Nuclear Physics Division
Fast Electronics Group

VSCM Manual

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12 December 2011

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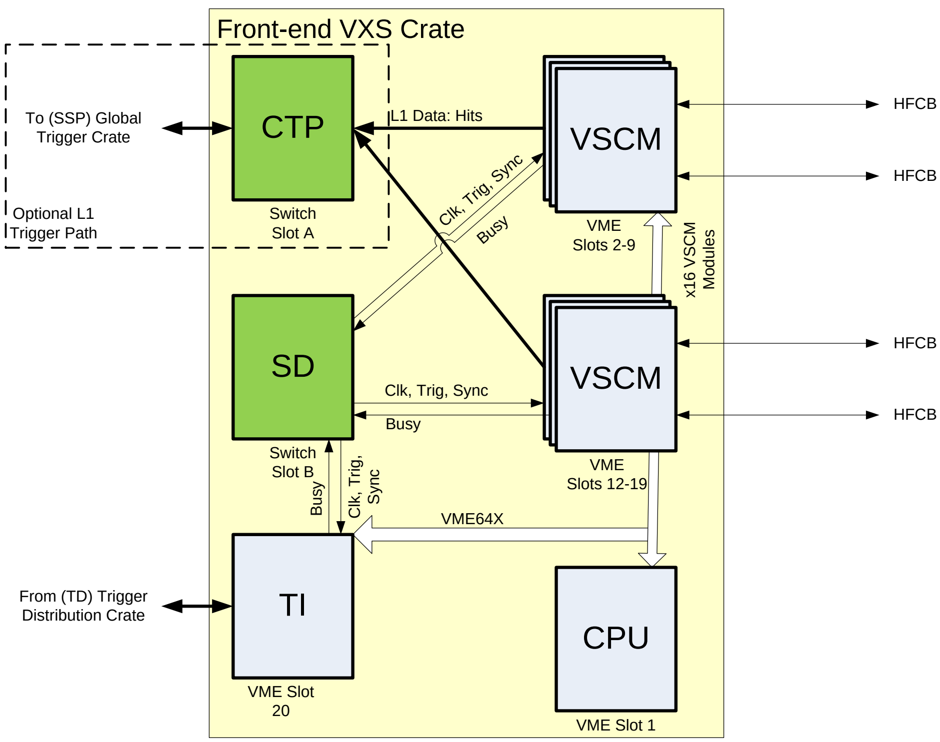
1 Introduction

The VSCM is a VME/VXS module that communicates with multiple FSSR2 chips on the Jefferson Lab Hybrid Flex Circuit Board (HFCB). The VSCM is responsible for configuring the FSSR2 registers, providing analog calibration pulses to the FSSR2 chips, delivering/monitoring proper control signals (clock, reset, status), and capturing serialized event data from the FSSR2. Each VSCM can interface to 2 HFCB modules and each HFCB has 4 FSSR2 chips. Up to 16 VSCM modules can reside in a VXS crate as shown in Figure 1a. When multiple VSCM modules are used additional cards are required to ensure event & timing synchronization. These additional modules are shown in Figure 1a and are the Trigger Interface (TI) and Signal Distribution (SD). Please refer to the particular module manual for further information. The VSCM does support a stand-alone mode useful when only 1 or 2 HFCB interfaces are used.

Figure 1a: VSCM in the 20 Slot VXS Crate



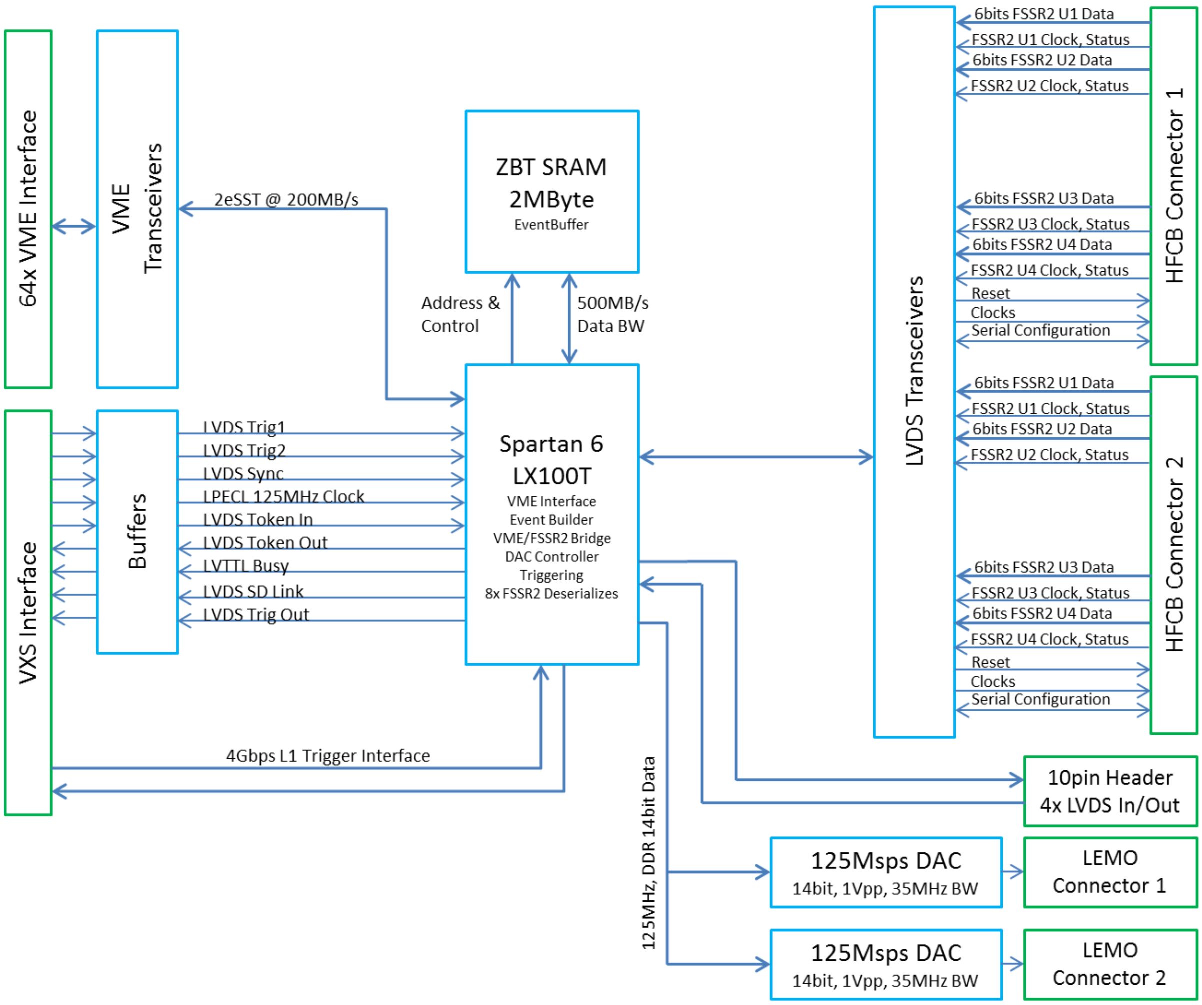
2. Purpose of the module

The main purpose of the VSCM is to convert the FSSR2 data-driven information stream into sparsified & triggered events that are correlated with external detectors. Idle status words are suppressed to minimize event size, but these status words are monitored to for diagnostic purposes of the individual FSSR2 chips. The event builder of the VSCM uses the BCO clock timestamp from each FSSR2 data word and matches it to the global system clock timestamp. Since the BCO clock is derived from the global system clock, triggers received by the VSCM will cause the event builder to extract only hits with specific BCO timestamps that correspond to a programmable time window where the physics event could have occurred on the HFCB. When a trigger is received the appropriate FSSR2 data words are copied into an event buffer and pushed into an event FIFO. These events can be readout in order with other modules in the system and event-level synchronization across all modules in the system is maintained.

3. Functional Description

In Figure 3a the block diagram of the VSCM is shown. The LX100T FPGA performs most of the work providing the VME interface, event building, event buffer logic, DAC waveform generator, L1 trigger logic, and synchronizes all FSSR2 data paths. Further details on each of these pieces are discussed below.

Figure 3a: VSCM Hardware Block Diagram



3.1 VME Interface

The VME interface is used to provide access to configuration registers on the VSCM, bridge access to the FSSR2 registers, and provide a high bandwidth interface to the CPU for event readout.

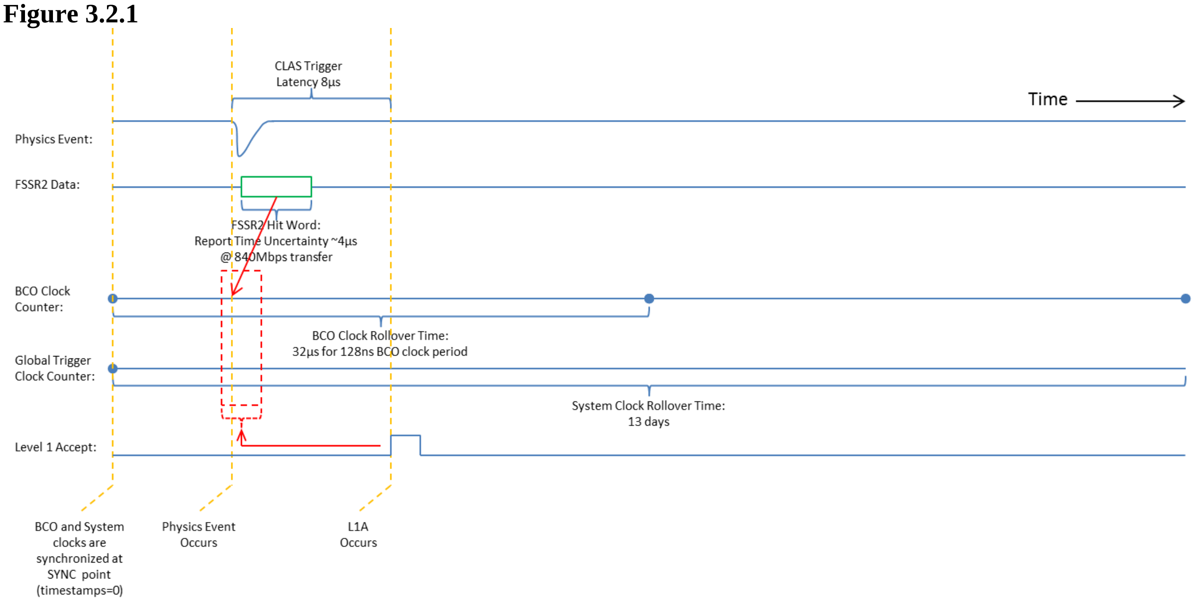
The A32 address space is dedicated to the event builder FIFO, roughly 2MB in size on each VSCM, and can be read using single-cycle and block transfer VME protocols. Typically block transfer protocols will be used for event readout and specifically the 2eSST is intended for use to maximize performance. The 2eSST protocols provides nearly 200MB/s sustained transfer rate and supports the proprietary Jlab token-passing scheme that allows a single DMA operation on the CPU to transfer data from all VSCM modules in a sequential manner eliminating overhead compared to individual board transfers.

The A24 address space is reserved for board register access. This address range does not support block transfer modes. Register access details will be provided in the board register description section discussed later.

3.2 Event Builder

In CLAS12, the trigger latency is expected to be around 8µs. The VSCM is setup to extract event data within a programmable look-back window relative to the received trigger. Figure 3.2.1 shows a general timing diagram the may help to see how the event builder is able to select the correct FSSR2 data words that should be associated for a given trigger.

Figure 3.2.1



3.2.1 Determining which BCO numbers to readout on Trigger

All readout modules in the trigger system are derived from the same global clock (FSSR2 use a BCO clock that is derived from this same clock). All onboard global clock counters and FSSR2 BCO clock counters are synchronously reset.

The trigger data window, defined by the dashed red-line, has an associated start and stop BCO number. After the release of a global reset/sync, the start number is initialized to the value the BCO number would be to match the desired look-back time. The stop number is initialized to the value of the start number plus the desired time window size where FSSR2 hits are desired to capture. For example:

Operating conditions (All units in system clock tick periods of 8ns):
BCOPeriod: 16 (=128ns)
Lookback: 1,000 (=8,000ns)
Window: 25 (=200ns)

Calculated initialization values for the BCO trigger window:
So the trigger start BCO counter is initialized to:
TRIG_BCO_START = 256 – Lookback / BCOPeriod
TRIG_BCO_START_CNT = (BCOPeriod – Lookback % BCOPeriod) % BCOPeriod

The trigger stop BCO counter is initialized to:
TRIG_BCO_STOP = 256 – (Lookback – Window + 1) / BCOPeriod
TRIG_BCO_STOP_CNT = (BCOPeriod –(Lookback – Window + 1) % BCOPeriod) % BCOPeriod

Which gives:
TRIG_BCO_START = 193
TRIG_BCO_START_CNT = 8
TRIG_BCO_STOP = 195

TRIG_BCO_STOP_CNT = 0

The TRIG_BCO_START_CNT and TRIG_BCO_STOP_CNT values are counter that increment at the system clock rate (125MHz) and rollover to 0 when they hit the BCO clock period count (in system clock ticks). When a rollover happens, the corresponding BCO number (TRIG_BCO_START or TRIG_BCO_STOP) will increment, which means the trigger window moves along in time at the system clock rate and tags the BCO start and stop times the trigger window touches.

When synchronization reset is released these start/stop BCO parameters will increment with a frequency of the BCO clock so that the look-back window tracks the desired time and this makes trigger processing easier since the next stages work in terms of BCO numbers. When a trigger is received by the VSCM, all FSSR2 hits reported in the BCO trigger start to stop time range are used to build an event corresponding to that trigger.

In the following table, the BCO numbers that correspond to hits that happened 8,000ns to 7,800ns ago is highlighted indicated the example numbers from above (at T=0):

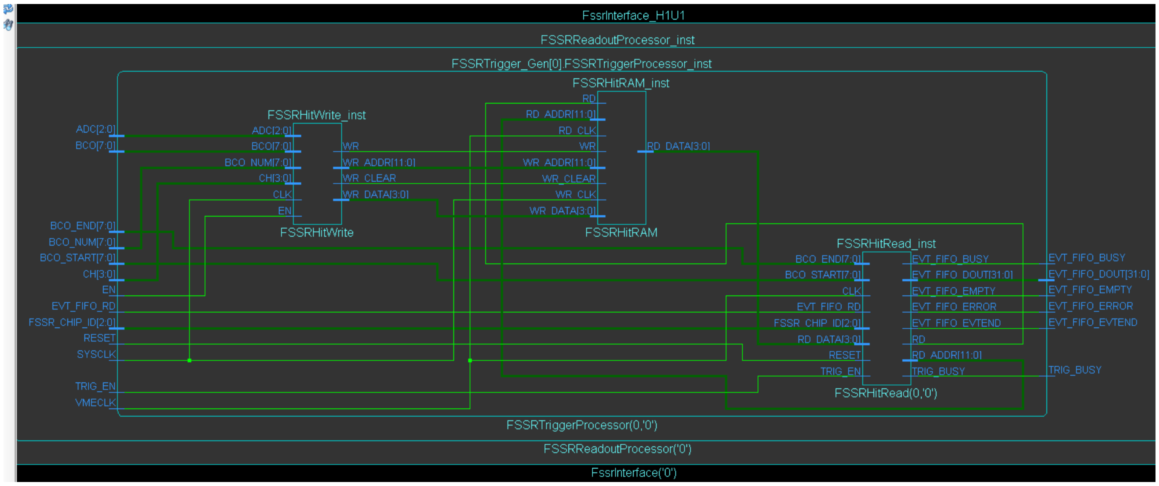
BCONUM	TrigStartTime(ns)	TrigStopTime(ns)
189	-8576	-8449
190	-8448	-8321
191	-8320	-8193
192	-8192	-8065
193	-8064	-7937
194	-7936	-7809
195	-7808	-7681
196	-7680	-7553
197	-7552	-7425
198	-7424	-7297
199	-7296	-7169

Note that all BCO numbers that span time inside the trigger window are tagged for readout. Stepping this window at the system clock rate of 125MHz provides an important feature that reduces overall occupancies. It is expected that the overall uncertainty of trigger to SVT hit is less than a BCO clock period. By specifying a window that covers this uncertainty you can notice, from the BCO start and stop trigger calculations, that when the window of uncertainty falls within a BCO clock period only 1 BCO clock period of data will be used to extract an event, but if this window overlaps times that fall into 2 or more BCO windows then those events will extract 2 or more BCO windows worth of data,

3.2.2 Extracting Triggered Event Hits

There are 8 FSSR2 chips per VSCM and each has a dedicated deserializer inside the XC6SLX100T FPGA. After deserialization, the status words are used for monitoring purposes and the event words are split up into 64 parallel trigger processors that each handle 16 strips out of the total 1,024 per VSCM.

A block-level schematic representation (Xilinx Planahead VHDL-to-schematic translator) for 1 of the identical 64 trigger processors is shown here:



In this schematic, the first parallel trigger processor of the VSCM is shown, which handles strips 0-15 of the first FSSR2.

FSSRHitWrite

The "FSSRHitWrite_inst" component receives the strip channel, BCO number, and ADC for any hit the FSSR2 reports for strips 0-15. This forms a 12bit address from the strip number (4bits) and BCO number (8bits) and writes to a 4bit x 4kword dual port RAM shown as the component "FSSRHitRAM_inst". The value written to this address is the 3bit ADC value for the hit and a 1bit valid flag indicating the sample is valid.

The "FSSRHitWrite_inst" component also continuously clears old data in the dual port RAM by clearing the 1bit valid flag of each address with BCO equal to the current BCO clock - 128 (BCO_NUM-128). For an 8MHz BCO clock this means that only the most recent 16µs of RAM is valid (128 BCO clocks at 8MHz = 16µs).

FSSRHitRead

The "FSSRHitRead_inst" component receives receives the trigger window parameters (BCO_START and BCO_END) for each trigger that is accepted by the VSCM. When the TRIG_EN signal goes high, the "FSSRHitRead_inst" component extracts all valid hits from the dual port RAM that is in the range of BCO_START and BCO_END and puts these hits into an event FIFO and terminates the end of event with a special word to indicate to the next state event builder consolidator.

The event FIFO signals (EVT_FIFO_*) are used by the event builder consolidator to combine data from 8 trigger processors into a single event/FIFO and this is done again until all 1,024 channels are processed into a single FIFO at the VME readout buffer level. Header and trailer words are put into each event and blocks of events for upstream event builders to ensure event level synchronization.

3.3 Event Buffer

The event buffer uses the 2MB external SRAM to form a large event FIFO. This buffer is large enough to hold several hundred events assuming an unrealistic 100% occupancy. This allows the event builder to create blocks of many events, which decreases data overhead. The bandwidth (500MB/s) into the SRAM is enough to support continuous readout at the VME 2eSST 200MB/s bandwidth while simultaneously writing into the buffer at that rate. Also, the VME 2eSST 200MB/s is across typically 10+ boards so the average readout bandwidth per board is much smaller.

3.4 Calibration Pulser

The calibration pulser circuit provides a 1Vpp dynamic range, up to 125Msps, and 14bit resolution (for pulse height steps to be in sub mV increments). The bandwidth is sufficient to allow ~10ns rise times to be delivered over several feet of 50ohm triax cable terminated with 50ohms. Two independent outputs are provided to drive both HCFB modules. The pulser signal phase can be placed with a deterministic phase relationship to the BCO clock that drives the FSSR2.

3.5 FSSR2 Data Path

The FSSR2 chips provide event data through up to 6 LVDS pairs with a source synchronous clock. The VSCM supports receiving data from all 6 LVDS pairs from each FSSR2. The VSCM is fully capable of receiving DDR data at up to 70MHz (840Mbps per FSSR2). The LVDS signals are done using discrete transceivers with much better common mode range and ESD performance than any FPGA LVDS I/O.

3.6 VXS/Front Panel I/O

The VXS connection is used to interface to the trigger system without the need for loose cabling. This interface provides the following signals:

Signal	Description	Direction	Signal Type
Clock	125MHz System Synchronous Clock	Input	LVPECL
Trig1	L1 accept trigger bit, synchronous to clock	Input	LVPECL
Trig2	L1 accept trigger bit, synchronous to clock	Input	LVPECL
Sync	L1 synchronization bit, synchronous to clock	Input	LVPECL
Busy	Module busy signal	Output	LVTTL
Token In	Used in VME 2eSST token passing scheme	Input	LVDS
Token Out	Used in VME 2eSST token passing scheme	Output	LVDS
Trigger Out	Module trigger bit	Output	LVDS
SD Link	Undefined serial link to SD	Output	LVDS
L1 Trigger	5Gbps link used to generate L1 trigger	Input/Output	CML

Clock
This clock signal is derived from the TI or Trigger Distribution Crate and is used to allow synchronous operation across multiple modules within a crate as well as across multiple crates.

Trig1, Trig2
These trigger bits tell the module when to capture and store an event. Upon receipt of a trigger signal, the VSCM will parse the front-end data and extract physics event data that matches a time-window related to the received Trig1/Trig2 time.

Sync
The sync signal is used to align/start board timers at the same time as other boards in the crate and system. This signal will also be used to reset the FSSR2 chips to ensure the BCO clock timer are synchronized to the VSCM global timer.

Busy
Busy is normal held low, but if the VSCM module event buffers become close to full the busy signal can be set high to signal that the trigger supervisor must stop sending triggers so the module buffers to not overflow. If buffer overflows happen event synchronization from this module to another is lost.

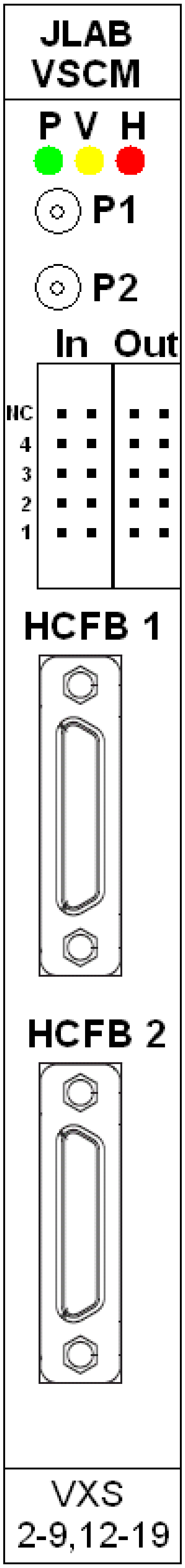
Token In/Token Out
These are used by the VME interface when performing 2eSST transfers with token passing.

SDLink
Currently a undefined serial link to the Signal Distribution board.

L1 Trigger
This is a high speed serial link to the CLAS12 Crate Trigger Processor (CLAS12 CTP) used to send processed front-end data to the Global Trigger System that can be correlated with other modules/detectors to generate a L1 trigger accept. Currently the SVT is not planned to be part of the L1 trigger, but the VSCM supports this feature if it is desired in the future. Potentially some level of track reconstruction on the SVT could be done in hardware to provide a high level trigger that would benefit experiments. The large 8μs trigger decision time in CLAS12 allows the relatively long latency of FSSR2 data to make it into the L1 trigger decision.

The CLAS12 CTP would be capable of receiving all the FSSR2 hits from an entire crate (roughly 4Gbps bandwidth is need for each VSCM). The CTP could then identify hits that have corresponding hits on the stereo axis and ship this information upstream through a ~20Gbps fiber optic link to the Global Trigger Crate where all regions of the SVT are consolidated in a single model where hits in the different regions can be linked together to identify tracks. The SSP is a potential board in the Global Trigger Crate that could be used for the consolidation of data, but depending on required performance and resources the SSP may or may not be a suitable candidate. Further research will be required in the future to determine the needs at the Global Trigger Crate if a need for using the SVT in the L1 trigger arises; however, the VSCM implementation allows all information to flow to the following trigger stages and therefore sets no bottleneck.

4. Specifications



MECHANICAL
- Single width VITA 41 Payload Module

HIGH SPEED SERIAL P0 INPUTS/OUTPUTS:
- 125MHz LVPECL Clock
- Trig 1, Trig 2, Sync Inputs
- 4x 2.5-3.125Gbps Lanes to CTP

Front Panel INPUTS/OUTPUTS:
- 2x HCFB Microdot Connectors
    - 6x LVDS 70MHz DDR lines per FSSR2
    - Serial Configuration
    - 3-10MHz programmable BCO clock
    - 0-70Mhz programmable RCLK
- 2x Triax DAC Pulser Calibration Outputs
- 4x LVDS Outputs
- 4x AnyLevel Differential Inputs (LVPECL, ECL, LVDS)

INDICATORS: (Front Panel)
- Power OK – Red LED
- VME DTACK – Green LED
- Status – Yellow LED

EVENT BUILDER:
- 2MB Event FIFO
- High trigger rate capable >>10kHz
- 16μs maximum trigger latency

DIAGNOSTICS:
- Per channel scalers (1,024)
- FSSR2 data integrity monitor
- FSSR2 chip status
- Event builder status

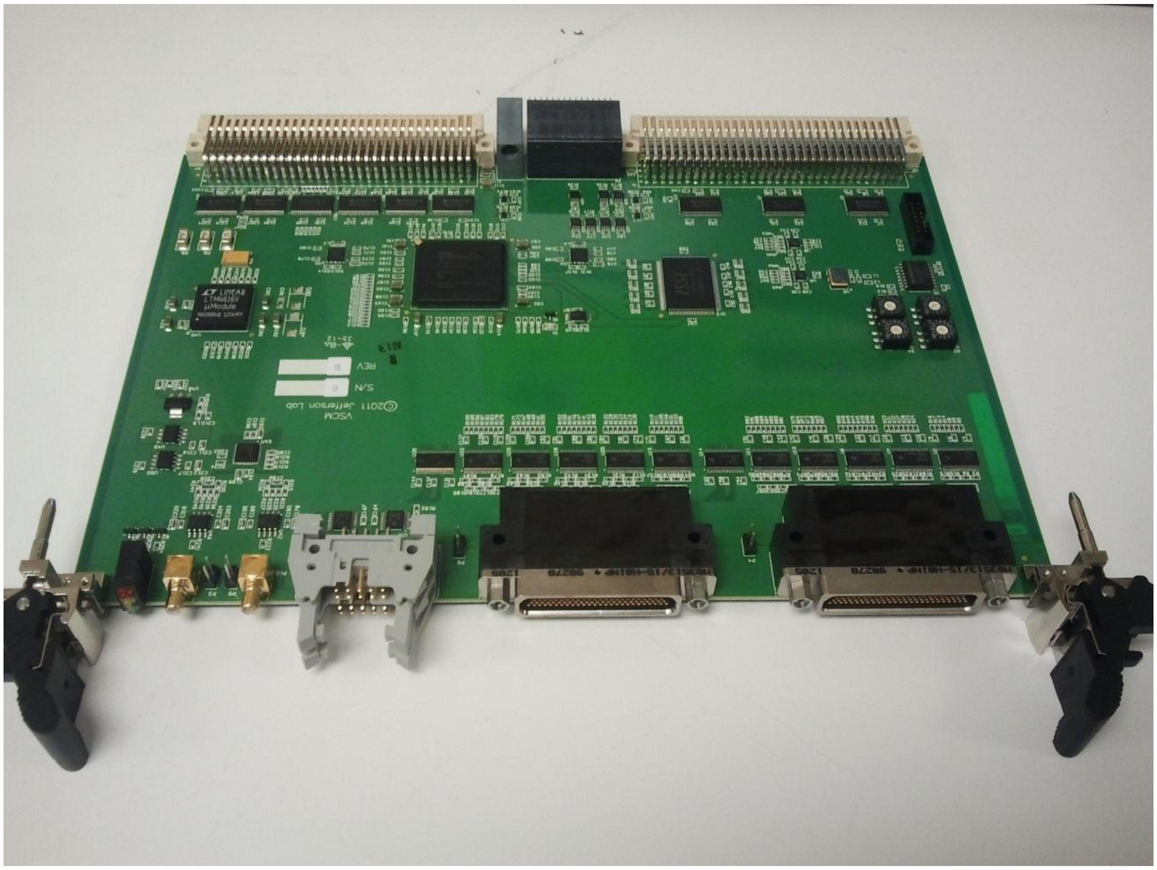
PROGRAMMING:
- On board JTAG Port, VME

POWER REQUIREMENTS:
- +5.0v @ 4A Typ

ENVIRONMENT:
- Commercial grade components (70 Celsius)

5. PCB Assembly View

The VSCM PCB is a 12 layer FR-370HR design. It is mostly digital, but does contain an analog section for the DAC pulser and jitter/noise sensitive differential pairs used for clocks and Giga-bit transceiver channels.



6. VSCM Readout Data Format

The VSCM 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	BCO Start/Stop Time
5	Reserved
6	Reserved
7	Reserved
8	FSSR2 Strip Hit
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)

<table>
<tr><td>31</td><td>30</td><td>29</td><td>28</td><td>27</td><td>26</td><td>25</td><td>24</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td colspan="3">SLOTID</td></tr>
<tr><td>23</td><td>22</td><td>21</td><td>20</td><td>19</td><td>18</td><td>17</td><td>16</td></tr>
<tr><td colspan="2">SLOTID</td><td colspan="6">NUM_EVENTS</td></tr>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td></tr>
<tr><td colspan="5">NUM_EVENTS</td><td colspan="3">BLOCK_NUMBER</td></tr>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="8">BLOCK_NUMBER</td></tr>
</table>

BLOCK_NUMBER:
Event block number (used to align blocks when building events)

NUM_EVENTS:
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	TRIGGER_NUMBER		
23	22	21	20	19	18	17	16
TRIGGER_NUMBER							
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 125MHz 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_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

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_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

Data Type: BCO Start/Stop Time

Type: 0x4
Size: 1 word
Description: Indicates the trigger time window used to extract FSSR2 hits in terms of the BCO clocks.

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

BCOSTART_TIME:
BCO number for the beginning of the capture window (which includes this number)
BCOSTOP_TIME:
BCO number for the end of the capture window (which DOES NOT include this number)

Data Type: FSSR2 Strip Hit

Type: 0x8
Size: 1 word
Description: FSSR2 strip hit words. A separate word is used for each strip hit that is inside the trigger window.

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

ADC:
3bit ADC value for the strip hit determined by the FSSR2

BCONUM:
BCO number the hit occurred. This can be used with the TRIGGER_TIME and/or BCOSTART_TIME to know where the hit occurred relative to the trigger window.

STRIPID:
0-127 value indicating which strip was hit on the FSSR2 chip.

CHIPID:
Chip ID as reported by the FSSR2 event.

HFCB:
'0' – HFCB1 interface reported the hit
'1' – HFCB2 interface reported the hit

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							

7. VME Registers

All VSCM board registers can be accessed through the VME bus in the following mode:

- A24: single cycle accesses, 32bit aligned read or write access (register specific)

Event readout can be access through the VME bus in the following modes:

- A32: single cycle, BLT, MBLT, 2eVME, 2eSST
- Note: transfer rate for 2eSST is 200MB/s

Register Summary:

Register Name	Description	Address Offset
Board Information		
A_FIRMWARE_REV	Firmware revision	0x0000
A_BOARDID	Board identification	0x0004
Debug/upgrade Configuration		
A_ICAP	FPGA configuration interface	0x0008
A_SPI_FLASH	Non-volatile flash interface	0x0014
A_SRAM_DBG_ADR	Sram test address	0x0060
A_SRAM_DBG_DATA	Sram test data	0x0064
Readout Configuration		
A_TRIG_WINDOW	Trigger readout window	0x0148
A_CLOCK_CFG	Clock setup	0x0030
A_TRIG_LATENCY	Trigger processing latency	0x0038
A_TRIG_BUSY_THR	Busy threshold	0x003C
A_ADR32M	Multi-board readout address	0x0034
A_AD32	Readout address	0x0044
A_INTERRUPT	Interrupt setup	0x0048
A_INTERRUPT_ACK	Interrupt acknowledge	0x004C
A_GEO	Geographical address	0x0050
A_RESET	Soft reset	0x0068
A_EVT_FIFO_STATUS	Event FIFO status	0x007C
A_FIFO_WORD_CNT	Event FIFO word count	0x0054
A_FIFO_EVENT_CNT	Event FIFO event count	0x0058
A_READOUT_CFG	Readout interrupt setup	0x005C
A_BLOCK_CFG	Event blocking setup	0x0028
I/O Configuration		
A_TRIG	Trigger setup	0x0100
A_SYNC	Sync setup	0x0104
A_SWAGPIO	VXS-SWA GPIO setup	0x0108
A_SWBGPIO	VXS-SWB GPIO setup	0x010C
A_FPOUTPUT_0	Front panel output 0 setup	0x0138
A_FPOUTPUT_1	Front panel output 1 setup	0x013C
A_FPOUTPUT_2	Front panel output 2 setup	0x0140
A_FPOUTPUT_3	Front panel output 3 setup	0x0144
A_TOKENIN_CFG	Readout token input setup	0x0018
A_TOKENOUT_CFG	Readout token output setup	0x001C
A_SDLINK_CFG	VXS-SDLINK setup	0x0020
A_TRIGOUT_CFG	VXS-TRIGOUT setup	0x0024

Pulser Configuration		
A_PULSER_PERIOD	Pulser period	0x0120
A_PULSER_LOW	Pulser high cycle time	0x0124
A_PULSER_NPULSES	Pulser pulse count	0x0150
A_PULSER_START	Pulser start	0x0154
A_PULSER_STATUS	Pulser status	0x0158

FSSR Configuration		
A_FSSR_CLK_CFG	FSSR BCO clock period	0x006C
A_FSSR_MASK	FSSR got hit mask	0x00AC
A_FSSR_ADDR_H1	FSSR chip address HFCB 1	0x00A4
A_FSSR_ADDR_H2	FSSR chip address HFCB 2	0x00A8
A_MCLK_STATUS	MCLK PLL status	0x0070
A_MCLK_CFG	MCLK PLL interface	0x0074

FSSR Serial Interface		
A_FSSR_SER_CFG	FSSR serial configuration	0x0080
A_FSSR_SER_CLK	FSSR serial clock sync	0x00A0
A_FSSR_SER_DATA0	FSSR serial data	0x0084
A_FSSR_SER_DATA1	FSSR serial data	0x0088
A_FSSR_SER_DATA2	FSSR serial data	0x008C
A_FSSR_SER_DATA3	FSSR serial data	0x0090

DAC Pulser		
A_DAC_TRIG	DAC trigger setup	0x014C
A_DAC_CFG	DAC setup	0x0094
A_DAC_CH0	DAC data ch0	0x0098
A_DAC_CH1	DAC data ch1	0x009C

Scalers		
A_SCALER_LATCH	Latch scalers	0x0078
A_SCALER_FP_OUTPUT0	Front panel output 0 scaler	0x0FC8
A_SCALER_FP_OUTPUT1	Front panel output 1 scaler	0x0FCC
A_SCALER_FP_OUTPUT2	Front panel output 2 scaler	0x0FD0
A_SCALER_FP_OUTPUT3	Front panel output 3 scaler	0x0FD4
A_SCALER_FP_INPUT0	Front panel input 0 scaler	0x0FD8
A_SCALER_FP_INPUT1	Front panel input 1 scaler	0x0FDC
A_SCALER_FP_INPUT2	Front panel input 2 scaler	0x0FE0
A_SCALER_FP_INPUT3	Front panel input 3 scaler	0x0FE4
A_SCALER_BUSY	Busy scaler	0x0FE8
A_SCALER_BUSY_CYCLES	Busy time scaler	0x0FEC
A_SCALER_VMECLK	VME clock scaler	0x0FF0
A_SCALER_SYNC	VXS-SYNC input scaler	0x0FF4
A_SCALER_TRIG1	VXS-TRIG1 input scaler	0x0FF8
A_SCALER_TRIG2	VXS-TRIG2 input scaler	0x0FFC

FSSR Chip Scalers (x: 1-2, y: 1-4)		
A_FSSR_LAST_STAT_HxUy	FSSR last status word	0x1000+0x400*(x-1)+0x100*(y-1)
A_FSSR_STAT_CNT_HxUy	FSSR status word scaler	0x1004+0x400*(x-1)+0x100*(y-1)
A_FSSR_EVENT_CNT_HxUy	FSSR event word scaler	0x1008+0x400*(x-1)+0x100*(y-1)
A_FSSR_WORD_CNT_HxUy	FSSR word scaler	0x100C+0x400*(x-1)+0x100*(y-1)
A_FSSR_IDLE_CNT_HxUy	FSSR idle scaler	0x1010+0x400*(x-1)+0x100*(y-1)
A_FSSR_AQBCO_CNT_HxUy	FSSR AQBCO scaler	0x1014+0x400*(x-1)+0x100*(y-1)
A_FSSR_MARKERR_CNT_HxUy	FSSR mark error scaler	0x1018+0x400*(x-1)+0x100*(y-1)
A_FSSR_ENCERR_CNT_HxUy	FSSR encoding error scaler	0x101C+0x400*(x-1)+0x100*(y-1)
A_FSSR_CHPIDERR_CNT_HxUy	FSSR chip ID error scaler	0x1020+0x400*(x-1)+0x100*(y-1)
A_FSSR_HIST_CFG_HxUy	FSSR histogram setup	0x1024+0x400*(x-1)+0x100*(y-1)
A_FSSR_GOTHIT_CNT_HxUy	FSSR gothit scaler	0x1028+0x400*(x-1)+0x100*(y-1)
A_FSSR_HIST_CNT_HxUy	FSSR histogram data	0x102C+0x400*(x-1)+0x100*(y-1)
A_FSSR_REF_CNT_HxUy	FSSR reference scaler	0x1030+0x400*(x-1)+0x100*(y-1)
A_FSSR_HIST_TIME_HxUy	FSSR histogram time	0x1034+0x400*(x-1)+0x100*(y-1)
A_FSSR_CORETALK_CNT_HxUy	FSSR coretalking scaler	0x1038+0x400*(x-1)+0x100*(y-1)

7.1 Board Information Registers Section

Basic board information registers can be used to verify that this board is the VSCM and check for the software revision, which should be checked for compatibility.

Register: A_FIRMWARE_REV

Address Offset: 0x0000
Size: 32bits
Reset State: 0xXXXXXXXX

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

FIRMWARE_REV_MAJOR (RO):
Major firmware revision number
FIRMWARE_REV_MINOR (RO):
Minor firmware revision number

Register: A_BOARDID

Address Offset: 0x0004
Size: 32bits
Reset State: 0x5653434D

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

BOARD_ID (RO):
0x5653434D = “VSCM” in ASCII

7.2 Debug/upgrade Configuration Registers Section

The registers in this section are not intended to be used by a typical user of this board. These provide access to the configuration flash memory and the direct FPGA configuration. The SRAM registers provide a simple interface to test the external memory, which bypasses the FIFO logic the event builder uses when accessing this memory.

Register: A_ICAP

Address Offset: 0x0008
Size: 32bits
Reset State: 0xXXXXXXXX

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

DATA (R/W):
SPARTAN6_ICAP data port
WRITE (WO):
SPARTAN6_ICAP write port
CLK (WO):
SPARTAN6_ICAP clk port
CE (WO):
SPARTAN6_ICAP ce port
BUSY (RO):
SPARTAN6_ICAP busy port
Notes:
1) This interface provides direct access to the FPGA configuration interface. Only intended use is for a VME based FPGA reload after new firmware has been programmed into flash memory.

Register: A_SPI_FLASH

Address Offset: 0x0014
Size: 32bits
Reset State: 0x00000007

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

MOSI, CLK, NCS (WO):
SPI interface outputs to flash memory
MISO (RO):
SPI interface input from flash memory
Notes:
1) This interface is used for firmware updates and general non-volatile parameter storage.

Register: A_SRAM_DBG_ADR

Address Offset: 0x0060
Size: 32bits
Reset State: 0x00000000

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

ADDR (WO):

Address to use for read/write when A_SRAM_DBG_DATA is accessed

Notes:

1) This interface is used for testing read/write accesses to the external SRAM, which is normally controlled by the event builder FIFO.

Register: A_SRAM_DBG_DATA

Address Offset: 0x0064
Size: 32bits
Reset State: 0x00000000

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

DATA (R/W):

When read (written), this reads (writes) data from (to) the external SRAM at the address specified in A_SRAM_DBG_ADR

Notes:

1) This interface is used for testing read/write accesses to the external SRAM, which is normally controlled by the event builder FIFO.

7.3 Readout Configuration Registers Section

Register: A_TRIG_WINDOW

Address Offset: 0x0148
Size: 32bits
Reset State: 0x00000000

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

WINDOW_START_I (R/W):
When the trigger system SYNC is released, this register initializes the trigger logic BCO start capture counter (integer start BCO counter).

WINDOW_START_R (R/W):
When the trigger system SYNC is released, this register initializes the trigger logic BCO start capture counter (remainder start BCO counter).

WINDOW_STOP_I (R/W):
When the trigger system SYNC is released, this register initializes the trigger logic BCO stop capture counter (integer stop BCO counter).

WINDOW_STOP_R (R/W):
When the trigger system SYNC is released, this register initializes the trigger logic BCO stop capture counter (remainder stop BCO counter).

Notes:

1) These counters together define the effective capture window width and lookback time when a trigger is received. These also relate the global trigger system time to the slower BCO clock counters of the FSSR2.

Register: A_CLOCK_CFG

Address Offset: 0x0030
Size: 32bits
Reset State: 0x00000000

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

CLKSEL (R/W):
'0' – selects onboard local 125MHz oscillator source for triggering/FSSR reference
'1' – selects VXS-SWB 125MHz oscillator source for triggering/FSSR reference

CLKRST (R/W):
'0' – clock system reset cleared
'1' – clock system reset set

Notes:

1) When changing CLKSEL, the CLKRST must be set and cleared to ensure.
2) A soft reset must be applied after changing clock sources. See A_RESET register.

Register: A_TRIG_LATENCY

Address Offset: 0x0038
Size: 32bits
Reset State: 0x00000000

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

LATENCY (R/W):

When a trigger is received it is timestamped. The LATENCY register is the minimum time elapsed from receipt of trigger to when it is processed by the event builder (i.e. TRIGGER_TIMESTAMP + LATENCY > CURRENT_TIME). These units are in 8ns ticks.

Notes:

1) The use of this register is required when triggering readout data where the latency from the FSSR2 outputs cause data to show up after a trigger is received. This is a function of the trigger data window start/stop times and FSSR2 readout bandwidth.

Register: A_TRIG_BUSY_THR

Address Offset: 0x003C
Size: 32bits
Reset State: 0x00000080

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

BUSY_THRESHOLD (R/W):

Defines the number of outstanding triggers the event builder has to process before a BUSY status is asserted. This can be used to inhibit triggers at the global trigger distribution.

Register: A_ADR32M

Address Offset: 0x0034
Size: 32bits
Reset State: 0x00000000

31	30	29	28	27	26	25	24
STATUS	-	-	TAKE	LAST	FIRST	EN	ADR_MAX
23	22	21	20	19	18	17	16
ADR_MAX							
15	14	13	12	11	10	9	8
							ADR_MIN
7	6	5	4	3	2	1	0
ADR_MIN							

ADR_MIN (R/W):
Low A32 address (bits 31:23) used for multi-board, token-passing readout
ADR_MAX (R/W):
High A32 address (bits 31:23) used for multi-board, token-passing readout
EN (R/W):
'0' – disables VME A32 multi-board addressing mode
'1' – enabled VME A32 multi-board addressing mode
FIRST (R/W):
'0' – not first board in token passing scheme
'1' – first board in token passing scheme
LAST (R/W):
'0' – not last board in token passing scheme
'1' – last board in token passing scheme
TAKE (R/W):
'0' – does nothing
'1' – gives board token
STATUS (R/W):
'0' – board does not have token
'1' – board does have token

Register: A_ADR32

Address Offset: 0x0044
Size: 32bits
Reset State: 0xXXXX8000

31	30	29	28	27	26	25	24
-	-	-	-	-	-	-	-
23	22	21	20	19	18	17	16
-	-	-	-	-	-	-	-
15	14	13	12	11	10	9	8
A32_BASE							
7	6	5	4	3	2	1	0
A32_BASE	-	-	-	-	-	-	A32_EN

A32_BASE (R/W):
A32 base address (bits 31:23)
A32_EN (R/W):
'0' – disables VME A32 addressing mode
'1' – enabled VME A32 addressing mode

Register: A_INTERRUPT

Address Offset: 0x0048
Size: 32bits
Reset State: 0x00000000

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

INT_ID (R/W):
VME bus interrupt ID

INT_LEVEL (R/W):
VME bus interrupt level

INT_EN (R/W):
VME bus interrupt enable

Register: A_INTERRUPT_ACK

Address Offset: 0x004C
Size: 32bits
Reset State: 0xXXXXXXXX

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

INTERRUPT_ACK (WO):
Writing to this register will acknowledge any outstanding interrupt. This will allow further interrupt from this module to interrupt on the VME bus if any interrupting condition persists or occurs in the future.

Register: A_GEO

Address Offset: 0x0050
Size: 32bits
Reset State: 0xXXXXXXXX

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

VME_ADDR (RO):

VME address switch settings. The lower 8 bits form the A24 base address. The upper 8 bits are not used in the firmware, but are available to the user for any purpose desired (for example, the user could read this and set the A32_BASE to this value to use dip switch controlled A32 VME addressing).

SLOTID (RO):

VME geographical addressing slot. Slot 30 will be reported on parity error.

Notes:

1) Geographical addressing is only support when module is used on aVME64X compatibly crate. A parity error will be generated on non-VME64X compatible crates.

Register: A_RESET

Address Offset: 0x0068
Size: 32bits
Reset State: 0xXXXXXXXX

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

RESET (WO):

‘0’ – clear “soft” reset
‘1’ – set “soft” reset. This will clear all event builder FIFOs. To ensure reliable reset, no triggers should be delivered during the reset period.

Register: A_EVT_FIFO_STATUS

Address Offset: 0x007C
Size: 32bits
Reset State: 0xXXXXXXXX

31	30	29	28	27	26	25	24
-	-	-	-	-	-	-	-
23	22	21	20	19	18	17	16
-	-	-	-	-	-	-	-
15	14	13	12	11	10	9	8
-	-	-	-	-	-	-	-
7	6	5	4	3	2	1	0
ERR7	ERR6	ERR5	ERR4	ERR3	ERR2	ERR1	ERR0

ERRx (RO):

'0' – no FIFO overrun on FSSR2 chip x trigger processing
'1' – FIFO overrun seen on FSSR2 chip x trigger processing

Notes:

1) A soft reset, writing to A_RESET, or hardware reset must be applied to clear this condition.
2) An error here indicates data is dropping due to very high occupancies, large trigger windows, very high trigger rates, and/or too slow bandwidth on VME bus.

Register: A_FIFO_WORD_CNT

Address Offset: 0x0054
Size: 32bits
Reset State: 0xXXXXXXXX

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

WORD_CNT (RO):

The number of 32bit event builder words currently residing in readout FIFO.

Register: A_FIFO_EVENT_CNT

Address Offset: 0x0058
Size: 32bits
Reset State: 0xXXXXXXXX

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

EVENT_CNT (RO):

The number of event builder events currently residing in readout FIFO.

Register: A_READOUT_CFG

Address Offset: 0x005C
Size: 32bits
Reset State: 0x00000000

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

EVT_WORD_INT_LEVEL (R/W):

Range: 0 to 65535. Sets the 32bit word interrupt threshold for the event builder. If the number of 32bit event words inside the event builder FIFO is greater-than or equal to this value an interrupt will be generated if enabled by the A_INTERRUPT register.

EVT_NUM_INT_LEVEL (R/W):

Range: 0 to 32767. Sets the event count interrupt threshold for the event builder. If the number of events inside the event builder FIFO is greater-than or equal to this value an interrupt will be generated if enabled by the A_INTERRUPT register.

BERREN (R/W):

'0' – disable VME bus error assertion for end-of-event signaling (user must know event size or parse readout contents to ensure event synchronization/alignment)

'1' – enables VME bus error assertion for end-of-event signaling

Register: A_BLOCK_CFG

Address Offset: 0x0028
Size: 32bits
Reset State: 0x00000000

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

BLOCK_SIZE (R/W):

Number of events per block to be built by the event builder.

7.4 I/O Configuration Registers Section

This section covers the registers control how I/O signals interact with the firmware. Most of the signals support multiplexing to provide flexibility to aid in various configurations or debug. The multiplexor inputs are all the same for all signal that have support for multiplexed inputs and is defined as follows:

Multiplexor Input	Signal	Description
0	0	Constant '0'
1	1	Constant '1'
2	PULSER_OUTPUT	Onboard pulser output
3	FP_INPUT0	Front panel LVDS input 0
4	FP_INPUT1	Front panel LVDS input 1
5	FP_INPUT2	Front panel LVDS input 2
6	FP_INPUT3	Front panel LVDS input 3
7	VXS_SWB_SYNC	VXS Switch B Sync input
8	VXS_SWB_TRIG1	VXS Switch B Trig1 input
9	VXS_SWB_TRIG2	VXS Switch B Trig2 input
10	VXS_SWA_GPIO0	VXS Switch A GPIO Input 0
11	VXS_SWA_GPIO1	VXS Switch A GPIO Input 1
12	VXS_SWB_GPIO0	VXS Switch B GPIO Input 0
13	VXS_SWB_GPIO1	VXS Switch B GPIO Input 1
14	BUSY	Internal busy
15	FSSR_GOTHIT	FSSR GotHit pin status OR'd across enabled chips
16	DAC_TRIGGER	DAC Trigger (no delay)
17	DAC_TRIGGER_DELAYED	DAC Trigger (with delay)
18	BCOCLK	BCOCLK
19	TOKENOUT	VME Token Out
20	TOKENIN	VXS Switch B Token input
31-21	Reserved	Reserved

Register: A_TRIG

Address Offset: 0x0100
Size: 32bits
Reset State: 0x00000000

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

MUX_SRC (R/W):

Selects trigger input source: see MUX_SRC description at the beginning of this section for source signal description.

Register: A_SYNC

Address Offset: 0x0104
Size: 32bits
Reset State: 0x00000000

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

MUX_SRC (R/W):

Selects sync input source: see MUX_SRC description at the beginning of this section for source signal description.

Register: A_SWAGPIO

Address Offset: 0x0108
Size: 32bits
Reset State: 0x01000100

31	30	29	28	27	26	25	24
-	-	-	-	-	-	-	DIR1
23	22	21	20	19	18	17	16
-	-	-	MUX_SRC1				
15	14	13	12	11	10	9	8
-	-	-	-	-	-	-	DIR0
7	6	5	4	3	2	1	0
-	-	-	MUX_SRC0				

MUX_SRCx (R/W):

Selects VXS-Switch-A-SEx driver source: see MUX_SRC description at the beginning of this section for source signal description.

DIRx (R/W):

‘0’ – Set as output (drives VXS-Switch-A-SEx line)
‘1’ – Set as input (weak pull-up on VXS-Switch-A-SEx line)

Notes:

1) Default values should be left unchanged.

Register: A_SWBGPIO

Address Offset: 0x010C
Size: 32bits
Reset State: 0x01000100

31	30	29	28	27	26	25	24
-	-	-	-	-	-	-	DIR1
23	22	21	20	19	18	17	16
-	-	-	MUX_SRC1				
15	14	13	12	11	10	9	8
-	-	-	-	-	-	-	DIR0
7	6	5	4	3	2	1	0
-	-	-	MUX_SRC0				

MUX_SRCx (R/W):

Selects VXS-Switch-B-SEx driver source: see MUX_SRC description at the beginning of this section for source signal description.

DIRx (R/W):

'0' – Set as output (drives VXS-Switch-B-SEx line)
'1' – Set as input (weak pull-up on VXS-Switch-B-SEx line)

Notes:

1) Default values should be left unchanged.

Register: A_FPOUTPUT_0 -> A_FPOUTPUT_3

Address Offset: 0x0138, 0x013C, 0x0140, 0x0144
Size: 32bits
Reset State: 0x00000000

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

MUX_SRC (R/W):

Selects LVDS output driver source: see MUX_SRC description at the beginning of this section for source signal description.

DELAY (R/W):

0-8191: Delayed output in 8ns ticks (0 to 65,528ns range)

Register: A_TOKENIN_CFG

Address Offset: 0x0018
Size: 32bits
Reset State: 0x00000014

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

MUX_SRCx (R/W):

Selects readout token input source: see MUX_SRC description at the beginning of this section for source signal description.

Notes:

1) Default values should be left unchanged.

Register: A_TOKENOUT_CFG

Address Offset: 0x001C
Size: 32bits
Reset State: 0x00000013

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

MUX_SRCx (R/W):

Selects readout token input source: see MUX_SRC description at the beginning of this section for source signal description.

Notes:

1) Default values should be left unchanged.

Register: A_SDLINK_CFG

Address Offset: 0x0020
Size: 32bits
Reset State: 0x00000000

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

MUX_SRCx (R/W):

Selects readout token input source: see MUX_SRC description at the beginning of this section for source signal description.

Notes:

1) Default values should be left unchanged.

Register: A_TRIGOUT_CFG

Address Offset: 0x0024
Size: 32bits
Reset State: 0x00000000

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

MUX_SRCx (R/W):

Selects readout token input source: see MUX_SRC description at the beginning of this section for source signal description.

Notes:

1) Default values should be left unchanged.

7.5 Pulser Configuration Registers Section

Register: A_PULSER_PERIOD

Address Offset: 0x0120
Size: 32bits
Reset State: 0x00000000

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

PERIOD (R/W):

Defines number of 8ns ticks for the pulser period

Register: A_PULSER_LOW

Address Offset: 0x0124
Size: 32bits
Reset State: 0x00000000

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

LOW_CYCLES (R/W):

Defines number of 8ns ticks of the pulser period the output stays low.

Register: A_PULSER_NPULSES

Address Offset: 0x0150
Size: 32bits
Reset State: 0x00000000

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

COUNT (R/W):

0x00000000: disable pulser output
0x00000001 to 0xFFFFFFFE: number of periods to deliver pulser output
0xFFFFFFFF: infinite cycle count for pulser output

Notes:

1) When using fixed count of pulses the pulser must be trigger to start by writing to the A_PULSER_START register

Register: A_PULSER_START

Address Offset: 0x0154
Size: 32bits
Reset State: 0x00000000

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

PULSER_START (WO):

Write any value to start pulser operation. The pulse number counter is cleared.

Register: A_PULSER_STATUS

Address Offset: 0x0158
Size: 32bits
Reset State: 0x00000000

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

DONE (RO):

‘0’ – pulser is still delivering pulses as defined in A_PULSER_NPULSES
‘1’ – pulser is is not active (either disabled or has finished fixed pulse count)

7.6 FSSR Configuration Registers Section

Register: A_FSSR_CLK_CFG

Address Offset: 0x006C
Size: 32bits
Reset State: 0x00000010

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

BCOCLK_PERIOD (R/W):

0x02 to 0xFE: BCO clock period defined in 8ns ticks. Must be an even number.

Notes:

1) BCO clock periods should range between 32 (3.90625MHz) and 16 (7.8125MHz)
2) The slow control serial interface between the FSSR2 and VSCM is designed to work up to 12.5MHz (BCO clock period of 10 ticks). BCO clock frequencies beyond 8MHz on the FSSR2 have not been part of the chip specifications and so impacts on timing reliability for the FSSR2 are unknown by the VSCM developer.

Register: A_FSSR_MASK

Address Offset: 0x00AC
Size: 32bits
Reset State: 0x000000FF

31	30	29	28	27	26	25	24
-	-	-	-	-	-	-	-
23	**22**	**21**	**20**	**19**	**18**	**17**	**16**
-	-	-	-	-	-	-	-
15	**14**	**13**	**12**	**11**	**10**	**9**	**8**
-	-	-	-	-	-	-	-
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
GOTHIT7	GOTHIT6	GOTHIT5	GOTHIT4	GOTHIT3	GOTHIT2	GOTHIT1	GOTHIT0

GOTHITx (R/W):

'0' – disables GOTHIT signal from OR that feed the MUX input "FSSR_GOTHIT"
'1' – enables GOTHIT signal from OR that feed the MUX input "FSSR_GOTHIT"

Notes:

1) GOTHIT0 corresponds to HFCB1-U1
   GOTHIT1 corresponds to HFCB1-U2
   …
   GOTHIT4 corresponds to HFCB2-U1
   …

Register: A_FSSR_ADDR_H1

Address Offset: 0x00A4
Size: 32bits
Reset State: 0x0C0B0A09

31	30	29	28	27	26	25	24
-	-	-	CHIP_ADDR_U4				
23	22	21	20	19	18	17	16
-	-	-	CHIP_ADDR_U3				
15	14	13	12	11	10	9	8
-	-	-	CHIP_ADDR_U2				
7	6	5	4	3	2	1	0
-	-	-	CHIP_ADDR_U1				

CHIP_ADDR_Ux (R/W):

Defines 5bit chip address used in slow control serial interface on HFCB 1 connector. This chip ID is also used for error checking of the event words reported by the FSSR2.

Register: A_FSSR_ADDR_H2

Address Offset: 0x00A8
Size: 32bits
Reset State: 0x0C0B0A09

31	30	29	28	27	26	25	24
-	-	-	CHIP_ADDR_U4				
23	22	21	20	19	18	17	16
-	-	-	CHIP_ADDR_U3				
15	14	13	12	11	10	9	8
-	-	-	CHIP_ADDR_U2				
7	6	5	4	3	2	1	0
-	-	-	CHIP_ADDR_U1				

CHIP_ADDR_Ux (R/W):

Defines 5bit chip address used in slow control serial interface on HFCB 2 connector. This chip ID is also used for error checking of the event words reported by the FSSR2.

Register: A_MCLK_STATUS

Address Offset: 0x0070
Size: 32bits
Reset State: 0xXXXXXXXX

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

DATA (RO):
MCLK PLL configuration data output

RDY (RO):
‘0’ - MCLK PLL configuration not ready
‘1’ - MCLK PLL configuration ready

LOCKED (RO):
‘0’ - MCLK PLL is not locked
‘1’ - MCLK PLL is locked

Register: A_MCLK_CFG

Address Offset: 0x0074
Size: 32bits
Reset State: 0x00000000

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

DATA (R/W):
MCLK PLL configuration data input

ADDR (R/W):
MCLK PLL configuration address input

DEN (R/W):
‘0’ - MCLK PLL configuration data not valid
‘1’ - MCLK PLL configuration data valid

DWE (R/W):
‘0’ - MCLK PLL configuration data read
‘1’ - MCLK PLL configuration data write

RST (R/W):
‘0’ - MCLK PLL not reset
‘1’ - MCLK PLL reset

7.7 FSSR Serial Interface Registers Section

Register: A_FSSR_SER_CFG

Address Offset: 0x0080
Size: 32bits
Reset State: 0x00000000

31	30	29	28	27	26	25	24
RESET	-	-	-	CHIP_SEL			
23	**22**	**21**	**20**	**19**	**18**	**17**	**16**
NBITS							
15	**14**	**13**	**12**	**11**	**10**	**9**	**8**
RUN	RDY	-	-	-	CMD		
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
-	-	-	REG_ADDR				

REG_ADDR (R/W):
FSSR2 register address

CMD (R/W):
FSSR2 register command:
"001" - write, "010" - set, "100" - read, "101" - reset, "110" - default

RDY (RO):
'0' – shift register transfer is still active
'1' – shift register transfer is idle/complete

RUN (RO):
'0' – does nothing
'1' – starts shift register transfer (auto-clearing bit)

NBITS (R/W):
Number of bits to transfer (doesn't include chip, register, or command bit length)

CHIP_SEL (R/W):
"0000" – Select HFCB1, U1
"0001" – Select HFCB1, U2
"0010" – Select HFCB1, U3
"0011" – Select HFCB1, U4
"0100" – Select HFCB2, U1
"0101" – Select HFCB2, U2
"0110" – Select HFCB2, U3
"0111" – Select HFCB2, U4
"1000" – Select HFCB1 U1-U4, HFCB2 U1-U4 (Wild Chip ID used)
"1001" – Select HFCB1, U1-U4 (Wild Chip ID used)
"1010" – Select HFCB2, U1-U4 (Wild Chip ID used)

RESET (R/W):
'0' - FSSR2 MasterReset not asserted
'1' - FSSR2 MasterReset asserted

Register: A_FSSR_SER_CLK

Address Offset: 0x00A0
Size: 32bits
Reset State: 0x00000000

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

BCONUM (R/W):
FSSR2 BCONUM to issue command on

SYNC (R/W):
'0' – do not synchronize issued command with a particular BCONUM
'1' – synchronize issued command with BCONUM

Notes:

1) This register is used to deliver commands exactly on specified BCO clock number. This allows BCO clock synchronization checks across chips and provides the mechanism for synchronizing BCO counters across FSSR2 chips even if commands are issues to chips one at a time.

Register: A_FSSR_SER_DATA0 -> A_FSSR_SER_DATA3

Address Offset: 0x0084, 0x0088, 0x008C, 0x0090
Size: 32bits
Reset State: 0x00000000

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

DATAx (R/W):
FSSR2 shift register data input/output.

Notes:

1) Writing this register sets the initial contents to load into the FSSR2 serial shift register transmitter. Reading this register provides the received shift register data from the FSSR2 at the end of a read.
2) Four 32bit registers are used to support the maximum shift register data transfer of 128bits.

7.8 DAC Pulser Registers Section

Register: A_DAC_TRIG

Address Offset: 0x0014C
Size: 32bits
Reset State: 0x00000000

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

MUX_SRCx (R/W):
Selects DAC waveform trigger input source: see MUX_SRC description at the beginning of this section for source signal description.

DELAY (R/W):
Amount of delay after the DAC is triggered, in 8ns ticks, that the waveform output begins. In SYNC=1, this delay happens after the trigger has been synchronized with the BCOCLK.

SYNC (R/W):
'0' – does not synchronize the DAC waveform with the BCOCLK
'1' – synchronizes the DAC waveform with the BCOCLK

Register: A_DAC_CFG

Address Offset: 0x00094
Size: 32bits
Reset State: 0x00000000

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

DATA (R/W):
8bit data for DAC serial configuration

ADDR (WO):
8bit DAC serial address for configuration

IDLE_DAC_CODE (R/W):
14bit DAC code used when no waveform is being output.

START (WO):
'0' – does nothing
'1' – starts serial transfer for DAC configuration (auto clearing bit)

Register: A_DAC_CH0

Address Offset: 0x00098
Size: 32bits
Reset State: 0x00000000

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

DATA (WO):
14bit DAC waveform data
ADDR (WO):
9bit DAC waveform address
LEN (R/W):
9bit DAC waveform length
Notes:
1) Writing to this register will load the sample a DAC waveform sample (DATA) into the waveform address location (ADDR). LEN should match the address of the last waveform sample.

Register: A_DAC_CH1

Address Offset: 0x0009C
Size: 32bits
Reset State: 0x00000000

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

DATA (WO):
14bit DAC waveform data
ADDR (WO):
9bit DAC waveform address
LEN (R/W):
9bit DAC waveform length
Notes:
1) Writing to this register will load the sample a DAC waveform sample (DATA) into the waveform address location (ADDR). LEN should match the address of the last waveform sample.

7.9 Scalers Registers Section

Register: A_SCALER_LATCH

Address Offset: 0x00078
Size: 32bits
Reset State: 0xXXXXXX00

31	30	29	28	27	26	25	24
GLOBAL	-	-	-	-	-	-	-
23	**22**	**21**	**20**	**19**	**18**	**17**	**16**
-	-	-	-	-	-	-	-
15	**14**	**13**	**12**	**11**	**10**	**9**	**8**
-	-	-	-	-	-	-	-
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
H2U4	H2U3	H2U2	H2U1	H1U4	H1U3	H1U2	H1U1

HxUy (R/W):

‘0’ – disabled histogram bin filler for FSSR2 HxUy chip
‘1’ – enables histogram bin filler for FSSR2 HxUy chip
‘1’->’0’ – latches all scalers for FSSR2 HxUy chip

GLOBAL (WO):

‘0’ – does nothing
‘1’ – latches all scalers, except ones related to FSSR2 chip

Notes:

1) Scalers are all buffered and auto-cleared when latched for readout.
2) Histograms are currently not buffered and are only cleared when read. These must be disabled during readout.

Register: A_SCALER_FP_OUTPUT0 -> A_SCALER_FP_OUTPUT3

Address Offset: 0x0FC8, 0x0FCC, 0x0FD0, 0x0FD4
Size: 32bits
Reset State: 0xXXXXXXXX

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

SCALER_FPOUTPUTx (RO):

Number of rising edges seen on FPOUTPUTx since last scaler latch

Register: A_SCALER_FP_INPUT0 -> A_SCALER_FP_INPUT3

Address Offset: 0x0FD8, 0x0FDC, 0x0FE0, 0x0FE4
Size: 32bits
Reset State: 0xXXXXXXXX

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

SCALER_FPOUTPUTx (RO):

Number of rising edges seen on FPINPUTx since last scaler latch

Register: A_SCALER_BUSY

Address Offset: 0x0FE8
Size: 32bits
Reset State: 0xXXXXXXXX

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

SCALER_BUSY (RO):

Number of rising edges seen on internal BUSY since last scaler latch

Register: A_SCALER_BUSY_CYCLES

Address Offset: 0x0FEC
Size: 32bits
Reset State: 0xXXXXXXXX

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

SCALER_BUSY_CYCLES (RO):

Number of clock cycles (125MHz) internal BUSY was seen high since last scaler latch.

Register: A_SCALER_VMECLK

Address Offset: 0x0FF0
Size: 32bits
Reset State: 0xXXXXXXXX

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

SCALER_VMECLK (RO):

Number of VMECLK clock edges (50MHz) seen since last scaler latch.

Notes:

1) This scaler can be used to normalize other scalers latched by the GLOBAL.

Register: A_SCALER_SYNC

Address Offset: 0x0FF4
Size: 32bits
Reset State: 0xXXXXXXXX

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

SCALER_SYNC (RO):

Number of rising edges seen on the VXS-SWB-SYNC input since last scaler latch

Register: A_SCALER_TRIG1

Address Offset: 0x0FF8
Size: 32bits
Reset State: 0xXXXXXXXX

31	30	29	28	27	26	25	24
SCALER_TRIG1							
23	22	21	20	19	18	17	16
SCALER_TRIG1							
15	14	13	12	11	10	9	8
SCALER_TRIG1							
7	6	5	4	3	2	1	0
SCALER_TRIG1							

SCALER_TRIG1 (RO):

Number of rising edges seen on the VXS-SWB-TRIG1 input since last scaler latch

Register: A_SCALER_TRIG2

Address Offset: 0x0FFC
Size: 32bits
Reset State: 0xXXXXXXXX

31	30	29	28	27	26	25	24
SCALER_TRIG2							
23	22	21	20	19	18	17	16
SCALER_TRIG2							
15	14	13	12	11	10	9	8
SCALER_TRIG2							
7	6	5	4	3	2	1	0
SCALER_TRIG2							

SCALER_TRIG2 (RO):

Number of rising edges seen on the VXS-SWB-TRIG2 input since last scaler latch

7.10 FSSR Chip Scalers Registers Section

Register: A_FSSR_LAST_STAT_HxUy

Address Offset: 0x1000, 0x1100,…,0x1700
Size: 32bits
Reset State: 0xXXXXXXXX

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

LAST_STAT_HxUy (RO):

Last FSSR2 status word seen on readout interface from FSSR2 HxUy chip since last latch of HxUy scalers.

Register: A_FSSR_STAT_CNT_HxUy

Address Offset: 0x1004, 0x1104,…,0x1704
Size: 32bits
Reset State: 0xXXXXXXXX

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

STAT_CNT_HxUy (RO):

Number of FSSR2 status word seen on readout interface from FSSR2 HxUy chip since last latch of HxUy scalers.

Register: A_FSSR_EVENT_CNT_HxUy

Address Offset: 0x1008, 0x1108,…,0x1708
Size: 32bits
Reset State: 0xXXXXXXXX

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

EVENT_CNT_HxUy (RO):

Number of FSSR2 event word seen on readout interface from FSSR2 HxUy chip since last latch of HxUy scalers.

Register: A_FSSR_WORD_CNT_HxUy

Address Offset: 0x100C, 0x110C,…,0x170C
Size: 32bits
Reset State: 0xXXXXXXXX

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

WORD_CNT_HxUy (RO):
Number of FSSR2 words seen (status+event) on readout interface from FSSR2 HxUy chip since last latch of HxUy scalers.

Register: A_FSSR_IDLE_CNT_HxUy

Address Offset: 0x1010, 0x1110,…,0x1710
Size: 32bits
Reset State: 0xXXXXXXXX

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

IDLE_CNT_HxUy (RO):
Number of idle clock cycles (125MHz domain) where no FSSR2 words seen on readout interface from FSSR2 HxUy chip since last latch of HxUy scalers.

Register: A_FSSR_AQBCO_CNT_HxUy

Address Offset: 0x1014, 0x1114,…,0x1714
Size: 32bits
Reset State: 0xXXXXXXXX

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

AQBCO_CNT_HxUy (RO):
Number of FSSR2 status words seen on readout interface with AQBCO set from FSSR2 HxUy chip since last latch of HxUy scalers.

Register: A_FSSR_MARKERR_CNT_HxUy

Address Offset: 0x1018, 0x1118,…,0x1718
Size: 32bits
Reset State: 0xXXXXXXXX

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

MARKERR_CNT_HxUy (RO):

Number of FSSR2 words seen on readout interface with having a mark error from FSSR2 HxUy chip since last latch of HxUy scalers.

Register: A_FSSR_ENCERR_CNT_HxUy

Address Offset: 0x101C, 0x111C,…,0x171C
Size: 32bits
Reset State: 0xXXXXXXXX

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

ENCERR_CNT_HxUy (RO):

Number of FSSR2 event words seen on readout interface with invalid channel from FSSR2 HxUy chip since last latch of HxUy scalers.

Register: A_FSSR_CHIPIDERR_CNT_HxUy

Address Offset: 0x1020, 0x1120,…,0x1720
Size: 32bits
Reset State: 0xXXXXXXXX

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

CHIPIDERR_CNT_HxUy (RO):

Number of FSSR2 status words seen on readout interface with invalid chip ID from FSSR2 HxUy chip since last latch of HxUy scalers.

Register: A_FSSR_HIST_CFG_HxUy

Address Offset: 0x1024, 0x1124,…,0x1724
Size: 32bits
Reset State: 0xXXXXXXXX

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

MODE (R/W):

‘0’ – Histogram for FSSR2 HxUy chip data in channel hit mode
‘1’ – Histogram for FSSR2 HxUy chip data in latency mode

Register: A_FSSR_GOTHIT_CNT_HxUy

Address Offset: 0x1028, 0x1128,…,0x1728
Size: 32bits
Reset State: 0xXXXXXXXX

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

GOTHIT_CNT_HxUy (RO):

Number of FSSR2 gothit rising edges seen from FSSR2 HxUy chip since last latch of HxUy scalers.

Register: A_FSSR_HIST_CNT_HxUy

Address Offset: 0x102C, 0x112C,…,0x172C
Size: 32bits
Reset State: 0xXXXXXXXX

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

HIST_CNT_HxUy (RO):

After FSSR2 HxUy histograms are disabled for readout the bin pointer is reset to 0. Each read of HIST_CNT_HxUy increments the bin address pointer so that subsequent reads to this address read out the following bins in sequential order.

Each time a bin is read it is also cleared. All histogram bins used should be read to clear them for the next latch period.

Register: A_FSSR_REF_CNT_HxUy

Address Offset: 0x1030, 0x1130,…,0x1730
Size: 32bits
Reset State: 0xXXXXXXXX

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

REF_CNT_HxUy (RO):

Number of 125MHz clock edges seen since last scaler latch of HxUy scalers.

Notes:

1) This scaler can be used to normalize other scalers latched by the HxUy latch bit.

Register: A_FSSR_HIST_TIME_HxUy

Address Offset: 0x1034, 0x1134,…,0x1734
Size: 32bits
Reset State: 0xXXXXXXXX

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

HIST_TIME_HxUy (RO):

Number of 125MHz clock edges seen during the histogram enable period since last scaler latch of HxUy scalers.

Notes:

1) This scaler can be used to normalize the histogram bins that are enabled/disabled by the HxUy latch bit.

Register: A_FSSR_CORETALK_CNT_HxUy

Address Offset: 0x1038, 0x1138,…,0x1738
Size: 32bits
Reset State: 0xXXXXXXXX

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

CORETALK_CNT_HxUy (RO):

Number of FSSR2 coretalking rising edges seen from FSSR2 HxUy chip since last latch of HxUy scalers.