DStar Co-channel and Adjacent Channel Performance

N5RFX 4/21/08

Introduction

The purpose of this initial paper is to describe and show the results of DStar co-channel and adjacent channel interference testing at the N5RFX shack.

The Receiver

The ID-800 was used to perform the tests. Figure 1 shows the signal path from the first IF stage to the detector, CODEC and audio circuits.

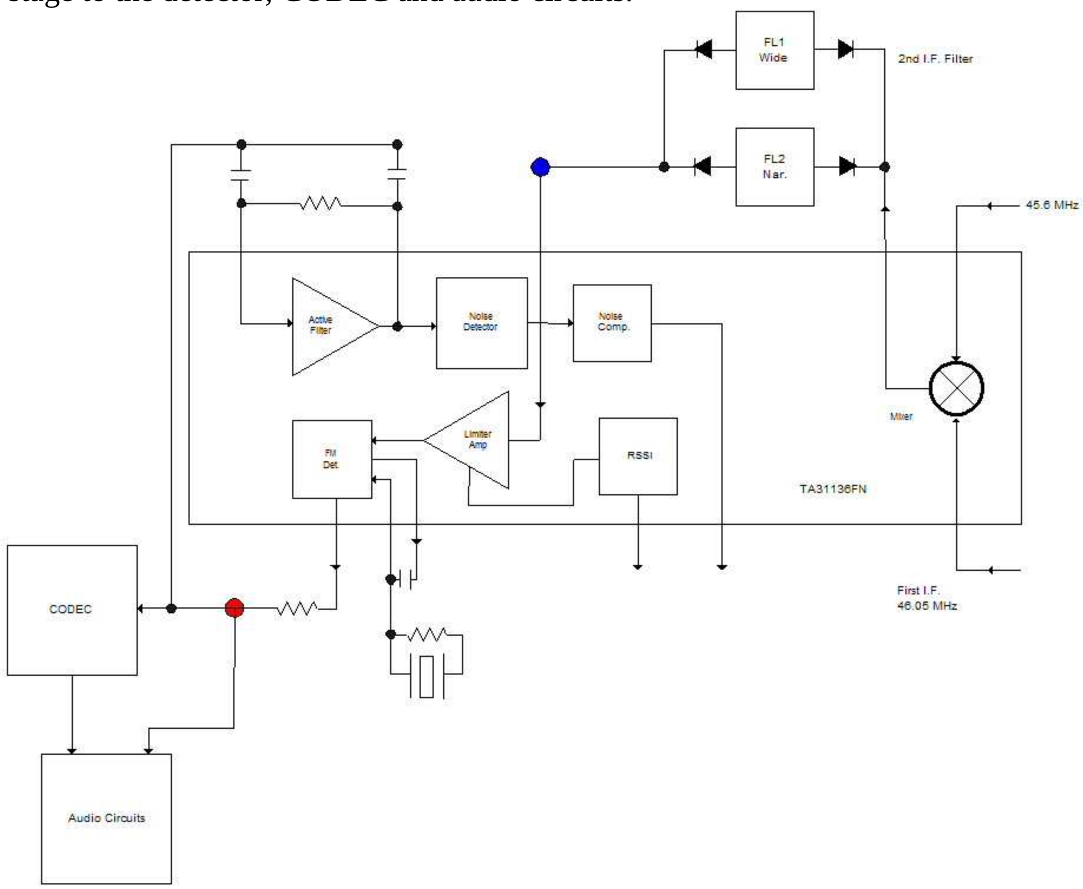

Figure 1 ID-800 IF Detector Stage

The TA31136FN IC IC 4 contains the second mixer, quadrature detector, RSSI and noise detector. The 40.065 MHz first I.F. is mixed with 45.6 MHz to produce the 450 kHz I.F. The ID-800 uses two 450 kHz IF filters to set the selectivity of the radio. The wide filter, FL1, is a CFWLA450KHFA-B0. According to the spec for this filter the 6 dB bandwidth is +/- 3 KHz and the 50dB bandwidth is +/- 9 kHz. I measured 20 kHz at -26dbc and just under 22 KHz at -60dBc. The narrow filter, FL2, is a CFWLB450KE2A-B0. A data sheet for this filter is not available at the time this paper was written, but measurements show a little more than 10.5 kHz bandpass at -26dBc and a little more than 11.5 kHz at -60 dBc. According to the repeater schematics, the DStar repeater uses the same TA31136FN chip, and the narrow ceramic filter. The DStar repeater does not have the wide bandwidth ceramic filter.

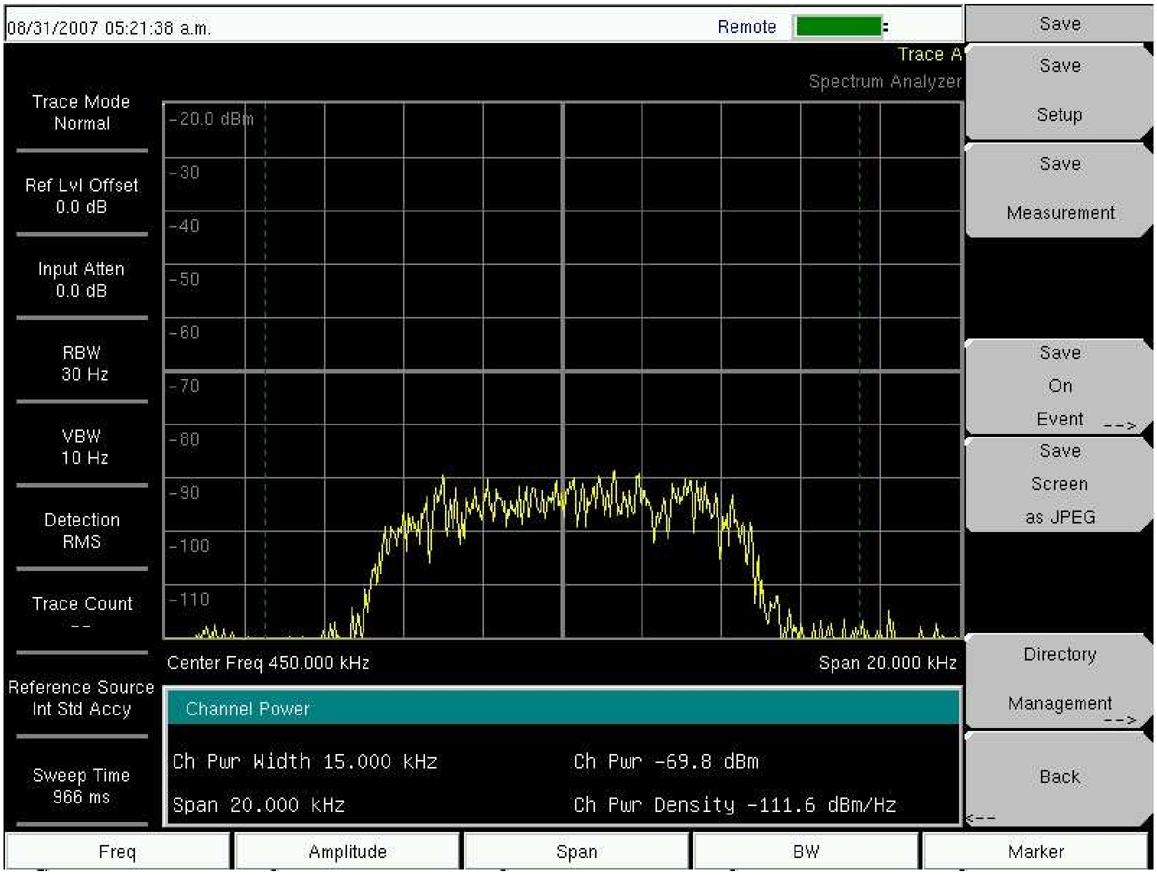

Figure 2 ID-800 450 kHz IF Prior to Detection (Blue Dot in Figure 1) with No Signal Applied

Figure 2 shows a spectrum analyzer display of the 450kHz I.F. after passing through the narrow filter FL2, prior to the limiter amplifier in IC4 (blue dot in Figure 1). No signal is present at the input of the receiver. Figure 3 shows the 450 kHz I.F. at the blue dot in Figure 1, but with a DStar signal applied at the receiver input. The 26 dBc occupied bandwidth of the DStar signal is slightly less than 6.25 kHz.

The output from the FM detector (red dot in Figure 1) is applied through a switch to the CODEC and analog audio circuits. Tests have shown that the CODEC requires a 3 dB signal to noise ratio at the output of the FM detector to provide reasonable decoded audio.

Test Setup

Figure 4 shows the test setup. The two R.F. signal sources were the K5TIT port B repeater and a HP8920A communications analyzer. The K5TIT signal is received over the air to the N5RFX station. At the N5RFX station the received signal is fed to a pair of attenuators that give 0 to 100 dB attenuation in 1 dB steps. The K5TIT signal is then fed to a splitter/combiner. The second R.F. signal is generated by the HP8920A and fed to the second port of the splitter combiner. The HP8920A is modulated by signals from a PC. The PC contains wave files that are used as interfering signals. The GMSK wave file was produced using an IC-91AD demodulated by the HP8920A and recorded by a M-Audio Delta 44 sound card. The 24 mile path between K5TIT and N5RFX is has Fresnel clearance with obstructions as shown in Figure 5. K5TIT is approximately 921 ft. AGL and N5RFX is approximately 25 feet AGL.

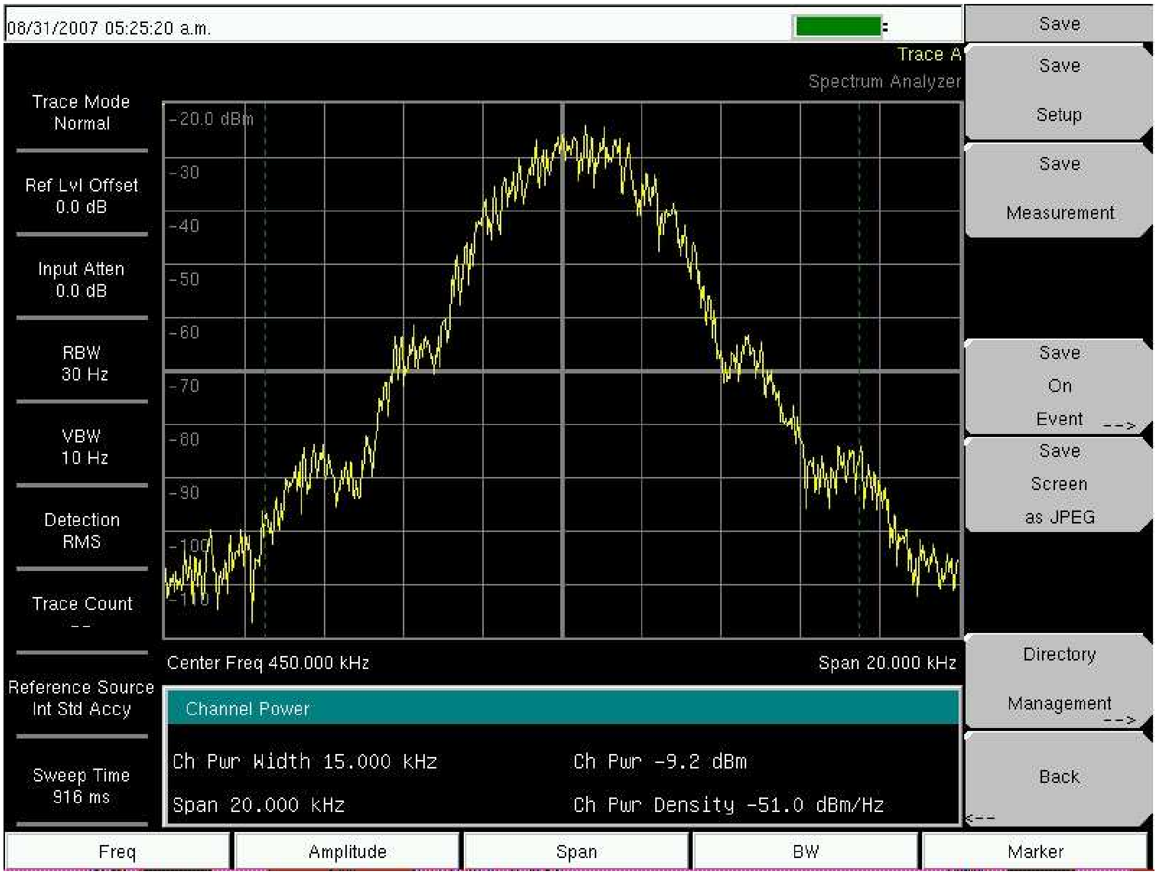

Figure 3 ID-800 450 kHz IF with a DStar Signal Prior to Detection

Reference Levels

The ID-800 S meter indicates 5 when a –104dBm signal is applied to the port 1 input of the splitter/combiner. To achieve this level from the K5TIT repeater, 21 dB of attenuation is required. The undesired signal is adjusted by the HP8920A. The ratio of desired to undesired signal is the difference in dB between the attenuated K5TIT signal and the output of the 8920A.

Test Results

Figure 6 shows the results of the tests. Three interfering signals were produced. The first was a DStar signal, the second and third were analog FM signals at 2.5kHz and 5kHz deviation. When the K5TIT repeater was active on 442 MHz, the ID-800 began decoding the voice signal. The 8920A was tuned to the offsets shown in Figure 6 and the RF level adjusted to produce an intelligible voice signal. DStar messages were not decoded when the ID-800 was able to just produce an intelligible voice signal. The FM capture of the ID-800 was greater than 10 dB for both the narrow and wide bandwidths. In Figure 6 the y-axis is the desired signal minus the undesired signal, and the x-axis is the frequency offset of the undesired signal versus the desired signal. When both signals are at the same frequency, the desired signal must be 3 dB higher than the undesired signal for the desired signal to be decoded. As the undesired signal moves away from the desired signal frequency, there is a hump that requires the desired signal to be 10 dB higher than the undesired signal. As the undesired signal moves further from the desired signal's frequency the undesired signal level must exceed the desired signal's level to disrupt communications.

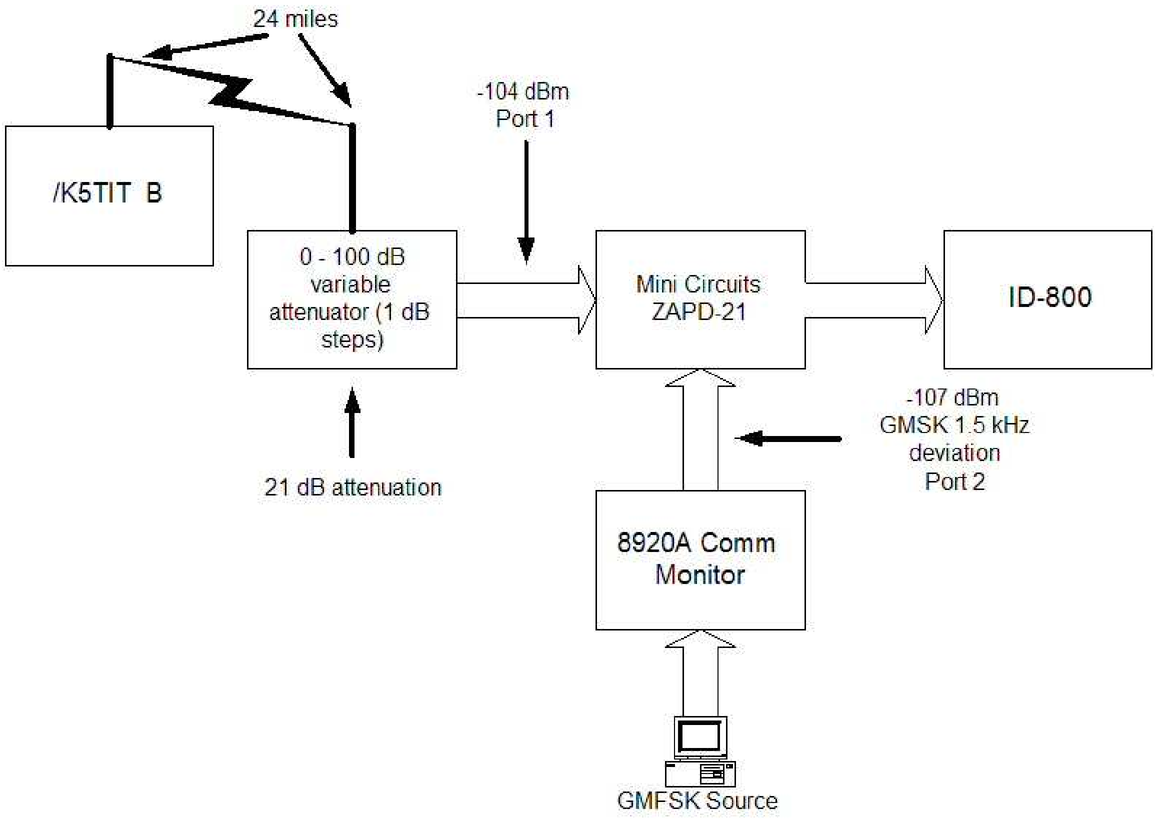

Figure 4 Test Setup

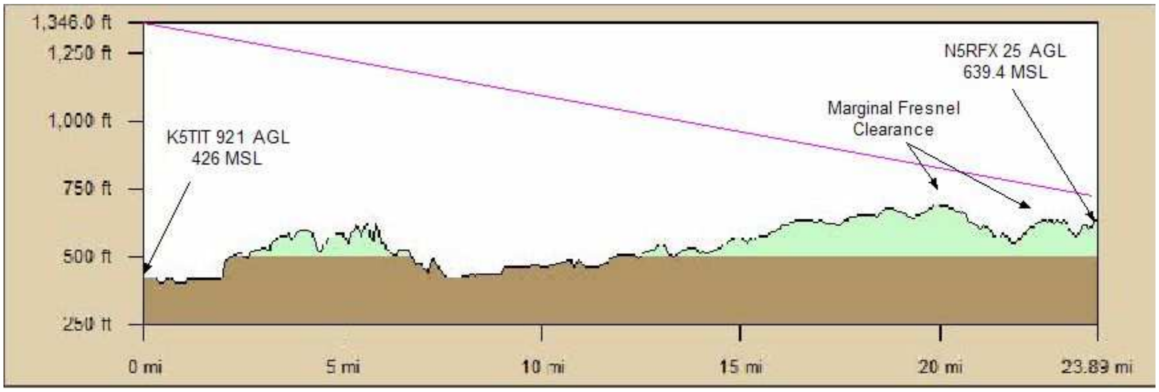

Figure 5 K5TIT to N5RFX Terrain Profile

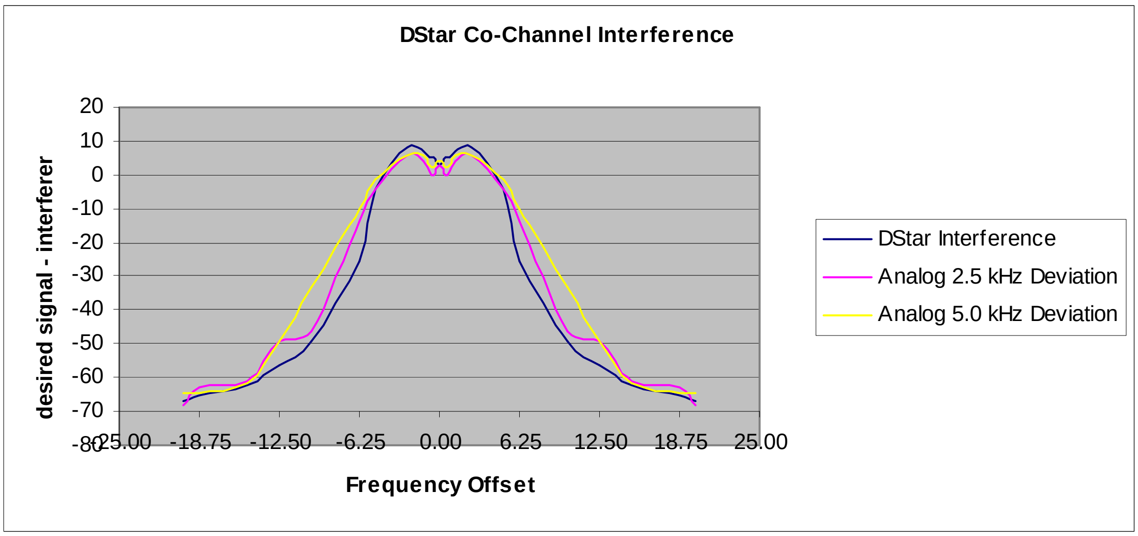

Figure 6 Test Results