*TB 9-4931-505-24

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR DIFFERENTIAL COMPARATOR, TEKTRONIX TYPE 5A13N

Headquarters, Department of the Army, Washington, DC
6 May 2008

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.

*This bulletin supersedes TB 9-4931-505-50, 15 September 1978, including all changes.

SECTION I
IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Differential Comparator, Tektronix Type 5A13N. The manufacturer's manual was used as the prime data source in compiling these instructions. The equipment being calibrated will be referred to as the TI (test equipment) throughout this bulletin.

a. Model Variations. None.

b. Time and Technique. The time required for this calibration is approximately 4 hours, using the dc and low frequency technique.

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. 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
Deflection factor	Range: 1 mV dc to 5 V dc in 12 calibrated steps of 1, 2, 5 sequence Accuracy: ±3%
Frequency response: Dc coupled Ac coupled	 Bandwidth: Dc to 2 MHz Bandwidth: 2 Hz or less at -3 dB; 10 kHz bandwidth mode. Dc to 10 kHz within 2 kHz
Input R and C	Range: 1 MΩ paralleled by about 51 pF; time constant normalized for 51 μs ±3% between channels
Maximum safe input voltage: Dc input coupled Ac input coupled	 ±350 V (dc + peak ac, 1 kHz or less) 350 V dc
Maximum input gate current	100 pA or less at +25°C
Common-mode signal	Range: for deflection factor 1 to 50 mV/div, at least ±15 V; for 0.1 to 5 V/div, at least ±350 V
Overdrive recovery	Range: 1 μs to recover to within 3.0 V, and 0.1 ms to recover to within 1.5 mV after removal of signal between ±15V

Table 1. Calibration Description - Continued

Test instrument parameters	Performance specifications
Common-mode rejection	Ratio: 10,000: 1 Range: dc to 10 kHz at 1 to 50 mV/div dc coupled, with up to 20 V p-p sine wave, decreasing to 100:1 at 1 MHz. At least 400:1, dc to 10 kHz at 0.1 to 5 V/div dc coupled, with up to 100 V p-p sine wave, decreasing to 40:1 at 1 MHz. For frequencies above 5 kHz ac coupled, CMRR is same as dc coupled. Below 5 kHz ac coupled, CMRR decreases to 400:1 at 10 Hz
Position	Range: + and - approx. 8 div from graticule center
Internal comparison voltage	Range: 0 to ±10 V and 0 to ±1 V. Accuracy: ±0.2% of dial setting plus 5 mV from ± 5 to +10 V; ±0.2% of dial setting plus 1 mV from ±25 mV to ±1 V of 0 to ±1 V range. From 0 V to ±25 mV, use on-screen display for greater resolution.
Comparison	Vc OUT resistance 15 KΩ. Electrical zero 0.5 mV or less

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 Sets 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 required for this calibration are common usage accessories, issued as indicated in paragraph **4** above, and are not listed in this calibration procedure. The following peculiar accessories are required for this calibration: EXTENDER, Tektronix, type 067-0645-00 and STANDARDIZER, 5 – 80 pF; BNC plug to BNC jack.

Table 2. Minimum Specifications of Equipment Required

Common name	Minimum use specifications	Manufacturer and model (part number)
CALIBRATOR	Range: 1.7145 mV to 14.14 V rms at 100 Hz and 1 kHz Accuracy: ±0.75%	Fluke, Model 5720A (5720A) (p/o MIS-35947)
MULTIMETER	Range: 1 to 10 V dc Accuracy: ±0.75%	Hewlett Packard, Model 3458A (3458A)
OSCILLOSCOPE	Must be provided with TI	Tektronix, Type R5440 (MIS-28706-1)

Table 2. Minimum Specifications of Equipment Required - Continued

Common name	Minimum use specifications	Manufacturer and model (part number)
OSCILLOSCOPE CALIBRATOR	Range: 10 Hz to 2 MHz	Fluke, Model 5820A-5C-GHZ (5820A-5C-GHZ)
TIME BASE UNIT	Must be provided with TI	Tektronix, Type 5B42 (MIS-28706-4)

SECTION III
CALIBRATION PROCESS

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 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 step within the performance check where applicable.

a. Remove left side panel from TI.

b. Connect TI to oscilloscope left compartment, using extender, and install time base unit into right compartment.

c. Position TI controls as listed in (1) through (11) below:

(1) **DISPLAY** pushbutton pressed.

(2) **POSITION** control to midrange.

(3) **COMPARISON VOLTAGE (Vc)** dials (inner and outer) to **0** (zero).

(4) **COMPARISON VOLTAGE (Vc)** polarity selector to **+** (positive).

(5) **0-10 V** pushbutton pressed.

(6) **VOLTS/DIV** switch to **50m**.

(7) **CAL** control fully cw (clockwise).

(8) **STEP ATTEN BAL** (screwdriver) control to midrange.

(9) **+INPUT** and **-INPUT** coupling pushbuttons to **GND**.

(10) Both **AC** pushbuttons released to **DC**.

(11) **BANDWIDTH LIMIT 10 kHz** pushbutton released.

d. Adjust time base unit for a 1 ms sweep.

e. Energize oscilloscope and allow 30 minutes for equipment to warm-up and stabilize.

8. Dc Balance

a. Performance Check

(1) Center trace on oscilloscope graticule centerline, using **POSITION** control.

(2) Set **VOLTS/DIV** switch back and forth between **10m** and **50m** positions. If trace on oscilloscope shifts, perform **b** (1) below.

(3) Set **VOLTS/DIV** switch back and forth between **1m** and **5m** positions. If trace on oscilloscope shifts, perform **b** (2) below.

(4) Set **VOLTS/DIV** switch back and forth between **5m** and **10m** positions. If trace on oscilloscope shifts, adjust front panel **STEP ATTEN BAL** control for minimum trace shift.

(5) Rotate **VOLTS/DIV CAL** control throughout its range. If trace on oscilloscope shifts, perform **b** (3) below.

(6) Reset **CAL** control to detent position (fully cw).

b. Adjustments

(1) Adjust R112 (fig. 1) for minimum oscilloscope trace shift.

(2) Adjust R212 (fig. 1) for minimum oscilloscope trace shift.

(3) Adjust R194 (fig. 1) for minimum oscilloscope trace shift while rotating **CAL** control throughout its range.

9. Amplifier Gain and Vertical Deflection

a. Performance Check

(1) Connect calibrator output to TI **+INPUT**.

(2) Set **VOLTS/DIV** switch to **1 mV** and release input coupling **+GND** pushbutton.

(3) Adjust calibrator frequency to 1 kHz and amplitude for a 5 division vertical deflection on oscilloscope. If calibrator does not indicate between 1.7145 and 1.8205 mV, perform **b** below.

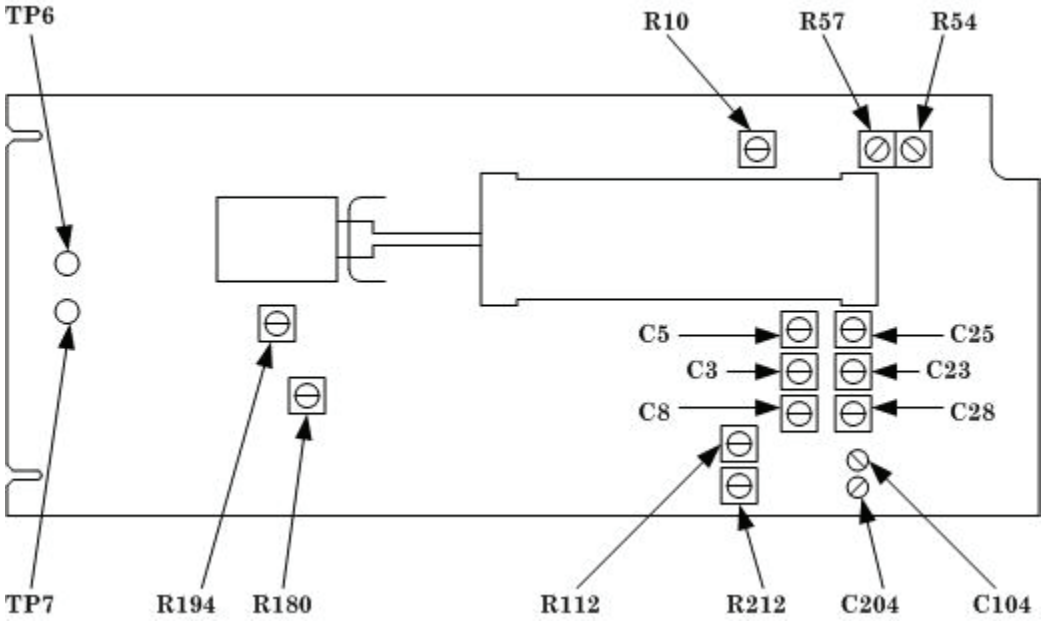

Figure 1. Adjustment locations - left side view.

(4) Repeat technique of (2) and (3) above for **VOLTS/DIV** switch settings and calibrator indications listed in table 4. At each position, calibrator will indicate within the limits specified.

Table 4. Vertical Gain Check

VOLTS/DIV switch settings	Calibrator indications (rms)	
	Min	Max
2 m	3.4290 mV	3.6411 mV
5 m	8.5724 mV	9.1036 mV
10 m	17.145 mV	18.205 mV
20 m	34.290 mV	36.411 mV
50 m	85.724 mV	91.026 mV
0.1 V	171.45 mV	182.05 mV
0.2 V	342.90 mV	364.11 mV
0.5 V	857.24 mV	910.26 mV
1 V	1.7145 V	1.8205 V
2 V	3.4290 V	3.6411 V
5 V	8.5724 V	9.1026 V

b. Adjustments. Set calibrator for a 1.7675 mV output and adjust R180 for a 5 division vertical deflection on oscilloscope (R).

10. Overdrive Recovery

a. Performance Check

(1) Set **VOLTS/DIV** switch to 2 and adjust time base unit sweep rate for a 10 ms sweep.

(2) Set time base unit sweep mode to normal and trigger source to external.

(3) Connect oscilloscope calibrator **SOURCE/MEASURE CHAN 1**to TI **+INPUT** using 50 Ω feedthrough termination.

(4) Connect oscilloscope calibrator **SOURCE/MEASURE CHAN 5** to time base unit external input.

(5) Adjust oscilloscope calibrator frequency for 10 Hz and amplitude for a 5 division vertical deflection on oscilloscope.

(6) Set **VOLTS/DIV** switch to **1m** and time base unit for a 20 μs sweep.

(7) Press **ZERO Vc REF** pushbutton and hold while adjusting **POSITION** control to center trace on oscilloscope graticule centerline and then release. If trace does not return to centerline within ±1.5 divisions when released, perform **b** (1) below.

(8) Move cable from TI **+INPUT** to **-INPUT**.

(9) Press **+INPUT** coupling pushbutton to **GND** and release **-INPUT** coupling pushbutton to **DC** (out positions).

(10) Repeat technique of (7) above and, if necessary, perform **b** (2) below.

b. Adjustments

(1) Adjust C104 (fig. 1) until trace returns to graticule centerline within ±1.5 divisions in 0.1 ms (final adjustment made in paragraph **12 b**) (R).

(2) Adjust C204 (fig. 1) until trace returns to graticule centerline within ±1.5 divisions in 0.1 ms (final adjustment made in paragraph **12 b**) (R).

11. Input Compensation

a. Performance Check

(1) Connect oscilloscope calibrator **SOURCE/MEASURE CHAN 1** to TI **-INPUT** connector, using standardizer.

(2) Set **VOLTS/DIV** switch to **50m**.

(3) Adjust time base unit for a few cycle display and set triggering source switch to left.

(4) Adjust oscilloscope calibrator square wave output for 1 kHz and amplitude for a 6 division square wave display on oscilloscope.

(5) Adjust standardizer for an optimum square wave display on oscilloscope. If square wave indicates roll off or overshoot, perform **b** (1) below.

(6) Set **VOLTS/DIV** switch to **0.1** while maintaining a 6 division oscilloscope display with oscilloscope calibrator amplitude. If leading corner of square wave indicates roll off or overshoot, perform **b** (2) below.

(7) Move cable from TI **-INPUT** to **+INPUT**.

(8) Press **-INPUT** coupling pushbutton to **GND** and release **+INPUT GND** pushbutton.

(9) Set **VOLTS/DIV** switch to **50m** and repeat technique of (4) above. If optimum square wave is not displayed, perform **b** (3) below.

(10) Set **VOLTS/DIV** switch to **0.1** and repeat technique of (4) above. If optimum square wave is not displayed, perform **b** (4) below.

(11) Remove standardizer.

b. Adjustments

(1) Adjust standardizer and C28 (fig. 1) for optimum square wave (R).

(2) Adjust C23 (fig. 1) and C25 (fig. 1) for minimum roll-off and overshoot on leading comer of square waveform (R).

(3) Adjust C8 (fig. 1) for same display as in (1) above (R).

(4) Adjust C3 (fig. 1) and C5 (fig. 1) for same display as in (2) above (R.)

12. Low-Frequency CMR

a. Performance Check

(1) Set **VOLTS/DIV** switch to **5** and both **+** and **-INPUT** coupling pushbuttons to **GND**.

(2) Adjust time base unit for a 5 ms sweep.

(3) Connect calibrator to TI **+INPUT** and **-INPUT** connectors.

(4) Adjust calibrator frequency for 100 Hz and output for 7.070 V rms.

(5) Release **+INPUT** and **-INPUT GND** coupling pushbuttons and set **VOLTS/DIV** switch to **1m**. If oscilloscope does not indicate less than 2 divisions of display, perform **b** (1) below.

(6) Set **VOLTS/DIV** switch to **5** and adjust ac calibrator for 14.14 V rms.

(7) Set **VOLTS/DIV** switch to **0.2**. If amplitude of oscilloscope display is not 0.2 division or less, perform **b** (2) and (3) below.

b. Adjustments

(1) Adjust C104 (fig. 1) or C204 (fig. 1) until oscilloscope display is less than 2 divisions (R). If more than 2 turns are required, adjust C104 (fig. 1) and C204 (fig. 1) in equal and opposite amounts and perform paragraph **10 a** (7).

(2) Adjust R10 (fig. 1) for minimum deflection of oscilloscope display.

(3) Adjust calibrator frequency for 1 kHz and readjust R10 (fig. 1), if necessary, until oscilloscope display is 0.2 division or less.

13. Amplifier Bandwidth

a. Performance Check

(1) Connect oscilloscope calibrator **SOURCE/MEASURE CHAN 1**to TI **+INPUT**.

(2) Set **VOLTS/DIV** switch to **0.1 V**, **-INPUT** to **GND**, and **+INPUT** to **AC**.

(3) Adjust time base unit for a 2 ms sweep.

(4) Adjust oscilloscope calibrator level sine output frequency for 100 kHz and amplitude for an 8 division vertical deflection on oscilloscope.

(5) Slowly increase oscilloscope calibrator frequency until oscilloscope display reaches its upper -3dB limit of 5.66 divisions. Oscilloscope calibrator will indicate frequency of 2 MHz or greater.

(6) Press **BANDWIDTH LIMIT 10 kHz** pushbutton and adjust oscilloscope calibrator frequency for 1 kHz and amplitude for an 8 division oscilloscope display.

(7) Increase oscilloscope calibrator frequency until oscilloscope displays 5.66 divisions (upper -3dB limit). Test oscillator will indicate frequency between 8 and 12 kHz.

(8) Release **BANDWIDTH LIMIT 10 kHz** pushbutton.

b. Adjustments. No adjustments can be made.

14. Input Gate Current

a. Performance Check

(1) Set **VOLTS/DIV** switch to **1 mV** and press both **+INPUT** and **-INPUT** coupling pushbuttons to **GND** and release both **AC** pushbuttons to **DC**.

(2) Adjust time base unit for a 1 ms sweep.

(3) Align trace on oscilloscope graticule centerline, using **STEP ATTEN BAL** control.

(4) Release **+INPUT** coupling **GND** pushbutton. Trace will remain centered on oscilloscope graticule 0 division.

(5) Release **-INPUT** coupling **GND** pushbutton. Trace will remain centered on oscilloscope within ±0.1 division.

b. Adjustments. No adjustments can be made.

15. Comparison Voltage

a. Performance Check

(1) Connect multimeter to TI **Vc OUT** and chassis ground.

(2) Set **COMPARISON VOLTAGE (Vc)** (outer) dial to 10.00 and press **0-10 V** pushbutton. If multimeter does not indicate between 9.975 and 10.025 V dc, perform **b** (1) below.

(3) Release **COMPARISON VOLTAGE (Vc) 0-10** pushbutton to **OUT 0-1 V**. If multimeter does not indicate between 0.998 and 1.003 Vdc, perform **b** (2) below.

b. Adjustments

(1) Adjust R54 (fig. 1) until multimeter indicates 10.00 Vdc (R).

(2) Adjust R57 (fig. 1) until multimeter indicates 1.00 Vdc (R).

16. Final Procedure

a. Deenergize and disconnect all equipment and reinstall protective covers on TI if necessary.

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

By Order of the Secretary of the Army:

GEORGE W. CASEY, JR.
General, United States Army
Chief of Staff

Official:

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

0807007

Distribution:

To be distributed in accordance with the initial distribution number (IDN) 342068, requirements for calibration procedure TB 9-4931-505-24.

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.