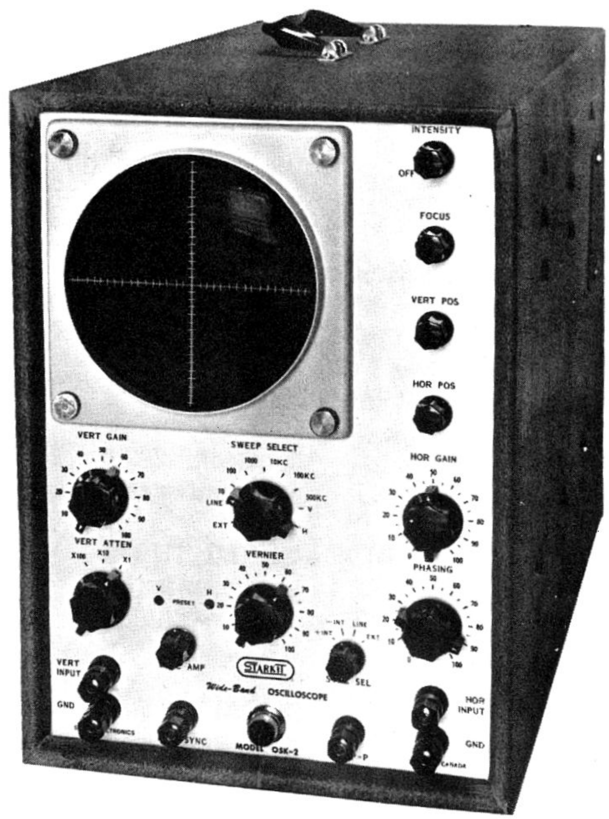
INSTRUCTION MANUAL

STARKIT

WIDE BAND

OSCILLOSCOPE

MODEL OSK-2



STARK ELECTRONIC INSTRUMENTS LIMITED
AJAX ONTARIO

OSK-2-8-62

SECTION I

1.1 TECHNICAL REFERENCE DATA

1. Equipment Supplied

1 Cathode Ray Oscilloscope Model OSK-2
1 Instruction Manual
1 Assembly Instructions (if supplied in kit form only)
1 Shielded test cable

2. Vertical Amplifier

1. SENSITIVITY:
   .030 volts RMS per inch at 1 Kc.

2. FREQUENCY RESPONSE:
   Flat within ± 1 db from 10 cps to 2.5 mc and
   + 1 to -5.5 db from 5 cps to 5 mc.

3. RISE TIME:
   Less than .08 microseconds.

4. INPUT IMPEDANCE:
   (a) Attenuator at X1, 3 meg./20 mmfd. paralleled.
   (b) Attenuator at X10 and X100, 3.3 meg./10mmfd. paralleled.

5. ATTENUATOR:
   Three position switch, frequency compensated.

6. INPUT CHARACTERISTICS:
   600 VDC maximum input.

7. POSITIONING:
   Push pull type. ± 2 inches from center.

3. Horizontal Amplifier

1. SENSITIVITY:
   .25 volt (RMS) per inch.

2. FREQUENCY RESPONSE:
   Flat within ± 3 db from 5 cps to 350 Kc.

3. INPUT IMPEDANCE:
   4.7 meg. shunted by 30 mmfd.

4. GAIN:
   Gain control of the cathode follower type.

5. INPUT CHARACTERISTICS:
   Selector switch allows the use of an external signal through a panel terminal, of an internal line frequency, phase controlled signal, or of the internal sweep signal.

6. POSITIONING:
   Push pull type, permits a wide range of positioning necessary to examine any part of the trace even with fullhorizontal gain.

4. Sweep Generator

   1. RANGE:
      (a) From 10 cps to 500 Kc variable in five steps.
      (b) Two preset sweep frequencies are included in the circuit.

   2. SYNCRONIZATION:
      Internal positive or negative locking signal, self limiting circuit. Provision made for external variable sync. input.

   3. RETRACE BLANKING:
      Positive retrace blanking regardless of sweep frequency.

5. Power Supply

   AC supply only, 117V/50-60 cycles or 220V/50-60 cycles, consumption 90 watts.
   FUSED for 2 amperes on 117 volt operation.
   HIGH VOLTAGE 1300 volts (CRT supply).
   LOW VOLTAGE 350 volts fully regulated.
   FILAMENT VOLTAGE 6.3 volts AC.

1.2 DESCRIPTION

Purpose

The Starkit OSK-2 is a general purpose oscilloscope designed to meet the needs of Radio and Television Industries and to allow complete visual analysis of electrical and electronic circuits. It is designed to accurately portray sinusoidal waveforms, non-sinusoidal waves of special shapes such as square waves, etc., within the amplifier limitations. By direct application to the Cathode Ray Tube plates, waveforms with characteristics which exceed the amplifier limits may be viewed.

The Starkit Model OSK-2 weighs approximately 30 pounds and is housed in a wrinkle finish steel case. The panel is of a satin finish aluminum with markings permanently etched. All controls are located on the front of the panel and clearly marked as to their function. At the side of the cabinet, under a covering plate is located a terminal strip which allows for the connecting of a signal directly to the deflection plates of the Cathode Ray Tube. An auxiliary spot-shape control is accessible through a hole at the rear of the cabinet.

SECTION II

Theory of an Oscilloscope

2.1 GENERAL

The cathode-ray oscilloscope is an instrument for plotting a visual curve of one electrical quantity as a function of another electrical quantity. The resultant curve is displayed on the fluorescent screen of the cathode ray tube. The cathode ray tube consists of the following: an electron gun assembly which generates the electron beam, a means of focusing the electron beam into a sharp spot, and a means of deflecting the electron beam both horizontally and vertically.

Figure 2 shows the general construction of a cathode ray tube. The electron beam is generated by the cathode, controlled by the grid potential, focused by the first anode, accelerated by the second anode and controlled in position by the potential placed on the vertical and horizontal deflection plates. The trace is visible due to the effect of the electron beam on the fluorescent screen. The aquadag (colloidal graphite) coating is to further accelerate the electrons and to provide a means for the return of stray electrons due to secondary emission.

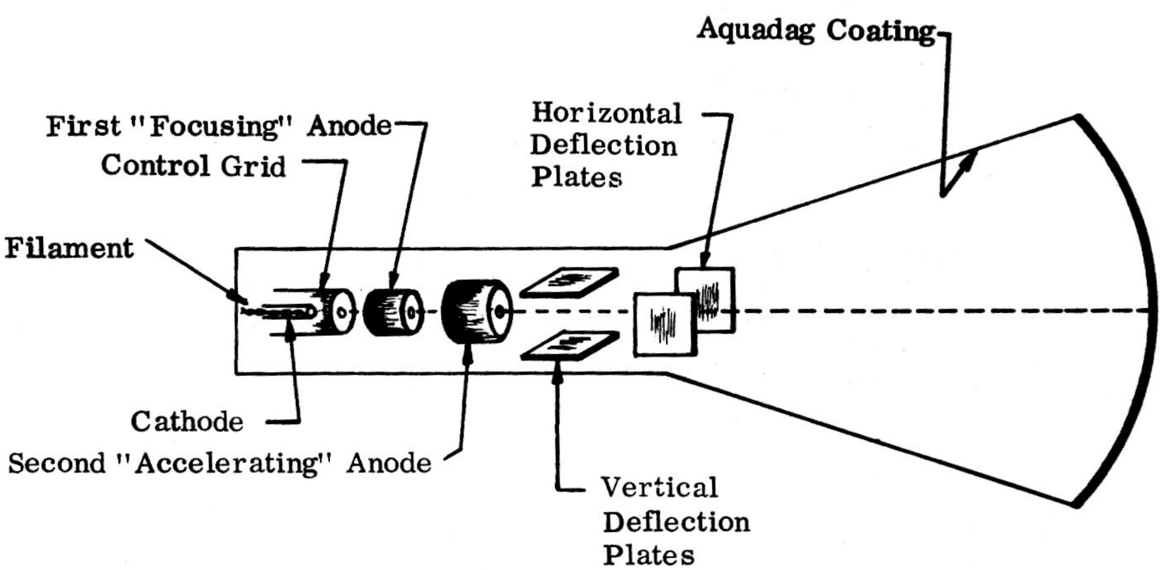


Figure 2 Cathode Ray Tube

In oscilloscopes such as the OSK-2 which are used for testing electronic equipment, the voltage to be observed is applied to the cathode ray tube in such a manner as to deflect the beam vertically The horizontal deflection is arranged so that the spot moves from left to right across the screen at a constant rate of speed and then rapidly returns to the left and repeats this action. If the repetition frequency of the linear sweep is equal to, or is an integral sub-multiple of the frequency of the vertical deflection voltage, a stationary pattern appears on the screen of the cathode ray tube; this pattern is the vertical deflection voltage plotted against time. The ratio of the frequency of the vertical deflection voltage to the frequency of the sweep voltage determines the number of cycles which appear on the screen.

If the amplitude of the signal to be observed is small, it is necessary to include amplifiers in the oscilloscope circuit to increase the amplitude to a usable value. Also included in the oscilloscope circuit are means for focusing the spot on the CR tube screen, positioning the image on the screen, and synchronizing the linear sweep with the voltage to be observed.

2.2 CONSTRUCTION

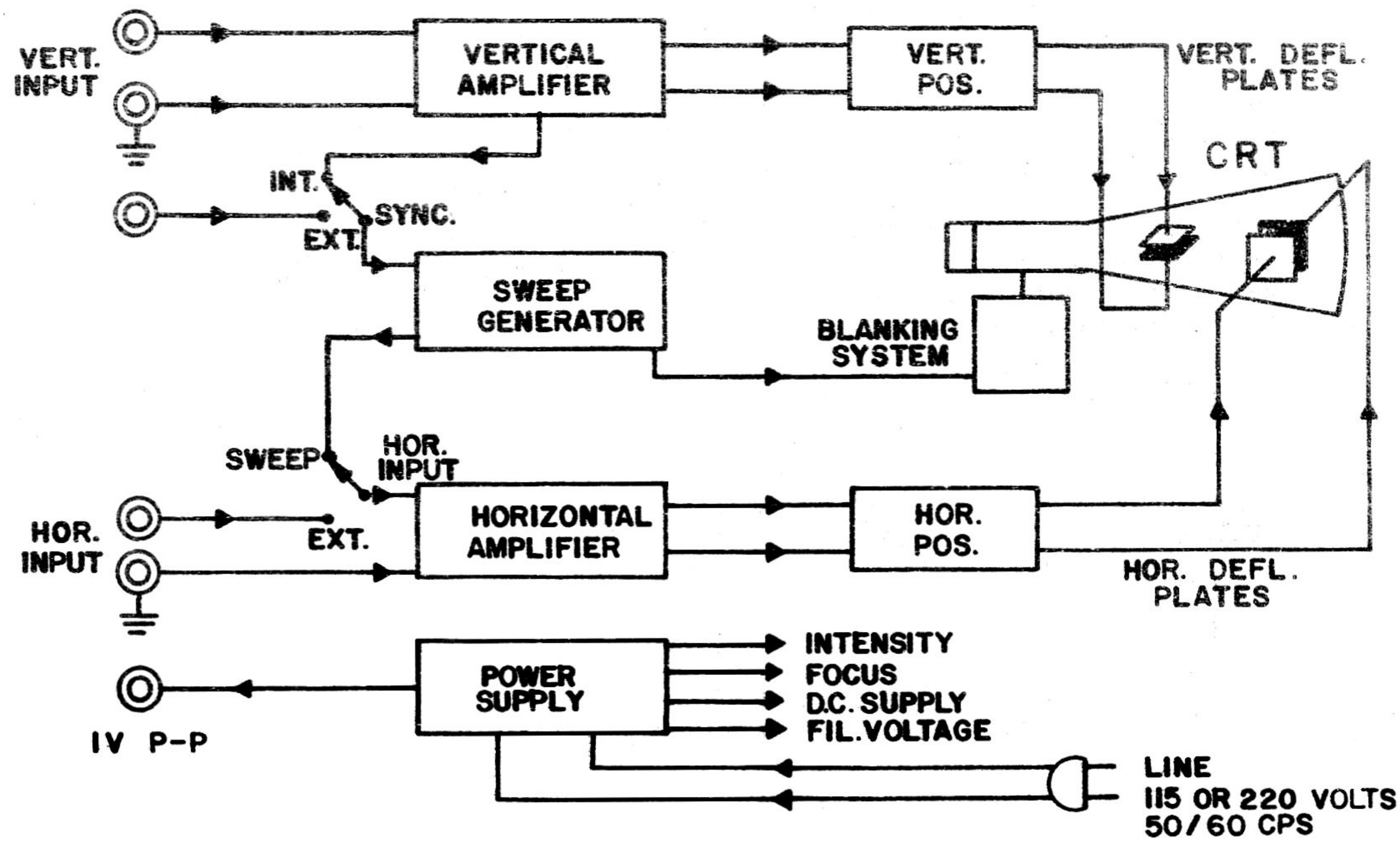


Figure 3
A simplified block diagram of the Starkit OSK-2 Oscilloscope.

2.3 THE VERTICAL AND HORIZONTAL AMPLIFIERS

In order that an oscilloscope may have a wide range of use, it is desirable that an amplifier circuit be provided for the observation of small amplitude signals. Such an amplifier must accurately reproduce the shape of the waveform applied, it must have a uniform phase shift and uniform gain for all frequencies over a wide band. The frequency response of the Starkit OSK-2 vertical amplifier is flat within 1 db to 2.5 mc and within 5.0 db to 5 mc. The vertical amplifier will faithfully reproduce complex waveforms that contain many harmonics. The hori zontal amplifier has a sufficiently wide band-width so as not to distort the output of the sweep generator. It is capable of passing a sawtooth voltage in order to get a linearly changing voltage on the horizontal deflection plates. This characteristic is very important during the flyback time of the sawtooth since it is of extremely short duration.

2.4 THE SWEEP GENERATOR CIRCUIT

The function of the sweep generator circuit is to move the electron beam in a steady continuous stroke across the screen so as to establish a reference of time. The waveform is referred to as sweep waveform while the circuit which produced the waveform is called a sweep generator. The output of this sweep generator is a sawtooth voltage which when applied to the horizontal deflection plates will cause the electron beam to move from left to right at a constant rate of speed, return to the left very rapidly, and then repeat the action. In most applications, the sweep voltage causes the electron beam to move horizontally while a signal is applied to the vertical deflection plates so that the beam is deflected in such a manner that it reproduces the vertical signal on the fluorescent coating of the cathode ray tube.

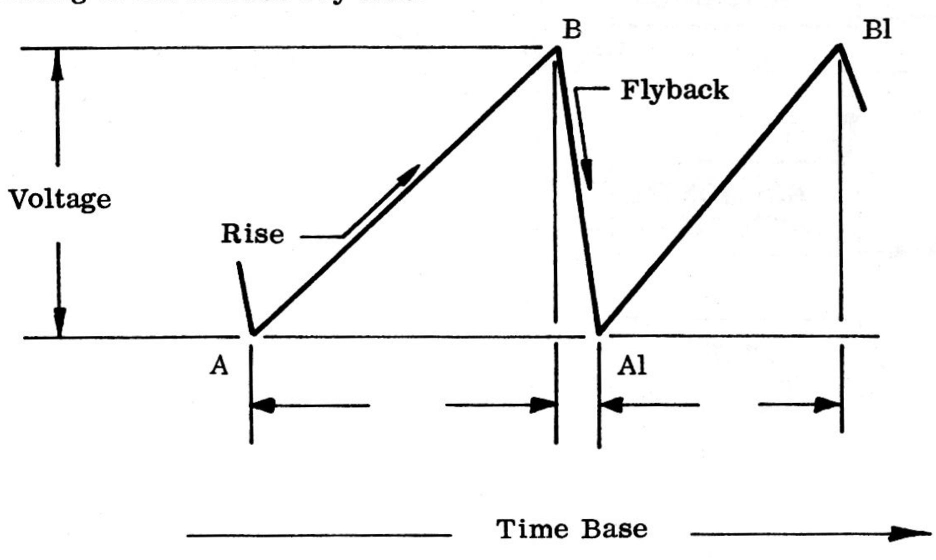


Figure 4 Saw Tooth Waveshape

Figure 4 illustrates the sawtooth voltage that is used for the sweep by applying it to the horizontal deflection plates. The voltage is made to rise from point (A) along a straight line to point (B). This is known as a linear rise. If this voltage is applied to the horizontal deflection plates, the electron beam will move as desired, i.e. from left to right. In order to return the beam to the left again, this voltage must drop down to the value it had at point (A). Time T1 is called the rise time while T2 is called the flyback time, since it represents the time during which the beam is being moved back to the starting point. The return trace is blanked out by means of a blanking amplifier so this portion of the trace is not visible on the screen. The simplest way of obtaining the gradual rise in voltage followed by a sudden drop is by charging and discharging a condenser. This is generally accomplished by means of a relaxation oscillator.

Figure 5 shows the basic circuit of a relaxation oscillator of the common cathode feedback multivibrator type. This is one type of oscillator circuit used in oscilloscopes. The saw-tooth voltage which is applied to the horizontal amplifier is developed by the slow charging of the plate capacitor C2. The charge is built up as the electrons flow into the lower plate of the capacitor while they flow away from the top plate through the relatively highresistor R2 and to B+. Because the resistor R2 and the capacitor C2 are variable the time of charging is variable. This produces the long sloping part of the saw-tooth wave (A-B). However, the moment V2 starts to conduct, capacitor C2 is rapidly discharged through this tube. Thus the sudden drop in the waveform is brought about. As soon as the tube ceases conduction, the slow charge part of the cycle begins again. During the charging interval, tube V2 must be held at cut-off, and this is accomplished by the action of triode section V1. As the multivibrator oscillates due to the transfer of energy from section V1 to V2 and back to V1, the grid of V2 is driven momentarily positive. This causes grid current in V2, which quickly charges C1. As this capacitor slowly discharges through R1 to ground, the voltage so produced holds tube V2 at cut-off so that C2 will have a long interval in which to charge. When the resistance to ground of R1 and the capacitor C1 is reduced or increased by varying the position of the sweep selector or vernier control, the blocking bias of V2 will decay more or less rapidly. This in turn will cause the tube to conduct sooner or later, discharging C2 and varying the rate of saw-tooth cycle. The incoming vertical synchronizing signal will take hold of the multivibrator circuit and keep the frequencies timed with those of the vertical amplifier.

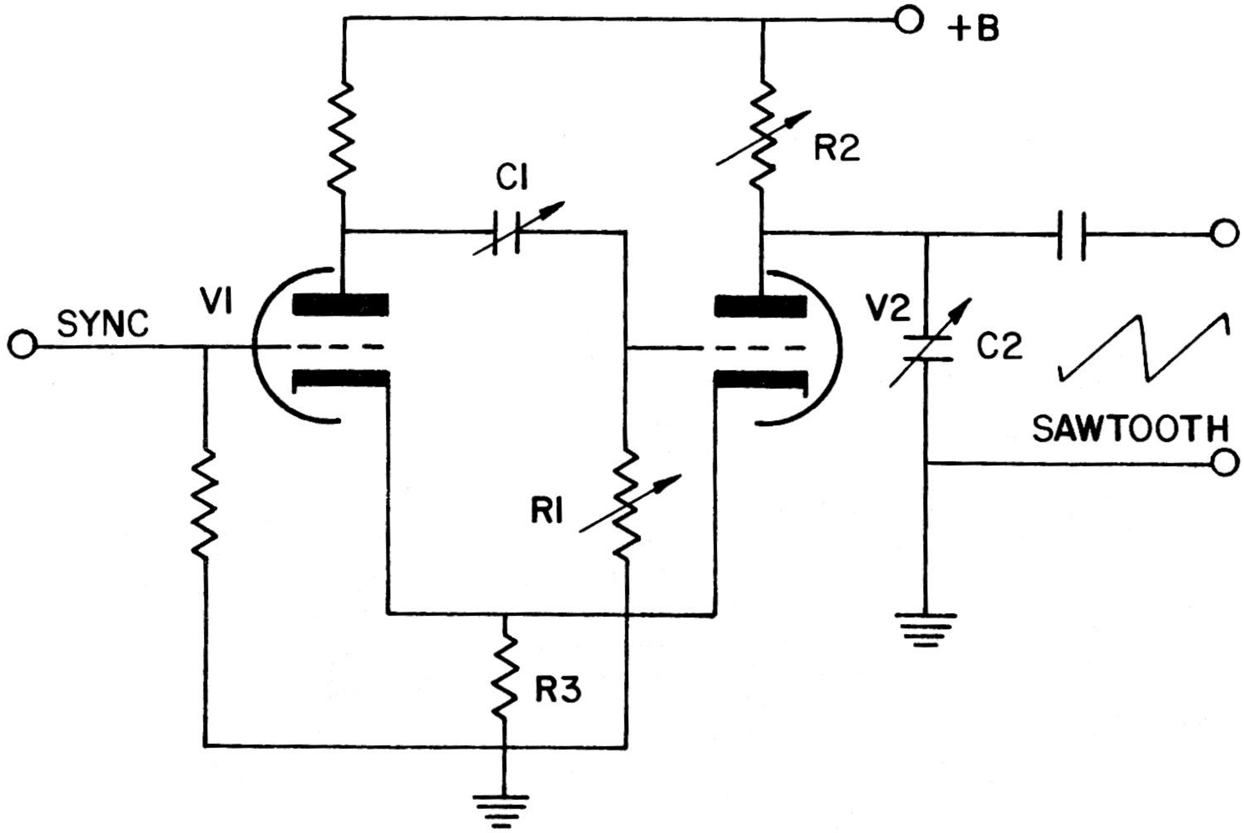


Figure 5 Basic Multivibrator Circuit

In order to obtain a Stationary pattern on the oscilloscope screen, the period of sweep must be exactly equal to the period of waveform, or some whole multiple thereof. If the length of the two periods are almost the same, the pattern will drift across the face of the screen. The speed at which the movement takes place depends upon the difference in frequency between the signal and the sweep.

It is necessary to synchronize the sweep generator with the waveform being observed in order to obtain a stationary pattern. This is accomplished by synchronizing the signal applied to the sweep generator in such a manner as to trigger the oscillator at exactly the correct interval of time, as was shown in block diagram figure 3. Synchronization may also be obtained from other sources, such as the 60 cycle line voltage, or any other external voltage that may be desired. The switch on the front of the panel marked "Sync" controls the selection of internal or external sync. When the switch is at "Ext", the synchronizing voltage must be connected to the external "Sync Input" binding posts.

2.6 POSITIONING CONTROLS

In almost every application of the cathode ray oscilloscope, it is necessary to be able to move the whole trace to the most desirable part of the screen. Positioning is accomplished by the application of a DC voltage to the deflection plates. To move the trace on the screen in any direction, a DC voltage is applied to the vertical and horizontal plates by the controls marked Vert., Pos. and Hor. Pos. on the OSK-2 front panel.

2.7 POWER SUPPLY

In order to supply the voltages required by the various circuits of the cathode ray oscilloscope, the power supply consists of three separate voltages.

(1) high voltage negative supply
(2) low voltage positive supply
(3) heater supply

The high voltage negative supply provides the cathode ray tube accelerating anode potential as well as operating potentials for proper intensity and focusing of the cathode ray tube beam.

The low voltage positive supply provides the necessary D.C. potential for operation of the horizontal and vertical amplifiers, and the synchronizing and sweep circuits. The heater supply supplies A.C. voltage to the filaments of the tubes, the 1 volt peak to peak calibrating voltage and the operating voltage for the phasing control.

SECTION III

OPERATION

This section will serve to explain the functioning of the controls and terminals on the front panel of the Starkit Model OSK-2 oscilloscope.

3.1 INTENSITY

This is a dual function power switch and Intensity control. Rotating the intensity control from the OFF position will turn the unit on, as indicated by the pilot light. The control is further rotated until the trace is visible with sufficient brightness. The trace should be kept just sufficiently bright for easy viewing.

3.2 FOCUS

Controls the size of the electron beam on the cathode ray tube. The focus control should be adjusted to give a trace that is sharp and clear. Re-focusing is generally necessary when re-adjustment of the intensity control is made.

NOTE: A sharply focused line or spot of high intensity, having short length or small area, should not be permitted to remain stationary on the screen for any considerable length of time. Under such conditions, the entire energy of the beam is concentrated over a small area, thus subjecting the screen material to burning and discoloration.

3.3 VERT. POS.

Adjusts the position of the beam either up or down.

3.4 HOR. POS.

Adjusts the position of the beam either to the left or right.

3.5 VERT. GAIN

Controls the amplitude of the vertical deflection.

3.6 HOR. GAIN

Controls the amplitude of the horizontal deflection.

3.7 VERT. ATTEN.

Provides for input signal attenuations of 1, 10 and 100.

3.8 SWEEP SELECT

Selects horizontal sweep frequency in five steps as follows:

10 to 100 cps,
100 to 1000 cps,
1 to 10 kc,
10 to 100 kc,
100 to 500 kc.

On position V, the sweep frequency may be present for any frequency between 10 and 100 cps bymeans of preset marked V, and is normally preset for 30 cps. On position H, the sweep frequency may be preset for any frequency between 1 and 10 kc by means of preset marked H, and is normally preset for 7875 cps.

On LINE FREQ. position, the horizontal sweep frequency is the same as the power line frequency. When it is desired to use an external signal for the horizontal deflection, the switch is rotated to the EXT. INPUT position.

3.9 VERNIER

A Variable Control of the frequency of the sawtooth sweep oscillator within the range covered by any one of the five positions of the SWEEP SELECT switch.

3.10 PHASING

Effective only when the SWEEP SELECT switch is in the LINE FREQ. position and is used to superimpose the forward and return trace when the oscilloscope is used for visual alignment.

3.11 SYNC AMP.

A variable control permitting adjustment of the amount of locking voltage used to synchronize the sweep circuit oscillator.

3.12 SYNC SELECT

Selects the type of synchronization desired, either positive or negative internal synchronization, or positive or negative external synchronization. When external synchronization is desired, the synchronizing signal is connected to the EXT. SYNC. terminal.

3.13 VERT. INPUT

A binding post connection for external signals to be applied to the vertical amplifier.

3.14 HOR. INPUT

A binding post connection for external signals to be applied to the horizontal amplifier. When this mode of operation is desired, the SWEEP SELECT. switch must be in the EXT. INPUT position.

3.15 EXT. SYNC

External voltages may be applied to this terminal for locking the sweep oscillator.

3.16 IV.P-P

A terminal supplying a fixed voltage of 1 volt peak to peak for calibrating the vertical amplifier.

In addition to the above controls and terminals, there is a spot-shape control and a Z axis input terminal located at the rear of the chassis and accessible without removing the cabinet.

The spot-shape control is used in conjunction with the focus control to initially adjust the trace for best focus.

The Z axis input terminal provides for connection of external signals to intensity modulate the trace.

3.17 SEQUENCE OF OPERATION

(a) Plug in line cord.
(b) Turn on ON-OFF switch (Intensity Control).
(c) SYNC. SEL. switch to + INT.
(d) Set SWEEP SELECT switch to desired frequency.
(e) Set Horizontal and Vertical positioning controls to center of rotation.
(f) Increase intensity control until brilliance of trace is at the desired brightness.
(g) Adjust focus for sharpest trace.
(h) Advance Horizontal and Vertical gain controls for desired deflection.
(i) Further setting of the controls will depend upon the application made.

3.18 CAUTIONS

(a) Never exceed the input peak voltages to the input terminals. Refer to page 1 of technical specifications for maximum input allowable.

(b) The life of the cathode ray tube will depend on the brilliancy used.

(c) To prevent horizontal distortion, use as little synchronizing voltage as possible which will cause the trace to remain stationary.

(d) The power transformer has a specially tapped primary winding for use on 110 or 220 volts A.C. Refer to the figure 6 for the proper connections for the power line voltage in your locality.

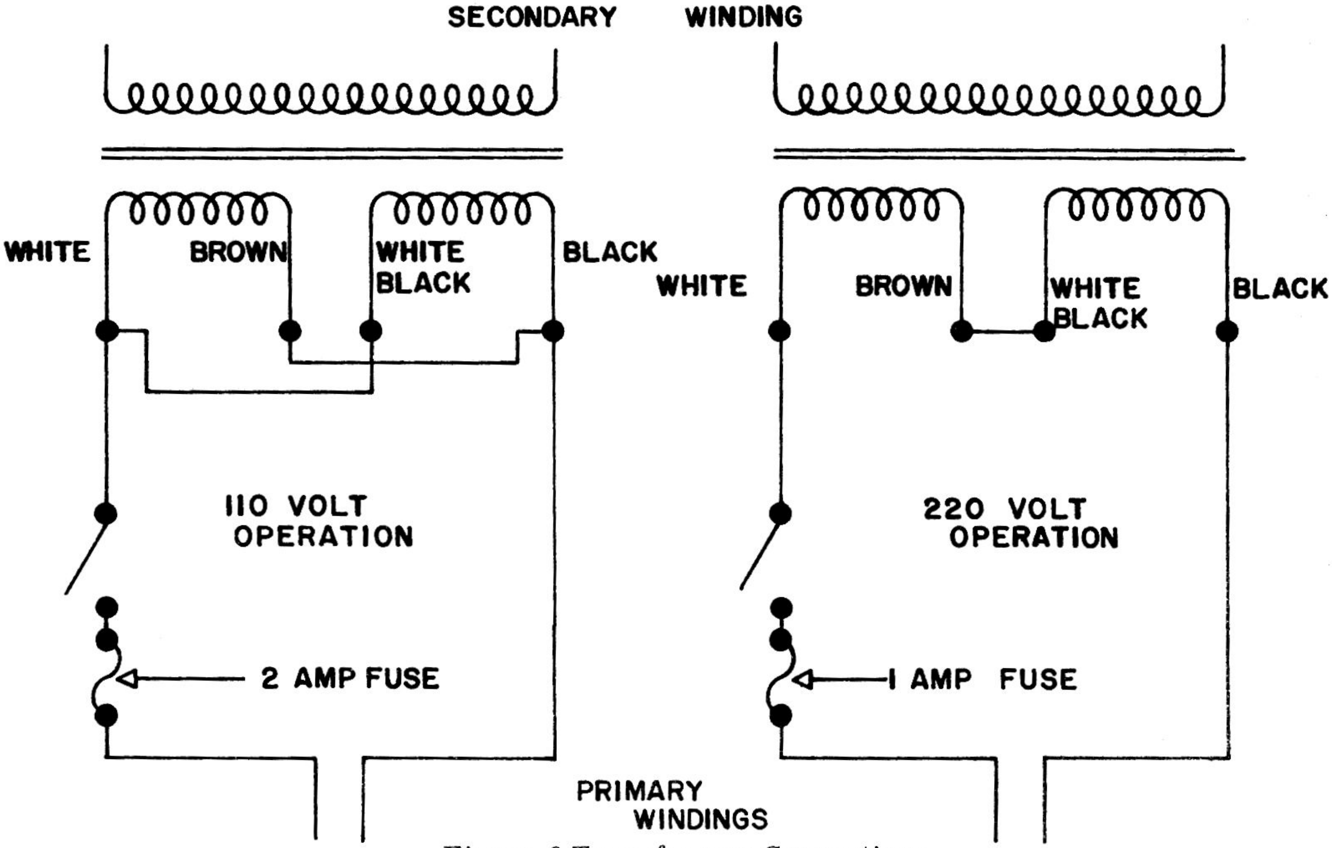


Figure 6 Transformer Connections

3.19 Vertical and Horizontal Plates, Direct Connection

Connections directly to the Cathode Ray Tube deflection plates are accessible after removing the covering plate on the right side rear of the Cabinet.

WARNING: The voltages that appear at the terminals of the Direct Connection Terminal board are by necessity high and dangerous to human life. Before making any changes or connections to the terminal board, the oscilloscope must be disconnected from the power source.

For normal operation, the Horizontal and Vertical amplifier terminals are connected to the Cathode Ray Tube deflection plates by means of the jumper wire as shown in figure. 7.

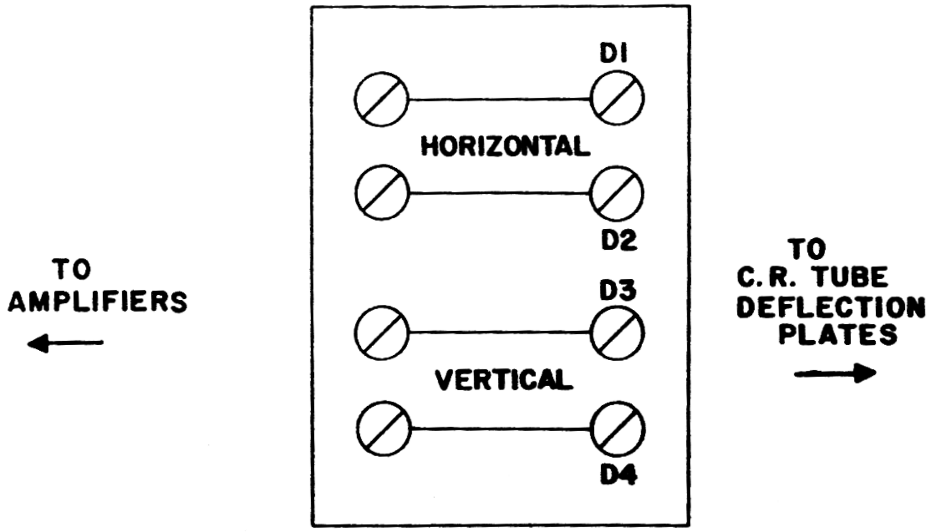


Figure 7 Deflection Plate Direct Connection

To connect directly to the Vertical Deflection Plates of the Cathode Ray Tube, remove the jumper wires connecting the Vertical Amplifier terminals to the direct terminals D3 & D4.

For balanced inputs, connect the signal to terminals D3 & D4 through a .1 mfd 400 Volt isolating capacitor

Join the oscilloscope and the signal source by means of a common ground.

For unbalanced inputs, connect terminal D4 to ground through a .1 mfd 400Volt capacitor. Connect the signal source directly to ground and through a .1 mfd 400 Volt capacitor to terminal D3.

To connect directly to the Horizontal Deflection Plates, follow the procedure as outlined for the Direct Vertical Connection, but making connections to Horizontal Terminals D1 & D2.

SECTION IV

CALIBRATION

When purchased as a factory wired unit, the model OSK-2 oscilloscope is fully calibrated at the factory and requires no further calibration.

When the oscilloscope is purchased as a kit, the vertical attenuator must be frequency compensated in the x10 and x100 positions by means of trimmer capacitors C1-A and C1-B respectively.

Compensation is adjusted by applying a 10 kc square wave to the VERTICAL INPUT terminals and adjusting the appropriate trimmer to pass the square wave with minimum of distortion. In figure 8, "A" represents proper adjustment, while "B" and "C" represent conditions of over-compensation and under-compensation respectively.

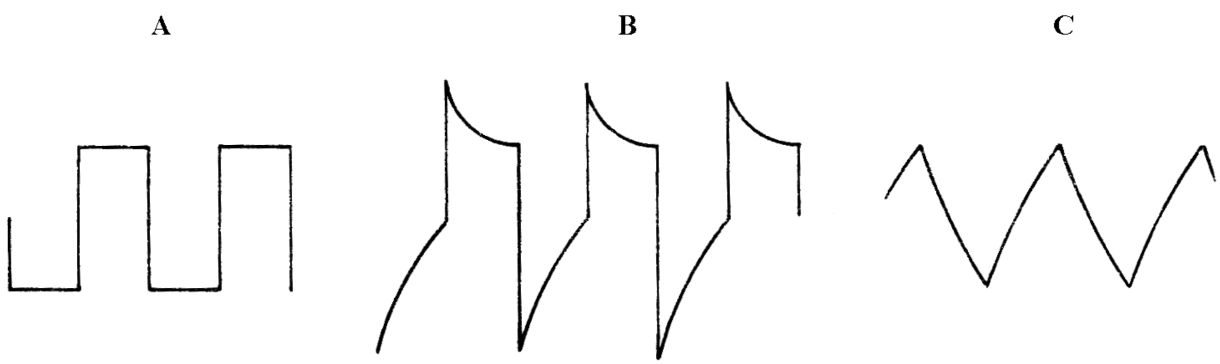


Figure 8 Square Wave Adjustment

Set the controls as follows:

(a) Intensity and focus controls for proper brightness and clearness of trace.
(b) Horizontal and Vertical positioning controls for centering trace location on screen.
(c) Vertical and Horizontal Gain controls for desired amplitude of trace.
(d) Sweep Selector Switch to 10 kc.
(e) Sync. Amplifier and Vernier controls set to lock a steady pattern.
(f) Sync. Selector to + INT position.

With the vertical Attenuator set at the x10 position, apply the 10 kc square wave to the Vertical Input binding posts and adjust the output of the generator and Vertical gain control for approximately a two inch deflection. Using a non-metallic screwdriver adjust the top trimmer at the side of the chassis near the vertical gain control until the square wave shows minimum distortion.

Switch to the x100 position, adjust the output of the square wave generator for appropriate deflection and adjust the bottom trimmer until the square wave shows minimum distortion.

If a square wave generator is not available, the following method will give a good approximation of correct frequency compensation:

Turn the power off. Temporarily solder a wire to the ungrounded side of the Horizontal Gain control, R47, and connect the other end to the Vertical In-Put binding post.

Set the Sweep Select. switch to the 1-10-kc position; the Vernier control to zero; the Vertical attenuator switch to x100; the Vertical amplifier to 10.

Turn on the power and adjust the focus, Intensity, Vertical Position, Horizontal Position and Horizontal Amplifier controls to obtain one of the diagonal lines illustrated in Figures 9A, 9B and 9C. It may be necessary to reduce the setting of the Vertical Gain control to reduce the height of the pattern.

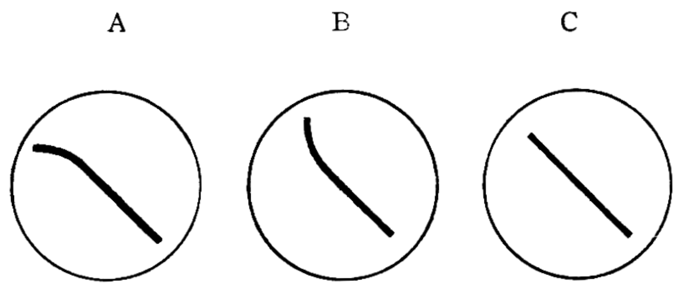


Figure 9 Vertical Attenuator Compensation

Using a non-metallic screwdriver, adjust the bottom trimmer capacitor C1-B to obtain the straight line pattern of figure 9C.

Set the Vertical Attenuator Switch to the x10 position and adjust the Vertical Amplifier control to obtain a pattern of the proper height. Adjust the top trimmer (C1-A) to obtain the straight line pattern of figure 9C. Turn the oscilloscope power off and remove the temporarily connected wire.

SECTION V

APPLICATIONS

5.1 AS A VOLTMETER

The advantages of the oscilloscope as a voltmeter are its very high input impedance, its ability to measure equally well voltages of a very wide frequency range, and its ability to indicate magnitude regardless of waveform. The oscilloscope will indicate peak-to-peak values of voltage.

In order for the oscilloscope to be used as a measuring device, it must first be calibrated. By calibration, it is meant to note the deflection in inches of the Vertical trace when a known voltage is applied to the Vertical Input terminals. A1 volt peak-to-peak (.354 volts r.m.s.) voltage is available at the 1V P-P terminal of the OSK-2.

To calibrate the Vertical amplifier, connect the 1V. P-P terminal to the Vertical Input terminal. Set the vertical Gain Control and Vertical Attenuator for the desired amplitude of trace. Remove the connection between the 1V. P-P and Vertical input terminals. Without re-adjusting the Vertical Gain and Vertical Attenuator controls, apply a signal to the Vertical Input terminals. The voltage of the unknown signal is then the ratio of the amplitude of the trace to the amplitude of the trace from the 1V. P-P signal. For instance, if the controls were set for 1" of trace on the 1V. P-P signal and the new signal caused a 2" deflection, then the unknown signal is 2 volts. It should be noted that the oscilloscope must be calibrated for various settings of the vertical gain control. A chart may be made from this which will calibrate the oscilloscope for any setting of the gain control, since the control used is of a linear type. Note that the signal is not attenuated at all but is fed directly to the vertical amplifier on the x1 position of the vertical attenuator.

On the x10 position, the signal is attenuated by a factor of 10, in other words, the trace will have one-tenth the amplitude it had on the x1 position.

On the x100 position, the signal is attenuated by a factor of 100, or the trace will have one-hundredth the amplitude it had on the x1 position.

5.2 AS AN AMMETER

It is possible to use an oscilloscope as a sensitive device to indicate current values. The method is indirect, but nevertheless accurate. It is based on Ohms law, that is, the voltage drop across a resistor is proportional to the current passed through it, providing the resistance is kept constant. An example of this would be: If we had an unknown current to be measured, we would first calibrate the scope as explained in 5.1. (The chart may be used if completed). We would then pass the unknown current through a resistor of known value and connect leads from the vertical terminals of the oscilloscope to either side of the resistor. In this way, we are measuring the voltage drop across the resistor and can interpret this value by noting the deflection of the electron beam. After the voltage drop of the resistor is determined, we merely use Ohms law to solve for current since we know the size of the resistor and the voltage drop across it. (I equals E/R).

5.3 AS A DISTORTION INDICATING DEVICE

If the output of some receiver is distorted and perhaps the audio section is suspected as the cause of the distortion, a sine wave at an audio frequency can be fed to the input of the audio section and a scope can be connected in turn to each of the stages, to find at which point the distortion is being introduced.

5.4 Frequency Measurement

5.4.1 When an alternating voltage is applied to both vertical and horizontal input circuits of the oscilloscope and the frequency of either one is changed, the pattern on the scope screen will change accordingly. It might seem that the shifting patterns are without rhyme or reason. Actually this is not the case. Many of these patterns, if carefully studied will indicate the frequency or phase relationship between the voltages applied to the vertical and horizontal plates and perhaps the waveform of the voltages as well

We know for instance that if a sawtooth voltage is applied to the horizontal input of the scope, and a sine wave of the same frequency is applied to the vertical input, the results will be the appearance of a single cycle of the sine wave voltage on the screen. Fig. 10

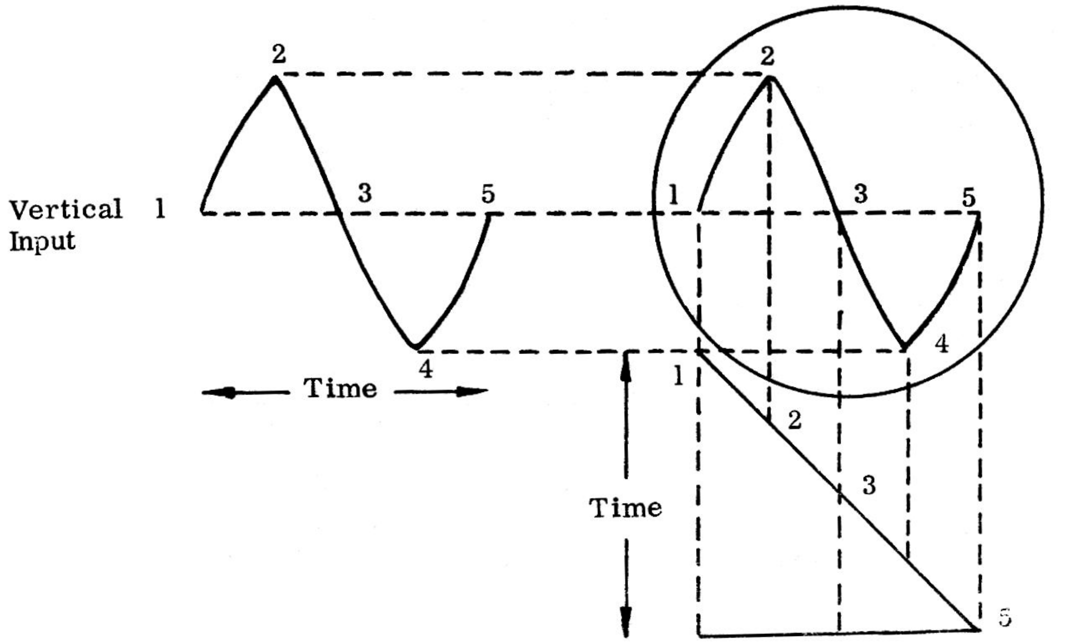


Fig. 10 Horizontal Sweep & Vertical Input Frequency are equal

5.4.2 If the sine wave input is double in frequency (or if the frequency of the sawtooth is cut in half) the resulting image will consist of two cycles. Figure 11.

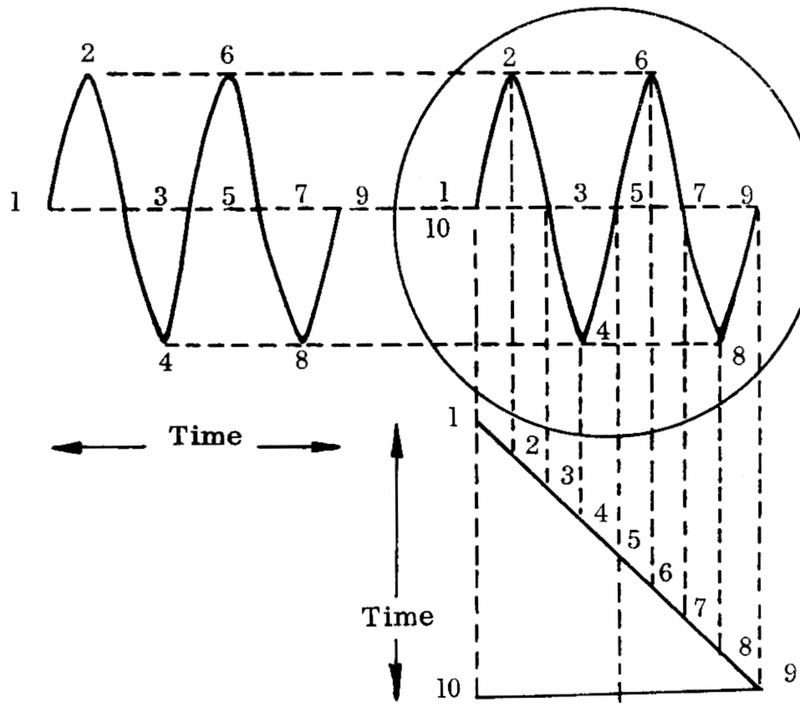


Fig. 11 Vertical Input Frequency is twice that of Horizontal Sweep Frequency

5.4.3 If however the frequency of the sawtooth is greater than the frequency of the Vertical Input, it will result in figures that are sub-multiples. Figure. 12 shows a sub-multiple pattern in the screen.

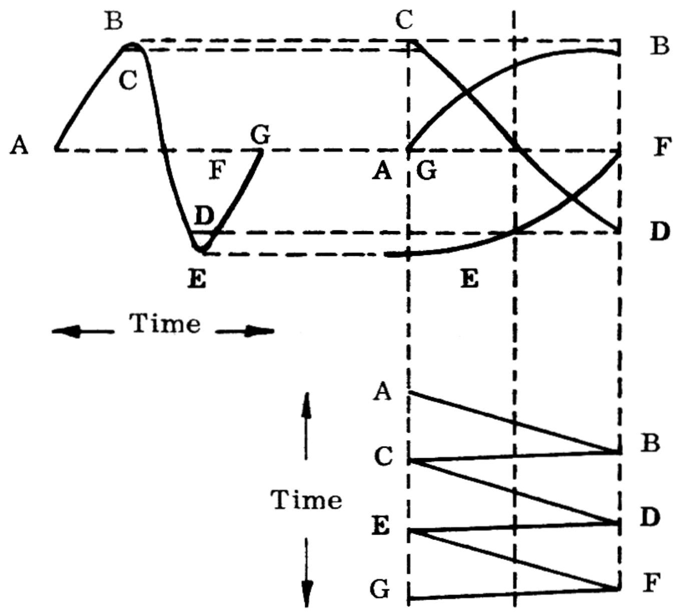


Fig. 12 Horizontal sweep frequency is three times that of Vertical Input frequency.

Referring to figure 12, the sawtooth voltage, being three times the frequency of that of the vertical input, must complete itself three times in order to trace out one cycle of the vertical input. Sawtooth #1 will trace out portion A to B, sawtooth #2 will trace out portion C to D, sawtooth # 3 will trace out portion EF. This results in a pattern similar to that shown in figure 12 depending on the settings of the gain controls. Time B to C, D to E and F to G, are retrace times in which the beam moves rapidly back to the left too fast to leave an impression on the screen.

5.4.4 The pattern created on an oscilloscope when sine wave voltages are applied to both horizontal and vertical plates is called a Lissajous figure. A large variety of patterns may be obtained, depending on the ratio of the frequency applied to the deflection plates. The Lissajous figure is useful in the determination of an unknown frequency by comparison with a standard frequency. The signal of unknown frequency is applied to the vertical amplifier of the oscilloscope. Signals from the generator capable of precise frequency settings are applied to the horizontal amplifier. If the two frequencies are 90 degrees out of phase and if their frequency is the same (that is if the ratio of their frequencies is 1:1) the resultant is a circle on the screen. However if they are in phase a straight line would appear on the screen Figure 13 shows a Lissajous pattern when the two frequencies differ.

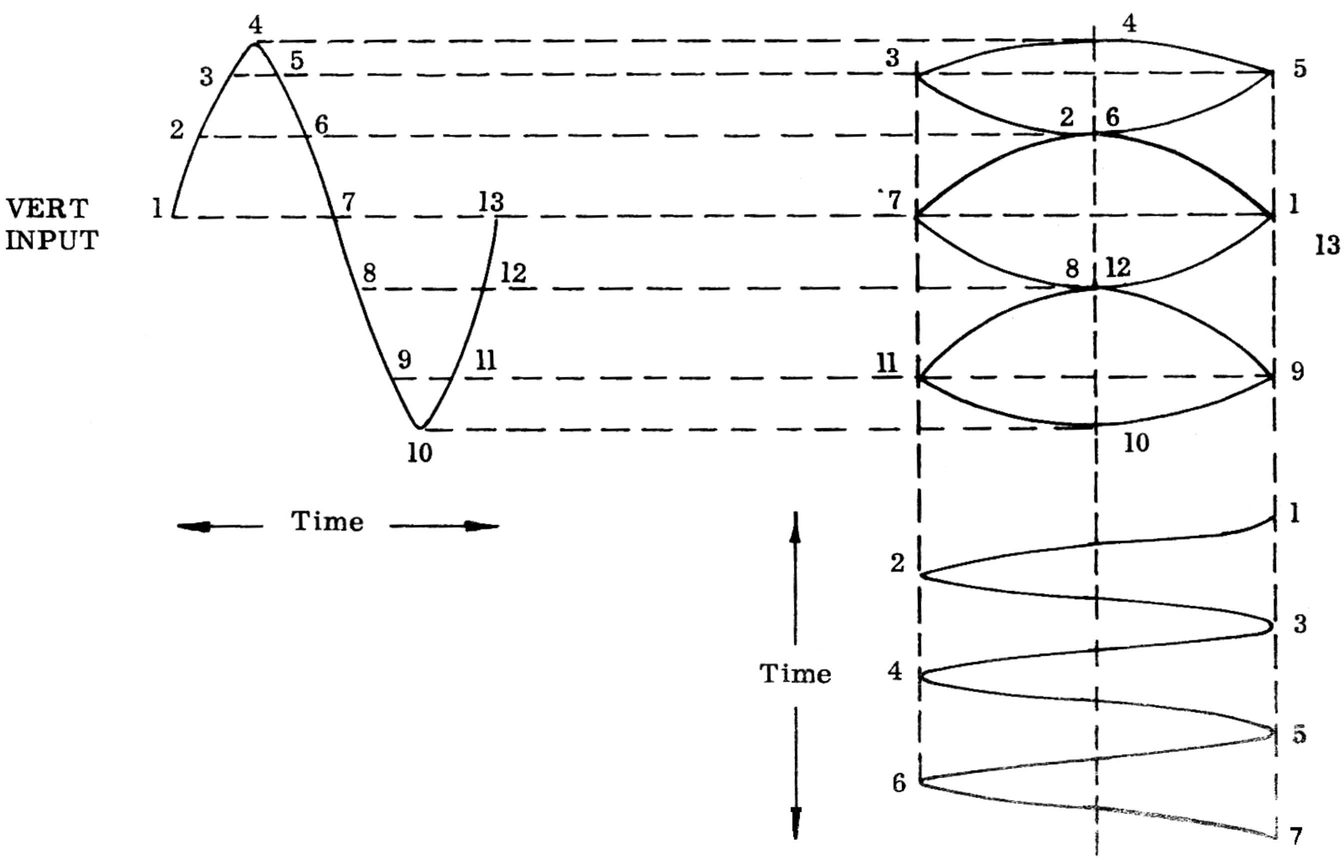


Figure 13 Lissajous Figure with 3:1 Ratio

Figure 13 shows a Lissajous figure with three loops This means that one frequency is three times as great as the other, when the loops are in a vertical plane it means that the horizontal frequency is three times the vertical If the Lissajous figure was rotated 90 degrees the vertical frequency would be three times the horizontal. The ratio of the frequencies can very simply be determined by counting the number of loops Four loops the frequency would have a 4:1 ratio, five 5:1 etc. Therefore the unknown frequency would be multiple or a fraction of the standard frequency depending on the phase of the Lissajous curve and the factor used to determine the frequency is the number of loops.

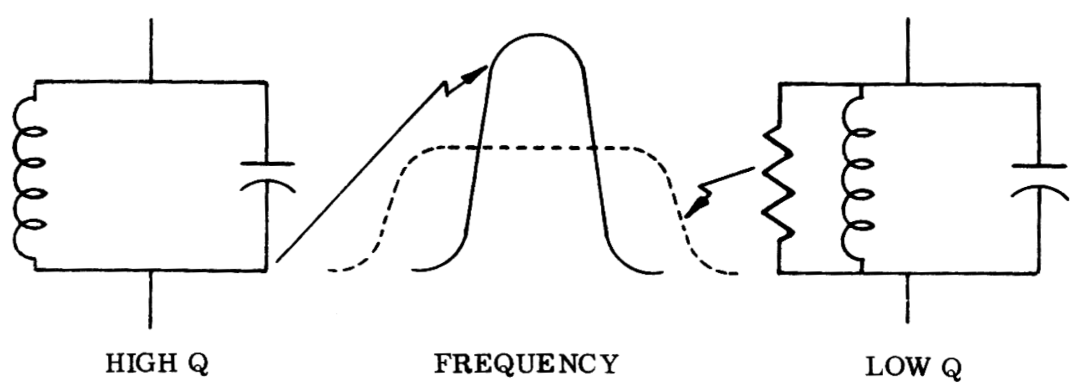
5.5 Alignment of tuned Circuits

A tuned circuit allows signals of only a certain frequency band to pass. The process by which tuned circuits are adjusted to pass the proper frequency is called alignment. Correct alignment of television or receivers is almost impossible without visual alignment equipment, therefore an instrument such as an oscilloscope is essential.

There are many variations of tuned circuits - some very sharply tuned - some with broad band of resonance. Therefore to precisely align a TV receiver the resonant curve of the particular set should be known.

Various Resonant curves are shown in figure 14, 15 & 16

Fig. 14



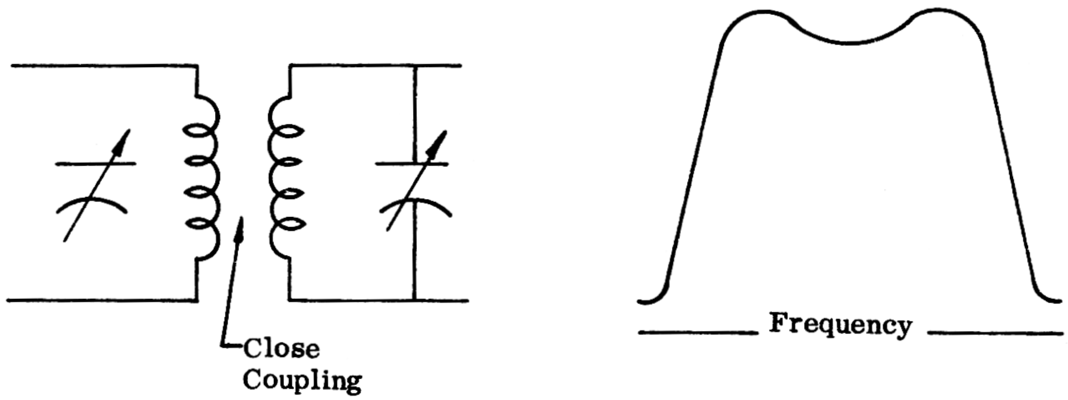


Fig. 15

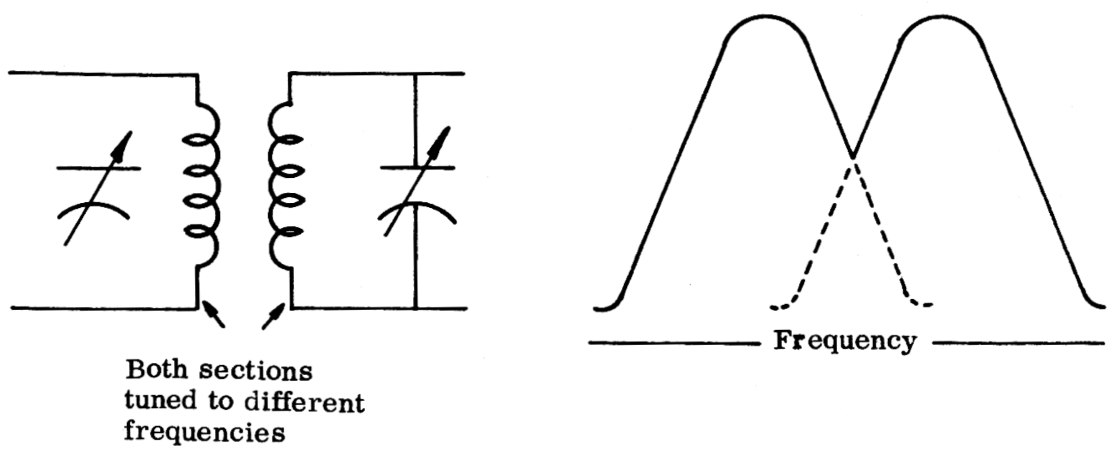


Fig. 16

During the alignment of I. F. or sound section of a receiver it is advisable to short the antenna; this eliminates spurious signals such as might be picked up by the antenna.

Fig. 17 shows the proper points to connect the oscilloscope for alignment of IF and Discriminator circuits.

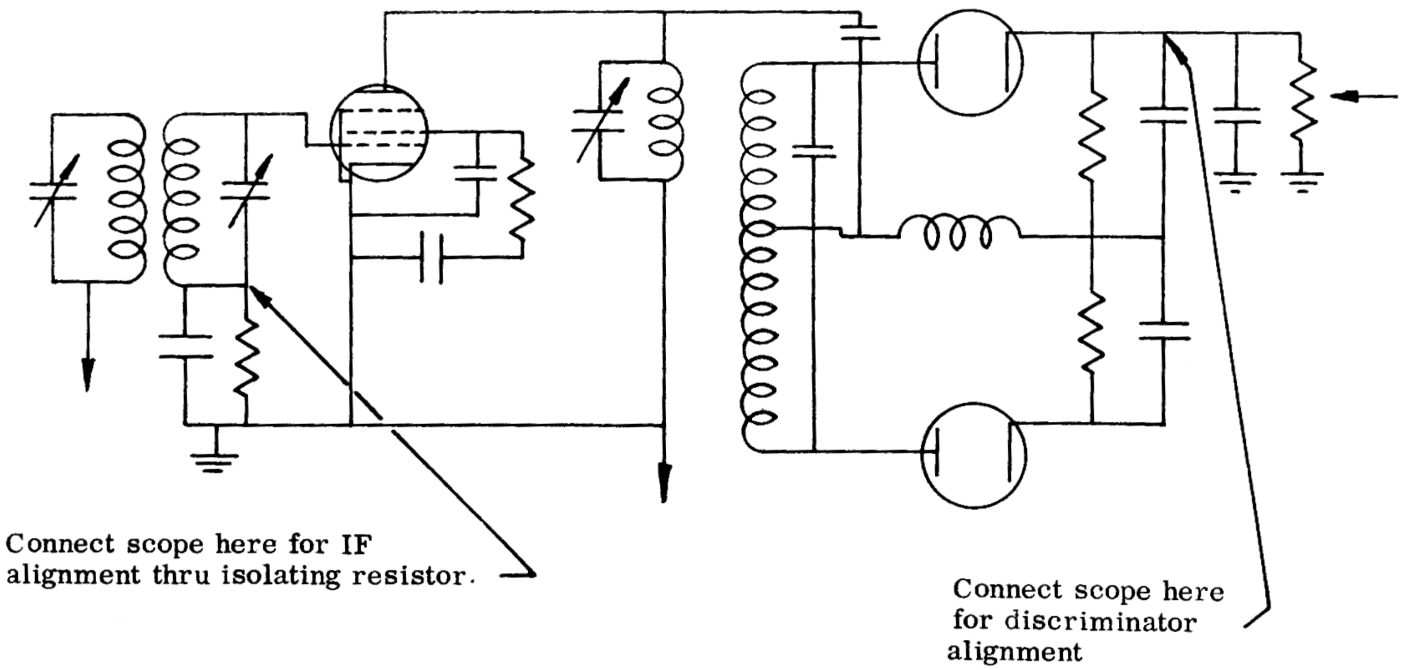


Fig. 17 - Foster Seeley Discriminator

The curve that will be viewed when the discriminator is properly aligned is shown in Fig. 18

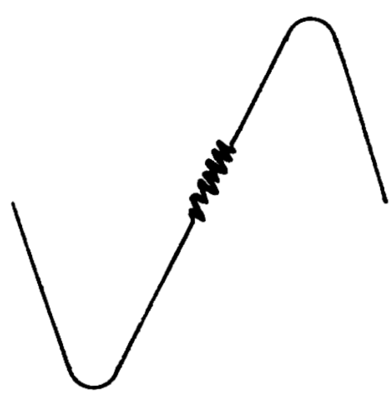


Fig. 18 Discriminator Response

Section V Maintenance

6. 1 Maintenance

No maintenance other than routine replacement of tubes should be necessary. However, should repairs be required, the schematic diagram, and a voltage and resistance chart are included in the instruction manual.

6. 2 Removal from Cabinet

To remove the oscilloscope from the cabinet, remove the eleven screws holding the back panel to the rear of the cabinet, and the two screws which hold the small side plate to the cabinet. The oscilloscope can now be removed through the rear of the cabinet.

6. 3 Fuses

The oscilloscope is protected by one fuse in the primary circuit of the transformer. The fuse is mounted in a bracket on the underside of the chassis, directly behind the power transformer.

CAUTION When changing fuses in the model OSK-2, always disconnect the power cord from the source before removing from the case.

6. 4

All vacuum tubes are operated below their normal rating to insure long life and uniform service. All tubes are easily accessible after the chassis has been removed from the case as described in paragraph 6. 2.

6. 5 Cathode Ray Tube

(a) The Cathode ray tube type 5DEPl requires care in use and care in handling There are three common causes for failure:

1. Mechanical breakage
2. Burning of the screen
3. Loss of emission of the cathode

(b) To replace the cathode ray tube, the following procedure should be used:

1 Disconect the line cord.
2 Remove the oscilloscope from the cabinet
3. Remove the socket from the tube (a screwdriver will help separate.)
4. Unscrew the four knurled nuts holding the bezel to the front panel.
5. Remove the bezel and graticule.
6. Loosen the tightening screw at the top of the large clamp around the face of the cathode ray tube.
7. Loosen the tightening screw at the top of the small clamp around the base of the tube.
8. Pass the cathode ray tube through and out of the large hole in the panel.
9. Reverse this procedure when installing a new cathode ray tube.

SECTION Vll
PARTS LIST

The components listed in this parts list are those that have an electrical bearing on the operation of the Starkit OSK-2 Oscilloscope. When ordering replacement parts, be sure to list the Model number of the kit, and the serial number as well as the part number, symbol and complete description A complete parts list is included in the assembly instructions.

Part #	Symbol	Description	Quantity
103-9-11	J1, J2, J3, J4, J5, J6	Binding post, 5-way Black	6
111-2-14		Line Cord, 1/64 Pot insulation, 5ft long	1
112-6-41	C27	Capacitor, Ceramic disc 500 mmf, ± 20%, 600 VDC	1
112-6-48	C36	Capacitor, paper, .25 mfd 1600 VDC	1
112-9-38	C4	Capacitor, paper, tubular .1 mfd, 600 VDC	1
112-9-16	C9	Capacitor, ceramic disc, 1000 mmf ± 10%	1
112-1-14	C12	Capacitor, paper, tubular .05 mfd 600 VDC	1
112-10-5	C11	Capacitor, ceramic disc, .01 mdf 600 VDC	1
112-10-35	C2, C13	Capacitor, ceramic disc, 47 mmf, GMV, 600 VDC	2
112-10-41	C35, C16, C14	Capacitor, paper, tubular .01 mfd, 400 VDC	3
112-10-43	C6, C8, C10, C29, C28	Capacitor, paper, tubular .1 mfd 400 VDC	5
112-10-44	C15, C34	Capacitor, paper, tubular .05 mfd, 400 VDC	2
112-10-46	C18, C25, C33	Capacitor, paper, tubular .25 mfd, 400 VDC	3
112-10-50	C37	Capacitor, paper, .1 mfd, 1600 VDC	1
112-10-65	C21	Capacitor, ceramic disc 220 mmf, GMV, 600 VDC	1
112-10-73	C19	Capacitor, ceramic disc .02 mfd, 600 VDC	1
112-10-83	C3	Capacitor, ceramic disc 390 mmf 600 VDC	1
112-10-84	C5	Capacitor, electrolytic axial leads, 100 mfd 50 VDC	1
112-10-85	C22	Capacitor, ceramic disc 20 mmf, ± 20%, 600 VDC	1
112-10-86	C20, C24	Capacitor, ceramic disc .002 mfd, GMV, 600 VDC	2

SECTION Vll

PARTS LIST

Part #	Symbol	Description	Quantity
112-10-87	C7, C26	Capacitor, electrolytic, axial leads, 20 mfd, 150 VDC	2
112-10-90	C17, C32	Capacitor, ceramic disc .02 mfd, GMV, 1.6 KVDC	2
112-10-91	C23	Capacitor, paper, tubular .2 mfd, 400 VDC	1
112-10-92	C30	Capacitor, electrolytic, 40 x 40 x 20 x 20 mfd, 450 VDC	1
112-10-93	C31	Capacitor, electrolytic, 40 x 40 x 20 x 20 mfd, 450 VDC	1
112-10-94	C1	Capacitor, trimmer, dual, 2.7-30 mmf(insulated) 50-380 mmf, mounted on U bracket	1
115-9-61		Graticule, green	1
122-4-49	L5, L6	Peaking Coil, 90 MH on 10M resistor, yellow/white dot	2
122-4-69	L1, L2	Peaking Coil, 61 uh on 10 M resistor, blue/white dot	2
122-4-70	L3	Peaking Coil, 30 uh on 2K resistor, Red/white dot	1
122-4-71	L4, L7	Peaking Coil, 33 uh on 3.3K resistor, green/white dot	2
125-1-3	F1,	Fuse 3AG, 2 amp, 250 volt (For 115 volt operation)	1
125-9-9	F1,	Fuse 3AG, 1 amp, 250 volt (For 220 volt operation)	1
125-2-5	PL-1	Lamp 6-8 volt, GE #47, bayonet base	1
134-1-16	R29, R47	Potentiometer, composition carbon 50 K ohms, linear, 1/2 watt, 20%	2
134-3-8	R65/SW4	Potentiometer composition carbon 500 K ohms, linear, 1/2 watt, 20%	1
134-3-9	R41, R64	Potentiometer, composition carbon 2 megohms, linear, 1/2 watt, 20%	2
134-5-26	R76	Potentiometer, composition carbon 250K ohms. linear, 1/2 watt. 20%	1
134-5-67	R8	Potentiometer, composition carbon 2K ohms, linear, 1/2 watt, 20%	1
134-5-79	R51	Potentiometer, composition carbon with centre tap, 200 K ohms, linear, 1/2 watt, 20%	1

SECTION VII

PARTS LIST

Part #	Symbol	Description	Quantity
134-5-80	R16	Potentiometer, composition carbon 20K ohms, linear with centre tap, 1/2 watt 20%	1
134-5-81	R36, R37	Potentiometer, composition carbon 2 megohms, linear, 1/2 watt, 20% Snap-in-type	2
134-5-93	R28	Potentiometer, composition carbon 1 megohm, linear, 1/2 watt, 20% Snap-in-type	1
144-9-95	SW3	Switch, rotary, 1 deck, 9 position Sweep Selector	1
144-9-96	SW2	Switch, rotary, 1 deck, 4 position Sync. Selector	1
144-9-97	SW1	Switch, rotary, 1 deck, 3 position Vert. Attenuator.	1
148-9-56	T1	Transformer, power, 110/220 volt 50/60 cycles	1
163-1-4	V8, V9, V10	Tube 12AU7A	3
163-1-26	V3, V4	Tube 6C4	2
163-1-36	V6	Tube 12B47	1
163-1-45	V5	Tube 6AN8	1
163-1-46	V7	Tube 6DT6	1
163-1-62	V1	Tube 1V2	1
163-1-63	V2	Tube 6X4	1
163-1-68	V11	Tube, Cathode Ray 5DEP1	1
	R75	Resistor, fixed, composition 62 ohms, 10%, 1/2 watt	
	R5, R19, R20 R52, R53	Resistor, fixed, composition 100 ohms, 20%, 1/2 watt	5
	R14	Resistor, fixed composition 150 ohm, 1/2w, 10%	1
	R68	Resistor, fixed, composition 220 ohms, 20%, 1/2 watt	1
	R74	Resistor, fixed, composition 470 ohms, 10%, 1/2 watt	1

SECTION VII

PARTS LIST

Symbol	Description	Quantity
R6	Resistor, fixed, composition 560 ohms, 10%, 1/2 watt	1
R48, R79	Resistor, fixed, composition 1000 ohms, 20%, 1/2 watt	2
R23, R24	Resistor, fixed, composition 1000 ohms, 10%, 1 watt	2
R71	Resistor, wire wound, 1000 ohms, 10%, 7 watt	1
R21	Resistor, fixed, composition 1200 ohms, 10%, 2 watt	1
R57	Resistor, fixed composition 1500 ohms, 10%, 1 watt	1
R10, R13, R4w, R45	Resistor, fixed, composition 2200 ohms, 20%, 1/2 watt	4
R7	Resistor, fixed, composition 3300 ohms, 10%, 1/2 watt	1
R11, R26, R27	Resistor, fixed, composition 3300 ohms, 20%, 1/2 watt	3
R22, R25	Resistor, fixed, composition 3300 ohms, 10%, 2 watt	2
R58, R59, R60	Resistor, fixed, composition 3900 ohms, 10%, 1/2 watt	3
R70	Resistor, fixed, composition 4700 ohms, 10%, 2 watt	1
R69	Resistor , wire wound, 5000 ohms, 10%, 10 watt	1
R78	Resistor, fixed, composition 10 K ohms, 20%, 1/2 watt	1
R54	Resistor, fixed, composition 12K ohms, 2 watt, 20%	1

SECTION Vll

PARTS LIST

Symbol	Description	Quantity
R31	Resistor, fixed, composition 15 K ohms, 20%, 1/2 watt	1
R61	Resistor, fixed, composition 18 K ohms, 20%, 1/2 watt	1
R49	Resistor, fixed, composition 22 K ohms, 10%, 1/2 watt	1
R32	Resistor, fixed, composition 22 K ohms, 20%, 1/2 watt	2
R55, R56	Resistor, fixed, composition 27 K ohms, 10%, 1 watt	2
R17	Resistor, fixed, composition 33 K ohms, 10%, 1/2 watt	1
R3	Resistor, fixed, composition 36 K ohms, 5%, 1/2 watt	1
R46	Resistor, fixed, composition 47 K ohms, 20%, 1/2 watt	1
R38, R40	Resistor, fixed, composition 68K, ohms, 20%, 1/2 watt	2
R15, R67	Resistor, fixed, composition 100 K ohms, 20%, 1/2 watt	2
R35	Resistor, fixed, composition 100 K ohms, 20%, 1 watt	1
R39 R39,	Resistor, fixed, composition 150 K ohms, 20%, 1/2 watt	1
R72	Resistor, fixed, composition 220 K ohms, 20%, 1 watt	1
R2	Resistor, fixed, composition 330 K ohms, 5%, 1/2 watt	1
R12, R30, R66	Resistor, fixed, composition 470 K ohms, 20%, 1/2 watt	3
R73	Resistor, fixed, composition 470 K ohms, 10%, 1/2 watt	1

SECTION Vll

PARTS LIST

Symbol	Description	Quantity
R77	Resistor, fixed, composition 1 megohm, 10%, 1 watt	1
R63	Resistor fixed, composition 1 megohm, 20%, 1/2 watt	1
R34	Resistor, fixed, composition 2.2 megohms, 20%, 1/2 watt	1
R1	Resistor, fixed, composition 3.3 megohms, 5%, 1/2 watt	1
R18	Resistor, fixed, composition 3.3 megohms, 10%, 1/2 watt	1
R4, R50	Resistor, fixed, composition 3.3 megohms, 20%, 1/2 watt	2
R62	Resistor, fixed, composition 3.3 megohms, 10%, 1 watt	1
R42, R80, R81, R82, R83	Resistor, fixed, composition 4.7 megohms, 20%, 1/2 watt	5
R9, R33	Resistor, fixed, composition 10 megohms, 20%, 1/2 watt	2

CAUTION:

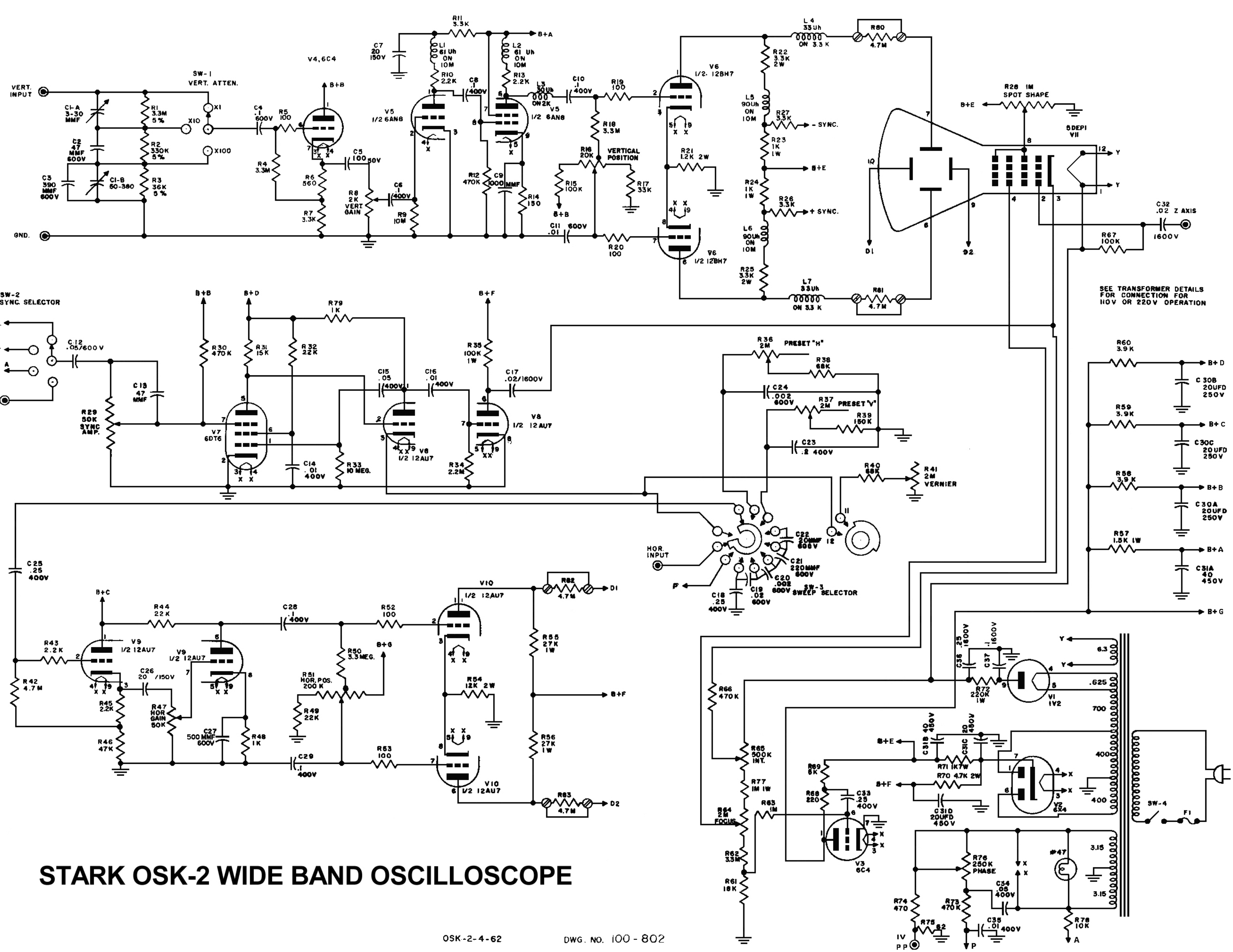
EXTREME CARE MUST BE EXERCISED WHEN WORKING ON THIS UNIT WHEN OUT OF THE CABINET AND WITH THE POWER ON. THE VOLTAGES ARE DANGEROUS TO LIFE.

When taking voltage readings, set controls as follows:

- Intensity and Focus set for comfortable viewing.
- Vertical and Horizontal positioning set to center the trace.
- Vertical Attenuator at x100
- Vertical and Horizontal Gain at 0.
- Sweep Select at 1000-10KC position.
- Vernier at 50
- Sync Sel. at x Int.
- Sync amp at 0.

VOLTAGE CHART

TUBE	PIN											
	1	2	3	4	5	6	7	8	9	10	11	12
V1 1V2	NC	NC	NC	NS	NS	NC	NC	NC	-1.5KV			
V2 6X4	420 AC	NC	3.15 AC	3.15 AC	NC	420 AC	440					
V3 6C4	145	NS	3.15 AC	3.15 AC	NC	-.5	0					
V4 6C4	120	NS	3.15 AC	3.15 AC	NC	NS	18					
V5 6AN8	65	NS	0	3.15 AC	3.15 AC	100	115	NS	1.4			
V6 12BH7	285	NS	45	3.15 AC	3.15 AC	285	35	45	3.15 AC			
V7 6DT6	-.3	0	3.15 AC	3.15 AC	85	0	0					
V8 12AU7	125	90	100	3.15 AC	3.15 AC	45	-.5	0	3.15 AC			
V9 12AU7	130	NS	70	3.15 AC	3.15 AC	70	0	2	3.15 AC			
V10 12AU7	260	NS	90	3.15 AC	3.15 AC	260	80	90	3.15 AC			
V11 5DEP1	-1450	-1450	-1350	-900	NC	285	285	300	260	260	NC	-1450



STARK OSK-2 WIDE BAND OSCILLOSCOPE

OSK-2-4-62

DWG. NO. 100 - 802