

ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Find the *Keithley 7158* at our website: ***Click HERE***

Model 7158 Low Current Scanner Card

Instruction Manual

Contains Operating and Servicing Information

KEITHLEY

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

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.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE. THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES.

NEITHER KEITHLEY INSTRUMENTS, INC. NOR ANY OF ITS EMPLOYEES SHALL BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OF ITS INSTRUMENTS AND SOFTWARE EVEN IF KEITHLEY INSTRUMENTS, INC., HAS BEEN ADVISED IN ADVANCE OF THE POSSIBILITY OF SUCH DAMAGES. SUCH EXCLUDED DAMAGES SHALL INCLUDE, BUT ARE NOT LIMITED TO: COSTS OF REMOVAL AND INSTALLATION, LOSSES SUSTAINED AS THE RESULT OF INJURY TO ANY PERSON, OR DAMAGE TO PROPERTY.

KEITHLEY

Keithley Instruments, Inc. • 28775 Aurora Road • Cleveland, OH 44139 • 216-248-0400 • Fax: 216-248-6168 • http://www.keithley.com

CHINA:	Keithley Instruments China • Yuan Chen Xin Building, Room 705 • No. 12 Yumin Road, Dewai, Madian • Beijing, China 100029 • 8610-2022886 • Fax: 8610-2022892
FRANCE:	Keithley Instruments SARL • BP 60 • 3 allée des Garays • 91122 Palaiseau Cédex • 31-6-0115155 • Fax: 31-6-0117726
GERMANY:	Keithley Instruments GmbH • Landsberger Straße 65 • 82110 Germering • 49-89-849307-0 • Fax: 49-89-84930759
GREAT BRITAIN:	Keithley Instruments, Ltd. • The Minster • 58 Portman Road • Reading, Berkshire RG30 1EA • 44-01734-575666 • Fax: 44-01734-596469
ITALY:	Keithley Instruments SRL • Viale S. Gimignano 38 • 20146 Milano • 39-2-48303008 • Fax: 39-2-48302274
JAPAN:	Keithley KK • Aibido Bldg. • 7-20-2 Nishishinjuku • Shinjuku-ku, Tokyo 160 • 81-3-5389-1964 • Fax: 81-3-5389-2068
NETHERLANDS:	Keithley Instruments BV • Avelingen West 49 • 4202 MS Gorinchem • 31-(0)183-635333 • Fax: 31-(0)183-630821
SWITZERLAND:	Keithley Instruments SA • Kriesbachstrasse 4 • 8600 Dübendorf • 41-1-8219444 • Fax: 41-1-8203081
TAIWAN:	Keithley Instruments Taiwan • 1, Ming-Yu First Street • Hsinchu, Taiwan, R.O.C. • 886-35-778462 • Fax: 886-35-778455

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Model 7158 Low Current Scanner Card
Instruction Manual

© 1987, Keithley Instruments, Inc.
Test Instrumentation Group
All rights reserved.
Cleveland, Ohio, U.S.A.
June 1990, Second Printing
Document Number: 7158-901-01 Rev. B

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

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.

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.**

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 rear panel, or switching card.

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

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

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 on the test fixture, connect it to safety earth ground using #18 AWG or larger wire.

The ⚡ symbol on an instrument or accessory indicates that 1000V or more may be present on the terminals. Refer to the product manual for detailed operating information.

Instrumentation and accessories should not be connected to humans.

Maintenance should be performed by qualified service personnel. Before performing any maintenance, disconnect the line cord and all test cables.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

SPECIFICATIONS

MODEL 7158 LOW CURRENT SCANNER CARD

CHANNELS PER CARD: 10

CONTACT CONFIGURATION: Single pole. When a channel is open, signal HI is connected to signal LO. Signal LO is common for all 10 channels and output.

CONNECTOR TYPE: BNC

RELAY DRIVE CURRENT: 100mA per card typical.

MAXIMUM SIGNAL LEVEL: 100mA, 30V, peak (resistive load)

3dB BANDWIDTH: 1MHz typical.

CONTACT LIFE: 10^7 closures (cold switching); 10^6 closures (at maximum signal level)

CONTACT RESISTANCE: $<1\Omega$ to rated life

CONTACT POTENTIAL: $<200\mu V$

ACTUATION TIME: <1ms, exclusive of mainframe

OFFSET CURRENT: $<10^{-13}A$ ($<3 \times 10^{-14}A$ typical)

COMMON MODE VOLTAGE: 30V peak

GENERAL

ENVIRONMENT,

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

Storage: −25° to 65°C

DIMENSIONS, WEIGHT: 32mm high × 114mm wide × 272mm long (1¼" × 4½" × 10¾"). Net weight 0.58kg (20.5 oz.)

ACCESSORY SUPPLIED: Model 4801 Low Noise Cable

ACCESSORY AVAILABLE: Model 4804 triax female to BNC male adapter

Specifications subject to change without notice.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

TABLE OF CONTENTS

SECTION 1 - GENERAL INFORMATION

1.1 Introduction 1
1.2 Warranty Information 1
1.3 Manual Addenda 2
1.4 Safety Symbols and Terms 2
1.5 Unpacking and Inspection 2
1.6 Specifications 3

SECTION 2 - OPERATION

2.1 Introduction 5
2.2 Safety Precautions 5
2.2.1 High Impedance Considerations 5
2.2.2 Static Precautions 6
2.3 Connections and Cabling 6
2.4 Installation and Removal 8
2.5 Operation 10
2.5.1 Scanner Control of the Channels 11
2.5.2 Operation Notes 18
2.6 Applications 18

SECTION 3 - SERVICING INFORMATION

3.1 Introduction 25
3.2 Handling and Cleaning 25
3.3 Relay Replacement 26
3.4 Recommended Test Equipment 27
3.5 Offset Current Test 27
3.6 Contact Resistance Test 29

SECTION 4 - REPLACEABLE PARTS

4.1 Introduction 33
4.2 Parts Lists 33
4.3 Ordering Information 33
4.4 Factory Service 35
4.5 Component Layout and Schematic Diagram 35

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

LIST OF TABLES

SECTION 2 - OPERATION

2-1 Example Channel Assignments in 2-Pole Mode 12
2-2 Example Channel Assignments in 1-Pole Mode 13
2-3 Example Channel Assignments in Matrix (0-Pole) Mode 14
2-4 Scanner Control of Model 7158 4-Pole Mode 15
2-5 Scanner Control of Model 7158 2-Pole Mode 15
2-6 Scanner Control of Model 7158 1-Pole Mode 16
2-7 Scanner Control of Model 7158 Matrix (0-Pole) Mode ... 17

SECTION 3 - SERVICING INFORMATION

3-1 Recommended Test Equipment 27

SECTION 4 - REPLACEABLE PARTS

4-1 Model 7158 Electrical Parts 34
4-2 Model 7158 Mechanical Parts 35

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

LIST OF ILLUSTRATIONS

SECTION 2 - OPERATION

2-1 Multi-Card Connection 7
2-2 Installing Card in Model 705 9
2-3 Installing Card in Model 706 10
2-4 Model 7158 Simplified Schematic 11
2-5 Capacitor Leakage Schematic 20
2-6 Capacitor Leakage Instrument Setup 21
2-7 Measuring Leakages with One Card 23

SECTION 3 - SERVICING INFORMATION

3-1 Offset Current 28
3-2 Coax Pigtail Preparation 30
3-3 Contact Resistance 31

SECTION 4 - REPLACEABLE PARTS

4-1 Model 7158 Component Layout 36
4-2 Model 7158 Schematic Diagram 37

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

SECTION 1
GENERAL INFORMATION

1.1 INTRODUCTION

The Model 7158 Low Current Scanner Card has ten channels of paired single-pole single-throw (SPST), normally open (NO) relays. The card will switch any one of ten signals to one output, or switch one signal to any one of ten outputs.

Signal HI is connected to signal LO (analog ground) when the scanner mainframe channel is open, and to output HI when the channel is closed. Signal LO is common to all ten channels and the output. An additional relay isolates all circuitry on the card from the output when no channel is closed.

Features of the scanner card include:

- Low offset current error (<1pA specified, <30fA typical).
- Switching of AC or DC signals up to 100mA.
- BNC input and output connectors.
- Two outputs for daisy-chaining of Model 7158 cards.
- Configurable for low current or low voltage switching.

The Model 7158 is field-installable in the Models 705 and 706 scanner mainframes.

1.2 WARRANTY INFORMATION

Warranty information is stated on the inside front cover of this manual. If there is a need for service, contact the Keithley representative or authorized repair facility in your area. Check the back cover for addresses. The service form supplied at the end of the manual should be used to provide the service facility with information concerning any difficulty.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

1.3 MANUAL ADDENDA

Product improvements or changes to this manual will be explained on an addendum included with the manual. It is recommended that this information be incorporated immediately into the appropriate places in the manual.

If an additional instruction manual is required, order the manual package (Keithley Part Number 7158-901-00). The manual package includes an instruction manual and all pertinent addenda.

1.4 SAFETY SYMBOLS AND TERMS

The symbol ⚠ on the card denotes that the user should refer to the operating instructions.

The **WARNING** used in this manual explains dangers that could result in personal injury or death.

The **CAUTION** used in this manual explains hazards that could damage the card.

1.5 UNPACKING AND INSPECTION

The Model 7158 was inspected both electrically and mechanically before shipment. Upon receiving the Model 7158, unpack all items from the shipping carton and check for any obvious damage that may have occurred during transit. Report any damage to the shipping agent. Retain and use the original packaging materials in case reshipment is necessary. The following items are shipped with every Model 7158:

Model 7158 Low Current Scanner Card
Model 7158 Instruction Manual
Model 4801 Low Noise Coax Cable (48 in., supplied accessory)

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

The following item is an optional accessory:

Model 4804 Triax (F) to BNC (M) Adapter

1.6 SPECIFICATIONS

Detailed specifications of the Model 7158 precede the Table of Contents of this manual.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

SECTION 2
OPERATION

2.1 INTRODUCTION

This section contains an operation overview, safety information, connections and cabling information, an installation procedure, operating instructions, and an application for the card.

2.2 SAFETY PRECAUTIONS

WARNING

Maintain inputs and outputs within 30V peak of earth ground. Turn off all power and discharge stored energy in external circuitry before making or breaking connections.

1. The maximum signal level is 100mA peak (30V compliance).
2. Make sure the scanner mainframes are grounded through an earth grounded receptacle before operation.
3. Inspect all connections for wear and defects such as cracks and exposed wires.

2.2.1 High Impedance Considerations

Because of the high impedance circuits on the card, be careful when handling it to avoid contamination from such foreign materials as body oils. Such contamination can substantially lower leakage resistance, degrading performance.

Handle the card only by the edges. If you remove the relay covers, be careful not to touch board surfaces or exposed parts.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

To avoid dirt build-up over a period of time, operate the scanner and scanner card only in a clean environment. If contamination is suspected, the card should be carefully cleaned using the procedure given in paragraph 3.2.

2.2.2 Static Precautions

The card's IC chips are static-sensitive and can be damaged by static discharge, rendering the card partially or completely inoperative. For that reason, be careful not to touch exposed areas of the circuit board if static is thought to be a problem.

CAUTION

Static discharge to exposed circuits can damage the card and might invalidate the warranty.

2.3 CONNECTIONS AND CABLING

Signal input and output connections are made with BNC connectors on the card. The locations for each channel input and the outputs are indicated on the relay covers. The two output connectors permit multiple Model 7158 cards to be connected together. For example, a 20-channel scanner system can be connected as shown in Figure 2-1.

In addition to card-to-card connections, the Model 4801 low noise cable can be used for scanner-to-scanner connections when daisy-chaining up to five scanner mainframes.

CAUTION

Keithley's Model 7058 low current scanner card has triax connectors. Be careful not to interchange triax and BNC connectors to avoid damaging them.

Caps are provided for all connectors. Unused connectors should be capped to prevent contamination of the insulators, which could degrade performance.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

The supplied low noise coax cable has a conductive lubricant (graphite) to minimize the error current caused by friction between cable insulators and conductors. This becomes a consideration when measuring current levels in the picoamp range. Since cable flexing due to vibration and cable expansion and contraction due to temperature fluctuation cause friction, the signal cables should be fastened to a rigid surface and not subject to temperature changes. (The temperature changes normally experienced in laboratory environments are not a problem).

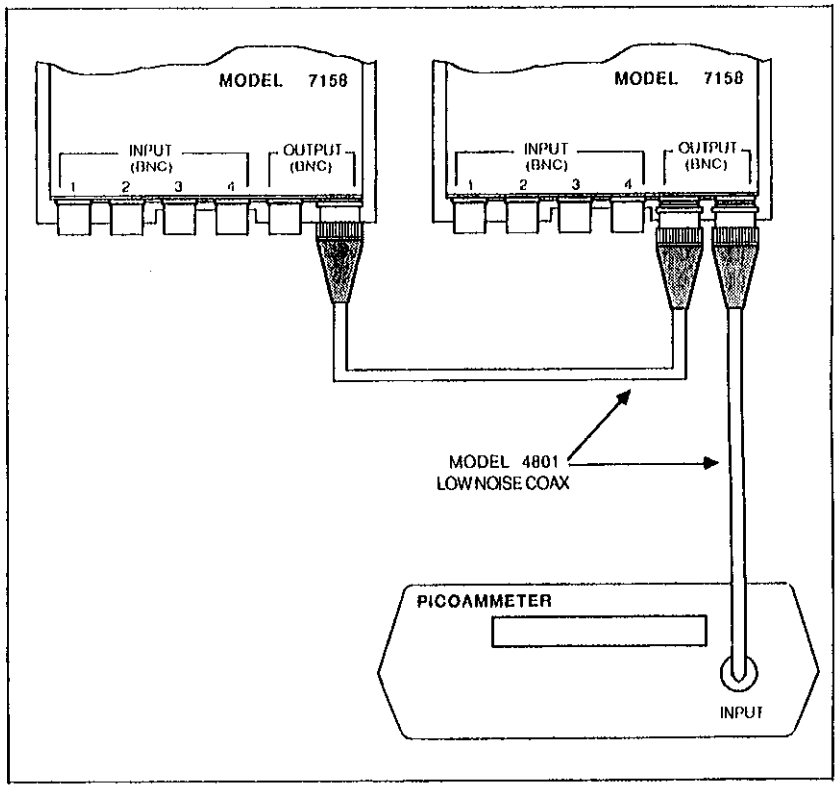


Figure 2-1. Multi-Card Connection

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

2.4 INSTALLATION AND REMOVAL

The procedures to install the Model 7158 in the Model 705 or 706 Scanners are similar except for the card orientation. See Figure 2-2 for a Model 705 and Figure 2-3 for a Model 706.

WARNING

Turn off the scanner mainframe and disconnect the power cord before installing or removing scanner cards.

CAUTION

Leave the Model 7158 in its anti-static bag until ready for cabling and installing to avoid possible static damage.

Once the card is cabled, insert it card edge first into the scanner mainframe by aligning it with the grooves in the appropriate slot. Make sure it is properly seated into the mainframe connector. Push the locking tabs forward to the center of the card to lock it in.

To remove a card, first turn off the mainframe and all other equipment connected to the card. Unfasten the locking tabs on the card by pulling the tabs outward. Grasp the end of the card and carefully pull it out of the mainframe.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

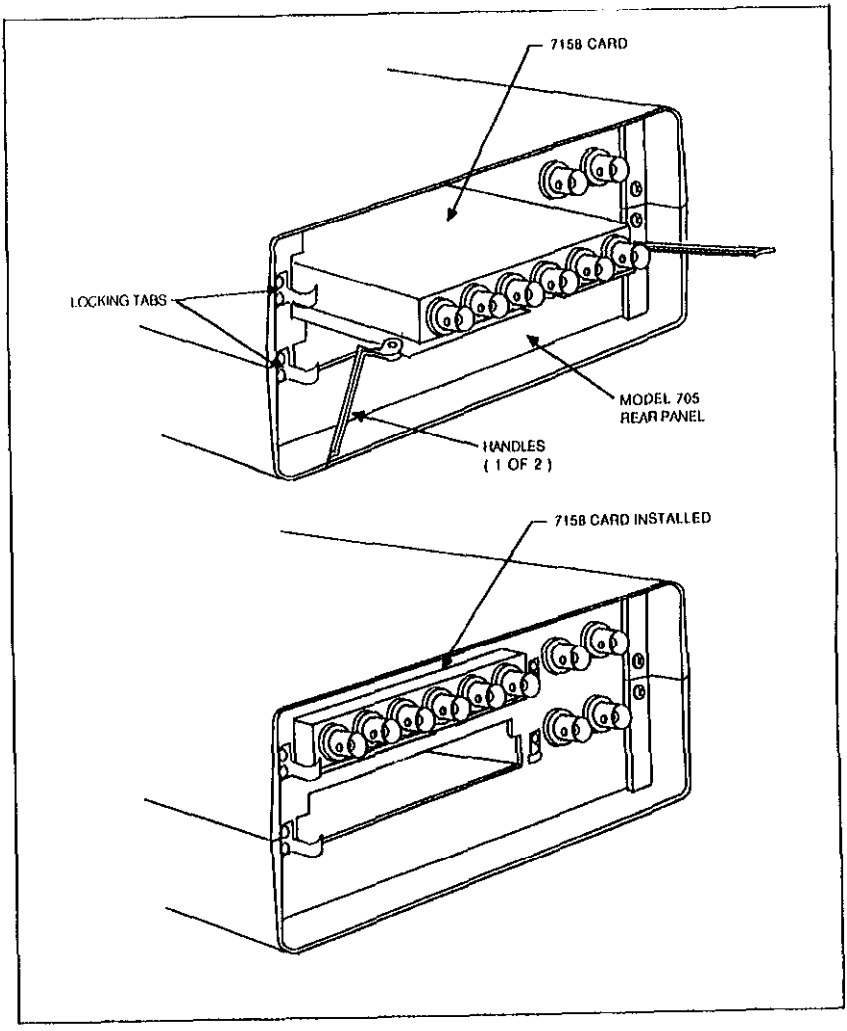


Figure 2-2. Installing Card in Model 705

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

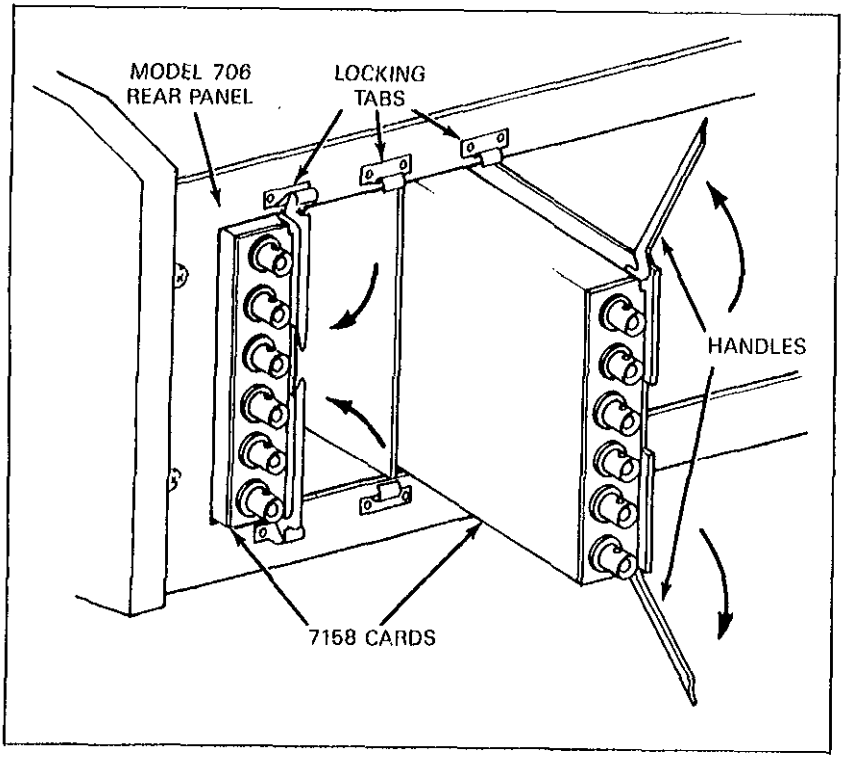


Figure 2-3. Installing Card in Model 706

2.5 OPERATION

As shown in Figure 2-4A for current switching, each channel on the Model 7158 has a pair of single-pole single-throw (SPST), normally open (NO) relays. The relay pair switches signal HI between signal LO (analog ground) and output HI. Signal LO (outside shell of the BNC) is common to all channels and outputs in the system.

An additional relay isolates all circuitry on the card from the outputs when no channel is closed. That is, the isolation relay is open when all channels are open, and it is closed when any channel is closed.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

The card is designed for scanning current sources: when a channel is not selected, a current path is maintained through its signal HI to LO relay. This protects sensitive devices under test from spikes when switching an ammeter in and out of each circuit.

The Model 7158 can also be configured for voltage switching (schematic shown in Figure 2-4B). This configuration is made possible by removing the socketed driver chips (U1 and U2) for the channel HI to LO relay coils. (These chips are static sensitive. See paragraph 3.2 for handling precautions).

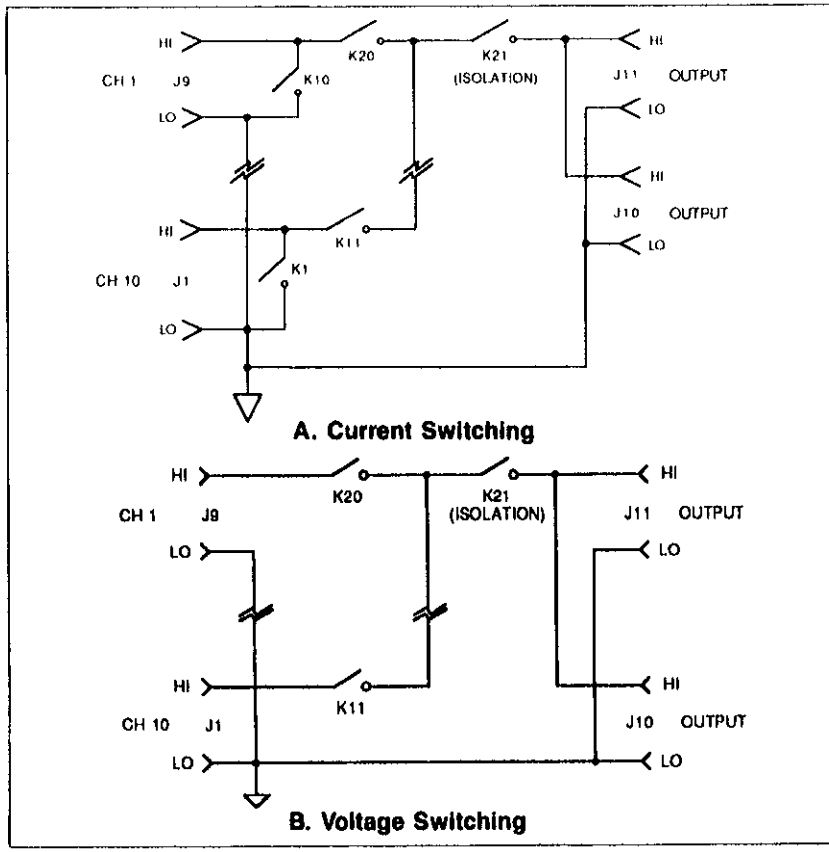


Figure 2-4. Model 7158 Simplified Schematic

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

2.5.1 Scanner Control of the Channels

Since the Model 7158 is a 10-channel card, set the scanner to the 2-pole mode when using the Model 7158 by itself or when intermixing with other 10-channel cards (such as Models 7056, 7058, 7059, 7066, and 7067). In the 2-pole mode, each scanner channel controls one channel on one 10-channel card.

As an example, consider the combination of a Model 7158 and Model 7059. Table 2-1 shows the scanner and card channel assignments for a master scanner.

Table 2-1. Example Channel Assignments in 2-Pole Mode

Card 1 - Model 7158 10 channels		Card 2 - Model 7059 10 channels	
Scanner Ch. No.	7158 Ch. No.	Scanner Ch. No.	7059 Ch. No.
001	1	011	1
002	2	012	2
003	3	013	3
004	4	014	4
005	5	015	5
006	6	016	6
007	7	017	7
008	8	018	8
009	9	019	9
010	10	020	10

The Model 7158 can be mixed with cards other than 10-channel cards, but there are complications when changing the pole mode to support a mix of card types. When using a Model 7158 in combination with a 20-channel card, such as the Model 7064, set the scanner to 1-pole mode. In this mode, each scanner channel controls one channel on one 20-channel card. The effect on the Model 7158 channel assignments is shown in Table 2-2.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

NOTE

In the 1-pole scanner mode, close one channel at a time when using the Model 7158. Otherwise, other channels are closed on the card and show up on the mainframe display. For example, close channels 2 and 5, channels 1 and 6 also close.

Table 2-2. Example Channel Assignments in 1-Pole Mode

Card 1 - Model 7158 10 channels		Card 2 - Model 7064 20 channels	
Scanner Ch. No.	7158 Ch. No.	Scanner Ch. No.	7064 Ch. No.
001	1	021	1
002	1	022	2
003	2	023	3
004	2	024	4
005	3	025	5
006	3	026	6
007	4	027	7
008	4	028	8
009	5	029	9
010	5	030	10
011	6	031	11
012	6	032	12
013	7	033	13
014	7	034	14
015	8	035	15
016	8	036	16
017	9	037	17
018	9	038	18
019	10	039	19
020	10	040	20

Next, consider a mix of a 10-channel card (Model 7158), a 20-channel card (Model 7064), and a matrix card (Model 7052) in a Model 706 scanner mainframe. Since a matrix card is present, the scanner is set to matrix (0-pole) mode. The scanner crosspoints and card channel assignments for a master scanner are shown in Table 2-3.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Table 2-3. Example Channel Assignments in Matrix (0-Pole Mode)

Card 1 - Model 7158 10 channels		Card 2 - Model 7064 20 channels		Card 3 - Model 7052 5 Columns by 4 rows	
706 Crosspoint	7158 Ch. No.	706 Crosspoints	7064 Ch. No.	706 Crosspoint	7052 Column, Row
001,1	1	006,1 007,3	1	011,1	1,1
002,1	2	006,1 006,3	2	011,2	1,2
003,1	3	007,1 007,3	3	011,3	1,3
004,1	4	007,1 006,3	4	011,4	1,4
005,1	5	008,1 007,3	5	012,1	2,1
001,2	6	008,1 006,3	6	012,2	2,2
002,2	7	009,1 007,3	7	012,3	2,3
003,2	8	009,1 006,3	8	012,4	2,4
004,2	9	010,1 007,3	9	013,1	3,1
005,2	10	010,1 006,3	10	013,2	3,2
		006,2 007,3	11	013,3	3,3
		006,2 006,3	12	013,4	3,4
		007,2 007,3	13	014,1	4,1
		007,2 006,3	14	014,2	4,2
		008,2 007,3	15	014,3	4,3
		008,2 006,3	16	014,4	4,4
		009,2 007,3	17	015,1	5,1
		009,2 006,3	18	015,2	5,2
		010,2 007,3	19	015,3	5,3
		010,2 006,3	20	015,4	5,4

When using 20-channel cards in matrix mode, two crosspoints must be closed for each of the card channels.

In general, the rules for choosing different scanner pole modes are:

matrix (0-pole) - If a matrix card is present.
1-pole - If a 20-channel card is present, but no matrix card.
2-pole - If a 10-channel card is present, but no 20-channel or matrix cards.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

4-pole - If 4-pole switching is desired with two 2-pole, 10-channel cards.

Tables 2-4 through 2-7 list the scanner channels that control Model 7158 channels for all scanner pole configurations.

Table 2-4. Scanner Control of Model 7158 4-Pole Mode

Card No.	Scanner Channel No.	7158 Channel No.	Scanner
1	01-10	1-10	705, 706
2	01-10	1-10	705, 706
3	11-20	1-10	706
4	11-20	1-10	706
5	21-30	1-10	706
6	21-30	1-10	706
7	31-40	1-10	706
8	31-40	1-10	706
9	41-50	1-10	706
10	41-50	1-10	706

Table 2-5. Scanner Control of Model 7158 2-Pole Mode

Card No.	Scanner Channel No.	7158 Channel No.	Scanner
1	01-10	1-10	705, 706
2	11-20	1-10	705, 706
3	21-30	1-10	706
4	31-40	1-10	706
5	41-50	1-10	706
6	51-60	1-10	706
7	61-70	1-10	706
8	71-80	1-10	706
9	81-90	1-10	706
10	91-100	1-10	706

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Table 2-6. Scanner Control of Model 7158 1-Pole Mode

Card 1	Card 2	Card 3	Card 4	Card 5	
Scanner Ch. No.	*Scanner* Ch. No.	*Scanner* Ch. No.	*Scanner* Ch. No.	*Scanner* Ch. No.	7158 Ch. No.
01, 02	21, 22	41, 42	61, 62	81, 82	1
03, 04	23, 24	43, 44	63, 64	83, 84	2
05, 06	25, 26	45, 46	65, 66	85, 86	3
07, 08	27, 28	47, 48	67, 68	87, 88	4
09, 10	29, 30	49, 50	69, 70	89, 90	5
11, 12	31, 32	51, 52	71, 72	91, 92	6
13, 14	33, 34	53, 54	73, 74	93, 94	7
15, 16	35, 36	55, 56	75, 76	95, 96	8
17, 18	37, 38	57, 58	77, 78	97, 98	9
19, 20	39, 40	59, 60	79, 80	99, 100	10
705, 706	705, 706	706	706	706	

Card 6	Card 7	Card 8	Card 9	Card 10	
Scanner Ch. No.	*Scanner* Ch. No.	*Scanner* Ch. No.	*Scanner* Ch. No.	*Scanner* Ch. No.	7158 Ch. No.
101, 102	121, 122	141, 142	161, 162	181, 182	1
103, 104	123, 124	143, 144	163, 164	183, 184	2
105, 106	125, 126	145, 146	165, 166	185, 186	3
107, 108	127, 128	147, 148	167, 168	187, 188	4
109, 110	129, 130	149, 150	169, 170	189, 190	5
111, 112	131, 132	151, 152	171, 172	191, 192	6
113, 114	133, 134	153, 154	173, 174	193, 194	7
115, 116	135, 136	155, 156	175, 176	195, 196	8
117, 118	137, 138	157, 158	177, 178	197, 198	9
119, 120	139, 140	159, 160	179, 180	199, 200	10
706	706	706	706	706	

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Table 2-7. Scanner Control of Model 7158 Matrix (0-Pole) Mode

Card 1	Card 2	Card 3	Card 4	Card 5	
Scanner Ch. No.	Scanner Ch. No.	Scanner Ch. No.	Scanner Ch. No.	Scanner Ch. No.	7158 Ch. No.
01, 1	06, 1	11, 1	16, 1	21, 1	1
02, 1	07, 1	12, 1	17, 1	22, 1	2
03, 1	08, 1	13, 1	18, 1	23, 1	3
04, 1	09, 1	14, 1	19, 1	24, 1	4
05, 1	10, 1	15, 1	20, 1	25, 1	5
01, 2	06, 2	11, 2	16, 2	21, 2	6
02, 2	07, 2	12, 2	17, 2	22, 2	7
03, 2	08, 2	13, 2	18, 2	23, 2	8
04, 2	09, 2	14, 2	19, 2	24, 2	9
05, 2	10, 2	15, 2	20, 2	25, 2	10
705, 706	705, 706	706	706	706	

Card 6	Card 7	Card 8	Card 9	Card 10	
Scanner Ch. No.	Scanner Ch. No.	Scanner Ch. No.	Scanner Ch. No.	Scanner Ch. No.	7158 Ch. No.
26, 1	31, 1	36, 1	41, 1	46, 1	1
27, 1	32, 1	37, 1	42, 1	47, 1	2
28, 1	33, 1	38, 1	43, 1	48, 1	3
29, 1	34, 1	39, 1	44, 1	49, 1	4
30, 1	35, 1	40, 1	45, 1	50, 1	5
26, 2	31, 2	36, 2	41, 2	46, 2	6
27, 2	32, 2	37, 2	42, 2	47, 2	7
28, 2	33, 2	38, 2	43, 2	48, 2	8
29, 2	34, 2	39, 2	44, 2	49, 2	9
30, 2	35, 2	40, 2	45, 2	50, 2	10
706	706	706	706	706	

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

2.5.2 Operation Notes

1. Extreme environmental conditions can cause the offset current to exceed the 1pA specification. If the card has been exposed to high humidity and/or temperature (for example during shipping), stabilize the board within the specified environmental limits for 24 hours.
2. When a channel is opened or closed, there is a charge transfer in the picocoulomb range. This is because of the mechanical release or closure of the contacts, the contact to coil capacitance, and the stray capacitance between signal and relay drive lines. The charge transfer causes a current pulse. The effect on the signal depends on the magnitude of the source being measured.
3. Each relay on the Model 7158 draws 10mA. For current switching, there are either ten or eleven relays energized with any combination of open and closed channels. The maximum current draw of one card from the mainframe power supply is 110mA. (For voltage switching, there are between zero and eleven relays energized for any open/closed channel combination.) There are no restrictions on the maximum number of simultaneous channel closures unless relays from other card types are energized at the same time.
4. System response is affected by cable capacitance. This should be considered when the sources are connected to the scanner. Use of a feedback ammeter (or an electrometer in the FAST mode) for currents below 10^{-5}A is recommended to increase measurement speed and decrease the effects of cable capacitance.
5. Power Limits - To prevent overheating or damage to the relay contacts, never exceed the signal level specifications of the card. Maximum switched and carry current and voltage levels are 100mA, 30V. The card can switch low power AC (typical bandwidth up to 1MHz). Maximum switched and carry current and voltage levels are 100mA, 30V, peak (resistive loads).
6. Switching Speed - Relay actuation time is 1msec maximum plus the mainframe programming time. Maximum relay switching rate is 100 cycles per second (10msec). This is the maximum rate of the scanner mainframe. For extended relay life, use low power or cold switching (turn on sources after the channel is closed).

2.6 APPLICATIONS

The Model 7158 can be used in a variety of applications to switch low

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

current levels. Typical applications include those where sourcing voltage and measuring current are required, such as:

- Leakage currents (e.g. capacitor, FET gate)
- PCB test coupons
- Materials research and characterization
- Semiconductor sub-threshold current

Voltage applications include those where the Model 7158 can be used to switch a single-pole of low voltage sources. (Refer to the application example that follows.)

When measuring low currents, the following sources of noise current should be considered:

- Triboelectric currents are caused by friction between a conductor and insulator when a coax cable flexes due to vibration or temperature fluctuation. To minimize, use low noise cables and tie down to a rigid surface.
- Piezoelectric currents are caused by mechanical stress to the insulating materials of connectors. Remove the stress from the insulators and use material with low piezoelectric effects to minimize.
- Electrochemical effects generate current between PCB conductors due to contamination of the card surface. To minimize, handle the card by the edges only and follow the cleaning instructions in paragraph 3.2.

For a specific application, consider measuring capacitor leakage current to calculate insulation resistance. The amount of leakage current depends on the capacitor dielectric material as well as the applied voltage. The schematic of Figure 2-5 shows a Model 7055/7056 card on the source side, but a Model 7158 could be used in its voltage configuration when the test voltage does not exceed 30V.

The configuration shown is the direct method of measuring leakage currents: a feedback type picoammeter in series with the capacitor under test. This test is fully explained (including controlling software

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

and test fixture construction) in Application Note #120, "Capacitor Leakage Measurements".

NOTE

The indirect method, with a voltmeter reading the voltage drop across a resistor in series with the capacitor, is recommended for capacitor values above 1μF to maintain stability and noise performance.

The instrument setup is shown in Figure 2-6. For clarity, only four channels are shown. Obviously, all ten channels are available for testing purposes.

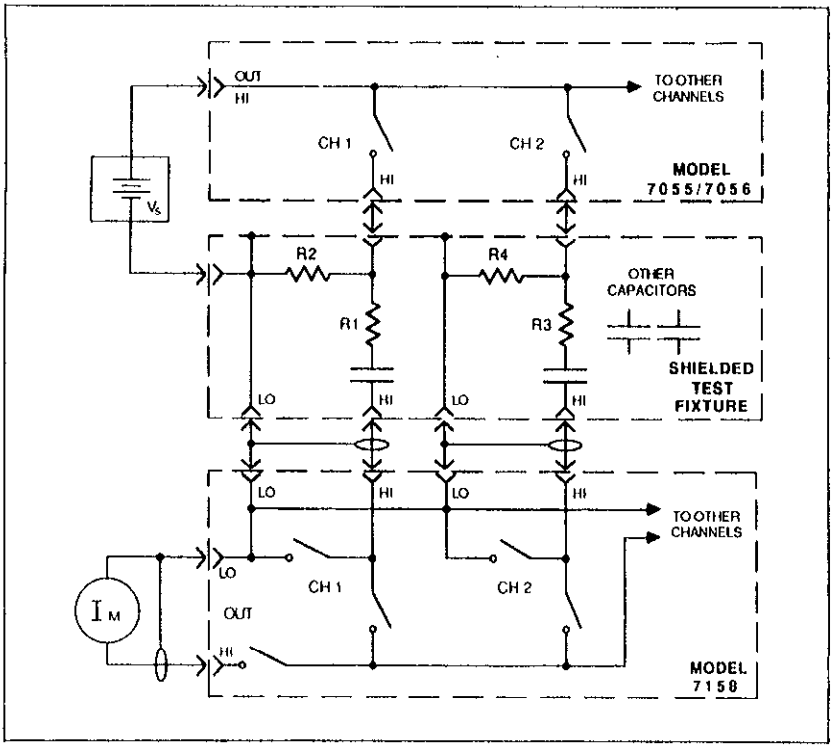


Figure 2-5. Capacitor Leakage Schematic

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

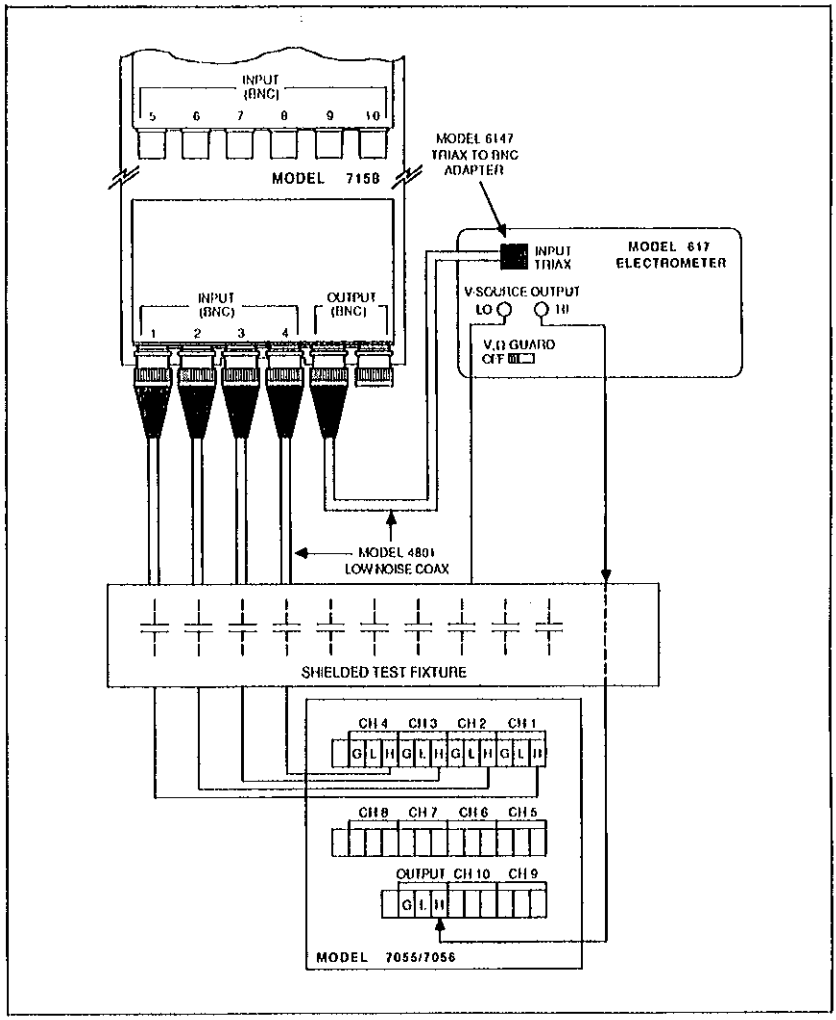


Figure 2-6. Capacitor Leakage Instrument Setup

The internal voltage source of a Model 617 electrometer stagger charges the capacitors when the corresponding channels are closed on a Model 7056 general purpose card. (At this time, the signal HI to LO relay on

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

the Model 7158 is closed, completing the circuit.) Resistor R1 is needed to limit current in case the capacitor is shorted and it also helps reduce noise.

After each capacitor is fully charged (usually 10 times R1C), the Model 7158 channel is programmed to close. This switches in the Model 617 for reading current or resistance (V/I mode).

Once the Model 617 has settled and the measurement is taken, the Model 7158 channel is opened and the signal HI to LO relay closes to shunt the current to ground. Then the Model 7056 channel is opened to avoid a current surge through the electrometer and resistors R1 and R2 bleed off the capacitor charge.

With this two-card configuration, the capacitors have equal soak times. This is important when comparing low leakage levels (picoamps).

Having equivalent soak times is not as critical at higher leakage levels (e.g. the nanoamp range of tantalum capacitors). In this case, the one-card configuration shown in Figure 2-7 is sufficient. Since the settling time of the Model 617 is less when measuring higher currents, the channels can be switched faster.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

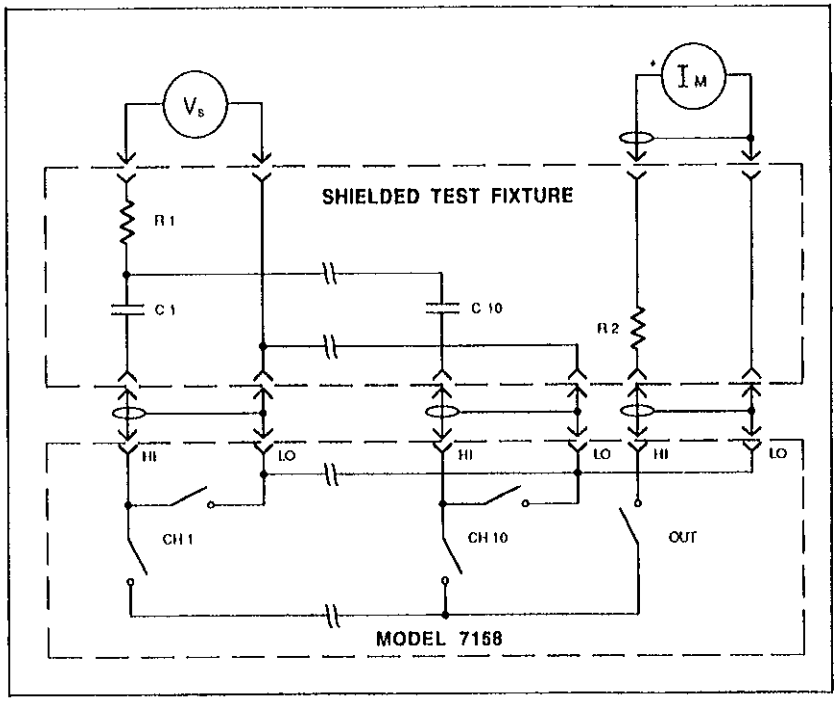


Figure 2-7. Measuring Leakages with One Card

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

SECTION 3
SERVICING INFORMATION

3.1 INTRODUCTION

This section describes tests for verifying the performance of the Model 7158. Perform these tests in an environment of 18°C to 28°C up to 70% RH.

Because of the low signal levels measured in these tests, the test cables should be kept as still as possible to help minimize noise.

Recommended maintenance includes inspection of the card and the card edge connector to ensure good electrical contact.

3.2 HANDLING AND CLEANING

Because of the high impedance of the board, take special care when handling and using to prevent degradation of performance. Handle the board by the edges to avoid contaminating it with dirt, body oil, etc.

CMOS and other high-impedance devices are subject to possible static discharge damage because of the high impedance levels involved. When handling such devices (indicated by * in the parts list), use the following precautions:

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 of plastic or foam. Keep these parts in their original containers until ready for installation.
2. Remove the devices from their protective containers only at a properly grounded work station. Also, ground yourself with a suitable wrist strap.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

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 also be grounded to the bench or table.
5. Use only anti-static de-soldering tools and grounded-tip soldering irons.

Before cleaning the board, remove the front and rear relay covers. Clean the board with cotton swabs or a soft brush saturated with an uncontaminated solvent, such as Freon® TMS or TE. After the solvent has been applied and is still liquid, blow-dry the board with dry-pumped nitrogen gas.

3.3 RELAY REPLACEMENT

If you have determined that a relay is defective, use the following procedure to replace it:

1. Remove the screws that secure the appropriate relay cover and remove the cover.
2. Unsolder the defective relay and clean the card holes with a desoldering tool or wick. Solder in a replacement relay.
3. Clean the card according to the method given in paragraph 3.2 using localized cleaning only, then reinstall relay covers.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

3.4 RECOMMENDED TEST EQUIPMENT

Table 3-1 lists recommended test equipment for performance verifica tion. Other test equipment may be substituted if specifications equa or exceed those stated.

Table 3-1. Recommended Test Equipment

Description	Specification	Mfr.	Model
Scanner Mainframe	—	Keithley	705 or 706
Extender Card	—	Keithley	7061
Low Noise Coax Cable	4 feet long	Keithley	4801
Electrometer	10^{-12}A sensitivity	Keithley	617
Triax to BNC Adapter	—	Keithley	6147
Ohmmeter-DMM	$<1\Omega$ sensitivity	Keithley	196
Kelvin Test Leads	—	Keithley	5806

3.5 OFFSET CURRENT TEST

This test verifies that the offset current for each channel is within specification.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

1. Set up the equipment as shown in Figure 3-1 with caps on all inputs and the unused output.
2. Insert the card into the mainframe.
3. Set the electrometer to the 2pA range and zero check.
4. Turn on the mainframe and close channel 1.
5. Zero correct the Model 617 and release its zero check. Note the offset current long enough to allow the switching transients to decay and the current to stabilize. The current indicated by the electrometer should be less than 1pA, exclusive of noise. Open the channel after taking the reading.
6. Close the remaining channels one at a time and repeat step 5.

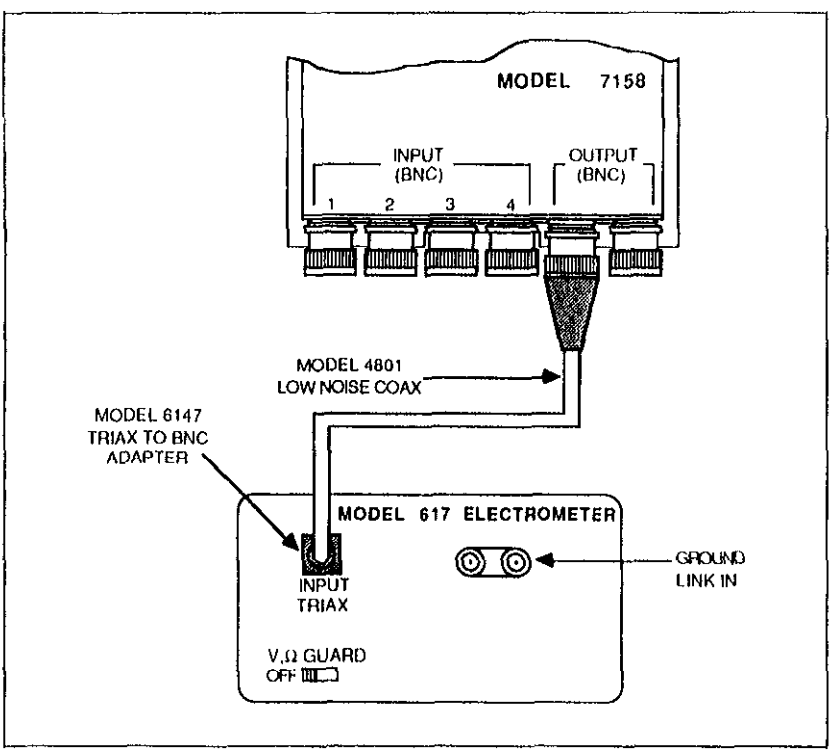


Figure 3-1. Offset Current

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

3.6 CONTACT RESISTANCE TEST

This test verifies that the contact resistance of the relays does not exceed the specification. The procedure is in three parts:

- Setting up equipment.
- Checking contacts of signal HI to LO relays (when channel is open).
- Checking contacts of signal HI to output HI relays in combination with the isolation relay (when channel is closed).

Setting Up Equipment

1. Turn on the Model 196 DMM and let it warm up (two hours if from cold-start).
2. Using the following procedure, prepare two BNC male connectors with coax pigtails as shown in Figure 3-2.
   - Use an X-acto® knife to cut and strip 1½ inches of outer insulation without cutting the shield.
   - With the knife point, unravel the braided shield and twist it off to the side.
   - Strip one inch of insulation off the center conductor.
3. Connect the Model 7158 to the scanner through the Model 7061 Universal Adapter Card, which is used as an extender to allow access to all connectors.
4. Select the 300Ω range on the Model 196. Temporarily short the test leads and zero the instrument. Leave zero enabled for the duration of the test.

Checking Signal HI to LO Relays

5. Connect one of the BNC plugs to an input connector on the card. Connect the Kelvin leads to the coax pigtail as shown in Figure 3-3A.
6. With all channels open, verify that the contact resistance is less than 1Ω.
7. Verify the resistance of the remaining signal HI to LO relays by just moving the BNC plug and Kelvin leads to the remaining input connectors and taking readings.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

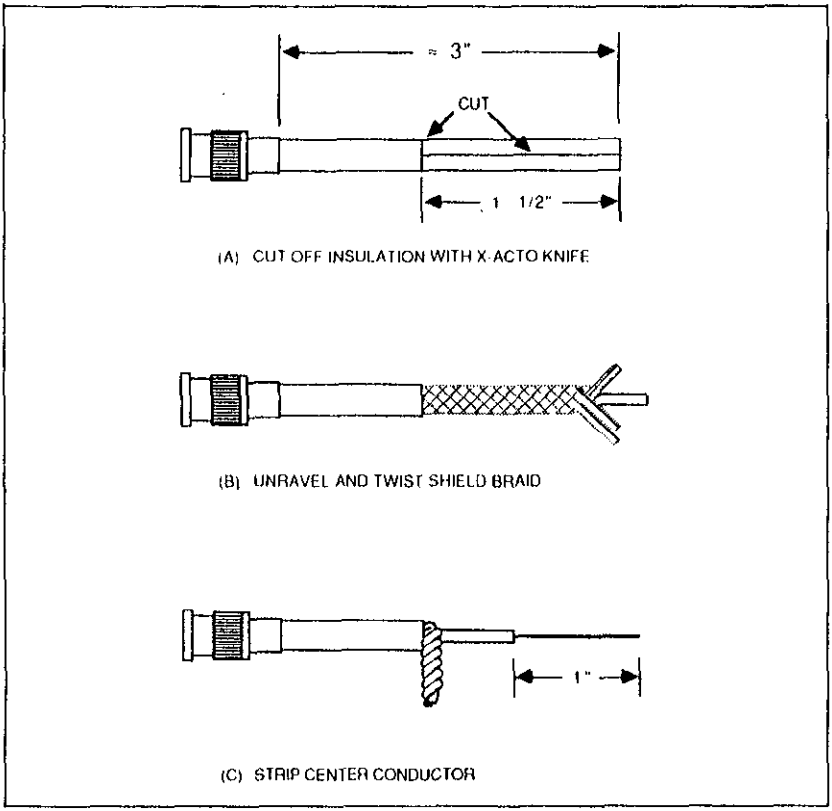


Figure 3-2. Coax Pigtail Preparation

Checking Signal HI to Output HI Relays and Isolation Relay

8. Connect one of the BNC plugs to an input connector and the other BNC plug to an output connector. Connect the Kelvin leads to the coax pigtails as shown in Figure 3-3B.
9. Program the scanner to close the channel being tested. This closes both the signal HI to output HI relay and the isolation relay for measuring.
10. Verify that the contact resistance of the relay combination (signal HI to LO relay and isolation relay) is less than 1Ω. Open the channel after taking the reading.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

11. Continue with the remaining channels by leaving one BNC plug on the output connector and moving the other BNC plug and Kelvin leads to the remaining input connectors. Take readings with the appropriate channel closed.

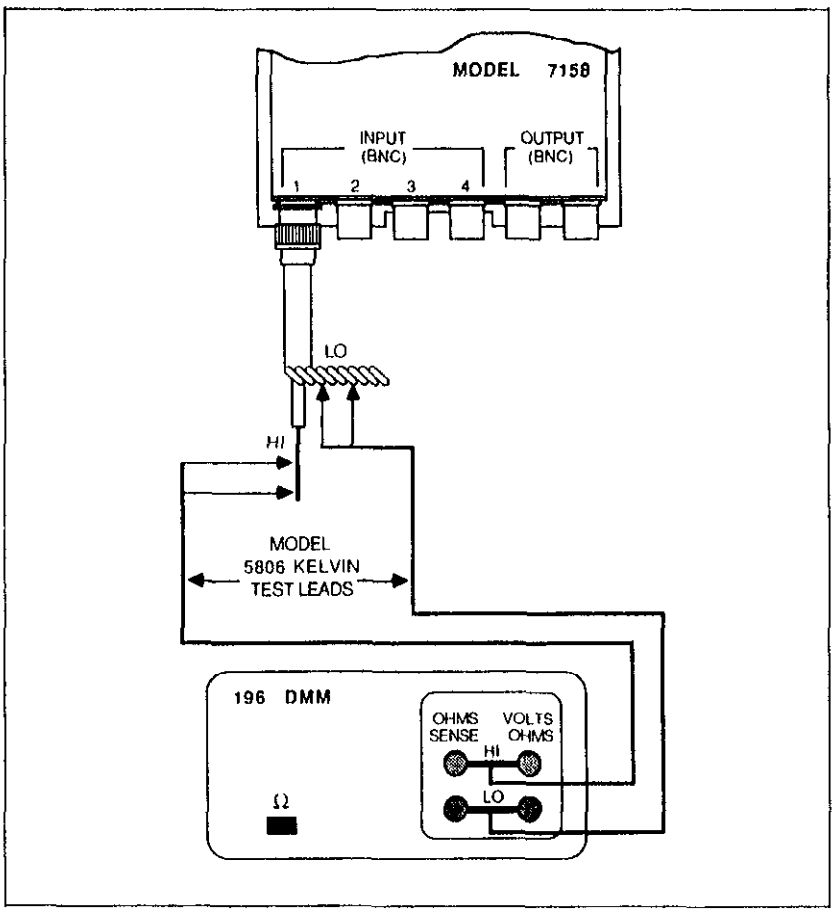


Figure 3-3A. Contact Resistance (Signal HI to LO Relays)

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

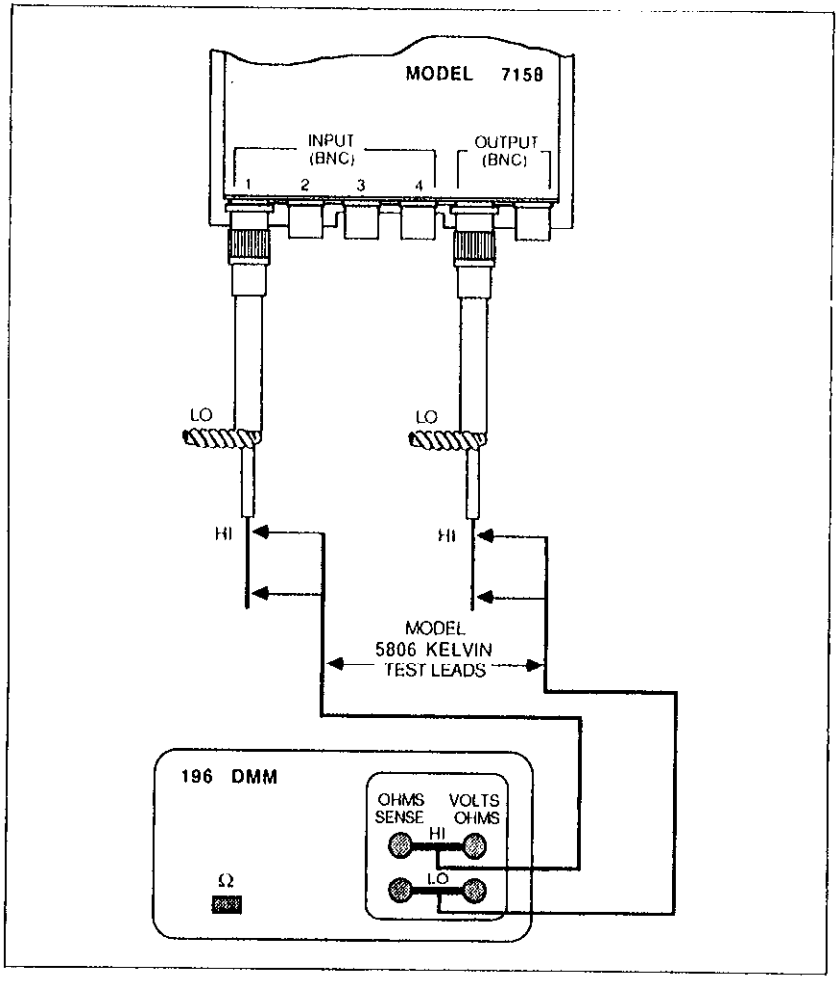


Figure 3-3B. Contact Resistance (Signal HI to Output HI Relays)

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

SECTION 4
REPLACEABLE PARTS

4.1 INTRODUCTION

This section contains replacement parts information, a component layout, and a schematic diagram for the Model 7158.

4.2 PARTS LISTS

Electrical parts are listed in order of circuit designation in Table 4-1. Table 4-2 summarizes mechanical parts.

4.3 ORDERING INFORMATION

To place a parts order or to obtain information about replacement parts, contact your Keithley representative or the factory. See the back cover for addresses. When ordering parts, be sure to include the following information:

- Scanner card model number (7158)
- Card serial number
- Part description
- Circuit description (if applicable)
- Keithley part number

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Table 4-1. Model 7158 Electrical Parts

Circuit Desig.	Description	Sch Loc	Keithley Part No.
C1	Capacitor, 10μF, 25V, Aluminum Electrolytic	A1	C-314-10
C2-C5	Capacitor, 0.1μF, 50V, Ceramic Film	sev	C-237-.1
J1-J12	Connector, Coaxial Female	sev	CS-249
K1-K21	Relay, SPST	sev	RL-70
R1-R10	Resistor, 330kΩ, 5%, ¼W, Carbon Composition	sev	R-76-330k
R11	Not used		
R12, R13	Resistor, 10kΩ, 5%, ¼W, Carbon Composition	B2	R-76-10k
R14	Resistor Network, 10kΩ, 2%, 1.5W, Thick Film	sev	TF-39
TE3, TE4, TE6, TE7, TE11, TE12	Terminal, Teflon®	sev	TE-105-1
U1, U2*	IC, Buffer/Line Driver and Receiver, 74HC241	sev	IC-520
U3, U4*	IC, Hex Inverter, 74HC04	sev	IC-354
U5*	IC, 13-input NAND Gate, 74HC133	B1	IC-547
W1	Cable Assembly Sockets (2) #18 AWG Bare Buss Wire #22 AWG Bare Buss Wire #22 AWG Natural Thinwall Teflon® Tubing	C4	7158-070 SO-84-20

*These parts are static sensitive. See paragraph 3.2 for handling precautions.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Table 4-2. Model 7158 Mechanical Parts

Qty.	Description	Keithley Part No.
1	Bracket, Front Connector Mounting (CH5-CH10)	7158-303
1	Bracket, Rear Connector Mounting (CH1-CH4, OUTPUT)	7158-302
1	Cable Clamp	CC-38-4
1	Cover, Front Relay (CH5-CH10)	7158-307
1	Cover, Rear Relay (CH1-CH4, OUTPUT)	7158-304
12	Protective Cap (for BNC jacks)	CAP-18
5	#4-40 × 3/16 Phillips pan head sems screw (for bracket mounting)	
6	#6-32 × 1/4 Phillips pan head sems screw (for cover mounting)	

4.4 FACTORY SERVICE

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

1. Photocopy and 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 DEPARTMENT on the shipping label.

Note that it is not necessary to return the scanner mainframe with the card.

4.5 COMPONENT LAYOUT and SCHEMATIC DIAGRAM

Figure 4-1 shows a component layout of the Model 7158. Figure 4-2 shows a schematic diagram of the Model 7158.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

LTR.	ECO NO.	REVISION	ENG.	DATE
A	11855	RELEASED	MS	12-24-86
B	11952	CHANGED REV FROM A TO B	MS	3-10-87
B1	12076	ADDED DETAIL FOR TP-10	SZ	4-2-87
B3	12933	DELETED DETAIL 'B'.	SZ	12-11-87
B4	12511	ADDED SO-84-20 TO U1 & U2	SZ	12-28-87

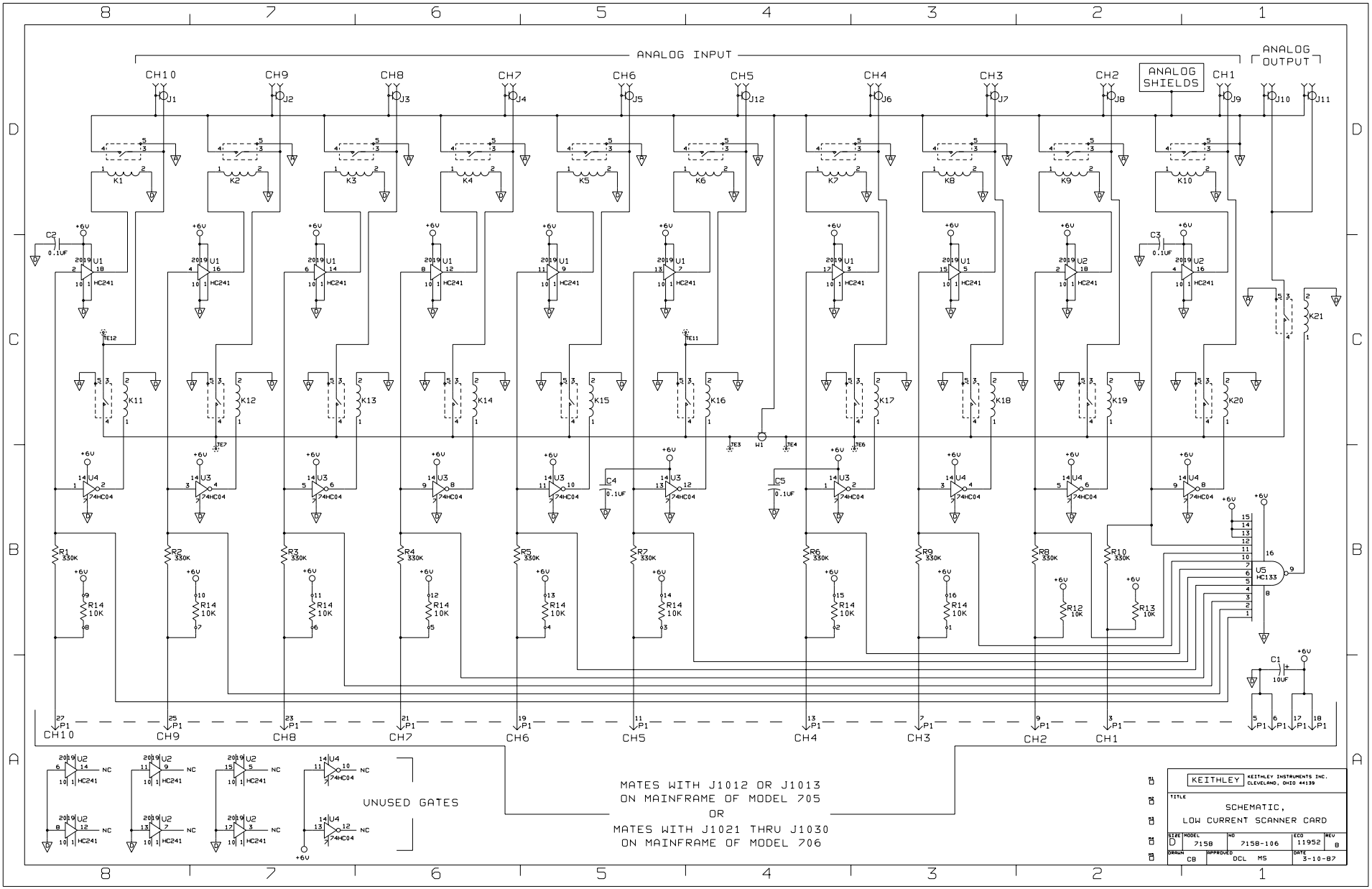
MODEL	NEXT ASSEMBLY	QTY.
7158		

USED ON

DO NOT SCALE THIS DRAWING	DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED	DATE 2/11/87	SCALE 1:1	TITLE COMPONENT LAYOUT, LOW CURRENT SCANNER CARD
KEITHLEY INSTRUMENTS INC. CLEVELAND, OHIO 44139	XX=±.015 ANG.=±1°	DRN. MH	ENG APPR. DCL	MATERIAL
	XXX=±.005 FRAC.=±1/64	SURFACE MAX.	FINISH	NO. 7158-100 C

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com



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

- ❑ 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.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

KEITHLEY

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

Printed in the U.S.A.

Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP