



## Subject: Measurement Techniques for Accurately Measuring 2nd Harmonics of an FM Transmitter

Date: September 26, 2006

### Purpose of this document:

The following document describes the measurement techniques for accurately measuring 2nd harmonic performance. This document shows harmonic measurement methods and the erroneous results that can come from these methods. This document is no way suggesting that the TX in question is not having harmonic performance issues, but rather a suggested measurement methodology to rule out any measurement related issues.

### Erroneous Spectrum Analyzer Measurements Taken Without a Notch Filter:

The plots below show the carrier at 89.5MHz at 0dBm reference on the spectrum analyzer in **Figure 1** and the resultant 2nd harmonic measurement in **Figure 2**. As can be seen if a measurement is made in this manner, the 2nd harmonic performance appears to be -69dB below carrier which is well out of the specification of -80dB. However, as identified in the next page the harmonic is well below this erroneous reading.

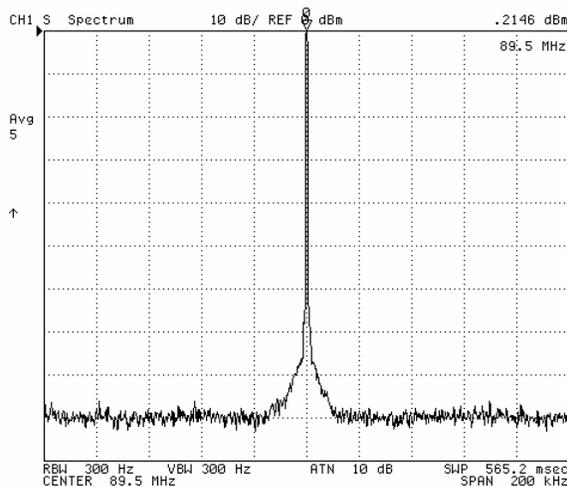


Figure 1:

Carrier at 89.5 MHz, 0dB reference, no notch



Figure 2:

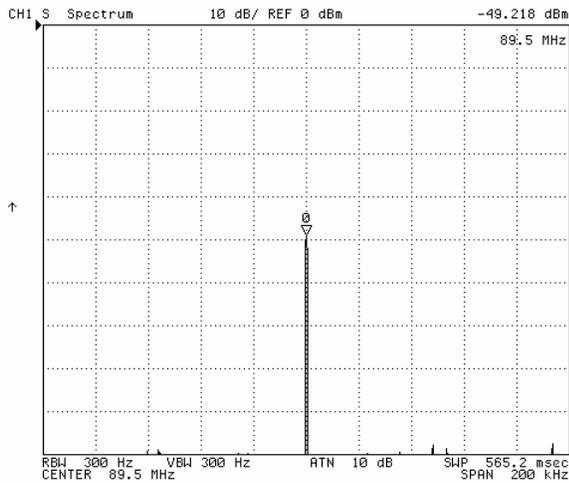
2<sup>nd</sup> harmonic at 179 MHz, with carrier at 0dB reference, no notch

## Accurate Spectrum Analyzer Measurements Taken With a Notch Filter:

The plots below show the carrier at 89.5MHz at 0dBm reference on the spectrum analyzer in **Figure 3** with the notch filter inserted in line with the input of the spectrum. The performance of the notch is shown in **Figure 5** below. The resultant 2nd harmonic measurement is shown in **Figure 4**.

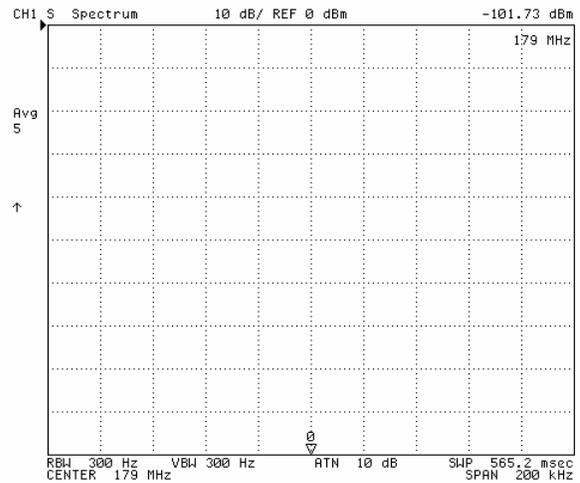
**NOTE:** The notch filter only has impact on the main carrier level and not the harmonic as indicated in the notch filter plot in **Figure 5**.

As can be seen, if a measurement is made in this manner the 2nd harmonic performance is better than 100dB below carrier which is well within the specification of -80dB.



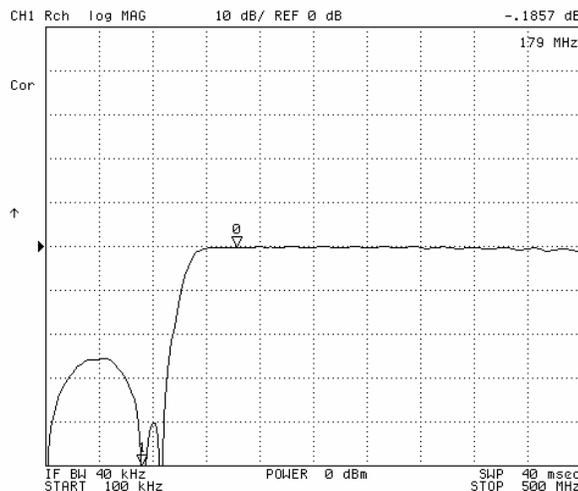
**Figure 3:**

Carrier at 89.5MHz, 0dB reference, 49dB notch on carrier



**Figure 4:**

2<sup>nd</sup> harmonic at 179MHz, with carrier at 0dB reference, notch on carrier



**Figure 5:**

Notch Filter Performance, ~50dB attenuation at 89.5MHz, 0.2dB attenuation at 179MHz

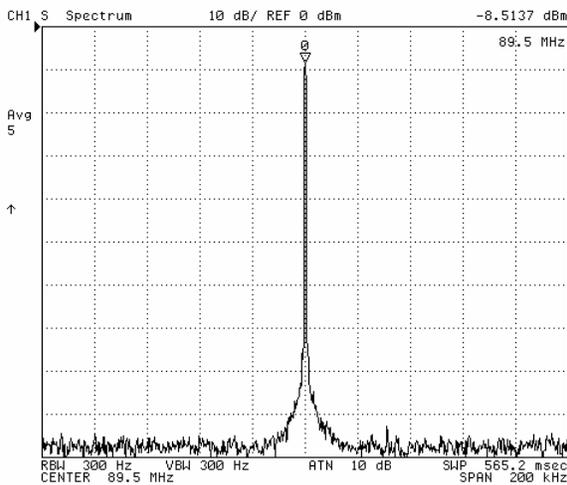


## Technique for Determining if there is Overdrive on the Spectrum:

Another method to determine if overdrive on the spectrum is an issue is to simply add an external attenuator on the input of the spectrum analyzer. If overdrive is an issue the carrier will drop by the attenuator value, but the harmonic will drop much further than the attenuator value. The plot in **Figure 6** below shows the carrier at 89.5MHz at 0dBm reference with  $\sim 8.5$ dB attenuation added external to the input of the spectrum analyzer. **Figure 7** shows the resultant harmonic performance.

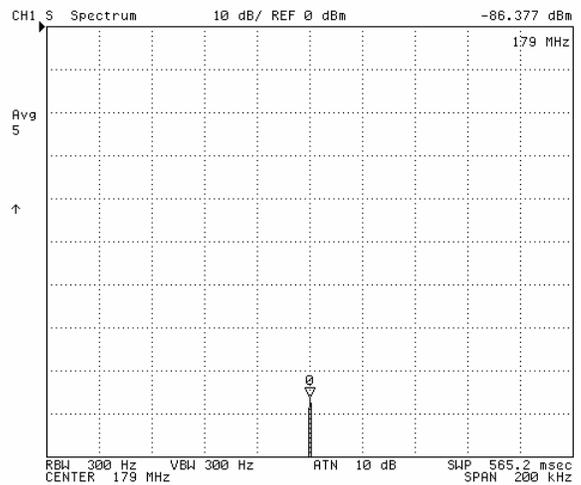
**NOTE:** The external attenuator affects both the carrier and harmonic level.

As can be seen, in this example, the 2nd harmonic drops a lot more than the  $\sim 8.5$ dB attenuation added, it actually drops from -69 to -86dB, a change of 17dB. This is a clear sign overdrive is an issue.



**Figure 6:**

Carrier at 89.5MHz, 0dB reference,  $\sim 10$ dB  
attenuation added



**Figure 7:**

2<sup>nd</sup> harmonic at 179MHz, with carrier at 0dB  
reference,  $\sim 10$ dB attenuation added