MODEL 1120

THERMOCOUPLE SIMULATOR/CALIBRATOR

(PATENTED)

IEEE-488

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
- Temperature Alarms
- Temperature Recorders

Linear Applications:

Calibration of:

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

Features:

- Simulates up to 10 T/C types
- Key Temperature in Degrees C or F
- Digital Conformity to NBS < 1μV
- Keyable Self Contained Ref. Junctions
- Key Millivolts or Volts Directly
- 0.005% of Reading Accuracy
- Optional IEEE-488 Interface
- Microprocessor Based

Ectron® CORPORATION

GENERAL DESCRIPTION

The ECTRON Model 1120 Thermocouple Simulator/ Calibrator is a precision voltage source designed to perform calibration of thermocouple temperature measuring, indicating and recording instruments efficiently and without various auxiliary equipment.

In addition to providing thermocouple simulation, the 1120 is a precision DC voltage calibrator with a conventional linear output from −11 to +11 volts in two ranges, i.e. millivolts and volts with resolution to .01 microvolt.

The efficiency of temperature calibration with the 1120 far exceeds that previously available with the traditional methods using an ice point reference, DC voltage standard, and the NBS Monograph 125 tables. With much less possibility for error, the 1120 allows easier and faster calibration of temperature instruments.

Featuring direct digital input via a keyboard, thermally compensated output terminals, a 5½ digit display with floating decimal and up to eight (8) thermocouple types, the 1120 is unsurpassed as the calibration standard for thermocouple type instruments.

The Ectron Model 1120 Thermocouple Simulator/ Calibrator operates under microprocessor control to provide an output conforming to the emf output of any of eight thermocouple types when the thermocouple type and temperature is keyed directly in degrees Celsius (C) or Fahrenheit (F).

Precise conformity to the non-linearity of nine thermocouple types (E, J, K, T, R, S, B, C and N) is controlled by optional plug-in thermocouple type modules, one for each of the nine thermocouple types offered. Each thermocouple type module includes a ROM containing the polynomial equation that corresponds to NBS Monograph 125. Using 32-bit floating-point arithmetic, digital conformity errors are reduced to virtual insignificance.

Coupled with the ability to command a temperature directly, the 1120 provides accuracies traceable to NBS and superior to all but the most elaborate laboratory setups. With more than sufficient margin to calibrate even the best thermocouple measuring, indicating, and recording instruments the 1120 offers ACCURACY, not just resolution. As the leading manufacturer of Thermocouple Simulator/Calibrators, Ectron has embodied in the Model 1120 the latest technology to simplify operation and to reduce all errors, both hardware and operator, associated with the calibration of temperature instrumentation.

THERMOCOUPLE SIMULATOR

The Model 1120 operation is controlled by an 8085 microprocessor, which handles data entry, calculation, and DAC (digital to analog conversion) functions.

Entry to the 1120 is through a 16-key keyboard which allows the operator to specify temperature in degrees C or F, voltage in millivolts or volts, thermocouple type, and whether the output terminals perform as thermocouple alloy or copper. The user can also specify any reference junction temperature in either degrees C or F, over the range of the thermocouple type being used.

Above the keyboard is an LED display which indicates the simulation temperature or output voltage, unit of measure and the thermocouple type. Above the output terminals is an additional LED display which indicates the material to be connected to the terminals and output "not valid" conditions.

Additional features include the storage of seven sets of operating conditions in non-volatile memory, including simulation temperature or output voltage, thermocouple type, and the type of wire to be connected to the output. The user-entered reference junction temperature is also stored in this memory.

Within the 1120, the thermocouple emf's are calculated using polynomials, the coefficients for which are stored in the thermocouple type plug-in modules.

After the operator has entered the desired output conditions and presses the "EXECUTE" key, the instrument operates in one of the following four modes:

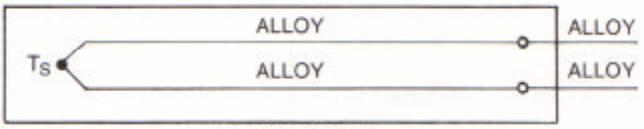
1. Thermocouple Simulator, Alloy Output
2. Thermocouple Simulator, Copper Output
3. Linear Voltage, Alloy Output
4. Linear Voltage, Copper Output

In Mode 1, the 1120 looks like a thermocouple of the specified type at the simulation temperature. Although the output connections are made to copper blocks, the temperature of that junction is measured and the generated emf is precisely compensated. Refer to figures 1 and 2 of the 1120 output block diagrams. Figure 1 shows the 1120 in mode 1 as it appears to the user.

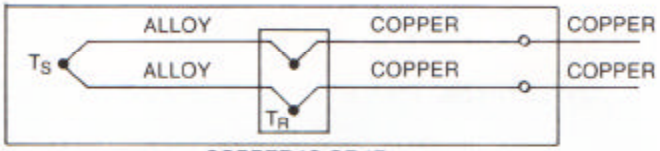
Figure 2 shows the instrument in mode 2. Here the 1120 looks to the user like the same thermocouple as in mode 1 with a junction to copper at a temperature specified as the referenced junction temperature.

As shown in Figure 3, mode 3 functions as a precision dc source with an output determined by the voltage specified. From the user point of view, the output is from terminals composed of the thermocouple alloys specified by the thermocouple type.

Mode 4, shown in Figure 4, is the simplest of all, being comprised of a precision dc voltage source feeding copper output terminals.



ALLOY °C OR °F
FIGURE 1



COPPER °C OR °F
FIGURE 2

DC VOLTAGE CALIBRATOR

Simply by keying in millivolts or volts the Model 1120 becomes a precision dc voltage source. Outstanding accuracy, stability and resolution make the 1120 ideal as a working standard to calibrate virtually any dc measuring instrument, from digital voltmeters to recorders to data systems.

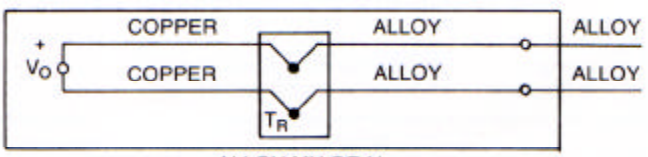
The selectable voltage ranges cover from −11 to +11 volts with 5 ½ digits of display and resolution to 0.01 microvolts.

Of special importance in low level calibration work is the low output impedance (0.05 ohm) on all ranges. Most dc calibrators have high output impedance (1 to 20 ohms) on low level ranges. When calibrating instruments with low or varying input inpedance, it is difficult if not impossible to obtain accurate and consistent results. Instruments in this category include chopper amplifiers, A–to–D converters and low level multiplexers. The 1120 greatly simplifies this problem because the output impedance is extremely low (typically 0.01 ohms) even for microvolt levels.

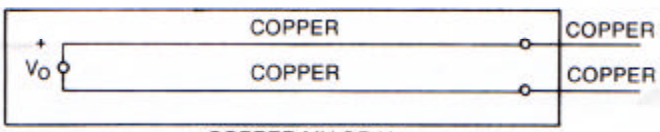
KEYBOARD

The front panel 16-key keyboard in a 4 x 4 array and a separate EXECUTE control are all that is necessary to operate the Model 1120. Coarse and fine variable controls are not used eliminating their inherent problems of instability, resolution, and setability. Through the use of the digital keyboard, all desired operating parameters can be selected, error free:

1. Thermocouple type
2. Output voltage or thermocouple temperature
3. Unit of measure in degrees C, degrees F or linear millivolts or volts
4. Output terminals of copper or thermocouple alloy
5. Any reference junction temperature in degrees C or F
6. Output polarity
7. Storage or recall of seven sets of complete operating conditions



ALLOY MV OR V
FIGURE 3



COPPER MV OR V
FIGURE 4

T_S is the simulated thermocouple temperature
V_O is the specified output voltage
T_R is the specified reference junction temperature

DISPLAYS

The main display consists of a 5½ digit (plus sign) seven-segment digital readout which indicates the numerical value of entered data. With a fully floating decimal, resolution of .00001 is obtainable. LED annunciators show the unit of measure, i.e. degrees C, degrees F, millivolts, or volts. Another indicator displays the thermocouple type selected. Additionally, should a reference junction other than 0 degrees C be entered another LED readout will so indicate. Three additional LED indicators complete the visual display. These are located above the output terminals and indicate the status of the terminals, ALLOY, COPPER, or NOT VALID. An "ALLOY" indication is displayed when the terminals are totally compensated and appear as thermocouple alloy material for the selected thermocouple type. A "COPPER" indication is displayed when the terminals appear as standard copper material. A "NOT VALID" indication is displayed when a change in output is pending or an excessive load is applied.

OUTPUT TERMINALS

A very important and unique part of the Model 1120 are its output terminal blocks. While there is only one set of output terminals for both the linear voltage and the eight thermocouple type outputs, the terminals and associated circuitry have the unique ability to appear electrically as copper or any of the thermocouple alloy materials.

One of the largest potential sources of error in a T/C simulator can be caused by the output terminals. Unless T/C materials are used (as in the Ectron Model 1100), junctions are formed between these terminals and the T/C wires going to the instrument being calibrated. To maintain the simulator's accuracy, the emfs generated at these two junctions must be precisely compensated, both for the ambient temperature of the two terminals and also for the difference in temperature between the two terminals. Unless exact compensation is provided, variations in accuracy will be caused by air drafts, by thermal conduction through the thermocouple wires and by errors in the compensation computation within the simulator. These errors are greatest for changing ambient conditions, e.g., the simulator moved from one environment to another or operation near an air conditioner vent. Generally these errors are degree for degree, that is, a degree in compensation produces a degree error in calibration accuracy.

To preserve the outstanding accuracy of the 1120, considerable design effort went into the output terminals of the unit and to the compensation circuitry. The terminals are large gold-plated pure copper blocks with imbedded copper terminals. Both blocks are thermally interconnected although electrically isolated. Sensing elements are imbedded in each half to provide continuous information to the microprocessor for use in compensation calculations of the thermocouple polynomials for the particular T/C material involved. In this manner truly accurate outputs are obtained regardless of the thermal conditions and the thermocouple materials connected. No

other thermocouple simulation instrument using standard terminals provides this unique and necessary contribution to overall accuracy. Guard and case ground terminals are also provided.

REFERENCE JUNCTION

Although in most instances a reference junction of 0°C (32°F) is desired , the Model 1120 allows the operator to enter any reference junction temperature within the temperature range of the thermocouple module in use. No longer are laborious calculations required for those specific systems utilizing ambient or other reference junction temperatures. The 1120 automatically compensates and provides the precise output. The reference junction temperature entered can be recalled and displayed at any time.

MEMORY REGISTERS

A non-volatile memory with eight memory registers permits storage or recall of seven sets of total operating conditions and one reference junction temperature. An internal replaceable lithium cell provides power to the memory in the absence of AC line power. Any memory register can be recalled for display without erasure.

These memory registers provide the user the ability to store frequently used conditions of operation for execution at the simple push of three keys.

ISOLATION

In order to preserve the microvolt accuracy of the Model 1120, the analog output is totally isolated from the case, power line and remote control bus. Extensive shielding including a box shielded power transformer allows the 1120 to accept the ground system of the instrument being calibrated without introducing ground loop currents.

COMPUTER CONTROL OPTION

A computer control interface option is available to allow full remote programming of the Model 1120, with support of all interface functions needed for convenient and flexible operation.

IEEE-488 Interface, option 02, allows the 1120 to be remotely controlled by data terminal equipment using the General Purpose Interface Bus (GPIB) and conforming to the IEEE-488 Standard.

Optical isolators provide complete isolation between the 1120 and bus grounds.

The interface option is a plug-in subassembly. It may be factory installed when the 1120 is ordered, or customer installed in the field, without any modification to the 1120 and without affecting calibration of the instrument.

SELF-TEST DIAGNOSTICS

The Model 1120 incorporates a self-test diagnostic routine that checks several hardware and software functions for proper operation. The diagnostic routine is automatically performed each time the instrument is turned on. In addition, the self-test diagnostic routine may be user initiated at any time by a simple two key command or by remote command via the G.P.I.B.

The tests performed include:

DIA 1. Front panel visual display test of all LED segments and indicators.

DIA 2. Check-sum and LRC of any and all T/C Type Modules installed.

DIA 3. Check-sum and LRC of the main memory.

A visual display of failure to pass any diagnostic is provided.

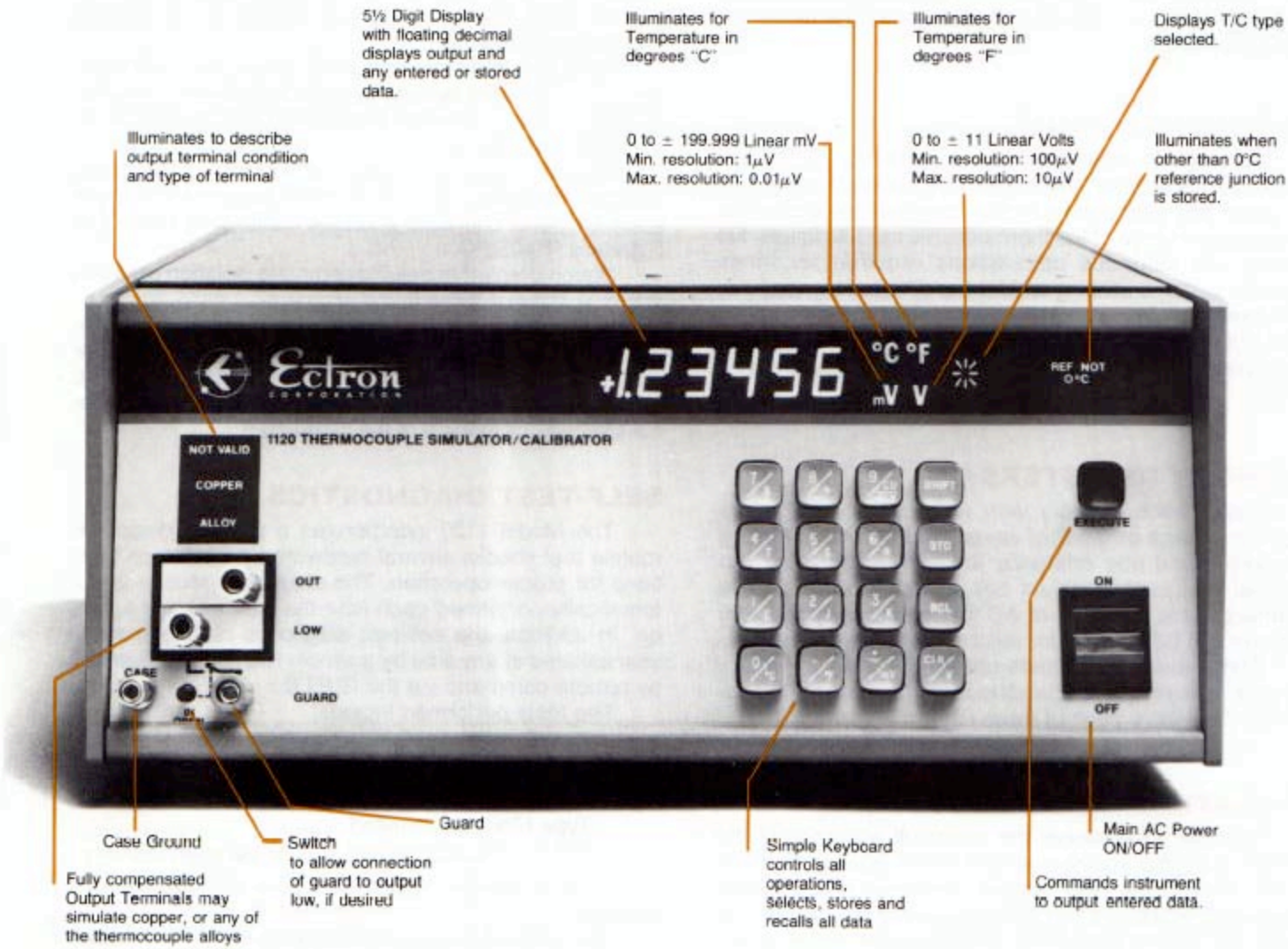
The self-test diagnostic routine is performed in less than 30 seconds and data previously entered into the eight memory registers is not affected.

The Model 1120 Thermocouple Simulator/Calibrator meets the following recognized standards:

T/C TYPE	STANDARD							
	NBS 125	ANSI MC96.1	ASTM E230	IPTS		BS 4937	JIS C1602	DIN 437-10
E	●	●				●	●	
J	●	●				●	●	●
K	●	●				●	●	●
T	●	●				●	●	●
R	●	●				●		
S	●	●			●	●		●
B	●	●		●	●			
C				●				
N	Per NBS Monograph 161							

NOW! ITS-90 per the latest NIST Thermocouple Specification Monograph 175

MODEL 1120 SHOWING ALL CONTROLS AND VISUAL DISPLAYS



U.S PATENT NO. 4,466,749

ORDERING INFORMATION

BASIC MODEL 1120
(WITHOUT T/C MODULES
UNIT ACCEPTS UP TO 8 T/C MODULES)

T/C MODULE, TYPE E

T/C MODULE, TYPE J

T/C MODULE, TYPE K

T/C MODULE, TYPE T

T/C MODULE, TYPE R

T/C MODULE, TYPE S

T/C MODULE, TYPE B

T/C MODULE, TYPE C*

T/C MODULE, TYPE N*

T/C MODULE, TYPE PL II*

OPTION 01, RACK MOUNT

OPTION 02, IEEE-488 INTERFACE

OPTION 03, REAR TERMINALS
(DELETES FRONT TERMINALS)

*Unofficial Designations. Unit will accept each but not more than one at a time.

SPECIFICATIONS

THERMOCOUPLE MODE

Temperature Ranges:

Type	°C	°F
E (Chromel/Constantan)	−270 to 1000	−454 to 1832
J (Iron/Constantan)	−210 to 1200	−346 to 2192
K (Chromel/Alumel)	−270 to 1372	−454 to 2501.6
T (Copper/Constantan)	−270 to 400	−454 to 752
R (Platinum 13% Rh/Pt)	−50 to 1767.6	−58 to 3213.6
S (Platinum 10% Rh/Pt)	−50 to 1767.6	−58 to 3213.6
B (Platinum 6% Rh/Pt 30% Rh)	0 to 1820	32 to 3308
C* (Tungsten 5% Re/W 26% Re)	0 to 2316	32 to 4200.8
N (Nicrosil/Nicil)	−270 to 1300	−454 to 2372
PL II*(Platinel II)	−100 to 1395	−58 to 2192

*C and PLII are unofficial designations.

Accuracy:

0.01% of setting ± 4μV (30 Day)

Includes 30 day stability, temperature of 23°C ± 5°C all conformity errors, output terminal compensation and up to 70% relative humidity after 30 minute warm-up.

0.018% of setting ± 8μV (6 Month)

Includes 6 month stability, temperature of 23°C ± 10°C all conformity errors, output terminal compensation and up to 70% relative humidity after 30 minute warm-up.

Conformity Errors:

Total conformity errors compared to NBS monograph 125 are under 1μV. (Does not include type C which is not covered by monograph 125)

Resolution:

0.0625μV on all thermocouple ranges. (Although it is possible to key in temperature to a resolution of 0.01 millidegrees C or F the output emf will react in 0.0625μV increments)

Temperature Coefficient:

± 0.001% of setting/°C ± 0.2μV/°C ± 0.008°/°C

DC VOLTAGE CALIBRATOR MODE

Voltage Ranges:

0 to ± 19.9999mV	0.1μV steps
0 to ± 199.999mV	1μV steps
0 to ± 1.99999V	10μV steps
0 to ± 11.0000V	100μV steps

Resolution:

0.0625μV for output settings from 0 to ± 85.937mV
1.0μV for output settings from ±85.938mV to ± 1.37500V
8.0μV for output settings from ± 1.37501V to ± 11.0000V

Accuracy:

0.005% of setting ± 3μV (30 Day)

Includes 30 day stability, temperature of 23°C ± 5°C and up to 70% relative humidity after 30 minute warm-up.

0.014% of setting ± 7μV (6 Month)

Includes 6 month stability, temperature of 23°C ± 10°C and up to 70% relative humidity after 30 minute warm-up.

Temperature Coefficient:

± 0.001% of setting/°C ± 0.2μV/°C

SPECIFICATIONS THAT APPLY TO BOTH MODES

Output Impedance:

< 0.05 ohms at dc shunted by 3.5μf (typically under 0.01 ohms)

Output Current:

Up to ± 10mA, short circuit protected. Max current <30mA.

Settling Time:

Within 15ppm of final output in 2 seconds.

Regulation

Less than 0.0005% of setting ± 2μV for a ± 5% line voltage change.

Output Noise 0.1 to 10Hz Bandwidth:

Thermocouple mode 3μV peak
DC Voltage Calibrator mode 3μV peak

Isolation:

The output terminals are isolated and guard shielded from case (power ground) and the remote control bus. A front panel switch enables the guard to be tied to output low to give maximum isolation. A front panel terminal provides connection to the guard.

Power safety ground is connected to the case and is available at a front panel terminal.

The output may be floated 100V dc or peak ac from chassis.

With guard tied to output low, leakage current will be less than 500nA dc to 500Hz.

Common mode rejection, output to case or Remote Input to case is 160db at dc and 140dB to 400 Hz. (Guard connected to output low) Common mode rejection is defined as the ratio of the amplitude of the voltage applied between the specified points and the amplitude of any resulting effects at that output.

Remote Control:

Control of all functions except power and guard switches is available using the remote input connector. Optional IEEE 488 plug-in interface is available. Optical isolation assures freedom from interface noise.

Memories:

Seven memories provide retention of seven sets of operating conditions including temperature or voltage setting; polarity; °C, °F, mV or V; An eighth memory retains the reference junction temperature. Battery backup is provided by a short circuit safe lithium primary cell. Battery life is at least two years.

Power Requirements:

100, 120 volts −10% + 5% 48 to 440Hz
220, 240 volts −10% + 5% 48 to 63Hz
(Rear panel selectable)
Approximately 25 VA without remote option.

Operating Environment:

0 to 50°C, up to 90% R.H.

Dimensions:

Width: 325mm (12.8")
Depth: 380mm (14")
Height: 133mm (5.25")

Weight:

Net: 8.6 Kg (19 lbs.), Nominal.
Shipping: 11.8 Kg (26 lbs.), Nominal.

Specifications subject to change without notice.

OTHER ECTRON PRODUCTS:

- Differential DC Amplifiers
- Strain Gage Signal Conditioners
- Thermocouple Signal Conditioners
- Environmental Amplifiers
- Signal Conditioning Systems
- Programmable Amplifiers

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