AARON

INSTRUCTION MANUAL

15MHz Dual Trace Oscilloscope

MODEL BS-310S

MOD STATE 'O'

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SECTION 1

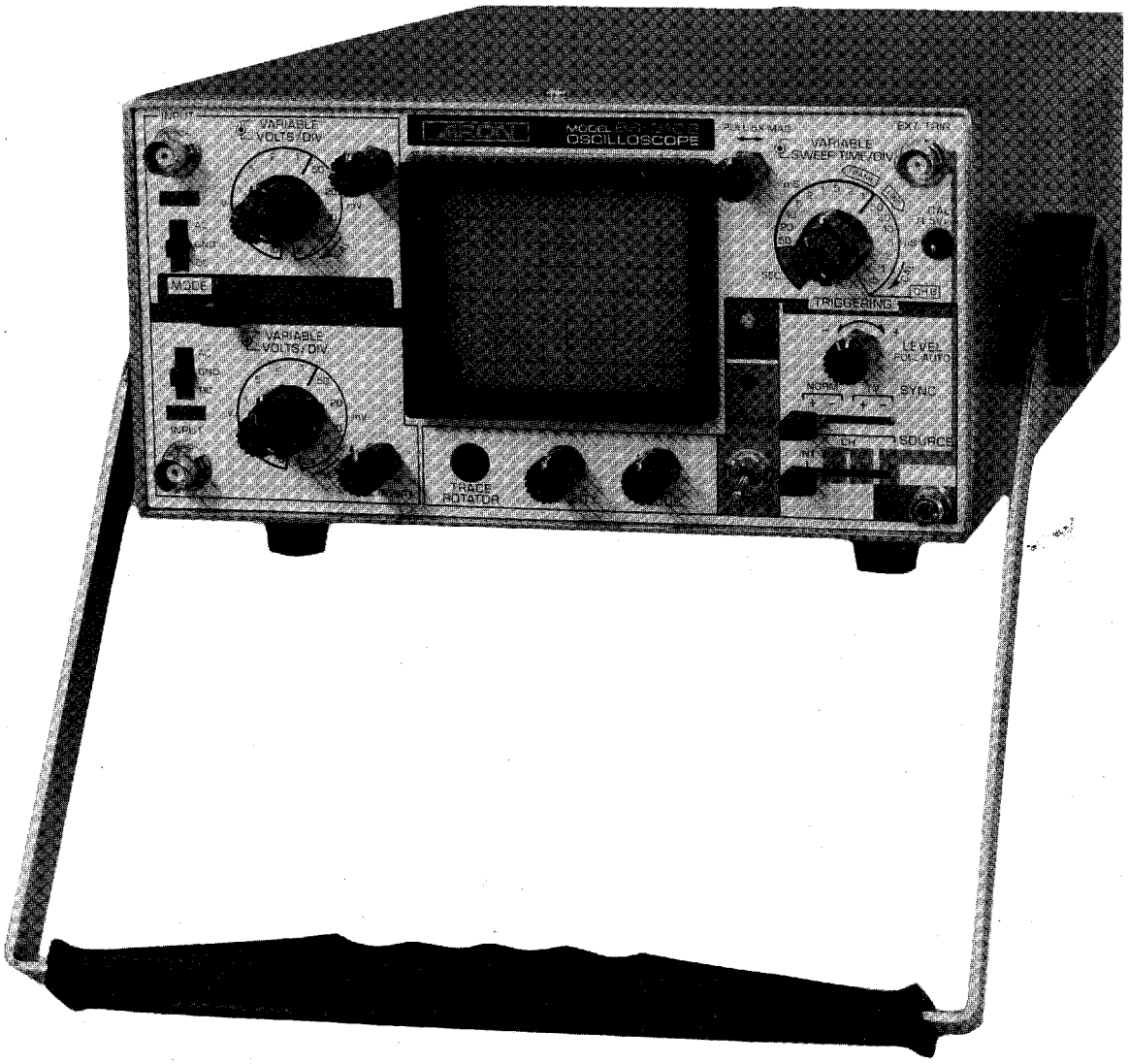
INTRODUCTION

The Model BS-310S is a dual trace, battery-operated, 15MHz Portable Oscilloscope of rectangular CRT with internal graticule.

Weight only 4.5kgs. and 113(H) x 223(W) x 298(D) mm in size, it is an ideal oscilloscope for the field service.

This BS-310S offers 2m V/DIV sensitivity, automatic selection of chopped or alternate mode, plus automatic selection of TV line or frame display. It further provides the choice of DC, Battery or AC line operation. Internal rechargeable batteries which provide 2 hours continuous operation.

The portability and performance compatibility realized by the BS-310S make it most attractive for use in "ON-SITE" maintenance applications; for example Telecommunication equipment, Computers, Marine and Airborne system, Industrial control equipment, Test equipment on cars, trains, etc.



VERTICAL DEFLECTION

Deflection Factor	2mV to 10V / DIV on 12 ranges in 1-2-5 step with fine control.
Bandwidth	DC: DC to 15MHz(-3dB)
	AC: 10Hz to 15MHz(-3dB)
Risetime	24nsec
Overshot	Less than 3%
Input Impedance	1MΩ shunted dy 20pE±3pF
Operating Modes	CH-A, CH-B, DUAL, ADD and CHOP
Chop Frequency	200KHz approx.
Channel Separation	Better than 60dB at 1kHz.
CH-B Polality	CH-B can be inverted

TIME BASE

Type	Automatic and triggered. In automatic mode, sweep is obtained without input signal.
Sweep Time	0.5μ sec to 0.5sec / DIV on 19 ranges in 1-2-5 step with fine control and X-Y.
Magnifier	x5 at all ranges
Linearity	Less than 3%

TRIGGERING

Sensitivity	INT: 1 DIV or more
	EXT: 1 Vp-p
Source	INT, CH-A, CH-B, or EXT
Slope	Positive and Negative, continuously variable level: Pull for AUTO
Range	20Hz to 15MHz
TV Sync	Vertical and Horizontal Sync separator circuitry allows any portion of complex TV video waveform to be synchronized and expanded for viewing.
	TV-H(Line)andTV-V (Frame)sync are switched automatically by SWEEP TIME / DIV switch.
	TV-V: 0.5sec / DIV to 0.1msec / DIV.
	TV-H: 50μ sec / DIV to 0.5μ sec / DIV.

HORIZONTAL DEFLECTION

Deflection Factor	2mVto 10V / DIV on 12 ranges in 1-2-5 step with fine control.
Frequency Response	DC to 1MHz
Input Impedance	1MΩ shunted by 20pF±3pF
Max Input Voltage	300V DC+AC peak or 600Vp-p
X-Y Operation	X-Y mode is selected by SWEEP TIME / DIV switch
	CH-A: Y axis
	CH-B: X axis

OTHER SPECIFICATIONS

CRT	95mm tube(approx. 1.5KV)
Calibration Voltage	0.5Vp-p±5%, 1KHz Squre Wave.
Power Requirements	AC: 90~130V or 180~260V; 48~440Hz
	DC: 11~30V; 7.2VA
	Battery: Ni-Cad Battery(up to 2 hour operation)
	Charging Time: 6hours (Scope not operated)
	16hours (While Scope operated)
Weight	4.5kgs(5.5kgs including battery)
	113(H)×223(W)×298(D)mm

SECTION 3 OPERATION

3-1 INITIAL OPERATION

Inspect the carton for serious damage which might have caused the failure of the instrument during transportation. And inspect the instrument itself. If damage is noted, notify the agent you bought from before making any operation.

INITIAL AC OPERATION

1. Prior to any kind of operation of the instrument, proceed as follows to get familiarized with the instrument.
   a) Set the POWER switch to OFF.
   b) Turn all the three POSITION controls to mid-position.
   c) Turn INTENSITY control to mid-position.
   d) Push the PULL 5X MAG control for normal.
   e) Pull TRIGGERING LEVEL control for AUTO.
   f) The rest of the controls remain at any position.
   g) Check the line voltage.
2. Connect the AC line cable into the AC receptacle on the rear panel of the instrument, and plug into an AC power outlet. Then the LED BATTERY CHARGE indicator is lit up in red, which means that the set is charging the internal Ni-Cd battery. (Power source; AC (or EXT DC) position)
3. Turn POWER to ON. After approximately 20 seconds, trace lines appear on CRT screen. If no trace lines appear, rotate INTENSITY clockwise till trace lines are easily observed.
4. Adjust FOCUS and INTENSITY controls for clear trace lines.
5. Readjust Vertical and Horizontal POSITION controls for locations required.
6. Connect a probe (10:1) to INPUT of CH-A and hook the tip of the probe to CAL 0.5Vp-p output.
7. Rotate CH-A Vertical attenuator VOLTS/DIV switch to 10mV/DIV and turn the VARIABLE on the same axis clockwise to detent. Turn TRIGGERING SOURCE to CH-A. Then a square-wave of 5 divisions is displayed on the screen.
8. Readjust INTENSITY, FOCUS for clearer display.
9. Remove probe tip from CAL 0.5Vp-p output. Now, the oscilloscope is ready for observation of waveforms.

3-2 INTERNAL BATTERY OPERATION

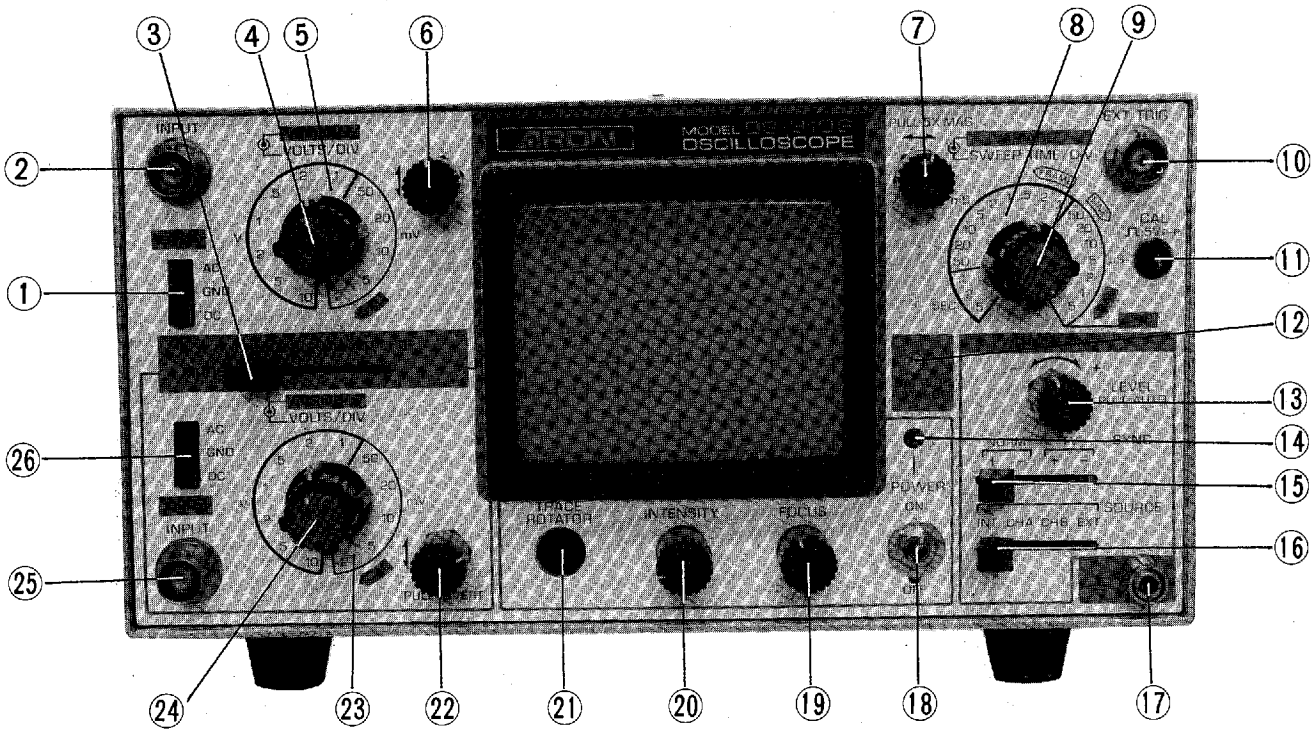
1. It is required to charge up internal battery to full before operation. It takes only 6 hours to recharge while the instrument is not in use. Whereas, while the instrument is in use, the recharging takes 16 hours to reach the full level of the battery.
2. RECHARGING
   Connect the AC power cable to AC outlet and to AC receptacle of the oscilloscope. Then recharging automatically begins whether POWER switch is ON or OFF. When it is turned to OFF, recharging requires only 6 hours, and when ON, it takes 16 hours for full recovery. Whenever the battery is charged, BATTERY CHARGE indicator changes its color from red to green. Then automatically trickle charging starts to maintain the full charged level.(Power source; AC (or EXT DC)position)
3. OPERATION
   Turn POWER SOURCE slide switch found on rear panel to BATTERY (INT), and operate the same way as AC operation.

3-3 EXTERNAL DC OPERATION

Make sure the EXT DC INPUT receptacle is correctly wired to its polarities (+ & –). The DC external source could be any type of 11V up to 30V, withstanding the current drain of 7.2VA. The wide voltage variation range means the fluctuations in-between would not ill-effect the operation of the instrument. The EXT DC source will not charge the internal battery.

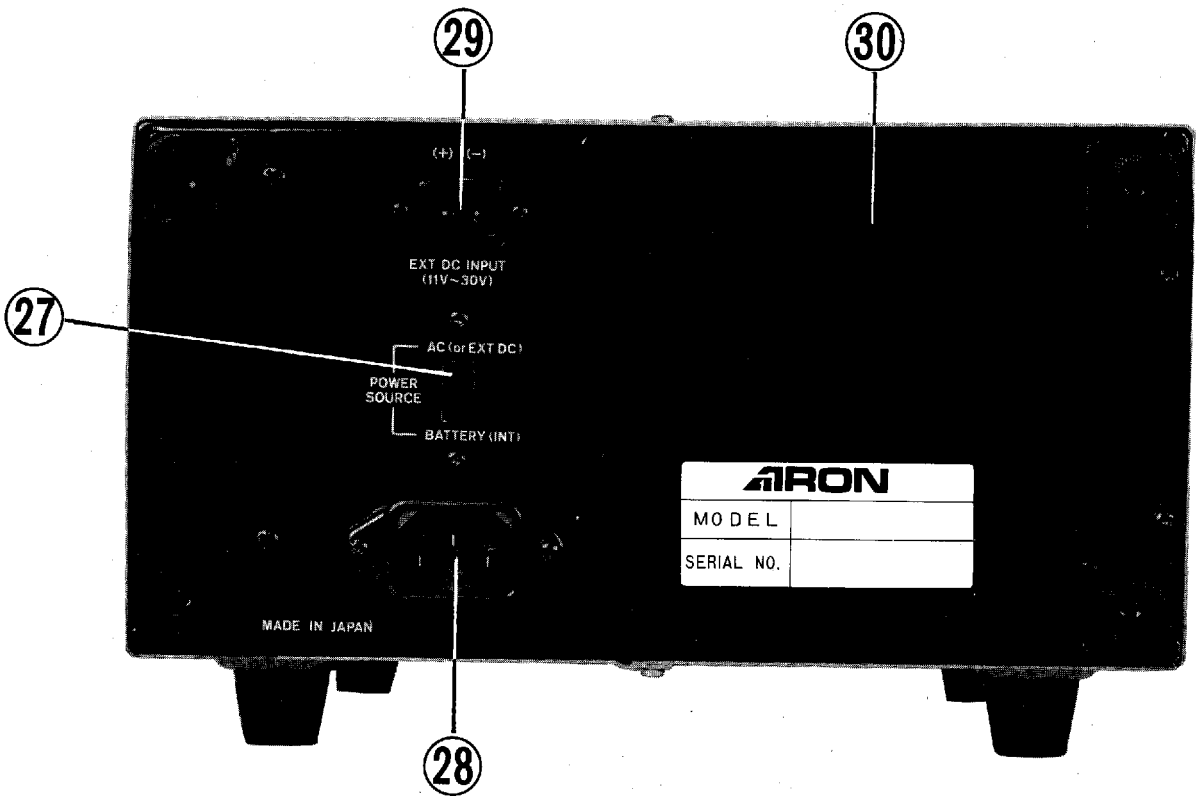
3-4 CONTROLS & INDICATIONS

1. VERTICAL INPUT
   Vertical input terminal for CH-A.
2. AC-GND- DC
   Vertical input coupling for CH-A. In AC position, the DC componet of input signal is blocked by capacitor. In GND position, the input terminal opens and the input of internal amplifier is grounded. In DC position, the input terminal is directly connected to the amplifier and all components of input signal are displayed.
3. MODE
   CH-A: Waveforms of CH-A are displayed.
   CH-B: Waveforms of CH-B are displayed.
   DUAL: In the range from 0.5sec / DIV up to 1msec / DIV, both channels are chopped at about 100KHz.
   In the range from 0.5msec / DIV up to 0.5 μ sec / DIV, both channels are switched alternately.
   ADD : CH-A and CH-B signals are added.
   CHOP: This is chop only mode all through the sweep ranges.
4. VOLTS / DIV VARIABLE
5. VOLTS / DIV
   Vertical attenuator for CH-A. The scale is graduated in voltage per "DIV" of CRT screen area.
   Calibrated voltage is indicated when VARIABLE is turned fully clockwise. Set this cnotrol for proper waveform according to the input voltage used. Selectable in 12 calibrated ranges from 2mV / DIV to 10V / DIV.
6. VERTICAL POSITION
   Vertical position adjuster for CH-A.
7. HORIZONTAL POSITION
   Horizontal position adjuster.
8. SWEEP TIME / DIV
   Horizontal sweep time selector. It selects sweep times of 0.5 μ sec / DIV to 0.5sec / DIV in 19 calibrated steps. X-Y operation is possible by turning the knob fully clockwise to CH-B.
   Change over between CHOP and ALTERNATE is also accomplished automatically by this selector in DUAL MODE.
9. SWEEP TIME / DIV VARIABLE
10. EXT. TRIG
    Input for external triggering signal.
11. CAL
    Calibration voltage terminal. Calibration voltage is 0.5Vp-p of about 1KHz square wave.
12. BATTERY CHARGE
    Indicates the charging and charged.
    When battery is chaged enough for use this lamp changes from red to green.
13. TRIGGERING LEVEL
    LEVEL control adjusts sync phase to determine the starting point of sweep on the slope of displayed waveform.
    PULL AUTO
    By pulling LEVEL knob toward you, auto-sweep is effected; the sweep is set in free-running state even when no input signal is applied, with trace line displayed on CRT.
    With trigger signal, triggered-sweep is effected where sync level is adjustable. When sync level is deviated, the sweep is set in free-running state.



FRONT VIEW

14. POWER ON LAMP
15. SYNC
    Sync polarity selector. At the "+" position of the switch, sweep is started with positive slope; at the "—" position, the sweep is started with negative slope.
16. SOURCE
    Sync source signal selector switch;
    INT : Mixed signal of CH-A and CH-B becomes sync source.
    CH-A : CH-A vertical input signal is used as sync signal.
    CH-B : CH-B vertical input signal is used as sync signal.
    EXT : The signal applied to EXT TRIG is used as sync signal.
17. GROUNDED TERMINAL
18. POWER SWITCH
    Turns power on or off. AC power line connected, normal charging while this switch is on and quick charging when turned off.
19. FOCUS
    Focus control to obtain optimum waveform display.
20. INTENSITY
    Adjust the brightness of waveform for easy viewing.
21. TRACE ROTATOR
    The earth magnetics effect the trace line. Rotate this with a screw driver for proper trace line.
22. PULL INVERT
    When pulled, CH-B is inverted, and this accomodates ADD to SUB mode.



REAR VIEW

23. VOLTS / DIV
    Same as 5. for CH-B
24. VOLTS / DIV VARIABLE
    Same as 4. for CH-B
25. VERTICAL INPUT
    Same as 1. for CH-B
26. AC-GND-DC
    Same as 2. for CH-B
27. POWER SOURCE
    AC(or EXT DC): AC operation and DC operation from 11V to 30V DC.
    BATTERY(INT): Internal battery operation.
28. AC POWER LINE RECEPTACLE
    90V-130V AC or 180V-260V AC, 40Hz to 440Hz
29. EXT DC
    With use of EXT DC INPUT receptacle, connect 11V to 30V DC source for operation. When the External DC plug is inserted, Priority is given to EXT DC source even other sources are connected. Power consumption is maintained the same level.
30. BATTERY COMPARTMENT
    Remove the right-side two legs on rear panel and take off the four screws for opening BATT COMPARTMENT. Pull off the connector of battery before taking out battery. Installation of battery should be done vice versa.

3-5 INTERNAL SWEEP AND TRIGGERING

1. TRIGGERING LEVEL knob selects either AUTO for automatic recurrent sweep or normal triggering sweep operation. PULL AUTO provides automatic recurrent sweep in the absence of input signal for triggering.
2. In the presence of input signal for triggering, no difference is found between AUTO and normal modes. The point on the trace at which sweep triggering occurs is selected by adjusting TRIGGERING LEVEL control. The main purpose of TRIGGERING LEVEL control is to obtain a stable waveform display.
3. Set SYNC switch to NORM(+) position if the sweep is to be triggered at a point on the positive going portion of the display waveform or to the (−) position if the sweep is to be triggered at a point on the negative going portion of the waveform.
4. Most waveforms can be observed by using INT, CH-A, CH-B as internal TRIGGERING SOURCE. When an external triggering source is required, turn to EXT and apply the triggering signal to EXT TRIG input.
5. For normal operation the magnifing switch, 5X MAG is pushed-in to operate without magnification. If magnification of a waveform is desired, pull 5X MAG switch out. That will expand the sweep and waveform to be observed horizontally by a factor of 5.
6. Set sweep TIME/DIV switch and VARIABLE control for the desired number of wave cycles to be displayed.

NOTE USING THE 5X MAG POSITION, THE TRACE LINE BECOMES DIMMER BECAUSE OF INCREASED SWEEP WHICH CAUSES LESS ELECTRON TO EMIT LIGHT FROM THE PHOSPHOR LAYER ON THE CRT FACE.

3-6 X-Y OPERATION

For some special cases, this instrument is specially designed for easy X-Y application. Simply turn SWEEP TIME/DIV switch to CH-B. Then all CH-B functions work as horizontal amplifier, whereas CH-A remains as vertical amplifier.

3-7 CALIBRATED VOLTAGE MEASUREMENTS

Peak voltages, peak-to-peak voltages, DC voltages and voltages of a specific portion of a complex waveform can be measured using this instrument as a voltmeter. Voltages can be measured whenever waveforms are observed using either CH-A or CH-B inputs. Proceed as follows;

1. Set VARIABLE control fully clockwise to CAL position, then set VOLTS/DIV control to display the waveform in proper size to be observed. Vertical POSITION controls may be turned to obtain division reference.
2. For DC or complex signals, set the input switch to GND, and adjust the vertical POSITION control to a convenient reference level. Set the switch to DC and observe the amount of deflection. A positive voltage will deflect trace upwards; a negative voltage will deflect the trace downward. To calculate the voltage reading, multiply the vertical deflection (by division) by the setting of the VOLTS/DIV switch.

NOTE WHEN A PROBE (10:1) IS USED, THE WAVEFORM DISPLAY IS ONLY 1/10 OF THE ACTUAL VOLTAGE MEASURED.

3-8 DUAL TRACE WAVEFORM OBSERVATION

MODE switch to be turned to DUAL. Other procedures are in the same manners as mentioned above.

3-9 TV SIGNAL SYNCHRONIZATION

Set TRIGGERING SYNC to TV (+ or −), then specially designed circuitry provides easy triggering for complexed TV frame and line signal. TV frame and line waveform are easily obtained by simply tuning SWEEP TIME/DIV control.

3-10 ADD & SUB MEASUREMENTS

Sinply turn MODE switch to ADD, added waveform of CH-A and CH-B is displayed.
With this MODE at ADD position, subtracted waveform is obtained by pulling PULL INVERT knob which inverts the polarity of CH-B.

3-11 BATTERY CHARGING

The Charging circuit in the power supply section operates from either 90V to 130V or 180V to 260V normal AC power. The internal charging circuit works in two ways.

1. When the instrument is switched on, the normal charge circuit charges the battery with 1/10C. The front panel BATTERY CHARGE indicator changes from red to green when the battery is fully charged, and normal charging is automatically changed to trickle to maintain the full charged level. Recharge requires 16 hours.
2. If the instrument is switched off, the internal quick charge charges the battery with approx. 1/4C and full recharge in this case takes 6 hours.
3. Whenever the internal battery is charged up to full, charging changes to trickle from either quick or normal charge.

NOTE THE EXTERNAL DC SOURCE WILL NOT CHARGE THE INTERNAL BATTERY.

3-12 APPLICATIONS

This is a dual trace oscilloscope which has full capability of single trace mode. Thanks to the dual-trace functions, various effective measurements are feasible.

〔SINGLE-TRACE APPLICATIONS〕

Either Channel A or Channel B can be used for single-trace operation. Channel A is referred to hereunder for simplicity.

Set controls:

AC-GND-DC	AC
MODE	CH-A
SYNC	NORM+
SOURCE	INT or CH-A
PROBE	to CH-A INPUT Jack (1 : 1)

Connect the tip of the probe to the point in the circuit where the wave form is to be measured, and its ground clip to the chassis or the ground part.

CAUTION!!! THE PEAK-TO-PEAK VOLTAGE AT THE POINT OF MEASUREMENT SHOULD NOT EXCEED 600 VOLTS.

3-12-(1) AC VOLTAGE AND FREQUENCY MEASUREMENT

When measuring voltage and frequency, set VOLTS / DIV VARIABLEs ④, ㉔ and SWEEP TIME / DIV VARIABLE ⑨ at their calibrated detent points (clockwise).

(EX) The signal displayed on the CRT is : Fig. 1

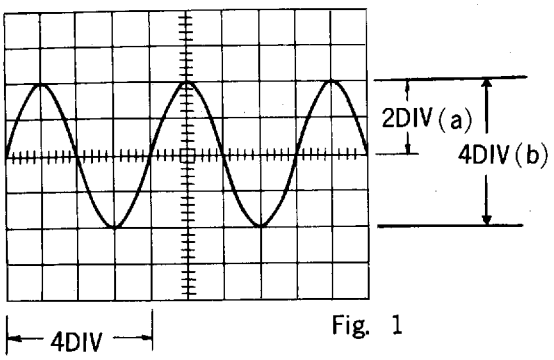


Fig. 1

VOLT / DIV ····· at 2V
SWEEP TIME / DIV ····· at 5 msec.

(a) Peak voltage . . . . 2 V / DIV × 2 DIV = 4 volts
(b) p-p voltage . . . . 2 V / DIV × 4 DIV = 8 volts
(c) Effective voltage . . . Peak voltage ÷ 2 = 4 (V) × 2
= 2.828 volts
(d) Frequency (Hz) . . . . . 1 / Time (second)
** Time = Number of DIVs for 1 cycle × value of SWEEP TIME / DIV

Therefore, the Fig 1 is :

$$\text{Frequency} = \frac{1}{5\text{ m sec} \times 4\text{ (DIV)}} = \frac{1}{20\text{m sec}}$$

$$= 50\text{ Hz}$$

NOTE! ! ! The input of this oscilloscope is 1MΩ shunted by 20pF capacitance. When the probe is used in 10:1 attenuation, the impedance becomes 10MΩ shunted by 15pF. Then the voltage reading must be multiplied by 10.

3-12-(2) DC VOLTAGE MEASUREMENT

AC-GND-DC being at AC position, only AC or AC component was displayed on the CRT screen. For DC Measurement, set the switch to GND and pull the TRIGGERING LEVEL knob ⑬ for a trace line, which must be positioned at a certain place as O volt reference.

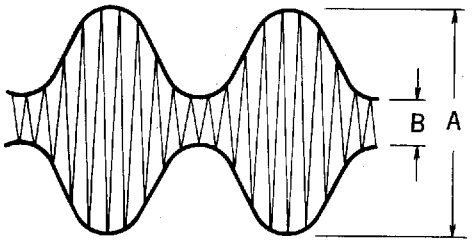
After that, turn the switch to DC. Then the trace line shifts up or down. The value of movement is the DC voltage.

DC voltage = Shift (DIV) × VOLTS / DIV

When the trace line shifts up-ward, the polarity is (+), and down-ward is (−).

3-12-(3) AM MODULATION MEASUREMENT

There are various ways of measurements, but herein this manual the envelope method is introduced. This method is applicable when the carrier frequency is within the frequency bandwidth of the oscilloscope. See Fig. 2



$$\text{Mod. } (\%) = \frac{A-B}{A+B} \times 100$$

Fig. 2

3-12-(4) DUAL-TRACE APPLICATIONS

MODE switch being turned to DUAL, both Channel A and Channel B works simultaneously. Then, comparison of two relative signals are easily compared such as level, waveforms, phase, etc.

3-12-(5) LEVEL COMPARISON

(EX) OUTPUT / INPUT of an amplifier

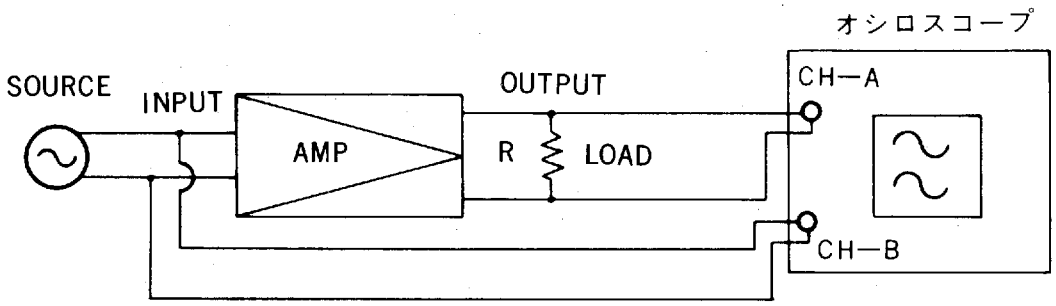


Fig. 3

With the connections of the Fig. 3, Set the displays of CH-A and CH-B the same (POSITION controls could be adjusted to place CH-B waveform onto CH-B). Then the difference between redings of CH-A VOLTS / DIV and CH-B's is the gain of the amplifier.

If the two signals do not match each other even variable controls are adjusted, the difference is the distortion caused in the amplifier. Then, simply turn the MODE switch to ADD and pull the CH-B position knod for invert (SUB MODE), for viewing only distortion. When there is no distortion originated in the amplifier, a straight trace line is displayed in SUB MODE.

3-12-(6) REPAIRING STEREO SYSTEMS

Every stereo equipment has two symmetrical amplifier circuits.

So, simultaneous comparison of the same stages makes it so easy to locate defective point.

3-12-(7) TV SERVICING

Triggered oscilloscope is indispensable. This model has the very convenient TV SYNC circuits of TV-V(Frame) and TV-H (line) for accurate synchronization to view VIDEO SIGNAL, BLANKING PEDESTALS, VITS and Vertical / Horizontal SYNC PULSES.

3-12-(8) COMPOSITE VIDEO ANALYSIS

The most important waveform in TV servicing is the composite signal consisting of the video signal, the blanking pedestals, and sync pulses. Fig. 4 and Fig. 5 shows composite signals synchronized with horizontal sync pulses and vertical blanking pulses.

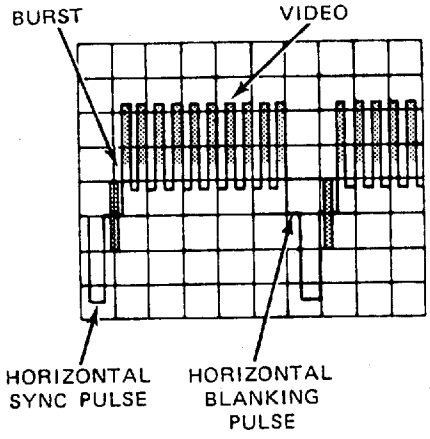
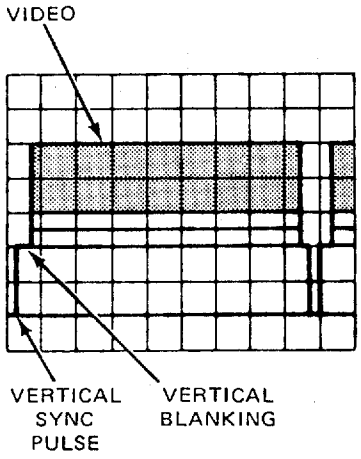


Fig. 4

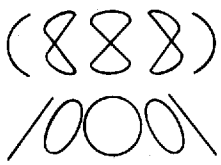
Fig. 5



3-12-(9) MEASUREMENT OF FREQUENCY BY X-Y

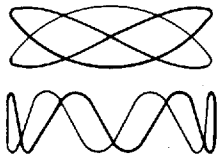
Simply turn SWEEP TIME / DIV switch to CH-B for X-Y operation. Then CH-A becomes Y axis and CH-B X axis. Connect a standard frequency signal to CH-B and unknown signal to CH-A. Lissajous' figure is displayed on the screen as shown in Fig. 6.

Standard signal frequency : Unknown signal frequency



$\frac{1}{2}$: 1

1 : 1

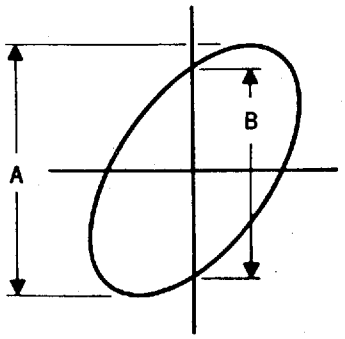


$1\frac{1}{2}$: 1

6 : 1

3-12-(10) PHASE MEASUREMENT

In X-Y function, apply twosignals to each CH-A and CH-B. Calculate according to the formula.



SINE $\phi = \frac{B}{A}$

ϕ = PHASE ANGLE

Fig. 6 shows the BLOCK DIAGRAM of the oscilloscope. The circuit is shown in the circuit diagram given at the SECTION 7 of this Manual.

4-1 OUTLINES OF CIRCUIT

This oscilloscope is provided with two identical input attenuators and two vertical pre-amplifiers. The input is attenuated to the required level, amplified at the pre-amplifier, and led to the switching circuit, a part of the signal being separated as trigger signal. The switching circuit consists of diode circuit and mode control logic circuit, which accomplishes the change-over between CH-A and CH-B, or DUAL as well as trigger signals.

In DUAL-TRACE operation, CHOP (at 200KHz) and ALTERNATE are automatically selected by SWEEP TIME/DIV switch. The input after proper switching is fed to the output amplifier and is finally applied to the vertical deflection plate of CRT. At the same time the trigger signal out of mode control logic circuit, or the external source, will be clock pulses that drive the saw-tooth generating circuit after being amplified at the trigger amplifier. The saw-tooth wave generated by the clock pulse is applied to the horizontal deflection plate of CRT, after being amplified.

This oscilloscope is operated by the three different power source; AC, EXT DC and Battery. In AC operation, the Battery is always being recharged whenever a line cord is connected. All voltages are supplied to the DC to DC converter connected with the Switching Regulator. Highly stable and efficient operation is made possible by the use of this Switching Regulator which controls the pulse width to supply constant output level, free from fluctuations. The converter output is supplied to each section as the power source. The high voltage for CRT is also being supplied, after being further stablized through the feedback-type constant voltage circuit.

4-2 VERTICAL AMPLIFIER CIRCUIT

The vertical input signal fed from the BNC input terminal is controlled by the AC-GND-DC switch and applied to the 1st attenuator, where 1/10 step (20dB) attenuation takes place. The out of input protection circuit Q1(Q25) is fed to the DUAL FET through high input impedance. DUAL FET is well DC balanced against temperature variation. The output is then applied to the 2nd attenuator composed of IC1(IC2). The 2nd attenuator composed of IC1(IC2). The 2nd attenuator makes the selection of 1/1,1/2.5,1/5 steps, modifying gain of IC1(IC2). After being DC balanced, through VR1, 3, 4(VR7, 9, 10), the output signal is fed to the diode switching circuit composed of D2-5, 16-19 as well as to the trigger amplifier made of Q7, 8, 31, 32.

The mode logic circuit which is controlled by the MODE switch, makes the selection of dual-trace, single-trace, CHOP and ALT possible. Dual-trace operation is obtained by the trigger select logic circuit driven by TRIG SOURCE switch, while the vertical MODE switch works prior to TRIG SOURCE switch and selects a proper trigger signal for single-trace operation.

In X-Y operation, controlled by the SWEEP TIME/DIV control, CH-B signal is supplied to the trigger amplifier and fed to the horizontal amplifier as the X signal.

The vertical signal through diode switching circuit passes the limiter circuit of Q11, 12 and D6-9 to obtain the adequate level, and then is fed to the output amplifier composed of Q15-24. The output obtained is sufficiently amplified by the feedback-type amplifier with the constant current circuit (Q19, 20, 23, 24). This amplifier is equipped with the booster (Q21, 22) for high frequency contents to obtain flat response signals. The signal is then fed to the vertical deflection plates of CRT.

4-3 HORIZONTAL/TIME BASE CIRCUIT

Time Base circuit consists of trigger section, the saw-tooth generating section and amplifier section. The output from trigger select circuit is led to sweep X-Y select circuit (Q7-10, 19). This select circuit works as the internal trigger amplifier and the saw-tooth wave amplifier in normal operation, and as the amplifier for CH-B signal in X-Y operation. The internal trigger signal is being amplified by IC2 and then fed to CMOS schmidt circuit (IC3b, c). The external trigger signal is directly fed to IC2. With TRIG SOURCE switch set to TV, IC output is connected to TV sync separator (Q1, 2) to obtain horizontal sync signal (TVH) or vertical sync signal (TVV) and to supply it to schmidt circuit. Changeover between TVH and TVV is automatically accomplished by the SWEEP TIME/DIV switch. The signal in the schmidt trigger circuit is shaped into square waves and becomes clock pulses for sweep control gate (IC5). The clock pulse is also supplied to auto sweep (Q20, IC4c, d). With no trigger input, the output of the auto sweep circuit becomes low level, and therefore sweep control gate starts automatic sweeping. With triggering input, or supply of clock pulse, the output of auto sweep circuit becomes high level and the gate F.F. is inverted by the clock pulses and the Miller integrator becomes charged. When the gate F.F. is inverted, and sets Q4 to OFF, the Miller integrator determines the sweep time by the C/R time constant selected by the SWEEP TIME/DIV switch to obtain saw-tooth waves of excellent linearity. When the output from the Miller integrator fully rises, the Hold-off F.F. is inverted and the sweep stops for the time determined by the Hold-off time constant. When the Hold-off time passes, the next clock pulse is set in standby mode and thereby the sweep returns to the original status.

The output of this Miller integrator passes through sweep X-Y select circuit and is fed to the horizontal amplifier (Q11-15). In this amplifier, by use of Q13 and MAG X5 switch, sweep time is expanded by factor of 5. With SWEEP TIME/DIV switch set to X-Y position, sweep X-Y select circuit is switched to separate the Miller integrator from the horizontal amplifier and then the vertical CH-B input is applied as horizontal input amplifier. In CHOP operation, blanking effects are given with the use of the horizontal Q output and CHOP signal generator. In ALT operation, the effects are given by Q output.

The output from multivibrator of IC1 is shaped to obtain the calibrating voltage output. The variable resistor of VR1 is used to adjust the output level of 0.5p-p.

4-4 POWER SUPPLY CIRCUIT

4-4-(1) BATTERY CHARGING CIRCUIT

Power transformer, rectifier, ripple filter and battery charger are equipped before POWER switch, and these circuits are operated whenever AC line cord is connected, whether POWER switch is turned ON or OFF. The major elements of the battery charger (Q1-8) consist of constant current regulator, normal and quick charge circuit, comparator (overcharge protection circuit) and LED indicator. When POWER switch is turned OFF, Q3 is set to OFF and constant current with 1/4C (300mA) is supplied. If POWER switch is turned ON, 10V DC is detected and Q3 is set to ON, starting 1/10C(120mA) charge. In either case, current is supplied to the red part of the two-color LED while the battery is charged. Charge reaching the fixed level, the comparator (Q7, 8) turns Q7, 4 ON, letting current flow to the green part of LED. At the same time, bias current of Q2 is decreased and trickle charge of 1/50C (24mA) starts.

4-4-(2) SWITCHING REGULATOR CIRCUIT

AC power, after rectified, is fed to the Switching Regulator. Switching signal pulse width is controled by input DC voltage, which is the feed-back from its DC output. Therefore this DC output is very well regulated and drives the next converter. When input voltage drops below the lower-operation-level of this circuit, comparator (IC3c, d, IC2a) turns switching circuit to OFF, and self-triggered multi. (IC3a, b) starts oscillating, making POWER LED lamp flicker.

4-4-(3) DC TO DC CONVERTER CIRCUIT

This converter is being driven by self-oscillation circuit (IC2c, d). The oscillated signal drives Q18, Q19 in turn, and the inconsecutive DC power source is supplied to the primary side of L5 transformer. The currents in the primary side of L5 alternate one after another, and square wave power is generated in the secondary side. Transistors (Q18, 19) are fully protected by diodes (D15~18).

4-4-(4) HIGH VOLTAGE SECTION FOR CRT & UNBLANKING CIRCUIT

An acceleration voltage of about −1.5KV DC is required for operation of CRT. This voltage is generated by DC to DC converter and stablized through the feedback-type constant voltage circuit, to protect from the change in high voltage due to increased luminance, etc. The blanking signal obtained from Sweep Time Section is amplified in the Cascade Amplifier (Q23-25, 35) keeping the fast rising characteristic, supplied to the DC regenerative circuit (D23-25, 35) and finally fed to the grid of CRT.

4-4-(5) BLOCK DIAGRAM

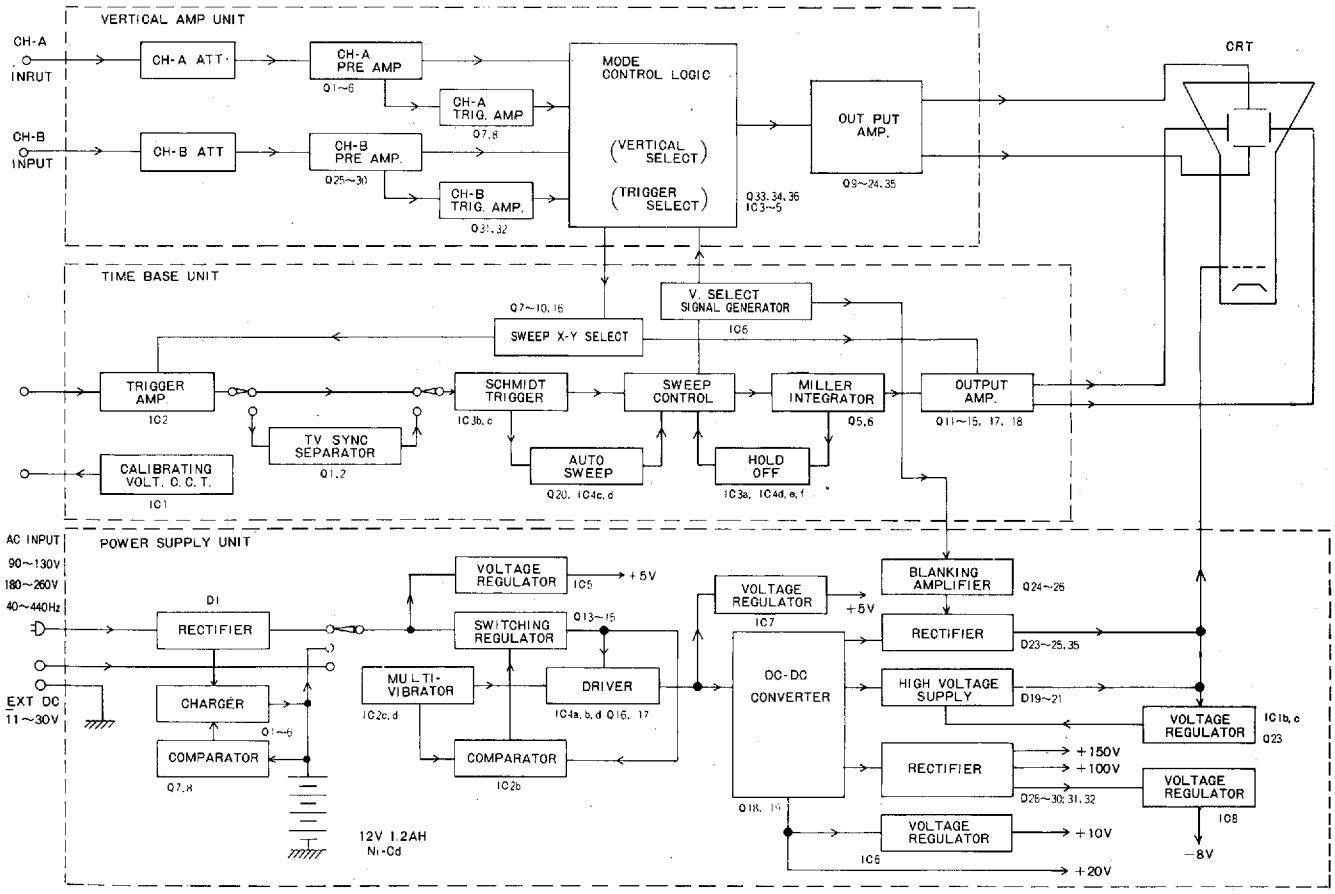


Fig. 6

SECTION 5 MAINTENANCE & ADJUSTMENTS

5-1 GENERAL

This section contains information for preventive maintenance, adjustment and calibration.

5-1-(1) PREVENTIVE MAINTENANCE

Preventive maintenance consists of periodic cleaning, and recalibration of the oscilloscope. It should be performed on a regular bases to keep the instrument in its best operational and appearance condition.

5-1-(2) CLEANING

Accumulation of dirt, dust and grime should be removed whenever they become noticeable. The frequency of cleaning is largely dependent upon the environment in which the instrument is used. Dirt on the outside covers may be removed with a soft cloth moistened with a diluted household cleaning solution.

5-1-(3) RECALIBRATION

Recalibration of the instrument at regular intervals will assure that measurements within the accuracy specification. It is recommended that the instrument be recalibrated after 1000 hours of operation, or twice a year. The calibration procedures are provided in the latter part of this section of the manual.

5-2 ADJUSTMENT AND CALIBRATION

Most of the problems resulting in a malfunction will be a defective component or a mechanical defect. Verify that the problem is not due to an incorrect switch position. The CRT display can be a valuable aid in pinpointing the area of many problems. The defect of any of the amplifiers, triggering circuit will be noticeable on the CRT.

5-2-(1) POWER SUPPLY UNIT ADJUSTMENTS

Some problems may result severe loading on the power supplies. The power supply unit for the BS-310S comprises a DC-to-DC converter. The normal operating frequency of the converter is approximately 17KHz. Modifying pulse width with the change of loads, this converter assures the constant voltage supply. When the secondary voltage of the converter is incorrect, remove the P3 and P4 connectors of the Power Supply unit for checking.

1. VOLTAGE ADJUSTMENTS . . . . . When voltages are out of adjustments, careful realignments may be necessary.

   a. 100V Adjustment . . . . . Adjust VR9 to obtain 100V ±0.5V between the 2nd pin on connector P3 and the ground.

   b. −1.4KV Adjustment . . . . . Adjust VR7 to maintain the voltage within −1.4KV between the 2nd Pin on Connector P2 and ground.

CAUTION!!! EXCESS VOLTAGE MAY DAMAGE CRT OR SHORTEN CRT LIFE.

2. ADJUSTMENT OF RECHARGING CIRCUIT . . . . . When the length of time for charging and discharging the battery is questionable. Adjustment of FULL-CHARGED VOLTAGE LEVEL may be necessary.

NOTE: FULL-CHARGED VOLTAGE LEVEL IS SUBJECT TO AMBIENT TEMPERATURE.

Adjust VR1 in accordance with the algebraic equation below.

CAUTION!!! ACCURATE ADJUSTMENTS ARE REQUIRED IN ORDER TO AVOID POSSIBLE DANGERS FROM BATTERY DUE TO OVER-CHARGE OR IMPERFECT CHARGE, AND TO MAINTAIN THIS INSTRUMENT'S IN-SPEC OPERATIONS FOR A LONG TIME.

FULL-CHARGED VOLTAGE LEVEL (V)

$(V) = 15.50 - (0.04 \times x^{\circ}C)$ ** $x^{\circ}C$ . . . . . Ambient Temperature

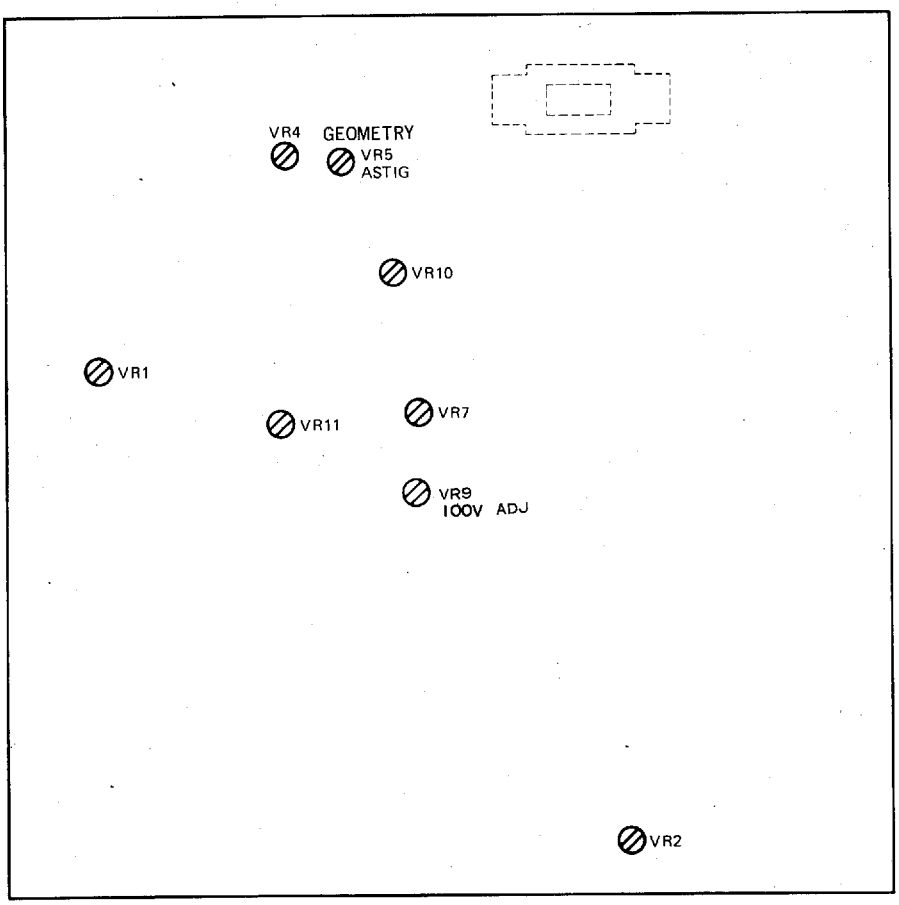
3. LOWER VOLTAGE LEVEL ADJUSTMENT FOR EXTERNAL DC SOURCE . . . . . If external DC supply voltage drops lower than 11V. This instrument stops functioning. That lower voltage level is adjustable with VR2.

4. ADJUSTMENTS ABOUT CRT . . . . . Aged CRT has tendency to lose brightness of trace line and distortion of waveform display increases.
   To compensate the detrition, readjustment may be required. In this case proceed as follows;

   a. When FLY-BACK LINE appears on the CRT with waveforms . . . . . Adjust VR10 to obtain the right tuning point of the lower blanking pulse level. And this to be done, observing the waveform between Emitter of Q14 and the ground.

   b. When Brightness decreased . . . . . Adjust VR11 for intensity control.

CAUTION!!! TOO MUCH BRIGHTNESS SHORTENS THE LIFE OF CRT.



FOIL SIDE VIEW

CALIBRATION LOCATIONS FOR POWER SUPPLY UNIT

5-2-(2) VERTICAL AMPLIFIER UNIT ADJUSTMENTS

1. ADJUSTMENTS OF ATTENUATORS . . . . . When the voltage readings are in error or waveform is distorted.

   a. Adjustments of voltage reading (VOLT/DIV)
      Adjustments : VR5 for CH-A
      VR11 for CH-B

   b. Adjusting Balance of attenuator steps . . . . . When trace line shifts with the change of VOLT/DIV switch.
      Adjustments : VR1 for CH-A
      VR7 for CH-B

   c. Adjustments of DC Balance (VARI BAL) . . . . . When trace line moves up or down while tuning VARIABLE knob.
      Adjustments : VR3 for CH-A
      VR9 for CH-B

2. ADJUSTMENTS OF VERTICAL AMPLIFIER

   a. When trace lines shift with the change of DC-GND-AC slide switch.
      Short the Test Pin and adjust VR6

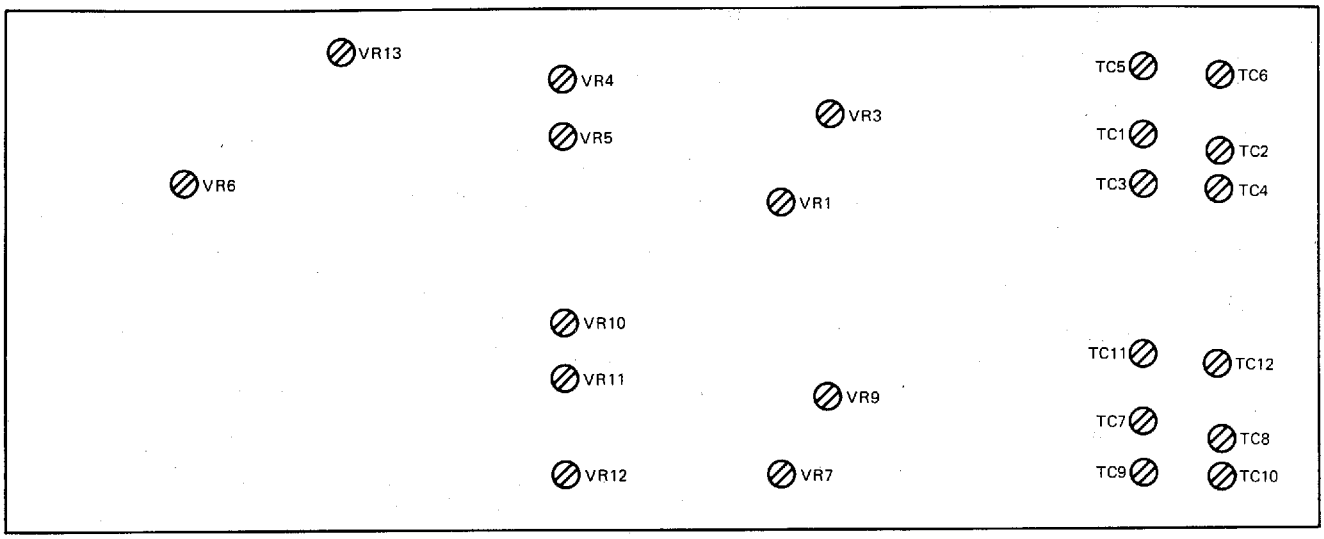
   b. Adjustment of Vertical POSITION's Linearity
      Adjust VR4 for CH-A and VR10 for CH-B.

   c. When adequate dynamic range is not obtained in display.
      Confirm +8.7V between Base of Q11 and ground.

3. ADJUSTMENT OF X-AXIS AMPLIFIER GAIN . . . After both channels are confirmed to be correct in normal operations, Set SWEEP TIME/DIV control to CH-B. If there is difference of sensitivity in Y-axis and X-axis, adjust VR12.

4. ADJUSTMENT OF ATTENUATOR CAPACITY

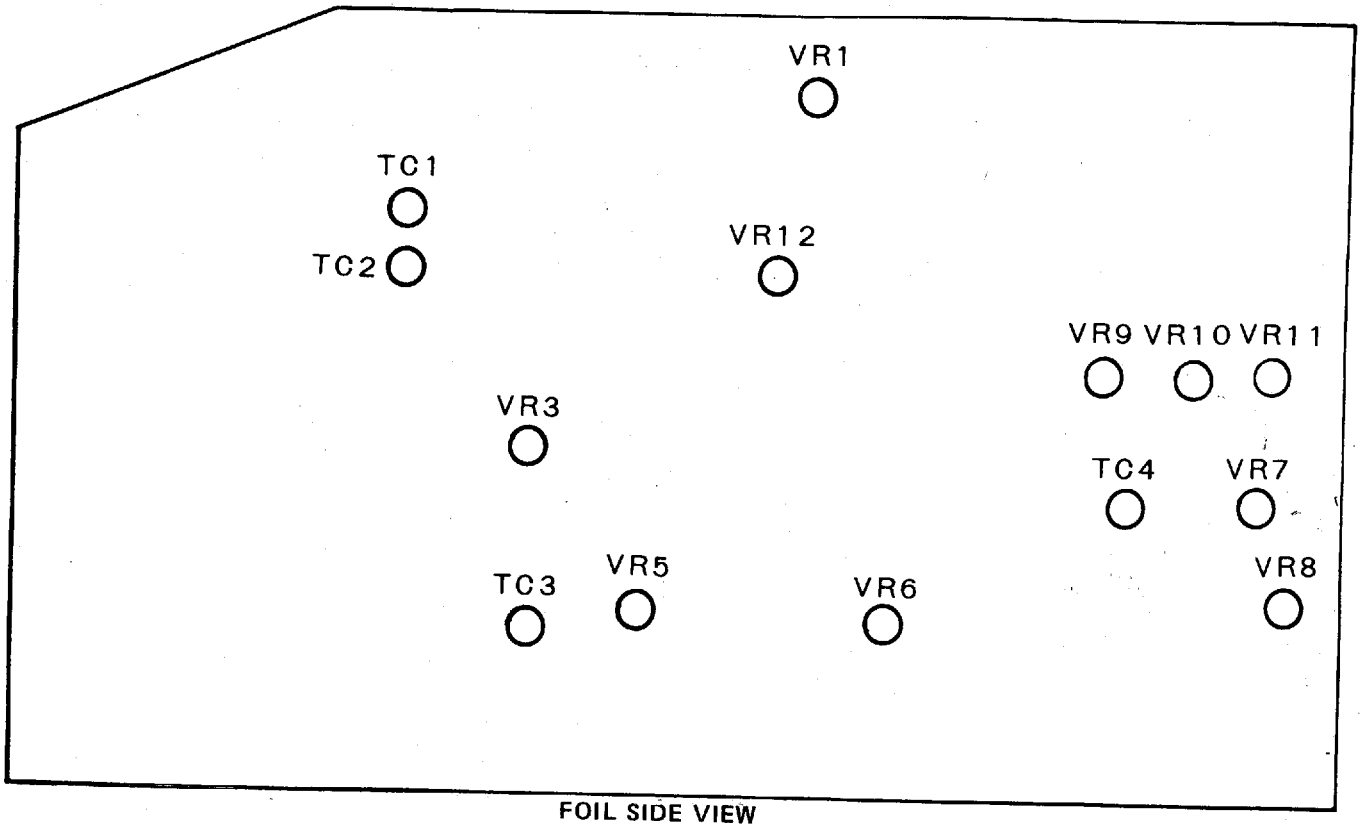
a. CH-A	TC1	1/10	ATT	Square waveform ADJ
	TC2	1/10	ATT	Input Cap. ADJ
	TC3	1/100	ATT	Square waveform ADJ
	TC4	1/100	ATT	Input Cap. ADJ
	TC5	1/1000	ATT	Square waveform ADJ
	TC6	1/1000	ATT	Input Cap. ADJ
b. CH-B	TC7	1/10	ATT	Square waveform ADJ
	TC8	1/10	ATT	Input Cap. ADJ
	TC9	1/100	ATT	Square waveform ADJ
	TC10	1/100	ATT	Input Cap. ADJ
	TC11	1/1000	ATT	Square waveform ADJ
	TC12	1/1000	ATT	Input Cap. ADJ



FOIL SIDE VIEW
CALIBRATION LOCATIONS FOR VERTICAL AMPLIFIER UNIT

5-2-(3) HORIZONTAL/TIME BASE UNIT ADJUSTMENTS

1. ADJUSTMENT OF SWEEP TIME/DIV (A standard time marker generator required.)
   - a. Adjust VR6 for realignment of the range from 0.1 msec/DIV to 0.5 sec/DIV.
   - b. Adjust TC1 for realignment of the range from 1 μsec/DIV to 50 μsec/DIV.
   - c. Adjust TC2 for realignment of the range from 0.5 μsec/DIV to 50 μsec/DIV.
2. ADJUSTMENT OF 5X MAGNIFIER
   - a. When magnification is inaccurate.
     Adjust VR9.
   - b. Shift of center position of screen. Adjust VR7 to obtain the same center position when the display is magnified.
3. OTHERS BESIDES TIME BASE CIRCUIT
   - a. Adjustment of Horizontal POSITION . . . . . When shift range is unbalanced to left and right. Adjust VR10 to obtain the same shift ranges.
   - b. Adjustment of Sweep Linearity . . . . . Adjust VR11.
4. ADJUSTMENT OF TRIGGERING . . . When the starting point shifts with the change of SYNC switch (+ to –, or vice versa), Adjust VR3.
5. ADJUSTMENT OF X-AXIS (CH-B) POSITION . . . . . With SWEEP TIME/DIV control set at CH-B, check if shift range is balanced when X-axis POSITION (CH-B VERTICAL POSITION) is turned. If there is unbalance, Adjust VR8.
6. ADJUSTMENT OF TRACE LINE LENGTH . . . . . Adjust VR5 to obtain the length of 11DIV on CRT screen.



FOIL SIDE VIEW

CALIBRATION LOCATIONS FOR HORIZONTAL/TIME BASE UNIT

PARTS LIST

6-1 CHASSIS

REF. NO.	PARTS NO.	DESCRIPTION	
	100-1005-02	Case	
	110-1002-02	Diecast Panel	
	118-1005-03	Ornamental Panel	
	126-1000-03	Rear Panel	
	230-1000-04	Battery Case	
	140-1000-03	Frame (A)	
	140-1001-03	" (B)	
	140-1002-03	" (C)	
	140-1003-03	" (D)	
	140-1004-03	" (E)	
	330-1000-03	CRT Shield Case	
	330-1010-03	CRT Shield Cover	
	330-1002-04	Shield Plate	
	255-1003-03	CRT Band	
	400-1000-03	Carrying Handle	
	403-1000-04	Handle Mounting Bracket(1)	
	403-1001-04	" (2)	
	315-1000-04	Spring	
	305-1001-03	Handle Cap	
	200-1000-03	"CAL" Terminal	
	200-1001-04	Grounding Terminal	
	250-1000-04	Joint Metal	
	245-1000-04	Bakelite Bar (A)	
	245-1001-04	" (B)	
	160-1002-03	Rotation Coil Bracket	
	235-1000-04	Molded Bearing	
	415-1001-03	Bezel	
	425-1000-04	Graticule	
		LED for Power	SG2-01B
		LED for charge - 98 '08 06'6	SG2-07
	215-1000-05	CRT Socket	
	205-1000-05	Power Connector	
	205-1001-05	Connector for EXT DC	
	210-1000-05	Connector Plug for EXT DC	
	260-1000-05	BNC Receptacle	
	275-1000-05	Grounding Lug for BNC Receptacle	
	290-1000-05	P.C.B. for LED	
	270-1000-05	Assembled Connector	3P-AC Connector
	270-1002-05	"	8P-8P
	270-1003-05	"	7P-7P
	270-1004-05	"	4P-DC Connector
	270-1005-05	"	5P-LED
	270-1006-05	"	3P-CRT
	270-1007-05	"	3P-CRT
	270-1008-05	"	3P-Position(CH-A)
	270-1009-05	"	" (CH-B)
	270-1010-05	"	" (HOR)
	270-1012-05	"	3P-CAL Terminal
	270-1013-05	"	3P-EXT TRIG
	270-1014-05	"	9P-CRT
	270-1016-05	"	3P-Battery
	270-1017-05	"	9P-9P
	270-1018-05	"	4P-PULL INVERT SW
	270-1019-05	"	4P-MAG SW

REF. NO.	PARTS NO.	DESCRIPTION	
	298-1000-05	Power Line Cord for UL/CSA type	
	298-1001-05	" CEE type	
	298-1002-05	" SAA type	
	298-1003-05	" JIS type	
	080-1000-05	Fuse 0.3A	
	080-1001-05	" 2A	
		Cathode Ray Tube	95GB31
	420-1000-04	Knob for Rotary Switch	
	420-1001-04	Knob for Potentiometer	
	420-1012-04	Knob for Rotary Switch	
	420-1003-04	Knob for Lever Switch	
	405-1000-04	Rubber Leg	
	340-1000-04	Felt (A)	
	340-1001-04	" (B)	
	435-1002-04	S/NO. Plate	
	435-1003-04	Plate for Power Source	90V - 130V
	435-1004-04	"	180V - 260V
	435-1006-04	Name Plate for ASTIG	
	435-1007-04	" CH-A BAL	
	435-1008-04	" CH-A STEP BAL	
	435-1009-04	" CH-B BAL	
	435-1010-04	" CH-B STEP BAL	
	370-1000-03	Packing Case	
	380-1000-03	Packing Material	
	375-1000-04	Polyethylene Bag	
	040-1000-05	Power Transformer	
	050-1000-05	Rotation Coil	
		Ferri-Inductor	FL4H2R2K(2.2μH)
	002-1000-05	Variable Resistor	1KΩ-B(V.Position CH-A)
	002-1007-05	"	1KΩ-B(" W/PULL SW)
	002-1001-05	"	20KΩ-B(H.Position)
		Carbon Resistor	330Ω 1/8W ±5%
		"	22Ω 1/8W ±5%
		Metal Filmed Capacitor	0.022μF 630V ±20%
	026-1000-05	Power Switch	Non-Shorting.
	020-1000-05	Slide Switch for AC-GND-DC	"
	020-1001-05	Slide Switch for Battery Operation	
	~~095-1000-05~~	Ni-Cd Battery	NR-SCU 1200mAH

VRECS 1800/10 by Sinpower Ltd

6-2 VERTICAL AMPLIFIER UNIT

REF. NO.	PARTS NO.	DESCRIPTION	
P1,2,5,7		Connector	5048-3A
P3		"	5048-7A
P4		"	5048-9A
P6		"	5048-4A
	290-1002-14	Printed Circuit Board	
L1-4		Ferri-Inductor	47μH
L5-6		"	0.68μH
L7-8		"	470μH
IC1-2		Linear Integrated Circuit	HA1127 orCA3046
IC-3		Digital Integrated Circuit	CD4001 or MC14001B
IC-4		"	CD4011B or MC14011B
IC-5		"	SN74LS03N
Q1,25		F.E.T.	2SK30A(O)
Q2,26		Dual F.E.T.	2SK58-1-M
Q3-6,9-10,27-30		Transistor	2SC535(C)
Q7-8,12-14,21-22,31-32,36		"	2SA836
Q11,15-16,23-24,33-35		"	2SC458D or E
Q17-18		"	2SC1628(Y)
Q19-20		"	2SA818(Y)
D1,11,15,20-22,24		Diode	1S1555
D2-9,16-19		"	1S1587
D10,14		Zener Diode	WZ050
D13		"	WZ065
VR1,7,13	008-1006-05	Variable Resistor	1KΩ-B Step ATT BAL
VR2,8	002-1004-05	"	5KΩ-A ATT VAR
VR3,5,9,11-12	008-1004-05	"	100Ω-B
VR4,10	008-1013-05	"	680Ω-B
VR6	008-1007-05	"	470KΩ-B
S1-2	018-1005-05	Rotary Switch	VOLT/DIV
S3	022-1002-05	Lever Switch	MODE

(Carbon Resistors of 1/8W Tolerance ±5% are not listed here.)

R2,106		Metal Filmed Resistor	900KΩ 1/2W ±1%
R3,107		"	111KΩ 1/4W "
R4,108		"	990KΩ 1/2W "
R5,109		"	10.1KΩ 1/4W "
R6,110		"	999KΩ 1/2W "
R7,57,60,111		"	1KΩ 1/2W "
R8,112		"	1MΩ 1/2W "
R12-13,63,116-117		"	6.8KΩ 1/4W "
R21-22,38,42,66,71,125-126,144-145		"	4.7KΩ 1/4W "
R23,127		"	510Ω 1/4W "
R24,129		"	390Ω 1/4W "
R26,131		"	68Ω 1/4W "
R29,31,133,135		"	330Ω 1/4W "
R32,39-40,136,142-143		"	680Ω 1/4W "
R35,138		"	220Ω 1/4W "
R36-37,139-140		"	12KΩ 1/4W "
R44-45,149-150		"	3KΩ 1/4W "
R46,153		"	100Ω 1/4W "
R64		"	13KΩ 1/4W "
R78,82		"	100KΩ 1/4W "
R85,93		"	1.8KΩ 1/4W "
TC1,3,5,7,9,11		"	ECV-1ZW04X64
TC2,4,6,8,10,12-13		"	ECV-1ZW10X64

REF. NO.	PARTS NO.	DESCRIPTION		
(Tolerance ±20% unless otherwise indicated.)				
C1,39		Mica Capacitor	33pF 50V	±5%
C2,40		"	220pF 50V	±5%
C3,41		Ceramic Capacitor	2pF 50V	±5%
C4,42		Mica Capacitor	1500pF 50V	±5%
C5,43		Metal Filmed Capacitor	0.01μF 600V	
C6,12,24,44,62		Semiconductor Ceramic	0.1μF 12V	+80%–20%
C7,18,22,45,49,59,63		Tantalum Capacitor	4.7μF 16V	
C8,46		Ceramic Capacitor	7pF 50V	±0.5pF
C9,47		"	47pF 50V	±5%
C10,48		Tantalum Capacitor	22μF 16V	
C11,13,50,52		Ceramic Capacitor	22pF 50V	±5%
C15–17,20,25,61		Tantalum Capacitor	1μF 25V	
C19		Ceramic Capacitor	20pF 50V	±5%
C21,56,58		"	10pF 50V	±5%
C23,28		"	1pF 500V	±0.5pF
C26,31,33–34,38		"	0.01μF 500V	
C27,32		Mylar Capacitor	0.01μF 12V	+80%–20%
C29,36		Ceramic Capacitor	150pF 50V	±5%
C30,35		"	180pF 50V	±5%
C54		"	2pF 50V	±5%
C55,57		"	5pF 50V	±5%
C60		"	0.01μF 50V	±5%

6-3 HORIZONTAL/TIME BASE UNIT

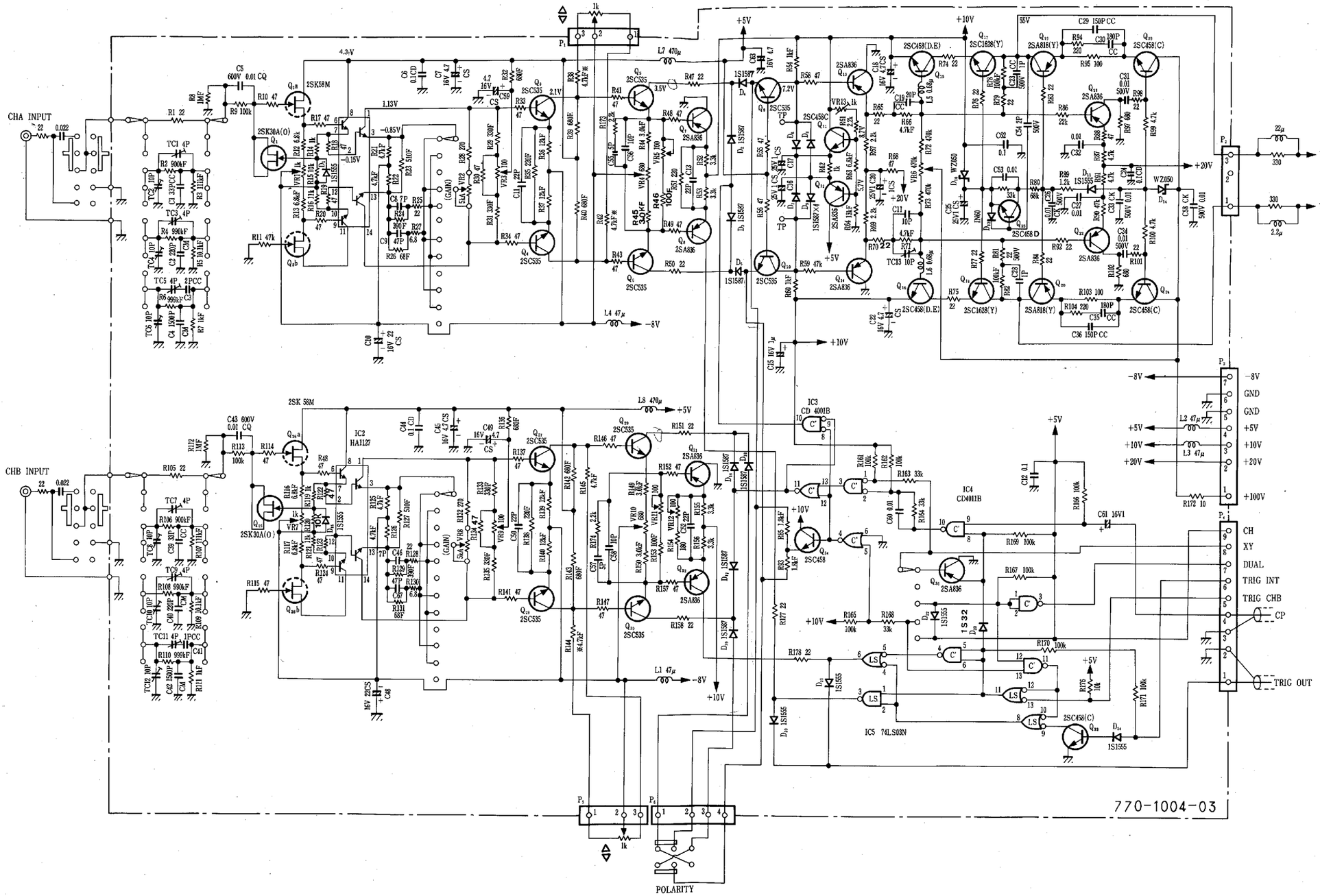
	736-1010-00	Complete Assembled Circuit Board		
P1		Connector	5048-8A	
P2		"	5048-9A	
P3-7		"	5048-3A	
	290-1004-04	Printed Circuit Board		
L1		Ferri-Inductor	FL4H2R2K	2.2μ
L4-5		"	FL5H470K	47μH
IC1,4		Digital Integrated Circuit	MC14572	
IC2		Linear Integrated Circuit	AN606	
IC3		Digital Integrated Circuit	SN74LS00N	
IC5		"	SN74LS76N	
IC6,7		"	MC14011B	
Q1-3,6,11-12,21-22		Transistor	2SC458D or E	
Q4,7-10,16-20		"	2SA836	
Q5		F.E.T.	2SK30A(O)	
Q13		Transistor	2SA912	
Q14-15		"	2SC1885	
D1-4,7-8,14-16		Diode	1S1555	
D5		Zener Diode	WZ-081	
D6,11		Diode	1S1587	
D9-10		Zener Diode	WZ-040	
D12-13,17		Diode	IN60	

REF. NO.	PARTS NO.	DESCRIPTION			
VR1	008-1009-05	Variable Resistor	4.7KΩ	CAL ADJ	
VR2	002-1005-05	"	20KΩ	TRIG LEVEL	
VR3	008-1010-05	"	47KΩ	TRIG SLOPE BAL	
VR4	002-1006-05	"	10KΩ	SWEEP TIME VAR	
VR5	008-1003-05	"	100KΩ	SWEEP LENGTH ADJ	
VR6	008-1010-05	"	47KΩ	SWEEP ADJ	
VR7	008-1010-05	"	47KΩ	MAG CENTER ADJ	
VR8	008-1001-05	"	22KΩ	CH-B POSI ADJ	
VR9	008-1008-05	"	220Ω	MAG GAIN ADJ	
VR10	008-1004-05	"	100Ω	HOR CENTER ADJ	
VR11	008-1012-05	"	470Ω	SWEEP LINEARITY ADJ	
VR12	008-1003-05	"	100KΩ	CAL CIRCUIT	
S2	018-1006-05	Rotary Switch	SWEEP/TIME		
S3-4	022-1001-05	Lever Switch			
(Carbon Resistors of 1/8W Tolerance ±5% are not listed.)					
R38,43,94		Metal Filmed Resistor	100KΩ	1/4W	±1%
R39		"	3MΩ	1/4W	±1%
R40		"	1MΩ	1/4W	±1%
R41		"	500KΩ	1/4W	±1%
R42		"	300KΩ	1/4W	±1%
R53		Carbon Resistor	100KΩ	1/4W	
R72		Metal Filmed Resistor	15KΩ	1W	
R75		"	20KΩ	1W	
(Tolerance ±20% unless otherwise indicated.)					
TC1		Ceramic Trimmer	ECV-1Z10X64		
C1		Mylar Capacitor	4700pF	50V	±10%
C2,18,57		Ceramic Capacitor	5pF	50V	±5%
C3,16,29-30,34,47		"	0.01μF	50V	±10%
C4,10,36-39,48-49,55-56		Tantalum Capacitor	22μF	16V	
C5,9,15,35,52-54		Semiconductor Ceramic Cap.	0.1μF	12V	+80%-20%
C6,13,40-43		Tantalum Capacitor	1μF	25V	
C7		Electrolytic Capacitor	47μF	10V	
C8		Mylar Capacitor	2200pF	50V	±10%
C11		Ceramic Capacitor	220pF	50V	±5%
C19		Tantalum Capacitor	0.01μF	50V	
C20,58		Ceramic Capacitor	15pF	50V	±10%
C21		Metalized Film Capacitor	0.47μF	200V	±5%
C22		"	0.004μF	200V	
C23		Ceramic Capacitor	39pF	50V	±5%
C24		"	22pF	50V	±5%
C25,44		"	47pF	50V	±5%
C32		"	680pF	50V	
C33		"	0.01μF		
C45		"	2pF	50V	±5%
C50		Electrolytic Capacitor	4.7μF	250V	

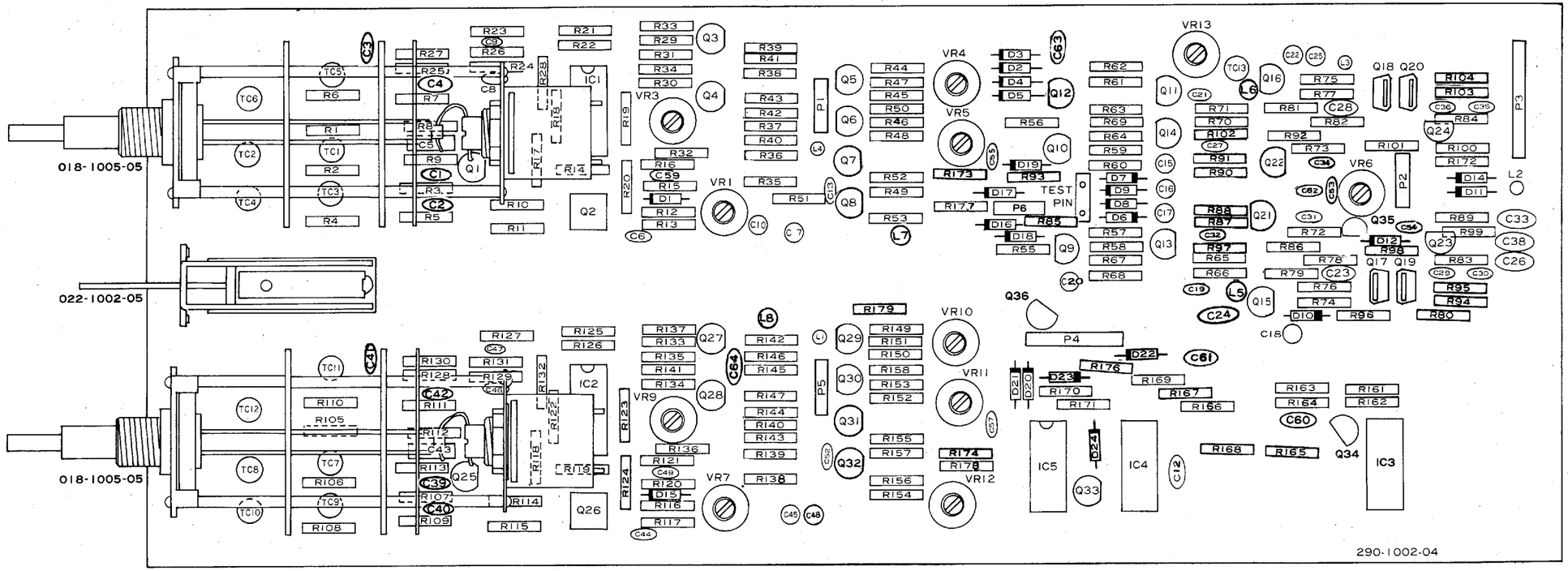
6-4 POWER SUPPLY UNIT

REF. NO.	PARTS NO.	DESCRIPTION	
	732-1000-00	Complete Assembled Printed Circuit Board	
P1		Assembled Connector	5048-3A
P2		"	5048-9A
P3		"	5048-8A
P4		"	5048-7A
P5		"	3055-3A
P6		"	3055-6A
P7	270-1015-05	"	for battery
P8		"	5048-5A
P9		"	5048-4A
F1-2	080-1000-05	Fuse	0.3A
F3	080-1001-05	"	2A
	225-1000-05	Fuse Holder	SN5053
	290-1001-24	Printed Circuit Board	
	330-1003-03	DC-DC Converter Shield Case	
	330-1004-03	DC-DC Converter Shield Cover	
L1		Choke Coil (1)	SN8D500 100μH 2A
L2	050-100 1-05	" (2)	800μH 1A
L3		Ferri-Inductor	FL5H470K 47μH
L4	040-1001-05	Drive Transformer	
L5	040-1002-05	DC-DC Converter Transformer	
L6-7		Ferri-Inductor	FL5H471K 470μH
L8		"	FL4H4R7K 4.7μH
L10		"	FL5H101K 100μH
VR1	008-1000-05	Variable Resistor	10KΩ FULL CHARGE ADJ
VR2	008-1000-05	"	10KΩ LOWER LEVEL ADJ
VR3	002-1003-05	"	50KΩ TRACE ROTATOR
VR4	008-1002-05	"	1MΩ GEOMETRY ADJ
VR5	008-1002-05	"	1MΩ ASTIGMATISM ADJ
VR6	002-1002-05	"	2MΩ FOCUS
VR7	008-1001-05	"	22KΩ 1.4KV ADJ
VR8	002-1003-05	"	50KΩ INTENSITY
VR9	008-1006-05	"	1KΩ 100V ADJ
VR10	008-1000-05	"	10KΩ INTENSITY ADJ(1)
VR11	008-1003-05	"	100KΩ INTENSITY ADJ(2)
S1	020-1002-05	Slide Switch	(UL) VOLTAGE SELECTOR
IC1-4		Digital Integrated Circuit	CD4011CN or MC14011A
IC5,7		Regulator Circuit	78L05
IC6		"	78L10
IC8		"	78L08
Q1		Transistor	2SC1846
Q2-3,7-8,12,15,20,26		"	2SC458D or E
Q4,11,14,21		"	2SA836(D)
Q5-6		"	2SK30A(GR)
Q13		"	(B) 140 ← 2SA886
Q16-17		"	2SC1318(R or S)
Q18-19		"	2SC1173(Y)
Q22,24-25		"	2SC1885
Q23		"	2SD470

REF. NO.	DESCRIPTION			
D1	Diode	WO2		
D2,12	"	RA-1ZN		
D3-4	Zener Diode	02BZ2.2		
D5,8-10,15-18,22,31-33	Diode	1S1555		
D6	Zener Diode	WZ-081		
D11	"	WZ-120		
D13,36	"	WZ-065		
D14	Diode	1S1834		
D19-21	"	SF-1		
D23-25,35	"	1S2463		
D26-30	"	UF-1		
D34	Zener Diode	WZ-050		
NE1-2	Neon Lamp	NE-38B		
ST1-2	Thermistor	SDT-100(1KΩ)		
(Carbon Resistors of 1/8W Tolerance ±5% are not listed.)				
R5	Metal Filmed Resistor	10Ω	1W	±2%
R35	Carbon Resistor	10MΩ	1/2W	±10%
R39	"	47KΩ	1/4W	±10%
R40	"	1MΩ	1/2W	
R41	Metal Filmed Resistor	10MΩ	1W	
R42	"	62KΩ	1/4W	±1%
R43-44	"	22MΩ	1/4W	±20%
R45	Carbon Resistor	100KΩ	1/4W	±10%
R59	Wire Wound Resistor	0.33Ω	1/2W	
(Tolerance ±20% unless otherwise indicated.)				
C1,6,13,16,23,25,47	Tantalum Capacitor	1μF	25V	
C2	Electrolytic Capacitor	470μF	50V	
C3	"	10μF	50V	
C4,7,43,52	Semiconductor Ceramic	0.1μF	12V	+80%-20%
C5,10	Electrolytic Capacitor	220μF	50V	
C9	Ceramic Capacitor	47pF	50V	±5%
C12	Electrolytic Capacitor	47μF	50V	
C14	"	470μF	25V	
C15	Mylar Capacitor	0.1μF	50V	±10%
C17,53	Ceramic Capacitor	220pF	50V	±5%
C18-19	"	47pF	50V	±5%
C20	"	150pF	50V	±5%
C21	"	10pF	50V	±5%
C22	Tantalum Capacitor	47μF	25V	
C24	Electrolytic Capacitor	10μF	50V	
C26,32	Ceramic Capacitor	0.01μF	50V	
C27,38,44	"	0.01μF	500V	
C28-29	"	0.01μF	1KV	+100%-0%
C30	Metalized Capacitor	0.022μF	630V	
C33-36	Ceramic Capacitor	0.01μF	1.6KV	+100%-0%
C37	Electrolytic Capacitor	1μF	160V	
C39,41-42	"	10μF	160V	
C40	"	2.2μF	250V	
C45	Ceramic Capacitor	1pF	50V	±5%
C46,51	Electrolytic Capacitor	220μF	16V	
C48	Ceramic Capacitor	0.01μF	50V	
C49	"	47pF	50V	±5%
C50	"	0.022μF	500V	



7-1 CIRCUIT DIAGRAM FOR VERTICAL AMPLIFIER UNIT



Junction D2 D3

CHA 0V

CH B 8V

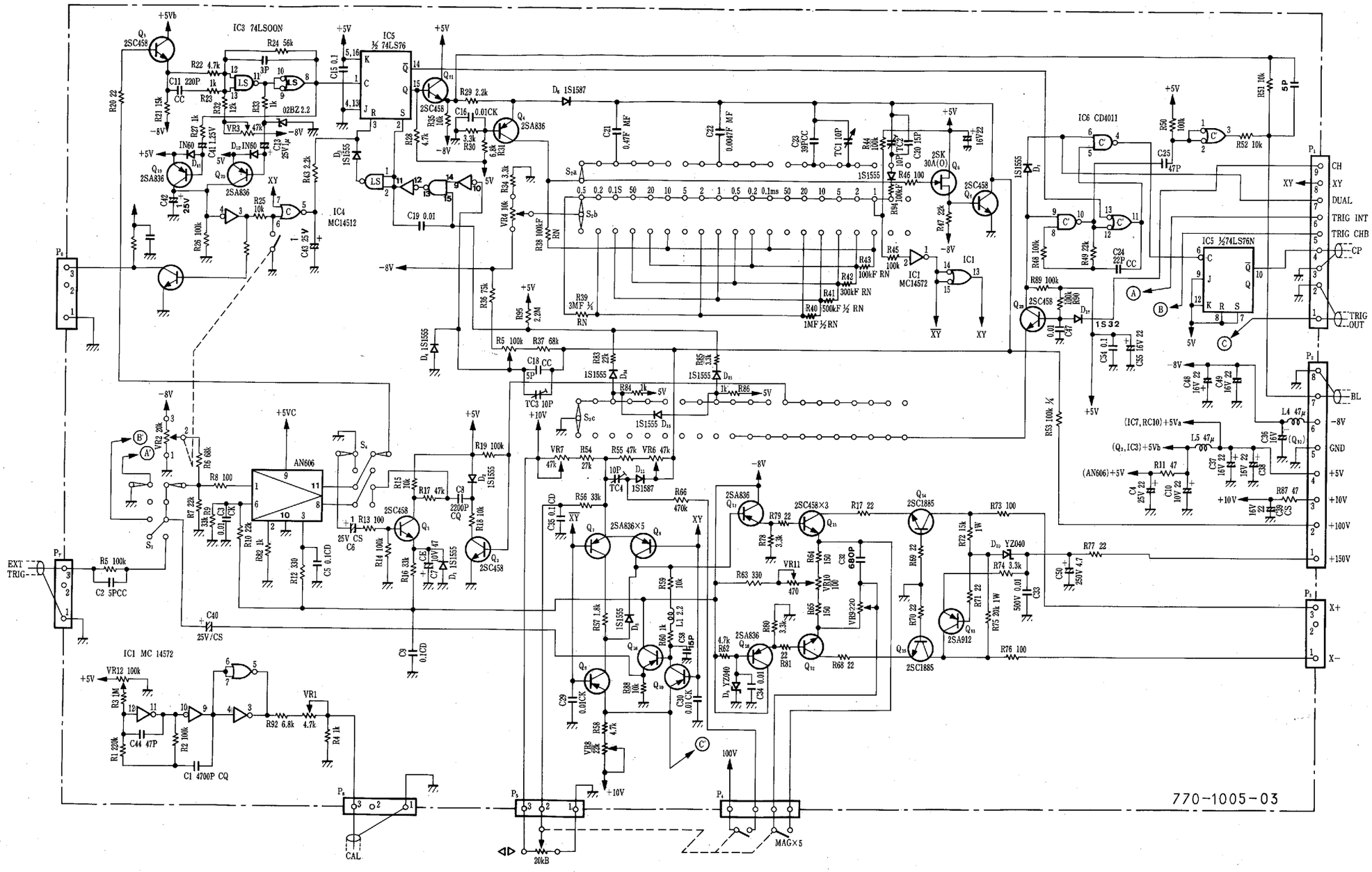
DUAL 6μS clock

ADD 0V

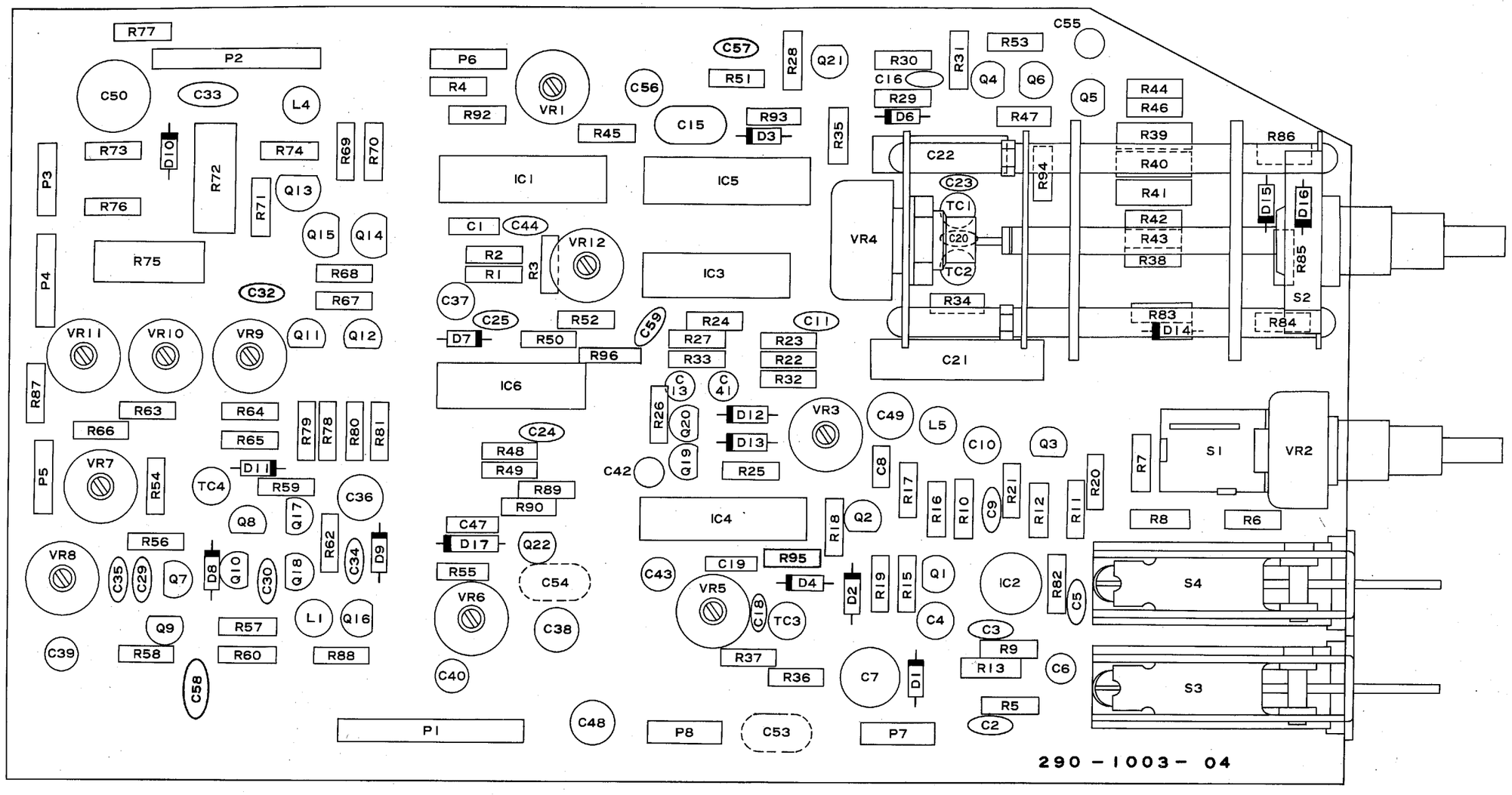
CHOP 6μS clock

TOP VIEW

7-1-(1) COMPONENTS LOCATION DIAGRAM FOR VERTICAL AMPLIFIER UNIT

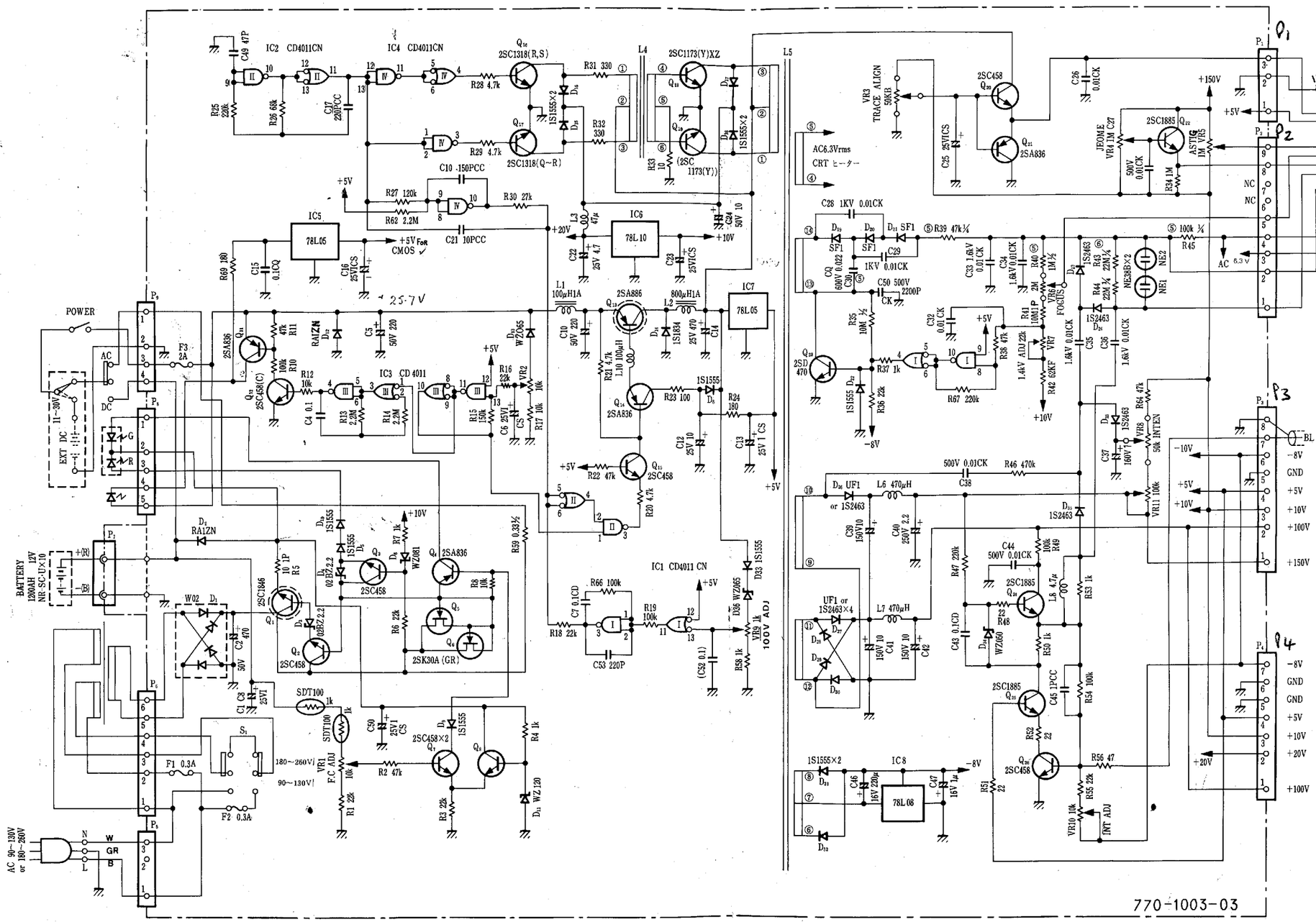


7-2 CIRCUIT DIAGRAM FOR HORIZONTAL/TIME BASE UNIT

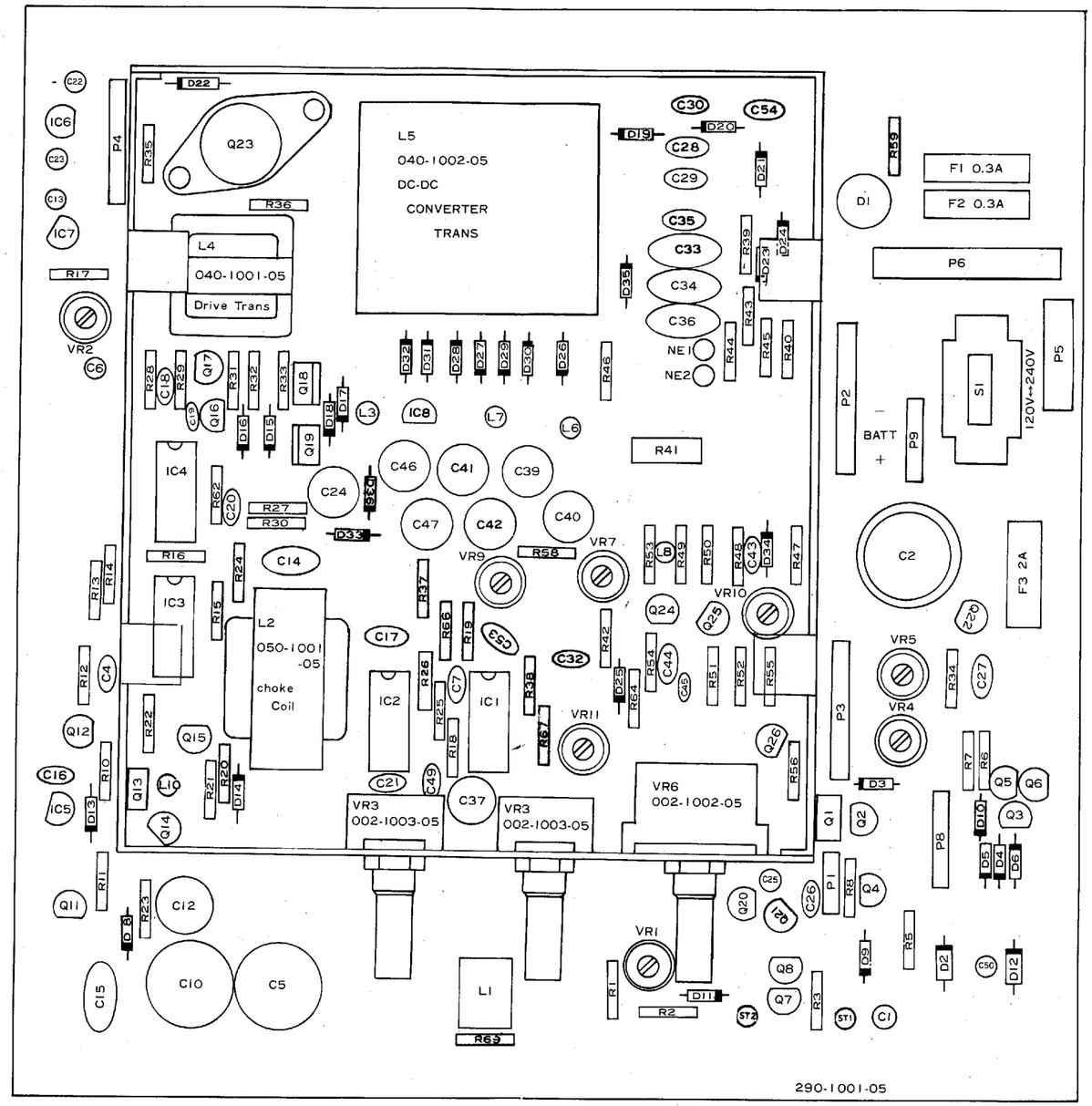


TOP VIEW

7-2-(1) COMPONENTS LOCATION DIAGRAM FOR HORIZONTAL/TIME BASE UNIT



7-3 CIRCUIT DIAGRAM FOR POWER SUPPLY UNIT



TOP VIEW

7-3-(1) COMPONENTS LOCATION DIAGRAM FOR POWER SUPPLY UNIT