Pulse Width Modulated Waveforms
Dynamically Stepping Duty Cycle From 1% To 99%

The LeCroy LW420 Arbitrary Waveform generator is an ideal source of pulse width modulated (PWM) signals commonly used in power, industrial control, and automotive electronics systems. The 1 Megabyte memory supports long test waveforms where the duty cycle of a pulsed waveform can be varied over a wide range without loss of signal continuity. Consider the following example:

Create a 10 KHz pulse waveform where the duty cycle steps from 1% to 99% at a rate of 1 % per pulse period.

This waveform is easily created in the LW420 using equations to describe the required linear stepped pulse width modulation. The 1 % to 99% duty cycle range requires the use of two different equations which are shown in figure 1:
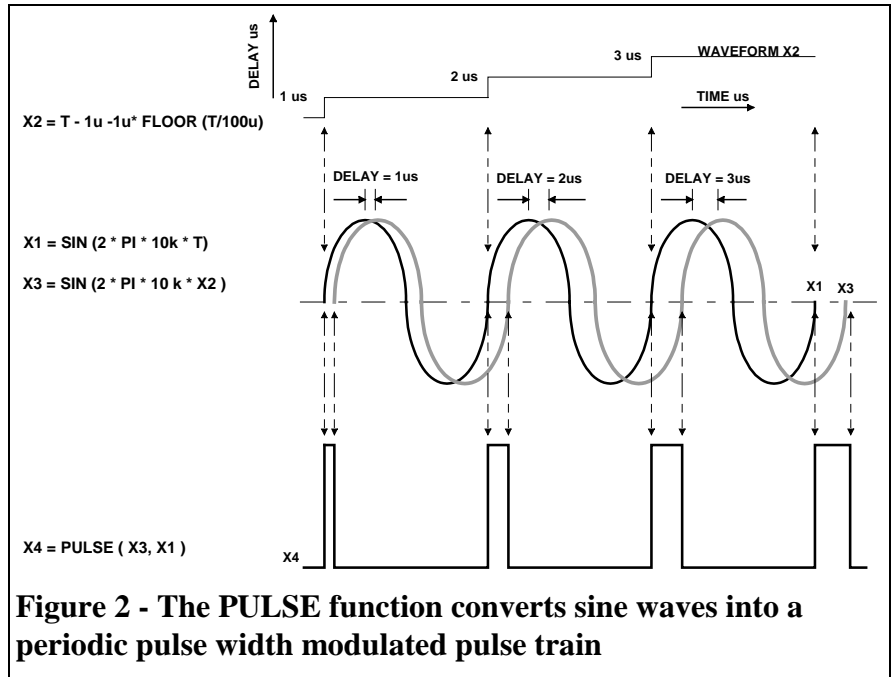
Figure 2 - The PULSE function converts sine waves into a periodic pulse width modulated pulse train

The waveform is created using the PULSE function with the sine wave arguments (in lines X1 and X3) as shown in figure 2. The sinewave described by line X3 is delayed in time, starting at 1 μs and increasing by 1 μ for each cycle of the sine wave. The pulse waveform begins when the sinewave in X1 goes positive and ends when X3 goes positive.

The test waveform is formed in two parts. One, line X4, creates a waveform PWM_1 with a duty cycle that steps from 1 % to 49% in 4.9 ms. In the second waveform PWM_2 created using the equation on line X5 the duty cycle varies from 50% to 99% in 4.9 ms. The two waveforms are concatenated using the LW420 waveform sequence PWM shown in figure 3.
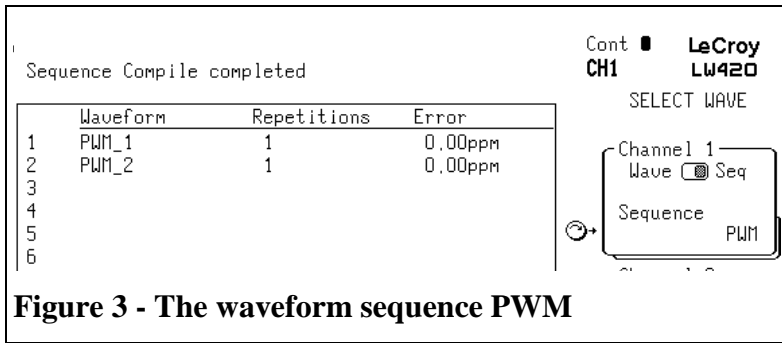

X1 = SIN (2 * PI * 10k * T) - *creates a 10 kHz sine wave*
X2 = T - 1μ - 1μ * FLOOR (T/100μ) - *Time variable with a stepped ramp delay*
X3 = SIN (2 * PI * 10k * X2) - *Delayed sine wave*
X4 = PULSE (X3 , X1) - *Pulse with 1% < duty cycle < 49%*
X5 = 1 - PULSE (X3 , - X1) - *Pulse with 50% <duty cycle< 99%*
Figure 1 - Lines X4 and X5 describe the PWM waveform

Figure 3 - The waveform sequence PWM

The waveform sequence produces a continuous waveform that steps through 98 cycles of the pulse period increasing the duty cycle smoothly from 1% to 99%. The entire waveform, as captured on a LeCroy 9354AL oscilloscope is shown in figure 4.

In addition to the acquired waveform (Ch2) three zoom traces show the pulse width at the beginning middle and end of the waveform while the local time over threshold parameter shows the range of pulse widths encountered.
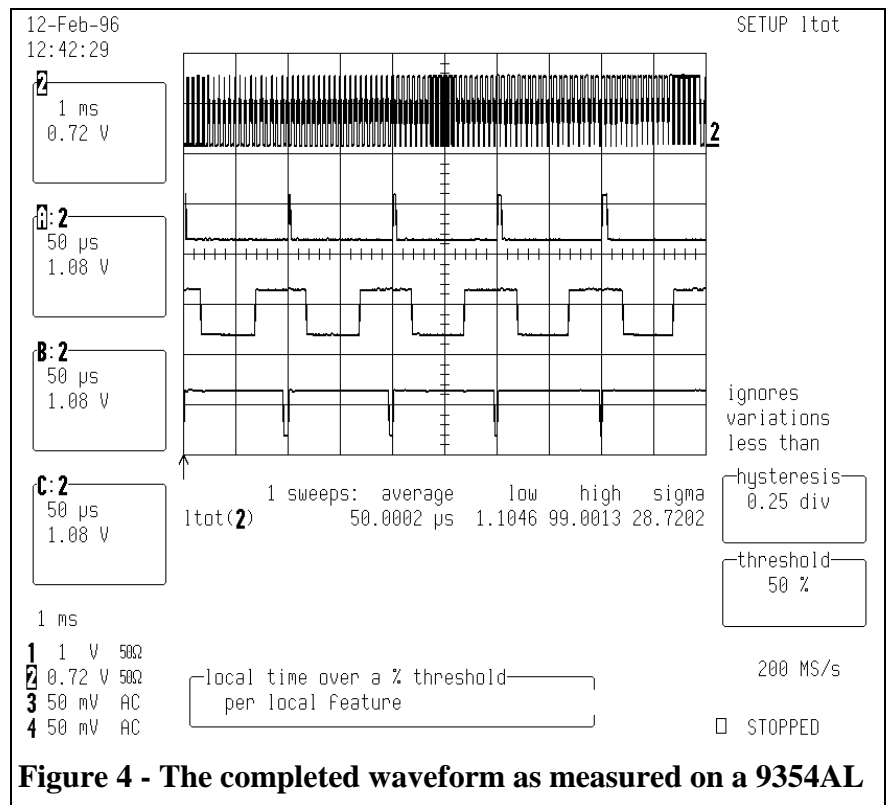

Figure 4 - The completed waveform as measured on a 9354AL