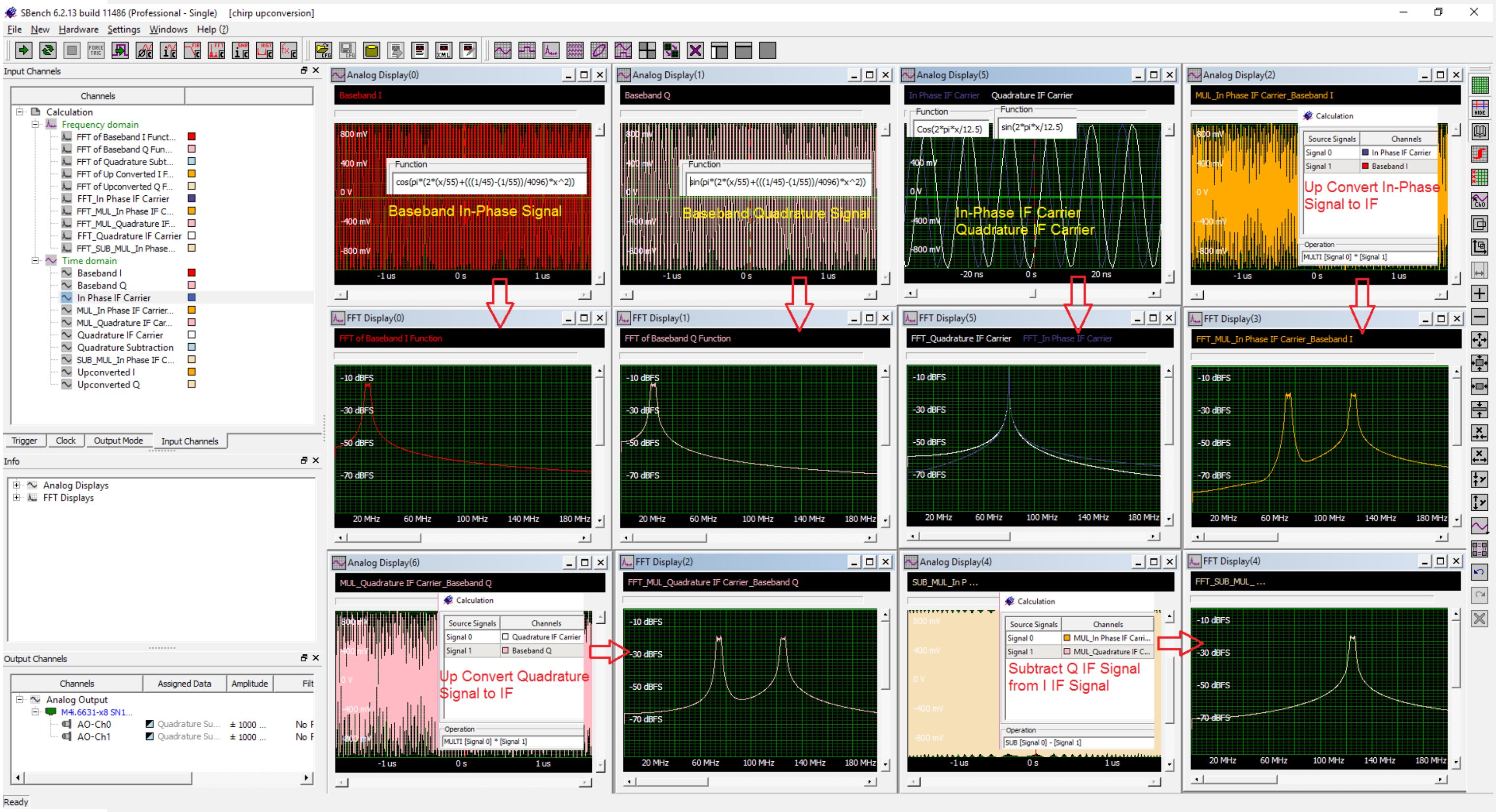
Academic Guide to SBench 6 – Example 4

Modulation, Simple and Complex

Sbench 6 can also generate a variety of modulation types for communications testing. Amplitude, phase, and frequency modulation can be easily created using equations and waveform arithmetic. Look at the example shown in Figure 1, where quadrature signal techniques are used to generate a ‘chirp’ waveform at an intermediate frequency (IF).

A chirp is a frequency modulated signal usually associated with RADAR systems. While it could easily be programmed directly using an equation, it is instructive to show a general approach that could be used to create other complex modulation.

The figure shows the steps in creating the chirp. It starts in the upper left grid, the grid immediately to the right, where linearly swept sine and cosine waveforms are shown in the time domain along with the equations used to create them using a 4kS memory and a 1.0 GS/s sample rate. These signals are in quadrature representing the in-phase (I) and Quadrature (Q) components of a quadrature modulation, but the phase difference does not show in the FFT’s of the waveforms shown below them. The FFTs show the sweep range from 22.7 to 27.7 MHz. These are baseband signals.



The baseband quadrature components are then up converted by multiplying the I and Q baseband signals by the cosine and sine of the intermediate frequency respectively. The intermediate frequency is 100 MHz. The IF carrier components are shown in the top row, third from the left with their FFT’s directly below. The upper right grid shows the time domain view of the up converted in-phase signal and the setup of the waveform math subtraction. The lower left grid shows the up converted quadrature signal with its FFT to its right. Note that the multiplication by a sinusoid has converted the baseband signals to double sideband suppressed carrier signals centered at 100 MHz with upper and lower sidebands extending from 22.7 to 27.7 MHz on either side of the center frequency of 100 MHz. What is not seen in the amplitude FFT is the phase of the two quadrature components. It is the differences in the phase spectra that will make the next step possible.

The final step in the process is to do a quadrature subtraction of the two IF components, Up Converted I and Up Converted Q. This is shown in the bottom row, third grid from the right. The FFT, to the immediate right shows that, as a result of the subtraction, the lower sideband has been cancelled leaving only the upper sideband. This signal sweeps from 122.7 to 127.7 MHz.

This example illustrates how the basic concepts of signal generation and chained quadrature processing can be followed to create complex waveforms associated with communications systems.