SIGLENT TECHNOLOGIES

The Best Value in Electronic Test & Measurement

SIGLENT®

SDS2000X HD 12-bit High Resolution Oscilloscope

SDS2000X HD

SDS2104X HD - 100 MHz

SDS2204X HD - 200 MHz

SDS2354X HD - 350 MHz

(Upgradable to 500 MHz max.)

Content

- Vertical Resolution
- Differences Between 8-bit and 12-bit
- Brief Introduction
- Comparison

PART ONE

01

Vertical Resolution

The Best Value In Electronic Test & Measurement

What's resolution?

- Resolution refers to the ability of a device to build details
- Many mass-consumer products have resolution metrics
- Resolution has gradually improved as the next generation continues to roll out

iPhone

Original display becomes retina display

4X

Digital Camera

3 Megapixels become 15 Megapixels

5X

Television

Standard definition TV becomes HDTV

6X

Oscilloscope resolution?

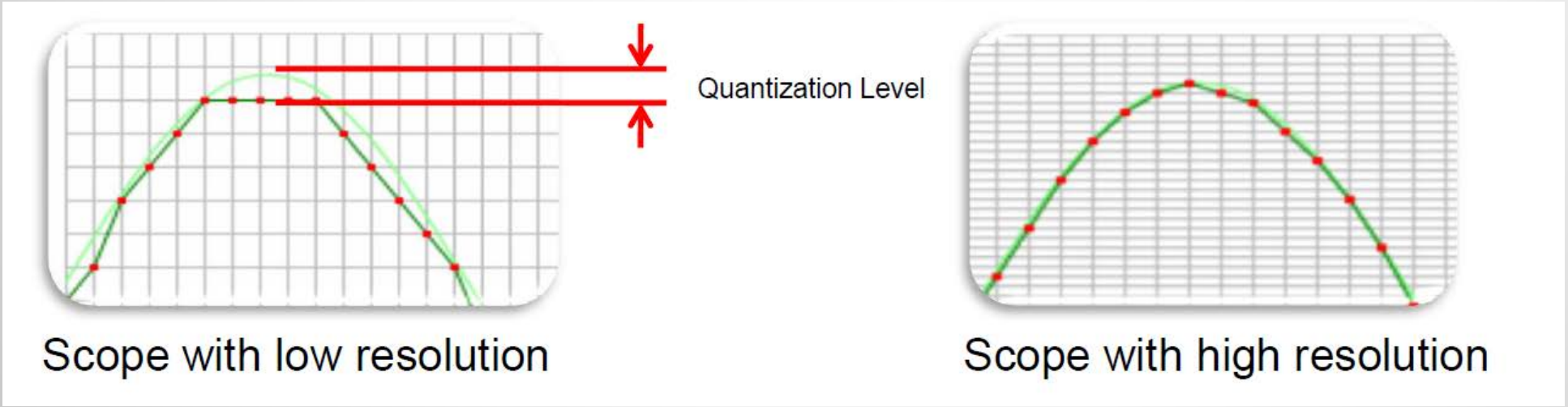
- The oscilloscope's ADC bits characterize the oscilloscope's signal resolution
- High resolution means the oscilloscope can display signal details in finer detail and make more precise measurements
- The Siglent SDS2000X HD high-resolution oscilloscope is a next-generation oscilloscope using a 12bit ADC, which is 16 times the signal resolution capability of a traditional 8bit oscilloscope

16X

12-bit ADCs provides 16 times the resolution of 8-bit ADCs

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

- ADC Dynamic Range = $20 \log_{10}(2^N)$ dB (ideal)
- Available Quantization Levels = $2^{\text{N bits of Resolution}}$
- DC Gain accuracy is +/- 0.5% (12-Bit) vs. +/- 1.5 – 2.0% (8-Bit)

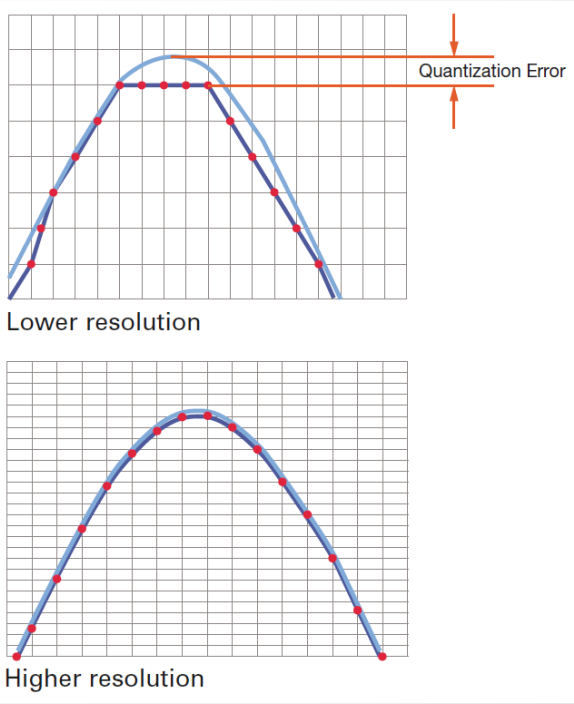


Highest Resolution Provides Small Voltage Step Size

12-bit resolution allows detection of smaller signal variations

Full Scale	Smallest Voltage Step	
	8-bit	12-bit
80 V	312.5 mV	19.5 mV
40 V	156.2 mV	9.76 mV
20 V	78.1 mV	4.88 mV
8 V	31.3 mV	1.95 mV
4 V	15.6 mV	976 µV
1.6 V	6.3 mV	390 µV
800 mV	3.1 mV	195 µV
400 mV	1.56 mV	97.6 µV
160 mV	625 µV	39 µV
80 mV	313 µV	19.5 µV
40 mV	156 µV	9.76 µV
16 mV	62.5 µV	3.9 µV
8 mV	31.2 µV	1.95 µV

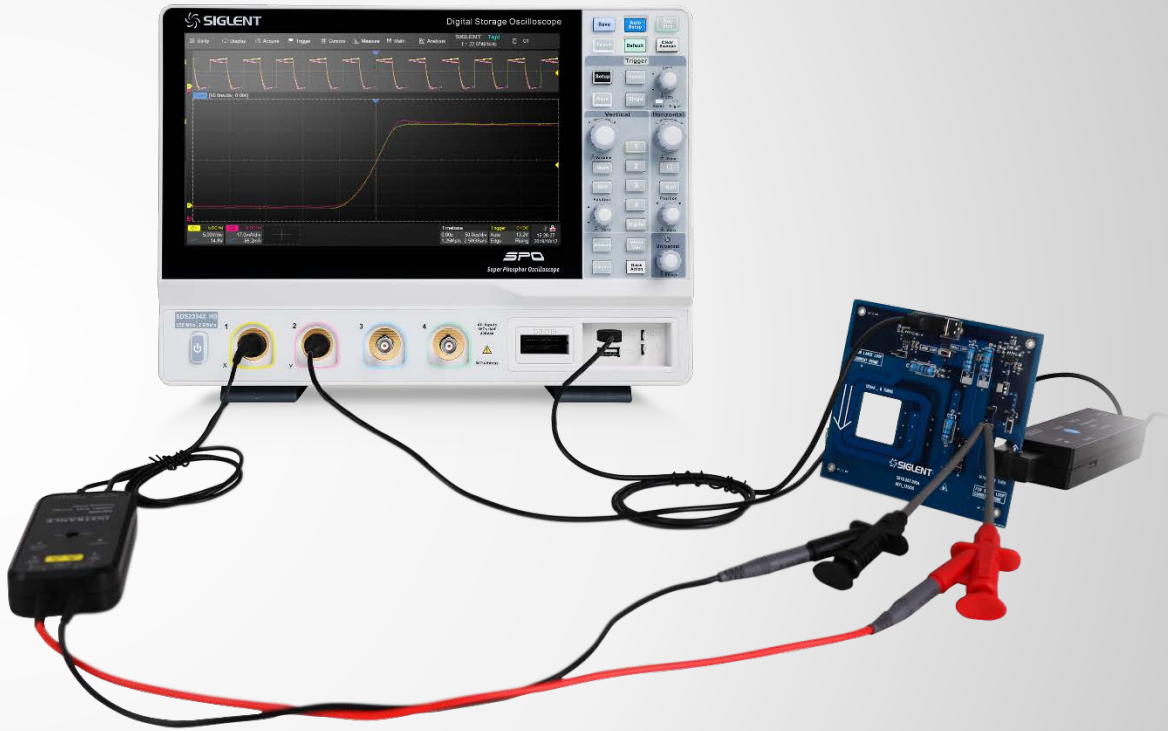
When measuring an 8 V signal, the smallest detectable voltage variation is 1.95 mV, compared with 31.3 mV on an 8-bit ADC.



Quantization levels: 16 times more for 12-bit scopes

12-bit high resolution Oscilloscope

- Guaranteed high accuracy:
- High sampling rate 12-bit ADCs
- lower noise floor
- The resolution accuracy is more than 16 times higher than that of the 8-bit oscilloscope in the current oscilloscope market
- More "cleaner", "clearer" waveform display
- Viewing more signal details
- More accurate waveform measurements



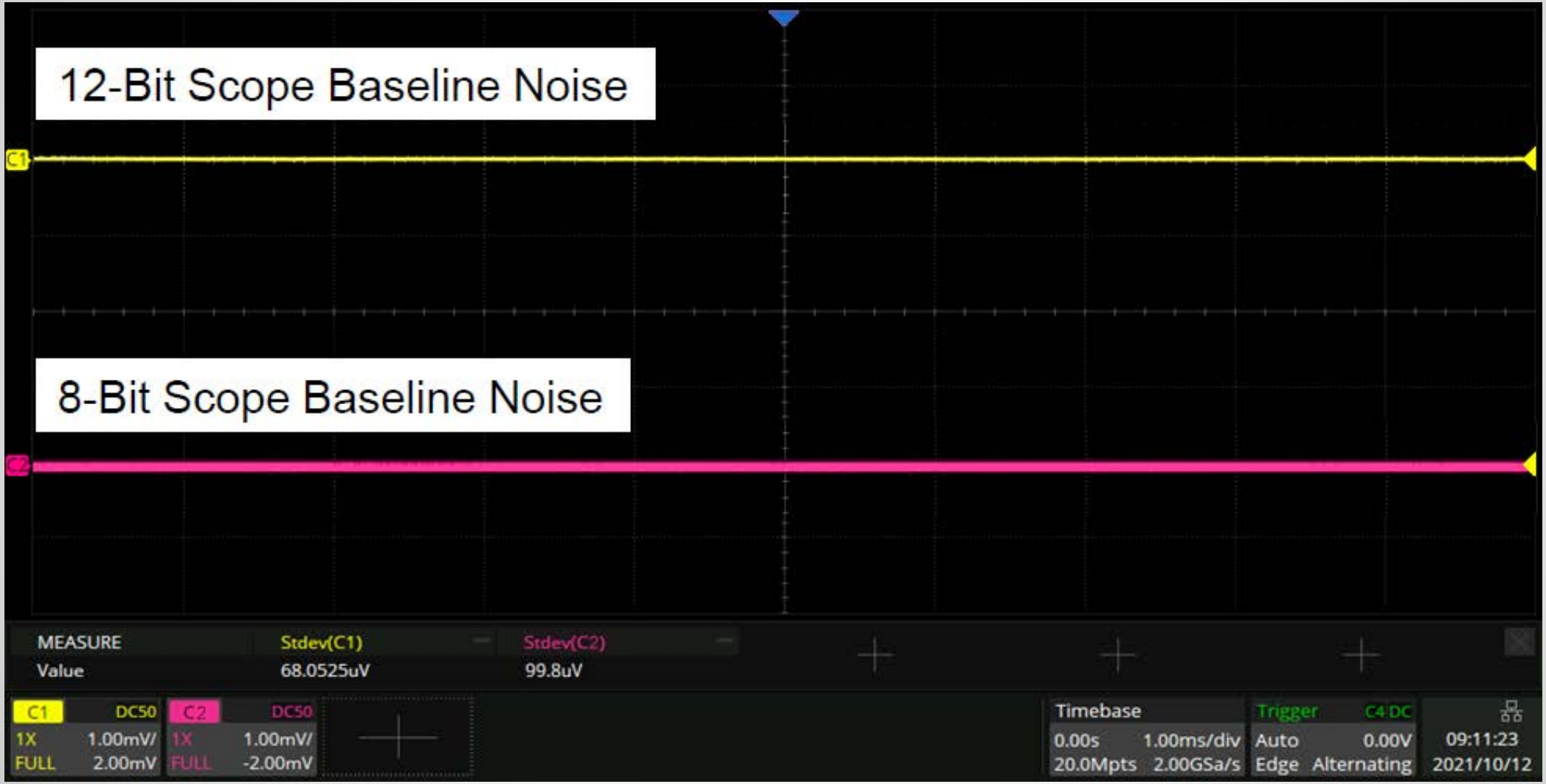
PART TWO

02

Differences Between 8-bit and 12-bit

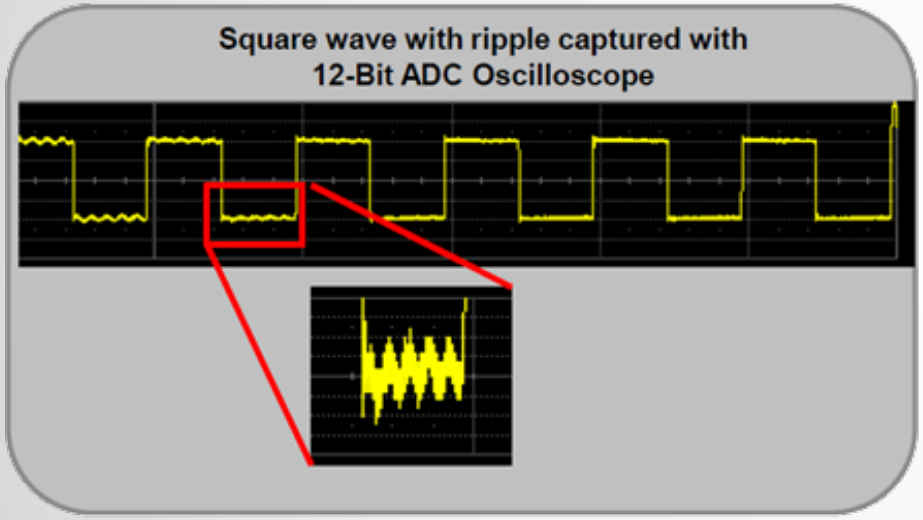
The Best Value In Electronic Test & Measurement

Lower Baseline Noise

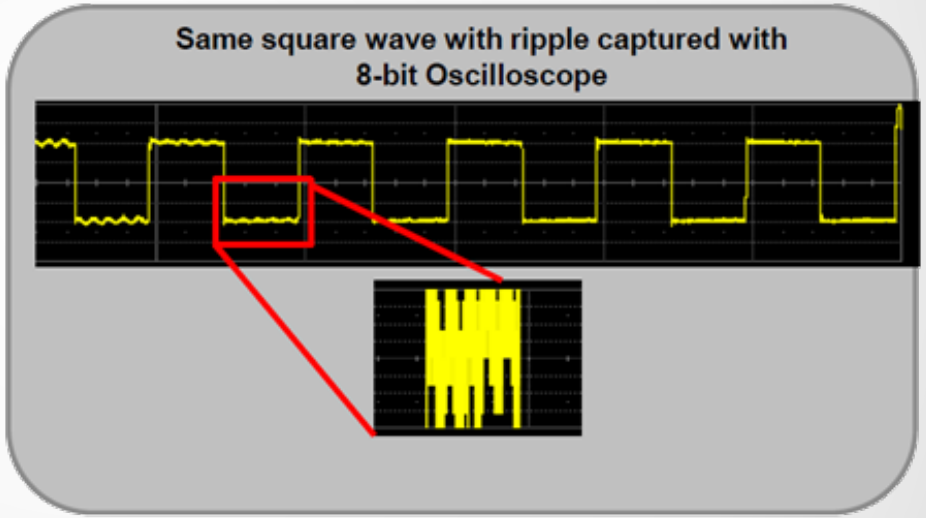


ADC Resolution – Comparison 12-bit vs. 8-bit

Waveform details become more visible, quantization noise is reduced, and measurement accuracy improves with additional vertical bits



High resolution allows ripple signal to be seen above the noise

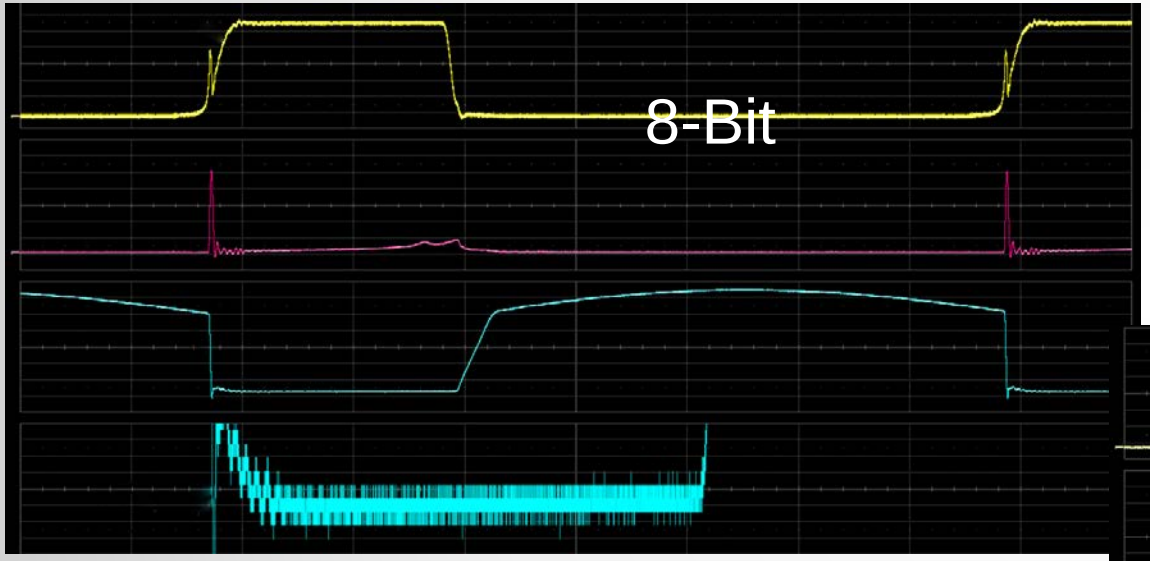


Ripple hidden in noise of the signal

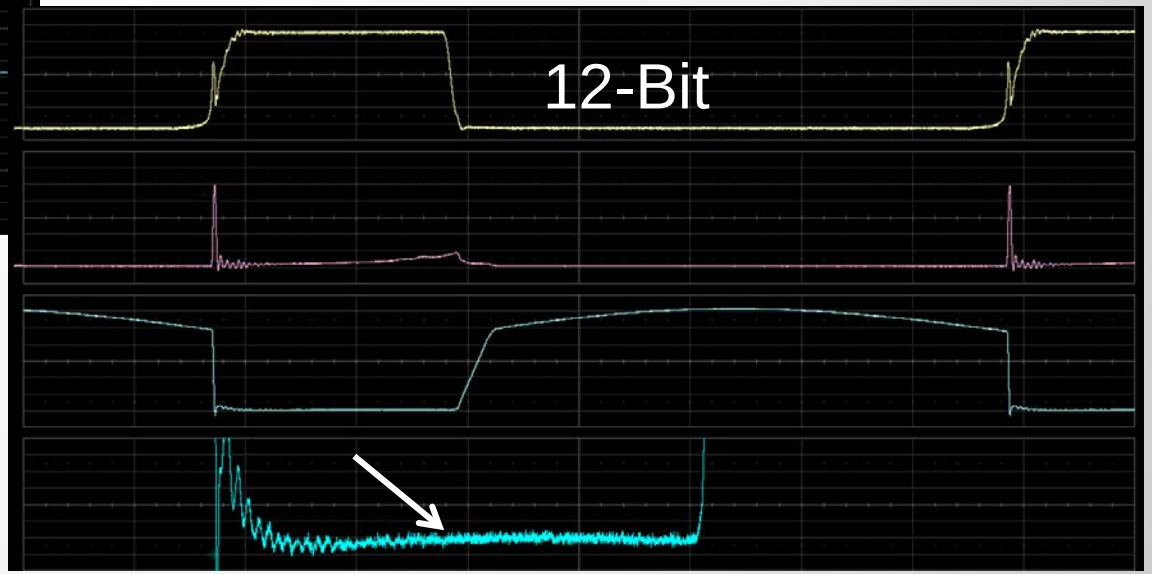
Viewing more signal details

The figure below shows the MOSFET signals in a switching power supply test application

Users needs to see VDS saturation voltage drop



8-bit oscilloscope shows blurred saturation voltage trace, details are buried in quantization noise



The 12-bit oscilloscope clearly shows details of saturation voltage

PART THREE

03

Brief Introduction

The Best Value In Electronic Test & Measurement

SDS2000X HD High Resolution Oscilloscope

- 12-bit ADC resolution, enhanced resolution to 15 bit
- 100 MHz，200 MHz，350 MHz (upgradable to 500 MHz) models
- Front ends with 70 μVrms noise floor @ 500 MHz bandwidth and 0.5% DC gain accuracy
- Deep Record Length 0f 200 Mpts
- Large 10.1” TFT-LCD display
- Capacitive touch screen supports multi-touch gestures
- Automatic measurements on 50+ parameters
- Search & Navigate
- Segmented acquisition (Sequence) mode
- History-Waveform playback
- MSO function
- Bode Plot
- Built-in web server supports remote control
- FFT-2 Mpts
- Power analysis
- Serial bus triggering and decoder

SDS2000X HD Main Specs

Model	Bandwidth	Channel	Sampling Rate	Memory Depth	Screen
SDS2104X HD	100 MHz	4	2 GSa/s	200 Mpts	10.1 inch Touch Screen
SDS2204X HD	200 MHz	4	2 GSa/s	200 Mpts	
SDS2354X HD	350 MHz	4	2 GSa/s	200 Mpts	
SDS2354X HD can be upgraded to 500 MHz by license					

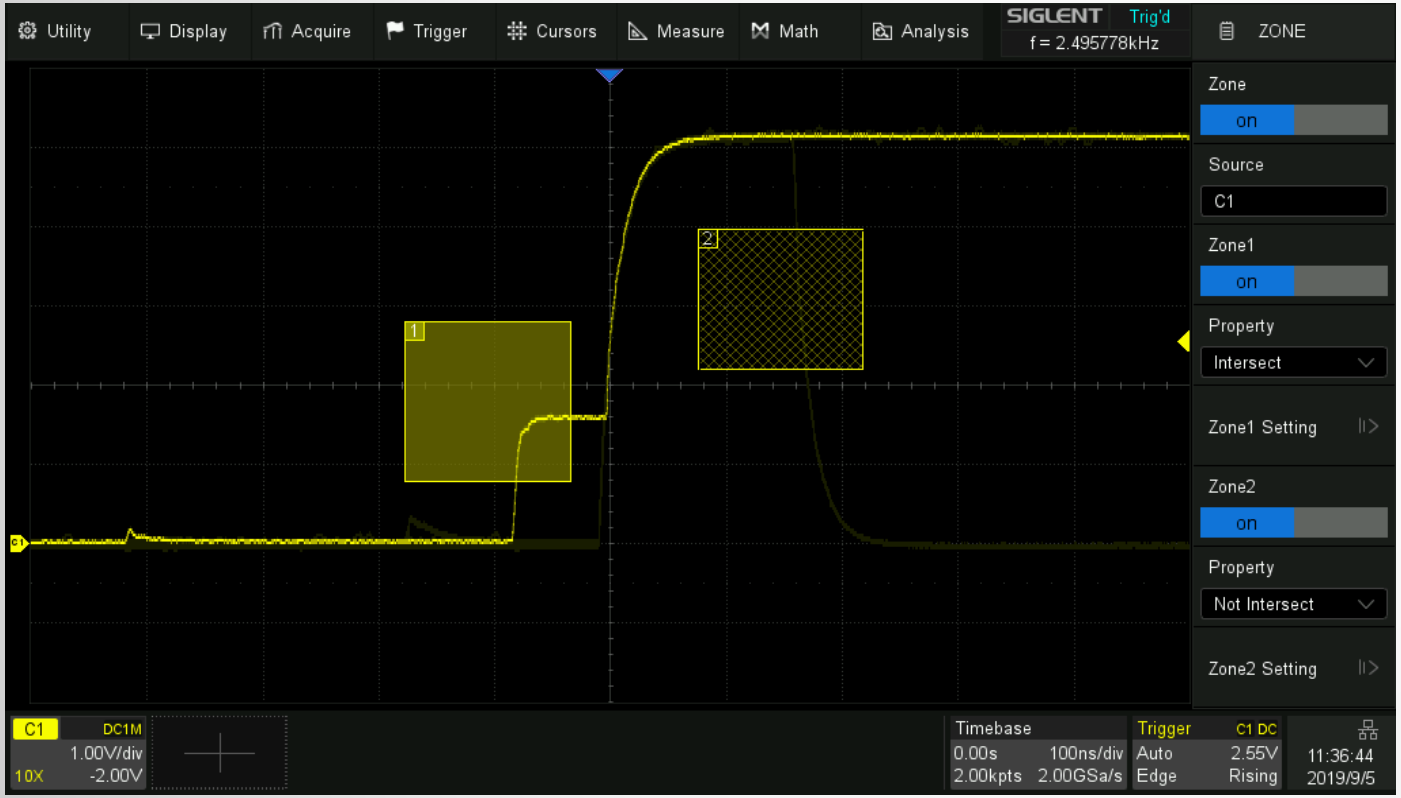
10.1" large screen display with multi-touch

- The touch screen greatly facilitates the following operations:
  - Channel settings
  - Trigger settings
  - Math
  - Parameter measurement

- Advanced multi-touch display
  - Stretch zoom operation
  - Finger drag

Zone Trigger

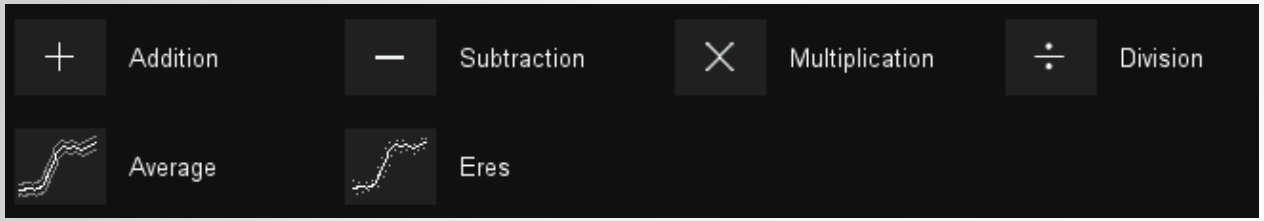
Quickly define trigger zones and isolate faults using the touch screen

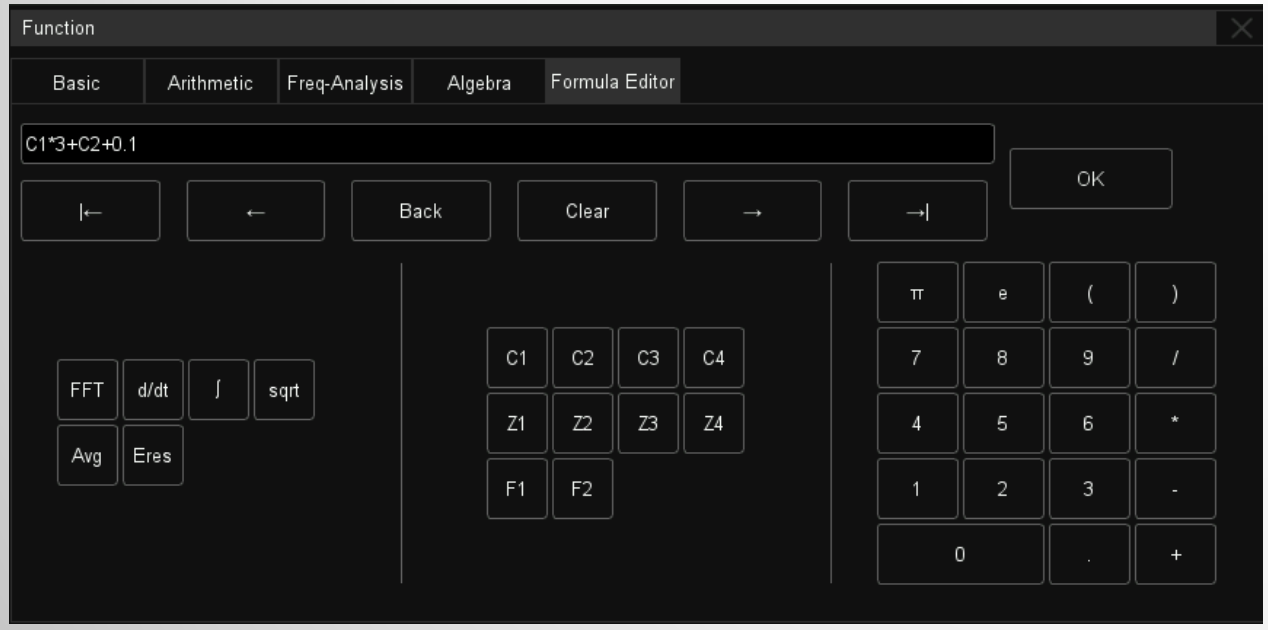


- Traditional trigger types can take time to configure for complex trigger conditions
- With Zone Triggering, simply draw a zone and select Intersect or Not Intersect

Advanced Math Functions

Calculate power, energy, and more using the powerful equation editor



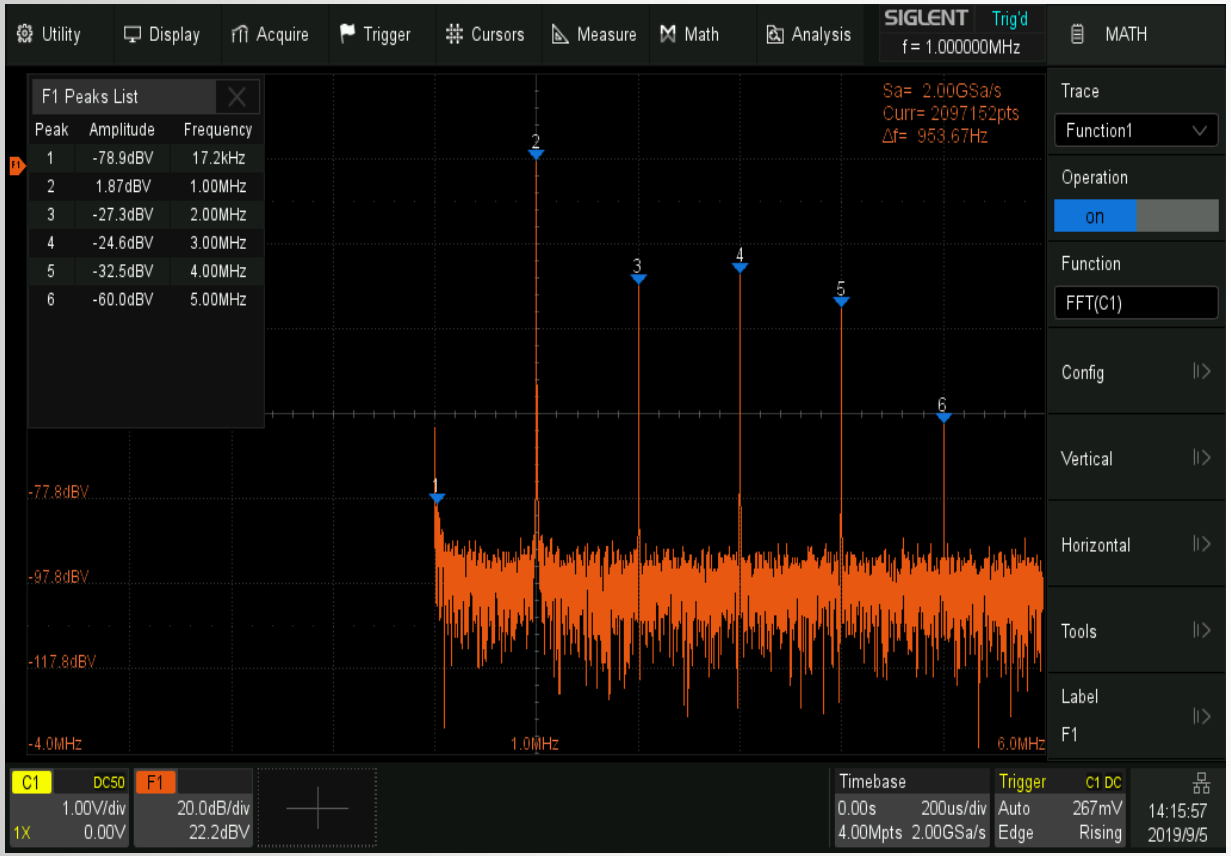


- No differential probe?

  No problem. Simply use the subtract operator so simulate a differential circuit
- Multiple kinds of operators, including derivative and integral
- Formula editor for advanced modifications of signals

Hardware Accelerated FFT

High frequency resolution with fast refresh rate

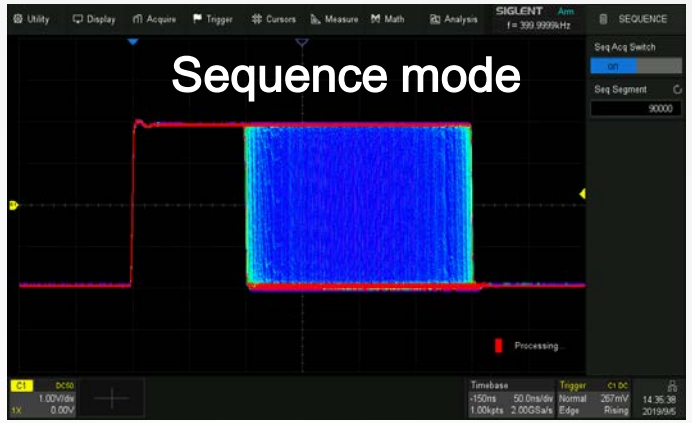


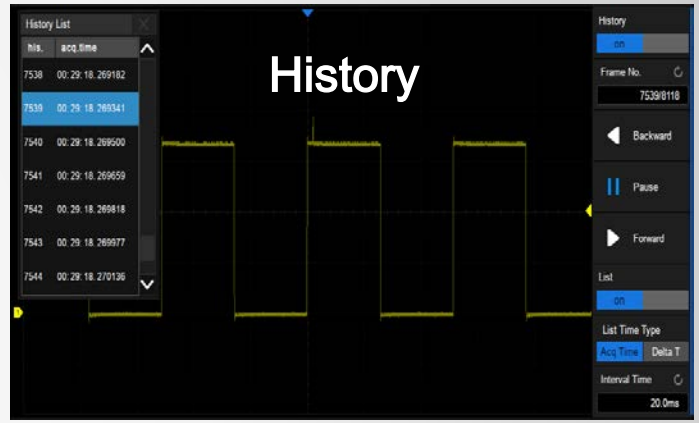
- Up to 2 M FFT points provides high frequency resolution with fast refresh rate.
- A variety of window functions adapt to different spectrum measurement needs.
- Three modes (Normal, Average and Max hold) can satisfy different requirements for observing the power spectrum.
- Auto peak detection and markers are supported.

Powerful debugging tools

Segmented memory

- Save memory
- Up to 80,000 segments
- Interval between segments as small as 2 µs



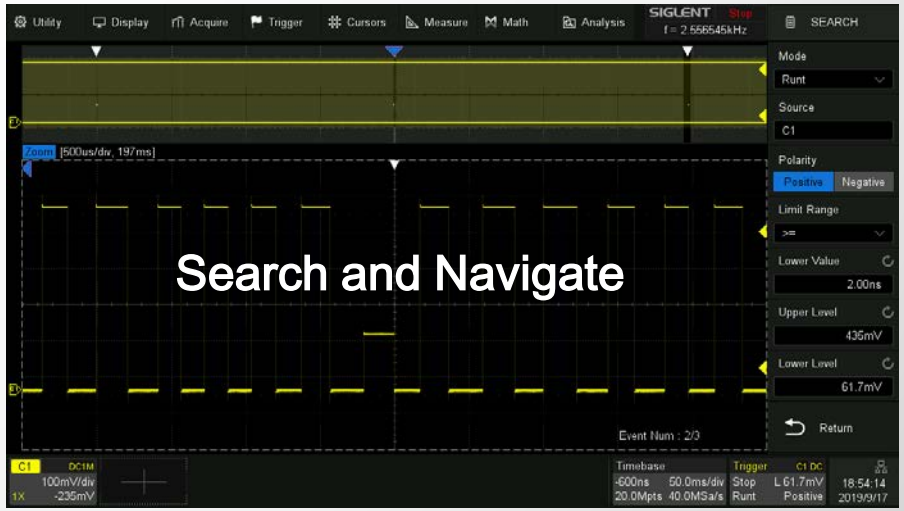


Background running History

- Serial Decode, Zoom, and cursors measurements can be used.
- Records up to 80,000 triggered waveforms.

Search and Navigate

- Easily find events within a record and history based on user specified trigger conditions.
- Useful in zoom view



Power Analysis and Bode Plot

Powerful tools for power engineers

Power Analysis (Opt.)

- Provides a full suite of power measurements and analysis
- Improving the efficiency of measurement in switching power supplies and power device designs

Power Analysis Function

Bode Plot (Std.)

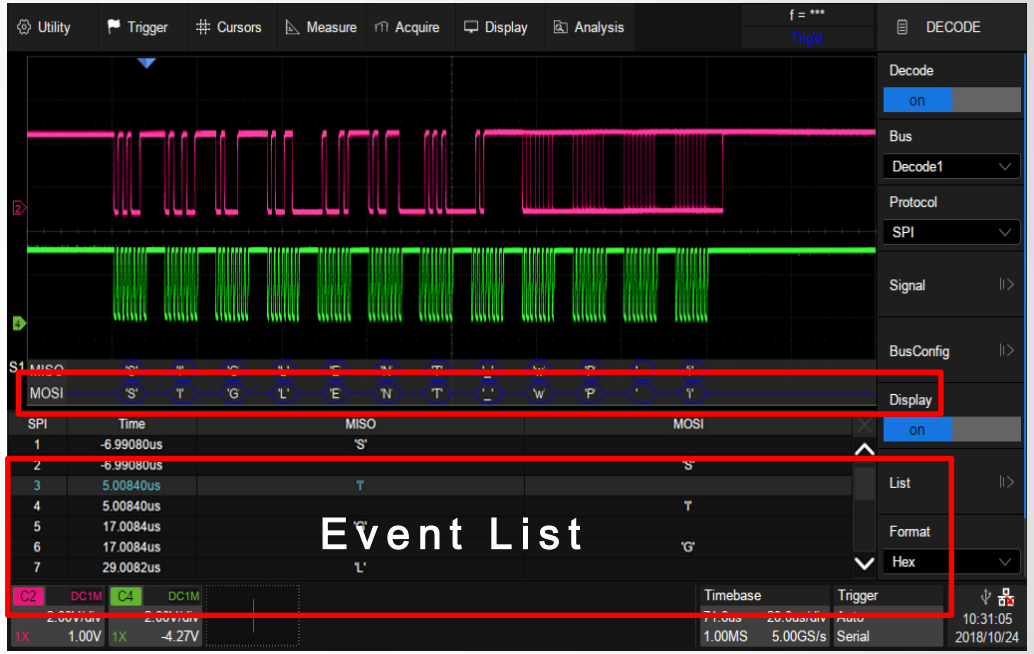
- Control the built-in waveform generator or any stand-alone SIGLENT SDG device
- Scan the amplitude and phase response over frequency
- Possible to replace expensive network analyzers in less demanding applications.

Power Supply Control Loop Response with Bode Plot

Wide range of Serial Decoders

Help to debug in various industries

- Independent trigger and decoding. Increased flexibility.. Trigger and/or decode from any input source: 2/4 analog + 16 digital channels
- Export decoding event list as a CSV file type for offline analysis
- Return Format
  - Binary
  - Decimal
  - Hex
  - ASCII



Standard included Decoding:

I2C, SPI	Embedded serial trigger and analyze
UART	Computer serial trigger and analyze
CAN, LIN	Automotive serial trigger and analyze

Optional Decoding:

CAN FD	Automotive serial trigger and analyze
FlexRay	Automotive serial trigger and analyze
I2S	Audio serial trigger and analyze
MIL-STD 1553B	serial trigger and analyze
SENT	Automotive serial trigger and analyze
Manchester	Serial trigger and analyze

MSO Function

Mixed signal oscilloscope, solution for both digital and analog problems

- View digital and analog channels on one timebase
- Full trigger and decoding on all analog and digital channels
- 16 channels; maximum waveform capture rate up to 500 MSa/s; record length up to 50 Mpts
- User defined label names, channel groups, and more

Application field for a 12-bit resolution Oscilloscope?

1, Measuring High-precision sensors and actuatior

2, Medical equipment (many signals in the medical field, such as EKG, ECG signal or EEG, EMG signal, etc., are very close to noise, so a high-precision oscilloscope is required.

3, Laser pulses (weak overshoots, dips, etc. in fast pulses)

4, RF signal/modulated signal (UWB/OFDM/IQ, etc. For IQ signal, the vector magnitude error "EVM" is an important measurement parameter)

5, Power measurement (noise overlay analysis)

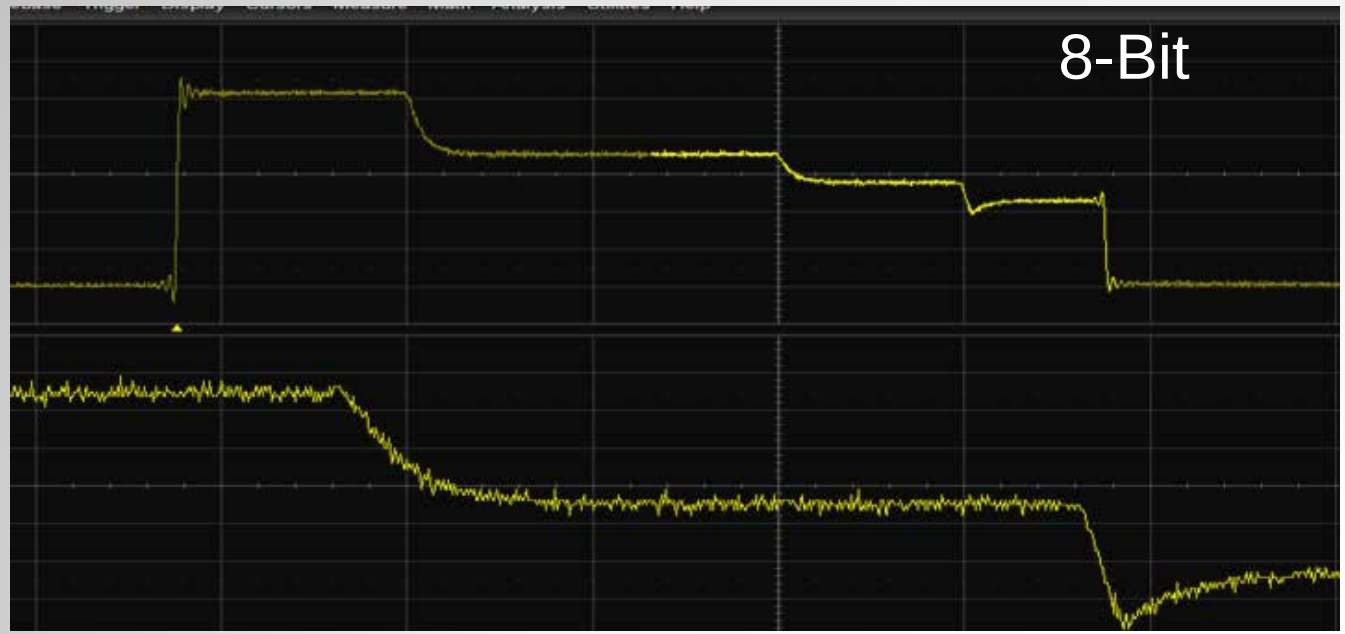
6, Others... (when it is necessary to observe small signals appearing in large signals, such as phase-locked loops)

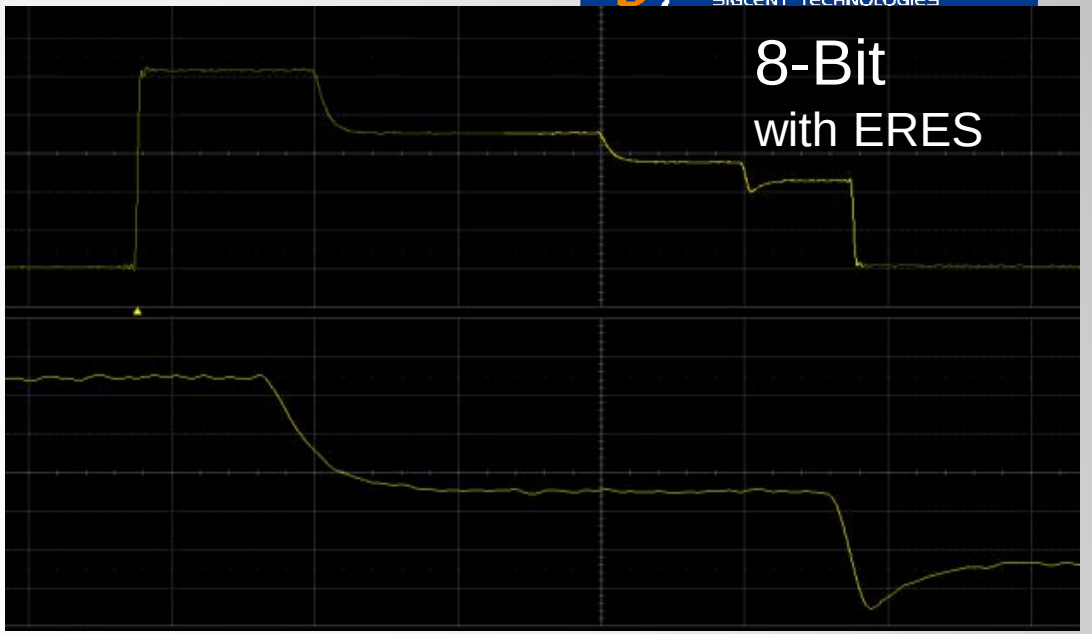
High Precision Sensor and Actuatior Measurement

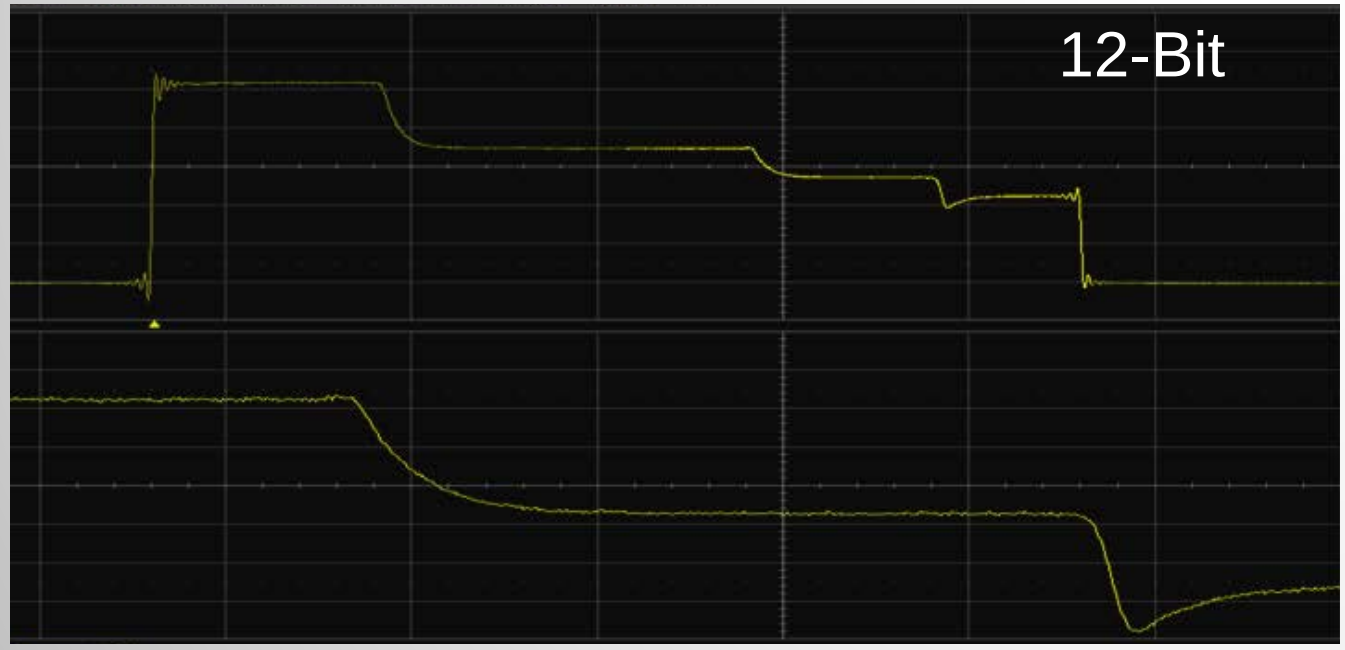
- Sensors and Actuatiors are usually very accurate
- 8-bit oscilloscopes can only provide a maximum resolution of the order of 256
- If measurements beyond 256-order resolution are required, then a higher precision oscilloscope will be required

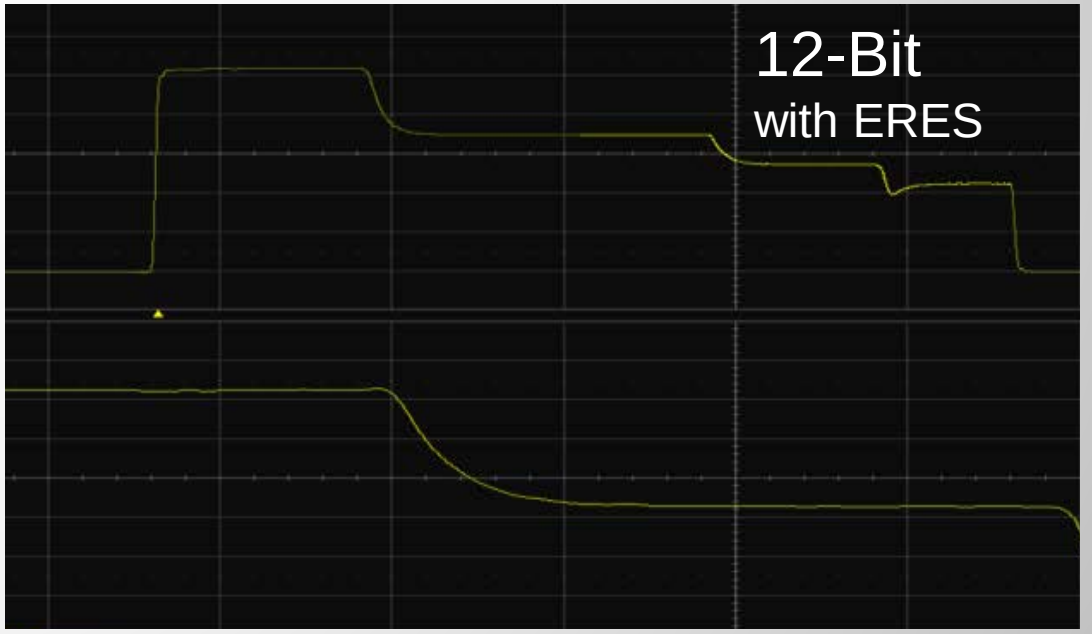
Example:

- Measurement of rotational speed (Revolutions PER minute, RPM)
- Height difference measurement
- discharge flow-through measurements


8-Bit


8-Bit
with ERES


12-Bit


12-Bit
with ERES

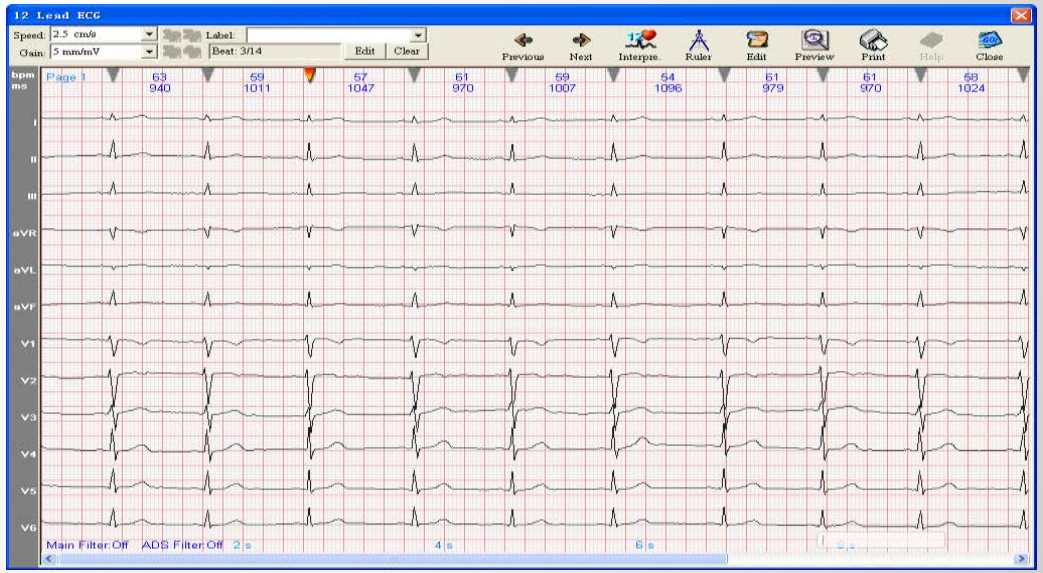
High Precision Sensor and Actuatior Measurement

Results:

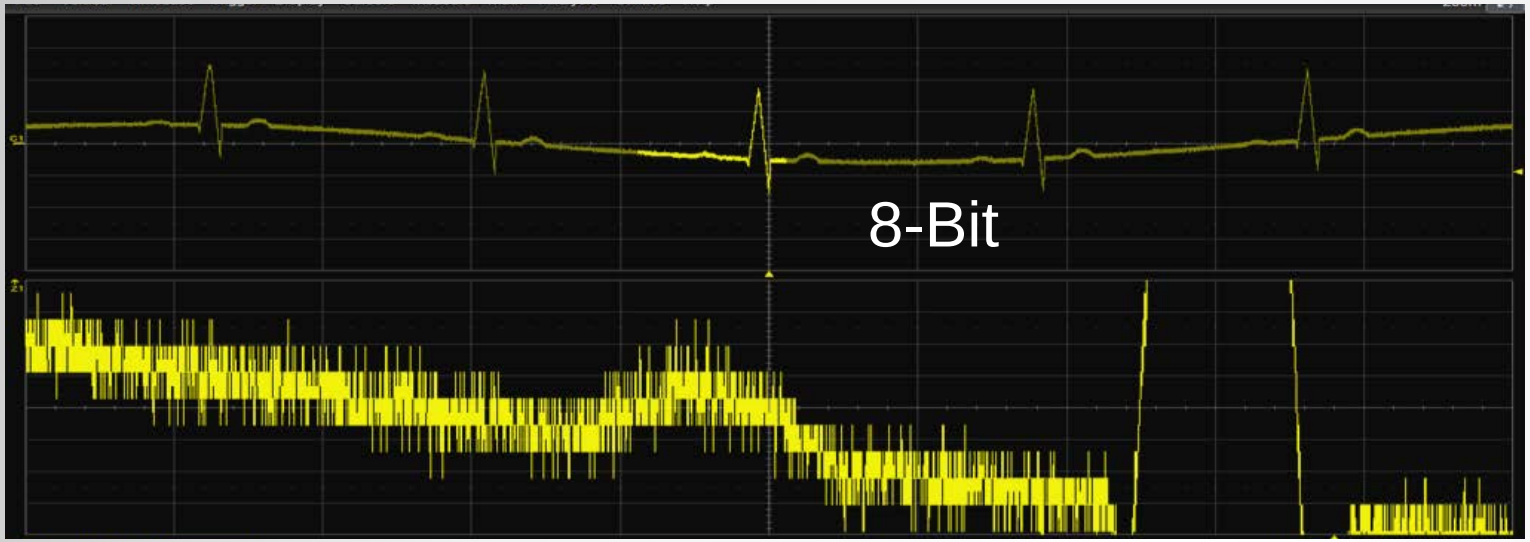
- High-precision sensors and Actuatior require higher-resolution oscilloscopes
- Using an 8-bit oscilloscope to measure high-resolution sensors and actuatiors can be very noisy.
- For better results, a noise filter (ERES - Enhanced Resolution Function) can be used.
- The ERES function sometimes filters out fast oscillations (or high frequency glitches) superimposed on the waveform.

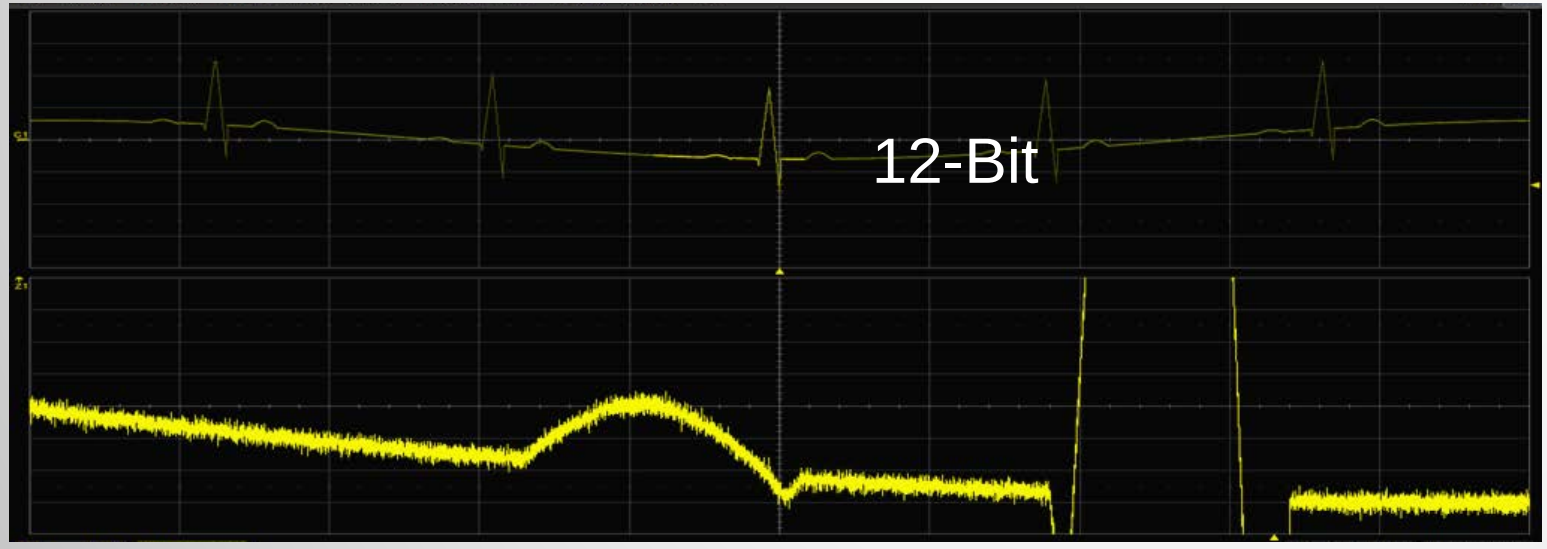
Measurement for medical applications

- Medical measuring instruments must be able to detect very low amplitude measurement signals, such as ECG signals or EEG signals
- Since 8-bit oscilloscopes do not have enough dynamic range, it is difficult to accurately measure such signals



Measurement for medical applications

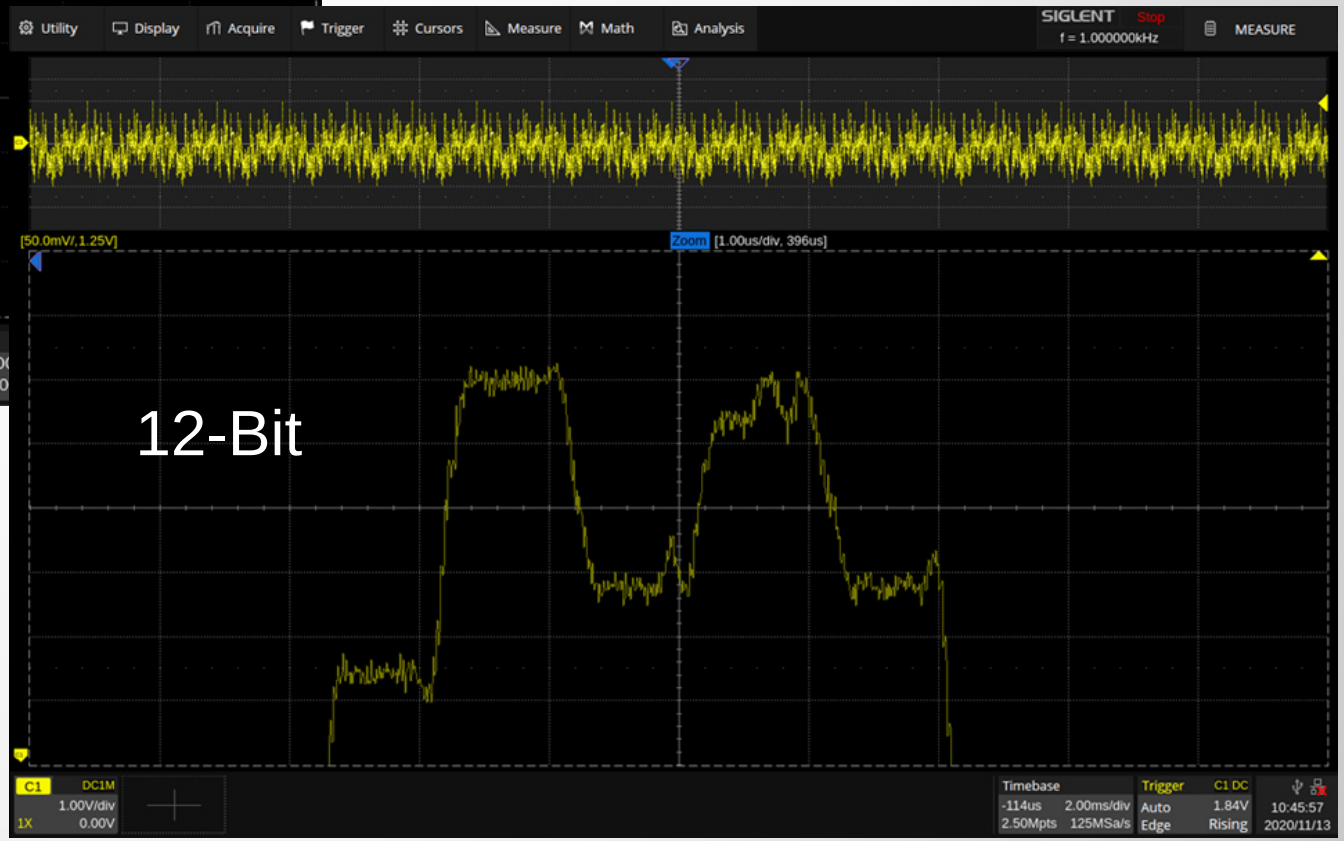




- When testing ECG analog signals, the test difference between 8-bit oscilloscope and 12-bit oscilloscope

Measurement for medical applications

- When testing EEG brainwave signals, the test difference between 8bit oscilloscope and 12-bit oscilloscope



Measurement for medical applications

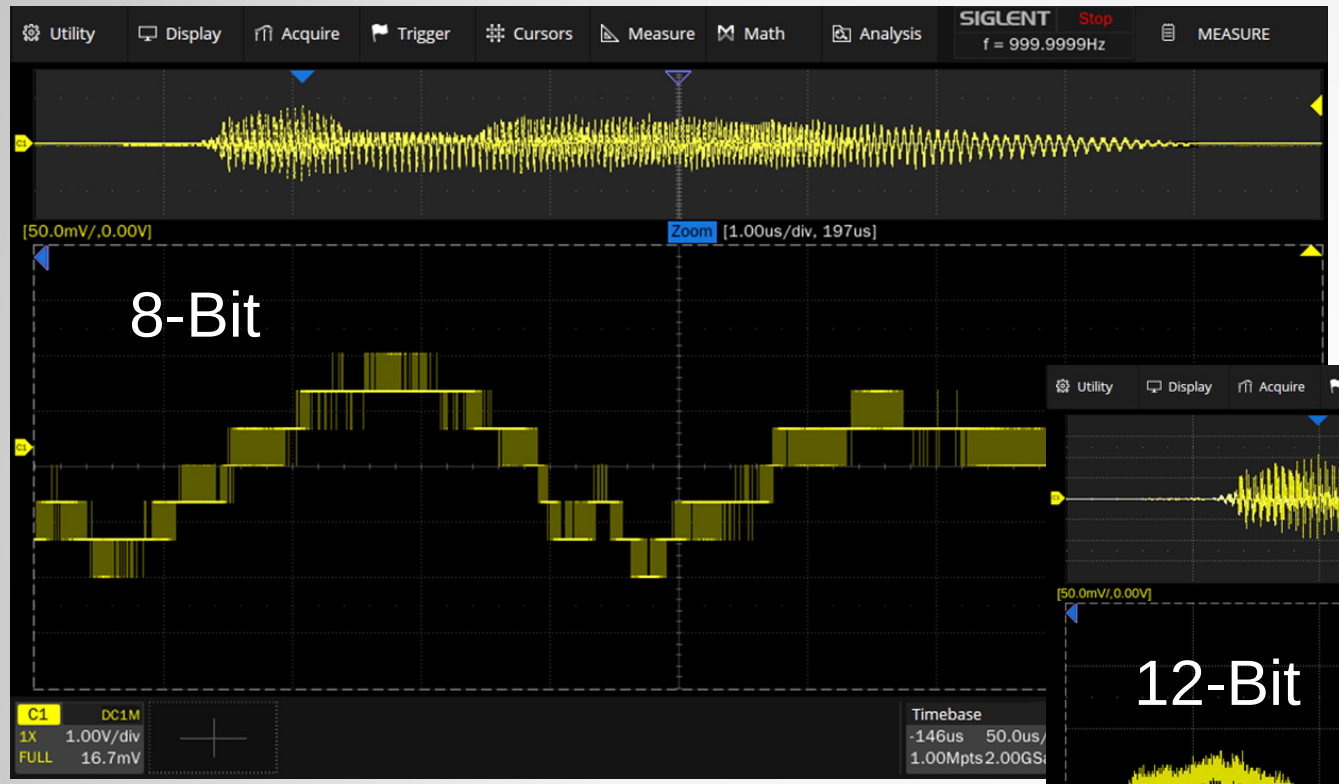
- When testing EMG signal, the test difference between 8-bit oscilloscope and 12-bit oscilloscope

Measurement for medical applications

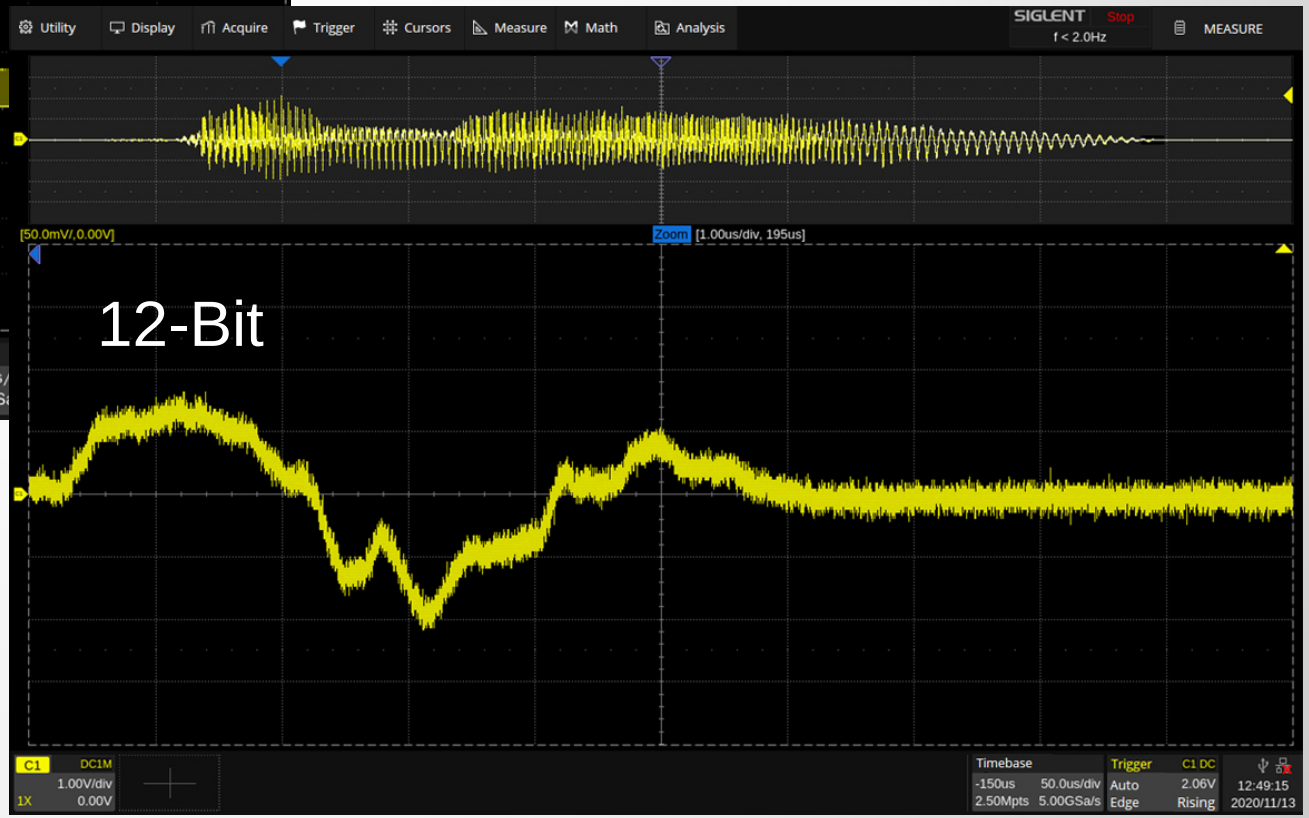
Results:

- Signals in medical fields such as electrocardiograms are very close to the noise floor of an 8-bit oscilloscope.
- Such weak signals can only be detected using the noise filter (ERES) function, but the signal quality is still poor.
- Important signal integrity issues such as overshoot or undershoot can only be measured by an oscilloscope using a 12-bit ADC

Audio Signal Measurement



- Test the audio signal, check the end oscillation, the test difference between 8-bit oscilloscope and 12-bit oscilloscope



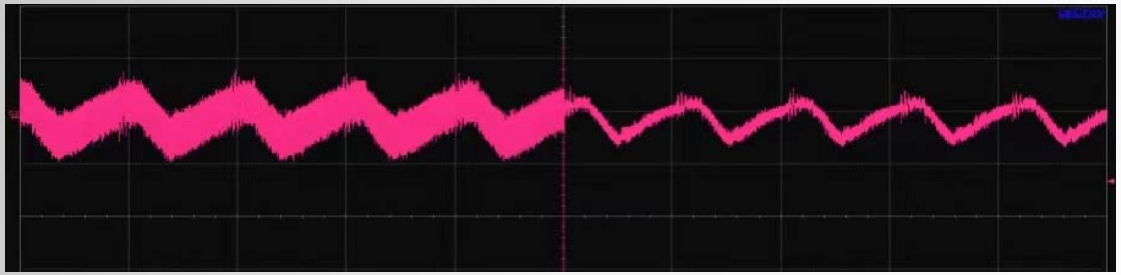
Power measurement

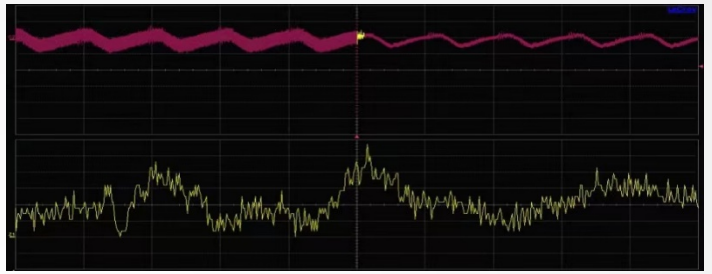
- Power measurement mainly includes the measurement of two parameters
- Measurement of current
- Voltage measurement

- The swing range of the measured value is usually very large and it must be accurate enough to observe small voltage or current changes

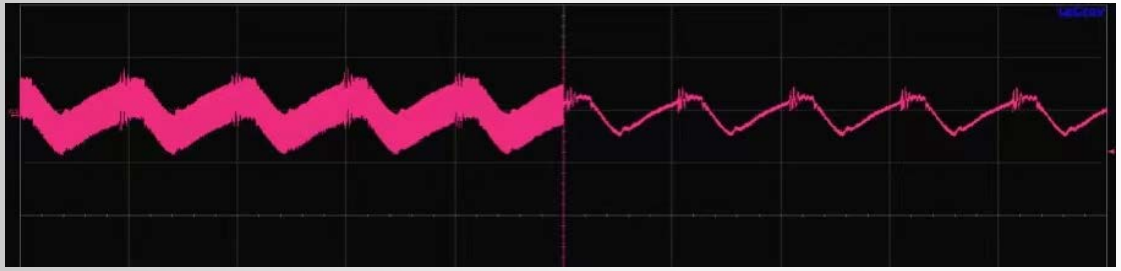
- It requires a for a long time to collect data, because it must ensure that at least one power cycle signal is collected, so the test instrument needs to have a deep acquisition memory depth

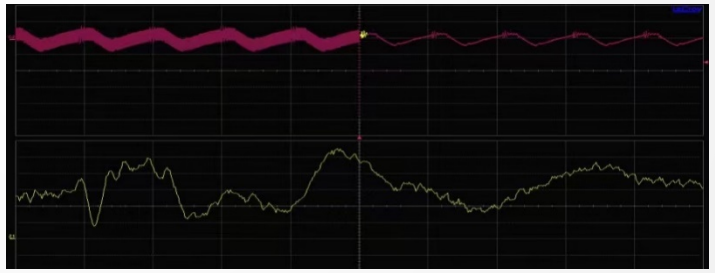
Power measurement





8-bit Oscilloscope





12-bit Oscilloscope

- Switching power supplies are widely used due to their high efficiency, low cost, and small size.
- The figure shows the output of the switching power supply when the load produces a small step change

The 8-bit oscilloscope can measure the step change of the voltage output but only the 12-bit oscilloscope can clearly display the details of the fluctuation superimposed on the voltage.

Power measurement

Results:

- Use a 12-bit high-precision oscilloscope to capture some important undershoot or overshoot Power calculations (voltage x current) will benefit even more from high-precision oscilloscope measurements.
- 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-amplitude ripple can only be captured with a high-precision oscilloscope
- Only using the ERES function to enhance the resolution will also filter out some high-frequency oscillations or overshoots.

PART FOUR

04

Comparison

The Best Value In Electronic Test & Measurement

SDS2000X HD

SDS2000X Plus

Model	Siglent SDS2000X HD		Siglent SDS2000X Plus	
Bandwidth	100/200/350 MHz	√	100/200/350 MHz	√
Vertical Resolution	12-bit	√	8-bit	X
Average	Hardware based	√	Only supported in Math	X
Analog Channel	4	X	2/4	√
Sampling rate	2 Gsa/s	√	2 Gsa/s	√
Memory Depth	200 Mpts	√	200 Mpts	√
Wavefrom Capture Rate	100,000 wfm/s normal mode	X	120,000 wfm/s normal mode	√
ERES	ERES 3-bit，hardware based	√	ERES 3-bit, only supported in Math	X
Vertical Scale	1 Mohm: 500 uV/div ~ 10 V/div 50 ohm: 500 uV/div ~ 1 V/div	√	1 Mohm: 500 uV/div ~ 10 V/div 50 ohm: 500uV/div ~ 1 V/div	√
DC Gain Accuracy	0.5mV/div ~ 4.95mV/div: ±1.5%; 5mV/div ~ 10V/div: ±0.5%	√	≤ 3.0%	X
Time base Accuracy	±2ppm initial; ±0.5ppm 1st year aging; ±3ppm 20-year aging	√	±1ppm initial; ±1ppm 1st year aging; ±3.5ppm 10-year aging	X
Nose floor	70 uVrms @ 500 MHz	√	80 uVrms @ 500 MHz	X
SFDR	≥ 45 dBc	√	≥40 dBc	X
CH to CH Isolation (@50Ω)	> 60 dBc, < 500MHz > 70 dBc, < 350MHz	√	DC～100 MHz: >40 dB 100 MHz ~ BW: ≥34 dB	X
Trigger types	Edge, Slope, Pulse, Window, Runt, Interval, Dropout, Pattern, Video, Qualified, Nth edge, Delay, Setup/Hold time, Serial	√	Edge, Slope, Pulse, Window, Runt, Interval, Dropout, Pattern, Video and Serial	X
Serial trigger and decode	Standard: I2C, SPI, UART, CAN, LIN Optional: CAN FD, FlexRay, I2S, MIL-STD-1553B, SENT, Manchester(decode only)	√	Standard: I2C, SPI, UART, CAN, LIN Optional: CAN FD, FlexRay, I2S, MIL-STD-1553B, SENT, Manchester(decode only)	√
Sequence	Up to 80,000 segments	X	Up to 90,000 segments	√
History	Up to 80,000 frames	X	Up to 90,000 frames	√
Display	10.1'' touch screen, 1024*600	√	10.1'' touch screen, 1024*600	√

SIGLENT®

Model	Siglent SDS2000X HD	R&S RTB2000	Keysight MSO/DSOX2000A	Tektronix MSO/DPO2000B
				
Bandwidth	100/200/350 MHz	70/100/200/300 MHz	70/100/200 MHz	70/100/200 MHz
Vertical Resolution	12-bit	10-bit	8-bit	8-bit
HiRes/ERES	ERES 3-bit， hardware based	HiRes 6-bit	-	-
Analog channel	4	2/4	2/4	2/4
Sampling rate	2 Gsa/s	2.5 Gsa/s	2 Gsa/s	1 GSa/s
Memory Depth	200 Mpts	20 Mpts	1 Mpts	1 Mpts
Wavefrom Capture Rate	100,000 wfm/s (normal mode), 400,000 wfm/s (sequence mode)	50,000 wfm/s (normal mode)	200,000 wfm/s	5,000 wfm/s
Vertical Scale	1 Mohm: 500 uV/div ~ 10 V/div 50 ohm: 500 uV/div ~ 1 V/div	1 mV/div to 5 V/div	1 MΩ: 1 mV/div ~ 5V/div	2 mV/div ~ 5 V/div
DC Gain Accuracy	0.5mV/div ~ 4.95mV/div: ±1.5%; 5mV/div ~ 10V/div: ±0.5%	≤ 5 mV/div: ±2 % of full scale; > 5 mV/div: ±1.5 % of full scale	± 3% full scale (≥ 10 mV/div); ± 4% full scale (< 10 mV/div) 2	10 mV/div ~ 5V/div: ±3% 2 mV/div ~ 5mV/div: ±4%
Timebase Scale	1 ns/div ~ 1000 s/div; 0.5 ns/div ~ 1000 s/div (500 MHz)	1 ns/div and 500 s/div	5 ns/div to 50 s/div 2 ns/div to 50 s/div	2 ns ~ 100s (200 MHz) 4 ns ~ 100s (70/100 MHz)
Time base Accuracy	±2ppm initial; ±0.5ppm 1st year aging; ±3ppm 20-year aging	±2.5 ppm	25 ppm ± 5ppm per yaer(aging)	±25 ppm, at any ≥1 ms interval
Trigger Zone	Support	No	No	No
FFT points	2 Mpts	128 kpts	64 kpts	-
AWG/FG	25 MHz	25 MHz	20 MHz	No
Bode plot	Support	Option	No	No
Logic analyzer	16 digital channels, 500 MSa/s	16 digital channels, 1.25 GSa/s	8 digital channels	16 digital channels (MSO), 1GS/s
Counter	7 digits	6 digits	5 digits	No
Digital multimeter	Support	Support	No	No
Screen	10.1'' touch screen, 1024*600	10.1'' touch screen, 1280*800	8.5'' WVGA color TFT LCD, 800*480	7'' WQVGA color screen, 480*234

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Thank You

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Headquarters

SIGLENT TECHNOLOGIES CO., LTD.
Add: Blog No.4 & No.5, Antongda Industrial Zone, 3rd Liuxian Road, Bao'an District, Shenzhen, 518101, China
Tel:+ 86 755 3688 7876
Fax:+ 86 755 3359 1582
sales@siglent.com
int.siglent.com

NA

SIGLENT Technologies NA, Inc.
Add: 6557 Cochran Rd Solon, Ohio 44139
Tel: 440-398-5800
Toll Free:877-515-5551
Fax: 440-399-1211
info@siglent.com
www.siglentna.com

Europe

SIGLENT TECHNOLOGIES GERMANY GmbH
Add: Staetzlinger Str. 70 86165 Augsburg, Germany
Tel: +49(0)-821-666 0 111 0
Fax: +49(0)-821-666 0 111 22
info-eu@siglent.com
www.siglenteu.com