LEADER TEST INSTRUMENTS

MODEL LBO - 310A

3" DC OSCILLOSCOPE

INSTRUCTION MANUAL

LEADER ELECTRONICS CORP.

5 MAINTENANCE

MODEL LBO-310A
OSCILLOSCOPE
OPERATING INSTRUCTIONS

SECTION 1

DESCRIPTION

1.1 General

LBO-310A is a general purpose 75mm (3") oscilloscope with high sensitivity (20mVp-p/div; 1div = 6mm) and a bandwidth from DC to 4MHz. It is designed for heavy duty in service shops, technical schools and amateur radio stations. It features DC-coupled amplifiers, FET's in input circuits, and smart compact construction.

1.2 Specifications

Vertical Axis

Deflection Sensitivity	: 20mVp-p/div (1div=6mm).
Bandwidth, −3dB	DC : DC to 4MHz
	AC : 2Hz to 4MHz.
Input Control	: ×100, ×10, ×1, and fine adjuster
Input Impedance	: 1MΩ shunted by less than 40pF.
Maximum Input	: 600V (Vp-p + DCV).
Direct CRT Connection	: to 450 MHz at 10Vp-p or better.

Horizontal Axis

Deflection Sensitivity	: 300mVp-p/div or better.
Bandwidth, −3dB	: DC to 250kHz.
Input Impedance	: 1MΩ shunted by less than 40pF.
Maximum Input	: 30V (Vp-p + DCV).
Sweep Control	: 10Hz to 100kHz in four ranges; con-

tinuously adjustable between steps. Synchronization: Internal with negative peak; sensitivity, 1div signal amplitude, automatic.

CRT Section

Accellerating Voltage	:	Approx. 1200V.
Display Area	:	6 X 8div (1div = 6mm).
Z-axis Modulation	:	Over 20Vp-p.
Power Supply	:	100, 115 or 230V as specified, 50/60Hz; approx. 12VA.
Size and Weight	:	180(H) x 125(W) x 300(D) mm; 4.5kg. 7-2/5" x 5" x 12", approx.: 9.9 lbs.

SECTION 2

CONTROLS AND CONNECTIONS

Before operating the LBO-310A, for the first time, it is advisable for the user to become familiar with functions of various switches, controls, etc., described below.

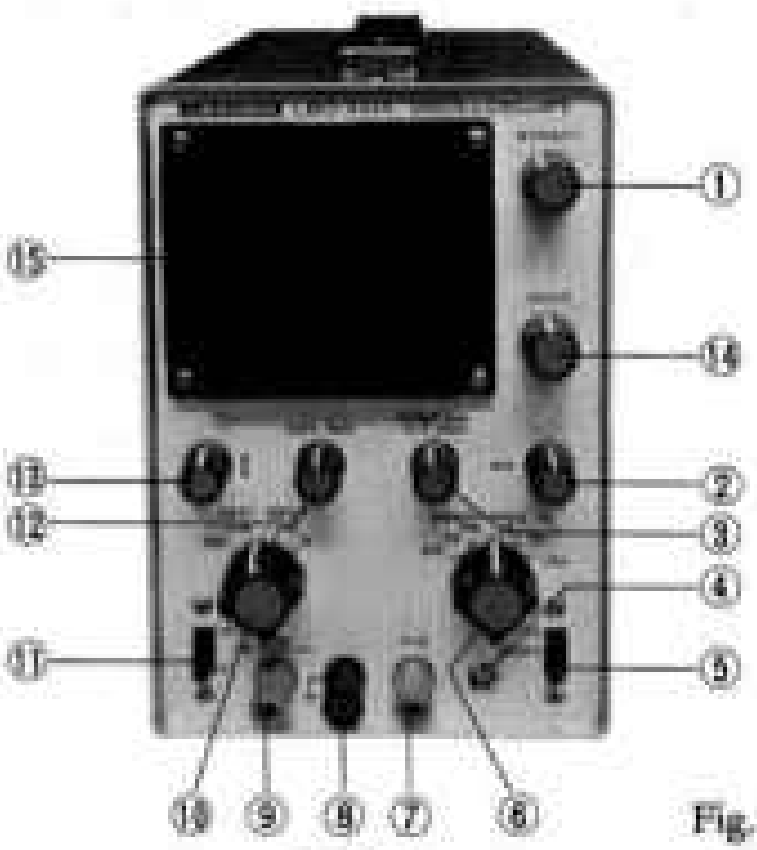
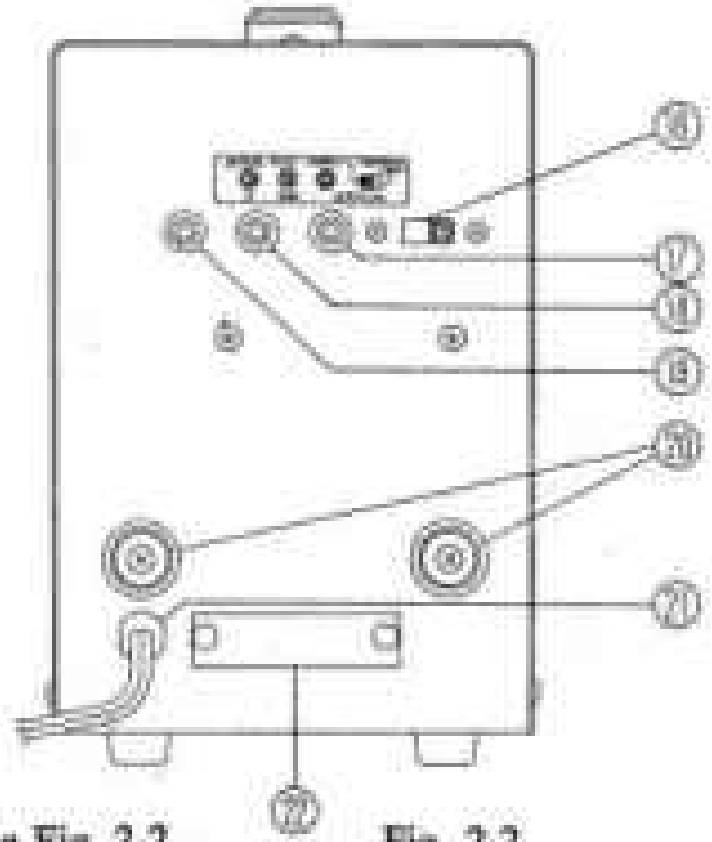


Fig. 2-1

2.1 Front Panel, see Fig. 2-1.

1.	INTENSITY	For adjusting the brightness of the CRT spot or trace.
2.	⟷ Position	For positioning the trace horizontally on the CRT screen.
3.	SWEEP VAR or H GAIN	For fine adjustment of sweep frequency between steps or width of horizontal trace amplitude at EXT SWEEP FREQ.
4.	Pilot lamp	Indicates when the AC power is on.
5.	POWER switch	For turning the AC power on and off.
6.	SWEEP FREQ Hz	Four steps to set sweep frequency range in 10Hz to 100kHz range; at EXT when an external signal is used for the sweep.
7.	H IN	For connection to an external sweep signal with SWEEP FREQ switch at EXT.
8.	Ground terminal	
9.	V IN	For connection to vertical input signal.
10.	VERT INPUT	Three ranges, X100, X10 and X1, for vertical input control; at GND the amplifier input is grounded (input signal is at open circuit).
11.	AC–DC	Switch for vertical amplifier input: AC to block out the DC component; DC for direct coupling.
12.	VERT GAIN	For adjusting the vertical amplitude between range steps.
13.	↕ Position	For positioning the trace vertically on the CRT screen.
14.	FOCUS	For adjusting the clarity of the CRT spot.
15.	Graticule	Marked in 8 vertical and 10 horizontal divisions, 6mm each, with 5 minor markings on center lines.



2.2 Rear Panel, see Fig. 2-2. Fig. 2-2

16. DIRECT-AMP Slide switch for CRT deflection mode: DIRECT for straight connection to vertical plates; AMP for input through V IN.
17. DIRECT Connector for display of signal up to 450MHz at vertical deflection plates.
18. Ground connector
19. INTEN MOD Z For connection to Z-axis modulating source.
20. AC cord hooks
21. AC cord
22. Nameplate

OPERATION

3.1 Precautions in Operation

3.1.1 AC Line Voltage

The AC voltage for operation should be kept within ±10% of the rating as specified. If lower, performance will be degraded; at higher voltages, internal power supplies may be damaged, especially when applied for long periods.

3.1.2 Maximum Input Voltages

Voltages applied to different input connectors must not exceed the values indicated in the chart below.

Connector	Max. Volts (Vp-p + DCV)
V IN	600V
H IN	30V
INTEN	30V
MOD Z	

Examples of maximum conditions are shown at "A" and "B" in Fig. 3-1.

A B

Fig. 3-1 Maximum voltages at V IN

CAUTION: Do not connect to the flyback circuit in TV sets.

3.1.3 Prevention of "Ion burns"

If the CRT beam is concentrated in a spot on the screen, there is the possibility of burning that particular portion of the screen. The INTENSITY control should be adjusted during stand-by periods to extinguish the spot, or the spot must be kept in

motion with the sweep frequency to avoid an "Ion burns".

3.1.4 Influence of Strong Magnetic Fields

The instrument should be operated in location where a strong local magnetic field is not present, otherwise there will be a distorted waveform display. (Keep the "gun type" soldering irons away from the scope.)

3.2 Preparation

A. Control settings:

INTENSITY	Near fully clockwise.
FOCUS	
↕ (vertical)	at midposition.
↔ (horizontal)	
VERT GAIN	Fully counter clockwise.
HOR GAIN	Fully clockwise.
VERT INPUT	X100.
AC-DC switch	at AC.
SWEEP FREQ Hz	10-100k.
VERTICAL switch	(rear panel) at AMP.
SWEEP VAR	any setting.

B. Connections:

1. Remove AC cord off the hooks at back of cabinet. Connect the plug to the AC line.
2. Test leads to V IN and ground.

C. Adjustments:

1. Set POWER switch at ON.
2. Adjust INTENSITY and FOCUS controls for clear trace.

3.3 Waveform Observation

3.3.1 General

1. Connect the leads from V IN to test point of circuit under examination.
2. AC-DC switch settings -
   AC: For AC input, or to pick out the AC component when there is superimposed DC voltage in the input signal.
   DC: Generally used when only the AC signal is under observation or for DC voltage measurements.
3. Set VERT INPUT switch at X100, X10, or X1 and adjust VERT GAIN for suitable trace amplitude.
4. Set H GAIN control for suitable trace width.
5. Set SWEEP FREQ switch at 10-100, etc., and adjust SWEEP VARIABLE control as required for the waveform display.
6. Adjust the spot positioning controls to position the trace on the graticule as required.

3.3.2 External Sweep Operation

1. Set SWEEP FREQ Hz switch at EXT.
2. Connect the external sweep input to H IN. NOTE: Do not apply more than 30Vp-p (Vp-p + DCV). Use a blocking capacitor when only the AC component is to be utilized.
3. Adjust H GAIN for desired sweep width.

3.4 Intensity Modulation

Frequency markers, timing pulses or other signals can be applied on the trace with connection from sweep generators, etc., to INTEN MOD on the rear panel. Approximately 20Vp-p input is required. An example is shown in Fig. 3-2.

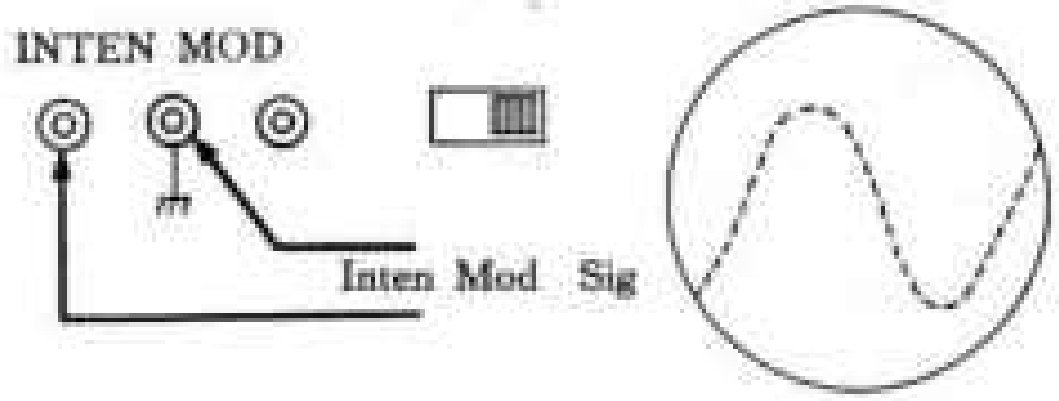


Fig. 3-2 Intensity modulated trace.

3.5 Voltage Measurements

When comparing the performance of amplifiers, tuners, etc., it is convenient to determine the response in terms of voltage. The method of calibration and use are given below.

3.5.1 Voltage Calibration

1. Switch settings:
   AC-DC at DC. VERT INPUT at X10.
   SWEEP FREQ at 10-100.
2. Disconnect any input connection at V IN.
3. Adjust the vertical positioning control to locate the trace at four divisions below the middle horizontal line.
4. Connect the "+" of a 1.5V battery to V IN and the "—" to ground.
5. Adjust VERT GAIN control so that the trace movement is 7.5 divisions.
   Do not touch VERT GAIN after this adjustment.
   Under this condition, the vertical axis is calibrated at 0.2Vp-p per div.
   At X1 and X100 respectively of VERT INPUT, the sensitivity will be 20mVp-p/div and 2Vp-p/div.
   NOTE: 1. Other sensitivities can be obtained with the same calibration method. For example, when using a +1V supply from a regulated DC source,

instead of the 1.5V battery, adjust VERT GAIN for a 5div movement; in this instance, the 0.2Vp-p/div condition is obtained.

2. The accuracy will depend on the actual voltage of the "1.5V" battery.

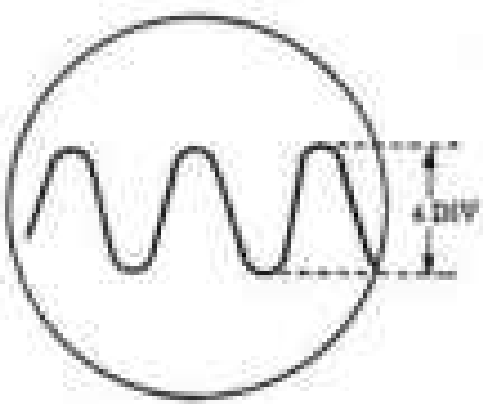
3.5.2 AC Voltage Measurements

1. After calibration, disconnect the DC voltage from V IN.
2. Set AC-DC switch at AC.
3. Connect the voltage under measurement to V IN.
4. Set the sweep frequency controls for two or three cycle display.
5. Set VERT INPUT at the range to place the waveform peaks within upper and lower lines on the graticule.
6. Note the distance between the peaks.

The peak-to-peak voltage is given by -

(Distance in div) X (Vp-p/div) X Multiplier = Vp-p.

Example: (See Fig. 3-3.)



At 4div, voltage is 0.8Vp-p when calibrated at 0.2Vp-p/div, and VERT INPUT at ×1

Fig. 3-3 Example of Vp-p measurement.

3.5.3 DC Voltage Measurements

1. Set AC-DC switch at DC.
2. Adjust vertical positioning to put the trace on middle line, Connect the voltage under measurement to V IN.

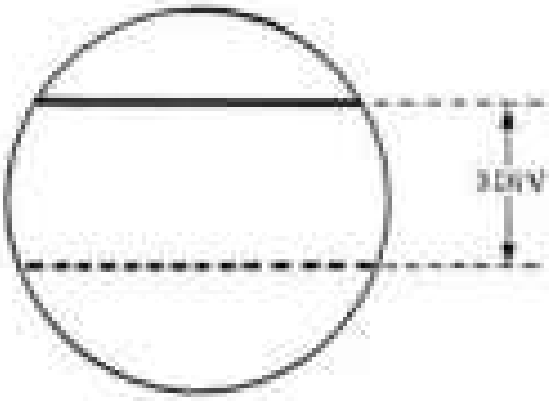
The trace will move up for +V and down for −V.

The voltage is given by -

(Distance of movement) × (Vp-p/div) × Multiplier = Volts DC.

Note that the DC voltage is the same as Vp-p for AC input.

Example: (See Fig. 3-4)



At 3div, voltage is +0.6V when calibrated at 0.2V/div and VERT INPUT at ×1

Fig. 3-4 Example of DC voltage measurement.

3.6 Frequency Comparison

Unkown frequencies under test can be compared or checked with a standard, or known, frequency by the lissajous pattern method.

1. Connect the unknown frequency to V IN.
   Adjust vertical controls for suitable amplitude.
2. Connect the standard frequency to H IN.
   Set SWEEP FREQ at EXT.
   Adjust H GAIN for suitable width.
3. Adjust the known, or unknown, frequency for a clearly defined single or multiple loop pattern.
4. The frequency is calculated from the following relation:

$$F_u = F_s \frac{Nx}{Ny}$$

where F_s = standard frequency (horizontal input).
F_u = unknown frequency (vertical input).
N_x = number of loops on upper line.
N_y = number of loops on left line.

The pattern for $F_u = F_x \times 3$ is shown in Fig. 3-5.

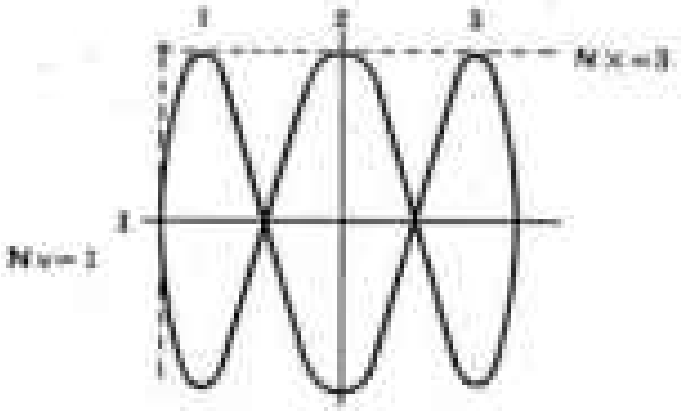


Fig. 3-5 Frequency comparison.

Examples:

A. Use of line frequency as standard.

1. Connect about 1Vrms from a line step down transformer to H IN. Adjust H GAIN for suitable width.
2. Connect a variable audio oscillator to V IN.
3. Adjust the oscillator frequency control.
   At 50, 100, 150Hz .... (or 60, 120, 180Hz ....), the pattern with 1, 2, 3 .... loops will be displayed; these are at multiples of the line frequency.

B. Use of a 1kHz standard.

When a 1kHz standard is used, the same patterns will be displayed at 1, 2, 3kHz .... At submultiples, namely, 500, 333, 250, 200Hz .... etc., the patterns will be rotated by 90° but the same formula is used in calculation.

3.7 Amplitude Modulation Measurement

Two methods will be described for determination of amplitude modulation of carrier frequencies up to 450 MHz in radio transmitters.

The input signal is connected to DIRECT and GND on the rear panel. The slide switch is set at DIRECT, see Fig. 3-6.

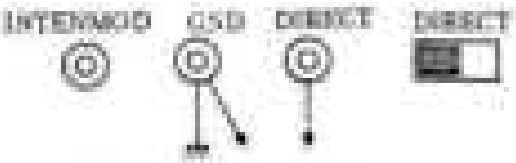


Fig. 3-6 Switching for AM measurement.

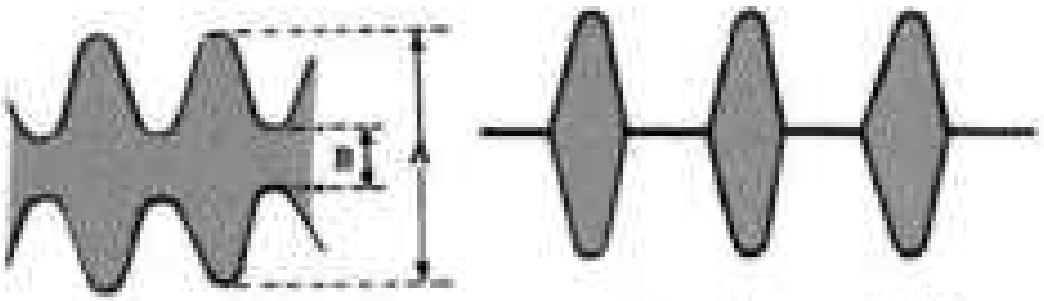
The signal is picked with a coil loosely coupled to the final stage in the transmitter. Care must be exercised when making transmitter measurements.

Depth of modulation, m, is calculated from the relation -

$$m = \frac{A - B}{A + B} \times 100\%$$

A. Envelope method.

Adjust sweep controls for a two-cycle display, see "A" in Fig. 3-7: overmodulated condition is shown at "B".

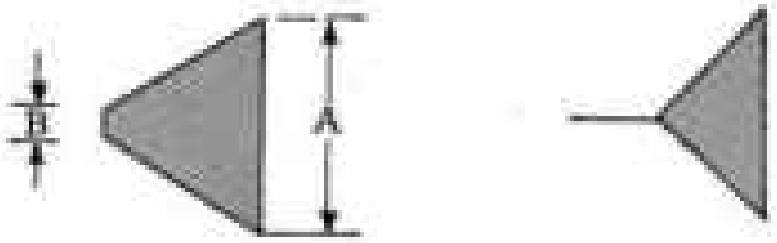


A: Typical B: Overmodulation

Fig. 3-7 Envelope method

B. Trapezoid method.

1. Set SWEEP FREQ switch at EXT.
2. Connect a part of the audio modulation source to H IN.
3. Adjust H GAIN for suitable width.
4. A typical pattern is shown at "A" in Fig. 3-8: overmodulation is shown at "B".



A: Typical B: Overmodulation

Fig. 3-8 Trapezoid method

IMPORTANT: After the measurements, do not forget to set the slide switch at AMP (NORMAL.)

CIRCUIT DESCRIPTION

4.1 General

In this section the circuits which compose the LBO-310A will be brifly described. Reference will be made to the functional block and schematic diagrams.

4.2 Vertical Amplifier

The signal to be displayed is connected to V Input. The AC-DC switch inserts a blocking capacitor for AC signals. For attenuation of the input, two frequency compensated attenuators are used at ×10 and ×100 positions of VERT INPUT switch.

The amplifier consists of a source follower, Q202, and a self-balancing stage, Q204-Q205, for pushpull output. The deflection amplifier stage is made up with Q206-Q207 (high voltage transistors).

Vertical gain is controlled with VR202 which adjusts the feedback in the Q202-Q205 stage. Spot positioning is done with VR203 which adjusts the base bias voltage on Q206-Q207 to produce the required static deflection.

Two diode connected transistors, Q201-Q203, are connected across the input of Q202 for overload protection.

4.3 Horizontal Circuits

4.3.1 Sweep Frequency Generator

A modified multivibrator circuit (run-down type) is used in generating the sweep frequency voltage, from 10Hz to over 100kHz, in four steps. Intermediate frequencies are set with SWEEP VAR control, VR301, which adjusts the time constant of the sawtooth waveform output. This control is used for H GAIN at the EXT setting of SWEEP FREQ switch.

For synchronizing the sweep frequency, the negative peak voltage picked off one side of the deflection stage is applied to the sweep generator. The sweep is automatically synchronized when there is about 1div trace amplitude.

4.3.2 Horizontal Amplifier

Inputs from the sweep generator and external horizontal source are selected with the SWEEP FREQ Hz switch. The amplifier consists of a source follower, Q301, and a self-balancing amplifier, Q302-Q303, for pushpull output to the horizontal CRT deflection plates.

4.4 Power Supplies and CRT Circuit

Four DC voltage supplies are used as follows:

−1220V (approx.) for CRT acceleration.

+160V for final stage and astigmatism adjustment.

+8V
−15V } for amplifiers and sweep circuit; zener diodes are used for stabilization.

MAINTENANCE

5.1 General

After a long period of use, it may be necessary to make minor adjustments and/or replacement of components. In this section, directions are given for checking and adjustments.

5.2 Exposing the Chassis

IMPORTANT: When checking with the AC power turned on, extreme care must be taken not to come into contact with the high voltage in the CRT circuit.

1. Disconnect AC plug from the AC line.
2. Referring to Fig. 5-1, remove screws as shown for covers on each side and take off the covers.

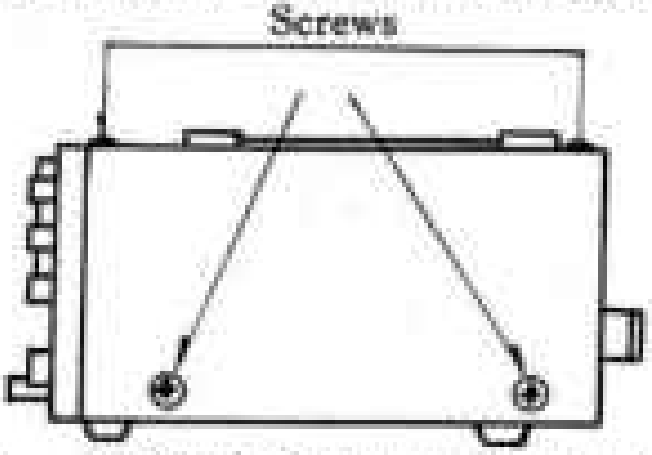


Fig. 5-1 Removal of covers (right side shown).

5.3 Location of Adjusters

Adjusters on the printed circuit board are shwon in Fig. 5-2.

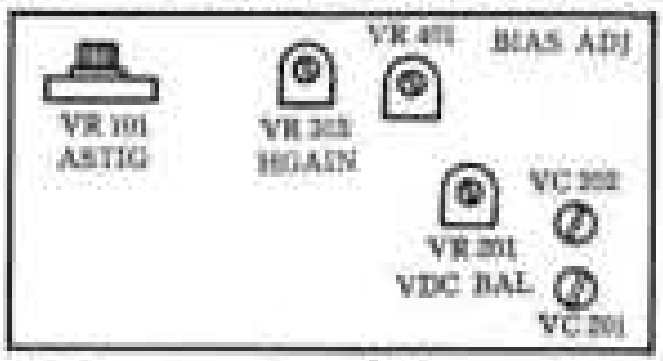


Fig. 5-2 Location of adjusters on PCB.

5.4 Vertical Amplifier Balancing

When there is a large shift in display as VERT GAIN control is adjusted, the following steps are taken. (NOTE: A slight amount of shift can be usually tolerated since it can be compensated with the positioning control without affecting the sensitivity.)

1. Control settings:

   VERT INPUT at GND.

   VERT GAIN at fully counterclockwise.

   HOR GAIN at fully counterclockwise.

2. Adjustments:

   a. Set vertical positioning for spot at middle horizontal line.

   b. Rotate VERT GAIN to fully clockwise. There should be no vertical shift for proper condition.

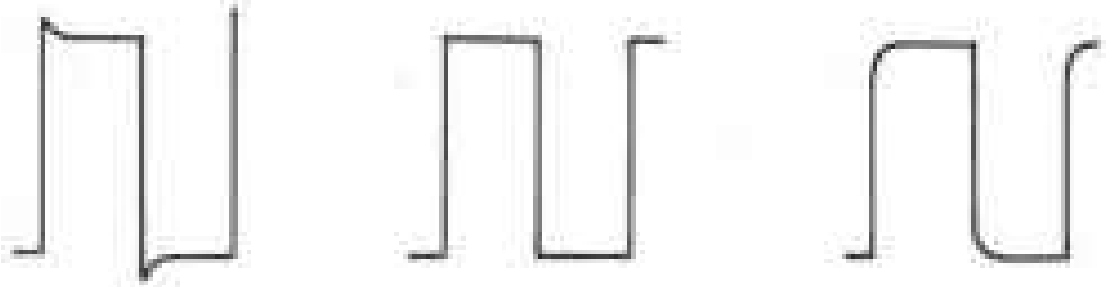
3. If any shift occurs, adjust V DC BAL, VR201, using a small screw driver, to return the spot to original position.

4. Repeat process of rotating VERT GAIN back and forth and adjusting VR201 until there is no spot movement, or a minimum condition.

5.5 Vertical Attenuator Frequency Compensation

1. Set the scope controls for waveform observation.
2. Set AC-DC switch at DC.
3. Connect a 1kHz square wave (overshoot and sag less than 1%) to V.IN.
4. The waveform display at VERT INPUT X10 and X100 should be as shown at "B" in Fig. 5-3, with perfect corners.

   If not, adjust trimmers VC201 and VC202 respectively at X10 and X100 settings of VERT INPUT.



A: Improper B: proper C: Improper

Fig. 5-3 Attenuator frequency compensation.

5.6 Upper Limit of Sweep Frequency

This adjustment is required only when a single wave of a 110kHz input is not properly displayed.

1. Control settings:

   SWEEP FREQ Hz at 100k range.

   Sweep Variable at fully clockwise.

2. Connect a 110kHz sine wave signal input to V.IN.
3. Adjust BIAS Adjuster, VR401, for the single wave display.

5.7 Horizontal Gain Limiting

This adjustment sets the width of internal sweep on the screen. At all settings of SWEEP FREQ Hz, namely 10Hz to 100kHz, the length of the sweep line should cover the full width of the screen. If not, adjust H GAIN Adjuster, VR303, to or near this condition.

5.8 Astigmatism

This adjustment is required only when the CRT has been replaced.

A simple method of adjustment is the use of a circular pattern produced by application of the lissajous method described in Sect. 3.6. The pattern is formed with use of line

frequency input to V. IN and an audio oscillator signal at the same frequency to H IN (set SWEEP FREQ switch at EXT).

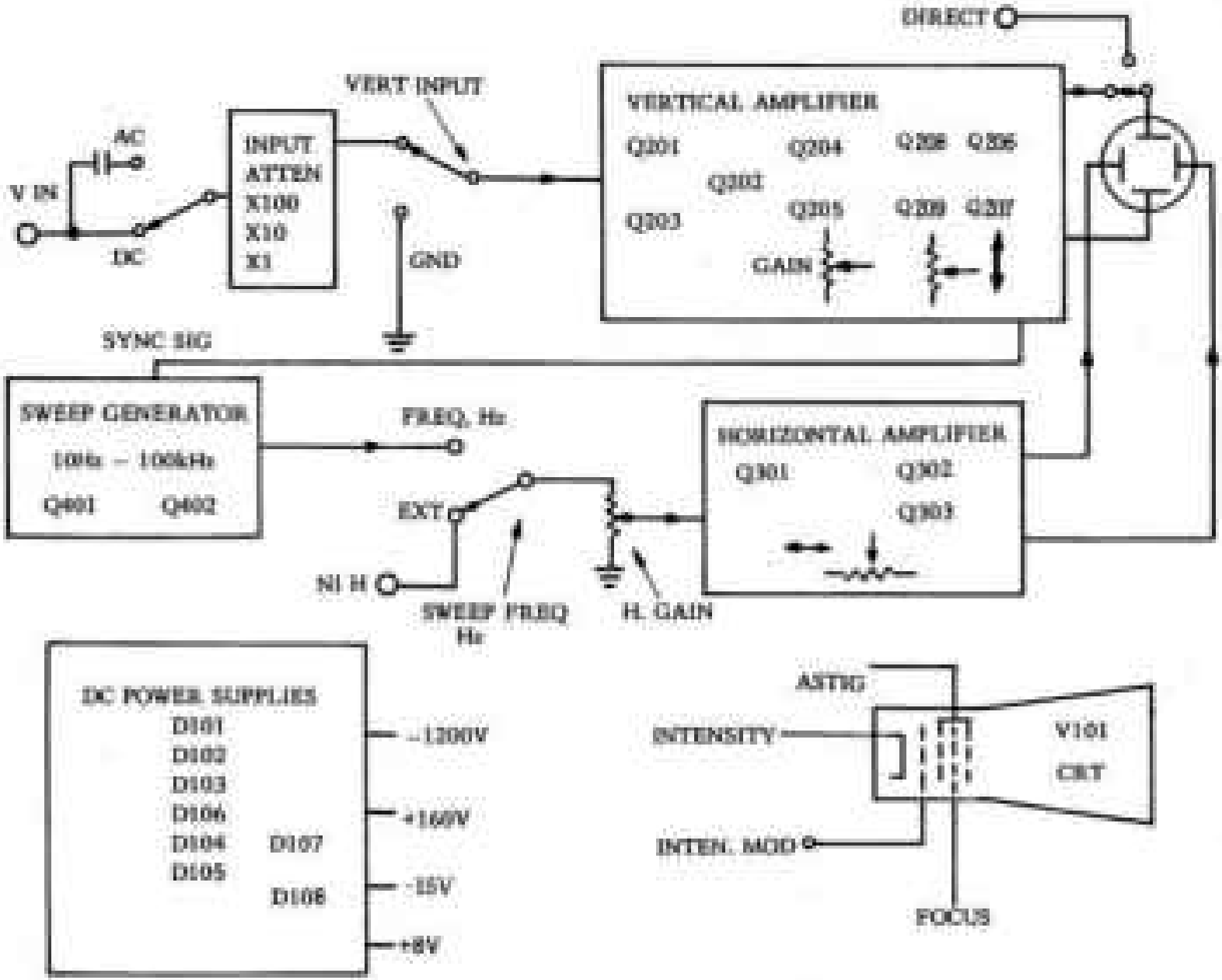
By adjusting the frequency to 1:1 ratio, set the gain controls for a trace about 9 div in diameter.

Adjust ASTIG, VR101, together with FOCUS control so that the traced line is uniform all around.

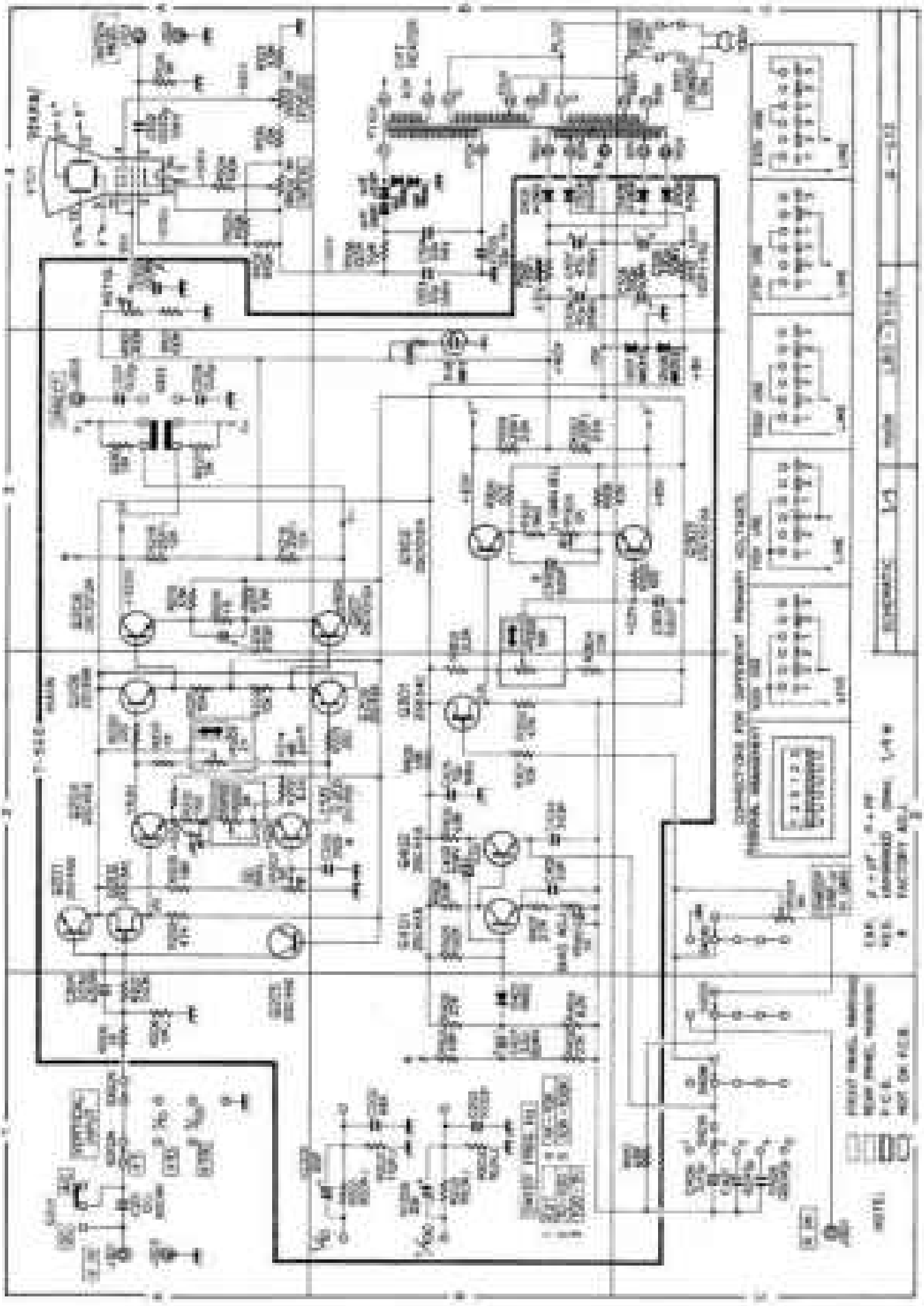
5.9 Fuse Replacement

Fuse Rating	Line Voltage
0.5A	100–115V
0.3A	200–230V

If the fuse blows after replacement, check the power supply circuits for defective parts, such as filter capacitors, etc.



FUNCTIONAL BLOCK DIAGRAM: LBO-310A



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