MCOR Hardware Design Notes

Version 7.0

Rev 2 Hardware

November 27, 2023

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# Revision History

## Document

|  |  |
| --- | --- |
|  |  |
| Version | Date |  |
| 1.0 | 7/20/2012 | USB Waveform, no interrupts |
| 2.0 | 7/20/2012 | Added Interrupt section |
| Updated Wave Form Acquisition section |
|  | 7/31/2012 | Added EVR Control Registers |
| 4.0 | 02/06/13 | ~~Change averaging~~ |
|  |  |  |
|  |  | Add Registers for Oversampling and Reference Control |
| 6.0 |  | Rev 2 Hardware |
|  |  | Added separate Fullscale for Monitor and Feedback ADC’s |
| 7.0 | 07/29/15 | Updated FPGA documentation |

##

## FPGA

| Version | Date |  |  |
| --- | --- | --- | --- |
| MCOR | EVR |  |  |  |
| 2.00 | 01 | 7/12/2012 | USB Waveform, no interrupts |  |
| Increased PCIe Address space to accommodate Wave Form Memory |  |
|  |  | 7/31/2012 | Added EVR Control Registers |  |
|  |  |  | Added EVR Functionality |  |
| 4.00 |  | 9/13/12 | Worked on EVR Functionality |  |
| 5.1 |  | 02/06/13 | ~~Change averaging. Added 64, 128 samples~~ |  |
|  |  |  | Add ADC Oversampling control which was left off the design |  |
|  |  |  | Add ADC External/Internal Reference Control |  |
|  |  |  | Changed UCF file to include Oversampling bits |  |
|  |  |  | Changed USB State Machine to accommodate plugging in the cableThis generates a bunch of long transitions on the RXF# and TXE# signals |  |
|  |  |  | Changed Start Convert. After Power-up, the ADC starts, when done it starts the Averaging. When the averaging is done, it starts the ADC again. The conversion rate is now dependent on the oversampling |  |
| 5.2 |  | 03/11/13 | Fixed EVR issues |  |
| 6.0 |  | 02/06/14 | Rev 2 Hardware |  |
|  |  | 03/06/14 | Conditioned USB Data with Power Enable from USB Chip |  |
| 7.0 |  | 07/29/14 | Fixed a bug in the PCIe writing of the ADC Full ScaleChanged wr\_strb to Fullscalewr in ADCChannelSeq |  |
| 8.0 |  | 08/01/14 | Added separate eGains for Monitor and Feedback ADC’s |  |
| 8.1 |  | 08/14/14 | Changed Ripple Init from 1Khz to 10hz since at max oversampling the ADC run at ~2-3Khz |  |
|  |  |  | Changed Default oversampling to 6 instead of 0 |  |
| 8.2 |  | 09/15/14 | Saturate DAC output so it won’t wrap from + full-scale to – Full-ScaleFix problem with writing Setpoint to Faulted channel |  |
| 8.5 |  | 10/15/14 | Set DAC gain to 10.2564Something happened to the project and I had to restore it from 10/15 am |  |
| 8.7 |  | 2/12/15 | Fixed MCOR Inhibit bus. Or with Water fault in xilinx |  |
|  |  |  | Add 62.5Mhz clock divider from PCIe bus instead of 100Mhz from external clock. |  |
| 8.71 |  | 2/18/15 | Water Sum Fault should be low true. |  |
| 9.01 |  | 4/7/15 | Fixed EVR version register, 02C. |  |
| 9.02 | 02 | 6/9/15 | Removed Event Interrupt Enable bit from the FIFO Status.(Interupt\_Register.vhd) | jjo |
| Changed MCOR Version to 9.02, EVR Version to 2 | jjo |
| 9.03 | 03 | 6/26/15 | Changed BAR2, EVR to 32k from 16k |  |
|  |  |  | Temporarily commented out MCOR memory to make space for testing interrupts. Wfmcapture.vhdUsed LED to output interrupt signals as test pointsMcor\_x.vhdOutput interrupttst.mcs for now |  |
|  |  |  |  |  |
| 9.10 | 03 | 7/2/15 | Changed Timing IRQ from using latched versions to rising edges.Timing – Interrupt\_Register.vhd |  |
| 10.00 | 03 | 7/21/15 | Found Interrupt problem. It was in Xilinx’s Tx/RX application interface. Rx done is a pulse to the Tx engine. If the Tx engine is not ready because the interface is busy servicing the interrupt, the Tx engine misses the Rx Done and the cycle hangs. Added a state in Xilinx’s Tx engine to wait for the Rx Done. |  |
|  |  | 7/29/15 | Fixed error reading the Event FIFO |  |
| 10.10 | 03 | 7/30/15 | Changed Event FIFO to First word Fall-thru mode |  |

# BAR 0 Memory Map – MCOR Registers

|  |  |
| --- | --- |
| BAR 0 Address |  |
| 0x00000 –0x003C0  | Channel Control Registers |
| 0x00400 –0x0043C  | Bulk Supply Registers |
| 0x00440 –0x0047C  | MCOR ADC Control Registers |
| 0x00480 –0x004BC | Fault Registers |
| 0x004C0 –0x004FC  | Waveform Capture Registers |
| 0x00500 –0x0053C  | Interlocks and Magnet Faults |
| 0x00540 –0x0057C | MCOR Voltage Monitor |
| 0x00580 –0x005BC | Xilinx System Monitor |
| 0x005C0 –0x005FC  | MCOR System Information |
| 0x00600 –0x0067C  | 512 Bytes Transceiver data |
| 0x00680 –0x006BC  | Interrupt Registers |
| 0x006C0 –0x006FC  | MCOR EVR Control Registers |
| 0x01000–0x017FE  | EVR Register Interface from USB (No BAR) |
| 0x01800 –0x01FFF  | EVR Data Buffer Memory from USB (No BAR) |
| 0x40000 –0x7FFFC  | Waveform Memory |

# BAR 2 Memory Map – EVR Registers

|  |  |
| --- | --- |
| 0x0000 –0xFFFF | ERV Interface Base |

# Configuration/Status Set/Reset Registers

Many of the MCOR functions are controlled by three registers within the block of registers.

Configuration/Status Register

This Register will contain the current value of the settings for the particular bits.

Set Register

Writing a ‘1’ to a bit in this register will SET the corresponding bit in the Configuration/Status register without affecting any other bits.

Reset Register

Writing a ‘1’ to a bit in the register will CLEAR the corresponding bit in the Configuration/Status register without affecting any other bits.

# Front Panel LED’s

Red and Green Blinking fast – Xilinx Boot done, no PCIe activity

Red blinking fast – PCIe link is up

Green Blinking Slow – A PCIe read has been executed

Green on steady – At least one channel on the MCOR has been configured.

# MCOR Channel Registers

Each channel has a set of Configuration and Data Registers.

|  |  |
| --- | --- |
| Channel Base |  |
| 0x0000 | Channel 0 |
| 0x0040 | Channel 1 |
| 0x0080 | Channel 2 |
| 0x00C0 | Channel 3 |
| 0x0100 | Channel 4 |
| 0x0140 | Channel 5 |
| 0x0180 | Channel 6 |
| 0x01C0 | Channel 7 |
| 0x0200 | Channel 8 |
| 0x0240 | Channel 9 |
| 0x0280 | Channel 10 |
| 0x02C0 | Channel 11 |
| 0x0300 | Channel 12 |
| 0x0340 | Channel 13 |
| 0x0380 | Channel 14 |
| 0x03C0 | Channel 15 |

## Channel Registers

|  |  |  |  |
| --- | --- | --- | --- |
| Offset | Reg |  |  |
| 0x00 | 0 | Set Point Requested. The Channel will not respond to setpoint commands unless the configure bit is set. | Int32 in uA |
| 0x04 | 1 | Current Set Point |
| 0x08 | 2 | Monitor ADC Reading |
| 0x0C | 3 | Monitor Average ADC Reading |
| 0x10 | 4 | Monitor Ripple Measurement |
| 0x14 | 5 | FeedBack ADC Reading |
| 0x18 | 6 | FeedBack Average ADC Reading |
| 0x1C | 7 | FeedBack Ripple Measurement |
| 0x20 | 8 | Fullscale DAC SetPoint Current |
| 0x24 | 9 | Fullscale Monitor ADC ReadBack Current |
| 0x28 | A | Ramp Rate | Int32 uA/sec |
| 0x2C | B | Samples per Average | UInt32 |
| 0x30 | C | Configuration/Status Register |
| 0x34 | D | Set Configuration Register |
| 0x38 | E | Reset Configuration Register |
| 0x3C | F | Fullscale FeedBack ADC ReadBack Current |

### Channel Configuration/Status Register

|  |  |  |  |
| --- | --- | --- | --- |
| Bit |  |  |  |
| 6 | Fault Status | ‘1’ à MCOR Power Module Faulted‘0’ à MCOR Power Module OK |  |
| 5 | Ramping | ‘1’ à Ramping in progress‘0’ à Ramping done |  |
| 4 | Standardized Direction | ‘1’ à Falling ‘0’ à Rising | Not implemented |
| 3 | Ramp Mode | ‘1’ à Immediate, no ramping‘0’ à Normal Ramp Mode Selected |  |
| 2 | Closed Loop(Auto Trim) | ‘1’ à Closed Loop‘0’ à Open Loop | Not implemented |
| 1 | Fast FeedBack  | ‘1’ à Channel being used for Fast Feedback‘0’ à Normal MCOR functionality | Not implemented |
| 0 | Configured | Cleared by power on, set to indicate the channel has been configured. The Channel will not respond to setpoint commands unless the configure bit is set. |  |

### Configuration Set/Reset Register

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| 4 | Standardized Direction | Not implemented |
| 3 | Ramp/Immediate |  |
| 2 | Closed Loop | Not implemented |
| 1 | Fast FeedBack  | Not implemented |
| 0 | Configured |  |

### Ramp Rate

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| [31:00] | Ramp Rate | Int32 in µA/sec |

## Full Scale Current

The Fullscale value for the SetPoint DAC and the ReadBack ADC can be different depending on the type of MCOR installed. MCOR 6, 9 and 12 have a ReadBack of 10V is 12A. MCOR 1, 1.5 and 2 have a ReadBack of 10V is 2A. The DAC full-scale voltage is 10.2564, so the actual DAC full-scale is 2.564% over the nominal value below.

|  |  |  |
| --- | --- | --- |
|  | Nominal Fullscale Current |  |
| MCOR | DAC  | Monitor ADC | FeedBack ADC | DAC Full Scale Setting |
| 30 | 30A | 30A | 30A | 30.7692A |
| 20 | 20A | 20A | 20A | 20.5128A |
| 12 | 12A | 12A | 12A | 12.30768A |
| 9 | 9A | 12A  | 9A  | 9.23076A |
| 6 | 6A | 12A  | 6A  | 6.15384A |
| 2 | 2A | 2A  | 2A  | 2.05128A |
| 1.5 | 1.5A | 2A | 1.5A | 1.53846A |
| 1 | 1A | 2A | 1A | 1.02564A |

### Full Scale DAC SetPoint Current

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| [31:00] | Full Scale Current | Int32 in µA |

### Full Scale ADC ReadBack Current

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| [31:00] | Full Scale Current | Int32 in µA |

### Samples/Average

Applies to both the Monitor and the FeedBack Channel

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| [31:03] | unused |  |
| [02:00] | Number of samples to average over | 0x5 à 320x4 à 160x3 à 80x2 à 40x1 à 20x0 à 1 |

# Bulk Supply

## Bulk Supply Registers

|  |  |  |  |
| --- | --- | --- | --- |
| ~~Offset~~ | ~~Reg~~ | ~~Base 0x0400~~ |  |
| ~~0x00~~ | ~~0~~ | ~~Bulk Voltage Request~~ | ~~Int32 in µV~~ |
| 0x04 | 1 | Bulk Supply Voltage 0-5V => 0-30V | Int32 in µV |
| ~~0x08~~ | ~~2~~ | ~~Bulk Supply Current~~ | ~~Int32 in µA~~ |
| 0x0C | 3 | Ground Fault Current | Int32 in µA |
| ~~0x10~~ | ~~4~~ | ~~Bulk Current Limit Request~~ | ~~Int32 in µA~~ |
| ~~0x14~~ | ~~5~~ | ~~Bulk Supply DAC Full Scale Voltage~~ | ~~Int32 in µV~~ |
| ~~0x18~~ | ~~6~~ | ~~Bulk Supply DAC Full Scale Current~~ | ~~Int32 in µA~~ |
| 0x1C | 7 | Bulk Supply ADC Full Scale Voltage | Int32 in µV |
| ~~0x20~~ | ~~8~~ | ~~Bulk Supply ADC Full Scale Current~~ | ~~Int32 in µA~~ |
| 0x24 | 9 | Bulk Supply ADC Full Scale Ground Current | Int32 in µA |
| 0x28 | A | Ground Fault Current Threshold | Int32 in µV |
| ~~0x2C~~ | ~~B~~ | ~~Ramp Rate~~ | ~~Int32 in µV/Sec~~ |
| 0x30 | C | Configuration/Status Register | UInt32 |
| 0x34 | D | Set Configuration Register | UInt32 |
| 0x38 | E | Reset Configuration Register | UInt32 |
| 0x3C | F |  |  |

### Bulk Supply Status/Configuration Register

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| 7 | Configured | ‘1’ à Bulk Supply Configured‘0’ à Bulk Supply not Configured |
| 6 | Ground Fault | ‘1’ à Bulk Supply Ground Fault‘0’ à No Bulk Supply Ground Fault |
| ~~5~~ | ~~Fault~~ | ~~‘1’ à Bulk Supply Fault~~~~‘0’ à No Bulk Supply Fault~~ |
| ~~4~~ | ~~Ramping~~ | ~~‘1’ à Ramping in progress~~~~‘0’ à Ramping done~~ |
| ~~3~~ | ~~Bulk On Status~~ ~~(Bulk PS\_OK)~~ | ~~‘1’ à Bulk Supply is ON~~~~‘0’ à Bulk Supply is OFF~~ |
| ~~2~~ | ~~Control Type~~ | ~~‘1’ à Slave~~~~‘0’ à Master~~ |
| ~~1~~ | ~~PS Reset~~~~(Bulk SO)~~ | ~~‘1’ à Reset Asserted~~~~‘0’ à Reset Not Asserted~~ |
| 0 | PS On/Off Request(Bulk ENA\_In/Out) | ‘1’ à Bulk Supply ON‘0’ à Bulk Supply OFF |

### Bulk Supply Set/Reset Configuration Register

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| ~~4~~ | ~~Control Type~~ | ~~‘1’ àSlave~~~~‘0’ à Master~~ |
| ~~1~~ | ~~PS Reset~~ | ~~‘1’ à Assert Reset~~~~‘0’ à De-assert Reset~~ |
| 0 | PS On/Off Request | ‘1’ à Turn Bulk Supply ON‘0’ à Turn Bulk Supply OFF |

# MCOR ADC Control

The ADC’s used for reading the MCOR has the option of running with oversampling. The following registers control the functionality of the ADC’s.

## ADC Control Registers

|  |  |  |
| --- | --- | --- |
| Offset | Base = 0x0440 |  |
| 0x00 | Control | Uint32 |
| 0x04 | Set Control |
| 0x08 | Reset Control |
| 0x0C | MCOR ADC Oversampling |
| 0x10 | MCOR ADC External Ref. |
| 0x140x3C |  |

### Control Register

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| [3] | Bulk ADC Timeout | ‘1’ à Bulk ADC timed out‘0’ à Bulk ADC OK |
| [2] | ADC Timeout | ‘1’ à One of the ADC’s timed out‘0’ à ADC’s OK |
| [1] | Bulk ADC Reset | ‘1’ à Bulk ADC Reset Asserted‘0’ à Bulk ADC Reset Not Asserted |
| [0] | MCOR ADC’s Reset | ‘1’ à MCOR ADC Reset Asserted‘0’ à MCOR ADC Reset Not Asserted |

### Control Set/Reset Register

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| [3]  | Reset Bulk ADC Timeout |  |
| [2] | Reset ADC Timeout |  |
| [1] | Bulk ADC Reset |  |
| [0] | MCOR ADC’s Reset |  |

### Oversampling Control

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| [14:12] | Bulk Supply | See Analog Devices AD7609 for more details |
| [11:09] | Feedback ADC Channels 15 – 8 |
| [08:06] | Feedback ADC Channels 7 – 0 |
| [05:03] | Monitor ADC Channels 15 – 8 |
| [02:00] | Monitor ADC Channels 7 – 0 |

Increasing the oversampling rate will slow down the conversion rate of the ADC, this will affect the 100Khz normal operation of the ADC.

From Analog Devices AD7609 datasheet

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| OS [2:0]  | OS Ratio  | SNR ±5V Range (dB)  | SNR ±10V Range (dB)  | −3 dB BW 5V Range (kHz)  | −3 dB BW 10V Range (kHz)  |
| 000  | No OS  | 90.8  | 91.5  | 22  | 33  |
| 001  | 2  | 93.3  | 93.9  | 22  | 28.9  |
| 010  | 4  | 95.5  | 96.4  | 18.5  | 21.5  |
| 011  | 8  | 98  | 98.9  | 11.9  | 12  |
| 100  | 16  | 100.6  | 101  | 6  | 6  |
| 101  | 32  | 101.8  | 102  | 3  | 3  |
| 110  | 64  | 102.7  | 102.9  | 1.5  | 1.5  |
| 111  | Invalid |

### Internal Reference Control

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| ~~[04]~~ | ~~Bulk Supply~~ | ‘1’ à Internal Reference‘0’ à External ReferenceSee Analog Devices AD7609 for more details |
| [03] | Feedback ADC Channels 15 – 8 |
| [02] | Feedback ADC Channels 7 – 0 |
| [01] | Monitor ADC Channels 15 – 8 |
| [00] | Monitor ADC Channels 7 – 0 |



# MCOR Faults

## Fault Registers

|  |  |  |
| --- | --- | --- |
| Offset | Base = 0x0480 |  |
| 0x00 | MCOR Power Module Fault Status | Uint32 |
| 0x04 | MCOR Power Module Latched Fault Status |
| 0x08 | Reset Latched Fault Status |
| 0x0C | Control |
| 0x10 | Set Control |
| 0x14 | Reset Control |
| 0x18 | Fault ByPass |
| 0x1C | Set Fault Bypass |
| 0x20 | Reset Fault Bypass |

The MCOR Faults are conditioned with a 2.55us filter.

### Fault Status

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| [15:00] | MCOR Power Module Fault Status |  |

### Latched Fault Status

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| [15:00] | MCOR Power Module Latched Fault Status |  |

### Reset Latched Fault Status

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| [15:00] | Reset MCOR Power Module Latched Fault Status |  |

### Control Register

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| [1] | MCOR Inhibit | ‘1’ à MCOR Inhibit Asserted‘0’ à MCOR Inhibit Not Asserted |
| [0] | MCOR Reset | ‘1’ à MCOR Reset Asserted‘0’ à MCOR Reset Not Asserted |

### Control Set/Reset Register

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| [1] | MCOR Inhibit |  |
| [0] | MCOR Reset |  |

# Interlocks

For future use, 4 Interlock outputs and 8 Magnet Fault inputs and 1 Water Sum Fault are provided. The Magnet Faults are conditioned with a 2.55us filter.

## Interlock and Magnet Fault Registers

|  |  |  |
| --- | --- | --- |
| Offset | Base = 0x0500 |  |
| 0x00 | External Interlocks Status |  |
| 0x04 | Set External Interlocks | UInt32 |
| 0x08 | Reset External Interlocks |
| 0x0C | Magnet Fault Status |
| 0x10 | Magnet Latched Fault Status |
| 0x14 | Reset Magnet Latched Fault Status |
| 0x100x0E |  |

### External Interlock Status (0x0000)

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| [31:04] | Unused |  |
| [03:00] | Output |  |

### External Interlock Set/Reset Output (0x0004,0x0008)

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| [31:04] | Unused |  |
| [03:00] | Output |  |

### Input Status (0x000C)

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| [31:09] |  |  |
| 8 | Water Fault (Turn off Bulk) |  |
| [07:00] | Inputs |  |

### Latched Input Status (0x0010)

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| [31:09] |  |  |
| 8 | Water Fault (Turn off Bulk) |  |
| [07:00] | Inputs |  |

### Clear Latched Input Status (0x0010)

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| [31:09] |  |  |
| 8 | Water Fault (Turn off Bulk) |  |
| [07:00] | Inputs |  |

# MCOR Voltage Monitor Interface

Several Board voltages are monitored. They can be read back in the following registers.

## Voltage Monitor Registers

|  |  |  |
| --- | --- | --- |
| Offset | Base = 0x0540 | Int32 |
| 0x00 | +15.0V(In) | $$V=N\*6.0\*305.18E^{-6}$$ |
| 0x04 | +12.0V(In) | $$V=N\*4.83\*305.18E^{-6}$$ |
| 0x08 | +5.0V(In) | $$V=N\*2.0\*305.18E^{-6}$$ |
| 0x0C | +3.3V | $$V=N\*305.18E^{-6}$$ |
| 0x10 | +3.3VCC IO | $$V=N\*305.18E^{-6}$$ |
| 0x14 | -15.0V(In) | $$V= N\*-16.0 \*305.18E^{-6}$$ |
| 0x18 | +15.0V(In) Current | $$I=N\*19.0735E^{-6}/60E^{-3}$$ |
| 0x1C | +12.0V(In) Current | $$I=N\*19.0735E^{-6}/150E^{-3}$$ |
| 0x20 | +5.0V(In) Current | $$I=N\*19.0735E^{-6}/30E^{-3}$$ |
| 0x24 | +3.3V Current | $$I=N\*19.0735E^{-6}/150E^{-3}$$ |
| 0x28 | +3.3VCCIO Current | $$I=N\*19.0735E^{-6}/150E^{-3}$$ |
| 0x2C | +2.5V Current | $$I=N\*19.0735E^{-6}/150E^{-3}$$ |
| 0x30 | +1.0V Current | $$I=N\*19.0735E^{-6}/150E^{-3}$$ |
| 0x34 | -15.0V(In) Current | $$I=N\*19.0735E^{-6}/60E^{-3}$$ |
| 0x38 | Board Temperature | N\* 0.0625 |
| 0x3C |  |  |

# Xilinx System Monitor

Base Address for the Xilinx System Monitor is 0x00000580

The Xilinx contains an on chip monitor that, among other things, allows access to the chip temperature and V(Int) and V(Aux). The current value as well as the Min and Max are stored in the Xilinx and can be readout via the System Monitor Interface.

## Read Xilinx Monitor

|  |  |  |
| --- | --- | --- |
| Offset | Base = 0x0580 |  |
| 0x00 | Current Temp | Int32 in ADC Counts |
| 0x04 | Current V(Int) |
| 0x08 | Current V(Aux) |
| 0x0C | Max Temp |
| 0x10 | Max V(Int) |
| 0x14 | Max V(Aux) |
| 0x18 | Min Temp |
| 0x1C | Min V(Int) |
| 0x20 | Min V(Aux) |
| 0x240x3C |  |  |

$$Temperature \left(°C\right)=(\frac{Counts}{64}\*503.975/1024)-273.15$$

$$Volts =\frac{counts}{64}/ 1024\*3$$

# System Information

|  |  |  |
| --- | --- | --- |
| Offset | Base = 0x05C0 |  |
| 0x00 | Firmware Version | 8 Bytes, ASCII = ” 00000001” |
| 0x08 | System ID | 4 Bytes, ASCII = “MCOR” |
| 0x0C | Sub Type | 10 Bytes, ASCII = “ “ |
| 0x16 | Firmware Date | 10 Bytes, ASCII = ” dd/mm/yyyy” |
| 0x1F |  |  |

# Beam Synchronous Acquisition (BSA) – NOT Implemented

|  |  |  |
| --- | --- | --- |
| Address |  |  |
|  | Time Stamp |  |
|  | ⁞ |  |
|  | Time Stamp |  |
|  | MCOR 0 Monitor Average ADC |  |
|  | ⁞ |  |
|  | MCOR 15 Monitor Average ADC |  |
|  | MCOR 0 FeedBack Average ADC |  |
|  | ⁞ |  |
|  | MCOR 15 FeedBack Average ADC |  |

# Interrupts

The MCOR Controller could generate several interrupts.

1. Fault Detected
2. Waveform Acquisition complete
3. BSA Message available
4. EVR Interrupts
5. Ramping Done

## Interrupt Registers

|  |  |  |
| --- | --- | --- |
| Offset | Base = 0x0680 |  |
| 0x00 | Interrupt Source | RW |
| 0x04 | Interrupt Source Enables | RO |
| 0x08 | Interrupt Source Set Enable | WO |
| 0x0C | Interrupt Source Reset Enable | WO |
| 0x10 | Set Software Interrupt | WO |

### Interrupt Source

|  |  |  |  |
| --- | --- | --- | --- |
| Bit |  |  |  |
| [31:09] | Unused |  |  |
| [08] | Software Interrupt |  |  |
| [07] |  |  |  |
| [06] | Ramp Done |  | Not Implemented |
| [05] | COMx GPI | From COMx GPIO |  |
| [04] | BSA Message Available |  | Not Implemented |
| [03]  | EVR Interrupt |  |  |
| [02] | OR of the Magnet Faults | External Interlocks | Not Implemented |
| [01] | OR of the MCOR Channel Faults  |  | Not Implemented |
| [00] | Waveform Acquisition complete |  | Not Implemented |

Writing a ‘1’ to a bit in the Interrupt Source will reset the corresponding bit if the cause of the interrupt has been cleared. If the cause of the interrupt has not been cleared, the corresponding bit will not be reset and another interrupt will be generated.

### Interrupt Source Enable, Set/Reset

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| [31:01] | Unused |  |
| [08] | Software Interrupt |  |
| [07:01] | Not implemented yet |  |
| [00] | End of Waveform Capture |  |

### Software Interrupt register

|  |  |  |  |
| --- | --- | --- | --- |
| Bit |  |  |  |
| [31:09] | Unused |  |  |
| [08] | Software Interrupt | Self Clearing | WO |
| [07:00] | unused |  |  |

###

# Fiber Optic Transceiver data

The Transceivers have diagnostics built in to facilitate component monitoring, fault isolation and predictive failure (See AVAGO app note 5016). All 512 bytes of diagnostic data is available in the Xilinx memory starting at location 0x1000. The byte data from the transceiver is read as 32 bit word.

|  |  |
| --- | --- |
| Offset | Base = 0x0600 |
|  | SFP 0xA0 | MSB LSB |
| 0x00 | Byte 3 | Byte 2 | Byte 1 | Byte 0 |
| 0x04 | Byte 7 | Byte 6 | Byte 5 | Byte 4 |
|  |  |  |  |  |  |
| 0x40 | SFP 0XA2 Extended Data | Byte 3 | Byte 2 | Byte 1 | Byte 0 |
| 0x44 | Byte 7 | Byte 6 | Byte 5 | Byte 4 |
|  |  |  |  |  |

## EEPROM Serial ID Memory Contents –

The following tables are from the AVAGO datasheet. For detailed information see AVAGO Datasheet.

### Serial ID data fields – Address 0xA0 (from SFF-8472 MSA).

|  |
| --- |
| BASE ID FIELDS |
| Byte # | Size | Name Field | Description Field |
| 0  | 1  | Identifier  | Type of serial transceiver  |
| 1  | 1 | Ext. Identifier  | Extended identifier of type of serial transceiver  |
| 2  | 1  | Connector  | Code for connector type  |
| 3-10  | 8 | Transceiver  | Code for electronic compatibility or optical compatibility  |
| 11  | 1 | Encoding  | Code for serial encoding algorithm  |
| 12  | 1 | BR, Nominal  | Nominal bit rate, units of 100 Mbits/sec. |
| 13  | 1 | Reserved |  |
| 14  | 1  | Length (9μm) km  | Link length supported for 9/125 Ïm fiber, units of km |
| 15  | 1  | Length (9μm)  | Link length supported for 9/125 Ïm fiber, units of 100m |
| 16  | 1  | Length (50μm)  | Link length supported for 50/125 Ïm fiber, units of 10m |
| 17  | 1  | Length (62.5μm) | Link length supported for 62.5/125 Ïm fiber, units of 10m |
| 18  | 1  | Length (Copper) | Link length supported for copper, units of meters |
| 19  | 1  | Reserved |  |
| 20-35  | 16 | Vendor name  | SFP vendor name (ASCII) |
| 36  | 1 | Reserved |  |
| 37-39 |  3  | Vendor OUI  | SRP vendor IEEE company ID |
| 40-55  | 16 | Vendor PN | Part number provided by SFP vendor (ASCII) |
| 58-59  | 4  | Vendor rev  | Revision level for part number provided by vendor (ASCII) |
| 60-61  | 2 | Wavelength  | Laser wavelength |
| 62 |  1 | Reserved |  |
| 63 |  1  | CC\_BASE | Check code for Base ID Fields (addresses 0 to 62) |
| EXTENDED ID FIELDS |
| 64-65 |  2  | Options  | Indicates which optional transceiver signals are implemented  |
| 66  | 1  | BR, max  | Upper bit rate margin, units of % |
| 67  | 1  | BR, min  | Lower bit rate margin, units of % |
| 68-83  | 16  | Vendor SN  | Serial number provided by vendor (ASCII) |
| 84-91  | 8  | Date Code  | Vendor’s manufacturing date code  |
| 92  | 1  | Diagnostic Monitoring Type | Indicates which type of diagnostic monitoring is implemented (if any) in the transceiver  |
| 93  | 1  | Enhanced Options | Indicates which optional enhanced features are implemented (if any) in the transceiver  |
| 94  | 1  | SFF-8472 Compliance  | Indicates which revision of SFF8472 the transceiver complies with  |
| 95  | 1  | CC\_EXT  | Check code for the Extended ID Fields addresses 64 to94 |
| VENDOR SPECIFIC ID FIELDS |
| 96-127  | 32  | Vendor Specific  | Vendor Specific EEPROM |
| 128-255  | 128 | Reserved | Reserved for future use  |

### Enhanced Feature Set Memory (Address A2h)

|  |  |  |  |
| --- | --- | --- | --- |
| Byte # |  | Byte # |  |
| 1  | Temp H Alarm LSB[1]  | 34  | Rx Pwr L Alarm MSB[5]  |
| 2  | Temp L Alarm MSB[1]  | 35  | Rx Pwr L Alarm LSB[5]  |
| 3  | Temp L Alarm LSB[1]   | 36  | Rx Pwr H Warning MSB[5]  |
| 4  | Temp H Warning MSB[1]   | 37  | Rx Pwr H Warning LSB[5]  |
| 5  | Temp H Warning LSB[1]   | 38  | Rx Pwr L Warning MSB[5]  |
| 6  | Temp L Warning MSB[1]   | 39  | Rx Pwr L Warning LSB[5]  |
| 7  | Temp L Warning LSB[1]   | 40-55  | Reserved  |
| 8  | Vcc H Alarm MSB[2]   | 56-94  | External Calibration Constants[6]  |
| 9  | Vcc H Alarm LSB[2] | 95  | Checksum for Bytes 0-94[7]  |
| 10 |  Vcc L Alarm MSB[2] | 96  | Real Time Temperature MSB[1] |
| 11  | Vcc L Alarm LSB[2]   | 97  | Real Time Temperature LSB[1] |
| 12  | Vcc H Warning MSB[2] | 98  | Real Time Vcc MSB[2] |
| 13  | Vcc H Warning LSB[2]   | 99  | Real Time Vcc LSB[2] |
| 14  | Vcc L Warning MSB[2]  | 100  | Real Time Tx Bias MSB[3] |
| 15  | Vcc L Warning LSB[2]  | 101  | Real Time Tx Bias LSB[3] |
| 16  | Tx Bias H Alarm MSB[3]  | 102  | Real Time Tx Power MSB[4] |
| 17  | Tx Bias H Alarm LSB[3]  | 103  | Real Time Tx Power LSB[4] |
| 18  | Tx Bias L Alarm MSB[3]  | 104 | Real Time Rx average MSB[5] |
| 19  | Tx Bias L Alarm LSB[3]  | 105  | Real Time Rx average LSB[5] |
| 20  | Tx Bias H Warning MSB[3]  | 106  | Reserved |
| 21  | Tx Bias H Warning LSB[3]  | 107  | Reserved |
| 22  | Tx Bias L Warning MSB[3]  | 110 | Status/Control |
| 23  | Tx Bias L Warning LSB[3]  | 111  | Reserved |
| 24  | Tx Pwr H Alarm MSB[4]  | 112  | Flag Bits |
| 25  | Tx Pwr H Alarm LSB[4] | 113  | Flag Bits |
| 26 | Tx Pwr L Alarm MSB[4] | 114  | Reserved |
| 27  | Tx Pwr L Alarm LSB[4]  | 115  | Reserved |
| 28  | Tx Pwr H Warning MSB[4]  | 116  | Flag Bits |
| 29  | Tx Pwr H Warning LSB[4]  | 117  | Flag Bits  |
| 30  | Tx Pwr L Warning MSB[4] | 118-127 | Reserved |
| 31  | Tx Pwr L Warning LSB[4]  | 128-247  | Customer Writeable |
| 32  | Rx Pwr H Alarm MSB[5] | 248-255  | Vendor Specific |
| 33  | Rx Pwr H Alarm LSB[5]  |  |  |

**Notes:**

1. Temperature (Temp) is decoded as a 16 bit signed two’s compliment integer in increments of 1/256°C.

2. Supply Voltage (Vcc) is decoded as a 16 bit unsigned integer in increments of 100 μV.

3. Laser bias current (Tx Bias) is decoded as a 16 bit unsigned integer in increments of 2 μA.

4. Transmitted average optical power (Tx Pwr) is decoded as a 16 bit unsigned integer in increments of 0.1 μW.

5. Received average optical power (Rx Pwr) is decoded as a 16 bit unsigned integer in increments of 0.1 μW.

6. Bytes 55-94 are not intended for use with AFCT-57R5APZ, but have been set to default values per SFF-8472.

7. Byte 95 is a checksum calculated (per SFF-8472) and stored prior to product shipment.

# MCOR Timing Receiver

## Timing Control Registers

|  |  |  |
| --- | --- | --- |
| Address | Register | Description |
| 0x0000 | Status | Status Register |
| 0x0004 | Control | Control Register |
| 0x0008 | IrqFlag | Interrupt Flag Register |
| 0x000C | IrqEnable | Interrupt Enable Register |
| 0x0010 | PulseIrqMap | Pulse Interrupt Map Register |
| 0x0014 –0x001C  | Unused |  |
| 0x0020 | DataBufCtrl | Rx Data Buffer Control and Status |
| 0x0024(1) | Reserved | (Tx Data Buffer Control and Status)  |
| 0x0028 | Unused |  |
| 0x002C(2) | FW Version | Firmware Version |
| 0x0030 –0x003C  | Unused |  |
| 0x0040 | EvntCntPresc | Event Counter Prescaler |
| 0x0044 –0x0048  | Unused |  |
| 0x004C | µsec Divider | Divider from Event Clock to 1Mhz |
| 0x0050(1) | Reserved | [Clock Control Register] |
| 0x0054 –0x0058  | Unused |  |
| 0x005C | SecSReg | Seconds Register |
| 0x0060 | SecCntr | TimeStamp Seconds Counter |
| 0x0064 | EvntCntr | TimeStamp Event Counter |
| 0x0068 | SecLatch | TimeStamp Seconds Latch |
| 0x006C | EvntCntrLatch | TimeStamp Event Counter |
| 0x0070 | EvntFIFOSec | Event FIFO Seconds Register |
| 0x0074 | EvntFIFOEvntCntr | Event FIFO Event Counter Register |
| 0x0078 | EvntFIFOEvntCode | Event FIFO Event Code Register |
| 0x007C(1) | Reserved | (Event Log Status Register) |
| 0x0080(1) | Reserved | (FracDiv) |
| 0x0084 | Unused |  |
| 0x0088(1) | Reserved | (RxInitPs) |
| 0x008C | Unused |  |
| 0x0090(1) | Reserved | (GPIO DIR) |
| 0x0094(1) | Reserved | (GPIO IN) |
| 0x0098(1) | Reserved | (GPIO OUT) |

(1) Not Used for MCOR

(2) SLAC MCOR Specific Definition

## Prescaler Control Registers

|  |  |  |
| --- | --- | --- |
| 0x0100 | Presc0 | Prescaler 0 Divider |
| 0x0104 | Presc1 | Prescaler 1 Divider |
| 0x0108 | Presc2 | Prescaler 2 Divider |

## Pulse Generator Control Registers

|  |  |  |
| --- | --- | --- |
| 0x0200 | PulseGen0 | Pulse Generator 0 Control Registers |
| 0x0204 | Pulse Generator 0 Prescaler Registers |
| 0x0208 | Pulse Generator 0 Delay Registers |
| 0x020C  | Pulse Generator 0 Width Registers |
| 0x0210 –0x021C | PulseGen1 | Pulse Generator 1 Registers |
| 0x0220 –0x022C  | PulseGen2 | Pulse Generator 2 Registers |
| 0x0230 –0x023C  | PulseGen3 | Pulse Generator 3 Registers |
| 0x0240 –0x024C | PulseGen4 | Pulse Generator 4 Registers |
| 0x0250 –0x025C  | PulseGen5 | Pulse Generator 5 Registers |
| 0x0260 –0x026C  | PulseGen6 | Pulse Generator 6 Registers |
| 0x0270 –0x027C  | PulseGen7 | Pulse Generator 7 Registers |
| 0x0280 –0x028C  | PulseGen8 | Pulse Generator 8 Registers |
| 0x0290 –0x029C  | PulseGen9 | Pulse Generator 9 Registers |

## Front Panel Mapping Registers

|  |  |  |
| --- | --- | --- |
| 0x0400  | FrntPnlMap | Front Panel Output 0 and 1 Map Registers |

## Data Buffer

|  |  |  |
| --- | --- | --- |
| 0x0800 –0x0FFF  | DataBufMem | Data Buffer Memory |

## Event Log

|  |  |  |
| --- | --- | --- |
| 0x2000 –0x2FFF  | EvntLog | Event Log |

## Map Ram

|  |  |  |
| --- | --- | --- |
| 0x4000 –0x5FFF  | MapRam1 | Event Mapping RAM 1 |
| 0x6000 –0x7FFF | MapRam2 | Event Mapping RAM 2 |

# Register Definitions

## Status Register

|  |  |
| --- | --- |
| Bit | Address 0x0000 |
| [31:24] | DBUS[07:00] | DBUS |
| 23 | Event FIFO Full |  |
| 22 | Event FIFO Empty |  |
| [21:17] | Unused |  |
| 16 | LEGVIO | Legacy VIO |
| [15:06] | Unused |  |
| 5 | FIFOStp | Event FIFO Stopped Flag |
| [04:00] | Unused |  |

## Control Register

|  |  |
| --- | --- |
| Bit | Address 0x0004 |
| 31 | EVREn | Event Receiver Enable |  |
| 30(1) | Reserved | (EvntFWD) |  |
| 29(1) | Reserved | (TXLP) |  |
| 28(1) | Reserved | (RXLP) |  |
| [27:15] | Unused |  |  |
| 14 | TSDBUS | Use DBU4 for TimeStamp Counter |  |
| 13 | RSTS | Reset TimeStamp | ‘1’ à Reset TimeStamp CounterSelf clearing |
| [12:11] | Unused |  |  |
| 10  | LTS | Latch TimeStamp | ‘1’ à Latch TimeStamp CounterSelf clearing |
| 9 | MAPEn | Event Mapping RAM Enable |  |
| 8 | MAPRS | Mapping RAM Select | ‘1’ à Select Mapping RAM2‘0’ à Select Mapping RAM1 |
| 7(1) | Reserved | (LOGRS) | Reset Event Log |
| 6(1) | Reserved | (LOGEN) | Enable Event Log |
| 5(1) | Reserved | (LOGDIS) | Disable Event Log |
| 4(1) | Reserved | LOGSE | Log Stop Event |
| 3 | RSFIFO | Reset Event FIFO | ‘1’ à Reset Event FIFOSelf clearing |
| [02:00] | Unused |  |  |

(1) Not Used for SLAC MCOR

## Interrupt Flag Register

|  |  |
| --- | --- |
| Bit | Address 0x0008 |
| [31:6] | Unused |  |  |
| 5 | IFDBUF | Data Buffer Flag |  |
| 4 | IFHW | Hardware Flag | See Hardware Interrupt Mapping Register |
| 3 | IFEV | Event Flag | Event FIFO not Empty |
| 2 | IFHB | HeartBeat FLAG |  |
| 1 | IFFF | Event FIFO Full Flag |  |
| 0 | IFVIO | Receiver Violation Flag |  |

The interrupt flag is normally cleared by writing a ‘1’ to the corresponding bit. However, the Event Flag is the Event FIFO Not Empty Flag. It is cleared when the FIFO has been read out.

## Interrupt Enable Register

|  |  |
| --- | --- |
| Bit | Address 0x000C |
| 31 | IRQEN | Master Interrupt Enable |  |
| [30:6] | Unused |  |  |
| 5 | IEDBUF | Data Buffer Interrupt Enable |  |
| 4 | IEHW | Hardware Interrupt Enable | See Hardware Interrupt Mapping Register |
| 3 | IEEV | Event Interrupt Enable |  |
| 2 | IEHB | HeartBeat Interrupt Enable |  |
| 1 | IEFF | Event FIFO Full Interrupt Enable |  |
| 0 | IEVIO | Receiver Violation Interrupt Enable |  |

## Hardware Interrupt Mapping Register

|  |  |
| --- | --- |
| Bit | Address 0x0010 |
| [31:6] | Unused |  |  |
| [05:00] | See Selection Control Word |  |  |

## Receive Data Buffer Control and Status Register

|  |  |
| --- | --- |
| Bit | Address 0x0020 |
| [31:16] | Unused |  |  |
| 15 | DBRX/DBENA |  | Writing a ‘1’ Enables Data Buffer Recorder for a Single Event. Clears CheckSum Error. Reads ‘0’ when Done. |
| 14 | DBRDY/DBDIS |  |  |
| 13 | DBCS | Data Buffer Checksum Error | Cleared by writing ‘1’ to DBENA or DBDIS or disabling the Data Buffer |
| 12 | DBEN | Data Buffer Enable | ‘1’ à Distributed BUS Multiplexed with Data Buffer‘0’ à Distributed BUS NOT Multiplexed with Data Buffer |
| 11 |  |  | ‘0’ |
| [10:00] | RX Size |  |  |

## FPGA Firmware Version Register

|  |  |
| --- | --- |
| Bit | Address 0x002C |
| [31:28] | EVR |  | 0x01 |
| [27:24](1) | Form Factor |  | 0x0F à SLAC MCOR….0x02 à VME64x0x01 à PMC0x00 à Compact PCI |
| [23:08] | Reserved |  |  |
| [07:00] | Version ID | Version |  |

(1) SLAC Added, NOT standard

## Event Counter Clock Prescaler Register

|  |  |
| --- | --- |
| Bit | Address 0x0040 |
| [31:16] | Unused |  |  |
| [15:00] | TSEvntCntrPresc | TimeStamp Event Counter Prescaler |  |

## Microsecond Divider Register

|  |  |
| --- | --- |
| Bit | Address 0x004C |
| [31:16] | Unused |  |  |
| [15:00] | µSDivider | Value to get 1µs timer from System Clock | For 119Mhz clock should be 119 |

## Seconds Shift Register

|  |  |
| --- | --- |
| Bit | Address 0x005C |
| [31:00] | SecSR | Seconds Shift Register |  |

## Seconds Counter Register

|  |  |
| --- | --- |
| Bit | Address 0x0060 |
| [31:00] | SecCntr | Seconds Counter Register |  |

## TimeStamp Event Counter Register

|  |  |
| --- | --- |
| Bit | Address 0x0064 |
| [31:00] | TsEvntCntr | TimeStamp Event Counter Register |  |

## Seconds Latch Register

|  |  |
| --- | --- |
| Bit | Address 0x0068 |
| [31:00] | SecLatch | Seconds Latch Register |  |

## TimeStamp Event Latch Register

|  |  |
| --- | --- |
| Bit | Address 0x006C |
| [31:00] | TsEvntLatch | TimeStamp Event Latch Register |  |

## Event FIFO Seconds Register

|  |  |
| --- | --- |
| Bit | Address 0x0070 |
| [31:00] | FIFOSec | FIFO Seconds | Only valid after reading the corresponding Event Code |

## Event FIFO TimeStamp Register

|  |  |
| --- | --- |
| Bit | Address 0x0074 |
| [31:00] | FIFOTs | FIFO TimeStamp | Only valid after reading the corresponding Event Code |

## Event FIFO Event Code Register

|  |  |
| --- | --- |
| Bit | Address 0x0078 |
| [31:08] | Unused |  |  |
| [07:00] | FIFOEvntCode | FIFO Event Code | Reading the Event Code also moves the Seconds and TimeStamp to the corresponding register to be read out |

## Prescaler Registers

|  |  |
| --- | --- |
| Offset | Base Address 0x0100 |
| 0x00 | Prescale 0 |
| 0x04 | Prescale 1 |
| 0x08 | Prescale 2 |

### Prescaler Register

|  |  |
| --- | --- |
| Bit |  |
| [31:00] | PrescVal |  |  |

## Pulse Generator Registers

|  |  |
| --- | --- |
| Offset | Base Address 0x0200 |
| 0x00 | Pulse Generator 0 Control Register |
| 0x04 | Pulse Generator 0 Prescaler RegisterDivides the Delay and Width clock by N+1 |
| 0x08 | Pulse Generator 0 Delay Register |
| 0x0C | Pulse Generator 0 Width Register |
| 0x10 – 0x1C | Pulse Generator 1 Registers |
| 0x20 – 0x2C | Pulse Generator 2 Registers |
| 0x30 – 0x3C | Pulse Generator 3 Registers |
| 0x40 – 0x4C | Pulse Generator 4 Registers |
| 0x50 – 0x5C | Pulse Generator 5 Registers |
| 0x60 – 0x6C | Pulse Generator 6 Registers |
| 0x70 – 0x7C | Pulse Generator 7 Registers |
| 0x80 – 0x8C | Pulse Generator 8 Registers |
| 0x90 – 0x9C | Pulse Generator 9 Registers |

### Pulse Generator (x) Control Register

|  |  |
| --- | --- |
| Bit |  |
| [31:08] | Unused |  |  |
| 08(1) | P(x)\_n | Re-Triggerable | ‘1’ à Generator is NOT Retriggerable‘0’ à Generator is Retriggerable |
| 07 | P(x)Out | Pulse Generator Output |  |
| 06 | P(x)SWS | Software Set | Terminates any previous Pulse Request |
| 05 | P(x)SWC | Software Reset | Terminates any previous Pulse Request |
| 04 | P(x)POL | Polarity Control | ‘1’ à Invert Polarity (Low True)‘0’ à Normal Polarity (High True) |
| 03 | P(x)MRE | Event Map Reset Enable |  |
| 02 | P(x)MSE | Event Map Set Enable |  |
| 01 | P(x)MTE | Event Map Trigger Enable |  |
| 00 | P(x)ENA | Pulse Enable |  |

(1) SLAC Added Control BIT, NOT standard

### Pulse Generator Retriggerability

If P(x)RTEN is a ‘0’ the Pulse Generator is Retriggerable. If a new Trigger Event is received while the Pulse is TRUE, the width will be stretched by programmed width. If a new Trigger Event is received while in the Delay period, it will be ignored.

### Pulse Generator Prescaler Register

The value in the Prescaler Register is used to divide the clock going to the Pulse Generator Delay and Width by N+1;

## Timing Output Mapping

|  |  |  |
| --- | --- | --- |
| Offset | Base Address 0x0400 |  |
| 0x00 | FPOutMap | Front Panel Mapping controlSee Selection Control Word |
| 0x04 –0x0F | Reserved  |  |
| 0x10 | Timing WFM Trigger |  |

### Front Panel Output Mapping

|  |  |
| --- | --- |
| Bit |  |
| [31:22] | Unused |  |  |
| [21:16] | FPMAP1 | Front Panel Output 1 Mapping | See Selection Control Word |
| [15:06] | Unused |  |  |
| [05:00] | FPMAP0 | Front Panel Output 0 Mapping | See Selection Control Word |

### Timing WFM Trigger

|  |  |
| --- | --- |
| Bit |  |
| [31:06] | Unused |  |  |
| [05:00] | WFMTrig | WaveForm Trigger | See Selection Control Word |

# Selection Control word

|  |  |
| --- | --- |
| Value | EVR Trigger |
| 63 | Force Output High |
| 62  | Force Output Low |
| [61:43] | Reserved |
| 42 | Prescaler 2 |
| 41  | Prescaler 1 |
| 40 | Prescaler 0 |
| [39:32] | Distributed Bus Bit [07:00] |
| [31:10] | Reserved |
| [09:00] | Pulse Generator Output [09:00] |

## Data Buffer (SLAC Specific)

|  |  |
| --- | --- |
| Offset | Base Address 0x0800 |
| 0x0000 | Type and Version |
| 0x0004 – 0x0010 | PNET Modifier |
| 0x0014 –0x0018 | EVR Extension |
| 0x001C –0x0020 | EPICS TimeStamp |
| 0x0024 –0x0030 | BSA Information |

### Type and Version

|  |  |  |
| --- | --- | --- |
| Offset | Bits |  |
| 0x000 | [31:16] | Type |
| [15:00] | Version |

### EPICS TimeStamp

|  |  |  |
| --- | --- | --- |
| Offset | Bits |  |
| 0x000 | [31:00] | Seconds since 1990 |
| 0x004 | [31:17] | \*131072 nSeconds  |
| [16:00] | Pulse ID |

## Event RAM

|  |  |  |
| --- | --- | --- |
| Offset | Event Code | Base Address 0x4000 |
| 0x0000  | 0x00 | Event Map Reset  |
| 0x0004 | Event Map Set |
| 0x0008 | Event Map Trigger |
| 0x000C | Functions |
| 0x0010 | 0x01 | Event Map Reset  |
| 0x0014 | Event Map Set |
| 0x0018 | Event Map Trigger |
| 0x001C | Functions |
| ----- | ----- | ----- |
| 0x0FF0  | 0xFF | Event Map Reset  |
| 0x0FF4 | Event Map Set |
| 0x0FF8 | Event Map Trigger |
| 0x0FFC | Functions |

### Event MAP Reset

|  |  |
| --- | --- |
| Bit |  |
| [31:10] | Unused |  |
| [09:00] | Reset Pulse Generator | If Enabled, Terminates any previous Pulse Request |

### Event MAP Set

|  |  |
| --- | --- |
| Bit |  |
| [31:10] | Unused |  |
| [09:00] | Set Pulse Generator | If Enabled, Terminates any previous Pulse Request |

### Event MAP Trigger

|  |  |
| --- | --- |
| Bit |  |
| [31:10] | Unused |  |
| [09:00] | Trigger Pulse Generator |  |

### Event MAP Functions

|  |  |  |
| --- | --- | --- |
| Bit |  | Event Code |
| 31 | Save Event in FIFO |  |  |
| 30 | Latch TimeStamp |  |  |
| 29 | Reserved | (LED Event) |  |
| 28 | Reserved | (Forward Event from RX to TX) |  |
| 27 | Reserved | (Stop Event Log) |  |
| 26 | Reserved | (Log Event) |  |
| [25:06] | Reserved |  |  |
| 5 | HeartBeat |  | 0x7A |
| 4 | Reset Prescalers |  | 0x7B |
| 3 | TimeStamp Reset Event |  | 0x7D |
| 2 | TimeStamp Clock Event |  | 0x7C |
| 1 | Seconds Shift Register ‘1’ |  | 0x71 |
| 0 | Seconds Shift Register ‘0’ |  | 0x70 |

# MCOR Voltage and Current Monitoring ADC

Three Linear Technology LTC2991, Octal I2C Voltage, Current and Temperature Monitor chips are used to read the MCOR Monitor voltage and Currents. They are configured as follows:

## Address “000”

|  |  |  |
| --- | --- | --- |
| Register |  | Value |
| 0x00 | Status Low |  |
| 0x01 | Channel Enable/Trigger | 0xF8 |
| 0x06 | V1-4 Control | 0xAA |
| 0x07 | V5-8 Control | 0xAA |
| 0x08 | Acquisition Mode | 0x18 |
| 0x0D-0x0C | V1-V2 | +3.3V Current |
| 0x11-0x10 | V3-V4 | +2.5V Current |
| 0x15-0x14 | V5-V6 | +1.0V Current |
| 0x19-0x18 | V7-V8 | +5.0V(In) Current |

### Register 1

|  |  |  |  |
| --- | --- | --- | --- |
| Bit |  |  | Value |
| 7 | Enable V7/V8 | +5.0V(In) Current | 1 |
| 6 | Enable V5/V6 | +1.0V Current | 1 |
| 5 | Enable V3/V4 | +2.5V Current | 1 |
| 4 | Enable V1/V2  | +3.3V Current | 1 |
| 3 | Enable Temp and VCC |  | 1 |
| 2 | Busy | Read Only | 0 |
| 1 | Tempature(Internal) Valid | Read Only | 0 |
| 0 | VCC Valid | Read Only | 0 |
|  |  |  | 0xF8 |

### Register 6

|  |  |  |  |
| --- | --- | --- | --- |
| Bit |  |  | Value |
| 7 | Enable Filter |  | 1 |
| 6 | Kelvin/Celsius |  | 0 |
| 5 | Temperature/Volts |  | 0 |
| 4 | V3-V4 | +2.5V Current | 1 |
| 3 | Enable Filter |  | 1 |
| 2 | Kelvin/Celsius |  | 0 |
| 1 | Temperature/Volts |  | 0 |
| 0 | V1-V2  | +3.3V Current | 1 |
|  |  |  | 0x99 |

### Register 7

|  |  |  |  |
| --- | --- | --- | --- |
| Bit |  |  | Value |
| 7 | Enable Filter |  | 1 |
| 6 | Kelvin/Celsius |  | 0 |
| 5 | Temperature/Volts |  | 0 |
| 4 | V7-V8 | +5.0V(In) Current | 1 |
| 3 | Enable Filter |  | 1 |
| 2 | Kelvin/Celsius |  | 0 |
| 1 | Temperature/Volts |  | 0 |
| 0 | V5-V6  | +1.0V Current | 1 |
|  |  |  | 0x99 |

### Register 8

|  |  |  |
| --- | --- | --- |
| Bit |  | Value |
| 7 | PWM[0] | 0 |
| 6 | PWM Invert | 0 |
| 5 | PWM Enable | 0 |
| 4 | Repeated Acquisition Mode | 1 |
| 3 | Temperature(Internal) Filter | 1 |
| 2 | Kelvin/Celsius | 0 |
| 1 | Reserved | 0 |
| 0 | Reserved | 0 |
|  |  | 0x18 |

## Address “001”

|  |  |  |  |
| --- | --- | --- | --- |
| Register |  | Value |  |
| 0x00 | Status Low |  |  |
| 0x01 | Channel Enable/Trigger | 0xF8 |  |
| 0x06 | V1-4 Control | 0xAA |  |
| 0x07 | V5-8 Control | 0xAA |  |
| 0x08 | Acquisition Mode | 0x18 |  |
| 0x0D-0xC | V1-V2 | +15.0V(In) Current |  |
| 0x11-0x10 | V3-V4 | -15.0V(In) Current |  |
| 0x15-0x14 | V5-V6 | +3.3VCCIO Current |  |
| 0x19-0x18 | V7-V8 | +12.0V(In) Current |  |
|  |  |  |  |

### Register 1 – Channel Enable

|  |  |  |  |
| --- | --- | --- | --- |
| Bit |  |  | Value |
| 7 | Enable V7/V8 | +12.0V(In) Current | 1 |
| 6 | Enable V5/V6 | +3.3VCCIO Current | 1 |
| 5 | Enable V3/V4 | -15.0V(In) Current | 1 |
| 4 | Enable V1/V2  | +15.0V(In) Current | 1 |
| 3 | Enable Temp and VCC |  | 1 |
| 2 | Busy | Read Only | 0 |
| 1 | Temperature(Internal) Valid | Read Only | 0 |
| 0 | VCC Valid | Read Only | 0 |
|  |  |  | 0xF8 |

### Register 6 – V1-V4 Control

|  |  |  |  |
| --- | --- | --- | --- |
| Bit |  |  | Value |
| 7 | Enable Filter |  | 1 |
| 6 | Kelvin/Celsius |  | 0 |
| 5 | Temperature/Volts |  | 0 |
| 4 | V3-V4 | -15.0V(In) Current | 1 |
| 3 | Enable Filter |  | 1 |
| 2 | Kelvin/Celsius |  | 0 |
| 1 | Temperature/Volts |  | 0 |
| 0 | V1-V2  | +15.0V(In) Current | 1 |
|  |  |  | 0xAA |

### Register 7 – V5-V7 Control

|  |  |  |  |
| --- | --- | --- | --- |
| Bit |  |  | Value |
| 7 | Enable Filter |  | 1 |
| 6 | Kelvin/Celsius |  | 0 |
| 5 | Temperature/Volts |  | 0 |
| 4 | V7-V8 | +12.0V(In) Current | 1 |
| 3 | Enable Filter |  | 1 |
| 2 | Kelvin/Celsius |  | 0 |
| 1 | Temperature/Volts |  | 0 |
| 0 | V5-V6  | +3.3VCCIO Current | 1 |
|  |  |  | 0xAA |

### Register 8 – Temperature Control

|  |  |  |
| --- | --- | --- |
| Bit |  | Value |
| 7 | PWM[0] | 0 |
| 6 | PWM Invert | 0 |
| 5 | PWM Enable | 0 |
| 4 | Repeated Acquisition Mode | 1 |
| 3 | Temperature(Internal) Filter | 1 |
| 2 | Kelvin/Celsius | 0 |
| 1 | Reserved | 0 |
| 0 | Reserved | 0 |
|  |  | 0x18 |

## Address “010”

|  |  |  |  |
| --- | --- | --- | --- |
| Register |  | Value |  |
| 0x00 | Status Low |  |  |
| 0x01 | Channel Enable/Trigger | 0x78 |  |
| 0x06 | V1-4 Control | 0x88 |  |
| 0x07 | V5-8 Control | 0x08 |  |
| 0x08 | Acquisition Mode | 0x18 |  |
| 0x0B-0x0A | V1 | +3.3V |  |
| 0x0D-0x0C | V2 | +3.3VCCIO |  |
| 0x0F-0x0E | V3 | +5.0V(In) |  |
| 0x11-0x10 | V4 | +15.0V(In) |  |
| 0x13-0x12 | V5 | -15.0V(In) |  |
| 0x15-0x14 | V6 | +12.0V(In) |  |

### Register 1

|  |  |  |  |
| --- | --- | --- | --- |
| Bit |  |  | Value |
| 7 | Enable V7/V8 | Unused | 0 |
| 6 | Enable V5/V6 | -15.0V(In) , +12.0V(In) | 1 |
| 5 | Enable V3/V4 | +5.0V(In) , +15.0V(In)  | 1 |
| 4 | Enable V1/V2  | +3.3V, +3.3VCCIO | 1 |
| 3 | Enable Temp and VCC |  | 1 |
| 2 | Busy | Read Only | 0 |
| 1 | Temperature(Internal) Valid | Read Only | 0 |
| 0 | VCC Valid | Read Only | 0 |
|  |  |  | 0x78 |

### Register 6

|  |  |  |  |
| --- | --- | --- | --- |
| Bit |  |  | Value |
| 7 | Enable Filter |  | 1 |
| 6 | Kelvin/Celsius |  | 0 |
| 5 | Temperature/Volts |  | 0 |
| 4 | V3 and V4 | +5.0V(In) , +15.0V(In) | 0 |
| 3 | Enable Filter |  | 1 |
| 2 | Kelvin/Celsius |  | 0 |
| 1 | Temperature/Volts |  | 0 |
| 0 | V1 and V2  | +3.3V, +3.3VCCIO | 0 |
|  |  |  | 0x88 |

### Register 7

|  |  |  |  |
| --- | --- | --- | --- |
| Bit |  |  | Value |
| 7 | Enable Filter |  | 0 |
| 6 | Kelvin/Celsius |  | 0 |
| 5 | Temperature/Volts |  | 0 |
| 4 | V7 and V8 | Unused | 0 |
| 3 | Enable Filter |  | 1 |
| 2 | Kelvin/Celsius |  | 0 |
| 1 | Temperature/Volts |  | 0 |
| 0 | V5 and V6  | -15.0V(In) , +12.0V(In) | 0 |
|  |  |  | 0x08 |

### Register 8

|  |  |  |
| --- | --- | --- |
| Bit |  | Value |
| 7 | PWM[0] | 0 |
| 6 | PWM Invert | 0 |
| 5 | PWM Enable | 0 |
| 4 | Repeated Acquisition Mode | 1 |
| 3 | Temperature(Internal) Filter | 1 |
| 2 | Kelvin/Celsius | 0 |
| 1 | Reserved | 0 |
| 0 | Reserved | 0 |
|  |  | 0x18 |

# USB Interface Protocol

The USB protocol consists of sending a header to define a read or write operation and 16/32 bit data. The Header is 8 Bytes with the following:

## USB Request Header

|  |  |  |  |
| --- | --- | --- | --- |
| Byte |  |  |  |
| [00] | Control Byte |  |  |
| [03:01] | 24 Bit Address |  |  |
| [05:04] | 16 Bit Byte Count |  |  |
| [07:06] | Dummy (Word Alignment) | “0000” |  |

### Control Byte

|  |  |  |
| --- | --- | --- |
| Bit |  |  |
| [07] | Response Flag | ‘1’ à Response from Board‘0’ à Request from USB  |
| [06] | Direction | ‘1’ à Read from Board‘0’ à Write to Board |
| [05] | Size | ‘1’ à 32 Bit Data |
| [04] | “0” |  |
| [03:00] | TAG | User definable. Returned in the response message |

Every USB transfer has a response message. For a write the response is the control byte followed by a zero. For a read, the response is the control byte, and a zero, followed by N-bytes of data.

## USB Response Header

|  |  |  |  |
| --- | --- | --- | --- |
| Byte |  |  |  |
| [00] | Control Byte |  |  |
| [01] | “0” |  |  |

## USB Write Request

|  |  |  |  |
| --- | --- | --- | --- |
| Byte |  |  |  |
| [00] | Control Byte |  |  |
| [03:01] | 24 Bit Address |  |  |
| [05:04] | 16 Bit Byte Count |  |  |
| [07:06] | Dummy (Word Alignment) | “0000” |  |
|  | N-Words of data |  |  |

# PCIe Testing

# BARA

/afs/slac/u/qb/strauman/bara -h

gives you usage info. The basic operation is

bara -s <signature> -r <resource>  -w <width>  offset [value]

signature: PCI signature  domain:bus:device.function, e.g., 0000:04:01.0
           (note that 'domain' must be 4 digits, 'bus' and 'dev' two
           and 'function' a single digit)

width:     access width (in bytes: 1,2 or 4)
resource:  bar number e.g., 2 (can be negative in which case the PCI config space is accessed)
offset:    byte offset into BAR
value:     if given, then a 'write' (and readback) is performed, otherwise a 'read'

ssh laci@eioc-b34-mg05

cd /afs/slac/g/lcls/epics/modules/R3-14-12/drvPciMcor/MAIN\_TRUNK/

cd /afs/slac1/g/lcls/epics/modules/R3-14-12/drvPciMcor/MAIN\_TRUNK/

bin/linuxRT-x86/pciMcorDemo bin/linuxRT-x86/demo.cexp

starts cexp. The script defines the base address of the MCOR as

'theMcor'

int md(unsigned address, int count, int size)

dumps 'count' items of 'size' starting at 'address'. Size maybe 1, 2 or 4 (bytes).

If not specified, 4 is assumed. To dump 52 (32-bit) words at offset xyz you say

md(theMcor + xyz, 52, 4)

Dump MCOR ID

md (theMcor + 0x5c0, 32, 1)

Dump Timging ID

md (theMcor + 0x102C, 4, 4)

Write Data Buffer Conrol, enable and trigger

\*(long \*)(theMcor + 0x1020) = 0x9000

Dump Data Buffer

md (theMcor + 0x1800, 52,1)