Latest AMD SoC-based Boards in MicroTCA.4 at DESY

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HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

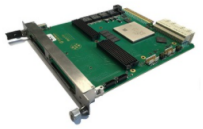
DESY.

Licensing Strategy

- We promote an ecosystem
- DESY has licensed almost all developments: components are available for us **and** for third parties
- Strategy: Concentrate on the application; purchase all “unexciting” infrastructure

AMC

DAMC-FMC2ZUP
Zynq Ultrascale+ MPSoC based Dual FMC/FMC+ Carrier Board with D1.1 RTM support



ADVANCED MEZZANINE CARDS

AMC boards (Advanced Mezzanine Card) are the key components of a MicroTCA system. Within the MicroTCA.4 crate, AMCs are placed in the front of the crate. They are connected by a high-speed backplane that carriers serial links, power and management data. Every AMC card is monitored and managed. This allows hot-plug, hot-swap, health monitoring and thermal management of the modules.

There are six standard sizes of AMCs: single and double width as well as compact, mid-size and full-size height. Every combination of width and height is valid. The power consumption of an AMC is divided into 3.3V management power plus 12V payload power.
AMC boards are used for digital processing. On every AMC board there is a controlling unit called MMC (Module Management Controller).
Plugging in the AMC board to the MTCA crate connects the board to the backplane of the crate. The backplane ensures the connection of the AMC boards with every other AMC board in the crate.
Plus, every AMC board is connected to the MCH (MicroTCA Carrier Hub), which is the overall management card of the MTCA system. The MCH gives management power to the AMCs first. This power is used to check if everything is ok with the AMC. If the MMC, the managing unit on the AMC detects no problems on the board, the MCH gives payload power to the AMC.

Clustering of AMCs in the system is possible.

DAMC-FMC1Z7IO
Cost-Optimized IO Controller Board with one FMC socket

DAMC-FMC25
AMC Dual HPC-FMC Carrier

DAMC-FMC20
AMC Dual FMC Carrier Board

DAMC-TCK7
AMC Data Processing and Telecommunication Module

X2TIMER
AMC Fast Timing System

DAMC-UNIZUP

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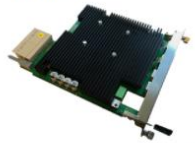
RTM

DRTM-MXC
Mobile GPU Carrier

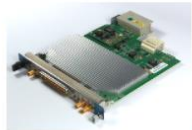


REAR-TRANSITION-MODULES

RTMs, the rear-transition-modules, are extension boards that are placed in the back of the MTCA.4 crate. They directly connect to the front AMCs via the Zone 3 connector.
The possibility to separate analogue and digital functions by moving sensitive analogue electronics to the RTM is one of the key strengths of MicroTCA.4.

DRTM-AD84
RTM 8Ch ADC, 4Ch DAC

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



DRTM-DWC10
RTM 10 Channel Down-Converter

DRTM-PZT4
RTM 4 Channel Piezo Driver

DRTM-LOG1300
eRTM Local Oscillator Generation

DRTM-DS8VM1
RTM 8-Channel Direct Sampling 1-Channel Vector Modulator

DRTM-VM2LF
RTM 2 Channel Vector Modulator Low Frequency

DRTM-VM2HF
RTM 2 Channel Vector Modulator High Frequency

DESY MMC Stamp

FMC

DFMC-DS800
FMC Direct-Sampling A-D Converter

FPGA MEZZANINE CARDS

FPGA Mezzanine Card (FMC) is a standard defining I/O mezzanine cards and corresponding carrier boards. Huge ecosystem of carrier boards, both in MicroTCA format and standalone boards, provides a good prototyping platform, suitable for experimental physics and industrial applications. The FMC mezzanine format provides additional degree of modularity for a lot of I/O applications, such as ADC and DAC boards, or communications boards.

DFMC-AD16
FMC 16-channel A-D Converter

DFMC-MD22
FMC 2 channel stepper motor driver

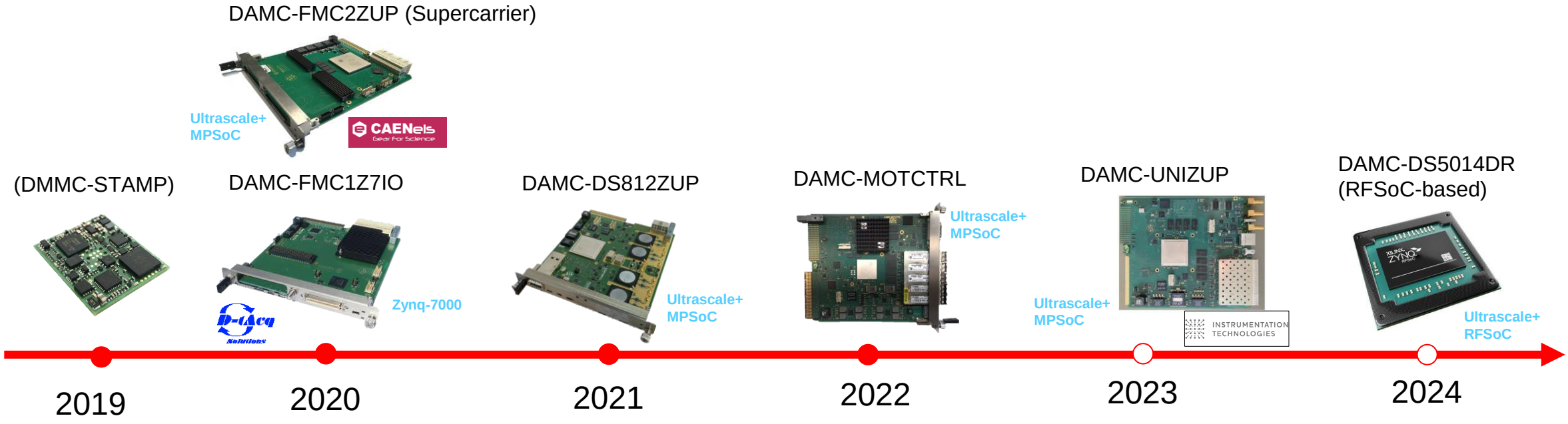
DFMC-UNI-IO
FMC Multi-Purpose I/O Board

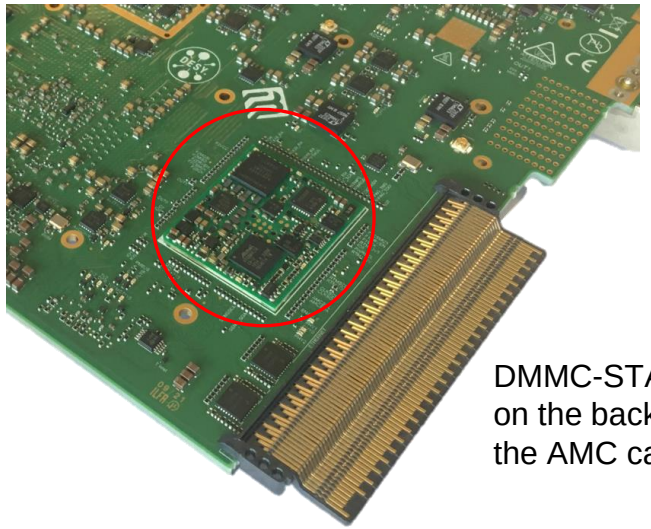
DFMC-TESTADP
FMC Loopback Adapter

DFMC-SFP4
FMC 4-Channel SFP+ Adapter

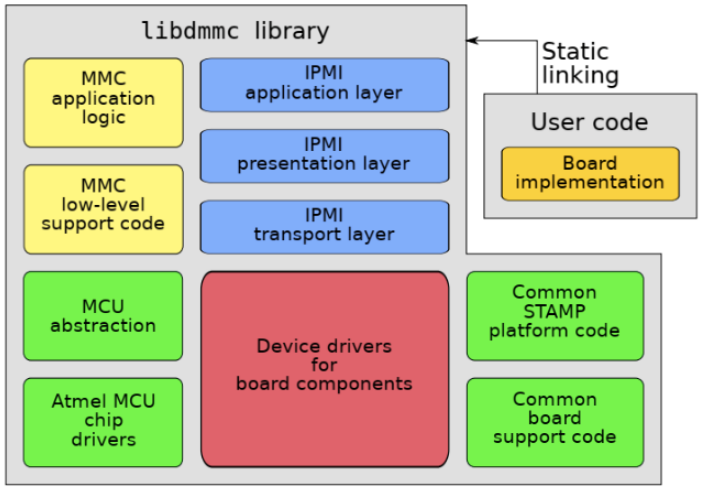
All SoC developments of the last few years

Similarity 1: Boards are all based on DMMC-STAMP





DMMC-STAMP on the back of the AMC card

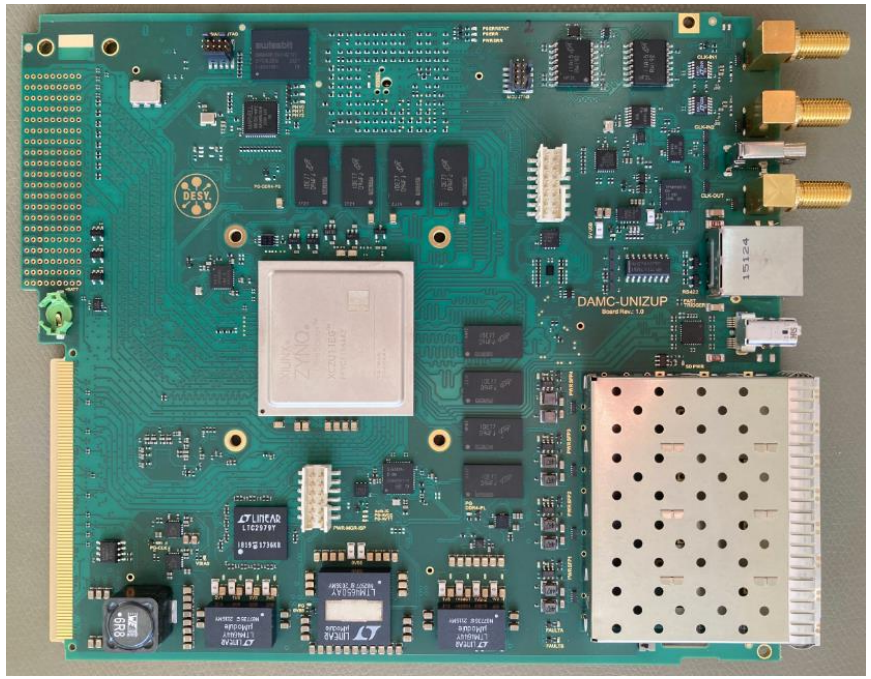


- DMMC-Stamp handles MicroTCA Management
- Complete software framework
- 95% re-use
- Compatibility with all MCHs we know of

- In-system update (from MMC and FPGA)
- Serial-over-IPMI (remote access to the FPGA and MMC UART)

- 2024: over 1000 pieces produced
- used by 30 partners
- 100% test in the needle test adapter

DAMC-UNIZUP



Vivado™ HLS

INSTRUMENTATION TECHNOLOGIES

Inherited features:

- Quad-Core ARM Cortex-A53 @1.5 GHz, Dual-Core ARM-R5 RT @600 MHz and Mali-400 MP2 graphics
- PCIe x4 (**x8** option on supported systems); Gen.3 supported
- **USB type-C Alternate Mode Display Port** for standalone operation (no need for additional AMC CPU Module)
- Flexible clocking scheme and front panel connector for external clock input and **White Rabbit support**
- Supported by all Xilinx development tools (e.g. Vivado HLx)

“Little Sister” of DAMC-FMC2ZUP

- Lower-cost-board with smaller FPGA: hundreds of units will be needed at Petra IV
- 14 instead of 16 layers, 0402 components, (only 0201 capacitors)

Facts

- Board inherits the **technology of DAMC-FMC2ZUP**
- Universal MPSoC board with high-performance **RTM connectivity**
- Large FPGA (in smaller package):
  Zynq Ultrascale+ **ZU7CG…ZU11EG**

New:

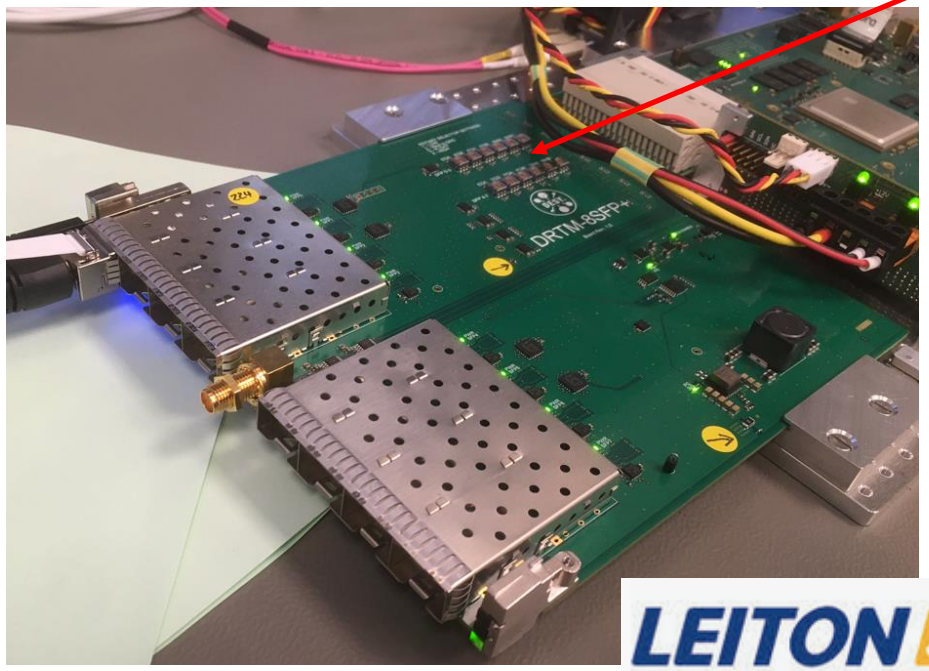
- **2 x 64bit wide** DDR4 interfaces (in total 8GiB RAM)
- **4 integrated SFP+** slots with 16.375 Gbps (not 28 Gbps GTY)
- Connectors for “**slow trigger”** (RS485 for machine protection) and **“fast trigger”** on Front Panel
- 2 Front panel clock inputs via SMA, 1 Output

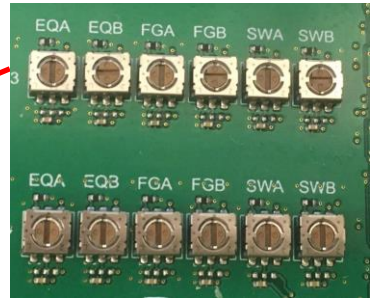
DESY.

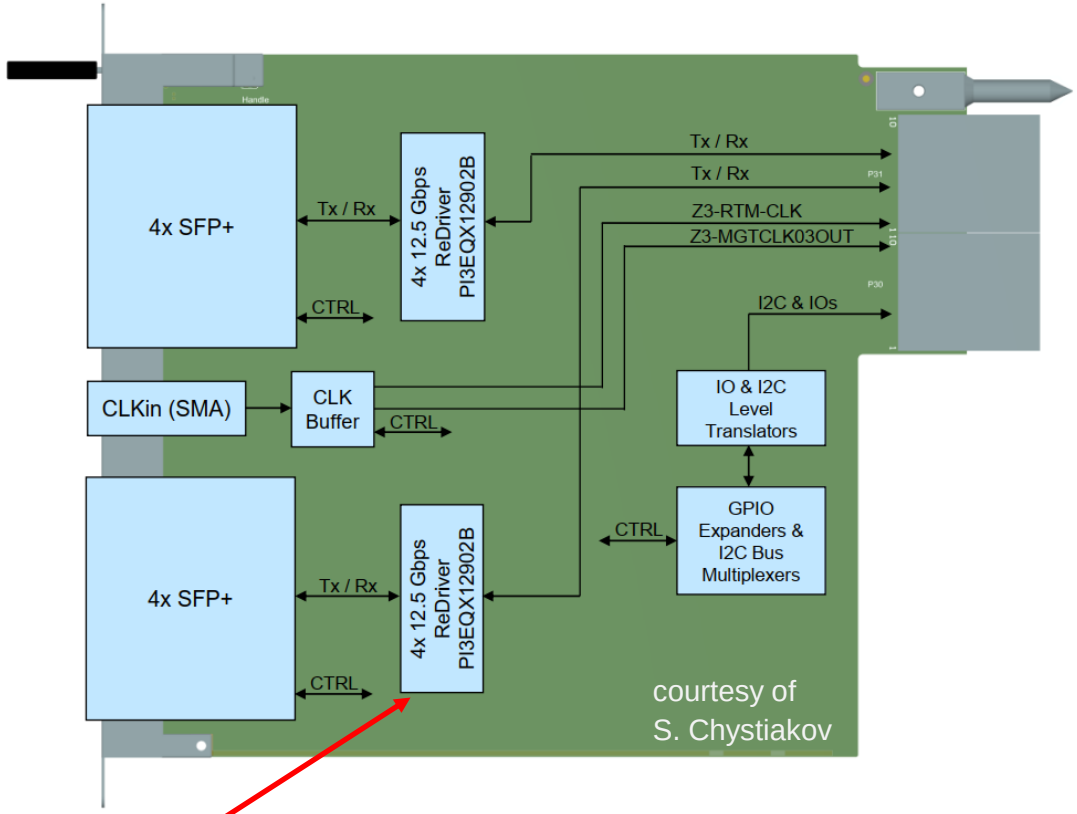
DAMC-8SFP+

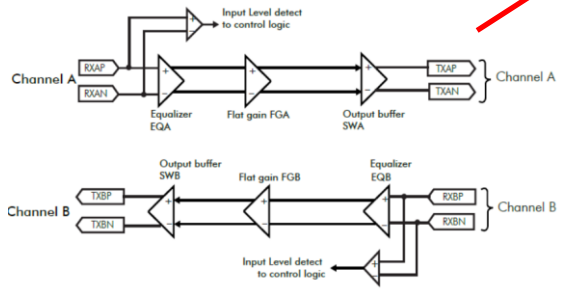
Fan-out of MGT Channels from DAMC-UNIZUP

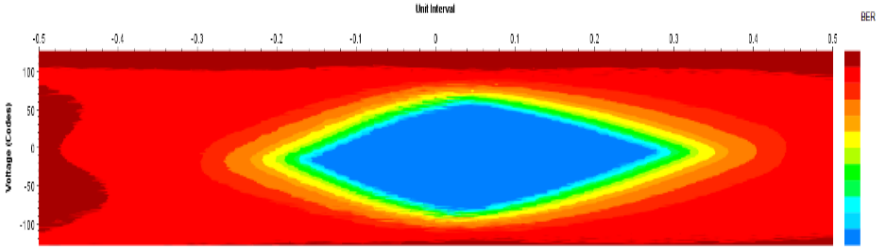
- We needed to verify UNIZUPs 8 MGTs to RTM
- We designed a 8-SFP+ RTM
- Board works on all other Digital Class AMCs
- Brings 1 to 8 MGTs to RTM **12.5 Gbps**: not trivial
- First use of “analog” equalizer
- Development time: 3 months
- Low-cost circuit board and components
- Manufactured in the “**PCB pool**” from Leiton (Berlin)
- Material: Panasonic R-1566W (Dk=0.010 !!!)







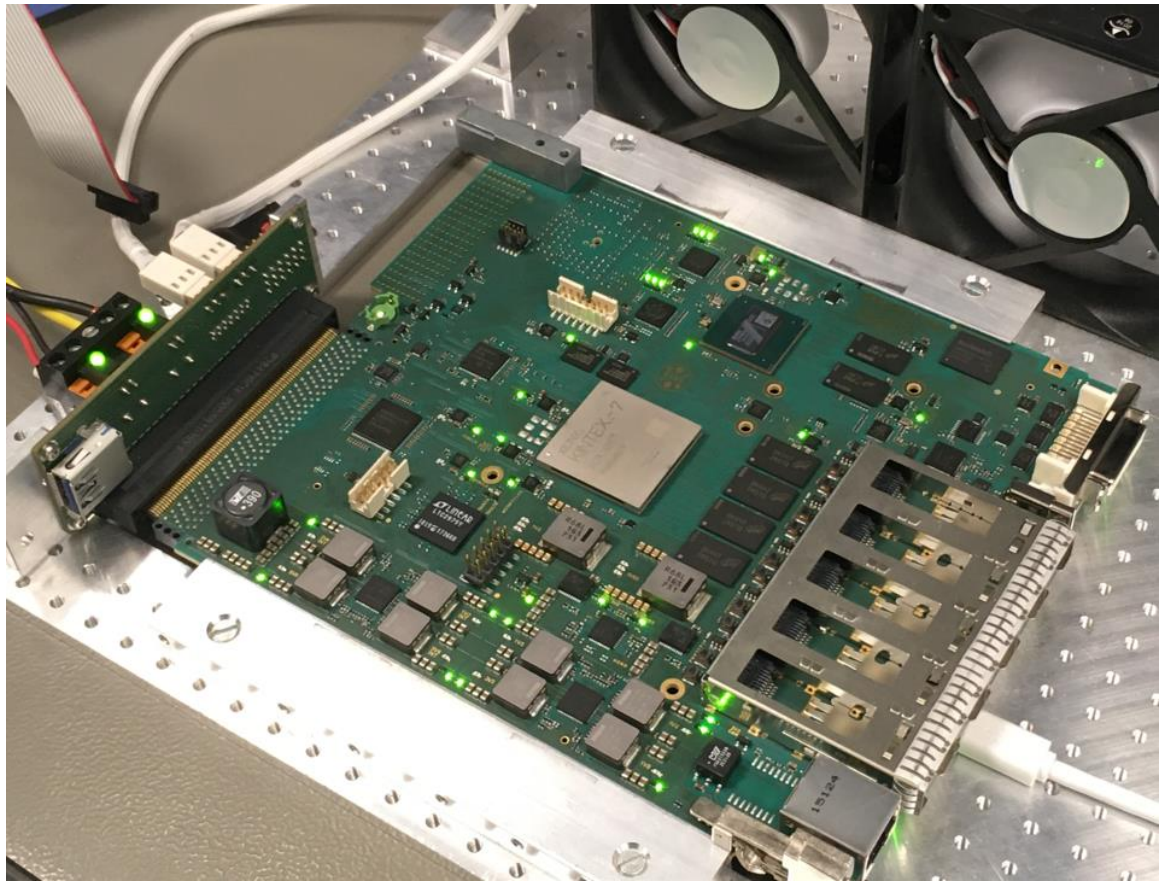




Name	TX	RX	Status	TX Polarity Invert	RX Polarity Invert	Bits	Errors	BER
Ungrouped Links (0)								
Link Group 0 (4)				■	■			
Link 3	Quad_224/MGT_X0Y3/TX (xczu11_0)	Quad_224/MGT_X0Y3/RX (xczu11_0)	10.313 Gbps	☐	☑	8.597E12	0E0	1.163E-13
Link 2	Quad_224/MGT_X0Y2/TX (xczu11_0)	Quad_224/MGT_X0Y2/RX (xczu11_0)	10.313 Gbps	☑	☑	8.597E12	0E0	1.163E-13
Link 1	Quad_224/MGT_X0Y1/TX (xczu11_0)	Quad_224/MGT_X0Y1/RX (xczu11_0)	10.313 Gbps	☑	☐	8.597E12	0E0	1.163E-13
Link 0	Quad_224/MGT_X0Y0/TX (xczu11_0)	Quad_224/MGT_X0Y0/RX (xczu11_0)	10.313 Gbps	☑	☐	8.597E12	0E0	1.163E-13

LEITON

MicroTCA Motion Controller Hardware



- Board in Rev. A fully functional
- Not a single patch wire

Heterogeneous approach
MPSoC (2 GB DDR4) and FPGA (4 GB DDR3)

- **MPSoC**:
  - Raspberry Pi in FPGA (Yocto Linux)
  - Non-real-time tasks
  - Communication with other cards
- **Kintex-7:** Real-time control
  - 5 SFP+-Ports (1 Gbit/s to 10 Gbit/s)
  - 3x Motor Interfaces, 2x Ring topology
  - HW-Support: CAN EtherCAT, SERCOS