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Table 1-1. Specifications.

DC VOLTAGE

Input Characteristics

Range	Maximum Reading (5 digit)	Resolution 6 Digit	Resolution 5 Digit	Resolution 4 Digit	Input Resistance	Maximum Input Voltage
0.1V	.119999V	100 nV	1 μV	10 μV	> $10^{10}\Omega$	±1000V peak
1.0V	1.19999V	1 μV	10 μV	100 μV	> $10^{10}\Omega$	
10.0V	11.9999V	10 μV	100 μV	1mV	> $10^{10}\Omega$	
100.0V	119.999V	100 μV	1mV	10mV	10MΩ ±.5%	
1000.0V	1000.00V	1mV	10mV	100mV	10MΩ ±.5%	

Guard to Chassis: ±500V peak
Guard to Low: ±200V peak

Measurement Accuracy: ± (% of Reading + Number of Counts).
Auto-zero on and filter off.

24 hours: 23°C ± 1°C

Range	6 Digit (≥ 10 PLC*)	6 Digit (1 PLC)	5 Digit (.1 PLC)	4 Digit (.01 PLC)
0.1V	.0022 + 24	0.0024 + 32	0.007 + 14	0.06 + 3
1.0V	0.0009 + 4	0.0012 + 5	0.007 + 3	0.06 + 2
10.0V	0.0008 + 2	0.0011 + 3	0.007 + 2	0.06 + 2
100.0V	0.0011 + 3	0.0014 + 4	0.007 + 2	0.06 + 2
1000.0V[1]	0.0011 + 2	0.0013 + 3	0.007 + 2	0.06 + 2

90 Day: 23°C ± 5°C

Range	6 Digit (≥ 10 PLC)	6 Digit (1 PLC)	5 Digit (.1 PLC)	4 Digit (.01 PLC)
0.1V	0.0034 + 24	0.0035 + 32	0.008 + 14	0.06 + 3
1.0V	0.0024 + 4	0.0025 + 5	0.007 + 3	0.06 + 2
10.0V	0.0023 + 2	0.0024 + 3	0.007 + 2	0.06 + 2
100.0V	0.0026 + 3	0.0027 + 4	0.007 + 2	0.06 + 2
1000.0V[1]	0.0024 + 2	0.0025 + 3	0.007 + 2	0.06 + 2

[1]Add $.012\left(\frac{\text{Input Voltage}}{1000}\right)^2$% to % reading.

> 90 days: 23°C ± 5°C
Add ± .0006% of Reading/month to 90 day accuracy.

Temperature Coefficient: (5 digit)[2] ± (% of Reading + Number of Counts)/°C

Range	0.1V	1.0V	10.0V	100.0V	1000.0V
Temp. Coef	0.0002 + 0.2	0.0002 + 0.02	0002 + .002	0.0002 + 0.02	0.0002 + 0.02

Auto-Zero OFF: (5 digit)[2]
For a stable environment ± 1°C, add 10 counts for .1V range, 1 count for 1V and 100 ranges, and .1 count for 10V and 1000V ranges.

Filter ON: Rejection is > 60 dB at 50 Hz. Add 2μV for .1V, 1.0V and 10V range and 200 μV for 100V and 1000V range.

[2]For 6 digits, multiply counts by 10
For 4 digits, multiply counts by .1

*Integration in POWER LINE CYCLES

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Table 1-1. Specifications (Cont'd).

Response Time:
Filter OFF - For default delay (0.0 seconds), error is < .0005 % of input voltage step

Filter ON: For default delay (.65 seconds), error is < .01% of input voltage step.

Integration Time in Power Line Cycles (PLC)	Noise Rejection (dB)		
	AC[3,4] NMR	AC[3,4] ECMR[4]	DC ECMR[4]
.01 PLC or .1 PLC	0	90	140
> 1 PLC	60	150	140
> 1 PLC with Filter	120	160	140

[3]For 50, 60 Hz (depending on option) ± .09%.
[4]1 KΩ unbalance in Lo

AC RMS VOLTAGE

Input Characteristics

Range	Maximum Reading (5 Digit)	Resolution 6 Digit	Resolution 5 Digit	Resolution 4 Digit	Input Impedance	Maximum Input Voltage
1.0V	1.19999V	1 μV	10 μV	100 μV	1MΩ ±.5% shunted by < 75pF	±1000V peak (700V rms) 10^8VHZ
10.0V	11.9999V	10 μV	100 μV	1mV		
100.0V	119.999V	100 μV	1mV	10mV		
1000.0V	700.00V	1mV	10mV	100mV		

Guard to Chassis: ±500V peak
Guard to Low: ±200V peak

Measurement Accuracy: ± (% of Reading + Number of Counts)
Auto-zero on, > 1% of full scale, and DC component < 10% of AC Component.
For inputs > 500V rms add .07% of reading.

24 hours: 23°C ± 1°C

Integration Time In Power Line Cycles (PLC)	Frequency in Hz				
	Filter Off— 20 to 30	400-20k 30-20k	20k to 50k 20k to 50k	50k to 100k 50k to 100k	[1]100k to 250k [1]100k to 250k
6 Digit (≥ 1 PLC)	.33 + 300	.05 + 550	.15 + 1500	.53 + 2700	5.0 + 6300
5 Digit (.1 PLC)	.34 + 33	.06 + 55	.16 + 150	.54 + 270	5.0 + 630
4 Digit (.01 PLC)	.39 + 5	.11 + 7	.21 + 17	.59 + 29	5.1 + 65

90 day: 23°C ± 5°C

Integration Time in Power Line Cycles (PLC)	Frequency in Hz				
	Filter Off— 20 to 30	400-20k 30-20k	20k to 50k 20k to 50k	50 k to 100k 50k to 100k	[1]100k to 250k [1]100k to 250k
6 Digit (≥ 1 PLC)	.35 + 500	.07 + 700	.17 + 1700	.55 + 2900	5.0 + 6500
5 Digit (.1 PLC)	.36 + 53	.08 + 73	.18 + 173	.56 to 293	5.0 + 653
4 Digit (.01 PLC)	.41 + 7	.13 + 9	.23 + 19	.61 + 31	5.1 + 67

[1]Frequencies > 100 kHz are specified for 1.0V and 10V ranges only.

> 90 day: 23°C ± 5°C (5 digit)[2]
Add ± 1.004% of Reading + 12 counts/month to 90 day accuracy.

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Table 1-1. Specifications (Cont'd.)

Temperature Coefficient: (5 digit)[2]
± (% of Reading + Number of Counts)/°C
± (.008 + 6)/°C for DC component < 10% AC component
± (.008 + 12)/°C otherwise

[2]For 6 digit, multiply counts by 10.
For 4 digit, multiply counts by .1.

DC Component > 10% of AC Component: (5 digit)[2]
Add ± (.05% of Reading + 50 counts) to accuracy.

Crest Factor: > 7 at full scale.

Common Mode Rejection (1kΩ unbalance in Lo): > 90 dB DC to 60 Hz

Auto-Zero Off: For stable environment ± 1°C no accuracy change.

Default Delays:
Filter Off[4] 0.6 seconds
Filter On - .8 seconds

Response Time: For default delay, error is < .1% of input voltage step.

RESISTANCE

Input Characteristics

Range	Maximum Reading (5 Digit)	6 Digit	Resolution 5 Digit	4 Digit	Current Through Unknown	Maximum Valid Reading Voltage	Maximum Open Circuit Voltage
100Ω	119.999Ω	100μΩ	1mΩ	10mΩ	1mA	1.2V	5.5V
1kΩ	1199.99Ω	1mΩ	10mΩ	100mΩ	1mA	1.2V	5.5V
10kΩ	11.9999kΩ	10mΩ	100mΩ	1Ω	100μA	1.2V	5.5V
100kΩ	119.999kΩ	100mΩ	1Ω	10Ω	50μA	6V	9.5V
1MΩ	1199.99kΩ	1Ω	10Ω	100Ω	5μA	6V	9.5V
10MΩ	11.9999MΩ	10Ω	100Ω	1kΩ	500nA	6V	9.5V
100MΩ	119.999MΩ	100Ω	1kΩ	10kΩ	≤ 500nA[1]	5V	6.5V
1GΩ	1000.00MΩ	1kΩ	10kΩ	100kΩ	≤ 500nA[1]	5V	5.5V

Non-destructive overload: 350V peak.

Measurement Accuracy: ± (% of Reading + Number of Counts)
Auto Zero on, filter off, and 4-wire ohms.

24 hours: 23°C ± 1°C

Range	6 Digit (≥ 10 PLC)	6 Digit (1 PLC)	5 Digit (.1 PLC)	4 Digit (.01 PLC)
100Ω	0.003 + 24	0.003 + 32	0.009 + 14	0.07 + 3
1kΩ	0.002 + 4	0.003 + 5	0.008 + 3	0.07 + 2
10kΩ	0.002 + 4	0.003 + 5	0.008 + 3	0.07 + 2
100kΩ	0.002 + 2	0.003 + 3	0.008 + 2	0.07 + 2
1MΩ	0.006 + 2	0.006 + 3	0.012 + 2	0.07 + 2
10MΩ	0.041 + 2	0.041 + 3	0.07 + 2	0.12 + 2
100MΩ	1.3 + 1	1.3 + 1	1.5 + 1	1.5 + 1
1GΩ	11 + 1	11 + 1	13 + 1	13 + 1

[1]Ohms source is a 500nA current source in parallel with a 10MΩ resistance

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Table 1-1. Specifications (Cont'd).

90 days: 23°C ± 5°C

Range	6 Digit (≥ 10 PLC)	6 Digit (1 PLC)	5 Digit (.1 PLC)	4 Digit (.01 PLC)
100Ω	0.004 + 24	0.004 + 32	0.01 + 14	0.07 + 3
1kΩ	0.003 + 4	0.004 + 5	0.009 + 3	0.07 + 2
10kΩ	0.003 + 4	0.004 + 5	0.009 + 3	0.07 + 2
100kΩ	0.003 + 2	0.004 + 3	0.009 + 2	0.07 + 2
1MΩ	0.007 + 2	0.007 + 3	0.013 + 2	0.07 + 2
10MΩ	0.042 + 2	0.042 + 3	0.07 + 2	0.12 + 2
100MΩ	1.8 + 1	1.8 + 1	2.0 + 1	2.0 + 1
1GΩ	16 + 1	16 + 1	18 + 1	18 + 1

> 90 days: 23°C ±5°C
Add ± 0004% of Reading/month to 90 day accuracy.

2-Wire Ohms Accuracy: Same as 4-wire ohms except add < .2 ohm offset.

Auto-Zero Off Accuracy: (5 digit)[2]
For a stable environment ± 1°C, add 10 counts for 100Ω range, 1 count for 1kΩ range and 10kΩ ranges, and .2 counts for ≥ 100kΩ ranges.. Changes in lead resistance are not corrected for a 4-wire ohms.

Range	Maximum Lead Resistance for 4-Wire Ohms	Maximum Offset Voltage for Offset Compensated Ohms	Default Delay in Seconds
100Ω	10Ω	.01V	0
1kΩ	100Ω	.1V	0
10kΩ	1000Ω	.1V	0
100kΩ	1000Ω	.5V	.001
1MΩ	1000Ω		.008
10MΩ	1000Ω		.08
100MΩ	1000Ω		.08
1GΩ	1000Ω		.08

Offset Compensated Ohms Accuracy: Same as 2-wire and 4 wire except maximum reading may be reduced by 9% for large offset voltages. 100Ω - 100kΩ range are used.

Response Time: With default delay and < 200pF of capacitance, first reading is in specification.

Filter is not operational in ohms.

Temperature Coefficient: (5 digit)[2] ± (% of Reading + Number of Counts)/°C

Range	100Ω	1kΩ 10kΩ 100kΩ	1MΩ	10MΩ	100MΩ	1GΩ
T.C.	.0004 +.2	.0004 −.02	.0004 +.004	.0010 +.004	.16 +0	1.6 +0

[2]For 4 digit, multiply counts by .1.
For 6 digit, multiply counts by 10.

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Table 1-1. Specifications (Cont'd).

RATIO

Type: DC/DC, AC/DC, or (AC+DC)/DC

Method: 4-Wire with Volts Lo input common.

$$\text{Ratio} = \frac{\text{Signal Voltage}}{\text{Ref. Hi Voltage} - \text{Ref. Lo Voltage}}$$

Signal Measurement: Same as DC Volts, or AC + DC Volts.

Reference Measurement: Automatically selects .1V, 1V, or 10V DC Volts range and a 0.0 msec. settling time. Filter is off.

Maximum Reference Voltage:

Ref. Hi:	± 12V
Ref. Lo:	± 9% of Ref. Hi.
Ref. Hi-Ref. Lo:	± 11.9999V
Protection:	± 350V peak

Accuracy: Total % signal error + total % reference error (same as .1V, 1V, or 10V DC volts)

MEMORY

Reading Store:

- Can store up to 350 most recent readings.
- Can be recalled from the HP-IB interface or the front panel.

Program Memory:

- Can execute an internal program which controls instrument configuration and measurement sequence.
- Program is input from the HP-IB interface with up to 1400 ASCII characters.

Memory Size:

- Total size 1400 bytes
- Memory used = 1 byte per ASCII character + 4 bytes per reading stored.

READING RATE

Reading rates are with autorange, math, display and filter off. Output is to internal memory using internal trigger and packed Mode. Packed output in place of internal memory adds .35 msec; ASCII output adds 2.3 msec.

Rates vs. Integration Time and Auto-Zero: DC Volts and 100Ω thru 10kΩ ranges with default (-0.0 sec.) delay. Also, AC or AC + DC Volts and 100kΩ thru 10MΩ ranges with 0.0 sec. delay.

Integration Time in Power Line Cycles (PLC)	Rates			
	Auto-Zero Off		Auto-Zero On	
	60 Hz	50 Hz	60 Hz	50 Hz
0.01	330	290	210	180
.10	210	180	120	100
1.00	48	40	25	20.8
10.00	5.8	4.8	2.9	2.4
100.00	.57	0.47	.29	0.24

Rates with 1 Power Line Cycle Integration and Default Delays.

	Rates	
	60 Hz	50 Hz
– DC Volts and 100Ω thru 10kΩ, Auto-zero Off	46.0	40.00
– DC Volts, Filter ON	1.40	1.47
– AC or AC + DC Volts, Auto zero OFF	12.0	11.00
– AC or AC + DC Volts, Filter ON	1.2	0.95
– 100kΩ range, Auto-zero OFF	46.0	35.0
– 1MΩ range, Auto-zero OFF	34.0	28.0
– 10MΩ range, Auto-zero OFF	9.9	9.0
– 100MΩ and 1GΩ range, Auto-zero OFF	6.6	6.10
– DC/DC ratio	5.2	4.40
Offset Compensated Ohms	10.0	9.00

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Table 1-1. Specifications (Cont'd).

MATH FUNCTION SPECIFICATIONS

General: Math function specifications do not include error in X (instrument reading) or in entered values (R,L,U,Y,Z). Range of values input or output is ± (0.000000 x 10^{-9} to 1999999 x 10^{9}). Out of range values send "LL" to display and + 1999999. x 10^{9} to HP-IB.

PASS/FAIL: Displays: "HI" for values > upper limit (U), "LO" for values < lower limit (L), and X for values between the limits, with no introduced error.

SRQ mask can be programmed to respond to HI or LO conditions.

Maximum execution time: 20ms

STATISTICS:

$$\text{Mean (M)} = X_1 + \frac{1}{C}\sum_{i=1}^{C}(X_i - X_1)$$

$$\text{Variance (V)} = \frac{\sum_{i=1}^{C}(X_i - X)^2 - \frac{1}{C}\left[\sum_{i=1}^{C}(X - X_1)\right]^2}{C - 1}$$

Maximum (U) and Minimum (L) are the most positive and negative instrument readings, respecitveiy. X is displayed during calculation of statistics.

X_1 is the first reading taken after enabling statistics and is stored in the Z register. The number of readings taken (C) is stored in the count register.

$$\text{Accuracy of Mean: } < + \frac{C(U-L)}{10^{11}} + 1 \text{ LSD}$$

$$\text{Accuracy of Variance: } < + \frac{C(U-L)^2}{10^{8}} + 1 \text{ LSD}$$

Maximum execution time: 50ms

NULL: X - X_1 (X_1 is the first valid reading taken after enabling null and is stored in the Z register).

Maximum execution time: 15ms

dBm(R): 10 log $\frac{X^2/R}{1mW}$ R is the user-entered impedance.

Output range: -280 to +340 dBm

Accuracy: ± .001 dBm

Maximum execution time: 150ms

THERMISTOR (°F): Converts resistance of thermistor HP0837-0164 to temperature in °F.

Output range: -112 to 302°F

Accuracy: -103 ≤ T ≤ + 266 °F: ± 11°F max.
-116 ≤ T ≤ + 320°F: + 27°F max.

Maximum execution time: 150ms

THERMISTOR (°C): Converts resistance of thermistor HP0837-1064 to temperature in °C.

Output range: -80 to 150°C

Accuracy: -75 ≤ T ≤ − 130°C ± 06°C max.
-80 ≤ T < + 150°C ± 15°C max.

Maximum execution time: 100ms

SCALE: (X Y)/Y

Accuracy: ± 1 LSD

Maximum execution time: 60ms

% ERROR: 100% x (X-Y)/Y

Accuracy: ± 1 LSD

Maximum execution time 60ms

dB: 20 log $\frac{X}{Y}$

Output Range: -620 to +620 dB

Accuracy: .001 dB

Maximum execution time: 100ms

GENERAL

Voltmeter Control Functions: Description: The voltmeter control function in the math section of the front panel is designed to control the measurement parameters of the 3456A. Included in this front panel section is the:

1) Number of digits displayed.
2) Number of readings per trigger.
3) Delay time between readings.
4) Integration time in number of power line cycles (PLC).

Number of Digits Displayed allows selection of 3 to 6 digits displayed plus sign and exponent. The range of the display is ± 1,999,999 = 9.

Number of Readings per Trigger allows selection of specific number of readings to be taken with just one trigger. The time between readings is controlled by the delay time selected.

Delay Time allows selection of the time between measurement cycles. It is provided to allow the selection of settling time. The range is from 0 to 999.999 sec. in 0.001/sec. increments. Accuracy is 1% of time selected.

Integration Time in Power Line Cycles allows the selection of the time for measurement integration. The units of integration time in power line cycles (PLC) apply for both 50 and 60 Hz power line frequencies. The range of integration time selection is from 0.01 to 100 power line cycles (PLC) per measurement.

Front-Rear Terminal Switch - On the front panel. Operated manually. Its status can be read via software.

The actual measurement time is a function of the integration time, the delay time, auto zero, filter, etc., voltmeter complete, external trigger, and function selected.

Operating Temperature: 0 C to 50 C

Warmup Time: One hour to meet all specifications

Humidity Range: 95% R.H., 0 C to 40 C

Storage Temperature: -40 C to +75 C

Power: 100/120/240V + 5%, -10% 48 Hz to line operation 80VA; 220V ± 10% 48 Hz to line operation 80VA.

Size: 88.9mm high x 425.5mm wide x 527.1mm deep (3½" high x 16¾" wide x 20¾" deep)

Weight: Net 10.49 kg (23.13lbs.)

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1-18. ACCESSORIES AVAILABLE.

1-19. The following is a list of available accessories for the 3456A:

Accessory No.	Description
10631A	HP-IB Cable 1 Meter (39.37 in.)
10631B	HP-IB Cable 2 Meter (78.74 in.)
10631C	HP-IB Cable 4 Meter (157.48 in.)
10631D	HP-IB Cable 0.5 Meter (19.69 in.)
11000A	Test Leads, Dual Banana Both Ends
11002A	Test Leads, Dual Banana to Probe and Alligator
34111A	High Voltage Probe (40 kV dc)
44414A	4 Thermistors

1-20. SAFETY CONSIDERATION.

1-21. The 3456A is a safety class 1 instrument (provided with a protective earth connection). The instrument and manual should be reviewed for safety symbols and instructions before using.

1-22. RECOMMENDED TEST EQUIPMENT.

1-23. Required equipment to maintain the Model 3456A is listed in Table 1-2. Other equipment may be substituted if it meets the requirements listed in the table. The table is also repeated in Section IV of the Operating and Service Manual.

Table 1-2. Recommended Test Equipment.

Instrument	Critical Specification	Recommended Model	Use
DC Voltage Standard	Voltage: 10mV to 1000V Accuracy: ±.005%	Systron Donner Model M107	PAT
DC Transfer Standard	Output Voltages: 1V, 10V, 1.018V, 1.019V Accuracy: ±5ppm Stability: ±.001% (30 Days)	Fluke Model 731B	PA
AC Calibrator	Frequency: 20 Hz to 250 kHz Output Level: 100mV to 1000V Accuracy: ±.1% Voltage Stability (6 mos.) ±.02%	Fluke Model 5200A and Mode 5215A	PAT
Reference Divider	Division Ratio Accuracy: ±.001% Output Voltage Range: 1V to 1kV	Fluke Model 750A	PA
Resistance Standard	Resistance: 100Ω Accuracy: ±.0005%	Guildline Model 9330/100 or 9330A/100	P
	Resistance: 1kΩ Accuracy: ±.0005%	9330/1K or 9330A/1K	PA
	Resistance: 10kΩ Accuracy: ±.001%	9330/10K or 9330A/10K	PA
	Resistance: 100kΩ Accuracy: ±.001%	9330/100K or 9330A/100K	PA
	Resistance: 1MΩ Accuracy: ±.002%	9330/1M	PA
	Resistance: 10MΩ Accuracy: ±.01%	9330/10M	PA
	Resistance*: 1GΩ Accuracy: ±2%	-hp- Part No. 03456-67902	P
DC Null Voltmeter	Voltage Range: 1μV to 10V	-hp- Model 419A	PA
Bus System Analyzer**	HP-IB Control Capability	-hp- Model 59401A	T
Desktop Computer	HP-IB Control Capability serves as printer for output data	-hp- Mode 9825A, 9825B, 9835A, 9845B, or 85A	OT
Oscilloscope**	Bandwidth: DC to 100 MHz Sweep Time: 50ns to 20ms/div	-hp- Model 1740A	I
Digital Voltmeter**	Voltage Range: 100μV to 1000V Resolution: 1 μV	-hp- Model 3456A (or 3455A)	T
Resistors	Resistances: 1 kΩ ± 10%	-hp- Part No. 0684-1021	
Signature Analyzer**		-hp- Model 5004A	T
Test Program Cartridges*		-hp- Part Number 03456-10001 (9825A/B) 03456-10002 (9835A, (9845A/B) 03456-10003 (85A)	T

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