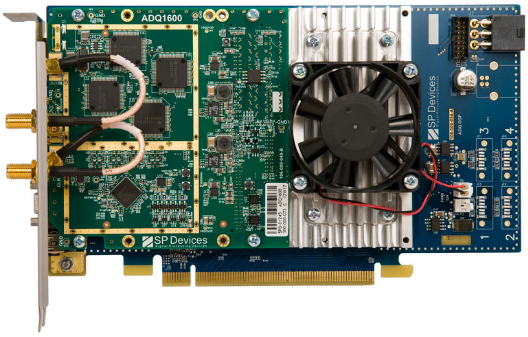

Application Note:
Biased input for unipolar pulses

Some of the ADQ series of digitizers is offered with a biased input. This is used for systems with unipolar pulses. A biased analog input makes it possible to use the entire signal range for the unipolar signal. This document is based on ADQ1600-PB. Differences may exist on other digitizer models.

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1 Introduction

The ADQ series of digitizers is available with a positive or negative bias applied to the input. The application note describes the properties of the biased input. The bias is fixed and installed at production. All examples in this documents assume a positive bias of 90% on an ADQ1600-PB digitizer[1]. The discussion in, however, valid for any positive or negative bias.

A typical application is a charge detector, where all signals have the same polarity. The system has a baseline and the pulses are unipolar from this baseline. By applying a bias on the analog input of the digitizer, the entire signal range can be used for the pulse. **Figure 1** illustrates how the signal range of the digitizer is optimized to capture a pulse with large amplitude.

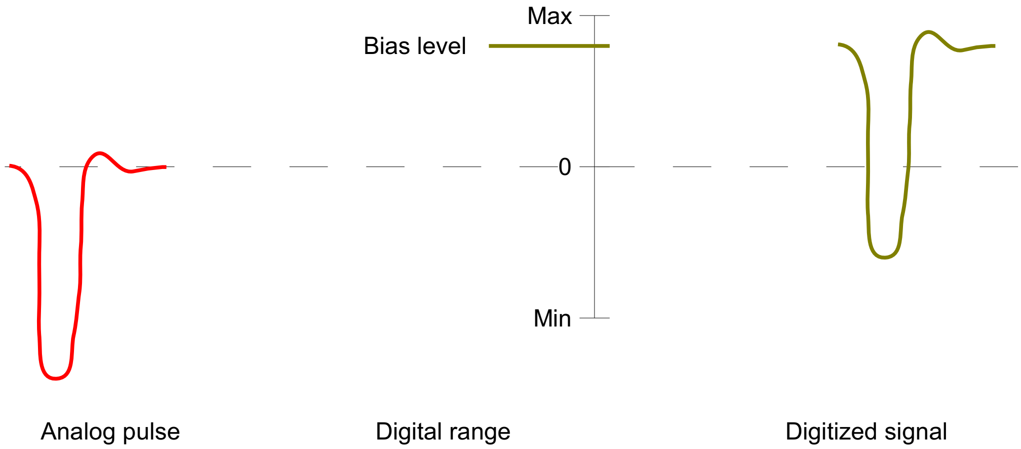

Figure 1: Signal levels for positive bias in a pulsed system.

2 Definition of bias level

The bias level is defined in percent of the total range. In this document, a positive bias of 90 % is applied to a 14 bits converter. The 14 bits converter has 2^{14} = 16384 codes with values ranging from –8192 to +8191. This means that 90 % bias correspond to the digital code 16384 * 0.9 –8192 = 6554. In calibration, this number is rounded to 6500.

The analog input is biased to 90 % of the range. The range for ADQ1600 is 2 Vpp. The bias is at 90 % of 2 V, meaning that the negative pulses can be up to –1.8 V and the positive overshoot can be 0.2 V.

1. There may be deviations on other digitizer models with positive bias.

3 Implementation

The block diagram for the implementation is shown in **Figure 2**. This diagram is used in the following description.

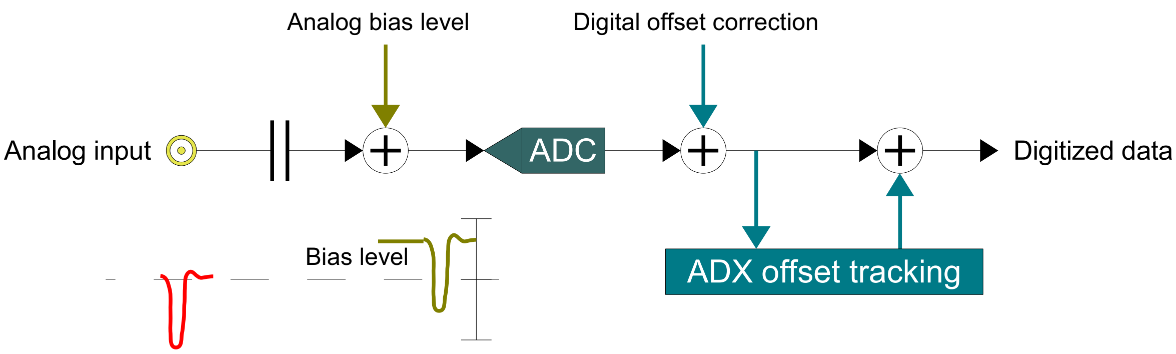

Figure 2: AC coupled biased input and digital correction.

4 Analog input

The analog input is AC coupled. The circuitry for the positive bias is placed after the AC coupling. It is therefore not seen on the analog input connector, **Figure 2**.

5 Calibration

The analog bias level is determined by electrical components with tolerances. The analog level is thus not exact. A digital calibration procedure is done at production to compensate for component mismatch. During the calibration, the offset level is measured and a compensation value is calculated. The compensation value is then is added to the digital signal out from the ADC in real time, **Figure 2**.

Since the calibration is digital, it will move the signal range and a few codes in one end will be lost. In the example in **Figure 3**, the analog bias is a bit too low. A digital correction is added to move the offset level to the desired ideal bias level. This is done digitally by adding a number to the digitized signal. The addition will also influence the range and a small part of the digital range will not be used. This unused range is in the order of a few percent and can be neglected in most systems.

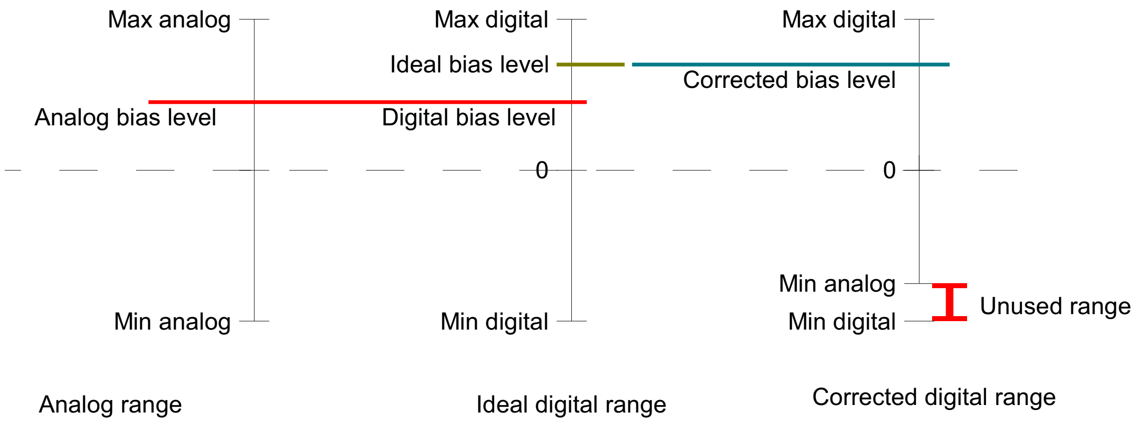

Figure 3: Example of calibrated positive bias. A few percent loss in signal range.

Table 1 list examples of digital calibration parameters. Calibration is done so that a zero analog input result in a digital code value at the calibration level. The maximum value of calibration parameter is the maximum level of unused rage in Figure 3.

MODEL	BIAS	CALIBRATION LEVEL	CALIBRATION PARAMETER MAX
ADQ1600	Positive bias 90%	6500 [codes]	500 [codes]

Table 1: Calibration levels for one case.

6 Base line tracking

The digital calibration is done at one occasion in the production. To follow fluctuations in the bias level over time, the SP Devices' proprietary interleaving technology ADX is included in the digitizer. ADX constantly analyzes the offset in the background updates correction parameters during operation, Figure 2. Read more about ADX in general in [2] and how to control ADX in [3].

7 User setting

It is possible to do an offset adjustment in user's software by using the SetGainAndOffset()-command, [1]. The calibration may also be bypassed by the SetGainAndOffset()-command. An offset adjustment procedure is typically

1. Terminate the analog input with 50 Ohms
2. Collect a large set of data and measure the offset as the mean value.
3. Set offset by using the SetGainAndOffset()-command.
4. Set target level in ADX.

Note that if ADX is activated and set to track to a certain level, any adjustment may be overruled by ADX. It is therefore necessary to, either set ADX to follow the offset in one of the interleaved ADCs or adjust the target level of ADX, [3].

8 Absolute maximum ratings

The bias in as analog signal level at the input of the sensitive analog to digital converters. This analog signal is added to the input signal as an offset. The result is that absolute maximum ratings is not symmetric. A positive biased digitizer will be more sensitive to positive pulses than to negative pulses. See **Table 2** for a comparison between biased and not biased inputs.

MODEL	BIAS	LIMITS	CONDITION
ADQ1600	No bias	+/– 2.15 V	Low frequency (<10MHz)
ADQ1600	No bias	+/– 4.3 V	High frequency (>10MHz)
ADQ1600-PB	Positive bias 90%	+ 1.76 V – 3.84 V	Low frequency (<10MHz)
ADQ1600-BP	Positive bias 90%	+ 3.54 V – 5.28 V	High frequency (>10MHz)

Table 2: Example of absolute maximum ratings for ADQ1600-PB (with biased input) and ADQ1600 without bias.

9 References

[1] "ADQ-API User Guide", 08-0214_ADQ-API_ug.pdf, SP Devices' software installation.

[2] "Digital Time-Interleaved ADC Mismatch Error Correction Embedded into High-Performance Digitizers", Per Löwenborg, white paper, doc no 13-1004, SP Devices' web.

[3] "13-0962-ADX_IP_user_guide_for_ADQ_A.pdf", SP Devices' software installation.

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