

# TYPE 531A 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 the TRIGGER LEVEL knob just snug enough so 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 $\Omega$  to ground, the -150 v more than 4K $\Omega$ , 225 v more than 5K $\Omega$ , 350 v more than 10K $\Omega$  and the 500 v supply above 25K $\Omega$ . 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. ( $\pm 2\%$ ) Check elevated heater supplies at transformer terminals. (100 v at 22 & 23, 225 v at 27 & 28, 350 v at 9 & 16, -hv at 24 & 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 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 (calibration 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 with respect 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 control against the position-indicating neon lights. Check scope for microphonics. Align the 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 or low 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 VERTICAL AMPLIFIER BALANCE.

Short crt vertical deflection plates to determine crt electrical center, then the 6197 plates, etc. through each vertical stage. Allowable unbalance per stage is 0.75 cm. Determine over-all balance by pressing TEST LOAD UNIT SHORT button. Allowable over-all unbalance  $\pm 2$  cm.

9. 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.

10. SET VERTICAL GAIN ADJ.

Switch TEST LOAD UNIT to 250:1 and apply a 10v 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.

11. CHECK ALTERNATE SWEEP OPERATION.

Check scope for ALTERNATE SWEEP operation by switching TEST LOAD UNIT to DUAL TRACE. Remove the TEST LOAD UNIT and install a 53/54 K PLUG-IN UNIT.

12. CHECK SQUARE-WAVE CALIBRATOR.

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

13. CHECK DC SHIFT COMP.

Vertically deflect trace with enough dc voltage to move the trace about 6 cm. The dc shift should be less than 1 mm after deflection.

14. SET TRIGGERING LEVEL CONTROL.

Set the trigger controls to +INT and DC. Set the test scope VERTICAL INPUT to .05 VOLTS/CM, DC, set the test scope trigger on LINE, AUTOMATIC and set the SWEEP TIME/CM switch to 2 MILLISEC. 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.

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

Position the trace of the scope under calibration to the center of 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.

16. 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 6 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 re-adjust TRIGGERING LEVEL CENTERING until there is no horizontal shifting of the switching portion of the multi waveform.

17. 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 as in Step 16.) 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.

18. 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 of 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.

19. 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.

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 0.5 μSEC. 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, Tektronix Type 190. Turn the generator to 50 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 MAIN SWEEP STABILITY.

23. ADJUST MAG. GAIN.

With TIME/CM switch at 1 MILLISEC, insert 1 millisecc 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. Check MAG ON neon.

24. ADJUST SWEEP CAL.

Apply 1 millisecc time marks to INPUT. TIME/CM switch set to 1 millisecc. 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.

25. ADJUST SWEEP LENGTH.

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

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. CHECK LF SWEEP TIMING, 5 SEC/CM THROUGH 0.1 MILLISEC/CM.

Using the time mark generator, check all timing ranges from 5 sec/CM through 0.1 millisecc/CM. Accuracy ±2%. Check VARIABLE coverage. Check UNCALIBRATED neon operation.

28. ADJUST HF TIMING.

Apply 10  $\mu$ sec markers to the scope with the MAGNIFIER ON and adjust C330 so the sweep starts at the same point for 50 and 100  $\mu$ sec sweep speeds. For the test of the sweep speeds, use external triggering on all sine wave markers and set:

<u>Time/CM</u>	<u>Time Mark Gen.</u>	<u>Adjust</u>	<u>For</u>
10 $\mu$ sec	10 $\mu$ sec	C160E	1 marker/cm
1 $\mu$ sec	1 $\mu$ sec	C160C	1 marker/cm
0.5 $\mu$ sec	1 $\mu$ sec	C160A	Position first marker to left of graticule.
			1 marker/ 2 cm
0.1 $\mu$ sec	10 MC	Adjust for linearity and timing	
2 $\mu$ sec	1 $\mu$ sec	C375 and C348 check timing	1 marker/cm
5 $\mu$ sec	5 $\mu$ sec	check timing	2 markers/cm
0.1 $\mu$ sec X5 Mag.	50 MC	C364 and 384	1 marker/cm

There will be interaction between the linearity adjustment of C348 and C375 and the timing adjustment of C160C and C160A so it will be necessary to go back and readjust these steps over again until the timing is correct.

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

Connect SAWTOOTH OUT into vertical INPUT. Switch HORIZONTAL DISPLAY to EXT. SWP. X1, 5X MAGNIFIER ON,. Adjust EXT. SWP. AMPL. D.C. BAL. FOR no horizontal shift of vertical trace when turning EXT. SWEEP ATTENUATOR 10-1 back and forth.

30. ADJUST EXT. SWEEP AMP COMP.

Apply 2 v of square wave to EXT. SWP. IN. and externally trigger sweep. Switch HORIZONTAL DISPLAY to X10, MAGNIFIER ON and adjust C301C for approximately the same presentation in X10 as is obtained in X1 position.

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. Increase Calibrator signal to 2 v, switch the attenuator to X10 and check X10 attenuator accuracy ( $\pm 2\%$ ).

32. CHECK HOLD OFF.

Connect a 10X 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 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 2 v of signal for every cm of vertical deflection on the scope under calibration.

34. 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.

35. CHECK DUAL TRACE CHOPPED BLANKING.

Insert a 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.

36. CHECK LINE TRIGGER FOR PROPER PHASE.

Connect a 10X probe to the input of the TEST LOAD UNIT or PLUG-IN. Connect the probe to the line at the fuse holder. Check that the Trigger SLOPE switch triggers on the proper phase with the TRIGGER SOURCE switch on LINE.

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