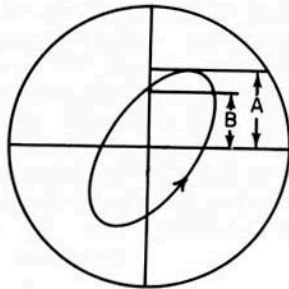


A CONVENIENT METHOD FOR MEASURING PHASE SHIFT

Oscilloscopes having horizontal and vertical amplifiers with almost identical amplification properties are useful for phase shift measurements. Identical amplification properties make it possible to obtain a pattern on the cathode ray tube whose character depends on the phase difference between signals applied to the oscilloscope's vertical and horizontal amplifiers.

A common technique for determining phase shift is:



$$\sin \theta = \frac{B}{A}$$

This method requires some tricky measurements on the crt face and, of course, the division B/A.

The attached mask, when fastened to the face of a crt permits phase shift to be read directly. No measurement or calculation is required, no oscilloscope modification is necessary, and the only external equipment necessary is a simple resistor and capacitor to give the phase angle quadrant.

This technique is described in "Accurate Oscilloscope Phase Shift Measurements", by Dr. Harold D. Webb in the January 15, 1956 issue of Electronic Design. Additional foil masks may be obtained from Hewlett-Packard for 75 cents each by ordering "Phase Shift Foil 1A".

PHASE ANGLE MEASUREMENT PROCEDURE

The procedure for using the mask provided for phase angle measurements is as follows:

a. Connect instruments as shown in figure 1 and place mask over face of crt. Adjust signal source to the desired frequency and to any convenient signal amplitude. Position mask with lines BB' and AA' superimposed over x and y axis respectively that are marked on the oscilloscope graticule.

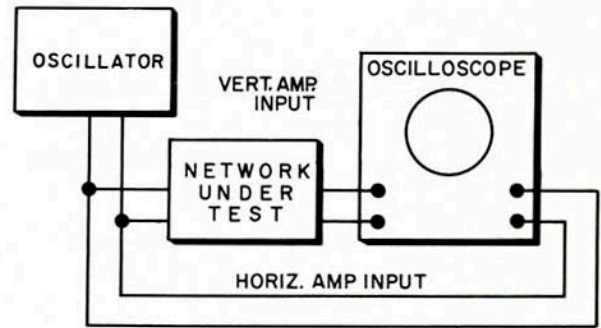


Figure 1.

- b. Remove horizontal signal from scope.
- c. Obtain a vertical trace eight centimeters tall.
- d. Remove vertical signal and connect horizontal signal to scope.
- e. Obtain a horizontal trace eight centimeters long, using horizontal sensitivity, vernier, and position controls. Do not change oscillator output or vertical controls.
- f. Replace vertical input. The resulting pattern may be a straight line, an ellipse, or a circle, depending on the phase angle.
- g. IF PATTERN IS A STRAIGHT LINE - If the line is tipped to the right between M and M', the phase angle is 0° or 360°. If tipped to the left between N and N', the phase angle is 180°.
- h. IF PATTERN IS AN ELLIPSE - An ellipse will always be tilted with the major axis along line MM' or NN'. The ellipse will always be tangent at some point to all four sides of square MN' M' N.

If the ellipse is tilted to the right (major axis along MM'), read the phase angle as an intercept on the calibrated scale along line NN'. The angle is in the first or fourth quadrant.

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If the ellipse is tilted to the left, read the phase angle as an intercept of the calibrated scale along line MM'. The angle is in the second or third quadrant.

To determine the quadrant of a particular phase angle, divide the length of the minor ellipse axis by the length of the major ellipse axis. This will give a ratio "r" having a value between 0 and 1. Insert the phase delay network shown in Figure 2 in series with the vertical input. Repeat steps b through h, and recalculate "r".

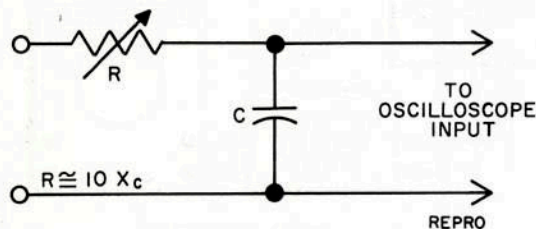


Figure 2.

If "r" has increased, the phase angle is in the first quadrant if ellipse is tilted to the right or in the third quadrant if ellipse is tilted to the left.

If "r" has decreased, the phase angle is in the fourth quadrant if ellipse is tilted to the right or in the second quadrant if ellipse is tilted to the left.

IF PATTERN IS A CIRCLE - A circle indicates a phase shift of 90° or 270°. The phase delay network of Figure 2 will tilt the axis to the left for 90° or to the right for 270°.

The actual component values for R and C in Figure 2 are not critical. They should be chosen so as to not

have too great a shunting effect on the oscilloscope amplifier input.

SPECIAL APPLICATIONS

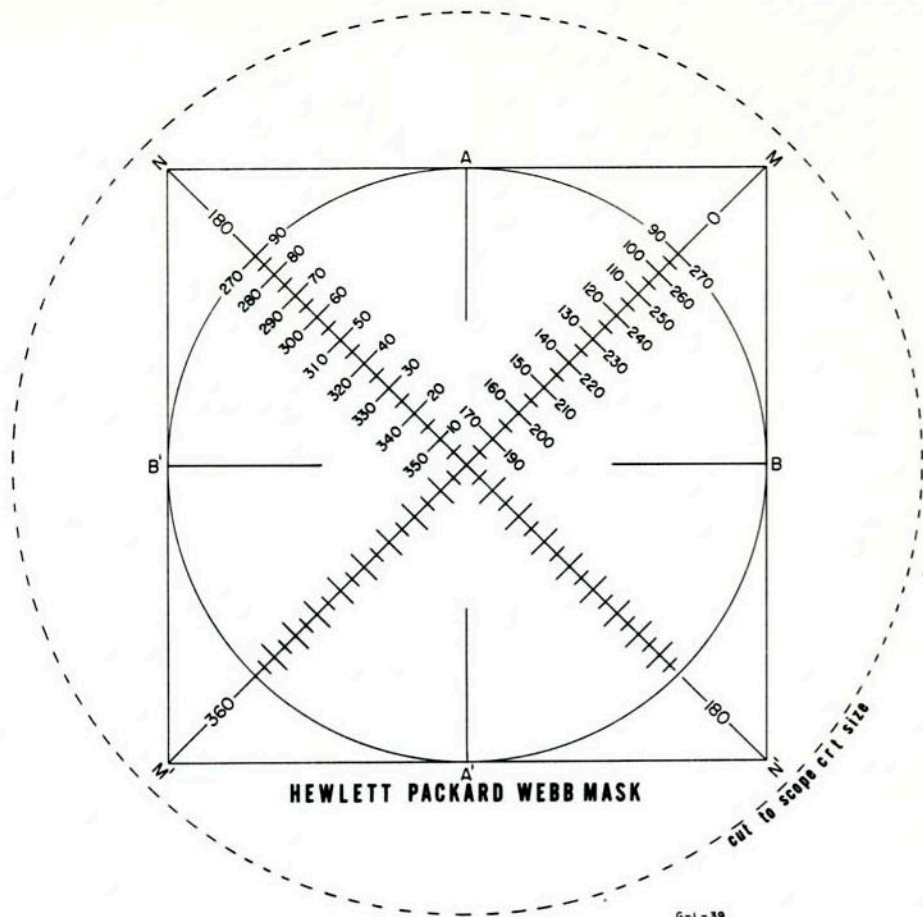
There may be a slight phase shift between the horizontal and vertical amplifiers of the oscilloscope. The phases of the amplifiers can be matched at the desired frequency by means of the phase shift network shown in Figure 2. Resistor R is made variable to permit adjustment of the phase shift introduced by the network.

This simple phase shift network is tried on one oscilloscope amplifier input. If the phase mismatch becomes worse, the phase shift network is transferred to the other amplifier input to make the phase correction.

The two vernier controls and sensitivity switches are first set according to instructions given in steps c through e of Phase Angle Measurement Procedure. The network under test is then replaced by a jumper, the vertical sensitivity control adjusted to restore the trace to the same or a slightly smaller size, and resistor R is adjusted until a straight line is produced. DO NOT CHANGE THE SETTING OF EITHER AMPLITUDE CONTROL DURING THIS ADJUSTMENT. The jumper around the network under test is then removed and the vertical sensitivity control is switched back to the original setting.

Slight readjustment of either vernier control may now be necessary. If so, repeat steps c through e of Phase Angle Measurement Procedure and then repeat the phase correction adjustment just given.

The phase angle is then measured as directed in steps f thru h of Phase Angle Measurement Procedure.



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