HIGH FREQ MODULATION
Getting Started - VISI 6.0

Applications of High Frequency Modulation tool

- View accumulated jitter in the modulation domain—the signal causing the jitter.
- Look at the frequency components of jitter using an FFT.
- View how the jitter changes over time or output cycles.

Introduction

The focus of this guide is to familiarize the user with the basic High Freq Modulation Analysis (HFMA) tool allowing quick and easy measurements and interpretation of results. Refer to the Help option of the VISI 6 software or VISI6 Manual for a more in-depth presentation.

The analysis of measurements gathered with the High Freq Modulation tool allows the user to see jitter accumulation. This tool automatically creates histograms over an increasing range of periods. The process is shown in Figure 1. The DTS builds a histogram of time measurements for a single period, then increments and makes another histogram of two periods, repeating this process until enough periods are spanned to cover the –3dB frequency.
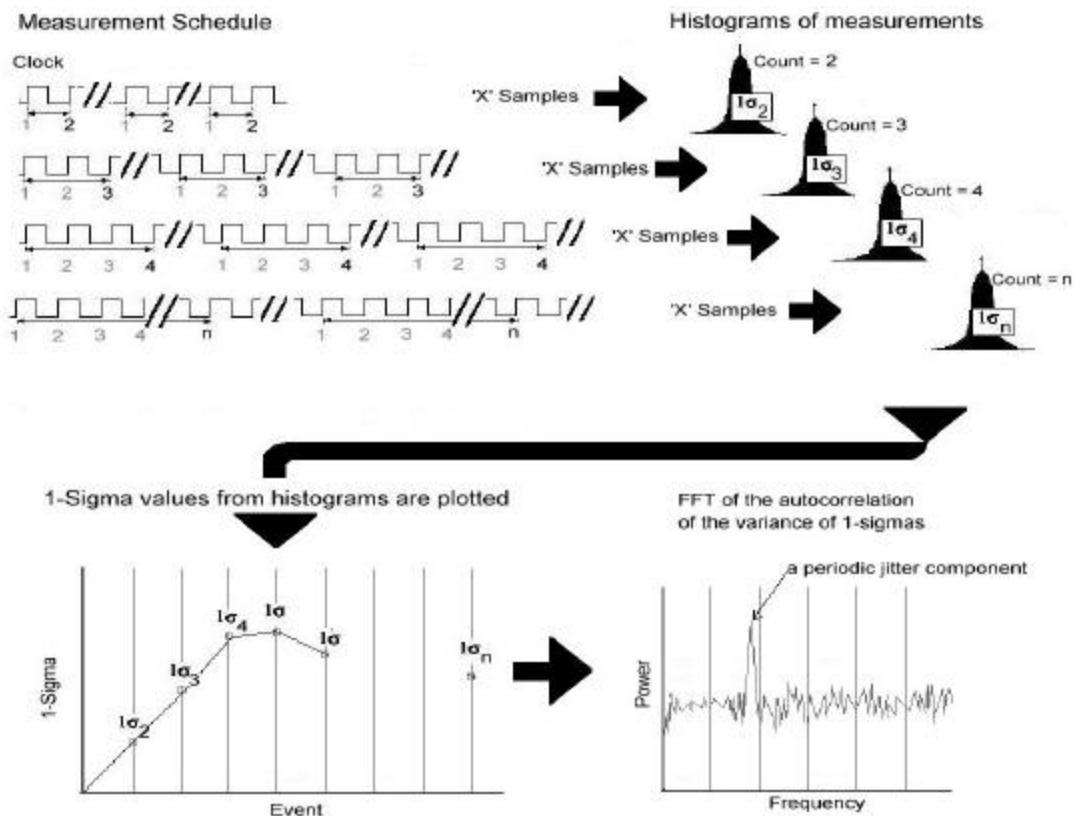

Figure 1. High Frequency Modulation Analysis data acquisition

The 1-Sigma and Peak-to-Peak from each histogram can then be plotted relative to the number of periods spanned. These plots allow you to see how jitter changes or accumulates over increasing numbers of periods. In doing so, we are able to see the Jitter Modulation. This time domain data can be transformed to the frequency domain by using an FFT of the autocorrelation of the variance of the 1-sigma values. Frequency vs. power can then be plotted.

High Freq Mod panel

Dialog Bar Menus
Access to Acquire, FFT algorithm, Arming, and Filter settings.

Plot area
<u>Zoom in</u>—hold down left mouse button, expand zoom box over area of interest.
<u>Zoom out</u>—double click left mouse.

VISI Panel
Cursor coordinates - Displayed in the box at lower right portion of the VISI Panel. Units are same as those in plot.

Statistics area
Contains measured data from each view/plot provided by the HFMA tool.

Figure 2. High Freq Mod Display

Dialog Bar, menu 1 of 4, Acquire Menus

View –
Select between 1-Sigma, Pk-Pk, FFT 1-Clk, FFT N-Clk, Summary View

Edge to Measure & Channel–
Select the input channel and the edge to be measured, rising or falling on this input channel.

Hits Per Measure –
Determines the number of time measurements that will be made for each edge.

-3dB Per Measure-
Determines the low frequencies visible on a FFT. A lower value extends the time required to acquire the measurement set.

Fmax Divider –
Scales the FFT. Reduces the resolution of the FFT. Also reduces the time to acquire a measurement set.

X-axis –
Plot either as the # of periods measured or the units of time measured.

Passes to Avg FFT –
Selects the number of passes to average an FFT. The will

Dialog Bar, menu 2 of 4, FFT Menus

FFT Window –
Used to reduce the spectral distortion of FFTs. The choice of signal will determine which spectral components will be isolated or separated, from the dominant frequency. The default is Kaiser-Bessel.

Padding Multiplier –
Padding increases the frequency resolution of the FFT. Default is 16. Generally, a higher padding value will increase the test times.

Alpha Factor –
Only used with Kaiser-Bessel FFT Window. Selects the number of passes to average an FFT. The varying of the Alpha Factor will affect the spectral peak width and the sidelobe rejection of the Kaiser-Bessel window.

Threshold Voltage –
Auto sets the threshold to the 50% point of the input signals. USER VOLTS allows the user to set the threshold voltage.

View
1-Sigma

FFT Window
Kaiser-Bessel

Padding Multiplier
16

Alpha Factor
8.000000

Threshold Voltage
Auto

Channel Voltage
0.167790

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Dialog Bar, Page 3 of 4, Filter Menus

These menus control the post processing filter applied after data acquisition. The filters determine what are considered peaks in the FFT view. The highlighted peaks are then reported among the values in the Summary View.

RJ+PJ Min Filter
Choose between Natural Rolloff and Brickwall.
Natural Rolloff – Adds no filtering, refers to the natural –3db rolloff, or high pass corner frequency.
Brickwall **–** is a high pass filter. Does not calculate RJ+PJ below user –selected value. Any value entered must be above the freq set for the –3db freq.

RJ+PJ Max Filter
Choose between Nyquist and Brickwall.
Nyquist – Adds no filtering, refers to highest possible freq component that will be displayed in the FFT views and data calculations. Normally is the measured clock frequency/2.
Brickwall **–** is a low pass filter. Does not calculate RJ+PJ above user –selected value.

View
1-Sigma

RJ+PJ Min Filter
Natural Rolloff

Min Filter (MHz)
0.637000

RJ+PJ Max Filter
Nyquist

Max Filter (MHz)
531.250000

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Dialog Bar, menu 4 of 4, Arming Menus

Menu 4 of 4 controls the arming of the instrument. This is an advanced topic and not covered here. For more information concerning Arming refer to the Quick Reference Guides titled "Auto Arming" and "External Arming" or the manual.

Making your measurement

- Connect your source to CH1.
- Open the High Frequency Modulation tool in VISI.
- On the top toolbar press Pulse Find 🔍. Verify the voltage levels and close out the pulse find box.
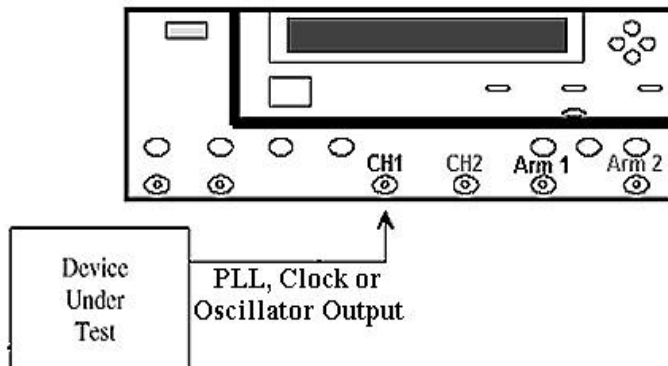- Press the Single Acquire button ▶️.

Figure 3. Typical setup

All of the measurements and data required to calculate and display the different views or plots available in the HFMA tool are gathered simultaneously on one pass or acquisition.

Before investigating the FFT, start by viewing the 1-Sigma vs span plot/view (Figure 4). Try to get at least two full cycles of the modulation of interest. Note that Figure 4 shows increasing jitter. Further data needs to be gathered over enough periods to determine if this is modulation or if it stops accumulating. This is done by decreasing the –3db Freq value in the Dialog bar menu. Be aware that test times increase when looking for lower freq modulation, since the tool will need to look over many more periods of the signal under test.
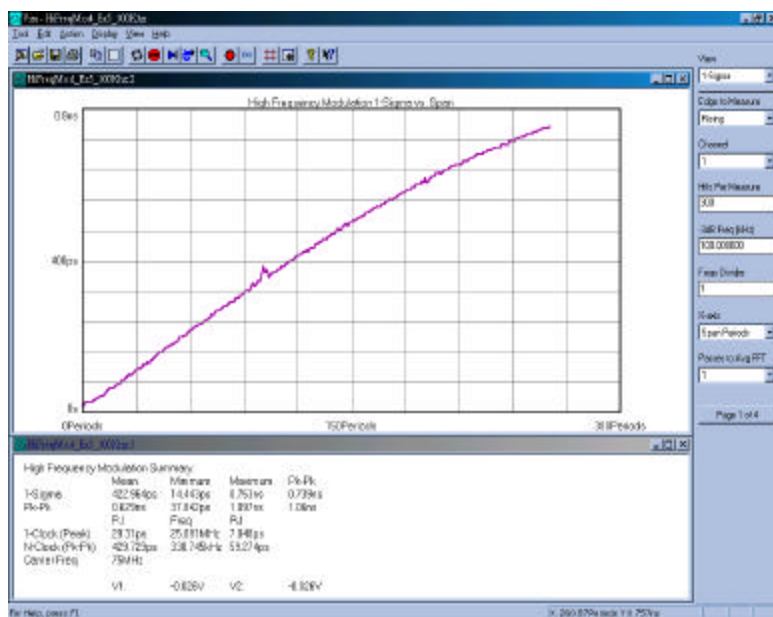

Figure 4. Shows increasing jitter—not enough info to determine if modulation is present.

In Figure 5, –3db Freq value in the Dialog bar menu has been decreased to 15.0 KHz (from 100KHz in figure 4). The periodic nature of the plot data clearly shows that there is modulation present. The jitter increases to a maximum of about 851ps over 370 Periods and decreases to a minimum over 748 periods. The minimum 1-sigma values are constant. A lower frequency modulation would be indicated if the minimum 1-Sigma values were increasing. A further reduction in the –3db Freq value would measure over more periods to show this modulation.

After viewing the data provided by the 1-sigma vs span view (see figures 4 & 5), use the keyboard Page up or Page down keys to see the frequency and amplitude of the periodic jitter components in the FFT views (Figure 6).
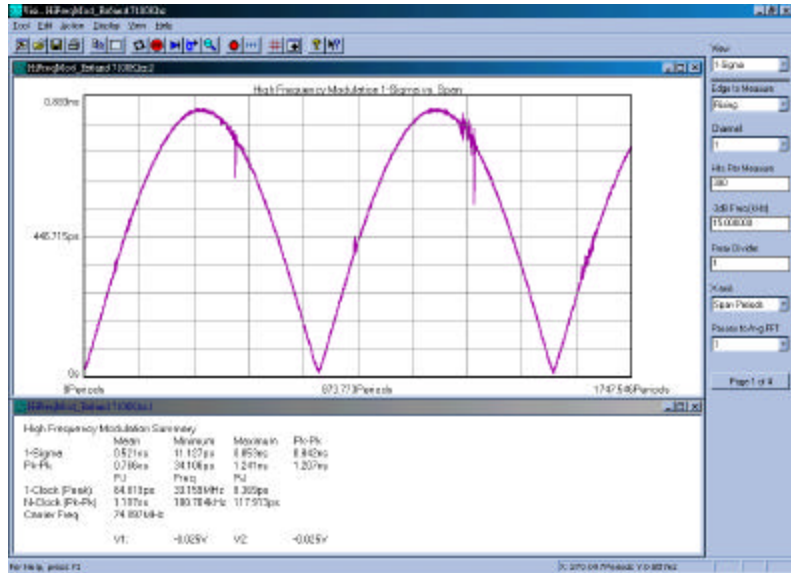

Figure 5. Shows the jitter modulation over more periods.

These views are FFT's of the autocorrelation, of the variance of the 1-sigma values in the 1-sigma vs span plot. Two FFT views are provided; an FFT N-clk and 1-clk views. The N-clk view shows every jitter frequency as having equal effects on a period of the carrier frequency.

The 1-clk view shows how the jitter frequency components and amplitude affect a single clock period. Low Frequency jitter has a smaller effect on the jitter of a single clock period. Compared to the N-clk view, the 1-clk view has a 20 db/decade roll-off for low frequencies. Therefore, Low frequency jitter components are lower in amplitude.
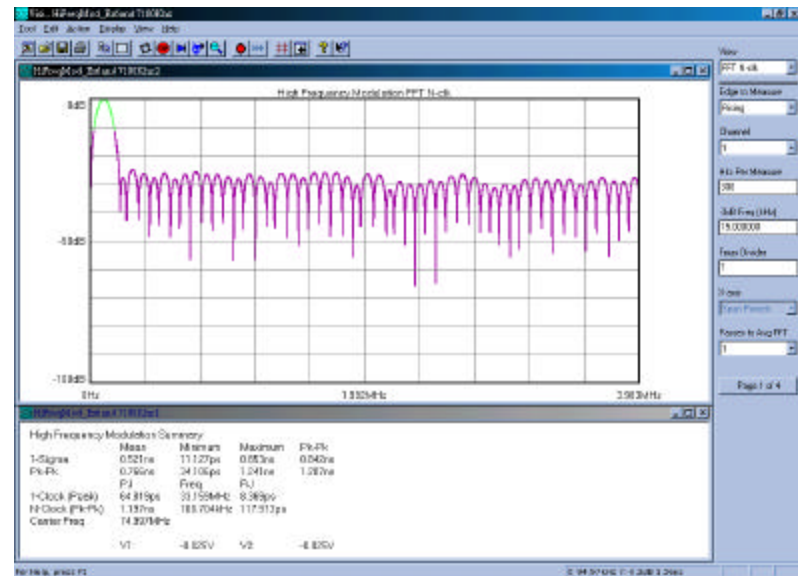

Figure 6. Shows the N-clk FFT. A 1MHz peak is present.

PLL Measurements

This section covers the measurement of Phase Locked Loop (PLL) devices using this tool. When analyzing PLL's, the 1-Sigma Plot responses produce a characteristic curve which indicates the noise response and bandwidth of the PLL's feedback loop.

Figure 7 shows the analysis of a PLL. In the displayed 1-Sigma vs Span view, note the characteristic loop response of the PLL over 'N' periods. The 1-sigma jitter values increase over a small number of periods (x-axis). This relates to high frequencies. At a certain number of periods (or frequency) the jitter stops accumulating, and the jitter (or modulation) effects are seen as hills and valleys.
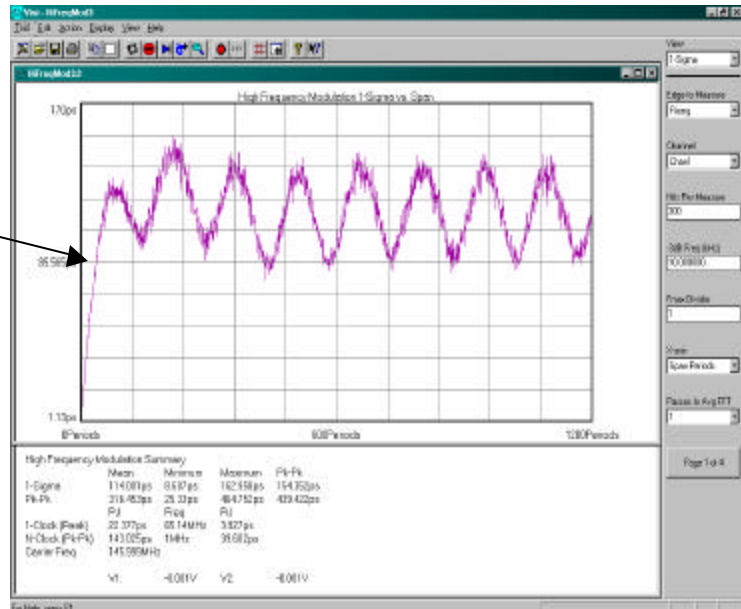

Figure 7. PLL response with modulation

Also, note that any rising curve that settles at a high level will be seen by an FFT as a low frequency component (see Figure 8). The FFT treats the rising curve as the first part of an entire modulation curve. The FFT will show a very low frequency spike which is an artifact. Any real frequency components will remain constant in frequency and amplitude as –3db Freq is decreased to view more cycles of the clock, but any artifact will move down in frequency.
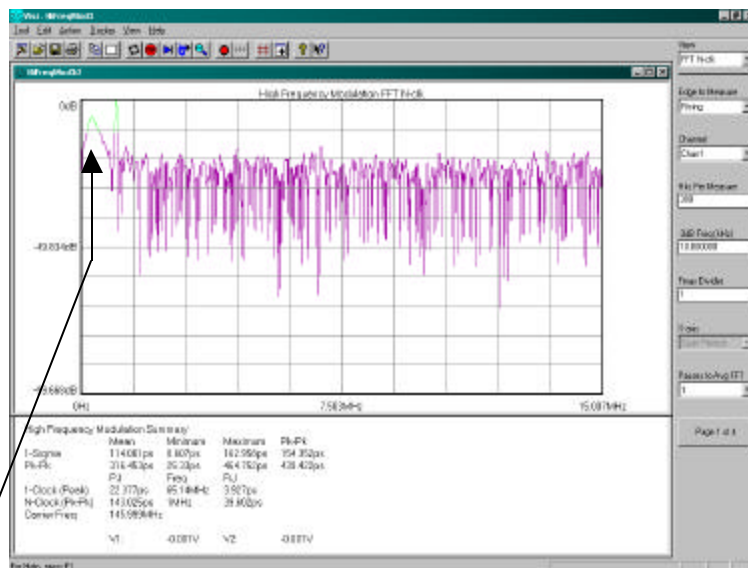
Figure 8 shows the FFT of the 1-sigma data from Figure 7. The low frequency shoulder is an artifact caused by the rising curve of the 1-Sigma plot.Notice that the frequency spike to the right of the artifact is the true deterministic jitter component at 1MHz.

Figure 8. The FFT of the data from Fig 8.

Summary

The High Frequency Modulation Analysis tool capitalizes on the capabilities of the DTS-207X's internal architecture, specifically, the Nth event counters. The ability of the counters to span multiple edges or periods allows the DTS to perform measurements allowing it to view any jitter modulation of the signal under test. This data is plotted on either a 1-sigma vs span view. Performing an FFT of the autocorrelation of the variance from the 1-sigma information will give a frequency vs power plot allowing the user to see the frequency components of the jitter modulation and their respective amplitudes.

Refer to Wavecrest *PLL Analysis 10 Minutes or Less* or for more information contact:

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