Q.Tip: Implementation Method of Q.bloxx & Q.bloxx-EC Filters

Introduction:
The digital input filter of the Q.bloxx and Q.bloxx-EC modules is part of the FPGA software. The filter is working with the internal frequency of the AD converters.

Sample Frequencies:
- 100 kHz per channel Modules: A101, A123, A124, and A128
- 10 kHz per channel Modules: A107, A108, and A116
- 100 Hz per channel Modules: A103 and A104 (these multiplexed modules do not have a filter included in the FPGA, a 1st order Lowpass filter is calculated in the DSP)

Filter Features:
The book called Digital Signal Processing was used as a guideline for the implementation of the filters. This book is available online via: http://www.dspguide.com/whatdsp.htm

Algorithm Features:
The basic information about the currently implemented algorithm can be read in chapter 20 of the DSP signal processing document. Inquire with Gantner Instruments technical support personnel to obtain this document.

The currently implemented filter is a Chebishev filter. The basic features of this implementation are:
- Chebyshev filter
- Type 1, ripple only allowed in the pass band
- The ripple is set to 0% > the filter is called the maximally flat or Butterworth filter
- The filter is implemented as 4 filters with 2nd order
- The filter configurations:
  - 4th order low pass (LP)
  - 4th order high pass (HP)
  - 4th order band pass (BP) – (4th order LP and 4th order HP)
  - 1st order 20dB/decade > 4th order 80dB/decade

FPGA Implementation Features:
- The filter is implemented with integer arithmetic
- The intermediate results are currently up to 72 bit wide
- The filter frequency ratio is possible up to 1/1000000 (i.e. A101 100 kHz > 0.1 Hz low pass frequency)

Available Parameters sets on the Module:
- Low pass (LP):
  - 1, 2, 5
  - 10, 20, 50
  - 100, 200, 500
  - 1000, 2000, 5000
  - 10000
- High pass (HP):
  - 0.1, 1, 10, 100

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The frequencies are not for all kind of sample rates available:

High Pass (HP):

Filter Ratio	100 kHz	10 kHz
0.0000001	0.1	0.01
0.000004		
0.000005		
0.00001	1	0.1
0.00004		
0.00005		
0.0001	10	0.1
0.0004		
0.0005		
0.001	100	10
0.004		
0.005		
0.01	1k	100
0.02	2k	
0.03	3k	
0.04		
0.05	5k	500

Low Pass (LP):

Right now, not all ratios are available for all sample frequencies. The available ratios are defined in this table. The filter ratio = cut_off_frequency / sample_frequency

Filter Ratio	100 kHz	10 kHz
0.000005		
0.000008		
0.00001	1	0.1
0.00002	2	0.2
0.000025		
0.00004		
0.00005	5	0.5
0.00008		
0.0001	10	1
0.0002	20	2
0.00025		
0.0004		
0.0005	50	5
0.0008		
0.001	100	10
0.00175		
0.002	200	20

0.0025		
0.004		
0.005	500	50
0.008		
0.01	1k	100
0.02	2k	200
0.025		
0.04		
0.05	5k	500
0.1	10k	1k

Band Pass (BP):

The band pass is possible for all combinations above.

Contact us today if you have any further questions!

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