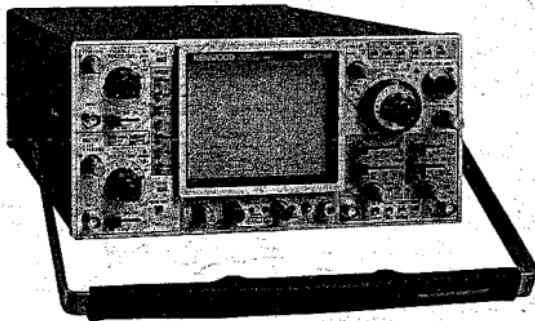


CS-2150

**150MHz
QUAD-TRACE
OSCILLOSCOPE**

SERVICE MANUAL



KENWOOD

WARNING

1. The following instructions are for use by qualified personnel only. To avoid electric shock, do not perform servicing other than contained in the operating instructions unless you are qualified to do so.
2. High voltage up to 20000 volts dc is present when the oscilloscope is operating. Line voltage (90 to 264 VAC) is present on the power supply UNIT, on-off switch, and fuse holder, any time the oscilloscope is connected to an ac power source, even if turned off. Always observe caution when the housing is removed from the unit. Contacting exposed high voltage could result in fatal electric shock.

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SPECIFICATIONS

CRT	150KTM31	Maximum undistorted amplitude:	8 divisions, minimum (DC to 150 MHz)
Model:		Bandwidth limiting:	Vertical system bandwidth with the 20 MHz BW pushbutton switch pushed is approximately 20 MHz
Type:	Rectangular, with internal graticule		
Accelerating potential:	20kV		
Display area:	8 div x 10 div (1 div = 1 cm)		
VERTICAL AXIS (Channel 1 and Channel 2 identical specifications)		Delay time difference CH1 to CH2;	Less than 0.5ns
Sensitivity	5mV/div to 5V/div (X1 mode) 1 mV/div to 1V/div (X5 mode) 500μV/div (Cascaded operation, CH1 to CH2)	CH1, CH2 to CH3, CH4:	Less than 1ns
Accuracy:	± 2% (10 ~ 35°C) ± 4% (0 ~ 50°C) ± 7% (Cascaded operation, CH1 to CH2)		
Attenuator:	5mV/div to 5V/div in 1.2-5 sequence, all 10 ranges with fine adjustment between steps.		
Input resistance:	1 MΩ ± 1%		
Input capacitance:	Approx 22pF		
Frequency response			
DC:	DC to 150 MHz (-3 dB) (not include at 5 V/div range) DC to 100 MHz (-3 dB) (x 5 mode)	DC component:	± 0.5V or less (ac + dc) (± 5V, 1/10 attenuated)
	DC to 70 MHz (-3 dB) (Cascaded operation, CH1 to CH2)	AC component:	1 Vp-p (10 Vp-p, 1/10 attenuated) or less
AC:	5 Hz to 150 MHz (-3 dB) (not include at 5 V/div range) 5 Hz to 100 MHz (-3 dB) (x 5 mode)		
	7 Hz to 70 MHz (-3 dB), (Cascaded operation, CH1 to CH2)		
Risetime:	2.3ns		
Signal delay time:	Approx 10ns as displayed on CRT screen		
Crosstalk:	-40 dB minimum		
Operating modes:			
CH1	CH1, single trace	SWEEP Modes	{switchable with the HORIZ DISPLAY switch):
CH2	CH2, single trace	A	A sweep
DUAL	CH1 and CH2, dual trace	ALT	B sweep waveform is displayed as an intensified portion of the A sweep and B sweep alternating
ADD	CH1 + CH2 (added) display	A-INT-B	B sweep waveform is displayed as an intensified portion of the A sweep.
QUAD	CH1 ~ CH4, quad trace		Delayed B sweep
ALT	Dual or quad trace alternating	B DLY'D	Dual sweep - A and B sweeps, independently
CHOP	Dual or quad trace chopped	DUAL	X-Y display mode
CHOP frequency:	Approx 250 kHz adjustable		
Channel polarity:	Normal or inverted, CH2 only inverted		
▲ Maximum input voltage: 800 Vp-p or 400V (dc + ac peak)			

SPECIFICATIONS

A sweep time:	20 ns/div to 0.5s/div in 23 ranges, in 1-2-5 sequence, vernier control provides fully adjustable sweep time between steps.
B sweep time:	20ns/div to 50ms/div in 20 ranges, in 1-2-5 sequence.
Accuracy:	$\pm 2\%$ (10 ~ 35°C) $\pm 4\%$ (0 ~ 50°C)
Sweep magnification:	X10 $\pm 5\%$ (10 ~ 35°C) $\pm 6\%$ (0 ~ 50°C)
Linearity:	20ns/div to 0.5s/div $\pm 3\%$ ($\pm 5\%$ with X10 magnification)
HOLDOFF:	Continuously adjustable for A sweep from NORM to X5
Trace separation:	B positionable up to 4 divisions separated from A sweep, continuously adjustable.
Delay method:	Continuous delay, Trigger delay
Delay time:	0.2 to 10 times the sweep time from 200ns to 0.5s, continuously adjustable.
Time difference measurement accuracy:	$\pm (1\% \text{ of measurement} + 0.1\% \text{ of full scale})$ (10 ~ 35°C) $\pm 4\%$ (0 ~ 50°C)
Delay jitter:	1/20000 of the full scale sweep time.

TRIGGERING

A TRIG

A trigger modes:	AUTO, NORM, SINGLE, FIX: at the center of the waveform
Trigger source:	V MODE, CH1, CH2, (EXT) CH3 1/1 and 1/10, LINE
Coupling modes:	AC, LFREJ, HFREJ, DC, VIDEO
Trigger level:	VIDEO-LINE sync automatically selected at sweep times of 50 μ s/div to 20ns/div.
Polarity:	VIDEO-FRAME sync automatically selected at sweep times of 0.5s/div to 0.1ms/div. $\pm 90^\circ$ adjustable +/-

B TRIG

B trigger modes:	STARTS AFTER DELAY, TRIGGERABLE AFTER DELAY
Trigger source:	CH1, CH2, (EXT) CH4 1/1 and 1/10
Coupling modes:	AC, LFREJ, HFREJ, DC
Trigger level:	$\pm 90^\circ$ adjustable +/-

TRIGGER SENSITIVITY (A AND B)

COUPLING	FREQ RANGE	MINIMUM SYNC AMPLITUDE		
		INT	EXT	EXT 1/10
DC	DC ~ 20 MHz	0.5 div	50 mV	0.5V
	DC ~ 50 MHz	1.0 div	100 mV	1.0V
	DC ~ 150MHz	2.0 div	280 mV	2.8V
AC	Same as for DC but with increased minimum level for below 20 Hz.			
AC HFREJ	Increased minimum level below 20 Hz and above 30 kHz.			
AC LFREJ	Increased minimum level below 30 kHz.			
VIDEO	FRAME/LINE	0.5 div	50 mV	0.5V

AUTO: Same as above specifications for above 50 Hz.

FIX: 40 Hz ~ 20 MHz, 1.5 div (150 mV)

40 Hz ~ 150 MHz, 3.0 div (420 mV)

Jitter: 0.5ns maximum at 150 MHz at 2ns/div sweep rate (X10 MAG on)

CALIBRATING VOLTAGE AND CURRENT

1 kHz $\pm 3\%$ Positive square wave

1V $\pm 1\%$ (10 ~ 35°C)

$\pm 2\%$ (0 ~ 50°C)

10 mA $\pm 2\%$ (10 ~ 35°C)

$\pm 4\%$ (0 ~ 50°C)

INTENSITY MODULATION

Input signal: TTL level, intensity decreasing with more positive levels

Input impedance: Approx. 10 k Ω

Usable frequency range: DC to 10 MHz

△ Maximum input voltage: 50V (dc + ac peak)

VERTICAL AXIS OUTPUT

Sampled CH1 output

Output voltage: 50 mVp-p/div (into 50 Ω load)

Output impedance: Approx. 50 Ω

Frequency response: DC to 100 MHz (-3 dB) (into 50 Ω load)

GATE OUTPUT (A and B)

Output voltage: Approx. 1.5V positive gate (into 500 Ω load)

TRACE ROTATION

POWER SUPPLY

Electrical, adjustable

Line voltage: 90 ~ 264V

Line frequency: 45 ~ 400 Hz

Power consumption: Approx. 60W (at 100V, 50Hz)

DIMENSIONS

Width: 284 mm (328 mm)

Height: 138 mm (150 mm)

Depth: 400 mm (471 mm)

() dimensions include protrusions from basic case outline dimensions.

SPECIFICATIONS

WEIGHT 7.4 kg

ENVIRONMENT

Operating temperature and
humidity for guaranteed
specifications: 10 ~ 35°C, 85% maximum RH
Full operating range: 0 ~ 50°C, 90% maximum RH
Storage temperature and
humidity range: -20 ~ +70°C
80% maximum

Altitude:

Operating: 5000 m
Non-operating: 12000 m

- Circuit and ratings are subject to change without notice due to developments in technology.

ACCESSORIES

STANDARD ACCESSORIES INCLUDED

Probe (PC-29) x 2.....Y87-1250-00
Attenuation..... 1/10
Input Impedance..... 10MΩ, 18 pF or less
Instruction Manual..... B50-7541-00
Handbook..... B50-7543-00
AC Power Cord..... See Fig. 3
Panel Cover..... F07-0923-02
Probe Holder..... J21-2903-03

OPTIONAL ACCESSORIES

Probe Pouch (MC-78)..... Y87-1600-00
AC Power Cord..... See Fig. 3

SPECIFICATIONS

CRT 150KTM31 SPECIFICATIONS

Screen and shape

Dimensions

Overall length; 380 mm Max.
Face plate dimensions; 149.3 ± 3.0 mm
Screen shape; Rectangular flat face, internal graticule, metal back

Deflection and focusing system; Electrostatic deflection, electrostatic focusing and post-deflection acceleration

Color; Green
Persistence; Medium short
Useful display area; Y axis....80 mm
X axis....100 mm

Heating

Heater voltage; 6.0 V
Heater current; 75 mA

Weight; Approx. 1.1 kg

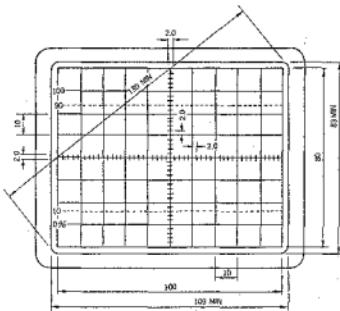


Fig. 1

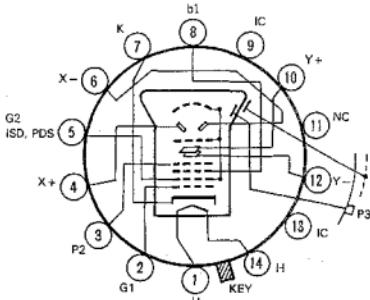


Fig. 2

SAFETY

SAFETY

Before connecting the instrument to a power source, carefully read the following information, then verify that the proper power cord is used and the proper line fuse is installed for power source. If the power cord is not applied for specified voltage, there is always a certain amount of danger from electric shock.

Line voltage

This instrument operates using ac-power input voltages that 90 V to 264 V at frequencies from 45 Hz to 400 Hz.

Power cord

The ground wire of the 3-wire ac power plug places the chassis and housing of the oscilloscope at earth ground. Do not attempt to defeat the ground wire connection or float the oscilloscope; to do so may pose a great safety hazard. The appropriate power cord is supplied by an option that is specified when the instrument is ordered.

The optional power cords are shown as follows in Fig. 3.

Line fuse

The fuse holder is located on the rear panel and contains the line fuse. Verify that the proper fuse is installed by replacing the line fuse.

Plug configuration	Power cord and plug type	Factory installed instrument fuse	Line cord plug fuse	Parts No. for power cord
	North American 120 volt/60 Hz Rated 15 amp (12 amp max; NEC)	1.2 A, 250 V Fast blow AGC/3AG	None	E30-1820-05
	Universal Europe 220 volt/50 Hz Rated 16 amp	1.2 A, 250 V Fast blow 5x20 mm	None	E30-1819-05
	U.K. 240 volt/50 Hz Rated 13 amp	1.2 A, 250 V Fast blow 5x20 mm	1.2 A Type C	—
	Australian 240 volt/50 Hz Rated 10 amp	1.2 A, 250 V Fast blow 5x20 mm	None	E30-1821-05
	North American 240 volt/60 Hz Rated 15 amp (12 amp max; NEC)	1.2 A, 250 V Fast blow AGC/3AG	None	—
	Switzerland 240 volt/50 Hz Rated 10 amp	1.2 A, 250 V Fast blow AGC/3AG 5x20 mm	None	—

Fig. 3 Power Input Voltage Configuration

CIRCUIT DESCRIPTION

VERTICAL ATTENUATOR

The input attenuator unit has a three stage configuration; the attenuation factor of the first stage is 1/100, of the second stage 1/10 and of the third stage 1/2 and 1/4. In combination, these comprise a 10 point input attenuator in 1, 2 and 5 sequence.

The attenuator consists of resistors and capacitors only and does not vary the gain of amplifiers. For this reason, step attenuator balance adjustment is not required.

In addition, since a 1/1000 attenuator is not used, the frequency response is good. The attenuators in both channel 1 and channel 2 use the same configuration.

VERTICAL PRE-AMPLIFIER CIRCUIT

Since this model employs four channel operation, four pre-amplifiers are used.

In the first stage amplifier of channel 1, single-ended transistor amplifiers (Q1 - Q5) with improved high-frequency response are applied with the dc feedback by low offset, low drift op-amp (IC1) to produce a low drift wide-band amplifier.

From the second stage amplifier onward, the amplifier is of a differential configuration. In the second stage amplifier circuit, switching transistors Q13 and Q14 are switched to vary gain to perform X5 gain operation.

In the third stage amplifier circuit, the vertical position control (VR) is connected. Q17 is provided as a constant current source so that the average potential of the output of this stage will not vary if the vertical position control is turned. In channel 2, the phase is inverted by switching transistors Q49 and Q50 to perform channel 2 INV.

Q24 and Q25 are trigger amplifiers whose output passes through buffer output amplifiers Q27 and Q29, and the output signal with an output impedance of 50 ohms is fed to A trigger switch PC board. In channel 1, the CH1 OUT signal is output to the rear panel via Q26 and Q28.

The fourth stage amplifier circuit comprises a cascade amplifier together with mixing amplifiers Q62 and Q63. Channel 2 has a similar circuit configuration to that of channel 1. The second amplifier of channels 3 and 4 has a similar circuit configuration to that of the fourth amplifier of channel 1 and 2.

The four signals of channel 1 through 4 are selected by diode switches D7 through D10, D21 through D24 and D29 through D36 and are connected to the emitter of Q62 and Q63.

Q67 and Q68 are buffer amplifiers to obtain matching with the delay line. These amplifiers have superb CMRR (common mode rejection ratio) in order to provide a balanced output to the delay line and reduce distortion in the waveform of the delay line.

Q73 and Q74 are trigger amplifiers which output the output signal of the mixing amplifier to the A trigger switch unit and are V MODE trigger source. Q64 is a load resistor switching transistor during ADD mode. Q65 through Q72 make up a 20 MHz band width circuit which sets the frequency response of the vertical axis to 20 MHz, (-3 dB).

The signals of channel 1 through 4 are appropriately switched by a combination of the vertical and horizontal modes by means of the logic circuit consisting of IC3 through IC7.

CH3, CH4 AMPLIFIER CIRCUIT

This circuit consists of the attenuator unit, buffer amplifier, first stage amplifier and trigger amplifier. Q1 drives relay RL1 to switch the attenuator unit to 1/1 and 1/10.

The output signal from this attenuator unit is converted in impedance by Q2 through Q4, amplified by Q5 and Q6, and fed to the second amplifier of the vertical pre-amplifier circuit. At the same time, the trigger signal is passed through trigger amplifiers Q7 and Q8, and applied to the A trigger switch unit.

Although channel 4 has an identical circuit to that of channel 3, the trigger signal is fed to the B trigger switch unit. On the same PC board, the wiring network connecting the CPU unit and trigger sweep unit to the HORIZ DISPLAY and TRIG MODE PC board is incorporated.

VERTICAL OUTPUT AMPLIFIER CIRCUIT

The signal passed through the delay line is applied to the vertical output amplifier. Q1 through Q4 are the cascade connection differential amplifiers. Q14 is a constant current biasing circuit. Q7 through Q12 are final stage output amplifiers; as the cases of Q11 and Q12 are mounted on the chassis to draw off heat, the heat radiation effect is improved compared with former final stage amplifiers. Q15, Q16 and Q17 make up the trace separation circuit, and Q13 and Q18 make up the beam finder circuit.

A TRIGGER SWITCH CIRCUIT

CH1, CH2, CH3, V MODE and LINE trigger signals are fed to the A trigger switch circuit. S1 is a trigger source select switch and S2 is a trigger coupling select switch. Q1 and Q2 are fixed sync circuits which detect the peak value of the trigger input signal to automatically set the trigger level.

Q3 is a dual FET to prevent temperature drift during the dc sync. Q4 and Q5 make up the emitter follower circuit which serves to lower the driving impedance for the following stage. Q6 and Q7 are feedback amplifiers which improve the CMRR (common mode rejection ratio) of both polarities of the trigger signal. Q8 and Q9 are circuits which prevent temperature drift. Q10 through Q15 are cascode amplifiers and make up a switching circuit of the negative and positive polarities of the trigger signal.

CIRCUIT DESCRIPTION

Q17 through Q25 are video sync circuits. Q17 through Q19 make up a switching circuit of the negative and positive polarities of the trigger signal and Q21 and Q22 make up a trigger waveshape circuit. Separation and selection of the vertical and horizontal sync signals are performed by Q24 which is interlocked with the SWEEP TIME/DIV control. Q18 receives the trigger signals from Q10 through Q15 or Q25 and feeds the trigger signal to the trigger sweep unit with an output impedance of 50 ohms.

B TRIGGER SWITCH CIRCUIT

Basically, this is the same as the A trigger switch circuit. However, the B trigger switch circuit does not have the video sync circuit and fixed sync circuit. Q1 extracts the trigger signal of channel 2, then feeds the X signal to the trigger sweep unit during the X-Y operation.

ROTARY SWITCH CIRCUIT

This is part of the sweep circuit and is mounted on a separate PC board which the rotary switch for selecting the sweep time resistors and the resistors for the holdoff circuit are installed.

TRIGGER SWEEP CIRCUIT

The sweep circuit employs a constant current integrating circuit which charges capacitors with a constant current to provide sawtooth waves. Q13, Q15 and Q17 are switching transistors of capacitors for A sweep time. In the case of the B sweep, Q43, Q45 and Q47 operate in the same manner as in the A sweep.

Q12, Q14 and Q16 are switching transistors for holdoff capacitors of the A sweep. In the case of the B sweep, Q42, Q44 and Q46 operate in the same manner as in the A sweep. The voltage supplied from the constant voltage circuit is converted into the constant current source by the voltage setting circuit consisting of IC3a and Q7 and resistors switched by the rotary switch. The capacitor for the sweep time is charged by this current and its terminal voltage is increased. This voltage is fed to the high impedance buffer amplifier consisting of Q18 and Q19. When the output of this amplifier reaches a certain voltage, IC7d is turned on and the flip-flop IC2b is reset; at the same time, IC2a is set. The output of IC2a turns Q6 on, then short-circuits the capacitor for the sweep time with the result that its terminal voltage is decreased. The constant current circuit formed by Q20 charges any one of holdoff capacitors C12, C16 or C20. The terminal voltage of the capacitor gradually increases and when it reaches a certain value, Q22 turns on. The output of Q22 turns on the Schmitt trigger consisting of IC7c, setting IC2b. The output from IC2b releases IC2a setting and starts sweeping again.

The trigger signal is passed through IC1a and IC1b, then triggers IC2a and releases the set flip-flop to start the sweep which is in sync with the trigger signal. IC1a and

IC1b make up the Schmitt trigger circuit.

The trigger signal shaped by IC1a and IC1b is applied to IC1c, Q1 and Q2. When the trigger signal is present, the gate of IC1d is closed and IC2a acts as a master-slave flip-flop. When the trigger signal disappears, as the gate of IC1d opens, IC2a acts as an R-S flip-flop. This is an auto free-running circuit.

Q24 through Q26 are the detection circuit for delayed sweep. When a voltage level determined by the delay time multiplier is reached, Q24 turns on and the gate of IC8a is triggered. IC8a and IC10b make up the logic differentiating circuit which produces a pulse with a certain pulse width. This pulse sets IC5b and starts the B sweep. The B sweep circuit is almost the same as the A sweep circuit except that the B sweep circuit does not have three ranges of low speed sweep.

The B STARTS AFTER DELAY switch permits the gate of the IC4d to switch from the trigger priority master-slave flip-flop to the R-S flip-flop, and it is possible to start sweep from the voltage level determined by the delay time multiplier.

The A sweep is adjusted in horizontal position by Q53 while the B sweep is adjusted in horizontal position by Q54 and the horizontal display is switched by Q55 through Q58. The A and B sweep waveforms are synthesized at the collectors of Q55 and Q58. The X-Y signals also pass through Q59 where they are synthesized. The signal passed through Q60 is improved in CMRR with Q62 before it is fed to the following stage. The signals at Q64, Q65 and Q66, Q68 are switched by Q69 and Q68 respectively to X1 and X10, then converted in impedance to 50 ohms and fed to the horizontal final stage amplifier.

Q77 through Q79 is a trace separation circuit which supplies two types of bias voltage to the vertical output amplifier by means of the select signals of the A and B sweeps. IC8d is a reset pulse generating circuit during single sweep operation.

IC13a, 14a, and 14e also produce a blanking control signal when the horizontal axis is displayed. This signal is combined by IC11 and 12d with the sweep signal and chop signal, then converted in impedance by Q72 through Q75 to become an input signal to the blanking circuit.

The channel select signal during dual and quad traces in the vertical axis mode is produced by IC12a, IC12b, IC13b, IC14c, IC15a, IC15b, IC15c, IC15d, Q76 and D62 through D64.

IC12a and IC12b are chop oscillators. The on/off of these oscillators is controlled by the vertical axis mode logic and the signal from the CPU unit. While the oscillation is stopped, these oscillators output the alternate signal by receiving the signal from Q76. The output from IC12a and IC12b turns off during vertical axis single trace, and is output in all other modes. The output from IC15d is fed to the vertical pre-amplifier and becomes the chop signal and alternate signal.

CIRCUIT DESCRIPTION

CALIBRATION VOLTAGE GENERATOR CIRCUIT

Q80 and Q81 make up a multivibrator circuit, and the signal decreased in impedance by Q82 is output as a calibration voltage. This voltage is changed into constant current by R307 and R308 and output to the current calibration loop on the rear panel. The power sources to all these circuits are stabilized by IC16 before being supplied.

HORIZONTAL OUTPUT AMPLIFIER CIRCUIT

The sweep signal supplied from the trigger sweep circuit is amplified by differential amplifier Q1 and Q2. The output from Q1 and Q2 is converted in impedance by the emitter-follower circuit Q3 and Q4 and drives Q5 and Q6. Q7 and Q8 make up a constant current circuit. These circuits each serve as a dc load for Q5 and Q6, and are provided with ac peaking by means of C11 and C12. Q9 and Q10 make up an auto biasing circuit which automatically determines the operation point of the output stage. These circuits also serve as a beam finder circuit; when the base of Q11 is grounded, the operation point of the output stage decreases and serves to compress the output waveform.

CPU CIRCUIT

The control of vertical MODE, HORIZ DISPLAY and TRIG MODE is performed by the CPU.

By means of the software key scanning system, the signal corresponding to the mode switch pressed is processed, and "L" output is sent to each LED indicator and each unit as a control signal.

The CH2 INV signal and 20 MHz B.W. switching signal are individually fed to the CPU, and their LED indicators are activated by the circuit in the vertical pre-amplifier.

As the lithium battery serves as a memory back-up power supply, information is held in memory even when the power is switched off.

SWITCHING POWER SUPPLY UNIT

Although this unit aims is compact and lightweight, it consumes nearly 60 W power. Therefore, the conventional series regulator system using a power transformer is not able to meet the specification. For this reason, a switching regulator is employed in this unit.

This switching regulator directly rectifies a voltage of 90 - 264 V, whose output is then converted into a dc current by smoothing capacitors. Next, this dc current is switched by power transistors and converted into ac current to drive the converter transformer. The converter transformer has six taps on its secondary winding. The six ac outputs are each rectified and filtered and supply dc outputs to the power blanking unit. However, the voltage at the control winding is compared with the reference voltage, then amplified by the differential amplifier. The output from the differential amplifier controls the base of the power transistor as the control winding is separate and isolated from

the primary winding, thereby stabilizing the output voltage from the secondary winding.

POWER BLANKING UNIT

Of the six voltages output from the switching power supply unit, five are stabilized by the series regulator again. Q1 and Q3 through Q6 are control transistors. IC1a, IC1b, IC2a and IC2b are differential amplifiers. With respect to the +20 V supply, as its stabilization is not so important, a voltage divider type regulator is used.

The dc-dc converter for high voltage employs the same circuit as conventional models. Q24 through Q26 make up a differential amplifier and Q28 is a control transistor. This scope allows the brightness of the A and B sweep to be varied independently. Q11 through Q13 are responsible for this operation.

Q14 is a beam finder circuit and even if the INTENSITY control is set to CCW, this circuit serves to provide trace on the CRT.

Q15 and Q16 make up an external intensity modulation circuit which darkens the screen of the CRT with "H" level signal of the TTL level.

These signals are synthesized at the base of Q17, and drive Q18. Q19 is a dc load for Q18 and is provided with ac peaking by C25.

Q20 and Q21 are an auto-focus circuit, and opposite phase signal to phase the blanking waveform is applied to the focus electrode of the CRT.

Q22 and Q23 are dc restorer circuit for the blanking and auto-focus circuits and configured as a differential amplifier, so that an isolated signal can be fed to each circuit. Q8 is a transistor for scale illumination, and Q9 and Q10 are transistors for trace rotation.

FILTER UNIT

L1 and C1 through C3 make up a line filter which prevents noise entering from the power line; the line filter also prevents the unit's internal signal radiating through the power line.

IC1 is a photocoupler which provides the trigger source for the line sync.

HIGH VOLTAGE BLOCK

The acceleration voltage at the subsequent stage of the unit extends to as much as 18 kV. Therefore, if the high voltage rectifier section is exposed, it is potentially dangerous. Besides, leakage current would not meet the safety standards. So, the unit employs a high voltage block whose high voltage rectifier section is solidified with resin. The dc-dc converter transformer and the rectifier circuit for 2 kV cathode voltage are incorporated in this block. The external output includes -2 kV dc, 6 V ac and 18 kV, which are output from the anode cap. Therefore, unless the anode cap is intentionally removed, as all other voltages are dc output, the high voltages are in the order of approx. 1/2

BLOCK DIAGRAM

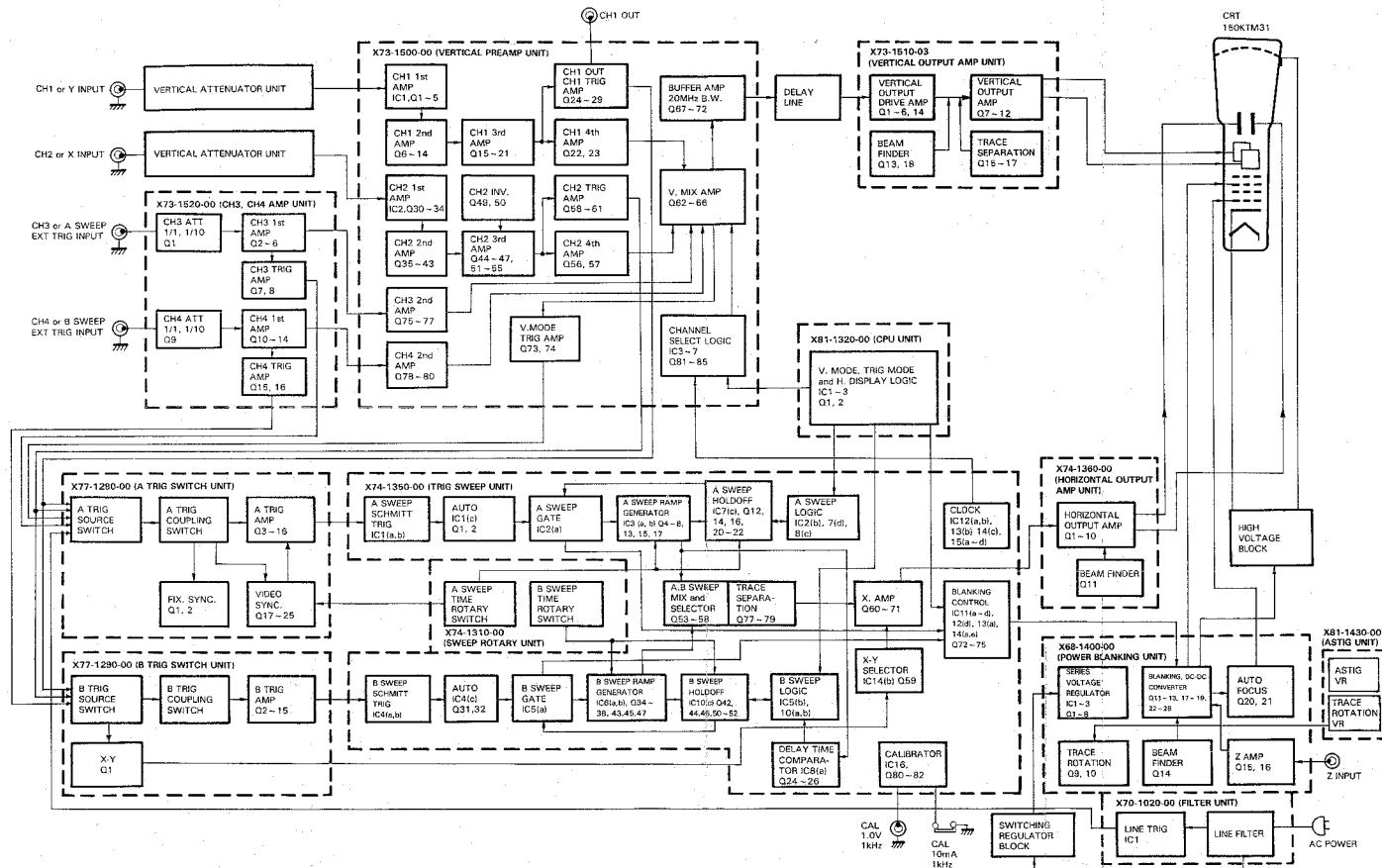
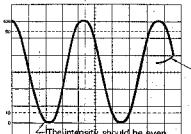


Fig. 4

ADJUSTMENT

Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark																											
ADJUSTMENT OF POWER SUPPLY AND CRT																																		
Check of Power Supply		X68-1400	475A DL-720		(1) Measurement and checking of voltages at P27 and P30 pins <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <th></th><th>1P</th><th>2P</th><th>3P</th><th>4P</th><th>5P</th><th>6P</th><th>7P</th><th>8P</th></tr> <tr> <td>P27</td><td>+120V</td><td>+55±1V</td><td>20V</td><td></td><td></td><td>5.2V</td><td>10V</td><td>-10V</td></tr> <tr> <td>P30</td><td>+130V±3V</td><td>55V</td><td>24V±2V</td><td></td><td>12V</td><td>7V±0.5V</td><td>-12V</td><td>+0.5V±1.5V</td></tr> </table>		1P	2P	3P	4P	5P	6P	7P	8P	P27	+120V	+55±1V	20V			5.2V	10V	-10V	P30	+130V±3V	55V	24V±2V		12V	7V±0.5V	-12V	+0.5V±1.5V		
	1P	2P	3P	4P	5P	6P	7P	8P																										
P27	+120V	+55±1V	20V			5.2V	10V	-10V																										
P30	+130V±3V	55V	24V±2V		12V	7V±0.5V	-12V	+0.5V±1.5V																										
Adjustment of -2.0 kV	VR3	X68-1400	DL-720 High voltage probe		(2) Measure the voltage on 2P of P33 and adjust VR3 to obtain -2.00kV (-2.00kV -- 2.005kV).																													
Coarse Adjustment of ASTIG and FOCUS	VR9 FOCUS Knob	X81-1430		HORIZ DISPLAY: X-Y CH1, CH2 AC-GND-DC: GND A INTENSITY: 3 o'clock 20MHz BW: ON	(1) Operate ↓ POSITION knobs for CH1 and CH2 to position the spot in the center of the CRT screen. (2) Adjust VR9 to make the spot round and smaller.																													
Adjustment of A INTENSITY	VR1	X68-1400		HORIZ DISPLAY: X-Y A INTENSITY: 9 o'clock CH1, CH2 AC-GND-DC: GND 20MHz BW: ON	Adjust VR1 so that the spot on the CRT screen disappears when A INTENSITY is set in the position of 9 o'clock. <Check> Make sure that the spot on the CRT screen increases in brightness when A INTENSITY is turned CW and that the trace becomes almost extinguished when A INTENSITY is turned CCW (9 o'clock position).																													
Check of B INTENSITY				HORIZ DISPLAY: ALT Vertical MODE: CH1 TRIG MODE: AUTO STARTS AFTER DELAY: PULL CH1 AC-GND-DC: AC B SWEEP TIME/DIV: 0.1ms	(1) Operate ↓ TRACE SEP to cause B sweep line in the center of the CRT screen. (2) Make adjustment so that the trace on the CRT screen increases in brightness when B INTENSITY is turned CW and that the trace becomes extinguished when B INTENSITY is turned to fully CCW. (3) Make adjustment so that the trace becomes extinguished when B INTENSITY is turned to fully CCW.																													
Adjustment of Blanking	TC2	X68-1400	SG-502	HORIZ DISPLAY: A Vertical MODE: CH1 TRIG MODE: AUTO A SOURCE: V MODE A COUPLING: AC A INTENSITY: Fully CW CH1 AC-GND-DC: AC A SWEEP TIME/DIV: 0.02μs	(1) Apply a sine wave signal of 10 MHz to CH1 INPUT and operate ↓ POSITION, ▲► POSITION and CH1 VOLTS/DIV to bring out a waveform with a vertical amplitude of 6 div on the screen. (2) Make adjustment so that there is no unevenness in intensity of the trace at the waveform starting point and there is no retrace.		The waveform edge should not return. The intensity should be even.																											
Adjustment of Z-axis Input Blanking	TC1	X68-1400	SG-503	HORIZ DISPLAY: A Vertical MODE: CH1 TRIG MODE: AUTO A SOURCE: V MODE CH1 AC-GND-DC: DC VOLTS/DIV: 2V	(1) Set A SWEEP TIME/DIV at 0.5 μs and apply a 1 MHz sine wave signal of 10Vp-p to CH1 INPUT so that a waveform with a vertical amplitude of 5 div appears on the screen. (2) Apply the same signal above to the Z INPUT, and turn A INTENSITY CCW so that the dark and bright area of the waveform are distinct. (3) Adjust so that the bright area of the sine waveform is symmetrical to the peak point.																													

CIRCUIT DESCRIPTION

to 1/3 as compared with our former oscilloscope models, thereby eliminating danger.

ASTIGMATISM CONTROL UNIT

In the power blanking unit, the variable resistor for trace rotation and the variable resistor for astigmatism control are mounted on a separate PC board to allow these controls to be adjusted on the front panel.

MAINTENANCE

REMOVAL OF CASE

1. Remove the 4 screws located at the rear of the case and the 1 located at bottom with a \oplus screwdriver. Carefully slide the body forward from the case.
2. To install the body in the case, place the case horizontally and slide the body into the case using the rails located at the bottom of the case. Then, place the body vertically and engage the case front edge into the front panel groove.

3. Temporarily insert the case retaining screws and then tighten them evenly.

CAUTION:

A voltage of 20 kV is applied to the CRT socket and anode cap. Before removing the case, turn the power off and pull out the power plug. After removing the case, take care not to touch them.

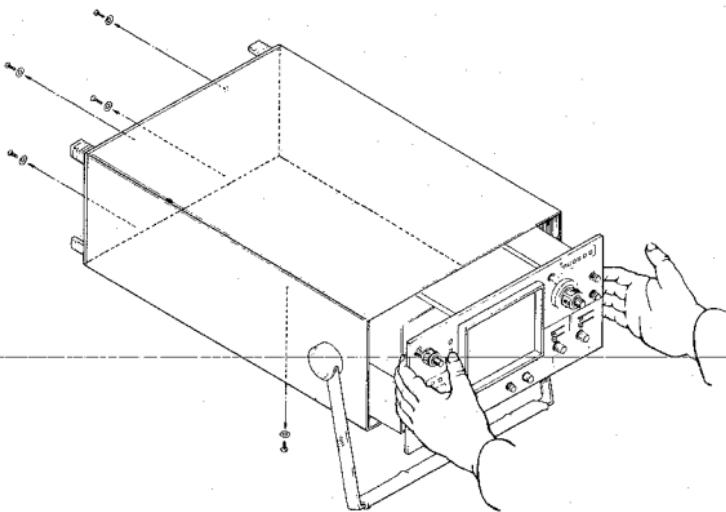


Fig. 5

REMOVING/INSTALLING CRT

1. To remove the cathode ray tube for servicing, disconnect the parallel cord connector located at the top of the shield case. Remove the screws securing the shield case. Remove the bracket screws without loosening the CRT band, move the CRT backward and remove the CRT by lifting up the socket.
2. To install the CRT, move the CRT together with the shield case to the front and tighten the screws securing the CRT band and shield case.
3. As slots are provided in the CRT brackets and the brackets are inclined by 45°, the CRT can be moved back and forth and right and left and positioned at any position.
Always secure the CRT band first, then the CRT brackets.

CAUTION:

There is a high tension voltage at the anode of the CRT. Before removing the CRT, connect the anode to the ground via a 100 k Ω load for 5 seconds to discharge the voltage.

TROUBLESHOOTING

1. If one of the mode LEDs does not light, the unit will not operate correctly. When using the unit, confirm that the LED lights up.
2. To service the unit effectively, isolate the failure first. Then, remove the case and check the wiring, P.C.B. pattern and parts.

ADJUSTMENT

To obtain the best performance, periodically accurately calibrate the unit.

Sometimes, only one mode need be calibrated, while at other times, all modes should be calibrated.

When one mode is calibrated, it must be noted that the other modes may be affected. When calibrating all modes, perform the calibration in the specified sequence.

The following calibration required an accurate measuring instrument and an insulated adjusting flat blade screwdriver. If they are not available, contact your dealer. For optimum adjustment, turn the power on and warm up the scope sufficiently (more than 30 minutes) before starting.

NOTE:

Calibrate the unit under the following condition.

Temperature: 10 - 35°C

Humidity: Less than 85%

POWER SUPPLY VOLTAGE

Before calibrating the unit check the power supply voltage. (90 - 264 V).

TEST EQUIPMENT REQUIRED

The following instrument of their equivalent should be used for making adjustments.

Test Equipment	Model	Minimum Specification
Digital Multi-Meter	DL-720 (TRIO)	Impedance: More than 10MΩ, Measuring range: 0.01 V to 199V
Sine Wave Generator	SG-502 (Tektronix)	Frequency: 10 Hz to 10MHz, constant voltage over tuning range
Sine Wave Generator	SG-503 (Tektronix)	Frequency: 50kHz to 100MHz, Output impedance: 50 Ω, constant voltage over tuning range.
Square Wave Generator	PG-506 (Tektronix)	Output signal: 1 kHz, Amplitude: 10 mVp-p to 10 Vp-p, Accuracy: within ±1%, Rise time: 35ns or less (1 MHz, 1ns or less)
Q Meter	4343B (YHP)	-
Color Pattern Generator	CG-911A (TRIO)	-
Oscilloscope	475A (Tektronix)	Sensitivity: More than 5 mV Frequency response: More than 250 MHz
Time Marker Generator	TG-501 (Tektronix)	Time mark: 0.5s to 0.1 μs repetitive waveform, Accuracy: within 0.1%
High Voltage Probe	-	Input Impedance: 1000 MΩ
Termination	TA-57 (TRIO)	Impedance: 50 Ω
Attenuator	011-0059-02 (Tektronix)	-20 dB attenuation (50 Ω)

Test Equipment	Model	Minimum Specification
Power Meter	2041 (YEW)	-
Auto transformer (variable)	SD-265 (Matsunaga)	-
Current Probe	P6302 AM-503 (Tektronix)	-
Frequency Counter	FC-756 (TRIO)	-

Table-3

PREPARATION FOR ADJUSTMENT

Control Setting

The control settings listed below must be used for each adjustment procedure. Exceptions to these settings will be noted as they occur. After completing a adjustment, return the controls to the following settings.

Power Section	POWER	ON
CRT Control Section		
A INTENSITY		Between 12 and 3 o'clock position
B INTENSITY		Between 12 and 3 o'clock position
FOCUS		Optimum position
SCALE ILLUM		Arbitrary position
BEAM FIND		OFF
Vertical Section		
VARIABLE (CH1 and CH2)		CAL
▼ POSITION (CH1 - CH4)		12 o'clock position
AC-GND-DC (CH1 and CH2)		AC
VOLTS/DIV (CH1 and CH2)		5V/DIV
× 5 GAIN		OFF (PUSH)
Horizontal Sweep Section		
A SWEEP TIME/DIV		0.1ms/DIV
B SWEEP TIME/DIV		0.1ms/DIV
A VARIABLE		CAL
DELAY TIME MULT		Arbitrary position
▼ TRACE SEP.		Fully CCW
HOLD OFF		NORM
B ENDS A		OFF
◀ ▶ POSITION		12 o'clock position
FINE PULL × 10 MAG		12 o'clock position (× 10 MAG OFF)
PULL CHOP F. SELECT		OFF (PUSH)
TRIG. Section		
A SOURCE		V. MODE
A COUPLING		AC
A LEVEL		12 o'clock position
A SLOPE		+
FIX		(PUSH)
B SOURCE		CH1
B COUPLING		AC
B LEVEL		12 o'clock position
B SLOPE		+
STARTS AFTER DELAY		(PUSH)
Mode Section		
Vertical MODE		CH1
20 MHz BW		OFF
CH2 INV		OFF
TRIG. MODE		AUTO
HORIZ. DISPLAY		A

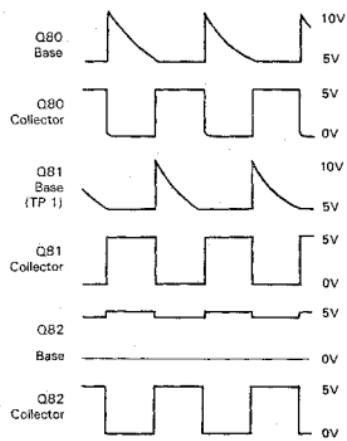
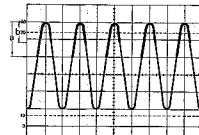
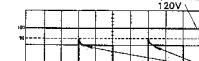
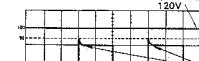
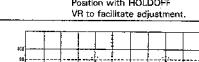
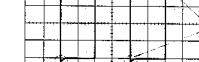
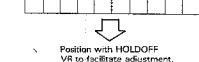
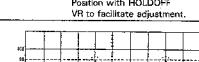
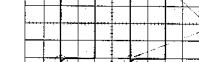
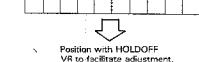
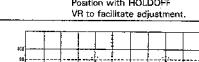
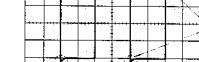
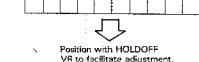
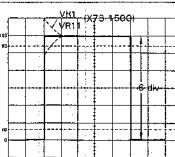


Fig. 7 CAL CIRCUIT WAVEFORMS

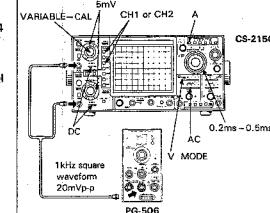
ADJUSTMENT

Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark	
								
Adjustment of Auto FOCUS Level	VR2	X68-1400	475A Probe (1/10)	HORIZ DISPLAY: A A INTENSITY: Fully CW TRIG MODE: AUTO Vertical MODE: CH1 A SOURCE: V MODE A SWEEP TIME/DIV: 20μs HOLDOFF: NORM	(1) Set the oscilloscope (475A) for the vertical axis sensitivity at 2V/div. (2) Observe the waveform of AUTO FOCUS circuit (Autofocus test point FTP marked pattern) with a probe and make adjustment so that DC level of top of the square wave is approx. 90V (4.5~5 div.)	        	<Note> Be sure that the AC-GND-DC selector switch of the oscilloscope (475A) is at "DC" position. Position with HOLDOFF VR to facilitate adjustment.	
Adjustment of Auto FOCUS Wave Forming	TC3	X68-1400		HORIZ DISPLAY: A A INTENSITY: Fully CW TRIG MODE: AUTO Vertical MODE: CH1 A SOURCE: V MODE A SWEEP TIME/DIV: 20μs HOLDOFF: NORM	Make adjustment so that the above-mentioned circuit has an ideal waveform.	       	       	
Adjustment of ASTIG and FOCUS	VR9 FOCUS Knob	X81-1430		HORIZ DISPLAY: X-Y CH1, CH2 AC-GND-DC: GND A INTENSITY : 3 o'clock	(1) Operate ♦ POSITION for CH1 and CH2 so that the bright spot is brought into the center of the CRT screen. (2) Make adjustment to make the spot round and smaller. <Check> (1) Make sure that the bright spot grows larger when the FOCUS knob is turned CW or CCW. (2) Make sure that the FOCUS knob is in a position within the range of 9 and 3 o'clock when the spot is smallest. (3) The most ideal point should be obtained by repeating the above operations and adjustment.		<Note> Be sure to bring the bright spot into the center of the CRT screen. It may be difficult to obtain the correct adjusting position near the edge of the screen due to the CRT peripheral blur.	

ADJUSTMENT

Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark
Adjustment of Trace Rotation	VR8	X81-1430		HORIZ DISPLAY: A Vertical MODE: CH1 TRIG MODE: AUTO CH1 AC-GND-DC: GND	(1) Operate \pm POSITION for CH1 to move the trace to the center of the CRT screen. (2) Make adjustment to align the trace with the horizontal center graticule line. <Check> (1) Make sure that the trace moves more than 0.5 div (10°) up and down from the horizontal center graticule line at its righthand end.		<Note> When the trace does not appear fully across the screen, make proper adjustment by operating VR9 (X74-1350) and VR7 (X74-1350).
Adjustment of CRT Center	VR3	X73-1510		HORIZ DISPLAY: A Vertical MODE: CH1 TRIG MODE: AUTO CH1 AC-GND-DC: GND	Short-circuit the test point of X73-1500 and adjust VR3 so that the trace becomes aligned with the horizontal center graticule line.		
ADJUSTMENT OF VERTICAL AXIS (I)							
Adjustment of CH1 DC BAL	VR2	X73-1500		HORIZ DISPLAY: A Vertical MODE: CH1 TRIG MODE: AUTO CH1 AC-GND-DC: GND CH1 VOLTS/DIV: 5mV CH1 X5 GAIN: PULL	(1) Turn CH1 VARIABLE knob to fully CCW. (2) Adjust CH1 \pm POSITION so that the trace becomes aligned with the horizontal center graticule line on the CRT screen. (3) Turn CH1 VARIABLE to CAL and make adjustment so that the trace becomes aligned with the horizontal center graticule line on the CRT screen. (4) Repeat the above procedure. <Check> [Movement of trace less than 0.3 div.]		<Note> If the trace does not come to the center of the screen even when \pm position is operated, adjust VR6 (X73-1500).
Adjustment of CH2 DC BAL	VR12	X73-1500		HORIZ DISPLAY: A Vertical MODE: CH2 TRIG MODE: AUTO CH2 AC-GND-DC: GND CH2 VOLTS/DIV: 5mV CH2 X5 GAIN: PULL	Same with the adjustment of CH1 DC BAL.		<Note> CH2 position center can be adjusted by VR16 (X73-1500).
CH1 Waveform Shaping in the Low Range (5mV range)	VR1	X73-1500	BNC-BNC cord PG-506	HORIZ DISPLAY: A Vertical MODE: CH1 TRIG MODE: AUTO A SOURCE: V MODE CH1 AC-GND-DC: DC CH1 VOLTS/DIV: 5mV CH1 VARIABLE: CAL	(1) Apply a 1 kHz square wave signal to CH1 INPUT and adjust the oscillator output to produce a waveform of 6 div on the CRT screen. (2) Adjust VR1 to shape the square waveform in the low range.		
CH2 Waveform Shaping in the Low Range (5mV range)	VR11	X73-1500		HORIZ DISPLAY: A Vertical MODE: CH2 TRIG MODE: AUTO A SOURCE: V MODE CH2 AC-GND-DC: GND CH2 VOLTS/DIV: 5mV CH2 VARIABLE: CAL	With vertical MODE selected to CH2, perform the same operations as described above to make adjustment.		

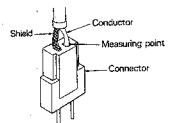
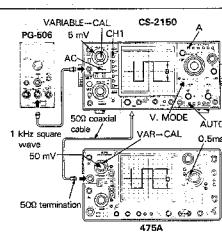
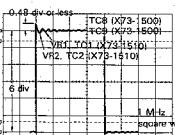
ADJUSTMENT

Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark		
Adjustment of CH1 Gain	VR7	X73-1500	BNC-BNC cord (T junction) PG-506	HORIZ DISPLAY: A Vertical MODE: CH1 TRIG MODE: AUTO A SOURCE: V MODE CH1 AC-GND-DC: DC CH1 VOLTS/DIV: 5mV CH1 VARIABLE: CAL 20MHz BW: ON	<p>(1) Apply a square wave signal of 20 mVp-p, 1 kHz to CH1 and CH2 INPUT. (2) Vertical MODE select to CH1 and operate CH1 \downarrow POSITION to produce a waveform in the center of the CRT screen. (3) Synchronize by operating A trigger LEVEL. (4) Adjust VR7 so that the vertical amplitude of the waveform becomes 4 div.</p> <p><Check> Turn CH1 VOLTS/DIV and input a reference signal so that the vertical amplitude will be 4 to 6 div in each range.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>Sensitivity error</td> <td>within $\pm 2\%$</td> </tr> </table>	Sensitivity error	within $\pm 2\%$	 <p>CS-2150</p> <p>PG-506</p>	<p><Reference></p> <p>Method of calculating of sensitivity error $\text{Sensitivity error} = \frac{a - b}{b} \times 100\%$</p> <p>a = CRT screen amplitude b = Input signal voltage : (VOLTS/DIV)</p> <p>(Example): CRT screen amplitude: 4.2 div Input signal: 20mVp-p 1 kHz square wave VOLTS/DIV: 5mV Sensitivity error = $\frac{4.2\text{div} - 20\text{mV}}{20\text{mV}/5\text{mV}} \times 100 = 5\%$</p> <p><Note></p> <p>Overshoot or tilt might appear to the reference signal of 1 kHz square wave. In this case, make coarse adjustment of square wave characteristics.</p>
Sensitivity error	within $\pm 2\%$								
Adjustment of CH2 Gain	VR18	X73-1500		HORIZ DISPLAY: A Vertical MODE: CH2 TRIG MODE: AUTO A SOURCE: V MODE CH2 AC-GND-DC: DC CH2 VOLTS/DIV: 5mV CH2 VARIABLE: CAL 20MHz BW: ON	<p>(1) With vertical MODE selected to CH2, turn VOLTS/DIV to 5 mV and perform the same operations as described above to make adjustment and check.</p> <p><Check></p> <p>(1) Select vertical MODE to DUAL and ALT position and turn VOLTS/DIV for CH1 and CH2 and apply a square wave of 20 mVp-p, 1 kHz to CH1 and CH2 INPUT jacks. Make sure that CH1 and CH2 have the same amplitude.</p> <p>(2) Switch vertical MODE to ADD and A SOURCE to CH1 (CH2) and press CH2 INV pushbutton switch (the lamp will go on when this switch is pressed). Operate \downarrow POSITION for CH1 and CH2 to produce a single trace in the center of the CRT screen. If a single and straight trace cannot be obtained, adjust VR7 again.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>Channel error</td> <td>within 2%</td> </tr> </table>	Channel error	within 2%		
Channel error	within 2%								
Adjustment of CH3 Gain and CH4 Gain	VR21 VR23	X73-1500 X73-1500	PG506	HORIZ DISPLAY: A Vertical MODE: QUAD, ALT A SOURCE: 1/1 B SOURCE: 1/1 A SWEEP TIME/DIV: 0.2ms TRIG MODE: AUTO CH1, CH2 AC GND-DC: GND	<p>(1) Apply a 0.5Vp-p, 1 kHz square wave signal simultaneously to CH3 and CH4 INPUT jacks and adjust A trigger LEVEL and B trigger LEVEL to obtain synchronization. Operate CH3 and CH4 \downarrow POSITION controls to bring the pattern to the center of the CRT screen.</p> <p>(2) Make adjustment so that the amplitude of CH3 and CH4 waveforms becomes 5 div respectively.</p> <p><Check></p> <p>(1) Sensitivity error must be within $\pm 2\%$. (See to reference for the adjustment of CH1 Gain) (2) With A SOURCE and B SOURCE switches set to 1/10, make the 1 kHz square wave signal 5 Vp-p and operate CH3 and CH4 \downarrow POSITION controls to bring the waveform to the center of the CRT screen. The amplitude at this time must be within the range of 4.9 - 5.1 div.</p>		<p><Note></p> <p>If tilt or overshoot occurs to the 1 kHz waveform, refer to the section devoted to CH3 and CH4 waveform shaping.</p>		

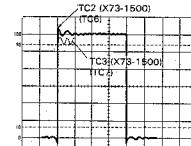
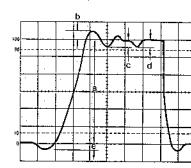
ADJUSTMENT

Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark
Adjustment of CH1 \downarrow POSITION and CH2 \downarrow POSITION	VR6 VR16	X73-1500 X73-1500		Vertical MODE: DUAL, ALT HORIZ DISPLAY: A TRIG MODE: AUTO CH1, CH2 VOLTS/DIV: 5mV CH1, CH2 AC-GND-DC: GND CH1, CH2 \downarrow POSITION: 12 o'clock A SWEEP TIME/DIV: 0.1ms	Adjust VR6 and VR16 so that the CH1 and CH2 traces become aligned with the horizontal center graticule line on the CRT screen. <Check> (1) The deviation from the horizontal center graticule line on the CRT screen must be within ± 1 div. (2) When \downarrow POSITION controls for both CH1 and CH2 are turned fully CW, each trace must move upward more than 4 div and when the knobs are turned fully CCW the trace must move downward more than 4 div.		
Adjustment of CH2 INV Position	VR17	X73-1500			Press CH2 INV (the lamp is on) and adjust VR17 to bring the trace to its position at CH2 NORM (the lamp is off). <Check> (1) Vertical deviation between CH2 NORM and INV must be within ± 0.5 div (2) Press CH2 INV and turn CH2 \downarrow POSITION fully CW and see if the trace moves more than 4 div upward and it moves more than 4 div downward when the knob is turned fully CCW.		
Adjustment of CH3 \downarrow POSITION and CH4 \downarrow POSITION	VR22 VR24	X73-1500 X73-1500		HORIZ DISPLAY: A Vertical MODE: QUAD, ALT A SOURCE: 1/1 B SOURCE: 1/1 TRIG MODE: AUTO CH3, CH4 \downarrow POSITION: 12 o'clock A SWEEP TIME/DIV: 0.1ms	Adjust VR22 and VR24 so that the CH3 and CH4 traces become aligned with the horizontal center graticule line on the CRT screen. <Check> (1) The deviation from the horizontal center graticule line on the CRT screen must be within ± 1 div. (2) When \downarrow POSITION controls for both CH3 and CH4 are turned fully CW, each trace must move upward more than 4 div and when the knobs are turned fully CCW, each trace must move downward more than 4 div.		
Adjustment of CH1 X5 Gain and CH2 X5 Gain	VR4 VR14	X73-1500 X73-1500	PG-506	HORIZ DISPLAY: A Vertical MODE: DUAL, ALT TRIG MODE: AUTO CH1, CH2 VOLTS/DIV: 5mV CH1, CH2 AC-GND-DC: DC CH1, CH2 X5 GAIN: PULL A SWEEP TIME/DIV: 0.2ms CH1, CH2 VARIABLE: CAL	(1) Apply a square wave signal of 5 mVp-p, 1 kHz to CH1 INPUT and make adjustment so that the CRT screen amplitude becomes 5 div. (2) Apply the same signal to CH2 and make the similar adjustment. <Check> (1) The sensitivity error must be within $\pm 2\%$ (2) For both CH1 and CH2, the lamp must go on when PULL X5 GAIN is pulled and go off when the knob is pressed. (3) The UNCAL lamp must go off when CH1 and CH2 VARIABLE controls are operated to CAL and go on when the knobs are turned to UNCAL. (CCW)		<Note> If no waveform appears on the screen when the knob is pulled, make coarse adjustment by operating X5 Gain Position Adjustment. CH1: VR5 (X73-1500) CH2: VR15 (X73-1500)
Adjustment of CH1 X5 Gain Position and CH2 X5 Gain Position	VR5 VR15	X73-1500 X73-1500		HORIZ DISPLAY: A Vertical MODE: DUAL, ALT TRIG MODE: AUTO CH1, CH2 VOLTS/DIV: 5mV CH1, CH2 AC-GND-DC: GND CH1, CH2 X5 GAIN: PULL CH1, CH2 \downarrow POSITION: 12 o'clock A SWEEP TIME/DIV: 0.1ms	Adjust VR5 and VR15 so that the traces of CH1 and CH2 become aligned with the horizontal center graticule line on the CRT screen. <Check> The distance from the center graticule line must be within ± 1 div.		<Note> If sometimes happens that the trace grows thicker at X5 GAIN, thus making it difficult to obtain proper adjustment. In this case, press 20 MHz BW (the lamp is on) button switch to make the line thinner.

ADJUSTMENT

Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark								
Adjustment of CH1 DC Trigger Level CH2 DC Trigger Level CH3 DC Trigger Level CH4 DC Trigger Level	VR10 VR19 VR1 VR2	X73-1500 X73-1500 X73-1520 X73-1520	DL-720	HORIZ DISPLAY: A Vertical MODE: QUAD CH1, CH2 AC-GND-DC: GND TRIG MODE: AUTO	(1) Operate CH1 and CH2 \downarrow POSITION and CH3 and CH4 \downarrow POSITION controls to align the trace with each other on the center of the CRT screen. (2) Make adjustment so that the voltage at all the check points may be zero (-0.008 - +0.008 V).		<Note> Use the connector lead for making measurement at the check points. Adjust the voltage in the conductor to zero.								
					<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Item of Adj</th> <th>Adj control</th> <th>Check point</th> </tr> </thead> <tbody> <tr> <td>CH1 DC Trigger Level</td> <td>VR10</td> <td>P15 (X73-1500)</td> </tr> <tr> <td>CH2 DC Trigger Level</td> <td>VR19</td> <td>P16 (X73-1500)</td> </tr> <tr> <td>CH3 DC Trigger Level</td> <td>VR1</td> <td>P17 (X73-1520)</td> </tr> <tr> <td>CH4 DC Trigger Level</td> <td>VR2</td> <td>P18 (X73-1520)</td> </tr> </tbody> </table>		Item of Adj	Adj control	Check point	CH1 DC Trigger Level	VR10	P15 (X73-1500)	CH2 DC Trigger Level	VR19	P16 (X73-1500)
Item of Adj	Adj control	Check point													
CH1 DC Trigger Level	VR10	P15 (X73-1500)													
CH2 DC Trigger Level	VR19	P16 (X73-1500)													
CH3 DC Trigger Level	VR1	P17 (X73-1520)													
CH4 DC Trigger Level	VR2	P18 (X73-1520)													
Adjustment of V MODE Trigger DC Level	VR20	X73-1500		Vertical MODE: CH1 CH1 AC-GND-DC: GND	(1) Operate CH1 \downarrow POSITION to align the trace with horizontal center graticule line on the CRT screen. (2) Make adjustment so that the voltage in the conductor of the connector P19 is zero (-0.008 - +0.008 V).										
Adjustment of CH1 OUT Gain	VR8	X73-1500	475A 500 Termination 500 Coaxial cable PG-506	HORIZ DISPLAY: A Vertical MODE: CH1 TRIG MODE: AUTO CH1 AC-GND-DC: AC CH1 VOLTS/DIV: 5mV CH1 VARIABLE: CAL	(1) Set the vertical axis sensitivity of oscilloscope (475A) to 50 mV and AC-GND-DC to DC. (2) Connect the cable to CH1 OUT on the rear panel of CS-2150 and oscilloscope (475A) via the 50Ω termination. (3) Apply a 1 kHz square wave signal to CH1 INPUT and adjust the oscillator output and \downarrow POSITION so that the amplitude may be 2 div upward and downward from the horizontal center graticule line on the CRT screen. (4) Make adjustment so that the oscilloscope (475A) waveform becomes 4 div.										
Adjustment of CH1 OUT DC Level	VR9	X73-1500	DL-720	HORIZ DISPLAY: A Vertical MODE: CH1 CH1 AC-GND-DC: GND TRIG MODE: AUTO	(1) Operate CH1 \downarrow POSITION to align the trace with the horizontal center graticule line on the CRT screen. (2) Make adjustment so that the voltage in the connector P21 (X73-1500) becomes less than OV (± 10 mV).										
Adjustment of Square wave Characteristics of CH3	VR1 TC1 VR2 TC2 TC8	X73-1510 X73-1510 X73-1510 X73-1510 X73-1500	PG-506 500 Termination	HORIZ DISPLAY: A Vertical MODE: QUAD, ALT TRIG MODE: AUTO CH1, CH2 AC-GND-DC: GND A SOURCE: CH3 1/1 A COUPLING: AC A SLOPE: +	(1) With A SOURCE to 1/1 (CH3) apply a 1 MHz square wave signal to CH3 INPUT and adjust the oscillator output to produce a square waveform of 6 div on the CRT screen. (2) Adjust VR1 and TC1 to shape the square waveform in the medium range. (3) Adjust VR2 and TC2 to shape the square waveform in the high range. (4) Adjust TC8 to shape the square waveform in the ultra-high range. <Check> <input type="checkbox"/> Overshoot less than 8%		<Note> When shaping the waveform, terminate the input terminal of oscilloscope to match the output impedance of the oscillator.								

ADJUSTMENT

Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark		
Adjustment of Square wave Characteristics of CH4	TC9	X73-1500	PG-506 50Ω Termination	HORIZ DISPLAY: B DLY/D Vertical MODE: QUAD, ALT TRIG MODE: AUTO CH1, CH2 AC-GND-DC: GND B SOURCE: CH4 1/1 B COUPLING: AC B SLOPE: +	Apply a 1 MHz square wave signal to CH4 INPUT and take the same steps as in (4) above to shape the waveform. <Check> <table border="1" style="margin-left: auto; margin-right: auto;"><tr><td>Overshoot</td><td>less than 8%</td></tr></table>	Overshoot	less than 8%		
Overshoot	less than 8%								
Adjustment of Square wave Characteristics of CH1 5 mV Range	TC3 TC2	X73-1500 X73-1500	PG-506 50Ω 2dB Attenuator 50Ω Termination 50 Ω Coaxial cable (BNC-BNC)	HORIZ DISPLAY: A TRIG MODE: AUTO CH1 AC-GND-DC: DC CH1 VOLTS/DIV: 5mV A SOURCE: CH1 A COUPLING: AC A SLOPE: + CH1 VARIABLE: CAL	(1) Set vertical MODE to CH1 and repeatedly apply a 1 MHz square wave signal to CH1 INPUT from the square wave oscillator and adjust the oscillator output so that the amplitude becomes 6 div. In doing this, the input terminal must be terminated to match the output impedance of the oscillator. When the output impedance is 50 Ω terminate the 50 Ω termination. (2) Adjust TC3 to shape the square waveform in the high range. (3) Adjust TC2 to shape the square waveform in the ultra-high range. <Check> <table border="1" style="margin-left: auto; margin-right: auto;"><tr><td>Overshoot</td><td>less than 8%</td></tr></table>	Overshoot	less than 8%		(1) Adjust A SWEEP TIME/DIV between 20 ns and 0.2 μs so that the waveform is visible. (2) As all measuring instruments are affected, repeat the adjustment individually.
Overshoot	less than 8%								
Adjustment of Square wave Characteristics of CH2 5 mV Range	TC7 TC6	X73-1500 X73-1500		HORIZ DISPLAY: A TRIG MODE: AUTO CH2 AC-GND-DC: DC CH2 VOLTS/DIV: 5mV A SOURCE: CH2 A COUPLING: AC A SLOPE: + CH2 VARIABLE: CAL	Set vertical MODE to CH2 and make adjustment as in the case of CH1. <Check> With VOLTS/DIV remaining at 5 mV, check the waveform quality when A SWEEP TIME/DIV is changed by varying the square wave frequency, from 100 kHz to 10 kHz, 1 kHz and back to 100 Hz sequentially. <Check> <table border="1" style="margin-left: auto; margin-right: auto;"><tr><td>Overshoot</td><td>less than 8%</td></tr></table>	Overshoot	less than 8%		
Overshoot	less than 8%								
CH1, CH2 Waveform Shaping in the Low Range (10 mV range)	TC1 TC5	X73-1500 X73-1500	PG-506 BNC-BNC cord	HORIZ DISPLAY: A Vertical MODE: CH1 or CH2 TRIG MODE: AUTO A SOURCE: V MODE CH1, CH2 AC-GND-DC: DC CH1, CH2 VOLTS/DIV: 10mV CH1, CH2 VARIABLE: CAL	(1) Apply a 1 kHz square wave signal to CH1 INPUT and adjust the oscillator output to produce a waveform of 5 ~ 6 div. In doing this, make adjustment so that the waveform quality of the 10mV range is equal to that of the 5 mV range. (2) Set vertical MODE to CH2 and make adjustment as in the case of CH1.				

ADJUSTMENT

Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark																											
Adjustment of CH1 ATT and CH2 ATT		S02-4502 -05	4343B PG-506	HORIZ DISPLAY: A CH1, CH2 AC-GND-DC: DC A SOURCE: V MODE A SWEEP TIME/DIV: 0.2 ms CH1, CH2 VARIABLE: CAL	<p>(1) Shaping of waveform Apply a 1 kHz square wave signal to CH1 and CH2 INPUT jacks and adjust the oscillator output to produce a waveform of 5~6 div. In doing this, make adjustment so that the waveform quality of each range is equal to that of the 5 mV range.</p> <p>(2) Input capacity (22 pF±3 pF) Connect a Q-meter (4343B) to CH1 and CH2 INPUT jacks and make adjustment so that the input capacity of each range is equal to that of the 5mV range.</p> <p style="text-align: center;">CH1 and CH2 Reference range: 5mV Range</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Sequence</th><th>Adjustment</th><th>Adj. control</th></tr> </thead> <tbody> <tr> <td>1</td><td>10mV range</td><td>Wave Shape</td></tr> <tr> <td>2</td><td>20mV range</td><td>Wave Shape</td></tr> <tr> <td>3</td><td>10mV range</td><td>Input Capacity</td></tr> <tr> <td>4</td><td>20mV range</td><td>Input Capacity</td></tr> <tr> <td>5</td><td>50mV range</td><td>Wave Shape</td></tr> <tr> <td>6</td><td>50mV range</td><td>Input Capacity</td></tr> <tr> <td>7</td><td>5V range</td><td>Wave Shape</td></tr> <tr> <td>8</td><td>5V range</td><td>Input Capacity</td></tr> </tbody> </table>	Sequence	Adjustment	Adj. control	1	10mV range	Wave Shape	2	20mV range	Wave Shape	3	10mV range	Input Capacity	4	20mV range	Input Capacity	5	50mV range	Wave Shape	6	50mV range	Input Capacity	7	5V range	Wave Shape	8	5V range	Input Capacity		<Note> Be sure to make the adjustment with the shield case being fitted in place.
Sequence	Adjustment	Adj. control																																
1	10mV range	Wave Shape																																
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7	5V range	Wave Shape																																
8	5V range	Input Capacity																																
CH3 Waveform Shaping	TC2 (A SOURCE 1/10)	X73-1520	PG-506	HORIZ DISPLAY: A Vertical MODE: QUAD, ALT A SOURCE: CH3 1/1 A SWEEP TIME/DIV: 0.2ms TRIG MODE: AUTO CH1, CH2 AC-GND-DC: GND	<p>(1) Apply a 1 kHz square wave signal of fast rise time to CH3 INPUT and adjust the oscillator output to produce a waveform of 6 div on the CRT screen.</p> <p>(2) With A SOURCE set to 1/10, produce a waveform of 6 div in the same manner and adjust TC3 to obtain the similar waveform as (1) above.</p>																													
CH4 Waveform Shaping	TC6 (B SOURCE 1/10)	X73-1520		HORIZ DISPLAY: DUAL Vertical MODE: QUAD, ALT A SOURCE: CH3 1/1 B SOURCE: CH4 1/1 A SWEEP TIME/DIV: 0.2ms B SWEEP TIME/DIV: 0.2ms	(1) Apply a 1 kHz square wave signal of fast rise time to CH4 INPUT and take the same steps as in (1) above to shape the waveform.																													
Adjustment of CH3 Input Capacity	TC3 (1/10)	X73-1520	4343B	A SOURCE: CH3 1/1	<p>(1) Check that the input capacity of CH3 becomes equal to the value of CH1 5mV range (22 pF±3 pF).</p> <p>(2) Make adjustment so that the input capacity of CH3 setted to 1/10 to become equal to that at 1/1.</p> <p style="text-align: center;"><Check></p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>The difference between A SOURCE 1/1 and A SOURCE 1/10: less than 1pF. It shall be the same with B SOURCE.</td> </tr> </table>	The difference between A SOURCE 1/1 and A SOURCE 1/10: less than 1pF. It shall be the same with B SOURCE.		<Note> Be sure to make adjustment of input capacity after making 1 kHz square waveshape.																										
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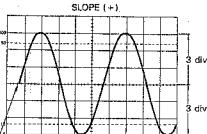
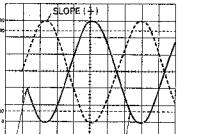
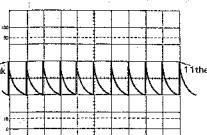
ADJUSTMENT

Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark
Adjustment of CH4 Input Capacity	TC7(1/10)	X73-1520	4343B	B SOURCE: CH4 1/1	Adjust the input capacity in the same manner as CH3. <Check> Check the input capacity in the same manner as CH3.		<Note> Be sure to make adjustment of input capacity after making 1 kHz square waveshape.
ADJUSTMENT OF VERTICAL AXIS (II)							
Check of 1 MHz Square wave Characteristics Square wave Characteristics of CH1 and CH2			PG-506 50Ω Termination	HORIZ DISPLAY: A A SOURCE: V MODE A SWEEP TIME/DIV: 0.2 μs ~ 20 ns TRIG MODE: AUTO A COUPLING: AC	(1) Check the square wave characteristics of CH1 and CH2 5 mV range. Turn the VOLTS/DIV knob for each channel to adjust the oscillator output so that CH1 and CH2 will produce a waveform of 6 div, respectively. (2) The overshoot must be less than 3% for each range.		<Note> As the VOLTS/DIV is manually rotated, the amplitude of 6 div cannot be obtained amplitude.
Square wave Characteristics of CH3 and CH4				HORIZ DISPLAY: DUAL, ALT Vertical MODE: QUAD, ALT A SOURCE: CH3 1/1 B SOURCE: CH4 1/1	(1) Apply a 1 MHz square wave signal to CH3 and CH4 INPUT jacks and see if the overshoot is less than 8% at this time. (2) The overshoot must be less than 8% when A SOURCE is turned from 1/1 to 1/10 and B SOURCE from 1/1 to 1/10.		
Check of CH1 and CH2 Frequency Characteristics			SG-503 500 Coaxial cable (BNC-BNC) 50Ω 20dB Attenuator 500 Termination	HORIZ DISPLAY: A TRIG MODE: AUTO A SOURCE: V MODE A COUPLING: AC CH1, CH2 AC-GND-DC: DC A SWEEP TIME/DIV: 2μs ~ 20 ns	(1) With CH1 VOLTS/DIV set to 5 mV, apply a sine wave signal of 50 kHz to INPUT and adjust the oscillator output to produce a waveform of 6 div on the CRT screen. (2) When the frequency is varied to 150 MHz with the oscillator output remaining unchanged, the amplitude on the screen must be over 4.25 div and there must be no sudden dips and peaks during attenuation. (3) Perform the same operations for CH2. <div style="border: 1px solid black; padding: 2px; display: inline-block;">Frequency characteristic 150 MHz, less than -3 dB</div> (4) When the specification are not satisfied, readjust the 1 MHz square wave characteristics.		
Adjustment of CH3 and CH4 Frequency Characteristics	TC4 (CH3 1/10) TC8 (CH4 1/10)	X73-1520	SG-503 500 Termination 500 Coaxial cable (BNC-BNC)	HORIZ DISPLAY: DUAL Vertical MODE: QUAD, ALT TRIG MODE: AUTO A SOURCE: CH3 1/1 B SOURCE: CH4 1/1	(1) Apply a sine wave signal of 50 kHz to CH3 INPUT and adjust the oscillator output to produce a waveform of 6 div on the CRT screen. (2) When the frequency is changed to 100 MHz with the oscillator output remaining unchanged, the amplitude on the screen must be over 4.25 div. (3) With A SOURCE to 1/10 position adjust TC4 so that the amplitude at 100 MHz is within the specification limits. <div style="border: 1px solid black; padding: 2px; display: inline-block;">Frequency characteristic 100 MHz, less than -3 dB</div> (4) Perform the same operations for CH4. (5) When the specification is not satisfied, readjust the 1 MHz square wave characteristics. (6) Perform the same adjustment for B SOURCE (TC8).		

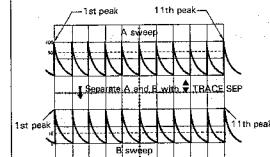
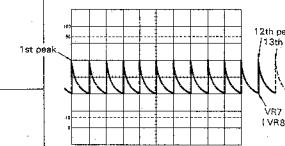
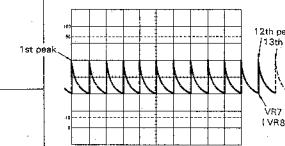
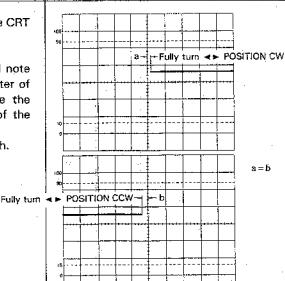
ADJUSTMENT

Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark
Check of CH1 and CH2 X5 GAIN Frequency Characteristics			SG-503 50Ω Termination	HORIZ DISPLAY: A A SOURCE: V MODE TRIG MODE: AUTO CH1, CH2 AC-GND-DC: DC CH1, CH2 VOLTS/DIV: 5mV CH1, CH2 X5 GAIN: PULL	(1) With vertical MODE set to CH1, apply a sine wave signal of 50 kHz to CH1 INPUT and adjust the oscillator output to produce a waveform of 6 div on the CRT screen. (2) When the frequency is varied to 100 MHz with the oscillator output remaining unchanged, the amplitude on the screen must be over 4.25 div. (3) Set vertical MODE to CH2 and make a similar check. X5 GAIN frequency characteristic 100 MHz, less than -3 dB.		
Check of 20 MHz BW Frequency Characteristics			SG-503 50Ω Termination	HORIZ DISPLAY: A Vertical MODE: CH1 A SOURCE: V MODE CH1 AC-GND-DC: DC CH1 VOLTS/DIV: 5mV 20 MHz BW: ON TRIG MODE: AUTO	(1) Apply a sine wave signal of 50 kHz to CH1 INPUT to produce a waveform of 6 div. (2) Vary the frequency of the input signal without changing to oscillator output and read the frequency at which the amplitude on the screen becomes 4.25 div. This frequency must be within the specification limits. 20 MHz BW frequency characteristic frequency of -3dB: 15 MHz to 25 MHz.		
Adjustment of CH1 OUT Frequency Characteristics	TC4	X73-1500	475A 500Ω Termination (through type) 500 Coaxial cord (BNC-BNC) SG-503	CH1 AC-GND-DC: AC CH1 VOLTS/DIV: 5mV CH1 POSITION: 12 o'clock	(1) With the vertical axis sensitivity of 475A set to 50 mV, lead a 50Ω coaxial cable from CH1 OUT and terminate it with 50Ω termination and connect it to CH1 OUT of 475A. (2) Apply a sine wave signal of 50 kHz to CH1 INPUT and adjust the oscillator output so that the vertical amplitude of 475A becomes 6 div. When the frequency is varied to 100 MHz without changing the oscillator output, adjust TC4 so that the amplitude on the CRT screen of 475A becomes over 4.25 div. CH1 OUT frequency characteristic 100 MHz, less than -3 dB.		<Note> If the square wave characteristics of CH1 PRE-AMP and V. OUTPUT AMP are readjusted the square wave characteristic and frequency characteristic will also change.
Adjustment of CAL Output	VR16 VR17	X74-1350 X74-1350	475A FC-756 DL-720		(1) Short-circuit TP1 (X74-1350) and adjust VR17 so that the voltage at CAL output terminal becomes 1.0 V \pm 1%. (2) Set the vertical axis sensitivity of 475A to 20 mV and the sweep time to 0.2 ms. (3) Lead a probe from the calibration voltage output terminal (CAL) of CS-2150 and connect it to CH1 INPUT of 475A. (4) Adjust VR16 so that the frequency becomes 1 kHz. <Check> Frequency: within 1 kHz \pm 3%. Output voltage: within 1.0 Vp-p \pm 1%. Duty ratio: within (50 \pm 2)%		<Note> For checking the frequency, a frequency counter (FC-756) may be used.

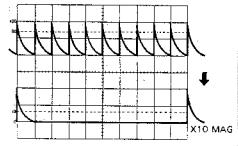
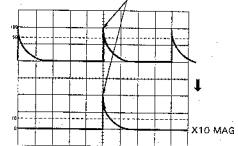
ADJUSTMENT

Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark	
ADJUSTMENT OF HORIZONTAL SWEEP								
Coarse Adjustment of A and B Trigger Center and SLOPE			SG-502	HORIZ DISPLAY: A Vertical MODE: CH1 TRIG MODE: AUTO CH1 AC-GND-DC: AC A SWEEP TIME/DIV: 0.2ms A SOURCE: V MODE A COUPLING: AC A trigger LEVEL: 12 o'clock A SLOPE: +	(1) Apply a sine wave signal of 1 kHz to CH1 INPUT and adjust the oscilloscope output and \downarrow POSITION to produce a waveform of amplitude 3 div above and below the horizontal center graticule line on the CRT screen. (2) Adjust VR2 so that the starting point of the waveform is aligned with the horizontal center graticule line on the CRT screen. (3) Set A SLOPE to (-) and adjust VR4 to bring the starting point to the position of the starting point of the waveform produced when A SLOPE is set to (+).	 Align the starting point with the horizontal center graticule line		
Coarse Adjustment of A Trigger Center and SLOPE	VR2 VR4	X77-1280 X77-1280				 Align SLOPE (-) with the starting point of SLOPE (+)		
Coarse Adjustment of B Trigger Center and SLOPE	VR2 VR3	X77-1290 X77-1290	SG-502	HORIZ DISPLAY: DUAL Vertical MODE: CH1 A SOURCE: V MODE B SOURCE: CH1 B COUPLING: AC B trigger LEVEL: 12 o'clock B SLOPE: + A SWEEP TIME/DIV: 0.5 ms B SWEEP TIME/DIV: 0.2 ms TRIG MODE: AUTO \downarrow TRACE SEP: NORM	(1) Set A INTENSITY to fully CCW. (2) Apply a sine wave signal of 1 kHz to CH1 INPUT and adjust the oscillator output and \downarrow POSITION to produce a waveform of amplitude 3 div above and below the horizontal center graticule line on the CRT screen. (3) Adjust VR2 so that the starting point of the waveform is aligned with the horizontal center graticule line on the CRT screen. (4) Next, set B SLOPE to (-) and adjust VR3 to bring the starting point of the waveform to the position of the starting point of the waveform produced when B SLOPE is set to (+).			
Adjustment of A Sweep Time	VR9	X74-1350	TG-501 50Ω Termination	HORIZ DISPLAY: A Vertical MODE: CH1 A SOURCE: V MODE A SWEEP TIME/DIV: 0.5ms TRIG MODE: AUTO A VARIABLE: CAL	(1) Apply a marker signal of 0.5 ms to CH1 INPUT. (2) Operate \leftrightarrow POSITION to bring the first peak of the marker signal to the left end of the graticule line and adjust VR9 for the 11th peak to the right end of the graticule line.	 1st peak 11th peak	<p><Note></p> <p>(1) When TG-501 is used, set CH1 AC-GND-DC to AC, VOLTS/DIV to 0.5/V/div, thru 50Ω termination.</p> <p>(2) If the 11th peak is not visible, adjust VR7 (X74-1350) for A sweep length adjustment.</p>	

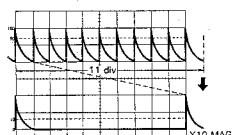
ADJUSTMENT

Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark
Adjustment of B Sweep Time	VR10	X74-1350	TG-501 50Ω Termination	HORIZ DISPLAY: DUAL Vertical MODE: CH1 A SOURCE: V MODE B SOURCE: CH1 A SWEEP TIME/DIV: 0.5ms B SWEEP TIME/DIV: 0.5ms TRIG MODE: AUTO A, B SLOPE: + A, B INTENSITY: Fully CW DELAY TIME MULT: 0.20	(1) Apply a marker signal of 0.5 ms to CH1 INPUT. (2) On the screen A and B sweeps of CH1 input signal will appear. Operate ↓ TRACE SEP to bring these sweeps into the positions where they can be easily adjusted. (3) Make adjustment so that the first peak of B sweep is brought to the left end of the graticule line on the screen and the 11th peak to the right end of graticule line on the screen. (4) Make sure that A and B TRIG'D lamps are on.		<Note> 1. When TG-501 is used, the knobs must be operated in the same manner as described above. 2. If the 11th peak is not visible, adjust VR8 (X74-1350) for B sweep length adjustment. 3. The B sweep time will not change even if A VARIABLE is turned.
Adjustment of A Sweep Length	VR7	X74-1350	TG-501 50Ω Termination	HORIZ DISPLAY: A Vertical MODE: CH1 A SOURCE: V MODE A SWEEP TIME/DIV: 0.5ms TRIG MODE: AUTO	(1) Apply a marker signal of 0.5 ms to CH1 INPUT. (2) Make adjustment so that the total length is 12 div.		<Note> Turn ← → POSITION to shift the base line two markers to the left then you can see the 12th time marker with the graticule area.
Adjustment of B Sweep	VR8	X74-1350		HORIZ DISPLAY: DUAL Vertical MODE: CH1 A SOURCE: V MODE B SOURCE: CH1 A SWEEP TIME/DIV: 0.5ms B SWEEP TIME/DIV: 0.5ms TRIG MODE: AUTO A, B SLOPE: + A, B INTENSITY: Fully CW DELAY TIME MULT: 0.20	(1) Apply a marker signal of 0.5 ms to CH1 INPUT. (2) A and B sweeps will appear on the screen. Use ↓ TRACE SEP to separate them. (3) Make adjustment so that the total length of B sweep is 12 div.		
Adjustment of A Sweep Position	VR11	X74-1350		HORIZ DISPLAY: A Vertical MODE: CH1 A SOURCE: V MODE A SWEEP TIME/DIV: 0.5ms TRIG MODE: AUTO	(1) Set CH1 AC-GND-DC to GND to bring the trace to the center of the CRT screen. (2) Set the FINE knob of ← → POSITION to 12 o'clock. (3) Turn ← → POSITION fully CW without turning the FINE knob and note the deviation between the starting point of the trace and the center of the screen. Next, turn ← → POSITION fully CCW and measure the distance between the ending point of the trace and the center of the screen. Make adjustment so that these deviations will have the same width. Width error less than 1 div.		

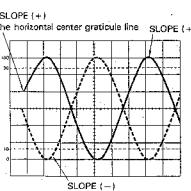
ADJUSTMENT

Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark
Adjustment of B Sweep Position	VR12	X74-1350	TG-501 50Ω Termination	HORIZ DISPLAY: DUAL Vertical MODE: CH1 A SOURCE: V MODE B SOURCE: CH1 A,B SWEEP TIME/DIV: 0.5ms TRIG MODE: AUTO A, B SLOPE: + A, B INTENSITY: Fully CW DELAY TIME MULT: 0.20	(1) Apply a marker signal of 0.5 ms to CH1 INPUT and align the first peak of A sweep to the leftmost division of the CRT screen. (2) Operate \downarrow TRACE SEP to separate A sweep and B sweep and set A VARIABLE to CAL. (3) Make adjustment so that the starting point of B sweep is aligned with that of A sweep in the horizontal position. <Check> Operate \downarrow TRACE SEP so that A sweep and B sweep are superimposed on one another and make sure that their starting points coincide with each other.		
Adjustment of X10 MAG Gain	VR13	X74-1350	TG-501 50Ω Termination	HORIZ DISPLAY: A Vertical MODE: CH1 A SOURCE: V MODE A SWEEP TIME/DIV: 0.1ms TRIG MODE: AUTO CH1 VOLTS/DIV: 1V CH1 AC GND-DC: DC	(1) Apply a marker signal of 0.1 ms to CH1 INPUT to produce a waveform of vertical amplitude of about 2 div. (2) Align the first peak of the marker signal with the left end of the graticule line on the CRT screen and the 11th peak with the right end and pull the X10 MAG switch. (3) Make adjustment so that the peak-to-peak distance is 10 div. <Check> Specification 10 times $\pm 5\%$		
Adjustment of X10 MAG Center	VR14	X74-1350		HORIZ DISPLAY: A Vertical MODE: CH1 A SOURCE: V MODE A SWEEP TIME/DIV: 0.1ms A VARIABLE: CAL TRIG MODE: AUTO A SLOPE: +	(1) Apply a marker signal of 0.5 ms to CH1 INPUT to produce 3 peaks waveform on the CRT screen. (2) Operate \leftrightarrow POSITION to bring the central peak to the vertical center graticule line on the screen. (3) Make adjustment so that the waveform will be aligned with the vertical center graticule line on the screen when the FINE knob is pulled out (X10 MAG position). <Check> Repeatedly push and pull the FINE knob to make sure that the center of the waveform does not move. Deviation less than 1 div.		
Adjustment of MAG Center and Gain					Recheck the center at X10 MAG and Gain.		
Adjustment of A Sweep Time, 50ms, 5μs and 0.1μs.	VR2 (50ms) VR1 (5μs) TC1 (0.1μs)	X74-1350 X74-1350 X74-1350	TG-501 50Ω Termination	HORIZ DISPLAY: A Vertical MODE: CH1 A SOURCE: V MODE TRIG MODE: AUTO A VARIABLE: CAL	(1) With A SWEEP TIME/DIV set to 50ms apply a marker signal of 50ms to CH1 INPUT. (2) Adjust VR2 so that the first peak of the marker signal is aligned with the left end of the graticule on the screen and the 11th peak with the right end. (3) Next, rotate the A SWEEP TIME/DIV to 5μs and apply a 5μs time marker to CH1 INPUT and adjust VR1 in the same manner as (2). (4) Next, A SWEEP TIME/DIV to 0.1μs and with 0.1μs time marker to CH1 INPUT, adjust TC1 in the same manner as (2).		

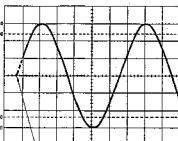
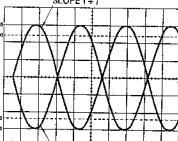
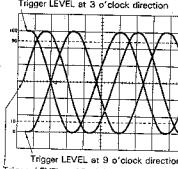
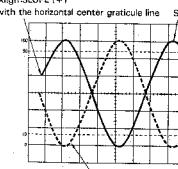
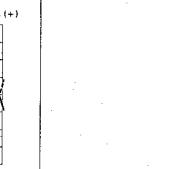
ADJUSTMENT

Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark		
Adjustment of B Sweep Time 50ms, 5μs and 0.1μs	VR4 (50ms) VR3 (5μs) TC2 (0.1μs)	X74-1350 X74-1350 X74-1350	TG-501 50Ω Termination	HORIZ DISPLAY: DUAL Vertical MODE: CH1 A SOURCE: V MODE B SOURCE: CH1 A,B SWEEP TIME/DIV: 0.5ms TRIG MODE: AUTO A, B SLOPE: + A, B INTENSITY: Fully CW DELAY TIME MULT: 0.20	(1) Set A and B SWEEP TIME/DIV to 50ms and apply a marker signal of 50ms to CH1. (2) Operate \downarrow TRACE SEP to separate A sweep and B sweep to be in the positions where adjustment can be made easily. (3) Adjust VR4 so that the first peak of the marker signal is aligned with the left end of the graticule line on the screen and the 11th peak with the right end. (4) Rotate A and B SWEEP TIME/DIV to 5μs and apply a 5μs time marker to CH1 INPUT and adjust VR3 in the same manner as (3). (5) Next, A and B SWEEP TIME/DIV to 0.1μs and with 0.1μs times marker to CH1 INPUT, adjust TC2 in the same manner as (3).				
Adjustment of 20ns A Sweep Linearity	TC3 TC5	X74-1350		HORIZ DISPLAY: A Vertical MODE: CH1 A SOURCE: V MODE A SWEEP TIME/DIV: 20ns A VARIABLE: CAL TRIG MODE: AUTO A SLOPE: +	(1) Apply a marker signal of 20ns to CH1 INPUT. (2) Make adjustment so that the total length of the waveform is 11 div. (3) Adjust TC5 to align the first peak of the marker signal with the left end of the graticule line and 2nd peak of marker signal with the right end of the graticule line when the FINE knob pulled out ($\times 10$ MAG position).				
Adjustment of 20ns B Sweep Linearity	TC4 TC6	X74-1350		HORIZ DISPLAY: DUAL Vertical MODE: CH1 A SOURCE: V MODE B SOURCE: CH1 TRIG MODE: AUTO A, B SLOPE: + A, B INTENSITY: Fully CW DELAY TIME MULT: 1.00	(1) With A and B SWEEP TIME/DIV to 20ns, apply a marker signal of 20ns to CH1 INPUT. (2) Operate \downarrow TRACE SEP to separate A sweep and B sweep into the positions where they can be easily adjusted. (3) Make adjustment so that the total length of the waveform is 11 div. (4) Adjust TC6 to align the first peak of the marker signal with the left end of the graticule line and 2nd peak of marker signal with the right end of the graticule line when the FINE knob pulled out ($\times 10$ MAG position).				
Check of Sweep Time Error in All the Range	(I)			HORIZ DISPLAY: A Vertical MODE: CH1 A SOURCE: V MODE TRIG MODE: AUTO A VARIABLE: CAL	(1) Apply a reference time marker signal for each range of A SWEEP TIME/DIV. (2) Measure the time error rate and make sure it is within the specification limits. <table border="1"><tr><td>Specification</td><td>within $\pm 2\%$.</td></tr></table>	Specification	within $\pm 2\%$.		
Specification	within $\pm 2\%$.								
	HORIZ DISPLAY: DUAL Vertical MODE: CH1 A SOURCE: V MODE B SOURCE: CH1 A VARIABLE: CAL TRIG MODE: AUTO A, B SLOPE: + A, B INTENSITY: Fully CW DELAY TIME MULT: 1.00	(1) Operate \downarrow TRACE SEP to separate A sweep and B sweep into the positions where they can be easily adjusted. (2) Apply a reference time marker signal in each of all the ranges (50ms – 20ns) of B sweep. (3) Measure the time error rate and make sure it is within the specification limits. <table border="1"><tr><td>Specification</td><td>within $\pm 2\%$.</td></tr></table>	Specification	within $\pm 2\%$.					
Specification	within $\pm 2\%$.								

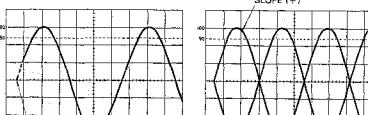
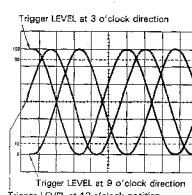
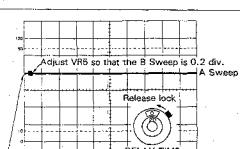
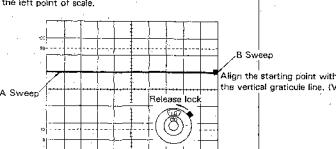
ADJUSTMENT

Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark		
ADJUSTMENT OF X-Y OPERATION									
Adjustment of X Position Center	VR15	X74-1350		HORIZ DISPLAY: A Vertical MODE: DUAL, ALT CH1, CH2 VOLTS/DIV: 5mV CH1, CH2 AC-GND-DC: GND A SOURCE: CH1 TRIG MODE: AUTO A SWEEP TIME/DIV: 0.1ms	<p>(1) Operate \downarrow POSITION for both CH1 and CH2 to superimpose the two traces on one another in the center of the CRT screen. (2) Make adjustment so that the bright spot comes to the center of the screen when HORIZ DISPLAY is switched in X-Y.</p> <p><Check> Operate CH2 \downarrow POSITION and make sure that the spot will move as described below. (1) When the knob is turned counterclockwise, the spot moves leftward more than 5 div. (2) When the knob is turned clockwise, the spot moves rightward more than 5 div.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>Distance between the spot and the center of the screen.</td> <td>within ± 1 div from the center of the screen.</td> </tr> </table>	Distance between the spot and the center of the screen.	within ± 1 div from the center of the screen.		<Note> When making X-Y adjustment, do not set both CH1 and CH2 to X5 GAIN.
Distance between the spot and the center of the screen.	within ± 1 div from the center of the screen.								
Adjustment of X Gain	VR25	X73-1500	PG-506	HORIZ DISPLAY: X-Y CH2 AC-GND-DC: AC CH2 VOLTS/DIV: 5mV	Apply a square wave signal of 20 mVp-p, 1 kHz to CH2 INPUT and make adjustment so that the horizontal amplitude is 4 div.				
Readjustment of X Position Center and X Gain					Readjust X position Center and X Gain.				
Check of X Axis Frequency Characteristic			SG-502	HORIZ DISPLAY: X-Y CH2 AC-GND-DC: DC CH2 VOLTS/DIV: 5mV	<p>(1) Apply a sine wave signal of 1 kHz to CH2 INPUT and adjust the oscillator output to produce a waveform of 10 div. (2) When the frequency is varied to 5 MHz without changing the oscillator output, the amplitude must be over 7.1 div (-3 dB).</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>Frequency characteristic</td> <td>DC to 5 MHz, less than -3 dB.</td> </tr> </table>	Frequency characteristic	DC to 5 MHz, less than -3 dB.		
Frequency characteristic	DC to 5 MHz, less than -3 dB.								
ADJUSTMENT OF TRIGGERING									
Adjustment of A Slope	VR4	X77-1280	SG-502	HORIZ DISPLAY: A Vertical MODE: CH1 A SOURCE: V MODE A COUPLING: AC CH1, CH2 AC-GND-DC: AC CH1, CH2 VOLTS/DIV: 5mV A SWEEP TIME/DIV: 0.2ms A SLOPE: + TRIG MODE: AUTO	<p>(1) Apply a sine wave signal of 1 kHz to CH1 INPUT and adjust the oscillator output to produce a waveform of 4-6 div on the CRT screen. (2) Operate A trigger LEVEL and CH1 \downarrow POSITION so that the waveform may have an amplitude equally above and below the horizontal center graticule line on the CRT screen. (3) Set A SLOPE to (+) and make adjustment so that the starting point of the waveform will be in the position of the starting point of the waveform when A SLOPE is in the (+) position.</p> <p><Check></p> <p>(1) Repeatedly turn the A SLOPE knob from (+) to (-) and make sure that the starting points are in the same positions. (2) Make sure that the rise slope of the waveform will be synchronized when the A SLOPE knob is in the (+) position and the fall slope will be synchronized when the knob is in the (-) position. (3) Feed the same signal to CH2 and set vertical MODE to CH2 to produce a waveform of CH2 and make sure that the rise slope of the waveform is synchronized when the A SLOPE knob is at (+) and the fall slope is synchronized when it is at (-) position.</p>	 <p>Align SLOPE (+) with the horizontal center graticule line SLOPE (-)</p>			

ADJUSTMENT

Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark
Adjustment A Trigger Level Center and Fix Sensitivity	VR2 VR3	X77-1280 X77-1280	SG-502	HORIZ DISPLAY: A Vertical MODE: CH1 A SOURCE: V MODE A COUPLING: AC CH1, CH2 AC-GND-DC: AC CH1, CH2 VOLTS/DIV: 5mV A SWEEP TIME/DIV: 0.2ms A SOURCE: + TRIG MODE: AUTO	<p>(1) Set A trigger LEVEL to 12 o'clock. (2) Apply a sine wave signal of 1 kHz to CH1 INPUT and adjust the oscillator output to produce a waveform of 4~6 div on the CRT screen. (3) Operate CH1 \downarrow POSITION to move the waveform so that its amplitude is equally above and below the horizontal center graticule line on the CRT screen. (4) Adjust VR2 so that the starting point of the waveform is on the horizontal center graticule line on the CRT screen. (5) Turn FIX knob and adjust the sine wave input signal of CH1 to obtain a waveform of 1 div. (6) When A SLOPE is alternately turned to (+) and (-), adjust VR3 to synchronize. (7) Repeat (2)~(6) procedures for several times.</p> <p><Check></p> <p>(1) When A SLOPE is alternately turned to (+) and (-), the starting point must be always on the horizontal center graticule line. (2) With A SLOPE remaining in the position of (+), turn trigger LEVEL clockwise toward 3 o'clock from near 9 o'clock and see if the waveform is as shown at right. (3) Adjust the oscillator output so that the waveform amplitude becomes 0.5 div and make sure that synchronization can be obtained by A trigger LEVEL.</p>	 <p>Align the starting point with the horizontal center graticule line</p>  <p>SLOPE (+)</p> <p>SLOPE (-)</p>	
Adjustment of 150 MHz Trigger	TC1 TC1	X77-1280 X77-1290	SG-503	A, B SOURCE: CH1	<p>(1) Apply a 150 MHz sine wave signal to CH1 INPUT and adjust the oscillator output to produce a waveform of 2 div on the CRT screen. (2) Adjust TC1 so that the waveform is synchronized at 2 div.</p> <p><Check></p> <p>Adjust the oscillator output so that the waveform amplitude becomes 1.5 div and make sure that synchronization can't be obtained by trigger LEVEL.</p>	 <p>Trigger LEVEL at 3 o'clock direction</p>  <p>Trigger LEVEL at 9 o'clock direction</p> <p>Trigger LEVEL at 12 o'clock position</p>	
Adjustment of B Slope	VR3	X77-1290	SG-502	HORIZ DISPLAY: DUAL Vertical MODE: CH1 A SOURCE: V MODE B SOURCE: CH1 A, B COUPLING: AC CH1, CH2 AC-GND-DC: AC CH1, CH2 VOLTS/DIV: 5mV A, B SWEEP TIME/DIV: 0.2ms A VARIABLE: CAL A, B SLOPE: + TRIG MODE: AUTO A, B INTENSITY: Fully CW	<p>(1) Apply a sine wave signal of 1 kHz to CH1 INPUT and adjust the oscillator output to produce a waveform of 4~6 div on the CRT screen. (2) Operate A trigger LEVEL, B trigger LEVEL and CH1 \downarrow POSITION to move waveform so that its amplitude is equally above and below the horizontal center graticule line on the screen. (3) Set A INTENSITY to CCW and B INTENSITY to an arbitrary position near 3 o'clock. (4) Set B SLOPE to (-) and make adjustment so that the starting point of the waveform comes to the same position of the starting point of waveform when B SLOPE is in the (+) position.</p> <p><Check></p> <p>(1) Turn B SLOPE knob alternately to (+) and (-) and make sure that the starting point is always on the horizontal center graticule line. (2) When B SLOPE is in the (+) position, the rise slope of the waveform should be synchronized and its fall slope be synchronized at (-). (3) Apply the same signal to CH2 and set vertical MODE to CH2 to produce a waveform of B sweep of CH2 on the screen to make sure that the rise slope of the waveform is synchronized when B SLOPE is at (+) and the fall slope is synchronized at (-).</p>	 <p>Align SLOPE (+) with the horizontal center graticule line</p>  <p>SLOPE (+)</p> <p>SLOPE (-)</p>	

ADJUSTMENT

Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark	
Adjustment of B Trigger Level Center	VR2	X77-1290	SG-502	HORIZ DISPLAY: DUAL Vertical MODE: CH1 A, B COUPLING: AC CH1, CH2 AC-GND-DC: AC CH1, CH2 VOLTS/DIV: 5mV A,B SWEEP TIME/DIV: 0.2ms A VARIABLE: CAL B SOURCE: CH1	<p>(1) Turn B trigger LEVEL knob to 12 o'clock. (2) Apply a sine wave signal of 1 kHz to CH1 INPUT and adjust the oscillator output to produce a waveform of 4 ~ 6 div on the CRT screen. (3) Operate CH1 ∇ POSITION so that the waveform has an amplitude equally above and below the horizontal center graticule line on the screen. (4) Turn A INTENSITY to CCW and B INTENSITY to position near 3 o'clock and make adjustment so that the starting point of the waveform is on the horizontal center graticule line.</p> <p><Check></p> <p>(1) Turn B SLOPE alternately to (+) and (-) and make sure that the starting point of the waveform is always on the horizontal center graticule line. (2) With B SLOPE knob remaining in the (+) position, turn trigger LEVEL knob clockwise toward 3 o'clock from near 9 o'clock and see if the waveform appear as shown at right. (3) Adjust the oscillator output so that the waveform amplitude becomes 0.5 div and make sure that synchronization is obtained at this time by operating B trigger LEVEL.</p>	 <p>Align the starting point with the horizontal center graticule line.</p>	 <p>Trigger LEVEL at 3 o'clock direction</p> <p>Trigger LEVEL at 9 o'clock direction</p> <p>Trigger LEVEL at 12 o'clock position</p>	
Adjustment of DELAY TIME MULT	VR5 VR6	X74-1350 X74-1350		HORIZ DISPLAY: ALT Vertical MODE: CH1 CH1 AC-GND-DC: GND TRIG MODE: AUTO A SWEEP TIME/DIV: 0.1ms B SWEEP TIME/DIV: 1μs ∇ TRACE SEP: NORM STARTS AFTER DELAY: PULL	<p>(1) Set DELAY TIME MULT to 0.20. (2) Operate A INTENSITY and B INTENSITY properly to make B trace brighter and A trace light dimmer. (3) Operate \blacktriangleleft POSITION to bring the starting point of A trace to the left end of the graticule line on the CRT screen. (4) Make adjustment so that B trace may appear as shown at right. (5) Next, set DELAY TIME MULT to 10.00. (6) Repeat (1) thru (5) 2 or 3 times.</p> <p><Check></p> <p>Set DELAY TIME MULT to 5.00 and make sure that the starting point of B trace is in a position within 5 div ± 0.2 div from the left end of the screen.</p>	 <p>Adjust VR6 so that the B Sweep is 0.2 div.</p> <p>A Sweep</p>	 <p>Release lock</p> <p>B Sweep</p> <p>A Sweep</p>	<p>Release lock</p> <p>Align the starting point with the left end of scale.</p> <p>Align the starting point with the vertical graticule line. (VR6)</p>

ADJUSTMENT

Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark
OPERATING CHECKS							
Check of Current CAL			Current probe P6302 AM503 475A		<p>Touch a current probe to current CAL terminal on the rear panel to make sure that the calibration current is $1\text{ kHz} \pm 3\%$ and $10\text{ mA} \pm 2\%$.</p>		
Check of Trigger Sensitivity			SG-502 SG-503 475A	<p>Vertical MODE: CH1 CH1 VOLTS/DIV: 5mV A, B SWEEP TIME/DIV: arbitrary position CH1 AC-GND-DC: AC TRIG MODE: NORM</p>	<p>(1) Make measurements of trigger sensitivity according to the table given next page. (For both A and B sweeps)</p> <p>[I] A Sweep, INT</p> <p>(1) Set HORIZ DISPLAY to A and A SOURCE to CH1. (2) Apply a sine wave signal to CH1 INPUT, vary the oscillator output and operate A trigger LEVEL to measure the minimum synchronizing amplitude on the CRT screen. When doing this, make sure that the A TRIG'D lamp is on. Check synchronization by each check frequency.</p> <p>[II] B Sweep, INT</p> <p>(1) Set HORIZ DISPLAY to B DLY'D, A SOURCE to CH1 and B SOURCE to CH1. (2) Apply a sine wave to CH1 INPUT, vary the oscillator output and operate B trigger LEVEL to measure the minimum synchronizing amplitude. When doing this, make sure that the A TRIG'D and B TRIG'D lamps are on. Check synchronization by each frequency.</p> <p>[III] A Sweep, EXT</p> <p>(1) Set HORIZ DISPLAY to A and A SOURCE to EXT 1/1 or 1/10. (2) Apply a signal of the same voltage simultaneously to CH1 and CH3 INPUT jacks. (3) Operate CH1 VOLTS/DIV to produce a waveform of 6 div on the CRT screen. (4) Vary the oscillator output and operate A trigger LEVEL to measure the minimum synchronizing amplitude by the oscilloscope (475A). Check synchronization by each check frequency. When doing this, make sure that A TRIG'D lamp is on.</p> <p>[IV] B Sweep, EXT</p> <p>(1) Set HORIZ DISPLAY to ALT, A SOURCE to CH1 and B SOURCE to EXT 1/1 or 1/10. (2) Apply a signal of the same voltage simultaneously to CH1 and CH4 INPUT jacks. (3) Operate CH1 VOLTS/DIV to produce a waveform of 6 div on the CRT screen. (4) Operate B trigger LEVEL and A trigger LEVEL to synchronize both A sweep and B sweep. (5) Vary the oscillator output and operate B trigger LEVEL and measure the minimum synchronizing amplitude by the oscilloscope (475A). Check synchronization by each check frequency. (6) Make sure that the B TRIG'D lamp is on.</p>		

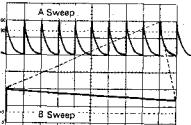
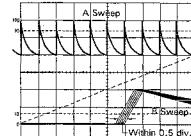
ADJUSTMENT

Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark																																																								
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ADJUSTMENT

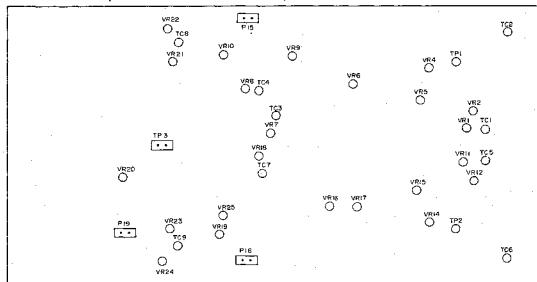
Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark										
					<p>(VIII) Check of trigger source (B sweep)</p> <p>(1) Set HORIZ DISPLAY to A, TRIG MODE to AUTO, Vertical MODE to DUAL, ALT and A SOURCE to V MODE.</p> <p>(2) Apply different signals to CH1, CH2 and CH4 and superimpose the signals of CH1 and CH2 on one another on the CRT screen and synchronize them by A trigger LEVEL.</p> <p>(3) Set HORIZ DISPLAY to B DLY'D and operate B SOURCE as described below to check the synchronization.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <th>B SOURCE</th><th>Operation</th></tr> <tr> <td>CH1</td><td>The signal of CH1 is synchronized with B sweep.</td></tr> <tr> <td>CH2</td><td>The signal of CH2 is synchronized with B sweep.</td></tr> <tr> <td>EXT 1/1</td><td>The signal of CH4 is synchronized with B sweep.</td></tr> <tr> <td>EXT 1/10</td><td>The signal of CH4 is attenuated to 1/10 and synchronized with B sweep.</td></tr> </table> <p>(4) Make sure that the B TRIG'D lamp is on.</p>	B SOURCE	Operation	CH1	The signal of CH1 is synchronized with B sweep.	CH2	The signal of CH2 is synchronized with B sweep.	EXT 1/1	The signal of CH4 is synchronized with B sweep.	EXT 1/10	The signal of CH4 is attenuated to 1/10 and synchronized with B sweep.		
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EXT 1/10	The signal of CH4 is attenuated to 1/10 and synchronized with B sweep.																
Check of Jitter		SG503 50Ω Termination	HORIZ DISPLAY: A A SOURCE: CH1 TRIG MODE: NORM A COUPLING: AC A SWEEP TIME/DIV: 20ns CH1 VOLTS/DIV: 0.1V CH1 AC-GND-DC: AC X10 MAG: PULL HOLDOFF: NORM		<p>(1) Apply a sine wave signal of 150 MHz to CH1 INPUT and adjust the oscillator output to produce a waveform of 4 div on the CRT screen.</p> <p>(2) Operate A trigger LEVEL to find a point where the jitter is minimized.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>Jitter</td><td>less than 0.25 div</td></tr> </table>	Jitter	less than 0.25 div										
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Check of DELAY TIME MULT		TG-501 50Ω Termination	HORIZ DISPLAY: ALT A, B SOURCE: CH1 TRIG MODE: AUTO Vertical MODE: CH1 STARTS AFTER DELAY: PULL CH1 AC-GND-DC: AC A SWEEP TIME/DIV: 1ms B SWEEP TIME/DIV: 5μs		<p>(1) Apply a marker signal of 1 ms to CH1 INPUT to produce a waveform of 2~3 div on the CRT screen.</p> <p>(2) Operate $\frac{1}{2}$ TRACE SEP to separate B sweep and A sweep.</p> <p>(3) Operate $\blacktriangle \rightarrow$ POSITION to align the first peak of the waveform with the left end of the screen.</p> <p>(4) Adjust A INTENSITY and B INTENSITY to bring the waveform into the positions where they can be easily visible.</p> <p>(5) Operate DELAY TIME MULT so that the patterns of the screen appear as shown at right (the second peak of the A sweep should be intensity modulated and should be aligned with the left end of B sweep scale) and note the dial reading at this time.</p>		<p><Note></p> <p>When TG-501 is used, CH1 VOLTS/DIV should be set to 0.5V thru 50Ω termination.</p>										

ADJUSTMENT

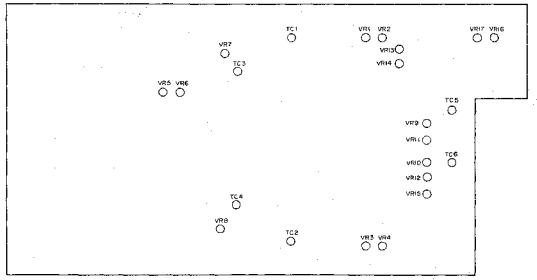
Item	Adjustment Control	P.C.B. No.	Test Equipment	Control Setting	Adjustment and Check	Illustration	Remark		
					<p>(6) Turn DELAY TIME MULT and operate \blacktriangleleft POSITION so that what is shown at right will happen at the 10th peak and note the dial reading at this time.</p> <p>(7) Make the following calculation from the dial reading to make sure that the error is within the specification limits. $(B) - (A) = 8.00 \pm 0.2$</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>Time multiplication error</td> <td>within $\pm(1\% \text{ of measurement} + 0.1\% \text{ of full scale})$</td> </tr> </table>	Time multiplication error	within $\pm(1\% \text{ of measurement} + 0.1\% \text{ of full scale})$	 <p>Measure the dial reading (B)</p> <p>DELAY TIME MULT</p>	
Time multiplication error	within $\pm(1\% \text{ of measurement} + 0.1\% \text{ of full scale})$								
Check of Delay Time Jitter		TG-501 500 Termination	HORIZ DISPLAY: ALT A SOURCE: CH1 B SOURCE: CH2 TRIG MODE: AUTO Vertical MODE: CH1 STARTS AFTER DELAY: PULL B ENDS A: ON CH1 AC-GND-DC: AC A SWEEP TIME/DIV: 1ms B SWEEP TIME/DIV: 1μs		<p>(1) Apply a marker signal of 1 ms to CH1 INPUT to produce a waveform of 2 ~ 3 div on the CRT screen.</p> <p>(2) Operate \blacktriangledown TRACE SEP to separate A sweep and B sweep.</p> <p>(3) Operate DELAY TIME MULT to obtain the patterns as shown at right. (DELAY TIME MULT is to be set to about 10.00).</p> <p>(4) Make sure that the jitter of B sweep is less than 0.5 div at this time.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>Specification</td> <td>less than 1/20,000</td> </tr> </table>	Specification	less than 1/20,000	 <p>Within 0.5 div.</p>	
Specification	less than 1/20,000								
Check of BEAM FIND			HORIZ DISPLAY: ALT A SOURCE: CH1 B SOURCE: CH2 TRIG MODE: AUTO Vertical MODE: CH1 STARTS AFTER DELAY: PULL B ENDS A: ON CH1 AC-GND-DC: AC A SWEEP TIME/DIV: 1ms B SWEEP TIME/DIV: 1μs		Make sure that the trace length is fully covered the screen when rotated SWEEP TIME/DIV to each range:				

ADJUSTMENT

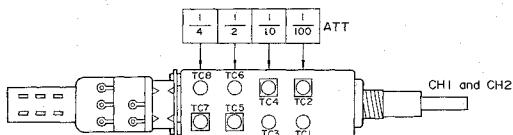
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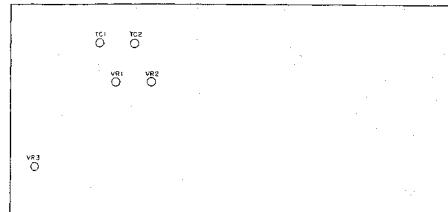
X74-1350-00 (TRIG SWEEP UNIT)



VERTICAL ATT.

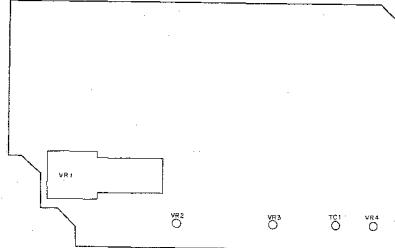


X73-1510-03 (VERTICAL OUTPUT AMP UNIT)

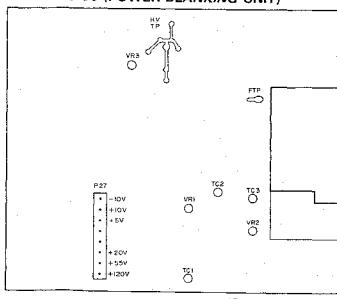


(Component side view)

X77-1280-00 (A TRIG SWITCH UNIT)

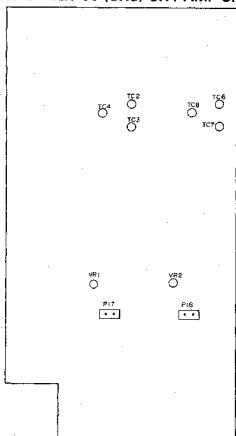


X68-1400-00 (POWER BLANKING UNIT)



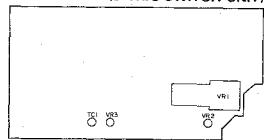
(Component side view)

X73-1520-00 (CH3, CH4 AMP UNIT)



(Component side view)

X77-1290-00 (B TRIG SWITCH UNIT)



X81-1430-00 (ASTIG UNIT)

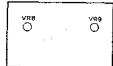
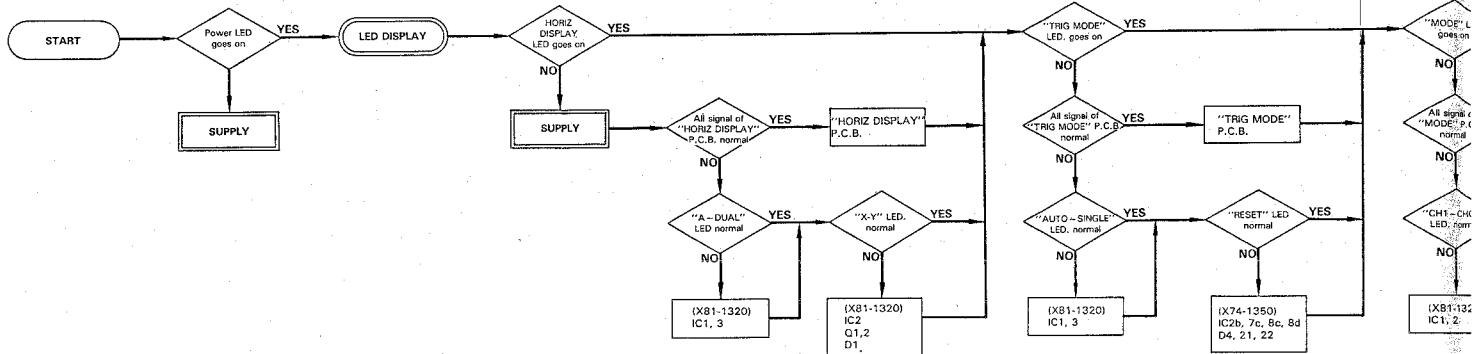
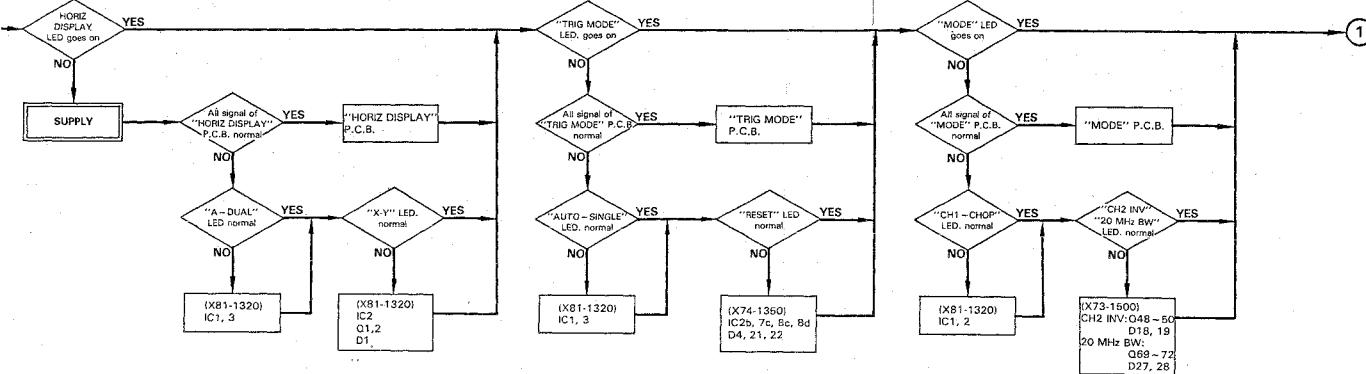


Fig. 6 LOCATION OF ADJ. CONTROLS

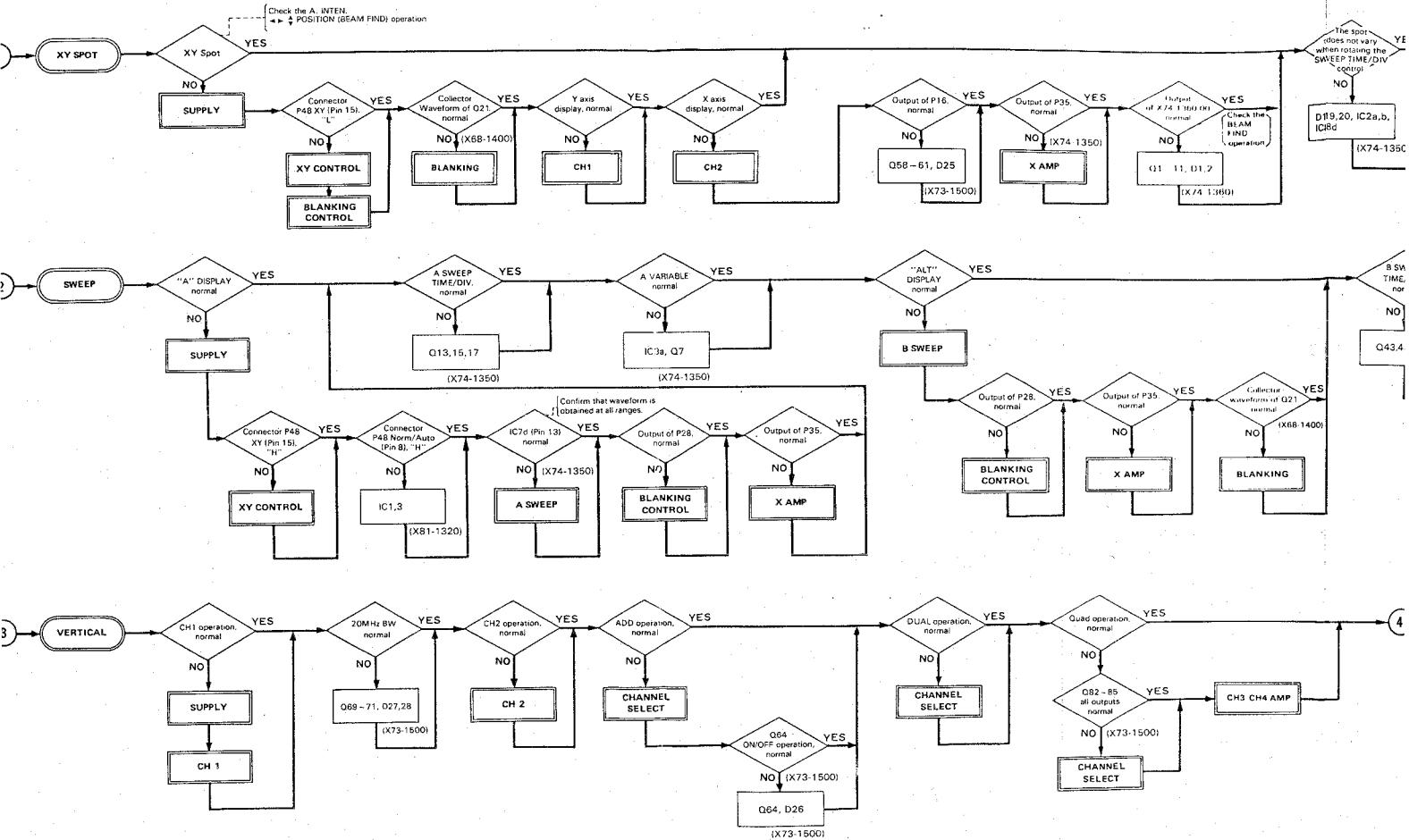
TROUBLESHOOTING



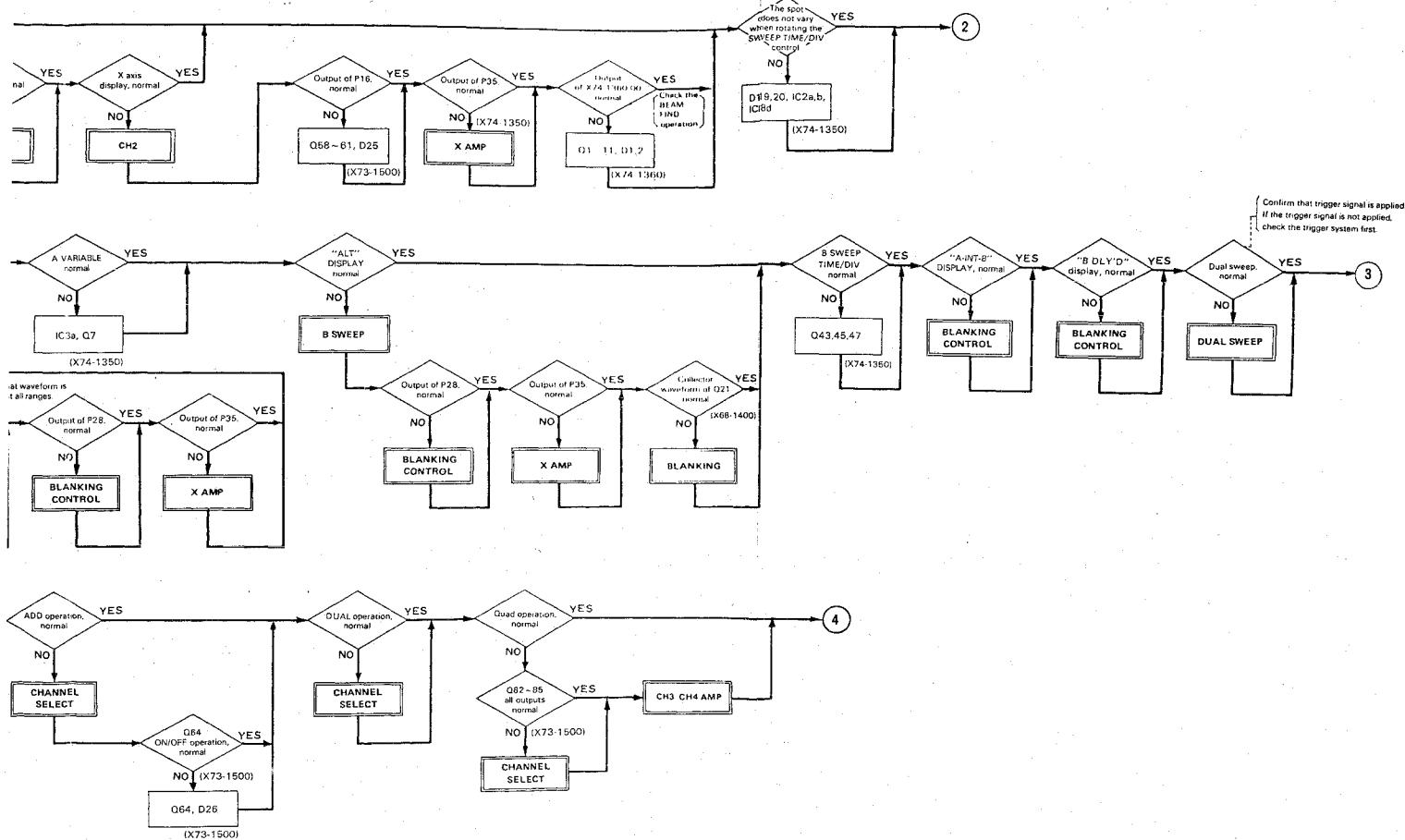
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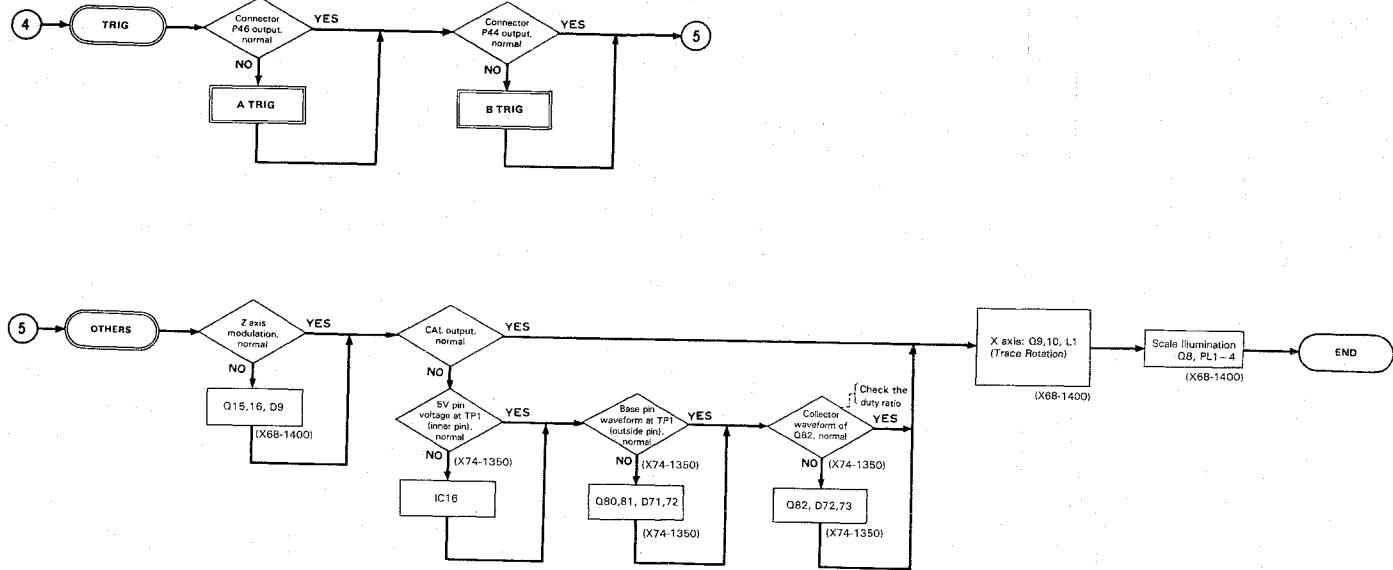
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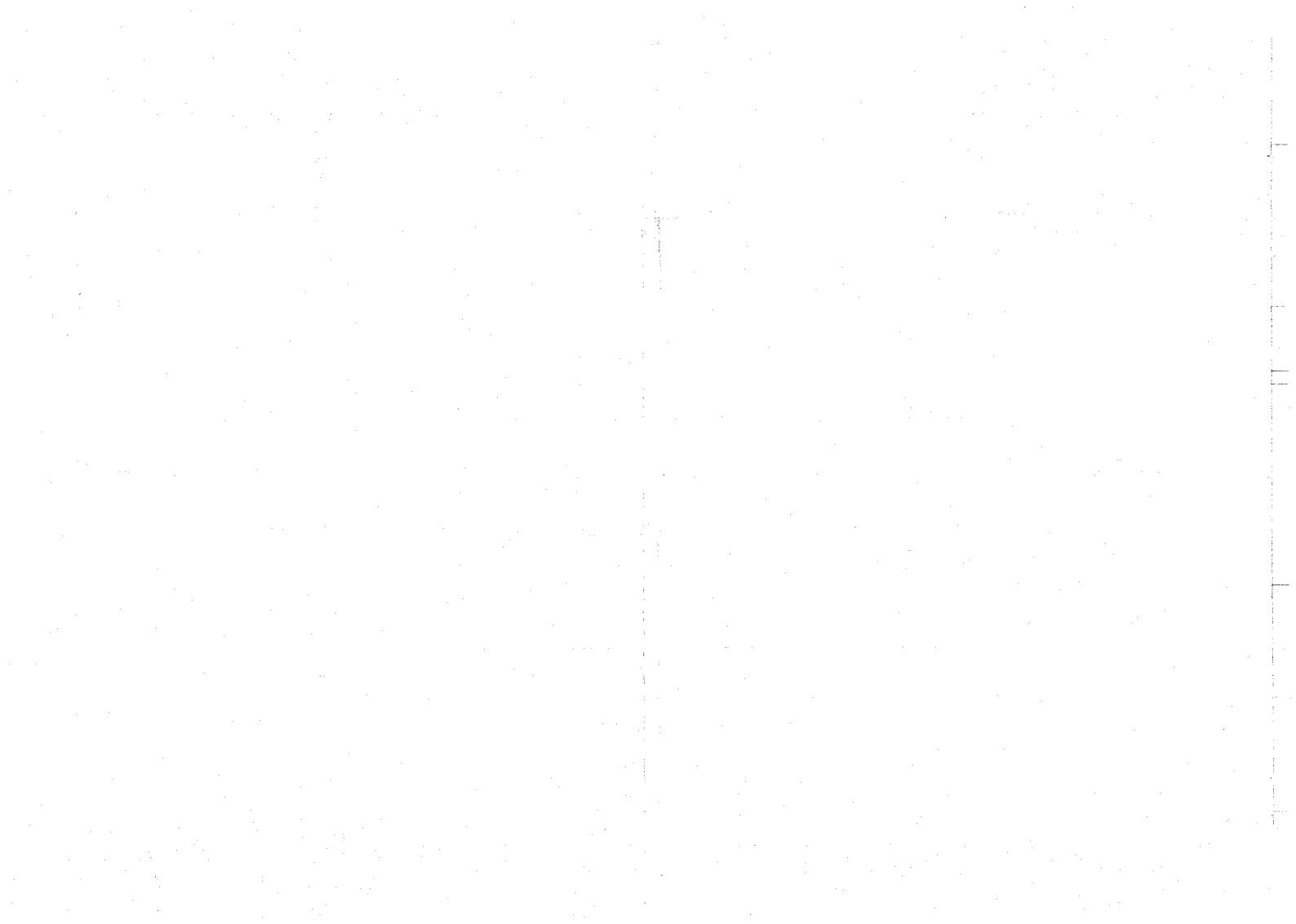


TROUBLESHOOTING



TROUBLESHOOTING

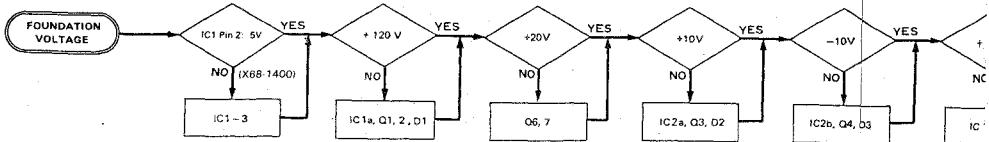
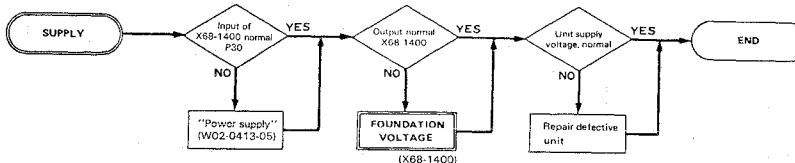
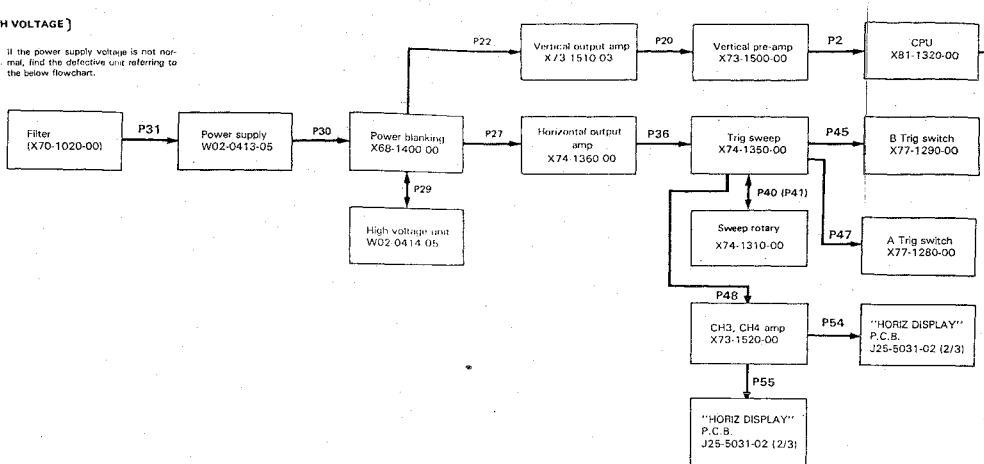




TROUBLESHOOTING

[POWER SUPPLY OF EACH VOLTAGE]

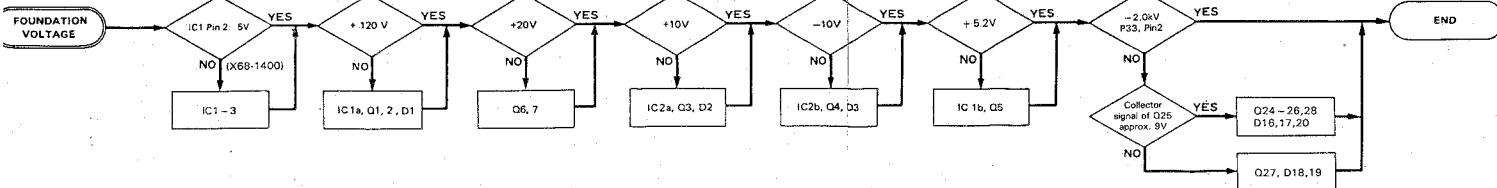
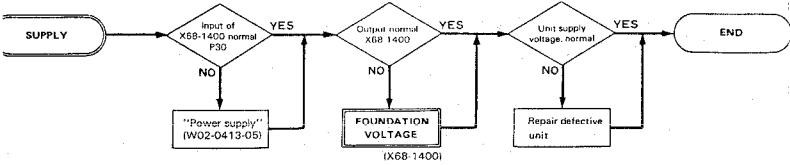
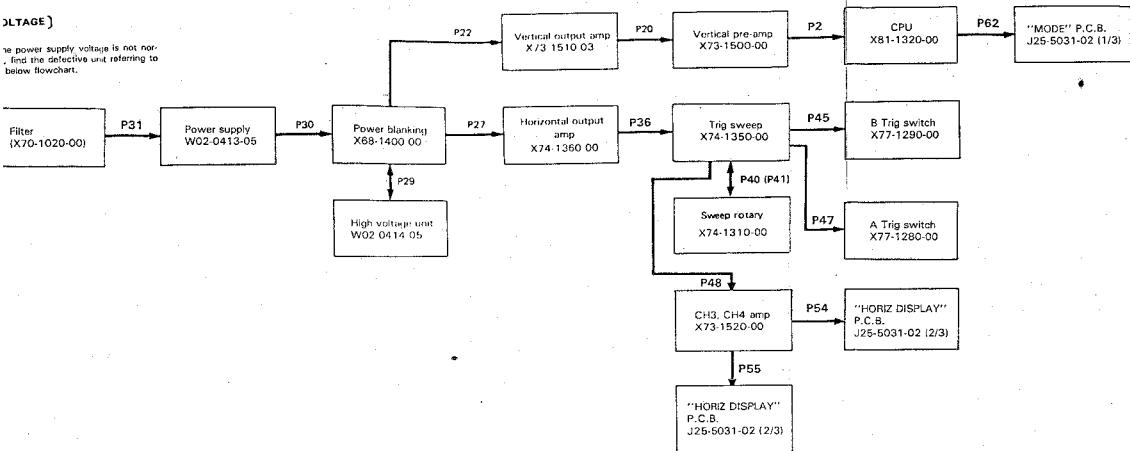
If the power supply voltage is not normal, find the defective unit referring to the below flowchart.



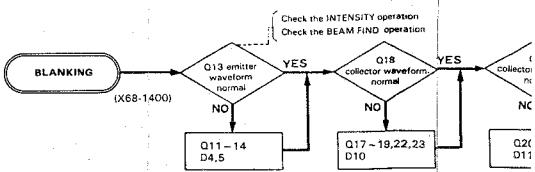
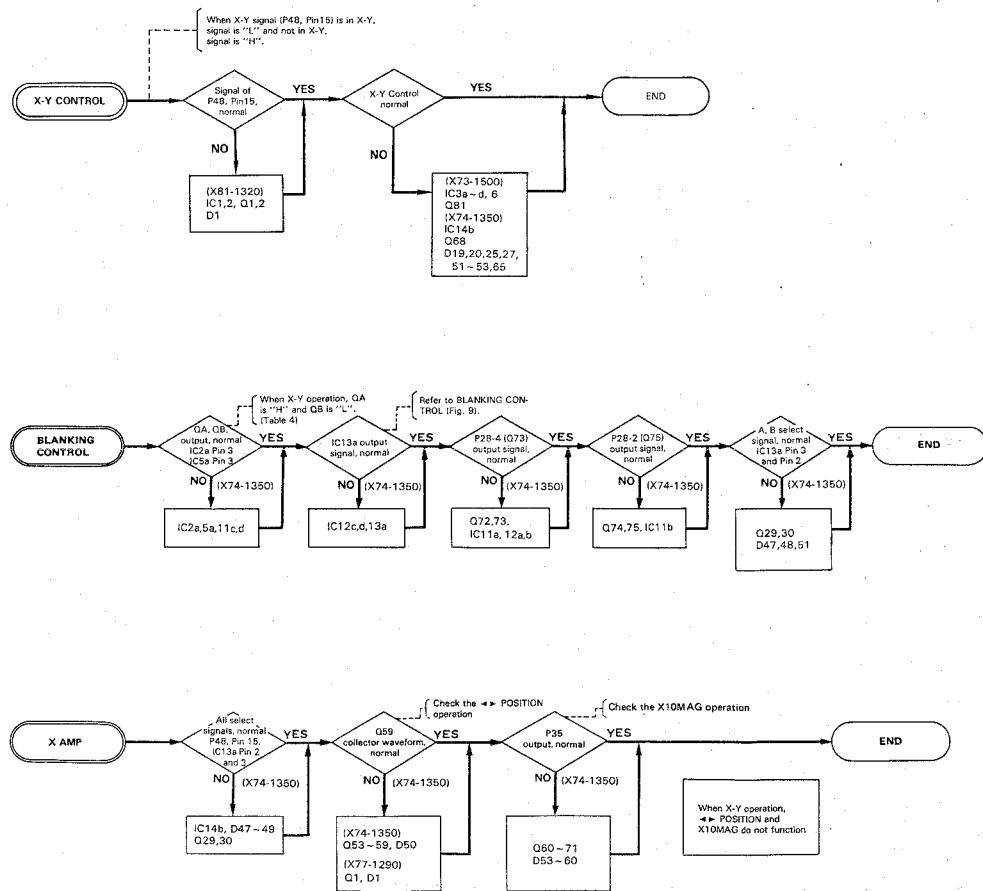
TROUBLESHOOTING

VOLTAGE

The power supply voltage is not normal. Find the defective unit referring to below flowchart.



TROUBLESHOOTING



BLANKING CONTROL

HORIZ DISPLAY	P48 X-Y BUFFER ISPin	IC13a			IC12d OUT	P28 A blank- ing 4 Pin
		IN	OUT	OUT		
A	H	H	L	H	L	H
ALT	H	L	L	TOGGLE	H	0A+ 0B
A-INT-B	H	H	L	H	L	0A 0B
B-DLY'D	H	L	H	L	H	H 0B
DUAL	H	L	L	TOGGLE	TOGGLE	0A+ 0B*
X-Y	L	H	L	H	L	H L H

Complex waveform IC11b output. When CHOP operation, output of P28 is complex CHOP signal waveform.

Table 4

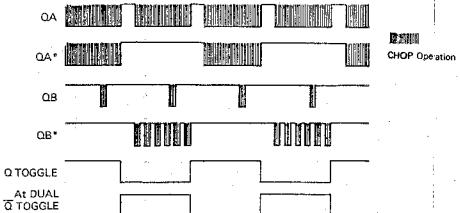
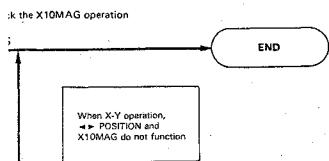
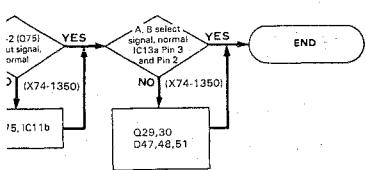
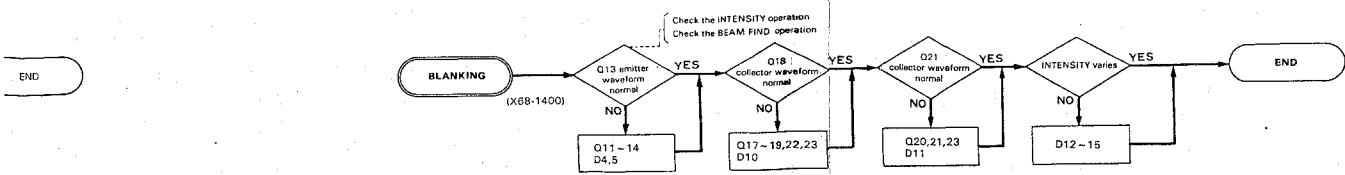


Fig. 8 RELATIONSHIP BETWEEN A, B SWEEP AND QA, QB

TROUBLESHOOTING



BLANKING CONTROL

HORIZ DISPLAY	P48 X-Y BUFFER 15Pin	IC13a		IC128 A, B blanking 4Pin 2Pin	P28
		IN	OUT		
A	H	H L L H L L	H O A H		
ALT	H	L L L T O G G L E	H O A + O B		
A-INT-B	H	H L L H L L	H O A O B		
B-DLY'D	H	L L H L L H H	H O B		
DUAL	H	L L L T O G G L E	T O G G L E O A + O B +		
X-Y	L	H L L H L L	H L H		

Complex waveform IC11b output. When CHOP operation,
output of P28 is complex CHOP signal waveform.

Table 4

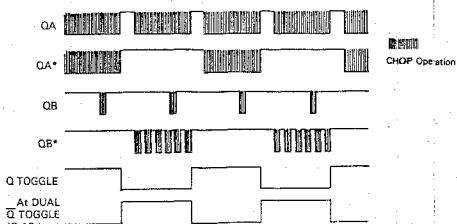


Fig. 8 RELATIONSHIP BETWEEN A, B SWEEP AND QA, QB

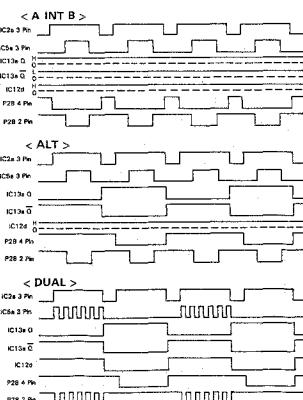
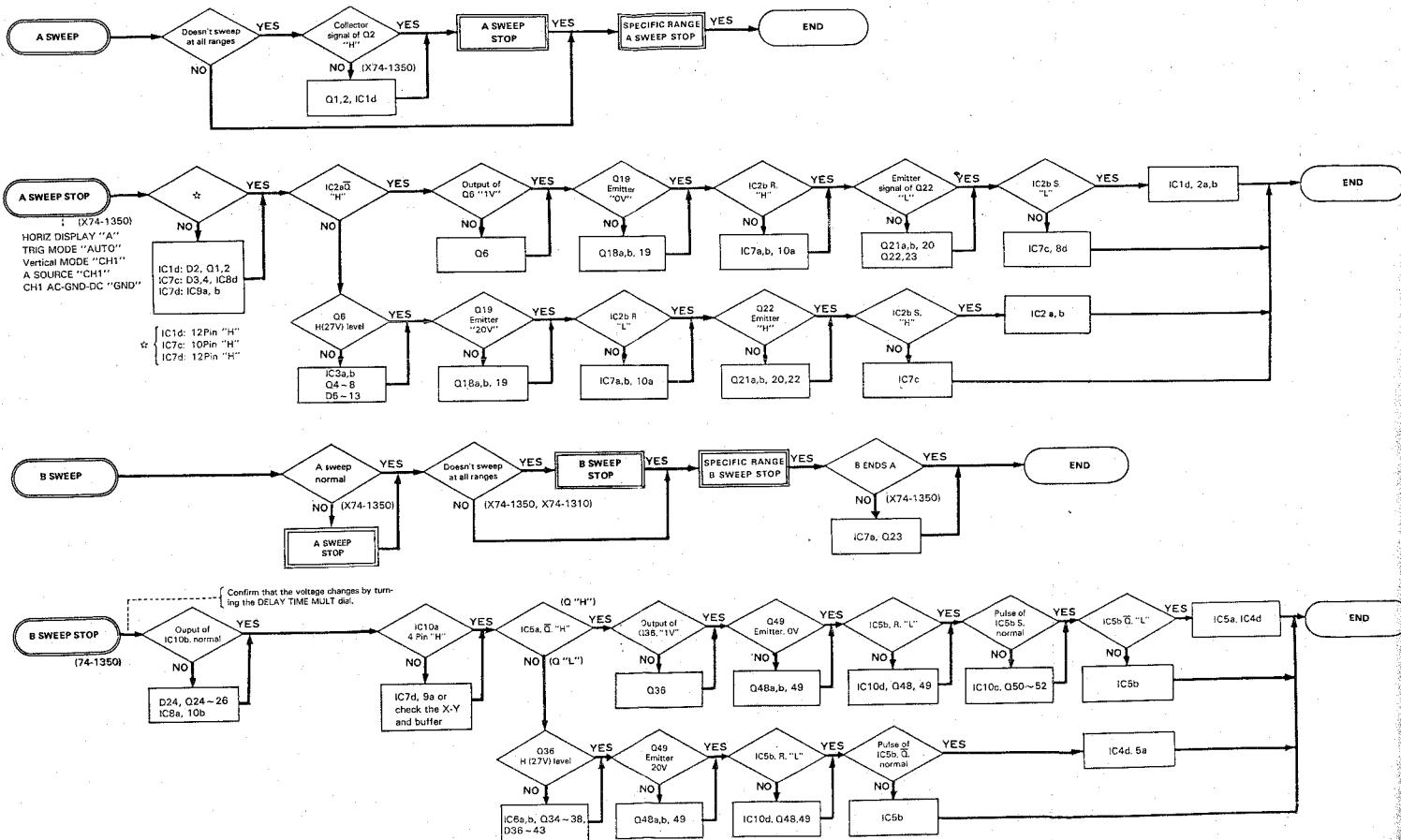
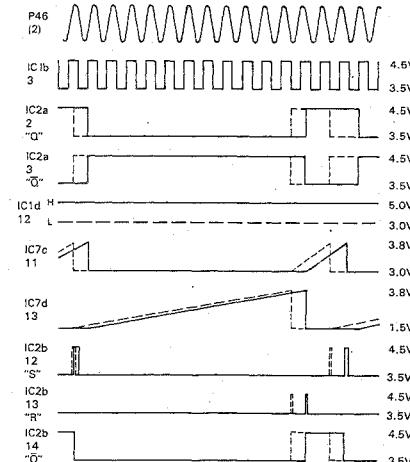
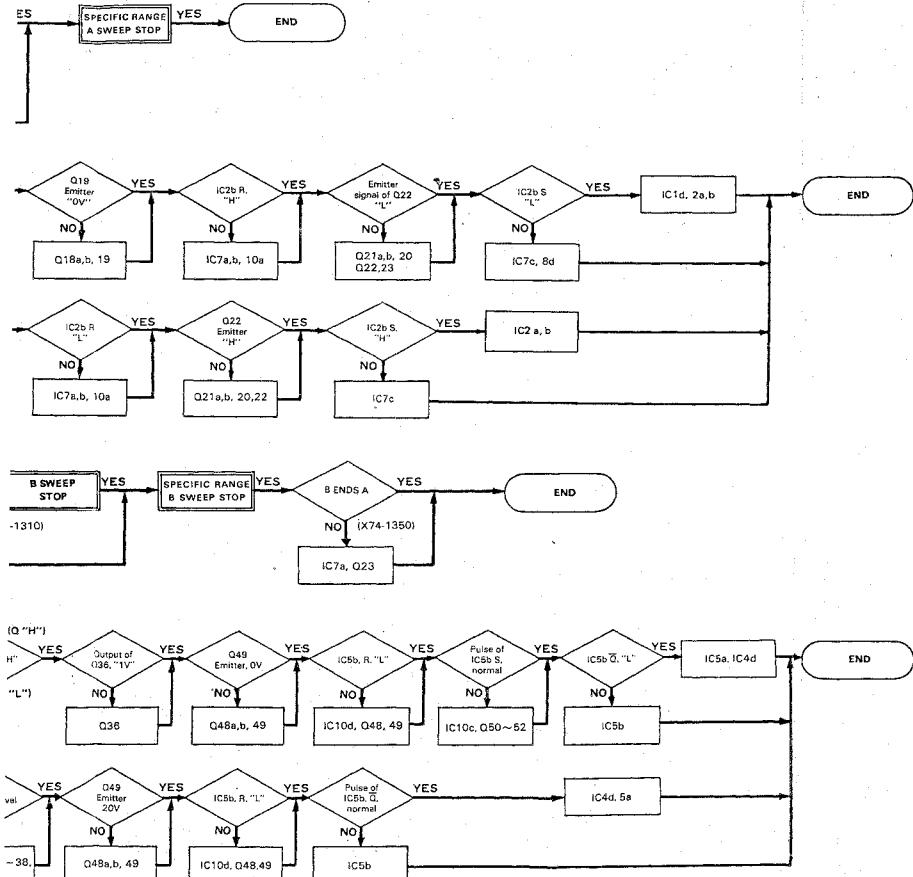


Fig. 9 BLANKING CONTROL

TROUBLESHOOTING



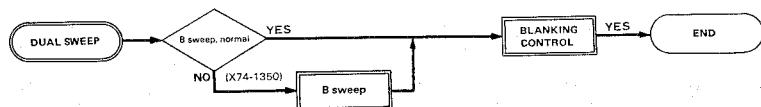
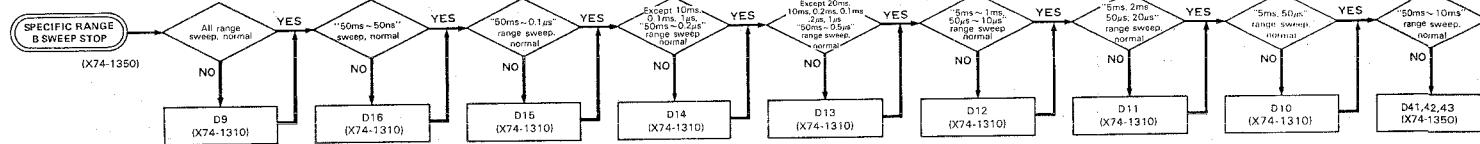
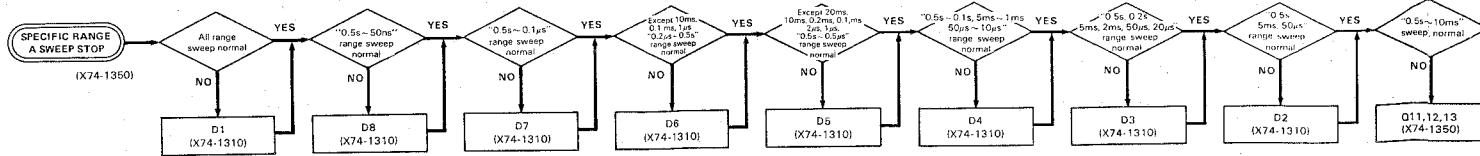
TROUBLESHOOTING



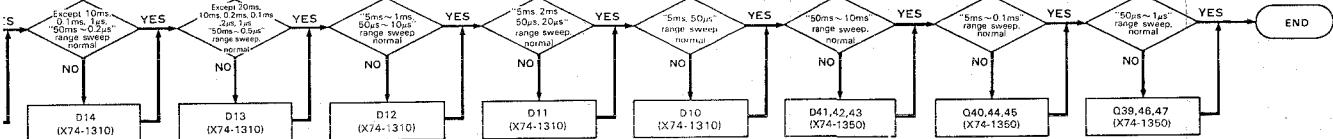
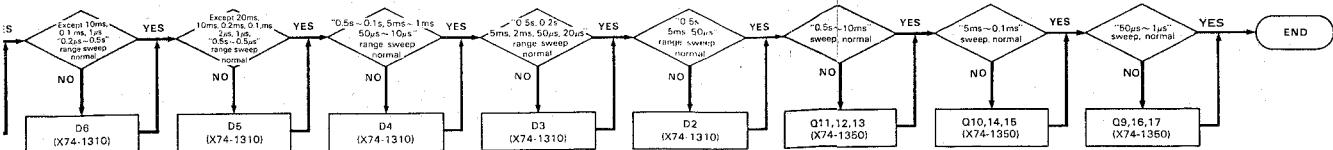
Note: Broke-line auto free run (at non-signal)

Fig. 10 Waveform in Sweep circuit (X74-1350-00)
(Input signal 1 kHz, SWEEP TIME 1 ms/div)

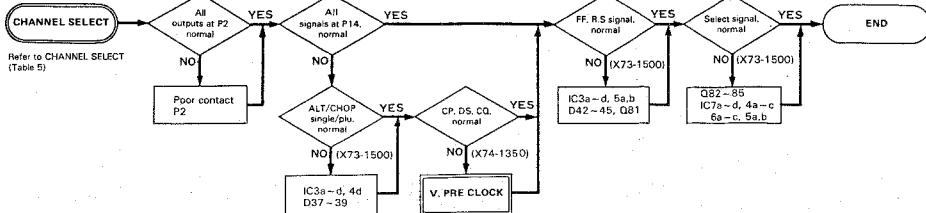
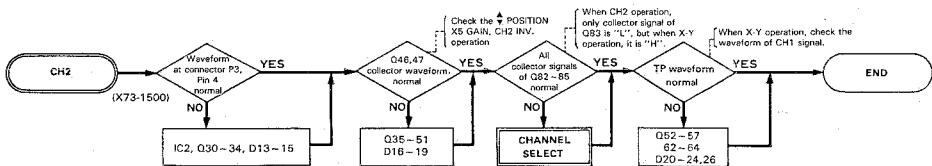
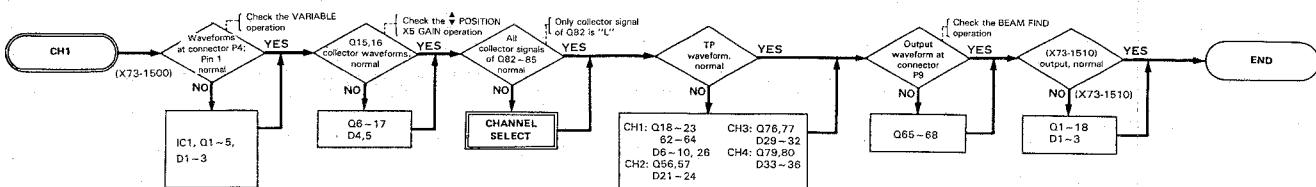
TROUBLESHOOTING



TROUBLESHOOTING



TROUBLESHOOTING



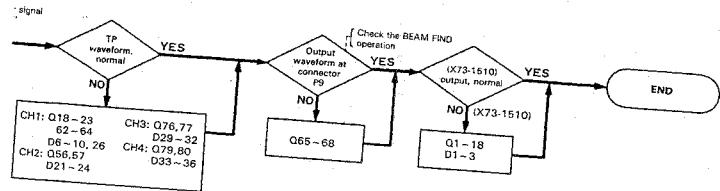
CHANNEL SELECT

MODE INPUT LOG OUTPUT signal (P2)						FLIP-FLOP PRESET CLEAR signal		
CH1	CH2	DUAL	ADD	ALT	X-Y	R5a	S5a	R5b
L	H	H	H	H	H	H	L	H
H	L	H	H	H	H	L	H	H
DUAL	ALT	CHOP	H	L	H	L	H	H
			H	H	L	H	L	H
ADD	ALT	CHOP	M	H	L	H	M	H
			H	H	H	H	L	L
SWEEP operation	X-Y operation	Same as above						L H H

Note: Number of ○ is No. of time chart. (See Fig. 11)

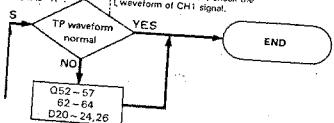
*1 Vertical MOI
DUAL : ALT
QUAD : ALT
ALT : ALT
HORIZ DISF
Time chart

TROUBLESHOOTING



CH2 operation,
display signal of
"L", but when X-Y
on, it is "H".

When X-Y operation,
check the
waveform of CH1 signal.



CHANNEL SELECT

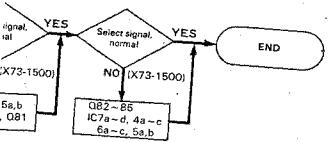
SWEEP operation	MODE INPUT LOG OUTPUT signal (P2)								FLIP-FLOP PRESET CLEAR signal		CHANNEL SELECT signal				FLIP-FLOP OUTPUT signal		VERTICAL CLOCK (P14)					
	CH1	CH2	DUAL	ADD	ALT	X-Y	R5a	S5a	R6b	CH1	CH2	CH3	CH4	G5a	G5b	G5c	ALT/OP select	CP**	DS	CO**		
CH1	L	H	H	H	H	H	H	L	H	L	H	A	H	L	H	L	L	L	QA	H	H	
CH2	H	L	H	H	H	H	H	L	H	H	L	H	H	L	H	L	L	L	QA	H	H	
DUAL																						
ALT	H	H	L	H	H	L	H	L	L	H	L	H	H	L	H	L	L	L	QA	H	H	
CHOP	H	H	L	H	H	L	H	L	L	H	L	H	H	L	H	L	L	L	QA	H	H	
ADD	H	H	H	L	H	L	H	L	L	H	L	H	H	L	H	L	L	L	QA	H	H	
QUAD	H	H	H	H	L	H	H	L	L	L	H	H	H	L	H	L	L	L	QA	H	H	
X-Y																						
operation	Same as above									L	H	H	H	L	H	H	L	L	L	L	H	H

Note: Number of ○ is No. of time chart. (See Fig. 11)

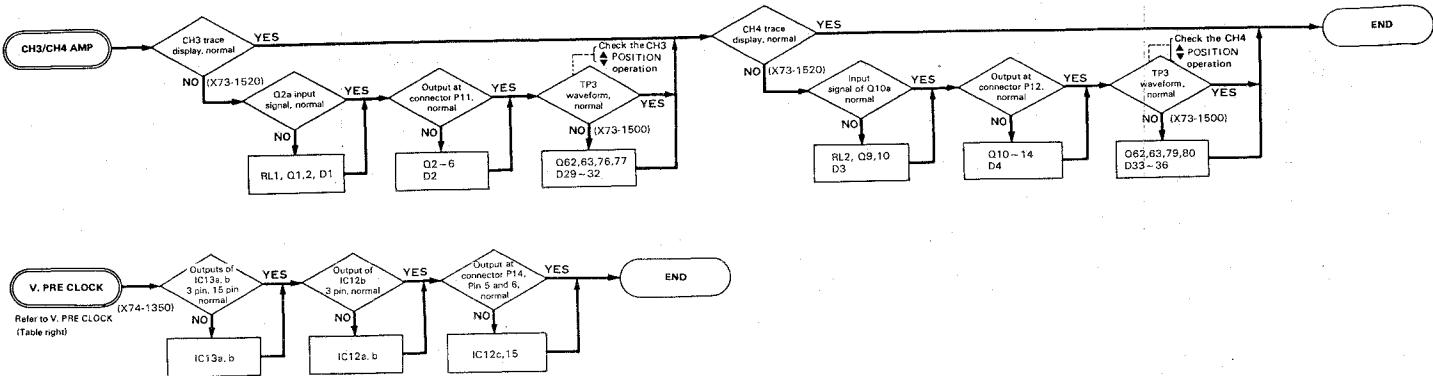
*1 Vertical MODE;
DUAL (ALT)
HORIZ DISPLAY, DUAL
Time chart No. ①.
*2 HORIZ DISPLAY,
ALT, DUAL
Time chart No. ③.
*3 Vertical MODE;
DUAL
DUAL
HORIZ DISPLAY;
DUAL
Time chart No. ① ~ ④.

*4 HORIZ DISPLAY;
DUAL
Signal level: "L"

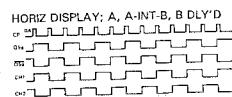
Table-5



TROUBLESHOOTING



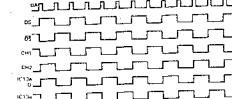
① Vertical MODE; DUAL (ALT)



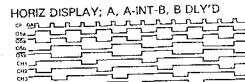
HORIZ DISPLAY; ALT



HORIZ DISPLAY; DUAL



② Vertical MODE; QUAD (ALT)



HORIZ DISPLAY; ALT



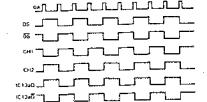
HORIZ DISPLAY; DUAL



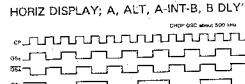
③ Vertical MODE; DUAL (CHOP)



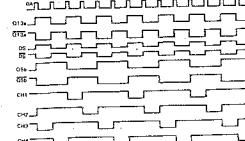
HORIZ DISPLAY; DUAL



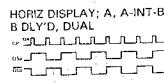
④ Vertical MODE; QUAD (CHOP)



HORIZ DISPLAY; DUAL



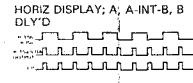
⑤ Vertical MODE; ADD



HORIZ DISPLAY; ALT



⑥ Vertical MODE; DUAL (ALT), QUAD (A)



HORIZ DISPLAY; ALT



HORIZ DISPLAY; DUAL

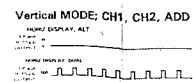
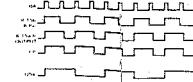
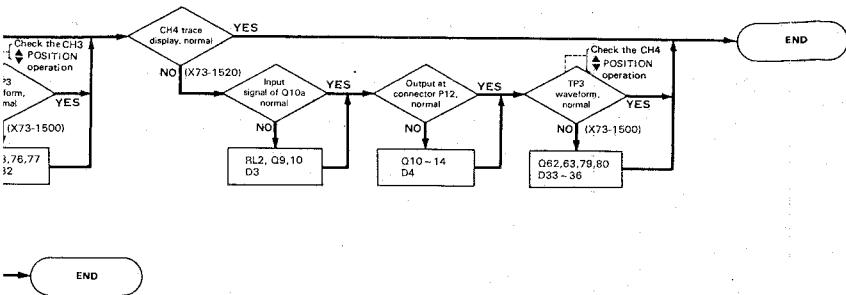


Fig. 11 Time Chart

TROUBLESHOOTING



V. PRE CLOCK

SWEEP generation	INPUT		OUTPUT	
	MODE	ALT/CHOP	IC15b	IC15a*
CH1	L	L	H	QA H
CH2	L	L	H	QA H
CH3	L	L	H	QA H
CHOP	ALT	L	H	QA H
DUAL	DUAL	ALT	L	QA H
ADD	ALT	L	L	QA H
CHOP	CHOP	H	H	QA L*
DUAL	ALT	L	H	QA L*
X-Y	CHOP	H	L	QA L H
Operation	X-Y	H	L	QA L H

Note: Number of \ominus is No. of time chart. (See Fig. 11)

*5 HORIZONTAL DISPLAY;

A-INT

DUAL

Time chart No. ⑤.

*6 Vertical MODE,

DUAL or

QUAD

Time chart No. ⑥.

*7 Vertical MODE

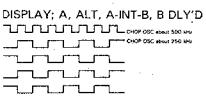
DUAL or

QUAD

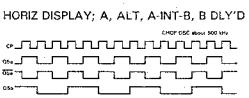
Time chart No. ① ~ ④.

Table-6

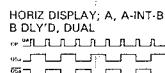
Vertical MODE; DUAL (CHOP)



④ Vertical MODE; QUAD (CHOP)



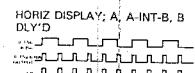
⑤ Vertical MODE; ADD



HORIZ DISPLAY; ALT



⑥ Vertical MODE; DUAL (ALT), QUAD (ALT)



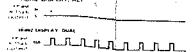
HORIZ DISPLAY; ALT



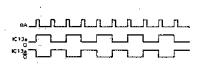
HORIZ DISPLAY; DUAL



Vertical MODE: CH1, CH2, ADD



⑦ HORIZ DISPLAY; ALT, DUAL



HORIZ DISPLAY; ALT

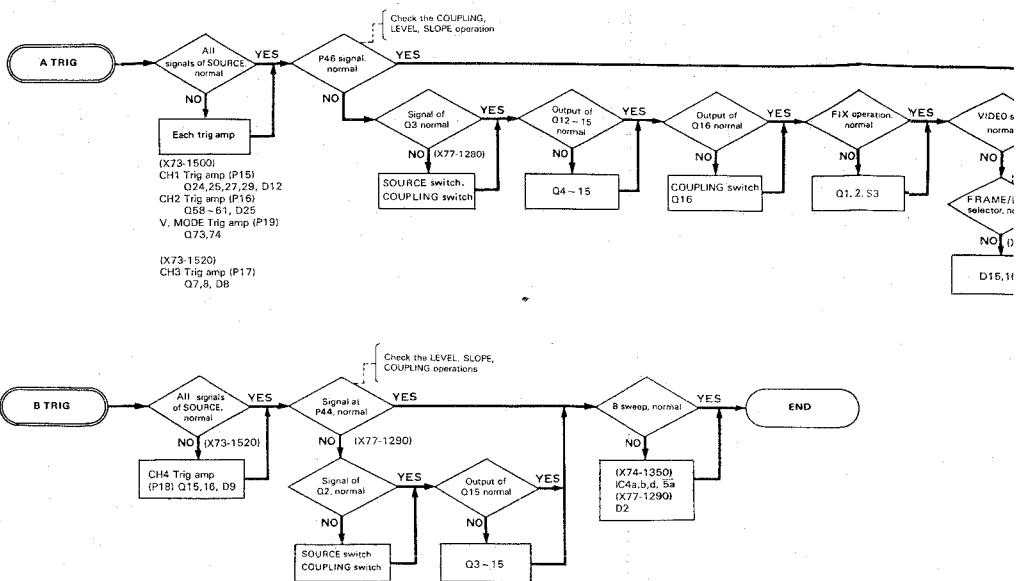


HORIZ DISPLAY; DUAL

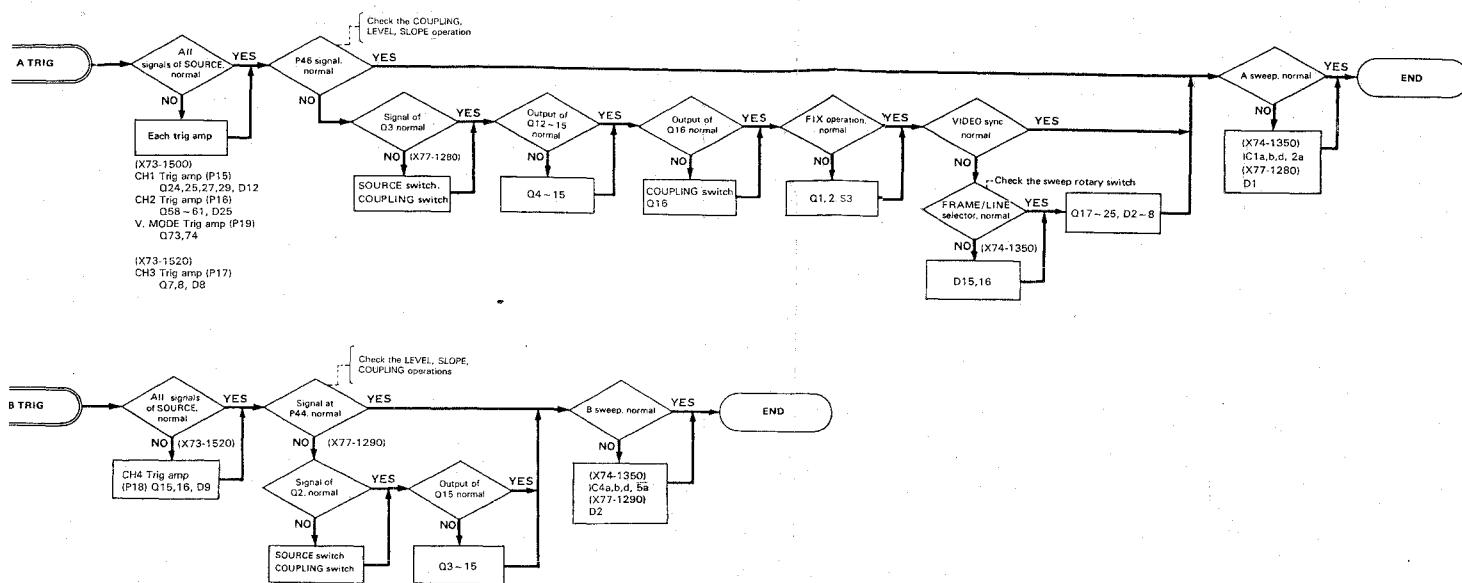


Fig. 11 Time Chart

TROUBLESHOOTING



TROUBLESHOOTING



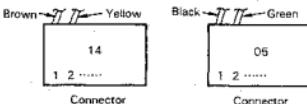
PARTS LIST

The specifications and parts list and schematic diagram may be changed without notice owing to a technical innovation.

The part No. of each connector is stamped or color-coded. The color-coding is as follows.

Black	Brown	Red	Orange	Yellow	Green	Blue	Purple	Grey	White
0	1	2	3	4	5	6	7	8	9

Example



Each connector can be classified by the color of pin 1 and pin 2.

PARTS LIST

REF. NO. PARTS NO. NAME & DESCRIPTION
T0009 C05-0031-15 CAP. TRIMMER 10P

TP001 E23-0506-04 TEST TERMINAL
TP002 E23-0503-04 TEST TERMINAL
TP003 E40-0211-05 PIN CONNECTOR 2 P

VR001 R12-0530-05 RES. SEMI FIXED 200 B
VR002 R12-3520-05 RES. SEMI FIXED 10K B
VR003 NO USE
VR004 R12-0421-05 RES. SEMI FIXED 100 B
VR005 R12-0421-05 RES. SEMI FIXED 100 B
VR006 R12-0421-05 RES. SEMI FIXED 100 B
VR007 R12-0421-05 RES. SEMI FIXED 100 B
VR008 R12-0535-05 RES. SEMI FIXED 200 B
VR009 R12-3520-05 RES. SEMI FIXED 10K B
VR010 R12-3520-05 RES. SEMI FIXED 10K B
VR011 R12-0530-05 RES. SEMI FIXED 200 B
VR012 R12-3520-05 RES. SEMI FIXED 10K B
VR013 NO USE
VR014 R12-0421-05 RES. SEMI FIXED 100 B
VR015 R12-0421-05 RES. SEMI FIXED 100 B
VR016 R12-0421-05 RES. SEMI FIXED 100 B
VR017 R12-0421-05 RES. SEMI FIXED 100 B
VR018 R12-0530-05 RES. SEMI FIXED 10K B
VR019 R12-3520-05 RES. SEMI FIXED 200 B
VR020 R12-0530-05 RES. SEMI FIXED 200 B
VR021 R12-0540-05 RES. SEMI FIXED 500 B
VR022 R12-0530-05 RES. SEMI FIXED 200 B
VR023 R12-0540-05 RES. SEMI FIXED 200 B
VR024 R12-0530-05 RES. SEMI FIXED 200 B
VR025 R12-0539-05 RES. SEMI FIXED 200 B

VERTICAL OUTPUT AMP UNIT

X73-1510-03

REF. NO.	PARTS NO.	NAME & DESCRIPTION
	E23-0512-05	TERMINAL
	F02-05001-04	HEAT SINK
	F03-05001-09	HEAT SINK
	J25-5035-02	PCB (UNPOINTED)
	L92-0110-05	BRAID CORE
	N09-0711-05	SCREW
	N89-306-46	SCREW, BINDING TAP TITE
	212-2014-05	TUBE (PLASTIC)
	C001 CK45FF1H103Z	CAP. CERAMIC 68P 5% 50V
	C002 CK45FF1H103Z	CAP. CERAMIC 0.01 50V
	C003 CK45FF1H103Z	CAP. CERAMIC 0.01 50V
	C004 CK55LH221J	CAP. CERAMIC 220P 5% 50V
	C005 C04E4U1330W	CAP. CERAMIC 0.1 20% 12V
	C006 C04E4U120J	CAP. CERAMIC 120P 5% 50V
	C007 CK45FF1H103Z	CAP. CERAMIC 0.01 50V
	C008 CK45FS24472K	CAP. CERAMIC 4700P 10% 500V
	C009 CK45FF1H103Z	CAP. CERAMIC 0.01 50V
	C010 CK45FF1H103Z	CAP. CERAMIC 0.01 50V
	C011 CK45FF1H103Z	CAP. CERAMIC 0.01 50V
	C012 CK45FF1H103Z	CAP. CERAMIC 4700P 10% 500V
	C013 CK45FS24472K	CAP. CERAMIC 4700P 10% 500V
	C014 CK45FF1H103Z	CAP. CERAMIC 0.01 50V
	C015 C04E4U1330W	CAP. ELECTRO 33 20% 35V
	C016 CK45FF1H103Z	CAP. CERAMIC 0.01 50V
	C017 C04E4U1330W	CAP. CERAMIC 0.1 20% 12V
	C018 CK45FS24472K	CAP. CERAMIC 4700P 10% 500V
	C019 C04-0298-05	CAP. CERAMIC 0.1 20% 12V
	C020 C04-0298-05	CAP. CERAMIC 0.1 20% 12V
	C021 NO USE	
	C022 C04-0298-05	CAP. CERAMIC 0.1 20% 12V
	C023 C04-0298-05	CAP. ELECTRO 47 20% 12V
	C024 CK45SLH1331J	CAP. CERAMIC 330P 5% 50V
	C025 CK45SLH1331J	CAP. CERAMIC 330P 5% 50V
	C026 CK45FF1H103Z	CAP. CERAMIC 0.01 50V
	C027 CK45FF1H103Z	CAP. CERAMIC 0.01 50V
	C028 CK45FS1H103Z	CAP. CERAMIC 0.01 50V
D001	MT224JC	D100E - ZENER 24V
D002	1S2660	D10DE
D003	1S2660	D10DE
L001	L73-0804-05	CHOKE COIL
L002	L73-0806-05	CHOKE COIL
L003	L40-2282-13	FERRI INDUCTOR 0.22uH
L004	L40-2282-13	FERRI INDUCTOR 0.22uH
L005	L40-4701-03	FERRI INDUCTOR 47uH
L006	L40-4701-03	FERRI INDUCTOR 47uH
L007	L40-4701-03	FERRI INDUCTOR 47uH
L008	L40-2262-01	FERRI INDUCTOR 0.22uH
L009	L40-2262-01	FERRI INDUCTOR 0.22uH
L010	L40-2282-01	FERRI INDUCTOR 0.22uH
P010	E40-0315-05	PIN CONNECTOR 3 P
P013	E40-0273-05	PIN CONNECTOR 2 P
P020	E40-0573-05	PIN CONNECTOR 5 P
P021	NO USE	
P022	E40-0773-05	PIN CONNECTOR 7 P
G001	2SC2671(H)	TR. SI. NPN
G002	2SC2671(H)	TR. SI. NPN
G003	2SA1206	TR. SI. NPN
G004	2SC2644	TR. SI. NPN
G005	2SC2671(H)	TR. SI. NPN
G006	2SC2671(H)	TR. SI. NPN
G007	2SC2644	TR. SI. NPN
G008	2SC2644	TR. SI. NPN
G009	2SC2644	TR. SI. NPN
G010	2SC2644	TR. SI. NPN
G011	2SC1164	TR. SI. NPN
G012	2SC1164	TR. SI. NPN
G013	2SA1309(Q.R)	TR. SI. NPN
G014	2SA1311(O.R)	TR. SI. NPN
G015	2SA1311(O.R)	TR. SI. NPN
G016	2SA1309(R.B)	TR. SI. NPN
G017	2SC3311(O.R)	TR. SI. NPN
G018	2SA1309(O.R)	TR. SI. NPN
R001	RN146B2C2000F	RES. METAL FILM 200 1% 1/6W
R002	RD146B2C220J	RES. CARBON 22 5% 1/6W
R003	RD146B2C220J	RES. CARBON 22 5% 1/6W
R004	RD146B2C332J	RES. CARBON 3.3K 1/6W
R005	RN146B2C757RF	RES. METAL FILM 75.0 1% 1/6W
R006	RN146B2C757RF	RES. METAL FILM 75.0 1% 1/6W
R007	RN146B2C757RF	RES. METAL FILM 75.0 1% 1/6W
R008	RD146B2C470J	RES. CARBON 47 5% 1/6W
R009	RD146B2C101J	RES. CARBON 100 1% 1/6W
R010	RN146B2C3900F	RES. METAL FILM 390 1% 1/6W
R011	RN146B2C3900F	RES. METAL FILM 390 1% 1/6W
R012	RD146B2C200J	RES. CARBON 22 5% 1/6W
R013	RD146B2C220J	RES. CARBON 22 5% 1/6W
R014	RD146B2E361J	RES. CARBON 360 5% 1/6W
R015	RD146B2E361J	RES. CARBON 360 5% 1/6W

PARTS LIST

REF. NO.	PARTS NO.	NAME & DESCRIPTION
R016	RD14B82C220J	RES. CARBON 22 S% 1/6W
R017	RD14B82C220J	RES. CARBON 22 S% 1/6W
R018	RD14B82C220J	RES. CARBON 22 S% 1/6W
R019	RD14B82C220J	RES. CARBON 22 S% 1/6W
R020	NO USE	
R021	RD14B82C153J	RES. CARBON 15K S% 1/6W
R022	RD14B82C153J	RES. CARBON 15K S% 1/6W
R023	RD14B82C153J	RES. CARBON 680 S% 1/6W
R024	R45-4256093	
R025	R45-4256093	
R026	RD14B82E220J	RES. CARBON 9.8 S% 1/4W
R027	RD14B82E220J	RES. CARBON 22 S% 1/4W
R028	RD14B82E220J	RES. CARBON 22 S% 1/4W
R029	RD14B82E220J	RES. CARBON 470 S% 1/6W
R030	RD14B82E220J	RES. CARBON 470 S% 1/6W
R031	R47-5847-15	
R032	R47-5847-15	
R033	RD14B82C2471J	RES. CARBON 470 S% 1/6W
R034	RD14B82C2471J	RES. CARBON 470 S% 1/6W
R035	RD14B82C2471J	RES. CARBON 470 S% 1/6W
R036	RD14B82C2471J	RES. CARBON 6.8K S% 1/6W
R037	RN14BK2C4701F	RES. METAL FILM 4.7K 1% 1/6W
R038	RN14BK2C4701F	RES. METAL FILM 4.7K 1% 1/6W
R039	RN14BK2C3300F	RES. METAL FILM 330 1% 1/6W
R040	RN14BK2C3300F	RES. METAL FILM 330 1% 1/6W
R041	RN14BK2C4011F	RES. METAL FILM 2.4K 1% 1/6W
R042	RN14BK2C220J	RES. CARBON 50 S% 1/6W
R043	RN14BK2C2700J	RES. METAL FILM 47.0 1% 1/6W
R044	RD14B82C220J	RES. CARBON 50 S% 1/6W
R045	RD14B82C220J	RES. METAL FILM 47.0 1% 1/6W
R046	RN14BK2C1509F	RES. METAL FILM 1.0 1% 1/6W
R047	RN14BK2C2201F	RES. METAL FILM 2.2K 1% 1/6W
R048	RN14BK2C2701F	RES. METAL FILM 2.7K 1% 1/6W
R049	RD14B82C101J	RES. CARBON 100 S% 1/6W
R050	RD14B82C4701J	RES. CARBON 47 S% 1/6W
R051	RD14B82C220J	RES. CARBON 10K S% 1/6W
R052	RD14B82C101J	RES. CARBON 150 S% 1/6W
R053	RD14B82C101J	RES. CARBON 100 S% 1/6W
R054	RD14B82C1135J	RES. CARBON 15K S% 1/6W
R055	RD14B82C1135J	RES. CARBON 680 S% 1/6W
R056	RD14B82C1135J	RES. CARBON 680 S% 1/6W
R057	RD14B82C101J	RES. CARBON 25K 2A 1/6W
R058	NO USE	
R059	NO USE	
R060	RN14BK2C1000F	RES. METAL FILM 100 1% 1/6W
R061	RN14BK2C1000F	RES. METAL FILM 100 1% 1/6W

TC001 C05-0412-05
TC002 C05-0412-05

TH001 C0T1000 THERMISTOR

VR001	R12-0543-05	RES. SEMI FIXED 500 S
VR002	R12-0543-05	RES. SEMI FIXED 500 S
VR003	R12-0543-05	RES. SEMI FIXED 500 S

PARTS LIST

CH3, CH4 AMP UNIT

X73-1520-00

REF. NO.	PARTS NO.	NAME & DESCRIPTION
	J25-5839-22	PCB (UNROUTED)
	N09-0709-05	SCREW
C001	CC4504H1H050J	CAP. CERAMIC 39P % 500
C002	CC4504H1H032	CAP. CERAMIC 0.01 500
C003	CC4504H1H032	CAP. CERAMIC 0.01 500
C004	CC4504H1H032	CAP. METAL FILM 0.01 20% 500
C005	CC4504H1H01J	CAP. CERAMIC 100P % 500
C006	CC4504H1H050C	CAP. CERAMIC 5P 0.25P 500
C007	NO USE	
C008	CC4504H1H390J	CAP. CERAMIC 39P % 500
C009	CC4504H1H032	CAP. CERAMIC 0.01 500
C010	CC4504H1H032	CAP. CERAMIC 0.01 500
C011	Q91-0502-05	CAP. METAL FILM 0.01 20% 620U
C012	CC4504H1H01J	CAP. CERAMIC 100P % 500
C013	CC4504H1H050C	CAP. CERAMIC 5P 0.25P 500
C014	NO USE	
C015	CC4504H1C700H	CAP. ELECTRO 47 20% 16W
C016	CC4504H1C700H	CAP. ELECTRO 47 20% 16W
C017	CC4504H1C700H	CAP. ELECTRO 47 20% 16W
C018	CC4504H1H032	CAP. CERAMIC 0.01 500
C019	CC4504H1H032	CAP. CERAMIC 0.01 500
C020	CC4504H1H032	CAP. CERAMIC 0.01 500
C021	CC4504H1H032	CAP. CERAMIC 0.01 500
C022	CC4504H1H032	CAP. CERAMIC 0.01 500
C023	CC4504H1H032	CAP. CERAMIC 0.01 500
C024	CC4504H1H032	CAP. CERAMIC 0.01 500
C025	CC4504H1H032	CAP. CERAMIC 0.01 500
C026	CC4504H1H032	CAP. CERAMIC 0.01 500
C027	CC4504H1H032	CAP. CERAMIC 0.01 500
C028	CC4504H1H032	CAP. CERAMIC 0.01 500
C029	CC4504H1H032	CAP. CERAMIC 0.01 500
C030	CC4504H1H032	CAP. CERAMIC 0.01 500
C031	CC4504H1H032	CAP. CERAMIC 0.01 500
L001	L40-2201-03	FERRI INDUCTOR 22UH
L002	L40-2201-03	FERRI INDUCTOR 22UH
L003	L40-2201-03	FERRI INDUCTOR 22UH
P011	E40-0473-05	PIN CONNECTOR 4 P
P012	E40-0473-05	PIN CONNECTOR 4 P
P017	E40-0273-05	PIN CONNECTOR 2 P
P018	E40-0273-05	PIN CONNECTOR 2 P
P048	E40-7414-05	PIN CONNECTOR 16P
P054	E40-7414-05	PIN CONNECTOR 16P
P055	E40-7414-05	PIN CONNECTOR 16P
P056	E23-0503-05	TERMINAL
P057	NO USE	
P058	E23-0503-05	PIN CONNECTOR 2 P
P059	NO USE	
P060	E23-0503-05	TERMINAL
P061	E40-7414-05	PIN CONNECTOR 16P
P001	2SD43X(F)	TR. SI. NPN
P002	DN1901	FET, DUAL SI. N-CHANNEL
P003	2SC3354(T,S)	TR. SI. NPN
P004	2SC3354(T,S)	TR. SI. NPN
P005	2SA1205	TR. SI. PNP
P006	2SA1205	TR. SI. PNP
P007	2SA2671(H)	TR. SI. NPN
P008	2SC2671(H)	TR. SI. NPN
P009	2SD35(F)	TR. SI. NPN
P010	DN1901	FET, DUAL SI. N-CHANNEL
P011	2SC3354(T,S)	TR. SI. NPN
P012	2SC3354(T,S)	TR. SI. NPN
P013	2SA1205	TR. SI. PNP
P014	2SA1205	TR. SI. PNP
P015	2SC2671(H)	TR. SI. NPN
P016	2SC2671(H)	TR. SI. NPN
P001	RD14B82C470J	RES. CARBON 47 S% 1/6W
P002	RD14B82C2003D	RES. METAL FILM 200K 0.5% 1/6W
P003	RD14B82E1113D	RES. METAL FILM 111K 0.5% 1/6W
P004	RD14B82C550J	RES. CARBON 56 S% 1/6W
P005	RD14B82C1122J	RES. CARBON 1.2K S% 1/6W
P006	RD14B82E1004D	RES. METAL FILM 0.52K 1/6W
P007	RD14B82E1004J	RES. METAL FILM 690K 1/6W
P008	RD14B82C181J	RES. CARBON 180 S% 1/6W
P009	RD14B82C181J	RES. CARBON 180 S% 1/6W

PARTS LIST

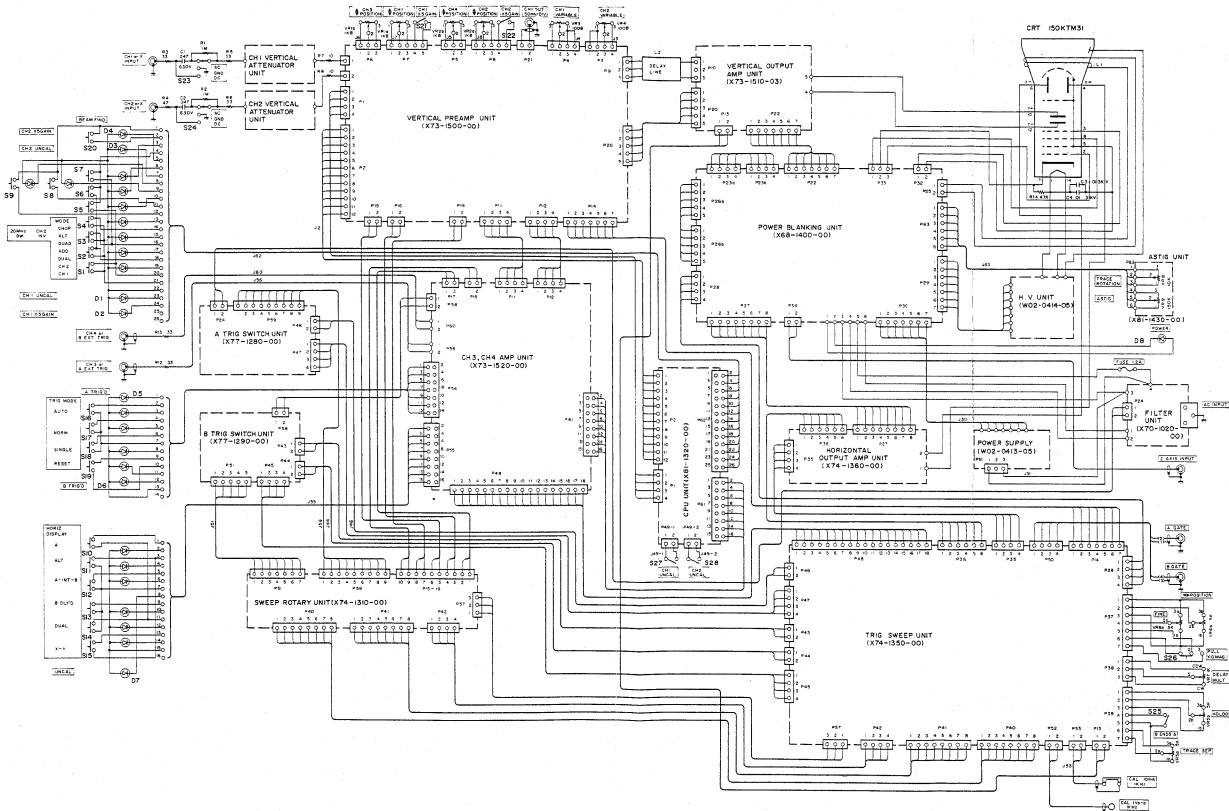
REF. NO.	PARTS NO	NAME & DESCRIPTION
VR005	R12-0532-05	RES. SEMI FIXED 200 B
VR006	R12-2512-05	RES. SEMI FIXED 5K B
VR007	R12-1212-05	RES. SEMI FIXED 10K B
VR008	R12-2512-05	RES. SEMI FIXED 5K B
VR009	R12-2512-05	RES. SEMI FIXED 5K B
VR010	R12-2512-05	RES. SEMI FIXED 5K B
VR011	R12-1212-05	RES. SEMI FIXED 2K B
VR012	R12-0532-05	RES. SEMI FIXED 200 B
VR013	R12-0532-05	RES. SEMI FIXED 500 B
VR014	R12-0540-05	RES. SEMI FIXED 500 B
VR015	NO USE	
VR016	R12-5516-05	RES. SEMI FIXED 100K B
VR017	R12-0539-05	RES. SEMI FIXED 200 B

HORIZONTAL OUTPUT AMP UNIT

X74-1360-00

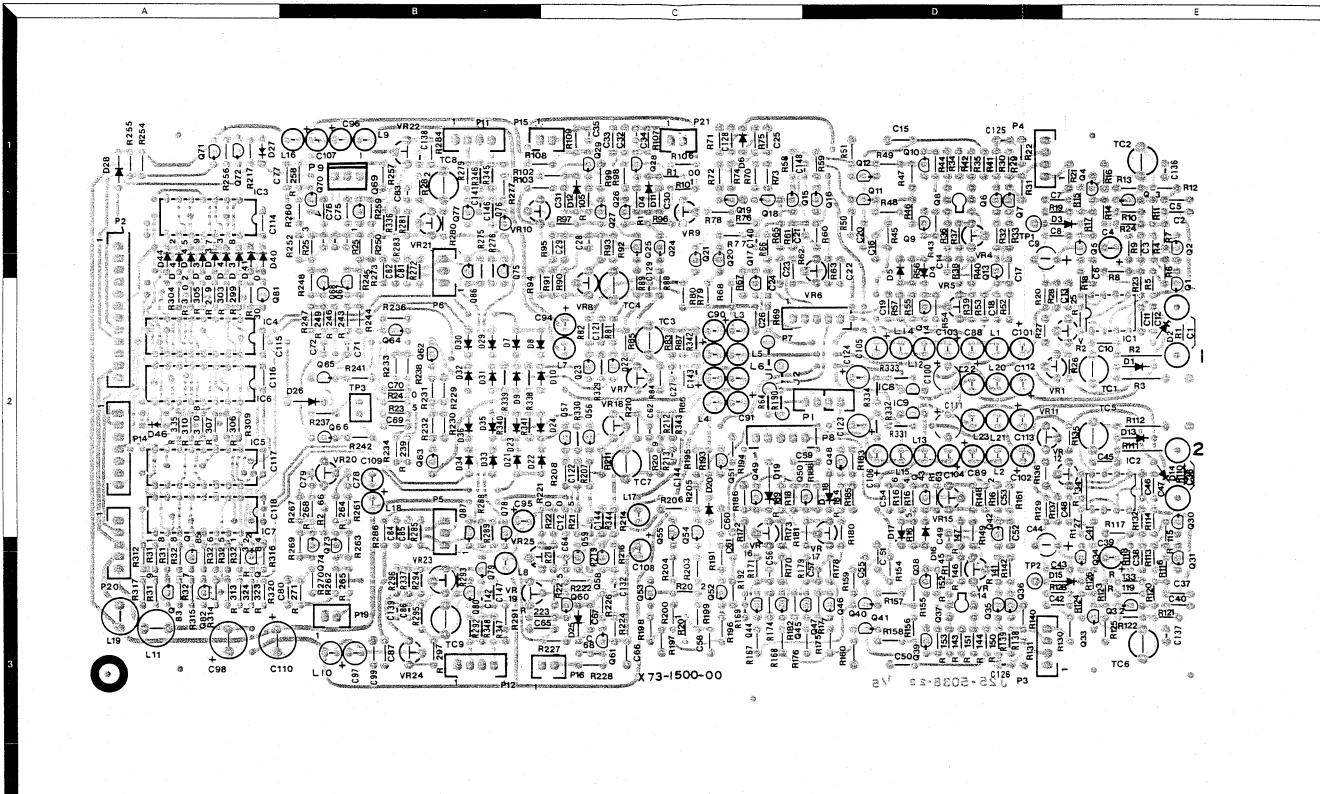
REF. NO.	PARTS NO	NAME & DESCRIPTION	REF. NO.	PARTS NO	NAME & DESCRIPTION
E23-0512-05	F01-0544-05	TERMINAL	E23-0512-05	J25-0539-22	HEAT SINK
C001	CK45FF1H103Z	CAP. CERAMIC	C002	CK45FF1H103Z	CAP. CERAMIC
C003	CK45FF1H103Z	CAP. CERAMIC	C004	CK45FF1H103Z	CAP. CERAMIC
C005	CK45FF1H103Z	CAP. CERAMIC	C006	CK45FF1H103Z	CAP. CERAMIC
C007	CK45CH04010C	CAP. CERAMIC	C008	CK45CH04020C	CAP. CERAMIC
C009	CK45CH04010C	CAP. CERAMIC	C010	CK45FF1H103Z	CAP. CERAMIC
C011	CK45FF1H103Z	CAP. CERAMIC	C012	CK45FF1H103Z	CAP. CERAMIC
C013	CK45FF1H103Z	CAP. CERAMIC	C014	C91-0549-05	CAP. TANTALUM
C015	CK45FF1H103Z	CAP. CERAMIC	C016	C91-0549-05	CAP. TANTALUM
C017	C91-0549-05	CAP. TANTALUM	C018	C91-0549-05	CAP. CERAMIC
C019	CE04W1C101M	CAP. ELECTRO	C020	CE04W1C101M	CAP. ELECTRO
C021	CE04W2A100D	CAP. ELECTRO	C022	CE04W2C2R2	CAP. ELECTRO
C023	CE04W2C3R2	CAP. ELECTRO	C024	CE04W2C3R2	CAP. ELECTRO
C025	CE04W2C3R3	CAP. ELECTRO	C001	ISS132	DIODE
C002	MT251JB	DIODE ZENER	C003	ISS132	DIODE
C004	ISS132	DIODE	L001	L40-1011-04	FERRI INDUCTOR
L002	L40-1011-04	FERRI INDUCTOR	L003	L40-1011-04	FERRI INDUCTOR
L004	L40-1011-04	FERRI INDUCTOR	P027	E40-0673-05	PIN CONNECTOR
P035	E40-0473-05	PIN CONNECTOR	P036	E40-0673-05	PIN CONNECTOR
P001	2SA1323(B)	TR. SI. PNP	P002	2SA1323(B)	TR. SI. PNP
P003	2SA1323(B)	TR. SI. PNP	P004	2SA1323(B)	TR. SI. PNP
P005	2SC2912(S)	TR. SI. NPN	P006	2SC2912(S)	TR. SI. NPN
P007	2SA1210(S)	TR. SI. PNP	P008	2SA1210(S)	TR. SI. PNP
P009	2SA1311(R)	TR. SI. PNP	P010	2SA1311(R)	TR. SI. PNP
P011	2SA1311(R)	TR. SI. PNP	R001	RD14882C272J	RES. CARBON
R002	RD14882C272J	RES. CARBON	R003	RD14882C272J	RES. CARBON
R004	RD14882C270J	RES. CARBON	R005	RD14882C152J	RES. CARBON
R006	RD148Y2H473J	RES. CARBON	R007	RD148Y2H473J	RES. CARBON
R008	RD14882C521J	RES. CARBON	R009	RD14882C521J	RES. CARBON
R010	RD14882C102J	RES. CARBON	R011	RD14882C102J	RES. CARBON
R012	RD14882C102J	RES. CARBON	R013	RS14GB34223J	RES. METAL FILM
R014	RD14882C2134J	RES. CARBON	R015	RD14882C2134J	RES. CARBON
R016	RD148Y2H123J	RES. CARBON	R017	RD14882C102J	RES. CARBON
R018	RD14882C102J	RES. CARBON	R019	RD14882C220J	RES. CARBON
R020	RD14882C220J	RES. CARBON	R021	RD14882C545J	RES. CARBON
R022	RD14882C561J	RES. CARBON	R023	RD14882C431J	RES. CARBON
R024	RD14882C472J	RES. CARBON	R025	RD14882C472J	RES. CARBON
R026	RD14882C271J	RES. CARBON	R027	RD14882C512J	RES. CARBON

SCHEMATIC DIAGRAM



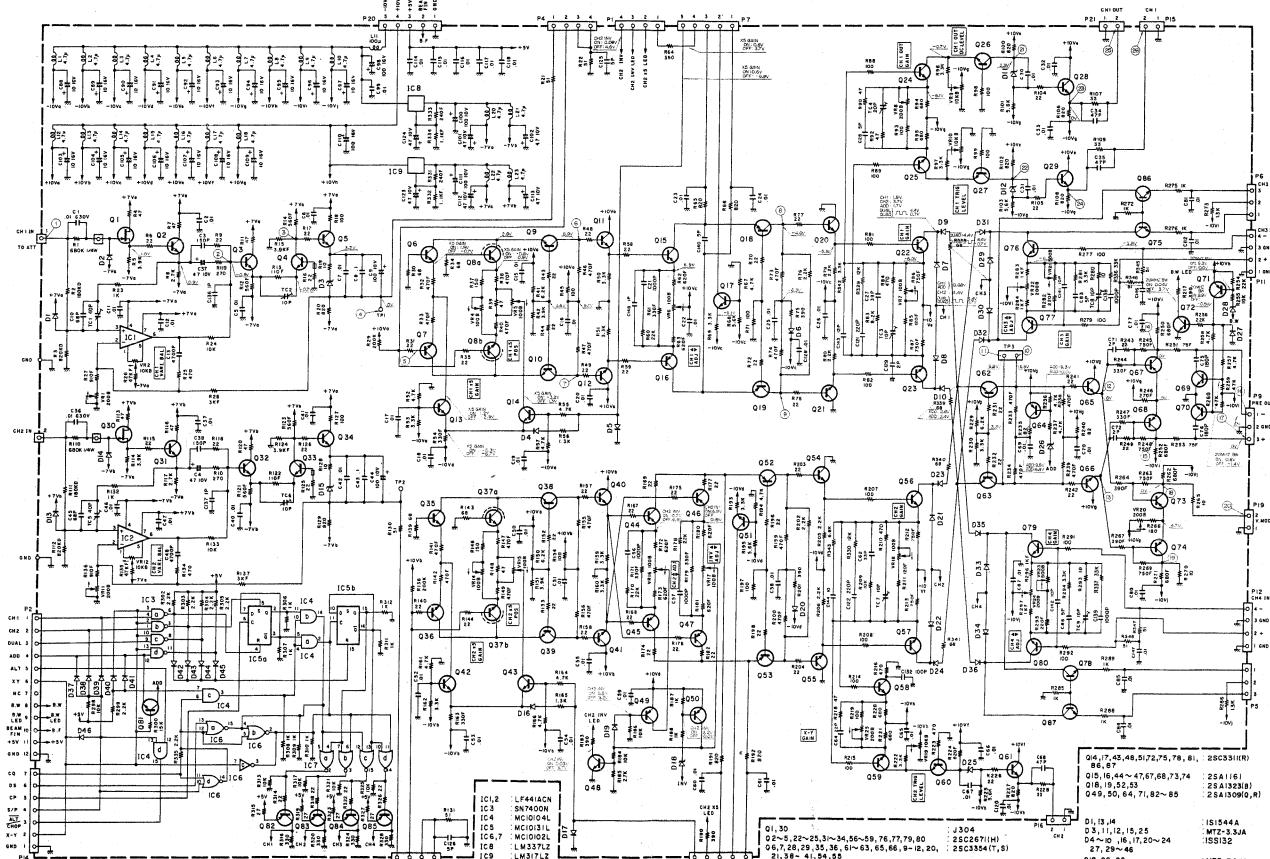
PC BOARD

VERTICAL PREAMP UNIT (X73-1500-00)



SCHEMATIC DIAGRAM

VERTICAL PREAMP UNIT (X73-1500-00)

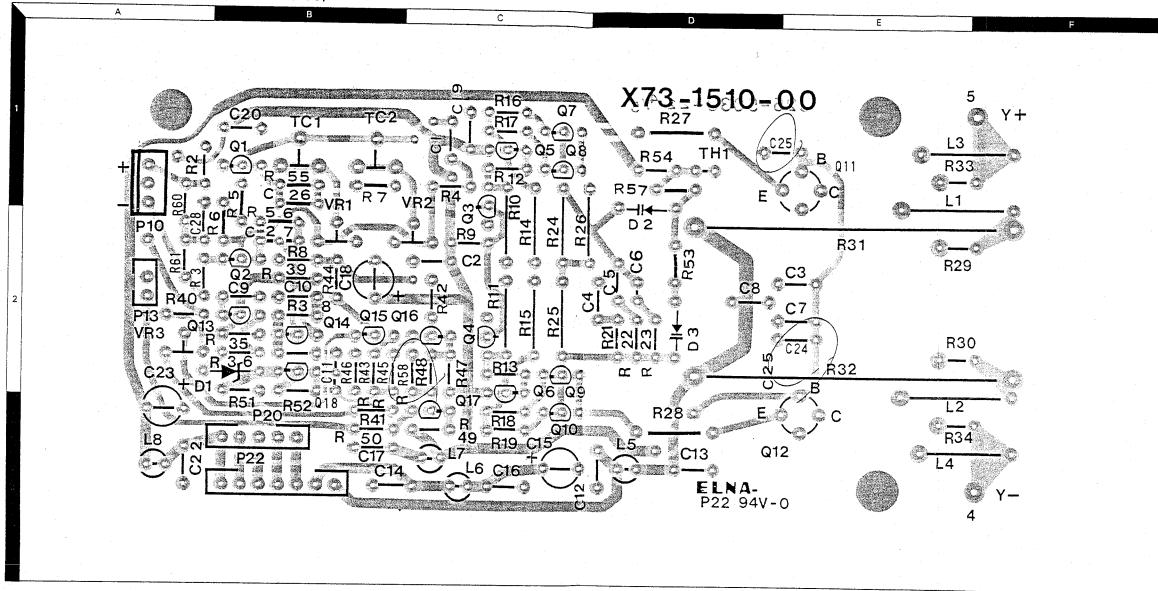


Q4, 7, 46, 51, 72, 75, 76, 81,
 2SC331(R)
 Q5, 87
 Q15, 16, 44, 47, 47, 67, 68, 73, 74
 2SA1(6)
 Q16, 19, 32, 33
 Q49, 50, 64, 71, 82~85
 2SA1098(R)

IS1544A
 MTZ-3.3JA
 ISS132
 2SC3347(R), S3
 2SC3347(R), S3
 D1, 13, 14
 D3, 11, 12, 15, 25
 D6, 16, 17, 20~24
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 D8, 26, 28
 D9
 MTZ-75JA
 IS60

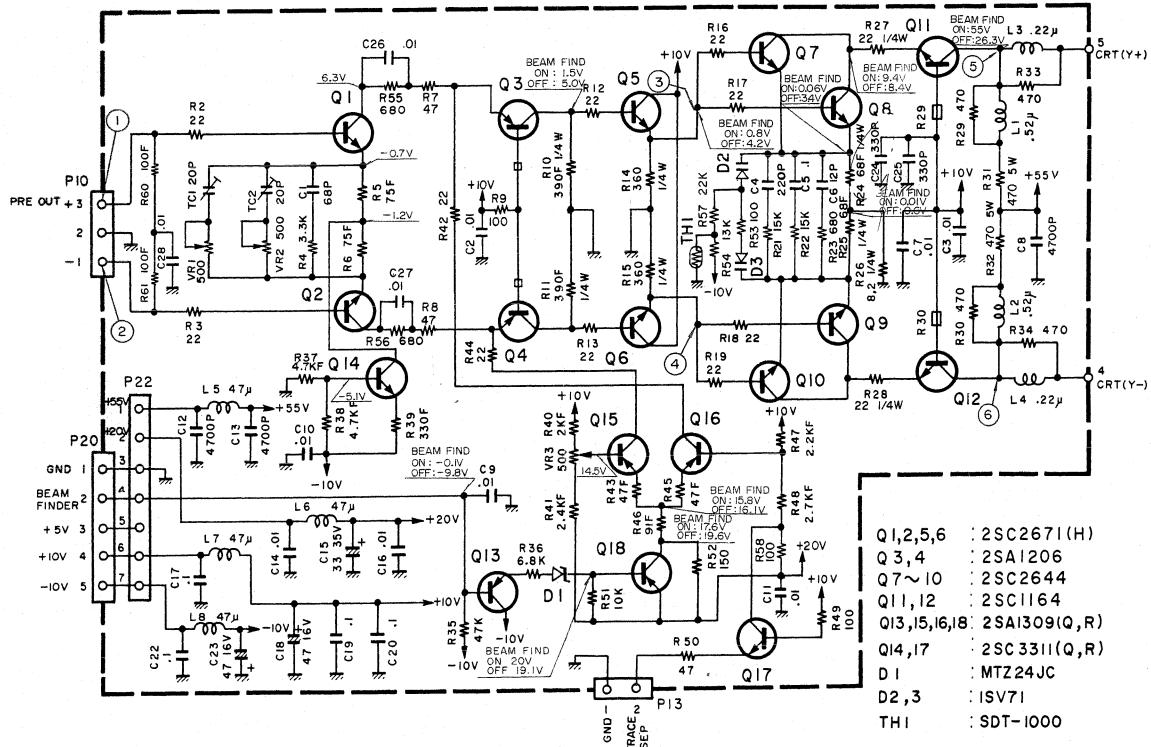
PC BOARD

VERTICAL OUTPUT AMP UNIT (X73-1510-03)



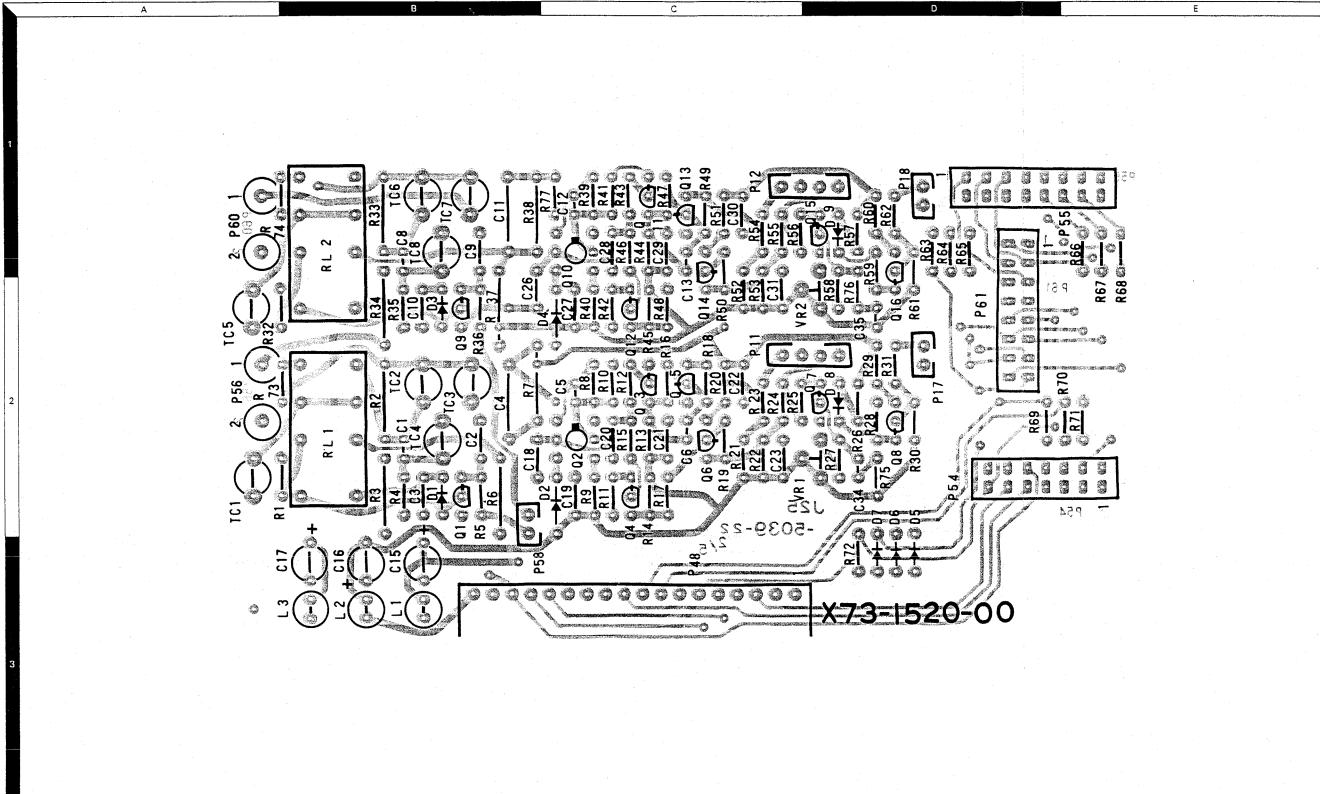
SCHEMATIC DIAGRAM

VERTICAL OUTPUT AMP UNIT (X73-1510-03)



PC BOARD

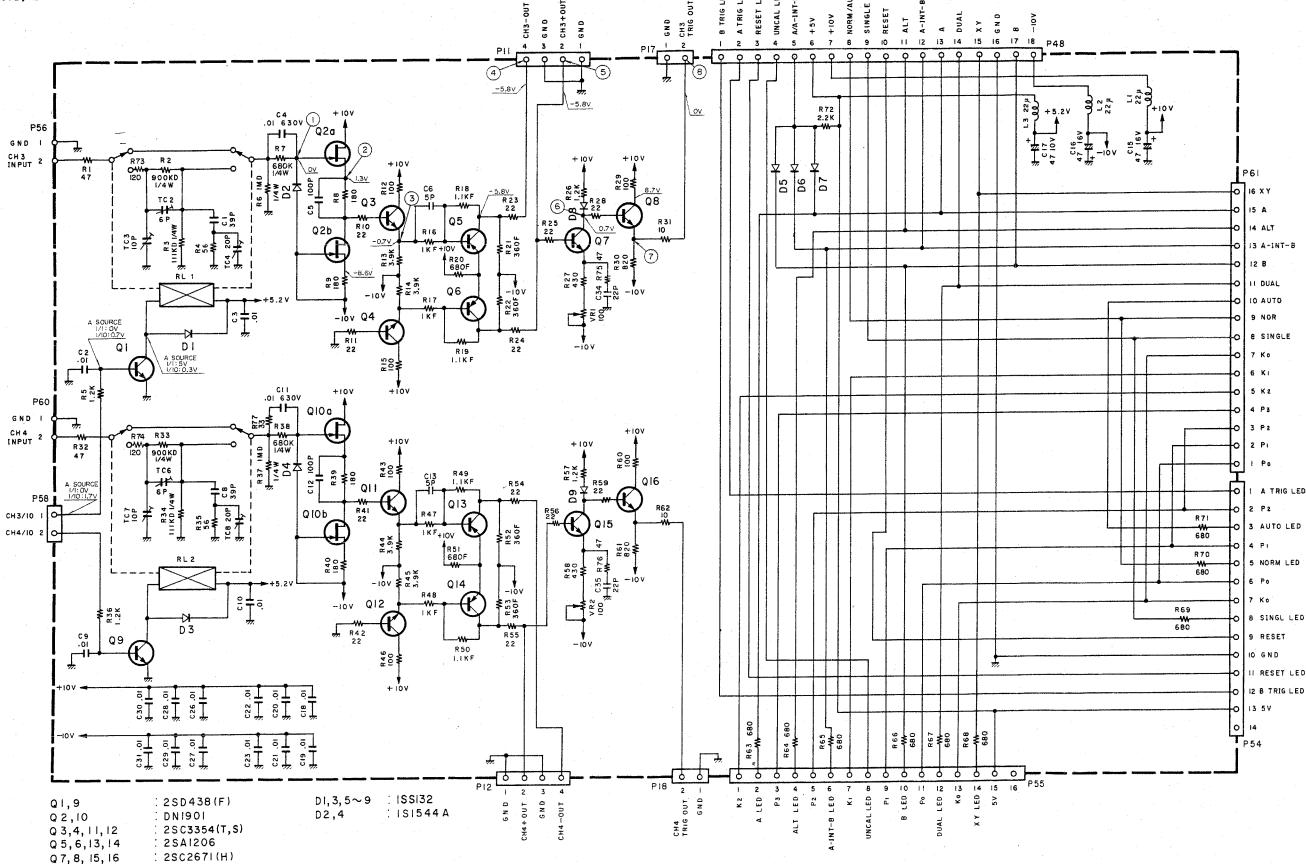
CH3, CH4 AMP UNIT (X73-1520-00)



X73-1520-00

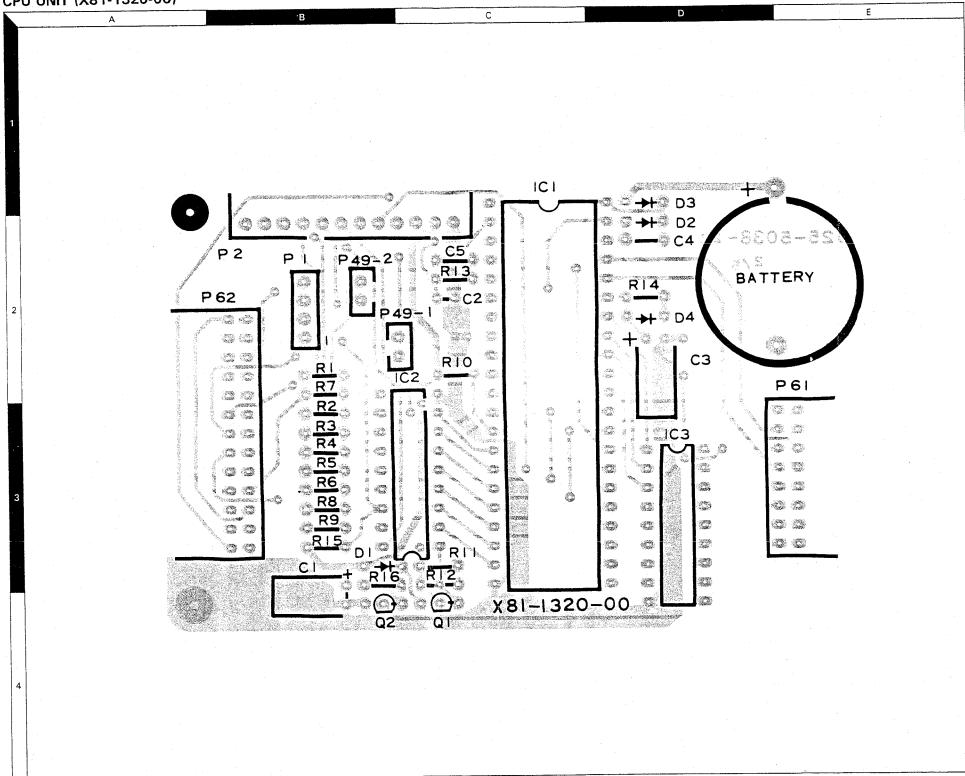
SCHEMATIC DIAGRAM

CH3, CH4 AMP UNIT (X73-1520-00)



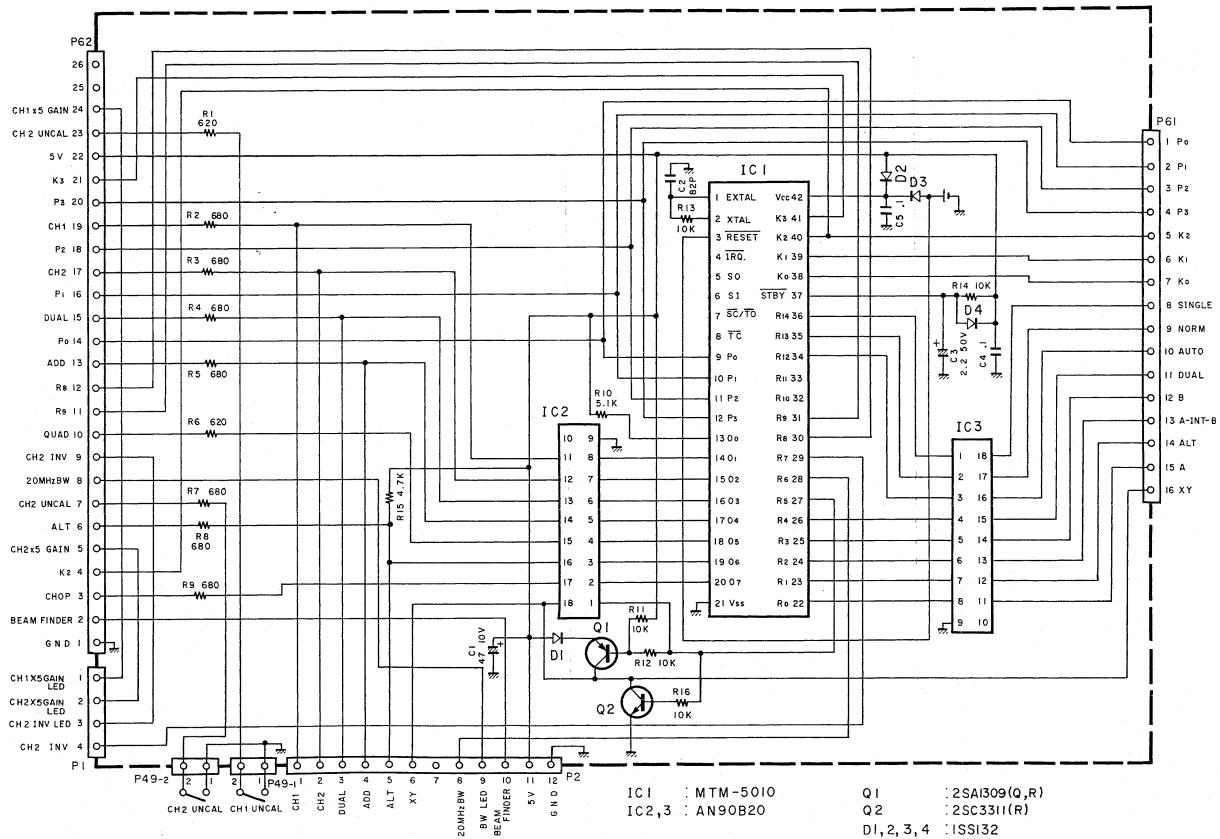
PC BOARD

CPU UNIT (X81-1320-00)



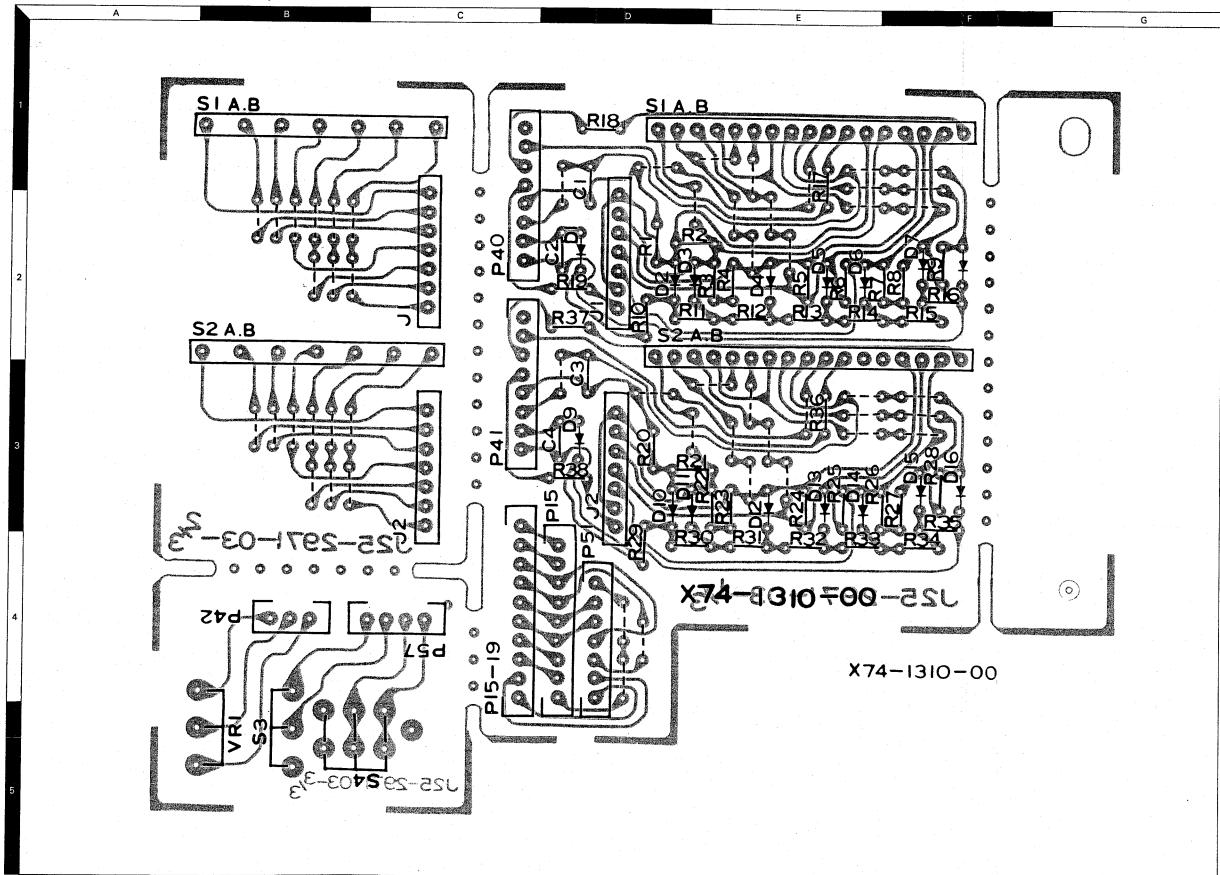
SCHEMATIC DIAGRAM

CPU UNIT (X81-1320-00)



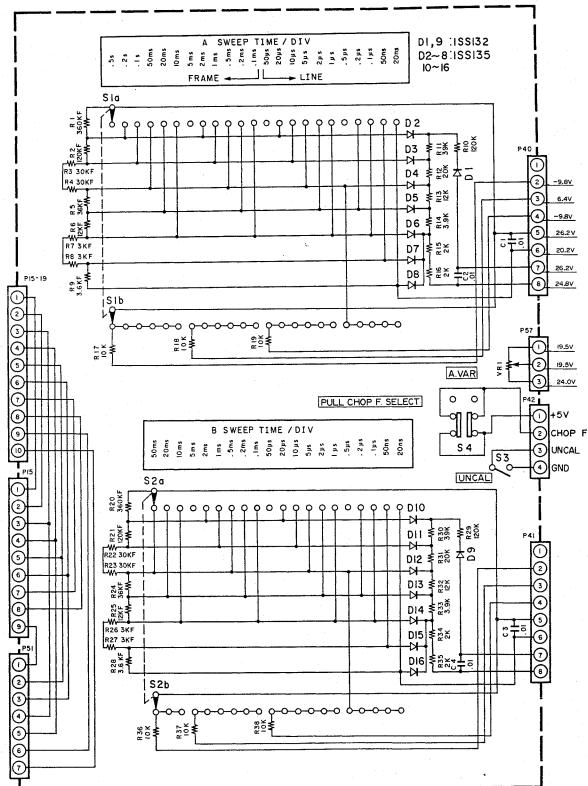
PC BOARD

SWEET ROTARY UNIT (X74-1310-00)



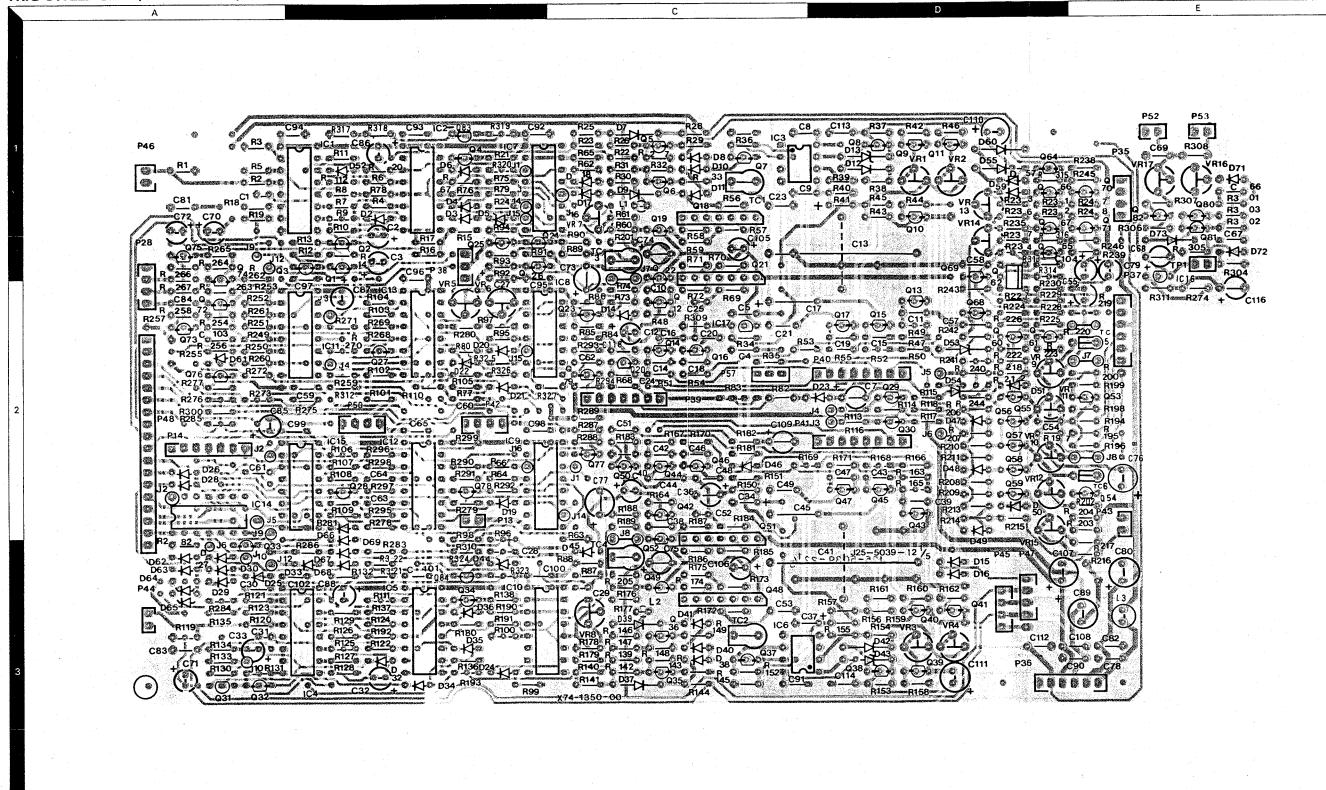
SCHEMATIC DIAGRAM

SWEEP ROTARY UNIT (X74-1310-00)



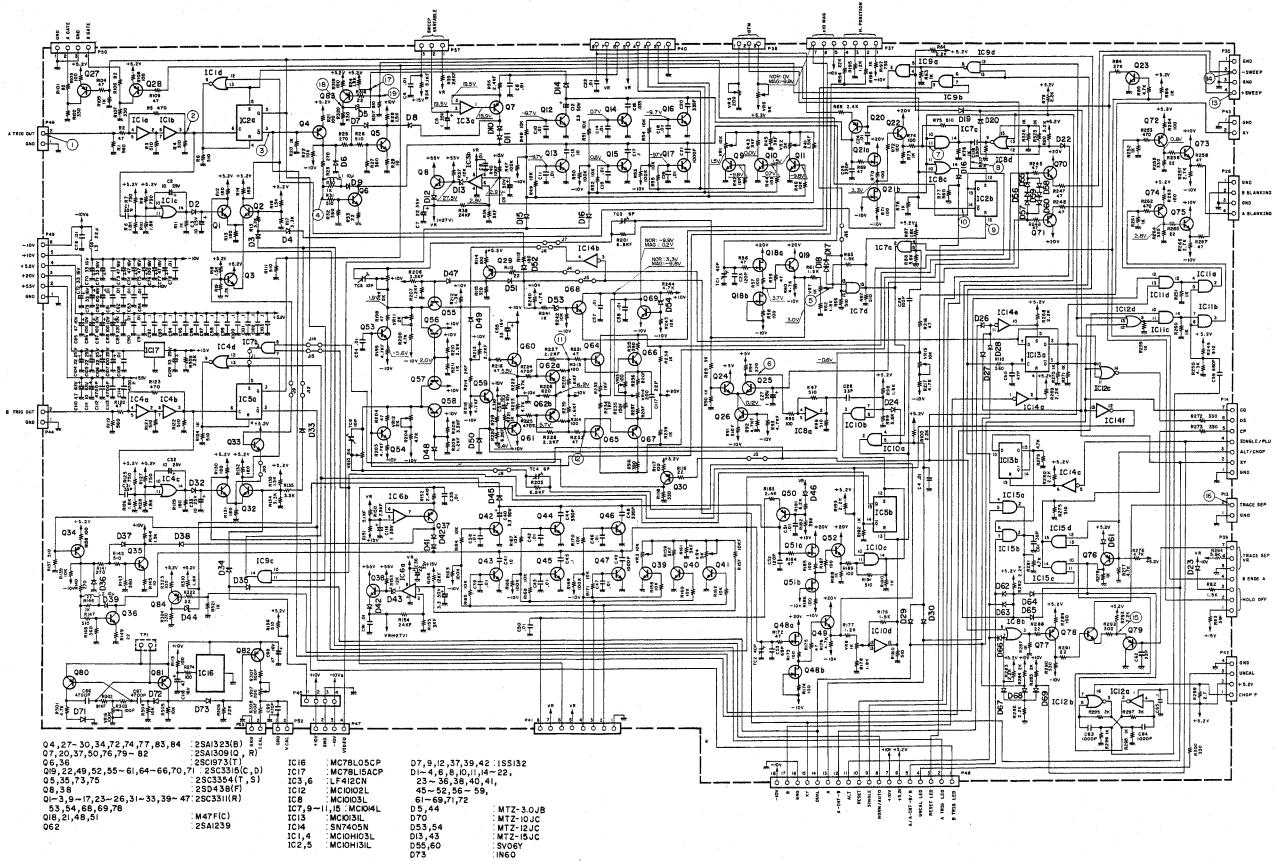
PC BOARD

TRIG SWEEP UNIT (X74-1350-00)



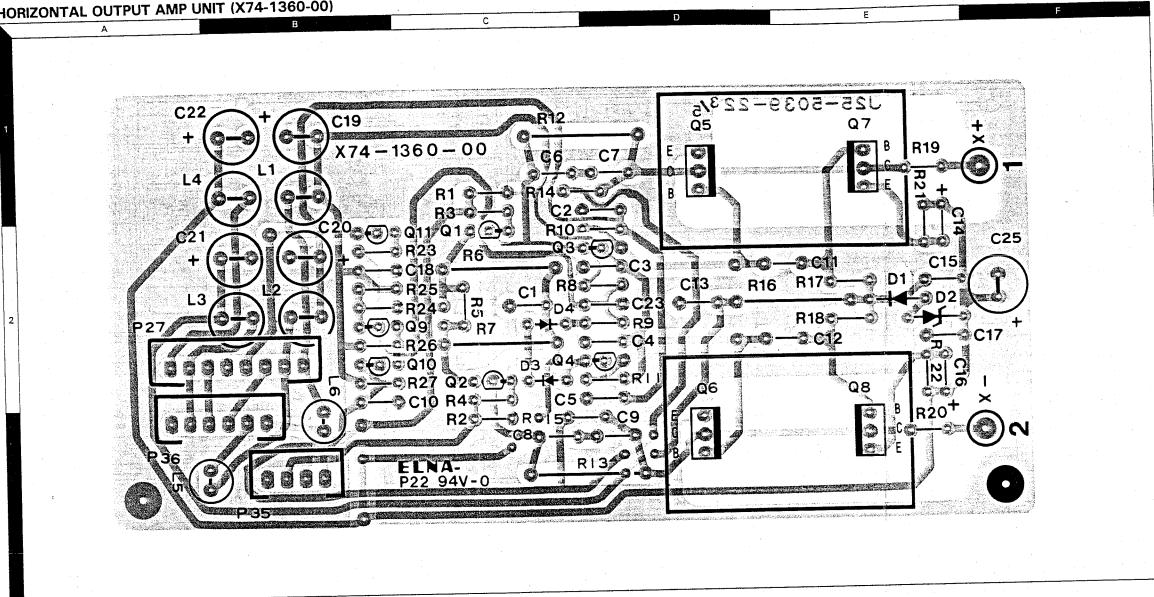
SCHEMATIC DIAGRAM

TRIG SWEEP UNIT (X74-1350-00)



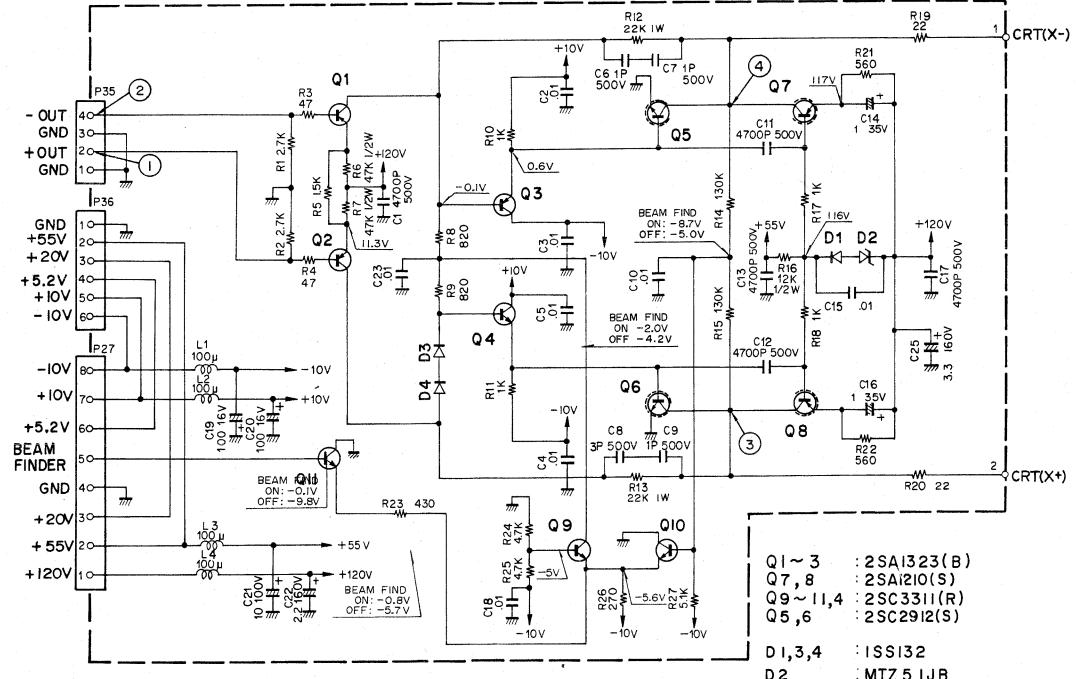
PC BOARD

HORIZONTAL OUTPUT AMP UNIT (X74-1360-00)



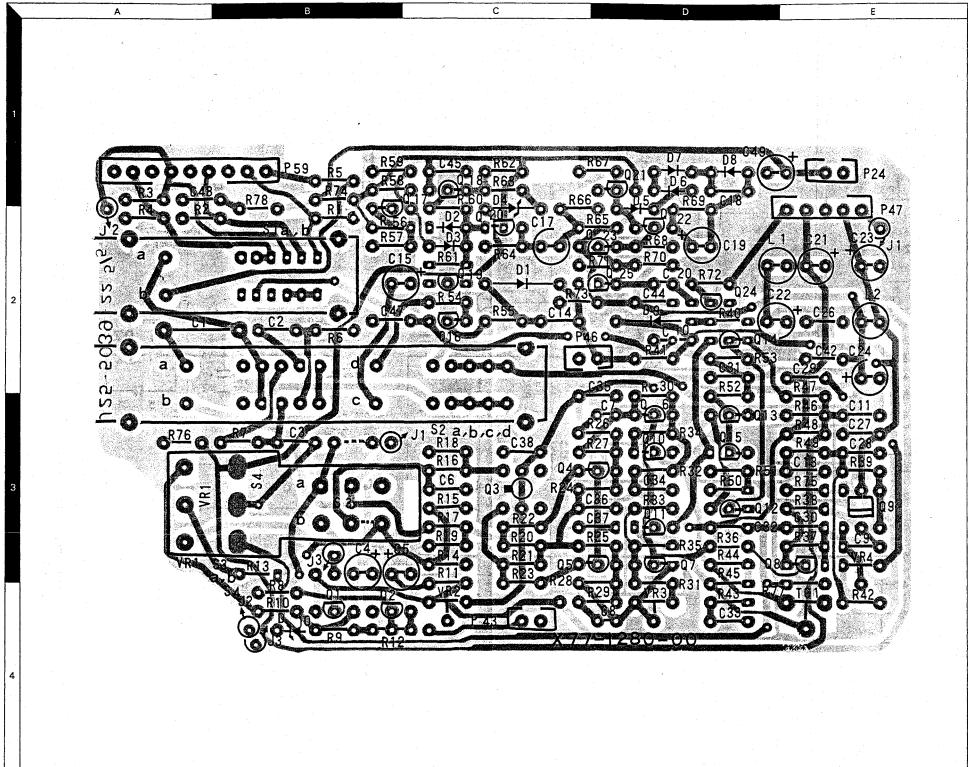
SCHEMATIC DIAGRAM

HORIZONTAL OUTPUT AMP UNIT (X74-1360-00)



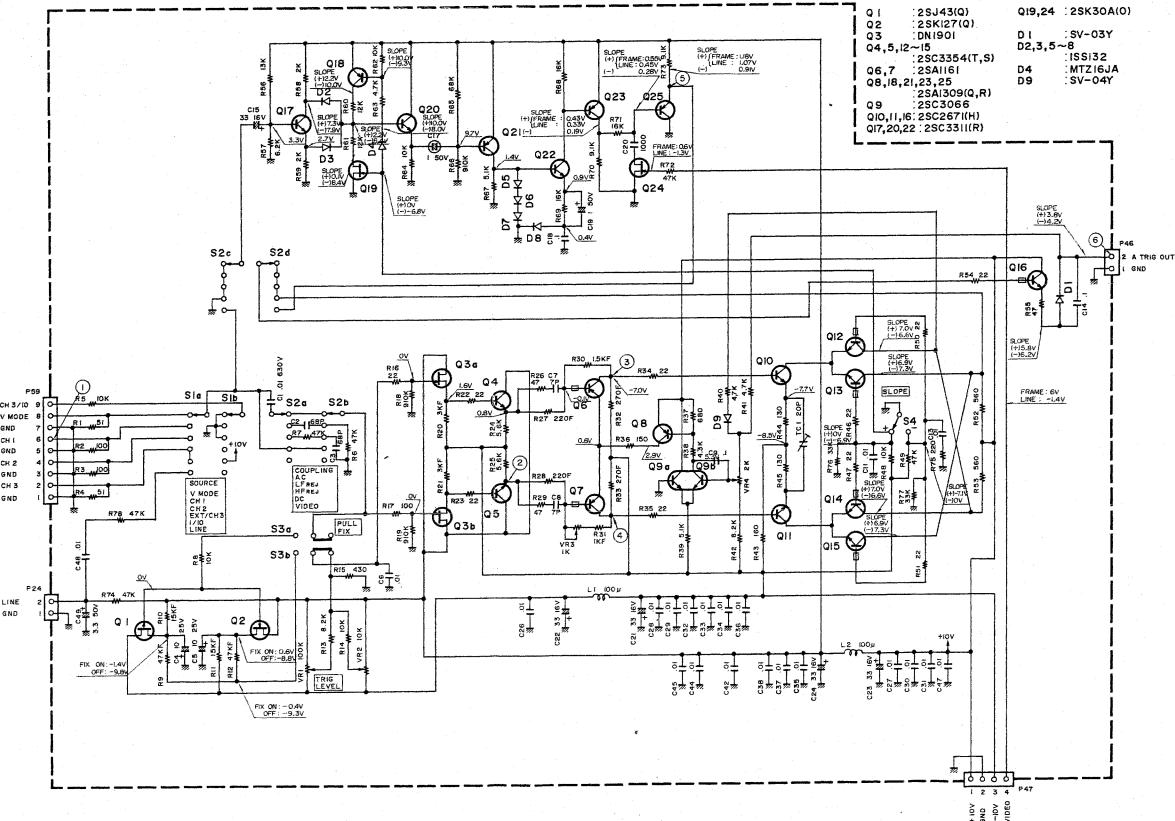
PC BOARD

A TRIG SWITCH UNIT (X77-1280-00)



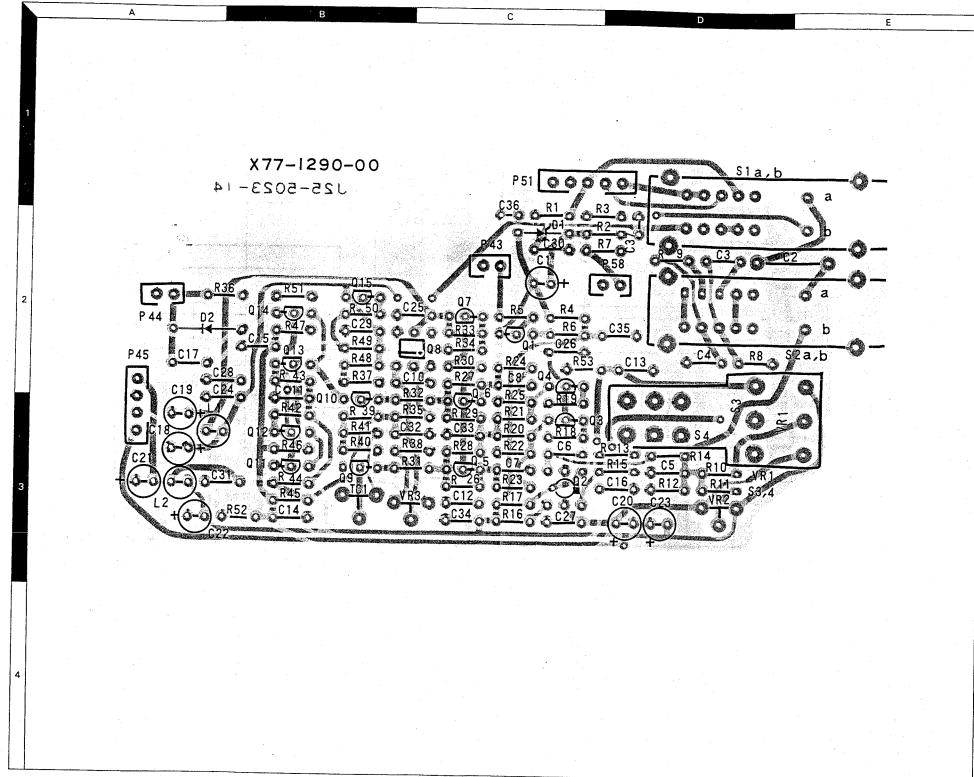
SCHEMATIC DIAGRAM

A TRIG SWITCH UNIT (X77-1280-00)



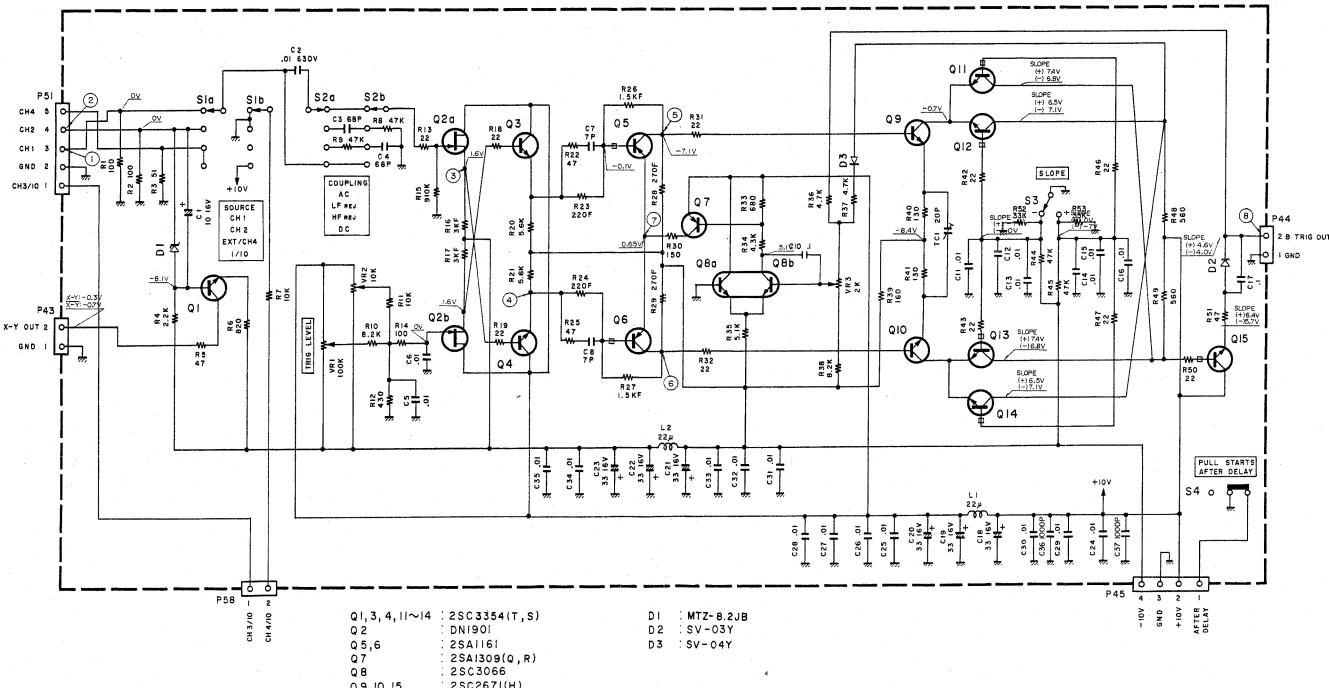
PC BOARD

B TRIG SWITCH UNIT (X77-1290-00)



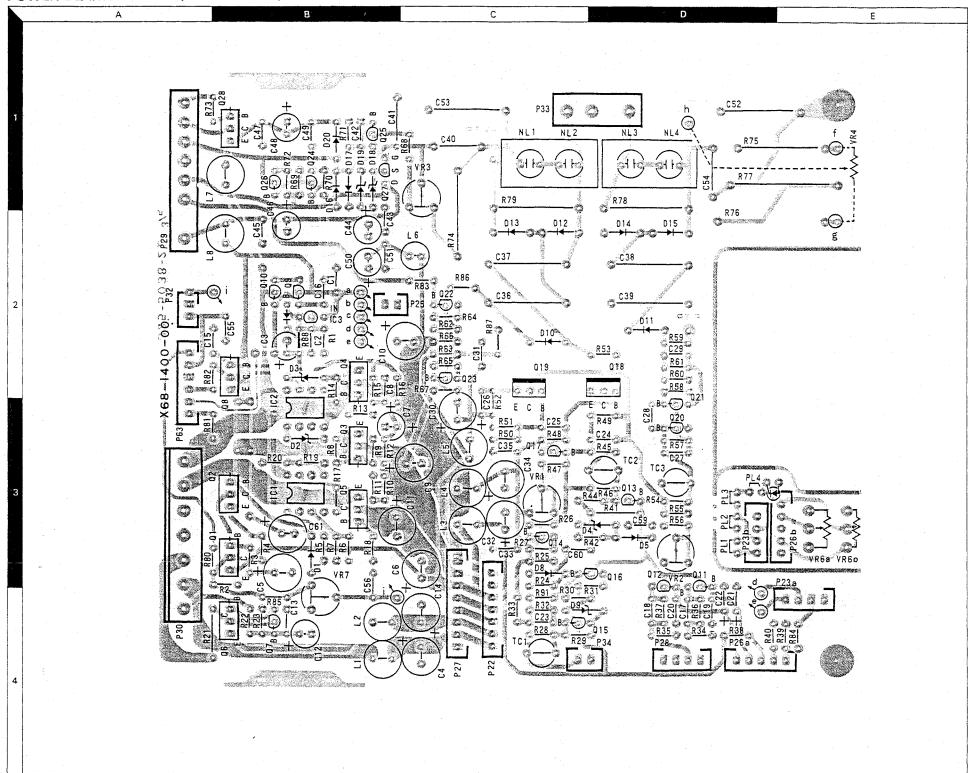
SCHEMATIC DIAGRAM

B TRIG SWITCH UNIT (X77-1290-00)



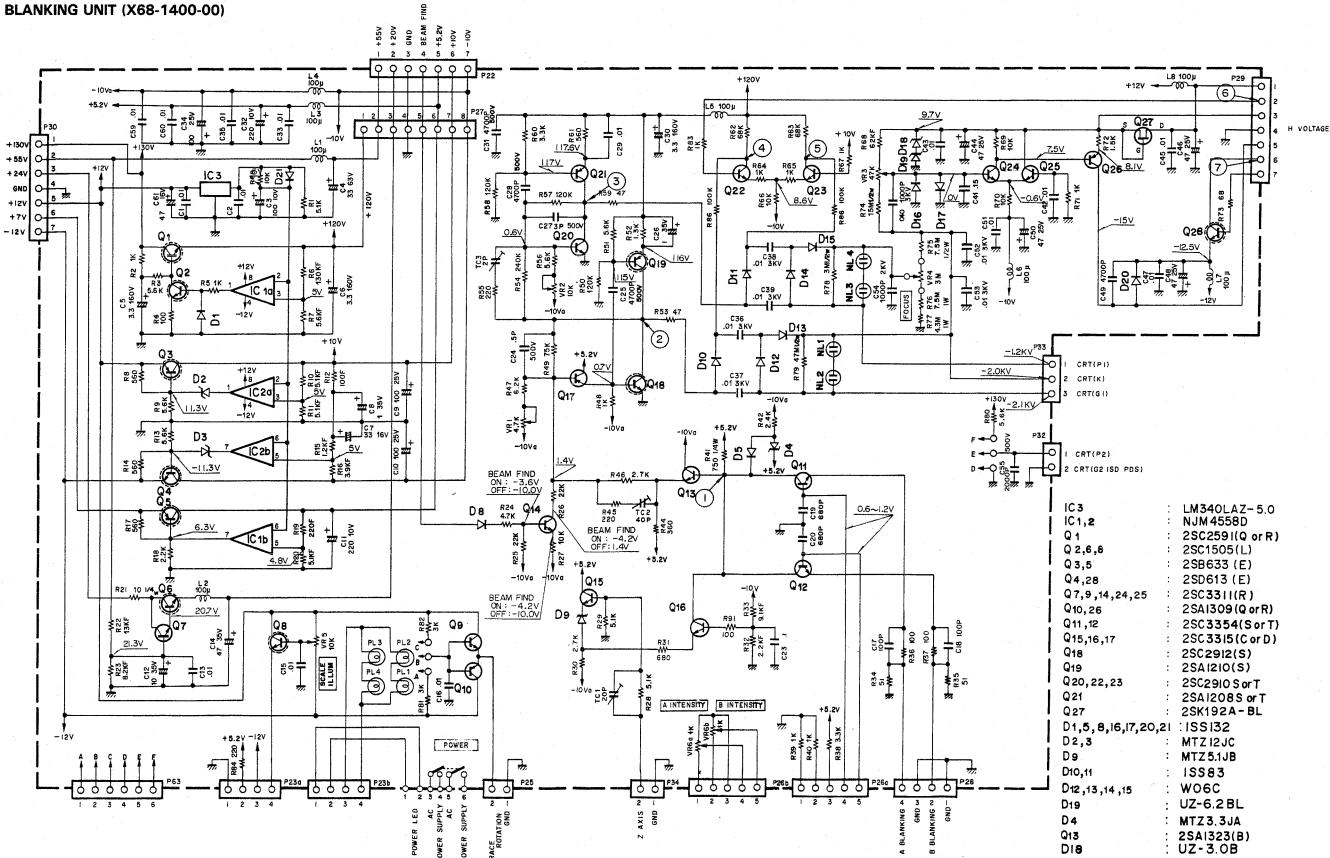
PC BOARD

POWER BLANKING UNIT (X68-1400-00)



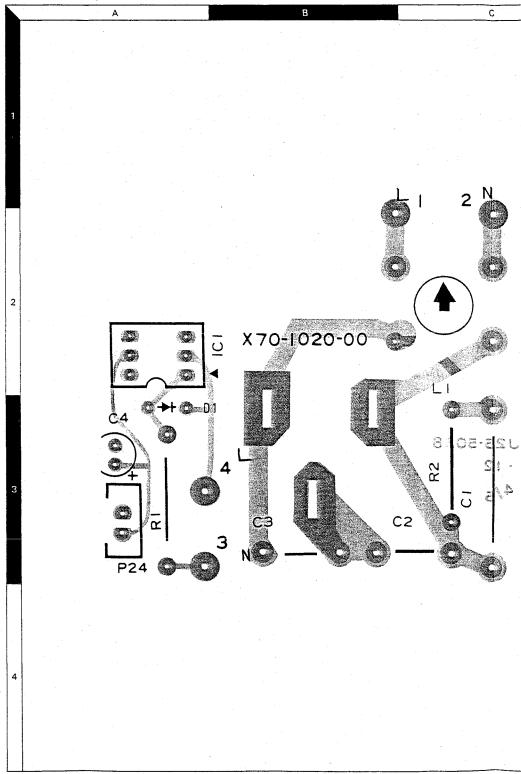
SCHEMATIC DIAGRAM

POWER BLANKING UNIT (X68-1400-00)

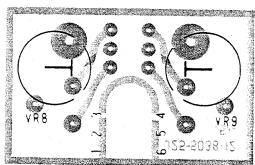


PC BOARD

FILTER UNIT (X70-1020-00)

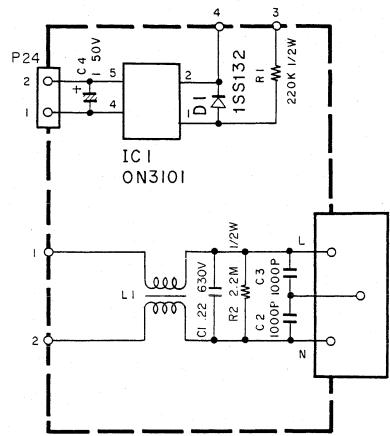


ASTIG UNIT (X81-1430-00)

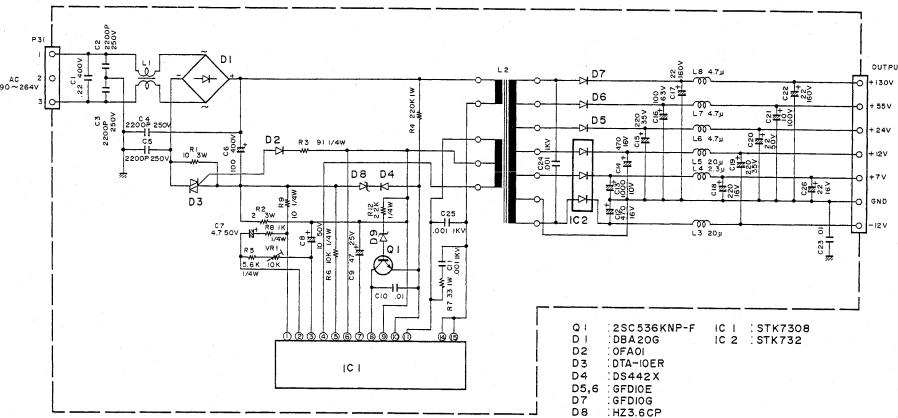


SCHEMATIC DIAGRAM

FILTER UNIT (X70-1020-00)



SWITCHING POWER SUPPLY UNIT (W02-0413-05)



Q1 : 2SC536KNP-F	IC1 : STK7308
D1 : DBA20G	IC2 : STK732
D2 : ZP100	
D3 : DTA-10ER	
D4 : DS442X	
D5,6 : GF410E	
D7 : GF410G	
D8 : HZ3.6CP	
D9 : GZA6.2Z	

VOLTAGES AND WAVEFORMS

The voltages and waveforms are measured on each schematic diagram as follows:

TEST EQUIPMENT

Digital multimeter : DL-720 (TRIO)
Oscilloscope : 475A (TEKTRONIX)
Sine wave generator : SG-502 (TEKTRONIX)

CONTROL SETTINGS

A INTENSITY	Midrange
FOCUS	Midrange
AC-GND-DC	GND for voltage measurement DC for waveform measurement
◆ POSITION	Midrange
CH1, CH2 x 5 GAIN	OFF
CH1, CH2 VARIABLE	CAL
CH1, CH2 VOLTS/DIV	0.2 V
CH2 INV	OFF
V. MODE	Unless otherwise specified CH1
20 MHz BW	OFF
A, B COUPLING	AC
A, B SLOPE	+
TRIG. MODE	AUTO
HOLDOFF	NORM
A SWEEP TIME/DIV	0.2 ms
B SWEEP TIME/DIV	50 μ s
A. VARIABLE	CAL
◀ ▶ POSITION	Midrange
HORIZ DISPLAY	A
X10 MAG	OFF

Voltage Measurements

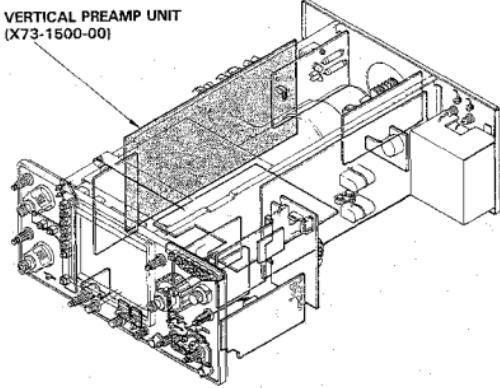
Voltage measurements are taken with no signal applied and the trace positioned to the center horizontal graticule line. The digital multimeter common should be connected to chassis ground at the nearest measurement point.

Waveform Condition

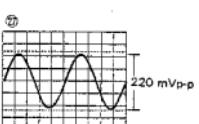
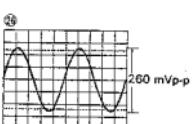
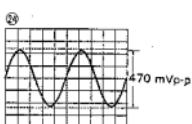
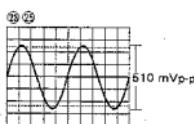
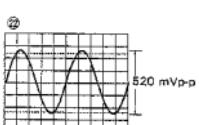
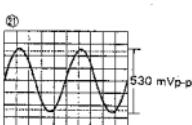
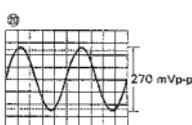
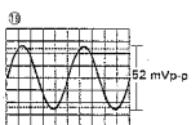
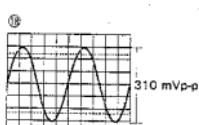
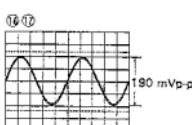
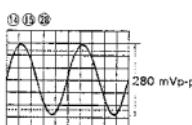
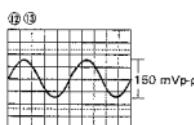
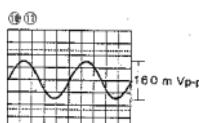
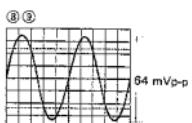
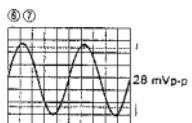
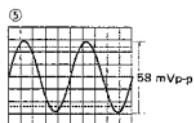
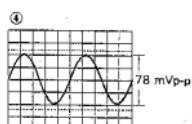
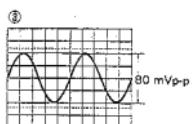
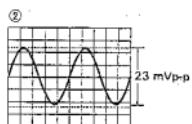
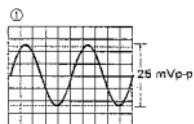
Waveforms are measured with 1 kHz 1 Vp-p sine wave applied CH1 input and 1 kHz 500 m Vp-p applied CH3 input.

NOTE:

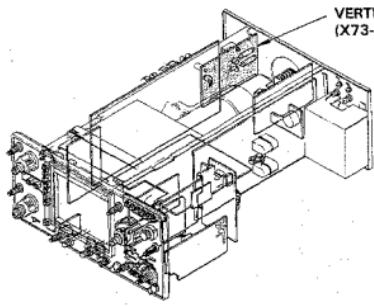
In differential circuit, the voltages and waveforms are shown only CH1 and CH3.



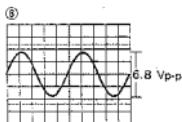
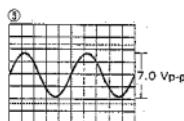
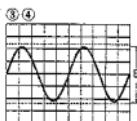
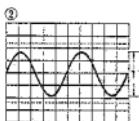
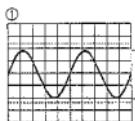
WAVEFORMS

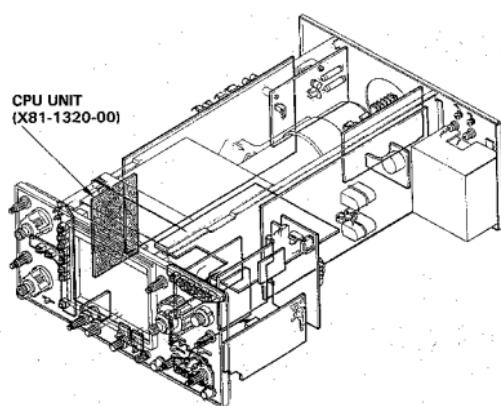


VERTICAL OUTPUT AMP UNIT
(X73-1510-03)

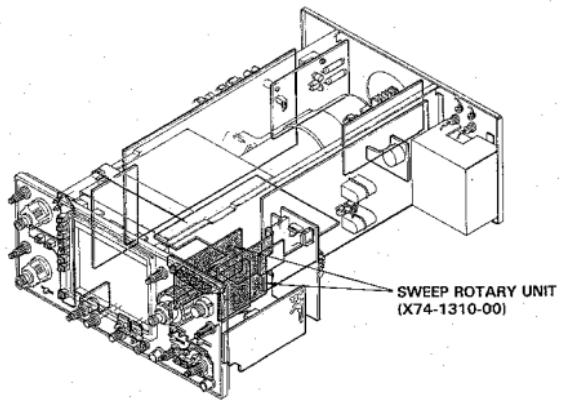


WAVEFORMS



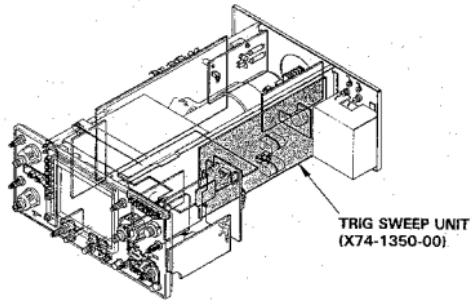


WAVEFORMS

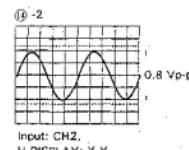
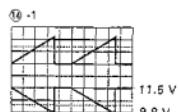
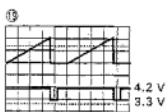
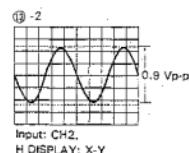
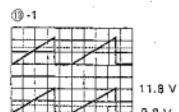
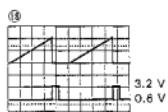
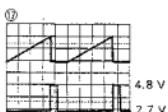
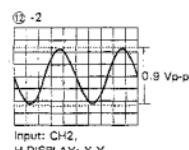
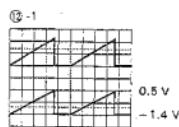
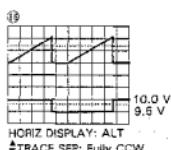
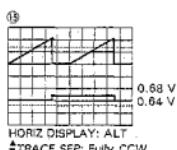
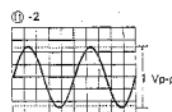
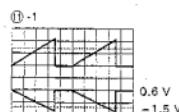
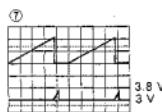
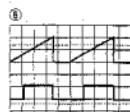
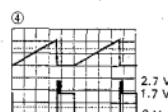
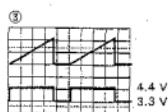
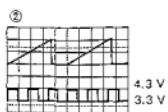
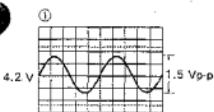


**SWEEP ROTARY UNIT
(X74-1310-00)**

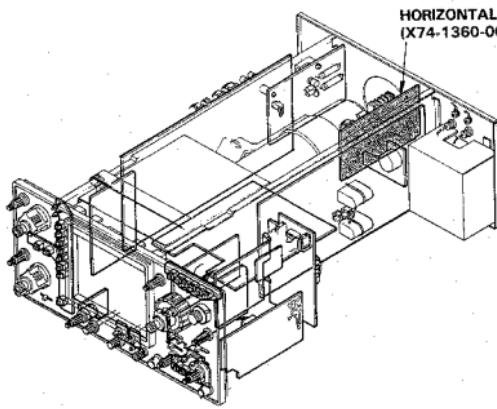
WAVEFORMS



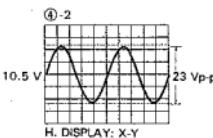
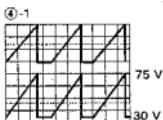
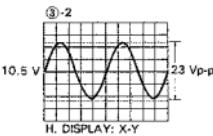
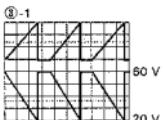
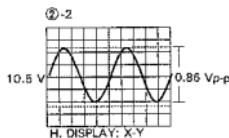
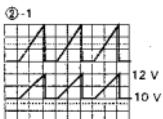
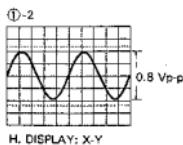
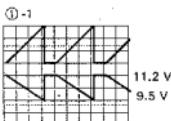
WAVEFORMS



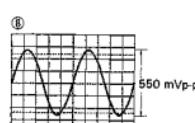
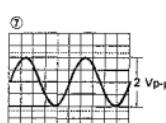
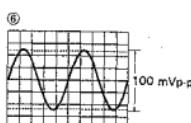
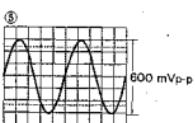
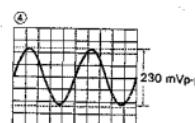
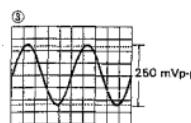
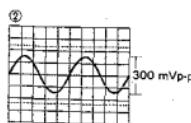
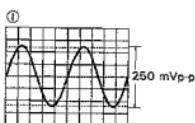
**HORIZONTAL OUTPUT AMP UNIT
(X74-1360-00)**

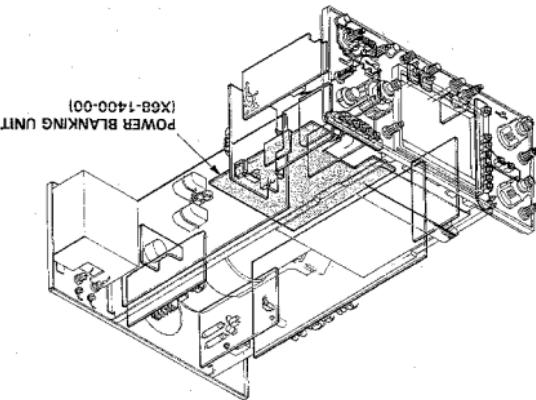


WAVEFORMS

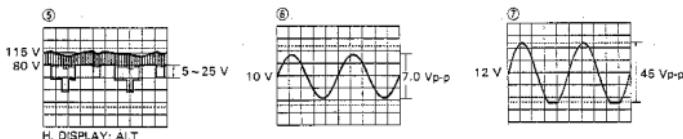
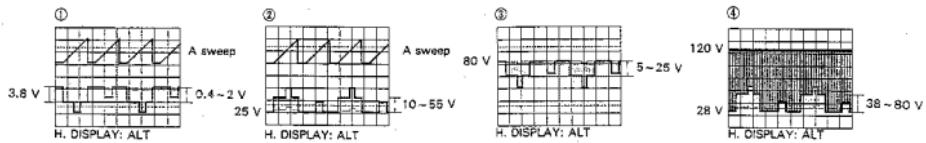


WAVEFORMS





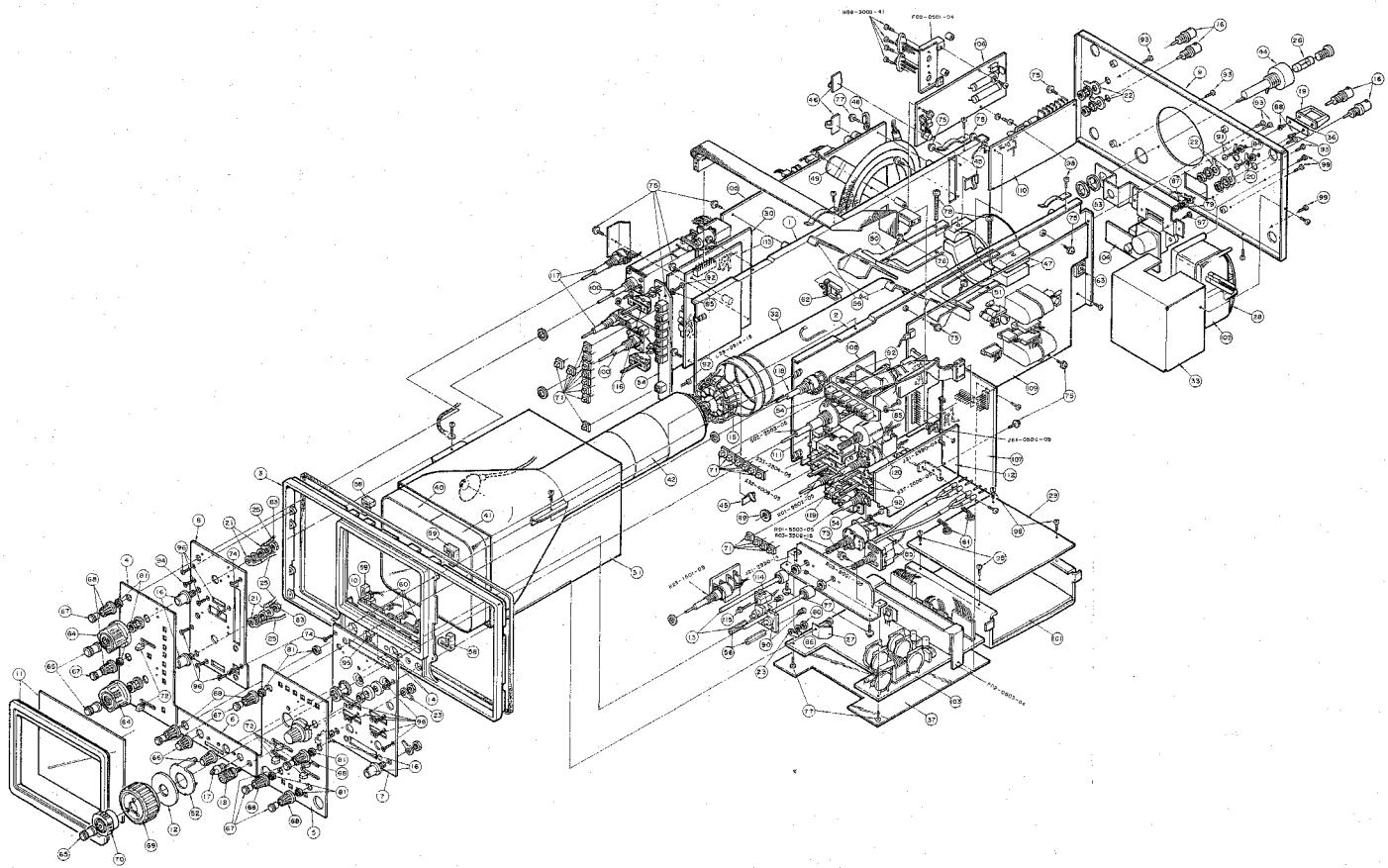
WAVEFORMS



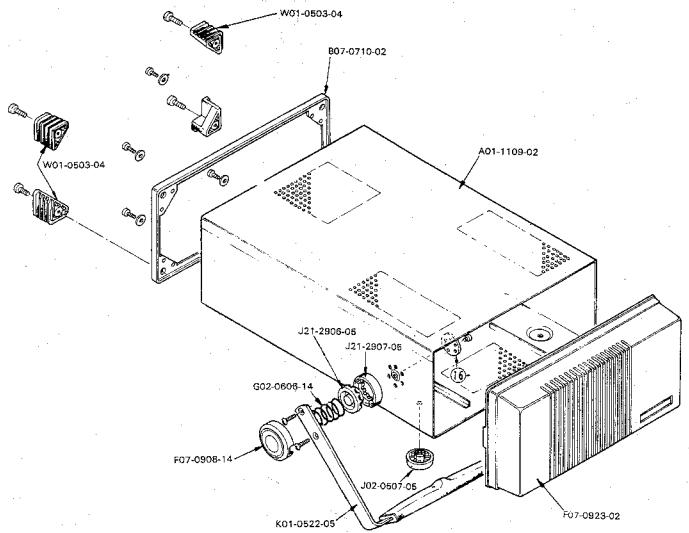
Note : IIII : CHOP Operation

WAVEFORMS

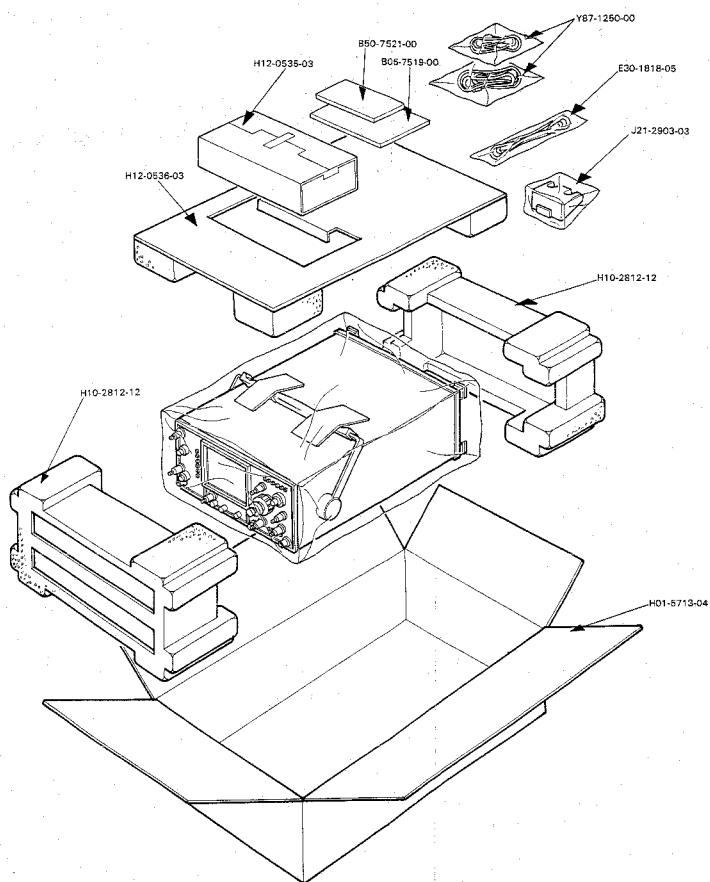
DISASSEMBLY



DISASSEMBLY

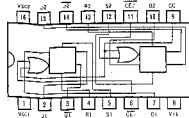
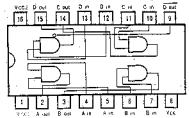
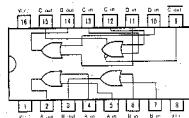
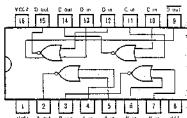


PACKING

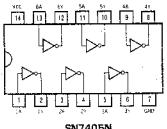
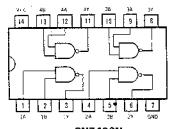


SEMICONDUCTORS

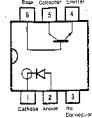
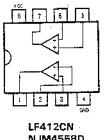
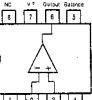
C-MOS IC



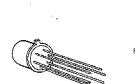
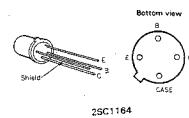
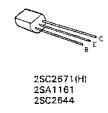
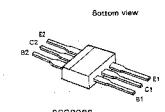
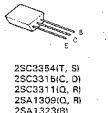
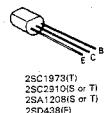
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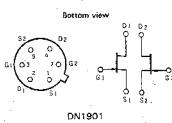
OTHER



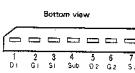
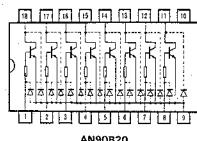
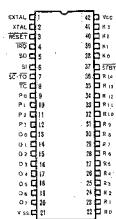
TRANSISTOR



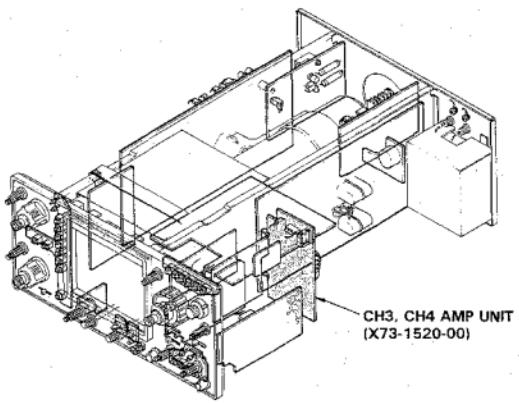
FET



CPU

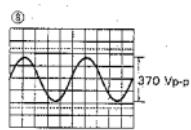
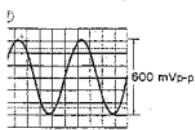
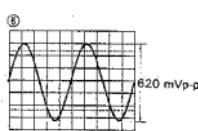
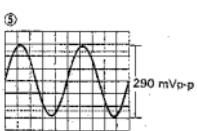
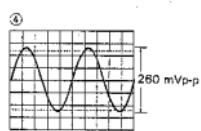
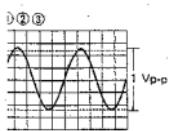


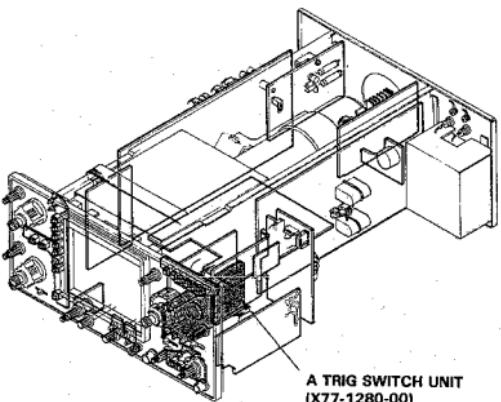
Bottom view



CH3, CH4 AMP UNIT
(X73-1520-00)

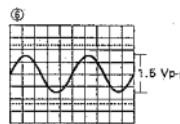
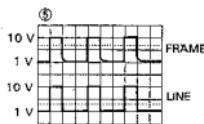
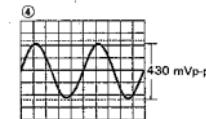
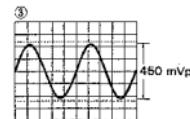
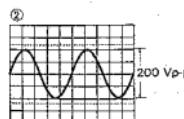
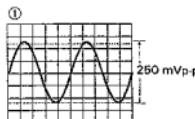
WAVEFORMS

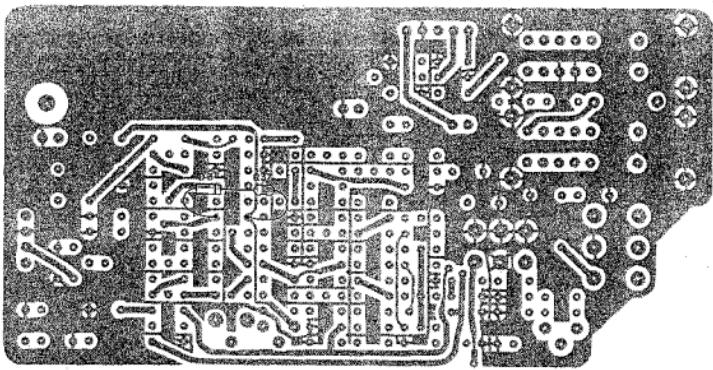




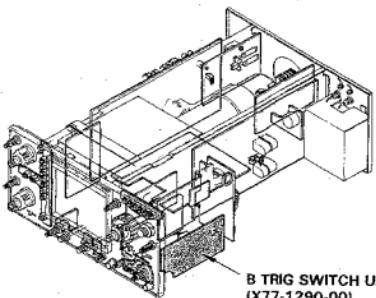
A TRIG SWITCH UNIT
(X77-1280-00)

WAVEFORMS

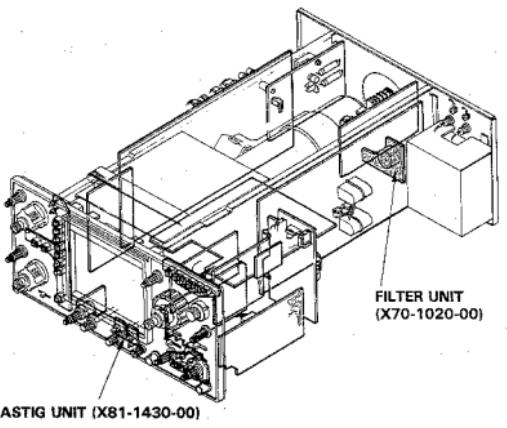




(COMPONENT SIDE VIEW)



B TRIG SWITCH UNIT
(X77-1290-00)



ASTIG UNIT (X81-1430-00)

**FILTER UNIT
(X70-1020-00)**