Oscilloscopes for PDV: Getting More out of your Scope

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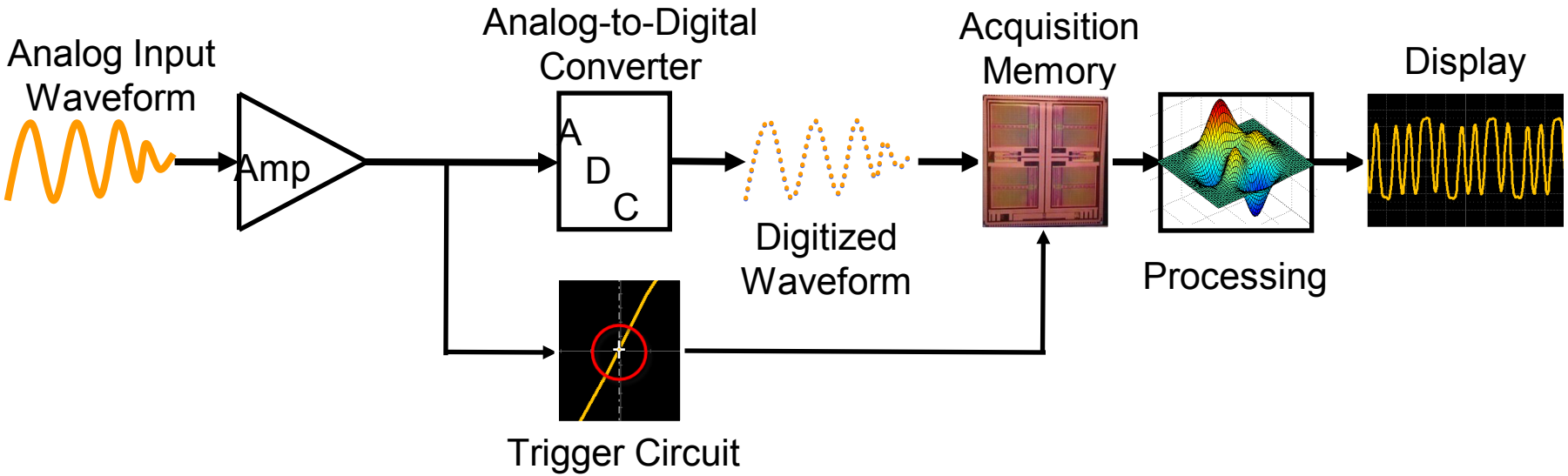
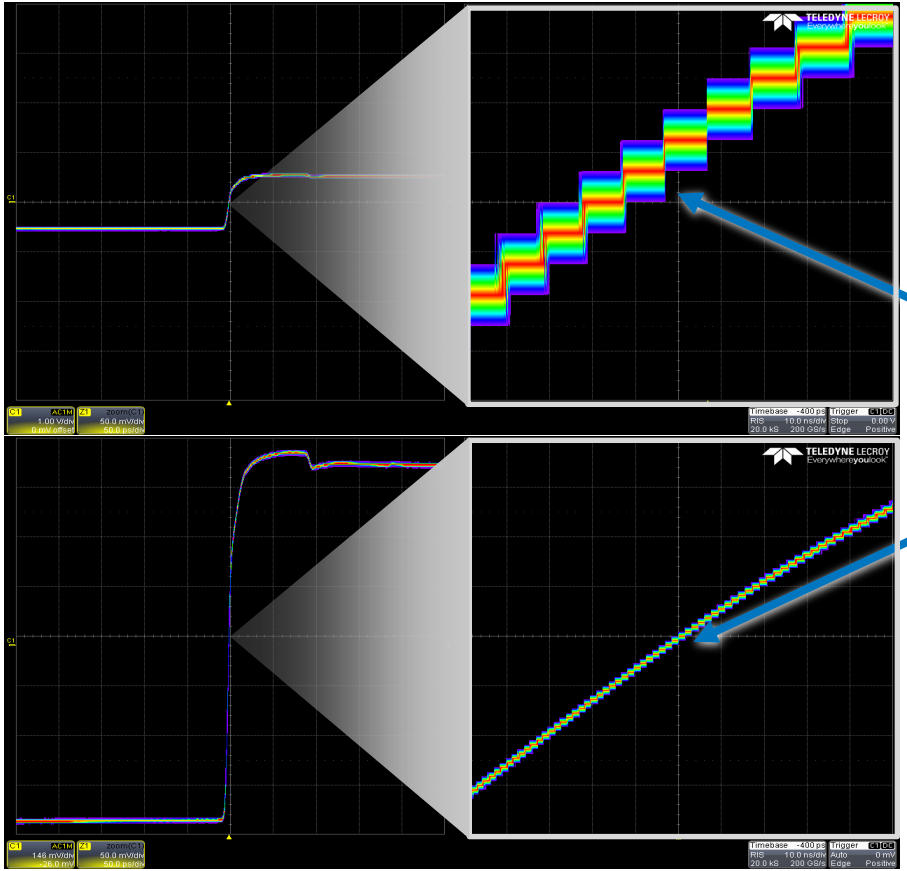
Oscilloscope Block Diagram



- Amplifiers and attenuators scale the input signals amplitude to match the input range of the Analog to Digital Converter (ADC)
- The ADC samples the analog signal and converts the voltage into a digital number

Quantization Error

4x attenuation of signal produces 4x larger quantization steps = 2 bits less resolution!



Zooms of rising edges show quantization levels

Enhanced Resolution

Description

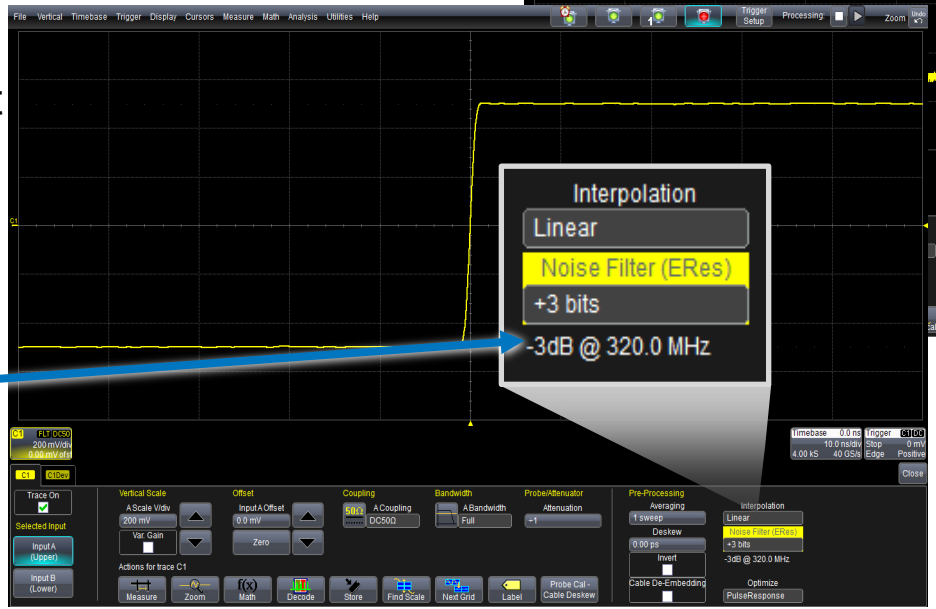
- ERES increases vertical resolution by filter the waveform
- Gain up to 3 bits of resolution in ½ bit steps

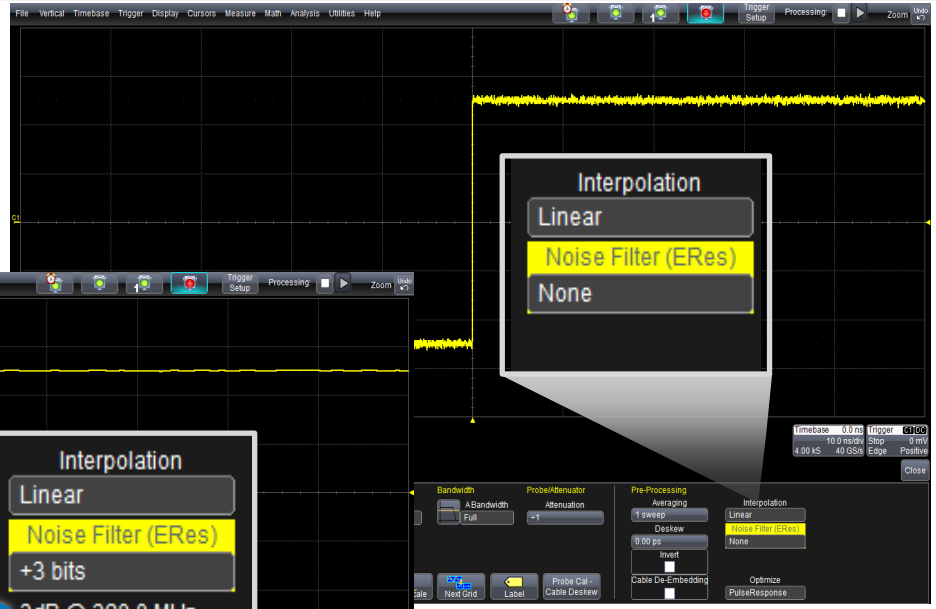
Usage

- Suitable for single-shot and repetitive waveforms
- Reduces noise
- Increases precision

Disadvantages

- Effective bandwidth decreased by 50% for every ½ bit gain





12-bit High Definition Technology – Teledyne LeCroy HDO6000

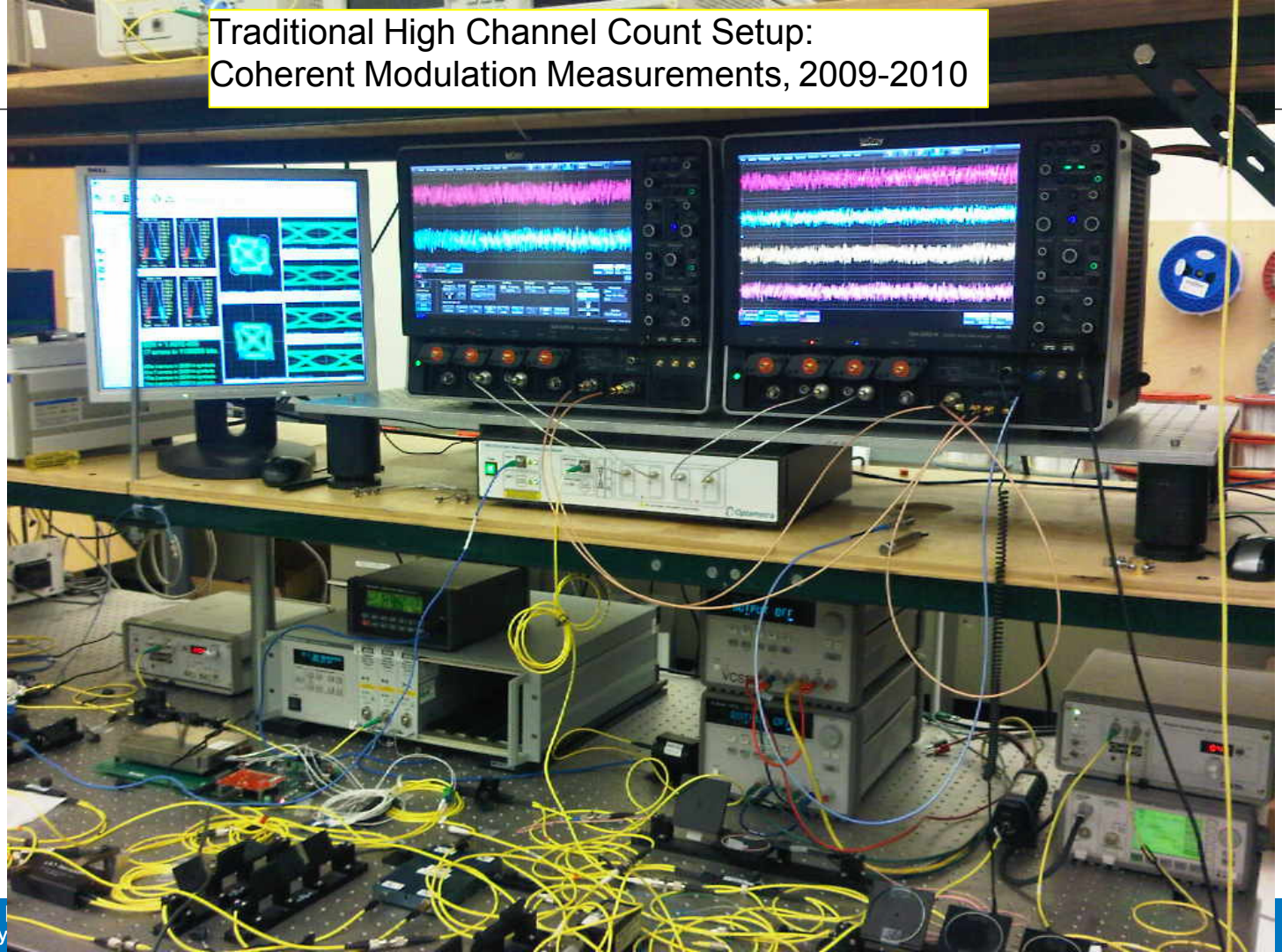
- Combination of
  - High Sample Rate 12-bit ADCs
  - High signal-to-noise input amplifiers
  - Low noise system architecture
- 16 times more resolution than traditional 8-bit scope
- Capture high frequency signals with 1GHz bandwidth
- Benefits
  - Clean, Crisp Waveforms
  - More Signal Details
  - Precise Waveform Measurements

Introducing the Teledyne LeCroy HDO8000 Oscilloscope

- *Further*
  - 8 analog input channels
    - Ideal for high power and three-phase power electronics analysis
    - Very useful for deeply embedded electronic/mechatronic systems
- *Finer*
  - 12-bit HD4096 High Definition Technology
    - “16x closer to perfect”
- *Faster*
  - Up to 1 GHz
    - Bandwidth for today’s ***and*** tomorrow’s technologies

HD4096 12-bit technology is being deployed into 8 channels to meet the needs of fast growing applications

Traditional High Channel Count Setup: Coherent Modulation Measurements, 2009-2010



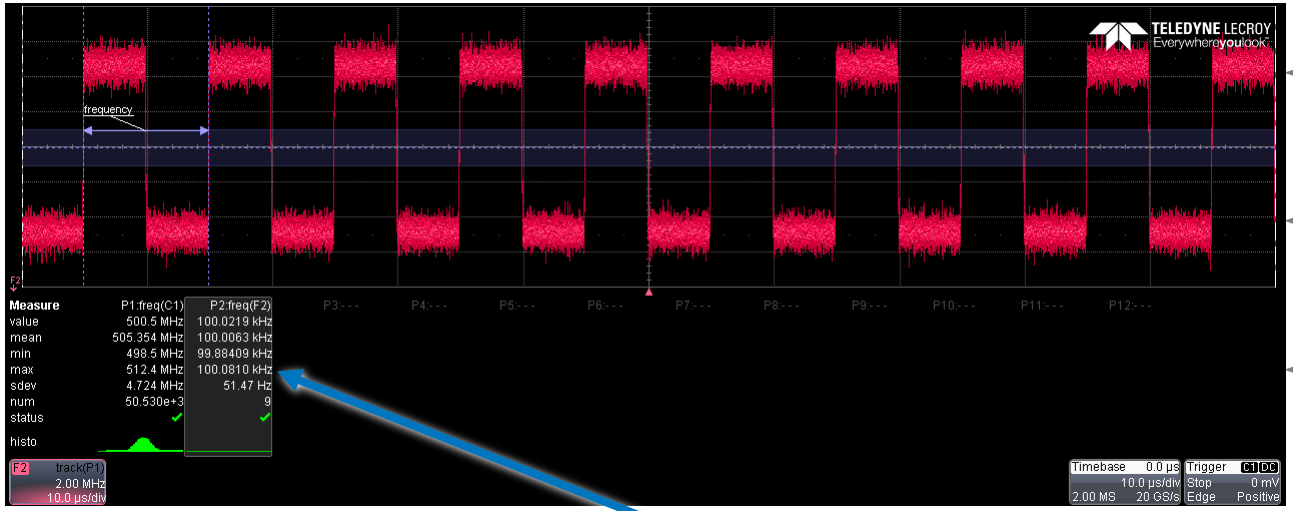
LabMaster 10-100 Zi 100 GHz Real Time Bandwidth

- Starting at 25 GHz bandwidth
- The highest bandwidth: Up to 100 GHz
- The fastest sample rate: Up to 240 GS/s
- The highest channel count:
  - Up to 80 channels @ 36 GHz
  - Up to 40 channels @ 65 GHz
  - Up to 20 channels @ 100 GHz

60 Channel 10Zi System at NY Factory

Track View

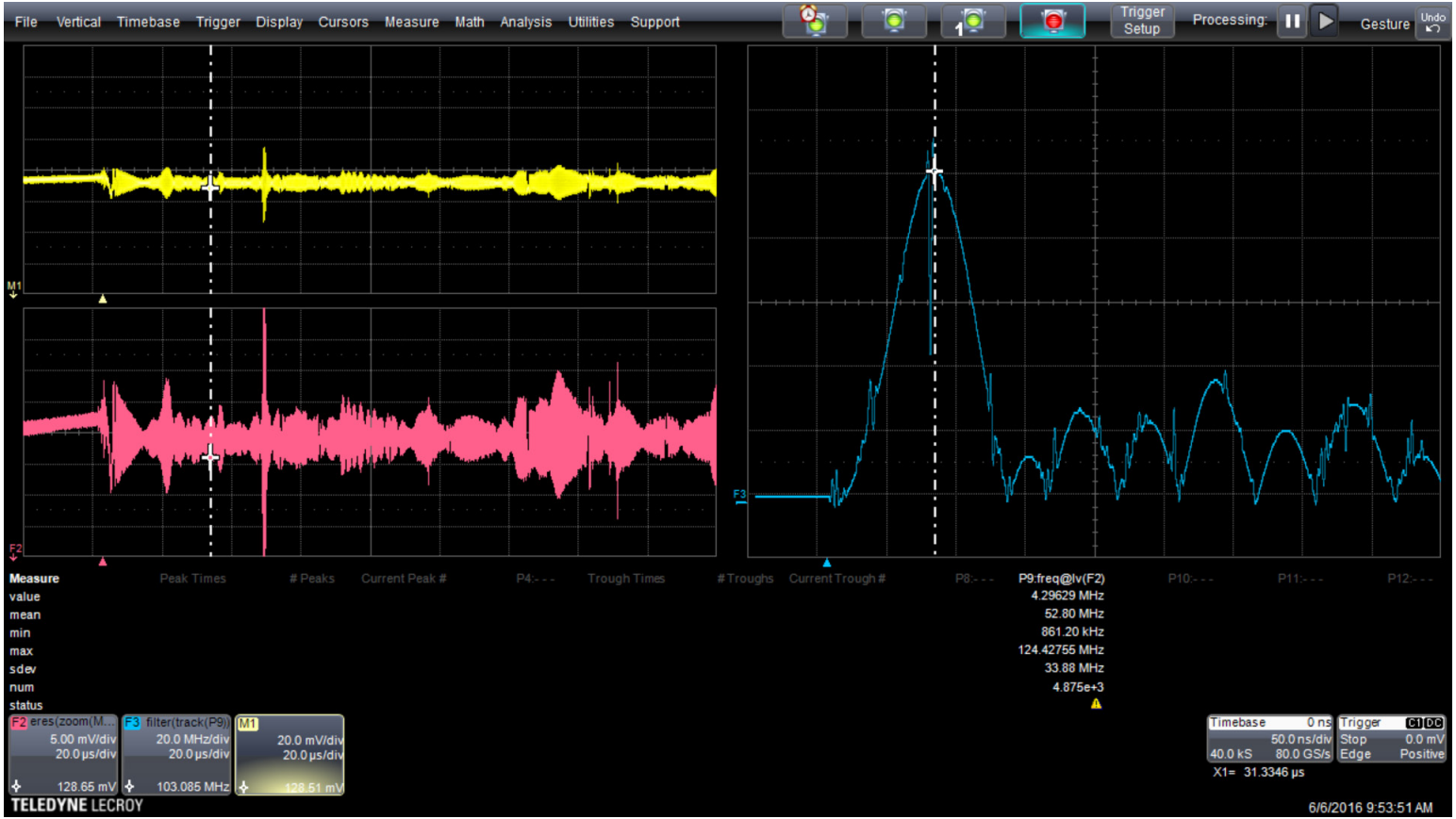
Frequency is measured and plotted for each cycle



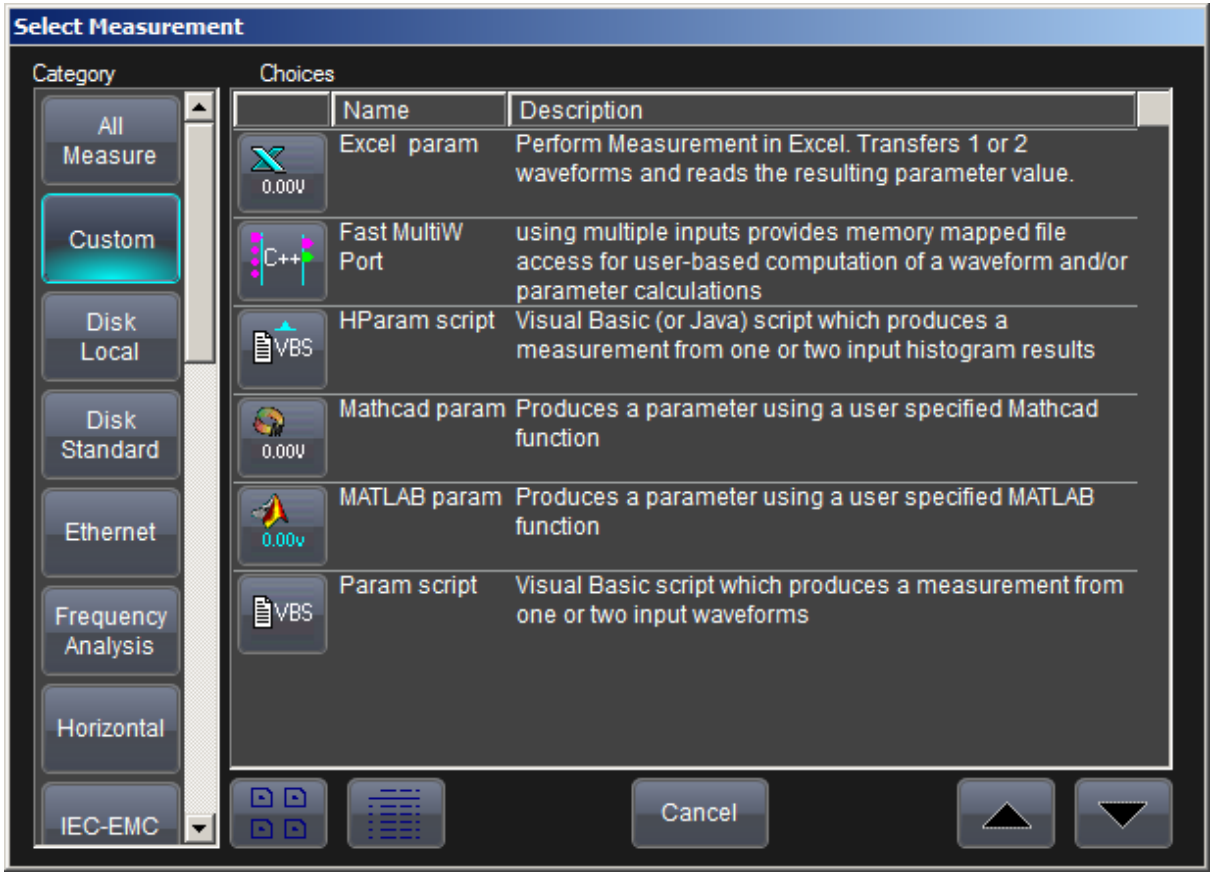
Frequency of Track plot reveals FM modulation rate of 100 kHz

- Histograms reveal statistical distribution of values, but they contain no timing information
- Track View plots the value of a measurement versus time
- Track waveform values are calculated cycle by cycle
- Track waveform is time coincident with source waveform

Track of Frequency Reveals Shape of Velocity Curve

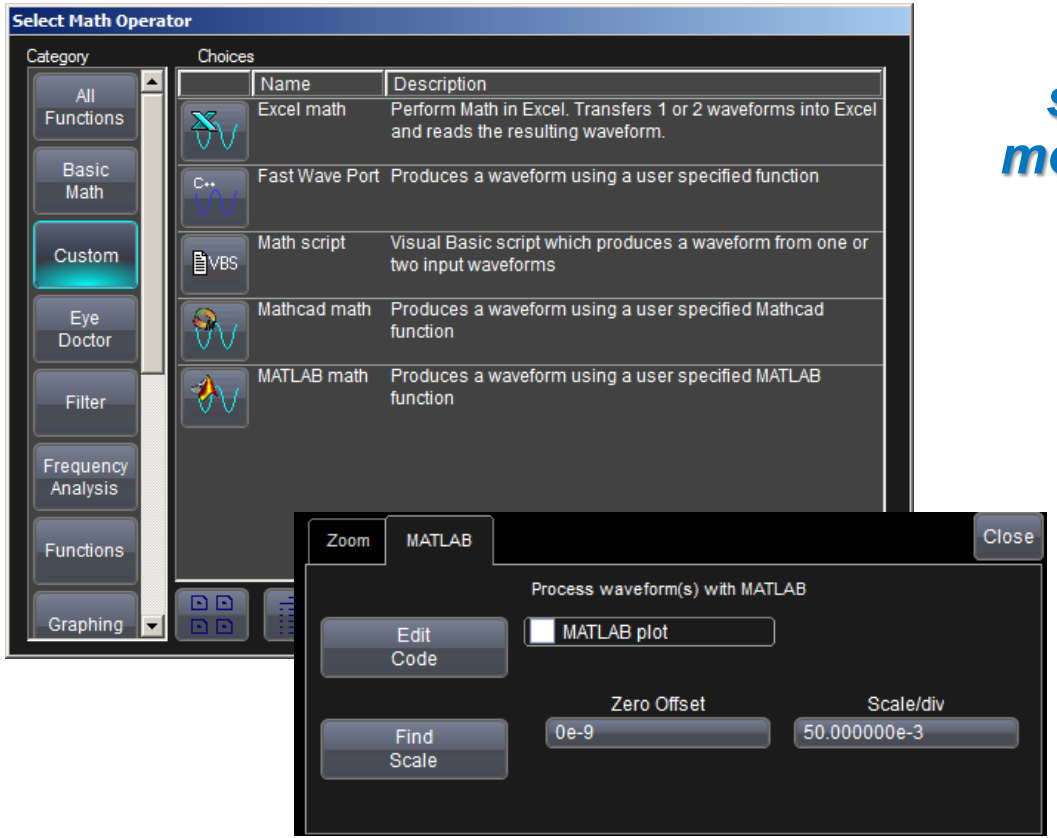


User-Defined Custom Measurements

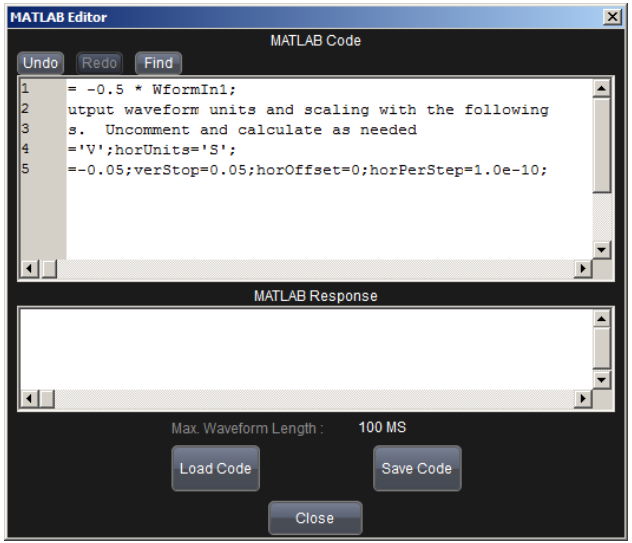


Custom parameters are selected from the measurement menu like any standard parameter. Supports Supports MATLAB, C/C++, Visual Basic Script, VBA, MS Excel, and JavaScript

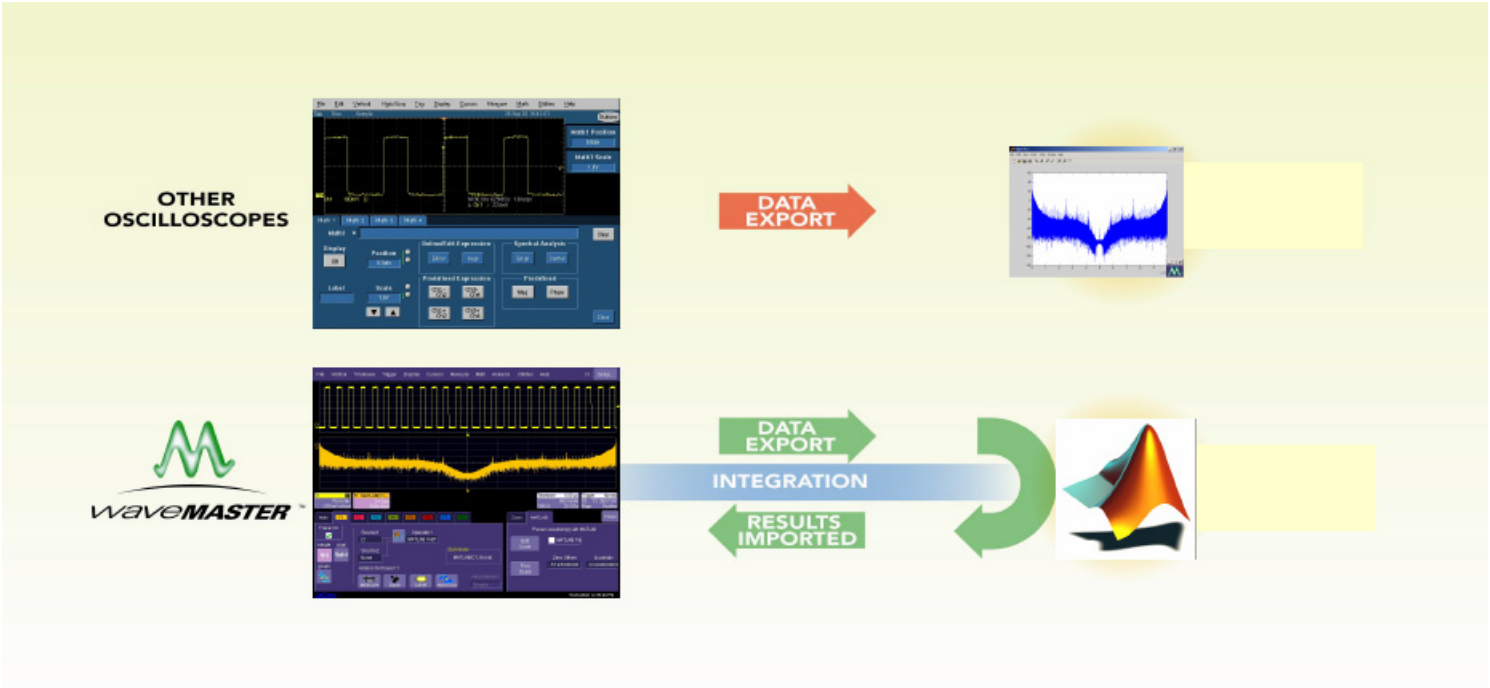
User-Defined Custom Math



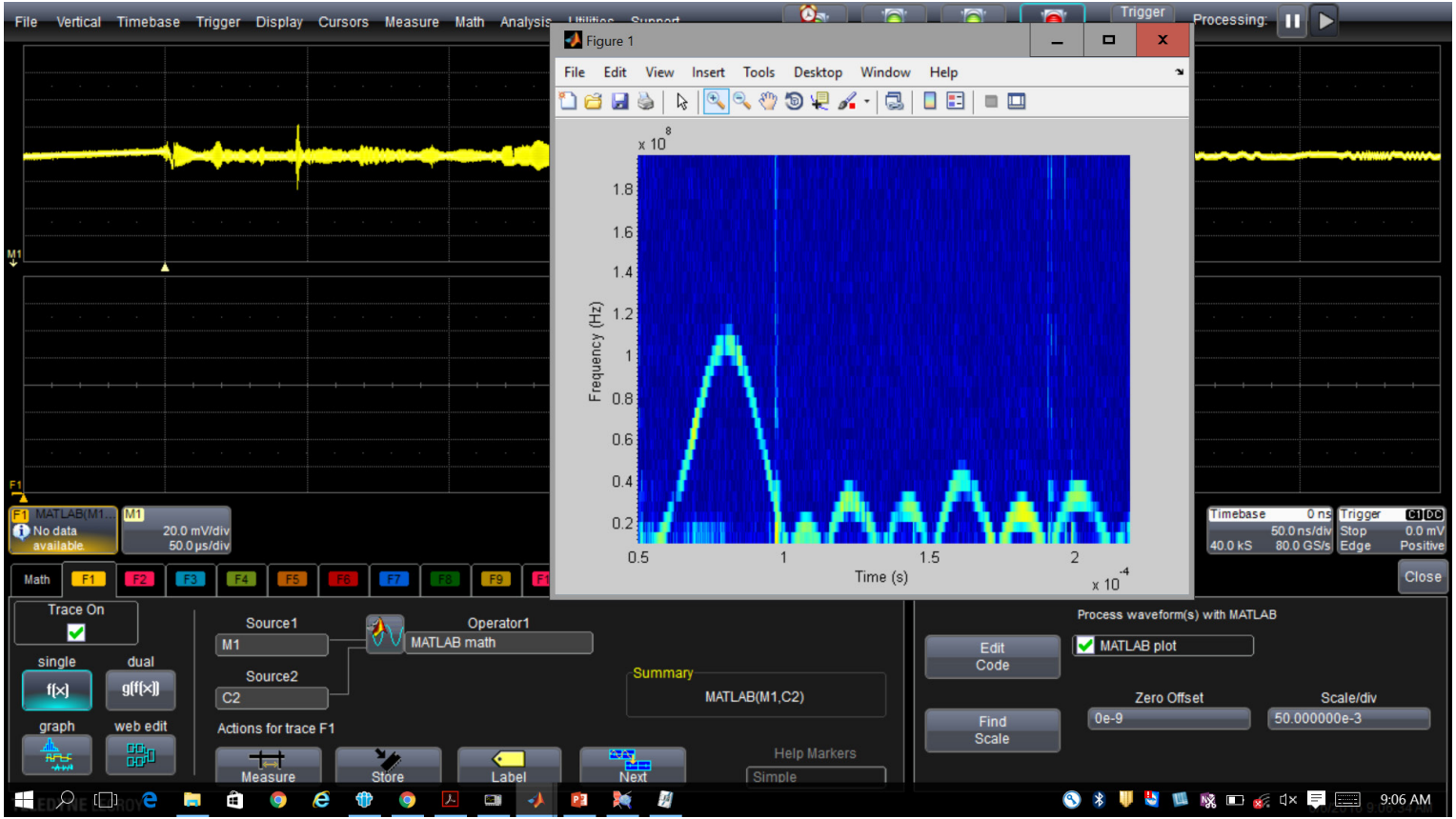
Custom math functions are selected from the math setup menu like any standard function. Script is entered in



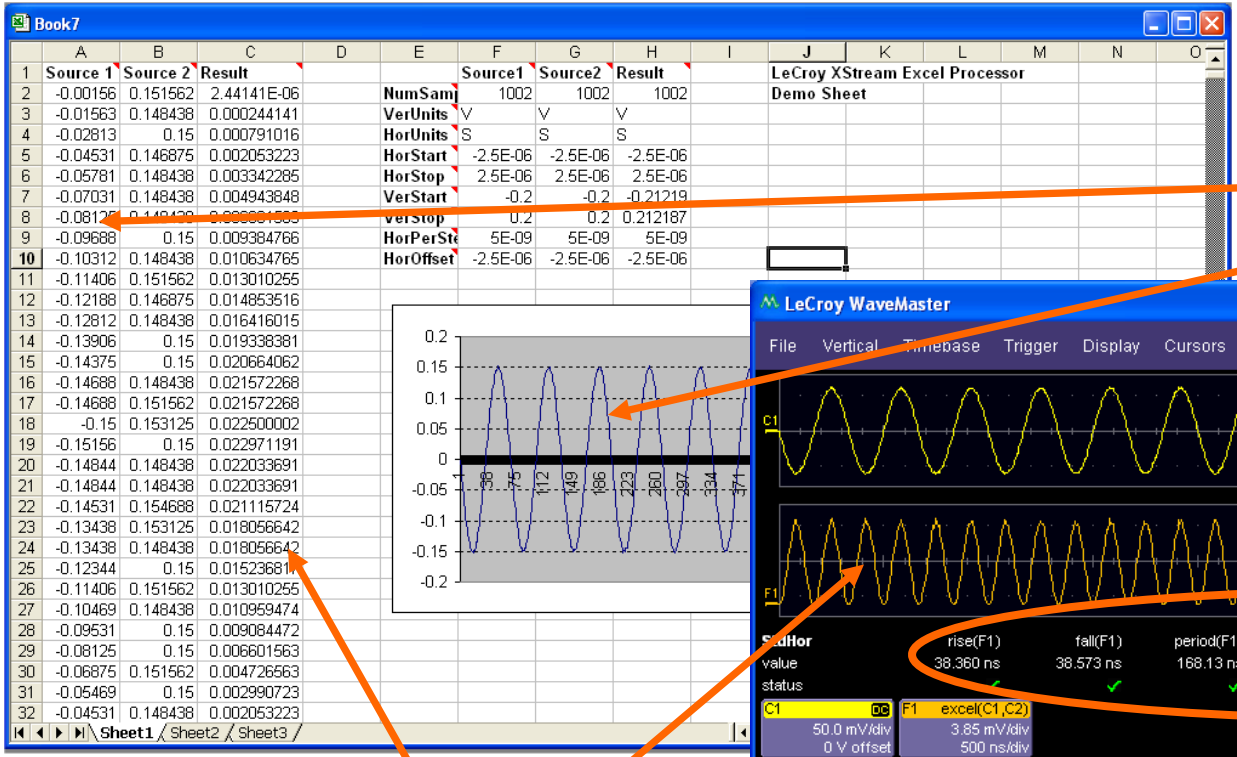
In-Line Custom Math and Measurements

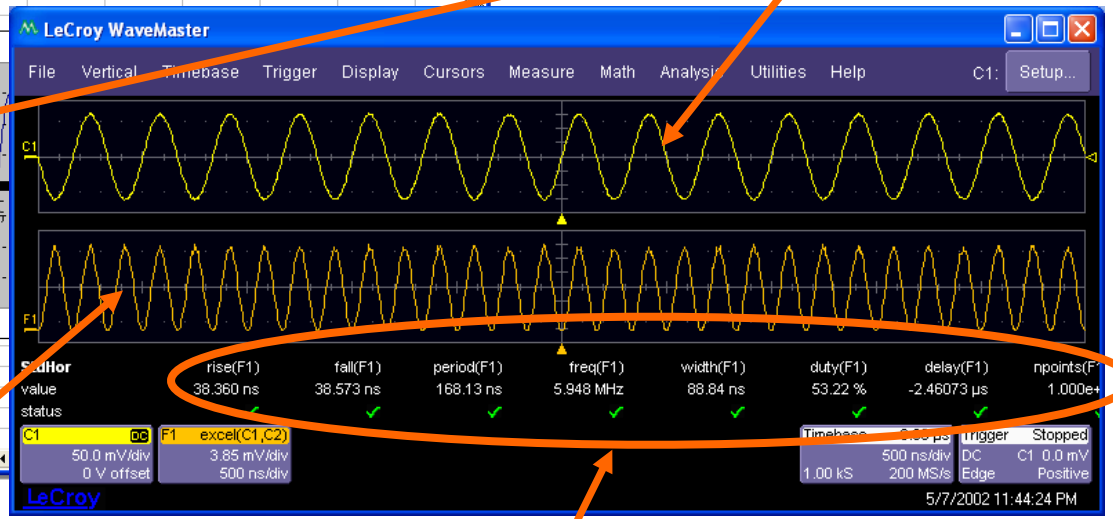


MATLAB Spectrogram on Scope



Create Custom Math Functions with Excel



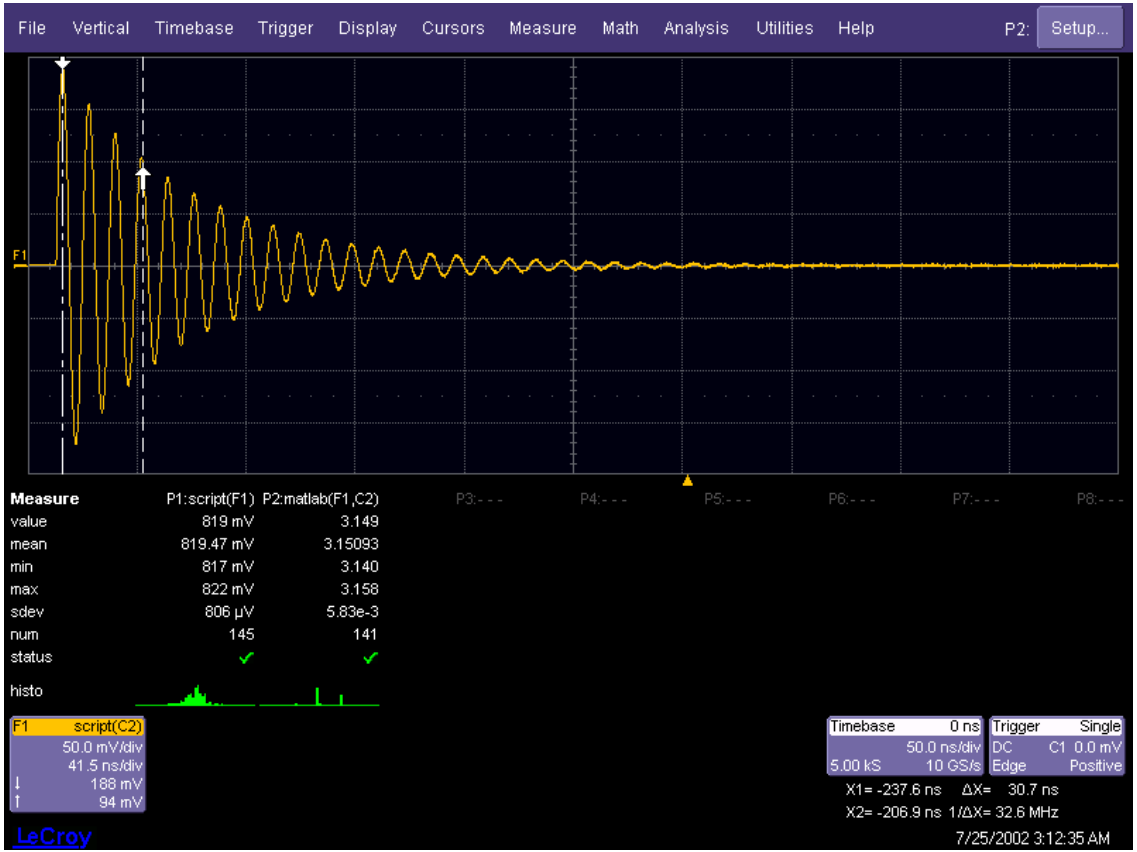


Acquired Trace

Trace generated in Excel

Measurements on Excel-generated trace

MATLAB Measurements



- Custom MATLAB parameter finds the half-life of the damped sine wave
- The value 3.149 is the number of cycles that have occurred when the signal reaches 50% of its peak amplitude