# FalconXn: Mapping Buffer Specification

The FalconX supports two high-speed data acquisition modes: MCA mapping mode (also called gated acquisition mode) and list mode. For MCA mapping mode, one full spectrum for each active channel is generated for each pulse on the GATE input. The list mode output, based largely upon the output available from the MAIA detector, can incorporate a wide variety of data into the output data stream: event energies (with or without time stamps), gate states, encoder values, as well as general time stamps – the list mode output data format is defined in a separate document. In order to provide a high level of backwards compatibility with existing applications for XIA spectrometers, we process the mapping data into formats similar to those used for high speed mapping on our DXP-Mercury and DXP-xMAP processors.

In mapping mode, the DXP processors use two independent memory buffers, which enables the processor to take data and store it in one buffer while the other buffer is read out by the host computer. The size of each buffer is 2MB, organized as 1Mword by 16 bits. For the FalconX, we use the same sort of ping-pong buffer scheme; however, the output buffers are built in computer memory, and do not have the same size constraints.

For all timing modes, the buffer starts out with a buffer header, containing general information about the data contained in the memory block. For MCA mapping mode, there is also a pixel header block for each time point, containing statistics information (used to make pileup corrections on a pixel by pixel basis) and other related data.

The format of the data contained in the buffers is described in detail in the following sections.

## *Buffer Header*

For all timing applications that use the dual buffers, the buffer header will have a fixed, 256-word length (16-bit words). The contents of the header are defined below:

| Word Number | Contents |
|---|---|
| 0 | Tag Word 0: 0x55AA |
| 1 | Tag Word 1: 0xAA55 |
| 2 | Buffer Header Size (=256) |
| 3 | Mapping Mode:<br>1: Full Spectrum<br>2: Reserved<br>3: List Mode |

| Word Number | Contents |
|---|---|
| 4 | Run Number |
| 5 to 6 | Sequential Buffer Number (low word first) |
| 7 | BufferID (0:A, 1:B) |
| 8 | Number of Pixels in buffer (0 for list mode) |
| 9 to 10 | Starting Pixel Number (low word first – 0 for list mode) |
| 11 | Module Serial Number?/Module # (not implemented) |
| 12 | Detector Channel |
| 13 | Detector Element (not implemented) |
| 14 to 19 | Reserved (set to 0) |
| 20 | Channel Size (number of words) (not implemented) |
| 21 to 23 | Reserved (set to 0) |
| 24 | Buffer errors: Buffer overrun<br>0: No error<br>>0: Number of extra pixels combined with last pixel in buffer<br>(not implemented) |
| 25 | Number of dropped pixels detected due to network errors |
| 26 to 27 | Total number of 16-bit words in buffer, including buffer header. Note that the FalconX list-mode data specification is organized around 32-bit words; there will be two 16-bit words used per raw 32-bit value. |
| 28 to 255 | Reserved (set to 0) |

## *Pixel Data Block*

For all mapping modes based upon pixels (or separate time periods of data collection), the data block for each pixel will start with a pixel header, followed by the data collected for the pixel. The header can differ in size for different mapping applications; in general, the header contains the statistics data required to make pileup corrections on a pixel-by-pixel basis (live time, real time, input triggers, and output events). The full data blocks are described below for the various mapping modes (for now, only full spectrum MCA mapping).

### Mapping Mode 1: Full Spectrum Mapping

The pixel header for full spectrum mapping mode is described below; due to the constraint in the DXP-Mercury that the spectra sizes are a multiple of 256 and must start on an even multiple of 256, the size of the pixel header is 256 words in this mode to maintain cross-compatibility.

The data block for full spectrum mapping mode contains the spectrum. The length of the spectrum can range up to 4096 channels. The format for the entire pixel block is described in the table below; please note that the pixel header definition is designed to be consistent with the xMAP, which requires room for three additional channels.

| Word Number | Contents |
|---|---|
| 0 | Tag Word 0: 0x33CC |
| 1 | Tag Word 1: 0xCC33 |
| 2 | Pixel Header Size (=256) |
| 3 | Mapping Mode (=1) |
| 4 to 5 | Pixel Number (low word first)<br>In the case of a mapping error where one pixel record combines data from several pixels, this is the number of the last pixel recorded. |
| 6 to 7 | Total Pixel Block size in words<br>(including header, low word first) |
| 8 | K: Number of words to store MCA (2 words per MCA bin) |
| 9 to 31 | Reserved (set to 0) |

| Word Number | Contents |
|---|---|
| 32 to 39 | Statistics:<br>Realtime (2 words, low word first, 320 ns per tick)<br>Livetime (2 words, 320 ns ticks)<br>Triggers (2 words)<br>Output events (2 words)<br>Note: when converting FalconX list mode data into mapping mode buffers, the statistics from the FalconX are converted to xMAP-style statistics. The statistics offered by the FalconXn are output events, Triggers, icr and ocr. Define xMAP statistics in terms of these values:<br>Realtime = output events/ocr<br>Livetime = Triggers/icr<br>Triggers = pulsesAccepted + pulsesRejected<br>Output events = pulsesAccepted |
| 40 to 56 | Channel Statistics, SITORO format:<br>Input Count Rate (double, 8 bytes)<br>Output Count Rate (double) |
| 57 to 254 | Reserved (set to 0) |
| 255 | Product Type (Not implemented) |
| 256 to (256 + K – 1) | Channel Spectrum (2 words/bin) |

## Mapping Mode 2: Reserved

This mode is reserved for Multiple SCA mapping.

## Mapping Mode 3: List Mode Mapping

For list mode, the events are not grouped into different pixels or time periods, so there is no need for a pixel header. The FalconX list mode buffers from Handel will consist of the 256-word buffer header followed by the list mode data as generated straight from the SITORO firmware. That list mode data specification is included as a separate document with each release of the FalconX firmware.