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Pierre Auger Observatory

Surface Detector Electronics Upgrade UUB Electrical Interface Control Document (EICD)

Abstract:

This document describes the electrical interfaces of the Upgraded Unified Board (UUB).

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ACRONYMS

ADC	Analog to Digital Converter
BGA	Ball Grid Array
CR	Configurational Requirement
DC	Direct Current
EICD	Electrical Interface Control Document
ER	Environmental Requirement
FPGA	Full Programmable Gate Array
FR	Functional Requirements
GPS	Global Positioning System
ICD	Interfaces Control Document
IR	Interface Requirements
JTAG	Joint Test Action Group
n/a	non applicable
OR	Operational Requirements
PBS	Product Breakdown Structure
PCB	printed Circuit Board
PR	Physical Requirements
QR	Quality Requirements
SDE	Surface Detector Electronics
SR	Support Requirements
TBC	To Be Confirmed
TBD	To Be Defined
TBW	To Be Written
UB	Unified Board
UC	Upgrade Committee
UUB	Upgraded Unified Board
UHE	Ultra High Energy
UHECR	Ultra High Energy Cosmic Ray
VM	Verification Matrix



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DOCUMENT CHANGE RECORD

Issue	Revision	Issue Date	Changes Approved by	Modified Pages Numbers, Change Explanations and Status
05	A	18/04/13		DRAFT for approbation
05	B	14/10/13	Stassi	Post Lisbon meeting updates
05	C	10/11/13	Stassi	Post Orsay meeting updates
05	D	26/02/14	Stassi	Post Grenoble meeting update
05	E	28/11/14	Stassi	Post col. meeting Nov 2014 update
05	F	08/04/15	Stassi	Digital connector pinout Update



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1 INTRODUCTION

This document describes the electrical interfaces of the Upgraded Unified Board (UUB).

1.1 *Reference Documents*

- RD1 Upgraded UB Development plan, WP10LPSC02_SDEU_Dev_Plan
- RD2 SDEU Specification, WP10LPSC03_SDEU_Specification

2 SDEU DIAGRAMS

2.1 SDEU Interaction diagram

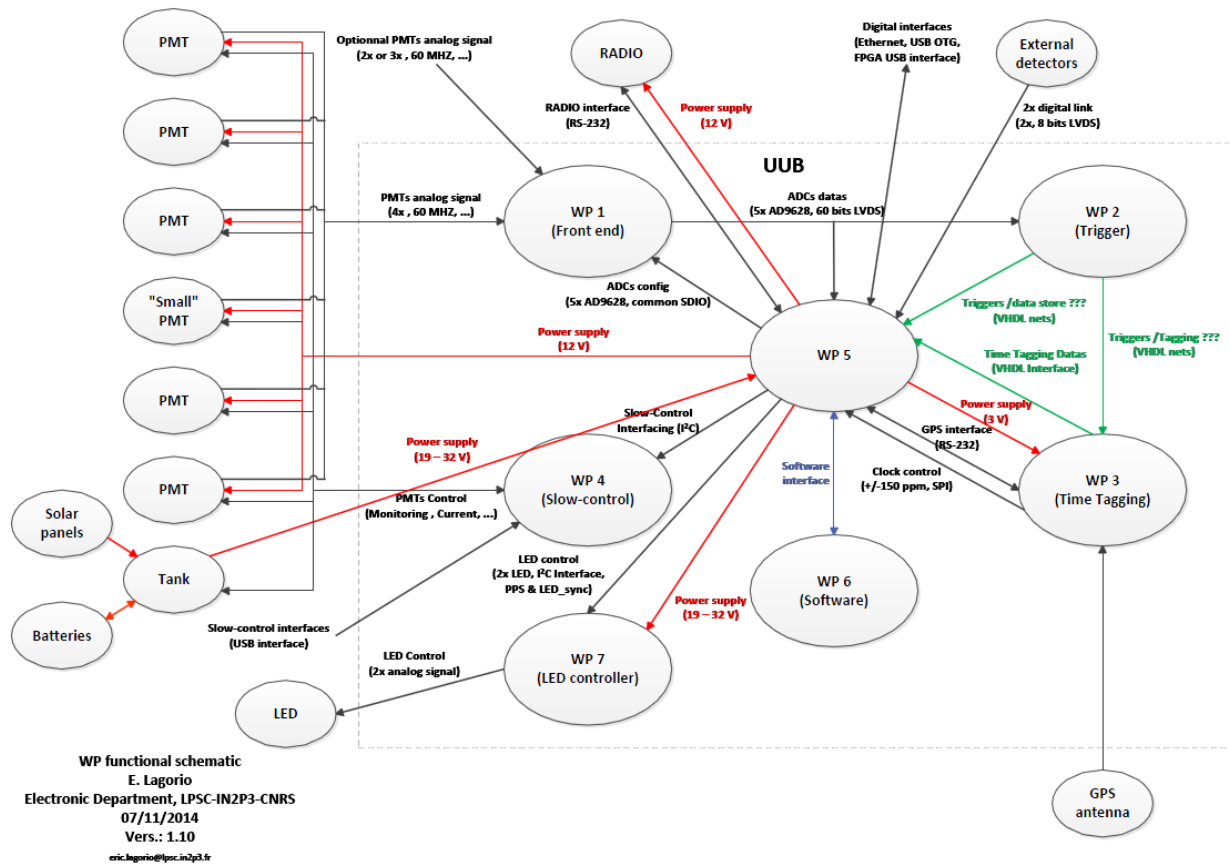


Figure 2.1.a: Interface configuration



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2.2 UUB Interconnections diagram

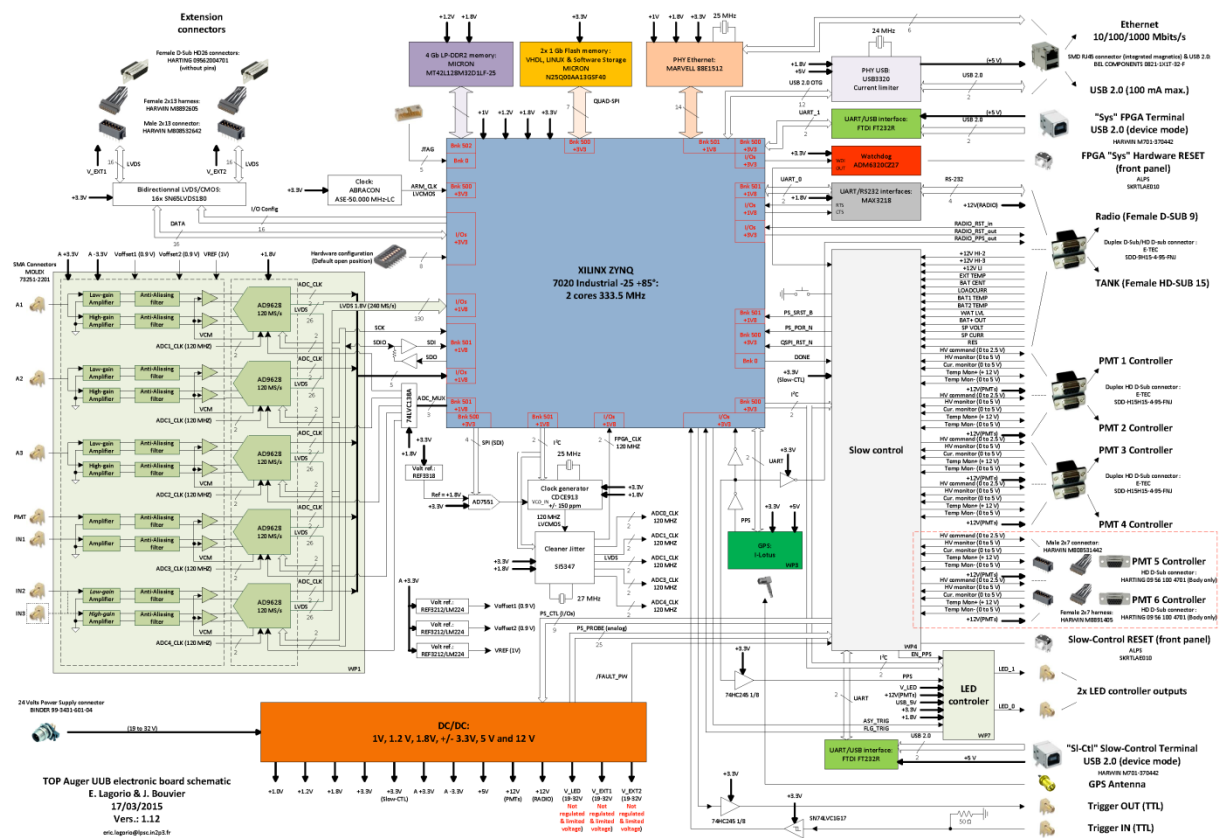


Figure 2.2.a: **SDEU Functional Block Diagram**



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3 UUB ELECTRICAL POWER DEMANDE

The table below shows the shows the electrical power demand for the UUB, taking into account the following assumption:

- DC-DC efficiency = 97%
- WP1 to WP4, values are maxima taken form datasheets.

Work Package	Function	Device	Maximum current (mA) / power supply (V) / Device										Max Power / Device	Nb.	Power	Power / WP	
			FPGA				Slow C	Analog		GPS	USB	Radio					PMT
			1	1,2	1,8	3,3	3,3	3,3	-3,3	5	5	12	12				
WP1	Front-End	Anti aliasing filter (T80)						0						0	3	0,00	
		Low-gain path filter proposal						0	0					0	3	0,00	
		High-gain path filter proposal						0	0					0	3	0,00	
		Dual Differential amplifier (ADA4927-2)						47,2	47,2					311,52	10	3115,20	
WP2	Trigger	12 bits ADC 120MS/s (Twin AD9628) proposal			155,5									279,9	5	1399,50	
		IN Digital Triggers (SN74LVC1G17)				0,5								1,65	1	1,65	
		OUT Digital Triggers (SN74LVC1G125)				0,5								1,65	1	1,65	
WP3	Time Tagging	Test connector (32 signal,) (2x 74LCX16245)				8								26,4	2	52,80	
		GPS (I-LOTUS: ref ???)				52								171,6	1	171,60	
WP4	Slow Control	Antenna (Type II ref ???)								26				130	1	130,00	
		µ-controller (MP5430F2618)					9,5							31,35	1	31,35	
		LED flasher controller (DAC 4 outputs : AD5624)					0,85							2,805	1	2,81	
		DAC (LTC2637-12)					1,3							4,29	1	4,29	
		Amplifiers (LT1112)					0,88							2,904	10	29,04	
WP5	VCO/ fanout/ Clock_ADC	MUX (ADG608)					0,01							0,0165	4	0,07	
		Clock generator (with VCO control) & DAC :															
		Clock generator with external VCO control (CDCE1913)			11,7									21,06	1	21,06	
		LVDS double fanout repeater (CDCUN1208LP)			85									153	1	153,00	
	FPGA (and µP)	DAC VCO control (AD7390 & REF3318: Rail to Rail)				1,5								4,95	1	4,95	
		Xilinx ZYNQ 7020 Industrial : 2 cores 333.5Mhz BRA	1864,8	150,15	432,6									2823,66	1	2823,66	
	Extention connector	interface used an external electronic:															
		Driver (2x DS90LV047ATM)				15								49,5	4	198,00	
	Watchdog/ RESET/ Clock CPU	Receiver differential (DS90LV048ATM)				37								122,1	4	488,40	
		WATCHDOG : MAX823EUK-S				0,012								0,0396	1	0,04	
	Control	RESET : MAX811EUS-S				0,01								0,033	1	0,03	
		ABRACON ASE-50,000MHz-LC				19								62,7	1	62,70	
System Memory	Switches												0	2	0,00		
	LP-DDR2 Low Power4 Gb: MICRON MT42L128M32D1LF-25		210	10									270	1	270,00		
Flash Memory	1 Gb : µ N25Q00A13G5F40 @ 3.3 V (Wrcycle)				20								66	1	66,00		
	Radio RS232 (MAX3218)			3									5,4	1	5,40		
	Terminal USB interface (FT232R, powered by USB link)												0	2	0,00		
	Ethernet phy (MARVELL 88E1510 in EEE mode	14		35	14								123,2	1	123,20		
WP?	PMT 1,2 & 3 PMT	USB (USB3320)			46,4								83,52	1	83,52		
		External Slave USB Power								100			500	1	500,00		
		Main PMT											44,44	533,28	3	1599,84	
WP?	RADIO	Small PMT (ESTIMATE POWER)											44,44	533,28	1	533,28	
												291,6	3499,2	1	3499,20		
Total Current / power supply (mA) :			1878,8	360,15	1401,2	331,522	20,47	472	472	26	100	291,6	177,76	Total power (mW):			15372,23
DC/DC efficiency (%) :			93,00	89,10	93,50	94,00	87,00	93,30	82,20	90,90	94,10						
Power for under 7V power supply (mW) :			2020,22	485,051	2697,5	1163,85	77,6448	1669,45	1894,89	143,014	531,35						
DC/DC efficiency (%) :			97,10%										97,50%	97,00%			
Power (mW) :			11002,03										3588,92	2199,09			
Internal Total Power (SDEU only) :			16 790,04 mW														
Total Power (including 6,4 watts power for external devices) :			23,19 W														

Table 3.a: **SDEU power budget estimation**



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4 UUB CONNECTORS LIST

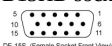
Connector Ref.	Schemat. Ref.	Connector Type	Connector Function	Connected to	Comment
J11	PX1-3	 SMA, socket	In, Anode PMT1	PMT Anode 1	On front panel
J12	PX1-4		In, Anode PMT2	PMT Anode 2	On front panel
J13	PX1-5		In, Anode PMT3	PMT Anode 3	On front panel
J14	PX1-2		In, Anode Small PMT	Small PMT An.	On front panel
J15	PX2-2		In, Analog 1	Scint. detector 1	On front panel
J16	PX1-1		In, Analog 2	Scint. detector 2	On front panel
J17	PX2-1		In, Analog 3	Ext. detector 3	On front panel
J21		 DB15HD socket	In/Out, PMT1 monitoring	PMT base 1	On front panel
J22	U3B		In/Out, PMT2 monitoring	PMT base 2	On front panel
J23	U4B		In/Out, PMT3 monitoring	PMT base 3	On front panel
J24	U3A		In/Out, Small PMT monitoring	Small PMT base	On front panel
J25	J4	 HE14 2x7 pin	In/Out, PMT 5 monitoring	PMT base 5	On board, connected to DB15S HD on front panel
J26	J5		In/Out, PMT 6 monitoring	PMT base 6	
J31	U4A	DB15HD socket	In, Slow control sensors reading	TPCB	On front panel
J41	J2-J3	 10 pin (2x5) socket	In/Out, GPS power and com.	GPS board	On board, connected to the GPS receiver board
J51	J1	 Binder 99-3431-202-04	In, 24V power supply	TPCB	On front panel
J61	PX3	 SMA, socket	Out, LED Flasher 1 cde.	LED Flasher 1	On front panel
J62	PX4		Out, LED Flasher 2 cde.	LED Flasher 2	On front panel
J71	PX2		In, External trigger input	TBD	On front panel
J72	PX1		Out, Internal trigger output	TBD	On front panel
J81		 USB Type B, Socket	In/Out, System com.	Maintenance	On front panel
J82			In/Out, Slow Control com.	Maintenance	On front panel
J83	CO1B	 USB Type A, Socket	In/Out, maintenance	Maintenance	On front panel 100 mA maxi
J84	CO1A	 RJ45, Socket	In/Out, Ethernet	Maintenance	On front panel
J85	U2	 SUBD9, socket	In/Out, Radio interface	BSRU (radio)	On front panel
J91	J7	 HARWIN M808542642, socket	In/Out, and out power supply	TBD	On board, connected to DB26S HD on front panel
J92	J9		In/Out, and out power supply	TBD	
J93	J6	 HE14 2x7 pin	In/Out, Jtag system (FPGA)	Maintenance	On board
J94			In/Out, Jtag system (Slow Cont.)	Maintenance	On board

Table 4.a: *UUB connectors list*



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5 UUB CONNECTORS PIN ALLOCATION (RD2)

Conn. ID	Name	Signal Name	Pin ¹ #	Direction	Signal description	Connector type
J11	PMT A1	Anode PMT1	n/a	IN	50Ω, -2V Fs	SMA, socket 
J12	PMT A2	Anode PMT2	n/a	IN	50Ω, -2V Fs	
J13	PMT A3	Anode PMT3	n/a	IN	50Ω, -2V Fs	
J14	PMT 4	PMT4	n/a	IN	50Ω, -2V Fs	
J15	DET IN1	Input 1	n/a	IN	50Ω, -2V Fs	
J16	DET IN2	Input 2	n/a	IN	50Ω, -2V Fs	
J17	DET IN3	Input 3	n/a	IN	50Ω, -2V Fs	
J21 J22 J23 J24	PMT 1 Monit. PMT 2 Monit. PMT 3 Monit. PMT 4 Monit. ²	HV command	2	OUT	DC, 0 to 2.5V	DB15HD socket 
		HV monitor	1	IN	DC, 0 to 5V	
		Cur. monitor	3	IN	DC, 0 to 5V	
		Temp. Mon +	4	OUT	DC, +12V	
		Temp Mon -	9	IN	DC, 0 to 5V	
		NC	11	n/a	Not currently used	
		NC	13	n/a	Not currently used	
		+12V	5	OUT	DC, +12V	
		GND	6	n/a	Ground	
		GND	7	n/a	Ground	
		GND	8	n/a	Ground	
		GND	10	n/a	Ground	
		GND	12	n/a	Ground	
		GND	14	n/a	Ground	
		GND	15	n/a	Ground	
J25 J26	PMT 5 Monit PMT 6 Monit	HV command	2	OUT	DC, 0 to 2.5V	HE14 2x7 pin 
		HV monitor	1	IN	DC, 0 to 5V	
		Cur. monitor	3	IN	DC, 0 to 5V	
		Temp. Mon +	4	OUT	DC, +12V	
		Temp Mon -	9	IN	DC, 0 to 5V	
		NC	11	n/a	Not currently used	
		NC	13	n/a	Not currently used	
		+12V	5	OUT	DC, +12V	
		GND	6	n/a	Ground	
		GND	7	n/a	Ground	
		GND	8	n/a	Ground	
		GND	10	n/a	Ground	
		GND	12	n/a	Ground	
		GND	14	n/a	Ground	
		GND	15	n/a	Ground	
J31	Slow Control	+12V HI-1	5	OUT	DC +12V through 1KΩ	DB15HD socket 
		+12V HI-2	4	OUT	DC +12V through 1KΩ	
		+12V HI-3	2	OUT	DC +12V through 1KΩ	
		+12V LI	1	OUT	DC +12V through 22KΩ	
		EXT TEMP	7	IN	0 to +5 V	
		BAT CENT	3	IN	0 to +5 V	
		LOADCURR	8	IN	0 to +5 V	
		BAT1 TEMP	9	IN	0 to +5 V	
		BAT2 TEMP	10	IN	0 to +5 V	
		WAT LVL	11	IN	0 to +5 V	
		BAT+ OUT	12	IN	0 to +5 V	
		SP VOLT	13	IN	0 to +5 V	
		SP CURR	14	IN	0 to +5 V	
		Not Used	15	n/a	Not Used	
		GND	6	n/a	GND	

¹ From the UUB point of view only

² Small PMT.

J41	GPS Board	RxD1	1	IN	Receive Data (3V logic)	10 pin (2x5) socket 
		TxD1	2	OUT	Transmit Commands (3V logic)	
		+3V PWR	3	OUT	Regulated 3Vdc supply	
		1PPS	4	IN	1 pulse-per-second input	
		Ground	5	n/a	Signal and Power common	
		Battery	6	OUT	Optional External Backup	
		Reserved	7	n/a	Not currently used	
		RTCM In	8	OUT	RTCM correction output	
		Antenna Bias	9	OUT	3V-5V antenna bias output	
		Reserved	10	n/a	Not currently used	
J51	Main Power	24VDC	1	IN	DC, +20 to +30V	Binder 99-3431-202-04 
		GND	2	n/a	n/a	
J61	LED FLASH 1	Uout 1	n/a	OUT	+0 to +20V	SMA, socket 
J62	LED FLASH 2	Uout 2	n/a	OUT	+0 to +20V	
J71	External Trigger	EXT TRIG	n/a	IN	TTL	
J72	Internal Trigger	INT TRIG	n/a	OUT	TTL	
J81	USB SYS	VCC	1	OUT	+5V	USB Type B, Socket 
		D-	2	IN/OUT	Data -	
		D+	3	IN/OUT	Data +	
		GND	4	n/a	GND	
J82	USB Slow Ctrl	VCC	1	OUT	+5V	
		D-	2	IN/OUT	Data -	
		D+	3	IN/OUT	Data +	
		GND	4	n/a	GND	
J83	USB OTG	VCC	1	OUT	+5V (100mA maxi)	USB Type A, Socket 
		D-	2	IN/OUT	Data -	
		D+	3	IN/OUT	Data +	
		GND	4	n/a	GND	
J84	Ethernet	T+	1	OUT	Transmit +	RJ45, Socket 
		T-	2	OUT	Transmit -	
		R+	3	IN	Receive +	
		NC	4	n/a	Reserved	
		NC	5	n/a	Reserved	
		R-	6	IN	Receive -	
		NC	7	n/a	Reserved	
		NC	8	n/a	Reserved	
J85	TELECOM ³	SU PWR	1	OUT	SU Power, DC +12V (14V, max)	SUBD9, socket 
		SU RXD	2	IN	SU RXD	
		SU TXD	3	OUT	SU TXD	
		1PPS	4	OUT	One pulse per second, +3.3V	
		GND	5	n/a	Ground	
		TELRESCPU	6	IN	SU Reset out, see SU spec., RD2	
		RTS	7	OUT	SU RTS	
		CTS	8	IN	SU CTS	
		CPURESTEL	9	OUT	SU Reset in, see SU spec., RD2	

³ Pin out from UUB point of view only, external Telecom cable is cross wired on pins 2 & 3, 4 & 6 and 7 & 8.



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J91	EXT 1	D1+	1	IN or OUT	Configurable	HE26 HARWIN M808542642 2x13 pin 
		D1-	2	IN or OUT	Configurable	
		VCC ⁴	3	OUT	+24V, unregulated, switchable	
		GND	4	n/a	Ground	
		D0+	5	IN or OUT	Configurable	
		D0-	6	IN or OUT	Configurable	
		D2+	7	IN or OUT	Configurable	
		D2-	8	IN or OUT	Configurable	
		VCC ³	9	OUT	+24V, unregulated, switchable	
		GND	10	n/a	Ground	
		D4+	11	IN or OUT	Configurable	
		D4-	12	IN or OUT	Configurable	
		D3+	13	IN or OUT	Configurable	
		D3-	14	IN or OUT	Configurable	
		VCC ³	15	OUT	+24V, unregulated, switchable	
		GND	16	n/a	Ground	
		D5+	17	IN or OUT	Configurable	
		D5-	18	IN or OUT	Configurable	
		D6+	19	IN or OUT	Configurable	
		D6-	20	IN or OUT	Configurable	
		VCC ³	21	OUT	+24V, unregulated, switchable	
		GND	22	n/a	Ground	
		D7+	23	IN or OUT	Configurable	
		D7-	24	IN or OUT	Configurable	
		VCC ³	25	OUT	+24V, unregulated, switchable	
		GND	26	n/a	Ground	

⁴ 100 mA maximum per connector.

Conn. ID	Name	Signal Name	Pin ⁵ #	Direction	Signal description	Connector type
J92	EXT 2	D1+	1	IN or OUT	Configurable	HE26 HARWIN M808542642 2x13 pin 
		D1-	2	IN or OUT	Configurable	
		VCC ⁶	3	OUT	+24V, unregulated, switchable	
		GND	4	n/a	Ground	
		D0+	5	IN or OUT	Configurable	
		D0-	6	IN or OUT	Configurable	
		D2+	7	IN or OUT	Configurable	
		D2-	8	IN or OUT	Configurable	
		VCC ⁵	9	OUT	+24V, unregulated, switchable	
		GND	10	n/a	Ground	
		D4+	11	IN or OUT	Configurable	
		D4-	12	IN or OUT	Configurable	
		D3+	13	IN or OUT	Configurable	
		D3-	14	IN or OUT	Configurable	
		VCC ⁵	15	OUT	+24V, unregulated, switchable	
		GND	16	n/a	Ground	
		D5+	17	IN or OUT	Configurable	
		D5-	18	IN or OUT	Configurable	
		D6+	19	IN or OUT	Configurable	
		D6-	20	IN or OUT	Configurable	
		VCC ⁵	21	OUT	+24V, unregulated, switchable	
		GND	22	n/a	Ground	
		D7+	23	IN or OUT	Configurable	
		D7-	24	IN or OUT	Configurable	
		VCC ⁵	25	OUT	+24V, unregulated, switchable	
		GND	26	n/a	Ground	
J93	JTAG System	GND	1	n/a	Ground	HE14 2x7 pin 
		+3.3V Bias	2	OUT	DC, +3.3 Volts	
		GND	3	n/a	Ground	
		JTAG TMS	4	IN	0 to +3.3V	
		GND	5	n/a	Ground	
		JTAG TCK	6	IN	0 to +3.3V	
		GND	7	n/a	Ground	
		JTAG TDO	8	OUT	0 to +3.3V	
		GND	9	n/a	Ground	
		JTAG TDI	10	IN	0 to +3.3V	
		GND	11	n/a	Ground	
		Not Used	12	n/a	Not currently used	
		GND	13	n/a	Ground	
		Not Used	14	n/a	Not currently used	
J94	JTAG Slow Ctrl	JTAG TDO	1	OUT	0 to +3.3V	HE14 2x7 pin 
		VCC OUT	2	OUT	DC, +3.3 Volts	
		JTAG TDI	3	IN	0 to +3.3V	
		VCC IN	4	IN	DC, +3.3 Volts	
		JTAG TMS	5	IN	0 to +3.3V	
		Not Used	6	n/a	Not currently used	
		JTAG TCK	7	IN	0 to +3.3V	
		Not Used	8	n/a	Not currently used	
		GND	9	n/a	Ground	
		Not Used	10	n/a	Not currently used	
		JTAG RST	11	IN	0 to +3.3V	
		Not Used	12	n/a	Not currently used	
		Not Used	13	n/a	Not currently used	
		Not Used	14	n/a	Not currently used	

Table 5.a: *UUB connector's pins allocation*

⁵ From the UUB point of view only

⁶ 100 mA maximum per connector

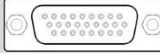


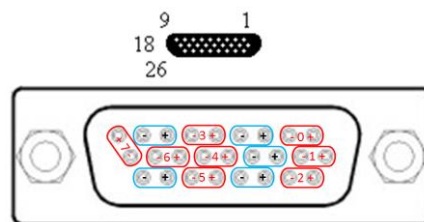
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Interconnections between onboard multipoint connectors and front panel connectors:

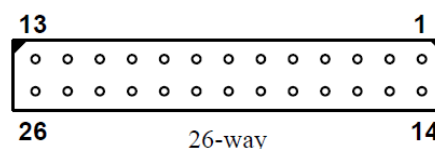
There are 4 connectors interconnections between the UUB and the front panel, 2 for the digital I/O connectors (table 5b) and 2 for the PMT5 and PMT6 slow control (table 5c).

Digital I/O connectors

UUB Conn. ID	Name	Signal Name	UUB connector HE26, 2x13 Pin  Pin#	Front Panel connector DB26 HD Socket  Pin#	Signal description
J91 J92	EXT 1 EXT 2	D1+	1	10	Configurable
		D1-	14	11	Configurable
		VCC	2	3	+24V, unregulated, switchable
		GND	15	4	Ground
		D0+	3	1	Configurable
		D0-	16	2	Configurable
		D2+	4	19	Configurable
		D2-	17	20	Configurable
		VCC	5	12	+24V, unregulated, switchable
		GND	18	13	Ground
		D4+	6	14	Configurable
		D4-	19	15	Configurable
		D3+	7	5	Configurable
		D3-	20	6	Configurable
		VCC	8	21	+24V, unregulated, switchable
		GND	21	22	Ground
		D5+	9	23	Configurable
		D5-	22	24	Configurable
		D6+	10	16	Configurable
		D6-	23	17	Configurable
		VCC	11	7	+24V, unregulated, switchable
		GND	24	8	Ground
		D7+	12	9	Configurable
		D7-	25	18	Configurable
		VCC	13	25	+24V, unregulated, switchable
		GND	26	26	Ground



Front panel view



Top view

Table 5.b: **Digital I/O interconnection pin out**



WP10	LPSC	05F
08/04/15		15/20

PMT 5 & 6, I/O connectors

UUB Conn. ID	Name	Signal Name	UUB connector HE14, 2x7 Pin  Pin#	Front Panel connector DB15HD Socket  Pin#	Signal description
J25 J26	PMT 5 Monit. PMT 6 Monit.	HV command	5	2	DC, 0 to 2.5V
		HV monitor	10	1	DC, 0 to 5V
		Cur. monitor	4	3	DC, 0 to 5V
		Temp. Mon +	3	4	DC, +12V
		Temp Mon -	6	9	DC, 0 to 5V
		NC	1	11	Not currently used
		NC	7	13	Not currently used
		+12V	2	5	DC, +12V
		GND	8	6	Ground
		GND	9	7	Ground
		GND	11	8	Ground
		GND	12	10	Ground
		GND	13	12	Ground
		GND	14	14	Ground
		GND	No pin	15	Ground

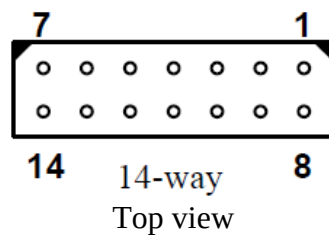
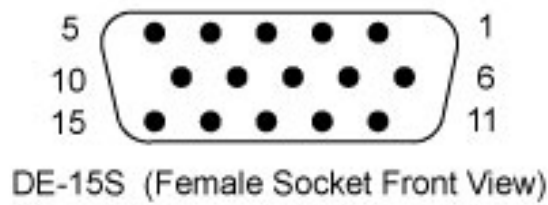
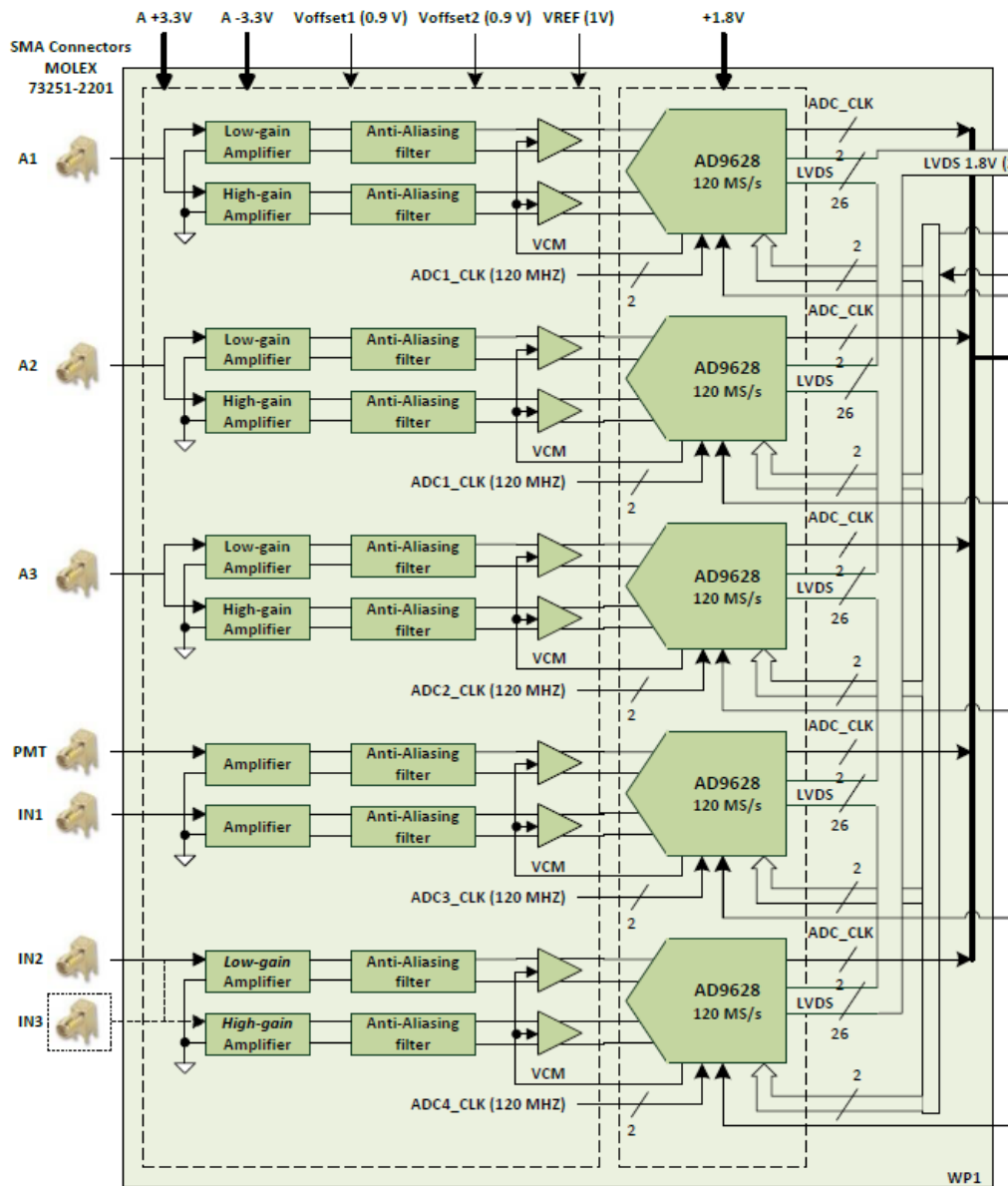


Table 5.c: **PMT5 and 6 SC interconnection pin out**

6 UUB ELECTRICAL INTERFACES DESCRIPTION

6.1 Analog input interfaces

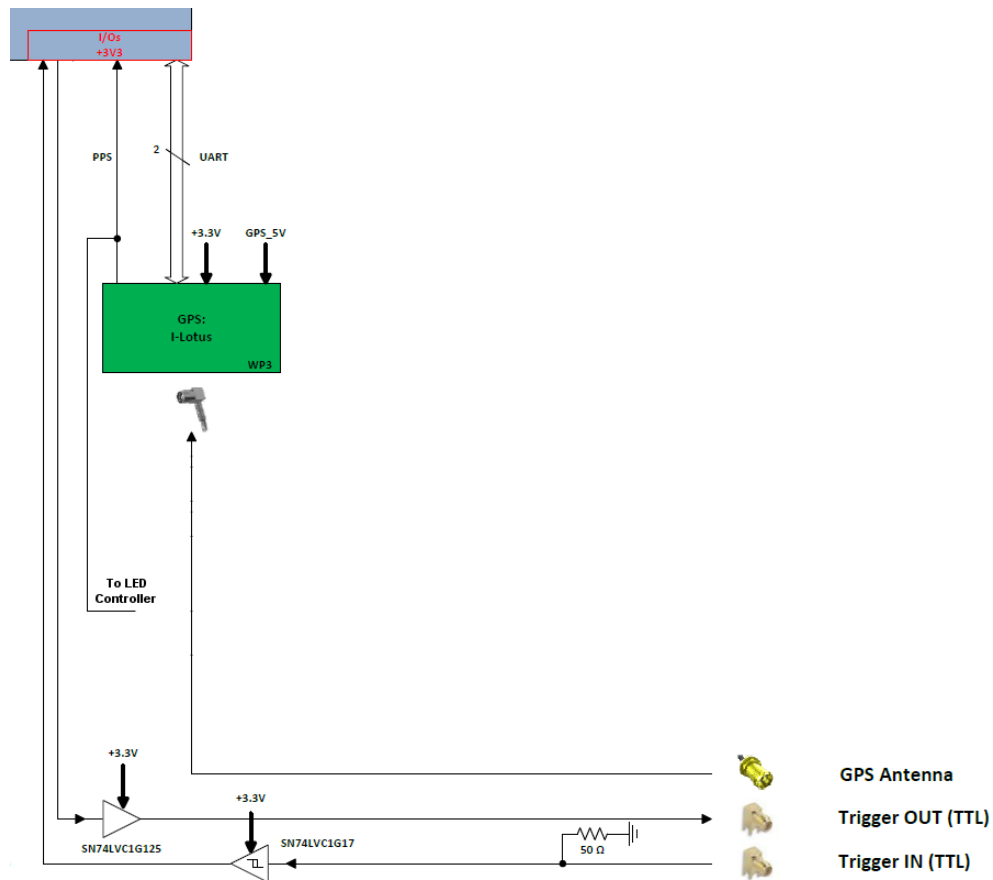




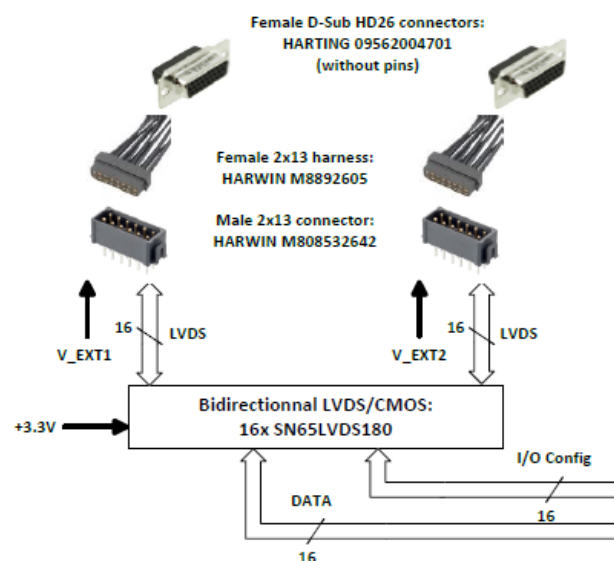
WP10	LPSC	05F
08/04/15		17/20

6.2 Digital interfaces

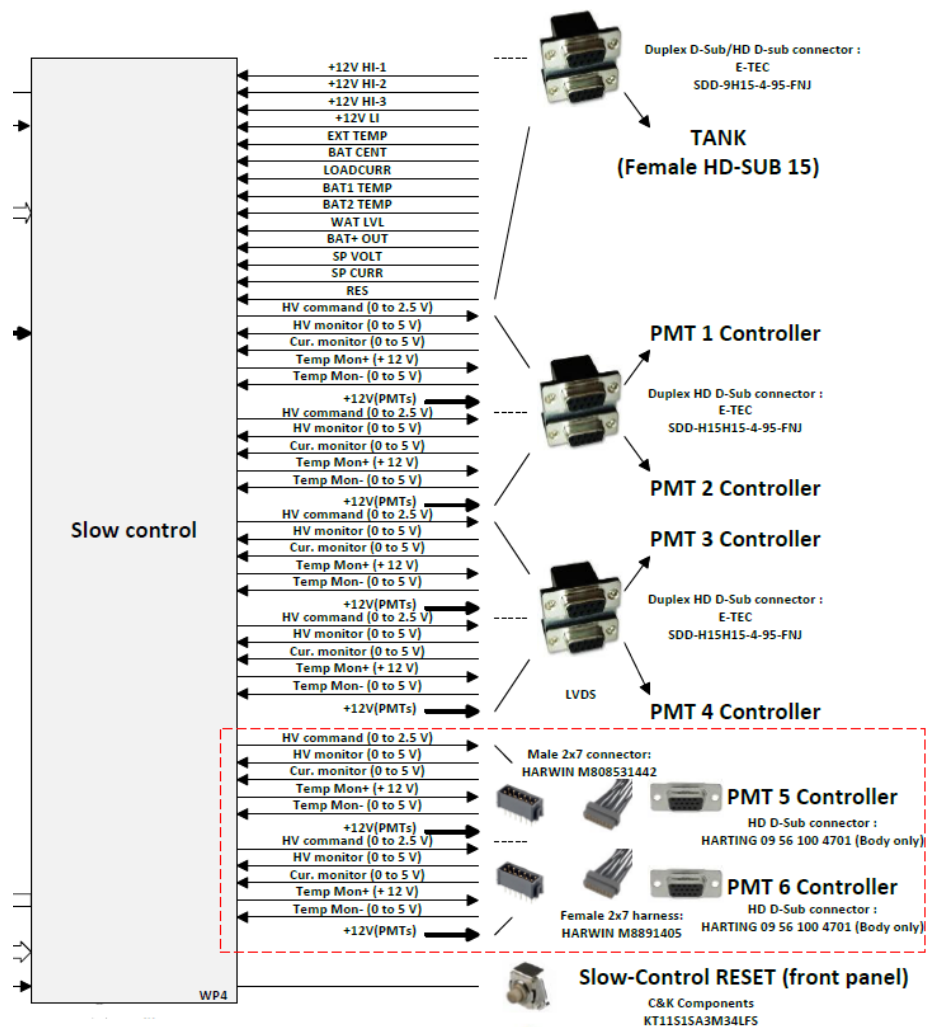
6.2.1 GPS Board and Trigger



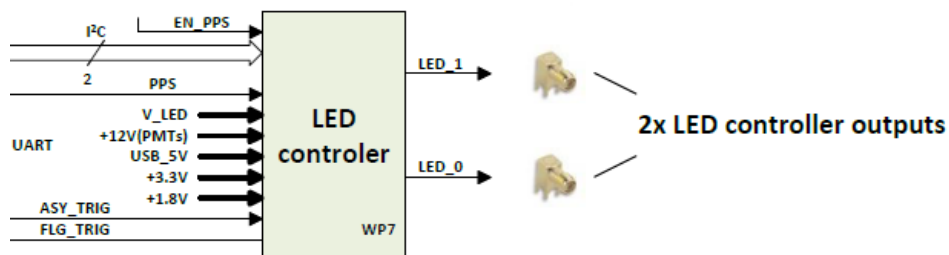
6.2.2 External detectors



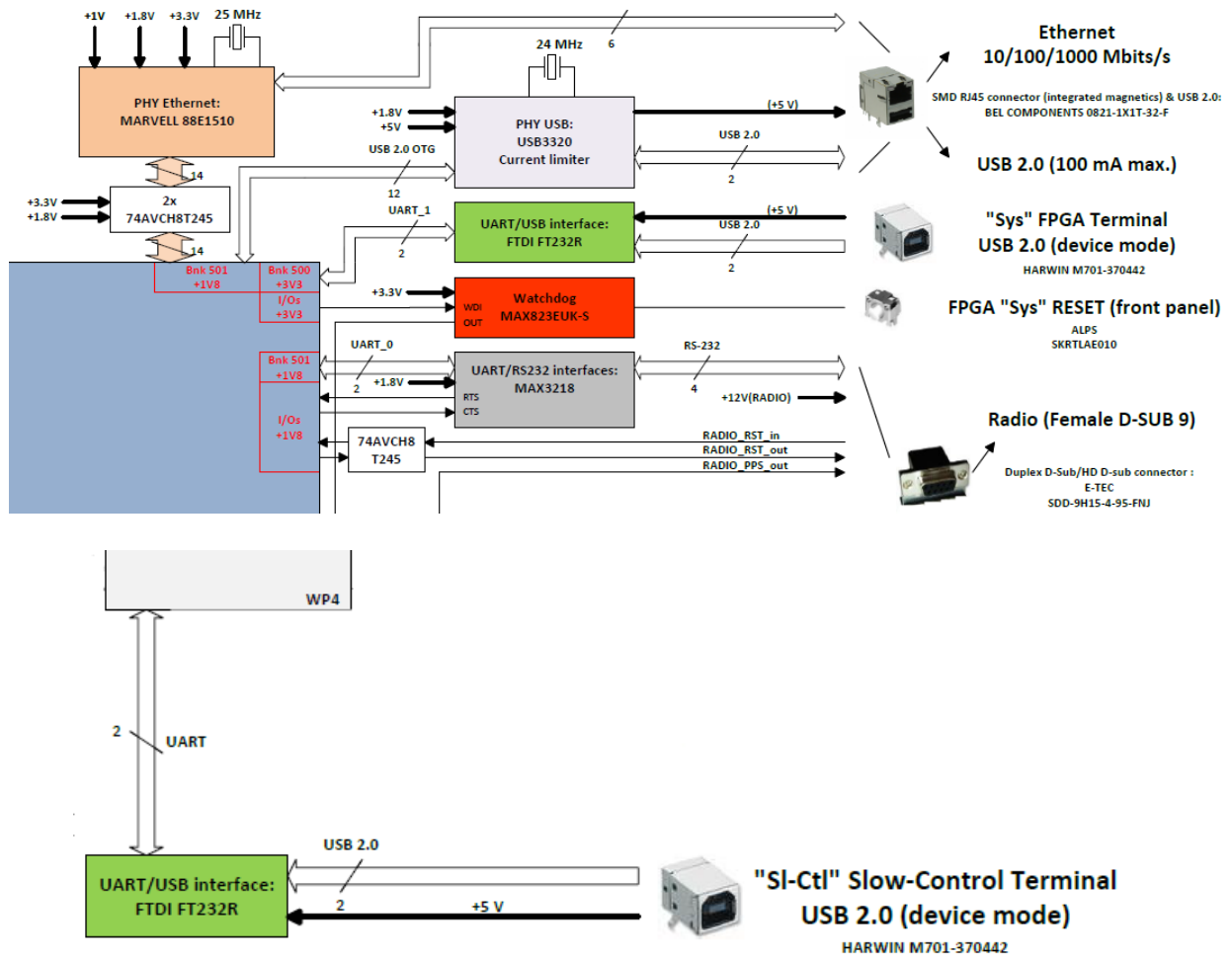
6.3 Slow Control interfaces



6.1 LED Controller



6.2 Communication interfaces



6.3 Power interface

