

TYPE 515A 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

First make a visual mechanical inspection. Check for long ends, unsoldered joints, wire dress, etc.

1. CHECK POWER SUPPLY RESISTANCE TO GROUND

Invert the scope and check power supply resistance to ground:

-150	5 K Ω	+160 unreg.	30 K Ω
+100	8 K Ω	+400 unreg.	15 K Ω
+300	15 K Ω		

Check transformer primaries for infinite resistance to ground.

2. SET -150 ADJ. AND CHECK LOW VOLTAGE SUPPLIES

Connect an accurate voltmeter to the -150 v bus. Set the -150 ADJ. control, located behind the delay line, to obtain a reading of -150 v. Check to see that the 100 v and 300 v supplies are within $\pm 2\%$ of their rated values. All the regulated supplies should remain steady as the line voltage is varied from 105 to 125 v. Check ripple on all regulated supplies.

3. SET CAL. ADJ.

Turn SQUARE WAVE CALIBRATOR OFF. Set CAL. ADJ. for 100 v at CAL. VOLTAGE CHECK jack. Turn SQUARE WAVE CALIBRATOR to .05. Voltage at CAL. VOLTAGE CHECK jack must read between 45 and 55 v.

4. SET -1675 V ADJ. AND CHECK HIGH VOLTAGE SUPPLY REGULATION

Connect a voltmeter to one of the black wires on the F&I chassis. Set the -1675 v ADJ. to obtain a reading of -1675 v. Regulation of the hv supply can be checked after a trace has been obtained by watching for blooming. Turn scope off before installing hv shield.

5. CHECK SCALE ILLUM. CONTROL

Check the SCALE ILLUM. control to see that there are no open spots in the pot and that it is wired so that the graticule lights are brightest when the control is full right (cw). With TIME/CM switch at 1 MILLISEC advance STABILITY and INTENSITY controls and position the trace on the crt with VERTICAL and HORIZONTAL POSITIONING. Align the trace with the horizontal graticule lines, push the crt forward against the graticule and tighten the crt clamp.

6. SET CRT GEOM ADJ.

From the SQUARE WAVE CALIBRATOR insert into INPUT 1 or 2 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 yet been adjusted so if its not possible to obtain a stable display, vary the TRIGGERING LEVEL CENTERING adjustment.) Adjust GEOM ADJ. (on bracket mounted on the sweep chassis) to obtain minimum curvature of the vertical traces.

7. SET DC BAL. AND CHECK GAS AND MICROPHONICS

With no vertical deflection of the trace, turn the VARIABLE VOLTS/CM control back and forth and at the same time adjust DC BAL. for no vertical shift. Tap the scope on the top edge of the front panel and watch the trace for indication of microphonic tubes. Set the VOLTS/CM switch to .05. Ground INPUT 1 and switch the INPUT SELECTOR from AC to DC. (1 mm of vertical shift is allowable.)

8. CHECK VERTICAL AMPLIFIER BALANCE

With the VERTICAL POSITIONING control in the center of its range, the trace must be within 1 cm of the center graticule line.

9. CHECK VERTICAL COMPRESSION OR EXPANSION

Apply a calibrator signal which provides 2 cm of vertical deflection when the display is centered vertically. This deflection should not be reduced or expanded by more than 0.5 mm when the display is raised to the top of the graticule or lowered to the bottom of the graticule by means of the VERTICAL POSITION control.

10. SET VERTICAL AMPLIFIER GAIN ADJ.

Set the VOLTS/CM switch to .05 and the VARIABLE control full right (cw). From the SQUARE WAVE CALIBRATOR obtain .2 volts. Set the GAIN ADJ. for 4 cm of vertical deflection. Check continuity of both INPUT 1 and 2, and proper action of the INPUT SELECTOR switch.

11. CHECK SQUARE WAVE CALIBRATOR VOLTAGE STEPS AND VOLTS/CM SWITCH STEPS

Set VOLTS/CM switch to .05 and VARIABLE full right (cw). Set SQUARE WAVE CALIBRATOR to .05. There should be 1 cm of vertical deflection on the crt. Now switch the calibrator to .1 for 2 cm of deflection. With .2 volts of calibrator signal there should be 4 cm of deflection. Continue switching thru the range of the SQUARE WAVE CALIBRATOR and the VOLTS/CM step switch as follows:

<u>VOLTS/CM</u> <u>SWITCH</u>	<u>SQUARE WAVE</u> <u>CALIBRATOR</u>	<u>DEFLECTION</u>
.1	.5	5 cm ±2%
.2	1	5 cm "
.5	2	4 cm "
1	5	5 cm "
2	10	5 cm "
5	20	4 cm "
10	50	5 cm "
20	100	5 cm "

12. CHECK VARIABLE VOLTS/CM CONTROL AND UNCALIBRATED NEON LAMP

Check the VARIABLE VOLTS/CM control for a range of 2.5X attenuation. Any time the VARIABLE control is rotated away from the full right (cw) extreme, the UNCALIBRATED lamp should be lighted.

13. ADJUST VOLTS/CM SWITCH COMPENSATIONS AND P410 PROBE

Connect a P410 probe to INPUT 1. Set INPUT SELECTOR to DC. Attach the probe to a fast-rise square wave generator. Set the VOLTS/CM switch to .05 and adjust the probe for an optimum flat-top square wave. (Use about 4 cm of vertical deflection in making these adjustments.)

<u>VOLTS/CM</u> <u>SWITCH</u>	<u>ADJ. FOR OPTIMUM</u> <u>SQUARE CORNER</u>	<u>ADJ. FOR OPTIMUM</u> <u>FLAT TOP</u>
.1	C306	C305
.2	C312	C311
.5	C316	C315
5	C320	C319

Check all the other ranges of the VOLTS/CM switch for proper stacking of the compensation networks.

14. CHECK VERTICAL DC SHIFT

Vertically deflect the trace with enough dc voltage to move the trace about 6 cm. After deflection the trace should not drift more than 1 mm.

15. SET TRIGGERING LEVEL CONTROL

Set the test scope vertical amplifier to .05 VOLTS/CM DC. Set the trigger controls to LINE, AUTOMATIC. Set the sweep TIME/CM switch to 1 MILLISEC. and the MULTIPLIER to 2. Use a 10X probe properly adjusted. Center the trace on the test scope for a zero reference. Set the trigger controls on the scope under test to +INT. and AC. Connect the probe to the grid end of the 1 megohm resistor from the arm of the TRIGGERING LEVEL pot on scope under test and set TRIGGERING LEVEL control to zero volts. Physically center knob and tighten set screw. Leave TRIGGERING LEVEL control at zero volts during succeeding adjustments.

16. SET INT. TRIG. DC LEVEL ADJ.

With the probe fastened to pin 2 of V10, vertically center the trace of the scope under calibration. Switch from +INT to -INT. DC, and adjust INT. TRIG. DC LEVEL ADJ. for zero volts as indicated by test scope.

17. ADJUST TRIGGERING LEVEL CENTERING

Set TRIGGER SELECTOR of scope under calibration to AC and +LINE. Switch test scope VOLTS/CM switch to 0.2 VOLTS/CM, AC. Connect probe to pin 1 of V30, on scope under calibration and adjust TRIGGERING LEVEL CENTERING so that the waveform on the test scope is symmetrical. For a finer adjustment, switch test scope MAG. ON and horizontally center switching portion of the multi waveform. Now switch the TRIGGER SELECTOR 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 waveform observed on the test scope.

18. CHECK TRIGGER SENSITIVITY

After the TRIGGERING LEVEL CENTERING has been properly adjusted, rotate the TRIGGERING LEVEL control and observe on the test scope (turn MAG. OFF) that the waveform duty cycle is controllable from zero to 100%. Check that no oscillation occurs at the ends of the TRIGGERING LEVEL range.

19. ADJUST PRESET STABILITY

Switch thw TRIGGER SELECTOR of the scope under calibration to AUTO. and +LINE. With the test scope VOLTS/CM switch at 0.5, DC, place the probe on the center arm of the PRESET STABILITY control. Advance the PRESET STABILITY control until the trace brightens. Notice the position of the trace on the test scope. Now turn the PRESET STABILITY control back until the trace stops. Again notice the position of the trace on the test scope. Now turn the PRESET STABILITY control back until the trace on the test scope is half-way between the two previously observed positions.

20. CHECK TRIGGER SELECTOR SWITCH

Check all positions of the TRIGGER SELECTOR switch for proper operation of all modes of triggering. HF SYNC can be checked later when measuring the vertical response with an rf generator.

21. ADJUST DELAY LINE AND VERTICAL HF COMPENSATIONS

Set the VOLTS/CM switch to .05 and the VARIABLE VOLTS/CM control full right (cw). From a properly terminated fast-rise square-wave generator, apply to INPUT 1 enough signal for a vertical deflection of about 3 cm of signal at 400 kc. Switch the TIME/CM switch to 1 MICROSEC. Adjust the trimmers and coils in the delay line with an insulated tool for optimum square wave response. (This means a fast risetime, a flat top, and a minimum of wrinkles.)

22. CHECK VERTICAL RESPONSE

Measure the bandwidth with a constant-amplitude sine-wave generator. Set the generator to 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.

23. CHECK HF SYNC OPERATION

Increase the frequency of the generator to 20 mc. Turn the TRIGGER SELECTOR switch to HF SYNC. A stable display should be obtained when the input signal is reduced so that the vertical deflection is about 2 cm or less.

24. SET MAG. GAIN ADJ. AND CHECK NEON LAMP

From a time-mark generator apply to INPUT 1 or 2 1 millisecc and 100 microsec markers. Turn the TIME/CM switch to 1 MILLISEC and HORIZ. DISPLAY to MAG. Adjust the MAG. GAIN ADJ., on a plastic bracket mounted on the top rail, for 2 small time marks every division and one large mark every 5 divisions. Check to see that the MAG. neon is on.

25. SET SWP. GAIN ADJ.

Turn HORIZ. DISPLAY to NORM. and adjust SWP GAIN ADJ. for 1 large time mark every graticule division and 10 small marks every division.

26. ADJUST SWP. MAG. REGIS.

With HORIZONTAL DISPLAY switch set to MAG., position the trace to the right so that the first time mark falls on the center line of the graticule. Switch HORIZ. DISPLAY to NORM. 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 magnifier registers properly on both ends of the sweep. (If the last three adjustments were not preset closely enough there will be enough interaction to throw the sweep timing off about 3%.)

27. ADJUST SWP. LENGTH

Set HORIZ. DISPLAY switch to NORM. Adjust SWP. LENGTH for approximately 10.5 cm of sweep.

28. CHECK HORIZONTAL DEFLECTION FACTOR

Set HORIZ. DISPLAY to EXT. and turn STABILITY or HORIZ. INPUT ATTEN. full right (cw). From SQUARE-WAVE CALIBRATOR apply 2 volts of signal to EXT. HORIZ. INPUT. There should be at least 1.5 cm of horizontal deflection. From a test scope insert a sawtooth waveform into the INPUT of the scope under calibration. To obtain a stable display it will be necessary to trigger the test scope from the calibrator of the scope under calibration. With the HORIZONTAL POSITIONING move the display to the left side of the graticule. There should be no distortion of the display as long as it is within the limits of the graticule.

The base line of the CALIBRATOR waveform should remain stationary on the screen as the HORIZ. INPUT ATTEN. is varied throughout its range.

29. CHECK SWEEP RATES 2 SEC/CM TO 0.1 MILLISEC/CM

Check sweep rates as follows:

<u>TIME/CM</u>	<u>TIME-MARK GENERATOR</u>	<u>OBSERVE</u>
2 sec	1 sec	2 marks/cm
1 sec	1 sec	1 "
.5 sec	500 millisecc	1 "
.2 sec	100 millisecc	2 "
.1 sec	100 millisecc	1 "
50 MILLISEC	50 millisecc	1 "
20 "	10 millisecc	2 "
10 "	10 millisecc	1 "
5 "	5 millisecc	1 "
2 "	1 millisecc	2 "
1 "	1 millisecc	1 "
.5 "	500 microsec	1 "
.2 "	100 "	2 "
.1 "	100 "	1 "

30. CHECK VARIABLE TIME/CM CONTROL AND NEON LAMP

Check VARIABLE TIME/CM for smooth operation and a complete range of control between the TIME/CM steps. The UNCALIBRATED neon lamp must light whenever the VARIABLE TIME/CM control is moved away from the full right (cw) position.

31. ADJUST SWEEP RATES 50 MICROSEC TO .04 MICROSEC

Sweep linearity adjustments are made at the start of the sweep and timing adjustments are made near the end of the sweep.

<u>TIME/CM</u>	<u>TIME-MARK GENERATOR</u>	<u>ADJUST TIMING</u>	<u>ADJUST LINEARITY</u>	<u>MARKS/DIV</u>
5 μ sec <u>MAG. ON</u>	1 μ sec	C160C	C210	1
(There will be interaction between C160C and C210.)				
10 μ sec <u>MAG. OFF</u>	10 μ sec	C160E		1
2 μ sec <u>MAG. OFF</u>	1 μ sec	C160C	C224	2
.5 μ sec <u>MAG. OFF</u>	1 μ sec	C160A		1 mark/2 div
.2 μ sec <u>MAG. OFF</u>	10 mc	C224	C260	2 cycles/div

(Recheck the adjustments on the .5 μ sec and .2 μ sec ranges for interaction.)

.2 μ sec <u>MAG. ON</u>	50 mc		C272	2 cycles/div
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It will be necessary to trigger the sweep externally when adjusting 50 mc linearity. Check 50 μ sec and 5 μ sec with MAG. ON. Any shift in trace position and timing with adjustment of TRIGGER LEVEL control should be at a minimum.

32. CHECK HOLD-OFF

Turn STABILITY full right (cw). Place a probe from a test scope, that is set for DC input, on the front of C210. Check all ranges of the TIME/CM switch for sufficient sweep hold-off time.

33. CHECK OUTPUT WAVEFORMS

Set the test scope 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-volts 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 fastest speeds where the base line should rise about 20 v.

34. CHECK CRT CATHODE INPUT

Remove CRT CATHODE, GND. strap from rear of scope and insert a signal from the SQUARE-WAVE CALIBRATOR and check sweep for intensity modulation. With normal intensity, 20 volts of calibrator signal will modulate the trace.

35. RECORD CRT TYPE AND SERIAL NUMBER ON CALIBRATION RECORD.