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Engineering Note

Topic: Pixel Rotation with S2000 Spectrometers

Product Affected: S2000 Spectrometer

Date Issued: 10/14/2004

Overview

Ocean Optics' S2000 Spectrometer platform supports stacking slave spectrometers on top of the master spectrometer. In the normal operating mode, data is acquired sequentially from the stack of spectrometers. The master's data is acquired first, then data from the first slave, then data from the second slave, etc. When all channels have been acquired, the master channel once again acquires data.

At an electronic level, all optical benches are acquiring and reading out spectral data during each acquisition period. It is the responsibility of the A/D card to select which spectrometer channel to "listen" to when the spectrometers read out their data.

Pixel Rotation Mode

With the introduction of the ADC1000 product line (ADC1000 and ADC1000-USB) and subsequently the ADC2000-PCI, Ocean Optics added a feature called Pixel Rotation. The purpose of this mode is to read out spectral data from all spectrometers in the stack with each acquisition cycle. Pixel Rotation does this by switching which spectrometer it is digitizing data from with each pixel acquired.

This example uses a 3-channel spectrometer system with a master and two slaves. In Normal mode, the Master's data is acquired, then the data from Slave 1, then the data from Slave 2. In Pixel Rotation mode, pixels are acquired as outlined in the table below:

Pixel	Spectrometer Channel
0	Master
1	Slave 1
2	Slave 2
3	Master
4	Slave 1

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Pixel	Spectrometer Channel
5	Slave 2
6	Master
7	Slave 1
8	Slave 2
9	Master
10	Slave 1
11	Slave 2
. . .	. . .
2046	Master
2047	Slave 1

In this example, 1/3 of the pixels are acquired from each of the spectrometer channels. For Ocean Optics software to accurately present the data, the device driver interpolates the missing pixels. A linear interpolation is performed to fill in these missing pixels, as shown below:

Pixel	Master	Slave 1	Slave 2
0	Acquired	Interpolated	Interpolated
1	Interpolated	Acquired	Interpolated
2	Interpolated	Interpolated	Acquired
3	Acquired	Interpolated	Interpolated
4	Interpolated	Acquired	Interpolated
5	Interpolated	Interpolated	Acquired
6	Acquired	Interpolated	Interpolated
7	Interpolated	Acquired	Interpolated
8	Interpolated	Interpolated	Acquired
9	Acquired	Interpolated	Interpolated
10	Interpolated	Acquired	Interpolated
11	Interpolated	Interpolated	Acquired
. . .			
2046	Acquired	Interpolated	Interpolated
2047	Interpolated	Acquired	Interpolated

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One consequence of this method of data acquisition is that pixel resolution is sacrificed. If enough channels are acquired in Pixel Rotation mode, it is possible that spectral features will be missed.

Special Pixel Rotation Mode

With the recent release of the ADC2000-PCI+ A/D, Ocean Optics provides a new pixel rotation mode in which pixel information is not lost. It accomplishes this by slowing down the master clock of the A/D, causing the spectrometer stack to read out spectral data at a slower speed. Decreasing the read-out speed allows the A/D card to switch the channel that it is digitizing repeatedly during the readout of a single pixel. In this way, all pixels from all spectrometer channels are read out and returned to the software. Ocean Optics refers to this mode as Special Pixel Rotation mode. The only consequence of Special Pixel Rotation mode is that the minimum rotation time is dependent on the number of channels being acquired, as illustrated in the example below:

Number of Channels Acquired	Minimum Integration Time (msec)
0 (normal mode)	3
1	5
2	7
3	9
4	11
5	13
6	15
7	17

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