	RF-34
J1-J12	CABLE ASS'Y	CA-53-1
J13-J20	CABLE ASS'Y	CA-53-2
J1021-1040, J1033B-1040B	CONTACT PIN	A24249
K101-196	RELAY, MINI-SIGNAL, EA2-5NJ	RL-163
R101	RES, 10K, 5%, 1/4W, COMPOSITION OR FILM	R-76-10K
R102	RES, 11K, 5%, 1/4W, COMPOSITION OR FILM	R-76-11K
R103	RES, 120K, 5%, 1/4W, COMPOSITION OR FILM	R-76-120K
R104	RES, 220, 5%, 1/4W, COMPOSITION OR FILM	R-76-220
R105	RES, 47K, 5%, COMPOSITION OR FILM	R-76-47K
R106	RES, 910, 5%, 1/4W, COMPOSITION OR FILM	R-76-910
TP101-111	CONN, TEST POINT	CS-553
U101-112	IC, 8-BIT SERIAL-IN/LTCH DRIVE,UCN-5841A	IC-536
U113	IC-LINE DRVR, W/3-STATE OUTPUT 74HC244	IC-489
U114	PROGRAM	7073-800
U115	IC, 8 BIT PARALLEL TO SERIAL, 74HCT165	IC-548
U116	IC, 12 STAGE BINARY RIPPLE COUNTER, 74HCT4040	IC-545
U117	IC, QUAD 2 INPUT NAND, 74HCT00	IC-399

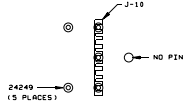
Table 5-2
Model 7073, Miscellaneous Parts List

Qty	Description	Keithley Part No.
1	HANDLE	HH-33-1
8	JUMPER	J-10-5
1	SHIELD, BOTTOM	7073-305
1	SHIELD, TOP	7073-304
1	SOCKET (FOR U114)	SO-69
8	STANDOFF	ST-137-4

"D7073-100

LTR.	ECO NO.	REVISION	ENG.	DATE
B	12320	RELEASED	SZ	8-24-87
C	12422	REVISED	SZ	11-12-87
D	12954	REVISED	SZ	12-29-87
E	13157	REVISED PER REV.E ARTWORK	SZ	11-14-88
F	13862	REVISED PER REV.F ARTWORK	SZ	5-3-90
G	15197	REVISED BOARD LAYOUT	SZ	3-12-92



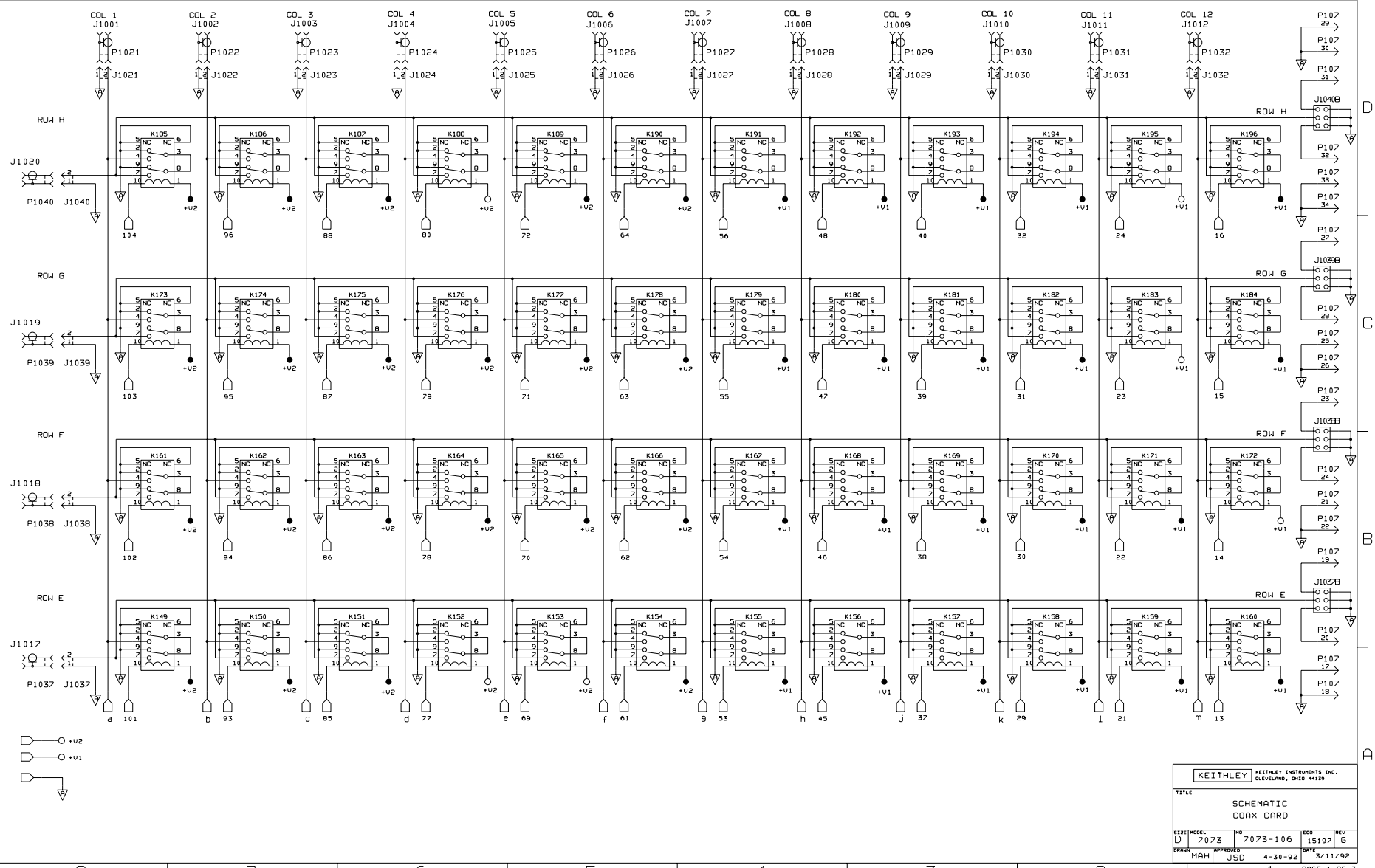


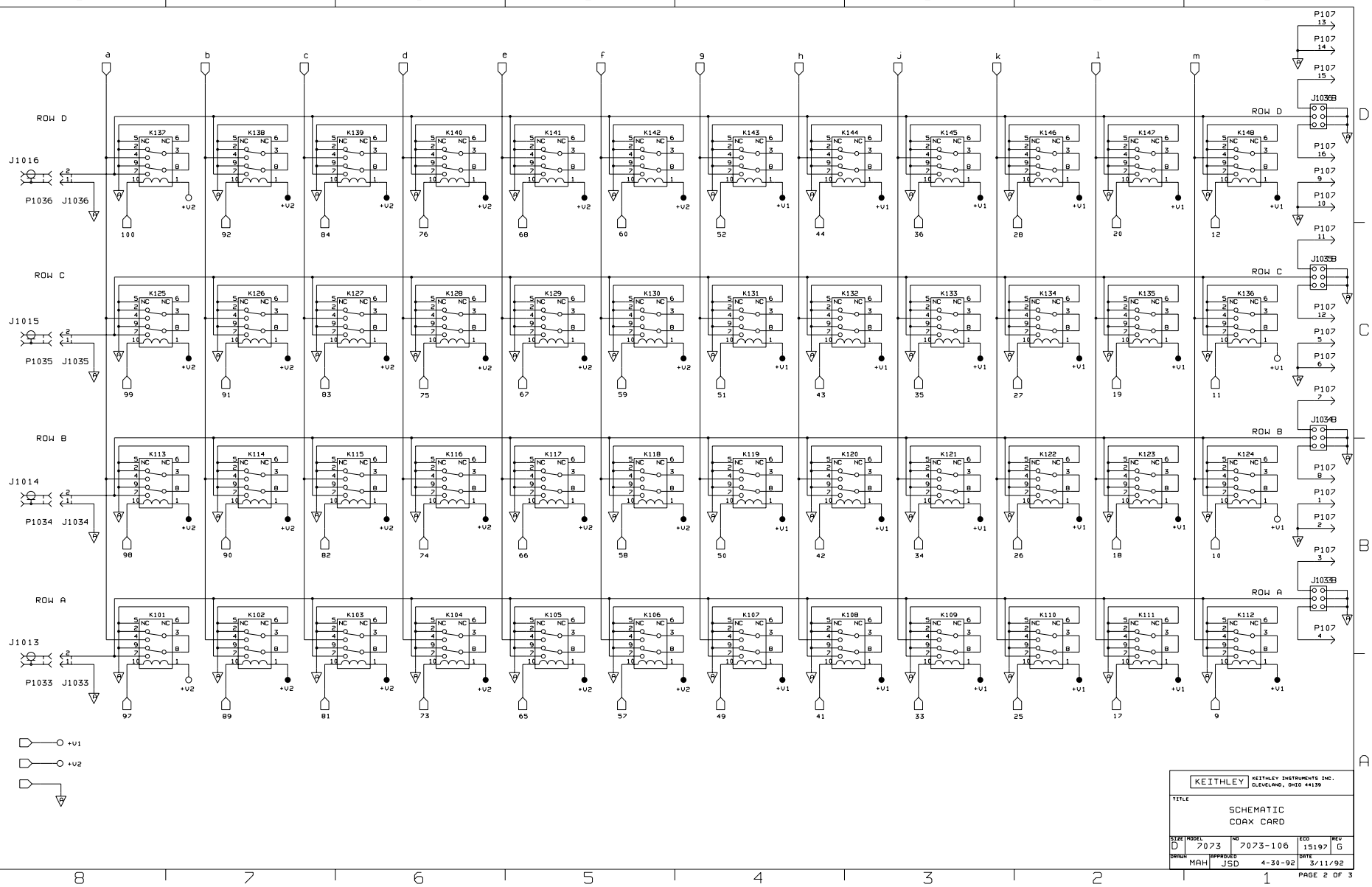
DETAIL "A"
NTS

NOTE:
FOR COMPONENT INFORMATION,
REFER TO PRODUCT STRUCTURE

7073		
MODEL	NEXT ASSEMBLY	QTY
USED ON		

DO NOT SCALE THIS DRAWING	DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED	DATE 8-22-87	SCALE 1:1	TITLE COMPONENT LAYOUT, COAX CARD
KEITHLEY KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139	XX=±.015 ANG.=±1°	DRN. CB	APP. ESB	
	XXX=±.005 FRAC.=±1/64	MATERIAL		NO. D 7073-100
	SURFACE MAX. 63	FINISH		


COL 1 J1001
COL 2 J1002
COL 3 J1003
COL 4 J1004
COL 5 J1005
COL 6 J1006
COL 7 J1007
COL 8 J1008
COL 9 J1009
COL 10 J1010
COL 11 J1011
COL 12 J1012
P1021 J1021
P1022 J1022
P1023 J1023
P1024 J1024
P1025 J1025
P1026 J1026
P1027 J1027
P1028 J1028
P1029 J1029
P1030 J1030
P1031 J1031
P1032 J1032
ROW H
ROW G
ROW F
ROW E
J1020
P1040 J1040
J1019
P1039 J1039
J1018
P1038 J1038
J1017
P1037 J1037
K185 K186 K187 K188 K189 K190 K191 K192 K193 K194 K195 K196
K173 K174 K175 K176 K177 K178 K179 K180 K181 K182 K183 K184
K161 K162 K163 K164 K165 K166 K167 K168 K169 K170 K171 K172
K149 K150 K151 K152 K153 K154 K155 K156 K157 K158 K159 K160
+V2
+V1
P107 29
P107 30
P107 31
P107 32
P107 33
P107 34
P107 27
P107 28
P107 25
P107 26
P107 23
P107 24
P107 21
P107 22
P107 19
P107 20
P107 17
P107 18
J1040B
J1039B
J1038B
J1037B
a b c d e f g h J k l m
KEITHLEY
KEITHLEY INSTRUMENTS INC.
CLEVELAND, OHIO 44139
TITLE
SCHEMATIC
COAX CARD
SIZE D
MODEL 7073
NO 7073-106
ECO 15197
REV G
DRAWN MAH
APPROVED JSD
4-30-92
DATE 3/11/92
PAGE 1 OF 3

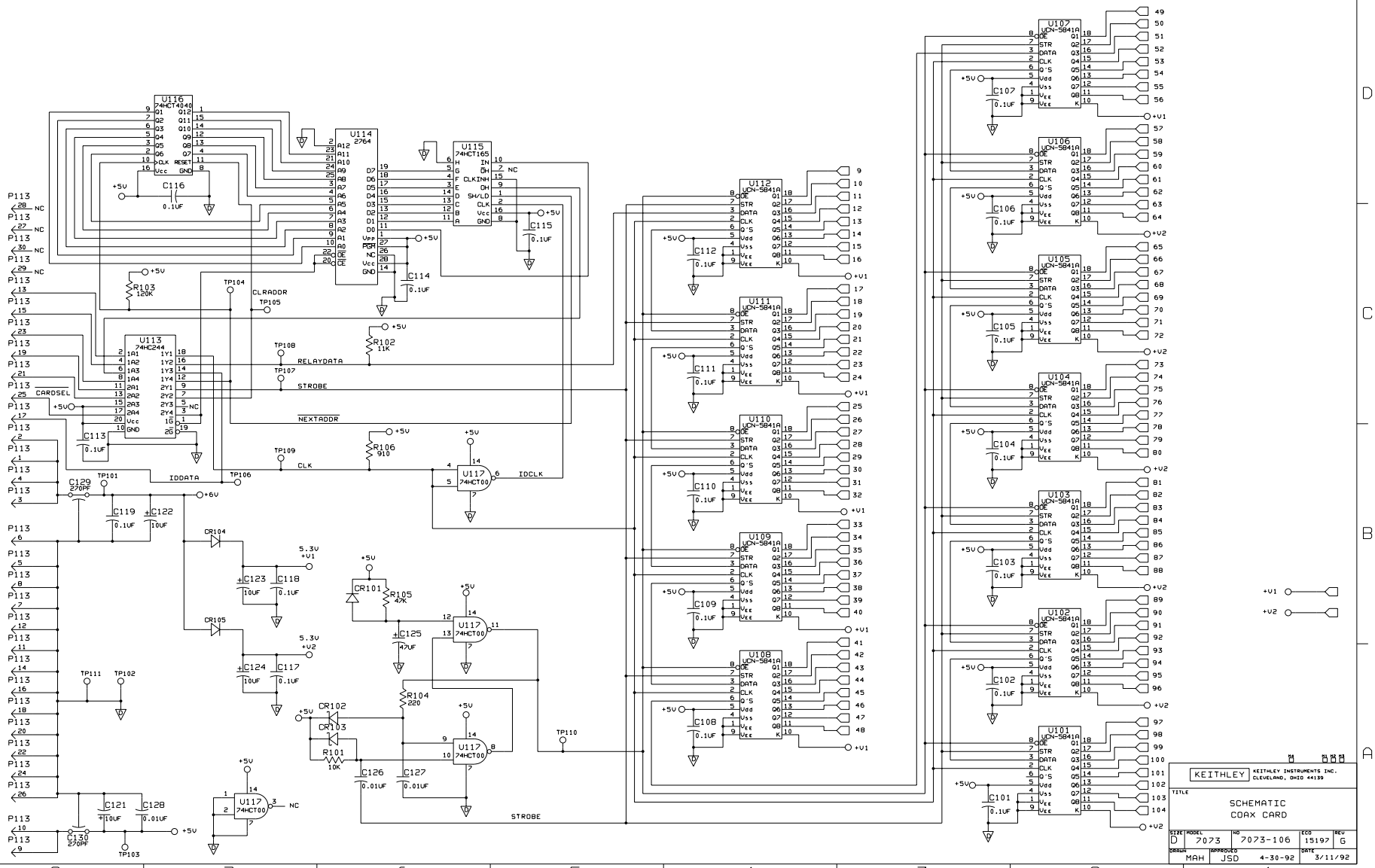


KEITHLEY — KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139

TITLE: SCHEMATIC COAX CARD

SIZE	MODEL	NO	ECO	REV
D	7073	7073-106	15197	G

DRAWN	APPROVED	DATE
MAH	JSD 4-30-92	3/11/92



KEITHLEY — KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139

TITLE: SCHEMATIC COAX CARD

SIZE	MODEL	NO	ECO	REV
D	7073	7073-106	15197	G

DRAWN	APPROVED	DATE
MAH	JSD 4-30-92	3/11/92

KEITHLEY

Service Form

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

Name and Telephone No. _____

Company _____

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

_____

_____

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

Display or output (check one)

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

- ❑ Calibration only
- ❑ Certificate of calibration required
- ❑ 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.

KEITHLEY

Test Instrumentation Group
Keithley Instruments, Inc.
28775 Aurora Road
Cleveland, Ohio 44139

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