

MODEL 2750 **MULTIMETER/SWITCH SYSTEM**

MODEL 2750 MULTIMETER/SWITCH SYSTEM

Introduction

The Model 2750 6½-digit Multimeter/Switch system blends Keithley's high performance DMM technology, our switching expertise, and our data acquisition knowledge into a compact, affordable, easy-to-use package. This technical data booklet provides a comprehensive overview of the system and includes complete detailed specifications.

The Model 2750 Multimeter/Switch System consists of the 2750 mainframe and a choice of nine switch/control modules. The five-slot mainframe allows five different types of multiplexer, matrix, or control modules to operate simultaneously. Input modules can be mixed or matched to provide a broad range of measurement, acquisition, and control capabilities.

The Model 2750 provides up to 200 channels of multiplexed measurement and control or 240 channels of matrix crosspoints in a 19" rack mount or a benchtop enclosure. Each channel can be configured independently. Settings can be configured via the computer controller (over GPIB or RS-232) or the front panel of the Model 2750 mainframe.

If you have any questions after reviewing this information, please contact your local Keithley representative or call one of our Applications Engineers at 1-800-552-1115 (U.S. only). Check Keithley's website (www.keithley.com) for the names and numbers of representatives around the world.

Figure 1. Model 2750 System Diagram

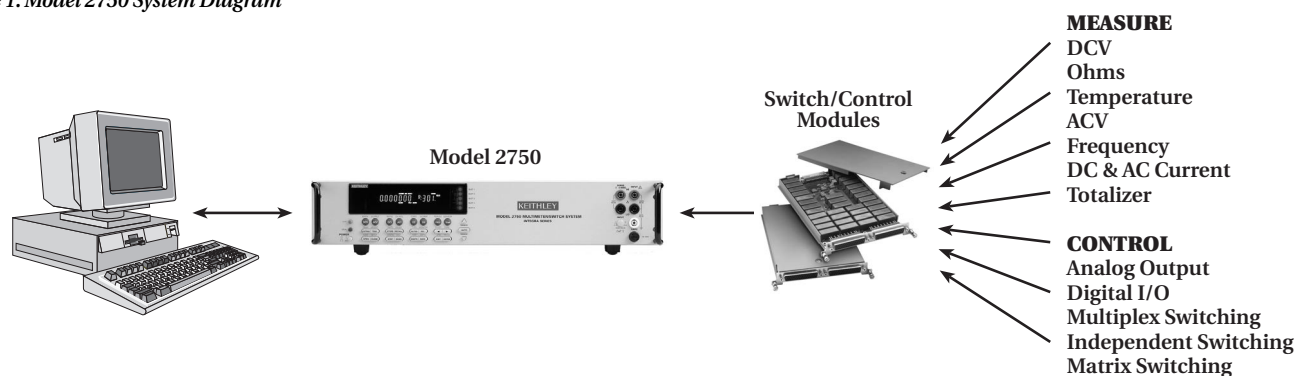
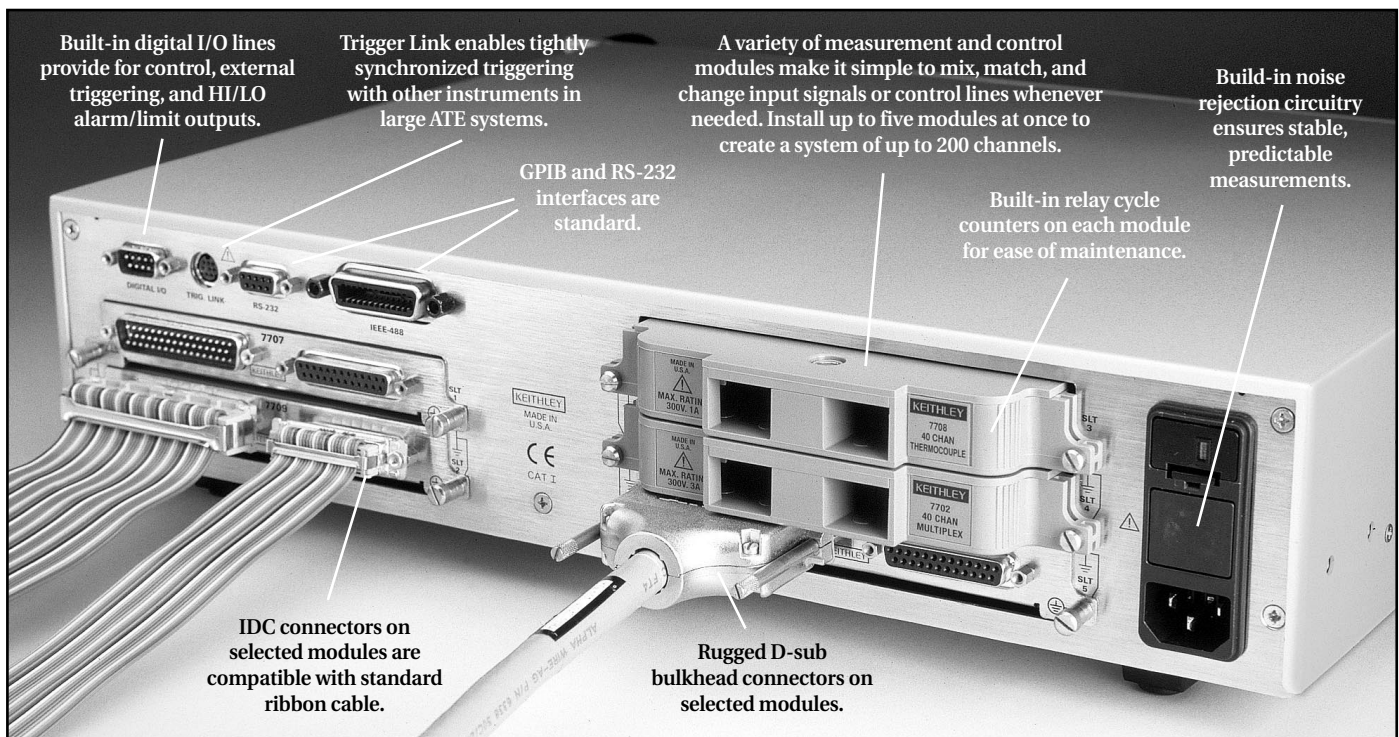
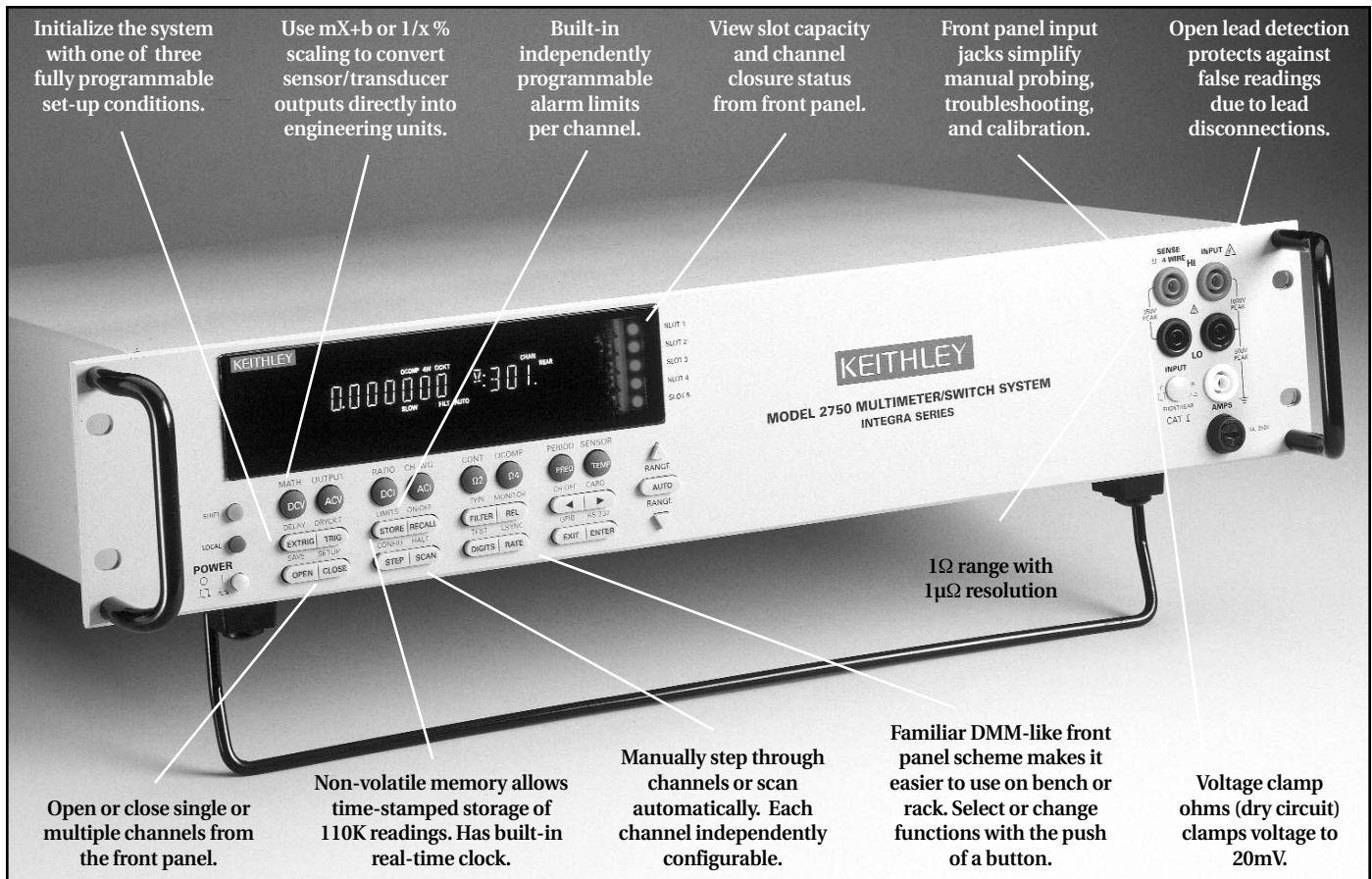


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MODEL 2750 MULTIMETER/SWITCH SYSTEM

Overview



Measurement Ranges for the Model 2750

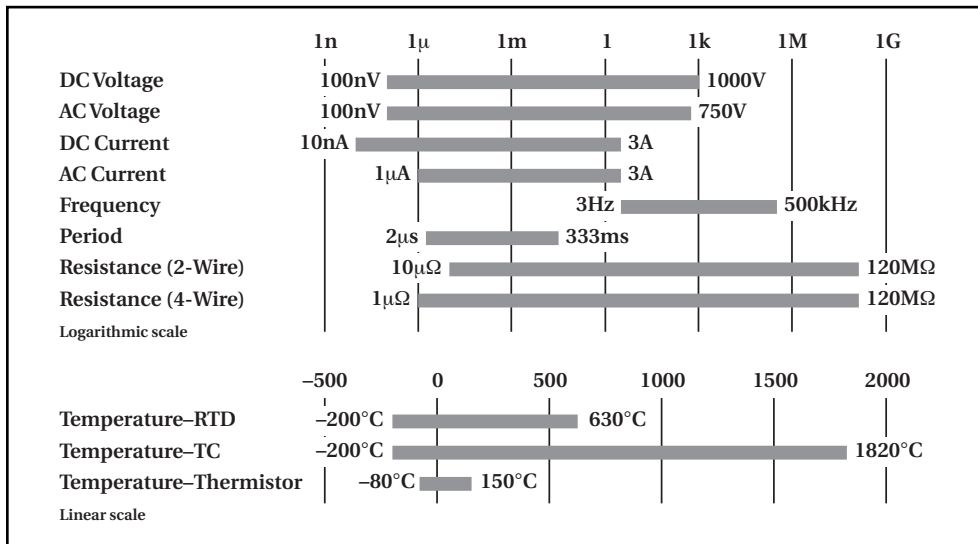


Figure 2. Measurement Ranges

Switch/Control Module Capabilities

The flexibility to mix and match switch/control modules in a single mainframe simplifies configuring Model 2750-based systems for a wide range of applications. Each module offers a different combination of capabilities, such as number of channels, speed, etc. Before selecting a module, it is critical to analyze the needs of the application carefully and consider future requirements for expansion.

Module Capabilities Overview

	7700	7701	7702	7703	7705	7706	7707	7708	7709
DC Volts	✓	✓	✓	✓		✓	✓	✓	✓
DC Current	✓		✓						
Temperature									
T/C w/Automatic CJC	✓					✓		✓	
T/C w/External CJC	✓	✓	✓	✓		✓	✓	✓	✓
RTD	✓	✓	✓	✓		✓	✓	✓	✓
Thermistor	✓	✓	✓	✓		✓	✓	✓	✓
Resistance (2- or 4-wire)	✓	✓	✓	✓		✓	✓	✓	✓
Continuity	✓	✓	✓	✓		✓	✓	✓	✓
AC Volts	✓	✓	✓	✓		✓	✓	✓	✓
AC Current	✓		✓						
Frequency	✓	✓	✓	✓		✓	✓	✓	✓
Event Counter/Totalizer						✓			
Signal Routing/Control	✓	✓	✓	✓	✓	✓	✓	✓	✓
Digital Input							✓		
Digital Output						✓	✓		
Analog Output						✓			

MODEL 2750 MULTIMETER/SWITCH SYSTEM

Module Selector Guide

This selector guide may prove helpful in identifying the best module for a specific application. Install up to five modules at a time in the 2750 mainframe.

Module	# Analog Inputs	Configuration	Differential*	4-pole	Type of Connector	Max. Voltage	Max. Switched Current	Current Measurement Channels	Digital I/O	Switch Speed	Other
7700	20	Multiplexer w/CJC	1 × 20 or two 1 × 10	1 × 10	Screw terminals	300V	1A	2 channels @ 3A	N/A	3 ms	Maximum power = 125VA.
7701	32	Multiplexer	1 × 32 or two 1 × 16	1 × 16	D-sub	150V	1A	N/A	N/A	3 ms	Maximum power = 125VA.
7702	40	Multiplexer	1 × 40 or two 1 × 20	1 × 20	Screw terminals	300V	1A	2 channels @ 3A	N/A	3 ms	Maximum power = 125VA.
7703	32	Multiplexer	1 × 32 or two 1 × 16	1 × 16	D-sub	300V	500mA	N/A	N/A	1 ms	Reed relays.
7705	40	Independent SPST	N/A	N/A	D-sub	300V	2A	N/A	N/A	3 ms	Maximum power = 125VA.
7706	20	Multiplexer w/CJC	1 × 20 or two 1 × 10	1 × 10	Screw terminals	300V	1A	N/A	16 Digital Out Only	3 ms	(2) ±12V analog output channels & 100kHz event counter/totalizer. Maximum power = 125VA.
7707	10	Multiplexer/Digital I/O	1 × 10 or two 1 × 5	1 × 5	D-sub	300V	1A	N/A	32 Digital I/O	3 ms	Maximum power = 125VA. (4) eight-bit word I/O.
7708	40	Multiplexer w/CJC	1 × 40 or two 1 × 20	1 × 20	Screw terminals	300V	1A	N/A	N/A	3 ms	Maximum power = 125VA.
7709	48	6 × 8 Matrix	Yes	Yes	D-sub	300V	1A	N/A	N/A	3 ms	Connects to internal DMM. Daisy chain multiple cards for up to a 6 × 40 matrix. Maximum power = 125VA.

* Can be disconnected from internal DMM for routing external signals

Connector Guide for Keithley 2750 Modules

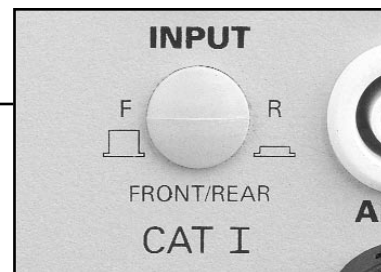
Module	Type of Connector	Included Accessories	Optional Accessories
7700	Oversize screw terminals	Strain relief	N/A
7701	50 pin female D-sub & 25 pin female D-sub	(1) 50 pin male IDC ribbon cable connector w/strain relief & (1) 25 pin male IDC ribbon cable connector w/strain relief	Keithley part number 7789 includes (1) 50 pin & (1) 25 pin male D-sub connectors with solder cup. Keithley part number 7790 includes IDC ribbon cable connector kit (ribbon cable not included).
7702	Oversize screw terminals	Strain relief	N/A
7703	Two 50 pin female D-sub	(2) 50 pin male D-sub connectors with solder cups. Cabling not included. Not compatible with IDC ribbon cable connectors.	Keithley part number 7788 includes 50 pin male connectors with solder cups.
7705	Two 50 pin female D-sub	(2) 50 pin male D-sub connectors with solder cups. Cabling not included. Not compatible with IDC ribbon cable connectors.	Keithley part number 7788 includes 50 pin male connectors with solder cups.
7706	Screw terminals	Strain relief	N/A
7707	50 pin male D-sub & 25 pin female D-sub	(1) 50 pin female IDC ribbon cable connector w/strain relief & (1) 25 pin male IDC ribbon cable connector w/strain relief	Keithley part number 7790 includes IDC Ribbon Cable Connector kit (ribbon cable not included).
7708	Oversize screw terminals	Strain relief	N/A
7709	50 pin female D-sub & 25 pin female D-sub	(1) 50 pin male IDC ribbon cable connector w/strain relief & (1) 25 pin male IDC ribbon cable connector w/strain relief	Keithley part number 7789 includes (1) 50 pin & (1) 25 pin male D-sub connectors with solder cup. Keithley part number 7790 includes IDC ribbon cable connector kit (ribbon cable not included).

Channel Configuration Capabilities

- **Measurement functions:** The 2750 can measure many different parameters: DC voltage, DC current, AC voltage, AC current, 2-wire Ω , 4-wire Ω , voltage clamped Ω , temperature (using thermocouples, RTDs, and thermistors), frequency, period, and continuity.
- **Math functions:** A variety of math functions are available at the push of a button, including channel average and ratio, $mX+b$ scaling, min, max, average and standard deviation. All are available on a per-channel basis.
- **Measurement setup:** Each channel can be configured independently for making measurements. Selectable channel parameters include:

• Speed	• Individual “m” and “b” values in $mX+b$ format	• CJC type
• Range	• Channel averaging	• Thermistor type
• Resolution	• Hi-Low limits	• Thermocouple type
• Number of power line cycles (NPLC)	• Resistance measurement method (2- or 4-wire)	• RTD type
• Math functions	• Offset compensation	• Voltage clamp ohms (dry circuit)
• Ratio calculation		

- **DUT- to-modules connections:** The 2750 makes it easy to connect the device under test to the switch/control modules. The 7703 and 7705 modules use dual 50-pin “D-sub” input connectors for secure, quick connections. These connectors are especially convenient for rapid system set-up. The 7701, 7707, and 7709 modules use “D-sub” connectors that are compatible with off-the-shelf standard ribbon cable. When greater connection flexibility is required, the 7700, 7702, and 7708 modules provide oversize screw-terminal connectors that simplify setup by eliminating the need to handle small connectors. The standard wires used are 20AWG.
- **Mainframe-to-modules connection:** Secure screws connect the modules to the mainframe. At power-up, the mainframe detects any attached modules automatically, which minimizes set-up time. All signals are routed internally from module to mainframe.
- **Front/rear switch:** The Model 2750’s front inputs are used for manual probing, troubleshooting, and calibration. A switch on the front panel makes it easy to shift between the front and rear inputs. This eases setting up the equipment and speeds verifying proper setup and connections prior to automating the measurement.



Scanning Capabilities

- **Relay Closure Counts:** Relay closure counts are logged in the 2750 every time a channel is closed. These counts are permanently written to the EEPROM on the module at a user-settable time interval (factory default of 10 minutes) or whenever the counts are queried. Valid intervals (set in integer number of minutes) are between 1 and 1440 minutes (24 hours). Relay closures are counted when a relay cycles from open to closed state.

Note: Any modules previously used in a 2700 and plugged into a 2750 will record relay closures only while in the 2750. No relay closures from the 2700 will be retrievable.

- **Open Sense Lead Indication.** The Model 2750 can alert the user if there is a sense lead disconnection on any channel. In this case, the front panel display will show “OVERFLOW.” Therefore, the Model 2750 does not need other equipment or calibration to inspect the broken connection or failed relay on the scanner card. In addition, the Model 2750 will protect against erroneously passed conditions.
- **Scan count:** The Model 2750 can be programmed to run a given number of scans up to 110,000 automatically and to record readings into the internal memory buffer. The instrument also allows programming the trigger source used to initiate each scan. (Refer to page 8 for more information on triggering.)

- **Scan interval:** The user can set the interval after which each succeeding scan will begin. Scan intervals can be set anywhere from 0 to 99 hours in increments of 1ms.
- **Scan sequence/omitting channels:** In addition to scanning in numerical sequence, the Model 2750 can be programmed to skip any channels that are not required for a particular test. This avoids recording irrelevant data and speeds the data acquisition process. This makes scanning both faster and more flexible.
- **Ratio (DCV only):** The instrument can calculate and display the ratio of measurements of paired channels. Ratios can only be determined for specific channel pairs, depending upon the input module used. For example, channel pairs on the Model 7702 include Channels 1 and 21, Channels 2 and 22, etc. Hi/Lo limits are fully supported.
- **Channel average (DCV and thermocouple only):** The instrument can calculate and display the average of two channel measurements. As with ratio calculations, only paired channels can be averaged. Hi/Lo limits are fully supported.

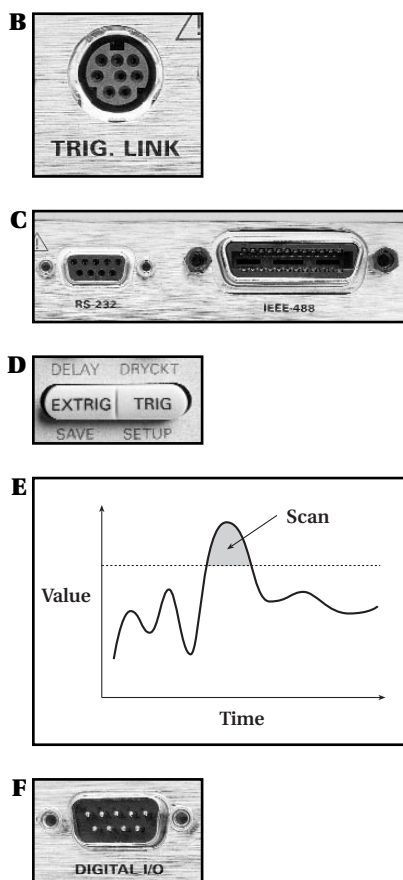
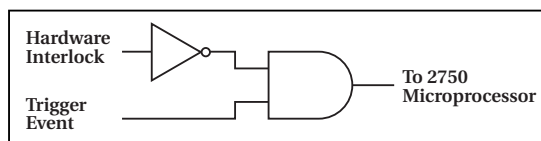
Triggering & I/O Capabilities

Trigger sources

Any of the following sources can be used for triggering a reading or scan sequence:

- A. Immediate:** The 2750 self-triggers automatically. This default method is the simplest way to take a measurement on a single channel.
- B. An external trigger** is received via the Trigger Link connector. Triggering through Trigger Link is very precise (0.5ms trigger latency) and provides tight timing control for synchronization in larger systems. Therefore, measurements can be taken at a precise time with very little uncertainty. This capability can be valuable when optimizing coordination with other system instruments, such as the Model 2400 SourceMeter® instrument in larger rack & stack applications.
- C. A bus trigger** is received (GET or *TRG) on GPIB or *TRG on RS-232.
- D. Manual:** Use of front panel TRIG key.
- E. Analog trigger:** A display reading on a particular channel can be programmed as an analog trigger. A scan sequence is started whenever such a reading is reached [programmed for either a greater than (>) or less than (<) condition as a trigger]. In other words, this feature can be used to initiate a scan sequence based on some external factor, such as a temperature, rising above a pre-set limit. After scanning all the configured channels on the instrument, the instrument then returns to the channel that acted as the analog trigger, and checks for the reading to be in conditional limits. Depending on the limits and current reading, the instrument decides whether to start the next scan. Only the data of interest are acquired, eliminating the need to spend hours searching through reams of normal readings to find anomalous data.
- F. Digital trigger:** Two digital inputs (TTL-level) are standard on the 2750 mainframe—one to serve as a trigger input and one to serve as a hardware interlock. The digital trigger is logical “and”-ed with the interlock. The interlock is default true. Therefore, the digital trigger input would be recognized for triggering only when the digital trigger and the interlock are both true. Thus, the interlock provides the user with a controlling mechanism for recognizing the digital trigger if necessary (see **Figure 3**).

Figure 3



Alarm Limits/Digital Outputs

The Model 2750's digital output lines can trigger external alarms without the need for a PC connection. The instrument can be programmed to provide alarms when any pre-set limits are breached. Limits can be applied to all measurement functions except continuity, which has its own alarm beeper. The limit test is performed after "mX + b" and math operations.

Limit types: Each channel has four independently programmable limits, each of which can be assigned a value. These are:

1. Limit1 High (for example, 1% higher than the expected reading)
2. Limit1 Low (for example, 1% less than the expected reading)
3. Limit2 High (for example, 5% higher than the expected reading)
4. Limit2 Low (for example, 5% less than the expected reading)

The outputs can be positive or negative true, pulse, or fixed level. Pulse widths are programmable.

Master Limit: In addition to these limit alarms, a master limit is provided. It is logically "or"-ed with the four limits and is active every time any of the other limits are breached.

Each of the alarm limits and the master alarm is mapped to a specific output pin on the 9-pin male connector that handles the output of that alarm limit.

Electrical Capabilities

- 250mA sink (output).
- TTL level outputs (no external supply is needed).
- Open collector output up to 33V with external supply.
- Ability to trigger or start a scan by connecting to one of the digital input lines.

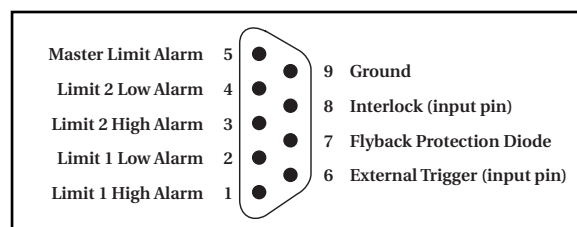


Figure 4. Structure of the 9-Pin Male Digital I/O Connector

On-board Data Storage

Buffer size and type: The 2750 has a 110,000-point non-volatile "read and transmit" memory (in other words, the buffer can be emptied while it is being filled.) The buffer can be configured in "wrap around" mode for recording readings continuously for long periods. There is no need to stop taking data, reset the instrument, or change memory cards. The wrap around memory can be configured to issue a Service Request (SRQ) at predetermined points in the scan. An SRQ can be issued when the buffer is one-quarter full, one-half full, three-quarters full, or completely full. The instrument can be commanded to download the readings without interfering with the current acquisition; therefore, data acquisition and retrieval can occur simultaneously. When the buffer is full, the instrument returns to the beginning of the buffer and starts writing in the locations emptied by the previous download.

Timestamp: The readings in the memory can be timestamped to trace the progress of a test. The time can be configured as either:

- Real time: The actual calendar day and time.
- Relative Time: Time is relative to the first reading stored in the buffer.

Saving/Recalling a Setup

All current set-up information for individual channels and the mainframe is battery backed and the measurement data is stored in the non-volatile memory. Therefore, while the instrument is switched off, the configuration for each channel is saved in the memory, then automatically recalled when the product is switched on again. Up to three different sets of setups can be recorded for each channel, so it's unnecessary to set up each channel before a different test.

Power Failure Recovery

All set-up information is battery backed and data is stored in non-volatile RAM, so the Model 2750 is immune to power failures and can resume scanning where it stopped once power is restored. There is no need to restart interrupted tests from the beginning. The scan resumption feature is user-selectable.

Channel Monitor

The channel monitor feature allows monitoring any specific input channel on the front panel display at any time during a scan. The Model 2750 can scan across channels very rapidly, so the channel monitor offers a convenient way to view only the channel of interest without interrupting a scan.

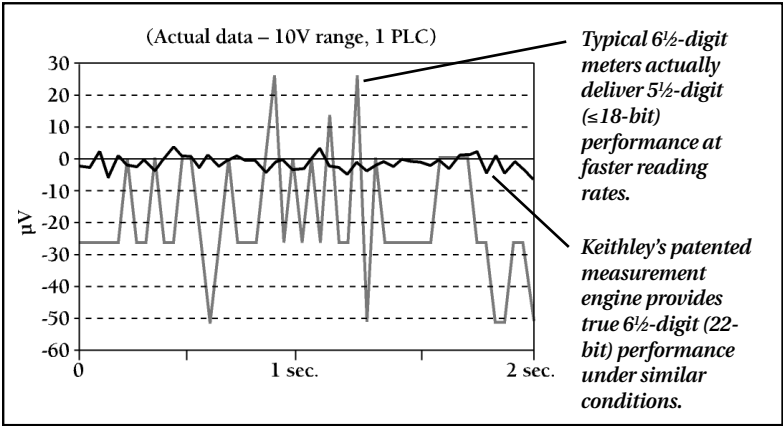


Figure 5. When the measurements matter, Keithley provides up to 10x better performance at equivalent reading rates or up to 10x faster speeds at equivalent measurement performance. Our patented A/D converter and high performance signal conditioning circuitry make this possible.

Specification Conversion Factors

Percent	PPM	Digits	Bits	dB	Portion of 10V
10%	100000	1	3.3	-20	1 V
1%	10000	2	6.6	-40	100 mV
0.1%	1000	3	10	-60	10 mV
0.01%	100	4	13.3	-80	1 mV
0.001%	10	5	16.6	-100	100 µV
0.0001%	1	6	19.9	-120	10 µV
0.00001%	0.1	7	23.3	-140	1 µV
0.000001%	0.01	8	26.6	-160	100 nV
0.0000001%	0.001	9	29.9	-180	10 nV

Model 2750 Performance
(6 1/2-digit, 22-bit)

Measurement Performance

The Model 2750 is a true 6 1/2-digit (22-bit) instrument designed for high measurement precision. Its high precision enhances measurement repeatability and stability.

Measurement performance is a key advantage of all of Keithley's products. The Model 2750 is based on a number of advanced technologies that improve its overall performance dramatically, including:

- Patented A/D converter IC circuitry design to increase the resolution, precision, and speed of measurement.
- Advanced signal conditioning hardware to filter out unwanted noise and provide necessary isolation.
- A unique "servo" front end design (Figure 6). While conventional DMMs typically measure and correct for the zero drift of front-end circuitry, the Model 2750's servo front end eliminates zero drift, which also eliminates the wasted measurement time usually required to check zero, further increasing measurement speed.

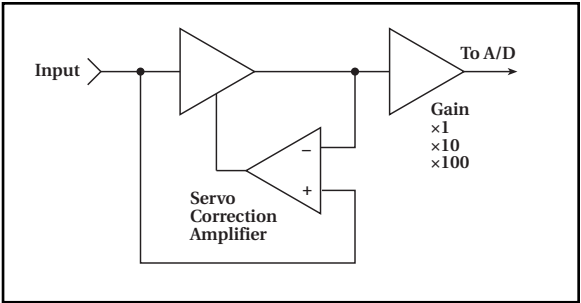


Figure 6.

Filtering

For each major measurement function, users can employ either averaging or advanced digital filtering to reduce noise and increase the effective resolution.

Averaging Filter

The averaging filter operates over a range of from 2 to 100 readings. All readings included in the filter range are weighted equally. A step input of any size will ramp up linearly to the final value after obtaining the number of readings specified by the user. The averaging filter may be configured as either a moving averaging or as a repeat filter. Operation over the GPIB bus is often done in “repeat” mode to ensure that all readings are fully filtered. Also, taking filtered measurements in repeat mode requires only one trigger, simplifying programming. Only the repeat filter can be used while scanning.

Advanced Filter

When a DMM is used in bench mode, it's often desirable for it to respond immediately upon connection to a test point, without the slow response associated with an averaging filter. The Model 2750's advanced filter addresses this need by providing a filter reset level. If the measured value deviates significantly from previous values, the filter is reset to the new value, and filtering is restarted. In this way, the user can set the filter reset level just above the maximum noise level anticipated and the multimeter will respond to new values immediately.

NPLC

Selectable power line cycle integration allows the user to specify the number of power line cycles (NPLC) over which to integrate (1, 5, 10, etc.). Use of line cycle integration provides rejection of noise from line cycle interference, the most common source of noisy readings. In general, the longer the integration time chosen, the greater the noise rejection will be. The 2750 can also be set to less than 1 NPLC integration time, as fast as 0.01NPLC ($\approx 167\mu\text{s}$) for faster data measurement (but without power line noise rejection).

Line Cycle Synchronization

To attain the highest possible line cycle noise rejection, it is important to trigger the reading at the beginning of a power line cycle. The Model 2750 can be set to start a measurement precisely when the power line signal crosses zero (see **Figure 7**). This function increases the normal mode noise rejection 30dB, providing an additional $\times 30$ reduction in noise due to line cycle interference.

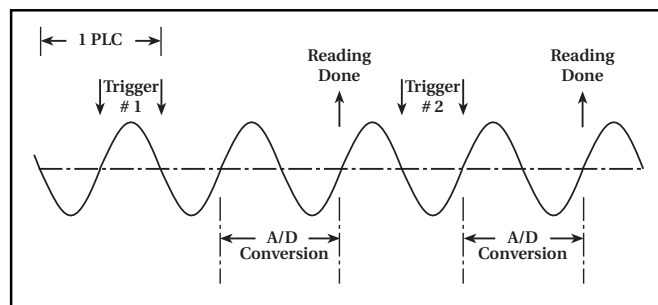


Figure 7

Autozero

Internal autozeroing is used to maintain the best measurement performance. The Model 2750's advanced firmware design does the required calculation automatically in the background. This enables the 2750 to provide faster reading rates (competitive products spend half their measurement time validating their own zero). Autozero can be disabled to increase measurement speed, but this may result in greater measurement uncertainty.

Low Ohms Measurement

The Model 2750 can measure low ohms on all of its switch/control modules that have multiplexers or matrix configurations. The 4-wire ohms measurement supports low ohms measurements down to the 1Ω range, with micro-ohm resolution. Measurements can be accommodated through ribbon cable or discrete wiring. On 4-wire ohms measurements, up to five additional ohms of cable/switch card resistance can be tolerated per cable lead. This allows the use of ribbon cable without overloading the range.

Offset Compensation

For more accurate low resistance measurements, the Model 2750 provides the offset compensation mode to eliminate errors from the thermoelectric EMF effects (V_{EMF}). During the measurement cycle, the built-in ohms current source is turned off, then turned on again, and the resulting EMF error is automatically subtracted. This technique is typically used when measuring values less than 100Ω using the 4-wire ohms method.

Voltage Limit/Dry Circuit Ohms (DRYCKT)

The use of dry circuit mode on the 2750, when selected, limits the open-circuit voltage to 20mV. This allows resistance measurements to be made with low power. When measuring contact and connector resistances, it is important not to puncture oxides and films that may have formed. Standard resistance measurements have open-circuit voltage levels from 5.4V to 12.8V, depending on the selected range.

Dry circuit ohms can be used on the 1Ω, 10Ω, 100Ω, and 1kΩ ranges for the four-wire ohms (Ω4) function. Also, offset compensated ohms (OCOMP) can be used with dry circuit ohms to cancel the effect of thermoelectric EMFs.

Dry circuit ohms should be used for any device that could be damaged by high open-circuit voltage. If not sure, and the slightly degraded accuracy is not a consideration, it is good practice to use dry circuit ohms to measure low resistance.

The accuracy specifications for all dry circuit ohms ranges are with offset compensated ohms and line synchronization enabled.

Temperature Measurements

The Model 2750 supports three major types of temperature sensors with built-in signal conditioning and linearization: thermocouples, RTDs, and thermistors.

	Thermocouples	RTDs	Thermistors
Temperature Range	–200 ~ 1820°C	–200 ~ 630°C	–80 ~ 150°C
Advantage	<ul style="list-style-type: none">• Self-powered• Wide temperature range	<ul style="list-style-type: none">• High stability• High accuracy• No CJC required	<ul style="list-style-type: none">• Interchangeability• No CJC required• High accuracy over limited temperature range
Cost	Low	High	Medium

The 2750 has built-in algorithms for a variety of thermocouples, RTDs, and thermistors. To begin using a sensor, simply hook it up and the 2750 does the rest.

- Thermocouples: Type J, K, N, T, E, R, S, B
- RTDs: D100, F100, PT100, PT385, PT3916, or user type
- Thermistors: 2250Ω, 5K, and 10K

Cold Junction Compensation Methods

Thermocouple measurements always require that the temperature be known at the point where the thermocouple is connected to the instrument. This connection point is known as the “cold-junction.” The Model 2750 supports three different methods for including this “cold-junction” temperature in the temperature measurements.

Automatic CJC

The CJC sensors are mounted on the multiplexer module's PC board (7700, 7706, and 7708). They sense the actual temperature across the module's connector, then compensate all temperature measurements accordingly. The CJC scaling is done automatically (in the background, like an autozero) so the user does not have to acquire it separately.

External CJC

A thermistor or RTD is attached to Channel 1 by the end user. This thermistor or RTD is then used to measure the temperature of the point(s) where the thermocouples are connected to the instrument or to copper wires leading to the instrument. The precision of the actual temperature measurement depends on the accuracy of the cold junction reading and how close the sensor is to the actual temperature of the connection.

Simulated CJC

When the “change” in temperature is of interest rather than the absolute temperature value, the user can enter a parameter as a cold junction reference point (for example, 23°C for room temperature). This parameter will be used to adjust the actual temperature measurement for each channel. This simulated temperature must be updated manually if ambient conditions change. This is also the method used when an actual ice bath is used to establish a cold junction of 0°C. The simulated parameter is then set to 0°C or 32°F.

Open Thermocouple Detect

The Model 2750 can alert the user if any thermocouple becomes broken or otherwise disconnected from the input terminal blocks. When the Open T/C Detect feature is enabled, the Model 2750 will perform (in the background) a 2-wire resistance measurement across each thermocouple input channel. If an open connection is detected, the front panel display will show “OVERFLOW” for that channel.

Calibration

The design of the Model 2750 and its calibration procedure were developed to address a variety of critical calibration issues. For example, the 2750 has front panel input jacks, so there's no need to disassemble the system for periodic recalibrations. There's also no need to buy, stock, and track spare “cal only” modules. The 2750 is connected to the calibrator through the front panel input jacks. The Model 2750's calibration procedure covers both verification and adjustment and can be performed through either the front panel or GPIB. The calibration interval is user-selectable.

Model 2750 Specifications



Specifications are subject to change without notice.

Download the latest specs from www.keithley.com.

MODEL 2750 MULTIMETER/SWITCH SYSTEM

MODEL 2750 SPECIFICATIONS

DC CHARACTERISTICS¹

CONDITIONS: MED (1 PLC)² or 10 PLC or MED (1 PLC) with Digital Filter of 10

FUNCTION	RANGE	RESOLUTION	TEST CURRENT ±5% OR BURDEN VOLTAGE	INPUT RESISTANCE OR OPEN CKT. VOLTAGE ³	ACCURACY: ±(ppm of reading + ppm of range) (ppm = parts per million) (e.g., 10ppm = 0.001%)			TEMPERATURE COEFFICIENT 0°–18°C & 28°–50°C
					24 Hour ⁴ 23°C±1°	90 Day 23°C±5°	1 Year 23°C±5°	
Voltage ¹¹	100.0000 mV	0.1 µV		>10 GΩ	15 + 30	25 + 35	30 + 35	(1 + 5)/°C
	1.000000 V	1.0 µV		>10 GΩ	15 + 6	25 + 7	30 + 7	(1 + 1)/°C
	10.00000 V	10 µV		>10 GΩ	10 + 4	20 + 5	30 + 5	(1 + 1)/°C
	100.0000 V	100 µV		10 MΩ ± 1%	15 + 6	35 + 9	45 + 9	(5 + 1)/°C
	1000.000 V ⁵	1 mV		10 MΩ ± 1%	20 + 6	35 + 9	50 + 9	(5 + 1)/°C
Resistance ^{6,8}	1.000000 Ω	1 µΩ	10 mA	5.9 V	25 + 80	80 + 80	100 + 80	(8 + 1)/°C
	10.00000 Ω	10 µΩ	10 mA	5.9 V	20 + 20	80 + 20	100 + 20	(8 + 1)/°C
	100.0000 Ω	100 µΩ	1 mA	12.2 V	20 + 20	80 + 20	100 + 20	(8 + 1)/°C
	1.000000 kΩ	1 mΩ	1 mA	12.2 V	20 + 6	80 + 6	100 + 6	(8 + 1)/°C
	10.00000 kΩ	10 mΩ	100 µA	6.8 V	20 + 6	80 + 6	100 + 6	(8 + 1)/°C
	100.0000 kΩ	100 mΩ	10 µA	12.8 V	20 + 6	80 + 10	100 + 10	(8 + 1)/°C
	1.000000 MΩ ²³	1.0 Ω	10 µA	12.8 V	20 + 6	80 + 10	100 + 10	(8 + 1)/°C
	10.00000 MΩ ^{7,23}	10 Ω	0.7 µA // 10M Ω	7.0 V	150 + 6	200 + 10	400 + 10	(35 + 1)/°C
	100.0000 MΩ ^{7,23}	100 Ω	0.7 µA // 10M Ω	7.0 V	800 + 30	2000 + 30	2000 + 30	(200 + 1)/°C
Dry Circuit Resistance ²¹	1.000000 Ω	1 µΩ	10 mA	20mV	80 + 40	80 + 40	100 + 40	(8 + 1)/°C
	10.00000 Ω	10 µΩ	1 mA	20mV	25 + 40	80 + 40	100 + 40	(8 + 1)/°C
	100.0000 Ω	100 µΩ	100 µA	20mV	25 + 40	90 + 40	140 + 40	(8 + 1)/°C
	1.000000 kΩ	1 mΩ	10 µA	20mV	25 + 90	180 + 90	400 + 90	(8 + 1)/°C
Continuity (2W)	1.000 kΩ	100 mΩ	1 mA	12.2 V	40 + 100	100 + 100	100 + 100	(8 + 1)/°C
Current	20.00000 mA	10 nA	< 0.2 V		60 + 15	300 + 40	500 + 40	(50 + 5)/°C
	100.0000 mA	100 nA	< 0.1 V		100 + 150	300 + 400	500 + 400	(50 + 50)/°C
	1.000000 A	1.0 µA	< 0.3 V ⁹		200 + 15	500 + 40	800 + 40	(50 + 5)/°C
	3.000000 A	10 µA	< 1.0 V ⁹		1000 + 15	1200 + 40	1200 + 40	(50 + 5)/°C

Channel (Ratio)¹⁰ Ratio Accuracy = Accuracy of selected Channel Range + Accuracy of Paired Channel Range

Channel (Average)¹⁰ Average Accuracy = Accuracy of selected Channel Range + Accuracy of Paired Channel Range

TEMPERATURE¹⁹

(Displayed in °C, °F, or K. Exclusive of probe errors.)

Thermocouples (Accuracy based on ITS-90.)

Type	Range	Resolution	90 Day/1 Year (23°C ± 5°C)			Temperature Coefficient 0°–18°C & 28°–50°C
			Relative to Simulated Reference Junction	Using CJC from Plug-In Module		
J	–200 to +760 °C	0.001°C	0.2°C	1.0°C		0.03°C/°C
K	–200 to +1372°C	0.001°C	0.2°C	1.0°C		0.03°C/°C
N	–200 to +1300°C	0.001°C	0.2°C	1.0°C		0.03°C/°C
T	–200 to +400°C	0.001°C	0.2°C	1.0°C		0.03°C/°C
E	–200 to +1000°C	0.001°C	0.2°C	1.0°C		0.03°C/°C
R	0 to +1768°C	0.1 °C	0.6°C	1.8°C		0.03°C/°C
S	0 to +1768°C	0.1 °C	0.6°C	1.8°C		0.03°C/°C
B	+350 to +1820°C	0.1 °C	0.6°C	1.8°C		0.03°C/°C

4-Wire RTD:

(100Ω platinum [PT100], D100, F100, PT385, PT3916, or user type. Offset compensation On)

–200° to	630°C	0.01 °C	0.06°C	0.003°C/°C
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Thermistor: (2.2kΩ, 5kΩ, and 10kΩ)²⁰

–80° to	150°C	0.01 °C	0.08°C	0.002°C/°C
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DC SYSTEM SPEEDS^{15,18}

RANGE CHANGES¹⁶: 50/s (42/s).

FUNCTION CHANGES¹⁶: 50/s (42/s).

AUTORANGE TIME¹⁶: <30ms.

ASCII READINGS TO RS-232 (19.2k BAUD): 55/s.

MAX. INTERNAL TRIGGER RATE: 2000/s.

MAX. EXTERNAL TRIGGER RATE: 375/s.

DC MEASUREMENT SPEEDS¹⁵

Single Channel, 60Hz (50Hz) Operation

FUNCTION	DIGITS	READINGS/s	PLCs
DCV, DCI, Ω (<10M), Thermocouple, Thermistor	6.5 ^{12,16}	5 (4)	10
	6.5 ¹⁶	35 (28)	1
	6.5 ^{12,16}	45 (36)	1
	5.5 ^{12,16}	150 (120)	0.1
	5.5 ^{16,17}	300 (240)	0.1
4WΩ (<10M)	5.5 ¹⁷	500 (400)	0.1
	4.5 ¹⁷	2500 (2000)	0.01
	6.5 ¹⁶	1.4 (1.1)	10
4WΩ OComp, RTD ²²	6.5 ¹⁶	15 (12)	1
	5.5 ¹⁷	33 (25)	0.1
	6.5 ¹⁶	0.9 (0.7)	10
Channel (Ratio), Channel (AVG)	6.5 ¹⁶	8 (6.4)	1
	5.5 ^{16,17}	18 (14.4)	0.1
	6.5 ¹⁶	2.5 (2)	10
	6.5 ¹⁶	15 (12)	1
	5.5 ¹⁷	25 (20)	0.1

Multiple Channels, Into and Out of Memory to GPIB^{15,18}

	Channels/s
7703 Scanning DCV	200/s
7703 Scanning DCV with Limits or Time Stamp On	180/s
7703 Scanning DCV alternating 2W	70/s
7702 Scanning DCV	65/s
7700, 7706, and 7708 Scanning Temperature (T/C)	50/s

MODEL 2750 SPECIFICATIONS

DC SPEED vs. NOISE REJECTION

Rate	Filter	Readings/s ¹²	Digits	RMS Noise		
				10V Range	NMRR	CMRR ¹⁴
10	50	0.1 (0.08)	6.5	< 1.2 μ V	110 dB ¹³	140 dB
1	Off	15 (12)	6.5	< 4 μ V	90 dB ¹³	140 dB
0.1	Off	500 (400)	5.5	< 22 μ V	—	80 dB
0.01	Off	2500 (2000)	4.5	< 150 μ V	—	80 dB

DC MEASUREMENT CHARACTERISTICS

DC Volts

A-D LINEARITY: 2.0 ppm of reading + 1.0 ppm of range.

INPUT IMPEDANCE:

100mV–10V Ranges: Selectable >10G Ω // with <400pF or 10M Ω \pm 1%.

100V, 1000V Ranges: 10M Ω \pm 1%.

Dry Circuit: 100k Ω \pm 1% // <1 μ F

INPUT BIAS CURRENT: <75pA at 23°C.

COMMON MODE CURRENT: <500nApp at 50Hz or 60Hz.

AUTOZERO ERROR: Add \pm (2ppm of range error + 5 μ V) for < 10 minutes and \pm 1°C.

INPUT PROTECTION: 1000V, all ranges. 300V with plug in modules.

Resistance

MAX 4W Ω LEAD RESISTANCE: 80% of range per lead (Dry Ckt mode). 5 Ω per lead for 1 Ω range; 10% of range per lead for 10 Ω , 100 Ω , and 1k Ω ranges; 1k Ω per lead for all other ranges.

OFFSET COMPENSATION: Selectable on 4W Ω , 1 Ω , 10 Ω , 100 Ω , 1k Ω , and 10k Ω ranges.

CONTINUITY THRESHOLD: Adjustable 1 to 1000 Ω

INPUT PROTECTION: 1000V, all Source Inputs, 350V Sense Inputs. 300V with plug-in modules.

DC Current

SHUNT RESISTORS: 100mA–3A, 0.1 Ω , 20mA, 5 Ω .

INPUT PROTECTION: 3A, 250V fuse.

Thermocouples

CONVERSION: ITS-90.

REFERENCE JUNCTION: Internal, External, or Simulated (Fixed).

OPEN CIRCUIT CHECK: Selectable per channel. Open >12k Ω .

EARTH ISOLATION: 500V peak, >10G Ω and <300pF any terminal to chassis.

DC Notes

- 20% overrange except on 1000V and 3A.
- Add the following to "ppm of range" uncertainty; 100mV 15ppm; 1V and 100V 2ppm; Dry Circuit Ω 40ppm; <1M Ω 2ppm, 20mA and 1A 10ppm, 100mA 40ppm.
- \pm 2% (measured with 10M Ω input resistance DMM, >10G Ω DMM on 10M Ω and 100M Ω ranges).
- Relative to calibration accuracy.
- For signal levels >500V, add 0.02ppm/V uncertainty for portion exceeding 500V.
- Specifications are for 4-wire Ω , 1 Ω , 10 Ω , and 100 Ω with offset compensation on. With offset compensation on, OPEN CKT. VOLTAGE is 12.8V. For 2-wire Ω add 1 Ω additional uncertainty. 1 Ω range is 4-wire only.
- Must have 10% matching of lead resistance in Input HI and LO.
- Add the following to "ppm of reading" uncertainty when using plug in modules:

	10 k Ω	100 k Ω	1 M Ω	10 M Ω	100 M Ω
All Modules:				220 ppm	2200 ppm
7701, 7703, 7707, 7709 Modules:	10 ppm	100 ppm	1000 ppm	1%	10%
7706, 7708 Modules:	5 ppm	50 ppm	500 ppm	5000 ppm	5%

- Add 1.5V when used with plug in modules.
- For RATIO, DCV only. For AVERAGE, DCV and Thermocouples only. Available with plug in modules only.
- Add 6 μ V to "of range" uncertainty when using Models 7701, 7703, and 7707, and 3 μ V for Models 7706 and 7709.
- Auto zero off.
- For LSYNC On, line frequency \pm 0.1 %. For LSYNC Off, use 60dB for \geq 1PLC.
- For 1k Ω unbalance in LO lead. AC CMRR is 70dB.
- Speeds are for 60Hz (50Hz) operation using factory defaults operating conditions (*RST). Autorange off, Display off, Limits off, Trigger delay = 0.
- Speeds include measurements and binary data transfer out the GPIB (reading element only).
- Sample count = 1024, auto zero off.
- Auto zero off, NPLC = 0.01.
- Additional Uncertainty

Type	Range	Plug-In Modules			
		7709 Simulated Ref. Junction	7701, 7703, 7707 Simulated Ref. Junction	7700, 7708 Using CJC	7706 Using CJC
J	–200 to 0°C	0.1	0.3	0.8	1.6
K	–200 to 0°C	0.2	0.4	0.8	1.6
N	–200 to 0°C	0.3	0.6	0.8	1.6
T	–200 to 0°C	0.1	0.3	0.8	1.6
E	–200 to 0°C	0.1	0.2	0.8	1.6
R	0 to +400°C	0.6	1.1	0.5	1.0
S	0 to +400°C	0.6	1.2	0.5	1.0
B	+350 to +1100°C	0.3	0.5	0.5	1.0

- For lead resistance >0 Ω , add the following uncertainty/ Ω for measurement temperatures of:

	70°–100°C	100°–150°C
2.2 k Ω (44004)	0.22°C	1.11°C
5.0 k Ω (44007)	0.10°C	0.46°C
10 k Ω (44006)	0.04°C	0.19°C

- For 4-wire Ω only, offset compensation on, LSYNC on.
- For Dry Circuit 1k Ω range, 2 readings/s max.
- For Front Inputs, operating environment specified for 0°C to 50°C and 50% RH at 35°C.

AC SPECIFICATIONS¹

					Accuracy: \pm (% of reading + % of range), 23°C \pm 5°C				
Function	Range	Resolution	Calibration Cycle		3 Hz–10 Hz	10 Hz–20 kHz	20 kHz–50 kHz	50 kHz–100 kHz	100 kHz–300 kHz
Voltage ²	100.0000 mV	0.1 μ V	90 Days		0.35 + 0.03	0.05 + 0.03	0.11 + 0.05	0.6 + 0.08	4.0 + 0.5
	1.000000 V	1.0 μ V							
	10.00000 V	10 μ V	1 Year		0.35 + 0.03	0.06 + 0.03	0.12 + 0.05	0.6 + 0.08	4.0 + 0.5
	100.0000 V	100 μ V							
	750.000 V	1.0 μ V							
(Temp. Coeff.)/°C ³					0.035 + .003	0.005 + .003	0.006 + .005	0.01 + .006	0.03 + .01
Current ²	1.000000 A	1.0 μ A	90 Day/1 Yr.		3 Hz–10 Hz	10 Hz–5 kHz			
	3.00000 A ¹⁴	10 μ A			0.30 + 0.04	0.10 + 0.04			
					0.35 + 0.06	0.15 + 0.06			
	(Temp. Coeff.)/°C ³				0.035 + 0.006	0.015 + 0.006			
Frequency ⁴ and Period	100 mV	0.333 ppm	90 Day/1 Yr.		(3 Hz–500 kHz) (333 ms–2 μ s)				
	to	3.33 ppm			100 ppm + 0.333 ppm (SLOW, 1s gate)				
	750 V	33.3 ppm			100 ppm + 3.33 ppm (MED, 100ms gate)				

MODEL 2750 SPECIFICATIONS

Additional Uncertainty ±(% of reading)

Low Frequency Uncertainty	MED	FAST
20 Hz - 30 Hz	0.3	—
30 Hz - 50 Hz	0	—
50 Hz - 100 Hz	0	1.0
100 Hz - 200 Hz	0	0.18
200 Hz - 300 Hz	0	0.10
>300 Hz	0	0

CREST FACTOR: ⁵	1 - 2	2 - 3	3 - 4	4 - 5
Additional Uncertainty:	0.05	0.15	0.30	0.40
Max. Fundamental Freq.:	50kHz	50kHz	3kHz	1kHz

AC MEASUREMENT CHARACTERISTICS

AC Volts

MEASUREMENT METHOD: AC-coupled, True RMS.

INPUT IMPEDANCE: 1MΩ ±2% // by <100pF.

INPUT PROTECTION: 1000Vp or 400VDC. 300Vrms with plug in modules.

AC Current

MEASUREMENT METHOD: AC-coupled, True RMS.

SHUNT RESISTANCE: 0.1Ω.

BURDEN VOLTAGE: 1A <0.3Vrms, 3A <1.5Vrms. Add 1Vrms when used with plug in modules.

INPUT PROTECTION: 3A, 250V fuse.

Frequency and Period

MEASUREMENT METHOD: Reciprocal Counting technique.

GATE TIME: SLOW 1s, MED 100ms, and FAST 10ms.

AC General

AC CMRR: 70dB.

MAXIMUM CREST FACTOR: 5 at full-scale.

VOLT HERTZ PRODUCT: ≤ 8 × 10⁷.

AC MEASUREMENT SPEEDS⁷

Single Channel, 60Hz (50Hz) Operation

Function	Digits	Readings/s	Rate	Bandwidth
ACV, ACI	6.5 ⁸	2s/Reading	SLOW	3 Hz–300 kHz
	6.5 ⁸	1.4 (1.1)	MED	30 Hz–300 kHz
	6.5 ⁹	4.8 (4)	MED	30 Hz–300 kHz
	6.5 ⁹	35 (28)	FAST	300 Hz–300 kHz
Frequency, Period	6.5	1 (1)	SLOW	3 Hz–300 kHz
	5.5	9 (9)	MED	30 Hz–300 kHz
	4.5	35 (35)	FAST	300 Hz–300 kHz
	4.5 ¹⁰	65 (65)	FAST	300 Hz–300 kHz

Multiple Channel

7703 SCANNING ACV^{10,13}: 180/s.

AC SYSTEM SPEEDS^{7,11}

RANGE CHANGES¹²: 4/s (3/s).

FUNCTION CHANGES¹²: 4/s (3/s).

AUTORANGE TIME: < 3s.

ASCII READINGS TO RS-232 (19.2k baud): 50/s.

MAX. INTERNAL TRIGGER RATE: 300/s.

MAX. EXTERNAL TRIGGER RATE: 250/s.

AC Notes

- 20 % overrange except on 750V and 3A.
- Specification are for SLOW mode and sine wave inputs >5% of range. SLOW and MED are multi-sample A/D conversions. FAST is DETector:BANDwidth 300 with nPLC = 1.0.
- Applies to 0°–18°C and 28°–50°C.
- For square wave inputs >10% of ACV range, except 100mV range. 100mV range frequency must be >10Hz if input is <20mV.
- Applies to non-sine waves >5Hz.
- For 1kΩ unbalance in LO lead.
- Speeds are for 60Hz (50Hz) operation using factory defaults operating conditions (*RST). Autorange off, Display off, Limits off, Trigger delay=0. Includes measurement and binary data transfer out GPIB (Reading Element only).
- 0.01 % of step settling error. Trigger delay = 400ms.
- Trigger delay = 0.
- Sample count = 1024.
- DETector:BANDwidth 300 with nPLC = 0.01.
- Maximum useful limit with trigger delay = 175ms.
- For Auto Delay On = 1.8/s.
- For signal levels >2.2A, add additional 0.4% to "of reading" uncertainty.

GENERAL SPECIFICATIONS:

EXPANSION SLOTS: 5.

POWER SUPPLY: 100V / 120V / 220V / 240V ±10%.

LINE FREQUENCY: 45Hz to 66Hz and 360Hz to 440Hz, automatically sensed at power-up.

POWER CONSUMPTION: 35VA.

OPERATING ENVIRONMENT: Specified for 0°C to 50°C. Specified to 80% RH at 35°C.

STORAGE ENVIRONMENT: –40°C to 70°C.

BATTERY: Lithium battery-backed memory, 3 years @ 23°C.

WARRANTY: 3 years.

EMC: Conforms to European Union Directive 89/336/EEC EN61326-1.

SAFETY: Conforms to European Union Directive 73/23/EEC EN61010-1, CAT I.

VIBRATION: MIL-PRF-28800F Class 3, Random.

WARM-UP: 2 hours to rated accuracy.

DIMENSIONS:

Rack Mounting: 89mm high × 485mm wide × 370mm deep (3.5 in × 19 in × 14.563 in).

Bench Configuration (with handle and feet): 104mm high × 485mm wide × 370mm deep (4.125 in × 19 in × 14.563 in).

SHIPPING WEIGHT: 13kg (28 lbs.).

DIGITAL I/O: 2 inputs, 1 for triggering and 1 for hardware interlock. 5 outputs, 4 for Reading Limits and 1 for Master Limit. Outputs are TTL compatible or can sink 250mA, diode clamped to 40V.

TRIGGERING AND MEMORY:

Window Filter Sensitivity: 0.01%, 0.1 %, 1%, 10%, or Full-scale of range (none).

Reading Hold Sensitivity: 0.01%, 0.1 %, 1%, or 10% of reading.

Trigger Delay: 0 to 99 hrs (1ms step size).

External Trigger Delay: <1ms.

External Trigger Jitter: <500μs.

Memory Size: 110,000 readings.

MATH FUNCTIONS: Rel, Min/Max/Average/Std Dev/Peak-to-Peak (of stored reading), Limit Test, %, 1/x, and mX + b with user defined units displayed.

REMOTE INTERFACE:

GPIB (IEEE-488.2) and RS-232C.

SCPI (Standard Commands for Programmable Instruments)

LabVIEW Drivers

ACCESSORIES SUPPLIED: Model 1751 Safety Test Leads, User Manual, Service Manual.

Specifications are subject to change without notice.

SWITCH/CONTROL MODULE SPECIFICATIONS

7700

7700 20-Channel Differential Multiplexer w/Automatic CJC**Features**

- 20 channels for general-purpose measurements, plus two channels to measure current.
- 2- or 4-wire measurement.
- Oversize screw terminal connection blocks are standard for easier connections.
- Automatic CJC sensors on the scanner card mean there are no other accessories are required to make thermocouple temperature measurements.
- Configurable as two independent banks of multiplexers.
- 300V, 1A capacity for voltage channels; 60W, 125VA.
- 3A capacity for current channels.
- Relay closures stored in on-board memory.

GENERAL

20 CHANNELS: 20 channels of 2-pole relay input. All channels configurable to 4-pole.

2 CHANNELS: 2 channels of current only input.

RELAY TYPE: Latching electromechanical.

ACTUATION TIME: <3ms.

CAPABILITIES

CHANNELS 1-20: Multiplex one of 20 2-pole or one of 10 4-pole signals into DMM.

CHANNELS 21-22: Multiplex one of 2 2-pole current signals into DMM.

INPUTS**MAXIMUM SIGNAL LEVEL:**

Channels (1-20): 300V DC or rms, 1A switched, 60W, 125VA maximum.

Channels (21-22): 60V DC or 30V rms, 3A switched, 60W, 125VA maximum.

CONTACT LIFE (typ): >10⁵ operations at max signal level.
>10⁸ operations cold switching.

CONTACT RESISTANCE: <1Ω at end of contact life.

CONTACT POTENTIAL: <±500nV typical per contact, 1μV max.
<±500nV typical per contact pair, 1μV max.

OFFSET CURRENT: <100pA.

CONNECTOR TYPE: Screw terminal, #20 AWG wire size.

ISOLATION BETWEEN ANY TWO TERMINALS: >10¹⁰Ω, <100pF.

ISOLATION BETWEEN ANY TERMINAL AND EARTH: >10⁹Ω, <200pF.

CROSS TALK (10MHz, 50Ω Load): <-40dB.

INSERTION LOSS (50Ω Source, 50Ω Load): <0.1dB below 1MHz.
<3dB below 2MHz.

COMMON MODE VOLTAGE: 300V between any terminal and chassis.

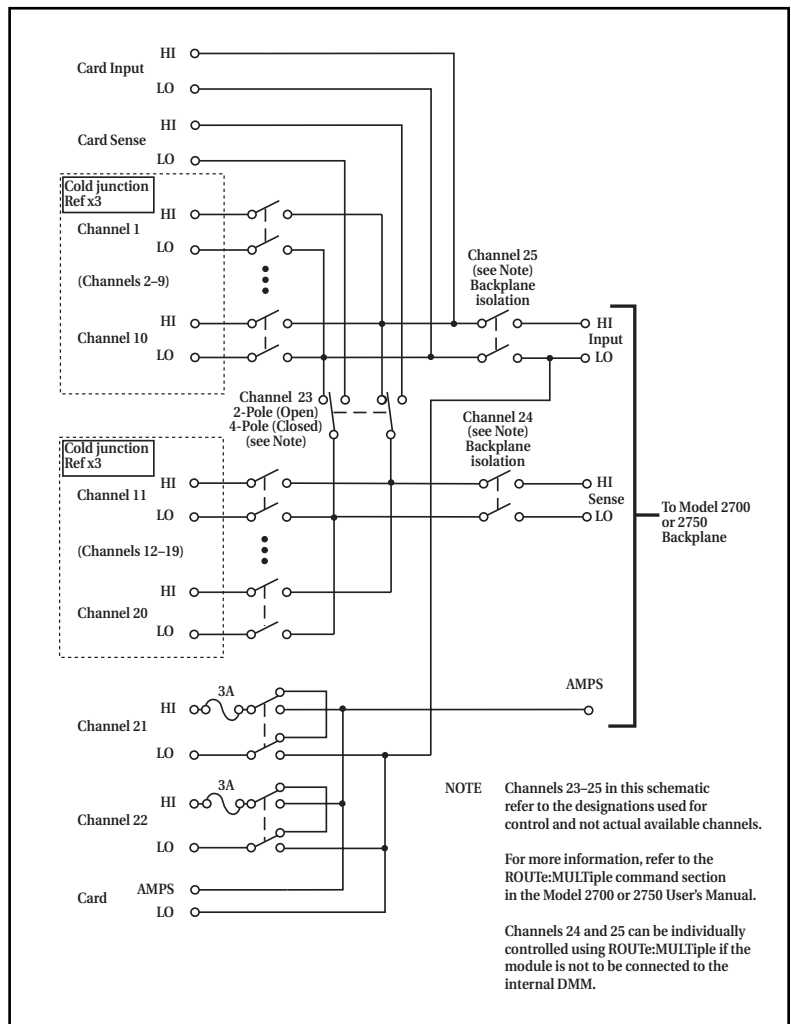
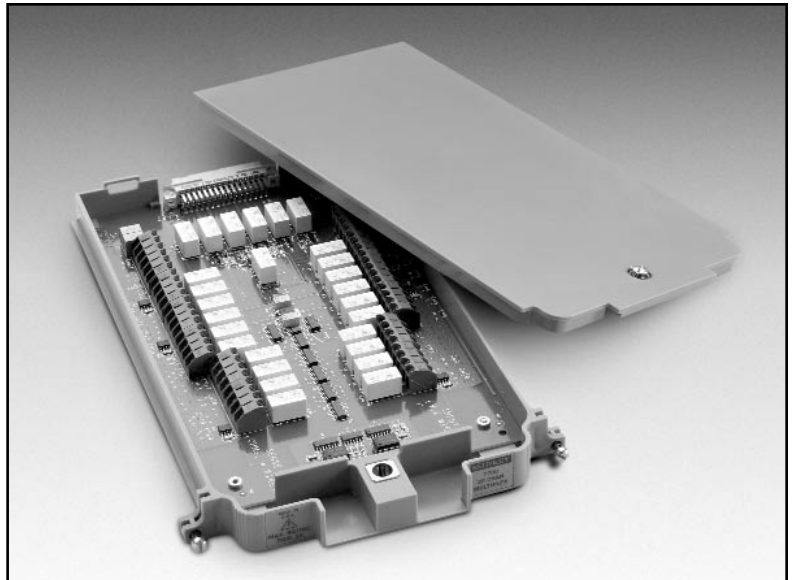
T/C COLD JUNCTION: 1.0°C (18°-28°C Mainframe Temp)
1.5°C (0°-18°C & 28°-50°C Mainframe Temp).

ENVIRONMENTAL:

OPERATING ENVIRONMENT: Specified for 0°C to 50°C.
Specified to 80% R.H. at 35°C.

STORAGE ENVIRONMENT: -25°C to 65°C.

WEIGHT: 0.45kg (1 lb).



SWITCH/CONTROL MODULE SPECIFICATIONS

7701

7701 Low-Voltage 32-Channel Differential Multiplexer

Features

- Configurable for 32 channels of differential measurements, with up to 16 channels of 4-pole measurements.
- Configurable for 32 channels of common-side 4-wire ohms.
- Configurable as two independent banks of multiplexers.
- Two female D-shell connectors are standard for secure hook-up and quick teardown.
- 150V, 1A capacity for voltage channels; 60W, 125VA.
- Two mating IDC connectors for ribbon cable (Model 7790) are supplied.
- Relay closures stored in on-board memory.
- Screw terminal jumpers allow user-configurable DMM connections.

GENERAL

32 CHANNELS: 32 channels of 2-pole relay input. All channels configurable to 4-pole.

RELAY TYPE: Latching electromechanical.

ACTUATION TIME: <3ms.

FIRMWARE: Specified for Model 2700 rev. B03 and Model 2750 rev. A01.

DMM CONNECTIONS: Screw terminals provide internal DMM connections to channels 34 and 35 and connections to external wiring access.

CAPABILITIES

CHANNELS 1–32: Multiplex one of 32 2-pole or one of 16 4-pole signals into DMM. Configuration supports dual 1×16 independent multiplexers.

INPUTS

MAXIMUM SIGNAL LEVEL: Any channel to Any Channel (1–32): 150V DC or 150Vrms (212V peak) for AC waveforms, 1A switched, 60W, 125VA maximum.

SAFETY: Conforms to European Union Directive 73/23/EEC EN61010-1, CAT I.

CONTACT LIFE (typ): >10⁵ operations at max signal level.
>10⁸ operations cold switching.

CONTACT RESISTANCE: <1Ω any path and additional 1Ω at end of contact life.

CONTACT POTENTIAL: <6μV per contact pair.

OFFSET CURRENT: <100pA.

CONNECTOR TYPE: 50-pin female D-shell, Channels 1–24.
25-pin female D-shell, Channels 25–32.

Supplied with male IDC ribbon cable connectors.

ISOLATION BETWEEN ANY TWO TERMINALS: >10⁹Ω, <200pF.

ISOLATION BETWEEN ANY TERMINAL AND EARTH: >10⁹Ω, <400pF.

CROSS TALK (1MHz, 50Ω Load): <–35dB.

INSERTION LOSS (50Ω Source, 50Ω Load): <0.35dB below 1MHz.
<3dB below 2MHz.

COMMON MODE VOLTAGE: 300VDC or 300Vrms (425V peak) for AC waveforms between any terminal and chassis.

ENVIRONMENTAL:

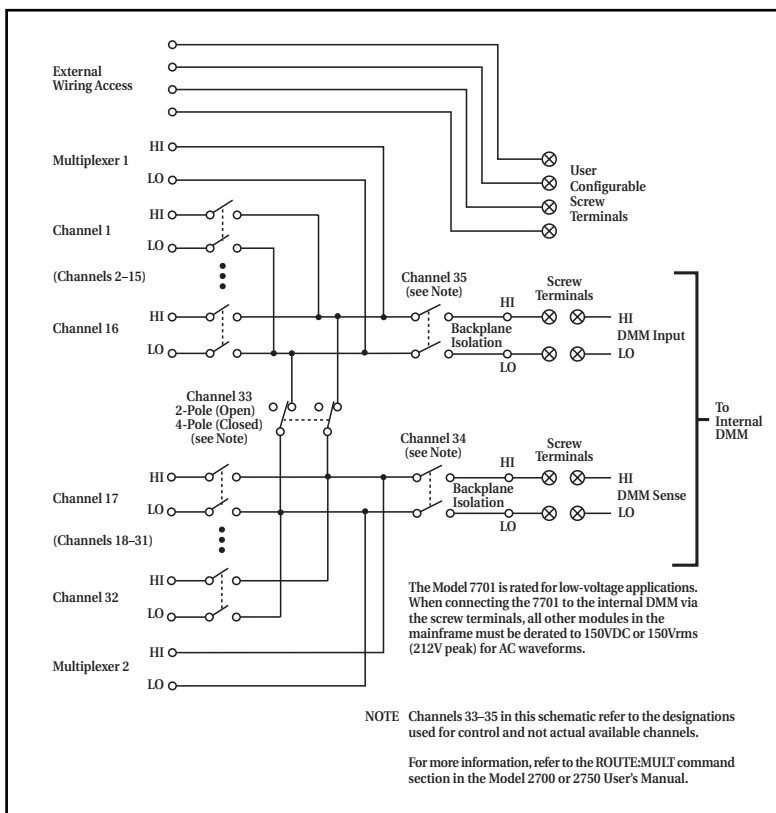
OPERATING ENVIRONMENT: Specified for 0°C to 50°C.
Specified to 50% R.H. at 35°C.

STORAGE ENVIRONMENT: –25°C to 65°C.

WEIGHT: <0.52kg (1.16 lb).

ACCESSORIES AVAILABLE:

- Model 7789 50/25 Pin Male D-Shell Solder Cup Connectors
- Model 7790 50/50/25 Pin Female/Male D-Shell IDC Connectors



See page 36 for common-side 4-wire ohms configuration example.

SWITCH/CONTROL MODULE SPECIFICATIONS

7702

7702 40-Channel Differential Multiplexer

Features

- There are 40 channels for general-purpose measurement, plus 2 channels to measure current.
- 2- or 4-wire measurement.
- Oversize screw terminal connection blocks are standard for easier connection.
- Configurable as two independent banks of multiplexers.
- 300V, 1A capacity for voltage channels; 60W, 125VA.
- 3A capacity for current channels.
- Relay closures stored in on-board memory.

GENERAL

40 CHANNELS: 40 channels of 2-pole relay input.
All channels configurable to 4-pole.

2 CHANNELS: 2 channels of current only input.

RELAY TYPE: Latching electromechanical.

ACTUATION TIME: <3ms.

CAPABILITIES

CHANNELS 1-40: Multiplex one of 40 2-pole or one of 20 4-pole signals into DMM.

CHANNELS 41-42: Multiplex one of 2 2-pole current signals into DMM.

INPUTS

MAXIMUM SIGNAL LEVEL:

Channels (1-40): 300V DC or rms, 1A switched, 60W, 125VA maximum.

Channels (41-42): 60V DC or 30V rms, 3A switched, 60W, 125VA maximum.

CONTACT LIFE (typ): >10⁵ operations at max signal level.
>10⁸ operations cold switching.

CONTACT RESISTANCE: <1 Ω at end of contact life.

CONTACT POTENTIAL: < \pm 500nV typical per contact, 1 μ V max.
< \pm 500nV typical per contact pair, 1 μ V max.

OFFSET CURRENT: <100pA.

CONNECTOR TYPE: Screw terminal, #20 AWG wire size.

ISOLATION BETWEEN ANY TWO TERMINALS: >10¹⁰ Ω , <100pF.

ISOLATION BETWEEN ANY TERMINAL AND EARTH: >10⁹ Ω , <200pF.

CROSS TALK (10MHz, 50 Ω Load): <-40dB.

INSERTION LOSS (50 Ω Source, 50 Ω Load): <0.1dB below 1MHz.
<3dB below 2MHz.

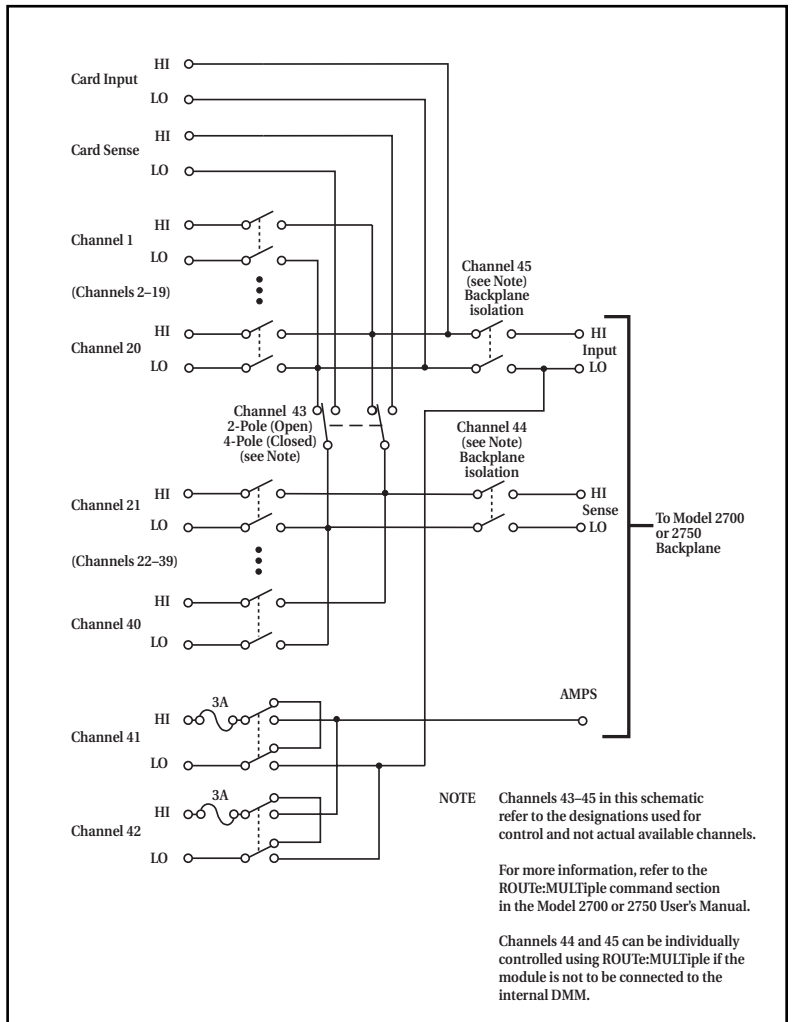
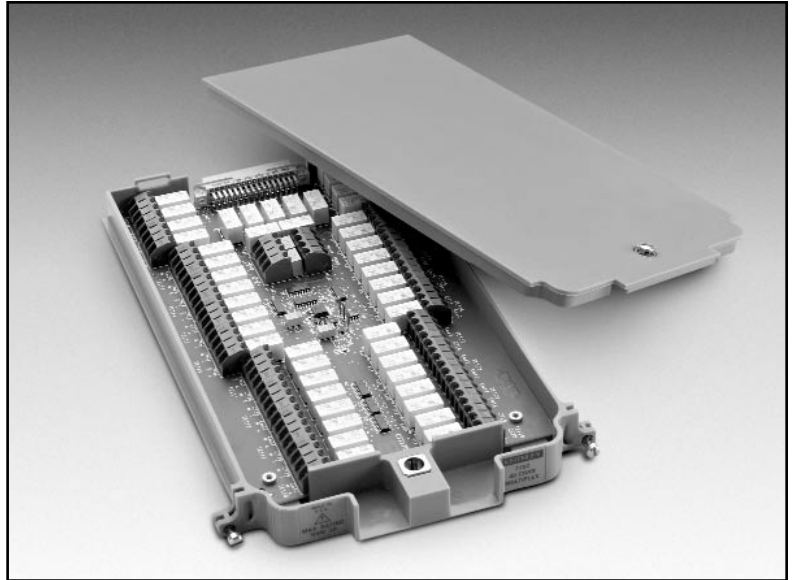
COMMON MODE VOLTAGE: 300V between any terminal and chassis.

ENVIRONMENTAL

OPERATING ENVIRONMENT: Specified for 0°C to 50°C.
Specified to 80% R.H. at 35°C.

STORAGE ENVIRONMENT: -25°C to 65°C.

WEIGHT: 0.5kg (1.1 lb).



SWITCH/CONTROL MODULE SPECIFICATIONS

7703

7703 32-Channel High Speed Differential Multiplexer

Features

- There are 32 channels for general purpose measurement.
- Relay actuation time of less than 1ms for high-speed scanning.
- 2 or 4 wire measurement.
- Two 50-pin female “D-sub” connectors are standard for secure hook-up and quick teardown.
- Configurable as two independent banks of multiplexers.
- Reed relay based design with 300 volt, 500mA; 10VA.
- Two mating connector with solder cup (Model 7788) are supplied.
- Relay closures stored in on-board memory.

GENERAL

32 CHANNELS: 32 channels of 2-pole relay input.
All channels configurable to 4-pole.

RELAY TYPE: Reed.

ACTUATION TIME: <1ms.

CAPABILITIES

CHANNELS 1-32: Multiplex one of 32 2-pole or one of 16 4-pole signals into DMM.

INPUTS

MAXIMUM SIGNAL LEVEL:

Channels (1-32): 300V DC or rms, 0.5A switched, 10W maximum.

Contact Life (typ): >5×10⁴ operations at max signal level.
>10⁶ operations cold switching.

CONTACT RESISTANCE: <1Ω at end of contact life.

CONTACT POTENTIAL: <±3μV typical per contact, 6μV max.
<±3μV typical per contact pair, 6μV max.

OFFSET CURRENT: <100pA.

CONNECTOR TYPE: 50 pin D-sub × 2.

RELAY DRIVE CURRENT: 20mA per channel.

ISOLATION BETWEEN ANY TWO TERMINALS: >10⁶Ω, <200pF.

ISOLATION BETWEEN ANY TERMINAL AND EARTH: >10⁶Ω, <400pF.

CROSS TALK (1 MHz, 50Ω Load): <-40dB.

INSERTION LOSS (50Ω Source, 50Ω Load): <0.35dB below 1MHz.
<3dB below 2MHz.

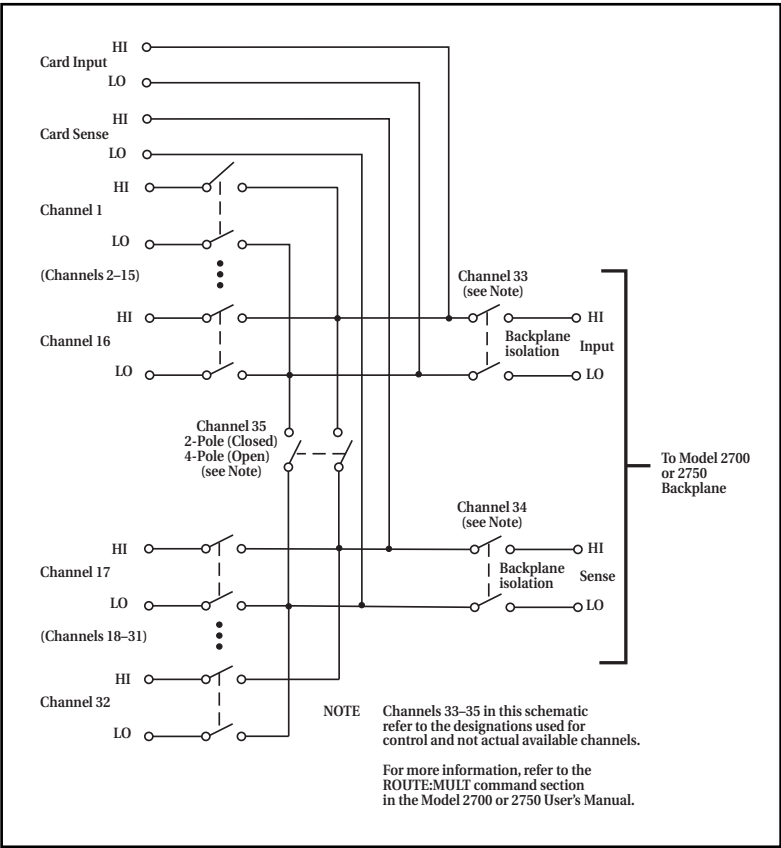
COMMON MODE VOLTAGE: 300V between any terminal and chassis.

ENVIRONMENTAL

OPERATING ENVIRONMENT: Specified for 0°C to 50°C.
Specified to 80% R.H. at 35°C.

STORAGE ENVIRONMENT: -25°C to 65°C.

WEIGHT: 0.8kg (1.75 lbs).



SWITCH/CONTROL MODULE SPECIFICATIONS

7705

7705 40-Channel Control Module

Features

- 40 channels designed for controlling power to the DUT, switching loads, controlling light indicators and relays, etc.
- Two 50-pin female “D-sub” connectors are standard for secure hook-up and quick teardown.
- 300V, 2A capacity.
- Two mating connectors with solder cup pins (Model 7788) are supplied.
- Relay closures stored in on-board memory.

GENERAL

RELAY SWITCH CONFIGURATION: 40 independent channels of 1-pole switching. Isolated from internal DMM.

CONTACT CONFIGURATION: 1 pole Form A.

RELAY TYPE: Latching electromechanical.

CONNECTOR TYPE: Two 50-pin female D-sub connectors.

INPUTS

MAXIMUM SIGNAL LEVEL: 300VDC or rms, 2A switched, 60W (DC, resistive), 125VA (AC, resistive).

CONTACT LIFE: **Cold Switching:** 10^8 closures.

At Maximum Signal Levels: 10^5 closures.

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

CONTACT POTENTIAL: $\leq 4\mu\text{V}$ per contact.

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

ACTUATION TIME: 3ms.

ISOLATION: Channel to Channel: $>10^9\Omega$, $<50\text{pF}$.

Common Mode: $>10^9\Omega$, $<100\text{pF}$.

CROSSTALK (1MHz, 50 Ω load): $<-35\text{dB}$.

INSERTION LOSS (50 Ω source, 50 Ω load): $<0.3\text{dB}$ below 1MHz, $<3\text{dB}$ below 10MHz.

COMMON MODE VOLTAGE: 300V between any terminal and chassis.

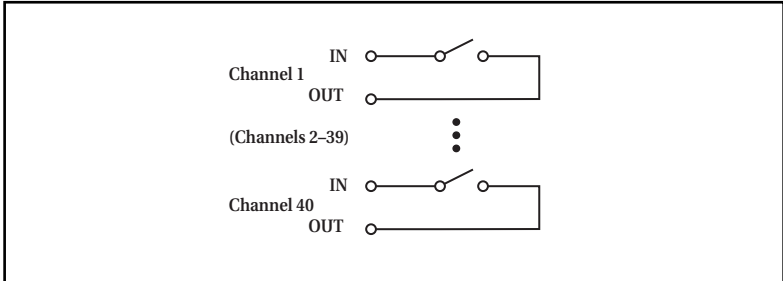
ENVIRONMENTAL

OPERATING ENVIRONMENT: Specified for 0°C to 50°C .

Specified to 80% R.H. at 35°C .

STORAGE ENVIRONMENT: -25°C to 65°C .

WEIGHT: 0.45kg (1 lb).



SWITCH/CONTROL MODULE SPECIFICATIONS

7706

7706 All-in-One I/O Module

Features

- 20 channels of analog input (w/automatic CJC) for general-purpose measurement.
- 16 channels of digital output.
- Event counter/totalizer can monitor and control system components, such as fixturing, limit switches, pass/fail indicators, external voltage sources, loads, door closures, revolutions, etc., while performing mixed signal measurement.
- 300V, 1A capacity; 60W, 125VA maximum.
- Configurable as two independent banks of multiplexers.
- Two analog outputs ($\pm 12V$, 5mA).
- Relay closures stored in on-board memory.

GENERAL

20 CHANNELS: 20 channels of 2-pole relay input.
All channels configurable to 4-pole.

RELAY TYPE: Latching electromechanical.

ACTUATION TIME: <3ms.

CAPABILITIES

CHANNELS 1–20: Multiplex one of 20 2-pole or one of 10 4-pole signals into DMM.

Channels 21–25 are referenced to chassis ground.

CHANNELS 21–22: 16 Digital Outputs.

CHANNELS 23–24: Analog Voltage Output (2).

CHANNELS 25: Totalize Input.

INPUTS

MAXIMUM SIGNAL LEVEL (Channels 1–20): 300V DC or rms, 1A switched, 60W, 125VA maximum.

CONTACT LIFE (typ.): >10⁵ operations at max. signal level: >10⁸ operations cold switching.

CONTACT RESISTANCE: <1 Ω at end of contact life.

CONTACT POTENTIAL: $\pm 2\mu V$ typical per contact, 3 μV max.

OFFSET CURRENT: <100pA.

CONNECTOR TYPE: Screw terminal, #20 AWG wire size.

ISOLATION BETWEEN ANY TWO TERMINALS: >10⁹ Ω , <100pF.

ISOLATION BETWEEN ANY TERMINAL AND EARTH: > 10⁹ Ω , <200pF.

CROSS TALK (10MHz, 50 Ω Load): <–35dB.

INSERTION LOSS (50 Ω Source, 50 Ω Load): <0.1dB below 1MHz.
<3dB below 2Mhz.

COMMON MODE VOLTAGE: 300V between any terminal and chassis.

T/C COLD JUNCTION: 1.0°C (18°C to 28°C mainframe temp.).
1.5°C (0°–18°C & 28°–50°C mainframe temp.).

TOTALIZE INPUT

MAXIMUM COUNT: 2³²–1.

TOTALIZE INPUT: 100kHz (max), rising or falling edge, programmable.

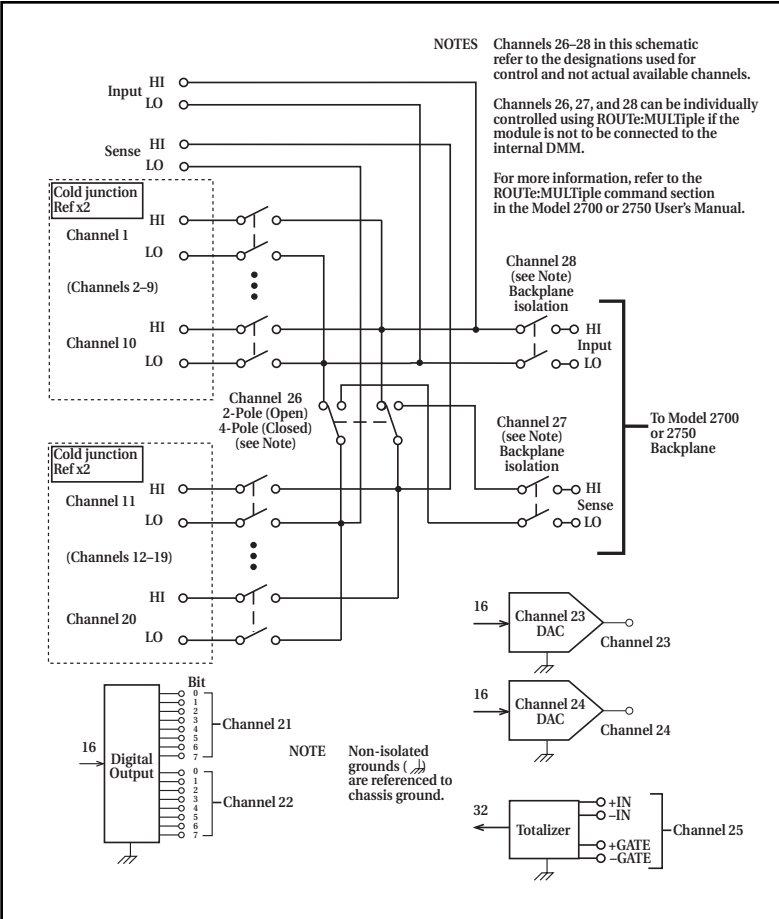
SIGNAL LEVEL: 1Vp-p (min), 42Vpk (max).

THRESHOLD: 0V or TTL, jumper selectable.

DATE INPUT: TTL-Hi, TTL-Lo, or none.

COUNT RESET: manual or Read+Reset.

READ SPEED: 50/s.



ANALOG VOLTAGE OUTPUT

DAC 1, 2: $\pm 12V$ in 1mV increments, non-isolated.

RESOLUTION: 1mV.

I_{OUT}: 5mA max.

SETTLING TIME: 1ms to 0.01% of output.

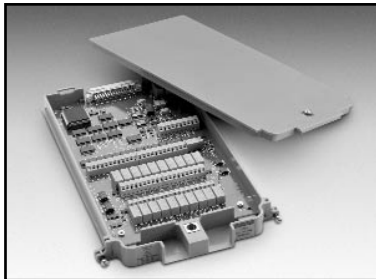
ACCURACY \pm (% of output + mV):

1 year $\pm 5^\circ C$: 0.15% + 19mV;

90 day $\pm 5^\circ C$: 0.1% + 19mV;

24 hour $\pm 1^\circ C$: 0.04% + 19mV.

TEMPERATURE COEFFICIENT:
 $\pm (0.015\% + 1mV) / ^\circ C$.



DIGITAL OUTPUT

V_{OUT}(L): <0.8V @ I_{out} = 400mA.

V_{OUT}(H): >2.4V @ I_{out} = 1mA.

V_{OUT}(H)MAX: <42V with external open drain pull-up.

WRITE SPEED: 50/s.

ENVIRONMENTAL

Specified for Model 2750 firmware revision AO2 or later.

OPERATING ENVIRONMENT: Specified for 0°C to 50°C.

Specified to 80% R.H. at 35°C.

STORAGE ENVIRONMENT: –25°C to 65°C.

WEIGHT: 0.5kg (1.1 lbs).

SWITCH/CONTROL MODULE SPECIFICATIONS

7707

7707 Multiplexer-Digital I/O Module

GENERAL

10 CHANNELS: 10 channels of 2-pole relay input.
All channels configurable to 4-pole.

RELAY TYPE: Latching electromechanical.

ACTUATION TIME: <3ms.

FIRMWARE: Specified for Model 2700 rev. B03 and Model 2750 rev. A01.

CAPACITY: Model 2700: (1) 7707 and (1) 770X, except 7706.
Model 2750: (3) 7707 and (2) 770X, except 7706. A 7706 module may be substituted for a 7707 module.

CAPABILITIES

CHANNELS 1–10: Multiplex one of 10 2-pole or one of 5 4-pole signals into DMM.

CHANNELS 11–14: 32 Digital Inputs/Outputs referenced to chassis ground.

THERMAL PROTECTION: Channels 11–14 are thermally protected to 1A.

INPUTS (Channels 1–10)

MAXIMUM SIGNAL LEVEL: Any Channel to Any Channel (1–10): 300VDC or 300Vrms (425V peak) for AC waveforms, 1A switched, 60W, 125VA maximum.

SAFETY CATEGORY: Conforms to European Union Directive 73/23/EEC EN 61010-1, CAT I.

CONTACT LIFE (typ.): >10⁵ operations at max. signal level; >10⁸ operations cold switching.

CONTACT RESISTANCE: <1Ω any path and additional 1Ω at end of contact life.

CONTACT POTENTIAL: <6μV typical per contact pair and additional 5μV with Channels 11–14 at rate $V_{OUT}(L)$.

OFFSET CURRENT: <100pA.

CONNECTOR TYPE: 50-pin male D-shell, Channels 11–14.

25-pin female D-shell, Channels 1–10.

Supplied with female and male IDC ribbon cable connectors.

ISOLATION BETWEEN ANY TWO TERMINALS: >10⁹Ω, <100pF with isolation channels 16 and 17 open.

ISOLATION BETWEEN ANY TERMINAL AND EARTH: > 10⁹Ω, <200pF.

CROSS TALK (10MHz, 50Ω Load): <–35dB.

INSERTION LOSS (50Ω Source, 50Ω Load): <0.1dB below 1MHz.
<3dB below 2MHz.

COMMON MODE VOLTAGE: 300VDC or 300Vrms (425V peak) for AC waveforms between any terminal and chassis.

DIGITAL INPUT/OUTPUT (Channels 11–14)

$V_{IN}(L)$: <0.8V (TTL).

$V_{IN}(H)$: >2V (TTL).

$V_{OUT}(L)$: <1.0V @ $I_{OUT} = 100\text{mA}$.

$V_{OUT}(H)$: >2.4V @ $I_{OUT} = 1\text{mA}$.

$V_{OUT}(H)\text{MAX.}$: <40V with external open drain pull-up.

READ/WRITE SPEED: 50/s.

ENVIRONMENTAL

OPERATING ENVIRONMENT: Specified for 0°C to 50°C.
Specified to 50% R.H. at 35°C.

STORAGE ENVIRONMENT: –25°C to 65°C.

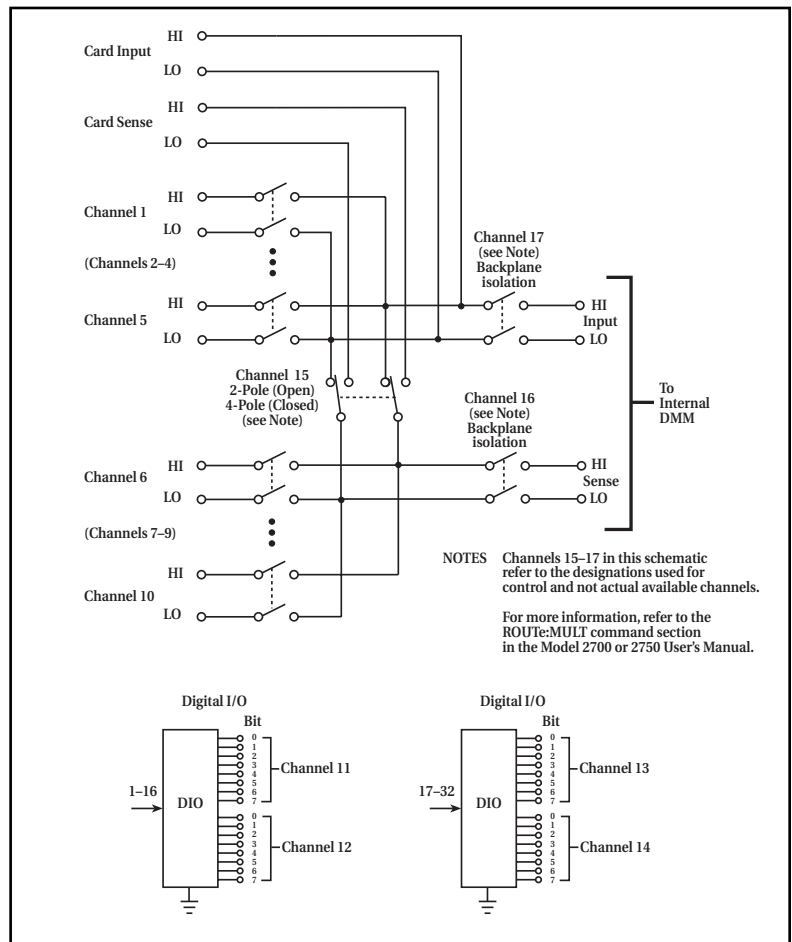
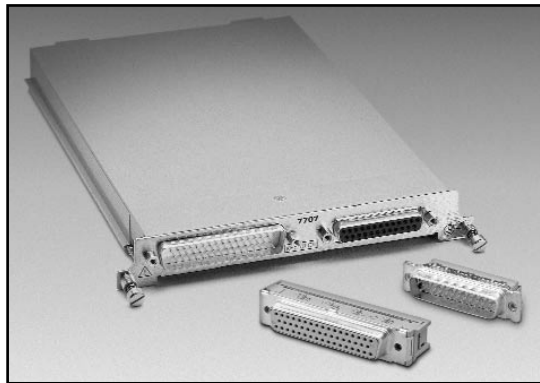
WEIGHT: <0.5kg (1.1 lbs).

ACCESSORY AVAILABLE:

Model 7790 50/50/25 Pin Female/Male D-Shell IDC Connectors

Features

- 10 channels of analog input for general-purpose measurement.
- 32 channels of digital input and output (four 8-bit ports) for I/O control.
- 300V, 1A capacity; 60W, 125VA maximum (analog).
- Configurable as two independent banks of multiplexers.
- 33V, 100mA capacity (digital).
- Two mating IDC connectors supplied (Model 7790).
- Digital outputs are short circuit protected.
- Relay closures stored in on-board memory.



SWITCH/CONTROL MODULE SPECIFICATIONS

7708

7708 40-Channel Differential Multiplexer Module

Features

- 40 differential channels for general-purpose measurements.
- 2- or 4-wire measurements.
- Oversize screw terminal connection blocks are standard for easier connection.
- 300V, 1A capacity for voltage channels; 60W, 125VA.
- Configurable as two independent banks of multiplexers.
- Built-in CJC sensors automatically linearize thermocouples.
- Relay closures stored in on-board memory.

GENERAL

40 CHANNELS: 40 channels of 2-pole relay input. All channels configurable to 4-pole.

RELAY TYPE: Latching electromechanical.

ACTUATION TIME: <3ms.

CAPABILITIES

CHANNELS 1–40: Multiplex one of 40 2-pole or one of 20 4-pole signals into DMM.

INPUTS

MAXIMUM SIGNAL LEVEL:

Channels (1–40): 300V DC or rms, 1A switched, 60W, 125VA maximum.

CONTACT LIFE (typ): >10⁵ operations at max. signal level.
>10⁸ operations cold switching.

CONTACT RESISTANCE: <1Ω at end of contact life.

CONTACT POTENTIAL: <±500nV typical per contact, 1μV max.
<±500nV typical per contact pair, 1μV max.

OFFSET CURRENT: <100pA.

CONNECTOR TYPE: Screw terminal, #20 AWG wire size.

ISOLATION BETWEEN ANY TWO TERMINALS: >10¹⁰Ω, <100pF

ISOLATION BETWEEN ANY TERMINAL AND EARTH: >10⁹Ω, <200pF

CROSS TALK (10MHz, 50Ω Load): <–40dB.

INSERTION LOSS (50Ω Source, 50Ω Load): <0.1dB below 1MHz.
<3dB below 2MHz.

COMMON MODE VOLTAGE: 300V between any terminal and chassis.

ENVIRONMENTAL:

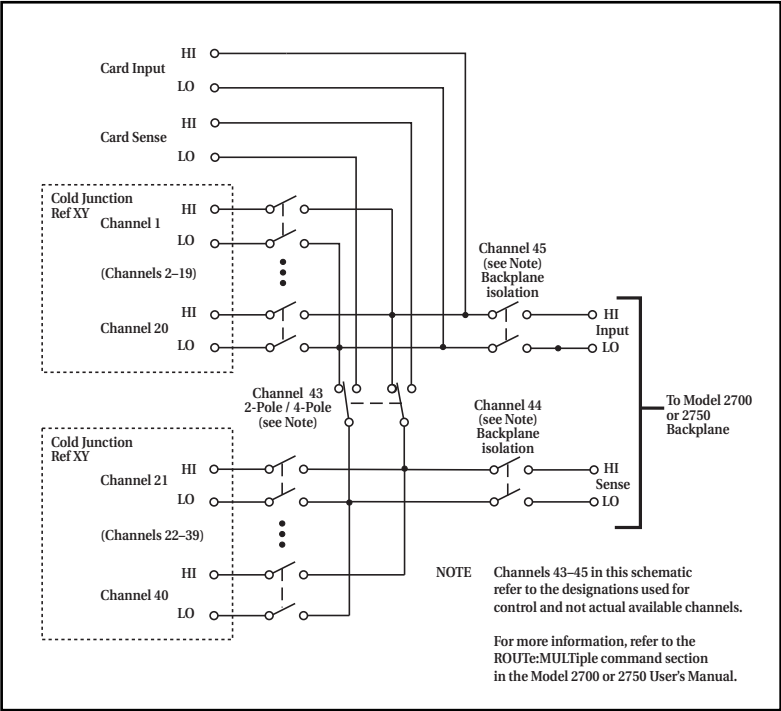
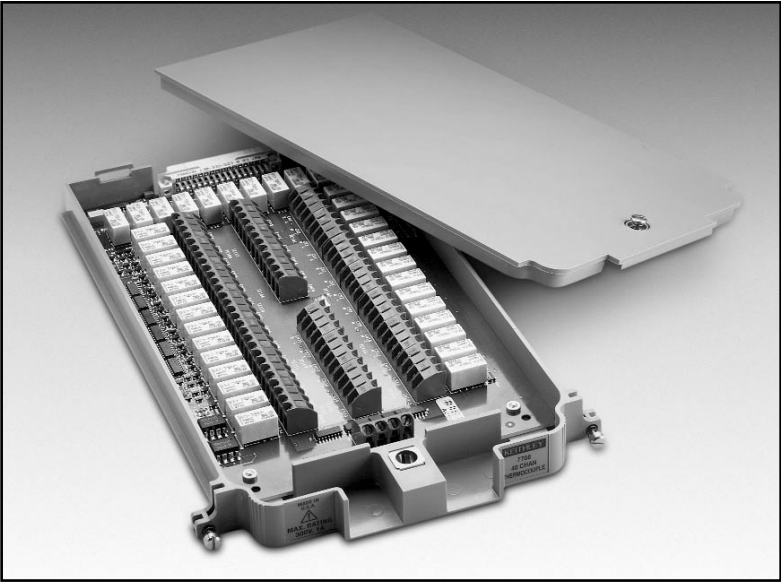
T/C COLD JUNCTION: 1.0°C (18°–28°C).

1.5°C (0°–18°C and 28°–50°C).

OPERATING ENVIRONMENT: Specified for 0°C to 50°C.
Specified to 80% R.H. at 35°C.

STORAGE ENVIRONMENT: –25°C to 65°C.

WEIGHT: 0.52kg (1.16 lb).



SWITCH/CONTROL MODULE SPECIFICATIONS

7709

7709 6×8 Matrix Module**Features**

- Automatic 2- or 4-wire connection to DMM
- 6 row × 8 column matrix
- Two female “D-sub” connectors are standard for secure hook-up and quick teardown.
- 300V, 1A capacity.
- Two mating IDC connectors for ribbon cable (Model 7790) are supplied.
- Relay closures stored in on-board memory.

GENERAL**MATRIX CONFIGURATION:** 6 rows × 8 columns.**CONTACT CONFIGURATION:** 2 pole Form A.**FIRMWARE:** Specified for Model 2700 rev. B03 and Model 2750 rev. A01.**RELAY TYPE:** Latching electromechanical.**ACTUATION TIME:** <3ms.**CAPABILITIES****DMM CONNECTION:****2-Wire Functions**

Row 1, channels 1–8, through channel 50.

4-Wire Functions

Row 1, channels 1–4 (Source) through channel 50 and Row 2, channels 13–16 (Sense), through channel 49.

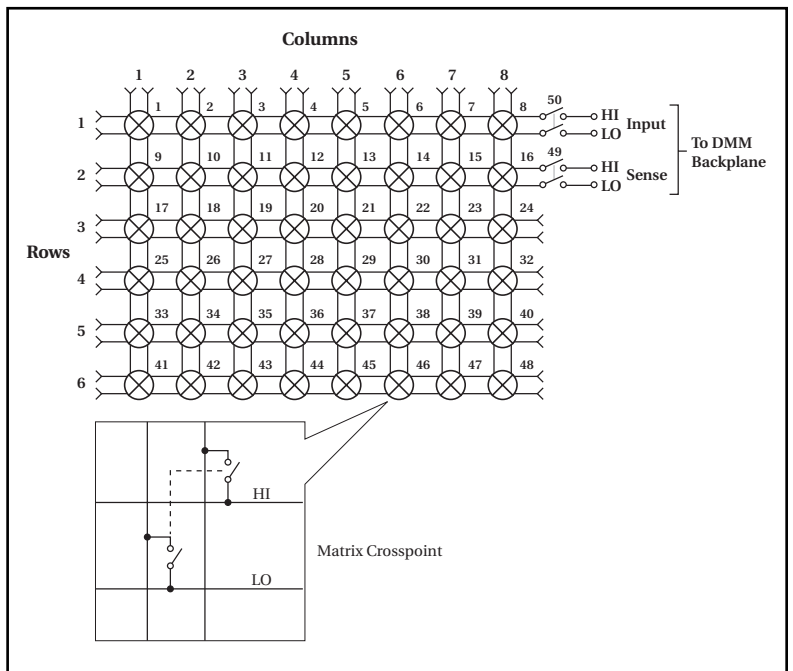
CLOSE CHANNEL: CLOSE command connects channels 1–8 to DMM.

For 4-wire, channels 1–4 are automatically paired with channels 13–16. ROUTE: MULTIPLE allows any combination of rows and columns to be connected at the same time.

INPUTS**MAXIMUM SIGNAL LEVEL: Any Channel to Any Channel (1–48):** 300VDC or 300Vrms (425V peak) for AC waveforms, 1A switched, 60W, 125VA maximum.**SAFETY:** Conforms to European Union Directive 73/23/EEC EN61010-1, CAT I.**CONTACT LIFE (typ):** >10⁵ operations at max signal level.
>10⁸ operations cold switching.**CONTACT RESISTANCE:** <1Ω any path and additional 1Ω at end of contact life.**CONTACT POTENTIAL:** <3μV per contact pair.**OFFSET CURRENT:** <100pA.**CONNECTOR TYPE:** 50-pin female D-shell for rows and columns.
25-pin female D-shell for “daisy-chain” rows.
Supplied with male IDC ribbon cable connectors.**ISOLATION BETWEEN ANY TWO TERMINALS:** >10⁹Ω, <200pF.**ISOLATION BETWEEN ANY TERMINAL AND EARTH:** >10⁹Ω, <400pF.**CROSS TALK (1MHz, 50Ω Load):** <–35dB.**INSERTION LOSS (50Ω Source, 50Ω Load):** <0.35dB below 1MHz.
<3dB below 2MHz.**COMMON MODE VOLTAGE:** 300VDC or 300Vrms (425V peak) for AC waveforms between any terminal and chassis.**ENVIRONMENTAL:****OPERATING ENVIRONMENT:** Specified for 0°C to 50°C.
Specified to 50% R.H. at 35°C.**STORAGE ENVIRONMENT:** –25°C to 65°C.**WEIGHT:** <0.52kg (1.16 lb).**ACCESSORIES AVAILABLE:**

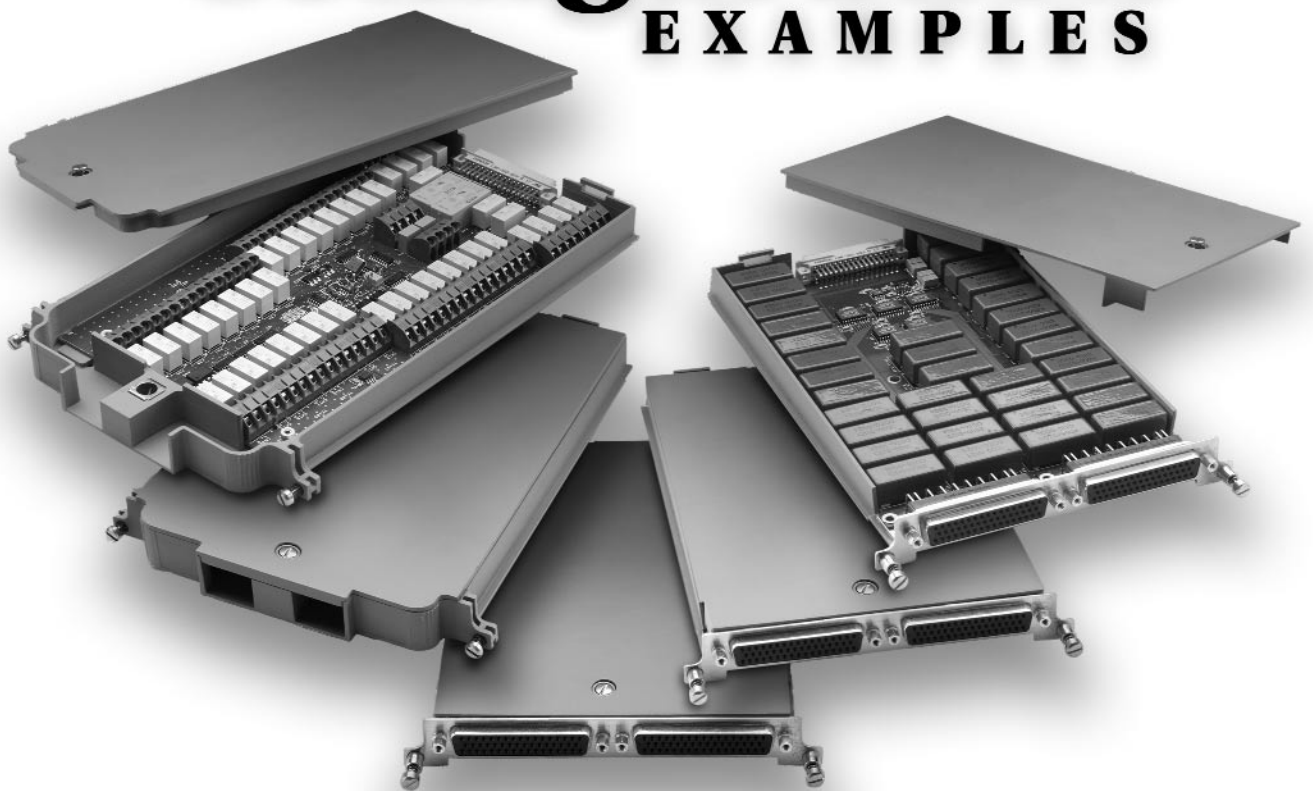
Model 7789 50/25 Pin Male D-Shell Solder Cup Connectors

Model 7790 50/50/25 Pin Female/Male D-Shell IDC Connectors



Module Configuration

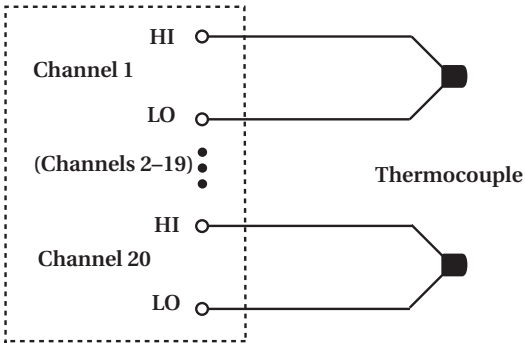
EXAMPLES



MODEL 2750 MULTIMETER/SWITCH SYSTEM

Thermocouple Configuration Example Using Internal CJC

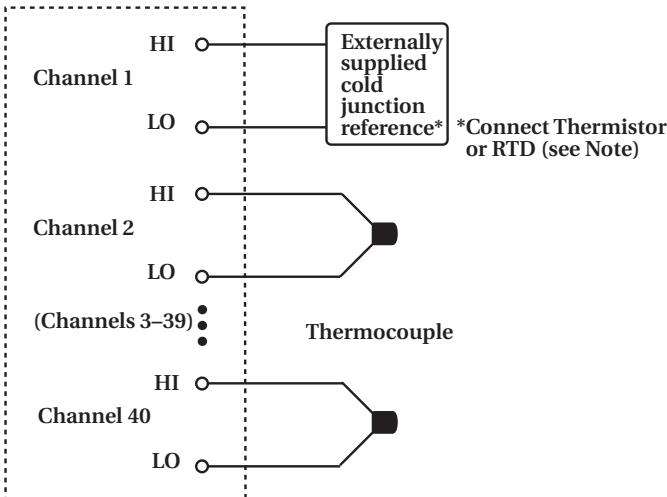
Thermocouple connections



NOTE: The red lead is the LO signal on all thermocouples. This applies to U.S. standards.

Thermocouple Configuration Example Using External CJC

Thermocouple connections

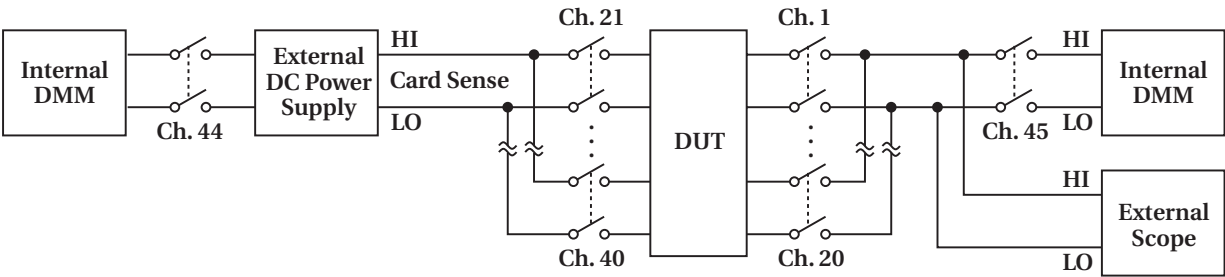


NOTE: If an RTD is connected as the cold junction reference, Channel 21 will be used for the sense leads of the RTD and is not available for connection of a thermocouple.

NOTE: The red lead is the LO signal on all thermocouples.

7708 Configuration Examples

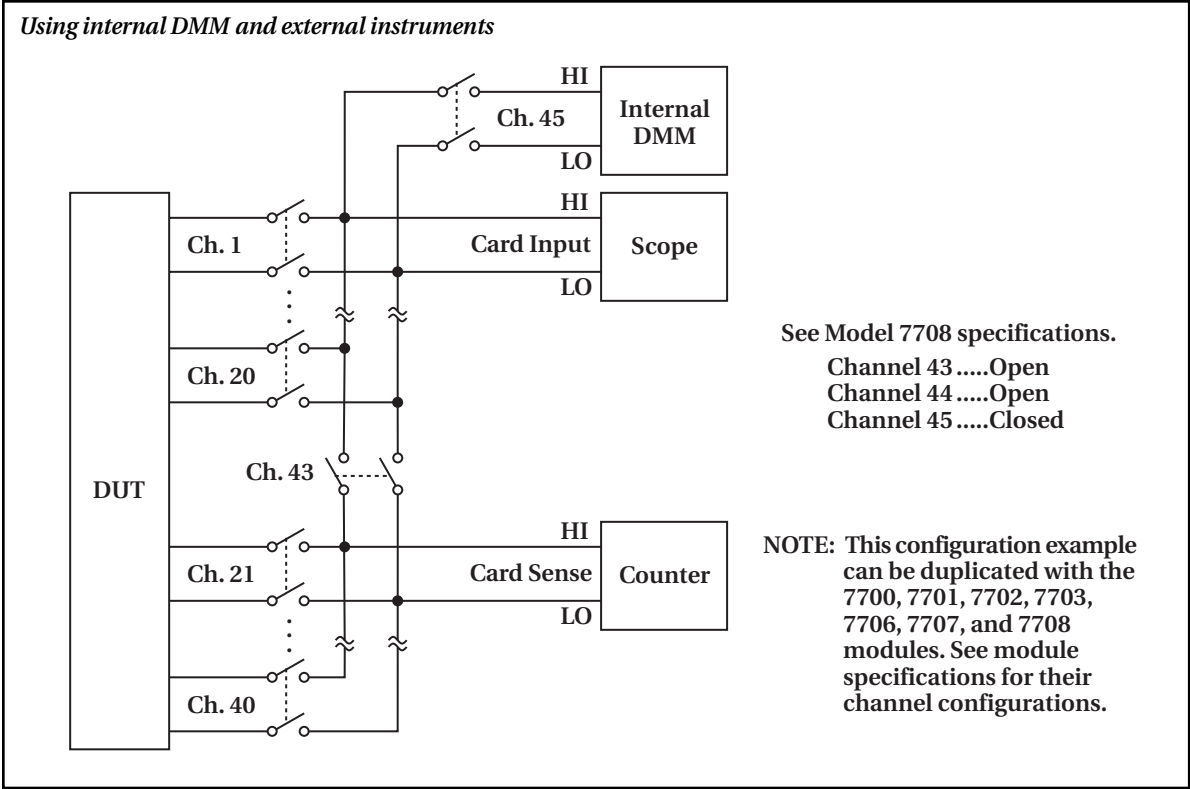
Dual multiplexer mode example #1



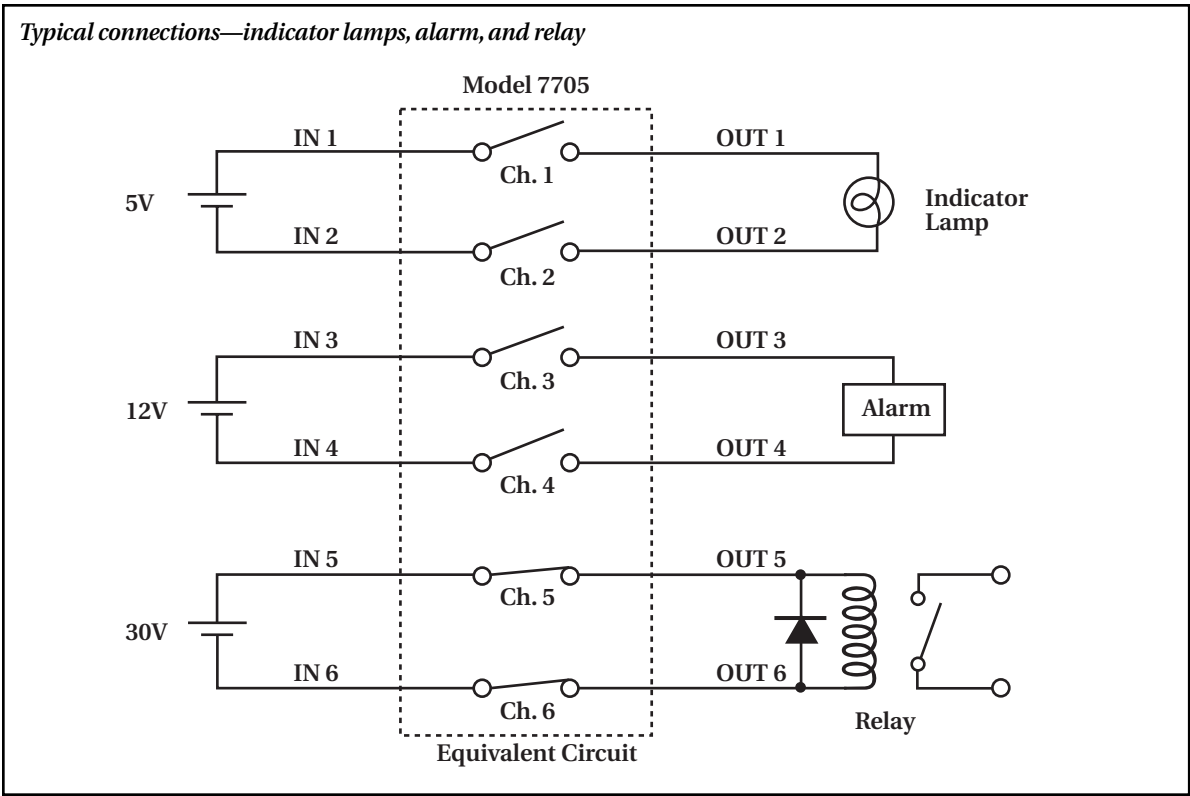
See Model 7708 specifications.
Channel 43Closed
Channel 44Open
Channel 45Closed for DMM measure

NOTE: This configuration example can be duplicated with the 7700, 7701, 7702, 7703, 7706, 7707, and 7708 modules. See module specifications for their channel configurations.

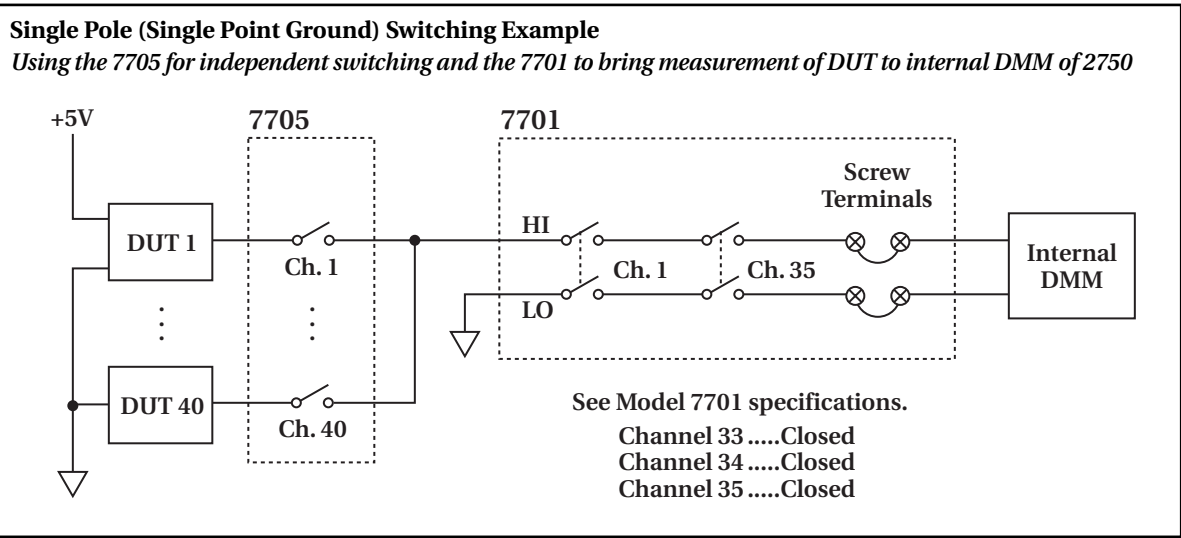
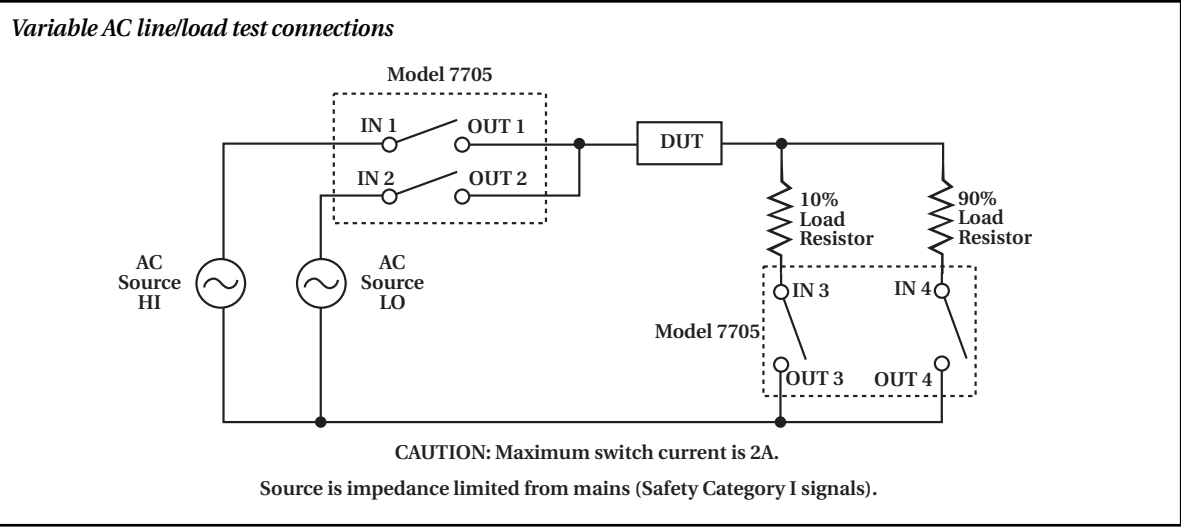
7708 Configuration Examples (continued)



7705 Configuration Examples

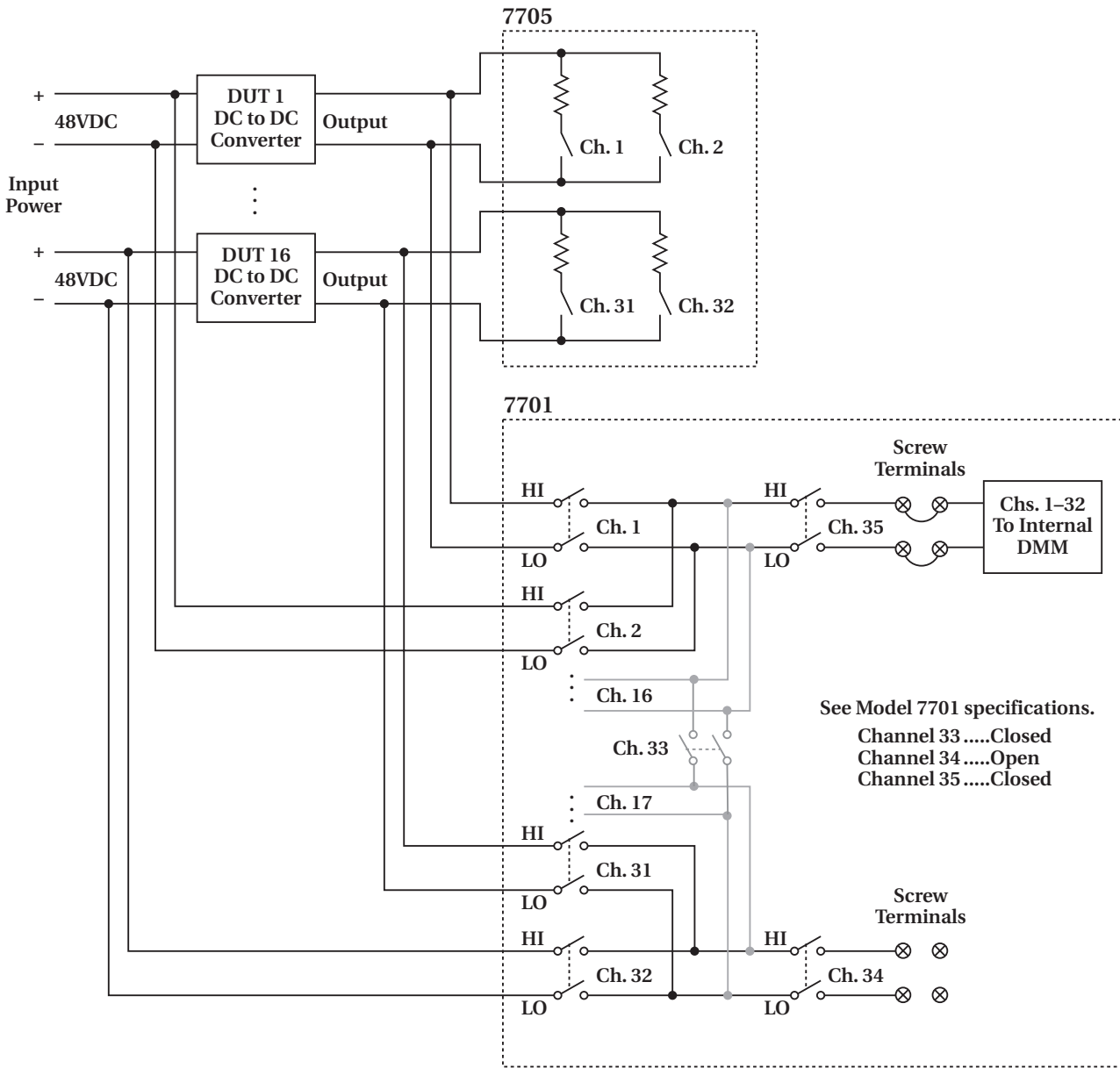


7705 Configuration Examples (continued)



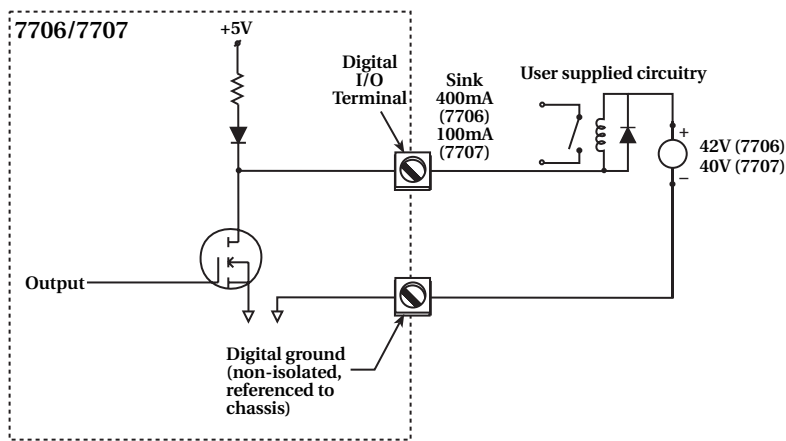
7705 Configuration Examples (continued)

7705 independent switch and 7701 multiplexer example



Analog Output and Digital I/O Examples

Typical digital output w/external power supply



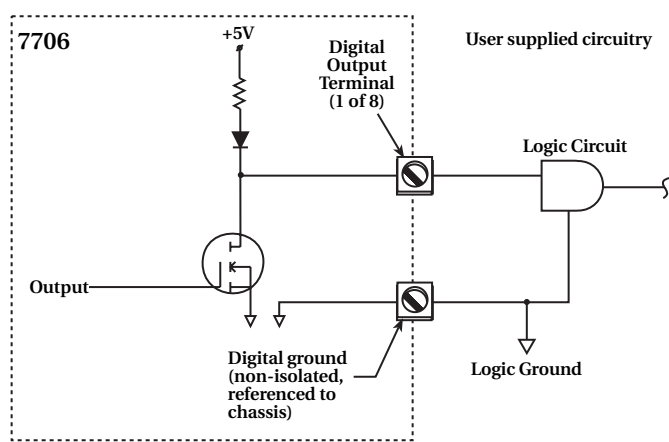
Digital Output

The 7706 module has two non-isolated 8-bit output ports that can be used for outputting digital patterns. The two ports can be combined to output a single 16-bit word or a dual 8-bit byte. A simplified diagram of a single output bit is shown here.

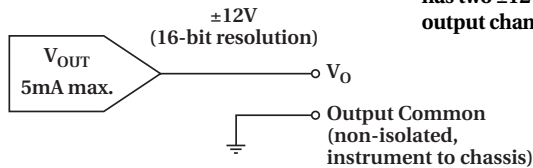
The 7707 module has four non-isolated 8-bit input/output ports that can be used for outputting digital patterns. The two ports can be combined to output a 16-bit word, or dual or quad 8-bit bytes.

The 7707 can also be configured (in blocks of 8) as digital inputs.

Typical digital output (no external power supply)

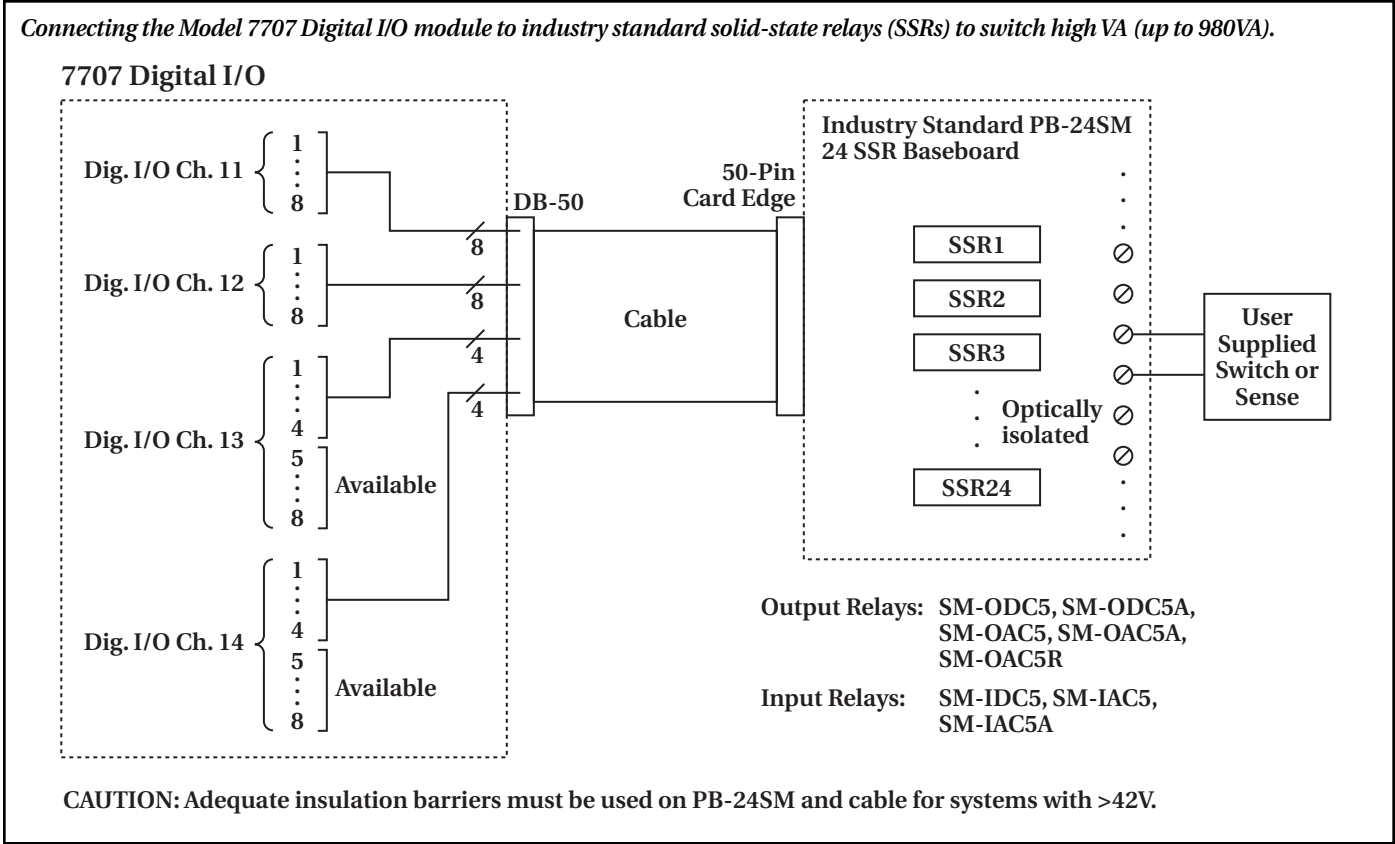


7706 analog output

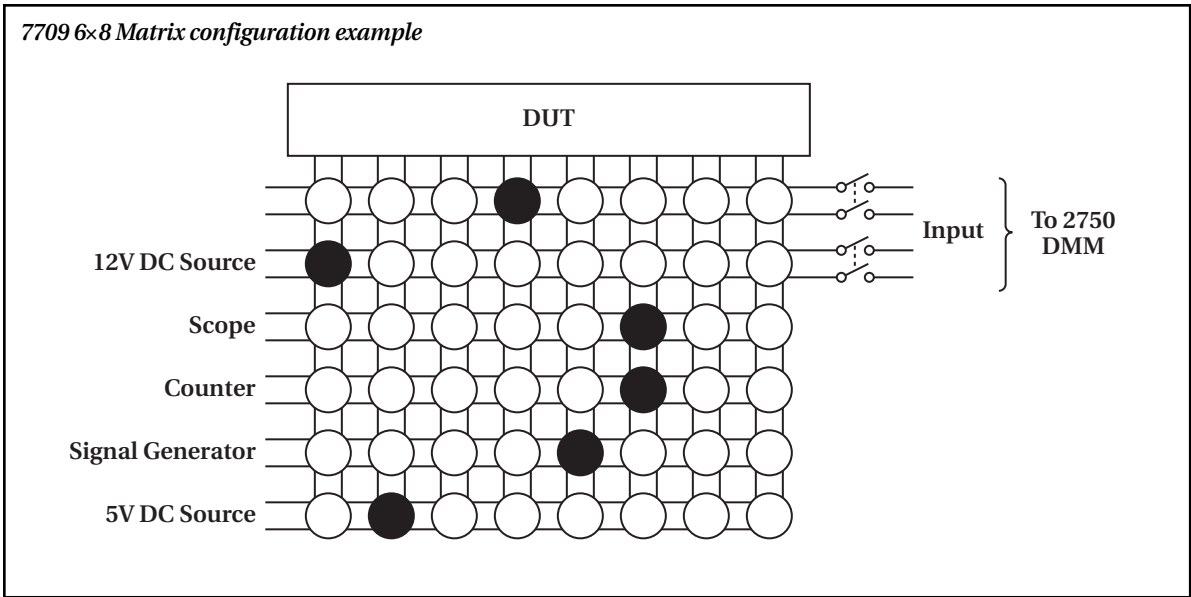


NOTE: The 7706 module has two $\pm 12V$ analog output channels.

Analog Output and Digital I/O Examples (continued)



Matrix Configuration Example

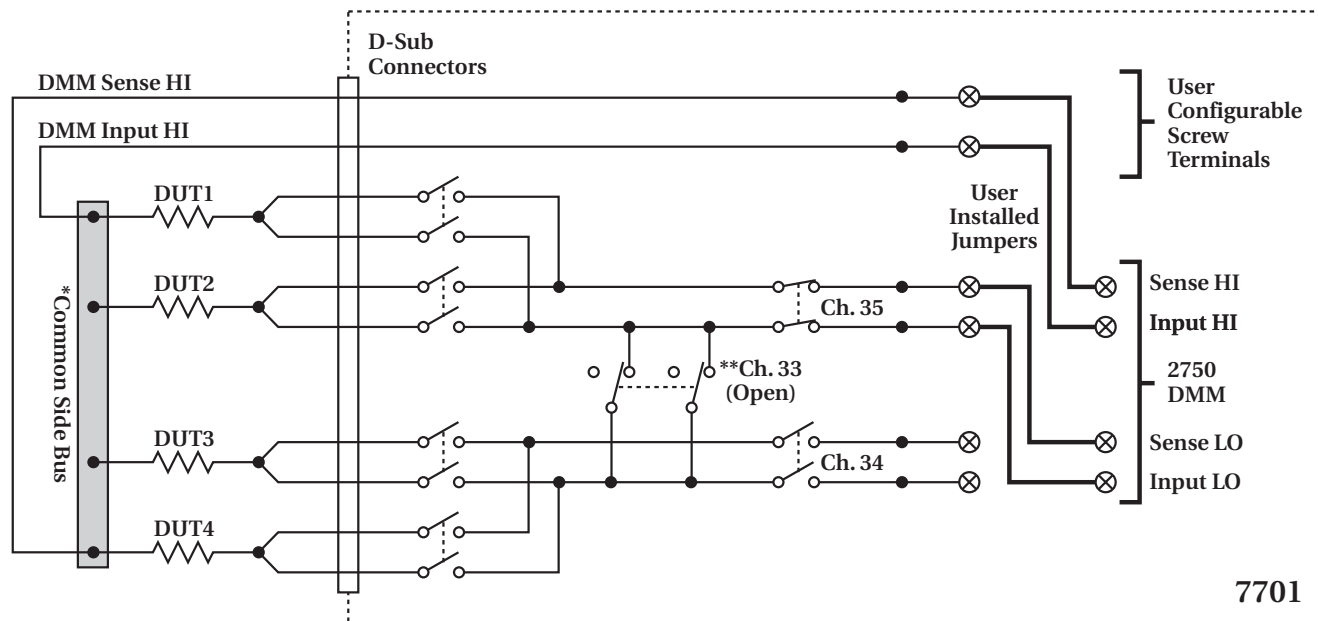


The 7709 Matrix Module can connect any combination of six differential channels of instrumentation to any combination of eight differential DUT channels. The instrumentation can be the 2750's internal DMM or external equipment (AC and DC sources, internal or external meters, oscilloscopes, etc.) This matrix configuration allows wide flexibility for complex test systems.

MODEL 2750 MULTIMETER/SWITCH SYSTEM

7701 Configuration Example

*7701 32-Channel common-side
4-wire Ohms configuration example*



***NOTE:** Common side connections must be made carefully to eliminate all lead resistance from the 4-wire ohms measurement. The common side bus should be a single wire or bus bar that connects the HI side of all the DUTs. DMM Input HI should be connected to one end of the common side bus and DMM Sense HI should be connected to the other end.

****NOTE:** Refer to ROUTE:MULT section of the 2700 or 2750 manual for more information.

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