

Neue Messanwendungen dank 12 Bit Oszilloskopen

Best Signal Fidelity

Highest Resolution

Lowest Electrical Noise

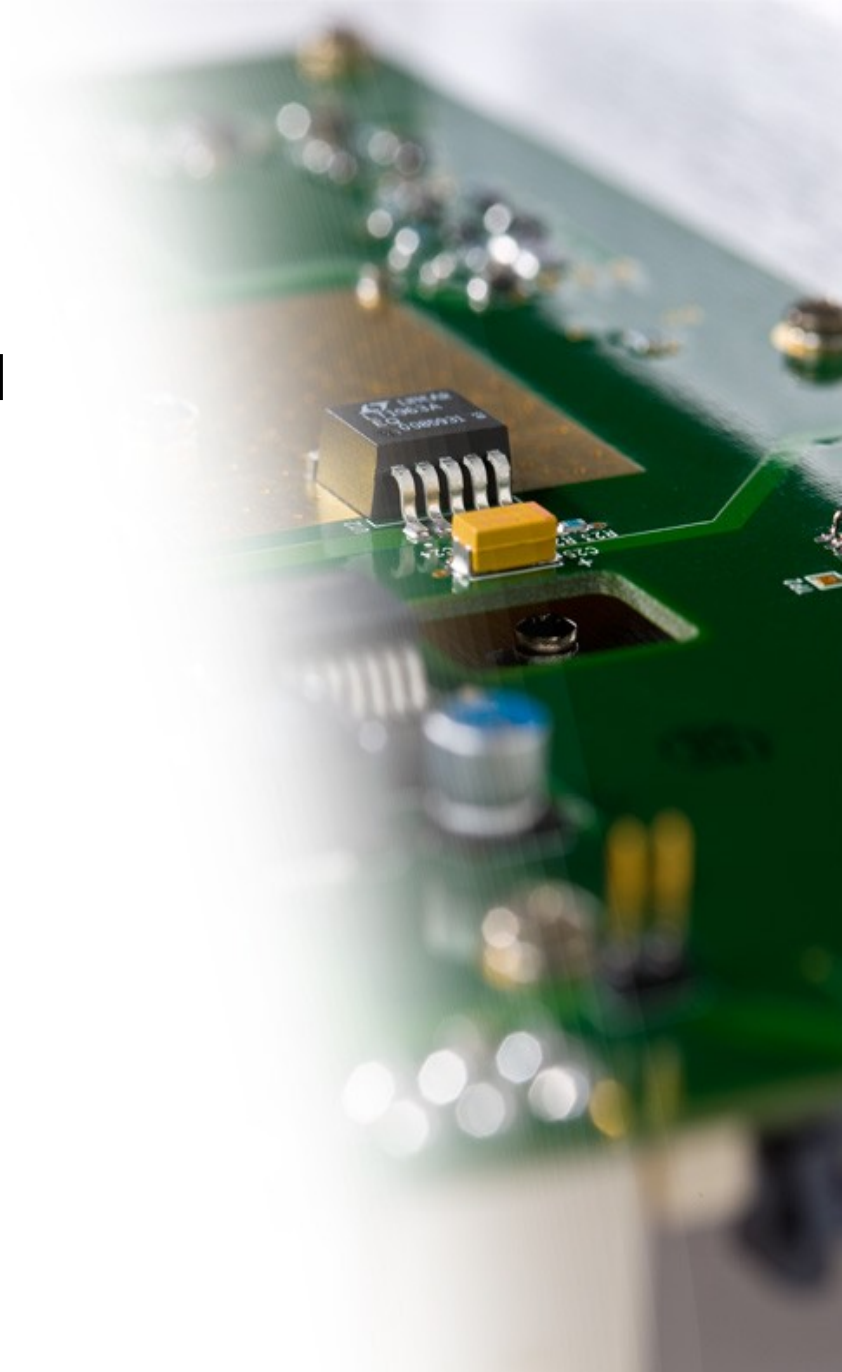
Maximum Accuracy



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Content

- Differences between 8-bit and 12-bit Oscilloscopes
- 12 Bit Application Examples
- WaveRunner HRO 6 Zi Facts
- Summary

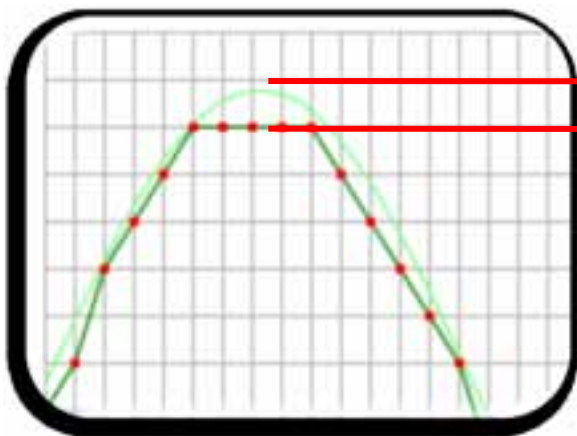


Highest Resolution

12-bits provides 16 times resolution compared to 8-bits

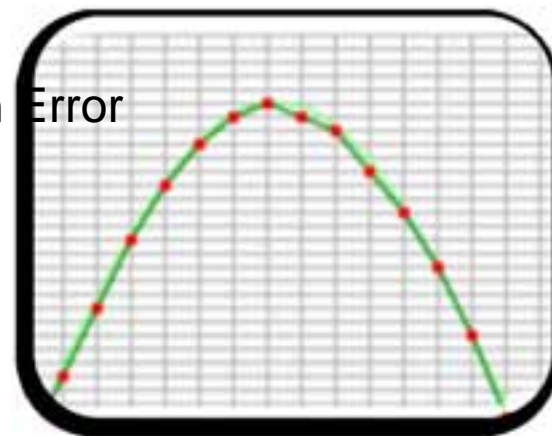
- Resolution = The number of available levels
= $2^{\text{bits of Resolution}}$

| ADC Resolution | Number of Steps | Dynamic Range |
|----------------|-----------------|---------------|
| 8 | 256 | 48 dB |
| 12 | 4096 | 72 dB |



Scope with low resolution

Quantization Error

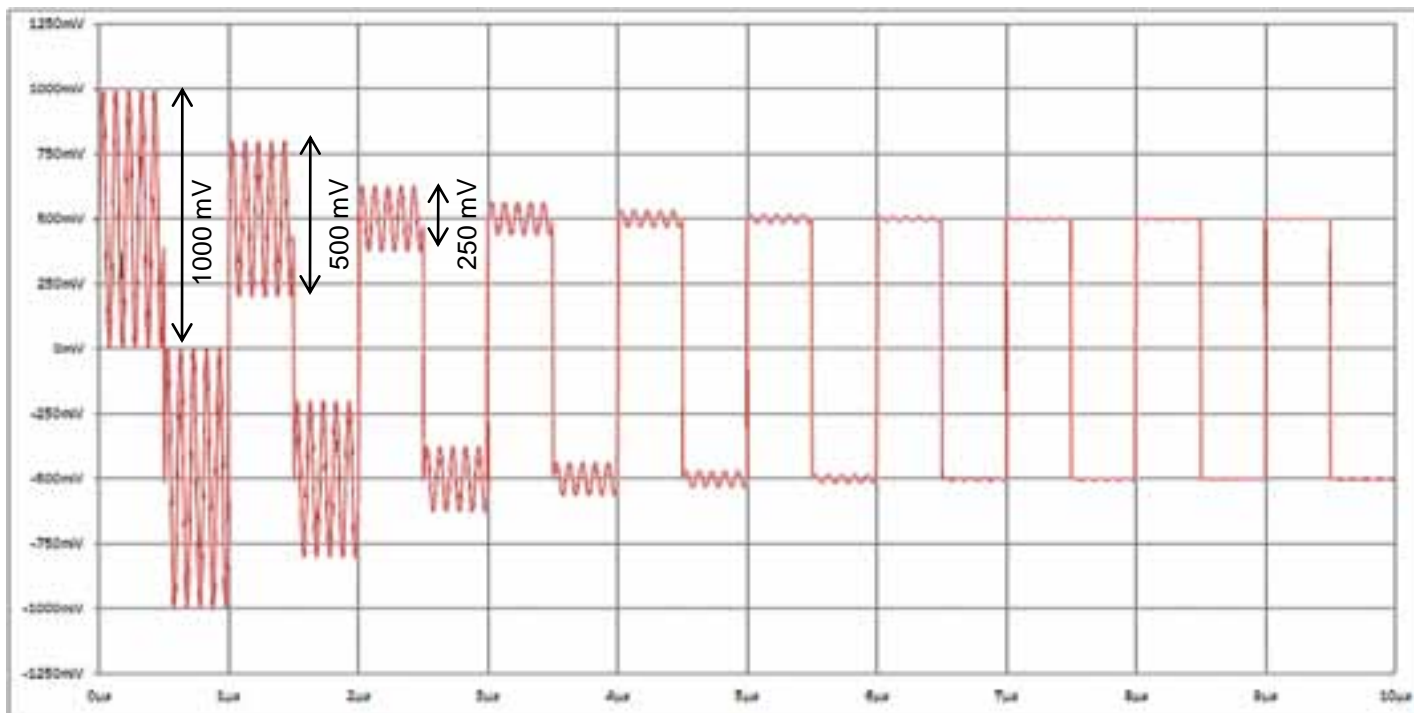


Scope with high resolution

Highest Resolution

12-bit allows detection of smaller signal variations

- The higher number of bits means the lower measurable voltage



| Resolution AD-converter | 1. Period (1000mV) | 2. Period (500mV) | 3. Period (250mV) | 4. Period (125mV) | 5. Period (62.5mV) | 6. Period (31.3mV) | 7. Period (15.6mV) | 8. Period (7.8mV) | 9. Period (3.9mV) | 10. Period (1.96mV) |
|-------------------------|--------------------|-------------------|-------------------|-------------------|--------------------|--------------------|--------------------|-------------------|-------------------|---------------------|
| 8bit | 100 | 50 | 25 | 13 | 6 | 3 | 2 | 1 | 0 | 0 |
| 9bit | 200 | 100 | 50 | 25 | 13 | 6 | 3 | 2 | 1 | 0 |
| 10bit | 400 | 200 | 100 | 50 | 25 | 13 | 6 | 3 | 2 | 1 |
| 12bit | 1600 | 800 | 400 | 200 | 100 | 50 | 25 | 13 | 6 | 3 |

Comparing Measurements of 8 bit and 12 bit Scopes



8 Bit Scope

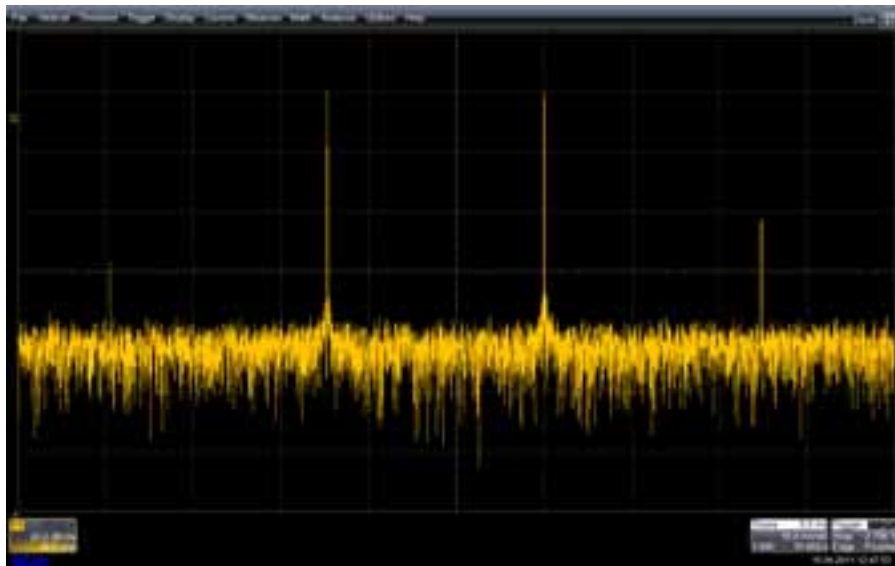


12 Bit Scope

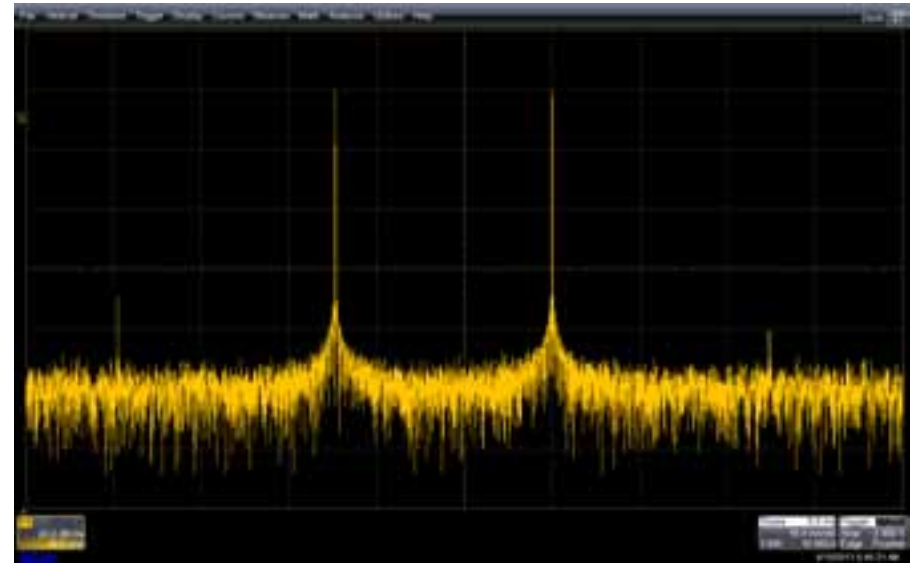
- Peak-to-Peak measurement of the fifth oscillation with the 8-bit and the 12-bit instrument.
- Although it seems that the oscillations can be displayed with the 8-bit instrument, comparing the measurement with that on the 12-bit instrument shows a substantial deviation.

Multi-tone

- The FFT of a two tone signal shows how much more dynamic range the 12-bit High Resolution Oscilloscope can detect.



8 Bit Scope



12 Bit Scope

Deep Memory and Fast Sample Rate

Capture the Fastest and Slowest Signals Easily

- 256 Mpts/ch of Analysis Memory – identical analysis capability as 8-bit WaveRunner Oscilloscope
- 2 GS/s on 4 channels



Capture a fast transient signal at the highest sample rate for the best resolution.

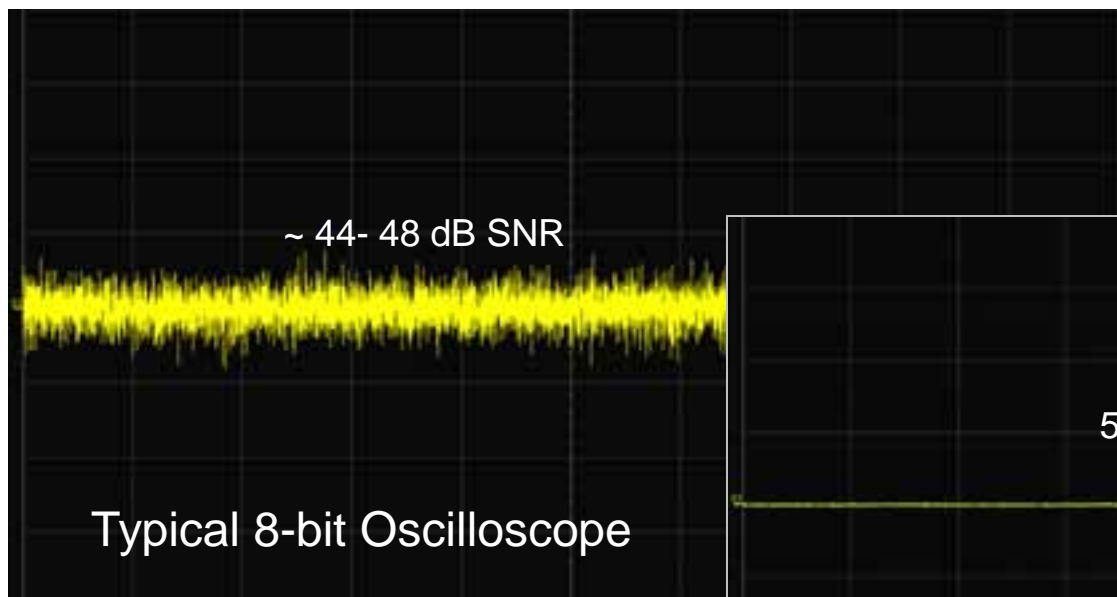


Capture up to 30 seconds of data at sample rates as high as 10 MS/s for trending and searching for events.

55 dB Signal to Noise Ratio

3-4 Times Better than Typical 8-bit Oscilloscopes

- Signal to noise ration (SNR):
 - The ratio, expressed in dB, of the RMS signal amplitude to the RMS sum of all other spectral components excluding the distortion and offset error
 - A typical SNR could be 48 dB for an 8 bit scope and 55 dB for a 12 bit Oscilloscope



WaveRunner High Resolution Oscilloscopes

12-bit Application Examples



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Problem Solving Examples

- **A few application examples for WaveRunner HRO 6 Zi**
 - Sensors and Actuators with high-resolution
 - Medical use (Signals are near to the noise level like EKG or EEG)
 - RF-Signals / Modulation Signals
 - Power Measurement
 - ...



Sensors and Actuators with high resolution

- **Sensors and Actuators often have high resolutions**

- 8 Bit scopes can only show a maximum resolution of 256 steps
- If more than 256 steps should be required, then you need a scope with higher resolution



- **Examples:**

- Revolutions per minute (RPM)
- Altitude difference measurement
- Discharge flow-through measurements
- ...



Sensors and Actuators with High Resolution



8 Bit Scope



8 Bit Scope with ERES



12 Bit Scope



12 Bit Scope with ERES

Medical Measurement

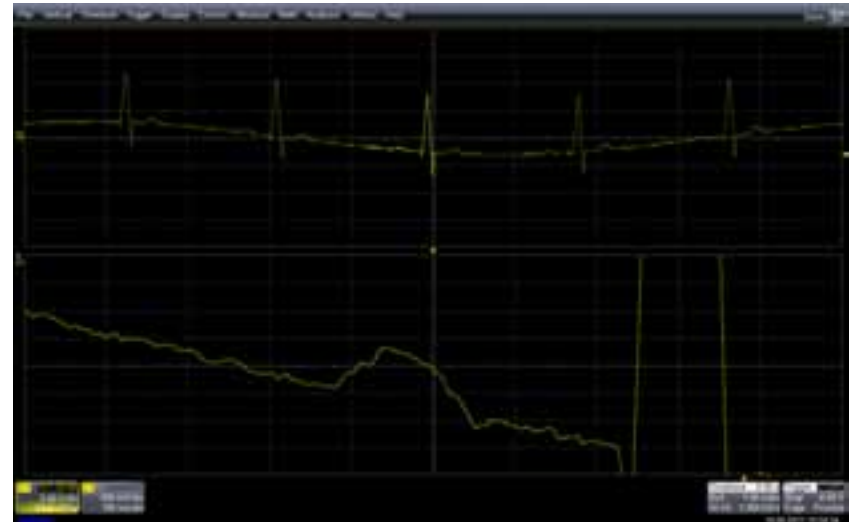
- Medical measuring instruments must detect signals with low amplitudes
 - 8 bit Scopes have problems to show these signals because the signal has insufficient dynamic range.



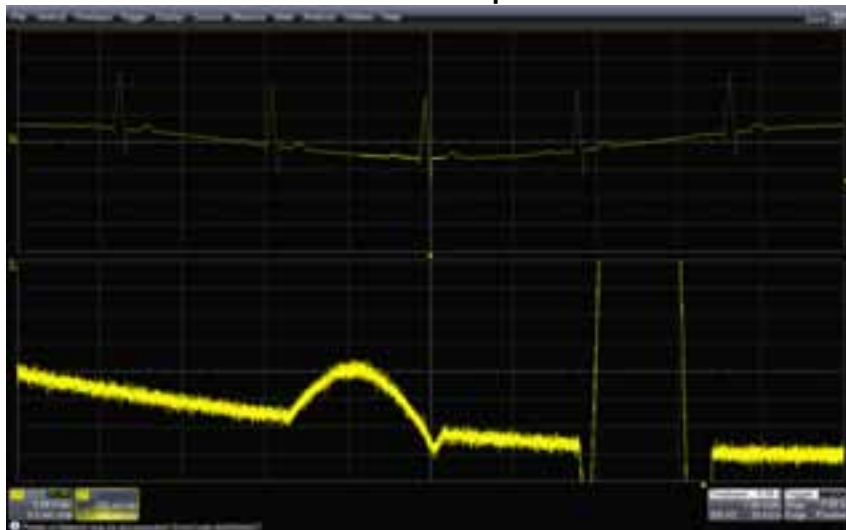
Medical Measurement



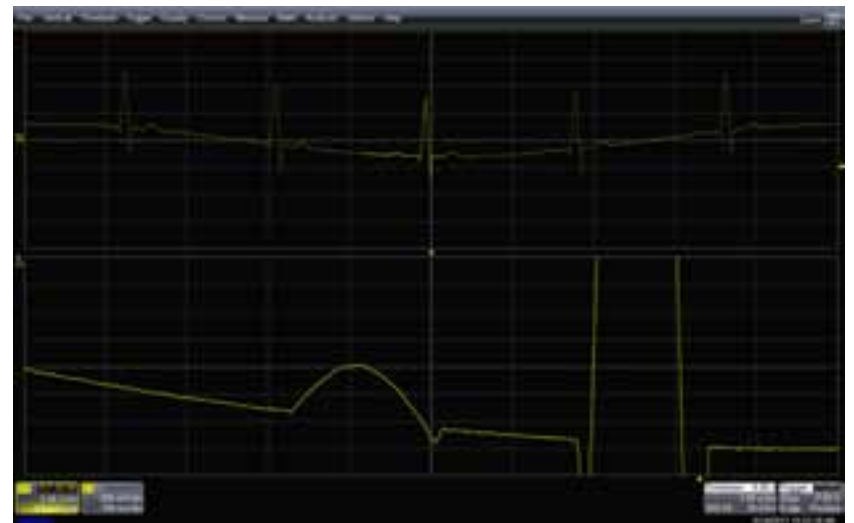
8 Bit Scope



8 Bit Scope with ERES



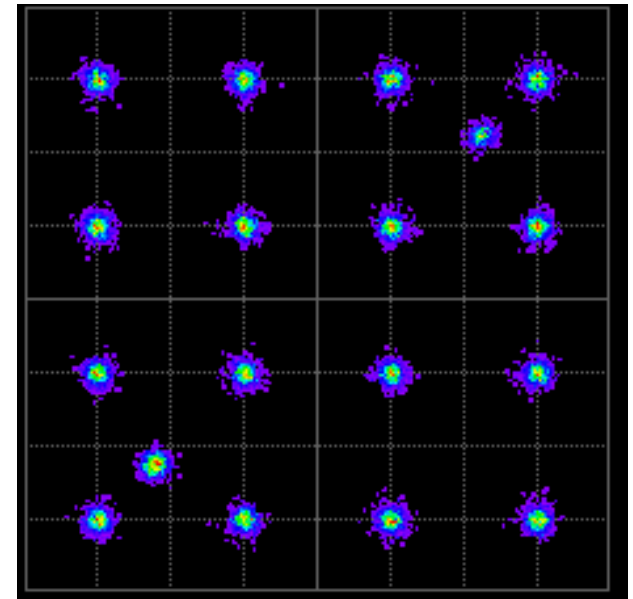
12 Bit Scope



12 Bit Scope with ERES

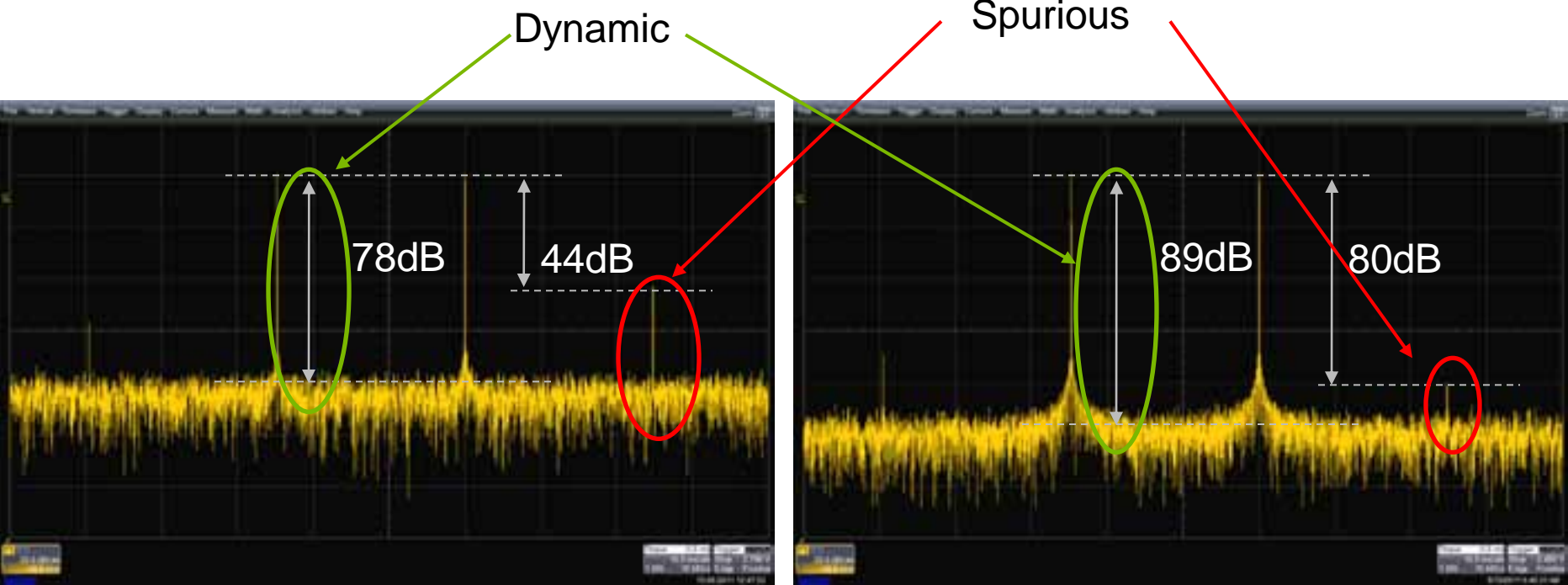
RF-Signals / Modulation Signals

- Capturing signals like UWB, OFDM, IQ-Signals in real time needs an A/D-converter with high bandwidth, but also with high dynamic range
- 8-bits is very often poor for resolving these signals
- The spurious-free dynamic range is also very often at the limit for this signal type



- Most of the signals could also be captured in the IF-Band so the bandwidth of the HRO is wide enough for the signals

RF-Signals / Modulation Signals



WaveRunner 6Zi 8bit

WaveRunner HRO 6Zi 12bit



■ **Results:**

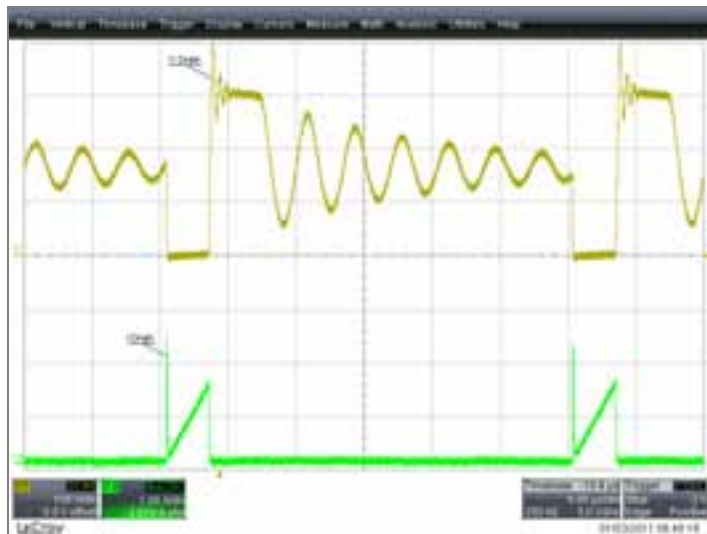
- For most of the applications 400 MHz/600 MHz analog bandwidth is sufficient to capture IF-Band signals
- 12-bit resolution gives higher dynamic range
- HRO has >55 dB Signal to Noise Ratio (SNR)
- HRO has a better spurious-free dynamic range
- For IQ-Signals EVM is one of the most important parameters.

For better EVM results the most important parameters are:

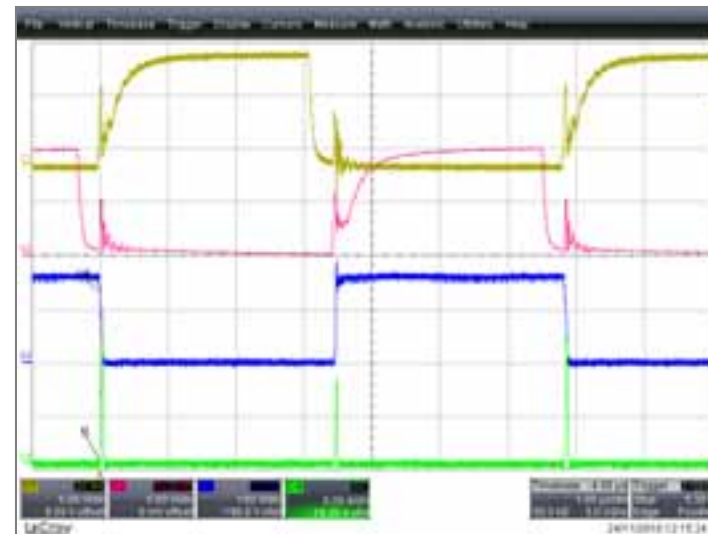
- Dynamic range
- Spurious free dynamic range
- Signal to Noise Ratio

Power Measurement

- There are two ways to make a power measurement
 - Measuring the current
 - Measuring the voltage
- The measurement must be done very often in a big range but with high resolution for little changes
- Long time-measurments are needed (a lot of memory is necessary)

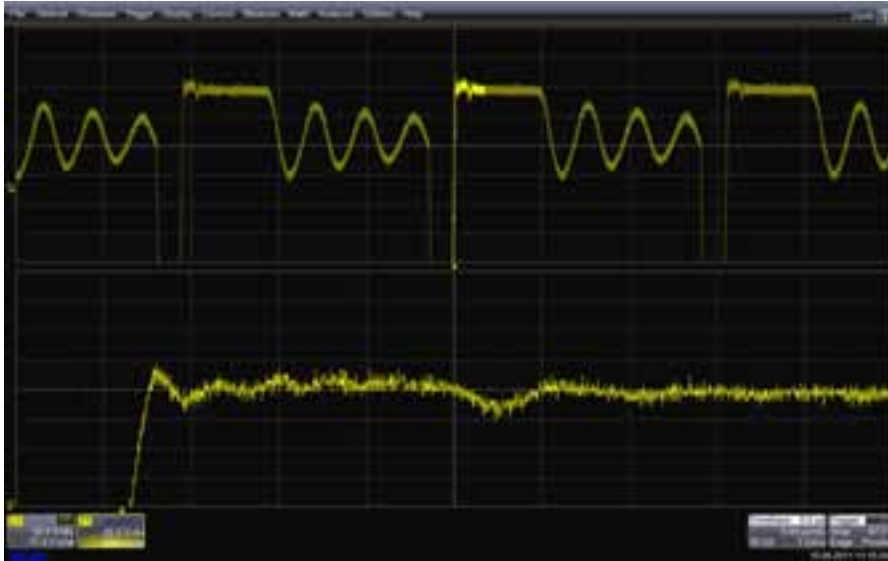


Voltage and Current measurement
at a Flyback Converter

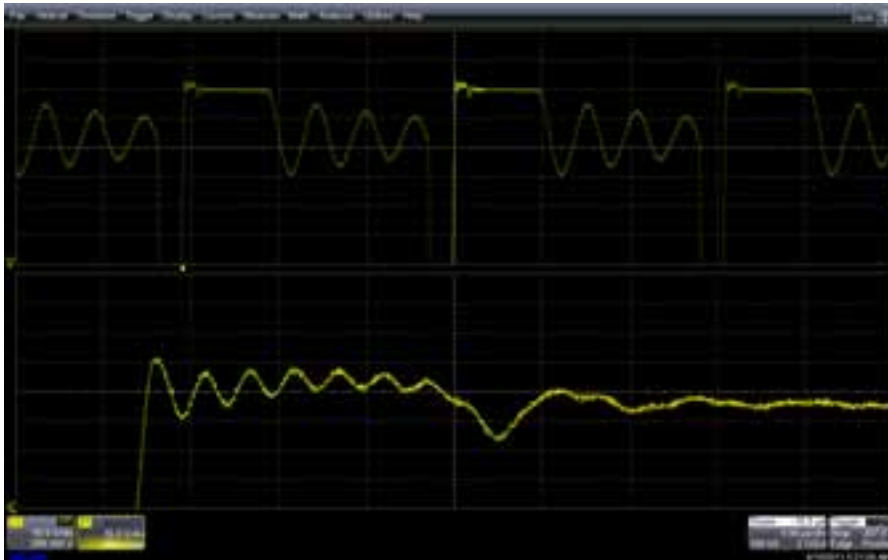


High dv/dt differential mode measurements
with a DA1855A Differential Amplifier
and a AP015 Current Probe

Power Measurement

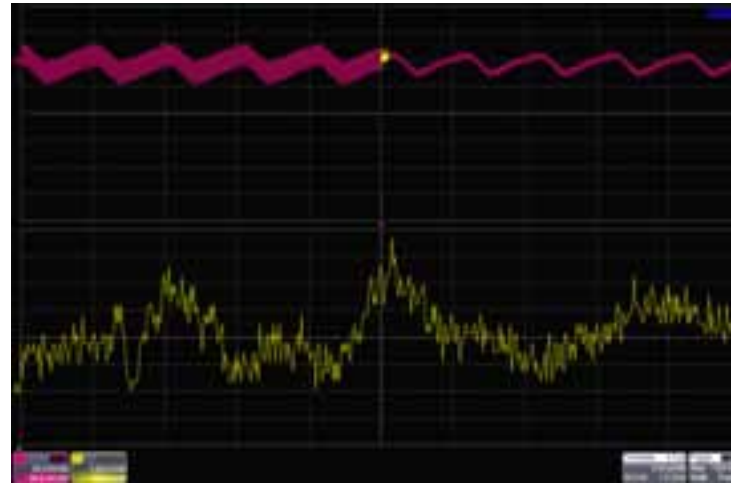
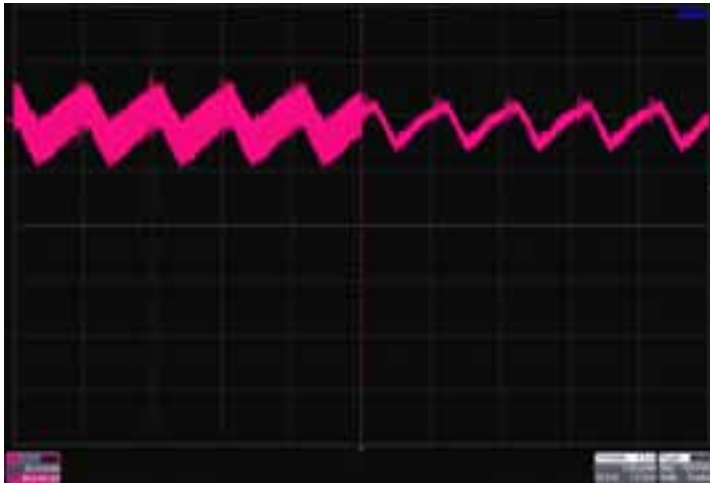


- 8 Bit Voltage Measurement

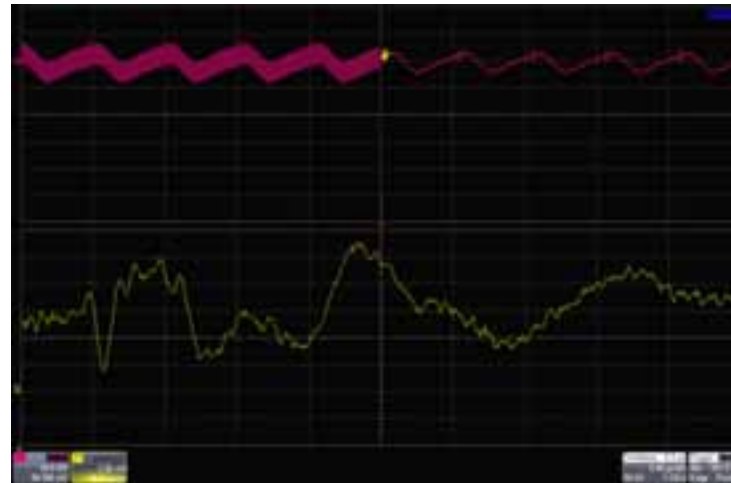
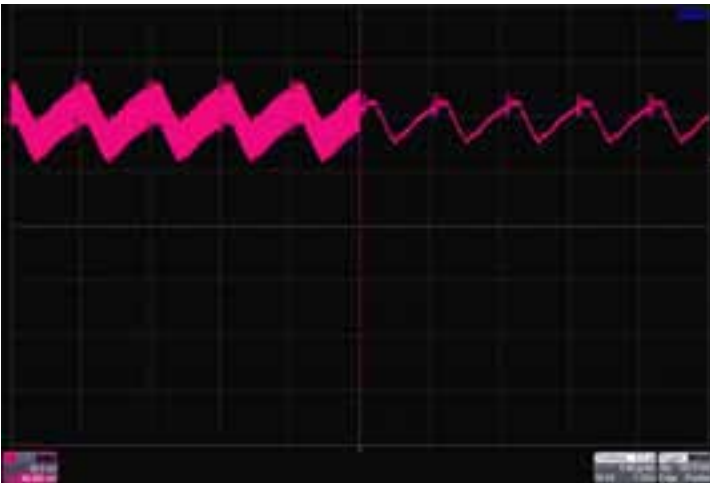


- 12 Bit Voltage Measurement

Power Measurement - Switched Mode Power Supplies



Conventional 8 bit Scope



12 Bit HRO Scope

- Switched mode power supplies are widely used due to their high efficiency, low cost and small size.
- The images show the output of an example power supply subjected to a small load step.
- The 8 bit scope displays the step in the output but only the 12 bit scope shows the high frequency oscillation in detail.

Power Measurement

- **Results:**
 - Important under- or overshoots can only be detected with 12 Bits
 - Power calculation (voltage x current) will benefit from the higher resolution.
 - 8-bit voltage x 8-bit current = 256 Points x 256 Points = 65,536 Points
 - 12-bit voltage x 12-bit current = 4096 Points x 4096 Points = 16,777,216 Points
 - Small ripples can only be evaluated with high resolution
 - With ERES it can be that some fast oscillations at edges are filtered out

WaveRunner High Resolution Oscilloscopes

Facts and Specifications



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WaveRunner HRO 6 Zi Oscilloscopes

- 12-bit ADC resolution
 - 15-bit resolution with ERES
 - 55 dB Signal to Noise Ratio (SNR)
- Highest Accuracy
 - $\pm 0.5\%$ DC Vertical Gain Accuracy
- Deep Memory
 - 256 Mpts/ch
- All Scope Analysis Tools of the 6Zi Series
 - Math & Measurements
 - Advanced FFTs
 - Jitter & Timing Analysis
 - 17 Serial Decode and Trigger Solutions
 - Multi-stage and Measurement Triggers
 - MSO options



WaveRunner HRO 6 Zi Oscilloscopes

- 400 MHz and 600 MHz models available
- 2 GS/s Sample rate on all channels
- 1 mV vertical Sensitivity @ full bandwidth
- Up to ± 400 V offset capability
- 20 MHz, 100 MHz, 200 MHz, 350 MHz filters for additional noise filtering
- Innovative 12.1" Rotating and Pivoting Touchscreen Display



Summary

- 12-bit resolution (15-bit resolution with ERES)
- 55 dB Signal to Noise Ratio (SNR)
 - Signals with a low amplitude can be measured easy
- $\pm 0.5\%$ DC Vertical Gain Accuracy
- 1 mV vertical Sensitivity @ full bandwidth
- Up to ± 400 V offset capability
 - 8 bit scopes often have only a range of ± 10 V
- ERES limits the bandwidth and can modify the signal waveform
 - Better to use 12 bit without ERES than 8 bit with ERES for authentic signal waveform rendering
- Measurements of signal waveforms with big amplitudes are possible without the reduction of a fine vertical resolution for a detailed view

Thank you for your attention!



Any Questions?