Plan for Slow Control Network

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Proposal

Replace CCU by I^2C block of Quad TBM

Disadvantages of the CCU

- CCU more complex than required
- Question about radiation and SEU hardness
- CCU in Deep Sub-Micron $\rightarrow$ level translation.
- CCU token ring unnecessarily complicated.
- CCU may not allow the Extended RAL Addressing Mode

Advantages of Quad TBM hubs

- Quad TBM has four I^2C ports, easily expandable
- Eliminate need for CCU
- Design done by pixel group
- Continuous I^2C network between FEC and detector front-end

Implementation

- Details of architecture (EB,YK,SS)
- Details of the addressing (EB,YK,SS)
- Accommodate specifics of barrel and forward pixels (EB,YK,SS)
- Implement I^2C connection over fibers (EB)
- Design I^2C block of TBM (LP)
- Modify FEC to generate I^2C protocol (YK)

Architecture

Guidelines

- Adaptable to both barrel and forward pixels
- Flexible to allow changes in modularity
- Minimize number of critical failure items
- Configured so that an I^2C failure is limited whereever possible to a single group of ROC's

Assumptions for Barrel

- For each I^2C one FEC channel master
- Failure of I^2C communication to an ROC likely fatal to all ROC's in group.
- Failure of I^2C communication to PLL, DCU or the lasers not necessarily fatal
- One I^2C network per quarter-ladder (4 modules)
- 4 groups of ROC's per module; 4 ROC's per group
- Per quarter-ladder: 1 PLL, 1 Digital laser TX/RX
- Per module: 1 DCU, 1 Quad laser TX package, 1 Quad TBM

Addressing

FEC $\Leftrightarrow$ Hubs

- Design for 8 Hubs per network with 8 Ports each

  $\Rightarrow$ 3-bits for adressing Hub

  $\Rightarrow$ 3-bit for addressing specific Port

- Allow for addressing all ports within a given Hub or for addresssing all Hubs in a single command

  $\Rightarrow$ 2-bit Broadcast Command

00	send to addressed port in addressed Hub
01	send to all ports in addressed Hub
10	send to addressed port in all Hubs
11	send to all ports in all Hubs

- First byte of a command from the FEC

Brdcst. Command [1 : 0]	Hub Addr. [2 : 0]	Port Addr. [2 : 0]

Hub $\Leftrightarrow$ Port Devices

$\rightarrow$ Command Format

Start

Brdcst.Command	Hub Addr.	Port Addr.	Ack
[1 : 0]	[2 : 0]	[2 : 0]	[0]

Device Address	R/W	Ack
[6 : 0]	[0]	[0]

Data 1	Ack
[7 : 0]	[0]

$\vdots$

Data n	Ack
[7 : 0]	[0]

Stop

Functionality

- Start internal clock
- Output SCL to CLK_TO_FEC line
- Check MSB of Broadcast Command to see if general broadcast
- Check 3-bit Hub Address to see if Hub is being addressed
- If addressed, send Acknowledge Bit to FEC
- Strip off leading byte
- Check LSB of Broadcast Command to see if all ports are addressed
- Check Port Address
- Output remaining command stream to SDA line of addressed port(s)
- Output internal clock to SCL line of addressed port(s)
- Output the "AND" of DAT_TO_HUB with SDA to DAT_TO_FEC
- Upon receipt of Stop signal, cease above functioning and reset internal clock

Connections

Hub ⇔ Port Devices

Standard, bi-directional, 2-wire I^2C lines

SDA:	Data
SCL:	Clock

FEC ⇔ Hubs

Four uni-directional fibers

CLK_TO_HUB:	40 MHz Clock with embedded L1 trigger
DAT_TO_HUB:	I^2C Data
CLK_TO_FEC:	Clock “Wired AND” of all SCL lines
DAT_TO_FEC:	Data “wired-AND” of DAT_TO_HUB and all SDA lines

Clocking Issues

- CLK_TO_HUB will carry 40 MHz clock with L1 trigger embedded
- Extraction of L1 phase stabilization of 40 MHz clock will be performed by PLL
- I^2C clock will be produced by each Hub by prescaling 40 MHz clock
- May want to adjust phase of each Hub clock
- To monitor phase, CLK_TO_FEC will be "AND" of SCL lines
- If phase is well adjusted duty cycle is 50%
- 200 meter length $\Rightarrow$ I^2C clock $<$ 500 kHz
- Scale factor of 128 would give 312.5 kHz
- May wish to make scale factor adjustable