TELEDYNE | LECROY

ERES & Native 12-Bit

From 8-bit ADCs to 15-bit precision: how ERES and native 12-bit hardware work together to maximise measurement resolution

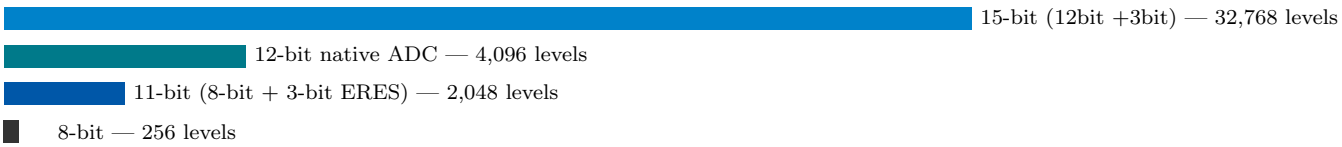
1. OSCILLOSCOPE VERTICAL ACCURACY — THE RESOLUTION CHALLENGE

Teledyne LeCroy's native 12-bit Oscilloscopes provide **16 times higher resolution** than legacy 8-bit architectures, allowing clearer capture of small-signal details. Advanced pre- and post-processing tools such as ERES (Enhanced Resolution) and averaging further enhance resolution at the cost of bandwidth and memory.

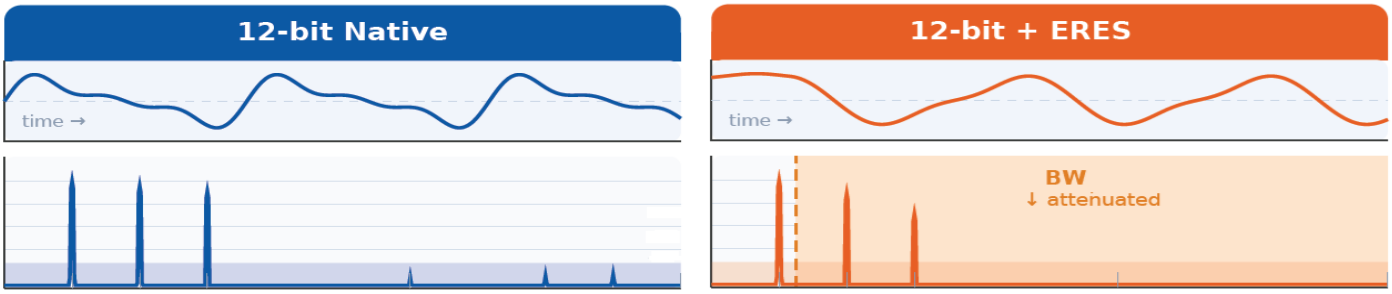
2. ERES LEVELS: HOW RESOLUTION IS GAINED

ERES Lvl	Bits Added	Total # of Bits (8-b)	Total # of Bits (12-b)	HDO6104-B Bandwidth
0 (off)	+0.0 b	8.0 bits	12.0 bits	1 GHz
0.5	+0.5 b	8.5 bits	12.5 bits	625 MHz
1	+1.0 b	9.0 bits	13.0 bits	301 MHz
1.5	+1.5 b	9.5 bits	13.5 bits	151 MHz
2	+2.0 b	10.0 bits	14.0 bits	72.5 MHz
2.5	+2.5 b	10.5 bits	14.5 bits	36 MHz
3	+3.0 b	11.0 bits	15.0 bits	20 MHz

3. AMPLITUDE LEVEL COMPARISON BY BIT DEPTH



4. ERES IN PRACTICE: SUM-OF-SINES SIGNAL — TIME DOMAIN & FFT



5. HOW ERES AND OTHER ACQUISITION FEATURES RAISE ENOB

ERES: Post-Acquisition Weighted Running Average

ERES applies a **weighted running average** (Gaussian-shaped) **ERES is reversible**: toggle on/off without re-acquiring.

Other Acquisition Features

Waveform averaging, hi-res mode, and digital filtering can raise effective resolution under specific conditions.

6. WHY ENOB IS A SUBJECTIVE AND SETTINGS-DEPENDENT METRIC

What is ENOB? Effective Number of Bits (ENOB) quantifies real dynamic performance of an acquisition system (noise + distortion). Derived from SINAD (Signal-to-Noise And Distortion ratio) per IEEE Std. 1057:

$$\text{ENOB} = \frac{\text{SINAD (dBc)} - 1.76}{6.02}$$

Key limitation: ENOB is measured with a *single sinewave* (typically 10 MHz). Real signals — square waves, clocks, power rails — span the full acquisition bandwidth. A high single-frequency ENOB does *not* guarantee broadband fidelity.

- **Summary** — ENOB is settings-, frequency-, and amplitude-dependent; degrades at higher frequencies. ERES/averaging improve ENOB at the cost of usable bandwidth. Never compare native full-BW ENOB against post-processed values.

✓ **Best Practice** — Compare with native hardware only, all processing disabled, and identical oscilloscope settings.

References

[1] TL, *Enhanced Resolution*, AN-006A, https://cdn.teledynelecroy.com/files/appnotes/an_006a.pdf

[2] TL, *ERES vs HiRes*, App. Brief 2011, https://www.teledynelecroy.com/doc/differences-between-eres-and-hires

[3] Pupalaikis (TL), *DesignCon 2017*, https://cdn.teledynelecroy.com/files/whitepapers/designcon-2017-understanding-vertical-resolution.pdf

[4] TL, *Digital Oscilloscopes — ERES*, https://www.teledynelecroy.com/doc/digital-oscilloscopes-enhanced-resolution

[5] IEEE Std. 1057-2007, *Standard for Digitizing Waveform Recorders*.