## applicntion/anRON

## INSTRUCTION MANUAL

# 15MHz Dual Trace Oscilloscope MODEL BS-310S 

# Application/AARON BS-310S oscilloscope <br> is equivalent to <br> TTM Model 303 

AARON CORPORATION
2-2, Nishikicho, Kanda
Chiyoda-ku, Tokyo, 101
Phone: 291-1991
Telex: 222-2341 TTMTYO

## TABLE OF CONTENTS

SECTION 1 INTRODUCTION ..... Prye I
SECTION 2 SPECIFICATIONS ..... 2
SECTION 3 OPERATIONS
3-1 INITIAL OPERATION (AC Power Line) ..... 3
3-2 INTERNAL BATTERY OPERATION ..... 3
3-3 EXTERNAL DC OPERATION ..... 4
3-4 CONTROLS AND INDICATIONS ..... 4
3-5 INTERNAL SWEEP AND TRIGGERING ..... 7
3-6 X-Y OPERATION ..... 7
3.7 CALIBRATED VOLTAGE MEASUREMENTS ..... 7
3-8 DUAL TRACE WAVEFORM OBSERVATION ..... 7
3-9 TV SIGNAL SYNCHRONIZATION ..... 7
3-10 AĐD \& SUB MEASUREMENTS ..... 8
3-11 BATTERY CHARGING ..... 8
3-12 APPLICATIONS ..... 8
SECTION 4 CIRCUIT DESCRIPTION
4-1 OUTLINES OF CIRCUIT ..... 13
4-2 VERTICAL AMPLIFIER CIRCUIT ..... 13
4-3 HORIZONTAL/TIME BASE CIRCUIT ..... 14
4-4 POWER SUPPLY CIRCUIT ..... 14
4-4-(1) Battery Charging Circuit ..... 14
4-4-(2) Switching Regulator Circuit ..... 14
4-4-(3) DC-DC Converter Circuit ..... 15
4-4-(4) High Voltage Section for CRT and Unblanking Circuit ..... 15
4-4-(5) BLOCK DIAGRAM ..... 15
SECTION 5 MAINTENANCE AND ADJUSTMENTS
5-1 GENERAL16
5-1-(1) Preventive Maintenance ..... 16
5-1-(2) Cleaning ..... 16
5-1-(3) Recalibration ..... 16
5-2 ADJUSTMENTS AND CALIBRATION
5-2-(1) Power Supply Unit Adjustments ..... 16
5-2-(2) Vertical Amplifier Unit Adjustments ..... 18
5-2-(3) Horizontal/Time Base Unit Adjustments ..... 20
SECTION 6 PARTS LIST
6-1 CHASSIS ..... 21
6-2 VERTICAL AMPLIFIER UNIT. ..... 23
6-3 HORIZONTAL/TIME BASE UNIT ..... 24
64 POWER SUPPLY UNIT ..... 26
SECTION 7 SERVICING
7-1 CIRCUIT DIAGRAM FOR VERTICAL AMPLIFIER UNIT ..... 28
7-1-(1) Components Location Diagram ..... 29
7-2 CIRCUIT DIAGRAM FOR HORIZONTAL/TIME BASE UNIT ..... 30
7-2-(1) Components Location Diagram ..... 31
7-3 CIRCUIT DIAGRAM FOR POWER SUPPLY UNIT ..... 32
7-3-(1) Components Location Diagram ..... 33

The Model BS-3I0S is a dual trace, battery-operated, 15 MHz Portable Oscilloscope of rectangular CRT with internal graticule.
Weight only 4.5 kgs . and $113(\mathrm{H}) \times 223(\mathrm{~W}) \times 298(\mathrm{D}) \mathrm{mm}$ in size, it is an ideal oscilloscope for the field service.
This BS-310S offers 2 m 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-3IOS 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 $\quad 2 \mathrm{mV}$ to $10 \mathrm{~V} /$ DIV on 12 ranges in $1-2-5$ step with fine control.
Bandwidth $\quad \mathrm{DC}: \mathrm{DC}$ to $15 \mathrm{MHz}(-3 \mathrm{~dB})$
$\mathrm{AC}: 10 \mathrm{~Hz}$ to $15 \mathrm{MHz}(-3 \mathrm{~dB})$
Risetime $\quad 24 \mathrm{nsec}$
Overshot Less than 3\%
Input Impedance
Operating Modes
Chop Frequency
$1 \mathrm{M} \Omega$ shunted dy $20 \mathrm{pE} \pm 3 \mathrm{pF}$
$\mathrm{CH}-\mathrm{A}, \mathrm{CH}-\mathrm{B}, \mathrm{DUAL}, \mathrm{ADD}$ and CHOP
200 KHz approx.
Channel Separation Better than 60 dB at 1 kHz .
CH-B Polality $\quad$ CH-B can be inverted
TIME BASE
Type Automatic and triggered. In automatic mode, sweep is obtained without input signal.
Sweep Time $\quad 0.5 \mu \mathrm{sec}$ to $0.5 \mathrm{sec} /$ DIV on 19 ranges in $1-2-5$ step with fine control and X-Y.
Magnifier $\quad x 5$ 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 $\quad 20 \mathrm{~Hz}$ to 15 MHz
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: $0.5 \mathrm{sec} / \mathrm{DIV}$ to $0.1 \mathrm{msec} / \mathrm{DIV}$.
TV-H: $50 \mu \mathrm{sec} /$ DIV to $0.5 \mu \mathrm{sec} /$ DIV.

## HORIZONTAL DEFLECTION

Deflection Factor 2 mV to $10 \mathrm{~V} /$ DIV on 12 ranges in 1-2-5 step with fine control.
Frequency Response $\quad \mathrm{DC}$ to 1 MHz
Input Impedance $\quad 1 \mathrm{M} \Omega$ shunted by $20 \mathrm{pF} \pm 3 \mathrm{pF}$
Max Input Voltage $\quad 300 \mathrm{~V}$ DC +AC peak or 600 V p-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 $\quad 95 \mathrm{~mm}$ tube(approx. 1.5 KV )
Calibration Voltage $\quad 0.5 \mathrm{Vp-p} \pm 5 \%, 1 \mathrm{KHz}$ Squre Wave.
Power Requirements AC: $90 \sim 130 \mathrm{~V}$ or $180 \sim 260 \mathrm{~V} ; 48 \sim 440 \mathrm{~Hz}$
DC: $11 \sim 30 \mathrm{~V} ; 7.2 \mathrm{VA}$
Battery: Ni-Cad Battery(up to 2 hour operation)
Charging Time: 6hours (Scope not operated)
16hours (While Scope operated)
Weight $\quad 4.5 \mathrm{kgs}(5.5 \mathrm{kgs}$ including battery)
$113(\mathrm{H}) \times 223(\mathrm{~W}) \times 298(\mathrm{D}) \mathrm{mm}$

## 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 0.5 Vp -p output.
7. Rotate CH -A Vertical attenuator VOLTS/DIV switch to $10 \mathrm{mV} / \mathrm{DIV}$ 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 0.5 Vp -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 11 V up to 30 V , withstanding the current drain of 7.2 VA . 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 $\mathrm{CH}-\mathrm{B}$ are displayed.
DUAL: In the range from $0.5 \mathrm{sec} /$ DIV up to $1 \mathrm{msec} /$ DIV, both channels are chopped at about 100 KHz .
In the range from $0.5 \mathrm{msec} /$ DIV up to $0.5 \mu \mathrm{sec} / \mathrm{DIV}$, both channels are switched alternately.
$\mathrm{ADD}: \mathrm{CH}-\mathrm{A}$ and $\mathrm{CH}-\mathrm{B}$ 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 $2 \mathrm{mV} /$ DIV to $10 \mathrm{~V} /$ 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 $0.5 \mu \mathrm{sec} /$ DIV to $0.5 \mathrm{sec} /$ 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 MQDE.
9. SWEEP TIME/DIV VARIABLE
10. EXT. TRIG

Input for external triggering signal.
11. CAL

Calibration voltage terminal. Calibration voltage is 0.5 Vp -p of about 1 KHz 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.
$\mathrm{CH}-\mathrm{A}$ : $\mathrm{CH}-\mathrm{A}$ vertical input signal is used as sync signal.
$\mathrm{CH}-\mathrm{B}$ : $\mathrm{CH}-\mathrm{B}$ 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 ${ }^{B}$ 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 $\mathrm{CH}-\mathrm{B}$
25. VERTICAL INPUT

Same as 1. for $\mathrm{CH}-\mathrm{B}$
26. AC-GND-DC

Same as 2. for CH-B
27. POWER SOURCE

AC (or EXT DC): AC operation and DC operation from 11 V to 30 V DC
BATTERY(INT): Internal battery operation.
28. AC POWER LINE RECEPTACLE
$90 \mathrm{~V}-130 \mathrm{~V}$ AC or $180 \mathrm{~V}-260 \mathrm{~V} \mathrm{AC}, 40 \mathrm{~Hz}$ to 440 Hz
29. EXT DC

With use of EXT DC INPUT receptacle, connect 11 V to 30 V 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, 5 X MAG is pushed-in to operate without magnification. If magnification of a waveform is desired, pull 5 X 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 VOLTACE 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.

## SECTION 3

OPERATION

## 3-10 ADD \& SUB MEASUREMENTS

Sinply turn MODE switch to ADD, added waveform of $\mathrm{CH}-\mathrm{A}$ and $\mathrm{CH}-\mathrm{B}$ 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 90 V to 130 V or 180 V to 260 V 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 $1 / 10 \mathrm{C}$. 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. $1 / 4 \mathrm{C}$ 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


VOLT / DIV $\cdots \cdots$ at 2 V
SWEEP TIME / DIV $\cdots \cdots$ at 5 msec .
(a) Peak voltage . . . $2 \mathrm{~V} /$ DIV $\times 2$ DIV $=4$ volts
(b) p-p voltage . . . $2 \mathrm{~V} /$ DIV $\times 4$ DIV $=8$ volts
(c) Effective voltage . . . Peak voltage $\div 2=4$ (V) $\times 2$

$$
=2.828 \text { volts }
$$

(d) Frequency (Hz) . . . . $1 /$ Time (second)
** $\quad$ Time $=$ Number of DIVs for 1 cycle $\times$ value of SWEEP TIME / DIV
Therefore, the Fig 1 is:

$$
\begin{aligned}
\text { Frequency } & =\frac{1}{5 \mathrm{~m} \mathrm{sec} \times 4(\text { DIV })}=\frac{1}{20 \mathrm{~m} \mathrm{sec}} \\
& =50 \mathrm{~Hz}
\end{aligned}
$$

NOTE! ! ! The input of this oscilloscope is $1 \mathrm{M} \Omega$ shunted by 20 pF capacitance. When the probe is used in $10: 1$ attenuation, the impedance becomes $10 \mathrm{M} \Omega$ shunted by 15 pF . 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.

$$
\text { DC voltage }=\text { Shift }(\text { DIV }) \times \text { VOLTS } / \text { DIV }
$$

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

## SECTION 3

## 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

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

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 $\mathrm{CH}-\mathrm{B}$ waveform onto $\mathrm{CH}-\mathrm{B}$ ). Then the difference between redings of $\mathrm{CH}-\mathrm{A}$ VOLTS/DIV and $\mathrm{CH}-\mathrm{B}$ '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 pul ses.


Fig. 4
Fig. 5


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

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

Standard signal frequency: Unknown signal frequency

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


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.


$$
\text { SINE } \begin{aligned}
\phi & =\frac{B}{A} \\
\phi & =\text { PHASE ANGLE }
\end{aligned}
$$

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 changeover between CH-A and CH-B, or DUAL as well as trigger signals.

In DUAL-TRACE operation, CHOP (at 200 KHz ) 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 $(20 \mathrm{~dB})$ attenuation takes place. The out of input protection circuit $\mathrm{Q} 1(\mathrm{Q} 25)$ 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 2 nd attenuator composed of 1 C 1 (IC2). The 2 nd attenuator composed of IC 1 (IC2). The 2 nd 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 $\mathrm{X}-\mathrm{Y}$ 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 $\mathrm{CH}-\mathrm{B}$ signal in $\mathrm{X}-\mathrm{Y}$ 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 $1 / 4 \mathrm{C}(300 \mathrm{~mA})$ is supplied. If POWER switch is turned ON, 10 V DC is detected and Q3 is set to ON , starting $1 / 10 \mathrm{C}(120 \mathrm{~mA})$ 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 $(\mathrm{Q} 7,8$ ) 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 $1 / 50 \mathrm{C}(24 \mathrm{~mA})$ 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. (!C3a, b) starts oscillating, making POWER LED lamp flicker.

## SECTION 4

## 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 -1.5 KV 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 ( $\mathrm{D} 23-25,35$ ) 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 17 KHz . 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. 100 V Adjustment ............. Adjust VR9 to obtain $100 \mathrm{~V} \pm 0.5 \mathrm{~V}$ between the 2 nd pin on connector P3 and the ground.
b. -1.4 KV Adjustment . . . . . . . . . . . Adjust VR7 to maintain the voltage within -1.4 KV between the 2 nd Pin on Connector P2 and ground.

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

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

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

Adjust VR1 in accordance with the algebraic equation below.


#### Abstract

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)
$(\mathrm{V})=15.50-\left(0.04 \times \mathrm{x}^{\circ} \mathrm{C}\right) \quad{ }^{* *} \mathrm{x}^{\circ} \mathrm{C} \ldots$ Ambient Temperature
3. LOWER VOLTAGE LEVEL ADJUSTMENT FOR EXTERNAL DC SOURCE $\qquad$ If external DC supply voltage drops lower than 11 V . 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.



## SECTION 5

## 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 $\mathrm{CH}-\mathrm{A}$
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 +8.7 V 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 |  |
|  | 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 $0.1 \mathrm{msec} /$ DIV to $0.5 \mathrm{sec} /$ DIV.
b. Adjust TC1 for realignment of the range from $1 \mu \mathrm{sec} /$ DIV to $50 \mu \mathrm{sec} /$ DIV.
c. Adjust TC2 for realignment of the range from $0.5 \mu \mathrm{sec} /$ DIV to $50 \mu \mathrm{sec} /$ DIV.
2. ADJUSTMENT OF 5 X 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 $\qquad$ 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 | 11 (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 | 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 ${ }^{\text { }}$ | 3P-AC Connector |
| 270-1002-05 | " | 8P-8P |
| 270-1003-05 | " | 7P-7P |
| 270-1004-05 | " | 4P-DC Connector |
| 270-1005-05 | " | 5 P -LED |
| 270-1006-05 | " | 3P-CRT |
| 270-1007-05 | " | 3P-CRT |
| 270-1008-05 | " | 3P-Position(CH-A) |
| 270-1009-05 | " | $" \quad(\mathrm{CH}-\mathrm{B})$ |
| 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 | 95 GB 31 |
|  | 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 ( $2.2 \mu \mathrm{H}$ ) |
|  | 002-1000-05 | Variable Resistor | $1 \mathrm{KS}-\mathrm{B}$ (V.Position CH-A) |
|  | 002-1007-05 | " | $1 \mathrm{~K} \Omega-\mathrm{B}\left({ }^{\text {c }}\right.$ ( W/PULL SW) |
|  | 002-1001-05 | " | 20KS-B(H.Position) |
|  |  | Carbon Resistor | 3308 $1 / 8 \mathrm{~W} \quad \pm 5 \%$ |
|  |  | " | 228 1/8W $\pm 5 \%$ |
|  |  | Metal Filmed Capacitor | 0.022 F 630V $\pm 20 \%$ |
|  | 026-1000-05 | Power Switch |  |
|  | 020-1000-05 | Slide Switch for AC-GND-DC | Non-Shorting. |
|  | 020-1001-05 | Slide Switch for Battery |  |
|  |  | Operation |  |
|  | 095-1000-05 | Ni-Cd Battery | NR-SCU 1200mAH |

## 6-2 VERTICAL AMPLIFIER UNIT

REF. NO.
P1,2,5,7
P3
P4
P6
L1-4
L1-4
L7-8
IC1-2
IC-3
IC-4
IC-5
Q1,25
Q2,26
Q3-6,9-10, 27-30
Q7-8,12-14,21-22,31-32,36
Q11,15-16,23-24,33-35
Q17-18
Q19-20
D1,11,15,20-22,24
D2-9,16-19
D10,14
D13
VR1,7,13
VR2,8
VR3,5,9,11-12
VR4,10
VR6
S1-2
S3

PARTS NO.

|  | Connector $"$ $"$ $"$ |
| :---: | :---: |
| 290-1002-14 | Printed Circuit Board Ferri-Inductor <br> " <br> " |
|  | Linear Integrated Circuit Digital Integrated Circuit 11 |
|  | F.E.T. |
|  | Dual F.E.T. |
|  | Transistor " |
|  | " |
|  | " |
|  | " |
|  | Diode |
|  | Zener Diode |
| 008-1006-05 | Variable Resistor |
| 002-1004-05 | " |
| 008-1004-05 | " |
| 008-1013-05 | " |
| 008-1007-05 | " |
| 018-1005-05 | Rotary Switch |
| 022-1002-05 | Lever Switch |

5048-3A
5048-7A
5048-9A
5048-4A
$47 \mu \mathrm{H}$
$0.68 \mu \mathrm{H}$
$470 \mu \mathrm{H}$
HA1127 orCA3046
CD4001 or MCl4001B
CD4011B or MC14011B
SN74LSO3N
2Sk30A(0)
2SK58-1-M
2SC535(C)
2SA836
2SC458D or E
2SC1628(Y)
2SA818(Y)
1S1555
1S1587
WZ050
WZ065
1KR-B Step ATT BAL
5K
1008-B
6808-B
470KR-B
VOLT/DIV
MODE
(Carbon Resistors of $1 / 8 \mathrm{~W}$ Tolerance $\pm 5 \%$ are not listed here.)
R2,106
R3,107
R4,108
R5,109
R6,110
R7,57,60,111
R8,112
R12-13,63,116-117
R21-22,38, 42, 66,71,125-126,144-145
R23,127
R24,129
R26,131
R29,31,133,135
R32,39-40,136,142-143
R35,138
R36-37,139-140
R44-45,149-150
R46,153
R64
R78, 82
Metal Filmed Resistor
"
"
$"$
$"$
"
"
"
"

R85,93
TCl,3,5,7,9,11
TC2,4,6,8,10,12-13

| 900K 8 | 1/2W | $\pm 1 \%$ |
| :---: | :---: | :---: |
| $111 \mathrm{~K} / 2$ | 1/4W |  |
| 990K8 | $1 / 2 \mathrm{~W}$ | " |
| $10.1 \mathrm{~K} \Omega$ | 1/4W | " |
| 999Kת | 1/2W | " |
| $1 \mathrm{~K} \Omega$ | 1/2W | " |
| 1 M 2 | 1/2W | " |
| $6.8 \mathrm{~K} \Omega$ | 1/4W | " |
| $4.7 \mathrm{~K} \Omega$ | 1/4W | " |
| 5108 | 1/4W | " |
| 3908 | 1/4W | " |
| 688 | 1/4W |  |
| 3308 | 1/4W | " |
| 6808 | 1/4W | " |
| 2208 | 1/4W | " |
| 12 K ת | 1/4W |  |
| $3 \mathrm{~K} \Omega$ | 1/4W | ' |
| 1008 | 1/4W | " |
| 13120 | 1/4W | " |
| 100kת | 1/4W | " |
| $1.8 \mathrm{~K} \Omega$ | 1/4W | " |
| ECV-1ZW04X64 |  |  |
| ECV-1Z | $10 \times 64$ |  |


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

### 6.3 HORIZONTAL/TIME BASE UNIT

|  | 736-1010-00 | Complete Assembled Circuit |  |  |
| :---: | :---: | :---: | :---: | :---: |
| P1 |  | Connector | 5048-8A |  |
| P2 |  | " | 5048-9A |  |
| P3-7 |  | " | 5048-3A |  |
|  | 290-1004-04 | Printed Circuit Board |  |  |
| L1 |  | Ferri-Inductor | FL4H2R2K | $2.2 \mu \mathrm{H}$ |
| L4-5 |  | " | FL5H470K | $47 \mu \mathrm{H}$ |
| IC1,4 |  | Digital Integrated Circuit | MC14572 |  |
| IC2 |  | Linear Integrated Circuit | AN606 |  |
| IC3 |  | Digital Integrated Circuit | SN74LSOON |  |
| 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. | 2SK3OA (0) |  |
| Q13 |  | Transistor | $2 \mathrm{SA912}$ |  |
| 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.

| VR1 | $008-1009-05$ |
| :--- | :--- |
| VR2 | $002-1005-05$ |
| VR3 | $008-1010-05$ |
| VR4 | $002-1006-05$ |
| VR5 | $008-1003-05$ |
| VR6 | $008-1010-05$ |
| VR7 | $008-1010-05$ |
| VR8 | $008-1001-05$ |
| VR9 | $008-1008-05$ |
| VR10 | $008-1004-05$ |
| VR11 | $008-1012-05$ |
| VR12 | $008-1003-05$ |
| S2 | $018-1006-05$ |
| S3-4 | $022-1001-05$ |

PARTS NO.

DESCRIPTION
Variable Resistor
$" 1 "$
$"$
$"$
$"$
$"$
$"$
$"$
$"$
$"$
$"$
Rotary Switch
Lever Switch

| 4.7K | CAL ADJ |
| :--- | :--- |
| $20 \mathrm{~K} \Omega$ | TRIG LEVEL |
| $47 \mathrm{~K} \Omega$ | TRIG SLOPE BAL |
| $10 \mathrm{~K} \Omega$ | SWEEP TIME VAR |
| $100 \mathrm{~K} \Omega$ | SWEEP LENGTH ADJ |
| $47 \mathrm{~K} \Omega$ | SWEEP ADJ |
| $47 \mathrm{~K} \Omega$ | MAG CENTER ADJ |
| $22 \mathrm{~K} \Omega$ | CH-B POSI ADJ |
| $220 \Omega$ | MAG GAIN ADJ |
| $100 \Omega$ | HOR CENTER ADJ |
| $470 \Omega$ | SWEEP LINEARITY ADJ |
| $100 K \Omega$ | CAL CIRCUIT |
| SWEEP/TIME |  |


| $100 \mathrm{~K} \Omega$ | $1 / 4 \mathrm{~W}$ | $\pm 1 \%$ |
| :--- | :--- | :--- |
| $3 \mathrm{M} \Omega$ | $1 / 4 \mathrm{~W}$ | $\pm 1 \%$ |
| $1 \mathrm{M} \Omega$ | $1 / 4 \mathrm{~W}$ | $\pm 1 \%$ |
| $500 \mathrm{~K} \Omega$ | $1 / 4 \mathrm{~W}$ | $\pm 1 \%$ |
| $300 \mathrm{~K} \Omega$ | $1 / 4 \mathrm{~W}$ | $\pm 1 \%$ |
| $100 \mathrm{~K} \Omega$ | $1 / 4 \mathrm{~W}$ |  |
| $15 \mathrm{~K} \Omega$ | 1 W |  |
| $20 \mathrm{~K} \Omega$ | 1 W |  |

(Tolerance $\pm 20 \%$ unless otherwise indicated.)

| TCl | Ceramic Trimmer |
| :---: | :---: |
| Cl | Mylar Capacitor |
| C2,18,57 | Ceramic Capacitor |
| C3,16,29-30,34,47 | , |
| C4, 10, 36-39,48-49,55-56 | Tantalum Capacitor |
| C5,9,15,35,52-54 | Semiconductor Ceramic Cap. |
| C6,13,40-43 | Tantalum Capacitor |
| C7 | Electrolytic Capacitor |
| C8 | Mylar Capacitor |
| Cll | Ceramic Capacitor |
| C19 | Tantalum Capacitor |
| C20,58 | Ceramic Capacitor |
| C21 | Metalized Film Capacitor |
| C22 | " |
| C23 | Ceramic Capacitor |
| C24 | ${ }^{\prime \prime}$ |
| C25,44 | " |
| C32 | " |
| C33 | " |
| C45 | " |
| C50 | Electrolytic Capacitor |


| 1700 pF | 50 V | $\pm 10 \%$ |
| :--- | :--- | :--- |
| 5 pF | 50 V | $\pm 5 \%$ |
| $0.01 \mu \mathrm{~F}$ | 50 V | $\pm 10 \%$ |
| $22 \mu \mathrm{~F}$ | 16 V |  |
| $0.1 \mu \mathrm{~F}$ | 12 V | $+80 \%-20 \%$ |
| $1 \mu \mathrm{~F}$ | 25 V |  |
| $47 \mu \mathrm{~F}$ | 10 V |  |
| 2200 pF | 50 V | $\pm 10 \%$ |
| 220 pF | 50 V | $\pm 5 \%$ |
| $0.01 \mu \mathrm{~F}$ | 50 V |  |
| 15 pF | 50 V | $\pm 10 \%$ |
| $0.47 \mu \mathrm{~F}$ | 200 V | $\pm 5 \%$ |
| $0.004 \mu \mathrm{~F}$ | 200 V |  |
| 39 pF | 50 V | $\pm 5 \%$ |
| 22 pF | 50 V | $\pm 5 \%$ |
| 47 pF | 50 V | $\pm 5 \%$ |
| 680 pF | 50 V |  |
| $0.01 \mu \mathrm{~F}$ |  |  |
| 2 pF | 50 V | $\pm 5 \%$ |
| $4.7 \mu \mathrm{~F}$ | 250 V |  |

## 6-4 POWER SUPPLY UNIT

REF. NO.
PARTS NO.
DESCRIPTION


REF. NO.
DESCRIPTION

|  | Diode | W02 |  |  |
| :---: | :---: | :---: | :---: | :---: |
| D2,12 | Diode | RA-17N |  |  |
| D3-4 | Zener Diode | RA-1ZN |  |  |
| D5,8-10,15-18,22,31-33 | Diode | 1 S 1555 |  |  |
| D6 | Zener Diode | WZ-081 |  |  |
| Dll | " |  |  |  |
| D13,36 | " | WZ-120 |  |  |
| D14 | Diode | WZ-065 |  |  |
| 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(1KS) |  |  |
| (Carbon Resistors of $1 / 8 \mathrm{~W}$ Tolerance $\pm 5 \%$ are not listed.) |  |  |  |  |
| R5 | Metal Filmed Resistor | 108 | 1W | $\pm 2 \%$ |
| R35 | Carbon Resistor | 10M12 | 1/2W | $\pm 10 \%$ |
| R39 | " | 47K8 | 1/4W | $\pm 10 \%$ |
| R40 | " | $1 \mathrm{M} \Omega$ | 1/2W |  |
| R41 | Metal Filmed Resistor | 10 M 2 | 1 W |  |
| R42 | " | 62Kת | 1/4W | $\pm 1 \%$ |
| R43-44 | " | 22M8 | 1/4W | $\pm 20 \%$ |
| R45 | Carbon Resistor | $100 \mathrm{~K} \Omega$ | 1/4W | $\pm 10 \%$ |
| R59 | Wire Wound Resistor | 0.338 | 1/2w |  |
| (Tolerance $\pm 20 \%$ unless otherwise indicated.) |  |  |  |  |
| Cl,6,13,16,23,25,47 | Tantalum Capacitor | $1 \mu \mathrm{~F}$ | 25 V |  |
| C2 | Electrolytic Capacitor | 470 ${ }^{\text {F }}$ | 50 V |  |
| C3 ${ }^{\text {c }}$, 5 |  | $10 \mu \mathrm{~F}$ | 50 V |  |
| C4,7,43,52 | Semiconductor Ceramic | $0.1 \mu \mathrm{~F}$ | 12V | +80\% - $20 \%$ |
| C5,10 | Electrolytic Capacitor | $220 \mu \mathrm{~F}$ | 50 V |  |
| C9 Cl 2 | Ceramic Capacitor | 47pF | 50 V | $\pm 5 \%$ |
| $\mathrm{Cl2}$ Cl 4 | Electrolytic Capacitor | $47 \mu \mathrm{~F}$ | 50 V |  |
| Cl4 |  | 470 ${ }^{\text {F }}$ | 25 V |  |
| C15 C17,53 | Mylar Capacitor | $0.1 \mu \mathrm{~F}$ | 50 V | $\pm 10 \%$ |
| C17,53 $\mathrm{C} 18-19$ | Ceramic Capacitor | 220pF | 50 V | $\pm 5 \%$ |
| C20 | " | 47pF | 50 V | +5\% |
| C21 | " | 10pF | 50 V | $\pm 5 \%$ |
| C22 | Tantalum Capacitor | 47 $\mu \mathrm{F}$ | 25 V |  |
| C24 | Electrolytic Capacitor | $10 \mu \mathrm{~F}$ | 50 V |  |
| C26,32 | Ceramic Capacitor | $0.01 \mu \mathrm{~F}$ | 50 V |  |
| C27,38,44 | " | $0.01 \mu \mathrm{~F}$ | 500 V |  |
| C28-29 | " | $0.01 \mu \mathrm{~F}$ | 1 KV | +100\%-0\% |
| C30 | Metalized Capacitor | $0.022 \mu \mathrm{~F}$ | 630V |  |
| C33-36 | Ceramic Capacitor | $0.01 \mu \mathrm{~F}$ | 1.6 KV | $+100 \%-0 \%$ |
| C37 | Electrolytic Capacitor | $1 \mu \mathrm{~F}$ | 160 V |  |
| C39,41-42 | " | $10 \mu \mathrm{~F}$ | 160 V |  |
| C40 | " | $2.2 \mu \mathrm{~F}$ | 250 V |  |
| C45 | Ceramic Capacitor | 1 pF | 50 V | $\pm 5 \%$ |
| C46,51 | Electrolytic Capacitor | $220 \mu \mathrm{~F}$ | 16 V |  |
| C48 | Ceramic Capacitor | $0.01 \mu \mathrm{~F}$ | 50 V |  |
| C49 | " | 47 pF | 50 V | +5\% |
| C50 | " | $0.022 \mu \mathrm{~F}$ | 500 V |  |



7-1 CIRCUIT DIAGRAM FOR VERTICAL AMPLIFIER U!



TOP VIEW

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



7-2 CIRCUIT DIAGRAM FOR HORIZONTAL/TIME



TOP VIEW

7-2-(1) COMPONENTS LOCATION DIA HORIZONTAL/TIME BASE UNI


## TOP VIEW





TOP VIEW

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



TOP VIEW

MPONENTS LOCATION DIAGRAM FOR
WER SUPPLY UNIT

