■ DC Characteristics

Accuracy Specifications ± (% of reading + % of range) [1]

Function	Range [3]	Test Current or Burden Voltage	24 Hour [2] 23°C ± 1°C	90 Day 23°C ± 5°C	1 Year 23°C ± 5°C	Temperature Coefficient /°C 0°C – 18°C 28°C – 55°C
DC Voltage	100.0000 mV		0.0030 + 0.0030	0.0040 + 0.0035	0.0050 + 0.0035	0.0005 + 0.0005
	1.000000 V		0.0020 + 0.0006	0.0030 + 0.0007	0.0040 + 0.0007	0.0005 + 0.0001
	10.00000 V		0.0015 + 0.0004	0.0020 + 0.0005	0.0035 + 0.0005	0.0005 + 0.0001
	100.0000 V		0.0020 + 0.0006	0.0035 + 0.0006	0.0045 + 0.0006	0.0005 + 0.0001
	1000.000 V		0.0020 + 0.0006	0.0035 + 0.0010	0.0045 + 0.0010	0.0005 + 0.0001
Resistance [4]	100.0000 Ω	1 mA	0.0030 + 0.0030	0.008 + 0.004	0.010 + 0.004	0.0006 + 0.0005
	1.000000 kΩ	1 mA	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	0.0006 + 0.0001
	10.00000 kΩ	100 μA	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	0.0006 + 0.0001
	100.0000 kΩ	10 μA	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	0.0006 + 0.0001
	1.000000 MΩ	5 μA	0.002 + 0.001	0.008 + 0.001	0.010 + 0.001	0.0010 + 0.0002
	10.00000 MΩ	500 nA	0.015 + 0.001	0.020 + 0.001	0.040 + 0.001	0.0030 + 0.0004
	100.0000 MΩ	500 nA // 10 MΩ	0.300 + 0.010	0.800 + 0.010	0.800 + 0.010	0.1500 + 0.0002
DC Current	10.00000 mA	< 0.1 V	0.005 + 0.010	0.030 + 0.020	0.050 + 0.020	0.002 + 0.0020
	100.0000 mA	< 0.6 V	0.01 + 0.004	0.030 + 0.005	0.050 + 0.005	0.002 + 0.0005
	1.000000 A	< 1 V	0.05 + 0.006	0.080 + 0.010	0.100 + 0.010	0.005 + 0.0010
	3.000000 A	< 2 V	0.10 + 0.020	0.120 + 0.020	0.120 + 0.020	0.005 + 0.0020
Continuity	1000.0 Ω	1 mA	0.002 + 0.010	0.008 + 0.020	0.010 + 0.020	0.001 + 0.002
Diode Test	1.0000 V	1 mA	0.002 + 0.010	0.008 + 0.020	0.010 + 0.020	0.001 + 0.002
DC:DC Ratio	100 mV to 1000 V		(Input Accuracy) + (Reference Accuracy) *Input Accuracy* = accuracy specification for the HI-LO input signal. *Reference Accuracy* = accuracy specification for the HI-LO reference input signal.			

Transfer Accuracy (typical)

$$\frac{(\text{24 hour \% of range error})}{2}$$

Conditions:
- Within 10 minutes and ± 0.5°C.
- Within ±10% of initial value.
- Following a 2-hour warm-up.
- Fixed range between 10% and 100% of full scale.
- Using 6½ digit slow resolution (100 PLC).
- Measurements are made using accepted metrology practices.

Measuring Characteristics

DC Voltage

Measurement Method:	Continuously integrating, multi-slope III A/D converter.
A/D Linearity:	0.0002% of reading + 0.0001% of range
Input Resistance:	
0.1 V, 1 V, 10 V ranges	Selectable 10 MΩ or >10 GΩ [11]
100 V, 1000 V ranges	10 MΩ ±1%
Input Bias Current:	< 30 pA at 25°C
Input Terminals:	Copper alloy
Input Protection:	1000 V on all ranges

Resistance

Measurement Method:	Selectable 4-wire or 2-wire ohms. Current source referenced to LO input.
Max. Lead Resistance: (4-wire ohms)	10% of range per lead for 100 Ω, 1 kΩ ranges. 1 kΩ per lead on all other ranges.
Input Protection:	1000 V on all ranges

DC Current

Shunt Resistor:	0.1Ω for 1A, 3A. 5Ω for 10 mA, 100 mA
Input Protection:	Externally accessible 3A, 250 V fuse Internal 7A, 250 V fuse

Continuity / Diode Test

Response Time:	300 samples/sec with audible tone
Continuity Threshold:	Adjustable from 1 Ω to 1000 Ω

DC:DC Ratio

Measurement Method:	Input HI-LO / Reference HI-LO
Input HI-LO	100 mV to 1000 V ranges
Reference HI-Input LO	100 mV to 10 V ranges (autoranged)
Input to Reference	Reference LO to Input LO voltage < 2 V Reference HI to Input LO voltage < 12V

Measurement Noise Rejection
60 Hz (50 Hz) [5]
DC CMRR 140 dB

Integration Time	Normal Mode Rejection [6]
100 PLC / 1.67s (2s)	60 dB [7]
10 PLC / 167 ms (200 ms)	60 dB [7]
1 PLC / 16.7 ms (20 ms)	60 dB [7]
0.2 PLC / 3 ms (3 ms)	0 dB
0.02 PLC / 400 μs (400 μs)	0 dB

Operating Characteristics [8]

Function	Digits	Readings/s	Additional Noise Error
DCV, DCI, and Resistance	6½	0.6 (0.5)	0% of range
	6½	6 (5)	0% of range
	5½	60 (50)	0.001% of range
	5½	300	0.001% of range [10]
	4½	1000	0.01% of range [10]

System Speeds [9]

Function Change	26/sec
Range Change	50/sec
Autorange Time	<30 ms
ASCII readings to RS-232	55/sec
ASCII readings to HP-IB	1000/sec
Max. Internal Trigger Rate	1000/sec
Max. External Trigger Rate to Memory	1000/sec
Max. External Trigger Rate to HP-IB	900/sec

Autozero OFF Operation
Following instrument warm-up at calibration temperature ±1°C and <10 minutes, add 0.0002% range additional error + 5 μV.

Settling Considerations
Reading settling times are affected by source impedance, cable dielectric characteristics, and input signal changes.

Measurement Considerations
HP recommends the use of Teflon® or other high-impedance, low-dielectric absorption wire insulation for these measurements.

[1] Specifications are for 1-hour warm-up at 6½ digits.
[2] Relative to calibration standards.
[3] 20% overrange on all ranges, except 1000 Vdc, 3 A range.
[4] Specifications are for 4-wire ohms function, or 2-wire ohms using Math Null. Without Math Null, add 0.2 Ω additional error in 2-wire ohms function.
[5] For 1 kΩ unbalance in LO lead.
[6] For power-line frequency ± 0.1%.
[7] For power-line frequency ± 1%, subtract 20 dB. For ± 3%, subtract 30 dB.
[8] Readings speeds for 60 Hz and (50 Hz) operation, Autozero Off.
[9] Speeds are for 4½ digits, Delay 0, Autozero OFF, and Display OFF. Includes measurement and data transfer over HP-IB.
[10] Add 20 μV for dc volts, 4 μA for dc current, or 20 mΩ for resistance.
[11] For these ranges, inputs beyond ±17V are clamped through 100 kΩ (typical).

Teflon is a registered trademark of E.I. duPont deNemours and Co.

■ AC Characteristics

Accuracy Specifications ± (% of reading + % of range) [1]

Function	Range [3]	Frequency	24 Hour [2] 23°C ± 1°C	90 Day 23°C ± 5°C	1 Year 23°C ± 5°C	Temperature Coefficient/°C 0°C – 18°C 28°C – 55°C
True RMS AC Voltage [4]	100.0000 mV	3 Hz – 5 Hz	1.00 + 0.03	1.00 + 0.04	1.00 + 0.04	0.100 + 0.004
		5 Hz – 10 Hz	0.35 + 0.03	0.35 + 0.04	0.35 + 0.04	0.035 + 0.004
		10 Hz – 20 kHz	0.04 + 0.03	0.05 + 0.04	0.06 + 0.04	0.005 + 0.004
		20 kHz – 50 kHz	0.10 + 0.05	0.11 + 0.05	0.12 + 0.05	0.011 + 0.005
		50 kHz – 100 kHz	0.55 + 0.08	0.60 + 0.08	0.60 + 0.08	0.060 + 0.008
		100 kHz – 300 kHz [6]	4.00 + 0.50	4.00 + 0.50	4.00 + 0.50	0.20 + 0.02
	1.000000 V to 750.000 V	3 Hz – 5 Hz	1.00 + 0.02	1.00 + 0.03	1.00 + 0.03	0.100 + 0.003
		5 Hz – 10 Hz	0.35 + 0.02	0.35 + 0.03	0.35 + 0.03	0.035 + 0.003
		10 Hz – 20 kHz	0.04 + 0.02	0.05 + 0.03	0.06 + 0.03	0.005 + 0.003
		20 kHz – 50 kHz	0.10 + 0.04	0.11 + 0.05	0.12 + 0.05	0.011 + 0.005
		50 kHz – 100 kHz [5]	0.55 + 0.08	0.60 + 0.08	0.60 + 0.08	0.060 + 0.008
		100 kHz – 300 kHz [6]	4.00 + 0.50	4.00 + 0.50	4.00 + 0.50	0.20 + 0.02
True RMS AC Current [4]	1.000000 A	3 Hz – 5 Hz	1.00 + 0.04	1.00 + 0.04	1.00 + 0.04	0.100 + 0.006
		5 Hz – 10 Hz	0.30 + 0.04	0.30 + 0.04	0.30 + 0.04	0.035 + 0.006
		10 Hz – 5 kHz	0.10 + 0.04	0.10 + 0.04	0.10 + 0.04	0.015 + 0.006
	3.00000 A	3 Hz – 5 Hz	1.10 + 0.06	1.10 + 0.06	1.10 + 0.06	0.100 + 0.006
		5 Hz – 10 Hz	0.35 + 0.06	0.35 + 0.06	0.35 + 0.06	0.035 + 0.006
		10 Hz – 5 kHz	0.15 + 0.06	0.15 + 0.06	0.15 + 0.06	0.015 + 0.006

Additional Low Frequency Errors (% of reading)

Frequency	Slow	AC Filter Medium	Fast
10 Hz – 20 Hz	0	0.74	––
20 Hz – 40 Hz	0	0.22	––
40 Hz – 100 Hz	0	0.06	0.73
100 Hz – 200 Hz	0	0.01	0.22
200 Hz – 1 kHz	0	0	0.18
> 1 kHz	0	0	0

Additional Crest Factor Errors (non-sinewave) [7]

Crest Factor	Error (% of reading)
1 – 2	0.05%
2 – 3	0.15%
3 – 4	0.30%
4 – 5	0.40%

Sinewave Transfer Accuracy (typical)

Frequency	Error (% of range)
10 Hz – 50 kHz	0.002%
50 kHz – 300 kHz	0.005%

Conditions:

- Sinewave input.
- Within 10 minutes and ± 0.5°C.
- Within ±10% of initial voltage and ±1% of initial frequency.
- Following a 2-hour warm-up.
- Fixed range between 10% and 100% of full scale (and <120 V).
- Using 6½ digit resolution.
- Measurements are made using accepted metrology practices.

Measuring Characteristics

Measurement Noise Rejection [8]

AC CMRR	70 dB

True RMS AC Voltage

Measurement Method:	AC-coupled True RMS – measures the ac component of input with up to 400 Vdc of bias on any range.
Crest Factor:	Maximum 5:1 at full scale
AC Filter Bandwidth:	
Slow	3 Hz – 300 kHz
Medium	20 Hz – 300 kHz
Fast	200 Hz – 300 kHz
Input Impedance:	1 MΩ ± 2%, in parallel with 100 pF
Input Protection:	750 V rms all ranges

True RMS AC Current

Measurement Method:	Direct coupled to the fuse and shunt. AC-coupled True RMS measurement (measures the ac component only).
Shunt Resistor:	0.1 Ω for 1 A and 3 A ranges
Burden Voltage:	1 A range: < 1 V rms 3 A range: < 2 V rms
Input Protection:	Externally accessible 3A, 250 V fuse Internal 7A, 250 V fuse

Settling Considerations

Applying >300 V rms (or >1 A rms) will cause self-heating in signal-conditioning components. These errors are included in the instrument specifications. Internal temperature changes due to self-heating may cause additional error on lower ac voltage ranges. The additional error will be less than 0.02% of reading and will generally dissipate within a few minutes.

Operating Characteristics [9]

Function	Digits	Reading/s	AC Filter
ACV, ACI	6½	7 sec/reading	Slow
	6½	1	Medium
	6½	1.6 [10]	Fast
	6½	10	Fast
	6½	50 [11]	Fast

System Speeds [11] , [12]

Function or Range Change	5/sec
Autorange Time	<0.8 sec
ASCII readings to RS-232	50/sec
ASCII readings to HP-IB	50/sec
Max. Internal Trigger Rate	50/sec
Max. External Trigger Rate to Memory	50/sec
Max. External Trigger Rate to HP-IB/RS-232	50/sec

[1] Specifications are for 1-hour warm-up at 6½ digits, Slow ac filter, sinewave input.
[2] Relative to calibration standards.
[3] 20% overrange on all ranges, except 750 Vac, 3 A range.
[4] Specifications are for sinewave input >5% of range. For inputs from 1% to 5% of range and <50 kHz, add 0.1% of range additional error. For 50 kHz to 100 kHz, add 0.13% of range.
[5] 750 Vac range limited to 100 kHz or $8x10^7$ Volt-Hz.
[6] Typically 30% of reading error at 1 MHz.
[7] For frequencies below 100 Hz, slow AC filter specified for sinewave input only.
[8] For 1 kΩ unbalance in LO lead.
[9] Maximum reading rates for 0.01% of ac step additional error. Additional settling delay required when input dc level varies.
[10] For External Trigger or remote operation using default settling delay (Delay Auto).
[11] Maximum useful limit with default settling delays defeated.
[12] Speeds are for 4½ digits, Delay 0, Display OFF, and Fast AC filter.

■ Frequency and Period Characteristics

Accuracy Specifications ± (% of reading) [1]

Function	Range [3]	Frequency	24 Hour [2] 23°C ± 1°C	90 Day 23°C ± 5°C	1 Year 23°C ± 5°C	Temperature Coefficient/°C 0°C – 18°C 28°C – 55°C
Frequency, Period [4]	100 mV to 750 V	3 Hz – 5 Hz	0.10	0.10	0.10	0.005
		5 Hz – 10 Hz	0.05	0.05	0.05	0.005
		10 Hz – 40 Hz	0.03	0.03	0.03	0.001
		40 Hz – 300 kHz	0.006	0.01	0.01	0.001

Additional Low-Frequency Errors (% of reading) [4]

	Resolution		
Frequency	**6½**	**5½**	**4½**
3 Hz – 5 Hz	0	0.12	0.12
5 Hz – 10 Hz	0	0.17	0.17
10 Hz – 40 Hz	0	0.2	0.2
40 Hz – 100 Hz	0	0.06	0.21
100 Hz – 300 Hz	0	0.03	0.21
300 Hz – 1 kHz	0	0.01	0.07
> 1 kHz	0	0	0.02

Transfer Accuracy (typical)

0.0005% of reading

Conditions:

- Within 10 minutes and ± 0.5°C.
- Within ±10% of initial value.
- Following a 2-hour warm-up.
- For inputs > 1 kHz and > 100 mV.
- Using 6½ digit slow resolution (1 second gate time).
- Measurements are made using accepted metrology practices.

Measuring Characteristics

Frequency and Period

Measurement Method:	Reciprocal-counting technique. AC-coupled input using the ac voltage measurement function.
Voltage Ranges:	100 mV rms full scale to 750 V rms. Auto or manual ranging.
Gate Time:	10 ms, 100 ms, or 1 sec

Settling Considerations

Errors will occur when attempting to measure the frequency or period of an input following a dc offset voltage change. The input blocking RC time constant must be allowed to fully settle (up to 1 sec) before the most accurate measurements are possible.

Measurement Considerations

All frequency counters are susceptible to error when measuring low-voltage, low-frequency signals. Shielding inputs from external noise pickup is critical for minimizing measurement errors.

Operating Characteristics [5]

Function	Digits	Reading/s
Frequency,	6½	1
Period	5½	9.8
	4½	80

System Speeds [5]

Configuration Rates	14/sec
Autorange Time	<0.6 sec
ASCII readings to RS-232	55/sec
ASCII readings to HP-IB	80/sec
Max. Internal Trigger Rate	80/sec
Max. External Trigger Rate to Memory	80/sec
Max. External Trigger Rate to HP-IB/RS-232	80/sec

[1] Specifications are for 1-hour warm-up at 6½ digits.
[2] Relative to calibration standards.
[3] 20% overrange on all ranges, except 750 Vac range.
[4] Input > 100 mV.
For 10 mV input, multiply % of reading error x10.
[5] Speeds are for 6½ digits, Delay 0, Display OFF, and Fast AC filter.

■ General Information

General Specifications	
Power Supply:	100 V / 120 V / 220 V / 240 V ±10%.
Power Line Frequency:	45 Hz to 66 Hz and 360 Hz to 440 Hz. Automatically sensed at power-on.
Power Consumption:	25 VA peak (10 W average)
Operating Environment:	Full accuracy for 0°C to 55°C Full accuracy to 80% R.H. at 40°C
Storage Environment:	-40°C to 70°C
Operating Altitude:	Up to 2,000 meters
Rack Dimensions (HxWxD):	88.5 mm x 212.6 mm x 348.3 mm
Weight:	3.6 kg (8 lbs)
Safety:	Designed to CSA 231, UL 1244, IEC 1010-1 (1990)
EMI: [1]	MIL-461C (data on file), CE B
Vibration and Shock:	MIL-T-28800E Type III, Class 5 (data on file)
Warranty:	3 years standard

Accessories Included
Test Lead Kit with probes, alligator, and grabber attachments.
User's Guide, Service Guide, test report, and power cord.

Triggering and Memory	
Reading HOLD Sensitivity:	0.01%, 0.1%, 1%, or 10% of reading
Samples per Trigger:	1 to 50,000
Trigger Delay:	0 to 3600 sec (10 μs step size)
External Trigger Delay:	< 1 ms
External Trigger Jitter:	< 500 μs
Memory:	512 readings

Math Functions
Null, Min/Max/Average, dB, dBm, Limit Test (with TTL output).
dBm reference resistances: 50, 75, 93, 110, 124, 125, 135, 150, 250, 300, 500, **600**, 800, 900, 1000, 1200, or 8000 ohms.

Standard Programming Languages
SCPI (*Standard Commands for Programmable Instruments*)
HP 3478A Language Emulation
Fluke 8840A, Fluke 8842A Language Emulation

Remote Interface
HP-IB (IEEE-488.1, IEEE-488.2) and RS-232C

[1] Slight accuracy degradation may result when subjected to 3 V/m radiated fields.