



Naftali Kirsh &lt;naftali.kirsh@mail.huji.ac.il&gt;

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**Support ticket #1951: Noise and low-power measurements with ADQ412**11 messages

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**Stefan Ahlqvist** <stefan.ahlqvist@spdevices.com>

Mon, Nov 17, 2014 at 4:46 PM

To: Naftali Kirsh &lt;naftali.kirsh@mail.huji.ac.il&gt;

Cc: Ulrik Lindblad &lt;ulrik.lindblad@spdevices.com&gt;, Jan-Erik Eklund &lt;jan-erik eklund@spdevices.com&gt;

Hello,

I have registered a support ticket for your report (#1951).

At a rough first glance it looks like the raw ADC performance is in line with comparing to our measurements and specification of the product.

When you do Waveform Averaging, there are some other things that may help (or not help) in reducing this noise. Some questions:

- How is your triggering scheme set up for the pulse? (internal, sw, external, pxie, user-defined?)
- Is the trigger synchronous to the digitizer?

We do also have a special developed algorithm called DBS (Digital Baseline Stabilization) that are used by some of our customers, in the application fields of characterizing pulses that are averaged with many triggers. That function has been a real revolution for those customers, and it may be something that you would be interested in.

Regarding (1): No, you are correct, there's no way to perform hardware WFA in ADCaptureLab.

Regards,

Stefan

**Stefan Ahlqvist**

Development Manager

Signal Processing Devices Sweden AB

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**Naftali Kirsh** <naftali.kirsh@mail.huji.ac.il>  
To: Stefan Ahlqvist <stefan.ahlqvist@spdevices.com>  
Cc: Ulrik Lindblad <ulrik.lindblad@spdevices.com>, Jan-Erik Eklund <jan-erik eklund@spdevices.com>

Tue, Nov 18, 2014 at 11:28 AM

Hi,

Thank you for the quick response.

1. I use an external trigger which is synchronized with the signal. Both the DAC which outputs the signal and trigger and the digitizer are synchronized using the same 10 MHz reference (which is connected to the "CREF IN" port of the ADQ). I call the ADQ412\_SetClockSource API command with the "external reference" (=1) option before setting-up triggering and WFA.
2. Regarding compliance with the device spec: as I wrote, to my understanding, 12 bits with input range of 800 mV p2p should support signals with a p2p voltage of 0.2 mV without a significant noise (according to the data sheet SNR should be ~50 dB), the results of measurements which I send you have a low SNR, which might be unacceptable for our applications. Even with ~1mV p2p voltage the measurements are very noisy.
3. Can you give more details about the DBS algorithm: is it relevant only when the same identical pulse is repeated, or also when we average on different pulses? is it implemented in firmware or software?

Thanks,  
Naftali Kirsh  
Racah Institute of Physics,  
Hebrew University,  
Jerusalem, Israel

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**Stefan Ahlqvist** <stefan.ahlqvist@spdevices.com>  
To: Naftali Kirsh <naftali.kirsh@mail.huji.ac.il>  
Cc: Ulrik Lindblad <ulrik.lindblad@spdevices.com>, Jan-Erik Eklund <jan-erik eklund@spdevices.com>

Tue, Nov 18, 2014 at 3:59 PM

OK, the measurement method itself will not reduce any of the systematic errors of the interleaved ADC array, it will assure to keep them. If you for instance would have triggered with a non-phase-locked clock, those systematic errors would have been smeared out – higher number of averages = lower systematic errors.

3) In our recent newsletter, there is a very short explanation of DBS in a PDF (just click the DBS icon in the newsletter). It is relevant for any type of pulses (with the definition of a pulse being present a small amount of the total time). It is a firmware function. I think it could get you very much better performance in this case. In addition to that, if it would be possible to NOT have the digitizer and generating sensor to be phase-locked, it could help with additional decibels.

Link to newsletter:

<http://spdevices.com/index.php/newsletter-10>

Regards,

Stefan

**Stefan Ahlqvist**

Development Manager

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**Från:** Naftali Kirsh [<mailto:naftali.kirsh@mail.huji.ac.il>]**Skickat:** den 18 november 2014 10:28**Till:** Stefan Ahlqvist**Kopia:** Ulrik Lindblad; Jan-Erik Eklund**Ämne:** Re: Support ticket #1951: Noise and low-power measurements with ADQ412

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**Naftali Kirsh** <[naftali.kirsh@mail.huji.ac.il](mailto:naftali.kirsh@mail.huji.ac.il)>

Wed, Nov 19, 2014 at 9:31 AM

To: Nadav Katz <[katzn@phys.huji.ac.il](mailto:katzn@phys.huji.ac.il)>

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**Naftali Kirsh** <[naftali.kirsh@mail.huji.ac.il](mailto:naftali.kirsh@mail.huji.ac.il)>

Wed, Nov 19, 2014 at 4:58 PM

To: Stefan Ahlqvist <[stefan.ahlqvist@spdevices.com](mailto:stefan.ahlqvist@spdevices.com)>Cc: Ulrik Lindblad <[ulrik.lindblad@spdevices.com](mailto:ulrik.lindblad@spdevices.com)>, Jan-Erik Eklund <[jan-erik eklund@spdevices.com](mailto:jan-erik eklund@spdevices.com)>, Nadav Katz <[katzn@phys.huji.ac.il](mailto:katzn@phys.huji.ac.il)>

Hi again,

Thank you for your answers.

1. For our experiments we must everything to be phase-locked.
2. Can you suggest a way to get rid of the systematic errors? I tried to find out how do they couple to the signal. It doesn't seem that the errors measured with no input are only added to/multiply the signal. Is there a way to subtract these errors?
3. Regarding the DBS algorithm: if I understand correctly it helps when the signal baseline changes during the measurements due to external drifts, such as temperature changes, but here we have systematic reproducible errors which seem to be related to the ADQ device itself, and not to external changes.

P.S

I have added Nadav (our lab's PI) as Cc, please keep him corresponded.

Thanks,  
Naftali Kirsh  
Racah Institute of Physics,  
Hebrew University,

Jerusalem, Israel

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**Stefan Ahlqvist** <stefan.ahlqvist@spdevices.com>

Wed, Nov 19, 2014 at 5:09 PM

To: Naftali Kirsh <naftali.kirsh@mail.huji.ac.il>

Cc: Ulrik Lindblad <ulrik.lindblad@spdevices.com>, Jan-Erik Eklund <jan-erik.eklund@spdevices.com>, Nadav Katz <katzn@phys.huji.ac.il>

1. Can you explain why you have to keep the ADQ412 digitizer phase-locked with the source? If you only use the digitizer at “the end” of the chain in the experiment it should not be necessary (if I haven’t overlooked some detail that is not in my knowledge). Of course, if you use trigger out or other such functions, phase-locking may be necessary anyway. To spread the trigger over the ADC phases would suppress this noise greatly when you average 64k records or more.

3. The DBS algorithm takes care of these errors also to a good extent; it’s not really clear from the short-handed information document.

The “problem” is that there is significant variations in the systematic errors, on a per-sample basis they are added/multiplied but over time it changes quite rapidly. That is one of the reasons that the DBS approach works so elegantly for this. From a pure technical point of view I would suggest to try out the DBS algorithm for this application. I will have to bring my colleague Ulrik Lindblad in the discussion for any commercial conditions & terms, though.

Regards,

Stefan

### Stefan Ahlqvist

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**Från:** Naftali Kirsh [<mailto:naftali.kirsh@mail.huji.ac.il>]

**Skickat:** den 19 november 2014 15:59

**Till:** Stefan Ahlqvist

**Kopia:** Ulrik Lindblad; Jan-Erik Eklund; Nadav Katz

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**Ulrik Lindblad** <ulrik.lindblad@spdevices.com>

Mon, Dec 1, 2014 at 5:38 PM

To: Stefan Ahlqvist <stefan.ahlqvist@spdevices.com>, Naftali Kirsh <naftali.kirsh@mail.huji.ac.il>

Cc: Jan-Erik Eklund <jan-erik eklund@spdevices.com>, Nadav Katz <katzn@phys.huji.ac.il>

Dear All,

Sorry for the delay in me getting back to you on this.

How are things progressing?

Best regards,

/Ulrik

**Ulrik Lindblad**

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**From:** Stefan Ahlqvist

**Sent:** den 19 november 2014 16:10

**To:** Naftali Kirsh

**Cc:** Ulrik Lindblad; Jan-Erik Eklund; Nadav Katz

**Subject:** SV: Support ticket #1951: Noise and low-power measurements with ADQ412

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**Naftali Kirsh** <naftali.kirsh@mail.huji.ac.il>

Tue, Dec 2, 2014 at 10:38 AM

To: Ulrik Lindblad <ulrik.lindblad@spdevices.com>

Cc: Stefan Ahlqvist <stefan.ahlqvist@spdevices.com>, Jan-Erik Eklund <jan-erik eklund@spdevices.com> ,

Nadav Katz <katzn@phys.huji.ac.il>

Hi,

We are still checking and trying to overcome this issue, but we are very disappointed with the product.

Why was this issue not mentioned in all our long technical discussions?

We always implicitly assumed that although there is noise, given in the spec, it is not technical, invariant noise, and that it will properly average to zero upon many samplings.

We need the clock synchronizations, since our measurements are multiplexed IQ phase sensitive to 100s of MHz's and a smearing of a few nsec is unacceptable! This DBS algorithm, although not detailed to us, seems to be a form of a low-pass filter that will smear this background/noise signal out. Again, this is not what we need. This is not why we chose your product!

Since this is a constant noise, why is there no appropriate narrowband algorithm to deconvolve it from the signal? It seems to be mixing with our signal in a nontrivial, but reproducible way...

Looking forward to a firmware/FPGA/software update that will overcome this, at the single shot level. We are willing to take calibration measurements that can then be used for a reliable "deconvolving" of this unwanted background.

Thanks,

Naftali and Nadav.

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**Ulrik Lindblad** <ulrik.lindblad@spdevices.com>

Tue, Dec 2, 2014 at 10:48 AM

To: Naftali Kirsh <naftali.kirsh@mail.huji.ac.il>

Cc: Stefan Ahlqvist <stefan.ahlqvist@spdevices.com>, Jan-Erik Eklund <jan-erik.eklund@spdevices.com>, Nadav Katz <katzn@phys.huji.ac.il>

Hi Naftali,

I am very sorry to hear that you are disappointed with the product, and we will of course do whatever we can to change that.

I cannot say why this did not come up during our discussions, but as you probably understand it is never our intention to deliberately mislead our customers in any way since it is never good to have disappointed customers.

Let me discuss further with engineering to see if we can come up with something.

I will get back to you as soon as possible.

Thank you and best regards,

/Ulrik

**Ulrik Lindblad**

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**From:** Naftali Kirsh [mailto:[naftali.kirsh@mail.huji.ac.il](mailto:naftali.kirsh@mail.huji.ac.il)]  
**Sent:** den 2 december 2014 09:39  
**To:** Ulrik Lindblad  
**Cc:** Stefan Ahlqvist; Jan-Erik Eklund; Nadav Katz  
**Subject:** Re: Support ticket #1951: Noise and low-power measurements with ADQ412

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**Stefan Ahlqvist** <[stefan.ahlqvist@spdevices.com](mailto:stefan.ahlqvist@spdevices.com)> Tue, Dec 2, 2014 at 4:58 PM  
To: Naftali Kirsh <[naftali.kirsh@mail.huji.ac.il](mailto:naftali.kirsh@mail.huji.ac.il)>  
Cc: Jan-Erik Eklund <[jan-erik eklund@spdevices.com](mailto:jan-erik eklund@spdevices.com)>, Nadav Katz <[katzn@phys.huji.ac.il](mailto:katzn@phys.huji.ac.il)>, Ulrik Lindblad <[ulrik.lindblad@spdevices.com](mailto:ulrik.lindblad@spdevices.com)>

Hello,

Unfortunately further calibration measurements is not part of the solution, as the “unwanted background” has significant random frequency content which is not possible to estimate/predict by measurements. By not possible I mean that we have investigated this extensively and come to that conclusion, and we are a company with leadership in ADC characterization and postprocessing algorithms.

The unwanted background is directly originating from how this ADC part (which is on the board) works, after the calibration done by the ADC manufacturer, the ADC part’s internal background calibration and the calibration we perform of the whole digitizer.

No, that is not a good description of DBS. Actually it is more of a narrowband algorithm that attenuates the errors you have problems with greatly. So I am quite sure it will help much, but there is always an uncertainty as to if you would reach your desired numbers and if it will work well with all the for us unknown ifs and buts that are properties of each specific acquisition task/experiment. If you have a locked clock, the averaging itself will not attenuate the systematic errors between the interleaved ADC cores. If you unlock the clock, you will have sample precision of the triggering, not several nanoseconds. However also sample precision is not as tight as locking the clocks are.

DBS is designed for pulsed applications, where there is a defined baseline that the signal is close to, a significant amount of the total time. It would be a good idea to try it out at least, to see how it fits your experiment.

Regards,

Stefan

**Stefan Ahlqvist**

Development Manager

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**Från:** Naftali Kirsh [<mailto:naftali.kirsh@mail.huji.ac.il>]**Skickat:** den 2 december 2014 09:39**Till:** Ulrik Lindblad**Kopia:** Stefan Ahlqvist; Jan-Erik Eklund; Nadav Katz

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**Ulrik Lindblad** <[ulrik.lindblad@spdevices.com](mailto:ulrik.lindblad@spdevices.com)>

Mon, Dec 8, 2014 at 2:54 PM

To: Naftali Kirsh <[naftali.kirsh@mail.huji.ac.il](mailto:naftali.kirsh@mail.huji.ac.il)>Cc: Nadav Katz <[katzn@phys.huji.ac.il](mailto:katzn@phys.huji.ac.il)>, Stefan Ahlqvist <[stefan.ahlqvist@spdevices.com](mailto:stefan.ahlqvist@spdevices.com)>

Naftali,

Sorry for the lack of follow-up on this - we are under very heavy work load at that moment due to the upcoming Holidays.

I just want you to know that we stay committed to doing everything in our power to help you out.

I understand and respect that you are disappointed about the outcome so far, and whereas I cannot give any promises in terms of technical aspects I can certainly promise that we do not intend to "abandon" you.

It is not my intention to make you spend a lot of time "reporting back" to us, but please keep us informed and we'll do our best to help you out.

Admittedly I am not following all the technical aspects of the discussion, but if you feel that for example a telephone conference would be of help then please let me know and I'll try set something up.

Best regards,



/Ulrik

**Ulrik Lindblad**

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**From:** Stefan Ahlqvist

**Sent:** den 2 december 2014 15:58

**To:** Naftali Kirsh

**Cc:** Jan-Erik Eklund; Nadav Katz; Ulrik Lindblad

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