Getting 4 GSPS at 14 bits resolution from ADQ14-2X

The ADQ14-2X is a leading 14 bits digitizer featuring 2 channels sampling at 2 GSPS each. This application note illustrates how to combine the 2 channels into a single channel with outstanding sample rate for pulse capture.

- Remarkable 4 GSPS at 14 bits resolution for pulse capture
- Matching enabled by SP Devices’ technology DBS
- Combine with SP Devices’ advanced thresholding and waveform averaging
1 Reaching 4 GSPS with 14 bits resolution

The market leading 14 bits digitizer ADQ14-2X operate 2 channels at 2 GSPS each. This application note shows how to take this specification further and combine the inputs for faster pulse capture by interleaving. Interleaving in itself is an established method for increasing sample rate. But it is only in combination with signal processing from SP Devices that the systems performance is preserved and the artifacts from interleaving is removed.

For example, the baseline matching of the channels has to drastically improve to benefit from the high resolution of the digitizer. SP Devices’ proprietary technology for baseline stabilization, DBS, enables this performance boost.

DBS, ADX are proprietary technologies of SP Devices for adaptive signal correction. Schematics of the setup is in Figure 1. The introduction to SP Devices’ technologies for signal enhancement are in Section 2.

![Figure 1: Block diagram](image)

<table>
<thead>
<tr>
<th>#</th>
<th>DESCRIPTION</th>
<th>REFERENCE</th>
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</thead>
<tbody>
<tr>
<td>a</td>
<td>The analog signal is split into 2 branches</td>
<td>15-1593 ADQ14 manual</td>
</tr>
<tr>
<td>b</td>
<td>The one branch is delayed through 250 ps delay-line. This is one clock period at 4 GSPS. The delay-line can be built by adjusting the cable length. 250 ps is in the order of 50 mm, but may differ for different cables.</td>
<td>14-1290 ADQ14 datasheet Section 2</td>
</tr>
<tr>
<td>c</td>
<td>The ADQ14-2X is a unique digitizer with 2 interleaved inputs at 2 GSPS. Interleaving those in again reaches 4 GSPS.</td>
<td>Section 2</td>
</tr>
<tr>
<td>d</td>
<td>SP Devices provides proprietary IP for signal enhancement. The ADX is an algorithm for interleaving of A/D converters which his is available on interleaved models. The DBS is a baseband stabilizer.</td>
<td>Section 2</td>
</tr>
<tr>
<td>e</td>
<td>Advanced threshold included in the –FWATD firmware package</td>
<td>Section 3</td>
</tr>
<tr>
<td>f</td>
<td>Waveform averaging included in the –FWATD firmware package</td>
<td>Section 3</td>
</tr>
<tr>
<td>g</td>
<td>The double buffer FIFO handles data transfer to the host PC to avoid dead-time.</td>
<td>15-1593 ADQ14 manual</td>
</tr>
<tr>
<td>h</td>
<td>The Super speed USB or the PCIe transfers streaming data to the host PC for further analysis.</td>
<td>15-1593 ADQ14 manual</td>
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</table>

2 Channel matching from SP Devices’ digital signal processing expertise

SP Devices’ proprietary technology for time interleaving of ADCs, ADX, which enables unique performance in digitizers. ADX handles the typical artifacts, which are well known for interleaved digitizers. The performance with ADX is typically as good as the ADC components in itself, which means that the sample rate can be increased with maintained high dynamic range.

For pulse data system, the baseline is a reference point in calculating timing and energy. SP Devices’ proprietary technology Digital Baseline Stabilizer, DBS, is an interleaving technology for pulse data system, that tracks and adjusts the baseline with up to 22 bits precision.
3 Real-time signal processing

3.1 Firmware option –FWATD

The waveform averaging firmware –FWATD can be configured to operate on 4 GSPS data stream\(^1\).

3.2 Firmware option –FWPD

The pulse detection firmware –FWPD will be available for a 4 GSPS data stream\(^2\).

4 Result

The configuration is tested on an asynchronous 1 ns pulse, Figure 2. The figure contains the sample points for all individual records. One typical record is highlighted and the average of the records is marked. DBS is activated\(^3\).

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1. The threshold function is not yet implemented for 4GSPS. Contact SP Devices for more information.
2. Contact SP Devices for more information.
3. DBS is preferred for pulse applications and ADX for RF applications.
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