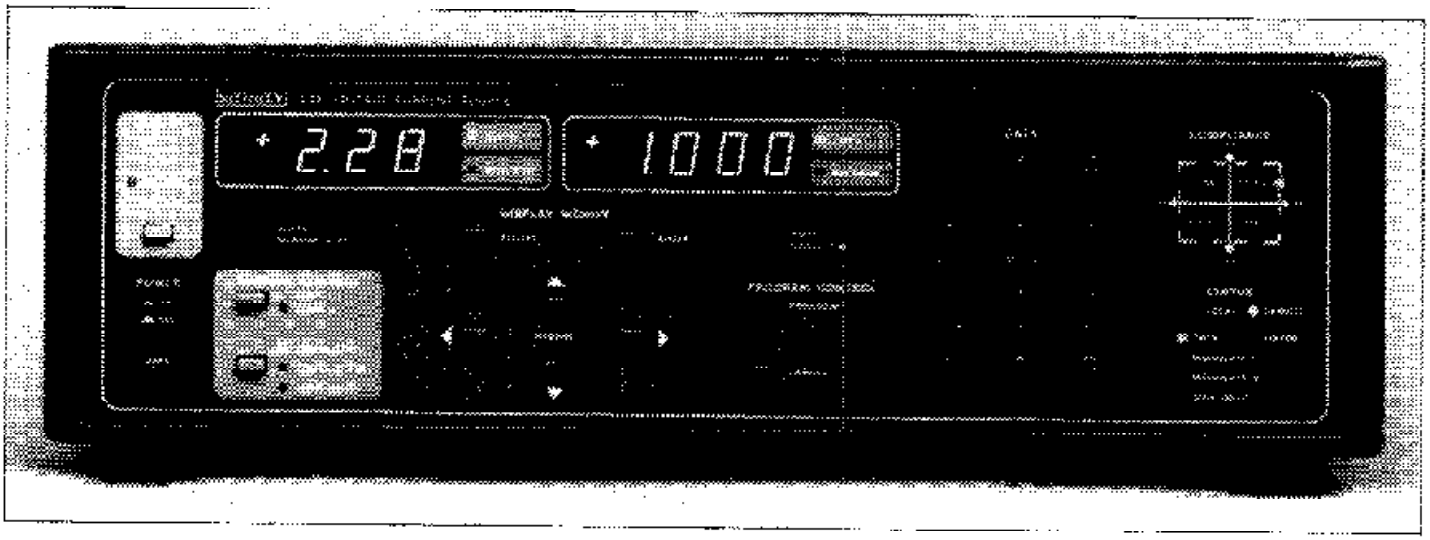
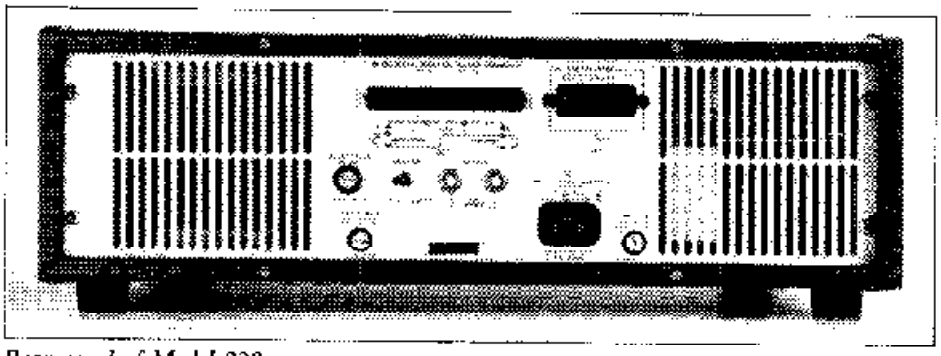
228/Voltage/Current Source

Programmable



- **100 watt sink or source**
- **< 1ms transient recovery**
- **External modulation**
- **Built-in monitors**



Rear panel of Model 228.

The Model 228 is a precision programmable source with the capacity to sink or source up to 100 watts. Its six ranges accurately regulate a constant voltage or a constant 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 228 is capable of bipolar source or sink up to a full 100 watts without derating in the sink quadrants, permitting it to act as a voltage or current supply or as an active load. Operating status is continuously shown on front panel LEDs.

The 228'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 1ms, without troublesome overshoot or oscillation.

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

Switch-selectable remote sensing assures the full rated voltage accuracy at the device under test, even when delivering high currents. And our unique safety disconnect design eliminates dangerous external terminal blocks and barrier strips.

Fully Programmable. The IEEE-488 interface is standard with the 228, 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 228 checks its own operation and provides diagnostic error messages. An SRQ can be programmed to alert the system of many operating conditions. All output parameters can be pre-programmed in the internal 100-point memory, allowing you to step through repetitive test sequences with minimal bus activity. The battery maintained memory can retain programmed data through power down, brownout, or even a month or more in storage.

The 228 joins the popular 220, 224, and 230 Sources in the growing Keithley line of compatible, modular programmable instruments. Easy operation and simple, consistent command syntax assure you of fast, reliable test setups—every time.

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	5.0 mV p-p	15 mV p-p	25 mV p-p
	10 V	2.0 mV p-p	15 mV p-p	25 mV p-p
	1 V	0.7 mV p-p	15 mV p-p	25 mV p-p

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

OUTPUT INDUCTANCE: 100μH typical.

SENSING: Rear panel switch selectable REMOTE and LOCAL sensing.

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 (1 Year, 18°-28°C)			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	25 mA p-p	25 mA p-p	25 mA p-p
	1 A	5 mA p-p	5 mA p-p	25 mA p-p
	0.1 A	0.5 mA p-p	2 mA p-p	3 mA p-p

OUTPUT RESISTANCE (min.): 10A Range: 10MΩ. 1A Range: 10MΩ. 0.1A Range: 10MΩ.

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% of full scale; +10V decreases magnitude of programmed output by 100% of 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.

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.

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.

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

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

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:** 20ms to 1000s. **Accuracy of Dwell Times:** ±(0.05% + 2ms).

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: <100ms 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.

WARMUP: 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 (5¼ in. × 17⅛ in. × 17⅝ in.). Net weight 10.9kg (24 lbs.).

ACCESSORIES SUPPLIED: Output connector, instruction manual.