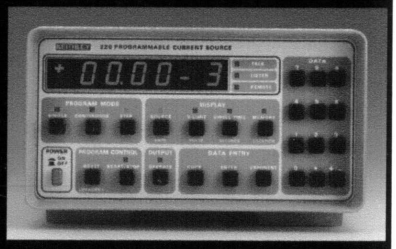
220/6514

High Impedance Hall Effect Test System



The Model 220 Current Source offers material researchers ±0.5pA/step to ±101mA DC output, combined with $10^{14}\Omega$ output resistance.

The Model 6514 Electrometer provides >200TΩ input impedance and <3fA input bias current.

Ordering Information

220	Programmable Current Source
6514	Programmable Electrometer

Extended warranty, service, and calibration contracts are available.

ACCESSORIES AVAILABLE

2000	Digital Multimeter
6167	Guarded Input Adapter
CABLES	
7024-10	Triax Cable, 3m (10 ft)
7025-10	Low Noise Triax Input Cable, 3m (10 ft)
7078-TRX-10	Triax Cable, 3m (10 ft) (2 required)

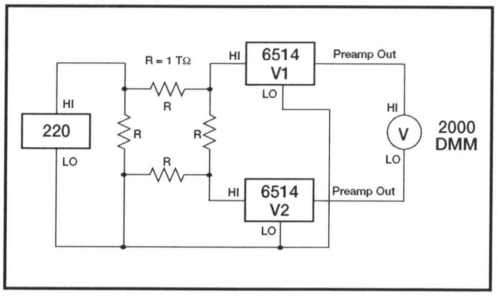
Alternative economical approaches to Hall coefficient and resistivity measurements

Occasionally, when working with samples with very high resistivity, semi-insulating GaAs, and similar materials with resistivities above $10^8\Omega$, alternative system configurations may be able to produce more reliable data than standard, pre-configured Hall Effect systems. Such systems demand careful shielding and guarding, and typically include a current source, two electrometer buffers, and an isolated voltmeter. The schematics show two suggested configurations for these high resistivity applications: one that requires manual switching and one with automated switching.

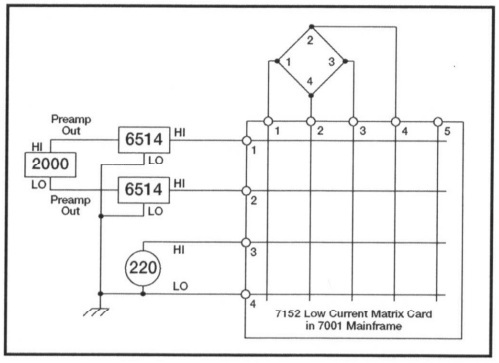
The range of the systems shown here is very wide. The high resistance end is limited by the minimum output of the current source. A current of 100pA can be supplied with an accuracy of about 2%. If the resistance of each leg of the sample is no more than 1TΩ, the maximum voltage developed will be 100V, within the range of the Model 220 current source and the Model 6514 electrometer. This system will provide good results with samples as low as 1Ω per leg, if a test current level of 100mA is acceptable. Even at 100mΩ per leg, accuracy is approximately 2%.

Leakage currents are the most important sources of error, especially at very high resistances. One important advantage of this circuit is that a guard voltage is available for three of the sample terminals, which virtually eliminates both leakage currents and line capacitance. The fourth terminal is at circuit LO or ground potential and does not need guarding.

Call Keithley for additional guidance in selecting equipment for specific high resistivity applications.



The equipment configuration with manual switching (above) was developed for very high resistance van der Pauw or Hall Effect measurements. This measurement system includes a Model 220 current source, two Model 6514 electrometers (used as unity-gain buffers) and a Model 2000 digital multimeter (DMM). The current source is used with a Model 6167 guarded input adapter, which minimizes the time constant of the current source and cable. A Model 7024-10 triax cable connects the source, and two Model 7078-TRX-10s connect the electrometers. Two insulated banana leads are used to connect the digital multimeter to the preamp outputs for the electrometers. The insulation resistance of the leads and supporting fixtures for the sample should be at least 100 times the leg resistance (R). The entire sample holder must be shielded to avoid electrostatic pickup. If the sample is in a dewar, this should be part of the shield.



One Model 7152 Matrix Card, housed in a Model 7001 mainframe, is used to connect the electrometers and the current source to the sample. Two Model 6514 Electrometers are used as unity gain buffers, and their output difference is measured with a Model 2000 DMM. To ensure faster measurement time, guarded measurements are made by turning the Guard switch ON for both of the Model 6514s, and by guarding the Model 220 output using a Model 6167 guarded input adapter. Call Keithley's Applications department for cabling information.

Hall Effect systems for high resistivity applications

SEMICONDUCTOR

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A GREATER MEASURE OF CONFIDENCE

220 Programmable Current Source

MODEL 220 CURRENT SOURCE

RANGE	MAXIMUM OUTPUT	ACCURACY (1 Year) 18°–28°C	STEP SIZE	TEMPERATURE COEFFICIENT/°C 0°–18°C & 28°–50°C	NOISE (pk-pk of range)	3dB BANDWIDTH
100 mA	±101.00 mA	0.1 % + 50 µA	50 µA	0.01 % + 2 µA	100 ppm	0.1 Hz to 30 kHz
10 mA	±19.995 mA	0.05% + 10 µA	5 µA	0.005% + 200 nA	100 ppm	0.1 Hz to 100 Hz
1 mA	±1.9995 mA	0.05% + 1 µA	500 nA	0.005% + 20 nA	100 ppm	0.1 Hz to 100 Hz
100 µA	±199.95 µA	0.05% + 100 nA	50 nA	0.005% + 2 nA	100 ppm	0.1 Hz to 100 Hz
10 µA	±19.995 µA	0.05% + 1 nA	5 nA	0.005% + 200 pA	100 ppm	0.1 Hz to 100 Hz
1 µA	±1.9995 µA	0.1 % + 1 nA	500 pA	0.01 % + 20 pA	100 ppm	0.1 Hz to 100 Hz
100 nA	±199.95 nA	0.3 % + 100 pA	50 pA	0.02 % + 2 pA	100 ppm	0.1 Hz to 100 Hz
10 nA	±19.995 nA	0.3 % + 10 pA	5 pA	0.02 % + 200 fA	200 ppm	0.1 Hz to 10 Hz
1 nA	±1.9995 nA	0.4 % + 2 pA	500 fA	0.02 % + 200 fA	400 ppm	0.1 Hz to 10 Hz

OUTPUT RESISTANCE: $>10^{14}\Omega$ (on 1nA range).
OUTPUT CAPACITANCE: <20pF.
LINE REGULATION: <0.01% for AC power line changes within specified limits.
VOLTAGE LIMIT: Bipolar, 1V to 105V in 1V programmable steps.
RESPONSE TIME: <3ms to within 0.1% of programmed change.
TRANSIENT RECOVERY TIME: <3ms to rated accuracy following any change in compliance voltage.
GUARD OUTPUT:
Maximum Load Capacitance: 10nF.
Maximum Load Current: Absolute total (Output + Guard) not to exceed 105mA.
Accuracy: ±1mV (excluding output lead voltage drop).
PROGRAM MEMORY:
Number of Locations: 100.
Range of Dwell Times: 3ms to 999.9s.
Accuracy of Dwell Time: ±(0.05%+200µs).
OUTPUT LOAD: Output load must be non-inductive.
EXTERNAL TRIGGER: TTL-compatible EXTERNAL TRIGGER INPUT and OUTPUT.
OUTPUT CONNECTIONS: Teflon® insulated 2-lug triax connector (Specialty Connector #30JR121-1) for output; five-way binding posts for GUARD, OUTPUT COMMON, and CHASSIS; BNC (chassis isolated) connectors for EXTERNAL TRIGGER INPUT and OUTPUT, Amphenol or Cinch Series 87 IEEE and printed circuit digital I/O port. All connections on rear panel.

IEEE-488 BUS IMPLEMENTATION

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.
INTERNAL PROGRAMMABLE PARAMETERS: Display Mode, Output, Prefix Data Format, EOI, SRQ (including mask for over Limit), Program Mode, Range, Trigger Mode, Terminator Character, Inputs (Source, Limit, Dwell Time, 100-Point Memory Locations), Output Status, Digital Self Test.
DIGITAL I/O PORT: A separate I/O port consisting of four input and four output lines as well as common (IEEE-488) and +5V DC. Outputs will drive one TTL load. Inputs represent one TTL load. The 220 or 230 can be programmed to generate an "SRQ" upon any change in the four bit input data. Mating connector supplied.

GENERAL

DISPLAY: 0.5 in LED digits, 4½-digit signed mantissa, 1-digit signed exponent.
SYSTEMS COMPATIBILITY: IEEE-488-1978.
LIMIT INDICATIONS (Voltage Limit): "V-LIMIT" LED will blink.
MAXIMUM ALLOWABLE COMMON MODE VOLTAGE (OUTPUT or OUTPUT COMMON to CHASSIS): 250V rms, DC to 60Hz.
SELF TEST: Digital RAM, ROM, front panel LEDs upon power ON.
EMC: Conforms to European Union Directive 89/336/EEC.
SAFETY: Conforms to European Union Directive 73/23/EEC (meets EN61010-1/IEC 1010).
WARM-UP: 1 hour to rated accuracy.
POWER: 105–125 or 210–250V AC (internal switch selected), 50 or 60Hz, 60W maximum (80VA maximum). 90–105 or 180–210V AC operation available.
COOLING: Internal fan for forced air cooling.
ENVIRONMENTAL LIMITS: Operating: 0°–50°C; up to 35°C at 70% non-condensing relative humidity. **Storage:** –25° to 70°C.
DIMENSIONS, WEIGHT: 127mm high × 216mm wide × 359mm deep (5 in × 8½ in × 14⅛ in). Net weight 4.4kg (9 lb 11 oz).
ACCESSORIES SUPPLIED: Model 6011 Triaxial Test Lead (3 ft).