SERVICE MANUAL

CS-1566A

DUAL TRACE OSCILLOSCOPE

TRIO

FEATURE

1566A1

Model CS-1566A Dual-Trace Oscilloscope is a high-performance, laboratory-quality instrument. Its performance, versatility, and operational features are designed to meet the needs of engineers and other advanced technologists in electronic research and design laboratories, test and analysis centers, and well-equipped service shops. The instrument is built for the professional who understands how to use scopes, with many operating conditions selected manually rather than automatically to permit greater versatility. For example, in dual-trace operation the sweep can be triggered by the CH1, CH2, LINE, or EXT signal, as manually selected by the user.

Performance features include DC to 20 MHz bandwidth (−3 dB) with smooth rolloff above 20 MHz to allow operation beyond 30 MHz, high sensitivity (5 mV/div), and calibration precision. Matched, dual vertical inputs permit simultaneous viewing of two waveforms. Chop or alternate sweep operation is manually selected. Add and subtract capability is also provided so that the sum or difference of two waveforms can be displayed as a single trace. The Channel 2 vertical input can be switched to become the horizontal input during X-Y operation; sensitivity of the horizontal axis equals that of the vertical axis.

Rectangular, domed, CRT provides constant electron beam length. Internal 8 × 10 division graticule reduces parallax error. Mesh type acceleration provides fine trace for accurate measurements.

For video applications such as video tape recorders, CATV and MATV networks, and television receivers, a built-in sync separator permits viewing of composite video waveforms.

Features like X10 magnification, electrical trace rotation (adjustable from the front panel), a slotted bezel for mounting a standard oscilloscope camera and the crisp, clean, modern styling will also be found.

CONTENTS

SPECIFICATIONS

Cathode Ray Tube

Type:
C5S106P31B
Acceleration voltage:
2 kV
Scale:
8 div × 10 div (1 div = 9.5 mm)

Vertical Amplifier (for Both CH1 and CH2)

Deflection Factor:
5 mV/div to 20 V/div ±5%
Attenuator:
12 steps in 1-2-5 sequence, 5 mV/div to 20V/div. With variable control for fully adjustable sensitivity between steps.
Input impedance:
1 MΩ ±2%
Input capacitance:
27 pF ±3 pF
Frequency response:
DC DC to 20 MHz (less than −3 dB)
[5 mV/div ~ 10 V/div]
AC 2 Hz to 20 MHz (less than −3 dB)
[5 mV/div ~ 10 V/div]
Risetime:
Less than 17.5 nsec.
Overshoot:
Less than 3% (at 100 kHz square wave)
Cross-talk:
ALT Less than −60 dB
CHOP Less than −50 dB
Operating modes:
CH1 CH1 only
CH2 CH2 only
ALT 2-channel with ALT (alternate sweep)
CHOP 2-channel with CHOP
ADD Single-trace algebraic sum of CH1 and CH2 (Single-trace algebraic difference of CH1 and CH2 when CH2 is inverted).
CHOP frequency:
Approx 200 kHz
Maximum input voltage:
600 Vp-p or 300 V (DC + AC peak)
Invert polarity:
CH2 only
Maximum undistorted amplitude:
More than 8 div (DC to 20 MHz)

Sweep Circuit

Sweep system:
Triggering sweep and auto sweep (free-running sweep at no signal time)
Sweep time:
0.5 μs/div to 0.5s/div (±5%) in 19 ranges, in 1-2-5 sequence. Each overlapping range provides for fine adjustment.
Magnification:
10 times ±5% (PULL × 10 MAG)
Linearity:
Less than 3% (2μs/div to 0.5s/div)
Less than 5% (0.5 μs/div to 1 μs/div)
Less than 10% (× 10 MAG)

Triggering

Source:
INT, CH1, CH2, LINE, EXT
Slope:
NORM Positive and negative
VIDEO Positive and negative (TV-H and TV-V automatically selected by SWEEP TIME/DIV)
TV-H (TV-line): 0.5 μs/div to 50 μs/div TV-V (TV-Frame): 0.1 ms/div to 0.5s/div
Sensitivity:

Trigger Type	Bandwidth	Minimum Sync Voltage	
		INT	EXT
NOR	50Hz ~ 15MHz 20Hz ~ 20MHz	0.5div 1.0div	0.5Vp-p 1.0Vp-p
AUTO	50Hz ~ 15MHz 20Hz ~ 20MHz	0.5div 1.0div	0.5Vp-p 1.0Vp-p
VIDEO	VIDEO signal	1.0div	1.0Vp-p

Horizontal Amplifier (CH2 input)

Operating modes:
X-Y mode is selected by SWEEP TIME/DIV.
CH1: Y axis
CH2: X axis
Deflection Factor:
Same as CH1 (5 mV/div to 20 V/div ±5%)
Frequency response:
DC DC to 2 MHz (less than −3 dB)
AC 2 Hz to 2 MHz (less than −3 dB)
Input impedance:
Same as CH1 (1 MΩ ±2%)
Input capacitance:
Same as CH1 (27 pF ±3 pF)
X-Y phase difference:
Less than 3° at 70 kHz

Calibrating Voltage

0.1 Vp-p ±3% at reference level 0 V. 1 kHz ±3% square wave, positive polarity.

Intensity Modulation

Input voltage:
TTL compatible. Positive voltage increases brightness, zero voltage decreases brightness.

SPECIFICATIONS

Input impedance:
15 kΩ ±20%
Bandwidth:
DC to 5 MHz
Maximum input voltage:
50 V (DC + AC peak)

Trace Rotation

Trace angle is adjustable by panel surface adjuster.

Power Requirements

Power supply voltage:
100/120/220/240 V ±10%, 50/60 Hz
Power consumption:
47 W

Dimensions

Width:
260 mm (277 mm)
Height:
190 mm (204 mm)
Depth:
328 mm (393 mm)
Figures in ( ) shows maximum sizes.
Weight:
8.4 kg

Accessories

Probe (PC-22) 2
Attenuation: 1/10
Input impedance: 10 MΩ
Input capacitance: Less than 18 pF
Instruction manual 1
Replacement fuse
0.5 A 2
0.8 A 2

CRT C5S106P31B SPECIFICATION

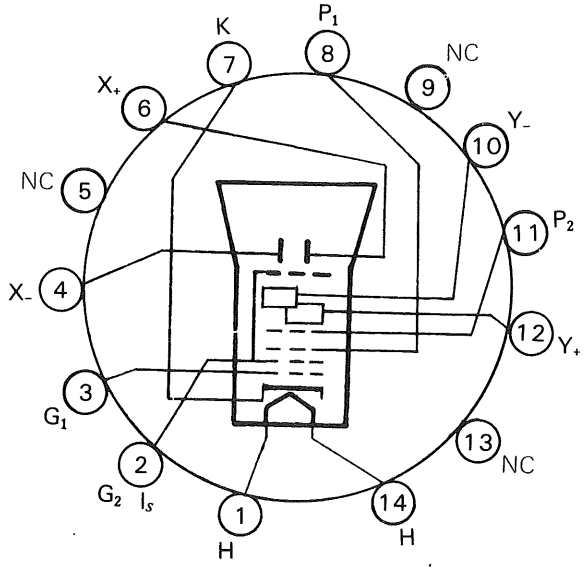
Dimensions:
Total length 335 Max. mm
Diagonal: Max 133±3 mm
Screen shape:
Rectangular, flat face, internal graticule
Focusing:
Electrostatic
Deflection:
Electrostatic
Fluorescence:
Green (Persistence: Medium short)
Display area:
100×80 mm²

Heater

Heater voltage:
6.3 V
Heater current:
0.3 A

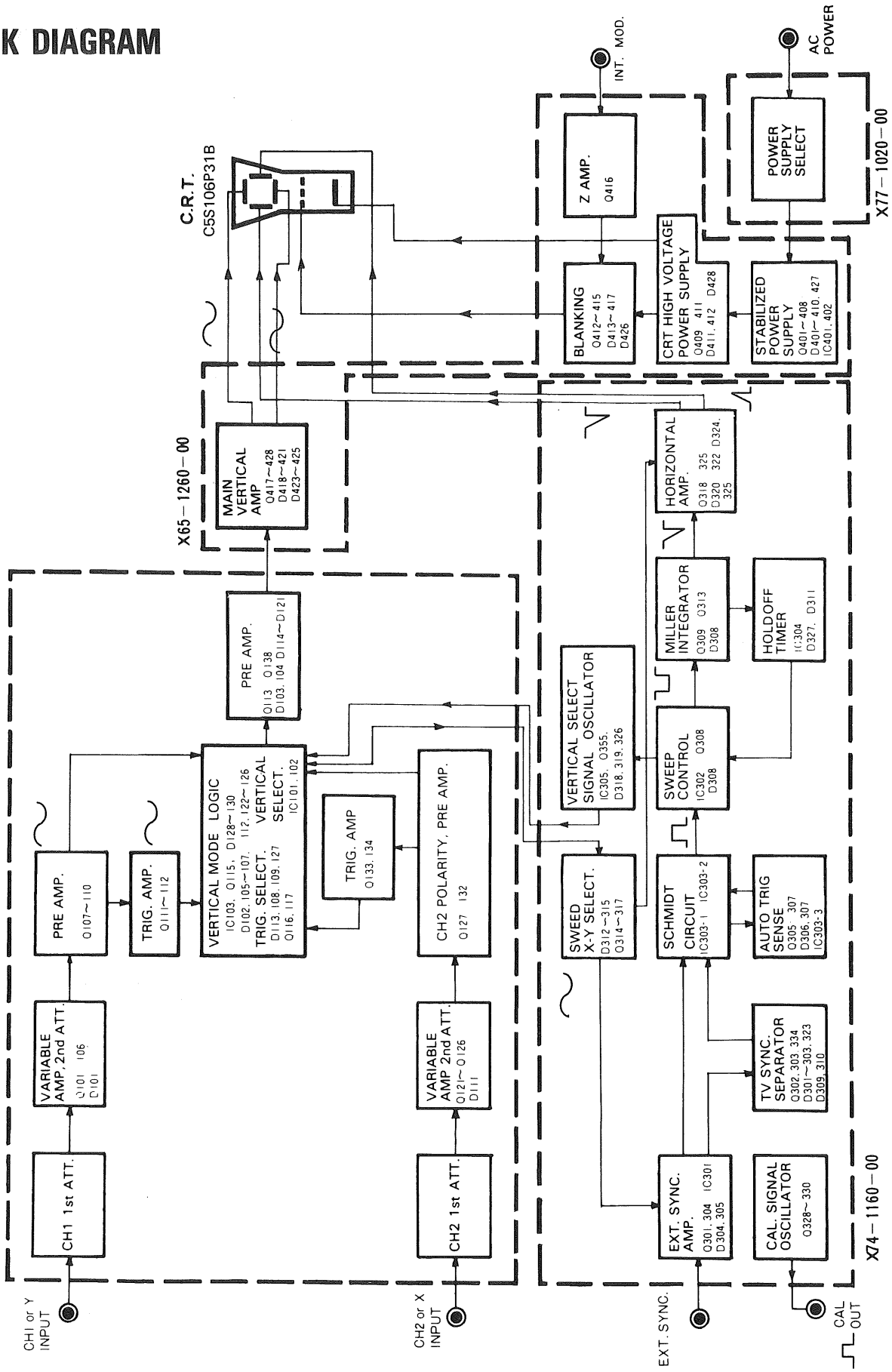
Maximum Rating

2nd plate voltage:
Max. 2000 V
2nd grid voltage:
Max. 2000 V



C5S106P31B Base Bottom

BLOCK DIAGRAM



CIRCUIT DESCRIPTION

VERTICAL AMPLIFIER

Two identical preamplifiers are used for CH1 and CH2. The signal applied to the BNC input is superposed on AC or DC component by the AC-GND-DC switch, attenuated to 1/1, 1/10, 1/100 or 1/1000 by the 1st attenuator according to the level of the signal, and fed to Q101a.

Q101a,b is a dual FET having excellent temperature balance characteristic. Q102 turns ON with a negative overvoltage to protect Q101a. VR101 is used to compensate for the characteristic of the DC element of the differential amplifier Q101—Q106 so that the 2nd attenuator S103 can be DC balanced. The signal passing through the source follower of Q101a is fed to the emitter follower of Q103 where the impedance is further lowered. This low impedance signal is then fed to the 2nd attenuator of Q106. The resistance across the emitters of Q105 and Q106 is switched by the 2nd attenuator to set the gain ratio to 1/1, 1/2 or 1/4. VR102 is a gain adjuster that varies the load resistance.

VR103 is a variable attenuator DC balance control. The signal from the 2nd attenuator is amplified by the cascode amplifier Q107—Q110. In CH2, the transistor on the grounded base side of the cascode amplifier has a switching function to invert the phase.

VR108 is vertical position control for CH1 and VR118 is for CH2. VR114 is vertical position control for CH2 INV.

IC101 is dual differential amplifier. It is a cascode circuit with a vertical mode selector circuit IC103 which selects the modes of dual signal operation using control signal. The signal from this circuit is sampled and amplified by Q111 and Q112 to obtain sync signal.

In X-Y mode, the CH2 amplifier also functions as X amplifier. The sensitivity is adjusted by VR117. The signal amplified by IC is further amplified by the drive amplifier Q113, Q114 and Q135—Q138. TC107 and VR106 are used to adjust high frequency response. VR107 is a balance control for the vertical output amplifier which is composed of the cascode circuit Q417 and Q419, the current regulator Q425 and Q427 as a load of the circuit, and the complementary type emitter follower Q421 and Q423. In this circuit, the current regulator is controlled by the output of the cascode amplifier to equivalently increase the product of gain and bandwidth.

TRIGGER AND SWEEP CIRCUITS

Sync signals for CH1 and CH2 from the vertical amplifier are selected by Q116. The signal selected passes through Q117, Q317 and Q301 and is further amplified by IC301. In X-Y mode, Q317 is OFF and the CH2 sync signal is amplified by Q316, which is then fed to the horizontal amplifier.

The signal amplified by IC301 is selected by S302 to determine the polarity and whether or not the signal is fed to the TV sync separation circuit. Then, it is fed through the buffer Q304 to the Schmidt circuit where it is shaped in square wave. The TV sync separation circuit clamps the emitter of Q302 to obtain only the sync signal for TV-H. When the circuit is integrated by R313 and C311, it produces sync signal for TV-V. The sync signal shaped by the Schmidt circuit is a clock pulse of the flip-flop IC302 which drives the mirror sweep circuit.

When the output of IC302 is inverted by the clock pulse, Q308 and D308 are OFF and the integration capacitors C321—C324 are charged with the constant current selected by Q309, Q310, and R335—R341 to produce saw-tooth wave having excellent linearity. The base potential of Q309 and Q310 is adjusted by VR303 to control the charging speed.

The mirror integrator output is properly sampled by VR305 and inputted to the comparator in IC304 and when the voltage increases to a given limit, the output of IC302 is inverted. Thus, the output of the mirror circuit is held in standby mode and, at the same time, the hold-off circuit (IC302) is triggered. Therefore, the hold-off period of IC302, which is determined by R331, R332 and C325—C328, is set with the clock pulse disregarded.

HORIZONTAL AMPLIFIER

The horizontal amplifier consists of Q318—Q325; the emitter follower, the common emitter and the cascode amplifier are cascade. Q321 is a current regulator. It improves CMRR of the differential circuit Q319 and Q320 to obtain the desired dynamic range of the horizontal amplifier. × 10 MAG is accomplished by changing the gain resistance across Q319 and Q320. The magnitude ratio is adjusted by VR310 and the magnitude position by VR309.

CRT CIRCUIT AND POWER SUPPLY CIRCUIT

The output of IC302 drives the vertical switching signal generator $IC305_{1, 2}$. It is also used as unblanking signal which passes through the gate of IC305 and is amplified by Q412—Q415. This signal is DC regenerated and is fed to the grid of CRT.

The CRT's acceleration power supply circuit uses DC—DC converter which is a feedback type voltage regulator with an error amplifier Q409 and Q410 to produce −1.9 kV.

Voltage of ± 10 V is obtained from the tracking regulator using the operation amplifier with zener diode D410 as an error amplifier.

Using −10 V as a reference, +21 V and +170 V are stabilized. The high tension voltage of −1.9 kV is stabilized using +10 V as a reference.

MAINTENANCE

TRACE ROTATION ADJUSTMENT

Strong magnetic fields, present in many locations where an oscilloscope may be used, may cause the trace to be tilted. The degree of tilt may vary as the scope is moved from on location to another. The TRACE ROTATION control provides an electrically adjustable offset to compensate for trace tilt.

Perform the adjustment as follows.

1. Set oscilloscope controls to produce a horizontal trace with no input signal (triggering MODE switch in AUTO)
2. Use POSITION control as required to position the trace along a horizontal line of the graticule scale.
3. Adjust TRACE ROTATION so trace parallel with the reference line on the graticule scale.

AC VOLTAGE CONVERSION

When operating the unit on voltage other than 240 V, set AC voltage selector switch to 100 V, 120 V or 220 V according to your local AC current. The voltage selector switch is locate on the rear panel of the unit as indicated by the arrow mark. When operating on 100 V or 120 V, remove the 0.5A fuse and replace it with one rate at 0.8A.

REMOVING THE CASE

The case is removed in two sections. The top section can be lifted off after removing seven Phillips-head screws from the top and sides of the case. The bottom section can be lifted off after removing four Phillips-head screws from the bottom of the case.

WARNING

High voltage up to 2000 volts DC is present on the CRT and power supply board when the oscilloscope is operating. Up to 170 volts DC is present on all circuit boards except the vertical amplifier board. Line voltage (120 or 240 VAC) is present on the power transformer, on-off switch, fuse holder, and line voltage selector assembly 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.

PROBE COMPENSATION

Probe compensation adjustment matches the probe to the input of scope. For best result, compensation of both should be adjusted initially, then the same probe always used with CH1 and CH2 respectively. Probe compensation should be readjusted whenever a probe from a different oscilloscope is used, or CH1 and CH2 probes are interchanged.

1. Connect probes to both V. INPUT terminal.
   Connect ground clip of probes to oscilloscope ground terminal and touch tips of both probes to CAL 1 kHz ⎍ 0.1 V_{p-p} terminal.
2. Select signal trace operation of CH1 and CH2 for steps 3 and 4.
3. Set oscilloscope control to display 3 or 4 cycles of CAL square wave at 5 or 6 divisions amplitude.
4. Adjust compensation trimmer on probe for optimum square wave, waveshape (minimum overshoot, rouding off and tilt).

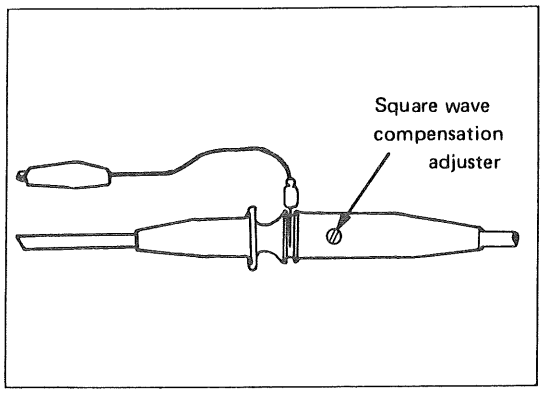


Fig. 1

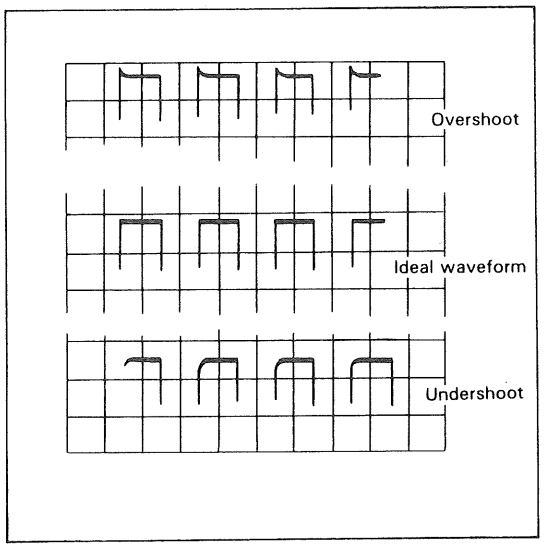


Fig. 2

MAINTENANCE

REPLACEMENT OF CATHODE RAY TUBE (CRT)

Caution:
The circuits around the CRT produce a voltage as high as 2000 V. To prevent electric shock, be sure to disconnect the power cord before replacing the CRT. Make certain that the circuits are fully discharged.

1. Remove the cases and molded cover.
2. Remove 2 screws from the CRT band holding the neck of the CRT shield.
3. Loosen 2 screws holding the CRT cover to the rear panel. Disconnect the white leads from the terminal pins.
4. Remove the CRT socket from the CRT. The CRT shield will now be removed completely from the main body.
5. Slide CRT shield and CRT backward and lift the CRT shield and slide the CRT forward to remove from the CRT shield.
6. The CRT is ready for removal. Replace it with a new one by following the above procedures in reverse order.
7. After replacing, make adjustments of ASTIG and others referring to the adjustment instructions.

REMOVING PRINTED CIRCUIT BOARD

Vertical amplifier board (X73-1280-00)

1. Remove 3 screws securing the board.
2. Unsolder the leads with resistors (R3, R4) from the BNC receptacles.
3. Remove VOLTS/DIV and SWEEP TIME/DIV knobs. Small knobs requires 1.5 mm Hex. screwdriver. Large knobs have two set screws.
4. Remove knobs from ▲▼ POSITION, ◀▶ POSITION, TRIG. LEVEL controls. Remove slotted hex. lock nuts and washers from shaft of ▲▼ POSITION, ◀▶ POSITION and TRIG. LEVEL controls.
5. Remove POWER, INTENSITY and FOCUS knobs. These knobs require 1.5 mm Hex. screwdriver.
6. Remove lever knobs from all the associated front panel lever switches.
7. Remove the decorative panel from the front panel.
8. Remove 2 screws securing the lever switch.
9. Gently remove board away from chassis and disconnected plugs P101 ~ P103. Power can be reapplied for testing and troubleshooting while board is removed from chassis by simply reconnecting P101 ~ P103.

Sweep circuit board (X74-1160-00)

1. Remove 3 screws securing the board.
2. Remove 2 screws securing the lever switches (SYNC and SOURCE).
3. Gently remove board away from chassis and disconnect plugs P301 ~ P310. Power can be reapplied for testing and troubleshooting while board is removed from chassis by simply reconnecting P301 ~ P310.

Power supply board (X68-1260-00)

1. Remove 4 screws securing the board and bracket from the rear escutcheon.
2. Disconnect plugs P401 ~ P408 from the board.
3. Disconnect the 2 white leads from the CRT to pin of the board.

ADJUSTMENT

Before making adjustment, perform the following notes.
1. Preset the scope controls as follow unless otherwise specified.
2. All adjustment should follow the following order.

Name of knob	Position
INTENSITY	3 o'clock
FOCUS	Optimum position
V. POSITION (CH1)	Mechanical center
H. POSITION	Push, Mechanical center
VARIABLE (both CH1 and CH2)	CAL
AC-GND-DC (both CH1 and CH2)	DC
TRIGGERING	PULL
SYNC	NORM (+)
SOURCE	INT
V. POSITION (CH2)	Push, Mechanical center
MODE	CH1
VOLTS/DIV (both CH1 and CH2)	5 mV

TEST EQUIPMENT REQUIRED

Test Equipment	Model	Minimum Specification
Digital Multi-Meter	DL-706 (TRIO)	Impedance: More than 10 MΩ, Measuring range: 0.01 V to 199 V
Sine-Wave Generator	651B (YHP)	Frequency: 10 Hz to 10 MHz, constant voltage over tuning range
Sine-Wave Generator	SG-503 (Tektronix)	Frequency: 50 kHz to 100 MHz, 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
Q Meter	4343B (YHP)	—
Color Pattern Generator	CG-911 (TRIO)	—
Oscilloscope	465 (Tektronix)	Sensitivity: more than 5 mV Frequency response: More than 100 MHz
Time-Marker Generator	TG-501 (Tektronix)	Time mark: 0.5 s to 0.1μs repetive waveform
High-Voltage Probe	—	Input Impedance: 1000 MΩ
Termination	—	Impedance: 50 Ω Accuracy: within 3%
Termination	—	3 watts type impedance: 50Ω
Attenuator	—	−20dB attenuation (50Ω)

POWER AND CRT CIRCUIT ADJUSTMENT

−10 V adjustment
1. Connect a digital multimeter to measure the voltage at P403, pin 3 or P404, pin 4 with respect to the chassis.
2. Adjust VR401 for a −10 V reading on the multimeter.

−1.9 kV adjustment
1. Connect a digital multimeter of high input impedance to measure the voltage at P405, pin 3 with respect to the chassis.
2. adjust VR402 for a −1.9 kV reading on the multimeter.

Check

	Voltage rating	Location
170 V	161.5-178.5 V	P404-1pin
5 V	4.75-5.25 V	P404-3pin
10 V	9.5-10.5 V	P404-5pin

Astigmatism adjustment
1. Set the SWEEP TIME/DIV control to X-Y position and both CH1 and CH2 AC-GND-DC switches to GND position. This will produce a spot on the screen.
2. With the INTENSITY control set about mid-range, adjust both VR404 and the FOCUS controls for the sharpest, roundest spot.
   Do not readjust ASTIG control after this step.

INTENSITY adjustment
1. Pull the PULL AUTO knob to display a horizontal trace.
2. Adjust VR403 so that the trace disappears when the INTENSITY control setting is reduced to the 9 to 11 o'clock position.

Check
1. Apply 1 MHz sine wave signal to CH1 input to display 6 divisions vertical amplitude waveform on the screen.
2. The thickness at the start of the sweep should be equal to the thickness at the other points and no retrace should be obtained at the end of the sweep.

CRT centering adjustment
1. Short-circuit the test terminal P104 of the vertical final-stage.
2. Pull the PULL AUTO knob to display a trace.
3. Adjust VR107 to center the trace vertically.

Vertical geometry adjustment
1. Pull the PULL AUTO knob to display a trace and adjust ▲▼ POSITION control to the trace vertically.
2. Short the short terminal P104 and connect a digital multimeter to measure the voltage at P104 in P.C.B. X73-1280-00.
3. Adjust VR405 for approx. 70 V reading on the multimeter.

ADJUSTMENT

VERTICAL AXIS CIRCUIT ADJUSTMENT

VARI. ATT. BAL. STEP ATT. BAL., and V. POSITION adjustment

1. Set scope controls for a single horizontal trace on CH1 with the CH1 AC-GND-DC switch set to GND position and set the SWEEP TIME/DIV control to 1 ms position.
2. Rotate the CH1 VARIABLE control from maximum clockwise to maximum counterclockwise, while observing the trace.
3. If the trace moves vertically, adjust VR103 (VARI. ATT. BAL.) for minimum or zero vertical movement when performing step 2.
4. Rotate the CH1 VOLTS/DIV control through the 5 mV, 10 mV and 20 mV position while observing the trace.
5. If the trace moves vertically, adjust VR101 (STEP ATT. BAL.) for minimum or zero movement when performing step 4.
6. Repeat the entire procedure for CH2, adjusting VR113 for VARIABLE step balance and VR111 for VOLTS/DIV balance.
7. When the ▲▼ POSITION control is set to the mechanical center, adjust VR108 (▲▼ V. POSITION) so that the trace can be positioned in the center.
8. Repeat the entire procedure for CH2, adjusting VR118 for ▲▼ V. POSITION.

Check

1. With CH1 and CH2 POSITION controls at mechanical center (12 o'clock), each trace should be approximately centered vertically. Turning each POSITION control fully clockwise should move trace up at least 5 divisions from center, fully counterclockwise should move trace down at least 5 divisions from center.

NOR-INV POSITION adjustment

1. Set the MODE switch to the CH2 position and the CH2 AC-GND-DC switch to GND position.
2. Pull the PULL AUTO knob to display a trace.
3. Alternately pull and push the CH2 PULL INVERT knob, adjusting VR114 so that the trace does not shift when the polarity is reversed.

100 kHz square wave compensation

1. Rotate VOLTS/DIV control to 2 mV, MODE switch to CH2, SOURCE switch to CH2 and CH2 AC-GND-DC switch to AC.
2. Apply 100 kHz square wave signal through a 50 Ω terminator to CH2 input and adjust square wave generator for 6 divisions of 100 kHz signal on the screen.
3. Rotate SWEEP TIME/DIV control from 2 μs to 0.2 μs. Adjust TC704 (mid range) and VR703 (high range) for minimum overshoot (within 3%) and ringing (within 3%) at point ⓐ and ⓑ on waveform as shown in Fig.3.
4. Keeping the signal level constant, gradually decrease the input signal to 10 kHz. Amplitude should roll off gradually with no dip or peaks.

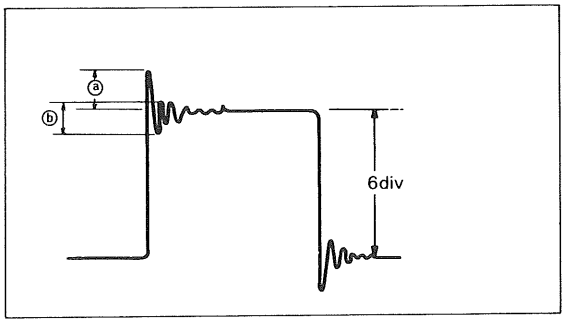


Fig. 3

1 kHz square wave compensation

1. With 1 kHz square wave signal applied set the SWEEP TIME/DIV control to 0.5 ms.
2. Adjust TC104 (10:1, 0.2 V), TC105 (100:1, 2 V), and TC106 (1000:1, 20 V) until the vertical amplitude reaches for exactly 4 divisions.
3. Repeat the entire procedure for CH2, adjusting TC114, TC115 and TC116.

Vertical gain adjustment

1. Set both CH1 and CH2, AC-GND-DC switches to DC and SWEEP TIME/DIV control to 0.5 ms.
2. Set both CH1 and CH2 VOLTS/DIV controls to 5 mV (VARIABLE to CAL) and apply a 20 mVp-p, 1 kHz square wave signal to CH1 input.
3. Adjust VR105 for exactly 4 divisions vertical amplitude waveform.
4. Repeat the entire procedure for CH2, adjusting VR116 for vertical gain adjustment.

Vertical gain adjustment

1. Set the MODE switch to the CH1 position.
2. Connect the CH1 input terminal to the CAL⎍0.1 V p-p terminal.
3. Set the CH1 VARIABLE control to the CAL position and the VOLTS/DIV control to 20 mV (probe set for DIRECT measurement).
4. Adjust VR105 for exactly 5 divisions vertical amplitude of 1 kHz square wave signal display.
5. Repeat the entire procedure for CH2, adjusting VR116.

Input capacity adjustment

1. Connect a Q meter to measure the input capacity at CH1 input terminal and check 27pF ± 3pF.
2. Rotate the VOLTS/DIV control through 5 mV, 50 mV and 0.5 V position, adjusting TC101, TC102 and TC103 so that the input capacity of each range is 27pF ± 3pF.
3. Repeat the entire procedure for CH2, adjusting TC111, TC112 and TC113.

ADJUSTMENT

HORIZONTAL AXIS CIRCUIT ADJUSTMENT

Sweep time and sweep length adjustments

1. Set MODE switch to CH1 and SWEEP TIME/DIV control to 1 ms.
2. Apply 1 ms marker signal to CH1 input.
3. Measuring the time period of the markers will assure calibration accuracy.
4 Adjust VR305 so that 11 visible markers occupy exactly 11 divisions of horizontal deflection as shown in Fig. 4.
5. Adjust VR304 for a total sweep length of 10 1/2 divisions.

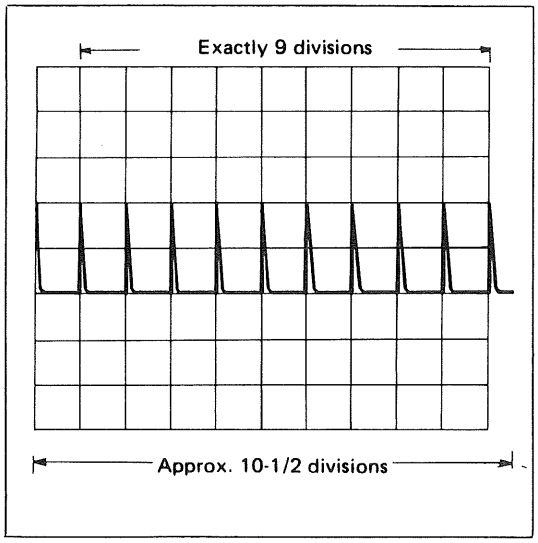


Fig. 4

Mag centering and mag gain adjustments

1. Set SWEEP TIME/DIV control to 1 ms and apply 1 ms marker signal to CH1 input to display 3 waves on the screen.
2. Pull ×5 MAG knob to magnify a trace and adjust VR310 so the center marker remains stationary whether the ×5 MAG knob is ON. Do not rotate the ◄► POSITION control.
3. Next, push ×5 MAG knob and adjust VR309 so that the 10 visible markers occupy exactly 10 divisions of horizontal deflection.
4. Recheck step 2. Repeat if required.

◄►H. POSITION adjustment

1. Set ◄► POSITION control at its mechanical center.
2. Rotate SWEEP TIME/DIV control to 0.2 ms and apply 1 ms marker signal to CH1 input to display 3 waves on the screen.
3. Adjust VR316 so the center marker remains stationary.

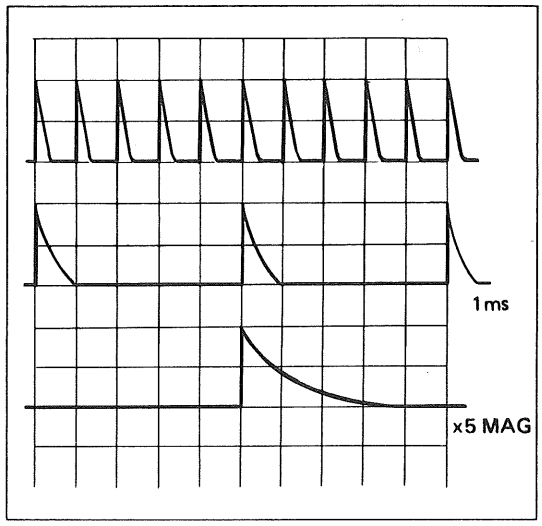


Fig. 5

Check

Turning ◄► POSITION control fully clockwise should move trace at least 5 divisions right from centered position, fully counterclockwise should move trace at least 5 divisions left from centered position.

5 μs, 0.5 μs ranges adjustments

1. Rotate SWEEP TIME/DIV control to 5 μs, 0.5 μs, gradually while appling the equal marker signal to CH1 input.
2. Adjust the following adjuster to duplicate the conditions shown in Fig. 4.

SWEEP TIME/DIV	Marker	Adj.
5 μs	5 μs	TC301
0.5 μs	0.5 μs	TC302

X gain and position adjustments

1. Rotate VOLTS/DIV control to 5 mV and set CH2 AC-GND-DC switch to AC.
2. Set MODE switch to X-Y. Apply a calibrated 1 kHz 20 mVp-p sine or square wave signal to CH2 input.
3. Adjust VR117 for exactly 4 divisions horizontal deflection between the 2 spots on the screen.
4. Next, set MODE switch to X-Y to display a spot on the screen.
5. Adjust VR307 to center the spot horizontally on the screen.

Linearity adjustment

1. Using ×10MAG, set the SWEEP TIME/DIV control to 0.5 μs and apply the CH1 input terminal to 0.5 μs marker signal.

2. With good sweep linearity, the screen should display 10 divisions, with each cycle having exactly equal horizontal deflection.
3. Adjust TC303 if needed for good sweep linearity.

SYNC. SLOPE and Triggering level adjustment

1. Set the SWEEP TIME/DIV control to 0.1 ms and connect the CH1 input terminal to 1 kHz sine wave signal.
2. Adjust the CH1 VOLTS/DIV control to obtain 6 divisions vertical amplitude on the CRT screen.
3. Check the waveform so that + sweep is triggered on positive-going slope of waveform as shown in Fig. 6-(a) and – sweep is triggered on negative-going slope of waveform as shown in Fig. 6-(b).
4. Adjust VR303 so that the start point of each waveform remain the same when the SYNC switch select + and – as shown in Fig. 6-(c).
5. Set the TRIGGERING LEVEL control to the mechanical center.
6. Adjust VR301 so that the start point of the waveform can be positioned in the center.

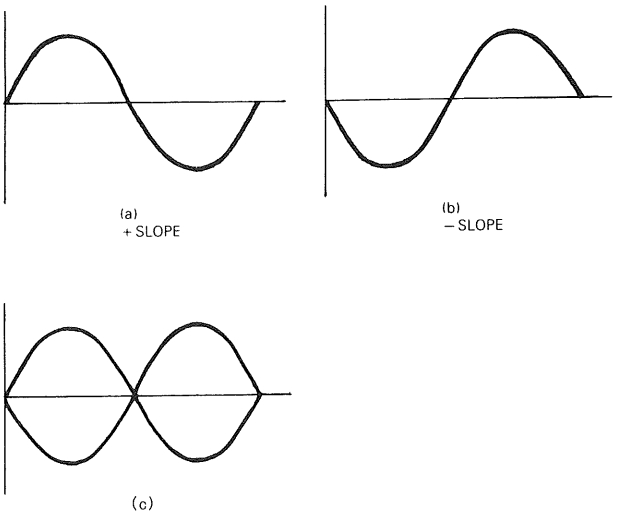


Fig. 6

CALIBRATING VOLTAGE ADJUSTMENT

1. A general check of calibration accuracy may be made by displaying the output of the CAL⎍0.1 V p-p terminal on the screen.
   This test signal has been factory-calibrated to provide an accurate square wave of 0.1 V p-p amplitude and 1 ms time duration per cycle.
2. At 20 mV/div this should produce exactly 5 divisions of vertical deflection on CH1 or CH2, or 5 divisions of horizontal deflection in X-Y operation when the VARIABLE controls are set to CAL. The 5 mV/div range may be used to check the 10:1 attenuation of the probe; exactly 2 divisions of deflection should result.
3. With a 0.1 ms/div sweep time and VARIABLE set to CAL, one cycle of the waveform should occupy exactly 10 divisions. At 1 ms/div sweep time, 10 cycles should exactly span the 10 divisions, while 1 cycle should cover the 10 divisions using ×10 MAG knob.
4. Perform the above procedures, then adjust VR312 (CAL symmetry adj.), VR313 (CAL frequency adj.) and VR314 (CAL voltage adj.)

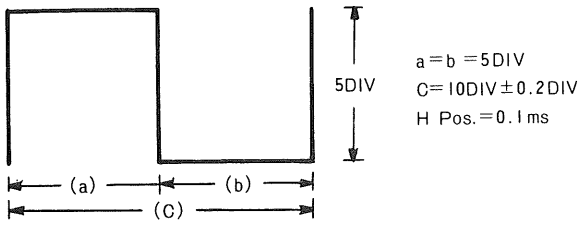


Fig. 7

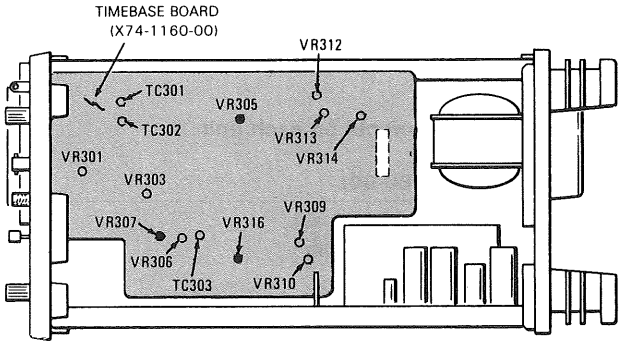
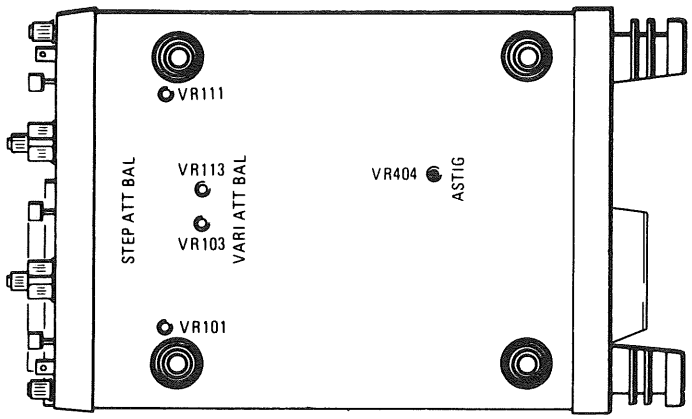


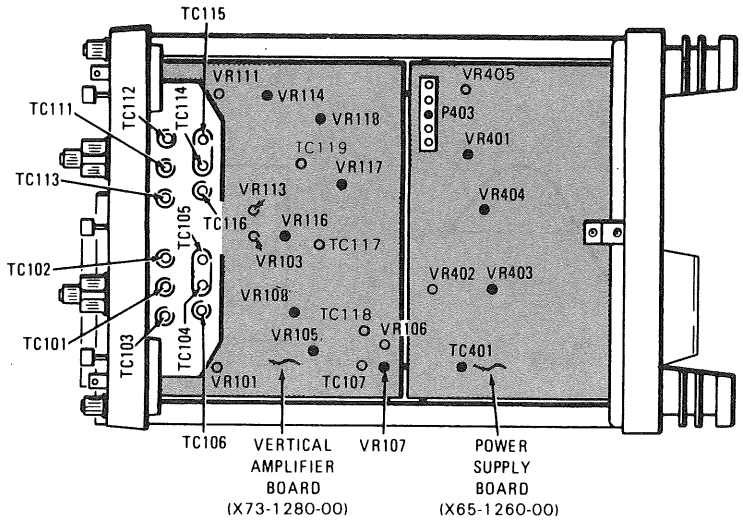
Fig. 8 Location of adjustments, right side of scope

ADJUSTMENT



Bottom cover in place

Fig. 9 Location of adjustments



Bottom cover removed

Fig. 10 Location of adjustments

Functions of adjustments on each unit

Vertical unit (X73-1280-00)

VR-101	CH1 ATT BAL adj.
VR-103	CH1 DC BAL adj.
VR-105	CH1 Gain adj.
VR-106	100kHz square wave compensation.
VR-107	CRT centering adj.
VR-108	CH1 Position adj.
VR-111	CH2 ATT BAL adj.
VR-113	CH2 DC BAL adj.
VR-114	CH2 Invert position adj.
VR-116	CH2 Gain adj.
VR-117	X Gain adj.
VR-118	CH2 Position adj.
TC-101	CH1 10:1 range input capacity adj.
TC-102	CH1 100:1 range input capacity adj.

TC-103	CH1 1000:1 range input capacity adj.
TC-104	CH1 10:1 range square wave compensation
TC-105	CH1 100:1 range square wave compensation
TC-106	CH1 1000:1 range square wave compensation
TC-111	CH2 10:1 range input capacity adj.
TC-112	CH2 100:1 range input capacity adj.
TC-113	CH2 1000:1 range input capacity adj.
TC-114	CH2 10:1 range square wave compensation
TC-115	CH2 100:1 range square wave compensation
TC-116	CH2 1000:1 range square wave compensation
TC-107	100kHz square wave compensation
TC-118	High frequency adj.
TC-117, 119	High frequency adj. (CH2)

ADJUSTMENT

Power supply unit (X65-1260-00)

VR-401	−10V adj.
VR-402	−1.9 kV adj.
VR-403	INTENSITY adj.
VR-404	ASTIG adj.
VR-405	Vertical Amp geometry adj.

Sweep circuit unit (X74-1160-00)

VR-301	Triggering level adj.
VR-303	SYNC SLOPE adj.
VR-305	Sweep length adj.
VR-306	Sweep time adj.
VR-307	X-Y POSITION adj.
VR-309	MAG centering adj.
VR-310	MAG gain adj.
VR-312	CAL symmetry adj.
VR-313	CAL frequency adj.
VR-314	CAL voltage adj.
VR-316	H. POSITION adj.
TC-301	Sweep time adj. (5 μs)
TC-302	Sweep time adj. (0.5 μs)
TC-303	Sweep linearity (0.5 μs)

PERFORMANCE TEST

After calibration adjustments are completed, the following tests will check non-adjustable circuit to confirm that oscilloscope operation meets all specifications.
If unsatisfactory performance is indicated, service and repair is required.

Frequency Response Check

1. Apply 1 kHz sine wave signal to CH1 input and adjust for 6 divisions amplitude on the screen. Keeping the signal level constant, gradually increase the frequency from DC to 20 MHz. Amplitude should roll off gradually with no dips or peaks; at 20 MHz amplitude should be at least 4.3 divisions.
2. Check CH1 and CH2 independently.

Linearity

1. Apply 20 MHz sine wave signal to CH1 input and adjust for 4 divisions amplitude on the screen.
2. When increasing the signal level by two times, amplitude should be at least from 7.8 to 8.2 divisions.
3. Then apply 20 MHz sine wave and set oscilloscope controls to display waveform of 2 divisions amplitude in the center of the screen.
4. Using the ▲▼ POSITION control to move the display to the top and bottom of the screen, there should be no more than from 2.2 to 1.8 divisions change in amplitude.
5. Check CH1 and CH2 independently.

Crosstalk

1. Apply 1 kHz sine wave to CH1 and set oscilloscope controls to display 6 divisions amplitude. (VOLTS/DIV control to 1 V/DIV)
2. Set CH2 AC-GND-DC switch to GND. The CH2 VOLTS/DIV control may be left in any position. Set MODE switch to DUAL so that both channels may be observed.
3. Rotate CH2 VOLTS/DIV from the 1 V/div to 5 mV/div thru 5 mV/div. (overdrive channel 1). Observe CH2 for crosstalk. Crosstalk amplitude should be less than 1.9 mV.
4. Repeat step 1 thru 3 for CH2 to CH1 crosstalk.

X-Y Frequency Response Check

1. Rotate the SWEEP TIME/DIV control to X-Y position.
2. Apply 1 kHz sine wave signal to CH2 input and adjust for 10 divisions amplitude on the screen. Keeping the signal level constant, gradually increase the frequency from DC to 2 MHz. Amplitude should roll off gradually with no dips or peaks; at 2 MHz amplitude should be at least 7.1 divisions.

SYNC

Check synchronization circuit sensitivity according to the table below.

Trigger Type	Bandwidth	Minimum Sync Voltage	
		INT	EXT
NORM	50 Hz-15 MHz 20 Hz-20 MHz	0.5 div 1.0 div	0.5 Vp-p 1.0 Vp-p
AUTO	50 Hz-15 MHz 20 Hz-20 MHz	0.5 div 1.0 div	0.5 Vp-p 1.0 Vp-p
VIDEO	VIDEO	1.0 div	1.0 Vp-p

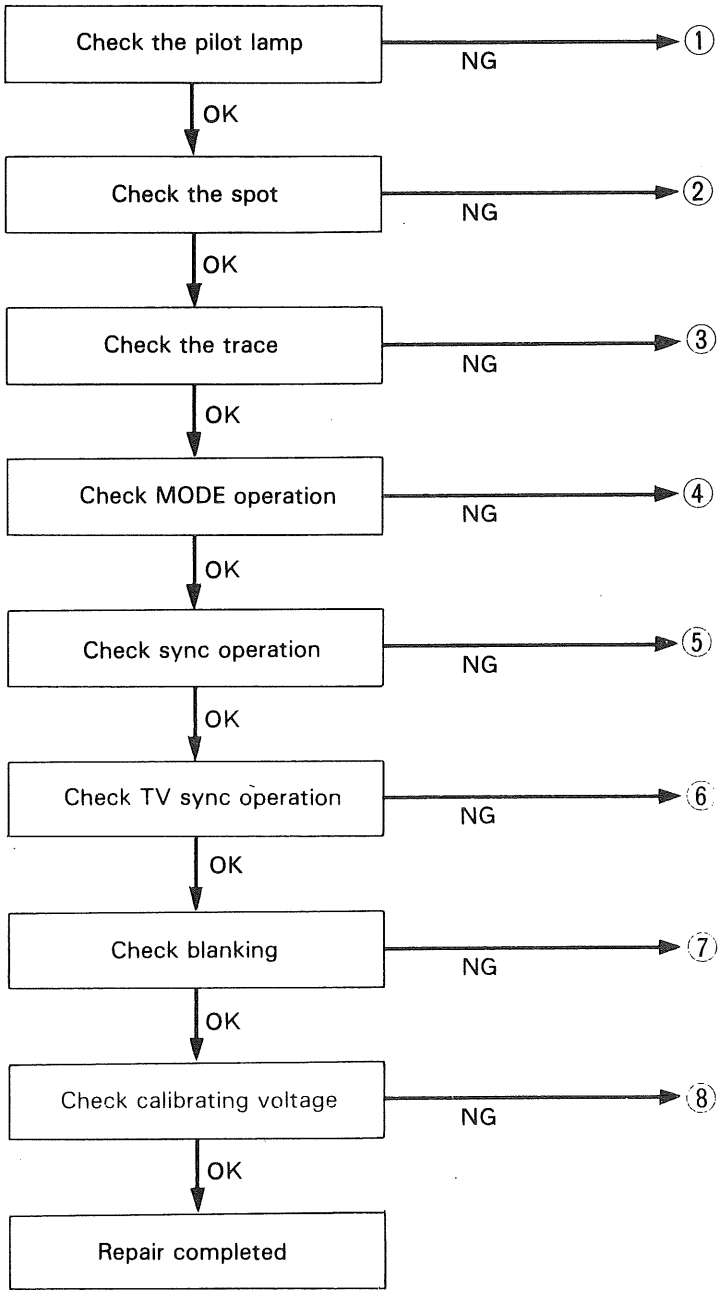
Intensity Modulation

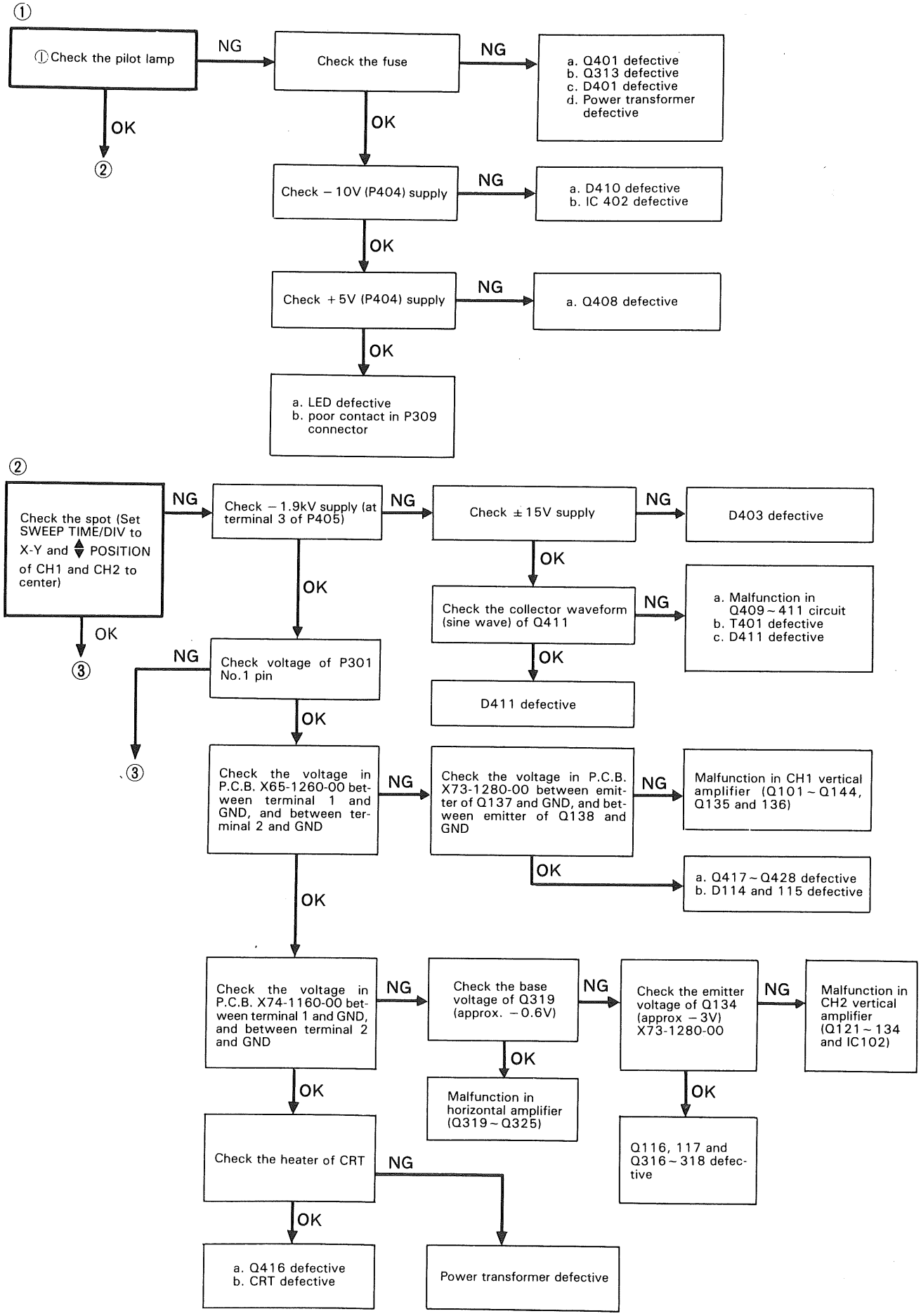
1. Set SWEEP TIME/DIV control to 1 ms and apply 1 kHz square wave to Z AXIS INPUT jack. To sync sweep, simultaneously apply square wave to EXT TRIG jack and use external sync.
2. Starting with square wave amplitude of approximately 10 volts, note intensity modulation (alternate bright and dim intervals on trace). Decrease amplitude of square wave to lowest level that gives clearly visible intensity modulation.
   Use low intensity to avoid masking effect. Intensity modulation should be visible at square wave levels of less than 5 volts peak-to-peak.

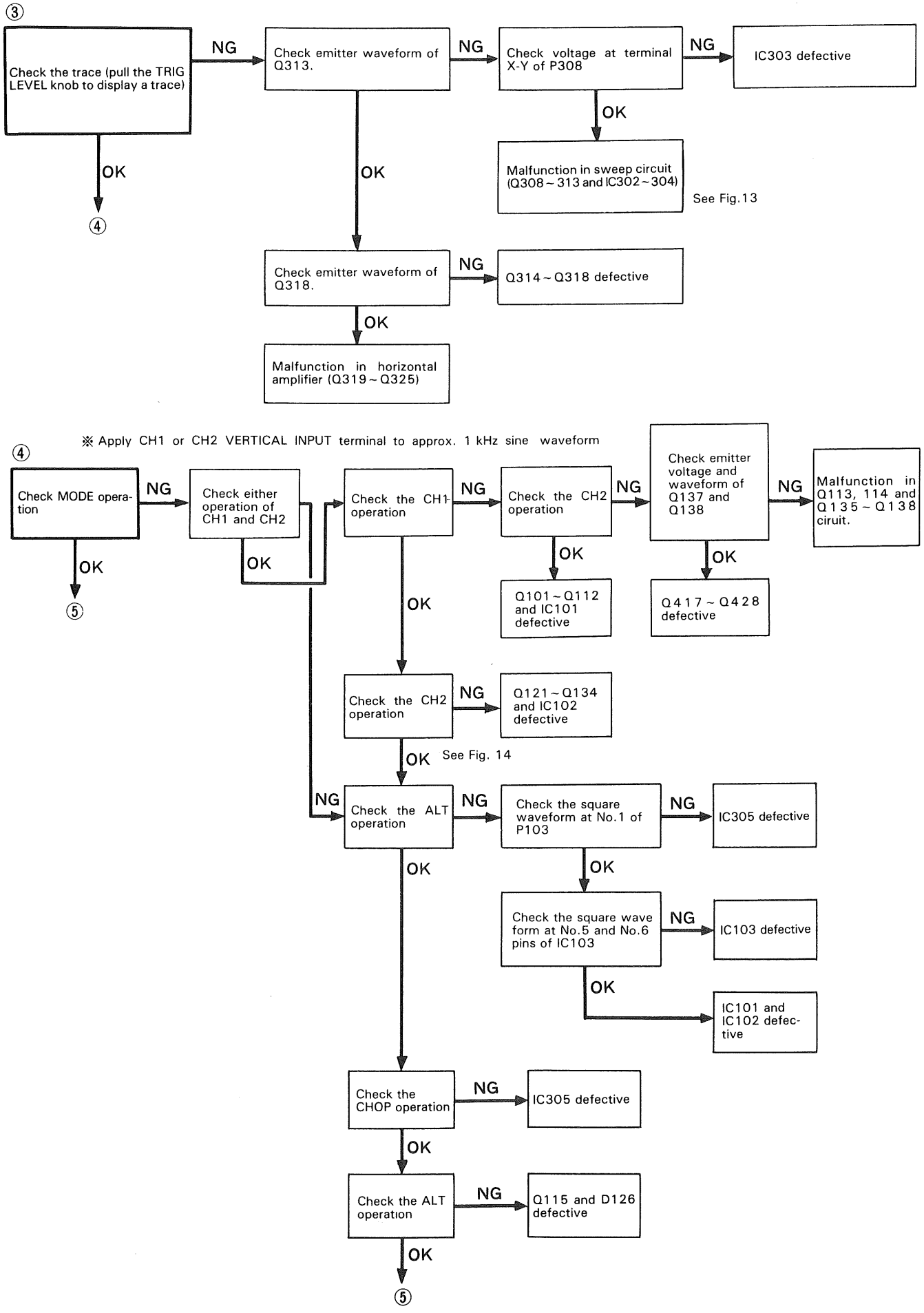
Hum Check

1. Set CH1 and CH2 AC-GND-DC switches to GND.
2. Hum should be less than 0.1 division on all sweep time and attenuator ranges.
3. Trace line shift should be within 0.3 division when AC-GND-DC switch is changed from one position to another.

TROUBLESHOOTING




①
①Check the pilot lamp
NG
Check the fuse
NG
a. Q401 defective
b. Q313 defective
c. D401 defective
d. Power transformer defective
OK
②
OK
Check −10V (P404) supply
NG
a. D410 defective
b. IC 402 defective
OK
Check +5V (P404) supply
NG
a. Q408 defective
OK
a. LED defective
b. poor contact in P309 connector
②
Check the spot (Set SWEEP TIME/DIV to X-Y and ▲▼ POSITION of CH1 and CH2 to center)
NG
Check −1.9kV supply (at terminal 3 of P405)
NG
Check ±15V supply
NG
D403 defective
OK
OK
OK
Check the collector waveform (sine wave) of Q411
NG
a. Malfunction in Q409~411 circuit
b. T401 defective
c. D411 defective
OK
③
NG
Check voltage of P301 No.1 pin
D411 defective
OK
③
Check the voltage in P.C.B. X65-1260-00 between terminal 1 and GND, and between terminal 2 and GND
NG
Check the voltage in P.C.B. X73-1280-00 between emitter of Q137 and GND, and between emitter of Q138 and GND
NG
Malfunction in CH1 vertical amplifier (Q101~Q144, Q135 and 136)
OK
a. Q417~Q428 defective
b. D114 and 115 defective
OK
Check the voltage in P.C.B. X74-1160-00 between terminal 1 and GND, and between terminal 2 and GND
NG
Check the base voltage of Q319 (approx. −0.6V)
NG
Check the emitter voltage of Q134 (approx −3V) X73-1280-00
NG
Malfunction in CH2 vertical amplifier (Q121~134 and IC102)
OK
OK
OK
Malfunction in horizontal amplifier (Q319~Q325)
OK
Q116, 117 and Q316~318 defective
Check the heater of CRT
NG
OK
a. Q416 defective
b. CRT defective
Power transformer defective


③
Check the trace (pull the TRIG LEVEL knob to display a trace)
NG
Check emitter waveform of Q313.
NG
Check voltage at terminal X-Y of P308
NG
IC303 defective
OK
Malfunction in sweep circuit (Q308 ~ 313 and IC302 ~ 304)
See Fig.13
OK
④
OK
Check emitter waveform of Q318.
NG
Q314 ~ Q318 defective
OK
Malfunction in horizontal amplifier (Q319 ~ Q325)
※ Apply CH1 or CH2 VERTICAL INPUT terminal to approx. 1 kHz sine waveform
④
Check MODE operation
NG
Check either operation of CH1 and CH2
Check the CH1 operation
NG
Check the CH2 operation
NG
Check emitter voltage and waveform of Q137 and Q138
NG
Malfunction in Q113, 114 and Q135 ~ Q138 ciruit.
OK
⑤
OK
OK
Q101 ~ Q112 and IC101 defective
OK
Q417 ~ Q428 defective
OK
Check the CH2 operation
NG
Q121 ~ Q134 and IC102 defective
OK
See Fig. 14
NG
Check the ALT operation
NG
Check the square waveform at No.1 of P103
NG
IC305 defective
OK
OK
Check the square wave form at No.5 and No.6 pins of IC103
NG
IC103 defective
OK
IC101 and IC102 defective
Check the CHOP operation
NG
IC305 defective
OK
Check the ALT operation
NG
Q115 and D126 defective
OK
⑤

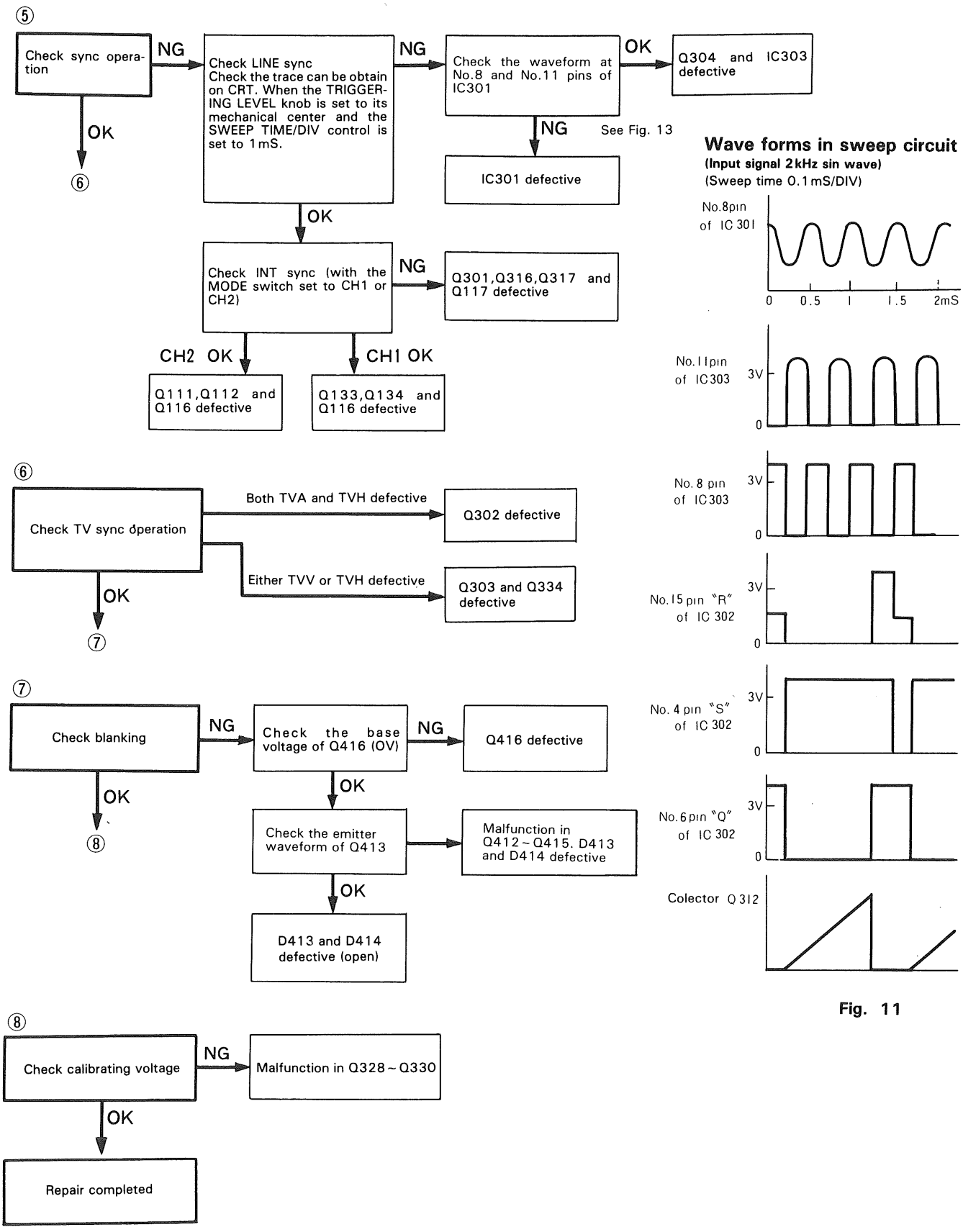

⑤
Check sync operation
NG
Check LINE sync
Check the trace can be obtain on CRT. When the TRIGGERING LEVEL knob is set to its mechanical center and the SWEEP TIME/DIV control is set to 1 mS.
NG
Check the waveform at No.8 and No.11 pins of IC301
OK
Q304 and IC303 defective
OK
⑥
NG
See Fig. 13
IC301 defective
OK
Check INT sync (with the MODE switch set to CH1 or CH2)
NG
Q301,Q316,Q317 and Q117 defective
CH2 OK
CH1 OK
Q111,Q112 and Q116 defective
Q133,Q134 and Q116 defective
⑥
Check TV sync operation
Both TVA and TVH defective
Q302 defective
Either TVV or TVH defective
Q303 and Q334 defective
OK
⑦
⑦
Check blanking
NG
Check the base voltage of Q416 (OV)
NG
Q416 defective
OK
OK
⑧
Check the emitter waveform of Q413
Malfunction in Q412~Q415. D413 and D414 defective
OK
D413 and D414 defective (open)
⑧
Check calibrating voltage
NG
Malfunction in Q328~Q330
OK
Repair completed
Wave forms in sweep circuit
(Input signal 2kHz sin wave)
(Sweep time 0.1 mS/DIV)
No.8pin of IC 301
0
0.5
1
1.5
2mS
No.11pin of IC303
3V
0
No. 8 pin of IC303
3V
0
No.15 pin "R" of IC 302
3V
0
No. 4 pin "S" of IC 302
3V
0
No.6 pin "Q" of IC 302
3V
0
Colector Q312

Fig. 11

MEMO

PARTS LIST

TOTAL ☆ on under side of p.c.board

Ref. No.	Parts No.	Description
—	A03-0863-03	Case (Top, J type)
—	A01-0831-03	Case (Top, M type)
—	A01-0864-03	Case (Bottom)
—	A13-0723-33	Frame (1)
—	A13-0725-23	Frame (2)
—	A13-0726-23	Frame (3)
—	A20-2735-12	Die-casting panel
—	A21-0877-12	Decorative panel
—	A23-1616-62	Rear panel
—	B07-0705-12	Rear escutcheon
—	B07-0707-03	Bezel frame
—	B19-0708-04	Filter
—	B30-0902-05	LED (POWER)
—	B30-0911-05	Lamp (ILLUM)
J9	B30-0914-15	Lamp ass'y (ILLUM)
—	B30-0915-05	Lamp ass'y (POWER)
—	B40-0765-04	Name plate (for serial No.)
—	B40-2775-03	Name plate (CS-1566A)
—	B41-0719-04	Voltage indicating plate
—	B50-2918-00	Instruction manual
—	B39-0407-04	Spacer (for auxiliary foot)
—	E01-1404-05	CRT socket
—	E03-0201-05	Power connector
—	E04-0251-05	BNC receptacle ×4
—	E21-0654-04	CAL terminal
—	E21-0657-04	Metal terminal
—	E23-0501-14	Grounding plate ×2
—	E23-0513-05	Earth lug ×2
—	E30-1818-05	JIS cord
J1	E31-0632-05	Lead wire with connector
J2	E31-0633-15	Lead wire with connector
J3	E31-0634-05	Lead wire with connector
J4	E31-0635-15	Lead wire with connector
J5	E31-0636-05	Lead wire with connector
J6	E31-0637-25	Lead wire with connector
J8	E31-0638-15	Lead wire with connector
J11	E31-0640-15	Lead wire with connector
J12	E31-0641-05	Lead wire with connector
J13	E31-0642-05	Lead wire with connector ×2
J14	E31-0643-15	Lead wire with connector
J15	E31-0644-15	Lead wire with connector
J16	E31-0645-15	Lead wire with connector ×2
J17	E31-0646-05	Lead wire with connector
J18	E31-0647-05	Lead wire with connector
J19	E31-0784-15	Lead wire with connector
J20	E31-0648-05	Lead wire with connector
J22	E31-0655-05	Lead wire with connector
—	E31-0532-05	Lead wire with 1P connector (for GND)
—	E31-0713-05	Lead wire with connector (for rotator coil)

Ref. No.	Parts No.	Description
—	E31-0717-01	Lead wire with connector
—	F02-0027-14	Heat sink
—	F05-8015-05	Fuse 0.8A
—	F05-5013-05	Fuse 0.5A
—	F07-0908-04	Grip cover ×2
—	F07-0913-14	CRT cover
—	F10-1525-24	Bezel shield
—	F10-1537-04	Shield plate
—	F11-0955-13	CRT shield
—	F15-0714-04	Felt (for CRT shield)
—	F15-0717-04	Felt (for CRT bracket)
—	F20-0610-04	Insulating sheet
—	F01-0824-04	Heat sink
—	G02-0603-14	Spring (handle) ×2
—	G13-0705-04	CRT mounting rubber ×2
—	G53-0015-14	Antenna bush
—	H01-2859-04	Packing case
—	H10-2807-02	Pad, foamed styrene ×2
—	H12-0523-04	Pad (carton)
—	H20-1712-04	Protective cover
—	H25-0029-04	Polyethylene bag
—	J21-2573-04	Bracket (for auxiliary foot)
—	J02-0089-05	Rubber leg ×4
—	J10-0079-03	Bezel ass'y
—	J10-0072-02	Bezel
—	J13-0033-15	Fuse holder
—	J21-2890-04	CRT band
—	J21-2888-04	CRT band
—	J21-2882-03	Bracket (for P.C. Board)
—	J21-2883-04	Bracket (for variable resistor)
—	J21-2875-15	Gear ×2 (for handle)
—	J21-2876-05	Ring ×2 (for handle)
—	J21-2916-13	Bracket (for CRT)
—	J29-0504-05	Bracket (for feeder cable)
—	J42-0510-04	Bushing (for auxiliary foot)
—	J61-0039-05	Wire clip ×2
—	J61-0049-05	Cable wrapping band ×11
—	J02-0510-04	Auxiliary food
—	K01-0507-05	Handle
—	K21-0819-03	Knob φ23 ×3
—	K21-0820-04	Knob φ15 ×7
—	K21-0822-14	Knob φ13 red
—	K27-0501-04	Knob (black) for lever switch ×3
—	K27-0502-04	Knob (gray) for lever switch ×2
—		CRT C5S106P31B
—	L01-9166-15	Power transformer
J7	L39-0510-05	Rotator coil
L1,2	L40-1591-41	Ferri-inductor 1.5μH
R1,2	RD14BB2E471J	Carbon resistor 470Ω ±5% 1/4W
R3,4	RD14BB2E470J	Carbon resistor 47Ω ±5% 1/4W
VR1	R05-8502-05	Variable resistor 2MΩB (FOCUS)
VR2	R01-1011-05	Variable resistor 1kΩB (INTEN)
VR3	R01-2012-05	Variable resistor with switch 5kΩB (POSITION)
VR4	R01-3027-05	Variable resistor 10kΩB (TRACE ROTATION)
VR5	R03-1021-05	Variable resistor with switch 1kΩB
S1	S59-2502-05	Power switch
Q401,402		Transistor 2SC1505
Q404,406		Transistor 2SA913
Q407		Transistor 2SC1913
—	W01-0503-04	Cord winder ×4

PARTS LIST

Ref. No.	Parts No.	Description
—	Y87-1330-00	Probe (PC-22) ×2
—	X65-1260-00	Power supply circuit unit
—	X73-1280-00	Vertical amplifier unit
—	X74-1160-00	Sweep circuit unit
—	X77-1020-00	Voltage selector unit

SWEEP CIRCUIT UNIT (X74-1160-00) ☆ on under side of p.c.board

Ref. No.	Parts No.	Description			
		RESISTOR			
R301, 302	RD14BB2E104J	Carbon	100kΩ	±5%	1/4W
R303	RD14BB2E124J	Carbon	120kΩ	±5%	1/4W
R304	RD14BB2E223J	Carbon	22kΩ	±5%	1/4W
R305	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R306	RD14BB2E681J	Carbon	680Ω	±5%	1/4W
R307	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R308	RD14BB2E222J	Carbon	2.2kΩ	±5%	1/4W
R309	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R310	RD14BB2E473J	Carbon	47kΩ	±5%	1/4W
R311	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
R312	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R313	RD14BB2E223J	Carbon	22kΩ	±5%	1/4W
R314	RD14BB2E473J	Carbon	47kΩ	±5%	1/4W
R315	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R316	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R317	RD14BB2E272J	Carbon	2.7kΩ	±5%	1/4W
R318	RD14BB2E221J	Carbon	220Ω	±5%	1/4W
R319	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R320	RD14BB2E152J	Carbon	1.5kΩ	±5%	1/4W
R321,322	RD14BB2E223J	Carbon	22kΩ	±5%	1/4W
R323	RD14BB2E152J	Carbon	1.5kΩ	±5%	1/4W
R324~326	RD14BB2E104J	Carbon	100kΩ	±5%	1/4W
R327	RD14BB2E681J	Carbon	680Ω	±5%	1/4W
R328,329	RD14BB2E332J	Carbon	3.3kΩ	±5%	1/4W
R330	RD14BB2E822J	Carbon	8.2kΩ	±5%	1/4W
R331	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
R332	RD14BB2E683J	Carbon	68kΩ	±5%	1/4W
R333	RD14BB2E272J	Carbon	2.7kΩ	±5%	1/4W
R334	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
R335	RN14BK2E1003F	Metal film	100kΩ	±1%	1/4W
R336	RD14BB2E563J	Carbon	56kΩ	±5%	1/4W
R337	R92-0709-05	Metal film	3MΩ	±1%	1/2W
R338	RN14BK2H1004F	Metal film	1MΩ	±1%	1/2W
R339	RN14BK2H5003F	Metal film	500kΩ	±1%	1/2W
R340	RN14BK2E3003F	Metal film	300kΩ	±1%	1/4W
R341	RN14BK2E1003F	Metal film	100kΩ	±1%	1/4W
R342	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R343	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
R344	RD14BB2E682J	Carbon	6.8kΩ	±5%	1/4W
R345	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R346	RD14BB2E153J	Carbon	15kΩ	±5%	1/4W
R347,348	RD14BY2H563J	Carbon	56kΩ	±5%	1/2W
R349	RD14BB2E682J	Carbon	6.8kΩ	±5%	1/4W
R350	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R351	RD14BB2E153J	Carbon	15kΩ	±5%	1/4W
R352	RD14BB2E183J	Carbon	18kΩ	±5%	1/4W
R353	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
R354	RD14BB2E221J	Carbon	220Ω	±5%	1/4W
R355	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R356	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
R357	RD14BB2E152J	Carbon	1.5kΩ	±5%	1/4W
R358	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R359	RD14BB2E682J	Carbon	6.8kΩ	±5%	1/4W
R360	RD14BB2E222J	Carbon	2.2kΩ	±5%	1/4W
R361	RD14BB2E272J	Carbon	2.7kΩ	±5%	1/4W
R362	RD14BB2E682J	Carbon	6.8kΩ	±5%	1/4W
R363	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R364	RD14BB2E473J	Carbon	47kΩ	±5%	1/4W
R365	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
R366	RD14BB2E681J	Carbon	680Ω	±5%	1/4W
R367	RD14BB2B182J	Carbon	1.8kΩ	±5%	1/8W
R368	RD14BB2E182J	Carbon	1.8kΩ	±5%	1/4W
R369	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R370	RD14BB2B331J	Carbon	330Ω	±5%	1/4W
R371	RD14BB2E682J	Carbon	6.8kΩ	±5%	1/4W
R372	RD14BB2E332J	Carbon	3.3kΩ	±5%	1/4W
R373	RD14BB2E152J	Carbon	1.5kΩ	±5%	1/4W
R374,375	RD14BB2E181J	Carbon	180Ω	±5%	1/4W
R376	RD14BB2E511J	Carbon	510Ω	±5%	1/4W
R377,378	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R379,380	RS14GB3F682J	Metal film	6.8kΩ	±5%	3W
R381~384	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
R385	RD14BB2E822J	Carbon	8.2kΩ	±5%	1/4W
R386	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
R387	RD14BB2E123J	Carbon	12kΩ	±5%	1/4W
R388	RD14BB2E331J	Carbon	330Ω	±5%	1/4W
R389	RD14BB2E270J	Carbon	27Ω	±5%	1/4W
R390	RD14BB2E561J	Carbon	560Ω	±5%	1/4W
R391	RD14BB2E332J	Carbon	3.3kΩ	±5%	1/4W
R392	RD14BB2E152J	Carbon	1.5kΩ	±5%	1/4W
R393	RN14BK2E4300F	Metal film	430Ω	±1%	1/4W
R394	RN14BK2E5600F	Metal film	560Ω	±1%	1/4W
R396	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R397	RD14BB2B152J	Carbon	1.5kΩ	±5%	1/8W
R398	RD14BB2E152J	Carbon	1.5kΩ	±5%	1/4W
R399	RD14BB2E272J	Carbon	2.7kΩ	±5%	1/4W
R400	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R300	RD14BB2E682J	Carbon	6.8kΩ	±5%	1/4W
R1	RD14BB2E181J	Carbon	180Ω	±5%	1/4W
R2	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
☆R4,5	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
☆R6	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
☆R7	RD14BB2E104J	Carbon	100kΩ	±5%	1/4W
VR301	R12-3040-05	Semi-fixed resistor	22kΩ(B)		
VR302	R01-4503-05	Variable resistor	50kΩ(B)(attached S303)		
VR303	R12-1501-05	Semi-fixed resistor	1.5kΩ(B)		
VR304	R01-2501-05	Variable resistor	5kΩ(B) (attached S304)		
VR305	R12-1028-05	Semi-fixed resistor	4.7kΩ(B)		
VR306	R12-3040-05	Semi-fixed resistor	22kΩ(B)		
VR307	R12-1033-05	Semi-fixed resistor	2.2kΩ(B)		
VR309	R12S1029-05	Semi-fixed resistor	1kΩ(B)		
VR310	R12-0060-05	Semi-fixed resistor	330Ω(B)		
VR312	R12-5025-05	Semi-fixed resistor	100kΩ(B)		
VR313	R12-3042-05	Semi-fixed resistor	47kΩ(B)		
VR314	R12-3040-05	Semi-fixed resistor	22kΩ(B)		
VR316	R12-3041-05	Semi-fixed resistor	10kΩ(B)		
		CAPACITOR			
C301	CC45CH1H050C	Ceramic	5pF	±0.25pF	
C302	C90-0298-05	Semiconductor ceramic	0.1μF	+80%,−20%	
C303	CE04BW1H010M	Electrolytic	1μF		50WV
C304	CS15E1E010M	Tuntalum Electrolytic	1μF	±20%	25WV
C305,307, 308	CK45D1H103M	Ceramic	0.01μF	±20%	
C309	CE04BW1H010M	Electrolytic	1μF		50WV
C310	CE04W1A470	Electrolytic	47μF		10WV
C311	CQ93M1H472K	Mylar	4700pF	±10%	
C313~315	CS15E1E010M	Tuntalum Electrolytic	1μF	±20%	25WV
C316	CC45CH1H100D	Ceramic	10pF	±0.5pF	
C317~320	CK45D1H103M	Ceramic	0.01μF	±20%	
C321	C91-0517-05	Polypropylen film	0.47μF	±1%	
C322	C91-0516-05	Polypropylen film	0.0047μF	±1%	
C323,324	CM93BD2A330J	Mica	33p	±5%	

PARTS LIST

Ref. No.	Parts No.	Description			
C325	CS15E1ER47M	Tuntalum Electrolytic	0.47μF	±20%	25WV
C326	CQ93M1H104M	Mylar	0.1μF	±20%	
C327	CQ93M1H472K	Mylar	4700p	±10%	
C328	CQ93M1H272K	Mylar	2700p	±10%	
C329	CC45CH1H470J	Ceramic	47p	±5%	
C330	CC45CH1H330J	Ceramic	33p	±5%	
C331~333	CK45D1H103M	Ceramic	0.01μF	±20%	
C335	CK45D2H103M	Ceramic	0.01μF	±20%	500WV
C337,338	CQ93M1H152K	Mylar	1500pF	±10%	
C339	CC45CH1H680J	Ceramic	68p	±5%	
C340,341	CQ93M1H103K	Mylar	0.01μF	±10%	
C342	CQ93M1H222K	Mylar	2200pF	±10%	
C343	CK45D1H103M	Ceramic	0.01μF	±20%	
C344	CE04W1A470	Electrolytic	47μF		10WV
C345	CK45D1H103M	Ceramic	0.01μF	±20%	
C346	CE04W1C470	Electrolytic	47μF		16WV
C347	CK45D1H103M	Ceramic	0.01μF	±20%	
C348	CE04W1E4R7	Electrolytic	4.7μF		25WV
C349	CK45D1H103M	Ceramic	0.01μF	±20%	
C350	CE04W1A470	Electrolytic	47μF		10WV
C351~354	CK45D1H103M	Ceramic	0.01μF	±20%	
☆C355	CE04W1C470	Electrolytic	47μF		16WV
☆C356	CE04W1A470	Electrolytic	47μF		10WV
☆C357,358	CE04W1A470	Electrolytic	47μF		10WV
☆C359	CE04W1C470	Electrolytic	47μF		16WV
☆C361	CC45CH1H220J	Ceramic	22pF	±5%	
☆C362	CC45SL1H271J	Ceramic	270pF	±5%	
☆C363	CC45SL1H221J	Ceramic	220pF	±5%	
☆C364~366	CK45D1H103M	Ceramic	0.01μF	±20%	
☆C367	CE04BW1H010M	Electrolytic	1μF		50WV
☆C368~371	CE04W1A470	Electrolytic	47μF		16WV
☆C373	CK45D1H103M	Ceramic	0.01μF	±20%	
☆C374	CE04W2E010	Electrolytic	1μF		250WV
TC301	C05-0401-05	Ceramic trimmer	20pF		
TC302,303	C05-0066-05	Ceramic trimmer	10pF		
SEMICONDUCTOR					
D301~304		Diode	1S1555		
D305		Diode	1N60		
D306,307		Diode	1S1555		
D308		Diode	1S1587		
D309~315		Diode	1S1555		
D318,319		Diode	1S1555		
D320		Zener diode	WZ-050		
D321~323		Diode	1S1555		
☆D324~326		Diode	1S1555		
☆D327		Zener diode	WZ-044		
Q301		Transistor	2SC1047(C)		
Q302,303		Transistor	2SC945(P)		
Q304~306		Transistor	2SC1047(C)		
Q307		Transistor	2SC945(P)		
Q308		Transistor	2SA733(Q)		
Q309,310		Transistor	2SC945(P)		
Q311		FET	2SK30A(O)		
Q312		Transistor	2SC945(P)		
Q313		Transistor	2SC1566		
Q314~316		Transistor	2SC945(P)		
Q317		Transistor	2SC1047(C)		
Q318~321		Transistor	2SC945(P)		
Q322,323		Transistor	2SC535(B)		
Q324,325		Transistor	2SC1566		
Q326		Transistor	2SC945(P)		
Q327		Transistor	2SA733(Q)		
Q328~330		Transistor	2SC945(P)		
Q331		Transistor	2SC1913		
Q332		Transistor	2SC945(P)		
Q333		Transistor	2SA733(Q)		
Q334,335		Transistor	2SC945(P)		
IC301		Linear IC	AN606		

Ref. No.	Parts No.	Description	
IC302		Digital IC	SN74LS112N
IC303		Digital IC	SN74LS00N
IC304		Linear IC	NJM555D
IC305		Digital IC	SN74LS00N
MISCELLANEOUS			
L301	L40-4701-03	Ferri-inductor	47μH
L303~306	L40-4701-03	Ferri-inductor	47μH
L307,308	L40-3311-03	Ferri-inductor	330μH
L310	L40-4701-03	Ferri-inductor	47μH
—	E23-0047-04	Terminal	
P301~303	E40-0267-05	Pin connector(2P)	
P304	E40-0367-05	Pin connector(3P)	
P305,306	E40-0267-05	Pin connector(2P)	
P307	E40-0867-05	Pin connector(8P)	
P308	E40-0967-05	Pin connector(7P)	
P309,310	E40-0267-05	Pin connector(2P)	
P311	E40-0567-05	Pin connector(5P)	
—	F01-0820-04	Heat sink ×2	
—	J13-6041-05	Fuse clip ×2	
—	J25-2852-23	Printed circuit board	
—	R92-0150-05	Jumper wire (resistor type) ×72	
S301	S32-4008-05	Lever switch	
S302	S37-2005-05	Lever switch	
S304	S29-2507-05	Rotary switch	

VERTICAL AMPLIFIER UNIT (X73-1280-00)

Ref. No.	Parts No.	Description			
RESISTOR					
R101	RD14BB2E105J	Carbon	1MΩ	±5%	1/4W
R102	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R103	RN14BK2H9003F	Metal film	900kΩ	±1%	1/2W
R104	RN14BK2H9903F	Metal film	990kΩ	±1%	1/2W
R105	RN14BK2H9993F	Metal film	999kΩ	±1%	1/2W
R106	RN14BK2E1113F	Metal film	111kΩ	±1%	1/4W
R107	RD14BB2E561J	Carbon	560Ω	±5%	1/4W
R108	RN14BK2E1012F	Metal film	10.1kΩ	±1%	1/4W
R109	RD14BB2E561J	Carbon	560Ω	±5%	1/4W
R110	RN14BK2E1001F	Metal film	1kΩ	±1%	1/4W
R111	RN14BK2H1004F	Metal film	1MΩ	±1%	1/2W
R112	RD14BB2E104J	Carbon	100kΩ	±5%	1/4W
R113,114	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R115,116	RN14BK2E5601F	Metal film	5.6kΩ	±1%	1/4W
R117,118	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R119	RN14BK2E8200F	Metal film	820Ω	±1%	1/4W
R120	RN14BK2E4301F	Metal film	4.3kΩ	±1%	1/4W
R121	RN14BK2E5101F	Metal film	5.1kΩ	±1%	1/4W
R122,123	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R124,125	RN14BK2E3001F	Metal film	3kΩ	±1%	1/4W
R126	RN14BK2E2000F	Metal film	200Ω	±1%	1/4W
R127	RN14BK2E1601F	Metal film	1.6kΩ	±1%	1/4W
R128	RD14BB2E4R7J	Carbon	4.7Ω	±5%	1/4W
R129	RN14BK2E1301F	Metal film	1.3kΩ	±1%	1/4W
R130	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R131	RN14BK2E4300F	Metal film	430Ω	±1%	1/4W
R132	RD14BB2E241J	Carbon	240Ω	±5%	1/4W
R133	RN14BK2E9100F	Metal film	910Ω	±1%	1/4W
R134	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R135	RN14BK2E9100F	Metal film	910Ω	±1%	1/4W
R136	RN14BK2E1001F	Metal film	1kΩ	±1%	1/4W
R137,138	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R139	RD14BB2E221J	Carbon	220Ω	±5%	1/4W
R140,141	RN14BK2E5601F	Metal film	5.6kΩ	±1%	1/4W
R142	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R143,144	RN14BK2E4300F	Metal film	430Ω	±1%	1/4W

PARTS LIST

Ref. No.	Parts No.	Description			
R145	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R146	RD14BB2E222J	Carbon	2.2kΩ	±5%	1/4W
R147	RD14BB2E202J	Carbon	2kΩ	±5%	1/4W
R148,149	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R150,151	RN14BK2E1801F	Metal film	1.8kΩ	±1%	1/4W
R152,153	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R154	RD14BB2E331J	Carbon	330Ω	±5%	1/4W
R155	RD14BB2E122J	Carbon	1.2kΩ	±5%	1/4W
R156,157	RD14BB2E272J	Carbon	2.7kΩ	±5%	1/4W
R158,159	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R160	RD14BB2E122J	Carbon	1.2kΩ	±5%	1/4W
R161,162	RD14BB2E392J	Carbon	3.9kΩ	±5%	1/4W
R163,164	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R165	RD14BB2E682J	Carbon	6.8kΩ	±5%	1/4W
R166	RD14BB2E332J	Carbon	3.3kΩ	±5%	1/4W
R167	RD14BB2E682J	Carbon	6.8kΩ	±5%	1/4W
R168	RD14BB2E272J	Carbon	2.7kΩ	±5%	1/4W
R169,170	RD14BB2E122J	Carbon	1.2kΩ	±5%	1/4W
R171	RD14BB2E105J	Carbon	1MΩ	±5%	1/4W
R172	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R173	RN14BK2H9003F	Metal film	900kΩ	±1%	1/2W
R174	RN14BK2H9903F	Metal film	990kΩ	±1%	1/2W
R175	RN14BK2H9993F	Metal film	999kΩ	±1%	1/2W
R176	RN14BK2E1113F	Metal film	111kΩ	±1%	1/4W
R177	RD14BB2E561J	Carbon	560Ω	±5%	1/4W
R178	RN14BK2E1012F	Metal film	10.1kΩ	±1%	1/4W
R179	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
R180	RN14BK2E1001F	Metal film	1kΩ	±1%	1/4W
R181	RN14BK2H1004F	Metal film	1MΩ	±1%	1/2W
R182	RD14BB2E104J	Carbon	100kΩ	±5%	1/4W
R183,184	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R185,186	RN14BK2E5601F	Metal film	5.6kΩ	±1%	1/4W
R187,188	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R189	RN14BK2E8200F	Metal film	820Ω	±1%	1/4W
R190	RN14BK2E4301F	Metal film	4.3kΩ	±1%	1/4W
R191	RN14BK2E5101F	Metal film	5.1kΩ	±1%	1/4W
R192,193	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R194,195	RN14BK2E3001F	Metal film	3kΩ	±1%	1/4W
R196	RN14BK2E2000F	Metal film	200Ω	±1%	1/4W
R197	RN14BK2E1601F	Metal film	1.6kΩ	±1%	1/4W
R198	RD14BB2E4R7J	Carbon	4.7Ω	±5%	1/4W
R199	RN14BK2E1301F	Metal film	1.3kΩ	±1%	1/4W
R200	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R201	RN14BK2E4300F	Metal film	430Ω	±1%	1/4W
R202	RD14BB2E241J	Carbon	240Ω	±5%	1/4W
R203	RN14BK2E9100F	Metal film	910Ω	±1%	1/4W
R204	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R205	RN14BK2E9100F	Metal film	910Ω	±1%	1/4W
R206	RN14BK2E1001F	Metal film	1kΩ	±1%	1/4W
R207,208	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R209	RD14BB2E241J	Carbon	240Ω	±5%	1/4W
R210,211	RN14BK2E5601F	Metal film	5.6kΩ	±1%	1/4W
R212	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R213,214	RN14BK2E4300F	Metal film	430Ω	±1%	1/4W
R215	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R216,217	RN14BK2E5601F	Metal film	5.6kΩ	±1%	1/4W
R218~221	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R222	RD14BB2E202J	Carbon	2kΩ	±5%	1/4W
R223	RD14BB2E222J	Carbon	2.2kΩ	±5%	1/4W
R224	RD14BB2E202J	Carbon	2kΩ	±5%	1/4W
R225	RD14BB2E222J	Carbon	2.2kΩ	±5%	1/4W
R226,227	RN14BK2E1801F	Metal film	1.8kΩ	±1%	1/4W
R228,229	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R230	RD14BB2E331J	Carbon	330Ω	±5%	1/4W
R231	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
R232,233	RD14BB2E272J	Carbon	2.7kΩ	±5%	1/4W
R234,235	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R236	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
R237,238	RD14BB2E392J	Carbon	3.9kΩ	±5%	1/4W
R239,240	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R241	RD14BB2E682J	Carbon	6.8kΩ	±5%	1/4W
R242	RD14BB2E332J	Carbon	3.3kΩ	±5%	1/4W
R243	RD14BB2E682J	Carbon	6.8kΩ	±5%	1/4W
R244	RD14BB2E222J	Carbon	2.2kΩ	±5%	1/4W
R245,246	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
R247	RD14BB2E272J	Carbon	2.7kΩ	±5%	1/4W
R248	RD14BB2E222J	Carbon	2.2kΩ	±5%	1/4W
R249,250	RD14BB2E122J	Carbon	1.2kΩ	±5%	1/4W
R251,252	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R253,254	RD14BB2E182J	Carbon	1.8kΩ	±5%	1/4W
R255,256	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R257,258	RD14BB2E181J	Carbon	180Ω	±5%	1/4W
R259	RD14BB2E331J	Carbon	330Ω	±5%	1/4W
R260,261	RN14BK2E8200F	Metal film	820Ω	±1%	1/4W
R262,R263	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R264,265	RD14BB2E152J	Carbon	1.5kΩ	±5%	1/4W
R266,267	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R268	RD14BB2E181J	Carbon	180Ω	±5%	1/4W
R269,270	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R271,272	RD14BB2E223J	Carbon	22kΩ	±5%	1/4W
R273~277	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R278,279	RN14BK2E1101F	Metal film	1.1kΩ	±1%	1/4W
R281	RD14BB2E562J	Carbon	5.6kΩ	±5%	1/4W
R282~284	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R285	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
R286	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R287,288	RD14BB2E471J	Carbon	470Ω	±5%	1/4W
R289	RD14BB2E153J	Carbon	15kΩ	±5%	1/4W
R290	RD14BB2E561J	Carbon	560Ω	±5%	1/4W
R291	RD14BB2E684J	Carbon	680kΩ	±5%	1/4W
R292	RD14BB2E181J	Carbon	180Ω	±5%	1/4W
VR101	R12-0058-05	Semi-fixed resistor		470Ω(B)	
VR102	R01-2508-05	Variable resistor		5kΩ(A)	
VR103	R12-0502-05	Semi-fixed resistor		100Ω(B)	
VR104	R01-0509-05	Variable resistor		300Ω(B)	
VR105	R12-0060-05	Semi-fixed resistor		330Ω(B)	
VR106	R12S1029-05	Semi-fixed resistor		1kΩ(B)	
VR107	R12-3042-05	Semi-fixed resistor		47kΩ(B)	
VR108	R12-0058-05	Semi-fixed resistor		470Ω(B)	
VR111	R12-0058-05	Semi-fixed resistor		470Ω(B)	
VR112	R01-2508-05	Variable resistor		5kΩ(A)	
VR113	R12-0502-05	Semi-fixed resistor		100Ω(B)	
VR114	R12-0058-05	Semi-fixed resistor		470Ω(B)	
VR115(S105)	R01-0510-05	Variable resistor (with switch)		300Ω(B)	
VR116	R12-0060-05	Semi-fixed resistor		330Ω(B)	
VR117	R12-0513-05	Semi-fixed resistor		680Ω(B)	
VR118	R12-0058-05	Semi-fixed resistor		470Ω(B)	
CAPACITOR					
C101	C91-0525-05	Metal film	0.1μF	±10%	630WV
C102	CM93BD2A470J	Mica	47pF	±5%	100WV
C103	CM93BD2A471J	Mica	470pF	±5%	100WV
C104	CM93BD2A332J	Mica	3300pF	±5%	100WV
C107	CM93D2H332J	Mica	3300pF	±5%	500WV
☆C108	CC45CH1H030C	Ceramic	3pF	±0.25pF	
C109	CC45CH1H010C	Ceramic	1pF	±0.25pF	
C110	CC45CH1H070D	Ceramic	7pF	±0.5pF	
C111	CC45CH1H220J	Ceramic	22pF	±5%	
C112	CC45CH1H100D	Ceramic	10pF	±0.5pF	
C113	CC45CH1H180J	Ceramic	18pF	±5%	
C114	CC45CH1H220J	Ceramic	22pF	±5%	
C115	CC45CH1H470J	Ceramic	47pF	±5%	
C116	CE04W1A470	Electrolytic	47μF		10WV
C117	CK45D1H103M	Ceramic	0.01μF	±20%	
C118	CE04W1A470	Electrolytic	47μF		10WV
C119	CE04W1C470	Electrolytic	47μF		16WV
C120	CE04W1A470	Electrolytic	47μF		10WV
C121	C91-0525-05	Metal film	0.1μF	±10%	630WV
C122	CM93BD2A470J	Mica	47pF	±5%	100WV
C123	CM93BD2A471J	Mica	470pF	±5%	100WV
C124	CM93BD2A332J	Mica	3300pF	±5%	100WV
C127	CM93D2H332J	Mica	3300pF	±5%	500WV
☆C128	CC45CH1H030C	Ceramic	3pF	±0.25pF	

PARTS LIST

Ref. No.	Parts No.	Description			
C129	CC45CH1H010C	Ceramic	1pF	±0.25pF	
C130	CC45CH1H070D	Ceramic	7pF	±0.5pF	
C131	CC45CH1H220J	Ceramic	22pF	±5%	
C132	CC45CH1H150J	Ceramic	15pF	±5%	
C134	CC45CH1H270J	Ceramic	27pF	±5%	
C135	CC45CH1H470J	Ceramic	47pF	±5%	
C136,137	CK45D1H103M	Ceramic	0.01μF	±20%	
C138	CE04W1A470	Electrolytic	47μF		10WV
C139	CE04W1C470	Electrolytic	47μF		16WV
C140	CK45D1H103M	Ceramic	0.01μF	±20%	
C141	CC45CH1H070D	Ceramic	7pF	±0.5pF	
C142	CC45CH1H220J	Ceramic	22pF	±5%	
C143	CE04W1A470	Electrolytic	47μF		10WV
C144,145	CK45D1H103M	Ceramic	0.01μF	±20%	
C149	CC45CH1H220J	Ceramic	22pF	±5%	
C150	CC45CH1H150J	Ceramic	15pF	±5%	
C151	CC45CH1H180J	Ceramic	18pF	±5%	
C152	CC45CH1H150J	Ceramic	15pF	±5%	
C153	CC45CH1H270J	Ceramic	27pF	±5%	
C154,155	CK45D1H103M	Ceramic	0.01μF	±20%	
C156	CC45SL1H151J	Ceramic	150pF	±5%	
☆C157	CK45D1H102M	Ceramic	1000pF	±20%	
C158	CC45SL1H680J	Ceramic	68pF	±5%	
C159	CK45D1H102M	Ceramic	1000pF	±20%	
TC101~103	C05-0404-05	Ceramic trimmer		10pF	
TC104~107	C05-0403-05	Ceramic trimmer		6pF	
TC111~113	C05-0404-05	Ceramic trimmer		10pF	
TC114~116	C05-0403-05	Ceramic trimmer		6pF	
TC117	C05-0405-05	Ceramic trimmer		20pF	
TC118	C05-0404-05	Ceramic trimmer		10pF	
☆TC119	C05-0030-15	Ceramic trimmer		20pF	
SEMICONDUCTOR					
D101,102		Diode	1S1555		
D103,104		Zener diode	WZ-065		
D105		Diode	1N60		
D106~109		Diode	1S1555		
D110		Zener diode	YZ-030		
D111,112		Diode	1S1555		
D114,115		Zener diode	YZ-030		
D116~121		Diode	1S1587		
D122~125		Diode	1S1555		
D126		Zener diode	WZ-071		
D127~129		Diode	1S1555		
D130		Diode	1N60		
Q101		Dual FET	2SK228 T-2&3		
Q102		FET	2SK30A(O)		
Q103~108		Transistor	2SC1047(C)		
Q109,110		Transistor	2SA838(C)		
Q111~114		Transistor	2SC1047(C)		
Q115		Transistor	2SA838(C)		
Q116		Transistor	2SC1047(C)		
Q117		Transistor	2SA838(C)		
Q121		Dual FET	2SK228 T-2&3		
Q122		FET	2SK30A(O)		
Q123~128		Transistor	2SC1047(C)		
Q129~132		Transistor	2SA838(C)		
Q133,134		Transistor	2SC1047(C)		
Q135~138		Transistor	2SC1360		
IC101,102		Linear IC	AN904		
IC103		Digital IC	SN74LS112N		
MISCELLANEOUS					
L101,102	L40-4701-03	Ferri-inductor		47μH	
L105,106	L40-4791-02	Ferri-inductor		4.7μH	
P101,102	E40-0567-05	Pin connector	5P		
P103	E40-0967-05	Pin connector	9P		
P104	E40-0211-05	Pin connector	2P		

Ref. No.	Parts No.	Description
—	F11-0147-24	Shield case ×2
—	F11-0916-14	Shield case ×2
—	F11-0939-04	Shield case ×2
—	J25-2856-32	Printed circuit board
S101,102	S32-4007-05	Lever switch
S103,104	S29-2505-25	Rotary switch
S106	S33-2501-05	Lever switch

POWER SUPPLY CIRCUIT UNIT (X65-1260-00)

Ref. No.	Parts No.	Description			
RESISTOR					
R401,402	RD14BB2E272J	Carbon	2.7kΩ	±5%	1/4W
R403	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
R404	RD14BY2H3R3J	Carbon	3.3Ω	±5%	1/2W
R405	RN14BK2E2203F	Metal film	220kΩ	±1%	1/4W
R406	RN14BK2E1302F	Metal film	13kΩ	±1%	1/4W
R407	RN14BK2E2001F	Metal film	2kΩ	±1%	1/4W
R409	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
R410	RN14BK2E9101F	Metal film	9.1kΩ	±1%	1/4W
R411	RN14BK2E3901E	Metal film	3.9kΩ	±1%	1/4W
R412	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
R413,414	RN14BK2E1002F	Metal film	10kΩ	±1%	1/4W
R415	RN14BK2E9101F	Metal film	9.1kΩ	±1%	1/4W
R416	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
R417	RN14BK2E1501F	Metal film	1.5kΩ	±1%	1/4W
R418	RN14BK2E3000F	Metal film	300Ω	±1%	1/4W
R419	RN14BK2E1101F	Metal film	1.1kΩ	±1%	1/4W
R420	RD14BB2E681J	Carbon	680Ω	±5%	1/4W
R421	RD14BB2E104J	Carbon	100kΩ	±5%	1/4W
R422	RD14BY2H564J	Carbon	560kΩ	±5%	1/2W
R423	R92-0707-05	Metal film	8.2MΩ	±5%	1W
R424	RC05GF2H473J	Solid	47kΩ	±5%	1/2W
R425	RC05GF2H185J	Solid	1.8MΩ	±5%	1/2W
R426,427	RC05GF2H226J	Solid	22MΩ	±5%	1/2W
R428	RD14BB2E473J	Carbon	47kΩ	±5%	1/4W
R429	RD14BB2E471J	Carbon	470Ω	±5%	1/4W
R430	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R431	RD14BB2E104J	Carbon	100kΩ	±5%	1/4W
R432	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R433	RD14BB2E224J	Carbon	220kΩ	±5%	1/4W
R434	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
R435	RD14BB2E154J	Carbon	150kΩ	±5%	1/4W
R436	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R437	RD14BB2E221J	Carbon	220Ω	±5%	1/4W
R438	RD14BB2E102J	Carbon	1kΩ	±5%	1/4W
R439	RD14BB2E333J	Carbon	33kΩ	±5%	1/4W
R440	RD14BB2E223J	Carbon	22kΩ	±5%	1/4W
R441,442	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R443	RD14BB2E333J	Carbon	33kΩ	±5%	1/4W
R444	RD14BB2E221J	Carbon	220Ω	±5%	1/4W
R445	RD14BB2E103J	Carbon	10kΩ	±5%	1/4W
R446	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R447	RD14BB2E332J	Carbon	3.3kΩ	±5%	1/4W
R448	RD14BB2E123J	Carbon	12kΩ	±5%	1/4W
R449	RD14BB2E472J	Carbon	4.7kΩ	±5%	1/4W
R450	RD14BB2E221J	Carbon	220Ω	±5%	1/4W
R451	RD14BB2E683J	Carbon	68kΩ	±5%	1/4W
R452~455	RD14BB2E101J	Carbon	100Ω	±5%	1/4W
R456	RD14BB2E562J	Carbon	5.6kΩ	±5%	1/4W
R457	RD14BB2E391J	Carbon	390Ω	±5%	1/4W
R458,459	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R460	RD14BY2H393J	Carbon	39kΩ	±5%	1/2W
R461	RD14BB2E681J	Carbon	680Ω	±5%	1/4W
R462	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R463	RD14BB2E222J	Carbon	2.2kΩ	±5%	1/4W
R464	RD14BB2E470J	Carbon	47Ω	±5%	1/4W
R465	R92-0746-05	Metal film	12MΩ	±5%	1W

PARTS LIST

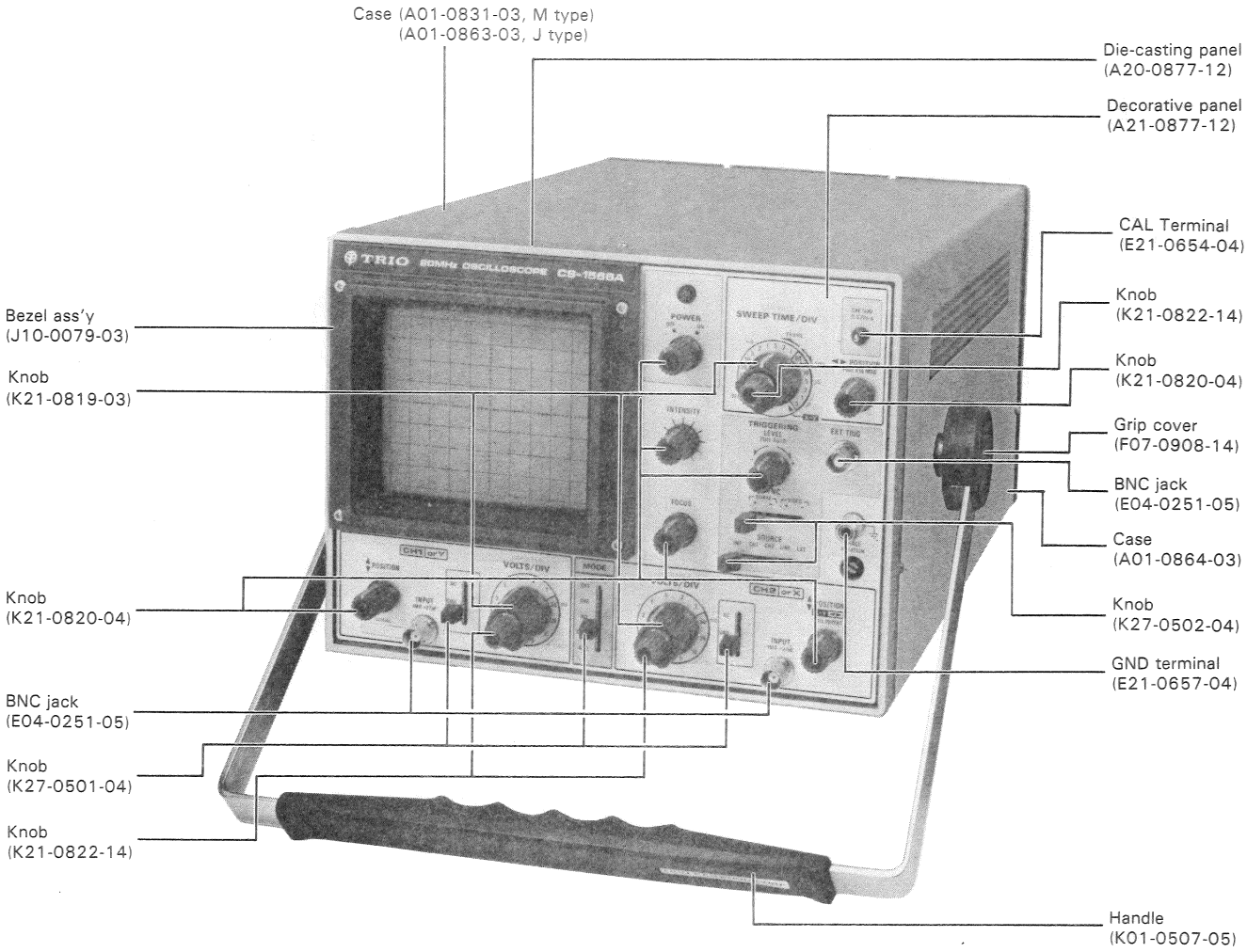
Ref. No.	Parts No.	Description
R466	RS14AB3D471J	Metal film 470Ω ±5% 2W
R467,468	RD14BB2E472J	Carbon 4.7kΩ ±5% 1/4W
R469,470	RD14BB2E101J	Carbon 100Ω ±5% 1/4W
R471	RD14BB2E683J	Carbon 68kΩ ±5% 1/4W
R472,473	RD14BB2E101J	Carbon 100Ω ±5% 1/4W
R474	RD14BB2E224J	Carbon 200kΩ ±5% 1/4W
R475	RD14BB2E822J	Carbon 8.2kΩ ±5% 1/4W
R476	RD14BB2E912J	Carbon 9.1kΩ ±5% 1/4W
VR401	R12-1033-05	Semi-fixed resistor 2.2kΩ(B)
VR402,403	R12-3042-05	Semi-fixed resistor 47kΩ(B)
VR404	R12-6005-05	Semi-fixed resistor 330kΩ(B)
VR405	R12-0513-05	Semi-fixed resistor 680Ω(B)
CAPACITOR		
C401	CE04W2E470	Electrolytic 47μF 250WV
C402	CE04W2E4R7	Electrolytic 4.7μF 250WV
C403	CE04W2E010	Electrolytic 1μF 250WV
C405	CE04W1V471	Electrolytic 470μF 35WV
C406	CE04W1E330	Electrolytic 33μF 25WV
C407,408	CE04W1E102	Electrolytic 1000μF 25WV
C409,410	CE04W1C470	Electrolytic 47μF 16WV
C411	CE04W1A470	Electrolytic 47μF 10WV
C412	CE04W1E100	Electrolytic 10μF 25WV
C413	CQ93M1H224M	Mylar 0.22μF ±20%
C414	CE04W1H471	Electrolytic 470μF 50WV
C415	CK45D1H103M	Ceramic 0.01μF ±20%
C416	CQ93M1H223M	Mylar 0.022μF ±20%
C417	CK45D3D102M	Ceramic 1000pF ±20% 2000WV
C418~421	CK45D3D103M	Ceramic 0.01μF ±20% 2000WV
C422	C90-0298-05	Semiconductor ceramic 0.1μF +80%,−20%
C423,424	CC45CH2H010C	Ceramic 1pF ±0.25pF 500WV
C425	CK45D1H103M	Ceramic 0.01μF ±20%
C426,427	CC45CH1H050C	Ceramic 5pF ±0.25pF
C428	CC45CH2H010C	Ceramic 1pF ±0.25pF 500WV
C429	CC45CH2H020C	Ceramic 2pF ±0.25pF 500WV
C430,431	CK45D1H103M	Ceramic 0.01μF ±20%
C432,433	CK45D2H103M	Ceramic 0.01μF ±20% 500WV
C434,435	CM93D2H332J	Mica 3300pF ±5% 500WV
C436	CE04W2E010	Electrolytic 1μF 250WV
C438,439	C90-0298-05	Semiconductor ceramic 0.1μF +80%,−20%
C440	CK45D2H103M	Ceramic 0.01μF ±20% 500WV
C441	CK45D1H102M	Ceramic 1000pF ±20%
C442	CK45D2H103M	Ceramic 0.1μF ±20% 500WV
TC401	C05-0403-05	Ceramic trimmer 6pF
SEMICONDUCTOR		
D401		Bridge rectifier S1QB60
D402		Diode V06B
D403		Bridge rectifier S2VB40F
D404		Diode 1S1555
D405		Zener diode WZ-280
D406~409		Diode 1S1555
D410		Zener diode WZ-090
D411		Diode Y16JA
D412		Diode 1S1555
D413,414		Diode W06C
D415		Diode 1SS-83
D416		Diode 1S1555
D417		Zener diode WZ-050
D418~421 423,424		Diode 1S1555
D425		Zener diode WZ-100
D426		Diode 1SS-83
D427		Zener diode WZ-100
D428		Diode 1S1555
Q403		Transistor 2SC945(P)
Q405		Transistor 2SC1505
Q408		Transistor 2SC1913

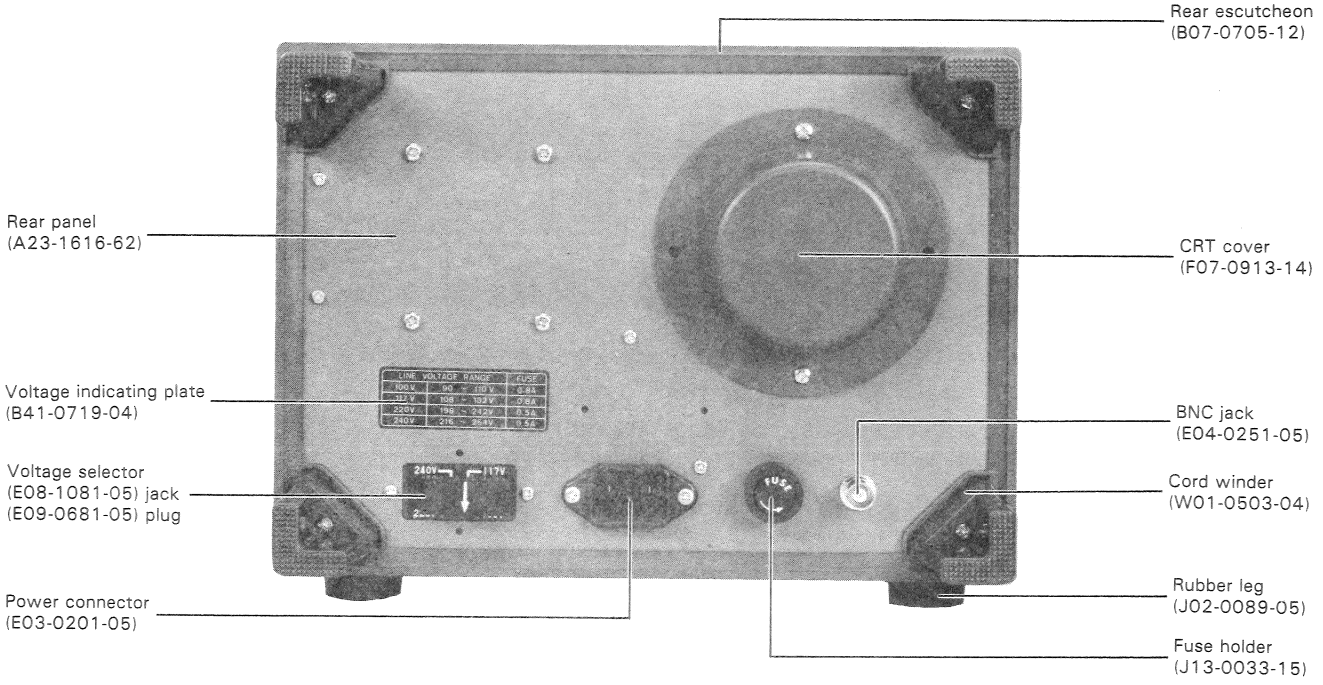
Ref. No.	Parts No.	Description
Q409		Transistor 2SC945(P)
Q410		Transistor 2SA733(Q)
Q411		Transistor 2SD401A(K)
Q412		Transistor 2SC983(Y)
Q413,414		Transistor 2SC1566
Q415,416		Transistor 2SC535(C)
Q417,418		Transistor 2SC1973(T)
Q419,420		Transistor 2SC805A-2(2) or (3)
Q421,422		Transistor 2SA923-2(2)
Q423,424		Transistor 2SC805A-2(2) or (3)
Q425,426		Transistor 2SA923-2(2)
Q427,428		Transistor 2SC1973(T)
Q429		Transistor 2SC983(Y)
IC401,402		Linear IC NJM4558D
MISCELLANEOUS		
L401	L40-4711-03	Ferri-inductor 470μH
L402	L40-4791-02	Ferri-inductor 4.7μH
—	E23-0046-04	Terminal
P401	E40-0632-05	Connector(6P)
P402,403	E40-0567-05	Connector(5P)
P404	E40-0867-05	Connector(8P)
P405	E40-0803-05	Connector(8P)
P406	E40-0303-05	Connector(3P)
P407	E40-0267-05	Connector(2P)
P408	E40-1267-05	Connector(12P)
P409	E40-0367-05	Connector(3P)
—	J30-0605-05	Spacer ×8
—	J61-0049-05	Cable wrapping band ×2
—	F01-0818-05	Heat sink
—	F01-0231-14	Heat sink
—	F02-0031-05	Heat sink
—	F11-0938-13	Shield case
—	J21-2885-04	Bracket (for P.C. Board)
—	J25-2851-62	Printed circuit board
—	J30-0605-05	Spacer
T401	L19-0407-05	Converter transformer
N401,402	NE-2B	Neon lamp
—	R92-0150-05	Jumper wire (resistor type)

VOLTAGE SELECTOR UNIT (X77-1020-00)

Ref. No.	Parts No.	Description
—	J25-2805-14	Printed circuit board
—	J12-0501-14	Mold pin
—	F19-0703-04	Changeover switch plate
—	E08-1081-05	Receptacle
—	E09-0681-05	Plug
—	E23-0047-04	Terminal
—	E40-0233-05	Pin connector 2p
—	E40-0533-05	Pin connector 5p
—	E40-0635-05	Pin connector 6p

EXTERNAL VIEW AND NAME OF PARTS

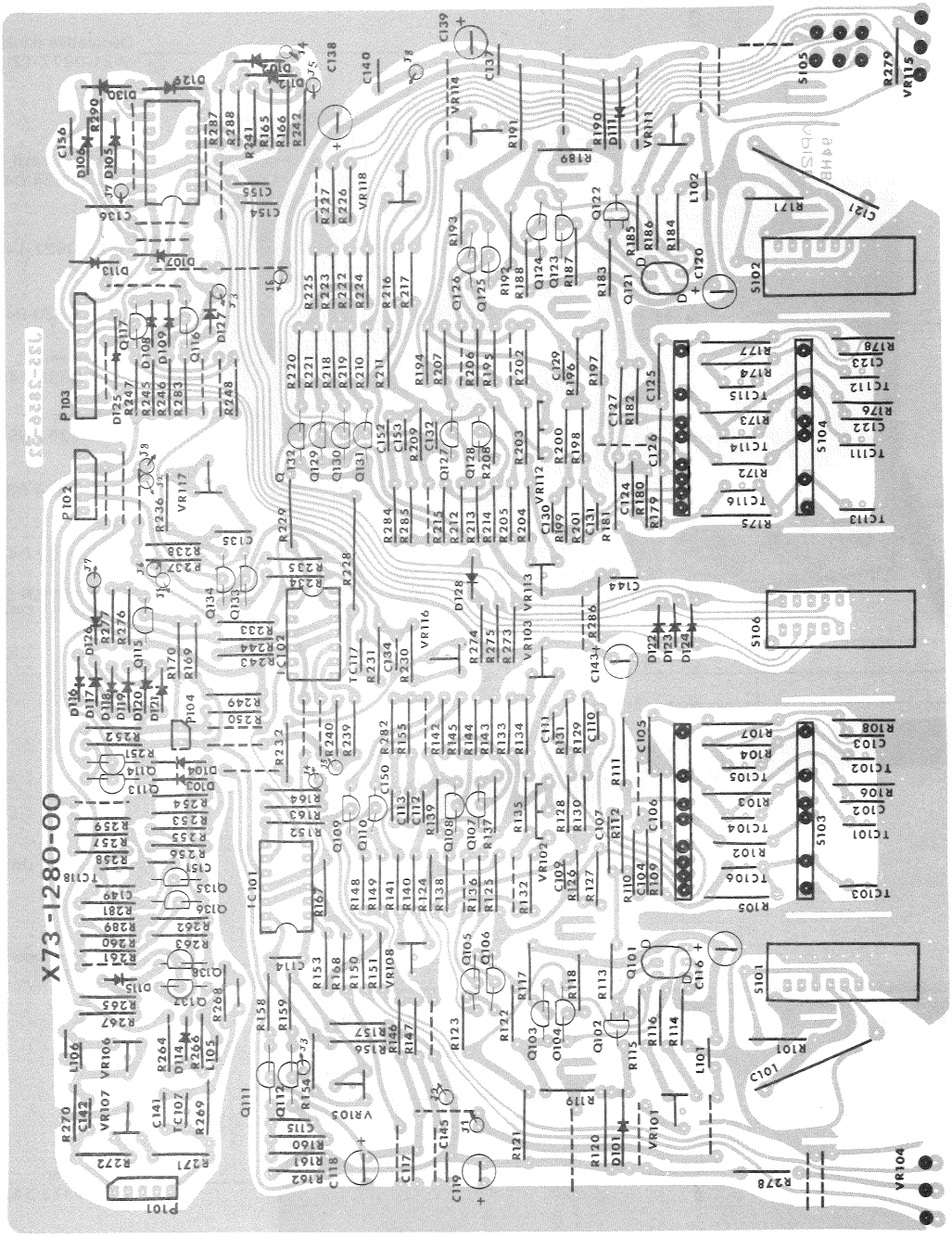


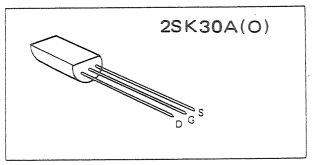


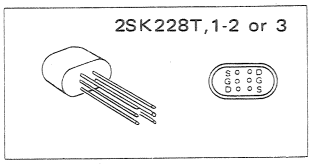
P.C. BOARD

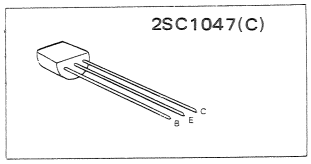
(on parts mounting side view)

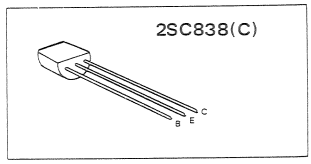
X73-1280-00

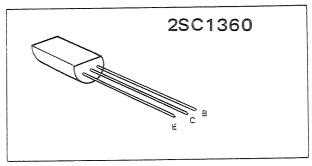










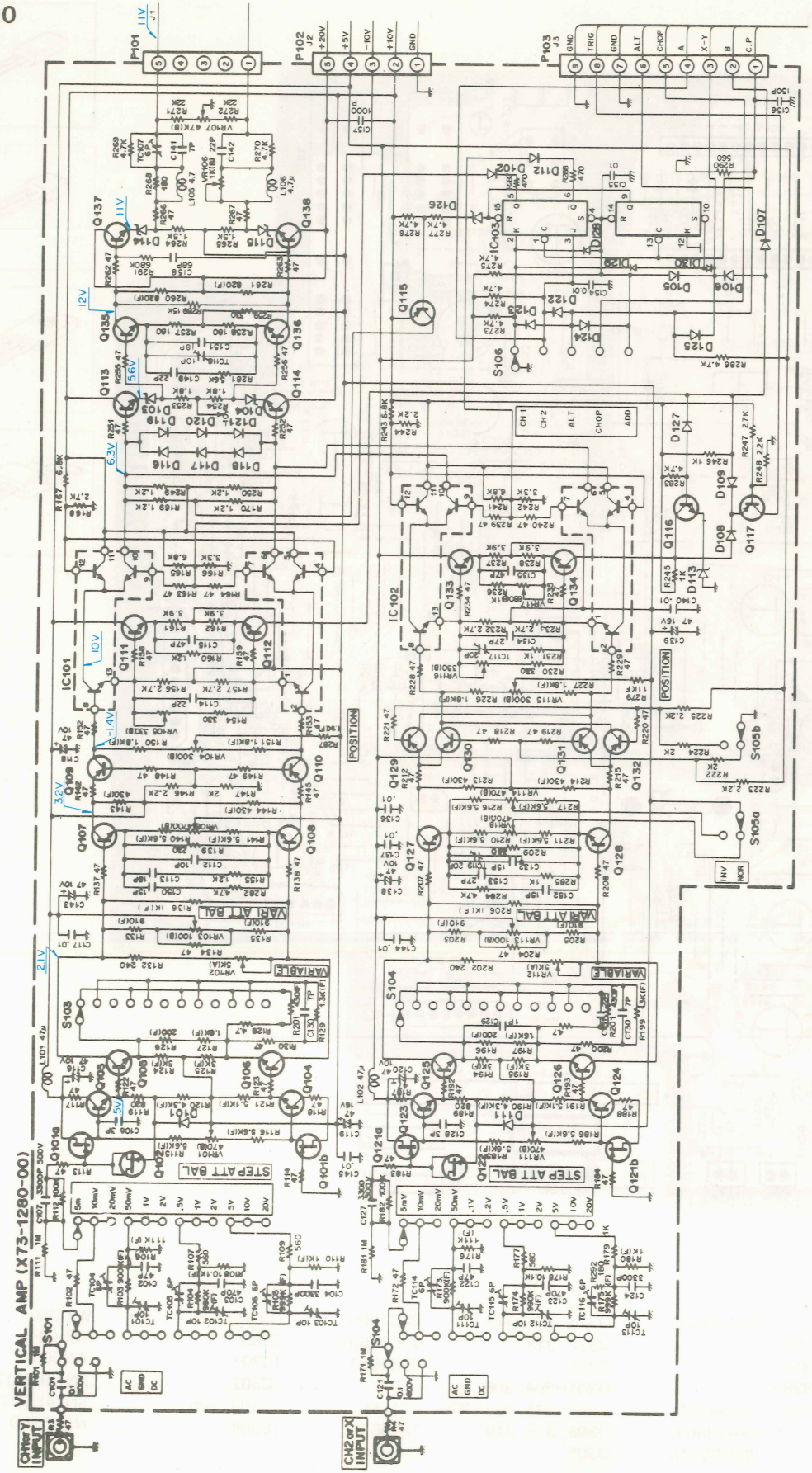


Q101, 121	:2SK228T1-2 or -1-3
Q102, 122	:2SK30A(O)
Q103~108, 111~114, 116, 123~128, 133, 134	:2SC1047(C)
Q109, 110, 115, 119, 129~132	:2SA838(C)
Q135~138	:2SC1360
IC101, 102	:AN904
IC103	:SN74LS112N

D101, 102, 106, 109 111, 112, 122~125, 127	:1S1555
D116~121	:1S1587
D103, 104	
D126	:WZ-061
D113~115	:YZ-030
D105, 130	:1N60

CIRCUIT DIAGRAM

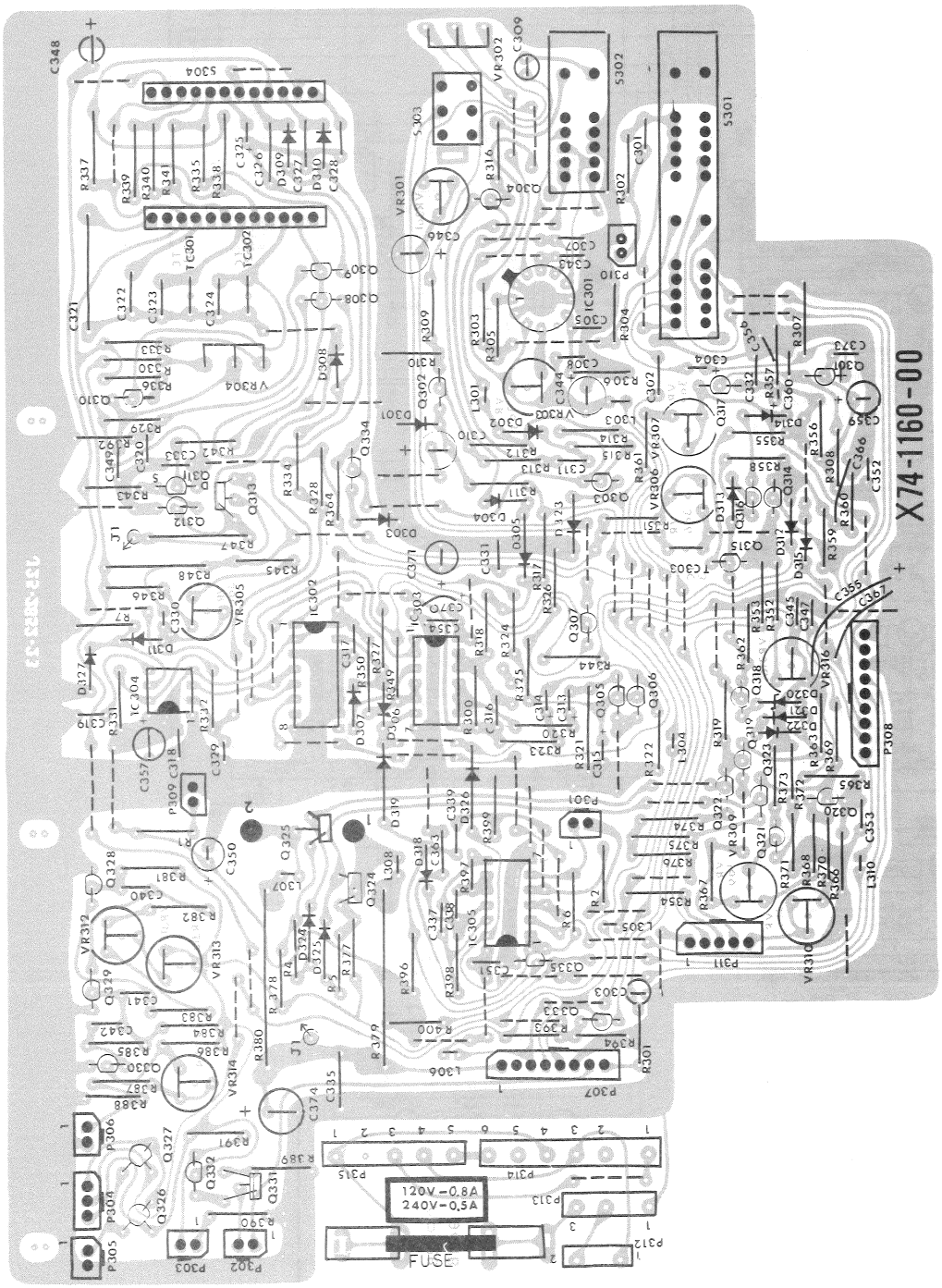
X73-1280-00

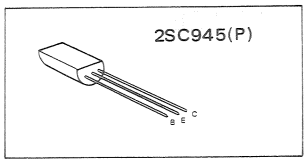


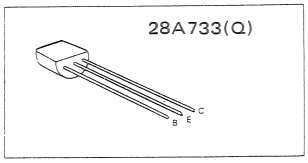
P.C. BOARD

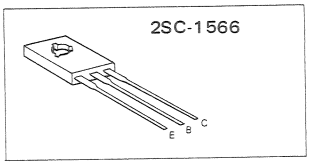
(on parts mounting side view)

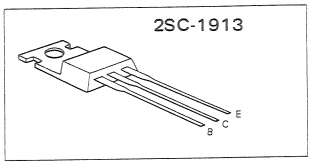
X74-1160-00







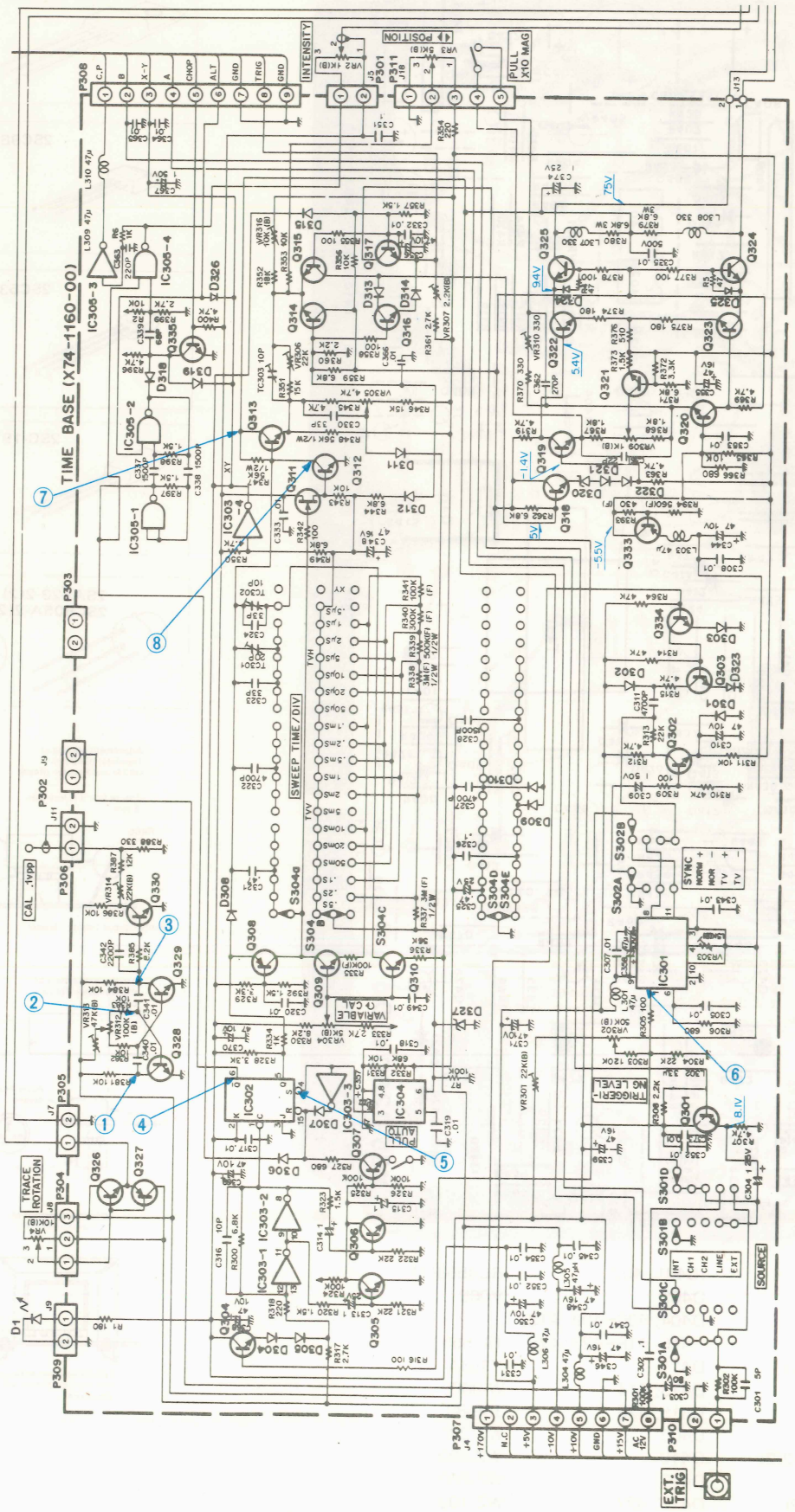


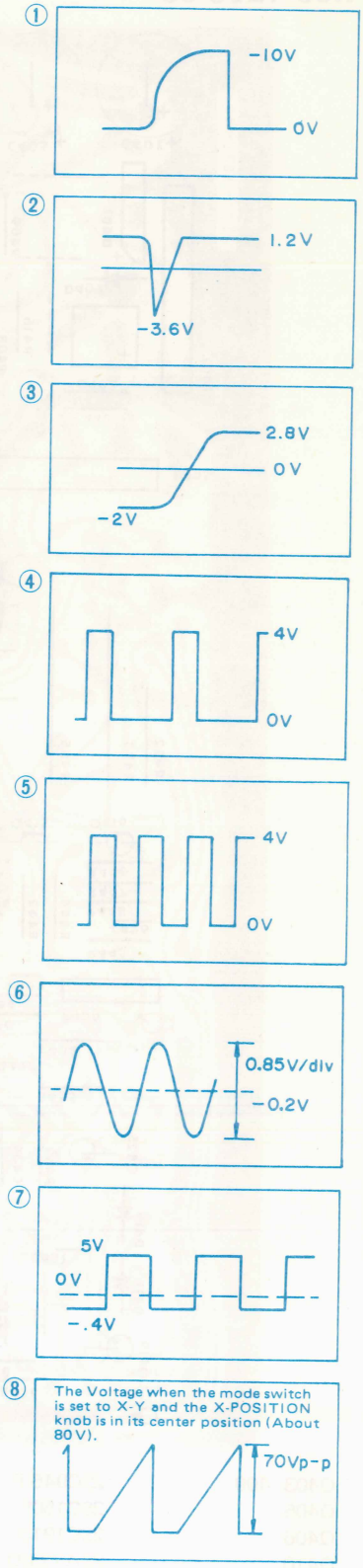


Q301, 304~306, 317	:2SC1047(C)	Q313, 324, 325	:2SC1566	D320	:WZ-050
Q302, 303, 307, 309, 310, 312, 314~316, 318~321, 326, 328~330, 332, 334, 335	:2SC945(P)	Q322, 323	:2SC535(B)	D327	:WZ-044
Q308, 327, 333	:2SA733(Q)	Q331	:2SC1913	IC301	:AN606
Q311	:2SK30A(O)	D301~304, 306, 309~315, 321~326	:1S1555	IC302	:SN74LS112N
		D308, 318, 319	:1S1587	IC303, 305	:SN74LS00N
		D305	:1N60	IC304	:NJM555D

CIRCUIT DIAGRAM

X74-1160-00

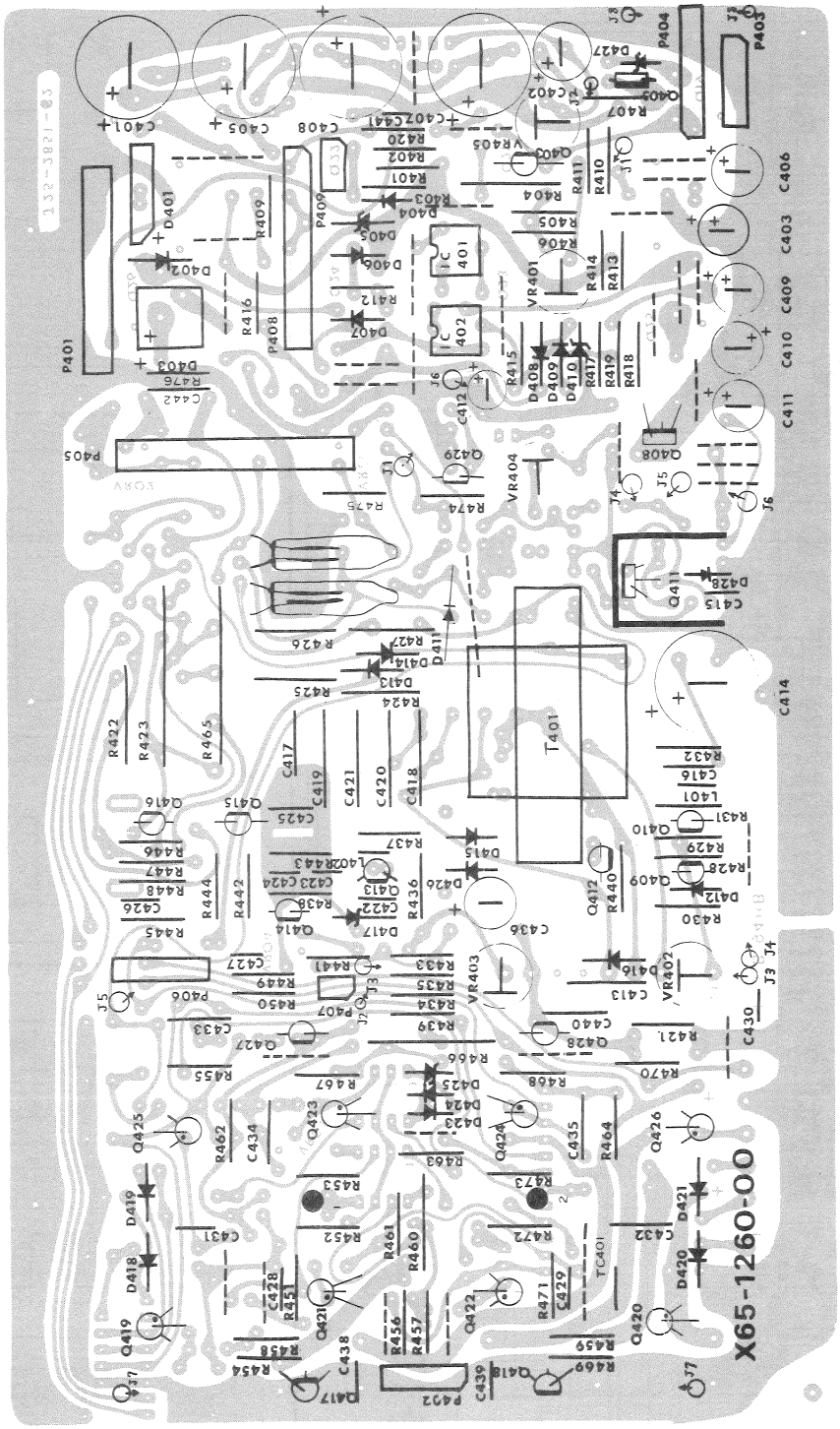


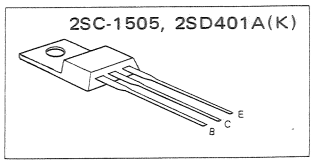


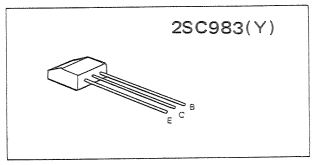
P.C. BOARD

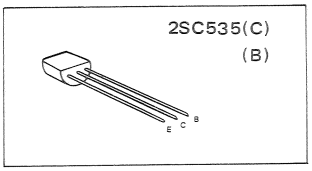
(on parts mounting side view)

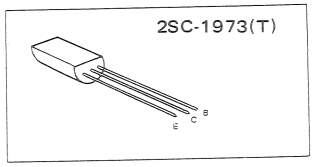
X65-1260-00

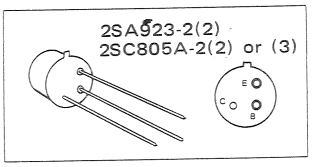




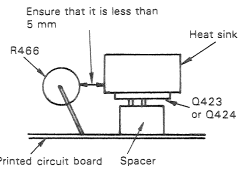




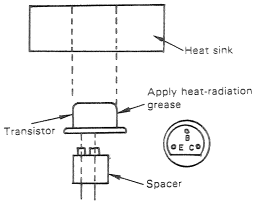




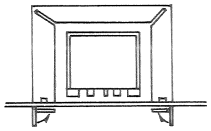
Attachment Method of Transistor (Q423 or Q424) and Resistor (R466)



Attachment Method of the Transistor (Q419 – Q426)



Attachment Method of the Transformer (T401)

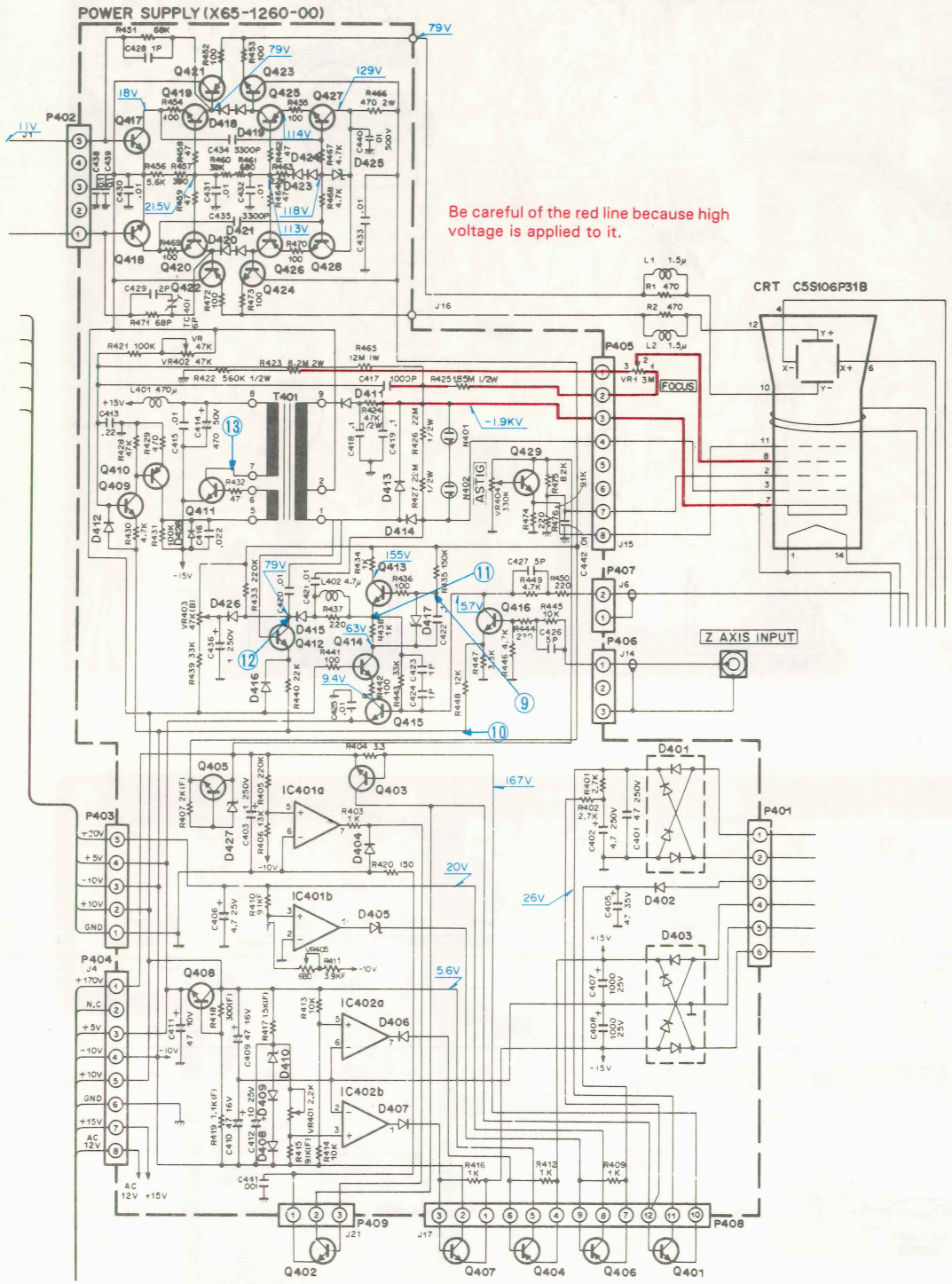


Fold it inside and solder so that the transformer will stay fixed.

Q403, 409	:2SC945(P)	IC401, 402	:RC4558(T)
Q405	:2SC1505	D402	:V06B
Q406	:2SC1913	D404, 406~409, 412, 416, 418~423, 428	:1S1555
Q410	:2SA733(Q)	D411	:Y16JA
Q411	:2SD401A(K)	D413, 414	:W-06C
Q412, 429	:2SC983(Y)	D415, 426	:1SS-83
Q415, 416	:2SC535(C)	D405	:WZ-280
Q417, 418, 427, 428	:2SC1973(T)	D410	:WZ-090
Q419, 420, 423, 424	:2SC805(A)-2(2)	D417	:WZ-050
Q413, 414	:2SC1566	D425, 427	:WZ-100
Q421, 422, 425, 426	:2SA923-2(2)		

CIRCUIT DIAGRAM

X65-1260-00



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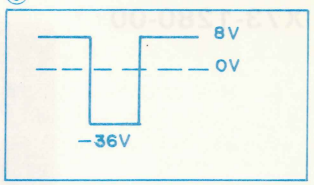

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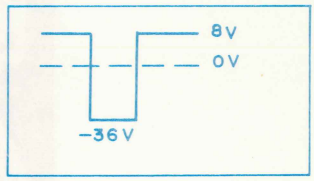

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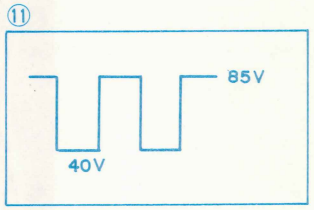

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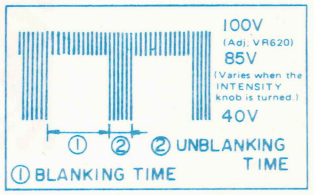
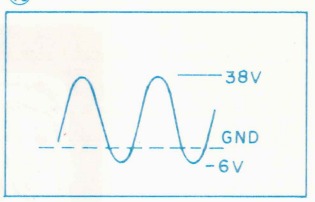


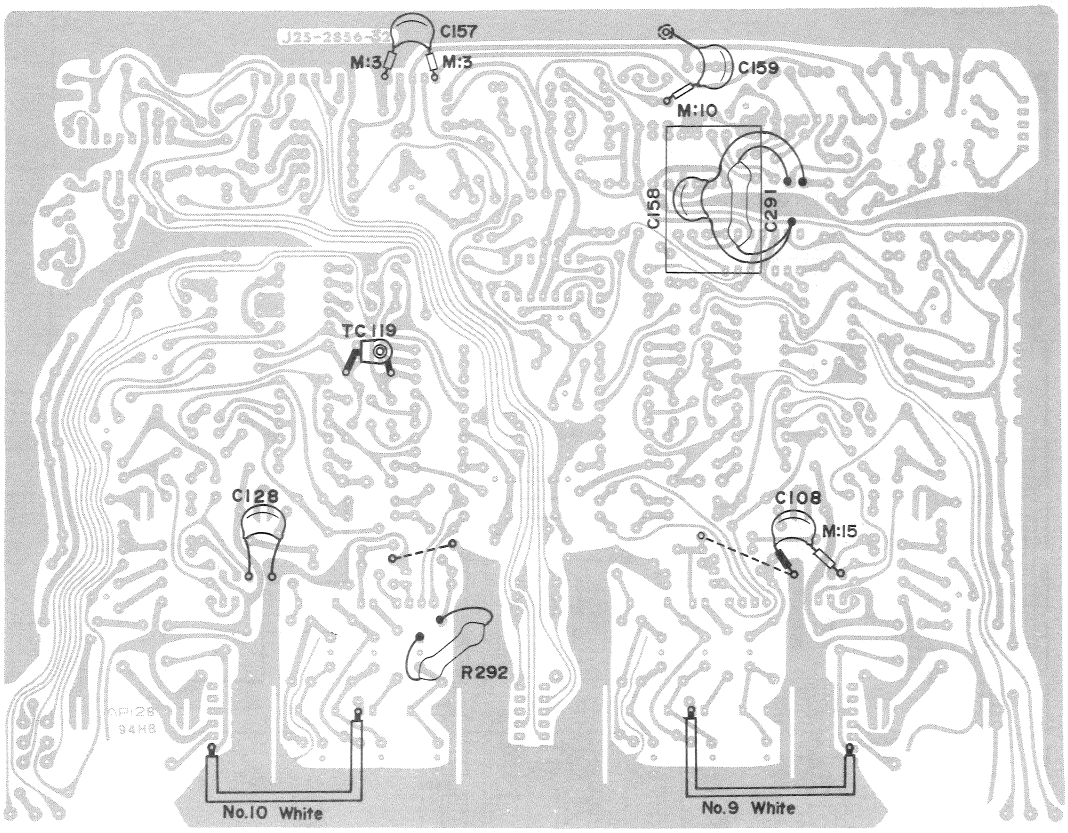
⑬



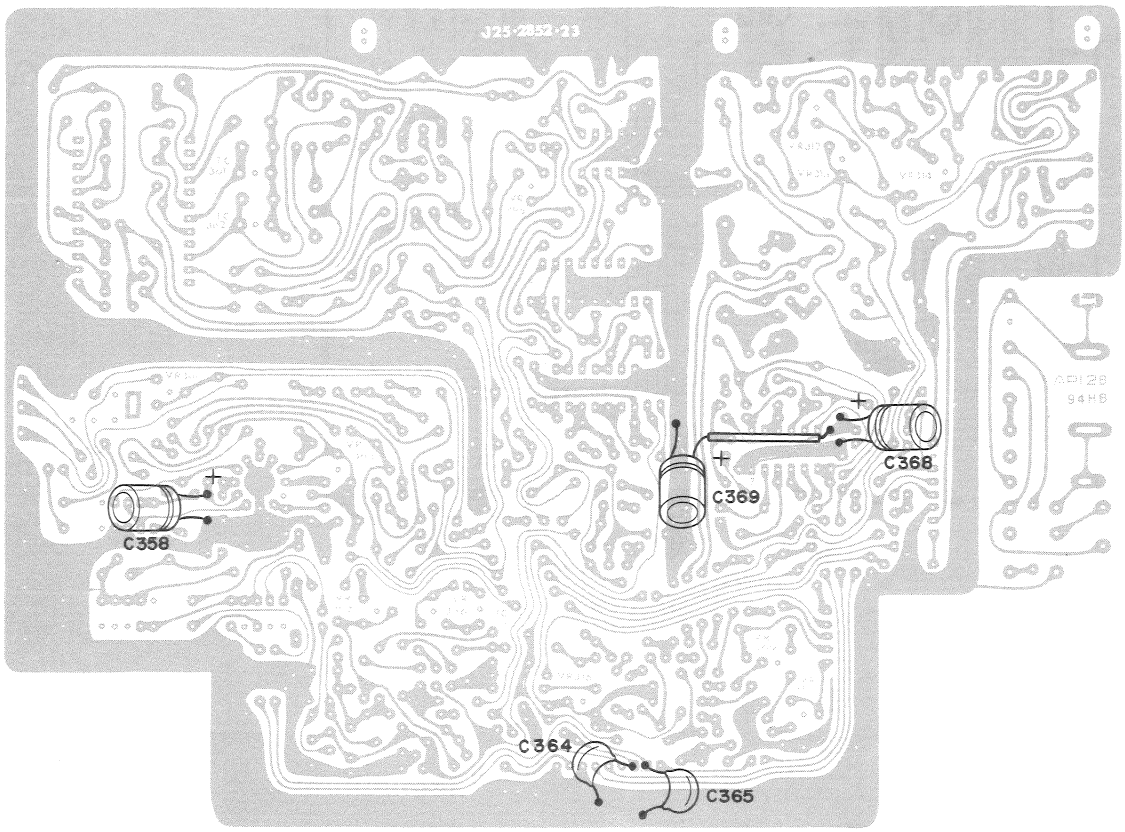
P.C. BOARD

(on foil side view)

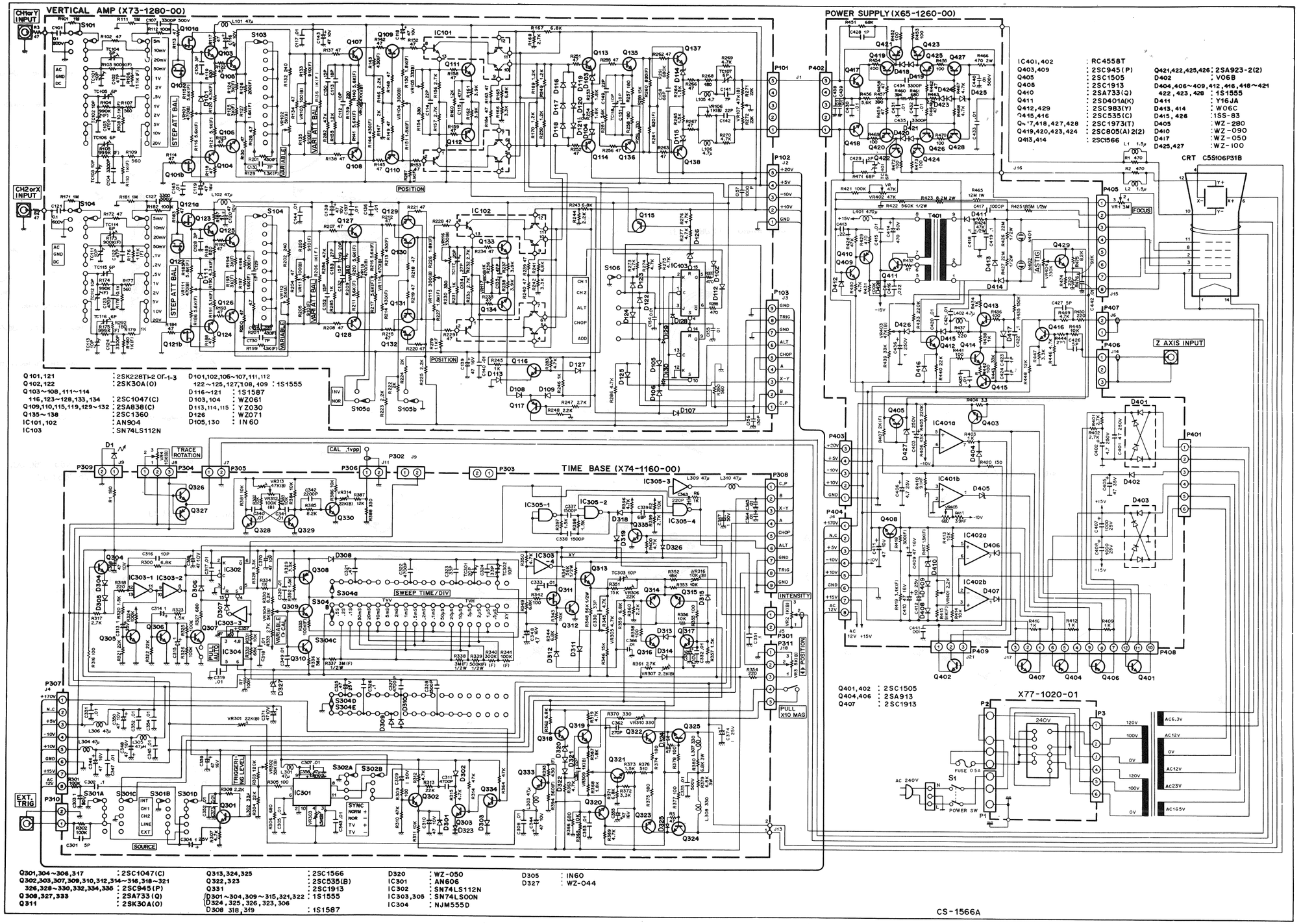
X73-1280-00



X74-1160-00



SCHEMATIC DIAGRAM



IC401,402	: RC4558T			Q421,422,425,426	: 2SA923-2(2)
Q403,409	: 2SC945(P)			D402	: V06B
Q405	: 2SC1505			D404,406~409,412,416,418~421	
Q406	: 2SC1913			422,423,428	: 1S1555
Q410	: 2SA733(Q)			D411	: Y16JA
Q411	: 2SD401A(K)			D413,414	: W06C
Q412,429	: 2SC983(Y)			D415,426	: 1SS-83
Q415,416	: 2SC535(C)			D405	: WZ-280
Q417,418,427,428	: 2SC1973(T)			D410	: WZ-090
Q419,420,423,424	: 2SC805(A)2(2)			D417	: WZ-050
Q413,414	: 2SC1566			D425,427	: WZ-100

Q101,121	: 2SK228TI-2 OT-1-3	D101,102,106~107,111,112 122~125,127,108,109	: 1S1555
Q102,122	: 2SK30A(O)	D116~121	: 1S1587
Q103~108,111~114 116,123~128,133,134	: 2SC1047(C)	D103,104	: WZ061
Q109,110,115,119,129~132	: 2SA838(C)	D113,114,115	: YZ030
Q135~138	: 2SC1360	D126	: WZ071
IC101,102	: AN604	D105,130	: IN60
IC103	: SN74LS112N		

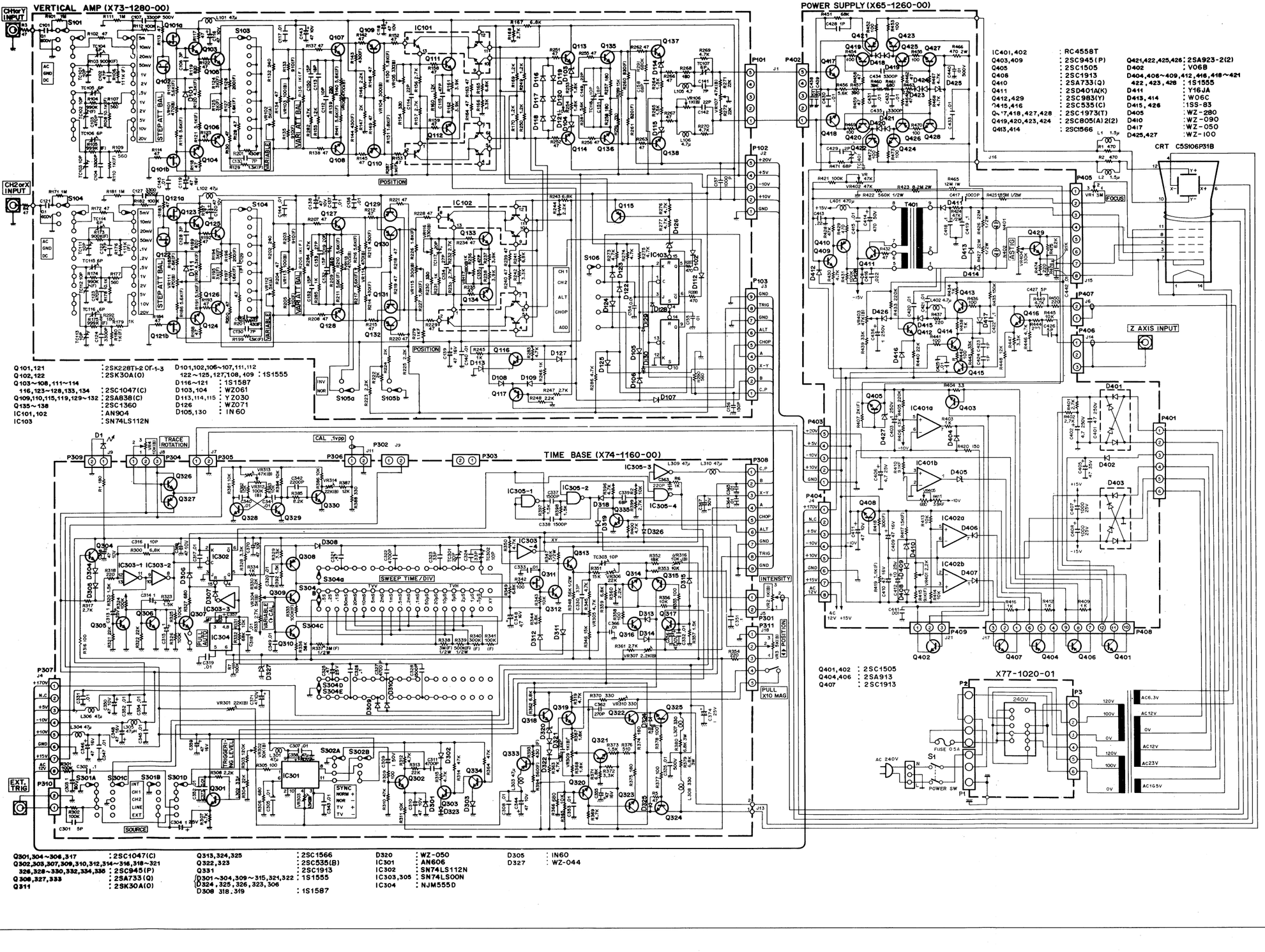
Q301,304~306,317	: 2SC1047(C)	Q313,324,325	: 2SC1566	D320	: WZ-050	D305	: IN60
Q302,303,307,309,310,312,314~316,318~321		Q322,323	: 2SC535(B)	IC301	: AN606	D327	: WZ-044
326,328~330,332,334,336	: 2SC945(P)	Q331	: 2SC1913	IC302	: SN74LS112N		
Q308,327,333	: 2SA733(Q)	D301~304,309~315,321,322	: 1S1555	IC303,305	: SN74LS00N		
Q311	: 2SK30A(O)	D324,325,326,323,306		IC304	: NJM555D		
		D308 318,319	: 1S1587				

Q401,402	: 2SC1505		
Q404,406	: 2SA913		
Q407	: 2SC1913		

KENWOOD

OSCILLOSCOPE

CS-1566D CS-1566A



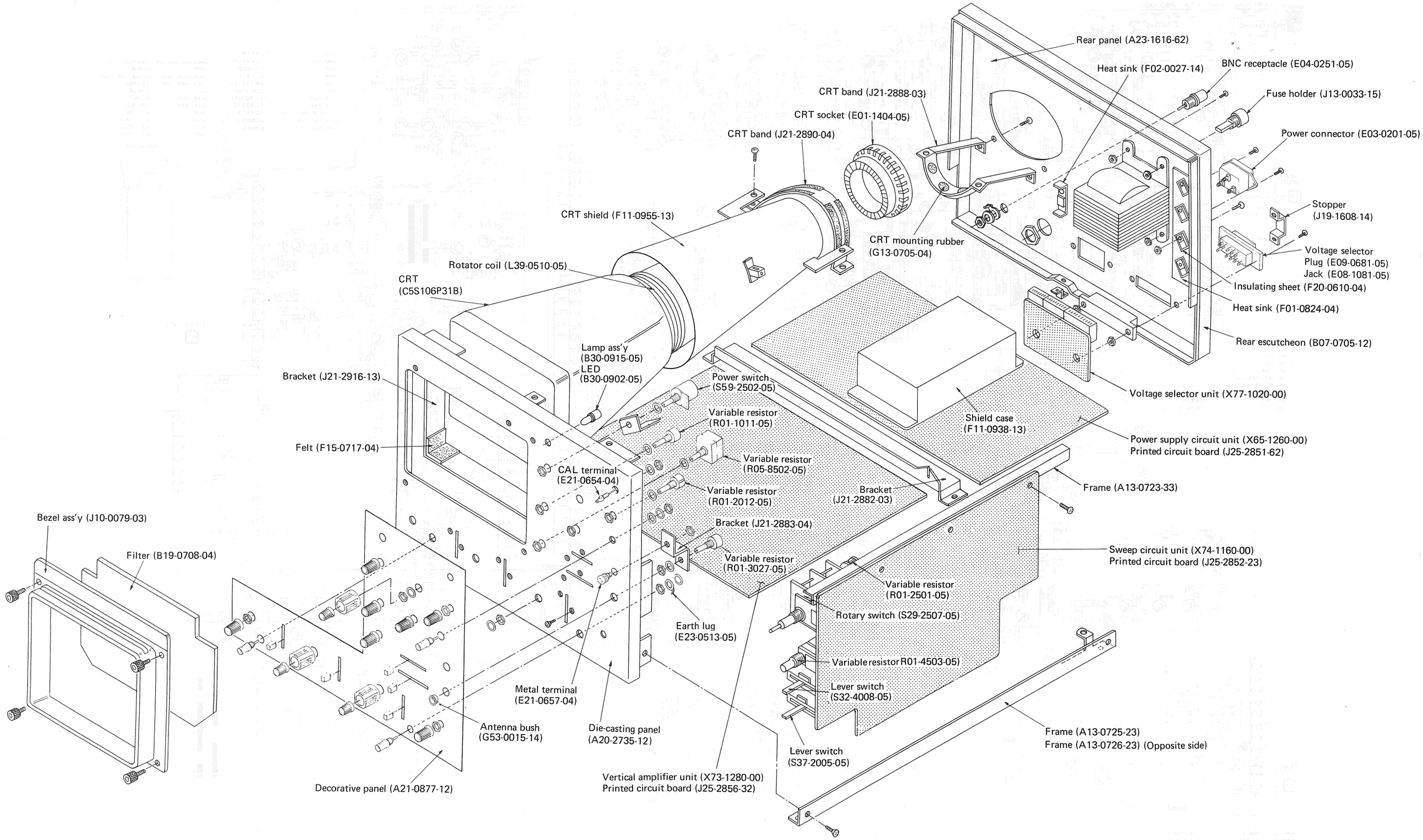
IC401,402	: RC4558T
Q403,409	: 2SC945(P)
Q405	: 2SC1505
Q406	: 2SC1913
Q410	: 2SA733(Q)
Q411	: 2SD401A(K)
Q412,429	: 2SC983(Y)
Q415,416	: 2SC535(C)
Q417,418,427,428	: 2SC1973(T)
Q419,420,423,424	: 2SC805(A)2(2)
Q413,414	: 2SC1566
Q421,422,425,426	: 2SA923-2(2)
D402	: V06B
D404,406~409,412,416,418~421	
422,423,428	: 1S1555
D411	: Y16JA
D413,414	: W06C
D415,426	: 1SS-83
D405	: WZ-280
D410	: WZ-090
D417	: WZ-050
D425,427	: WZ-100

Q101,121	: 2SK228TI-2 OR-1-3
Q102,122	: 2SK30A(O)
Q103~108,111~114	
116,123~126,133,134	: 2SC1047(C)
Q109,110,115,119,129~132	: 2SA838(C)
Q135~138	: 2SC1360
IC101,102	: AN904
IC103	: SN74LS112N
D101,102,106~107,111,112 122~125,127,108,109	: 1S1555
D116~121	: 1S1587
D103,104	: WZ061
D113,114,115	: YZ030
D126	: WZ071
D105,130	: IN60

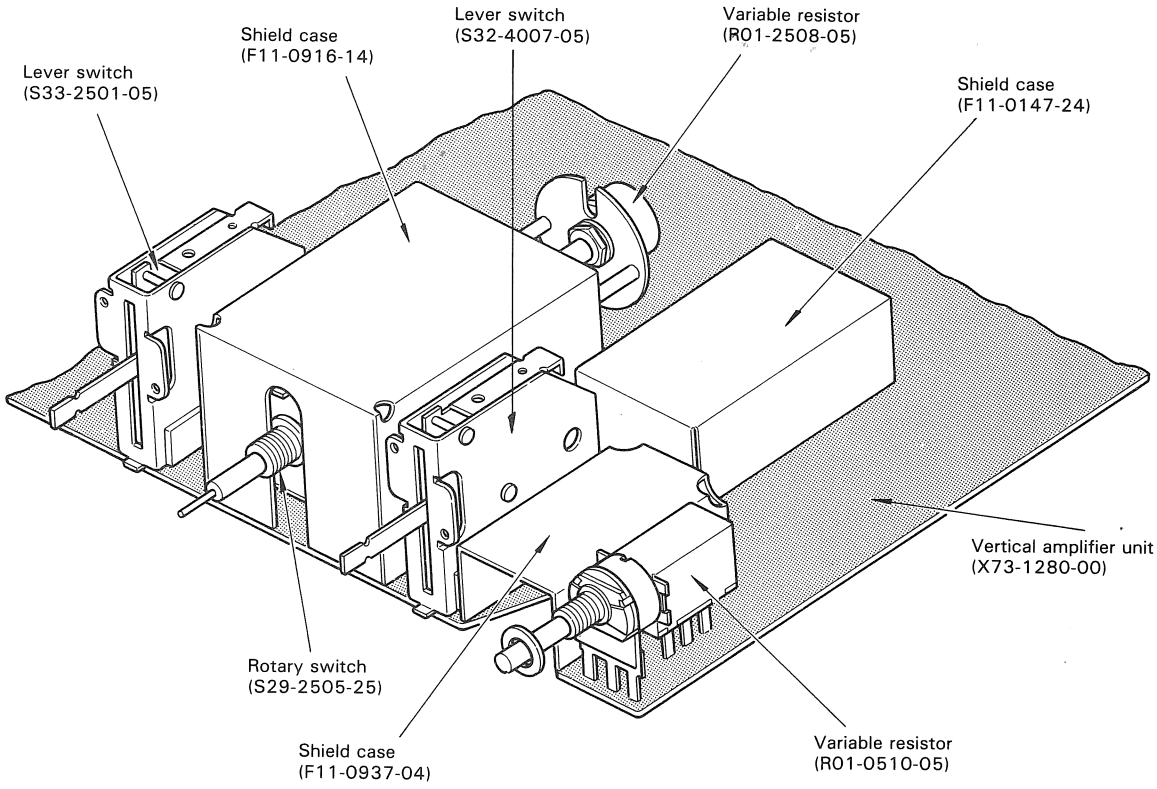
Q401,402	: 2SC1505
Q404,406	: 2SA913
Q407	: 2SC1913

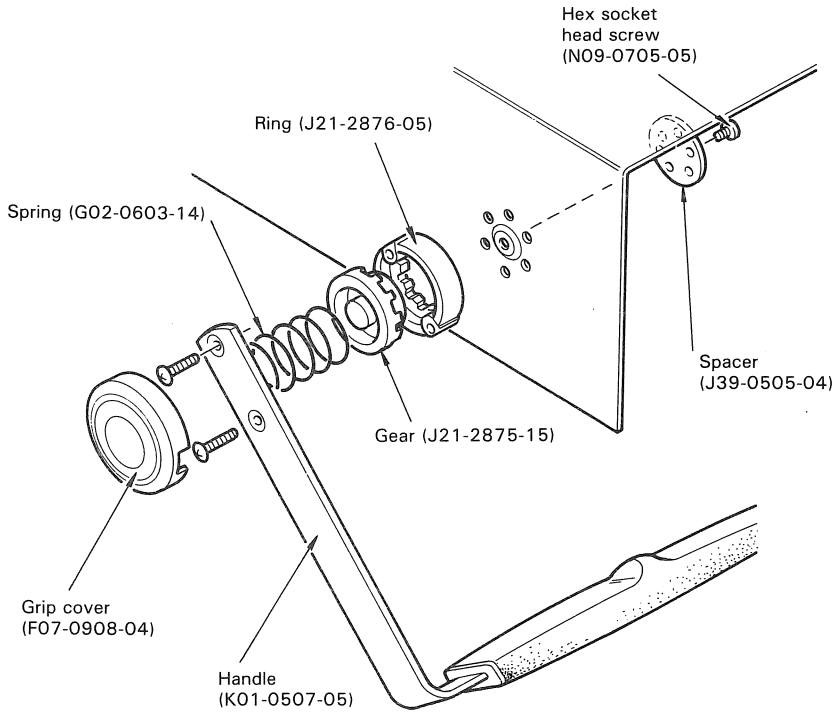
Q301,304~306,317	: 2SC1047(C)
Q302,303,307,309,310,312,314~316,318~321 326,328~330,332,334,335	: 2SC945(P)
Q308,327,333	: 2SA733(Q)
Q311	: 2SK30A(O)
Q313,324,325	: 2SC1566
Q322,323	: 2SC535(B)
Q331	: 2SC1913
D301~304,309~315,321,322	: 1S1555
D324,325,326,323,306	
D308 318.319	: 1S1587
D320	: WZ-050
IC301	: AN606
IC302	: SN74LS112N
IC303,305	: SN74LS00N
IC304	: NJM555D
D305	: IN60
D327	: WZ-044

DISASSEMBLY



DISASSEMBLY





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