236 237 238

Source-Measure Unit
High Voltage Source-Measure Unit
High Current Source-Measure Unit

The 236, 237, and 238 Source-Measure Units (SMU) are fully programmable instruments, capable of sourcing and measuring voltage or current simultaneously. These systems are really four instruments in one: voltage source, current source, voltage measure, and current measure.

Applications
These instruments address a wide variety of applications, including the characterization of semiconductor devices and the measurement of leakage currents or insulation resistance. They are particularly useful as source and measuring instruments in automated test equipment (ATE).

Wide Dynamic Range
The Model 236 will source voltage from 100µV to 110V, and current from 100fA to 100mA. It can also measure voltage from 10µV to 110V and current from 10fA to 100mA. The Model 237 offers the same capabilities with a decade enhancement in voltage source and measure (1100V). In this higher voltage range, current source and measure is 10mA maximum. The Model 238 offers a decade enhancement in current source and measure (1A). In this higher current range, voltage source and measure is 15V maximum.

Selectable Sweeps of Voltage and Current
The 236, 237, and 238 can be programmed to perform source-measurements as a function of a stepped voltage or current. Voltage and current can be swept linearly, logarithmically, or pulsed. The START, STOP, STEP method of setting sweep parameters allows operators to become proficient at using the instrument very quickly. Sweep parameters may be appended (APPEND key) to obtain more complex test sequences.

Creating custom sweeps of voltage or current is facilitated by the use of three waveform operations: CREATE, APPEND, and MODIFY. These allow the user to select waveform parameters, combine multiple waveforms, and select and change any points in a waveform previously created or appended.

Fully-Guarded Four-Terminal Measurements
The Model 236, 237, and 238 outputs and inputs are fully guarded, and the units are configured to allow four-terminal measurements. Two-terminal measurements are also available for more standard test procedures. These outputs can be floated up to ±200V from ground.

ACCESSORIES AVAILABLE
CABLES AND CONNECTORS
237TRX-NF 3-Slot Triax to 3-Lug Female Triax Connector
7078TRX-3 3-Slot, Low Noise Triax Cable, 0.9m (3 ft)
7078TRX-20 3-Slot, Low Noise Triax Cable, 6m (20 ft)
RACKS & RACK MOUNT KITS
1938 Fixed Rack Mount Kit
1939 Slide Rack Mount Kit
SOFTWARE
METRICS-ICS-35 1A CA Curve Tracer Software
“TestPoint” Test Development Software

1.888.KEITHLEY (U.S. only)
www.Keithley.com
Source-Measure Unit
High Voltage Source-Measure Unit
High Current Source-Measure Unit

SOURCE-Delay-Measure Cycle:

<table>
<thead>
<tr>
<th>Source Value</th>
<th>Source-Delay-Measure Cycle</th>
<th>Measure Integration Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default Delay</td>
<td>Delay</td>
<td>4-Digit Resolution</td>
</tr>
</tbody>
</table>

Default Delay: Fixed delay for instrument settling.
User Delay: Additional delay for device under test or system capacitance.

MEASURE Integration Time

<table>
<thead>
<tr>
<th>Fast</th>
<th>416 µs</th>
<th>4-digit resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>16.67 ms (60 Hz)</td>
<td>5-digit resolution</td>
</tr>
<tr>
<td>Line Cycle</td>
<td>20.00 ms (50 Hz)</td>
<td></td>
</tr>
</tbody>
</table>

EXECUTION SPEED

MINIMUM SOURCE-DELAY-MEASURE CYCLE TIME: 1ms.
RESPONSE TO IEEE-488 COMMAND (as a source): 25ms.
MEASUREMENT RATE: 1ms per point into internal buffer.
CONTINUOUS MEASUREMENT SPEED (source DC value over IEEE-488 bus): 110 readings per second.
TRIGGER LATENCY TIME: <2ms.

GENERAL

LOAD CAPACITANCE: Stable into 20,000pF typical.
REMOTE SENSE: Corrects for up to 2V drop in each output lead. Maximum 1kΩ per sense lead for rated accuracy. Residual output resistance (as a voltage source) is 0.5Ω.
GUARD: Output Resistance: ≥12kΩ.
Maximum Output Current: ≤2mA.
Offset Relative to Output HI: ±2mV max.
ISOLATION (Output LO to chassis): Typically >1014Ω in parallel with 500pF (650pF on Model 238).
MAXIMUM COMMON MODE VOLTAGE: 200V.
CONNECTORS: Outputs: 3-lug triax.
Trigger Input/Output: BNC.
Interlock: 3-pin miniature DIN.
TEMPERATURE COEFFICIENT (0°–18°C & 28°–50°C): ±(0.1% x applicable accuracy specification)°C.
ENVIRONMENT:
Operating: 0°–60°C, 70% relative humidity up to 35°C. Linearity derate 3% RH/°C, 35°–60°C.
Storage: –25° to 65°C.
EMC: Conforms to European Union Directive 89/336/EEC.
WARM-UP: One hour to rated accuracy.
COOLING: Internal fan forced air cooling.
DIMENSIONS, WEIGHT: 99mm high × 435mm wide × 48mm deep (3⅜ in x 17¼ in x 1¾ in). Net weight 9kg (19.75 lb).

VOLTAGE

<table>
<thead>
<tr>
<th>RANGE (Max. Value)</th>
<th>SOURCE V</th>
<th>ACCURACY (1 Year, 18°–28°C)</th>
<th>MEASURE V</th>
<th>ACCURACY (1 Year, 18°–28°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STEP SIZE</td>
<td>18°–24°C</td>
<td>100µA</td>
<td>100µA</td>
</tr>
<tr>
<td>236, 237 Only</td>
<td>11000 V</td>
<td>±(0.033% + 650µV)</td>
<td>100µA</td>
<td>±(0.025% + 100µV)</td>
</tr>
<tr>
<td></td>
<td>100 µV</td>
<td>±(0.028% + 300µV)</td>
<td>10 µV</td>
<td>±(0.025% + 100µV)</td>
</tr>
<tr>
<td>237 Only</td>
<td>11000 V</td>
<td>±(0.033% + 2.4mV)</td>
<td>100 µV</td>
<td>±(0.028% + 450µV)</td>
</tr>
<tr>
<td></td>
<td>10 mV</td>
<td>±(0.033% + 2.4mV)</td>
<td>1 mV</td>
<td>±(0.025% + 1 mV)</td>
</tr>
<tr>
<td>238 Only</td>
<td>15000 V</td>
<td>±(0.033% + 800µV)</td>
<td>100 µV</td>
<td>±(0.028% + 450µV)</td>
</tr>
<tr>
<td></td>
<td>1 mV</td>
<td>±(0.033% + 2.7mV)</td>
<td>1 mV</td>
<td>±(0.025% + 1 mV)</td>
</tr>
<tr>
<td></td>
<td>110 mV</td>
<td>±(0.033% + 24 mV)</td>
<td>10 mV</td>
<td>±(0.025% + 10 mV)</td>
</tr>
</tbody>
</table>

COMPLIANCE: Bipolar current limit set with single value.
Maximum: ±100mA (except ±10mA on 1100V range in Model 237 and ±1A on 15V range in Model 238).
Minimum: ±1% of range, except 0.5% of 1.1V range.
Accuracy, Step Size: Same as current source.

NOISE (p-p): 0.1 to 20MHz, 86dB ±p-p typical.
OVERSHOOT: <0.01% (110V step, 10mA range).
SETTLING TIME: <500µs to 0.01% (110V step, 10mA range).
WIDEBAND NOISE: <0.1% typical (10mA step, RL = 10kΩ).
NOISE (p-p of range):

<table>
<thead>
<tr>
<th>RANGE</th>
<th>0.1–10Hz DC–20MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>110V</td>
<td>&lt; 3ppm of range</td>
</tr>
<tr>
<td>11V</td>
<td>&lt; 3ppm of range</td>
</tr>
<tr>
<td>1.1V</td>
<td>&lt; 10ppm of range</td>
</tr>
</tbody>
</table>

CURRENT

<table>
<thead>
<tr>
<th>RANGE (Max. Value)</th>
<th>SOURCE I</th>
<th>ACCURACY (1 Year, 18°–28°C)</th>
<th>MEASURE I</th>
<th>ACCURACY (1 Year, 18°–28°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STEP SIZE</td>
<td>18°–20°C</td>
<td>100µA</td>
<td>100µA</td>
</tr>
<tr>
<td>All</td>
<td>10000 µA</td>
<td>±(0.3% + 450µA)</td>
<td>100 µA</td>
<td>±(0.3% + 100 µA)</td>
</tr>
<tr>
<td></td>
<td>10 µA</td>
<td>±(0.3% + 2 µA)</td>
<td>1 µA</td>
<td>±(0.3% + 1 µA)</td>
</tr>
<tr>
<td></td>
<td>±100.00 µA</td>
<td>±(0.21% + 20 µA)</td>
<td>10 µA</td>
<td>±(0.21% + 6 µA)</td>
</tr>
<tr>
<td></td>
<td>100 µA</td>
<td>±(0.05% + 200 µA)</td>
<td>100 µA</td>
<td>±(0.04% + 60 µA)</td>
</tr>
<tr>
<td></td>
<td>±10.00 µA</td>
<td>±(0.05% + 2 mA)</td>
<td>1 µA</td>
<td>±(0.035% + 700 µA)</td>
</tr>
<tr>
<td></td>
<td>1 µA</td>
<td>±(0.05% + 2 mA)</td>
<td>1 µA</td>
<td>±(0.035% + 700 µA)</td>
</tr>
<tr>
<td></td>
<td>±100.00 µA</td>
<td>±(0.05% + 20 mA)</td>
<td>10 µA</td>
<td>±(0.05% + 60 µA)</td>
</tr>
<tr>
<td></td>
<td>100 µA</td>
<td>±(0.05% + 200 µA)</td>
<td>100 µA</td>
<td>±(0.05% + 60 µA)</td>
</tr>
<tr>
<td></td>
<td>±100 µA</td>
<td>±(0.05% + 2 mA)</td>
<td>1 µA</td>
<td>±(0.05% + 60 µA)</td>
</tr>
<tr>
<td></td>
<td>10 µA</td>
<td>±(0.05% + 2 mA)</td>
<td>1 µA</td>
<td>±(0.05% + 60 µA)</td>
</tr>
<tr>
<td>238 Only</td>
<td>±1000 µA</td>
<td>±(0.1% + 200 µA)</td>
<td>10 µA</td>
<td>±(0.1% + 6 µA)</td>
</tr>
<tr>
<td></td>
<td>10 µA</td>
<td>±(0.1% + 200 µA)</td>
<td>10 µA</td>
<td>±(0.1% + 6 µA)</td>
</tr>
</tbody>
</table>

COMPLIANCE: Bipolar voltage limit set with single value.
Maximum: ±1100V (except ±110V in Model 238 and on 100mA range in Model 237).
Minimum: ±0.1% of selected current range.
Accuracy, Step Size: Same as voltage source.

NOISE (p-p of range): 0.1–10Hz: <3ppm (<20ppm on 1mA and 10mA ranges and on 1A range in Model 238).
OVERSHOOT: <0.01% (10mA step, 10mA range).
SETTLING TIME: <500µs to 0.01% (10mA step, 10mA range).
Overshoot: <0.01% typical (100mA step, RL = 10kΩ).
SETTLING TIME: <500µs to 0.01% (100mA step, 10mA range).
OUTPUT R, C: >1014 in parallel with <20pF.

1 Offset specification applies for 25°C ±1°C with suppression. Temperature coefficient 90°C/°C.
238 High Current Source-Measure Unit

SOURCE-MEASURE UNIT: Sources voltage while measuring current, or sources current while measuring voltage.

FUNCTION: Can be used as DC source or meter, sweep source, or full source-measure unit.

SOURCE-DELAY-MEASURE CYCLE:

Default Delay: Fixed delay for instrument settling.
User Delay: Additional delay for device under test or system capacitance.

MEASURE:

Integration Time

- Fast: 416 µs, 4-digit resolution
- Medium: 4 ms, 5-digit resolution
- Line Cycle: 16.67 ms (60 Hz), 5-digit resolution
- 20.00 ms (50 Hz)

Elapsed Time: Measures and stores time from sweep trigger to measurement complete for each step of sweep.

RANGING:

Source: Auto-ranging through keypad entry; fixed range selection using rotary dial and SELECT keys (DC function). Fully programmable in SWEEP function.
Measure: Auto or fixed range. Fixed range selection made by choice of COMPLIANCE value.
FILTER: Takes n measurements, calculates and outputs average (n = 2, 4, 8, 16, or 32, selectable).
SUPPRESS: Subtracts displayed measurement from subsequent readings.
DATA ENTRY: Numeric keypad or detented rotary dial.

TRIGGER:

Input and Output: Set for any phase of SOURCE-DELAY-MEASURE sequence or trigger output at end of sweep.
Origin: Internal, External (including front panel MANUAL TRIGGER button), IEEE-488 bus (TALK, GET, "X").
MEMORY: Stores one full sweep (up to 1000 points) of source, delay, and measure values, elapsed times, and sweep parameters. Lithium battery backup.
INTERLOCK: Use with test fixture or external switch. Normally closed; open puts instrument in standby.

SWEEP WAVEFORMS

| LEVEL, COUNT | (number of DELAY-MEASURE cycles), DELAY, BIAS |
| START, STOP, STEP, DELAY, BIAS |
| LEVEL, COUNT, T_ON, T_OFF, BIAS |
| START, STOP, POINTS/DECADE (5, 10, 25, or 50), DELAY, BIAS |
| START, STOP, POINTS/DECADE (5, 10, 25, or 50), T_ON, T_OFF, BIAS |

WAVEFORM OPERATORS

Allows selection of waveform parameters. Generates all source values.
Combines multiple waveforms and adds new points to those already in memory.
Select and change any points in a previously created (or appended) waveform.

2/23/01
Rev. A
238 High Current Source-Measure Unit

VOLTAGE SOURCE

<table>
<thead>
<tr>
<th>RANGE (Max. Value)</th>
<th>SOURCE CURRENT</th>
<th>MEASURE CURRENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>±1.5000V</td>
<td>100 µA</td>
<td>±0.03% + 450pA</td>
</tr>
<tr>
<td>±1.0000V</td>
<td>100 nA</td>
<td>±0.03% + 300pA</td>
</tr>
<tr>
<td>±0.1000V</td>
<td>10 µA</td>
<td>±0.03% + 20pA</td>
</tr>
<tr>
<td>±0.0100V</td>
<td>1 µA</td>
<td>±0.03% + 2pA</td>
</tr>
<tr>
<td>±0.0010V</td>
<td>100 nA</td>
<td>±0.03% + 2pA</td>
</tr>
<tr>
<td>±0.00010V</td>
<td>10 nA</td>
<td>±0.03% + 2pA</td>
</tr>
<tr>
<td>±0.00001V</td>
<td>100 µA</td>
<td>±0.03% + 2pA</td>
</tr>
<tr>
<td>±0.00000V</td>
<td>10 nA</td>
<td>±0.03% + 2pA</td>
</tr>
</tbody>
</table>

1 Specifications apply for 5-digit resolution. For 4-digit resolution add ±(0.1% + 700pA).
2 Offset specification applies for 23°C ± 5°C with suppression. Temperature coefficient 50fA/°C.

NOISE (p-p vs range): 0.1–10Hz <3ppm (<20ppm on 1nA, 10nA and 1A ranges).

OVERSHOOT: <0.01% (10mA step, RL = 10kΩ).

WIDE BAND NOISE: 0.1 to 20MHz, 8mV p-p typical.

INPUT IMPEDANCE: >10¹⁵Ω.

OPERATING TEMPERATURE COEFFICIENT: 0°C–18°C & 28°C–50°C ±0.1 x applicable accuracy specification)/°C.

ENVIRONMENT: Operating: 0°C–50°C, 70% relative humidity up to 35°C. Linearly derate 3% RH/°C, 35°C–50°C.

Storage: -25°C to 65°C.

WARM-UP: One hour to rated accuracy.

COOLING: Internal fan forced air cooling.


DIMENSIONS, WEIGHT: 435mm wide × 448mm deep × 171⁄8 in (10 in × 17.5 in). Linearly derate 1% RH/°C, 35°C–50°C.

ACCESSORIES AVAILABLE:
- Model 7078-TRX-10: Triax to Triax Cable, 3m (10 ft.) (2 supplied)
- Model 236-ILC-3: Interlock Cable

IEEE-488 BUS IMPLEMENTATION

MULTILINE COMMANDS: DCL, LLO, SDC, GET, GTL, UNT, UNL, SPE, SPD.
UNILINE COMMANDS: IFC, REN, EOJ, SRQ, ATN.
INTERFACE FUNCTIONS: SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, CR, EI.

All front panel functions and setups are available over the IEEE-488 bus, in addition to Status, Service Request, Output Format, EOI, Trigger, and Terminator.

IEEE-488 address is set from the front panel menu.

EXECUTION SPEED

MINIMUM SOURCE-DELAY-MEASURE CYCLE TIME: 1ms.

RESPONSE TO IEEE-488 COMMAND (as a source): 25ms.

MEASUREMENT RATE: 1mV per point into internal buffer.

CONTINUOUS MEASUREMENT SPEED (source DC value over IEEE-488 bus): 110 readings per second.

TRIGGER LATENCY TIME: 2ms.

SPECIFICATIONS

<table>
<thead>
<tr>
<th>LTR</th>
<th>REVISIONS</th>
<th>APP.</th>
<th>DATE</th>
<th>DRN.</th>
<th>DATE</th>
<th>CKD.</th>
<th>DATE</th>
<th>APP.</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

Purchased Item

Keithley Instruments, Inc.
Cleveland, Ohio 44139

238 High Current Source-Measure Unit

2/23/01 Rev. A