Modulation Analysis - AM

Time And Frequency Domain Analysis Of AM Signals

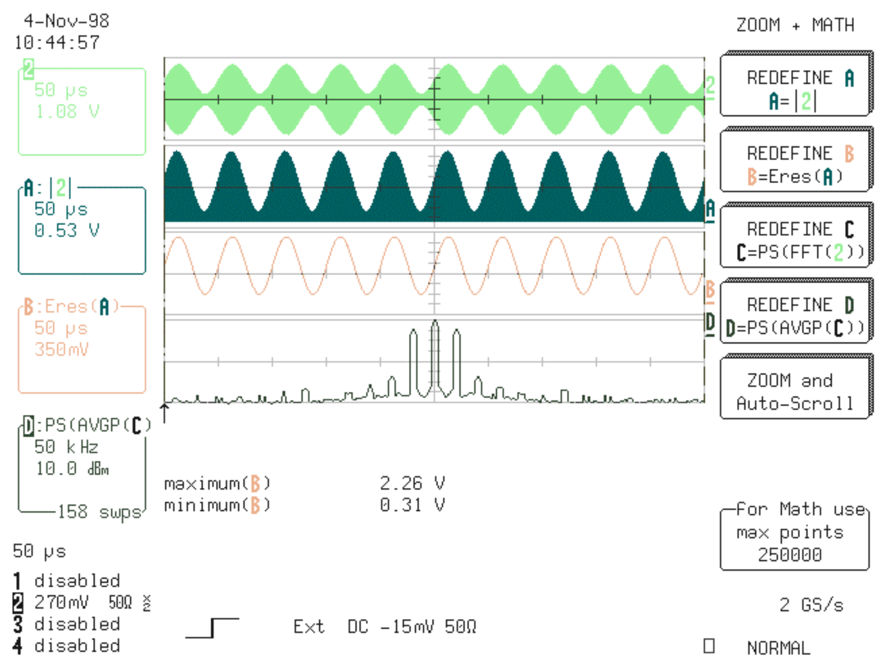

Figure 1–AM signal analysis in the time and frequency domains.

Oscilloscopes have been used to analyze amplitude modulated (AM) signals for decades. Classic time domain displays of amplitude modulation envelope, and trapezoidal X-Y displays provide a single dimension to the measurement of amplitude modulation. Frequency domain analysis, which reveals the sideband structure of the AM signal, provides a second dimension, showing the frequency components that make up the modulated signal.

LeCroy oscilloscopes include all the signal processing tools for in-depth analysis of amplitude modulated signals.

Consider the adjacent display, from a LeCroy LC534AL oscilloscope, it shows an amplitude modulated carrier in the top waveform (CH 2). The LC534AL is well equipped for acquiring and analyzing this type of modulated signal. The long acquisition memory provides record length needed to characterize the modulating signal while, simultaneously, maintaining the high sampling rate needed to properly acquire the carrier.

Classic analysis of this time domain signal can provide a measurement of the modulation index, m, based on the minimum, A, and maximum, B, peak to peak values of the signal:

$$m = \frac{B - A}{B + A}$$

Trace B contains the peak detected envelope of the signal. This was derived from the measured signal using the oscilloscopes absolute value function (|2|), shown in trace A, as a full wave peak detector. The waveform was then low pass filtered in trace B using the enhanced resolution (ERES) function as a digital low-pass filter. The maximum and minimum values of the modulation envelope are read automatically using measurement parameters. Using these values in the equation for modulation index yields a result of 76%

The third trace (traceD) is an averaged fast Fourier transform (FFT) of the signal. It shows the carrier frequency and the upper and lower sidebands. It also shows the harmonics of the modulating signal. These spurious signals are not readily observable on the time domain signal, but they show up very clearly of the frequency spectrum of the signal. FFT analysis has the advantage of very fine resolution bandwidth and over 70 dB dynamic range.

The accompanying display, shown in figure 2, is a more traditional trapezoidal modulation display. The input signal is plotted against the modulating signal using an X-Y display mode. The modulation index is determined using the equation:

$$m = \frac{B - A}{B + A}$$

Where A is the peak to peak value of the shorter vertical side of the trapezoid, and B is the peak to peak value of the larger vertical side. Measurement cursors, which also operate on X-Y displays, can be used to determine the amplitude values. In this example the vertical data was scaled to fit exactly into 8 divisions. The modulation index is then read by taking the ratio of width of the trapezoid (6 divisions) to the full width of the display (8 divisions) resulting in a modulation index of about 75%

LeCroy oscilloscopes provide a full range of analysis tools to characterize and measure modulation processes. These include traditional as well as mathematically based analysis techniques. Coupled with long acquisition memories and high sampling rates to accommodate a wide range of modulation and carrier frequencies, they are ideally suited for this type of analysis.

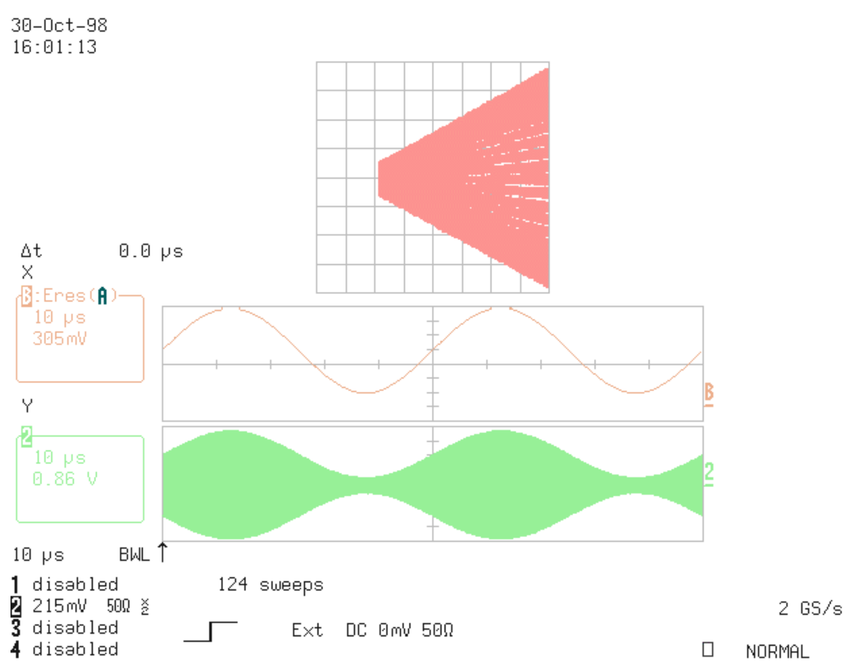

Figure 2 – Using a trapezoidal X-Y display to measure modulation index on an AM signal