

Single Cavity RF controls based on MTCA.4.

Helmholtz Validation Fonds Project

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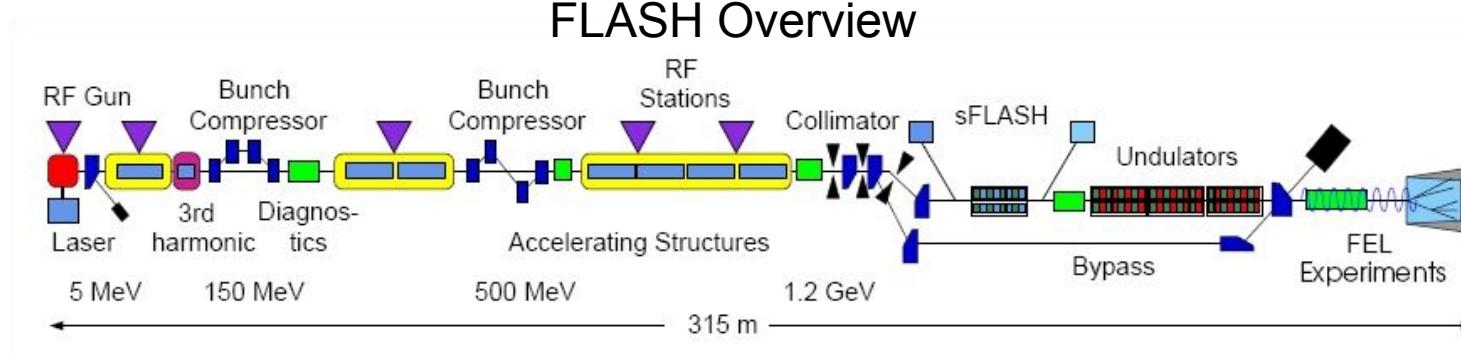
Overview.

- > Motivation
- > Cost and Performance Optimization
 - New RTM: DRTM-DWC8VM1
- > Supplementary Modules:
 - DAMC-FMC20 – AMC FMC Carrier Board
 - DRTM-PZT4 – RTM Piezo Driver Board
 - DFMC-MD22 – FMC 2 Channel Stepper Motor Driver

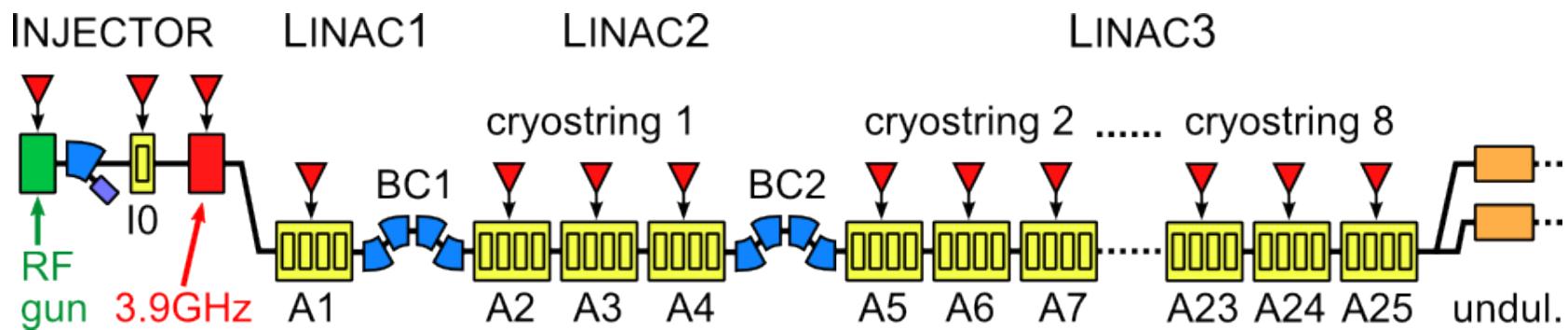
SRF Multi Cavity Configuration (e.g. FLASH, XFEL).

- > 8/16 (FLASH) or 32 (XFEL) Cavities per Klystron/RF Station
- > 24/48/96 Signals to Detect for RF Control (Probe, Forw., Refl.)

FLASH Overview



XFEL Overview



SRF Multi Cavity Configuration (e.g. FLASH, XFEL).

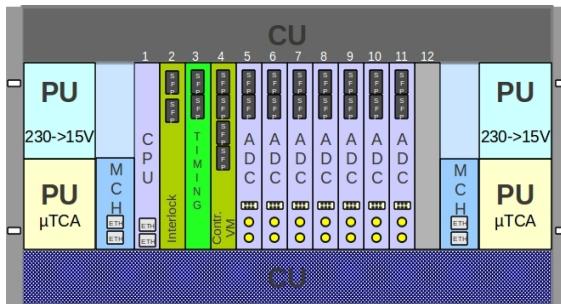
- 8/16 (FLASH) or 32 (XFEL) Cavities per Klystron/RF Station
- 24/48/96 Signals to Detect for RF Control (Probe, Forw., Refl.)
- Low Bandwidth (200Hz)
- Long Pulse Length (800us)
- Moderate Operation Speed (9MHz)

SRF Multi Cavity Configuration (e.g. FLASH, XFEL).

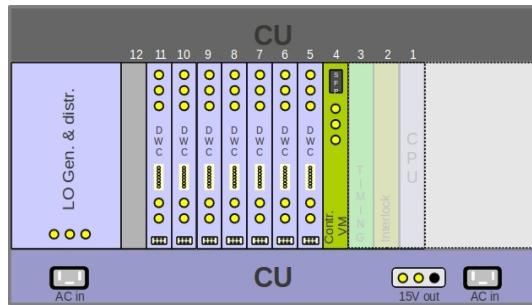
➤ Based on the LLRF Development for FLASH and XFEL:

- 3..6x 10 Channel Down-Converter (DWC8300 / DRTM-DWC10)
- 3..6x 10 Channel Digitizer (SIS8300 by Struck)
- 1x Main Controller Board (uTC / DAMC-TC7)
- 1x Klystron Driver / Vector Modulator (uVM / DRTM-VM2)

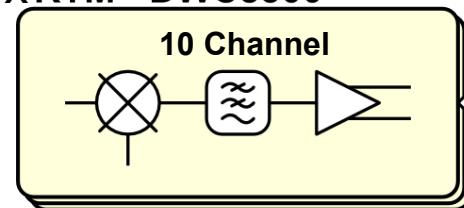
uTCA Front View



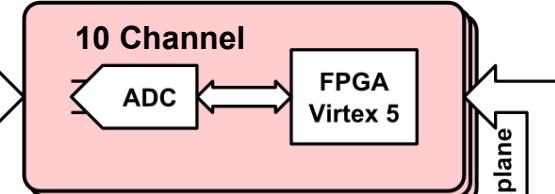
uTCA Rear View



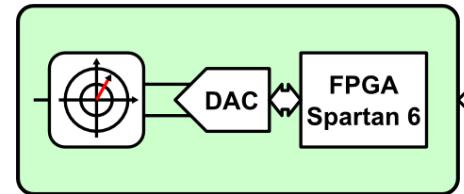
6xRTM - DWC8300



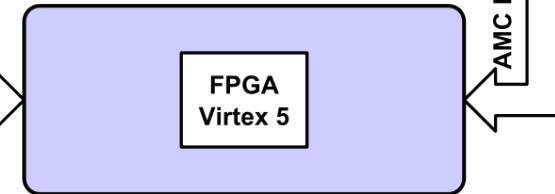
6xAMC - SIS8300



RTM - uVM



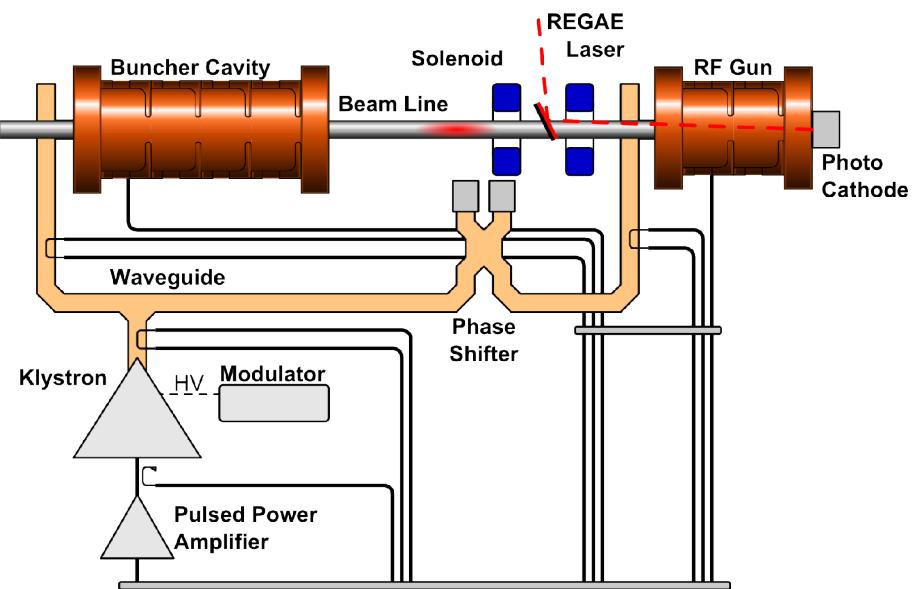
AMC - uTC



NRF Single Cavity Configuration (e.g. REGAE, PITZ-TDS).

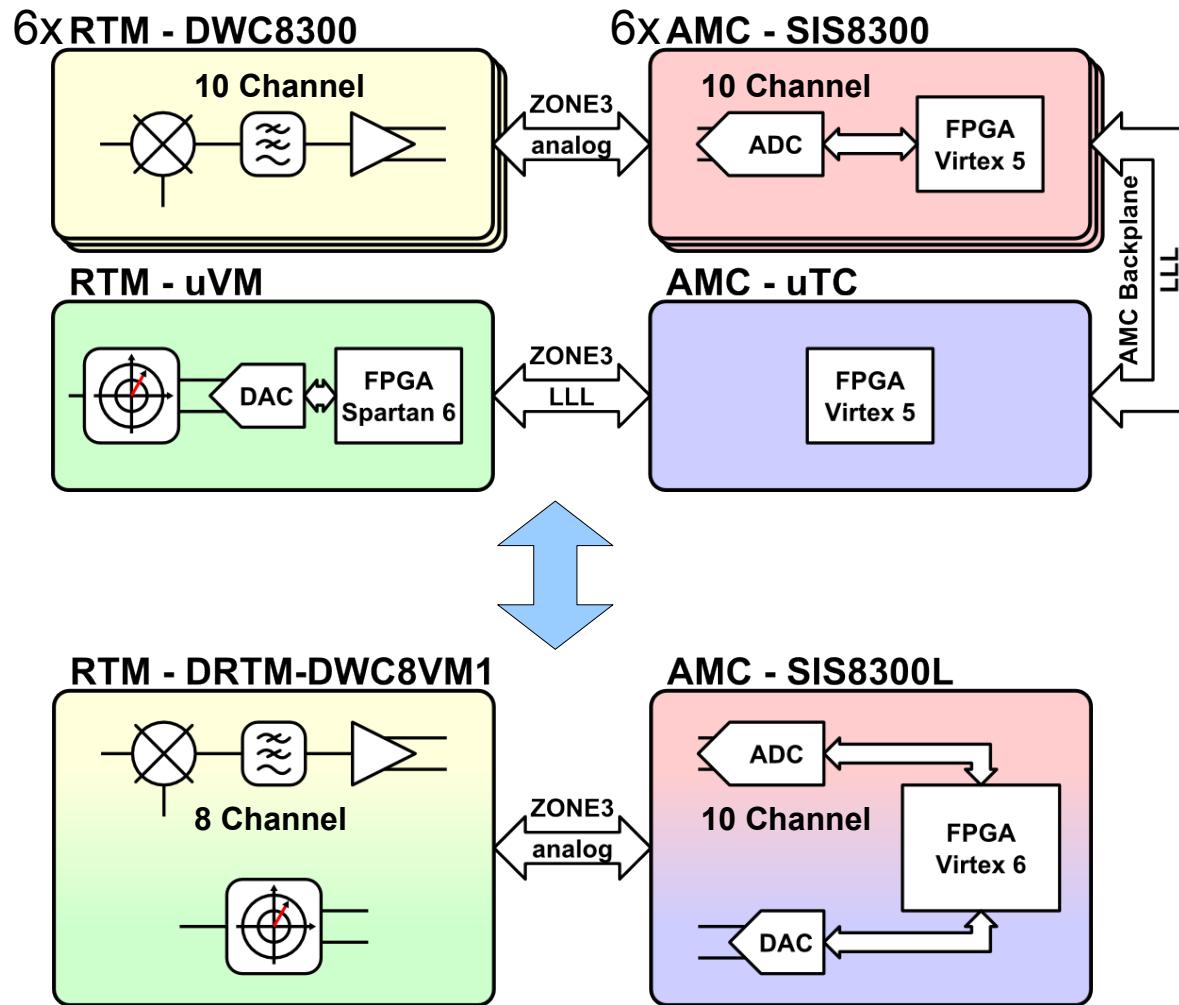
- 1 (TDS) – 2 (REGAE) Cavities per Klystron/RF Station
- Up to 6 Signals to Detect for RF Control (Probe, Forw., Refl.)
- Higher Dynamic/Bandwidth (60-400kHz)
- Short Pulse Length (3-10us)
- High Operation Speed (125MHz)

RF System at REGAE



Cost and Performance Optimization.

- > Combine Hardware (DWC and VM)
- > More Processing Power on SIS8300L by Virtex 6
- > Less Hardware:
 - 2 Boards instead of 4 for Main Control Loop
- > Less Latency:
 - No digital Communication Links
 - ~500ns Less Latency (~250ns per Link)
- > E.g. @ REGAE:
 - Current Loop Delay ~1us
 - Exp. Reduction to ~400ns (more powerfull FPGA)



[10] MTCA.4 digitizers, RTMs and applications,
Dr. Matthias Kirsch

DRTM-DWC8VM1 – RTM 8 Channel DWC/1 Channel VM.

> Main Features:

- 8 Down-Converter Channels (700..4000MHz)
- 2 DC Channels (DC..600MHz)
- 1 Up-Converter Channel (700..6000MHz)

> Additives:

- Adjustable Attenuators at Input and Output
- On Board: Power Level Monitors, User I2C Support

> Options:

- Extended Frequency Range (500..6000MHz)
- Full RF Backplane Support

RTM 8 Channel Down-Converter
1 Channel Up-Converter
DRTM-DWC8VM1



HELMHOLTZ
ASSOCIATION

APPLICATIONS

- Telecommunication
- Automation industry
- Medical application
- Civil aviation
- Accelerators
- Femtosecond synchronization
- Research & development



FEATURES

- Double width MTCA.4 Rear-transition module (RTM) Class A1.1 compatible
- 8 channel high frequency down-conversion from 700MHz to 4.0GHz Intermediate frequency range: 700MHz Short-term AM, PM stability: <0.005%, <10fs
- 2 analog DC channels (DC..600MHz)
- 1 channel high frequency up-conversion from 700MHz to 6.0GHz Modulation bandwidth: DC-50MHz
- Adjustable high-frequency input and output attenuators
- Local oscillator, ADC-Clock, and Reference from front panel or RF-backplane
- On board Power level monitors User I2C support

DESCRIPTION

The DRTM-DWC8VM1 is a combined high frequency eight channel down- and single channel up-conversion RTM compliant with the MTCA.4 standard. The unit covers the L and S-band. The down-conversion offers an excellent rms amplitude and phase short-term stability of typ. <0.005% and <10fs in the range of 10Hz to 1MHz.

Each intermediate frequency output of the down-conversion is available differential at the RTM Zone 3 connector. The differential up-converter baseband drive signals (In-phase and Quadrature) have to be provided through the RTM Zone 3 connector. The signals can be supported by Class A1.1 compatible AMC digitizer board.

The DRTM-DWC8VM1 offers switchable front-end power level attenuators for an accurate full-scale operation of AMC digitizers. The unit supports LO, ADC-clock, and reference input signals externally from the front panel as well as internally from an RF-backplane. The module offers on board power level monitors and user I2C interface for general purpose.

In addition the board provides two broadband DC

Datasheets/Announcements on HVF Webpage: mtca.desy.de



DRTM-DWC8VM1 (cont.).

> Zone3 Class A1.1 Compatible Digitizer Boards:

- SIS8300L (Struck)
- DAMC-DS800 (DESY)
- AMC520 (Vadatech)
- ...

depending on
your application

> Expected Performance (DWC)

- Phase Resolution (at 1MHz BW)
=> 0.004° (4fs @ 3GHz)
- Amplitude Resolution (at 1MHz BW)
=> 0.004%

> Expected Performance (UPC)

- Spectral Purity:
-155dBc/Hz (at 1MHz)
- Non-Linearity: -55dBc/ 0.2% error at nominal power level

RTM 8 Channel Down-Converter
1 Channel Up-Converter

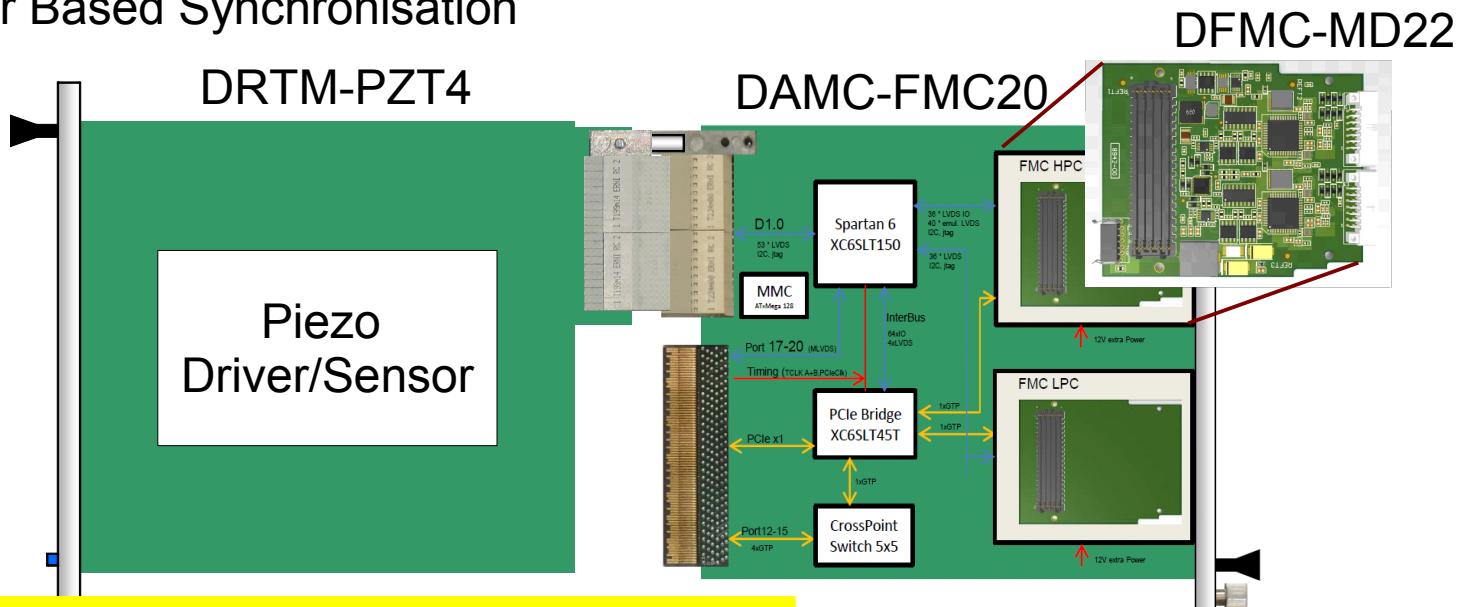
TECHNICAL SPECIFICATIONS

| Architecture | | | |
|-----------------------|-----------------------------|--------------------------------|---|
| Physical | | Dimensions | Double width, Mid-Height with Full-Height option Width: 148.5mm [5.486 inch] Depth: 7.110" (180.6 mm) |
| Standards | MicroTCA 4 | Rear-Transition-Module (RTM) | |
| Module management | | IPMI Version 2.0 | |
| Compatibility | Zone3 classification | Class A1.1 | |
| | RF-backplane support | Yes | |
| | Required EMI classification | not defined yet | |
| | Compatible AMC products | SIS8300L, DAMC-DS800, AMC520 | |
| Configuration | | | |
| Type | RTM Down-Converter | Number of channels | 8 |
| | | Frequency range | L and S-band 700MHz-4GHz |
| | RTM Up-Converter | Number of channels | 1 |
| | | Frequency range | L, S, and C-band 700MHz-6GHz |
| Electrical properties | | | |
| | Down-Conversion | Short-term amplitude stability | 0.003% in the range [10Hz, 1MHz] at 1.3GHz |
| | | Short-term phase stability | 4fs in the range [10Hz, 1MHz] at 1.3GHz |
| | | Noise figure (SSB) | typ. 12dB |
| | | Spectral purity | < -155dBc/Hz for offset frequencies > 10kHz |
| | | RF-input attenuation | 0.31 dB in 0.5dB steps |
| | | Non-linearity | < -55dBc, 1% error at nom. power level |
| | | Channel isolation | < -65dB, optional enhancement possible |
| | | Intermediate spurious | < -80dB |
| | | Total latency | TBD |
| | Up-Conversion | Short-term amplitude stability | TBD |
| | | Short-term phase stability | < 60fs in the range [10Hz, 1MHz] |
| | | Spectral purity | < -155dBc/Hz for offset frequencies > 1MHz |
| | | RF-output attenuation | 0.155dB in 0.25dB steps |
| | | Non-linearity | < -55dBc, 0.2% error at nom. power level |
| | | Intermediate spurious | TBD |
| | | Power consumption | < 20W |
| Connectivity | | | |
| Inputs | RF-inputs (CH1...CH8) | Front panel | 8 inputs |
| | | Connector type | FBB multi-coax, single-ended |
| | | Impedance / Coupling | 50 Ohm / AC |
| | | Return loss | <-10dB |
| | | Maximum input power level | +15dBm (for 0dB attenuation) |
| | | Input 1dB compression | +9dBm (for 0dB attenuation) |
| | | Adj. input attenuation | 0.5, 31.5dB |
| | REF-input (REF) | Front / Rear panel | 1 input, optional from RF-backplane |
| | | Connector type | SMA, single-ended |
| | | Impedance / Coupling | 50 Ohm / AC |
| | | Return loss | TBD |
| | | Maximum input power level | +15dBm (for 0dB attenuation) |
| | | Input 1dB compression | +9dBm (for 0dB attenuation) |



Supplementary Modules.

- > DAMC-FMC20 – AMC FMC Carrier Board
- > DFMC-MD22 – FMC 2 Channel Stepper Motor Driver
 - Cavity Motor Tuner, Beam Diagnostics (Beam-Arrival-Monitor)
- > DRTM-PZT4 – RTM 4 Channel Piezo Driver Board
 - Cavity Piezo Tuner
 - Laser Based Synchronisation



Datasheets/Announcements on HVF Webpage: mtca.desy.de

Possible Crate Configurations.

| | AMC | RTM |
|------|-------------------|------------------|
| # -1 | PM 1 | |
| # 0 | MCH | - |
| # 1 | CPU + HDD | - |
| # 2 | Timing | - |
| # 3 | DAMC-FMC20 + MD22 | DRTM-PZT4 |
| # 4 | Spare | Spare (e.g. BPM) |
| # 5 | SIS8300L | DRTM-DWC8VM1 |



> SIS8300L + DRTM-DWC8VM1

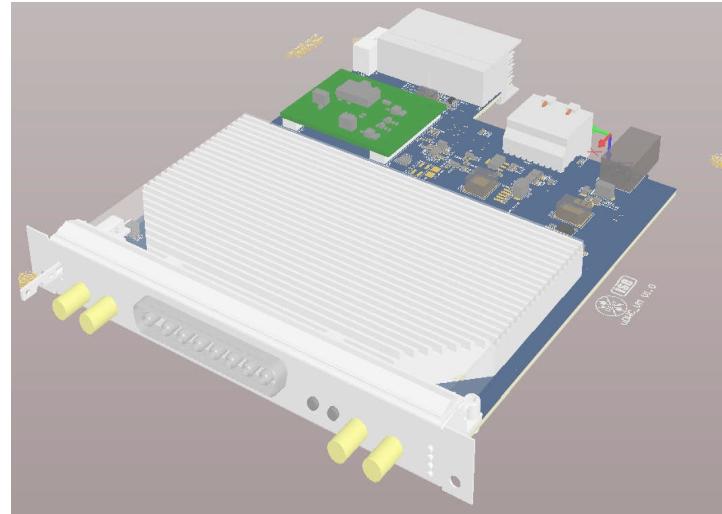
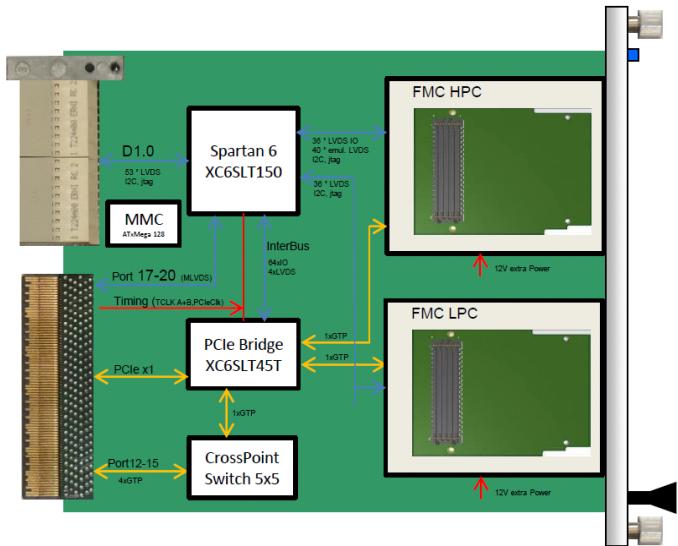
- NRF & SRF: LLRF Control

> DAMC-FMC20 + DFMC-MD22 + DRTM-PZT4

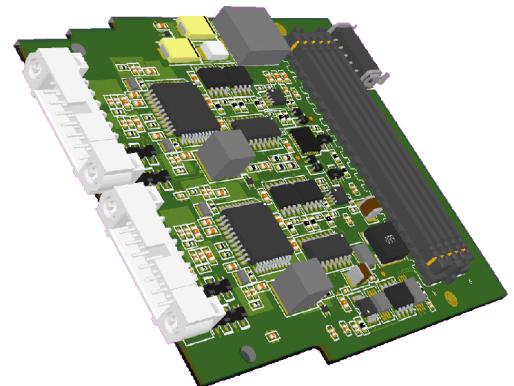
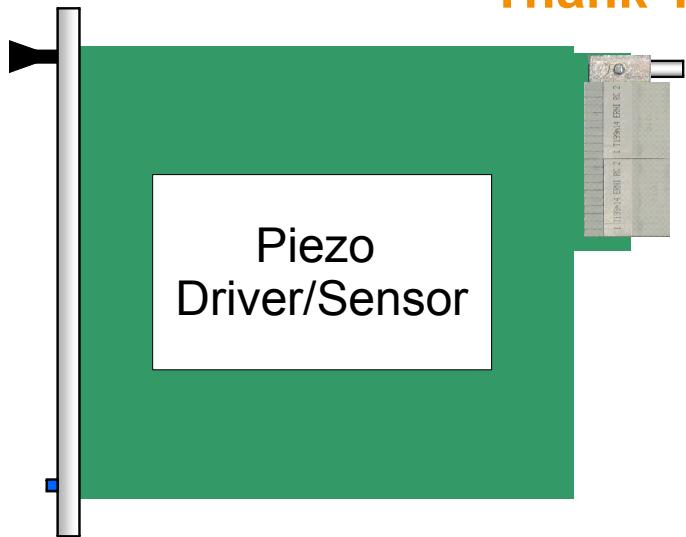
- NRF: Piezo Driver for Laser Synchronization
- SRF: Motor Driver (MD22) and Piezo Driver (PZT4) for Cavity Frequency Tuner

> Free Slot for:

- BPM, Fast Klystron Protection, Interlock, etc.



Thank You for Your Attention!

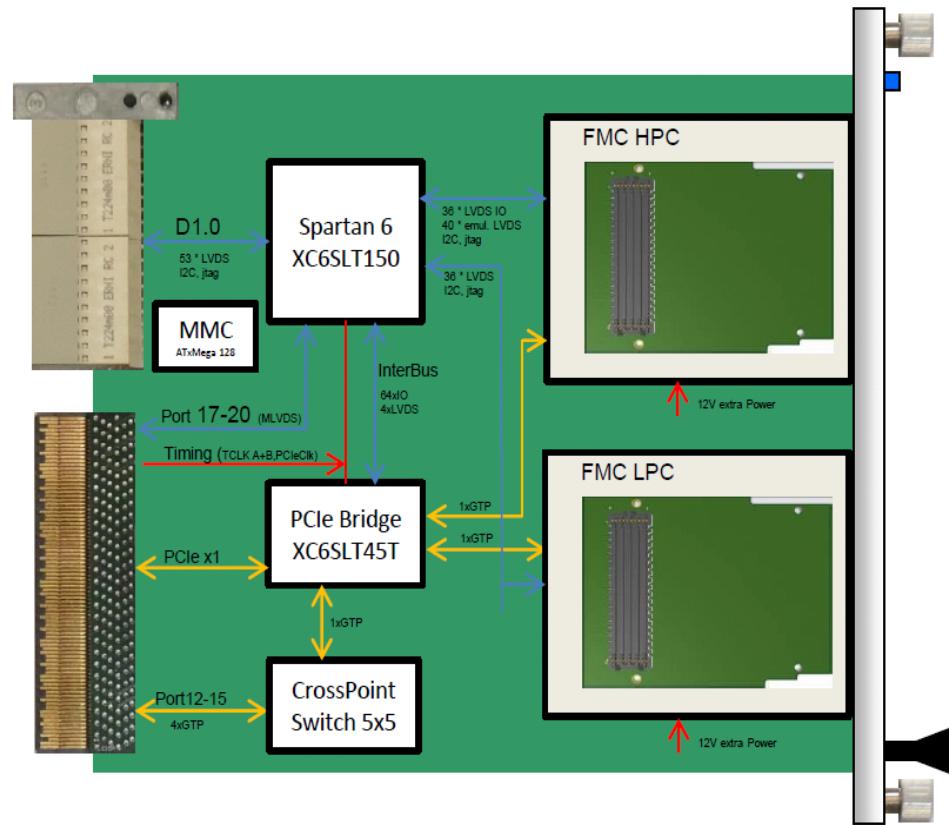


Backup Slides



DAMC-FMC20 – FMC Carrier.

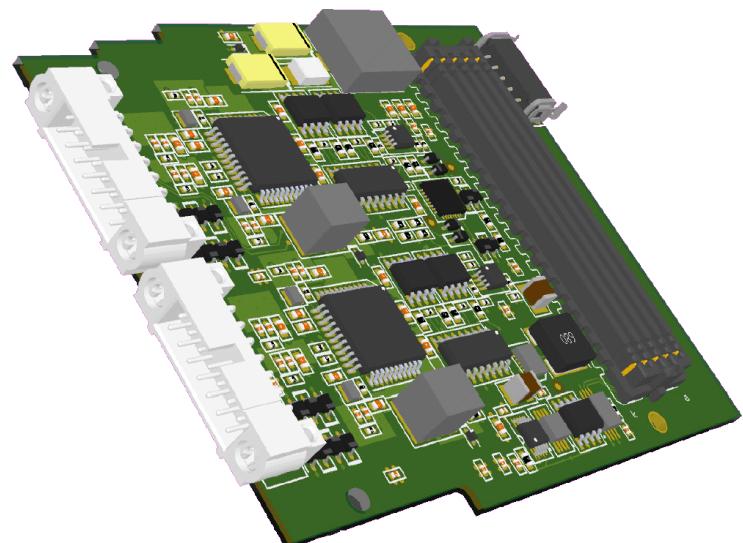
- Double Width MTCA.4
- Advanced-Mezzanine Card Class D1.0 Compatible
- Supports 2 FMCs
- ANSI/VITA 57.1 (LPC and HPC) compliant
- Extra power connector for FMCs
- Onboard Spartan-6 FPGA
- IMPI 1.1 compliant MMC
- RoHS compliant



Link to HVF Webpage: mtca.desy.de

DFMC-MD22 – FMC 2 Channel Stepper Motor Driver.

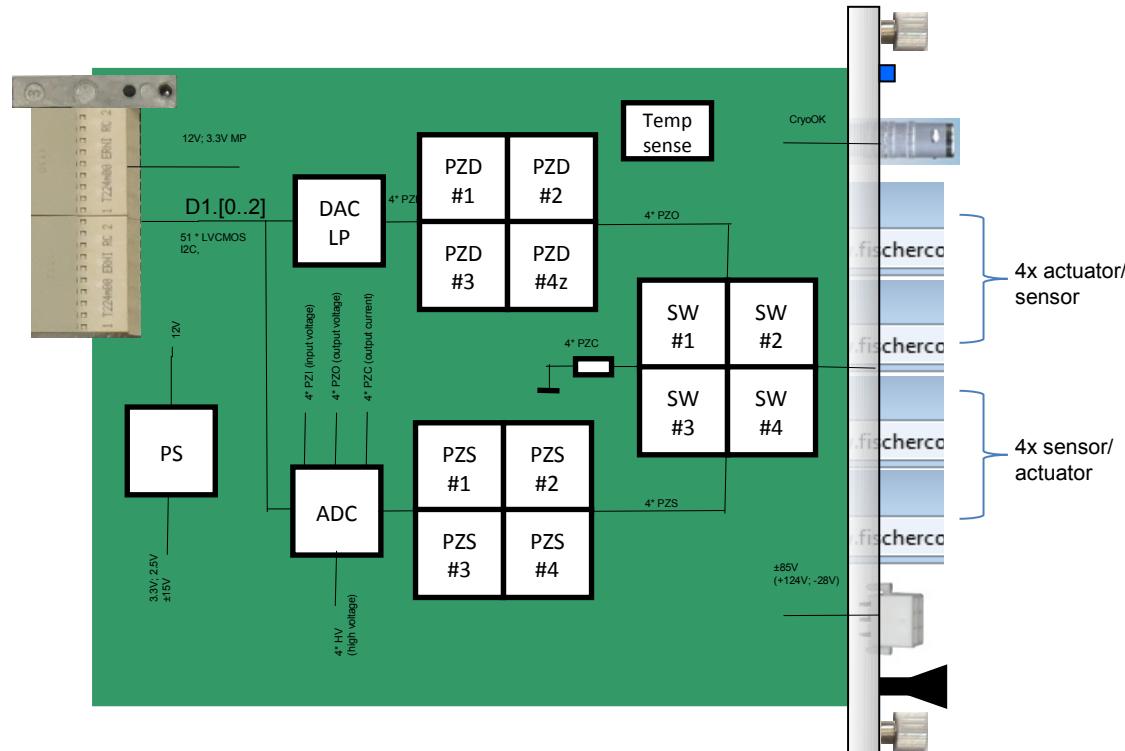
- 2 Channel Stepper Motor Driver
- ANSI/VITA 57.1 LPC Compliant
- Realtime Support
- Supports up to 1.8A Motor Coil Current
- Supports up to 256 Micro-Steps per Full Step
- Programmable Current Slopes
- Each Channel Supports Switchable EnDat2.2 or ABN-Encoder Readout
- RoHS Compliant



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DRTM-PZT4 – 4 Channel Piezo Driver/Sensor.

- Double Width MTCA.4
- Rear Transition Module Class D1.[0..2] Compatible
- Supports 4 Piezo Drivers and 4 Piezo Sensors
- Option: Unipolar or Bipolar Power Supply



Link to HVF Webpage: mtca.desy.de