SOFTHARD

MR11002

Image Acquisition Timings using Hardware Trigger

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2 Revision History

Revision	Date	Who	What
0.10	17.03.2009	MK	First version of application note.

3 Disclaimers

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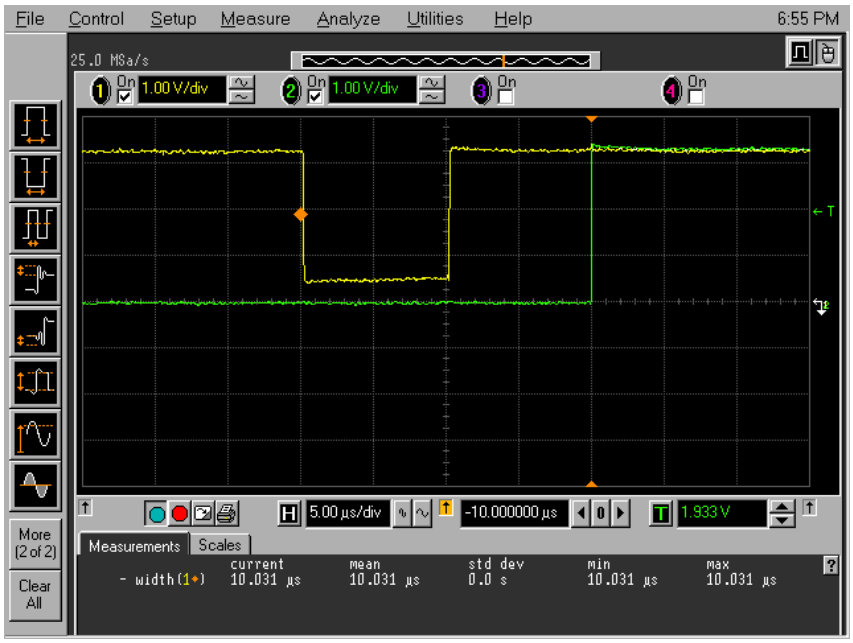
5 Document Scope and Purpose

This document describes image acquisition timings of the MR11002 camera when using hardware trigger.

6 Set up

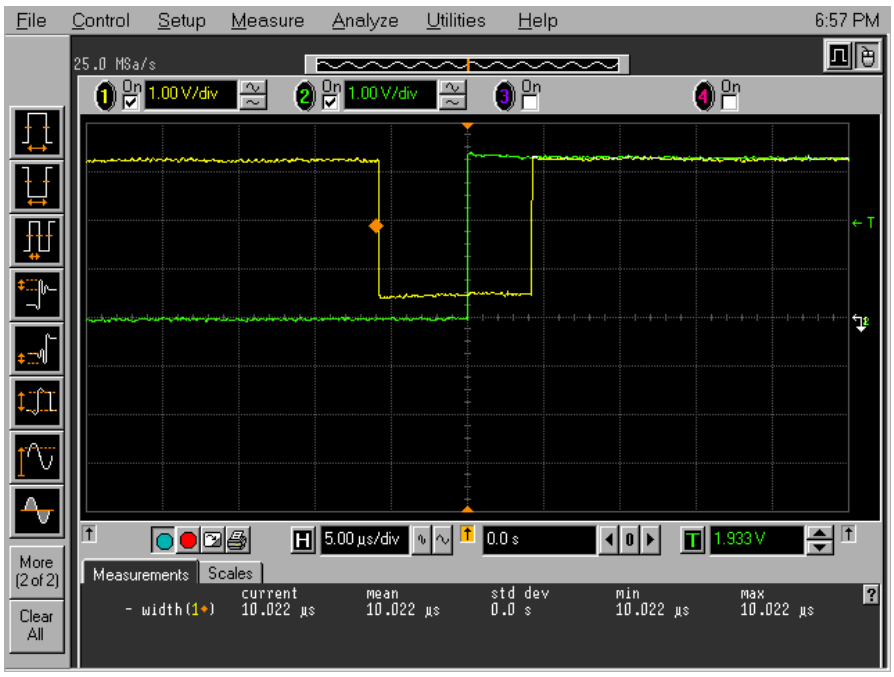
The measurement setup consists of MR11002 camera, FPGA development board, high brightness LED and HP Infinium Digital Oscilloscope. The FPGA generates hardware trigger signal for MR11002 camera upon pressing a button. Also it generates a 10µs LED pulse with a certain offset with respect to the trigger pulse. The trigger signal triggers MR11002 camera to capture an image, which is then analyzed, namely whether or not the LED pulse is captured on the image.

On the following screenshots from the oscilloscope the LED signal (active low) is shown in yellow color and the MR11002 trigger signal (rising edge) is green.

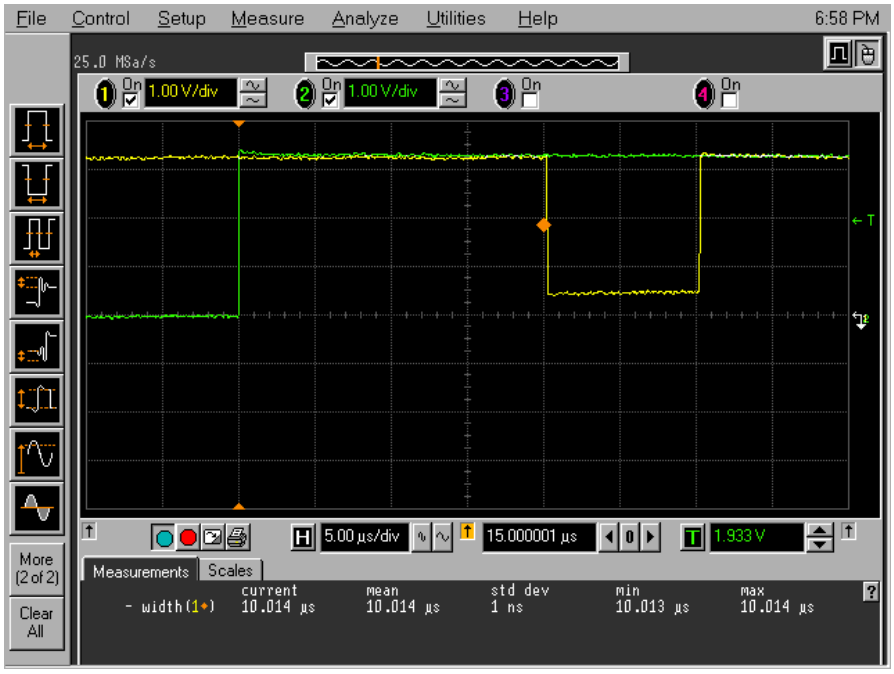


The initial LED pulse offset with respect to the trigger signal is 10µs. That means that LED is turned off 10µs before the trigger signal for MR11002 is issued. In this situation we don't expect to see light from the LED on the images and it is purely for completeness of the experiment.

After issuing several such pulses and analyzing acquired images, the LED pulse is shifted to the right with respect to the trigger pulse in 2µs discrete steps and more images are taken.

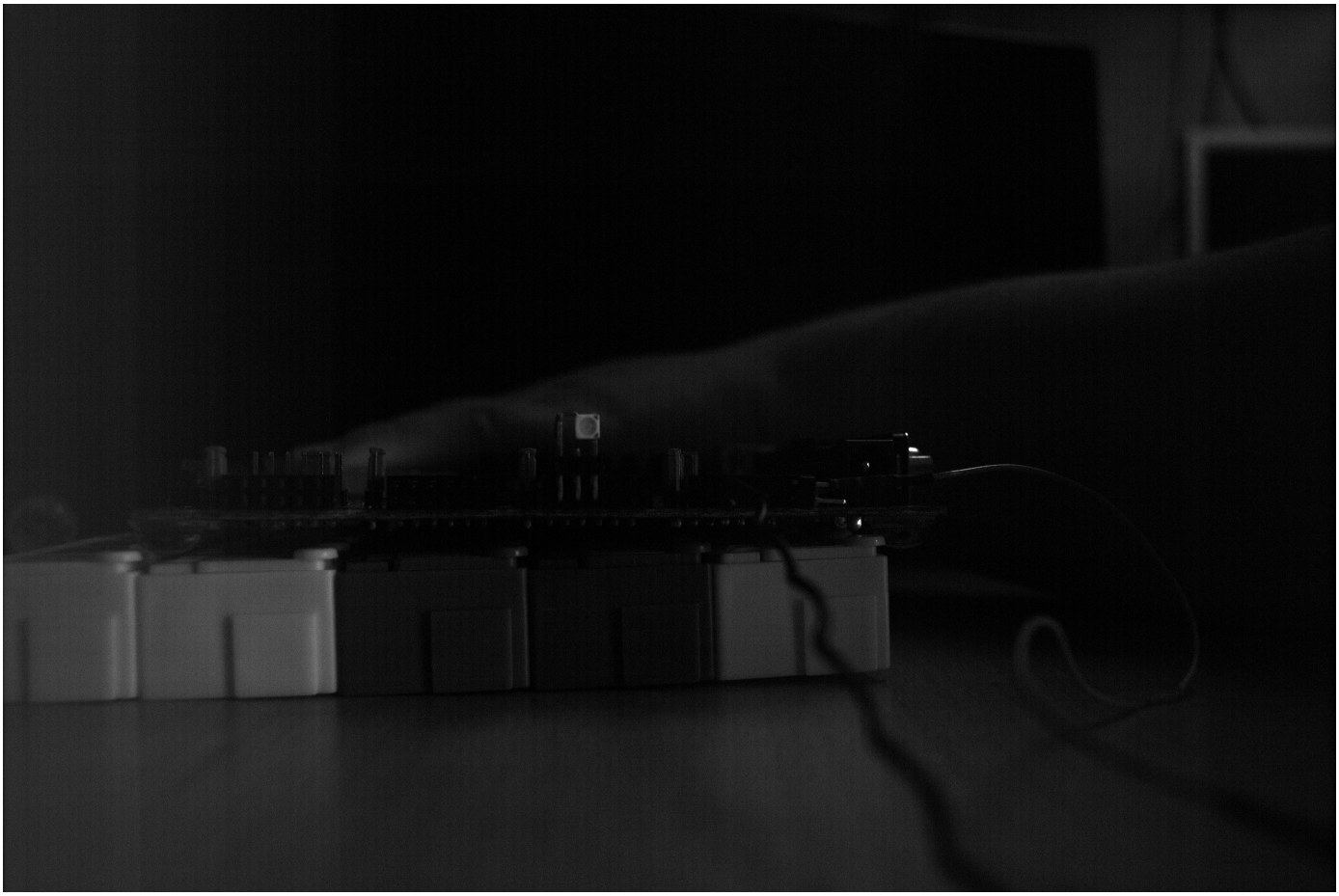


By shifting LED signal to the right until it start appearing on the acquired images we can measure the offset between the issued trigger pulse and the start of image acquisition.



In this way we can measure the trigger offset for the various exposition times. Note that due to the specific timings of the CCD sensor inside MR11002 the offset between trigger and the actual start of the exposition can differ for different values of exposition times. This however is typical only for exposition times lower than 200µs. For values larger than that the trigger offset is stable.

Below are shown two pictures taken during the experiment. On the first picture the LED is not yet emitting light, therefore we conclude that the exposition and led pulse do not overlap.



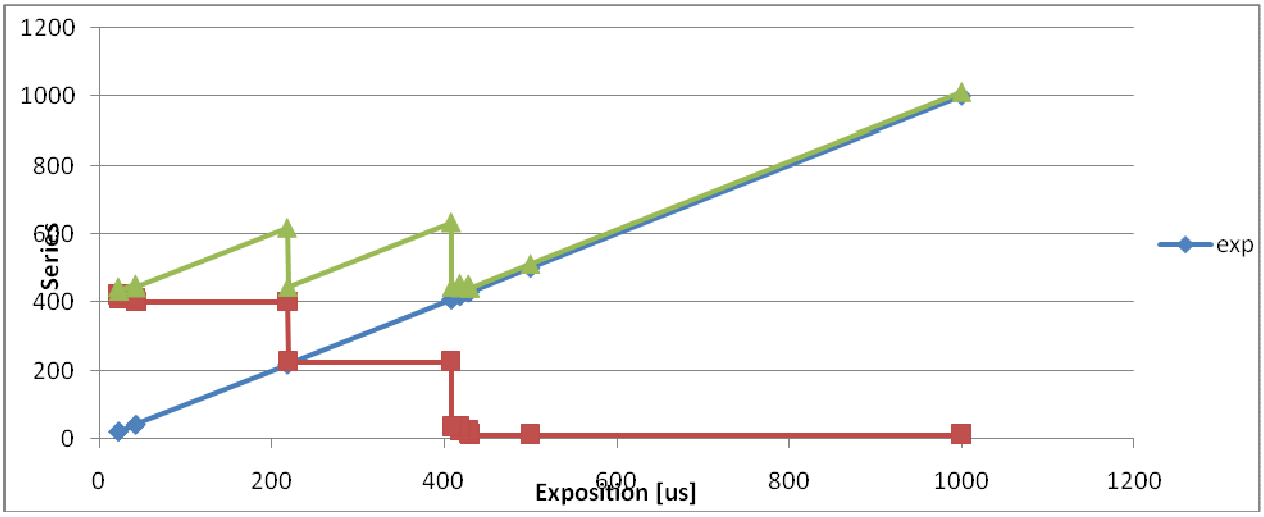
On the second picture the LED pulse and exposition start overlapping and so we know when the exposition really begins. In this way we experimentally measure the offset between trigger pulse and the start of exposition.

7 Results

The following offsets from trigger impulse to start of exposition have been measured for the different values of exposition time. (Note that offset value change was observed to change in steps and not linearly)

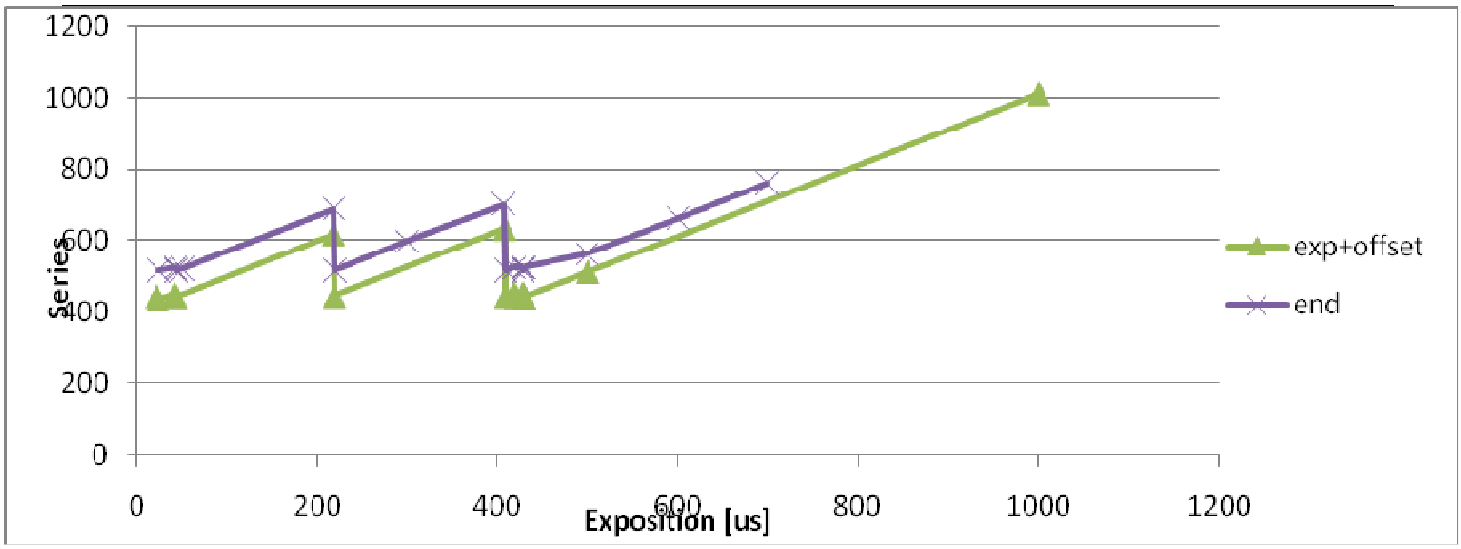
Exposition	Offset	Total Time
1000	2000	2000
500	1000	1000
430	860	860
429	858	858
428	856	856
419	838	838
418	836	836
409	818	818
408	816	816
219	438	438
218	436	436
43	86	86
42	84	84
23	46	46
22	44	44

These results are summarized in the following chart where x axis represents exposition time in µs and on the y axis are depicted values of offset, exposition and total time (exposition + offset).



Another interesting observation was the real end of exposition. Theoretically exposition should end after trigger offset + exposition value time. However, in practice even LED pulses after that period of time were captured on the image. This is partly explained by the time that it takes for the sensor to move acquired image values from sensitive sensor area to the internal buffer. During this period the sensitive sensor cells are still being exposed and therefore are capturing the image.

Exposition[us]	Theoretical End of Exposition	Measured End of Exposition	Difference	Real Exposition time
700	712	764	52	752
600	612	664	52	652
500	512	564	52	552
430	442	524	82	512
429	443	516	73	502
428	452	524	72	500
418	454	524	70	488
409	445	516	71	480
407	633	704	71	478
300	526	598	72	372
219	445	516	71	290
218	618	690	72	290
50	450	522	72	122
43	443	516	73	116
42	452	524	72	114
23	433	516	83	106



8 Conclusion

An experimental measurement of hardware trigger timings for MR11002 was performed. Offset time between issuing a trigger and the actual start of acquisition was measured and depicted in a chart. It can be concluded that for exposition times greater than 430µs the offset is constant and equal to 12µs, so the image acquisition start precisely 12 µs after a trigger is received by MR11002 camera. For exposition values lower than 430µs the offset increases in steps and therefore the exposition starts with a delay.
Therefore for applications where it is important to know the precise time when exposition was started it is recommended to use exposition times greater than 430 µs, which is sufficient for most of the typical applications. For applications where it is absolutely necessary to use exposition times lower than 430 µs it is important to bear in mind the increasing time offset between trigger and the start of exposition and include that in the subsequent calculations and results.
Another aspect covered in the performed measurements is real exposition duration. Due to the fact that sensor continues image acquisition during the data transfer from the sensitive part to the internal buffer, the real exposition time is somewhat prolonged. For applications that are very sensitive to this characteristics, these results should also be considered.