

Model 7999-2
Multiplexer Card
Instruction Manual

Contains Operating and Servicing Information

KEITHLEY

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

BELGIUM:	Keithley Instruments B.V.	Bergensesteenweg 709 • B-1600 Sint-Pieters-Leeuw • 02/363 00 40 • Fax: 02/363 00 64
CHINA:	Keithley Instruments China	Yuan Chen Xin Building, Room 705 • 12 Yumin Road, Dewai, Madian • Beijing 100029 • 8610-62022886 • Fax: 8610-62022892
FRANCE:	Keithley Instruments Sarl	B.P. 60 • 3, allée des Garays • 91122 Palaiseau Cédex • 01 64 53 20 20 • Fax: 01 60 11 77 26
GERMANY:	Keithley Instruments GmbH	Landsberger Strasse 65 • D-82110 Germering • 089/84 93 07-40 • Fax: 089/84 93 07-34
GREAT BRITAIN:	Keithley Instruments Ltd	The Minster • 58 Portman Road • Reading, Berkshire RG30 1EA • 0118-9 57 56 66 • Fax: 0118-9 59 64 69
INDIA:	Keithley Instruments GmbH	Flat 2B, WILOCRISSA • 14, Rest House Crescent • Bangalore 560 001 • 91-80-509-1320/21 • Fax: 91-80-509-1322
ITALY:	Keithley Instruments s.r.l.	Viale S. Gimignano, 38 • 20146 Milano • 02/48 30 30 08 • Fax: 02/48 30 22 74
NETHERLANDS:	Keithley Instruments B.V.	Postbus 559 • 4200 AN Gorinchem • 0183-635333 • Fax: 0183-630821
SWITZERLAND:	Keithley Instruments SA	Kriesbachstrasse 4 • 8600 Dübendorf • 01-821 94 44 • Fax: 01-820 30 81
TAIWAN:	Keithley Instruments Taiwan	1 Fl. 85 Po Ai Street • Hsinchu, Taiwan, R.O.C. • 886-3572-9077 • Fax: 886-3572-9031

Model 7999-2 Three-Pole Multiplexer Card Instruction Manual

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Cleveland, Ohio, U.S.A.
First Printing, September 1999
Document Number: 7999-2-901-01 Rev. A

Manual Print History

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

Revision A (Document Number 7999-2-901-01)..... September 1999

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, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

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

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

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

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) 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.


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


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


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

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

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

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

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

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

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

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

Instrumentation and accessories shall not be connected to humans.

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

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

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

7999-2 Three-Pole Multiplexer Card

RELAY SWITCH CONFIGURATION:

- 1 bank of 3:1 mux 3-pole switching.
- 1 bank of 4:1 mux 3-pole switching.

CONTACT CONFIGURATION: 3-pole Form A.

CONNECTOR TYPE:

- Mux Common Connector (1): 6-pin LEMO.
- Mux Input/Output Connectors (7): 3-pin LEMO.
- Control Connectors (1): 15-pin male D-sub.

MAXIMUM SIGNAL: 30V DC, 42V peak between any two inputs or chassis, 1A switched, CAT I.

CONTACT LIFE: Cold Switching: 10×10^6 closures.
At Maximum Signal Levels: 2×10^5 closures.

CHANNEL RESISTANCE (per conductor): $<1\Omega$.

CONTACT POTENTIAL: $<10\mu\text{V}$ per contact.

ACTUATION TIME: 3ms.

ISOLATION: Channel to Channel: $>10^9\Omega$, $<80\text{pF}$.
Common Mode: $>10^9\Omega$, $<150\text{pF}$.

CROSSTALK (1MHz, 50 Ω load): $<-40\text{dB}$.

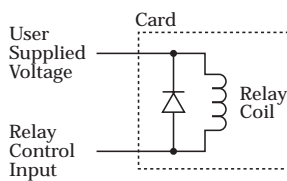
INSERTION LOSS (50 Ω source, 50 Ω load): $<0.1\text{dB}$ $\leq 20\text{kHz}$, $>25\text{dB}$ @ 2GHz.

RELAY DRIVE CURRENT (per relay): 8.5mA @ 24V (user supplied).

USER SUPPLIED VOLTAGE: 24V \pm 4V DC, 175mA max.

RELAY CONTROL INPUT: Relay Closed: $<2.0\text{V}$.
Relay Open: User supplied voltage.

RELAY DRIVE CONFIGURATION:



GENERAL

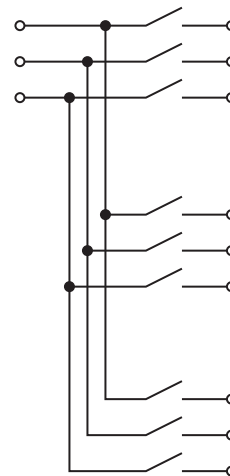
ENVIRONMENT: Operating: 0° to 50°C, up to 35°C $<80\%$ RH.
Storage: -25° to 65°C.

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

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

DIMENSIONS: 152mm long \times 102mm wide \times 13mm deep (6" \times 4" \times 1/2").

3:1 MUX 3-Pole Switch



4:1 MUX 3-Pole Switch

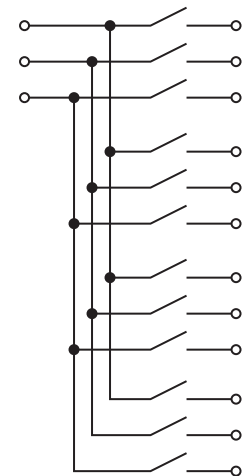


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1 General Information

Introduction

This section contains general information about the Model 7999-2 Three-Pole Multiplexer Card. The information is organized as follows:

- Feature overview
- Warranty information
- Manual addenda
- Safety symbols and terms
- Specifications
- Unpacking and inspection
- Recommended mating connectors

If you have any questions after reviewing this information, please contact your local Keithley representative or call a Keithley Applications Engineer at 1-800-348-3735 (U.S. and Canada only). Worldwide phone numbers are listed at the front of this manual.

Feature overview

The Model 7999-2 is a three-pole multiplexer card with the following features:

- One bank of 3:1 multiplexer 3-pole switching
- One bank of 4:1 multiplexer 3-pole switching
- External relay control and +24V DC power connections
- Lemo style connectors for multiplexer input/output and common connections
- Low insertion loss for audio frequencies (<0.1dB up to 20kHz)

Warranty information


Warranty information is located at the front of this instruction manual. Should your Model 7999-2 require warranty service, contact a Keithley representative or an authorized repair facility in your area for further information. When returning the card for repair, be sure to fill out and include the service form at the back of this manual to provide the repair facility with the necessary information.


Manual addenda

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

Safety symbols and terms

The following symbols and terms may be found on the multiplexer card or used in this manual.

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

The  symbol 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 multiplexer card. Such damage may invalidate the warranty.

Specifications

Full Model 7999-2 specifications are included at the front of this manual.

Unpacking and Inspection

Inspection for damage

The Model 7999-2 is packaged in a re-sealable, 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 precautions on handling discussed below.

Handling precautions

- Always grasp the card by the covers. Do not touch board surfaces or components.
- 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.
- When the card is not installed and connected, keep the card in its anti-static bag, and store it in the original packing carton.

Shipment contents

The following items are included with every Model 7999-2 order:

- Model 7999-2 Three-Pole Multiplexer Card
- Model 7999-2 Instruction Manual
- Additional accessories as ordered

Instruction manual

If an additional Model 7999-2 Instruction Manual is required, order the manual package, Keithley part number 7999-2-901-00. The manual package includes an instruction manual and any pertinent addenda.

Repacking for shipment

Should it become necessary to return the Model 7999-2 for repair, carefully pack the unit in its original packing carton or the equivalent, and perform the following:

- Call the Repair Department at 1-800-552-1115 for a Return Material Authorization (RMA) number.
- Advise as to the warranty status of the card.
- Write ATTENTION REPAIR DEPARTMENT and the RMA number on the shipping label.
- Fill out and include the service form located at the back of this manual.

Recommended connectors

The following mating connectors and receptacles are recommended for use with Model 7999-2 jacks:

- For 3-pin Lemo jack: Lemo FGG.0B.303 series mating plug
- For 6-pin Lemo jack: Lemo FGG.2K.306 series mating plug
- For 15-pin D-sub: AMP 747303-3 series mating receptacle

2 Connections

Introduction

This section contains information about overall card configuration and connections and is organized as follows:

- Handling precautions
- Card configuration
- Connections

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

Handling precautions

To maintain high-impedance isolation between channels, care should be taken when handling the card to avoid contamination from such foreign materials as body oils. Such contamination can reduce isolation resistance. To avoid possible contamination:

- Always grasp the card by the case.
- Do not touch connector insulators.
- Operate the card in a clean environment. If the card becomes contaminated, it should be thoroughly cleaned as explained in Section 4.

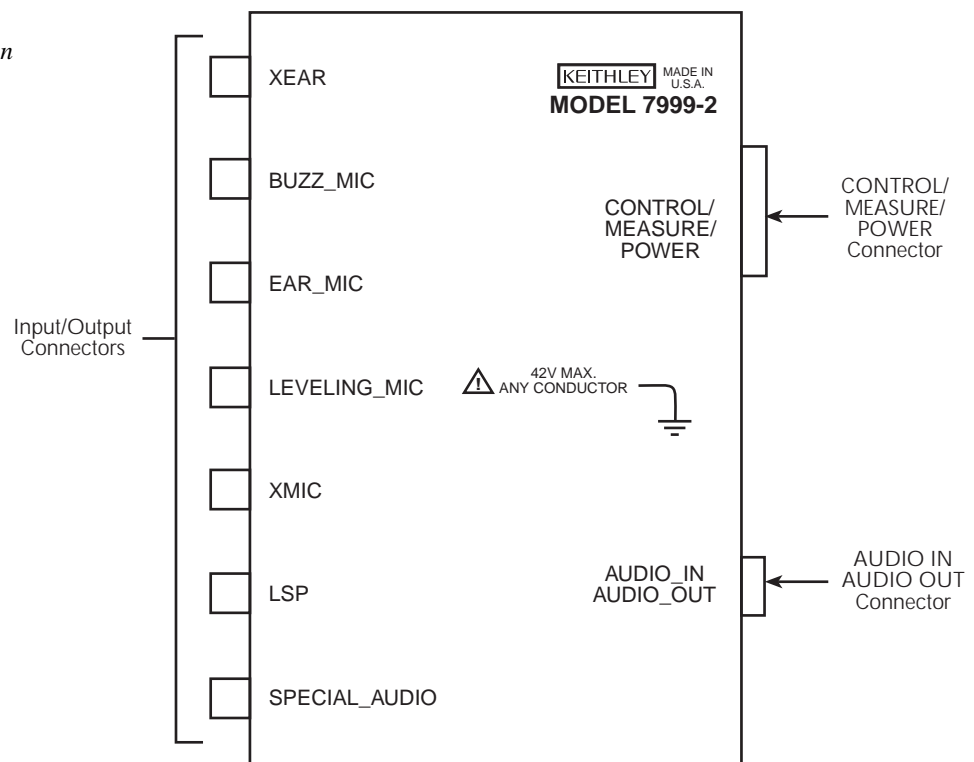
Card configuration

Card layout

Figure 2-1 shows the general layout of the Model 7999-2. Connectors include:

- Input/output connectors — A 3-pin Lemo connector is provided for each of the seven multiplexer input/output channels (XEAR, BUZZ_MIC, EAR_MIC, LEVELING_MIC, XMIC, LSP, SPECIAL_AUDIO).
- AUDIO_IN AUDIO_OUT — A 6-pin Lemo connector provides audio input/output terminals.
- CONTROL/MEASURE/POWER — This DB-15 connector provides terminals for relay control, DVM measurement connections, and +24V DC power connections.

Figure 2-1
Card configuration



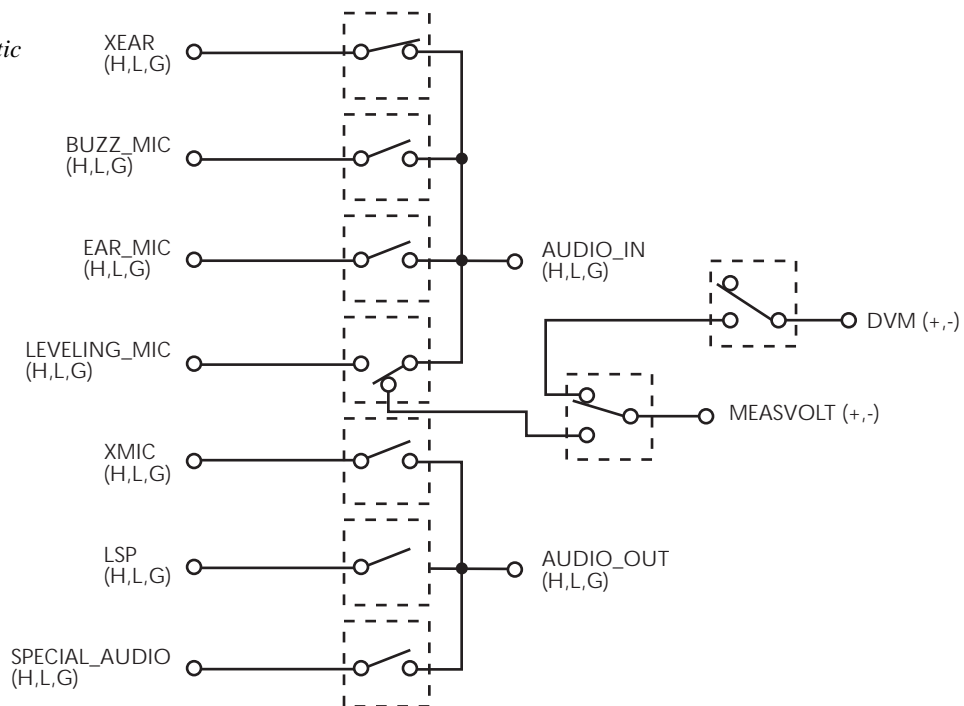
Simplified schematic

Figure 2-2 shows a simplified schematic diagram of the Model 7999-2. The card is arranged into two multiplexer banks:

- One bank of 3:1 3-pole switching
- One bank of 4:1 switching

NOTE Single pole switching is shown in Figure 2-2 for simplicity. H, L, and G indicates separate HI, LOW, and GND signal switching. + and - switched to HI and LOW where applicable. See the schematic diagram at the end of Section 5 for details.

Figure 2-2
Simplified schematic



NOTE: Single-pole switching shown for simplicity. H, L, G indicate separate HI, LOW, and GND signals. + and - switched to HI and LOW where applicable.

Card connections

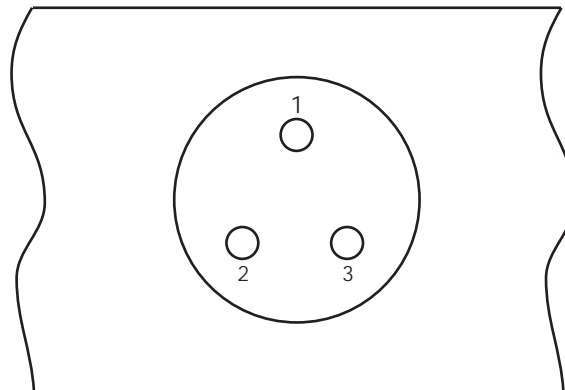
Input/output connectors

Figure 2-3 provides the terminal configuration for the input/output connectors (XEAR, BUZZ_MIC, EAR_MIC, LEVELING_MIC, XMIC, LSP, SPECIAL_AUDIO), while Table 2-1 summarizes signals.

Table 2-1
Input/output connector terminals

Connector pin	Signal
1	HI
2	LOW
3	GND

Figure 2-3
Input/output connector terminal designations



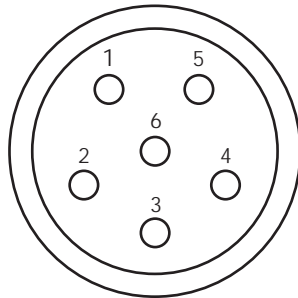
AUDIO IN and AUDIO OUT connector

Figure 2-4 shows the terminal configuration for the AUDIO IN AUDIO OUT connector, and Table 2-2 summarizes signals.

Table 2-2
AUDIO IN AUDIO OUT connector terminals

Connector pin	Signal
1	AUDIO OUT HI
2	AUDIO OUT LO
3	AUDIO OUT GND
4	AUDIO IN HI
5	AUDIO IN LO
6	AUDIO IN GND

Figure 2-4
*AUDIO IN
AUDIO OUT
connector terminals*



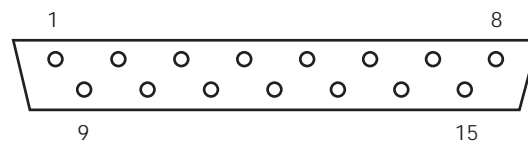
CONTROL/MEASURE/POWER connector

Figure 2-5 shows the terminal configuration for the CONTROL/MEASURE/POWER connector, and Table 2-3 summarizes terminal designations along with switched signals.

Table 2-3
CONTROL/MEASURE/POWER connector terminals

Terminal	Description	Switched signal(s)
1	DVM+	
2	CONTROL 6	EAR_MIC
3	DVM-	
4	CONTROL 7	MEASVOLT, LEVELING_MIC
5	+24V	
6	CONTROL 8	XMIC
7	CONTROL 1	XMIC
8	CONTROL 9	XEAR
9	CONTROL 2	AUDIO_OUT
10	MEASVOLT+	
11	CONTROL 3	SPECIAL_AUDIO
12	MEASVOLT-	
13	CONTROL 4	XEAR
14	NO CONNECTION	
15	CONTROL 5	AUDIO_IN

Figure 2-5
*CONTROL/MEASURE/
POWER connector terminals*



Relay power and control

To control relays, +24V DC must be applied to pin 5 of the CONTROL/MEASURE/POWER connector. A relay channel can be closed by setting the associated CONTROL line listed in Table 2-3 low.

3

Operating Considerations

Introduction

This section contains information about operating considerations for the Model 7999-2 Three-Pole Multiplexer Card. The information is organized as follows:

- Maximum signal considerations
- Relay power and control
- Switching considerations

Maximum signal considerations

WARNING Maximum voltage between any conductor and ground is 42V.

CAUTION To prevent damage to the Model 7999-2, do not exceed the following maximum signal level specifications of the card:

- Maximum voltage: 30V DC, 42V peak
- Maximum current: 1A DC, switched

Relay power and control

To control relays, an external +24V DC voltage source must be connected to pin 5 of the CONTROL/MEASURE/POWER connector. A channel is closed by setting the corresponding control signal low. See Section 2 for complete connection information. Table 2-3 in Section 2 lists switched signals.

Switching considerations

Signals switched by the Model 7999-2 may be subject to various effects that can seriously affect their integrity. The following paragraphs discuss these effects and ways to minimize them.

Keeping connectors clean

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

Oils and salts from the skin can contaminate connector insulators, reducing their resistance. Also, contaminants present in the air can be deposited on the insulator surface. To avoid these

problems, never touch the connector insulating material. In addition, the multiplexer card should be used only in clean, dry environments to avoid contamination.

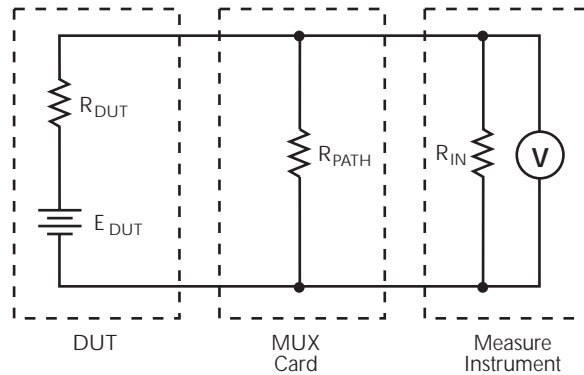
If the connector insulators should become contaminated, either by inadvertent touching, or from air-borne deposits, they can be cleaned with a cotton swab dipped in clean methanol. After thoroughly cleaning, they should be allowed to dry for several hours in a low-humidity environment before use, or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

Path isolation

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

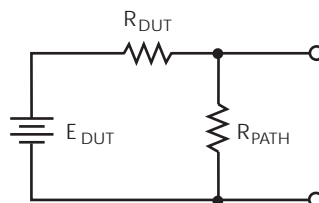
Path isolation resistance forms a signal path that is in parallel with the equivalent resistance of the DUT, as shown in Figure 3-1. For low-to-medium device resistance values, path isolation resistance is seldom a consideration; however, it can seriously degrade measurement accuracy when testing high-impedance devices. The voltage measured across such a device, for example, can be substantially attenuated by the voltage divider action of the device source resistance and path isolation resistance, as shown in Figure 3-2. Also, leakage currents can be generated through these resistances by voltage sources in the system.

Figure 3-1
Path isolation
resistance



- R_{DUT} = Source Resistance of DUT
- E_{DUT} = Source EMF of DUT
- R_{PATH} = Path Isolation Resistance
- R_{IN} = Input Resistance of Measuring Instrument

Figure 3-2
Voltage attenuation by
path isolation
resistance



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

Insertion loss

Insertion loss indicates signal lost while passing through the card. This loss occurs in the various signal path components through the card (connectors, PC board traces, and relays). The Model 7999-2 has an insertion loss figure of <0.1dB at audio frequencies up to 20kHz (50Ω source and load impedances), which should not be a consideration in most cases.

Crosstalk

The crosstalk figure indicates the amount of signal leakage between channels on the card. With similar power levels applied to the various channels, crosstalk will be of little consequence. With widely different power levels, however, crosstalk may result in undesired results. Note that the Model 7999-2 has crosstalk figure of <-40db @ 1MHz (50Ω load).

RFI/EMI

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

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

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

Ground loops

When two or more devices are connected together, care must be taken to avoid unwanted signals caused by ground loops. Ground loops usually occur when devices are connected with more than one signal return path such as power line ground. As shown in Figure 3-3, the resulting ground loop causes current to flow through LO signal leads and then back through power line ground. This circulating current develops a small but undesirable voltage between the LO terminals of the two devices. This voltage will be induced into the desired signal affecting its integrity.

Figure 3-3
Ground loops

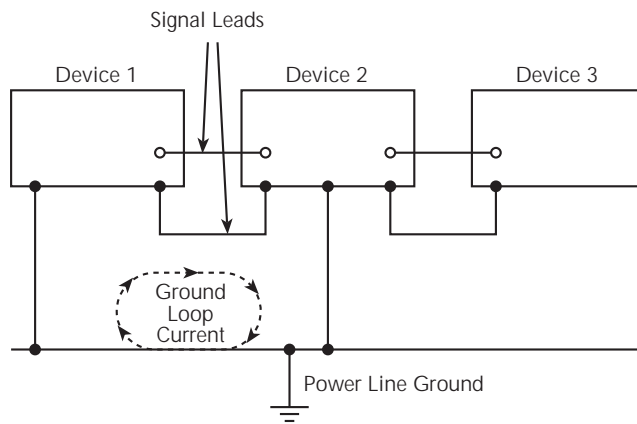
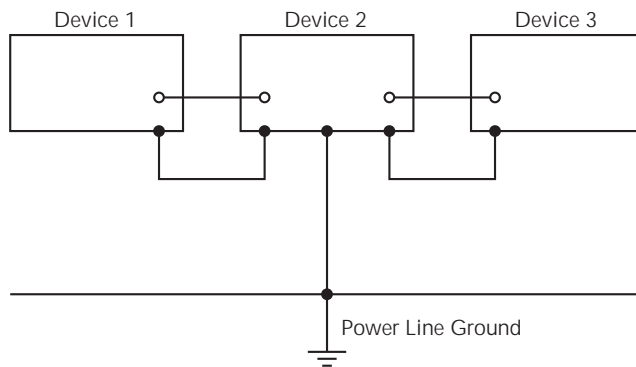


Figure 3-4 shows how to connect several devices together to eliminate this type of ground loop problem. Here, only one device is connected to power line ground.

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

Figure 3-4
Eliminating ground loops



4 Service Information

Introduction

This section contains service information for the Model 7999-2. The information is organized as follows:

- Handling and cleaning precautions
- Performance verification
- Component replacement

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

Handling and cleaning precautions

Because of the high-impedance areas on the Model 7999-2, care should be taken when handling or servicing the card to prevent possible contamination. The following precautions should be observed when servicing the card.

Handling precautions

Observe the following precautions when handling the multiplexer card:

- Handle the card only by the edges and cover.
- Do not touch connector insulators.
- Do not touch any board surfaces or components not associated with the repair.
- Do not touch areas adjacent to electrical contacts.
- When servicing the card, wear clean cotton gloves.
- Do not store or operate the card in an environment where dust could settle on the circuit board.

Card cleaning

- Use dry nitrogen gas to clean any dust off the circuit board and components.
- Clean the contaminated area with methanol, then blow dry the entire board with dry nitrogen gas.
- After cleaning, allow the card to dry in a 50°C low-humidity environment for several hours before use.

Performance verification

The following paragraphs discuss performance verification procedures for the Model 7999-2, including channel resistance, contact potential, and channel-to-channel and common-mode isolation.

CAUTION Contamination will degrade the performance of the card. To avoid contamination, always grasp the card by the cover; do not touch the connectors.

NOTE Failure of any performance verification test may indicate that the multiplexer card is contaminated. See "Handling and cleaning precautions" earlier in this section for information on cleaning the card.

Environmental conditions

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

Recommended equipment

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

Table 4-1
Recommended verification equipment

Description	Manufacturer/Model	Specifications	Test
Digital Multimeter	Keithley 2010	10Ω range, 60ppm	Channel resistance
Nanovoltmeter	Keithley 2182	10mV range, 50ppm	Contact potential
Electrometer	Keithley 6517A	2GΩ range, 0.225%	Isolation
Test Lead Sets (2)	Keithley 1681	Banana plug/clips	Channel resistance
Low Thermal Cable	Keithley 2107-4	Low thermal/lugs	Contact potential
Triax Cable	Keithley 237-ALG-2	Triax/clips	Isolation

Multiplexer card connections

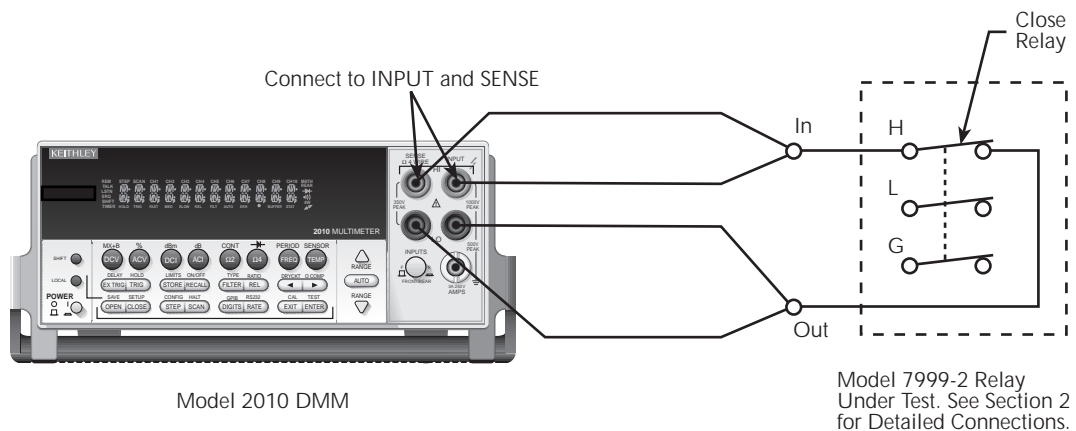
Test equipment connection diagrams in this section are generic in nature and are intended only to show basic connections on how to connect test equipment to the relay contact(s) under test. See Section 2 for complete details on card connections and terminal designations.

Channel resistance tests

Perform the following steps to verify that each contact of every relay is closing properly and that the channel resistance is within specification.

1. Turn on the Model 2010 DMM, and allow it to warm up for one hour before making measurements.
2. Set the Model 2010 to the 10Ω range, and connect the four test leads to the INPUT and SENSE Ω 4 WIRE jacks.
3. Short the free ends of the four test leads together, and enable REL on the Model 2010 to null out residual resistance. Leave REL enabled for the entire test.
4. Connect the Model 2010 INPUT and SENSE Ω 4 WIRE jacks to the relay contact to be tested, as shown in Figure 4-1. Note that 4-wire connections to the card terminals are used.
5. Close the relay being tested.
6. Note the resistance reading on the Model 2010, and verify that it is $<1\Omega$.
7. Open the relay being tested.
8. Repeat steps 4 through 7 for every relay contact on the card.

Figure 4-1
Channel resistance
test connections

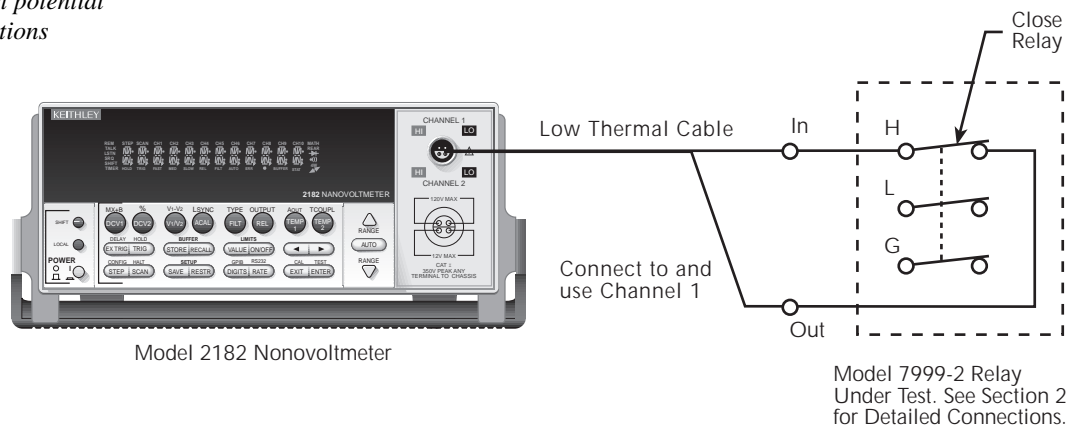


Contact potential tests

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

1. Connect the low-thermal cable to the Model 2182 Nanovoltmeter INPUT jack.
2. Turn on the Model 2182, and allow the unit to warm up for one hour to achieve rated accuracy.
3. Select the Model 2182 10mV range.
4. Temporarily short the Channel 1 HI and LO leads of the low-thermal cable.
5. Enable REL on the Model 2182.
6. Connect the Model 2182 to the relay contact being tested, as shown in Figure 4-2. Be sure to make connections to the Channel 1 input terminals, and use that channel for measurements.
7. Close the relay being tested.
8. Verify that the Model 2182 reading is $<10\mu\text{V}$.
9. Open the relay being tested.
10. Repeat steps 6 through 9 for all relays on the card.

Figure 4-2
Contact potential
connections



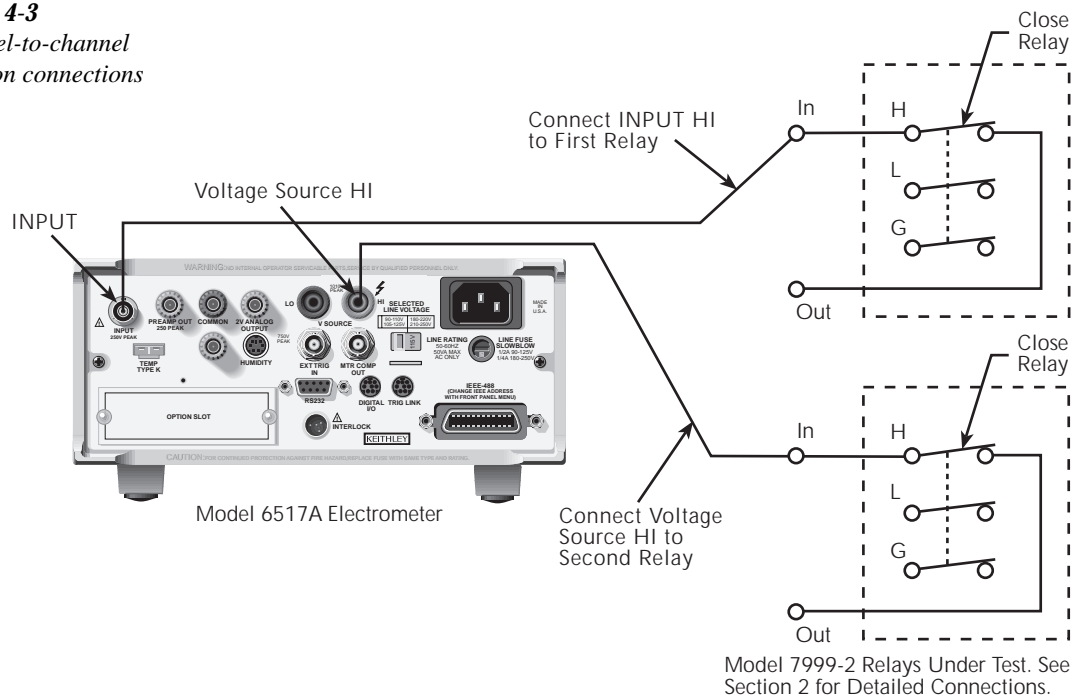
Channel-to-channel isolation tests

CAUTION The following procedure uses the Model 6517A voltage source to measure resistance. To avoid damage to the Model 7999-2, use the Model 6517A manual ohms mode to limit the test voltage to 30V as outlined in the procedure.

Perform the following steps to check channel-to-channel isolation:

1. Turn on the Model 6517A Electrometer, and allow the unit to warm up for one hour before testing.
2. Select the Model 6517A ohms function and 2G Ω range, and enable zero check. Make sure the voltage source is in standby.
3. Connect the electrometer to the two Model 7999-2 channels being tested, as shown in Figure 4-3. Note that electrometer INPUT HI is connected to one channel, while VOLTAGE SOURCE HI is connected to the other channel.
4. Put the Model 6517A in the manual ohms mode, and set the voltage source to +30V.
5. Place the Model 6517A voltage source in operate, and disable zero check.
6. Allow the reading to settle, then verify that the resistance reading is >1G Ω .
7. Enable zero check, and place the Model 6517A voltage source in standby.
8. Repeat steps 3 through 7 for all other two-channel combinations on the card.

Figure 4-3
Channel-to-channel
isolation connections



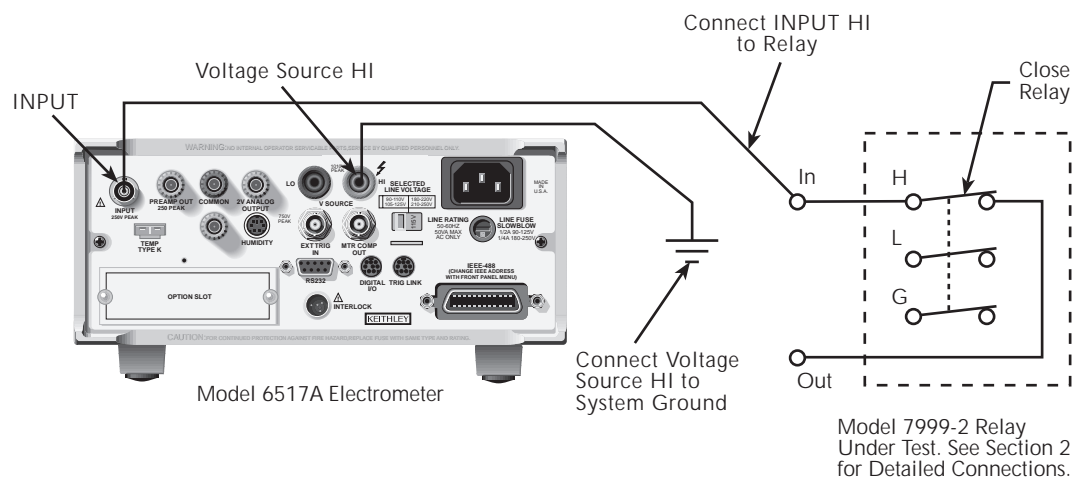
Common-mode isolation tests

CAUTION The following procedure uses the Model 6517A voltage source to measure resistance. To avoid damage to the Model 7999-2, use the Model 6517A manual ohms mode to limit the test voltage to 30V as outlined in the procedure.

Perform the following steps to check common-mode isolation:

1. Turn on the Model 6517A Electrometer, and allow the unit to warm up for one hour before testing.
2. Select the Model 6517A ohms function and $2G\Omega$ range, and enable zero check. Make sure the voltage source is in standby.
3. Connect the electrometer to the Model 7999-2 channel being tested, as shown in Figure 4-4. Note that electrometer INPUT HI is connected to the tested channel, while VOLTAGE SOURCE HI is connected to system ground.
4. Put the Model 6517A in the manual ohms mode, and set the voltage source to +30V.
5. Place the Model 6517A voltage source in operate, and disable zero check.
6. Allow the reading to settle, then verify that the resistance reading is $>1G\Omega$.
7. Enable zero check, and place the Model 6517A voltage source in standby.
8. Repeat steps 3 through 7 for all other channels on the card.

Figure 4-4
Common-mode
isolation connections



Replacing components

Replacement parts

Replacement parts can be obtained directly from Keithley Instruments, Inc. See the parts list in Section 5 for part numbers.

Replacement precautions

CAUTION Observe the following precautions when replacing components:

- **To avoid contamination, which could degrade card performance, always handle the card only by the covers and side edges. Do not touch the connector, board surfaces, or components on the card.**
- **Use care when removing relays from the PC board to avoid pulling traces away from the circuit board. Before attempting to remove a relay, use an appropriate de-soldering tool, to clear each mounting hole completely free of solder. Each relay pin must be free to move in its mounting hole before removal. Also, make certain that no burrs are present on the ends of the relay pins.**

Soldering considerations

When using solder on the circuit board, observe the following precautions:

- Use an OA-based (organic activated) flux, and take care not to spread the flux to other areas of the circuit board.
- Remove the flux from the work areas when the repair has been completed. Use pure water along with clean cotton swabs or a clean soft brush to remove the flux.
- Once the flux has been removed, swab only the repaired area with methanol, then blow dry the board with dry nitrogen gas.
- After cleaning, allow the card to dry in a 50°C low-humidity environment for several hours before use.

Disassembly

Perform the following steps to disassemble the Model 7999-2 to gain access to parts on the circuit board:

1. Remove the six screws that hold the case together.
2. Remove the nuts that secure the seven input/output connectors to the case.
3. Separate the two halves of the case.
4. Unplug the connectors from the PC board.
5. Remove the screws that secure the PC board to the case, then remove the board.

5

Replaceable Parts

Introduction

This section contains replacement parts information and component layout and schematic drawings for the Model 7999-2.

Parts list

The parts list for the Model 7999-2 is shown in Table 5-1.

Ordering information

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

- Card model number (Model 7999-2)
- Serial number
- Part description
- Component designation (if applicable)
- Keithley part number

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 instrument.
- Carefully pack the instrument in the original packing carton.
- Write ATTENTION REPAIR DEPARTMENT and the RMA number on the shipping label.

Component layout and schematic diagram

The following component layout and schematic diagram drawings are provided on the following pages:

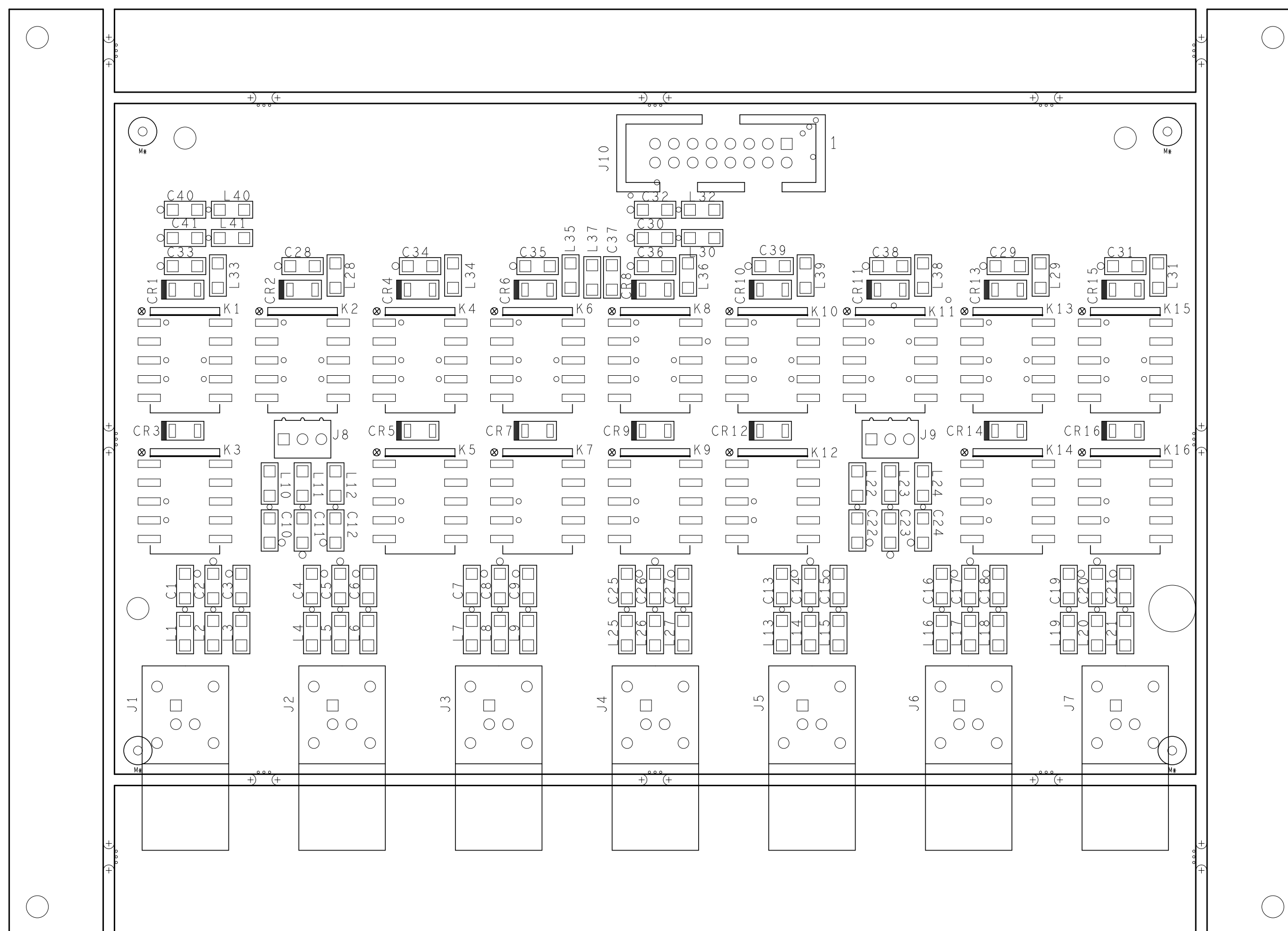
- Component layout drawing: 7999-2-100
- Schematic diagram: 7999-2-106

Table 5-1
Parts list

Circuit designation	Description	Keithley part no.
C1-C40 CR1-CR16 J1,J2,J3,J4,J5,J6,J7 J8,J9 J10 K1-K16 L1-L41	CAP, 22PF, 10%, 100V, CERAMIC DIODE, SWITCHING, 250MA, BAV103 CONN RT ANGLE RECEPTACLE LATCHING HEADER, FRICTON, SGL ROW CONN, HEADER STRAIGHT SOLDER PIN NON-LATCHING RELAY FERRITE BEAD CONN, FIXED RECEPTACLE CONNECTOR CONNECTOR, HOUSING TOP COVER BOTTOM COVER	C-451-22P RF-89 CS-1064 CS-724-3 CS-368-16 RL-233 CH-91 CS-1063 CS-236 CS-638-3 7999-2-301A 7999-2-302A

001-2-666L ON

LTR.	ECA NO.	REVISION	ENG.	DATE
A	N/A	PRELIMINARY	MAH	1/5/99
B	23290	RELEASED	MAH	7/21/99

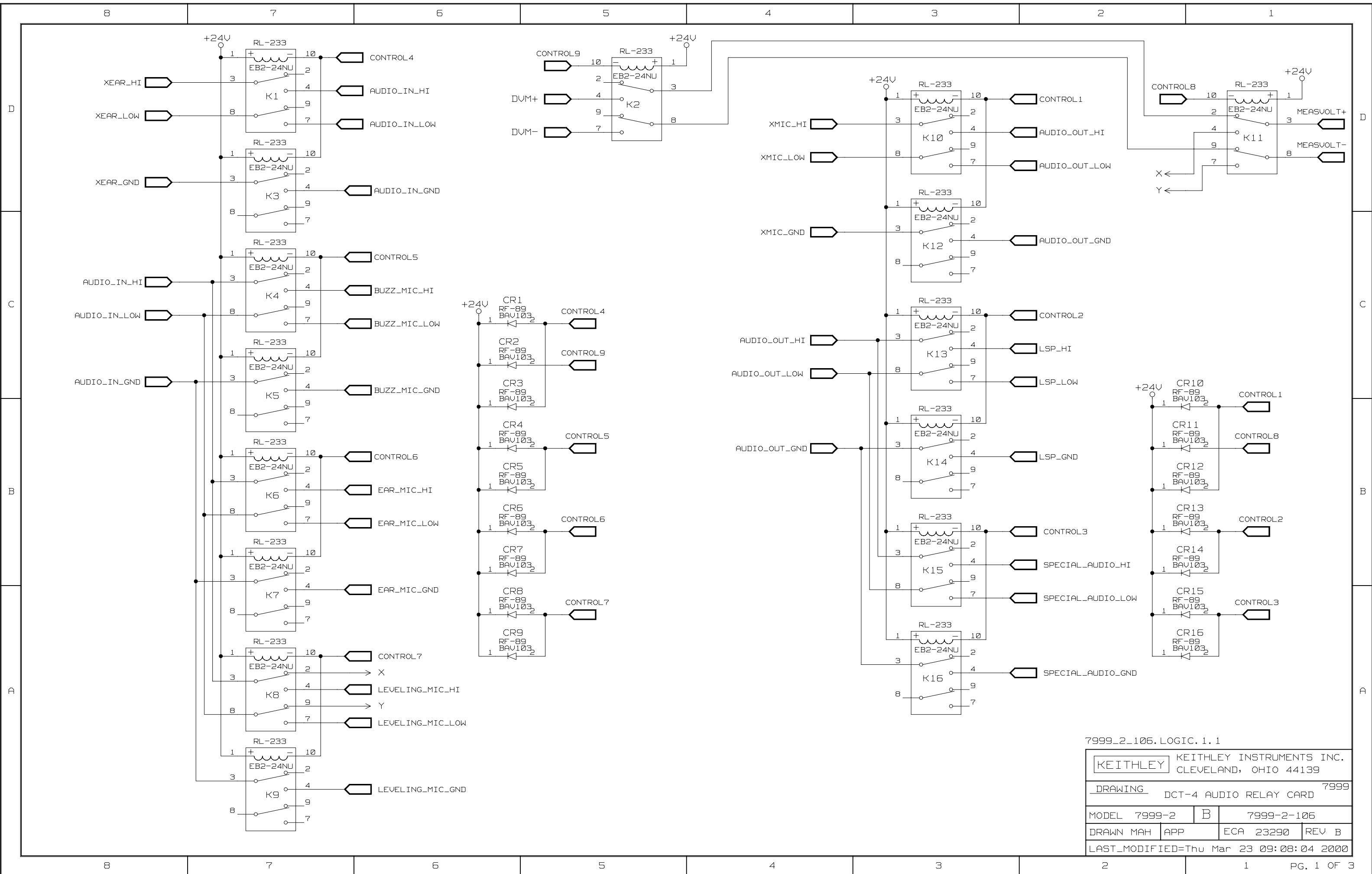


REFER TO THE 7999-2-102 PRODUCT STRUCTURE FOR FURTHER COMPONENT INFORMATION.

MODEL	NEXT ASSEMBLY	QTY.

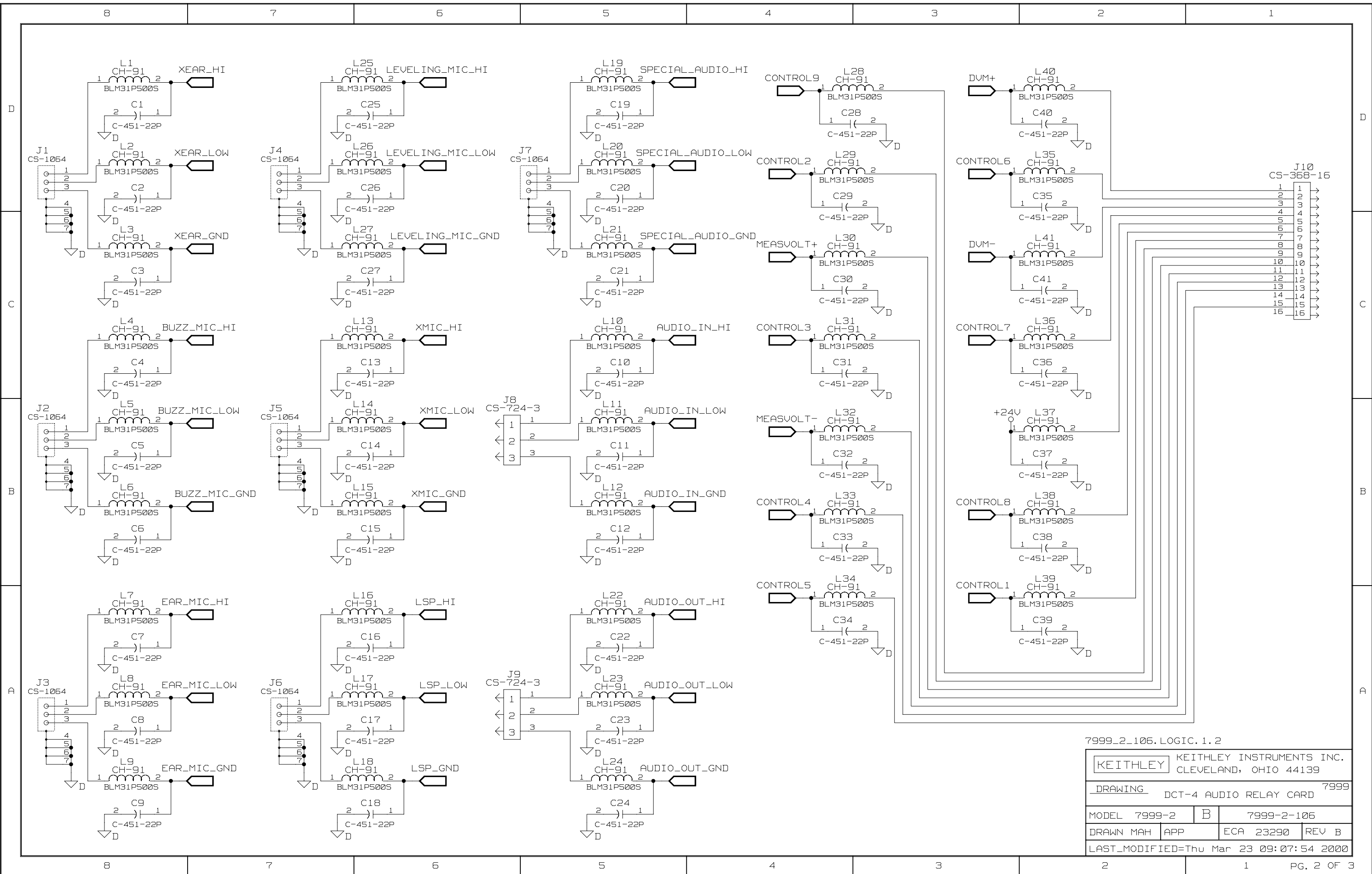
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	DIM. TOL. UNLESS OTHERWISE SPECIFIED	DRN MAH	APPR.	
XX=+.01 XXX=+.005	ANG.=+1 FRAC.=+1/64	DO NOT SCALE THIS DRAWING		NO. 7999-2-100



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KEITHLEY		KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139	
DRAWING		DCT-4 AUDIO RELAY CARD	
MODEL 7999-2	B	7999-2-106	
DRAWN MAH	APP	ECA 23290	REV B
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MODEL 7999-2	B	7999-2-106	
DRAWN MAH	APP	ECA 23290	REV B
LAST_MODIFIED=Thu Mar 23 09:07:54 2000			

*** Signal Cross-Reference ***
 --- for the entire design ---

AUDIO_IN_GND 1C8 1D7 2B5
 AUDIO_IN_HI 1C8 1D7 2C5
 AUDIO_IN_LOW 1C8 1D7 2B5
 AUDIO_OUT_GND 1B4 1C3 2A5
 AUDIO_OUT_HI 1C4 1D3 2A5
 AUDIO_OUT_LOW 1C4 1D3 2A5
 BUZZ_MIC_GND 1C7 2B8
 BUZZ_MIC_HI 1C7 2C8
 BUZZ_MIC_LOW 1C7 2B8
 CONTROL1 1B1 1D3 2A3
 CONTROL2 1B1 1C3 2D4
 CONTROL3 1A1 1B3 2C4
 CONTROL4 1C5 1D7 2B4
 CONTROL5 1B5 1C7 2A4
 CONTROL6 1B5 1B7 2D3
 CONTROL7 1A5 1A7 2C3
 CONTROL8 1B1 1D1 2B3
 CONTROL9 1C5 1D5 2D4
 DVM+ 1D5 2D3
 DVM- 1D5 2C3
 EAR_MIC_GND 1B7 2A8
 EAR_MIC_HI 1B7 2A8
 EAR_MIC_LOW 1B7 2A8
 LEVELING_MIC_GND 1A7 2C6
 LEVELING_MIC_HI 1A7 2D6
 LEVELING_MIC_LOW 1A7 2D6
 LSP_GND 1B3 2A6
 LSP_HI 1C3 2A6
 LSP_LOW 1C3 2A6
 MEASVOLT+ 1D1 2C4
 MEASVOLT- 1D1 2B4
 SPECIAL_AUDIO_GND 1A3 2C5
 SPECIAL_AUDIO_HI 1B3 2D5
 SPECIAL_AUDIO_LOW 1A3 2D5
 X 1A7 1D2
 XEAR_GND 1D8 2C8
 XEAR_HI 1D8 2D8
 XEAR_LOW 1D8 2D8
 XMIC_GND 1C4 2B6
 XMIC_HI 1D4 2C6
 XMIC_LOW 1D4 2B6
 Y 1A7 1D2

*** Unit Cross-Reference ***
 --- for the entire design ---

C1 CAPACITOR 2D8
 C2 CAPACITOR 2D8
 C3 CAPACITOR 2C8
 C4 CAPACITOR 2C8
 C5 CAPACITOR 2B8
 C6 CAPACITOR 2B8
 C7 CAPACITOR 2A8
 C8 CAPACITOR 2A8
 C9 CAPACITOR 2A8
 C10 CAPACITOR 2C5
 C11 CAPACITOR 2B5
 C12 CAPACITOR 2B5
 C13 CAPACITOR 2C6
 C14 CAPACITOR 2B6
 C15 CAPACITOR 2B6
 C16 CAPACITOR 2A6
 C17 CAPACITOR 2A6
 C18 CAPACITOR 2A6
 C19 CAPACITOR 2D5
 C20 CAPACITOR 2D5
 C21 CAPACITOR 2C5
 C22 CAPACITOR 2A5
 C23 CAPACITOR 2A5
 C24 CAPACITOR 2A5
 C25 CAPACITOR 2D6
 C26 CAPACITOR 2D6
 C27 CAPACITOR 2C6
 C28 CAPACITOR 2D4
 C29 CAPACITOR 2D4
 C30 CAPACITOR 2C4
 C31 CAPACITOR 2C4
 C32 CAPACITOR 2B4
 C33 CAPACITOR 2B4
 C34 CAPACITOR 2A4
 C35 CAPACITOR 2D2
 C36 CAPACITOR 2C2
 C37 CAPACITOR 2B2
 C38 CAPACITOR 2B2
 C39 CAPACITOR 2A2
 C40 CAPACITOR 2D2
 C41 CAPACITOR 2C2
 CR1 RF-89 1C6
 CR2 RF-89 1C6
 CR3 RF-89 1C6
 CR4 RF-89 1B6
 CR5 RF-89 1B6
 CR6 RF-89 1B6
 CR7 RF-89 1B6
 CR8 RF-89 1A6
 CR9 RF-89 1A6
 CR10 RF-89 1C2
 CR11 RF-89 1B2
 CR12 RF-89 1B2
 CR13 RF-89 1B2
 CR14 RF-89 1B2
 CR15 RF-89 1A2
 CR16 RF-89 1A2
 J1 CS-1064 2D8
 J2 CS-1064 2B8
 J3 CS-1064 2A8
 J4 CS-1064 2D7

J5 CS-1064 2B7
 J6 CS-1064 2A7
 J7 CS-1064 2D5
 J8 CS-724-3 2B6
 J9 CS-724-3 2A6
 J10 CS-368-16 2D1
 K1 RL-233 1D7
 K2 RL-233 1D5
 K3 RL-233 1D7
 K4 RL-233 1C7
 K5 RL-233 1C7
 K6 RL-233 1B7
 K7 RL-233 1A7
 K8 RL-233 1A7
 K9 RL-233 1A7
 K10 RL-233 1D3
 K11 RL-233 1D1
 K12 RL-233 1C3
 K13 RL-233 1C3
 K14 RL-233 1B3
 K15 RL-233 1B3
 K16 RL-233 1A3
 L1 CH-91 2D8
 L2 CH-91 2D8
 L3 CH-91 2C8
 L4 CH-91 2C8
 L5 CH-91 2B8
 L6 CH-91 2B8
 L7 CH-91 2A8
 L8 CH-91 2A8
 L9 CH-91 2A8
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KEITHLEY		KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139	
DRAWING		CREFOUT DCT-4 AUDIO RELAY CARD	
MODEL 7999-2	B	7999-2-106	
DRAWN MAH	APP	ECA 23290	REV B
LAST_MODIFIED=Wed Jul 21 13:47:13 1999			

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KEITHLEY

Keithley Instruments, Inc.

28775 Aurora Road
Cleveland, Ohio 44139

Printed in the U.S.A.