

## EVALUATION OF VARIOUS PORTABLE “PRECISION DIGITAL THERMOCOUPLE/MILLIVOLT INSTRUMENT CALIBRATORS”

There are several instruments of this description being offered by several companies, all with virtually the same appearance and design. These units are advertised as portable calibrators that can generate as well as measure thermocouple signals, and therefore some believe that they compete with the Ectron Models 1100CF and 1120 thermocouple simulator-calibrators. Although they are touted as precision calibrators with millivolt and thermocouple modes, these units have several serious deficiencies, as noted below, that preclude their use for many applications.

1. When operating as a source, their output is quite unstable, particularly in the thermocouple mode.
2. Adjusting the output to a specific reading is difficult because of a lack of resolution of the coarse and fine adjusting pots.
3. Output resistance is up to 40  $\Omega$ . (vs. 0.2  $\Omega$  and 0.05  $\Omega$  for the Models 1100CF and 1120, respectively)
4. Output accuracy is not as good as that of the Ectron Model 1100CF and especially that of the Model 1120.
5. As voltage sources, they only cover from -12 mV to +80 mV (vs. -11 V to +11 V for the 1120).

### How They Work

As shown in the figure, these units consist of an adjustable dc supply and a DVM. In the measure mode, the dc supply is disconnected and these units measure the external emf using the DVM, or by switching circuitry around, the DVM is converted to a digital thermometer. In this mode a sensor (S) is used to compensate the brass-to-thermocouple junctions of the input-output terminals.

When operating as a source, the supply is connected to the terminals, and the DVM reads the output emf, either in millivolts or, when converted, in  $^{\circ}\text{C}$  or  $^{\circ}\text{F}$ . Therefore, the principal difference between these units and the Ectron models is that the Ectron

instruments generate the appropriate output emf in response to a selected temperature, whereas these other units simply indicate the equivalent temperature of the emf produced by the adjustable dc supply.

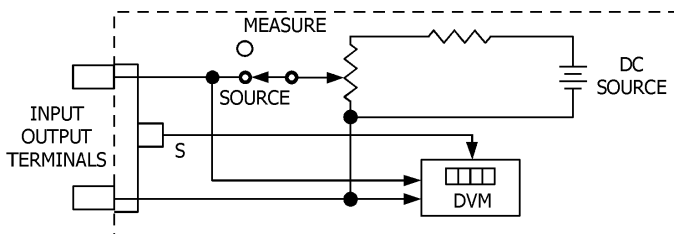
### What's Wrong With Them

The stability deficiency, which is especially noticeable in the thermocouple source mode, arises from the fact that the source of the emf is not particularly stable but also because the cold-junction sensor compensates the *meter* and *not the source*. Therefore, if the terminal temperature changes, the sensor will change (with some lag because one sensor is used to compensate both sets of terminals), which correctly changes the reading on the meter. However, the result is a change in *effective output signal*, a significant problem for someone trying to run a stability test or to calibrate to a specific temperature. This means, of course, that this stability deficiency is magnified in a poor temperature environment. (A rather poor characteristic for a portable unit “designed” for field use.)

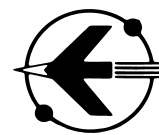
Frequently it is necessary to set the output of a thermocouple simulator to a specific temperature to perform a calibration step on an instrument. To adjust to a specific reading takes considerable “twiddling” of the coarse and fine controls. (Try setting the unit to 1000.0 $^{\circ}\text{C}$  on type K.) If the instrument being calibrated requires time to adjust or if a stability check is required, the technician would have to readjust frequently. These problems virtually eliminate his type of unit for serious calibration testing.

If 0.1% calibration is desired, you don't want to waste any accuracy on loading errors. Although metering at the output cancels most of the fixed loading errors, varying loads would require frustrating re-adjustments. Many chopper amplifier and recorders have input impedances that vary at the chopper frequency. Such devices could not be calibrated properly with these calibrators.

An additional problem with these units is caused by the poor thermal connection between the terminals (two pairs are used) and the sensing detector. Although a metal bar is used to thermally interconnect these points, considerable time is required to reach a stable reading. For example, handling the wires at the terminals will cause an offset that may require up to half a minute for recovery.



A comparison with the Ectron units will show virtually no effect for this type of change. The Model 1100CF uses the thermocouple type material terminals, and therefore, no junction exists at the terminals. The Model 1120 uses heavy solid copper blocks with compensating sensors imbedded in each block to automatically update the calculations used to generate the proper output.



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