TIMS Lab 1: Modeling an Equation

An exploration in telecommunications signal nulling

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Abstract:

The following experiment was conducted to familiarize the lab technician with operating the TIMS-301C telecommunications modeling system. The experiment took two sinusoidal signals of the same magnitude and frequency and summed them together, then by using a phase modulator cancel the resultant signal. This illustrates the concept of "nulling" a signal.

Practical Applications:

In radio communications, when a radio antenna has a radiation pattern with "blank" locations, as in the radio is not capable of emitting radio-waves in those directions, that is said to be a *null* for the radio. This being caused by the destructive interference of waves in those locations, which is caused by waves of *differing phase* super-imposed on each other.

TIMS Results:

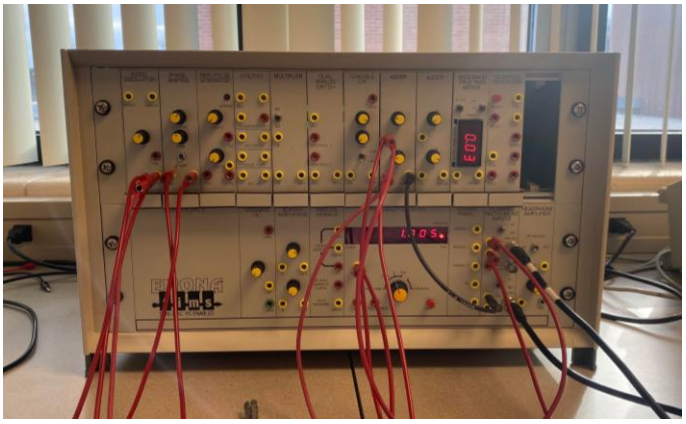

Figure 1: TIMS-301C Experimental Setup

From the AUDIO OSCILLATOR, two 4V sinusoidal signals driven to run at 1.005kHz via the FREQUENCY COUNTER were sent to the ADDER and PC BASED INSTRUMENT INPUTS modules. However, one of the sinusoids was first routed through the PHASE SHIFTER to allow for the added signals to be of different phase.

Into the oscilloscope, the individual sinusoids can be viewed one at a time in CH1 (yellow signal) and the resultant sinusoid can be viewed in CH2 (green signal).

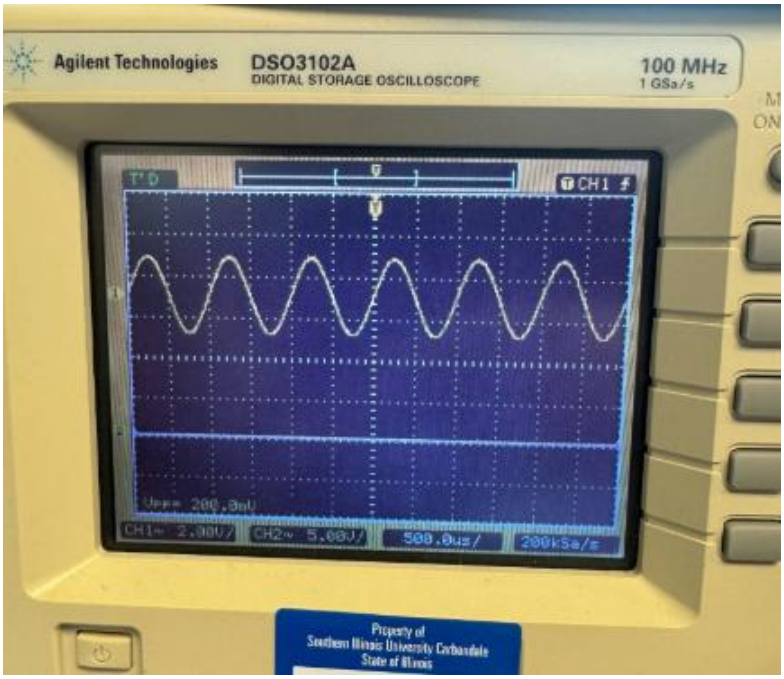

Figure 2: Nulled signal.

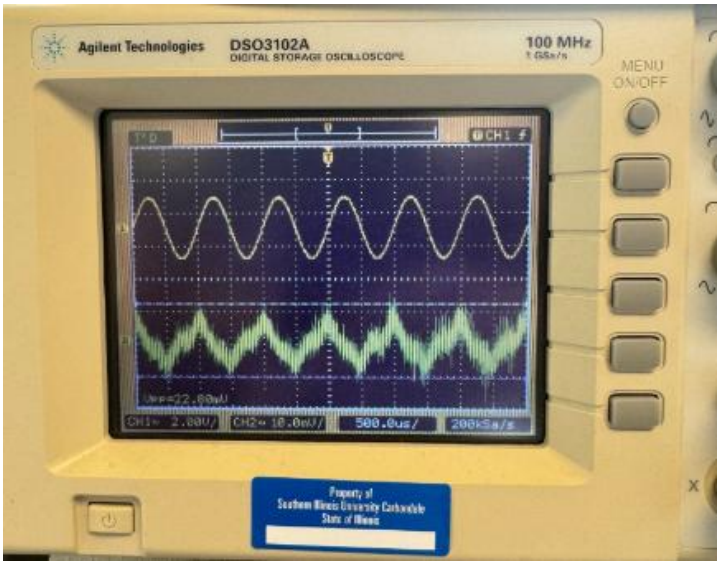

Figure 3: Nulled signal 10mV/div; System noise.

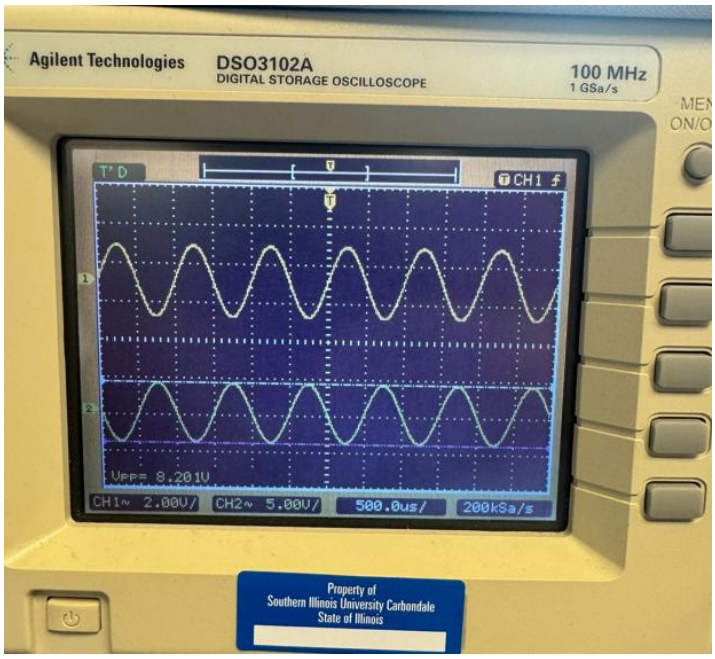

Figure 4: Fully constructed signal.

Figures 2 and 3 show the resultant signal in its nulled state; this requires the signals to be 180 degrees out of phase, and minor adjustments due to the non-calibrated system. Ambient noise keeps the nulled signal around 20mV peak-to-peak. Figure 4 shows instead the result of the input signals being in phase and therefore double the peak-to-peak when summed.

MATLAB/Simulink Recreation:

Using Simulink in MATLAB, we can model a block diagram of the system, where two sinusoids (one chosen to be 180 degrees out of phase) added together.

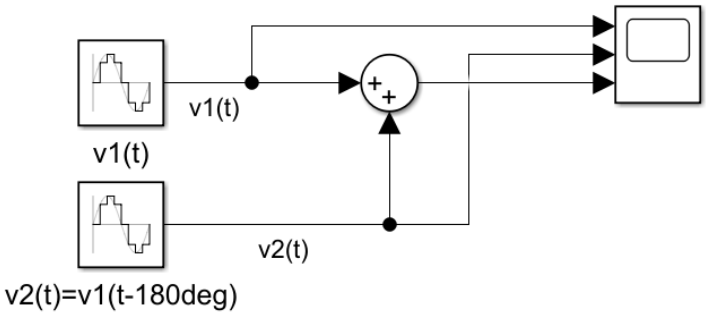

Figure 5: Block diagram of system.

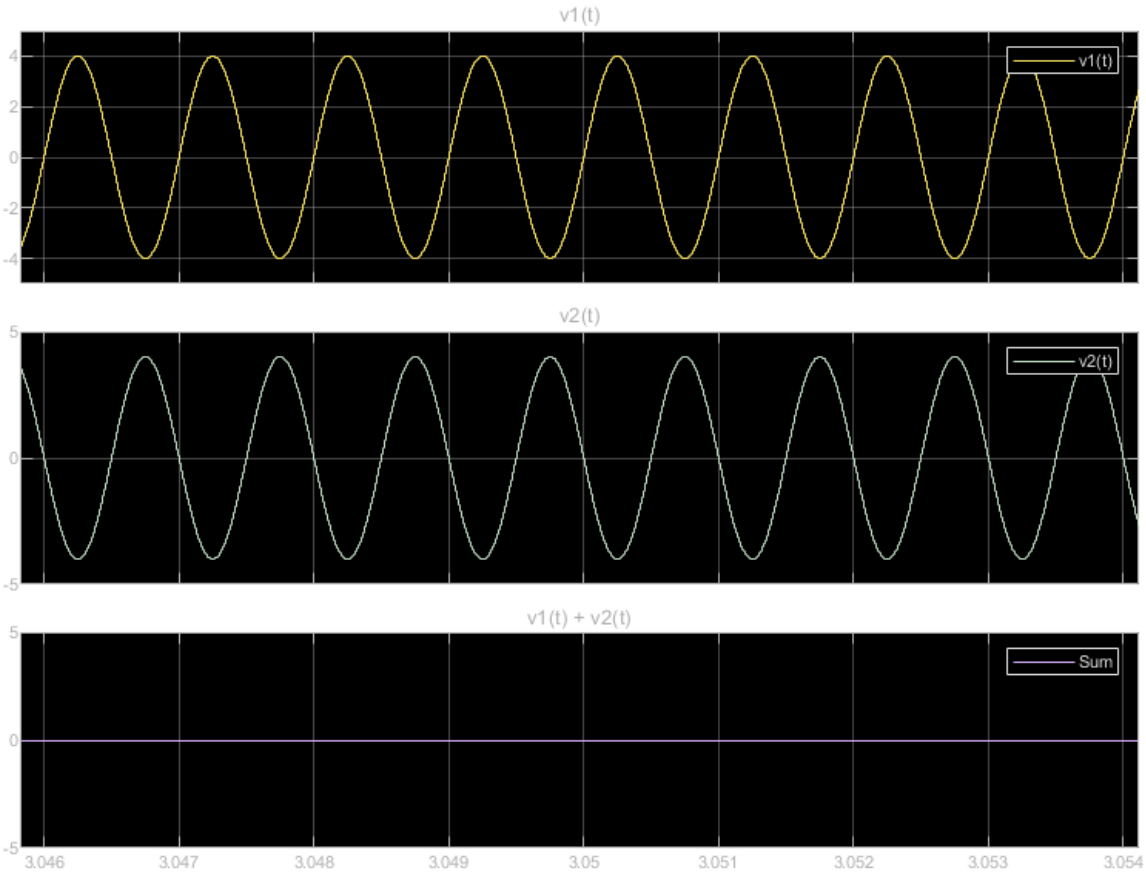

Figure 6: System signals; purple is nulled signal.