Alice ITS Upgrade

Readout Electronic – WP10

DCS & ITSC

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Summary

This documents lists all the parameters which can be retrieved from the ITS Readout Units and all the command they can parse.

Contents

1.1 System overview

1.1.1 Layout

The ITS is organized in seven layers, each further segmented into staves. A different number of staves composes each layer, and staves belonging to different layers have different sensor count and topology. Nevertheless, from the interface point of view, each stave is controlled by a single Readout Unit (RU), independently from the layer it sits within, and all RUs are connected to the CRU in identical way. Table 2 details the RUs distribution per layer.

Layer	Staves	RUs per stave	RUs per layer	VTRx per layer	VTTx per layer	GBT uplink	GBT downlink
0	12	1	12	24	12	36	12
1	16	1	16	32	16	48	16
2	20	1	20	40	20	60	20
3	24	1	24	48	24	48	24
4	30	1	30	60	30	60	30
5	42	1	42	84	42	126	42
6	48	1	48	96	48	144	48
Total	**192**		**192**	**384**	**192**	**576**	**192**

Table 1 – Staves and RUs for the entire ITS, with link to/from the CRU

The RUs as well manage the staves power. Power is actually provided by custom-made Power Units (PU), connected to the stave power and bias buses, fed by the CAEN power supplies, and controlled via I2C by the RU itself (Figure 1). Due to practical optimization the Power Units hardware is not matched 1:1 with the staves, but even in this case the RU interface is: i.e. a RU controls and monitor the power of an entire stave.

1.1.2 Connections and interfaces

Each RU employs four GBT links to connect to the CRU: three upstream links and one downstream link. For baseline operations, only one of the three upstream link will be actually used. The RU receives the trigger via a dedicated (Single mode) GBT link directly from the ITS LTU: the CRU to RU downlink is therefore free from trigger duties, and its bandwidth will be used to quickly stream commands/data to RU in case of need. Figure 1 sketches the main RU connections and the Power Unit.

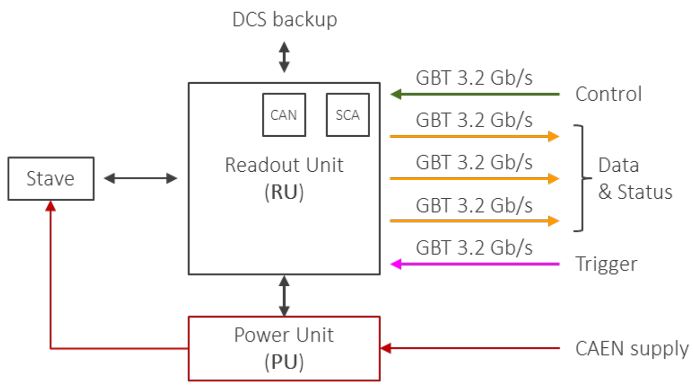

Figure 1 – RU main connections

The RU hosts a SCA chip, which can serve many purposed, including the direct monitoring of some RU parameters like current and temperature. The SCA chip is also connected to a Microsemi PA3 FLASH FPGA via both JTAG and I2C links, to guarantee a radiation-tolerant link to reprogram the main FPGA in case of need.

A back-up CAN-bus connection is also available, in case of CRU/FLP failure. Due to the limited bandwidth, it is envisaged to only monitor temperature and power supply values through this channel.

1.2 Power interface

The power interface can monitor/control the power status of the Readout Unit itself and of the attached stave. All the parameters and commands listed here affect these two systems, NOT directly the sensors, which methods are listed in 1.3.

1.2.1 Status parameters

Each RU reads the PU status parameters reported in Table 2. Latch-up detection-and-response is built-in the RU for speed reason, the *Analogue Status* or *Digital Status* parameters reporting a flag in case a channel has been disconnected. These parameters are likely to go through the main GBTx uplink (but could be also fed to the SCA chip).

Parameter	**Size [bits]**	**Frequency [Hz]**	**Channels per RU**		
			Inner	Middle	Outer
Analogue Voltage	12	1 Hz	1	8	14
Analogue Current	12	1 Hz	1	8	14
Analogue Status	16	1 Hz	1	1	1
Digital Voltage	12	1 Hz	1	8	14
Digital Current	12	1 Hz	1	8	14
Digital Status	16	1 Hz	1	1	1
Bias Voltage	12	1 Hz	1	8	14
Bias Current	12	1 Hz	1	8	14

Table 2 – Readout parameters from a stave power management

Other than the Power Unit tatus, each RU monitors its own power parameters, which are listed in Table 3. These parameters are available only through the SCA chip.

Parameter	**Size [bits]**	**Frequency [Hz]**	Channels
Analogue Voltage	12	1 Hz	7
Analogue Current	12	1 Hz	7
Board temperature	12	1 Hz	2

Table 3 – Power status parameters from a RU (through SCA chip only)

1.2.2 Control commands

Here we must define the commands we want to perform on the powering system of both RU and PU.

Command	Payload [bits]	Timing	Channels per RU		
			Inner	Middle	Outer
General Reset	16	Not critical	1	16	28
Analogue Reset	16	Not critical	1	16	28
Digital Reset	16	Not critical	1	16	28
Analogue Voltage Set	16	Not critical	1	16	28
Digital Voltage Set	16	Not critical	1	16	28
Bias switch	16	Not critical	1	1	1

Table 4 – Commands targeting a stave power management

1.3 Sensor interface

The sensor parses a wide range of commands, and provides autonomous (from the power system) internal readings of various parameters through an embedded ADC.

1.3.1 Status parameters

All the parameters listed in this section are retrieved/logged by the DCS system,

Parameter	Size [bits]	Frequency [Hz]	Sensors per RU		
			Inner	Middle	Outer
Temperature	12	1 Hz	9	112	196
Supply Current	12	1 Hz	9	112	196

Table 5 – Parameters from a single sensor

1.3.2 Control commands

All commands listed in this section are issued by the DCS system toward stave/module/sensor clusters.

Command	Payload [bits]	Timing	Sensors per RU		
			Inner	Middle	Outer
General Reset	16	Not critical	9	112	196
Analogue Reset	16	Not critical	9	112	196
Digital Reset	16	Not critical	9	112	196
Analogue Voltage Set	16	Not critical	9	112	196
Digital Voltage Set	16	Not critical	9	112	196
Bias switch	16	Not critical	9	112	196

Table 6 – Commands targeting a single sensor

ITS Control (ITSC) commands

Commands and operation listed here are managed by an ITS specific system/agent (likely hosted in the FLP servers) and sent through the CRU to the ITS RUs. This is to optimize all those operations requiring specific data format, and/or large data amount to/from the detector.

Command	Payload [bits]	Timing	Sensors per RU		
			Inner	Middle	Outer
Default Registers set	4k	Not critical	9	112	196
Pixel Mask set	512k	Not critical	9	112	196

Table 7 – Commands targeting a single sensor

Command	Payload [bits]	Timing	Sensors per RU		
			Inner	Middle	Outer
Reboot	16	Not critical	9	112	196
Pixel Mask set	512k	Not critical	9	112	196

Table 8 – Commands targeting RU behaviour