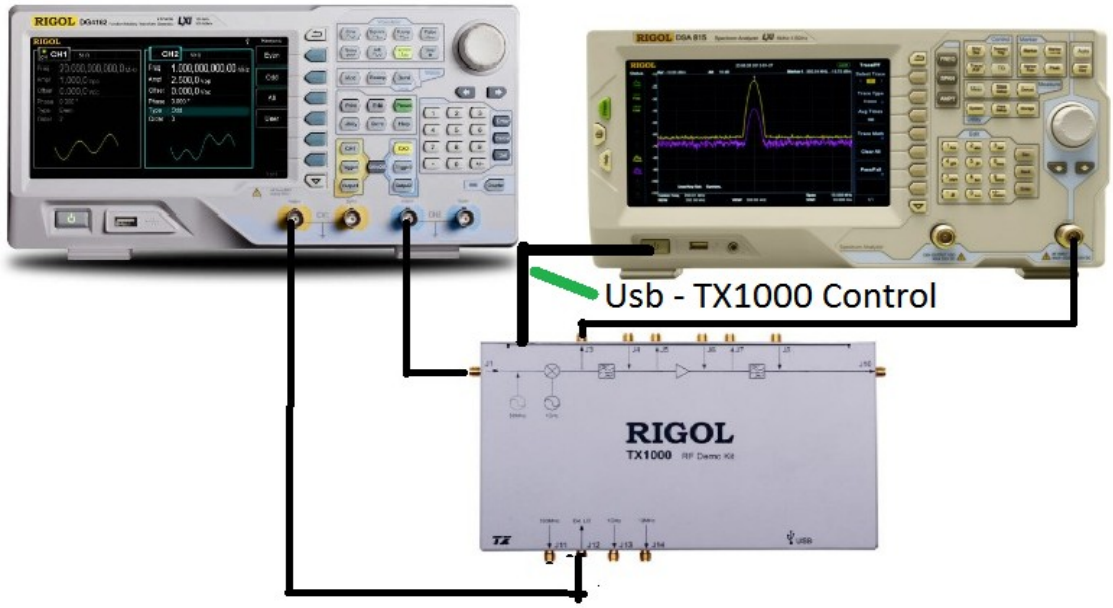
Mixing RF Signals (Tutorial)

Being able to map or move signals from one frequency (or band) to another is a basic capability and fundamental requirement of communications systems. This tutorial uses Rigol's TX1000 (RF Demo Kit), its DSA815-TG(1.5 GHz Spectrum Analyzer), and its DG4162 (A 2 channel 160 MHz Arbitrary Function Generator) to investigate the behavior of a mixer.

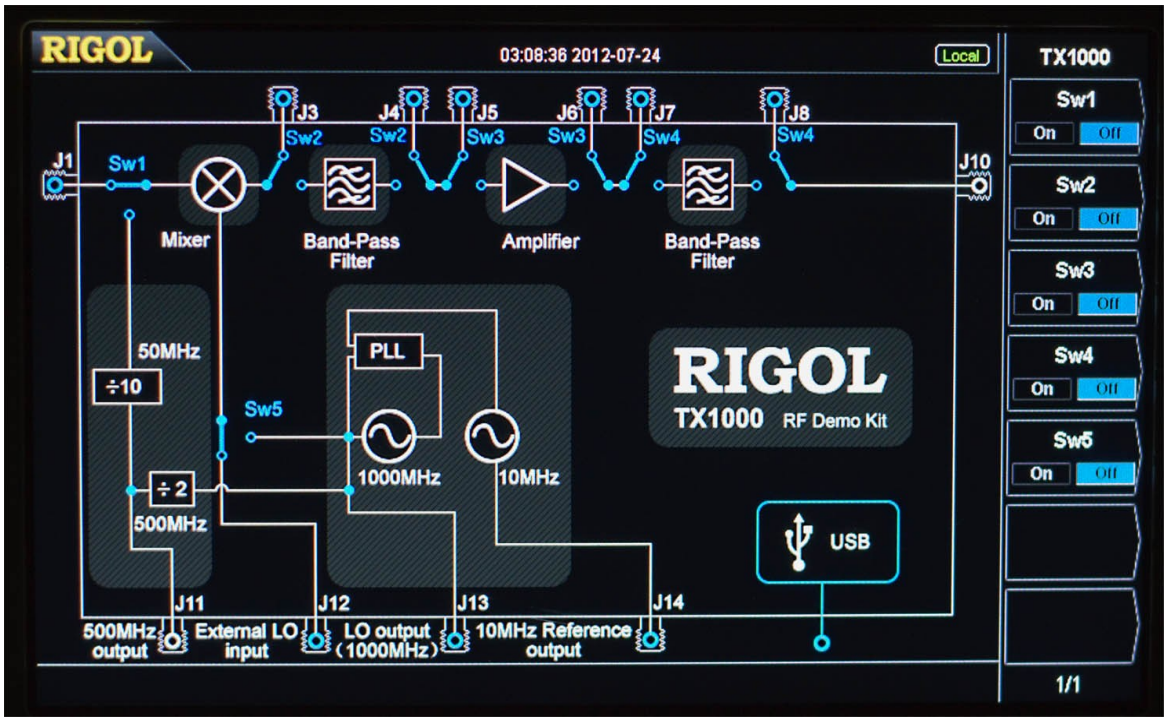
The output signal from a Mixer is generally indicated as the product of the two inputs. The multiplication of two sine waves generates an output with two frequencies of equal amplitudes - one having a frequency equal to the sum of the two input frequencies and the second wave having a frequency equal to the difference of the two input frequencies. (*Notice that for a perfect mixer the output has no signal at either of the two input frequencies - Indeed, one measure of the mixers quality is defined by the amount of the carrier or input frequency that shows up in the output - less is better)*

The DG4162 has two identical channels. For this demonstration, both units are configured for an output of 50 ohms at an output level of -8 dBm. Channel 1, the carrier, is set to 100 MHz and Channel 2, the modulator, is set to 10 MHz.

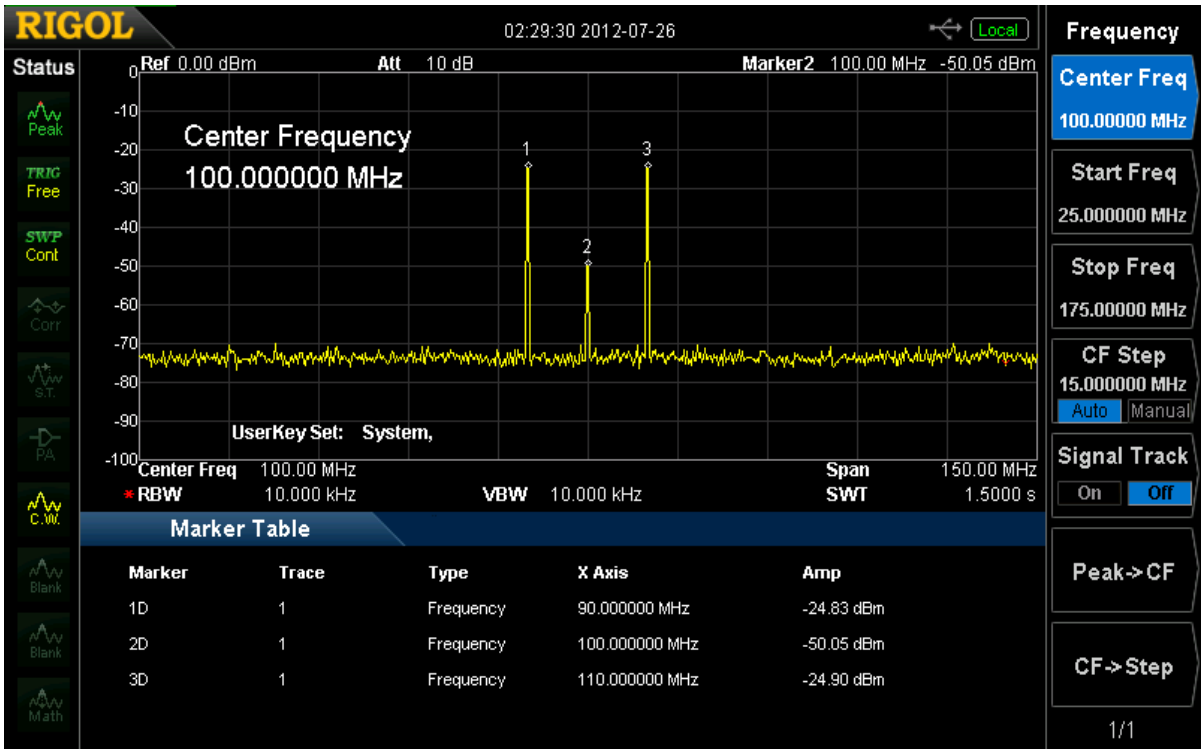
The test equipment is configured as shown here.



The TX1000 runs from a USB cable and is controlled from the front panel of the DSA815 (or from a Windows XP application). Shown below is the TX1000 configuration for this test. Switch SW1 and SW5 are closed to connect the two external channels to the front of the mixer.



With the test system configured in this fashion, the DSA815 will show that the output from the Mixer (TX1000) does not totally reject the 100 MHz Carrier. The DSA815's screen image can be saved as a .bmp image – shown here - on a USB stick by inserting the USB stick into the DSA815 and pressing it's print button

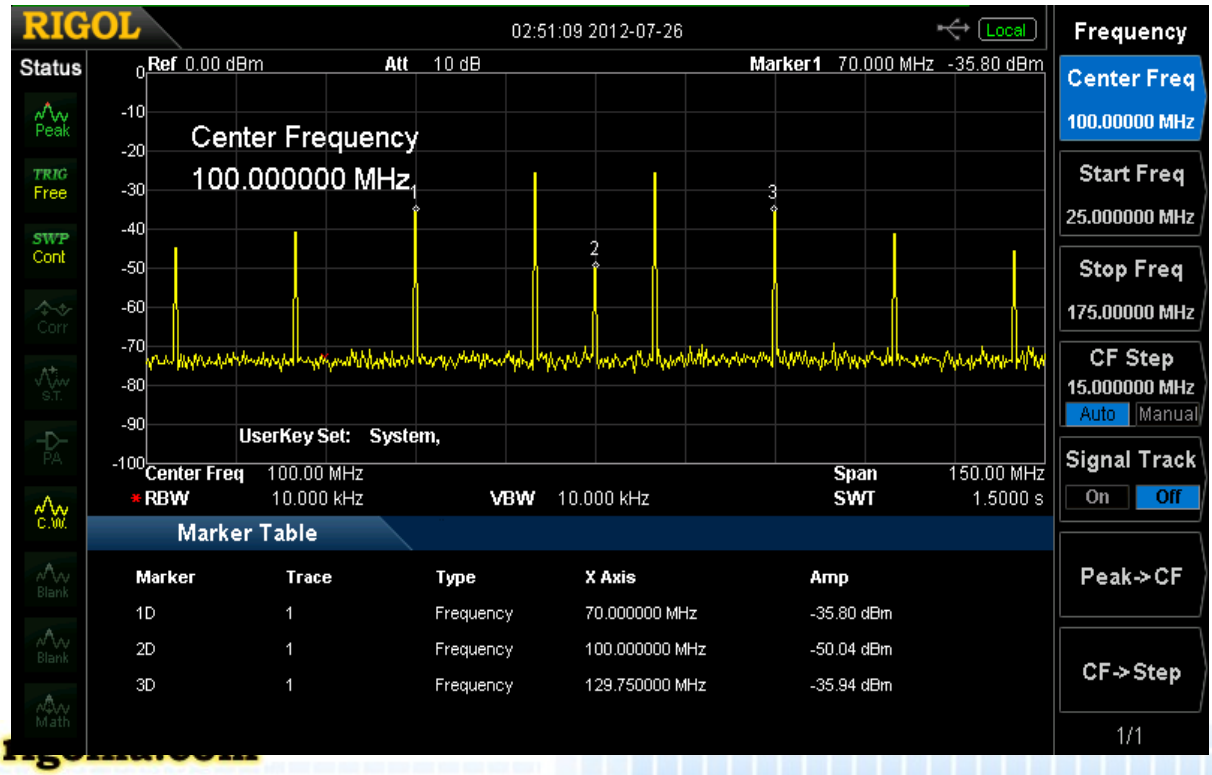


The DSA815-TG's span has been configured so that the center of its screen shows any signal at 100 HHz with the entire display showing frequencies between 25 MHz and 175 MHz (the Span is 150 MHz)

In addition, to illustrating the signals at the expected sum and difference frequencies, this illustration has also displayed the optional Marker Table that lists the X-Y coordinates of the three markers – the unit can display as many as 4 markers- (As the markers are moved (with the rotary Knob, for example) the Marker Table is updated to show their current position. For this test the marker table shows

1) the signals at 90 and 110 MHz are at the same level and
2) The carrier is -25db below the sum and difference signals.

When the modulating signal is changed to a square wave, the DSA-815 shows how the harmonic content of it are carried into the output signal of the modulator.



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Notice that not only does the screen show the 1,3,5 sequence of harmonics, but cursors 1 and 3 have been moved to show that, indeed, the amplitude of 3rd harmonic is 1/3 (-10 Db) of the fundamental.