TB 9-6625-2088-35

CHANGE 1

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR FUNCTION/PULSE GENERATOR WAVETEK, MODEL 145

Headquarters, Department of the Army, Washington, DC
10 September 2004

TB 9-6625-2088-35, 27 April 2004, 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	Insert pages
3 and 4	3 and 4
7 and 8	7 and 8

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

By Order of the Secretary of the Army:

Official:

PETER J. SCHOOMAKER
General, United States Army
Chief of Staff

JOEL B. HUDSON
Administrative Assistant to the
Secretary of the Army

0419601

Distribution:

To be distributed in accordance with IDN 342227, requirements for calibration procedure TB 9-6625-2088-35.

*TB 9-6625-2088-35

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CALIBRATION PROCEDURE FOR FUNCTION/PULSE GENERATOR WAVETEK, MODEL 145

Headquarters, Department of the Army, Washington, DC
27 April 2004

REPORTING OF ERRORS AND RECOMMENDED 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, US Army Aviation and Missile Command, AMSAM-MMC-MA-NP, Redstone Arsenal, AL 35898-5000. A reply will be furnished to you. You may also provide DA Form 2028 information to AMCOM via e-mail, fax, or the World Wide Web. Our fax number is DSN 788-6546 or Commercial 256-842-6546. Our e-mail address is 2028@redstone.army.mil. Instructions for sending an electronic 2028 may be found at the back of this manual. For the World Wide Web, use https://amcom2028.redstone.army.mil.

*This technical bulletin supersedes TB 9-6625-2088-35, dated 6 August 1990.

SECTION I
IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Function/Pulse Generator, Wavetek, Model 145. 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 instrument) throughout this bulletin.

a. Model variations. On some models, the power supply test points and adjustments are not accessible without extensive disassembly.

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. 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 applications which pertain to this calibration are listed in table 1.

Table 1. Calibration Description

Test instrument parameters	Performance specifications
Frequency[1]	Range: 0.001 Hz to 20 MHz Accuracy: ±3% of full range from X.01 Hz to X1 MHz ±5% of full range on X10 MHz
Frequency response[2]	Range: 0.001 Hz to 20 MHz Accuracy: ± 0.1 dB, 0.001 Hz to 200 kHz ± 0.5 dB, 200 kHz to 2 MHz ± 3 dB, 2 to 20 MHz
VCG linearity[3]	Range: 10 Hz to 2 MHz Accuracy: ±0.2%, l0 Hz to 100 kHz ±0.75%, 0.001 Hz to 2 MHz
Attenuation	Range: 0 to 80 dB Accuracy: ±0.3 dB/20 dB at 2 kHz
Sine distortion	<0.5%. X100 Hz to X10 kHz <1%, X.01 to X10 Hz and X100 kHz
Time symmetry	Square wave variation less than: ± 1%, 0.001 Hz to 200 kHz ±0.5%, 20 Hz to 20 kHz
Pulse and square wave (15 V p-p into 50 Ω)	Risetime: <20 ns Falltime: <20 ns
Function output	Range: Variable to 15 V p-p into 50 Ω

[1]Not verified below .02 Hz

[2]Not verified below 200 Hz or above 1 MHz.

[3]Verified from 1 to 10 kHz.

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-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 the calibration procedure. The following peculiar accessories are also required for this calibration: Attenuator X10, Tektronix, Type 011-0059-02; and termination, 50 Ω feedthrough, Hewlett-Packard, Model 11048C.

Table 2. Minimum Specifications of Equipment Required

Common name	Minimum use specifications	Manufacturer and model (part number)
AUDIO ANALYZER	Range: 1 and 100 kHz Distortion capability: < 0.5%	Boonton, Model 1121 (1121)
CALIBRATOR	Range: 0.1 to 5 V dc Accuracy: ± 0.5%	Fluke, Model 5720A (5720A/EP)
FREQUENCY COUNTER	Range: 0.001 Hz to 21 MHz Accuracy: ± 0.05%	Fluke, Model PM6681/656 (PM6681/656)
MULTIMETER	Range: 5 mV to 25 V dc Accuracy: ± 0.03%	Fluke, Model 8840A/AF-05/09 (AN/GSM-64D)
OSCILLOSCOPE	Range: 0.l to 15 V p-p Risetime: < 5 ns Accuracy: ± 3%	Tektronix, Type 2465B-46 (2465B-46)
THERMAL CONVERTER	Range: 2 kHz to 1 MHz Voltage range: 3 V ac input Accuracy: ± 0.3% to 100 KHz ± 0.5% 100 kHz to 1 MHz	Ballantine, Model 1395-3 (7913198-1)
TRUE RMS VOLTMETER	Frequency: 2 kHz Range: 4.8 mV to 5.3 V ac Accuracy: ± 0.9% (± l%)	Fluke, Model 8922A/AA (8922A/AA)

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 manufacturer's manual for this TI.

d. When indications specified in paragraphs **8** through **14** are not within tolerance, perform the power supply check prior to making adjustments. After adjustments are made, repeat paragraphs **8** through **14.** Do not perform power supply check if all other parameters are within tolerance.

e. 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 checks where applicable.

a. Position controls as listed in (1) through (10) below:

(1) Frequency dial to **1.05** (black scale).

(2) **FREQ/PERIOD MULTI (Hz/s)** switch to **10K** (black scale) and **VERNIER** control to **CAL**.

(3) **GENERATOR MODE** switch to **CONT** and **TRIGGER LEVEL** control fully ccw.

(4) **TRIGGER START/STOP** switch to **0° CAL** (detent).

(5) **PULSE DELAY** switch to **50 ns/100 ns** and **VARIABLE** control fully cw.

(6) **NORMAL/DOUBLE/DELAYED** switch to **NORMAL**.

(7) **PULSE WIDTH** switch to **OFF** and **VARIABLE** control to midrange.

(8) **DC OFFSET** control to **OFF** (detent).

(9) **FUNCTION** switch to (square).

(10) **ATTENUATION** switch to **20/0** and **VERNIER** control fully ccw.

b. Connect TI to 115V ac source.

c. Set **POWER** switch to **ON** and allow at least 30 minutes for equipment to warm-up.

8. VCG Linearity

a. Performance Check

(1) Connect negative terminal of calibrator to positive side of **VCG IN** and positive terminal to negative side.

(2) Connect frequency counter to **FUNCTION OUT**.

(3) Adjust frequency counter for a 100 ms gate time and display.

(4) Adjust calibrator DC output until frequency counter indicates 10.000 kHz. Record calibrator output as E_1.

(5) Adjust calibrator DC output until frequency counter indicates 1.000 kHz. Record calibrator output as E_2.

(6) Subtract E_1 from E_2 and divide by nine. Record result as E_3.

Example:

E_2 = - .9159

E_1 = - .0359
-0.88 = Difference

-0.88 ÷ 9 = - 0.0977

E_3 = - 0.0977

(7) Adjust calibrator DC output voltage to calculated values listed in table 3. Frequency counter will indicate within limits specified.

Table 3. Linearity Check

Calibrator DC output voltage	Frequency counter indications (kHz)	
	Min	Max
$E_1 + E_3 =$	8.982	9.018
$E_1 + (2 \times E_3) =$	7.984	8.016
$E_1 + (3 \times E_3) =$	6.986	7.014
$E_1 + (4 \times E_3) =$	5.988	6.012
$E_1 + (5 \times E_3) =$	4.990	5.010
$E_1 + (6 \times E_3) =$	3.992	4.008
$E_1 + (7 \times E_3) =$	2.994	3.006
$E_1 + (8 \times E_3) =$	1.996	2.004

b. Adjustments. No adjustments can be made.

9. Symmetry and VCG Null

a. Performance Check

(1) Connect oscilloscope to **FUNCTION OUT** using 50 Ω feedthrough termination.

(2) Turn frequency dial to **.02** and adjust **ATTENUATION VERNIER** control for a 5 V p-p indication on oscilloscope.

(3) Adjust oscilloscope to display 1 cycle at 5 major divisions (horizontal).

(4) Using a shorting lead, alternately short and open **VCG IN** terminal while observing oscilloscope display. If waveform shifts horizontally, perform **b** (1) below.

(5) Disconnect oscilloscope from TI and connect TI to frequency counter.

(6) Set **FREQ/PERIOD MULTI (Hz/s)** switch to **100K** and **VERNIER** control fully ccw. If frequency counter does not indicate 5 ms or greater, perform **b** (2) below.

(7) Adjust frequency counter to measure symmetry of square wave. If T_1 is not within ±0.5 percent of T_2 (fig. 1), perform **b** (3) and (4) below.

NOTE

To measure T_1, set frequency counter INPUT A slope switch to **+** (positive) and INPUT B slope switch to **-** (negative). Reverse slope switches to measure T_2. FUNCTION to TIME INT.

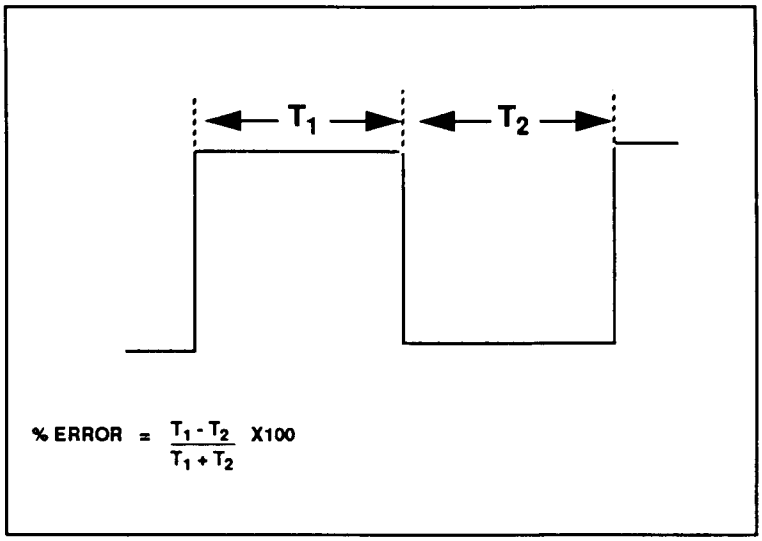

Figure 1. Symmetry waveform.

(8) Position controls as listed in (a) through (c) below:

(a) **FREQ/PERIOD MULTI (Hz/s)** switch to **1 K**.
(b) Frequency dial to **2.0**.
(c) **FREQ/PERIOD MULTI (Hz/s) VERNIER** control fully cw.

(9) Measure symmetry of square wave. If T_1 is not within ± 0.5 percent of T_2 (fig. 1), perform **b** (5) below.

b. Adjustments

(1) Adjust R12 (fig. 2) for minimum shift.

(2) Adjust R13 (fig. 2) for greater than 5 ms.

(3) Adjust R16 (fig. 2) for best symmetry ± 0.5 percent (R).

(4) Repeat **a** (6) and (7) above due to interaction.

(5) Adjust R35 (fig. 2) for best symmetry ± 0.5 percent (R).

10. Risetime

a. Performance Check

(1) Adjust **ATTENUATION VERNIER** control fully ccw and set **FREQ/PERIOD MULTI (Hz/s)** switch to **1 M**.

(2) Connect oscilloscope to **FUNCTION OUT,** using X10 attenuator.

(3) Adjust **ATTENUATION VERNIER** control fully cw.

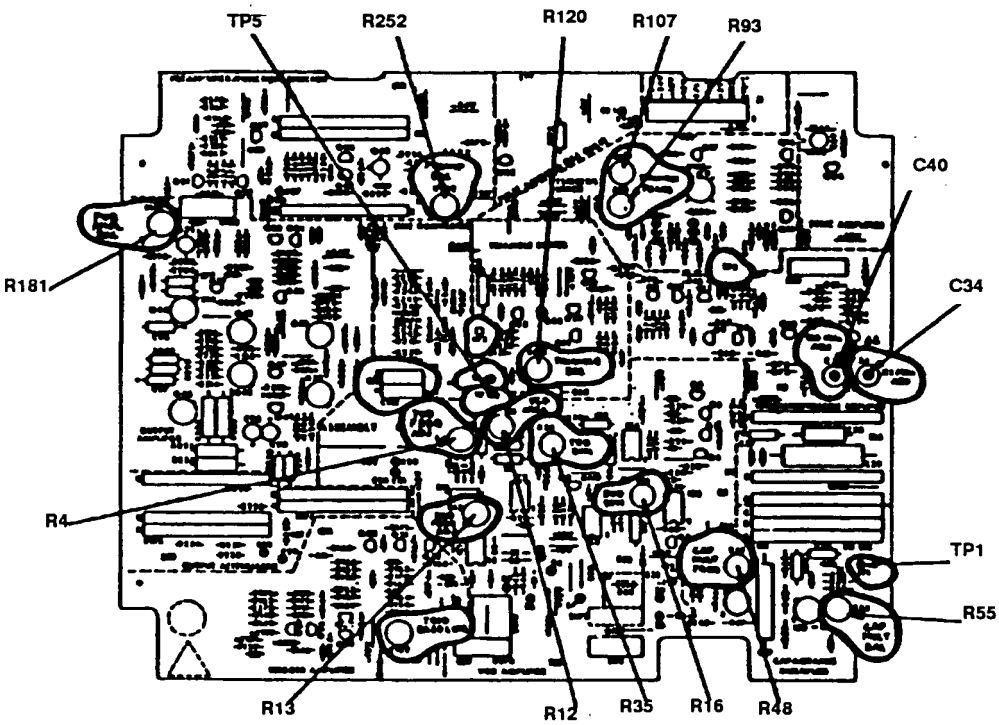

Figure 2. Test instrument - bottom view.

(4) Measure risetime and falltime. Risetime and falltime will be less than 20 ns.

b. Adjustments. No adjustments can be made.

11. Sine Distortion

a. Performance Check

(1) Connect audio analyzer to **FUNCTION OUT** using 50 Ω feedthrough termination.

(2) Position controls as listed in (a) through (c) below:

(a) **FUNCTION** switch to ~ (sine).
(b) **FREQ/PERIOD MULTI (Hz/s)** switch to **1 K** and **VERNIER** control to **CAL**.
(c) Frequency dial to **1.0**.

(3) Measure distortion at 1 kHz. If audio analyzer does not indicate less than 0.5 percent distortion, perform **b** (2) and (3) below.

(4) Set **FREQ/PERIOD MULTI (Hz/s)** switch to **100K**.

(5) Measure distortion at 100 kHz. If audio analyzer does not indicate less than 1 percent distortion, perform **b** below.

b. Adjustments

(1) Repeat **a** (2) above.

(2) Connect oscilloscope to audio analyzer output. Sync oscilloscope with **SYNC OUT** using 50 Ω feedthrough termination.

(3) Adjust R120 (fig. 2) for symmetrical wave form as indicated on oscilloscope.

(4) Slightly adjust R93 and R107 (fig. 2) for minimum distortion.

(5) If R93 or R107 (fig. 2) is adjusted near a stop, recenter both adjustments and repeat paragraph **9** above.

12. Frequency

a. Performance Check

(1) Adjust **ATTENUATION VERNIER** control to midrange and set **FUNCTION** switch to ~ (sine).

(2) Connect frequency counter to **FUNCTION OUT**.

(3) Position controls to values listed in table 4. If frequency counter does not indicate within limits specified, perform **b** below.

Table 4. Frequency

Test instrument		Frequency counter indications	
FREQ/PERIOD MULTI (Hz/s) switch settings	Frequency dial settings	Min	Max
.01	2.0	48.50 s	51.50 s
.1	2.0	4.850 s	5.150 s
1	2.0	0.485 s	0.515 s
10	2.0	48.50 ms	51.50 ms

Table 4. Frequency Continued

Test instrument		Frequency counter indications			
FREQ/PERIOD MULTI (Hz/s) switch settings	Frequency dial settings	Min		Max	
100	2.0	4.85	ms	5.15	ms
1K	2.0	1.94	KHz	2.06	KHz
10K	2.0	19.4	KHz	20.6	KHz
10K	1.4	13.4	KHz	14.6	KHz
10K	1.0	9.4	KHz	10.6	KHz
10K	.6	5.4	KHz	6.6	KHz
10K	.2	1.4	KHz	2.6	KHz
100K	2.0	194	KHz	206	KHz
1M	2.0	1.94	MHz	2.06	MHz
10M	2.0	19	MHz	21	MHz

b. Adjustments

NOTE

Perform adjustments in order and repeat as required for best intolerance condition.

(1) Set **FREQ/PERIOD MULTI (Hz/s)** switch to **1 K** and frequency dial to **2.0**.

(2) Adjust R4 (fig. 2) until frequency counter indicates between 1990 and 2010 Hz (R).

(3) Set **FREQ/PERIOD MULTI (Hz/s)** switch to **10**.

(4) Adjust R48 (fig. 2) until frequency counter indicates between 19.9 and 20.1 Hz (R).

(5) Set **FREQ/PERIOD MULTI (Hz/s)** switch to **10M**.

(6) Adjust C40 (fig. 2) for best intolerance condition while varying frequency dial over entire range (R).

(7) Set **FREQ/PERIOD MULTI (Hz/s)** switch to **1 M**.

(8) Adjust C34 (fig. 2) for best intolerance condition while varying frequency dial over entire range (R).

13. Frequency Response

a. Performance Check

(1) Position controls as listed in (a) through (c) below:

(a) **ATTENUATION** switch to **20/0** and **VERNIER** control fully ccw.
(b) **FREQ/PERIOD MULTI (Hz/s)** switch to **1 kHz**.
(c) Frequency dial to **2.0**.

CAUTION

Observe safety precautions to prevent damage to thermal converter.

(2) Connect thermal converter to **FUNCTION OUT**. Monitor output of thermal converter using multimeter.

(3) Adjust **ATTENUATION VERNIER** control for a 5 mV reference indication on multimeter.

(4) Set **FREQ/PERIOD MULTI (Hz/s)** switch and frequency dial to positions listed in table 5. Multimeter will indicate within limits specified.

b. Adjustments. No adjustments can be made.

Table 5. Frequency Response

Test instrument		Multimeter indications (mV)	
FREQ/PERIOD MULTI (Hz/s) switch settings	Frequency dial settings	Min	Max
1K	.2	4.94	5.06
1K	1.0	4.94	5.06
10K	2.0	4.94	5.06
100K	1.0	4.94	5.06
1M	1.0	4.72	5.30

14. Attenuator and Output

a. Performance Check

(1) Set **FREQ/PERIOD MULTI (Hz/s)** switch to **1 K** and frequency dial to **2.0**.

(2) Connect true rms voltmeter to **FUNCTION OUT** using 50 Ω feedthrough termination.

(3) Set **ATTENUATION** switch to **20/0** and **VERNIER** control fully cw. True rms voltmeter will indicate 5.3 V or more.

(4) Adjust **VERNIER** control for an indication of 5.30 V on true rms voltmeter.

(5) Set **ATTENUATION** switch to positions listed in table 6. True rms voltmeter will indicate within limits specified.

Table 6. Attenuation

Test instrument **ATTENUATION** switch settings	True rms voltmeter indications	
	Min	Max
20/40	0.512 V	0.549 V
40/60	49.4 mV	56.8 mV
60/80	4.8 mV	5.9 mV

b. Adjustments. No adjustments can be made.

15. Power Supply

NOTE

Do not perform power supply check if all other parameters are within tolerance.

a. Performance Check

NOTE

Some models do not contain all of the power supply test points or adjustments. Perform only those that are available or accessible (see paragraph **1 a** above).

(1) Connect multimeter to test points listed in table 7. If multimeter does not indicate within limits specified, perform corresponding adjustments and adjust for best in-tolerance condition.

Table 7. Power Supply

Test points (figs. 3 and 4)		Multimeter indications (Vdc)		Adjustments (figs. 3 and 4)
Common	Positive	Min	Max	
TP1	TP2	14.98	15.02	R27 (R)
	TP3	-14.95	-15.05	---
	TP4	23.00	25.00	---
	TP5	-23.00	-25.00	---
	TP6	4.80	5.20	---
	TP7	-5.19	-5.21	R18 (R)

(2) Connect multimeter between TP5 (common) and TP1 in figure 2. If multimeter does not indicate less than 5 mV dc, perform **b** (1) below.

(3) Connect multimeter to **FUNCTION OUT** using 50 Ω feedthrough termination. If multimeter does not indicate 0 ± 0.01 V dc, perform **b** (2) below.

(4) Repeat (3) above except set **ATTENUATION VERNIER** control fully cw. If multimeter does not indicate 0 ± 0.01 Vdc, perform **b** (3) below.

b. Adjustments

(1) Adjust R55 (fig. 2) for minimum indication less than 5 mV (R).

(2) Adjust R181 (fig. 2) for zero volt ± 0.01 V (R).

(3) Adjust R252 (fig. 2) for zero volt ± 0.01 V (R).

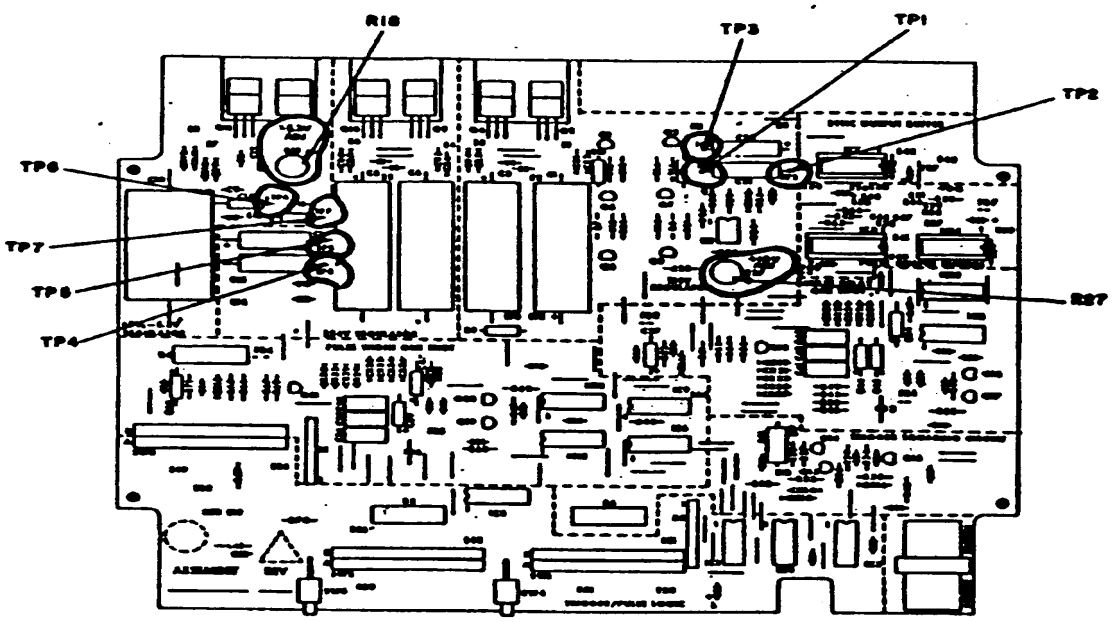

Figure 3. Test instrument - top view.

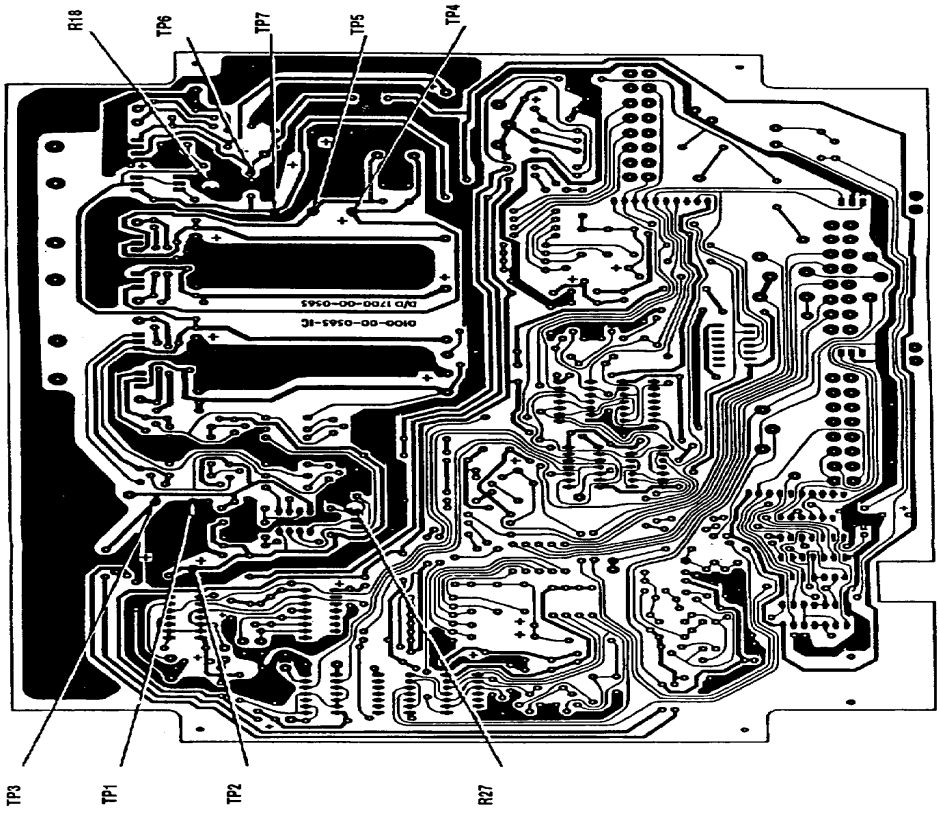

Figure 4. Trig/pulse board - bottom view.

16. Final Procedure

a. Deenergize and disconnect all equipment.

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

By Order of the Secretary of the Army:

Official:

PETER J. SCHOOMAKER
General, United States Army
Chief of Staff

JOEL B. HUDSON
Administrative Assistant to the
Secretary of the Army

0406101

Distribution:

To be distributed in accordance with initial distribution number (IDN) 342227 requirements for calibration procedure TB 9-6625-2088-35.

THESE ARE THE INSTRUCTIONS FOR SENDING 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@avma27.army.mil

To: 2028@redstone.army.milT

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**: TB 9-6625-xxxx-35
9. **Pub Title**: Calibration Procedure for …
10. **Publication Date**:
11. Change Number:
12. **Submitted Rank**: MSG
13. **Sumitter 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