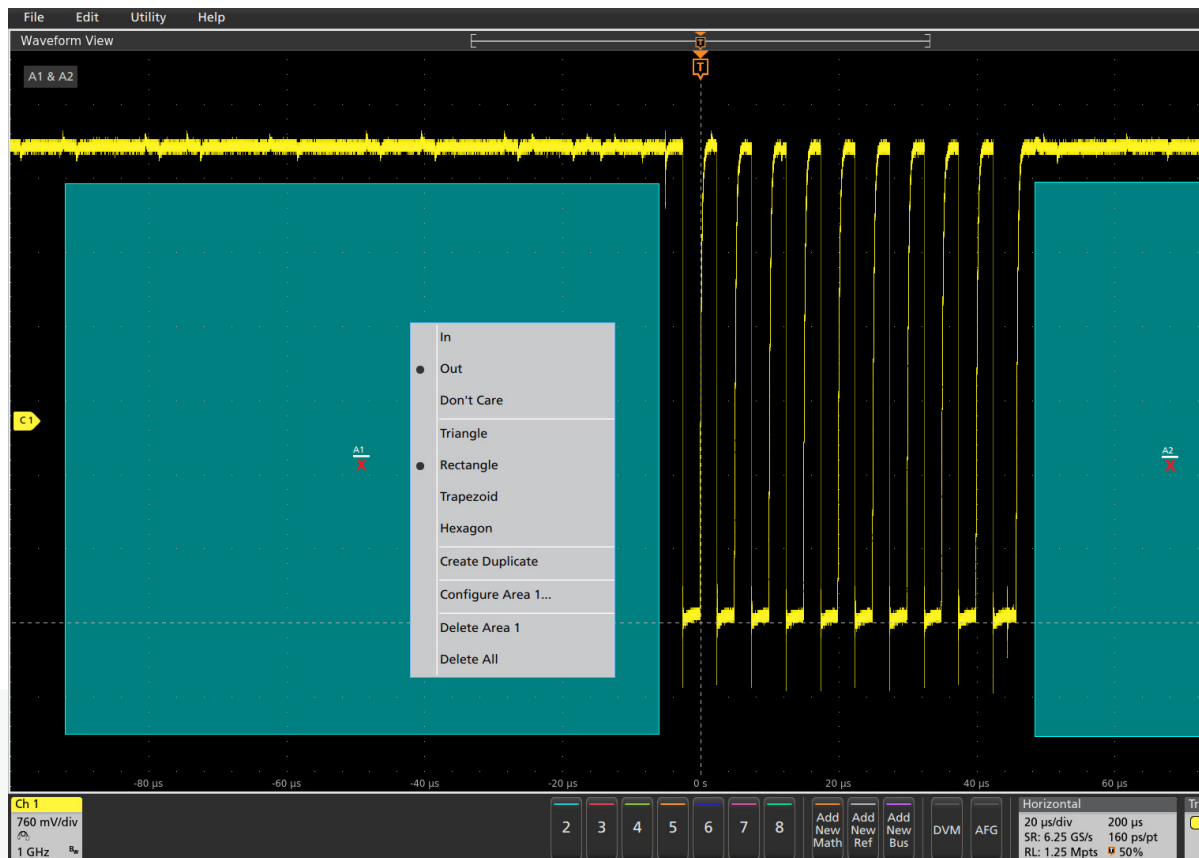




Visual Triggers: Graphical Methods for Capturing Bursts and Other Complex Signals on Oscilloscopes

TECHNICAL BRIEF



Capturing and finding the right characteristic of a complex signal can require hours of collecting and sorting through thousands of acquisitions for the event of interest. Defining a trigger that isolates the desired event and shows data only when the event occurs will speed up this process.

Visual Triggering on an oscilloscope makes the identification of the desired waveform events quick and easy by scanning through all analog waveform acquisitions and comparing them to on-screen areas or geometric shapes. This technical brief discusses some common challenges with capturing events of interest within complex signals and how to overcome them using the capabilities of Visual Triggering.

Basic Oscilloscope Triggering

Oscilloscopes contain a specialized hardware circuit called a trigger which allows predictable acquisition and display of time-correlated signals. The trigger makes repetitive waveforms appear stationary by displaying the same portion of the input signal at the same horizontal position on the oscilloscope display.

Edge triggering is the simplest trigger mode, which identifies a portion of the signal that crosses a specified threshold level and then positions that cross-over point at the trigger point on the display. Advanced trigger modes – including runt, glitch, pulse width, timeout, transition, pattern, state, setup/hold violation, window, serial pattern, or sequences of these events – allow specification of more complex signal characteristics.

However, even the most advanced oscilloscope trigger hardware can only identify a limited number of signal characteristics, and those characteristics must be specified with numerical values such as voltage levels or pulse widths. Oscilloscopes are visual devices and many users would like to graphically interact with the instrument, especially when working with complex signals.

This Technical Brief

- Explains the concept of visual triggering and when graphical triggering can be useful
- Describes visual trigger controls and explains how to use them
- Gives an example of using visual triggers to capture specific serial bus activity

This technical brief uses a 5 Series MSO with no additional options. Although the 5 Series MSO is used in this document, visual triggering operates the same on 4 Series and 6 Series MSOs, including the B versions. Visual trigger also operates identically on 7 Series DPO oscilloscopes.

Some oscilloscopes allow the user to draw a “box” on the display (with a mouse or touch-screen) to define an area for graphical zoom, histogram analysis, or measurement gating. The Visual Trigger application extends this graphical capability to allow definition of trigger criteria.

Visual Trigger

Visual Trigger makes the identification of the desired waveform events quick and easy by scanning through all acquired analog waveforms and graphically comparing them to geometric shapes on the display. By discarding acquired waveforms which do not meet the graphical definition, Visual Triggering extends the oscilloscope’s trigger capabilities beyond the traditional hardware trigger system.

Although Visual Trigger is similar in appearance to mask testing, where acquired waveforms are graphically compared to mask regions on the display, there is an important difference. Visual Trigger actually discards waveforms which do not conform to the specified shape, so only conforming waveforms can be displayed, measured, and saved to a reference.

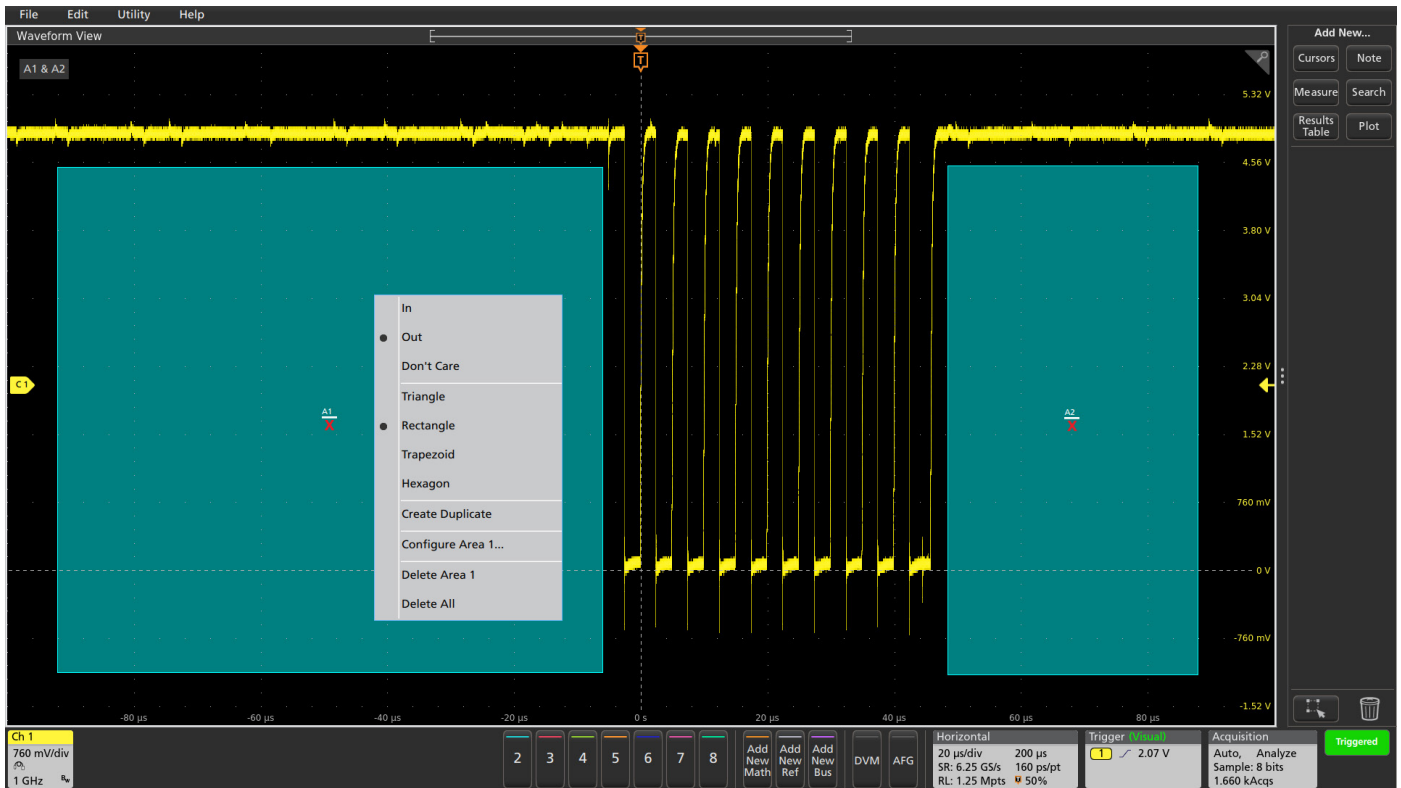


Figure 1. Visual Trigger areas (blue-green) may be defined using a mouse or with the touchscreen. Areas can be set to capture when the signal is inside the area or outside the area.

Basic Setup

The Visual Trigger process always begins with setting up the oscilloscope's hardware trigger system to acquire the waveforms in Normal trigger mode. The trigger can be as simple as an edge trigger or as complex as a parallel or serial bus trigger, or a sequence trigger.

The next step is to add one or more Visual Trigger areas using a mouse or touchscreen. This is shown in **Figure 1**. By default, the shape is a rectangle, but variety of other shapes (triangles, hexagons, trapezoids, and custom shapes) can be used to specify the desired trigger behavior. Once shapes are created on the oscilloscope's display, they can be re-positioned, re-sized, and/or edited interactively to create ideal trigger conditions.

Each of the visual trigger areas is associated with a specific analog input channel. Once created, the user can change the shape of the area, change whether the signal must go inside or stay outside of the area, create a duplicate area, or delete the area. Basic Visual Trigger controls are simply a "right-click" away.

The example above shows a bursty I²C clock signal. To capture only bursts of a specific width, one Visual Trigger area is placed before the trigger point and another after the end of the desired burst width. By specifying that the signals must remain out of these areas, only the desired bursts are captured.

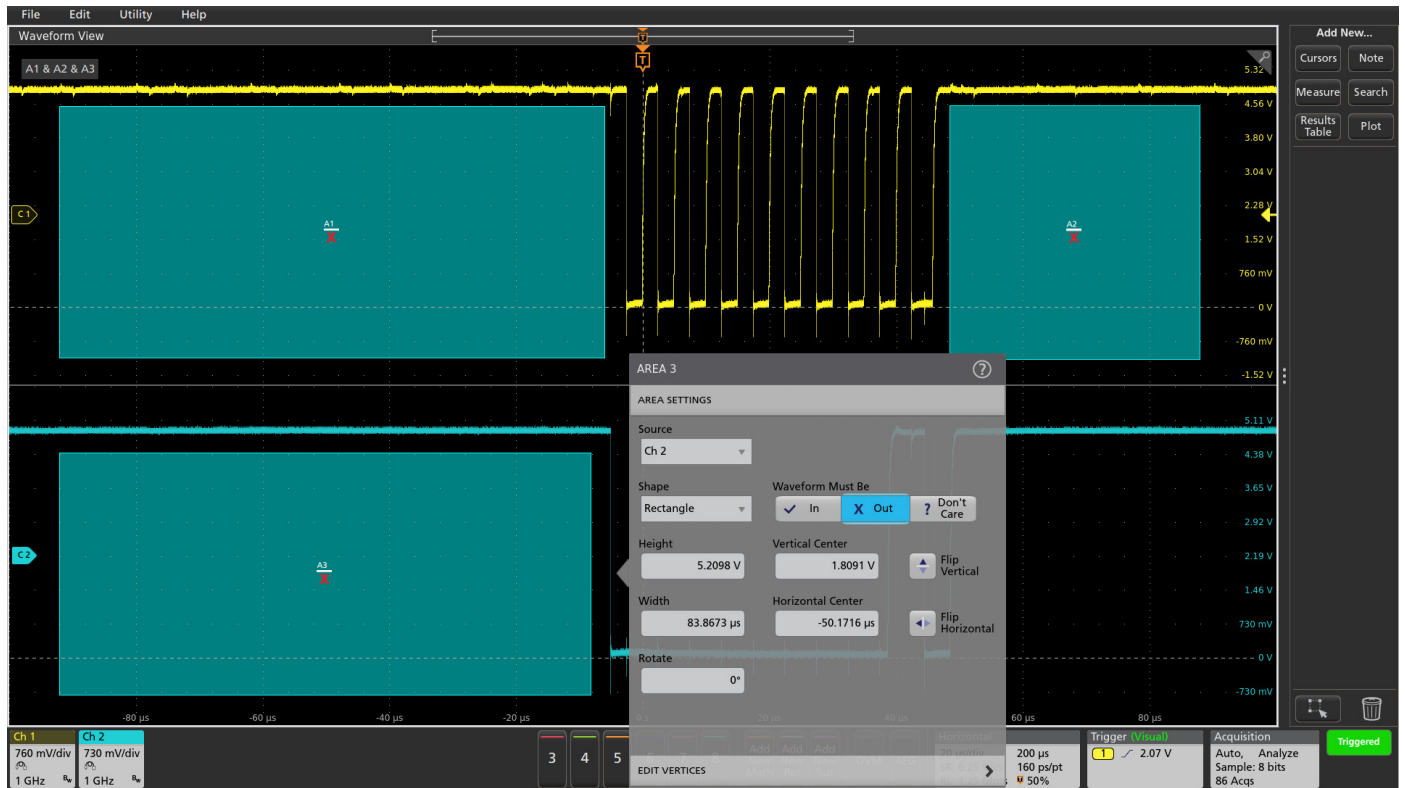


Figure 2. Detailed settings for a Visual Trigger area provide precise control over shape, voltages and times.

Visual Trigger Controls

For more precise control of each Visual Trigger area, the configuration menu (Figure 2) allows the user to edit the shape, size, and position of each area. Exact coordinates for the vertices for each area can be specified in amplitude and time values.

The Visual Trigger configuration menu in the example above shows the details that can be adjusted for each area.

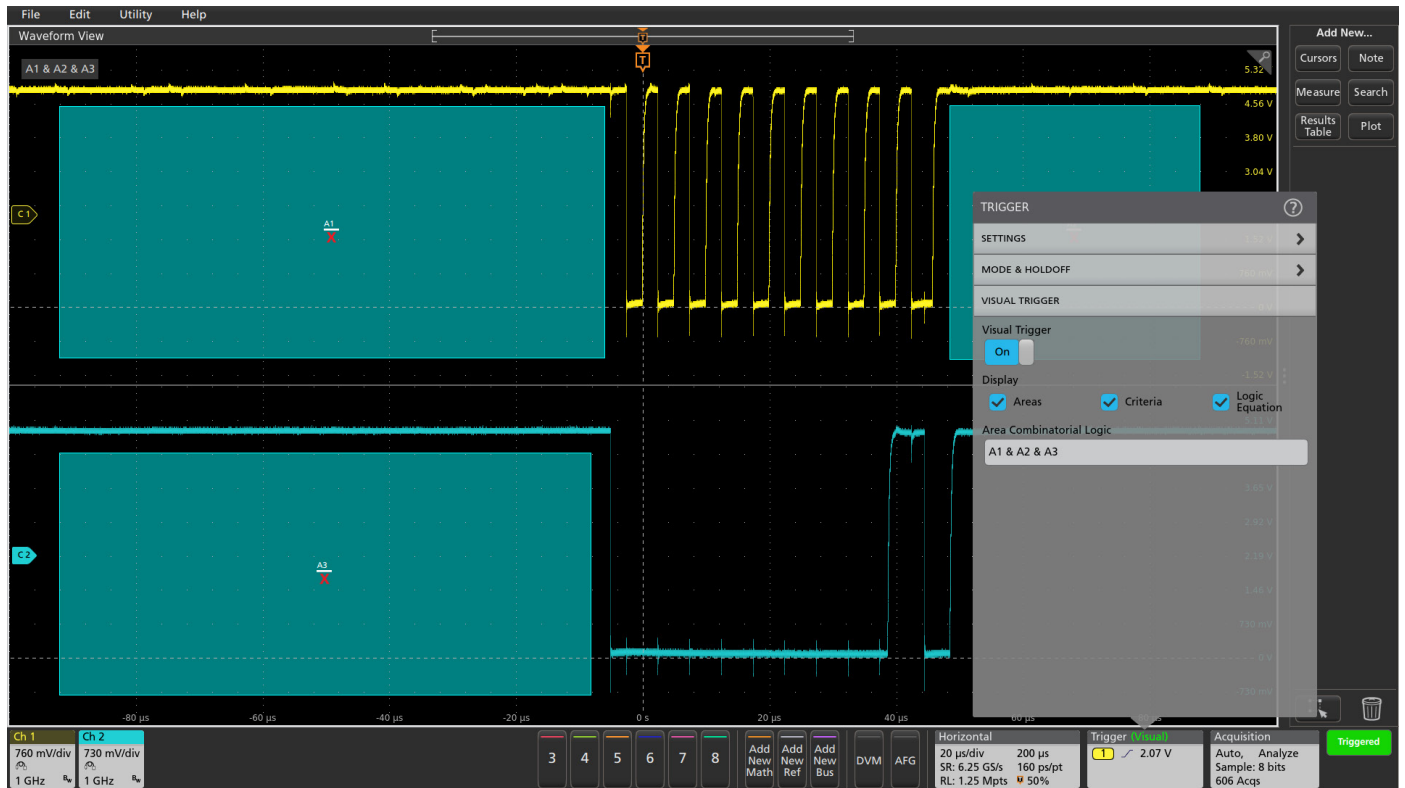


Figure 3. When multiple areas are defined a logic expression specifies conditions for waveform display. In this example the areas are ANDed (must all be true).

On the 5 Series MSO, and other scopes with the same user interface, Visual Trigger controls are found on the VISUAL TRIGGER panel in the Trigger configuration menu (shown in Figure 3). Controls are provided to turn Visual Trigger on and off, customize the display, and enable editing of the

Visual Trigger combinatorial logic equation. This equation describes how Visual Trigger will logically combine the areas to determine which acquired waveforms are displayed and which are discarded.

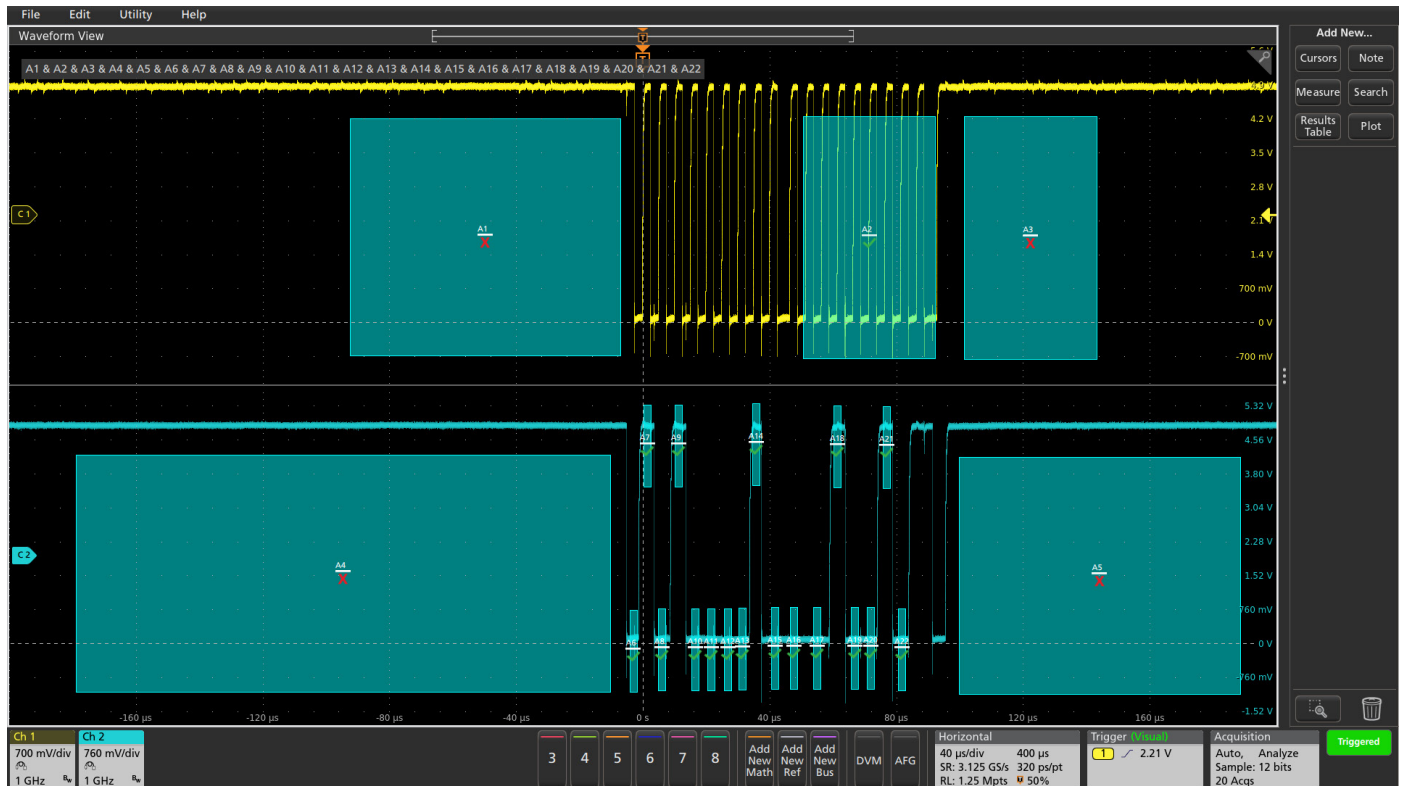


Figure 4. Visual Triggers can be used to define complex capture criteria. This example captures a specific serial bus packet.

More Advanced Applications

In the example in **Figure 4**, Visual Trigger areas have been added to the I²C signal to build a custom serial pattern trigger.

Visual Trigger areas 1 and 2 provide framing for the serial signal, capturing only signals that occur after the clock (yellow channel 1 signal) has been idle for an extended period of time, and when the clock is long enough to support both an address and a data packet.

The remaining areas are used to specify the serial data pattern (cyan channel 2 signal) which is sampled at the rising edge of the clock signal. In this case, the pattern of areas captures bus reads from binary I²C address 1010000 followed by the binary data value 00010010.

The horizontal positions of the areas for the data pattern can be adjusted to correspond to the valid setup and hold timing around the clock edges, and the vertical sizes and positions of the areas can be adjusted to correspond to valid high and low logic levels.

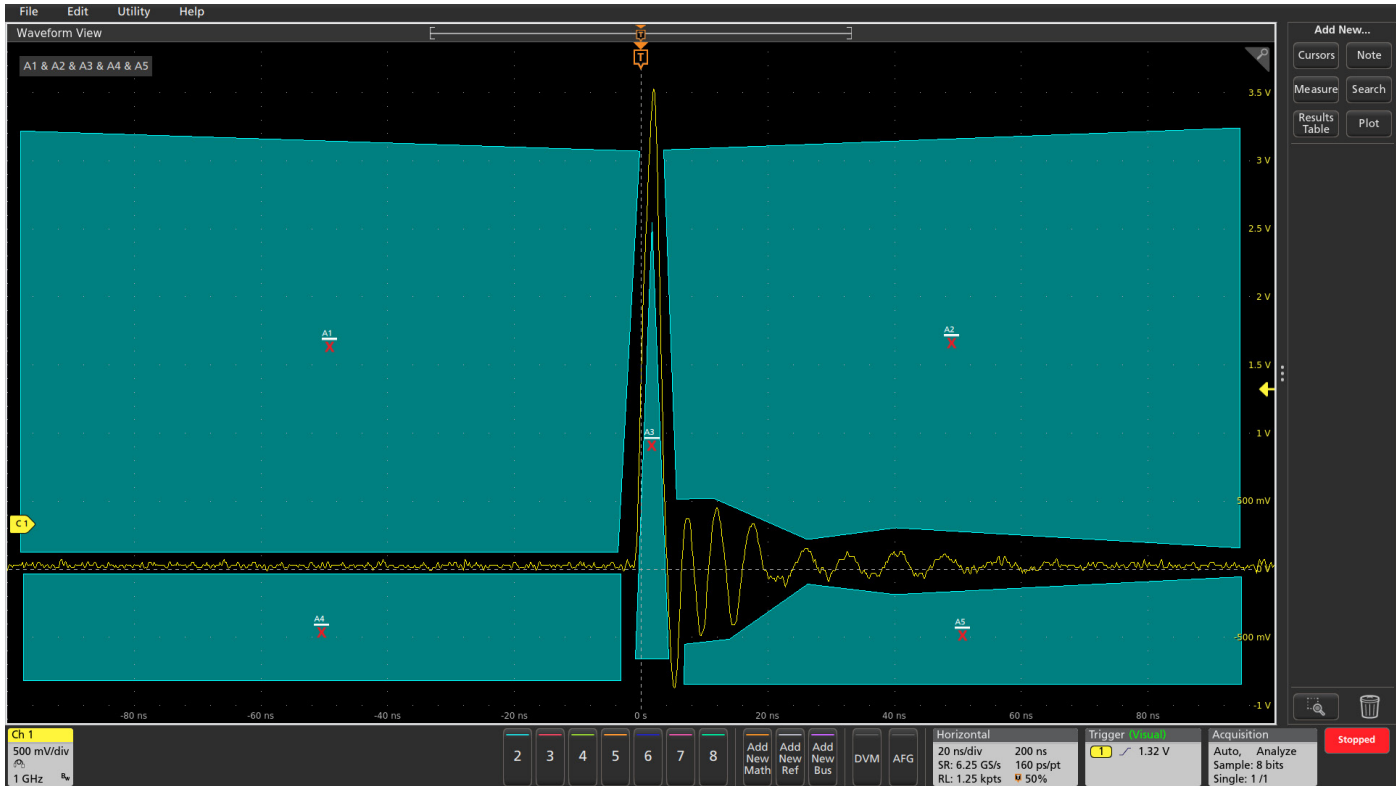


Figure 5. In addition to rectangles, Visual Trigger areas can be polygons.

By default, Visual Trigger areas are rectangles. But Visual Trigger areas can be edited to define very complex shapes.

In **Figure 5**, Visual Trigger areas have been extensively edited and then used to capture only signals with a specified pulse width and amount of ringing.

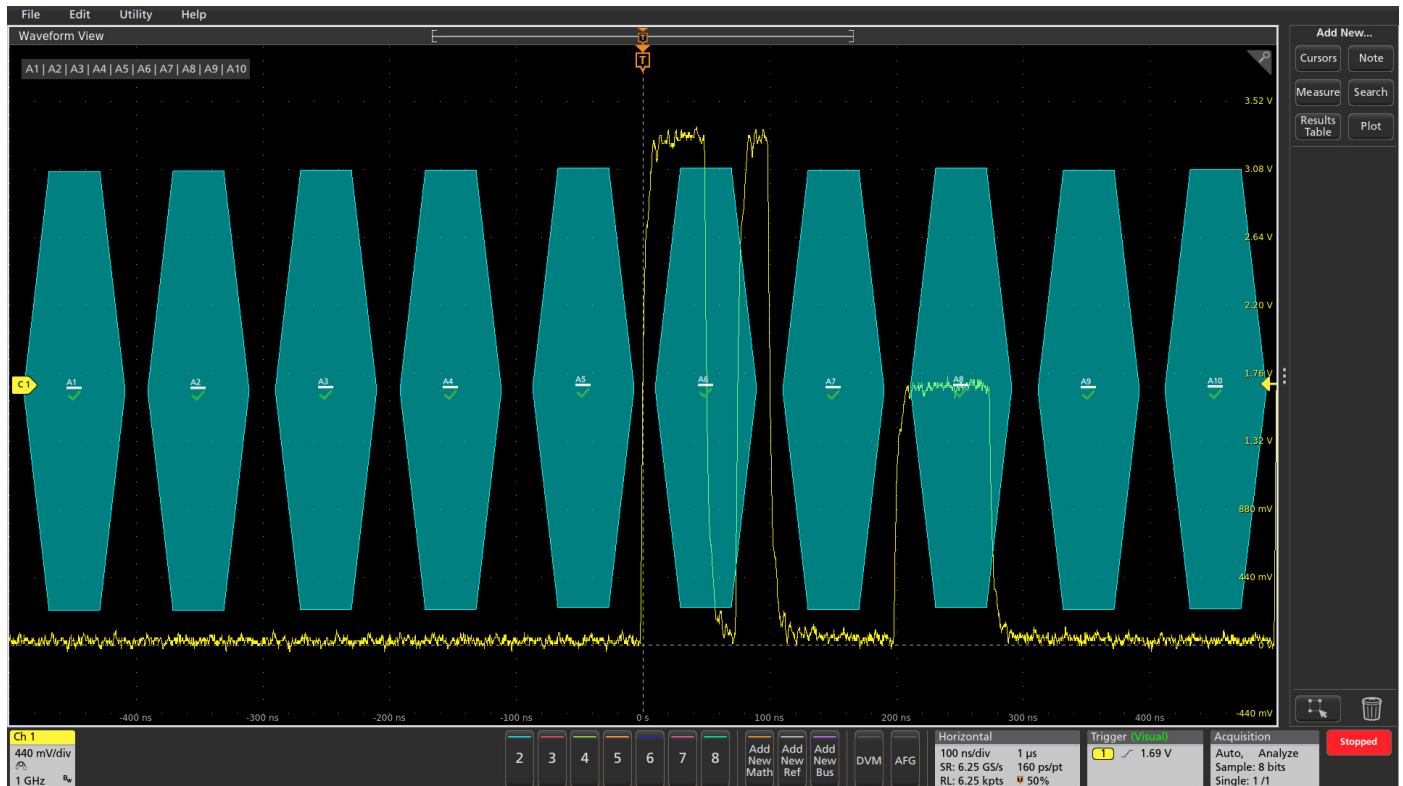


Figure 6. Hexagonal areas define the nominal unit interval of a serial data signal and uncover an anomaly.

Figure 6 shows how Visual Trigger can be used in an unattended monitoring application to capture infrequent anomalies. First, a hexagonal area is placed in the center of each unit interval of this CAN signal. Then the logic equation is edited to logically OR all of the areas together. Finally, infinite persistence is used to capture all trigger events while the circuit is running for an extended period of time. Only the “mask” violations are captured.

Visual Trigger extends the Tektronix oscilloscope’s triggering capabilities beyond the hardware trigger system, enabling easy and efficient definition and capture of important events in complex signals. By automatically capturing only the most important signal events, hours of capturing and manually searching through acquisitions for the right signal can be reduced to seconds or minutes.

Contact Information:

Australia 1 800 709 465
Austria* 00800 2255 4835
Balkans, Israel, South Africa and other ISE Countries +41 52 675 3777
Belgium* 00800 2255 4835
Brazil +55 (11) 3530-8901
Canada 1 800 833 9200
Central East Europe / Baltics +41 52 675 3777
Central Europe / Greece +41 52 675 3777
Denmark +45 80 88 1401
Finland +41 52 675 3777
France* 00800 2255 4835
Germany* 00800 2255 4835
Hong Kong 400 820 5835
India 000 800 650 1835
Indonesia 007 803 601 5249
Italy 00800 2255 4835
Japan 81 (3) 6714 3086
Luxembourg +41 52 675 3777
Malaysia 1 800 22 55835
Mexico, Central/South America and Caribbean 52 (55) 88 69 35 25
Middle East, Asia, and North Africa +41 52 675 3777
The Netherlands* 00800 2255 4835
New Zealand 0800 800 238
Norway 800 16098
People's Republic of China 400 820 5835
Philippines 1 800 1601 0077
Poland +41 52 675 3777
Portugal 80 08 12370
Republic of Korea +82 2 565 1455
Russia / CIS +7 (495) 6647564
Singapore 800 6011 473
South Africa +41 52 675 3777
Spain* 00800 2255 4835
Sweden* 00800 2255 4835
Switzerland* 00800 2255 4835
Taiwan 886 (2) 2656 6688
Thailand 1 800 011 931
United Kingdom / Ireland* 00800 2255 4835
USA 1 800 833 9200
Vietnam 12060128

* European toll-free number. If not accessible, call: +41 52 675 3777

Rev. 02.2022

Find more valuable resources at [TEK.COM](https://www.tek.com)

Copyright © Tektronix. All rights reserved. Tektronix products are covered by U.S. and foreign patents, issued and pending. Information in this publication supersedes that in all previously published material. Specification and price change privileges reserved. TEKTRONIX and TEK are registered trademarks of Tektronix, Inc. All other trade names referenced are the service marks, trademarks or registered trademarks of their respective companies.

04/2026 SBG 48W-61452-1

