Measuring Instructions

3-1 ADJUSTMENTS NECESSARY BEFORE MEASUREMENT

It may be necessary to adjust the adjusters on the front panel and bottom before attempting measurements in order to assure accuracy of measurements. In case of measuring with a probe, its phase adjustment is necessary. Whichever the case, the adjusting screwdriver (supplied as an accessory to the probes) may be used for adjustment purposes.

About 30 minutes of warmup is recommended for stabilizing operation before adjusting the controls and probe phase.

3-1-1 TRACE ROTATION Adjustment

Trace may become not parallel to the graticule lines on the CRT screen due to geomagnetic effect or other cause.

If that occurs, display a trace on the CRT screen, move it to the center of the screen with POSITION, and adjust the trace parallel to the graticule lines with TRACE ROTATION. Before making this adjustment, install the SS-5705 in the normal place of use for measurements.

3-1-2 Probe Phase Adjustment

10 : 1 Passive probe phase adjustment

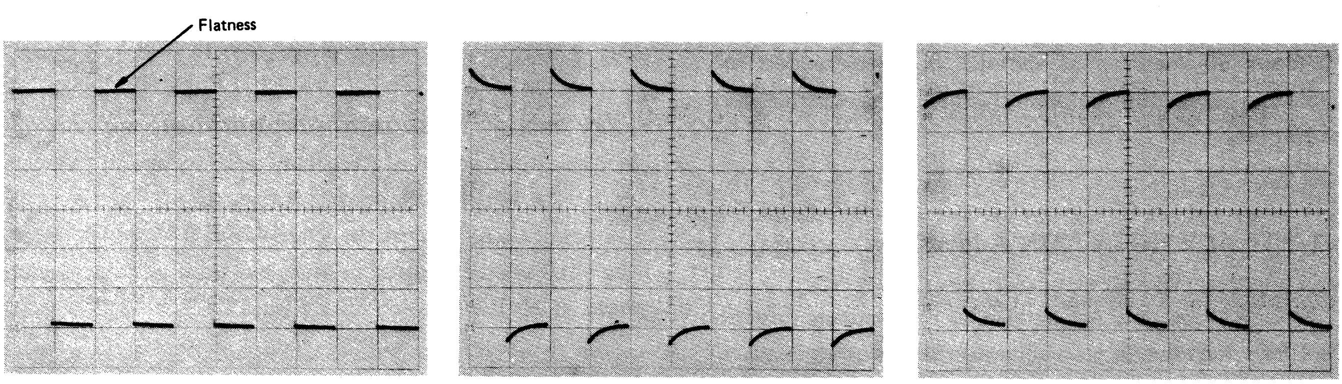
The following probes can be used for the SS-5705: Type SS-0011 (1.5 m long) with an attenuation ratio of 10 : 1; SS-0001 (1 m long), SS-0002 (1.5 m long), and SS-0003 (2 m long), the later three with an attenuation ratio of 1 : 1. (Those probes with an attenuation ratio of 1 : 1 are optional.)

A mismatched probe phase can result in measuring the wrong waveform. Be sure to correctly adjust the probe before use.

First, set VOLTS/DIV to 5 mV., connect the probe to INPUT and the CAL 0.3 V output terminal so that a calibration voltage waveform with an amplitude of 6 divisions is displayed on the CRT screen.

Next, turn the variable capacitor of the probe. The waveform changes as shown in figure 3-1 b or c. Adjust the variable capacitor correctly until the waveform is as shown in Figure 3-1 a.

Figure 3-1. Probe phase waveforms



a. Correct compensation   b. Excessive compensation   c. Insufficent compensation

3-2 MEASURING METHODES

3-2-1 Voltage Measurement

Quantitative Measurement

The quantitative measurement of voltage can be made by setting the VOLTS/DIV VARIABLE control to the CAL position. The measured value can be calculated by Equation (3-1)or (3-2).

a. Measurement with the x1 position of the probe;
Voltage (V) = VOLTS/DIV setting value (V/div)
x Displayed amplitude of input signal (div)
. . . . (3-1)

b. Measurement with the x10 position of the probe;
Voltage (V) = VOLTS/DIV setting value (V/div)
x Displayed amplitude of input signal (div) x10 . . . . (3-2)

DC Voltage Measurement

This instrument functions as a high input resistance, high sensitivity, quick response DC volt meter in order to measure DC voltage. Measurement procedure is as follows:

1. Set the sweep MODE switch to AUTO. and select a sweep rate so that the trace may not flicker.
2. Set the AC-GND-DC switch to GND. The vertical position of the trace in this case is used as 0-volt reference line as shown in Figure. 3-2. Adjust the vertical POSITION control in order to place the trace exctly on a horizontal graticule, which facilitates the reading of signal voltage.
3. Set the AC-GND-DC switch to DC, and apply the voltage to be measured to the input connector. The vertical diaplacement of the trace gives the voltage amplitude of the signal. When the trace shifts upward, the measured voltage is positive with regard to the ground potential. When the trace shifts downward, the voltage is negative. The voltage can be obtained by Equation (3-1) or (3-2).

AC Voltage Measurement

The measurement of the voltage waveform is performed as follows; Set the VOLTS/DIV switch in order to obtain the amplitude for easy reading, read the amplitude as shown in Figure 3-3 and calculate by Equation (3-1) or (3-2).

When the waveform superimposed on DC current is measured, set the AC-GND-DC switch to DC in order to measure the value including DC component, or set this switch to AC in order to measure AC component only.

The measured value by means of this procedure is peak value (Vp-p). Effective value (Vrms) of a sine wave signal can be given by Equation (3-3.)

Figure 3-2. DC Voltage Measurement

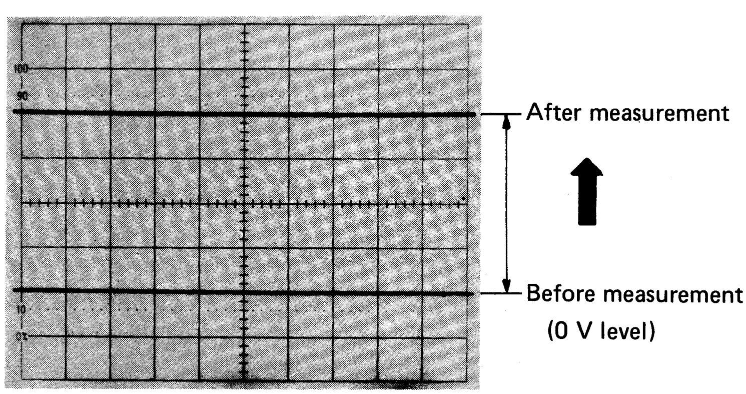
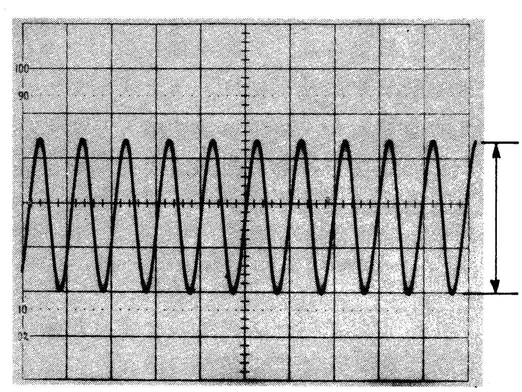


Figure 3-3. AC voltage measurement



$$\text{Effective voltage (V rms)} = \frac{\text{Peak voltage (V p-p)}}{2\sqrt{2}} \quad \ldots(3\text{-}3)$$

3-2-2 Time Measurement

The time interval of two points on a signal waveform can be calculated as follows: Set the TIME/DIV VARIABLE control to CAL. read the setting values of the TIME/DIV and x5 MAG switches and calculate the time by Equation (3-4).

Time (s) = TIME/DIV setting value (s/div)
x Length corresponding to the time to be measured (div)
x Reciprocal number of x5 MAG setting value. . . . . (3-4)

Where, the reciprocal number of the x5 MAG setting value is 1 when the sweep is not magnified, and 1/5 when the sweep is magnified.

Pulsewidth Measurement

The basic pulsewidth measurement procedure is as follows:

1. Display the pulse waveform vertically so that the distance between the top part of the pulse waveform and the horizontal center line of the graticule may be equal to the distance between the bottom part of the pulse and the horizontal center line as shown in Figure 3-4.
2. Set TIME/DIV switch in order to make the easy observation of the signal.
3. Read the distance between centers of rising and falling edges, i.e., the distance between two points at which pulse edges cross the horizontal center line of the graticule. Calculate the pulsewidth by Equation (3-4).

Rise (or Fall) Time Measurement

The rise (or fall) time measurement of the pulses is obtained as follows.

1. Display the pulse waveform vertically and horizontally in the same manner as for the pulsewidth measurement procedure.
2. Turn the horizontal POSITION control in order to set the upper 10% point of the waveform on the vertical center line of the graticule. (In Figure 3-5, the upper 10% point is 0.4 division below the top of the pulse since the displayed amplitude is 4 divisions.) Read the distance T_1 between the vertical center line and the point at which the rising (or falling) edge crosses the horizontal center line.
3. Shift and set the lower 10% point of the waveform to the vertical center line of the graticule as shown by the dotted line in Figure 3-5. Read the distance T_2 between the vertical center line and the point at which the rising (or falling) edge crosses the horizontal center line.
4. Calculate the rise (or fall) time by substituting the sum of T_1 and T_2 for Equation (3-4).

Figure 3-5. Pulsewidth measurement

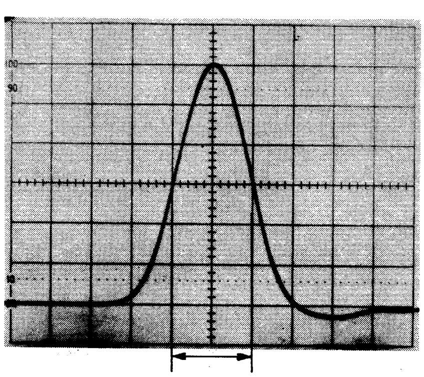
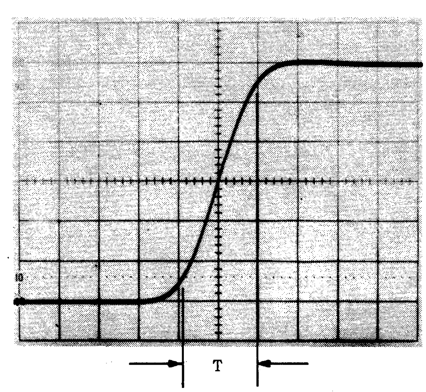


Figure 3-6. Rise (or fall) time measurement



3-2-3 Frequency Measurement

Of the frequency measurement procedure, there are the following methods.

The first method: Calculate the one-cycle time (interval) of the input signal by Equation (3-4) as shown in Figure 3-6, and obtain th frequency by Equation (3-5).

$$\text{Frequency (Hz)} = \frac{1\ (c)}{\text{Period (s)}} \ldots\ldots\ldots\ldots (3\text{-}5)$$

The second method: Count the repetition number N per 10 divisions in the viewing area, and calculate the frequency by Equation (3-6).

$$\text{Frequency (Hz)} = \frac{N\ (c)}{\text{TIME/DIV setting value (s/div)} \times 10\ \text{(div)}} \ldots (3\text{-}6)$$

When N is large (30 to 50), the second method can give a higher accuracy level than that obtained with the first method. This accuracy is approximately equal to the rated accuracy of sweep rate. However, when N is small, the count below decimal point becomes very ambiguous, which results in considerable error.

For the measurement of comparatively low frequencies having a simple pattern such as sine wave, square wave, triangle wave, and sawtooth wave, measurement with high accuracy can be effected by the follwing method: Operate the oscilloscope as an X-Y scope, make the Lissajou's pattern by applying the signal of which frequency is known, and read the necessay value.

3-2-4 Phase Difference Measurement

Of the measurement of phase difference between two signals, there are the follwing two methods:

The first one is the Lissajou's pattern method by using the instrument as an X-Y scope. The phase difference of signals can be calculated form the amplitudes A and B of the pattern shown if Figure 3-8 and by Equation (3-7).

$$\text{Phase defference (deg)} = \sin^{-1}\frac{A}{B} \ldots\ldots\ldots\ldots (3\text{-}7)$$

The second method is an application of dual-trace function Figure 3-9 shows an example of dual-trace display of leading and lagging sine wave signals having the same frequency. In this case, the SOURCE switch must be set to a channel which is connected to the leading signal, and set the TIME/DIV switch so that the length of 1-cycle of the displayed sine wave may be 9 divisions.

Then, 1-division graticule represents a waveform phase of 40° (1 cycle $=2\pi=360°$). The phase difference between the two signals can be easily calculated by Equation (3-8).

$$\text{Phase difference (deg)} = T\ \text{(div)} \times 40° \ldots\ldots\ldots (3\text{-}8)$$

Where, T is the distance between two points at which the leading and lagging signals cross the horizontal center line of the graticule.

Figure 3-7. Frequency measurement (1)

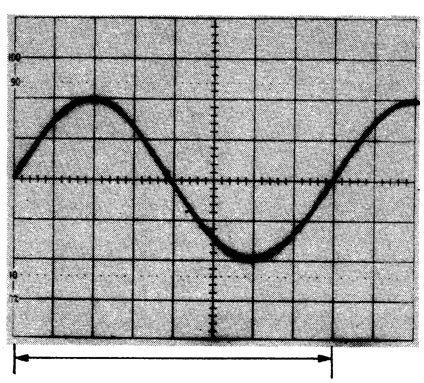
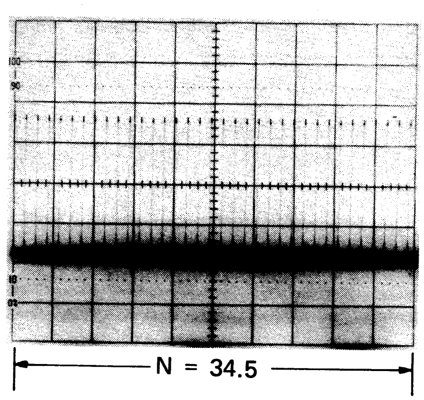


Figure 3-8. Frequency measurement (2)



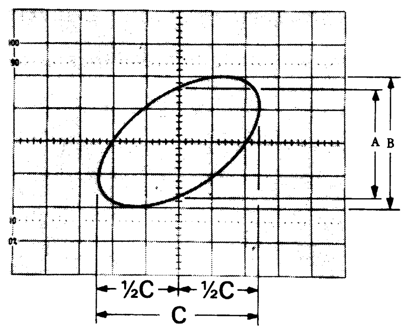


Figure 3-9 Phase difference measurement using Lissajou's pattern

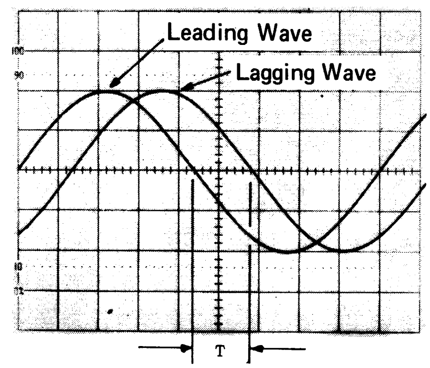


Figure 3-10. Phase difference measurement by dual-trace display

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