

2701 Ethernet Multimeter/Data Acquisition System

DC CHARACTERISTICS¹

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

FUNCTION	RANGE	RESOLUTION	TEST CURRENT		INPUT RESISTANCE OR OPEN CKT. VOLTAGE ³	ACCURACY: $\pm$ (ppm of reading + ppm of range) (ppm = parts per million) e.g., 10ppm = 0.001%)			TEMPERATURE COEFFICIENT 0°-18°C & 28°-50°C
			$\pm 5\%$ OR BURDEN VOLTAGE			24 Hour ⁴ 23°C $\pm 1^\circ$	90 Day 23°C $\pm 5^\circ$	1 Year 23°C $\pm 5^\circ$	
Voltage ¹	100.0000 mV	0.1 μ V			>10 G Ω	15 + 30	25 + 35	30 + 35	(1 + 5)/°C
	1.000000 V	1.0 μ V			>10 G Ω	15 + 6	25 + 7	30 + 7	(1 + 1)/°C
	10.0000 V	10 μ V			>10 G Ω	10 + 4	20 + 5	30 + 5	(1 + 1)/°C
	100.0000 V	100 μ V			10 M $\Omega \pm 1\%$	15 + 6	35 + 9	45 + 9	(5 + 1)/°C
	1000.000 V ⁵	1 mV			10 M $\Omega \pm 1\%$	20 + 6	35 + 9	50 + 9	(5 + 1)/°C
Resistance ^{6,8}	100.0000 Ω	100 $\mu\Omega$	1 mA		6.9 V	20 + 20	80 + 20	100 + 20	(8 + 1)/°C
	1.000000 k Ω	1 m Ω	1 mA		6.9 V	20 + 6	80 + 6	100 + 6	(8 + 1)/°C
	10.00000 k Ω	10 m Ω	100 μ A		6.9 V	20 + 6	80 + 6	100 + 6	(8 + 1)/°C
	100.0000 k Ω	100 m Ω	10 μ A		12.8 V	20 + 6	80 + 10	100 + 10	(8 + 1)/°C
	1.000000 M Ω	1.0 Ω	10 μ A		12.8 V	20 + 6	80 + 10	100 + 10	(8 + 1)/°C
	10.00000 M Ω ⁷	10 Ω	0.7 μ A // 10M Ω		7.0 V	150 + 6	200 + 10	400 + 10	(95 + 1)/°C
	100.0000 M Ω ⁷	100 Ω	0.7 μ A // 10M Ω		7.0 V	800 + 30	2000 + 30	2000 + 30	(900 + 1)/°C
Continuity (2W) ²¹	1.000 k Ω	100 m Ω	1 mA		6.9 V	40 + 100	100 + 100	100 + 100	(8 + 1)/°C
Current	20.00000 mA	10 nA	<0.2 V			60 + 30	300 + 80	500 + 80	(50 + 5)/°C
	100.0000 mA	100 nA	<0.1 V			100 + 300	300 + 800	500 + 800	(50 + 50)/°C
	1.000000 A	1.0 μ A	<0.5 V ⁹			200 + 30	500 + 80	800 + 80	(50 + 5)/°C
	3.000000 A	10 μ A	<1.5 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

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

Thermocouples (Accuracy based on ITS-90.)

Type	Range	Resolution	90 Day/1 Year (23°C $\pm 5^\circ$ C)			Temperature Coefficient 0°-18°C & 28°-50°C
			Relative to Simulated Junction	Using 77XX 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:

(100 Ω 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: (2.2k Ω , 5k Ω , and 10k Ω)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) (excludes 4 Wire Ohms).

FUNCTION CHANGES¹⁶: 50/s (42/s).

AUTORANGE TIME¹⁶: <30ms.

ASCII READINGS TO RS-232 (115.2k BAUD): 300/s.

MAX. INTERNAL TRIGGER RATE: 2800/s.

MAX. EXTERNAL TRIGGER RATE: 2000/s.

DC MEASUREMENT SPEEDS¹⁵

Single Channel, 60Hz (50Hz) Operation

DC SPEED vs. NOISE REJECTION

RMS Noise						
Rate	Filter	Readings/s ¹²	Digits	10V Range	NMRR	CMRR ¹⁴
10	50	0.1 (0.08)	6.5	<2.5 μ V	110 dB ¹³	140 dB

1	Off	15 (12)	6.5	<6 μ V	90 dB ¹³	140 dB
0.1	Off	500 (400)	5.5	<40 μ V	-	80 dB
0.006	Off	3000 (3000)	4.5	<300 μ V	-	80 dB
0.002	Off	3500 (3500)	3.5	<1 mV	-	60 dB

FUNCTION	DIGITS	READINGS/s	PLCs
DCV, DCI, Ω (<10M), Thermocouple, Thermistor	6.5 ^{12,16}	5 (4)	10
	6.5 ¹⁶	35 (24)	1
	6.5 ^{12,16}	50 (48)	1
	5.5 ^{12,16}	150 (120)	0.1
	5.5 ^{16,17}	300 (240)	0.1
	5.5 ¹⁷	500 (400)	0.1
4W Ω (<10M)	4.5 ¹⁷	3000 (3000)	0.006
	3.5 ¹⁷	3500 (3500)	0.002
4W Ω 0Comp, RTD	6.5 ¹⁶	1.4 (1.1)	10
	6.5 ¹⁶	15 (12)	1
	5.5 ^{16,17}	33 (25)	0.1
Channel (Ratio), Channel (AVG)	6.5 ^{16,17}	0.9 (0.7)	10
	6.5 ^{16,17}	8 (6.4)	1
	5.5 ^{16,17}	18 (14.4)	0.1
Channel (Ratio), Channel (AVG)	6.5 ^{16,17}	2.5 (2)	10
	6.5 ^{16,17}	15 (12)	1
	5.5 ^{16,17}	25 (20)	0.1

Multiple Channels Into Memory^{15,18}

7710 Scanning DCV	500/s
7710 Scanning with Limits or Time Stamp On	500/s
7710 Scanning DCV alternating 2W Ω	115/s
7710 Scanning Temperature (T/C)	500/s
7700 and 7708 Scanning Temperature (T/C)	80/s

Multiple Channels Into and Out of Memory^{15,16,17,18}

7710 Scanning DCV	440/s
7710 Scanning with Limits or Time Stamp On	440/s
7710 Scanning DCV alternating 2W Ω	110/s
7710 Scanning Temperature (T/C)	440/s
7700 and 7708 Scanning Temperature (T/C)	80/s
7702 Scanning DCV	75/s

Specifications are subject to change without notice.

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DC MEASUREMENT CHARACTERISTICS

DC Volts

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

INPUT IMPEDANCE:

100mV-10V Ranges: Selectable >10GΩ// with <400pF or 10MΩ ±1%.

100V, 1000V Ranges: 10MΩ ±1%.

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

INPUT BIAS CURRENT: <75pA at 23°C.

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

AUTOZERO ERROR: Add ±(2ppm of range error +5μV) for <10 minutes and ±1°C.

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

Resistance

MAX 4WΩ LEAD RESISTANCE: 10% of range per lead for 100Ω and 1kΩ ranges; 1kΩ per lead for all other ranges.

OFFSET COMPENSATION: Selectable on 4WΩ 100Ω, 1kΩ, and 10kΩ ranges.

CONTINUITY THRESHOLD: Adjustable 1 to 1000Ω.

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

DC Current

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

INPUT PROTECTION: 3A, 250V fuse.

Thermocouples

CONVERSION: ITS-90.

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

OPEN CIRCUIT CHECK: Selectable per channel. Open >11.4k ±200Ω.

DC Notes

- 20% overrange except on 1000V and 3A.
- Add the following to "ppm of range" uncertainty; 100mV 15ppm, 1V and 100V 2ppm, 100Ω 30ppm, 1k→<1MΩ 2ppm, 10mA and 1A 10ppm, 100mA 40ppm.
- ±2% (measured with 10MΩ input resistance DMM, >10GΩ DMM on 10MΩ and 100MΩ ranges).
- Relative to calibration accuracy.
- For signal levels >500V, add 0.02ppm/V uncertainty for portion exceeding 500V.
- Specifications are for 4-wire Ω, 100Ω with offset compensation on, 77xx plug-in module with LSYNC and offset compensation on. With offset compensation on OPEN CKT. VOLTAGE is 12.8V. For 2-wire Ω add 1.0Ω to "ppm of range" uncertainty.
- 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 kΩ	100 kΩ	1 MΩ	10 MΩ	100 MΩ
All Modules:				220 ppm	2200 ppm
7701, 7703, 7707, and 7709 Modules:	10 ppm	100 ppm	1000 ppm	1%	10%
7706, 7708 Modules:	5 ppm	50 ppm	500 ppm	5000 ppm	5%
7710 Model 23°C ±5°C:	11 ppm	110 ppm	1100 ppm	1.1%	11%
7710 Model Temp Coeff. >28°C→50°C:	0.3 ppm/°C	3 ppm/°C	30 ppm/°C	0.03%/°C	0.3%/°C

- Add 1.0V when used with plug-in modules.
- For RATIO, DCV only. For AVERAGE, DCV and Thermocouples only. Available with plug-in modules only.
- Add 6μV to "of range" uncertainty when using Models 7701, 7703, and 7707, 3μV for Models 7706, 7709, and 7710.
- Auto zero off.
- For LSYNC On, line frequency ±0.1%. For LSYNC Off, use 60dB for ≥ 1PLC.
- 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.
- Speeds include measurements and data transfer out the ethernet (reading elements only). (100BaseT Ethernet, 3 meter RJ-45 crossover cable, PIII-800, Windows version 98 SE, VB version 6.0, direct Winsocket interface).
- Sample count = 1000 (into memory buffer), auto zero off.
- Auto zero off, NPLC = 0.002.
- Additional Uncertainty

Type	Range	7710 Module Using CJC
J	0 to +760°C	1.5°C
K	0 to +1372°C	—
N	0 to +1300°C	0.5°C
T	0 to +400°C	0.5°C
E	0 to +1000°C	0.5°C
R	+400 to +1768°C	0.9°C
S	+400 to +1768°C	0.9°C
B	+1100 to +1820°C	0.9°C

Plug-In Modules						
Front Terminals		7709 Sim.	7701, 7703, 7700 and 7707 Sim.	7708 Using CJC	7706 Using CJC	7710 Using CJC
Type	Range	Sim. Ref. Junction	Ref. Junction	Ref. Junction	CJC	CJC
J	-200 to 0°C	0.1	0.1	0.3	0.8	1.6
K	-200 to 0°C	0.2	0.2	0.4	0.8	1.6
N	-200 to 0°C	0.3	0.3	0.6	0.8	1.6
T	-200 to 0°C	0.2	0.1	0.4	0.8	1.6
E	-200 to 0°C	-	0.1	0.3	0.8	1.6
R	0 to +400°C	0.4	0.6	1.2	0.5	1.0
S	0 to +400°C	0.4	0.6	1.2	0.5	1.0
B	+350 to +1100°C	0.8	0.3	1.7	0.5	1.0

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

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

- Front Panel resolution is limited to 0.1Ω.

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AC SPECIFICATIONS¹

					Accuracy: $\pm$ (% of reading + % of range), 23°C $\pm$ 5°C				
Function	Range	Resolution	Calibration Cycle		3 Hz-10 Hz ¹⁴	10 Hz-20 kHz ⁸	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	(all ranges)						
	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	(all ranges)						
	750.000 V	1.0 mV							
(Temp. Coeff.) ⁹ /°C ³					0.035 + 0.003	0.005 + 0.003	0.006 + 0.005	0.01 + 0.006	0.03 + 0.01
Current ²	1.000000 A	1.0 μ A	90 Day/1 Yr.		3 Hz-10 Hz	10 Hz-3 kHz	3 kHz-5kHz		
	3.00000 ¹⁵ A	10 μ A			0.30 + 0.04	0.10 + 0.04	0.14 + 0.04		
					0.35 + 0.06	0.15 + 0.06	0.18 + 0.06		
					(Temp. Coeff.) ⁹ /°C ³	0.035 + 0.006	0.015 + 0.006	0.015 + 0.006	
					Accuracy $\pm$ (ppm of reading + offset ppm) (3 Hz-500 kHz) (333 ms-2 μ s)				
Frequency ⁴ and Period	100 mV	0.333 ppm	90 Day/1 Yr.		80 ppm + 0.333 ppm (SLOW, 1s gate)				
	to	3.33 ppm			80 ppm + 3.33 ppm (MED, 100ms gate)				
	750 V	33.3 ppm			80 ppm + 33.3 ppm (FAST, 10ms gate)				

Additional Uncertainty $\pm$ (% of reading)

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

CREST FACTOR ⁵ :	1-2	2-3	3-4	4-5
Additional Uncertainty:	0.05	0.15	0.30	0.40
Maximum Crest Factor: 5 at full-scale.				

AC MEASUREMENT CHARACTERISTICS

AC Volts

MEASUREMENT METHOD: AC-coupled, True RMS.

INPUT IMPEDANCE: 1M Ω $\pm$ 2% // by <100pF.

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

AC Current

MEASUREMENT METHOD: AC-coupled, True RMS.

SHUNT RESISTANCE: 0.1 Ω .

BURDEN VOLTAGE: 1A <0.5Vrms, 3A <1.5Vrms. Add 1.5Vrms 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 CMRR⁶: 70dB.

VOLT HERTZ PRODUCT¹⁶: $\leq 8 \times 10^7$ Volt-Hz.

AC MEASUREMENT SPEEDS^{7,13}

Single Channel, 60Hz (50Hz) Operation

Function	Digits	Readings/s	Rate	Bandwidth
ACV, ACI	6.5	2s/Reading	SLOW	3 Hz-300 kHz
	6.5	4.8 (4)	MED	30 Hz-300 kHz
	6.5 ⁹	40 (32)	FAST	300 Hz-300 kHz

Function	Digits	Readings/s	Rate	Bandwidth
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 Into Memory^{10,11}

7710 SCANNING ACV: 440/s.

7710 Scanning ACV with Auto Delay On: 2s/reading.

AC SYSTEM SPEEDS^{7,9,11}

RANGE CHANGES¹²: 4/s (3/s).

FUNCTION CHANGES¹²: 4/s (3/s).

AUTORANGE TIME: < 3s.

ASCII READINGS TO RS-232 (115.2k baud): 300/s.

MAX. INTERNAL TRIGGER RATE: 2800/s.

MAX. EXTERNAL TRIGGER RATE: 2000/s.

AC Notes

- 20% overrange except on 750V and 3A.
- Specifications 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.
- Specifications are for square wave inputs only. Input signal must be >10% of ACV range. If input is <20mV on the 100mV range then the frequency must be >10Hz. For sinewave inputs, frequency must be >100Hz.
- Applies to non-sine waves >5Hz and <500Hz. Crest factor greater than 4.3 is guaranteed by design only.
- For 1k Ω 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.
- For ACV inputs at frequencies of 50 or 60Hz ($\pm$ 10%) add the following to “% of Range” uncertainty: 100mv 0.25%, 1V 0.05%, 10V 0.13%, 100V 0.03%, 750V 0.01%.
- Auto Zero off.
- Sample count = 1000 (into memory buffer).
- DETector:BANDwidth 300 with nPLC = 0.006.
- Maximum useful limit with trigger delay = 175ms.
- Includes measurement and data transfer out Ethernet (Reading Element only). (100bTx Ethernet, 3 meter RJ-45 crossover cable, PIII-800, Windows version 98 SE, VB version 6.0, direct WinSocket interface).
- Typical uncertainties. Typical represents two sigma or 95% of manufactured units measure < 0.35% of reading and three sigma or 99.7% < 1.06% of reading.
- For signal levels >2.2A, add additional 0.4% to “of reading” uncertainty.
- 750Vac range limited to 707Vrms and 85kHz (sinewave input) or 8×10^7 Volt-Hz.

2701 Ethernet Multimeter/Data Acquisition System

GENERAL SPECIFICATIONS

EXPANSION SLOTS: 2.
POWER SUPPLY: 100V / 120V / 220V / 240V.
LINE FREQUENCY: 50Hz to 60Hz and 400Hz, automatically sensed at power-up.
POWER CONSUMPTION: 80VA.
OPERATING ENVIRONMENT: Specified for 0°C to 50°C. Specified to 80% RH at 35°C. Altitude up to 2000 meters.
STORAGE ENVIRONMENT: -40°C to 70°C.
BATTERY: Lithium Ion battery-backed memory, 30 days of buffer storage @ 23°C and >4 hours charge time. Battery lifetime: 3 years @ 23°C, 1.5 years @ 50°C.
WARRANTY: 1 year, excludes battery.
EMC: Conforms to European Union EMC Directive.
SAFETY: Conforms to European Union Low Voltage Directive.
VIBRATION: MIL-PRF-28800F Class 3, Random.
WARM-UP: 2 hours to rated accuracy.
DIMENSIONS:
Rack Mounting: 89mm high × 213mm wide × 370mm deep (3.5 in. × 8.375 in. × 14.563 in.).
Bench Configuration (with handle and feet): 104mm high × 238mm wide × 370mm deep (4.125 in. × 9.375 in. × 14.563 in.).
SHIPPING WEIGHT: 4.75kg (10 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.
Memory Size: 450,000 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:
Ethernet: RJ-45 connector, TCP/IP (Auto sensed 10bT or 100bTx) and RS-232C.
SCPI (Standard Commands for Programmable Instruments)
ACCESSORIES SUPPLIED: Model 1751 Safety Test Leads, Product Information CD-ROM, Model 2701 Networking Manual, Model 2701 Getting Started Foldout, 3m crossover Ethernet cable. Software CD-ROM with IVI/VISA drivers for VB, VC/C++, LabVIEW, TestPoint, and LabWindows/CVI, and free runtime startup software.
ACCESSORIES AVAILABLE:
77XX Modules
Extended Warranty
ExcellINX-1A (Excel add-in datalogger software)
TestPoint™ Software Development Package
IP CONFIGURATION: Static or DHCP
PASSWORD PROTECTION: 11 characters
SOFTWARE: Windows 98, NT, 2000, ME and XP compatible, Internet Explorer 5.0 or higher required. Web pages served by 2701.