# SIS3316 Average Mode of Operation

Averaging mode is available starting with ADC firmware version 0x02500004.
Originally this mode was implemented for the maXs (Micro-Calorimeter Arrays for High Resolution X-ray Spectroscopy) application. You can average 4, 8, 16, 32, 64, 128 or 256 samples (defined by the setting of the three average mode bits), program a 12-bit wide average pretrigger delay and define a 16-bit wide number of averaged samples (average sample length) to be aqcuired. The internal clock range from 10 MHz to 125 MHz corresponds to a sampling speed of some 40 KSPS to 500 KSPS in combination with 256 sample averaging. The average count status information in the data allows for timing of the first sample of the first averaged value relative to the trigger as illustrated below. The averaged values are shifted to 16-bit to enable storage of two averaged samples in one 32-bit data word.

Especially with a higher number of samples to be averaged, the effective number of bits (ENOB) is virtually equal to the nominal number of bits.

Raw data (written to the Memory with „Raw_Buffer_Start_Index" = 0)
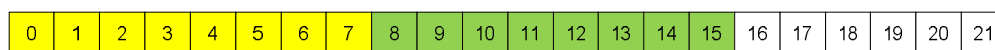
average count status = 0
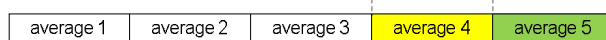
Averaged data
- written to the Memory with „Average Pretrigger Delay" = 0
- Average Mode = 2 -> average over 8 samples

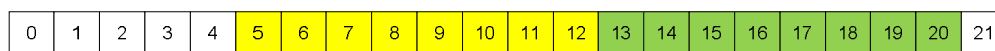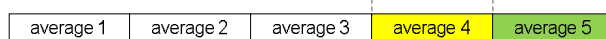Raw data (written to the Memory with „Raw_Buffer_Start_Index" = 0)

average count status = 5

Averaged data
- written to the Memory with „Average Pretrigger Delay" = 0
- Average Mode = 2 -> average over 8 samples

SIS3316 Average Data Format

The data format with averaging mode is illustrated below.
You can store raw data in addition to averaged data to allow for higher resolution sampling at the leading edge of the signal e.g.

31	16	15	4	3	0
Timestamp [47:32]		Channel ID		Format bits	
Timestamp [31:16]		Timestamp [15:0]			
Index of Peakhigh value [15:0]		Peakhigh value [15:0]			
Information [7:0]		Accumulator sum of Gate 1 [23:0]			
"0000"	Accumulator sum of Gate 2 [27:0]				
"0000"	Accumulator sum of Gate 3 [27:0]				
"0000"	Accumulator sum of Gate 4 [27:0]				
"0000"	Accumulator sum of Gate 5 [27:0]				
"0000"	Accumulator sum of Gate 6 [27:0]				
"0000"	Accumulator sum of Gate 7 [27:0]				
"0000"	Accumulator sum of Gate 8 [27:0]				
"0000"	MAW maximum value [27:0]				
"0000"	MAW value after Trigger [27:0]				
"0000"	MAW value before Trigger [27:0]				
Start Energy value (Energy value from first value of Trigger Gate)					
Max. Energy value (during Trigger Gate active)					

If Format bit 0 = 1

If Format bit 1 = 1

If Format bit 2 = 1

If Format bit 3 = 1

31-28	27	26	25-0
0xE Or 0xA	MAW Test Flag	RePileup or Pileup Flag	number of raw samples (x 2 samples, 32-bit words)

0xE : end of header

0xA : an average entry follows

31-28	27-24	23-16	15-0
0xE	reserved	average count status	number of average samples (x 2 samples, 32-bit words)

ADC raw data if number of raw samples != 0x0

sample 2	sample 1
sample 4	sample 3

sample N	sample N-1

ADC average data if number of average samples != 0x0

average 2	average 1
average 4	average 3

average N	average N-1

MAW Test data

Information [7:0]

- bit 7: Overflow flag
- bit 6: Underflow flag
- bit 5: RePileup flag
- bit 4: Pileup flag
- bit 5-0: reserved