

TYPE 316 OSCILLOSCOPE

FACTORY CALIBRATION PROCEDURE

First make a visual mechanical inspection. 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 the knob can be *turned on the shaft. Turn SCALE ILLUM and INTENSITY controls full left (ccw).
*Rm16 or RS16 scopes will have some adjustments in the 400 series.

1. CHECK POWER SUPPLY RESISTANCE TO GROUND

Invert the scope and check power supply resistance to ground:

-150	5 K Ω
+100	8 K Ω
+300	15 K Ω
+400 unreg.	16 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 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 CALIBRATOR OFF. Set CAL. ADJ. for 100 v at the CAL. VOLTAGE CHECK jack. Turn CALIBRATOR to .05. Voltage at CAL. VOLT. CHECK jack must read between 45 and 55 v.

4. Set HV ADJ. AND CHECK HIGH-VOLTAGE SUPPLY REGULATION

Connect a voltmeter to the black wire on the F & I chassis. Set the H.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/DIV 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. ADJUST ASTIG. CONTROL

Adjust the ASTIG. control in conjunction with the FOCUS control to obtain a fine trace.

7. SET CRT GEOM. ADJ.

From the CALIBRATOR apply to INPUT 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 it is not possible to obtain a stable display, vary the TRIG. LEVEL CENT. adjustment.) Set GEOM. ADJ. for minimum curvature of the vertical traces.

8. ADJUST VARIABLE ATTEN. BAL.

Position trace to about the center horizontal graticule line with the VERTICAL POSITIONING control. Adjust dc balance (VARIABLE ATTEN. BAL.) control so that the trace remains stationary on the screen as the VARIABLE VOLTS/DIV knob is varied throughout its range.

9. CHECK VERTICAL AMPLIFIER BALANCE

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

10. SET VERTICAL AMPLIFIER GAIN ADJ.

Set the VOLTS/DIV switch to .1 and the VARIABLE control full right (cw). From the CALIBRATOR obtain .5 v. Set the GAIN ADJ. control for 5 divisions of vertical deflection.

11. SET PREAMP GAIN ADJ.

Set the VOLTS/DIV switch to .01 and the VARIABLE control full right (cw). From the CALIBRATOR obtain .05 v. Set the PREAMP GAIN ADJ. for 5 divisions of vertical deflection.

12. CHECK CALIBRATOR VOLTAGE STEPS AND VOLTS/DIV SWITCH STEPS

Set VOLTS/DIV switch to .01 and VARIABLE full right (cw). Set CALIBRATOR to .05. There should be 5 divisions of vertical deflection. Switch thru the range of the CALIBRATOR switch and the VOLTS/DIV switch as follows:

<u>VOLTS/DIV</u> <u>SWITCH</u>	<u>CALIBRATOR</u> <u>SWITCH</u>	<u>DEFLECTION</u>
.02	.1	5 div
.05	.2	4 div
.1	.5	5 div
.2	1	5 div
.5	2	4 div
1	5	5 div
2	10	5 div
5	20	4 div
10	50	5 div
20	100	5 div
50	100	2 div

13. CHECK VARIABLE VOLTS/DIV CONTROL AND UNCALIBRATED NEON LAMP

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

14. CHECK VERTICAL COMPRESSION OR EXPANSION

Check vertical compression or expansion by positioning 2 divisions of CALIBRATOR signal up and down within the graticule lines. Allowable compression or expansion is 0.25 (one quarter) a minor division.

*15. ADJUST VOLTS/DIV SWITCH COMPENSATIONS AND P510 PROBE

Connect a P510 probe to INPUT. Set AC DC switch to DC. Attach the probe to a Type 105 SQUARE-WAVE GENERATOR. Set the VOLTS/DIV switch to .1 and adjust the probe for an optimum flat-top squarewave. (Use about 4 divisions of vertical deflection in making these adjustments). With the probe still attached make the following adjustments:

<u>VOLTS/DIV</u> <u>SWITCH</u>	ADJUST FOR OPTIMUM SQUARE CORNER	ADJUST FOR OPTIMUM FLAT TOP
.2	C132	C130
.5	C126	C124
1	C118	C116
10	C112	C110
.01	-	C141

Check all the other ranges of the VOLTS/DIV switch for proper stacking of the compensating networks.

16. ADJUST PREAMP LOW FREQ. ADJ.

With the scope set on the .1 range, AC coupled, insert 50 cps square wave and note the resulting waveshape with 5 major divisions of deflection. Switch to the preamp, .02 and adjust the LOW FREQUENCY ADJ. for the same waveshape as obtained in the main amp AC coupled.

17. 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 the scope under test and set the TRIGGERING LEVEL control to zero volts. Physically center knob and tighten set screw. Leave TRIGGERING LEVEL control at zero volts during succeeding adjustments.

18. ADJUST TRIGGER 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 V435, on scope under calibration and adjust TRIG. LEVEL CENT. 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 a +LINE to -LINE and at the same time re-adjust TRIG. LEVEL CENT. until there is no horizontal shifting of the switching portion of the waveform observed on the test scope.

19. CHECK TRIGGER SENSITIVITY

After the TRIG. LEVEL CENT. 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

20. ADJUST PRESET STAB.

Switch the 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 STAB. control. Advance the PRESET STAB. control until the trace brightens. Notice the position of the trace on the test scope. Now turn the PRESET STAB. control back until the trace stops. Again notice the position of the trace on the test scope. Now turn the PRESET STAB. control back until the trace on the test scope is half-way between the two previously observed positions.

21. SET INT. TRIGGER D.C. LEVEL ADJ.

With the probe fastened to pin 2 of V 414, 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.

22. 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.

23. ADJUST DELAY LINE AND VERTICAL HF COMPENSATIONS

Set the VOLTS/DIV switch to .1 and the VARIABLE VOLTS/DIV control full right (cw). From a Type 107 SQUARE WAVE GENERATOR apply to INPUT enough signal for a vertical deflection of about 3 divisions of signal at 400 kc. Switch the TIME/DIV switch to 1 MICROSEC. Adjust the trimmers and coils on the delay line with an insulated tool for optimum square-wave response. (This means a fast risetime, flat top and a minimum of wrinkles.)

*24. ADJUST PRE-AMPLIFIER HF COMPENSATIONS

Set VOLTS/DIV switch to .01 and VARIABLE VOLTS/DIV full right (cw). From a Type 107 SQUARE WAVE GENERATOR, apply to INPUT enough signal for a vertical deflection of about 3 divisions of signal at 400 kc. Switch the TIME/DIV switch to 1 MICROSEC. Adjust L150 and L177 for optimum square-wave response.

25. CHECK MAIN-AMPLIFIER RESPONSE

Set VOLTS/DIV switch to .1 and VARIABLE VOLTS/DIV control full right (cw). From a TYPE 190 CONSTANT-AMPLITUDE SIGNAL GENERATOR, obtain 4 divisions of vertical deflection at about 500 kc. Now adjust TYPE 190 to obtain a frequency of 10 mc (do not change TYPE 190 OUTPUT AMPLITUDE) and see that there is at least 2.8 divisions of vertical deflection remaining (3db point).

26. CHECK PRE-AMPLIFIER RESPONSE

Set VOLTS/DIV switch to .01 and VARIABLE VOLTS/DIV control full right (cw). From a TYPE 190 CONSTANT-AMPLITUDE SIGNAL GENERATOR, obtain 4 divisions of vertical deflection at about 500 kc. Now adjust TYPE 190 to obtain a frequency of 9 mc (do not change TYPE 190 OUTPUT AMPLITUDE) and see that there is at least 2.8 divisions of vertical deflection remaining (3 db point).

27. CHECK HF SYNC

From TYPE 190 obtain about 2 divisions of vertical deflection at 20 mc. Turn the TRIGGER SELECTOR switch to HF SYNC. Adjust STABILITY control for a stable display.

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

From a time-mark generator apply to INPUT, 1 millisecc and 100 microsecc markers. Turn the TIME/DIV switch to 1 MILLISEC AND DISPLAY switch 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.

29. SET HORIZ. GAIN ADJ.

From a time-mark generator apply to INPUT, 1 millisecc and 100 microsecc markers. Turn the TIME/DIV switch to 1 MILLISEC and DISPLAY switch to NORM. Set HORIZ. GAIN ADJ. for 1 large time mark every major graticule division and 2 small marks every minor divisions.

30. ADJUST NOR./MAG. REGIS.

Turn DISPLAY switch to MAG. and position the trace to the right so that the first time mark falls on the center line of the graticule. Switch DISPLAY to NORM. and adjust NOR./MAG. REGIS control 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.

31. ADJUST SWP. LENGTH

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

32. CHECK HORIZONTAL DEFLECTION FACTOR

Set DISPLAY switch to EXT. and turn STABILITY OR HORIZ. INPUT ATEN. control full right (cw). From CALIBRATOR apply 2 volts of signal to HORIZ. INPUT. There should be at least 1.5 divisions 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.

33. CHECK SWEEP RATES 2 SEC/DIV to 0.1 MILLISEC/DIV

Check sweep rates as follows:

<u>TIME/DIV</u>	<u>TIME-MARK GENERATOR</u>	<u>OBSERVE</u>
<u>2 sec</u>	1 sec	2 marks/div
<u>1 sec</u>	1 sec	1 marks/div
<u>.5 sec</u>	500 millisecc	1 marks/div
<u>.2 sec</u>	100 millisecc	2 marks/div
<u>.1 sec</u>	100 millisecc	1 marks/div
<u>50 MILLISEC</u>	50 millisecc	1 marks/div
<u>20 MILLISEC</u>	10 millisecc	2 marks/div
<u>10 MILLISEC</u>	10 millisecc	1 marks/div
<u>5 MILLISEC</u>	5 millisecc	1 marks/div
<u>2 MILLISEC</u>	1 millisecc	2 marks/div
<u>1 MILLISEC</u>	1 millisecc	1 marks/div
<u>.5 MILLISEC</u>	500 microsecc	1 marks/div
<u>.2 MILLISEC</u>	100 microsecc	2 marks/div
<u>1 MILLISEC</u>	100 microsecc	1 marks/div

34. CHECK VARIABLE TIME/DIV CONTROL AND NEON LAMP

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

35. 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/DIV</u>		TIME-MARK GENERATOR	ADJUST TIMING	ADJUST LINEARITY	MARKS/DIV
5 μ sec	<u>MAG. ON</u>	1 μ sec	C160C	C310	1
(There will be interaction between C160C and C310)					
10 μ sec	<u>MAG. OFF</u>	10 μ sec	C160E		1
2 μ sec	<u>MAG. OFF</u>	1 μ sec	C160C	C324	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	C324	C358	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		C372	2 cycles/div

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.

36. 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 C310. Check all ranges of the TIME/DIV switch for sufficient sweep hold-off time.

37. 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 volts in amplitude with its base line on a zero reference; except on the fastest speeds where the base line should raise about 20 v.

38. CHECK CRT CATHODE INPUT

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

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