Error Vectors

Measure Error Vectors In Quadrature Modulation Systems

LeCroy oscilloscopes includes the ability to measure the vector magnitude and phase of a quadrature modulated signal using an X-Y display of the in-phase (I) and quadrature (Q) components. This is illustrated in figure 1 where the absolute time cursor is being used to read the vector sum of the I and Q components of a 16 QAM signal. The cursor readouts of radius (vector magnitude) and angle (vector angle relative to the X-axis) appear in the upper left in the figure in the X-Y polar readout annotation fields. Note that the cursor also simultaneously measures the amplitudes of the I and Q components (shown as the lower reading in the trace annotation boxes for channels 2 and 3).

Sometimes erroneous states appear in the vector or constellation diagrams and it is necessary to characterize them. Figure 2 shows an example of measuring the magnitude and phase angle of the incorrect state on a constellation diagram.

Using the relative time cursors we can also measure the vector difference between the normal and error state. This is shown in figure 3. This difference represents the error vector from the correct state phase and magnitude to the incorrect state. This direction is set by placing the

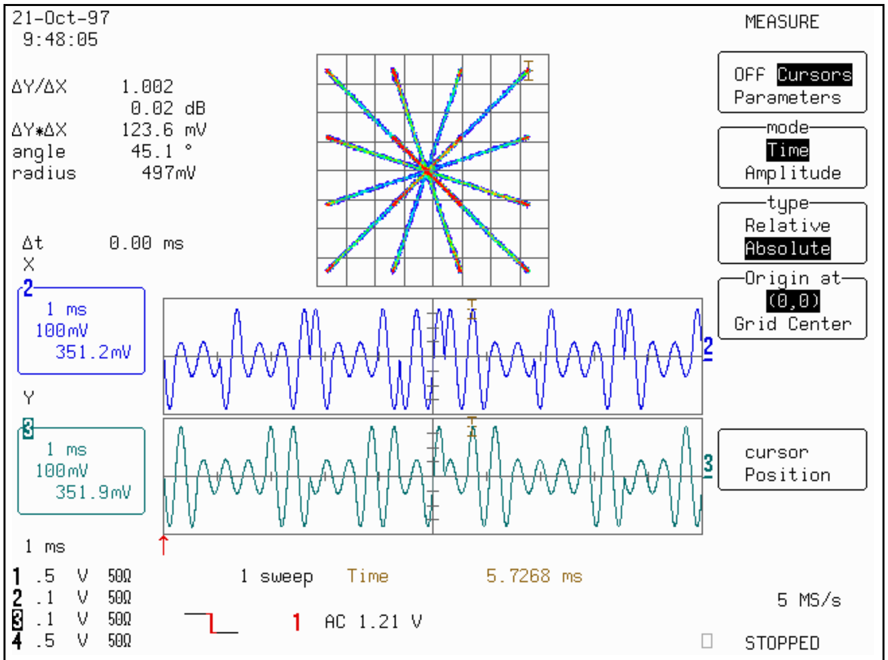

Figure 1 -Using the absolute time cursor to measure the vector magnitude (radius) and phase (angle) of a 16 QAM signal state on a vector (state transition) diagram

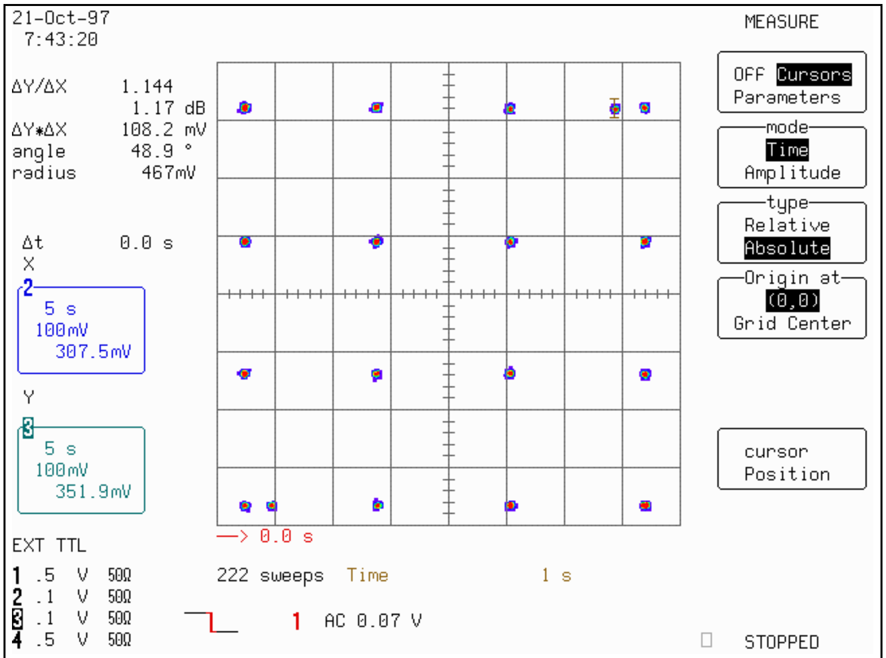

Figure 2 - Measuring the magnitude and phase angle of an error state

reference cursor on the correct state location and the difference cursor on the incorrect state location. The magnitude of the error vector is 56.3 mV and the angle is 180°.

The same measurement can be made using the relative amplitude cursors as shown in figure 4. The advantage here is that the line cursors are often easier to see in complex displays.

LeCroy oscilloscopes include cursors the operate in both normal and X-Y displays and include polar as well as Cartesian readouts of cursor locations. This permits direct measurement of vector error in communications systems using quadrature modulation techniques.

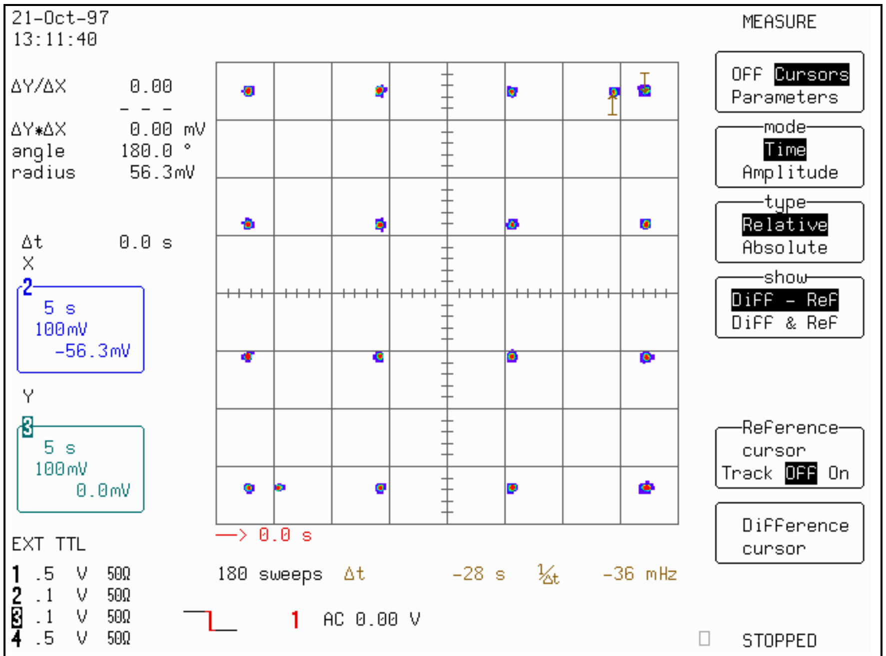

Figure 3 - Using the relative time cursors to measure the vector difference between the correct state (reference cursor ⌉) and the error state (difference cursor -).

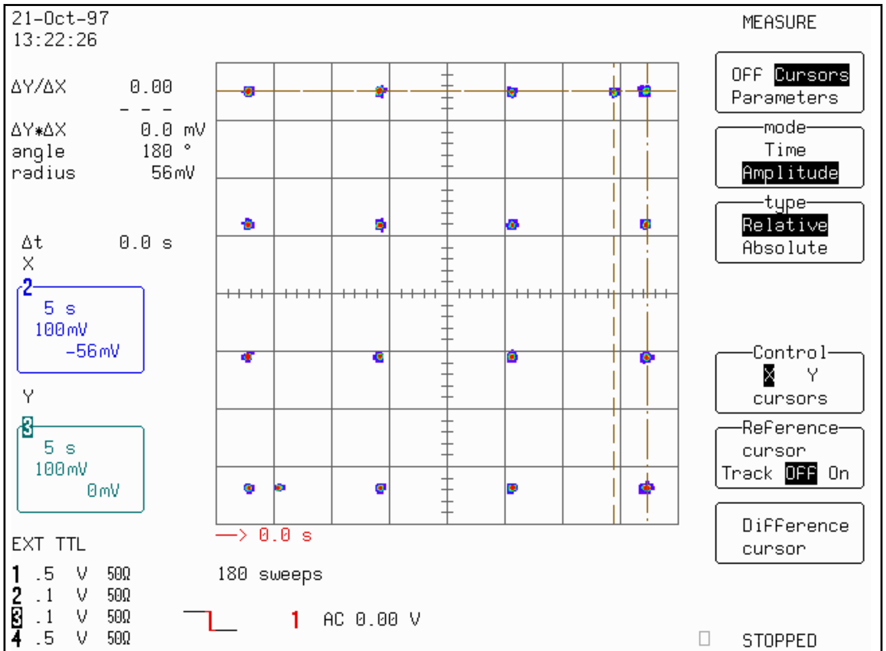

Figure 4 - The measurement of error vector magnitude and phase using the relative amplitude cursors