LEADER TEST INSTRUMENTS

MODEL LBO-502

OSCILLOSCOPE/VECTORSCOPE

OPERATING INSTRUCTIONS

AND SERVICE MANUAL

LEADER ELECTRONICS CORP.

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1. INTRODUCTION

The LBO-502 is an all solid state wideband oscilloscope/vectorscope. It is extremely compact, lightweight and offers a new ease of operational convenience.

It has broad applications in every conceivable branch of electronics and has no equal in the servicing and trouble-shooting of home entertainment products. It's use is very highly recommended in laboratories, schools, and production facilities.

2. SPECIFICATIONS

Vertical Amplifier	
Sensitivity	10MVp-p/cm to 20Vp-p/cm ±3%, calibrated in 11 steps, 1-2-5 sequence and continuous adjuster (uncalibrated)
Bandwidth	DC to 15MHz, –3dB (with 3cm deflection)
Rise Time	23 nanoseconds
Input Impedance	1MegΩ shunted by 40pfd (with 10:1 probe, 10MegΩ shunted by 15pfd or less)
Input Connector	BNC
Calibration Voltage	0.5Vp-p ±3%, 1kHz; square wave
Horizontal Amplifier	
Sensitivity	200MVp-p/cm
Bandwidth	2Hz – 200kHz, –3dB
Input Impedance	1MegΩ, shunted by 40pfd
Time Base	
Sweep Speeds	1μs/cm to 0.2s/cm, calibrated in 17 steps, 1-2-5 sequence and uncalibrated continuous adjuster; TV-V (33.3ms/10cm; 30Hz) and (127μs/10cm; 15.750/2kHz) preset positions.
Magnification	×5 (max. speed 200 nanosecs/cm)
Synchronization	Triggered and automatic, internal or external at + or – slope.
Intensity Modulation	External input over 15Vp-p, negative polarity.
Power Supply	115/230V; 50/60Hz; 40VA ± 5VA
Size and Weight	73/8"h x 91/8"w x 15"d, 17lbs. approx.
Accessories	Direct/Low capacitance probe LP-8X 1
	Terminal adaptor 1
	Test leads (three per set) 1
	Operating instruction 1

3. PRECAUTIONS

3-1 Power Source Voltage

The AC power input is normally wired for 105 ~ 125V, 50/60Hz operation. For other voltages, changes are necessary in the transformer primary connections. Refer to Fig. 3-1 for connections to match the average line voltage, 100, 115, 200, 215 or 230V.

Terminal Arrangement and Wiring Diagram of Primary Windings

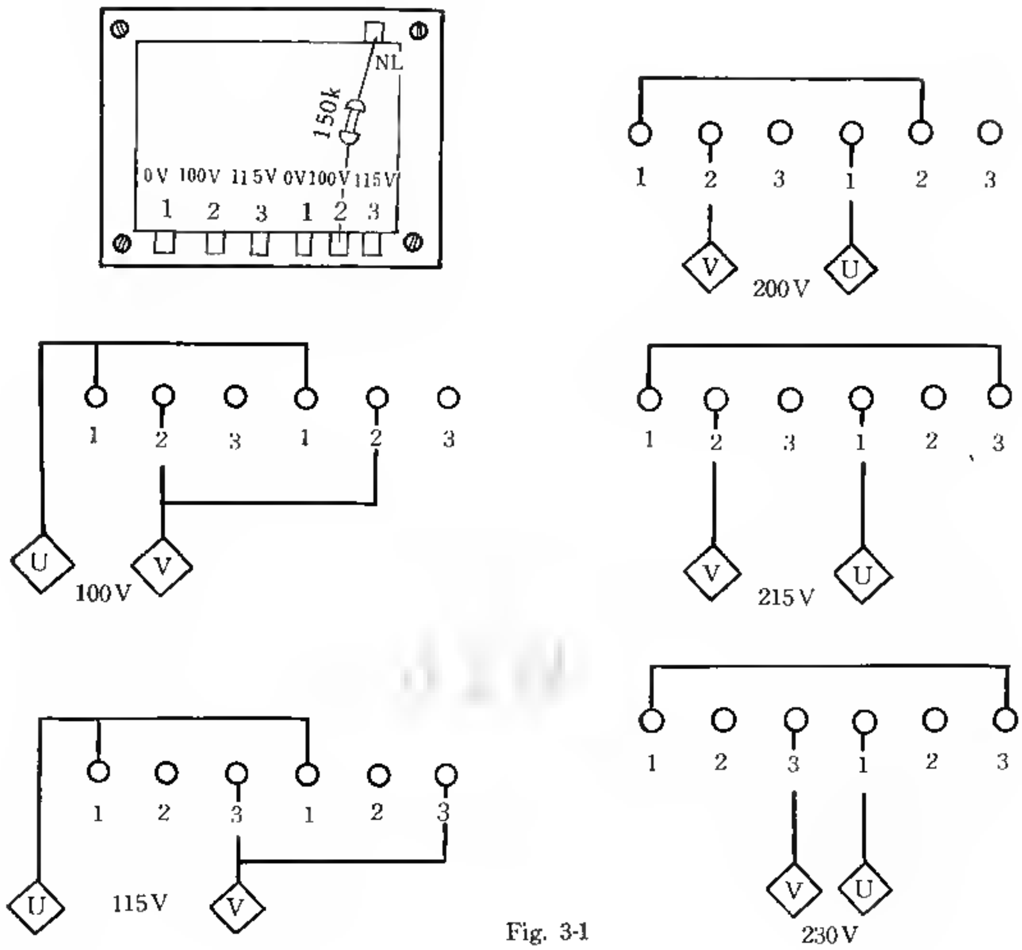


Fig. 3-1

The AC line fuse ratings are shown below.

Average Line Voltage	Fuse Rating
100V 115V	1A, slow blow
200V 215V 230V	0.5A, slow blow

3-2 Signal Input

A voltage higher than 600V (P-P+D.C.) applied to the Vert. Input, Ext. H, Trig. Input or the low capacitance probe may damage circuit components.

The value of 600V (P-P+D.C.) is shown in the following figures:

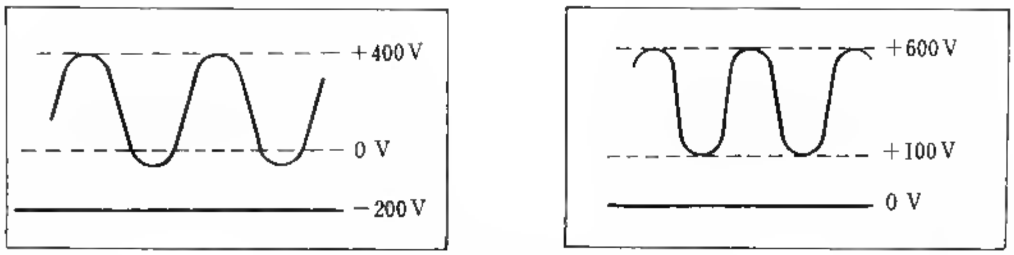


Fig. 3-2

3-3 Intensity

An accelerating voltage of 1800V is applied to the cathode ray tube during operation. If the cathode ray tube is left with a bright dot, (no sweep), or with unnecessarily raised intensity, the fluorescent screen may be stained with ion spots in the form of white lines or black blots.

The Intensity should be maintained at a minimum level.

3-4 Tilt of Horizontal Traces

The effect of the earth's magnetic field may cause slight tilting of the traces due to placement of the instrument. If the tilt is operationally inconvenient, change the placement of the unit or slope the scale by means of the SCALE TILT knob on the hood so that the scale is parallel with the traces.

3-5 Operation in a Powerful Magnetic Field

Operation in a powerful magnetic field will cause distortion of waveforms or make traces tilt excessively. If the instrument is operated close to machinery or equipment that use a large transformers(200 or 300VA rating), a great deal of hum will be noted. In the worst case, the traces may be so severely tilted that self-restoration is not possible. In this case, demagnetize the instrument with a degaussing coil such as used in a color television set.

4. DESCRIPTION OF PANEL FUNCTIONS

The operational functions on the front and rear panels are described below. The numbers refer to their placement as shown on the following panel drawings.

4-1 Front Panel

(1) CRT Hood (Bezel)
Removal of the four hood nuts, will free the hood, scale plate, spacer and green filter. (Hold the SCALE TILT knob during the above procedure to avoid loss of scale assembly.)

(2) The large boxes on the scale plate are calibrated in centimeters; the small markings on the center vertical and center horizontal scale lines are spaced at 2 millimeters.

Front Panel

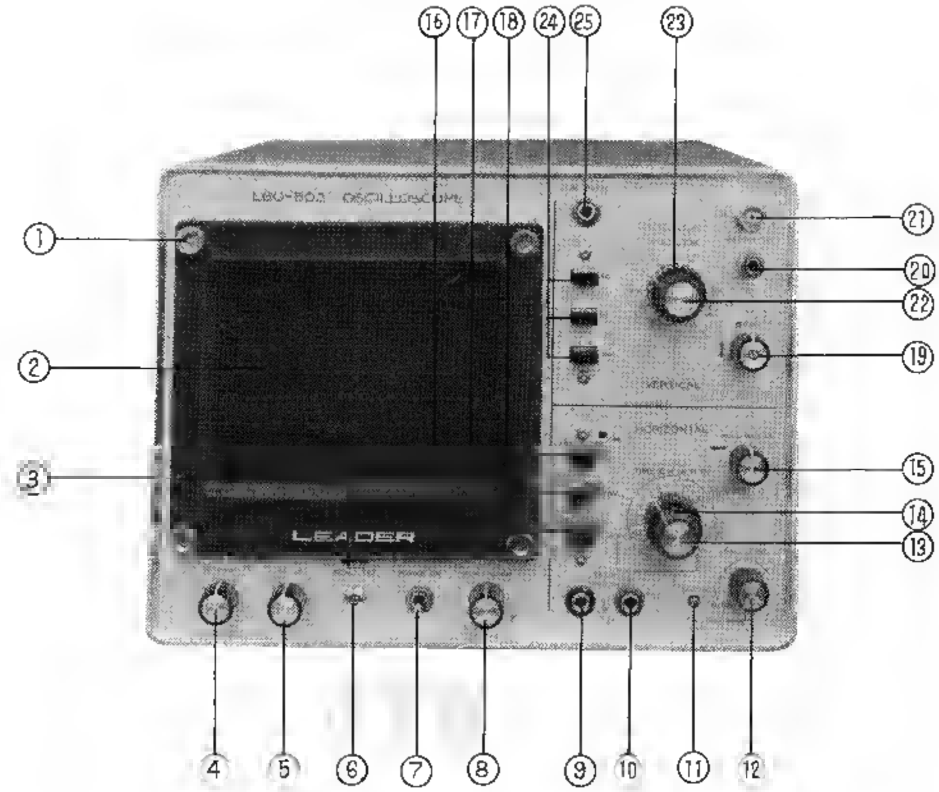


Fig. 4-1

Rear panel

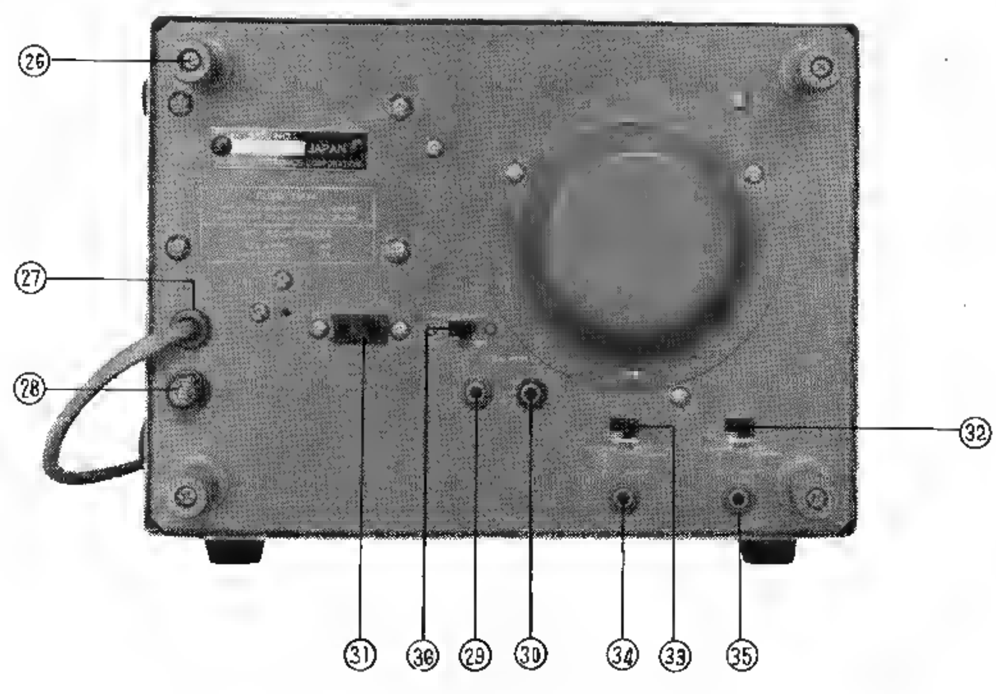


Fig. 4-2

In addition, the oblique lines, every 30 degrees, pointing towards the center of the scale are for vectorscope or vector pattern use. (This application is covered in detail on page 22 of this manual.)

(3) SCALE TILT ⬌
Slight Horizontal line tilt due to the influence of the earth's magnetic field or any other magnetic field may be corrected with the scale tilt adjustment.

(4) INTEN (Intensity Adjustment)
Varies the bias on the control grid of the cathode ray tube to adjust pattern luminance or brightness. High luminance will cause return trace lines to appear on the screen.

(5) FOCUS (Focus Adjustment)
Adjusts focus grid voltage for best clarity of display.

(6) PILOT LAMP
Lamp lights when the power is on.

(7) PWR ON (Power Supply Switch)
Turns power on or off.

(8) SCALE ILLUM. (Scale Illumination)
Provides illumination on the scales at proper brightness for easy scale and trace readings.

(9) ⏚ (Ground Terminal)

(10) EXT. H or TRIG. IN (External Horizontal Axis Input or External Trigger Input Terminal)
External signals may be fed to the horizontal amplifier through this terminal when switch (14) is set in the H IN position. If external sweep or internal sweep in a range other than the H IN are used, and external trigger synchronization is desired, the synchronizing signal is added to this terminal with switch (16) at Ext. position.

(11) TRIG.'D LAMP (Synchronization Indicating Lamp)
This lamp indicates whether or not trigger synchronization is operating. When it does not light, waveforms will be unstable (not locked in) or no trace will appear.

(12) TRIG. LEVEL (Synchronization Level Adjustment)
This is for stabilizing the starting point of trigger sweep at a proper level. If the fixed value is taken off the complex portion of the waveform under observation, trig. lamp (11) will go out and sweep will stop, and no trace will appear on the screen due to unblaning action of the CRT circuit. The same action will take place when there is no input signal.

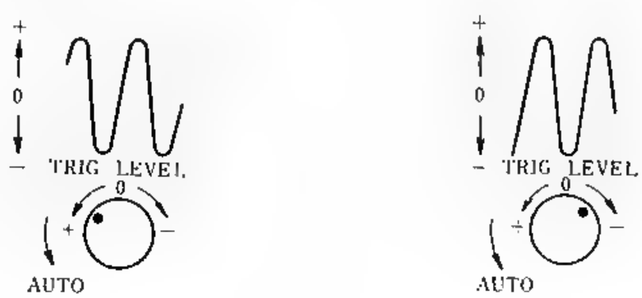


Fig. 4-3

Automatic synchronization is accomplished by turning this knob fully counter-clockwise until it clicks. In this case, horizontal bright lines (Traces) will appear even when there is no input signal, automatic synchronization will be performed around the approximate center of its waveform and the lamp (11) will light.

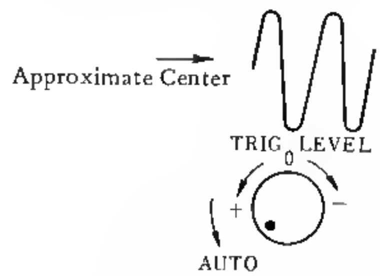


Fig. 4-4

(13) VARIABLE (Fine Adjustment of Sweep Time or Horizontal Sensitivity, Red Knob)

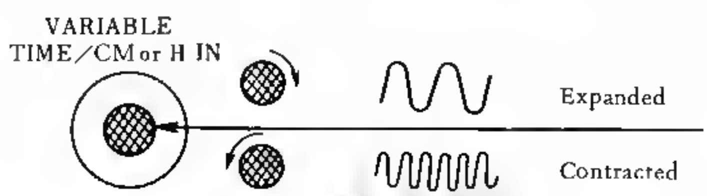


Fig. 4-5

It will not work when the switch (14) is in TV-V or TV-H range.. In H IN range and when a signal is fed to the horizontal axis by way of EXT. or TRIG. IN. terminal of (10), it will operate as a fine adjuster of horizontal sensitivity.

(14) TIME/CM. or H IN (Switching of Sweep Time and External Horizontal Axis, Black Knob)
Seventeen steps from 1μs/CM to 0.2s/CM. When measurement is made by the use of the indicated time, set the VARIABLE (13) (red knob) to CAL'D by turning it fully clockwise.

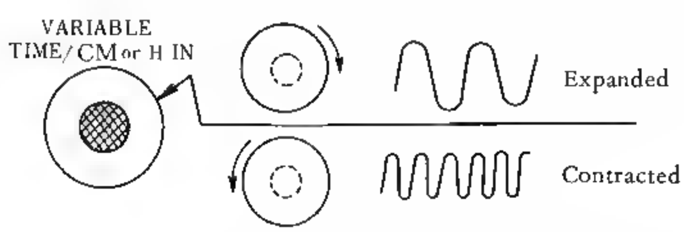


Fig. 4-6

The TV-V and TV-H ranges are preset to observe two cycles each of the vertical and horizontal periods of television on 10CM. In this case, of course, the VARIABLE control (13) does not work. With this knob (14) in the H IN range, the time axis circuit stops working, and a signal can be fed to the horizontal amplifier directly from an external source.

(15) ⟷ Knob

Clockwise rotation will shift the pattern to the right and vice versa.

PULL MAG X5

Switch for increasing gain of the horizontal amplifier. When pulled, the speed of TIME/CM,(14) will be multiplied five times; the sweep time will be 1/5 of the indicated value.

(16) TRIG. SOURCE (Synchronizing Signal Source Switch)

Selects synchronizing signal source. At INT., part of the signal taken from the vertical input is utilized for synchronization. Normal operation is performed with this switch at the INT. position.

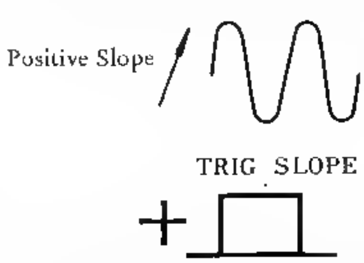
EXT. position is used when synchronization is desired from another signal in close relation to the period of the signal fed to the vertical input. This synchronization signal is fed to terminal (10).

(17) TRIG. MODE

In normal operation, this switch must be set to NORM. position. It must be set to TV position when the switch (14) is in TV-V or TV-H range, or when synchronization with the TV composite video signal is desired.

(18) TRIG. SLOPE (Synchronization Slope Switch)

If triggered sweep is desired against the positive slope of waveforms displayed on the screen, set this switch to (+) position, and against negative slope, set it to (−) position, whichever is applicable.



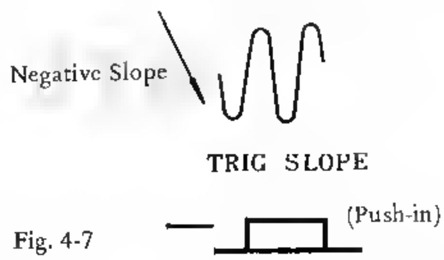
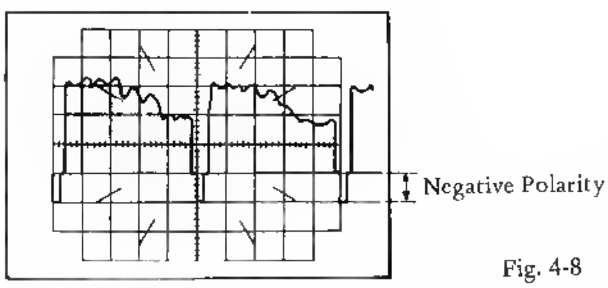


Fig. 4-7

For observation of composite T V video signals it is necessary to follow procedure (17) and at the same time select the same slope polarity as the synchronizing signal of the video signals.



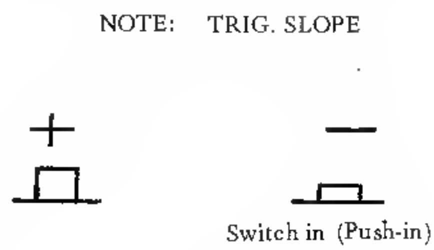


Fig. 4-8

For positive polarity, set the TRIG. SLOPE to (+) position.

(19) ↕ (Vertical Positioning Adjustment)

Clockwise rotation will move pattern up, and vice versa.

⊘ GAIN (Sensitivity Adjuster)

After (22) turned fully clockwise and clicked adjustment can be made to bring sensitivity of Vertical Amplifier to indicated value.

(20) (Ground Terminal)

(21) IN (Vertical Axis Input Terminal)

(22) VARIABLE (Vertical Sensitivity Fine Adjustment Red Knob)

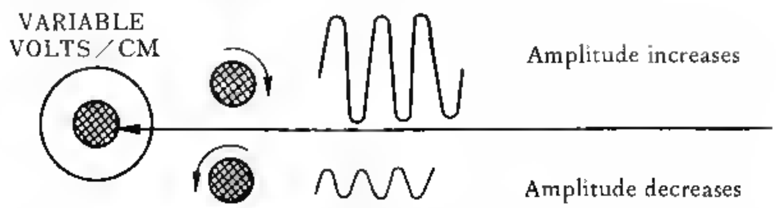


Fig. 4-9

(23) VOLTS/CM (Vertical Sensitivity Switch, Black Knob)

Eleven steps from 0.01V/CM to 20V/CM. If measurement is made with use of the indicated voltage sensitivity, set the VARIABLE (22) (red knob) to CAL'D by turning it fully clockwise until clicked. Note that the indicated voltage sensitivity is only applicable to the signal directly fed to Input Terminal (21). If a 10 to 1 low capacitance probe (such as LPB-15X and LP-8X made by LEADER) is connected to the Input Terminal (21), the values are ten times the indicated voltage.

SCALE IN Use

It will be noted that markings, A, B, and C, on the switch at different ranges correspond with the scale graduations on the graticule, see Fig. 4-10 and Fig. 4-11. When the VARIABLE (red) knob is at CAL'D, the scale in use will be illuminated. If the illumination is not required, set the RANGE ILLUM. switch, (36) on rear panel, at OFF.

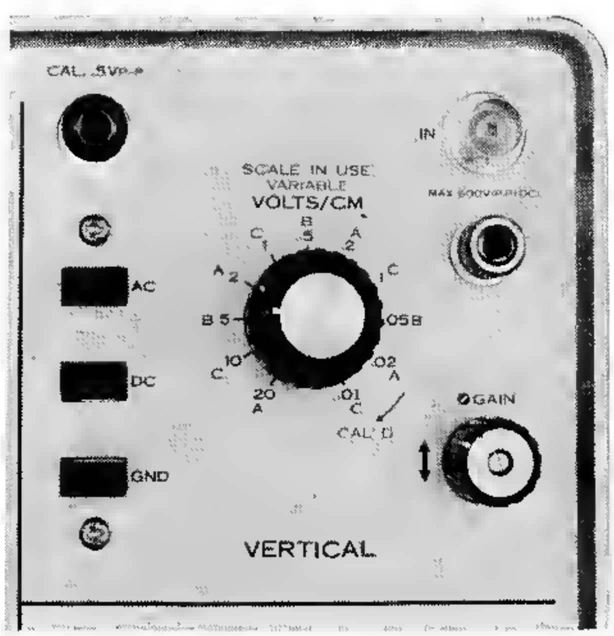


Fig. 4-10

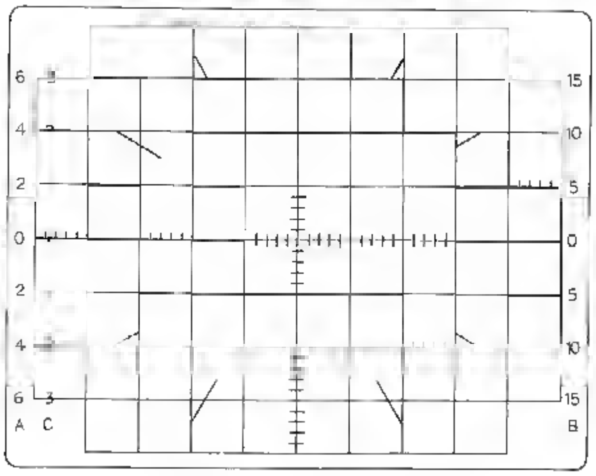


Fig. 4-11

(24) AC-DC-GND. (Alternating Current-Direct Current-Ground Switch)
Switches the coupling of the signal to Vertical Axis Input (21). DC coupling is obtained at the DC position, at AC position the direct current component is removed by a capacitor. The GND position grounds the amplifier input and opens Input Terminal (21).

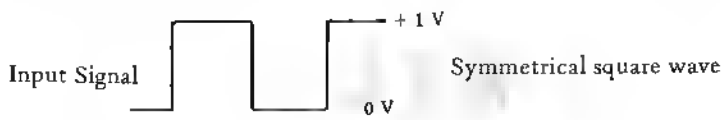


Fig. 4-12

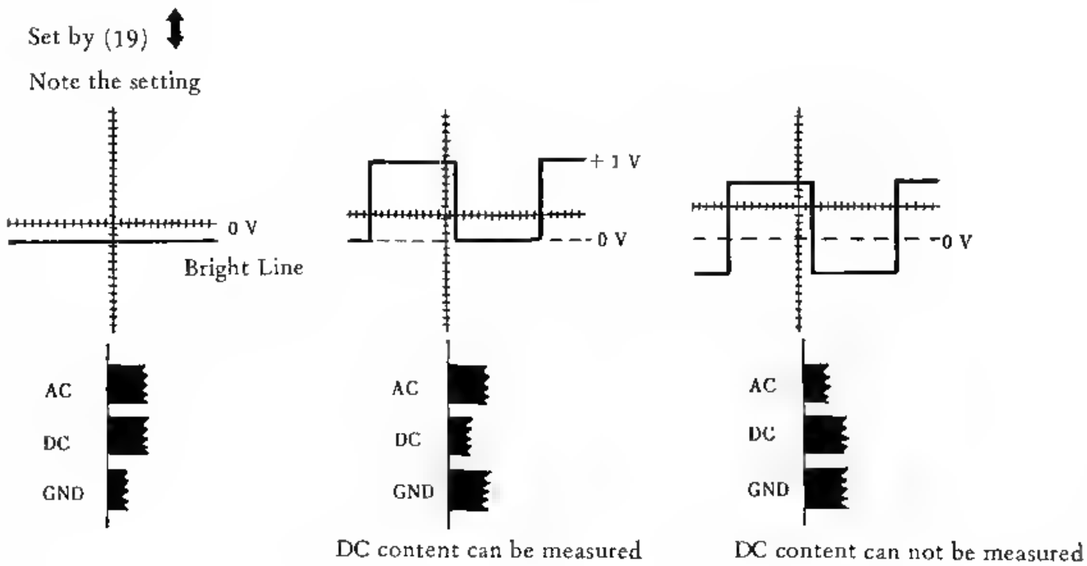


Fig. 4-13

(25) CAL 0.5Vp-p (Calibration Wave)

Standard signal output terminal for amplitude and waveform calibration. The frequency is a square wave signal, 0.5Vp-p, at 1kHz.

Fig. 4-14

4-2 Rear Panel

(26) Legs used for Vertical Viewing and/or A.C. line cord winding convenience.
Wind thc AC cord aroung legs.

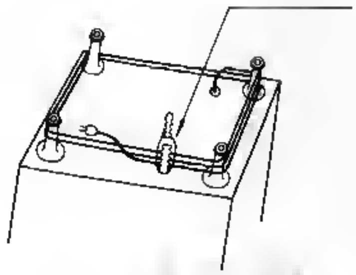


Fig. 4-15

(27) AC Cord

Obscrve caution relative to the rated line voltage.
(Refer to Section 3-1).

(28) FUSE

Fuse is released with the cap when rotated counter-clockwise. Note the type and rating of the fuse to be used. (Refer to Section 3-1).

(29) INTEN. MOD. Z (Intensity Modulation Terminal)

(30) Ground Terminal

(31) AC RECEPTACLE

Outlet for direct power connection to auxiliary equipment, independent of power switch and line fuse; indicated current rating is not to be exceeded.

(32) } (33) } VECTOR AMP (NORMAL) switches

To be set at VECTOR when the instrument is used as a vectorscope. Normally set at NORMAL position.

(34) } (35) } R-Y INPUT and B-Y INPUT terminals

For connections to R-Y and B-Y signals in a color TV set when the instrument is used as a vectorscope. The R-Y INPUT is used when checking modulation in an AM transmitter.

(36) RANGE ILLUM.

Switch for turning on the lamps used in illuminating thc relevant scales for the VOLTS/CM ranges, see (23).

5. OPERATING INSTRUCTIONS

The LBO-502 differs from conventional oscilloscopes in that a trigger signal obtained from the input signal triggers and controls the sweep signal generator circuit (Trigger Sweep). When a signal is fed to the input, trigger pulses synchronizing with the input signal are generated. These pulses start the sweep circuit and display bright lines or traces on the screen. If traces are desired to constantly show on the screen as with a conventional oscilloscope, set the TRIG LEVEL (12) at the AUTO position by turning it counter clockwise until clicked.

5-1 Preparation For Use

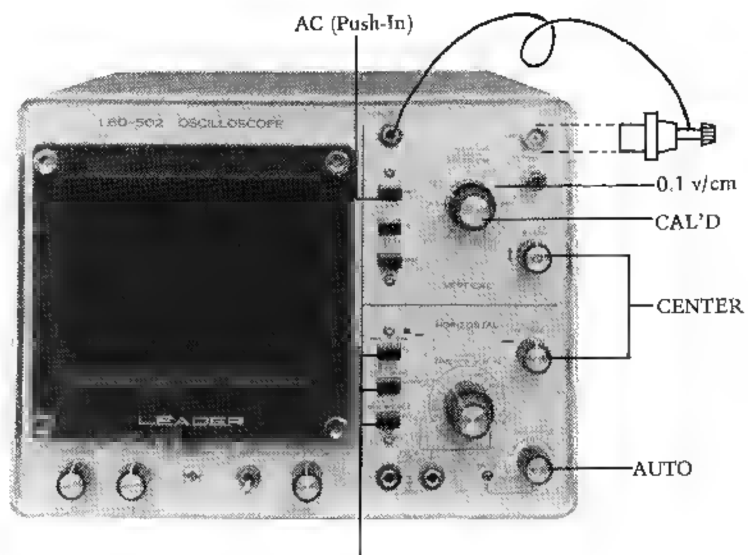


Fig. 5-1

Do not turn on power until all other settings shown on Fig. 1 have been made.

Notes: 1. Set the VERTICAL VARIABLE (red knob) (22) on the CAL'D position by turning it clockwise until a click is heard.

2. Set the TRIG. LEVEL (12) on the AUTO position by turning it counterclockwise until a click is heard.

After all settings are made, connect line cord to A.C. outlet. Turn the power switch to the POWER ON position. A display will appear on the screen in approximately ten seconds. The CAL. 0.5Vp-p is applied to the 0.1V/CM range, a square wave form with an amplitude of 5 CM shows on the screen. Since AUTO SYNC. setting is used a stable (locked) waveform is displayed. Position the waveform for best viewing by adjusting the INTEN., (4) FOCUS., (5) and/or (19) ↕ , (15) ↔ controls.

5-2 Auto Synchronization

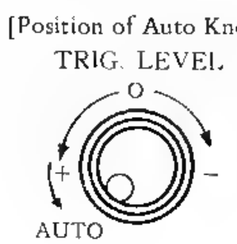


Fig. 5-2

AUTO Synchronization is used for synchronization of comparatively simple waveforms. With AUTO Synchronization, the sweep circuit is on even when no input signals are applied. Once an input signal is present the TRIG'D lamp (11) is lit and a synchronizing signal is developed from the input signal to lock in the input signal waveform. Thus, a trace will always be present in the AUTO synchronization position as in conventional oscilloscopes. (Example of AUTO Operation)

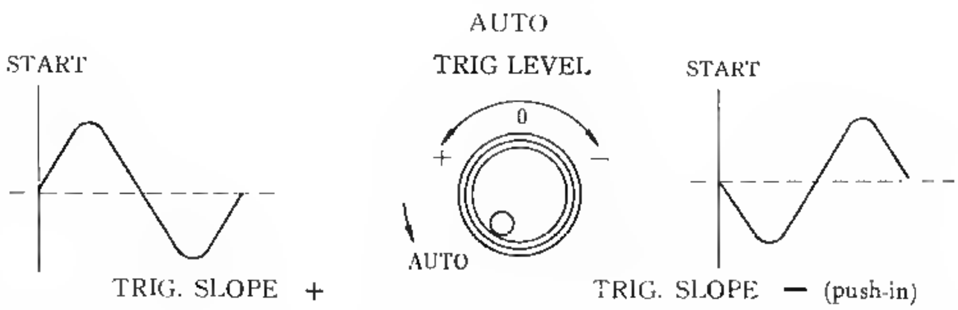


Fig. 5-3

During AUTO operation, sweeping always starts near the center of a waveform. Even if the amplitude of the input signal varies, synchronization is maintained as long as the amplitude does not fall below a minimum synchronization amplitude of 1 CM. When the waveform is difficult to stabilize (lock), increase the vertical amplitude or use the TRIG SLOPE switch, (18) choose the proper polarity for lock in of waveform. If complexity of the waveform still prevents synchronization, adjust the TRIG. LEVEL knob as explained in the next paragraph 5-3.

5-3 LEVEL Synchronization

It possible to start sweeping at any desired point of a waveform by adjusting the TRIG. LEVEL knob. (Example of LEVEL Operation)

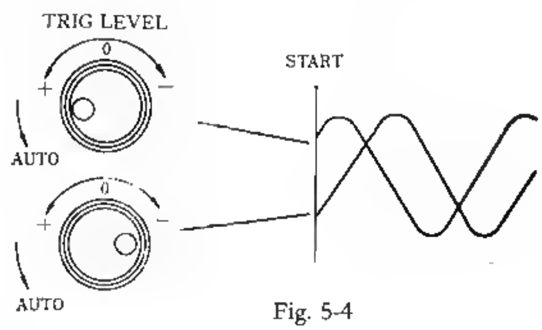


Fig. 5-4

If the LEVEL knob is turned as illustrated above, synchronization will be lost, or if no input signal is applied, bright lines (traces) on the screen will disappear as the sweep stops functioning. (These phenomena are inherent in a Trigger Oscilloscope.) Therefore, if LEVEL is set on an upper or a lower point of a waveform, even a slight change in the amplitude of the input signal can overrun a permissible range of fluctuation, causing the waveform to disappear from the screen. Namely, the sweep is halted. If it is difficult to obtain synchronization in the AUTO position, use LEVEL as shown below:

(Advantage of LEVEL)

AUTO. makes the sweep starting point unstable as shown above.

LEVEL and SLOPE make it possible to move the sweep starting point to obtain stable synchronization.

Fig. 5-5

5-4 Synchronization by EXT. TRIG. SOURCE

Although the TRIG. SOURCE is used normally with INT.; EXT. can also be utilized under certain conditions. The EXT. trigger is affected by a vertical axis input signal plus an additional synchronizing signal to the EXT. H or the TRIG. IN terminal. In this case, the frequency of the additional input signal must be the same as that of the vertical axis input signal or the two frequencies must have a whole number (integer) relationship.

Example of Use with a TV Set

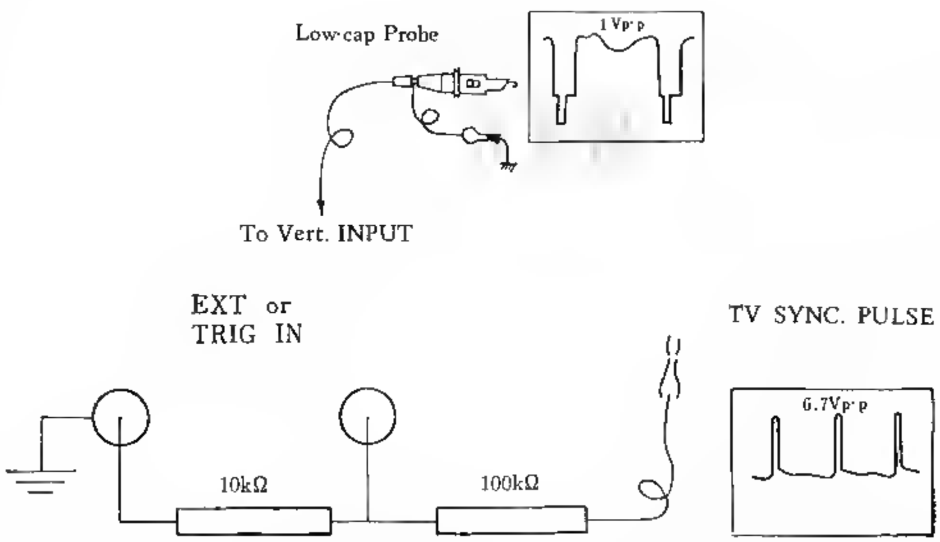


Fig. 5-6

In the observation of VIF detection output of complex or composite waveforms of a video amplifier, synchronization must be readjusted every time the signal changes its level. However, if only synch signals following synch separation from a TV set are added to the EXT. INPUT, then synchronization once attained will not be disrupted even if the magnitude of the vertical axis signal varies. (For Example, the point of measurement may be changed to another amplitude but the waveform will hold sync if a 0.1 – 2.0Vp-p signal is fed to the EXT. TRIG. IN (External Synchronizing Input) terminal. (If the signal is too great, attenuate the signal by means of a resistive network connected externally as shown above). In the case of horizontal pulses, just having a lead wire dangling inside the receiver will do for synchronization.

5-5 Synchronization To TV Waveforms

When the TIME/CM switch is set on the position of the TV. V range or TV. H range, the V or H sync. selector (Sync Separator) circuit readily functions on a composite video signal to present a stable waveform on the screen.

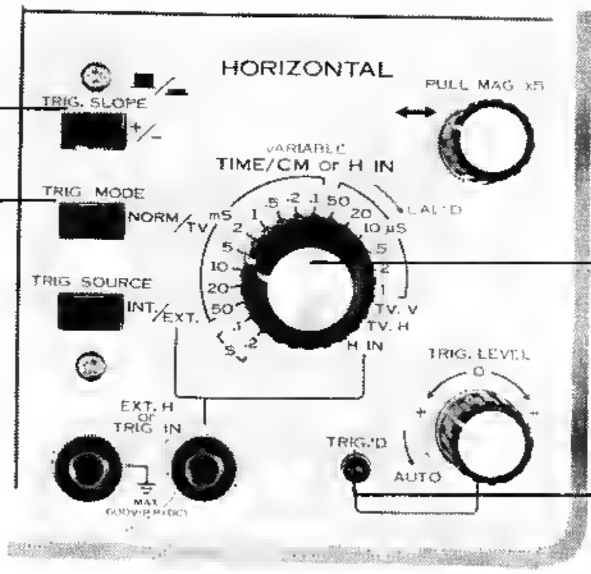


Fig. 5-7

Note: Refer also to No. 18 in Item 4-1.

5-6 Voltage Measurement

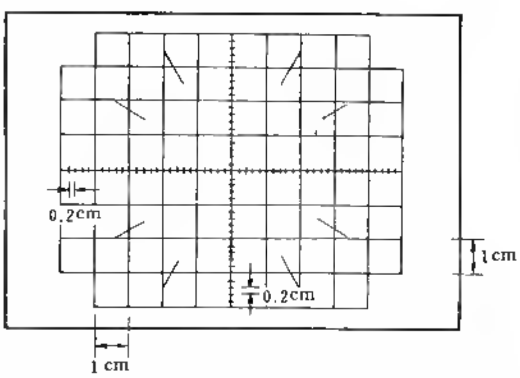
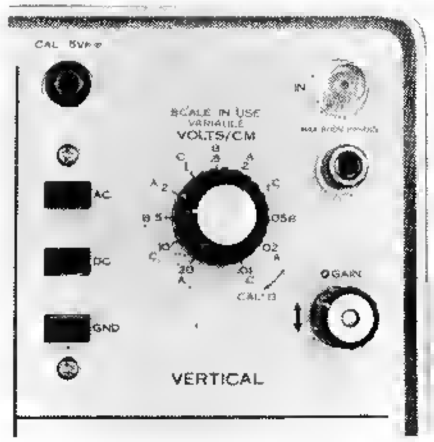


Fig. 5-8



The graticule scale is provided with 0.2CM and 1CM markings. When the VERTICAL VARIABLE (red knob) is turned fully clockwise till a click is heard, the CAL'D position is reached. The value indicated at the VOLTS/CM represents the value of voltage/CM of the display or waveform (peak value or DC value) and may be read directly from the scale.

5-6-1 Low Capacity Probe

When a low capacity probe (LPB-15X, LP-8X, etc.) is applied to the vertical axis INPUT, either the VOLTS/CM must indicate ten times the actual value or, conversely, measured voltages must be increased ten times. This applies to all measurements, either AC or DC, because the probe has a 10:1 attenuation factor.

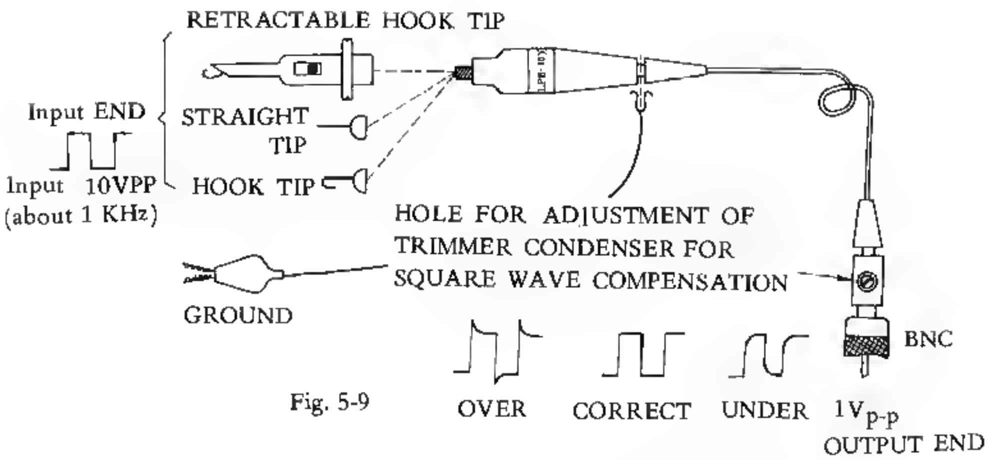


Fig. 5-9

A lo-cap probe is used to reduce loading effects upon the circuitry under test. Input impedance when the lo-cap probe is used is 10MΩ, 15pF or less.

5-6-2 AC Voltage

The AC voltage is the variable portion remaining after the DC component is eliminated, e.g. pulses and sine waves.

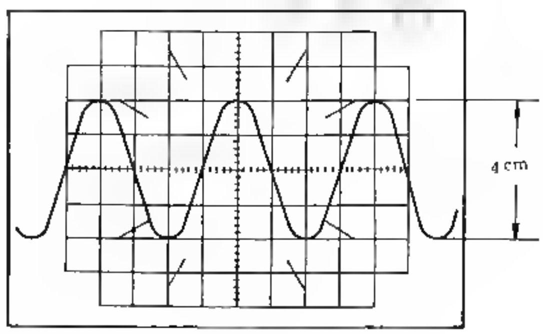


Fig. 5-10

As shown in Fig. 5-10, the voltage of the signal being measured is calculated as follows:
V = (Amplitude observed on the screen) x (Range indicated at the Volts/CM) Therefore, V = 4CM x 0.05V/CM = 0.2V(p-p)

The above represents an input signal fed by a lead wire directly to the INPUT (Input Terminal). The observed value must be increased ten times, if a low capacity probe of 10:1 attenuation type is used at the INPUT. (Example: Measurement using a lo-cap, 10:1 Probe)

VOLTS/CM: 0.2V/CM

Vertical Amplitude on the screen: 4CM

Probe: 10:1 low capacity type (LPB-15X, LP-8X, etc.)

V = (Amplitude on the screen, CM) x (VOLTS/CM, range) x (Probe's magnification, 10)

Therefore, V = 4CM x 0.2V/CM x 10 = 8V(p-p)

If the input waveform is a sine wave, the measured voltage (p-p) can be converted to effective voltage (r.m.s.). The following relationship exists between the r.m.s. and the p-p values: r.m.s. Voltage $\times 2\sqrt{2}$ = p-p Voltage where $2\sqrt{2} = 2.828$

0.2Vp-p for instance, is converted to r.m.s. value as follows: $0.2\text{Vp-p} = \frac{1}{2\sqrt{2}} \times 0.2\text{V r.m.s.} = 0.0707\text{V r.m.s.} = 70.7\text{mV r.m.s.}$

5-6-3 DC Voltage

DC voltage is measured by observing the distance and the direction of the movement of the vertical position.

An upward shift of the bright line (trace) represents (+) and a downward shift (–).

VOLTS/CM: 2V/CM

TIME/CM: 0.1ms/CM

TRIG. LEVEL: AUTO.

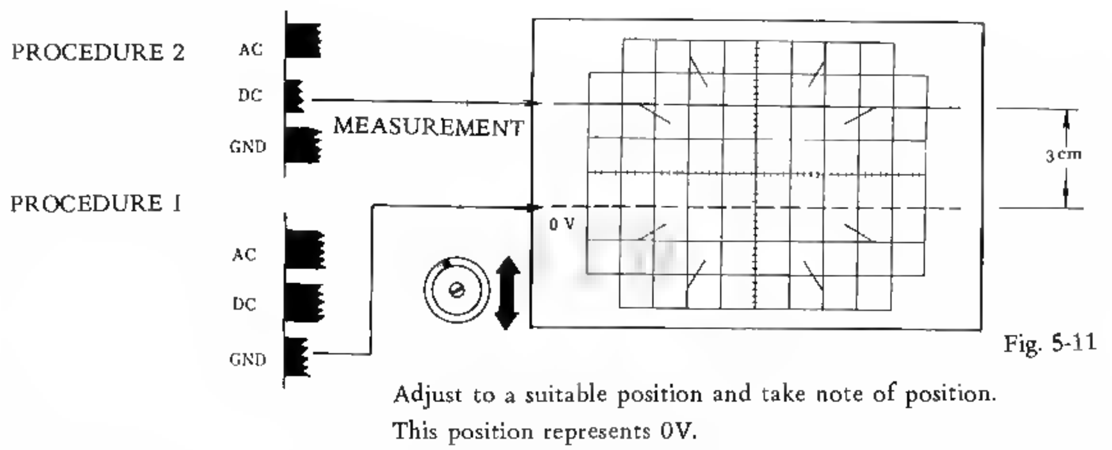


Fig. 5-11

As shown above, the upward shift of the bright line (trace) indicates positive polarity. The value is obtained in the same manner as for the measurement of AC voltage, i.e.

$V = +2\text{V/CM} \times 3\text{CM} = +6\text{V}$

5-6-4 AC Voltage Containing OC Component

When it is desired to observe the distribution of DC voltage component within an AC wave form, the "DC" and the "GND" are used as in the case of the measurement of DC voltage.'

VOLTS/CM: 1V/CM

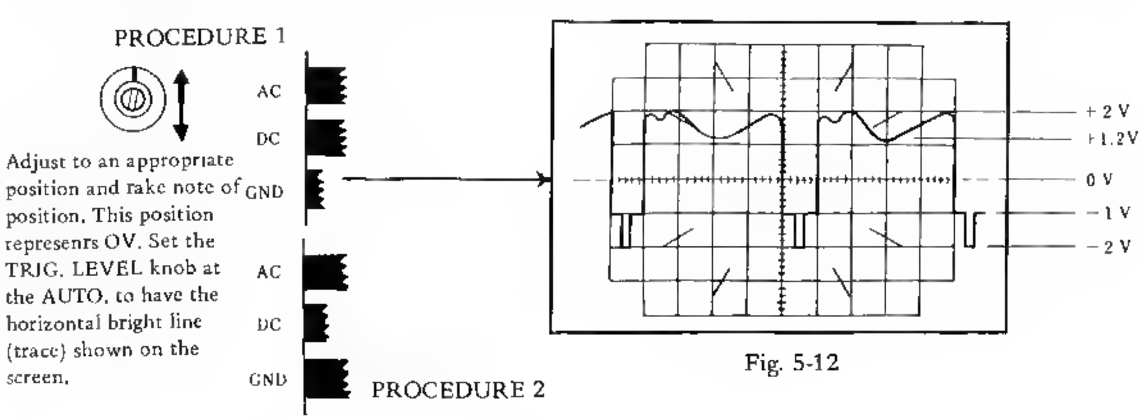


Fig. 5-12

Waveform will shift up or down from 0V. Amount of shift determines the value of D.C. Component. An upward shift represents a positive value; a downward shift represents a negative value.

Note: When the DC component is much greater than the AC content of the waveform, measurement by the procedures above will result in a very small waveform on the screen. Turning the VOLTS/CM range clockwise in an attempt to enlarge the waveform will merely let the DC component push the waveform off the screen making observation impossible.

5-6-5 High Frequency Voltage

In making high frequency voltage measurements careful consideration must be given to the frequency characteristics of the vertical axis amplifier of the LBO-502. When a sine wave input signal with a constnat voltage is applied the vertical axis input terminal, amplitude shown on the screen decreases along with the frequency.

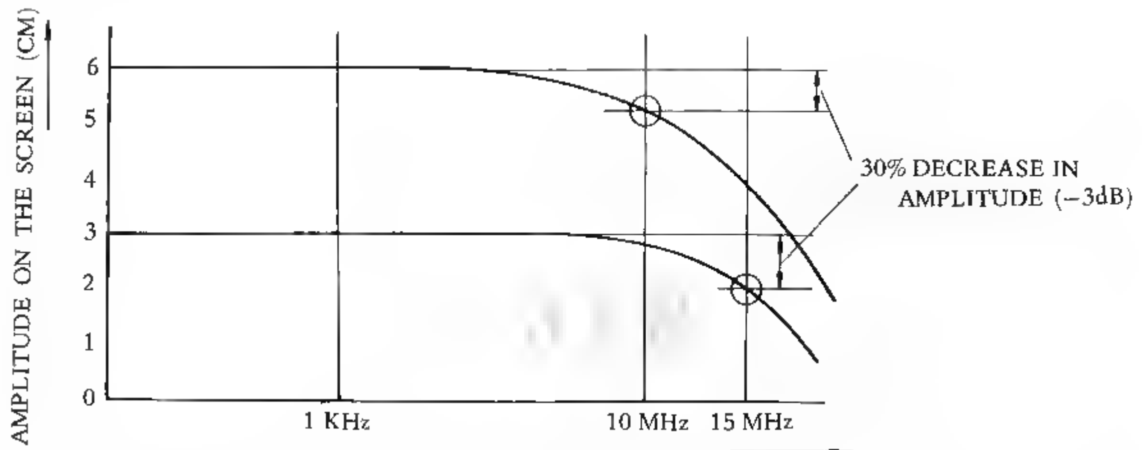


Fig. 5-13

For example, with an amplitude of 4.2CM on the screen, 1V/CM range and a frequency of 10MHz:

$$V = 4.2CM \times 1V/CM \times \frac{1}{1-0.3} = 6V$$

Further, high frequency measurement involves very small input capacities, the circuit being tested will be adversely affected unless input impedance is sufficiently high. For this reason, it is advisable to employ a low capacity probe.

5-7 Pulse Measurements

With a time axis incorporated, the width (Tw) or the rise time of a pulse can be measured directly on the screen in a manner similar to that for the measurement of voltage.

When the VARIABLE (red knob) for the time axis is turned fully clockwise the CAL'D position is reached, the value indicated at the TIME/CM represents time per CM. (If setting is at MAG x 5, the indication will be one fifth the value actually shown on TIME/CM.)

Pulse width (Tw) is measured as follows:

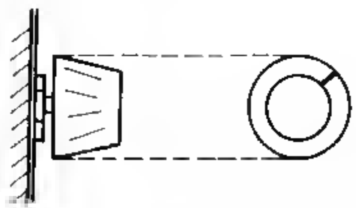
Tw = (TIME/CM range) x (Horizontal Distance CM)

5-7-1 Magnifier

The Magnifier increases the gain of the horizontal amplifier by five, all the ranges of the TIME/CM switch, i.e.,TV-V, TV-H, EXT. H IN ranges, are operational.

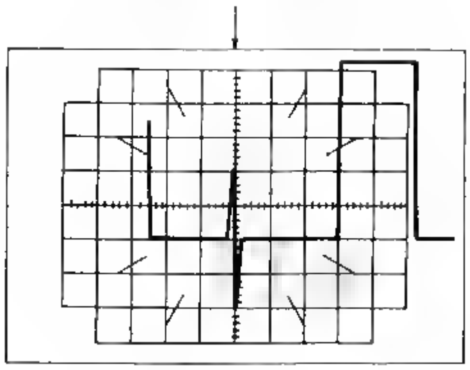
This Magnifier is used for the detailed observation of a portion of a waveform. This is especially convenient when the enlargement of a portion of a waveform, away from its sync. sweep starting point, is desired.

Procedure 1
MAGNIFIER: X 1

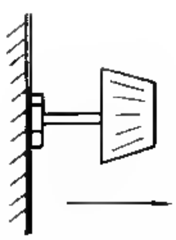


Push-in (normal)

PORTION BEING OBSERVED



Procedure 2
MAGNIFIER: X 5



Pull out

5 TIMES MAGNIFICATION
TO THE BOTH SIDES.

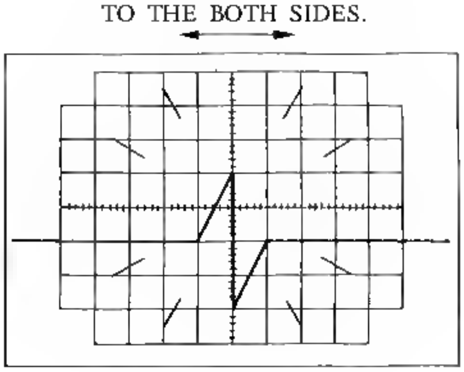


Fig. 5-14

Place the portion being observed on the center of the scale by means of the horizontal positioning knob.

Note: When MAGNIFIER x 5 is used, brightness is decreased. Furthermore, as only one fifth the normal size of a waveform is shown on the screen, the waveform is visible only intermittently in the case of slow sweep. Time must also be calculated based on one fifth the value measured. Unless otherwise required, always leave the MAGNIFIER at the x 1 position.

5-7-2 Rise Time of Pulse

The rise time of a pulse is measured making use of the MAGNIFIER.

Procedure 1

TRIG SLOPE: – (Push-in)

MAGNIFIER: x 1

Set TIME/CM so that the rising portion of the pulse is caught on the screen. Position the VARIABLE (red knob) to the end of its clockwise rotation.

Procedure 2

Position the pulse so that the flat portion is placed on the screen at a height with no fractional values, e.g. just 4cm or 6cm. (This is for easy calculation of 10% upper and lower deduction, when required.)

Procedure 3

Place the rising portion of the pulse on the center line of the scale by means of the horizontal positioning knob.

Procedure 4

Make certain the MAGNIFIER is set at x 5 (Pull-out)

Shown below are examples of measurement and calculation:

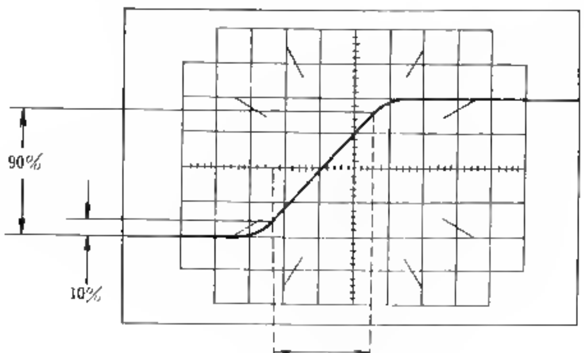


Fig. 5-15

Calculation of rise time;

Tr = (TIME/CM range) x (Horizontal Distance on the screen, CM) x (Magnification Rate, 1/5)

Tr = 2μs/CM x 2.9CM x 1/5 = 1.16μs

On the basis of this rise time, Tr, the upper limit frequency of the amplifier, fc (–3dB), can be determined.

For instance, on the assumption that the above measurement was performed with input pulses which were fast enough and that the value calculated represents the output waveform of the amplifier being tested, then the upper limit frequency, fc, of the amplifier can be found.

This is relationship to determine fc (–3dB) from rise time of square wave pulse.

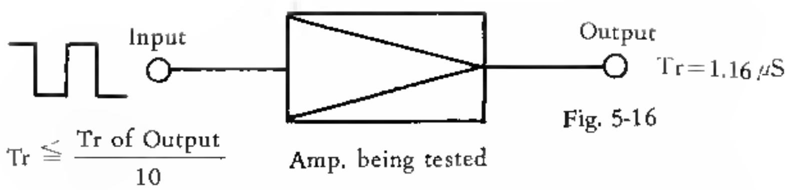


Fig. 5-16

$$Tr \leqq \frac{\text{Tr of Output}}{10}$$

$$\left(fc = \frac{0.35}{Tr} \right) = \frac{0.35}{1.16 \times 10^{-6}} = 0.3 \times 10^6 = 300\text{kHz}, \ (-3\text{dB})$$

Units of time are enumerated below for reference:

Millisecond; ms = 10^{-3} Sec.

Microsecond; μs = 10^{-6} Sec.

Nanosecond; ns = 10^{-9} Sec.

Picosecond; ps = 10^{-12} Sec.

In the measurement of a comparatively fast pulse, the rise time of the LBO-502 must also be taken into consideration.

Rise time of The LBO-502; Ta = 0.023μs

Rise time of the output of the amplifier being tested; Ti

Rise time observed on the screen; Tr

With this data, the true rise time Ti is calculated:

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

5-8 Frequency Measurement

Frequency can be calculated from one period of a repetitive wave form.

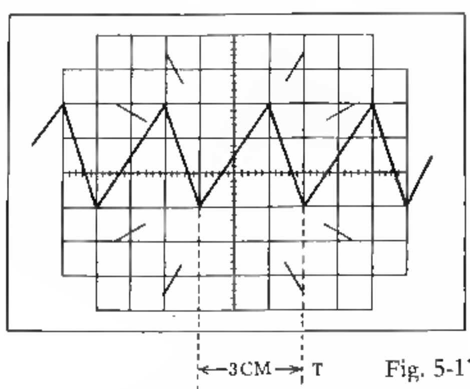


Fig. 5-17

Time of 1 period is:

T = [TIME/CM range] × [Horizontal Distance of 1 period] = 50μs/CM × 3CM = 150μs

Frequency, f, is:

$$f = \frac{1}{T} = \frac{1}{150 \times 10^{-6}} = 0.67 \times 10^4$$

$$f = 6.7 \times 10^3 = 6.7\text{kHz}$$

Units of frequency are enumerated below for reference:

Kilohertz; kHz = 10^3 Hz

Megahertz; MHz = 10^6 Hz

Gigahertz; GHz = 10^9 Hz

5-9 TV-V and TV-H Range

The TIME/CM switch is provided with two special-purpose sweep ranges, TV-V and TV-H, for the convenience of servicing TV sets. These two ranges are preadjusted at 33.3ms/10CM and 127μs/10CM respectively, while the function of the VARIABLE is nullified. Since the function of the MAGNIFIER is left effective, it is still possible to magnify a specified point of a waveform for minute observation.

Also, as a TV sync. selector (sync. separator) circuit is built in, the observation of the waveform of a composite video signal is performed following the procedures as described in Item 5-5.

Notes: 1. When the brightness of a TV picture makes a sudden change, the composite waveform shown on the screen may disappear for an instant due to the trigger signal being developed from a rapidly changing portion of the composite signal.

2. In the case of circuits similar to color demodulators, if there are no horizontal sync. pulses present as shown here the T.V. sync. selector circuit will not function. The EXT. TRIG. SOURCE, if used as explained in Item 5-5, serves to present a locked in waveform without fail.

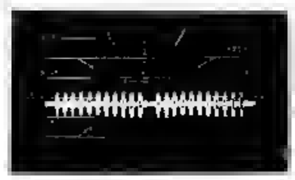


Fig. 5-18

5-10 EXT H IN

When the TIME/CM switch is set for the H IN range, the internal time axis circuit ceases to function and only the horizontal axis amplifier is operating. A signal may then be fed through the EXT H IN terminal.

MAG. x 5 is also left effective, when the VARIABLE is turned to its limit, thus the deflection sensitivity of the horizontal axis is less than 200mV/CM. (The less the value, the higher the sensitivity.)
If used in combination with a sweep generator, it is possible to observe frequency response, or to display Lissajous figures on the screen by feeding separate sine waves to the V and H inputs. For combined use with a sweep marker generator, such as type LSW-330, connect the V scope to the VERTICAL INPUT and the H scope to the EXT. H IN and follow the rest of the details as outlined in the LSW-330 operation manual.
(Example of how to check Diode Characteristics)

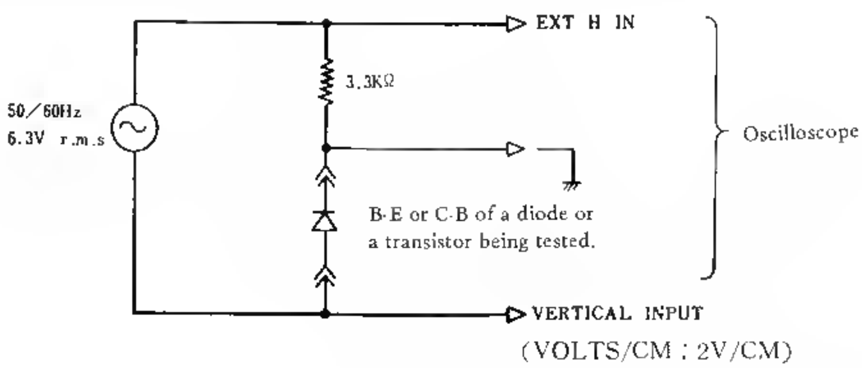
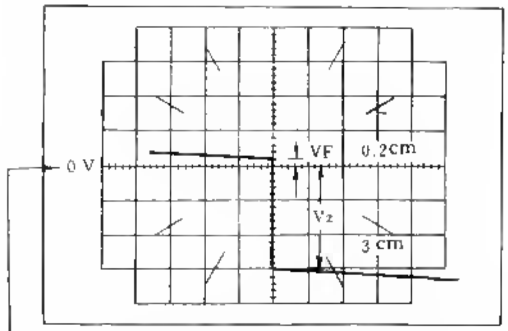


Fig. 5-19



From the waveform shown, Zener voltage Vz and forward voltage Vf can be calculated as follows:

$$V_f = 2V/CM \times 0.2CM = 0.4V$$

$$V_z = 2V/CM \times 3CM = 6V$$

Fig. 5-20

When the AC-DC-GND switch is set for GND, perform measurement after placing the bright line trace on this position by adjusting the ↕ knob.

Note: Determine the suitable values of AC voltage and series resistance, based on rated values of both forward and backward currents for the diode being tested.

5-11 VECTORSCOPE Application

5-11-1 Color TV Signal Checking: Gated Rainbow Method

The signals in a color TV set can be observed for checking and adjusting the circuits for color saturation, or amplitude, and color tint, or hue, when used with a color bar pattern generator. Suggested LEADER Color Pattern Generators are: LCG-388, -382, -384B, -386 and -381.

GATED RAINBOW PATTERN

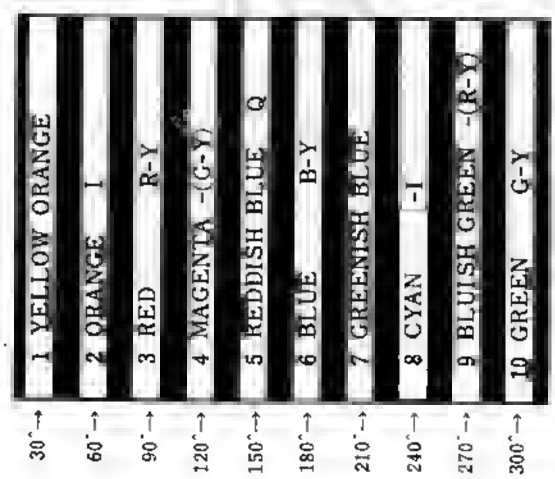


Fig. 5-21

The ten colors of the gated rainbow pattern are shown in Fig. 5-21.
Circuit adjustments can be made through observation of the respective waveforms as shown in Fig. 5-22.

Notes: Waveforms are shown for pickup at the CRT grids.
For cathode pickup (cathode modulation system), the waveform displays will be inverted.

The oscilloscope can be synchronized with the horizontal sync signal in the following manner: Set the TRIG SOURCE at "EXT". Connect a short insulated wire to the EXT TRIG IN terminal and hang this wire at a suitable place within the TV set to pick up the horizontal pulse signal by "static" coupling. The waveforms should be "near sinewave" in shape at the peaks; if not, then color saturation is indicated.

Waveforms at Grid Terminals (or at cathodes, with inverted display).

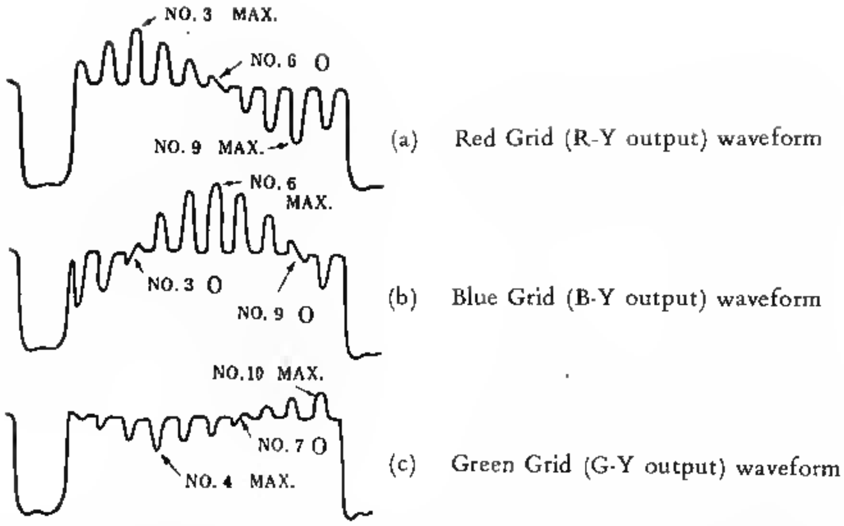


Fig. 5-22

In the rainbow pattern tests, if counting the peaks in the waveforms is tedious, use of LEADER Color Pattern Generator, LCG-388, is recommended. With use of this generator, the three respective waveforms will be displayed in the manner shown in Fig. 5-23.

R-Y, B-Y and -(G-Y) Waveforms using LCG-388

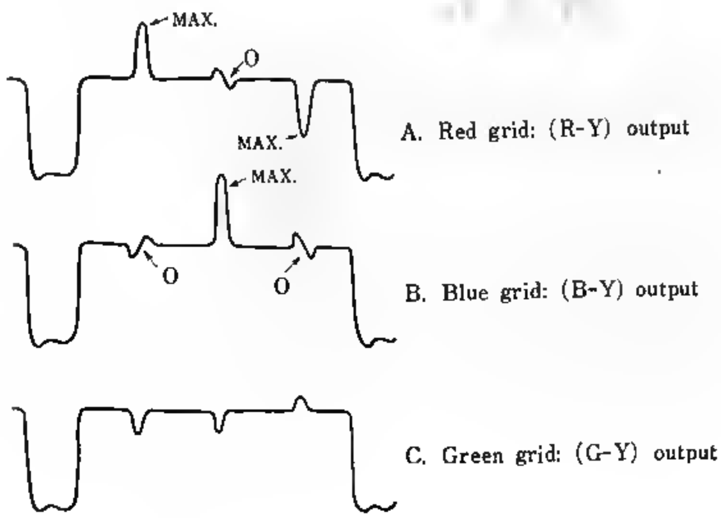


Fig. 5-23

5-11-2 Vector Display of R-Y and B-Y Signals

By connecting the R-Y and B-Y grids (or cathodes) respectively to the R-Y and B-Y terminals at back of the oscilloscope, the vector characteristic, Fig. 5-24, can be observed.

Phase relationship of the gated rainbow signals

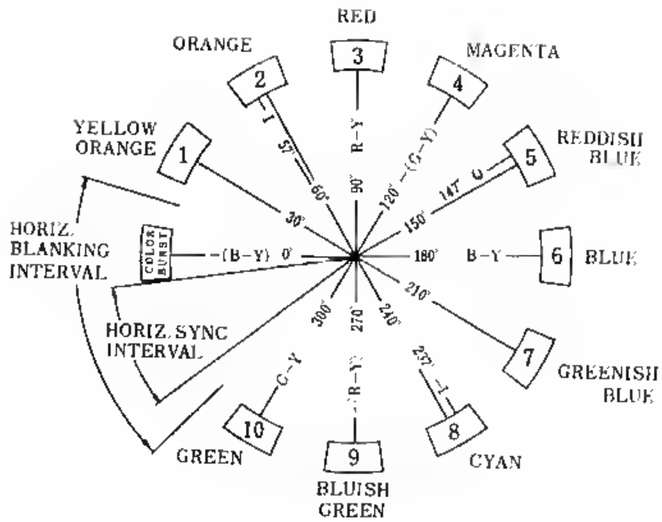


Fig. 5-24

The switch and control settings on the front panel for the vector display are shown in Fig. 5-25. Note that the settings are not used for vertical or horizontal inputs; only the positioning controls are to be used.

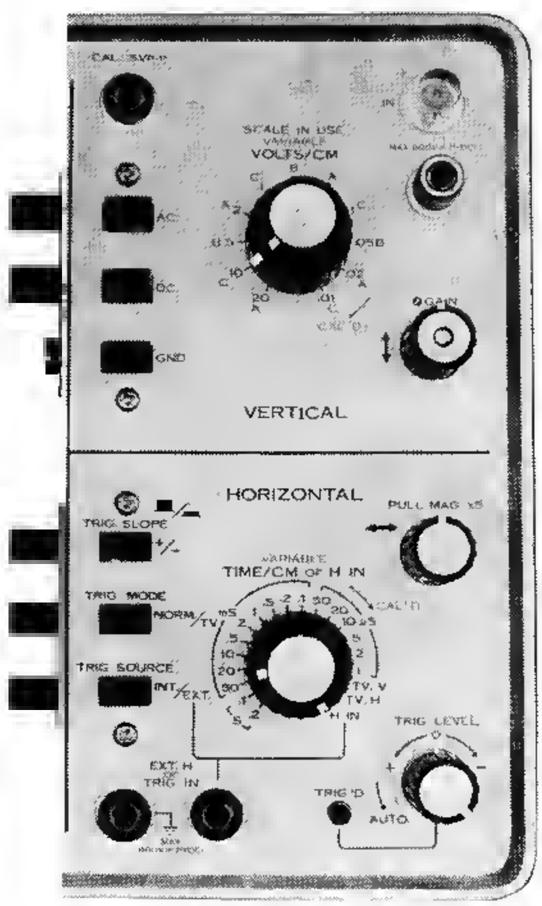


Fig. 5-25

The switch settings and input connections at the back of the oscilloscope are shown in Fig. 5-26.

Switch settings: Both slide switches at the VECTOR side.

Connections: R-Y signal to R-Y terminal.
B-Y signal to B-Y terminal.
INTEN MOD ground to chassis ground.

The gated rainbow signal from the color bar pattern generator is connected to the input of the color TV set.

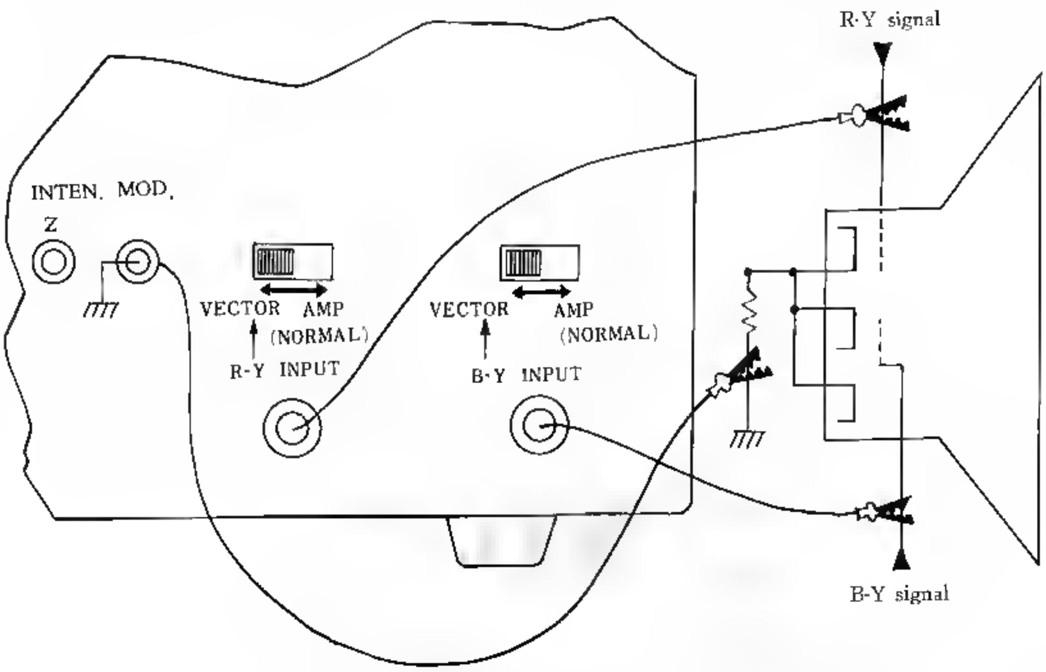


Fig. 5-26

When the tint (or hue) control in the set is adjusted, the pattern shown in Fig. 5-27 will be displayed.

Adjustments are made to properly align the peaks on the short slanted lines on the graticule.

If there is flattening of the "peaks" in the pattern, over-control or saturation is indicated.

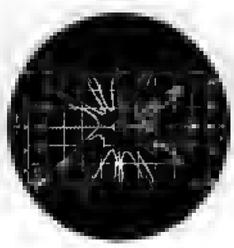


Fig. 5-27

IMPORTANT NOTE: After the vector pattern test, always set both slide switches at the AMP position.

5-12 Checking Modulation in AM Transmitters

The oscilloscope can be used in checking the modulation in AM transmitters up to 30MHz, with direct connections to the R-Y input. The deflection sensitivity is approximately 30Vp-p/cm.

PRECAUTION: Always turn off the transmitter power when connecting or disconnecting the leads.

A. Envelope Method.

The connections and switch settings are shown in Fig. 5-28. Note that the B-Y slide switch is at AMP. The sweep time depends on the audio modulation frequency; set for a two cycle display.

Setup for Envelope Method:

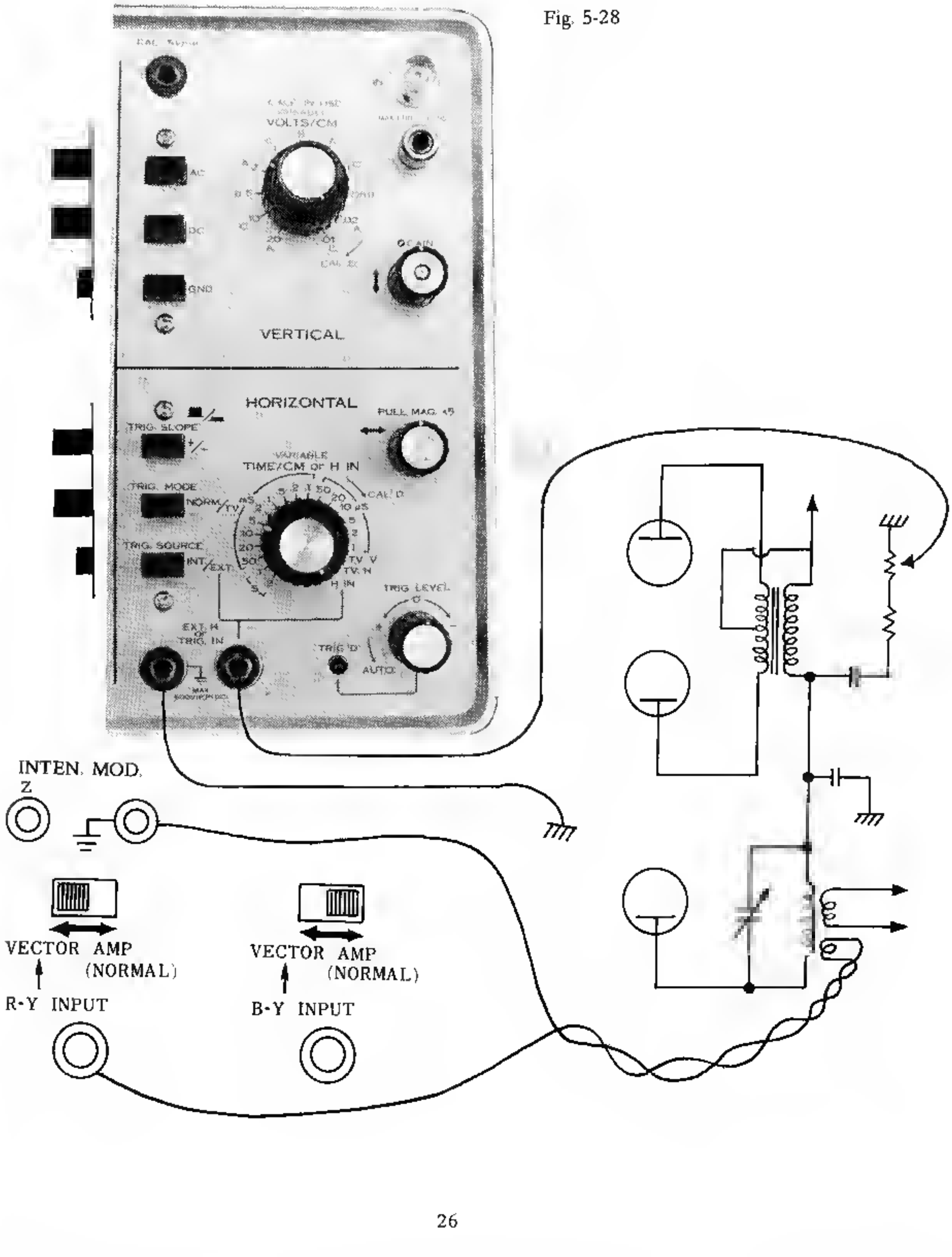


Fig. 5-28

The degree of modulation is calculated from the following relation –

$$\text{Modulation in } \% = \frac{\text{Emax} - \text{Emin}}{\text{Emax} + \text{Emin}} \times 100$$

Where Emax and Emin are shown in Fig. 5-29.

Envelope Pattern:

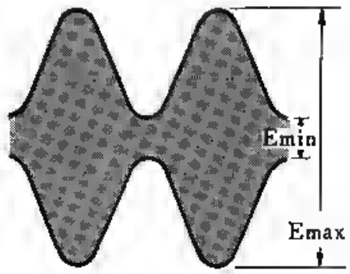


Fig. 5-29

B. Trapezoid Pattern Method.

In this method, the connections are the same as shown in Fig. 5-28. The switch settings are the same except that the TIME/CM is set at H IN.

The displayed pattern is shown in Fig. 5-30.

The degree of modulation is calculated as given for the envelope method.

Trapezoid Pattern:

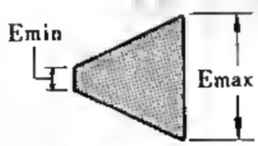


Fig. 5-30

5-13 Time Measurement and Frequency Marking

With intensity modulation of the CRT beam, it is possible to make time (period) measurements with use of an accurate external pulse generator. Furthermore, frequency markers can be applied to the response curves when the oscilloscope is used in circuit alignment procedures.

The signal, unknown time or detected sweep output, is connected to the INPUT. The panel controls are set for waveform observation or sweep operation.

Input from the pulse generator, or marker generator, is connected to the INTEN. MOD Z terminals on the rear panel.

The pulse input voltage required is in the range from 5Vp-p to 30Vp-p. Positive pulses create dark spots; negative pulses bright spots.

6. CIRCUIT DESCRIPTION

The circuits which comprise the LBO-502 will be described briefly in this section. Refer to the block diagram and schematic.

6-1 Vertical Input

The signal under examination at the INPUT connector is applied to the AC-DC-GND Push switch for AC coupling through a blocking capacitor or is directly coupled (DC). A 11 step attenuator is used to lower the input voltage to suitable levels for amplification. The input voltage in volt per CM deflection is adjusted by suitable combination of four frequency-compensated attenuator pads.

6-2 Amplifiers

6-2-1 Vertical Preamplifier

The signal from the input attenuator is fed to FET Q403 by way of the input protection circuit of Q401 and Q402. After the high input impedance of the input is converted to a low impedance at Q405, it becomes a balanced output signal through Q407 and Q408.

Q404 and Q406 act as a temperature compensation circuits to cancel direct current drift.

6-2-2 Horizontal

The operational amplifier configuration, Q803~Q805 is used in the horizontal deflection stage. The amplification is dependent on the ratio of the feedback 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, Q806~Q808 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 for impedance conversion. The input is AC coupled and includes a diode for protection against voltage overload.

The X 5 magnification raises the gain by a factor of five. The spot position is adjusted by varying the bias on the base of Q803

6-3 Time Base

Control of the triggered sweep with calibrated speeds is accomplished as follows. A triggered signal from the input is picked off at Q408 in the vertical amplifier and through the buffer Q411then to the polarity changer Q601-Q604. The external triggering is applied from the EXT H or TRIG. IN jack. The TRIG LEVEL control, VR603. 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 trigger wirh Q605-Q606 is used for waveshaping and generation of sharp pulses. These pulses are applied to the sweep gating and switching multivibrator made up of Q612-Q613.

Sawtooth waveforms are generated by the Miller integrator consisring of Q615-Q617, D610, D611. The TIME/CM switch controls the sweep timing in μs, ms and second per CM., 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 Q618, Q619, 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 VR608. The sweep is prevenred from starting, or being triggered, until the sweep voltage has dropped to zero.

The pulse for unblanking is picked off at the multivibrator output by Q614. In use, the pulse extinguishes the beam when there is no sweep action due to absence of the triggering signal. When the signal is applied to the intensity control circuit of the CRT. the trace is displayed.

When set to AUTO and the trigger pulse is not generated at the trigger shaper, the one-shot multivibrator consisting of Q608 and Q609 will be OFF for Q609, OFF for Q610 and ON for D606 lowering the STABILITY presetting of VR606, thus the sweep loop made up of Q612 to Q618 will be free running.

When trigger pulse is generated at the trigger shaper, the pulse will be added to the one-shot multivibrator through Q607.

Q609 turns on only when the pulse arrives, because of the time constant of C612 and R624 to R626 in the collector circuit of Q609.

Then, Q610 turns ON, D606 turns OFF, and VR606 returns to its initial triggered sweep condition.

6-4 CRT Section

The CRT, V101, is a 5-inch flat-face type operated with an accelerating potential of 1800V.
To intensity the beam only when the sweep is in operation, unblanking action is used. The control signal from Q614 is amplified to apply apprxoimately 160Vp-p to grid No 1 of the CRT.

Voltage Calibrator

The 0.5 Vp-p voltage used in calibration of the vertical sensitivity is generated with a multivibrator Q904-Q905. The square waveform, at 1kHz is fed to the amplifier Q906. The output voltage is taken off adjuster VR901 at the collector circuit.

Power Supplies

The following power supplies are used in the operation:

TYPE	OUTPUT Voltage	USE
Regulated	+12V	Vertical Preamplifier
	+27V −27V	Amplifier, time base, Voltage calibrator
Unregulated	−1600V	CRT acceleration voltage
	−40V	Vertical Output Amplifier
	+210V	Vertical output amplifier, Unblanking circuit, Astigmatism adjuster, CH-1, CH-2 and TRIG'D LAMP.
	+320V	Horizontal Amplifier

CHART 6-1

7. MAINTENANCE

7-1 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, 1800V approximately, when checking the CRT circuit.

7-2 Exposing the Chassis

The covers are removed by unscrewing the 11 screws which hold them to the frame.

Fig. 7-1

Removing the cover screws.

7-3 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-502 MAIN label)

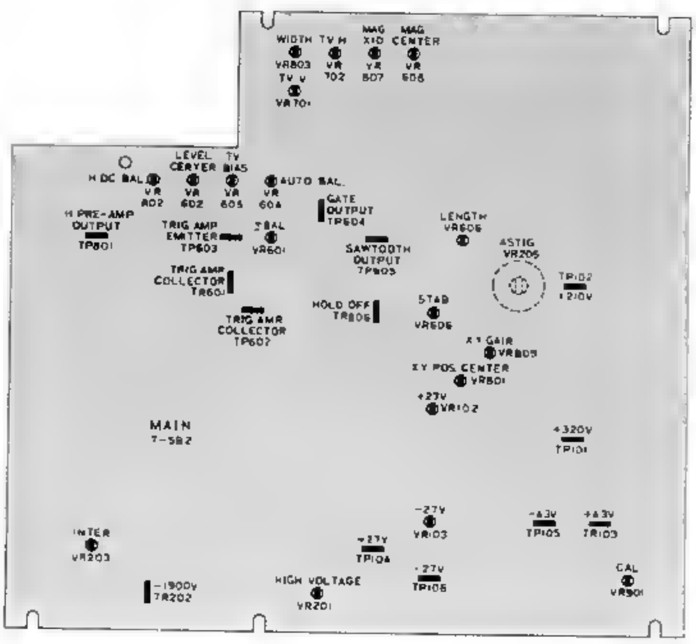


Fig. 7-3

(Attenuator Trimmers, top view label)

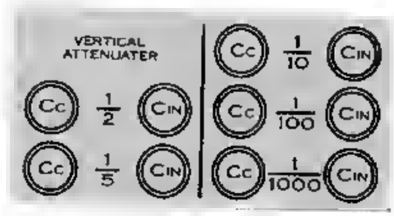


Fig. 7-2

(LBO-502 V-AMP label)

Fig. 7-4

7-4 CRT Circuit

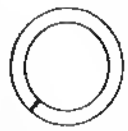
7-4-1 Limited control of spot intensity

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 104	+27	±2	VR102
TP 106	−27	±2	VR103
TP 202	−1600	±100	

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

INTEN



INTENsity as shown at the right

TRIG LEVEL to AUTO (switched)

TIME/CM to 5 ms

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

7-4-2 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 1 to 2mm per 10cm. This amount can be corrected by Scale tilt knob. (If the sloping is great, then the CRT must be repositioned by loosening the clamp at front of the CRT. CARE!! High voltage, −1800 approx., is present at the INTENsity and FOCUS controls and caution must be exercised.)

7-4-3 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 VR205.

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

7-5 CAL 0.5Vp-p Output

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

The proper voltage is 0.5Vp-p ±3%. If necessary, adjust VR901 CAL adjuster.

7-6 Vertical Amplifier Circuit

7-6-1 Improper Square Wave Display

The display of the square wave input should have correct value and be clean cut.

If not, adjustments must be made using a lab grade square wave generator at about 1kHz and a capacitance meter. The latter is used to adjust the input capacitance of CIN to 40pF.

Trimmers for the different attenuator pads are listed in CHART 7-1.

CHART 7−1 ATTENUATOR TRIMMERS

PAD	Cc	CIN
1/2	VC301	VC302
1/5	VC303 .	VC304
1/10	VC305	VC306
1/100	VC307	VC308
1/1000	VC309	VC310

Refer to 7·3 for location of trimmers

Adjust according to the steps in CHART 7-2.

CHART 7−2 ORDER OF TRIMMER ADJUSTMENTS

STEP	VOLTS/CM SETTING	TRIMMERS	
		SQUARE WAVE Cc	FOR 40PF INPUT CAPPACITANCE Gn
1	0.01	–	
2	0.02	VC301	VC302
3	0.05	VC303	VC304
4	0.1	VC305	VC306
5	0.2, 0.5	CHECK ONLY	
6	1	VC307	VC308
7	2, 5	CHECK ONLY	
8	10	VC309	VC310
9	20	CHECK ONLY	

NOTES: 1. The order of the steps must not be changed.

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

7·6·2 Vertical shift when VOLTS/CM switch is changed.

Control settings for check:

AC-DC-GND switch to GND.

TRIG. LEVEL Knob to AUTO (switched).

Short the VERTICIAL INPUT to ground.

Rotate the VOLTS/CM from 0.01 to 0.1 cm

The vertical shift tolerance should be less than 10mm. If the shift is less than about 5mm but affects the measurements, correction can be made with the gate current adjuster VR401

If the shift is over 5mm, leakage of the order of 5nA may be present in the input circuit caused by extremely high humidity conditions. Check by drying with forced hot air on the attenuator components. If the trouble persists, replacement of components may be necessary.

7-6-3 Vertical shift when VARIABLE of VOLTS/CM is rotated.

Control settings for check:

AC-DC-GND switch to GND.
TRIG. LEVEL Knob to AUTO (switched).
Rotate the VARIABLE control.

The shift should not exceed 10mm.

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 VR404 DC BAL adjuster to return the trace to the position in STEP 1.
STEP 4 Repeat STEPS 1, 2 and 2 as required to produce a no shift condition.

7-6-4 Compression of vertical 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 Q403 and Q404.

Assuming that the FET's are functioning properly, voltage at TP401 and TP402 should be 0.5V. If not within ±0.3V of 0.5V, adjust VR402 and/or VR403. (The voltmeter must have a resistance of 10kΩ or higher on the range used.)

The voltage at the two points must be the same, otherwise the DC balance is upset and requires an adjustment of VR404 as mentioned in the previous section, 7-6-3.

When replacing the FET's Q403 and Q404, a matched pair must be selected in which the drain current I_{DSS} is within ±10%. Typical I_{DSS} is 5mA at V_{GS} = OV and V_{DS} = 10V.

7-7 Time Base Circuit

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

Control setting for check:

TIME/CM switch to 5 ms.

Faults:
1. Trace cannot be exitnguished 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:

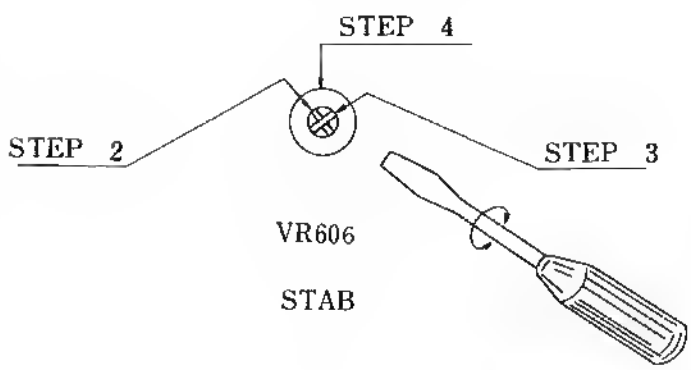
STEP 1. Control settings

TIME/CM switch to 5 ms.
AC-DC-GND switch to AC.
0.5Vp-p CAL connect to V IN and VOLTS/CM Switch to 0.1V.

STEP 2. Rotate the TRIG LEVEL control to full + or – direction and set VR606 STAB adjuster to the point where the trace just appears.
Note this setting.

STEP 3. Set the TRIG LEVEL control to "O" (Center) and set VR606 adjuster to the point where the trace just disappears.
Note this setting.

STEP 4. Finally, set VR606 at the position midway between the settings.



(VR606 and screw driver)

Stability adjustments.

Fig. 7-5

7-7-2 AUTO TRIG. is hard to synchronize.

When the TRIG. LEVEL knob is set to "O", a sine wave of about 1kHz should synchronize correctly at less than 10mm with the SLOPE + or –. If it does not, adjust VR604 and AUTO BAL. so that the sine wave of about 1kHz will synchronize within 5 to 10mm even if the SLOPE is switched to + or – when AUTO is set.

7-7-3 TV synchronization is hard to synchronize.

Check whether the AUTO synchronization is being performed correctly or not. If it is not synchronizing within an amplitude of less than 10mm, correct it in accordance with the procedure of the above section 7-7-2. and make check again.

Then, adjust VR605 and TV bias so that synchronization of the TV signal occurs even when AUTO is set.

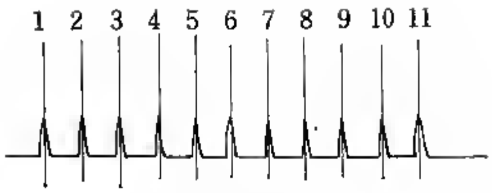
If possible, it would be best to check both positive and negative polarities.

7-7-4 Sweep timing incorrect on all ranges.

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

When there is an error of more than ±5% in timing on all ranges, adjust VR803 WIDTH adjuster.

As shown below, the 11th pulse must lie exactly on the 11th vertical line. If the pulse is ±5mm off, the error is ±5%.



Timing pulse display. Fig. 7-6

In the calibration procedure, VR803 WIDTH adjuster must be set at the point where pulses in the range 0.2ms to 1μs are applied at the proper TIME/CM settings. The final setting of VR803 is made at the average point.
When a signal generator (sine wave) is used for calibration, the adjacent peaks will lie on one division of the scale; refer to CHART 7-3 for the TIME/CM VS. frequency relationship.

CHART 7-3 TIME/CM VS. FREQUENCY

TIME/CM SETTING AND TIME PER CYCLE	FREQUENCY Hz	TIME/CM 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

7-7-5 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 as for the 11 - pulses display given in Section 7-7-4 above.

CHART 7-4

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

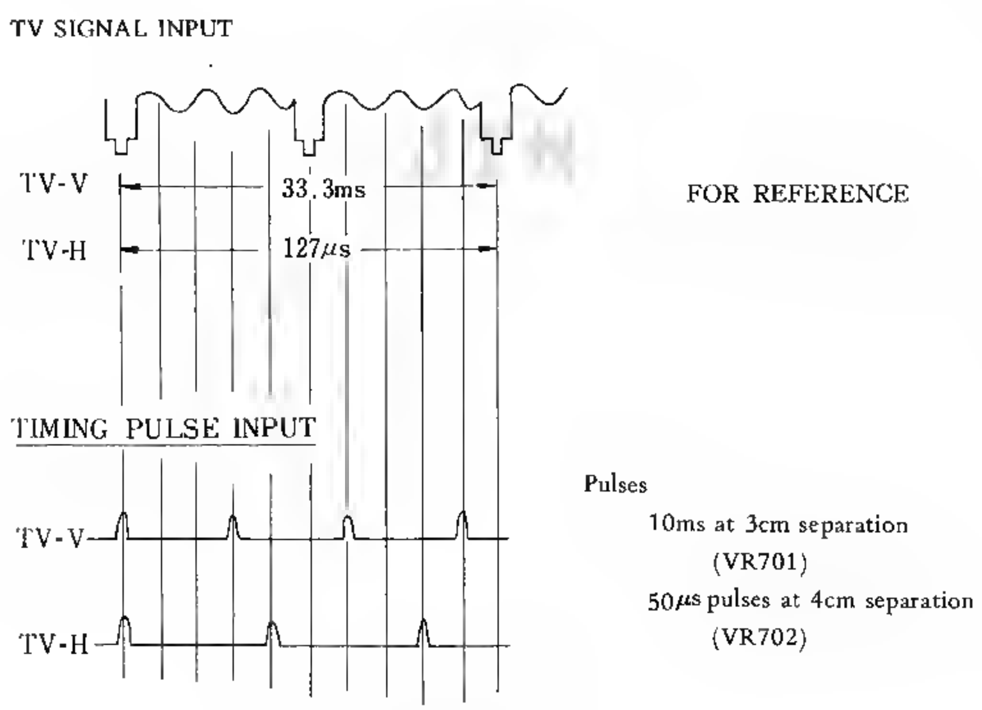
TV-V and TV-H width adjustment.

At each setting of the TIME/CM switch, two cycles of the respective TV signals should cover 10cm. If there is a discrepancy, adjustment is made as shown below.

CHART 7-5

SETTING	ADJUSTER
TV - V	VR704
TV - H	VR705

Use of two input signals, TV and pulse,



TV-V and TV-H adjustments.

Fig. 7-7

7-7-6 MAG X 5 adjustments.

A. Calibration is off:

When the sweep is not magnified (expanded) properly at Five times, adjust VR807 the MAG X 5 adjuster.

B. Trace shift at MAG X 5 :

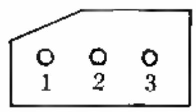
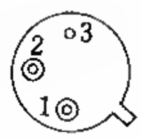
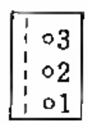
When the portion of the display is centered on the scale but shifts in position by 2 or 3cm when the button is pushed, adjust VR808 theMAG CENTER adjuster for centering.

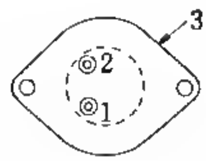
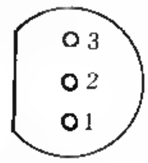
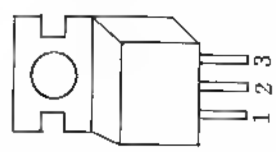
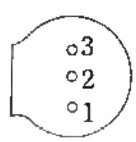
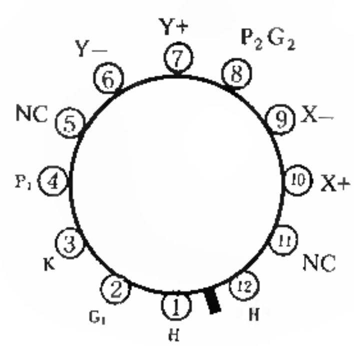
7-7-7 Horizontal shift when VARIABLE at EXT H IN is adjusted.

Set the Mag X 5 .

If the trace shifts by more than 2 or 3cm, set VR802 DC BAL adjuster to the point where the shift is eliminated, or minimized.

8. PIN CONNECTIONS, TRANSISTORS AND CRT

NAME	TYPE	CONNECTIONS	
2SA678	PNP		1. Emitter 2. Collector 3. Base
2SC154C 2SC423 2SC1012A	NPN NPN NPN		1. Emitter 2. Base 3. Collector (case)
2SC458	NPN		1. Emitter 2. Collector 3. Base

2SC499	NPN	 1. Emitter 2. Collector 3. Base
2SC685A/515 2SC508 2SD150	NPN NPN NPN	 1. Base 2. Emitter 3. Collector (case)
2SC645	NPN	 1. Emitter 2. Collector 3. Base
2SC869	NPN	 1. Base 2. Collector 3. Emitter
2SD235	NPN	 1. Base 2. Collector 3. Emitter
2SK34	FET	 1. Source 2. Gate 3. Drain
130ARB1	CRT	

9. TRANSISTOR CHECKING

Transistors can be checked quickly with an ohmmeter, using the R×100 or R×1000 range. (Disconnect the power supply.)

By considering transistor as two diodes with a common connection, tests can be made in the same manner as when determining the quality and diodes.

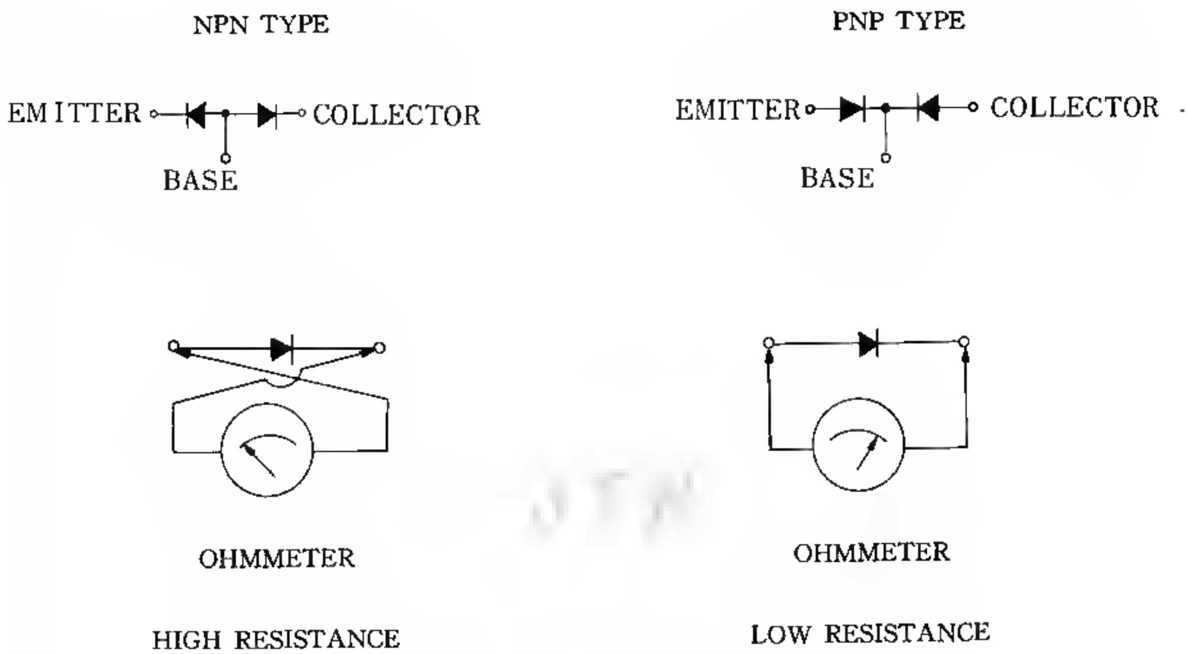


Fig. 9-1

Condition for a good transistor.

10. VOLTAGE AND WAVEFORM CHART

TP No.	VOLTAGE AND WAVEFORM
TP101	+320V
TP102	+210V
TP103	+43V
TP104	+27V
TP105	–42V
TP106	–27V
TP202	–1600V
TP401	+0.5V
TP402	+0.5V
TP403	+12V
TP601	–7.6V
TP602	–7.6V
TP603	–19V
TP604	 2Vp-p
TP605	 12Vp-p
TP606	 8Vp-p
TP801	+0.2V

11. NAME AND NUMBER OF PCB's

NAME	No.
V AMP	T-664
V FINAL	T-588A
MAIN	T-592
V ATT	T-663
HV RECT	T-666
VECTOR	T-294A
PILOT	T-665

SCH. No.	Symbol No.	Description			LEADER Parts No.		Note
		RESISTORS					
1	R101	Carbon film ½W	330Ω	±10%	RD½PSZK	330Ω	
1	R102	Carbon film ½W	56Ω	±10%	RD½PSZK	56Ω	
1	R103	Carbon film ½W	47Ω	±10%	RD½PSZK	47Ω	
1	R104	Carbon film ¼W	1KΩ	±5%	RD¼PNYJ	1KΩ	
1	R105	Carbon film ¼W	4.7KΩ	±5%	RD¼PNYJ	4.7KΩ	
1	R106	Carbon film ¼W	1.8KΩ	±5%	RD¼PNYJ	1.8KΩ	
1	R107	Carbon film ¼W	4.7KO	±5%	RD¼PNYJ	4.7KΩ	
1	R108	Carbon film ¼W	1.8KΩ	±5%	RD¼PNYJ	1.8KΩ	
1	R109	Carbon film ½W	220Ω	±10%	RD½PSZK	220	
1	R110	Carbon film ½W	47Ω	±10%	RD½PSZK	47Ω	
1	R111	Carbon film ¼W	1KΩ	±5%	RD¼PN YJ	1KΩ	
1	R112	Carbon film ¼W	4.7KΩ	±5%	RD¼PNYJ	4.7KΩ	
1	R113	Carbon film ¼W	4.7KΩ	±5%	RD¼PNYJ	4.7KΩ	
1	R114	Carbon film ¼W	4.7KΩ	±5%	RD¼PNYJ	4.7KΩ	
1	R115	Carbon film ¼W	150KΩ	±5%	RD¼PNYJ	150KΩ	
1	R117	Carbon film ½W	5.6Ω	±10%	RD½PSZK	5.6Ω	
1	R118	Carbon film 1W	18Ω	±10%	RD1SPZK	18Ω	
2	R201	Carbon film ½W	47KΩ	±10%	RD½PSZK	47KΩ	
2	R202	Carbon film ½W	68KΩ	±10%	RD½PSZK	68KΩ	
2	R203	Carbon film ½W	1MΩ	±10%	RD½PSZK	1MΩ	
2	R204	Carbon film ½W	33KΩ	±10%	RD½PSZK	33KΩ	
2	R205	High Meg. 1W	1.5MΩ	±10%	HM1PK	1.5MΩ	
2	R206	Carbon film 1W	1.5MΩ	±10%	RD1PYJ	1.5MΩ	
2	R207	Carbon film 1W	1.5M	±10%	RD1PYT	1.5MΩ	
2	R208	Carbon film 1W	1.5MΩ	±10%	RD1PYT	1.5MΩ	
2	R209	Carbon film 1W	1.5MΩ	±10%	RD1PYJ	1.5MΩ	
2	R210	Carbon film ¼W	47KΩ	±5%	RD¼PNYJ	47KΩ	Factory Adj.
2	R211	Carbon film ¼W	27KΩ	±5%	RD¼PNYJ	27KΩ	
2	R212	Carbon film ¼W	100Ω	±5%	RD¼PNYJ	100Ω	
2	R213	Carbon film ½W	47KΩ	±10%	RD½PSZK	47KΩ	
2	R214	Carbon film ½W	68KΩ	±10%	RD½PSZK	68K	
2	R215	Carbon film ½W	68KΩ	±10%	RD½ PSZK	68K	
2	R216	Carbon film ¼W	33K	±5%	RD¼PNYJ	33K	
2	R217	Carbon film ¼W	2.2K	±5%	RD¼PNYJ	2.2K	
2	R218	High Meg. 1W	3.6MΩ	±10%	HM1PK	3.6MΩ	
2	R219	High Meg. 1W	3.3MΩ	±10%	HM1PK	3.3MΩ	
2	R230	Carbon film ½W	1MΩ	±10%	RD½PSZK	1MΩ	
2	R231	Carbon film ½W	1MΩ	±10%	RD½PSZK	1MΩ	
2	R232	Carbon film ½W	1MΩ	±10%	RD½PSZK	1MΩ	
2	R233	Carbon film ½W	1MΩ	±10%	RD½PSZK	1MΩ	
2	R234	Carbon film ½W	1MΩ	±10%	RD½PSZK	1MΩ	
2	R235	Carbon film ½W	1MΩ	±10%	RD½PSZK	1MΩ	
2	R236	Carbon film ½W	4.7KΩ	±10%	RD½PSZK	4.7KΩ	Factory Adj.
2	R237	Carbon film ½W	2.2MΩ	±10%	RD½PSZK	2.2MΩ	
2	R238	Carbon film ½W	2.2MΩ	±10%	RD½PSZK	2.2MΩ	
2	R239	Carbon film ½W	2.2MΩ	±10%	RD½PSZK	2.2MΩ	
2	R240	Carbon film ½W	2.2MΩ	±10%	RD½PSZK	2.2MΩ	
2	R241	Carbon film ½W	2.2MΩ	±10%	RD½PSZK	2.2MΩ	
2	R242	Carbon film ½W	2.2MΩ	±10%	RD½PSZK	2.2MΩ	
2	R243	Carbon film ½W	2.2MΩ	±10%	RD½PSZK	2.2MΩ	
2	R244	Carbon film ½W	2.2MΩ	±10%	RD½PSZK	2.2MΩ	
2	R245	Carbon film ½W	1MΩ	±10%	RD½PSZK	1MΩ	
2	R246	Carbon film ½W	1MΩ	±10%	RD½PSZK	1MΩ	
2	R247	Carbon film ½W	1MΩ	±10%	RD½PSZK	1MΩ	
2	R248	Carbon film ½W	150KΩ	±10%	RD½PSZK	150KΩ	
2	R249	Carbon film ¼W	1KΩ	±5%	RD¼PNYJ	1KΩ	
2	R250	Carbon film ¼W	22KΩ	±5%	RD¼PNYJ	22KΩ	
3	R301	Metal film ½W	500KΩ	±0.5%	EF½D	500KΩ	
3	R302	Metal film ½W	1MΩ	±0.5%	EF½D	1MΩ	
3	R303	Metal film ½W	800KΩ	±0.5%	EF½D	800KΩ	
3	R304	Metal film ½W	250KΩ	±0.5%	EF½D	250KΩ	

SCH. No.	Symbol No.	Description		LEADER Parts No.		Note
			RESISTORS			
3	R305	Metal film ½W	900KΩ ±0.5%	EF½D	900KΩ	
3	R306	Metal film ½W	111KΩ ±0.5%	EF½D	111KΩ	
3	R307	Metal film ½W	990KΩ ±0.5%	EF½D	990KΩ	
3	R308	Metal film ½W	10.1KΩ ±0.5%	EF½D	10.1KΩ	
3	R309	Carbon film ¼W	33Ω ±5%	RD¼PNYJ	33Ω	
3	R310	Metal film ½W	1MΩ ±0.5%	EF½D	1MΩ	
3	R311	Metal film ½W	1KΩ ±0.5%	EF½D	1KΩ	
4	R401	Carbon film ¼W	100Ω ±5%	RD¼PNYJ	100Ω	
4	R402	Carbon film ¼W	1KΩ ±5%	RD¼PNYJ	1KΩ	
4	R403	Carbon film ¼W	560KΩ ±5%	RD¼PNYJ	560KΩ	
4	R404	Metal film ½W	1MΩ ±0.5%	EF½D	1MΩ	
4	R405	Carbon film ½W	3.3MΩ ±10%	RD½PSZK	3.3MΩ	
4	R406	Carbon film ¼W	22Ω ±5%	RD¼PNYJ	22Ω	
4	R407	Carbon film ¼W	12KΩ ±5%	RD¼PNYJ	12KΩ	
4	R408	Carbon film ¼W	4.7KΩ ±5%	RD¼PNYJ	4.7KΩ	
4	R409	Carbon film ¼W	4.7KΩ ±10%	RD¼PNYJ	4.7KΩ	
4	R410	Carbon film ¼W	4.7KΩ ±5%	RD¼PNYJ	4.7KΩ	
4	R411	Carbon film ¼W	4.7KΩ ±5%	RD¼PNYJ	4.7KΩ	
4	R412	Carbon film ¼W	15KΩ 5%	PD¼PNYJ	15KΩ	
4	R413	Carbon film ¼W	15KΩ ±5%	RD¼PNYJ	15KΩ	
4	R414	Carbon film ¼W	680Ω ±5%	RD¼PNYJ	680Ω	
4	R415	Carbon film ¼W	820Ω ±5%	RD¼PNYJ	820Ω	
4	R416	Carbon film ¼W	820Ω ±5%	RD¼PNYJ	820Ω	
4	R417	Carbon film ¼W	15KΩ ±5%	RD¼PNYT	15KΩ	
4	R418	Carbon film ¼W	15KΩ ±5%	RD¼PNYJ	15KΩ	
4	R419	Carbon film ¼W	220Ω ±5%	RD¼PNYJ	220Ω	
4	R420	Carbon film ¼W	10KΩ ±5%	RD¼PNYJ	10KΩ	
4	R421	Carbon film ¼W	10KΩ ±5%	RD¼PNYJ	10KΩ	
4	R422	Carbon film ¼W	220Ω ±5%	RD½PNYJ	220Ω	
4	R423	Carbon film ¼W	220Ω ±5%	RD¼)NYJ	220Ω	
4	R424	Carbon film ¼W	15KΩ ±5%	RD¼PNYJ	15KΩ	
4	R425	Carbon film ¼W	15KΩ ±5%	RD¼PNYJ	15KΩ	
4	R426	Carbon film ¼W	15KΩ ±5%	RD¼PNYJ	15KΩ	
4	R427	Carbon film ¼W	22Ω ±5%	RD¼PNYJ	22Ω	
4	R428	Carbon film ¼W	4.7KΩ ±5%	RD¼ PNYJ	4.7KΩ	
4	R429	Carbon film ¼W	1.5KΩ ±5%	RD¼PNYJ	1.5KΩ	
4	R430	Carbon film ¼W	1.5KΩ ±5%	RD¼PNYJ	1.5KΩ	
4	R431	Carbon film ¼W	4.7KΩ ±5%	RD¼PNYJ	4.7KΩ	
4	R432	Carbon film ¼W	3.9KΩ ±5%	RD¼PNYJ	3.9KΩ	
4	R433	Carbon film ¼W	2.7KΩ ±5%	RD¼PNYJ	2.7KΩ	Factory Adj.
4	R434	Carbon film ¼W	2.7KΩ ±5%	RD¼PNYJ	2.7KΩ	Factory Adj.
4	R435	Carbon film ¼W	3.9KΩ ±5%	RD¼PNYJ	3.9KΩ	
4	R436	Carbon film ¼W	1KΩ ±5%	RD¼PNYJ	1KΩ	
4	R437	Carbon film ¼W	2.2K ±5%	RD¼PNYJ	2.2KΩ	
4	R438	Carbon film ¼W	1KΩ ±5%	RD¼PNYJ	1KΩ	
4	R439	Carbon film ¼W	1.5KΩ ±5%	RD¼PNYJ	1.5KΩ	
4	R440	Carbon film ¼W	1.5KΩ ±5%	RD¼PNYJ	1.5KΩ	
4	R441	Carbon film ¼W	100Ω ±5%	RD¼PNYJ	100Ω	
4	R442	Carbon film ¼W	1.2KΩ ±5%	RD¼PNYJ	1.2KΩ	
4	R443	Carbon film ¼W	3.9KΩ ±5%	RD¼PNYJ	3.9KΩ	
4	R444	Carbon film ¼W	1.2KΩ ±5%	RD¼PNYJ	1.2KΩ	
4	R445	Carbon film ¼W	100 ±5%	RD¼PNYJ	100Ω	
4	R446	Carbon film ¼W	1KΩ ±5%	RD¼PNYJ	1KΩ	
4	R447	Carbon film ¼W	47Ω ±5%	RD¼PNYJ	47Ω	
4	R448	Carbon film ¼W	10KΩ ±5%	RD¼PNYJ	10KΩ	
4	R449	Carbon film ¼W	15KΩ ±5%	RD¼PNYJ	15KΩ	
4	R450	Carbon film ¼W	100Ω ±5%	RD¼PNYJ	100Ω	
4	R451	Carbon film ¼W	100Ω ±5%	RD¼PNYJ	100Ω	
4	R452	Carbon film ¼W	150Ω ±5%	RD¼PNYJ	150Ω	
4	R453	Metal film 2W	1KΩ ±10%	MOR2XPK	1KΩ	

SCH. No.	Symbol No.	Description			LEADER Parts No.	Note
			RESISTORS			
4	R454	Carbon film ¼W	150Ω	±5%	RD¼PNYJ 150Ω	
4	R455	Carbon film ¼W	100Ω	±5%	RD¼PNYJ 100Ω	
4	R456	Carbon film ¼W	100Ω	±5%	RD¼PNYJ 100Ω	
4	R457	Metal film 7W	4.7KΩ	±10%	MOR7SPK 4.7KΩ	
4	R458	Metal film 7W	4.7KΩ	±10%	MOR7SPK 4.7KΩ	
4	R459	Carbon film ¼W	68Ω	±5%	RD¼PNYJ 68Ω	
6	R601	Carbon film ¼W	100Ω	±5%	RD¼PNYJ 100Ω	
6	R602	Carbon film ¼W	100Ω	±5%	RD¼PNYJ 100Ω	
6	R603	Carbon film ¼W	56Ω	±5%	RD¼PNYJ 56Ω	
6	R604	Carbon film ¼W	50Ω	±5%	RD¼PNYJ 56Ω	
6	R605	Carbon film ¼W	330Ω	±5%	RD¼PNYJ 330Ω	
6	R606	Carbon film ¼W	560Ω	±5%	RD¼PNYJ 560Ω	
6	R607	Carbon film ¼W	1.2KΩ	±5%	RD¼PNYJ 1.2KΩ	
6	R608	Carbon film ¼W	1.2KΩ	±5%	RD¼PNYJ 1.2KΩ	
6	R609	Carbon film ¼W	2.2KΩ	±5%	RD¼PNYJ 2.2KΩ	
6	R610	Carbon film ¼W	4.7KΩ	±5%	RD¼PNYJ 4.7KΩ	
6	R611	Carbon film ¼W	10KΩ	±5%	RD¼PNYJ 10KΩ	
6	R612	Carbon film ¼W	22KΩ	±5%	RD¼PNYJ 22KΩ	
6	R613	Carbon film ¼W	1MΩ	±5%	RD¼PNYJ 1MΩ	
6	R614	Carbon film ¼W	100KΩ	±5%	RD¼PNYJ 100KΩ	
6	R615	Carbon film ¼W	820Ω	+5%	RD¼PNYJ 820Ω	
6	R616	Carbon film ¼W	2.7KΩ	±5%	RD¼PNYJ 2.7KΩ	
6	R617	Carbon film ¼W	12KΩ	±5%	RD¼PNYJ 12K Ω	
6	R618	Carbon film ¼W	4.7KΩ	±5%	RD¼PNYJ 4.7KΩ	
6	R619	Carbon film ¼W	5.6KΩ	±5%	RD¼PNYJ 5.6KΩ	
6	R620	Carbon film ¼W	100Ω	±5%	RD¼PNYJ 100Ω	
6	R621	Carbon film ¼W	10KΩ	±5%	RD¼PNYJ 10KΩ	
6	R622	Carbon film ¼W	22KΩ	±5%	RD¼PNYJ 22KΩ	
6	R623	Carbon film ¼W	100KΩ	±5%	RD¼PNYJ 100KΩ	
6	R624	Carbon film ¼W	22KΩ	±5%	RD¼PNYJ 22KΩ	
6	R625	Carbon film ¼W	82KΩ	±5%	RD¼PNYJ 82KΩ	
6	R626	Carbon film ¼W	22KΩ	±5%	RD¼PNYJ 22KΩ	
6	R627	Carbon film ¼W	680Ω	±5%	RD¼PNYJ 680Ω	
6	R628	Carbon film ¼W	22KΩ	±5%	RD¼PNYJ 22KΩ	
6	R629	Carbon film ¼W	22Ω	±5%	RD¼PNYJ 22Ω	
6	R630	Carbon film ¼W	680Ω	±5%	RD¼)NYJ 680Ω	
6	R631	Carbon film ¼W	4.7KΩ	±5%	RD¼PNYJ 4.7KΩ	
6	R632	Carbon film ¼W	220KΩ	±5%	RD¼PNYJ 220KΩ	
6	R633	Carbon film ¼W	1MΩ	±5%	RD¼PNYJ 1MΩ	
6	R634	Carbon film ¼W	220KΩ	±5%	RD¼PNYJ 220KΩ	
6	R635	Carbon film ¼W	6.8KΩ	±5%	RD¼PNYJ 6.8KΩ	
6	R636	Carbon film ¼W	100KΩ	±5%	RD¼PNYJ 100KΩ	
6	R637	Carbon film ¼W	4.7KΩ	±5%	RD¼PNYJ 4.7KΩ	
6	R638	Carbon film ¼W	560KΩ	±5%	RD¼PNYJ 560KΩ	
6	R639	Carbon film ¼W	18KΩ	±5%	RD¼PNYJ 18KΩ	
6	R640	Carbon film ¼W	3.3KΩ	±5%	RD¼PNYJ 3.3KΩ	
6	R641	Carbon film ¼W	10KΩ	±5%	RD¼PNYJ 10KΩ	
6	R642	Carbon film ¼W	47Ω	±5%	RD¼PNYJ 47Ω	
6	R643	Carbon film ¼W	10KΩ	±5%	RD¼PNYJ 10KΩ	
6	R644	Carbon film ¼W	4.7KΩ	±5%	RD¼PNYJ 4.7KΩ	
6	R645	Carbon film ¼W	8.2KΩ	±5%	RD¼PNYJ 8.2KΩ	
6	R646	Carbon film ¼W	12KΩ	±5%	RD¼PNYJ 12KΩ	
6	R647	Carbon film ¼W	10KΩ	±5%	RD¼PNYJ 10KΩ	
6	R648	Carbon film ¼W	1KΩ	±5%	RD¼PNYJ 1KΩ	
6	R649	Carbon film ¼W	27KΩ	±5%	RD¼PNYJ 27KΩ	
6	R650	Carbon film ¼W	1KΩ	±5%	RD¼PNYJ 1KΩ	
6	R651	Carbon film ¼W	10KΩ	±5%	RD¼PNYJ 10KΩ	
6	R652	Carbon film ¼W	10KΩ	±5%	RD¼PNYJ 10KΩ	

SCH. No.	Symbol No.	Description		LEADER Parts No.	Note
			RESISTORS		
6	R653	Carbon film ¼W	5.6KΩ ±5%	RD¼PNYJ 5.6KΩ	
6	R654	Carbon film ¼W	10KΩ ±5%	RD¼PNYJ 10KΩ	
6	R655	Carbon film ¼W	100KΩ ±5%	RD¼PNYJ 100KΩ	
6	R656	Carbon film ¼W	1KΩ ±5%	RD¼PNYJ 1KΩ	
6	R657	Carbon film ¼W	1.5KΩ ±5%	RD¼PNYJ 1.5KΩ	
6	R658	Carbon film ¼W	3.9KΩ ±5%	RD¼PNYJ 3.9KΩ	
6	R659	Carbon film ¼W	100KΩ ±5%	RD¼PNYJ 100KΩ	
6	R660	Carbon film ¼W	47KΩ ±5%	RD¼PINYJ 47KΩ	
7	R701	Carbon film ¼W	22KΩ ±5%	RD¼PNYJ 22KΩ	
7	R702	Carbon film ¼W	2.4MΩ ±1%	RDIPXF 2.4MΩ	
7	R703	Carbon film 1W	2.4MΩ ±1%	RDIPXF 2.4MΩ	
7	R704	Carbon film 1W	1.2MΩ ±1%	RDIPXF 1.2MΩ	
7	R705	Carbon film 1W	1.2MΩ ±1%	RDIPXF 1.2MΩ	
7	R706	Carbon film ½W	600KΩ ±1%	RD¼PXF 600KΩ	
7	R707	Carbon film 1W	2.4MΩ ±1%	RD1PXF 2.4MΩ	
7	R708	Carbon film 1W	1.2MΩ ±1%	RDIPXF 1.2MΩ	
7	R709	Carbon film ¼W	18KΩ ±5%	RD¼PNIJ 18KΩ	
7	R710	Carbon film ¼W	56KΩ ±5%	RD¼PNYJ 56KΩ	
7	R711	Carbon film ¼W	18KΩ ±5%	RD¼PNYJ 18KΩ	
7	R712	Carbon film ¼W	33KΩ ±5%	RD¼PNYJ 33KΩ	
8	R801	Carbon film ½W	1MΩ ±10%	RD½PSZK 1MΩ	
8	R802	Carbon film ¼W	10KΩ ±5%	RD¼PNYJ 10KΩ	
8	R803	Carbon film ¼W	560KΩ ±5%	RD¼PNYJ 560KΩ	
8	R804	Carbon film ¼W	1KΩ ±5%	RD¼PNYJ 1KΩ	
8	R805	Carbon film ¼W	100Ω ±5%	RD¼ PNYJ 100Ω	
8	R806	Carbon film ¼W	220Ω ±5%	RD¼PNYJ 220Ω	
8	R807	Carbon film ¼W	150 ±5%	RD¼PNYJ 150KΩ	
8	R808	Carbon film ¼W	12K ±5%	RD¼PNYJ 12KΩ	
8	R809	Carbon film ¼W	22K ±5%	RD¼PNYJ 22KΩ	
8	R810	Carbon film ¼W	150K ±5%	RD¼PNYJ 150KΩ	
8	R811	Carbon film ¼W	22KΩ ±5%	RD¼PNYJ 22KΩ	
8	R812	Carbon film ¼W	33K ±5%	RD¼PNYJ 33KΩ	
8	R813	Carbon film ¼W	18K ±5%	RD¼PNYJ 18KΩ	
8	R814	Carbon film ½W	390KΩ ±5%	RD¼PNYJ 390KΩ	
8	R815	Carbon film ¼W	1KΩ ±5%	RD¼PNYJ 1KΩ	
8	R816	Carbon film ¼W	39KΩ ±5%	RD¼PNYJ 39KΩ	
8	R817	Carbon film ½W	68KΩ ±10%	RD½PSZK 68KΩ	
8	R818	Carbon film ½W	68KΩ ±10%	RD½PSZK 68KΩ	
8	R819	Metal film 5W	22KΩ ±10%	MOS5SPK 22KΩ	
8	R820	Carbon film ½W	390KΩ ±10%	RD½ PSZK 390KΩ	
8	R821	Carbon film ¼W	39KΩ ±5%	RD¼PNYJ 39KΩ	
8	R822	Carbon film ½W	39KΩ ±10%	RD¼ PNYJ 39KΩ	
8	R823	Carbon film ½W	390KΩ ±10%	RD½ PSZK 390KΩ	
8	R824	Carbon film ¼W	1KΩ ±5%	RD¼ PNYJ 1KΩ	
8	R825	Carbon film ¼W	39KΩ ±5%	RD¼PNYJ 39KΩ	
8	R826	Carbon film ¼W	39KΩ ±5%	RD¼PNYJ 39KΩ	
8	R827	Carbon film ½W	68KΩ ±10%	RD½PSZK 68KΩ	
8	R828	Carbon film ½W	68KΩ ±10%	RD½PSZK 68KΩ	
8	R829	Metal film 5W	22KΩ ±10%	MOR5SPK 22KΩ	
8	R830	Carbon film ¼W	2.2KΩ ±5%	RD¼ PNJ 2.2KΩ	
8	R831	Carbonfilm ¼W	22KΩ ±5%	RD¼PNYJ 22KΩ	
8	R832	Carbon film ¼W	47KΩ ±5%	RD¼PNYJ 4.7KΩ	
9	R901	Carbon film ¼W	100Ω ±5%	RD¼PNYJ 100Ω	
9	R902	Carbon film ¼W	100Ω ±5%	RD¼PNYJ 100Ω	
9	R903	Carbon film ¼W	8.2KΩ ±5%	RD¼PNYJ 8.2KΩ	
9	R904	Carbon film ¼W	8.2KΩ ±5%	RD¼PMYJ 8.2KΩ	
9	R905	Carbon film ¼W	12Ω ±5%	RD¼PNYJ 12Ω	
9	R906	Carbon film ¼W	12Ω ±5%	RD¼PNYJ 12Ω	
9	R907	Carbon film ¼W	8.2KΩ ±5%	RD¼PNYJ 8.2KΩ	
9	R908	Carbon film ¼W	82KΩ ±5%	RD¼PNYJ 82KΩ	

SCH. No.	Symbol No.	Description		LEADER Parts No.	Note
9	R909	Carbon film ¼W	56KΩ ±5%	RD¼PNYJ 56KΩ	
9	R910	Carbon film ¼W	22KΩ ±5%	RD¼PNYJ 22KΩ	
9	R911	Carbon film ¼W	2.2MΩ ±5%	RD¼PNYJ 2.2MΩ	
9	R912	Carbon film ¼W	1KΩ ±5%	RD¼PNYJ 1KΩ	
9	R913	Carbon film ¼W	470KΩ ±5%	RD¼YNYJ 470KΩ	
9	R914	Carbon film ¼W	15KΩ ±5%	RD¼PNYJ 15KΩ	
9	R915	Carbon film ¼W	10KΩ ±5%	RD¼PNYJ 10KΩ	
9	R916	Carbon film ¼W	10KΩ ±5%	RD¼PNYJ 10KΩ	
9	R917	Carbon film ¼W	4.7KΩ ±5%	RD¼PNYJ 4.7KΩ	
9	R918	Carbon film ¼W	10KΩ ±5%	RD¼PNYJ 10KΩ	
9	R919	Carbon film ¼W	10KΩ ±5%	RD¼PNYJ 10KΩ	
9	R920	Carbon film ¼W	4.7KΩ ±5%	RD¼PNYJ 4.7KΩ	
9	R921	Carbon film ¼W	4.7KΩ ±5%	RD¼PNYJ 4.7KΩ	
9	R922	Carbon film ¼W	100KΩ ±5%	RD¼PNYJ 100KΩ	
9	R923	Carbon film ¼W	100KΩ ±5%	RD¼PNYJ 100KΩ	
9	R924	Carbon film ¼W	10KΩ ±5%	RD¼PNYJ 10KΩ	
9	R925	Carbon film ¼W	8.2KΩ ±5%	RD¼PNYJ 8.2KΩ	
9	R926	Carbon film ¼W	82KΩ ±5%	RD¼PNYJ 82KΩ	
9	R927	Carbon film ¼W	4.7KΩ ±5%	RD¼PNYJ 4.7KΩ	
9	R928	Carbon film ¼W	5.6KΩ ±5%	RD¼PNYJ 5.6KΩ	
9	R929	Carbon film ¼W	330Ω ±5%	RD¼PNYJ 330Ω	

VARIABLE RESISTORS

SCH. No.	Symbol No.	Description		LEADER Parts No.	Note
1	VR102	Solid 0.15W	1KΩ ±25%	SR19R-B 1KΩ	⊘ + 27V
1	VR103	Solid 0.15W	1KΩ ±25%	SR19R-B 1KΩ	⊘ − 27V
1	VR101	W.W ½W	50Ω ±105	RA16YN15SB50ΩK	SCALE ILLUM
2	VR205	Solid 0.3W	100KΩ ±25%	SM19R-B 100KΩ	⊘ ASTIG
2	VR204	Carbon film 0.25W	1MΩ ±20%	V24L5 (8x10)N20SB1MΩ	[FOCUS]
2	VR203	Solid 0.15W	10KΩ ±25%	SR19R-B10KΩ	⊘ INTEN
2	VR206	Carbon film 0.5W	10KΩ ±20%	V24L5GN (8x10)	[INTEN.]
2	VR207	Carbon film 0.5W	100KΩ ±20%	20SB 10K/100K	
4	VR401	Solid 0.15W	470Ω ±25%	SR19R-B 470KΩ	⊘ GATE CURR
4	VR402	Solid 0.15W	4.7KΩ ±25%	SR19R-B 4.7KΩ	⊘ FET BIAS FINE
4	VR403	Solid 0.15W	100KΩ ±25%	SR19R-B 100KΩ	⊘ FET BIAS COARSE
4	VR404	Solid 0.15W	3.3KΩ ±25%	SR19R-B 3.3KΩ	⊘ DC BAL
4	VR405	Carbon film 0.1W	300Ω ±20%	DMIOA15R-B 10KΩ/B300Ω	[⊘ GAIN] Gang with VR407
4	VR406	Carbon film 0.5W	300Ω ±20%	V24L5 S2 (DF) 15SC300Ω	[VARIABLE] with S401 and S103 (F.C.W. lock)
4	VR407	Carbon film 0.5W	10KΩ ±20%	DM10A15R-B10KΩ/B300Ω	[↕] Gang wirh VR405
4	VR408				not assigned
4	VR409	Solid 0.15W	2.2KΩ ±25%	SR19R-B 2.2KΩ	⊘ MF
6	VR601	Solid 0.15W	330Ω ±25%	SR19R-B330Ω	⊘ ± BAL
6	VR602	Solid 0.15W	4.7KΩ ±25%	SR19R-B 4.7KΩ	⊘ LEVEL CENTER
6	VR603	Carbon film	5KΩ		[TRIG. LEVEL] with S602
6	VR604	Solid 0.15W	1MΩ ±25%	SR19R-B 1MΩ	⊘ AUTO BAL
6	VR605	Solid 0.15W	100KΩ ±25%	SR19R-B 100KΩ	⊘ TV. BIAS
6	VR606	Solid 0.15W	3.3KΩ ±25%	SR19R-B 3.3KΩ	⊘ STAB
6	VR607	Carbon film 0.5W	10KΩ ±20%		[VARIABLE] Gang wirh VR803
6	VR608	Solid 0.15W	2.2KΩ ±25%	SR19R-B 2.2KΩ	⊘ LENGTH
7	VR701	Solid 0.15W	33KΩ ±25%	SR19R-B 33KΩ	⊘ TV-V
7	VR702	Solid 0.15W	33KΩ ±25%	SR19R-B 33KΩ	⊘ TV-H
8	VR802	Solid 0.15W	33KΩ ±25%	SR19R-B 33KΩ	⊘ DC BAL
8	VR803	Solid 0.15W	33KΩ ±25%	SR19R-B 33KΩ	⊘ WIDTH
8	VR804	Carbon film 0.5W	100KΩ ±20%		[VARIABLE] Gang with VR607
8	VR805	Carbon film 0.5W	50KΩ ±20%		[↔] with S801
8	VR807	Solid 0.15W	10KΩ ±25%	SR19R-B 10KΩ	⊘ MAG x 5
8	VR808	Solid 0.15W	10KΩ ±25%	SR19R-B 10KΩ	⊘ MAG CENTER
9	VR901	Solid 0.15W	470Ω ±25%	SR19R-B 470Ω	⊘ CAL

SCH. No.	Symbol No.	Description	LEADER Parts No.	Note
		CAPACITORS		
1	C101	Electrolytic 150V 47µF	160T47	
1	C102	Electtolytic 470V 22µF	470T22	
1	C103	Electrolytic 300V 47µF	315T47	
1	C104	Electtoytic 300V 47µF	317T47	
1	C105	Electrolytic 80V 1000µF	ECE-M80R1000E	
1	C106	Electrolytic 50V 22µF	50VBSN22	
1	C107	Plastic film 50V 0.1µF ±10%	CQ92MB1H104K	
1	C108	Plastic film 50V 0.01µF ±10%	CQ92MH1H103K	
1	C109	Electrolytic 50V 1µF	50VBSN1	
1	C110	Plastic film 50V 0.1µF	CQ92MB1H104K	
1	C111	Electrolytic 80V 1000µF ECE-	ECE-M80R1000E	
1	C112	Electrolytic1 100V 47µF	CE02D2A470	
1	C113	Electrolytic 50V 22µF	50VBSN22	
1	C114	Plastic film 50V 0.1µF ±10%	CQ92MB1H104K	
1	C115	Electrolytic 50V 1µF	50VBSN1	
1	C116	Plastic film 50V 0.1µF ±10%	CQ92HBIH 104K	
1	C117	Electrolytic 16V 470µF	16T470	
1	C118	Electrolytic 16V 470µF	16T470	
2	C201	Plastic film 400V 0.01µF ±20%	MD22G103M	
2	C202	Oil 3KV 0.022µF ±20%	ECN-D30223M	
2	C203	Ceramic 3KV 470pF	DD6200YW470pF	
2	C204	Plastic film 50V 1000pF	CQ92MB1H102K	
2	C205	Plastic film 250V 0.1µF ±20%	MD22E104M	
2	C206	Plastic film 50V 470pF ±10%	CQ08SC1H471H	
2	C216	Mica 500V 10pH ±10%	FM05ZC100K	
2	C217	Oil 400V 0.01µF ± 20%	CP021E2G103M	
2	C218	Oil 400V 0.01µF ±20%	CP021E2G103M	
2	C219	Electtolytic 500V 4.7µF	500T 4.7	
2	C220	Electrolytic 500V 4.7µF	500T4.7	
2	C221	Electtolytic 500V 4.7µF	500T4.7	
2	C222	Electrolytic 500V 4.7µF	500T4.7	
2	C223	Electrolytic 500V 4.7µF	500T4.7	
2	C224	Electrolytic 500V 4.7µF	500T4.7	
2	C225	Oil 1.5KV 0.5µF	K150DCLU504M	
2	C226	Oil 1.5KV 0.5µF	K150DCLU504M	
2	C227	Oil 1.5KV 0.5µF	K150DCLU504M	
2	C228	Oil 1.5KV 0.5µF	K150DCLU504M	
3	C301	Plastic film 630V 0.1µF ±10%	6MFT-D104K	
3	C302	Mica 500V 18pF ±10%	FM06ZC180K	
3	C303	Mica 500V 5pF ±10%	FM05ZC050K	
3	C304	Mica 500V 33pF ±100%	FM07ZC330K	
3	C305	Mica 500V 120pF ±10%	FM10ZC121K	
3	C306	Plastic film 50V 1500µF ±10%	CQ92MB1H152K	
3	C307	Plastic film 50V 0.01µF ±10%	CQ92MB1H103K	
4	C401	Plastic film 50V 0.01µF ±10%	CQ92MB1H103K	
4	C402	Plastic film 630V 0.01µF ±20%	MD22J103M	
4	C403	Ceramic 50V 1000pF	RD204YM102	
4	C404	Ceramic 50V 1000pF	RD204YM102	
4	C405	Ceramic 50V 0.01µF	RD204YM103	
4	C406	Mica 500V 10pF ±10%	FMO5ZC100K	
4	C407	Ceramic 50V 0.01µF	RD204YM103	
4	C408	Electrolytic 50V 4.7µF	50VBsN4R7	
4	C409	Ceramic 50V 0.01µF	RD204YM103	
4	C410	Mica 500V 18pF ±10%	FM06ZC180K	
4	C411	Ceramic 50V 0.01µF	RD204YM103	
4	C412	Electrolytic 50V 4.7µF	50VBSN4R7	
4	C413	Mica 500V 27pF ±10%	FM07ZC270K	
4	C414	Mica 500V 56pF ±10%	FM08ZC560K	

SCH. No.	Symbol No.	Description				LEADER Parts No.	Note
4	C415	Cermic	50V	0.01μF		RD204YM103	
4	C416	Cermic	50V	0.01μF		RD204YM103	
4	C417	Electrolytic	50V	1μF		50VBSN1	
6	C601	Mica	500V	10pF	±10%	FM05ZC100K	
6	C602	Mica	500V	220pF	±10%	V-FM08ZC221K	
6	C603	Electrolytic	50V	3.3pF		50VBSN3R3	
6	C604	Ceramic	50V	0.05pF		RD209YM503Z50	
6	C605	Plastic film	100V	0.47μF	±20%	IMFT-D474	
6	C606						not assigned
6	C607	Mica	500V	3pF	±10%	FM05ZCO30K	
6	C608						not assigned
6	C609	Mica	500V	47pF	±10%	FM08ZC470K	
6	C610	Mica	500V	27pF	±10%	FMO7ZC270K	
6	C611	Mica	500V	22pF	±10%	FM06ZC220K	
6	C612	Plastic film	100V	0.47μF	±20%	IMET-D474	
6	C613	Mico	500V	5pF	±10%	FM05ZC50K	
6	C614	Mica	500V	15pF	±10%	FM05ZC150K	
6	C615	Mica	500V	10pF	±10%	FM05ZC100K	
6	C616	Ceramic	50V	0.01μF		RD209YM103	
6	C617	Mica	50V	100pF	±10%	V-FM06ZC101K	
6	C618						not assigned
6	C619	Mica	50V	100pF	±10%	V-FM06ZC101K	
6	C620	Mica	50V	220pF	±10%	V-FM08ZC221K	
7	C701	Electrolytic	50V	1μF	±10%	50 VBSN1	
7	C702	Plastic film	50V	0.1μF	±10%	CQ92MB1H104K	
7	C703	Plastic film	50V	0.01μF	±10%	CQ92MB1H103K	
7	C704	Plastic film	50V	1000pF	±10%	CQ92MB1H102K	
7	C705	Mica	500V	68pF	±2%	FM082ZC680K	
7	C706	Plastic film	100V	1μF	±2%	CQ-14T2A105G	
7	C707	Plastic film	100V	0.1μF	±2%	TNX104G 100V	
7	C708	Plastic film	100V	0.01μF	±2%	TNX103G 100V	
7	C709	Plastic film	125V	1000pF	±2%	CQ08P2B102G	
7	C710	Mica	500V	82pF	±10%	FM09ZC820K	
7	C711	Mica	500V	33pF	±10%	FM07ZC330K	
8	C801	Plastic film	630V	0.1μF	±10%	6MFT-D104K	
8	C802	Mica	500V	220pF	±10%	FM12ZC221K	
8	C803	Ceramic	50V	1000pF		RD204YM102	
8	C804	Plastic film	50V	680pF	±10%	CQ08SCH1H681K	
8	C805	Plastic	500V	1pF	±10%	ECG-N5010K	
8	C806	Plastic	500V	1pF	±10%	ECG-N5010K	
8	C807	Plastic	500V	1pF	±10%	ECG-N5010K	
8	C808	Plastic	500V	1pF	±10%	ECG-N5010K	
8	C809	Plastic	500V	1pF	±10%	ECG-N5010K	
8	C810	Plastic	500V	1pF	±10%	ECG-N5010K	
8	C811	Ceramic	50V	0.01μF		RD204YM103	
9	C901	Electrolytic	50V	1μF		50VBSN1	
9	C902	Plastic film	100V	0.47μF	±20%	IMFT-D474	
9	C903	Electrolytic	50V	1μF	±10%	50VBSN1	
9	C904	Plastic film	50V	0.047μF	±10%	CQ92MB1H473K	
9	C905	Plastic film	50V	1000pF	±10%	CQ92MB1H102K	
9	C906	Plastic film	50V	1000pF	±10%	CQ92MB1H102K	
9	C907	Plastic film	50V	1000pF	±10%	CQ92MB1H102K	
9	C908	Plastic film	50V	0.047μF	±10%	CQ92MB1H473K	
9	C909	Plastic film	50V	0.047μF	±10%	CQ92MB1H473K	
9	C910	Electroytic	16V	47μF		16VBSN47	
9	C911	Plastic film	50V	6800pF	±10%	CQ92MB1H682K	
9	C912	Plastic film	50V	6800pF	±10%	CQ92MB1H682K	
9	C913	Mica	500V	27pF	±10%	FM07ZC270K	

SCH. No.	Symbol No.	Description			LEADER Parts No.	Note
		VARIABLE CAPACITORS				
3	VC301	Ceramic	500V	20pF	ECV-1ZW20P32	⊘ Vertical Attenuator
3	VC302	Ceramic	500V	20pF	ECV-1ZW20P32	⊘ Vertical Attenuator
3	VC303	Ceramic	500V	20pF	ECV-1ZW20P32	⊘ Vertical Attenuator
3	VC304	Ceramic	500V	20pF	ECV-1ZW20P32	⊘ Vertical Attenuator
3	VC305	Ceramic	500V	20pF	ECV-1ZW20P32	⊘ Vertical Attenuator
3	VC306	Ceramic	500V	20pF	ECV-1ZW20P32	⊘ Vertical Attenuator
3	VC307	Ceramic	500V	20pF	ECV-1ZW20P32	⊘ Vertical Attenuator
3	VC308	Ceramic	500V	20pF	ECV-1ZW20P32	⊘ Vertical Attenuator
3	VC309	Ceramic	500V	20pF	ECV-1ZW20P32	⊘ Vertical Attenuator
3	VC310	Ceramic	500V	20pF	ECV-1ZW20P32	⊘ Vertical Attenuator
4	VC401	Ceramic	500V	20pF	ECV-1ZW20P32	⊘ Vertical Attenuator
4	VC402	Ceramic	500V	50pF	ECV-1ZW50P32	⊘ HF
7	VC701	Ceramic	500V	20pF	ATSWECV20pF	⊘ Time BASE
7	VC702	Ceramic	500V	20pF	ATSWECV20pF	⊘ Time Bdse
		TUBES				
2	V201	CRT			130ARB1/B7	
2	V202	NEON	68V		NE-2	
2	V203	NEON	68V		NE-2	
2	V204	NEON	68V		NE-2	
2	V205	NEON	68V		NE-2	
		TRANSISTORS				
1	Q101	NPN	Vceo = 40V, Pt = 15W		2SD150	or 2SD315, 2SC1160
1	Q102	NPN	Vceo = 100V		2SC499-Y	
1	Q103	NPN	Vceo = 100V		2SC499-Y	
1	Q104	NPN	Vceo = 40V, Pt = 1.5W		2SD150	or 2SD315, SSC1160
1	Q105	PNP	Vceo = 50V		2SA678-6	
1	Q106	PNP	Vceo = 50V		2SA678-6	
2	Q201	NPN	Vcbo = 300V		2SC515A	or 2SC685A.
2	Q202	NPN	Vcbo = 250V, Pc = 2.5W (Tc-125°C)		2SC1012A	
2	Q203	NPN	Vcbo = 250V, Pc = 2.5W (Tc = 125°C)		2SC1012A	
4	Q401	NPN	Vceo = 30V		2SC458-B	or 2SC459-C
4	Q402	NPN	Vceo = 30V		2SC458-B	or 2SC458-C
4	Q403	J-FET	Vdgo =30V, IDSS = 2.5~6mA		2SK34-D	Selected Pair IDSS 10%
4	Q404	J-FET	Vdgo= 30V, IDSS =2.5~6mA		2SK34-D	
4	Q405	NPN	Vceo = 30V		2SC458-B	or 2SC458-C
4	Q406	NPN	Vceo = 30V		2SC458-B	or 2SC458-C
4	Q407	NPN	Vceo = 30V		2SC458-B	or 2SC458-C
4	Q408	NPN	Vceo = 30V		2SC458-B	or 2SC458-C
4	Q409	NPN	Vceo = 30V		SSC458-B	or 2SC458-C
4	Q410	NPN	Vceo = 30V		2SC458-B	or 2SC458-C
4	Q411	NPN	Vceo = 30V		2SC458-B	or 2SC458-C
4	Q412	PNP	Vceo = 50V		2SC678-6	
4	Q413	PNP	Vceo = 50V		2SA678-6	
4	Q414	NPN	Vceo = 30V		2SC458-B	or 2SC458-C
4	Q415	NPN	Vceo = 30V		2SC458-B	or 2SC458-C
4	Q416	NPN	Vcbo = 40V, Pc=500mW		2SC423-D	
4	Q417	NPN	Vcbo=250V, Pc=2.5W (Tc=R5°C)		2SC1012A	
4	Q418	NPN	Vcbo=40V, Pc=500mW		2SC423-D	
4	Q419	NPN	Vcbo=250V, Pc=2.5W(Tc=125°c) (Tc=125°C)		2SC1012A	
4	Q420	NPN	Vceo=35V, Pc=1.5W		2SD235-0	
6	Q601	NPN	Vcbo=30V		2SC645	
6	Q602	NPN	Vcbo = 30V		2SC645	
6	Q603	NPN	Vcbo = 30V		2SC645	

SCH. No.	Symbol No.	Description			LEADER Parts No.	Note
6	Q604	NPN	Vcbo=30V		2SC645	
6	Q605	NPN	Vcbo=30V		2SC645	
6	Q606	NPN	Vcbo=30V		2SC645	
6	Q607	NPN	Vcbo=30V		2SC645	
6	Q608	NPN	Vceo=30V		2SC458-B	or 2SC458-C
6	Q609	NPN	Vceo=30V		2SC458-B	or 2SC458-C
6	Q610	PNP	Vceo=50V		2SA678-6	
6	Q611	NPN	Vcbo=160V		2SC869	
6	Q612	NPN	Vceo=30V		2SC458-B	or 2SC458-C
6	Q613	NPN	Vceo=30V		2SC458-B	or 2SC458-C
6	Q614	NPN	Vceo=30V		2SC458-B	or 2SC458-C
6	Q615	J-FET	Vdgo= 30V, IDSS=2.6~6mA		2SK34-D	
6	Q616	NPN	Vceo=30V		2SC458-B	or 2SC458-C
6	Q617	NPN	Vceo=100V		2SC499-Y	
6	Q618	NPN	Vceo=30V		2SC458-B	or 2SC458-C
6	Q619	NPN	Vceo=30V		2SC458-B	or 2SC458-C
8	Q801	NPN	Vceo=100V		2SC499-Y	
8	Q802	NPN	Vceo=100V		2SC499-Y	
8	Q803	PNP	Vceo=50V		2SA678-6	
8	Q804	NPN	Vceo=200V		2SC154-C	or 2SC1012A
8	Q805	NPN	Vceo=200V		2SC154-C	or 2SC1012A
8	Q806	PNP	Vceo=50V		2SA678-6	
8	Q807	NPN	Vceo=200V		2SC154-C	or 2SC1012A
8	Q808	NPN	Vceo=200V		2SC154-C	or 2SC1012A
8	Q809	NPN	Vceo=30V		2SC458-B	or 2SC458-C
9	Q901	NPN	Vceo=30V		2SC458-B	or 2SC458-C
9	Q902	NPN	Vceo=30V		2SC458-B	or 2SC458-C
9	Q903	NPN	Vcbo=160V		2SC869	
9	Q904	NPN	Vceo=30V		2SC458-B	or 2SC458-B
9	Q905	NPN	Vceo=30V		2SC458-B	or 2SC458-B
9	Q906	NPN	Vceo=50V		2SA678-6	

DIODES

SCH. No.	Symbol No.	Description			LEADER Parts No.	Note
1	D101	Rect.	400V	1.1A	V06E	
1	D102	Rect.	600V	1.1A	V06G	
1	D103	Rect.	600V	1.1A	V06G	
1	D104	Rect.	200V	1.1A	V06C	
1	D105	Rect.	200V	1.1A	V06C	
1	D106	Rect.	200V	1.1A	V06C	
1	D107	Rect.	200V	1.1A	V06C	
1	D108	Zener	7V		RD7A	
1	D109	Det.	35V		1S1555	or 1S1588
1	D110	Rect.	100V	1.1A	V06B	
1	D111	Rect.	100V	1.1A	V06B	
1	D112	Rect.		1.1A	V06B	
1	D113	Rect		1.1A	V06B	
2	D201	Rect.	100V	0.5A	1S1941	
2	D202	Zener	6V		RD6A	
2	D203	Zener	6V		RD6A	
2	D204	Det	35V		1S1555	or 1S1588
2	D206	Rect	1.5KV	0.1A	1S2355	or S1R150
2	D207	Rect	1.5KV	0.1A	1S2355	or S1R150
2	D208	Rect.	1.5KV	0.1A	1S2355	or S1R150
2	D209	Rect.	1.5KV	0.1A	1S2355	or S1R150
2	D210	Rect	1.5KV	0.1A	1S2355	or S1R150
2	D211	Rect.	1.5KV	0.1A	1S2355	or S1R150
2	D212	Rect.	1.5KV	0.1A	1S2355	or S1R150
2	D213	Rect.	1.5KV	0.1A	1S2355	or S1R150

SCH. No.	Symbol No.	Description			LEADER Parts No.	Note
4	D401	Det.	35V		1S1588	or 1S1555
4	D402	Det.	35V		1S1588	or 1S1555
4	D403	Det.	35V		1S1588	or 1S1555
4	D404	Det.	35V		1S1588	or 1S1555
4	D405	Zener	6V		RD6A	
6	D601	Rect	100V	0.5A	1S1941	
6	D602	Rect	100V	0.5A	1S1941	
6	D603	Rect	100V	0.5A	1S1941	
6	D604	Ge. Det	35V		1N60	
6	D605	Ge. Det	35V		1N60	
6	D606	Det	35V		1S1588	or 1S1555
6	D607	Det	35V		1S1588	or 1S1555
6	D608	Det	35V		1S1588	or 1S1555
6	D609	Rect	100V	0.5A	1S1941	
6	D610	Det	35V		1S1588	or 1S1555
6	D611	Det	35V		1S1588	or 1S1555
8	D801	Det	60V		1S2076A	
8	D802	Rect	100V		1S1941	
8	D803	Det	35V		1S1588	or 1S1555
9	D901	Ge. Det	35V		1N60	
9	D901	Ge. Det	35V		1N60	
9	D902	Zener	6V		RD6A	
9	D903	Det	35V		1S1588	or 1S1555

TRANSFORMERS

SCH. No.	Symbol No.	Description			LEADER Parts No.	Note
1	PT102	Power Transformer			J-295 (502-J-002A),	

PRINTED CIRCUIT BOARDS

SCH. No.	Symbol No.	Description			LEADER Parts No.	Note
2		HV RECT			T-666	
3		V.ATT			T-663	
4		V. AMP			T-664	
4		V. FINAL			T-588A	
6		MIAN			T-592	
1		PILOT			T-665	
1		PILOT			T-665	
2		VECTOR			T-294A	

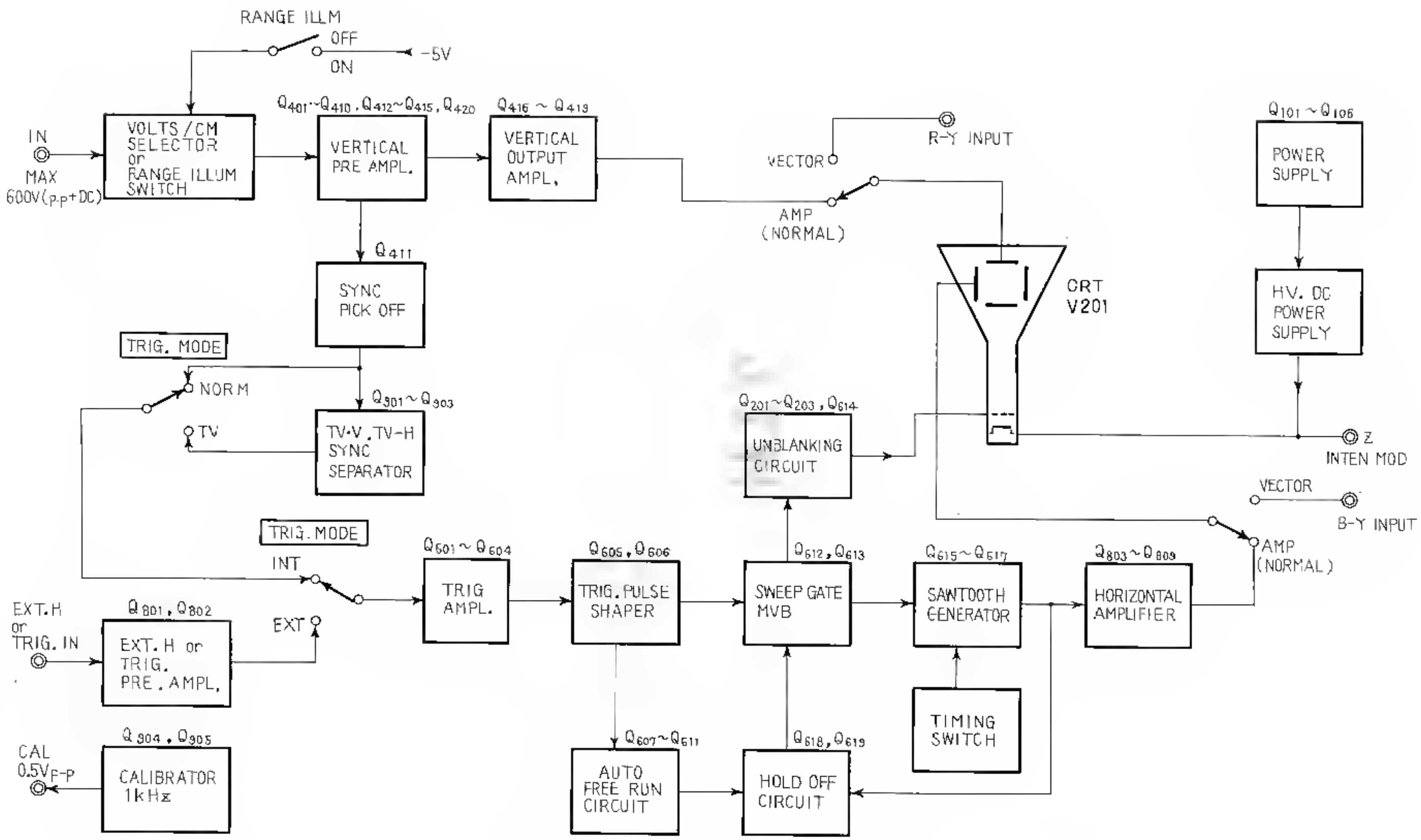
FUSE & LAMP

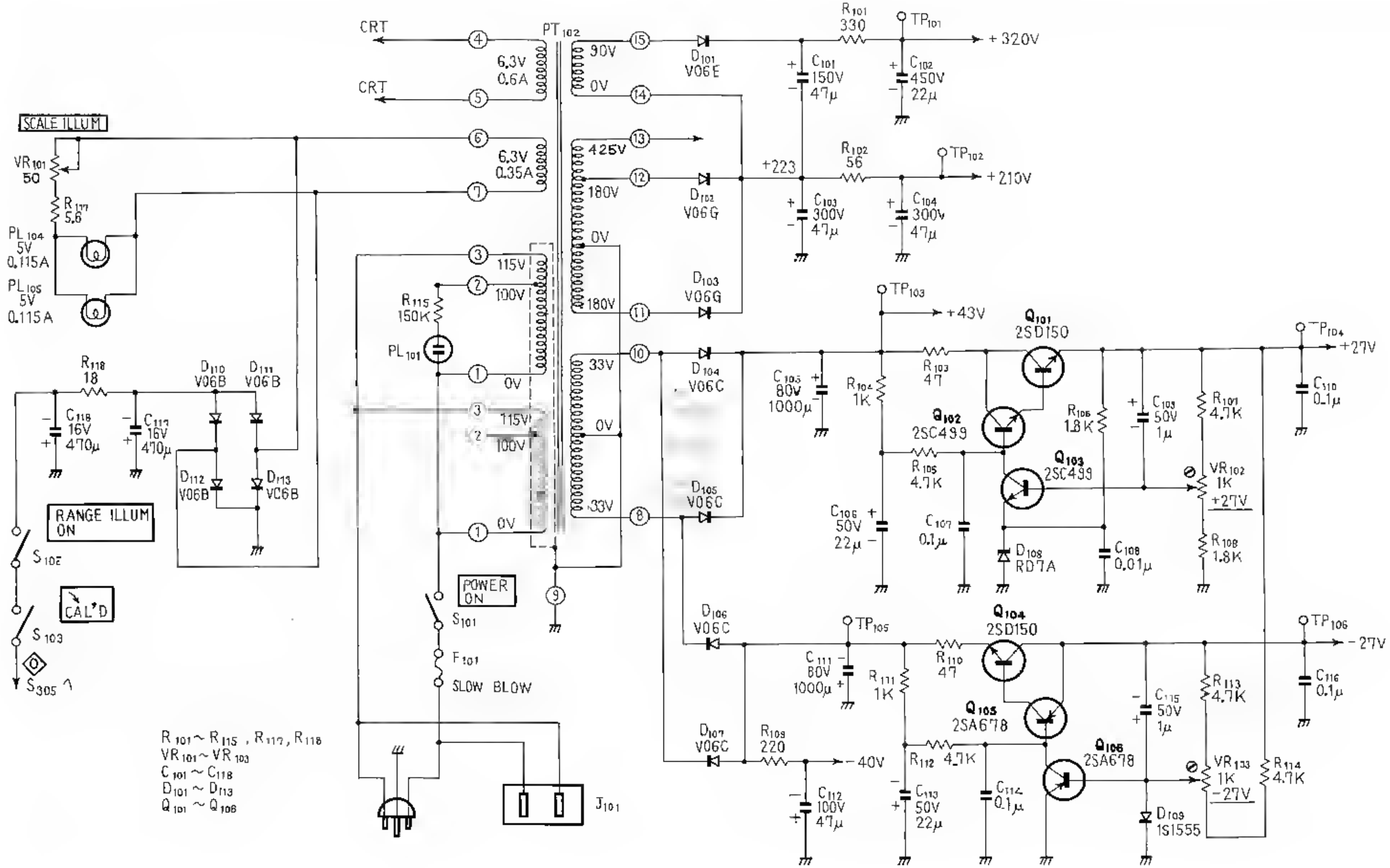
SCH. No.	Symbol No.	Description			LEADER Parts No.	Note
1	F101	SLOW BLOW		100~115V 1A (200~230V, 0.5A)		
1	F101	HOLDER			FH003	
1	PL101	Neon			BNB-2	Transparency
1	PL104		5V	0.115A	BQ034-22212A	
1	PL105		5V	0.115A	BQ034-22212A	
3	PL301		5V	0.115A	BQ034-22212A	
3	PL302		5V	0.115A	BQ034-2221.2A	
3	PL303		5V	0.115A	BQ034-22212A	
6	PL601	Neon			BNB-2	Transparency

SWITCHES

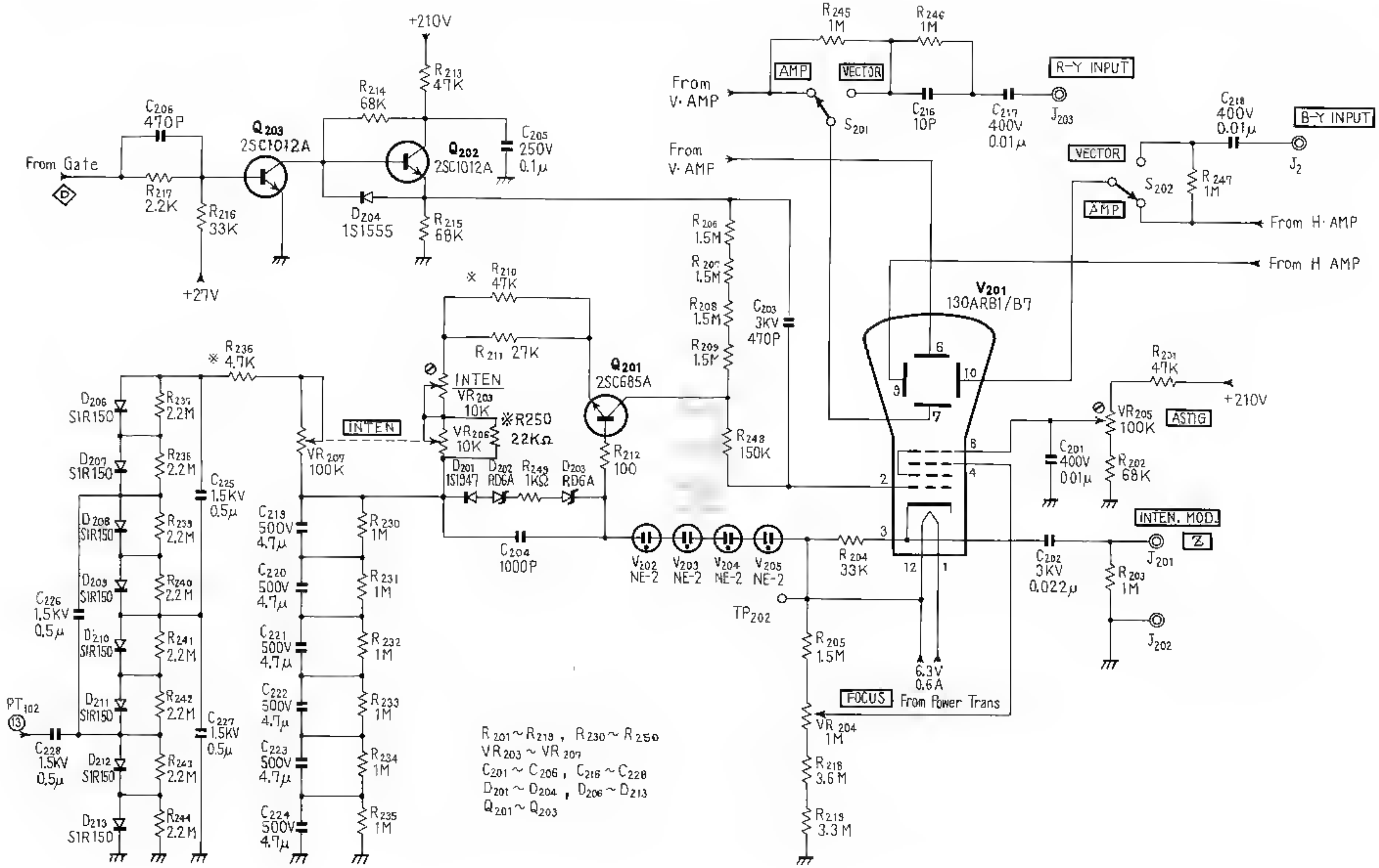
SCH. No.	Symbol No.	Description			LEADER Parts No.	Note
1	S101	Toggle			MST-106D	Power
1	S102	Slide			S2200	
1	S103					with VR406
2	S201	Slide			S2200	
2	S202	Slide			S2200	
3	S301	Push	3 key		Q-302 (502-Q-4)	
3	S302	Push	3 key		Q-302 (502-Q-4)	
3	S303	Push	3 key		Q-302 (502-Q-4)	
3	S305	Rotary			Q-301 (502-Q-2)	S22/VR 3-6-11
4	S401					with VR406

SCH. No.	Symbol No.	Description		LEADER Parts No.	Note
6	S601	Push	3 key	Q-303 (502-Q-5)	
6	S602				with VR603
6	S603	Push	3 key	Q-303 (502-Q-5)	
7	S701	Rotary		Q-271	S32/VR 5-11-20
7	S702	Push	3 key	Q-303 (502-Q-5)	
8	S801				with VR805
		TERMINALS & CONNECTORS			
1	J101	AC RECEPTACLE		S-7070	
2	J201	Banana Jack		No. 375 (Red)	
2	J202	Banana Jack		No. 375 (Black)	
2	J203	Banana Jack		No. 375 (Red)	
2	J204	Banana Jack		No. 375 (Red)	
3	J301	BNC		BNC-BR2	
3	J302	Metal Terminal		D-1376	
8	J801	Banana Jack		No. 375 (Red)	
8	J802	Banana Jack		No. 375 (Black)	
9	J901	Banana Jack		No. 375 (Red)	

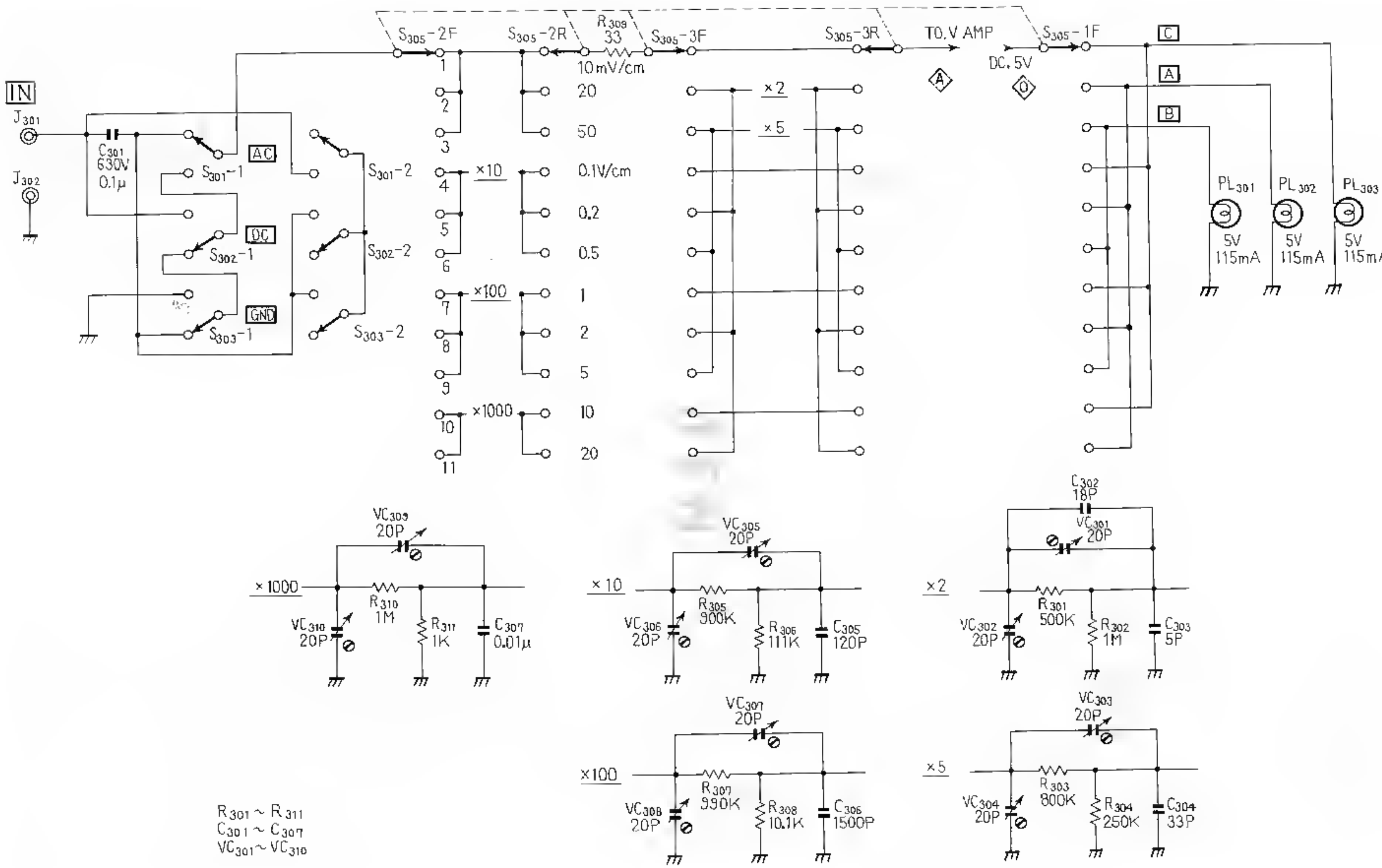

RANGE ILLM
OFF
ON
-5V
IN
MAX
600V(p-p+DC)
VOLTS/CM SELECTOR or RANGE ILLUM SWITCH
Q401~Q410, Q412~Q415, Q420
VERTICAL PRE AMPL.
Q416 ~ Q419
VERTICAL OUTPUT AMPL.
VECTOR
R-Y INPUT
AMP (NORMAL)
CRT V201
Q101 ~ Q106
POWER SUPPLY
HV. DC POWER SUPPLY
Q411
SYNC PICK OFF
TRIG. MODE
NORM
TV
Q901 ~ Q903
TV-V, TV-H SYNC SEPARATOR
Q201 ~ Q203, Q614
UNBLANKING CIRCUIT
Z
INTEN MOD
VECTOR
B-Y INPUT
AMP (NORMAL)
TRIG. MODE
INT
Q601 ~ Q604
TRIG AMPL.
Q605, Q606
TRIG. PULSE SHAPER
Q612, Q613
SWEEP GATE MVB
Q615 ~ Q617
SAWTOOTH GENERATOR
Q803 ~ Q809
HORIZONTAL AMPLIFIER
EXT. H or TRIG. IN
Q801, Q802
EXT. H or TRIG. PRE. AMPL.
EXT
TIMING SWITCH
Q904, Q905
CAL 0.5Vp-p
CALIBRATOR 1kHz
Q607~Q611
AUTO FREE RUN CIRCUIT
Q618, Q619
HOLD OFF CIRCUIT



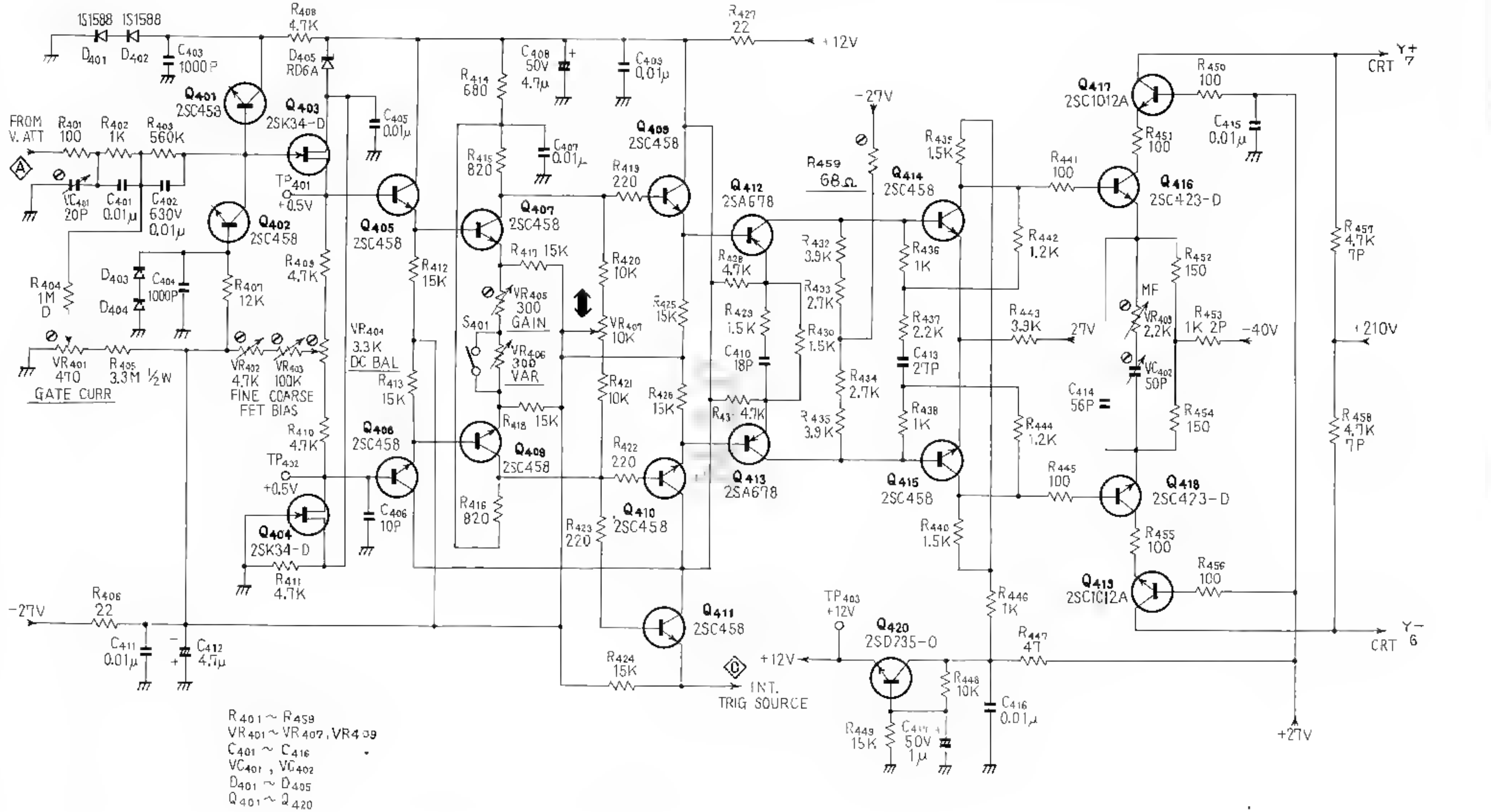
CRT
CRT
PT102
6.3V 0.6A
90V
0V
425V
180V
0V
180V
33V
0V
33V
6.3V 0.35A
115V
100V
0V
SCALE ILLUM
VR101 50
R117 5.6
PL104 5V 0.115A
PL105 5V 0.115A
R115 150K
PL101
R118 18
D110 V06B
D111 V06B
C118 16V 470μ
C117 16V 470μ
D112 V06B
D113 V06B
RANGE ILLUM ON
S102
CAL'D
S103
S305
POWER ON
S101
F101
SLOW BLOW
J101
D101 V06E
D102 V06G
D103 V06G
D104 V06C
D105 V06C
D106 V06C
D107 V06C
R101 330
TP101
+320V
C101 150V 47μ
C102 450V 22μ
+223
R102 56
TP102
+210V
C103 300V 47μ
C104 300V 47μ
TP103
+43V
Q101 2SD150
TP104
+27V
C105 80V 1000μ
R104 1K
R103 47
Q102 2SC499
R106 1.8K
C109 50V 1μ
R107 4.7K
C110 0.1μ
R105 4.7K
Q103 2SC499
VR102 1K +27V
C106 50V 22μ
C107 0.1μ
D108 RD7A
C108 0.01μ
R108 1.8K
TP105
Q104 2SD150
TP106
-27V
C111 80V 1000μ
R111 1K
R110 47
Q105 2SA678
C115 50V 1μ
R113 4.7K
C116 0.1μ
R109 220
-40V
R112 4.7K
Q106 2SA678
VR103 1K -27V
R114 4.7K
C112 100V 47μ
C113 50V 22μ
C114 0.1μ
D109 1S1555
R101 ~ R115 , R117, R118
VR101 ~ VR103
C101 ~ C118
D101 ~ D113
Q101 ~ Q106

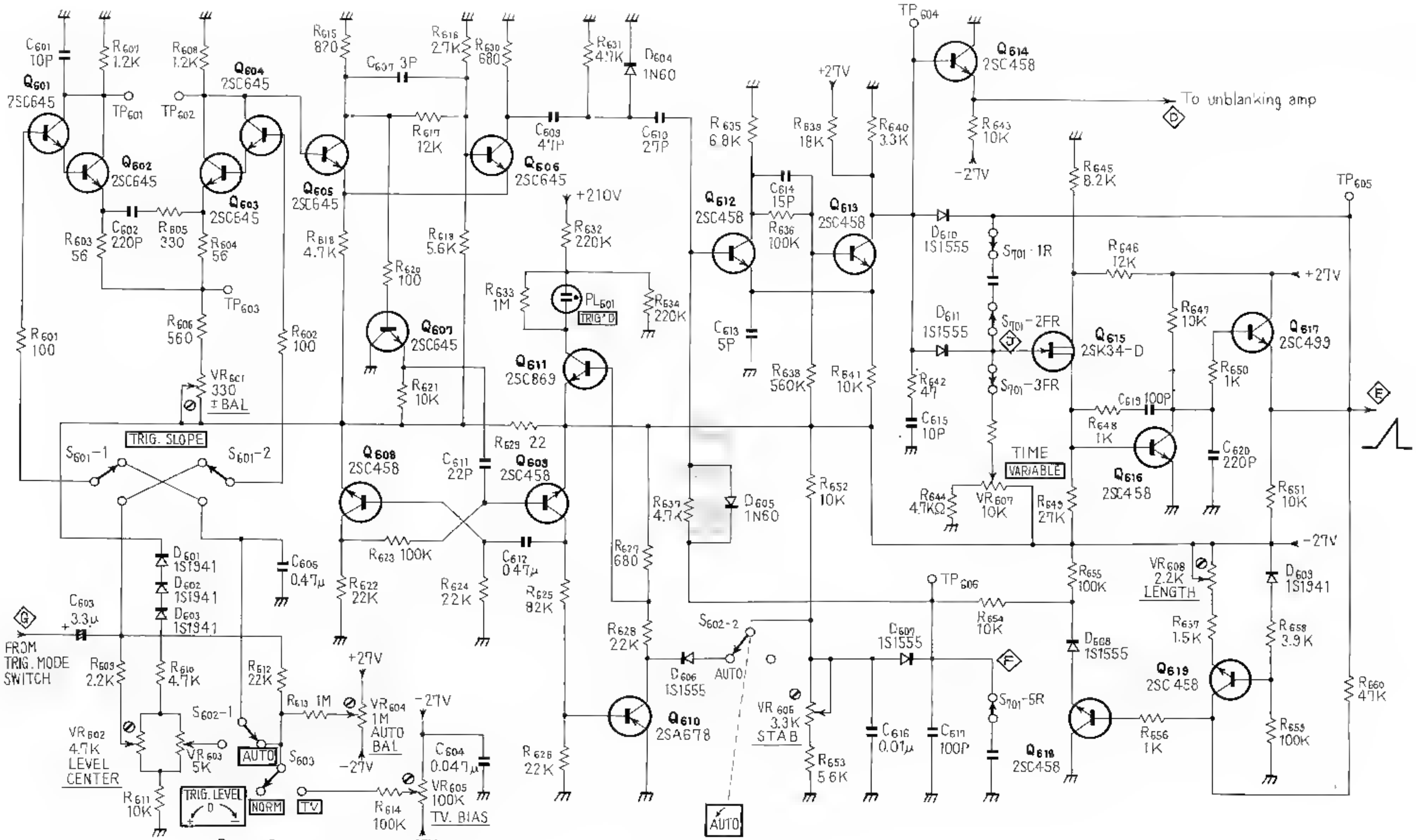


+210V
R213 47K
R214 68K
C206 470P
From Gate
R217 2.2K
R216 33K
+27V
Q203 2SC1012A
Q202 2SC1012A
C205 250V 0.1μ
D204 1S1555
R215 68K
R245 1M
R246 1M
From V·AMP
AMP
VECTOR
S201
C216 10P
C217 400V 0.01μ
R-Y INPUT
J203
C218 400V 0.01μ
B-Y INPUT
J2
From V·AMP
VECTOR
S202
AMP
R247 1M
From H·AMP
From H AMP
R206 1.5M
R207 1.5M
R208 1.5M
R209 1.5M
C203 3KV 470P
R210 47K
R211 27K
INTEN VR203 10K
VR206 10K
※R250 22KΩ
Q201 2SC685A
V201 130ARB1/B7
R236 4.7K
INTEN
VR207 100K
R248 150K
R212 100
D201 1S1947
D202 RD6A
R249 1KΩ
D203 RD6A
R231 47K
+210V
VR205 100K
ASTIG
C201 400V 0.01μ
R202 68K
INTEN. MOD.
Z
D206 S1R150
D207 S1R150
D208 S1R150
D209 S1R150
D210 S1R150
D211 S1R150
D212 S1R150
D213 S1R150
R237 2.2M
R238 2.2M
R239 2.2M
R240 2.2M
R241 2.2M
R242 2.2M
R243 2.2M
R244 2.2M
C225 1.5KV 0.5μ
C226 1.5KV 0.5μ
C227 1.5KV 0.5μ
C228 1.5KV 0.5μ
PT102
C219 500V 4.7μ
C220 500V 4.7μ
C221 500V 4.7μ
C222 500V 4.7μ
C223 500V 4.7μ
C224 500V 4.7μ
R230 1M
R231 1M
R232 1M
R233 1M
R234 1M
R235 1M
C204 1000P
V202 NE-2
V203 NE-2
V204 NE-2
V205 NE-2
R204 33K
TP202
C202 3KV 0.022μ
J201
R203 1M
J202
R205 1.5M
6.3V 0.6A
FOCUS From Power Trans
VR204 1M
R218 3.6M
R219 3.3M
R201~R219 , R230~R250
VR203 ~ VR207
C201 ~ C206 , C216 ~ C228
D201 ~ D204 , D206 ~ D213
Q201 ~ Q203

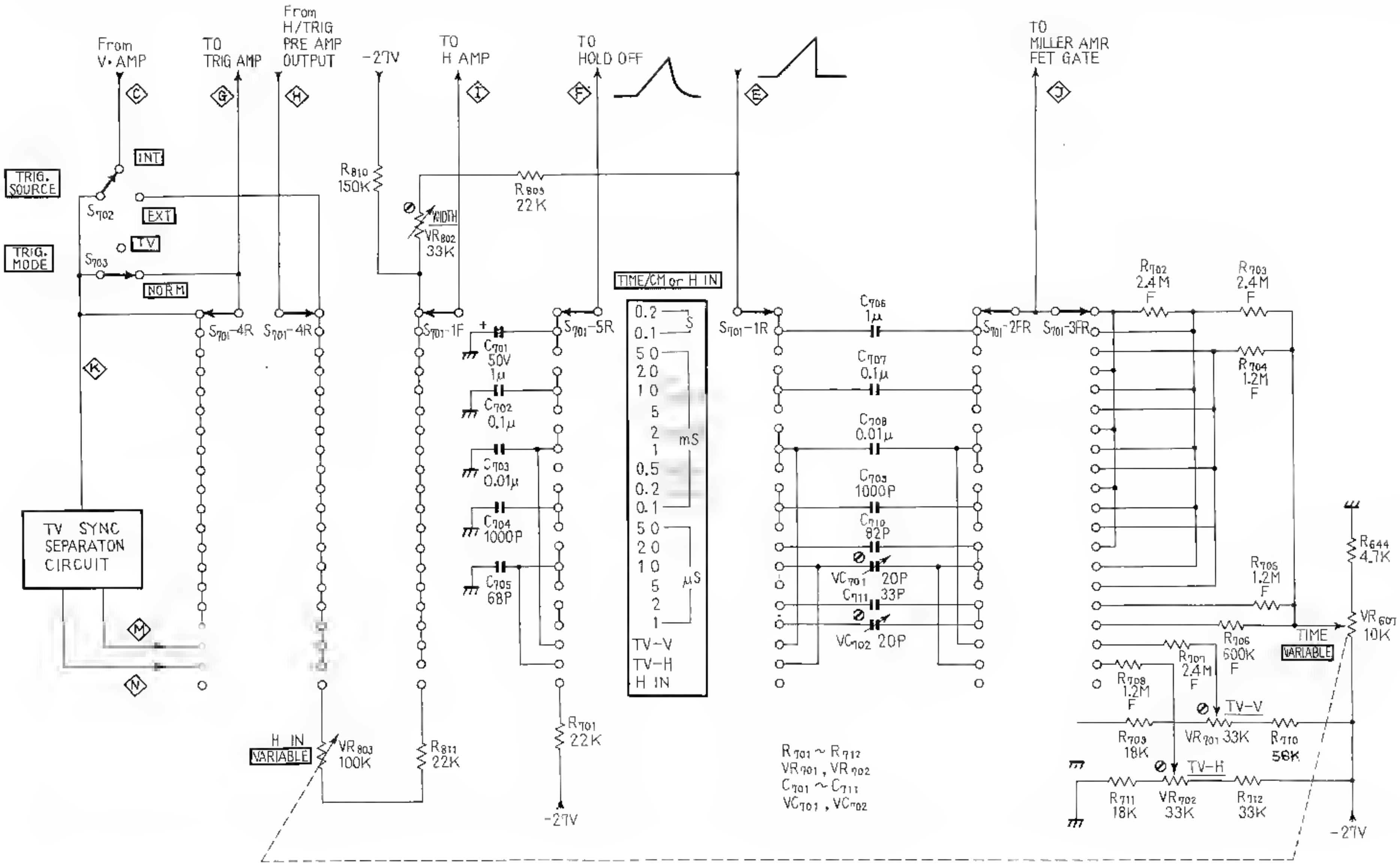


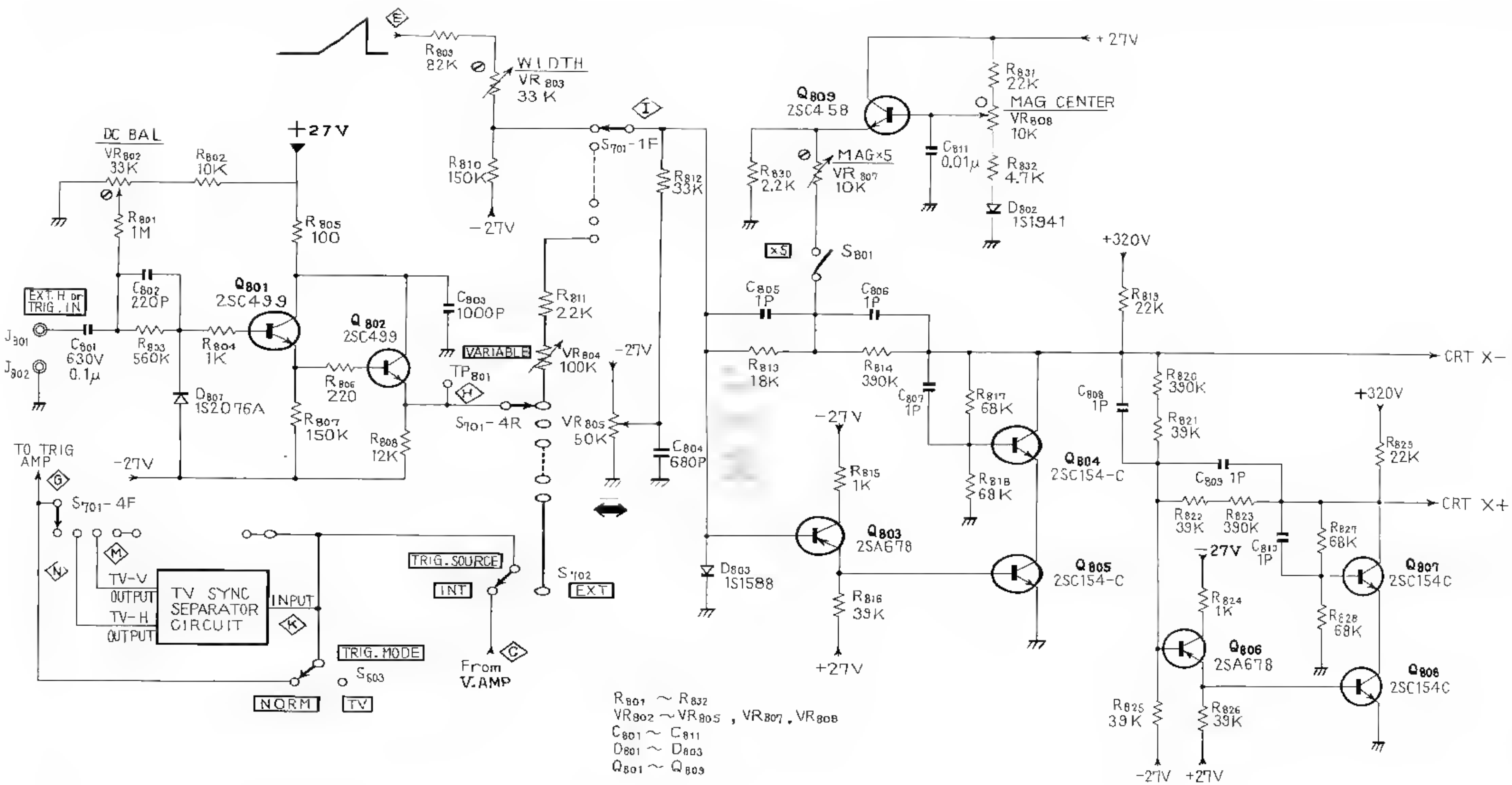
IN
J301
J302
C301
630V
0.1μ
AC
DC
GND
S301-1
S301-2
S302-1
S302-2
S303-1
S303-2
S305-2F
S305-2R
R309
33
S305-3F
S305-3R
TO.V AMP
S305-1F
DC. 5V
10mV/cm
20
50
0.1V/cm
0.2
0.5
1
2
5
10
20
×10
×100
×1000
×2
×5
C
A
B
PL301
PL302
PL303
5V
115mA
VC309
20P
×1000
R310
1M
VC310
20P
R311
1K
C307
0.01μ
VC305
20P
×10
R305
900K
VC306
20P
R306
111K
C305
120P
C302
18P
VC301
20P
×2
R301
500K
VC302
20P
R302
1M
C303
5P
VC307
20P
×100
R307
990K
VC308
20P
R308
10.1K
C306
1500P
VC303
20P
×5
R303
800K
VC304
20P
R304
250K
C304
33P
R301 ~ R311
C301 ~ C307
VC301 ~ VC310


FROM V. ATT
+12V
-27V
+27V
-40V
+210V
Y+ CRT 7
Y- CRT 6
INT. TRIG SOURCE
GATE CURR
FINE COARSE FET BIAS
DC BAL
GAIN
VAR
R401 ~ R459
VR401 ~ VR407, VR409
C401 ~ C416
VC401, VC402
D401 ~ D405
Q401 ~ Q420

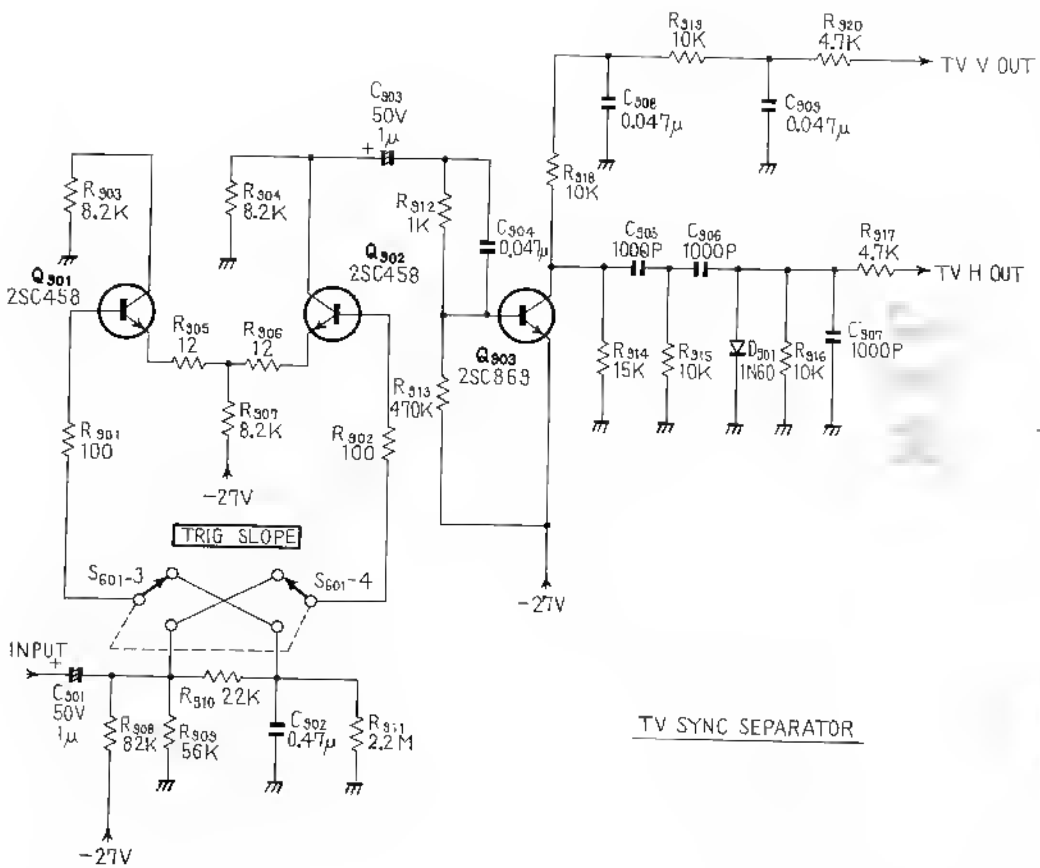


R601 ~ R660
VR 601 ~ VR 608
C601 ~ C605, C607, C609 ~ C617, C619, C620
D601 ~ D611
Q601 ~ Q619

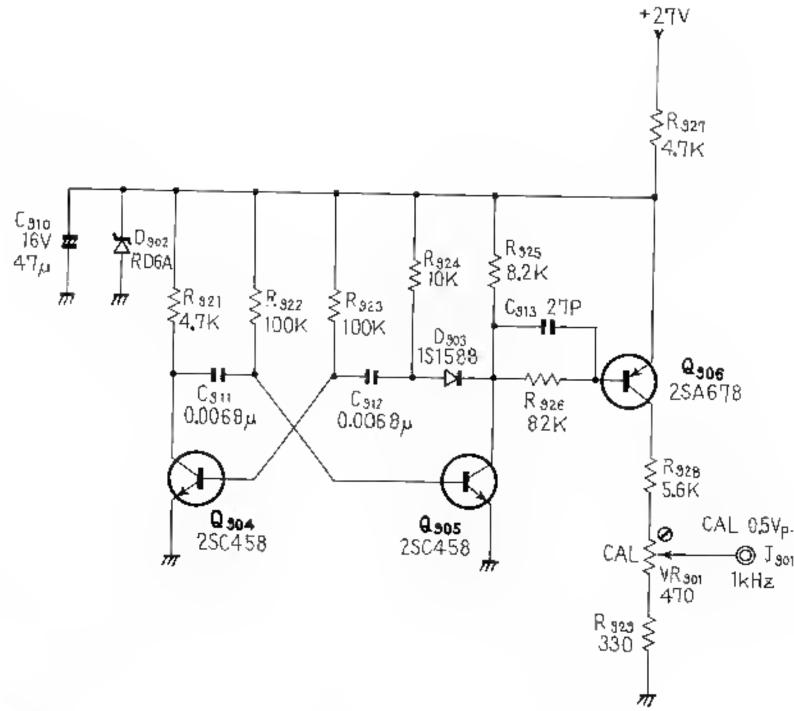

From V·AMP
TO TRIG AMP
From H/TRIG PRE AMP OUTPUT
-27V
TO H AMP
TO HOLD OFF
TO MILLER AMR FET GATE
TRIG. SOURCE
INT
EXT
TV
NORM
TRIG. MODE
TV SYNC SEPARATON CIRCUIT
R810 150K
R805 22K
WIDTH
VR802 33K
TIME/CM or H IN
0.2 0.1 S
50 20 10 5 2 1 0.5 0.2 0.1 mS
50 20 10 5 2 1 μS
TV-V
TV-H
H IN
C701 50V 1μ
C702 0.1μ
C703 0.01μ
C704 1000P
C705 68P
C706 1μ
C707 0.1μ
C708 0.01μ
C709 1000P
C710 82P
VC701 20P
C711 33P
VC702 20P
R702 2.4M F
R703 2.4M F
R704 1.2M F
R705 1.2M F
R706 600K F
R707 2.4M F
R708 1.2M F
R709 18K
VR701 33K
R710 56K
R711 18K
VR702 33K
R712 33K
R644 4.7K
VR601 10K
TIME VARIABLE
H IN VARIABLE
VR803 100K
R811 22K
R701 22K
-27V
R701 ~ R712
VR701, VR702
C701 ~ C711
VC701, VC702



EXT. H or TRIG. IN
J801
J802
DC BAL
VR802 33K
R802 10K
R801 1M
C802 220P
C801 630V 0.1μ
R833 560K
R804 1K
D807 1S2076A
+27V
R805 100
Q801 2SC499
Q802 2SC499
R806 220
R807 150K
R808 12K
C803 1000P
-27V
TO TRIG AMP
S701-4F
TV-V OUTPUT
TV-H OUTPUT
TV SYNC SEPARATOR CIRCUIT
INPUT
TRIG. MODE
S603
NORM
TV
TRIG. SOURCE
INT
EXT
S702
From V. AMP
R803 82K
WIDTH
VR803 33K
R810 150K
S701-1F
R812 33K
R811 2.2K
VARIABLE
VR804 100K
TP801
S701-4R
VR805 50K
C804 680P
Q809 2SC458
+27V
R831 22K
MAG CENTER
VR808 10K
C811 0.01μ
R832 4.7K
D802 1S1941
R830 2.2K
MAG×5
VR807 10K
×5
S801
C805 1P
C806 1P
R813 18K
R814 390K
C807 1P
R815 1K
Q803 2SA678
D803 1S1588
R816 39K
R817 68K
R818 68K
Q804 2SC154-C
Q805 2SC154-C
+320V
R819 22K
CRT X−
C808 1P
R820 390K
R821 39K
C809 1P
R822 39K
R823 390K
CRT X+
R829 22K
C810 1P
R827 68K
R828 68K
Q807 2SC154C
Q806 2SA678
Q808 2SC154C
R824 1K
R825 39K
R826 39K
R801 ~ R832
VR802 ~ VR805 , VR807, VR808
C801 ~ C811
D801 ~ D803
Q801 ~ Q809



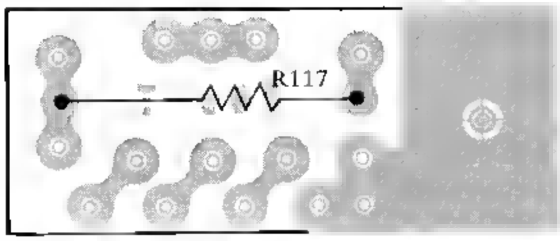
TV SYNC SEPARATOR



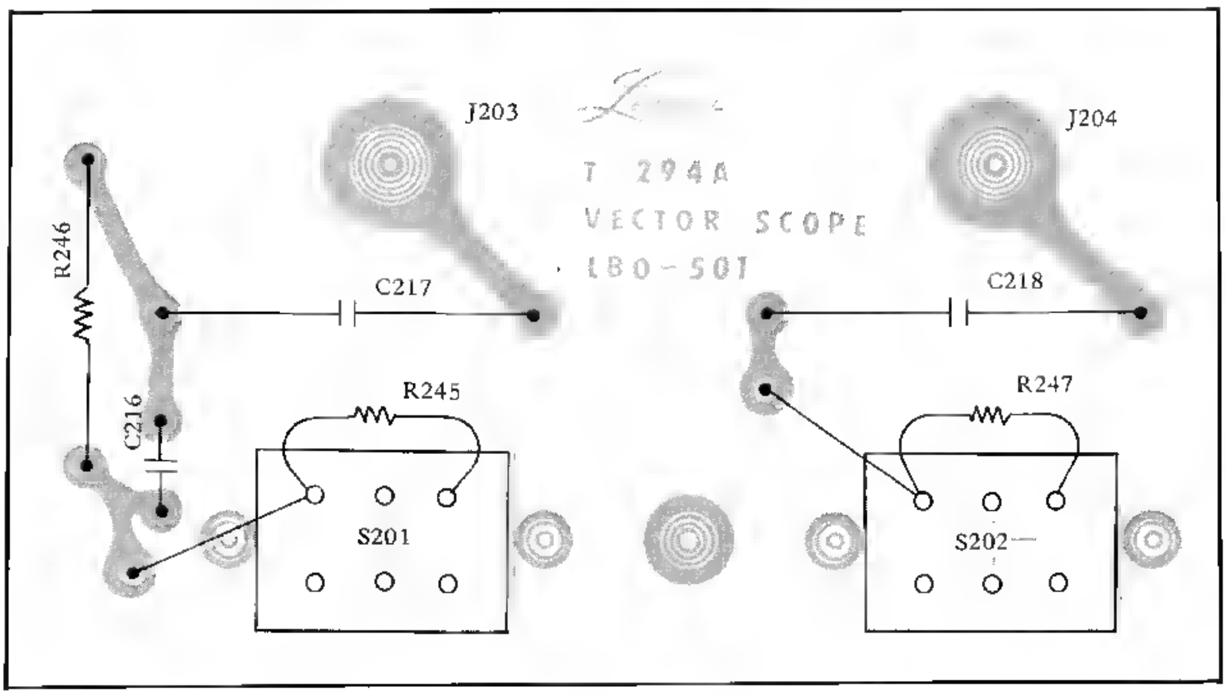
CALIBRATOR

$R_{901} \sim R_{929}$
VR_{901}
$C_{901} \sim C_{913}$
$D_{901} \sim D_{903}$
$Q_{901} \sim Q_{906}$

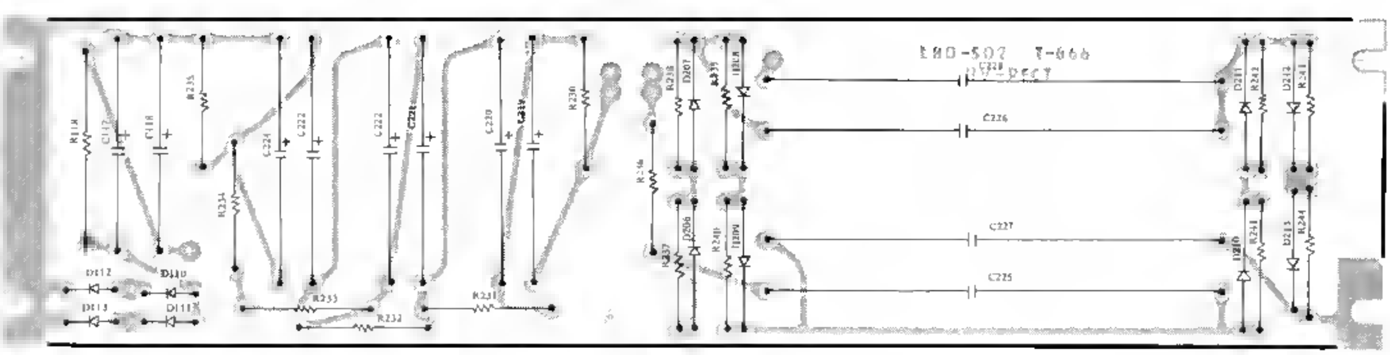
PILOT T-665



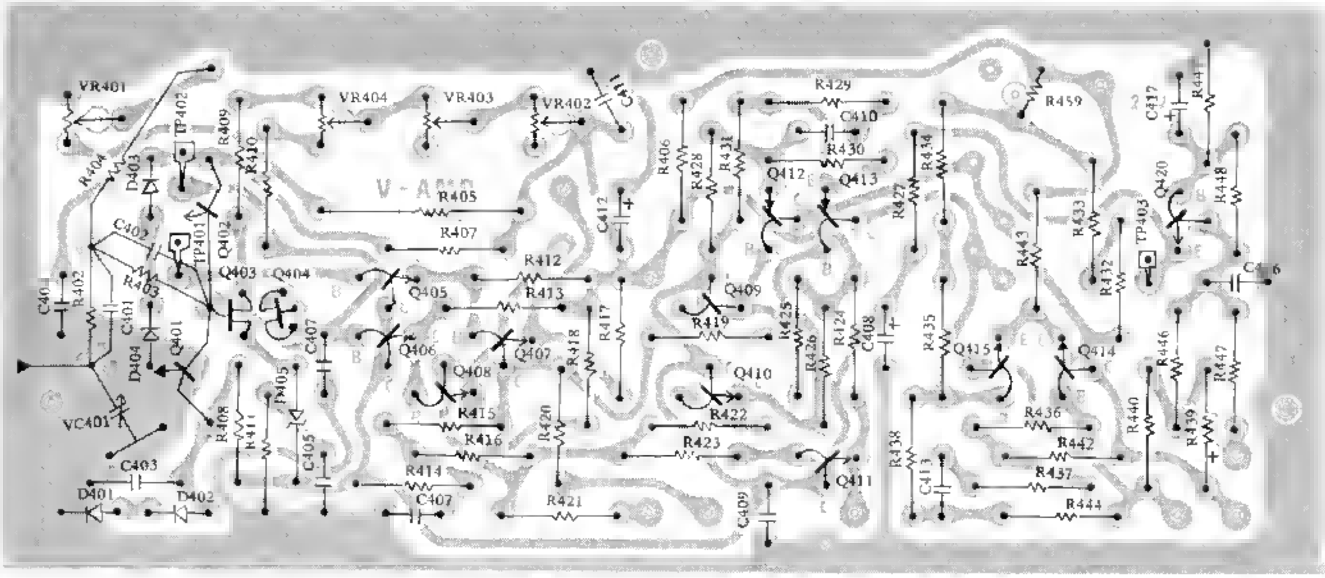
VECTOR T-294A



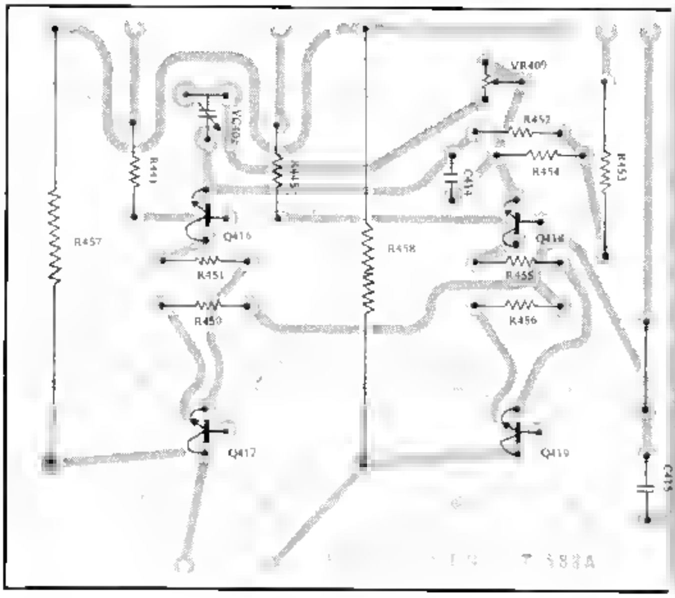
HV·RECT T-666



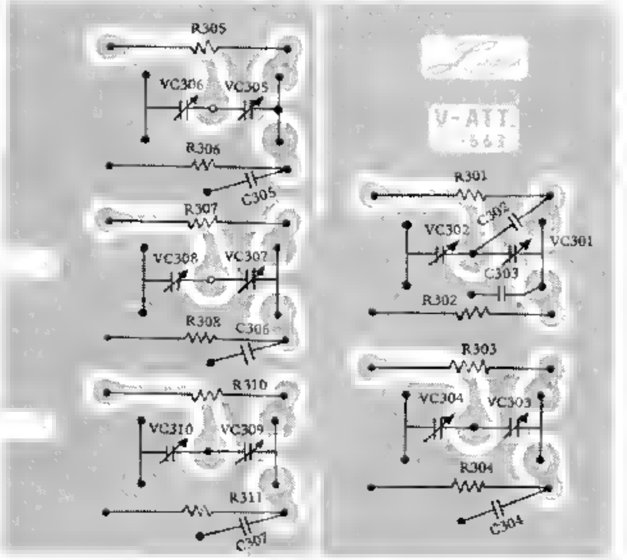
V·AMP T-664



V·FINAL T-588A



V·ATT T-663



MAIN T-592