Nuclear Physics Division
Fast Electronics Group

SSP_MPD Event Format

Benjamin Raydo
4 September 2020

1. Readout Data Format

The SSP readout data format utilizes the same encoding scheme defined for the JLAB FADC250. The word length for the readout data is 32bits. The event length is variable and depends on several factors (detector occupancy, headers, trailers, filler words).

Data Word Categories

Data words from the module are divided into two categories: <u>Data Type Defining</u> (bit 31 = 1) and <u>Data Type Continuation</u> (bit 31 = 0). Data Type Defining words contain a 4-bit data type tag (bits 30 - 27) along with a type dependent data payload (bits 26 - 0). Data Type Continuation words provide additional data payload (bits 30 – 0) for the *last defined data type*. Continuation words permit data payloads to span multiple words and allow for efficient packing of various data types spanning multiple data words. Any number of Data Type Continuation words may follow a Data Type Defining word.

Data Type List

0	Block Header
1	Block Trailer
2	Event Header
3	Trigger Time
4	Reserved
5	MPD Data Frame
6	Reserved
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Data Not Valid (empty module)
15	Filler Word (non-data)

Data Type: Block Header

Type:	0x0
Size:	1 word
Description:	Indicates the beginning of a block of events. (High-speed readout of a board or a set of boards is done in blocks of events)

31	30	29	28	27	26	25	24
1	0	0	0	0		SLOTID	
23	22	21	20	19	18	17	16
SLOTID		0	0	0	0	BLOCK_NUMBER	
15	14	13	12	11	10	9	8
BLOCK_NUMBER							
7	6	5	4	3	2	1	0
BLOCK_SIZE							

BLOCK_NUMBER:
Event block number (used to align blocks when building events)
BLOCK_SIZE:
Number of events in block
SLOTID:
Slot ID (set by VME64x backplane)

Data Type: Block Trailer

      Type: 0x1

      Size: 1 word

      Description: Indicates the end of a block of events. The data words in a block are bracketed by the block header and trailer.

31	30	29	28	27	26	25	24
1	0	0	0	1		SLOTID	
23	22	21	20	19	18	17	16
SLOTID		NUM_WORDS					
15	14	13	12	11	10	9	8
NUM_WORDS							
7	6	5	4	3	2	1	0
NUM_WORDS							

      NUM_WORDS:

          Total number of words in block of events

      SLOTID:

          Slot ID (set by VME64x backplane)

Data Type: Event Header

      Type: 0x2

      Size: 1 word

      Description: Indicates the start of an event. The included trigger number is useful to ensure proper alignment of event fragments when building events. The 27bit trigger number (134M count) is not a limitation, as it will be used to distinguish events within event blocks, or among events that are concurrently being built or transported.

31	30	29	28	27	26	25	24
1	0	0	1	0			
23	22	21	20	19	18	17	16
15	14	13	12	11	10	9	8
TRIGGER_NUMBER							
7	6	5	4	3	2	1	0
TRIGGER_NUMBER							

      TRIGGER_NUMBER:

          Accepted event/trigger number

Data Type: Trigger Time

Type:	0x3
Size:	2 words
Description:	Time of trigger occurrence relative to the most recent global reset. The time is measured by a 48bit counter that is clocked from the 250MHz system clock. The assertion of the global reset clears the counter. The de-assertion of global reset enables counter and thus sets t=0 for the module. The trigger time is necessary to ensure system synchronization and is useful in aligning event fragments when building events.

Word 1:

31	30	29	28	27	26	25	24
1	0	0	1	1	0	0	0

23	22	21	20	19	18	17	16
TRIGGER_TIME_L							

15	14	13	12	11	10	9	8
TRIGGER_TIME_L							

7	6	5	4	3	2	1	0
TRIGGER_TIME_L							

TRIGGER_TIME_L:
This is the lower 24bits of the trigger time

Word 2:

31	30	29	28	27	26	25	24
0	0	0	0	0	0	0	0

23	22	21	20	19	18	17	16
TRIGGER_TIME_H							

15	14	13	12	11	10	9	8
TRIGGER_TIME_H							

7	6	5	4	3	2	1	0
TRIGGER_TIME_H							

TRIGGER_TIME_H:
This is the upper 24bits of the trigger time

Data Type: MPD Frame

 Type: 0x5
 Size: variable (up to 1+3*N words)
 Description: this data type contains a complete MPD data frame (after SSP processing). After the header
 word, an integer number of 6 APV sample sets follow supplied in groups of 3 words

Word 1:

31	30	29	28	27	26	25	24
1	0	1	0	1	UNDEFINED		
23	22	21	20	19	18	17	16
UNDEFINED			FIBER				
15	14	13	12	11	10	9	8
UNDEFINED							
7	6	5	4	3	2	1	0
UNDEFINED			MPD_ID				

FIBER:
 SSP fiber number MPD frame is received from (0 to 31)

MPD_ID:
 This ID is a programmble on the MPD (or dipswitch setting?)

Word 2+3*N+0

31	30	29	28	27	26	25	24
0	APV_CHANNEL_NUM4:0					APV_SAMPLE1	
23	22	21	20	19	18	17	16
APV_SAMPLE1							
15	14	13	12	11	10	9	8
APV_SAMPLE1			APV_SAMPLE0				
7	6	5	4	3	2	1	0
APV_SAMPLE0							

APV_CHANNEL_NUM(4:0):
 APV channel number for samples reported in this group of 3 words. Channel number ranges from
 0 to 127 and must be combined with next word to form full 7bit APV_CHANNEL_NUM.

APV_SAMPLE0:
 APV sample 0 for APV_CHANNEL_NUM. 13bit, signed integer.

APV_SAMPLE1:
 APV sample 1 for APV_CHANNEL_NUM. 13bit, signed integer.

Word 2+3*N+1

31	30	29	28	27	26	25	24
0			APV_CHANNEL_NUM(6:5)			APV_SAMPLE3	
23	22	21	20	19	18	17	16
APV_SAMPLE3							
15	14	13	12	11	10	9	8
APV_SAMPLE3			APV_SAMPLE2				
7	6	5	4	3	2	1	0
APV_SAMPLE2							

APV_CHANNEL_NUM(6:5):
> APV channel number for samples reported in this group of 3 words. Channel number ranges from 0 to 127 and must be combined with previous word to form full 7bit APV_CHANNEL_NUM.

APV_SAMPLE2:
> APV sample 2 for APV_CHANNEL_NUM. 13bit, signed integer.

APV_SAMPLE3:
> APV sample 3 for APV_CHANNEL_NUM. 13bit, signed integer.

Word 2+3*N+2

31	30	29	28	27	26	25	24
0			APV_ID			APV_SAMPLE5	
23	22	21	20	19	18	17	16
APV_SAMPLE5							
15	14	13	12	11	10	9	8
APV_SAMPLE5			APV_SAMPLE4				
7	6	5	4	3	2	1	0
APV_SAMPLE4							

APV_ID:
> APV_ID that samples are for.

APV_SAMPLE4:
> APV sample 4 for APV_CHANNEL_NUM. 13bit, signed integer.

APV_SAMPLE5:
> APV sample 5 for APV_CHANNEL_NUM. 13bit, signed integer.

Data Type: Data Not Valid

Type:	0x14
Size:	1 word
Description:	Module has no data available for readout. This can if the module is being read out too quickly after receiving (event building is in process and no data words have been put into the buffer yet) a trigger or if the module doesn't have any events to report.

31	30	29	28	27	26	25	24
1	1	1	1	0	UNDEFINED		

23	22	21	20	19	18	17	16
UNDEFINED							

15	14	13	12	11	10	9	8
UNDEFINED							

7	6	5	4	3	2	1	0
UNDEFINED							

Data Type: Filler Word

Type:	0x15
Size:	1 word
Description:	Non-data word appended to the block of events. This is used to force the total number of 32-bit words read out of a module to be a multiple of 2 or 4 when

31	30	29	28	27	26	25	24
1	1	1	1	1	UNDEFINED		

23	22	21	20	19	18	17	16
UNDEFINED							

15	14	13	12	11	10	9	8
UNDEFINED							

7	6	5	4	3	2	1	0
UNDEFINED							