TYPE 541A OSCILLOSCOPE

F A C T O R Y

C A L I B R A T I O N P R O C E D U R E

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 screws 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). If, during the calibration there is any question concerning tolerances or limits of any of the circuits refer to the Factory Specifications on Type 541 and 545 Oscilloscopes.

1. CHECK POWER SUPPLY RESISTANCE TO GROUND

   The 100 v will be more than 400Ω to ground, the -150 v more than 2KΩ, 225 v more than 5KΩ, 350 v more than 10KΩ and the 500 v supply above 25KΩ. Check transformer primary for infinite resistance to ground.

2. CHECK TIME DELAY RELAY

   Turn the scope on and check time delay relay (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. (±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 also, 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.)

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 v and 55 v. (Calibrator symmetry ±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 POSITION 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. Check hv regulation by varying line from 105 v to 125 v. There should be no trace blooming with high intensity.

7. SET CRT GEOM. ADJ.

Insert from the SQUARE-WAVE CALIBRATOR enough signal so that only the rising and falling 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.

8. CHECK DISTRIBUTED AMPLIFIER BALANCE

Invert the scope and place a volt meter across the grid lines of the distributed amplifier. Adjust VERTICAL POSITION to the point where there is zero volts from one grid line to the other. With the plus probe of the meter, check either cathode of each stage in the amplifier for at least one volts of bias.

9. CHECK VERTICAL AMPLIFIER BALANCE

Short the crt vertical deflection plates to determine the crt electrical center. Short the grid lines together and observe the trace shift. This shift should not exceed 2 mm in all of the 6DK6 stages combined. Next, short the grids of the 6DJ8's and then the 12BY7's. No more than 1 cm of unbalance in these stages and overall amplifier unbalance should not exceed 1.5 cm. Adjust the graticule positioning cam to align the graticule center line with the center of the usable area of the crt.

10. CHECK VERTICAL COMPRESSION OR EXPANSION

Position 2 cm of calibrator signal up and down within the graticule lines. Allowable compression or expansion is ±0.5 mm.

11. SET VERTICAL GAIN ADJ.

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 ALTERNATE SWEEP AND CHOPPED BLANKING

Check scope for ALTERNATE SWEEP operation by switching TEST LOAD UNIT to DUAL TRACE. Switch TEST LOAD UNIT to CHOPPED or install a "C" unit switched to CHOPPED. With normal INTENSITY, switch CRT CATHODE SELECTOR switch to DUAL TRACE CHOPPED BLANKING, transient spikes should be blanked out. Remove the TEST LOAD UNIT and install a 53/54 K PLUG-IN UNIT.

13. CHECK SQUARE-WAVE CALIBRATOR

Check accuracy of SQUARE-WAVE CALIBRATOR voltage steps with the K unit VOLTS/CM step switch.

14. CHECK DC SHIFT COMPENSATION

Vertically deflect the trace with enough dc voltage to move the trace about 4 cm. After the trace stops, watch for a few seconds to see the drift. It is generally negligible.

15. 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 470K 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.

16. 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 R8, 47Ω to pin 7 of V8. 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.

17. ADJUST TRIGGER LEVEL CENTERING

Set TRIGGERING MODE switch to AC SLOW and TRIGGER SLOPE switch to +LINE. Switch test scope VOLTS/CM switch to 0.2 VOLTS/CM, AC. Connect probe to pin 1 of V20, on scope under calibration, and adjust TRIGGERING LEVEL CENTERING so that the waveform on the test scope is symmetrical. For final adjustment switch test scope MAGNIFIER, ON and horizontally center switching portion of the multi waveform. Now switch the TRIGGER SLOPE switch, of the scope under calibration, back and forth from +LINE to -LINE and at the same time readjust TRIGGERING LEVEL CENTERING until there is no horizontal shifting of the switching position of the multi waveform.

18. ADJUST TRIGGER SENS

Turn the TRIG. SENS. pot to the right (cw) until oscillation occurs at the leading and trailing edges of the multi waveform. (Test scope probe should still be as in Step 17.) Note the amplitude of the spike on the waveform just at the point of oscillation. Now turn the TRIG. SENS. left (ccw) until this spike is slightly less than one-half (0.5) of the original size.

19. ADJUST PRESET STABILITY

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

20. 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.

21. 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.

22. MEASURE VERTICAL RESPONSE

Measure the bandwidth with a constant amplitude sine-wave generator, for example, Tektronix Type 190. Turn the generator to 50 kc and insert enough signal for 4 cm of vertical deflection, increase the frequency to 30 mc. The signal should still be at least 2.8 cm in amplitude.

23. 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 MAIN SWEEP STABILITY.

24. ADJUST SWEEP LENGTH

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

25. ADJUST MAG GAIN

With TIME/CM switch at 1 MILLISEC insert 1 millisec and 100 μsec markers from the time mark generator. Turn MAGNIFIER ON and adjust MAG GAIN for 5X magnification. (1 large mark every 5 cm and 2 small marks every cm. Check magnifier linearity over the entire sweep length.)

26. ADJUST SWP/MAG REGIS.

With MAGNIFIER ON, position the trace so that the first time mark falls on the center line of the graticule. Turn MAGNIFIER OFF 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. ON. and MAG OFF positions register properly in the middle and at the end of the sweep.

27. ADJUST SWEEP CAL.

Apply 1 millisec time marks to INPUT. TIME/CM switch set to 1 MILLISEC. Adjust SWEEP CAL. for one time-mark per cm. When any timing adjustments are made always make them from the 1 cm line to the 9 cm line on the graticule.

28. CHECK SWEEP RATES

Check timing of all sweep rates between 2 sec/CM and 0.1 millisec/CM. Timing ±2%. Check VARIABLE sweep rate control for coverage between ranges. Check to see that the UNCALIBRATED neon comes on whenever the VARIABLE control is not in the CALIBRATED position.

29. ADJUST FAST SWEEP TIMING

Insert 50 μsec markers into scope, X5, MAG ON. Switch from 0.1 msec/cm to 50 μsec/cm and adjust C330 so that the sweep starts at the same point at both sweep speeds.

For the following sweep speeds, set:

SWP SPEED	Time marks	Adjust	For
10μsec	10 μsec	C160E	Timing
1μsec	1 μsec	C160C	Timing
0.5 μsec	1 μsec	C160A	Timing
0.1 μsec	10 MC *	C348	Timing
		C375	Linearity
0.1 μsec X5 MAG	50 MC *	C364	Timing
* Sync Externally		C384	Timing

All adjustments from 1 μsec/CM through 50 MC timing interact so it may take several adjustments to bring all ranges within the required 2% tolerance. Check timing of all intermediate ranges.

30. ADJUST EXT. SWP. AMPL DC BAL. AND COMPENSATIONS

Connect SAWTOOTH OUT into vertical INPUT. With MAG ON, switch HORIZONTAL DISPLAY to EXT SWEEP. Adjust EXT SWP AMPL DC BAL for no horizontal shift of vertical trace when turning EXT. SWEEP ATTENUATOR 1-10 back and forth.

Apply 0.5 v of square wave to EXT SWP IN with MAGNIFIER ON. Externally trigger the scope. Switch HORIZONTAL DISPLAY to X10. Adjust C301C for the same presentation in the X10 position as that obtained in the X1 position. Check ATTENUATOR for 10 to 1 attenuation. (±2%)

31. CHECK EXT. SWEEP IN DEFLECTION FACTOR

With 0.2 v of calibrator signal fed into the EXT. SWEEP IN, EXT SWEEP ATTENUATOR switch X1, Variable control full right (cw) MAG ON, at least one cm of horizontal deflection must be observed.

32. CHECK HOLD-OFF

Connect a probe from test scope, set for DC input, to the right hand end of C330. Set STABILITY full right (cw). Check all ranges of TIME/CM switch for sufficient hold-off.

33. CHECK THE FRONT PANEL WAVEFORMS

With a test scope set for DC input, using a 1X (straight through) 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 approximately 2 v of signal for every cm of vertical deflection on the scope under calibration.

34. 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 ±.

35. CHECK CRT CATHODE INPUT

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

36. CHECK FOR CATHODE INTERFACE

Display about 3 cm of 400 kc square wave. Cathode interface will appear to be a spiking of the front corner of the square wave. Interface can be most readily identified by varying the line voltage. It will be worst at low line voltages and will be least at high voltages.

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