TECHNICAL INFORMATION

13V" HIGH-RESOLUTION
COLOR DISPLAY MONITOR
MODEL C-3470
OCT. 1982

MITSUBISHI ELECTRIC CORPORATION
HEAD OFFICE MITSUBISHI DENKI BLDG., MARUNOUCHI TOKYO 100. TELEX J24532 CABLE MELCO TOKYO

First Edition, First Printing

SECTION 1
SPECIFICATIONS

Mitsubishi Electric, MODEL C-3470 SERIES COLOR DISPLAY MODULE is a high resolution module for clear display of 2,000 characters in alphabet, numerals and graphic symbols.

This module is equipped with IN-LINE GUNS/SHADOW MASK CRT and a PCB with solid state active elements.

MODEL C-3470 SERIES features stable convergence, easy maintenance, compact style. This standard model accepts TTL inputs for R.G.B. video, HD and VD signals. This model is supplied without a cabinet.

1. FEATURE

(A) Compact style

Width, height and depth are small enough to replace monochrome monitors.

(B) All solid state except for CRT

All active elements except for CRT are solid state elements as IC or Transistor.

(C) Easy maintenance

PCB can be replaced without use of special tools and most of parts can be checked and replaced without disassembling any constructions.

(D) Anti spark circuit

All circuits are designed to avoid damage caused by spark in the CRT.

(E) Stable convergence

Self convergence assemblies are mounted on the CRT. Complicated convergence procedures are not necessary, because electric convergence circuits are not equipped.

2. ELECTRICAL SPECIFICATION

2.1 AC Power Voltage : AC 100 ~ 120 V or 220 ~ 240 V
$\pm$ 10% Tap selectable

2.2 AC Power Frequency : 50 or 60 Hz

2.3 Power Consumption : Max. 80W

2.4 Input Signal

(a) Connector : Miniature nylon connector
Molex 1625-15P (03-06-2151)

(b) Sorts of inputs

This module accepts positive TTL inputs for R.G.B. video, HD and VD signals. (ALL POSITIVE GOING)

Video signals are terminated by 470 ohm pull-up resistors.

Minimum input impedance of HD/VD is 2.2 K ohm.

* Refer the interface circuit. Another inputs versions are available to order.

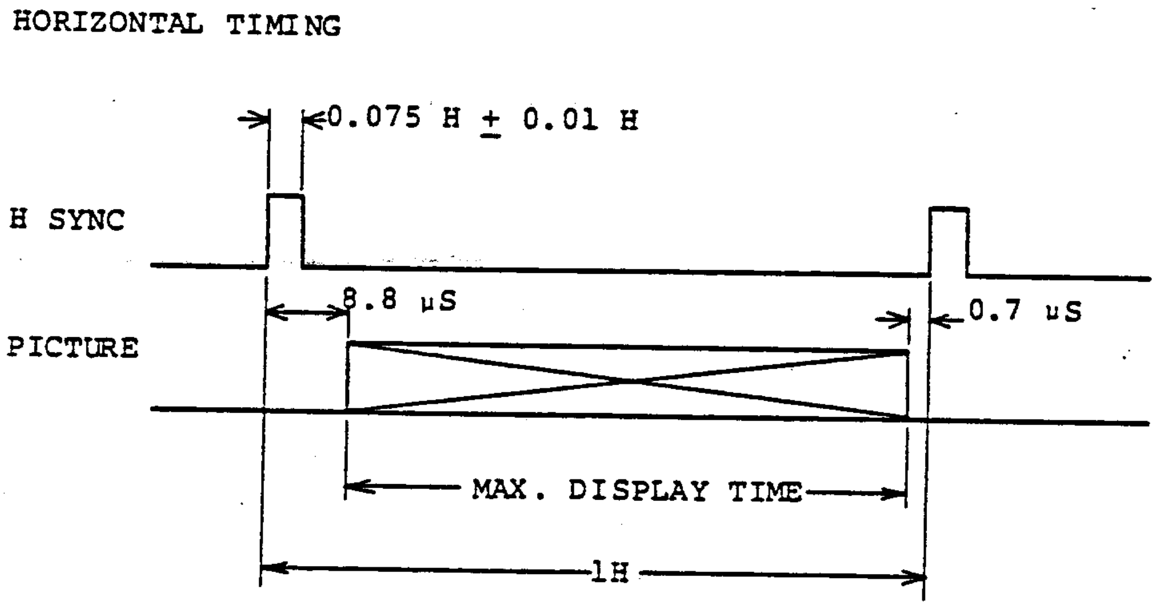
  Please contact Mitsubishi when you need special inputs.

(c) Timing requirements

Fig. 1 shows Timing Chart for recommendation of input signals.

The module input signals conform generally with EIA-STD-RS170 and RS343.

Fig. 1 Recommendable Timing Chart



VERTICAL TIMING

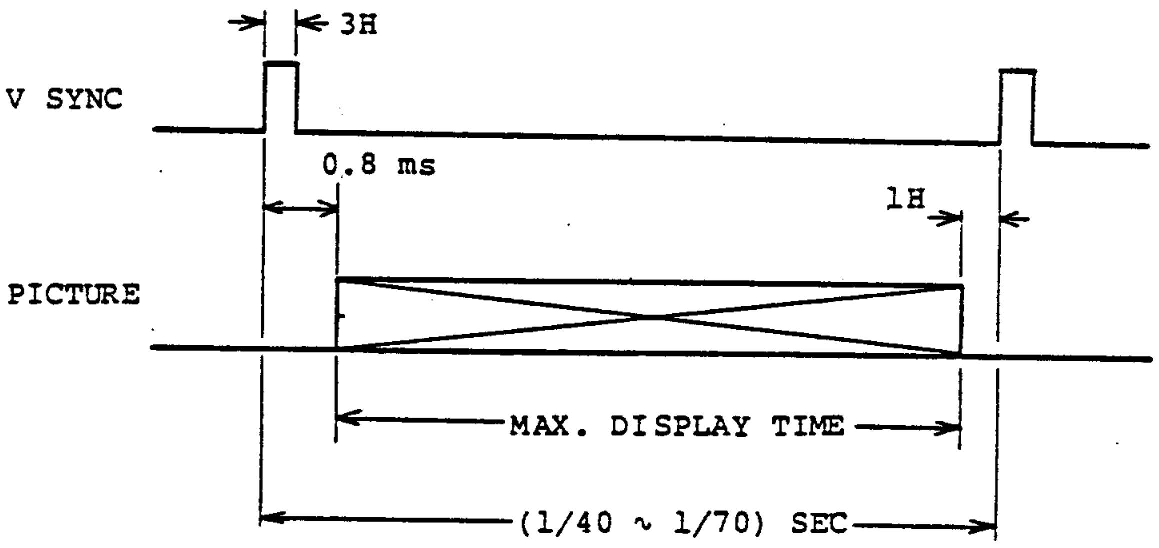
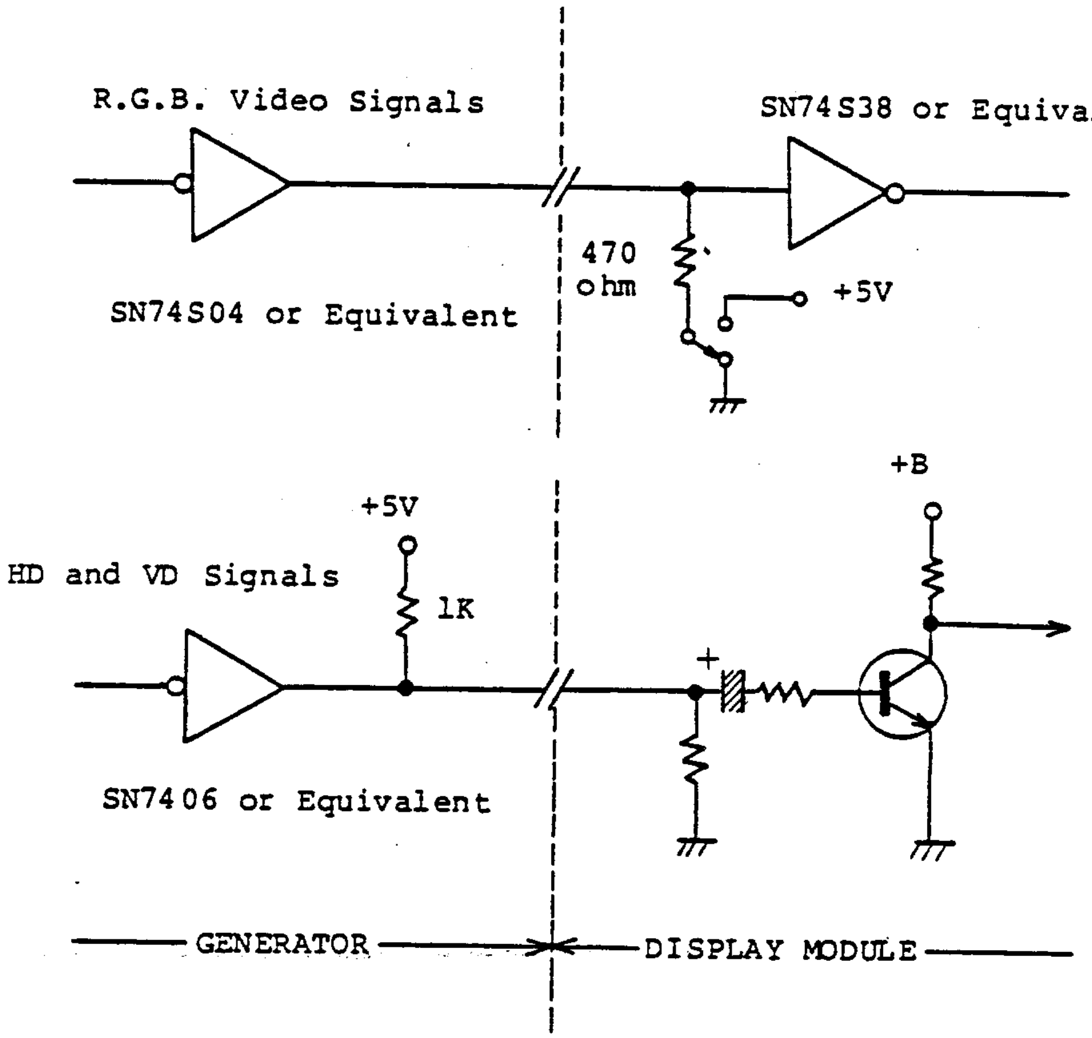


Fig. 1 Recommendable Timing Chart (Cont.)

(d) Interface Circuit



High level shall be 2.0 ∿ 5.0 V
Low level shall be 0 ∿ 0.8 V

Fig. 2 Interface Circuit

Table 1 Signal Input Pin Connection

Connector : MOLEX 1625-15P

Pin No.	Signal	Pin No.	Signal
1	HD	(4)	SG-HD
2	Red	(5)	SG-R
3	Green	(6)	SG-G
7	Blue	(10)	SG-B
15	VD	(14)	SG-VD

SG : Signal Ground

2.5 Scanning Frequency

Scanning Frequencies shall be specified by users before order is placed.

Vertical frequency : 50 ∿ 60 Hz

Horizontal frequency: One spetify frequency between 15.0 and 18.0 kHz

One specify frequency between 19.0 and 24.0 kHz

2.6 Max. Effective Screen

250 W x 190 H (mm) is available. Users are requested to advise timings and actual area of use. In order to avoid trouble caused by timings, manufacturer wants signal source made by user.

2.7 Linearity

Linearity measured by cross-hatch method is better than 7%.
Calculation formula is as follows.

$$\frac{\text{MAX} - \text{MIN}}{\text{MEAN}} \times \frac{1}{2} \times 100 \ (\%)$$

Raster distortion is less than 2 %.

2.8 Convergence

Shall not deviate more than 0.5 mm in a centrally located area bounded by a circle.
The diameter of this circle is equal to picture height.
Elsewhere, the deviation shall not exceed 0.8 mm.

2.9 Raster Size Regulation

Rester Size Change caused by change of CRT beam current 0 to 200 μA is less than 1% of raster height.

2.10 Pulse Characteristics

Pulse rise and fall times of the video amplifier are better than 20 ns.

2.11 Ambient Temperature

Ambient temperature shall be 0 °C to +50 °C for chassis without cover.

2.12 Warm-Up Time

Warm-up time is 20 minutes maximum. At the end of warm-up period, no adjustments or service is necessary to meet the specifications contained herein.

2.13 Package Environment

Package air temperature

This equipment with stands room air temperature of -30 °C to 60 °C and 50 cm free drops encountered during transportation, handling and storage.
Also this withstands to Rleative Humidity of 0 to 95%.

2.14 CRT

14" (13"V) Self-convergence type,dot-phospher shadow mask tube and in-line electron gun.

Phosphors are Red, Green and Blue for the standard model.

In order to reduce FLICKER, Long Persistance Phosphors are recommended.

AT1429LBL8	R.G. Sky-Blue Long
AT1429LBL5	R.G. Long, B. Medium

2.15 Degaugging

Automatic Degaussing Circuit

3. Identification and Marking

The following markings are provided.

1) DHHS Warning labels on the CRT or chassis.

2) High voltage warning labels on the chassis.

3) Rating labels on the chassis to show power source, model number, etc.

4) Serial number label on the chassis.

4. Spare Parts

Fuses and connectors are furnished in the package.

Connectors	MOLEX 1625-15R	(Signal)
	MOLEX 3191-03R	(POWER)

5. Controls

The Contrast control located on the rear panel.

6. <u>Configulation</u>

1) Dimension

Refer to attached Drawings Fig. 3

2) Weight

15 kg without cover

7. <u>DOCUMENTATION</u>

The following documents are arranged and supplied to the users.

1) Service manual containing circuits description, operating Procedures, maintenance instruction parts list and schematic diagram.

2) Specification

3) Drawings showing outline of equipment and details for installation.

SECTION 2
INSTALLATION

2.1 GENERAL

This section explains how to install the color display module and how to verify its basic operation. Like most commercial TV receivers, the module is thoroughly adjusted and checked out at the factory, but it may require certain minor adjustments to adapt it to a particular display generator or other controller and to compensate for minor adjustment disturbances caused during shipment. For convenient reference, complete adjustment procedures and other basic checks are consolidated in Section 3, but only selected, simple procedures should be necessary for initial installation.

2.2 UNPACKING

The monitor is normally packaged in a separate shipping container unless it is incorporated into a system by MITSUBISHI ELECTRIC CORPORATION.
Carefully open the top of the container.
Remove the inside packing material and lift out the monitor.

2.3 ASSEMBLY

The color display module is supplied without cabinet.
The line voltage apply through the connector (PA) to the module.

2.4 CAUTION BEFORE "POWER ON"

Please make sure that PCBs, wires, connectors, components and structures are in perfect mechanical order and not damaged during transportation. Particular attention should be paid to the anode cap of the CRT.

Check the position of the line voltage plug (PE) and the value of the line fuse before plugging in the line cord.

The plug (PE) and fuse are mounted on the PCB-POWER, with voltage settings.

Table 2-1 Rear Panel Connectors

CONNECTOR	FUNCTION	CONNECTOR TYPE
VA Pin No.		Miniature Nylon Connector molex 10P
1 (2)	Red	
3 (4)	Green	
5 (6)	Blue	
7 (8)	HD	
9 (10)	VD	
PA	Power Input 100 ∿ 120 VAC/ 220 ∿ 240 VAC	

SECTION 3
CIRCUIT DESCRIPTION

3.1 DETAILED DISCRIPTION

This section contains detailed descriptions of circuits operation for the Model C-3470 Color Display Monitor according to Fig. 3-1. In reading this section, reference should be made to the monitor schematic diagrams.

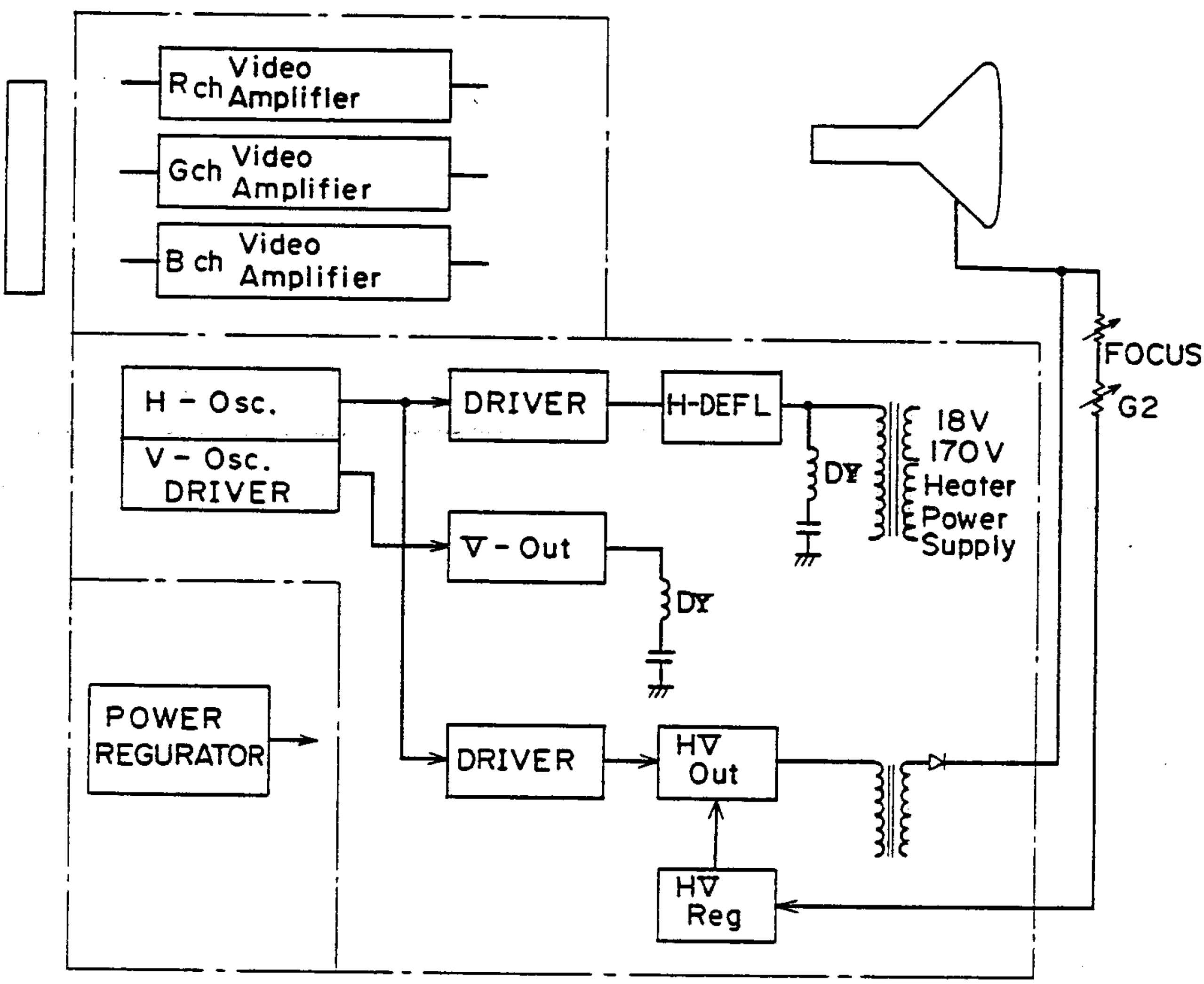


Fig. 3-1 Block diagram of the Model C-3470

3.2 VIDEO-CIRCUIT

3.2.1 Video Amplifiers

This circuits amplify the input signal to the active level.

The color monitor contains three video amplifiers, one for each primary color. These three amplifiers for the red, green, and blue CRT guns are identical. Therefore, the operation of only one channel (RED) is described here.

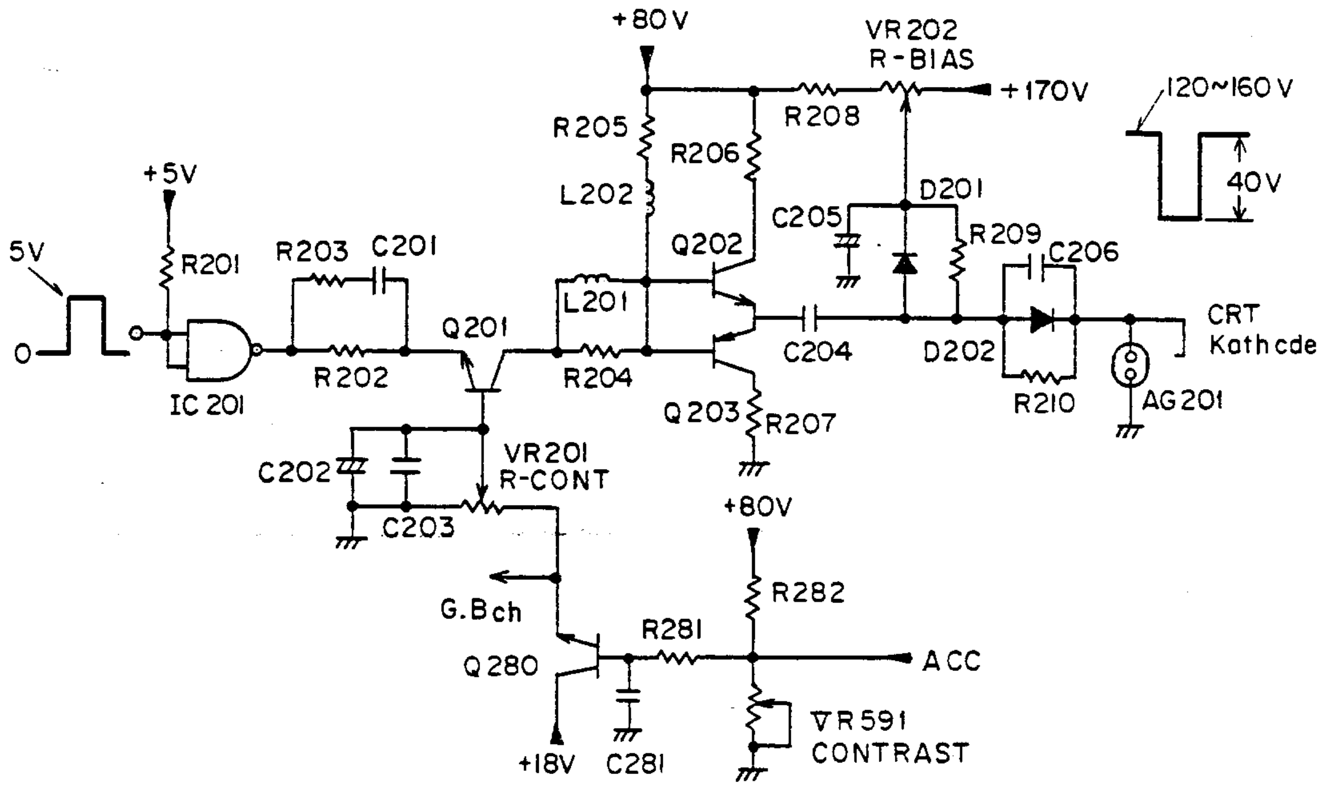


Fig. 3-2 Schematic diagram of the Video Amplifier

Input signal from the generator is applied to the buffer IC201. The output of IC201 is open-collector output stage, and it's output transistor and Q201 form a cascade amplifier.
This cascade amplifier amplifies the input signal to enough amplitude of voltage to drive the cathode of the CRT, and it is applied to the collector of Q201.

The emitter peaking formed with R203, C201 and series, parallel peaking formed with L201, L202 are high frequency emphasizing circuit.

The output signal from Q201 collector is transformed into low impedance by emitter-follower formed with Q202 and Q203, and applied to the cathode of the CRT through the capacitor C204. As following figure, this signal is clamped by the clamp circuit formed with C204, D201, and R209.

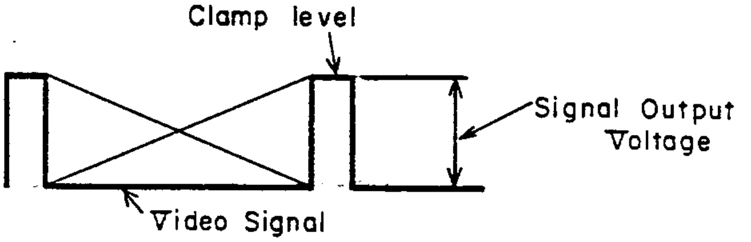


Fig. 3-3 The wave form of Clamp Circuit

The clamp level in this figure is adjustable by VR202 (R-BIAS).
This is the circuit adjusting the cut-off voltage of each 3 guns identically.

VR201 (R-CONT) and VR591 (CONTRAST) is for adjusting signal output voltage. There are VR231 (G-CONT) for green channel and VR261 (B-CONT) for blue (white) channel like VR201 (R-CONT), and adjusting signal voltage of each circuit to balance 3 colors. VR591 (CONTRAST) is adjustable the signal voltage of 3 colors at the same time, and adjusts the brightness of the screen.

Electric discharge gap AG201 and R210 are prepared for the circuit protection at the time of flushover inside of the CRT.

3.2.2 Sync Circuit

The positive-polarity horizontal sync signal (HD) from the connector VA, pin #7 is applied to the base of Q501 via C501 and R502.
The negative-polarity horizontal sync signal (HD) at the collector of Q501 is applied to the IC401, pin #16.

The positive-polarity vertical sync signal (VD) from the connector VA, pin #9 is applied pulse invertor Q401.
The negative-polarity output pulse of Q401 is applied to the IC401, pin #8.

3.2.3 ACC Circuit (Automatic Contrast Control)

The ACC circuit controls the video signal output for the stable picture. The schematic diagram is shown as Fig. 3.4.

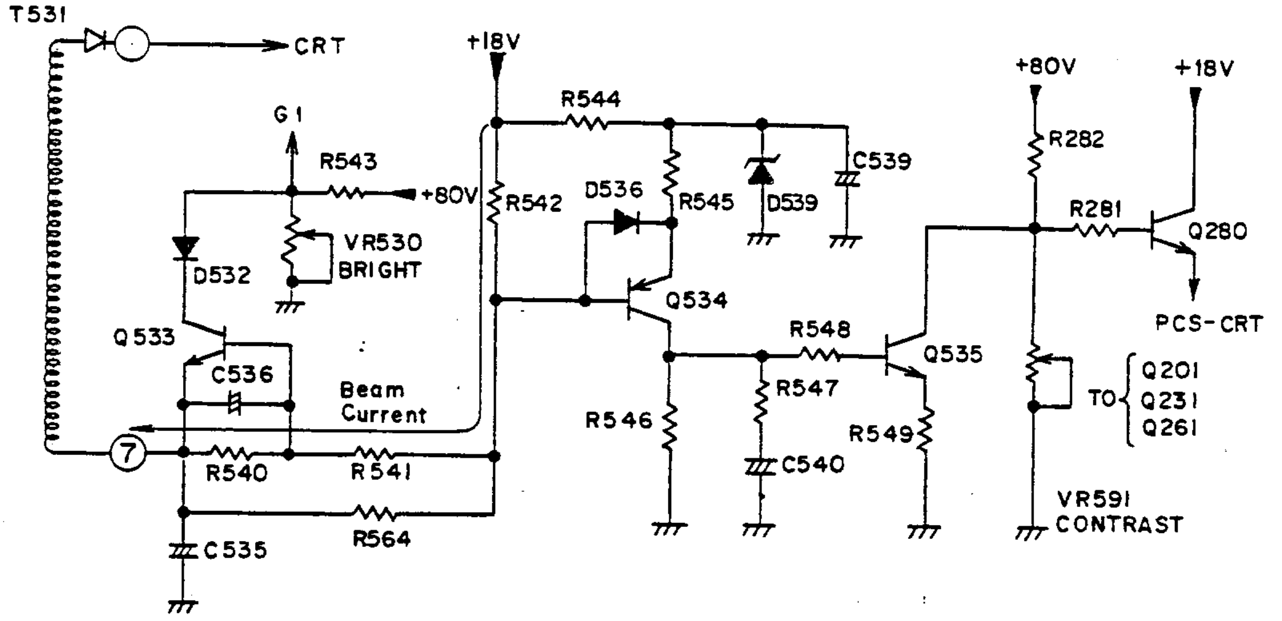


Fig. 3.4 ACC Circuit

Q534 is turn on when the beam current increases more than a certain level. Then Q535 is turned on, and the collector voltage devided by R282 and VR591 begins decreasing. This collector is connected to Q280 of the video output circuit, and control the video output level.

3.3 HORIZONTAL DEFLECTION CIRCUIT

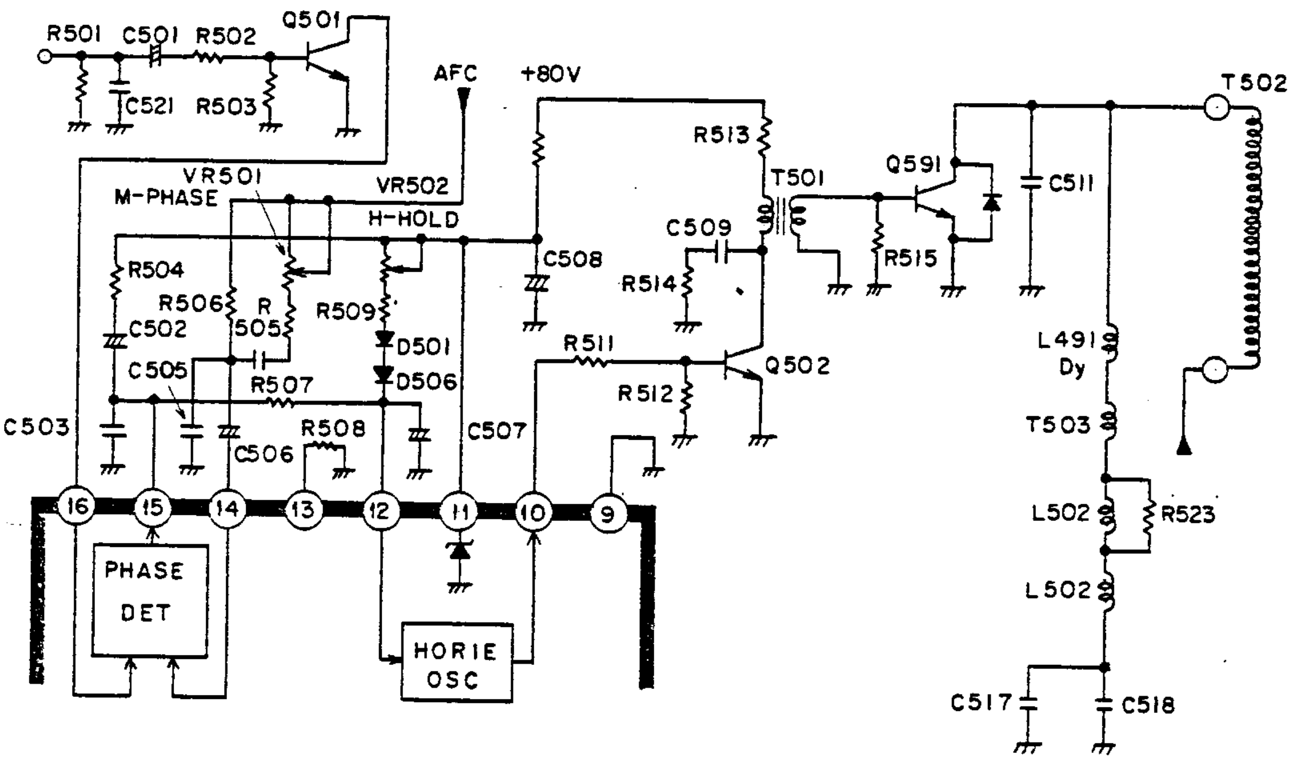


Fig. 3-5 Horizontal Deflection Circuit

Horizontal deflection circuit is composed of oscilater, driver and output stage.

Not only as a deflection circuit, but also this circuit is used as a power supply of heater voltage and so on.

Schematic diagram of horizontal deflection circuit is shown as Fig. 3-5.

3.3.1 Output Circuit

Fig. 3-6 is a fundamental diagram of horizontal deflection circuit. In this circuit, transistor TR acts as switch with dumper diode D. Therefore the equivalent circuit is shown as Fig. 3-7.

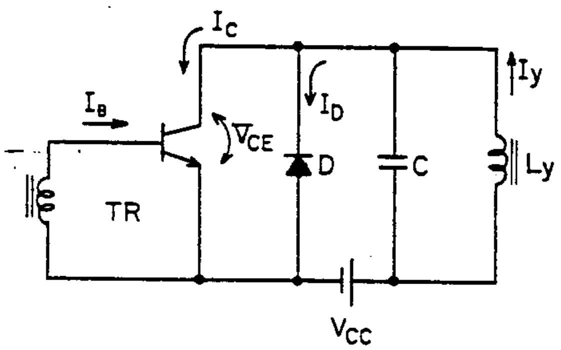


Fig. 3-6 Fundamental Circuit

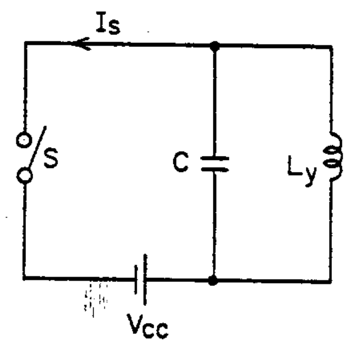


Fig. 3-7 Equivalent Circuit

Following, the action of this circuit is described using Fig. 3-6, Fig. 3-7 and Fig. 3-8.

When switch is turned on at the time t1, the current of deflection yoke Ly increase linearlly. When switch is opened at a suitable time t2, current Is becomes zero at once. However Iy doesn't become zero at

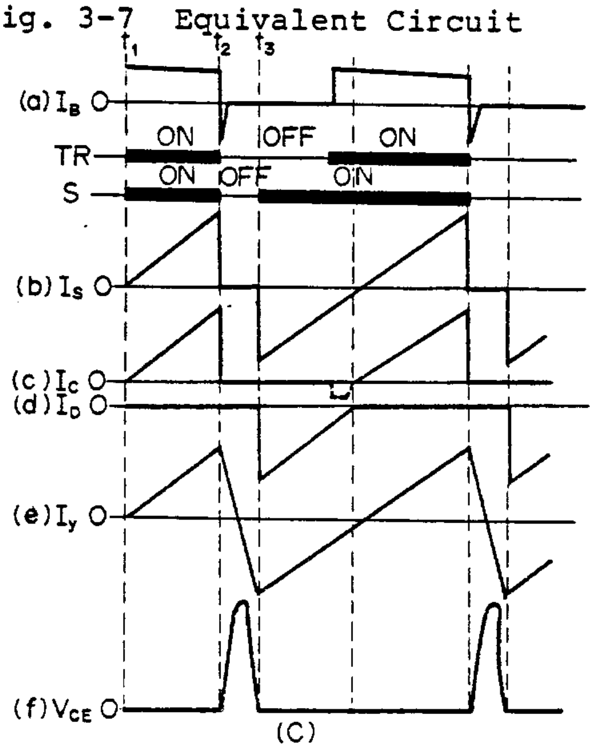


Fig. 3-8 Wave form of each part

once, and flows into capacitor C, and oscillates.

At the time t3 when the half cycle is completed, Iy becomes maximum of reverse. Then when switch S is turned on the oscillation stops and 1 cycle is completed. The energy flows out during the time from t1 to t2, and at the time t3 the energy flows back to the power supply, therefore power loss of this circuit is very small. The period from t2 to t3 is depends on resonance frequency of Ly and C. During this period, deflection current changes from positive peak to negative peak, and the voltage between both sides of C is shown as Fig. 3-8-(f).

The description as mentioned above is the fundamental action of horizontal deflection circuit. However, in the practical circuit horizontal output transformer T502 is connected in parallel to the deflection yoke.

DC voltage from 80V power supply is supplied to T502 and it supplies the pulse to AFC circuit or makes 18 volts and 170 volts power supply for the heater of CRT using this pulse.

In the practical circuit there are resistance element of the circuit, therefore deflection current of the deflection yoke is not change lineally. To correct it, linearity modulating coil L503 is prepared in series of the deflection yoke. As to horizontal linearity, because of the curveture of the front CRT, there are a tendency to extend in the both sides and be shortened in the center of the CRT. To correct it, capacitor C517 and C518 are connected in series to the deflection yoke.

The amplitude adjusting coil L502 and PCC transformer T503 is connected in series to the deflection yoke.

3.3.2 Horizontal Centering Circuit

VR503 (H-CENT) is adjustable the DC current of the deflection yoke, and scans the rasters right and left.

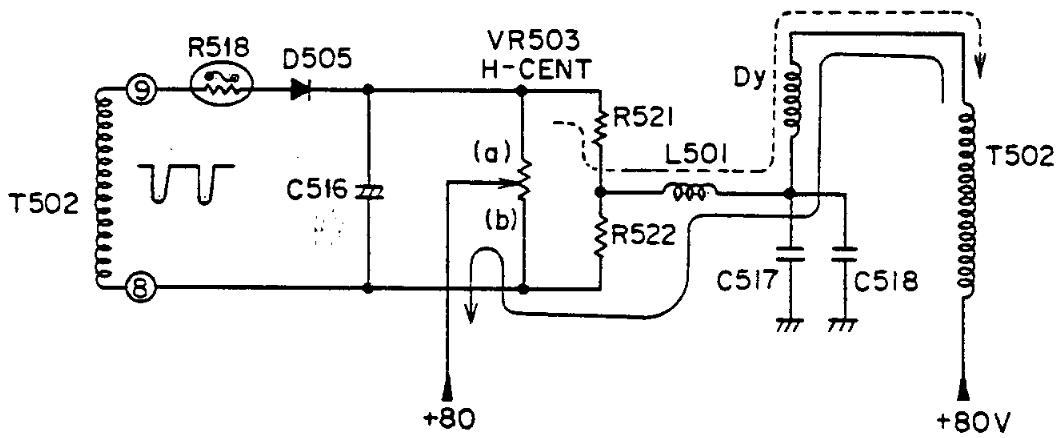


Fig. 3-9

In above figure, there are retrace pulse between pin #9 and #8 of T502. D505 and C515 supplies DC voltage V_B by rectifying the retrace pulse.

In case VR503 inclines to side (a), the current flows like the real line and the raster moves right side. In case VR503 inclines to side (b), the current flows like the dotted line and the raster moves left side. This changing width is approximately ± 5 mm.

3.3.3 Horizontal Oscillater and Driver

All signal processing is performed by IC401 same as vertical circuit. DC voltage is applied to the pin #12.
The oscillation frequency depends on the charge and discharge time constant of C507, which can be adjusted by VR (H-HOLD).

The sawtooth wave voltage supplied here is changed to rectangular wave in order to drive Q502 in next stage, and supplied to pin #10.

The horizontal sync signal flowed into pin #16 and VR502 (H-HOLD) adjusts oscillating frequency to be synchronized with input signal frequency.

The flyback pulse from pin #3 of horizontal output transformer T502 is applied to the horizontal oscillation circuit for synchronization stability. And it is supplied to pin #14 through the integrating circuit formed with R506 and C505 for better synchronization stability.

VR501 (H-PHASE) is prepared for adjusting video position.

Because drive output enough to drive output circuit cannot be obtained in oscillation circuit output, drive circuit formed with Q502 and T501 amplifies the pulse.
This circuit supplies forward base current enough to saturate the output transistor and reverse base current enough to be turn off the output transistor.

3.4 PCC CIRCUIT

In this monitor, side pincushion shown as Fig. 3-9-(a) is modulated by following method.

In order to decrease the deflection current of the top and bottom of the screen, horizontal deflection current is modulated shown as Fig. 3-10-(b).

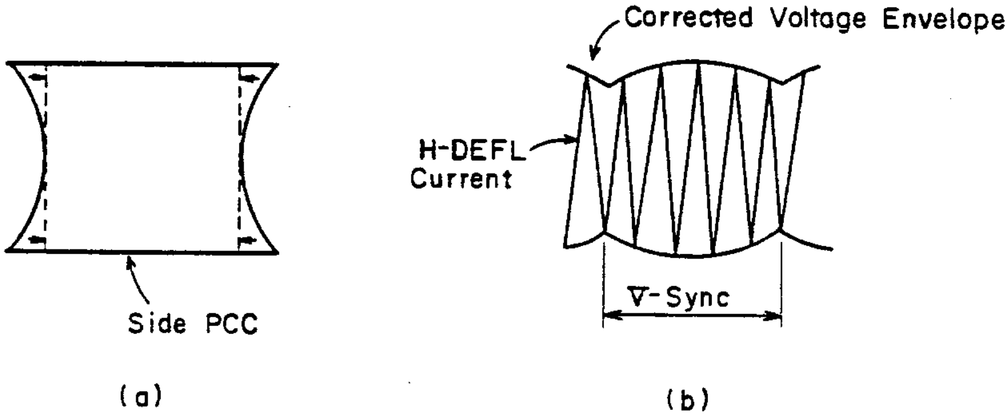


Fig. 3-10 Side PCC and Waveform of PCC Circuit

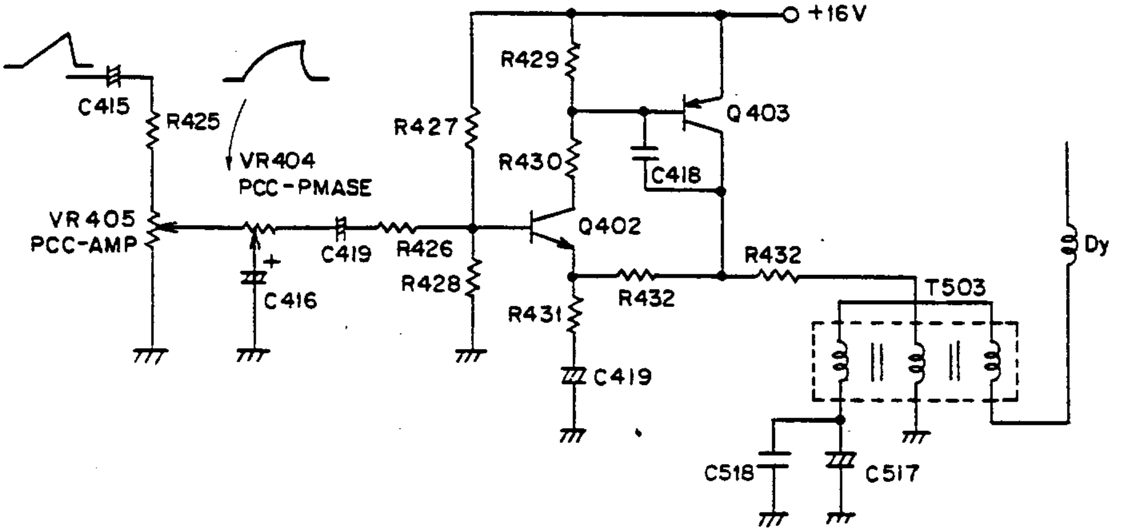


Fig. 3-11 PCC Circuit

The sawtooth wave voltage supplied from vertical circuit supplied parabolic voltage through the integurating circuit formed with VR404 and C416, and it is added to PCC transformer through the output stage formed with Q402 and Q403. Because secondary coil of T503 is connected in series to horizontal deflection yoke, the inductance of secondary coil can be adjusted by parabolic current of primary side of T503. And then pincushion is corrected.

VR405 (PCC-AMP) adjusts quantity and VR404 (PCC-PHASE) adjusts position of correction.

3.5 HIGH VOLTAGE CIRCUIT

This is the circuit for supplying stable DC high voltage to CRT anode. The operation of high voltage output circuit is the same as that of horizontal deflection output circuit.

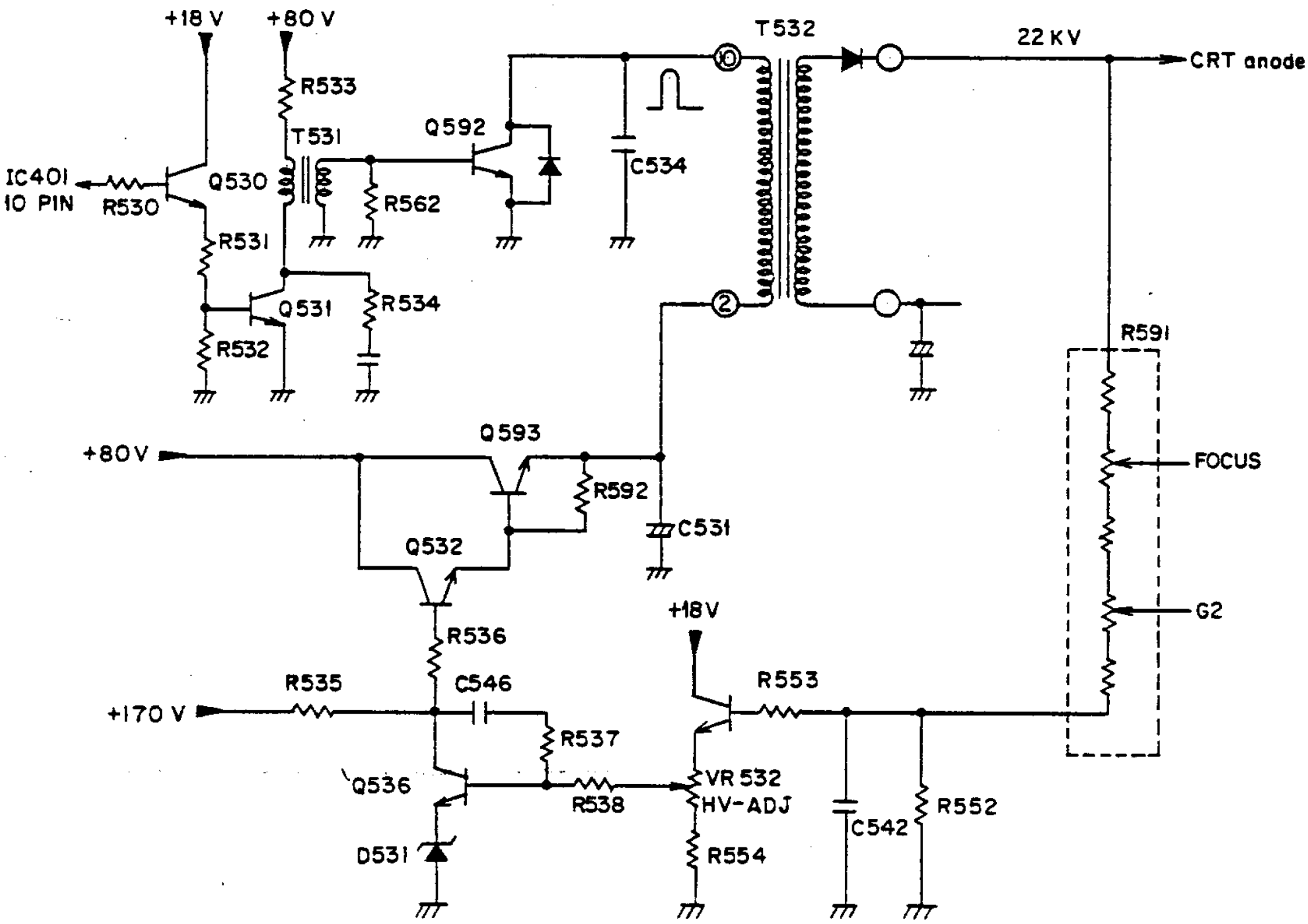


Fig. 3-12 High Voltage Circuit

The rectangulation wave voltage passes through the buffer transistor Q530, and in the driver circuit and output circuit as mentioned above, the voltage wave shown as Fig. 3-13 is obtained and supplied to pin #10 of T532. This flyback pulse is risen to more than 20 kV by T532, and rectified by the diode inside of T532 and the capacity in the CRT.

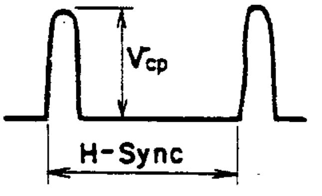


Fig. 3-13 Voltage waveform

The beam current (anode current of the CRT) changes according to video signal. The circuit controls the power supply to pin #2 of T532 for the stable high voltage.
Q593 is a series regulation. Q536, D531 and R535 form the error amplifier, R591 and R552 form senser.

When the anode current increases (for example, white all of the screen), high voltage output decreases and the sensed voltage of R552 also decreases. At the same time, the base voltage of Q536 decreases and collector voltage increases, as a result, the emitter voltage of Q593 and the input power voltage of flyback transistor T532 increase, therefore high voltage output increases.

By contraries, in case the anode current decreases and high voltage output increases, the operation is contrary to that mentioned above, as a result, high voltage output decreases.

Therefore the stable high voltage is always obtained regardless of the anode current.

VR532 (HV-ADJ) is an adjuster for setting high voltage output.

3.6 HIGH VOLTAGE SAFETY CIRCUIT

The high voltage safety circuit that stops the high voltage output when the output increases more than a certain extent is provided. This safety circuit is provided to prevent occasional increase of the high voltage that may cause radiation of harmfull level.

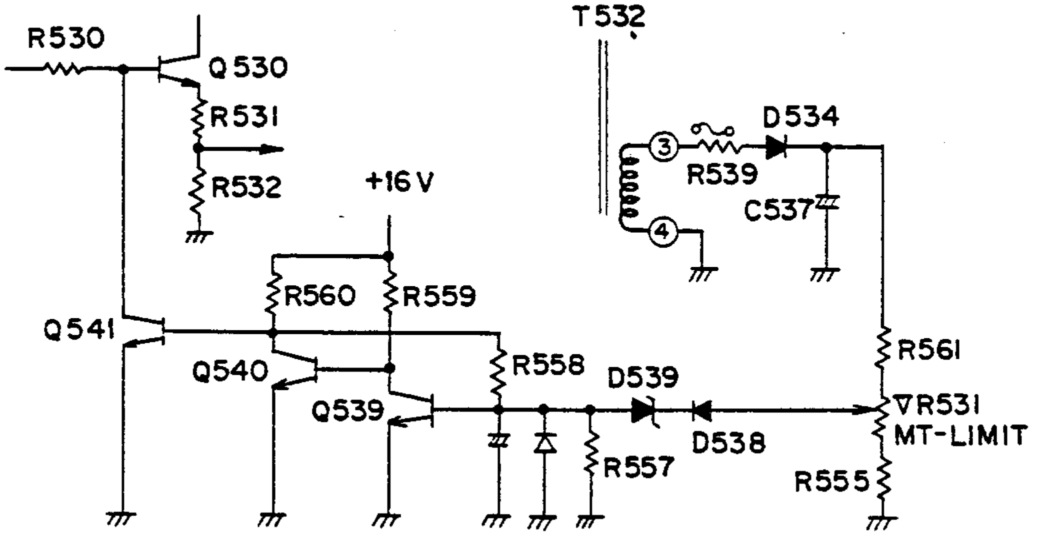


Fig. 3-14 High Voltage Safety Circuit

The flyback pulse of the third coil of T532 is rectified by D534, and this voltage is in proportion to the high voltage output. When high voltage output increases, Q539 is turned on by the voltage devided R561, VR531, and R555, and Q540 in next stage is turned off. Then Q541 is turned on, and the rectangular wave voltage flows into Q541, and high voltage output circuit stops the operation.

VR531 (HV-LIMT) is an adjuster for setting this stopping level of high voltage.

HV AND SAFETY CIRCUIT

Safety Circuit is provided to prevent occasional increase of the high voltage that may cause radiation of harmfull level. No modification shall be applied on the high voltage and safety circuit.

3.7 VERTICAL DEFLECTION CIRCUIT

Schematic diagram of the vertical deflection circuit is shown following figure.

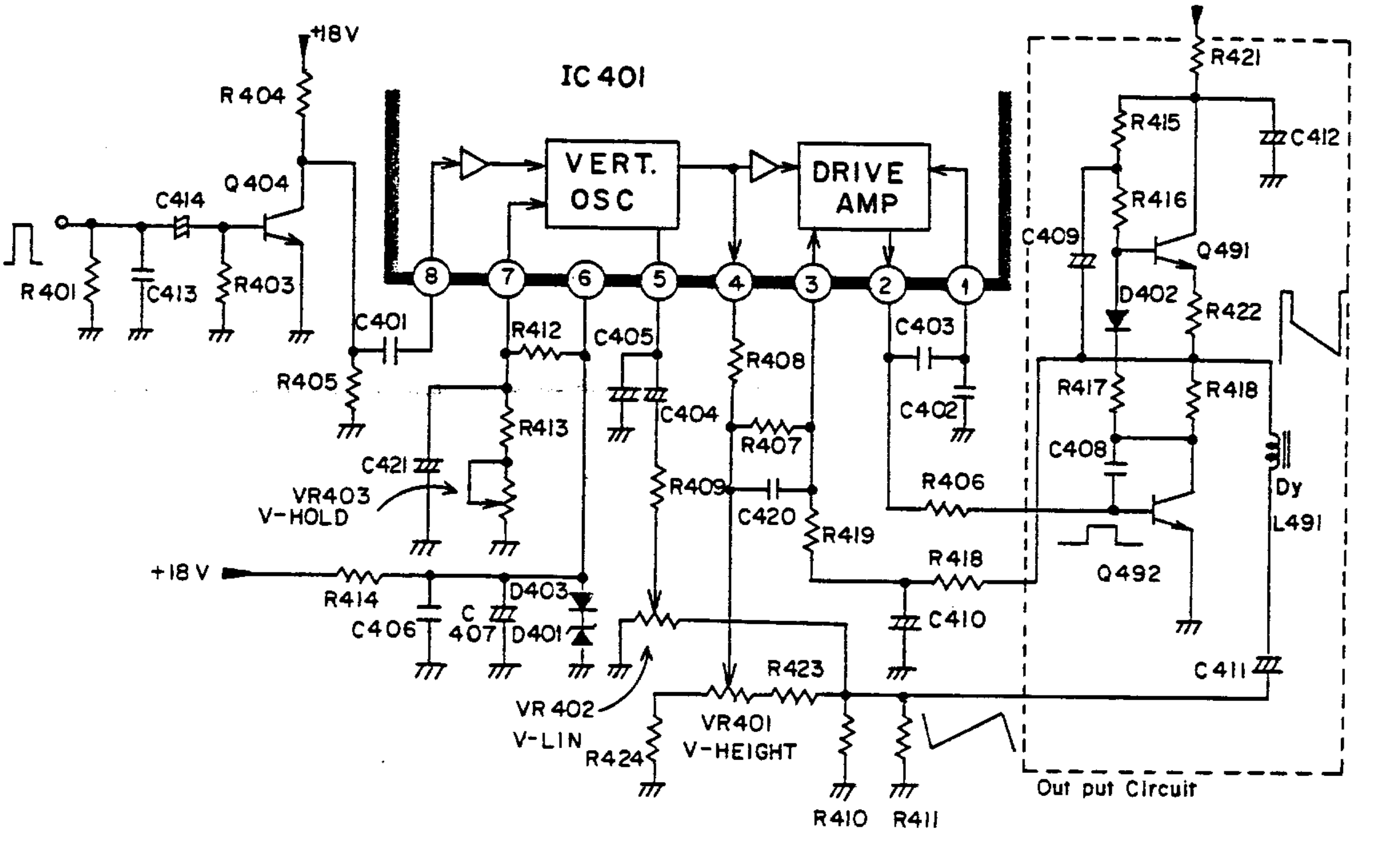


Fig. 3-15 Vertical Deflection Circuit

3.7.1 Output Circuit

In the output stage of this stage, OTL circuit called SRPP (Shunte Regulated Push Pull) is used.

SRPP can decrease the reactive current loss by means of activating the load resistance of A-class-amplifier.

Fundamental operation is explained as follows:

The part shown by dotted line in Fig. 3-15 is a vertical output circuit. When the power is turned on, Q491 is turned on by forward bias made by R415, R416, D402, R418, and R422. At the same time, collecter current flows into C411 from L491 (DY), and C411 is charged.

This current is a sawtooth wave current, and the magnetic field in proportion to the current amplitude deflects the electric beam inside the CRT.
Then, when Q492 is turned on, according to the charging voltage of C411, the current flows into Q492 through L491, R418. This current deflects the electric beam as above-mentioned during the half cycle of the vertical sawtooth wave current. According to the on-off action of Q491 and Q492, the deflection current is flowed into deflection yoke, and the electric beam is scanned vertically.

When Q492 is turned on and charging current of C411 flows into Q492, Q491 is turned "OFF" according to the potential of R418.

R421 and C412 are selected so as to decrease the power loss of Q491 by decreasing the voltage between collector and emitter as shown in Fig. 3-16.

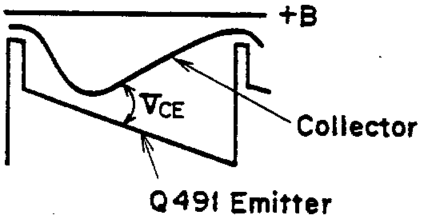


Fig. 3-16 Wave form of Collector and Emitter

3-7-2 Vertical Oscillator, Driver

The signal processing of Oscillation and drive circuit is performed inside of IC401, therefore in this section, the part of each pin and additional circuit are explained except description inside of IC.

When DC voltage is added on pin #7 the action of oscillation circuit is started. The oscillating frequency depends on the charge and discharge time constant of C405, which is adjustable by VR403 (V-HOLD) connected to pin #7.
Because the input vertical synchronized signal flows into pin #8, VR403 (V-HOLD) adjusts oscillating frequency to be synchronized with input signal frequency.

The oscillation output is added to the output circuit from pin #2 through the drive stage. In order to correct the linearity of the screen, the deflection current adjusted by VR402 (V-LIN) is added to pin #5. And VR401 (V-HEIGHT) adjusts the vertical amplitude.

For the stabilization of DC-voltage and linearity, the voltage distributed by R418, R419, R407, and C410 is applied to pin #3 as a DC-feedback.

3.8 PCB-POWER CIRCUIT

3.8.1 Power Regulator Circuit

Fig. 1 shows blockdiagram of power circuit.

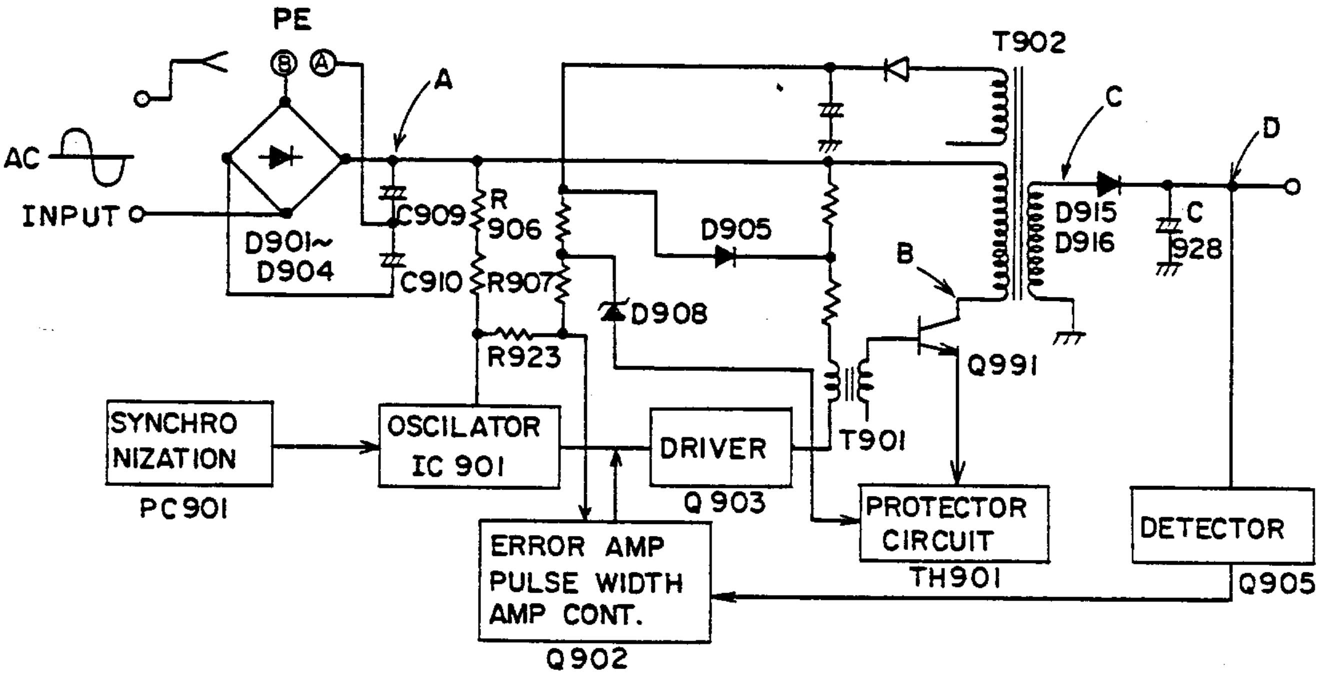


Fig. 3-17 Power Regulator Circuit

1. Rectifier circuit

(1) In case of AC100-120V input
Input alternative voltage is rectified by doubler which is composed of D904-C909,

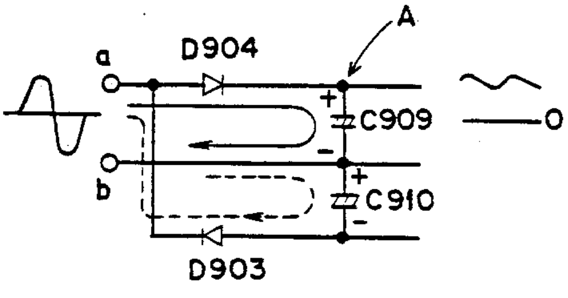


Fig. 3-18 Rectifier Circuit

D903-C910. When terminal "a" is positive, current flows C909 through D904 and C909 charges up, and at next half cycle, terminal "a" is negative (terminal "b" is positive) current flows C910 through D903, as a result, output rectified voltage is sum of C909 voltage and C910 voltage.

(2) In case of AC200-240V input
Input alternative voltage is rectified by a bridge rectifier which is composed of D902, C909, C910, D903 and D904, C909, C910, D901. As a whole, output voltage at "A" point is same voltage at both AC100-120V input and AC200-240V input.

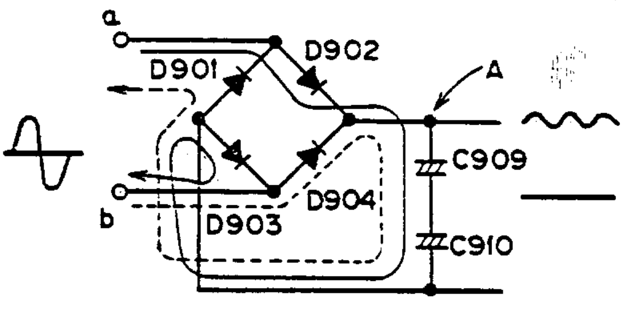


Fig. 3-19 Bridge Rectifier

2. Output circuit

Rectified DC voltage is switched by Q991 and at "B" point, switched voltage is obtained.

Secondary rectifier circuit

At "C" point of output transformer T902 secondary circuit, switching pulse, which is opposite polarity of "B" is induced and rectified by D915, D916, C928. At "D" point, rippleless DC voltage is obtained.

3. Oscillater, driver

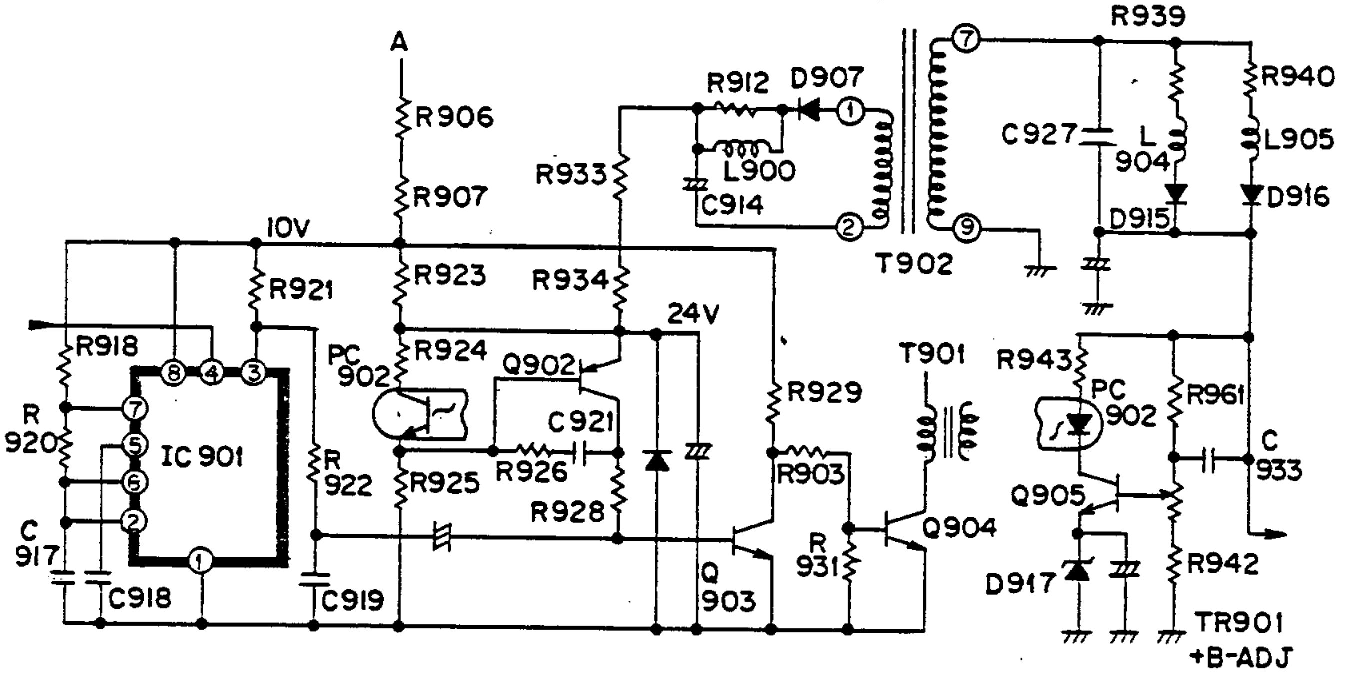


Fig. 3-20 Oscillater driver

Oscillater circuit depends on IC901 operation, its frequency is decided by R918, R920, C917. At turn on, DC voltage is supplied to IC901 from "A" point through R906, R907 and IC901 begins to oscillate, after that, DC power supply which is made from pulse at T902 terminal 1 by D907, C914 is supplied to IC901 through R933, R934, R923. +10V, +24V DC power supply are made as above mentioned. Oscillator output signal of IC901 comes out at terminal 3 as a priodical square wave, and it is made into ramp wave signal by integlator R922, C919. This ramp wave signal is amplified by Q903, Q904 and drives output switching transistor Q991.

4. Voltage control circuit

At secondary circuit of output transformer T902, switched voltage appears and it is made into DC voltage by rectifying. This DC voltage changes according to input voltage or load current, but it is stabilized as mentioned below. At "C" point of secondary circuit of T902, E3 voltage which is opposite polarity of primary circuit generates as shown Figure (C). E3 is proportional to primary circuit voltage E, that is, depending directly on voltage variation at "B" point.

In order to stabilize DC output voltage, it is necessary to control E1 to get constant value. In this display monitor, to realize above purpose, pulse width control system is adopted.

Switching voltage signal at primary circuit of T902 is proportional to DC supply voltage at "A", if E1 changes by ΔE1 as shown Figure (C), E1 voltage can be stabilized by changing pulse duty ratio

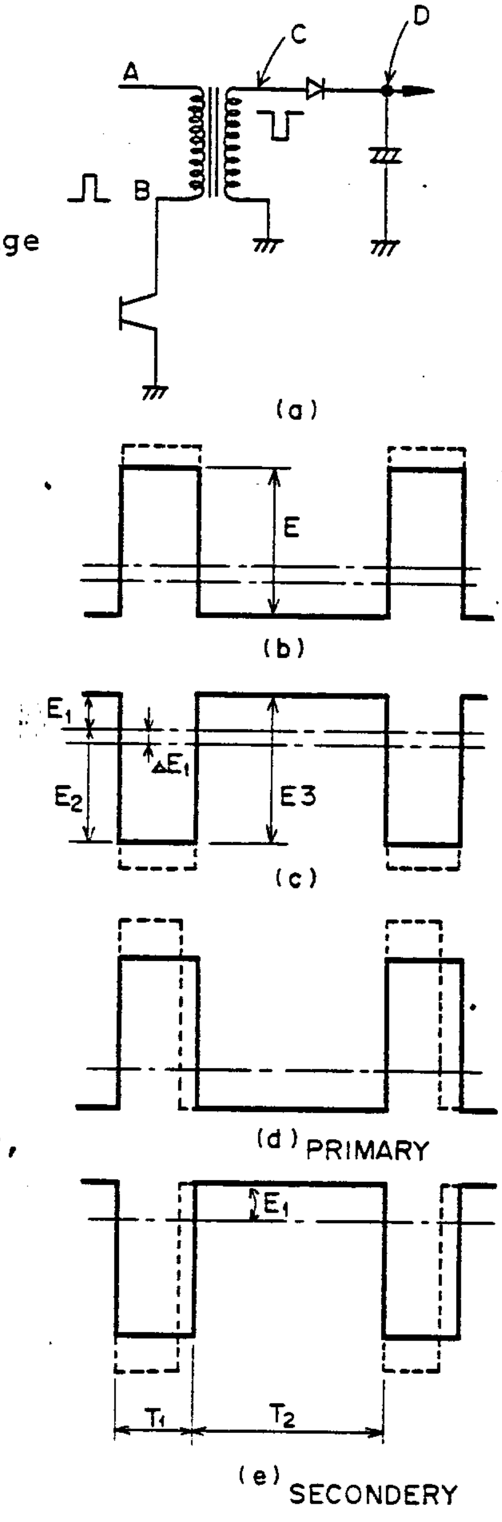


Fig. 3-21 Voltage Control Circuit

as shown Figure (d), (e).

For example, when input voltage increases and pulse amplitude goes up, constant E1 voltage can be obtained by setting T1/T1+T2 smaller.
On the contrary when input voltage decreases and pulse amplitude goes down, E1 voltage can be conpensated by setting T1/T1+T2 bigger.

5. Error Amplifier

In order to do above control, output DC voltage deviation is detected and amplified by Q905 lighting photocouple PC902 to transfer to Q902. For example, if output DC voltage increase, Q905 colector voltage goes down, PC902 photocoupler turn on and base bias of Q902 increase, Q902 impedance changes to high impedance, therefore Q903 base voltage goes down.

This base bias controls turn on duty of Q903 B - E. Potential of ramp wave which comes from ramp generator through C922 changes according to above base bias, if original bias is real line as shown figure, in this case, turn on duty T1/T1+T2 changes smaller like dotted line.

As mentioned above, output DC voltage is stabilized by controling pulse width, even if input AC voltage varies or load current changes.

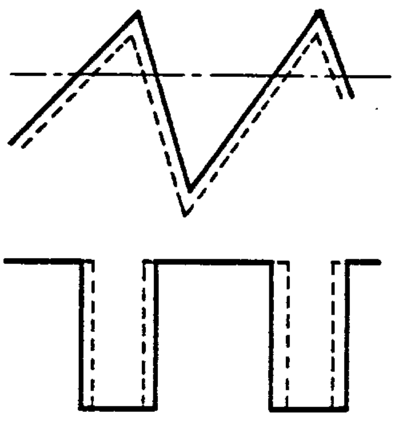


Fig. 3-22