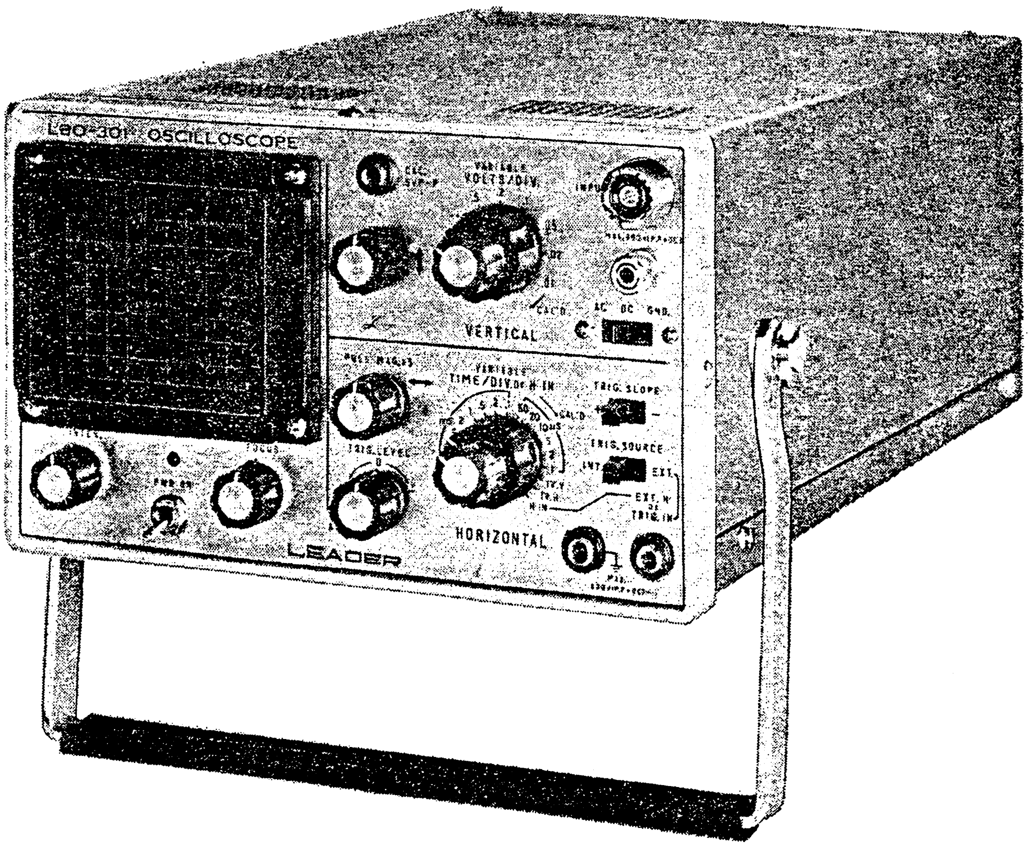
LEADER TEST INSTRUMENTS

MODEL LBO-301

OSCILLOSCOPE

OPERATING INSTRUCTIONS
and SERVICE MANUAL



LEADER ELECTRONICS CORP.

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MODEL LBO-301

OSCILLOSCOPE

OPERATING INSTRUCTIONS and SERVICE MANUAL

1. DESCRIPTION

1.1 General

LBO-301 is a compact 3-inch scope featuring high sensitivity and wide bandwidth. It is engineered specially for servicing color TV and computer circuitry in the shop and in the field.

The vertical amplitude is calibrated in volts per division (1 div. = 6 mm). Display area is 8×10 div., 1μs to 0.5 s/div. time base with ×5 magnifier (max. speed 0.2μs), preset vertical and horizontal sweep for TV circuit testing, VECTORSCOPE connection and 0.5 Vp-p calibration voltage make this scope outstanding for general use.

1.2 Specifications

Vertical Amplifier

Deflection Sensitivity	10 mVp-p to 5 Vp-p per division (1 div. is 6 mm) in 9 steps, 1–2–5 sequence ; uncalibrated continous control between steps and up to 10 Vp-p/div. ; accuracy, ± 3 %.
Bandwidth	DC or 2 Hz to 7 MHz.
Rise Time	0.07 μs. (70 nanosecs)
Input Impedance	Direct : 1 MΩ/40 pF. With probe : 10 MΩ/15 pF or less.
Input Connector	UHF type.

Time Base

Sweep Speed	1 μs to 0.2 s per division in 17 steps, 1–2–5 sequence ; accuracy; ± 5 %. Uncalibrated continuous control betueen oteps and up to 0.5 s per division.
Magnifier	×5 at all TIME/DIV settings (max. speed, 0.2 μs/div.)

Sweep Synchronization

Mode	Triggered and automatic.
Control	Internal and external, + or − slope.
Sensitivity	

	Display Amplitude	1 div.	1.5 div.
Internal	Level controlled	2 Hz ~ 2 MHz	1 Hz ~ 7 MHz
	Automatic	20 Hz ~ 2 MHz	10 Hz ~ 5 MHz

External	Input Voltage	100 mVp-p	150 mVp-p
	Level controlled	3 Hz ~ 2 MHz	2 Hz ~ 7 MHz
	Automatic	20 Hz ~ 2 MHz	10 Hz ~ 5 MHz

Controllable Trig. Level (at 1 kHz)	Internal : 16 div. maximum. External : 2 Vp-p, maximum.
Horizontal Amplifier	
Deflection Sensitivity	1 Vp-p/div., normal ; 200 mVp-p/div. at ×5 magnification.
Bandwidth	2 Hz to 200 kHz.
Calibrator	0.5 Vp-p, 1 kHz ± 3 % square wave.
Power Supply	115/230V, 50/60 Hz ; 25 VA approx.
Size and Weight	4 ~ ¾″H × 8″W × 12″D ; 8.8 lbs.
Accessories, furnished	Instruction Manual 1 copy

Option : Carrying case with strap on separate order.

2. CONTROLS AND CONNECTORS

2.1 General

Before operating the LBO-301, especially for the first time, it is advisable for the user to become familiar with the functions of the various switchs, controls, etc., described below to achieve maximum performance.

2.2 Front Panel, (Fig. 2-1)

1.	Hood for CRT	Fastened with four screws.
2.	Graticule	Marked in 8 vertical and 10 horizontal divisions, each division = 6 mm, with 5 minor divisions on centerlines, and with 12 markings 30° apart for vectorscope application.
3.	Handle	For carrying or use a tilt stand.
4.	INTENsity	For adjusting the brightness of the trace.
5.	PWR ON	Swith for AC power.
6.	Pilot lamp	Lights when AC power is on.
7.	FOCUS	For adjusting the clarity of the trace.
8.	Positioning	For positioning the trace horizontally.
	PULL MAG ×5	The knob when pulled forward magnifies the sweep time by a factor of 5 at all TIME/DIV settings of switch 10, Fig. 2-1.

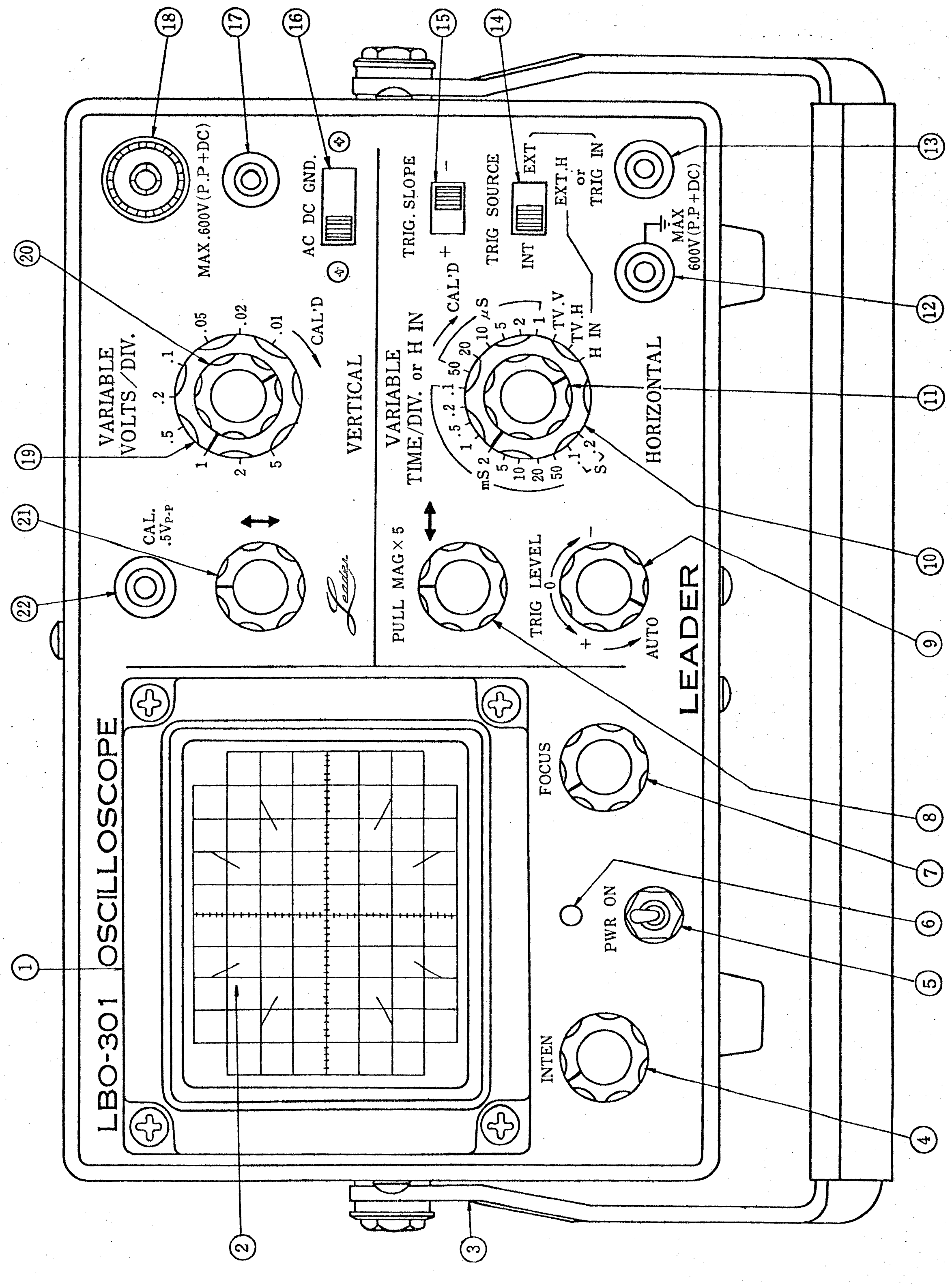


Fig. 2·1 Front panel control

9.	TRIG LEVEL	For setting the starting point in the displayed waveform ; at AUTO position (switched) the sweep becomes free-runnning.
10.	TIME/DIV or H IN	Black knob. For selecting the calibrated sweep speeds from 0.2 s to 1 μs per division preset TV–V and TV–H and external horizontal input.
11.	VARIABLE	Red knob, continuous adjuster for the sweep speed between calibrated steps, except TV–V and TV–H, for uncalibrated speeds, normally set at fully clockwise; also for control of external horizontal input amplitude at EXT H IN.
12.	Jack	For ground connection.
13.	EXT H or TRIG IN	For connection to an external horizontal input or triggering signal source.
14.	TRIGger SOURCE	Switch for the triggering signal to the time base : INTernal for triggering with the signal connected to the vertical input or normal setting ; EXTernal for triggering signal at the TRIG IN jack.
15.	TRIGger SLOPE	Marked + and − for selection of the slope direction of the trigger signal.
16.	AC–DC–GND	Vertical amplifier input switch : AC for blocking the DC component ; DC for direct coupling ; GND shorts the amplifier input and disconnects the input signal.
17.	Terminal jack	For ground connection.
18.	INPUT	Connector for probe cable or adapter.
19.	VOLT/DIV	Black knob. With nine positions to set the vertical deflection sensitivity from 5 to 0.01 Vp-p per division with the red knob at CAL'D position (switched). NOTE : When the low-cap probe, LPB–10Y, 10 : 1, is used, multiply the reading by 10.
20.	VARIABLE	Red knob. For continuous and uncalibrated adjustment of the vertical amplitude between calibrated steps.
21.	Positioning	For positioning the trace vertically.
22.	CAL 0.5 Vp-p	Square wave voltage source for calibration of vertical amplitude. (1 kHz approx.)

2.3 Rear panel, (Fig. 2-2)

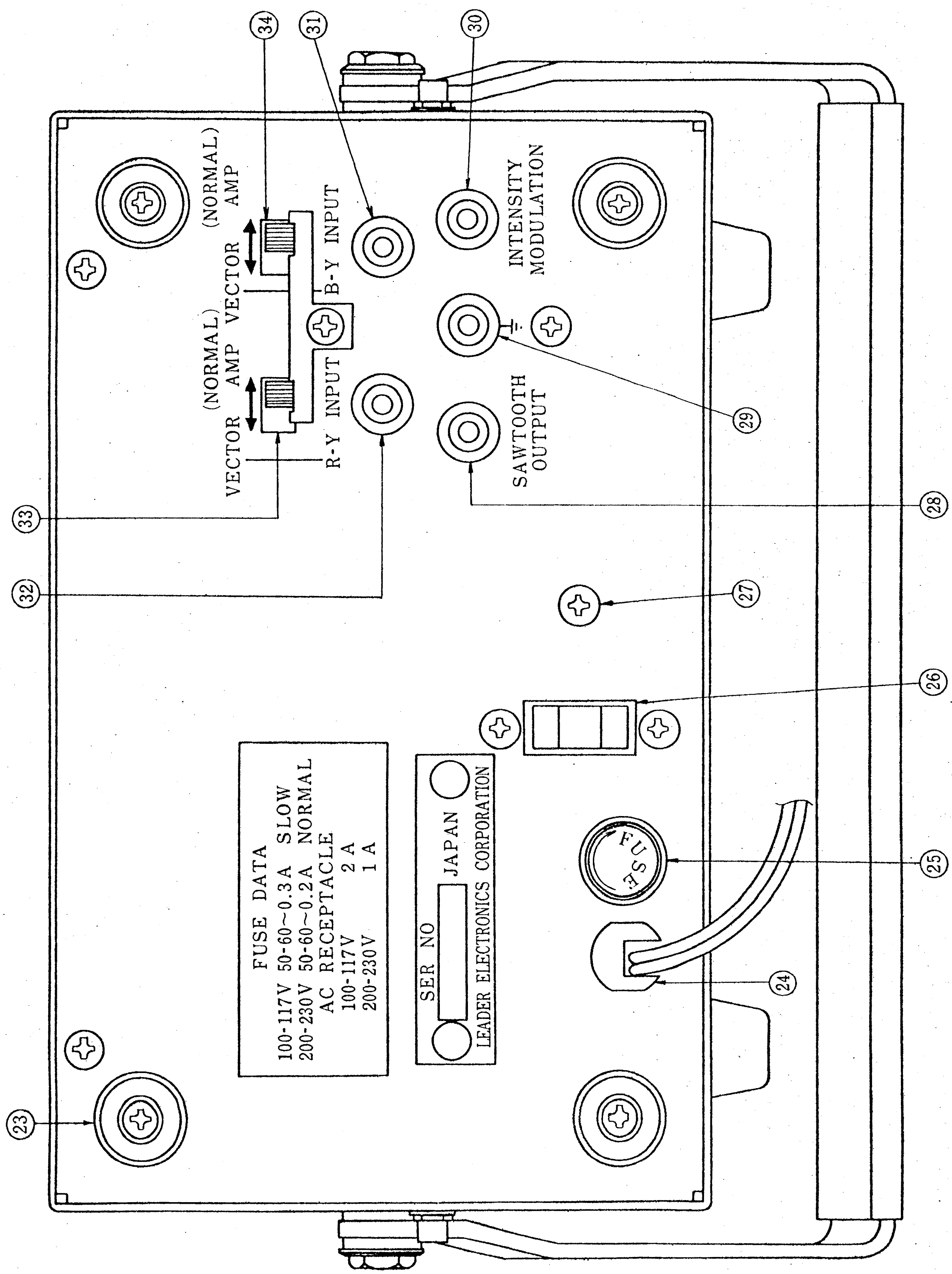


Fig. 2-2 Rear panel controls.

23.	Standoffs	For vertical operation and storing AC cord in transit.
24.	AC cord	For connection to the AC line.
25.	Fuseholder	For insertion of the AC line fuse. (Refer to par 3.2)
26.	AC RECEPTACLE	Outlet for direct power connection to auxiliary equipment, independent of power switch and line fuse; indicated current rating not to be exceeded.
27.	Grounding screw	For connection to grounding lead when the three-lead AC adapter is used.
28.	SAWTOOTH OUTPUT	Sawtooth voltage used in the internal sweep at TIME/DIV is available at this jack; amplitude is constant at approximately 10 Vp-p.
29.	Jack	Common ground.
30.	INTENSITY MODULATION	For connection to an external pulse source for modulation of the CRT beam.
31. 32.	B-Y INPUT, R-Y INPUT	For connections from B-Y and R-Y terminals at the color CRT in the vecotrscope application.
33. 34.	VECTOR - AMP	Two switches set at VECTOR positions only when displaying the vector color bar pattern; nomally set at AMP in waveform application. By loosening the screw on the clamp, both switches can be slid in position.

3. OPERATION

3.1 General

The LBO–301 differs from the general purpose scopes in some respects, mainly in the sweep action. Instead of varying the sweep frequency, the time function is used whereby the input signal waveform will be "spread out" in terms of time. The sweep is triggered by the input signal, or external source and the display starts with its application. In addition it is possible to set the point on the input waveform at which the sweep starts. The free-running state, similar to the conventional sweep with synchronization, is employed when the trigger level control is set to the automatic position.

Directions are given in this section for the various application of this scope.

3.2 Preliminary Notes

A. AC Line Voltage.

The scope is designed to operate within ± 10 % of the rated AC input voltage. Higher voltage may overload the internal power supply and cause damage to the components; lower voltage will result in subnormal operation.

Rated and usable voltages ranges are shown in the chart.

Rated, V	Range, V	Fuse
100	90 ~ 110	0.3 A, slow–blow
115	105 ~ 125	
200	180 ~ 220	0.2 A. normal blow
215	195 ~ 235	
230	210 ~ 250	

The primary winding of the power transformer is tapped for different voltage connections as shown in the schematic.

B. Input Overloading.

The maximum input voltage rating at the vertical INPUT, EXT H or TRIG IN and the low-cap probe is 600 Vp-p+DCV. Exccess voltage may damage or burn out the components in circuit.

Typical examples of the 600V maximum condition are shown in Fig. 3-1.

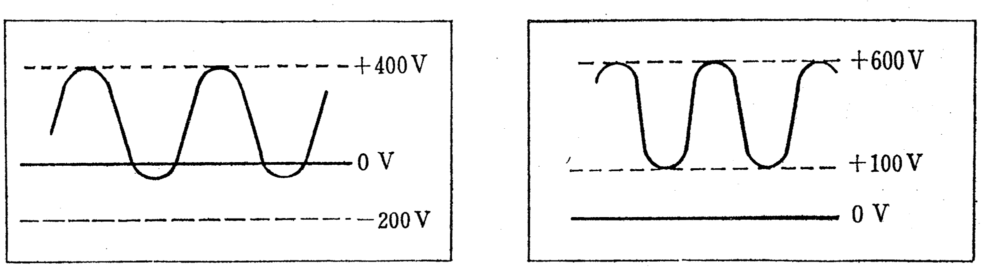


Fig. 3-1 600 V maximum conditions.

C. Control of CRT Spot Brightness.

When the CRT deam is concentrated on the screen, there is a possibility of burning that particular area. The INTENsity control should be adjusted to dim or, cut off during standby periods, or, the beam must be kept in motion with application of the sweep, by setting the TRIG LEVEL control at AUTO (switched). This reduces the "ion burn" effect.

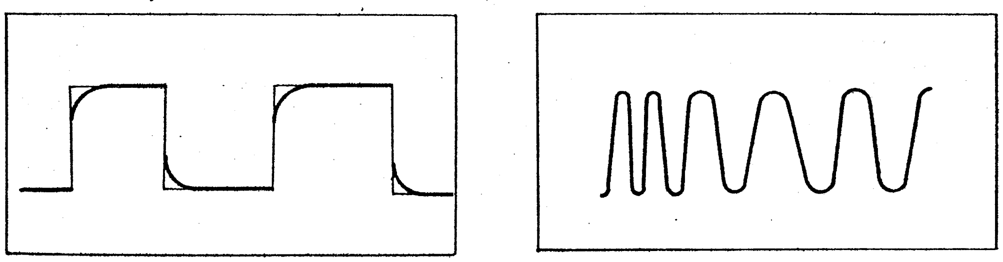
D. Influence of Magnetic Fields.

1. A slight horizontal tilt in the display may be detected, depending on the location where the scope is used. This is caused by the influence of the earth's magnetic field or other magnetic effects which may distort the display. When the amount of this tilt is objectionable, the scope should be oriented for compensation. Alternatively, the graticule can be shifted slightly by loosening the screws holding the hood in place.

2. When in the vicinity of strong magnetic fields, such as equipment using power transformers of 200 VA or more, AC induction may produce distorted displays, and the beam may possibly be permanently misdirected. In this event, the whole frame should be demagnetized with a lerge type degausser designed for color TV use. (Keep "gun type" soldering irons away from the scope.)

E. VECTOR - AMP (NORMAL) Switches.

At the VECTOR setting, the scope is used in the vectorscope application only. It is to be noted that the waveform display at this setting will be distorted or the sweep linearity will be degraded, see examples in Fig. 3-2.



R-Y Switch on B-Y switch on

Fig. 3-2 Waveform display at VECTOR switch settings.

3.3 Preparation

1. Set the PWR switch at off (down).
2. Remove the AC cord from the standoffs at back of cabinet. Connet the plug to the AC line after marking certain that the voltage is at the rated value for the scope.
3. Control settings :
   a. Positioning knobs, vertical and horizontal, with white bar at top.
   b. TRIG LEVEL control, fully counterclockwise, at the AUTO position (switched).
   c. TRIG SOURCE switch at INT.
   d. TRIG SLOPE switch at +.
   e. VOLTS/DIV switch (black knob) at 0.1 and VARIABLE (red knob) at CAL'D (switched).
   f. AC-DC-GND switch at AC.
   g. TIME/DIV switch (black knob) at 1ms and VARIABLE (red knob) at fully clockwise (CAL'D).
   h. INTENsity and FOCUS with white bar at top.
   i. Rear panel switches :

      AMP-VECTOR-both switches-at AMP.

4. Initial adjustments :

Set the PWR switch at ON, the pilot lamp will light.

After about 30 seconds, a trace will be observed on the screen ; allow a few minutes for stabilization.

Adjust the FOCUS and INTENsity controls for a clear trace.

5. Connect the 0.5 Vp-p output to the vertical INPUT.

A square waveform will be displayed covering 5 vertical division on the scale. This serves as a check on the operation.

6. Disconnect the lead.

3.4 Connections

Connect leads from the vertical input and ground terminal to the signal pickup point.

NOTE : When the low-cap probe is connected and used, the voltage at the INPUT connector is lowered by a factor of 10.

3.5 AUTOmatic Sweep Mode

The AUTOmatic mode of operation is characterized by synchronizing the time base with the input signal and the trace is always displayed. At fast sweep speeds, the trace becomes somewhat dim but normal brightness is restored when the signal is applied.

1. Control settings :

a. TRIG LEVEL at AUTO (switched), see Fig. 3-3.

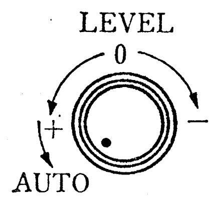


Fig. 3-3. TRIG LEVEL setting for AUTOmatic sweep mode.

b. VOLTS/DIV for suitable trace amplitude, VALIABLE control at CAL'D (switched).

c. TRIG SOURCE at INT.

d. TRIG SLOPE at +.

e. TIME/DIV for desired number cycles.

VARIABLE at CAL'D (fully clockwise). When the sweep timing is not important, this control can be adjusted as required.

NOTES : 1. In the AUTOmatic mode, the trace is always displayed and the sweep will start at approximately the middle of the waveform. The "direction" at the start depends on the setting of the TRIG SLOPE switch. The conditions are shown in Fig. 3-4. If the sweep is not stable, change the TRIG SLOPE switch setting.

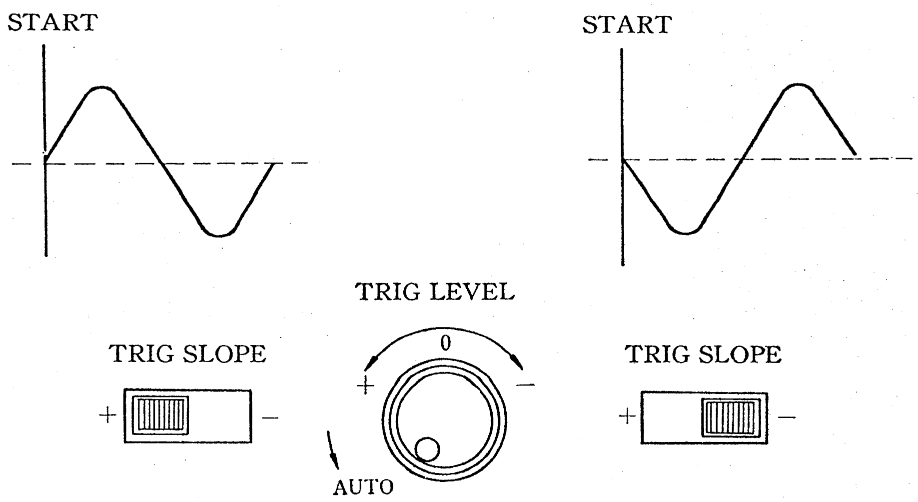


Fig. 3-4. AUTOmatic sweep operation.

2. The sweep will be synchronized with the input signal when the displayed amplitude is 1 div. or more, depending on the frequency.
3. When the VARIABLE knob of TIME/DIV is at CAL'D, the trace (sine wave for example) may have a part cut off at the right hand side. This is a normal condition since the waveform frequency may not be in proper relation with the calibrated sweep speed. If the timing is not important, adjust the VARIABLE control.
4. When synchronizing with an external source, connections are made to TRIG IN with the TRIG SOURCE switch set to EXT.

3. 6 Triggered Sweep Mode

The use of the TRIGger LEVEL control in triggering the sweep will be described, The setting of the controls is the same as for the AUTOmatic mode outlined in Sect. 3.5 above.

It is possible to vary the starting point (at left) in the displayed wavefom with rotation of the TRIG LEVEL control. The "direction" at the start will depend on the setting of the TRIG SLOPE switch, + or −.

The conditions are shown in Fig. 3-5 and Fig. 3-6 respectively.

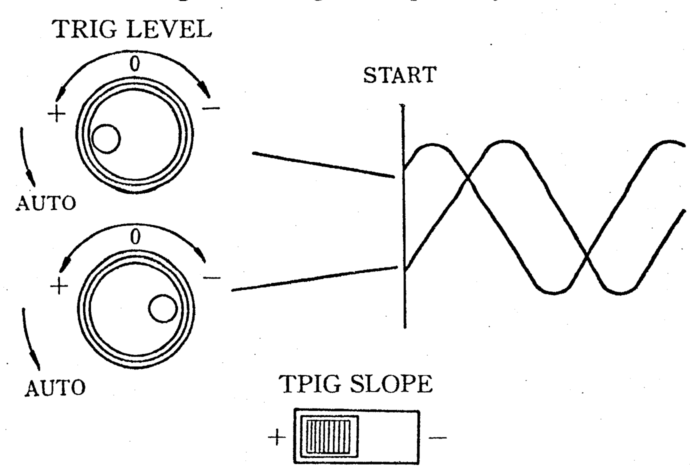


Fig. 3-5 Start of display with TRIG LEVEL control and TRIG SLOPE at +.

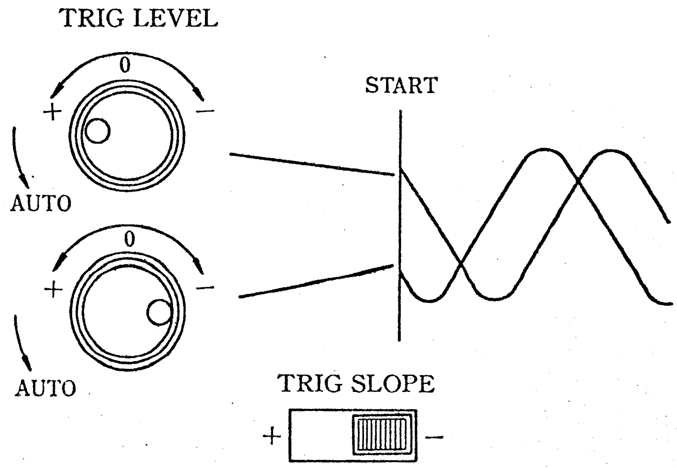


Fig. 3-6 Start of display with TRIG LEVEL control and TRIG SLOPE at −.

NOTES : 1. When there is no display, rotate the TRIG LEVEL knob in both directions. The trace will not appear when there is no input signal. This can be checked by touching thc "hot" input lead with a finger. (At the AUTO or switched position, the horizontal trace will appear to serve as a check on the sweep.)

2. It is important to note that the control action is effective only at that portion in the waveform where the amlitude is changing, namely, increasing or decreasing. There will be no control at the peak or trough of sine waves or at the flat part of square waveforms. When the trace amplitude is insufficient, the display will disappear, and synchronization will not occur.

3.7 Sweep Magnification

When it is desired to investigate a certain portion in the displayed waveform, the PULL MAG ×5 knob (same as the horizontal positioning control) is pulled forward. The display will be magnified, or expanded, by five times. This is done in the following manner.

1. Position the portion of the waveform under investigation to the center vertical line on the graticule.
2. Pull forward the MAG ×5 knob, see Fig. 3-7.

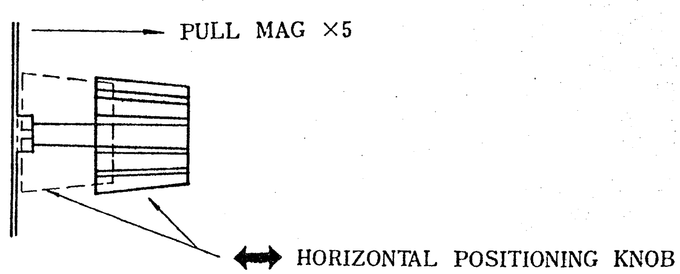


Fig. 3-7 Position of MAG ×5 knob in use.

3. The sweep time will be 1/5 (one-fifth) of that marked for the speed in DIV with the VARIABLE knob at CAL'D (fully clokwise). In Fig. 3-8, Ⓐ and Ⓑ show the normal and magnified waveforms respectively.

For example, when the setting is at 1 μs/DIV the sweep speed is 1/5 × 1 μs/DIV or 0.2 μs per division, etc.

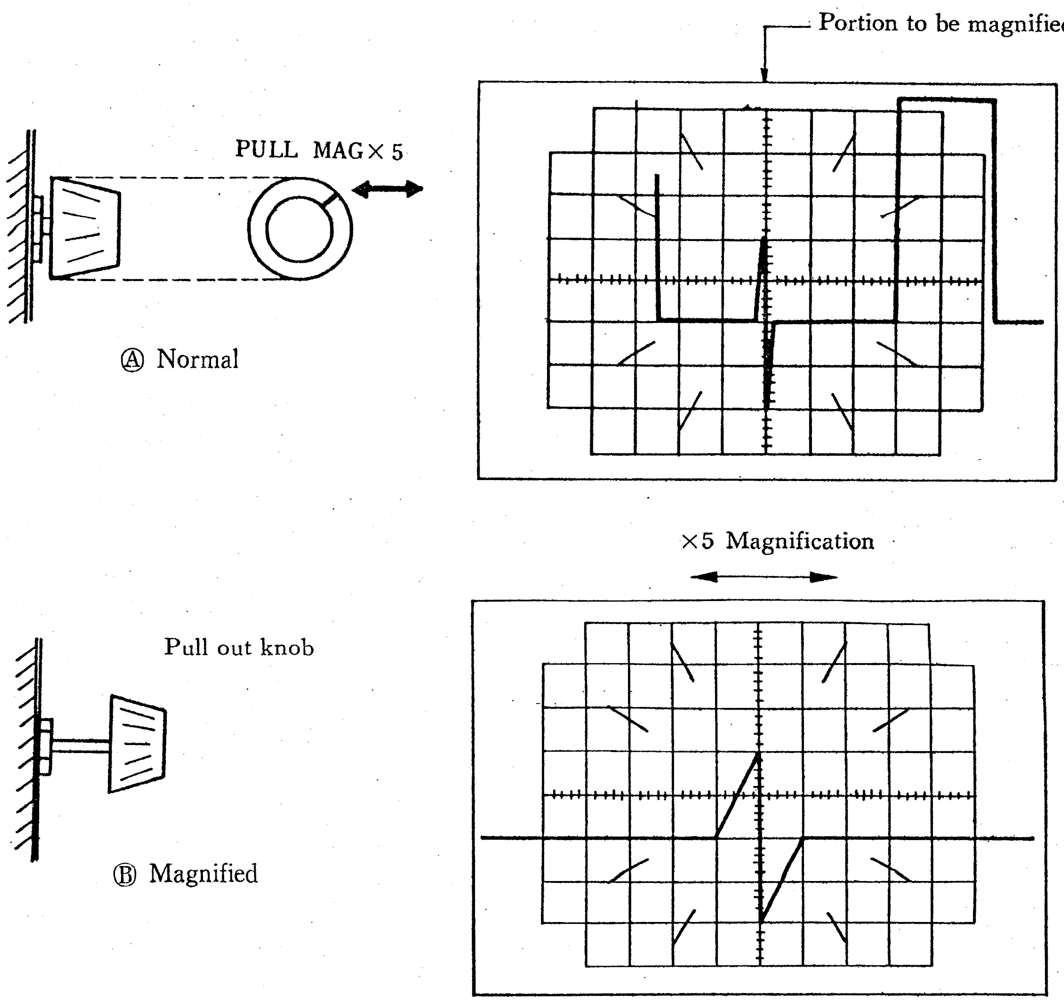


Fig. 3-8 Use of ×5 magnification.

4. After its use, the knob should be pushed in to the former position. This will prevent error in other measurements.

3.8 Triggering from an External Source

The sweep can be triggered with an external synchronizing signal when its frequency is the same or integrally related with the signal under investigation. This feature is useful when testing circuits such as pulse generators and multivibrators where the waveforms of the output and input are different.

In this application the controls are set as follows :

TRIG LEVEL to AUTO (switched).
Vertical AC–DC–GND switch to AC.
TRIG SLOPE switch to + or −, depending on the predominant peak.
TRIG SOURCE switch to EXT.

The triggering signal is connected from the sync signal source to the EXT H or TRIG IN jacks. The voltage should be in the 0.1 to 2 Vp-p range; if higher, it must be lowered with an external voltage divider, typically with a 10 K resistor across the input jacks and an appropriate series resistor, see Fig. 3-9.

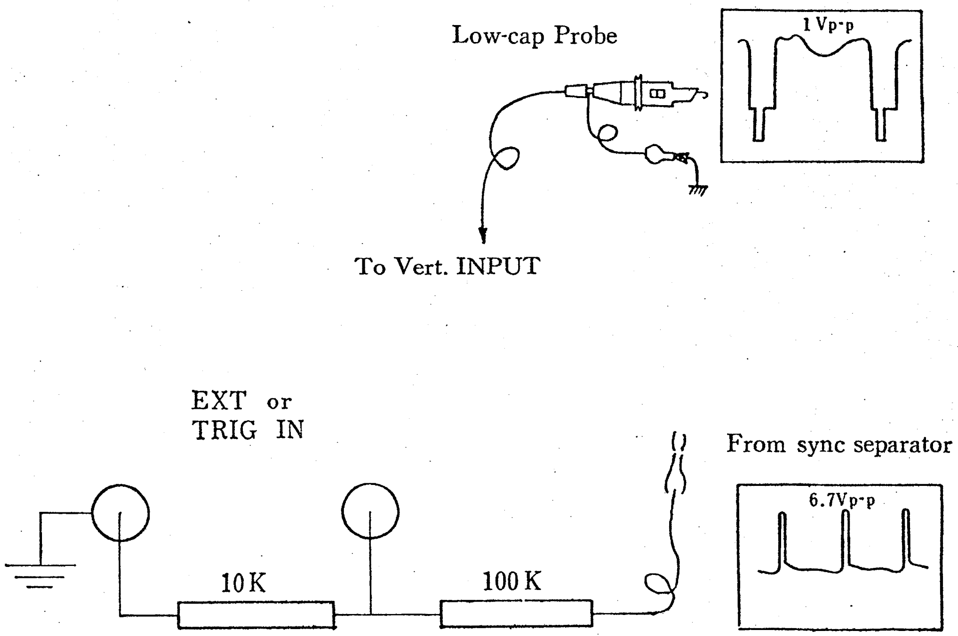


Fig. 3-9 Use of voltage divider at TRIG IN.

The connection to the INPUT is made direct or through the low-cap probe.

When a sine wave signal is used in triggering, it is possible to position the pulse(s) with adjustment of the TRIG LEVEL control. With proper adjustment, an action corresponding to use of a delayed sweep is achieved.

3.9 Vertical and Horizontal Sweep for TV Signals

Vertical and horizontal signals in the TV receiver circuits are displayed by setting the TIME/DIV switch at TV–V and TV–H respectively. The sweep timing is preset to display two "cycles" of the waveforms automatically. (Note: The VARIABLE control is inoperative.) The low-cap probe is connected at the test point designated in the manufacturer's service instructions.

In operation, the TRIG LEVEL control is adjusted for maximum stability. At TV–V, for best synchronization. this control is set at the point where the display is extinguished. (Note: There may be a momentary disappearance in the display caused by changes in the brightness of the image in the TV screen; this is due to the blocking capacitor in circuit and is a normal condition.)

3.10 Color TV Waveforms

To display the waveforms in the color TV receiver, a color bar pattern generator such as the LEADER LCG–384, –388, –389, –390 or equivalent is required.

In using the patterns available from the pattern generator, refer to specific directions for connections and adjustments in the manufacturer's servicing information for the particular receiver model.

The gated rainbow pattern is shown in Fig. 3-10.

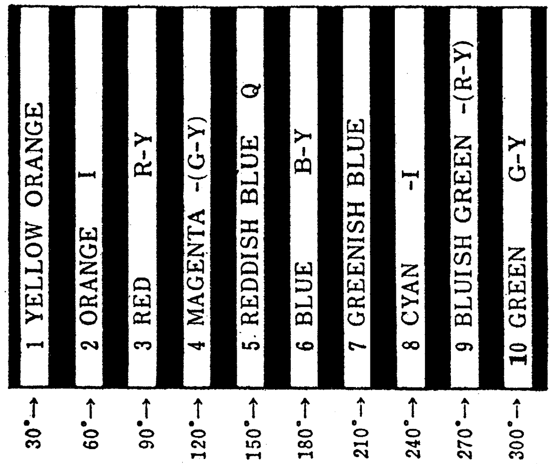


Fig. 3-10 Gated rainbow pattern.

Waveforms of the gated rainbow signal are shown Fig. 3-11. (Note : The waveforms will be inverted in the cathode modulation system.)

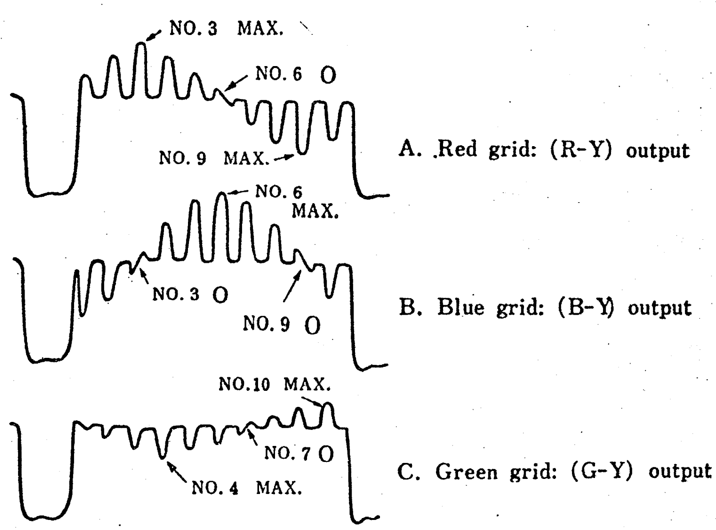


Fig. 3-11 Gated rainbow signal waveforms.

3. 11 **VECTORSCOPE Application**

The VECTOR connections are used to display color signal characteristics in vector form.

A color bar pattern generator, as noted in Section 3. 10 above is required.

Phase relationships in the gated rainbow signal are shown in Fig' 3-12.

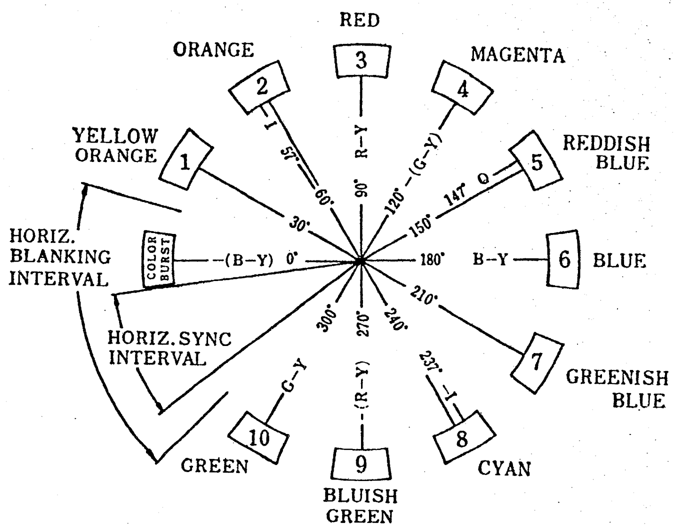


Fig. 3-12 Phase relationships in the gated rainbow signal

In operation, all external connections, if any are disconnected on the front panel.

Switches and controls are set as follows :

VOLTS/DIV switch to 5 V.
AC-DC-GND switch to GND.
TIME/DIV switch at H IN.
Others at any setting.

At the back of the cabinet, loosen the clamp screw of the VECTOR - AMP switches and slide the switches to the VECTOR position.

2. Color TV receiver connections :

IMPORTANT !! Turn off the AC power switch in the receiver.

a. RF output with keyed or gated rainbow pattern from generator to the TV antenna input.

b. Connect leads from chassis to scope ground and R-Y and B-Y grid terminals on the CRT to respctive jacks at the back of the scope, see Fig. 3-13.

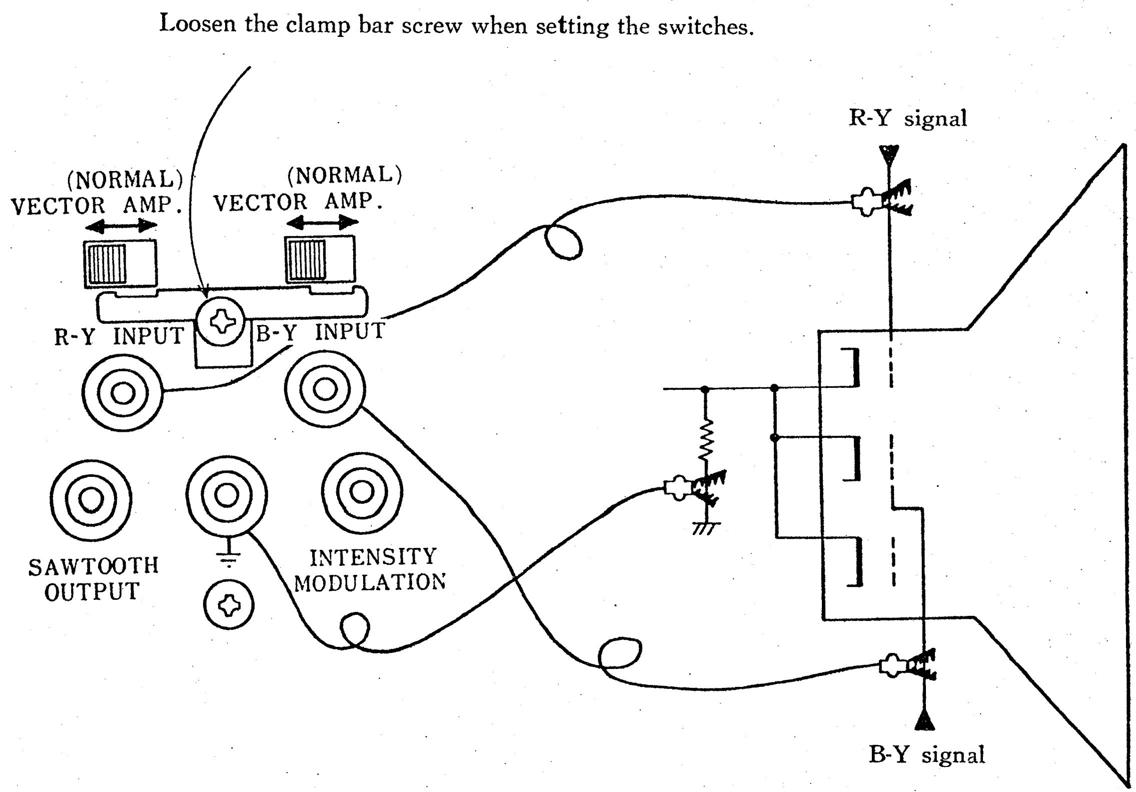
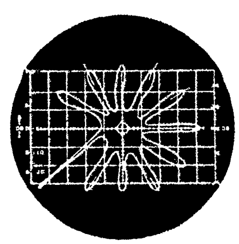


Fig. 3-13 VECTORSCOPE connection

c. Turn on the power switch in the receiver.

3. Center the display with the positioning controls.
4. Set th tint or hue control in the receiver to line up the lobes with the 30° markings on the graticule, Fig. 3-14.



Fig' 3-14 Vector pattern display.

If the pattern is not "round" or lobes are distorted, the color saturation control is not adjusted properly.

5. After the test, turn off the AC power in the receiver before disconnecting the leads.
Set the VECTOR-AMP switches at AMP and tighten the clamp screw.

3.12 Voltage Measurements

3.12.1 General

The p-p, or peak-to-peak, voltage of AC waveforms and DC voltage can be measured by using the scope as a voltmeter. The AC voltage can be measured simultaneously with waveform observation.

The initial conditions for measurements are as follows :

a. With no sweep and TIME/DIV switch at lms, the INTENsity control is set to barely cxtinguish the spot.

b. The AC line voltage must be at or within $\pm 10\%$ of the rating.

c. The VARIABLE knob of VOLTS/DIV is set at CAL'D (switched).
This is important.

3.12.2 AC Voltage

1. AC–DC–GND switch setting :
    a. AC or DC when there is no superimposed DC.
    b. AC when DC voltage is superimposed.
2. Panel controls are set for waveform observation.
Set the VOLTS/DIV switch so that the peaks lie in the space between the top and bottom horizontal lines on the graticule. For sine and similar waveforms, position the trace symmetrically with respect to the center horizontal line.
3. The p-p voltage is determined by the following relation :

$$\text{(No. of div)} \times \text{(VOLTS/DIV)} = \text{Vp-p.}$$

When the low-cap probe, LPB–10Y, is used, multiply the result by 10.
The "No. of div" is the distance between peaks, see Fig. 3-15.

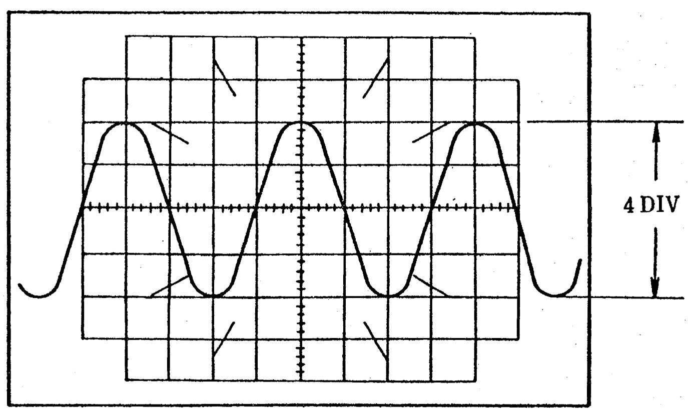


Fig. 3-15 Peak-to-peak voltage measurement.

Example : Amplitude is 4 div and VOLTS/DIV is at 1V, then

$$(4 \text{ div}) \times 1\text{ V} = 4\text{ Vp-p}$$

For sine waves, the p-p voltage is $2.83 \times$ Vrms and

$$\text{Vrms} = \frac{\text{p-p Volt(s)}}{2.83}$$

In the above example, for a sine wave, the rms value is $4 \text{ Vp-p}/2.83 = 1.41$ Vrms.

NOTE : In measurements of high frequency voltages, the bandwidth characteristic must be taken into account. There will be a gradual falling off effect above approximately 3 MHz.

12.3 DC Voltage

1. Control settings:
   a. TRIG LEVEL control to CAL'D (switched)
   b. TIME/DIV switch to 1ms.
   c. AC–DC–GND switch to GND.
   d. Vertical positioning control to set the trace on the middle horizontal line for initial 0 reference. If the polarity is known beforehand, i.e. where the INPUT lead or probe is connected, this reference can be on one of the lines above or below the middle; a wider range of measurement is possible.
   c. VOLTS/DIV switch to 2 or 5; VARIABLE to CAL'D (switched).
2. Connect the voltage under measurement to vertical INPUT, and ground terminal.
3. Set the AC–DC–GND switch to DC.
4. Adjust the VOLTS/DIV switch to set the trace within the vertical scale lines on the graticule.
   The amount of trace shift above or below the reference line determines the voltage.
   The polarity is positive (+) for an upward shift and vice versa.
5. The voltage is the sift in number of div multiplied by VOLTS/DIV. When the low-cap probe, LPB–10Y, is used, multiply the result by 10.

3.12.4 Composite Waveform Voltage.

Measurement of the AC and "DC" components in TV signals can be made by setting up the scope initially for DC voltage input mode. The signal is then applied and the proper sweep timing is selected.

For example, the input waveform in Fig. 3-16, is displayed on the scope as shown in Fig. 3-17. The magnitude of the different portions in the waveform is calculated by noting the number of div referred to the 0 center and multiplying by the setting of the VOLTS/DIV switch, see Fig. 3-17.

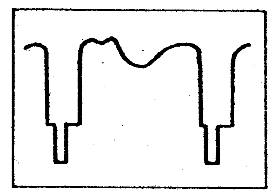


Fig. 3-16 Composite waveform.

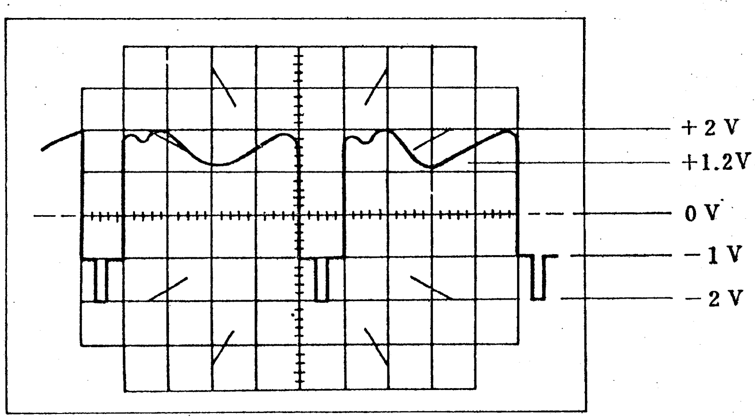


Fig. 3-17 Example of composite waveform voltage.

3.13 Time Measurements

3.13.1 General

The time element which plays an important role in nonsinusoidal waveforms, especially pulse, sawtooth waveforms, etc., can be readily measured with the TIME/DIV calibration.

In the measurements described below, the VARIABLE knob of TIME/DIV must be at the CAL'D position, or fully clockwise ; this is important.

3.13.2 Pu!se Rise time

1. The pulse under test is displayed with adjustment of the appropriate controls. Unless the actual amplitude is measured at the same time, it is advisable to use the VARIABLE control on VOLTS/DIV switch to set the pulse height to cover 4 div, Fig. 3-19.
2. Referring to the figure, the leading edge is positioned to set the 10% level at 2 minor divs. and the 90% level at 2 minor divs below the upper limit.

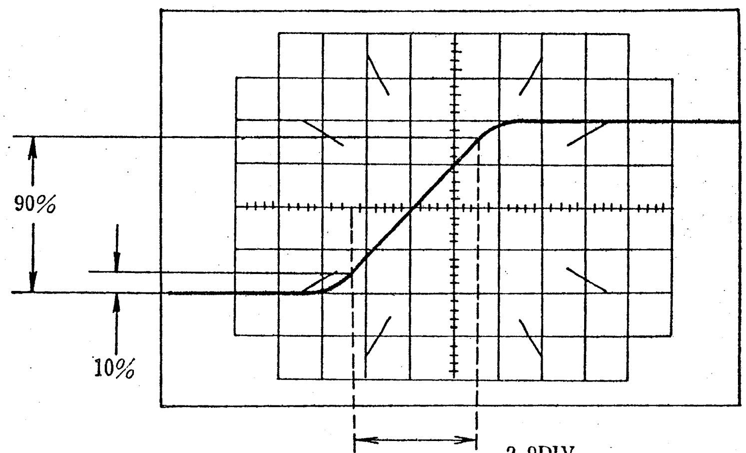


Fig. 3-18 Rise time measurement.

3. The horizontal distance between the 10% and 90% levels correspond to Tr, or rise time, and is determined from th relation

$$(\text{No. of div}) \times (\text{TIME/DIV in } \mu s, \text{ ms or s}) = \text{Tr}.$$

where (No. of div) is the distance.

Example : No. of div is 2.9 and TIME/DIV is 2 μs, then

$$\text{Tr} = 2.9 \times 2\,\mu s. = 5.8\,\mu s.$$

If the ×5 magnification is used, Tr = 1.16 μs.

NOTES : a. When pulses of relatively fast rise time are under measurement, the rise time in the LBO-301 must be taken into account ; this time is approximately 0.07 μs.

The relations are :

Let Ta = rise time of LBO-301

Ti = rise time of input waveform

Tr = measured rise time

Then

$$Tr = \sqrt{Ti^2 + Ta^2}$$

and

$$Ti = \sqrt{Ti^2 - Ta^2}$$

b. It is possible to estimate the upper frequency limit, or −3 dB point, in amplifiers, filters, etc., with the rise time mersurement. This is done by applying a well-define pulse from a pulse generator to the test circuit.

The relation is

$$fc = \frac{0.35}{Tr}$$

where fc = frequency at −3 dB point, and
Tr = rise time of input waveform.

Use the following units for different ranges.

fc	Tr
Hz	s
kHz	ms
MHz	μs

Example : Tr = 15μs, or 0.015 ms, then
fc = 23.3 kHz (0.35/0.015).

3.13.2 Pulse Width

Pulse width detemination is dependent on the level, flat top, 90%, 50%, etc., where the measurement is made. In the measurements, see the VARIABLE control of TIME/DIV at the CAL'D position (fully clockwise).

After the pulse amplitude measurement, set the height with VARIABLE of VOLTS/DIV to cover 4 div on the vertical scale. Position the pulse to set the left end of the flat top, 90% or 50% point on one of the vertical lines, see Fig. 3-19.

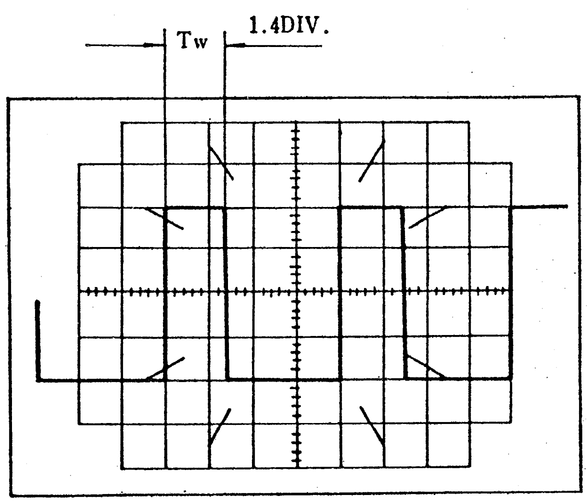


Fig. 3-19 Pulse width measurement.

Measure the distance in div to the corresponding point on the trailing edge.
The pulse width, Tw, is

(No. of div) × TIME/DIV.

Example : No. of div = 1.4 and time is 1 ms ; the pulse width is

$$Tw = 1.4 \times 1 = 1.4 \text{ ms.}$$

If the ×5 magnification is used, Tw = 0.28 ms.

3.14 Frequency Measurements

The frequency of the input waveform is measured using the TIME/DIV calibration. It is important that the VARIABLE knob is set at the CAL'D position (fully clockwise).

The procedure is similar to that for time measurements described in Section 3. 13 above. The difference is that distance covered by one cycle is measured as shown in Fig. 3-20.

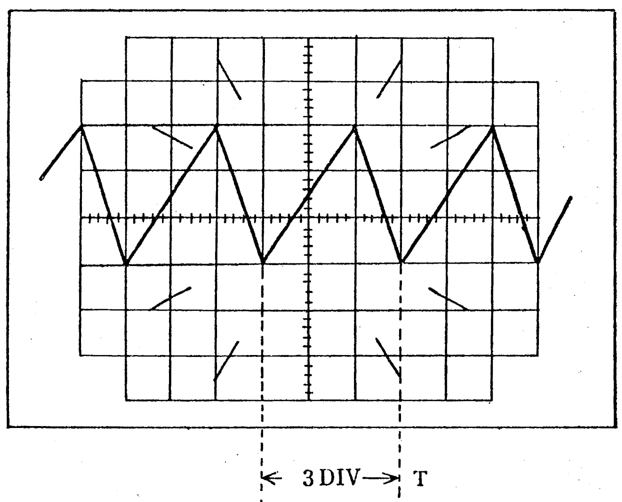


Fig. 3-20 Frequency measurement.

The frequency is given by the relation

$f = \frac{1}{T}$ where T is the distance per one complete cycle multiplied by the sweep per div, or

$$f = \frac{1}{(\text{Distance in div}) \times (\text{TIME/DIV})} \text{ Hz.}$$

Example : Distance = 3 div.
TIME/DIV = 50 μs, and T = 150 μs.
frequency, f = 1/150 μs = 6.7 kHz.

15 External Sweep Signal Input

When the scope is used without using the internal sweep, an external sweep input is connected to the EXT H input jack. Visual alignment, frequency comparison using Lissajous patterns and other applications are possible.

In operation, the TIME/DIV switch is set to H IN. The VARIABLE control is used in the amplitude adjustment. Approximately 1 Vp-p input is repuired for 1 div deflection. Higher sensitivities are possible with use of the ×5 magnifier.

Typical uses include display of the diode characteristic of zeners, rectifiers, and B-E and C-B connections in transistors.

In Fig. 3-21, connetions are shown for diode testing. The vertical input is set to DC. The series resistor and the AC voltage will depend upon the component under test. Measurements are made in the same manner as for DC voltage, see Section 3. 12. 3.

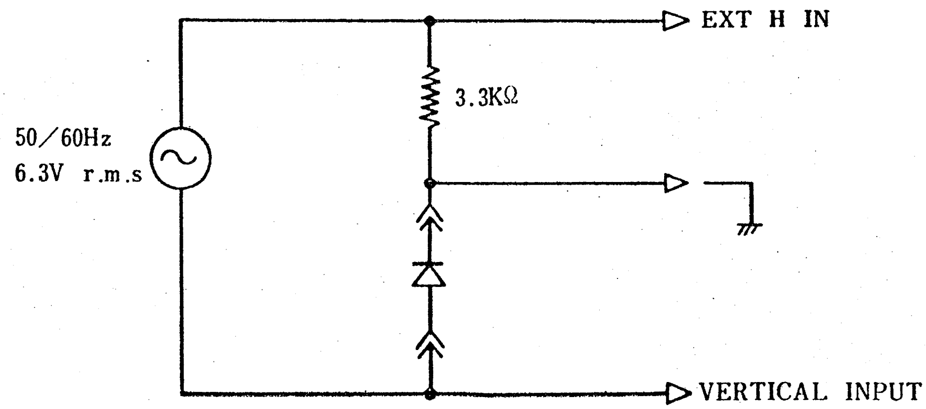


Fig. 3-21 Diode testing.

The characteristic of a 6 volt zener diode is shown in Fig. 3-22. With the VOLTS/DIV switch set to 2 V, the forward and reverse voltages are 0.4 V and 6 V respectively. Switches are set as follows : AC–DC–GND to DC, TRIG SLOPE to +, TRIG SOURCE to INT and TIME/DIV to H IN ; the VARIABLE knob is adjusted for suitable amplitude.

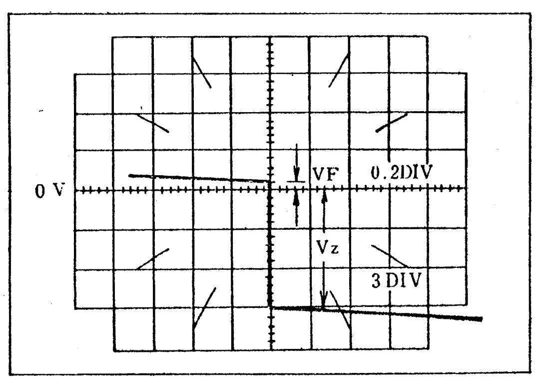


Fig. 3-22 Zener diode characteristic.

3.16 Intensity Modulation

For accurate measurements involving time, the CRT beam cau be "modulated" with external timing pulses. Output from an accurate pulse generator at 5 to 30 Vp-p is connected to the INTENSITY MODULATION jack at the back of the cabinet.

A negative pulse will intensify the beam and vice versa.

In visual circuit aligment procedures, frequency markers in pulse form from the sweep generator can be used.

3.17 Sawtooth Waveform Output

Approximatelv 10 Vp-p sawtooth voltage output, with or without synchronization, in available at the SAWTOOTH OUTPUT jack at the back of the cabinet. Output impedance is approximately 20 kΩ and the load circuit must have high impedance to prevent distortion at the high sweep speeds. The waveform is shown Fig. 3-23.

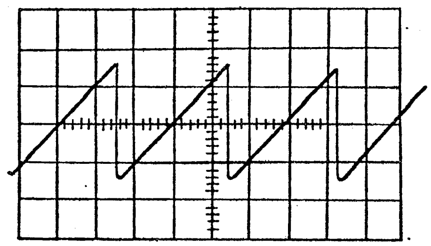


Fig. 3-23 Sawtooth waveform.

This sawtooth voltage has may uses, it can be connected to the horizontal input of scopes not equipped with a sweep circuit, or, for a two-scope operation with "dual-trace" display and a synchronized sweep.

4. CIRCUIT DESCRIPTION

The circuits which compose the LBO-301 will be described briefly in this section. Refer to the block diagram and schematic.

4.1 Vertical Input

The signal under examination at the INPUT connector is applied to the AC—DC–GND switch for AC coupling through a blocking capacitor or is directly coupled (DC). A nine-step attenuator is used to lower the input voltage to suitable levels for amplification. The input voltage in volt per div (division) deflection is adjusted by suitable combination of four frequency-compensated attenuator pads.

4.2 Amplifiers

4.2.1 Vertical

The input stage in an FET, Q501, used as an impedance converter and connected to an emitter follower Q503. A self-balancing paraphase stage, Q505-Q506, is used to produce the pushpull signal to the driver, Q507-Q508 and the CRT deflection stage, Q509-Q510.

To maintain a highly stable DC balanced condition in the input circuit against changes in temperature and supply voltage, two additional transistors, Q502 and Q504, are used; there transistors are matched with the counterparts Q501 and Q503. Adjusters are provided for setting the gate current (VR501) and bias (VR502–VR503). The overall DC balance is set with VR504.

A circuit is provided at the input of Q501 for protection against overvoltage application. Diodes and diode-connected transistors, D501～D506, are used.

The variable gain control, VR506 (on panel) adjusts the feedback in the emitter circuit of Q505–Q509. A shunt "padding" circuit, R516–VR505, limits the control range of VR506 so that linear amplificaton is assured. The positioning is adjusted by unbalancing the base bias in the driver circuit. The triggering sync signal for triggering the time base is picked off at the input of Q510 by Q511. The +12V DC supply voltage to the transistors in the input circuit is derived from the voltage-dropping filter circuit with Q512 in the +27V line.

4.2.2 Horizontal

The operational amplifier configuration. Q803–Q804, is used in the horizontal deflection stage. The amplification is dependent on the ratio of the feedabck and input resistances. The amplitude of the horizontal signals, namely, the sawtooth voltage for the time base and preamplifier output are preset or controlled with adjusters and variable resistors.

The amplifier is single-ended and another identical stage, Q805–Q806, with unity gain is used as a phase inverter for pushpull deflection.

The preamplifier, Q801–Q802, for external horizontal input or triggering signals uses the Darlington circuit in impedance conversion. The input is AC coupled and includes a diode D801 for protection against overvoltage.

The ×5 magnification, pulling the MAG ×5 knob, raises the gain by a factor of five. The spot position is adjusted by varying the bias on the base of Q803.

4.3 Time Base

Control of the triggered sweep with calibrated speeds is accomplished as follows. A triggered signal from the input is picked off at Q510 in the vertical amplifier and through the buffer Q511, then to the polarity changer Q601–Q602. The external triggering is applied from the EXT H or TRIG IN jack. The TRIG LEVEL control, VR601, is for control at any chosen portion of the slope of the triggering waveform. The direction is selected with the TRIG SLOPE switch S601.

A Schmitt trrigger with Q603–Q604 is used for waveshaping and generation of sharp pulses. These pulses are applied to the sweep gating and switching multivibrator made up of Q605–Q606.

Sawtooth waveforms are generated by the Miller integrator consisting of Q608–Q609–Q610–D604–D605. The TIME/DIV switch controls the sweep timing in μs, ms and second per div., TV–V and TV–H by selection of the different RC combinations. The controlled sweep is then fed to the horizontal deflection amplifier.

The holdoff circuit with Q611–Q612–D603–D606 is used to start the sweep with the trigger signal and will keep the sweep in action, i. e., until the sweep is stopped as determined by the preset LENGTH adjuster VR604. The sweep is prevented from starting, or being triggered, until the sweep voltage has dropped to zero.

The pulse for unblanking is picked off at the multivibrator output with Q607. In use, the pulse extinguishes the beam when there is no sweep action in absence of the triggering signal. The signal is applied to the intensity control circuit of the CRT. Note however, that in the AUTO mode, described below, the sweep is in operation and the trace is displayed.

In the AUTO sweep mode, the Schimitt trigger is operated as an astable multivibrator. It is in the free-runningstate at a low frequency but will synchronize readily with an applied signal and trigger the sweep.

The multivibrator is in operation, even with no input signal, the triggering signal at low frequency is present and the trace is always displayed.

4.4 CRT Section

The CRT, V401, is a 3-inch flat-face type operated with an accelerating potential of 1500 V. This voltage is generated in the flyback transfomer circuit with the driver Q401., voltage doubler D401–D402 and filter system. A constant output voltage from the oscillator is maintained by feedback to stabilize the regulator circuit, Q402–Q403–Q406. The operating voltage is set with the adjuster VR401 across the +27V input.

To intensify the beam only when the sweep is in operation, the unblanking action is used. The control signal from Q607 is amplified to apply approximately 70 Vp-p to grid no. 1 of the CRT.

4.5 Voltage Calibrator

The 0.5 Vp-p voltage used in calibration of the vertical sensitivity is generated with a multivibrator Q201–Q202. The square waveform, at 1 kHz is fed to the amplifier Q203. The output voltage is taken off the adjuster VR201 in the collector circuit.

4.6 Power Supplies

The following power supplies are used in the operation :

Type	Output Voltage	Use
Regulated	+ 27 V − 27 V	Amplifier, time base, Voltage calibrator, CRT high voltage generation.
	− 1500 V	CRT acceleration voltage.
Unregulated	+ 130 V	Unblanking circuit (Q404), Astigmatism adjuster, Vertical deflection stage.
	+ 150 V	Horizontal deflection stage.

MAINTENANCE

5. 1 General

In this section, the performance checks and the internal adjustments, when required will be described.

Precautions :

1. Checks should be made after a 30 minute warmup.
2. Care must be exercised not to come in contact with the high voltage, 1500 V approximately, when checking the CRT circuit.
3. Voltage checks at the test points, TP, should be made with the AC line voltage set between 112 and 118V.

5. 2 Exposing the Chassis

The covers are removed by unscrewing the nine screws which hold them to the frame, Fig. 5-1.
When the carrying case is used, the bolts for the handle must be taken off first, Fig. 5-2.

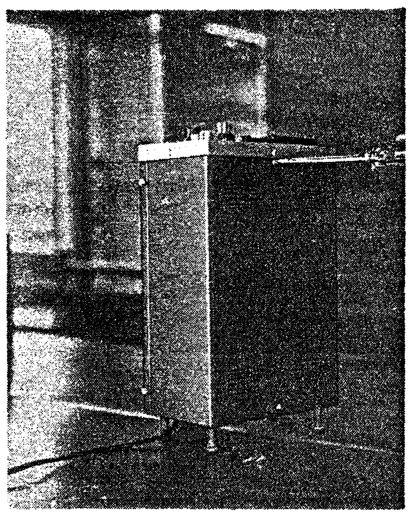


Fig. 5-1 Removing the cover screws.

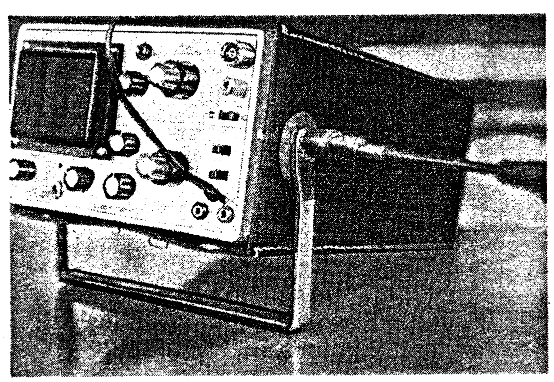
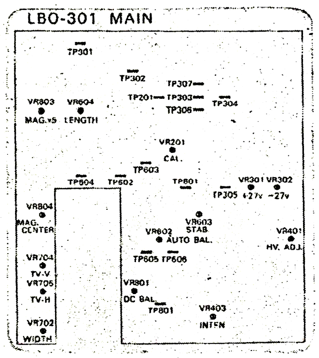


Fig. 5-2. Removing the handle.

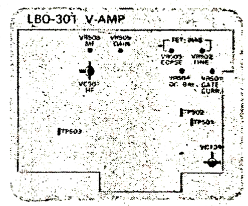
5.3 Location of Adjusters and Test Points

On the inside of the top and bottom covers, labels are pasted which indicate the location of the different adjusters and test points. Prefix "TP" indicates the test points.

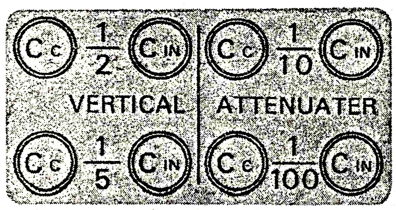
(LBO-301 MAIN label)



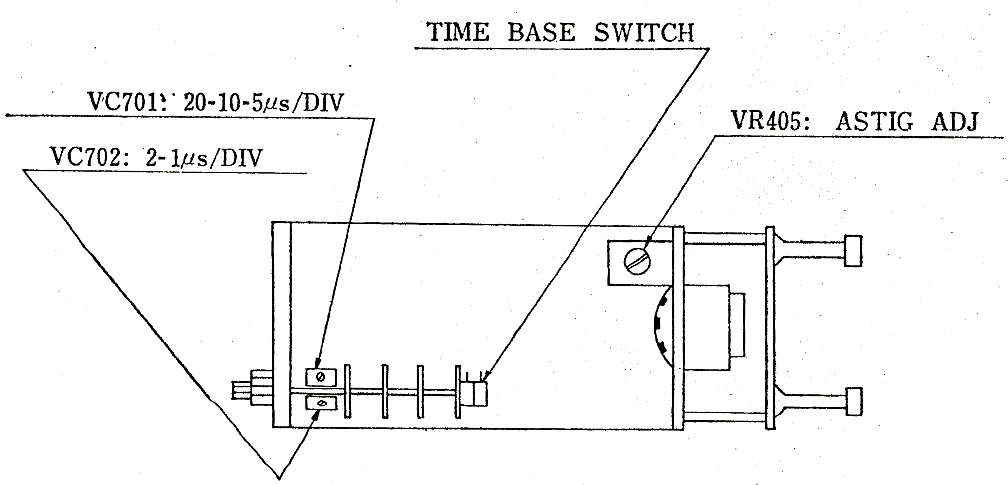
(LBO-301 V-AMP label)



(Attenuator Trimmers, top view label)



(Cut for side view)



CRT Circuit

5. 4. 1 Limited control of spot intensity

If the spot cannot be extinguished or made to appear with the INTENsity control, check the following voltages and adjust if necessary.

TEST POINT	VOLTAGE, V	ADJUSTER
TP 305	+ 27 ± 2	VR301
TP 306	− 27 ± 2	VR302
TP 402	− 1500 ± 100	VR401

Assuming that the voltage are proper, set the controls as follows :

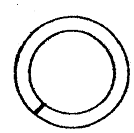
INTENsity as shown at the right

TRIG LEVEL to AUTO (switched)

TIME/DIV to 5 ms

Set the INTEN adjuster to a suitable brightness of the spot.

INTEN



5. 4. 2 Sloping of the horizontal trace

When the axis of the CRT is oriented 360° in the horizontal plane, there may be a slight sloping of the trace from the horizontal, about 0.1 to 0.2 div per 10 div. This amount can be corrected by loosening the hood and adjusting the graticule. (If the sloping is great, then the CRT must be repositioned by loosening the clamp at front of the CRT. CARE!! High voltage, 1500 V approx., is present at the INTENsity and FOCUS controllers and caution must be exercised.)

5. 4.3 Proper focussing cannot be achieved

If at the operating intensity, the vertical or horizontal display is not clear, adjustment is made with the ASTIGmatism adjuster VR405.

NOTE that when adjusted, there is possibility of a slight change, adout 1 %, in the vertical amplifier and time base characteristics.

5. 5 CAL 0. 5 Vp-p Output

The calibration voltage at 0.5 Vp-p can be checked with a digital voltmeter or a scope with accurate voltage calibration.

The proper voltage is 0.5 Vp-p ± 3 %. If necessary, adjust VR201 CAL adjuster.

5. 6 Vertical Amplifier Circuit

5. 6. 1 Improper Square Wave Display

The display of the square wave input should be clear cut. If not, then adjustments must be made using a high grade square generator at about 1 kHz and a capacitance meter. The latter is used adjusting the input capacitance with C_{IN} to 40 pF.

Trimmers for the different attenuator pads are listed in CHART 5-1.

CHART 5-1 ATTENUATOR TRIMMERS

PAD	C_C	C_{IN}
1/2	VC105	VC106
1/5	VC107	VC108
1/10	VC101	VC102
1/100	VC103	VC104

In the adjustments, the steps are made in the order given in CHART 5-2.

CHART 5-2 ORDER OF TRIMMER ADJUSTMENTS

STEP	VOLTS/DIV SETTING	TRIMMERS	
		SQUARE WAVE C_C	FOR 40 pF INPUT CAPACITANCE, C_{IN}
1	0.01		VC109
2	0.02	VC106	VC105
3	0.05	VC108	VC107
4	0.1	VC102	VC101
5	0.2, 0.5	CHECK ONLY	
6	1	VC104	VC103
7	2, 5	CHECK ONLY	

NOTES : 1. The steps in adjustment must not be changed.

2. If equipment for the 40 pF input capacitance measurement is not available, adjust the C_C trimmer only.

5.6.2 Vertical shift when VOLTS/DIV switch is adjusted

Control settings for check :

AC–DC–GND switch to GND.

TIME/DIV switch to AUTO (switched).

Short the VERTICAL INPUT to ground.

Rotate the VOLTS/DIV from 0.01 to 0.1 div.

The vertical shift tolerance is less than 0.1 div.

If the shift is less than about 0.5 div but affect the measurements, correction can be made with the gate current adjuster VR501.

If the shift is over 0.5 div, Ieakage of the order of 5 nA may be present in D503, D504 and Q501 caused by humidity conditions. Check by dring with forced hot air on these components. If the trouble persists, replacment is required.

5. 6. 3 Vertical shift when VARIABLE of VOLTS/DIV is adjusted.

Control settings for check :

AC-DC-GND switch to GND.

TIME/DIV switch to AUTO (switched).

Rotate the VARIABLE control.

The shift should not exceed 1 div.

If the shift is over this amount and affects the measurements, adjustments are required. Note, however, that the sensitivity and bandwidth characteristics are not affected.

STEP 1 Set the VARIABLE knob to fully clockwise.
Note the position of the trace on the scale.

STEP 2 Set the VARIABLE knob to fully counterclockwise.

STEP 3 Adjust VR504 DC BAL adjuster to return the trace to the position in STEP 1.

STEP 4 Repeat STEPS 1, 2 and 3 as required to produce a no shift condition.

5. 6. 4 Compression of veartical trace.

When the displayed waveform is distorted by compression, or "clipping effect" at the peaks, regardless of the vertical positioning control, it is an indication of improper bias on the input FET's Q501 and Q502.

Assuming that the FET's are functioning properly, voltage at TP501 and TP502 shold be 0.5 V. If not within ± 0.3 V of 0.5 V, adjust VR502 and/or VR503. (The voltmeter must have a resistance of 10 kΩ or higher in the range used.)

The voltage at the two points must be the same, otherwise the DC balance will be upset and requires a adjustment of VR504 mentioned in the previous section, 5. 6. 3.

When replacing the FET's Q501 and Q502, a mached pair must be selected in which the drain current I_{DSS} is within ±10%. Typical I_{DSS} is 5 mA at $V_{GS} = 0$ V abd $V_{DS} = 10$ V.

5. 6. 5 VOLTS/DIV calibration is off.

Control settings for check :

TIME/DIV switch to AUTO (switched).

VOLTS/DIV switch to 0.1 V and VARIABLE to CAL'D.

Connect the CAL 0.5 $V_{p\text{-}p}$ to the vertical input.

The trace should cover 5 ±0. 2 vertical divisions. If not adjust VR505 GAIN adjuster for the 5 div amplitude.

5. 7 Time Base Circuit

5. 7. 1 No sync action or no display.

Control setting for check :

TIME/DIV switch to 5 ms.

Faults : 1. Trace cannot be extinguished when the TRIG LEVEL control is rotated fully in the + or − direction.

2. Trace does not apper when the TRIG LEVEL switch is set to AUTO (switched).

Adjustments :

STEP 1. Control settings

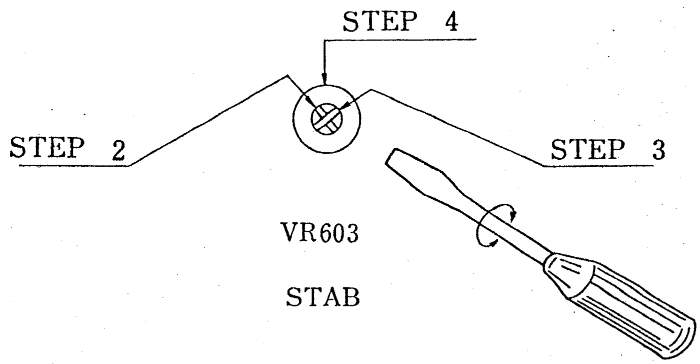
TIME/DIV switch to 5 ms.

AC-DC-GND switch to GND.

STEP 2. Rotate the TRIG LEVEL control to full + or − direction and set VR603 STAB adjuster to the point where the trace just appears.
Note this setting.

STEP 3. Set the TRIG LEVEL control to AUTO (switched) and set VR603 adjuster to the point where the trace just disappears.
Note this setting.

STEP 4. Finally, set VR603 at the position midway between the settings, see Fig. 5-3.



(VR603 and screw driver)

Fig. 5-3 Stability adjustments.

5.7.2 TRIG SLOPE control effective only in one direction, + or −.

Under the AUTO (free running) sync condition, when the TRIG SLOPE control is effective only in the + or − direction, check the voltage at test points TP605 and TP606.

The voltage should be approximately − 7 V at both points. If not, adjust VR602 AUTO BAL adjuster.

5.7.3 Sweep timing incorrect on all ranges.

An accurate time marker or a wideband signal generator is required in the checking.

When there is an error of more than ± 5 % in timing at all ranges, adjust VR702 WIDTH adjuster.

AS shown in Fig. 5-4, the 11th pulse must lie exactly on the 11th vertical line. If the pulse is ±0.5 div off, the error is ± 5 %.

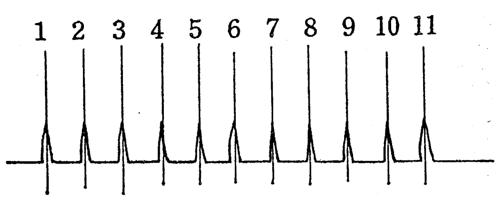


Fig. 5-4 Timing pulse display.

In the calibration, VR702 WIDTH adjuster is set at the point where pulses in the range 0.2 ms to 1 μs are applied at the respective TIME/DIV settings. The final setting of VR702 is made at the averaged point.

When a signal generator (sine wave) is used in the calibration, the adjacent peaks will lie on one division of the scale; refer to CHART 5-3 for the TIME/DIV VS. frequency relationship.

CHART 5-3 TIME/DIV VS. FREQUENCY

TIME/DIV SETTING AND TIME PER CYCLE	FREQUENCY Hz	TIME/DIV SETTING AND TIME PER CYCLE	FREQUENCY Hz
0.2 s	5	0.5 ms	2 k
0.1 s	10	0.2 ms	5 k
50 ms	20	0.1 ms	10 k
20 ms	50	50 μs	20 k
10 ms	100	20 μs	50 k
5 ms	200	10 μs	100 k
2 ms	500	5 μs	200 k
1 ms	1 k	2 μs	500 k
		1 μs	1 M

5.7.4 Sweep timing incorrect on 20-10-5 μs and 2-1 μs ranges only.

When only these ranges are incorrect in timing, adjustments are made in the same manner for the 11-pulse display given in Section 5.7.3 above.

RANGE	ADJUSTER
20–10–5 μs	VC701
2–1 μs	VC702

5.7.5 TV–V and TV–H width adjustment.

At each setting of the TIME/DIV switch, to cycles of the respective TV signals should cover 10 scale divisions. If there is a discrepancy, adjustment is made as shown below.

SETTING	ADJUSTER
TV - V	VR704
TV - H	VR705

Use of two input signals, TV and pulse, is shown in Fig. 5-5.

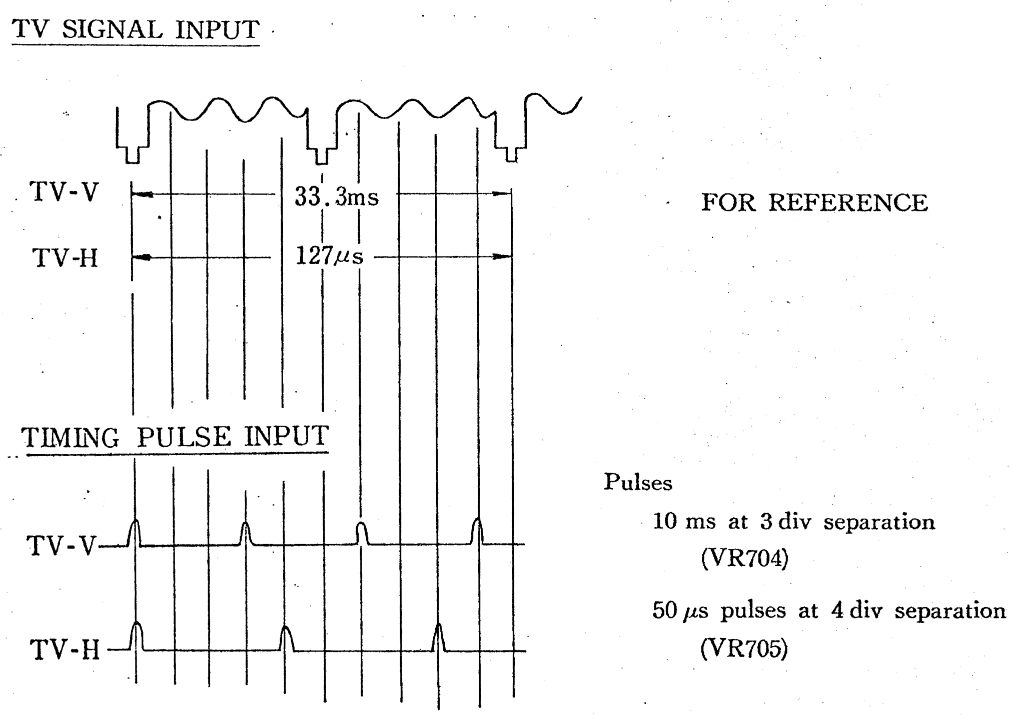


Fig. 5-5 TV–V and TV–H adjustments.

5.7.6 MAG ×5 adjustments.

A. Calibration is off :

When the sweep is not magnified (expanded) properly at five times, adjust VR803 MAG ×5 adjuster.

B. Trace shift at MAG ×5 :

When the portion of the display is centered on the scale but shifts in position by 2 or 3 divisions when the knob is pulled, adjust VR804 MAG CENTER adjuster for centering.

5.7.7 Horizontal shift when VARIABLE at EXT H IN is adjusted.

Connect a signal to the EXT H IN socket and set the Mag ×5 switch to on.

If the trace shifts by more than 2 or three divisions, set VR801 DC BAL adjuster to the point where the shift is eliminated, or minimum.

6. Replacement of CRT

1. Disconnect the AC plug from the AC line.
2. Disconnect the CRT socket.
3. Loosen the clamp at the front rim.
4. Remove the shield holding screw.

Holde the CRT and shield together and after moving them slightly towards the back, pull out both units. Take care that you do not drop the CRT.

7. Removal of Vertical Amplifier PCB for Inspection

1. Remove the screw holding it in place, Fig. 5-6.

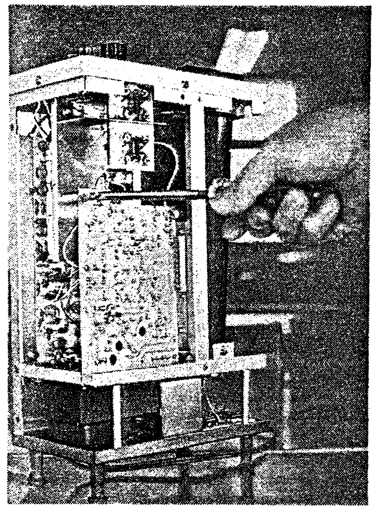


Fig. 5-6 Removing the PCB screw.

2. Disconnect the six connections with pin leades,
   When reconnecting the pins, inspect the contacts for good connection ; reshape the pins if necessary.
3. Remove the PCB from the connector.

8. Shield Plate Removal

When inspecting or checking the time base section, the shield plate between the vertical and horizontal circuits must be removed.

Unscrew the three screws and remove the plate, Fig. 5-7.

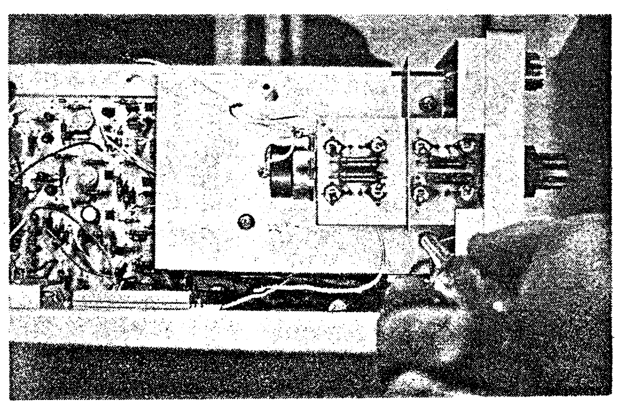
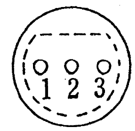
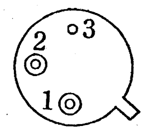
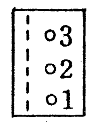
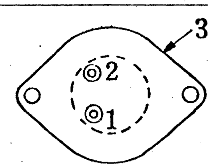
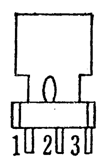
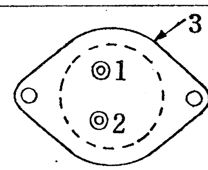
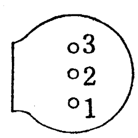
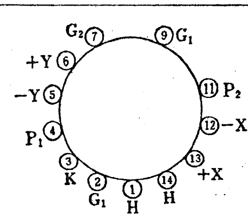


Fig. 5-7 Removing the shield plate.

9. Pin Connections, Transistors and CRT

NAME	TYPE	CONNECTIONS	
2SA561 2SC499	PNP NPN		1. Emitter 2. Collector 3. Base
2SC154C 2SC526	NPN		1. Emitter 2. Base 3. Collector (case)
2SC458	NPN		1. Emitter 2. Collector 3. Base
2SC685A/2SC515 2SC1059	NPN		1. Base 2. Emitter 3. Collector (case)
2SC1013	NPN		1. Collector 2. Base 3. Emitter
2SD150	NPN		1. Emitter 2. Base 3. Collector (case)
2SK34	FET		1. Source 2. Gate 3. Drain
M6525B1B/75AKB1			CRT

Transistors and Checking

Transistors can be checked quickly with an ohmmeter, using the Rx100 or Rx1000 range. (Disconnect the power supply.)

By considering transistors as two diodes with a common connection, tests can be made in the same manner as when determining their quality, see Fig. 5-8.

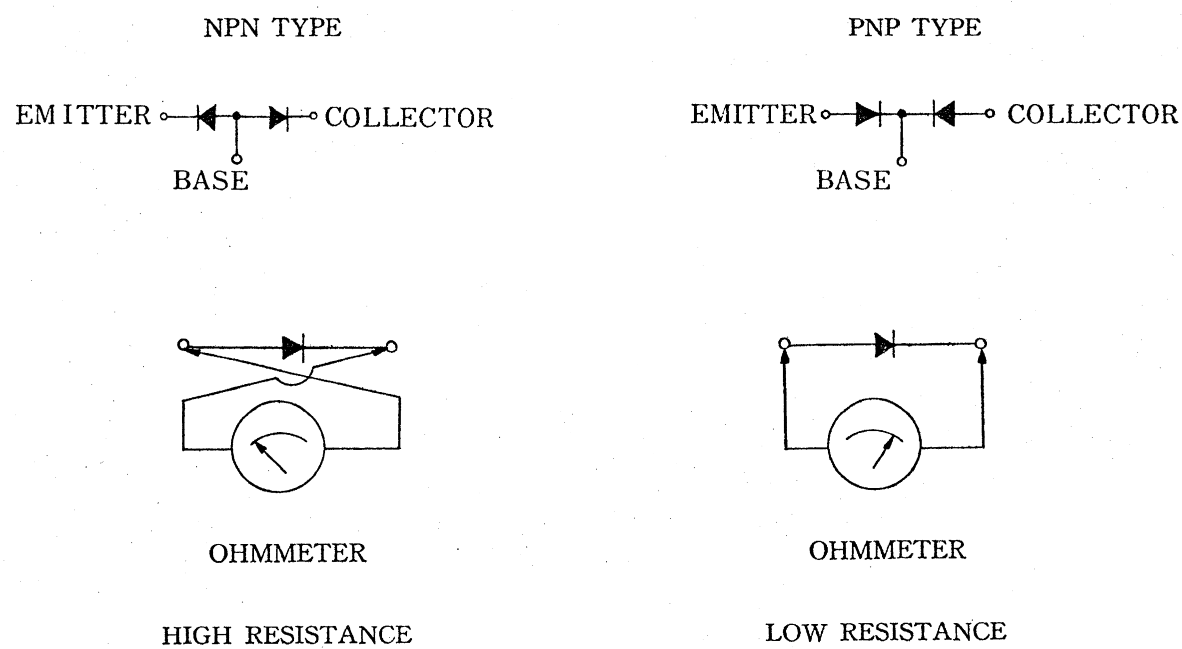
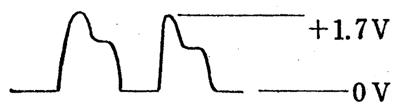
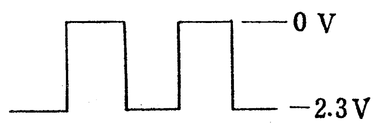
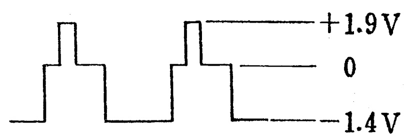
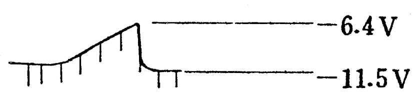
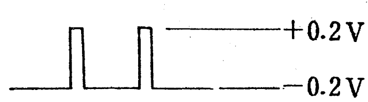


Fig. 5-8 Condition for a good transistor.

11. VOLTAGE AND WAVEFORM CHART

TP No.	VOLTAGE AND WAVEFORM
TP201	+ 6 V
TP301	+ 150 V
TP302	+ 130 V
TP303	+ 40 V
TP304	− 30 V
TP305	+ 27 V
TP306	− 27 V
TP307	− 40 V
TP401	
TP402	− 1500 V
TP505	+ 0.5 V
TP502	+ 0.5 V
TP503	+ 12 V
TP601	
TP602	
TP603	
TP604	
TP605	− 7 V
TP606	− 7 V
TP801	0 V

Name and Number of PCB's

NAME	No.
V ATTenuator	T-353
HV OSCillator	T-377
VECTORSCOPE	T-376
V AMPlifier	T-378
MAIN	T-380

※ Place	Symbol No.	Description			Note
		RESISTORS			
A2	R101	Carbon film	0.25W 33Ω ±10%	RD¼NYK33Ω	
A1	R102	Carbon film	0.5W 900KΩ ±1%	RD½PXF900KΩ	
A1	R103	Carbon film	0.5W 111KΩ ±1%	RD½PXF111KΩ	
A1	R104	Carbon film	0.5W 990KΩ ±1%	RD½PXF990KΩ	
A1	R105	Carbon film	0.5W 10.1KΩ ±1%	RD½PXF10.1KΩ	
A2	R106	Carbon film	0.5W 500KΩ ±1%	RD½PXF500KΩ	
A2	R107	Carbon film	0.5W 1MΩ ±1%	RD½PXF1MΩ	
A2	R108	Carbon film	0.5W 800KΩ ±1%	RD½PXF800KΩ	
A2	R109	Carbon film	0.5W 250KΩ ±1%	RD½PXF250KΩ	
D1	R201	Carbon film	0.25W 4.7KΩ ±10%	RD¼NYK4.7KΩ	
D1	R202	Carbon film	0.25W 100KΩ ±10%	RD¼NYK100KΩ	
D1	R203	Carbon film	0.25W 100KΩ ±10%	RD¼NYK100KΩ	
D1	R204	Carbon film	0.25W 10KΩ ±10%	RD¼NYK10KΩ	
D2	R205	Carbon film	0.25W 8.2KΩ ±10%	RD¼NYK8.2KΩ	
D2	R206	Carbon film	0.25W 82KΩ ±10%	RD¼NYK82KΩ	
D2	R207	Carbon film	0.25W 4.7KΩ ±10%	RD¼NYK4.7KΩ	
D2	R208	Carbon film	0.25W 5.6KΩ ±10%	RD¼NYK5.6KΩ	
D2	R209	Carbon film	0.25W 330Ω ±10%	RD¼NYK330KΩ	
C6	R301	Carbon film	0.25W 150KΩ ±10%	RD¼NYK150KΩ	
C5	R302	Carbon film	0.5W 330Ω ±10%	RD½PZK330Ω	
C5	R303	Metal film	2W 2.2KΩ ±10%	MOR2XPK2.2KΩ	
D5	R304	Carbon film	0.5W 680Ω ±10%	RD½PZK680Ω	
C5	R305	Carbon film	0.25W 1KΩ ±10%	RD¼NYK1KΩ	
C5	R306	Carbon film	0.25W 47Ω ±10%	RD¼NYK47Ω	
C5	R307	Carbon film	0.25W 4.7KΩ ±10%	RD¼NYK4.7Ω	
C5	R308	Carbon film	0.25W 3.9KΩ ±10%	RD¼NYK3.9KΩ	
C5	R309	Carbon film	0.25W 5.6KΩ ±10%	RD¼NYK5.6KΩ	
C5	R310	Carbon film	0.25W 2.2KΩ ±10%	RD¼NYK2.2KΩ	
D5	R311	Carbon film	0.25W 1KΩ ±10%	RD¼NYK1KΩ	
D5	R312	Carbon film	0.25W 47Ω ±10%	RD¼NYK47Ω	
D5	R313	Carbon film	0.25W 4.7KΩ ±10%	RD¼NYK4.7KΩ	
D5	R314	Carbon film	0.25W 6.8KΩ ±10%	RD¼NYK6.8KΩ	
D5	R315	Carbon film	0.25W 6.8KΩ ±10%	RD¼NYK6.8KΩ	
C5	R316	Carbon film	3W 470Ω ±10%	MOR3XPK470Ω	
C4	R401	Carbon film	0.25W 5.6KΩ ±10%	RD¼NYK5.6KΩ	
B4	R402	Carbon film	0.25W 10KΩ ±10%	RD¼NYK10KΩ	
B4	R403	Carbon film	0.25W 10Ω ±10%	RD¼NYK10Ω	
B5	R404	Carbon film	0.25W 820Ω ±10%	RD¼NYK820Ω	
B4	R405	Carbon film	0.25W 100Ω ±10%	RD¼NYK100Ω	
B4	R406	Carbon film	0.25W 560KΩ ±10%	RD¼NYK560KΩ	
B5	R407	Carbon film	0.25W 2.2KΩ ±10%	RD¼NYK2.2KΩ	
B5	R408	Carbon film	0.25W 33KΩ ±10%	RD¼NYK33KΩ	
A5	R409	Carbon film	0.5W 68KΩ ±10%	RD½PZK68KΩ	
B5	R410	Carbon film	1W 1.8MΩ ±5%	RD1PYJ1.8MΩ	
B5	R411	Carbon film	1W 1.8MΩ ±5%	RD1PYJ1.8MΩ	
B5	R412	Carbon film	1W 1.8MΩ ±5%	RD1PYJ1.8MΩ	
B6	R413	Carbon film	0.25W 150KΩ ±10%	RD¼NYK150KΩ	
B5	R414	Carbon film	0.25W 3.3KΩ ±10%	RD¼NYK3.3KΩ	
B5	R415	Carbon film	0.25W 22KΩ ±10%	RD¼NYK22KΩ	
B6	R416	Carbon film	0.5W 390KΩ ±10%	RD½PZK390KΩ	
B5	R417	Carbon film	0.5W 390KΩ ±10%	RD½PZK390KΩ	
B6	R418	Carbon film	0.5W 33KΩ ±10%	RD½PZK33KΩ	
B6	R419	Carbon film	0.5W 56KΩ ±10%	RD½PZK56KΩ	
C6	R420	Carbon film	1W 2.2MΩ ±10%	HM1PK2.2MΩ	
A6	R421	Carbon film	0.5W 1MΩ ±10%	RD½PZK1MΩ	
A6	R422	Carbon film	0.5W 1MΩ ±10%	RD½PZK1MΩ	
A6	R423	Carbon film	0.5W 1MΩ ±10%	RD½PZK1MΩ	
B6	R424	Carbon film	0.25W 15KΩ ±10%	RD¼NYK15KΩ	
B6	R425	Carbon film	0.25W 15KΩ ±10%	RD¼NYK15KΩ	
		rb			
B6	R426	Carbon film	0.5W 100KΩ ±10%	RD½PZK100KΩ	
B5	R427	Carbon film	0.5W 22KΩ ±10%	RD½PZK22KΩ	
B5	R428	Carbon film	0.5W 22KΩ ±10%	RD½PZK22KΩ	
B4	R429	Carbon film	0.25W 12KΩ ±10%	RD¼NYK12KΩ	
B4	R430	Carbon film	0.25W 33KΩ ±10%	RD¼NYK33KΩ	
B5	※				
A3	R501	Carbon film	0.25W 1KΩ ±10%	RD¼NYK1KΩ	
A3	R502	Carbon film	0.5W 1MΩ ±1%	RD½PXF1MΩ	
A3	R503	Carbon film	0.5W 3.3MΩ ±10%	RD½PZK3.3MΩ	
A3	R504	Carbon film	0.25W 560KΩ ±10%	RD¼NYK560KΩ	
A3	R505	Carbon film	0.25W 4.7KΩ ±10%	RD¼NYK4.7KΩ	
A3	R506	Carbon film	0.25W 12KΩ ±10%	RD¼NYK12KΩ	
A3	R507	Carbon film	0.25W 33Ω ±10%	RD¼NYK33Ω	
A3	R508	Carbon film	0.25W 4.7KΩ ±10%	RD¼NYK4.7KΩ	
B3	R509	Carbon film	0.25W 4.7KΩ ±10%	RD¼NYK4.7KΩ	
A3	R510	Carbon film	0.25W 15KΩ ±10%	RD¼NYK15KΩ	
A3	R511	Carbon film	0.25W 15KΩ ±10%	RD¼NYK15KΩ	
A3	R512	Carbon film	0.25W 10KΩ ±10%	RD¼NYK10KΩ	
A3	R513	Carbon film	0.25W 10KΩ ±10%	RD¼NYK10KΩ	
A4	R514	Carbon film	0.25W 33Ω ±10%	RD¼NYK33Ω	
A4	R515	Carbon film	0.25W 33Ω ±10%	RD¼NYK33Ω	
A3	R516	Carbon film	0.25W 180Ω ±10%	RD¼NYK180Ω	
A4	R517	Carbon film	0.25W 1.8KΩ ±10%	RD¼NYK1.8KΩ	
B4	R518	Carbon film	0.25W 1.8KΩ ±10%	RD¼NYK1.8KΩ	
A4	R519	Carbon film	0.25W 10KΩ ±10%	RD¼NYK10KΩ	
B4	R520	Carbon film	0.25W 10KΩ ±10%	RD¼NYK10KΩ	
A4	R521	Carbon film	0.25W 47Ω ±10%	RD¼NYK47Ω	
B4	R522	Carbon film	0.25W 47Ω ±10%	RD¼NYK47Ω	
A4	R523	Carbon film	0.25W 15KΩ ±10%	RD¼NYK15KΩ	
B4	R524	Carbon film	0.25W 15KΩ ±10%	RD¼NYK15KΩ	
A4	R525	Carbon film	0.25W 47Ω ±10%	RD¼NYK47Ω	
B4	R526	Carbon film	0.25W 47Ω ±10%	RD¼NYK47Ω	
B4	R527	Carbon film	0.25W 15KΩ ±10%	RD¼NYK15KΩ	
B4	R528	Carbon film	0.25W 220Ω ±10%	RD¼NYK220Ω	
A4	R529	Carbon film	0.25W 220Ω ±10%	RD¼NYK220Ω	
A4	R530	Carbon film	0.25W 220Ω ±10%	RD¼NYK220Ω	
A4	R531	Carbon film	1W 2.2KΩ ±10%	RD1PZK2.2KΩ	
A4	R532	Metal film	2W 10KΩ ±10%	MOR2XPK10KΩ	
B4	R533	Metal film	2W 10KΩ ±10%	MOR2XPK10KΩ	
B3	R534	Carbon film	0.25W 12KΩ ±10%	RD¼NYK12KΩ	
B3	R535	Carbon film	0.25W 15KΩ ±10%	RD¼NYK15KΩ	
A4	R536	Carbon film	0.25W 22Ω ±10%	RD¼NYK22Ω	
A3	R537	Carbon film	0.25W 100Ω ±10%	RD¼NYK100Ω	
	R601				Not assigned
B1	R602	Carbon film	0.25W 22KΩ ±10%	RD¼NYK22KΩ	
B1	R603	Carbon film	0.25W 15KΩ ±10%	RD¼NYK15KΩ	
B1	R604	Carbon film	0.25W 47Ω ±10%	RD¼NYK47Ω	
B1	R605	Carbon film	0.25W 47Ω ±10%	RD¼NYK47Ω	
B1	R606	Carbon film	0.25W 82Ω ±10%	RD¼NYK82Ω	
B1	R607	Carbon film	0.25W 82Ω ±10%	RD¼NYK82Ω	

※ Place	Symbol No.	Description			Note
B1	R608	Carbon film	0.25W 3.3KΩ ±10%	RD¼NYK3.3KΩ	
B1	R609	Carbon film	0.25W 4.7KΩ ±10%	RD¼NYK4.7KΩ	
B1	R610	Carbon film	0.25W 4.7KΩ ±10%	RD¼NYK4.7KΩ	
B2	R611	Carbon film	0.25W 68KΩ ±10%	RD¼NYK68KΩ	
B2	R612	Carbon film	0.25W 560KΩ ±10%	RD¼NYK560KΩ	
B2	R613	Carbon film	0.25W 2.2KΩ ±10%	RD¼NYK2.2KΩ	
B2	R614	Carbon film	0.25W 3.3KΩ ±10%	RD¼NYK3.3KΩ	
B2	R615	Carbon film	0.25W 33KΩ ±10%	RD¼NYK33KΩ	
B2	R616	Carbon film	0.25W 1KΩ ±10%	RD¼NYK1KΩ	
B2	R617	Carbon film	0.25W 6.8KΩ ±10%	RD¼NYK6.8KΩ	
B2	R618	Carbon film	0.25W 1KΩ ±10%	RD¼NYK1KΩ	
B2	R619	Carbon film	0.25W 2.2KΩ ±10%	RD¼NYK2.2KΩ	
B2	R620	Carbon film	0.25W 4.7KΩ ±10%	RD¼NYK4.7KΩ	
B2	R621	Carbon film	0.25W 12KΩ ±10%	RD¼NYK12KΩ	
B2	R622	Carbon film	0.25W 18KΩ ±10%	RD¼NYK18KΩ	
B2	R623	Carbon film	0.25W 12KΩ ±10%	RD¼NYK12KΩ	
B2	R624	Carbon film	0.25W 18KΩ ±10%	RD¼NYK10KΩ	
C2	R625	Carbon film	0.25W 10KΩ ±10%	RD¼NYK10KΩ	
C2	R626	Carbon film	0.25W 5.6KΩ ±10%	RD¼NYK5.6KΩ	
C2	R627	Carbon film	0.25W 4.7KΩ ±10%	RD¼NYK4.7KΩ	
B2	R628	Carbon film	0.25W 6.8KΩ ±10%	RD¼NYK6.8KΩ	
B2	R629	Carbon film	0.25W 100KΩ ±10%	RD¼NYK100KΩ	
C2	R630	Carbon film	0.25W 560KΩ ±10%	RD¼NYK560KΩ	
C2	R631	Carbon film	0.25W 10KΩ ±10%	RD¼NYK10KΩ	
	R632	Carbon film	0.25W 3.3KΩ ±10%	RD¼NYK3.3KΩ	
B2	R633	Carbon film	0.25W 18KΩ ±10%	RD¼NYK18KΩ	
B3	R644	Carbon film	0.25W 10KΩ ±10%	RD¼NYK10KΩ	
C3	R635	Carbon film	0.25W 8.2KΩ ±10%	RD¼NYK8.2KΩ	
C3	R636	Carbon film	0.25W 12KΩ ±10%	RD¼NYK12KΩ	
C3	R637	Carbon film	0.25W 27KΩ ±10%	RD¼NYK27KΩ	
C4	R638	Carbon film	0.25W 1KΩ ±10%	RD¼NYK1KΩ	
C4	R639	Carbon film	0.25W 10KΩ ±10%	RD¼NYK10KΩ	
C4	R640	Carbon film	0.25W 1KΩ ±10%	RD¼NYK1KΩ	
C3	R641	Carbon film	0.25W 10KΩ ±10%	RD¼NYK10KΩ	
C4	R642	Carbon film	0.25W 22KΩ ±10%	RD¼NYK22KΩ	
D3	R643	Carbon film	0.25W 47KΩ ±10%	RD¼NYK47KΩ	
D3	R644	Carbon film	0.25W 1.5KΩ ±10%	RD¼NYK1.5KΩ	
D3	R645	Carbon film	0.25W 5.6KΩ ±10%	RD¼NYK5.6KΩ	
D3	R646	Carbon film	0.25W 100KΩ ±10%	RD¼NYK100KΩ	
D3	R647	Carbon film	0.25W 1KΩ ±10%	RD¼NYK1KΩ	
D3	R648	Carbon film	0.25W 100KΩ ±10%	RD¼NYK100KΩ	
D3	R649	Carbon film	0.25W 10KΩ ±10%	RD¼NYK10KΩ	
C1	R701	Carbon film	0.25W 1KΩ ±10%	RD¼NYK1KΩ	
D3	R702	Carbon film	0.25W 150KΩ ±10%	RD¼NYK150KΩ	
C3	R703	Carbon film	0.25W 22KΩ ±10%	RD¼NYK22KΩ	
D2	R704	Carbon film	0.25W 22KΩ ±10%	RD¼NYK22KΩ	
D3	R705	Carbon film	0.25W 22KΩ ±10%	RD¼NYK22KΩ	
C3	R706	Carbon film	1W 2.4MΩ ±1%	RD1PXF2.4MΩ	
C3	R707	Carbon film	1W 2.4MΩ ±1%	RD1PXF2.4MΩ	
C3	R708	Carbon film	1W 1.2MΩ ±1%	RD1PXF1.2MΩ	
C3	R709	Carbon film	1W 1.2MΩ ±1%	RD1PXF1.2MΩ	
	R710	Carbon film	0.5W 600KΩ ±1%	RD1PXF600KΩ	
	R711	Carbon film	1W 2.4MΩ ±1%	RD1PXF2.4MΩ	
C3	R712	Carbon film	1W 1.2MΩ ±1%	RD1PXF1.2MΩ	
C3	R713	Carbon film	0.25W 4.7KΩ ±10%	RD¼NYK4.7KΩ	

※ Place	Symbol No.	Description			Note
C3	R714	Carbon film	0.25W 18KΩ ±10%	RD¼NYK18KΩ	
C3	R715	Carbon film	0.25W 56KΩ ±10%	RD¼NYK56KΩ	
C2	R716	Carbon film	0.25W 18KΩ ±10%	RD¼NYK18KΩ	
C2	R717	Carbon film	0.25W 33KΩ ±10%	RD¼NYK33KΩ	
C1	R801	Carbon film	0.25W 10KΩ ±10%	RD¼NYK10KΩ	
C1	R802	Carbon film	0.25W 1MΩ ±10%	RD½PZK1MΩ	
C1	R803	Carbon film	0.25W 560KΩ ±10%	RD¼NYK56KΩ	
C1	R804	Carbon film	0.25W 1KΩ ±10%	RD¼NYK1KΩ	
D1	R805	Carbon film	0.25W 150KΩ ±10%	RD¼NYK150KΩ	
D1	R806	Carbon film	0.25W 12KΩ ±10%	RD¼NYK12KΩ	
D4	R807	Carbon film	0.25W 39KΩ ±5%	RD¼NYJ39KΩ	
D4	R808	Carbon film	0.25W 22KΩ ±10%	RD¼NYK22KΩ	
D4	R809	Carbon film	0.25W 220KΩ ±5%	RD¼NYJ220KΩ	
D4	R810	Carbon film	0.25W 100KΩ ±10%	RD¼NYK100KΩ	
C4	R811	Metal film	2W 15KΩ ±10%	MOR2XPK15KΩ	
D4	R812	Carbon film	0.25W 5.6KΩ ±10%	RD¼NYK5.6KΩ	
D4	R813	Carbon film	0.25W 220KΩ ±5%	RD¼NYJ220KΩ	
D4	R814	Carbon film	0.25W 43KΩ ±5%	RD¼NYJ43KΩ	
D4	R815	Carbon film	0.25W 240KΩ ±5%	RD¼NYJ240KΩ	
D4	R816	Carbon film	0.25W 100KΩ ±10%	RD¼NYK100KΩ	
D4	R817	Metal film	2W 15KΩ ±10%	MOR2XPK15KΩ	
C1	R818	Carbon film	0.25W 100Ω ±10%	RD¼NYK100Ω	
C1	R819	Carbon film	0.25W 220Ω ±10%	RD¼NYK220Ω	

VARIABLE RESISTORS

※ Place	Symbol No.	Description			Note
D2	VR201	Carbon film	0.15W 470Ω B	SR19RB470ΩB	∅CAL
C5	VR301	Carbon film	0.15W 3.3KΩ B	SR19RB3.3KΩB	∅+27V
D5	VR302	Carbon film	0.15W 3.3KΩ B	SR19RB3.3KΩB	∅−27V
C4	VR401	Carbon film	0.15W 22KΩ B	SR19RB22KΩB	∅H.V
B5	VR402	Carbon film	0.25W 5KΩ B	RV24N21RB5KΩ	[INTEN]
B5	VR403	Carbon film	0.15W 10KΩ B	SR19RB10KΩ	∅INTEN
C6	VR404	Carbon film	0.25W 1MΩ B	RV24N21RB1MΩ	[FOCOS]
B6	VR405	Carbon film	0.25W 22KΩ B	VO24LNSL(BP)B22	∅ASTIG
A3	VR501	Carbon film	0.15W 470Ω B	SR19RB470Ω	∅GATE CURR
A3	VR502	Carbon film	0.15W 4.7KΩ B	SR19RB4.7KΩ	∅TINE
A3	VR503	Carbon film	0.15W 100KΩ B	SR19RB100KΩ	∅COARSE
A3	VR504	Carbon film	0.15W 3.3KΩ B	SR19RB3.3KΩ	∅DC BAL
A4	VR505	Carbon film	0.15W 330Ω B	SR19RB330Ω	∅GAIN
A3	VR506	Carbon film	0.25W 300Ω C	RV24Z15SC300Ω	[VARIABLE]
A4	VR507	Carbon film	0.25W 20KΩ B	RV24N15RB20KΩ	V POS
A4	VR508	Carbon film	0.15W 2.2KΩ B	SR19RB2.2KΩ	∅M.F
B2	VR601	Carbon film	0.25W 5KΩ B	RV24N15RB5KΩQ	[TRIG LEVEL]
B2	VR602	Carbon film	0.15W 4.7KΩ B	SR19RB4.7KΩ	∅AUTO BAL
C2	VR603	Carbon film	0.15W 3.3KΩ B	SR19RB3.3KΩ	∅STAB
D3	VR604	Carbon film	0.15W 2.2KΩ B	SR19RB2.2KΩ	∅LENGTH
D2	VR701	Carbon film	0.25W 100KΩ B	RV24G10SB100KΩ	[VARIABLE]
C3	VR702	Carbon film	0.15W 33KΩ B	SR19RB33KΩ	∅WIDTH
C3	VR703	Carbon film	0.25W 10KΩ B	RV24G10SB10KΩ	[VARIABLE]
C3	VR704	Carbon film	0.15W 33KΩ B	SR19RB33KΩ	∅TV-V
C2	VR705	Carbon film	0.15W 33KΩ B	SR19RB33KΩ	∅TV-H
C1	VR801	Carbon film	0.15W 33KΩ B	SR19RB33KΩ	∅DC BAL
D4	VR802	Carbon film	0.25W 50KΩ B	RV24N15RB50KΩ	[H POS]
D4	VR803	Carbon film	0.15W 10KΩ B	SR19RB10KΩ	∅MAG X5
D4	VR804	Carbon film	0.15W 4.7KΩ B	SR19RB4.7KΩ	∅MAG CENTER

※ Place	Symbol No.	Description			Note
		CAPACITORS			
A1	C101	metalized film	630WV 0.2μF ±20%	MD12J104M	
A1	C102	mica film	500WV 120PF ±10%	FM10ZC121K	
A2	C103	Plastic film	50WV 1500PF ±10%	CQ92MB1H152K	
A2	C104	mica film	500WV 5PF ±10%	FM05ZC050K	
A2	C105	mila film c	500WV 33PF ±10%	FM07ZC330K	
A2	C106	mica film	500WV 18PF ±10%	FM06ZC180K	
D1	C201	Electrolytic	16WV 47μF	16VBSN47	
D1	C202	Plastic film	50WV 6800PF ±10%	CQ92MB1H682K	
D1	C203	Plastic film	50WV 6800PF ±10%	CQ92MB1H682K.	
D2	C204	mica film	50WV 27PF ±10%	V-FM04ZC270K	
C4	C301	Electrolytic	250WV 50μF		
C5	C302	Electrolytic	250WV 50μF	ECE-P250VT50A	
C4	C303	Electrolytic	250WV 50μF		
C5	C304	Electrolytic	100WV 100μF	CE02D2A470	
D5	C305	Electrolytic	100WV 100μF	CE02D2A101	
D5	C306	Electrolytic	100WV 47μF	CE02D2A470	
C5	C307	Electrolytic	50WV 22μF	50VBSN22	
C5	C308	Plastic film	50WV 0.033μF ±10%	CQ92MB1H333K	
D5	C309	Ceramic	50WV 0.01μF	RD204YM103	
C5	C310	Electrolytic	50WV 1μF	50VBSN1	
C4	C311	Plastic film	50WV 0.1μF ±10%	CQ92MB1H104K	
D5	C312	Electrolytic	50WV 22μF	50VBSN22	
D5	C313	Plastic film	50WV 0.033μF ±10%	CQ92MB1H333K	
D5	C314	Electrolytic	50WV 1μF	50VBSN1	
D5	C315	Plastic film	50WV 0.1μF ±10%	CQ92MB1H104K	
C4	C401	Plastic film	50WV 0.1μF ±10%	CQ92MB1H104K	
B4	C402	metalized film	400WV 0.01μF ±20%	MD22G103M	
B5	C403	metalzed film	400WV 0.01μF ±20%	MD22G103M	
B5	C404	Plastic film	50WV 0.1μF ±10%	CQ92MB1H104K	
B4	C405	Plastic film	50WV 1000PF ±10%	CQ92MB1H102K	
B5	C406	Ceramic	3000WV 1000PF +100% −0%	CK621YZ102PY3000	
B5	C407	Ceramic	3000WV 1000PF +100% −0%	CK621YZ102PY3000	
B6	C408	Ceramic	3000WV 1000PF +100% −0%	CK621YZ102PY3000	
A5	C409	Plastic film	50WV 470PF ±10%	CQ08SC1H471K	
B6	C410	mica film	2500WV 33PF ±10%	CM20ZA330K25	
B5	C411	Electrolytic	16WV 22μF	16VBSN22	
B5	C412	Electrolytic	16WV 22μF	16VBSN22	
B5	C413	Electrolytic	25WV 100μF	25VBSN100	
A6	C414	mica film	500WV 10PF ±10%	FM05ZC100K	
A6	C415	metalized film	400WV 0.01μF ±20%	MD22G103M	
B6	C416	metalized film	250WV 0.033μF ±20%	MD22E333M	
B6	C417	Oil	2000WV 0.022μF ±20%	ECN-D20223M	
C6	C418	Ceramic	3000WV 470PF +100% −0%	CK62Y5P471MY3000	
A6	C419	metalized film	400WV 0.01μF ±20%	MD22G103M	
B5	C420	Ceramic	3000WV 1000PF +100% −0%	CK621YZ102PY3000	
A3	C501	Plastic film	50WV 0.01μF ±10%	CQ92MB1H103K	
A3	C502	metalized film	630WV 0.01μF ±20%	MD12J103M	
A3	C503	Plastic film	50WV 1000PF ±10%	CQ92MB1H102K	
A3	C504	Plastic film	50WV 1000PF ±10%	CQ92MB1H102K	
A3	C505	Ceramic	50WV 0.01μF ±10%	RD204YM103	
B3	C506	mica	50WV 10PF ±10%	V-FM04ZC100K	
A4	C507	Plastic film	50WV 330PF ±10%	CQ08SC1H331K	
A4	C508	metalized film	50WV 0.033μF ±20%	MD22E333M	
B4	C509	Electrolytic	50WV 1μF	50VBSN1	

※ Place	Symbol No.	Description			Note
B3	C510	Electrolytic	25WV 1μF	25VBSN1	
B3	C511	Ceramic	50WV 0.01μF ±10%	RD204YN103	
A4	C512	mica	50WV 39PF ±10%	V-FM04ZC390K	
B1	C601	Electrolytic	50WV 3.3μF	50VBSN3R3	
	C602				Not assigned
B1	C603	mica	50WV 18PF ±10%	V-FM04ZC180K	
B1	C604	Plastic film	50WV 390PF ±10%	CQ08SC1H391K	
B2	C605	mica film	200WV 0.47μF	2MFT-D474	
B2	C606	mica film	50WV 47PF ±10%	V-FM04ZC470K	
B2	C607	mica film	50WV 22PF ±10%	V-FM04ZC220K	
B2	C608	mica film	50WV 100PF ±10%	V-FM06ZC101K	
B2	C609	mica film	50WV 100PF ±10%	V-FM06ZC101K	
B1	C610	Electrolytic	50WV 1μF	50VBSN1	
B2	C611	Ceramic	50WV 0.01μF ±10%	RD204YM103	
C2	C612	Ceramic	50WV 0.01μF ±10%	RD204YM103	
B2	C613	mica film	50WV 15PF ±10%	V-FM04ZC150K	
D3	C614	mica film	50WV 39PF ±10%	V-FM04ZC390K	
C3	C615	mica film	50WV 100PF ±10%	V-FM06ZC101K	
C4	C616	mica film	50WV 220PF ±10%	V-FM08ZC221K	
C2	C617	mica film	50WV 5PF ±10%	V-FM04ZC050K	
C2	C701	Plastic film	50WV 0.039μF ±10%	CQ92MB1H393K	
D2	C702	Electrolytic	50WV 1μF	50VBSN1	
D2	C703	Plastic film	50WV 0.1μF ±10%	CQ92MB1H104K	
D2	C704	Plastic film	50WV 0.01μF ±10%	CQ92MB1H103K	
D3	C705	Plastic film	50WV 1000PF ±10%	CQ92MB1H102K	
D3	C706	mica film	50WV 68PF ±10%	V-FM05ZC680K	
C3	C707	metalized film	100WV 1μF ±2%	CQ-14T2A105G	
C3	C708	Plastic film	100WV 0.1μF ±2%	TNX104G100V	
C3	C709	Plastic film	100WV 0.01μF ±2%	TNX103G100V	
C3	C710	Plastic film	125WV 1000PF ±2%	CQ08P2B102G	
C3	C711	mica film	50WV 82PF ±10%	V-FM06ZC820K	
C3	C712	mica film	50WV 33PF ±10%	V-FM04ZC330K	
C1	C801	metalized film	630WV 0.1μF ±20%	MD12J104M	
C1	C802	mica film	500WV 220PF ±10%	FM12ZC221K	
D4	C803	mica film	500WV 2PF ±10%	FM05ZC020K	
D4	C804	Plastic film	50WV 180PF ±10%	CQ08SC1H181K	
D4	C805	Plastic film	50WV 330PF ±10%	CQ08SC1H331K	
D4	C806	mica film	500WV 2PF ±10%	FM05ZC020K	
D4	C807	mica film	500WV 2PF ±10%	FM05ZC020K	
D4	C808	mica film	500WV 2PF ±10%	FM05ZC020K	
C1	C809	Plastic film	50WV 1000PF ±10%	CQ92MB1H102K	
		VARIABLE CAPACITORS			
A1	VC101	Ceramic	500WV 20PF	ECV-1ZW20P32	
A1	VC102	Ceramic	500WV 20PF	ECV-1ZW20P32	
A1	VC103	Ceramic	500WV 20PF	ECV-1ZW20P32	⊘ Vertical
A1	VC104	Ceramic	500WV 20PF	ECV-1ZW20P32	Attenuator
A2	VC105	Ceramic	500WV 20PF	ECV-1ZW20P32	
A2	VC106	Ceramic	500WV 20PF	ECV-1ZW20P32	
A2	VC107	Ceramic	500WV 20PF	ECV-1ZW20P32	
A2	VC108	Ceramic	500WV 20PF	ECV-1ZW20P32	
A3	VC109	Ceramic	500WP 20PF	ECV-1ZW20P32	
A4	VC501	Ceramic	500WV 50PF	ECV-1ZW50P32	⊘ H.F
C3	VC701	Ceramic	500WV 20PF	ATSWECV20PF	⊘ Time Base
C3	VC702	Ceramic	500WV 20PF	ATSWECV20PF	

※ Place	Symbol No.	Description				Note
		TUBES				
A6	V401	CRT			75AKB1	
		TRANSISTORS				
D1	Q201				2SC458-B	or 2SC458-C
D1	Q202				2SC458-B	or 2SC458-C
D2	Q203				2SA561-O	or 2SC561-Y
C5	Q301				2SD150	
C5	Q302				2SC499-Y	
C5	Q303				2SC499-Y	
D5	Q304				2SD150	
D5	Q305				2SA561-O	or 2SA561-Y
D5	Q306				2SA561-O	or 2SA561-Y
B5	Q401				2SC1059	
B4	Q402				2SC458-B	or 2SC458-C
C4	Q403				2SC458-B	or 2SC458-C
A5	Q404				2SC526	
B6	Q405				2SC685A	or 2SC515
C4	Q406				2SA561-O	or 2SA561-Y
A3	Q501	FET			2SK34-C	or 2SK34-D
B3	Q502	FET			2SK34-C	or 2SK34-D
A3	Q503				2SC458-B	or 2SC458-C
B3	Q504				2SC458-B	or 2SC458-C
A4	Q505				2SC458-B	or 2SC458-C
B4	Q506				2SC458-B	or 2SC458-C
A4	Q507				2SC458-B	or 2SC458-C
B4	Q508				2SC458-B	or 2SC458-C
A4	Q509				2SC526	
B4	Q510				2SC526	
B4	Q511				2SC458-B	or 2SC458-C
B3	Q512				2SC1013	
B1	Q601				2SC458-B	or 2SC458-C
B1	Q602				2SC458-B	or 2SC458-C
B2	Q603				2SC458-B	or 2SC458-C
B2	Q604				2SC458-B	or 2SC458-C
B2	Q605				2SC458-B	or 2SC458-C
C2	Q606				2SC458-B	or 2SC458-C
B3	Q607				2SC458-B	or 2SC458-C
C3	Q608	FET			2SK34-C	or 2SK34-D
C4	Q609				2SC458-B	or 2SC458-C
C4	Q610				2SC499-Y	
D3	Q611				2SC458-B	or 2SC458-C
D3	Q612				2SC458-B	or 2SC458-C
C1	Q801				2SC499-Y	
C1	Q802				2SC499-Y	
C4	Q803				2SA561-O	or 2SA561-Y
D4	Q804				2SC154C	
D4	Q805				2SA561-O	or 2SA561-Y
D4	Q806				2SC154C	
		DIODES				
D1	D201	Zener	6V	0.25W	RD6A	
D1	D202				1S1555	
C5	D301	Rect	600V	1.1A	V-06G	
C5	D302	Rect	600V	1.1A	V-06G	
C5	D303	Rect	200V	1.1A	V-06C	

※ Place	Symbol No.	Description				Note
C5	D304	Rect	200V	1.1A	V-06C	
C5	D305	Rect	200V	1.1A	V-06C	
C5	D306	Rect	200V	1.1A	V-06C	
D5	D307	Zener	7V	0.25W	RD7A	
D5	D308				1S1555	
B5	D401	Rect	3500V	2.2mA	3HT5	
B5	D402	Rect	3500V	2.0mA	3HT5	
B5	D403	Rect	100V	1.1A	V-06B	
B5	D404	Rect	100V	1.1A	V-06B	
B5	D405	Zener	9V	0.25W	RD9A	
B5	D406				DS16A	
A5	D407	Zener	35V	0.25W	RD35A	
B5	D408	Zener	35V	0.25W	RD35A	
A3	D501				1S1555	
A3	D502				1S1555	
A3	D503				2SC458-B	or 2SC458-C
A3	D504				2SC458-B	or 2SC458-C
A3	D505				1S1555	
A3	D506				1S1555	
B2	D601				1S1555	
C2	D602				1S1555	
C2	D603				1S1555	
B3	D604				1S1555	
C3	D605				1S1555	
D3	D606				1S1555	
D1	D801				1S2076A	
D4	D802				1S1555	
		SWITCHES				
A1	S101	Slide	2Poles 3Position		SL-83	
A2	S102	Rotary	9Section 4Position		S-22	VOLTS/DIV
C6	S301	Toggle	Single-pole 2-throw		MST-106D	
A6	S401	Slide	2Section 2Position		S2200	
A6	S402	Slide	2Section 2Position		S2200	
A4	S501		Single-pole Single-throw			with VR506
B1	S601	Slide	2Section 2Position		S-2200	
B1	S602		2Section 2Position			with VR601
C3	S603	Rotary	10Section 20Position		S-32	TIME/DIV
C2	S801	Slide	2Section 2Position		S2200	
D4	S802	Pull ON	1Section 1Position			with VR802
		TRANSFORMERS				
C6	PT301	Power Transformer			J257	
B5	PT401	Hight Volt OSC			J258	
		PRINTED CIRCUIT BOARDS				
A4		V AMP			T-378	
B3		MAIN			T-380	
A1		V-ATT			T-353	
A5		VECTOR			T-376	
B5		H.V. OSC			T-377	
		FUSE				
C6	F301	100～115V (200～230V	SLOW 0.3A 60°C NORM 0.2A)			
		LAMP				
C6	PL301	Neon Lamp			PL-5	

※ Place	Symbol No.	Description		Note
		TERMINALS and CONNECTORS		
A1	J101	UHF Receptacle	MJ-1	
A1	J102	metal terminal	SQ-0204-2	
D1	J201	Banana jack	NO375(Red)	
A6	J401	Banana jack	NO375(Red)	
A6	J402	Banana jack	NO375(Red)	
B6	J403	Banana jack	NO375(Red)	
B6	J404	Banana jack	NO375(Black)	
C4	J601	Banana jack	NO375(Red)	
C1	J801	Banana jack	NO375(Red)	
D1	J802	Banana jack	NO375(Black)	

※ Place	Symbol No.	Description	Note

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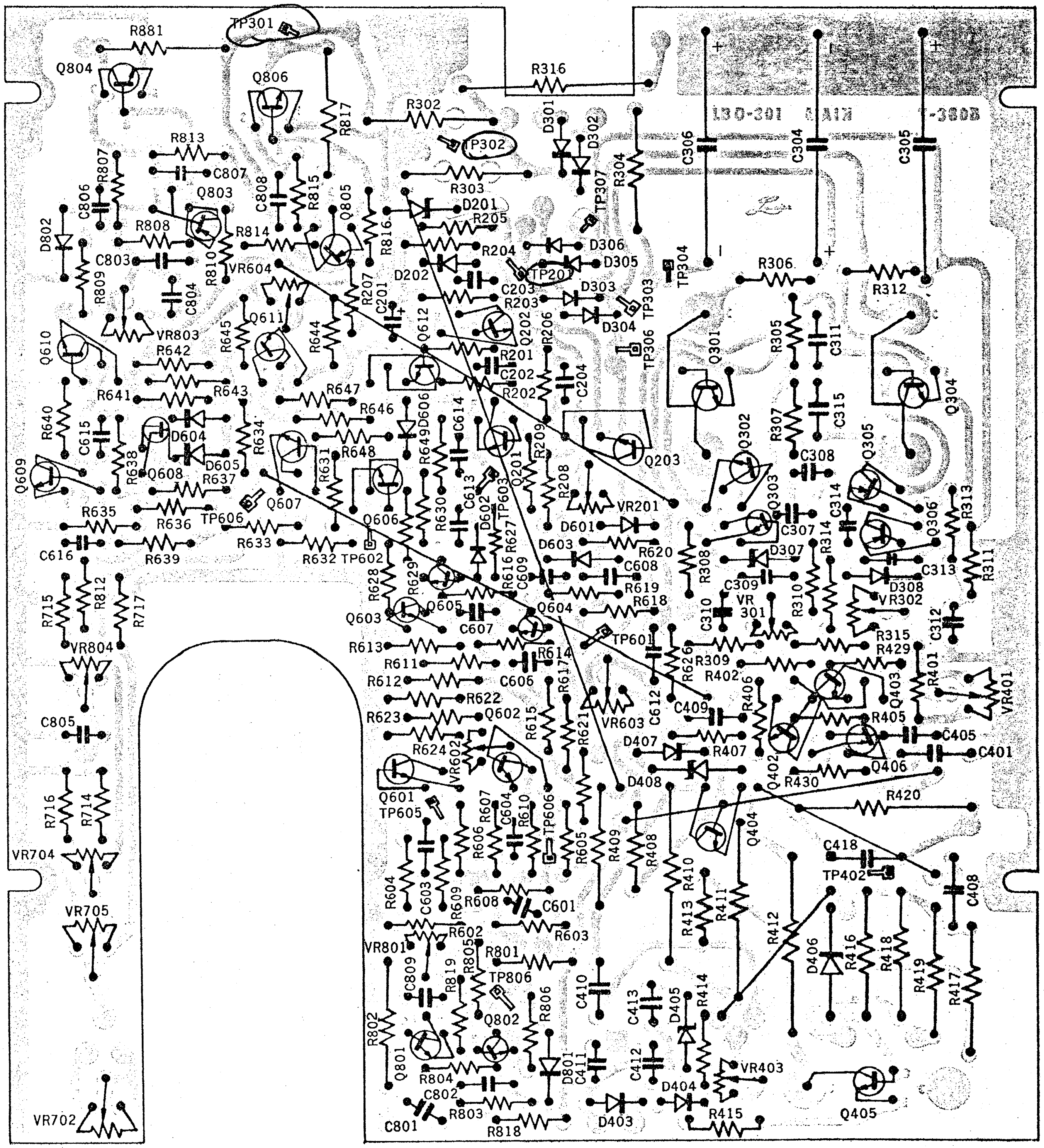

TP301
R881
Q804
Q806
R817
R302
R316
D301
D302
TP302
R304
C306
C304
C305
R813
C807
R807
C806
Q803
C808
R815
Q805
R303
D201
R205
TP307
D802
R808
R814
R816
R204
D306
C803
R810
VR604
D202
TP201
D305
TP304
R306
R312
R809
C804
VR803
R645
Q611
R644
R207
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C308
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TP606
Q607
Q606
R630
VR201
C307
Q306
C616
R639
R633
R632
TP602
R627
R616
D601
D603
R620
R308
D307
R314
R311
R628
R629
C609
C608
R619
C309
R310
D308
C313
R715
R812
R717
Q603
Q605
Q604
R618
VR 301
VR302
C310
R315
C312
VR804
R613
C607
TP601
R626
R309
R429
R611
R614
R402
R401
VR401
R612
C606
R617
C612
R406
Q403
R622
VR603
C409
R405
R623
Q602
R615
R621
D407
R407
C405
R624
VR602
D408
Q402
R430
Q406
C401
C805
Q601
TP605
R607
C604
R610
TP606
R420
R716
R714
R606
R605
R409
R408
Q404
C418
TP402
VR704
R604
C603
R609
R410
R413
R411
R412
C408
R608
C601
VR705
R602
R603
VR801
R805
R801
D406
R416
R418
R419
R417
C809
R819
TP806
Q802
R806
C410
C413
D405
R414
R802
Q801
D801
C411
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VR403
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D404
Q405
R803
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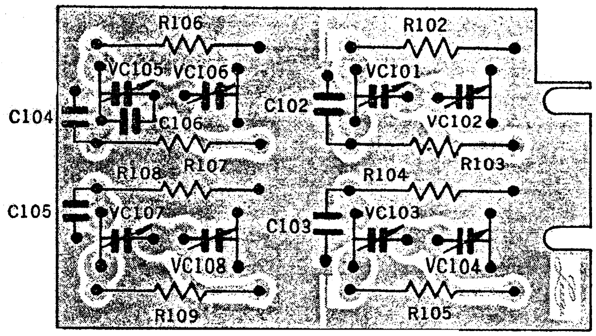
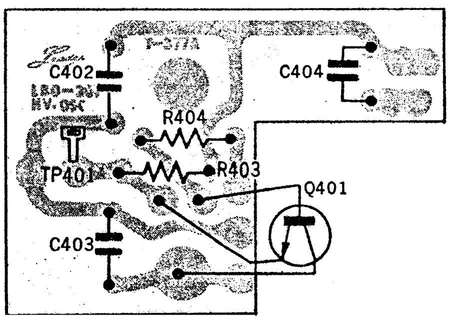
R415
C801
R818
VR702

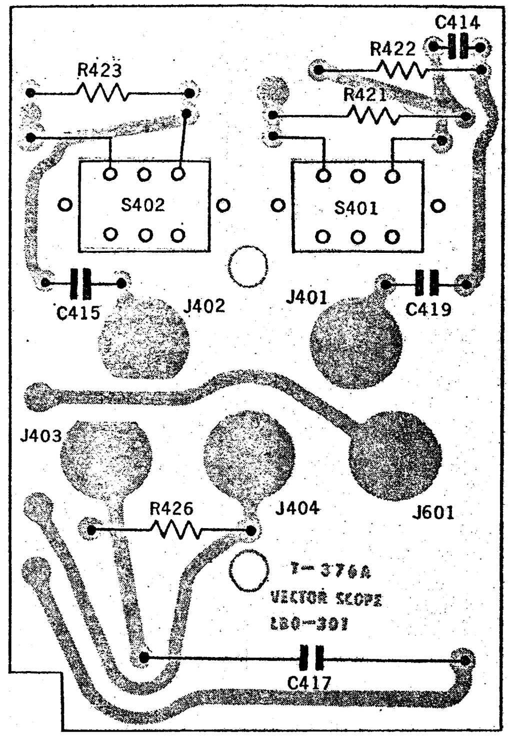
V ATT T-353



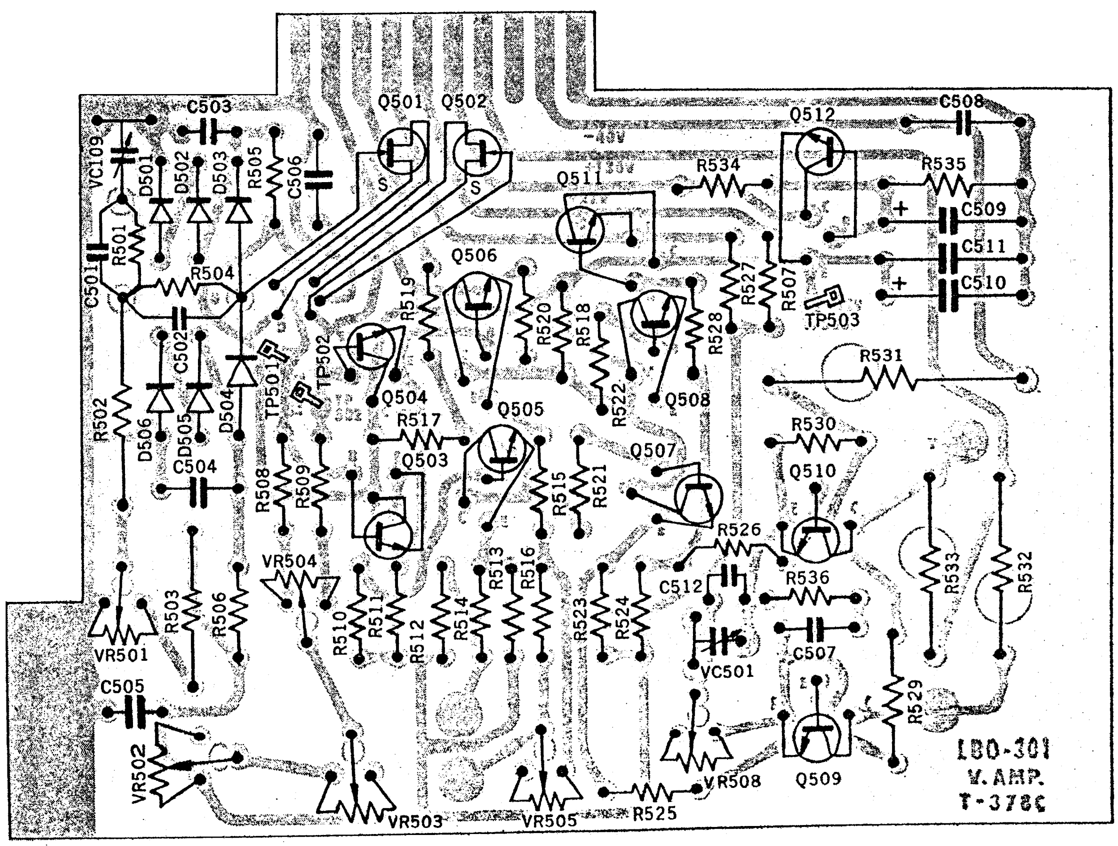
HV OSC T-377

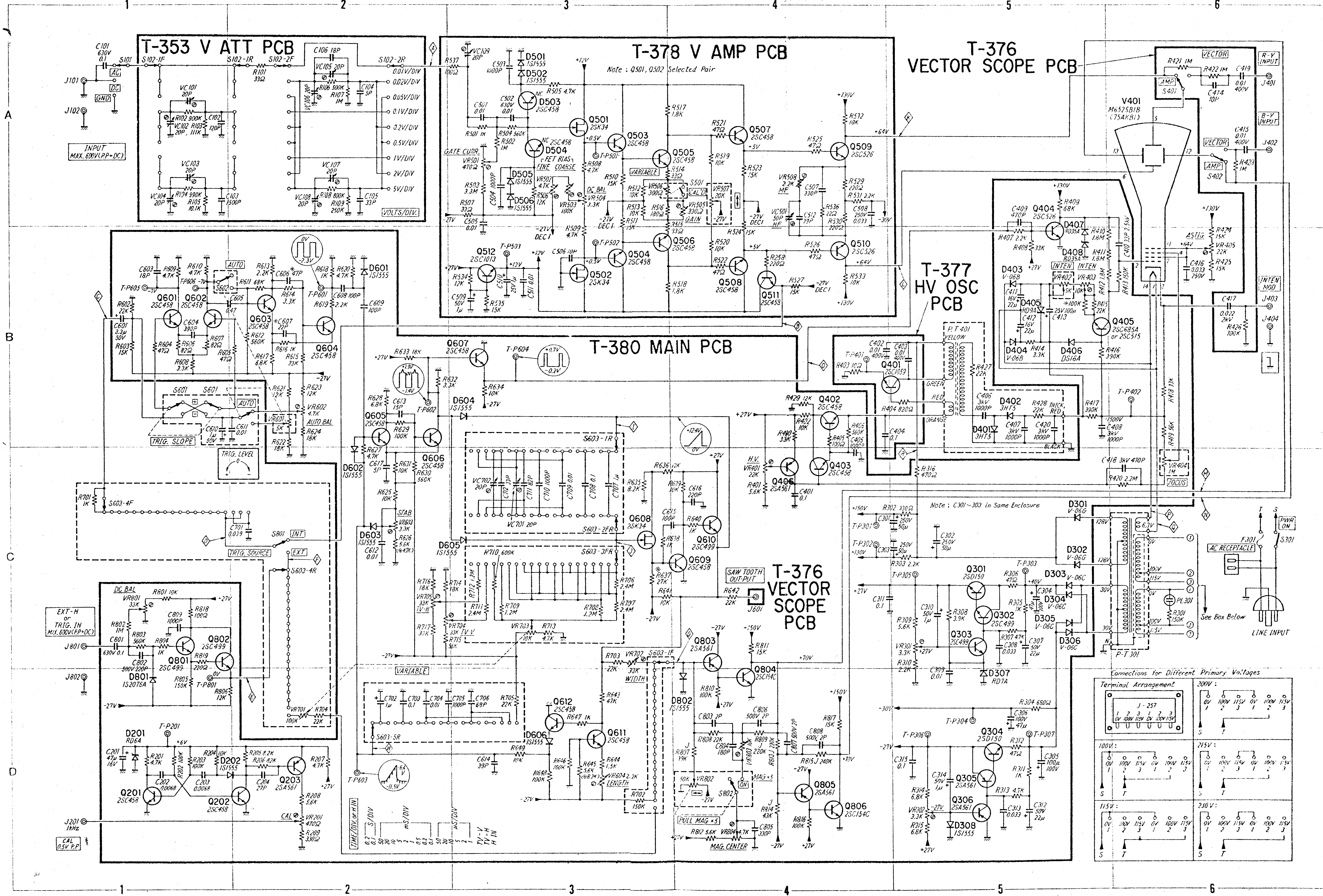


VECTOR SCOPE T-376



V AMP T-378




T-353 V ATT PCB
T-378 V AMP PCB
Note : Q501, Q502 Selected Pair
T-376 VECTOR SCOPE PCB
T-377 HV OSC PCB
T-380 MAIN PCB
T-376 VECTOR SCOPE PCB
INPUT MAX. 600V (PP+DC)
EXT-H or TRIG. IN MAX. 600V(PP+DC)
CAL 0.5V P.P
TRIG. SLOPE
TRIG. LEVEL
TRIG. SOURCE
AUTO BAL
VOLTS/DIV.
SAW TOOTH OUT-PUT
PULL MAG ×5
MAG. CENTER
Note : C301~303 in Same Enclosure
AC RECEPTACLE
PWR ON
LINE INPUT
See Box Below
Connections for Different Primary Voltages
Terminal Arrangement
J-257
200V :
100V :
215V :
115V :
230V :