TEST EQUIPMENT OPERATION

During the D.C. block of instruction, the only test equipment needed was the multimeter, but when testing of an alternating current circuit is required, it will take different types of test equipment. During this conference you will become familiar with three types of test equipment used to generate and measure different A.C. signals and voltages within an A.C. circuit. The Function Generator is used to produce three A.C. signals at a wide range of frequencies at different amplitudes; the AN/USM-488 oscilloscope is used to analyze the waveshape and measure amplitude, period and pulse width of the A.C. signals; and the digital multimeter is used to measure the RMS voltage of an A.C. sinewave.

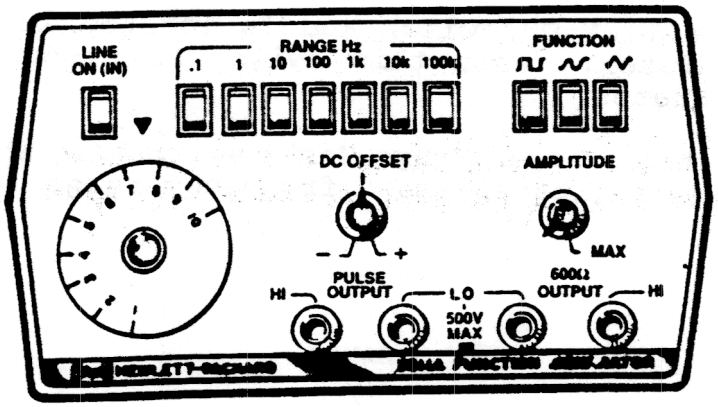

FIGURE 3

The purpose of the function generator is to produce positive pulses, square waves, sine waves, and triangular waveforms. The generator can also produce a DC voltage at the same time. These signals are used as inputs to other equipment and circuits.

Before operating the function generator you should know the purpose and location of the controls. The following views and instructions will provide this knowledge.

The function generator can generate frequencies from 0.1 Hertz to 1.0 Mega Hertz.

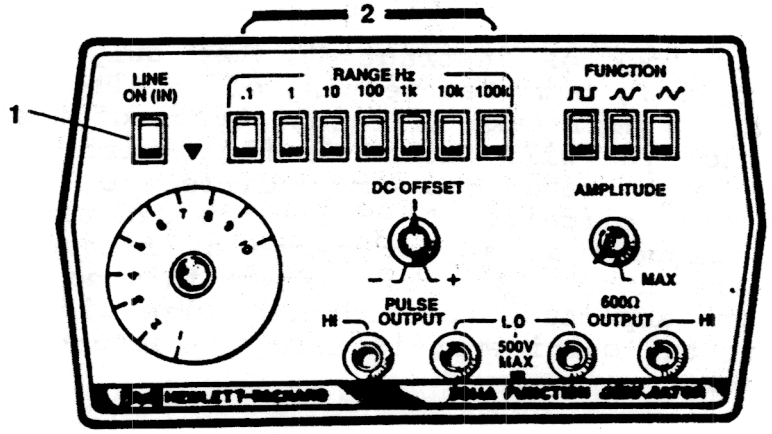

FIGURE 4

Number 1 is the LINE ON switch and is located in the upper left corner of the generator. When this switch is pressed in, power is applied to the generator.

Number 2 consists of seven Range Hertz switches. When one of these switches is pressed in, it selects a frequency range indicated by the number above it.

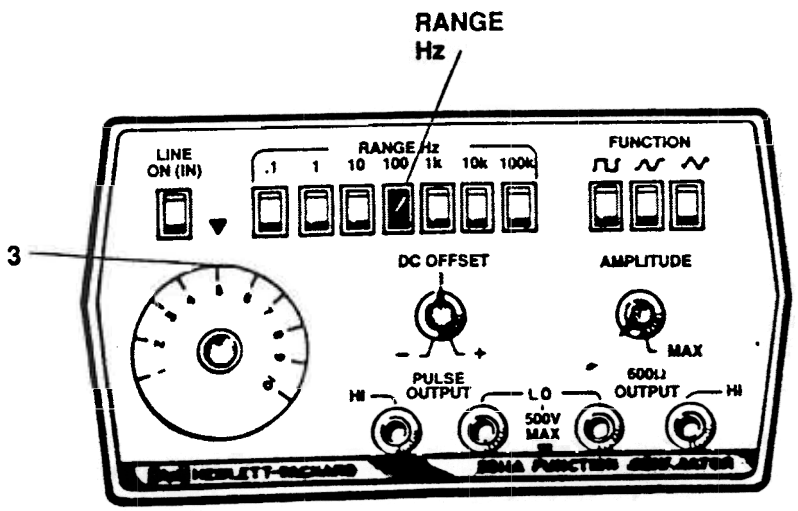

FIGURE 5

Number 3 is the Frequency Dial. This dial setting and the Range Hertz switches determine the output frequency of the generator.

Assume that the Frequency Dial is set to 5 and that the Range Hertz switch 100 is pressed in. The output frequency would be 500 hertz. In other words, the output frequency is the Range Hertz switch setting multiplied by the Frequency Dial setting.

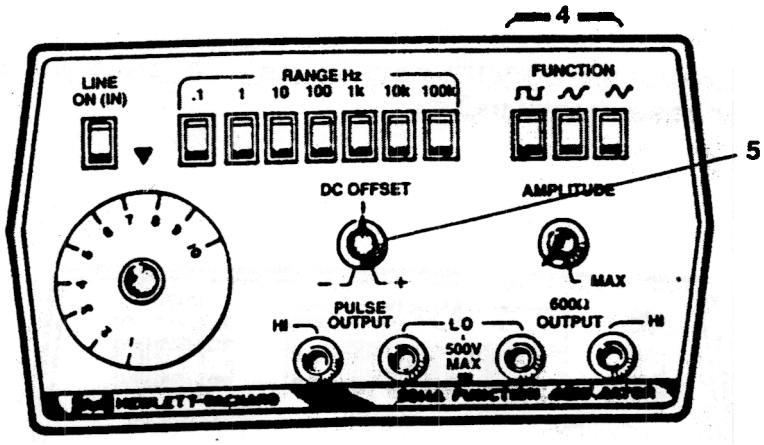

FIGURE 6

Number 4 is the FUNCTION SELECTOR switches. These three switches select three output waveforms. Square, sine, and triangle waveforms are available.

Number 5 is the DC OFFSET control. It adjusts the amplitude and determines the polarity of the DC OFFSET voltage output from the generator. When the control is in the position shown, NO DC OFFSET voltage should be available at the output of the generator.

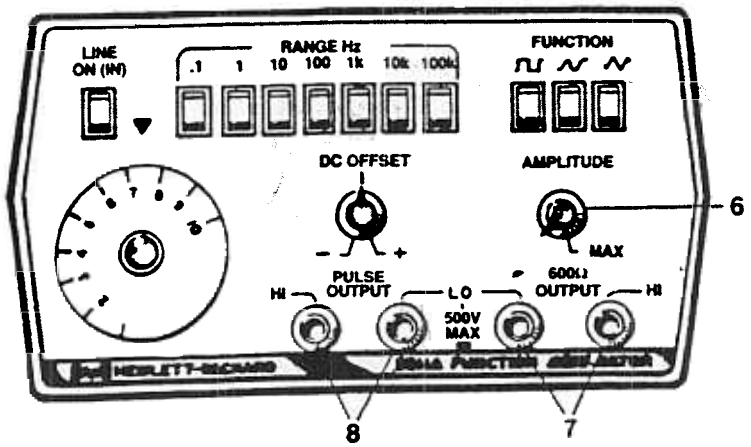

FIGURE 7

Number 6 is the AMPLITUDE CONTROL. It adjusts the output level of the square wave, sine wave and triangle wave signals, just like the volume control on a radio.

Number 7 is the 600 ohm OUTPUT terminals for the square wave, sine wave and triangle wave signals. HI is the signal terminal and LO is the zero or ground terminal.

Number 8 is the PULSE OUTPUT terminals. A zero to 3 volt pulse can be obtained from these terminals.

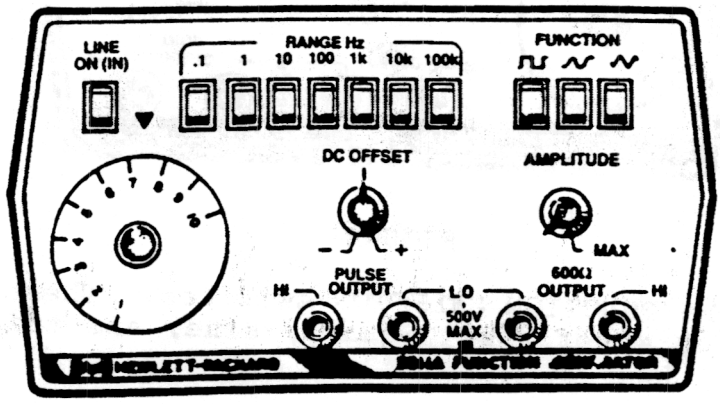

FIGURE 8

Before operating the function generator let's review some of the controls and switches.

The LINE ON switch applies power to the generator when the generator line cord is plugged into a 120 volt 60 hertz source. Seven RANGE Hz switches provide selection of the desired frequency range. The FREQUENCY DIAL selects the desired frequency within the range set by the RANGE switches.

Three FUNCTION switches select the output waveforms desired at the 600 ohms output terminals. The AMPLITUDE control adjusts the level or amplitude of the selected output waveform.

Before operating the FUNCTION GENERATOR it is necessary to be able to read the FREQUENCY DIAL correctly. Note the marks or subdivisions between the numbers on the DIAL.

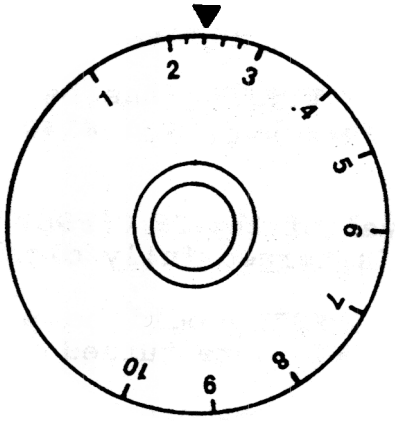

FIGURE 9

Each subdivision is 0.2.

In this view the FREQUENCY DIAL is set to the second mark between 2 and 3.

Since each mark represents 0.2 the actual DIAL reading is 2.4.

This means that the FREQUENCY DIAL reading of 2.4 would be multiplied times the RANGE SWITCH selection to obtain the frequency OUTPUT.

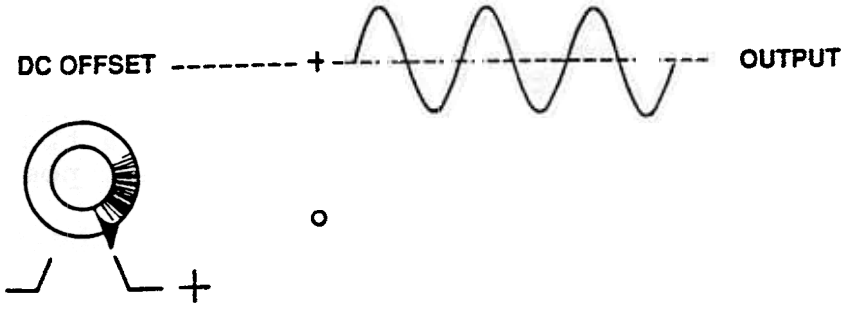

FIGURE 10

It is also necessary to know more about the function of the DC OFFSET CONTROL on the function generator before operating the function generator. For example, in this view the control is turned clockwise to the maximum positive position.

Assume that a sine wave FUNCTION has been selected. This means that the OUTPUT from the generator is a sine wave riding on a positive DC OFFSET voltage.

The OUTPUT positive level of the DC OFFSET voltage in this case is maximum since the control is turned fully clockwise.

A maximum negative DC OFFSET would be present at the generator output if the DC OFFSET CONTROL were turned fully counterclockwise.

QUESTION: What type of waveforms can be obtained from the function generator?

ANSWER: Sine wave, square wave, sawtooth, and pulse.

TEKTRONIX AN/USM-488 OSCILLOSCOPE:

The TEKTRONIX oscilloscope is a rugged, light-weight, dual-channel 100 MHz instrument that features a bright, sharply defined trace on an 80 by 100mm cathode-ray tube (CRT). Its vertical system supplies calibrated deflection factor from 2mV per division to 5V per division. Trigger circuits enable stable triggering over the full bandwidth of the vertical system. The horizontal system provides calibrated sweep speeds from 0.5 Sec per division to 50nSec per division, along with delayed-sweep features. A X10 magnifier circuit extends the maximum sweep speed to 5 nSec per division when the A and B SEC/DIV switch is set to 0.05 Sec per division.

Signals to be displayed on the CRT are applied to either the CH1 or X input connector or the CH2 or Y input connector. These signals may be directly (DC) coupled to the Attenuator circuit or ac (AC) coupled through an input-coupling capacitor. The input signals may also be disconnected from the oscilloscope circuitry and the input attenuator ground by setting the coupling switch to the GND position.

Input signals are selected for display by the Channel Switching circuit under control of the front-panel VERTICAL MODE Switches.

For locating the position of off-screen displays, the dynamic range of the Amplifier can be limited with the Beam Find circuitry. This circuitry also intensifies the trance and limits horizontal deflection.

The "A" Trigger circuitry uses either an Internal Trigger signal, or a Line Trigger signal obtained from the ac power line to develop the gate signal for the "A" Sweep Generator. The "B" Trigger circuitry uses only the Internal Trigger signal to gate the "B" Sweep Generator.

A TV Field sync circuit provides stable triggering on television vertical-sync pulses. Triggering at the television line rate is accomplished when either P-P Auto or Norm mode is selected.

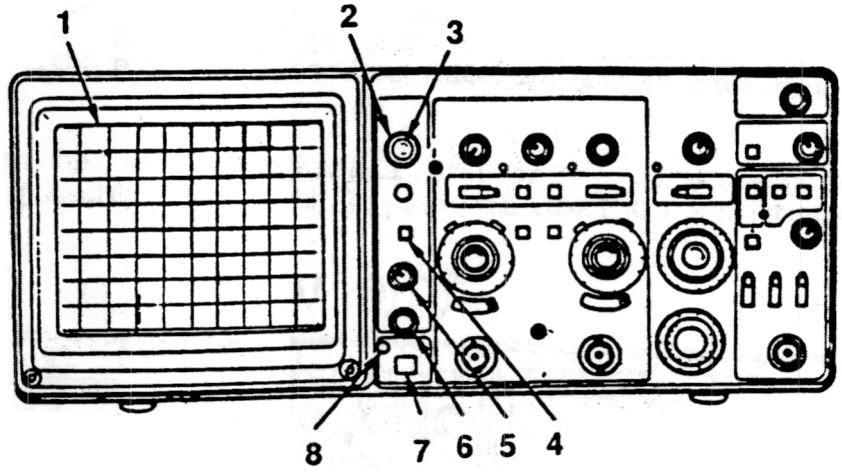

FIGURE 11

1. INTERNAL GRATICULE - Eliminates parallax error (an optical illusion which makes an object appear displaced when viewed from a different angle) between the trace and graticule lines. Rise-time amplitude and measurement points are indicated at the left edge of the graticule.

2. "A" INTENSITY CONTROL - Controls the brightness of "A" sweep trace.

3. "B" INTENSITY CONTROL - Controls the brightness of "B" sweep trace.

4. BEAM FIND SWITCH - When held in, compresses the display to within the graticule area and provides a visible viewing intensity to aid in locating off-screen displays.

5. SCALE ILLUMINATION CONTROL - Adjusts the light level of the graticule illumination.

6. FOCUS CONTROL - Adjusts for optimum display definition.

7. POWER SWITCH - Turns instrument power on and off. Press in for "ON"; Press again for "OFF".

8. POWER INDICATOR - An LED that illuminates when the instrument is operating.

9. POSITION CONTROL - The POSITION CONTROLS are used to vertically position the display on the CRT. When the SEC/DIV switch is set to X-Y, the Channel 2 POSITION CONTROL moves the display vertically (Y-axis), and the HORIZONTAL POSITION CONTROL moves the display horizontally (X-axis). To invert CHANNEL 2 display, pull out the CHANNEL 2 POSITION CONTROL knob. With the Channel 2 display inverted, the instrument can be operated as a differential amplifier when the VERTICAL MODE switches are in BOTH and ADD positions.

10. UNCAL INDICATOR Ch 1. - The LED illuminates to indicate that the VOLTS/DIV VARIABLE CONTROL is out of the calibrated position.

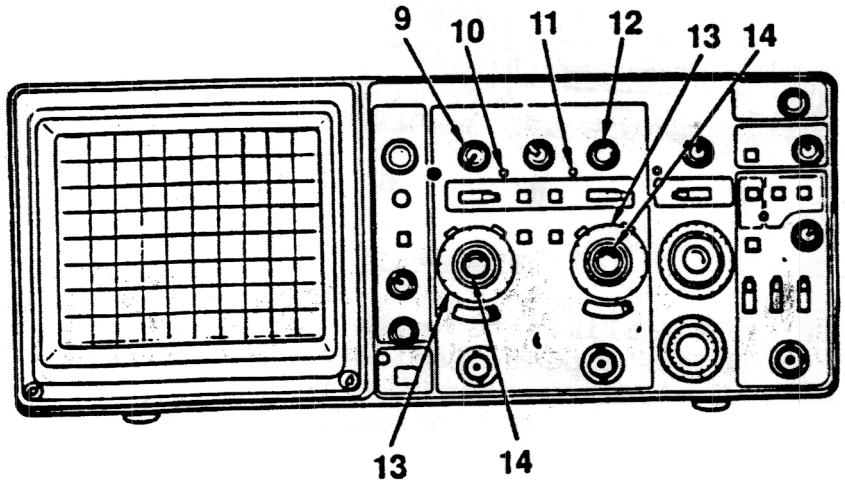

FIGURE 12

11. UNCAL INDICATOR - Ch 2

12. POSITION CONTROL - 9

13. CH 1 and CH 2 VOLTS/DIV SWITCH - CH 1 VOLTS/DIV and CH 2 VOLTS/ DIV are used to select the vertical deflection factor in a 1-2-5 sequence. To obtain a calibrated deflection factor, the VOLTS/ DIV VARIABLE control must be in the calibrated (CAL) detent (fully clockwise). 1X - Indicates the deflection factor selected when using either a 1X probe or a coaxial cable. 10X - Indicates the deflection factor selected when using a 10X probe.

14. CH 1 and CH 2 VOLTS/DIV VARIABLE CONTROL - When rotated counter-clock-wise out of their calibrated detent positions, these control provide continuously variable, uncalibrated deflection factors between the calibrated settings of the VOLTS/DIV switches.

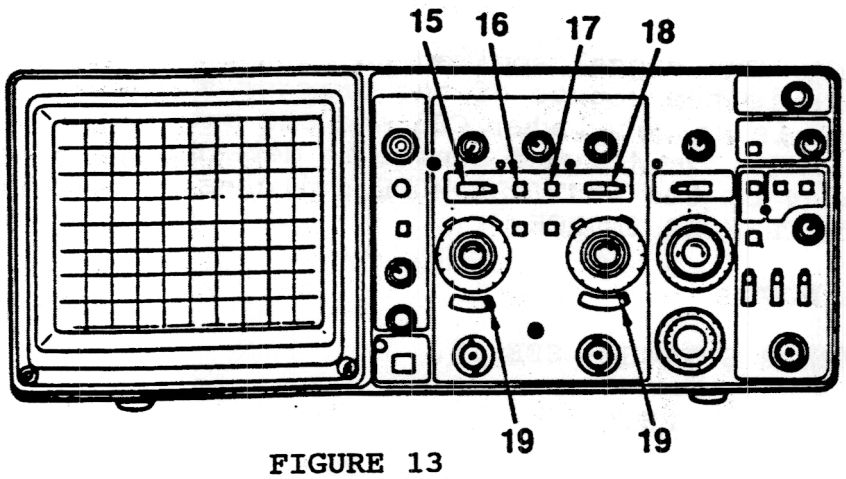

FIGURE 13

15. VERTICAL MODE

CH1/BOTH/CH2 SWITCH - Two three-position switches are used to select the mode of operation for the vertical amplifier system.

CH1 - Selects only the Channel 1 input signal for display.

BOTH - Selects both Channel 1 and Channel 2 input signals for display. The CH1-BOTH-CH2 switch must be in the BOTH position for either ADD, ALT, or CHOP operation.

CH2 - Selects only the Channel 2 input signal for display.

ADD - Displays the algebraic sum of the Channel 1 and Channel 2 input signals.

ALT - Alternately displays Channel 1 and Channel 2 input signals. The alternation occurs during retrace at the end of each sweep. This mode is useful for viewing both input signals at sweep speeds from 0.05 micro Sec per division to 0.2 m Sec per division.

CHOP - The display switches between the Channel 1 and Channel 2 input signals during the sweep. The switching rate is approximately 500 Khz. This mode is useful for viewing both Channel 1 and Channel 2 input signals at sweep speed from 0.5 mSec per division to 0.5 microSec per division.

16. CH 1 TRIGGER SOURCE SWITCH - Two buttons that select the source.

17. CH 2 TRIGGER SOURCE SWITCH of the internal triggering signal for the "A" TRIGGER when the "A" SOURCE switch is set to "INT".

CH1 - The signal applied to the CH1 or X input connector is the source of the trigger signal.

CH2 - The signal applied to the CH2 or Y input connector is the source of the trigger signal. The CHANNEL 2 POSITION control, when "PULLED OUT", will invert Channel 2 TRIGGER SIGNAL.

COMPOSITE - The signal applied to either or both vertical input connectors is the source of the trigger signal. COMPOSITE TRIGGER SOURCE is selected when CH1 and CH2 buttons are either "OUT" or pressed "IN". The trigger source is determined by signals selected for display by the VERTICAL MODE switches. See Table 3-1 for COMPOSITE TRIGGER SOURCE.

VERTICAL MODE

ADD/ALT/CHOP SWITCH - SEE 15.

19. AC/GND/DC SWITCHES.

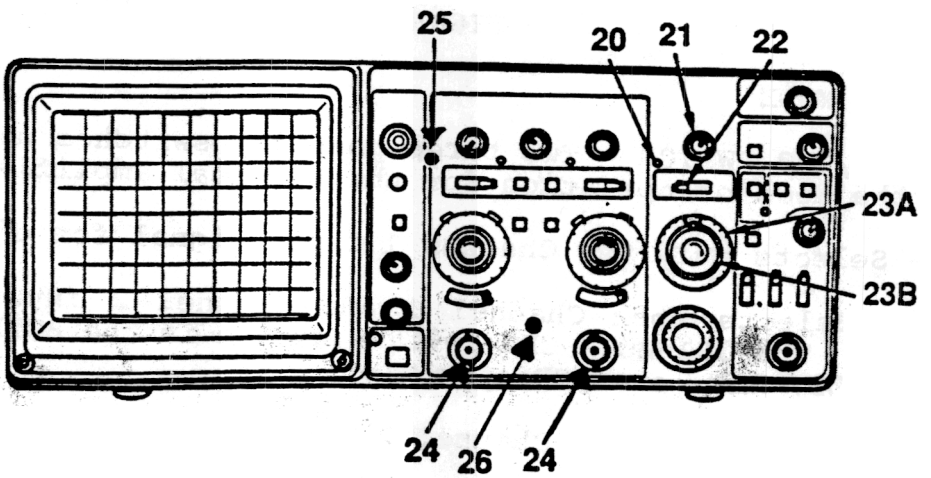

FIGURE 14

20. UNCAL INDICATOR - The LED illuminates to indicate that the SEC/ DIV Variable control is out of the calibrated position.

21. POSITION CONTROL - Horizontally positions both the "A" Sweep and the "B" Sweep displays and horizontally positions X-axis in the X-Y Mode.

HORIZONTAL MODE

A/ALT/B SWITCH - Three-position switch determines the mode of operation for the horizontal deflection system.

A - Horizontal defection is provided by the "A" Sweep generator at a sweep speed determined by the "A" SEC/DIV switch setting.

ALT - Alternates the horizontal displays between the "A" Sweep (with an intensified zone) and the "B" Delayed Sweep. The "A" Sweep speed is determined by the setting of the "A" SEC/DIV switch. The "B" Sweep speed and the length of the intensified zone on the "A" Sweep are both determined by the "B" SEC/DIV switch setting.

B - Horizontal deflection is provided by the "B" Sweep generator at a sweep speed determined by the "B" SEC/DIV switch setting. The

start of the "B" Sweep is delayed from the start of the "A" Sweep by a time determined by the setting of both the "A" SEC/DIV switch and the "B" DELAY TIME POSITION Control.

A and B SEC/DIV SWITCH - Used to select the sweep speeds for "A" and "B" Sweep generators in a 1-2-5 sequence. To obtain calibrated sweep speeds, the "A" and "B" SEC/DIV Variable control must be in the calibrated detent (fully clockwise).

A SEC/DIV - The calibrated sweep speed is shown between the two black lines on the clear plastic skirt. This switch also selects the delay time for delayed-sweep operation when used in conjunction with the "B" DELAY TIME POSITION Control.

23B. B SEC/DIV - The "B" Sweep speed is set by pulling out the DLY'D SWEEP knob and rotating it clockwise to a setting opposite the white line scribed on the knob. The "B" Sweep circuit is used only for delayed-sweep operation.

CH1 OR X and CH2 OR Y CONNECTORS - Provide for application of external signals to the vertical deflection system or for an X-Y display. In the X-Y mode (SEC/DIV switch set to X-Y), the signal connected to the CH1 OR X input connector provides horizontal deflection (X-axis) and the signal connected to the CH2 or Y input connector provides vertical deflection (Y-axis).

AMP CAL CONNECTOR - Provides an approximately 0.5 V, negative-going, square-wave voltage (at approximately 1KHz) that permits an operator to compensate voltage probes and to check operation of the oscilloscope vertical system. It is not intended for verifying the accuracy of the vertical gain or time-base circuitry.

GND CONNECTOR - Provides direct connection to the instrument chassis ground.

SUMMARY:

This lesson presented two pieces of test equipment, the function generator and the oscilloscope. The purpose of the function generator is to produce AC waveforms at various frequencies. The purpose of the oscilloscope is to show a presentation of a waveform, which allows certain waveform characteristics to be determined. Both pieces of test equipment have many controls, and it will take some amount of practice to become efficient at equipment operation. During the rest of Primary Circuits, these pieces of test equipment will be used.