

FACTORY CALIBRATION PROCEDURE

CONTENTS:

This is the guide for calibrating new instruments in Product Manufacturing. The procedure consists of 4 sections:

Equipment Required

Factory Test Limits - Factory Test Limits are limits an instrument must meet before leaving Manufacturing. These limits are often more stringent than advertised performance requirements. This is to insure that the instrument will meet advertised requirements after shipment, allows for individual differences in test equipment used, and (or) allows for changes in environmental conditions.

Short Form Procedure - The Short Form Procedure has the same sequence of steps and the same limits on checks or adjustments as the Main Procedure.

Main Procedure - The Main Procedure gives more detailed instructions for the calibration of the instrument. This procedure may require that some checks and adjustments be made so that performance is better than that required by the Factory Test Limits. This insures the Factory Test Limits will be met when side panels are added, permits some normal variation in test equipment and plug-in scopes, etc.

Abbreviations in this procedure will be found listed in TEKTRONIX STANDARD A-100. Definitions of terms used in this procedure may be found in TEKTRONIX STANDARD A-101.

In this procedure, all front panel control labels and Tektronix instrument names are in capital letters (VOLT/DIV, etc). Internal adjustment labels are capitalized only (Gain Adj, etc).

CHANGE INFORMATION:

This procedure has been prepared by Product Manufacturing Staff Engineering. For information on changes made to this procedure, to make suggestions for changing this procedure, or to order additional copies: please contact PMSE, 39-307.

*This procedure is
company confidential*

R116

Tek form number:
0-454
January 1968
For all serial
numbers.



EQUIPMENT REQUIRED:

The following equipment is necessary to complete this procedure:

a. *TEKTRONIX Instruments*

- 1 TYPE 547 OSCILLOSCOPE
- 1 TYPE 1A1 DUAL-TRACE PLUG-IN UNIT
- *1 TYPE W PLUG-IN UNIT
- 1 TYPE 561A OSCILLOSCOPE
- 1 TYPE 3S1 DUAL-TRACE SAMPLING UNIT
- 1 TYPE 3T2 RANDOM SAMPLING SWEEP
- 1 TYPE 114 PULSE GENERATOR
- *1 TYPE 184 TIME-MARK GENERATOR
- *1 TYPE 191 CONSTANT AMPLITUDE SIGNAL GENERATOR
- 2 TYPE P6028 PROBES
- 1 TYPE 76TU LINE VOLTAGE CONTROL UNIT

b. *Test Fixtures and Accessories*

- 1 DC Voltage Bridge (DCVB) (067-0543-99)
- *1 STANDARD AMPLITUDE CALIBRATOR (SAC) (067-0502-00)
- 1 BNC T, Male to 2 Female (103-0030-00)
- 1 50 Ω End-line termination, GR connector (017-0081-00)
- 2 50 Ω BNC Terminations (011-0049-00)
- 1 GR 50 Ω X10 Attenuator (017-0078-00)
- 2 BNC to GR Adapters (017-0064-00)
- 1 5ns Cable (017-0502-00)
- 2 50 Ω BNC cable (012-0057-00)
- 1 R116 Remote Program Test Fixture (PMPE Dwg #1647-C)
- 1 AC Trigger Adapter (PMPE Dwg #1803-B)
- 1 1k Ω Termination (PMPE Dwg #1804-B)

c. *Other equipment*

- 1 20,000 Ω /VDC Multimeter (Triplet Model 630-NA, or equivalent).

*This equipment must be traceable to NBS for instrument certification.

Substitute test equipment may be used. The Plant Staff Engineer must approve any substitutions. All equipment listed must perform within its manufacturer's specifications, unless otherwise stated.

It is assumed that all equipment is provided with BNC connectors; if equipment used has other than BNC connectors, adapters, not listed, may be needed.

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FACTORY TEST LIMITS

QUALIFICATION

Factory Test Limits are qualified by the conditions specified in the main body of the Factory Calibration Procedure. The numbers and letters to the left of the limits correspond to the procedure steps where the check or adjustment is made. Steps without Factory Test Limits (set-ups, presets, etc.) are not listed. Instruments may not meet Factory Test Limits if calibration or checkout methods and test equipment differ substantially from those in this procedure.

6. POWER SUPPLIES

- c. Power supply voltages:
 - +25V $\pm 0.25V$, max
 - 27V $\pm 0.6V$, max
 - 6V $\pm 0.5V$, max
 - +7V $\pm 1V$, max
 - 13.5V $\pm 2V$, max
 - +24.4V $\pm 0.63V$, max
 - +9.5V $\pm 0.7V$, max

9. AMPLITUDE

- b. Amplitude Range Cal
Error $\pm 2\%$ of dial reading, max
- c. Amplitude Mult
Error $\pm 2\%$ of dial reading, max

10. BASELINE CLAMP

- b. Baseline Clamp
1.6V shift $\pm 3\%$, max

12. PROGRAM CLAMP

- b. Program Clamp
DC Level: 0V $\pm 0.8V$, max

13. DC OFFSET ACCURACY

- b. DC offset accuracy
Pulse baseline at graticule center $\pm 1.75\text{cm} \pm (5\% + 100\text{mV})$

14. AMPLITUDE

- b. + amplitude accuracy
 - 1V $\pm 2\% \pm 50\text{mV}$, max
 - .5V $\pm 2\% \pm 25\text{mV}$, max
 - .2V $\pm 2\% \pm 15\text{mV}$, max
- c. - amplitude accuracy
Same as + amplitude accuracy
- d. + and - amplitude accuracy
in REMOTE
 - 1V $\pm 4\% \pm 50\text{mV}$, max
 - .5V $\pm 4\% \pm 25\text{mV}$, max
 - .2V $\pm 4\% \pm 15\text{mV}$, max

15. RISETIME AND FALLTIME

- b. Tr timing
Tr: $10\mu\text{s} \pm 4\%$, max
- c. Risetime Mult Cal
Tr: $1\mu\text{s} \pm 4\%$, max
- d. Tf Timing
Tf: $10\mu\text{s} \pm 4\%$, max
- e. Falltime Mult Cal
Tf $1\mu\text{s} \pm 4\%$, max
- f. RISETIME FALLTIME RANGE
accuracy at $1\mu\text{s}$ and 100ns
Error: $\pm 4\%$, max
- g. RISETIME FALLTIME RANGE
accuracy with REMOTE PROGRAM
Error: $\pm 6\%$, max
- h. RISETIME MULT and FALLTIME MULT
linearity Error: $\pm 4\%$ of dial
reading, max

16. TRIGGER SENSITIVITY

- b. Trigger sensitivity
Triggering at all WIDTH RANGE
and MULTIPLIER settings

17. PULSE WIDTH

- b. Width Mult Cal
Pulse width: $50\mu\text{s} \pm 3\%$, max
- c. Width Timing
Pulse width: $500\mu\text{s} \pm 3\%$, max
- d. 10ns Width
Pulse width: $500\text{ns} \pm 5\%$, max
- e. WIDTH accuracy:
 $50\mu\text{s} \pm 3\%$, max

17. (cont'd)
- e. $5\mu\text{s} \pm 3\%$, max
 $500\text{ns} \pm 3\%$, max
 $50\text{ns} \pm 5\%$, max
 $550\text{ns} \pm 5\%$, max
 $5.5\mu\text{s} \pm 3\%$, max
 $55\mu\text{s} \pm 3\%$, max
 $550\mu\text{s} \pm 3\%$, max
 - f. REMOTE WIDTH accuracy
 $50\text{ns} \pm 7\%$, max
 $550\text{ns} \pm 5\%$, max
 $5\mu\text{s} \pm 5\%$, max
 $50\mu\text{s} \pm 5\%$, max
18. PULSE PERIOD
- b. Period Mult Cal
Error: $\pm 2\%$, max
 - c. Period Timing
Error: $\pm 2\%$, max
 - d. $1\mu\text{s}$ period
Error: $\pm 2\%$, max
 - e. $100\mu\text{s}$ Period
Error: $\pm 3\%$, max
 - f. PERIOD MULTIPLIER linearity:
Timing Error: $\pm 3\%$, max
 - g. 100ns REMOTE PERIOD
Error: $\pm 5\%$, max
 - h. REMOTE PERIOD $1\mu\text{s}$ to 1ms
Error: $\pm 4\%$, max
19. DELAYED TRIGGER SENSITIVITY
- b. DLY'D TRIGGER sens requirement:
Triggered double pulse.
20. DELAY OR BURST TIME
- b. Delay or Burst Time Mult Cal:
Timing Error: $\pm 2\%$, max
 - c. Delay Timing
Timing Error: $\pm 2\%$, max
 - d. Delay timing, 100ns to $10\mu\text{s}$
ranges. Error: $\pm 2\%$, max
 - e. REMOTE delay timing
Timing error: $\pm 4\%$, max
 - f. DELAY OR BURST TIME MULTIPLIER
linearity Error: $\pm 2\%$, max
21. BURST MODE
- c. Burst WIDTH
Error: ± 1 pulse, max
 - d. Pulse timing
Error: $\pm 2\%$, max
 - e. Pulse width
Error: $\pm 2\%$, max
 - f. REMOTE width
Error: $\pm 4\%$, max
23. TRIGGER INPUT
- b. 10MHz trigger:
triggered on 4V , 10MHz signal.
 - d. Trigger amplitude requirement.
Triggering on 2 to 20V signal.
 - e. Manual trigger
Triggering in all modes except
GATED OUTPUT.
24. TRIGGER OUTPUT
- a. + PRETRIGGER OUT:
Amplitude 2V , min
 - b. + DELAYED TRIGGER OUT
Amplitude 2V , min
25. PULSE ABERRATIONS
- b. Pulse aberrations overshoot
or undershoot 2% , max
 - c. Level aberrations: $\pm 2\%$, max
 - d. - POLARITY aberrations: $\pm 2\%$,
max
 - e. REMOTE PROGRAM aberrations:
 $\pm 4\%$, max
26. 1ns & 10ns RISETIME AND FALLTIME
RANGE
- b. 1ns RISETIME FALLTIME RANGE
 $10\text{ns} \pm 10\%$, max
 - c. 1ns RISETIME FALLTIME RANGE in
REMOTE PROGRAM $10\text{ns} \pm 12\%$, max
 - d. 10ns RISETIME FALLTIME RANGE:
 $20\text{ns} \pm 10\%$, max
 - e. 10ns RISETIME FALLTIME RANGE in
REMOTE PROGRAM $20\text{ns} \pm 12\%$, max

27. 10ns WIDTH RANGE

- b. 50ns Width 50ns $\pm 2\%$, max
- c. REMOTE 50ns width 50ns $\pm 4\%$, max
- d. 500ns width 500ns $\pm 2\%$, max
- e. REMOTE 550ns width 550ns $\pm 4\%$, max

28. 10ns DELAY RANGE

- b. 50ns Delay 100ns delay $\pm 2\%$, max
- c. 500ns delay 500ns delay $\pm 2\%$, max
- d. 50ns delay in REMOTE 50ns $\pm 4\%$, max
- e. 550ns delay in REMOTE 550ns $\pm 4\%$, max

SHORT FORM PROCEDURE

Factory TEST LIMITS are limits an instrument must meet before it leaves Manufacturing; therefore, it must be possible to inspect to these limits. Because of normal variations in test equipment and plug-in scopes, addition of side panels, etc, it is necessary to set up some circuits so their performance is better than required by Factory Test Limits. Therefore, the instructions given in the Factory Calibration Procedure may call for checks or adjustments which result in less error than that allowed by the Factory Test Limits.

+25V	±0.25V, max
-27V	±0.6V, max
-6V	±0.5V, max
+7V	±1V, max
-13.5V	±2V, max (chassis ground)
+24.4V	±0.63V, max

d. Check 9.5V supply 9.5V ±0.7V, max

7. DC OFFSET RANGE

- a. Setup
- b. Preset DC Offset Range, R32N, + Offset Zero, R466 and - Offset Zero, R476

1. PRELIMINARY INSPECTION

- a. Make general inspection
- b. Check fuses

8. DC OFFSET

- a. Setup
- b. Preset DC Offset Cal, R544

2. PRESET CONTROLS

- a. Preset TYPE R116 controls
- b. Preset R116 Remote Program Test Fixture controls
- c. Preset TYPE 547 controls
- d. Preset TYPE W controls

9. AMPLITUDE

- a. Setup
- b. Adjust Range Cal, R85F
Error: ±2% of dial reading, max
- c. Adjust Amplitude Mult Cal, R532:
Error: ±2% of dial reading, max

3. RESISTANCE

- a. Check Remote Program Input resistance
- b. Check Power Supply resistance

10. BASELINE CLAMP

- a. Setup
- b. Adjust Baseline Clamp R25M
1.6V shift ±3%, max

4. LINE VOLTAGE SELECTOR

11. - AMPLITUDE AND - DC LEVEL

5. + OFFSET ZERO

- a. Setup
- b. Preset + Offset Zero, R466

- a. Setup
- b. Preset -Amplitude, R42M, -DC Level, R34M and - Offset Zero, R476

6. POWER SUPPLIES

- a. Setup
- b. Adjust +25V, R14I 25V± 1%, max
- c. Check power supply voltages and ripple:
Check ripple and regulation from 94.5 VAC line to 137VAC line as follows:

12. PROGRAM CLAMP

- a. Setup
- b. Adjust Program Clamp, R54N DC Level: 0V ±0.8V, max

13. DC OFFSET ACCURACY

- a. Setup
- b. Check DC offset accuracy:
Pulse baseline at graticule
center $\pm 1.75\text{cm}$, max (5% $\pm 100\text{mV}$)

14. AMPLITUDE

- a. Setup
- b. Check + Amplitude Accuracy
1V: $\pm 2\% \pm 50\text{mV}$, max
.5V: $\pm 2\% \pm 25\text{mV}$, max
.2V: $\pm 2\% \pm 15\text{mV}$, max
- c. Check - Amplitude accuracy
(Same as + Amplitude accuracy)
- d. Check + and - Amplitude accuracy
in REMOTE:
1V $\pm 4\% \pm 50\text{mV}$, max
.5V $\pm 4\% \pm 25\text{mV}$, max
.2V $\pm 4\% \pm 15\text{mV}$, max

15. RISE TIME AND FALL TIME

- a. Setup
- b. Adjust T_r Timing, R64F
- c. Adjust Risetime Mult Cal, R564
 T_r : $1\mu\text{s} \pm 4\%$, max (10% to 90%
amplitude $4\text{cm} \pm 0.16\text{cm}$, max)
- d. Adjust T_f Timing, R54F
 T_f : $10\mu\text{s} \pm 4\%$, max (10% to 90% Amplitude
 $4\text{cm} \pm 0.16\text{cm}$, max)
- e. Adjust Falltime Mult Cal, R554
 T_f : $1\mu\text{s} \pm 4\%$, max (10% to 90% Amplitude
 $4\text{cm} \pm 0.16\text{cm}$, max)
- f. Check RISE TIME FALL TIME RANGE
accuracy at $1\mu\text{s}$ and 100ns Error:
 $\pm 4\%$, max (10% to 90% Amplitude 4cm
 $\pm 0.16\text{cm}$, max)
- g. Check RISE TIME FALL TIME RANGE accuracy
with REMOTE PROGRAM Error: $\pm 6\%$, max
(10% to 90% Amplitude $4\text{cm} \pm 0.24\text{cm}$, max)
- h. Check RISE TIME MULT and FALL TIME MULT
linearity Error: $\pm 4\%$ of dial reading,
max (10% to 90% amplitude $4\text{cm} \pm 0.16\text{cm}$, max)

16. TRIGGER SENSITIVITY

- a. Setup
- b. Adjust Trig Sens, R22E: Triggering at all
WIDTH RANGE and MULTIPLIER Settings

17. PULSE WIDTH

- a. Setup
- b. Adjust Width Mult Cal, R522:
Pulse width $50\mu\text{s} \pm 2\%$, max
- c. Adjust Width Timing, R41E:
Pulse width $500\mu\text{s} \pm 2\%$, max
- d. Adjust 10ns width, C32:
Pulse width $500\text{ns} \pm 4\%$, max
- e. Check WIDTH accuracy:
 $50\mu\text{s} \pm 2\%$, max
 $5\mu\text{s} \pm 2\%$, max
 $500\text{ns} \pm 2\%$, max
 $50\text{ns} \pm 4\%$, max
 $550\text{ns} \pm 4\%$, max
 $5.5\text{ns} \pm 4\%$, max
 $55\mu\text{s} \pm 2\%$, max
 $550\mu\text{s} \pm 2\%$, max
- f. Check REMOTE WIDTH accuracy
 $50\text{ns} \pm 6\%$, max
 $550\text{ns} \pm 4\%$, max
 $5\mu\text{s} \pm 4\%$, max
 $50\mu\text{s} \pm 4\%$, max

18. PULSE PERIOD

- a. Setup
- b. Adjust Period Mult Cal, R502
Error: $\pm 2\%$, max
- c. Adjust Period Timing, R34B
Error: $\pm 2\%$, max
- d. Adjust $1\mu\text{s}$ Period, C55B
Error: $\pm 2\%$, max
- e. Adjust 100ns Period, C52B
Error: $\pm 3\%$, max
- f. Check PERIOD MULTIPLIER
linearity: Timing error
 $\pm 3\%$, max
- g. Check 100ns REMOTE PERIOD
Error: $\pm 5\%$, max
- h. Check REMOTE PERIOD, $1\mu\text{s}$ to
 1ms Error: $\pm 4\%$, max

19. DLY'D TRIGGER SENSITIVITY

- a. Setup
- b. Adjust Trig Sens, R22C
Requirement: Triggered double
pulse

20. DELAY OR BURST TIME

- a. Setup
- b. Adjust Delay or Burst Time
Mult Cal, R512 Timing Error:
 $\pm 2\%$, max
- c. Adjust Delay Timing, R41C
Timing error: $\pm 2\%$, max
- d. Check Delay Timing, 100ns to
10 μ s ranges: Error: $\pm 2\%$, max
- e. Check REMOTE delay timing
Timing Error: $\pm 4\%$, max
- f. Check DELAY or BURST TIME
MULTIPLIER linearity Error:
 $\pm 2\%$, max

21. BURST MODE

- a. Setup
- b. Check burst PERIOD: 1ms burst
of pulses
- c. Check burst WIDTH Error: ± 1
pulse, max
- d. Check Pulse timing Error:
 $\pm 2\%$, max
- e. Check Pulse timing Error:
 $\pm 2\%$, max
- f. Check REMOTE WIDTH Error:
 $\pm 4\%$, max

22. GATED OUTPUT

- a. Setup
- b. Check GATED OUTPUT MODE
- c. Check REMOTE GATED OUTPUT MODE

23. TRIGGER INPUT

- a. Setup
- b. Check 10MHz trigger:
Triggered on 4V, 10MHz signal
- c. Check simulated R116 trigger
- d. Check trigger amplitude
Requirement: triggering on 2 to
20 VOLT signal.
- e. Check manual trigger:
Triggered in all modes except
GATED OUTPUT.

24. TRIGGER OUTPUT

- a. Check + PRETRIGGER OUT Amplitude:
2V, min
- b. Check + DELAYED TRIGGER OUT:
Amplitude: 2V, min

25. PULSE ABERRATIONS

- a. Setup
- b. Adjust + Pulse overshoot, C50M
overshoot or undershoot $\pm 2\%$, max
- c. Adjust Level, C82M aberrations:
 $\pm 2\%$, max
- d. Check - POLARITY aberrations:
 $\pm 2\%$, max
- e. Check REMOTE PROGRAM aberrations:
 $\pm 4\%$, max

26. 1ns & 10ns RISETIME AND FALLTIME RANGE

- a. Setup
- b. Adjust 1ns RISETIME FALLTIME RANGE,
C72F: 10ns $\pm 10\%$, max
- c. Check 1ns RISETIME FALLTIME RANGE
in REMOTE PROGRAM: 10ns $\pm 12\%$, max
- d. Check 10ns RISETIME FALLTIME RANGE:
20ns $\pm 10\%$, max
- e. Check 10ns RISETIME FALLTIME RANGE
in REMOTE PROGRAM: 20ns $\pm 12\%$, max

27. 10ns WIDTH RANGE

- a. Setup
- b. Adjust 50n sec width, R523 50ns $\pm 2\%$,
max
- c. Check REMOTE 50ns width: 50ns $\pm 4\%$,
max
- d. Adjust 500ns width, C32E 500ns
 $\pm 2\%$, max
- e. Check REMOTE 550ns width 550ns
 $\pm 4\%$, max

28. 10ns DELAY RANGE

- a. Setup
- b. Adjust 50ns Delay, R513 100ns
delay $\pm 2\%$, max
- c. Adjust 500ns Delay, C32C 500ns
delay $\pm 2\%$, max
- d. Check 50ns Delay in REMOTE 50ns
 $\pm 4\%$, max
- e. Check 500ns Delay in REMOTE 550ns
 $\pm 4\%$, max

THE END

1. PRELIMINARY INSPECTION*a. Make General Inspection**b. Check Fuses*

<u>Location</u>	<u>Schematic number</u>	<u>Part number</u>	<u>Description</u>
Front panel	F401	159-0043-00	0.6A slo-blo
Front panel	F402	159-0043-00	0.6A slo-blo
Motor base	F403	159-0053-00	5A
Motor base	F404	159-0053-00	5A

2. PRESET CONTROLS*a. Preset TYPE R116 controls*

TRIGGER SOURCE	INTERNAL
MODE	SINGLE
PERIOD	1ms X1
DELAY OR	
BURST TIME	10 μ s X5
WIDTH	10 μ s X5
AMPLITUDE	1V X10
PROGRAM	REMOTE
DC OFFSET	0
RISETIME-FALLTIME	
RANGE	1 μ s
RISETIME MULT	cw
FALLTIME MULT	cw
POLARITY	+
POWER	OFF
LINE VOLTAGE	
SELECTOR	115V (Rear Panel)

a. Hereafter RANGE and MULTIPLIER settings will be described under a single notation. Example: PERIOD RANGE 1ms and MULTIPLIER X10 will be described as: PERIOD 1ms X10.

b. Preset R116 Remote Program Test Fixture controls

TRIGGER SOURCE	INTERNAL
MODE	SINGLE
PERIOD	1ms X1
DELAY OR	
BURST TIME	10 μ s X10

2.b (cont'd)

WIDTH 10 μ s X5
 AMPLITUDE 1V X10
 DC OFFSET 0
 RISETIME-FALLTIME
 RANGE 1 μ s
 RISETIME MULT X10
 FALLTIME MULT X10
 POLARITY +

c. Preset TYPE 547 controls

HORIZONTAL DISPLAY B
 B TRIGGERING
 MODE AUTO STABILITY
 SLOPE +
 COUPLING AC
 SOURCE NORM INT
 B TIME/CM .2mS
 TIME/CM VARIABLE CALIBRATED

d. Preset TYPE W controls

V_c RANGE 0
 COMPARISON VOLTAGE 5
 DISPLAY A-V_c
 INPUT ATTEN 1
 A & B INPUT DC
 MILLIVOLTS/CM 50
 VARIABLE CALIB

3. RESISTANCE

a. Check Remote Program Input Resistance

Check resistance between J10 and chassis ground as in the following table:

Approximate resistance			
Pin	Positive meter lead to ground	Negative meter lead to ground	Meter scale
1	900 Ω	2.3k Ω	Ω X1k
2	1k Ω	2.4k Ω	Ω X1k
3	600 Ω	340 Ω	Ω X100
4	75 Ω	75 Ω	Ω X100
5 thru 17	Inf	Inf	Ω X1k
18	6.5k Ω	Inf	Ω X1k
19	Inf	20k Ω	Ω X1k
20 thru 33	Inf	Inf	Ω X1k
34	2.2k Ω	2.7k Ω	Ω X1k
35	Inf	Inf	Ω X1k
36	0 Ω	0 Ω	Ω X1k

b. Check Power supply resistance

Measure the resistance from Q423 base to ground, approximately 800 .
Change the common meter lead to signal ground, Pin 1 of J9 and measure power supply resistance as follows:

Approximate resistance

Test Point	Supply	Positive meter lead to ground	Negative meter lead to ground	meter scale
J9 Pin 2	-27V	500 Ω	375 Ω	Ω X100
J9 Pin 3	-6V	530 Ω	340 Ω	Ω X100
J9 Pin 4	+25V	130 Ω	130 Ω	Ω X100
J9 Pin 26	-7V	220 Ω	260 Ω	Ω X100
J7 Pin 8	+9.5V	1050 Ω	500 Ω	Ω X100

4. LINE VOLTAGE SELECTOR

Set the multimeter to a range suitable to measure 35VAC.
Connect the multimeter leads to T401 terminals 10 & 11 and set TYPE R116 POWER on. Measure and note the AC voltage. Change the Line Voltage Selector to 230V. Check that the voltage at T401 terminals 10 & 11 is approximately one half that previously measured. Change the Line Voltage Selector to 115V and POWER to off.

5. + OFFSET ZERO*a. Setups*

Connect TYPE R116 PULSE OUTPUT--50 Ω BNC Cable--BNC T adapter 50 Ω precision termination--TYPE W A INPUT. Connect TYPE R116 J10 Remote Program--R116 Remote Program Test Fixture J10 Remote Program. Set TYPE R116 POWER ON and allow 5 minute warm-up period.

b. Preset + Offset Zero, R466

Establish test scope graticule center at zero volts by setting TYPE W INPUT A to GND. Change TYPE W INPUT A to DC and adjust

5.b (cont'd)

R466 to place the baseline of the pulse at test scope graticule center. (R466 will be readjusted later in the procedure).

6. POWER SUPPLIES

a. Setup

Set TYPE W A & B INPUTS to AC and DISPLAY to A-B. Connect two X1 probes to TYPE W INPUTS and connect one of the probes to TYPE R116 J9 pin 1. Connect the DCVB COMMON to J9 Pin 1 and TYPE W Probe and DCVB \pm INPUT to J9 pin 4. Set the DCVB RANGE to 110V and READOUT to 2-5-0.

b. Adjust +25V, R14I 25V \pm 1%, max

Adjust R14I for a null on the DCVB.

c. Check power supply voltages and regulation

Check power supply voltages with the DCVB and ripple with the TYPE W and TYPE 547. Check ripple and regulation from 94.5 VAC line to 137 VAC line as in the following table:

Supply	Test Point	Voltage limit	Set by
+25V	J9 Pin 4	\pm 0.25V, max	D2
-27V	J9 Pin 2	\pm 0.6V, max	--
-6V	J9 Pin 3	\pm 0.5V, max	--
+7V	J9 Pin 26	\pm 1V, max	D30
-13.5V	Chassis ground	\pm 2V, max	D434
+24.4V	J7 Pin 8	\pm 0.63V, max	--

d. Check 9.5V supply 9.5V \pm 0.7V, max

Change the DCVB common lead to chassis ground and measure 9.5V at the emitter of Q423. Return the line to 115 VAC.

6. CAUTION Do not short signal ground to chassis.

A capital letter following the schematic number of an adjustment indicates the etched circuit card on which the adjustment is located.

b. Noise on the power supply signals can be reduced by setting the TYPE R116 TRIGGER SOURCE to EXTERNAL or MANUAL. Return the switch to INTERNAL after checking power supplies.

d. If the 9.5V Supply fails to meet the test limit check D413.

7. DC OFFSET RANGE

a. Setup

Set the TYPE R116 POLARITY to REMOTE PROGRAM and TYPE W DISPLAY to A- V_c , A & B INPUT's to DC MILLIVOLTS/CM to 50 and COMPARISON VOLTAGE to 5-0-0. Set TYPE 547 B TIME/CM to .2mSEC and B TRIGGERING SOURCE to NORM R116 PULSE OUTPUT to TYPE W A INPUT.

b. Preset DC offset Range, R32N, + Offset Zero, R466 and - Offset Zero, R476

Establish test scope graticule center at zero volts by setting the TYPE W INPUT A to GND and positioning the trace to graticule center. Change the TYPE W INPUT A to DC. Set the R116 Remote Program Test Fixture POLARITY to + and adjust +Offset Zero R466 to place the baseline of the pulse at test scope graticule center. Change the R116 Remote Program Test Fixture POLARITY to - and adjust - Offset Zero, R476 to place the baseline of the pulse at test scope graticule center. Change the R116 Remote Program Test Fixture OFFSET to -5V and TYPE W V_c RANGE to -11. Adjust Offset Range, R32N to place the baseline of the pulse at graticule center. Change the R116 Remote Program Test Fixture OFFSET to +5V, POLARITY to + and TYPE W V_c RANGE to +11. Adjust + Offset Zero, R466 and Offset Range, R32N together to place the baseline of the pulse at graticule center. Repeat step 7b as necessary.

b. It may not be possible to obtain a final adjustment of R32N, R466 and R476 until step 10 is completed.

8. DC OFFSET*a. Setup*

TYPE R116
 PROGRAM INT
 POLARITY +
 TYPE W
 V_c RANGE 0

b. Preset DC offset Cal, R544

Check that the DC OFFSET knob is positioned to the center of pot rotation. Reposition the knob on the pot shaft if necessary. Set the DC OFFSET to 0. Adjust R544 to position the base of the pulse to graticule center.

9. AMPLITUDE*a. Setup*

TYPE R116
 POLARITY +
 AMPLITUDE 1 X10
TYPE W
 COMPARISON VOLTAGE 10-0-0

b. Adjust Range Cal, R85F Error: ±2% of dial reading, max

Position the base of the pulse to graticule center with DC OFFSET. Set the TYPE W V_c RANGE to +11 and position the top of the pulse to graticule center.

c. Adjust Amplitude Mult Cal, R532 Error: ±2% of dial reading, max

Change the TYPE R116 AMPLITUDE to 1X2 and TYPE W COMPARISON VOLTAGE to 2-0-0. Change the TYPE W V_c RANGE to +11. Adjust R532 to position the top of the pulse to graticule center.

10. BASELINE CLAMP

a. Setup

<u>TYPE R116</u>	
PROGRAM	REMOTE
<u>TYPE W</u>	
V _c RANGE	0
INPUT ATTEN	100
MILLIVOLTS/CM	10
<u>R116 Remote Program</u>	
<u>Test Fixture</u>	
DC OFFSET	0

*b. Adjust Baseline Clamp R25M
1.6V shift ±3%, max*

Set A INPUT to GND and set the test scope trace to graticule center. Change A INPUT to DC and check that the baseline of the pulse is at graticule center. Remove the 9-6-0 lead from the square pin on the ceramic strip adjacent to L484. Adjust R25M to position the baseline of the pulse exactly 1.6V positive from the zero reference. (1.6cm above graticule center). Replace the 9-6-0 lead on the square pin and readjust + Offset Zero, R466 to position the pulse baseline to graticule center. Repeat steps 7, 8, 9 and 10 as necessary.

11. - AMPLITUDE AND - DC LEVEL

a. Setup

<u>TYPE R116</u>	
PROGRAM	REMOTE
DC OFFSET	0
AMPLITUDE	1V X10
POLARITY	+
<u>TYPE W</u>	
INPUT ATTEN	100
MILLIVOLTS/CM	20

- b. *Preset - Amplitude, R42M, - DC Level, R34M and - offset zero, R476.*

Set TYPE W INPUT to GND and establish the test scope graticule center at zero volts. Change A INPUT to DC and check that the baseline of the pulse is at graticule center. Adjust the TYPE W VARIABLE for exactly 3cm of display amplitude. Change the TYPE R116 POLARITY to - and adjust - Offset Zero, R476, to position the base of the pulse to graticule center. Change the PROGRAM to INT and adjust -DC Level, R34M to position the base of the pulse to graticule center and - Amplitude, R42 for exactly 3cm of display amplitude. Repeat step 11B as necessary.

- b. It may be necessary to adjust the - amplitude about 100mV low with the AMPLITUDE at 1V X10, so the amplitude will be correct with the AMPLITUDE at 1V X2.

12. PROGRAM CLAMP

- a. *Setup*

<u>TYPE R116</u>	
PROGRAM	INT
POLARITY	+
<u>TYPE W</u>	
V _c RANGE	0

- b. *Adjust Program Clamp, R54N*
DC Level: 0V ±0.8V, max

Remove the R116 Remote Program Test Fixture plug from J10 of the TYPE R116. Note the position of the trace on the test scope. Change the TYPE R116 PROGRAM to REMOTE and adjust R54N to position the trace to the level noted. Replace the R116 Remote Program Test Fixture plug in J10 and return the TYPE R116 PROGRAM to INTERNAL.

13. DC OFFSET ACCURACY

a. Setup

TYPE R116
 AMPLITUDE 1V X5
TYPE W
 INPUT ATTEN 10
 MILLIVOLTS/CM 10

b. Check DC offset accuracy:

Pulse baseline at graticule center $\pm 1.75\text{cm}$ (5% $\pm 100\text{mV}$).

Check DC offset accuracy as in the following table:

		Oscilloscope		Offset		
DC OFF-SET	POLAR-ITY	COMP VOLTAGE	V _C RANGE	Voltage	Baseline Displacement from Centerline	
					Internal	External
-5	+	5.000	-1.1	-5V	$\pm 1.75\text{cm}$ (5% $\pm 100\text{mV}$)	$\pm 2.5\text{cm}$ (8% $\pm 100\text{mV}$)
-5	-	5.000	-1.1	-5V	$\pm 1.75\text{cm}$	$\pm 2.5\text{cm}$
+5	-	5.000	+1.1	+5V	$\pm 1.75\text{cm}$	$\pm 2.25\text{cm}$ (7% $\pm 100\text{mV}$)
+5	+	5.000	+1.1	+5V	$\pm 1.75\text{cm}$	$\pm 2.25\text{cm}$

14. AMPLITUDE

a. Setup

TYPE R116
 AMPLITUDE 1V X10
 POLARITY +
 PROGRAM INT
 DC OFFSET 0
TYPE W
 INPUT ATTEN 10
 MILLIVOLTS/CM 20
 V_C RANGE 0
 COMPARISON VOLTAGE 10-0-0

b. Check + Amplitude accuracy:

- 1V: $\pm 2\% \pm 50mV$, max
- .5V: $\pm 2\% \pm 25mV$, max
- .2V: $\pm 2\% \pm 15mV$, max

Position the pulse baseline to graticule center, then change TYPE W V_c RANGE to +1.1V and check the amplitude of the pulse. In a similar manner check the accuracy of the + pulse as in the following table:

AMPLITUDE		Test Scope			Maximum Displacement from Graticule Center
RANGE	MULTIPLIER	INPUT ATTEN	MILLIVOLTS/CM	(Vc)	
1V	10	10	20	10-0-0	$\pm 1.25cm$
.5V	10	10	10	5-0-0	$\pm 1.25cm$
.2V	10	10	5	2-0-0	$\pm 1.05cm$
.2V	2	1	10	4-0-0	$\pm 2.3cm$
.5V	2	10	2	1-0-0	$\pm 2.3cm$
1V	2	10	5	2-0-0	$\pm 1.8cm$

c. Check - Amplitude accuracy

- 1V: $\pm 2\% \pm 50mV$, max
- .5V: $\pm 2\% \pm 25mV$, max
- .2V: $\pm 2\% \pm 15mV$, max

Change the POLARITY to - and set the AMPLITUDE to 1V X10. Position the pulse baseline to graticule center. Check the accuracy of the - pulse as in the above table.

d. Check + and - Amplitude accuracy in REMOTE:

- 1V = $\pm 4\% \pm 50mV$, max
- .5V = $\pm 4\% \pm 25mV$, max
- .2V = $\pm 4\% \pm 15mV$, max

Change the TYPE R116 AMPLITUDE to REMOTE and POLARITY to REMOTE PROGRAM. Using R116 Remote Program Test Fixture check + and - amplitude accuracy as in the following table:

14.d (cont'd)

AMPLITUDE		Test Scope			Maximum Displacement from Graticule Center
RANGE	MULTIPLIER	INPUT ATTEN	MILLIVOLTS/CM	V _c	
1V	10	10	20	10-0-0	±2.25cm
.5V	10	10	10	5-0-0	±2.25cm
.2V	10	10	5	2-0-0	±1.85cm
.2V	2	1	10	4-0-0	±3.1cm
.5V	2	10	2	1-0-0	±3.3cm
1V	2	10	5	2-0-0	±2.6cm

Replace the test scope TYPE
W with a TYPE 1A1.

15. RISETIME AND FALLTIME

a. Setup

TYPE R116

TRIGGER SOURCE EXTERNAL OR MANUAL
RISETIME FALLTIME
RANGE 1μs
RISETIME MULT 10
FALLTIME MULT 10
PROGRAM INT
POLARITY +
AMPLITUDE 1V X10

TYPE 547

B TIME/CM 10μSEC
TYPE 1A1
CHANNEL 1 VOLTS/CM 2
VARIABLE VOLTS/CM CALIB
MODE CH 1
INPUT SELECTOR DC

TYPE 184

MARKER SELECTOR 10μs
TRIGGER SELECTOR 10μs
MARKER AMPLIFIER -

Connect TYPE R116 PULSE OUTPUT--
50Ω BNC Cable--BNC T adapter--TYPE
1A1 A INPUT--50Ω precision termination

15. Risetime and falltime are products of RISETIME or FALLTIME RANGE and MULT settings and AMPLITUDE RANGE and MULTIPLIER settings.

EXAMPLE:

RISETIME FALLTIME RANGE= 1μs
MULT= 10 AMPLITUDE= 1V
MULTIPLIER= 10
RISETIME= 1μs X10X10= 100μs

15. a (cont'd)

TYPE 184 TRIGGER OUTPUT-- 50Ω
 cable--TYPE R116 + TRIGGER IN.
 TYPE 184 MARKER AMPLIFIER OUTPUT--
 50Ω cable--BNC clip lead adapter--
 TYPE 547 External CRT cathode.

b. *Adjust T_r Timing R64F Tr:*
 $10\mu\text{s} \pm 4\%$, max (10% T_0 90%
 Amplitude $4\text{cm} \pm 0.16\text{cm}$, max)

Adjust the TYPE 547 B TIME/CM and VARIABLE to obtain exactly 10 time marks in 10cm. Center the display above and below the center horizontal graticule line. Adjust the TYPE 547 B TRIGGERING LEVEL to position the start of the display to the first vertical graticule line exactly 2cm below the center horizontal graticule line. Adjust R64F so the display crosses the last vertical graticule line exactly 2cm above the center horizontal graticule line. See Fig. 1.

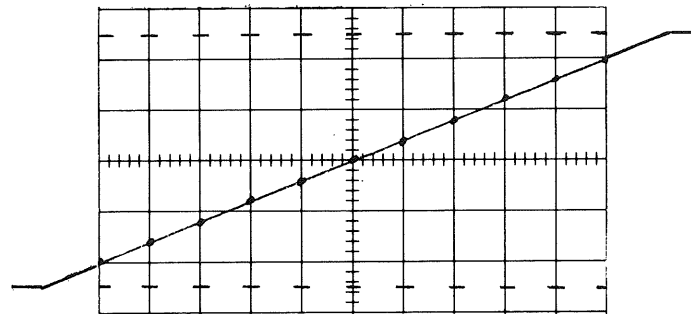


Fig 1

c. *Adjust Risetime Mult Cal, R564*
 $T_r: 1\mu\text{s} \pm 4\%$, max (10% to 90%
 amplitude $4\text{cm} \pm 0.16\text{cm}$, max)

Change the TYPE R116 RISETIME MULT to 1, TYPE 184 MARKER and TRIGGER SELECTOR to $1\mu\text{s}$ and TYPE 547 B TIME/CM to $1\mu\text{SEC}$. Adjust R564 for the same result as in step 15b. because of interaction, repeat steps 15 b and c as necessary.

d. *Adjust T_f Timing, R54F*
 $T_f: 10\mu\text{s} \pm 4\%$, max (10% to 90%
 amplitude $4\text{cm} \pm 0.16\text{cm}$, max)

Change the TYPE 184 MARKER and TRIGGER SELECTOR to $10\mu\text{s}$ and TYPE 547 B TIME/CM to $10\mu\text{SEC}$. Change the TYPE 547 TRIGGERING SLOPE to -. Adjust R54F as in step 15b, except for a negative slope. See Fig. 2.

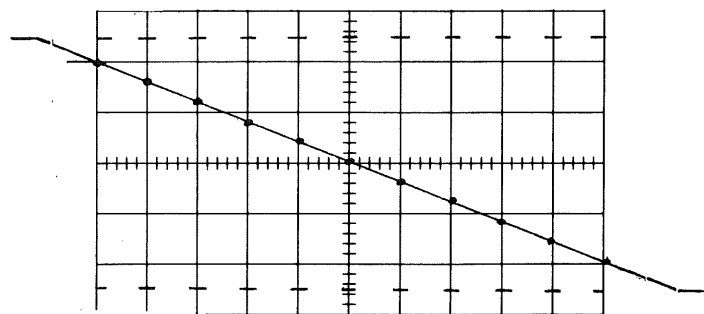


Fig 2

e. *Adjust Falltime Mult Cal, R554*
 $T_f: 1\mu\text{s} \pm 4\%$, max (10% to 90%
 amplitude $4\text{cm} \pm 0.16\text{cm}$, max).

15. e (cont'd)

Change the TYPE R116 FALLTIME MULT to 1, TYPE 184 MARKER and TRIGGER SELECTOR to 1 μ s and TYPE 547 B TIME/CM to 1 μ SEC. Adjust R554 for the same result as in step 15 d. Repeat steps 15 d and e as necessary.

f. Check RISETIME FALLTIME RANGE accuracy at 1 μ s and 100ns
 Error: $\pm 4\%$, max (10% to 90% amplitude 4cm ± 0.16 cm, max)

Check T_r and T_f as in the following table:

RISETIME FALLTIME RANGE	RISETIME MULT	FALLTIME MULT	B TIME/CM	TRIGGERING SLOPE
1 μ s	10	10	10 μ SEC	+
1 μ s	10	10	10 μ SEC	-
1 μ s	1	1	1 μ SEC	+
1 μ s	1	1	1 μ SEC	-
100ns	10	10	1 μ SEC	+
100ns	10	10	1 μ SEC	-
100ns	1	1	.1 μ SEC	+
100ns	1	1	.1 μ SEC	-

g. Check RISETIME FALLTIME RANGE accuracy with REMOTE PROGRAM
 Error: $\pm 6\%$, max (10% to 90% amplitude 4cm ± 0.24 cm, max)

Change the TYPE R116 PROGRAM to REMOTE and check T_r and T_f as in step 15f.

h. Check RISETIME MULT and FALLTIME MULT linearity Error: $\pm 4\%$ of dial reading, max (10% to 90% amplitude 4cm ± 0.16 cm, max)

Set TYPE R116 RISETIME FALLTIME RANGE to 1 μ s, TYPE 547 B TRIGGER SELECTOR to + and TIME/CM to 10 μ SEC. Set TYPE 184 MARKER SELECTOR and TRIGGER SELECTOR to 10 μ s. Check RISETIME MULT and FALLTIME MULT linearity as in the following table:

15. h (cont'd)

TYPE R116		TYPE 184	TYPE 547	
RISETIME	FALLTIME	MARKER &	SET B TIME/CM	B TRIGGERING
MULT	MULT	TRIGGER SELECTOR	& VARIABLE for	SLOPE
10	10	10 μ s	10 marks/10cm	+
10	10	10 μ s	10 marks/10cm	-
9	9	10 μ s	9 marks/10cm	+
9	9	10 μ s	9 marks/10cm	-
8	8	10 μ s	8 marks/10cm	+
8	8	10 μ s	8 marks/10cm	-
7	7	10 μ s	7 marks/10cm	+
7	7	10 μ s	7 marks/10cm	-
6	6	10 μ s	6 marks/10cm	+
6	6	10 μ s	6 marks/10cm	-
5	5	10 μ s	5 marks/10cm	+
5	5	10 μ s	5 marks/10cm	-
4	4	10 μ s	4 marks/10cm	+
4	4	10 μ s	4 marks/10cm	-
3	3	10 μ s	3 marks/10cm	+
3	3	10 μ s	3 marks/10cm	-
2	2	1 μ s	20 marks/10cm	+
2	2	1 μ s	20 marks/10cm	-
1	1	1 μ s	10 marks/10cm	+
1	1	1 μ s	10 marks/10cm	-

16. TRIGGER SENSITIVITY

a. Setup

TYPE R116

TRIGGER SOURCE INTERNAL
 RISETIME FALLTIME
 RANGE 1ns
 RISETIME MULT 1
 FALLTIME MULT 1
 PERIOD 10 μ s X1
 WIDTH 10ns (MULTIPLIER CW)

TYPE 547

B TIME/CM .1 μ SEC
 B TRIGGERING SLOPE +

b. *Adjust Trig Sens R22E: Triggering at all WIDTH RANGE and MULTIPLIER SETTINGS*

Trigger the test scope. Turn R22E ccw until the displayed pulse is not triggered (free running). Turn R22E cw until the displayed pulse just triggers. Check that the pulse remains triggered at all other WIDTH RANGE and MULTIPLIER settings.

17. PULSE WIDTH

a. *Setup*

TYPE R116

MODE	SINGLE
TRIGGER SOURCE	INTERNAL
PERIOD	1ms X1
DELAY or	
BURST TIME	10ns X10
WIDTH	10 μ s X5
AMPLITUDE	1V X10
POLARITY	+
RISETIME FALLTIME	
RANGE	1ns
RISETIME MULT	1
FALLTIME MULT	1

TYPE 547

B TIME/CM 5 μ SEC

TYPE 1A1

MODE ALT

TYPE 184

MARKER SELECTOR 50 μ s

Connect TYPE 184 MARKER OUTPUT to TYPE 1A1 CHANNEL 2. Set CHANNEL 2 VOLTS/CM for a 5cm display of time markers. Adjust B TRIGGERING LEVEL for a stable display.

b. *Adjust Width Mult Cal, R522: Pulse width 50 μ s \pm 2%, max*

Adjust R522 for a pulse 50 μ s wide using the 50 μ s time marks as a reference (see Fig 3).

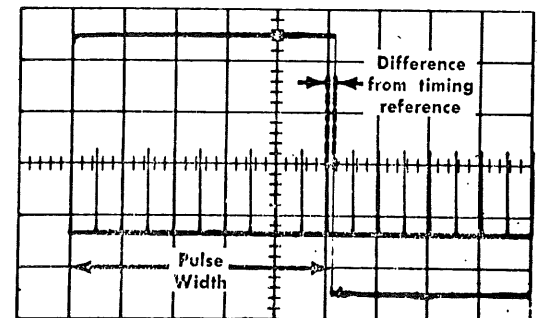


Fig 3

17.b (cont'd)

Change the TYPE 547 SWEEP MAGNIFIER to X10. Check the accuracy of the pulse width at the 50% amplitude points at the start and end of the pulse.

c. *Adjust Width Timing, R41E*
 Pulse Width: 500µs ±2%, max

Change the TYPE R116 WIDTH MULTIPLIER to 50. Change TYPE 547 B TIME/CM to 50µSEC and TYPE 184 MARKER SELECTOR to .5ms. Adjust R41E for same result as in step 17b. Repeat step 17b and c as necessary.

d. *Adjust 10ns Width, C32 Pulse width 500ns ±4%, max*

Change the TYPE R116 PERIOD RANGE to 1µs and WIDTH to 10ns X50. Change the TYPE 184 MARKER SELECTOR to 50ns. Change the TYPE 547 B TIME/CM to .1µSEC. Adjust C32 for a pulse 500ns wide using the 50ns time marks as a reference (see Fig. 4). Change the TYPE 547 SWEEP MAGNIFIER to X10 check the pulse width at the 50% amplitude points at the start and end of the pulse.

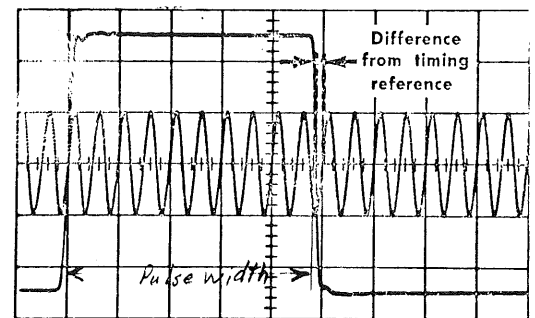


Fig 4

e. *Check WIDTH accuracy*

PERIOD RANGE	WIDTH RANGE	WIDTH MULTIPLIER	Time Markers	TYPE 547 B TIME/CM	Pulse Width	
					Time	Difference from Reference
1mS	10µS	5	5µs	10µ SEC	50µs ±2%	±1mm over 5cm display
100µS	1µS	5	0.5µs	1µSEC	5µs ±2%	±1mm over 5cm display
10µS	100nS	5	50ns	.1µSEC	500ns ±2%	±1mm over 5cm display
1µS	10nS	5	10ns	.1µSEC (X10)	50ns ±4%	±2mm over 5cm display
1µS	10nS	55	50ns	.1µSEC	550ns ±4%	±2.2mm over 5.5cm display
100µS	100nS	55	0.5µs	1µSEC	5.5µs ±2%	±1.1mm over 5.5cm display
1mS	1µS	55	5µs	10µSEC	55µs ±2%	±1.1mm over 5.5cm display
1mS	10µS	55	50µs	.1µSEC	550µs ±2%	±1.1mm over 5.5cm display

17. e (cont'd)

Readjust R522, R41E, or C32 as necessary.

- f. *Check REMOTE WIDTH accuracy*
 Change the TYPE R116 WIDTH to REMOTE and PERIOD to 1μs X1.
 Set the Remote Program Test Fixture WIDTH to 10ns X5.

Set the TYPE 547 B TIME/CM to .1μ SEC and SWEEP MAGNIFIER to X10.
 Set the TYPE 184 for 10ns markers.
 Check for 50ns pulse width ±6% (±3mm over a 5cm display). Change the POLARITY to -. Check that pulse width is the same as before. Return the POLARITY to +. Continue checking REMOTE WIDTH as in the following table:

PERIOD RANGE	WIDTH (Remote Program)	Time Markers	TYPE 547 B TIME/CM	Pulse Width	
				Time	Difference and Reference
10μs	10ns X 55	.1μS	.1μSEC	550ns ±4%	2.2mm in 5.5cm display
100μs	1μs X 5	.5μS	1μSEC	5μs ±4%	2mm in 5cm display
1ms	10μs X 5	5μS	10μSEC	50μs ±4%	2mm in 5cm display

18. PULSE PERIOD

a. *Setup*

TYPE R116

PERIOD 1ms X1
 WIDTH 10ns X50

TYPE 547

B TIME/CM 1mSEC
 SWEEP MAGNIFIER OFF

TYPE 184

MARKER SELECTOR 1ms

- b. *Adjust Period Mult Cal, R502*
 Error: ±2%, max

Adjust R502 to superimpose pulse on time marks.

- b. Greater resolution may be obtained by changing the test scope SWEEP MAGNIFIER to X10.

- c. *Adjust Period timing, R34B*
 Error: $\pm 2\%$, max

Change the TYPE R116 PERIOD MULTIPLIER to 10m TYPE 547 B TIME/CM to 10mSEC and TYPE 184 MARKER SELECTOR to 10ms. Adjust R34B for the same result as in step 18 b.

- d. *Adjust 1 μ s Period, C55B Error:*
 $\pm 2\%$, max

Change the TYPE R116 PERIOD to 1 μ s X1, TYPE 547 B TIME/CM to 1 μ SEC and TYPE 184 MARKER SELECTOR to 1 μ s. Adjust C55B for the same result as step 18b and c.

- e. *Adjust 100ns period, C52B Error:*
 $\pm 3\%$, max

Change the TYPE R116 PERIOD to 100ns X1, TYPE 547 B TIME/CM to .1 μ SEC and TYPE 184 MARKER SELECTOR to .1 μ s. Adjust C52B for the same result as in steps 18b, c and d.

- f. *Check PERIOD MULTIPLIER linearity.*
 Timing error: $\pm 3\%$, max

Change the TYPE R116 PERIOD to 1 μ s, MULTIPLIER to 1, TYPE R116 PERIOD to 1 μ s, MULTIPLIER to 1, TYPE 547 B TIME/CM to .1 μ SEC and TYPE 184 MARKER SELECTOR to 1 μ s. Check the linearity of the PERIOD MULTIPLIER as in the following table:

TYPE 547 B TIME/CM	TYPE R116 PERIOD MULTIPLIER	Display	Maximum Displacement error
.1 μ SEC	1	1 Pulse/marker	± 3 mm in 10cm
.2 μ SEC	2	1 Pulse/2 markers	± 3 mm in 10cm
.5 μ SEC	3	1 Pulse/3 markers	± 1.5 mm in 5cm
.5 μ SEC	4	1 Pulse/4 markers	± 2.4 mm in 8cm
.5 μ SEC	5	1 Pulse/5 markers	± 3 mm in 10cm
1 μ SEC	6	1 Pulse/6 markers	± 1.8 mm in 6cm
1 μ SEC	7	1 Pulse/7 markers	± 2.1 mm in 7cm
1 μ SEC	8	1 Pulse/8 markers	± 2.4 mm in 8cm
1 μ SEC	9	1 Pulse/9 markers	± 2.7 mm in 9cm
1 μ SEC	10	1 Pulse/10 markers	± 3 mm in 10cm
2 μ SEC	11	1 Pulse/10 markers	± 1.5 mm in 5cm

- g. Check 100ns REMOTE PERIOD
Error: $\pm 5\%$, max

Change the TYPE R116 PERIOD to REMOTE, R116 Remote Program Test Fixture PERIOD to 100ns, TYPE 547 B TIME/CM to $.1\mu\text{SEC}$ and TYPE 184 MARKER SELECTOR to $.1\mu\text{s}$. Check pulse period accuracy with PERIOD MULTIPLIER at X1 and X10.

- h. Check REMOTE PERIOD, $1\mu\text{s}$ to 1ms Error: $\pm 4\%$, max

Check the pulse period from $1\mu\text{s}$ to 1ms as in step 18g using appropriate markers and sweep rates.

19. DLY'D TRIGGER SENSITIVITY

- a. Setup

TYPE R116

PERIOD	10 μs X1
WIDTH	10ns X5
DELAY OR BURST TIME	10ns
MULTIPLIER	full cw
MODE	DOUBLE

TYPE 547

B TIME/CM	$1\mu\text{s}$
TYPE 1A1	CH 1

- b. Adjust Trig Sens, R22C:
Requirement: Triggered double pulse

Rotate R22C fully cw, then ccw just to the point where a stable double pulse is displayed. Change PERIOD to 100 μs , then 1ms and readjust R22C as necessary to display stable pulses on all three PERIOD ranges.

20. DELAY OR BURST TIME

- a. Setup

TYPE R116

PERIOD	1ms X2
DELAY OR BURST TIME	10 μs X5

20.a (cont'd)

TYPE 547

B TIME/CM 5μSEC

TYPE 1A1

MODE ALT

TYPE 184

MARKER SELECTOR 50μs

b. *Adjust Delay or Burst Time*
Mult Cal, R512 Timing Error:
±2%, max

Adjust R512 to superimpose pulses on time marks.

c. *Adjust Delay Timing, R41C*
Timing error: ±2%, max

Change the TYPE R116 DELAY MULTIPLIER to 50, the TYPE 547 B TIME/CM to 50μ SEC and the TYPE 184 MARKER SELECTOR to .5ms. Adjust R41C for the same result as in step 20b. Repeat steps 20b and 20c as necessary.

d. *Check delay timing, 100ns to 10μs ranges Error: ±2%, max*

Check delay timing as in the following table:

DELAY OR BURST TIME	B TIME/CM	MARKER SELECTOR	Display	Max Error
100ns X5	.05μSEC	.5μs	1 Pulse/marker	±2%
100ns X50	.5μSEC	5μs	1 Pulse/marker	±2%
1μs X5	.5μSEC	5μs	1 Pulse/marker	±2%
1μs X50	5μSEC	50μs	1 Pulse/marker	±2%
10μs X5	5μSEC	5μs	1 Pulse/marker	±2%
10μs X50	5μSEC	.5ms	1 Pulse/marker	±2%

e. *Check REMOTE delay timing*
Timing error: ±4%, max

Change the DELAY OR BURST TIME to REMOTE. Check the delay accuracy with the R116 Remote Program Test Fixture DELAY OR BURST TIME set to 100ns X5, 1μs X5 and 10μs X5.

f. Check DELAY OR BURST TIME
MULTIPLIER linearity Error:
±2%, max

Set the DELAY OR BURST TIME to
10µs. Check DELAY OR BURST TIME
MULTIPLIER as in the following
table:

DELAY OR BURST TIME MULTIPLIER	MARKER SELECTOR	B TIME/CM	DISPLAY	Max Displacement Error
10	.1ms	10µSEC	1 Pulse/marker	10cm ±0.2cm
20	.1ms	20µSEC	1 Pulse/marker	10cm ±0.2cm
30	.1ms	50µSEC	1 Pulse/3 marker	6cm ±0.12cm
40	.1ms	50µSEC	1 Pulse/4 marker	8cm ±0.16cm
45	50µs	50µSEC	1 Pulse/9 marker	9cm ±0.18cm
55	50µs	.1mSEC	1 Pulse/11 marker	5.5cm ±0.11cm

21. BURST MODE

a. Setup

TYPE R116

PERIOD 10µs X1
DELAY OR
BURST TIME 10µs X10
WIDTH 1µs X10
MODE BURST

TYPE 547

B TIME/CM 1ms

TYPE 1A1

MODE CH 2
CHANNEL 2
VOLTS/CM 1

TYPE 114

PERIOD 1ms
VARIABLE ccw
WIDTH 1µs
VARIABLE ccw
AMPLITUDE 1 to 3V

Connect the TYPE 114 OUTPUT through
a 50Ω cable and 50Ω termination to
TYPE 1A1 INPUT 2. Adjust TYPE 114
AMPLITUDE VARIABLE for a 2 volt pulse.

21. a (cont'd)

Remove the TYPE 114 signal connection from TYPE 1A1 INPUT 2 and connect to TYPE R116 + TRIGGER INPUT . Change the TYPE 1A1 MODE to CH 1.

b. *Check burst PERIOD: 1ms
burst of pulses*
Check for a 1ms burst of pulses.

c. *Check burst WIDTH Error:
±1 pulse, max*

Change TYPE 547 B TIME/CM to .1mS and check for a burst of pulses with a duration of 100μs. Change the DELAY OR BURST TIME MULTIPLIER and note a change in the burst width. Return the DELAY OR BURST TIME MULTIPLIER to 10.

d. *Check pulse timing Error:
±2%, max*

Change the TYPE 547 B TIME/CM to 10μSEC. Check for a pulse every 10μs, corresponding to the PERIOD setting.

e. *Check pulse width Error:
±2%, max*

Change the TYPE 547 B TIME/CM to 1μSEC. Check for a pulse width of 10μs, corresponding to the WIDTH setting.

f. *Check REMOTE width Error:
±4%, max*

Change the TYPE R116 DELAY OR BURST TIME to REMOTE and check for the same display as in step 21e.

22. GATED OUTPUT*a. Setup*TYPE R116

PERIOD 10 μ s X1
 MODE GATED OUTPUT

TYPE 114

WIDTH 100 μ s

b. Check GATED OUTPUT MODE

Check for same displays as in
 step 21d and e.

c. Check REMOTE GATED OUTPUT MODE

Change the DELAY OR BURST TIME to
 REMOTE. Check for the same displays
 as in step 22b.

23. TRIGGER INPUT*a. Setup*TYPE R116

TRIGGER SOURCE EXTERNAL OR MANUAL
 MODE DLY'D SINGLE

TYPE 191

FREQUENCY RANGE 8-18MHz
 Vernier 10
 AMPLITUDE RANGE .5-5V
 AMPLITUDE 40

TYPE 1A1

MODE CH 2

Connect the TYPE 191 OUTPUT through
 a 5ns cable, GR to BNC adapter and
 50 Ω BNC termination to TYPE 1A1 INPUT
 2. Adjust the TYPE 191 for 4cm of
 deflection. Remove the TYPE 191
 signal from TYPE 1A1 INPUT 2 and
 connect it to TYPE R116 + TRIGGER
 INPUT. Change the TYPE 1A1 MODE
 to CH 1.

- b. Check 10MHz trigger: Triggered on 4 volts, 10MHz signal*

Check for a display of pulses on the test scope. Remove the TYPE 191 signal and check that pulses disappear.

- c. Check simulated R116 trigger*

Adjust the TYPE 114 for a 2V signal and connect the TYPE 114 OUTPUT through an AC Trigger adapter to TYPE R116 + TRIGGER INPUT. Check for a display of pulses on the test scope. Remove the TYPE 114 signal and check that pulses disappear.

- d. Check trigger amplitude requirement: Triggering on 2 to 20 volt signal*

Connect the SAC to + TRIGGER INPUT. Check that pulses are displayed on the test scope as SAC AMPLITUDE is changed from 2 VOLTS to 20 VOLTS. Remove the SAC connection.

- e. Check manual trigger: Triggered in all modes except GATED OUTPUT.*

Change the TYPE 547 TRIGGERING MODE to TRIG. Press the TRIG button and check for a display of a pulse in all settings of the MODE switch except GATED OUTPUT.

24. TRIGGER OUTPUT

- a. Check + PRETRIGGER OUT:
Amplitude 2V, min*

Connect + PRETRIGGER OUT through a 50 Ω cable and 1k termination to TYPE 1A1 INPUT 1. Check for triggers at least 2V in amplitude.

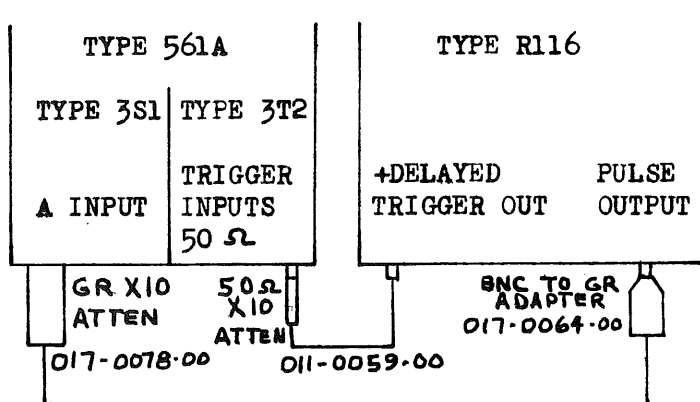
b. Check + DELAYED TRIGGER OUT:
Amplitude, 2V, min

Move the 50Ω cable and 1kΩ termination from + PRETRIGGER OUT to + DELAYED TRIGGER OUT. Check for same result as in step 24 a.

25. PULSE ABERRATIONS

a. Setup

Make connections as in the following diagram:



Set controls as follows:

TYPE R116

PERIOD	100ns X3
DELAY OR BURST TIME	10ns X5
WIDTH	10ns X5
RISETIME-FALLTIME	1ns X1

TYPE 3S1

MODE	CHANNEL A
SMOOTH-NORMAL	NORMAL
A mVOLTS/DIV	200
INVERT-NORM	NORM
SAMPLING MODE	TRIGGERED

TYPE 4S2

RANGE	1μs
TIME MAGNIFIER	X10
DISPLAY MODE	NORMAL
DISPLAY MAG	X1

- b. *Adjust + Pulse Overshoot,
C50M Overshoot or undershoot
2%, max*

Check for 5div of display amplitude, then change A m/ Volts/DIV to 20. Position the top of the display to graticule center with DC OFFSET $\pm 1V$ and adjust C50M for optimum risetime consistent with overshoot not to exceed 2% (1 div). See fig. 5. Position the bottom of the display to graticule center with DC OFFSET $\pm 1V$ and check the bottom of the waveform for overshoot not to exceed 2% (1 div). See fig. 6.

- c. *Adjust level, C82M aberrations:
 $\pm 2\%$, max*

Position the top of the waveform to graticule center with DC OFFSET $\pm 1V$.

Adjust C82M for optimum level. Position the bottom of the waveform to graticule center with DC OFFSET $\pm 1V$ and check the bottom of the waveform for aberrations not to exceed $\pm 2\%$ (1 div).

- d. *Check - POLARITY
Aberrations: $\pm 2\%$, max*

Change the TYPE R116 POLARITY to - and repeat steps 25 b and c for negative pulses.

- e. *Check REMOTE PROGRAM aberrations:
 $\pm 4\%$, max*

Change POLARITY to REMOTE PROGRAM. Check pulse aberrations on both + and - positions of the R116 Remote Program Test Fixture POLARITY switch.

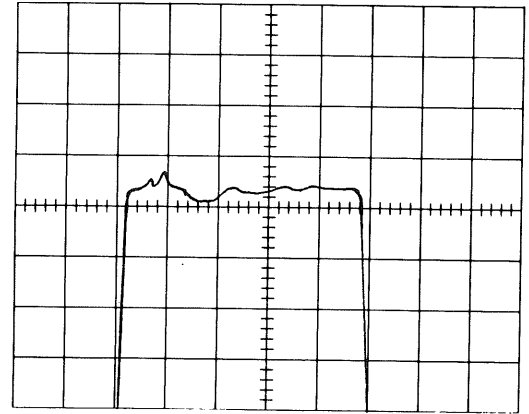


Fig 5

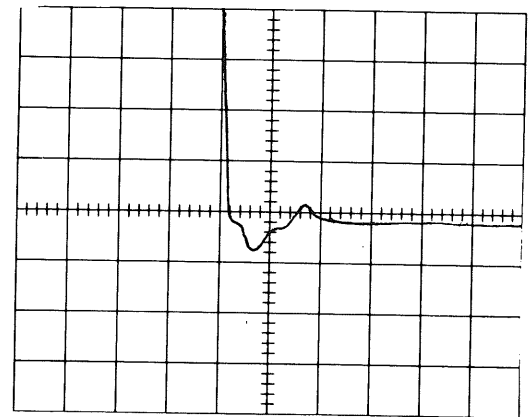


Fig 6

26. 1ns & 10ns RISETIME AND
FALLTIME RANGE

a. *Setup*

TYPE R116

PERIOD	1 μ s X1
DELAY OR	
BURST TIME	10ns X5
WIDTH	100ns X5
RISETIME-FALLTIME	
RANGE	1ns
RISETIME MULT	5
FALLTIME MULT	5
AMPLITUDE	1V X2

TYPE 3S1

A mVolts/Div 50

TYPE 3T2

RANGE	100ns
TIME MAGNIFIER	X1

b. *Adjust 1ns RISETIME FALLTIME RANGE,
C72F: 10ns \pm 10%, max*

Adjust TYPE 3S1 mVOLTS/DIV VARIABLE for exactly 5 div of display amplitude. Measure risetime from the 10% amplitude point to the 90% amplitude point. Adjust C72F for optimum risetime.

b, c. Check and note errors in TYPE 3T2. These errors must be taken into account in checking 1ns and 10ns rise-time and falltime accuracy.

c. *Check 1ns RISETIME FALLTIME RANGE
in REMOTE PROGRAM: 10ns \pm 12%, max*

Change the PROGRAM to REMOTE. Repeat step 26b.

d. *Check 10ns RISETIME FALLTIME RANGE:
20ns \pm 10%, max*

Change RISETIME FALLTIME RANGE to 10ns, RISETIME MULT 1, FALLTIME MULT to 1. Measure risetime from the 10% amplitude point to the 90% amplitude point.

e. *Check 10ns RISETIME FALLTIME RANGE
in REMOTE PROGRAM: 20ns \pm 12%, max*

Change the PROGRAM to REMOTE. Set the R116 Remote Program Test Fixture RISETIME FALLTIME RANGE to 10ns X1. Repeat step 26 c.

27. 10ns WIDTH RANGE*a. Setup*

Change the PERIOD to $10\mu\text{s}$ X1,
WIDTH to 10ns X5, RISETIME FALL-
TIME RANGE to 1ns and PROGRAM to
INT.

*b. Adjust 50nSEC Width, R523:
50ns $\pm 2\%$, max*

Measure the pulse width at the
50% amplitude point. Adjust R523
for 50ns wide pulse.

*c. Check REMOTE 50ns Width:
50ns $\pm 4\%$, max*

Change the WIDTH to REMOTE. Set
the R116 Remote Program Test Fixture
WIDTH to 10ns X5.

*d. Adjust 500ns Width, C32E: 500ns
 $\pm 2\%$, max*

Change the WIDTH to 10ns X50. Change
TYPE 3T2 RANGE to $1\mu\text{s}$ and TIME MAGNI-
FIER to X1. Adjust C32E for a 500ns
wide pulse. Repeat steps 27b and d
as necessary.

*e. Check REMOTE 550ns width: 550ns
 $\pm 4\%$, max*

Change the WIDTH to REMOTE. Set the
R116 Remote Program Test Fixture
WIDTH to 10ns X55. Check for a
500ns wide pulse.

28. 10ns DELAY RANGE*a. Setup*TYPE R116

PERIOD	$10\mu\text{s}$ X1
DELAY OR BURST TIME	10ns X10
WIDTH	10ns X5
<u>TYPE 3T2</u>	

RANGE	$1\mu\text{s}$
TIME MAGNIFIER	X10

28. a (cont'd)

Connect + PRETRIGGER OUT through a 50Ω cable and 50Ω X10 attenuator to TYPE 3T2 TRIGGER INPUTS 50Ω.

b. *Adjust 50ns Delay, R513: 100ns delay ±2%, max*

Center the display vertically. Position the start of the display to the first vertical graticule line. Adjust R513 to position the end of the display at the last graticule line see fig. 7.

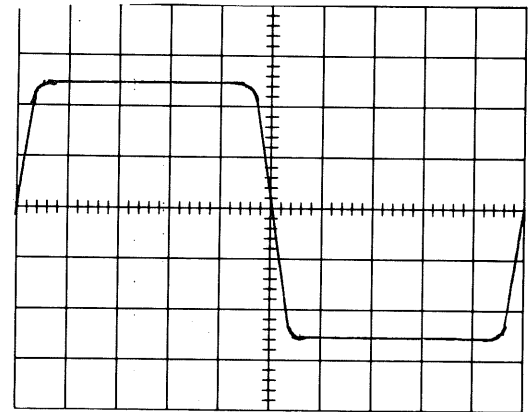


Fig 7

c. *Adjust 500ns Delay, C32C: 500ns delay ±2%, max*

Change the TYPE R116 DELAY OR BURST TIME MULTIPLIER to 50. Again center the display vertically and position the start of the display to the first vertical graticule line. Adjust C32C to position the end of the display to the last vertical graticule line see fig. 8.

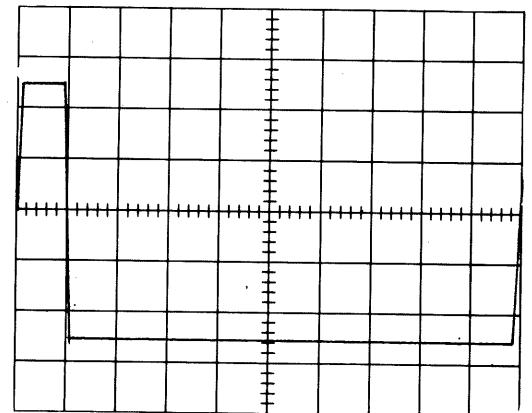


Fig 8

d. *Check 50ns delay in REMOTE 50ns ±4%, max*

Change the DELAY OR BURST TIME to REMOTE. Change the TYPE 3T2 RANGE to 1μs and TIME MAGNIFIER to X10. Check for same display as in step 28b.

e. *Check 550ns delay in REMOTE 550ns ±4%, max*

Change the R116 Remote Program Test Fixture DELAY OR BURST TIME MULTIPLIER to 55. Change the TYPE 3T2 RANGE to 10μs and TIME MULTIPLIER to X10. Check for two pulses 5.5 horizontal divisions apart ±0.22 div, max.