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DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR PULSE GENERATOR HEWLETT-PACKARD MODEL 214B

Headquarters, Department of the Army, Washington, DC
11 January 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.

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*This bulletin supersedes TB 9-6625-1176-35, 6 May 1987, including all changes.

SECTION I
IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Pulse Generator, Hewlett-Packard, Model 214B. The manufacturer's manual was 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. 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. 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
Repetition rate	Range: Repetition rate 10 Hz to 10 MHz in six decade ranges. In 30 to 100 V amplitude range, maximum repetition rate is 4 MHz. Calibrated vernier provide continuous adjustment within ranges Accuracy: ±(10% of setting + 1% of FS)
Pulse width	Range: 25 ns to 10 ms in 6 decade ranges; continuously adjustable by vernier Accuracy: ±(10% of setting + 1% of FS + 5 ns)
Duty cycle	≥ 10% for 30 to 100 V amplitude range ≥ 50% for all other ranges (maximum 10 ms width)
Transition times	Accuracy: ≤ 15 ns for leading and trailing edges
Preshoot, overshoot, and ringing	Accuracy: ≤ +5% of pulse amplitude
Pulse polarity	Positive or negative, switch selectable
Pulse delay	Pulse can be delayed with respect to trigger output from +10 ns (+ fixed delay) to +10 ms in 5 decade ranges (fixed delay is 50 ± 10 ns) Accuracy: ±(10% of setting + 1% of FS) + fixed delay (fixed delay is 50 ± 10 ns)
Pulse advance	Pulse can be advanced with respect to trigger output from +10 ns (- fixed delay) to +10 ms in 5 decade ranges (fixed delay is 50 ± 10 ns) Accuracy: ±(10% of setting + 1% of FS) + fixed delay (fixed delay is 50 ± 10 ns)

Table 1. Calibration Description - Continued

Test instrument parameters	Performance specifications
Pulse amplitude	Range: 0.3 V to 100 V into 50 Ω, 5 ranges with calibrated vernier providing continuous adjustment within ranges. Accuracy: ± 10% of setting
Constant duty cycle	Duty cycle of output pulse remains constant when pulse period is changed. Typically 8% fixed for 10 - 1 MHz frequency range 2.5% to 10% for 1 to 0.1 MHz frequency range, 0.25% to 10% for 0.1 MHz - 10 Hz frequency range, and 0.1% to 10% for all other frequency ranges Accuracy: ±(15% of setting +1% of FS)
Trigger output amplitude Pulse width	≥+5 V (from 50 Ω into open circuit) 10 ns typical
Double pulse	5 MHz maximum in all ranges except 30 to 100 V range. In 30 to 100 V range, maximum frequency is 2 MHz. Minimum separation between double pulse is 100 ns.
External input: Trigger level Sensitivity	Range: Dc to 10 MHz Continuously variable from -5 V to +5 V Sensitivity: ≤ 500 mV p-p, dc coupled

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 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 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 four-to-one 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. Whenever 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)
FREQUENCY COUNTER	Range: 1 Hz to 10 MHz Accuracy: ± 1.25%	Fluke, Model PM6681/656 (PM6681/656)
FUNCTION/ARBITRARY GENERATOR	Range: 300 mV to 11 V p-p Sensitivity: ≤ 125 mV p-p	Agilent, Model 33250A (33250A)
MULTIMETER	Range: 5 to 300 V dc Accuracy: ± 0.02%	Agilent, Model 3458A (3458A)
OSCILLOSCOPE	Range: 10 Hz to 200 MHz Accuracy: ± 5%	(OS-303/G)

Table 3. Accessories Required

Common name	Description (part number)
ADAPTER (CALIBRATION FIXTURE)	Flexible T-type, 2 jacks, 1 plug (067-05250-01 or 067-0525-02)
ATTENUATOR	X10, Tektronix, Type 011-0059-02
PROBE (TEST LEAD)	36-in., BNC plug to X10 probe, Tektronix. Type P6106 (010-6106-01)
TERMINATION (DUMMY LOAD)	Narda, Model 374BNM (374BNM)

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 tables 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 **13** are not within tolerance, perform the power supply check prior to making adjustments. After adjustments are made, repeat paragraphs **8** through **13**. 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 check where applicable.

a. Remove TI protective covers as required for adjustment.

b. Connect TI to a 115 V 60 Hz ac source.

c. Energize equipment and allow sufficient time for equipment to warm-up and stabilize.

8. Pulse Repetition Rate

a. Performance Check

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

(a) **MODE NORM** pushbutton pressed.
(b) **PERIOD .1μ-1μ** pushbutton pressed.
(c) **PERIOD VERNIER** dial to **10**.
(d) **PULSE POSITION l0n-.1μ** pushbutton pressed.
(e) **PULSE POSITION VERNIER** dial to **1**.
(f) **DUTY CYCLE %** pushbutton released (out).
(g) **WIDTH .1μ-1μ** pushbutton pressed.
(h) **WIDTH VERNIER** dial fully ccw.
(i) **AMPLITUDE 3-10** pushbutton pressed.
(j) **AMPLITUDE VERNIER** dial to **3**.
(k) **INT LOAD** pushbutton released (out).
(l) **SLOPE** switch to **POS**.
(m) **DELAY/ADVANCE/DOUBLE PULSE** switch to **DELAY**.
(n) **POLARITY** switch to **POS**.

(2) Connect **TRIG OUTPUT** to frequency counter A input, using 50 Ω termination.

(3) Measure **REPETITION RATE**, using standard measurement technique. If frequency counter does not indicate between 890 and 1110 ns, perform **b** below.

(4) Repeat technique of (3) above for settings listed in table 4. If indications are not within specified tolerance, perform **b** below.

Table 4. Repetition Rate

Test Instrument		Frequency counter indications	
PERIOD pushbuttons	PERIOD VERNIER dial settings	Min	Max
1 μ - 10 μ	10	8.900 μs	11.100 μs
10 μ - 0.1 m	10	89 μs	111 μs
0.1 m – 1 m	10	890 μs	1.100 ms
1 m – 10 m	10	8.900 ms	11.1 ms
10 m - 0.1	10	89 ms	111 ms
10 m - 0.1	1	8.000 ms	12.000 ms
1 m – 10 m	1	800 μs	1.200 ms
0.1 m – 1 m	1	80 μs	120 μs
10 μ - 0.1 m	1	8.000 μs	12.000 μs
1 μ - 10 μ	1	800 ns	1.200 μs
0.1 μ - 1 μ	1	80 ns	120 ns
0.1 μ - 1 μ	2	170 ns	230 ns
0.1 μ - 1 μ	3	260 ns	340 ns
0.1 μ - 1 μ	4	350 ns	450 ns
0.1 μ - 1 μ	5	440 ns	560 ns
0.1 μ - 1 μ	6	530 ns	670 ns
0.1 μ - 1 μ	7	620 ns	780 ns
0.1 μ - 1 μ	8	710 ns	890 ns
0.1 μ - 1 μ	9	800 ns	1.000 μs

b. Adjustments

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

(a) **PERIOD .1μ-1μ** pushbutton pressed.
(b) **PERIOD VERNIER** dial fully ccw.
(c) **PULSE POSITION 10n-.1μ** pushbutton pressed.
(d) **PULSE POSITION VERNIER** dial to **1**.
(e) **DUTY CYCLE %** pushbutton pressed.
(f) **WIDTH 1μ-10μ** pushbutton pressed.
(g) **WIDTH VERNIER** dial to **1**.

(2) Adjust R126 (fig. 1) for 12.5 MHz indication on frequency counter (R).

(3) Set **PERIOD VERNIER** dial to **1** and then to **10.** If frequency counter does not indicate between 8.9 and 11.1 MHz for vernier setting of 1, and between 0.8 and 1.2 MHz at 10, readjust R126.

(4) Position controls as listed in (a) through (e) below:

(a) **PERIOD 1m-1m** pushbutton.
(b) **PERIOD VERNIER** dial to **10**.
(c) **PULSE POSITION 1μ-.10μ** pushbutton pressed.
(d) **PULSE POSITION VERNIER** dial to **1**.
(e) **DUTY CYCLE %** pushbutton released (out).

(5) Adjust R69 (fig. 2) for a frequency counter indication of 1000 μs (R).

(6) Set **PERIOD VERNIER** dial to **1**.

(7) Adjust R46 (fig. 1) for a frequency counter indication of 100 μs (R).

(8) Set **PERIOD VERNIER** dial to **10** and repeat (5) through (7) above for best in-tolerance condition.

9. Pulse Position

a. Performance Check

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

(a) **PERIOD VERNIER** dial to **10**.
(b) **DUTY CYCLE %** pushbutton pressed.
(c) **AMPLITUDE 1-3** pushbutton pressed.
(d) **PULSE POSITION VERNIER** dial to **10**.

(2) Connect **TRIG OUTPUT** to frequency counter A input, using 50 Ω termination. Connect **OUTPUT** to frequency counter B input.

NOTE

If an out-of-tolerance reading is obtained in (3) through (10) below, perform **b** below.

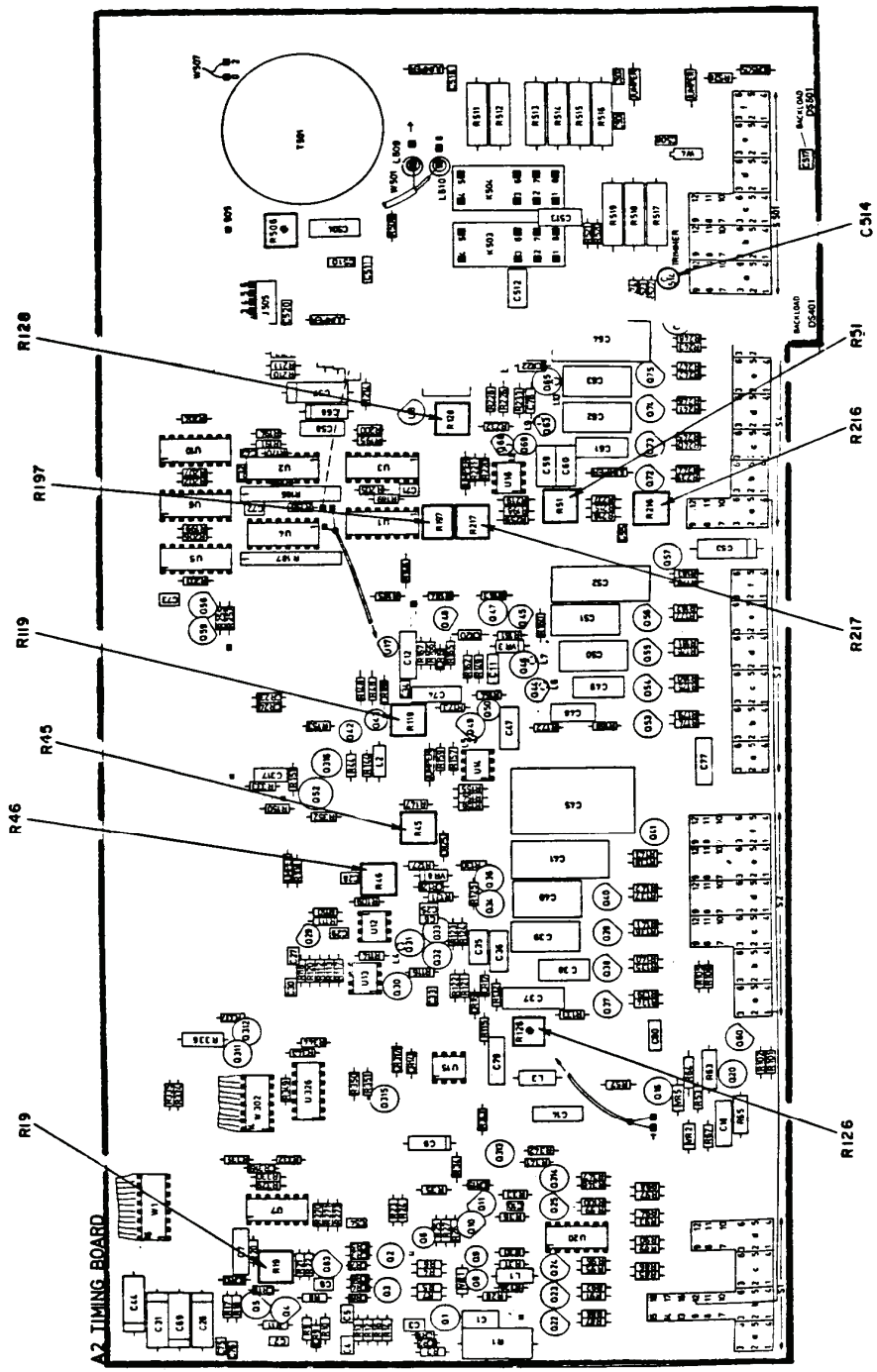

Figure 1. A2 (timing board) adjustment locations (top forward view).

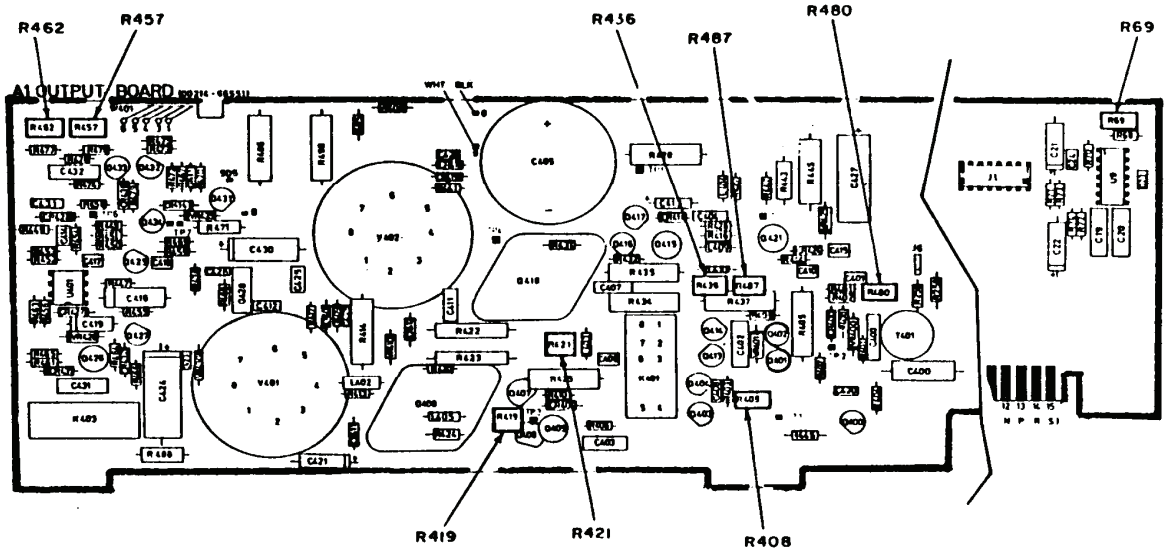

Figure 2. A1 (amplifier board) - adjustment locations.

(3) Measure time between **TRIG OUTPUT** and **OUTPUT** pulses, using standard measurement technique. Frequency counter will indicate between 129 and 171 ns.

(4) Set **PULSE POSITION VERNIER** dial to **1**. Frequency counter will indicate between 48 and 72 ns.

(5) Disconnect **OUTPUT** from frequency counter and set **DELAY/ ADVANCE/DOUBLE PULSE** switch to **ADVANCE.** Connect **TRIG OUTPUT** to oscilloscope CH 1 input. Connect **OUTPUT** to oscilloscope CH 2 input.

(6) Measure time between **TRIG OUTPUT** and **OUTPUT** pulses, using standard measurement technique. The results will be between 28 and 52 ns.

(7) Set **PULSE POSITION VERNIER** dial to **10** and connect TI **OUTPUT** to oscilloscope CH 2 and CH 3 inputs, using adapter (calibration fixture).

(8) Set oscilloscope trigger source to CH 3 and measure the time between **OUTPUT** and **TRIG OUTPUT** pulses. Results will be between 29 and 71 ns.

(9) Disconnect cables from oscilloscope inputs and repeat (2) above.

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

(a) **PERIOD l0m-.1** pushbutton pressed.
(b) **PERIOD VERNIER** dial to **1**.
(c) **PULSE POSITION .lμ-lμ** pushbutton pressed.
(d) **DELAY/ADVANCE/DOUBLE PULSE** switch to **DELAY**.

(11) Repeat technique of (3) above for settings listed in table 5. Indications will be within specified limits.

Table 5. Time Measurement for Delay Accuracy

Test instrument		Frequency counter indications	
PULSE POSITION pushbuttons	**VERNIER** dial settings	Min	Max
0.1 μ-1 μ	10	930 ns	1.170 μs
1 μ-10 μ	10	8.94 μs	11.16 μs
10 μ-0.1m	10	89.04 μs	111.06 μs
0.1 m-1 m	10	890 μs	1.110 ms
1 m-10 m	10	8.900 ms	11.100 ms
0.1 μ-1 μ	1	120 ns	180 ns
1 μ - 10 μ	1	840 ns	1.26 μs
10 μ - 0.1 m	1	8.04 μs	12.06 μs
0.1 m – 1 m	1	80 μs	120 μs
1 m – 10 m	1	800 μs	1.200 ms
1 m – 10 m	2	1.700 ms	2.300 ms
1 m – 10 m	3	2.600 ms	3.400 ms
1 m - 10 m	4	3.500 ms	4.500 ms
1 m – 10 m	5	4.400 ms	5.600 ms
1 m – 10 m	6	5.300 ms	6.700 ms
1 m – 10 m	7	6.200 ms	7.800 ms
1 m – 10 m	8	7.100 ms	8.900 ms
1 m – 10 m	9	8.000 ms	10.000 ms

b. Adjustments

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

(a) **PERIOD 1m-10m** pushbutton pressed.
(b) **PERIOD VERNIER** dial to **10**.
(c) **PULSE POSITION .1m-1m** pushbutton pressed.
(d) **PULSE POSITION VERNIER** dial to **10**.
(e) **DUTY CYCLE %** pushbutton released (out).
(f) **WIDTH 1μ-10μ** pushbutton pressed.
(g) **WIDTH VERNIER** dial to **10**.
(h) **AMPLITUDE 3-10** pushbutton pressed.
(i) **DELAY/ADVANCE/DOUBLE PULSE** switch to **DELAY**.

(2) Connect **TRIG OUTPUT** to frequency counter input, using 50 Ω termination. Connect **OUTPUT** to frequency counter **B** input.

(3) Adjust R45 (fig. 1) for a frequency counter indication between 990 and 1010 μs (R).

(4) Set **PULSE POSITION VERNIER** dial to **1.** Adjust R119 (fig. 1) for a frequency counter indication between 90 and 110 μs (R).

(5) Set **PULSE POSITION VERNIER** dial to **10** and repeat (3) and (4) above for best in-tolerance condition.

10. Pulse Width and Duty Cycle

a. Performance Check

(1) Connect equipment as shown in figure 3.

(2) Position controls as listed in (a) through (j) below.

(a) **PERIOD 1μ-10μ** pushbutton pressed.
(b) **PERIOD VERNIER** dial to **10**.
(c) **PULSE POSITION 10n-.1μ** pushbutton pressed.
(d) **PULSE POSITION VERNIER** dial to **10**.
(e) **DUTY CYCLE %** pushbutton released (out).
(f) **WIDTH 25n-.1μ** pushbutton pressed.
(g) **WIDTH VERNIER** dial to **2.5**.
(h) **AMPLITUDE 10-30** pushbutton pressed.
(i) **AMPLITUDE VERNIER** dial to **3 (30V).**
(j) **INT LOAD** pushbutton pressed.

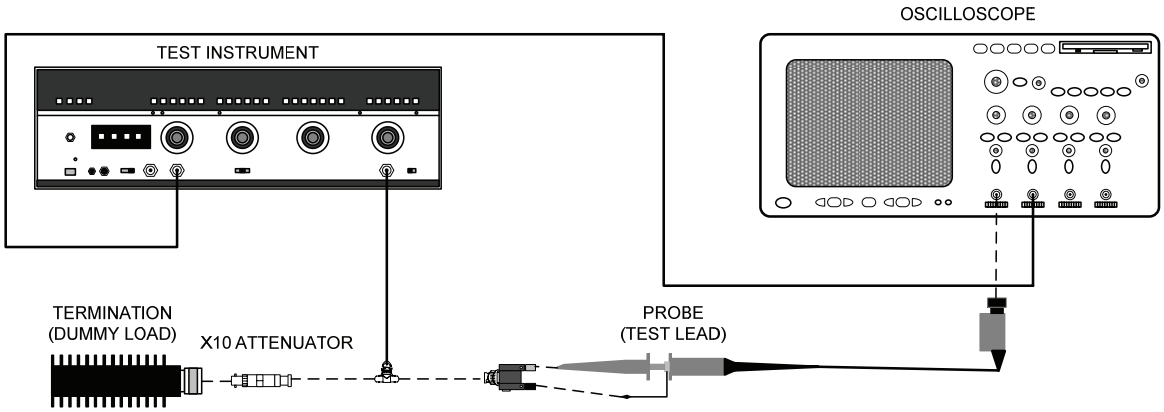

Figure 3. Equipment setup - pulse width and duty cycle.

NOTE

If an out-of-tolerance condition is noted in (3) through (27) below, perform **b** below.

(3) Adjust controls of oscilloscope to display 1 pulse of TI output. Pulse width will be between 21.5 and 33.5 ns.

(4) Set **WIDTH VERNIER** dial to **10**. Pulse width will be between 89 and 116 ns.

(5) Press **WIDTH .1μ-1μ** pushbutton. Pulse width will be between 0.890 and 1.115 μs.

(6) Set **WIDTH VERNIER** dial to **1**. Pulse width will be between 80 and 125 ns.

(7) Press **PERIOD .1μ-1μ** pushbutton and set **PERIOD VERNIER** dial to **3**. Adjust oscilloscope controls to display 1 period of TI output.

(8) Slowly increase **WIDTH VERNIER** dial until oscilloscope display disappears. Oscilloscope display will disappear at a duty cycle of 50 percent or greater (pulse width of 150 ns or greater).

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

(a) **WIDTH 25n-.1μ** pushbutton pressed.
(b) **AMPLITUDE 30-100** pushbutton pressed.
(c) **AMPLITUDE VERNIER** dial to **10 (50V)**.

(10) Repeat technique of (8) above. Oscilloscope display will disappear at a duty cycle of 10 percent or greater (pulse width of 30 ns or greater).

(11) Position controls as listed in (a) through (e) below:

(a) **PERIOD 10m-. 1** pushbutton pressed.
(b) **AMPLITUDE 1-3** pushbutton pressed.
(c) **AMPLITUDE VERNIER** dial to **3**.
(d) **WIDTH 1μ-10μ** pushbutton pressed.
(e) **WIDTH VERNIER** dial to **1**.

(12) Disconnect TI from oscilloscope and connect **OUTPUT** to frequency counter A and B inputs, using adapter (calibration fixture).

(13) Measure pulse width, using standard measurement technique. Frequency counter will indicate between 0.8 and 1.205 μs.

(14) Repeat technique of (13) above, using settings listed in table 6. Indications will be within specified limits.

(15) Disconnect **OUTPUT** from frequency counter and connect to oscilloscope CH 1 input, using X10 attenuator.

(16) Connect **TRIG OUTPUT** to frequency counter A input and oscilloscope CH 2, using adapter (calibration fixture) and 50 Ω termination.

(17) Position controls as listed in (a) through (e) below:

(a) **PERIOD .1μ-1μ** pushbutton pressed.
(b) **PERIOD VERNIER** dial to **10**.
(c) **PULSE POSITION VERNIER** dial to **1**.
(d) **DUTY CYCLE %** pushbutton pressed.
(e) **INT LOAD** pushbutton released (out).

(18) Set **PERIOD VERNIER** for exactly 1000 ns frequency counter indication. Oscilloscope will display a pulse width of approximately 80 ns (8 percent duty cycle).

(19) Press **PERIOD 1μ-10μ** pushbutton and set **PERIOD VERNIER** for a 10,000 ns frequency counter indication (2.5-10 percent duty cycle **LED** is illuminated).

Table 6. Pulse Width

Test instrument		Frequency counter indications (μS)	
WIDTH pushbuttons	**VERNIER** dial settings	Min	Max
10 μ - 0.1 m	1	8.00	12.00
0.1 m – 1 m	1	80	120
1 m – 10 m	1	800	1200
1 μ - 10 μ	10	8.90	11.10
10 μ - 0.1 m	10	89.0	111.0
0.1 m – 1 m	10	890	1110
1 m – 10 m	10	8900	11100
1 m – 10 m	9	8000	10000
1 m – 10 m	8	7100	8900

Table 6. Pulse Width – Continued

Test instrument		Frequency counter indications (μS)	
WIDTH pushbuttons	**VERNIER** dial settings	Min	Max
1m - 10m	7	6200	7800
1m - 10m	6	5300	6700
1m - 10m	5	4400	5600
1m - 10m	4	3500	4500
1m - 10m	3	2600	3400
1m - 10m	2	1700	2300

(20) Set **WIDTH** (duty cycle) **VERNIER** dial to **2.5**. Oscilloscope will display a pulse width between 202 and 297 ns.

(21) Set **WIDTH** (duty cycle) **VERNIER** dial to **10**. Oscilloscope will display a pulse width between 840 and 1160 ns.

(22) Position controls as listed in (a) through (e) below:

(a) **PERIOD 10m-.1** pushbutton pressed.
(b) **PERIOD VERNIER** dial to **10**.
(c) **PULSE POSITION VERNIER** dial to **10**.
(d) **DUTY CYCLE .1-1** pushbutton pressed.
(e) **WIDTH** (duty cycle) **VERNIER** dial to **1**.

(23) Disconnect TI from oscilloscope and frequency counter and connect TI **OUTPUT** to frequency counter A and B inputs, using adapter (calibration fixture) and 50 Ω termination.

(24) Using standard measurement technique measure pulse width. Frequency counter will indicate between 75 and 125 μs (0.1 percent duty cycle).

(25) Set **WIDTH** (duty cycle) **VERNIER** dial to **10**. Frequency counter will indicate between 840 and 1160 μs (1 percent duty cycle).

(26) Press **DUTY CYCLE 1-10** pushbutton and set **WIDTH** (duty cycle) **VERNIER** dial as listed in table 7. Frequency counter will indicate within specified limits.

(27) Set **PERIOD VERNIER** dial to **1**. Frequency counter will indicate between 75 and 125 μs.

b. Adjustments

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

(a) **PERIOD 1m-10m** pushbutton pressed.
(b) **PERIOD VERNIER** dial to **10**.
(c) **PULSE POSITION .1μ-1μ** pushbutton pressed.
(d) **PULSE POSITION VERNIER** dial to **1**.
(e) **DUTY CYCLE %** pushbutton pressed.
(f) **DUTY CYCLE 1-10** pushbutton pressed.

(g) **WIDTH** (duty cycle) **VERNIER** dial to **10**.

(2) Connect **OUTPUT** to frequency counter A and B inputs, using adapter (calibration fixture).

(3) Set frequency counter to measure period and set **PERIOD VERNIER** for a 10,000 μs frequency counter indication.

(4) Set frequency counter to measure pulse width and adjust R51 (fig. 1) for a 1000 μs frequency counter indication (10 percent duty cycle) (R).

(5) Repeat technique of **b** (3) above and set **PERIOD VERNIER** for a 1000 μs frequency counter indication.

(6) Repeat technique of **b** (4) above and adjust R217 (fig. 1) for a 100 μs frequency counter indication (1 percent duty cycle) (R).

NOTE

Due to interaction between adjustments, repeat **b** (3) through (6) above if necessary.

(7) Release **DUTY CYCLE %** pushbutton.

(8) Press **WIDTH .1m-1m** pushbutton and set **WIDTH VERNIER** dial to **10**. Adjust R216 (fig. 1) for a 1000 μs pulse width indication on frequency counter (R).

(9) Set **WIDTH VERNIER** dial to 1 and adjust R128 (fig. 1) for a 100 μs frequency counter indication (R).

(10) Press **PERIOD .1μ-1μ** and **DUTY CYCLE %** pushbuttons. Adjust R197 (fig. 1) for a 80 ns frequency counter indication (R).

Table 7. Duty Cycle Vernier Accuracy Check

Test instrument	Frequency counter indications (ms)	
WIDTH (duty cycle) **VERNIER** dial settings	Min	Max
10	8.4	11.6
9	7.55	10.45
8	6.70	9.30
7	5.85	8.15
6	5.00	7.00
5	4.15	5.85
4	3.30	4.70
3	2.45	3.55
2	1.60	2.40
1	.75	1.25

11. Pulse Amplitude and Characteristics

a. Performance Check

(1) Position controls as listed in (a) through (g) below

(a) **PERIOD 10μ-.1m** pushbutton pressed.

(b) **PULSE POSITION .1μ-1μ** pushbutton pressed.
(c) **DUTY CYCLE %** pushbutton released (out).
(d) **WIDTH 25n-.1μ** pushbutton pressed.
(e) **WIDTH VERNIER** dial to **10**.
(f) **AMPLITUDE 30-100** pushbutton pressed.
(g) **AMPLITUDE VERNIER** dial to **3 (30V).**

(2) Connect equipment as shown in figure 3.

NOTE

If an out-of-tolerance condition is noted in (3) or (4) below, perform **b** (1) through (7) below.

(3) Oscilloscope will display a pulse with an amplitude between 27 and 33 V. Press **INT LOAD** pushbutton. Pulse amplitude will be between 13.5 and 16.5 V.

(4) Repeat technique of (3) above for settings listed in table 8. Oscilloscope will indicate within specified limits.

(5) Press **AMPLITUDE 10-30** pushbutton and set **AMPLITUDE VERNIER** dial to **1 (10V)**.

(6) Using standard measurement technique, measure the rise time and decay time of the **OUTPUT** pulse. If the rise time and decay time are not less than 15 ns, perform **b** (8) through (21) below.

(7) Set **POLARITY** switch to **NEG** and repeat (6) above.

(8) Measure preshoot, overshoot, and ringing of positive and negative **OUTPUT** pulse. If measurement is not lest than 5 percent as shown in figure 4, perform **b** (8) through (21) below.

b. Adjustments

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

(a) **PERIOD l0m-.1** pushbutton pressed.
(b) **PERIOD VERNIER** dial to **10**.
(c) **PULSE POSITION l0n-.1μ** pushbutton pressed.
(d) **PULSE POSITION VERNIER** dial to **1**.
(e) **DUTY CYCLE %** pushbutton pressed.
(f) **DUTY CYCLE 1-10** pushbutton pressed.
(g) **WIDTH VERNIER** dial to **5**.
(h) **AMPLITUDE 30-100** pushbutton pressed.
(i) **AMPLITUDE VERNIER** dial to **3 (30V).**
(j) **INT LOAD** pushbutton released (out).

Table 8. Pulse Amplitude Accuracy Check

Test instrument		Oscilloscope indications			
AMPLITUDE range pushbuttons	**VERNIER** dial settings	**INT LOAD OFF** (V)		**INT LOAD ON** (V)	
		Min		Max	
30-100	10	90	110	45	55
10-30	3	27	33	13.5	16.5
10-30	1	9	11	4.5	5.5
0.3-1	3	0.27	0.33	- - -	- - -
0.3-1	10	0.9	1.1	- - -	- - -
1-3	3	2.7	3.3	- - -	- - -
1-3	1	.9	1.1	- - -	- - -
3-10	3	2.7	3.3	- - -	- - -
3-10	4	3.6	4.4	- - -	- - -
3-10	5	4.5	5.5	- - -	- - -
3-10	6	5.4	6.6	- - -	- - -
3-10	7	6.3	7.7	- - -	- - -
3-10	8	7.2	8.8	- - -	- - -
3-10	9	8.1	9.9	- - -	- - -
3-10	10	9	11	- - -	- - -

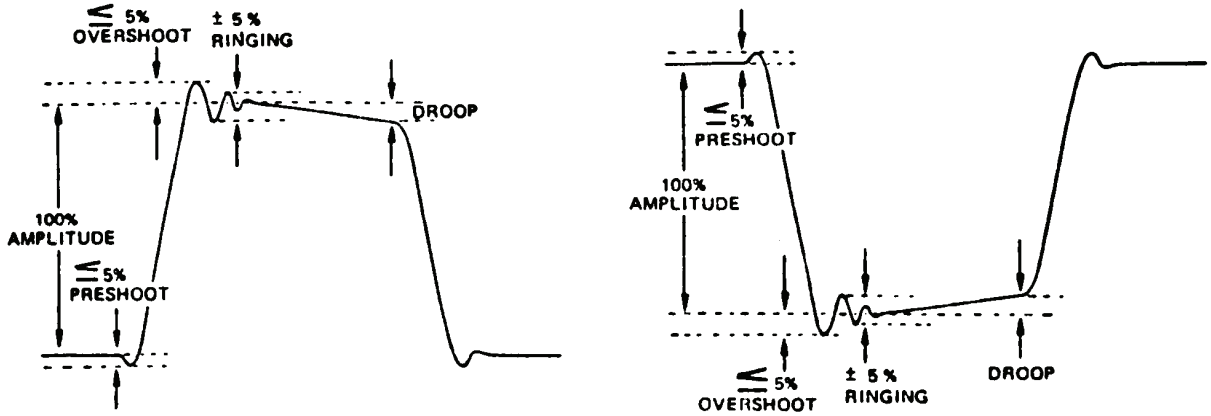

Figure 4. Preshoot, overshoot, and ringing characteristics.

(2) Set R462 (fig. 2) fully cw and adjust R457 (fig. 2) for a 29 V pulse amplitude display on oscilloscope (R).

(3) Set **AMPLITUDE VERNIER** dial to **10** and adjust R462 (fig. 2) for a 105 V pulse amplitude display on oscilloscope (R).

(4) Repeat (2) and (3) above for best in tolerance condition.

(5) Press **AMPLITUDE 10 - 30** pushbutton and set **AMPLITUDE VERNIER** dial to **1**. Oscilloscope will display a pulse amplitude between 9 and 11 V.

(6) Set **AMPLITUDE VERNIER** dial fully ccw. If oscilloscope does not display a pulse amplitude of less than 10 V, readjust R457 (fig. 2).

(7) Press **AMPLITUDE 3 -10** pushbutton and set **AMPLITUDE VERNIER** dial fully cw. If oscilloscope does not display a pulse amplitude greater than 10 V, readjust R462 (fig. 2).

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

(a) **PERIOD lμ-10μ** pushbutton pressed.
(b) **PERIOD VERNIER** dial to **10**.
(c) **PULSE POSITION l0n-.1μ** pushbutton pressed.
(d) **PULSE POSITION VERNIER** dial to **1**.
(e) **WIDTH VERNIER** dial to **2.5**.
(f) **AMPLITUDE 10-30** pushbutton pressed.
(1) **DUTY CYCLE** pushbutton pressed.
(2) **WIDTH 25N-.lμ** pushbutton pressed.
(g) **AMPLITUDE VERNIER** dial to **3 (30V).**
(h) **POLARITY** switch to **POS**.
(i) **DUTY CYCLE** pushbutton released (out).
(j) **WIDTH 25n-.1μ** pushbutton pressed.

(9) Adjust R480 (fig. 2) for a 25 ns pulse width indication on oscilloscope (R).

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

(a) **WIDTH .lμ-lμ** pushbutton pressed.
(b) **WIDTH VERNIER** dial to **2**.
(c) **INT LOAD** pushbutton pressed.
(d) **AMPLITUDE 30 - 100** pushbutton pressed.
(e) **AMPLITUDE VERNIER** dial to **10 (50V)**.

(11) Adjust R436 and R408 (fig. 2) for fastest risetime display indication on oscilloscope (R).

(12) Adjust R419 (fig. 2) for minimum overshoot on oscilloscope display (R).

(13) Observe oscilloscope risetime, overshoot, and ringing. If risetime is not less than 15 ns, and overshoot and ringing less than 5 percent, readjust R419, R436, and R408 (fig. 2).

(14) Press **AMPLITUDE 10 - 30** pushbutton and set **AMPLITUDE VERNIER** dial to **3**.

(15) Adjust C501 (fig. 5) for an overshoot equal to pulse ringing (R).

(16) Adjust R487 and R421 (fig. 2) for flat pulse top, and adjust C504 (fig. 5) for optimum overshoot and ringing (R).

(17) Observe oscilloscope risetime, overshoot, and ringing. If risetime is not less than 15 ns, and overshoot and ringing less than 5 percent, readjust C501, C504 (fig. 5), R421, and R487 (fig. 2) for optimum pulse.

(18) Release **INT LOAD** pushbutton and repeat technique of (17) above.

(19) Press **AMPLITUDE 30-100** pushbutton and set **AMPLITUDE VERNIER** dial to **10 (100V)**. Repeat technique of (17) above.

(20) Press **INT** LOAD pushbutton and repeat technique of (17) above.

(21) Press **AMPLITUDE .3-1** pushbutton and adjust C514 (fig. 1) for minimum ringing (R).

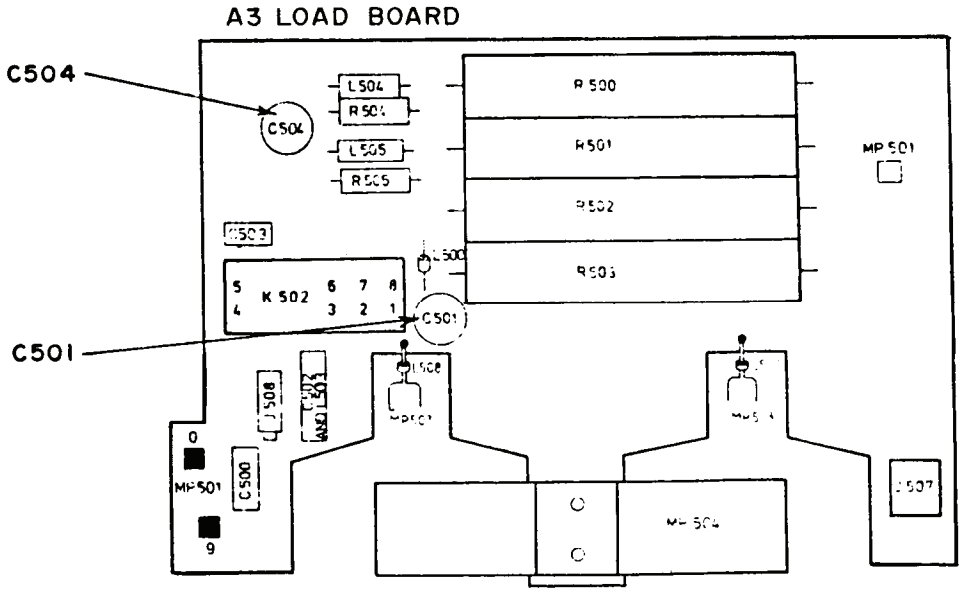

Figure 5. A3 (load board) - adjustment locations.

12. Trigger Output and Double Pulse

a. Performance Check

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

(a) **PERIOD .1μ-1μ** pushbutton pressed.
(b) **PERIOD VERNIER** dial to **2**.
(c) **PULSE POSITION 10n-.1μ** pushbutton pressed.
(d) **PULSE POSITION VERNIER** dial to **1**.
(e) **AMPLITUDE 3-10** pushbutton pressed.
(f) **AMPLITUDE VERNIER** dial to **3**.
(g) **INT LOAD** pushbutton released (out).

(2) Connect **TRIG OUTPUT** to oscilloscope CH 1 input, using 50 Ω termination. Oscilloscope will display a pulse amplitude greater than 2.5 V and a pulse width of 10 ns.

(3) Connect equipment shown in figure 3.

(4) Position controls as listed in (a) through (h) below:

(a) **PERIOD VERNIER** dial to **5**.
(b) **PULSE POSITION .1μ-1μ** pushbutton pressed.
(c) **PULSE POSITION VERNIER** dial to **2**.
(d) **WIDTH 25n-.1μ** pushbutton pressed.
(e) **WIDTH VERNIER** dial to **2**.
(f) **AMPLITUDE 30-100** pushbutton pressed.
(g) **AMPLITUDE VERNIER** dial to **5**.

(h) **DELAY/ADVANCE/DOUBLE PULSE** switch to **DOUBLE PULSE**.

(5) Adjust **PULSE POSITION VERNIER** dial slowly ccw. Oscilloscope will still display both pulses when minimum separation of 100 ns is reached.

(6) Set **PERIOD VERNIER** dial to **2** and press **AMPLITUDE 3-10** pushbutton. Oscilloscope will display corresponding double pulse.

b. Adjustments. No adjustments can be made.

13. External Trigger Level and Sensitivity

a. Performance Check

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

(a) **MODE EXT TRIG** pushbutton pressed.
(b) **PULSE POSITION 10n-.1μ** pushbutton pressed.
(c) **PULSE POSITION VERNIER** dial to **1**.
(d) **WIDTH .1μ-1μ** pushbutton pressed.
(e) **WIDTH VERNIER** dial to **10**.
(f) **DELAY/ADVANCE/DOUBLE PULSE** switch to **DELAY**.

(2) Connect equipment as shown in figure 6.

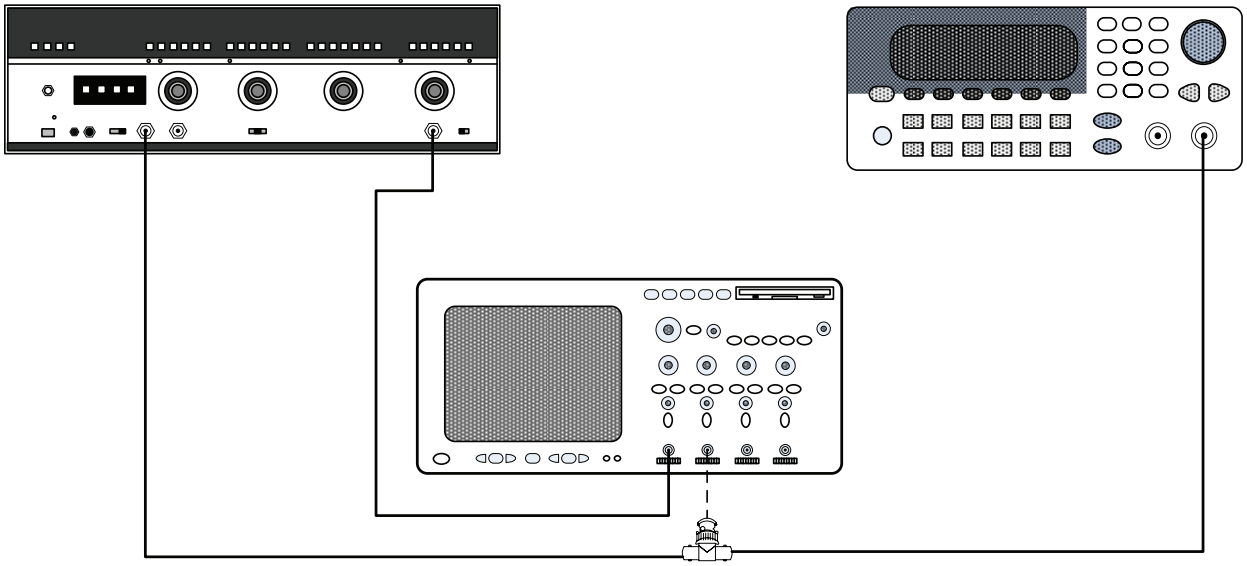

Figure 6. Variable trigger - equipment setup.

(3) Adjust function/arbitrary generator controls for an output of 100 kHz at 11 V p-p.

(4) Vary **EXT INPUT LEVEL** control from fully ccw to fully cw and observe that oscilloscope CH 1 displays an OUTPUT pulse as the level control is varied within +5V and -5V limits.

(5) Set **SLOPE** switch to **NEG** and repeat (4) above.

b. Adjustments

NOTE

It might be necessary to set the **LEVEL** vernier slightly off center position to get trigger on **NEG** and **POS SLOPE**. The arrow of knob should stay within ±1 mm of center position.

(1) Adjust function/arbitrary generator to 100 kHz and 300 mV p-p display indication on oscilloscope.

(2) Set **EXT INPUT LEVEL** control to midrange.

(3) Adjust R19 (fig. 1) until output pulses appear on the oscilloscope.

(4) Repeat technique of (3) above with **SLOPE** switch set to **NEG**.

14. Power Supply

a. Performance Check

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

(a) **AMPLITUDE 3-10** pushbutton pressed.
(b) **POLARITY** switch to **NEG**.
(c) **MODE EXT TRIG** pushbutton pressed.
(d) **DUTY CYCLE %** pushbutton released (out).
(e) **DELAY/ADVANCE DOUBLE PULSE** switch to **DELAY**.

(2) Connect negative input of multimeter to TP7 (fig. 7) and positive input to TP1 (fig. 7). Multimeter will indicate approximately 155 V. Record multimeter indication.

(3) Move positive lead to TP5 (fig. 7). Multimeter will indicate approximately 133 V dc. If the difference between indication recorded in (2) above and this indication is not between 21.780 and 22.220 V dc, perform **b** below.

(4) Press **AMPLITUDE 30-100** pushbutton. Multimeter will indicate approximately 263 V dc at TP1 and approximately 241 V dc at TP5.

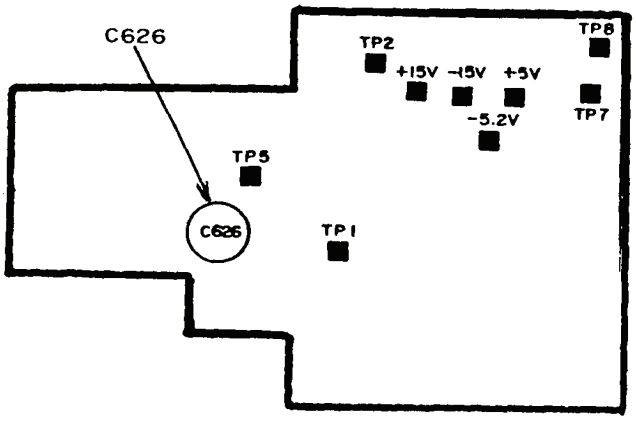

Figure 7. A4 power supply board - top left center.

(5) Repeat technique of (2) above for settings and indications listed in table 9.

b. Adjustments. Adjust A4 R604 so that the voltage difference between TP1 and TP5 (fig. 7) is 22V ± 220 mV (R).

Table 9. Power Supply Check

Test instrument		Multimeter indications (V)	
Voltage	Test point	Min	Max
-5.2	Marked on PC board	4.94	5.46
+15	Marked on PC board	14.25	15.75
-15	Marked on PC board	14.25	15.75
+5	Marked on PC board	4.75	5.25

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.

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

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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.

PIN: 084514-000