Libera **2BPMRTM**

The beam position processing module

The Libera 2BPMRTM module is a MTCA.4 RTM module intended for processing and digitizing the signals from two beam position monitors.

Highlights

- Eight input channels with 125 MHz 16-bit A/D converters
- Analog front-end with customized filtering and amplification
- RJ-45 interfaces to control the external switching module
- D1.2 backplane connector for the AMC module
- FPGA and software support

Hardware

The module features eight input channels with an analog front-end customized for the BPM application for electron synchrotrons . Channels are equipped with a programmable attenuator and combination of low-pass and band-pass filtering components that condition the signals from the pickups, The central frequencies are typically around 352 MHz and 500 MHz, but others can also be supported.

The two RJ-45 interfaces are intended for driving the external switching modules. The control signal for the external switching modules is provided by the AMC module. Besides the control signals, the raw ADC data is transferred through the D1.2 connector to the AMC module.
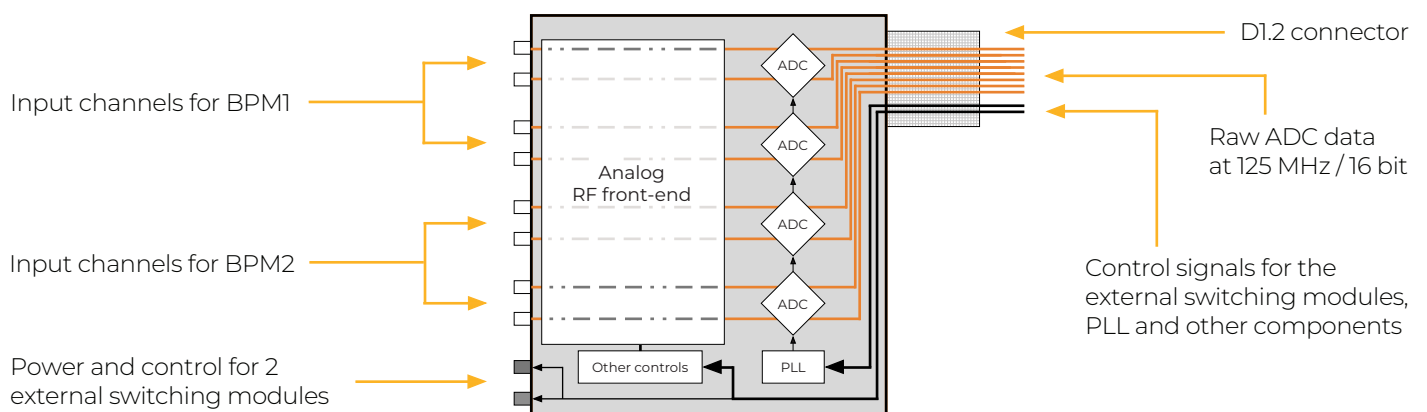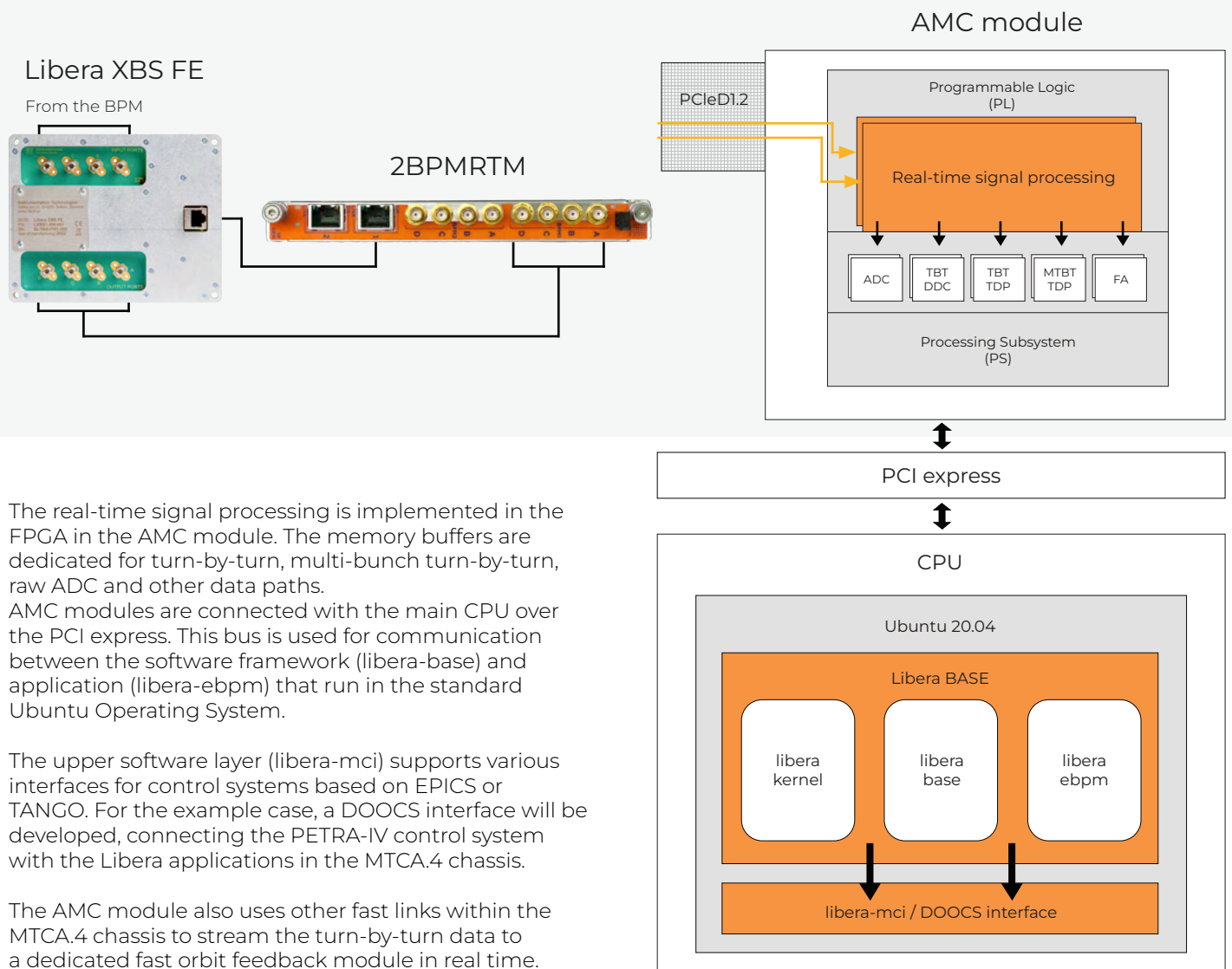

Specifications	
Input signal frequency range	(500±8) MHz bandpass, -3 dB
Maximum input signal amplitude	0 dBm, CW, at full attenuation
Input channels	8 (2x 4), SMA-F
Input impedance	50 Ω
A/D converters	125 MHz, 16 bit
Variable attenuation	0 dB to 31 dB
Maximum crosstalk	-76 dB (between 4 channels) -95 dB (between BPM1 channel D and BPM2 channel A)
Input noise density	-144 dBm/Hz (31 dB attenuation) -169 dBm/Hz (0 dB attenuation)

INSTRUMENTATION TECHNOLOGIES

Application **example**

The first series of the 2BPMRTM module is used in the prototype BPM readout system for the PETRA-IV project. The MTCA.4 chassis is configured with six such modules that support readout from 12 BPMs. The external switching module is the commercially available Libera XBS FE which is compatible with the 2BPMRTM module and latest generation Libera Brilliance+ instrument.

How it works

The Libera XBS FE is installed in the tunnel and connected between the BPM pickup and BPM electronics. It is controlled by the 2BPMRTM module at distances of up to 200 meters.

AMC module

Libera XBS FE

From the BPM

2BPMRTM

PCIeD1.2

Programmable Logic (PL)

Real-time signal processing

| ADC | TBT DDC | TBT TDP | MTBT TDP | FA |

Processing Subsystem (PS)

PCI express

CPU

Ubuntu 20.04

Libera BASE

| libera kernel | libera base | libera ebpm |

libera-mci / DOOCS interface

The real-time signal processing is implemented in the FPGA in the AMC module. The memory buffers are dedicated for turn-by-turn, multi-bunch turn-by-turn, raw ADC and other data paths.
AMC modules are connected with the main CPU over the PCI express. This bus is used for communication between the software framework (libera-base) and application (libera-ebpm) that run in the standard Ubuntu Operating System.

The upper software layer (libera-mci) supports various interfaces for control systems based on EPICS or TANGO. For the example case, a DOOCS interface will be developed, connecting the PETRA-IV control system with the Libera applications in the MTCA.4 chassis.

The AMC module also uses other fast links within the MTCA.4 chassis to stream the turn-by-turn data to a dedicated fast orbit feedback module in real time.

Performance specifications	
RMS uncertainty 0-2 kHz bandwidth (@ -20 dBm)	100 nm
RMS uncertainty 0-50 kHz bandwidth (@ -20 dBm)	500 nm
Temperature drift	150 nm/K