plug & play instruments
oscilloscopes

Triggering Guided Tour

Welcome to the Cleverscope Triggering Guided Tour

This resource uses a PAL video signal to illustrate the Cleverscope triggering capabilities.

Cleverscope provides two sequenced comprehensive trigger definitions. You can trigger on the following conditions:

- Trigger 1 only.
- A count of Trigger 1, the count varies from 1 to 2.147×10^9.
- Trigger 2 follows trigger 1 with a specified duration.
  The duration may be less than a period, in a period, or greater than a period. The period ranges from 10ns to 42.9 secs with 10ns resolution.
- A count of Trigger 2, following Trigger 1. The count varies from 1 to 2.147×10^9.

Triggering Guided Tour

28 Ranfurly Rd
Epsom 1005
Auckland, New Zealand

Ph +64 9 524 7456
Fax +64 9 524 7457
www.cleverscope.com
info@cleverscope.com

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PAL video signal overview

We will use a PAL video signal to illustrate the triggering options. A PAL video signal is composed of 625 lines transmitted at a 25 Hz frame rate. Lines are interlaced, and 312.5 lines are displayed as one frame first, followed by another 312.5 lines as one frame second. The second frame is offset vertically from the first frame by one line, so that a complete 625 line picture is produced. Note that only 575 lines are actually displayed, the remaining lines are used to provide a blank area above and below the visible picture.

Each line has a format as shown in the graph below.

For a monochrome picture, the luminance (Y or intensity) of the beam that sweeps from the left side of the picture tube to the right side is set by the amplitude, which varies from 0 (black) to 700 mV (white).

For a colour picture the intensity of each colour component (RGB) is needed. This is done by transporting both a luminance (Y) signal and two colour difference signals modulated on to a 4.43 MHz carrier impressed on the Y signal. The Y signal is a composite:

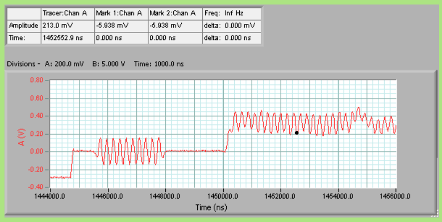
$$Y = 0.3R + 0.59G + 0.11B$$

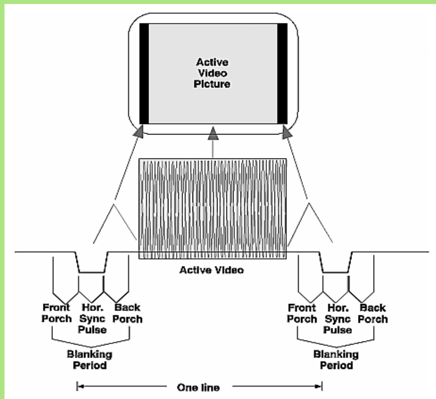
If the signal is high frequency degraded, or received by a Black and White TV, this luminance information delivers a grey-scale image.

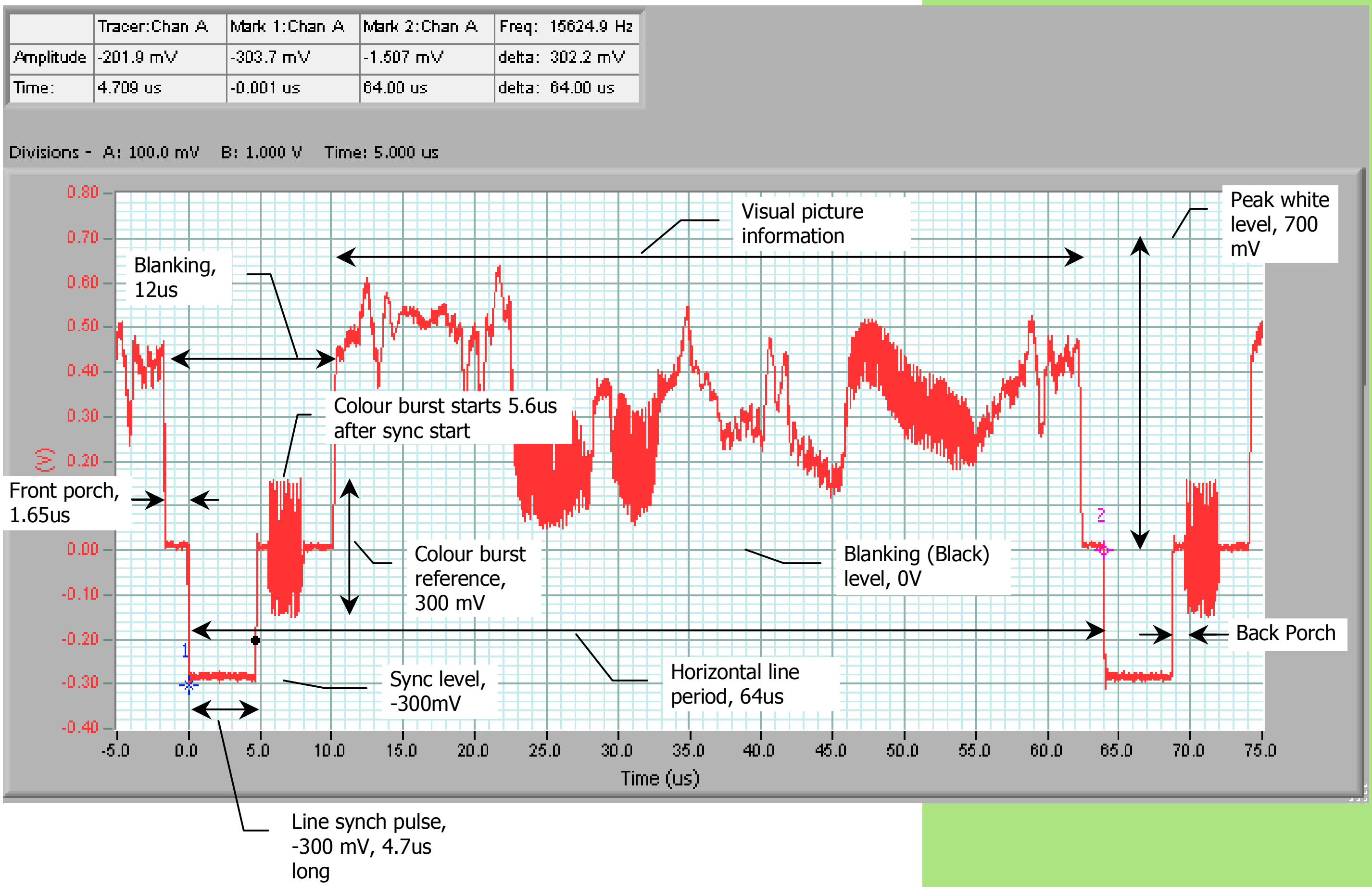
Peak Captured sampling

The display has been captured with peak captured sampling, to ensure high frequency information is not lost.

The tracking graph can display the full resolution (in this case 10 ns) while the scope graphs displays the big picture. Here the tracking graph shows the 4.43MHz colour burst followed by video.





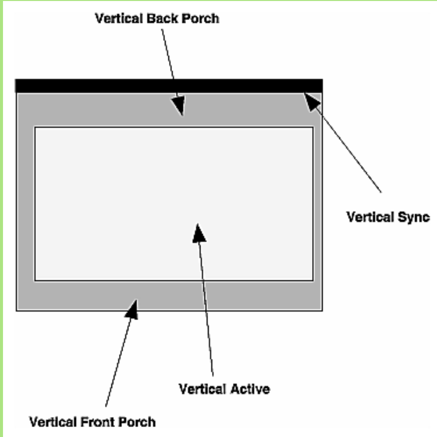


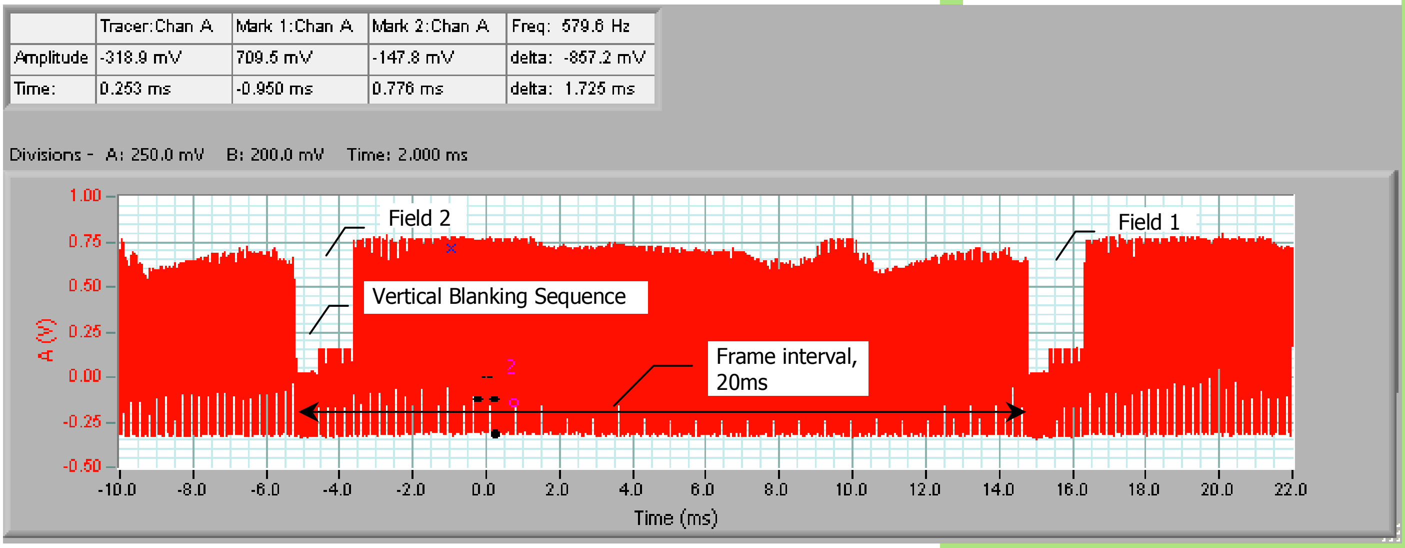
PAL video field format

PAL encodes two interlaced fields, at 50 HZ, to create a complete picture, with a 25 Hz update rate.

A complete field is shown below. You can see the vertical sync pulse sequences at 20 msec intervals.

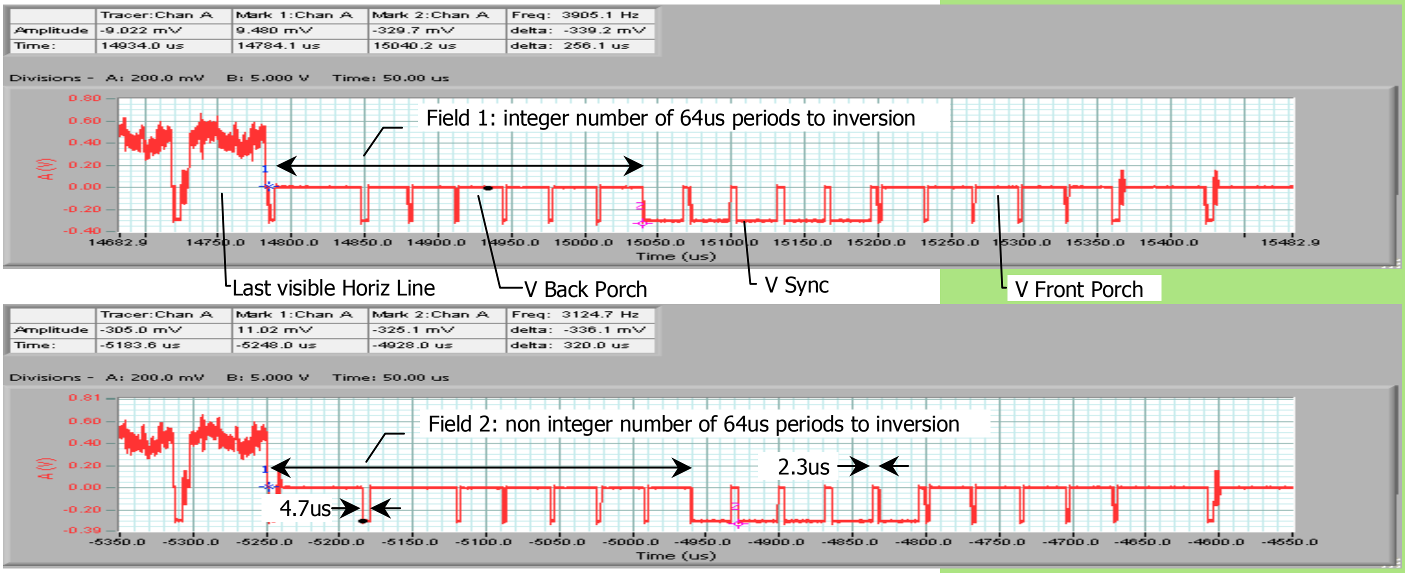
The vertical sync period is also used to encode time information in many systems. For a PAL system, The first field displayed [1] has an integer number of 64us vertical periods before the sense transition (see below). The second field has the sense transition in the middle of a 64 us vertical period. No colour burst or video is encoded in the vertical sync interval.





We can zoom in and see the vertical blanking sequence which establishes which field - Field 1 [first] or Field 2 [second] is being displayed.

The vertical sync sequence uses 2.3us wide pulses rather than the standard 4.7us pulses.



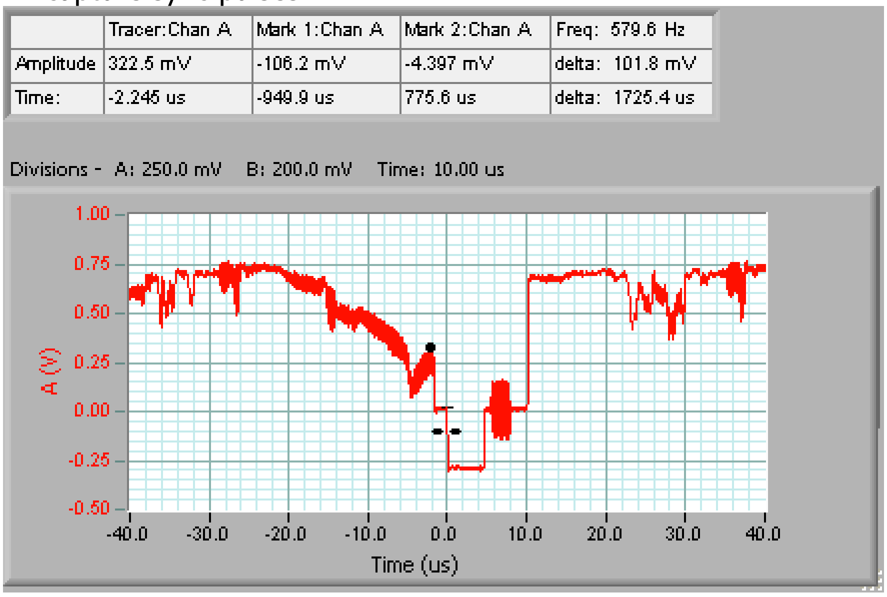
Triggered video capture.

The trigger is always placed at time zero on the graph. The video signal is used to illustrate Cleverscopes' triggering capabilities.

Simple Triggering

Only Trigger 1 is used. Ensure that the Period Trigger entry is none.

Here Chan A has been set to trigger on a falling edge at –0.1V. This will capture sync pulses.



Single pulse duration triggering

This helps us find synch pulses, but it might be any line in the field. Suppose we want to find a field. We know that the vertical blanking sequence starts with a 2.3us synch pulse.

We want to look for a pulse that goes low through the trigger amplitude, and then goes high through the same trigger amplitude some 2.2-2.4us later. Open the Trigger 2 settings window (View/Display Trigger 2 Settings), and ensure the Trigger 1 inverted option is selected.

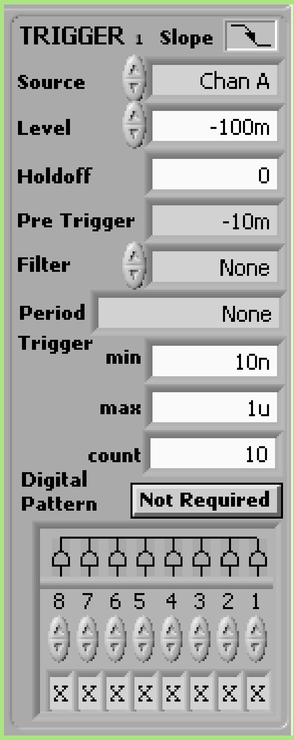
On the Control Panel, set the period trigger to min<T1~2<max, and set min to 2.2u and max to 2.4u. Leave the Slope as negative going.

Set the Scope graph to about 25 msec duration, with the trigger point one division in from the left. Connect the video, and click on single, and you should get a display with frame aligned to time 0.

Simple trigger setup

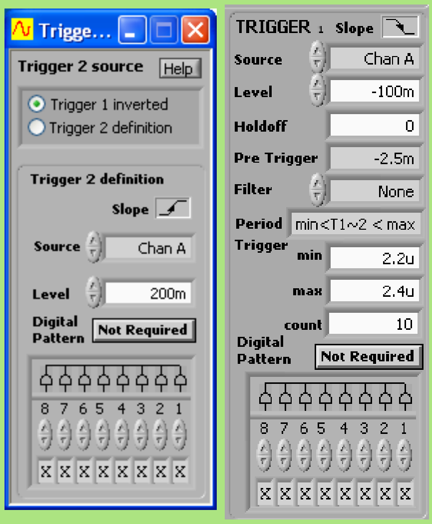
This is the simplest trigger 1 set-up.

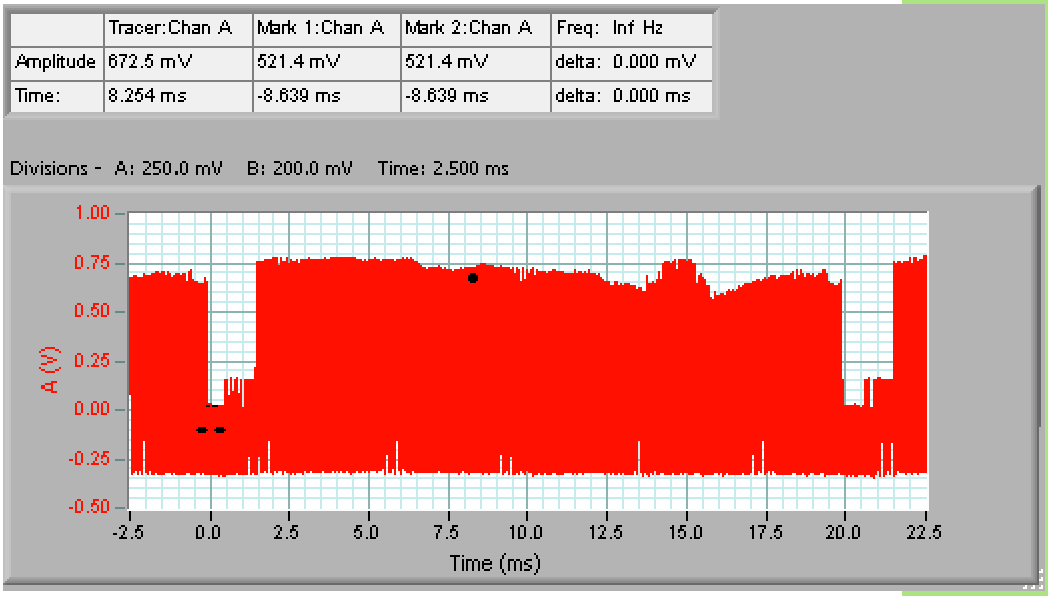
The period trigger is not used, and the digital pattern is not used.



Here Chan A is the source, falling edge triggered at –100mV.

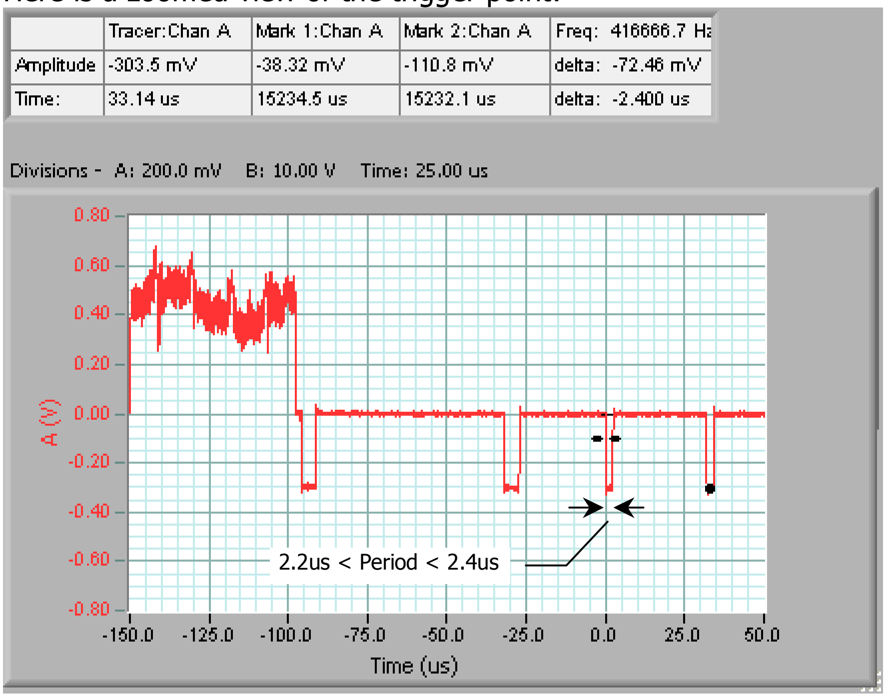
Trigger Settings:





The trigger is the first pulse that meets the trigger specification.

Here is a zoomed view of the trigger point:



This method of using Trigger 2 (being Trigger 1 inverted) is useful for finding single pulses where the trigger level for both rising and falling edges is the same, and applies to the same source.

Useful examples are:

- Finding glitches – use Trig 1~2 < min, where the min is smaller than valid pulses. (For example valid pulses might be 50 ns or longer, set min to 20 ns and you will find glitches 20ns or shorter).
- Finding start of frame and the like - as we have done here.
- Finding pulses that are too long – eg watch dog timeouts.
  For example Trig 1~2 > max, where max =1, will find failed watchdog pulses that should have happened at least once per second.

Zooming

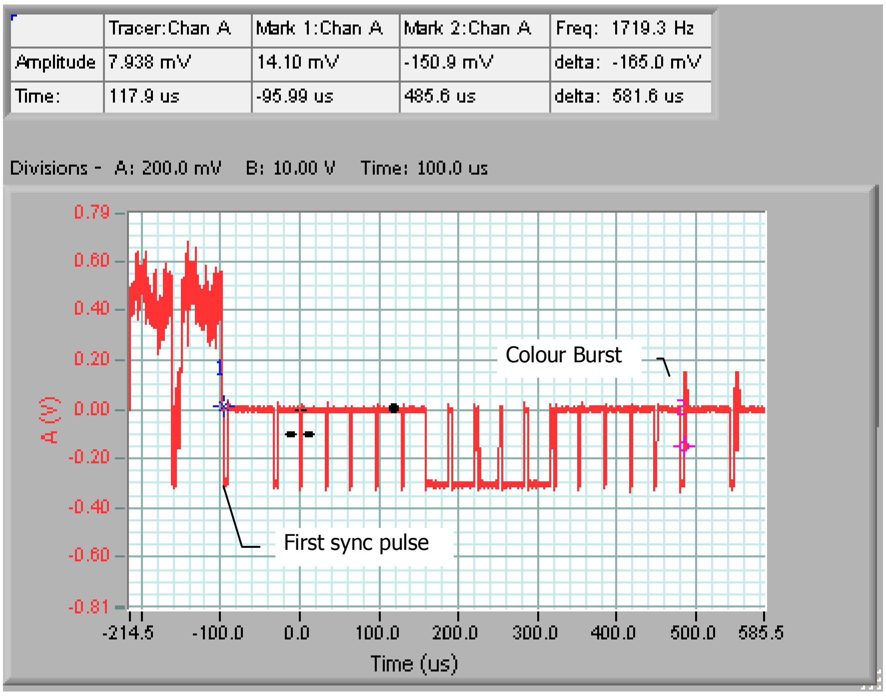
Cleverscope contains 2M samples per captured frame. So with a 30 ms frame period (as we have here – 25ms + 2.5ms either side), we get 20ns resolution. This is still more than enough to resolve the video signal correctly – no matter where in the field we are.

In any case you should be aware that the trigger system always runs at 100 MHz, which means that even if the display system cannot resolve to 10ns, the trigger system will.

Separated event duration triggering

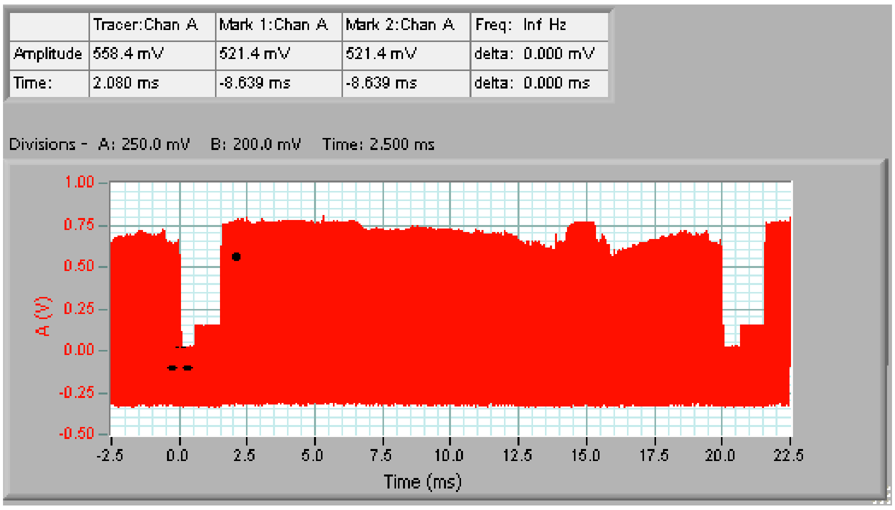
By providing a completely separate specification for trigger 2, quite complex events can be located and triggered on.

As an example we can find the start of frame again, but this time observe that there is a gap between the first falling sync pulse falling edge and the start of the colour burst signal of 581.6 us.



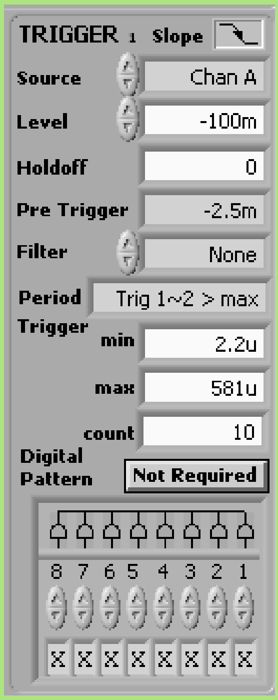
A suitable level for the colour burst signal threshold is 40 mv. We set up trigger 1 to trigger on a falling edge at –100mV, and trigger 2 to trigger on a rising edge, on Chan A, at 40 mV. We set the Period Trigger to Trig 1~2 > max, and use a period of 581us.

Here is the successful result:

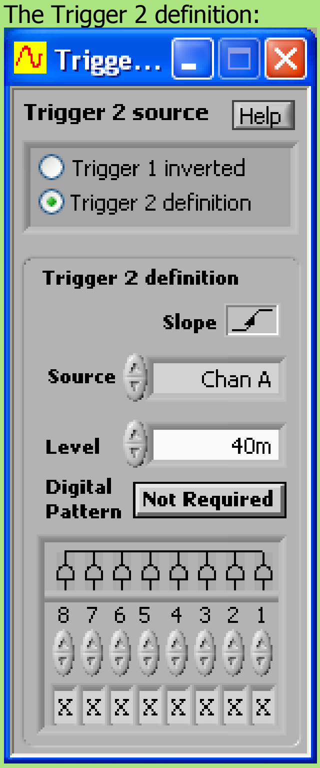


Event Trigger Definition
The trigger definitions for Trigger 1 and Trigger 2 can be completely different.

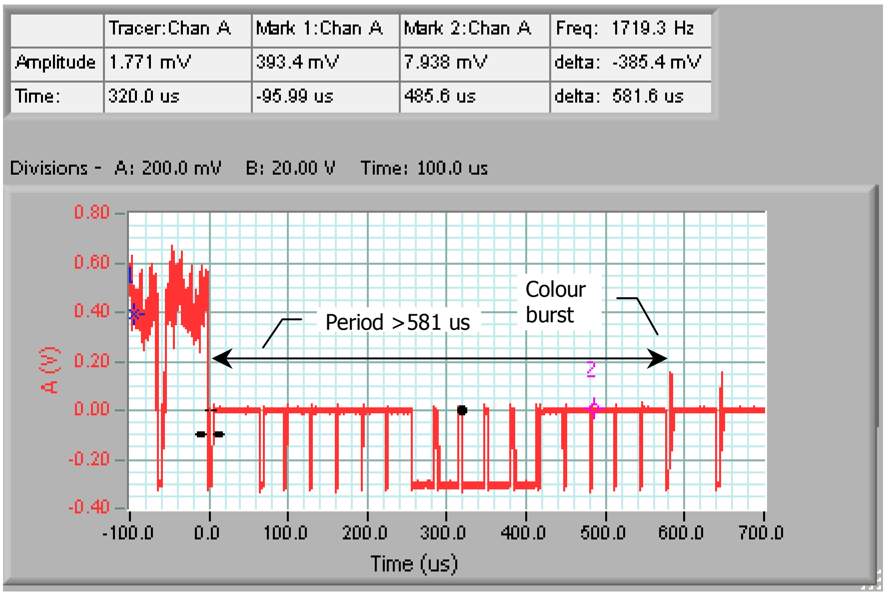
For example you could trigger on Chan A - say a power supply rising, and then use a Digital Trigger combination as Trigger 2.



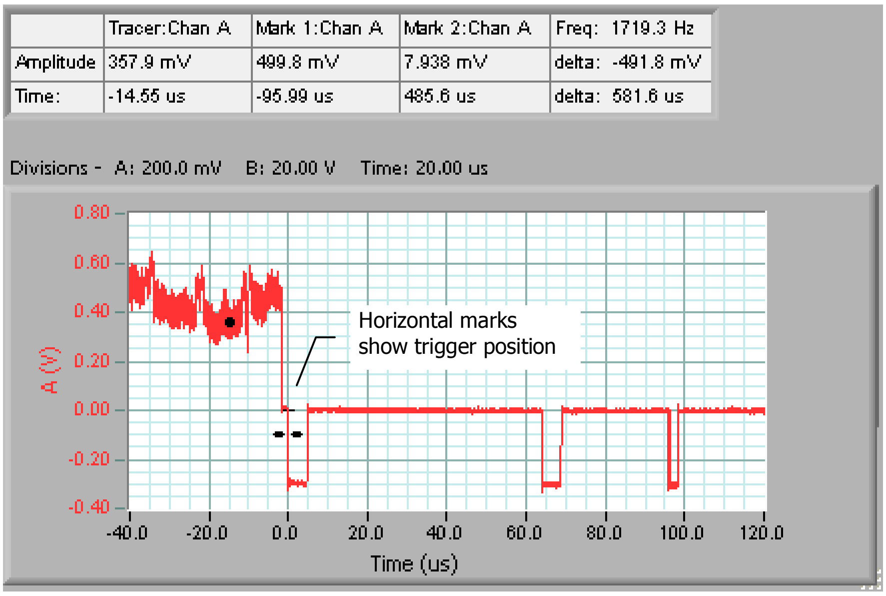
The Trigger 2 definition:



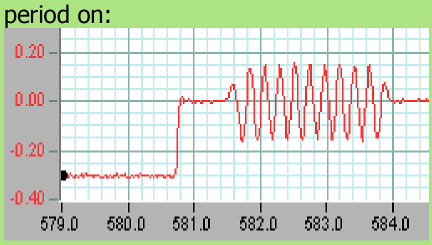
Zooming in we see that the trigger does start with the negative transition of the first sync pulse:



zooming in again shows the sync pulse detail:



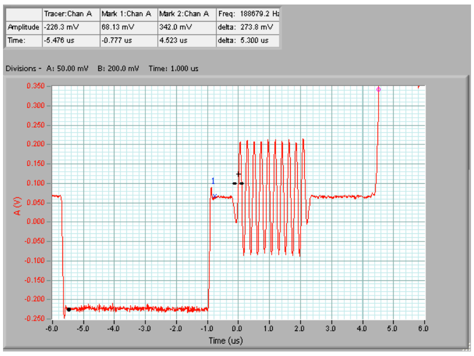
This is the colour burst we ended the period on:



Amplitude and duration (Runt pulse) triggering

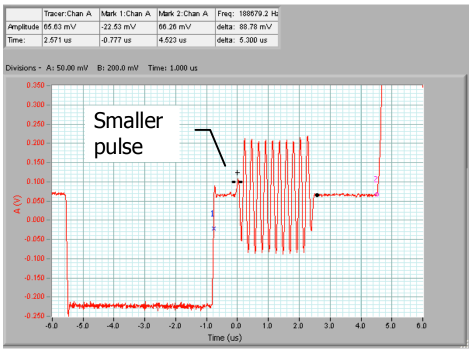
As each trigger specification includes amplitude, we can trigger on events in which both time and amplitude are part of the trigger specification.

As an example we will find pulses whose amplitude are too small. We'll find these pulses in the colour burst.



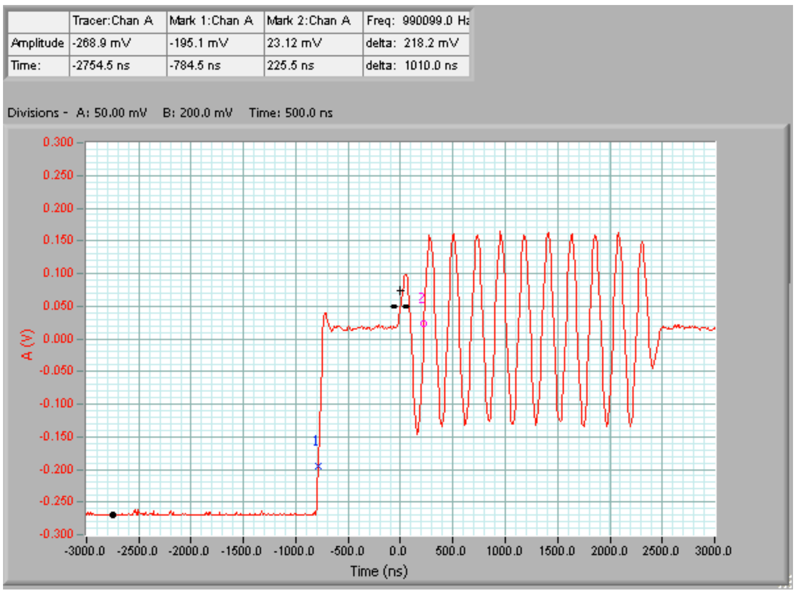
Normally the colour burst amplitudes are constant, as shown in this graph.

Here we triggered at 100 mV. We have set up the scope graph to get a good view of the colour burst.

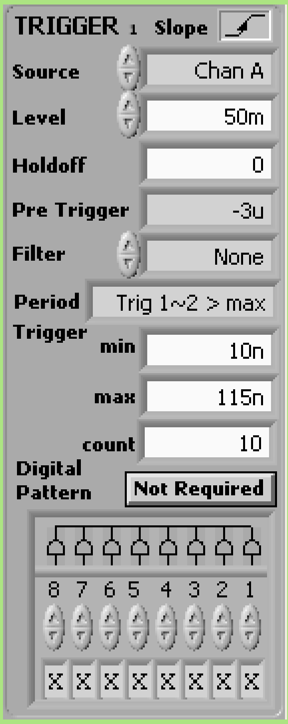


Notice that sometimes the first pulse is smaller than the others. We would like to trigger on this.

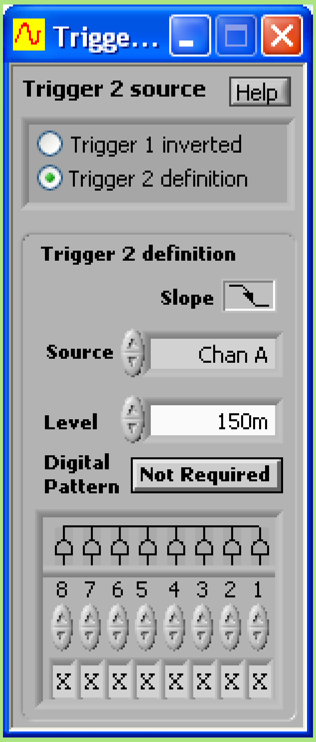
We notice that a single colour burst pulse lasts about 115 ns. So we want to trigger if the amplitude has risen through 50 mV, but not fallen through 150 mV within 115 ns. The trigger definitions are shown to the right. Once set up like this, we can find these 'runt' pulses easily, like this:



Amplitude event trigger setup
Here are the trigger setups for finding 'runt' colour burst pulses:

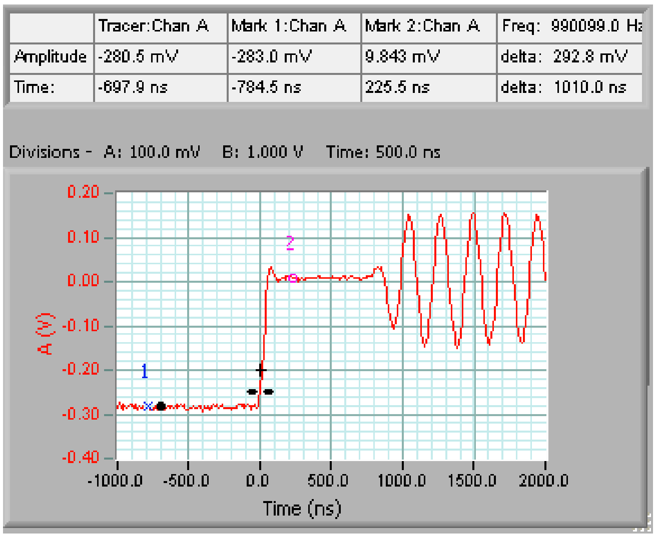


The Trigger 2 definition:

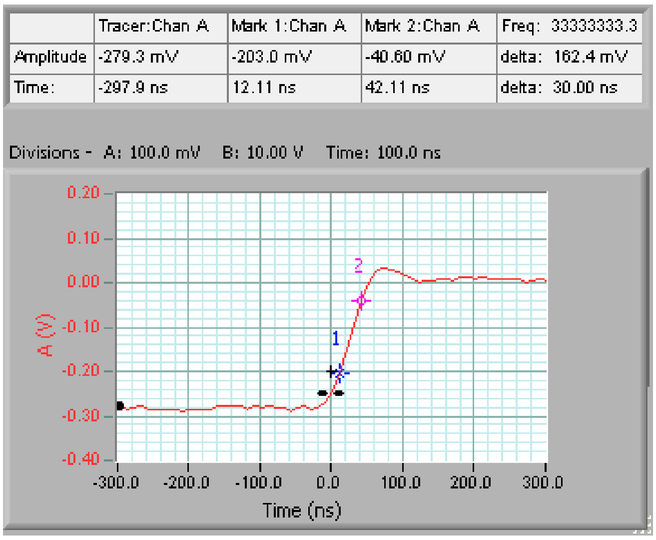


Rise/fall time based triggering

We can specify the time and duration to capture edges that have a specific rise or fall time. We can verify in this way that edge rates meet EMI or bandwidth specifications.



Here we have set up the triggers to catch all sync pulses whose rising edges take between 10 and 30ns to traverse from –250mV to –50mV,

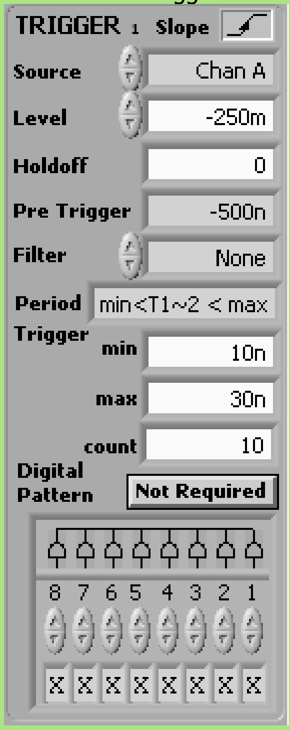


Here is a zoomed view and you can see the rise time was 30ns.

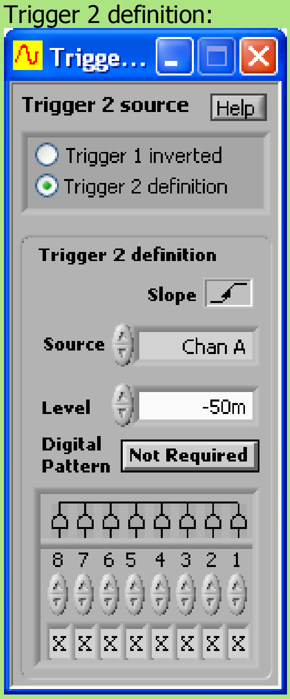
Next we set the min and max time values to 40ns and 1u, and found we captured no sync pulses. From this we can confirm that all sync pulses have a rise time of less than or equal to 30 ns.

Rise Fall/Time Trigger setup

The standard trigger:



Trigger 2 definition:



Count based triggering

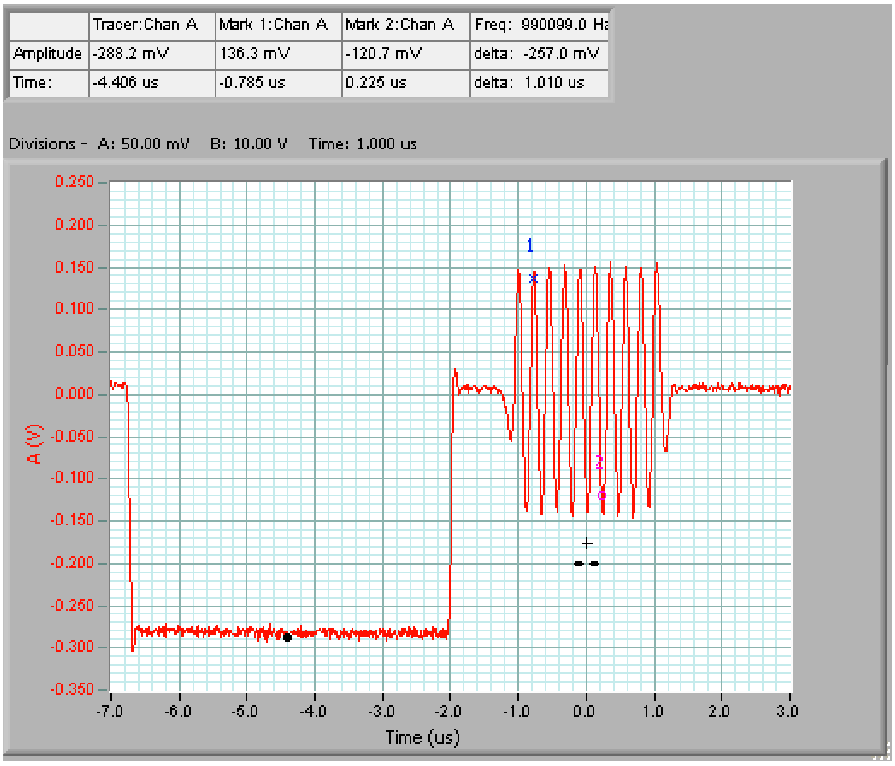
In some circumstances we would like to trigger after a pre-determined number of events. We can trigger on a count of Trigger 1 events, or a count of Trigger 2 events, following Trigger 1.

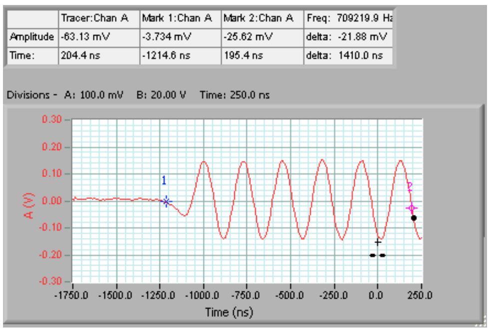
As an example, we will count colour burst cycles, following a sync pulse. We wish to trigger on the 5th falling colour burst cycle.

We set up Trigger 1 to trigger on the rising edge of a synch pulse, at –200 mV. We set up Trigger 2 to trigger on the falling edge of the colour burst signal at –100 mV. We set the count to 5.

For a count, the trigger location is shown as the point at which the count specification was met. The trigger amplitude indicated by the graph trigger marks refers to the Trigger 1 amplitude.

The result:

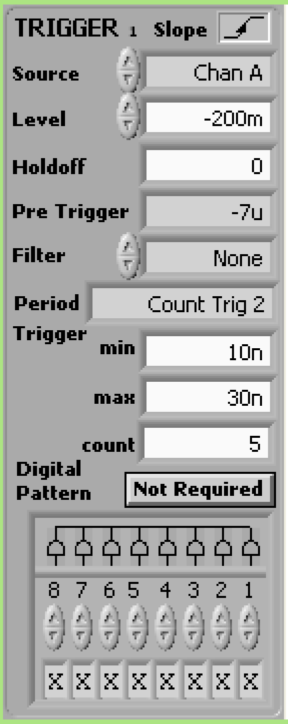




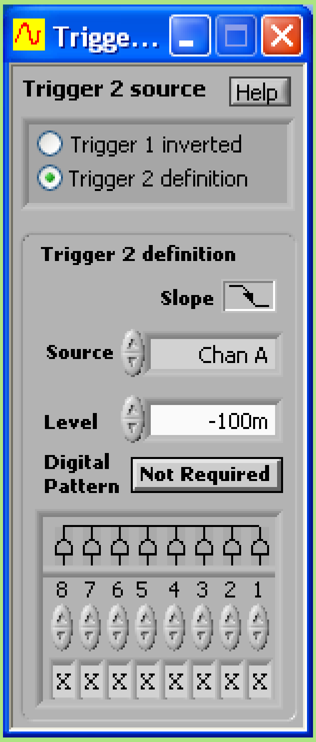
The zoomed in view shows that we captured 5 transitions through –100mV to set the trigger position.

County based setup

The standard trigger:

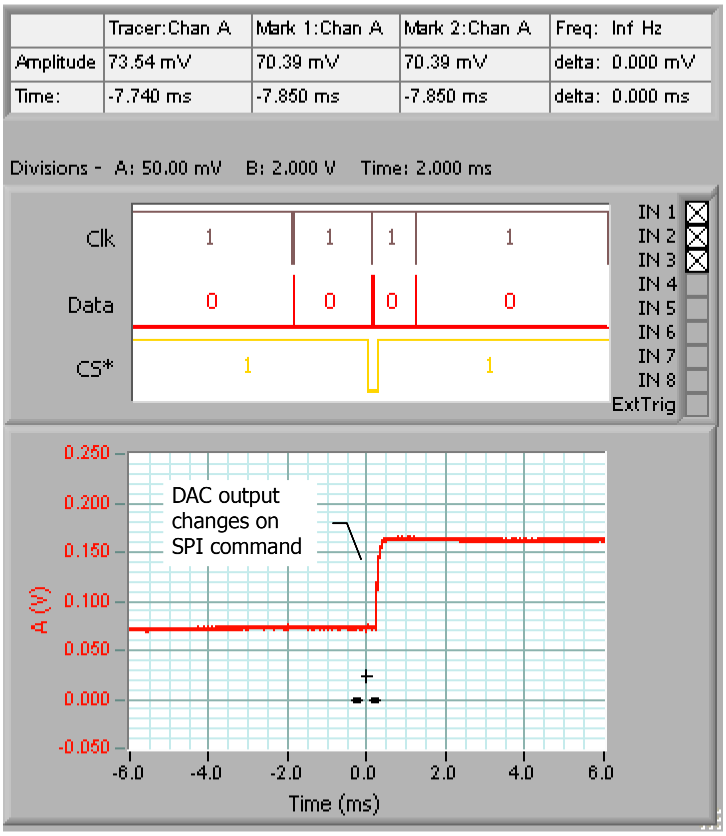


Trigger 2 definition:

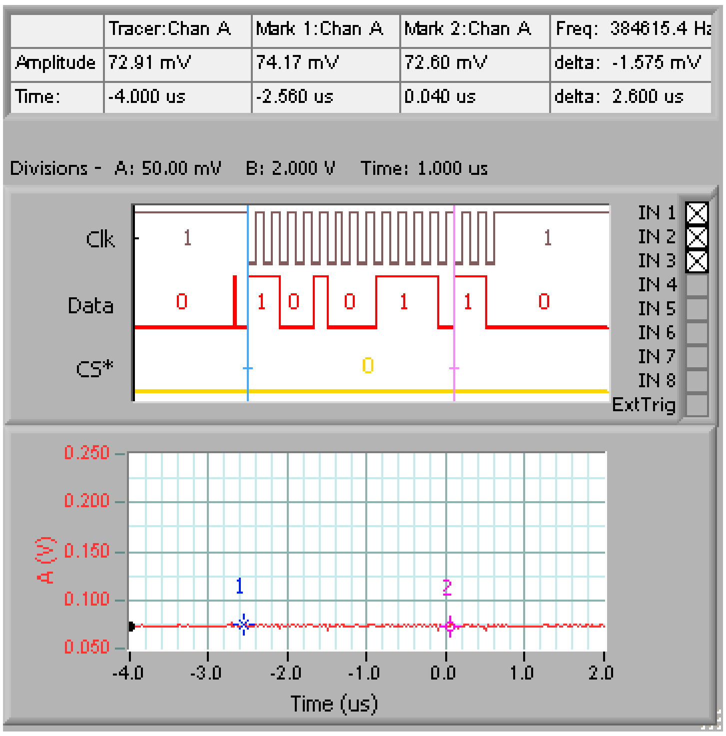


Mixed Signal Triggering

As an example, we use a DAC7616 to output analog values in response to SPI bus messages. The DAC is addressed when CS* is low. We want to trigger on the 4th rising data pulse in an addressed message.

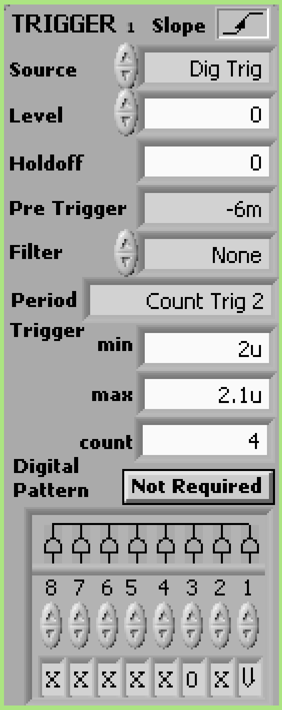


Zoomed view of SPI message. Time 0 is the 4th Data pulse.

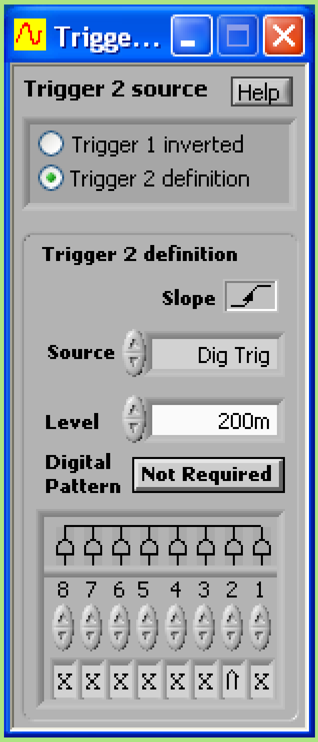


Rise Fall/Time Trigger setup

Trigger 1 definition. We are looking for a digital trigger, based on clock (In1) going low, while CS* (In3) is low.
We have are counting 4 Trigger 2 events.



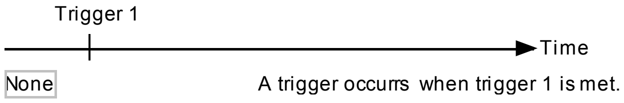
Trigger 2 definition:
The digital inputs are the trigger source. Input 2 is the Data line, we are looking for a rising edge.



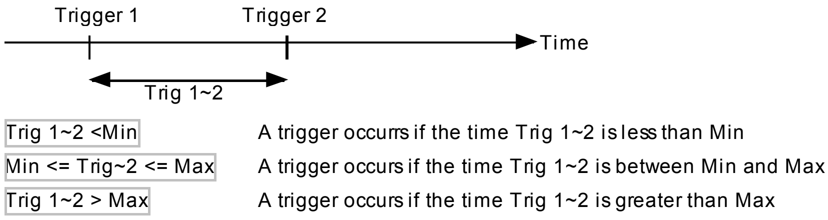
Summary

Cleverscope provides a powerful set of two mixed signal triggers that can be used to trigger under the following circumstances:

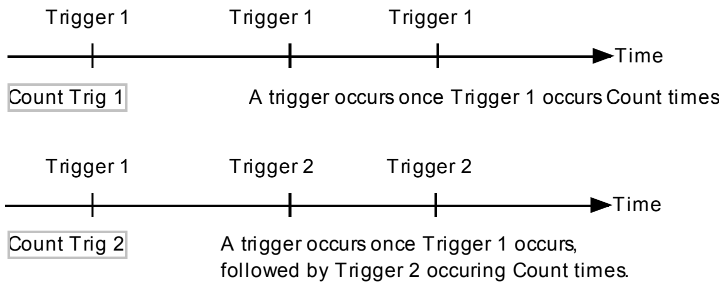
Edge or State Trigger



Duration Triggers



Count Triggers



Each trigger definition provides a comprehensive mixed signal definition which provides triggering based on amplitude, duration and count.

How we compare with the Tek DPO4000

Cleverscope offers the same triggering capabilities provided by high-end oscilloscopes, such as the Tek DPO4000:

1. Edge
2. Pulse/Width
3. Runt
4. Logic
5. Setup and hold violation
6. Rise/Fall Time
7. Video

In addition Cleverscopes' mixed signal trigger setups support triggering not available on many commercial oscilloscopes, including the DPO4000.

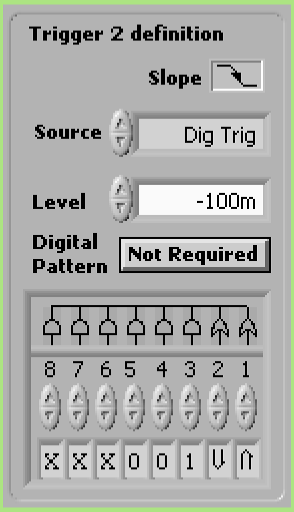
Trigger Definition

Each trigger definition specifies the source (Chan A, Chan B, External Trigger or Digital Inputs), the trigger level (if analog), and a digital pattern, if used.

The external trigger and digital input thresholds are set using the Settings/Acquisition Settings… menu.

For digital triggering you can specify rising, falling, high level, low level, or don't care for each input. You can AND or OR bits to create a complete digital definition.

As an example, this definition will trigger if either (Input 1 is rising, OR Input 2 is falling), AND inputs 5..3 = 001, for example.



Here, for example, we have the external trigger threshold at 0V, and the digital threshold at 2V.