A VXCO Upgrade of LO3 To Reduce ±100 MHz Sideband Image Ghosts

Toney Minter and Mike Stennes

August 16, 2007

1 Introduction

In GBT Memo 247 [1], ghost images of spectral lines at ±100 MHz in the GBT IF system were discussed. In this memo we repeat the measurements made in GBT Memo 247 after the upgrade to the VXCO for LO3 was implemented to reduce the level of these 100 MHz sidebands.

2 The VXCO Upgrade

While there exists coupling (modulation) of 100 MHz at many points in the GBT LO and IF systems, it was found that the dominant contributor was the fixed-frequency (10.5 GHz) third LO. 100 MHz sidebands which exist on the GBT's third LO, will modulate the desired signal (test tones, spectral lines of celestial origin).

The basis for the GBT's third LO is a VCXO whose fundamental frequency of oscillation is 100 MHz. This 100 MHz signal is frequency multiplied to 10.5 GHz. Due to the nature of this frequency generation scheme, 100 MHz sidebands will always exist at some low level. The key to reducing the sidebands to an acceptable level is to filter them sufficiently, folloing the first X5 multiplier. This was achieved by installing a new VCXO unit (a 100 MHz fundamental oscillator, followed by a X5 multiplier and filtering - a unit purchased from Wenzel Associates) in the Analog Filter Rack. The new VCXO unit produces a 500 MHz reference signal that is identical to the original in all respects, except that its 100 MHz sideband levels are reduced by 25 dB. A corresponding reduction in 100 MHz sideband level was seen at the 10.5 GHz third LO.

Potentially, the 25 dB reduction in sideband level seen at that 500 MHz reference could be realized for the entire LO system. However, since 100 MHz modulation has many other points of entry along the signal path, observed sideband level reduction on a test tone might be somewhat less than 25 dB.

2.1 Test Measurements Made With The LO1B Test Tone

Measurements of the ±100 MHz sideband ghost images were made using the Ku-band receiver and the LO1B test tone signal. The measurments were made using exactly the same setup and methodoligy as was used in GBT Memo 247. The reader is referred to GBT Memo 247 for these details.

In Figures 1 and 2 we show the results of the measurements with the test tone set to its maximum power setting. The 100 MHz sidebands are not detected with the new VXCO. The test tone signal is equivalent to a spectral line with a brightness temperature of 540,000 K (about 300,000 Jy). This corresponds to at least a 20 dB reduction in the power levels of the 100 MHz sidebands. It is worth noting that there are still ghosts of the spectral line present from aliasing occurring during the FFTing of the data.

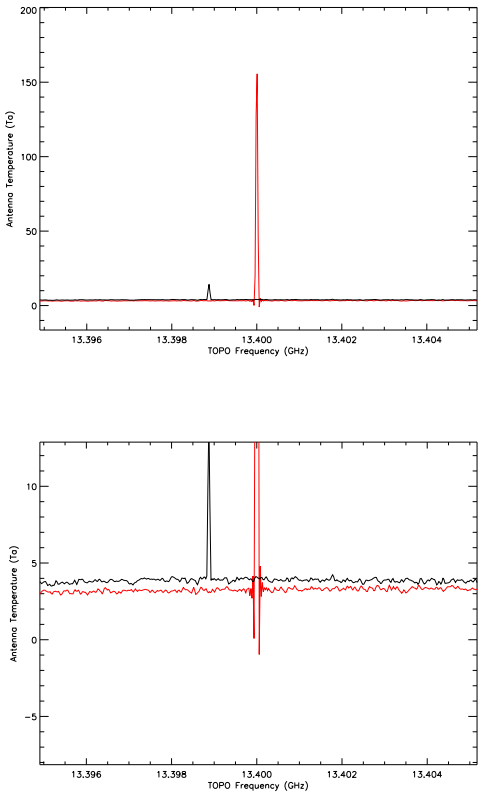

Figure 1: Comparison of the old VXCO (red) with the new VXCO (black). The top panel is a broad view while the lower panel is a zoomed in view. The -100 MHz sidebands are not detected with the VXCO. Note that there is a slight frequency shift between the data sets due to Doppler Tracking effects which results in an aliased image ghost from the FFT to be present at approximately 13.399 GHz.

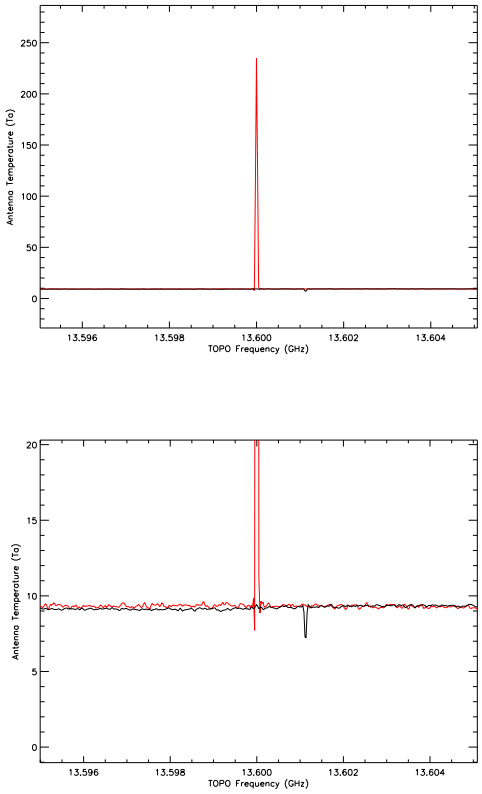

Figure 2: The same as Figure 1 except the +100 MHz is shown. There is an aliased image ghost from the FFT present at approximately 13.601 GHz.

3 References

[1] GBT Memo 247, "Ghost Images of Strong Signals Arising at +/-100 MHz and from Aliased Power in GBT Spectrometer Spectra", by Toney Minter, dated June 4, 2007, http://wiki.gb.nrao.edu/pub/Knowledge/GBTMemos/gbt_memo247.pdf