INSTRUCTION MANUAL

OSCILLOSCOPE

SS-5702

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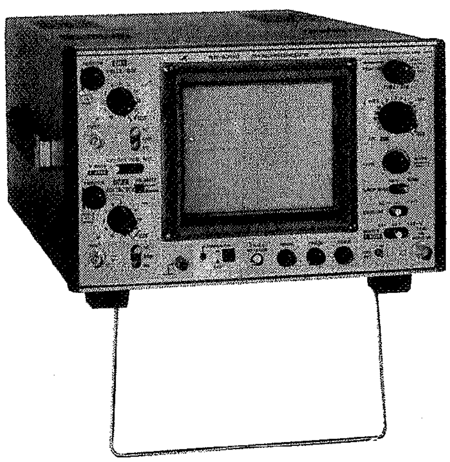

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OSCILLOSCOPE

SS-5702

G5066-421751(I)

CONTENTS

General

The SS-5702 is a compact and lightweight oscilloscope which covers a frequency bandwidth from DC to 20 MHz. The SS-5702 is designed for dual-trace measurement respectively.

The vertical deflection factor is from 5 mV/div to 10 V/div in a 1-2-5 sequence.

The trigger system provides an internal triggering, external triggering and TV triggering for TV composite signal.

The horizontal deflection system provides sweep rates from 0.5 μ S/div to 0.2 S/div in a 1-2-5 sequence, 5 times sweep magnification (maximum sweep rate becomes 0.1 μ S/div) and external horizontal/X-Y operation for Lissajou's pattern.

The cathode-ray tube has a viewing area of 8 divisions (vertical) by 10 divisions (horizontal)and high intensity quantitative measurement is possible by means of the stable accerelating voltage of 2 kV.

Internal circuit are designed as a full solid-state structure, and stability and reliability are ensured.

Specification

Cathode-Ray Tube (CRT)

Graticule — 8 div X 10 div (1 div = 10 mm)
Internal graticule parallax free

Phosphor — B31 (standard)
P7, B11 (option)

Accelerating Potential
Apporoximately 2kV

Vertical Deflection System

Display Mode — Channel1, Channel2, Dual display of Channel 1 and Channel 2, Added display of Channel 1 and Channel 2 (In the dual mode, setting the sweep rate to a range lower than 1 mS/div allows chopped display and setting it to a range higher than 0.5 mS/div permits alternate display
Chopped repetition rate:
100 kHz ±50%

Deflection Factor — POSITION is pushed (X 1):
5 mV/div to 10 V/div in 11 calibrated steps in a 1-2-5 sequence
5 mV/div to 25 V/div continuously variable with control
Accuracy : ± 4% (10 °C to 35° C)
POSITION is pulled (PULL X 5 GAIN):
1 mV/div, 2 mV/div
1 mV/div to 5 mV/div continuously variable with control
Accuracy : ± 5% (10°C to 35°C)

Frequency Response
DC to 20 MHz –3dB
(in center 6 divisions and ranges from 5 mS/div to 0.2 V/div. The AC-coupled lower –3 dB frequency is 4 Hz or less.)

Rise Time — 17.5 nS or less

Input Coupling — AC, GND, DC

Input RC — Direct: 1M Ω± 3%//30 pF ± 3pF
X 1 position of probe:
1 M Ω± 3%//170 pF ±10pF
X 10 position of probe:
10 M Ω±5%//23pF ± 3pF

Maximum Input Voltage
Direct: 250V (dc + peak ac)
X 1 position of probe:
250 V (dc + peak ac)
X 10 position of probe:
600V (dc + peak ac)

Polarity Inversion — Provided only for Channel 2

Triggering

Source — Internal (CH1, CH2), External

Coupling — AC (internal only), DC (external only), TV-V

Slope — Positive-going, Negative-going

External Input RC — 1 M Ω ±10%//30 pF ±5pF

External Maximum Input Voltage
150V (dc + peak ac)

Sensitivity — Shown in Table 1-1.

Table 1-1

Frequency range	Level: Internal (displayed amplitude)	Level: External (input voltage)
DC to 20 Hz	–	0.5V
20 Hz to 50 Hz	2.0div	0.5V
50 Hz to 5 MHz	0.5div	0.5V
5 MHz to 15 MHz	1.5div	1.5V
15MHz to 20 MHz	2.0div	2.0V

Notes:

1. Signals below 20 Hz are attenuated in the internal triggering.
2. In the automatic sweep mode, the lower end of triggarable frequency is 50 Hz.
3. In the TV-V triggering, the trigger level is 1 division or more with displayed amplitude of sync signal portion of composite signal.

Horizontal Deflection System;

Sweep Mode	Automatic, Triggered
Sweep Rate	0.5 μS/div to 0.2S/div in 18 calibrated steps in a 1-2-5 sequence 0.5μS/div to 0.5S/div continuously variable with control Accuracy I (over center 8 divisions): (10°C to 35°C) 0.5μ S/div to 5mS/div ± 4% 10 mS/div to 0.2S/div ±5% Accuracy II (over any 2 divisions within center 8 divisions): ±10% (10°C to 35°C)
Sweep Magnification	5 times (Maximum sweep rate: 0.1 μ S/div) Accuracy I (over center 8 divisions): (10°C to 35°C) 0.1 μS/div to 1mS/div ±5% 2mS/div to 40mS/div ±7% Accuracy II (over any divisions within center 8 divisions): (10°C to 35°C) 0.1μ s/div to 1mS/div ± 15% 2mS/div to 40mS/div ± 10%

X-Y Operation

Input	X: SOURCE (X MODE) Y: V MODE (Y MODE)
X-Axis	
Sensitivity	Same as Channel 1, Channel 2 or EXT which is selected by SOURCE (X MODE) Accuracy: ±5% (10°C to 35°C)
Frequency Response	DC to 500 kHz –3dB
Input RC	Same as Channel 1, Channel 2 or EXT which is selected by SOURCE (X MODE)
Maximum Input Voltage	Same as Channel 1, Channel 2 or EXT which is selected by SOURCE (X MODE)
Y-axis	V MODE (Same as Y MODE)
X-Y Phase Difference	3° or less DC to 20kHz (When SOURCE is set to CH1 or CH2) DC to 10 kHz (When SOURCE is set to EXT)

Z Axis

Input Voltage	3 Vp-p for noticeable intensity modulation. Positive-going signal decreases intensity
Frequency Range	DC to 1 MHz
Input Resistance	Approximately 20 kΩ
Maximum Input Voltage	50 V (dc + peak ac)

Calibrator

Waveshape	Square wave
Repetition Rate	1 kHz Accuracy : ± 50%
Output Voltage	0.3 V p-p Accuracy: ±3% (10° C to 35° C)
Duty Ratio	40% to 60%

Power Supply

Line Voltage	90 to 110/104 to 128/194 to 238/ 207 to 257 Vac Selected by the Line Voltage selector

Line Frequency 50 to 400 Hz

Power Consumption

Approximately 30W (at 100 Vac)

Physical Characteristics

Weight Approximately 6 kg

Dimensions (260 ±2) W x (160 ±2) H x (400± 2) L mm

Refer to Figure 1-1.

Environmental Characteristics

Operating Temperature

0°C to 40°C

Operating Humidity 90% RH, 40°C

Storage Temperature

–20°C to 70°C

Storage Humidity 80% RH, 70°C

Altitude Operating: 5,000 m maximum (balometric pressure: 405 mmHg)

Non-operating: 15,000m maximum (balometric pressure: 90.4mmHg)

Vibration (non-operating)

Vibrate for 15 minutes along each axis at a total displacement of 0.67 mm p-p with the frequency varied from 10-55 Hz in one-minute cycle.

Shock (non-operating)

Lift one bottom edge of the instrument 10 cm over a hard bench, and drop.

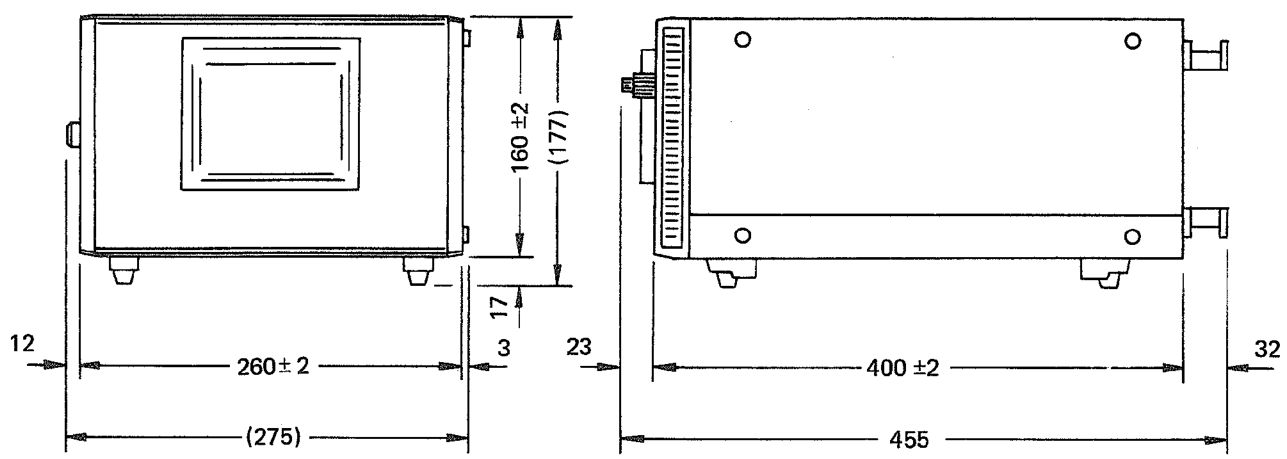
(45° maximum in elevation angle)

Repeat 3 times for each edge.

Drop (package drop)

Drop from a height of 75 cm on one corner, all edges radiating from that corner and all flat surfaces.

Figure 1-1. Dimensions



NOTES

Section 2

Operating Information

Precautions

Ambient Temperature and Air Ventilation

The ambient temperature range of this instrument performing normal operation is from 0° C to 40° C. The use of this instrument with the temperature exceeding this range may result in trouble; therefore, the operation in this range is essential,. Moreover, do not place other devices or apparatus on the ventilation hole of the cover in order to improve the efficiency of the heat radiation.

Line Voltage

Desired operating voltage can be selected from four voltage ranges shown in Table 2-1 by the line voltage selector located on the rear panel. Check the line voltage prior to connection of the power cord and set the selector so that its arrow mark can be lined with a voltage range indication on the panel which covers the line voltage. Note that mis-setting may result in trouble of the instrument.

Before changing the voltage range, check that a fuse shown in Table 2-1 is set in the fuse holder on the rear panel.

Table 2-1

Selector setting position	Voltage range	
A	90 to 110V	0.5A slow-blow
B	104 to 128V	
C	194 to 238V	0.3A slow-blow
D	207 to 257V	

Do not Intensify Unnecessarily

The brightness of the spots or traces on the viewing area must not be increased excessively. Excessively intensified spots or traces may irritate an operator. If such spots or traces are stopped at the same position for a long time, it may result in burning of phosphorescence coating of the CRT.

Do not Apply an Excessively High Input Voltage

The rated maximum allowable input voltage for each input connector is as follows. Observe this restriction on voltage.

INPUT	250 V (dc + peak ac)
Input of probe	
x 1 position:	250V (dc + peak ac)
x 10 position:	600 V (dc + peak ac)
EXT INPUT	150 V (dc + peak ac)
Z AXIS INPUT	50 V (dc + peak ac)

Use in a Vertical Elevation Setting

This instrument can be used in the vertical elevation setting, namely, in positioning with the screen up. In this case, do not bring the instrument down by pulling a probe forcefully or by striking with other devics or apparatus.

Replace the Fuse with Specified Type

To prevent the damage in the circuit with excessive current, the fuses shown in Table 2-2 are used.

In case of fusing, thoroughly check the cause and replace with the specified fuse after repairing any defects.

Use of fuse other than the specified fuses may cause the serious trouble as well as being exremely dangerous.

Table 2-2

Circuit number	Standard of fuse	Function	Position of the fuse holder
F 701	0.5A slow-blow	With the Line voltage selector set at A or B	Rear panel
	0.3A slow-blow	With the Line voltage selector set at C or D	
F702	1A slow-blow	CRT circuit protection	Refer to Figure 2-1
F703	0.2A fast-blow	+240V circuit protection	

Stand

A bail-type stand is mounted on the bottom cover. This stand permits the instrument to be positioned for convenient operation. The instrument may also be set on the rear or right feet either for operation or storage.

CONTROLS AND CONNECTORS

The major controls and connectors for operation of the SS-5702 are located on the front panel of the instrument. A few auxiliary functions are provided on the rear panel. Figure 2-2 show the front and rear panels. A brief description of each control and connector is given here. More detailed operating information is given in later section "OPERATING INSTRUCTION"

Front Panel

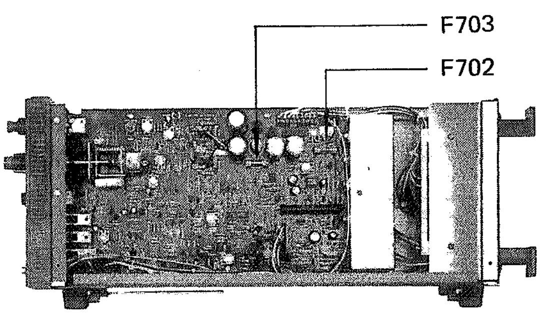
POWER

Power line switch. Power is supplied to the instrument when this switch is turned on and the pilot light glows.

INTEN

Controls brightness of the display.

Figure 2-1. Installed position of foses



FOCUS

Provides adjustment for optimum definition.

SCALE

Controls brightness of the scale illumination.

TRACE ROTATION

Control to align the trace with the horizontal graticule lines mechanically.

⏊

Ground terminal for connection between input signal source and this instrument.

V MODE (Y MODE)

Selects the vertical operation mode and X-Y operation mode. The following modes can be selected.

CH1: displays Channel 1 only. In the X-Y opetation, the Channel 1 function is decided by source switch.

CH2: Displays Channel 2 only. In the X-Y operation, the Channel 2 function is decided by the SOURCE switch too.

DUAL: Dual-trace display of signals on both channels. In this mode, setting the sweep rate to a range lower than 1 mS/div allows chopped display and setting it to a range higher than 0.5 mS/div permits alternate display.

ADD: Signals applied to the CH 1 and CH 2 INPUT connectors are algebraically added and the sum is displayed on the CRT screen. The CH 2 POLARITY switch alows the display to be CH 1 + CH 2 or CH 1 – CH 2.

⇕ POSITION (PULL X 5 GAIN)

Controls vertical position of the displayed waveform. This control also functions as the push-pull switch to magnify the sensitivity by 5 times.

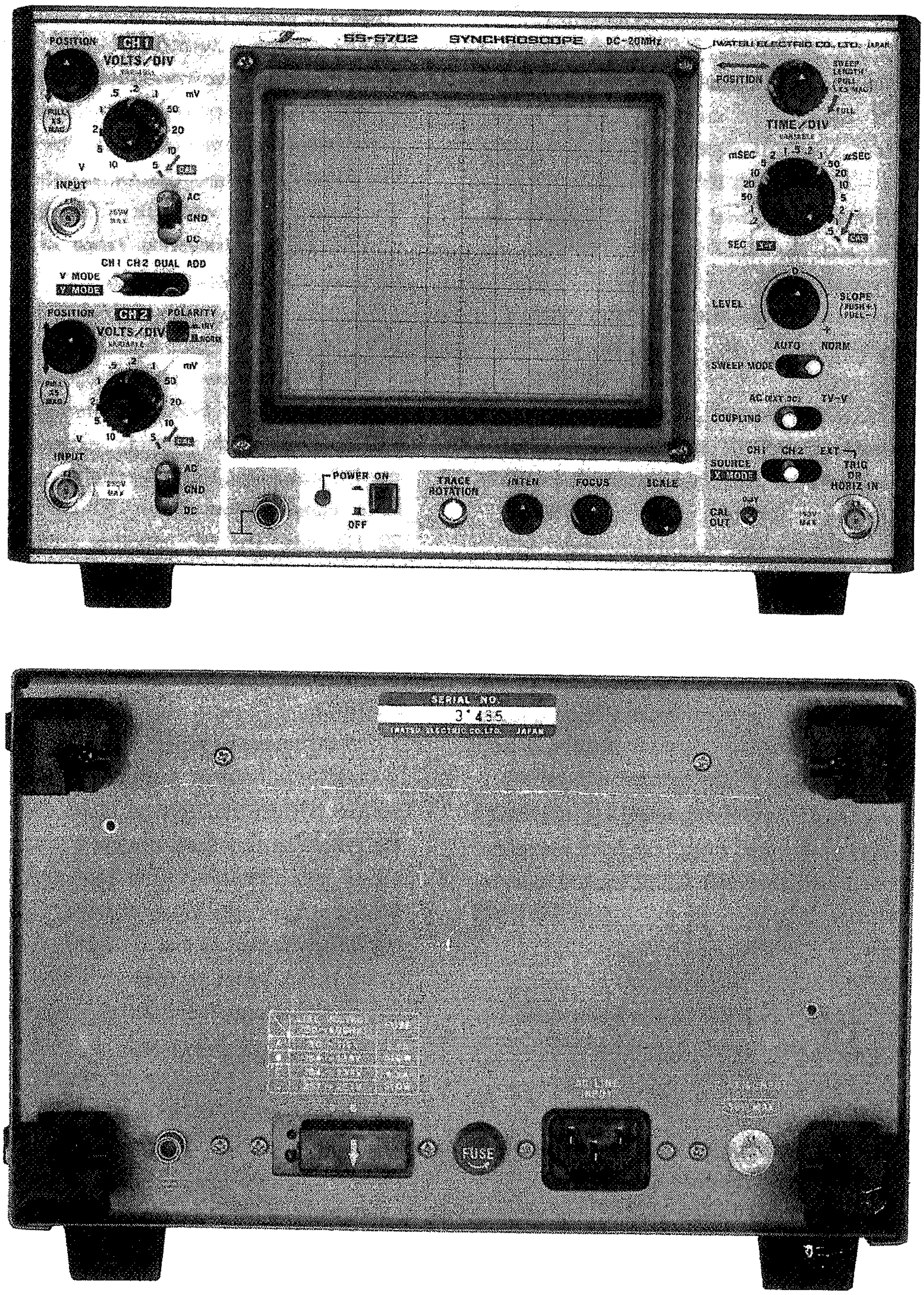
VOLTS/DIV (Black knob)

Selects vertical deflection factor in 11 steps in a 1-2-5 sequence. For calibrated deflection factor, the VARIABLE control must be set to the CAL position.

VARIABLE (Red Knob)

Provides continuously variable uncalibrated deflection factors between the calibrated settings of the VOLTS/DIV switch.

Figure 2-2. SS-5702 front and rear panels



CH1 CH2 INPUT

Input connector for Channel 1/Channel 2 deflection signals or Y-axis/X-axis deflection signals in the X-Y mode of operation.

AC-GND-DC

Selects the following input coupling.

AC: Signal is capacitively coupled to the Vertical Amplifier. DC component of signal is blocked. Low-frequency limit (low –3dB point) is about 4 Hz.

GND: Input signal is removed from the input of the Vertical Amplifier and the input is grounded. Does not ground the input singal.

DC: All components of the input signal are passed to the Vertical Amplifier.

POLARITY

Switch to invert polarity of the channel 2 display. The polarity is inverted by setting the button to in-position.

⇔ POSITION

Controls horizontal position of the display.

SWEEP LENGTH (PULL X 5 MAG)

Controls the sweep length of the display. This control functions also as the pull switch that increases the displayed sweep rate by a factor of 5.

TIME/DIV (Black Knob)

Selects the sweep rate in 18 steps in a 1-2-5 sequency. For calibrated sweep rate, the VARIABLE control must be set to the CAL position.

VARIABLE (Red Knob)

Provides continuously variable sweep rates between the calibrated settings of the TIME/DIV switch.

LEVEL/SLOPE

Controls trigger level. This control also functions as the push-pull switch for selection of trigger slope. Positive-going slope is selected in the pushed state of the knob and pulling it allows negative-going slope.

SWEEP MODE

Selects the following modes.

AUTO: Sweep can be initiated by signals that have repetition rates above 50 Hz and are within the frequency range selected by the COUPLING switch. When the LEVEL control is turned to outside of the triggering range or no trigger signal is supplied to the Trigger Circuit, the sweep free-runs to produce a reference trace.

NORM: Sweep can be initiated by signals that are within the frequency range selected by the COUPLING switch. The sweep stops when the LEVEL control is turned to outside of the triggering range or no trigger signal is supplied to the Trigger Circuit.

COUPLING

Selects the following trigger signal couplings.

AC (EXT DC): Selecting internal triggering allows the AC coupling and selecting external triggering permits the DC coupling. The AC coupling rejects DC and attenu-attes signals below about 20 Hz. Signals above about 20 Hz pass. The DC coupling accepts all trigger signals from DC to 20 MHz.

TV-V: This coupling is suitable for measurement of TV composite signal.

SOURCE

Selects source of trigger signal.

CH1/CH2: Internal triggering is obtained in these two positions.When the Vertical Mode switch is set to DUAL, the following signals are used as a trigger signal; a sample of the signal connected to the CH1 INPUT connector in the CH 1 position; a sample of the signal connected to the CH2 INPUT connector in the CH2 position. When the Vertical Mode switch is set to CH1 or CH2 its setting selects the trigger signal and the SOURCE switch setting makes no effect.

EXT: Trigger signal is obtained from signal which is connected to the INPUT connector.

INPUT

Input connector for external trigger signal or external horizontal signal.

CAL OUT

Output connector for 0.3V calibration voltage signal.

Rear Panel

Z AXIS INPUT
Input connector for external intensity modulation signal.

AC LINE INPUT
Connector to connect the accessory power cord.

FUSE
Fuse holder which contains a 0.5 A or 0.3 A slow-blow fuse according to the line voltage used.

LINE VOLTAGE
Selects the operating voltage range of the instrument in accordance with the line voltage used.

⏚
Ground terminal to connect earth.
Make sure to ground to prevent any danger.

OPERATING INSTRUCTIONS

Basic Operation

Power and Sweeping
1. Make sure of the line voltage used and the LINE VOLTAGE selector setting.
2. Turn off the POWER switch and connect the accessory power cord between the AC LINE INPUT connector and the line receptacle.
3. Set the controls as follows.

Vertical POSITION	Mid-range
Horizontal POSITION	Mid-range
INTEN	Fully clockwise
V MODE	CH 1
SWEEP MODE	AUTO
TIME/DIV	1mSEC
SWEEP LENGTH	Fully clockwise

4. Turn on the POWER switch. The trace appears after about 15 seconds.

Focusing
1. Shift the trace to the center of the viewing area with the vertical POSITION control.
2. Set brightness of the trace to desired degree with the INTEN control.
3. Adjust the FOCUS control to make thin and clear trace.

Triggering by Signal Apply
1. Set the controls as follows.

V MODE	CH1
AC-GND-DC (CH 1)	DC
VOLTS/DIV (CH 1)	5 mV
VARIABLE (CH 1)	CAL
COUPLING	AC (EXT DC)
SOURCE	CH 1

2. Connect the CAL OUT signal to the CH1 INPUT connector using the accessory probe.
3. Set the attenuation ratio of the probe to x10 and adjust the LEVEL control for triggering.

The above-mentioned operation allows most ordinary type triggering (AUTO operation by internal triggering and AC coupling) and a six divisions signal is displayed on the CRT. For details of triggering, see the later section "Triggering".

Obtaining Spot
Setting the MODE switch to NORM and the AC-GND-DC switch to GND allows a spot to be appeared.

Single-Trace

Setting the Vertical Mode switch, CH1-CH2-DUAL-ADD to CH1 or CH2 allows the single-trace display of channel 1 or channel 2.

Signal Connection

The signal to be measured is connected to the CH1 and/or CH2 INPUT connectors. A Probe is generally used as the means to connect the signal source with the INPUT connector. The Type 1036 probe is used for this instrument. This probe is convenient to measurements as 1 : 1 (x1) and 10 : 1 (x10) of the attenuation ratio can be selected by a switch.

The probes can protect the signal to be measured from the interference caused by the external electrical field. The x 10 position of the 1036 probe provides a higher input impedance and decrease the load effect to the signal source. So, signals from higher output impedance source and at higher frequencies can be correctly measured with the x 10 position. As the x 10 position attenuates the signal to 1/10, the value indicated by the VOLTS/DIV switch must be multiplied by 10

The x 1 position of the probe does not attenuate low frequency signals. However, the x 1 position increases the input impedance and gives bigger load effect to a high frequency signal source. So, the x 1 position is useful for measurements of lower frequency signals at lower output impedance sources.
For the details, see the instruction manual of the probe.

Signal Input Coupling

Many kinds of signals are measured; DC, AC and mixed signals. To measure these signals correctly, an adequate signals input coupling must be selected with the AC-GND-DC switch.

This switch selects the input coupling mode of the vertical deflection system. In the AC mode, the input connector and the input of the vertical amplifier are connected with a capacitor, in the DC mode, they are connected directly, and in the GND mode, they are disconnected together and the input of the vertical amplifier is grounded.

In the AC coupling, the capacitor blocks the DC component of the signal, and the displayed signal can be magnified without being deflected outside of the viewing area by the DC component. The AC coupling, however, produces sags in low frequency square waves, or displays the decreased amplitude of sine waves. The amplitude decreases appoximately 3 dB at 4 Hz. The DC coupling passes all components of the signal. The DC coupling is generally used if the DC component is not need to be blocked.

In the GND mode, the input of the vertical amplifier is grounded, and the ground level is traced on the viewing area. The level is used as the reference level in measurements.

Deflection Factor

For accurate measurement of signal waveforms, it is essential to display adequate amplitude of the waveforms on the viewing area. An excessively small or large signal compared with the viewing area enables no adequate measurement. If the signal to be measured is small, it need to be amplified, and if large, need to be attenuated.

The deflection factor is selected by the VOLTS/DIV switch and finely adjusted by the VARIABLE control. Each deflection factor becomes equal to the value indicated by the VOLTS/DIV switch when the VARIABLE control is set to the fully clockwise position. The values show the voltage for one division on the viewing area. The sensitivity is decreased when the VARIABLE control is turned counterclockwise and becomes less than 1/2.5 of each indicated value at the fully counterclockwise position.

Triggering

This section describes the triggering procedures briefly and in detail explains the operating method of controls used for triggering.

Trigger Procedure I (Internal Triggering)

1. Set the SOURCE switch to CH 1 or CH 2.
2. Select a trigger coupling mode with the COUPLING switch according to trigger signals (input signals).
3. Select a trigger mode with the MODE switch according to measurement object.
4. Adjust the displayed amplitude of the input signals to a value higher than the prescribed one shown in Table 1-1.
5. Select a trigger slope and a trigger level with the LEVEL/SLOPE control.

Triggering Procedure II (External Triggering)

1. Set the SOURCE switch to EXT.
2. Connect an external trigger signal, which has amplitude higher than the prescribed one shown in Table 1-1, to the EXT INPUT connector.
3. Select a trigger coupling mode with the COUPLING switch according the external trigger signal.
4. Select a trigger mode with the MODE switch according

to measurement object.

5. Select a trigger slope and a trigger level with the LEVEL/SLOPE control.

Trigger Source

In order to observe the input signal waveform in the viewing area by triggering, the input signal itself or a signal having an integer relationship with respect to the input signal in frequency (which is called a trigger signal) must be supplied to the trigger circuit in order to actuate the trigger generator which sends a trigger pulses and conducts the horizontal sweeping of display.

The internal triggering is obtained by setting the SOURCE switch to CH1 or CH 2. In this case, a portion of input signals applied to the INPUT connector is supplied to the trigger circuit through a stage in the vertical deflection system.

The external triggering is obtained by setting the SOURCE switch to EXT. In this case, the trigger signals from the external devices are supplied to the trigger circuit.

Internal Triggering: In this operation, the input signals applied to the INPUT connector are amplified because a portion of the signals in the vertical deflection system is supplied to the trigger circuit as a trigger signals. Therefore, the display can be suitably triggered even if the input signal amplitude is small. The internal triggering is simple in operation and is popular for ordinary measurements.

External Triggering: This operation offers the following unique features.

First, the external triggering is free from influence of vertical deflection settings. In the internal triggering, as changing the deflection factor allows trigger signal amplitude to vary, the readjustment of the LEVEL control is often required to resume proper triggering level. On the other hand, the external triggering needs no readjustment of the LEVEL control against any changing of vertical deflection setting so long as the external trigger signal amplitude is retained unchanged.

Second, when it is desired to start the sweep a certain time before or after the input signal the desired waveform can be displayed by using a signal of such timing as the external trigger signal, provided such signal is available.

Internal Trigger Signal

In the internal triggering mode, the trigger signals are selected in the following way.

When the Vertical Mode switch is set to CH1 or CH2 the trigger signal supplied from the channel which must be selected by the SOURCE switch.

When the Vertical Mode switch is set to DUAL, setting the SOURCE switch to CH1 allows the selection of the CH1 trigger signal, while setting it to CH2 permits the selection of the CH2 trigger signal. Therefore, when the input signal frequencies are the same, selecting the channel to which the signal having higher amplitude and lesser noise component is applied allows stable triggering.

When the input signal frequencies differ from each other (but, there is no phase shift between these signals), the one of the lower frequency should be used as the trigger signal. If the other signal having the higher frequency is used as the trigger signal, the one of the lower frequency is displayed in duplication. When the dual-trace display is intended for measurement of phase difference between two signals, the one with the leading phase must be selected as the trigger signal.

Trigger Coupling

The COUPLING switch is designed to select the coupling mode between the trigger signal and the trigger circuit. Two coupling modes are available: AC (EXT DC) and TV-V.

These couplings are selected to obtain a stable triggering in accordance with kind of the trigger signals, e.g, DC signals, AC signals, AC signals superimposed on DC signals and signals superimposed by high frequency noise.

AC (EXT DC): In this position, selecting the internal triggering allows the AC coupling and selecting the external triggering permits the DC coupling.

The AC coupling passes the trigger signal to the trigger circuit through a capacitor, therefore DC and a low frequency component are rejected and attenuated respectively. This coupling is advantageous for ordinal signal measurements as the triggering is free from DC, but the triggering is difficult when the trigger signal frequency is below about 20 Hz.

The DC coupling passes all trigger signals to the trigger circuit, so the triggering is possible from DC.

TV-V: This coupling gives a stable triggering for measurement of composite video signals.

Sweep Mode and Trigger Level

Two sweep modes, AUTO and NORM, can be selected by the sweep MODE switch. Each mode has the following features, so use one mode which is suitable for measurement object.

In both modes, triggering is obtained in a certain range from the center of the LEVEL control and range width varies according to the trigger signal amplitude.

In the AUTO mode, 'free-running' sweep occurs when triggering is not accomplished, in other word, the LEVEL control is set to outside of the triggering range or no trigger signal is supplied to the trigger circuit. So, the trace of ground level is provided by setting the AC-GND-DC switch to GND. Triggering, however, is not obtained in signals below 50 Hz. In such case, use the NORM mode.

In the NORM mode, the triggering is possible form DC, but the sweep stops when the triggering is not obtained.

Trigger Slope

The trigger slope can be selected by push-pull switching of the LEVEL control. In the pushed state of the LEVEL control, the positive-going slope is selected, and pulling it permits the negative-going slope.

Sweep Rate

The signals to be measured varies in many ways, from high to low repetition frequencies, or from fast to slow rise time pulses. In order to measure such signals, a suitable sweep rate must be selected according to the repetition frequencies or the rise time.

The sweep rate is selected by the TIME/DIV switch. Each setting value is slowed down when turning the VARIABLE control counterclockwise and set less than 1/2.5 of the value at the fully clockwise position, CAL.

Application Operation

Oscilloscope has many convenience functions to display the provided signal. Here, the application operation is described to ovserve the input signal with operating functions.

Dual-Trace

Setting the vertical Mode switch to DUAL permits the dual-trace display of channel 1 and channel 2. The alternate modeand chopped mode for the dual-trace display are changed by the TIME/DIV switch setting ie., setting the TIME/DIV switch to a position faster than or equal to 0.5 mS/div allows the alternate mode and setting it to a position slower than or equal to 1 mS/div permits the chopped mode. By changing of these modes, dual-trace display for phenomena over a wide range from low speed up to high speed is made.

ADD Operation

A signal showing the sum of difference of the signals applied to CH1 and CH2 can be observed by setting the vertical mode to ADD and switching the POLARITY switch. When observing the signal showing the sum, push out POLARITY switch, and push it in when observing the signal showing the difference.

<Cautions>

(1)When performing in differentical input (POLARITY is set to INV), equalize the input coupling of the both channels.

(2)In ADD operation, the trace position can be moved by POSITION (PULL x5 GAIN) controls of both channels, For accurate observation, set both POSITION (PULL x5 GAIN) controls at approximately mid position.

(3)Set the trace in the center of viewing area when switching the POLARITY switch. As the polarity inversion of this instrument is performed symmetrically against the center line of the viewing area, if the polarity is switched over with the trace not in the center area, its vertical position will changed.

Sweep Magnifying

A part of the input waveform can be magnified with ragard to time by the use of faster sweep rate. However, the part which is far from the sweep start position may be out of the viewing area when the sweep rate is increased.

The part to be measured can be magnified 5 times by shifting its part to the center of the viewing area with the horizontal POSITION control and then pulling the POSITION (PULL x5 MAG) knob. Entire length of the trace is magnified to approximately 50 divisions wide though only the center 10 divisions part is displayed in the viewing area. The magnified trace can be fully observed by sequenctially adjusting the horizontal POSITION control.

The sweep rate at 5 magnification can be calculated by multiplying the TIME/DIV setting value by 1/5. Therefore, the available maximum sweep rate can be obtained by the following calculation: 0.5 μS/div (the maximum sweep rate at no magnification) x 1/5 = 100nS/div.

X-Y Scope

Setting the controls as follows allows the SS-5702 to be operated as an X-Y scope.

TIME/DIV X-Y

In the X-Y scope of operation, the signals applied to the INPUT connectors of the Channel 1 and Channel 2 drive the Y and X axis respectively to make a Lissajou's pattern. The display can be shifted vertically and horizontally by the vertical and horizontal POSITION controls.

The deflection factor is selected by the VOLTS/DIV switch and finely adjusted by the VARIABLE control. The deflection factor becomes equal to the value indicated by the VOLTS/DIV switch when the VARIABLE control is set to the fully clockwise position.

The vertical and horizontal deflection factor is multipled to five when the Vertical and Horizontal POSITION controls are pulled (PULL x5 MAG). When use the CH1 or CH2 input signal as X axis deflection signal, the x5 GAIN is never used, because at the X-Y operation the x5 GAIN is not warranted.

The deflection factor is set to 0.5V/div when the signal is applied to the EXT INPUT connector, and is set to 0.1V/div when the PULL x5 is pulled.

NOTES

Measuring Instruction

Probe Phase Adjustment

Proper adjustment of the probe phasing is required before measurements as the incorrect phasing results in erroneous measurements when the x10 position is selected.

1. Set the controls as follows:

VOLTS/DIV	5mV
VARIABLE	CAL
TIME/DIV	0.5 mSEC
VARIABLE	CAL
Horizontal POSITION	Mid-range

2. Set the probe switch to x10 and connect the probe between the input connector and the CAL OUT terminal.
3. Display the calibration voltage waveform with six divisions amplitude.
4. Adjust the variable capacitor of the probe (located in a hole of the input connector side) using the accessory adjusting driver, and set the top of the waveform to the correct phasing shown in Figure 3-1.

Voltage Measurement

Quantitative Measurement

The quantitative measurement of voltage can be made by setting the VOLTS/DIV VARIABLE control to the CAL position. The measured value can be calculated by Equation (1) or (2).

a. Measurement with the x1 position of the probe:
   Voltage (V) = VOLTS/DIV setting value (V/div) x Displayed amplitude of input signal (div). . . . . .(1)

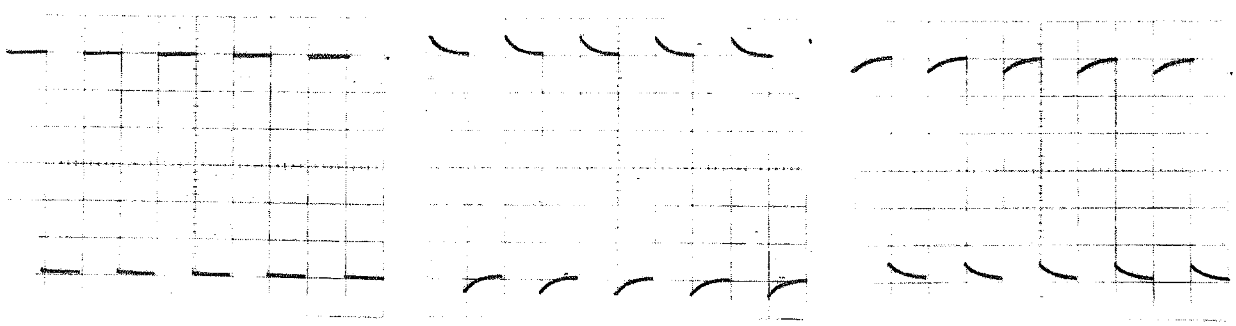
b. Measurement with the x10 position of the probe:
   Voltage (V) = VOLTS/DIV setting value (V/div) x Displayed amplitude of input signal (div) x 10 . .(2)

DC Voltage Measurement

This instrument functions as a high input resistance, high sensitivity, quick response DC volt meter in order to measure DC voltage. Measurement procedure is as follows:

1. Set the sweep MODE switch to AUTO, and select a sweep rate so that the trace may not flicker.
2. Set the AC-GND-DC switch to GND. The vertical position of the trace in this case is used as 0-volt reference line as shown in Figure. 3-2. Adjust the vertical POSITION control in order to place the trace exactly on a hori-

Figure 3-1. Phasing of probe and displayed waveform



Correct Compensation — Excessive Compensation — Insufficent Compensation zontal graticule, which facilitates the reading of signal voltage.

3. Set the AC-GND-DC switch to DC, and apply the voltage to be measured to the input connector. The vertical diaplacement of the trace gives the voltage amplitude of the signal. When the trace shifts upward, the measured voltage is positive with regard to the ground potential. When the trace shifts downward, the voltage is negative. The voltage can be obtained by Equation (1) or (2).

AC Voltage Measurement

The measurement of the voltage waveform is performed as follows: Set the VOLTS/DIV switch in order to obtain the amplitude for easy reading, read the amplitude as shown in Figure 3-3, and calculate by Equation (1) or (2).

When the waveform superimposed on DC current is measured, set the AC-GND-DC switch to DC in order to measure the value including DC component, or set this switch to AC in order to measure AC component only.

The measured value by means of this procedure is peak value (Vp-p). Effective value (Vrms) of a sine wave signal can be given by Equation (3).

$$\text{Effective voltage (Vrms)} = \frac{\text{Peak voltage (V p-p)}}{2\sqrt{2}} \quad \cdots (3)$$

Time Measurement

The time interval of two points on a signal waveform can

Figure 3-2. DC Voltage measurement

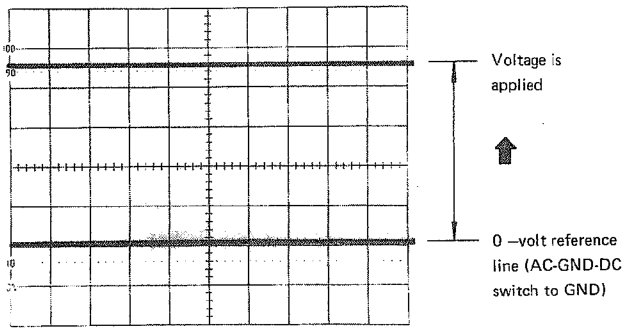


Figure 3-3. AC Voltage measurement

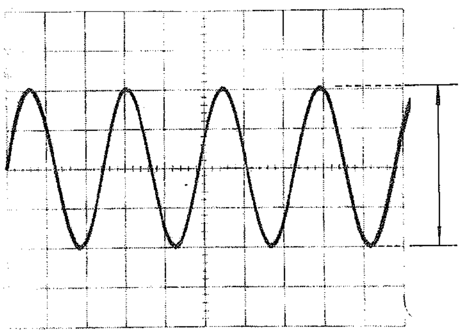


Figure 3-4. Pulseswitch measurement

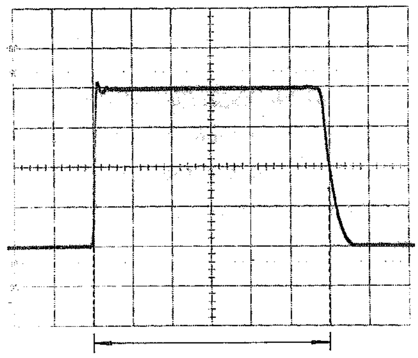
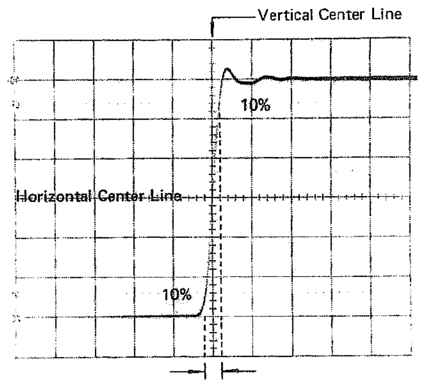


Figure 3-5. Rise (or fall) time measurement



be calculated as follows: Set the TIME/DIV VARIABLE control to CAL, read the setting values of the TIME/DIV and x5 MAG switches and calculate the time by Equation(4)

Time (s) = TIME/DIV setting value (s/div)
x Length corresponding to the time to be measured (div)
x Reciprocal number of x5 MAG setting value . . . .(4)

Where, the reciprocal number of the x5 MAG setting value is 1 when the sweep is not magnified, and 1/5 when the sweep is magnified.

Pulsewidth Measurement

The basic pulsewidth measurement procedure is as follows:

1. Display the pulse waveform vertically so that the distance between the top part of the pulse waveform and the horizontal center line of the graticule may be equal to the distance between the bottom part of the pulse and the horizontal center line as shown in Figure 3-4.
2. Set the TIME/DIV switch in order to make the easy observation of the signal.
3. Read the distance between centers of rising and falling edges, i.e., the distance between two points at which pulse edges cross the horizontal center line of the graticule. Calculate the pulsewidth by Equation (4).

Rise (or Fall) Time Measurement

The rise (or fall) time measurement of the pulses is obtained as follows.

1. Display the pulse waveform vertically and horizontally in the same manner as for the pulsewidth measurement procedure.
2. Turn the horizontal POSITION control in order to set the upper 10% point of the waveform on the vertical center line of the graticule. (In Figure 3-5, the upper 10% point is 0.4 division below the top of the pulse since the displayed amplitude is 4 divisions.) Read the distance T_1 between the vertical center line and the point at which the rising (or falling) edge crosses the horizontal center line.
3. Shift and set the lower 10% point of the waveform to the vertical center line of the graticule as shown by the dotted line in Figure 3-5. Read the distance T_2 between the vertical center line and the point at which the rising (or falling)edge crosses the horizontal center line.
4. Calculate the rise (or fall) time by substituting the sum of T_1 and T_2 for Equation (4).

Frequency Measurement

Of the frequency measurement procedure, there are the following methods.

The first method: Calculate the one-cycle time (interval) of the input signal by Equation (4) as shown in Figure 3-6, and obtain the frequency by Equation (5).

$$\text{Frequency (Hz)} = \frac{1\ (c)}{\text{Period}\ \ (s)} \cdots\cdots\cdots\cdots (5)$$

Figure 3-6. Frequency measurement (1)

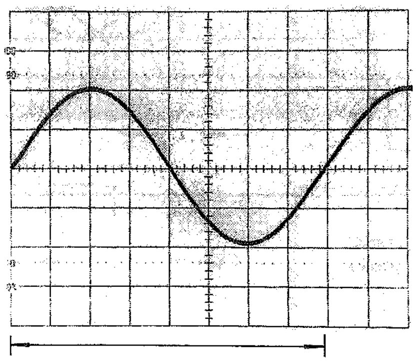
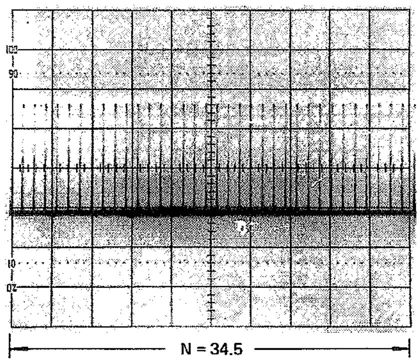


Figure 3-7. Frequency measurement (2)



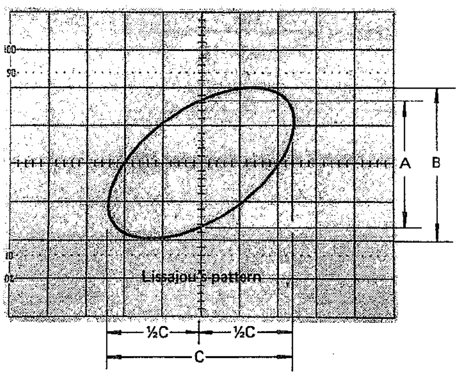
The second method: Count the repetition number N per 10 divisions in the viewing area, and calculate the frequency by Equation (6).

$$\text{Frequency (Hz)} = \frac{\text{N (c)}}{\text{TIME/DIV setting value (s/div)} \times 10 \text{ (div)}} \quad \cdots (6)$$

When N is large (30 to 50), the second method can give a higher accuracy level than that obtained with the first method. This accuracy is approximately equal to the rated accuracy of sweep rate. However, when N is small, the count below decimal point becomes very ambiguous, which results in considerable error.

For the measurement of comparatively low frequencies having a simple pattern such as sine wave, square wave, triangle wave, and sawtooth wave, measurement with high accuracy can be effected by the following method: Operate the oscilloscope as an X-Y scope, make the Lissajou's pattern by applying the signal of which frequency is known, and read the necessary value.

Figure 3-8. Phase difference measurement using



Phase Measurement

Of the measurement of phase difference between two signals, there are the following two methods:

The first one is the Lissajou's pattern method by using the instrument as an X-Y scope. The phase differnce of signals can be calculated form the amplitudes A and Bof the pattern shown in Figure 3-8 and by Equation (7).

$$\text{Phase defference (deg)} = \sin^{-1} \frac{A}{B} \quad \cdots\cdots\cdots\cdots (7)$$

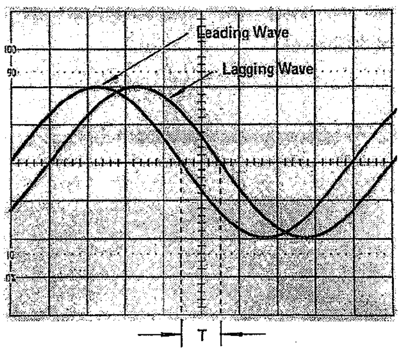
The second method is an application of dual-trace function Figure 3-9 shows an example of dual-trace display of leading and lagging sine wave signals having the same frequency. In this case, the SOURCE switch must be set to a channel which is connected to the leading signal, and set the TIME/DIV switch so that the length of 1-cycle of the displayed sine wave may be 9 divisions.

Then, 1-division graticule represents a waveform phase of 40° (1cycle $=2\pi=360°$). The phase difference between the two signals can be easily calculated by Equation (8).

$$\text{Phase difference (deg)} = \text{T (div)} \times 40° \quad \cdots\cdots\cdots (8)$$

Where, T is the distance between two points at which the leading and lagging signals cross the horizontal center line of the graticule.

Figure 3-9 Phase difference measurement by dual-trace display



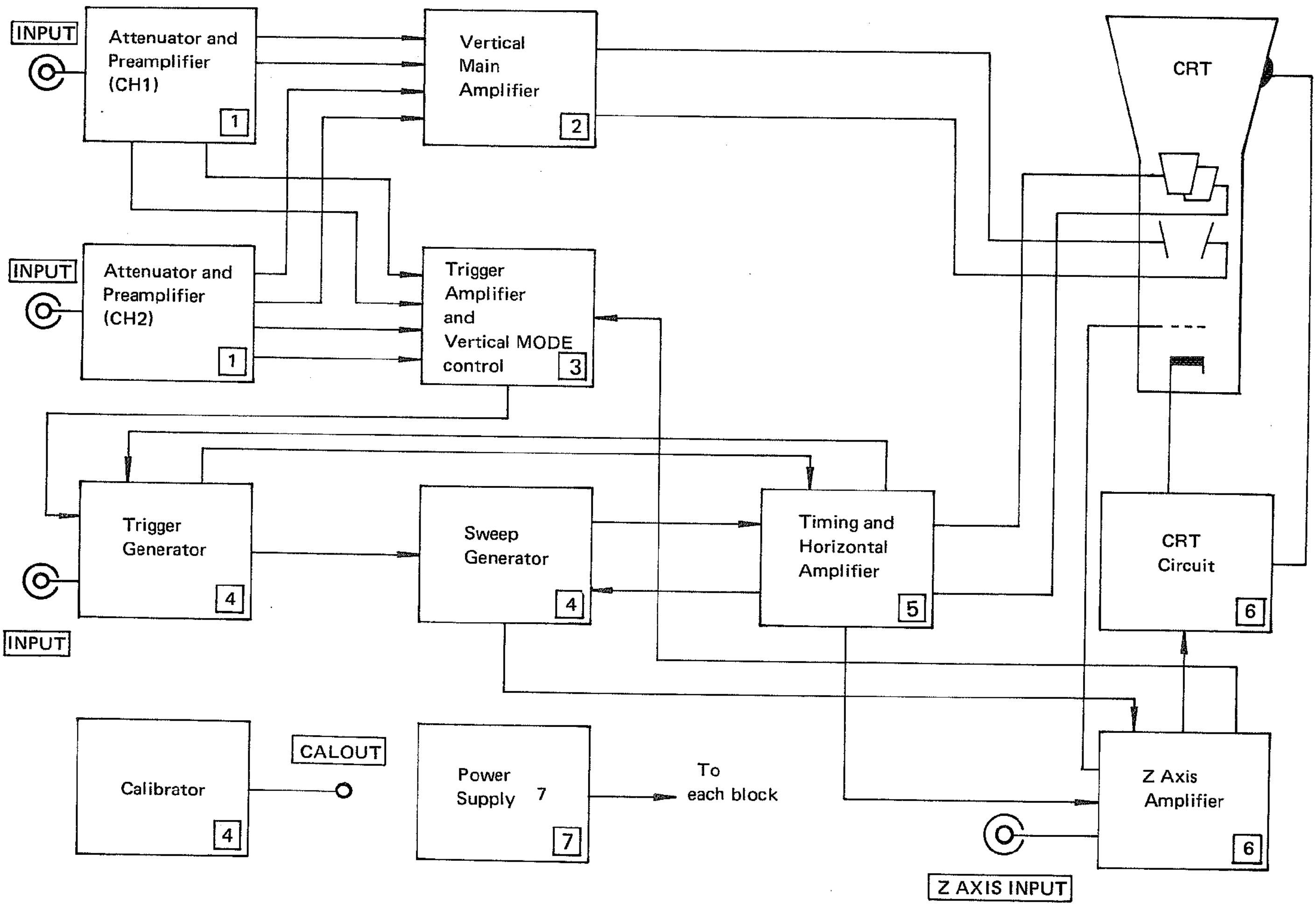
Operating Principle

A basic block diagram of the SS-5702 is shown in Figure 4-1.

The Vertical Deflection System consists of two independent Attenuators and Preamplifiers and one Main Amplifier. Signal to be displayed on the CRT is applied to the INPUT connector, converted into a push-pull output signal and amplified in the Preamplifier, and connected to the Main amplifier.

The Vertical MODE switch, CH1-CH2-DUAL-ADD selects the following three modes; Either Channel 1 or Channel 2 alone (CH1 or CH2) or two signals electonically switched (DUAL) or the algebraic sum (ADD). In the DUAL mode, setting the TIME/DIV switch to a position faster than or equal to 0.5 mS/div allows the alternate mode

Figure 4-1 Overall block diagram



and setting it to a position slower than or equal to 1 mS/div permits the chopped mode. In the alternate mode, the Vertical Mode Switching circuit in the Main Amplifier is driven by the alternate signal from the Sweep Generator, resulting in an alternalte display of the Channel 1 and Channel 2 signals as complet sweeps. In the chopped mode, the Vertical Mode Switching circuit oscillates on a free-running basis at a repetition rate of approximately 100kHz which switches the Diode Gate (opens or closes) causing the output signals from the two channels to be chop-displayed at a repetition rate of approximately 100kHz regardless of the sweep rate. In this mode, the chop blanking signal is supplied from the Vertical Mode Switching circuit to the Z Axis Amplifier to blank the transients of the switching action.

A sampling of the input signal is supplied from the Pre-amplifier to the Trigger Amplifier and Selector circuit where it is amplified and supplied to the Trigger Generator circuit.

The Main Amplifier provides the final amplication and deflects the beam vertically in the CRT.

The main Amplifier provides the final amplication and deflects the beam vertically in the CRT.

The Trigger Generator circuit converts trigger signal of its input into a first-rise trigger pulse which initiate the sawtooth signal produced by th Sweep Generator circuit.

The Sweep Generator circuit produces a linear sawtooth signal of which the slope is determined by the TIME/DIV switch. The Sweep Generator circuit also produces an un-blanking gate signal to unblank the CRT.

The Horizontal Amplifier provides the amplification of the sawtooth signal or the X-axis signal in the X-Y mode and deflects the beam horizontally in the CRT.

The Z Axis Amplifier circuit determines the CRT intencity and blanking. This circuit sums current inputs from the INTEN control, Gate circuit of the Sweep Generator and external Z AXIS binding post. The output of this circuit is connected to the control grid of the CRT.

The Power Supply circuit produces the 6.3 V AC supply used for the graticule illumination lamps and the low DC voltage supplies to operate each circuit of this instrument.

The Calibrator circuit produces a square-wave signal with accurate amplitude which can be used to check the deflection factor and compensation of the probes.

Maintenance

Warning

The following items must be cared when the maintenance work is executed.

1. Dangerous potentials exist at several points throughout this instrument.
2. When the instrument is operated with the cover removed, do not touch exposed connections or components.
3. Some transistors may have elevated cases and heat sinks in the voltage.
4. Always disconnect the instrument from the power source before cleaning the instrument or replacing parts.

Cover Removel

The top cover can be removed by loosing four mounting screws and bottom cover can be removed by loosing one (five) mounging screw(s) respectively.

PREVENTIVE MAINTENANCE

These are the precautions on preventive maintenance which will protect the instrument from trouble and keep it clean over a long period of time.

Cleaning

Since the extent of instrument smearing depends on the ambient condition in which the oscilloscope is used, the frequency of the cleaning operations cannot be defined initially. Cleaning should be accomplished as required. Dust deposited inside the instrument affects the normal flow of cooling air and invites the local overheating of component parts of results in trouble. Smeared switch contacts of connector pins can be the cause of defective contact, and smearing of the circuit can cause arcing between circuits, particularly in moist season.

Cleaning agents recommended and those prohibited are listed in Table 5-1.

Table 5-1

Recommended agent	Alcohol, gasoline of kerosene
Prohibited agent	Acetone, tri-ethyl-Ketone, ether, lacquer thinner or agent containing ketone series solvent.

Cleaning the Cover

Normal smearing of the cover can be cleaned by washing the cover with a neutral chemical cleaner. For greasy smearing, use a recommended agent in Table 5-1 with a soft cloth.

Front and Other Panels

Clean the smeared panel with a soft cloth moistened with a recommended agent. Note that cleaning with alcohol may leave slight blotting. A neutral chemical cleaner may be used but the cleaner left on the panel or knob must be removed with a cloth soaked in water.

Dust in Instrument

The best way to remove dust inside the instrument is the blowing of conpressed air. Remove persistent dust with a soft paintingbrushand blow the air again.

CRT

The CRT screen will be smeared if it is used for too long without the filter. Ordinary dust of fingerprintleft on the

CRT can be cleaned by a soft cloth. Use a soft cloth moisted with alcohol to remove persistent smearing.

Filter

The filter may be clogged when used for a long time. Dust or fingerprint can be cleaned with a dry, soft cloth. Use a soft cloth moisted with alcohol to remove persistent smearing.

Before Preserving the Osilloscope

Before preserving the oscilloscope, remove the probe and adapter from the panel, and store these accessories in the accessory bag provided. Cover the oscilloscope, and store it in a dry place. It prevents deposition of dust.

Visual Inspection

Periodically inspect the condition of the internal circuit. Burnt resistor, defective contact of connection, broken printed circuit board and many other defects can be checked easily. Prompt repair of these minor defects can prevent troubles, or limit the defect within minor level.

Periodical Calibration

In order to use the oscilloscope accurately, periodical calibration of circuits is essential. When this oscilloscope is used frequently, a calibration will be required at every 1000 hours of operation. The frequency of calibration may be extended to 6 months, if the oscilloscope is used infrequently.

TROUBLESHOOTING

Troubleshooting Reference

Schematic Diagrams

In this manual, schematic diagrams are grouped, in general, with the circuit blocks classified in Figure 4-1.

Circuit Layout

Layout of circuits is printed on the circuit board with dotted lines.

Parts Layout

Refer to part No. printed on the circuit board to identify parts mounted on the board.

Color Cord of Resistors and Capacitors

Most of the resistors and capacitors in the circuit are color coded by resistance or capacitance value. See Figure 5-1 for the color code.

Electrodes Marking of Diodes and Transistors

Table 5-2 and 5-3 show the electrodes marking of diodes and transistors, by type.

Instruments Required for Troubleshooting

The following instruments are required at least for troubleshooting of this oscilloscope.

(1) Multimeter

Input resistance	: 10 M Ω
Voltage range	: 0 to 300V and special position for 2 kV
Ohm-range	: 0 to 10 MΩ

(2) Transistor curve tracer

(3) Oscilloscope

Frequency bandwidth	: DC to 10 MHz
Sensitivity	: 5mV/div

Troubleshooting Steps

The first thing in troubleshooting is to examine if a irregular event like "a circuit trouble" is really due to a troubles within the circuit, or caused by external events. For example, certain irregular operations will occur, in a normal oscilloscope, if the line voltage is out of the rated voltage range, or an signal input connector is affected by induction of an external signal.

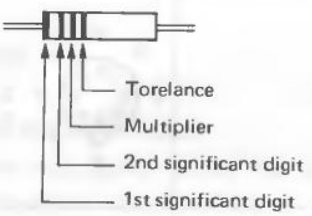
Then, repeatability of the trouble must be checked. For example,when sweep is normal but an irregular signal is displayed with a signal supplied to the signal input connector, the other signal must be supplied to the input to check if the same irregular display occurs (if it occurs, the oscilloscope is responsible for the trouble).

When troubles perist again these preparatory checks, the following actual steps must be performed.

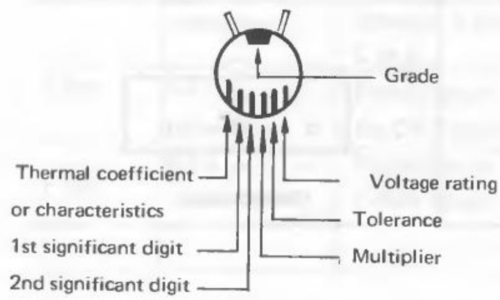
1. Remove the covers from the instrument and ascertain the circuit which has the trouble by the troubleshooting flow chart shown in Figure 5-5.
2. Visually inspect parts, wirings, coupling of connectors, soldering and copper foils of the circuit board, which are suspect.
3. Check the action of the ascertained circuit by using a multimeter or test oscilloscope and refering the voltages and waveforms shown in the schematic diagram.
4. Finally, check suspect parts for the trouble by using a multimeter or curve tracer and replace the defective parts.

Figure. 5-1. Color coading of resistor and capacitor

Resistor



Capacitor



Color	Resistance or capacitance value		Tolerance for resistor	Tolerance for capacitor		Voltage rating for capacitor
	1st or 2nd significant digit	Multiplier		Above 10pF	Below 10pF	
BLK	0	1	–	±20.0	±2.0	–
BRN	1	10	±1	±1.0	–	–
RED	2	10^2	±2	±2.0	–	250V
ORG	3	10^3	–	±2.5	–	300V
YEL	4	10^4	–	–	–	–
GRN	5	10^5	–	±5.0	±0.5	500V
BLU	6	10^6	–	±100	–	–
VLT	7	10^7	–	–	–	–
GRY	8	10^8	–	±10.0	±0.25	–
WHT	9	19^9	–	–	±1.0	1000V
GOLD	–	10^{-1}	±5	–	–	–
SIL-VER	–	10^{-2}	±10	–	–	–
No color	–	–	±20	–	–	–

Table 5-2 Marking for diode electrode

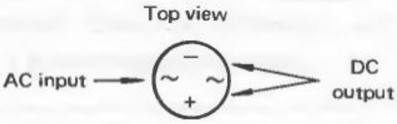
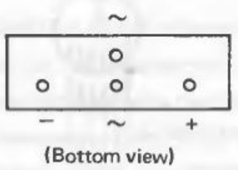
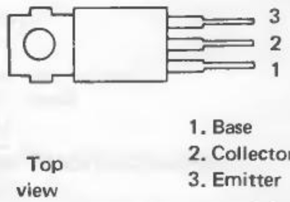
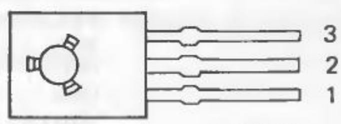
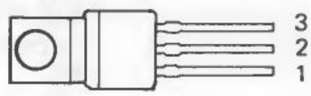
Type of diode	Electrode making	Polarity
1S953 ESJA35-12		
RD 3.0EB RD 5.1EB		
1G4B1		
SIRBA		

Table 5-3 Marking for transistor electrode (bottom view)

Type of transistor	Electrode marking
2SC1834 2N3905	 1. Emitter 2. Base 3. Collector
2SK30A-Y	 1. Source 2. Gate 3. Drain
2SA1015Y/O 2S1815GR	 1. Emitter 2. Collector 3. Base
µPA61A	 1. Source 2. Drain 3. Gate 5. Source 6. Drain 7. Gate 4. Case
2SB857C 2SC1061C 2SC1505	 1. Base 2. Collector 3. Emitter
2SD668	 1. Emitter 2. Collector 3. Base
2SB718 2SC1514 2SD758	 1. Base 2. Collector 3. Emitter

CIRCUIT BOARD REMOVAL

Vertical Board

1. Remove the top and bottom covers.
2. Disconnect two connectors (yellow and blue wires) from the CRT socket.
3. Disconnect two connectors connected to the INPUT BNC connector(s) and its earth lug (s).
4. Desolder the earth wire.
5. Remove knobs of the VARIABLE control and the VOLTS/DIV switch using the hexagonal wrench provided as an option and loosen nut of the VOLTS/DIV switch and Vertical POSITION controls.
6. Disconnect four connectors on the board.
7. Loosen seven mounting screws.
8. Pull the board backward and outward.

Horizontal Board

1. Remove the top and bottom covers.
2. Disconnect two connectors (white and black wires) from the CRT socket.
3. Remove the cover of the CRT circuit by loosen two mounting screws.
4. Remove knob of the POSITION, SWEEP LENGTH, TIME/DIV, VARIABLE and LEVEL controls using the hexagonal wrench provided as an option.
5. Loosen nut of the TIME/DIV switch.
6. Disconnect 13 connectors on the board.
7. Loosen five mounting screws.
B. Pull the board back and outward.

PARTS REPLACEMENT

In this paragraph, the replacement procedures of the defective parts are described.

When the replacement of the parts is required, be sure to disconnect the instrument from the power source.

Fuse Replacement

This instrument uses the fuses shown in Table 5-4 in order to prevent damage to the circuit due to overcurrent,

If these fuses are blown, check its cause correctly, repair the defective parts or circuits, and exchange the blown fuse with the pres cribed new ones. The use of a new fuse which is not prescribed may result in danger; therefore, such use is prohibited.

Table 5-4

Circuit No.	Type of Fuses	Function	Location
F701	0.5A slow-blow	Use this fuse when the Line Voltage Selector is set to A or B.	Rear panel
	0.3A slow-blow	Use when the Selector is set to C or D.	
F702	1A slow-blow	Protection of the CRT circuit	Right side board (POWER SUPPLY Circuit)
F703	0.2A fast-blow	Protection of +240V circuit	

Parts on Printed Circuit Board

When replacing transistors, ICs, diodes, resistors or capacitors mounted on the printed circuit board, particular care must be exercised on the handing of the soldering iron so as not to peel the copper foil off or break parts.

The semiconductors are delicate to heat. When desoldering or soldering, hold the semiconductor side of the wire lead being heated with pliers or tweezers to absorb the soldering heat. Complete soldering or desoldering quickly.

The semiconductors must be replaced with qualified ones. Refer to Table 5-2 and 5-3 for identification of electrodes. Pins of ICs are numbered as shown in Figure 5-3 when the slot is positioned leftward.

Resistors, capacitors and other passive parts must be also replaced with new ones. Burnign out of resistors or short circuitting of capacitors can occur incidentally with short-circuitting of semiconductors or excessive variations in the characteristics. Therefore, check and remove the cause of these defects before replacing the passive parts.

CRT

Dropping of or excessive shock to the CRT is very hazardous. Handle the CRT with special care.

Replace the CRT, when required, in the procedure given below:

1. Remove the top cover.
2. Desolder a wire (blue) between the CRT shield case.
3. Loosen two tightening screws of the rear CRT stopper. (See Figure. 5-4)
4. Loosen two tightening screws of the upper CRT stopper.
5. Disconnect the CRT socket.
6. Gradually pull the CRT together with the shild case backward and outward.

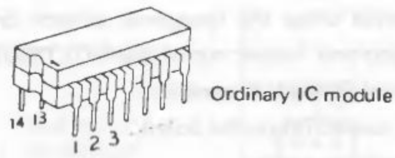
The CRT can be mounted in the reversed manner.

When the CRT is replaced, the deflection factor and sweep rate must be calibrated.

Power Transistor

The power transistors in the CRT and Power Supply circuits are mounted on the heatsink on the horizontal board with a insulation mylar film sheet inserted between the transistor and the heatsink. The mylar sheet is coated with the silicon grease to improve the thermal condition. In case of replacement of these transistors, the mylar sheet coated with the silicon grease must be correctly inserted.

Figure 5-2. Pin No. of IC



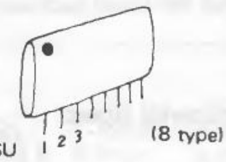


Figure 5-3. Circuit Layout

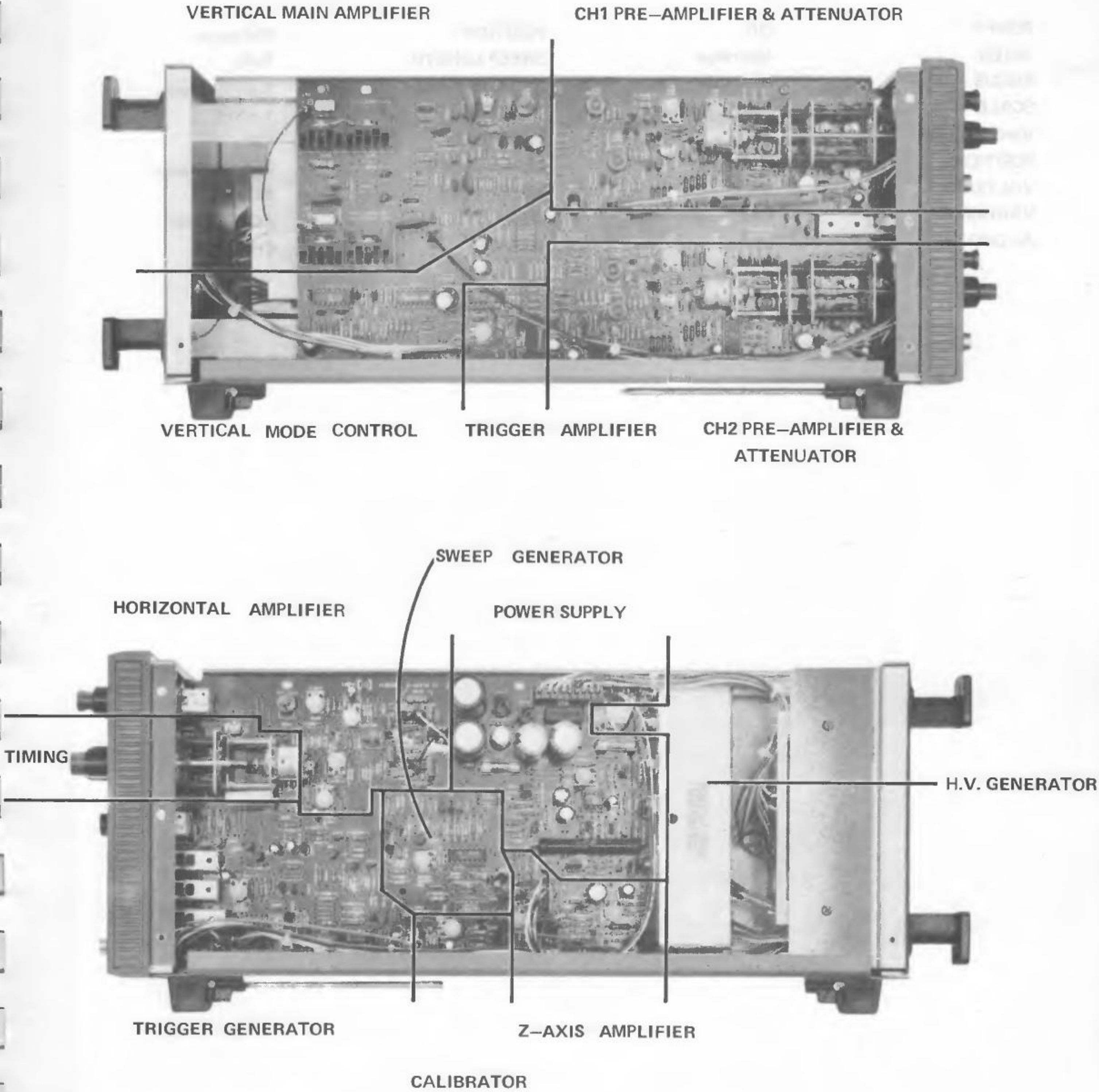
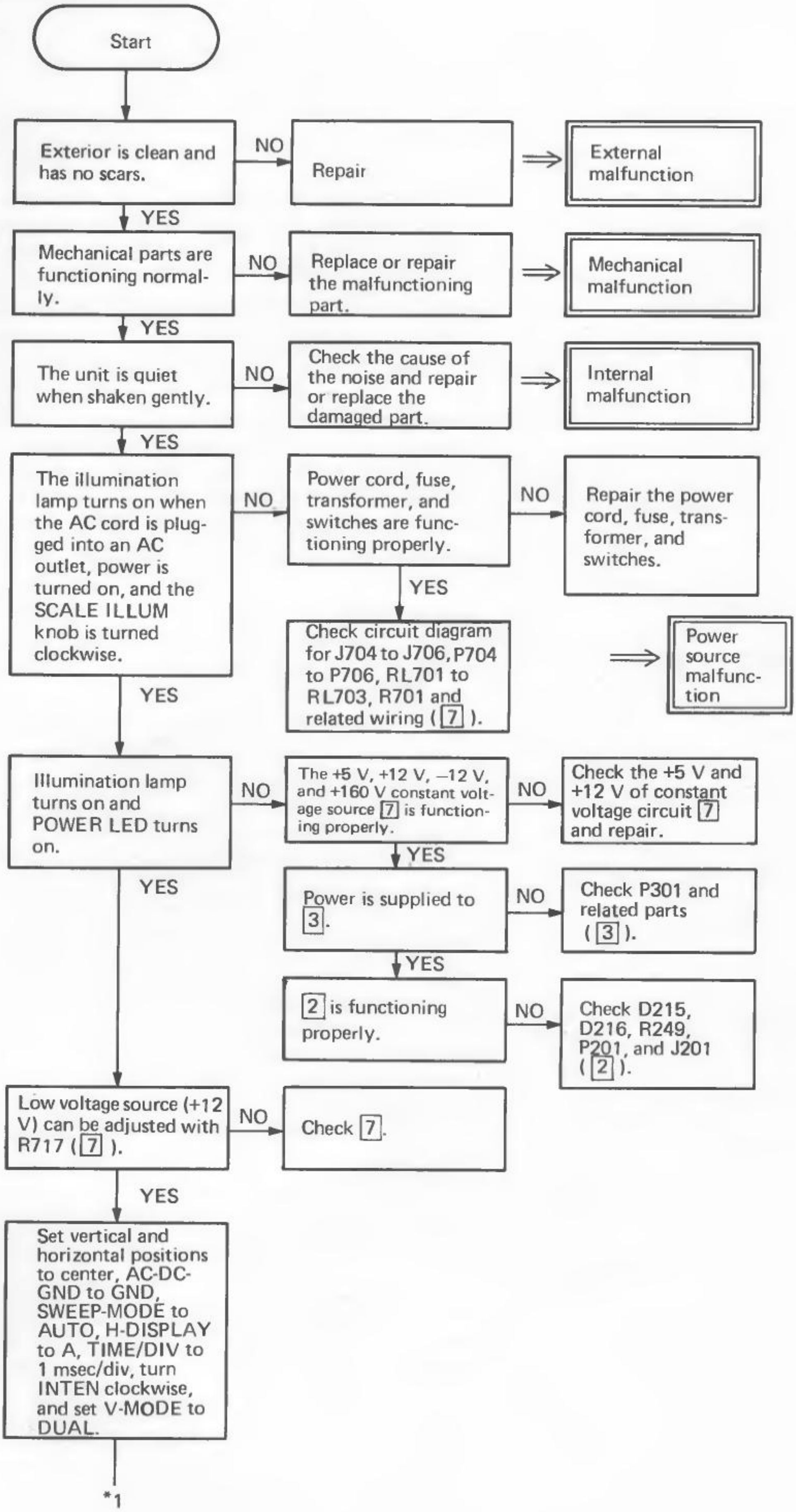
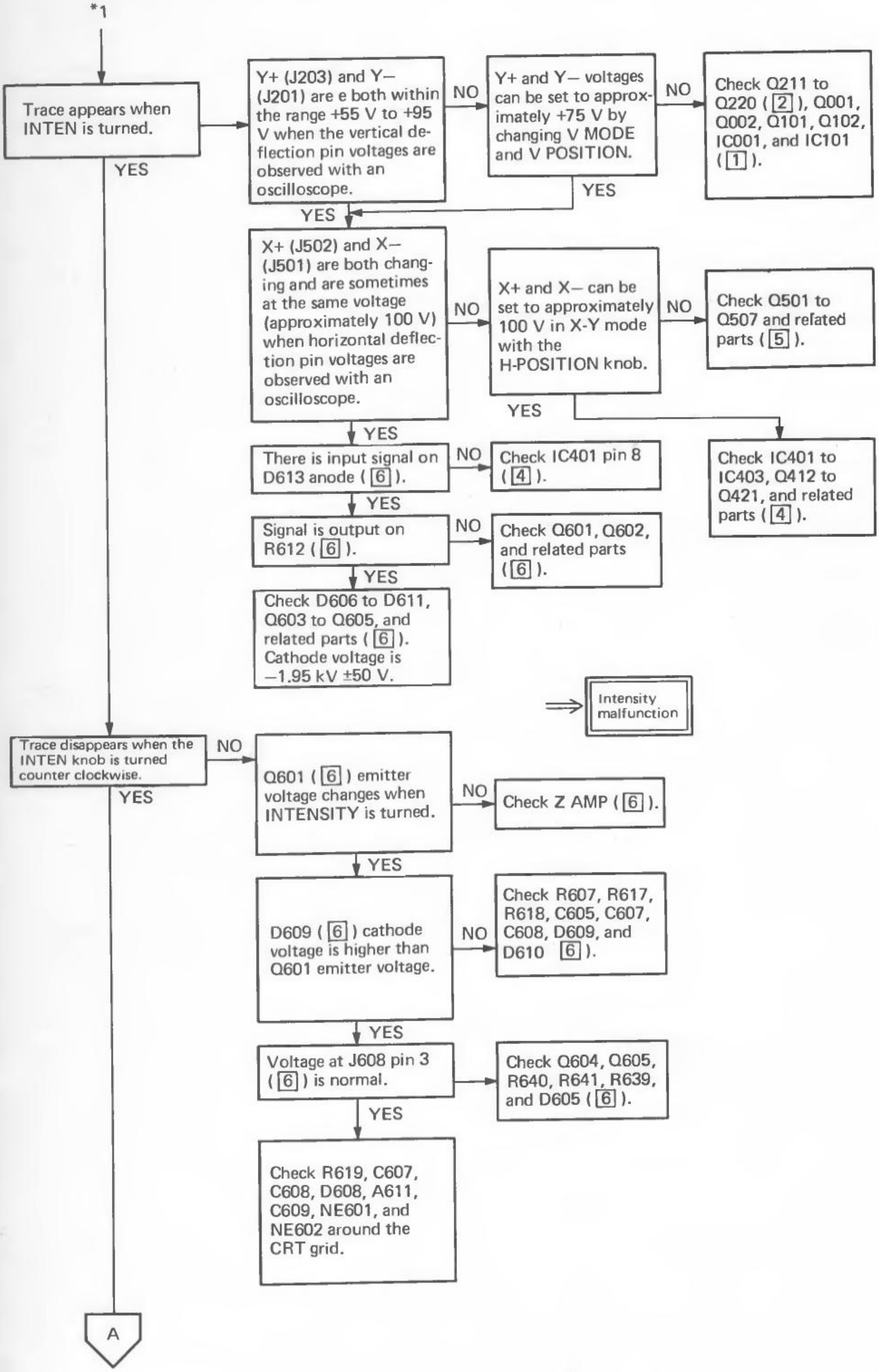


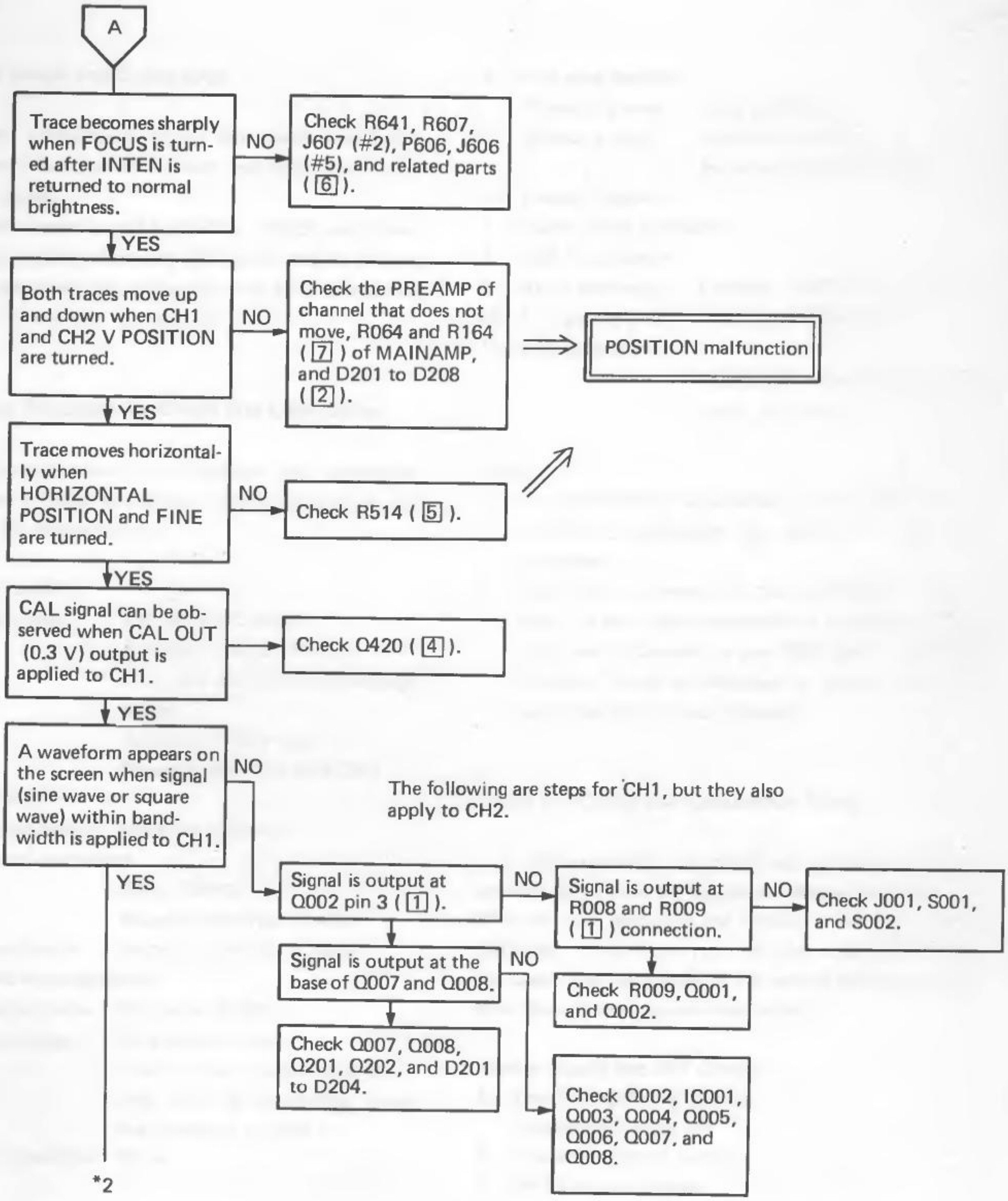
Figure 5-4. Troubleshooting flow chart

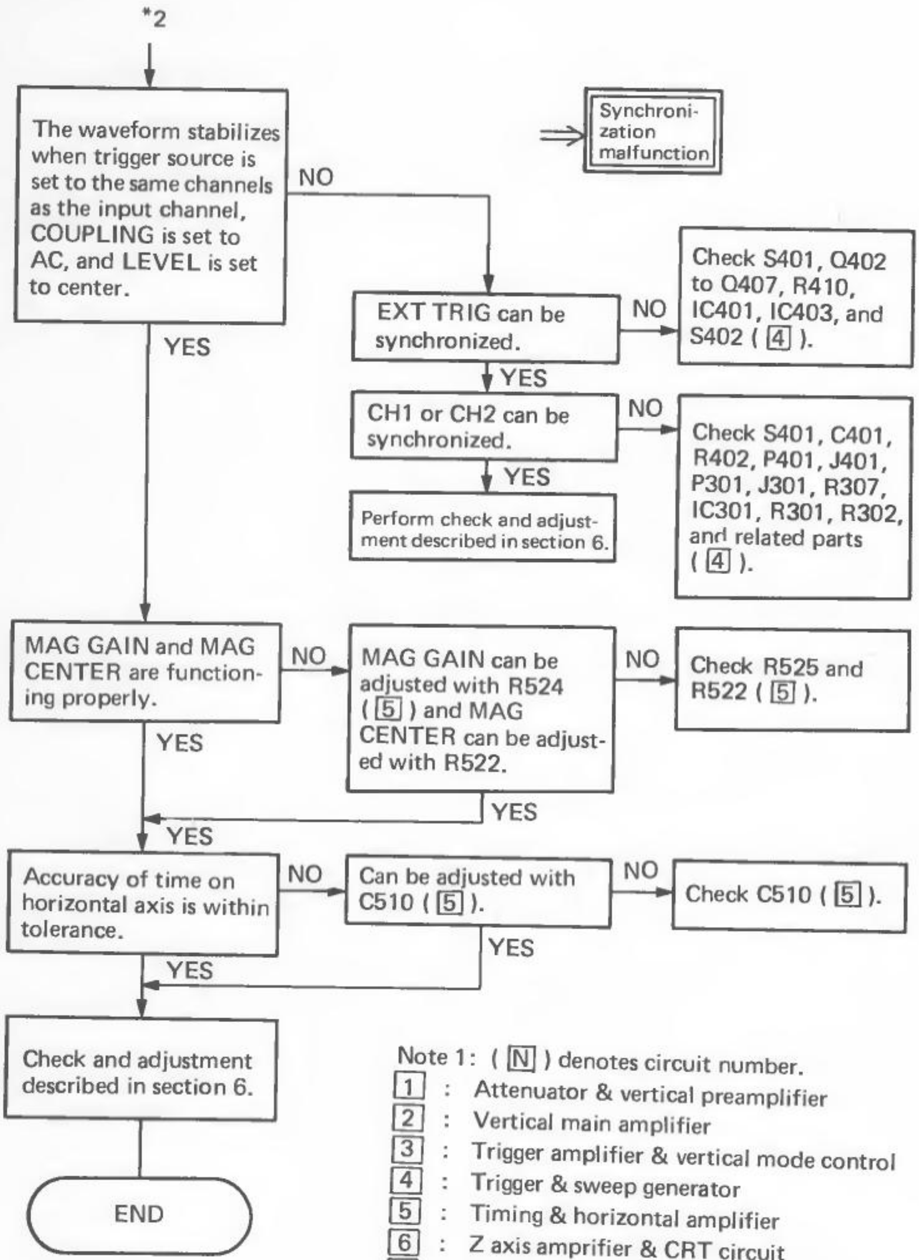
POWER	Off	POSITION	Mid-range
INTEN	Mid-range	SWEEP LENGTH (PULL x5 MAG)	Push, Fully clockwise
FOCUS	Mid-range	TIME/DIV	1 mSEC
SCALE	Fully clockwise	VARIABLE	CAL
Vertical MODE	CH 1	LEVEL/SLOPE	Push, Mid-range
POSITION	Mid-range	SWEEP MODE	NORM
VOLTS/DIV	5 mV	COUPLING	AC (EXT DC)
VARIABLE	CAL	SOURCE	CH1
AC-GND-DC	DC		

TROUBLESHOOTING FLOW CHART




*1
Trace appears when INTEN is turned.
YES
Y+ (J203) and Y– (J201) are e both within the range +55 V to +95 V when the vertical deflection pin voltages are observed with an oscilloscope.
NO
Y+ and Y– voltages can be set to approximately +75 V by changing V MODE and V POSITION.
NO
Check Q211 to Q220 (2), Q001, Q002, Q101, Q102, IC001, and IC101 (1).
YES
YES
X+ (J502) and X– (J501) are both changing and are sometimes at the same voltage (approximately 100 V) when horizontal deflection pin voltages are observed with an oscilloscope.
NO
X+ and X– can be set to approximately 100 V in X-Y mode with the H-POSITION knob.
NO
Check Q501 to Q507 and related parts (5).
YES
YES
There is input signal on D613 anode (6).
NO
Check IC401 pin 8 (4).
Check IC401 to IC403, Q412 to Q421, and related parts (4).
YES
Signal is output on R612 (6).
NO
Check Q601, Q602, and related parts (6).
YES
Check D606 to D611, Q603 to Q605, and related parts (6). Cathode voltage is –1.95 kV ±50 V.
⟹ Intensity malfunction
Trace disappears when the INTEN knob is turned counter clockwise.
NO
YES
Q601 (6) emitter voltage changes when INTENSITY is turned.
NO
Check Z AMP (6).
YES
D609 (6) cathode voltage is higher than Q601 emitter voltage.
NO
Check R607, R617, R618, C605, C607, C608, D609, and D610 6).
YES
Voltage at J608 pin 3 (6) is normal.
Check Q604, Q605, R640, R641, R639, and D605 (6).
YES
Check R619, C607, C608, D608, A611, C609, NE601, and NE602 around the CRT grid.
A


A
Trace becomes sharply when FOCUS is turned after INTEN is returned to normal brightness.
NO
Check R641, R607, J607 (#2), P606, J606 (#5), and related parts ([6]).
YES
Both traces move up and down when CH1 and CH2 V POSITION are turned.
NO
Check the PREAMP of channel that does not move, R064 and R164 ([7]) of MAINAMP, and D201 to D208 ([2]).
POSITION malfunction
YES
Trace moves horizontally when HORIZONTAL POSITION and FINE are turned.
NO
Check R514 ([5]).
YES
CAL signal can be observed when CAL OUT (0.3 V) output is applied to CH1.
Check Q420 ([4]).
YES
A waveform appears on the screen when signal (sine wave or square wave) within bandwidth is applied to CH1.
NO
The following are steps for CH1, but they also apply to CH2.
YES
Signal is output at Q002 pin 3 ([1]).
NO
Signal is output at R008 and R009 ([1]) connection.
NO
Check J001, S001, and S002.
Signal is output at the base of Q007 and Q008.
NO
Check R009, Q001, and Q002.
Check Q007, Q008, Q201, Q202, and D201 to D204.
Check Q002, IC001, Q003, Q004, Q005, Q006, Q007, and Q008.
*2



Note 1: (N) denotes circuit number.

1 : Attenuator & vertical preamplifier
2 : Vertical main amplifier
3 : Trigger amplifier & vertical mode control
4 : Trigger & sweep generator
5 : Timing & horizontal amplifier
6 : Z axis amprifier & CRT circuit
7 : Power supply

Note 2: Refer to figure 5-3 for printed circuit board N.

Performance Check and Calibration

Period of Check and Calibration

Since the performance of this instrument is subjected to aging variation, periodical check and calibration of the device is required.

If the instrument is used frequently, a check and calibration will be required after each 1000 hours, but the interval after the last check and calibration may be prolonged to 6 months, if it not used so frequently.

Instrument Required for Check and Calibration

The following measuring instruments and accessories are required in order to provide a performance check and calibration for this instrument.

1. Digital voltmeter
   - Voltage range: 0 to 300V DC (direct)
     Accuracy: ±0.05% +1 dgt.
     0 to 2kV DC (with high-voltage probe)
     Accuracy: ± 5% +1dgt
     Example: IWATSU VOAC767
2. Oscilloscope
   - Deflection factor: 5 mV/div or more
   - Frequency bandwidth: DC to 20MHz
     Example: IWATSU SS-4211
3. Scope calibrator — Example: IWATSU SC-340
4. Standard signal generator
   - Frequency range: 50 kHz to 20 MHz
   - Output voltage: 80 mVp-p or more (The required output level accuracy must be maintained when the frequency is varied.)
   - Output impedance: 50 Ω
5. Sine wave generator
   - Frequency range: 1kHz to 20 kHz
   - Output voltage: 40 mVp-p or more
     Example: IWATSU FG-330
6. Voltage regulator
7. Passive probe (accessory)
8. BNC-T connector
9. 10 dB attenuator — Example: IWATSU AA-10B
10. 1 : 1 passive prove — Examle: IWATSU 116/117
11. Adjusting driver — Example: Probe adjustment screwdriver, an accessory.

Notes:

1. The performance requirements shown above are the minimum requirements for testing the instruments concerned.
2. Signal input connector of this instrument is the BNC type . If the output connector of a terminator or another test instrument is not BNC type, a conversion connector must be prepared to connect the instrument directly to this oscilloscope.

Table for Check and Calibration Items

In this paragraph, the check and calibration items are enumerated to show the interaction among the items.
When an item which has the interaction for other items is calibrated, those items must be also calibrated. Besides, the check and calibration of the vertical deflection system must be performed in numerical order.

–Power Supply and CRT Circuits–

1. Low Voltage Power Supply
   (Interaction: 2 : to 24)
2. Operating Voltage Range
3. CRT Cathode Voltage
   (Interaction: 4,5, 11, 12, 19, 20, 23, 24, 25)

4. Intensity
5. Focus
6. Parallelness of Trace to Horizontal Graticule Line
7. Pattern Distortion

—Vertical Deflection System—
8. Step Balance
   (Interaction: 9, 10, 11)
9. Variable Balence
10. x 5 MAG Balance
11. Polarity Switching Balance
12. Deflection Factor
    (Interaction: 28)
13. Pulse Response
    (Interaction: 14)
14. Frequency Response
15. Linearity
16. Attenuator Phase

—Calibrator—
17. Output Voltage

—Triggering—
18. Level Centering

—External Horizontal —
19. Position Centering
    (Interaction: 20, 26, 27)
20. Sensitivity
    (Interaction: 19, 26, 27)
21. Pulse Response

—Sweep—
22.Sweep Length
23. Magnifier Centering
24. Sweep Rate
    (Interaction: 25)
25. Sweep Rate at Magnified Sweep

—X-Y Operation—
26. Position Centering
27. Sensitivity
28. Phase Difference

Precautions

The following precautions must be observed before checking and calibrating the performance of this instrument.

1. It is assumed, in this section, that the setting of controls is made in the position descibed in the section concerning "Preparation". Therefore, the controls must be set to the positions given in "Preparation", prior to starting check and calibration of all items or limited to partial ones.
2. Signal outputs of signal generators must be terminated with the rated output impedance (terminator).
3. Since the low power supply voltages are commonly supplied to all circuits, excessive increase in the ripples and voltage error will affect the performance of the circuits. Be sure to check the power supplies before starting the check and calibration of the circuit performance.
4. If a circuit does not operate as descibed, or it does not satisfy the rated performance, troubleshooting is required as given in section of Maintenance. Repeat calibration of the circuit, after repaired.

Preparation

Be sure to complete the prepatation given below before starting the check and calibration.

1. Adjust the ambient temperature within 18°C to 28°C.
2. Set controls as given below before supplying the power to the instrument.

POWER	Off
INTEN	Mid-position
FOCUS	Mid-position
SCALE	Fully clockwise
Vertical MODE	CH1
POLARITY	NORM
POSITION (Vertical)	Push, Mid-position
VOLTS/DIV	5mV
VARIABLE	CAL
AC-GND-DC	DC
POSITION (Horizontal)	Mid-position
TIME/DIV	1 mSEC

VARIABLE	CAL
LEVEL	Push, Mid-position
SWEEP MODE	AUTO
COUPLING	AC (EXT DC)
SOURCE	CH1
SWEEP LENGTH	Push, Fully clockwise

3. Set the Line Voltage Selector located on the rear panel to a connection matched to your line voltage. Connect the power cord on the line receptacle. If the line voltage is out of the voltage range to be covered by the selector, use the voltage requlator to adjust the power supply voltage.
4. Turn on the POWER switch, adjust the intensity of the traces and allow the instrument to warm up for about 15 minutes.

—Power Supply and CRT Circuits—

1. Low Voltage Power Supply

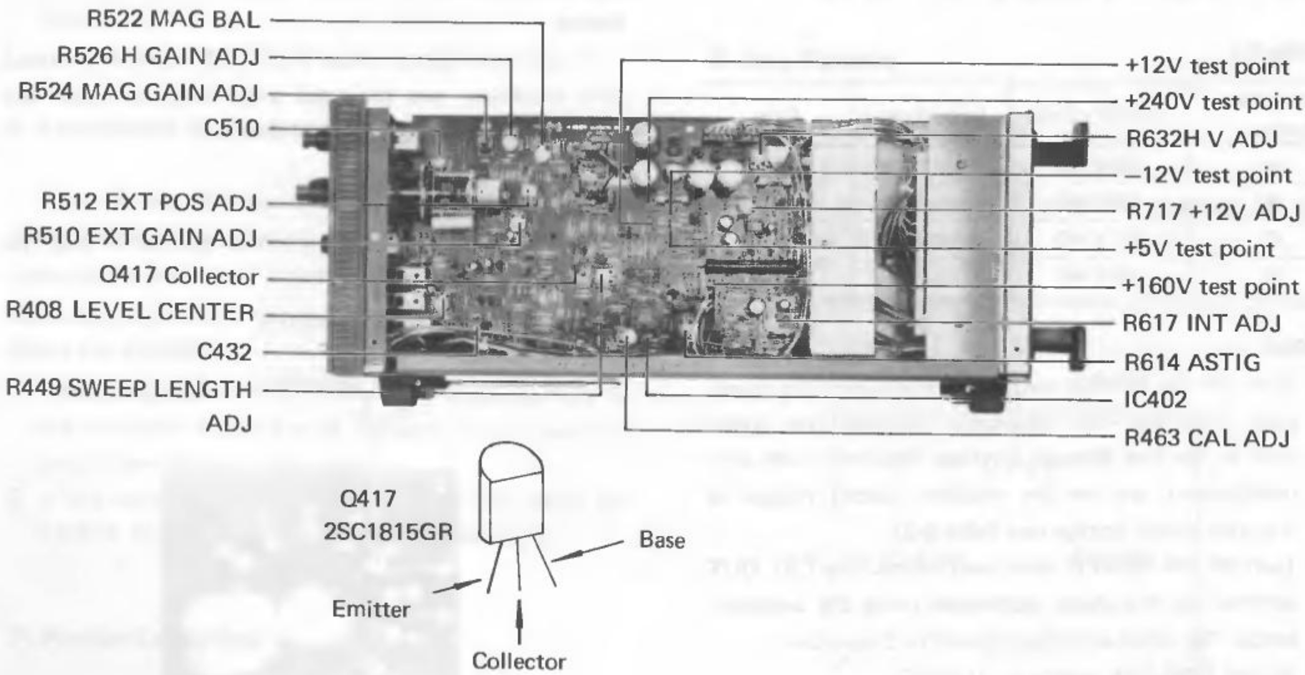
Rating

Output DC voltages and ripple component must be within the range shown in Table 6-1.

Table 6-1

Nominal voltage	Output voltage accuracy	Ripple voltage	Calibration control
+ 5 V	Within ±0.5V	10 mVp-p	——
−12 V	Within ±0.7V	10 mVp-p	——
+12 V	Within ±0.1V	10 mVp-p	R717
+160 V	150 to 170V	——	——
+240 V	240 to 280V	——	——

Figure 6-1. Calibration control and test (right)



Check and Calibration

1. Connect a digital voltmeter between each test point shown in Figure 6-1 and the chassis, and check if the output voltage are within the range given in Table 6-1.
2. If the supply voltage are out of the rating, calibrated +12V circuit by R717 +12V ADJ (see Figure 6-1), and check other output voltage (the Power Supply circuit is designed so that other voltage outputs are in the rated range by no calibration when the calibration of +12V supply is completed).
3. Set the SWEEP MODE switch to NORM to stop the sweep.
4. Check the amplitude of ripple component of each DC line by using a test oscilloscope. Increase the vertical deflection factor of the test oscilloscope to 5 or 10 mV/div and use a 1 : 1 passive probe.

2. Operating Voltage Range

Rating

The display must be sufficiently stable against variation in the operating voltages given in Table 6-2.

Table 6-2

Line voltage selector	Center voltage	Voltage range	Fuse
A	100V AC	90 to 110V	0.5A Slow
B	117V AC	104 to 128V	
C	217V AC	194 to 238V	0.3A Slow
D	234V AC	207 to 257V	

Check

1. Turn off the POWER switch and disconnect the power cord from the line receptacle. Connect the power cord to the line through a voltage regulator (slide auto transformer), and set the regulator output voltage to the rated center voltage (see Table 6-2).
2. Turn on the POWER switch and connect the CAL OUT terminal to the input connector using the accessory probe. The signal amplitude should be 6 divisions.
3. Set the TIME/DIV switch to 10 mSEC.
4. Vary the regulator output voltage continuously within the rated voltage range. Neither ripple nor intensity modulation must appear in the display.

3. CRT Cathode Voltage

Rating

The CRT cathode voltage with respect to the ground must be within −1950 ±50V.

Note: If the CRT cathode voltage is within the rating. this voltage must not be calibrated excepting the following cases.

1. Overall calibration of all items.
2. Calibration of the deflection factor and the sweep rate.

Check and Calibration

1. Check that the CRT cathode voltage is within the rating, by connecting a digital voltmeter (with a high voltage probe) between CRT cathode voltage test point (see Figure 6-2) and chassis.
2. If the voltage is out of the rating, adjust R632 HV ADJ (see Figure 6-1).

4. Intensity

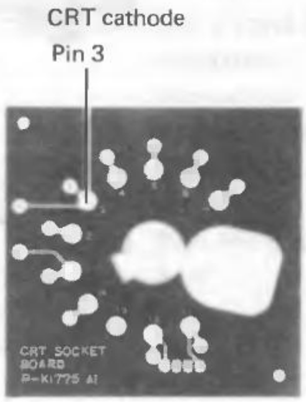
Rating

A spot must appear when the INTEN control is rotated fully clockwise, and the trace must disappear when the control is rotated fully counterclockwise.

Check and Calibration

1. Set the SWEEP MODE switch to NORM to stop the sweep.

Figure 6-2. Voltage of CRT cathode



2. Rotate the INTEN control fully clockwise and check that a spot is visible on the CRT.
3. Start the sweep by setting the SWEEP MODE switch to AUTO.
4. Rotate the INTEN control fully counterclockwise and check that the trace disappear.
5. If above checks reveal unsatisfactory result, adjust R617 INT ADJ (see Figure 6-1).

5. Focus

Check and Calibration

1. Connect the OUTPUT 2 signal of the scope calibrator SC-340 to the INPUT connector and push the SINE WAVE left button of the SC-340.
2. Rotate the VOLTS/DIV switch and the VARIABLE control to set the displayed amplitude to 8 divisions.
3. Adjust the INTEN and FOCUS controls in order to obtain the optimum sharpness of the trace and check that the trace of the waveform on the whole viewing area is sharp.
4. If the trace is not sharp, adjust R614 ASTIG (see Figure 6-1).

6. Parallelness of Trace to Horizontal Graticule Lines

Note: As the parallelness of the trace to a graticule line in somewhat affected by the ground magnetism, check and calibrate the instrument in the actually used position.

Check and Calibration

1. Adjust the vertical POSITION control to see the trace on the horizontal center line of the graticule and check the parallelness of trace to the line.
2. If the trace is not parallel to the center line, adjust the TRACE ROTATION controler on the front panel.

7. Pattern Distortion

Rating

When a raster is fully displayed in the 8 divisions (V) by 10 divisions (H) area, the sides of the raster must be straight not exceeding the limit 0.13 division (vertical) and 0.1 division (horizontal) as shown in Figure 6-2.

Check and Calibration

1. Connect the signal of a sine wave generator to the INPUT connector.
2. Adjust the signal output level to set the displayed amplitude to 8 divisions.
3. Set the signal frequency to approximately 20 kHz and the TIME/DIV switch to 1mSEC so that a raster may be displayed.
4. Check the curvature of the upper and lower ends of the raster from the horizontal lines of the graticule.
5. Adjust the horizontal POSITION control to set the vertical ends of the raster with the left or the right ends of the vertical line, and check the curvature of the raster from the lines.

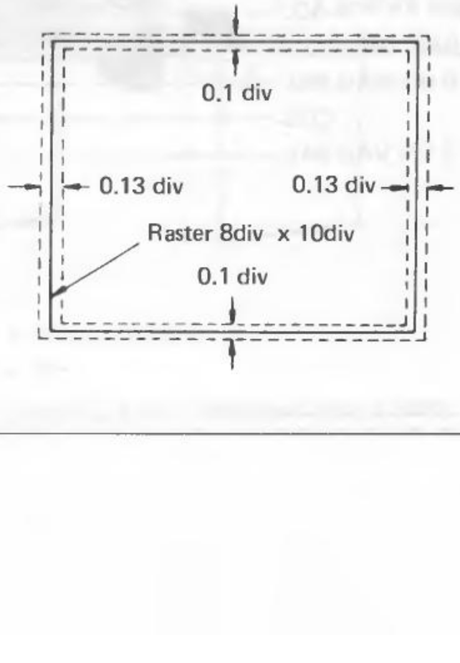
—Vertical Deflection System—

8. Step Balance

Check and Calibration

1. Set the vertical MODE switch to DUAL.
2. Set the traces to vertical center-line graticule by the Vertical POSITION controls.

Figure 6-3. Pattern distortion



3. Rotate the VOLTS/DIV switches of CH1 and CH2 from 5 mV to 20 mV and check the trace shift to the vertical direction.
4. If the traces shift, adjust R013 (CH1)/R113 (CH2) DC BAL (see Figure 6-4).

9. Variable Balance

Check and Calibration

1. Set the Vertical MODE switch to DUAL.
2. Set the traces to vertical center-line graticule by the vertical POSITION controls.
3. Rotate the VARIABLE controls of CH1 and CH2 and check the trace shift to the vertical direction.
4. If the traces shift, adjust R035 (CH1)/R135 (CH2) VAR BAL (see Figure 6-4).

10. x5 MAG Balance

Check and Calibration

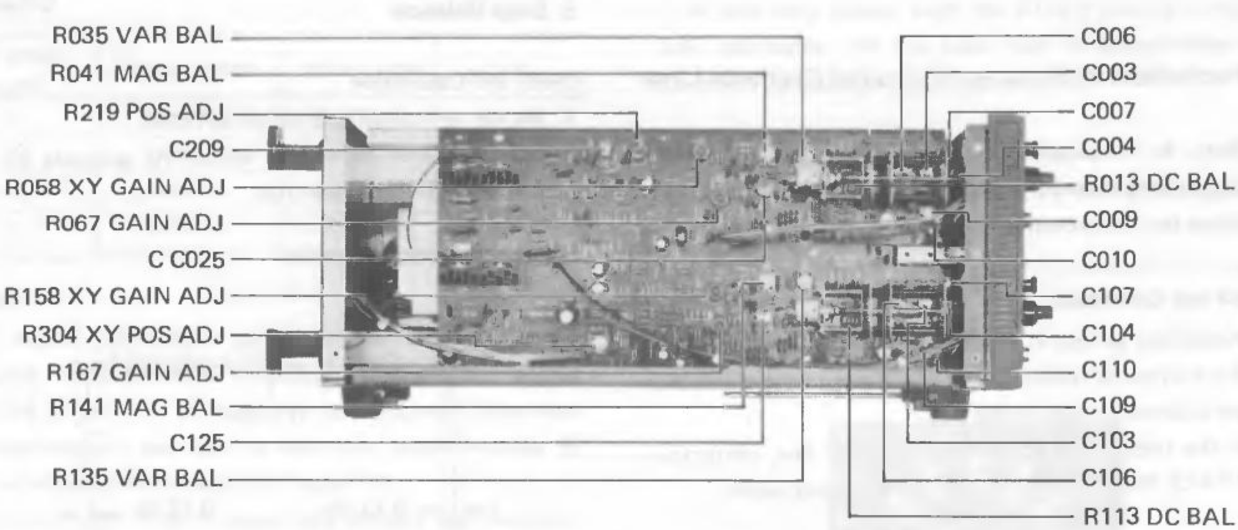
1. Set the vertical MODE switch to DUAL.
2. Set the traces to horizontal center-line graticule by the CH1 and CH2 vertical POSITION controls.
3. The traces are not shifted when the POSITION controls are pushed and pulled.
4. If the traces are shifted, adjust R041 (CH1)/R141(CH2) MAG BAL (see Figure 6-4).

11. POLARITY Switching Balance

Check and Calibration

1. Set the switches as follows:
   Vertical MODE CH2

Figure 6-4. Calibration controls (left)



AC-GND-DC (CH 2)   GND

2. Set the CH 2 trace to horizontal center-line graticule by the CH2 Vertical POSITION control.
3. The trace is not shifted when the POLARITY switch is switched to INV/NORM.
4. If the trace is shifted, adjust R219 POS ADJ (see Figure 6-4).

12. Deflection Factor

Rating

within ±4%

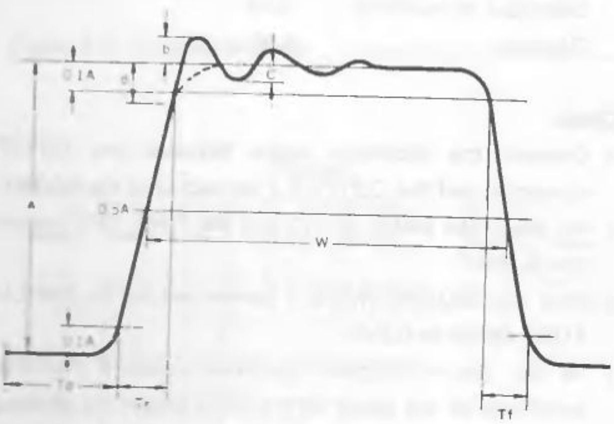
Check and Calibration

1. Connect the OUTPUT 2 signal of the scope calibrator, SC-340 to the INPUT connector.
2. Set the VOLTS/DIV switches to 20mV.
3. Set the controls of the SC-340 as follows:

   SQUARE WAVE 1   Push
   AMPLITUDE   120 mV

4. Shift the display to the center of the viewing area and check if the displayed amplitude is within 6 divisions ± 4%.
5. Check the accuracy of each deflection factor by rotating the VOLTS/DIV and AMPLITUDE switches as shown in Table 6-3.
6. If the accuracy is out of the rating, calibrate it with R067 (CH1)/R167 (CH2) GAIN ADJ (see Figure 6-3).

Figure 6-5. Definition of pulse terms (by MEA-27, Japanese Electric Machinery Industry Association)



A: Basic amplitude   T: Rise time
b/A: Overshoot   Tf: Fall time
c/A: Ringing   d/A: Rounding
W: Pulsewidth   Td: Signal delay time

Table 6-3

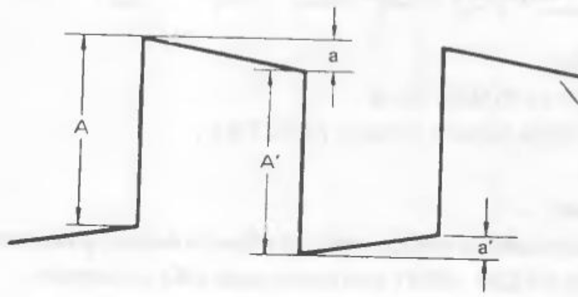
Setting of VOLTS/DIV	Setting of AMPLITUDE	Displayed Amplitude
5	30	6 div ±4%
10 mV	60 mV	6 div ± 4%
20	120	6 div ±4%
50	.3	6 div ± 4%
.1	.6	6 div ± 4%
.2	1 .2	6 div ± 4%
.5 V	3 V	6 div ± 4%
1	6	6 div ± 4%
2	12	6 div ± 4%
5	30	6 div ± 4%
10	60	6 div ± 4%

13. Pulse Response

Rating

Overshoot: 8%
Sag (at 1 kHz):   2%

Figure 6-6. Sag waveform (by MEA-27, Japanese Electric Machinery Industry Association)



A: Basic amplitude
a: Sag
Sag=a/A (or a'/A' whichever large) x 100%

Other distortion: 7%
(In 10 mV/div to 20 m/div and the center 4 divisions of the CRT. Refer to Figures 6-5 and 6-6.)

Check and Calibration

1. Connect the OUTPUT 3 signal of the SC-340 to the INPUT connector using a 10 dB attenuator.
2. Set the controls of the SC-340 as follows:

SQUARE WAVE 2	Push
REPETITION	1 kHz
AMPL	Adjust to set the displyaed amplitude to 4 divisions.

3. Shift the display to the center of the viewing area and check the sag.
4. Set the REPETITION switch to 500 kHz, the TIME/DIV switch to 0.5 μSEC and pull the x5 MAG switch.
5. Check the overshoot and other distortion.
6. If the overshoot exceeds the rating, adjust the following calibration controls (see Figure 6-4).
Note that these controls must be adjusted so that the rising edge of the waveform can rise as sharp as possible while minimizing overshoot, otherwise, frequency response will be affected.

For CH1:	C025
For CH2	C125
Common to CH1 and CH2:	C209

Note: When the above adjustment is made, the frequency response must be checked with the procedure explained in the following item, Frequency Response.

14. Frequency Response

Rating

DC to 20 MHz –3 dB
(In the center 4 divisions of the CRT.)

Check

1. Connect the output signal of a standard signal generator to the CH1 INPUT connector, using 50Ω termination.
2. Set the signal frequency to 50 kHz and adjust the signal output level to set the displayed amplitude to 4 divisions.
3. Shift the display to the center 4 divisions area.
4. Set the signal frequency to 20 MHz and check if the displayed amplitude is 2.83 divisions or more (–3 dB referred to 4 divisions).
5. Check the CH2 as above method.

15. Linearity

Rating

±5% (at 1 kHz)

Check

1. Connect the OUTPUT 2 signal of the SC-340 to the INPUT connector and push the SINE WAVE left button.
2. Rotate the VOLTS/DIV switch and the VARIABLE control to set the displayed amplitude to 2 divisions in the center 2 divisions area.
3. Shift the waveform to the upper/lower of the graticule area until the top/bottom of the waveform reaches the end of the graticule and check that the variation of the display amplitude is whthin 0.1 division (± 5%).

16. Attenuator Phase

Rating

Overshoot or rounding:	±3%
Flatness:	±4%

Check

1. Connect the accessory probe between the INPUT connector and the OUTPUT 2 connector of the SC-340.
2. Set the probe switch to x10 and the TIME /DIV switch to 0.5 mSEC.
3. Push the SQUARE WAVE 1 button and set the AMPLITUDE switch to 0.3V.
4. As the above-mentioned operation allows 6 divisions amplitude of the signal on the CRT, adjust the phasing capacitor of the probe so that the correct phasing can be obtained. (See Figure 6-7.).
5. Set the VOLTS/DIV switch and the AMPLITUDE switch to 50 mV and 3 V respectively and check if the correct phasing is given in the overshoot or rounding and flatness.
6. Similarly, check the phasing in each range of the VOLTS /

DIV switch.

Calibration

Adjust the calibration controls shown in Table 6-4 and Figure 6-

Table 6-4

VOLTS/DIV	CH 1		CH 2	
	Overshoot or rounding	Flat - ness	Overshoot or rounding	Flat-ness
5mV	—	Phase adjuster of probe	—	Phase adjuster of probe
10mV~50mV	C003	C004	0103	C104
0.1V ~0.5V	C006	C007	C106	C107
1V ~10V	C009	C010	C109	C110

—Calibrator—

17. Output Voltage

Rating

0.3V ±3%

Check and Calibration

1. Connect the CAL OUT signal to the INPUT connector.
2. Set the VOLTS/DIV switch to 50 mV and check that the displayed amplitude of the CAL OUT signal is within 6 divisions ±3%.
3. If it is out of the rating, adjust 463 CAL ADJ (see Figure 6-1).

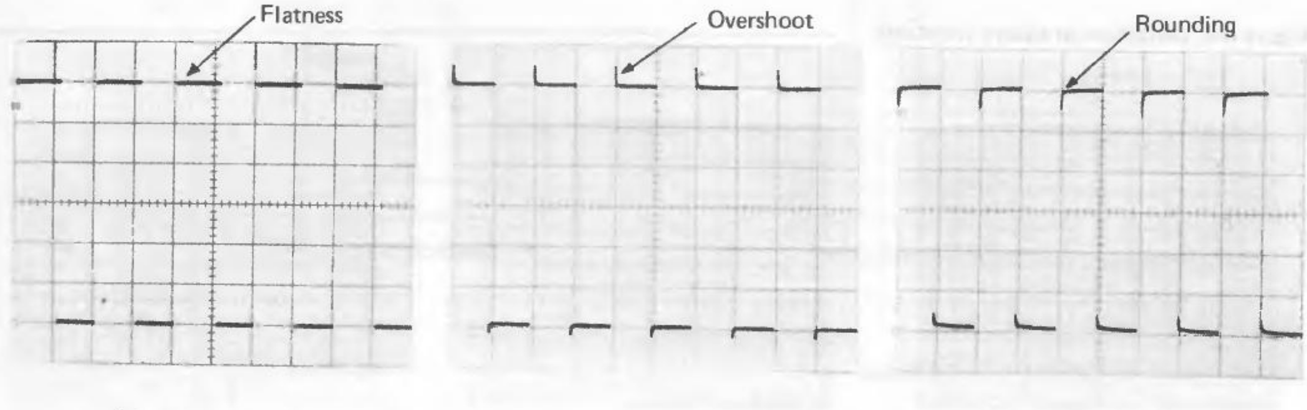
—Triggering—

18. Level Centering

Check and calibration

1. Connect the OUTPUT 2 signal of the SC-340 to the INPUT connector.
2. Push the SINE WAVE left button of the SC-340 and rotate the VOLTS/DIV switch and its VARIABLE control to set the displayed amplitude to 6 divisions.
3. Shift the display to the center 6 divisions of the graticule.
4. Allow the triggering by setting the LEVEL/SCOPE control to the mid-range.
5. Repeat the push-pull switching of the LEVEL/SLOPE control and check if the sweep start points of positive-

Figure 6-7. Attenuator phase



(a) Correct phasing (b) Incorrect (over-compensation) (c) Incorrect (poor compensation)

going and negative-going slopes are positioned on the horizontal center line of the graticule.
6. If the start points deviate from the center line, adjust R408 LEVEL CENTER (see Figure 6-1).

—External Horizontal—

19. POSITION Center

Check and Calibration

1. Set the SOURCE switch to EXT.
2. Set the start point of the trace to the left-end of the vertical graticule when the TIME/DIV switch is set to 1 mSEC.
3. Spot is appeared at center of vertical graticule when the TIME/DIV switch is switched to X-Y.
4. If the spot is not appeared at center of vertical graticule, adjust R512 EXT POS (see Figure 6-1).

20. Sensitivity

Rating

0.5V/div within ±5%

Check and Calibration

1. Set the TIME/DIV and SOURCE switches to X-Y and EXT.
2. Connect the OUTPUT 2 signal of the SC-340 to the HORIZ IN connector.
3. Set the controls of the SC-340 as follows and check if the trace length is within 6 divisions ±0.3 division.

SQUARE WAVE 1	Push
AMPLITUDE	3V

4. If the error is large, adjust R510 EXT GAIN (see Figure 6-1).

21. Square Wave-form Response

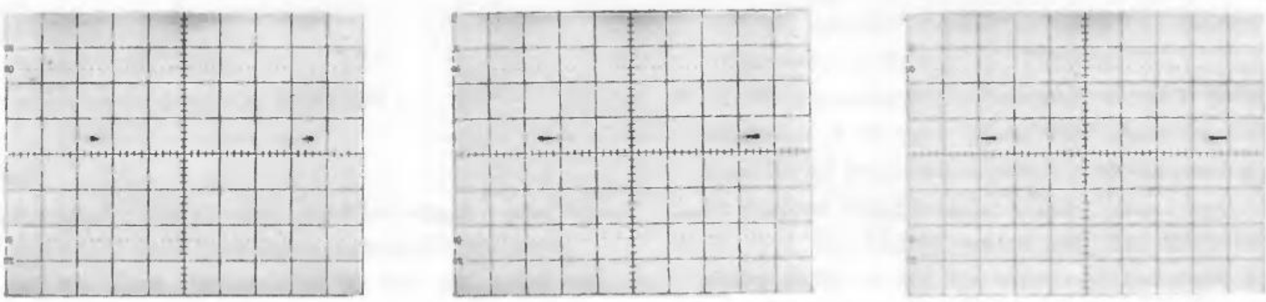
Check and Calibration

1. Set the switches as follows:

SOURCE	EXT
TIME/DIV	X–Y

2. Connect the OUTPUT 3 signal of the SC-340 to the HORIZ IN connector.
3. Push the SQUARE WAVE 2 button of the SC-340 and set the REPETITION switch to 20 kHz.
4. Adjust the AMPL control of the SC-340 and display the trace horizontally to 6 divisions at center of the CRT screen.
5. Check if the waveform is correctly displayed as shown in Figure 6-8 (a).
6. If the waveform is displayed as shown inFigure 6-8 (b) or (c), adjust C432 (see Figure 6-1).

Figure 6-8. Distortion of square waveform



(a) (b) (c)

—Horizontal Deflection System—

22. Sweep Length

Check and Calibration

1. Set the TIME/DIV switch to 1 mSEC and its VARIABLE control to CAL.
2. Push the PULSE TRAIN left button of the SC-340 and connect the OUTPUT 2 signal to the INPUT connector.
3. Set the REPETITION switch to 0.5 mSEC and check if 22 pulses are displayed on the CRT.
4. If the error is large, adjust R449 SWEEP LENGTH ADJ (see Figure 6-1).

23. Magnifier Centering

Check and Calibration

1. Connect the CAL OUT signal to the INPUT connector.
2. Set the start point of the display (rising of the CAL OUT signal) to the vertical center line of the graticule with the horizontal POSITION control.
3. Pull the PULL x5 MAG switch and check if the start point shifts from the vertical center line.
4. If the start point shifts excessively, set the start point of the magnified sweep correctly to the vertical center line with the horizontal POSITION control. Next push the PULL x5 MAG switch and adjust R522 MAG BAL (see Figure. 6-1) so that the start point of the unmagnified sweep is positioned to vertical center line correctly.

24. Sweep Rate

Rating

Accuracy I (over center 8 divisions):

0.5μS/div to 5mS/div:	± 4%
10mS/div to 0.2S/div:	±5%

Accuracy II (over any 2 divisions within center 8 division): ±10%

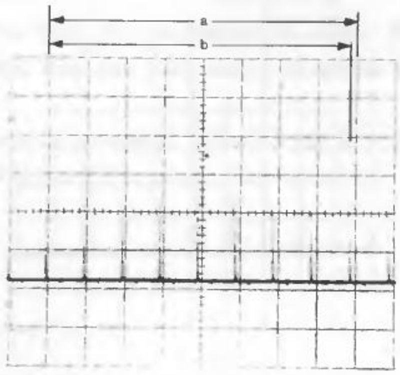
Check

1. Connect the OUTPUT 2 signal of the SC-340 to the INPUT connector.
2. Set the controls of the SC-340 as follows:

PULSE TRAIN	Push the left button
REPETITION	1 mSEC

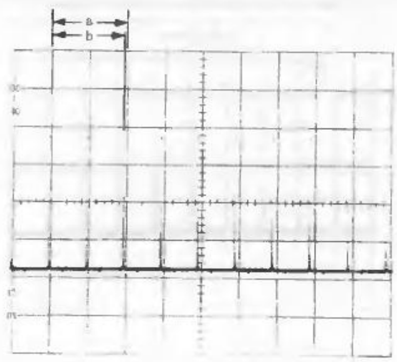
3. Allow triggering and check the accuracy I and II (see Figure 6-9).
4. Repeat the same check of the accuracy for different

Figure 6-9. Sweep rate error



$$\text{Error rate} = \frac{a-b}{a} \times 100\ (\%)$$

where a: Horizontal effective scale (8 div)
b: Measured value of pulse train corresponding to a.



$$\text{Error rate} = \frac{a-b}{a} \times 100\ (\%)$$

where a: Any 2 divisions of effective scale
b: Measured value of pulse train corresponding to a.

combinations of the settings between the TIME/DIV and REPETITION switches.

Calibration

1. Calibrate the accuracy for ranges from 0.2 S/div to 50μS/div with R526H GAIN ADJ (see Figure 6-1).
2. Calibrate the accuracy for ranges from 20μS/div to 0.5μS/div with C510 (see Figure 6-1).

25. Sweep Rate Magnified Sweep

Rating

Accuracy I (over center 8 divisions): ±5%

0.1μS/div to 1mS/div : ±5%

2mS/div to 40mS/div : ±7%

Accuracy II (over any 2 divitions within center 8 divisions):

0.1 μS/div to 1mS/div: ±15%

2mS/div to 40mS/div: ±10%

Note: The above-mentioned accuracy is rated excepting 300 ns from the start point and end of the sweep.

Check

1. After the check procedure explained in "Sweep Rate", set the TIME/DIV and RETITION switches to 0.2 mSEC and shift the start pulse to the left end of the graticule.
2. Set the TIME/DIV switch to 1 mSEC and pull the PULL x5 MAG switch.
3. Check the accuracy I and II (see Figure 6-10).
4. Repeat the same check of the accuracy for different combinations of the settings between the TIME/DIV and REPETITION switches.

Calibration

If the error is large, adjus the magnified sweep rate with R524 MAG GAIN ADJ (see Figure 6-1).

—X-Y Scope —

26. POSITION Center

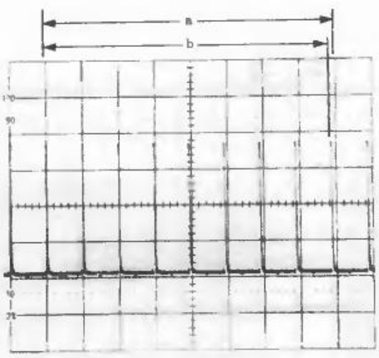
Check and Calibration

1. Set the switches as follows:

TIME/DIV	X-Y
SOURCE	EXT

2. The spot is appeared at center of vertical graticule.
3. The spot is not shifted by switching the SOURCE switch to CH2.

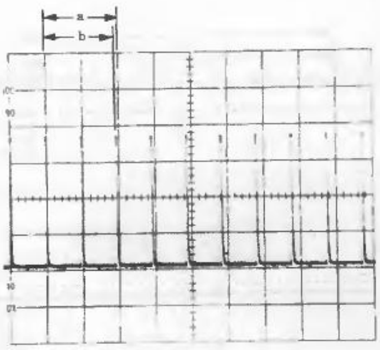
Figure 6-10. Sweep rate error at magnified sweep



Error rate = $\frac{a-b}{a}$ x 100 (%)

where a: Horizontal effective scale (8 div)

b: Measured value of pulse train corresponding to a.



Error rate = $\frac{a-b}{a}$ x 100 (%)

where a: Any 2 divisions of effective scale

b: Measured value of pulse train corresponding to a.

4. If the spot is shifted by above methode, adjust R 304 X-Y POS ADJ (see Figure 6-4).

27. Sensitivity

Rating

± 5%

± 7% (When the PULL x5 MAG switch is pulled)

Check and Calibration

1. Set the control as follows:

Vertical MODE	CH2
TIME/DIV	X-Y
SOURCE	CH1
VOLTS/DIV (CH1,CH2)	20mV

2. Connect the OUTPUT 2 signal of the SC-340 to the CH1 INPUT connector and set the SC-340 controls as follows:

SQUARE WAVE 1	Push
AMPLITUDE	120mV

3. Shift the trace to the vertical center 6 divisions and check that the trace length is within 6 divisions ± 5%.
4. If the error is large, adjust R058 X-Y GAIN ADJ(see Figure 6-4).
5. Connect the OUTPUT 2 signal to the CH2 INPUT connector.
6. Set the controls as follows:

Vertical MODE	CH1
SOURCE	CH2

7. Shift the trace to the horizontal center 6 divisions and check that the trace length is within 6 divisions ± 0.5%.

   If the accuracy is poor, adjust R158 X-Y GAIN (see Figure 6-4).

28. Phase

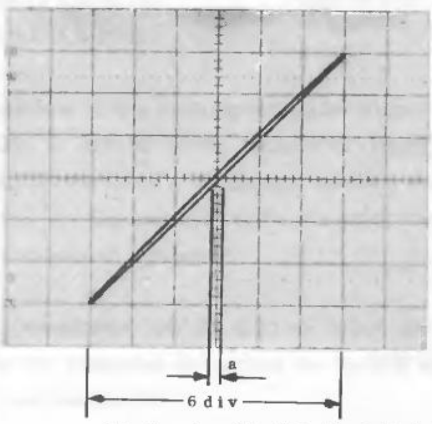
Rating

Withing 3°(for DC to 20 kHz sine wave)

Check

1. Set the controls as given at the item 1 of the sensitivity check and calibration.
2. Connect the signal of a sine wave generator to the CH1 INPUT and CH2 INPUT connectors by using a BNC-T connector.
3. Set the signal frequency to 20 kHz, and adjust the signal output level to set the horizontal amplitude of the Lissajou's pattern to 6 divisions.
4. Check the width "a" in Figure 6-11 which must be smaller than 0.3 division.

Figure 6-11. X - Y phase difference



a ; Opening at horizontal center line

Schematic Diagrams

Voltage and Waveforms

In the schematic diagrams, the voltages and waveforms in the normal acting of the instrument are shown. These voltage and waveforms are useful for troubleshooting.

The voltages and waveforms are measured by the following condition.

1. The CAL 0.3V signal is connected to the input connector as the test signal. For this connection, the following probes are used.
   For connections to Channel 1 and Channel 2 input connectors: 10 : 1 passive probe.

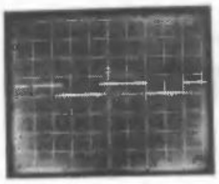
2. The switches and controls of this instrument are set as follows;

POWER	On
INTEN	Mid position
FOCUS	Mid-position
SCALE	Arbitrary position
V MODE	CH1
AC-GND-DC (CH1, 2)	DC
VOLTS/DIV (CH1, 2)	10mV
VARIABLE (CH1, 2)	CAL
POSITION (CH1, 2) (PULL x 5 MAG)	Push, adjust to set the waveform to the center of the graticule area.
CH2 POLARITY	NORM (■)
SWEEP MODE	AUTO
COUPLING	AC
SOURCE	CH1
LEVEL-SLOPE	Push, mid-position
TIME/DIV	1mSEC
VARIABLE	CAL
POSITION	Adjust to set the start point of the waveform to the left end of the graticule area.
SWEEP LENGTH (PULL X 5 MAG)	Push, mid-position

3. Exceptions in the controls setting are shown by "VOLTAGE & WAVEFORM READING CONDITIONS" noted on the schematic diagram. Besides, the asterisks marked on the diagrams show the point measured by the exceptional settings.

4. The waveforms which starting from the negative slope are measured by setting the SLOPE switch of a test oscilloscope to–.

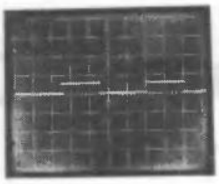
①



30mV 0V

0.2mS

②

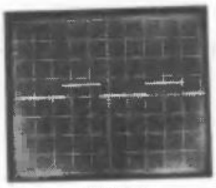


60mV ≈+2.2V

0.2mS

AC COUPLED

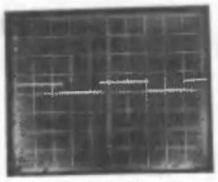
③



0.3V ≈–4.2V

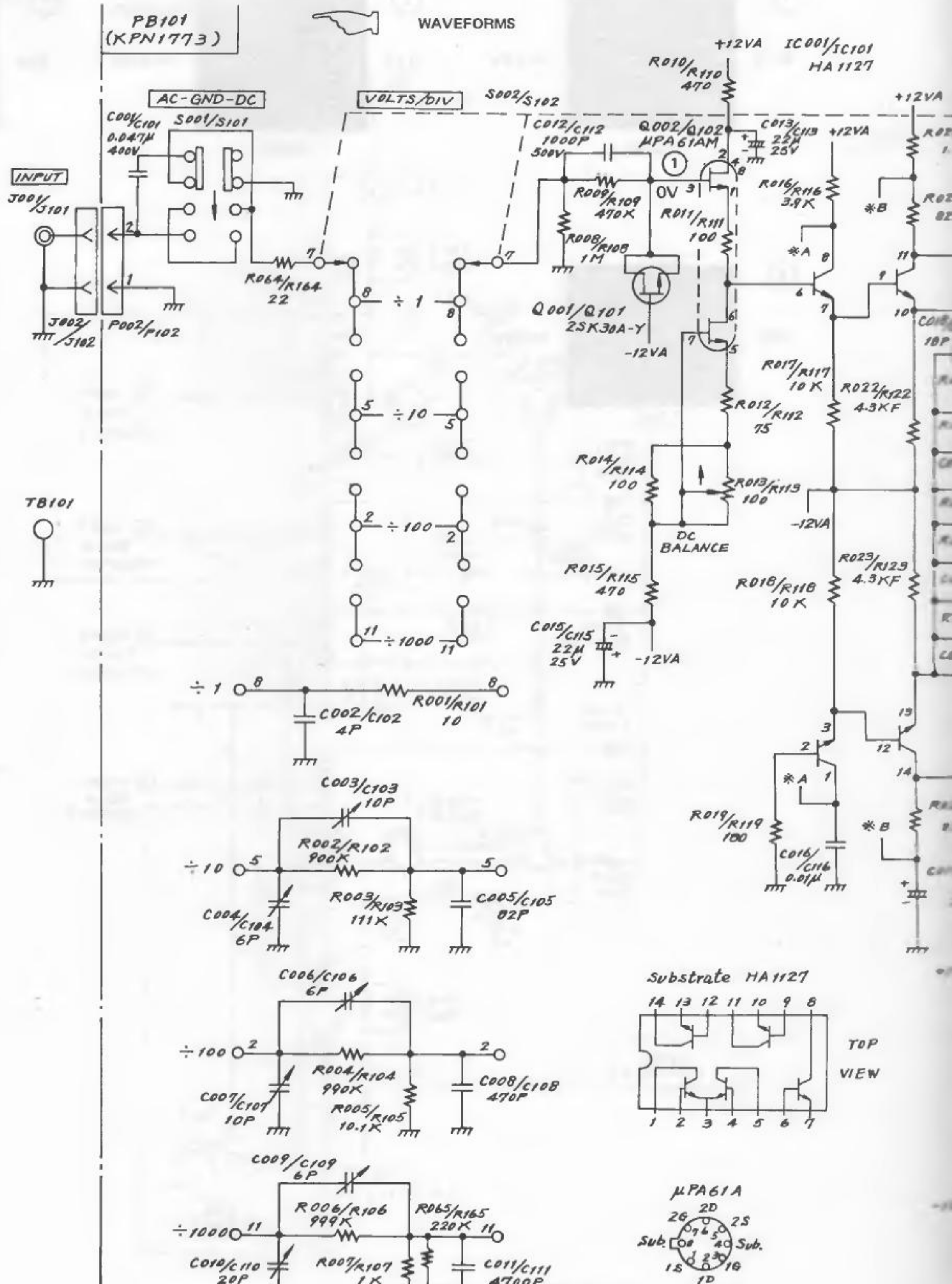
0.2mS

④

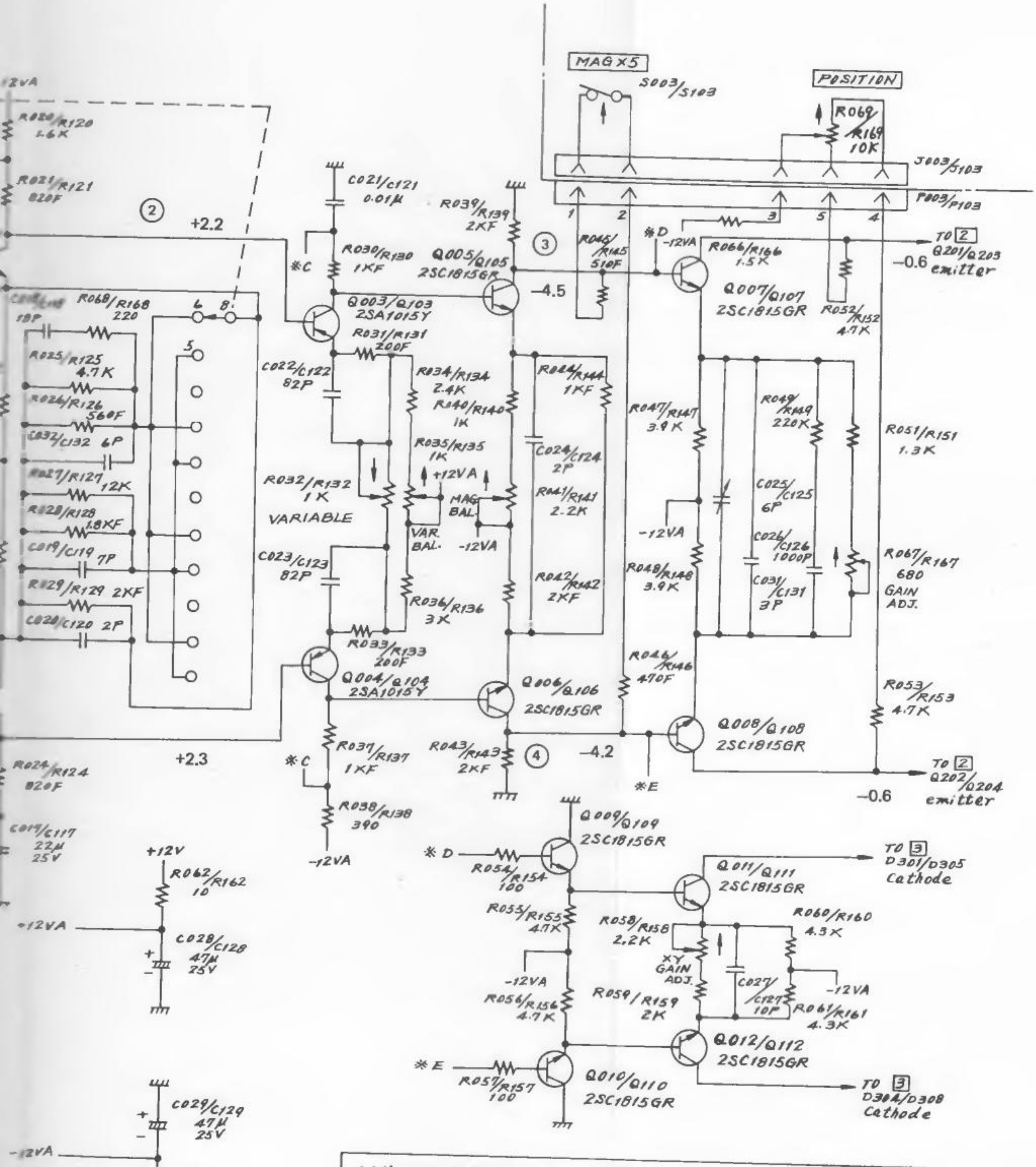


0.2V ≈–4V

0.2mS



PB101
(KPN1773)
WAVEFORMS
INPUT
J001/J101
J002/J102
P002/P102
AC-GND-DC
S001/S101
C001/C101 0.047μ 400V
VOLTS/DIV
S002/S102
R064/R164 22
÷1
÷10
÷100
÷1000
TB101
+12VA
IC001/IC101 HA1127
R010/R110 470
C012/C112 1000P 500V
Q002/Q102 μPA61AM
C013/C113 22μ 25V
R009/R109 470K
0V
R011/R111 100
R008/R108 1M
Q001/Q101 2SK30A-Y
-12VA
R016/R116 3.9K
R017/R117 10K
R022/R122 4.3KF
R012/R112 75
R014/R114 100
R013/R113 100
DC BALANCE
R015/R115 470
C015/C115 22μ 25V
R023/R123 4.3KF
R018/R118 10K
R019/R119 180
C016/C116 0.01μ
R001/R101 10
C002/C102 4P
C003/C103 10P
R002/R102 900K
R003/R103 111K
C004/C104 6P
C005/C105 82P
C006/C106 6P
R004/R104 990K
C007/C107 10P
R005/R105 10.1K
C008/C108 470P
C009/C109 6P
R006/R106 999K
R065/R165 220K
C010/C110 20P
R007/R107 1K
C011/C111 4700P
C030/C130 1000P
Substrate HA1127
TOP VIEW
μPA61A
TOP VIEW



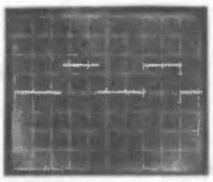
Q201, Q202, D301, D304, R0** C0** Q0** etc are used to Dual-Trace display.

SS-5702

ATTENUATOR & VERTICAL PREAMPLIFIER 1

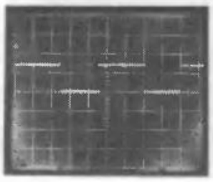
K-607133 2

①

0.7V

≈–0.5V

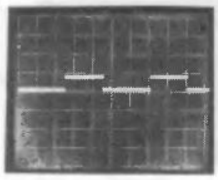
0.2mS

②

0.7V

≈–0.3V

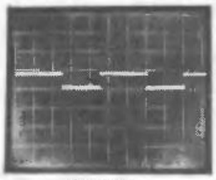
0.2mS

③

35V

≈+55V

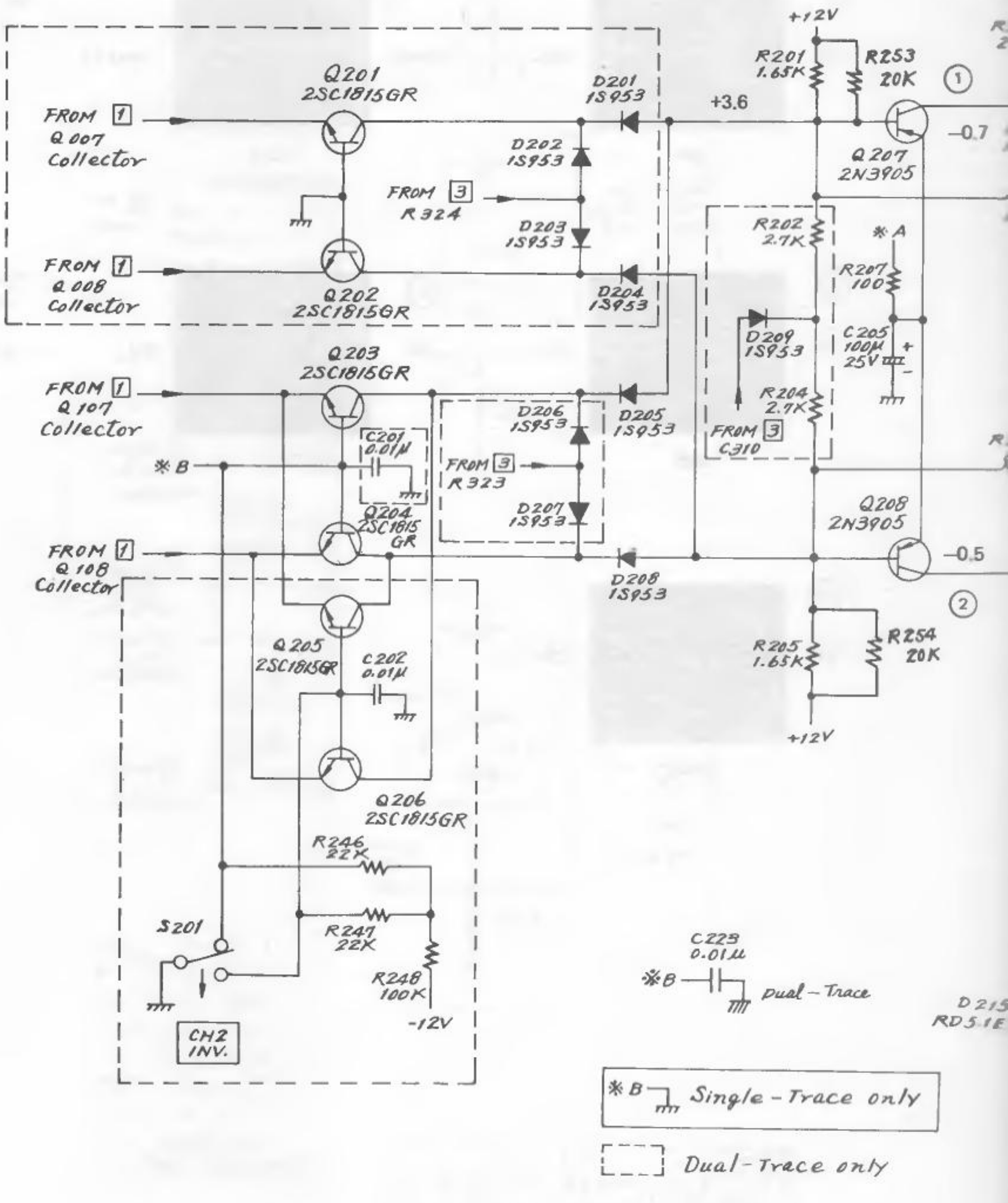
0.2mS

④

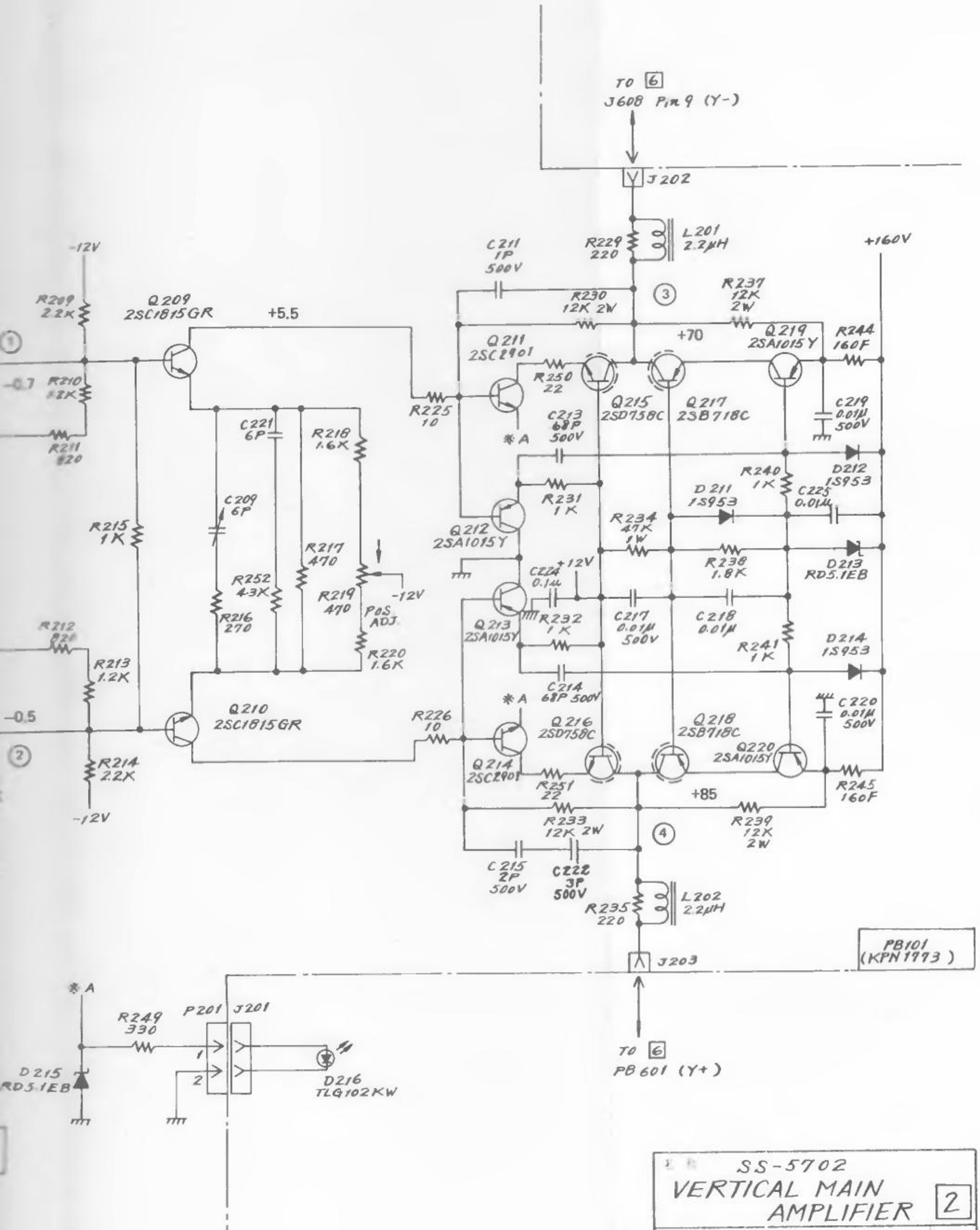
35V

≈+60V

0.2mS

WAVEFORMS



+12V
R201
1.65K
R253
20K
Q201
2SC1815GR
D201
1S953
+3.6
FROM 1
Q007
Collector
D202
1S953
Q207
2N3905
-0.7
FROM 3
R324
D203
1S953
R202
2.7K
※A
R207
100
FROM 1
Q008
Collector
Q202
2SC1815GR
D204
1S953
D209
1S953
C205
100μ
25V
Q203
2SC1815GR
R204
2.7K
FROM 1
Q107
Collector
D206
1S953
D205
1S953
FROM 3
C310
※B
C201
0.01μ
FROM 3
R323
Q204
2SC1815
GR
D207
1S953
Q208
2N3905
FROM 1
Q108
Collector
D208
1S953
-0.5
Q205
2SC1815GR
C202
0.01μ
R205
1.65K
R254
20K
+12V
Q206
2SC1815GR
R246
22K
S201
R247
22K
R248
100K
-12V
CH2
INV.
C223
0.01μ
※B
Dual-Trace
D215
RD5.1E
※B Single-Trace only
Dual-Trace only

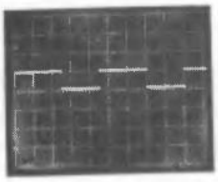


SS-5702

VERTICAL MAIN AMPLIFIER 2

K-607134 3

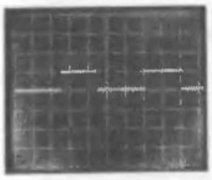
* ① 0.1V



≈–2.8V

0.2mS
AC COUPLED

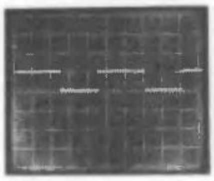
② 0.1V



≈–2.9V

0.2mS
AC COUPLED

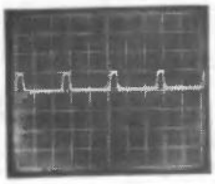
③ 1V



0V

0.2mS

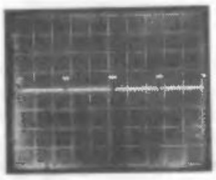
* ④ 9V



0V

2μS

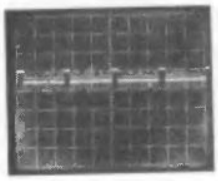
⑤ 30mV



≈+0.7V

5mS
AC COUPLED

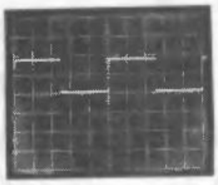
* ⑥ 1V



0V

5mS

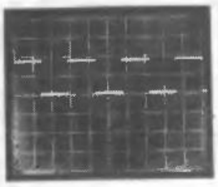
* ⑦ 9V



0V

2μS

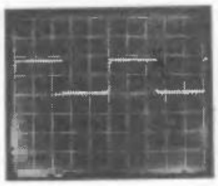
** ⑧ 9V



0V

5mS

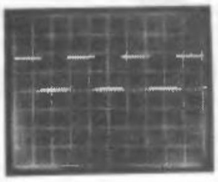
* ⑨ 9V



0V

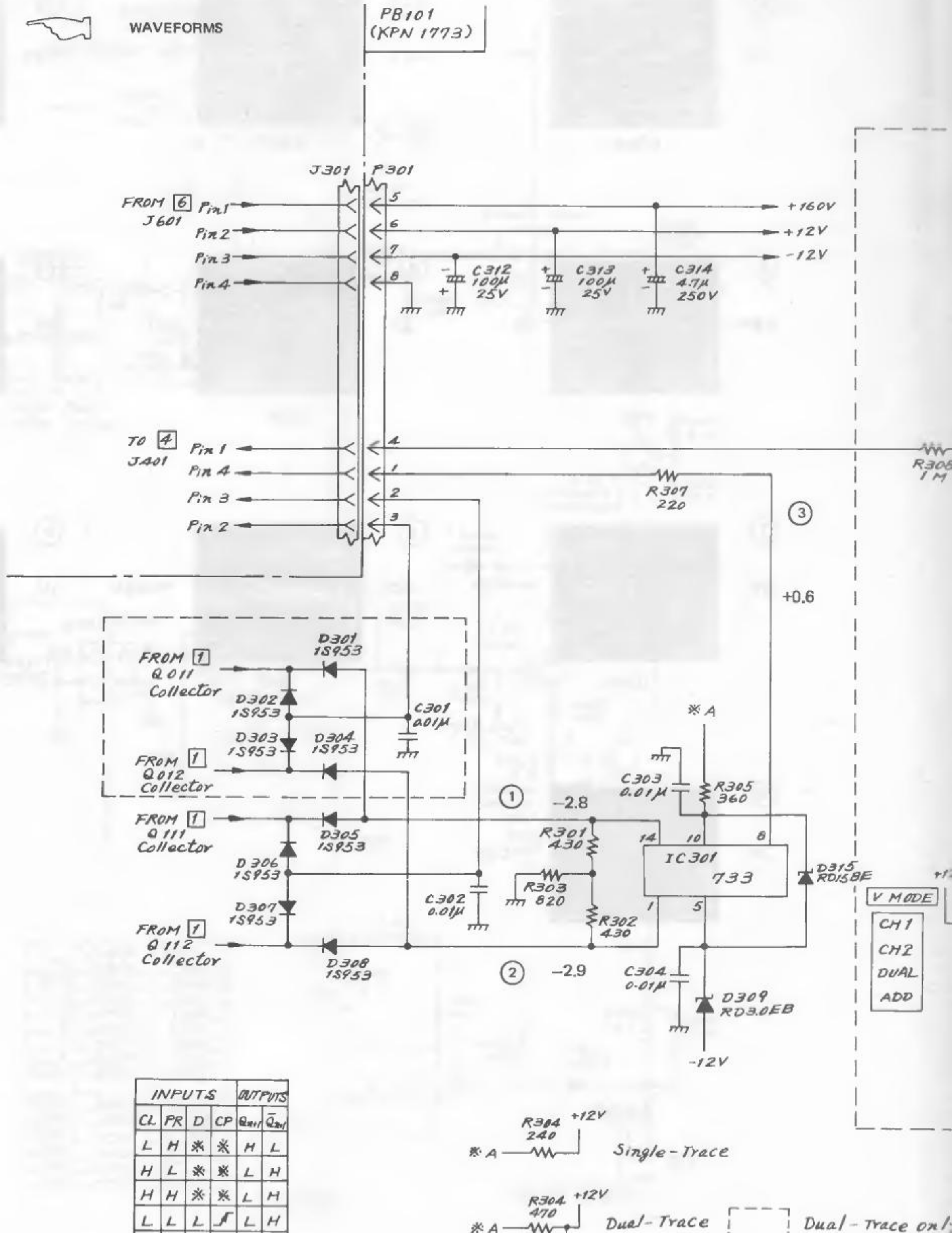
2μS

** ⑩ 9V

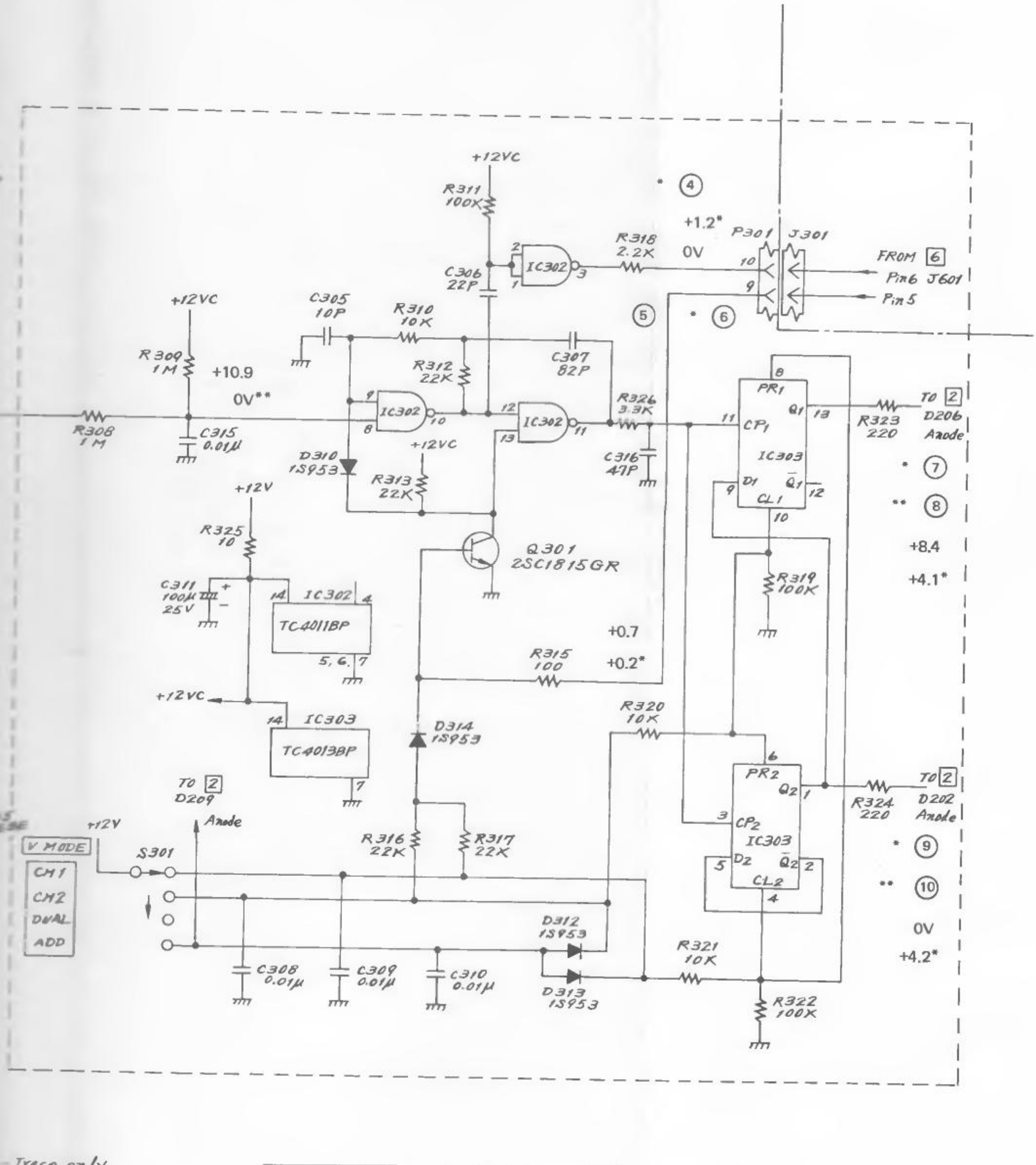


0V

5mS



INPUTS				OUTPUTS		
CL	PR	D	CP	Q_{311}	$\bar{Q}_{301}$	
L	H	※	※	H	L	
H	L	※	※	L	H	
H	H	※	※	L	H	
L	L	L	↑	L	H	
L	L	H	↑	H	L	
L	L	※	↓	Qn	$\bar{Q}n$	NO CHANGE



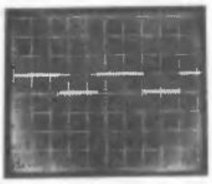
– Trace only

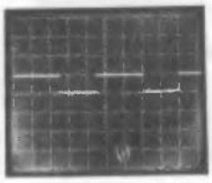
VOLTAGE & WAVEFORM READING CONDITIONS	
*V MODE	DUAL
**V MODE	DUAL
TIME/DIV	0.5mSEC

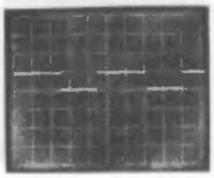
SS-5702

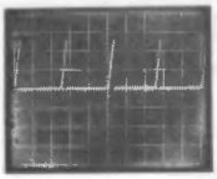
TRIGGER AMPLIFIER & VERTICAL MODE CONTROL 3

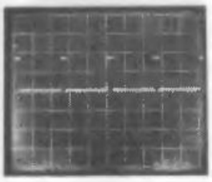
K-607135 2

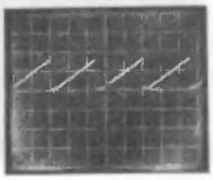
① 1V

0V
0.2mS

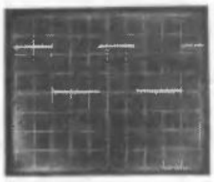
② 0.9V

0V
0.2mS

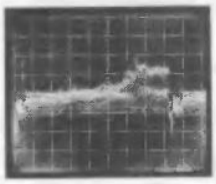
③ 4.5V

≈+2V
0.2mS

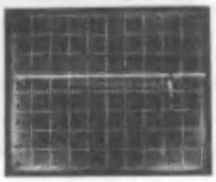
④ 0.5V

0V
5mS

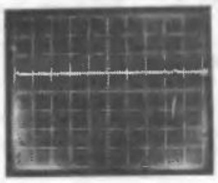
⑤ 3V

0V
5mS

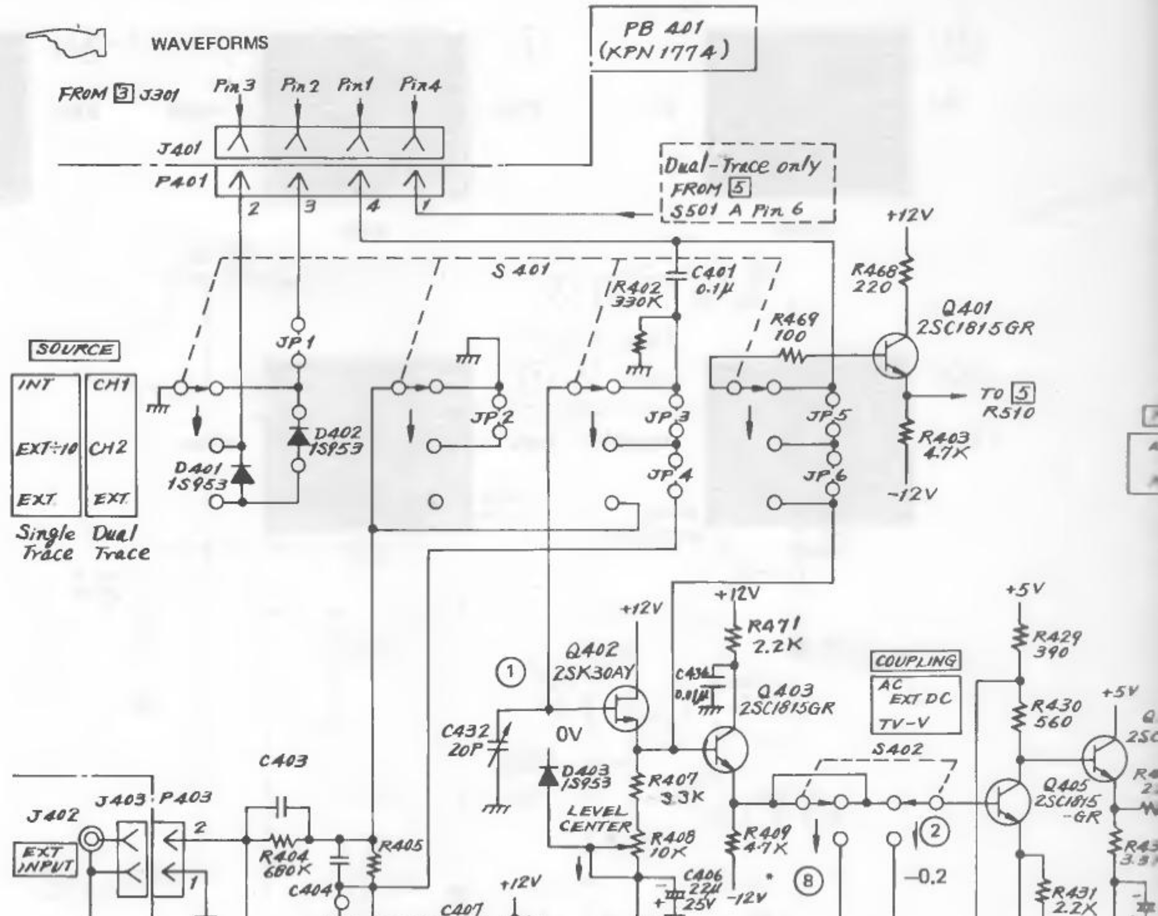
⑥ 8V

≈+3V
5mS

⑦ 5V

≈+0.2V
0.2mS

• ⑧ 0.2V

≈−0.6V
2mS

• ⑨ 1V

0V
2mS

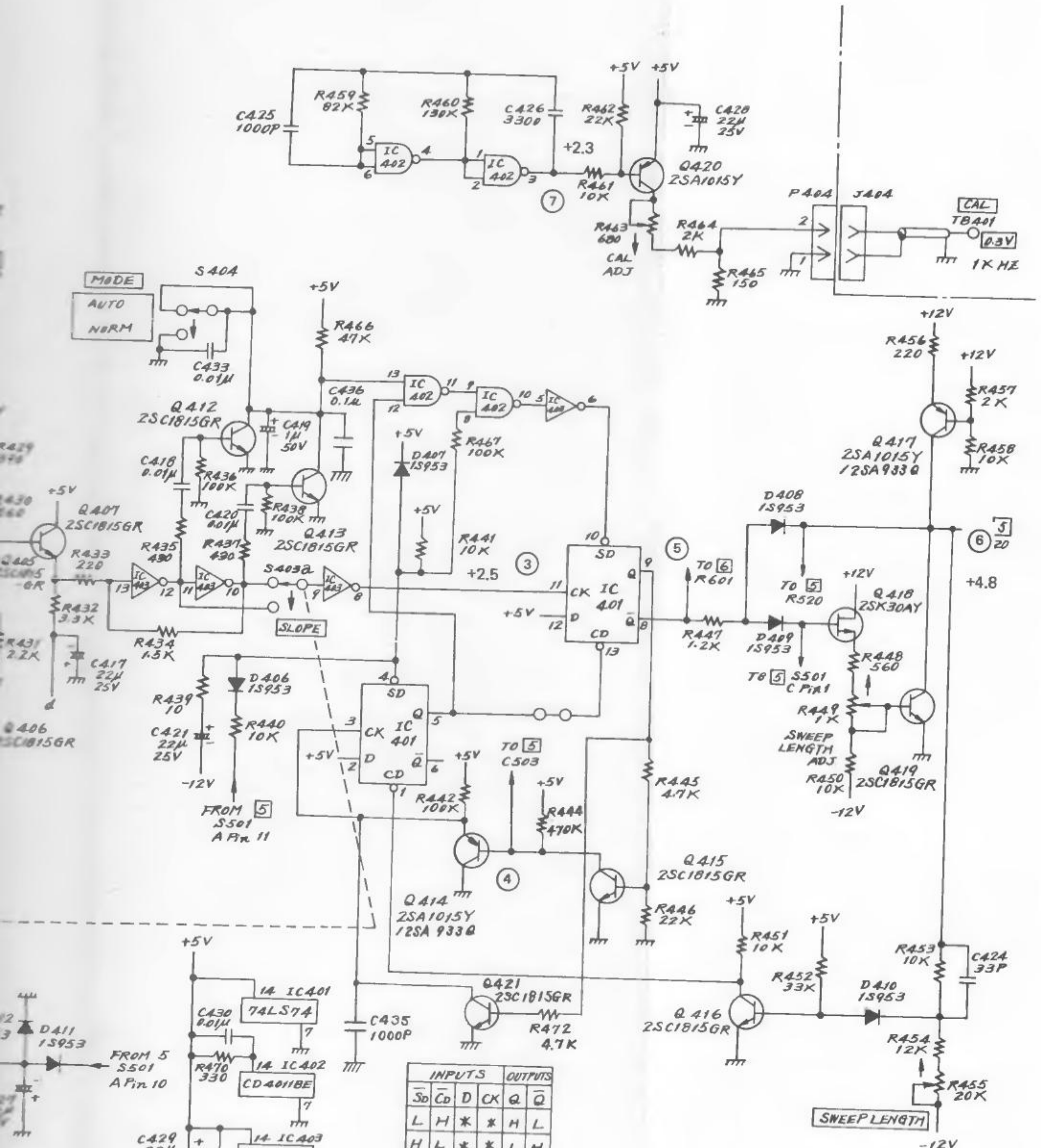
• ⑩ 2V

≈+0.6V
2mS



	Single Trace	Dual Trace
JP 1	OPEN	SHORT
2	OPEN	SHORT
3	OPEN	SHORT
4	SHORT	OPEN
5	OPEN	SHORT
6	SHORT	OPEN
D402	OPEN	1S953
R405	300KΩ	330KΩ
406	33KΩ	0Ω
C402	——	2P 500V
403	——	33P 500V
404	——	39P
405	——	SHORT

VOLTAGE & WAVEFORM READING CONDITIONS

*COUPLING .... TV–V



INPUTS				OUTPUTS	
$\overline{SD}$	$\overline{CD}$	D	CK	Q	$\overline{Q}$
L	H	*	*	H	L
H	L	*	*	L	H
L	L	*	*	H	H
H	H	H	∫	H	L
H	H	L	∫	L	H
H	H	*	L	Q_0	$\overline{Q}_0$

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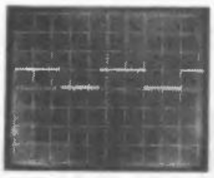
TRIGGER & SWEEP GENERATOR 4

K-607136 3

(1)

1V

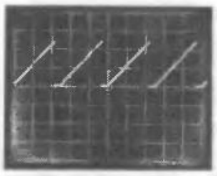


0V

0.2mS

(2)

120V

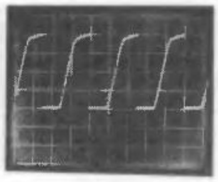


≈+50V

5mS

* (3)

200V

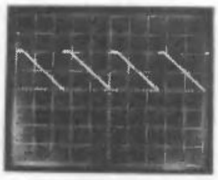


≈+20V

5mS

(4)

100V

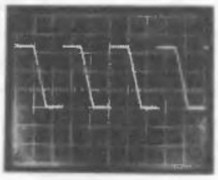


≈+50V

5mS

* (5)

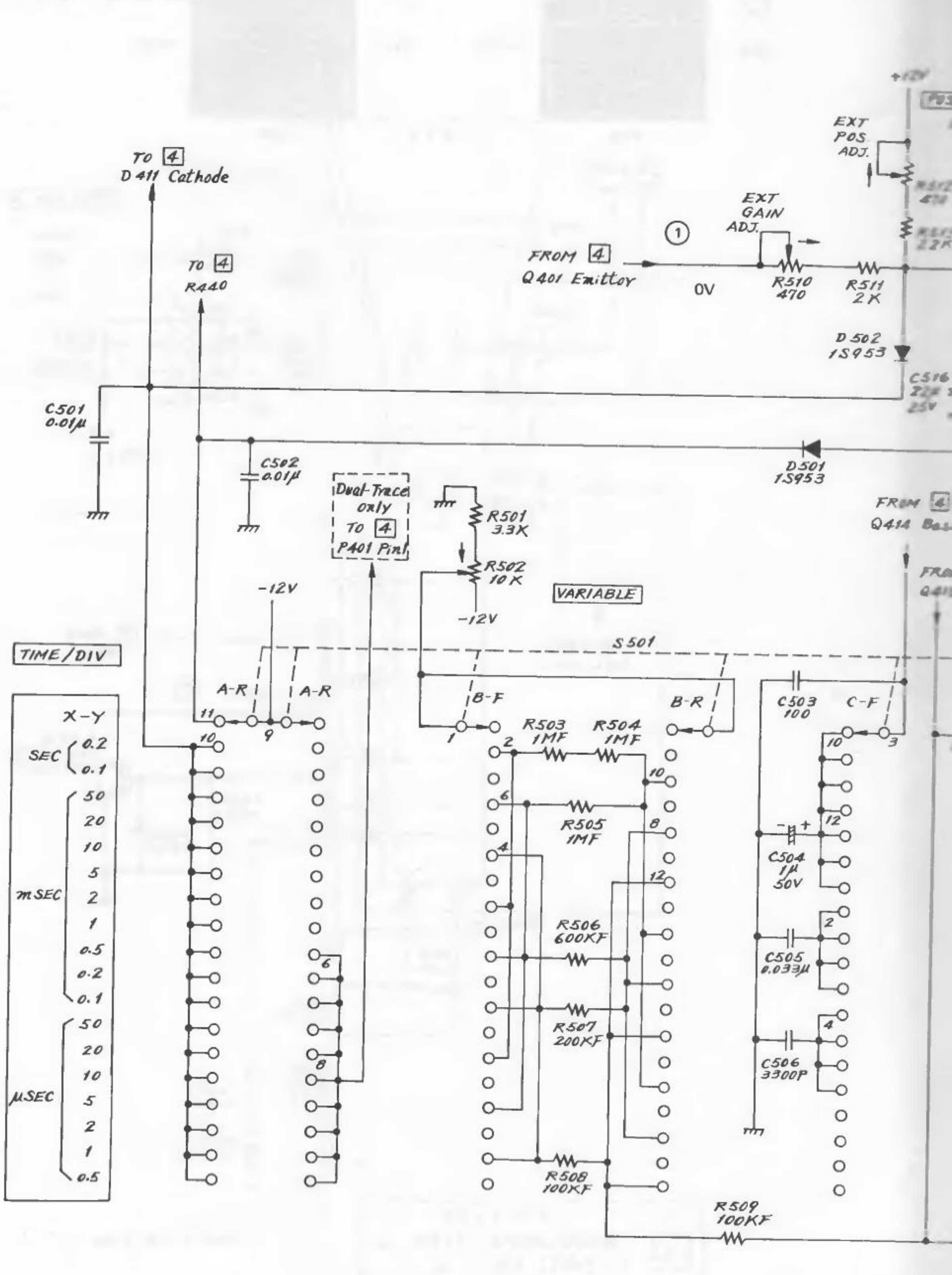
170V



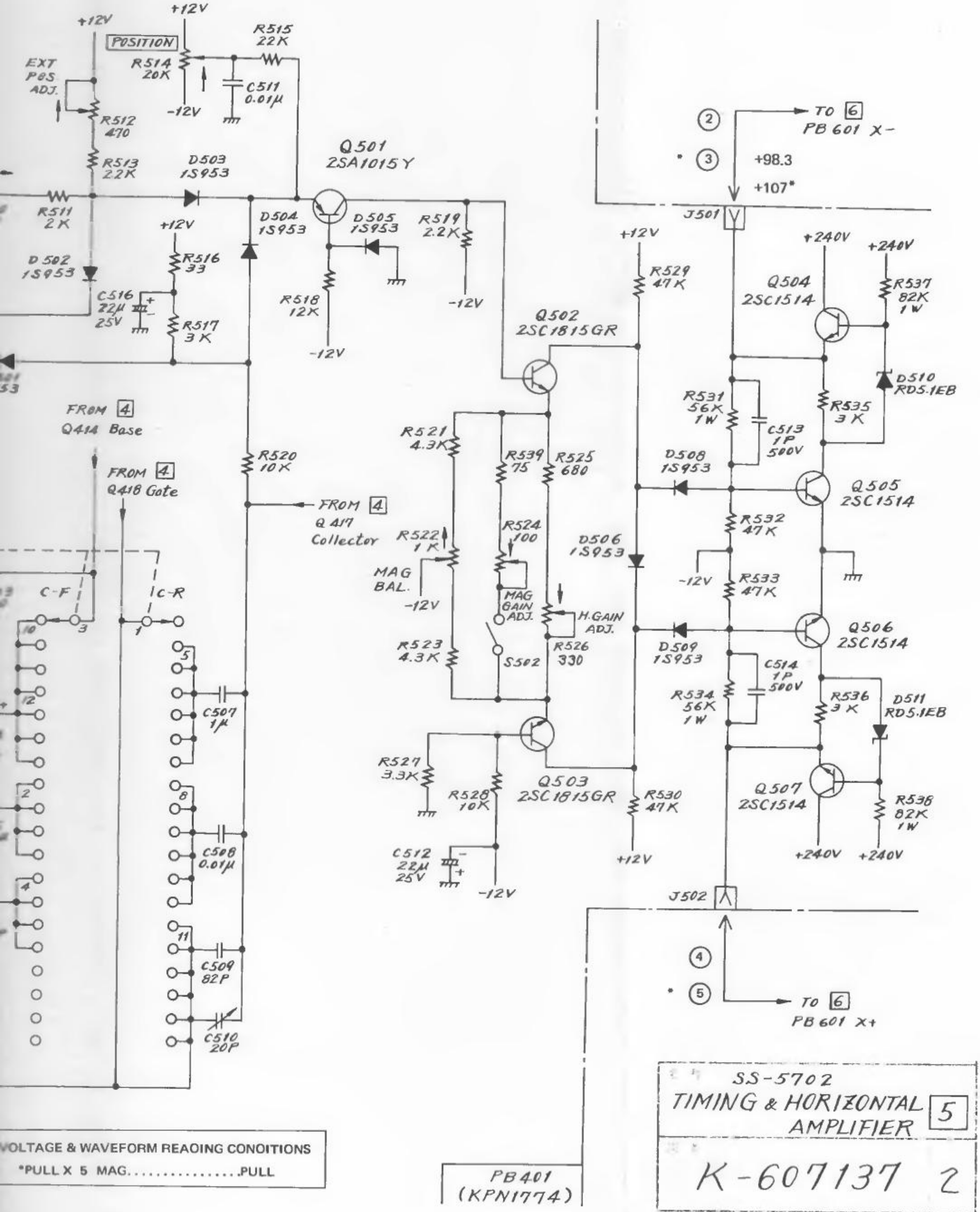
≈+20V

5mS

WAVEFORMS

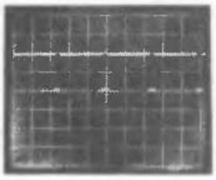


TO 4
D411 Cathode
TO 4
R440
C501
0.01μ
C502
0.01μ
Dual-Trace only
TO 4
P401 Pin1
-12V
R501
3.3K
R502
10K
-12V
VARIABLE
S501
TIME/DIV
X-Y
SEC
0.2
0.1
mSEC
50
20
10
5
2
1
0.5
0.2
0.1
μSEC
50
20
10
5
2
1
0.5
A-R
A-R
B-F
B-R
C-F
R503
1MF
R504
1MF
R505
1MF
R506
600KF
R507
200KF
R508
100KF
R509
100KF
C503
100
C504
1μ
50V
C505
0.033μ
C506
3300P
EXT
POS.
ADJ.
EXT
GAIN
ADJ.
FROM 4
Q401 Emittor
0V
R510
470
R511
2K
D502
1S953
D501
1S953
FROM 4
+12V
VOLTAGE & WAVEF
*PULL X 5 MAG.


POSITION
EXT POS ADJ.
R514 20K
R515 22K
C511 0.01μ
R512 470
R513 2.2K
R511 2K
D502 1S953
D503 1S953
D504 1S953
D505 1S953
Q501 2SA1015Y
R516 33
R517 3K
C516 22μ 25V
R518 12K
R519 2.2K
R520 10K
FROM 4 Q414 Base
FROM 4 Q418 Gate
FROM 4 Q417 Collector
C-F
C-R
C507 1μ
C508 0.01μ
C509 82P
C510 20P
Q502 2SC1815GR
Q503 2SC1815GR
R521 4.3K
R522 1K
MAG BAL.
R523 4.3K
R539 75
R525 680
R524 100
MAG GAIN ADJ.
H.GAIN ADJ.
R526 330
S502
R527 3.3K
R528 10K
C512 22μ 25V
R529 47K
R530 47K
D506 1S953
D508 1S953
D509 1S953
R531 56K 1W
C513 1P 500V
R532 47K
R533 47K
R534 56K 1W
C514 1P 500V
Q504 2SC1514
Q505 2SC1514
Q506 2SC1514
Q507 2SC1514
R535 3K
R536 3K
R537 82K 1W
R538 82K 1W
D510 RD5.1EB
D511 RD5.1EB
J501
J502
+98.3
+107*
TO 6 PB601 X-
TO 6 PB601 X+
+12V
-12V
+240V
VOLTAGE & WAVEFORM READING CONDITIONS
*PULL X 5 MAG. . . . . .PULL
PB401 (KPN1774)
SS-5702
TIMING & HORIZONTAL AMPLIFIER 5
K-607137 2

①

20V

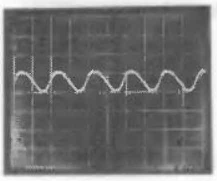


≈+16V

5mS

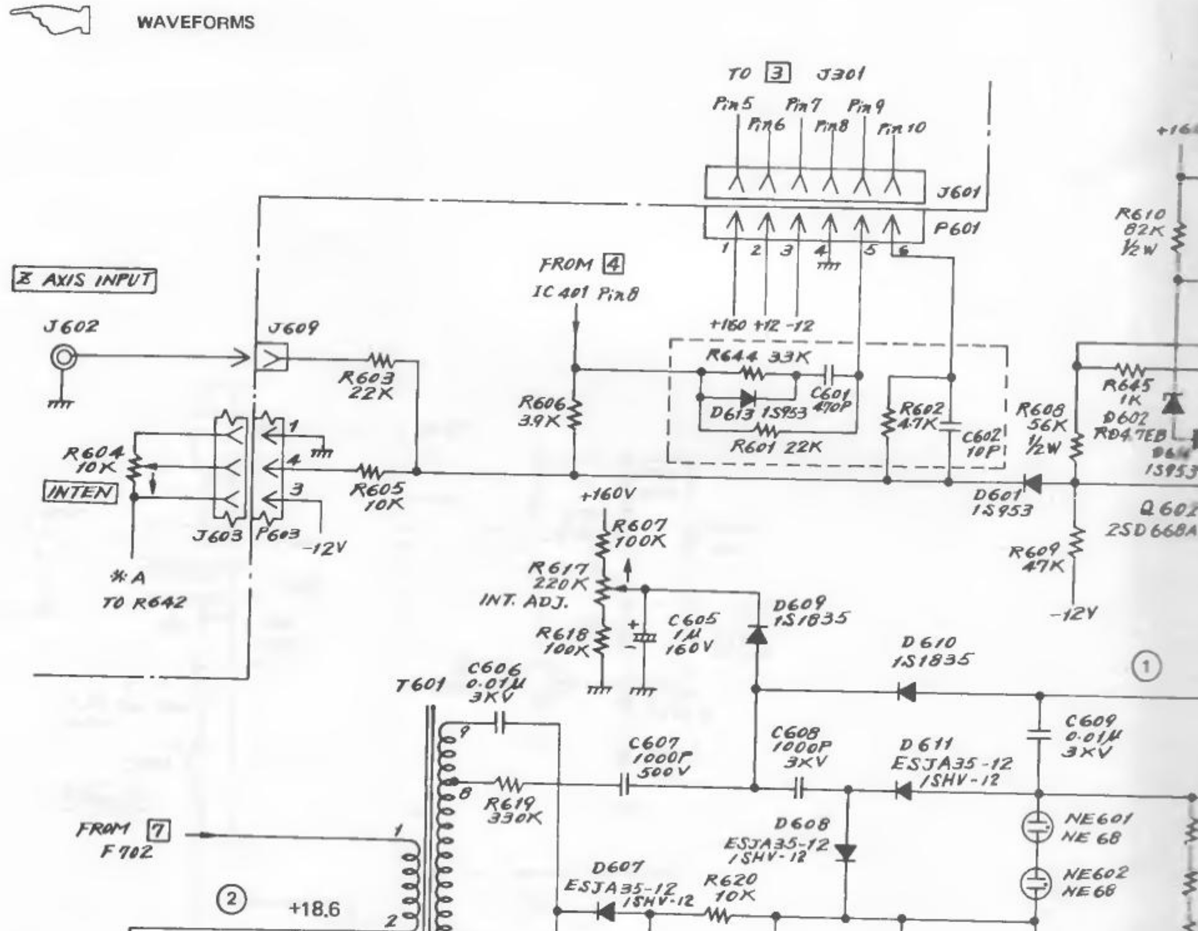
②

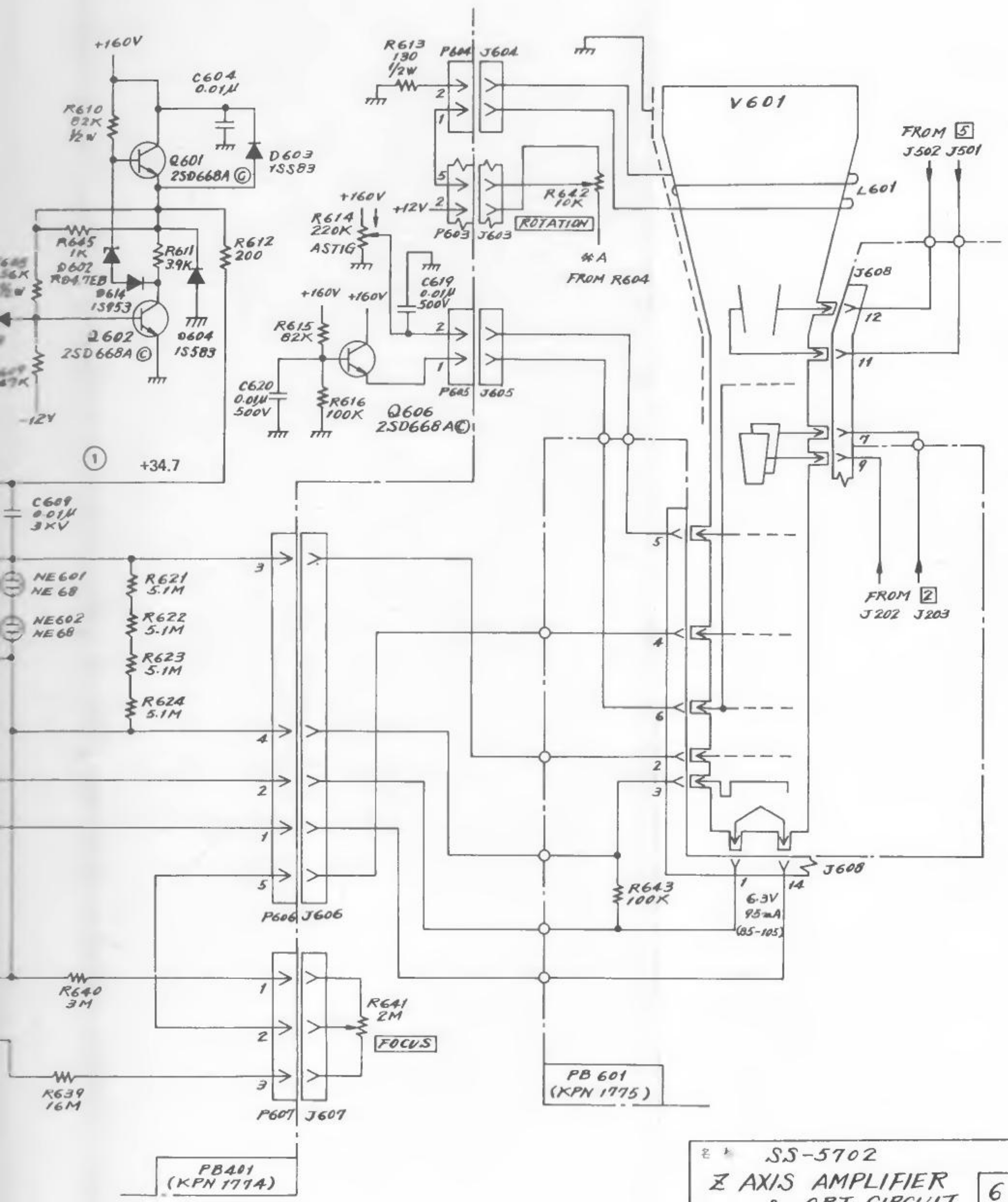
20V



≈+10V

10μS


WAVEFORMS
TO 3 J301
Pin5 Pin6 Pin7 Pin8 Pin9 Pin10
J601
P601
1 2 3 4 5 6
+160 +12 -12
Z AXIS INPUT
J602
J609
R603 22K
FROM 4
IC401 Pin8
R644 33K
C601 470P
D613 1S953
R601 22K
R602 4.7K
C602 10P
R606 3.9K
R604 10K
INTEN
J603 P603
R605 10K
-12V
*A
TO R642
+160V
R607 100K
R617 220K
INT. ADJ.
R618 100K
C605 1μ 160V
D609 1S1835
D610 1S1835
R610 82K 1/2W
R645 1K
D602 RD4.7EB
R608 56K 1/2W
D601 1S953
Q602 2SD668A
R609 47K
-12V
T601
C606 0.01μ 3KV
C607 1000P 500V
R619 330K
C608 1000P 3KV
D611 ESJA35-12 /SHV-12
C609 0.01μ 3KV
NE601 NE68
NE602 NE68
FROM 7
F702
D608 ESJA35-12 /SHV-12
D607 ESJA35-12 /SHV-12
R620 10K
+18.6
Q603 2SC1061C /2SD1134C
D606 ESJA35-12 /SHV-12
C610 0.01μ 3KV
C611 0.01μ 3KV
C612 0.01μ 3KV
R626 470
D605 1S953
R625 13
+12V
C615 22μ 25V
R629 10
R630 100K
Q604 2SA1015Y
HV ADJ.
R632 47K
R633 240K
C617 1000P 3KV
R640 3M
Q605 2SC1815GR
R628 1.5K
C614 3300
R627 1K
R631 2.2K
C616 22μ 25V
D612 1S953
C618 0.22μ
R639 16M
-12V
Dual Trace only



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Z AXIS AMPLIFIER & CRT CIRCUIT

6

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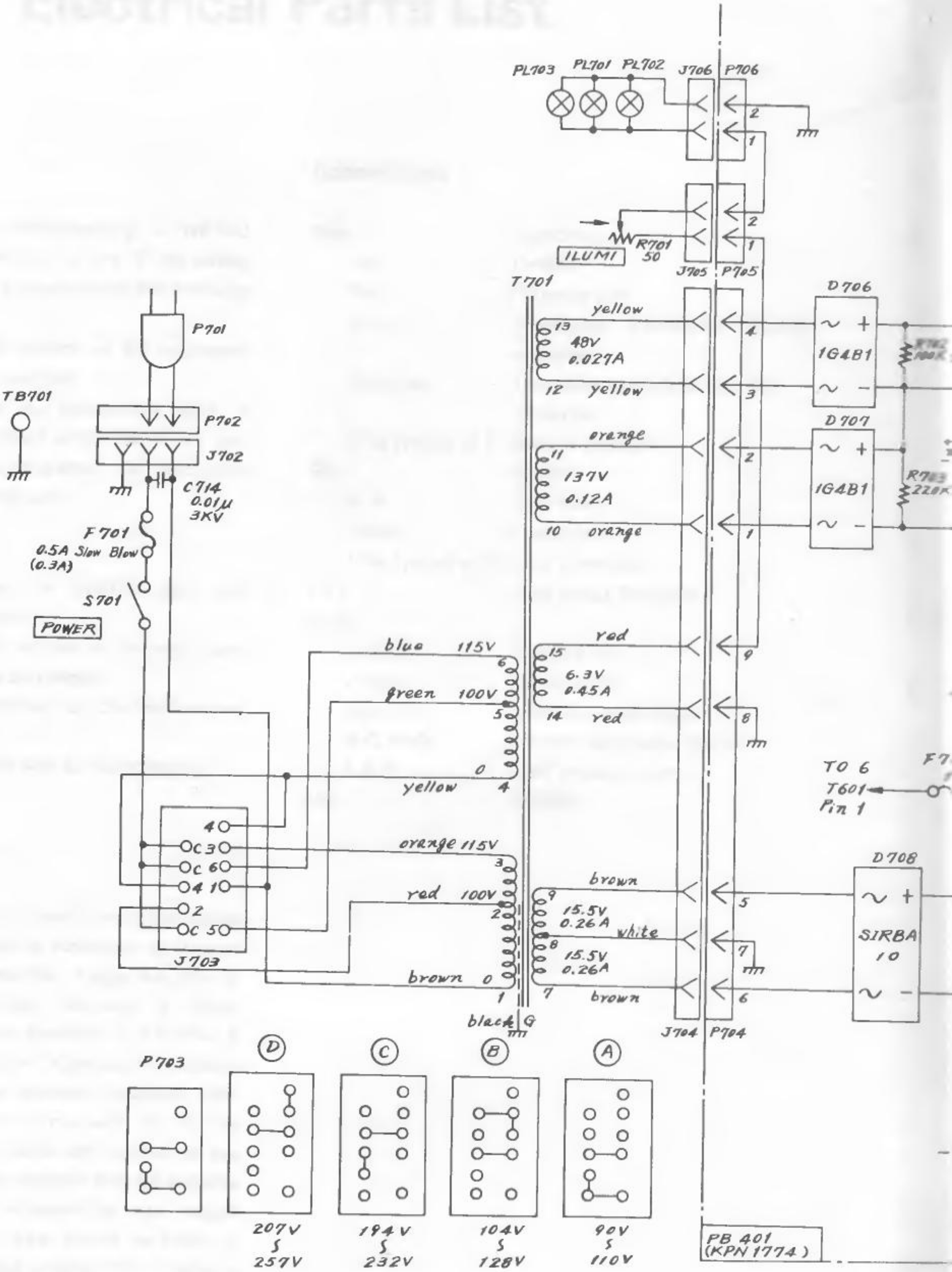
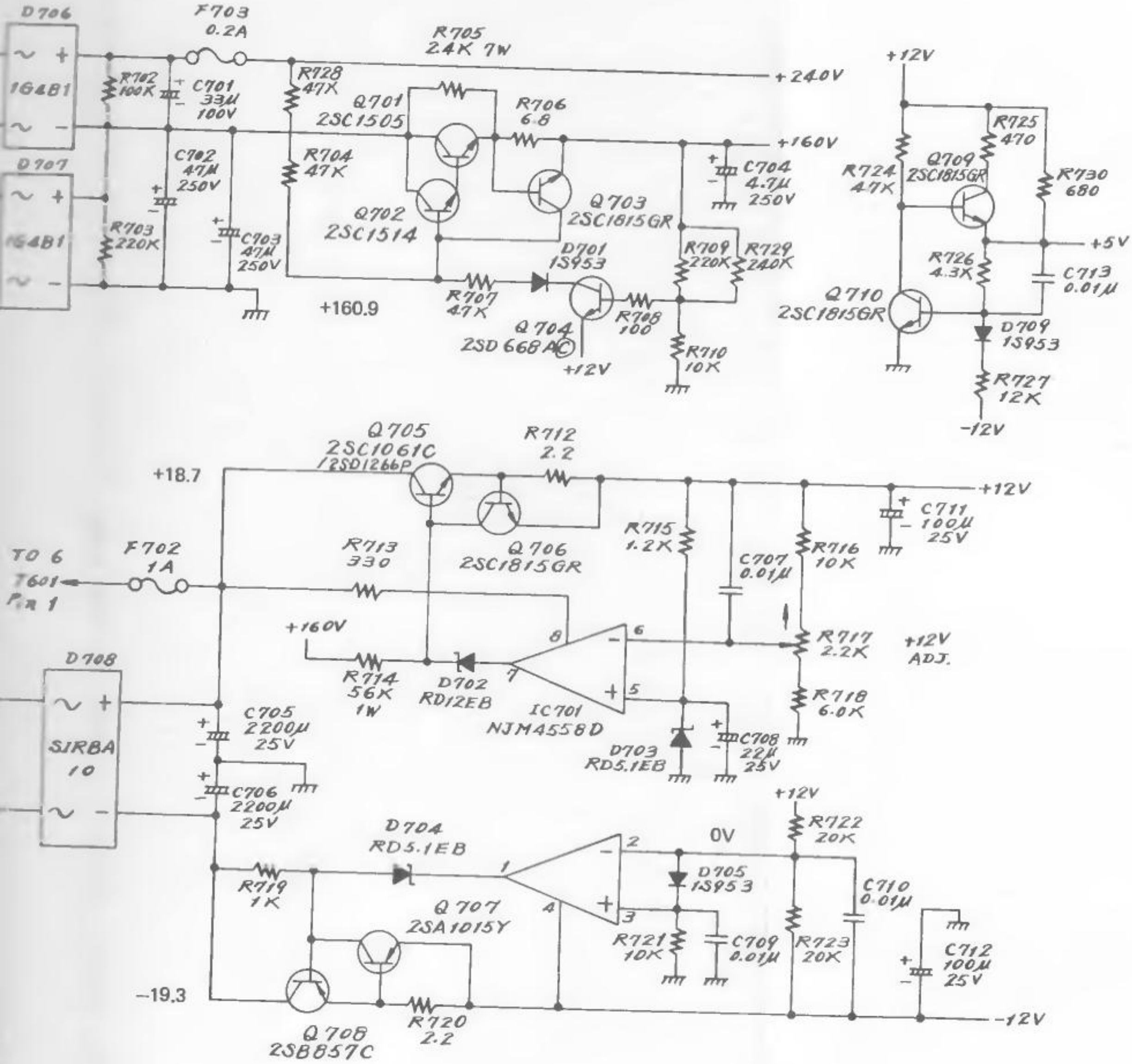
2


PL703 PL701 PL702
J706 P706
ILUMI
R701 50
J705 P705
T701
D706
1G4B1
D707
1G4B1
P701
TB701
P702
J702
C714 0.01μ 3KV
F701 0.5A Slow Blow (0.3A)
S701
POWER
yellow
48V 0.027A
yellow
orange
137V 0.12A
orange
red
6.3V 0.45A
red
blue 115V
green 100V
yellow
orange 115V
red 100V
brown 0
brown
15.5V 0.26A
white
15.5V 0.26A
brown
black G
J703
J704 P704
TO 6 T601 Pin 1
D708
SIRBA 10
P703
D
C
B
A
207V ~ 257V
194V ~ 232V
104V ~ 128V
90V ~ 110V
PB 401 (KPN 1774)



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POWER SUPPLY 7

K-607139 2

Electrical Parts List

Ordering Information

Replacement parts may be ordered through an IWATSU representative of directly from the factory. To be certain of receiving the proper parts, a ways include the following information with the order.

a. Model Number and serial number of the instrument on which the parts will be installed.
b. Circuit reference number and subassembly name, if applicable, for which the part is intended. If the part does not have a circuit reference, the description from the parts list should be used.
c. Iwatsu part number.

For factory repair, contact the IWATSU agent and include the following information.

a. Model number and serial number of the instrument on which the work is to be performed.
b. Details concerning the nature of the malfunction, or, type of repair desired.
   Shipping instructions will be sent to you promptly.

How to use This Parts List

The parts list is divided into subsections corresponding to the schematic diagrams such as Attenuator & Vertical Pre-amplifier, Vertical Main amplifier, Trigger Amplifier & Vertical MODE Control, Trigger Generator & Sweep Generator, Timing & Horizontal Amplifier, Z Amplifier & CRT Circuit and Power Supply. Component locations can be determined from the schematic diagrams, each component appears only once in the parts list. At the begining of each subsection are listed part number for any complete subassemblies in that category that are available as replacement parts. These subassemblies may include individually-listed components; care should be taken to locate malfunctions to the lowest possible level of replacement part and thus avoid the time and cost involved in "over-repair".

Abbreviations

Cap. . . . . .Capacitor
  Cer . . . . .Ceramic
  Poly . . . . .Polyester film
  Elect. . . . . .Aluminium electrolytic chemical condenser
  Elect. tan, ...Tan-talum electrolytic chemical condenser
  [The symbol of F (farad) is omitted]
Res. . . . . .Resistor
  W.W. . . . . .Wire wound
  Compo. . . . . .Composition
  [The symbol of Ω (ohm) is omitted]
FET . . . . .Field Effect Transistor
Diode
  T.diode . . . . .Tunnel diode
  Z.diode . . . . .Zenner diode
  S.B.diode. . . . . . .Schottky barrier diode
  V.C. diode . . . . . .Variable capacitance diode
  L.E.D . . . . .Light emission diode
Var. . . . . .Variable

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
ATTENUATOR & VERTICAL PRE-AMPLIFIER		
C001/101	Cap., 0.047 μ, ±0.5%, 400V, Film	DCF168011
C002/102	Cap., 4p, ±0.25p, 500V, Cer.	DCC250801
C003/103	Cap., 12p, Var., 250V, Cer.	DCV019701
C004/104	Cap., 2 ~ 8p, Var., 250V, Cer.	DCV019691
C005/105	Cap., 82p, ±5%, 100V, Cer.	DCC246511
C006/106	Same as C004	
C007/107	Same as C003	
C008/108	Cap., 470p, ±5%, 50V, Cer.	DCC237481
C009/109	Same as C004	
C010/110	Cap., 22.5p, Var., 250V, Cer.	DCV019711
C011/111	Cap., 4,700p, ±5%, 50V, Styrol	DCF127311
C012/112	Cap., 1,000p, ±10%, 500V, Cer.	DCC151811
C013/113	Cap., 22 μ, −10 ~ +100%, 25V, Elect.	DCE225151
C015/115	Same as C013	
C016/116	Cap., 0.01 μ, −20 ~ +80%, 50V, Cer.	DCC133571
C017/117	Same as C013	
C018/118	Cap., 18p, ±5%, 50V, Cer.	DCC232201
C019/119	Cap., 7p, ±0.5p, 50V, Cer.	DCC231101
C020/120	Cap., 2p, ±0.25p, 50V, Cer.	DCC230501
C021/121	Same as C016	
C022/122	Cap., 82p, ±5%, 50V, Cer.	DCC233801
C023/123	Same as C022	
C024/124	Same as C020	
C025/125	Same as C004	
C026/126	Cap., 1,00p, ±10%, 50V, Film	DCF120111
C027/127	Cap., 10p, ±0.5p, 50V, Cer.	DCC231701
C028/128	Cap., 47 μ, −10 ~ +100%, 25V, Elect.	DCE225171
C029/129	Same as C028	
C030/130	Same as C026	
C031/131	Cap., 3p, ±0.25p, 50V, Cer.	DCC230701
C032	Cap., 6p, ±0.5p, 50V, Cer.	DCC231001
C132	Same as C032	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
R001/101	Res., 10, ± 5%, ¼W, Carbon	DRD134351
R002/102	Res., 900k, ±1%, ¼W, Metal	DRE139821
R003/103	Res., 111k, ±1%, ¼W, Metal	DRE132641
R004/104	Res., 990k, ±1%, ¼W, Metal	DRE139831
R005/105	Res., 10.1k, ±1%, ¼W, Metal	DRE132631
R006/106	Res., 999k, ±1%, ¼W,Metal	DRE139841
R007/107	Res., 1k, ±1%, ¼W, Metal	DRE130831
R008/108	Res., 1M, ±1%, ¼W, Metal	DRE139851
R009/109	Res., 470k, ±5%, ¼W, Carbon	DRD135471
R010/110	Res., 470,± 5%, ¼W, Carbon	DRD134751
R011/111	Res., 100, ± 5%, ¼W, Carbon	DRD134591
R012/112	Res., 75,± 5%, ¼W, Carbon	DRD134561
R013/113	Res., B100, Var., 0.5W, Metal	DRV430541
R014/114	Same as R011	
R015/115	Same as R010	
R016/116	Res., 3.9k, ±5%, ¼W, Carbon	DRD134971
R017/117	Res., 10k,± 5%, ¼W, Carbon	DRD135071
R018/118	Same as R017	
R019/119	Res., 180,± 5%, ¼W, Carbon	DRD134651
R020/120	Res., 1.6k, ±5%, ¼W, Carbon	DRD134881
R021/121	Res., 820, ±1%, ¼W, Metal	DRE130811
R022/122	Res., 4.3k, ±1%, ¼W, Metal	DRE130981
R023/123	Same as R022	
R024/124	Same as R021	
R025/125	Res., 4.7k,± 5%, ¼W,Carbon	DRD134991
R026/126	Res., 560, ±1%, ¼W, Metal	DRE130771
R027/127	Res., 12k,± 5%, ¼W, Carbon	DRD135091
R028/128	Res., 1.8k, ±1%, ¼W, Metal	DRE130891
R029/129	Res., 2k, ±1%, ¼W, Metal	DRE130901
R030/130	Same as R007	
R031/131	Res., 200, ±1%, ¼W, Metal	DRE130661
R032/132	Res., B1k, Var., 0.1W, Metal	DRV147281
R033/133	Same as R031	
R034/134	Res., 2.4k,± 5%, ¼W, Carbon	DRD134931
R035/135	Res., B470, Var., 0.5W, Metal	DRV430561
R036/136	Res., 3k,± 5%, ¼W, Carbon	DRD134941
R037/137	Same as R007	
R038/138	Res., 390,± 5%, ¼W, Carbon	DRD134731
R039/139	Same as R029	
R040/140	Res., 1k,± 5%, ¼W, Carbon	DRD134831
R041/141	Res., B2.2k, Var., 0.5W, Metal	DRV430581
R042/142	Same as R029	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
R043/143	Same as R029	
R044/144	Same as R007	
R045/145	Res., 510, ±1%, ¼W, Metal	DRE130761
R046/146	Res., 470, ±1%, ¼W, Metal	DRE130751
R047/147	Same as R016	
R048/148	Same as R016	
R049/149	Res., 220k, ±5%, ¼W, Carbon	DRD135391
R051/151	Res., 1.3k, ±5%, ¼W, Carbon	DRD134861
R052/152	Res., 4.7k, ±5%, ¼W, Carbon	DRD134991
R053/153	Same as R052	
R054/154	Same as R011	
R055/155	Same as R052	
R056/156	Same as R052	
R057/157	Same as R011	
R058/158	Res., B1k, Var., 0.5W, Metal	DRV430581
R059/159	Res., 2k, ±5%, ¼W, Carbon	DRD139451
R060/160	Res., 4.3k, ±5%, ¼W, Carbon	DRD130981
R061/161	Same as R060	
R062/162	Same as R001	
R063/163	Same as R001	
R064/164	Res., 22, ±5%, ¼W, Carbon	DRD134431
R065/165	Res., 220k, ±5%, ¼W, Carbon	DRD238391
R066/166	Res., 1.5k, ±5%, ¼W, Carbon	DRD134871
R067/167	Res., B680, Var., 0.5W, Metal	DRV430651
R068/168	Res., 220, ±5%, ¼W, Carbon	DRD134671
R069/169	Res., B10k, Var., 0.1W, Carbon	DRV147321
Q001/101	FET, 2SK30A-Y	DTR210141
Q002/102	FET, μPA61AM	DTR295361
Q003/103	Transistor, 2SA1015Y	DTR116111
Q004/104	Same as Q003	
Q005/105	Transistor, 2SC1815GR	DTR139011
Q006/106	Transistor, 2SC1815GR	DTR137781
Q007/107	Same as Q006	
Q008/108	Same as Q005	
Q009/109	Same as Q005	
Q010/110	Same as Q006	
Q011/111	Same as Q006	
Q012/112	Same as Q005	
IC001/101	IC(Transistor Array), HA1127	DTR190631

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART NO.
P002/102	Connector. M36-02-30-114P	DCN034851
P003/103	Connector, M33-05-30-114P	DCN034671
J001/101	Connector, BNC080	DCN040711
J002/102	Connector, M36 • M87-02	DCN034601
	M31 • C8-4	DCN034951
J003/103	Connector, M33 • M87-05	DCN034581
S001/101	Slide-switch, SLEP223C-F	DSW055741
S002/102	Rotary-switch, PS22BH 3-3-11/RV	DSW034562
TB101	Terminal, 8ϕ (GND)	DTA020501

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
VERTICAL MAIN AMPLIFIER		
C201	Cap., 0.01µ, −20～+80%, 50V, Cer.	DCC133571
C202	Same as C201	
C205	Cap., 100µ, −10～+100%, 25V, Elect.	DCE225181
C208	Cap., 10p, ±0.25p, 50V, Cer.	DCC231701
C209	Cap., 2～8p, Var., 250V, Cer.	DCV019561
C211	Cap., 1p, ±0.25p, 500V, Cer.	DCC250301
C213	Cap., 100p, ± 10%, 500V, Cer.	DCC254031
C214	Same as C213	
C215	Cap., 2p, ± 0.25p, 500V, Cer.	DCC250501
C217	Cap., 0.01µ, ± 10%, 500V, Cer.	DCC153501
C218	Cap., −20 ±80%, 50V, Cer.	DCC133571
C219	Same as C217	
C220	Same as C217	
C221	Cap., 6p, ± 0.25p, 50V, Cer.	DCC231001
C222	Cap.,3p, ± 0.25p, 500V, Cer.	DCC250701
L201	Inductance, SP0406・2R-2K-6	DCL111701
L202	Same as L201	
R201	Res., 1.65k, ±1%, ¼W, Metal	DRE132911
R202	Res., 2.7k, ±5%, ¼W, Carbon	DRD134931
R204	Same as R202	
R205	Same as R201	
R207	Res., 100, ± 5%, ¼W, Carbon	DRD134591
R209	Res,.2.2k, ± 5%, ¼W, Carbon	DRD134911
R210	Res., 1.2k, ± 5%, ¼W, Carbon	DRD134851
R211	Res., 820, ± 5%, ¼W, Carbon	DRD134811
R212	Same as R211	
R213	Same as R210	
R214	Same as R209	
R215	Res., 1k, ± 5%, ¼W, Carbon	DRD134831
R216	Res., 270, ± 5%, ¼W, Carbon	DRD134691
R217	Res., 470, ± 5%, ¼W, Carbon	DRD134751
R218	Res., 1.6k, ± 5%, ¼W, Carbon	DRD134881
R219	Res., B470, Var., 0.5W, Metal	DRV430561
R220	Same as R218	
R225	Res., 10, ± 5%, ¼W, Metal	DRD134351
R226	Same as R225	
R229	Res., 220, ± 5%, ¼W, Carbon	DRD134671
R230	Res., 12k, ± 5%, 2W, Metal	DRS130561
R231	Same as R215	
R232	Same as R215	
R233	Same as R230	
R234	Res., 47k, ± 5%, 1W, Metal	DRS220631
R235	Same as R229	
R237	Same as R230	
R238	Res., 1.8k, ± 5%, ¼W, Carbon	DRD134891
R239	Same as R230	
R240	Same as R215	
R241	Same as R215	
R244	Res., 160, ±1%, ¼W, Metal	DRE130641
R245	Same as R244	
R246	Res., 22k, ± 5%, ¼W, Carbon	DRD135151
R247	Same as R246	
R248	Res., 100k, ± 5%, ¼W, Carbon	DRD135311
R249	Res., 330, ± 5%, ¼W, Carbon	DRD134711
R250	Res., 22, ± 5%, ¼W, Carbon	DRD134431
R251	Same as R250	
R252	Res., 4.3k, ± 5%, ¼W, Carbon	DRD135141
D201	Diode, 1S953	DDD010051
D202 to D209	Same as D201	
D211	Same as D201	
D212	Same as D201	
D213	Z・Diode, RD5.1B3	DDD032121
D214	Same as D201	
D215	Z・Diode, RD5.1EB2	DDD032071
D216	LED, TLG102KW	DDD070931
Q201 to Q206	Transistor, 2SC1815GR	DTR137781
Q207	Transistor, 2N3905	DTR150011
Q208	Same as Q207	
Q209	Same as Q201	
Q210	Same as Q201	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
Q211	Transistor, 2SC1834	DTR131031
Q212	Transistor, 2SA1015Y	DTR116111
Q213	Same as Q212	
Q202	Transistor, 2SC1815GR	DTR139011
Q205	Same as Q202	
Q214	Same as Q211	
Q215	Transistor, 2SD758C	DTR145161
Q216	Same as Q215	
Q217	Transistor, 2SB718C	DTR125241
Q218	Same as Q217	
Q219	Same as Q212	
Q220	Same as Q212	
P201	Connector, M36-02- 30-114P	DCN034851
J201	Connector, M36 • M87-02	DCN034601
	Connector, M31 • C8-4	DCN034951
J202	Wire-post, WP22-1B	DCN033821
J203	Same as J202	
S201	Push-switch, SPJ222N	DSW014961

TRIGGER AMPLIFIER & VERTICAL MODE CONTROL

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
C301 to C304		
	Cap., 0.01μ, −20 ~+80%, 50V, Cer.	DCC133571
C305	Cap., 10p,± 0.5p, 50V, Cer.	DCC231701
C306	Cap., 22p, ± 5%, 50V, Cer.	DCC232401
C307	Cap., 82p,± 5%, 50V, Cer.	DCC233801
C308 to 310		
	Same as C301	
C311 to C313		
	Cap., 100μ, −10~+100%,25V, Elect.	DCE225181
C314	Cap., 4.7μ, −10~ +100%, 250V, Elect.	DCE270401
C315	Same as C301	
C316	Cap., 47p,± 5%, 50V, Cer.	DCC233201
R301	Res., 430, ±5%, ¼W, Carbon	DRD134741
R302	Same as R301	
R303	Res.,820, ± 5%, ¼W, Carbon	DRD134811
R304	Res., B470, Var., 0.5W, Metal	DRV430561
R305	Res., 360, ±5%, ¼W, Carbon	DRD134721
R307	Res., 220, ±5%, ¼W, Carbon	DRD134671
R308	Res., 1M, ±5%, ¼W, Carbon	DRD135551
R309	Same as R308	
R310	Res., 10k, ± 5%, ¼W, Carbon	DRD135071
R311	Res., 100k, ±5%, ¼W, Carbon	DRD135311
R312	Res., 22k, ±5%, ¼W, Carbon	DRD135151
R313	Same as R312	
R315	Res., 100, ± 5%, ¼W, Carbon	DRD134591
R316	Res., 22k, ±5%, ¼W, Carbon	DRD135151
R317	Same as R316	
R318	Res., 2.2k, ±5%, ¼W, Carbon	DRD134911
R319	Same as R311	
R320	Same as R310	
R321	Same as R310	
R322	Same as R311	
R323	Res., 220, ±5%, ¼W, Carbon	DRD134671
R324	Same as R323	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R325	Res., 10, ± 5%, ¼W, Carbon	DRD134351
R326	Res., 3.3k, ±5%, ¼W, Carbon	DRD134951
D301 to 308	Diode, 1S953	DDD010051
D309	Z. Diode, RD3.0EB	DDD030621
D310	Same as D301	
D312 to 314	Same as D301	
D315	Z. Diode, RD15EB	DDD030351
Q301	Transistor, 2SC1815GR	DTR137781
IC301	IC, UA733CN(Video-Amp.)	DIC623081
IC302	IC, TC4011BP	DIC410101
IC303	IC, TC4013BP	DIC420121
P301	Connector, M33-10-30-114P	DCN034721
J301	Connector, M31 • M87-10	DCN034531
	M31 • C8-4	DCN034951
S301	Lever-switch, SLR024	DSW045012

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
TRIGGER GENERATOR & SWEEP GENERATOR		
C401	Cap., 0.1μ, ±10%, 50V, Film	DCF120351
C402	Cap., 2p, ± 0.25p, 500V, Cer.	DCC250501
C403	Cap., 33p, ±10%, 500V, Cer.	DCC252801
C404	Cap., 39p,± 5%, 50V, Cer.	DCC233001
C406	Cap., 22μ, −10~ +100%, 25V, Elect.	DCE225151
C407	Same as C406	
C408	Cap., 0.01μ, −20~ +80%, 50V, Cer.	DCC133571
C409	Same as C406	
C410	Same as C408	
C412	Cap., 22 μ, −10~ +100%, 25V, Cer.	DCE225301
C413	Same as C412	
C414	Cap., 0.01μ, ± 10%, 50V, Film	DCF129051
C417	Same as C406	
C418	Cap., 0.01μ, ±10%, 50V, Film	DCF120231
C419	Cap., 1μ, −10~ +100%, 50V, Elect.	DCE245021
C420	Same as C414	
C421	Same as C412	
C424	Cap., 33p, ± 5%, 50V, Cer.	DCC232801
C425	Cap., 1,000μ,± 10%, 50V, Film	DCF120111
C426	Cap., 3,300μ,± 10%, 50V, Film	DCF120171
C427 to 429	Same as 412	
C430	Same as C408	
C431	Cap., 100μ, −10 ~ +100%, 25V, Elect.	DCE225181
C432	Cap., 22.5p, Var., 250V, ± 200ppm/°C, Cer.	DCV019711
C433	Same as C408	
C434	Same as C408	
C435	Same as C425	
C436	Cap., 0.1μ, −20~ +80%, 50V, Cer.	PCV019531

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R402	Res., 330k, ±5%, ¼W, Carbon	DRD135431
R403	Res., 4.7k, ±5%, ¼W, Carbon	DRD134991
R404	Res., 680k, ±5%, ¼W, Carbon	DRD135511
R405	Same as R402	
R407	Res., 3.3k, ±5%, ¼W, Carbon	DRD134951
R408	Res., B10k, Var., 0.5W, Metal	DRV430591
R409	Same as R403	
R410	Res., B10k, Var., 0.5W, Carbon Ganged with S403a, b	DRV147311
R411	Res., 16k, ±5%, ¼W, Carbon	DRD135121
R412	Res., 1k, ±5%, ¼W, Carbon	DRD134831
R413	Same as R403	
R414	Res., 20k, ±5%, ¼W, Carbon	DRD135141
R415	Res., 22k, ±5%, ¼W, Carbon	DRD135151
R416	Res., 100k, ±5%, ¼W, Carbon	DRD135311
R417	Same as R416	
R418	Res., 1k, ±5%, 1/6W, Carbon	DRD199501
R419	Same as R403	
R420	Res., 1.2k, ±5%, ¼W, Carbon	DRD134851
R423	Same as R415	
R424	Res., 3.3k, ±5%, ¼W, Carbon	DRD134951
R425	Same as R415	
R426	Same as R403	
R427	Same as R416	
R428	Same as R416	
R429	Res., 390, ±5%, ¼W, Carbon	DRD134731
R430	Res., 560, ±5%, ¼W, Carbon	DRD134771
R431	Res., 2.2k, ±5%, ¼W, Carbon	DRD134911
R432	Same as R424	
R433	Res., 220, ±5%, ¼W, Carbon	DRD134671
R434	Res., 1.5k, ±5%, ¼W, Carbon	DRD134871
R435	Res., 430±5%, ¼W, Carbon	DRD134741
R436	Res., 100k, ±5%, 1/6, Carbon	DRD199551
R437	Same as R435	
R438	Same as R416	
R439	Res., 10, ±5%, ¼W, Carbon	DRD134351
R440	Res., 10k, ±5%, ¼W, Carbon	DRD135071
R441	Same as R440	
R442	Same as R416	
R444	Res., 470k, ±5%, ¼W, Carbon	DRD135471
R445	Same as R403	
R446	Same as R415	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R447	Same as R420	
R448	Same as R430	
R449	Res., B1k, Var., 0.5W, Metal	DRV430571
R450	Same as R440	
R451	Same as R440	
R452	Res., 33k, ±5%, ¼W, Carbon	DRD135191
R453	Same as R440	
R454	Res., 12k, ± 5%, ¼W, Carbon	DRD135091
R455	Res., B2k, Var., 0.1W, Carbon Ganged with R514 and S502	DRV147361
R456	Same as R433	
R457	Res., 2k, ±5%, ¼W, Carbon	DRD134901
R458	Same as R440	
R459	Res., 82k, ±5%, ¼W, Carbon	DRD135291
R460	Res., 130k, ±5%, ¼W, Carbon	DRD135341
R461	Same as R440	
R462	Same as R415	
R463	Res., B470, Var., 0.5W, Metal	DRV430561
R464	Same as R431	
R465	Res., 150, ±5%, ¼W, Carbon	DRD134631
R466	Res., 47k, ± 5%, ¼W, Carbon	DRD135231
R467	Same as R416	
R468	Same as R433	
R469	Res., 100, ±5%, ¼W, Carbon	DRD139291
R470	Res., 330, ±5%, ¼W, Carbon	DRD134711
R471	Same as R431	
R472	Same as R403	
D401 to 403	Diode, 1S953	DDD010051
D404	Diode, 1K34A	DDD010101
D405 to 411	Same as D401	
D412	Same as D401	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
Q401	Transistor, 2SC1815GR	DTR137781
Q402	FET, 2SK30A-Y	DTR210141
Q403 to 412	Same as Q401	
Q414	Transistor, 2SA1015Y	DTR116111
Q415	Same as Q401	
Q416	Same as Q401	
Q417	Same as Q414	
Q418	Same as Q402	
Q419	Same as Q401	
Q420	Same as Q414	
Q421	Same as Q410	
IC401	IC, SN74LS74AN	DIC155741
IC402	IC, CD4011BE	DIC410101
IC403	IC, SN74LS04N	DIC140051
J401	Connector, M33 · M87-04	DCN034571
J402	Connector, BNC080	DCN040711
J403	Connector, M36-M87-02	DCN034601
	M31-C8-4	DCN034951
J404	Same as J403	
P401	Connector, M33-04-30-114P	DCN034661
P403	Connector, M36-02-30-114P	DCN034851
P404	Same as P403	
S401	Lever-switch, SLR343	DSW045031
S402	Lever-switch, SLR322	DSW045022
S404	Same as R402	
TB401	Terminal (CAL)	DTA010871

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
TIMING & HORIZONTAL AMPLIFIER		
C501	Cap., 0.01μ , −20 ~ +80%, 50V, Cer.	DCC133571
C502	Cap., 0.01μ , −20 ~ +80%, 50V, Cer	DCC133571
C503	Cap., 100p, ± 5%, 50V, Cer.	DCC234001
C504	Cap., 1μ , −10 ~ +100%, 50V, Elect.	DCE245021
C505	Cap., 0.033 μ , ±10%, 50V, Film	DCF120291
C506	Cap., 3,300p, ±10%, 50V, Film	DCF120171
C507	Cap., 1μ , ±0.5p, 250V, Film	DCF260151
C508	Cap., 0.01μ , ± 0.25p, 50V, Film	DCF125771
C509	Cap., 82p, ±5%, 50V, Cer.	DCC246511
C510	Cap., 22.5p, Var., 250V, Cer.	DCV019531
C511	Same as C501	
C512	Cap., 22 μ, −10 ~ +100%, 25V, Elect.	DCE225151
C513	Cap., 1p, ± 0.25p, 500V, Cer.	DCC250301
C514	Same as C513	
C515	Cap., 150p, ±5%, 50V, Cer.	DCC234201
C516	Same as C512	
R501	Res., 3.3k, ± 5%, ¼W, Carbon	DRD134951
R502	Res., B10k, Var., 0.1W, Carbon	DRV147291
R503 to 505	Res., 1M, ±1%, ¼W, Metal	DRE139851
R506	Res., 600k, ±1%, ¼W, Metal	DRE139811
R507	Res., 200k, ±1%, ¼W, Metal	DRE131381
R508	Res., 100k, ±1%, ¼W, Metal	DRE131311
R509	Same as R508	
R510	Res., B500, Var., 0.5W, Metal	DRV420611
R511	Res., 2k, ±5%, ¼W, Carbon	DRD134901
R512	Res, B470, ±5%, ¼W, Metal	DRV430561
R513	Res, 2.2k, ± 5%, ¼W, Carbon	DRD134911
R515	Res., 22k, ± 5%, ¼W, Carbon	DRD135141
R516	Res., 33, ±5%, ¼W, Carbon	DRD134471
R517	Res., 3k, ±5%, ¼W, Carbon	DRE999511
R518	Res., 12k, ±5%, ¼W, Carbon	DRD135091
R519	Res., 2.2k, ±5%, Carbon	DRE999291
R520	Res., 10k, ±5%, ¼W, Carbon	DRE999371
R521	Res., 4.3k, ±5%, ¼W, Carbon	DRD134981

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R522	Res., B1k, Var., 0.5W, Metal	DRV430571
R523	Same as R521	
R524	Res., B 100, Var., 0.5W, Metal	DRV430541
R525	Res., 680, ±5%, ¼W, Carbon	DRD134791
R526	Res., B330, Var., 0.5W, Metal	DRV430681
R527	Same as R501	
R528	Same as R520	
R529	Res., 47k, ± 5%, ¼W, Carbon	DRD135231
R530	Same as R529	
R531	Res., 56k, ±5%, 1W, Metal	DRS220641
R532	Same as R529	
R533	Same as R529	
R534	Same as R531	
R535	Same as R157	
R536	Same as R517	
R537	Res., 82k, ±5%, 1W, Metal	DRS220661
R538	Same as R537	
R539	Res., 75, ±5%, ¼W, Carbon	DRD134561
D501 to 506		
	Diode, 1S953	DDD010051
D508	Same as D501	
D509	Same as D501	
D510	Z. Diode, RD5.1EB	DDD030571
D511	Same as D510	
Q501	Transistor, 2SA1015Y	DTR116111
Q502	Transistor, 2SC1815GR	DTR137781
Q503	Transistor, 2SC1815GR	DTR137781
Q504 to 507		
	Transistor, 2SC1514	DTR136961
J501	Terminal, WP22-1B	DCN033821
J502	Same as J501	
S501	Rotaly-switch, PS22BH (24) 3-5-19/10KB	DSW034672

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
Z AXIS AMPLIFIER & CRT CIRCUIT		
C601	Cap., 470p,± 5%, 50V, Cer.	DCC235301
C602	Cap., 10p,± 0.5p, 50V, Cer.	DCC231701
C604	Cap., 0.01μ, ±10%, 500V, Cer.	DCC153501
C605	Cap., 1μ, −10∼+100%, 160V, Elect.	DCE260251
C606	Cap., 0.01μ, −20 ∼+80%, 3kV, Cer.	DCC173501
C607	Cap., 1,000p ±10%, 500V, Cer.	DCC151811
C608	Cap., 1,000p,± 20%, 3kV, Cer.	DCC171831
C609 to C612		
	Same as C606	
C614	Cap., 3,300p,± 10%, 50V, Film	DCF120171
C615	Cap., 22μ, −10∼+100%, 25V, Elect.	DCE225151
C616	Same as C615	
C617	Same as C608	
C618	Cap., 0.22μ, ±10%, 50V, Film	DCF129711
C619	Same as C604	
C620	Same as C604	
R601	Res., 22k,± 5%, ¼W, Carbon	DRD135151
R602	Res., 4.7k,± 5%, ¼W, Carbon	DRD134991
R603	Same as R601	
R604	Res., B10k, Var., 0.1W, Carbon	DRV147331
R605	Res., 10k,± 5%, ¼W, Carbon	DRD135071
R606	Res., 3.9k,± 5%, ¼W, Carbon	DRD134971
R607	Res., 100k, ± 5%, ¼W, Carbon	DRD135311
R608	Res., 56k, ±1%, ½W, Metal	DRE141251
R609	Res., 47k,± 5%, ¼W, Carbon	DRD135231
R610	Res., 82k, ±1%, ½W, Metal	DRE141291
R611	Same as R606	
R613	Res., 130,± 5%, ½W, Carbon	DRD144621
R614	Res., B220k, Var., 0.5W, Metal	DRV430611
R615	Res., 82k,± 5%, ¼W, Carbon	DRD135291
R616	Same as R607	
R617	Same as R614	
R618	Same as R607	

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R619	Res., 330k, ±5%, ¼W, Carbon	DRD135431
R620	Same as R605	
R621 to 624		
	Res., 5.1M, ±5%, ¼W, Carbon	DRD238721
R625	Res., 13,± 5%, ¼W, Carbon	DRD134381
R626	Res., 470, ±5%, ¼W, Carbon	DRD134751
R627	Res., 1k,± 5%, ¼W, Carbon	DRD134831
R268	Res., 1.5k, ±5%, ¼W, Carbon	DRD134871
R629	Res., 10 ±5%, ¼W, Carbon	DRD134351
R630	Same as R607	
R631	Res., 2.2k, ±5%, ¼W, Carbon	DRD134911
R632	Res., B47k, Var., 0.5W, Metal	DRV430601
R633	Res., 240k, ±5%, ¼W, Carbon	DRD135401
R639	Res., 16M, Var., ± 5%, ½W, Metal glaze Film	DRG940291
R640	Res., 3M,± 5%, 1/3W, Carbon	DRD190131
R641	Res., B2M, Var., 1.0W, Metal	DRV350152
R642	Res., B10k, Var., 1.5W, Metal	DRV350162
R643	Res., 100k,± 5%, ¼W, Carbon	DRD135311
R644	Res., 3.3k, ± 5%, ¼W, Carbon	DRD134951
R645	Res., 1k,± 5%, ¼W, Carbon	DRD134831
D601	Diode, 1S953	DDD010051
D602	Z.Diode, RD4.7EB	DDD033511
D603	Diode, 1SS83	DDD010381
D605	Same as D601	
D606 to 608		
	Diode, ESJA35-12	DDD022111
D609	Diode, 1S1835	DDD990131
D610	Same as D609	
D611	Same as D606	
D612	Same as D601	
D613	Same as D601	
D614	Diode, 1S953	DDD010051

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
Q601	Transistor, 2SD668AC	DTR145381
Q602	Same as Q601	
Q603	Transistor, 2SC1061C	DTR130661
Q604	Transistor, 2SA1015Y	DTR116111
Q605	Transistor, 2SC1815GR	DTR137781
Q606	Same as Q601	
V601	CRT.150BTB31	DET012611
NE601	Neon-lamp, NE-68	DLP025051
NE602	Same as NE601	
L601	Trace rotation coil, FS-33656	DCL140312
T601	High-voltage transformer, HVT-3D4011	DCL220321
P601	Connector, M33-06-30-114P	DCN034681
P603	Connector, M33-05-30-114P	DCN034671
P604	Connector, M36-02-30-114P	DCN034851
P605	Same as P604	
P606	Same as P603	
J601	Connector, M33 M87-06	DCN034591
J602	Connector, BNC080	DCN040711
J603	Connector, M33 M87-05	DCN034581
J605	Same as J604	
J606	Same as J603	
J607	Connector, M33 M87-03	DCN034561
J608	CRT-socket, S-B0864	DSK010291
J609	Terminal, WP22-1B	DCN033821

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
POWER SUPPLY		
C701	Cap., 33μ, −10～+100%, 100V, Elect.	DCE255081
C702	Cap., 47μ, −10～+100%, 250V, Elect.	DCE270651
C703	Same as C702	
C704	Cap., 4.7μ, −10～+100%, 250V, Elect.	DCE270401
C705	Cap., 2,200μ, −10～+100%, 25V, Elect.	DCE225231
C706	Same as C705	
C707	Cap., 0.01μ, −20～+80%, 50V, Cer.	DCC133571
C708	Cap., 22μ, −10～+100%, 25V, Elect.	DCE225151
C709	Same as C707	
C710	Same as C707	
C711	Cap., 100μ, −10～+100%, 25V, Elect.	DCE225181
C712	Same as C711	
C713	Same as C707	
C714	Cap., 0.01μ, ±10%, 3000V, Cer.	DCC173501
R701	Res., B50, Var., 1.5W, Metal	DRV350142
R702	Res., 100k, ±5%, ¼W, Carbon	DRD135311
R703	Res., 220k, ±5%, ¼W, Carbon	DRD135391
R704	Res., 47k, ±5%, ¼W, Carbon	DRD135231
R705	Res., 2.4k, ±5%, 7W, Metal	DRS270841
R706	Res., 6.8, ±5%, ¼W, Carbon	DRD134311
R707	Same as R704	
R708	Res., 100, ±5%, ¼W, Carbon	DRD134591
R709	Same as R703	
R710	Res., 10k, ±5%, ¼W, Carbon	DRD135071
R712	Res., 2.2, ±5%, ¼W, Carbon	DRD134191
R713	Res., 330, ±5%, ¼W, Carbon	DRD134711
R714	Res., 56k, ±5%, 1W, Metal	DRS220641
R715	Res., 1.2k, ±5%, ¼W, Carbon	DRD134851
R716	Same as R710	
R717	Res., B2.2k, Var., 0.5W, Metal	DRV430581
R718	Res., 6.8k, ±5%, ¼W, Carbon	DRD135031

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
R719	Res., 1k, ±5%, ¼W, Carbon	DRD134831
R720	Same as R712	
R721	Same as R710	
R722	Res., 20k, ±5%, ¼W, Carbon	DRD135141
R723	Same as R722	
R724	Res., 4.7k, ±5%, ¼W, Carbon	DRD134991
R725	Res., 470, ±5%, ¼W, Carbon	DRD134751
R726	Res., 4.3k, ±5%, ¼W, Carbon	DRD134981
R727	Res., 12k, ±5%, ¼W, Carbon	DRD135091
R728	Same as R704	
R729	Res., 240k, ±5%, ¼W, Carbon	DRD135401
R730	Res., 680, ±5%, ¼W, Carbon	DRD134791
D701	Diode, 1S953	DDD010051
D702	Z. Diode, RD12EB	DDD033191
D703	Z. Diode, RD5.1EB	DDD030571
D704	Same as D703	
D705	Same as D701	
D706	Diode, stack, 1G4B1 (Rectifying)	DDD021031
D707	Same as D706	
D708	Diode, stack, SIRBA10 (Rectifying)	DDD023271
D709	Same as D701	
Q701	Transistor, 2SC1505	DTR130921
Q702	Transistor, 2SC1514	DTR136961
Q703	Transistor, 2SC1815GR	DTR137781
Q704	Transistor, 2SD668AC	DTR145381
Q705	Transistor, 2SC1061C	DTR130661
Q706	Same as Q703	
Q707	Transistor, 2SA1015Y	DTR116111
Q708	Transistor, 2SB857C	DTR125231
Q709	Same as Q703	
Q710	Same as Q703	
IC701	IC, NJM4558D	DIC613031

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
T701	Power transformer, FS-33545	DCL212991
J702	Socket (Inlet), CM-3	DCN013361
J703	Socket, S-I 7220#04	DCN093521
J704	Connector, 128-09-10-281S	DCN032491
J705	Connector, M36 · M87-02	DCN034601
	M31 · C8-4	DCN034951
P703	Plug, X-I7213	DCN093511
P704	Connector, 128-09-10-281P	DCN032481
P705	Connector, M36-02-30-114P	DCN034851
F701	Fuse, FSA-0.5	DFU020131
	Fuse-holder, S-N1009	DSK060111
F702	Fuse, FSA-1	DFU020141
F703	Fuse, FA-0.2	DFU010131
PL701 to 703	Scale illumination lamp, BQ064-22013A	DLP016101
TB701	Terminal (GND), 8ϕ	DTA020501
S701	Push-switch, SDL1P	DSW014991

CIRCUIT REFERENCE	DESCRIPTION	IWATSU PART No.
PB101	Printed circuit board, V board	KPN177351
PB401	Printed circuit board, H board	KPN177451
PB601	Printed circuit board, CRTsocket board	KPN177521