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Subject: Measurements of cross-talk and spurious signals levels

A] Cross-Talk

We measured the cross-talk between channels on the dual channel DBE by connecting independent noise sources to each analog input, recording the DBE VSI outputs and cross-correlating the two channels.

The following results were obtained

Frequency range	Cross-talk	Comments
0-300 MHz	-55 dB	
300-400 MHz	-50 dB	
400-1200 MHz	-40 dB	-Nyquist zone 2
1200-2000 MHz	-35 dB	-Nyquist zone 3

The cross-talk increases with frequency which is expected based on the ADC specifications.

B] Spurious levels

There are 3 types of "spurious" signals present in the DBE using the VLBI polyphase filtering:

1] Harmonics generated by non linearities in the ADC

2] Aliased signals which are not completely rejected by the limited number of taps in the filter function:

3] Truly spurious signals which are the result of modulation of the sampling clock or cross-talk from other signals on the ADC or IBOB.

To measure the spurious signals we took a signal at 155.5 MHz and added Nyquist zone filtered noise at a total power level of 20 dB below the 155.5 MHz signal. The frequency of 155.5 MHz was somewhat arbitrary. It is low enough to contain harmonics in the analyzed band and is not simply related to the 1024 MHz sampling frequency. Noise was added to allow the power level of signals in the PFB channels to be measured from the quantized VSI outputs. In fact since the signal levels in all the PFB channels except the channel with the 155.5 MHz are weak so that only the sign bit is useful.

The PFB channel gains were all set at 1000 and the 155.5 MHz signal level was set at -11 dBm which is a good working level for the DBE as at -6 dBM the ADC saturates. The data was analyzed by using a 8K FFT to derive the spectrum of the 1-bit data from the VSI, transformer to the autocorrelation, apply the Van Vleck clipping correction and transform back to obtain the corrected spectrum. If we assume that the added noise is uniform across the PFB channels then the noise power in each PFB channel is -20 -12 = -32 dB below the 155.5 MHz. This means that any spur which appears in a PFB channel, other than the channel with the 155.5 MHz, will appear to be 32 dB stronger due to the normalization which occurs in the 1-bit autocorrelation. Figure 1 shows the spectra of all 15 PFB channels superimposed to illustrate the method.

Spurious measued with 155.5 MHz at -11 dBm plus total Nyquist zone filtered added noise at -20 dBc and again with 1179.5 MHz plus 3rd Nyquist zone added noise at -20 dBc.

Harmonic #	Level dBc
2	-50
3	-47
5	-63
6	-61
7	-53

The results for the first and third Nyquist zones are very similar which suggests that the harmonic distortion is in the ADC post sampling. We have only listed a few harmonics. There are, of course, more spurs seen (mostly well below -60 dBc) which are aliased versions of the signal and the harmonics of the signal mixed with harmonics of the sample clock. At the level of integration (1000 spectra averaged) there are no spurs which are not related to the signal, its harmonics and its aliases. Only the first 7 harmonics are labeled in Figure 1.

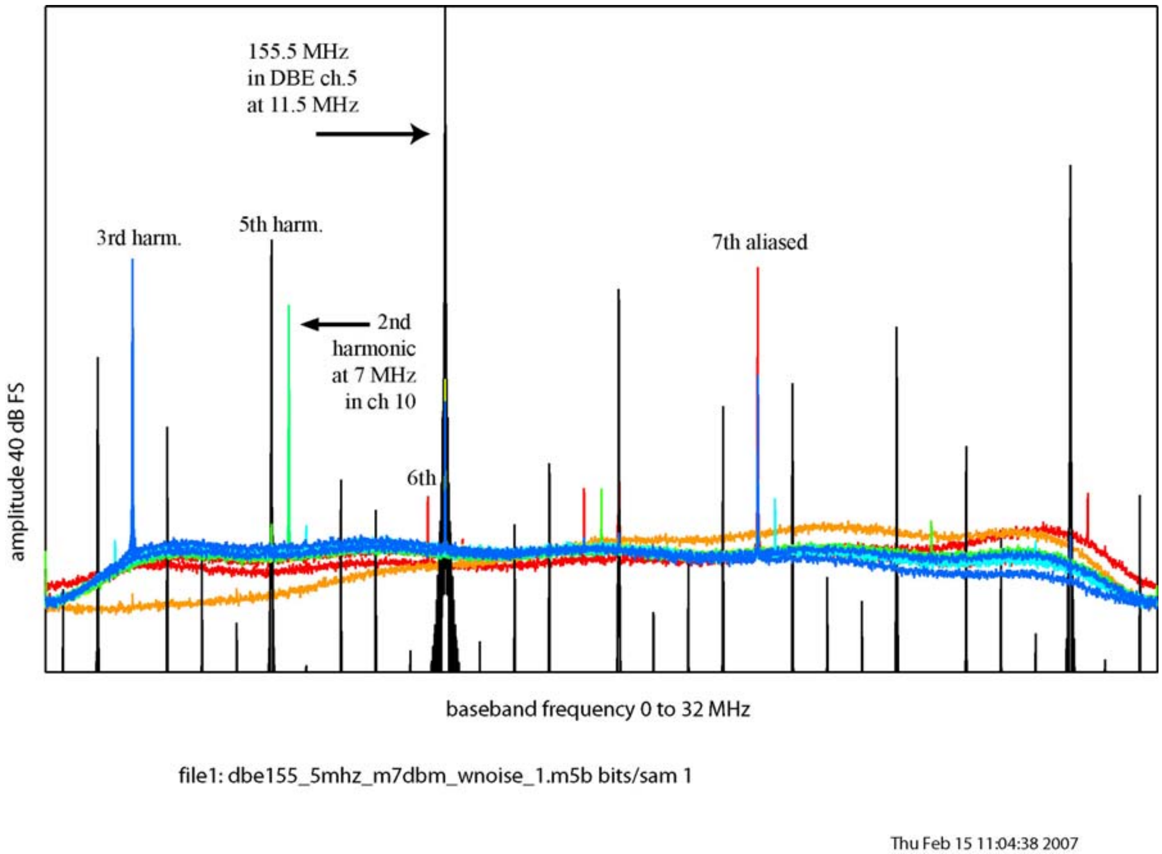

Figure 1. Example of spectra used to measure spurious signal levels.