

TYPE 533 OSCILLOSCOPE

FACTORY CALIBRATION PROCEDURE

Quick check for long ends, unsoldered joints, wire dress, etc. Preset all pots and trimmers to mid-range, except delay line. Check to see that the CRT pin connections are tight. Tighten set screw in TRIGGER LEVEL knob just snug enough that the knob can be turned on the shaft. Install TEST LOAD UNIT switched to LO LOAD with the scope in upright position and turn the INTENSITY and SCALE ILLUM. controls full left (ccw).

1. CHECK POWER SUPPLY RESISTANCE TO GROUND

The 100 v will be more than 400 Ω to ground, the -150 v more than 4 k Ω , 225 v more than 4 k Ω , 350 v more than 20 k Ω , and the 500 v supply above 25 k Ω . Check transformer primary for infinite resistance to ground.

2. CHECK TIME DELAY RELAY

Turn the scope on and check time delay relay delay. (15 to 45 seconds)

3. CHECK VOLTAGES AND MEASURE RIPPLE AND REGULATION

Adjust -150 v supply with -150 ADJ. Check 100 v, 225 v, 350 v, and 500 v supplies. (+ or - 2%) Check elevated heater supplies at transformer terminals. (100 v at 22 and 23, 225 v at 27 and 28, 350 v at 9 and 16, -hv at 24 and 25.)

Check power supplies for proper regulation with line at 105 v, TEST LOAD UNIT switched to HI LOAD, and with line at 125 v, TEST LOAD UNIT switched to LO LOAD. The ripple on each supply in regulation will be approximately as follows: -150 v, 5 millivolts. 100 v, 5 millivolts, 225 v, 3 millivolts. 350 v, 6 millivolts. 500 v 7 millivolts. (measured with a test scope.) Ripple may be as high as 10, 10, 5, 15, and 15 millivolts respectively.

4. SET CAL ADJ.

With the SQUARE WAVE CALIBRATOR OFF, adjust CAL. ADJ. for 100 v at CAL. TEST PT. Turn CALIBRATOR ON. Voltage at CAL TEST PT. must read between 45 and 55 v. (Calibrator symmetry $\pm 10\%$)

5. SET HV ADJ.

Turn scope to an upright position and adjust H.V. ADJ. control for -1350 v. Read at front of the 27K resistor at the forward ceramic strip located above the crt shield. This adjustment can be made conveniently on the 1200 v scale on the meter by measuring to -150 v instead of ground. Turn off the scope and install shield over high voltage supply. (If protective slide rails are being used, install a modified shield.) With TIME/CM switch at 1 MILLISEC, advance STABILITY and INTENSITY controls and position the trace on the CRT with the VERTICAL and HORIZONTAL controls.

6. CHECK SCALE ILLUM. AND POSITIONING CONTROLS.

Check the SCALE ILLUM. control. Check position controls against the position-indicating neon lights. Check scope for microphonics. Align trace with horizontal graticule lines, push crt forward against graticule and tighten crt clamp.

7. CHECK HV REGULATION

Check hv regulation by varying line from 105 v to 125 v. There should be no trace blooming at high or low intensity.

8. SET CRT GEOM. ADJ.

Insert from the SQUARE WAVE CALIBRATOR enough signal so that only the vertical portions of the signal are visible within the graticule. Adjust STABILITY and TRIGGERING LEVEL controls for a stable display. (The trigger circuit has not been adjusted so if it is not possible to obtain a stable display, adjust the TRIG SENS and/or TRIGGERING LEVEL CENTERING pot.) Adjust GEOM ADJ. to obtain minimum curvature of the vertical traces.

9. CHECK VERTICAL AMPLIFIER BALANCE

Short crt vertical deflection plates to determine the crt electrical center. Short the grids of the 6197's, 6DJ8's, and 12BY7's in that 0.75 cm per stage with no more than 2 cm overall.

10. CHECK VERTICAL COMPRESSION OR EXPANSION

Position 2 cm of calibrator signal up and down within the graticule lines. Allowable compression or expansion is 1 mm.

11. SET VERTICAL GAIN ADJUST

Switch TEST LOAD UNIT to 250:1 and apply a 100 v signal from SQUARE WAVE CALIBRATOR and adjust AMPL. GAIN for 4 cm of vertical deflection. Switch SQUARE WAVE CALIBRATOR to 0.2 v, TEST LOAD UNIT to 1:1 and check for 2 cm of vertical deflection.

12. CHECK SQUARE WAVE CALIBRATOR and VOLTS to MILLIVOLTS DIVIDER.

Remove the TEST LOAD UNIT and install a 53/54 K PLUG IN UNIT. Check accuracy of SQUARE WAVE CALIBRATOR voltage steps with the K UNIT VOLTS/CM step switch. Compare the VOLTS range to the MILLIVOLTS range.

13. CHECK VERTICAL SHIFT COMPENSATION

Vertically deflect the trace with enough dc voltage to move the trace about 4 cm. Note the drift after the trace stops. This is a very slow drift and must be watched for a few seconds to see the direction of drift. This drift should be limited to 1mm or less.

14. SET TRIGGERING LEVEL CONTROL

Set the trigger controls to +INT and DC, TIME/CM to 100 μsec, STABILITY full left (ccw) but not to PRESET. Set the test scope VERTICAL INPUT to .05 VOLTS/CM, DC, set the trigger on LINE, AUTOMATIC, and set the sweep TIME/CM switch to 1 MILLISEC, X2. Use a 10X probe properly adjusted. Center the trace on the test scope for a zero reference. Connect the probe to the grid end of the 470 K resistor from the arm of TRIGGERING LEVEL pot on scope under calibration and set pot to zero volts. Physically center knob and tighten set screw. Leave TRIGGERING LEVEL control at zero volts during succeeding adjustments. (Connect a jumper to ground from the grid end of the 470 K resistor to make sure it remains at zero volts.)

15. SET INT. TRIG. D.C. LEVEL ADJ.

Position the trace of the scope under calibration to the center of the graticule, recheck the test scope zero reference, and connect the probe to R26 47Ω to pin 7 of V24. This point should be at zero volts. Now switch the scope under calibration from +INT to -INT and adjust INT. TRIG. D.C. LEVEL ADJ. for zero volts as indicated on the test scope.

16. ADJUST TRIGGER LEVEL CENTERING AND TRIGGER SENS.

Using a 10X probe on the test scope, set the test scope at: AUTO, +int, sweep rate 2 MILLISEC/CM, and vertical at 0.5V/CM. With the grid end of R19 grounded, connect the probe to pin #6 of V45. Obtain 2 mm of vertical deflection from the calibrator. (The lowest level it is desired to trigger on.) Adjust the TRIGGER LEVEL CENTERING for multivibrator operation. Back off the TRIGGER SENS. until the oscillations on the multi waveform cease and the multi is stable on + and - triggering.

17. ADJUST PRESET STABILITY.

Turn TRIGGERING MODE to AUTOMATIC, + LINE. Turn the PRESET control clockwise until the sweep triggers. (STABILITY control set to PRESET position.) The center arm of the control should read about 80 v on a meter. Now continue turning PRESET control until the sweep free runs. (Trace will brighten.) The center arm on the control should be between 15 and 25 volts higher. Turn the control back until the meter reads half way between the two readings.

18. CHECK TRIGGER CIRCUIT FOR PROPER OPERATION

Obtain 2 mm of vertical deflection from the calibrator and see that the trigger circuit will work properly in all positions, except LINE and HF SYNC, of the TRIGGER SLOPE and TRIGGERING MODE switches. Remove grounding jumper.

19. CHECK LINE TRIGGER FOR PROPER PHASE

Connect a 10X probe to the input of the scope. Connect the probe to the ac line at the fuse holder. Check that the scope triggers on the proper phase with the TRIGGER SLOPE switch on LINE + and -.

20. ADJUST DELAY LINE AND HF COMPENSATIONS.

With the VOLTS/CM switch at 0.05, variable VOLTS/CM control full right (cw), insert into the K UNIT from a properly terminated fast rise time square wave generator, a 400 kc signal of about 3 cm of vertical deflection. A TYPE 53/54 P UNIT can also be used. Switch the TIME/CM to 1 μsec X5. Adjust the trimmers in the delay line with an insulated tool for optimum square-wave response. The variable coils control the amount of spike on the leading edge of the waveform.

21. MEASURE VERTICAL RESPONSE.

Measure the bandwidth with a constant amplitude sine wave generator, for example, TYPE 190. Turn the generator to approximately 500 kc and insert enough signal for 4 cm of vertical deflection, increase the frequency to 15 mc. The signal should still be at least 2.8 cm in amplitude.

22. CHECK HF SYNC.

Turn the signal generator to 30 mc, switch TRIGGERING MODE to HF SYNC. A stable display should be obtained with about 2 cm or less of vertical deflection by adjusting the STABILITY control.

23. ADJUST X10 CAL. (R342).

From time mark generator apply 10, 100 and 1000 μsec markers to vertical INPUT. With scope timing controls at 1 MILLISEC X10 adjust R342 for one 100 μsec marker/cm.

24. ADJUST X1 CAL. (R368).

Set SWEEP MAGNIFIED to X1 and adjust R368 for one 1000 μsec marker/cm.

25. ADJUST X100 CAL. (R356)

Set SWEEP MAGNIFIED to X100 and adjust R356 for one 10 μ sec marker/cm. Repeat steps 23, 24, and 25 as these steps interact.

26. ADJUST HORIZONTAL DC SHIFT COMPENSATION.

With no signal applied TIME/DIV switch in 1 msec and magnifier to X100, turn STABILITY control cw until sweep free runs. Observe drift in start of sweep and adjust R365, HORIZONTAL DC SHIFT for minimum drift.

27. ADJUST SWEEP LENGTH.

Adjust SWP LENGTH control for approximately 10.5 cm of horizontal sweep.

28. ADJUST SWP/MAG REGIS.

Using 1 millisecc time marks with MAGNIFIER X100, position the trace so that the first time mark falls on the center line of the graticule. Turn MAGNIFIER, X1 and adjust SWP. MAG/REGIS., so that the first time mark again falls on the center line of the graticule. Check to see that the MAG. X100 and MAG. X1 positions register properly in the middle and at the end of the sweep.

29. CHECK ALL POSITIONS OF THE SWEEP MAGNIFIED SWITCH.

With 10, 100 and 1000 μ sec time markers applied to vertical INPUT, check all positions of magnifier.

30. CHECK SWEEP RATES, 5 SEC/CM TO .1 MILLISEC/CM.

Switch HORIZONTAL DISPLAY to NORMAL, apply time markers as indicated and check timing as follows:

<u>TIME/CM</u>	<u>Time Markers</u>	<u>Observe</u>
<u>1 MILLISEC</u>	1 millisecc	1 marker/cm
<u>2 MILLISEC</u>	1 millisecc	2 marker/cm
<u>5 MILLISEC</u>	5 millisecc	1 marker/cm
<u>10 MILLISEC</u>	10 millisecc	1 marker/cm
<u>100 MILLISEC</u>	100 millisecc	1 marker/cm
<u>1 SEC</u>	1 sec	1 marker/cm
<u>2 SEC</u>	1 sec	2 marker/cm
<u>5 SEC</u>	5 sec	1 marker/cm
<u>100 μSEC</u>	100 μ sec	1 marker/cm

31. CHECK VARIABLE SWEEP RATE CONTROL. CHECK UNCALIBRATED NEONS AND MAGNIFIER ON INDICATOR.

Check VARIABLE TIME/CM for smooth operation and a complete range of control between the TIME/CM steps. The UNCALIBRATED neon must light whenever the VARIABLE TIME/CM control is moved away from full cw position. MAGNIFIER ON indicator must light on all positions of SWEEP MAGNIFIED switch except NORMAL. MAGNIFIER UNCALIBRATED indicator must light whenever sweep speeds exceed 20 millimicro sec/cm.

32. ADJUST FAST SWEEP SPEED TIMING.

Preset C387 and C388 with slugs about 3/8" out. Preset C378 and C382 to maximum capacitance. NOTE: All magnified sweep speed linearity checks should be made at 10% from the start of the sweep, 10% from the end of the sweep as well as at the center of the sweep.

32. ADJUST FAST SWEEP SPEED TIMING. (Cont.)

<u>TIME/CM</u>	<u>SWEEP MAGNIFIED</u>	<u>Time Markers</u>	<u>Check or Adjustment</u>
<u>50 μSEC and</u> <u>100 μSEC</u>	<u>X1</u>	10 μsec	C337 for same starting position when <u>TIME/CM</u> switch is operated.
<u>.1 μSEC</u>	<u>X1</u>	10 mc	C160A for timing and C361 A for linearity.
<u>10 μSEC</u>	<u>X1</u>	10 μsec	C160 E for 1 marker/cm.
<u>1 μSEC</u>	<u>X1</u>	1 μsec	C160 C for 1 marker/cm.
<u>2 μSEC</u>	<u>X1</u>	1 μsec	Resistor check 2 markers/cm.
<u>5 μSEC</u>	<u>X1</u>	1 μsec	Resistor check 5 markers/cm.
<u>2 μSEC</u>	<u>X100</u>	50 mc	C387 and C388 for linearity and timing.
<u>1 μSEC</u>	<u>X50</u>	50 mc	Check timing and linearity.
<u>.5 μSEC</u>	<u>X20</u>	50 mc	Check timing and linearity. (5 cycles over 4 cm).
<u>.2 μSEC</u>	<u>X10</u>	50 mc	Check timing and linearity.
<u>.1 μSEC</u>	<u>X5</u>	50 mc	C361E for linearity.
<u>.1 μSEC</u>	<u>X2</u>	50 mc	C361C for linearity. (5 cycles over 2 cm).
<u>.1 μSEC</u>	<u>X1</u>	10 mc	C361A for linearity

Recheck timing 50 μSEC to .1 μSEC.

33. SET LOCKOUT LEVEL ADJUST R125.

Set HORIZONTAL DISPLAY at NORMAL. Connect a voltmeter to pin 7, cathode, of V125 bring up STABILITY control to the point just before the sweep free runs and observe reading. Switch to SINGLE SWEEP, trigger sweep (ready light should extinguish indicating that sweep is locked out), then set LOCKOUT LEVEL ADJ. for a meter reading 11 volts lower (less negative) than previous reading. Operate SINGLE SWEEP switch to RESET to arm the sweep circuit, then trigger sweep with signal applied to vertical INPUT. After sweep has been triggered once turn STABILITY ccw slowly to insure that sweep does not retrigger.

34. ADJUST EXT. SWP. AMPL. D.C. BAL.

Connect SAWTOOTH OUT into vertical INPUT and switch HORIZONTAL DISPLAY to EXT. SWEEP adjust EXT. HORIZ. AMPL. D.C. BAL. for no horizontal shift of vertical trace when turning EXTERNAL HORIZONTAL VARIABLE control back and forth.

35. SET EXT. HORIZ. AMP. CAL. R361M.

Apply .5 VOLTS of calibrator signal to EXTERNAL HORIZ. IN. With EXTERNAL HORIZONTAL switch in .1 VOLT/CM, VARIABLE control cw, adjust R361M for 5 cm of horizontal deflection. Check 1 and 10 VOLT/CM positions with 5 and 50 VOLTS of calibrator signal.

36. CHECK EXTERNAL HORIZONTAL ATTENUATOR COMPENSATION.

With .5 VOLTS of calibrator signal applied check the .1 position of the EXTERNAL HORIZONTAL switch for square wave presentation. Switch to 1 on EXTERNAL HORIZONTAL and 5 VOLTS on calibrator, adjust C310 for optimum square wave presentation. Switch to 10 and 50 VOLTS and adjust C313. Check EXTERNAL HORIZONTAL VARIABLE control to be smooth in operation and continuously variable between switch steps.

37. CHECK HOLD-OFF

Connect a probe from test scope, set for DC input, to the right hand end of C337. Set STABILITY full right (cw). Check all ranges of TIME/CM switch for sufficient hold-off.

38. CHECK THE FRONT PANEL WAVEFORMS

With a test scope set for DC input, using a 1X (straight thru) probe, check + GATE OUT for a gate waveform of about 20 v amplitude with its base on the zero volt reference line on the test scope. SAWTOOTH OUT should be about 150 v in amplitude with its base line on a zero reference except on the two fastest speeds where the base line should raise about 20 v. Out of the VERT. SIG. OUT there should be 2 v of signal for every cm of vertical deflection on the scope under calibration.

39. CHECK CRT CATHODE INPUT.

Remove CRT CATHODE GND. strap from rear of scope and insert signal from calibrator and check sweep for intensity modulation. With normal intensity, 20 v of calibrator signal will modulate the trace.

40. CHECK DUAL TRACE CHOPPED BLANKING.

Insert 53/54 C PLUG-IN UNIT. Operate MODE switch to CHOPPED and obtain two traces with VERTICAL POSITION controls. With TIME/CM switch at 5 μSEC obtain a stable display. With normal operating INTENSITY, operate CRT CATHODE SELECTOR switch to DUAL TRACE CHOPPED BLANKING, transient spikes should be blanked out.

41. MAKE A NOTE OF CRT TYPE AND SERIAL NUMBER AND RECORD ON CALIBRATION RECORD.