

*TB 9-4910-555-24

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR SIMPLIFIED TEST EQUIPMENT FOR INTERNAL COMBUSTION ENGINE (STE/ICE-R)

Headquarters, Department of the Army, Washington, D.C.
24 June 2008

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REPORTING OF ERRORS AND RECOMMENDING IMPROVEMENTS

You can improve this manual. If you find any mistakes or if you know of a way to improve these procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms) directly to: Commander, U.S. Army Aviation and Missile Command, ATTN: AMSAM-MMC-MA-NP, Redstone Arsenal, AL 35898-5000. A reply will be furnished to you. You may also send in your comments electronically to our E-mail address: 2028@redstone.army.mil or by fax 256-842-6546/DSN 788-6546. For the World Wide Web use: <https://amcom2028.redstone.army.mil>. Instructions for sending an electronic 2028 can be found at the back of this manual.

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**SECTION I
IDENTIFICATION AND DESCRIPTION**

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Simplified Test Equipment for Internal Combustion Engine (STE/ICE-R). TM 9-4910-571-12&P and TM 9-4910-571-34&P 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. The STE/ICE-R is reprogrammable.

b. Time and Technique. The time required for this calibration is approximately 4 hours, using the dc/low 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 the 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
Dc voltage ¹	Range: 0 to 0.49 V dc Accuracy: $\pm 6\%$ of FS Range: 0.50 to 4.49 V dc Accuracy: $\pm 3\%$ of FS Range: 4.50 to 45 V dc Accuracy: $\pm 1\%$ of FS
Dc current ¹	Range: 0 to 1500 A Accuracy: $(\pm 7.0 \text{ to } 8.0\% \text{ of input}) + (\pm 2\% \text{ of FS})^2$
Resistance ¹	Range: 0 Ω to 4500 Ω Accuracy: $(\pm 3.0\% \text{ of indication}) + (\pm 0.2\% \text{ of FS})$ Range: 0 Ω to 40,000 Ω Accuracy: $(\pm 3\% \text{ of indication}) + (\pm 0.5\% \text{ of FS})$
Frequency	Range: 40 to 500 Hz Accuracy: $(\pm 7\% \text{ of input}) + (\pm 0.65\% \text{ of FS})$
RPM	Range: 50 to 5000 RPM Accuracy: $\pm 0.5\%$ of FS

See footnotes at end of table.

Table 1. Calibration Description - Continued

Test instrument parameters	Performance specifications
Pressure ¹	Range: 0 to 25 psig 0 to 1000 psig 0 to 10,000 psig (optional transducer) ³ Accuracy: (±2.5% of indication) + (±1.5% of FS)
Vacuum	Range: 0 to 30 inHg Accuracy: (±2.5% of indication) + (±1.5% of FS)

¹Offset test required.

²Max error is 7.0% up to 1000 amperes and increases linearity to 8.0% at 1500 amperes.

³Not part of accessory tray.

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 Transfer Calibration Standards Set AN/GSM-286, AN/GSM-287, or AN/GSM-705. 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. Where the four-to-one ratio cannot be met, the actual accuracy of the equipment selected is shown in parenthesis.

5. Accessories Required. The accessories listed in table 3 are issued as indicated in paragraph 4 above and are used 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)
CALIBRATOR	Range: 0 to 45 V dc Accuracy: ±0.25%	Fluke, Model 5720A (5720A) (p/o MIS-35947); w amplifier, Fluke 5725A/AR (5725A/AR)
DC CURRENT SHUNT	Range: 0 to 75 A Accuracy: ¹	Guildline, Model 9711 (7912323)
FUNCTION GENERATOR	Range: 0 to 10 V p-p; 500 Hz square wave Accuracy: ±0.5 %	Agilent, Model 33250A (33250A)
HYDRAULIC PRESSURE STANDARD	Range: 25 to 1000 psig Accuracy: +1%	DHI, RPM3D-A10000 (13534030)
MULTIMETER	Range: 0 to 75 mV dc Accuracy: ¹	Hewlett-Packard, Model 3458A (3458A)
PNEUMATIC PRESSURE STANDARD	Range: 0 to 1000 psig Accuracy: +1%	Druck, DPI 145/R (MIS-45842)
RESISTANCE STANDARD	Range: 0 Ω to 40,000 Ω Accuracy: 0 Ω to 1500 Ω +0.9% 1500 Ω to 40,000 Ω +0.85%	Biddle-Gray, Model 71-631 (7910328)

¹Combined accuracy of dc current shunt and multimeter: ±1.8% to ±2.1%.

Table 3. Accessories Required

Common name	Description (part number)
DC POWER SUPPLY NO. 1	Sorensen, Model DCS40-30E (13589313)
DC POWER SUPPLY NO. 2	Dynamic Industries Corp., Model 55314-104054 (MIS-38956)
HYDRAULIC COMPARATOR	3712-4-3 (13534038)
NITROGEN SOURCE	Compressed cylinder (7916197)
PRESSURE CONTROLLER	(MIS-10324)
PRESSURE REGULATOR	(MIS-10325, Type 2)
VACUUM PUMP	(7915882)

SECTION III CALIBRATION PROCESS FOR VEHICLE TEST METER (VTM)

6. Preliminary Instructions

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

b. Items of equipment used in this procedure are referenced within the text by common name as listed in tables 2 and 3.

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 TM 9-4910-571-12&P and TM 9-4910-571-34&P for this TI.

d. Unless otherwise specified, all controls and control settings in this section refer to the TI.

e. Label current probe, high-pressure transducer, and low-pressure transducer with the following: **“To be used only with VTM, Serial # _____ for VTM calibration to be valid”**.

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 step within the performance check where applicable.

a. Connect cable W2 to TI J4 connector.

b. Connect cable W5 to TI J1 connector.

c. Connect cable W5 red and black leads to the + (positive) and - (negative) terminals of dc power supply No. 1. Observe polarity.

NOTE

Dc power supply No. 1 will remain connected, as stated in **c** above, throughout this procedure unless otherwise specified.

CAUTION

Throughout this procedure be sure dc power supply No. 1 is adjusted for 24 V dc output before pressing the TI power switch to **ON** position.

- d.** Adjust dc power supply No. 1 for 24 V dc output.
- e.** Press power switch to **ON** position. Verify that TI displays **8.8.8.8.** two times and then automatically starts self-test. After several numbers appear (approximately 15 seconds), display will alternate between the software revision number and the status message **PASS**. If not, perform steps **f** through **h** below.
- f.** Pull power switch to **OFF** position then press power switch to **ON** position. Verify that TI displays **8.8.8.8.** for about 2 seconds then becomes — — — —.
- g.** Set **TEST SELECT** switches to **66** and press and release **TEST** pushbutton. VTM will display **0066**.
- h.** Set **TEST SELECT** switches to **99** and press and release **TEST** pushbutton. After several numbers appear (approximately 15 seconds), TI will display, alternately, **PASS** and 4 digit software revision code.

8. Dc Voltage**a. Performance Check****NOTE**

If TI is turned off for any reason, repeat paragraph **7 e** above.

- (1) Short red and black leads of cable W2 together.
- (2) Set **TEST SELECT** switches to **89**.
- (3) Press and hold **TEST** pushbutton until **CAL** appears on TI. Release **TEST** pushbutton.
- (4) Wait for offset value to appear on display. Offset value will be between **-6.8** and **+6.8**. Press and release **TEST** pushbutton.
- (5) Connect cable W2 red and black leads (shorted together) to positive connector of dc power supply No. 1. If TI does not display between -0.20 and +0.20, perform **b** (1) through (9) below.

NOTE

If adjustments are made in (5) above, leave assembly A4 on extender board for (6) through (8) below.

- (6) Connect cable W2 red and black leads to calibrator + (positive) and - (negative) output connections.
- (7) Press and release **TEST** pushbutton.

(8) Adjust calibrator to 40.0 V. If TI does not indicate between 39.6 and 40.4 V, perform **b** (1) through (8) below (if not performed in (5) above), and **b** (10) through (12) below.

b. Adjustments

- (1) Disconnect cable W2 from + (positive) connector.
- (2) Pull power switch to **OFF** position and disconnect leads from dc power supply No. 1.
- (3) Remove protective cover of TI and remove assembly A4, using board removal tool (board holding bracket becomes removal tool).

NOTE

If extender board 2386761-501 is not available and TI requires adjustment during calibration, remove TI board, adjust “slightly,” reinstall, check, and if necessary repeat technique until desired indication is obtained.

- (4) Insert extender board into assembly A4 connector and insert assembly A4 into extender board.
- (5) Connect W5 leads to dc power supply No. 1 and press power switch to **ON** position.
- (6) Reconnect cable W2 red and black leads (shorted together) to + (positive) connector of dc power supply No. 1.
- (7) Set **TEST SELECT** switches to **89**. Press and hold **TEST** pushbutton until **CAL** is displayed. Release **TEST** pushbutton. Wait for offset value to appear on display.
- (8) Press and release **TEST** pushbutton.
- (9) Adjust R10 on assembly A4 for display of **00.0** on TI (R).
- (10) Connect cable W2 red and black leads to calibrator + (positive) and – (negative) output connections.
- (11) Adjust calibrator to 40.0 dc V.
- (12) Adjust R3 on assembly A4 for display of **40.0** on TI (R).

9. Resistance

a. Performance Check

- (1) Short cable W2 red and black leads together.
- (2) Set **TEST SELECT** switches to **91**.
- (3) Press and hold **TEST** pushbutton until **CAL** appears on TI. Release **TEST** pushbutton.
- (4) Wait for offset value to appear on display. Offset value will be between **-225** and **+225**.
- (5) Connect cable W2 red and black leads to resistance standard high and low connectors. Press and release **TEST** pushbutton. Display will flash.
- (6) Adjust resistance standard controls to 1400 Ω . If TI does not indicate between 1349.0 Ω and 1451.0 Ω , perform **b** (1) through (10) below.
- (7) Set **TEST SELECT** switches to **92**.

- (8) Short cable W2 red and black leads together.
- (9) Press and hold **TEST** pushbutton until **CAL** appears on TI. Release **TEST** pushbutton.
- (10) Wait for offset value to appear on display. Offset value will be between -6.00 and +6.00.
- (11) Connect cable W2 red and black leads to resistance standard high and low connectors. Press and release **TEST** pushbutton. Display will flash.
- (12) Adjust resistance standard controls for 18,000 Ω . If TI does not indicate between 17.26 and 18.74, perform **b** (1) through (5) below (if not performed in (7) above), and **b** (11) through (13) below.

b. Adjustments

- (1) Set power switch to **OFF** position.
- (2) Open rear panel of TI and remove assembly A3, using board removal tool.
- (3) Insert extender board 2386761-501 into assembly A3 connector and insert A3 into extender board.
- (4) Press power switch to **ON** position.
- (5) Adjust resistance standard controls for 0.0 Ω .
- (6) Set **TEST SELECT** switches to **91**.
- (7) Press and hold **TEST** pushbutton until **CAL** appears on TI. Release **TEST** pushbutton.
- (8) Wait for offset value to appear on display. Press and release **TEST** pushbutton.
- (9) Adjust resistance standard controls for 1400 Ω .
- (10) Adjust R25 on assembly A3 for display of **1400** on TI (R).
- (11) Set **TEST SELECT** switches to **92**. Press and hold **TEST** pushbutton until **CAL** appears on TI. Release **TEST** pushbutton. Wait for offset value to appear on display. Press and release **TEST** pushbutton.
- (12) Adjust resistance standard controls for 18,000 Ω .
- (13) Adjust R28 on assembly A3 for display of 18.00 on TI (R).

10. Dc Current

a. Performance Check

- (1) Connect equipment as shown in figure 1.

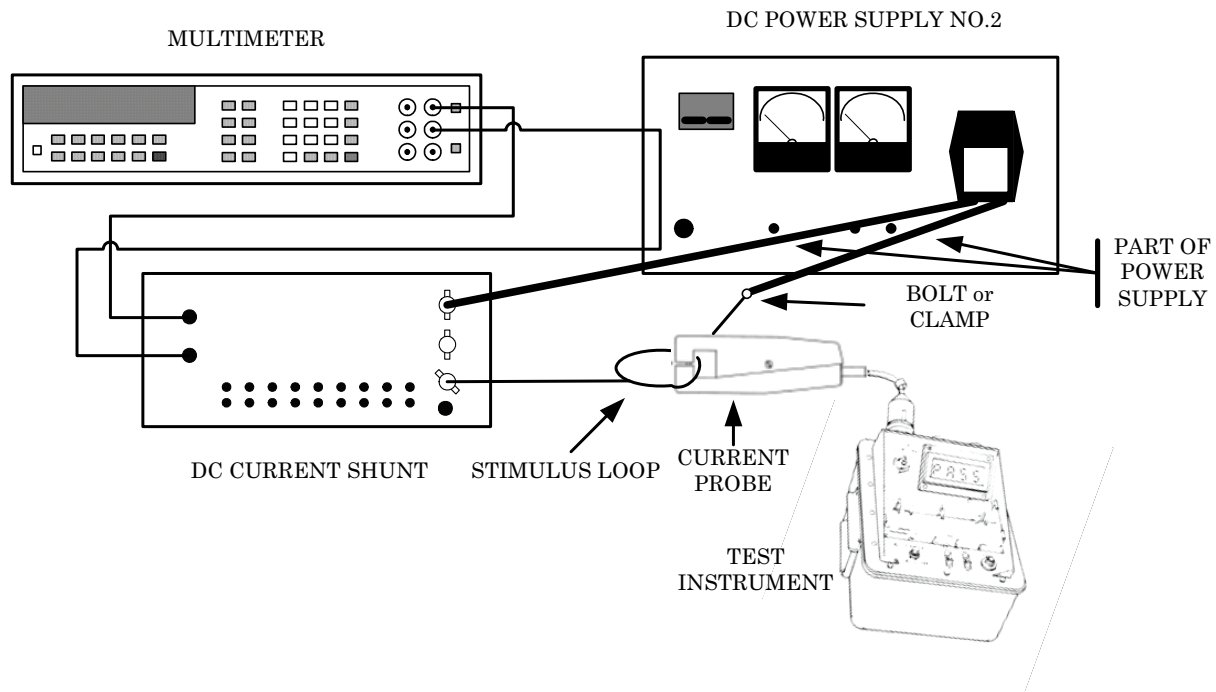


Figure 1. Dc current - equipment setup.

NOTE

Fabricate a current stimulus loop as shown in figure 1. The loop design should be 20 turns of No. 10 insulated copper wire with a bundle diameter of the turns being no more than 1 inch. The inside diameter of the loop should be 6 inches, ± 1 inch. Care should be taken to ensure that the loop does not overheat.

NOTE

Clamp current probe to stimulus loop with arrow on probe pointing in direction of current flow.

CAUTION

While performing this paragraph, minimize the time that current is running through the loop. High current will cause the wire to heat, thus increasing resistance and decreasing the loop current.

- (2) Set **TEST SELECT** switches to **90**.
- (3) Press and hold **TEST** pushbutton until **CAL** appears on TI display. Release **TEST** pushbutton.
- (4) Wait for offset values to appear on display. Offset values will be between **-225** and **+225**.
- (5) Place shorting plugs in 100 A position on dc current shunt.
- (6) Adjust dc power supply No. 2 for a 25 mV indication on multimeter (25 A output).

(7) Press and release **TEST** pushbutton. If a – (negative) output occurs, reverse the current probe. If TI does not display between 435 and 565, perform **b** below.

NOTE

The current probe cannot be opened while the loop is energized due to the induced magnetic field.

(8) Repeat technique of (6) and (7) above for values and indications shown in table 4. If TI does not indicate within the limits specified, perform **b** below.

Table 4. Dc Current

Multimeter indications (mV)	Test instrument display	
	Min	Max
50	900	1100
55	990.8	1209.2
60	1081.2	1318.8
65	1171.2	1428.8
70	1260.8	1539.2
75	1350	1650

b. Adjustments

- (1) Peel back decal on topside of probe to expose adjustment access hole.
- (2) Adjust full-scale and span adjustments as necessary. Full-scale adjustment is closest to input connector end of current probe.

11. Frequency

a. Performance Check

- (1) Connect function generator to TI J4 using cable W2.
- (2) Adjust function generator for 500 Hz, and for a 6 to 10 V p-p square wave (**DC OFFSET** to **OFF**).
- (3) Set **TEST SELECT** switches to **96**.
- (4) Press and release **TEST** pushbutton.
- (5) TI will indicate between 461.8 and 538.3 Hz.

b. Adjustments. No adjustments can be made.

12. RPM

a. Performance Check

- (1) Connect function generator to TI J3 using cable W3 and W4.
- (2) Set **TEST SELECT** switches to **60**.
- (3) Press and release **TEST** pushbutton. Display will indicate **UEH**.
- (4) Set **TEST SELECT** switches to **01**.

- (5) Press and release **TEST** pushbutton. Display will indicate **1**.
- (6) Set **TEST SELECT** switches to **10**.
- (7) Press and release **TEST** pushbutton. Display will indicate **0**.
- (8) Adjust function generator for square wave (positive pulse) output of 7 to 13 V and 5000 RPM indication on TI display. Function generator will indicate between 165.84 and 167.50 Hz.
- (9) Repeat technique of (4) through (8) above for indications listed in table 5. Function generator will indicate within limits specified.

Table 5. RPM

Test instrument indications (RPM)	Function generator indications (Hz)	
	Min	Max
4500	149.16	150.83
4000	132.50	134.16
3500	115.83	117.49
3000	99.17	100.83
2500	82.50	84.16
2000	65.83	67.49
1500	49.16	50.83
1000	32.50	34.16
500	15.83	17.49
300	9.16	10.83
100	2.50	4.16
50	0.83	2.49

b. Adjustments. No adjustments can be made.

13. Pressure

NOTE

Operate hydraulic pressure standard in zero mode.

NOTE

Perform step **a** (17) through **a** (24) below for optional 10,000 psig transducer (PN: 12258956) that is not part of the TI and label in accordance with paragraph **6 e** above.

a. Performance Check

- (1) Connect equipment as shown in figure 2.

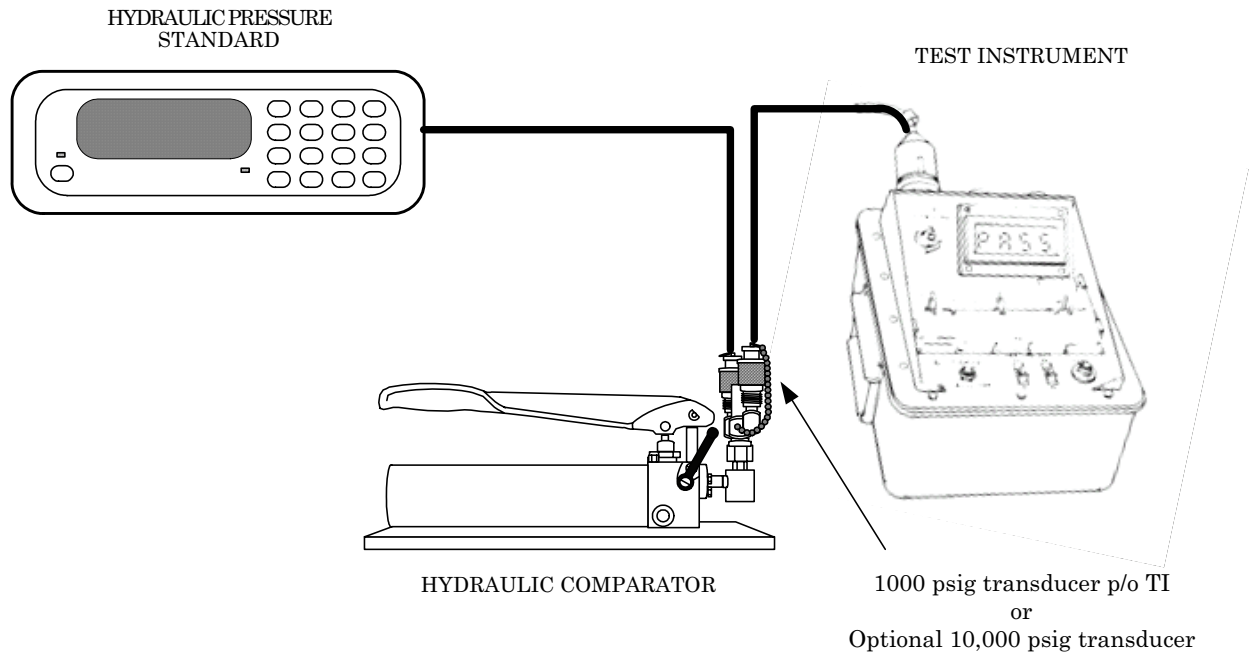


Figure 2. Pressure - equipment setup (1000/10,000 psi).

- (2) Set **TEST SELECT** switches to **50**.
- (3) Operate hydraulic pressure standard to apply 1000 psi and return to **0** three times.
- (4) With pressure at **0**, press and hold **TEST** pushbutton until **CAL** appears on TI display. Release **TEST** pushbutton.
- (5) Wait for offset value to appear on display. Offset value will be between **-150** and **+150**.
- (6) Press and release **TEST** pushbutton.
- (7) Operate hydraulic pressure standard to apply 300 psi. TI will indicate between 277.5 and 322.5.
- (8) Operate hydraulic pressure standard to apply 1000 psi. TI will indicate between 960 and 1040.
- (9) Connect equipment as shown in CONNECTION A (fig. 3).
- (10) Set **TEST SELECTOR** switches to **49**.

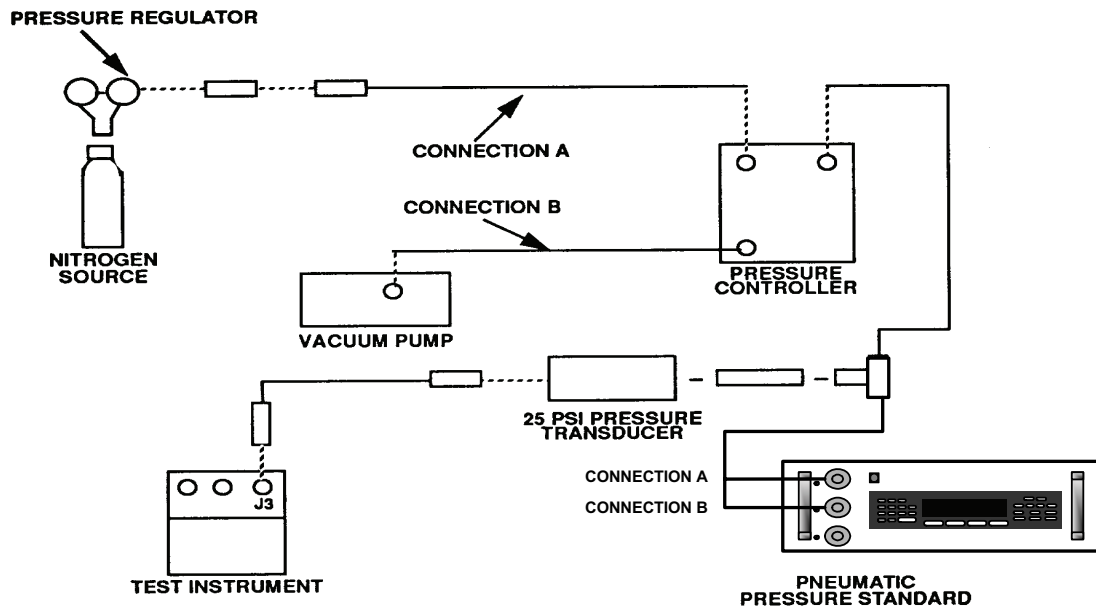


Figure 3. Pressure and vacuum - equipment setup (25 psi).

- (11) Operate pneumatic pressure standard to apply 25 psi and reduce to **0** three times.
- (12) With pressure at **0**, press and hold **TEST** pushbutton until **CAL** appears on display. Release **TEST** pushbutton.
- (13) Wait for offset value to appear on display. Offset value will be between **-4** and **+4**.
- (14) Press and release **TEST** pushbutton.
- (15) Operate pneumatic pressure standard to apply 5 psi. TI will indicate between 4.5 and 5.5.
- (16) Operate pneumatic pressure standard to apply 25 psi. TI will indicate between 24 and 26.

NOTE

Perform step **a** (17) through a (24) below for optional 10,000 psig transducer (PN: 12258956) that is not part of the TI and label in accordance to paragraph **6 e** above.

- (17) Connect equipment as shown in figure 2.
- (18) Set **TEST SELECT** switches to **51**.
- (19) Operate hydraulic pressure standard to apply 10,000 psi and return to **0** three times.
- (20) With pressure at **0**, press and hold **TEST** pushbutton until **CAL** appears on TI display. Release **TEST** pushbutton.
- (21) Wait for offset value to appear on display. Offset value will be between **-450** and **+450**.

(22) Press and release **TEST** pushbutton.

(23) Operate hydraulic pressure standard to apply 3000 psi. TI will indicate between 2775 and 3225.

(24) Operate hydraulic pressure standard to apply 9500 psi. TI will indicate between 9112 and 9888.

b. Adjustments. No adjustments can be made.

14. Vacuum

a. Performance Check

(1) Connect equipment as shown in CONNECTION B (fig. 3).

(2) Set **TEST SELECT** switches to **45**.

(3) Operate vacuum pump and adjust pressure controller and pneumatic pressure standard controls for 18 inHg indication and back to **0** three times.

(4) Stop the vacuum pump and, with pneumatic pressure standard indicating **0**, press and hold **TEST** pushbutton until **CAL** appears on display. Release **TEST** pushbutton.

(5) Wait for offset value to appear on display. Offset value will be between **-4.5** and **+4.5**.

(6) Press and release **TEST** pushbutton.

(7) Operate vacuum pump and adjust necessary controls for 18.00 inHg indication on pneumatic pressure standard. TI will display between 17.10 and 18.90.

b. Adjustments. No adjustments can be made.

15. Final Procedure

a. Deenergize and disconnect all equipment and reinstall protective cover on TI.

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

c. Label current probe, high-pressure transducer and low-pressure transducer with the following: **“To be used only with VTM, Serial # _____ for VTM calibration to be valid”**.

By Order of the Secretary of the Army:

Official:



JOYCE E. MORROW
*Administrative Assistant to the
Secretary of the Army*

0812102

GEORGE W. CASEY, JR.
*General, United States Army
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To be distributed in accordance with the initial distribution number (IDN) 342040, requirements for calibration procedure TB 9-4910-555-24

INSTRUCTIONS FOR SUBMITTING AN ELECTRONIC 2028

The following format must be used if submitting an electronic 2028. The subject line must be exactly the same and all fields must be included; however, only the following fields are mandatory: 1, 3, 4, 5, 6, 7, 8, 9, 10, 13, 15, 16, 17, and 27.

From: "Whomever" whomever@redstone.army.mil
To: <2028@redstone.army.mil

Subject: DA Form 2028

1. **From:** Joe Smith
2. **Unit:** home
3. **Address:** 4300 Park
4. **City:** Hometown
5. **St:** MO
6. **Zip:** 77777
7. **Date Sent:** 19-OCT -93
8. **Pub no:** 55-2840-229-23
9. **Pub Title:** TM
10. **Publication Date:** 04-JUL-85
11. **Change Number:** 7
12. **Submitter Rank:** MSG
13. **Submitter FName:** Joe
14. **Submitter MName:** T
15. **Submitter LName:** Smith
16. **Submitter Phone:** 123-123-1234
17. **Problem:** 1
18. **Page:** 2
19. **Paragraph:** 3
20. **Line:** 4
21. **NSN:** 5
22. **Reference:** 6
23. **Figure:** 7
24. **Table:** 8
25. **Item:** 9
26. **Total:** 123
27. **Text**

This is the text for the problem below line 27.

