TMCB Rev. 2.0

Overview & Proposal for Revision

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TMCB – Overview & Proposal for Revision

Advanced Techniques in LLRF control for XFEL - Collaboration Workshop

19. - 21. February 2013, Otwock-Swierk

HELMHOLTZ ASSOCIATION

DESY

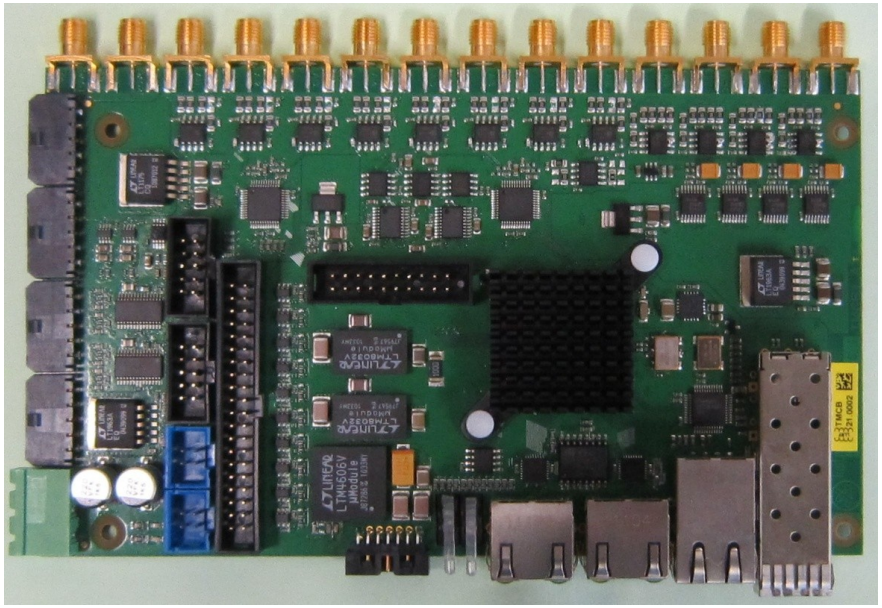
TMCB 1.0

General requirements

- low cost
- high precision temperature control & monitoring
- high precision data acquisition

Interfacing to

- DCM, REFM, LOGM & (with Rev. 2.0) BAM, TDS



Rev. 1.0: TMCB features

- 1x Spartan-6 FPGA (XC6SLX45T-2FGG484C)
- 8x Analog Input, 1 MSPS, 16 bit (2x AD7655 ADC)
- 4x Analog Input, 128 kSPS, 24 bit (4x AD7767 ADC)
- 2x Analog Output, 1 MSPS, 18 bit (2x AD5781)
- 4x Temp. Sensor (2x ADC1248)
- 2x Peltier (1x DAC8552 DAC, 2x LTC2365 ADC)
- GPIO (20x IO)
- Ethernet (1x DP83848, RMII mode)
- RocketIO fiber interface (1x SFP)
- 13x LVDS pairs
- 2x I2C channels
- 8x LED

Specifications: requested changes for Rev. 2.0

Overview on all requirements

	Amount	Device	Signals	Range	min. Resolution	Comment	BAM	TDS	L2RF	DCM	
Form Factor						compact; similar to current version	x!			x!	
						pluggable board → connector?				x!	
Interfaces	2x	SFP								x	
	14 pins	GPIO		3.3 V					x	x	
	4x	I2C				addressed to ADT7420				x	
	1x	RJ45				LVDS line from timing module			x		
Input (to board)		ADC	VDC	0 - 2 V	12 bit	power monitoring		5			
		ADC	VDC	0 - 2 V	16 bit	optical power monitor	4 (5)				
		ADS1255	VDC	0 - 2.5 V	24 bit	should have separate analogue cell				2	
		ADC	VDC	0 - 4 V	16 bit	slow; ~1 kHz	1				
		ADC	VDC	0 - 15 V	12 bit	power monitoring	3	3			
		ADC	RF power	-1 - 1 V		slow			2		
		ADC		-1 - 1 V	16 bit	1 Ms/sec~, 100 kHz BW			3		
		ADC	VDC	-5 - 5 V	24bit	10kSps			2		
Output (from board)		DAC	VDC	0 - 4 V	12 bit	100 ks/sec	4				
		DAC	"	0 - 12 V	12 bit	100 ks/sec	2				
		DAC		-1 - 1 V	16 bit	50 Ohm; 1 Ms/sec, ~ 100 kHz			2		
		DAC		-6 - 6 V	16 bit	50 Ohm; 1 Ms/sec, ~ 100 kHz			1		
		DAC	"	-10 - 10 V	12 bit	> 5 kOhm;	2 (3)				
Temperature Controller & Read-Out for Controller		PWM or analogue linear				exchangable; to be optimised for indivual application	x			x	
					24 bit	NTC 10 kOhm; 4-wire read-out					
						individual regulation loops	2 (3)	1	2	3	→ use external power supply for Peltier
Temperature Monitor (out-of-loop)											
		ADT7420			16 bit (< 1 mK)	Temp.-sensor; I2C read-out				4	
					16 bit (< 1 mK)	additional monitoring temperature sensors: PT1000; 4-wire read-out; 0,5 mA (possibly 24 bit)	4 (6)	4	4		

legend:
x! limitation
x demanded
(...) optional

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legend:
x! limitation
x demanded
(...) optional

High-Precision (Low-drift)
2x ADC 24-bit, 100 ksps (TMCB, ADC1255)
2x ADC 24-bit, 100 ksps (Slot#1, option)

Monitoring (power, optical)
8x multiplexed ADC 16-bit, 1ksps
+ individual voltage drivers

Precision (Low-noise, fast)

4x ADC 16-bit, 1Msps
TMCB → AD7655

Precision (Low-noise, fast) *1
2x DAC 18-bit, 1Msps (AD5784)
+ 50 Ohm option
2x DAC 18-bit, 1Msps (AD5781)
+ 50 Ohm option

Standard *1
8x internal DAC 16-bit, 1 ksps? (TMCB)

High-Precision (Slot #1, option)

4 Temp. Sensors – 2x ADC1248

→ use external power supply for Peltier

Precision 4x I2C

(TMCB or Slot #1, option)

Precision 4x Sensors 2x ADC1248

*1: individual voltage ranges per software ? -5 V ... +5 V Limit? (DAC specific)

DESY

Summary: Specifications for Rev. 2.0

- Connector assignment and choice
  - TMCB: mixed-mode connectors / single connectors

Function	No. of pins / signals
Monitoring (power, optical) 8x multiplexed ADC 16-bit, 1ksps	16pins, DC-analog signals ,8 GNDs, common shield
Precision (Low-noise, fast) 4x ADC 16-bit, 1Msps (TMCB, AD7655)	4 coax, RF-analog signals, each shielded
Precision (Low-noise, fast) *1 2x DAC 18-bit, 1Msps (AD5781) + 50Ohm Option	2 coax, RF-signals each shielded
High-Precision (Low-drift) 2x ADC 24-bit, 100ksps (TMCB, ADS1255)	2 coax, RF-signals, each shielded
Standard *1 8x internal DAC 16-bit, 1ksps ? (TMCB)	16pins, DC-analog signals, common shield using GNDs
Precision 4x Sensors - 2x ADS1248	20pins, DC-analog signals, 4 wire, each group shielded
GPIO	40pins, digital signals, section shield, separated
TMCB_PWS	3 pins, power input, +15V, GND, -15V

  - Slot #1 : direct connections, mixed-mode connector / single connectors

function	No. of pins / signals
Precision (Low-noise, fast) *1 2x DAC 18-bit, 1Msps (AD5781) + 50Ohm Option	2 coax, RF-signals each shielded
High-Precision 4 Temp Sensors - 2x ADS1248	20 pins, DC-analog signals, 4 wire, each group shielded
Precision 4x I2C on (TMCB or Slot #1, option)	2 pins, digital signal
PWS	3 pins, power input, Vcc, GND – Vcc, 6 pins, output driver

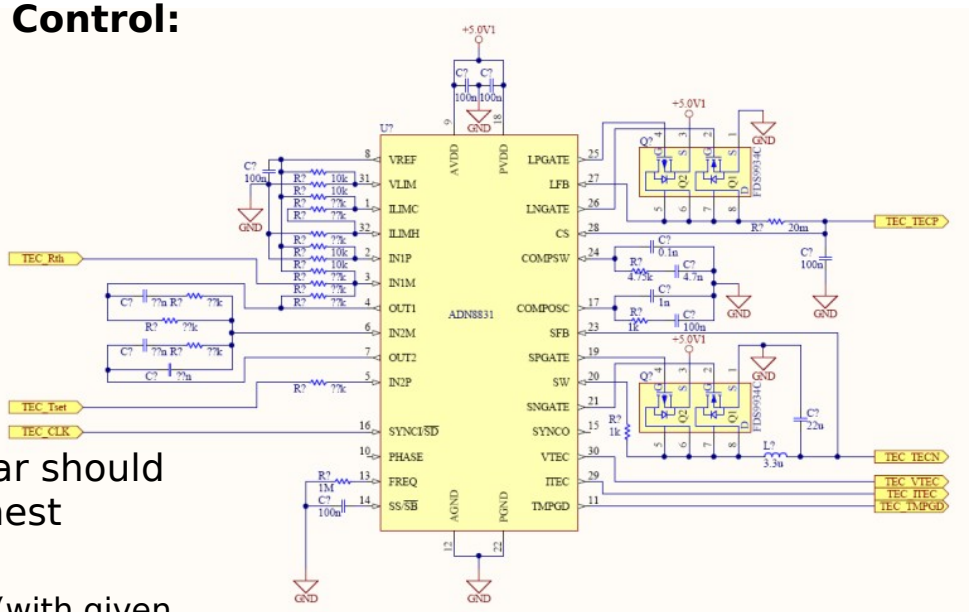
Temperature Controller

Solution using Piggy-Back

- largest flexibility to cover all different applications

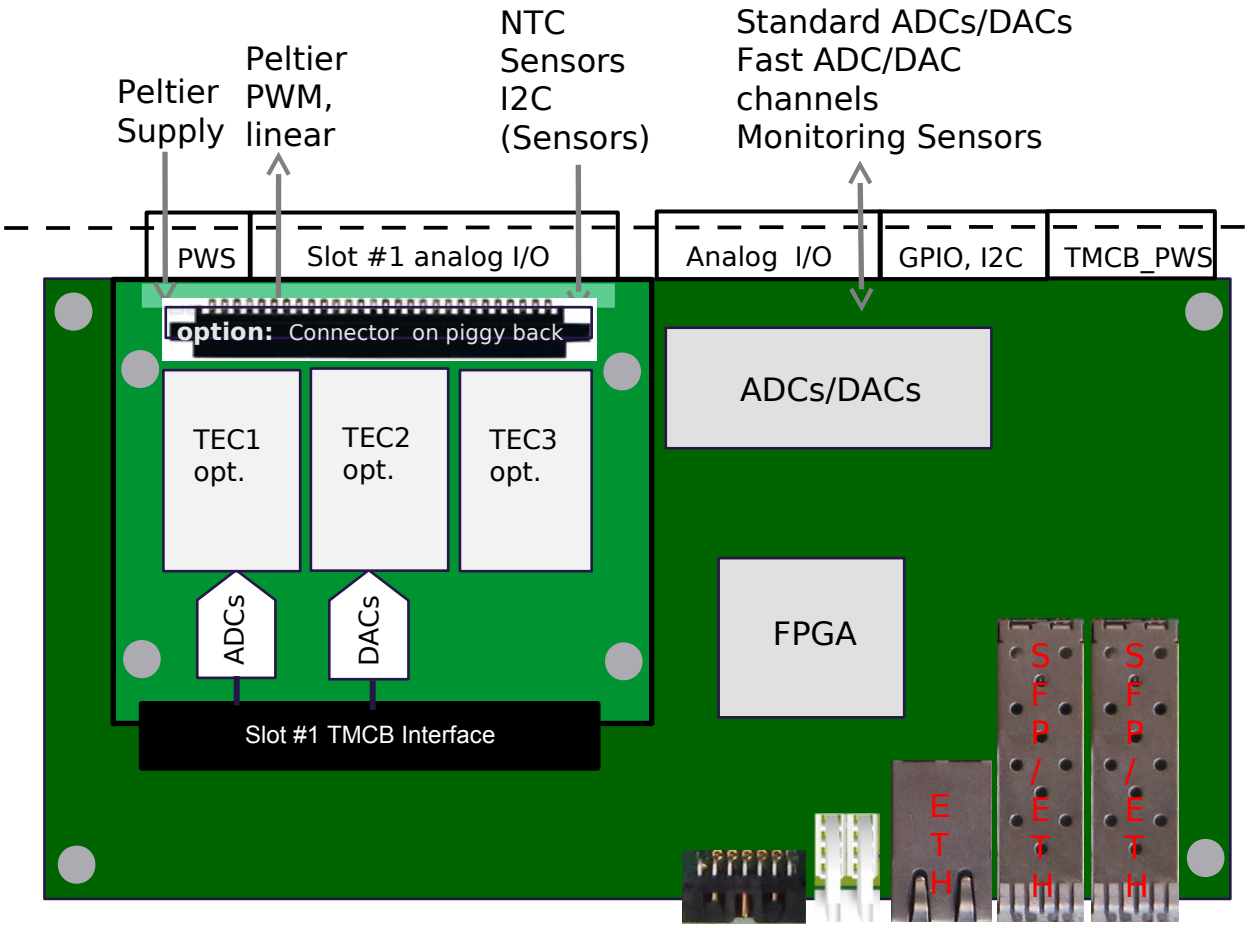
Option	Interfacing	External	Comment
Analog Contr. + H-Bridge	Set-points	Peltier	- -
Analog Contr.	Set-points	H-Bridge + Peltier	– /+
ADC → FPGA → DAC + H-Bridge	PWM or Linear	Peltier	– /+
ADC → FPGA → DAC	PWM or Linear	H-Bridge + Peltier	++

- **Main specifications for Temp. Control:**
  - 3 individual control loops
  - 1 mK resolution of NTC sensor
  - remote control of …
    - » T-Setpoint, Gains, On/Off
  - read-out of ….
    - » Set-point, Ist value, Peltier current
  - decision if PWM or analog linear should be chosen by application (highest flexibility)
    - » customised piggy-back possible (with given interface on TMCB)



Proposal for Board Layout

> TMCB layout & form factor



TMCB_PWS : +15V / GND / -15V

GPIO : 20x bi-directional
I2C : Buffered I2C bus
Clock-signals : CC-pins

Analog I/O
- 8 Monitor ADCs, DACs channels
- 2x 24bit ADCs, 100 ksps
- 4x 16bit ADCs, 1 Msps
- 2x 18bit DACs, 1 Msps
- 4x Monitoring Temp. Sensors

PWS : Slot#1 High-Power connection
Slot#1 analog I/O (shielded)
- 4x Sensors
- Analog voltages inputs
- Analog voltages outputs

Slot#1 TMCB Interface :
- Power Supply
- I2C
- Digital signals (e.g. ADC, DAC, serial interface)

Board Layout: open questions

- Form Factor
  - Foot print: which dimensions are still acceptable ? Limitations ?
  - Max. acceptable height
- Temp.-Controller
  - Plug-in (flat)
  - Piggy-back. **Advantage**: space underneath piggy-back free for signal routing.
  - Signal routing through back connector? Or with extra connector from top ? Flexibility
- Pluggable Board Design
  - Limited space on rear-edge of board:
    - Dense mixed-mode connectors acceptable / available?
    - Shielding of individual lines?
    - Additional GND lines for all sensitive signals (analog)
  - Type of rear connector: 3 choices
    - Back-plane style: expensive, space-consuming
    - Feed-throughs in mechanical frame: search for suitable connectors
    - Direct connection with spare length of cables.
      Disadvantage: space consuming,.