SELECTING YOUR NEXT OSCILLOSCOPE

Why fast update rate matters

White paper | Version 01.00

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ROHDE & SCHWARZ PRODUCTS

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1 OVERVIEW

Since oscilloscope update rate characteristics are often presented differently by each manufacturer, interpreting them can be confusing or misleading. Oscilloscope manufacturers typically provide an update rate value that describes an oscilloscope model at its fastest acquisition rate. Because update rate values are heavily impacted by numerous oscilloscope settings, it is often difficult to compare one vendor's update rate value with a different vendor's value.

This document provides:

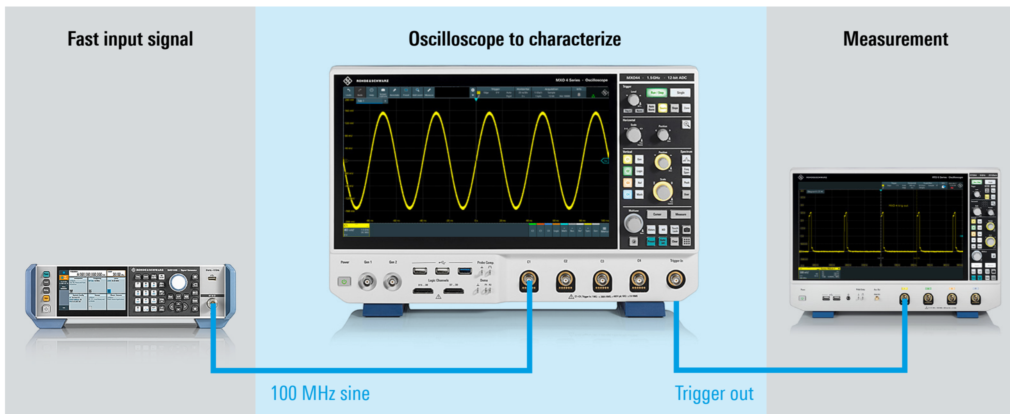
- An explanation of update rate
- How users can quickly perform their own update rate characterization
- How to compare vendor update rates
- Benefits of fast update rate

2 UNDERSTANDING UPDATE RATE

The update rate is a measure of oscilloscope acquisitions per second. Other equivalent terms include acquisitions per second, waveforms per second and capture rate. The update rate relates to processing speed when the oscilloscope is in run (repetitive) mode and is not relevant for static single-shot acquisitions.

Fig. 1: Setup for update rate characterization

The setup includes a signal that generates a fast rate of trigger events, the oscilloscope to be characterized, and a second oscilloscope for update rate measurement. A counter can also be used for average update rate measurement, but using a second oscilloscope provides additional detailed insights.



Making a simple update rate measurement provides a foundation for additional discussion:

- ▶ Supply a fast signal to the oscilloscope whose update rate will be measured. The speed of the input signals should be much faster than the oscilloscope’s update rate. The fastest oscilloscopes in the world have an update rate of less than 5 million acquisitions per second. A 100 MHz sine wave, which creates 100 million trigger events per second, is thus sufficiently fast to characterize any oscilloscope.
- ▶ On the oscilloscope to be characterized, set the trigger type to edge and trigger mode to norm. This ensures that the oscilloscope will specifically trigger on a defined trigger event. Set the oscilloscope's trigger out to generate a pulse each time the oscilloscope captures a trigger event.
- ▶ Use a second oscilloscope to capture the trigger out pulses. Each time the primary oscilloscope captures a trigger event, it will send a pulse out. The pulses correspond to successive trigger events captured by the primary oscilloscope. Using a second oscilloscope instead of another channel on the primary oscilloscope ensures that the primary oscilloscope's update rate is not impacted by turning on a second channel. A counter provides a better statistical overview when measuring the oscilloscope’s update rate, but misses insights that using an oscilloscope gives, such as the number of acquisitions per display refresh as well as the duration and frequency of display refreshes.

This document will use an R&S®MXO 4 Series oscilloscope for update rate characterization. A second oscilloscope, the R&S®RTO6, measures the R&S®MXO 4 update rate. The R&S®MXO 5 Series achieves the same update rate as the R&S®MXO 4 Series on a single channel and has a faster update rate with multiple channels enabled.

Our 100 MHz source presents a trigger event to the primary oscilloscope every 10 ns as shown on the left side of Fig. 2. Each time the oscilloscope triggers, it emits a trigger out pulse. By measuring the rate of trigger out pulses, we can determine the oscilloscope's update rate. In this R&S®MXO 4 Series example, the oscilloscope's trigger out pulses show that it captures a trigger once every 220 ns. The update rate is $(1/(220\ \text{ns}))$ or 4.5 million acquisitions/s. We could also easily measure this with a counter.

Fig. 2: Measuring the time between successive oscilloscope acquisitions

The trigger events are presented to an R&S®MXO 4 Series oscilloscope every 10 ns. The trigger out signal shows a distance of 220 ns between oscilloscope triggers. The R&S®MXO 4 Series oscilloscope has a timebase setting of 20 ns/div. Capture is ten horizontal divisions for a total of 200 ns. This means the oscilloscope is missing one trigger event at the end of each acquisition.

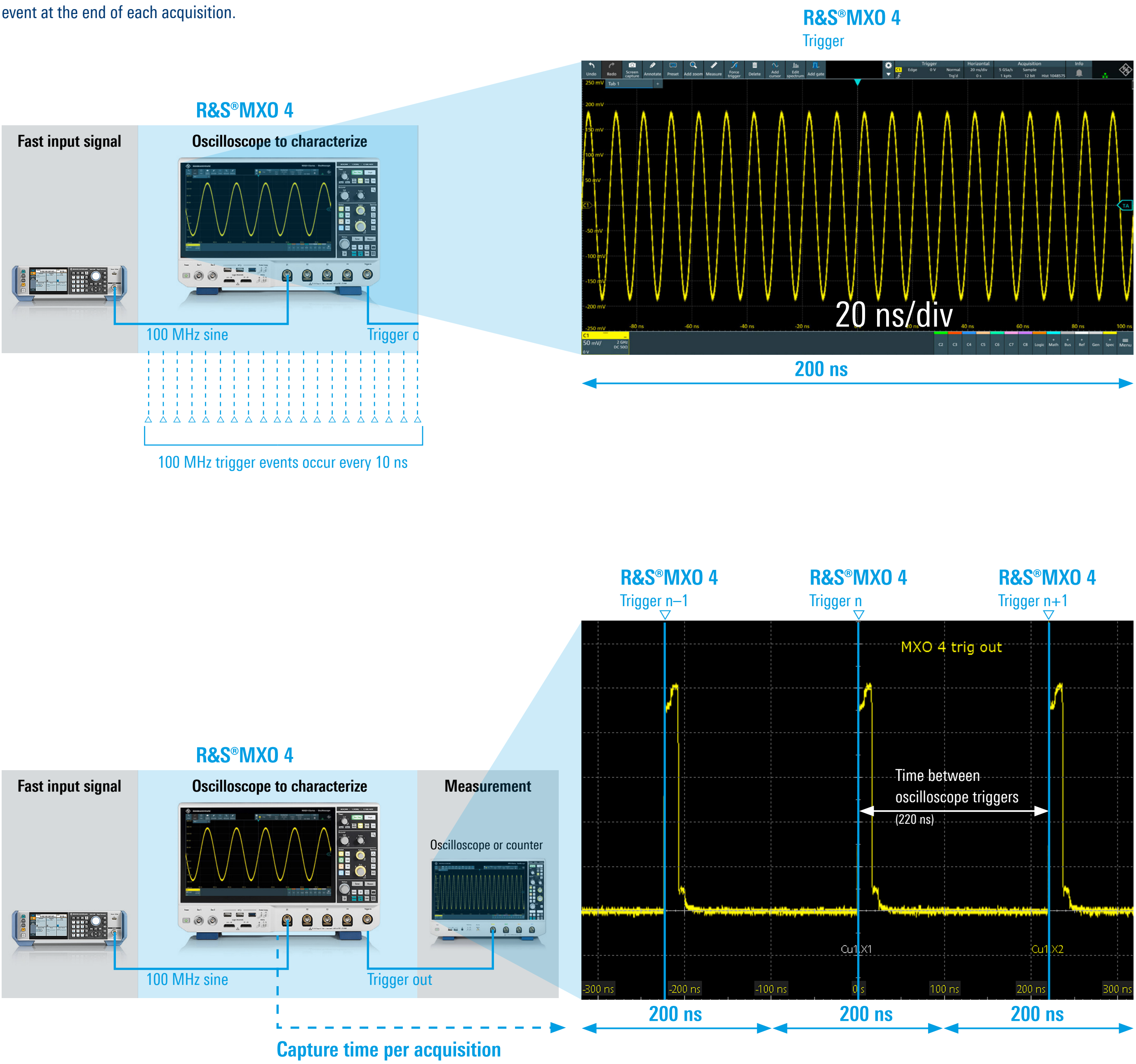
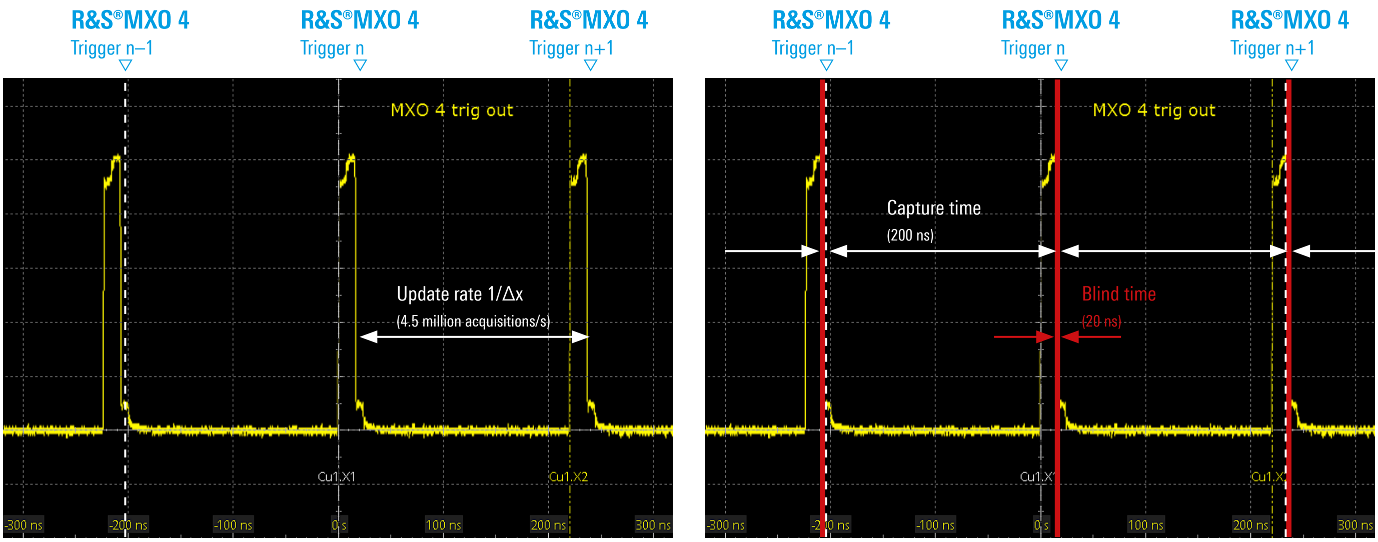


Fig. 3: Calculating the update rate and blind time from trigger out pulses

The reciprocal of the time between oscilloscope trigger out pulses equals the update rate. For the R&S®MXO 4 and R&S®MXO 5 Series oscilloscopes, this is 4.5 million acquisitions/s. Remember that the time between trigger out pulses was 220 ns. The oscilloscope is capturing 200 ns out of each 220 ns in real time, meaning that 90 % of real-time signal activity is captured and displayed by the oscilloscope. This is an exceptionally high percentage for an oscilloscope.



This example represents an ideal update rate measurement where the trigger out pulses are equally spaced. In reality, trigger out pulses will not always occur at regular intervals, as described later in this paper.

2.1 Blind time and capture percentage

Blind time is the amount of real-time signal activity that the oscilloscope does not capture. It is sometimes also called dead time. In Fig. 1, the oscilloscope for which the update rate is being characterized has a timebase setting of 20 ns/div. Thus, it captures 200 ns in each acquisition. The trigger out pulses are spaced 220 ns apart. This means the oscilloscope takes 20 ns after each acquisition to rearm the trigger and to begin looking for the next trigger event. In this example, the blind time is 20 ns per every 200 ns captured or 10 %.

What is a typical blind time for traditional digital oscilloscopes? While users expect to instantly see all signal details when connecting an oscilloscope to a device under test, in reality, for both analog and digital oscilloscopes, some amount of time is missed and not captured. The amount of blind time depends on the oscilloscope's settings as well as its internal architecture. For both the R&S®MXO 4 and R&S®MXO 5 Series, the best-case settings yield an industry-best blind time of just 10 % at 20 ns/div and 1 % at 1 µs/div. The majority of oscilloscopes in normal mode with typical settings have update rates in the tens to thousands of updates/s, meaning they capture less than 1 % of real-time signal activity.

Fig. 4: Comparison of update rate, blind time and percentage of real-time signal captured on three different oscilloscopes in the same oscilloscope class

Setting conditions: preset/default setup, timebase 20 ns/div and trigger: norm

This ensures that the maximum sample rate is used if not already set by default. Blind time ranges from 99.9% on the slowest instrument to 14% on the oscilloscope with the fastest update rate.

Value	Tektronix MSO 4 Series	Keysight 4000X Series	Rohde & Schwarz R&S®MXO 4 Series
Input signal: 100 MHz sine wave			
Update rate in waveforms/s	50	675000	4.5 million
Blind time	99.9%	87%	14%
Real-time signal capture	0.1%	14%	86%
Oscilloscope settings	preset/default setup		
Timebase	20 ns/div		
Trigger	norm/edge/C1		

Value	Tektronix MSO 5 Series	Keysight EXR/MXR Series	Rohde & Schwarz R&S®MXO 5 Series
Input signal: 100 MHz sine wave			
Update rate in waveforms/s	70	0.175 million	4.5 million
Blind time	99.9%	96.5%	14%
Real-time signal capture	0.1%	3.5%	86%
Oscilloscope settings	preset/default setup		
Timebase	20 ns/div		
Trigger	norm/edge/C1		

The update rate inherently slows as the timebase is increased due to time captured. For example, with a timebase setting of 20 ns, the fastest theoretical oscilloscope update rate is $1/(10\ div \times 20\ ns/div)$ or 5 million acquisitions/s. While the oscilloscope can capture ten times more time with a timebase setting of 200 ns/div, the fastest theoretical oscilloscope update rate is $1/(10\ div \times 200\ ns/div)$ or 500000 acquisitions/s. With a slower timebase, such as 100 µs/div, the theoretical update limit is $1/(10\ div \times 100\ \mu s/div)$ or 1000 acquisitions/s.

The percentage of real-time signal capture is a mathematical formula that includes the timebase setting and measured update rate:

$$Capture\ \% = (Capture\ time)/(Capture\ time + Blind\ time)$$

$$Capture\ \% = (Timebase \times 10)/(1/Update\ rate)$$

$$Capture\ \% = (Timebase \times 10 \times Update\ rate)$$

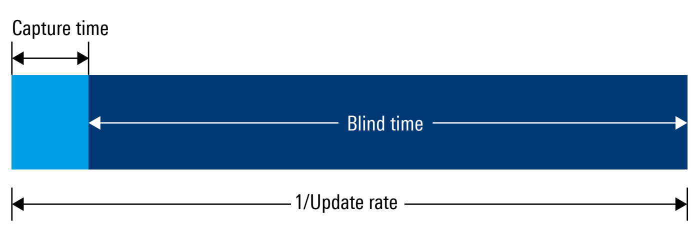
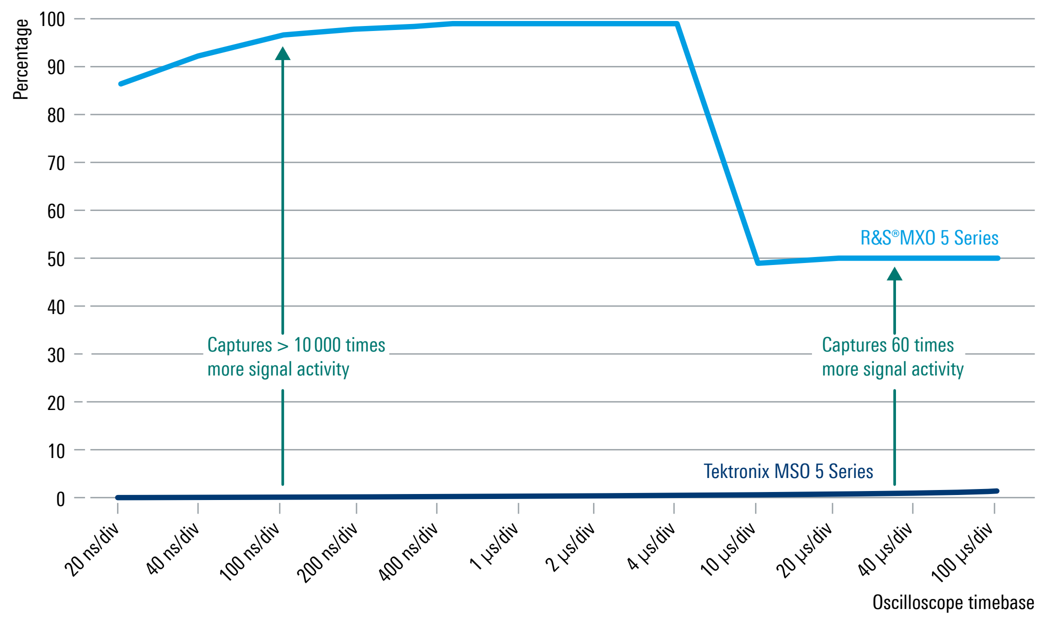


Fig. 5: Percentage of real-time signal activity plotted versus a number of horizontal timebase settings

The resulting plot shows how much of a real-time signal is captured as a percentage of total signal activity. The comparison over a variety of horizontal timebase settings shows how much real-time acquisition is captured at each horizontal setting. On both oscilloscopes, the default setup/preset was used followed by setting the trigger to norm.



Shown below is a swept sine wave from 50 MHz to 55 MHz. It is easy to see this on the instrument with a high percentage of real-time signal capture, but difficult to quickly understand what is happening on the oscilloscope with a slow update rate.

Fig. 6: Update rate impact on signal visualization

This image corresponds to the 20 ns/div input signal viewing a 50 MHz to 55 MHz swept sine wave. Oscilloscopes with higher real-time signal capture percentage instantly show superior signal details.

2.2 Trigger rearm time

Take a signal that produces a trigger event occurring much faster than the oscilloscope update rate, for example the 100 MHz sine wave previously mentioned. The minimum trigger rearm time equals $1/((\textit{Time between captured trigger events}) - (\textit{Primary oscilloscope acquisition time}))$. After each acquisition, the oscilloscope must process the captured information before rearming the trigger to look for the next trigger event. The amount of time during which the oscilloscope is blind to trigger conditions is called the minimum trigger rearm time. If a new trigger event occurs during this window before the oscilloscope's trigger is armed to look for the next trigger, the oscilloscope will miss the trigger event. Oscilloscope manufacturers may characterize and include the minimum rearm time in their specifications. This is a best-case characterization and is valid for just a single specific setup.

Fig. 7: Comparison of measured trigger rearm time captured on three different oscilloscopes in the same oscilloscope class

Based on measured results and using a 20 ns/div timebase setting on all oscilloscopes under comparison, the fastest trigger rearm times are in the range of tens of ns, while slower oscilloscope architectures have trigger rearm times measured in ms, more than 70 000 times slower.

Value	Tektronix MSO 4 Series	Keysight 4000X Series	Rohde & Schwarz R&S®MXO 4 Series
Measured trigger rearm time	15 ms	1.85 µs	21 ns
Oscilloscope settings	preset/default setup		
Timebase	20 ns/div		
Trigger	norm/edge		

Value	Tektronix MSO 5 Series	Keysight EXR/MXR Series	Rohde & Schwarz R&S®MXO 5 Series
Measured trigger rearm time	15 ms	5.6 µs	21 ns
Oscilloscope settings	preset/default setup		
Timebase	20 ns/div		
Trigger	norm/edge		

Many engineers consider minimum trigger rearm time to be more important than the update rate specification. Minimum trigger rearm has a specific value for specific settings and users can often visualize how close together trigger events may occur. Knowing the minimum trigger rearm time enables users to estimate if or what percentage of signal trigger events will be missed by the oscilloscope. Like the update rate, the trigger rearm time changes with the oscilloscope settings. For example, when decode is turned on, an oscilloscope with slow trigger rearm time may miss two closely spaced events if the trigger rearm time is greater than the time between the trigger events.

One of the factors in trigger rearm time is the trigger architecture. Oscilloscopes with digital triggers have shorter rearm times. Analog oscilloscope triggers have longer trigger rearm times due to the technical implementation.

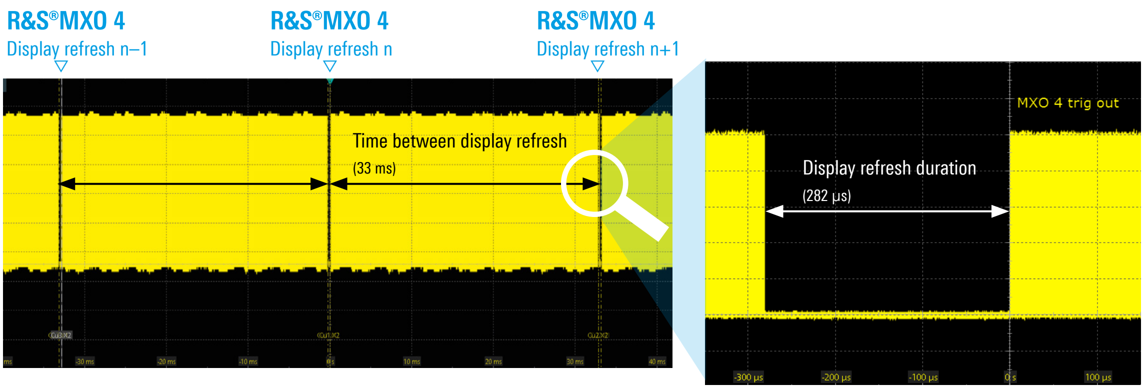
Oscilloscope update rate and display refresh rate

Returning to our characterization setup, moving to a slow timebase on the second oscilloscope enables a broader view of trigger output behavior. Between a potentially large number of acquisitions, there are gaps during which no trigger pulse occurs. This gap represents the time the instrument takes to update the display with the previous collection of acquisitions.

The R&S®MXO 4 and R&S®MXO 5 Series display updates every 33 ms or 30 times/s. When acquiring at 4.5 million acquisitions/s, every display update is built from 150 000 collected waveforms. An algorithm, typically implemented in an ASIC, combines all of the acquisitions and determines how brightly to illuminate each pixel to represent the collection of waveforms. If oscilloscope settings such as variable or infinite persistence are on, the algorithm incorporates this information as well. For elements such as decode, measurement values and other text-based results, the oscilloscope provides a single update per display refresh so that text is not overwritten.

Fig. 8: Oscilloscope display refresh cycles

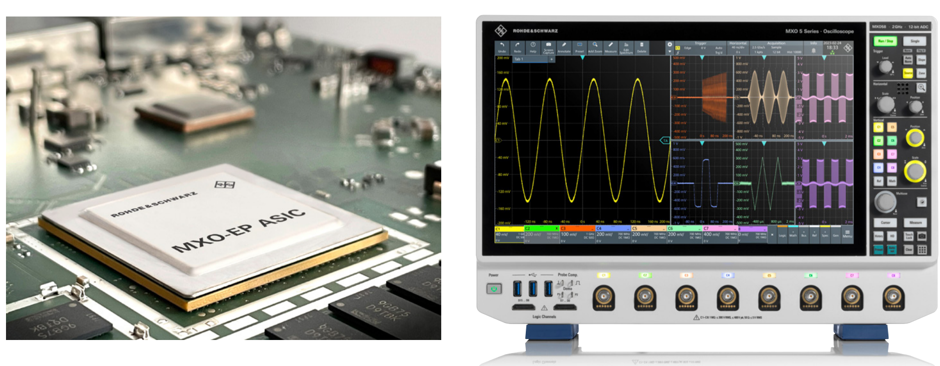
The yellow regions show a large number of sequential trigger out pulses. The gap between the yellow regions is the time the instrument takes to refresh the oscilloscope's display with all new acquisitions since the last display refresh. The width of this display refresh gap equals the amount of time the oscilloscope takes to update the display. During this time, the instrument does not look for trigger events. This display update gap time is also blind time, and each oscilloscope architecture has a varying gap time where no acquisitions can be taken. Instrument manufacturers typically do not include this blind time gap area when they provide a best-case update rate value. For the R&S®MXO 4 and R&S®MXO 5 Series, the measured gap width is 282 µs. During this time, the oscilloscope will be blind to new trigger events.



One approach to removing the gaps is to run the oscilloscope in segmented mode and have the display only update after all segments have been stored. Since the update rate between segments on some oscilloscopes has a faster value, some oscilloscope manufacturers will provide the rate between segments as their maximum update rate. This can make it difficult to credibly compare equivalent update rate values across vendors. Segmented mode has limitations relative to normal mode and the update rate is most relevant to normal mode when the oscilloscope runs repetitively.

Fig. 9: For the R&S®MXO 4 and R&S®MXO 5 Series oscilloscopes, the key technology block that accelerates the update rate is the MXO-EP (extreme performance) ASIC

The ASIC processes 12-bit samples and digital signals and includes the digital trigger processing unit circuitry. The 26 nm CMOS chip, with 36 million gates, has an aggregate throughput of 200 Gbit/s.



2.3 Trigger capture rate

The trigger capture rate equals *1/(Time captured + Trigger rearm time + Time until next trigger event)*. Any of the terms in the denominator can be dominant.

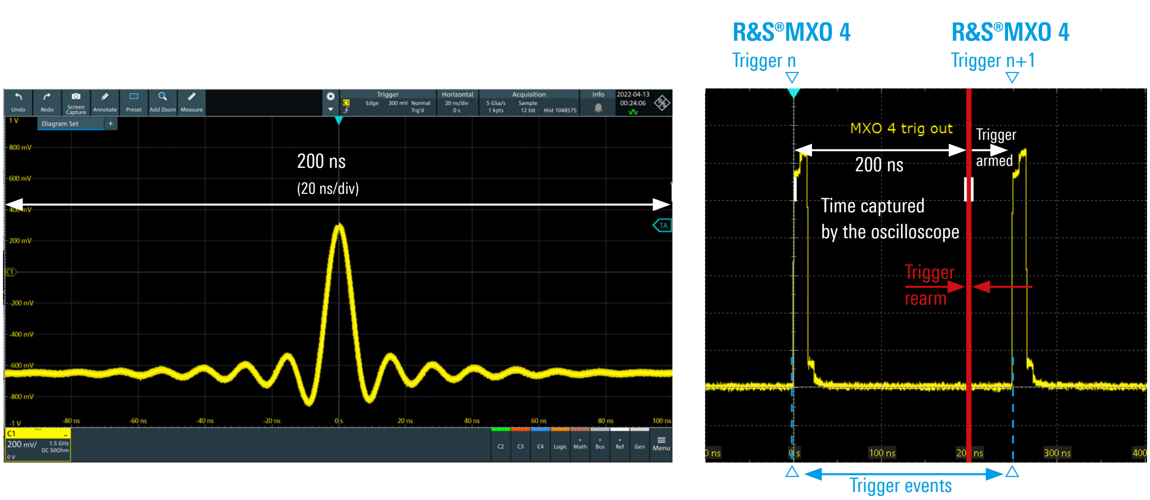
- If the oscilloscope timebase is set to a slow value, for example 100 ms/div, then the oscilloscope will capture 10 divisions of time and take 1 s for each acquisition. Thus, the fastest potential trigger capture rate is slightly slower than 1/s.
- For a fast timebase, for example 1 ns/div and a fast signal trigger event rate, for example of 10 million trigger events/s, the trigger rearm time will dominate.
- If trigger events occur at a much slower rate, for example, once every 5 s, than the time until the next trigger event will dominate.

The trigger rate describes the maximum rate of trigger events the oscilloscope can capture and process without missing a trigger event. Oscilloscopes with faster trigger rearm rates enable a higher percentage of trigger events to be captured, while oscilloscopes with slower trigger rearm rates will miss a higher percentage of trigger events. When a user sets the oscilloscope trigger condition, the instrument is guaranteed to find, trigger and capture the first occurrence of the trigger event. However, the oscilloscope may miss a number of successive trigger events while processing the first acquisition that contained the trigger event. During this time, it is blind to successive trigger events that occur before the trigger is armed and ready to find the next trigger event.

Let's look at an example that helps to characterize the trigger capture rate. A good choice for the input signal is one that has a short burst of activity followed by idle time between bursts. The sinc function, also known as cardinal sine or sin(x)/x, exhibits this type of behavior. Any signal with idle time between bursts makes it easier to determine the trigger capture rate along with how many trigger events are missed. The sinc input signal repeats every 250 ns or at a rate of 4 MHz.

Fig. 10: Impact of trigger event rate on update rate

For an input signal that repeats a trigger event every 250 ns (4 MHz trigger rate), the R&S®MXO 4 and R&S®MXO 5 Series oscilloscopes capture 200 ns each acquisition and are rearmed fast enough to capture 100 % of trigger events.



On the R&S®MXO 4 and R&S®MXO 5 Series oscilloscopes with a timebase setting of 20 ns/div, the instruments capture 200 ns each acquisition. We previously measured the minimum trigger rearm time to be 21 ns. For trigger events that are each spaced 250 ns apart with 200 ns per acquisition and a trigger rearm time of 21 ns, the R&S®MXO 4 captures 100 % of trigger events. Increasing the test signal frequency shows a 100 % trigger event capture rate up to 4.3 million acquisitions/s.

2.4 Probability of capturing infrequent anomalies

If a user can set up a trigger to capture an infrequent event, the oscilloscope captures at least the first instance of this event. What if a user is not sure of what trigger to set up, but suspects that something is happening infrequently? One of the benefits of a fast update rate is that rare events can be seen on the oscilloscope more frequently.

What is the probability that your oscilloscope will see a rare event? It depends on the oscilloscope settings, observation time and how often the rare event occurs. There is an equation that defines how likely the oscilloscope will allow a user to see a rare event.

The probability of the oscilloscope seeing a rare event = $100 \times (1 - [1 - E \times A]^{(U \times T)})$

T = Observation time (amount of time user waits while oscilloscope is connected to device under test)

E = Rare event occurrence rate

A = Oscilloscope acquisition time (10 × timebase setting)

U = Oscilloscope update rate

The more frequently the rare event occurs, the higher the probability the oscilloscope will see it. The more acquisitions your oscilloscope captures, the higher the probability one of these acquisitions will include the anomaly. How fast does your oscilloscope update? Oscilloscopes with faster update rates are more likely to find infrequent events than oscilloscopes with a slow update rate over the same observation time.

Fig. 11: Comparison of update rate, glitch values and observation time captured on three different oscilloscopes in the same oscilloscope class

The probability of an oscilloscope seeing an infrequent signal anomaly is related to the instrument's update rate, observation time and how often the rare event occurs. Oscilloscopes with faster update rates provide significantly higher probability of seeing infrequent events for a given user observation time. With default settings and a timebase of 20 ns/div, the three oscilloscopes below range in probability of glitch capture from 97 % down to less than 1 %.

Value	Tektronix MSO 4 Series	Keysight 4000X Series	Rohde & Schwarz R&S®MXO 4 Series
Update rate in waveforms/s	50	675 000	4.5 million
Glitch occurrence rate	2/s		
Observation time	3 s		
Glitch capture probability	0.006 %	56.000 %	99.4 %
Oscilloscope settings	preset/default setup		
Timebase	20 ns/div		
Trigger	norm/edge/C1		

Value	Tektronix MSO 5 Series	Keysight EXR/MXR Series	Rohde & Schwarz R&S®MXO 5 Series
Update rate in waveforms/s	70	172 000	4.5 million
Glitch occurrence rate	2/s		
Observation time	3 s		
Glitch capture probability	0.008 %	18.6 %	99.4 %
Oscilloscope settings	preset/default setup		
Timebase	20 ns/div		
Trigger	norm/edge/C1		

3 IMPACT OF OSCILLOSCOPE SETTINGS ON UPDATE RATE

An oscilloscope's update rate is not a single static value. The update rate is impacted by a large number of instrument settings. In fact, most oscilloscope settings have some degree of impact on the update rate. While some processing is hardware-accelerated, other processing tasks are implemented in software. The update rate impact of one specific setting varies significantly across vendors and oscilloscope families. To understand a manufacturer's update rate value, it must be evaluated in the context of the other oscilloscope settings remaining static.

A large number of oscilloscope settings impact the update rate. These include:

- How many times a source signal generates an event that matches the oscilloscope trigger parameters
  - The update rate will inherently be equal to or slower than the number of trigger events generated by the input signal.
- Oscilloscope timebase
  - The update rate will inherently be slower than the amount of time captured in each acquisition.
  - The R&S®MXO Series oscilloscopes obtain their fastest update rate at 20 ns/div.
- Memory depth
  - For all oscilloscopes, increasing the acquisition memory depth slows the update rate. Memory depth has a significant impact on the update rate as more memory means more processing needs.
- Other
  - The number of enabled channels can impact the update rate if multiple analog input sources share the same processing block.
  - Logic (MSO) channels impact the update rates on some oscilloscopes.
  - Cursors are on: The oscilloscope is typically making a minimum delta measurement, and this additional processing impacts the update rate.
  - Measurements decrease the update rate.
  - Math requires the oscilloscope to perform additional processing.
  - Serial bus decoding requires additional processing and hence slows the update rate.
  - Analysis tools such as FFT, eye diagrams, jitter analysis, bandwidth limiting (DSP or software), deembedding or other computationally intensive algorithms consume processing power and slow the update rate.
  - Acquisition mode (interpolation, high resolution and/or high definition mode)

4 COMPARING DIFFERENT OSCILLOSCOPES

Oscilloscope vendors will often share a single update rate value that is measured using settings chosen to maximize the update rate. For a valid comparison, the same settings must be used on both oscilloscopes. Turning on a simple math function on one oscilloscope may slow its update rate by a factor of 1000, while on another oscilloscope this will only impact the update rate performance by a factor of 2.

Some vendors may choose to communicate a maximum update rate achieved exclusively in a special mode, while the oscilloscope's update rate in normal mode is very slow. While special modes can show a fast update rate value at first glance, special modes always come with tradeoffs. For example, the special mode may only support 1 kpoints of memory, potentially creating significant aliasing. Or, the special mode may apply only to analog waveforms, but functions like math, FFT and serial decode have a significantly reduced update rate.

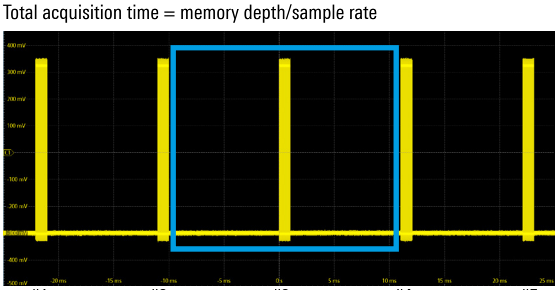
Users should also be wary of update rate values that apply to segmented/sequence memory, but not to normal repetitive mode. In segmented memory, oscilloscopes can be set to acquire a certain number of segments, and then paint them all simultaneously to the instrument display. Vendors who provide a maximum update rate or a minimum trigger rearm time only when operating in segmented mode often do so because their normal update rate is not competitive.

Fig. 12: Update rate is a throughput metric best applied when the oscilloscope is running repetitively

When oscilloscopes are in segmented mode (sequence mode), an update rate value applies only within a single segment, and the acquisition is done in a single shot.

Traditional single-shot acquisition

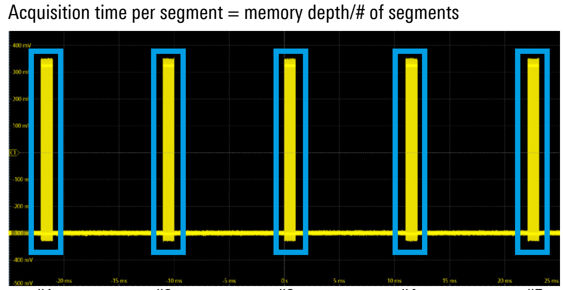
Total acquisition time = memory depth/sample rate



#1 #2 #3 #4 #5 Segment

Segmented memory acquisition

Acquisition time per segment = memory depth/# of segments



#1 #2 #3 #4 #5 Segment

5 BENEFITS OF FAST UPDATE RATE

Oscilloscopes with fast update rates have a number of advantages over oscilloscopes with slow update rates.

Accurate and superior signal visibility

Oscilloscopes with faster update rates show a higher percentage of real-time behavior in a given amount of observation time. Because oscilloscopes with fast update rates provide excellent signal visibility, the resulting waveform trace is often thicker. Oscilloscopes with slow update rates typically show thinner waveshapes, while turning on infinite persistence and waiting for an extended amount of time builds up a more accurate waveform.

Fig. 13: Signal visibility

The instrument on the right with a much faster update rate accurately shows a swept 50 MHz to 55 MHz sine wave. The slower oscilloscope on the left will never accurately represent the signal unless the user switches to infinite persistence and waits for some time for an equivalent display to be built up.

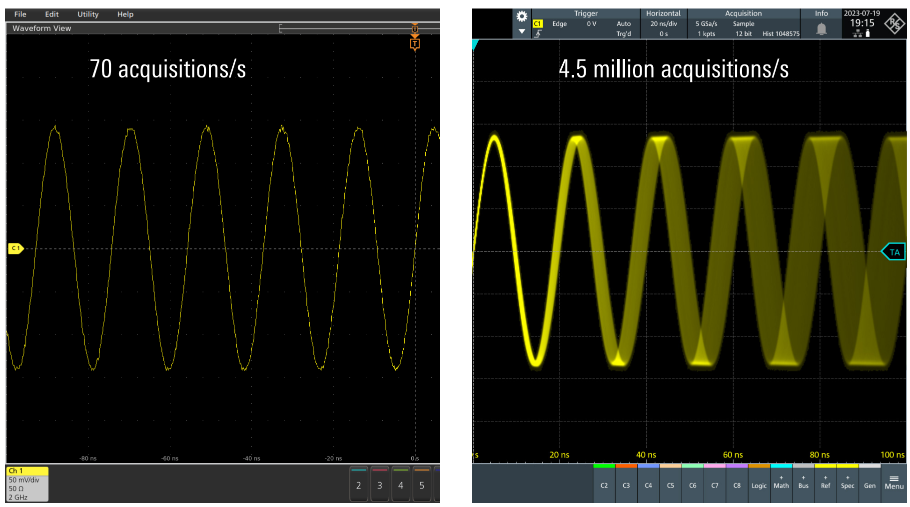


Fig. 14: Impact of fast update rate on an oscilloscope's ability to accurately show spectral content

The Tektronix MSO 5 Series on the left updates at 60 FFT/s with spectrum turned on 20 ns/div timebase, while the R&S®MXO 5 Series on the right updates at 45 000 FFT/s.

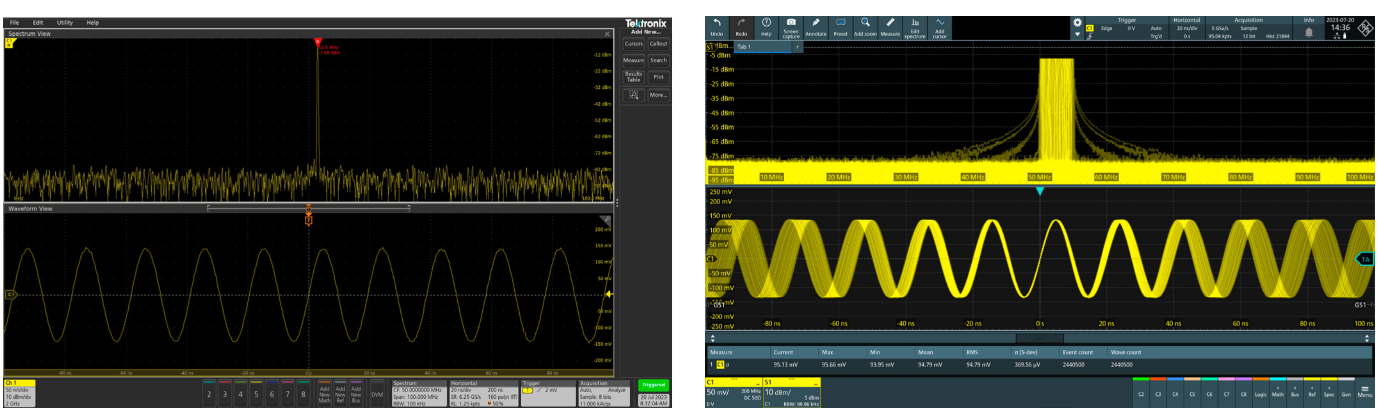
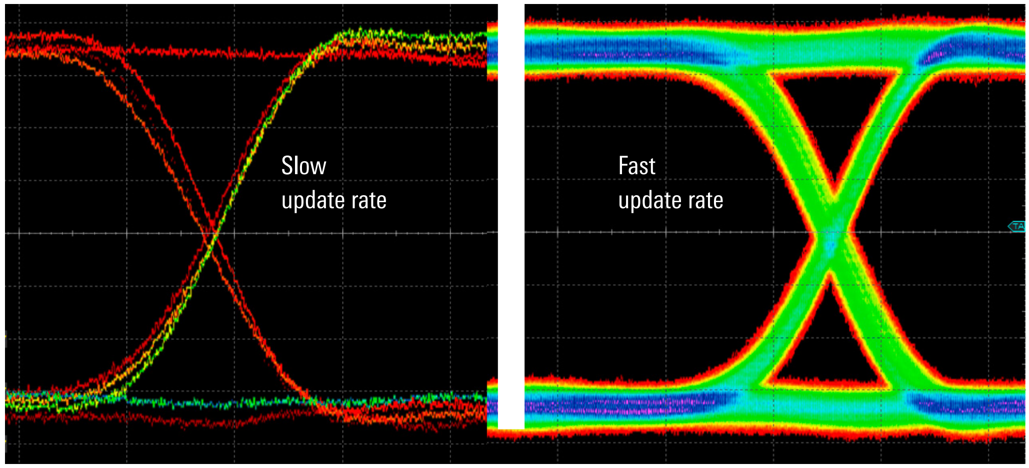


Fig. 15: Comparison of a modulated signal and an eye diagram on an oscilloscope with a slow update rate versus an oscilloscope with a fast update rate



Ability to trigger on closely separated trigger events

Oscilloscopes that have shorter minimum trigger rearm times will capture closely-spaced events that are missed on oscilloscopes with longer trigger rearm times. This becomes more differentiated with deep memory, protocol triggering, additional use of math and measurement functions or other functionalities that impact the trigger rearm time. Oscilloscopes with slow trigger rearm times may miss a large percentage of trigger events, decreasing the probability of capturing infrequent events and thus increasing the overall test time.

Speed of test

Oscilloscopes with a fast update rate enable faster testing. An oscilloscope with a fast update rate provides the insight you need in a fraction of the time required by oscilloscopes with a slower update rate. Analysis has a significant impact on the oscilloscope update rate. Oscilloscopes with hardware based analysis are less prone to slowing down when analysis is turned on. For example, in the R&S®RTO6 and R&S®RTP (B models) oscilloscopes, histogram analysis is performed in hardware and does not impact the update rate.

Improved usability/responsiveness

Oscilloscopes with fast update rates provide a much more pleasant user experience. The instrument is responsive to control setting changes, and users have increased confidence in oscilloscope operation. On oscilloscopes with slow update rates, changing settings feels sluggish, making users wonder if the change was accepted.

Faster statistical convergence

Oscilloscopes with faster update rates have faster measurement statistical convergence. Performing automatic measurements 1000 times on a power rail to check the worse-case violations takes 1 s on an oscilloscope that updates 1000 times/s with measurements on, but nearly 3½ min on a oscilloscope that updates only 5 times/s when measurements are on.

Fig. 16: Time required by two oscilloscopes in the same class to quantify 5000 V (RMS) measurements

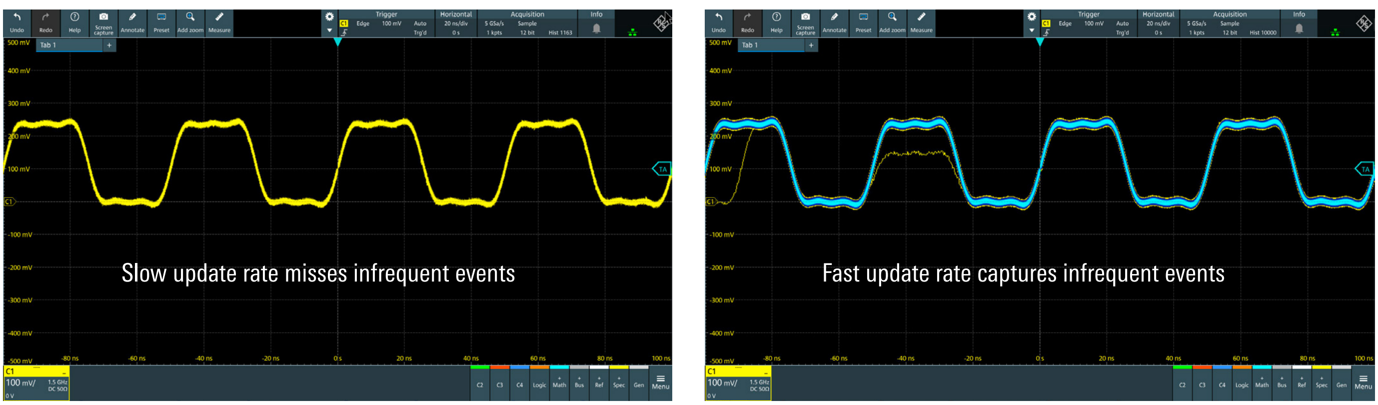
The R&S®MXO 5 Series oscilloscopes have a "free run" trigger mode that is useful in applications like power integrity and EMI where a trigger is not needed. The oscilloscope performs reacquisition as quickly as possible without looking for a trigger condition.

Seeing infrequent events

The visibility of signal anomalies such as glitches is a function of the update rate, the observation time and the rate at which the glitches occur.

Fig. 17: Comparison of update rates

Oscilloscopes with slow update rates miss most infrequent events, while oscilloscopes like the R&S®MXO 5 Series with fast update rates can reveal infrequent events.



6 CONCLUSION

The update rate should be a primary consideration when selecting a new oscilloscope. A fast update rate provides significant user benefits, and the update rate is a key part of the daily user experience. Unlike other features that can have both a benefit and a tradeoff, a fast update rate has no downside. After bandwidth, memory depth and sample rate, an oscilloscope's update rate is often the next most important specification/characteristic.

Oscilloscope manufacturers communicate a best-case update rate for each oscilloscope family. Care should be taken to make sure update rates are compared using the same settings. The update rate in repetitive run and normal mode after a default setup (preset) represents the most important and realistic update rate setting. The update rate can be quickly characterized using a second oscilloscope or a counter. A large number of oscilloscope settings will impact the update rate.

Rohde & Schwarz has invested into ASIC processing technology to provide Rohde & Schwarz oscilloscopes with the industry's fastest update rate performance.

Fig. 18: Investment by Rohde & Schwarz into ASIC technology

This technology facilitates the industry's fastest update rate, without having to default to an update rate value that only works in a special mode or only in segmented mode. Rohde & Schwarz instruments that incorporate ASIC technology for the fastest update rates include the R&S®MXO 4 and R&S®MXO 5 Series, R&S®RTO6 and R&S®RTP.

R&S®MXO 4 Series	R&S®MXO 5 Series	R&S®RTO6 Series	R&S®RTP Series
These are the first instruments in the next generation of R&S®MXO oscilloscopes. Each instrument comes equipped with MXO-EP (extreme performance) ASIC technology that achieves 4.5 million waveforms/s in normal mode, making this family the fastest in the world. The ASIC enables hardware acceleration of a host of other oscilloscope functions.	These are the first instruments with up to eight channels in the next generation of R&S®MXO oscilloscopes. Each instrument comes equipped with MXO-EP (extreme performance) ASIC technology that achieves 4.5 million waveforms/s in normal mode across up to four channels and up to 45 000 FFT/s, making this family the fastest in the world. The ASIC enables hardware acceleration of a host of other oscilloscope functions.	These instruments incorporate an ASIC developed by Rohde & Schwarz that enables up to 1 million waveforms/s. The R&S®RTO6 has the fastest update rate in its class. The instrument includes significant hardware acceleration for functionality like FFT, mask testing and histograms.	These instruments include the same backend processing ASIC as the R&S®RTO6 and achieve an update rate of 600 000 waveforms/s. Numerous analysis capabilities, such as deembedding and CDR, are hardware accelerated.

Rohde & Schwarz

The Rohde & Schwarz technology group is among the trailblazers when it comes to paving the way for a safer and connected world with its leading solutions in test & measurement, technology systems and networks & cybersecurity. Founded more than 85 years ago, the group is a reliable partner for industry and government customers around the globe. The independent company is headquartered in Munich, Germany and has an extensive sales and service network with locations in more than 70 countries.

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Selecting your next oscilloscope: Why fast update rate matters
Data without tolerance limits is not binding | Subject to change
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