

# TB 9-6685-331-50

CHANGE 1

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## DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

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### CALIBRATION PROCEDURE FOR PRECISION RTD THERMOMETER AZONIX, MODEL A1012 W/TEMPERATURE PROBE INSTRULAB, MODEL 4101-10X

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Headquarters, Department of the Army, Washington, DC

18 March 2002

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TB 9-6685-331-50, dated 22 November 1995 is changed as follows:

1. Remove old pages and insert new pages as indicated below. New or changed material is indicated by a vertical bar in the margin of the page.

**Remove pages**

1 and 2

9 and 10

**Insert pages**

1 and 2

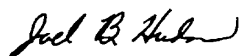
9 and 10

2. File this change sheet in front of the publication for reference purposes.

**By Order of the Secretary of the Army:**

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# TB 9-6685-331-50

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### CALIBRATION PROCEDURE FOR PRECISION RTD THERMOMETER AZONIX, MODEL A1012 W/ TEMPERATURE PROBE INSTRULAB , MODEL 4101-10X

Headquarters, Department of the Army, Washington, D. C.  
22 November 1995

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#### **REPORTING OF ERRORS AND RECOMMENDING IMPROVEMENTS**

You can help improve this publication. If you find any mistakes or if you know of a way to improve the procedure, please let us know. Mail your letter or DA Form 2028 to: Commander, U. S. Army Aviation and Missile Command, ATTN: AMSAM-MMC-MA-NP, Redstone Arsenal, AL 35898-5230. A reply will be furnished to you. You may also send in your comments electronically to our e-mail address: [2028@redstone.army.mil](mailto:2028@redstone.army.mil), or FAX 256-842-6546/DSN 788-6546

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**SECTION I  
IDENTIFICATION AND DESCRIPTION**

**1. Test Instrument Identification.** This bulletin provides instructions for the calibration of Precision RTD Thermometer, Azonix, Model A1012 w/Temperature Probe, Instrulab, Model 4101-10X. The manufacturers' manuals were used as the prime data sources in compiling these instructions. The equipment being calibrated will be referred to as the TI (test instrument) throughout this bulletin.

**a. Model Variations.** Variations among models are described in text.

**b. Time and Technique.** The time required for this calibration is approximately 4 hours, using the secondary reference dc and low frequency and physical techniques.

**2. Forms, Records, and Reports**

**a.** Forms, records, and reports required for calibration personnel at all levels are prescribed by TB 750-25.

**b.** Adjustments to be reported are designated (R) at the end of a sentence in which they appear. When adjustments are in tables, the (R) follows the designated adjustment. Report only those adjustments made and designated with (R).

**3. Calibration Description.** TI parameters and performance specifications which pertain to this calibration are listed in table 1.

Table 1. Calibration Description

Test instrument parameters	Performance specifications
Resistance	Range: 50Ω to 300Ω Accuracy: ±50 ppm
Temperature	Ice point: 0 °C Accuracy: .1° plus .1% of reading Range: -25 °C to 250 °C Accuracy: ±.25° of the reference standard

**SECTION II  
EQUIPMENT REQUIREMENTS**

**4. Equipment Required.** Table 2 identifies the specific equipment to be used in this calibration procedure. This equipment is issued with Secondary Reference Calibration Standards Set, NSN 4931-00-621-7878. Alternate items may be used by the calibrating activity. The items selected must be verified to perform satisfactorily prior to use and must bear evidence of current calibration. The equipment must meet or exceed the minimum use specifications listed in table 2. The accuracies listed in table 2 provide a four-to-one ratio between the standard and TI.

**5. Accessories Required.** The accessories required for the calibration are common usage accessories, issued as indicated in paragraph 4 above and are not listed in this calibration procedure. When necessary, these items may be substituted by equivalent items, unless specifically prohibited.

Table 2. Minimum Specifications Of Equipment Required

Common name	Minimum use specifications	Manufacturer and model (part number)
AUTOMATIC TEMPERATURE BRIDGE	Range: -25 to 250 °C Accuracy: $\pm 0.02^\circ$	Automatic Systems Laboratories Model F26 (7916922)
RESISTANCE STANDARD NO. 1	Range: 100 $\Omega$ Accuracy: $\pm 10$ ppm	L&N, Model 4030B (8616291)
RESISTANCE STANDARD NO. 2	Range: 50 $\Omega$ 200 $\Omega$ 300 $\Omega$ Accuracy: $\pm 10$ ppm	Julie Research Labs, Model MRS-506 (13440137) (set of 3)

**SECTION III  
CALIBRATION PROCESS FOR  
PRECISION RTD THERMOMETER, AZONIX, MODEL A1012**

**6. Preliminary Instructions**

**a.** The instructions outlined in paragraphs 6 and 7 are preparatory to the calibration process. Personnel should become familiar with the applicable sections before beginning the calibration.

**b.** Items of equipment used in this procedure are referenced within the text by common name as listed in table 2.

**c.** Unless otherwise specified, verify the result of each test and, whenever the test requirement is not met, take corrective action before continuing with the calibration. Adjustments required to calibrate the TI are included in this procedure. Additional maintenance information is contained in the manufacturers' manuals for this TI.

**d.** Unless otherwise specified, all controls and control settings refer to the TI.

**7. Equipment Setup**

**WARNING**

HIGH VOLTAGE is used or exposed during the performance of this calibration. DEATH ON CONTACT may result if personnel fail to observe safety precautions. REDUCE OUTPUT(S) to minimum after each set within the performance check where applicable.

**a.** Turn on the TI and verify that it cycles through the self-check procedure. The self-check ends with **PASS** followed by the TI model **1012** and **REVA**. Allow the TI to warm up for a minimum of 30 minutes.

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**b.** Connect a four terminal 100Ω standard resistor to probe No. 1 using the interface connection device. Be careful to ensure the excitor and sense leads are properly wired.

**NOTE**

Throughout this procedure probe 1 will often be referred to as channel 1, probe 2 as channel 2, etc.

**c.** Press the **Ohm** and **READ PROBE 1** (or **NEXT PROBE**) keys on the TI to read the measured resistance.

**d.** Compare the measured resistance value shown in the TI **Data Values** window with the actual value (test report value) of the resistance standard. If the two readings are within  $\pm 50$  ppm ( $\pm 005\Omega$ ) of each other, no further calibration is required for RTD input channel 1. If the readings are not within the specified tolerance, the channel will require recalibration.

**e.** Repeat steps **b** through **d** for channel and probe No. 2. Repeat for channels 3 and 4, only if they are to be used. Disconnect the 100Ω resistor.

**8. Recalibration of A1012.** Before recalibration of the A1012 can be accomplished several preliminary system set-ups must be performed

**a.** The precision display of the probe has to be established.

**b.** The probe must be configured to read the raw analog-to-digital (a/d) counts.

**c.** Temporary mantissa values of **1.0** and zero (**0**) must be substituted for the existing values of **M** and **B** before new mantissa values can be calculated and re-programmed into the TI.

**CAUTION**

Each paragraph of performance checks involves pressing a series of keys that are prompted by the TI. It is important that the test sequence be kept in the order as written. If the wrong key is inadvertently pressed, abort the test segment and start over. This can be done by pressing **EXIT** and **YES** keys.

## **9. Precision Display of the Probe**

### **a. Performance Check**

(1) Apply the magnetized configuration panel to the front of the A1012. Press the **SHIFT** and **ENTER** keys on the panel.

(2) At the **PRB?** prompt, press **NO** key until **SYS?** is displayed in the right window.

(3) Press **YES** key at **SYS?** to accept the system mode.

(4) Type in **123456** at the **CODE** prompt and press **ENTER** key for the system access code.

(5) Press **YES** key for **USR?** to select the user channel. Press **YES** key for **OLD?**, and **YES** key again at **CFG?** to confirm configuration of the old channel.

(6) At the **UCHN** (user channel) prompt, press **01** and **ENTER** keys to select probe No. 1. This could be probe 2, 3, or 4 depending on which probe and channel is being calibrated.

(7) Press **YES** key for **NRM?** and **YES** key again for **DAT?**.

(8) **PCHI** is displayed in the right window. Press the down arrow key until **DISP** appears in the right window.

### **NOTE**

To display a decimal point, press **SHIFT** and the **8** keys

(9) Press the **CE** key until the center display window is cleared. Enter zeros (**0**) and a decimal point until **0000.0** is displayed. Press **ENTER** key. Refer to note above.

(10) Press a zero (**0**) and **ENTER** keys at **DV1**. Center display should indicate **0.00000**. Press **ENTER** key at the **DV2** prompt and again at **DV3**

(11) The right display will now indicate **END**. Press **ENTER** key. Press **EXIT** key at the **ALM?** prompt to save the data.

(12) Press **YES** key at **EXT?** to confirm exit if no other probes are to be configured for a precision readout; otherwise, press **NO** key and repeat steps (2) through (12) above for probe (channel) numbers 2, 3, or 4.

(13) This completes the set-up to configure a precision display of the probe. The TI now indicates **PANL**.

**b. Adjustments.** No adjustments are required. Continued with next paragraph.

**10. Configuration Mode of Probe to Read Ohms**

**a. Performance Check**

- (1) Momentarily open and re-seat the magnetized configuration panel on the A1012. The TI will run through the self-check routine. Press **SHIFT** and then **ENTER**.
- (2) Press **YES** key at the **PRB?** prompt

**CAUTION**

The TI uses two different numbering systems for the user channel (UCHN) and the physical channel (PCHN). Probe/channel numbers for UCHN are 01, 02, 03, and 04. The PCHN uses 04, 08, 12, and 16 for channels 1 through 4.

- (3) Press **01** and **ENTER** keys at the **PRB#** prompt to select probe No. 1. Press **NO** key until **OHM?** is displayed in the units window and then press **YES** key.
- (4) The TI quickly flashes **DONE** and then prompts **PRB#** for another probe number. Press **EXIT** and then **YES** keys if no other probes are to be selected. If other probes are to be selected, press the probe number and **ENTER** key.
- (5) **PANL** will be displayed on the TI.
- (6) The configuration mode of the probe is now ready to read ohms.

**b. Adjustments.** No adjustments are required. Continued to next paragraph.

**11. Temporary Mantissas for M and B**

**a. Performance Check.**

- (1) Momentarily lift and re-seat the configuration panel plate. Verify self-check. Press **SHIFT** and **ENTER** keys.
- (2) **PRB?** will be displayed in the right window. Press **NO** key until **SYS?** appears and then press **YES** key.
- (3) Input the system access code, **123456**, and press **ENTER** key.
- (4) At the **USR?** prompt, press **NO** key until **I/O** is displayed. Select **I/O** by pressing **YES** key.
- (5) Press **YES** key for **OLD?** and again for **CFG?**.
- (6) Enter the physical channel number to be configured at the **PCHN** prompt. Press **04** and **ENTER** keys for channel number **1**, **08** and **ENTER** keys for channel number **2**. Press **12** and **ENTER** keys and **16** and **ENTER** keys for channel numbers **3** and **4**. See **CAUTION** statement above.



(7) Press down arrow at **INP?** until **MX+B** appears in the display. Press **ENTER** key. Press **ENTER** key again when **M** is displayed.

(8) Numbers will appear in the center display window and the high mantissa for **M**, indicated by **MANH**, appears in the right display. Press **CE** key until all numbers have been deleted from the center window.

(9) Press **1**; press and release **SHIFT** and the **8** key to display **1** and the decimal point (**1.**).

(10) Press **00000**. The center display should be **1.00000**. This is the temporary mantissa high number for **M**. Press **ENTER** key.

(11) The mantissa low **MANL** will appear in the right window while numbers are displayed in center window. Press **CE** key until the numbers are cleared. Replace with zeros (**000000**). Press **ENTER** key.

(12) Change the exponent **EXPO** to **00** (if the exponent has a negative sign, press the **SHIFT** and **1** keys to clear) and then press **ENTER**.

(13) Press **ENTER** key to view the new value for **M (1.00000)**. The exponent will be (**E 00**). Press **ENTER** key.

(14) **B** appears in the right window. Press **ENTER** key to continue.

(15) Press **CE** key to clear the existing numbers for the **B MANH** (if the value has a negative sign, press **SHIFT** and **1** keys to clear) and then press **ENTER**. Add a zero (**0**) and a decimal point then zero fill until **0.00000** shows for **MANH**. Press **ENTER** key.

(16) Press **CE** key to clear the present number for **MANL** and add zeros (**0**) until **000000** is displayed for **MANL**. Press **ENTER** key.

(17) Change exponent **EXPO** and sign to **00** and press **ENTER** key. Press **ENTER** key again at the **E-00** display.

(18) Temporary mantissas of **1.00000** and **000000** for **M** and **B** are now installed in the A1012 (TI).

(19) Press down arrow at the **99999 +FSC** display until **OLD?** appears in the right window. Press **EXIT** key and confirm by pressing **YES** key.

(20) Remove the configuration panel

**b. Adjustments.** No adjustments are required.

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**12. Calculation of New Mantissas**

**a. Performance Check**

(1) Connect the 100 $\Omega$  standard resistor to RTD channel 04 (probe No. 1). Allow 5 to 10 minutes for warm-up and settling time.

(2) The reading in the **Data Value** window is the raw a/d count of the 100 $\Omega$  resistor. After warm up, record the mean value of several readings. This reading will be used in later calculations

(3) Repeat steps (1) and (2) using the 50 $\Omega$ , 200 $\Omega$ , and 300 $\Omega$  resistance standards. Record the mean of each.

(4) Steps (1) through (3) must be repeated for each channel (probe) that has to be calibrated.

(5) Access the ARMYCAL.BAS computer program and, as prompted by the program, enter the appropriate data to be calculated. This will include the serial number of the TI, channel number, mean value of the a/d count for each resistor, and the actual (test report) value of the corresponding standard resistor.

(6) Results of the program will provide new mantissa values for **M** and **B** and the computed resistance values of the standard resistors.

(7) Review the program results to verify that the resistor values are within the specified tolerance of  $\pm 50$  ppm.

(8) If the results are acceptable, continue with next section; if not acceptable, the channel(s) in question will require factory repair.

**b. Adjustment.** No adjustment can be made.

**13. Install New Mantissa Values for M and B**

**a. Performance Check**

(1) Apply the configuration panel to front of the TI.

(2) Press **SHIFT** and **ENTER** keys

(3) Repeat paragraph **11**, steps **a(2)** through **a(20)** to install new mantissas. BE VERY CAREFUL to clear the temporary high and low mantissas for **M** and **B** by pressing CE key at the appropriate prompts, and replace them with the new **M** and **B** values obtained from the computed calibration report. Be sure to include the exponent with the proper sign (+ or -) for each mantissa.

**14. Verification of Calibration.** Before the resistance measurement of  $\pm 50$  ppm ( $\pm 0.005\Omega$ ) accuracy can be verified, the precision display of the probe must be changed back to its original setting. This must be done for all channels being calibrated.

**a. Performance Check**

- (1) With the configuration panel in place, press **SHIFT** and **ENTER** keys.
- (2) Repeat paragraph **9**, steps **a(2)** through **a(12)** above. The display in step **a(9)** should be changed to indicate **000.000** to provide enough resolution for ppm measurements.
- (3) Remove the configuration panel and connect a standard resistor to probe No. 1 of the A1012
- (4) After warm up and stabilization, compare the resistance value displayed on the TI with the test report value. If the readings are within the required tolerance of  $\pm 50$  ppm, the channel and probe are calibrated; if not, the TI will require factory service.
- (5) Disconnect the resistor from probe No. 1 and repeat step (4) above for each probe (channel) requiring calibration.
- (6) The TI is now calibrated

**b. Adjustment.** No adjustment is required.

**SECTION IV**  
**CALIBRATION PROCESS FOR TEST INSTRUMENT**  
**W/TEMPERATURE PROBE, INSTRULAB, MODEL 4101-10X**

**15. Preliminary Instructions**

- a.** The instructions outlined in paragraphs **15** and **16** are preparatory to the calibration process. Personnel should become familiar with the applicable sections before beginning the calibration
- b.** Items of equipment used in this procedure are referenced within the text by common name as listed in table 2.
- c.** Unless otherwise specified, verify the result of each test and, whenever the test requirement is not met, take corrective action before continuing with the calibration. Adjustments required to calibrate the TI are included in this procedure. Additional maintenance information is contained in the manufacturers' manuals for this TI.
- d.** Unless otherwise specified, all controls and control settings refer to the TI.

**16. Equipment Setup**

**WARNING**

HIGH VOLTAGE is used or exposed during the performance of this calibration. DEATH ON CONTACT may result if personnel fail to observe safety precautions. REDUCE OUTPUT(S) to minimum after each step within the performance check where applicable.

- a. Turn on the TI and verify that it cycles through the self-check procedure. The self-check ends with **PASS**, followed by the TI model number, **1012**, and then **REVA**.
- b. Connect the temperature probe (4101-10X) to one of the RTD input channels of the TI. Verify that the TI is still in the resistance measurement mode; if not, press the **ohm** key on keyboard.
- c. Prepare an ice bath to determine the probe resistance at ice-point temperature, zero degrees Celsius.
- d. Place end of probe into the bath and allow at least 30 minutes settling time before reading the resistance. This value should be approximately 100Ω as indicated by the TI. Record this measurement for later use.

**17. Ice Point Calibration of Temperature Probe**

**a. Performance Check**

- (1) Place configuration panel over front panel keyboard of the TI. Press **SHIFT** and **ENTER** keys.
- (2) The TI **Units** window displays **PRB?** Press **YES** to configure the probe.
- (3) The **Units** window will prompt **PRB#**. Enter the probe or channel number being used and press **ENTER** key.
- (4) The TI should indicate **OHM?**. Press **NO** key until **STD** appears in the **Units** window and then press **YES**.
- (5) Several options are available under the **STD** function. Press **NO** key until **3850PT** is displayed. Select this option by pressing **YES** key.
- (6) The TI prompts **Ro**. Press **ENTER** key to continue.

(7) When **MANH** is indicated, enter the first six digits of the resistance reading obtained in **16d** above. Press **ENTER** key.

(8) Enter the remaining six digits of  $R_o$  at the **MANL** prompt. This could be all zeros. Press **ENTER** key.

(9) When **EXPO** is prompted, be sure **00** appears in the **Data Values** window. Press **ENTER**.

(10) The **Data Values** window will indicate the six most significant digits of  $R_o$ . Press **ENTER** key to confirm the reading and continue.

(11) Press the **EXIT** key, and when **EXT** appears press **YES** to confirm. **PANL** will be indicated on the TI read-out.

(12) Remove the configuration panel from the TI. The TI will cycle through self-check procedure and then return to the measurement mode.

(13) Press **C** on the keyboard to read the ice point in degrees Celsius. Record reading.

measuremen (14) Press **F** on the keyboard to read the ice point in degrees Fahrenheit. Record reading.

(15) Ice Point t accuracy is  $\pm .1^\circ$  plus .1 percent of reading.

**b. Adjustment.** No adjustment can be made. If out of tolerance, return TI with temperature probe to the Primary Lab, Redstone Arsenal, Alabama.

## **18. Calibration of Temperature Range (-25 °C to 250 °C).**

### **a. Performance Check**

#### **NOTE**

Calibrating the temperature range of the TI using the 4101-X10 probe consists of comparing the TI set up against the reference standard such as the Automatic Systems Laboratories, Model F26. Points for comparison are -25 °C, 50 °C, 100 and 250 °C

(1) Place the TI and the F26 probes into the temperature bath. Set the bath for -25 °C and allow at least 30 minutes for temperature stabilization.

(2) When the temperature stabilizes, record the readings of the TI and the laboratory standard. The TI should read within  $\pm 0.25$  degrees of the standard.

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(3) Set the bath to next temperature setting and after stabilization, record and compare TI and standard readings.

(4) Each designated point of the range should be read and compared to the laboratory standard.

**b. Adjustments.** No adjustment can be made. If TI does not read within  $\pm 0.25$  degrees of the laboratory standard, return it to the Army Primary Standards Laboratory, Redstone Arsenal, Alabama.

**19. Final Procedure**

**a.** Deenergize and disconnect all equipment.

**b.** Annotate and affix DA label/form in accordance with TB 750-25.

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**By Order of the Secretary of the Army:**

**DENNIS J. REIMER**  
*General, United States Army*  
*Chief of Staff*

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**YVONNE M. HARRISON**  
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