MODEL 1100
THERMOCOUPLE SIMULATOR/CALIBRATOR

simplifies precise calibration of thermocouple measuring instruments: includes linear DC calibration capability

THERMOCOUPLE APPLICATIONS:

Calibration of:

- Temperature Indicators
- Data Systems
- Temperature Transmitters
- Amplifiers and Linearizers
- Temperature Controllers
- Thermocouples (requires bath)

LINEAR APPLICATIONS:

Calibration of:

- DC Digital Voltmeters
- Panel Meters
- Strip Chart Recorders
- Millivoltmeters
- VCO's and Amplifiers
- DC Power Supplies

FEATURES:

- Simulates 4 TC types
- Dial Temperature in Degrees
- Digital Conformity to NIST 0.1°
- Self-Contained Ref. Junction
- Dial Millivolts Directly
- 0.01% of Reading Accuracy
- Optional Remote Programming

Ectron® CORPORATION

GENERAL DESCRIPTION

The Model 1100 is a sophisticated and versatile instrument which has been designed both to generate and to measure precise voltages. It is equally useful on the production line and in the laboratory. Although its most frequent application is to calibrate temperature indicating devices such as digital thermometers, thermocouple recorders, etc., it actually functions in four separate and distinct ways.

A. As a Thermocouple Simulator. In this mode the built-in computing capability and memory enable the operator to simply select a thermocouple type, dial a temperature in °C or °F and automatically obtain the proper output voltage for the selected thermocouple type on terminals made of the proper thermocouple material.
B. As a thermocouple calibrator (Differential Temperature Measurement).
C. As a linear dc voltage standard (DC Voltage Calibrator).
D. As a linear DC Differential Voltmeter.

The Model 1100 may be remotely programmed in any of the above modes of operation, making it especially useful when calibrating large numbers of instruments or on the production line. Details of the operating modes and remote programming capability are given below.

A. THERMOCOUPLE SIMULATOR MODE

In this mode, the instrument simulates a thermocouple that can be set to any temperature by front panel switches (or remote control lines). The output corresponds very closely to the tables in NIST Monograph 175. while delivering up to 5mA of current into an external load. (See Digital Conformity in Table 2.) The output is available on terminals constructed of thermocouple material. Alternatively, the output is available on copper terminals with a selectable reference junction temperature.

The Model 1100 simulates thermocouple types E (Chromel* Constantan), J (Iron Constantan), K (Chromel* Alumel*) and T (Copper Constantan). This simulation covers the entire temperature range given for each of these types in NIST Monograph 175. The instrument may simulate temperatures in degrees Celsius (Centigrade) or Fahrenheit, or both, depending on the options selected. In either case the temperature may be set to within 0.1 degree by adjusting five lever switches. The integral switch readouts indicate the temperature directly.

*Trademark - Hoskins Mfg. Co.

Figure 1 is a simplified block diagram of the Model 1100 applicable to all four modes of operation. It shows that the instrument is fundamentally a precision dc voltage source, consisting of a stable dc reference and a digital-to-analog converter (DAC). Changing the input commands to the DAC and/or the routing of the analog voltage determines which of the four modes the instrument will operate in.

In the thermocouple simulator mode the operation is as follows:

1. The operator selects the thermocouple type, Scale (C or F) and desired temperature.
2. The output of the switches addresses the arithmetic unit which in turn interrogates the appropriate ROM.
3. The ROM, programmed with information from NBS thermocouple tables, responds with an appropriate digital number which commands the DAC.
4. The DAC produces the appropriate millivolt output.
5. The operator sets the Reference Junction Temperature Switch and selects copper or thermocouple-material output terminals as required by the device to be calibrated.

B. DIFFERENTIAL TEMPERATURE MEASUREMENT MODE

This mode is used to measure the temperature of thermocouples to a high degree of accuracy. The instrument functions in the same manner as in the Thermocouple Simulator Mode, except that it is used as a measuring device rather than as a voltage source. The output from the thermocouple to be measured is compared with the voltage generated by the Model 1100. When these voltages are equal, the temperature of the external thermocouple is equal to the temperature indicated by the readouts of the lever switches.

A sensitive amplifier and null-meter are permanently connected internally between the negative output terminals (SOURCE) and the input terminals (METER) on the panel labeled THERMOCOUPLE. The thermocouple to be measured is connected between one of the "common" terminals and a METER terminal. (See front page photo and Figs. 1 and 2.) The lever switches are adjusted for a zero reading on the null-meter and the temperature is then read directly from the switches.

Calibration of a thermocouple can be accomplished by immersing the thermocouple in a suitable bath and adjusting for a null as described above. In this way, a calibration point can be established for the particular thermocouple at the temperature of the bath.

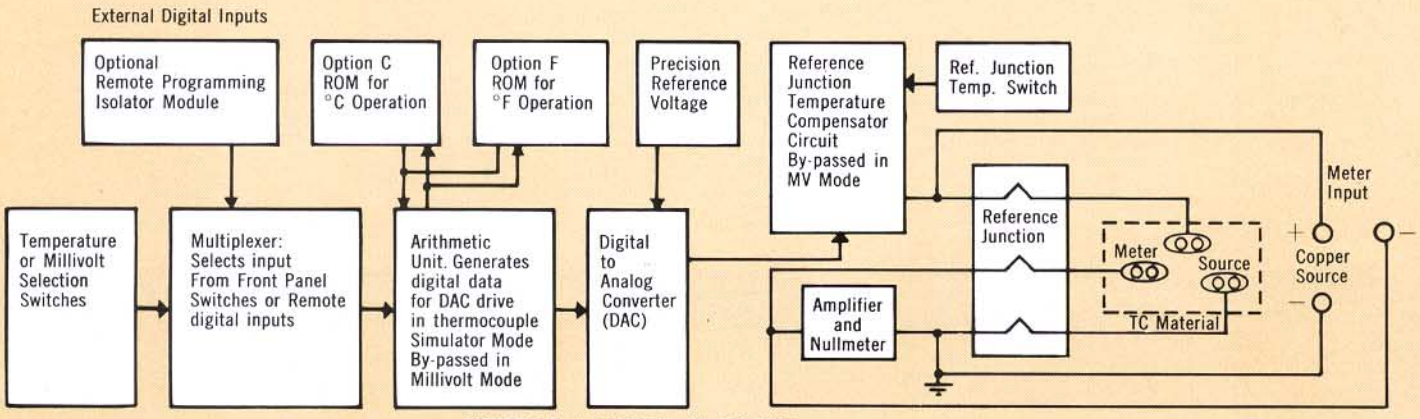

FIGURE 1, Model 1100 Simplified Block Diagram

C. DC VOLTAGE CALIBRATOR

Since the Model 1100 is fundamentally a variable precision dc source, it can operate in a linear mode as a dc voltage calibrator. The excellent stability (±0.005% ±1 μV for 6 months) and the high resolution (1 μV on the lowest range) make it ideal for calibrating digital voltmeters, recorders, and other precision dc equipment.

In this mode, the lever switch which selects °C or °F is moved to one of three ranges: MV, MV x 0.1 or MV x 0.01. These positions provide full-scale ranges of 10V, 1V and 100mV respectively. In the MV positions the arithmetic portion of the instrument is bypassed and the DAC is controlled directly by the decade lever switches. The precise output voltage desired is present on copper terminals at the binding post pair labeled COPPER SOURCE.

D. DC DIFFERENTIAL VOLTMETER MODE

The incorporation of a nullmeter in the Model 1100 adds considerably to its versatility by permitting it to operate as a dc differential voltmeter. In this linear mode of operation the instrument again functions as a measuring device rather than a voltage source with the capability of measuring dc voltages to an accuracy of 0.015% ±1μV. The external voltage is connected to the binding posts labeled METER INPUT (See cover photo and Fig. 2), the appropriate MV scale is chosen and the lever switches are adjusted for zero indication on the nullmeter. The precise value of the external voltage is then given by the readouts of the lever switches.

INPUT/OUTPUT TERMINAL ARRANGEMENT

The versatility of the Model 1100 is enhanced considerably by the use of input and output terminals made of several different thermocouple materials as well as copper. The panel labeled THERMOCOUPLE contains terminals made of copper, iron, constantan, alumel and chromel as shown on the cover photo. These are arranged so that terminal pairs selected from the center ("common" terminals) and from the side labeled SOURCE provide output voltages from E, J, K or T thermocouple material, while pairs selected from the center and the side labeled METER provide input terminals for voltage from external thermocouples of the same four types.

In addition to this terminal panel there are copper terminal pairs in the form of bindng posts. The pair labeled COPPER SOURCE is used as voltage output terminals, and the pair labeled METER INPUT is used as voltage input terminals from an external source.

The choice of terminal material and the choice of internal reference junction temperature permit operation with the internal or an external reference junction, with instruments which are separated from their reference junctions, etc.

REMOTE PROGRAMMING, OPTION A

Figure 1 shows that the temperature or voltage setting can be selected by either the front panel switches or remote digital logic. The remote programming capability is added by specifying Option A. This includes the plug-in isolator module and the digital multiplexing circuitry which selects the local or remote control lines. In the remote mode, the external system can control selection of +, −, °C, °F, MV, MV X0.1, MV X0.01 plus a five digit temperature or voltage. All other controls are set manually.

The remote control option electrically isolates the external logic lines from the internal circuitry to minimize ground loops and resulting line-related noise. The digital input interface is TTL compatible. Since the input buffers are electrically isolated from the 1100, the external system must supply 5V dc power at 300mA to these buffers.

SUMMARY OF CAPABILITIES

The ability to accurately simulate a thermocouple with controls which read directly in degrees is the most unique feature of the Model 1100. This eliminates the need for performing calibrations with a collection of three or four pieces of laboratory equipment and most important, it eliminates the need for constant referral to thermocouple tables.

The use of thermocouple tables is tedious, time consuming and costly. It can also lead to calibration errors and the "short cutting" of test procedures. To illustrate the latter, consider the testing and calibration of a digital thermocouple indicator which has internal linearization consisting of 30 to 50 individual segments. This instrument should not be certified until all segments have been fully tested, preferably at several points. This type of comprehensive testing can take hours if each reading must be looked up in a five or six-place table. The excessive time required can easily lead to the omission of important test steps.

The addition of differential and linear modes of operation together with its remote programming capability make the 1100 one of the most versatile and useful precision instruments available today.

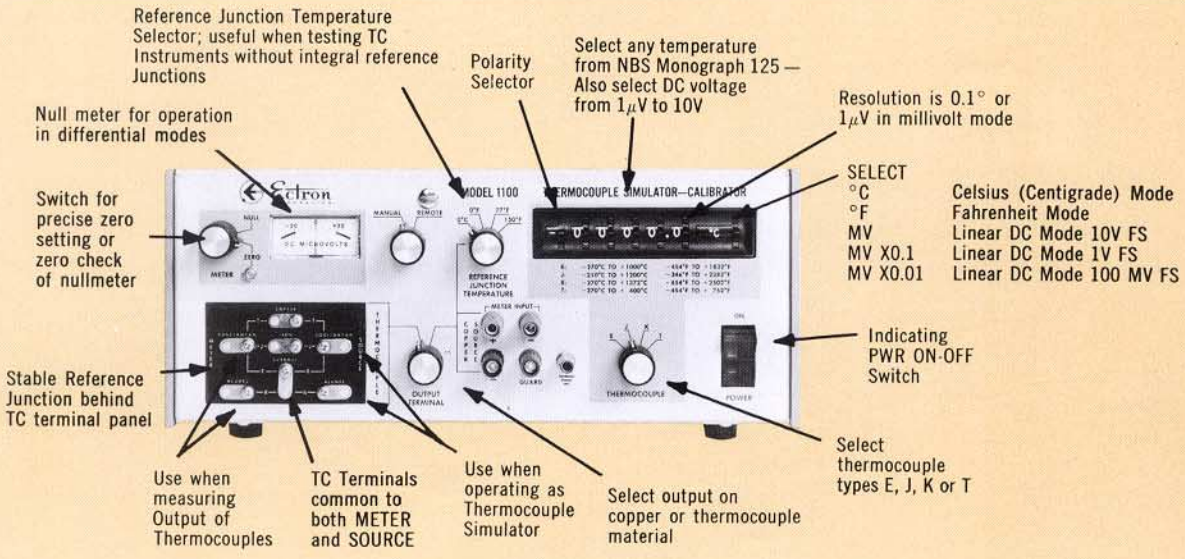

Figure 2, Model 1100 Functions and Controls

Accuracy, General

In the linear source mode, the accuracy and stability of the 1100 is expressed the same as for conventional DC voltage calibrators. As a thermocouple simulator, the digital conformity of the arithmetic unit must also be considered together with the accuracy of the internal reference junction compensation.

To allow maximum application flexibility, errors due to zero drift are listed separately since the instrument's zero condition can be adjusted in the field without the use of primary standards (see self-contained null meter). For those who prefer that no adjustments of any type be made, a worst case, 6 month zero stability specification is included. Separate zero specifications are listed for the copper and thermocouple output terminals. These are **not** additive.

Unless otherwise noted, all specifications apply at 23°C ±1°C including line voltage variations from 105 to 125V rms and the reference selector switch set to 0°C. For other settings of this switch, see table 4 below. Allow ½ hour warm-up for full specified accuracy and stability.

Table 1 — Specifications (Percentages shown are percent of output voltage, not of full scale.)

Mode	T.C. Simulator	MV	MV X0.1	MV X0.01
Full Scale	See table 2	±9999.9 mV	±999.99 mV	±99.999 mV
Resolution	0.1 (°C or °F)	100 μV	10 μV	1 μV
Accuracy (less zero)	±.015% plus conformity	±.01% ±50 μV	±.015% ±5 μV	±.015% ±1 μV
Stability, 6 mos.	±.005% ±1 μV	±.005% ±1 μV	±.005% ±1 μV	±.005% ±1 μV
Temp. Coefficient	±.003%/°C	±.0025% ±2 μV/°C	±.0025% ±1 μV/°C	±.0025%/°C
Zero, copper terminals				
Initial	±3 μV	±20 μV	±5 μV	±3 μV
Stability, 6 mos.	±5 μV	±20 μV	±7 μV	±5 μV
Temp. Coefficient	±0.5 μV/°C	2.5 μV/°C	1 μV/°C	0.5 μV/°C
Zero, T.C. terminals				
Initial	±5 μV	N/A	N/A	±5 μV
Stability, 6 mos.	±10 μV	N/A	N/A	±10 μV
Temp. Coefficient	±1 μV/°C	N/A	N/A	±1 μV/°C
Noise, peak 3 sigma				
.1 Hz to 10 Hz	2 μV	10 μV	5 μV	2 μV

Table 2 — Thermocouple Ranges and Conformity

	Type E	Type J	Type K	Type T
Min Temp °C	−270	−210	−270	−270
°F	−454	−346	−454	−454
Max Temp °C	1000	1200	1372	400
°F	1832	2192	2502	752
Digital conformity				
−270°C to −200°C	±4 μV	±3 μV	±3 μV	±3 μV
−200°C to −150°C	±4 μV	±3 μV	±3 μV	±2 μV
−150°C to −100°C	±4 μV	±3 μV	±2 μV	±2 μV
−100°C Up	±2 μV	±2 μV	±2 μV	±2 μV

Table 3 — Other Specifications

Settling Time	1 sec.
Output Impedance	0.2 ohm (max.)
Output Current	5mA (min.)
Line Voltage	105-125V/210-250V; 50/60 Hz
Power Consumption	35 watts nominal
Operative Environment	15°C to 35°C, up to 90% R.H.
Dimensions, nominal	5.25" (13.34 cm) high, 12.375" (31.43 cm) wide, 15.5" (39.37 cm) deep
Shipping weight	22 lbs. (10 Kg), nominal

Table 4 — Ref. Temp. Selector, Max. Offset

0°C	No additive offset
0°F	0.5 μV max, all TC types
77°F	0.5 μV max, all TC types
150°F	3 μV max, type E
	2 μV max, type J
	1 μV max, types K & T

Table 5 — Ordering Information

Model 1100CF

Includes options:
- "C" TC types, E, J, K, T (°C)
- "F" TC types, E, J, K, T (°F)

Other options (not required)
- "A" Remote programming interface
- "R" Rack Mounting Kit

FOB San Diego, CA Terms Net 30. Delivery 30 days ARO

Specifications subject to change without notice.

OTHER ECTRON PRODUCTS:

- Differential DC Amplifiers
- Strain Gage Signal Conditioners
- Thermocouple Signal Conditioners
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- Transducer Conditioning Amplifiers

Ectron CORPORATION®
8159 Engineer Road
San Diego, CA 92111
Tel. (858) 278-0600
Fax: 858-278-0372
Call Toll Free (800) 732-8159

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