MODEL 1211
CURRENT PREAMPLIFIER

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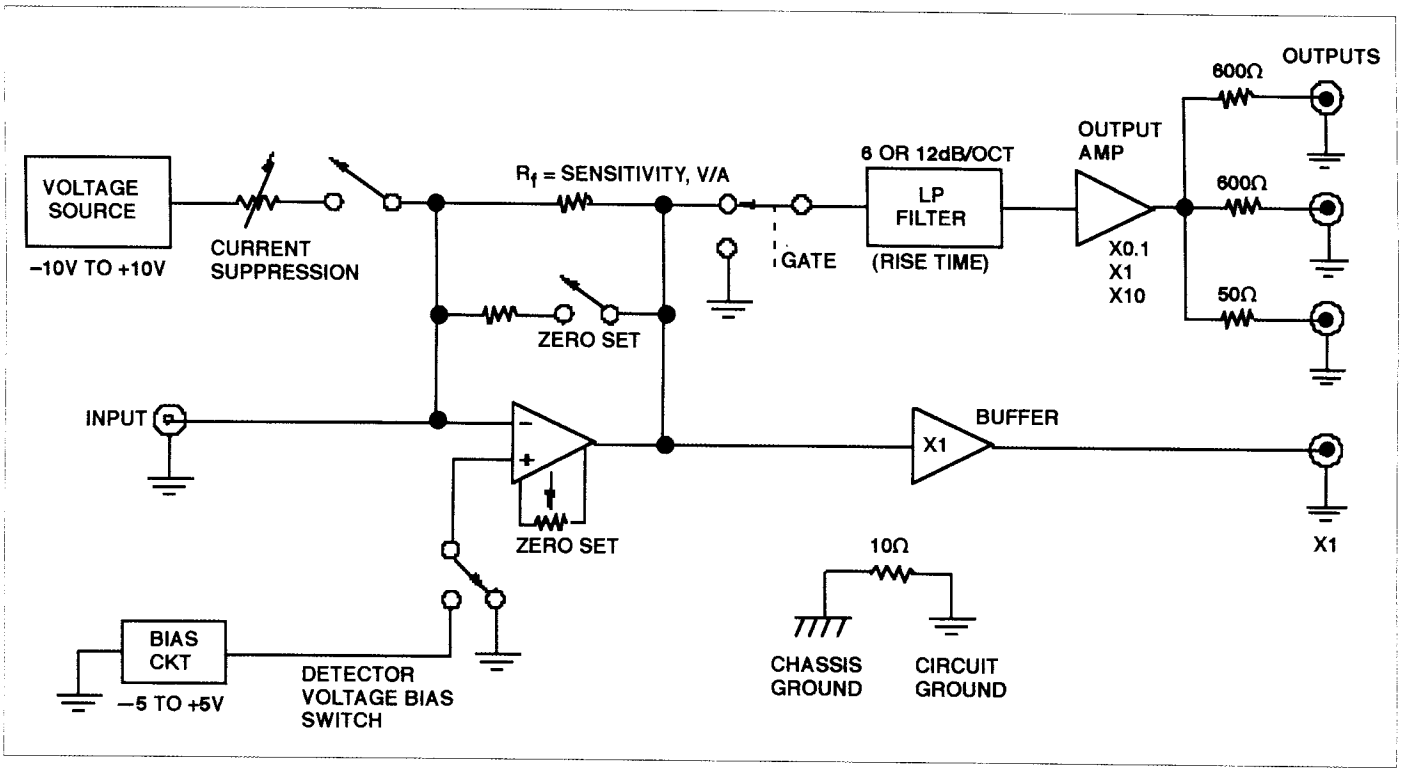
The Model 1211 Current Preamplifier was designed to provide all of the features required of a modern laboratory preamplifier. It measures cur rents with full scale sensitivity ranging from 10^{-2} to 10^{-12} amperes. With a dynamic range of 96 dB and an output stability better than 0.003% per °C or per day plus a gain stability of 0.05% per °C or per day,its performance is unexcelled. The classic analog design provides a clean signal without the high frequency "hash" encountered with microprocessor based designs employing multiplexed front panel displays. The wide gain bandwidth product permits calibrated, front panel rise time settings from 10 μsec to 1 second.

The 1211 has a 600 Ω output, a 50 Ω output and a zero Ω unity gain (converter) output. It may be gated off and on by a TTL Level Pulse at a rear panel connector at a rate up to 5 kHz for input overload suppression, etc.

Other convenience features include a 0–5 volt adjustable detector bias supply with 100 ppm per °C stability and calibrated current suppression of 10^{-3} to 10^{-10} amperes in 8 ranges.

The unit may be battery operated with the addition of the Option 10 Battery Pack. This allows the unit to run on batteries only, line power only, or while recharging from the line. Fast charge and trickle charge rates are switch selectable.



1211 Block Diagram

1211 CURRENT PREAMPLIFIER

For applications information, ask for IAN 50 *"Noise Analysis and Gain Considerations in Selecting the Right Current Preamplifier"* and IAN 55 *"Applying the Model 1211 Current Preamplifier to Tunneling Microscopy."*

SPECIFICATIONS

(maximum or minimum as applicable unless otherwise noted)

SENSITIVITY 10^{-3} to 10^{-11} ampere/volt with nine decade current gain ranges.

GAIN MULTIPLIER Output gain multiplier varies sensitivity in 3 steps, X0.1, X1.0 and X10, for optimum dynamic range and overload capability.

GAIN ACCURACY ±2% of reading (10^{-3} to 10^{-9} ampere/volt ranges); ±3% of reading (10^{-9} thru 10^{-11} ampere/volt ranges).

INPUT OFFSET CURRENT Less than $0.5X10^{-13}$ ampere @ 50°C. Typically 1 x 10^{-14} @ 25°C.

INPUT VOLTAGE DROP Less than 200 microvolts, 10^{-5} to 10^{-11} ampere/volt ranges.

RISE TIME (Low Pass Filter) Front panel adjustable from 10 microseconds to 1 second in a 1–3–10 sequence; MIN position rise time is less than 5 microseconds. Standard rolloff is 12 dB/octave. Jumper option for 6 dB/oct when 1211 is applied in feedback control loops.

OUTPUT Four outputs (BNC) as follows:

a) 600 Ω outputs (2)
b) Lo–Z output (to 25 mA, 50 Ω)
c) Unity gain output (X1)

OUTPUT LEVEL 22 Vpp into 1 K load (Lo–Z out)

OUTPUT POLARITY Unity gain (X1) Non inverted
Lo–Z (50 Ω) Inverted
600 Ω Inverted

OUTPUT STABILITY Output voltage offset stability better than 0.003% per °C.

ZERO SET Input offset nulling. Used to adjust for precisely zero bias voltage on detectors such as photovoltaic diodes. Alternatively, can adjust for zero d.c. offset on output.

CURRENT SUPPRESSION 10^{-3} ampere to 10^{-10} ampere with eight decade ranges: front panel vernier (10–turn) allows continuous suppression with 0.1% resolution. Stability is better than .02%/°C or day (10^{-3} to 10^{-8} ampere); better than 0.2%/°C or day (10^{-9} and 10^{-10} ampere).

DETECTOR BIAS Zero to ±5 volts, adjustable and polarity–selectable with rear panel vernier (10–turn) and switch. Stability is 100ppm/°C.

GATING TTL–compatible logic 0 or switch closure to ground (rear panel BNC input) provides gated operation of preamplifier signal path; maximum gating frequency is 5 kHz.

POWER 100 to 130 or 200 to 260 VAC (switch–selectable), 50–60 Hz, 10 Watts.

DIMENSIONS 90 x 215 x 380 (3.5" high x 8.5" wide x 15" deep)

WEIGHT: 3.7 kg (8 lb 2 oz), less Battery pack

OPERATING TEMPERATURE: 5°C to 50°C

MOUNTING: Benchtop standard. 19" rack mount via RM–2 (single unit) or RM–1 (dual unit) option.

1211 RISE TIME, DYN RANGE, INPUT Z AND B.W.

Sensitivity (A/V)	Minimum Rise Time μ Sec	Dynamic Range [1] dB (SNR)	Input Resistance Ohms	3 dB BW [2] kHz
10^{-3}	10	96 (63000)	0.5	60
10^{-4}	10	96 (63000)	0.5	50
10^{-5}	10	96 (63000)	2	45
10^{-6}	15	88 (25000)	20	30
10^{-7}	25	78 (8000)	200	25
10^{-8}	40	68 (2500)	2K	13
10^{-9}	250	62 (1250)	20K	4
10^{-10}	450	55 (560)	200K	.8
10^{-11}	1100	48 (250)	2M	.4

1 Dynamic Range values are given with gain multiplier setting of X1 and rise time control set to min. It equals the ratio of greatest peak–to–peak signal output (at least 22 Vpp) to specified maximum wideband output noise with 100 pF input shunt capacitance.

2 Measured at 50 Ω or 600 Ω output.

NOISE PERFORMANCE, REFERRED TO INPUT [3]

Sensitivity A/V	Limited BW Noise at Indicated Rise Time Setting [4] A rms	Msec	Min. Rise Time Full BW Noise [4] A rms	Spectral Noise Density A rms/√Hz
10^{-3}	20 x 10^{-9}	.1	50 x 10^{-9}	75 x 10^{-12}
10^{-4}	2 x 10^{-9}	.1	5 x 10^{-9}	7.5 x 10^{-12}
10^{-5}	200 x 10^{-12}	.1	500 x 10^{-12}	1 x 10^{-12}
10^{-6}	30 x 10^{-12}	.1	150 x 10^{-12}	200 x 10^{-15}
10^{-7}	8 x 10^{-12}	.1	40 x 10^{-12}	60 x 10^{-15}
10^{-8}	700 X 10^{-15}	1	15 x 10^{-12}	15 x 10^{-15}
10^{-9}	60 x 10^{-15}	1	3 x 10^{-12}	5 x 10^{-15}
10^{-10}	4 x 10^{-15}	10	600 x 10^{-15}	2.5 x 10^{-15}
10^{-11}	1 x 10^{-15}	300	150 x 10^{-15}	1.5 x 10^{-15}

[3] Noise at X1 gain multiplier setting using 50 Ω or 600 Ω output. For 10^{-3} to 10^{-5} sensitivity, the noise would be substantially lower using the direct 1X buffered output.

[4] Broadband noise measured with 100 pF input shunt capacitance.

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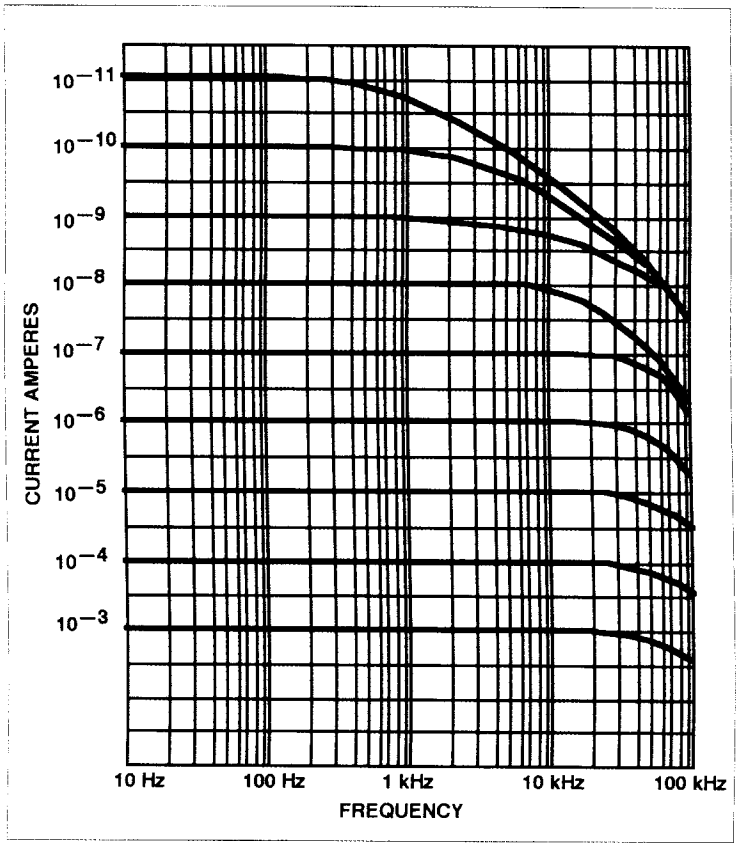
TYPICAL OVERSHOOT VS INPUT SHUNT CAPACITANCE

Sensitivity A/V	Capacitance pf	Overshoot on Step Input
10^{-3}	33,000	6%
10^{-4}	10,000	2%
10^{-5}	5,700	10%
	4,300	4%
	3,200	2%
10^{-6}	1,000	4%
	500	0%
10^{-7}	500	8%
	350	4%
10^{-8}	220	20%
	110	10%
10^{-9}	330	14%
	110	0%
10^{-10}	500	6%
	225	0%
10^{-11}	225	6%
	150	2%



Model 1211 Frequency Response

1211 OPTION 10 BATTERY PACK

The retrofittable Nickel Cadmium Battery Pack installs inside the chassis, and is charged from the 1211 power supply.

BATTERY CHARGE TIME (fast charge) <15 hr.
BATTERY OPERATING TIME >25 hr.
WEIGHT 1.2 kg (2 lb. 10 oz.)

For more information contact

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