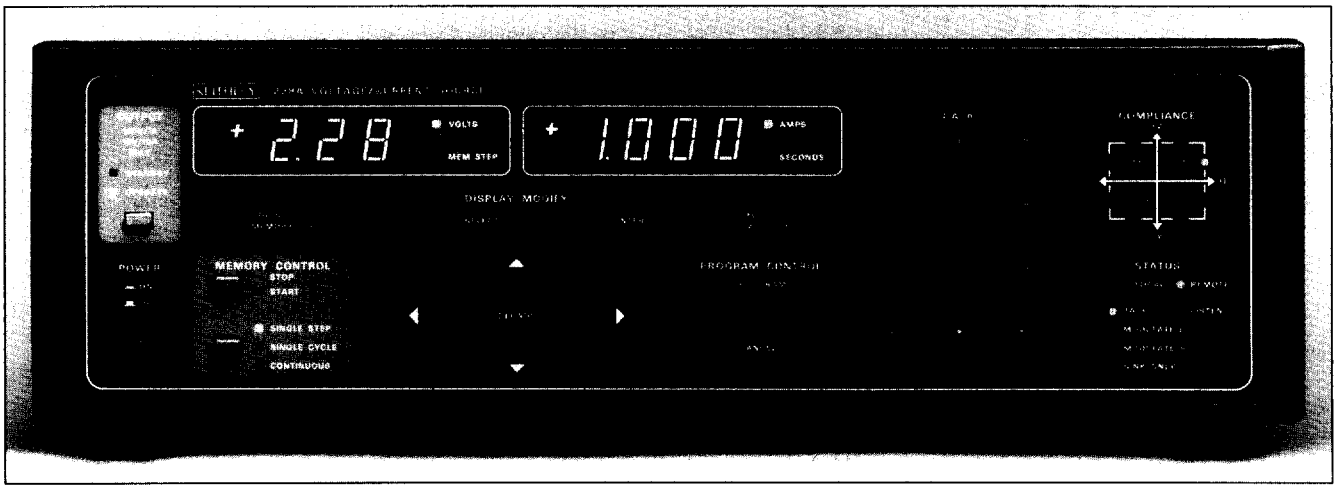
# PROGRAMMABLE VOLTAGE/CURRENT SOURCES • 228A

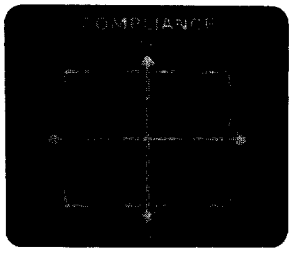
IEEE-488 INTERFACEABLE




- **100 watt source or sink**
- **<1msec. transient recovery**
- **Low noise**
- **Smooth range changes**
- **Built-in voltage and current monitors**

The Model 228A is a precision programmable source with the capacity to sink or source up to 100 watts. Six ranges accurately regulate a voltage or current as determined by the load. And because it is two programmable sources in one (with built-in monitors), you get the flexibility for a broader range of test setups, without having to buy separate sources.

**4-Quadrant Operation.** The 228A is capable of bipolar source or sink up to a full 100 watts without derating, permitting it to act as a voltage or current supply or as an active load. Operating status is continuously shown on front panel LEDs.

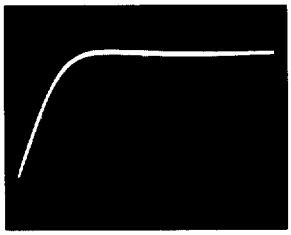



*Front panel LEDs continuously display operating status.*

The 228A's modulation input allows voltage programming. DC to 600Hz inputs can be used to vary the output within the full scale range of the source, simulate variable load conditions in sink, provide a power boost, or test power supply rejection.

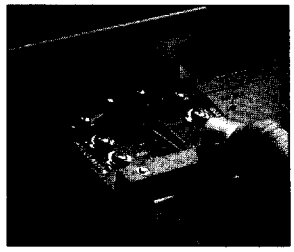
**Fast Response.** Load transient recovery time is less than 1msec., without overshoot or oscillation.

**Voltage and Current Monitor.** The output voltage and current are continuously monitored and displayed. These values can also be read back over the IEEE-488 bus, eliminating the need for separate measurement instruments.



*Actual 228A transient response, 100V range @ 1A. Vert.: 20V/div. Horiz.: 0.2msec./div.*

Remote sensing assures the full rated voltage under test, even when delivering high currents. And our unique safety disconnect design eliminates external terminal blocks and barrier strips.



*Keithley's unique disconnect design assures safe setup and operation.*

**Fully Programmable.** The IEEE-488 interface is standard with the 228A, and all front panel controls and capabilities are available over the bus. TRIGGER IN/OUT enables synchronization with other components in your test setup, and the programmable dwell time allows settling before TRIGGER OUT is issued.

The 228A checks its own operation and provides diagnostic error messages. An SRQ can be programmed to alert the system of many operating conditions. The internal 100-point memory retains programmed data through power down, brownout, or even a month or more in storage, and allows you to step through repetitive test sequences with minimal bus activity.

**ORDERING INFORMATION**

| | |
|---|---|
| **228A** | Programmable Voltage/Current Source with IEEE-488 Interface |

## IEEE-488 BUS IMPLEMENTATION (IEEE-488-1978)

**MULTILINE COMMANDS:** DCL, LLO, SDC, GET, GTL, UNT, UNL, SPE, SPD.

**UNILINE COMMANDS:** IFC, REN, EOI, SRQ, ATN.

**INTERFACE FUNCTIONS:** SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0, E1.

**PROGRAMMABLE PARAMETERS:** Output (Operate or Standby), Range, Voltage, Current, Trigger Mode, Sink, Modulation (Voltage or Current), Display Mode, Output Prefix (data format on readback), SRQ Mask, EOI, Terminator Characters, Status, Self Test, Memory Location (100 point memory), Dwell Time.

See page 241 for complete Ordering Information.

# 228A • PROGRAMMABLE VOLTAGE/CURRENT SOURCE

IEEE-488 INTERFACEABLE

## AS A CONSTANT VOLTAGE SOURCE

| | OUTPUT | | | COMPLIANCE (Source or Sink) | | |
|---|---|---|---|---|---|---|
| RANGE | MAXIMUM | RESOLUTION | ACCURACY* (1 Year) 18°–28°C | MAXIMUM | RESOLUTION | ACCURACY (1 Year) 18°–28°C |
| 100 V | ±101.0 V | 100 mV | ±(0.1% + 0.1 V) | ±1.010 A | 1 mA | ±(0.1% + 4 mA) |
| | | | | ±0.1010 A | 100 µA | ±(0.1% + 400 µA) |
| 10 V | ±10.10 V | 10 mV | ±(0.1% + 10 mV) | ±10.10 A | 10 mA | ±(0.5% + 40 mA) |
| | | | | ±1.010 A | 1 mA | ±(0.1% + 4 mA) |
| | | | | ±0.1010 A | 100 µA | ±(0.1% + 400 µA) |
| 1 V | ±1.010 V | 1 mV | ±(0.1% + 1.0 mV) | ±10.10 A | 10 mA | ±(0.5% + 40 mA) |
| | | | | ±1.010 A | 1 mA | ±(0.1% + 4 mA) |
| | | | | ±0.1010 A | 100 µA | ±(0.1% + 400 µA) |

*Above 0.4% of range.

**TEMPERATURE COEFFICIENT (0°–18°C & 28°–50°C):** ±(0.1 × applicable accuracy specification)/°C.

**NOISE:**

| RANGE | 0.1–300 Hz | 0.1–300 kHz | 0.1–20 MHz* |
|---|---|---|---|
| 100 V | 2.5 mV p-p | 15 mV p-p | 25 mV p-p |
| 10 V | 1.0 mV p-p | 15 mV p-p | 25 mV p-p |
| 1 V | 0.35 mV p-p | 15 mV p-p | 25 mV p-p |

*Typical.

**OUTPUT RESISTANCE (maximum):** 100V Range: 10mΩ. 10V Range: 100µΩ. 1V Range: 100µΩ.

**OUTPUT INDUCTANCE:** 100µH typical.

**SENSING:** REMOTE or LOCAL.

**REMOTE SENSING:** Corrects for up to 0.5V drop per output lead. Maximum 5Ω per sense lead for rated accuracy. Maximum 0.5Ω per sense lead for rated output resistance.

## AS A CONSTANT CURRENT SOURCE

| | OUTPUT | | | COMPLIANCE (Source or Sink) | | |
|---|---|---|---|---|---|---|
| RANGE | MAXIMUM | RESOLUTION | ACCURACY* (1 Year) 18°–28°C | MAXIMUM | RESOLUTION | ACCURACY (1 Year) 18°–28°C |
| 10 A | ±10.10 A | 10 mA | ±(0.5% + 10 mA) | ±10.10 V | 10 mV | ±(0.1% + 40 mV) |
| | | | | ±1.010 V | 1 mV | ±(0.1% + 4 mV) |
| 1 A | ±1.010 A | 1 mA | ±(0.1% + 1.0 mA) | ±101.0 V | 100 mV | ±(0.1% + 400 mV) |
| | | | | ±10.10 V | 10 mV | ±(0.1% + 40 mV) |
| | | | | ±1.010 V | 1 mV | ±(0.1% + 4 mV) |
| 0.1 A | ±0.1010 A | 100 µA | ±(0.1% + 0.1 mA) | ±101.0 V | 100 mV | ±(0.1% + 400 mV) |
| | | | | ±10.10 V | 10 mV | ±(0.1% + 40 mV) |
| | | | | ±1.010 V | 1 mV | ±(0.1% + 4 mV) |

*Above 0.4% of range.

**TEMPERATURE COEFFICIENT (0°–18°C & 28°–50°C):** ±(0.1 × applicable accuracy specification)/°C.

**NOISE:**

| RANGE | 0.1–300 Hz | 0.1–300 kHz | 0.1–20 MHz* |
|---|---|---|---|
| 10 A | 5 mA p-p | 15 mA p-p | 25 mA p-p |
| 1 A | 1.5 mA p-p | 5 mA p-p | 25 mA p-p |
| 0.1 A | 0.5 mA p-p | 5 mA p-p | 3 mA p-p |

*Typical.

**OUTPUT RESISTANCE (min.):** 10A Range: $10^4\Omega$. 1A Range: $10^5\Omega$. 0.1A Range: $10^6\Omega$.

**OUTPUT CAPACITANCE:** 0.2µF typical.

**OUTPUT LOAD:** Must be non-inductive.

## CURRENT MONITOR OUTPUT

**SCALE FACTOR:** 1V = 100% of range.

**ACCURACY:** Same as constant current mode.

**BANDWIDTH:** 5kHz typical. **OUTPUT RESISTANCE:** 10kΩ.

## EXTERNAL MODULATION

**INPUT RESISTANCE:** 6.8kΩ.

**SENSITIVITY:** –10V increases magnitude of programmed output by 100% full scale; +10V decreases magnitude of programmed output by 100% full scale.

**ACCURACY:** 2% typical, DC to 60Hz.

**MAXIMUM MODULATION:** Modulation and programmed setting should not cause operation exceeding the range of 0 to 100% of full scale.

**MODULATION FREQUENCY:** 600Hz bandwidth.

## GENERAL

**DISPLAY:** Dual 3½-digit LED (0.5 in.) displays indicate programmed values in Standby and output values in Operate.

**FRONT PANEL PROGRAMS:** COPY, SINK, IEEE Address, MOD V, MOD I, TEST, RESET.

**READBACK ACCURACY:** Same as output accuracy.

**STANDBY:** Programs output to 0V, 0A without changing ranges or polarity.

**LOAD TRANSIENT RECOVERY TIME:** With a resistive load the output will recover 90% of any load changes within 1msec. after end of changes, provided the changes do not cause transfer to another control mode.

**LINE REGULATION:** <0.01% output change for AC power line changes within specified limits.

**PROGRAM MEMORY (battery backed-up):** Stores up to 100 output settings.
**Range of Dwell Times:** 10msec. to 1000sec.
**Accuracy of Dwell Times:** ±(0.05% + 2msec.).

**BATTERY BACKUP:** Rechargeable 3.6V nickel-cadmium. 1 month retention of data with unit turned off.

**TRIGGER:** IN and OUT TTL-compatible.

**PROGRAMMING RESPONSE TIME:** <100msec. on fixed range (typical).

**MAXIMUM COMMON MODE VOLTAGE (output or output common to chassis):** 100V DC.

**OUTPUT CONNECTIONS:** Quick disconnect card with screw terminals for output, modulation, current monitor, and external sense. BNC (chassis isolated) connectors for TRIGGER IN/OUT.

**SELF TEST:** Analog and digital circuits tested at power-on. Power supplies, temperatures, and output continuously monitored.

**WARM-UP:** 10 minutes to rated accuracy.

**COOLING:** Internal fan for forced air cooling.

**POWER:** 105–125 or 210–250V AC (internally switch selectable), 50 or 60Hz, 500VA maximum.

**ENVIRONMENT: Operating:** 0° to 50°C, <80% non-condensing RH below 35°C. **Storage:** –25° to 70°C.

**DIMENSIONS, WEIGHT:** 133mm high × 435mm wide × 448mm deep (5.25 in. × 17.125 in. × 17.625 in.). Net weight 10.9kg (24 lbs.).

**ACCESSORIES SUPPLIED:** Model 2286 Safety Output Connector, instruction manual.

**ACCESSORIES AVAILABLE:**

| | |
|---|---|
| Model 2286: | Safety Output Connector |
| Model 2288: | Fixed Rack Mounting Kit |
| Model 2289A: | Slide Rack Mounting Kit |
| Model 7007-1: | Shielded IEEE-488 Cable, 1m |
| Model 7007-2: | Shielded IEEE-488 Cable, 2m |
| Model 7008-3: | IEEE-488 Cable, 0.9m (3 ft.) |
| Model 7008-6: | IEEE-488 Cable, 1.8m (6 ft.) |

See page 143 for descriptions of all accessories.



See page 241 for complete Ordering Information.