The picture below shows two waveforms at the same frequency, but with a difference in phase angle. The period, T, of the signal can be measured by the Oscilloscope using the **measure mode**, as long as there is at least slightly more than a complete cycle on the screen (at least three zero crossings). Use AC coupling and carefully set the zero of both signals at the center of the screen. Then the difference in time between the adjacent zero crossings of the **same slope** can be measured using the cursor mode.
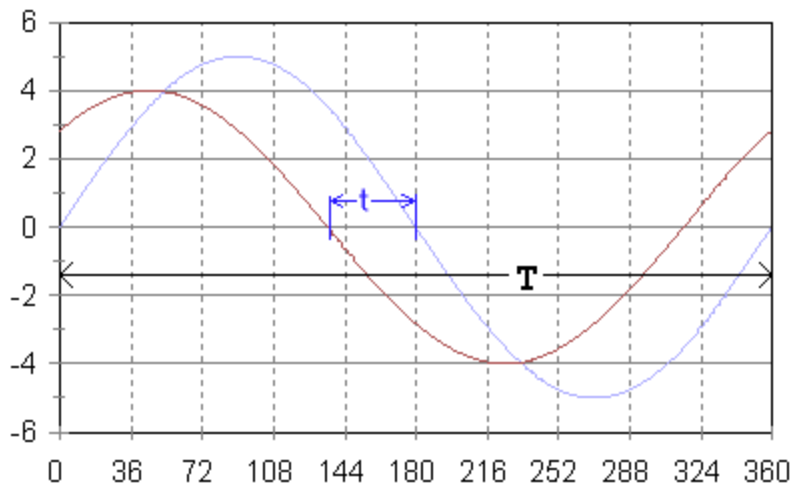
To improve the accuracy of this measurement, use the horizontal position control to center the interval, t, on the screen and then expand the time scale to make the interval cover as much of the screen as possible. Also expand the vertical scale so the zero crossings are steep enough to make it easy to see exactly where the line crosses zero. Use the cursor mode to measure this interval as accurately as possible. The phase angle is then calculated as
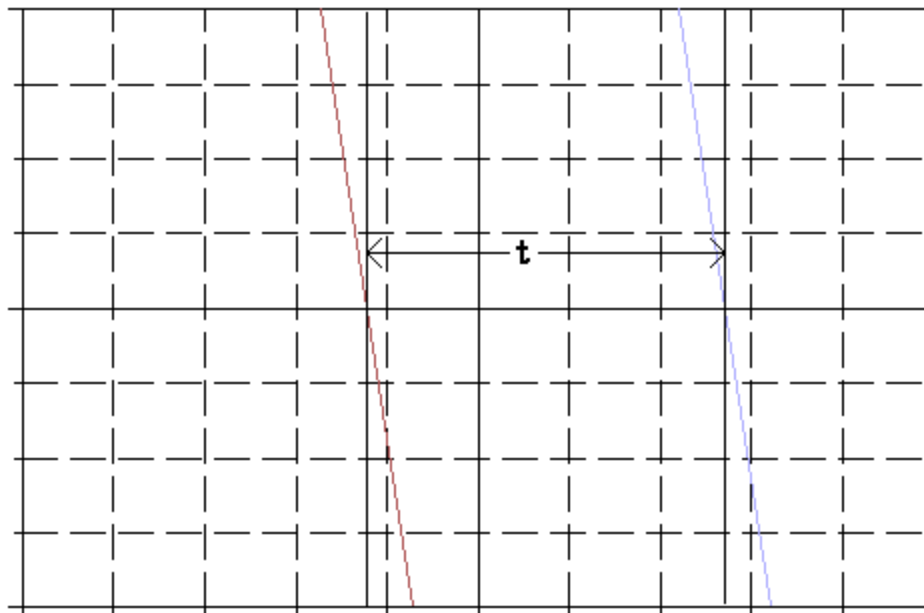

$$\theta = \frac{delta\ t}{T} 360°$$

The sign of the angle depends on which of the two waveforms is used as the reference for zero phase. If

the blue waveform (the one crossing zero at the center of the screen) in the picture above is used as the reference, then since the other waveform reaches zero before the reference reaches zero it is leading the reference waveform. This is a positive phase shift. A negative phase shift would move the waveform to the right of the reference waveform.

On the picture the difference in time (or phase) of the two negative slope zero crossings is labeled as, t. The total width of the waveform, T, is the length of time the wave takes to repeat. It can be most accurately measured between two successive zero crossings **of the same slope** on the same wave. Never try to determine the period by measuring from one peak to the next. The results will be less accurate due to the difficulty in finding the exact center of the peaks. The second waveform shown in the illustration above leads the reference waveform by 45 degrees. It is leading because it crosses zero at an earlier time than the reference waveform. In this case the angle is in the first quadrant since the zero crossing is between 0 and 90 degrees ahead of the reference.
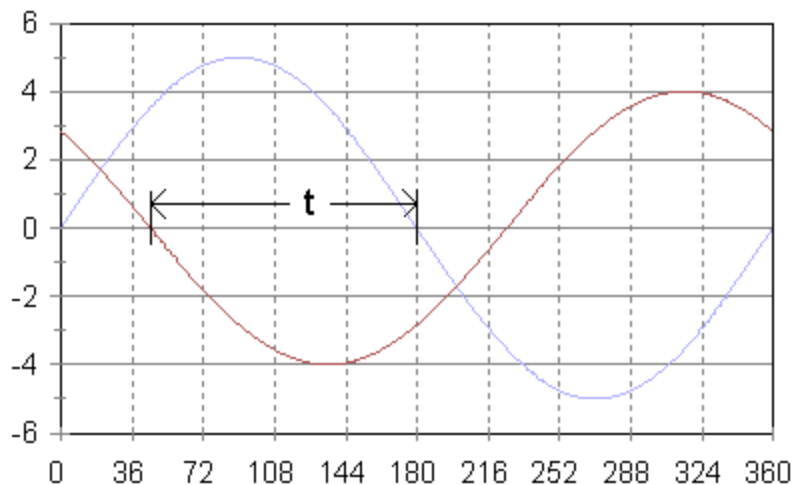
This waveform leads the reference by 135 degrees(second quadrant). It crosses zero between 1/4 and 1/2 a period before the reference waveform. This angle could also be expressed as -225 degrees.
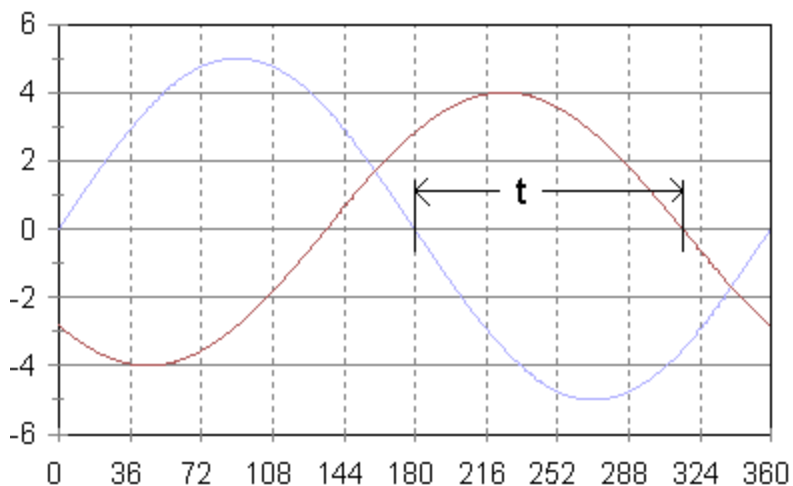

The phase angle of this waveform is in the third quadrant. It leads by 1/2 to 3/4 of a period or it lags by 1/4 to 1/2 of a period. the actual value in this case is an angle of -135 degrees or 135 degrees lagging or 225 degrees leading.
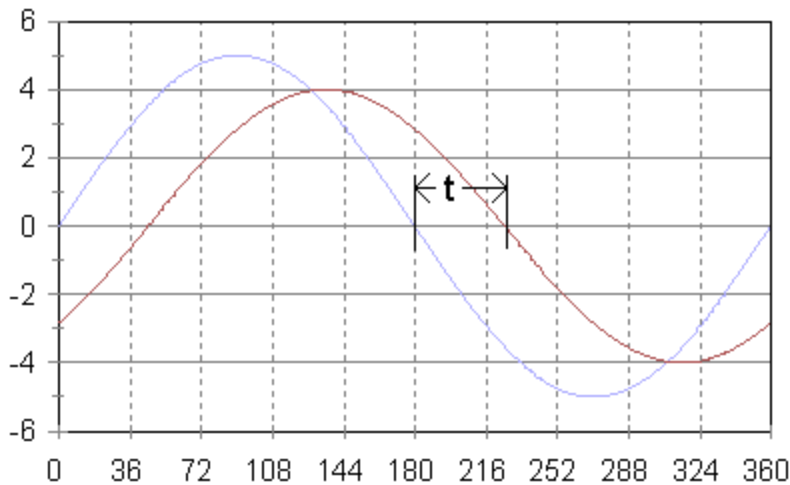
In this picture the phase angle is -45 degrees or +315 degrees or 45 degrees lagging. This angle is in the fourth quadrant between 0 and 1/4 period lagging behind the reference waveform.

An alternate method for determining phase angle difference between two signals is as follows:

Switch the display mode from Voltage-time mode to X-Y mode. The display on the oscilloscope will show an elliptical pattern similar to the following. Always adjust the oscilloscope horizontal scale so that the ellipse, X total, is the full width of the screen. this will maximize the accuracy of the measurements. Before measuring the, X zero, distance increase the vertical gain to make the zero crossings steep for more accurate measurements. Having the top and bottom of the figure off the screen will not effect the measurement since the distance measured is along the horizontal axis. The horizontal scale does not matter since both measurements are measured with the same scale. Therefore the scale factor cancels out when the two values are divided. Also check to make sure the vertical zero is exactly in the center of the screen.
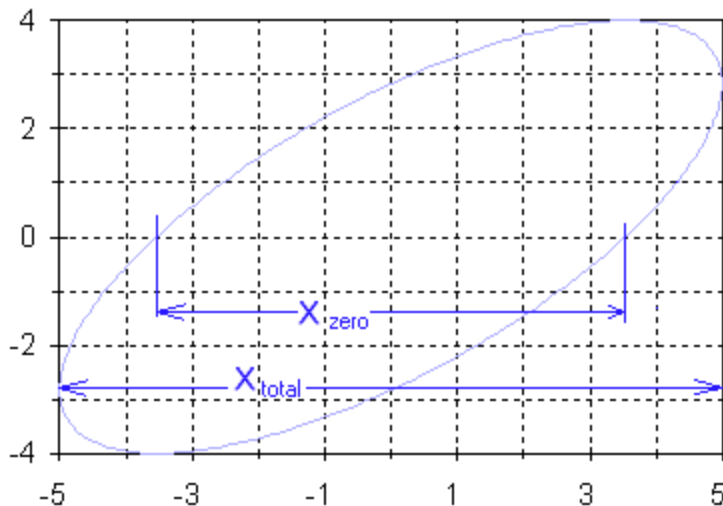
This pattern corresponds to a phase difference of 45 degrees, or -45 degrees, and if the ellipse were sloping in the other direction as shown below it would correspond to 135 degrees, or -135 degrees. The big problem with this method is that you cannot determine if the angle is leading or lagging from this figure. You will have to go back to the voltage-time scale to determine this.
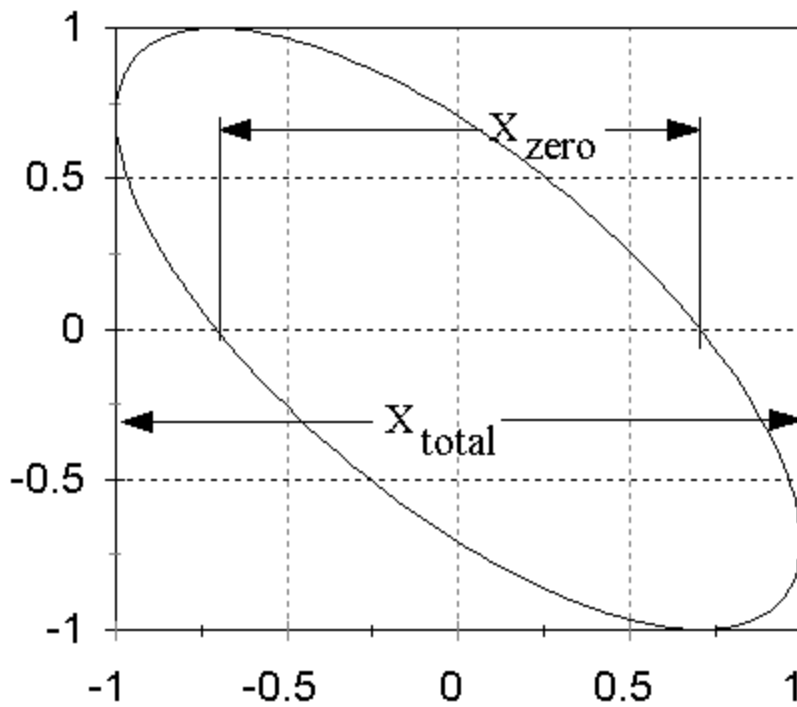
The angle is then calculated as

$$\theta = \sin^{-1} \frac{X_{zero}}{X_{total}}$$

This method is usually more accurate when it is necessary to estimate the distances on an oscilloscope that does not have built in measurement functions. This is especially true for phase angles near zero or 180 degrees except that it does not provide the sign of the angle. It is not very good for angles near 90 degrees or 270 degrees.