VME Data Format Standards for JLAB Modules

There are a number of custom designed VME modules being used in experiments for the 12 GeV upgrade. These modules need to support certain VME standards and practices to provide the most efficient readout for data acquisition with CODA.

Below is an outline for data formats for use with modules that will generate "Event" driven data. It is based on the native 32 bit data width for VME hardware. It supports the feature of readout of fixed "blocks" of events where an event block contains between 1 and 255 events. Events are defined in modules as data associated with a single trigger.

Data Word Categories for JLAB Modules

Data words from a module are divided into two categories: Data Type Defining (bit 31 = 1) and Data Type Continuation (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 raw data. Any number of Data Type Continuation words may follow a Data Type Defining word.

EXCEPTION:

In order to allow full 32-bit User payload data for specific modules, the User may create Data Type Defining Words (for the Data Types 4 – 13) that include the specific number of 32 bit Continuation words that follow. In this way the full 32 bits for each Continuation word may be used (and bit 31 is not required to be 0).

Data Type List

0 – Block header
1 – Block trailer
2 – Event header
3 – Trigger time [optional]

4 – 13 – User defined (i.e. module specific)

14 – Data not valid [optional] (e.g. empty module, trigger error)
15 – Filler word

Note: For data decoding (e.g. in offline analysis) the User will still need to have correct information for the valid User Defined Data Types. These will be different for every module.

Module Type List (JLAB VME Modules)

0 – Trigger Interface (TI)
1 – FADC 250
2 – FADC 125
3 – F1TDC 32 Chan
4 – F1TDC 48 Chan
5 – Trigger Supervisor
6 – Trigger Distribution Module (TD)
7 – SSP
8 – JLAB Discriminator
9-15 - Reserved

Data Types

Block Header (0) – indicates the beginning of a block of events. (High-speed readout of a board or set of boards is done in blocks of events.)

(31)	= 1
(30 – 27)	= 0
(26 – 22)	= slot number (set by VME64x backplane)
(21 – 18)	= module ID (predefined and fixed in the module)
(17 – 8)	= block number (incrementing scalar counting completed blocks)
(7 – 0)	= number of events contained in a block (1-255)

Block Trailer (1) – indicates the end of a block of events. The data words in a block are bracketed by the block header and trailer.

(31)	= 1
(30 – 27)	= 1
(26 – 22)	= slot number (set by VME64x backplane)
(21 – 0)	= total number of words in the event block

Event Header (2) – indicates the start of event specific data. The included event number is useful to ensure proper alignment of event fragments when building events. The 22-bit trigger number will roll over but (4 M 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)	= 1
(30 – 27)	= 2
(26 – 22)	= slot number (set by VME64x backplane)
(21 – 0)	= event number (trigger number)

Trigger Time (3) – Time of trigger occurrence relative to the most recent global reset. Time is measured by a local counter/scalar that is clocked by the system clock or by a local module clock that may or may not have been synchronized with the system clock. In principle a global reset signal is distributed to every module. The assertion of the

global reset will clear the counters and inhibits counting. The de-assertion of global reset enables counting 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. For example, in the FADC250 there is a 48 bit counter (1 count = 4 ns). The six bytes of the trigger time:

$$\text{Time} = T_A\ T_B\ T_C\ T_D\ T_E\ T_F$$

are reported in two words (Type Defining + Type Continuation):

Word 1:

(31) = 1
(30 – 27) = 3
(26 – 24) = reserved (read as 0)
(23 – 16) = T_D
(15 – 8) = T_E
(7 – 0) = T_F

Word 2:

(31) = 0
(30 – 24) = reserved (read as 0)
(23 – 16) = T_A
(15 – 8) = T_B
(7 – 0) = T_C

Data Not Valid (14) – module has no data available for read out, or there is an error condition in the module that will not allow it to transfer data.

(31) = 1
(30 – 27) = 14
(26 – 22) = slot number (set by VME64x backplane)
(21 – 0) = user defined

Filler Word (15) – non-data word appended to the block of events. Forces the total number of 32-bit words read out of a module to be a multiple of 2 or 4 when 64-bit or 2e VME block transfers are used.

(31) = 1
(30 – 27) = 15
(26 – 22) = slot number (set by VME64x backplane)
(21 – 0) = undefined