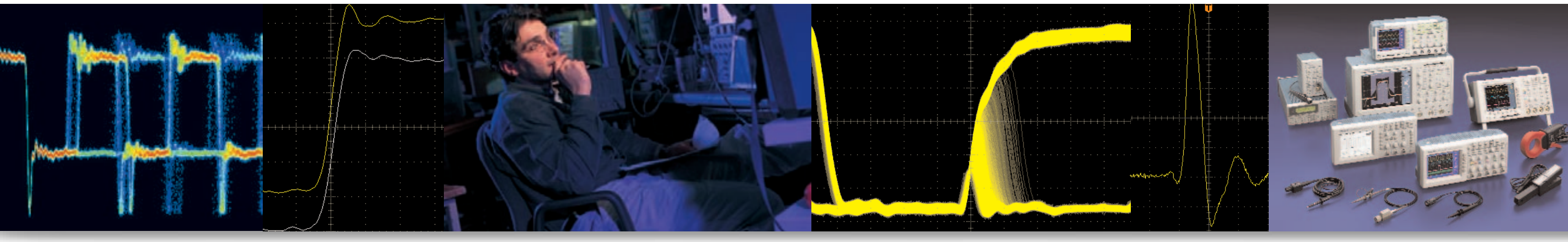
# If I Could... Imagine Perfect Vision



With the right oscilloscope you can create better designs, faster. You can characterize circuit performance with greater precision and confidence. You can verify system compliance more easily. And, you can streamline troubleshooting by finding the most elusive events quickly. The right oscilloscope can give you perfect vision.

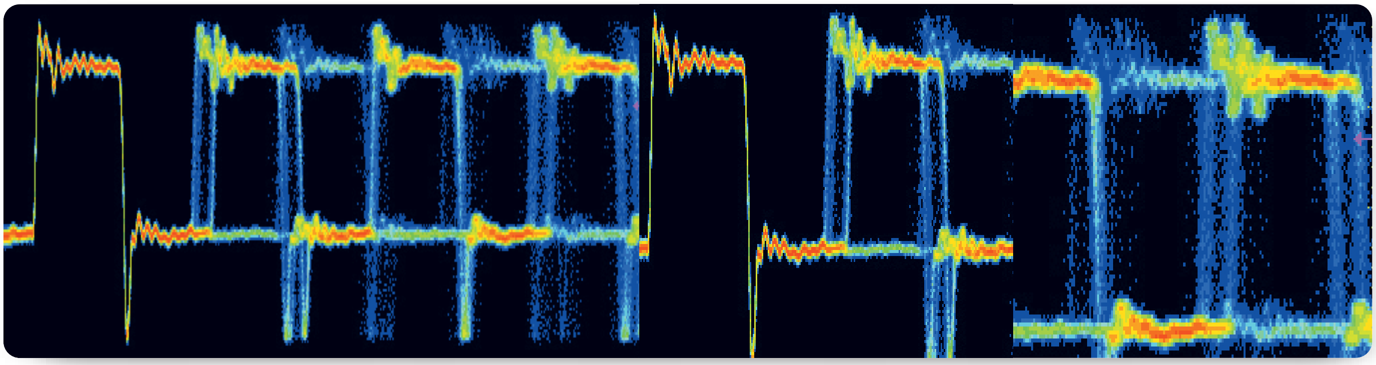
**Just imagine what perfect vision could mean to you.**

The key to any good oscilloscope system is its ability to accurately capture and display your signal – known as measurement fidelity. As an engineer or designer, you face faster clock rates and edge speeds, increasingly complex signals and mounting time-to-market pressures. Now more than ever, an oscilloscope's measurement fidelity is a critical factor to your success.

Tektronix
Enabling Innovation

# If I Could...

## Be Sure I Have Enough...



**Higher Speeds Demand Greater Bandwidth**

Bandwidth is the most important single criterion in choosing an oscilloscope. It determines an oscilloscope's fundamental ability to measure a signal. Without adequate bandwidth, your oscilloscope will not be able to resolve high-frequency changes. Amplitudes and edges will be distorted. Glitches will vanish. Details will be lost. Without adequate bandwidth, your measurement results will be inaccurate.

Oscilloscope bandwidth is specified as the frequency at which a sinusoidal input signal is attenuated to 70.7% of the signal's true amplitude, known as the -3dB point. To determine the oscilloscope bandwidth required to accurately characterize signal amplitude in your specific application, apply the 5 Times Rule:

**Oscilloscope Bandwidth Required = Highest Frequency Component of Measured Signal x 5**

(Another way to estimate the bandwidth of your signal is to simply divide the constant k by the 10% to 90% rise time of your fastest signal component, where k is a value between 0.35 and 0.45, depending on the shape of your oscilloscope's frequency response curve and pulse rise time response.)

An oscilloscope selected using the 5 Times Rule will give you greater than +/-2% accuracy in your amplitude measurements – typically sufficient for today's applications. However, as signal speeds increase, it may not be possible to achieve this rule of thumb. Always keep in mind that the higher the instrument bandwidth, the more accurate the reproduction of your signal… and the longer the useful life of the oscilloscope.

Tektronix offers a wide range of bandwidth selections to best suit the needs of your most demanding projects, so that you can complete your tasks on time and with confidence.

### In Digital Systems, Rise Time is Paramount

In the digital world, rise time measurements are critical. Your oscilloscope must have sufficient rise time to accurately capture the details of rapid transitions. To calculate the oscilloscope rise time requirement for your signals, use the following equation:

**Oscilloscope Rise Time Required = Fastest Rise Time of Measured Signal / 5**

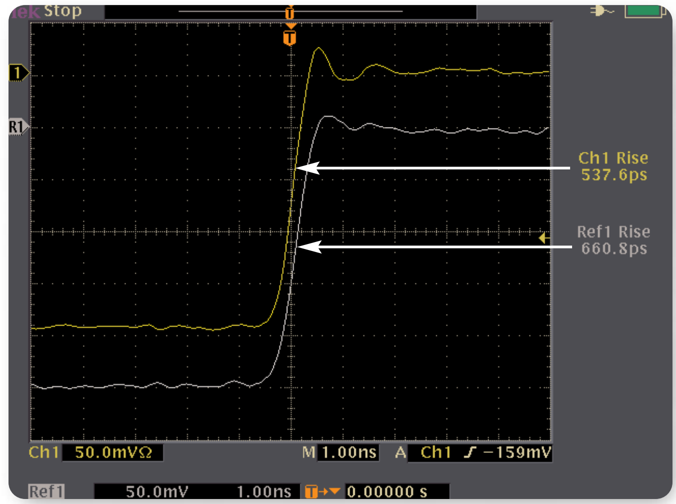
Rise time affects both amplitude and time measurement accuracy. In many digital applications, the edge rate (rise time) of the measured signal may mandate a faster oscilloscope than the signal's repetition rate might imply, because even slow signals can have fast edges. Achieving the rule of thumb above may not always be possible, but remember that an oscilloscope with a faster rise time will more accurately capture the critical details of fast transitions.

An oscilloscope's rise time is closely related to its bandwidth. An oscilloscope with higher bandwidth provides far more insight into signal behavior simply because the oscilloscope's rise time becomes part of the measurement, as described by this formula:

**Measured Rise Time =**

$$\sqrt{(\text{Oscilloscope Rise Time})^2 + (\text{Signal Rise Time})^2}$$

A digital signal that appears to be normal when viewed at a lower bandwidth may have an aberration in its leading edge, causing it to create a timing error. Or a narrow transient might escape notice, causing erratic operation on subsequent device inputs. As the formula implies, a 600 MHz oscilloscope can more accurately capture details that are obscured on a 500 MHz instrument.




The higher the bandwidth, the more accurate the reproduction of your signal, as illustrated with a 20 ps rising edge measured on 500 MHz and 600 MHz instruments.

The benefits of greater bandwidth are not limited to viewing and measuring signal edges. Amplitude, signal symmetry and many other aberrations can be observed more readily – and overlooked less often – when using an oscilloscope with higher bandwidth and rise time.

Tektronix offers oscilloscopes with rise times to match applications that range the full gamut of logic families.

# If I Could...

## Capture Those Elusive Glitches and Intermittent Events – The First Time...

### Keep Your Eyes Open

Discovery of rare glitches, setup and hold violations, and bus contention faults can be the most difficult problems you face. Intermittent or infrequent occurrences are difficult to capture with a DSO because the oscilloscope can be blind to your signal's behavior most of the time. You can spend minutes, hours, or days in search of these intermittent conditions that can cause your design to behave unreliably or fail unexpectedly.

Imagine a world where your oscilloscope lets you see a signal anomaly, pinpoint the nature of the fault, and trigger on the event to isolate it—all in a matter of minutes. Imagine having total confidence and trust that you're accurately capturing the details of an entire signal, and viewing a true representation of what it really looks like.

That world exists. It's called the Digital Phosphor Oscilloscope (DPO).

All digital oscilloscopes blink. That is, they open their eyes a given number of times per second to capture the waveform, and close their eyes in between. This is the waveform capture rate, expressed as waveforms per second (wfms/s). Oscilloscopes with high continuous waveform capture rates provide significantly more insight into signal behavior, and dramatically increase the probability that the oscilloscope will quickly capture transient anomalies such as jitter, runt pulses, glitches and transition errors.

**Speed Design and Troubleshooting with Confidence**

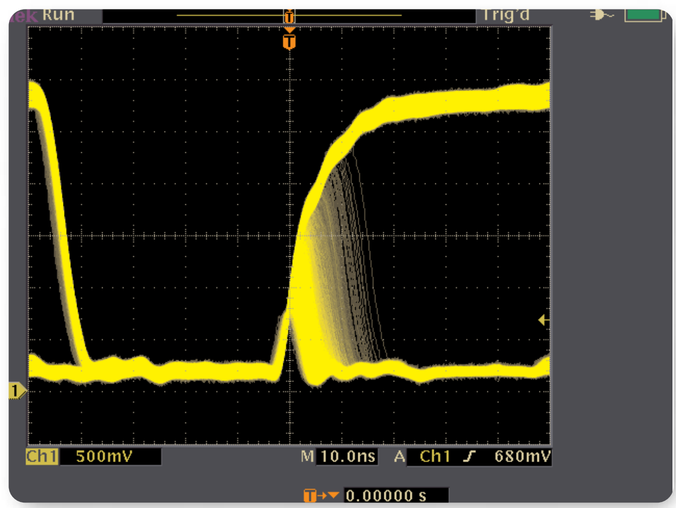
A DPO shows you a world others don't with the speed, precision, and insight needed to quickly verify, characterize, and debug even the most sophisticated designs.

The power of a digital phosphor oscilloscope (DPO) lies in its parallel-processing architecture. The DPO uses this unique architecture to dramatically shrink signal-processing time and proportionally increase the time spent capturing valuable signal information. The result – fast continuous waveform capture rates that significantly increase the probability of capturing intermittent and elusive events and provide you with more data for in-depth analysis. Some oscilloscope vendors claim high waveform capture rates for short bursts of time, but only a DPO can deliver these fast waveform capture rates on a continuous basis – saving minutes, hours, or even days by quickly revealing the nature of faults so powerful triggering modes can be applied to isolate them.

A DPO also offers unmatched insight into critical signal behavior by acquiring, storing, and displaying complex signals in real-time using three dimensions of signal information – amplitude, time, and distribution of amplitude over time. The subsequent real-time intensity-graded display makes it easy to pinpoint infrequent signals and anomalies, and allows you to characterize dynamic, complex signals and subtle behavior patterns much more quickly.

Digital Storage. A conventional DSO's slower waveform capture rate may mean that you miss critical signal information and elusive events.

Digital Phosphor. A DPO's fast waveform capture rate delivers unmatched signal insight and maximizes the probability of capturing rare or random glitches.




The TDS3000B DPO provides unmatched insight into complex signal behavior, such as metastable events.

In addition, the DPO's real-time intensity grading highlights the details about the "history" of a signal's activity, making it easier to understand the characteristics of the waveforms you've captured. It intensifies the areas where the signal crosses the display more frequently, much like an analog oscilloscope. An infrequent transient is dimmer than the main waveform that repeats continuously, yet it's still very visible and distinguishable.

# If I Could...

## Be Sure I'm Seeing All The Details of My Signal...

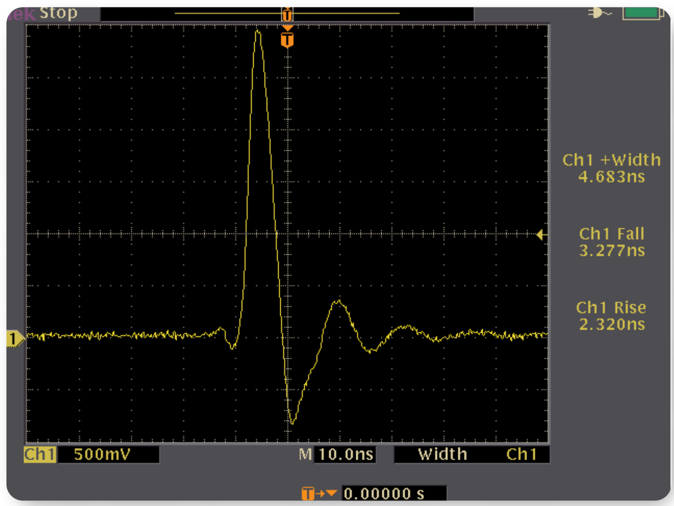

### Sample Rate Equals Resolution

Real-world events are dynamic and occur in real time. Shouldn't your oscilloscope be equipped with the technology to accurately capture dynamic signals in real time as well?

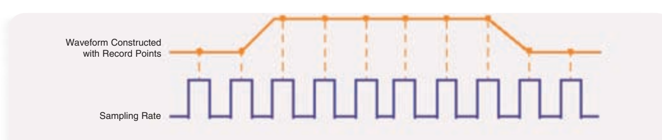
As an engineer or technician, you need the confidence and trust that you're accurately capturing the details of your signal. Sample rate – specified in samples per second (S/s) – refers to how frequently a digital oscilloscope takes a snapshot or sample of the signal, analogous to the pixel resolution on a digital camera. If an oscilloscope's sample rate isn't fast enough, transient signal details are lost, resulting in errors.

How do you calculate your sample rate requirements? The method differs based on the type of waveform you are measuring, and the method of signal reconstruction used by the oscilloscope.

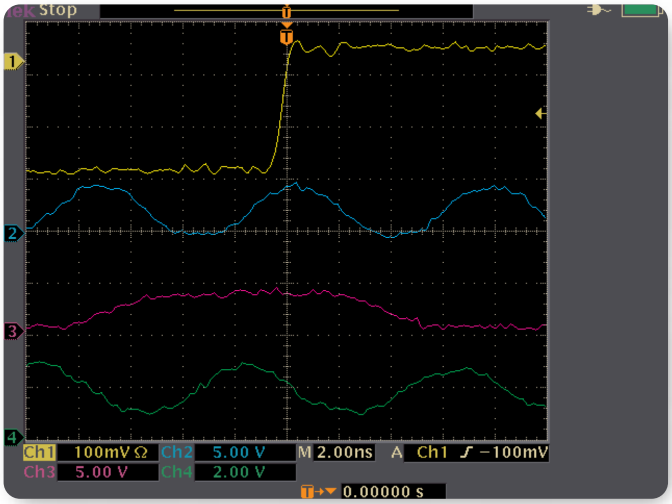
**For accurate reconstruction using sin(x)/x interpolation, your oscilloscope should have a sample rate at least 2.5 times the highest frequency component of your signal. Using linear interpolation, sample rate should be at least 10 times the highest frequency signal component.**



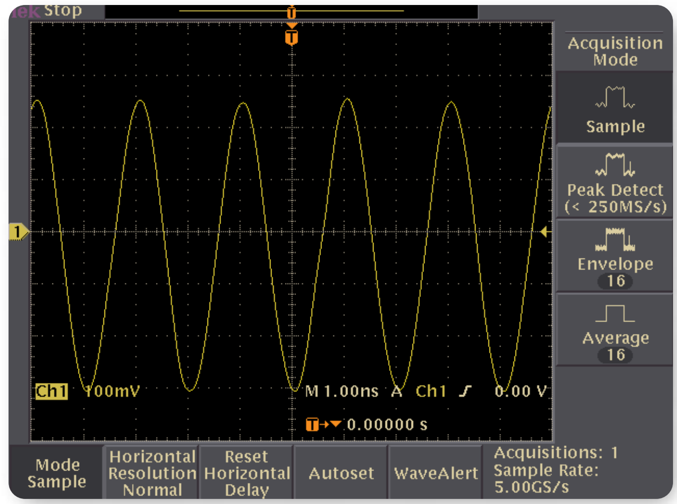

A higher sample rate provides greater signal resolution, ensuring that you'll see narrow and intermittent events.




The Solution...Digital Real-time (DRT) Sampling Technology




Accurately acquire and display multiple, high-speed signals with DRT sampling technology and sin(x)/x interpolation.

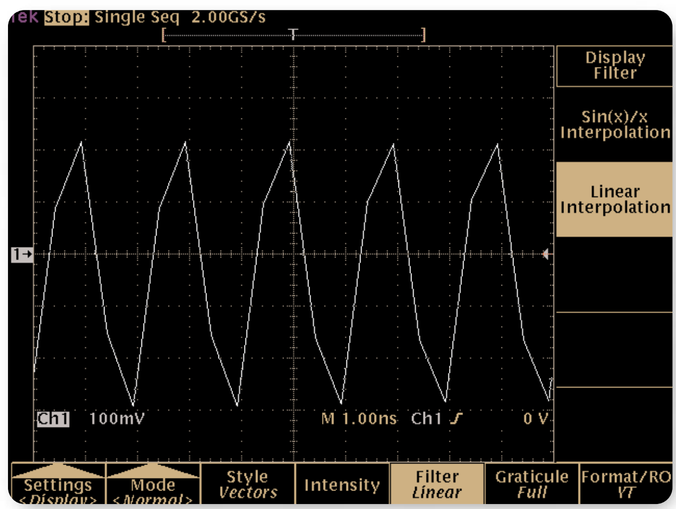



The TDS3000B Series' 5 GS/s real-time sample rate and sin(x)/x interpolation ensure accurate reconstruction of a 500 MHz sine wave.

### Debug and Characterize Signals Faster

Tektronix digital oscilloscopes, like the TDS3000B Series, employ unique digital real-time (DRT) sampling technology to capture enough samples of the signal in a single acquisition cycle on all channels simultaneously to faithfully reconstruct a waveform. Unlike equivalent-time sampling, which depends on repetitive signals, and channel interleaving, which compromises full, simultaneous sample rate across all channels, DRT sampling technology allows you to characterize a wide range of signal types on all channels simultaneously and makes it possible to capture single-shot or infrequent events that elude other oscilloscopes in its class.

These oscilloscopes combine DRT sampling technology with sin(x)/x interpolation to ensure accurate reconstruction of each waveform. In order to reconstruct your signal from the acquired samples, an oscilloscope interpolates between data points. Unlike linear interpolation, which can lead to inaccurate reconstruction, sin(x)/x interpolation ensures precise signal reconstruction.




Even with 2 GS/s sample rate, which exceeds the Nyquist requirement of 2X oversampling, linear interpolation does not provide accurate reconstruction of the same 500 MHz sine wave.

Together, DRT sampling technology and sin(x)/x interpolation deliver a complete view of your signal to speed debug and characterization.

# If I Could...

## Imagine Perfect Vision...

### Conclusion

New technologies, more complex signaling and faster speeds are making it more difficult for you to get your designs completed. These problems can affect time-to-market, product reliability, compliance and more. These increasingly complex challenges demand test and measurement equipment that delivers superior measurement fidelity and allows you to speed the design cycle, so that you can deliver your products to customers on time – if not before.

The right oscilloscope will enable you to quickly overcome these obstacles, so that you can create better designs in less time, characterize circuit performance with greater precision and confidence, verify system compliance more easily, and streamline troubleshooting by finding the most elusive events quickly.

The right oscilloscope can give you perfect vision. Just imagine what perfect vision could mean to you.


Contact Tektronix:

**ASEAN / Australasia / Pakistan** (65) 6356 3900
**Austria** +43 2236 8092 262
**Belgium** +32 (2) 715 89 70
**Brazil & South America** 55 (11) 3741-8360
**Canada** 1 (800) 661-5625
**Central Europe & Greece** +43 2236 8092 301
**Denmark** +45 44 850 700
**Finland** +358 (9) 4783 400
**France & North Africa** +33 (0) 1 69 86 80 34
**Germany** +49 (221) 94 77 400
**Hong Kong** (852) 2585-6688
**India** (91) 80-22275577
**Italy** +39 (02) 25086 1
**Japan** 81 (3) 6714-3010
**Mexico, Central America & Caribbean** 52 (55) 56666-333
**The Netherlands** +31 (0) 23 569 5555
**Norway** +47 22 07 07 00
**People's Republic of China** 86 (10) 6235 1230
**Poland** +48 (0) 22 521 53 40
**Republic of Korea** 82 (2) 528-5299
**Russia, CIS & The Baltics** +358 (9) 4783 400
**South Africa** +27 11 254 8360
**Spain** +34 (91) 372 6055
**Sweden** +46 8 477 6503/4
**Taiwan** 886 (2) 2722-9622
**United Kingdom & Eire** +44 (0) 1344 392400
**USA** 1 (800) 426-2200
**USA** (Export Sales) 1 (503) 627-1916
For other areas contact Tektronix, Inc. at: 1 (503) 627-7111
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