LIBERA

SOLUTIONS FOR PARTICLE ACCELERATORS

LIBERA BOOK'24

INSTRUMENTATION TECHNOLOGIES

LIBERA

SOLUTIONS FOR PARTICLE ACCELERATORS

LIBERA REFERENCES

ASIA

BARC
HIRFL—CSR
HiSOR
HUST
IBS—RISP
IHEP-CAS—BEPC II, ADS, CSNS, HEPS
IMP-CAS—C-ADS, LEAF, SSC-LINAC,
IMS—UVSOR
Inter University Accelerator Centre
ISSP
KAERI—KOMAC
KEK—PF, PF-AR, LINAC, SUPER B,
J-PARC, cERL
Nagoya University—Aichi Synchrotron
NewRT Medical Systems
NSRRC—TLS, TPS
PAL—PLS II, PAL XFEL, EUV, 4GSR, PIEAS
RRCAT—INDUS, INDUS II
SACLA—Spring-8
SAGA
SINAP—SSRF, SXFEL
SJTU
SLRI—SPS
Tsinghua University
USTC—NSRL

AUSTRALIA

ANSTO—Australian Synchrotron

EUROPE

AVO-ADAM—LIGHT
BINP Physics—SKIF
CELLS—ALBA
CERN
CNAO
DESY—DORIS III, European XFEL,
FLASH, PETRA III, PETRA IV
Diamond Light Source
ELI-NP—VEGA
ESFR—ESRF-EBS
Forschungszentrum Jülich—COSY
Fritz Haber Institute
GSI—FAIR
HZB—BESSY II, MLS
HZDR—ELBE
INFN-LNF—Daphne, ELI-NP, SPARC,
Latino, Sabina, CLEAN, STAR
INFN-LNS
INFN-LNL—SPES
Jagiellonian University—SOLARIS
JINR—NICA
KIT—KARA
IJCLab —ThomX
Lund University—MAX III, MAX IV
MedAustron
Physics Institute of the University of Bonn
PSI—SLS, SwissFEL
Research Instruments
RRC Kurchatov Institute—SIBERIA II
ScandiNova
SCK-CEN—MYRTE, MINERVA
SESAME
Sincrotrone Trieste—Elettra, Elettra 2.0,
FERMI
Synchrotron SOLEIL
STFC ASTeC—EMMA, CLARA

NORTH AMERICA

ANL—APS, APS-U
Best Medical International
BNL—ERL, NSLS II, X-RAY ring
Bridge 12
Canadian Light Source
Cornell University—CHESS, CESR
Fermilab
LBNL—ALS
NUSANO
Oak Ridge National Laboratory
RadiaBeam
SLAC—LCLS, SPEAR 3

SOUTH AMERICA

ABTLuS—LNLS

A word from our CEO

“The Libera folks,” that’s how the accelerator community knows us, and we’ve made quite an impression since we began our story back in 2003. Over the last two decades we have supplied nine out of ten synchrotron light sources around the world with our Libera beam position monitoring and stabilization systems. We believe Libera is much more than just the sum of its parts. It offers the best possible performance for the price, with proactive engineering, reliability and long-term support. But for us, it is the relationships with our customers that Libera has enabled us to develop over the years that we cherish the most.

Today, Libera addresses a wider range of particle accelerator applications including Beam Loss Monitoring, Digital Low-Level RF controls and RF generation and distribution, offered for both circular and linear machines. This means more tools for our users and also the possibility to enter exciting new application areas, such as Particle Therapy and Isotope production.

In the last few years we have also started to offer our domain knowledge and technical expertise to users that have chosen different HW platforms, and this resulted in the first projects using the standard MTCA.4 boards and in the first industrialization of prototypes developed by the customers.

Going forward, we believe that combining our expertise and the building blocks developed thus far with a flexible, proactive approach and long term support will enable us to partner with the most challenging projects, and to find innovative ways to meet the requirements for the machines of the future.

Elvis Janežič,

CEO of Instrumentation Technologies

TABLE OF CONTENTS

BEAM POSITION MONITOR ELECTRONICS

Libera Beam Position Monitor (BPM) electronics feature a high-resolution position measurement of the beam (electrons, protons, ions, photons, etc.) Their flexible digital signal processing calculates the beam position with different bandwidths and techniques, enabling measurements in different beam modes and regimes.

- pulsed, single bunch
- pulsed, micro/macro pulse
- bunch-by-bunch
- turn-by-turn
- first-turn measurement
- closed loop (fast, slow)

HADRON	ELECTRON	PHOTON
• Libera Hadron	• Libera Brilliance+	• Libera Photon
• Libera Single Pass H	• Libera Single Pass E	
• Libera Spark	• Libera Spark	
	• Libera CavityBPM	

HADRON
Beam Position Monitor Electronics

Instruments intended for use in Hadron machines are shown in Figure 1. Several versions are available, based on different technology and form factors. They provide various levels of measurement performance and functionalities. The BPM pickup types supported are button and shoebox pickups.

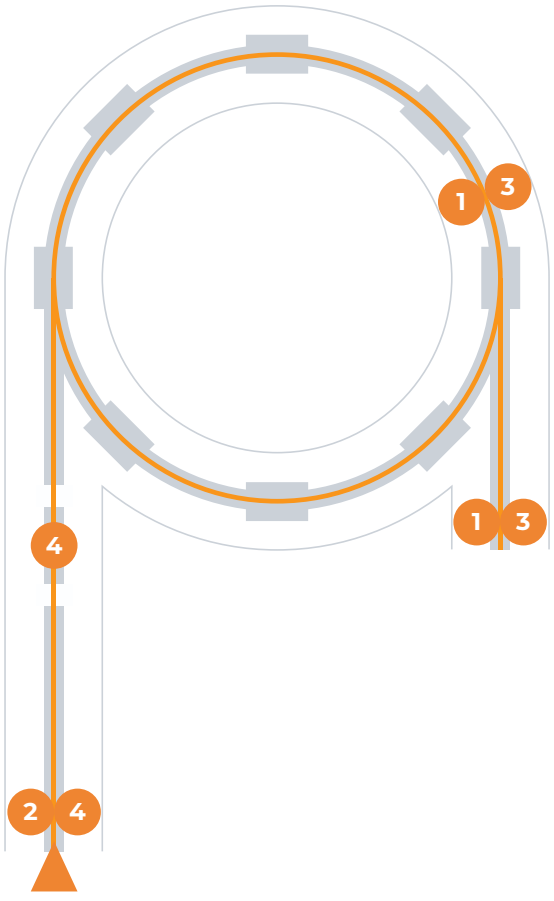


Figure 1: Example of hadron machine: LINAC injector, transfer line, synchrotron, and extraction line

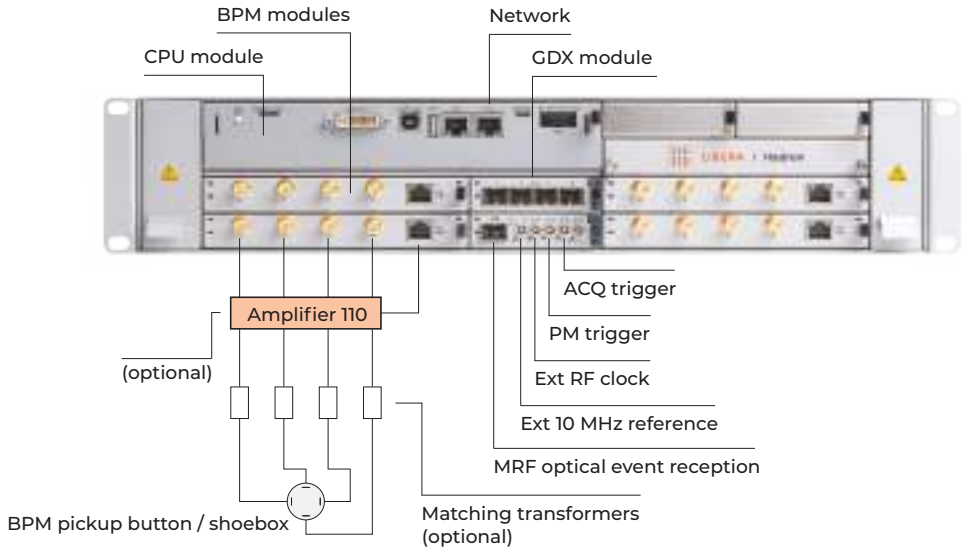
1 Libera Hadron

More

Used in proton/hadron synchrotrons

Libera Hadron is a beam position processor. It can perform beam position measurements, tune measurement, FFT processing, FFT peak calculation, slow position monitoring, etc. The modular platform hosts up to four BPM modules, a timing module and optionally a Gigabit Data Exchange (GDX) module.
Accessories: Libera Amplifier 110.
Extensions: real-time data streaming, feedback application, serial I/O interface.

Figure 2: Libera Hadron front panel (block diagram)



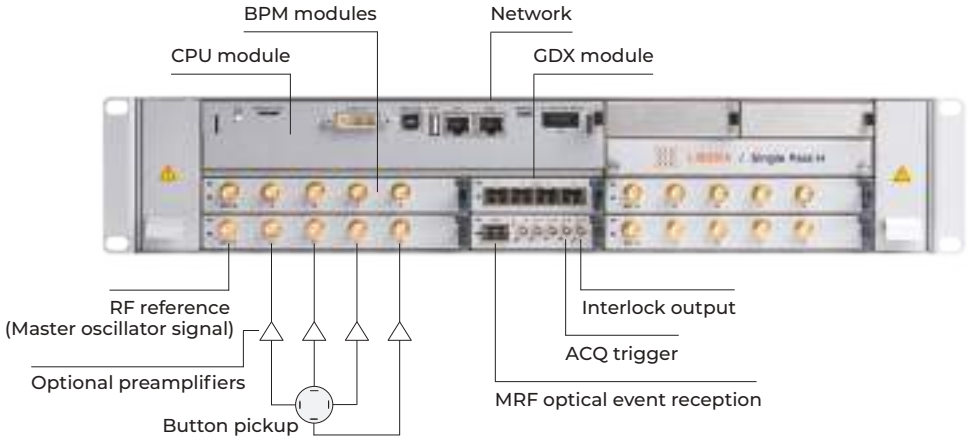
2 Libera Single Pass H

More

Used in proton/hadron linear accelerators

Libera Single Pass H is a beam position and phase processor. It can perform beam position and phase measurements for two signal harmonics simultaneously. The modular platform hosts up to four BPM modules, a timing module and optionally a Gigabit Data Exchange (GDX) module.
Extensions: real-time data streaming, feedback application, serial I/O interface.

Figure 3: Libera Single Pass H front panel (block diagram)



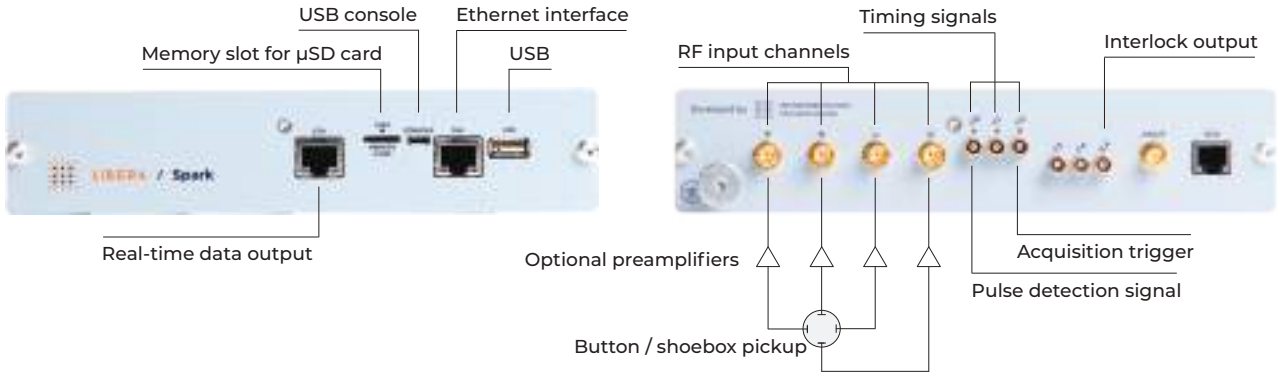
3 Libera Spark HR

More

Used in proton/hadron synchrotrons and ring-to-target beam transfers

Libera Spark HR is a beam position processor that supports the readout from a single BPM and enables bunch-by-bunch data processing. The instrument can output a real-time data stream and can be integrated with the machine protection system (Interlock detection).
Extensions: Interlock output, real-time data streaming, analog output, digital (serial) I/O.

Figure 4: Libera Spark HR front and back panel (block diagram)



4 Libera Spark HL

More

Used in proton/hadron linear accelerators and transfer lines

Libera Spark HL is a beam position processor that supports the readout from a single BPM. Position information is accessible at various configurable data rates. The instrument can output a real-time data stream and can be integrated with the machine protection system (Interlock detection).
Extensions: Interlock output, real-time data streaming, analog output, digital (serial) I/O.

The front and back panel of the Libera Spark HL are identical to those shown in Figure 4.

Table 1: Technical specifications of hadron beam position monitors

	For CIRCULAR machines		For LINEAR machines	
	Libera Spark HR	Libera Hadron	Libera Spark HL	Libera Single Pass H
General product code	LSHR	LHAD	LSHL	LSPH
Capabilities				
BPM slots	1	1 - 4	1	1 - 4
Supported input frequency range	<35 MHz / <45 MHz	<55 MHz	<750 MHz	<700 MHz
A/D conversion	125 MHz/14 bit	250 MHz/16 bit	125 MHz/14 bit	130 MHz/16 bit
Cooling	Passive	Active (fans)	Passive	Active (fans)
Power supply	PoE	110/220 V, 250 W	PoE	110/220 V, 250 V
Timing signals	Electrical (up to 3) *	Electrical (4)/Optical	Electrical (up to 3) *	Electrical (4)/optical
Fast data links	RJ-45	RJ-45 & SFP	RJ-45	RJ-45 & SFP
Maximum input signal *	<1.2 V peak pulse voltage *	<2 V peak pulse voltage *	<+10 dBm *	<+10 dBm *
Input gain/attenuation	Programmable, 31dB	Fixed	Programmable, 31dB	Fixed
Temperature drift, typical	<2 µm/°C	<2 µm/°C	<1 µm/°C	<1 µm/°C
Position RMS at bunch-by-bunch data rate	10 µm **	6 µm **	/	/
Position RMS at fast 10 kHz data rate	/	<1 µm **	/	/
Position RMS at slow 10 Hz data rate	/	<1 µm **	/	/
Position RMS at 1 MHz data rate	/	/	<1 µm	<3 µm, <0.03 °
Dimensions	H: 1 U, W: 9.5” (rack mountable with a kit), D: 210 mm	H: 2 U, W: 19” (rack mountable), D: 310 mm	H: 1 U, W: 9.5” (rack mountable with a kit), D: 210 mm	H: 2 U, W: 19” (rack mountable), D: 310 mm
* Can be extended/customized depending on user requirements				
** Measured with K=10mm				
Functionalities				
Bunch-by-bunch processing	Yes	Yes	No	No
Real-time data streaming	Optional *	Optional *	Optional *	Optional *
Slow data	No	Yes	No	No
Gain control	No	Libera Amplifier 110, external variable gain amplifier	Yes	No
Selectable processing window	Yes	Yes	Yes	Yes
Processing delay	Yes	Yes	Yes	Yes
Multi-chassis synchronization	Trigger-based	Reference clock with PLL	Trigger-based	Trigger-based
Data time stamping	Trigger-counter	Based on external RF clock	Trigger-counter	Trigger-counter
Interlock detection and output	Optional **	No	Optional **	Yes
Postmortem capability	No	Yes	No	Yes
FFT/FFT peak	No	Yes	No	No
Single-pass measurement	Yes	Yes	Yes	Yes
Additional Digital I/O channels and Analog output	Optional **	No	Optional **	No
Closed Orbit Feedback Application	No	Yes, see page 35	No	No
* Requires additional module	GbE interface	GDX module	GbE interface	GDX module
** Requires additional module	DAI module		DAI module	

ELECTRON
Beam Position Monitor Electronics

Instruments intended for use in linear and circular electron machines are shown in Figure 5 and Figure 6. Several versions are available, based on different technology and form factors. They provide different levels of measurement performance and functionalities. The BPM pickup types supported are button, stripline, and cavity-type pickups.

Figure 5: Example of a 3rd generation light source (synchrotron)

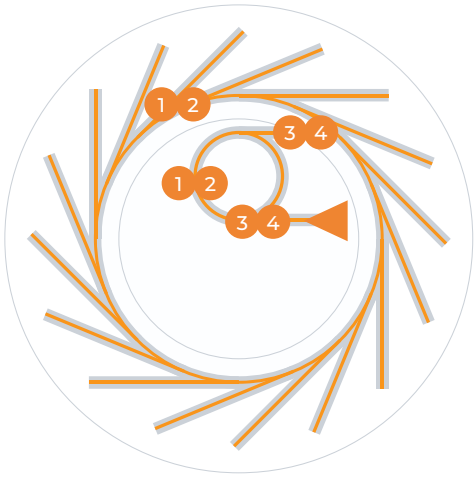
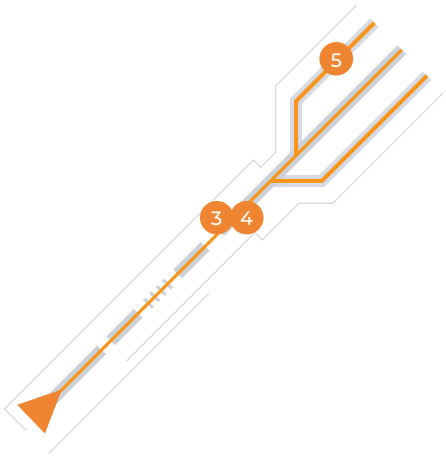


Figure 6: Example of a 4th generation light source (FEL/ERL)



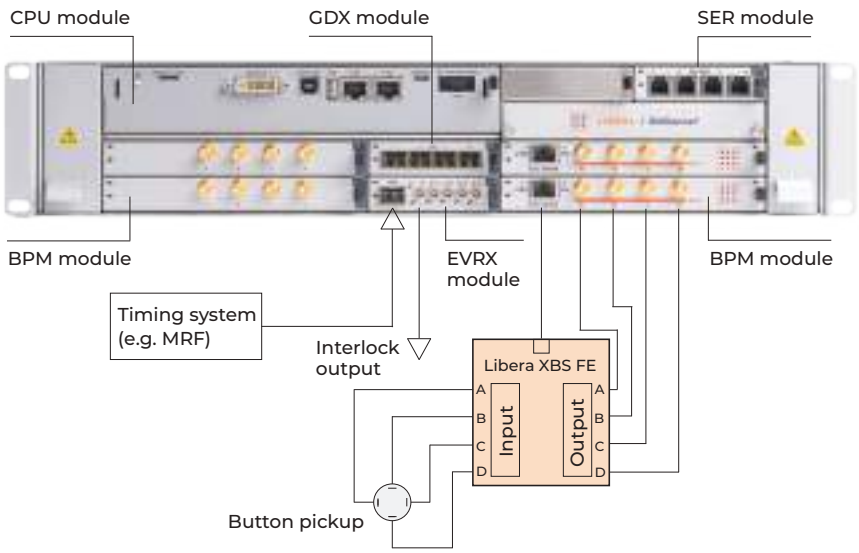
1 Libera Brilliance+

More

Used in electron synchrotrons

Libera Brilliance+ is a beam position processor. The modular platform hosts up to four BPM modules (4 channels each), a timing module and a Gigabit Data Exchange (GDX) module. The main advantage of the Libera Brilliance+ is in its active mechanism that compensates the drift in electronics as well as in RF cables (using Libera XBS FE).
Extensions: Fast Orbit Feedback application, serial I/O interface.

Figure 7: Libera Brilliance+ front panel (block diagram)



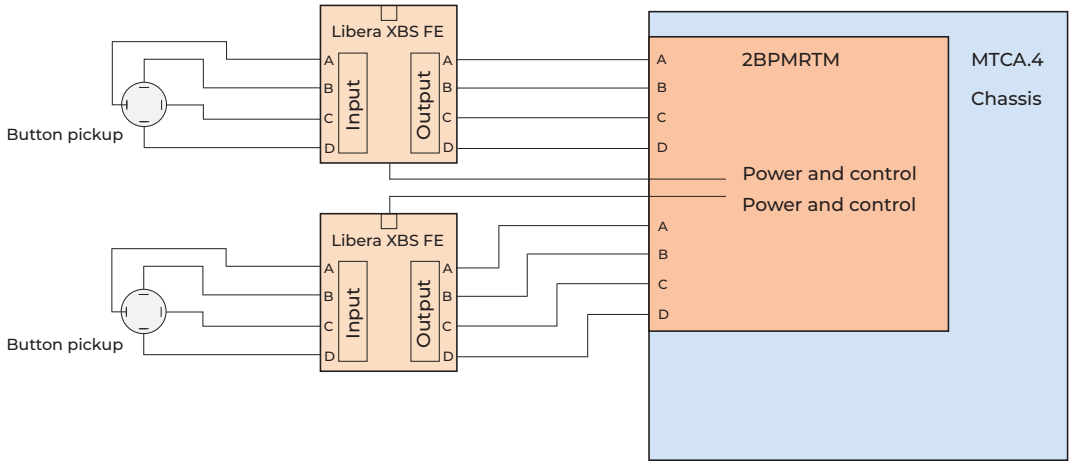
Libera 2BPMRTM

More

The Libera 2BPMRTM module is a MTCA.4 Rear Transition Module (RTM) intended for processing and digitizing the signals from two beam position monitors (8 channels).

Figure 8: Libera 2BPMRTM front panel

Figure 9: Libera 2BPMRTM configuration with two BPM pickups in a MTCA.4 chassis



The module features 8 input channels with an analog front-end customized for the BPM application for electron synchrotrons. The input channels are equipped with a programmable attenuator and a combination of low-pass and band-pass filtering components that condition the signals from the pickups. Typically, the central frequencies are around 352 MHz and 500 MHz but others can be supported, too.

The 2 RJ-45 interfaces are intended for driving the external switching modules (Libera XBS FE). The control signal for the external switching modules is provided by the Advanced Mezzanine Card (AMC). Besides the control signals, the raw ADC data is transferred through the D1.2 connector to the AMC module.

2 Libera Spark ERXR / ERPT

More

Used in electron synchrotrons

Libera Spark ERXR / ERPT is a beam position processor that supports the readout from a single BPM (4 channels) and processes the data both in frequency and time domains. The ERPT version supports the Libera Pilot Tone FE and processes the input signals at two RF frequencies. The instrument can output a real-time data stream (e.g. at 10 kHz) and can be integrated with the machine protection system (Interlock detection).
Extensions: Interlock output, real-time data streaming, analog output, digital (serial) I/O.

Figure 10: Libera Spark ERXR/ERPT front panel

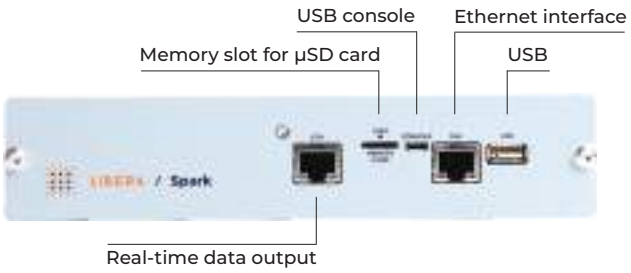


Figure 11: Libera Spark ERXR back panel (block diagram)

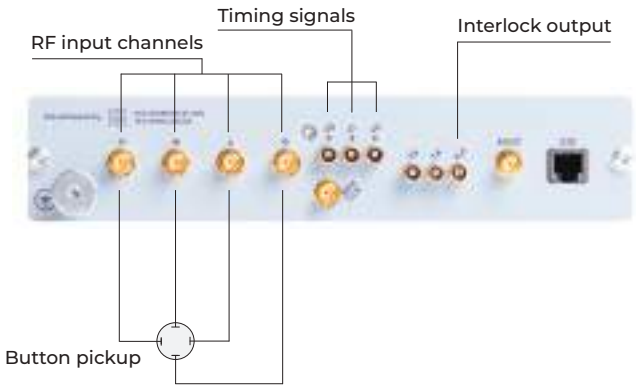
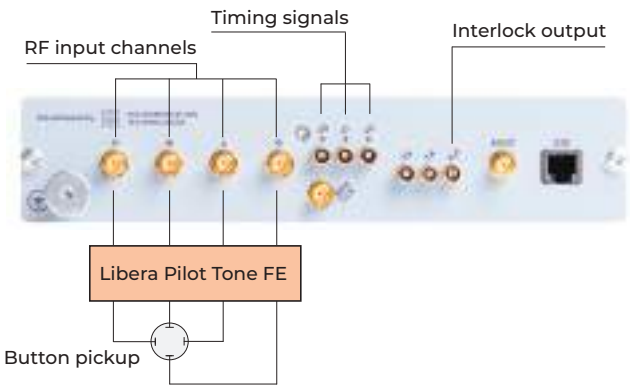


Figure 12: Libera Spark ERPT back panel (block diagram)



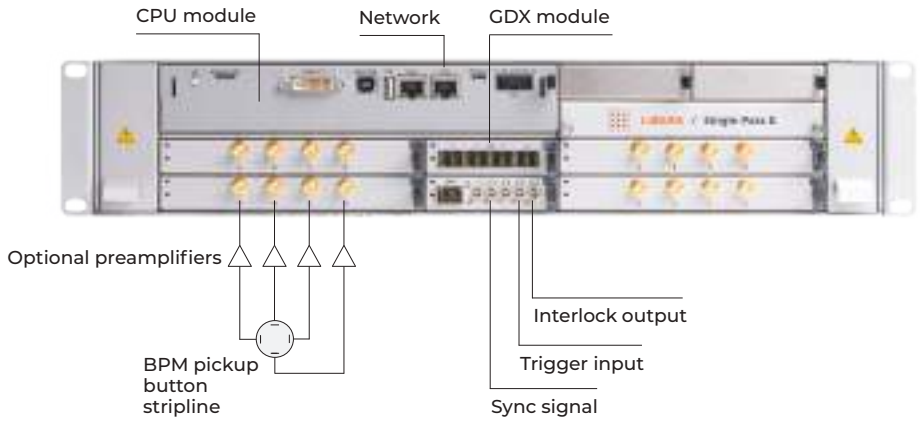
3 Libera Single Pass E

More

Used in electron LINACs

Libera Single Pass E is a single pass beam position processor. With its flexible digital signal processing it can process various filling patterns from single bunch to CW and it can be integrated with the machine protection system (Interlock detection). The modular platform hosts up to four BPM modules, a timing module and optionally a gigabit data exchange (GDX) module.
Extensions: Real-time data streaming, serial I/O interface.
Accessories: Libera DWC.

Figure 13: Libera Single Pass E front panel (block diagram)



4 Libera Spark EL

More

Used in electron LINACs and transfer lines

Libera Spark EL is a beam position processor that supports the readout from a single BPM. With its flexible digital signal processing it can process various filling patterns from short macro-pulse to CW and deliver results at various configurable data rates. The instrument can output a real-time data stream and can be integrated with the machine protection system (Interlock detection).
Extensions: Interlock output, real-time data streaming, analog output, digital(serial) I/O.
Accessories: Libera DWC.

The front and back panel of the Libera Spark EL are identical to those shown in Figure 4.

5 Libera CavityBPM

More

Used in electron LINACs

Cavity BPM applications involve precise measurement of beam position, and Libera CavityBPM is specifically engineered to efficiently process signals from RF cavities to accurately determine beam positions.
Extensions: Interlock output, real-time data streaming, analog output, digital (serial) I/O.

Figure 14: Libera CavityBPM front and back panel

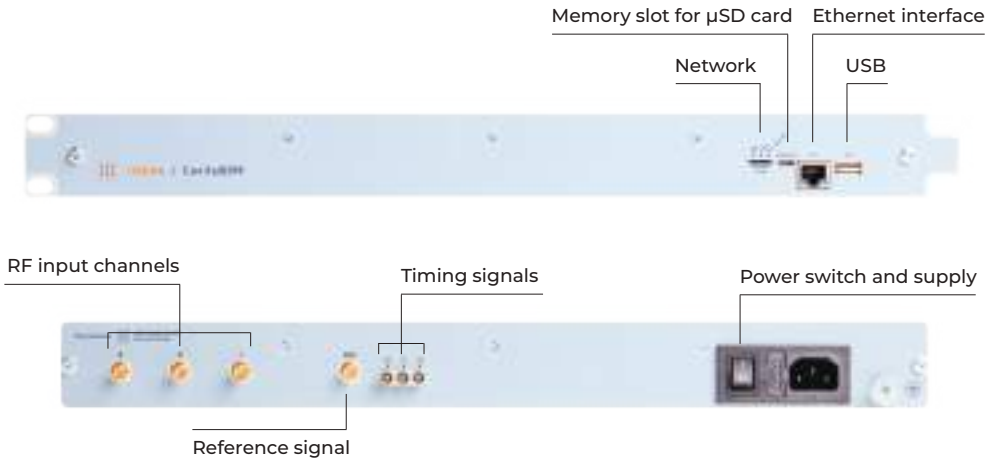


Table 2: Technical specifications of electron beam position monitors

	for CIRCULAR machines			for LINEAR machines		
	Libera Spark ERXR	Libera Spark ERPT	Libera Brilliance+	Libera Spark EL	Libera Single Pass E	Libera CavityBPM
General product code	LSXR	LSPT	LBRP	LSEL	LSPE	LCAV
Capabilities						
BPM slots	1	1	1 - 4	1	1 - 4	1
Supported input frequency range	<750 MHz	<750 MHz	<700 MHz	<750 MHz	<700 MHz	<6 GHz
A/D conversion	125 MHz/14 bit	125 MHz/14 bit	130 MHz/16 bit	125 MHz/14 bit	160 MHz/16 bit	500 MHz/14 bit
Cooling	Passive	Passive	Active (fans)	Passive	Active (fans)	Passive
Power supply	PoE	PoE	110/220 V	PoE	110/220 V	110/220 V
Timing signals	Electrical (3) *	Electrical (3) *	Electrical (4)/Optical	Electrical (up to 3) *	Electrical (4)/Optical	Electrical (up to 3) *
Calibration	Manual	Pilot Tone ****	Crossbar switch DSC Libera XBS FE	Manual/Static	Manual/Static	Manual/Static
Fast data link	RJ-45	RJ-45	RJ-45 & SFP	RJ-45	RJ-45 & SFP	/
Maximum input signal *	<+5 dBm continuous	<-10 dBm continuous	<+4 dBm continuous	<5 V peak pulse voltage	<7 V peak pulse voltage	16 dBm
Input gain/attenuation	Programmable, 31 dB	Programmable, 31 dB	Programmable, 31 dB, automatic mode	Programmable, 31 dB	Programmable, 31 dB	Programmable, 31 dB
Temperature drift, typical	2 µm/°C	<1 µm/°C ***	0.2 µm/°C	0.3 µm/°C	0.3 µm/°C	0.3 µm/°C
Position RMS at turn-by-turn data rate	0.3 µm **	1 µm ***	0.5 µm **	/	/	/
Position RMS at fast 10 kHz data rate	0.04 µm **	0.1 µm ***	0.07 µm **	/	/	/
Position RMS at slow 10 Hz data rate	0.02 µm **	0.05 µm ***	0.02 µm **	/	/	/
Position RMS at single bunch	<10 µm **	/	/	4 µm **	1 µm **	<1 µm
Position RMS at macro pulse/ continuous wave	/	/	/	<4 µm	<1 µm	<1 µm
Dimensions	H: 1 U, W: 9.5" (rack mountable with a kit), D: 210 mm	H: 1 U, W: 9.5" (rack mountable with a kit), D: 210 mm	H: 2 U, W: 19" (rack mountable), D: 310 mm	H: 1 U, W: 9.5" (rack mountable with a kit), D: 210 mm	H: 2 U, W: 19" (rack mountable), D: 310 mm	H: 2 U, W: 19" (rack mountable), D: 236 mm
* Can be customized						
** Measured with K=10 mm						
*** Depends on setup configuration						
**** Requires Libera Pilot Tone FE - see page 39						
Functionalities						
Bunch-by-bunch processing	No (only single bunch/single turn)			Yes	Yes	Yes
Turn-by-turn processing	Yes	Yes	Yes, multi bunch option	No	No	No
Real-time data streaming	Optional *	Yes	Optional *	Optional *	Optional *	No
Slow data	Yes	Yes	Yes	No	No	No
Gain control	Yes	Yes	Yes (automatic)	Yes	Yes	Yes
Multi-chassis synchronization	Reference clock with PLL	Reference clock with PLL	Reference clock with PLL	Trigger-based	Trigger-based	Trigger-based
Data time stamping	Yes	Yes	Yes	Trigger-counter	Trigger-counter	Trigger-counter
Interlock detection and output	Optional **	Optional **	Yes	Optional **	Yes	Optional **
Postmortem capability	No	No	Yes	No	No	No
Single-pass measurement	No	No	Yes	Yes	Yes	Yes
Frequency down-conversion	Direct (with ADCs)	Direct (with ADCs)	Direct (with ADCs)	Optional ***	Optional ***	Internal (with mixer)
Additional Digital I/O channels and Analog output	Optional **	Optional **	No	Optional **	No	Optional **
Closed Orbit Feedback Application	No	No	Yes, see page 35	No	No	No
* Requires additional modules	GbE interface	GDX module	GbE interface	GDX module		
** Requires additional modules	DAI module		DAI module		DAI module	
*** Requires additional modules				Libera DWC	Libera DWC	

PHOTON
Beam Position Monitor Electronics

1 Libera Photon

More

Used in synchrotron and FEL beamlines

The Libera Photon serves as a photon beam position processor, designed to work with diamond detectors, blade XBPMs, and ionization chambers. It supports external BIAS source that is applied to each of its 4 input channels. Beam position information is accessible at various configurable data rates and bandwidths. Additionally, Libera Photon features a dedicated RJ-45 interface for real-time streaming of data.

Figure 15: Libera Photon front and back panel

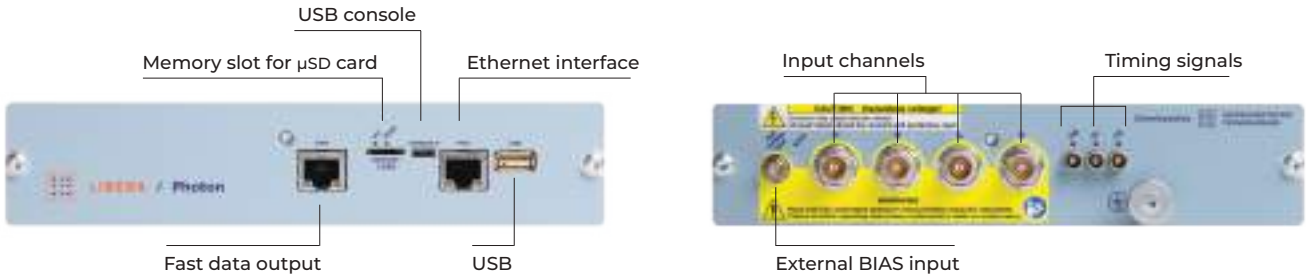


Table 3: Technical specifications of photon beam position monitors

General product code	LPHO
Capabilities	
Input channels	4
Current ranges	±60 nA, ±02 A, ±2 A, ±.20 µA, ±200 A, ±2 mA
Input frequency range	Depends on current data range, from 10 kHz to 80 kHz
A/D conversion	2.5 MHz/18 bit
Cooling	Passive
Power supply	PoE
Timing signals	LVTTL (3.3 V), ~10 kΩ termination
Calibration	Manual
Fast data link	RJ-45
Maximum input signal	<2 mA
Temperature drift, typical	0.01 µm/°C
8-hour stability (23 °C, 200 µA)	0.02 µm
RMS uncertainty at 180 µA (10 kHz data rate)	<0.02 µm
RMS uncertainty at 180 µA (10 Hz data rate)	<0.01 µm
Dimensions:	H: 1 U, W: 19" (rack mountable with a kit), D: 236 mm
Functionalities	
Position calculation	The instrument determines the beam's position based on the current obtained from its 4 channels. Signal conditioning involves scaling and offset adjustments (for dark current removal), along with averaging over a window that users can configure. The equation used for position calculation is also customizable, allowing for different combinations of input channels to be utilized
Short pulse detection	Used for pulsed currents with signal dynamics within the measurement bandwidth. Pulse repetition up to 2 Hz is supported
DC digital monitoring	Typically used for monitoring the currents from blade detectors or other current-type detectors in the beamlines
Postmortem data storage	Dedicated memory buffer is intended for storing the data just before a Postmortem trigger event. Complete functionality provides configurable buffer size, write offset and reports important information about the absolute time of the Postmortem trigger event
External BIAS support	External BIAS source (max ±150 V) can be connected directly to the instrument to apply a high voltage BIAS to all 4 channels

BEAM LOSS MONITOR

1 Libera BLM

More

The beam loss monitor electronics can process various types of losses ranging from a single particle to strong or frequent losses that occur during injection or parts of the machine exposed to leakage or mis-steered beam. The Libera BLM can be connected with Libera Beam Loss Detector (BLD) or other compatible beam loss detectors with various particles' sensitivities. It can be used with pulsed and/or quasi CW beams.

Figure 16: Libera BLM front and back panel

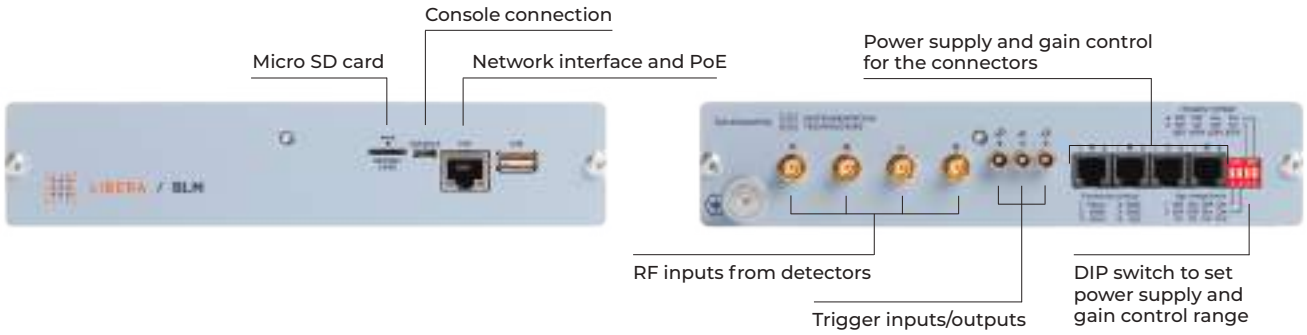
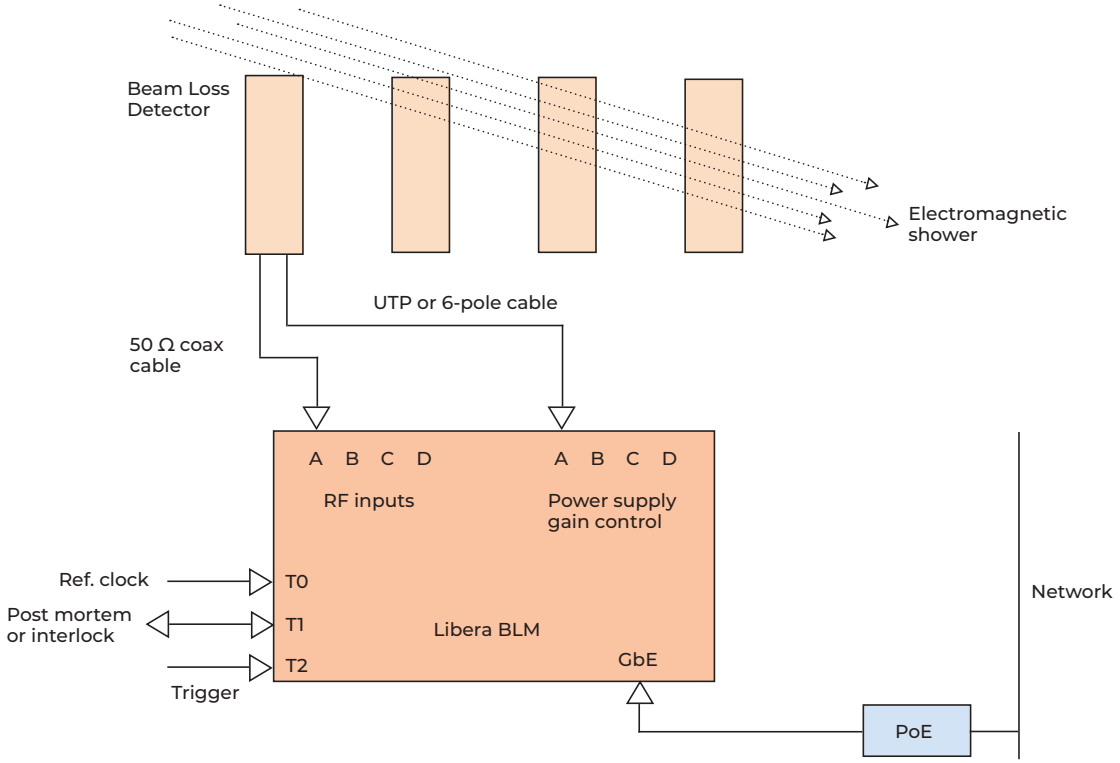


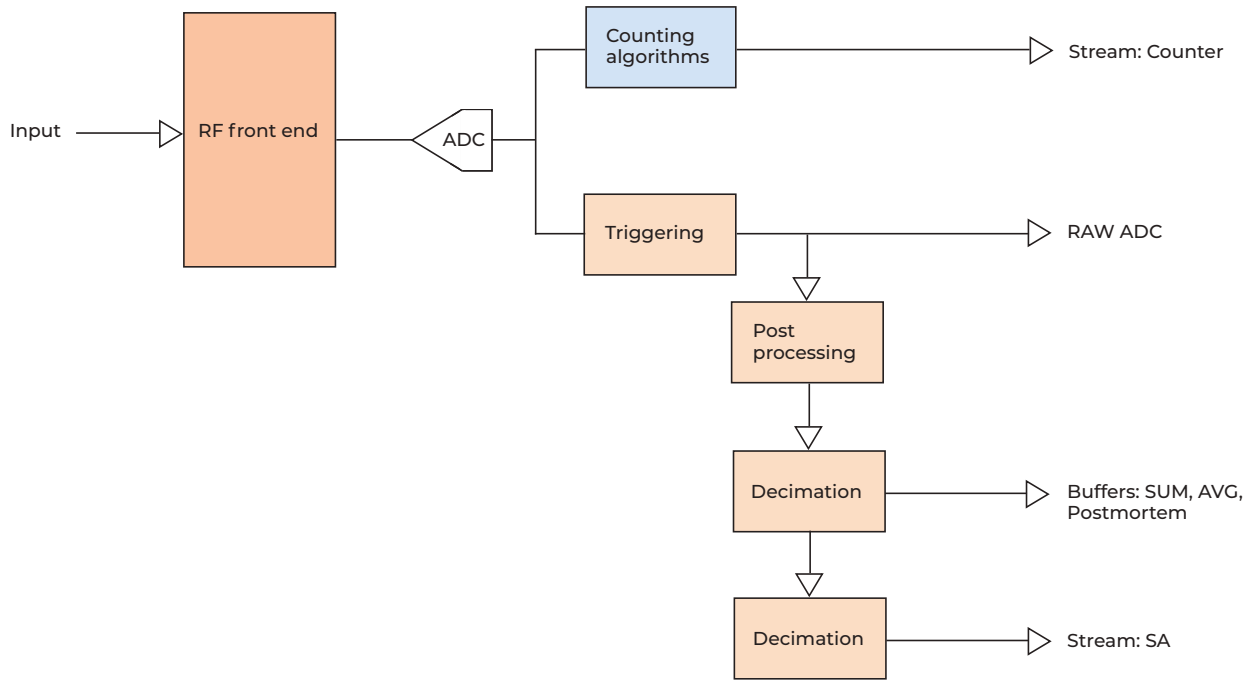
Figure 17: Libera BLM block diagram



The Libera BLM provides power and gain control to up to four detectors (Libera BLD) which can be placed up to 100 m / 330 ft away. Installation requires a 6-pole flat cable and a standard 50-Ohm cable. Detectors are optionally shielded by a 2 mm thick Pb shield.

Optionally, the Libera BLM can be provided with an Interlock detection functionality and can be integrated into the Machine Protection System.

Figure 18: Libera BLM signal processing



Loss counting algorithms monitor the raw ADC data with 8 ns period and is done on each channel independently. A special algorithm also detects coincidence loss events on selectable detectors and in configurable time window. Additionally, losses can be monitored in two configurable observation masks.

Buffered data is processed on external or signal-based trigger. Buffers include raw ADC and two more buffers with post-processed data. Post-processing includes integrating or averaging operations, offset removal, selectable decimation factors and configurable observation mask.

A special buffer is dedicated for keeping historical data before a critical event (Postmortem). Optionally, the interlock functionality can monitor the raw ADC data and activate the hardware interface towards the machine protection system when pre-defined threshold limits have been exceeded.

Table 4: Technical specifications of Libera BLM and the Libera BLD

Libera Beam Loss Monitor		Libera Beam Loss Detector			
General product code	LBLM	General product code	LBLD1.000.001	LBLD1.000.002 LBLD1.000.003	LBLD1.000.004
Capabilities					
Input channels	4	Scintillator material	Scintillating rod	Optical fiber	Scintillating rod
Input frequency range	~35 MHz large signal bandwidth ~50 MHz small signal bandwidth	Sensitivity to particles	Gamma, X-ray		Neutron
Matching impedance	50 Ω/1M Ω, selectable	Peak wavelength of the scintillator	425 nm		450 nm
A/D conversion	125 MHz/14 bit	Peak wavelength of the PMT	400 nm		
Cooling	Passive	Rise time of the PMT	0.57 ns		
Power supply	PoE	Supply voltage	5 V		
Timing signals	Electrical (3)	Gain control voltage	0 to 1 V		
Maximum input signal	±1.25 V @ 1M Ω ±5 V @ 50 Ω				
Output channels	4x power supply (up to ±15 V) 4x gain control (up to +12 V)				
Dimensions	H: 1 U, W: 9.5” (rack mountable with a kit), D: 210 mm				
Functionalities					
Low loss detection	Detecting volumes as low as a single electron loss using high input impedance and high gain				
Strong and fast loss detection	Detecting strong losses during injection (typically)				
Automatic loss detection	Adjustable threshold for automatic buffer storage				
Configurable processing parameters	ADC offset compensation, integration and averaging window lengths, loss detection windows and individual channel delays				
Counting modes	Select between static and dynamic thresholds for loss counts. Apply a custom recovery time and threshold				
Coincidence loss detection	Compare up to 4 channels for simultaneous loss events				
Loss value calibration	Compensate the raw loss value with current gain settings (attenuation, photosensor, dynamic gain and photosensor static gain)				
Postmortem data storage	Dedicated memory buffer is intended for storing the data just before a postmortem trigger event				
Photosensor control	Provide power supply and adjust gain control voltage to up to 4 independent channels				
Interlock detection and output	Monitor the accumulated loss value and trigger an output signal for the machine protection system				

Figure 19: Libera BLD (LBLD1.000.001)

Figure 20: Libera BLD (LBLD1.000.002 and LBLD1.000.003)

DIGITIZERS

Libera digitizers provide users with a base from which to develop their own application. The instruments provide all the building blocks from the gain-controlled RF input signals to the ADC data storage, from the offset removal to the exposure of processing parameters through the control system interface.
The available software and firmware infrastructures provide an already working template, with the possibility to extend its functionalities, focusing only on their core part: the signal processing algorithms. The instruments are network-attached devices, with standard interfaces that facilitate integration into the control system (EPICS, Tango, TCP-IP socket, etc.).

1 Libera Digit 125

More

The Libera Digit 125 is a 4 channel general purpose digitizer and a sampling frequency of 125 MS/s with 14 bit resolution. Data is stored in a configurable buffer, with a maximum of 8 million data samples stored per channel.

Figure 21: Libera Digit 125 front and back panel

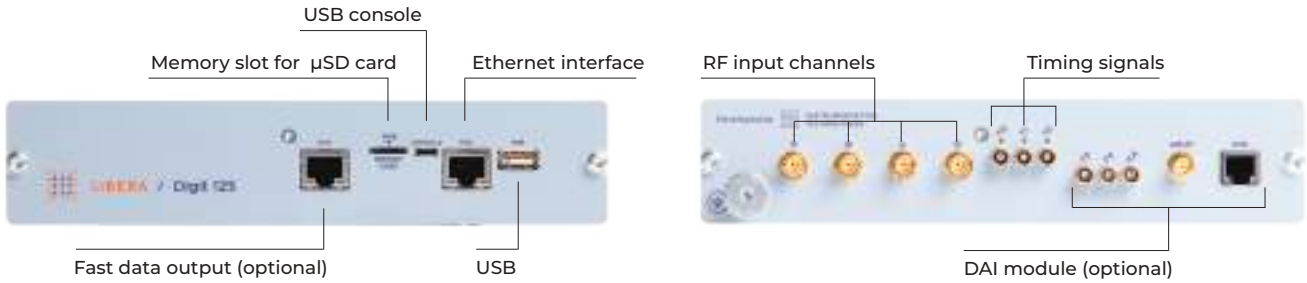
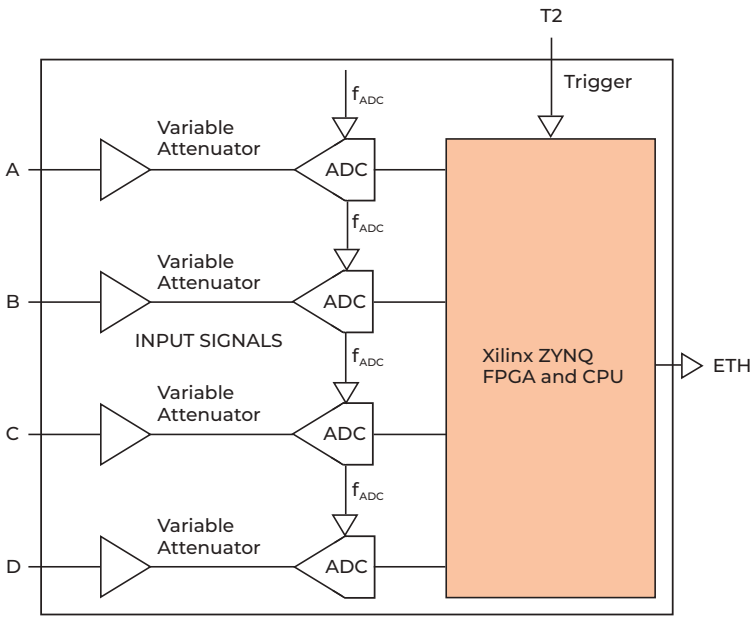


Figure 22: Libera Digit 125 block diagram



- 4 independent input channels
- 125 MS/s and 14 bit resolution ADCs
- AC coupled and DC coupled versions
- DC version includes a 31 dB variable attenuator
- Support for EPICS, TANGO

2 Libera Digit 500

More

The Libera Digit 500 is a low-noise and wide dynamic range digitizer with 4 channels and a sampling frequency of max. 500 MS/s, phase locked to an external reference signal. The data is stored in a configurable segmented buffer, with different acquisition modes and trigger rates up to 1 kHz. The instrument is available in AC and DC coupled version. It can optionally provide 4 SFP ports for fast ADC data streaming.

FIgure 23: Libera Digit 500 front and back panel

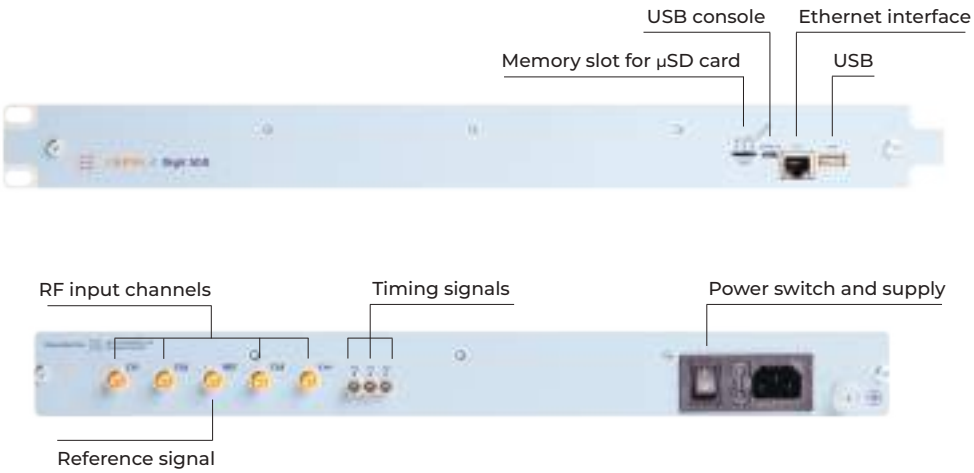
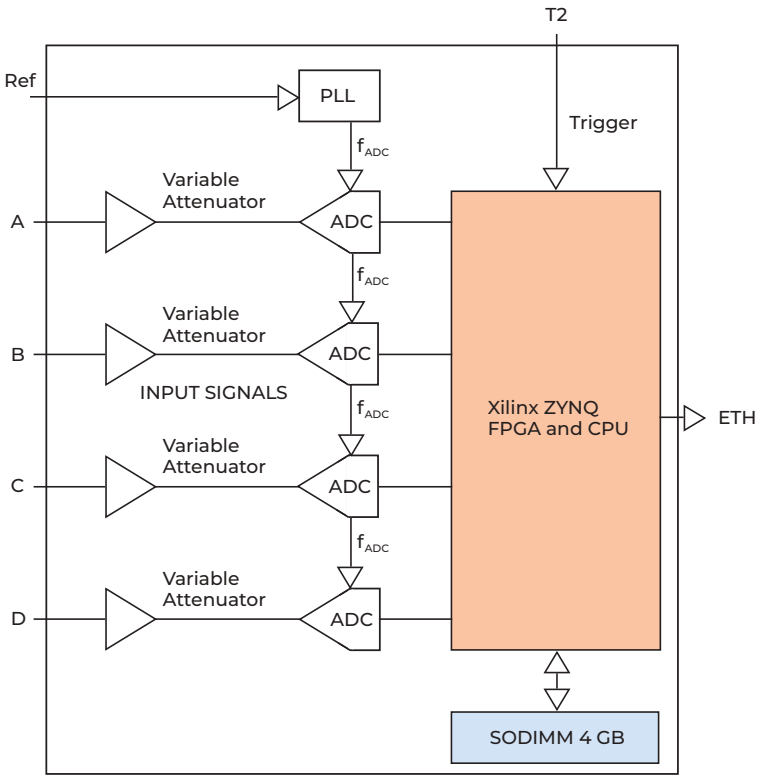


FIgure 24: Libera Digit 500 block diagram



- 4 independent input channels
- 500 MS/s and 14 bit resolution
- AC coupled and DC coupled versions
- 31 dB variable gain, more than 90 dB dynamic range
- Support for EPICS, TANGO
- SFP support for fast data streaming
- Additional modules available in different SW release:
  - Pulse processing
  - Digital Phase shifters
  - Digital Downconversion
  - Bunch Charge Calculation

Table 5: Technical specifications of digitizers

	Libera Digit 125		Libera Digit 500	
Variant	DC	AC	DC	AC
General product code	L1251.00D	L1251.00A	L5001.00D	L5001.00A
Capabilities				
Channel number	4	4	4	4
Sampling frequency [MS/s]	125	125	500	500
Resolution [bit]	14	14	14	14
BW	DC-40 MHz	10 MHz - 700 MHz	DC-250 MHz	1 MHz - 2 GHz
Coupling	50 Ω / 1M Ω	50 Ω	50 Ω	50 Ω
Max input	±5 V @ 50 Ω, 1.25 V @ / 1M Ω	1 V / 10 dBm	1 V / 10 dBm	1 V / 10 dBm
Input gain / attenuation	0-31 dB		0-31 dB	0-31 dB
Triggering level	3.3 V TTL LEMO	3.3 V TTL LEMO	3.3 V TTL LEMO	3.3 V TTL LEMO
Max trigger frequency [Hz]	2	2	500 (can be extended to 1000)	500 (can be extended to 1000)
Reference clock	No	No	Yes	Yes
FPGA	Xilinx Zynq 7020	Xilinx Zynq 7020	Xilinx Zynq 7035	Xilinx Zynq 7035
PoE	Yes	Yes	No	No
Access interfaces	SSH/Tango/Epics/ Labview	SSH/Tango/Epics/ Labview	SSH/Tango/Epics/ Labview	SSH/Tango/Epics/ Labview
Available extensions (SW to be developed by the user)	• DAI1 module • SFP connectors on LD500			
Max acquisition lenght [samples]	8 M	8 M	~500 M	~500 M
Dimensions	H: 1 U, W: 9.5” (rack mountable with a kit), D: 210 mm	H: 1 U, W: 9.5” (rack mountable with a kit), D: 210 mm	H: 2 U, W: 19” (rack mountable), D: 236 mm	H: 2 U, W: 19” (rack mountable), D: 236 mm

Functionalities (Libera Digit 500)
• Pulse processing module: pulse area calculation, pulse width calculation, root square sum and integral sum
• SFP connectors: four optional small pluggable slots (SFP) which can be used for fast data
• Digital phase shifters to fine-tune the phase differences between the input channels
• Digital Downconverter module: allows extraction of the amplitude and frequency of a specific signal component
• Bunch Charge Calculation module: allows the calculation of the bunch charge over several turns in electron synchrotrons

CURRENT METER

1 Libera Current Meter

More

The Libera Current Meter is a general purpose current meter operating from the nA to the mA region applicable to blade monitors, diamond detectors, and Faraday cups. Capable of high sampling rate, it includes 4 input channels and is capable of low current measurements from nA to 2 mA. This low-current ammeter features six measurement ranges that can be calibrated using a known current source. The reconfigurable processing scheme enables measurements of fast current pulses as well as DC currents.

Figure 25: Libera Current Meter front and back panel

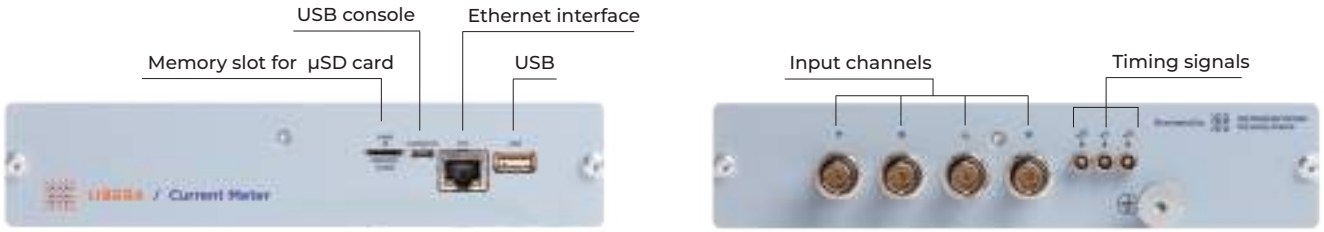


Figure 26: Libera Current Meter block diagram

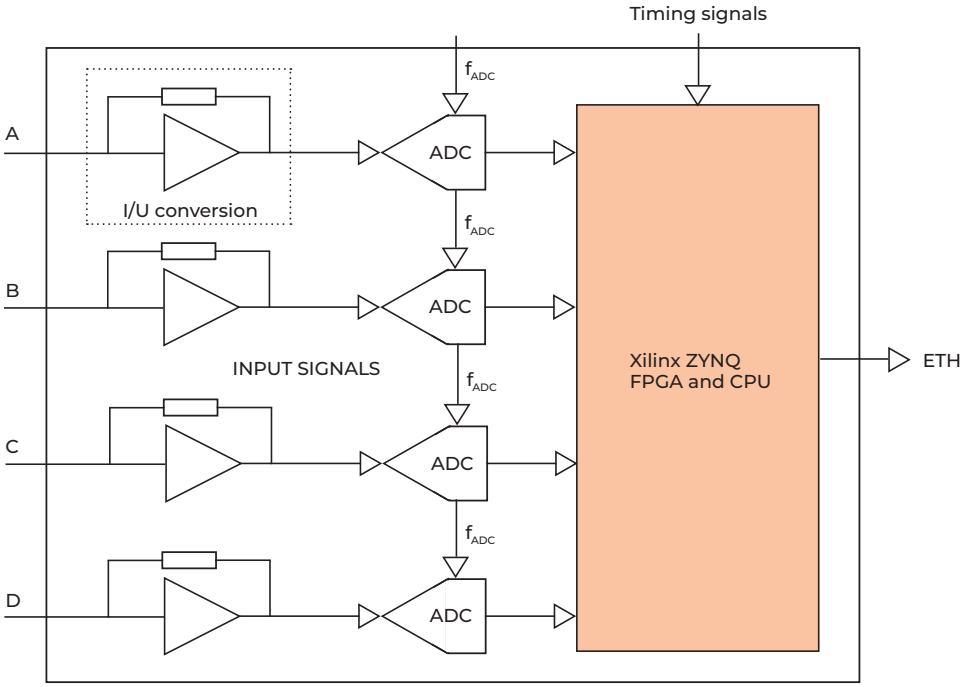


Figure 27: Libera Current Meter Digital signal processing

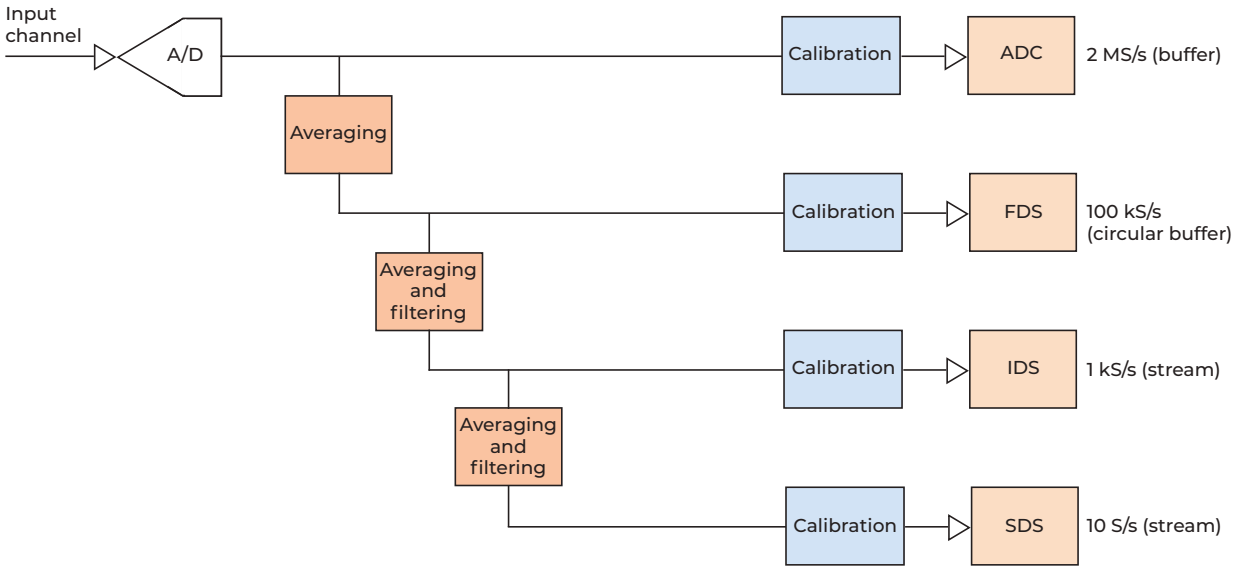


Table 6: Technical specifications of the Libera Current Meter

Variant	BNC version	TRIAX version
General product code	LCMB	LCMT
Capabilities		
Input channels	4	4
Current ranges	±60 nA, ±02 A, ±2 A, ±20 A, ±200 µA, ±2 mA	±60 nA, ±02 A, ±2 A, ±20 A, ±200 A, ±2 mA
Input frequency range	Depends on current range, from 10 kHz to 80 kHz	Depends on current range, from 10 kHz to 80 kHz
A/D conversion	2 MHz / 18 bit	2.5 MHz / 18 bit
Cooling	Passive	Passive
Power supply	PoE	PoE
Timing signals	LVTTL (3.3 V), ~10 kΩ termination	LVTTL (3.3 V),~10 kΩ termination
Calibration	Manual	Manual
Fast data link	RJ-45	RJ-45
High voltage polarization (needs an external high voltage source)	No	Support up to ±150 V
High voltage polarization (needs an external high voltage source)	No	Support up to ±150 V
Temperature drift, typical	<1 % /°C	<1 % /°C
8-hour stability (1 °C) (23 °C, 1 µA)	30 nA peak-to-peak	30 nA peak-to-peak
RMS uncertainty @ 1 µA (slow 10 Hz data)	<50 pA	<50 pA
RMS uncertainty @ 1 µA (slow 10 Hz data)	<50 pA	<50 pA
Dimensions	H: 1 U, W: 9.5” (rack mountable with a kit), D: 210 mm	H: 1 U, W: 9.5” (rack mountable with a kit), D: 210 mm
Functionalities		
Current readout	Input currents are immediately converted into voltage via a trans-impedance amplifier, with six different gains depending on the current range selected via software. The signals are then digitized and the data is available from a (triggered) buffer, and as a continuous data stream. Each channel can be re-calibrated for offset and gain using a nominal current source	
WebGUI	Easy access is provided by a WebGUI: to connect and acquire data it is sufficient to simply connect to the instrument using a web browser	
Different data rates	Different data rates available in parallel thanks to the filtering scheme: 2.5 MS/s, 100 kS/s, 1kS/s and 10 S/s	

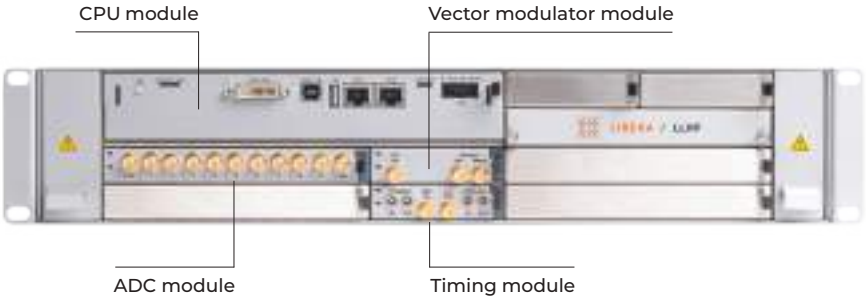
DIGITAL LLRF

1 Libera LLRF

More

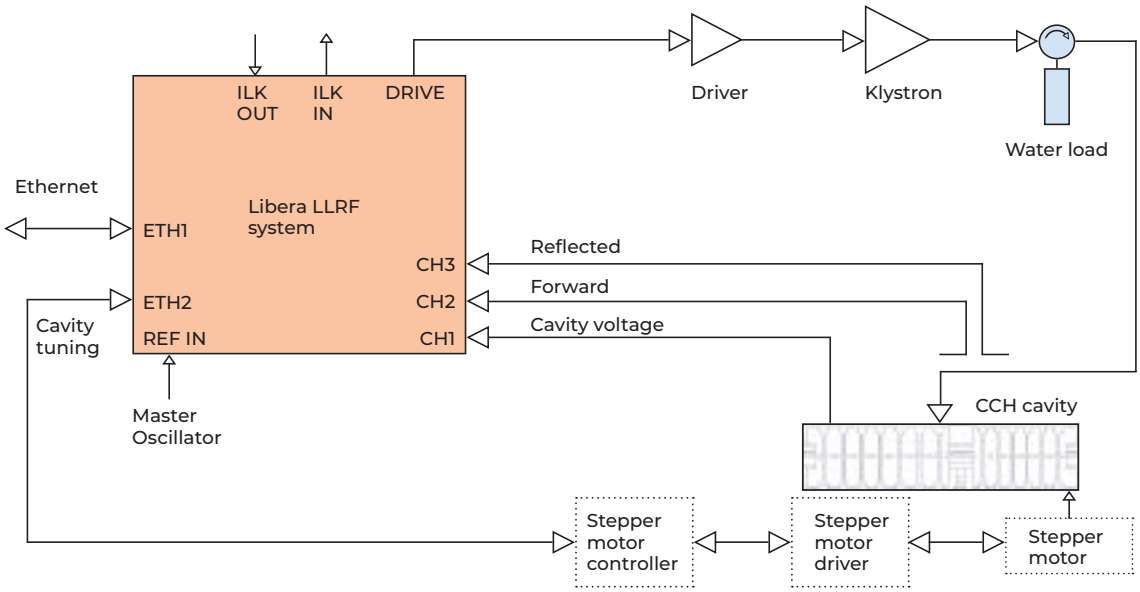
The Libera LLRF is a digital processing and feedback system that monitors and stabilizes the quality of the beam acceleration by controlling the phase and amplitude of the RF field injected into the machine accelerating structures. Being designed to be modular and reconfigurable, the system can fit the exact requirements of any kind of accelerator, providing three core functions: stabilization of the cavities' RF fields, keeping the cavities at resonance through tuning, and machine diagnostics for signal analysis and event monitoring.

Figure 28: Libera LLRF front panel



The system can incorporate up to four ADC modules, with the channel configuration (6 or 8 channels per module) depending on the version. This setup enables the processing of a total of 24 to 32 channels. Depending on signal requirements, the number of ADC modules can be adjusted accordingly.

Figure 29: Possible configuration of Libera LLRF in the accelerator environment



The phase rotation block ensures calibration of each input signal's phase and amplitude, mitigating the impact of RF cabling variances and beam time delays on LLRF control. This functionality supports both intra-pulse and pulse-by-pulse feedback mechanisms, typically

applied to either individual signals or the vector sum of all signals. The vector sum combines all acquired signals into one unified input for the control algorithm.
The signals acquired by the Libera LLRF can be also used for diagnostics purposes and represented with the expert GUI provided with the instrument.

Figure 30: Libera LLRF system signal processing

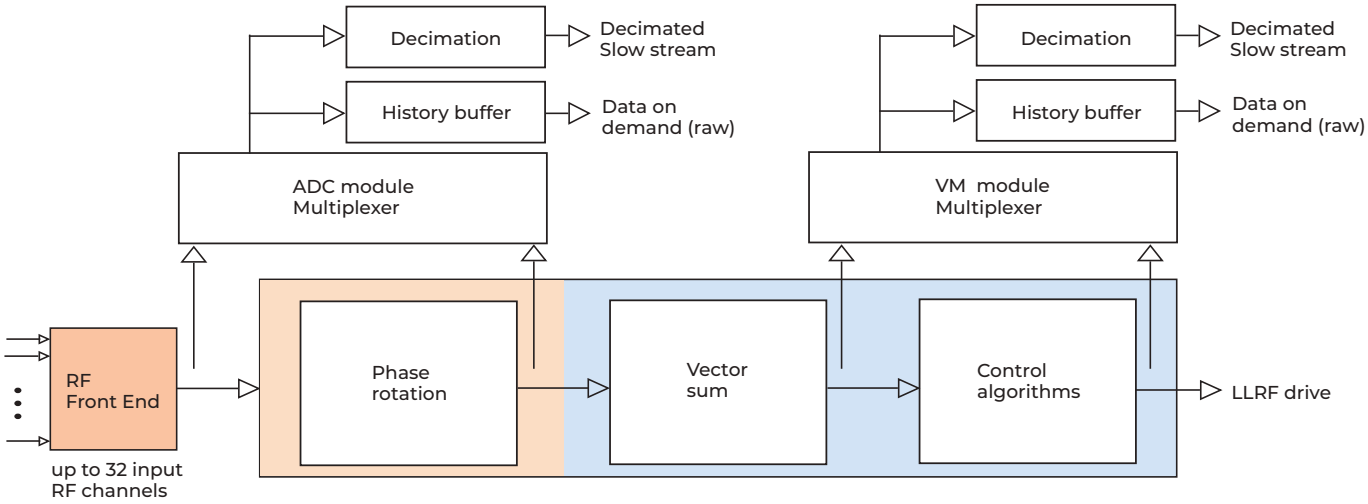


Table 7: Technical specifications of the Libera LLRF system

General product code	LLRF
Capabilities	
RF input channels	Up to 24 / 32 channels (6/8 channels per ADC module)
RF input frequency	Up to 12 GHz
Maximum RF power input	+20 dBm
A/D conversion	130 MSps / 250 MSps (16 bits)
FPGA processing	Xilinx Kintex Ultrascale
RF output channels	2 (1 RF drive, 1 auxiliary)
Maximum RF drive output power	+10 dBm
Cooling	Active
Power supply	110/220 V
Dimensions	Libera LLRF processing unit: H: 2 U, W: 19” (rack mountable), D: 310 mm Libera TSRF: H: 2U, W: 19” (rack mountable), D: 456 mm
Functionalities	
Supported modes of operation	Continuous Wave (CW) Pulsed
Feedback and control	Intra-Pulse and Pulse-by-pulse feedback Beam loading compensation Power amplifier non-linear response compensation
Cavity tuning	Directional coupler based detuning calculation and cavity field decay analysis Slow tuning PID controller and different stepper-motor interfaces support
Machine protection	Low latency interlock interface (Input and Output) with active failsafe logic
Temperature stabilization	Temperature stabilized RF front-end option
Amplitude stability	< 0.01 % RMS
Phase stability	< 0.01° RMS
Latency (input to drive output)	Down to 250 ns
Long-term temperature stability with temperature stabilized RF front-end	<100fs RMS / 72 hours

Figure 31: Optional Libera LLRF temperature stabilized RF front-end (TSRF) front panel

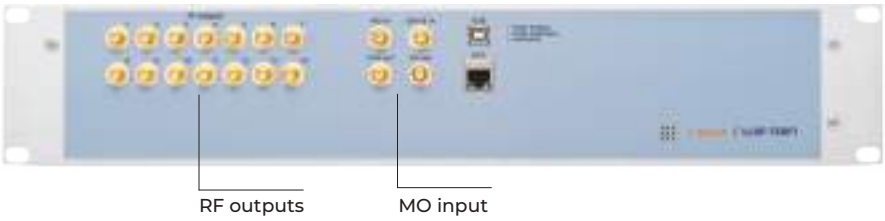


Figure 32: Optional Libera LLRF temperature stabilized RF front-end (TSRF) back panel

2 Libera Trigger Synchronization Unit

More

The purpose of the Libera TSU (Trigger Synchronization Unit) is to synchronize trigger signals across multiple RF stations controlled by LLRF systems, utilizing a master oscillator (MO) reference, while ensuring flexibility in precise timing control of the output signals.

Figure 33: Libera TSU front panel

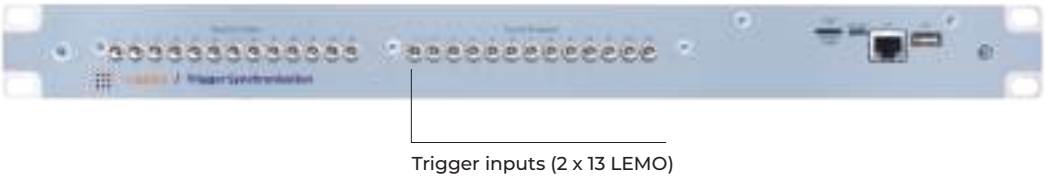
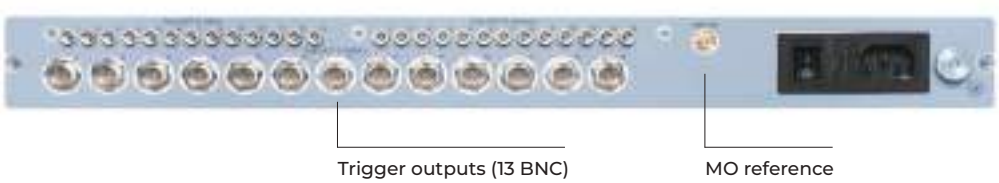


Figure 34: Libera TSU back panel

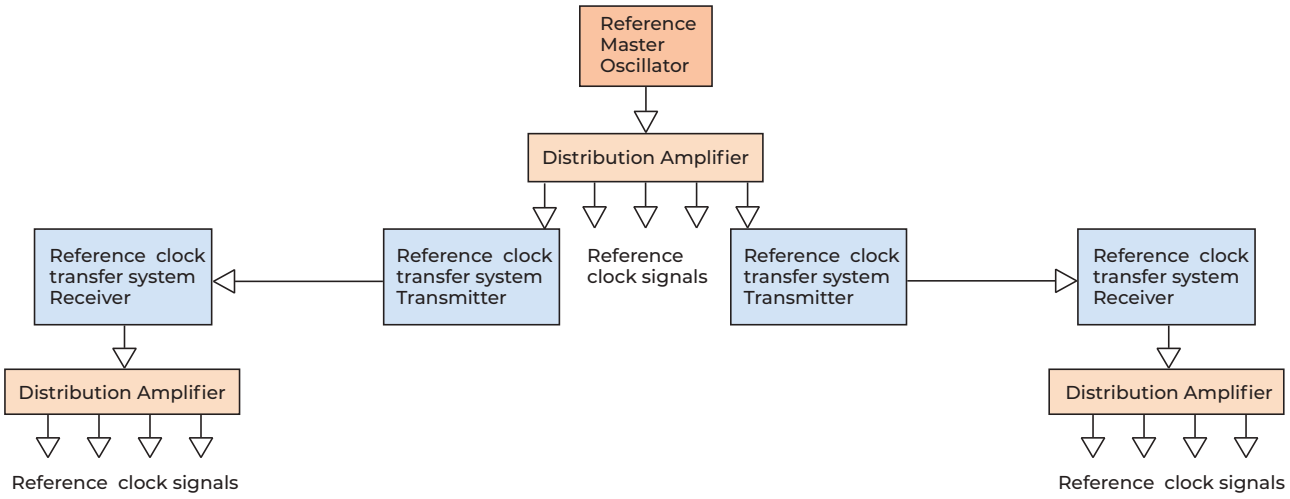


SYNCHRONIZATION

Synchronization of different devices e.g. LLRF stations along an accelerator is crucial for its operation. It is achieved by means of reference clock signals. A synchronization system typically consists of the following building locks:

- A reference master oscillator, which serves as a common source of the reference RF signal for all devices
- Distribution amplifiers split and generate all RF reference signals that can be used by multiple devices
- Reference clock transfer systems enable to transfer the reference clock over longer distances while preserving the required quality

Figure 35: Synchronization system typical topology



1 Libera RMO

More

The Libera RMO - Reference Master Oscillator is a low phase noise and stable source of an RF signal, which can be used as a reference signal for synchronization of different devices (e.g. LLRF stations in an accelerator). The device free-runs on an internal Oven Controlled Crystal Oscillator (OCXO) which can additionally be locked to an external 10 MHz reference signal.

Figure 36: Libera RMO front and back panel

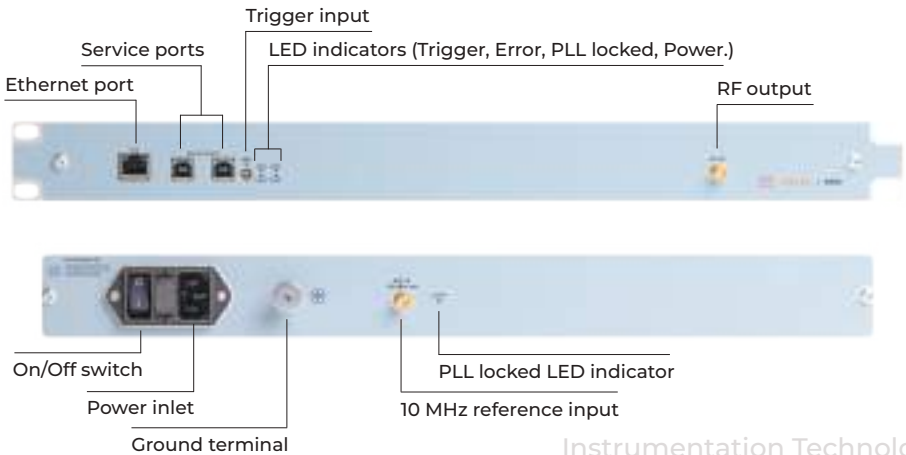


Figure 37: Libera RMO block diagram

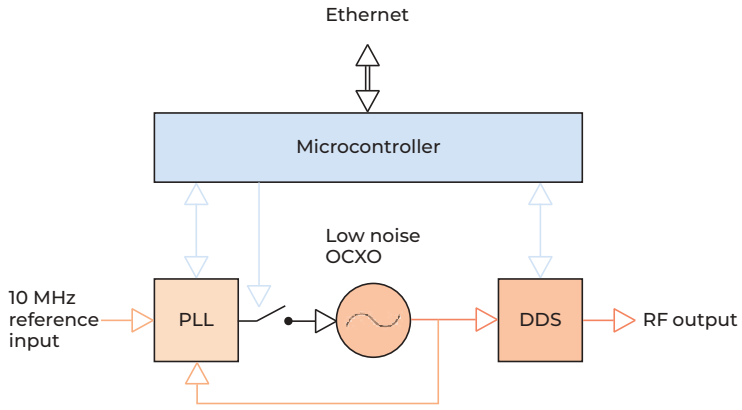


Table 8: Technical specifications of the Libera RMO

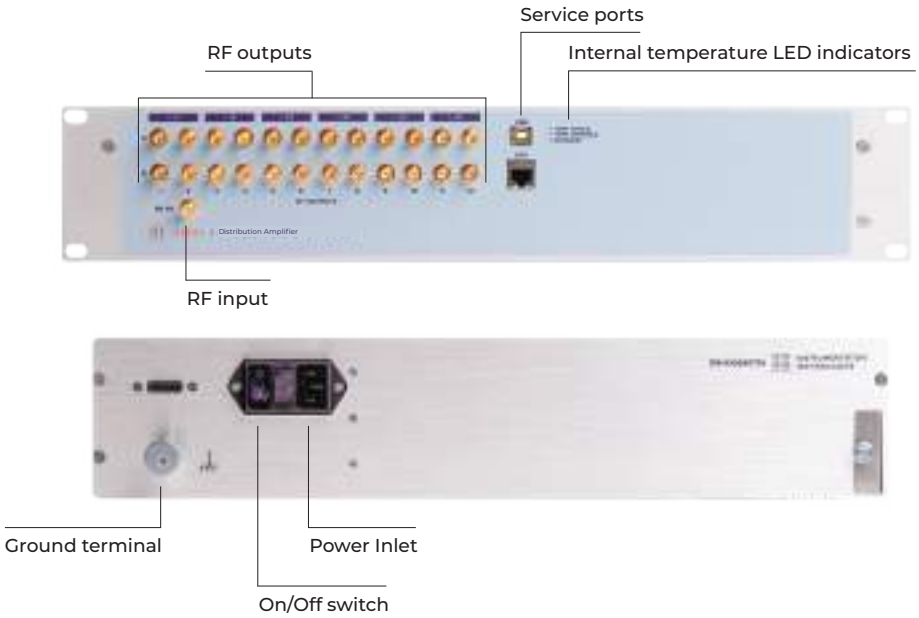
General product code	LRMO
Capabilities	
Supported frequency ranges	50 MHz - 3120 MHz
RF output	1, SMA connector, 50 Ω
Nominal RF output power	+15 dBm at least
RF output power stability	0.05 dB/K
Phase noise (integrated from 10 Hz to 10 MHz)	Max: <90 fs RMS Typically: 40 - 60 fs RMS
Harmonic suppression	<50 dBc up to the 5th harmonic
Frequency stability (in free running mode)	5*10^-11 (Allan deviation)
RF output return loss	-15 dB
RF reference input	1, SMA connector, 50 Ω
RF reference input frequency	10 MHz ± 20 Hz
RF reference input power	-20 dBm - +10 dBm
PLL lock time	<30 s
Stability operation temperature range	20 - 25 °C
Operating relative humidity range	0 - 80 %
Dimensions	H: 1 U, W: 19” (rack mountable), D: 358 mm
Functionalities	
Locking to an external 10 MHz reference signal by means of a PLL	
Frequency sweep	
Frequency setting on trigger	
Remote control via Ethernet	
EPICS IOC	

2 Libera Distribution Amplifier

More

The Libera Distribution Amplifier serves to split an input RF signal to multiple output RF signals at specified output power levels. Additionally, by applying multiplication and division stages it also enables the generation of higher and sub harmonics coherent with the input RF signal. Both functionalities are performed with minimum added jitter and assuring long-term phase stability.

Figure 38: Libera Distribution Amplifier front and back panel



The modular design of the Libera Distribution Amplifier supports up to 6 custom output modules with up to 4 RF outputs each. The output modules can be customized to generate coherent harmonics according to the user's needs.

Figure 39: Libera Distribution Amplifier block diagram

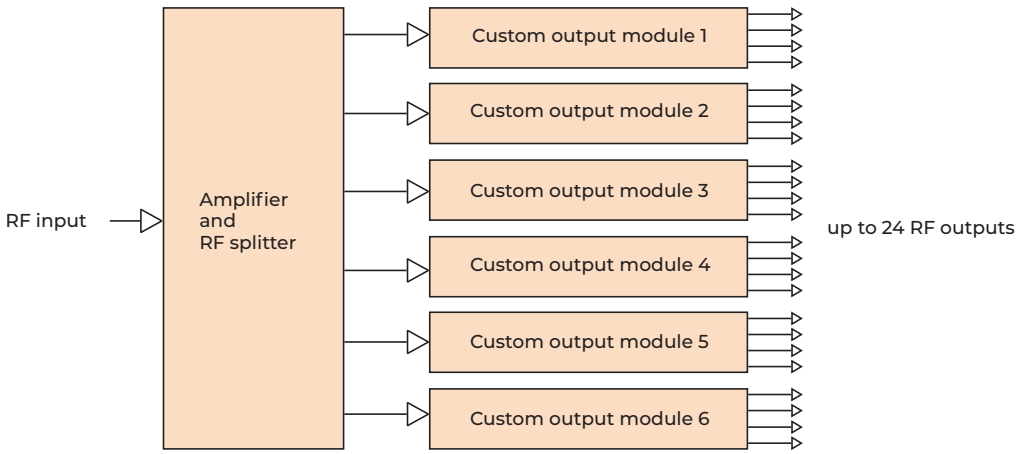


Table 9: Technical specifications of the Libera Distribution Amplifier

General product code	LMDA
Capabilities	
Supported frequency ranges	50 MHz - 3120 MHz
RF output	1, SMA connector, 50 Ω
Nominal RF input power	+15 dBm ±1 dB *
RF outputs	Up to 24, SMA connectors, 50 Ω
Nominal power per RF output	+16 dBm ±1 dB
Added jitter (integrated from 10 Hz to 10 MHz)	<10 fs RMS **
Operating temperature range	20 - 27°C
Operating relative humidity range	0 - 80 %
Dimensions	H: 2 U, W: 19” (rack mountable), D: 456 mm
* RF input power can be adapted to a fixed value down to +5 dBm	
** For outputs at ~3 GHz. Added jitter of the outputs at higher and sub harmonics depends on multiplication and division factors	
Functionalities	
RF signals amplification and fan-out	
Generation of harmonics coherent with the input RF signal	
Temperature stabilization to guarantee long-term phase stability	

3 Libera Sync

More

The Libera Sync is a continuous wave reference clock transfer system, which is used to transmit the RF clock signals over longer distances while preserving their high-quality in terms of low jitter and good long-term stability. The Libera Sync is based on the RF over fiber (RFoF) technology. It consists of a transmitter and a receiver unit.

Figure 40: Libera Sync Transmitter front panel

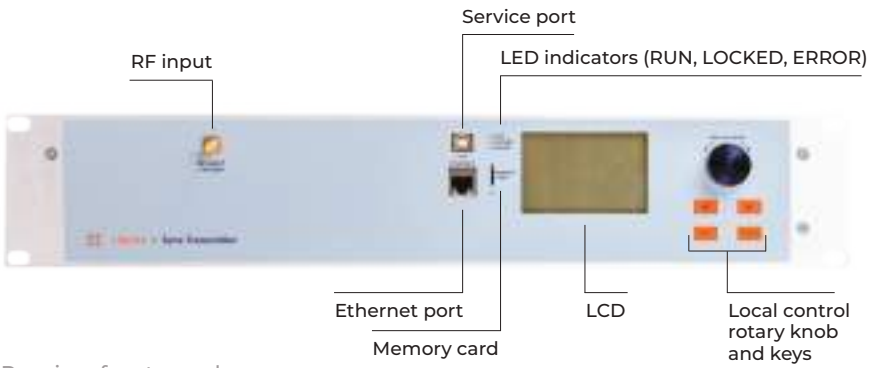


Figure 41: Libera Sync Receiver front panel

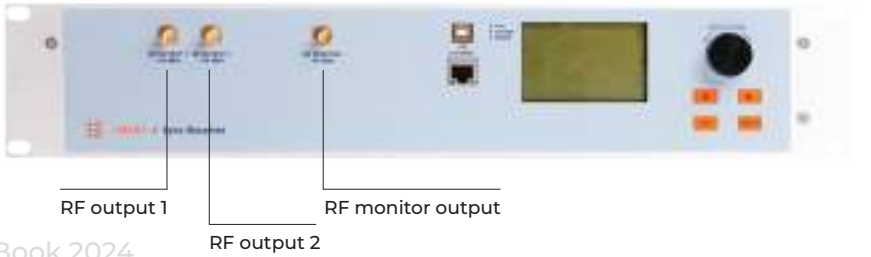


Figure 42: Libera Sync Transmitter and Receiver back panel

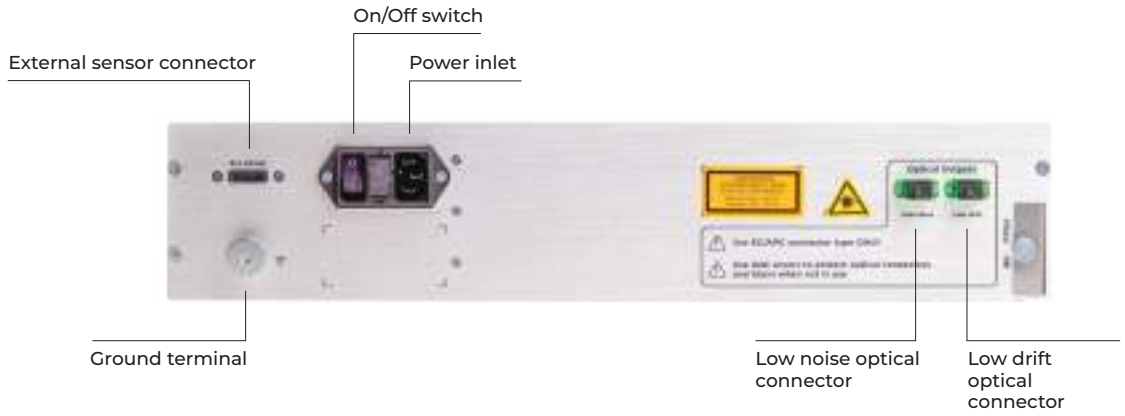


Figure 43: Libera Sync setup

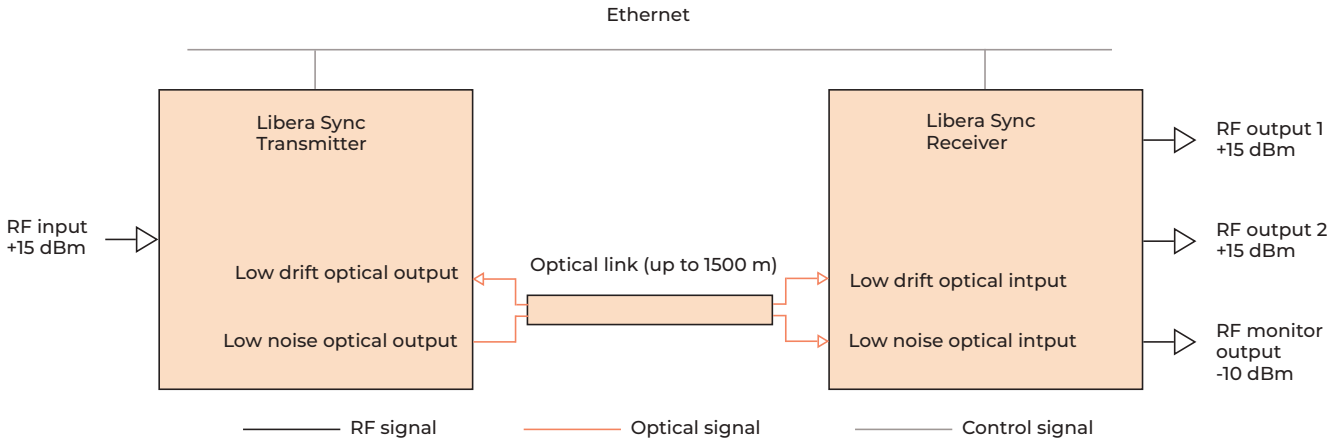


Table 10: Technical specifications of the Libera Sync

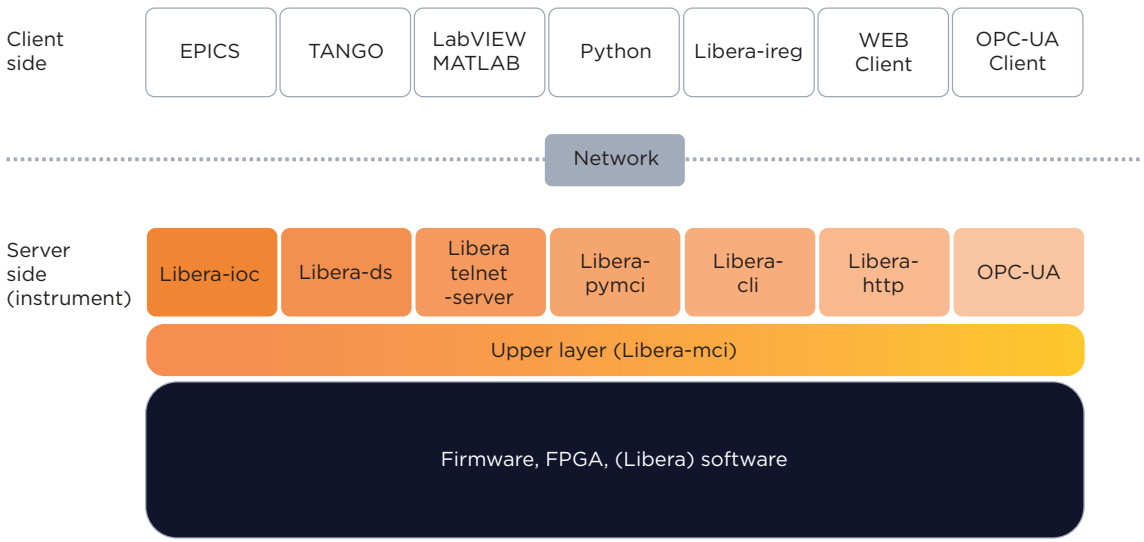
General product code	LSYN
Capabilities	
Carrier frequency *	2.6 GHz - 3 GHz
Added jitter (integrated from 10 Hz to 10 MHz)	<8 fs RMS
Long term drift (typical in 24 hours) Long term drift (typical in 16 hours)	<40 fs peak-to-peak <20 fs peak-to-peak
Optical link lenght	Up to 1500m, longer would require more stable environmental conditions along the link
Optical fiber drift compensation range	500 ps
RF input	1, SMA connector, 50 Ω
RF input power	+15 dBm ±1dB
RF outputs	2, SMA connectors, 50 Ω 1 monitor, SMA connector, 50 Ω
RF output powers	+15 dBm ±0.5 dB -10 dBm ±2 dB (monitor output)
Operating temperature range	20 - 28°C
Operating temperature stability	±1°C
Operating relative humidity range	0 - 80%
Operating relative humidity stability	±5 %
Dimensions	H: 2 U, W: 19” (rack mountable), D: 456 mm
* Custom frequencies are possible, e.g. 178.5 MHz, 500 MHz, etc. The performance parameters are deteriorated for frequencies below 2.6 GHz	

Functionalities
Fully automated start-up and tuning procedure
Remote and/or local control and monitoring
Local data logging on the memory card
EPICS IOC

ARCHITECTURE AND CONTROL SYSTEM INTEGRATION

All Libera instruments, regardless of the Hardware platform on which they are based, have a similar SW architecture. At the lowest levels, the Firmware and the FPGA code run in the dedicated Hardware modules and interface with the higher-level software through the libera-kernel layer.
The Software runs within the CPU of the instruments, where standard Linux distributions are used (e.g. Ubuntu, Rocky OS, etc..). Most of the Software is based on a general Software framework called Libera BASE, which on the lowest end provides hardware abstraction and interfaces to the Hardware components. The instrument-specific application is integrated within the Libera BASE framework that provides access to the application's configuration parameters, data buffers, and data streams. Finally, the Measurement and Control Interface (MCI) layer transfers parameters and data between the Libera application and various control system adapters (see Figure 44).

Figure 44: Software interfaces and building blocks within Libera instruments



For most of the instruments, an EPICS-based Graphical User Interface is available to the user, providing access to all the instrument parameters and data. Depending on the GUI technology used, GUIs are currently available based on EDM panels, CSS, and Qt: see the examples in Figures 45 and 46. In the last years, for some instruments also a Web-server was introduced as well as a web-based GUI (see Figure 47).

If you are interested in accessing the FPGA and Software sources, please contact sales@i-tech.si.

Figure 45: Example of EDM GUI

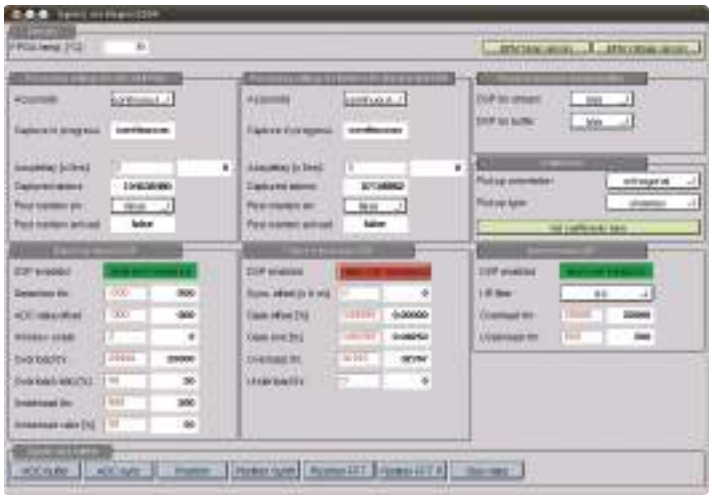


Figure 46: Example of CSS GUI

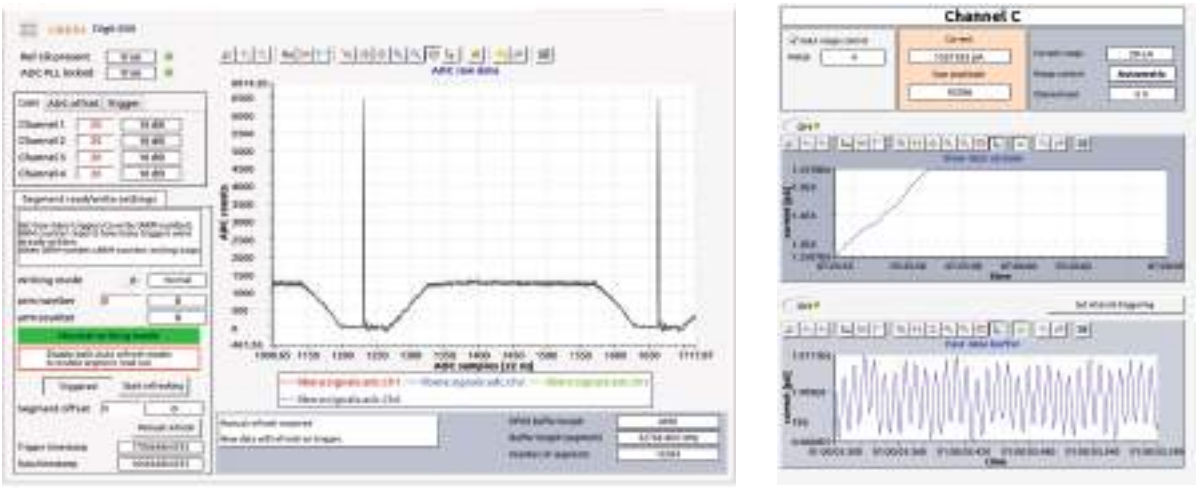


Figure 47: Example of a web based GUI

EXTENSIONS

Libera instruments can be integrated with other accelerators' subsystems by extending their functionalities using specific modules and custom-developed applications (refer to Table 11).

Table 11: Extensions options for Libera instruments

Interface	Description / example	Works with	Required module
Fast Orbit Feedback solution	Complete solution for electron machines that use Libera Brilliance+ instruments (Figure 48)	Libera Brilliance+	GDX module SER module Orbit Feedback application software Dedicated optical network Magnet correction data receiver*
	Complete solution for hadron machines that use Libera Hadron instruments (Figure 48)	Libera Hadron	GDX module SER 2 module COFB application software Dedicated optical network Magnet correction data receiver*
Real-time data streaming	Real time data streaming directly from the FPGA through a dedicated instrument interface	Libera Brilliance+ Libera Single Pass E Libera Hadron Libera Single Pass H Libera Spark Libera Digit 500**	GDX module or GbE interface (depending on the instrument)
Interlock detection and output	Interlock detection and hardware interface towards Machine Protection System Compatible with Libera integrated platform instruments	Libera Spark Libera Cavity BPM Libera BLM	DAI module Interlock detection software
Additional Digital I/O channels	Add 2 extra digital I/O interfaces (LEMO) for communication and/or control of auxiliary components	Libera Spark Libera Digit 125 Libera Digit 500	DAI module I/O control software**
Analog outputs	Add an analog output to control an auxiliary component or transform a selected digital value (e.g. SUM, position, etc.) into a 16-bit analog value	Libera Spark Libera Digit 125 Libera Digit 500	DAI module DAC control software**
Serial interface	Add a RS-485 interface for half-duplex communication with auxiliary components Add multiple RS-485 interfaces for real-time data streaming towards magnet receivers	Libera Spark Libera Digit 125 Libera Digit 500	DAI module RS-485 control software**
Frequency down conversion	Convert the RF input signal to a lower frequency to match the input capabilities of a Libera instrument	Libera Spark EL Libera Single Pass E	Libera DWC

* Not provided by Instrumentation Technologies

** Basic control included only. Can be customized by users using source code

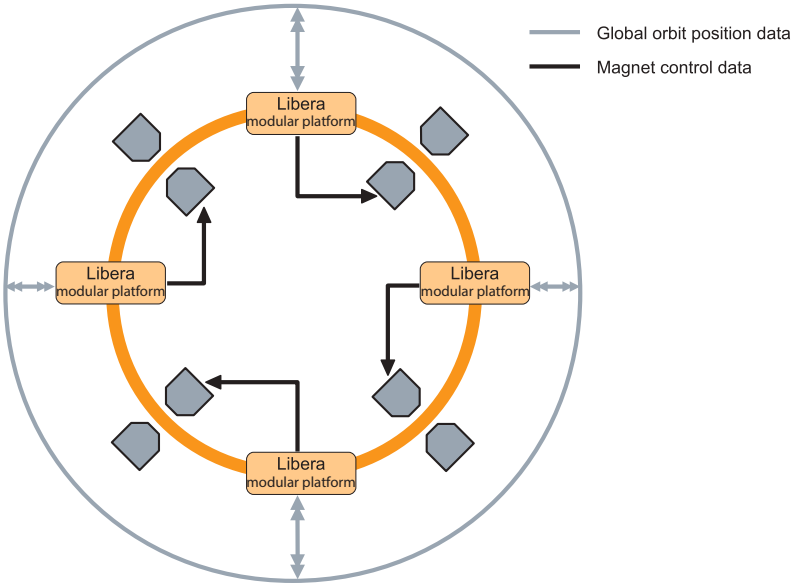
1 Orbit feedback solutions

Orbit feedback application is implemented in the GDX module which is compatible with Libera Brilliance+ and Libera Hadron instruments. Beam position data is exchanged via a dedicated network (daisy chain). Inside of every GDX module, corrections for magnet controllers are calculated in several matrix multiplication stages. Correction values can be applied locally (via the optional SER or SER II modules) or globally via optical or copper link.

Default implementation supports up to 256 BPM IDs and 128 magnet IDs, but can be extended, if required. Calculation rate is conditioned by the beam position data update rate (tested up to 30 kHz).

For testing and diagnostic purposes, synthetic waveform generation inside of the BPM electronics modules is is supported.

Figure 48: Complete orbit feedback solution for electron/ hadron machines



2 DAI module

The DAI module extends the interconnection capabilities of Libera instruments as shown in Table 12 (Applicable for Libera Spark, Libera Digit 125 and Libera Digit 500).

Figure 49: DAI module

Table 12: Technical specifications of the DAI module

General product code: MDAI1.000.001	
Interface	**Description**
LEMO single (2x)	Single-ended LEMO, Input/Output configurable
LEMO differential (1x)	Differential LEMO, Interlock output (requires external circuit)
SMA (1x)	16-bit 100 kSps DAC output, 1 V at 50 Ohm
RJ-14 (1x)	Up to 20 Mbps, half-duplex

3 SER module

The SER module features four RS-485 interfaces directly controlled from the GDX module. The protocol and the baud rate are specified by the application in the GDX modue (Table 13).

Figure 50: SER module

Table 13: Capabilities of the SER module

General product code: MSER1.000.001	
I/O interfaces	RJ-25, LVDS links to GDX
Baud rate*	Up to 2.5 Mbit/s
Protocol*	Asynchronous protocol EIA 485, byte per byte

* Specified by application in the GDX module

4 SER 2 module

The SER 2 module features eight RS-485 RJ-45 interfaces controlled via the PCI express link (Table 14).

Figure 51: SER 2 module

Table 14: Capabilities of the SER 2 module

General product code: MSER1.000.002	
I/O interfaces	RJ-45, PCI express link to AMC connector
Electrical	EIA 485
Protocol	High speed USI protocol

5 GDX module

The GDX module extends the interconnection capabilities of the BPM electronics. Four protocol independent small form pluggable (SFP) slots can be used to build a closed loop of all the instruments in the accelerator. It features a Virtex6 FPGA, which is completely open to user-developed applications. It can process the internal (within the chassis) and external position data at various data rates (Table 15).

Figure 52: GDX module

Table 15: Capabilities of the GDX module

General product code: MGDX1.000.001	
FPGA chip	Xilinx Virtex 6
Memory	2 GB DDR3
I/O interfaces	4x SFP+ compliant, multiprotocol operations, LVDS links to AMC connector
SFP protocol	AURORA, GbE, others on request; independent to each SFP
PCI express x4 bus interface to AMC connector	
On-board clock synthesizer and programmable VCXO for clock generation	
Board management is already established	

6 Libera DWC

The DWC-SP circuit is a four-port RF downconverter that can be used to down-convert the RF input signals from S-band to an intermediate frequency (Table 16).

Figure 53: Libera DWC

Table 16: Technical specifications of the Libera DWC module

	1 GHz	1.3 GHz	3 GHz
General product code	LDWC1.000.001	LDWC1.000.002	LDWC1.000.003
Supply voltage	6 V DC	6 V DC	6 V DC
RF input connector	SMA	SMA	SMA
RF input frequency	~1000 MHz	~1300 MHz	~3000 MHz
RF input power	Max 15 dBm	Max 15 dBm	Max 15 dBm
LO input connector	SMA	SMA	SMA
LO input frequency	Max 500 MHz	Max 900 MHz	Max 2800 MHz
LO input power	5 dBm	5 dBm	5 dBm
RF output connector	SMA	SMA	SMA
RF output frequency	<600 MHz	<600 MHz	<600 MHz

7 Libera Amplifier 110

The Libera Amplifier 110 is a four-channel, low noise, non inverting measurement amplifier. Its gain can be set in increments of 10 dB from -50 dB to 60 dB via an SPI control interface (Figure 54).

The Libera Amplifier 110 is intended to reduce wide dynamic ranges in order to enable further signal processing and acquisition. An example of an application is pickup signals in beam position monitoring in accelerators, where the Libera Amplifier 110 can be used in combination with Libera Hadron.

Figure 54: Libera Amplifier 110 front and back panel

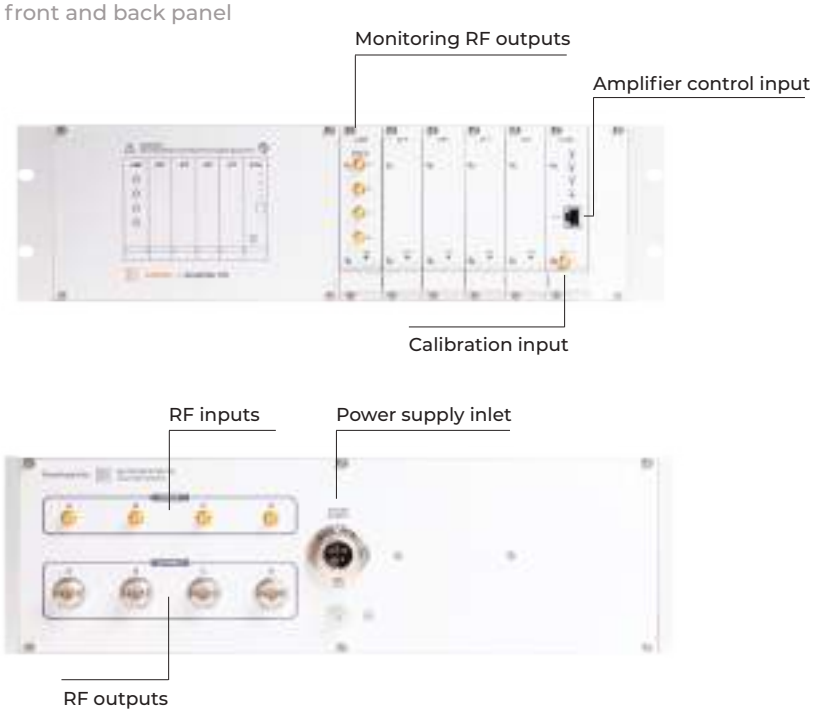


Table 17: Technical specifications of the Libera Amplifier 110

General product code: LAMP	
Dynamic range	From -50 dB to 60 dB
Input voltage	Max. 230 V peak (max. average input power 1.5 W per channel)
Output voltage	±2 V peak
Bandwidth	From 40 kHz to 55 MHz
Gain error between channels	Max. ±0.1 dB
Output reffered added noise	<15 mVrms, for gain 60 dB <5 mVrms, for gains <60 dB
Input and output impedance	50 Ω

8 Libera Pilot Tone FE

More

The Libera Pilot Tone FE is an analog front-end installed in the tunnel and connected between the BPM pickup and BPM electronics. It combines the RF BPM signals with a pilot tone signal that is slightly offset to the RF. Both signals pass through the RF cables to the BPM electronics and are exposed to the same disturbances.

The Libera Pilot Tone FE is the result of a partnership between Elettra Sincrotrone Trieste and Instrumentation Technologies.

Figure 55: Libera Pilot Tone FE front and back panel

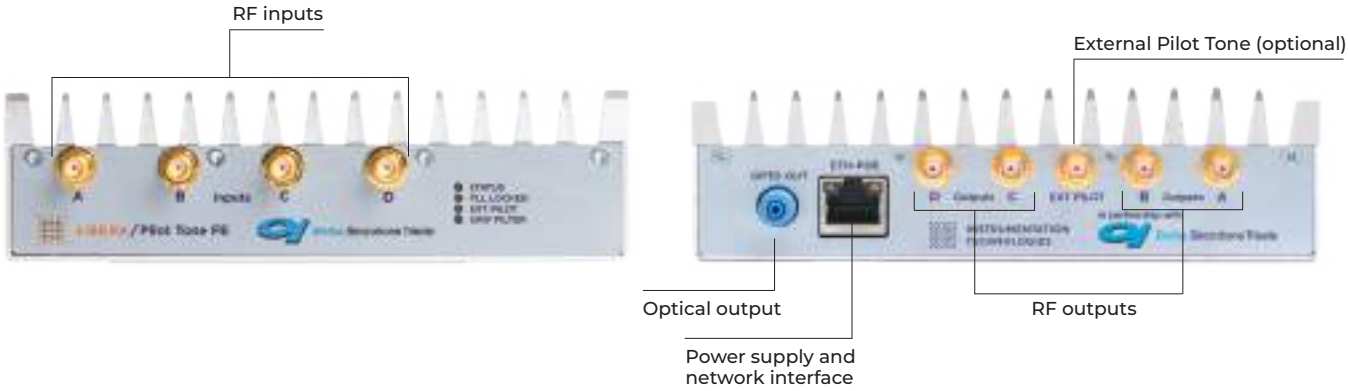
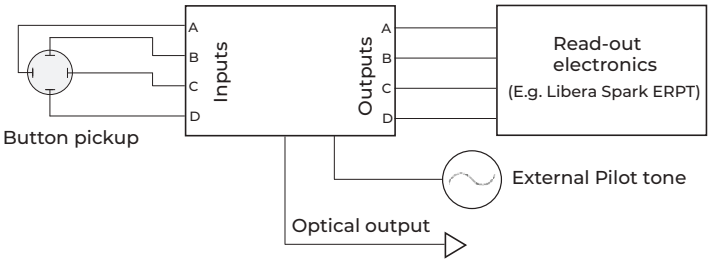


Figure 56: Example setup of the Libera Pilot Tone FE in combination with Libera Spark ERPT



Most common RF frequencies are supported: 352 MHz, 408 MHz and 500 MHz. The Libera Pilot Tone FE is powered and controlled through a PoE RJ-45 interface via TCP-IP. Important parameter settings are confirmed through an optical interface.

Such BPM system ensures stable position readout with long-term stability <1 µm.

Table 18: Technical specifications of the Libera Pilot Tone FE

General product code: LPTFE	
Frequency versions	500 MHz 408 MHz 352 MHz
Input/Output channels	4 / 4 (SMA-F connectors)
Input impedance	50 Ohm
Programmable attenuation	0 to 90 dB
1 dB compression point	+16 dBm
Crosstalk	Better than -60 dB
Pilot tone generation	Internal or external (SMA-F input)
Control interface	TCP-IP over Ethernet
Power supply	PoE or 9-12 V, 1 A
Dimensions	175 x 151 x 40 mm
Weight	1,2 kg
Temperature dependence	Frequency dependence: Approximately -250 Hz/°C Amplitude dependence: Approximately -0.03 dB/°C

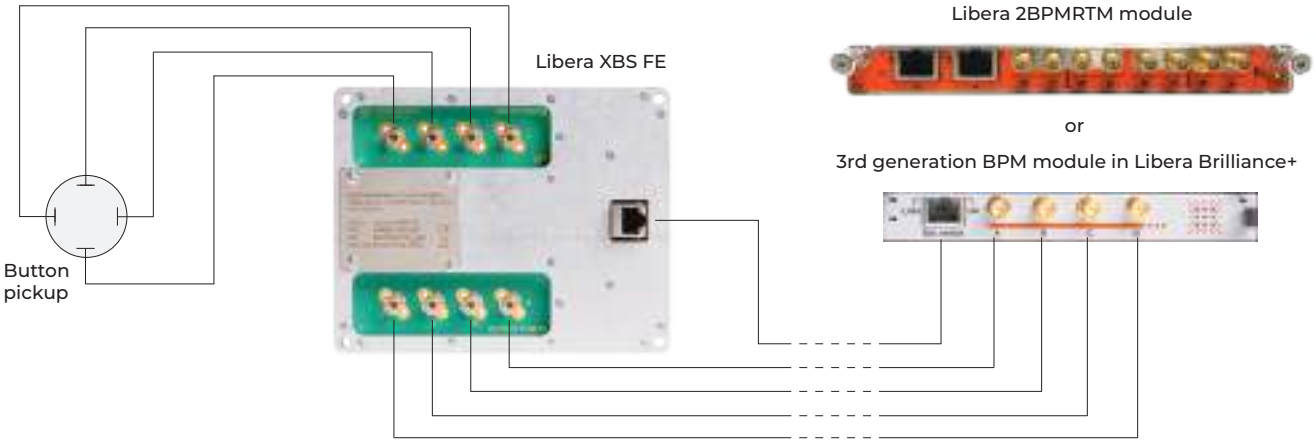
9 Libera XBS FE

Libera XBS FE is a supplementary analog front-end for the Libera Brilliance+ BPM electronics, to be used in combination with the 3rd generation BPM module. The Libera XBS FE contains a cross-bar switch matrix, similar to the one used in the standard Libera Brilliance+ BPM modules, and is intended to be installed in the tunnel, as close as possible to the BPM pickup.

The advantage of switching the RF signals already in the tunnel, is the possibility to compensate the long-term drifts that are induced on the long RF cables, in addition to the ones in the electronics.

The system of Libera XBS FE and Libera Brilliance+ ensures a stable position readout with RF cables as long as 200 meters.

Figure 57: Connection scheme of Libera XBS FE and the 3rd generation BPM module in Libera Brilliance+ (or Libera 2BPMRTM module)



The Libera XBS FE supports all standard synchrotron RF frequencies. It is powered and controlled by the 3rd generation BPM module through a standard Cat.7 cable and RJ-45 interface. The switching frequency is configurable by the digital control in the Libera Brilliance+ and is fully synchronized with the Digital Signal Conditioning that calculates the calibration coefficients.

Table 19: Technical specifications of the Libera XBS FE

General product code: LXBS1.000.001	
Frequency range	350 MHz to 510 MHz
Input/Output channels	4 / 4 (SMA-F connectors)
Maximum input signal range	+4 dBm CW
Maximum distance to the BPM module	200 meters (tested)
Power supply and control cable	Cat.7 S/FTP
Temperature dependence	<200 nm / K
Dimensions	173 x 129 x 19 mm
Weight	~0.8 kg

LIBERA

SERVICES & SUPPORT

COMMISSIONING ASSISTANCE

Assistance in installation, commissioning, and integration into the control system.

ON-SITE AND REMOTE SUPPORT

Get in touch with our skilled engineers, who have a full knowledge of the system. We will help you with hardware, software, or system integration issues throughout the product's lifecycle.

ON-SITE DEMONSTRATION AND TESTING

Try the instruments on your machine. One of our experts can visit you and assist you with testing.

TRAINING

Hands-on training sessions on the use of Libera instruments are organized either on-site or at Instrumentation Technologies premises.

INSTRUMENT COSTUMIZATION

Our flexible hardware and software architecture provides different options for extending functionalities.

WARRANTY EXTENSION

Extend the standard warranty period for the instruments and fix the cost of potential malfunctions in advance.

SOFTWARE AND OS UPGRADES

Keep your instruments updated to the latest released Operating System and Instrument Software version.

Get in touch

Libera Newsletter

HQ

Instrumentation Technologies d.o.o.

Address
Velika pot 22
SI-5250 Solkan
Slovenia

Web
i-tech.si

Contacts
P: +386 5 33 52 600
F: +386 5 33 52 601
E: info@i-tech.si

Customer support
E: support@i-tech.si

Sales/Marketing
E: sales@i-tech.si

CHINA

Parlitec (Beijing)

Address
A903,
Chaoyang north road 13,
Chaoyang district,
Beijing,
China

Contacts
P: +8601059396219
F: +8613811181795
E: info@parlitec.com

JAPAN

Positive ONE Systems Corporation

Address
Shibuya Mark City, 1-12-1,
Dougenzaka,
Shibuya-ku
Tokyo, Japan

Web
positive-one.biz

Contacts person
Mr. Masaharu Umeda
P: +81-3-3256-3933
E: masaharu.umeda
@positive-one.com

Customer support
E: support@i-tech.si

Sales/Marketing
E: sales@i-tech.si

INDIA

Geebee International

Address
12 - A, Lane W - 16,
Sainik Farms
New Delhi
India

Web
geebeeinternational.com

Contacts person
Sahil Pershad
P: +91 98107 54666
F: +91 (11) 2 955 2109
E: sahil@
geebeeinternational.com

SOUTH KOREA

Hanmac Corporation

Address
Seongsuil-ro 55,
Seongdong-gu, Seoul,
South Korea

Web
hanmacco.com

Contact person
Daegyu Yoon
P: 82-2-467-7447
E: dgyoon@
hanmacco.com

LIBERA

MORE AT WWW.I-TECH.SI

Visit our website to read more about Libera products and download conference papers on the use of Libera in different accelerators around the world.

WHERE IDEAS MEET TECHNOLOGY

LIBERA

INSTRUMENTATION
TECHNOLOGIES

CONTACT US AT

info@i-tech.si
www.i-tech.si