UTCA/STAND-ALONE BEAM POSITION MONITORING

High precision beam position measurements.

The beam monitoring system is available on the uTCA or stand-alone form-factors for best in-class BPM solutions.

The digital beam position monitoring system (BPM) provides an accurate measure of the beam position in the XY plane defined by the section of the accelerating cavities. It plays a crucial role in the commissioning and operation of the cavities that compose any particle accelerator. In addition to position, thanks to the BPM system it can be measured the spread and the current of the beam as well as the time of flight (TOF). The solution is tailored on customer needs and takes full advantage of our previous expertise on PCIe-S BPM equipment, now working with the most advanced crate technologies.

- Continuous and pulsed measuring of the beam position, phase, and current.
- Measures at the fundamental and the first harmonic.
- Analog conditioning of RF signals.
- 2 BPM channels in one uTCA based system.
- Generation of alarms in position, phase and current (configurable thresholds).
- Autocalibration capabilities (electronics and cables).
- Post interlock/alarm analysis capabilities.
- EPICS control system support and easy user interface.
- Compatible with White-Rabbit and IEEE-1588 protocols. Seamless integration into the Timing system for triggering and timestamping control operations.
- Great performance:
  - Dynamic range: [-75, 0] dBm
  - Position precision < 25um
  - Phase precision < 0.1°
  - Position, phase and current alarms with response time < 2us.
    - Position precision < 250um.
    - Phase precision < 1°

Safran Electronics & Defense is with you every step of the way, building in the intelligence that gives you a critical advantage in observation, decision-making and guidance.

Frequency range of operation

The system can be customized to measure signals up to 750MHz.

Continuous and pulsed mode

Position, phase and current measures in continuous wave or pulsed wave.

Second harmonic

Possibility of measuring at the fundamental frequency and at the first harmonic.

Wide dynamic range

High precision measures in the input level range from -75dBm to 0dBm.

Analog signal conditioning

Programmable analog attenuators for signal level conditioning prior to digitalization.

Configurable averaging

Two configurable stages of averaging to smooth the measures.

Alarm generation

Generation of alarms based on position, phase, and current measures. Configurable thresholds and setpoints. Response time less than 2us.

Analog outputs

Analog outputs for mapping the measures in amplitude, position, phase and/or current to voltage in the range from 0V to 10V.

Self-calibration

The system incorporates special electronic and SW to perform a self-calibration process in two stages. Self-calibration allows a transparent way to achieve quadrupole symmetry. The system estimates a set of amplitude and phase constants to compensate for mismatches between the four electronics paths and the cables.

Machine diagnostics

The system stores the digitized signals for real time monitoring and for a postmortem analysis allowing the user to know at every moment the state of the system and the causes of an event. The triggers to generate postmortem files are configurable, as well as the capture rate, depth, and pre-trigger capture time.

White Rabbit compatible

Compatible with White-Rabbit and IEEE-1588 protocols. Seamless integration into the Timing system for triggering and timestamping control operations.

EPICS based

EPICS control system supports an easy graphic user interface (GUI) to configure and monitor the operation of the system.

Technical Specifications

System on Chip

SoC	Xilinx Zynq Ultrascale+ series
CPU	Quad ARM® Cortex™-A53 1.5GHz
Memory	8GB DDR4 16 GB SD card

Front End board

- RTM with double height and mid-size form factor uTCA.4.
- 1 x RF MO Ref.: sine wave for LLRF reference.
- 2 x BPM channels, 4 x RF inputs per channel (V+, V-, H+, H-).
- 4 x Analog output [0, +10] V.
- Direct sampling architecture.
- RF input power dynamic range: [-75, 0] dBm.
- Filters at fundamental and second harmonic frequencies.
- I2C RF switches for self-calibration (channels and cables calibration).
- RF pilot signal generation for self-calibration.
- Fail-safe for overheating mode.
- EEPROM memory.

Digitizer board

- 10 x ADC channels.
- 16 bits, 250MSPS ADCs - QDR LVDS interface.
- 7 x configurable input/output TTL connectors.
- Zynq UltraScale+ FPGA from Xilinx.
- PLL for low phase noise distribution clocks.
- 8GB DDR4 for processor and data storage (postmortem analysis).
- ETH & SFP port (White Rabbit compatible).
- uTCA MMC controller.
- Fail-safe for overheating mode.
- uSD socket, uUSB port.

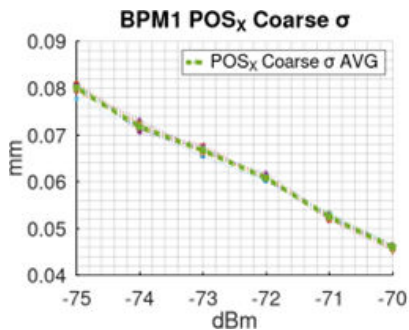## Management

OS	Linux (Kernel v4.14 & buildroot)
Control	EPICS/TANGO
Monitoring	CSS/GUI & Taurus

Performance

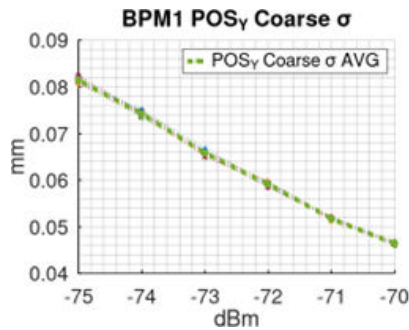|	
Dynamic range	[-75, 0] (dBm)
Position precision	< 25 µm
Phase precision	< 0.1°
Alarm time response	< 2 us
Position precision	< 250 µm
Phase precision	<1°

* These performances are fulfilled in the entire dynamic range.

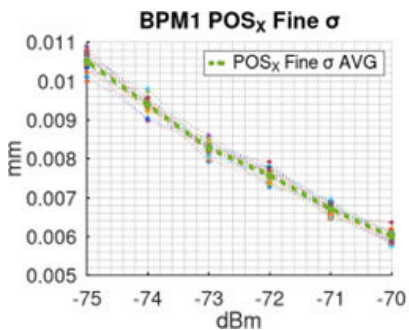## Position precision [-75, -70] dBm, 2us integration time

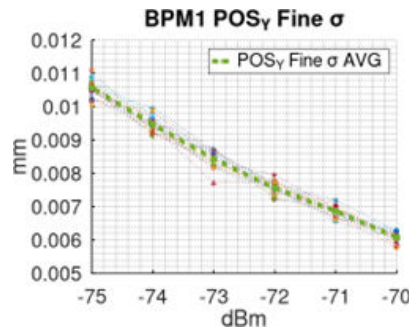25 averaged X position precision curves (2us integration)

25 averaged Y position precision curves (2us integration)

Position precision [-75, -70] dBm, 100us integration time

25 averaged X position precision curves
(100us integration)

25 averaged Y position precision curves
(100us integration)

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