

# Advantages of 12-bit vs 8-bit Oscilloscopes

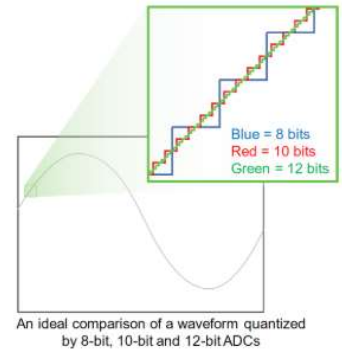
There is an increasing trend toward higher resolution in the world of oscilloscopes. Teledyne LeCroy set the trend quite a few years ago, but now Siglent, Rigol, and others are producing high resolution or HD instruments. 12-bit oscilloscopes offer significantly better resolution and accuracy compared to 8-bit oscilloscopes, leading to more precise waveform representation and improved signal analysis capabilities. This enhanced resolution allows for the capture of finer details and subtle variations in signals, making it easier to diagnose faults and analyze complex waveforms. While more expensive, 12-bit devices have recently become much more affordable.



Here's a more detailed breakdown:

## 1. Higher Resolution:

- **Resolution:** 12-bit oscilloscopes have a resolution of 4096:1 ( $2^{12}$ ), while 8-bit oscilloscopes have a resolution of 256:1 ( $2^8$ ). This means a 12-bit scope can distinguish up to 16 times more voltage levels than an 8-bit scope.
- **Improved Accuracy:** This higher resolution translates to more accurate measurements, particularly for signals with subtle variations, high dynamic range, or on a voltage offset.
- **Example:** In a square wave, the 12-bit scope can reveal finer details and imperfections in the waveform (e.g. overshoot), which an 8-bit scope might miss [according to ElektronikFOKUS](#).



## 2. Better Signal Representation:

- **Detailed Waveform Capture:** 12-bit oscilloscopes excel at capturing fine details and slight variations in signals, making them ideal for applications where precise signal analysis is crucial.
- **Noise Reduction:** The higher resolution can also contribute to better noise reduction, allowing for clearer and more accurate signal display. 12-bit scopes need a low input noise design in order to make these fine measurements.
- **Example:** When analyzing jitter (unwanted signal variations), a 12-bit scope can capture and analyze these nuances more effectively.

## 3. Enhanced Dynamic Range:

- **Higher Dynamic Range:** 12-bit scopes can handle a wider range of signal amplitudes, making them suitable for applications with high dynamic range requirements, such as radar, sonar, and medical imaging.
- **Improved Measurement of Small Signals:** With 12-bit resolution, small signals within larger waveforms can be more easily measured, even if the larger signal obscures the smaller one.
- **Example:** Analyzing signals with both large and small voltage variations (e.g., in power integrity measurements) is easier with a 12-bit scope.

## 4. Improved DC Accuracy:

- **More Accurate DC Measurements:** 12-bit scopes generally offer better DC accuracy (around 0.5%) compared to 8-bit scopes (around 1.5% to 2%), [says Electronic Design](#).
- **Example:** In applications where precise DC voltage levels are critical, 12-bit scopes provide a more accurate representation.

## 5. Applications:

- 12-bit oscilloscopes are beneficial in various applications, including:
  - **Radar, Sonar, and LiDAR:** For accurate signal analysis and ranging.
  - **Medical Imaging (NMR, MRI):** For capturing subtle signal variations.
  - **Non-Destructive Testing (NDT):** For detecting defects in materials.
  - **Power Integrity Measurements:** For analyzing voltage fluctuations and noise.
  - **Serial Data Analysis:** For capturing and decoding serial communication protocols like I2C, SPI, and CAN.
  - **Troubleshooting:** For debugging complex electronic circuits.

