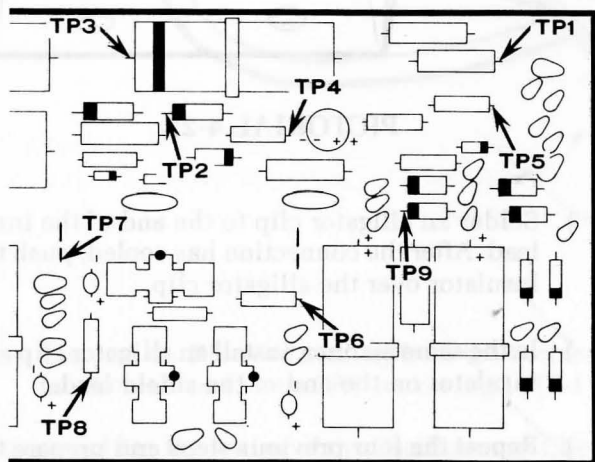


INITIAL TESTS



PICTORIAL 5-1

RESISTANCE MEASUREMENTS

- (1) If an ohmmeter is available, measure the resistance between each flat plug prong and the round prong on the line cord. In both measurements you should obtain an infinite indication. Be sure the test probe is not touching the chassis or any connection.

If you do not obtain infinite indications, recheck all primary wiring and make sure no fine wire strands at any connection are touching another connection.

Use an ohmmeter to make the following resistance measurements before you apply power to the Oscilloscope. This will insure that the power supply will not be damaged due to a wiring error or some incorrectly installed or faulty part. If you do not get the proper indication in a step, check the wiring and installation of the parts listed in the "Possible Cause" column for that step. You may also refer to the "In Case of Difficulty" section of the Manual (Page 97). Be sure you obtain the correct resistance reading before proceeding.

Refer to Pictorial 5-1 for the following steps.

- () Position the Oscilloscope bottom side up.
- () Connect the negative ohmmeter lead to the chassis of the Oscilloscope. Then touch the positive meter lead to the points indicated in the following chart.

NOTE: Not all ohmmeters are polarized the same. Therefore, if you do not get the correct meter reading the first time, connect the positive meter lead to the chassis and touch the negative meter lead to the point indicated in the chart. If this produces the correct indication, cross out the word "positive" in the heading of the first column and write in "negative."

NOTE: The ohmmeter that was used to make the following measurements was powered by a 1.5 volt battery and set on the RX1000 range.

Make all of the following measurements on the power supply circuit board.

M-104 / (IM-16)

POSITIVE METER LEAD TO:	APPROXIMATE METER READING	POSSIBLE CAUSE
(✓) TP1.	600 k Ω -1 M Ω	<ol style="list-style-type: none"> 1. Resistors R310, R309. 2. Focus control R2 and resistor R3. 3. Diodes D317, D302, and D301. 4. Capacitors C301, C302, and C303. 5. Power Transformer.
() TP2. <i>7 MΩ (100 MΩ)</i> () TP3.	600 k Ω -1 M Ω	<ol style="list-style-type: none"> 1. Power transformer. 2. Diodes D301 and D302. 3. Capacitors C301, C302, and C303.
(✓) TP4.	900 k Ω -1.5 M Ω	<ol style="list-style-type: none"> 1. Power transformer. 2. Diodes D301 and D302. 3. Capacitors C301, C302, and C303.
() TP5. <i>3.2 MΩ (1 MΩ)</i>	600 k Ω -1.5 M Ω	<ol style="list-style-type: none"> 1. Power transformer. 2. Diodes D301 and D302. 3. Capacitors C301, C302, C303, C314, and C315.
(✓) TP6.	400 Ω -1000 Ω	<ol style="list-style-type: none"> 1. Capacitor C310. 2. IC U302. 3. Resistors R334, R335, and R336.
(✓) TP7.	300 Ω -800 Ω	<ol style="list-style-type: none"> 1. Capacitor C309. 2. IC U301. 3. Connections to other circuit boards.
(✓) TP8.	400 Ω -1000 Ω	<ol style="list-style-type: none"> 1. Capacitor at C311. 2. IC U303. 3. Resistors R334, R335, and R336. 4. Connections to other circuit boards.
() TP9.	9000 Ω -20 k Ω	<ol style="list-style-type: none"> 1. Diodes D307, D308, D309, and D310. 2. All sections of capacitor C308. 3. Connections to other circuit boards.

This completes the Initial Tests. Proceed to "Calibration."

CALIBRATION

In this section, you will set the circuit board and front panel controls of your Oscilloscope for proper operation. To do this, you will need a high input impedance voltmeter and a sine-square wave generator. Perform the adjustments exactly as instructed and DO NOT connect the line cord to an AC outlet until you are instructed to do so.

Refer to Pictorial 6-1 (Illustration Booklet, Page 23) for the following steps.

Set the front panel controls as follows:

- (-) Y1 POS: Center of rotation.
- (-) Both AC-GND-DC: GND.
- (-) Both VOLTS/CM: 0.02.
- (-) Both VARIABLE: Full clockwise.
- (-) Y1-Y2-CHOP-ALT: Y1.
- (-) Y2 POS: Center of rotation.
- (-) POWER: OFF.
- (-) INTENSITY: Full clockwise.
- (-) FOCUS: Center of rotation.
- (-) TRIG LEVEL: Center of rotation.
- (-) HORIZ POS: Center of rotation.
- (-) TIME/CM: 200 μ S.

(-) SWEEP VAR/HORIZ GAIN: Full clockwise.

(-) Y1-Y2-EXT-LINE: Y1.

(-) AC-DC-TV: AC.

(-) +/-: +.

(-) AUTO-NORMAL: AUTO.

(-) Refer to Detail 6-1A and push the alignment tool blade into the end of the plastic nut starter. Always use this tool to adjust the trimmer capacitors and controls in the following steps.

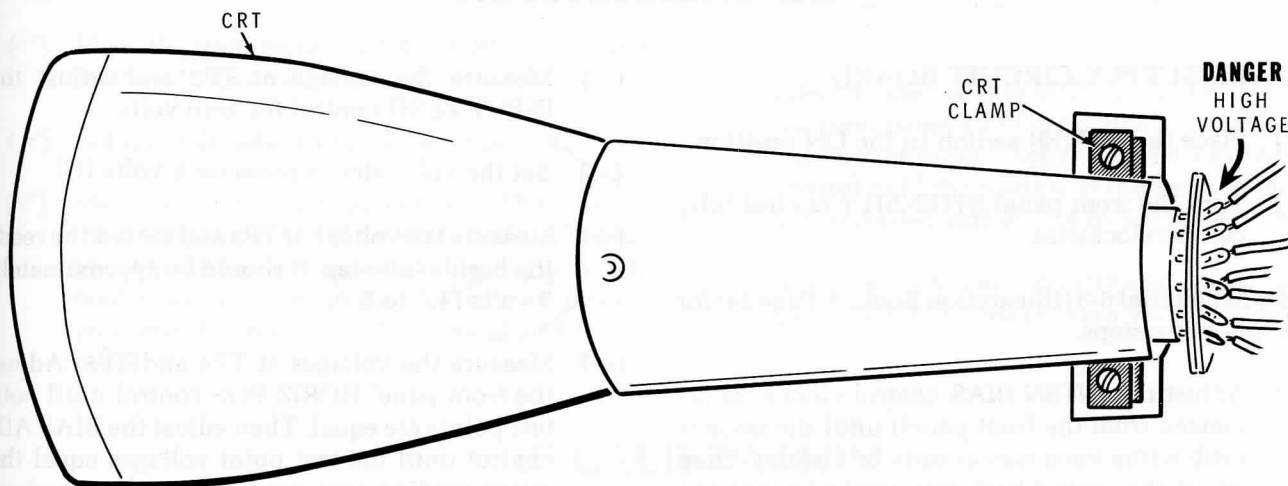
(/) Set all the circuit board controls to their centers of rotation.

(-) On the vertical circuit board, turn all the trimmer capacitors clockwise until they are snug. Then turn them counterclockwise 1/2 turn.

CAUTION: AC and DC voltages in some areas of the Oscilloscope may exceed 1300 volts. Be very careful when you make the following adjustments. Make sure the Oscilloscope is setting on a nonmetallic surface and is not within reach of a water pipe or other ground conductor. The "Dangerous Voltage Areas" are shown on Page 26 in the Illustration Booklet.

(-) Connect the Oscilloscope line cord to an AC outlet.

NOTE: If you do not get the proper results in the following steps, recheck the steps to make sure you have adjusted the correct controls. If you still do not get the indicated results, turn the Oscilloscope off and refer to the "In Case of Difficulty" section on Page 97.



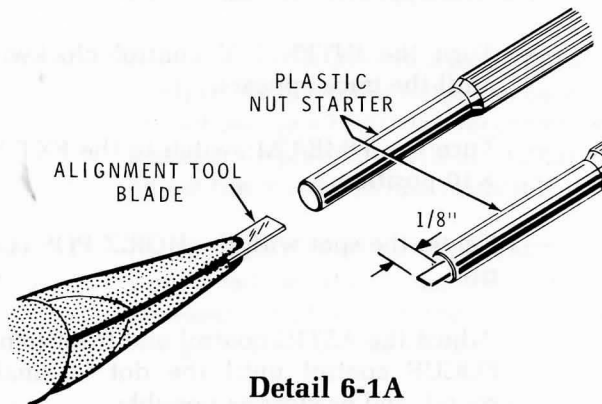
PICTORIAL 6-2

- () Set the ON-OFF switch on the Oscilloscope to the ON position. The red Power Lamp should light. Allow the Oscilloscope at least one minute to warm up.

NOTE: You may have to adjust the vertical (Y1 POS or Y2 POS) and HORIZ POS controls to get the trace on the CRT in the next step.

- (X) Check to see if the CRT trace is parallel with the horizontal graticule lines. If it is not parallel, perform the following numbered steps.

1. Note the position of the trace and turn off the power.
2. Refer to Pictorial 6-2 and loosen the CRT clamp.
3. Rotate the CRT to align the trace.
4. Turn the power on and check the position of the trace.



Detail 6-1A

5. Repeat steps 1, 3, and 4 as necessary to align the trace to the horizontal graticule lines.
6. After the correct results have been obtained, turn the power off and tighten the CRT clamp.

DC CALIBRATION

POWER SUPPLY CIRCUIT BOARD

- (✓) Place the POWER switch in the ON position.
- () Turn the front panel INTENSITY control fully counterclockwise.

Refer to Pictorial 6-3 (Illustration Booklet, Page 24) for the following steps.

- (✓) Adjust the INTEN BIAS control clockwise (as viewed from the front panel) until the trace is visible (the trace may already be visible). Then adjust the control back counterclockwise until the trace disappears.
- (✓) Adjust the ASTIG control:
 - Turn the INTENSITY control clockwise until the trace appears.
 - Turn the TIME/CM switch to the EXT IN $\times 10$ position.
 - Center the spot with the HORIZ POS control.
 - Adjust the ASTIG control and front panel FOCUS control until the dot is small, round, and as clear as possible.

HORIZONTAL CIRCUIT BOARD

- (✓) Use the front panel HORIZ POS control and center the spot on the screen.
- () Connect the negative voltmeter lead to the chassis of the Oscilloscope.
- () Set the voltmeter to measure 1.5 volts DC.

Refer to Pictorial 6-4 (Illustration Booklet, Page 24) for the following steps.

NOTE: In the following steps, when a step calls for an adjustment of zero volts, make the adjustment to zero volts ± 50 millivolts.

- (✓) Touch the voltmeter probe to TP1 and adjust the ZERO ADJ control for zero volts.

- (✓) Measure the voltage at TP2 and adjust the INPUT ZERO control for zero volts.
- (✓) Set the voltmeter to measure 5 volts DC.
- (✓) Measure the voltage at TP3 and record the reading beside this step. It should be approximately 5 volts (4.8 to 5.2).
- (✓) Measure the voltages at TP4 and TP5. Adjust the front panel HORIZ POS control until both test points are equal. Then adjust the BIAS ADJ control until the test point voltages equal the meter reading you recorded in the previous step.

VERTICAL CIRCUIT BOARD

- (✓) Set the voltmeter to measure 1.5 volts DC.

Refer to Pictorial 6-5 (Illustration Booklet, Page 24) for the following steps.

- (✓) Measure the voltage at TP6. Then adjust the Y2 DC BAL control for zero volts.
- (✓) Measure the voltage at TP7 and adjust the Y1 DC BAL control for zero volts.
- (✓) Place the front panel Y1, Y2, CHOP, ALT switch in the ALT position. Two traces should be on the screen. If necessary, use the Y1, or Y2 POS controls to position the traces near one another.
- (✓) Rotate the Y1 VARIABLE control fully counterclockwise. Place your finger on the CRT to mark the new location of the Y1 trace line if it moved. Return the Y1 VARIABLE control to its CAL position. Then adjust the Y1 DC BAL control to move the Y1 trace to the location marked by your finger. Repeat this procedure as many times as necessary until the trace no longer moves when you rotate the Y1 VARIABLE control. If the trace did not move initially, no adjustment of the DC BAL control is needed.
- (✓) In the same manner, check the Y2 trace line and adjust the Y2 DC BAL control.

NOTE: Because of the normal aging of your Oscilloscope, you may have to repeat the previous adjustment periodically.

- (✓) Place the front panel Y1-Y2-CHOP-ALT switch in the Y1 position.
- (✓) Set the voltmeter to measure 5 volts DC.
- (✓) Measure the voltages at TP8 and TP9. Adjust the front panel Y1 POS control until both readings are the same. Then adjust the Y1 BIAS ADJ control until the reading is the same as the one you recorded earlier in the Manual (4.8 to 5.2 volts).

- (✓) Measure the voltage at TP10 and adjust the Y1 TRIG ZERO control for zero volts.
- (✓) Place the front panel Y1-Y2-CHOP-ALT switch in the Y2 position.
- (✓) Measure the voltages at TP11 and TP12. Adjust the front panel Y2 POS control until both readings are the same. Then adjust the Y2 BIAS ADJ control until the reading is the same as the one you recorded earlier (4.8 to 5.2 volts).
- (✓) Measure the voltage at TP13 and adjust the Y2 TRIG ZERO control for zero volts.

AC CALIBRATION

Set the front panel controls as follows:

- (✓) Both VOLTS/CM: 0.05
- (✓) Both VARIABLE: Full clockwise.
- (✓) Y1-Y2-CHOP-ALT: Y1
- (✓) Y1-Y2-EXT-LINE: Y1
- (✓) TIME/CM: 200 μ s
- (✓) Use the Y1 pos and HORIZ POS controls and center the trace on the screen.
- (✓) Place the Y1 AC-GND-DC switch in the AC position.
- (✓) Refer to Pictorial 6-6 (Illustration Booklet, Page 24) and connect a 1 kHz square wave signal to the Y1 INPUT connector. Adjust the generator output to produce a display that is 4 or 5 cm high. Adjust the TRIG LEVEL as required.

in Pictorial 6-7. If it will not adjust, then adjust the $\times 10$ trimmer capacitor.

2. () Set the VOLTS/CM switch to the 1 position, readjust the generator output as necessary, and adjust the $\times 1000$ trimmer capacitor for a proper display. If it will not adjust, then adjust the $\times 100$ trimmer capacitor.
3. () Set the VOLTS/CM switch to the 10 position, readjust the generator output as necessary, and adjust the $\times 10$ trimmer capacitor for a proper display.
4. () Repeat the above three steps until the compensation is correct.
- () Set the Y1-Y2-CHOP-ALT switch to Y2, the Y2 AC-GND-DC switch to AC, the Y1-Y2-EXT-LINE switch to Y2, connect the square wave signal to the Y2 INPUT connector, and repeat the previous four steps for channel Y2.

VERTICAL CALIBRATION AND ATTENUATOR COMPENSATION

Refer to Pictorial 6-5 (Illustration Booklet, Page 24) for the following steps.

NOTE: In the following steps, use the channel Y1 switches and trimmer capacitors.

1. () Set the VOLTS/CM switch to the 0.1 position. Use a nonmetallic screwdriver to adjust the $\times 100$ trimmer capacitor for a proper display like the one labeled RIGHT

NOTE: If you do not have a calibrated voltage source, disregard the next three steps and use the 1 V (P-P) 60 Hz signal that is available at the front panel. Connect the signal to the Y2 INPUT connector, set the TIME/C switch to 2 mS, set the VOLTS/CM switch to 0.2, and adjust the Y2 CAL control for a display that is 4.5 cm high. The Y2 VARIABLE control must be set fully clockwise.

1. () Set the generator output to .1 V.
2. () Set the Y2 VOLTS/CM switch to .02.

3. () Adjust the Y2 CAL control for a display 5 cm high.

() Set the TIME/CM switch to 0.2 μ s.

() Set the generator frequency to 1 MHz and adjust its output to produce a display that is four or five cm high.

() Adjust the Y2 H.F. COMP trimmer capacitor for a square wave with a smooth leading edge as shown in Pictorial 6-8 (Illustration Booklet, Page 24).

() Connect the 1 MHz square wave signal to the Y1 INPUT connector.

() Set the Y1 VOLTS/CM switch to 0.1 (be sure the VARIABLE control is fully clockwise), the Y1-Y2-CHOP-ALT switch to Y1, and the Y1-Y2-EXT-LINE switch to Y1. Adjust the square wave generator until the display is 4 or 5 cm high.

() Adjust the Y1 H.F. COMP trimmer capacitor for a square wave with a smooth leading edge as shown in Pictorial 6-7.

NOTE: If you do not have a calibrated voltage source, disregard the next three steps and use the 1 V (P-P) 60 Hz signal that is available at the front panel. Connect the signal to the Y1 INPUT connector, set the TIME/CM switch to 2 ms, set the VOLTS/CM switch to 0.2, and adjust the Y1 CAL control for a display that is 4.5 cm high. The Y1 VARIABLE control must be set fully clockwise.

1. () Set the Y1 VOLTS/CM switch to .02.
2. () Set the generator output to 0.1 V.
3. () Set the TIME/CM switch to 200 μ s.
4. () Adjust the Y1 CAL control for a display 5 cm high.

HORIZONTAL AMPLIFIER ADJUSTMENTS

() Set the Y1 AC-GND-DC switch to GND.

Refer to Pictorial 6-4 for the following steps.

() Adjust the SWEEP LENGTH control for a trace that is 10 cm long (just fills the screen).

() Set the Y1 AC-GND-DC switch to AC.

() Set the generator frequency to 5 kHz.

() Adjust the horizontal circuit board CAL control and the HORIZ POS control so there are ten complete waveforms in 10 cm as shown in Pictorial 6-9 (Illustration Booklet, Page 24).

NOTE: If a calibrated signal source is not available, use the 1 V (P-P) 60 Hz output. Set the TIME/CM switch to 2 ms and adjust the HORIZ CAL control for a waveform that is 8.6 cm long. The 1 V (P-P) 60 Hz output can be used for the remaining Horizontal Amplifier Adjustments.

() Set the Y1 AC-GND-DC switch to GND.

() Readjust the SWEEP LENGTH control for a trace that is 10 cm long (just fills the screen).

() Move the trace one division to the left with the HORIZ POS control and again adjust the SWEEP LENGTH control until the trace again fills the screen. The trace is now 11 cm long.

() Set the generator frequency to produce a sine wave approximately 500 Hz.

() Set the Y1 AC-GND-DC switch to AC.

() Set the TIME/CM switch to 2 ms.

() Adjust the Y1 POS control to center the trace vertically on the screen.

() Adjust the HORIZ POS control so the left end of the trace is on the screen.

() Adjust the TRIG LEVEL control so the trace starts on the zero base line (center of the graticule). Then move the +/– switch to the “–” position. Adjust the TRIG BAL control so the trace starts on the zero base line. Move the +/– switch back and forth to make this final adjustment.

() Move the TRIGGER COUPLING switch to DC. If the trace starting point moves, adjust the Y1 TRIG ZERO control (on the vertical board) until there is no movement when you switch the coupling switch back and forth between the AC and DC positions. Use the TRIG LEVEL control to keep the trace starting on the zero base line.

() Move the signal cable from the Y1 INPUT to the Y2 INPUT. Change the Y-Y2-CHOP-ALT switch



from Y1 to Y2 and the Y1-Y2 EXT-LINE switch from Y1 to Y2.

- () Now repeat the trigger zero adjustment for the Y2 channel.

LOW-CAPACITY PROBE

NOTE: If you do not have a low capacity probe, disregard the following steps and proceed to "Final Assembly."

- () Set the Y1-Y2-CHOP-ALT switch to Y1 and the TRIGGERING switches to Y1, AC, +, and AUTO.
- () Set the TIME/CM switch to 200 μ s.
- () Set the Y1 VOLTS/CM switch to 0.05 and the VARIABLE control fully clockwise.
- () Connect a low-capacity probe to the Y1 INPUT connector.
- () Connect the probe to a 1 kHz square wave signal.
- () Adjust the output of the generator to produce a display that is 4 cm high.
- () Adjust the compensation capacitor on the probe for a proper square wave with no overshoot as shown in Pictorial 6-7.
- () Set the VOLTS/CM switch to 0.5.
- () Readjust the generator output for a 4 cm display.
- () Adjust Y1 trimmer capacitor #1 for a proper square wave. If you cannot make this adjustment, readjust the probe capacitor and capacitor #1 until the correct waveform is displayed.

- () Set the VOLTS/CM to 0.05 and readjust the generator output for a 4 cm display again.
- () Adjust trimmer capacitor #2 for a proper square wave.

NOTE: If necessary, repeat the previous steps until a proper square wave is displayed.

- () Repeat the previous steps under "Low-Capacity Probe" for the Y2 channel. However, whenever Y1 is called for, insert Y2. If may be possible to adjust channel Y2 without changing the probe compensation capacitor. If this happens, then you will be able to use the same probe on either channel and will not need to make any adjustments when using the probe.
- () Disconnect the Low-Capacity Probe.

PHASE ADJUSTMENT

- () Change the Y1-Y2-CHOP-ALT switch to the CHOP position.
- () Change the TIME/CM switch to the 2 μ s position.
- () Set the four TRIGGERING switches to the EXT, DC, +, and AUTO positions.
- () Adjust the SWEEP VAR Y1 POS and Y2 POS controls for a pattern similar to that shown in Pictorial 6-10.
- () Adjust the PHASE ADJ control (see Pictorial 6-5) so there is no vertical trace information at the beginning, between, or after any of the horizontal trace lines.
- () Turn off the Oscilloscope POWER switch and unplug the line cord.

This completes the Calibration of the Oscilloscope. Proceed to the "Final Assembly" section of the Manual.