DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR OSCILLOGRAPHIC RECORDER (HEWLETT-PACKARD TYPE 7402A) AND MEDIUM GAIN DC PREAMPLIFIER (HEWLETT-PACKARD TYPE 17401A)

Headquarters, Department of the Army, Washington, DC
20 May 1981

REPORTING OF ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this bulletin. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommend Changes to Publication and Blank Forms), direct to: Commander, U. S. Army Armament Materiel Readiness Command, ATTN: DRSAR-MAS, Rock Island, IL 61299. A reply will be furnished to you.

SECTION I
IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Oscillographic Recorder (Hewlett-Packard Type 7402A) and Medium Gain DC Preamplifier (Hewlett-Packard Type 17401A), P/N 10554731 The manufacturer's instruction manual was used as the prime data source 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 test.

b. Time and Technique. The time required for this calibration is approximately 5 hours, using the dc and low frequency technique.

2. Calibration Data Card (DA Form 2416).

a. Forms, records, and reports required for calibration personnel at all levels are prescribed by TM 38-750. DA Form 2416 must be annotated in accordance with TM 38-750 for each calibration performed.

b. Adjustments to be reported on DA Form 2416 are designated (R) at the end of the sentence in which they appear. When adjustments are in tables, the (R) will follow 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
Preamplifier 17401A with Oscillographic recorder 7402A	
Dc balance	Input: 0 volts; output: 0 volts
Attenuator balance	Input: 30 volts peak-to-peak; output: null
Dc calibration	Gain: 0.5% of full scale value
Sensitivity vernier span	Attenuation: Greater than 2.5 times the indicated per-millimeter-division value
Frequency response	Dc to 40 Hz flat < 3dB down at 55 Hz

Table 1. Calibration Description - Continued

Test instrument parameters		Performance specifications
Oscillographic recorder 4702A with preamplifier 17401A		
Paper speed	Range:	1, 5, 20, 100 mm/SEC Accuracy: + 0.5%
Span accuracy	Range:	1 mv/DIV to 5v/DIV Accuracy: + 0.5%
Linearity	Range:	2 mv/DIV, 50 mv/DIV, 2v/DIV Accuracy: + 0.5 mm of decrement
Step response	Input:	5 volt peak-to-peak square wave at 10 Hz. Accuracy: Less than 2% overshoot

SECTION II
EQUIPMENT REQUIREMENTS

4. Equipment Required. Table 2 identifies the specific equipment used in this calibration procedure. This equipment is issued with the secondary transfer standards calibration set, NSN 6695-00621-7877 and is to be used in performing this procedure. Alternate items may be used by the calibrating activity when the equipment listed in table 2 is not available. 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 accuracy's listed in table 2 provide a four-to-one accuracy ratio between the standard and TI.

5. Accessories Required. The accessories listed in table 3 are issued as indicated in paragraph 4 above and are to be 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

Item	Common Name	Minimum use specifications	Manufacturer, model and part number
A1	DC VOLTAGE STANDARD	Range: Accuracy:	+ 250v John Fluke, Model 332 BAF + 0.25% (JF 332 BAF).
A2	DIGITAL VOLTMETER	Voltage range: -30lv to 37.3v Accuracy: + 0.5%	DANA, Model 5000-S2351(7912606).
A3	ISOLATION POWER TRANSFORMER	Standard power plug and receptacle connectors.	Power, Model 5T200A (7913165).
A4	OSCILLOSCOPE	Range: Amplitude:	60 Hz Tektronix, Type R 5440 (MIS28706-1). 30 vp-p Dual trace 5A48 (MIS28706-3). Delaying time base 5B42 (MIS28706-4).
A5	SQUARE WAVE GENERATOR	Frequency range: 10 Hz Output:5vp-p	Tektronix, Model 106 (MIS10284 Type 1)
A6	TEST OSCILLATOR	Frequency range: 10 Hz to 100 Hz Voltage range: 1 millivolt to 3.16 volts	Hewlett Packard, Model 652A (MIS10224).
A7	TIME MARK GENERATOR	Accuracy: Range:	+ 0.0002% Tektronix, Type 184, Model 146B 1 SEC (7912042-2)
A8	VARIABLE POWER TRANSFORMER	Range: Accuracy: + 3%	0-125 vac General Radio, Mode W10OMT3AS3 (7910809).

Table 3. Accessories Required

Item	Common Name	Description and part number
B1	ADAPTER	Dual-banana plug to BNC (7909401).
B2	CABLE ASSEMBLY	Dual-banana plug to probe plus alligator clip (7911305).
B3[1]	CABLE	60-inch, dual-banana plug to guarded two-conductor connector.
B4[2]	POWER CABLE	60-inch, NEMA plug to guarded two-conductor connector, both inputs shorted to guard, grounded shell.

1 Supplied as accessory with chart recorder.
2 Not available at secondary transfer set. Fabricate as shown in figure 1.

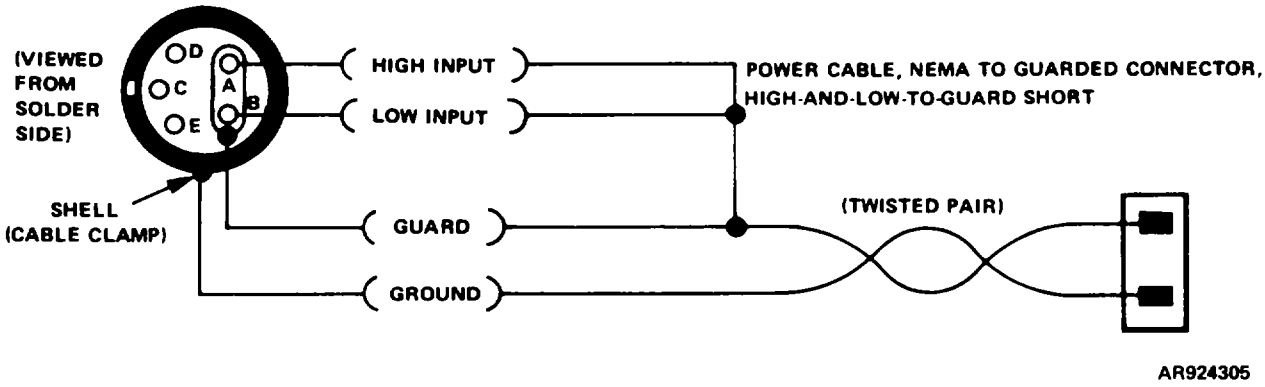

Figure 1. Fabricated power cable

SECTION III
PRELIMINARY OPERATIONS

6. Preliminary Instructions.

a. The instructions outlined in this section 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 and item identification number as listed in tables 2 and 3. For the identification of equipment referenced by item numbers prefixed with A, see table 2, and for prefix B, see table 3.

WARNING

HIGH VOLTAGE is used during the performance of this calibration. DEATH ON CONTACT may result if personnel fail to observe safety precautions.

NOTE

Unless otherwise specified, verify the results 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 9-6625-2802-14&P for this TI.

NOTE

When indications specified in paragraphs 8 through 12 are not within tolerance, perform the power supply check prior to making adjustments After ad-austments are made, repeat par-agraphs 8 through 12Do not perform power supply check if all other parameters are within tolerance.

7. Equipment Setup.

a. Remove protective cover from TI as required for adjustments.

b. Position controls as listed in (1) through (6) below:

(1) PEN POSITION: centered
(2) CHART SPEED: STOP
(3) LINE switch: OFF
(4) EVENT MARKERS, 1 SEC/MARK: MARK
(5) Preamplifier INPUT: ZERO
(6) Preamplifier V/DIV: 5

SECTION IV
CALIBRATION PROCESS, PREAMPLIFIER

NOTE

Unless otherwise specified, verify the results of each test and take corrective action whenever the test requirement is not met before continuing with the calibration.

NOTE

The following paragraphs contain circuit checks and adjustments that are used to assure proper circuit performance. Be sure to perform the checks in sequence; some checks assume previous settings.

8. DC Balance

a. Performance Check

(1)Set INPUT switch to ZERO, range switch to 1 mV /DIV and CAL control fully clockwise

(2)Set dc voltage standard (Al) to +15 mV and apply to input of preamplifier

(3) Set CHART SPEED to 1 mm/sec and position CHANNEL 1 pen to center line of grid.

(4) Set INPUT switch to OPR. If pen does not track grid line 15 millimeters left of center line within +0.5 mm, perform adjust-ment in paragraph 8 b.

(5) Set INPUT switch to ZERO and apply -15 millivolts to the pre-amplifier input.

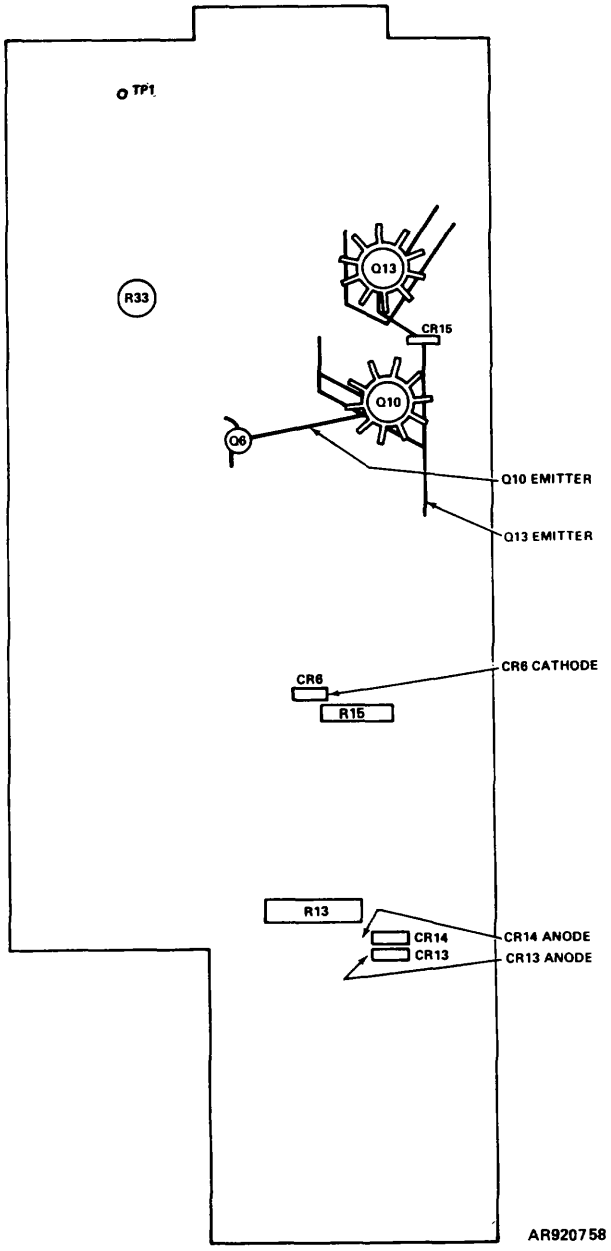

Figure 2. Printed circuit assembly - top view

(6) Set INPUT switch to OPR. Pen should track grid line 15 millimeters right of center line, + 0.5 mm.

(7) Repeat steps (1) through (6) above for channel 2.

b. Adjustments.

(1) Turn LINE switch to OFF and remove dc voltage standard.

(2) Remove top right cover, slide preamplifier out of chassis, remove its cover and reinsert it into the chassis.

(3) Connect cable assembly (B2) from the digital voltmeter (A2) to TP1 on the preamplifier (see fig. 2).

(4) Set LINE switch to ON and INPUT switch to ZERO.

(5) Adjust PREAMP BAL resistor (R13) (see fig. 2) for zero volt at TP1.

9. Attenuator Balance.

a. Performance Check.

(1) Set up preamplifier INPUT switch to OPR and range switch to .5V/DIV.

(2) Use adapter (B1) to connect cable assembly (B2) to oscilloscope (A4).

(3) Connect variable power transformer (A8) to isolation power transformer (A3); connect isolation power transformer (A3) through power cable (B4) to the preamplifier input.

(4) Use cable assembly (B2) to monitor the ac output from variable power transformer on oscilloscope; set variable power 8 transformer for a 30 volt (peak-to-peak) output as observed on oscilloscope.

(5) Connect cable assembly (B2) to the preamplifier output CHANNEL OUT 1 of terminal block on the back so as to monitor an amplitude null on oscilloscope. If a null is not evident, perform adjustments in paragraph 9 b.

(6) Repeat steps (1) through (5) above for channel 2.

b. Adjustments.

(1) Adjust resistor R9 on range switch (see fig. 3) for an amplitude null as observed on oscilloscope at CHANNEL OUT 1 terminal block (rear panel).

(2) Disconnect variable power transformer (A8).

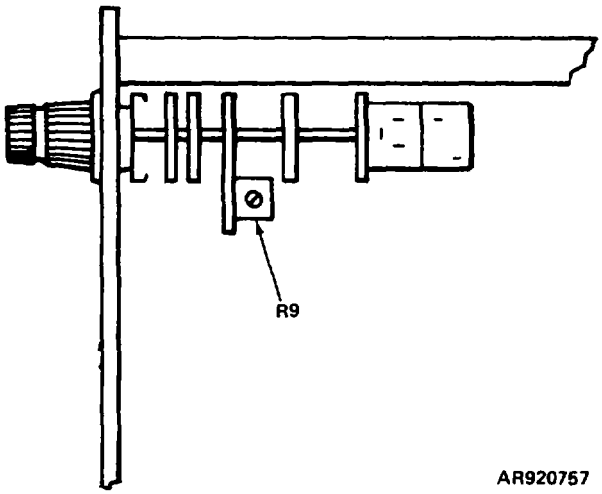

Figure 3. Range switch assembly 10. Dc Calibration.

10. Dc Calibration

a. Performance Check.

(1) Use cable (B3) to connect dc voltage standard (Al) to the channel preamplifier input.

(2) Connect preamplifier output, CHANNEL OUT 1 (rear panel terminal block) to digital voltmeter (A2) using cable (B2).

(3) Set dc voltage standard (Al) for a zero-volt output on its one-volt range.

(4) Set the preamplifier sensitivity range to 1 mV/DIV.

(5) Set the INPUT lever switch to OPR.

(6) Observe and record the indicated output of the preamplifier at digital voltmeter (A2).

(7) Set dc voltage standard (Al) for a 50 millivolt output.

(8) If there is not a 5 volt difference from the previous value recorded in step (6), perform adjustments in b. below.

b. Adjustments. Set CAL resistor R33 (see fig. 2) for a 5 volt difference from the previous value recorded in step (6) above (R).

11. Sensitivity Vernier Span.

a. Performance Check.

(1) Set the preamplifier sensitivity selector switch to 1 mV/DIV, INPUT switch to OPR and CAL control fully clockwise.

(2) Apply 50 millivolts from the dc voltage standard (Al) to preamplifier input.

(3) Measure and record the output voltages of CHANNEL 1 and SIG COMMON on rear panel terminal strip.

(4) Turn CAL control slightly counterclockwise; observe voltage to be greater than or equal to voltage in step (3) above.

(5) Turn CAL control fully counterclockwise; the voltage should not be greater than the measurement in step (3) above divided by 2.5.

(6) Repeat steps (1) through (5) above for channel 2.

b. Adjustments. No adjustments can be made.

12. Frequency Response.

a. Performance Check.

(1) Set range switch to 50 mV/DIV, INPUT switch to OPR and CAL control fully clockwise.

(2) Set test oscillator (A6) frequency to 10 Hz sinusoidal and connect to preamplifier.

(3) Set CHART SPEED to 5 mm/SEC and CHANNEL 1 pen to center of grid.

(4) Adjust amplitude of test oscillator to a full scale deflection on chart. Increase frequency to 40 Hz. The amplitude should not change more than + 0.5 mm.

(5) Continue to increase test oscillator frequency until amplitude is 35 mm full scale. The frequency should then be 55 Hz or greater.

(6) Repeat steps 1 through 5 above for channel 2.

b. Adjustments. No adjustments can be made.

13. Power Check.

a. Performance Check. Perform the voltage supply checks by connecting

cable assembly (B2) to digital voltmeter (A2) so as to observe the voltage listed in table 4 (see fig. 2).

b. Adjustments. No adjustments can be made.

14. Final Procedure.

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

b. In accordance with TM 38-750, annotate and affix DA Label 80 (U.S. Army Calibration System). When the TI cannot be adjusted within tolerance, annotate and affix DA Form 2417 (Unserviceable Equipment) tag.

c. If the TI can be used for certain maintenance functions, even though not meeting all calibration specifications, affix DA Label 163 (Limited or Special Calibration) to identify equipment which can be used for some specific procedures.

Table 4. Power Supply Voltage Checks

Source	Minimum	Nominal	Maximum
Q10 emitter	+35.7	+36.5	+37.3
CR6 cathode	-0.6	-0.7	-0.8
CR13 anode	-6.06	-6.19	-6.32
CR14 anode	-22.1	-23.1	-24.1
Q13 emitter	-30.1	-31.6	-33.1

SECTION V
CALIBRATION PROCESS, OSCILLOGRAPHIC RECORDER

NOTE

All performance checks are made with both preamplifiers installed.

15. Paper Speeds.

a. Performance Check.

(1) Connect time mark generator (A7) to either preamplifier input using cable (B3) and adaptor (B1). Set generator to 1 SEC.
(2) Turn LINE switch to ON and preamplifier INPUT to ZERO.
(3) Set CHART SPEED to 1 mm/SEC.
(4) Position pens on center lines numbered 1 and 2.
(5) Set INPUT to OPR and run about 100 mm (four divisions) of paper.
(6) Measure distance between first and eleventh time mark. Chart speed accuracy is number of marks multiplied by chart rate (1 mm = 0.0394 in.). The distance measured should be accurate to +0.05% and the accuracy can be calculated from the following formula:

$$\text{Error} = \frac{D_{diff}}{D_T} \times 100$$

where D_T represents the true distance: time marks multiplied by 0.0394 and Ddiff represents the difference between measured distance and true distance.

Example: Error is $\frac{0.394-0.392}{0.394} \times 100 = 0.51\%$

(7) Set CHART SPEED to 5 mm/ SEC and run about 200 mm of chart paper (5 mm = 0.197 inches). Calculate accuracy as shown in step (6) above.

(8) Set CHART SPEED to 20 mm/ SEC and run about 200 mm of chart paper (20 mm = 0.788 inches). Calculate accuracy as shown in step (6) above.

(9) Set CHART SPEED to 100 mm/ SEC and run about 800 mm of chart paper (100 mm = 3.94 inches). Calculate accuracy as shown in step (6) above.

(10) Disconnect time mark generator from preamplifier input.

b. Adjustments. No adjustments can be made.

16. Paper Weave.

a. Performance Check.

(1) Set CHART SPEED to 1 mm/ SEC and INPUT switch to ZERO.

(2) Position channel 1 pen on extreme left grid line and channel 2 pen on extreme right grid line.

(3) Select various speeds and run about 400 mm of chart paper (15.76 inches).

(4) Traces should be straight on grid lines and should not vary more than 1/2 minor chart division peak-to-peak.

b. Adjustments. No adjustments can be made.

17. Event Marker, 1 SEC.

a. Performance Check.

(1) Set CHART SPEED to 1 mm/SEC and EVENT MARKER to 1 SEC. A mark should occur at each millimeter mark.

(2) Set CHART SPEED to 5 mm/SEC and EVENT MARKER to 1 SEC. A mark should occur every 5 millimeters.

b. Adjustments. No adjustments can be made.

18. Span Accuracy.

a. Performance Check.

(1) Set dc voltage standard (Al) to 0 Vdc and connect to input of CHANNEL 1 preamplifier with cable (B 3).

(2) Set CHART SPEED to 5 mm/SEC, INPUT switch to OPR and CHANNEL 1 pen position to right hand grid line.

(3) Set preamplifier RANGE switch and apply dc voltage standard output as indicated in table 5. If a full scale positive deflection within tolerance does not occur, perform 18 b. adjustments.

(4) Set CHANNEL 1 pen position to left hand grid and apply negative voltages from the dc voltage standard and perform the test as indicated in table 5.

(5) Repeat steps (1) through (4) above for channel 2.

b. Adjustments.

(1) Remove left cover. See

figure 4 for circuit board locations.

(2) Make the following adjustments on the servo amplifier boards (A7) (see fig. 5): GAIN (R7) center range, R.H. LIMIT (R10) and L.R. LIMIT (R13) fully clockwise.

(3) Set dc voltage standard to 0 Vdc.

Table 5. Span Accuracy Checks

DC standard output	RANGE switch	Full scale positive	Full scale negative	Tolerance (millimeters)
50 mv	1mV /DIV			+ 0.5
100 mv	2mV/DIV			+ 0.5
250 mv	5mV/DIV			+ 0.5
1.0 v	20mV/DIV			+ 0.5
2.5 v	50mV /DIV			+ 0.5
5.0 v	1V/DIV			+ 0.5
10 v	2VIDIV			+ 0.5
25 v	5V/DIV			+ 0.5
50 v	1V/DIV			+ 0.5
100 v	2V/DIV			+ 0.5
250 v	5V/DIV			+ 0.5

(4) Set preamplifier selector to .1V/DIV, CHART SPEED to 1 mm/SEC and position pen to center grid line.

(5) Set dc voltage standard to +5 volts and adjust L.H. LIMIT (R13) until pen is 2 mm outside grid on left side (R).

(6) Set dc voltage standard to -5 volts and adjust R.H. LIMIT R10) until pen is 2 mm outside grid on right side (R).

(7) Set dc voltage standard to 0 volts and pen to right grid line.

(8) Set dc voltage standard to +5 volts.

(9) Adjust gain control (R7) until pen is on left grid line (R).

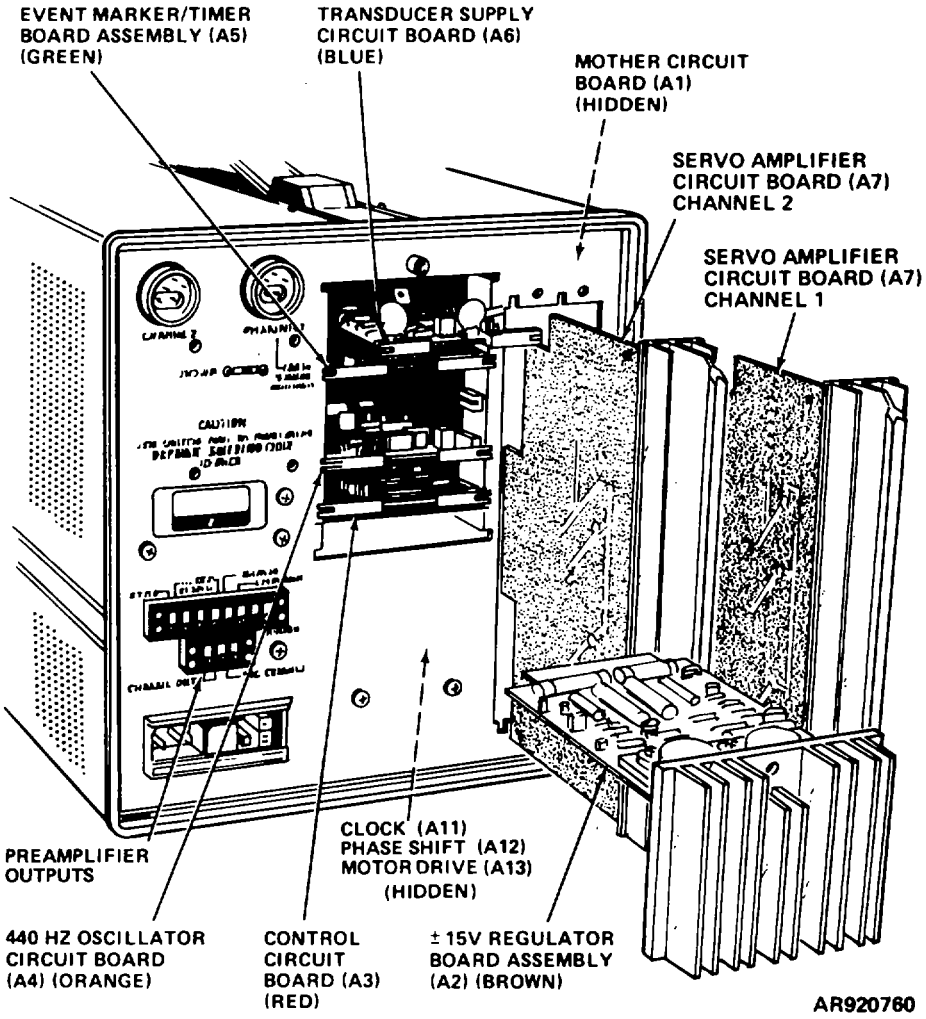

Figure 4. Circuit board locations

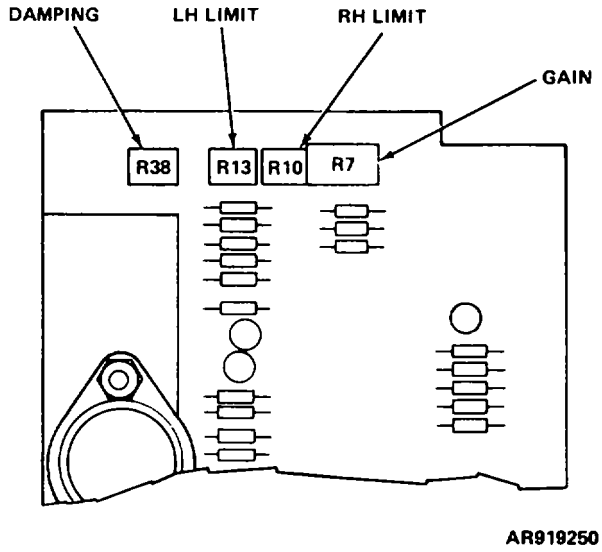

Figure 5. Servo amplifier adjustments

(10) Repeat steps (1) through (4) above.

19. Linearity.

a. Performance Check.

(1) Set dc voltage standard (Al) to 0 Vdc and CHART SPEED to 5 mm/SEC.
(2) Set CHANNEL 1 pen position to right hand grid line.
(3) Set preamplifier to 2 mV/DIV and adjust dc voltage standard (Al) to set pen on left hand grid line. Divide the dc voltage standard output by five to obtain the test decrement.
(4) Decrease the dc voltage standard by the test decrement. The pen should be within + 0.5 mm of the grid line.

(5) Perform steps (3) and (4) above for 50 mV/DIV and 2 V/ DIV.

(6) Repeat steps (1) through (5) above for channel 2.

b. Adjustments. No adjustments can be made.

20. Electrical Limits.

a. Performance Check.

(1) Set dc voltage standard (Al) to 0 Vdc, CHART SPEED to 5 mm /SEC, CHANNEL 1 pen to center line of grid, and preamplifier selector to 0.1 V/DIV.

(2) Set dc voltage standard to +3 volts. Pen should be approximately 2 mm to left of left hand grid line.

(3) Set dc voltage standard to -3 volts. Pen should be 14 approximately 2 mm to right of right hand grid line. Right hand grid line

(4) Repeat steps (1) through (3) above for channel.

b. Adjustment Use span accuracy procedure , paragraph 18 b. , only upon failure

21. Step Response.

a. Performance Check.

(1) Set the preamplifier to .1V/DIV, CHART SPEED to 100 mm/SEC and CHANNEL 1 pen to center line of grid.

(2) Set square wave generator (A5) for a 10 Hz, 5 volt peak-to-peak square wave and apply to the input of the preamplifier. If overshoot is less than 2%, 1 mm perform b. below.

(3) Repeat steps (1) and (2) above for channel 2.

b. Adjustments. Adjust DAMPING control on the servo amplifier board if the overshoot is greater than 2%.(R).

22. Final Procedure.

a. De-energize and disconnect all equipment and reinstall protective cover on TI.

b. In accordance with TM 38-750, annotate and affix DA Label 80 (U.S. Army Calibration System). When the TI cannot be adjusted within tolerance, annotate and affix DA Form 2417 (Unserviceable Equipment) tag.

c. If the TI can be used for certain maintenance functions, even though not meeting all calibration specifications, affix DA Label 163 (Limited or Special Calibration) to identify equipment which can be used for some specific procedures.

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