

KEITHLEY

238

The Keithley Model 238 is a high-precision, high-current Source-Measure Unit (SMU) designed for characterization of semiconductor devices, materials, and electronic components. It offers four-quadrant operation, acting as a bipolar voltage or current source while simultaneously measuring current or voltage. Fully guarded and supporting both 2-terminal and 4-terminal remote sensing, the Keithley 238 delivers high accuracy, low noise, and flexible sweep sequencing.

SPECIFICATIONS

General

Interfaces	IEEE-488 (GPIB)
Display	10-character alphanumeric LED display with 3-character exponent
Warm-up Time	1 hour to rated accuracy

Physical

Power Supply	90-125 V AC or 180-250 V AC (rear panel switch selectable), 47-63 Hz, 350 VA maximum
Operating Temperature	0°C to 50°C °C
Dimensions (W×H×D)	133 mm H × 435 mm W × 448 mm D mm
Weight	11.1 kg
Cooling	Forced air (internal fan)

Source Specifications

Voltage Source Range	±100 µV to ±110 V
Current Compliance (Voltage Source)	Up to 1 A (except 100 mA on the 110 V range)
Current Source Range	±100 fA to ±1 A
Voltage Compliance (Current Source)	Up to 110 V (except 15 V on the 1 A range)
Voltage Noise (0.1 - 10 Hz)	<3 ppm of range (110 V and 11 V ranges), <10 ppm of range (1.1 V range) peak-to-peak typical
Voltage Wideband Noise	8 mV p-p typical (0.1 to 20 MHz)
Voltage Sourcing Overshoot	<0.01% (110 V step, 10 mA range)
Voltage Sourcing Settling Time	<500 µs to 0.01% (110 V step, 10 mA range)
Current Noise (0.1 - 10 Hz)	<3 ppm of range (<20 ppm on 1 nA and 10 nA ranges, <200 ppm on 1 A range) peak-to-peak
Current Sourcing Overshoot	<0.01% typical (10 mA step, RL = 10 kΩ)
Current Sourcing Settling Time	<500 µs to 0.01% (10 mA step, RL = 10 kΩ)

Measurement Specifications

Voltage Measurement Range	$\pm 10\ \mu\text{V}$ to $\pm 110\ \text{V}$ (except $15\ \text{V}$ on the $1\ \text{A}$ range)
Current Measurement Range	$\pm 10\ \text{fA}$ to $\pm 1\ \text{A}$ (except $100\ \text{mA}$ on the $110\ \text{V}$ source range)
Normal Mode Noise Rejection (NMRR)	$>60\ \text{dB}$ at 50 or $60\ \text{Hz}$ (with LINE CYCLE integration time selected)
Common Mode Noise Rejection (CMRR)	$>120\ \text{dB}$ at DC, 50 or $60\ \text{Hz}$ (with LINE CYCLE integration time selected)
Voltage Input Impedance	$>10^{14}\ \Omega$ paralleled by $<20\ \text{pF}$ (as a voltmeter)
Current Output Impedance	$>10^{14}\ \Omega$ paralleled by $<20\ \text{pF}$ (on $1\ \text{nA}$ range)
Maximum Common Mode Voltage	$200\ \text{V}_{\text{peak}}$

Guard and Sense Characteristics

Sensing Configurations	2-terminal (local) or 4-terminal (remote sense)
Remote Sense Drop Correction	Corrects for up to $2\ \text{V}$ drop in each output lead
Maximum Remote Sense Lead Resistance	$100\ \Omega$ per sense lead for rated accuracy
Residual Output Resistance (Voltage Source)	$<100\ \text{m}\Omega$
Guard Output Resistance	$<100\ \text{m}\Omega$
Maximum Guard Output Current	$\pm 2\ \text{mA}$
Guard Open Circuit Offset	$\pm 1\ \text{mV}$ maximum relative to output HI
Floating Output Capability	Up to $\pm 200\ \text{V}$ from ground

Sweep, Timing, and Triggering

Sweep Waveform Types	Fixed Level, Linear Stair, Logarithmic Stair, Pulse, Linear Stair Pulse, Logarithmic Stair Pulse
Waveform Operators	CREATE, APPEND, MODIFY
Minimum Source-Delay-Measure Cycle Time	$1\ \text{ms}$
IEEE-488 Source Response Time	$10\ \text{ms}$
Internal Buffer Measurement Rate	$1\ \text{ms}$ per point
Continuous Measurement Speed	110 readings per second (source DC value over IEEE-488 bus)
Trigger Latency Time	$<2\ \text{ms}$
Load Capacitance Stability	Stable into $20,000\ \text{pF}$ typical
Logarithmic Sweep Density Options	5 , 10 , 25 , or 50 points/decade
Fixed Level Sweep Parameters	LEVEL, COUNT, DELAY, BIAS
Linear Stair Sweep Parameters	START, STOP, STEP, DELAY, BIAS
Logarithmic Stair Sweep Parameters	START, STOP, POINTS/DECADE, DELAY, BIAS
Pulse Sweep Parameters	LEVEL, COUNT, T_ON, T_OFF, BIAS
Linear Stair Pulse Sweep Parameters	START, STOP, STEP, T_ON, T_OFF, BIAS
Logarithmic Stair Pulse Sweep Parameters	START, STOP, POINTS/DECADE, T_ON, T_OFF, BIAS

Environmental

Storage Temperature Range	-25°C to 65°C
Operating Humidity Range	0% to 70% RH (non-condensing) up to 35°C; derate 3% RH/°C from 35°C to 50°C
Temperature Coefficient	%b1(0.1 %d7 accuracy spec) / %b0C (0%b0C to 18%b0C & 28%b0C to 50%b0C)

Data Storage

Internal Memory Capacity	1000 readings
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Timing

Source Delay Range	0 to 65000 ms in 1 ms steps
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Connectivity

Output Connections	3-slot triaxial connectors (rear panel)
Trigger Input	BNC connector, TTL-compatible
Trigger Output	BNC connector, TTL-compatible

Power Limits

Maximum Output Power	15 W
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Sourcing Resolution & Accuracy

Minimum Voltage Source Resolution	100 µV
Minimum Current Source Resolution	100 fA

Measurement Resolution & Accuracy

Minimum Voltage Measurement Resolution	10 µV
Minimum Current Measurement Resolution	10 fA

Pulse Mode

Pulse Width Range	150 µs to 65.5 ms
Maximum Pulse Duty Cycle	10% (at 1 A)

Power Specifications

Maximum Power Consumption	270 VA
Line Frequency	50 Hz / 60 Hz

TECHNOLOGY

Source-Measure Unit (SMU)

APPLICATIONS

Semiconductor characterization, electronic component testing, materials research

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