Generating tone bursts and sweeps for ultrasonic tests

1 Rationale

The blue pulser boxes generate an impulse electric waveform that excites the transducer at its natural frequency. To change the frequency, one uses a transducer with a different natural frequency. Fine tuning is not possible with this sort of impulse waveform. By contrast, if one uses as input, a burst of several sinusoidal cycles, then the frequency of these cycles can be tuned continuously. The transducers we use are broadband and heavily damped, so they can respond adequately at frequencies off the natural frequency. Continuous tuning is helpful in probing the behavior of composites, in particular local resonance of micro - structural heterogeneity in the composite.

1.1 Use of Stanford Research DS 345 function generator

First set the frequency to correspond to the natural frequency of the transducer. Set the amplitude to maximum, 10 volts.

Set burst mode: in the sweep / modulate group of buttons, select burst mode. Set the burst count: press shift burst count, second button from top, above Rate button. This sets the number of cycles in the burst waveform.

Set trigger rate to control the rate at which pulses are generated. Press shift trig source above 0 button. Use modify keys on right, set rate. Press shift trig rate above 1 button. A rate of 1 kHz is reasonable.

Look at the signal on a scope. Also Trig'd light should go on above the frequency button. If necessary, one may have to reset Burst mode.

The frequency of the sinusoids is set using the frequency button. The maximum for burst mode of sinusoids is 1 MHz even though the function generator is capable of 30 MHz.

One can go down at least to 0.2 MHz and get quality waves through a brass block using 1 MHz transducers.

To stop burst mode and return to continuous sinusoid, go to MOD /SWP column and press sweep on / off. Press again to resume burst.

1.2 FFT

The Tektronix oscilloscopes are capable of displaying a fast Fourier transform (FFT). To get better resolution in the FFT, use a slower sweep such as 20 μs / div rather than 4 μs / div.

A burst of one cycle gives rise to a broad hump in the FFT as expected. A burst of 8 cycles or more gives rise to a much sharper peak.

1.3 How to generate a frequency sweep display

Set up the SRS 345 function generator to sweep frequency through a range containing the expected resonant frequencies. The rate can be 1 Hz for a high damping material such as a polymer, but should be 0.1 Hz or lower for low damping metals (otherwise ringing occurs, broadening the peaks).

Trigger the Tektronix TDS oscilloscope via the blank lift output from the SRS 345 function generator. The signal is a pulse of 5v amplitude, 400 microseconds long.

The scope horizontal scale needs to match the sweep from the function generator. For example a 0.1 Hz rate on the function generator corresponds to a period of 10 seconds, or one second per division on the scope.

Amplify the transducer output enough to obtain at least several volts at the resonance peaks.

Pass the amplified signal through a circuit box containing a diode in order to rectify the oscillating signal. This is a resistor box with the diode path indicated in yellow on the side. The threshold for a diode is about half a volt; that is why the signal must be amplified first. The output goes into the oscilloscope. If the sweep appears noisy, use signal averaging via Acquire menu on the right of scope panel. Alternatively rectify the signal by post-processing using the absolute value function.