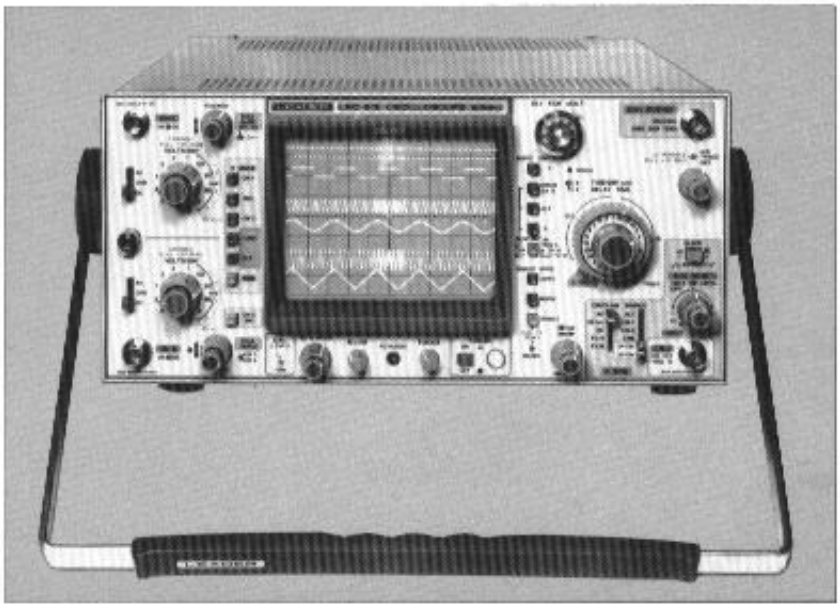
$35

LBO-516

100 MHz delayed time base oscilloscope



Maintenance And Calibration

For professionals who know the difference.

LEADER Instruments Corporation

WARNING!

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TABLE OF CONTENTS (Continued)

3. MAINTENANCE AND CALIBRATION

3-0. The following test equipment is required to perform the calibration/maintenance procedures described in this section. The performance specifications given are the minimum necessary to accurately calibrate the oscilloscope.

Description	Minimum Specifications
1. Digital Voltmeter	DC Voltage Range: 0-200 VDC Accuracy: +0.5%
2. High Voltage Voltmeter	DC Voltage Range: 0-2000 VDC Accuracy: -+ 1%
3. Frequency Counter	Frequency Range: 100 Hz - 200 MHz Overall Accuracy: +0.001%
4. Time Mark Generator	Marker Outputs: 2nS - 0.5 S with calibrated ±5% offset adjust Accuracy: -+0.1%
5. Sine Wave Generator	Frequency Range: lkHz - 200 kHz Output Level: 15 mV - 5 Vp.p Accuracy: -+.3 dB, 1 MHz - 200 MHz as frequency is changed
6. Test Oscilloscope	100 MHz Bandwidth
7. Square Wave Generator	Frequency: 1 kHz - 100kHz, -+1% Output Level: I mV - 1.0 Vp-p, -+1% Rise Time: 3 nS
8. Amplitude Calibrator	Output: 1 kHz square wave Frequency Accuracy: -+0.25% Output Level: 2 mV - 20 Vp-p
9. Capacitance Meter	Range: 0-50 pF Accuracy: --- 1%

3-1. INITIAL SETUP CONDITIONS

POWER switch	Pushed in
A INTEN control	Centered*
B INTEN control	Centered*
ILLUM control	Clockwise
FOCUS control	Centered*
AC/GND/DC switches	DC
VOLTS/DIV switches	20mV
VARIABLE controls	Clockwise
X10 MAG switches	Pushed in
Vertical POSITION controls	Centered*.
PULL QUAD control	Pushed in
PULL TRIPLE control	Pushed in
V MODE switches	CH-1
CH-2 INV switch	Out
DLY TIME MULT control	Counterclockwise.
COUPLING switch	AC
SOURCE switch	CH-1
LEVEL control	0
HOLDOFF control	Detented counter clockwise and pulled out
A/B TRACE SEP control	Centered
SLOPE switch	Out
HORIZ DISPLAY switches.	A
START switch	Out
SWEEP MODE switches	AUTO
A TIME/DIV switch	.5 mS
B TIME/DIV switch	.1 mS
A VARIABLE control	Clockwise
Horizontal POSITION control	Centered*

*** Adjusted afterwards for best viewing**.

Allow 30 minutes warmup before making any adjustments. Remove the top and bottom covers to gain access to test points and internal adjustments.

3-2 POWER SUPPLY CHECK AND ADJUSTMENT

3-2-1 -8 Volt Adjustment

Connect a digital voltmeter's positive lead to the scope chassis (GND), and the voltmeter's negative lead to TP-5 located on PCB T-3153. Adjust VR-1 for -8.0 V.

3-2-2 Power Supply Check

Check the voltages listed below by moving the voltmeter's negative lead to chassis ground, and applying the positive lead, in turn, to each of the associated test points on PCB T-3153.

Test Point	Nominal Voltage	Tolerance
TP-I	+100	+98 VDC 'to 102VDC
TP-2	+ 50	49 51
TP-3	+ 12	11.75 12.25
TP-4	+ 8	7.85 8.15
TP-6	+ 5	4.8 5.2
TP-7	+ 19	17.5 20.5

3-2-3 High-Voltage Adjustment

Turn off the unit under test. Connect the positive lead of a HV voltmeter to chassis ground, and its negative lead to TP-8. Turn the scope on and allow a 2 minute warmup. Adjust VR-2 on PCB T-3162 for a reading of - 1950 volts. Connect an X10 probe to the test oscilloscope and hold its tip close to the face of the CRT under test. The high-voltage ripple displayed on the test oscilloscope should be less than 0.1Vp-p.

3-3. CRT CONTROL ADJUSTMENTS

Make sure the controls are set according to the initial setup conditions in Paragraph 3-1 before starting the following adjustments.

3-3-1 Intensity Range Adjustment.

Center the CH- 1 trace on the CRT with the vertical POSITION control. Set the A INTEN control knob mark to an approximate 45° angle as shown in Figure 3-1. Adjust VR-I on PCB T-3162 until the trace becomes just barely visible.

3-3-2 Astigmatism Adjustment

Connect a sine wave generator to the CH-1 input connector. Set generator frequency and output to produce five or six sine waves. Set output level and POSITION controls for a centered display 6 cm high. (Peaks of the sine waves just touching the graticule lines I cm above and below the bottom and topmost graticule lines.) Adjust A INTENS and FOCUS for a medium-bright, sharp display. Adjust VR- 1 on PCB T-3157 for optimum overall sharpness.

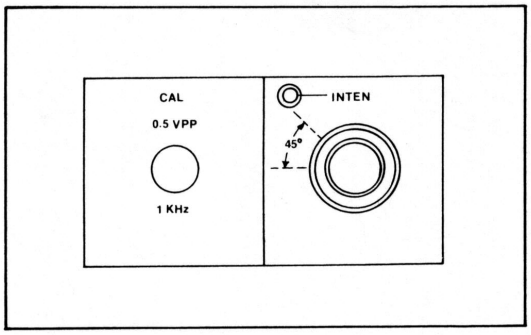

Figure 3-1.

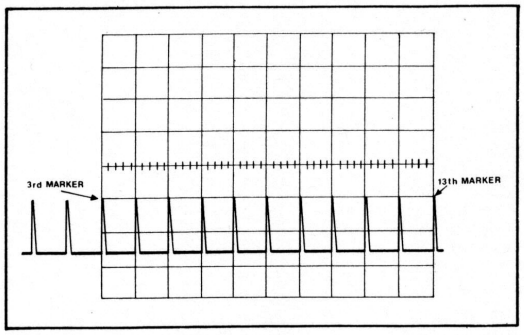

Figure 3-2.

3-4. CALIBRATION OUTPUT ADJUSTMENT

Connect the test oscilloscope to the CAL connector on the fron panel of the LBO-516. Adjust VR-1 on PCB T-3287 for a CAL output level of 0.5 Vp-p +-1%. The duty cycle of the square wave should be 45-55%.

Connect the CAL output to a frequency counter; the frequency should be 1000 Hz + - 10%.

3-5. A TIMEBASE ALIGNMENT

3.5-1 Slow Sweep Time

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1). Adjust the time-mark generator for an output of .5 mS and connect it to the CH-1 input connector. Using the horizontal POSITION control, align the first mark with the leftmost vertical graticule line. Adjust VR-22 on PCB T-3158 to align each subsequent mark with a major vertical graticule line.

3.5-2 Sweep Length

With the same conditions as in the previous paragraph, adjust the horizontal POSITION control to align the third mark with the leftmost vertical graticule line. (See Figure 3-2.) Adjust VR-1 on PCB T-3158 so the 13th mark is fully displayed on the CRT screen.

3.5-3 Fast Sweep Time

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1). Set the A TIME/DIV switch to 0.5 μS. Set the time-mark generator to 0.5/.μS and connect it to the CH- 1 input connector. Using the horizontal POSITION control, align the first mark with the leftmost vertical graticule line. (See Figure 3-2.) Adjust VC-22 on PCB T-3158 to align each subsequent mark with a major vertical graticule line.

3.5-4 Sweep Start Point

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1). Set the A TIME/DIV switch to 0.1 mS. With the horizontal POSITION control, adjust the trace startpoint to the first minor division (0,2 major division). Change the A T1ME/DIV switch to 50/aS and adjust VC-1 on PCB T-3158 so the sweep starts at the leftmost vertical graticule line.

3.5-5 Timebase Accuracy Check

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1). Set the A TIME/DIV switch to 0.5 S. Set the time-mark generator to 0.5 S and connect it to the CH- 1 input connector. Align the first mark with the left-most vertical graticule line. Adjust the generator so that each subsequent mark is aligned with a major vertical graticule line. Repeat for each A TIME/DIV switch setting from.2 S to 0.2μS, verifying that the timebase accuracy is within +-2% at each sweep speed.

3-6. A TIMEBASE X10 MAGNIFIER ADJUSTMENT

3-6-1 Magnifier Positioning

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1.) Set the CH-1 AC/GND/DC switch to GND, and press the INTEN BY B pushbutton. Set the B TIME/DIV switch to .5 mS. Adjust the horizontal POSITION control to start the A trace on the leftmost vertical graticule line. Adjust the DLY TIME MULT control to start the B (intensified) trace at the center vertical graticule line. Center the horizontal POSITION control knob. Pull the timebase X10 MAG switch. Adjust VR-33 on PCB T-3158 so that the B sweep starts on the center graticule line. Afterward, push in the X 10 MAG switch knob, and adjust VR-34 on PCB T-3158 so that the B sweep starts on the center graticule line. Repeat these two adjustments (VR-33 and VR-34) until the B trace starts on the center graticule line in both positions of the XI0 MAG switch.

3-6-2 Magnifier Speed Accuracy

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1). Connect a time-mark generator set for. 5 mS output to the CH-1 input connector. Set the A TIME/DIV switch and horizontal POSITION control so every third mark is aligned with a major vertical graticule line. Pull the X10 MAG knob, then adjust VR-35 on PCB T-3158 so a mark is aligned with the first, center, and last major vertical graticule line.

3-7. B TIMEBASE ALIGNMENT

3-7-1 Slow Sweep Time

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1.) Set the CH-1 VOLTS/DIV switch to. 1 V. Connect a time-mark generator set for .5 mS to the CH-1 input connector. Set the DLY TIME MULT control to 2.50, and press the B HORIZ DISPLAY pushbutton. Adjust the DLY TIME MULT control to align the nearest mark with the

leftmost vertical graticule line. Adjust VR-21 on PCB T-3158 to align each of the subsequent marks with a major vertical graticule line.

3-7-2 Length Adjustment

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1.) Connect a time-mark generator set for 0.5 mS to the CH- 1 input connector. Using the horizontal POSITION control, align the third mark with the leftmost vertical graticule line, and adjust VR-11 on PCB T-3158 so that the 13th mark is fully displayed on the CRT screen.

3-7-3 Sweep StartPoint

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1.) Press the B HORIZ DISPLAY pushbutton. Using the horizontal POSITION control, adjust the trace start point to a little less than the first minor division on the center horizontal graticule line (0.15 major division). Change the B TIME/DIV switch to 50 μS, then adjust VC- 11 on PCB T-3158 so the sweep starts at the leftmost vertical graticule line.

3-7-4 Fast Sweep Time

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1.) Set the A TIME/DIV switch to 1μS, and the B TIME/DIV switch to 0.5μS. Press the B HORIZ DISPLAY pushbutton. Connect a time-mark generator set for 0.5μS output to the CH-1 input connector. With the horizontal POSITION control, align the first mark with the leftmost vertical graticule line. Adjust VC-21 on PCB T-3158 to align each of the subsequent marks with the other vertical graticule lines.

3-7-5 Timebase Accuracy Check

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1.) Set the A and B TIME/DIV switches to 50 mS, and press the B HORIZ DISPLAY pushbutton. Connect a time-mark generator set for 50 mS output to the CH- 1 input connector. Align the first mark with the leftmost vertical graticule line. Adjust the generator so each subsequent mark is aligned with a major vertical graticule line. Repeat the above for each TIME/DIV setting from 20 mS to .02μS, verifying that the timebase accuracy is within +-2% at each sweep speed.

3-7-6 Start Points Alignment

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1). Set the CH- 1 AC/GND/DC switch to GND, and the B TIME/DIV switch to 5μS. Press the INTEN BY B HORIZ DISPLAY pushbutton, and adjust the A and B INTEN controls for a noticeable difference between the A and B traces. Using the horizontal POSITION control, make the A trace start at the leftmost vertical graticule line. Check that the DLY TIME MULT control is set at 0.2 (fully CCW), then adjust VR-13 on PCB T-3158 so that the B trace starts at the first **minor** vertical graticule line.

Turn the DLY TIME MULT control to 10.0 and adjust VR-12 on PC T-3158 to make the B trace start at the rightmost vertical graticule line. Repeat both of these adjustments until the B trace starts at the proper points.

3-8. VERTICAL AMPLIFIERS

3-8-1 DC Balance Adjustment

Retain the oscilloscope to the initial setup conditions. (See Paragraph 3-1). Set the CH-1 and CH-2 VOLTS/DB/ switches to 5 reV, the CH-I and CH-2 AC/GND/DC switches to GND, and center the trace vertically with the vertical POSITION control. Then, pull the CH-I X10 MAG switch knob, and adjust VR-5 on PCB T-3154 to recent^{er} the trace. Repeat the above by turning the X10 MAG switch on and off, and readjusting the vertical POSITION control and VR-5 for minimum shift.

Press the CH-2 V MODE pushbutton, and repeat the above procedure for CH-2. VR-15 on PCB T-3154 is the CH-2 adjustment.

3-8-2 Attenuator Step Balance

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1). Set the CH-I and CH-2 VOLTS/DIV switches to 10 mV, and the AC/GND/DC switches to GND. Center the trace vertically using the CH-I vertical POSITION control. Change the CH-1 VOLTS/DIV switch to 5 mV, and adjust VR4 on PCB T-3154 to recenter the trace. Repeat the above until there is very little shift in the trace when switching between I0 mV and 5 mV positions of the VOLTS/DIV switch.

Press the CH-2 V MODE pushbutton, and repeat the above procedure for CH-2. VR-14 on PCB T-3154 is the CH-2 adjustment.

3-8-3 X1 AC Gain Compensation

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1). Set the CH-1 and CH-2 VOLTS/DIV switches to 5 mV, the A TIME/DIV switch to .2 mS, and press the ALT V MODE pushbutton.

Connect a square-wave generator to the CH-1 and CH-2 input connectors. Adjust the generator frequency to I000 Hz, and its output level to 25 mVp-p.Adjust VR- 1 on PCB T-3154 for a correct square-wave display, per Figure 3-3. After channel 1 is compensated, adjust VR-11 on PCB T-3154 for a correct channel 2 display.

3-8-4 X10 AC Gain Compensation

With conditions set as in Paragraph 3-8-3, turn both VOLTS/DB/switches to 20 mV and pull both vertical X10 MAG control knobs. Set the square-wave generator output to 10 mVp-p.

Adjust VR-2 on PCB T-3154 for a correct square-wave display, per Figure 3-3. After channel 1 is compensated, adjust VR-12 on PCB T-3154 for a correct CH-2 display.

3-8-5 Gain Calibration

With conditions set as in Paragraph 3-8-4, turn both VOLTS/DIV switches to 5 mV, and remove the square wave generator.

Connect an amplitude calibrator whose output is set for 25 mVp-p to the CH-1 and CH-2 input connectors. Adjust VR-21 on PCB T-3155 for a CH-1 vertical deflection of~ major divisions. Adjust VR-23 on PCB T-3155 for a CH-2 vertical deflection of 5 major divisions.

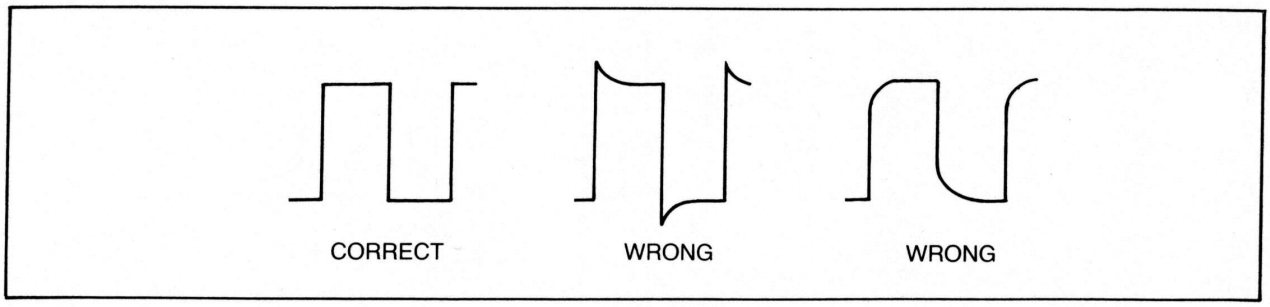

Figure 3-3.

3-8-6 CH-2 INV Balance Adjustment

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1.) Press the CH-2 V MODE switch, and set the CH-2 AC/GND/DC switch to GND.

Center the trace vertically using the CH-2 vertical POSITION control. Press the CH-2 INV switch, and note the amount that the trace shifts from the centered position. Using VR-11 on PCB T-3155, move the trace half the distance it shifted, back towards the center of the CRT screen. Release the CH-2 INV switch, and recenter the trace with the CH-2 vertical POSITION control. Repeat the above adjustments as the CH-2 INV switch is operated, until there is no trace shift from one position to the other.

3-8-7 CH-1/CH-2 Input Capacitance Adjustment

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1). Set the VOLTS/DIV switches to 5mV.

Connect a capacitance meter to the CH-1 input connector and adjust VC-1 (Ci-1) on PCB T-3154 for 30 pF. Reset the VOLTS/DIV switch to 20 mV and adjust 1/2 Ci for 30 pF. Reset the VOLTS/DIV switch to 50 mV and adjust 1/5 Ci for 30 pF. Reset the VOLTS/DIV switch to .1 V and adjust l/l0 Ci for 30 pF. Reset the VOLTS/DIV switch to 1 V and adjust 1/100 Ci for 30 pF.

Press the CH-2 V MODE pushbutton, and repeat the above adjustments on VC-11 for channel 2.

3-8-8 CH-1/CH-2 Input Attenuator Compensation

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1). Connect a square-wave generator to the CH-1 input connector. Set the generator controls for 100 mV output at 1000 Hz.

Adjust CH-1 1/2Cc on PCB T-3154 for a correctly compensated square-wave. (See Figure 3-3.) Reset the CH-1 VOLTS/DIV switch to 50 mV, and the generator output level for 250 mVp-p. Adjust CH-1 1/5Cc on PCB T-3154 for a correctly compensated square wave. Reset the CH-1 VOLTS/ DIV switch to .1 V, and the generator output level to .5 V. Adjust CH-1 1/10Cc on PCB T-3154 for a correctly compensated square-wave. Reset the CH-1 VOLTS/DIV switch to 1 V, and the generator output level to 5 Vp-p. Adjust CH-1 1/100Cc for a correctly compensated square-wave.

Press the CH-2 V MODE switch, and repeat the above procedure for CH-2, using the CH-2 1/2Cc, 1/5Cc, 1/10Cc. and 1/100Cc adjustment trimmers.

3-8-9 CH-3 Direct Input Capacitance Adjustment

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1.) Press the ALT V MODE pushbutton, pull the PULL TRIPLE control knob, set the SOURCE switch to .2 V/DIV, and the COUPLING switch to DC.

Connect a capacitance meter to the CH-3 input connector. Adjust VC-5 (C IN) on PCB T-3153 for a 30 pF indication.

3-8-10 CH-3 Attenuator Compensation

With conditions set as in Paragraph 3-8-9, reset the SOURCE switch to 2 V/DIV. Connect a square-wave generator to the CH-3 input connector. Set the generator controls for 10 Vp.p output at 1000 Hz.

Adjust VC-3 (CC) on PCB T-3153 for a correctly compensated square- wave, per Figure 3-3.

3-8-11 CH-3 Attenuator Input Capacitance Adjustment

With conditions set as in Paragraph 3-8-10, remove the square-wave generator and connect a capacitance meter to the CH-3 input connector. Adjust VC-3 (C-l) for 30pF meter indication.

3-8-12 CH-3 Gain Adjustment

With conditions set as in Paragraph 3-8-11, remove the capacitance meter and connect an amplitude calibrator to the CH-3 input connector. Set the calibrator controls for 1 Vp-p output at 1000 Hz. Adjust VR-26 on PCB T-3155 for 5 major divisions of vertical deflection on the CRT screen.

3-8-13 CH-1 Output Level Adjustment

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1.) Connect the CH-1 OUTPUT connector to a test oscilloscope having a 50-ohm feedthrough termination on its input. Set the test oscilloscope's input attenuator at 20 mV/div. Connect an amplitude calibrator adjusted for an output level of 100 mVp-p at 1000 Hz to.the CH-1 input connector of the LBO-516.Adjust the CH-1 VARIABLE control for 4 major divisions of vertical deflection on the LBO-516, then adjust VR- 1 on PCB T-3155 for 4 divisions of vertical deflection on the test oscilloscope.

Set the CH-1 AC/GND/DC switch to GND, and the CH-1 VARIABLE control to CAL'D. Make sure the test oscilloscope is DC coupled and its ground reference is known. Adjust VR-2 on PCB T-3155 for a 0 VDC output as indicated on the test oscilloscope.

3-8-14 CH-I/CH-2 HF Pulse Response Adjustment

Return the oscilloscope to the initial setup conditions. (See

Paragraph 3-1.) Set the CH-1 VOLTS/DIV switch to 5 mV, the A TIME/DIV switch to 2/aS, the B TIME/DIV switch to .2 μS, and press the INTEN BY B HORIZ DISPLAY pushbutton.

Connect a square-wave generator to the CH-1 input conneetor, and set the generator for 25 mVp-p output at 100 kHz. Adjust the DLY TIME MULT control so the B (intensified) trace is positioned over a leading edge of the displayed square wave. Press the B HORIZ DISPLAY pushbutton, and adjust VC-21 on PCB T-3155 and VC-1, VR-1, VC-2, VR-2, and VC-3 on PCB T-3156 for minimum observed overshoot and ringing. This can be checked by setting the CH-1 VOLTS/ DIV switch to 20 mV and pulling the CH-1 X10 MAG knob.

Cheek that the overshoot and ringing is less than 3% at all positions of the CH-1 VOLTS/DIV switch. In each case the generator output level should be adjusted for 5 major divisions of vertical deflection.

Repeat the above procedure for CH-2. The corresponding adjustment parts for CH-2 are VC-11 and VC- 12 on PCB T-3155, and VC-13 on PCB T-3154.

3-8-15 CH-1/CH-2 Frequency Response Check

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1.) Make sure the X10 MAG switches are pushed in. Set the VOLTS/DIV controls to 5 mV, and the A TIME/DIV switch to 2μS.

Connect a sine-wave generator to the CH-1 input connector, making sure the feedthrough termination appropriate for the generator is attached to the CH- 1 input connector. Adjust the generator for an output level of 40 mVp-p at 1 MHz; monitor the frequency with a frequency counter.

Increase the frequency until the display indicates 5.6 major divisions of vertical amplitude. This is the -3 dB point. The counter should indicate a frequency of over 100 MHz. Repeat the applicable adjustments in Paragraph 3-8-14 if it does not.

Move the generator to the CH-2 input connector, and press the CH-2 V MODE pushbutton. Set the SOURCE switch at CH-2, and repeat the above procedure for channel 2.

3-8-16 CH-1 Output Pulse Response

With conditions set as in Paragraph 3-8-13, set the CH-1 VOLTS/DIV switch of LBO-516 and that of the test oscilloscope to 5 mV/div.

Connect a square-wave generator adjusted for an output frequency of I00 kHz to the CH-1 input connector. Adjust the generator output level for 4 divisions of vertical deflection on the test oscilloscope. Then, adjust VC- 1 and VC-2 on PCB T-3155, and VC-3 on PCB T-3154 for less than 7% overshoot at the leading and trailing edges of the waveform displayed on the test oscilloscope.

3-8-17 CIt-1 & CH-2 Xl0 Magnifier Bandwidth Check

Return the oscilloscope to the initial setup conditions.(See Paragraph 3-1.) Set the A TIME/DIV switch to 2μS, and pull the CH-1 and CH-2 X10 MAG switch knobs.

Connect a sine-wave generator to the CH-1 input connector, and adjust it for 8 divisions deflection at 1 MHz. Monitor the generator frequency with a frequency counter. Increase the generator frequency until the displayed amplitude decreases to 5.6 divisions. This is the -3 dB point. The counter should indicate a frequency of over 5 MHz.

Move the generator to the CH-2 input Connector, and press the CH-2 V MODE pushbutton. Set the SOURCE switch at CH-2, and repeat the above procedure for CH-2.

3-8-18 Vertical POSITION Control Centering

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1.) Press the ALT V MODE pushbutton, and pull the PULL TRIPLE control knob. Make sure the CH-1, CH-2, and CH-3 vertical POSITION control knobs are set with their index marks pointing straight up.

Adjust VR-22 on PCB T-3155 to position the CH-1 trace on the center horizontal graticule line. Adjust VR-24 on PCB T-3155 to position the CH-2 trace on the center horizontal graticule line. Adjust VR-25 to position the CH-3 trace on the center horizontal graticule line.

3-8-19 ADD Balance Adjustment

With conditions set as in Paragraph 3-8-18, push in the ADD V MODE pushbutton. Adjust VR-27 on PCB T-3155 to position the trace on the center horizontal graticule line.

3-9 TRIGGER CIRCUITRY ADJUSTMENTS

3-9-1 Trigger Balance and Centering Adjustments

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1.) Set the CH-1 AC/GND/DC switch to AC, the COUPLING switch to DC, and the A TIME/DIV switch to .2 mS.

Connect a sine-wave generator set for 1.2 Vp-p output at 1000 Hz to the CH-1 input connector. Make sure the LEVEL control is centered (index mark up), and center the displayed sine wave by means of the CH-1 vertical POSITION control so the waveform extends from 3 major divisions above to 3 major divisions below the center horizontal graticule line. Adjust the horizontal POSITION control so the sweep starts on the first vertical graticule line. Adjust VR-21 on PCB T-3153 for symmetrical trigger points (above and below the center horizontal graticule line) when the SLOPE switch is changed from + to -. (See Figure 3-4.)

Adjust VR-32 on PCB T-3153 until the trigger point of the displayed sine wave starts on the center horizontal graticule line when the SLOPE switch is changed from + to -.

Reduce the output of the generator so the displayed sine wave's p-p amplitude is only 0.4 (2 minor) divisions. Then fine adjust VR-I and VR-12 on PCB T-3153 for a stable display in each position of the SLOPE switch.

3-9-2 Trigger Balance Adjustments for Multitrace Modes

Return the oscilloscope to the initial setup conditions (See Paragraph 3-1.) Set the AC/GND/DC switches to GND, press the ALT V MODE pushbutton, pull the PULL TRIPLE control knob, and set the SOURCE switch to CH-2.

Turn the CH-1 vertical POSITION control fully counter-clockwise, and center the CH-3 trace with the CH-3 vertical POSITION control. Change the COUPLING switch to DC and adjust VR-22 on PCB T-3153 to recenter the trace.

Set the SOURCE switch to .2 V/DIV and adjust VR-23 on PCB T-3153 to recenter the trace. Reset the AC/GND/DC switches to AC and recenter the trace if necessary.

Restore the COUPLING switch to AC and recenter the trace with VR-31 on PCB T-3153.

3-9-3 PRESET Trigger Adjustment

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1.) Connect a sine-wave generator to the CH-1 input connector. Adjust the generator output for 2 minor divisions of vertical deflection at I000 Hz. Pull the HOLDOFF control for PRESET trigger. Adjust VR-2 on PCB T-3159 until the waveform is triggered and the TRIG'D lamp lights.

3-9-4 CH-3 Pulse Response Adjustment

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1.) Press the ALT V MODE pushbutton, pull the PULL TRIPLE control knob, set the COUPLING switch to DC, and the SOURCE switch to.2 V/DIV. Center the CH-3 trace.

Connect a square-wave generator to the CH-3 input connector. Set the generator for 1 Vp-p output level at 100 kHZ. Adjust VC-6 on PCB T-3153 and VC-23 on PCB T-3155 to reduce overshoot and ringing to below 10%. Check the frequency response of CH-3 in the same manner as was done in Paragraph 3-8-15.

3-9-5 Interred Trigger-Pulse Response Adjustment

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1.) Set the VOLTS/DIV switches to 5 mV, the COUPLING switch to DC, and press the ALT V MODE pushbutton.

Connect a square-wave generator set for 25 mVp-p output at I00 kHz to the CH-1 input connector. Adjust VC-I on PCB T-3153 to minimize overshoot and ringing. Total overshoot and ringing should be less than 10%.

Repeat the above procedure for channel 2, adjusting VC-2 on PCB T-3153.

3-10. X-Y MODE ADJUSTMENTS

3-10-1 Gain Adjustment

Return the oscilloscope to the initial setup conditions. (See Paragraph 3-1.) Press the X-Y pushbutton.

Connect a square-wave generator set for 100mVp-p output at 1000 Hz to the CH-1 (X IN) connector. Adjust VR-31 on PCB T-3158 for 5 major divisions of separation between the two dots displayed on the CRT screen. (Note: the position of the dots will change when adjusting VR-31; this is normal.)

3-10-2 Balance Adjustment

With conditions set as in Paragraph 3-10-1, set both AC/GND/DC switches to GND. Check that the horizontal POSITION and X FINE control knobs are set with their index marks up, then adjust VR-32 on PCB T-3158 to center the dot horizontally on the CRT screen.

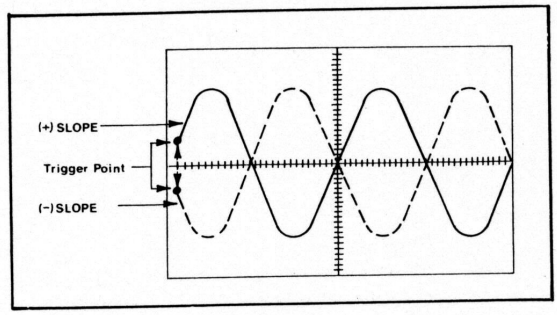

Figure 3-4.

4. REPLACEMENT PARTS LIST

LBO-516
MAIN FRAME

Symbol No.	Description			
	CRT			
V1	CRT	E8303B31		
	COILS			
L1	Rotation	L-678		
	DIODES			
D1	LED	SLP-751		
	CAPACITORS			
C1	Plastic film	630V	0.022μF	10%
C2	Plastic film	630V	0.022μF	10%
	CONNECTORS			
J1	BNC-080			
J2	BNC-080			
J3	BNC-080			
J4	BNC-080			
J5	BNC-080			
	RESISTORS			
R1	Carbon	10Ω	5%	¼W
R2	Carbon	10Ω	5%	¼W
R3	Carbon	10Ω	5%	¼W
R4	Carbon	10Ω	5%	¼W

Symbol No.	Description		
	VARIABLE RESISTORS		
VR1	VR468-R		
	SWITCHES		
S1	Power	SDG-5P-E	
S2	Slide	SSB423-N,P, 15L	
S3	Slide	SSB423-N,P, 15L	
S4	Slide	SSH20600	
S5	Slide	SSH20600	
	TRANSFORMERS		
T1	Power Transformer		J-465
	MISCELLANEOUS		
	AC Inlet	NC-173	
	Fuse for 100 ~ 120V ST4		1.25A
	Fuse for 200 ~ 240V ST4		0.8A
	Fuse Holder		FH-032
	Metal Terminal		D-1376A
	CAL Terminal		E-307B
	2606 Type Dial		LD-M6R-G
	ACCESSORIES		
	BNC Terminal Adaptor		E-258A
	(1/1, 1/10) Probe		LP-100X

T-3154
VERTICAL ATTENUATOR AND INPUT PREAMPLIFIER

Symbol No.	Description			
D1	Si Dual	MC931	75V	100mA
D2	Si Dual	MC931	75V	100mA
D3	Ge	1K60	40V	50mA
D4	Ge	1K60	40V	50mA
D5	Si Dual	MC931	75V	100mA
D6	Si Dual	MC931	75V	100mA
D7	Si Dual	MC931	75V	100mA
D21	Ge	1K60	40V	50mA
D22	Si Dual	MC931	75V	100mA
D23	Si Dual	MC931	75V	100mA
D24	Ge	1K60	40V	50mA
D25	Si Dual	MC931	75V	100mA
D26	Si Dual	MC931	75V	100mA
D27	Si Dual	MC931	75V	100mA
	INTEGRATED CIRCUITS			
IC1	Custom	VA1B		
IC11	Custom	VA1B		
	TRANSISTORS			
Q1	NPN	2SC1907		
Q2	NPN	2SC1907		
Q3	Dual FET	ITS30809		
Q4	NPN	2SC1907		
Q5	NPN	2SC1907		
Q21	NPN	2SC1907		
Q22	NPN	2SC1907		
Q23	Dual FET	ITS30809		

Symbol No.	Description			
Q24	NPN	2SC1907		
Q25	NPN	2SC1907		
	CAPACITORS			
C1	Not used			
C2	Plastic film	630V	0.01μF	20%
C3	Electrolytic	10V	220μF	20%
C4	Mica	50V	100pF	10%
C5	Elecrolytic	10V	220μF	20%
C6	Not used			
C7	Electrolytic	16V	220μF	20%
C8	Electrolytic	16V	220μF	20%
C9	Ceramic	50V	0.01μF	
C10	Ceramic	50V	0.01μF	
C11	Mica	500V	18pF	10%
C12	Mica	500V	12pF	10%
C13	Mica	500V	10pF	10%
C14	Ceramic	50V	0.01μF	
C15	Plastic film	50V	0.01μF	10%
C16	Ceramic	50V	0.01μF	
C17	Mica	500V	22pF	10%
C18	Mica	500V	5pF	10%
C19	Not used			
C20	Mica	500V	5pF	10%
C21	Mica	50V	68pF	10%
C31	Not used			
C32	Plastic film	630V	0.01μF	20%

Symbol No.	Description			
C33	Electrolytic	10V	220μF	20%
C34	Mica	50V	100pF	10%
C35	Electrolytic	10V	220μF	20%
C36	Not used			
C37	Electrolytic	16V	220μF	20%
C38	Electrolytic	16V	220μF	20%
C39	Ceramic	50V	0.01μF	
C40	Ceramic	50V	0.01μF	
C41	Mica	500V	18pF	10%
C42	Mica	500V	12pF	10%
C43	Mica	500V	10pF	10%
C44	Ceramic	50V	0.01μF	
C45	Plastic film	50V	0.01μF	10%
C46	Ceramic	50V	0.01μF	
C47	Mica	500V	18pF	10%
C48	Mica	500V	5pF	10%
C49	Not used			
C50	Electrolytic	16V	10μF	20%
C51	Not used			
C52	Electrolytic	16V	10μF	20%
C53	Not used			
C54	Mica	50V	68pF	10%
C55	Mica	500V	5pF	10%
	VARIABLE CAPACITORS			
VC1	Ceramic	250V	4pF	
VC2	Not used			
VC3	Ceramic	250V	20pF	
VC11	Ceramic	250V	4pF	
VC12	Not used			
VC13	Ceramic	250V	20pF	
	COILS			
L1	EL0606-1R8K	1.8μH	10%	
L2	EL0606-1R8K	1.8μH	10%	
	RESISTORS			
R1	Carbon	10Ω	5%	¼W
R2	Metal	330KΩ	0.5%	¼W
R3	Metal	1MΩ	0.5%	¼W
R4	Carbon	5.6KΩ	5%	⅛W
R5	Carbon	470Ω	5%	⅛W
R6	Carbon	470Ω	5%	⅛W
R7	Carbon	5.6KΩ	5%	⅛W
R8	Carbon	470Ω	5%	⅛W
R9	Carbon	470Ω	5%	⅛W
R10	Not Used			
R11	Carbon	220Ω	5%	⅛W
R12	Carbon	680Ω	5%	⅛W
R13	Carbon	470Ω	5%	⅛W
R14	Carbon	56Ω	5%	⅛W
R15	Carbon	22Ω	5%	⅛W
R16	Carbon	22Ω	5%	⅛W
R17	Carbon	120KΩ	5%	⅛W
R18	Metal	6.8KΩ	0.5%	¼W
R19	Metal	1MΩ	0.5%	¼W
R20	Metal	3.3KΩ	0.5%	¼W
R21	Metal	240Ω	0.5%	¼W
R22	Carbon	3.3Ω	5%	⅛W
R23	Metal	130Ω	1%	¼W

Symbol No.	Description			
R24	Carbon	180Ω	5%	⅛W
R25	Metal	470Ω	1%	¼W
R26	Carbon	100Ω	5%	⅛W
R27	Carbon	33Ω	5%	⅛W
R28	Carbon	270Ω	5%	⅛W
R29	Carbon	47KΩ	5%	⅛W
R30	Carbon	56KΩ	5%	⅛W
R31	Carbon	33KΩ	5%	⅛W
R32	Carbon	270Ω	5%	⅛W
R33	Carbon	33Ω	5%	⅛W
R34	Carbon	1KΩ	5%	⅛W
R35	Carbon	1KΩ	5%	⅛W
R36	Carbon	470Ω	5%	⅛W
R37	Carbon	100Ω	5%	⅛W
R38	Metal	200Ω	0.5%	¼W
R39	Metal	200Ω	0.5%	¼W
R40	Not Used			
R41	Not Used			
R42	Not Used			
R43	Not Used			
R44	Not Used			
R45	Not Used			
R46	Carbon	33KΩ	5%	⅛W
R47	Carbon	560Ω	5%	⅛W
R48	Carbon	330Ω	5%	⅛W
R49	Carbon	27Ω	5%	⅛W
R61	Carbon	10Ω	5%	¼W
R62	Metal	330KΩ	0.5%	¼W
R63	Metal	1MΩ	0.5%	¼W
R64	Carbon	5.6KΩ	5%	⅛W
R65	Carbon	470Ω	5%	⅛W
R66	Carbon	470Ω	5%	⅛W
R67	Carbon	5.6KΩ	5%	⅛W
R68	Carbon	470Ω	5%	⅛W
R69	Carbon	470Ω	5%	⅛W
R70	Not Used			
R71	Carbon	220Ω	5%	⅛W
R72	Carbon	680Ω	5%	⅛W
R73	Carbon	470Ω	5%	⅛W
R74	Carbon	56Ω	5%	⅛W
R75	Carbon	22Ω	5%	⅛W
R76	Carbon	22Ω	5%	⅛W
R77	Carbon	120KΩ	5%	⅛W
R78	Metal	6.8KΩ	0.5%	¼W
R79	Metal	1MΩ	0.5%	¼W
R80	Metal	3.3KΩ	0.5%	¼W
R81	Metal	240Ω	0.5%	¼W
R82	Carbon	3.3Ω	5%	⅛W
R83	Metal	130Ω	1%	¼W
R84	Carbon	180Ω	5%	⅛W
R85	Metal	470Ω	1%	¼W
R86	Carbon	100Ω	5%	⅛W
R87	Carbon	33Ω	5%	⅛W
R88	Carbon	270Ω	5%	⅛W
R89	Carbon	47KΩ	5%	⅛W
R90	Carbon	56KΩ	5%	⅛W
R91	Carbon	33KΩ	5%	⅛W
R92	Carbon	270Ω	5%	⅛W

Symbol No.	Description			
R93	Carbon	33Ω	5%	⅛W
R94	Carbon	1KΩ	5%	⅛W
R95	Carbon	1KΩ	5%	⅛W
R96	Carbon	470Ω	5%	⅛W
R97	Carbon	100Ω	5%	⅛W
R98	Metal	200Ω	0.5%	¼W
R99	Metal	200Ω	0.5%	¼W
R100	Carbon	27Ω	5%	⅛W
R101	Not Used			
R102	Not Used			
R103	Not Used			
R104	Not Used			
R105	Not Used			
R106	Carbon	33KΩ	5%	⅛W
R107	Carbon	560Ω	5%	⅛W
R108	Carbon	330Ω	5%	⅛W

Symbol No.	Description			
	VARIABLE RESISTORS			
VR1	Cermet	300Ω	20%	0.3W
VR2	Cermet	100Ω	20%	0.3W
VR3		500Ω	with ATT1	switch
VR4	Cermet	20KΩ	20%	0.3W
VR5	Cermet	10KΩ	20%	0.3W
VR11	Cermet	300Ω	20%	0.3W
VR12	Cermet	100Ω	20%	0.3W
VR13		500Ω	with ATT2	switch
VR14	Cermet	20KΩ	20%	0.3W
VR15	Cermet	10KΩ	20%	0.3W
	SWITCHES			
S1		Pull switch with VR3		
S11		Pull switch with VR13		
ATT1	Q519	ADR255 A50 B/RV		
ATT2	Q519	ADR255 A50 B/RV		
	PRINTED CIRCUIT BOARD			
	T-3154-R,P	V. ATT.and Input		

T-3155
VERTICAL PREAMPLIFIER

Symbol No.	Description			
	DIODES			
D1	Si	1S1588	35V	120mA
D2	Si	1S1588	35V	120mA
D11	Si	1S1588	35V	120mA
D21	Si Dual	MC911	75V	100mA
D22	Si Dual	MC911	75V	100mA
D23	Si Dual	MC911	75V	100mA
D24	Si Dual	MC911	75V	100mA
D25	Si	1S1588	35V	120mA
D26	Si Dual	MC911	75V	100mA
D27	Si Dual	MC911	75V	100mA
D28	Si Dual	MC931	75V	100mA
D30	Si	1S1588	35V	120mA
D31	Si	1S1588	35V	120mA
	INTEGRATED CIRCUITS			
IC1	TC40107BP			
	TRANSISTORS			
Q1	NPN	2SC2671		
Q2	NPN	2SC2671		
Q3	NPN	2SC1907		
Q4	NPN	2SC1907		
Q5	NPN	2SC1907		
Q6	NPN	2SC1907		
Q7	PNP	2SA781		
Q8	PNP	2SA781		
Q9	PNP	2SA781		
Q10	PNP	2SA781		
Q11	NPN	2SC1907		
Q12	NPN	2SC1907		

Symbol No.	Description	
Q21	NPN	2SC2671
Q22	NPN	2SC2671
Q23	NPN	2SC1907
Q24	NPN	2SC1907
Q25	NPN	2SC1907
Q26	NPN	2SC1907
Q27	NPN	2SC1907
Q28	NPN	2SC1907
Q29	PNP	2SA781
Q30	PNP	2SA781
Q31	PNP	2SA781
Q32	PNP	2SA781
Q33	NPN	2SC1907
Q41	PNP	2SA781
Q42	PNP	2SA781
Q43	PNP	2SA781
Q44	PNP	2SA781
Q45	NPN	2SC1907
Q46	NPN	2SC1907
Q47	NPN	2SC752(G)TM-0
Q48	PNP	2SA781
Q49	PNP	2SA781
Q50	PNP	2SA781
Q51	PNP	2SA781
Q52	NPN	2SC1907
Q53	NPN	2SC1907
Q54	NPN	2SC752(G)TM-0
Q55	NPN	2SC1907
Q56	NPN	2SC1907
Q57	PNP	2SA781
Q58	PNP	2SA781
Q59	NPN	2SC752(G)TM-0

Symbol No.	Description			
Q60	NPN	2SC1907		
Q61	NPN	2SC1907		
Q62	NPN	2SC1815-GR		
Q63	NPN	2SC1815-GR		
Q64	PNP	2SA781		
Q65	PNP	2SA781		
Q66	NPN	2SC1815-GR		
Q67	NPN	2SC2671		
Q68	NPN	2SC2671		
Q69	PNP	2SA781		
	CAPACITORS			
C1	Ceramic	50V	0.01μF	
C2	Ceramic	50V	0.01μF	
C3	Electrolytic	16V	10μF	20%
C4	Not used			
C5	Ceramic	50V	0.01μF	
C6	Ceramic	50V	0.01μF	
C7	Not used			
C8	Ceramic	50V	0.01μF	
C9	Ceramic	50V	0.01μF	
C10	Electrolytic	16V	10μF	20%
C11	Electrolytic	25V	10μF	20%
C12	Ceramic	50V	0.01μF	
C13	Mica	500V	5pF	10%
C14	Not used			
C15	Not used			
C16	Ceramic	50V	0.01μF	
C17	Electrolytic	16V	10μF	20%
C18	Ceramic	50V	0.01μF	
C31	Ceramic	50V	0.01μF	
C32	Ceramic	50V	0.01μF	
C33	Electrolytic	16V	10μF	20%
C34	Not used			
C35	Ceramic	50V	0.01μF	
C36	Ceramic	50V	0.01μF	
C37	Not used			
C38	Ceramic	50V	0.01μF	
C39	Ceramic	50V	0.01μF	
C40	Electrolytic	16V	10μF	20%
C41	Ceramic	50V	0.01μF	
C42	Ceramic	50V	0.01μF	
C43	Electrolytic	25V	10μF	20%
C44	Not used			
C45	Not used			
C46	Not used			
C47	Not used			
C48	Ceramic	50V	0.01μF	
C49	Ceramic	50V	0.01μF	
C50	Ceramic	50V	0.01μF	
C51	Ceramic	50V	0.01μF	
C52	Ceramic	50V	0.01μF	
C53	Electrolytic	16V	10μF	20%
C54	Electrolytic	16V	10μF	20%
C55	Electrolytic	16V	10μF	20%
C56	Not used			
C57	Not used			

Symbol No.	Description			
C71	Mica	500V	1pF	10%
C72	Ceramic	50V	0.01μF	
C73	Ceramic	50V	0.01μF	
C74	Ceramic	50V	0.01μF	
C75	Ceramic	50V	0.01μF	
C76	Mica	500V	1pF	10%
C77	Ceramic	50V	0.01μF	
C78	Ceramic	50V	0.01μF	
C79	Ceramic	50V	0.01μF	
C80	Ceramic	50V	0.01μF	
C81	Mica	500V	1pF	10%
C82	Ceramic	50V	0.01μF	
C83	Electrolytic	16V	10μF	20%
C84	Electrolytic	16V	10μF	20%
C85	Electrolytic	16V	10μF	20%
C86	Ceramic	50V	0.01μF	
C87	Not used			
C88	Not used			
C89	Not used			
C90	Ceramic	50V	0.01μF	
C91	Ceramic	50V	0.01μF	
C92	Ceramic	50V	0.01μF	
C93	Ceramic	50V	0.01μF	
C94	Electrolytic	16V	10μF	20%
C95	Ceramic	50V	0.01μF	
C96	Mica	500V	1pF	10%
C97	Mica	500V	1pF	10%
C98	Ceramic	50V	0.01μF	
C99	Mica	500V	5pF	10%
C100	Ceramic	50V	0.01μF	
	VARIABLE CAPACITORS			
VC1	Ceramic	250V	10pF	
VC2	Ceramic	250V	40pF	
VC11	Ceramic	250V	10pF	
VC12	Ceramic	250V	40pF	
VC21	Ceramic	250V	4pF	
VC22	Ceramic	250V	4pF	
VC23	Ceramic	250V	10pF	
	RESISTORS			
R1	Carbon	33Ω	5%	⅛W
R2	Carbon	33Ω	5%	⅛W
R3	Metal	1.3KΩ	1%	¼W
R4	Metal	1.3KΩ	1%	¼W
R5	Metal	130Ω	1%	¼W
R6	Carbon	82Ω	5%	⅛W
R7	Carbon	220Ω	5%	⅛W
R8	Carbon	100Ω	5%	⅛W
R9	Carbon	100Ω	5%	⅛W
R10	Carbon	220Ω	5%	⅛W
R11	Not used			
R12	Carbon	47Ω	5%	⅛W
R13	Carbon	3.3KΩ	5%	⅛W
R14	Carbon	2.2KΩ	5%	⅛W
R15	Metal	430Ω	1%	¼W
R16	Metal	430Ω	1%	¼W

Symbol No.	Description			
R17	Carbon	47Ω	5%	⅛W
R18	Carbon	47Ω	5%	⅛W
R19	Carbon	1.2KΩ	5%	⅛W
R20	Carbon	1.2KΩ	5%	⅛W
R21	Carbon	47Ω	5%	⅛W
R22	Carbon	47Ω	5%	⅛W
R23	Metal	680Ω	1%	¼W
R24	Metal	680Ω	1%	¼W
R25	Metal	680Ω	1%	¼W
R26	Metal	680Ω	1%	¼W
R27	Carbon	56Ω	5%	⅛W
R28		0Ω		
R29	Not used			
R30	Carbon	47Ω	5%	⅛W
R31	Carbon	47Ω	5%	⅛W
R32	Not used			
R33	Carbon	47Ω	5%	⅛W
R34	Carbon	2.7KΩ	5%	⅛W
R35	Carbon	1KΩ	5%	⅛W
R36	Metal	1.2KΩ	1%	¼W
R37	Carbon	47Ω	5%	⅛W
R38	Metal	2.4KΩ	1%	¼W
R39	Metal	270Ω	1%	¼W
R40	Metal	75Ω	1%	¼W
R41	Carbon	560Ω	5%	⅛W
R42	Carbon	47Ω	5%	⅛W
R43	Metal	2.4KΩ	1%	¼W
R44	Metal	270Ω	1%	¼W
R45	Metal	51Ω	1%	¼W
R46	Carbon	1.2KΩ	5%	⅛W
R61	Carbon	33Ω	5%	⅛W
R62	Carbon	33Ω	5%	⅛W
R63	Metal	1.2KΩ	1%	¼W
R64	Metal	1.2KΩ	1%	¼W
R65	Metal	130Ω	1%	¼W
R66	Carbon	82Ω	5%	⅛W
R67	Carbon	220Ω	5%	⅛W
R68	Carbon	100Ω	5%	⅛W
R69	Carbon	100Ω	5%	⅛W
R70	Carbon	220Ω	5%	⅛W
R71	Carbon	5.6KΩ	5%	⅛W
R72	Carbon	47Ω	5%	⅛W
R73	Carbon	47Ω	5%	⅛W
R74	Carbon	2.7KΩ	5%	⅛W
R75	Carbon	2.7KΩ	5%	⅛W
R76	Carbon	2.7KΩ	5%	⅛W
R77	Carbon	2.7KΩ	5%	⅛W
R78	Carbon	10KΩ	5%	⅛W
R79	Carbon	100Ω	5%	⅛W
R80	Metal	430Ω	1%	¼W
R81	Metal	430Ω	1%	¼W
R82	Carbon	47Ω	5%	⅛W
R83	Carbon	47Ω	5%	⅛W
R84	Carbon	1.2KΩ	5%	⅛W
R85	Carbon	1.2KΩ	5%	⅛W
R86	Carbon	47Ω	5%	⅛W
R87	Carbon	47Ω	5%	⅛W
R88	Metal	680Ω	1%	¼W

Symbol No.	Description			
R89	Metal	680Ω	1%	¼W
R90	Metal	680Ω	1%	¼W
R91	Metal	680Ω	1%	¼W
R92	Metal	82Ω	1%	¼W
R93	Not used			
R94	Not used			
R95	Not used			
R96	Carbon	47Ω	5%	⅛W
R97	Carbon	47Ω	5%	⅛W
R98	Not used			
R99	Carbon	47Ω	5%	⅛W
R100	Carbon	2.7KΩ	5%	⅛W
R101	Carbon	1KΩ	5%	⅛W
R102	Metal	1.2KΩ	1%	¼W
R103	Carbon	47Ω	5%	⅛W
R104	Metal	2.4KΩ	1%	¼W
R105	Metal	270Ω	1%	¼W
R106	Metal	75Ω	1%	¼W
R107	Carbon	1.2KΩ	5%	⅛W
R121	Carbon	47Ω	5%	⅛W
R122	Carbon	47Ω	5%	⅛W
R123	Metal	510Ω	1%	¼W
R124	Metal	510Ω	1%	¼W
R125	Carbon	390Ω	5%	⅛W
R126	Carbon	2.2Ω	5%	⅛W
R127	Carbon	2.2KΩ	5%	⅛W
R128	Carbon	47Ω	5%	⅛W
R129	Carbon	4.7KΩ	5%	⅛W
R130	Carbon	1.8KΩ	5%	⅛W
R131	Carbon	47Ω	5%	⅛W
R132	Carbon	270Ω	5%	⅛W
R133	Carbon	220Ω	5%	⅛W
R134	Carbon	1.8KΩ	5%	⅛W
R135	Carbon	1.8KΩ	5%	⅛W
R136	Carbon	10KΩ	5%	⅛W
R137	Carbon	4.7KΩ	5%	⅛W
R138	Carbon	220Ω	5%	⅛W
R139	Carbon	47Ω	5%	⅛W
R140	Carbon	47Ω	5%	⅛W
R141	Metal	510Ω	1%	¼W
R142	Metal	510Ω	1%	¼W
R143	Carbon	390Ω	5%	⅛W
R144	Carbon	2.2Ω	5%	⅛W
R145	Carbon	1.5KΩ	5%	⅛W
R146	Carbon	47Ω	5%	⅛W
R147	Carbon	4.7KΩ	5%	⅛W
R148	Carbon	1.8KΩ	5%	⅛W
R149	Carbon	47Ω	5%	⅛W
R150	Carbon	270Ω	5%	⅛W
R151	Carbon	220Ω	5%	⅛W
R152	Carbon	1.8KΩ	5%	⅛W
R153	Carbon	1.8KΩ	5%	⅛W
R154	Carbon	10KΩ	5%	⅛W
R155	Carbon	4.7KΩ	5%	⅛W
R156	Carbon	220Ω	5%	⅛W
R157	Carbon	4.7KΩ	5%	⅛W
R158	Carbon	270Ω	5%	⅛W
R159	Carbon	47Ω	5%	⅛W

Symbol No.	Description			
R160	Metal	75Ω	1%	¼W
R161	Carbon	47Ω	5%	⅛W
R162	Metal	1KΩ	1%	¼W
R163	Metal	1KΩ	1%	¼W
R164	Carbon	220Ω	5%	⅛W
R165	Carbon	10KΩ	5%	⅛W
R166	Carbon	10Ω	5%	⅛W
R167	Metal	560Ω	1%	¼W
R168	Metal	560Ω	1%	¼W
R169	Carbon	47Ω	5%	⅛W
R170	Metal	3.9KΩ	1%	¼W
R171	Metal	2.2KΩ	1%	¼W
R172	Carbon	10KΩ	5%	⅛W
R173	Carbon	22Ω	5%	⅛W
R174	Carbon	22Ω	5%	⅛W
R175	Carbon	22Ω	5%	⅛W
R176	Carbon	22Ω	5%	⅛W
R177	Carbon	22Ω	5%	⅛W
R178	Carbon	22Ω	5%	⅛W
R179	Carbon	4.7KΩ	5%	⅛W
R180	Carbon	4.7KΩ	5%	⅛W
R181	Carbon	4.7KΩ	5%	⅛W
R182	Carbon	100Ω	5%	⅛W
R183	Carbon	390Ω	5%	⅛W
R192	Carbon	330Ω	5%	⅛W
R193	Carbon	5.6KΩ	5%	⅛W
R194	Carbon	47Ω	5%	⅛W
R195	Carbon	150Ω	5%	⅛W
R196	Carbon	470Ω	5%	⅛W
R197	Metal	1KΩ	1%	¼W
R198	Metal	1KΩ	1%	¼W
R199	Metal	1.5KΩ	1%	¼W
R200	Metal	1.5KΩ	1%	¼W
R201	Metal	12KΩ	1%	¼W
R202	Metal	2.2KΩ	1%	¼W
R203	Metal	1.8KΩ	1%	¼W
R204	Metal	620Ω	1%	¼W
R205	Metal	4.7KΩ	1%	¼W

Symbol No.	Description			
R206	Metal	6.8KΩ	1%	¼W
R207	Metal	5.6KΩ	1%	¼W
R208	Carbon	10KΩ	5%	⅛W
R209	Carbon	22Ω	5%	⅛W
R210	Carbon	22Ω	5%	⅛W
R211	Carbon	47Ω	5%	⅛W
R212	Carbon	3.9KΩ	5%	⅛W
R213	Carbon	680Ω	5%	⅛W
R214	Carbon	680Ω	5%	⅛W
R215	Metal	510Ω	1%	¼W
R216	Carbon	47Ω	5%	⅛W
R217	Metal	510Ω	1%	¼W
R218	Metal	180Ω	1%	¼W
R219	Metal	510Ω	1%	¼W
R220	Carbon	47Ω	5%	⅛W
R221	Metal	510Ω	1%	¼W
R222	Carbon	1.5KΩ	5%	⅛W
R223	Carbon	1.5KΩ	5%	⅛W
R224	Metal	91Ω	1%	¼W
R225	Metal	91Ω	1%	¼W
R226	Carbon	270Ω	5%	⅛W
	VARIABLE RESISTORS			
VR1	Cermet	100Ω	20%	0.3W
VR2	Cermet	1KΩ	20%	0.3W
VR11	Cermet	300Ω	20%	0.3W
VR21	Cermet	1KΩ	20%	0.3W
VR22	Cermet	1KΩ	20%	0.3W
VR23	Cermet	1KΩ	20%	0.3W
VR24	Cermet	1KΩ	20%	0.3W
VR25	Cermet	500Ω	20%	0.3W
VR26	Cermet	300Ω	20%	0.3W
VR27	Cermet	300Ω	20%	0.3W
	PRINTED CIRCUIT BOARD			
	T-3155-R,P	V. Preamp		

T-3161
VERTICAL MODE AND VERTICAL POSITION

Symbol No.	Description		
	CAPACITORS		
C1	Ceramic	50V	0.01μF
C2	Ceramic	50V	0.01μF
	VARIABLE RESISTORS		
VR1	Carbon	VR466 (with	S1)
VR2	Carbon	VR456 (with	S2)
	SWITCHES		
S3	Q515		
	PRINTED CIRCUIT BOARD		
	T-3161-R,P	V. Mode & V. Pos.	

T-3156
DELAY LINE AND VERTICAL FINAL DRIVE

Symbol No.	Description			
	DIODES			
D1	Varicap	BB329A		
D2	Varicap	BB329A		
	TRANSISTORS			
Q1	NPN	2SC2671		
Q2	NPN	2SC2671		
Q3	NPN	2SC1907		
Q4	NPN	2SC1907		
Q5	NPN	2SC1253		
Q6	NPN	2SC1253		
	CAPACITORS			
C1	Mica	50V	56pF	10%
C2	Ceramic	50V	0.01μF	
C3	Ceramic	50V	0.01μF	
C4	Not used			
C5	Ceramic	50V	0.01μF	
C6	Electrolytic	16V	10μF	20%
C7	Ceramic	50V	0.01μF	
C8	Electrolytic	25V	10μF	20%
C9	Ceramic	50V	0.01μF	
C15	Ceramic	50V	0.01μF	
	VARIABLE CAPACITORS			
VC1	Ceramic	250V	40pF	
VC2	Ceramic	250V	40pF	
VC3	Ceramic	250V	10pF	
	RESISTORS			
R1	Metal	91Ω	1%	¼W
R2	Metal	91Ω	1%	¼W
R3	Carbon	47Ω	5%	⅛W
R4	Carbon	47Ω	5%	⅛W
R5	Metal	510Ω	1%	¼W
R6	Metal	510Ω	1%	¼W
R7	Metal	56Ω	1%	¼W
R8	Carbon	33Ω	5%	⅛W
R9	Carbon	2.7KΩ	5%	⅛W
R10		0Ω		

Symbol No.	Description			
R11	Carbon	220Ω	5%	⅛W
R12	Carbon	220Ω	5%	⅛W
R13		0Ω		
R14	Carbon	39KΩ	5%	⅛W
R15	Not used			
R16	Carbon	47Ω	5%	⅛W
R17	Metal	3.9KΩ	1%	¼W
R18	Metal	2.7KΩ	1%	¼W
R19	Carbon	3.3KΩ	5%	⅛W
R20	Metal	150Ω	1%	¼W
R21	Metal	150Ω	1%	¼W
R22	Metal	47Ω	1%	¼W
R23	Carbon	27Ω	5%	⅛W
R24	Carbon	27Ω	5%	⅛W
R25	Metal	430Ω	1%	¼W
R26	Metal	430Ω	1%	¼W
R27	Metal	430Ω	1%	¼W
R28	Metal	430Ω	1%	¼W
R29	Metal	430Ω	1%	¼W
R30	Metal	430Ω	1%	¼W
R31	Metal	91Ω	1%	¼W
R32	Carbon	33Ω	5%	⅛W
R33	Not used			
	VARIABLE RESISTORS			
VR1	Cermet	1KΩ	20%	0.3W
VR2	Cermet	2KΩ	20%	0.3W
	THERMISTORS			
TH1	SDT-1000			
TH2	SDT-1000			
TH3	D-33A			
	DELAY LINE			
V-116	Delay Line			
	PRINTED CIRCUIT BOARD			
	T-3156-R,P	D. Line & F. Drive		

T-3159
TRIGGER LEVEL AND TIME VARIABLE

Symbol No.	Description		
	LED		
D1	TLG-226		
	CAPACITORS		
C1	Ceramic	50V	0.01μF
C2	Ceramic	50V	0.01μF
C3	Ceramic	50V	0.01μF

Symbol No.	Description			
	VARIABLE RESISTORS			
VR1	Carbon	VR455 (with S1 and S2)		
VR2	Cermet	20KΩ	20%	0.3W
VR3	Carbon	VR465 (with S4)		
	SWITCHES			
S3	Q470			
	PRINTED CIRCUIT BOARD			
	T-3159-R,P	T. Level & T. Var.		

Symbol No.	Description			
	DIODES			
D1	Si Dual	MC911	75V	100mA
D2	Si	1S1588	35V	120mA
D3	Zener	RD3.0EB	3.0V	
D4	Si Dual	MC931	75V	100mA
D5	Si	1S1588	35V	120mA
D6	Si	1S1588	35V	120mA
D7	Si Dual	MC931	75V	100mA
D8	Ge	1K60	40V	50mA
D9	Ge	1K60	40V	50mA
D10	Si	1S1588	35V	120mA
D21	Si Dual	MC931	75V	100mA
D22	Si	1S1588	35V	120mA
D23	Si	1S1588	35V	120mA
D24	Si	1S1588	35V	120mA
D25	Zener	RD7.5EB	7.5V	
D26	Si	1S1588	35V	120mA
D31	Si	1S1588	35V	120mA
D32	Si	1S1588	35V	120mA
D33	Si	1S1588	35V	120mA
D34	Si	1S1588	35V	120mA
	INTEGRATED CIRCUITS			
IC1	ECL	HD-10102		
IC2	ECL	HD-10104		
IC3	ECL	HD-10131		
IC4	ECL	HD-10102		
IC5	ECL	HD-10131		
IC6	ECL	HD-10102		
IC7	OP-AMP	TL071CP		
IC8	OP-AMP	TL071CP		
IC9	C-MOS	TC-4053BP		
	TRANSISTORS			
Q1	NPN	2SC1907		
Q2	PNP	2SA1015-GR		
Q3	NPN	2SC1815-GR		
Q4	PNP	2SA1015-O or Y		
Q5	PNP	2SA1206		
Q6	NPN	2SC752(G)T M-0		
Q7	FET Dual	UPA71A-L		
Q8	PNP	2SA1206		
Q9	NPN	2SC1907		
Q10	NPN	2SC1907		
Q11	NPN	2SC752(G)T M-0		
Q12	PNP	2SA1206		
Q13	PNP	2SA1015-GR		
Q14	PNP	2SA1206		
Q15	NPN	2SC752(G)T M-0		
Q16	NPN	2SC1907		
Q17	NPN	2SC1907		
Q18	NPN	2SC1815-O or Y		
Q19	NPN	2SC1815-O or Y		
Q20	PNP	2SA1015-O or Y		
Q21	PNP	2SA1206		
Q22	NPN	2SC752(G)T M-0		

Symbol No.	Description			
Q23	FET Dual	UPA71A-L		
Q24	PNP	2SA1206		
Q25	NPN	2SC1907		
Q26	NPN	2SC1907		
Q27	NPN	2SC752(G)T M-0		
Q28	PNP	2SA1206		
Q29	NPN	2SC752(G)T M-Y		
Q30	NPN	2SC1815-O or Y		
Q31	NPN	2SC752(G)T M-0		
Q32	NPN	2SC752(G)T M-Y		
Q33	PNP	2SA1015-GR		
Q34	NPN	2SC1907		
Q35	PNP	2SA1206		
Q36	Not used			
Q37	Not used			
Q38	Not used			
Q39	Not used			
Q40	Not used			
Q41	PNP	2SA872E		
Q42	PNP	2SA872E		
Q51	NPN	2SC1907		
Q52	NPN	2SC1907		
Q53	PNP	2SA1206		
Q54	PNP	2SA1206		
Q55	PNP	2SA1015-GR		
Q56	PNP	2SA1015-GR		
Q57	PNP	2SA1206		
Q58	PNP	2SA1206		
Q59	PNP	2SA1015-GR		
Q60	PNP	2SA1015-GR		
	CAPACITORS			
C1	Electrolytic	50V	1μF	20%
C2	Electrolytic	50V	1μF	20%
C3	Electrolytic	10V	22μF	20%
C4	Ceramic	50V	0.01μF	
C5	Not used			
C6	Electrolytic	10V	22μF	20%
C7	Mica	500V	27pF	10%
C8	Mica	500V	5pF	10%
C9	Mica	50V	100pF	10%
C10	Ceramic	50V	0.01μF	
C11	Ceramic	50V	0.01μF	
C12	Ceramic	50V	0.01μF	
C13	Electrolytic	10V	22μF	20%
C14	Ceramic	50V	0.01μF	
C15	Electrolytic	10V	100μF	20%
C16	Electrolytic	10V	10μF	20%
C17	Not used			
C18	Plastic film	50V	220pF	10%
C19	Mica	50V	180pF	10%
C20	Ceramic	50V	0.01μF	
C21	Electrolytic	50V	1μF	20%
C22	Ceramic	50V	0.01μF	
C23	Electrolytic	10V	22μF	20%
C24	Electrolytic	10V	22μF	20%
C25	Ceramic	50V	0.01μF	

Symbol No.	Description			
C26	Ceramic	50V	0.01μF	
C27	Ceramic	50V	0.01μF	
C28	Not used			
C29	Mica	500V	33pF	10%
C30	Ceramic	50V	0.01μF	
C31	Not used			
C32	Ceramic	50V	0.01μF	
C33	Mica	500V	27pF	10%
C34	Mica	500V	5pF	10%
C35	Ceramic	50V	0.01μF	
C36	Ceramic	50V	0.01μF	
C37	Mica	50V	100pF	10%
C38	Not used			
C39	Ceramic	50V	0.01μF	
C40	Ceramic	50V	0.1μF	
C41	Electrolytic	10V	100μF	20%
C42	Ceramic	50V	0.1μF	
C43	Not used			
C44	Mica	500V	22pF	10%
C45	Electrolytic	10V	47μF	20%
C46	Ceramic	50V	0.01μF	
C47	Ceramic	50V	0.01μF	
C48	Ceramic	50V	0.01μF	
C49	Ceramic	50V	0.01μF	
C50	Mica	50V	100pF	10%
C51	Ceramic	50V	0.01μF	
C52	Ceramic	50V	0.01μF	
C53	Ceramic	50V	0.1μF	
C54	Electrolytic	10V	100μF	20%
C61	Plastic film	250V	1μF	2%
C62	Mica	50V	47pF	10%
C63	Ceramic	50V	1000pF	
C64	Ceramic	50V	1000pF	
C65	Ceramic	50V	0.01μF	
C66	Electrolytic	25V	10μF	20%
C67	Ceramic	50V	0.01μF	
C68	Electrolytic	16V	10μF	20%
C69	Ceramic	50V	0.01μF	
C70	Electrolytic	25V	10μF	20%
C71	Plastic film	50V	270pF	10%
C72	Plastic film	50V	1500pF	10%
C73	Plastic film	50V	8200pF	10%
C74	Plastic film	50V	0.039μF	10%
C75	Electrolytic	35V	0.22μF	20%
C76	Electrolytic	35V	0.68μF	20%
C77	Electrolytic	25V	1μF	20%
C78	Electrolytic	16V	15μF	20%
C79	Electrolytic	16V	47μF	20%
C80	Electrolytic	16V	100μF	20%
C81	Plastic film	250V	1μF	2%
C82	Mica	50V	47pF	10%
C83	Ceramic	50V	1000pF	
C84	Ceramic	50V	1000pF	
C85	Ceramic	50V	0.01μF	
C86	Electrolytic	16V	10μF	20%
C87	Electrolytic	25V	10μF	20%
C88	Ceramic	50V	0.01μF	
C89	Electrolytic	25V	1.5μF	20%
C90	Not used			

Symbol No.	Description			
C91	Ceramic	50V	0.01μF	
C92	Mica	500V	1pF	10%
C93	Not used			
C94	Electrolytic	10V	100μF	20%
C95	Ceramic	50V	0.01μF	
C96	Mica	500V	1pF	10%
C97	Electrolytic	16V	10μF	20%
C98	Ceramic	50V	0.01μF	
C99	Ceramic	50V	0.01μF	
C100	Electrolytic	25V	10μF	20%
C101	Not used			
C102	Not used			
C103	Ceramic	50V	0.01μF	
C104	Ceramic	50V	0.01μF	
C105	Ceramic	50V	0.01μF	
C106	Ceramic	50V	0.01μF	
C107	Electrolytic	25V	10μF	20%
	VARIABLE CAPACITORS			
VC1	Ceramic	250V	10pF	
VC11	Ceramic	250V	10pF	
VC21	Ceramic	250V	40pF	
VC22	Ceramic	250V	40pF	
	RESISTORS			
R1	Carbon	470Ω	5%	⅛W
R2	Carbon	10KΩ	5%	⅛W
R3	Carbon	470KΩ	5%	⅛W
R4	Carbon	1MΩ	5%	⅛W
R5	Carbon	1KΩ	5%	⅛W
R6	Carbon	47Ω	5%	⅛W
R7	Carbon	820KΩ	5%	⅛W
R8	Carbon	10KΩ	5%	⅛W
R9	Carbon	4.7KΩ	5%	⅛W
R10	Carbon	10KΩ	5%	⅛W
R11	Carbon	390Ω	5%	⅛W
R12	Carbon	1.5KΩ	5%	⅛W
R13	Carbon	1.5KΩ	5%	⅛W
R14	Carbon	1.5KΩ	5%	⅛W
R15	Carbon	1.5KΩ	5%	⅛W
R16	Carbon	4.7KΩ	5%	⅛W
R17	Carbon	1.5KΩ	5%	⅛W
R18	Carbon	1.5KΩ	5%	⅛W
R19	Carbon	1.5KΩ	5%	⅛W
R20	Carbon	1.5KΩ	5%	⅛W
R21	Carbon	1.5KΩ	5%	⅛W
R22	Carbon	27Ω	5%	⅛W
R23	Carbon	47Ω	5%	⅛W
R24	Metal	510Ω	1%	¼W
R25	Metal	2.7KΩ	1%	¼W
R26	Carbon	220Ω	5%	⅛W
R27	Carbon	820Ω	5%	⅛W
R28	Carbon	390Ω	5%	⅛W
R29	Carbon	100Ω	5%	⅛W
R30	Carbon	100Ω	5%	⅛W
R31	Carbon	47Ω	5%	⅛W
R32	Metal	4.7KΩ	1%	¼W
R33	Carbon	47Ω	5%	⅛W
R34	Carbon	47Ω	5%	⅛W
R35	Carbon	1.2KΩ	5%	⅛W

Symbol No.	Description			
R36	Carbon	3.3KΩ	5%	⅛W
R37	Carbon	1KΩ	5%	⅛W
R38	Carbon	1.8KΩ	5%	⅛W
R39	Carbon	330Ω	5%	⅛W
R40	Carbon	100Ω	5%	⅛W
R41	Carbon	47Ω	5%	⅛W
R42	Carbon	47Ω	5%	⅛W
R43	Carbon	1.5KΩ	5%	⅛W
R44	Carbon	1.5KΩ	5%	⅛W
R45	Carbon	1.5KΩ	5%	⅛W
R46	Carbon	1.5KΩ	5%	⅛W
R47	Carbon	1.5KΩ	5%	⅛W
R48	Carbon	18KΩ	5%	⅛W
R49	Carbon	5.6KΩ	5%	⅛W
R50	Carbon	10KΩ	5%	⅛W
R51	Carbon	18KΩ	5%	⅛W
R52	Carbon	18KΩ	5%	⅛W
R53	Carbon	2.2KΩ	5%	⅛W
R54	Carbon	470Ω	5%	⅛W
R55	Metal	510Ω	1%	¼W
R56	Metal	3KΩ	1%	¼W
R57	Carbon	2.2KΩ	5%	⅛W
R58	Carbon	1KΩ	5%	⅛W
R59	Carbon	47Ω	5%	⅛W
R60	Carbon	220Ω	5%	⅛W
R61	Carbon	220Ω	5%	⅛W
R62	Carbon	180Ω	5%	⅛W
R63	Carbon	47KΩ	5%	⅛W
R64	Carbon	2.2KΩ	5%	⅛W
R65	Carbon	2.2KΩ	5%	⅛W
R66	Carbon	4.7KΩ	5%	⅛W
R67	Carbon	10KΩ	5%	⅛W
R68	Carbon	10KΩ	5%	⅛W
R69	Carbon	22KΩ	5%	⅛W
R70	Carbon	10KΩ	5%	⅛W
R71	Carbon	100Ω	5%	⅛W
R72	Carbon	1.8KΩ	5%	⅛W
R73	Carbon	390Ω	5%	⅛W
R74	Carbon	1KΩ	5%	⅛W
R75	Carbon	2.2KΩ	5%	⅛W
R76	Carbon	22KΩ	5%	⅛W
R77	Carbon	1KΩ	5%	⅛W
R78	Carbon	2.2KΩ	5%	⅛W
R79	Not used			
R80	Not used			
R81	Carbon	1.5KΩ	5%	⅛W
R82	Carbon	1.5KΩ	5%	⅛W
R83	Carbon	1.5KΩ	5%	⅛W
R84	Carbon	27Ω	5%	⅛W
R85	Carbon	47Ω	5%	⅛W
R86	Metal	510Ω	1%	¼W
R87	Metal	2.7KΩ	5%	¼W
R88	Carbon	220Ω	5%	⅛W
R89	Carbon	820Ω	5%	⅛W
R90	Carbon	390Ω	5%	⅛W
R91	Carbon	100Ω	5%	⅛W
R92	Carbon	100Ω	5%	⅛W
R93	Carbon	47Ω	5%	⅛W

Symbol No.	Description			
R94	Carbon	4.7KΩ	5%	⅛W
R95	Carbon	47Ω	5%	⅛W
R96	Carbon	47Ω	5%	⅛W
R97	Carbon	4.7KΩ	5%	⅛W
R98	Carbon	1KΩ	5%	⅛W
R99	Carbon	1.8KΩ	5%	⅛W
R100	Carbon	100Ω	5%	⅛W
R101	Carbon	330Ω	5%	⅛W
R102	Carbon	47Ω	5%	⅛W
R103	Carbon	47KΩ	5%	⅛W
R104	Carbon	1.5KΩ	5%	⅛W
R105	Carbon	1.5KΩ	5%	⅛W
R106	Carbon	1.5KΩ	5%	⅛W
R107	Carbon	1.5KΩ	5%	⅛W
R108	Carbon	5.6KΩ	5%	⅛W
R109	Carbon	1.5KΩ	5%	⅛W
R110	Carbon	10KΩ	5%	⅛W
R111	Carbon	1.8KΩ	5%	⅛W
R112	Carbon	1KΩ	5%	⅛W
R113	Carbon	47Ω	5%	⅛W
R114	Carbon	1.5KΩ	5%	⅛W
R115	Carbon	47Ω	5%	⅛W
R116	Carbon	6.8KΩ	5%	⅛W
R117	Carbon	1.5KΩ	5%	⅛W
R118	Carbon	100Ω	5%	⅛W
R119	Carbon	6.8KΩ	5%	⅛W
R120	Carbon	12KΩ	5%	⅛W
R121	Carbon	4.7KΩ	5%	⅛W
R122	Carbon	1.2KΩ	5%	⅛W
R123	Carbon	4.7KΩ	5%	⅛W
R124	Carbon	4.7KΩ	5%	⅛W
R125	Carbon	47Ω	5%	⅛W
R126	Carbon	100Ω	5%	⅛W
R127	Carbon	8.2KΩ	5%	⅛W
R128	Carbon	10KΩ	5%	⅛W
R129	Carbon	10KΩ	5%	⅛W
R130	Carbon	330Ω	5%	⅛W
R131	Metal	7.5KΩ	1%	¼W
R132	Carbon	2.2KΩ	5%	⅛W
R133	Carbon	1.5KΩ	5%	⅛W
R134	Carbon	10KΩ	5%	⅛W
R135	Carbon	10KΩ	5%	⅛W
R136	Carbon	22Ω	5%	⅛W
R137	Carbon	2.2KΩ	5%	⅛W
R138	Not used			
R139	Not used			
R140	Not used			
R141	Carbon	470Ω	5%	⅛W
R142	Carbon	10KΩ	5%	⅛W
R143	Carbon	18KΩ	5%	⅛W
R144	Carbon	82KΩ	5%	⅛W
R145	Carbon	470Ω	5%	⅛W
R146	Carbon	10KΩ	5%	⅛W
R147	Carbon	3.3KΩ	5%	⅛W
R148	Carbon	47KΩ	5%	⅛W
R149	Carbon	82KΩ	5%	⅛W
R150	Metal	500.0Ω	0.5%	¼W
R151	Metal	500.0Ω	0.5%	¼W
R161	Metal	6.2KΩ	1%	¼W
R162	Carbon	100KΩ	5%	⅛W

Symbol No.	Description			
R163	Metal	7.5KΩ	1%	¼W
R164	Metal	5.1KΩ	1%	¼W
R165	Metal	5.1KΩ	1%	¼W
R166	Carbon	3.9KΩ	5%	⅛W
R167	Carbon	1.5KΩ	5%	⅛W
R168	Metal	3KΩ	1%	¼W
R169	Metal	2.7KΩ	1%	¼W
R170	Carbon	47Ω	5%	⅛W
R171	Carbon	47Ω	5%	⅛W
R172	Metal	2.7KΩ	1%	¼W
R173	Metal	1KΩ	1%	¼W
R174	Metal	1.5KΩ	1%	¼W
R175	Metal	1.5KΩ	1%	¼W
R176	Carbon	47Ω	5%	⅛W
R177	Carbon	47Ω	5%	⅛W
R178	Metal	51Ω	1%	¼W
R179	Metal	1.2KΩ	1%	¼W
R180	Not used			
R181	Carbon	82Ω	5%	⅛W
R182				
R183	Metal	330Ω	1%	¼W
R184	Metal	330Ω	1%	¼W
R185	Metal	270Ω	1%	¼W
R186	Metal	1.2KΩ	1%	¼W
R187	Metal	5.1KΩ	1%	¼W
R188	Carbon	100Ω	5%	⅛W
R189	Carbon	390Ω	5%	⅛W
R190	Carbon	390Ω	5%	⅛W

Symbol No.	Description			
R191	Carbon	10Ω	5%	⅛W
R192	Metal	560Ω	1%	¼W
R193	Metal	560Ω	1%	¼W
R194	Carbon	5.6Ω	5%	⅛W
R195	Carbon	5.6Ω	5%	⅛W
R196	Carbon	100Ω	5%	⅛W
R197	Metal	5.1KΩ	1%	¼W
R198	Carbon	10Ω	5%	⅛W
	VARIABLE RESISTORS			
VR1	Cermet	500Ω	20%	0.3W
VR11	Cermet	500Ω	20%	0.3W
VR12	Cermet	10KΩ	20%	0.3W
VR13	Cermet	3KΩ	20%	0.3W
VR21	Cermet	10KΩ	20%	0.3W
VR22	Cermet	10KΩ	20%	0.3W
VR31	Cermet	1KΩ	20%	0.3W
VR32	Cermet	10KΩ	20%	0.3W
VR33	Cermet	1KΩ	20%	0.3W
VR34	Cermet	300Ω	20%	0.3W
VR35	Cermet	100Ω	20%	0.3W
	RESISTOR ARRAY			
RA1	Carbon	1.5KΩX4	10%	⅛W
RA2	LRM-2		0.5%	
RA3	LRM-2		0.5%	
	PRINTED CIRCUIT BOARD			
	T-3158-R,P	Sweep		

T-3157
HORIZONTAL AND VERTICAL AMPLIFIER

Symbol No.	Description			
	DIODES			
D1	Zener	RD3.3EB	3.3V	
D2	Zener	RD5.6EB	5.6V	
D3	Si	1S1588	35V	120mA
D4	Si	1S1588	35V	120mA
	TRANSISTORS			
Q1	NPN	2N3866		
Q2	NPN	2N3866		
Q3	NPN	2SC1907		
Q4	NPN	2SC1907		
Q5	NPN	2SC1907		
Q6	NPN	2SC2911-S		
Q7	PNP	2SA1206		
Q8	NPN	2SC2911-S		
Q9	PNP	2SA1210S		
Q10	PNP	2SA1210S		
	COILS			
L1	SPO305R22M	0.22μH	20%	
L2	SPO305R22M	0.22μH	20%	

Symbol No.	Description			
	CAPACITORS			
C1	Ceramic	50V	0.01μF	
C2	Ceramic	50V	0.01μF	
C3	Ceramic	50V	0.01μF	
C4	Ceramic	500V	0.01μF	
C5	Ceramic	50V	0.01μF	
C6	Electrolytic	25V	10μF	20%
C7	Electrolytic			
C8	Ceramic	500V	0.01μF	
C9	Ceramic	500V	0.01μF	
C10	Ceramic	500V	0.51pF	10%
C11	Ceramic	500V	1000pF	
C12	Ceramic	500V	4700pF	
C13	Ceramic	50V	0.01μF	
C14	Ceramic	500V	1000pF	
C15	Ceramic	500V	0.51pF	10%
C16	Ceramic	500V	4700pF	
C17	Ceramic	500V	0.01μF	
C18	Electrolytic	250V	4.7μF	20%
C19	Electrolytic	25V	47μF	20%
C20	Ceramic	50V	0.01μF	
C21	Electrolytic	25V	10μF	20%
C22	Mica	50V	100pF	
C23	Mica	50V	100pF	

T-3157
HORIZONTAL AND VERTICAL AMPLIFIER

Symbol No.	Description			
	RESISTORS			
R1	Carbon	4.7Ω	5%	⅛W
R2	Carbon	33Ω	5%	⅛W
R3	Carbon	33Ω	5%	⅛W
R4	Carbon	4.7Ω	5%	⅛W
R5	Carbon	150Ω	5%	⅛W
R6	Not used			
R7	Carbon	3.9KΩ	5%	½W
R8	Metal	680Ω	5%	3W
R9	Metal	680Ω	5%	3W
R10	Metal	680Ω	5%	3W
R11	Metal	680Ω	5%	3W
R12	Carbon	47Ω	5%	⅛W
R13	Carbon	47Ω	5%	⅛W
R14	Carbon	4.7KΩ	5%	⅛W
R15	Carbon	47Ω	5%	⅛W
R16	Carbon	47Ω	5%	⅛W
R17	Carbon	47Ω	5%	⅛W
R18	Carbon	47Ω	5%	⅛W
R19	Carbon	27KΩ	5%	⅛W
R20	Carbon	47Ω	5%	⅛W
R21	Carbon	560Ω	5%	⅛W
R22	Carbon	47Ω	5%	⅛W
R23	Carbon	22Ω	5%	⅛W
R24	Metal	10KΩ	5%	2W
R25	Carbon	150Ω	5%	⅛W

Symbol No.	Description			
R26	Carbon	22Ω	5%	⅛W
R27	Carbon	10KΩ	5%	⅛W
R28	Metal	510Ω	1%	¼W
R29	Metal	10KΩ	5%	2W
R30	Carbon	22Ω	5%	⅛W
R31	Carbon	100Ω	5%	⅛W
R32	Carbon	47Ω	5%	⅛W
R33	Carbon	27KΩ	5%	⅛W
R34	Carbon	560Ω	5%	⅛W
R35	Carbon	100Ω	5%	⅛W
R36	Metal	10KΩ	5%	2W
R37	Carbon	2.2Ω	5%	⅛W
R38	Carbon	100Ω	5%	⅛W
R39	Metal	10KΩ	5%	2W
R40	Carbon	47Ω	5%	⅛W
R41	Metal	510Ω	1%	¼W
R42	Carbon	150KΩ	5%	⅛W
R43	Carbon	22Ω	5%	⅛W
R44	Carbon	10KΩ	5%	⅛W
R45	Carbon	1Ω	5%	⅛W
	VARIABLE RESISTORS			
VR1	Cermet	100KΩ	20%	0.3W
	PRINTED CIRCUIT BOARD			
	T-3157-R,P	V/H Final		

T-3160
HORIZONTAL DISPLAY

Symbol No.	Description			
	LED			
D1	TLY-226			
D2	TLR-226			
	RESISTORS			
R1	Carbon	2.2KΩ	5%	⅛W
	SWITCHES			
S1	Q490			
S2	Q489			
	PRINTED CIRCUIT BOARD			
	T-3160-R,P	H. Display		

T-3162
HIGH VOLTAGE OSCILLATOR

Symbol No.	Description			
	DIODES			
D1	Si (High Speed)	ED7TV	7KV	30mA
D2	Si (High Speed)	1SS83	300V	200mA
D3	Si (High Speed)	1SS83	300V	200mA
D4	Si (High Speed)	1SS83	300V	200mA
D5	Si (High Speed)	1SS83	300V	200mA
D6	Si	1S1588	35V	120mA
D7	Zener	RD36EB	36V	
D8	Si	1S1588	35V	120mA
D9	Si Dual	MC931	75V	100mA
	TRANSISTORS			
Q1	NPN	2SD568-K		
Q2	PNP	2SA1015-Y		
Q3	NPN	2SC1815-Y		
Q4	PNP	2SC1015-Y		
	CAPACITORS			
C1	Electrolytic	50V	47μF	20%
C2	Ceramic	3KV	4700pF	
C3	Ceramic	3KV	4700pF	
C4	Ceramic	500V	0.01μF	
C5	Ceramic	3KV	4700pF	
C6	Ceramic	3KV	4700pF	
C7	Ceramic	3KV	4700pF	
C8	Ceramic	3KV	4700pF	
C9	Electrolytic	160V	1μF	20%
C10	Plastic film	50V	0.12μF	10%
C11	Plastic film	50V	0.01μF	10%
C12	Ceramic	3KV	470pF	
C13	Ceramic	3KV	4700pF	
C14	Ceramic	50V	0.1μF	
	LAMPS			
V1	Neon	NE-38B		
V2	Neon	NE-38B		
V3	Neon	NE-38B		

Symbol No.	Description			
	RESISTORS			
R1	Carbon	2.2Ω	5%	½W
R2	Carbon	100Ω	5%	⅛W
R3	Carbon	47KΩ	5%	½W
R4	Carbon	100KΩ	5%	½W
R5	Carbon	100KΩ	5%	½W
R6	Carbon	22Ω	5%	⅛W
R7	Carbon	1KΩ	5%	⅛W
R8	Carbon	22KΩ	5%	⅛W
R9	Carbon	1.5KΩ	5%	⅛W
R10	Carbon	220KΩ	5%	⅛W
R11	Carbon	1KΩ	5%	⅛W
R12	Metal	51KΩ	1%	¼W
R13	Carbon	5.9KΩ	5%	⅛W
R14	Carbon	5.6KΩ	5%	⅛W
R15	Metal	22MΩ	5%	1W
R16	Metal	10MΩ	5%	½W
R17	Metal	3.3MΩ	5%	½W
R18	Metal	12MΩ	5%	1W
R19	Carbon	2.7MΩ	5%	½W
	VARIABLE RESISTORS			
VR1	Cermet	50KΩ	20%	0.3W
VR2	Cermet	10KΩ	20%	0.3W
	TRANSISTORS			
TI-1	Ferrite Coil	J423A-1		
TI-2	Voltage Multiplier	J423A-2		
	PRINTED CIRCUIT BOARD			
	T-3162-R,P	High Voltage		

T-3153
MAIN

Symbol No.	Description			
	DIODES			
D1	Bridge	W-04	400V	1.5A
D2	Bridge	W-02	200V	1.5A
D3	Bridge	2W-02	200V	1.8A
D4	Bridge	2W-02	200V	1.8A
D5	Bridge	2W-02	200V	1.8A
D6	Bridge	2W-02	200V	1.8A
D7	Bridge	2W-02	200V	1.8A
D8	Si	1DZ61	400V	1A
D9	Si	1DZ61	400V	1A
D21	Si	1S1588	35V	120mA
D22	Si	1S1588	35V	120mA

Symbol No.	Description			
D23	Si	1S1588	35V	120mA
D24	Zener	RD5.1EB	5.1V	
D25	Si	1S1588	35V	120mA
D31	Ge	1K60	40V	50mA
D32	Ge	1K60	40V	50mA
D33	Ge	1K60	40V	50mA
D34	Ge	1K60	40V	50mA
D41	Si	1S1588	35V	120mA
D42	Si	1S1588	35V	120mA
D43	Si	1S1588	35V	120mA
D44	Zener	RD5.1EB	5.1V	
D45	Si	1S1588	35V	120mA

Symbol No.	Description			
D46	Si Dual	MC-911	75V	100mA
D47	Zener	RD5.1EB	5.1V	
D48	Si	1S1588	35V	120mA
D49	Not used			
D50	Not used			
D51	Ge	1K60	40V	50mA
D52	Si	1S1588	35V	120mA
D53	Si	1S1588	35V	120mA
	INTEGRATED CIRCUITS			
IC1	Custom	PS1		
IC2	Custom	PS2		
IC3	Regulator +5V	HA17805P		
IC11	Custom	BL1		
IC12	TTL	74LS04		
IC13	TTL	74LS76		
IC14	TTL	74LS00		
IC15	TTL	74LS10		
IC16	TTL	74LS00		
IC21	TTL	74LS11		
IC22	TTL	74LS123		
IC23	TTL	74LS123		
IC24	TTL	74LS02		
IC25	TTL	74LS161		
IC26	TTL	74LS139		
IC27	TTL	74LS00		
IC31	Custom	TG1D		
IC32	Custom	TG1D		
IC33	Custom	TG1D		
IC34	TTL	74LS08		
IC35	TTL	74LS00		
IC36	TTL	7407		
IC41	Custom	TG2B		
IC42	Custom	TG3S		
IC43	TTL	74LS04		
IC44	ECL	HD-10104		
IC45	ECL	HD-10102		
	TRANSISTORS			
Q1	NPN	2SD859-Q		
Q2	NPN	2SD859-Q		
Q3	NPN	2SD880-Y		
Q4	NPN	2SD880-Y		
Q5	PNP	2SB435-O		
Q11	NPN	2SC1907		
Q12	NPN	2SC1907		
Q13	PNP	2SA1206		
Q14	NPN	2SC1907		
Q15	NPN	2SA1210-S		
Q16	NPN	2SC2911-S		
Q17	PNP	2SA1206		
Q18	PNP	2SA1091-R		
Q21	NPN	2SC752(G)TM-0		
Q31	PNP	2SA1015-GR		
Q32	PNP	2SA1206		
Q33	NPN	2SC1907		
Q34	PNP	2SA1206		
Q35	NPN	2SC1815-Y		
Q36	NPN	2SC1815-Y		
Q37	PNP	2SA1015-GR		

Symbol No.	Description			
Q38	NPN	2SC1815-Y		
Q39	NPN	2SC1907		
Q40	NPN	2SC1907		
Q41	Dual FET	ITS30809		
Q51	PNP	2SA1206		
Q52	NPN	2SC1907		
Q53	NPN	2SC1907		
Q54	NPN	2SC1815-GR		
Q55	PNP	2SA1206		
		CAPACITORS		
C1	Electrolytic	200V	100μF	20%
C2	Electrolytic	160V	220μF	20%
C3	Electrolytic	200V	2.2μF	20%
C4	Electrolytic	100V	2.2μF	20%
C5	Electrolytic	35V	2200μF	20%
C6	Electrolytic	25V	3300μF	20%
C7	Electrolytic	25V	10μF	20%
C8	Electrolytic	16V	10μF	20%
C9	Electrolytic	25V	3300μF	20%
C10	Electrolytic	50V	1μF	20%
C11	Electrolytic	16V	10μF	20%
C12	Electrolytic	16V	4700μF	20%
C13	Electrolytic	16V	10μF	20%
C14	Electrolytic	50V	1μF	20%
C15	Electrolytic	35V	2200μF	20%
C16	Ceramic	50V	0.01μF	
C17	Electrolytic	25V	10μF	20%
C18	Ceramic	50V	0.01μF	
C19	Electrolytic	16V	10μF	20%
C20	Ceramic	50V	0.01μF	
C21	Electrolytic	10V	22μF	20%
C22	Electrolytic	25V	10μF	20%
C23	Ceramic	50V	0.01μF	
C24	Ceramic	50V	0.01μF	
C25	Ceramic	50V	0.1μF	
C28	Ceramic	500V	4700pF	
C29	Ceramic	50V	0.01μF	
C30	Ceramic	50V	0.01μF	
C31	Not used			
C32	Mica	500V	27pF	10%
C33	Mica	500V	27pF	10%
C34	Mica	500V	10pF	10%
C35	Electrolytic	10V	100μF	20%
C36	Ceramic	500V	0.75pF	10%
C37	Ceramic	500V	1000pF	
C38	Ceramic	50V	1000pF	
C39	Ceramic	50V	0.01μF	
C40	Electrolytic	160V	4.7μF	20%
C41	Ceramic	50V	0.01μF	
C42	Not used			
C43	Ceramic	50V	0.01μF	
C44	Electrolytic	10V	22μF	20%
C45	Ceramic	50V	0.01μF	
C46	Electrolytic	16V	10μF	20%
C47	Ceramic	50V	0.01μF	
C48	Ceramic	50V	0.01μF	
C49	Ceramic	50V	0.01μF	
C50	Ceramic	50V	0.01μF	

Symbol No.	Description			
	CAPACITORS			
C51	Ceramic	50V	0.01μF	
C52	Mica	500V	22pF	10%
C53	Mica	50V	56pF	10%
C54	Mica	50V	100pF	10%
C55	Mica	50V	100pF	10%
C56	Ceramic	50V	0.01μF	
C57	Ceramic	50V	0.01μF	
C58	Electrolytic	10V	22μF	20%
C59	Ceramic	50V	0.01μF	
C60	Ceramic	50V	0.01μF	
C61	Not used			
C62	Mica	50V	56pF	10%
C63	Not used			
C64	Electrolytic	16V	10μF	20%
C65	Ceramic	50V	0.01μF	
C66	Mica	500V	5pF	10%
C67	Electrolytic	16V	10μF	20%
C68	Ceramic	50V	0.01μF	
C69	Ceramic	50V	0.01μF	
C70	Mica	50V	56pF	10%
C71	Mica	50V	56pF	10%
C72	Mica	500V	5pF	10%
C73	Electrolytic	16V	22μF	20%
C74	Ceramic	50V	0.01μF	
C75	Electrolytic	25V	10μF	20%
C76	Electrolytic	50V	4.7μF	
C77	Electrolytic	50V	1μF	20%
C78	Electrolytic	16V	22μF	20%
C79	Not used			
C80	Mica	50V	47pF	10%
C81	Plastic film	630V	0.01μF	10%
C82	Electrolytic	16V	10μF	20%
C83	Mica	500V	5pF	10%
C84	Electrolytic	16V	10μF	20%
C85	Electrolytic	16V	10μF	20%
C86	Mica	500V	7pF	10%
C87	Not used			
C88	Electrolytic	16V	22μF	20%
C89	Ceramic	50V	0.01μF	
C90	Ceramic	50V	0.01μF	
C91	Electrolytic	16V	10μF	20%
C92	Ceramic	50V	0.01μF	
C93	Ceramic	50V	0.01μF	
C94	Electrolytic	16V	10μF	20%
C95	Ceramic	50V	0.01μF	
C96	Ceramic	50V	0.01μF	
C97	Ceramic	50V	0.01μF	
C98	Not used			
C99	Electrolytic	16V	22μF	20%
C100	Ceramic	50V	0.01μF	
C101	Electrolytic	10V	22μF	20%
C102	Ceramic	50V	0.01μF	
C103	Ceramic	50V	0.01μF	
C104	Electrolytic	25V	10μF	20%
C105	Ceramic	50V	0.01μF	
C106	Ceramic	50V	0.01μF	
C107	Ceramic	50V	0.01μF	

Symbol No.	Description			
	CAPACITORS			
C111	Electrolytic	50V	4.7μF	20%
C112	Mica	500V	5pF	10%
C113	Mica	50V	100pF	10%
C114	Plastic film	50V	0.01μF	10%
C115	Ceramic	50V	1000pF	
C116	Ceramic	50V	0.01μF	
C117	Mica	50V	47pF	10%
C118	Mica	50V	47pF	10%
C119	Mica	500V	33pF	10%
C120	Ceramic	50V	0.01μF	
C121	Electrolytic	25V	10μF	20%
C122	Mica	500V	22pF	10%
C123	Electrolytic	16V	10μF	20%
C124	Electrolytic	25V	4.7μF	20%
C125	Electrolytic	50V	4.7μF	20%
C126	Ceramic	50V	0.01μF	
C127	Plastic film	50V	0.056μF	10%
C128	Ceramic	50V	0.1μF	
C129	Electrolytic	10V	3.3μF	−20%
C130	Ceramic	50V	0.01μF	
C131	Mica	500V	3μF	10%
C132	Ceramic	50V	0.01μF	
C133	Electrolytic	16V	10μF	20%
C134	Ceramic	50V	0.01μF	
C135	Ceramic	50V	0.01μF	
C136	Ceramic	50V	0.01μF	
C137	Electrolytic	16V	10μF	20%
C138	Ceramic	50V	0.01μF	
C139	Electrolytic	25V	10μF	20%
C140	Ceramic	50V	0.01μF	
C141	Electrolytic	10V	3.3μF	−20%
C142	Ceramic	50V	0.01μF	
C151	Ceramic	50V	0.01μF	
C152	Ceramic	50V	0.01μF	
C153	Ceramic	50V	0.01μF	
	VARIABLE CAPACITORS			
VC1	Ceramic	250V	40pF	
VC2	Ceramic	250V	40pF	
VC3	Ceramic	250V	10pF	
VC4	Ceramic	250V	6pF	
VC5	Ceramic	250V	4pF	
VC6	Ceramic	250V	40pF	
	RELAYS			
K1	DS2-S-DC12V			
K2	DS2-S-DC12V			
K3	DS2-S-DC12V			
	RESISTORS			
R1	Carbon	390KΩ	5%	⅛W
R2	Carbon	150KΩ	5%	⅛W
R3	Carbon	120KΩ	5%	⅛W
R4	Carbon	6.8Ω	5%	⅛W
R5	Carbon	2.7Ω	5%	⅛W

Symbol No.	Description			
	RESISTORS			
R6	Carbon	1.0Ω	5%	½W
R7	Carbon	1.0Ω	5%	½W
R8	Not used			
R9	Carbon	1.0Ω	5%	½W
R10	Carbon	1.0Ω	5%	½W
R11	Carbon	1.0Ω	5%	½W
R12	Carbon	4.7KΩ	5%	⅛W
R13	Carbon	2.2KΩ	5%	⅛W
R21	Carbon	10KΩ	5%	½W
R22	Carbon	56KΩ	5%	⅛W
R23	Carbon	1.2KΩ	5%	⅛W
R24	Carbon	2.7KΩ	5%	⅛W
R25	Carbon	1.2KΩ	5%	⅛W
R26	Carbon	2.7KΩ	5%	⅛W
R27	Carbon	330Ω	5%	⅛W
R28	Carbon	7.5KΩ	5%	⅛W
R29	Carbon	470Ω	5%	⅛W
R30	Carbon	2.2KΩ	5%	⅛W
R31	Carbon	560Ω	5%	⅛W
R32	Carbon	820Ω	5%	⅛W
R33	Carbon	1KΩ	5%	⅛W
R34	Metal	1.5KΩ	1%	¼W
R35	Metal	750Ω	1%	¼W
R36	Carbon	2.7KΩ	5%	⅛W
R37	Carbon	1.8KΩ	5%	⅛W
R38	Carbon	10KΩ	5%	⅛W
R39	Carbon	47Ω	5%	⅛W
R40	Metal	5.6KΩ	1%	¼W
R41	Metal	2.2KΩ	1%	¼W
R42	Carbon	47Ω	5%	⅛W
R43	Carbon	47Ω	5%	⅛W
R44	Carbon	270Ω	5%	⅛W
R45	Carbon	2.2KΩ	5%	⅛W
R46	Carbon	47KΩ	5%	⅛W
R47	Carbon	10KΩ	5%	⅛W
R48	Carbon	150KΩ	5%	⅛W
R49	Metal	510Ω	1%	¼W
R50	Carbon	12Ω	5%	⅛W
R51	Metal	15KΩ	5%	1W
R52	Carbon	10KΩ	5%	⅛W
R53	Carbon	100Ω	5%	⅛W
R54	Carbon	82KΩ	5%	⅛W
R55	Metal	15KΩ	5%	1W
R56	Carbon	68Ω	5%	⅛W
R61	Carbon	3.3KΩ	5%	⅛W
R62	Carbon	1.5KΩ	5%	⅛W
R63	Not used			
R64	Carbon	4.7KΩ	5%	⅛W
R65	Carbon	5.6KΩ	5%	⅛W
R66	Carbon	5.6KΩ	5%	⅛W
R67	Carbon	10KΩ	5%	⅛W
R68	Carbon	27KΩ	5%	⅛W
R69	Carbon	10KΩ	5%	⅛W
R70	Carbon	10KΩ	5%	⅛W
R71	Carbon	10KΩ	5%	⅛W
R81	Metal	75Ω	1%	¼W
R82	Metal	82Ω	1%	¼W
R83	Carbon	120Ω	5%	⅛W

Symbol No.	Description			
	RESISTORS			
R84	Carbon	5.6KΩ	5%	⅛W
R85	Carbon	270Ω	5%	⅛W
R86	Not used			
R87	Carbon	100Ω	5%	⅛W
R88	Carbon	5.6KΩ	5%	⅛W
R89	Carbon	3.3KΩ	5%	⅛W
R90	Carbon	33Ω	5%	⅛W
R91	Carbon	33Ω	5%	⅛W
R92	Metal	470Ω	1%	¼W
R93	Metal	390Ω	1%	¼W
R94	Metal	430Ω	1%	¼W
R95	Carbon	47Ω	5%	⅛W
R96	Carbon	47Ω	5%	⅛W
R97	Carbon	33Ω	5%	⅛W
R98	Carbon	33Ω	5%	⅛W
R99	Metal	300Ω	1%	¼W
R100	Carbon	47Ω	5%	⅛W
R101	Carbon	3.9KΩ	5%	⅛W
R102	Carbon	3.6KΩ	5%	⅛W
R103	Carbon	4.7KΩ	5%	⅛W
R104	Carbon	560Ω	5%	⅛W
R105	Carbon	3.3KΩ	5%	⅛W
R106	Carbon	100Ω	5%	⅛W
R107	Carbon	3.3KΩ	5%	⅛W
R108	Metal	75Ω	1%	¼W
R109	Metal	82Ω	1%	¼W
R110	Carbon	82Ω	5%	⅛W
R111	Carbon	5.6KΩ	5%	⅛W
R112	Carbon	270Ω	5%	⅛W
R113	Metal	22KΩ	1%	¼W
R114	Carbon	100Ω	5%	⅛W
R115	Metal	47KΩ	1%	¼W
R116	Not used			
R117	Metal	680Ω	1%	¼W
R118	Carbon	150Ω	5%	⅛W
R119	Carbon	10KΩ	5%	⅛W
R120	Carbon	4.7KΩ	5%	⅛W
R121	Carbon	10Ω	5%	⅛W
R122	Metal	900KΩ	1%	½W
R123	Not used			
R124	Metal	111Ω	1%	¼W
R125	Carbon	47Ω	5%	⅛W
R126	Metal	1.00MΩ	1%	½W
R127	Carbon	270KΩ	5%	⅛W
R128	Carbon	330KΩ	5%	⅛W
R129	Metal	510Ω	1%	¼W
R130	Metal	510Ω	1%	¼W
R131	Metal	820Ω	1%	¼W
R132	Carbon	180Ω	5%	⅛W
R133	Not used			
R134	Carbon	270Ω	5%	⅛W
R141	Carbon	6.8KΩ	5%	⅛W
R142	Carbon	4.7KΩ	5%	⅛W
R143	Carbon	390Ω	5%	⅛W
R144	Carbon	330Ω	5%	⅛W
R145	Carbon	100Ω	5%	⅛W
R146	Carbon	1KΩ	5%	⅛W
R147	Carbon	1KΩ	5%	⅛W

Symbol No.	Description			
		RESISTORS		
R148	Carbon	820Ω	5%	⅛W
R149	Carbon	820Ω	5%	⅛W
R150	Carbon	1.5KΩ	5%	⅛W
R151	Carbon	2.2KΩ	5%	⅛W
R152	Carbon	150Ω	5%	⅛W
R153	Carbon	47Ω	5%	⅛W
R154	Carbon	2.2Ω	5%	⅛W
R155	Carbon	2.2KΩ	5%	⅛W
R156	Carbon	2.7KΩ	5%	⅛W
R157	Carbon	12KΩ	5%	⅛W
R158	Carbon	100KΩ	5%	⅛W
R159	Carbon	47Ω	5%	⅛W
R160	Carbon	820Ω	5%	⅛W
R161	Carbon	820Ω	5%	⅛W
R162	Carbon	1KΩ	5%	⅛W
R163	Carbon	1KΩ	5%	⅛W
R164	Metal	75Ω	1%	¼W
R165	Carbon	2.2KΩ	5%	⅛W
R166	Carbon	2.2KΩ	5%	⅛W
R167	Not used			
R168	Not used			
R169	Carbon	10KΩ	5%	⅛W
R170	Carbon	10KΩ	5%	⅛W

Symbol No.	Description			
R171	Carbon	1KΩ	5%	⅛W
R172	Carbon	22KΩ	5%	⅛W
R173	Carbon	10KΩ	5%	⅛W
R174	Carbon	4.7KΩ	5%	⅛W
		VARIABLE RESISTORS		
VR1	Cermet	1KΩ	20%	0.3W
VR21	Cermet	100Ω	20%	0.3W
VR22	Cermet	100Ω	20%	0.3W
VR23	Cermet	100Ω	20%	0.3W
VR31	Cermet	2KΩ	20%	0.3W
VR32	Cermet	5KΩ	20%	0.3W
		RESISTOR ARRAY		
RA1	Carbon	10KΩ X8	10%	⅛W
RA2	Carbon	10KΩ X4	10%	⅛W
RA3	Carbon	10KΩ X4	10%	⅛W
RA4	Carbon	1.5KΩ X7	10%	⅛W
RA5	Carbon	10KΩ X4	10%	⅛W
		PRINTED CIRCUIT BOARD		
	T-3153-R,P	Main		

T-3287
CALIBRATION AND INTENSITY

Symbol No.	Description			
		INTEGRATED CIRCUITS		
IC1	Custom	C1		
		TRANSISTORS		
Q1	PNP	2SA1015-O or Y		
Q2	PNP	2SB435		
		CAPACITORS		
C1	Electrolytic	10V	47μF	20%
C2	Plastic film	50V	6800pF	2%
C3	Plastic film	50V	6800pF	2%
		LAMPS		
V1	No. A-53632	6.3V	0.2A	
V2	No. A-53632	6.3V	0.2A	
V3	No. A-53632	6.3V	0.2A	
		RESISTORS		
R1	Metal	100KΩ	1%	¼W
R2	Metal	100KΩ	1%	¼W

Symbol No.	Description			
R3	Carbon	390Ω	5%	⅛W
R4	Carbon	1.2KΩ	5%	⅛W
R5	Carbon	1.5KΩ	5%	⅛W
R6	Carbon	1.5KΩ	5%	⅛W
R7	Carbon	22Ω	5%	½W
R8	Carbon	22Ω	5%	½W
R9	Carbon	820Ω	5%	⅛W
R10	Carbon	470Ω	5%	⅛W
R11	Metal	3.3KΩ	1%	¼W
R12	Metal	8.2KΩ	1%	¼W
		VARIABLE RESISTORS		
VR1	Cermet	8500Ω	20%	0.3W
VR2	Carbon	VR458		
VR3	Carbon		20%	0.05W
VR4	Carbon	VR457		
		PRINTED CIRCUIT BOARD		
	T-3287-R,P	Cal & Inten		

5. BLOCK DIAGRAM, P.C. BOARDS, AND SCHEMATICS

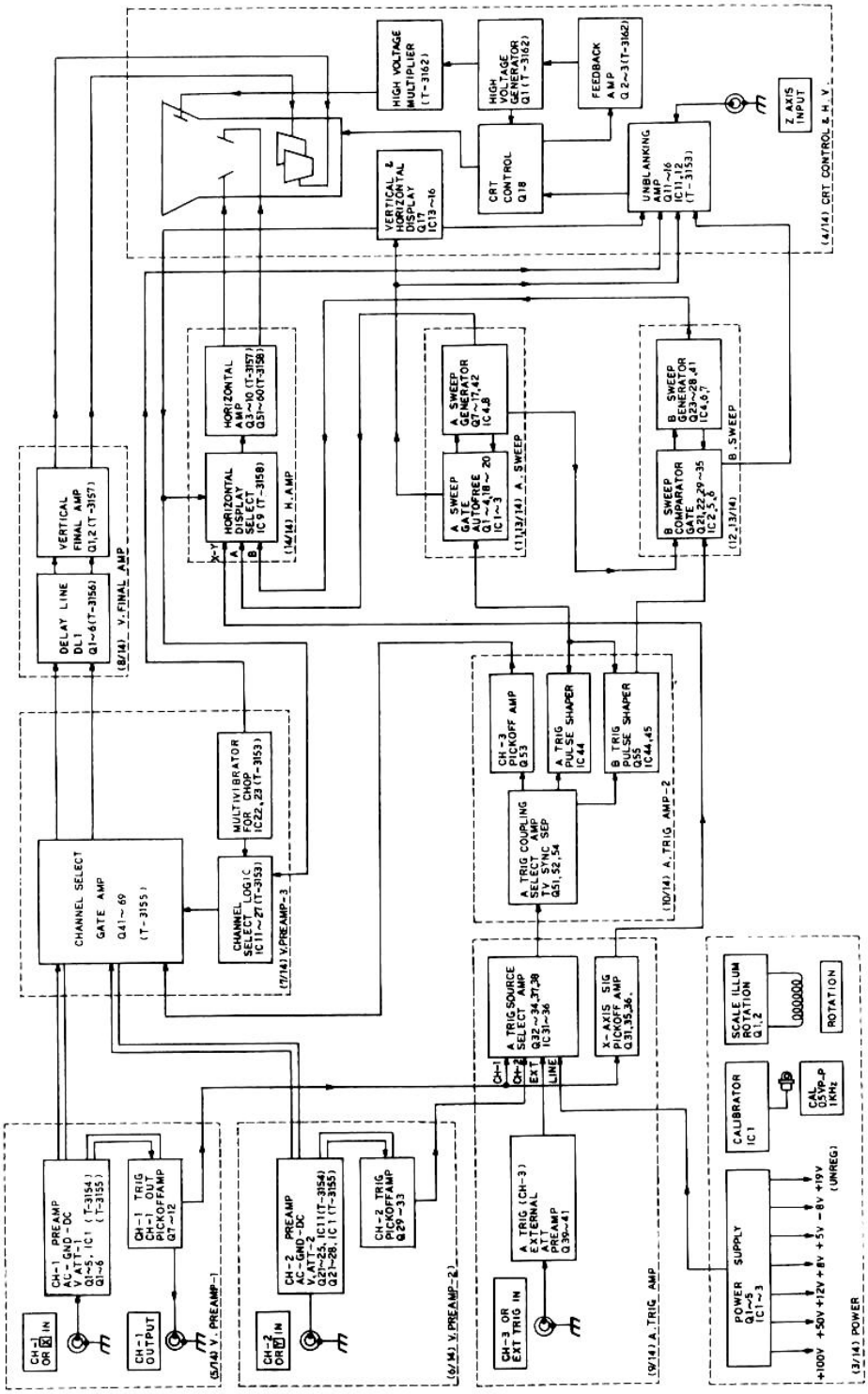

Figure 5-1.
LBO-516 Block Diagram

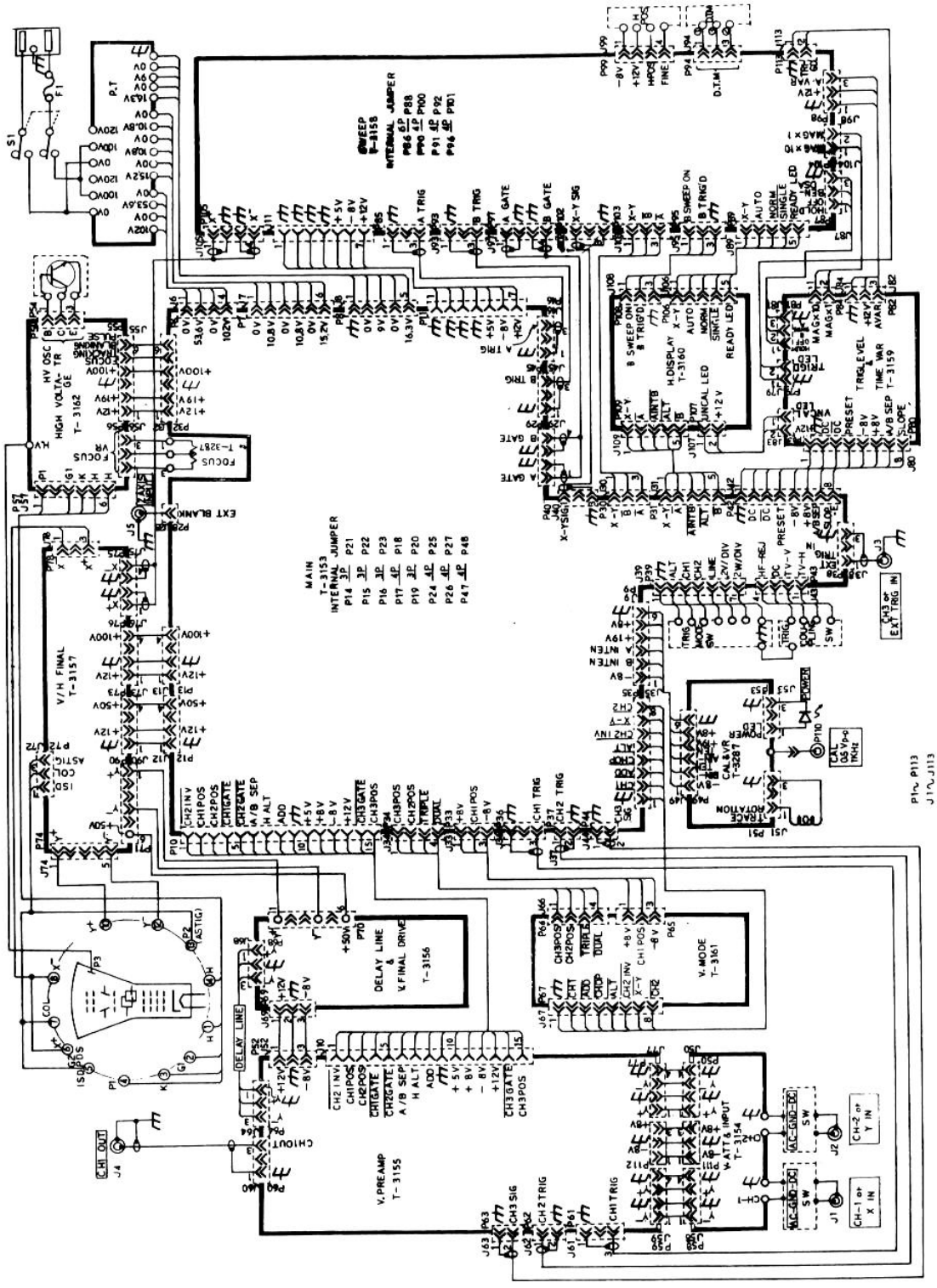

Figure 5-2.
LBO-516 Connection Diagram

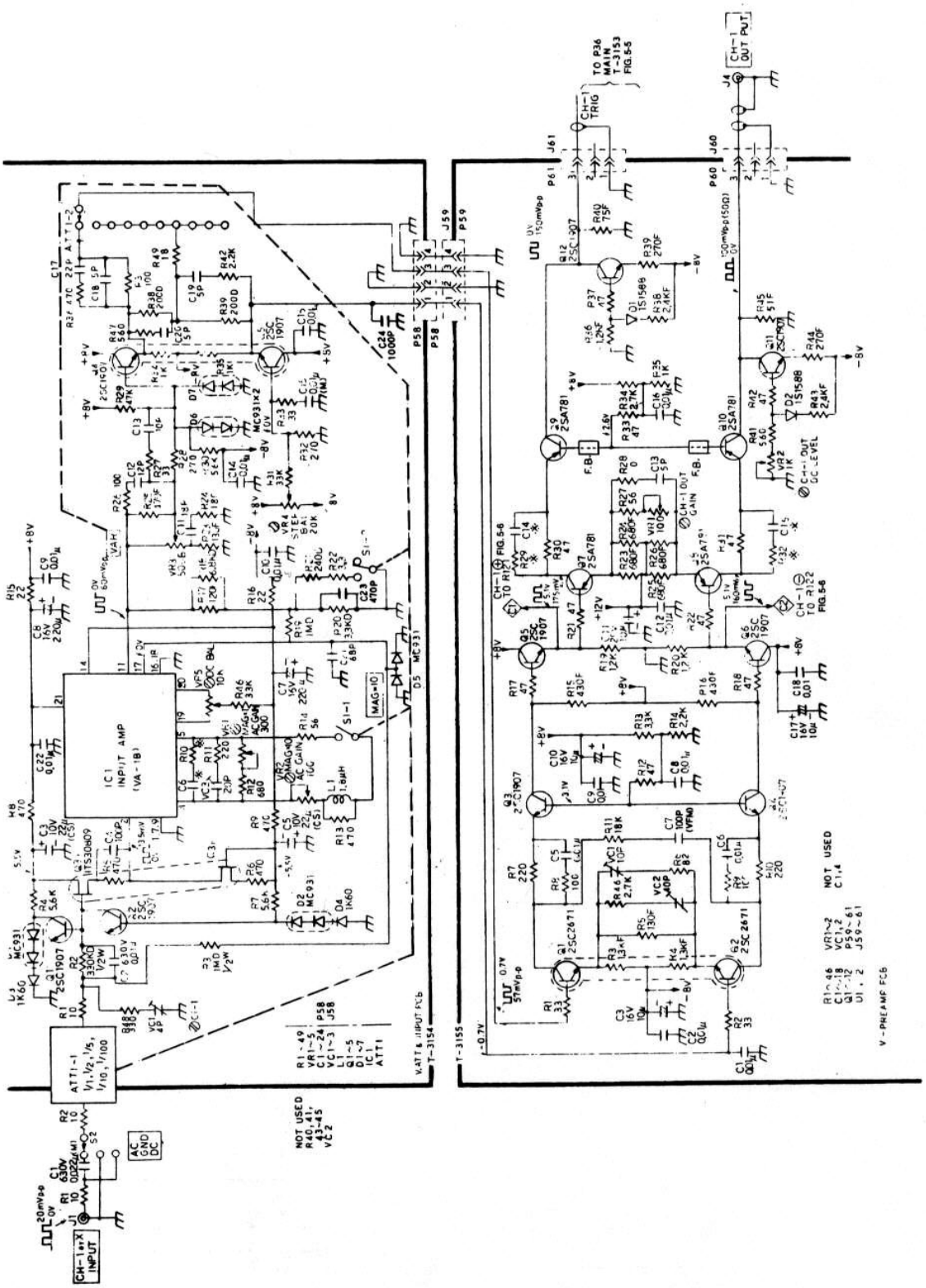

Figure 5-3.
LBO-516 CH-1 or X Input Preamplifiers

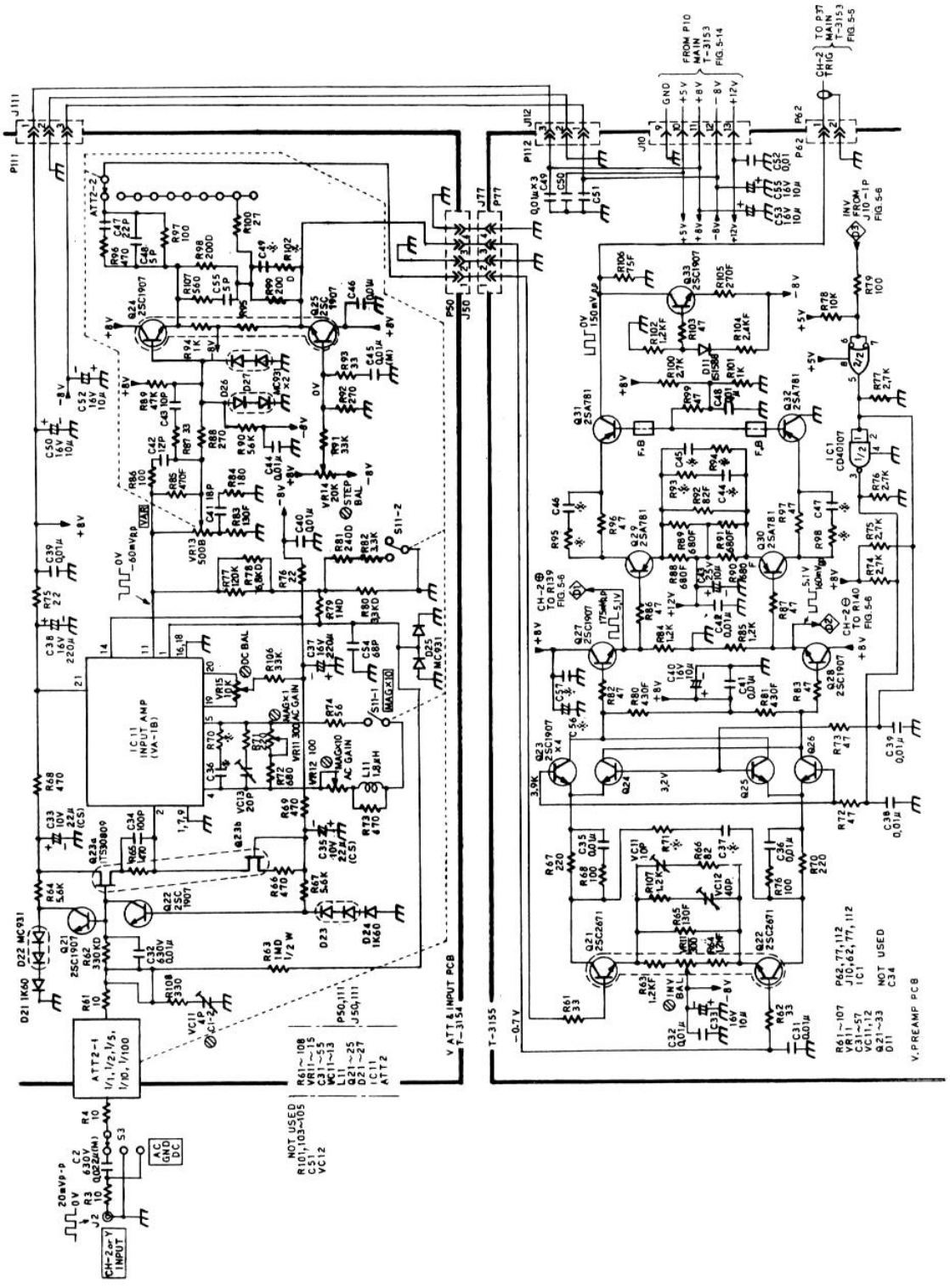

Figure 5-4.
LBO-516 CH-2 or Y Input Preamplifiers

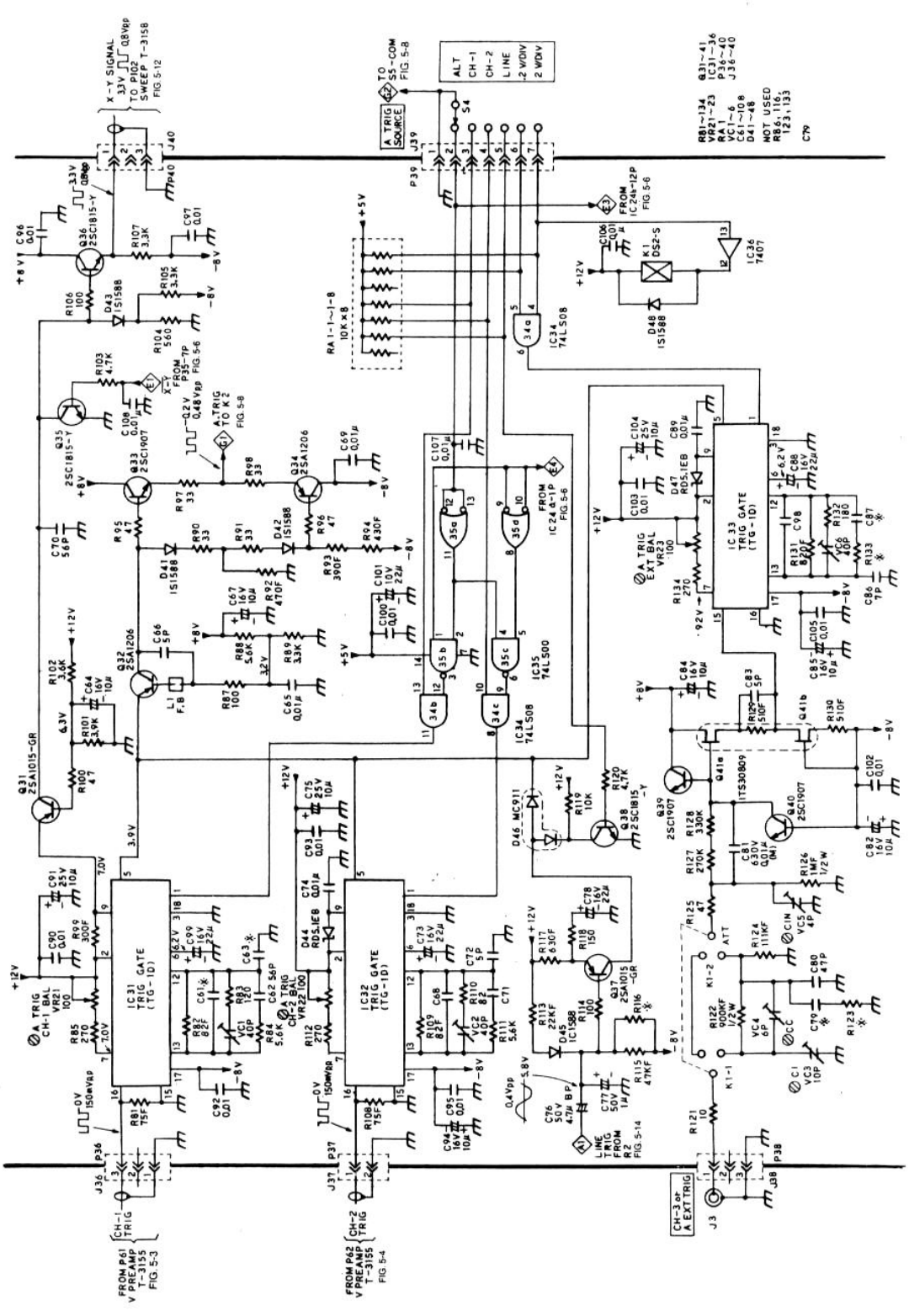

Figure 5-5.
LBO-516 CH-3 Input Circuits and A Time-Base Trigger Source Switching

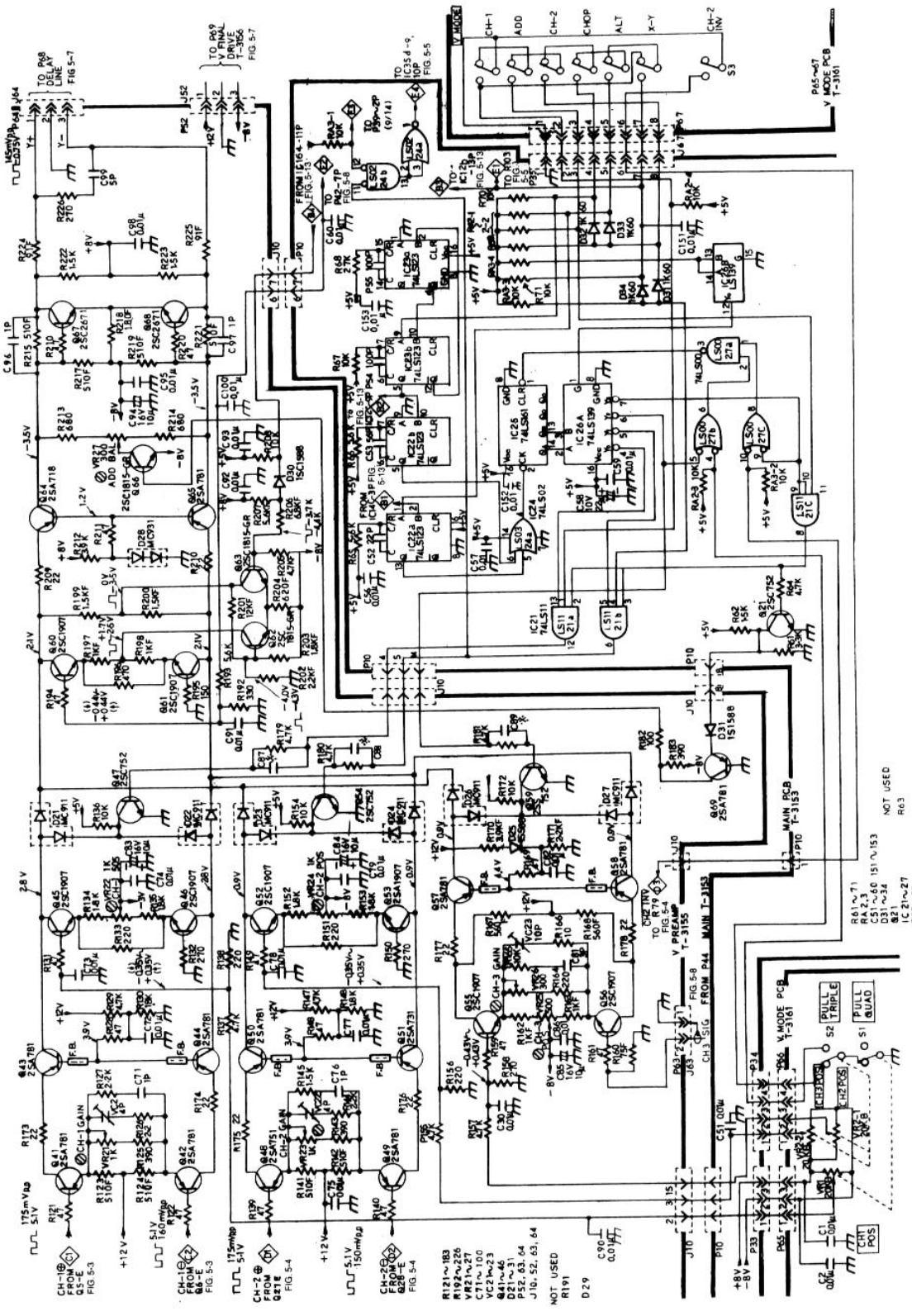

Figure 5-6.
LBO-516 CH-1 to CH-3 Signal Processing

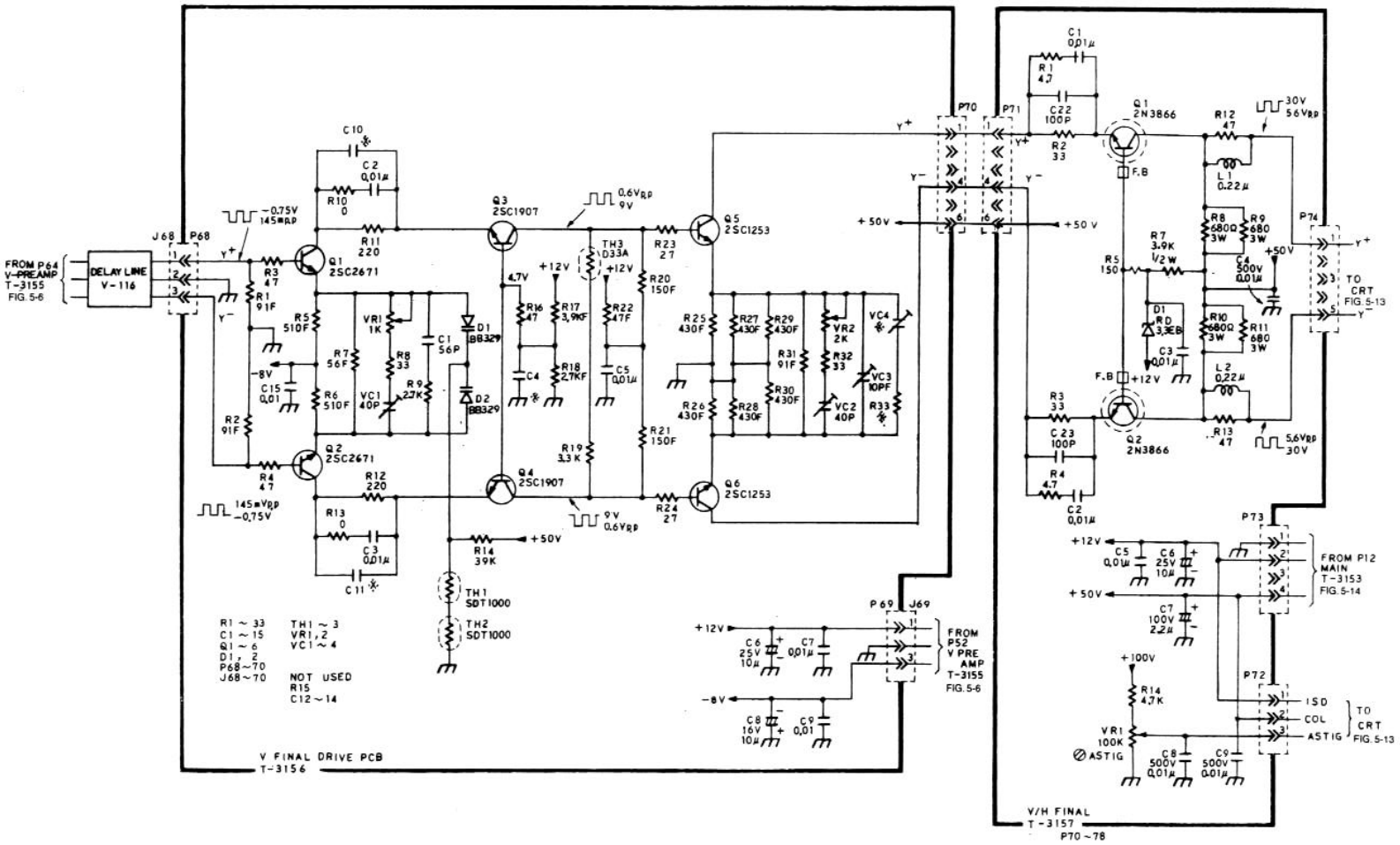

Figure 5-7.
LBO-516 Final Vertical Output Amplifier

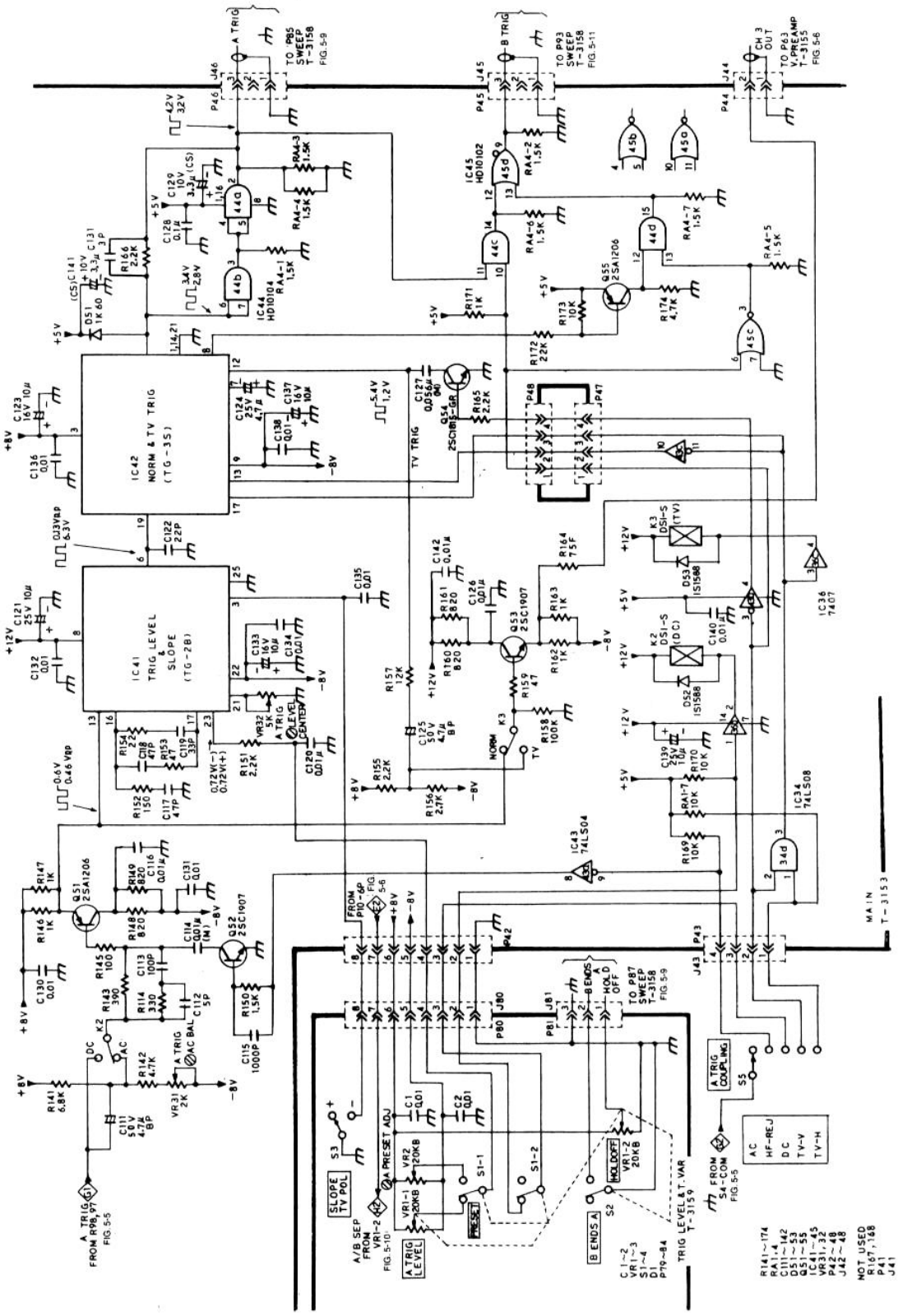

Figure 5-8.
LBO-516 A Time Base Trigger Coupling

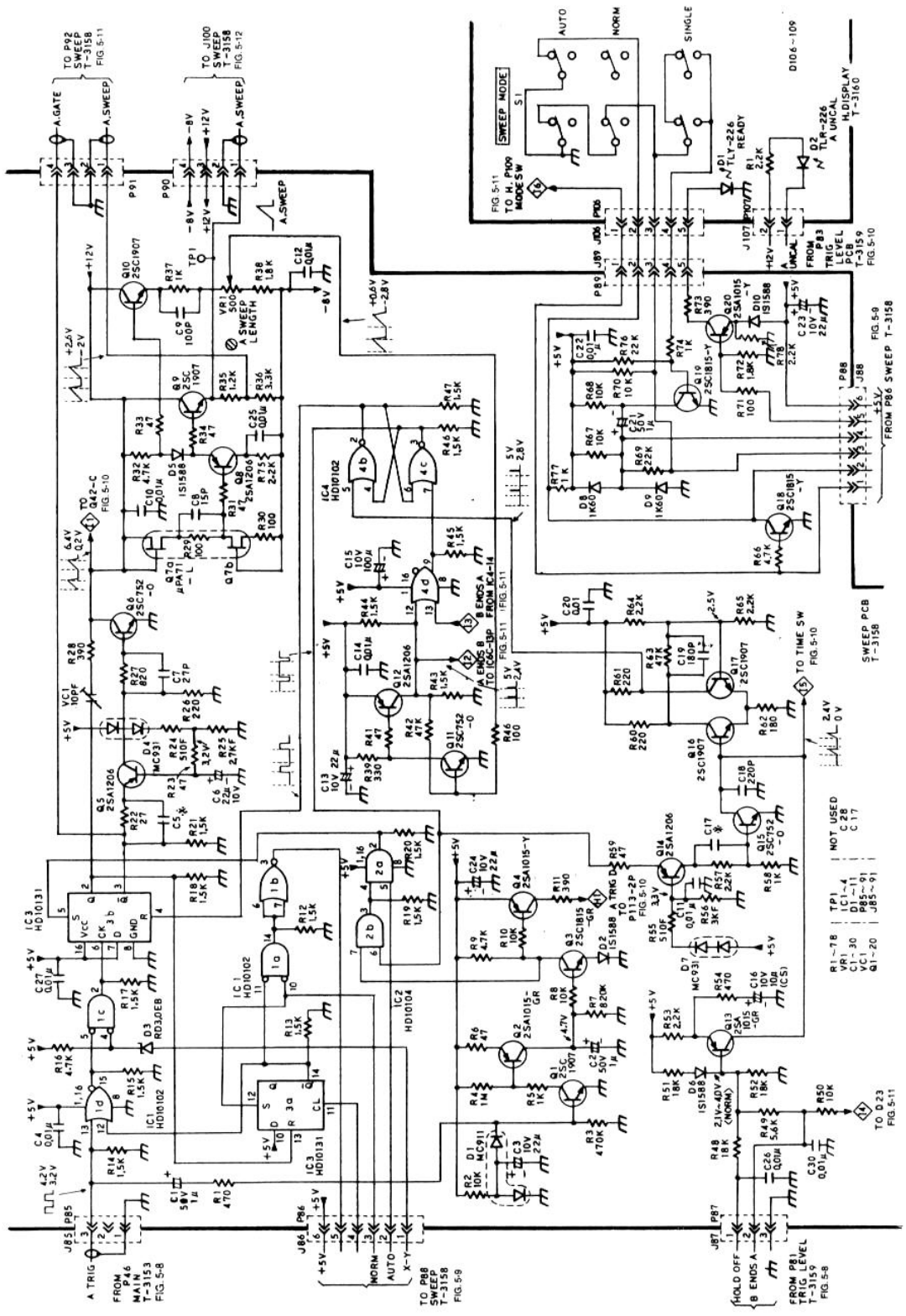

Figure 5-9.
LBO-516 A Time Base Circuit

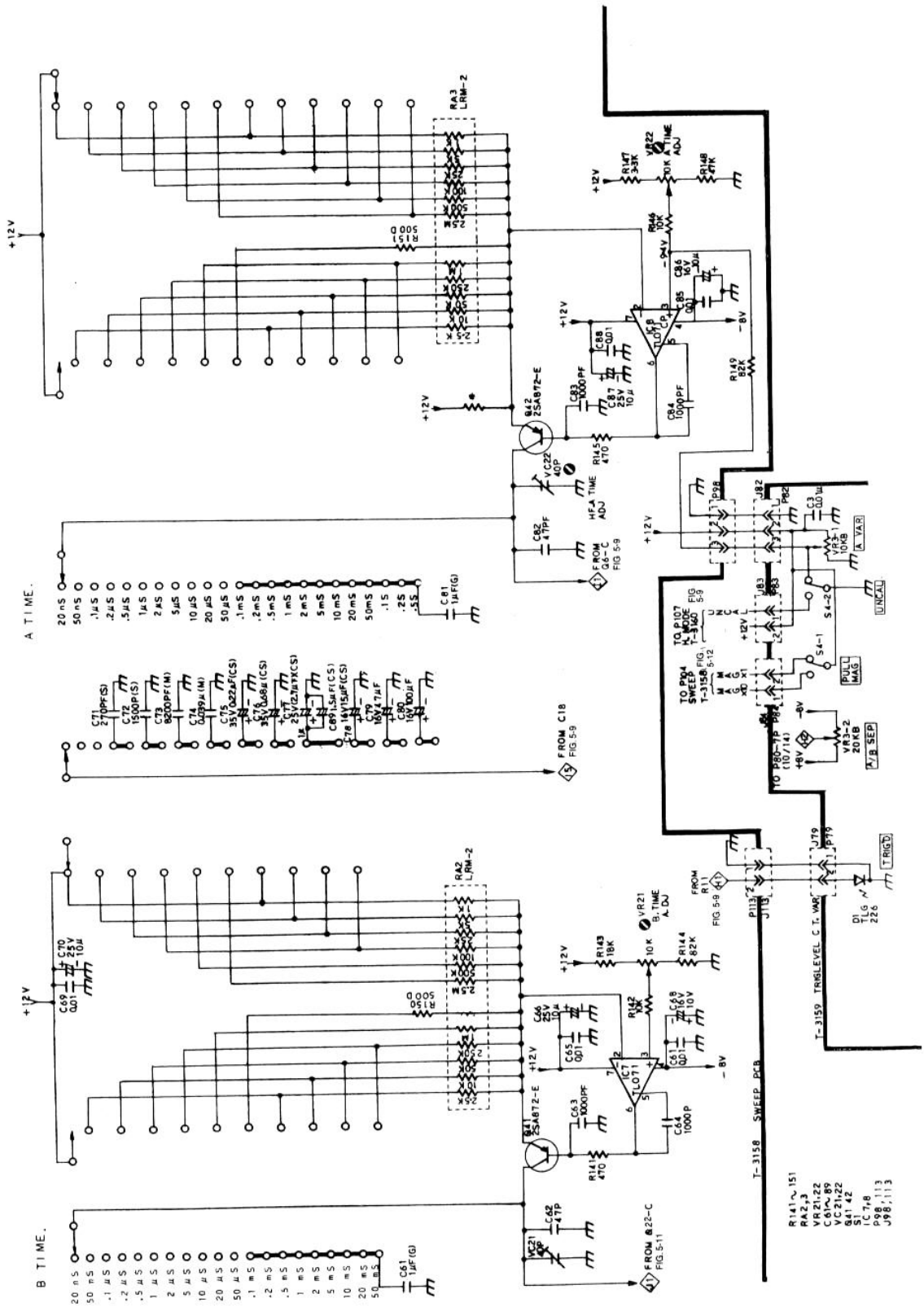

Figure 5-10.
LBO-516 A and B Sweep Section Circuits

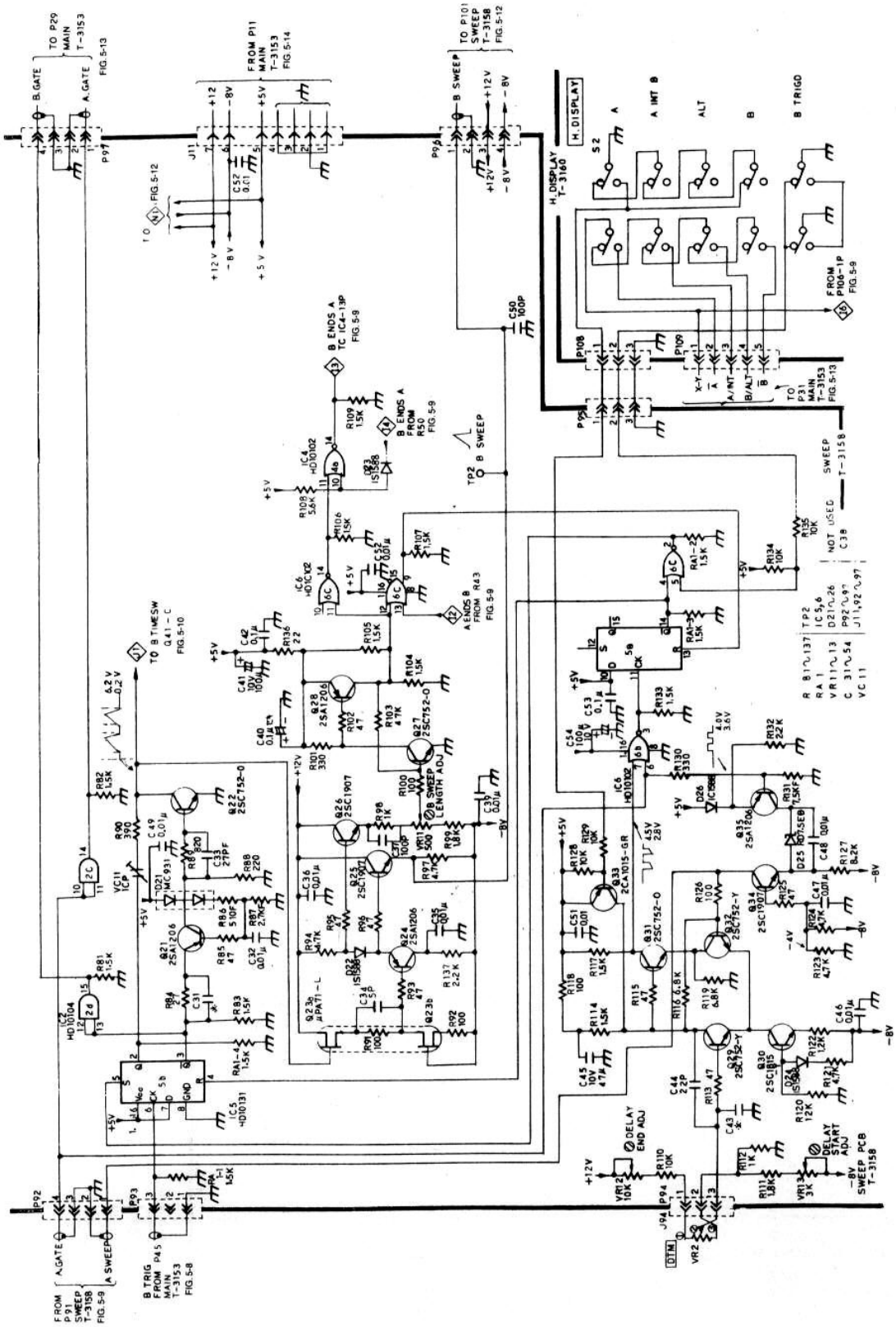

Figure 5-11.
LBO-516 B Time Base Circuit

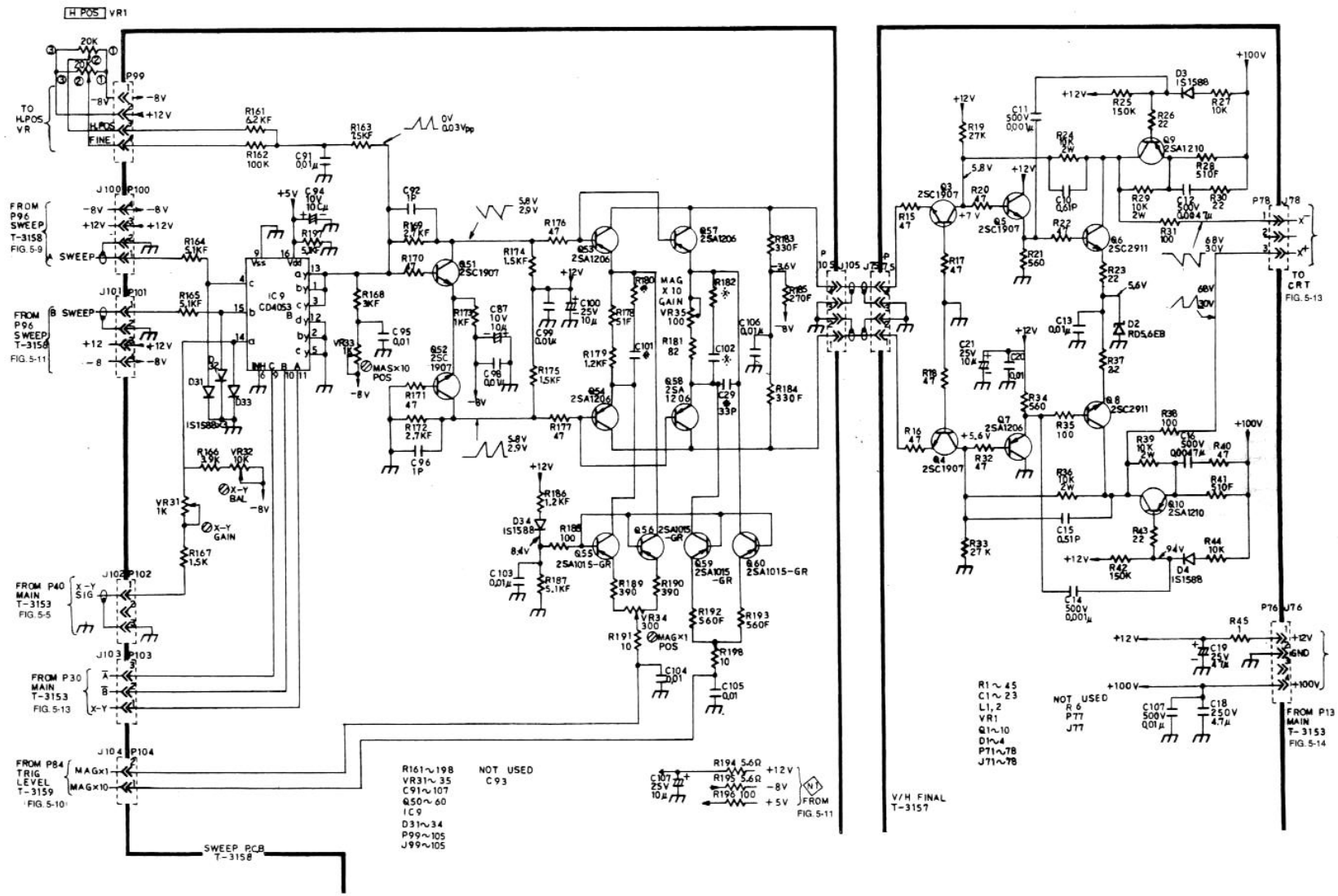

Figure 5-12.
LBO-516 Horizontal Amplifier

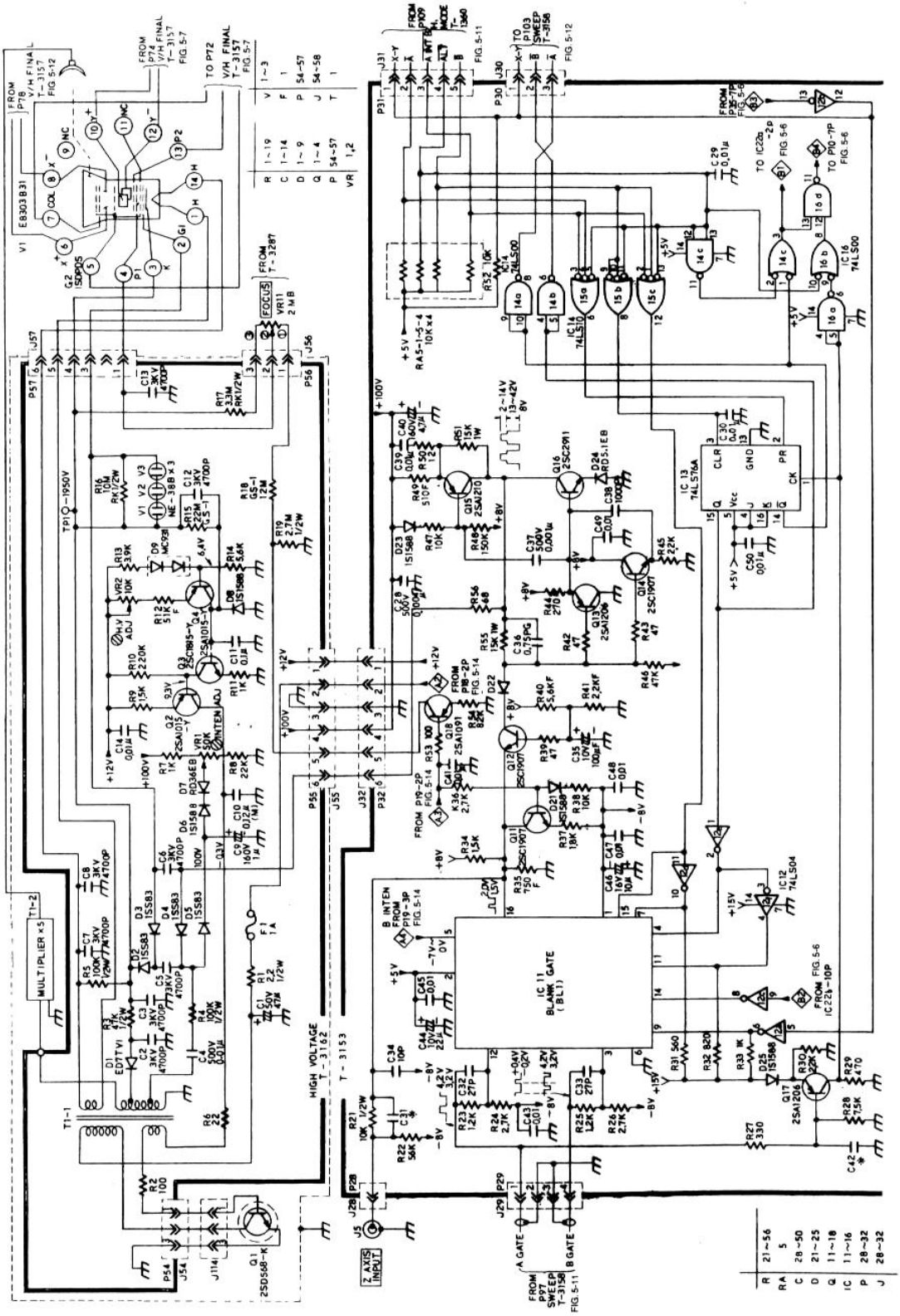

Figure 5-13.
LBO-516 CRT Support Circuits,
High-Voltage Power Supply and Blanking

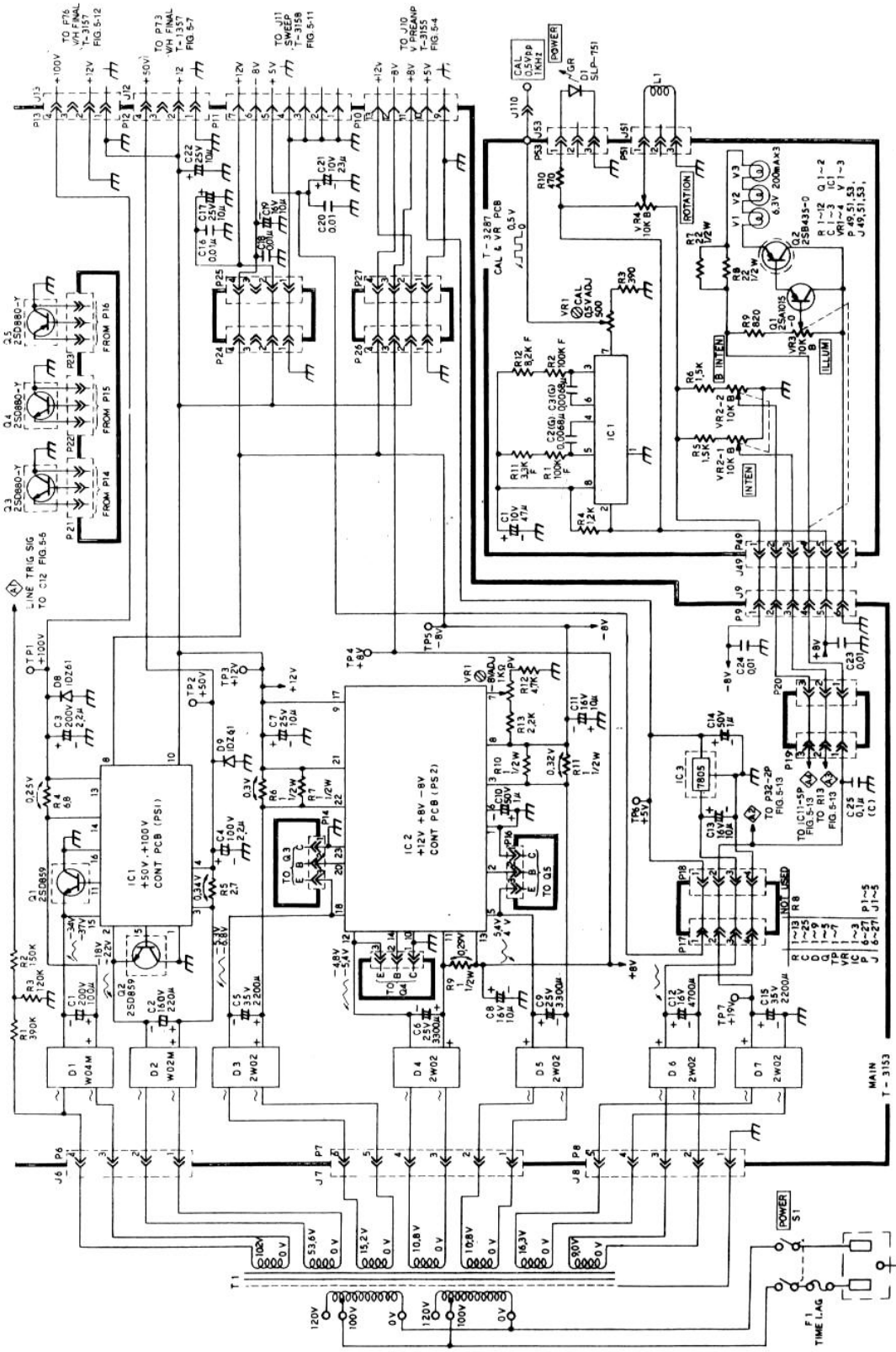

Figure 5-14.
LBO-516 Low Voltage Power Supplies

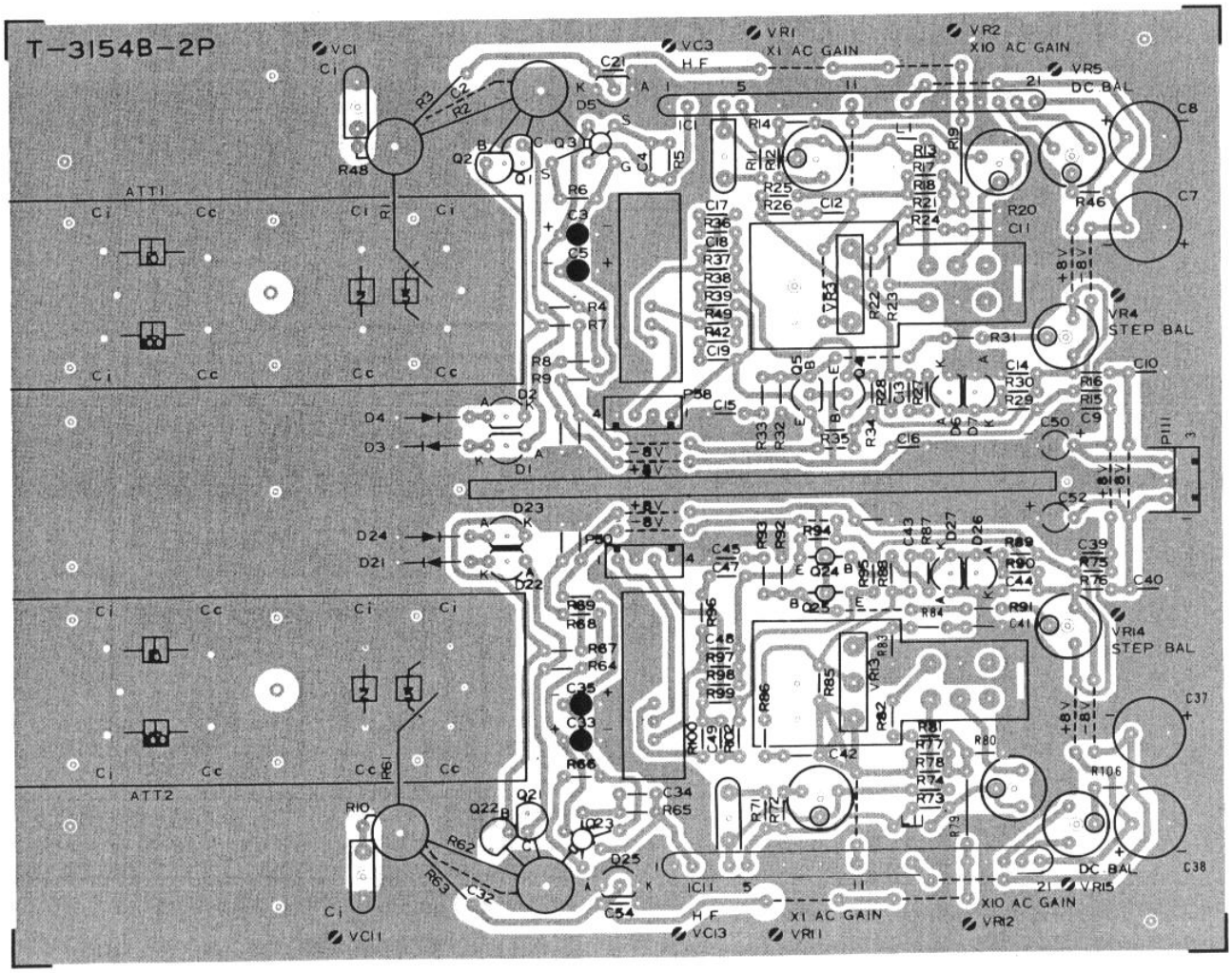

Figure 5-15.
LBO-516 Vertical Input Attenuator and Amplifier P.C. Board T-3154B

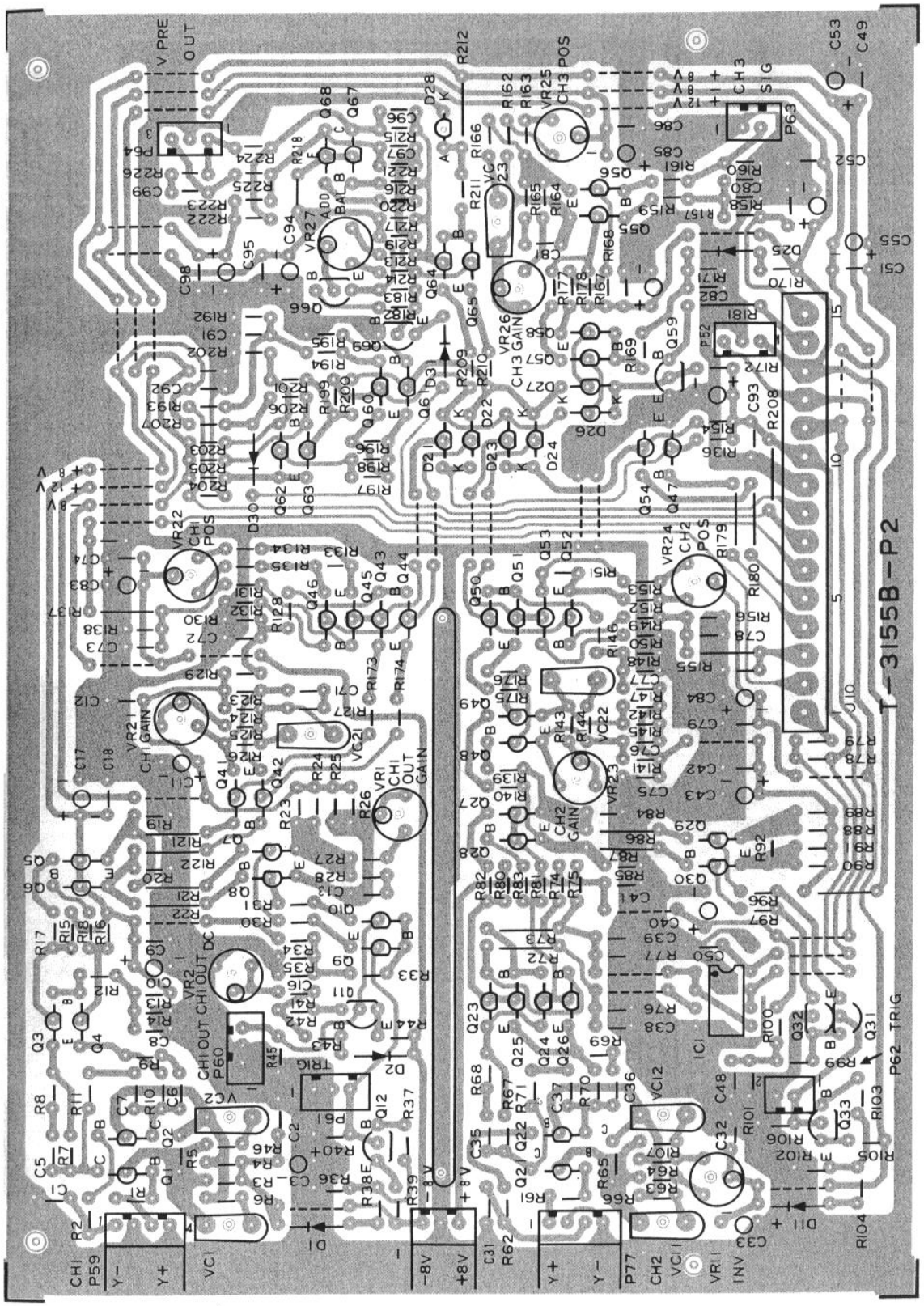

Figure 5-16.
LBO-516 Vertical Preamplifier P.C. Board T-3155B

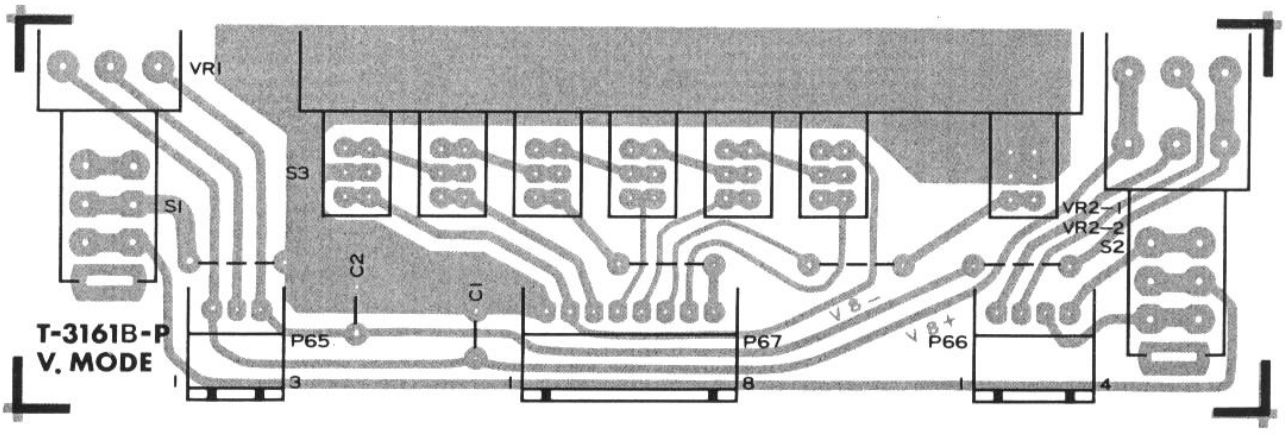

Figure 5-17
LBO-516 Vertical Mode P.C. Board T-3161B

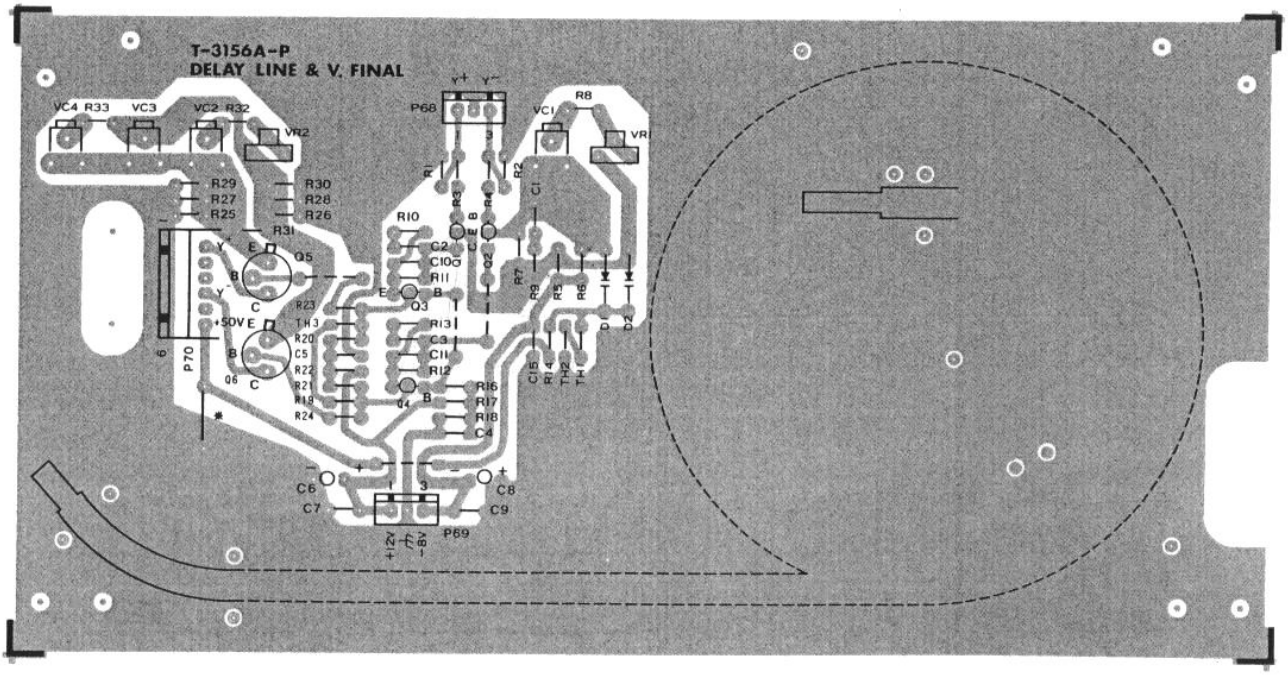

Figure 5-18
LBO-516 Delay Line and Vertical Final Drive P.C. Board T-3156A

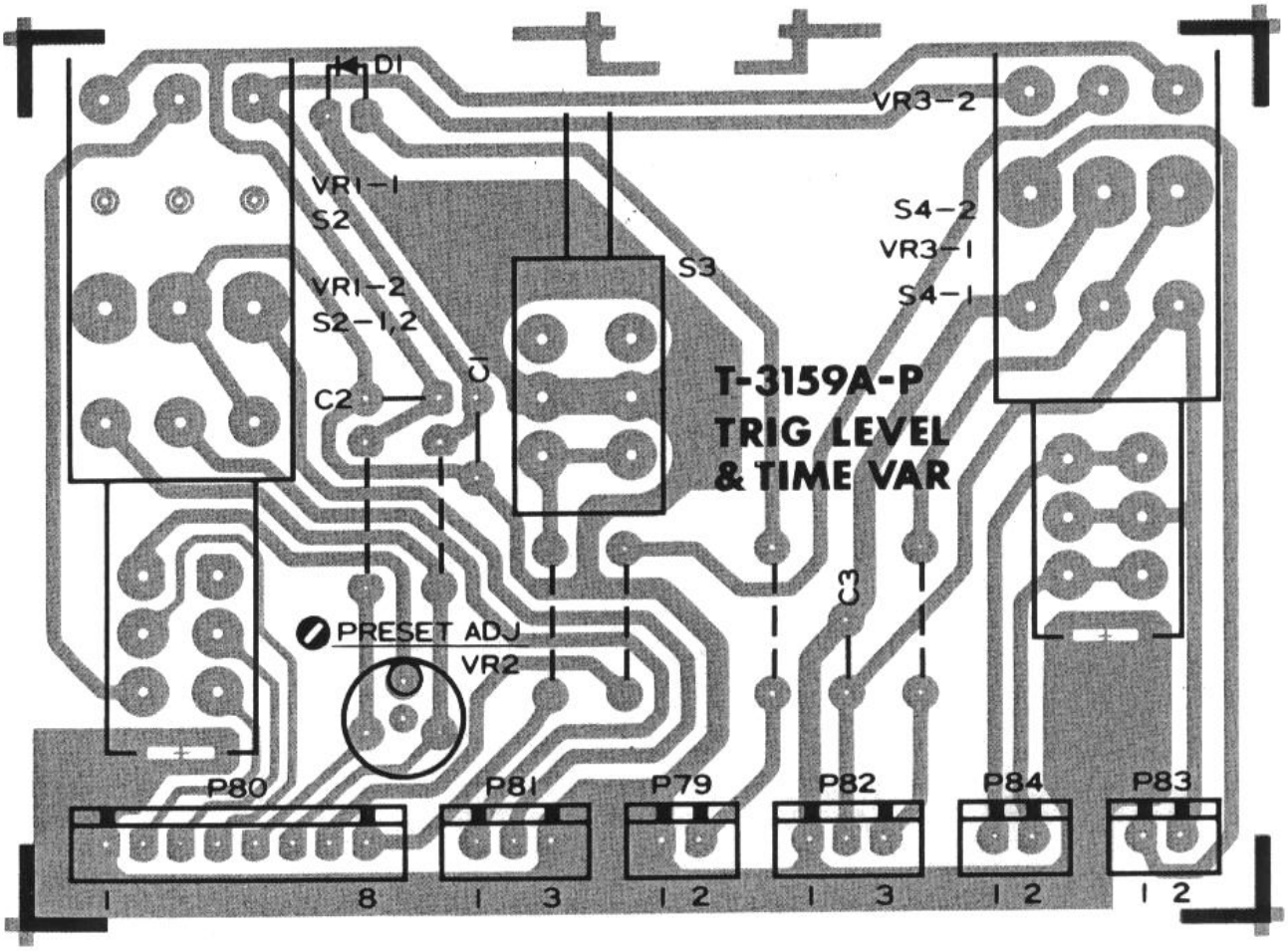

Figure 5-19
LBO-516 Trigger Level and Time Variable P.C. Board T-3159A

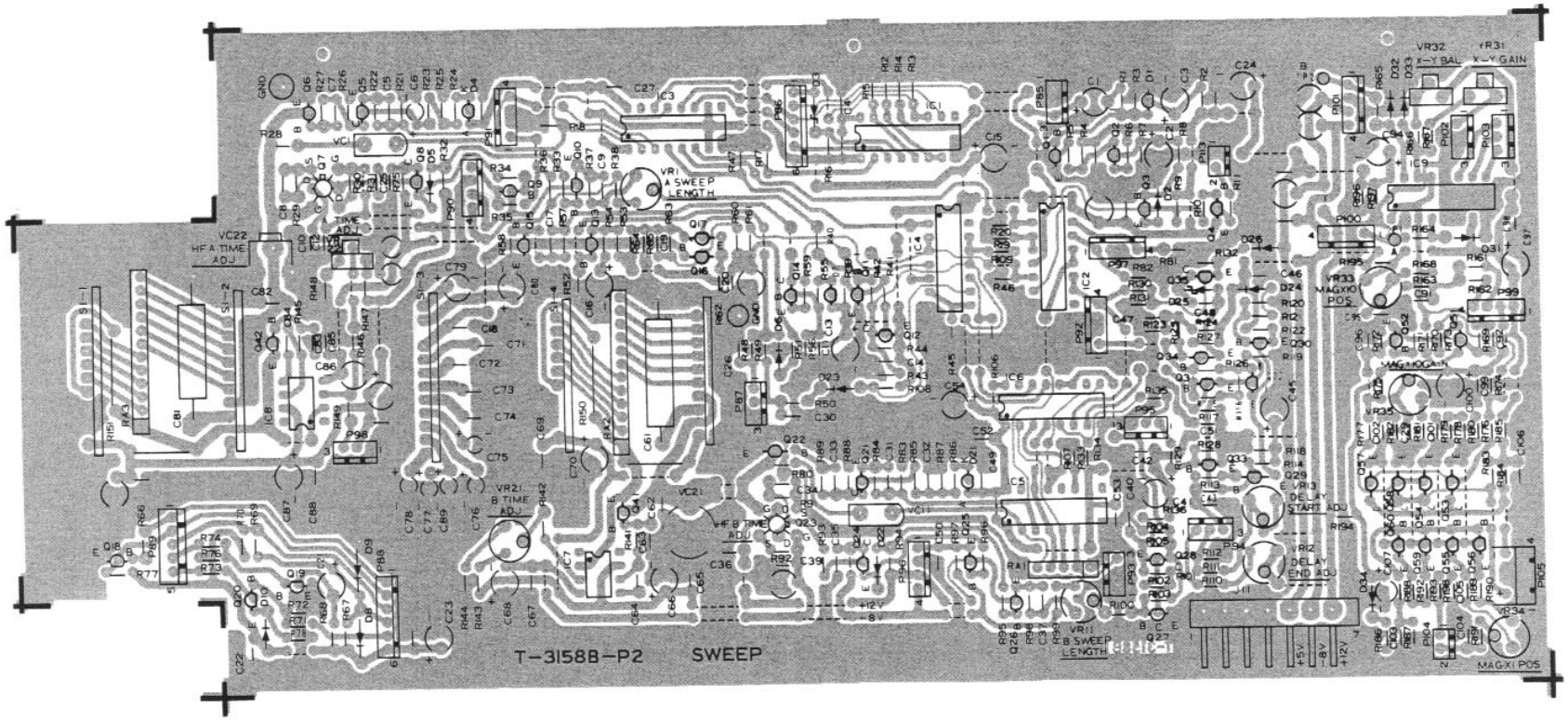

Figure 5-20
LBO-516 Sweep P.C. Board T-3158B

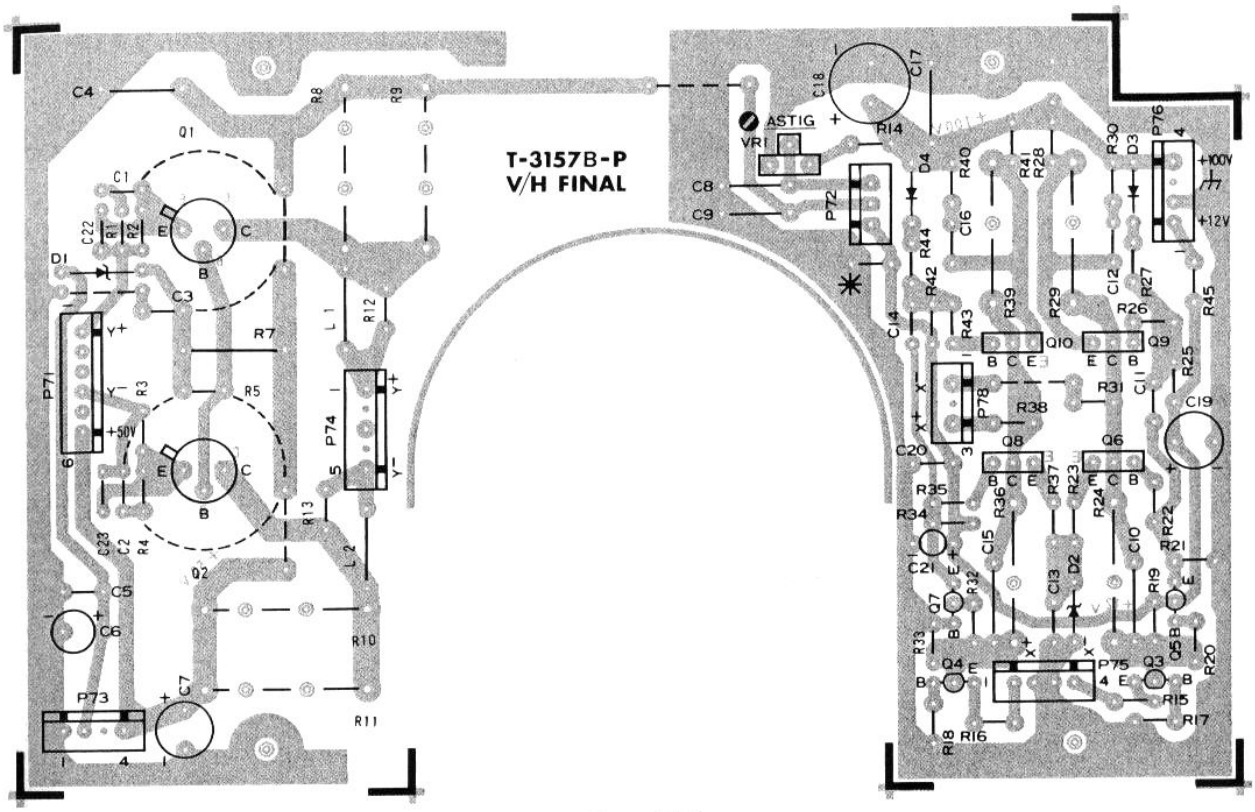

Figure 5-21
LBO-516 Horizontal and Vertical Final Amplifier P.C. Board T-3157B

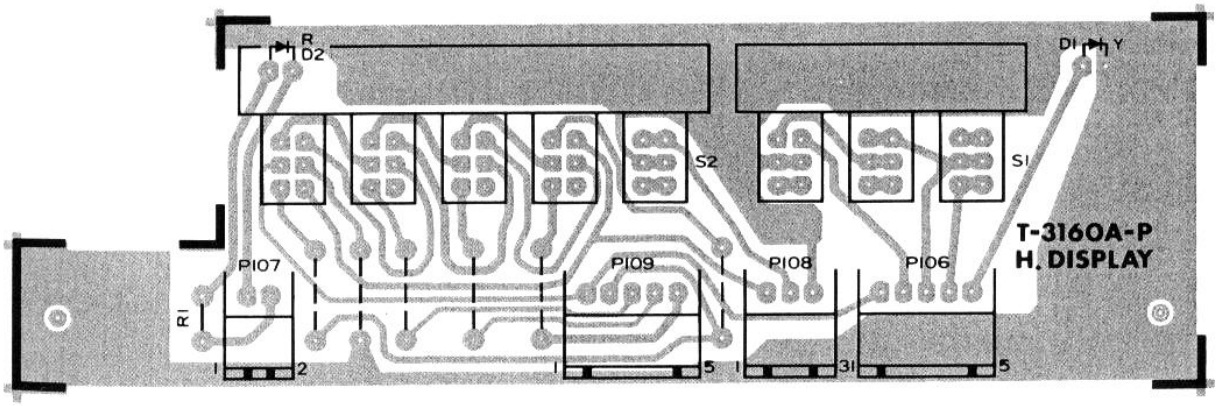

Figure 5-22
LBO-516 Horizontal Display P.C. Board T-3160A

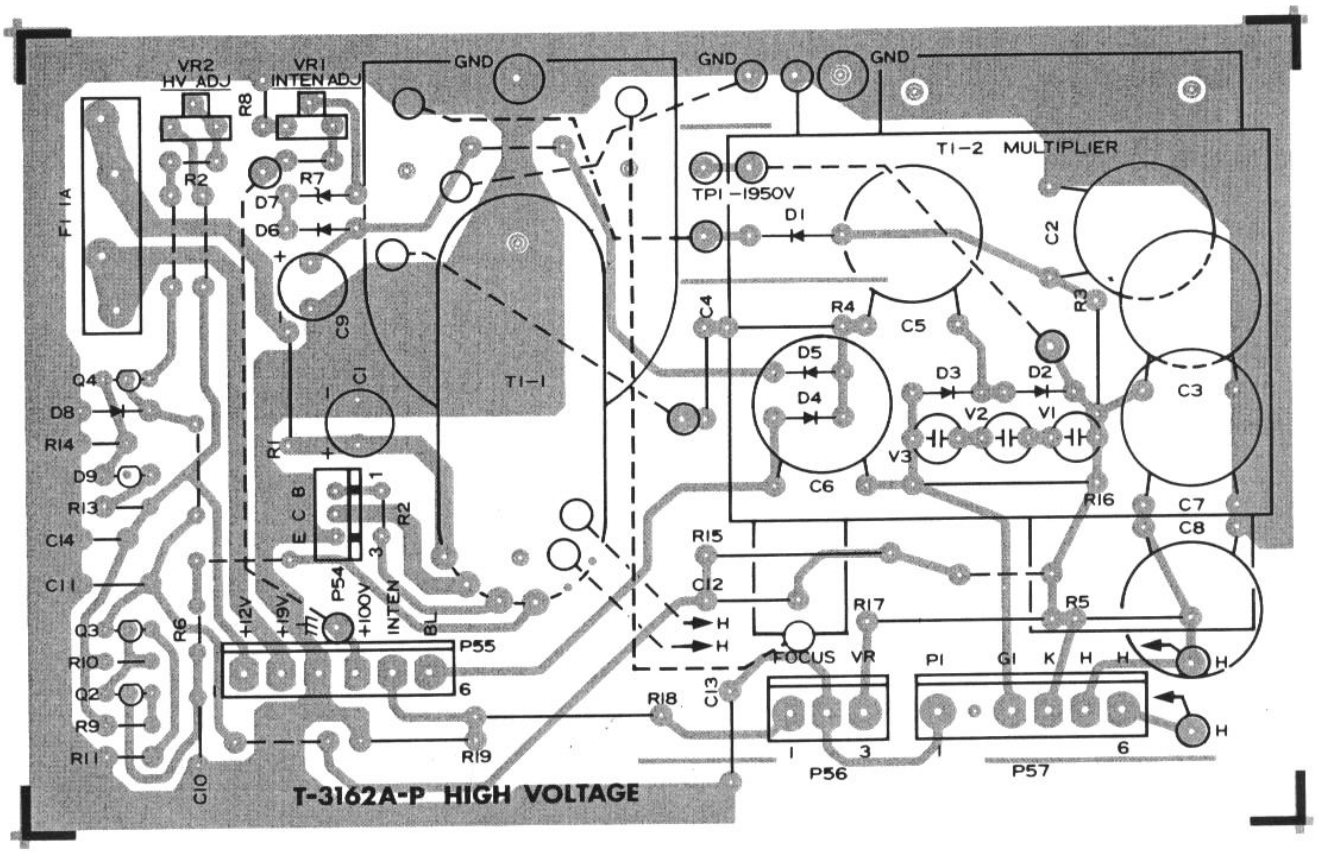

Figure 5-23
LBO-516 High Voltage Oscillator P.C. Board T-3162A

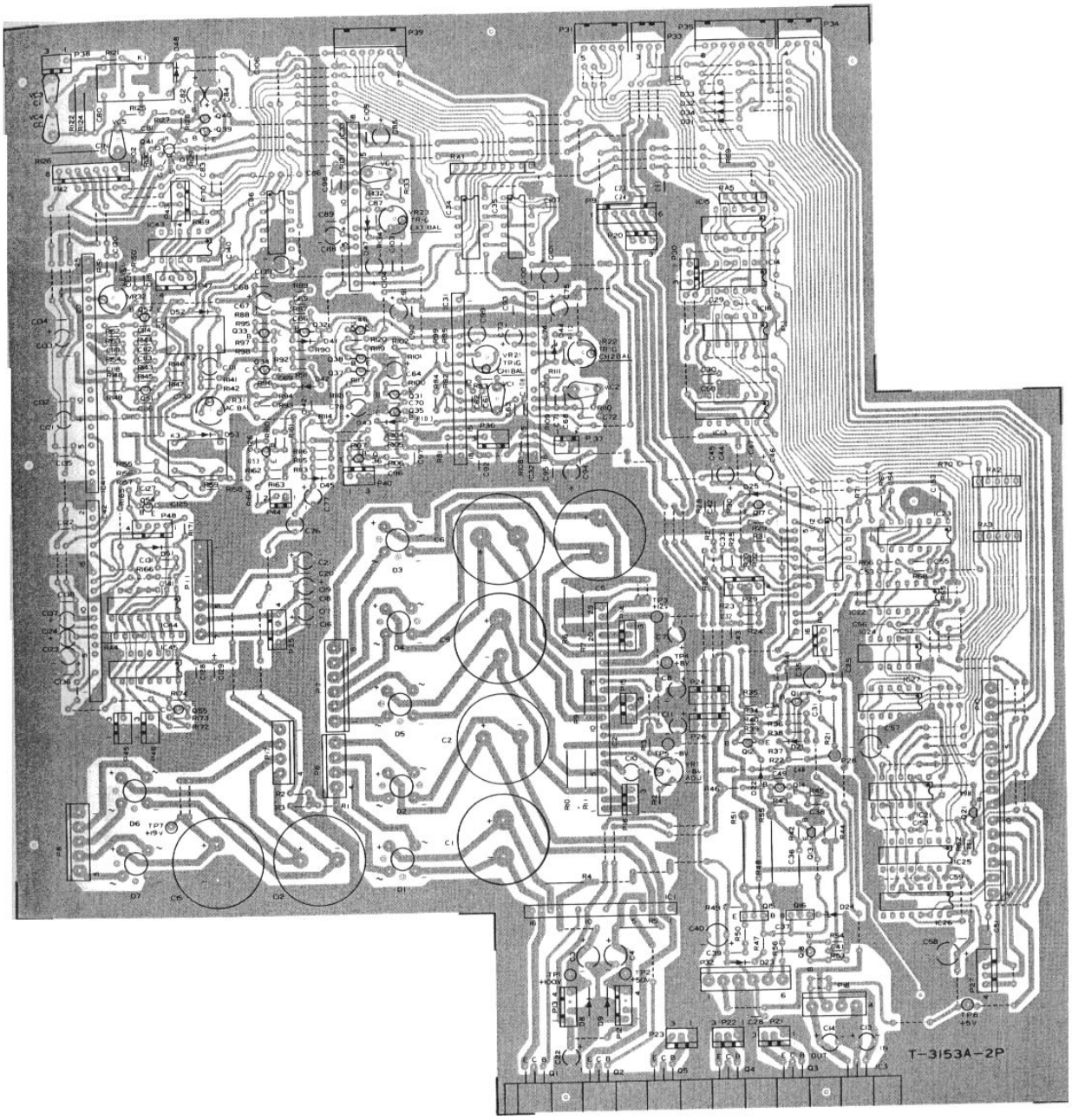

Figure 5-24
LBO-516 Main P.C. Board T-3153A

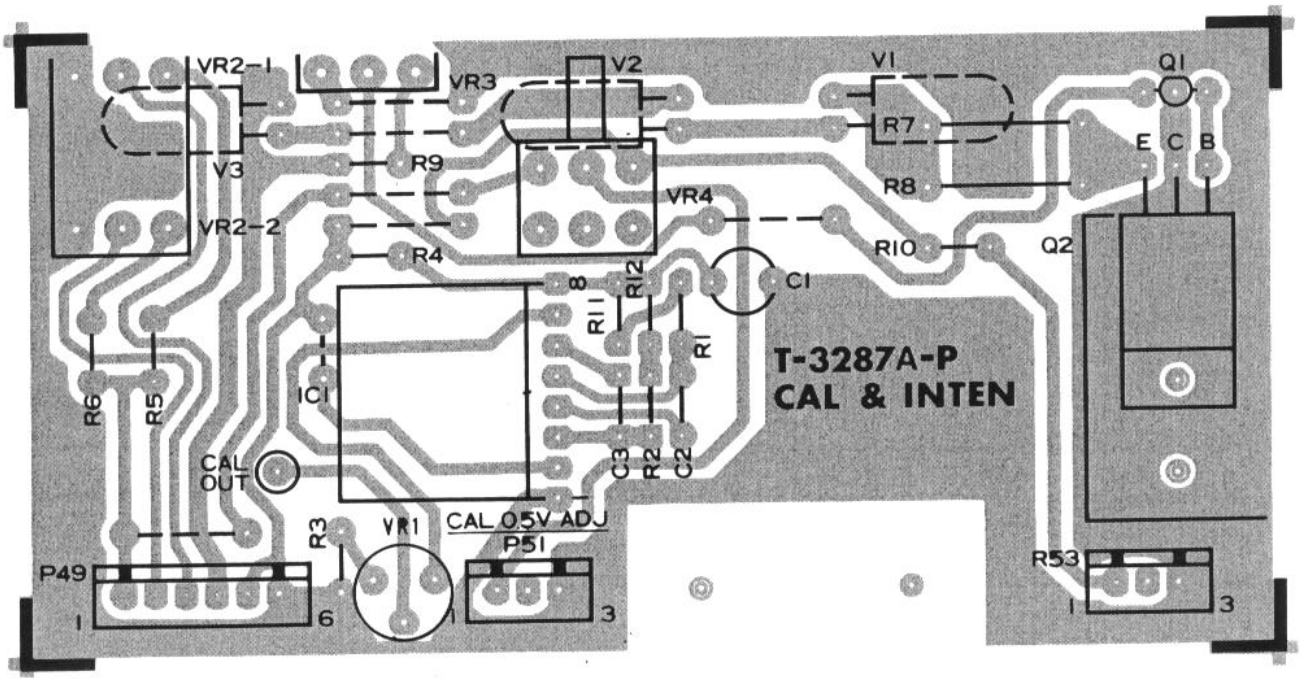

Figure 5-25
LBO-516 Calibrator and Intensity P.C. Board T-3287A