Bergoz Instrumentation, Non-intercepting beam measurement

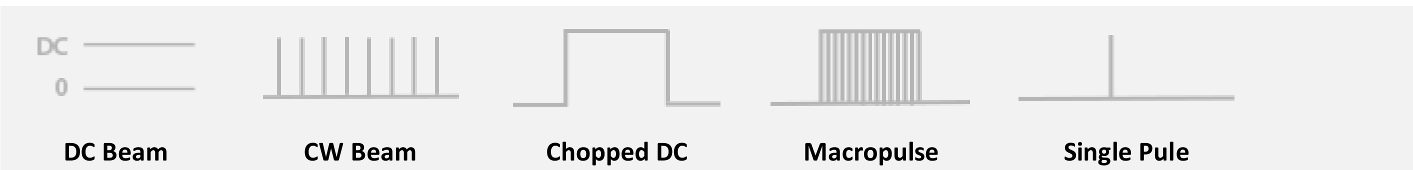
非拦截式束流测量与诊断

2018 Products Catalog

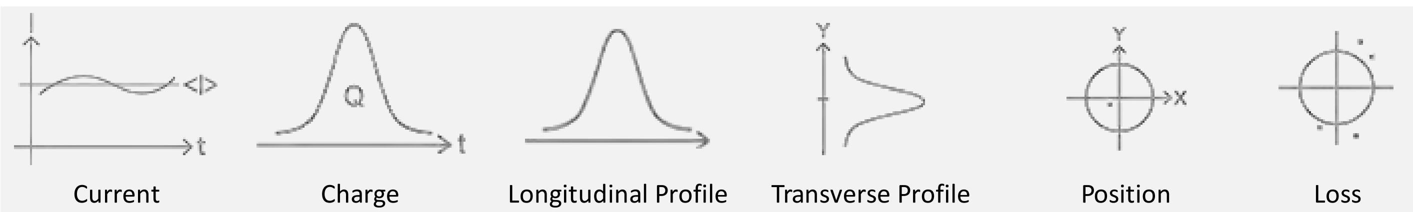
By CONVe-YI

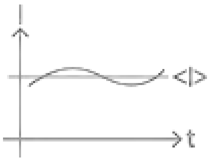
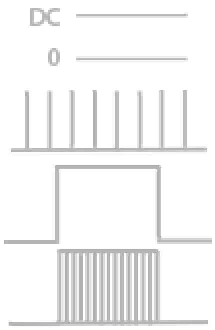
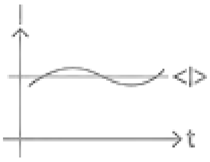
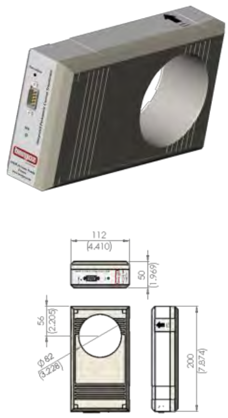
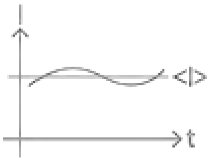
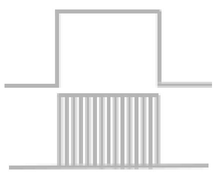
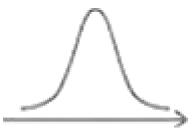
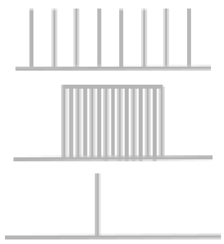
北京科维泰信

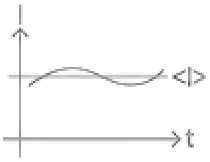
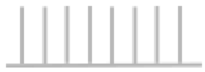
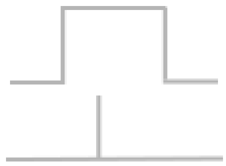
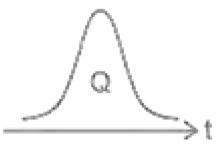
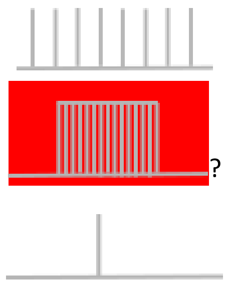
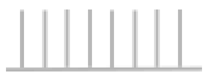
Beam Structure

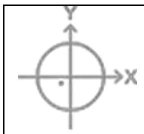
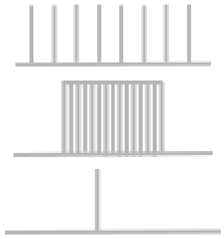
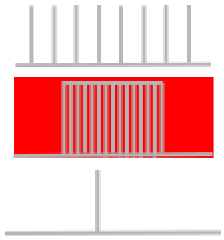
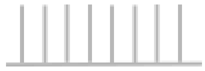
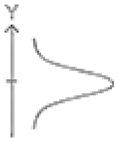
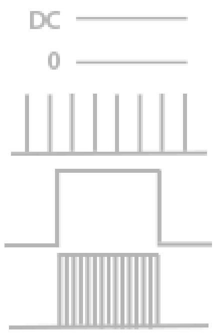
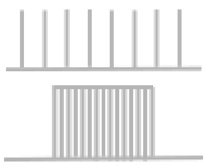


Diagnostics



Item	Specification	Photo	Application	Pg.
NPCT	**New Parametric Current Transformer** Rang: 2mA, 20mA, ±200mA, ±2A, ±20A Bandwidth: DC to 10 kHz Resolution: <0.5 μArms √ Hz  Current		 All average beam current	5
IPCT	**Integrated Parametric Current Transformer** Range: ±1mA to ±5A Bandwidth: DC to 4 kHz Resolution: <10μA 		 Return ground currents, DC and AC; Leakage current, DC and AC; Sum of low currents; Small difference of high currents; Standby systems charging currents	7
ACCT	**AC Current Transformer** Range: ±10mA to ±2A Bandwidth: <3Hz to 1MHz Resolution: <1.5 μArms 		 on all high-energy particle accelerators to observe very short beam pulses	9
FCT	**Fast Current Transformer** Bandwidth: Up to 2 GHz Rise time: <200 ps Sensitivity: From 0.5V/A to 10V/A  Longitudinal Profile			11

				
CWCT	**CWCT & BCM-CW** CW Current Transformer & Beam Charge Monitor for CW beams and macropulses **Range@0db:100mA,400mA@20V/A,5V/A** **Average current resolution: 1 µA** **Fast beam loss interlock: 1 µs** 			[13]
ICT	**ICT & BCM-IHR** Integrating Current Transformer & Beam Charge Monitor **BCM-IHR full scale ranges: 400pC to 800nC** **Noise in single bunch: 0.55 pCrms** 			[15]
T-ICT	**Turbo-ICT & BCM-RF** Turbo Integrating Current Transformer & RF Beam Charge Monitor **Noise in CW beam and - macropulse measurement: 0.1 µArms** **Noise in single bunch - measurement: 10 fC** 		 low noise and high accuracy. Turbo-ICT combines an ICT of a new kind and front-end filter and amplifier (FEFA) electronics in one assembly.	[17]
BPM Beam Position Monitor	**MX-BPM**: Multiplexed BPM Electronics **Beam charge range: >75 dB** **X and Y resolution: 1 µm**			[19]

	**LR-BPM**: Log-ratio BPM Electronics, for single bunch, long macropulse and CW **Beam charge range: >50 dB** **Repetition frequency: ≤500 MHz**			21
	S-BPM: S-band / L-band BPM Electronics, for single bunch, long macropulse and CW **S-band standard frequencies: 2.856 GHz and 2.999 GHz**			23
	BB-BPM: Baseband BPM Electronics, for ions / medical accelerators **Beam intensity range: >70 dB** **Operating frequency: Up to 25 MHz**	 		25
VWM	**Vibrating Wire Monitor** **Dynamic range: > 1E6** **Resolution for proton beam: 3pA** **Resolution for electron beam: 70pA** 	 		27
BLM	**Beam Loss Monitor** **Dynamic range: >1E8** **Count rate: >10 MHz** 			28

bergoz INSTRUMENTATION

NPCT – New Parametric Current Transformer

DC beam current non-destructive measurement

Four ranges ± 20mA, ±200mA, ±2A and ± 20A
<0.5uA/√ Hz noise, i.e. resolution, on option
DC to 10 kHz (-3dB) frequency response
< 0.1% linearity error
NPCT package includes spares for all electronics

The New Parametric Current Transformer is the latest evolution of the Unser Transformer, commonly called DCCT, developed at CERN in 1966 by Klaus B. Unser.

Application

The Parametric Current transformer is used on most particles accelerators in the world to measure the average beam current. It is an essential instrument for accelerator tuning and operation. It is primarily used on particle sources, cyclotrons, medical synchrotrons, HEP research accelerators and light sources.

Operating principle

The NPCT works on the second harmonic detection principle. Two cores are modulated to deep saturation in opposite phase. A primary DC current flowing through the cores shifts the cores' working point in opposite polarity which generates a second harmonic of the modulator frequency.

The primary current AC component is detected by an AC Hereward transformer. The two circuits are cascaded in a common feedback loop to generate a magnetic flux which always cancel the primary current flux. The NPCT output is the voltage developed by the feedback current passing through a precision resistor.

Two packaging types for the NPCT sensor

In-flange NPCT sensor to mount in the beam line

In-air NPCT sensor for installation over the vacuum chamber

NPCT Chassis with NPCT-E electronics and power supplies

DISTRIBUTORS

U.S.A.: GMW Associates
www.gmw.com
sales@gmw.com

India: GEEBEE International
www.geebeinternational.com
info@geebeeinternational.com

Japan: REPIC Corp.
www.repic.co.jp
sales@repic.co.jp

China: Beijing Conveyi Limited
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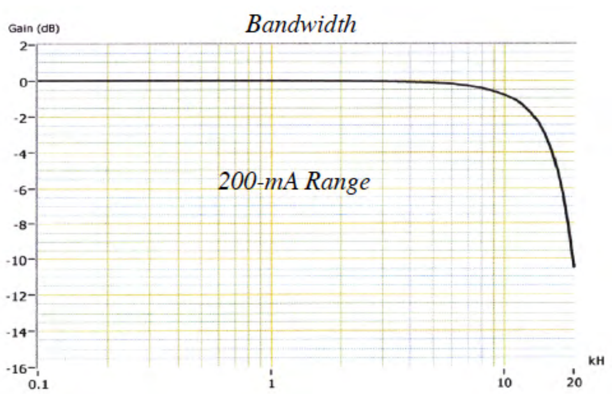
NPCT – New Parametric Current Transformer

Specifications

Full scale ranges	±20mA, ±200 mA, ±2A, ±20A
Range control	2 TTL lines on rear panel DB9
Output	±10 V
Output over range	up to ±12V
Output bandwidth (-3dB)	8 kHz in 20-mA range 10 kHz in other ranges
Response time (@ 90%)	< 50 us
Resolution	
Standard model	< 5µ Arms/sqrt(Hz)
High Resolution model	< 1µ Arms/sqrt(Hz)
Very High Resolution model	< 0.5 µArms/sqrt(Hz)
Output accuracy	± 0.1% ± zero-offset ± magnetic field sensitivity ± temperature drift
Linearity error	< 0.1%
Temperature coefficient	< 0.5uA/K typ.
Operating temperature	-40...80° C
Output impedance	100Ω
Output current	10mA max, source or sink
Output connectors	Isolated BNC on rear panel and front panel
Test function	Injects +100mA in sensor
Test control	TTL line on rear panel (DB9)
Calibration winding	10-turn floating calibration winding on sensor
Calibration current	from external source (2A max, Z > 100Ω)
Calibration connectors	Isolated BNC on rear panel and front panel

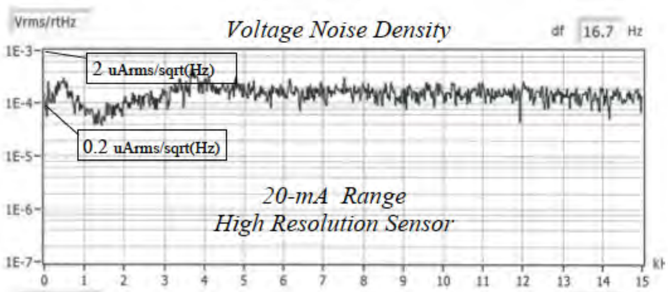
Sensor head

Connector	DB15 male
Temperature coefficient	5µA/K typ.
Sensor baking	<100° C, 212F.
Destructive level	DC current: Unlimited
Pulse charge	>100mC
Sensor saturation flux	10 mT (axial) typ. 2mT (radial) typ.
Sensor sensitivity to external magnetic fields	10µA/mT (axial) typ. 1mA/mT (radial) typ.



Dimensions & Ordering codes

In-flange NPCT order code	Pipe OD nominal	Mating flange	ID (mm)	H (axial)
NPCT-CF2"1/8-22.2-120-UHV-	1"	DN25 NW25CF	22.2	120
NPCT-CF2"3/4-34.9-120-UHV-	1.5"	DN40 NW35CF	34.9	120
NPCT-CF4"1/2-60.4-120-UHV-	2.5"	DN63 NW63CF	60.4	120
NPCT-CF6"-96.0-120-UHV-	4"	DN100 NW100CF	96.0	120
NPCT-CF8"-147.6-120-UHV-	6"	DN160 NW150CF	147.6	120
NPCT-CF10"-198.4-120-UHV-	8"	DN200 NW200CF	198.4	120
In-air NPCT order code	OD (mm)	Clears over flange	ID (mm)	H (axial)
NPCT-055-	98	DN16 NW16CF	55	108
NPCT-075-	118	DN40 NW35CF	75	108
NPCT-115-	158	DN63 NW50/63CF	115	108
NPCT-130-	175	DN63 NW50/63CF	130	108
NPCT-175-	222	DN100 NW100CF	175	108
NPCT-195-	250	Mitsubishi PT	197	108
NPCT-203-	248	DN160 NW150CF	203	108
NPCT-245-	298	DN200 reduced	245	108
Cable	Units	Type		
-Cxxx	meters	Polyproplylene FR-LS		
-RHCxxx	meters	Siltem Radiation-tolerant R.I.>7		
Sensor options (In-flange NPCT only)				
-ARB#xxx	Arbitrary (noncircular) aperture drawing #			
-316LN	Made out of AISI 316LN instead of 304			
Hiher resolution aptions (applies to all sensors)			Noise density	
-HR	High Resolution		<1µArms/rtHz	
-VHR	Very High Resolution		<0.5µArms/rtHz	
Radiation tolerant option (applies to sensor only)				
-H	Improved radiation tolerance	Improves critical materials radiation tolerance by 2-3 orders of magnitude		



NPCT package includes:

One NPCT sensor head
One interconnect cable
One 19" 3U RF-shielded chassis, with
Two power supplies, autorange AC input (one as spare)
Two NPCT electronics cassettes (one as spare)

DISTRIBUTORS

U.S.A.: GMW Associates
www.gmw.com
sales@gmw.com

India: GEEBEE International
www.geebeinternational.com
info@geebeinternational.com

Japan: REPIC Corp.
www.repic.co.jp
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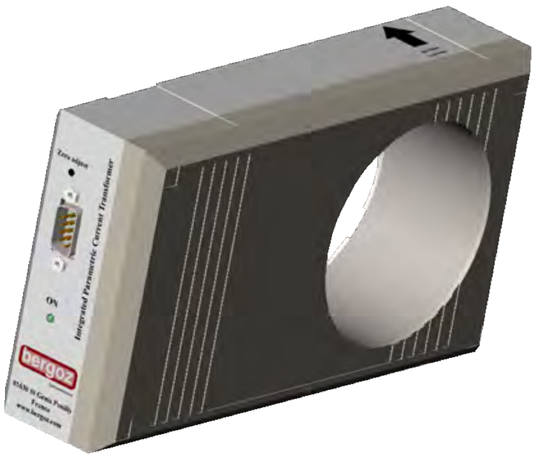
bergoz INSTRUMENTATION

IPCT - Integrated Parametric Current Transformer



Non-intercepting DC current measurement with 10 microamps resolution

To measure:

Return ground currents, DC and AC

Leakage current, DC and AC

Sum of currents

Small difference of high currents

Low current at high voltage

Power tube electrode currents

Electrostatic corona discharge

Electrochemically induced currents

Standby systems charging currents

Main features

The IPCT is a DC Current Transformer

Large aperture 82mm (3.23")

Widely used for Xray installations periodic recalibration

Full scale from ±1 mA to ±20 A factory preset

±10V analog output

DC to 3.8 kHz (-3dB) response

Accuracy independent of primary conductor position

Withstands 100kA 4/10µs discharges

100 times more precise than Hall effect devices

Increased sensitivity with multiple primary turns

Operating principle

The IPCT works on the principle of the DCCT, invented at CERN, the European Particle Physics Laboratory, by K.Unser in 1969. The DC component of the current flowing through the toroid sensor is detected by a magnetic modulator, also called fluxgate or second harmonic detector. The AC component is detected by an active Hereward transformer. The two circuits are cascaded in a common feedback loop to generate a magnetic flux which always cancels the primary current flux. The IPCT output is the voltage developed by the feedback current passing through a precision resistor.

DISTRIBUTORS

U.S.A.: GMW Associates
www.gmw.com
sales@gmw.com

India: GEEBEE International
www.geebeeinternational.com
info@geebeeinternational.com

Japan: REPIC Corp.
www.repic.co.jp
sales@repic.co.jp

China: Beijing Conveyi Limited
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BERGOZ Instrumentation
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01630 Saint Genis Pouilly, France
sales@bergoz.com

IPCT - Integrated Parametric Current Transformer

Specifications

Full scale range	Any value from ± 1mA to ± 20A, factory preset
Over range	120% full scale permanently
Saturation	>120% full scale
Damage level	DC: unlimited, AC: > 20Arms Discharge: > 100kA 4/10µs
Voltage isolation	5kV current conductor to ground
Resolution	See “Resolution” table below
Linearity error	<0.1% FS
Absolute accuracy	± 0.2% FS
Calibration	External current can be applied
Ripple	7kHz and even harmonics See “Ripple” table below
Bandwidth	DC to 3.8kHz (-3dB), See “Bandwidth” table below
Output	±10V, buffered, 20 mA max stands permanent short circuit
Zero adjust	20-turn front-panel potentiometer
Power supply	+-15V, 100mA
Connection	DB-9 male on front panel
Temperature drift	<5µA/K
Stabilization after overload	10ms max.
Magnetic field	50µA/Gauss typ. sensitivity
Mass	0.5 Kg

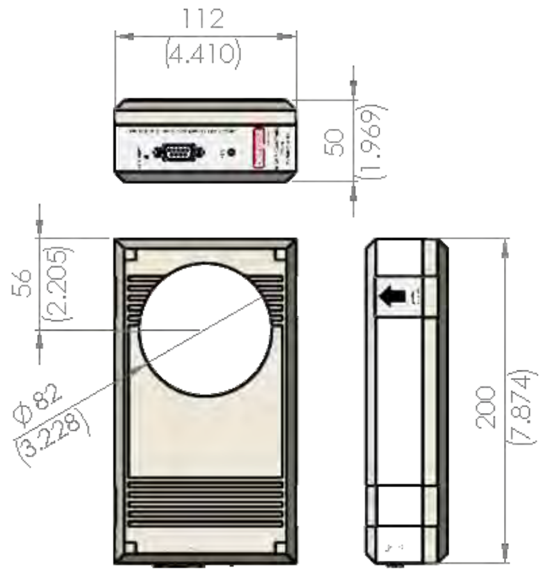
Resolution, bandwidth and ripple

Range	Resolution (Noise)	Bandwidth -3 dB	Ripple (7kHz)
+- 1 mA	1 uA/√Hz	> 150 Hz	< 80 mV rms
+- 10 mA	10 uA/√Hz	> 800 Hz	< 70 mV rms
+- 100 mA	10 uA/√Hz	> 3 kHz	< 70 mV rms
+- 2 A	30 uA/√Hz	> 3.8 kHz	< 12 mV rms
+- 20 A	200 uA/√Hz	> 2 kHz	<12 mV rms

Connections

Function	Pin
Power supply -15V	4
Power supply +15V	9
Power supply ground	5
Output (-10V to +10V)	2
Output ground	7
Optional external resistor	1
Optional external resistor	6
Calibration winding +	8
Calibration winding -	3

Dimensions



Order codes

IPCT-XXXmA	Integrated Parametric Current Transformer. Factory-preset Any range XXXmA up to ±20 A

Options

IPCT-0.01%	High accuracy calibration 0.01% ±10µA
IPCT-CALCERT	IPCT initial certificate of Calibration with test report
IPCT-PS-BNC	90-245Vac power supply & BNC output for IPCT

IPCT-PS-BNC (on option): Power supply & BNC output for IPCT

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ACCT - AC Current Transformer

Precise waveform measurement of long pulses and macropulses up to several milliseconds with minimal droop and noise.

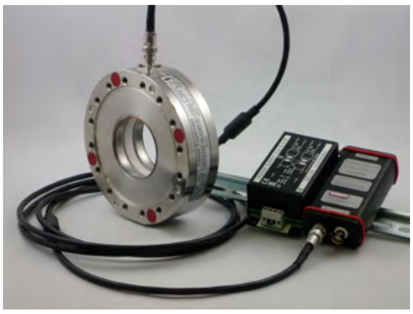
Bandwidth 3Hz to 1MHz
±10mA up to ±2A full scale current range
Output ±10V in high impedance
Dynamic range >1E4
Wideband noise ≈1,5μArms
Output signal droop <2%/ms

Cable from sensor to electronics up to 25m
Shielded twisted pair (radiation tolerant on option) with BNO (Twin BNC) connectors.

Operating principle
The ACCT is an evolution of the active transformer first proposed by Hereward in 1960.
Compared to the Hereward transformer, the ACCT presents much lower noise, a DC offset of the output reduced to a very small value and excellent long-term stability.

The sensor is built with a single winding, which requires only one wire pair between sensor and electronics; this allows much better EMI rejection when long cables are used.
The electronics circuit is multistage, implementing the best low-noise operational amplifier available for this application.

Three packaging types for the ACCT sensor



In-flange UHV installation in the beam line

In-air installation over the vacuum chamber

In-air installation with optional magnetic shield for high-resolution measurement in noisy environment.
Special shielding available on option

DISTRIBUTORS

U.S.A.: GMW Associates
www.gmw.com
sales@gmw.com

India: GEEBEE International
www.geebeinternational.com
info@geebeeinternational.com

Japan: REPIC Corp.
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bergoz INSTRUMENTATION

ACCT - AC Current Transformer

Specifications

Full scale range	Any value from ±10mA to ± 2A, factory preset range.
Output full scale	±10V
Lower cutoff (-3dB)	<3Hz
Droop	<2%/ms
Upper cutoff (-3dB)	1MHz
Risetime	350ns (10% - 90%)
Output offset	0.2mV typ. 0.5mV max.
Noise at 10mA F.S.	≈1.5µArms
Noise at 100mA F.S.	<5µArms
Power supply	+15Vdc and -15Vdc, 100mA ea.
Power supply unit	5U15-15B recommended Mains voltage 95-125Vac / 215-245Vac
Connectors	Sensor: BNO (Twin BNC) Electronics input: BNO (Twin BNC) Electronics output: BNC
Sensor cable	Twisted pair Up to 20 meters Above 20 meters overshoot may appear and rise time may increase
Primary DC current	1A max
Ratio accuracy error	<0.1% FS
Destructive level	DC current: Unlimited Spikes >100mC AC current >20Arms
Output current limit	±20mA max.
Mag. field sensitivity	When low currents are measured using "in-air" sensor, MSH optional magnetic shield is recommended.
Sensor saturation	External magnetic field: 2mT max Can be exceeded with optimal additional shielding
Temperature drift	Negligible

Order codes

In-flange ACCT sensors

In-flange ACCT sensor order code	Pipe OD	Mating flange	ID (mm)
ACCT-CF3"3/8-22.2-40-UHV	1"	DN/NW50CF	22.2
ACCT-CF4"1/2-34.9-40-UHV	1.5"	DN/NW63CF	34.9
ACCT-CF4"1/2-38.0-40-UHV	40	DN/NW63CF	38.0
ACCT-CF6"-47.7-40-UHV	2"	DN/NW100CF	47.7
ACCT-CF6"-60.4-40-UHV	2.5"	DN/NW100CF	60.4
ACCT-CF6"3/4-96.0-40-UHV	4"	DN/NW130CF	96.0
or ACCT-CF8"-96.0-40-UHV		DN160/NW150CF	
ACCT-CF10"-147.6-40-UHV	6"	DN/NW200CF	147.6
ACCT-CF12"-198.4-40-UHV	8"	DN/NW250CF	198.4
		Axial length H	40.0

In-air ACCT sensors

In-air ACCT sensor order code	ID (min)	OD (max)	H (max)	Mass (g)
Unshielded models				
ACCT-S-016	16	42	22	60
ACCT-S-028	28	64	22	115
ACCT-S-055	55	91	22	175
ACCT-S-082	82	118	22	250
ACCT-S-122	122	156	22	320
ACCT-S-178	178	226	22	700
Shielded models, with ACCT-MSH option				
ACCT-S-055-MSH	55	98	102	900
ACCT-S-075-MSH	75	118	102	1200
ACCT-S-115-MSH	115	158	102	1700
ACCT-S-130-MSH	130	175	102	2000
ACCT-S-175-MSH	175	222	102	2400
ACCT-S-197-MSH	198	250	102	2600
ACCT-S-202-MSH	202	250	102	2600
ACCT-S-245-MSH	245	298	102	3300

Options

- CAW　1-turn calibration winding
- 316LN　AISI 316LN instead of 304
- ARB#xx　Arbitrary shape aperture
- BK150C　150’C (300’F) bakeable, In-flange only
- BK185C　185’C (365’F) bakeable, In-flange only
- VAC　Degased in-air sensor
- MSH　Magnetic shield for in-air sensor
- H　Radiation tolerant sensor

Electronics

- ACCT-E-RM-xxxmA　DIN-rail mount electronics* where xxxmA is full scale

Power supply

- 5U15-15B　Power supply, DIN-rail mount

Cable　BNO-BNO twisted pair

- ACCT-Cxxx　Standard RG108 cable in PVC
- ACCT-RHCxxx　Radiation-tolerant Siltem cable
- Connectors　BNO (Twin BNC) straight 90˚ on option

* Fitting on DIN rail complying to Standard EN60715, 35mm width

The ACCT present versions were designed by Rémi Lubès and Hervé Bayle, based on Dipl. Ing. Klaus Unser original concept developed at CERN in the 1980s.

FCT - Fast Current Transformer

Most sensitive & fastest current transformer
Best non-destructive instrument to observe pulsed or CW beams. Yet, not a precise measuring instrument.

Higher sensitivity than a Wall Current Monitor: 5 V/A

Rise time down to 200ps

Up to 10 V/A with limited bandwidth

Technology
Composite* magnetic cores of Cobalt-based amorphous and nanocrystalline alloys provide high permeability and very fast risetime.
Alloys are thermally and magnetically processed in-house, to obtain unequalled performance.

Annealing techniques are the result of 20 years experience with cobalt-based alloy processing.
Proprietary multithread winding techniques and numerically analyzed modelling to assure uniform field density in magnetic core.

* Amorphous / nanocrystalline composite cores are made from two or more alloy composition batches.
Alloy batches are individually annealed to give each of them specific characteristics. High-temperature annealing is performed under fixed or 4π-rad rotating magnetic field.

Two packaging types

In-flange FCT is mounted in the beam line. Short axial length, includes a ceramic gap vacuum-brazed to kovar. Does not require bellows, wall current bypass nor electromagnetic shield. UHV compatible.

In-air FCT installation, over the vacuum chamber
Requires installation of a “gap” to prevent the wall current from flowing through the FCT aperture. The gap can be a brazed ceramic ring or an organic material O-ring depending on the vacuum requirements.
Typical installations include bellows, a wall current bypass and an electromagnetic shield enclosing the FCT completely.

DISTRIBUTORS

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MANUFACTURER

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FCT - Fast Current Transformer

Specifications

Wideband models (standard)
Technology: Predominantly amorphous

Sensitivity (nominal)	0.5	1.25	2.5	5.0	10	V/A
Turns ratio (old reference)	50:1	20:1	10:1	05:1	N/A	
Rise time (typ.)*	0.30	0.20	0.30	0.39	1.30	ns
Droop	<3	<6	<10	<32	<32	%/µs
Upper cutoff frequency -3dB typ.*	1.17	1.75	1.17	0.9	0.27	GHz
Lower cutoff frequency -3dB	<4.8	<9.5	<16	<32	<32	kHz
L/R time constant (min.)	35	1.75	10	5	5	µs
Max. charge/pulse (pulses <1ns)	1	0.4	0.2	0.1	0.1	µC
Max. peak current (pulses >1ns)	2	0.4	0.2	0.1	0.1	kA
Max. rms current (f >10kHz)	14	5.6	2.8	1.4	1.4	A

* Depends on FCT sensor dimensions and selected options

Low droop (-LD) models on option
Technology: Predominantly nanocrystalline

Sensitivity (nominal)	0.5	1.25	2.5	5.0	10	V/A
Turns ratio (old reference)	50:1	20:1	10:1	05:1	N/A	
Rise time (typ.)	0.54	0.40	0.50	0.78	1.30	ns
Droop	<0.2	<1	<3	<8	<8	%/µs
Upper cutoff frequency -3dB typ.	650	850	700	450	270	MHz
Lower cutoff frequency -3dB	<0.32	<1.6	<5	<13	<13	kHz
L/R time constant (min.)	500	100	30	12	12	µs
Max. charge/pulse (pulses <1ns)	1	0.4	0.2	0.1	0.1	µC
Max. peak current (pulses >1ns)	2	0.4	0.2	0.1	0.1	kA
Max. rms current (f >10kHz)	25	10	5	2.5	2.5	A

Options

-LD	Low droop
-316LN	AISI 316LN instead of 304
-ARB#xx	Arbitrary shape aperture
-BK150C	150°C (300°F) bakeable, In-flange only
-BK185C	185°C (365°F) bakeable, In-flange only
-VAC	Degassed in-air sensor
-MSH	Magnetic shield for in-air sensor
-H	Radiation tolerant sensor

Connector SMA jack 50Ω

Environment

Temperature
In-air models: 100°C (212°F) any time
In-flange models: 100°C (212°F) any time
On option: 150°C (300°F)
185°C (365°F)

Core saturation 2 mT radial field
2A permanent DC current

Radiation damage
Standard SMA PTFE: 1E3 Gray max
On option:
Rad-tolerant SMA PEEK: 6E7 Gray max
1E17 n/cm2 max

Order codes

In-flange FCT sensors

In-flange FCT sensor order code	Pipe OD	Mating flange	ID (mm)	H (mm)
FCT-CF3"3/8-22.2-40-UHV-xx	1"	DN/NW50CF	22.2	
FCT-CF4"1/2-34.9-40-UHV-xx	1.5"	DN/NW63CF	34.9	
FCT-CF4"1/2-38.0-40-UHV-xx	40	DN/NW63CF	38.0	
FCT-CF6"-47.7-40-UHV-xx	2"	DN/NW100CF	47.7	
FCT-CF6"-60.4-40-UHV-xx	2.5"	DN/NW100CF	60.4	
FCT-CF6"3/4-96.0-40-UHV-xx	4"	DN/NW130CF	96.0	
or FCT-CF8"-96.0-40-UHV-xx		DN160/NW150CF		
FCT-CF10"-147.6-40-UHV-xx	6"	DN/NW200CF	147.6	
FCT-CF12"-198.4-40-UHV-xx	8"	DN/NW250CF	198.4	
FCT-CFXX"-XXX-XX-UHV-10.0 V/A and lower				40.0

In-air FCT sensors

In-air FCT sensor order code	ID min (mm)	OD max (mm)	H max (mm)
FCT-016-xx	16	42	
FCT-028-xx	28	64	
FCT-055-xx	55	91	
FCT-082-xx	82	118	
FCT-122-xx	122	156	
FCT-178-xx	178	226	
FCT-XXX-2.5 V/A and lower			22
FCT-XXX-5.0 V/A and FCT-XXX-10.0 V/A			35

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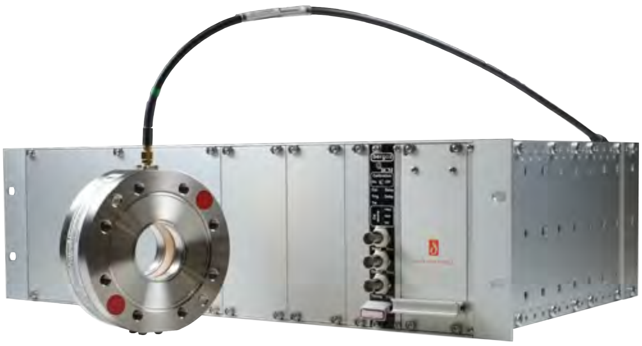
INSTRUMENTATION

ICT & BCM - Integrating Current Transformer with Beam Charge Monitor



Principle developed by K. Unser

ICT integrates bunch charge without loss
For FEL, transfer lines, injection/extraction monitoring
For laser-plasma, wakefield accelerators

Single very short bunches, down to femtoseconds are integrated without loss. Microsecond long trains of very short micro bunches are integrated with negligible loss.
High sensitivity for pC resolution pulse measurement

Operating principle
ICT combines two nested transformers: a shorted one-turn current transformer loads the full bunch charge instantly into capacitors. Then the charge is transferred to the output by a readout transformer, at a slow pace, to avoid core loss. Cores are specially annealed to lower their coercive field and further minimize core loss.
The ICT signal is integrated by BCM-IHR, a boxcar type asynchronous differential detector. The output voltage proportional to the beam pulse charge is available 30µs after the trigger. It is maintained up to 400µs, then reset. Another pulse can then be measured.

Two packaging types for the ICT

In-flange ICT are mounted directly in the beam line. UHV compatible. Available for many pipe diameters from 1” to 250mm. Also with elliptical aperture or other arbitrary shape aperture. Ceramic gap, shields and wall current bypass are included. Bellows are not required.

In-air ICT are installed over the vacuum chamber. It requires a “gap” in the vacuum chamber to prevent the wall current from flowing through the ICT aperture. The gap can be a brazed ceramic ring or an organic material O-ring depending on the vacuum requirements. Typical installations include bellows, a wall current bypass and an electromagnetic shield enclosing the ICT.

BCM-IHR-E inserts into a wired station of BCM-RFC, the 19” 3U RF-shielded chassis including power supplies.
Up to 10 stations per chassis can be installed.

Operating range
Using a 5Vs/C sensitive ICT, the noise per single bunch measurement is 0.55pC. Less noise may be obtained using higher sensitivity (10 or 20Vs/C) ICT.

DISTRIBUTORS

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CWCT & BCM-CW

CW Current Transformer
Beam Charge Monitor for
CW beams and macropulses

For CW beam and macropulses: ADS, SNS, HPPA

Beam repetition frequency 60~500 MHz
Average current with 1 μA resolution
Fast beam loss interlock 1 μs
Linearity error <1.5%
Beam loss resolution <1 %
Output voltage full scale (in 1 MΩ) -4 V ... +4 V

Independent of bunch shape and width
EMI, RFI, field and temperature immune

Based on our extensive knowledge of current transformers and analog electronics, the CWCT and the BCM-CW-E were designed by Hervé Bayle, Laurent Dupuy, Frank Stulle and Julien Bergoz.
Early sampling prototypes were developed by Hanjiao Chen, SINAP, Shanghai, during his internship at Bergoz Instrumentation.

Operating principle
The CWCT is a current transformer with strict limits on lower and upper cut-off frequencies, tailored to the beam RF. Its lower cut-off assures negligible droop between bunches. Yet, droop is high enough to allow fast differentiation.

Its upper cutoff is high enough to allow output signal return to baseline after each bunch, yet low enough to assure an output duty factor close to 50%. Thus it is tailored to the bunch length, allowing the measurement of short bunches.

The BCM-CW-E is the electronics module processing the CWCT output signal. By applying fast sample-and-hold techniques it measures the average beam current with microsecond response time. Properly adjusted signal amplification and filtering improves the resolution of small beam current fluctuations*.

* Patent pending EP17020307.9

Specifications

CWCT & BCM-CW sensitivity	20V/A			10V/A			5V/A		
Gain	0dB	20dB	40dB	0dB	20dB	40dB	0dB	20dB	40dB
Full scale	100mA	20mA	2mA	200mA	40mA	4mA	400mA	80mA	8mA
Uncertainty	+/- 100μA	+/- 10μA	+/- 1μA	+/- 200μA	+/- 20μA	+/- 2μA	+/- 400μA	+/- 40μA	+/- 4μA

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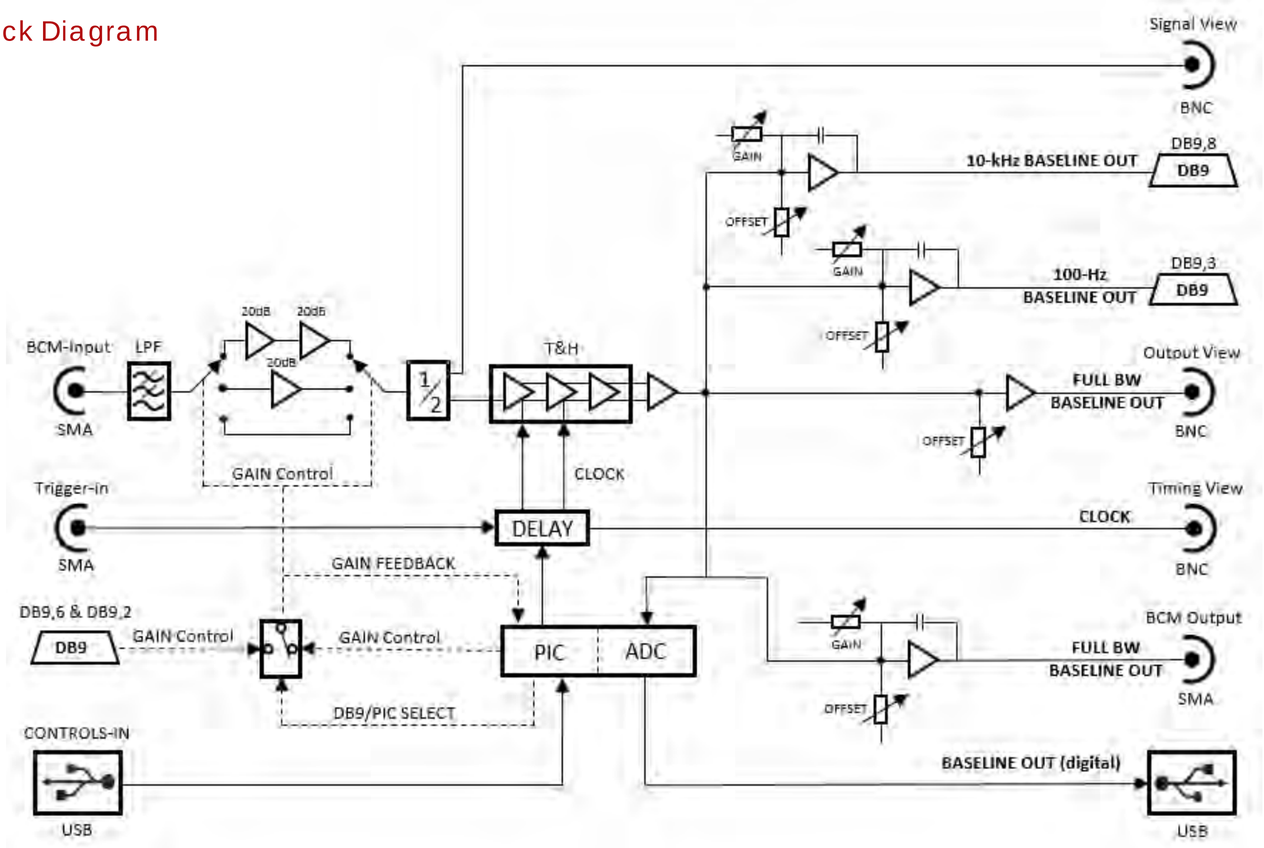
CWCT & BCM-CW

CW Current Transformer
Beam Charge Monitor for
CW beams and macropulses

Block Diagram



Order codes

CWCT dimensions

In-flange CWCT sensor (mating flange)	ID (mm)	Pipe OD	Part number	Beam RF
CF3"3/8 (DN50 NW50CF)	22.2	1"	CWCT-CF3"3/8-22.2-40-UHV-	xxx MHz
CF4"1/2 (DN63 NW63CF)	34.9	1.5"	CWCT-CF4"1/2-34.9-40-UHV-	xxx MHz
CF4"1/2 (DN63 NW63CF)	38.0	40 mm	CWCT-CF4"1/2-38.0-40-UHV-	xxx MHz
CF6" (DN100 NW100CF)	47.7	2"	CWCT-CF6"-47.7-40-UHV-	xxx MHz
CF6" (DN100 NW100CF)	60.4	2.5"	CWCT-CF6"-60.4-40-UHV-	xxx MHz
CF6"3/4 (DN130 NW130CF)	96.0	4"	CWCT-CF6"3/4-96.0-40-UHV-	xxx MHz
CF8" (DN160 NW150CF)	96.0	4"	CWCT-CF8"-96.0-40-UHV-	xxx MHz
CF10" (DN200 NW200CF)	147.6	6"	CWCT-CF10"-147.6-40-UHV-	xxx MHz
CF12" (DN250 NW250CF)	198.4	8"	CWCT-CF12"-198.4-40-UHV-	xxx MHz
			Axial length H	40 mm

Accessories

BCM-C-xx: SMA-SMA coaxial cable with PTFE connector dielectric, xx meters

BCM-RHC-xx: Radiation-tolerant SMA-SMA coaxial Radox cable with PEEK connector dielectric, xx meters

BCM-XTD: Module extender card

BCM-CW-E electronics

BCM-CW-E: Eurocard format 100 x 160mm, 20mm wide
To be plugged into BCM-RFC chassis station
May be mixed with BCM-IHR-E and BCM-RF-E in same chassis

BCM-RFC chassis

BCM-RFC/xx: 19”x3U RF-shielded chassis with xx wired stations (max. 10)
AC mains 90-125Vac or 220-245Vac
Switch selectable 50/60Hz

Options

-2CORE 2-core CWCT sensor doubles the sensitivity, halves the μA rms noise

-H Improved radiation tolerance

-316LN AISI 316LN instead of 304 SS

-ARBxxx Arbitrary aperture shape

ICT & BCM - Integrating Current Transformer with Beam Charge Monitor

In-flange ICT dimensions

In-flange ICT sensor order code	Pipe OD	Mating flange	ID (mm)
ICT-CF3"3/8-22.2-40-UHV-xx	1"	DN/NW50CF	22.2
ICT-CF4"1/2-34.9-40-UHV-xx	1.5"	DN/NW63CF	34.9
ICT-CF4"1/2-38.0-40-UHV-xx	40	DN/NW63CF	38.0
ICT-CF6"-47.7-40-UHV-xx	2"	DN/NW100CF	47.7
ICT-CF6"-60.4-40-UHV-xx	2.5"	DN/NW100CF	60.4
ICT-CF6"3/4-96.0-40-UHV-xx	4"	DN/NW130CF	96.0
or ICT-CF8"-96.0-40-UHV-xx		DN160/NW150CF	
ICT-CF10"-147.6-40-UHV-xx	6"	DN/NW200CF	147.6
ICT-CF12"-198.4-40-UHV-xx	8"	DN/NW250CF	198.4
ICT-CFXX"-XXX-XX-UHV-5 Vs/C and lower		Axial length H	40.0
ICT-CFXX"-XXX-XX-UHV-10 Vs/C and ICT-CFXX"-XXX-XX-UHV-20 Vs/C**			

In-air ICT dimensions

In-air ICT sensor order code	ID min (mm)	OD max (mm)	H max (mm)
ICT-016-xx	16	42	
ICT-028-xx	28	64	
ICT-055-xx	55	91	
ICT-082-xx	82	118	
ICT-122-xx	122	156	
ICT-178-xx	178	226	
ICT-XXX-2.5 Vs/C and lower			32
ICT-XXX-5.0 Vs/C and above			45
ICT-XXX-10 Vs/C and ICT-XXX-20 Vs/C**			

**For sensitivities 10 Vs/C and 20 Vs/C, please contact Bergoz Instrumentation for dimensions

Specifications

Sensitivity (nominal)	0.5	1.25	2.5	5.0	10	20	Vs/C
Turns ratio (old reference)	50:1	20:1	10:1	05:1	N/A	N/A	
Max. pulse train length	7.5	1.2	0.35	0.1	0.1	0.1	µs
- With Low droop option	20	4	10:01	0.25	0.25	0.25	µs

Integrating Current Transformer

Position dependence	Negligible
ICT output connectors	SMA, Radiation tolerant on option

Beam Charge Monitor - Integrate-Hold-Reset

Full scale ranges	Selectable in a range of 50:1 by TTL
Most sensitive range	800pC, using 5Vs/C ICT
Least sensitive range	400nC, using 0.5 Vs/C ICT
Range control	Full scale and polarity (4 TTL bits)
Noise on single bunch	0.55pCrms, limited by dynamic range
Dynamic range	>35'000, limited by resolution
Output	±8V, available 50µs after trigger, held for 350µs (up to 10ms on option)
Trigger	TTL, ≥10ns (NIM on option)
Trigger frequency	20kHz max. (ask factory for preset)
Front panel connectors	BNC 50Ω for oscilloscope: Signal View, Output View, Timing View
Back panel connectors	SMA Input, SMA Trigger input, SMA Output, DB9 for control lines
Front-panel controls	Integration window time potentiometer Trigger delay potentiometer
Calibration pulses	1pC, 10pC, 100pC, 1nC, accuracy ±2%
Calibration controls	Enable, polarity and charge, by TTL
Front-panel control	Calibration ON/OFF switch Calibration pulse delay potentiometer

Power Supply

Output	±15Vdc, 2 x 400mA, linear
Mains	95/125Vac - 215/245Vac, 48-62Hz, 30VA

Order codes

ICT	See codes in above tables
BCM-IHR-E	Beam Charge Monitor Integrate-Hold-Reset electronics module
BCM-RFC/xx	19"x3U RF-Shielded chassis, with xx equipped stations (max. 10)
BCM-Cxxx	SMA-SMA cable with PTFE dielectric plugs, XXX meters
BCM-RHCxxx	SMA-SMA cable with PEEK dielectric plugs, XXX meters

Options

-LD	Low droop
-316LN	AISI 316LN instead of 304
-ARB#xx	Arbitrary shape aperture
-BK150C	150°C (300°F) bakeable, In-flange only
-BK185C	185°C (365°F) bakeable, In-flange only
-VAC	Degassed in-air sensor
-H	Radiation tolerant sensor and connector

Environment

Temperature	
In-air models:	100°C (212°F) any time
In-flange models:	100°C (212°F) any time
On option:	150°C (300°F) 185°C (365°F)
Core saturation	2 mT radial field 2A permanent DC current
Radiation damage	
Standard SMA	PTFE: 1E3 Gray max
On option:	
Rad-tolerant SMA	PEEK: 6E7 Gray max 1E17 n/cm2 max

Turbo-ICT & BCM-RF

Turbo Integrating Current Transformer
RF Beam Charge Monitor

Optimized for low bunch charge >50fC
Optimized for low beam current >0.5µA

≈ 10fC noise in single bunch measurement
≈ 0.1µArms total wideband noise in current measurement

80dB measurement range without range switching
Resolution 1% / accuracy 4% of measured value
DC Output voltage, logarithmically proportional to input current or charge
USB 2.0 controls and readout up to 5kS/s
Negligible magnetic field dependence
UHV compatible down to 1E-10 mbar
Radiation tolerance of magnetic core material* >1016 n/cm2
* Est.: IRMM Geel, Dr. J.-M. Salomé

Innovative features of Turbo-ICT and BCM-RF
A low-loss alloy to limit core losses below 1% up to 350MHz.
Improved EMI/RFI immunity by a narrow-band transmission between Turbo-ICT and BCM-RF over an RF frequency carrier.

Turbo-ICT made with 1, 2 or 4 cores adjacent or superposed in a single In-flange package to achieve higher sensitivity.
Turbo-ICT amplifier and RF modulator powered by BCM-RF via the coaxial transmission cable to avoid ground loops.

BCM-RF allows two modes of operation:
- Track-Continuous mode for CW beam and long macropulses.
- Sample&Hold mode for single bunch, with auto trigger feature.
Output is logarithmically proportional to beam current or bunch charge.

Two modes of operation

CW and macropulse average current measurement
Typical measurement range 0.5µA – 3mA**
**Measurement range can be adapted for max currents up to 100mA
RF from 10 MHz to 350MHz
Output bandwidth >5MHz
Total noise ~0.1µArms over 5MHz

Single bunch charge measurement
For sub-nanosecond bunches
Typical measurement range 50fC – 300pC
Noise in single bunch measurement 10fCrms
Output DC voltage held until next bunch
Maximum bunch repetition rate 2 MHz

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Turbo-ICT & BCM-RF

Turbo Integrating Current Transformer - RF Beam Charge Monitor

Specifications

Beam type	CW beam and macropulses	Single bunch
BCM-RF set to	Track-Continuous Mode	Sample&Hold Mode
Measurement range	0.5µA - 3mA	50fC - 300pC
Bunch repetition frequency	10MHz - 350MHz	Single bunch <2MHz
Output specifications		
Voltage	0 - +5V log of beam current	0 - +5V log of bunch charge
Risetime	<70ns	<70ns
Reaction time	100ns for RF=100MHz 300ns for RF=10MHz	500ns to >99% final value
Noise	0.1µArms or 1% of current	10fC or 1% of charge
Non-linearity	≈2%	≈2%
Time response	Reports current variations to 10MHz	Hold till next bunch

* All values are typical performance
For special application, please contact us

Options

- -Turbo 1 — 1 core
- -Turbo 2 — 2 cores
- -Turbo 4 — 4 cores
- -CAL-FO — Calibrated fixed charge generator
Triggered by Fiber Optic signal
Mates with 1mm core plastic fiber
- -H — Improved radiation tolerance
- -316LN — AISI 316LN instead of 304 stainless steel
- -ARBxxx — Arbitrary aperture shape

Turbo-ICT is mounted directly on the beam line
UHV compatible to 1E-10 mbar
Improved radiation tolerance on option
Ceramic gap vacuum-brazed over kovar transitions
Material AISI-304, 316LN on option
Arbitrary shape aperture on option
1 core, 2 cores or 4 cores on option
Calibrated charge generator on option

Order codes

T-ICT dimensions

In-flange ICT sensor order code	Pipe OD	Mating flange	ID (mm)
ICT-CF3"3/8-22.2-40-UHV-	1"	DN/NW50CF	22.2
ICT-CF4"1/2-34.9-40-UHV-	1.5"	DN/NW63CF	34.9
ICT-CF4"1/2-38.0-40-UHV-	40	DN/NW63CF	38.0
ICT-CF6"-47.7-40-UHV-	2"	DN/NW100CF	47.7
ICT-CF6"-60.4-40-UHV-	2.5"	DN/NW100CF	60.4
ICT-CF6"3/4-96.0-40-UHV- or ICT-CF8"-96.0-40-UHV-	4"	DN/NW130CF DN160/NW150CF	96.0
ICT-CF10"-147.6-40-UHV-	6"	DN/NW200CF	147.6
ICT-CF12"-198.4-40-UHV-	8"	DN/NW250CF	198.4
		Axial length H	40.0

In-vacuum ICT sensor order code	Outer dimensions (mm)	ID (mm)
ICT-VAC-055-	175 x 126	55.0
ICT-VAC-082-	203 x 154	82.0
	Axial length H	30.0

BCM-RF-E electronics
BCM-RF-E: Eurocard format 100 x 160mm, 20mm wide to be plugged into BCM-RFC chassis station
May be mixed with BCM-IHR-E in same chassis

BCM-RFC chassis
BCM-RFC/xx: 19”x3U RF-shielded chassis with xx wired stations (max. 10)
AC mains 90-125Vac or 220-245Vac, switch selectable 50/60Hz

Turbo-ICT-VAC is installed in a laser-plasma vacuum enclosure
Vacuum compatible to 1E-7 mbar
Calibrated charge generator option not available
1 core or 2 cores on option

DISTRIBUTORS

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MX-BPM – Multiplexed BPM Electronics

Optimized for electron/positron Storage Rings
1μm X and Y resolution
Handles >75dB beam intensity range
Each button sampled up to 10 000 times per second

The Beam Position Monitor (BPM) is an all-analog electronics module with superior performance in a very small volume

On-board microstrip filters eliminate the need for costly tubular filters

GaAs switches provide superior button-to-button isolation and low insertion loss

On-board synthesized local oscillator eliminates the problem of external oscillator signal distribution with power splitters

Automatic Gain Control range >90dB provides optimum level for demodulator, independent of beam intensity, number of bunches

Phase-locked synchronous demodulation gives high linearity and noise suppression

Button signal range –70dBm...+5dBm at selected harmonic

X / Y output ±10V, 0V for on-center beam

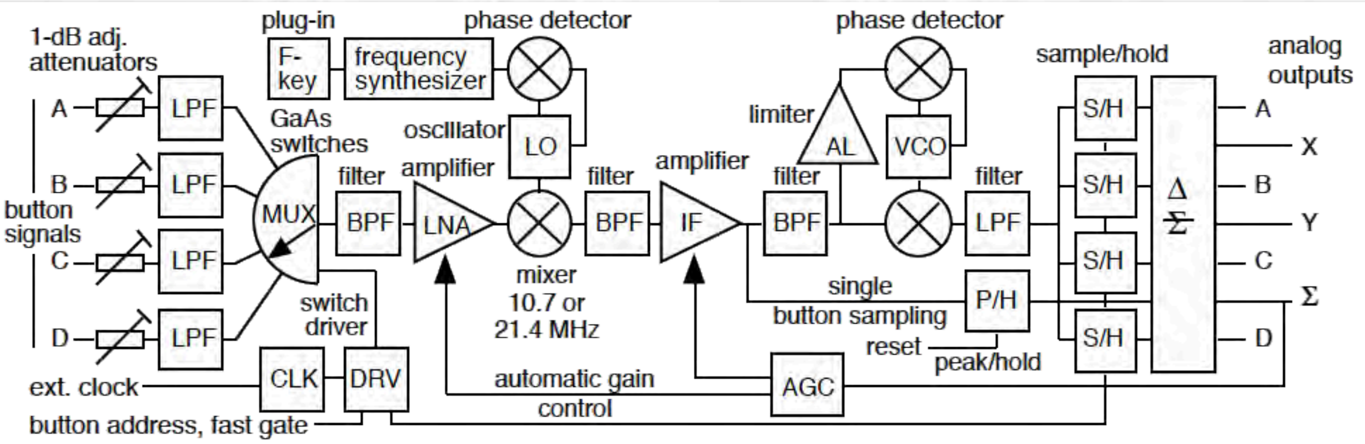
Operating principle

Button scanning mode

The signals from the four button electrodes are fed into the BPM module. The module processes the signals sequentially to give 3 analog output voltages: X, Y and Sum.
Four on-board variable 1-dB attenuators are used to equalize the button signals. Four on-board microstrip low-pass filters eliminate the unwanted beam harmonics before the signals are multiplexed by four GaAs switches. The switches close one at a time under the control of a local clock, sampling each button 2000 times per second. An external clock signal can override this onboard clock, to sample every button up to 10 000 times per second. The outputs of the four switches give a sequential signal, which is filtered by an on-board tunable band-pass filter. This filter allows easy selection of the chosen beam harmonic to be used. A low-noise preamplifier amplifies the signal under automatic gain control. A superheterodyne receiver processes the signal.
A mixer gives the intermediate frequency using its own on-board synthesized local oscillator. The LO frequency is given by a string of bits generated by a plug-in programmable frequency key. The automatic gain control of the intermediate frequency amplifier normalizes the sum of all button signals. A PLL synchronous demodulator provides high linearity. The demodulated signal is filtered and memorized by four sample-and-hold circuits under the control of the button scanning clock. The X and Y positions are obtained from the memorized value of the four buttons. Only additions and subtractions are needed to obtain the X and Y positions, because the sum of all four buttons is normalized at all times to a constant value.

MX-BPM – Multiplexed BPM Electronics

Block diagram



Specifications

Beam intensity range	>75dB
Input signals	+5dBm…–70dBm, 50Ω
Operating frequency	60…800MHz
Noise rms	<2mV [0…1 kHz] in +-10V @ +5dBm <5mV [0…1 kHz] in +-10V @ –35dBm <50mV [0…1 kHz] in +-10V @ –60dBm
Linearity error	On-center: <5mV [+5dBm…–35dBm] 2-mm off: <20 mV [+5dBm…–35dBm]
Sensitivity	User's choice. 1 V/mm recommended
X and Y gain	factory set according to pickup aperture
Buttons sampling	2 kSamples/s with internal clock Up to 10 kSamples/s with external clock
Local oscillator	Factory-set frequency
Intermediate frequency	21.4 MHz or 10.7 MHz, depending on *f*rev.
Outputs	X: ±10V, A–B–C+D, or D–B Y: ±10V, A+B–C–D, or A–C Sum: A+B+C+D, constant value (≈3V)
Front panel LED	PLL in lock
Single button sampling	Enable and Reset TTL commands
Button address	Two TTL addressing lines
Fast gate mode	Enable TTL command
Fast gate option	NIM (50Ω negative-going –16mA pulse)
Power supply	+15V, <200 mA, –15V, <40 mA
Connectors	Rear connector: DIN41612-M, 24+8 coax Coaxial connectors: 1.0/2.3 (4 units) Front panel connectors: DB9 female for test signal

Packaging

19" 3U RF-shielded chassis has up to 16 stations for BPM modules

Includes: ±15V power supply, 100…240Vac mains voltage
One test station
DB9 male connector for external commands
DB15 female connector per station, all outputs

Options

Fast NIM gate: to gate out specific bunch or bunch train

Accessories

Table-top test kit for one BPM. SMA connectors for button inputs, DB9 for external controls and DB15 for output signals.
Module extender for one BPM module. Allows one BPM module to be extended out of the chassis. Includes 1.0/2.3 coaxial connector extensions.
RF service module. Same size as BPM module, without electronics. When inserted in a station, connects the button signals from the chassis to four front-panel BNC.
TTL controls service module. Same size as BPM module, without electronics. When inserted in a station, connects the external control signals from the chassis to a front panel DB9.

Order codes

MX-BPM-xxxMHz-	BPM plug-in module, tuned to xxx-MHz operating frequency
-XxxxV/%-YxxxV/%	X and Y sensitivity
MX-BPM/CUS.xxx	One-time customizing charge for new frequency
Options:	
MX-BPM-FG	Fast NIM gate
Accessories:	
BPM-RFC/xx	Chassis with xx stations
BPM-KIT	Table-top test kit
BPM-XTD	Module extender card
BPM-SERV/RF	RF service module
BPM-SERV/CMD	TTL controls service module
BPM-LPF/1kHz	X and Y LP-filter
BPM-BPF/500MHz	SMA-SMA RF input BP-filter

DISTRIBUTORS

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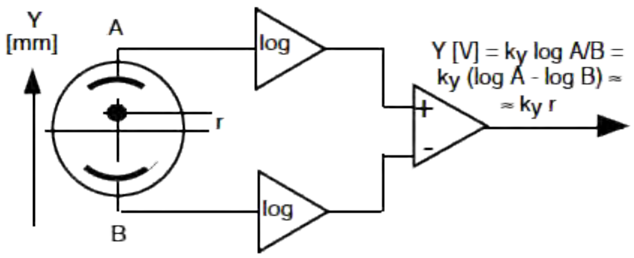
LR-BPM – Log-Ratio BPM Electronics

Non-interceptive beam position measurement
Optimal for single-pass short bunches
Linacs, transfer lines, first turns fast-cycling synchrotrons, boosters
Beam charge range >50dB

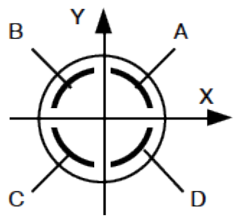
The Log-ratio BPM was developed by Alexander Kalinin, with contributions from Jim Hinkson and Klaus Unser. Based on Robert E. Shafer original concept.

Operating principle

Based on the pioneering work of Robert E. Shafer at Los Alamos Laboratory, the Log-Ratio BPM derives beam position from logarithm of the ratio of opposite pickup signals: Log(A/B).
Position measured by this method is more linear, over a wider range, than difference-over-sum.



The position of the beam from rotated pickups is obtained by axes translation to the vertical resp. horizontal plane by wideband analog circuits.



Signal processing

Signals from the pickups are stretched to produce bursts. This is essential to measure the single pass of a bunch. Four parallel logarithmic amplifiers detect the burst envelopes. Amplifiers' response is log of amplitude. Logs of opposite pickups are subtracted. If pickups are rotated, axes are translated to obtain X and Y positions. The process is all-analog, wideband.

The Log-Ratio Beam Position Monitor (LR-BPM) is an electronics module for fast analog processing of beam pickups signals.

Input signals parallel processing allows single-pass position measurement.

Bunches at any repetition rate up to 500MHz. Individual bunches can be distinguished from one another up to 5 MHz repetition.

L-band, S-band, X-band beams can be processed provided bunch groups are short (<3 ns).

±2V X and Y outputs are held until the next bunch when Sample & Hold mode (optional) is activated.

Provides log signal from each pickup electrode for computer analysis, with 5MHz bandwidth.

Log-Ratio BPM is plug compatible with Bergoz multiplexed BPM.

LR-BPM may be custom-built on daughter card for installation on user's DSP mother boards.

Cables length matching not critical: pickup signals don't need to be in phase

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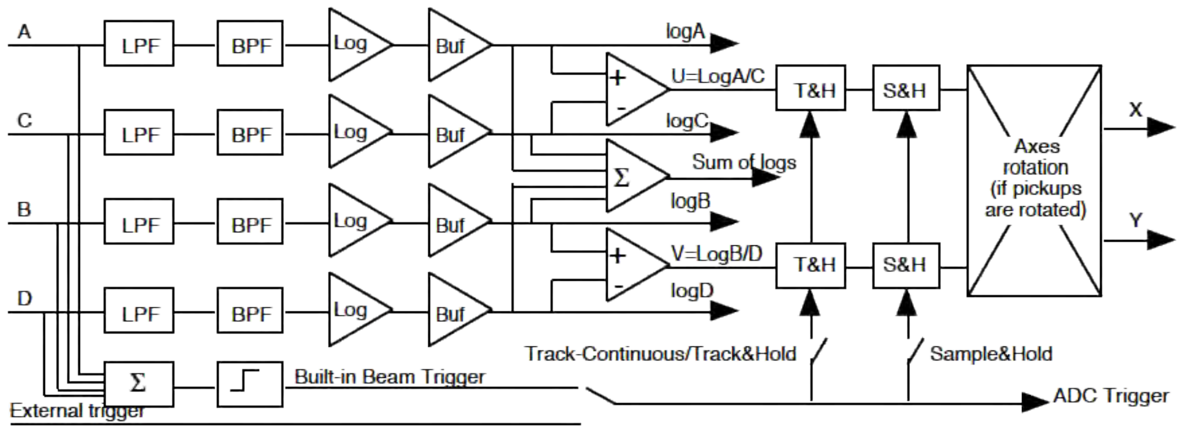
LR-BPM – Log-Ratio BPM Electronics

Block diagram



Specifications

Measures from single-pass bunch up to X-band under certain conditions. Below 5MHz repetition rate, individual position is reported. Above 5MHz repetition rate, average position is reported, with 5MHz response.
The input filter frequency *f* determines the acceptable bunch width. Filter frequency *f* is specified in Ordering Code LR-BPM-xxxMHz. Max. 500MHz.

Beam intensity range	>50dB. Single bunch 30pC ... 10nC
Single bunch (or group of bunches)	width ≤1/2*f* E.g. for *f*=50MHz: 10ns max width; *f*=500MHz: 1-ns max width
Bunch/group trains	*f* = repetition rate or multiple of rate *f*max=500MHz
Output frequency	<5-MHz rep rate, individual position is measured >5-MHz rep rate, average position is reported with 5-MHz bandwidth
Input signal max.	
Single bunch	10V in 1ns, 50Ω
Bunch trains	depends on *f*. At 500MHz: +5dBm, 50Ω
Outputs	X and Y: -2V...0...+2V, 40mA max Sum of logs: 0...+2V, 40mA max.
X and Y gain	1.5V = 1/2 of aperture radius for orthogonal pickups 1.0V = 1/2 of aperture for rotated pickups
Noise rms	
Single bunch	<3.5E-3 of aperture, e.g. <150µm in 20mm radius. Below 10pC (≈ 6E7 e-), increases 20dB/decade
Bunch trains	<2E-3 of aperture, in 0...5 MHz bandwidth, e.g. <100µm in 20mm radius Below -40dBm, increases 20dB/decade. Decreases with square root of bandwidth: E.g. <15µm above -40dBm in 100 kHz in 20mm radius.
Beam intensity position dependence	
On center	Near zero.
Off-center	Worst case when beam is 6dB off center (e.g. ±7mm in a 20mm radius aperture): ±3%
Temperature drift	0.6E-3 of aperture per degree, e.g. 25µm/K in 20mm radius aperture
Trigger output	>10-ns trigger after single bunch
Power supply	+15V, <300 mA; –15V, <300 mA

Order codes

LR-BPM-xxxMHz	Log-ratio BPM plug-in module
On-board factory-installed options:	
LR-BPM-SH	Sample and Hold on X and Y outputs
LR-BPM-TRG	Beam Trigger, built-in
LR-BPM-SUM	Sum of log (A,B,C,D)
Accessories:	
BPM-RFC/xx	RF-chassis, ≤16 stations 19" rack-mountable 3U-high EMIRFI-shielded chassis for 100~240V 50~60Hz mains power, features up to 16 stations for any mix of Log-ratio BPM or Multiplexed BPM
BPM-KIT	Table-top test kit 100~240V 50~60Hz powered kit Pickup inputs on SMAs Outputs on BNCs and DB15
BPM-XTD	Module extender card
BPM-SERV/RF	RF service module Passive module. Brings the pickup signals from the back connectors to front panel BNCs

Packaging

LR-BPM module is 3U-high x 160mm shielded Euromodule; 20-mm wide.
Interchangeable / plug-compatible with Bergoz Instrumentation Multiplexed BPM modules. Both log-ratio and multiplexed BPMs can be installed in same chassis for mixed applications.
LR-BPM can be supplied as a custom-built daughter card for user installation on DSP mother boards.

S-BPM – S-band / L-band BPM Electronics

Non-interceptive beam position measurement
For linacs, microtrons and transfer lines
Single bunch, macropulse and CW
Beam charge range > 1000

The S-band / L-band Beam Position Monitor (S-BPM) is an electronics module for fast analog processing of beam pickups signals.

Single-pass bunch and macropulses can be measured thanks to parallel processing of inputs.

Macropulses and single bunches up to 2MHz repetition rate can be measured individually. X and Y coordinates are memorized until the next macropulse or bunch.

CW beam can be measured continuously. X and Y coordinates are available permanently. Beam position motions up to 5MHz can be observed.

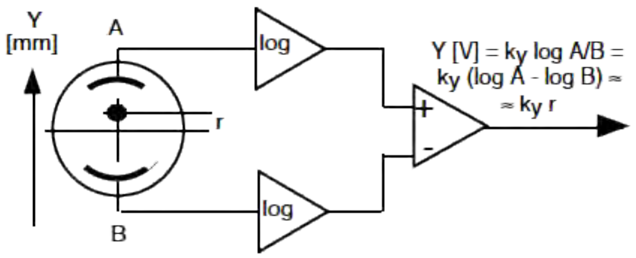
X and Y outputs are strong analog ±2V signals.

S-band / L-band BPM is compatible with Bergoz' multiplexed BPM and Log-Ratio BPM. They can be plugged in the same chassis.

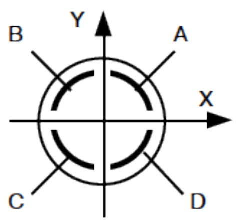
Precise phase matching of input signals is not required.

Operating principle

Based on the pioneering work of Robert E. Shafer at Los Alamos Laboratory, the Log-Ratio BPM derives beam position from logarithm of the ratio of opposite pickup signals: Log(A/B).
Position measured by this method is more linear, over a wider range, than difference-over-sum.



The position of the beam from rotated pickups is obtained by axes translation to the vertical resp. horizontal plane by wideband analog circuits.



Signal processing

Signals from the pickups are stretched to produce bursts. This is essential to measure the single pass of a bunch. Four parallel logarithmic amplifiers detect the burst envelopes. Amplifiers' response is log of amplitude. Logs of opposite pickups are subtracted. If pickups are rotated, axes are translated to obtain X and Y positions. The process is all-analog, wideband.

Front-end Filter / Amplifier FEFA

One Front-end Filter / Amplifier is required for every BPM pickup electrode. It is tuned to the beam RF or an harmonic and powered from the S–BPM module via the coaxial cable linking them together. S-BPM FEFA must be installed close to the BPM pickup block, e.g. 1 meter.

DISTRIBUTORS

U.S.A.: GMW Associates
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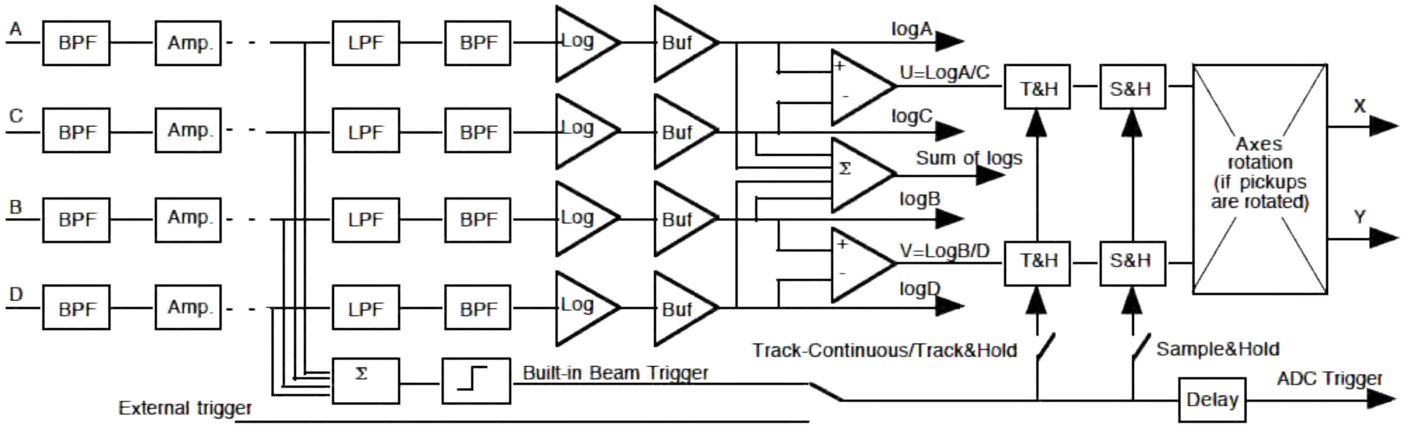
S-BPM – S-band / L-band BPM Electronics

Block diagram



Specifications

S–BPM measures beam position from buttons or stripline pickups. It can measure CW beams or single pass of single bunches and macropulses up to 2 MHz repetition rate.
The position output of CW beams has 5 MHz bandwidth.
The operating frequency is determined by the FEFA Front-End Filter / Amplifier frequency. E.g. S-FEFA/2856MHz.
For S-band, 2 frequencies are standards: 2.856 GHz and 2.999 GHz.
For L-band, all filter frequencies are made to order.

Single bunch range	10 pC ... 10 nC*
Macropulse and CW	36 uA ... 36 mA*
	*assuming 45° pickup subtending angle
Repetition rate	5 MHz max, or CW
Outputs	X and Y: -2V... 0...+2V, 40mA max Sum of logs: 0...+2V, 40mA max
X and Y gain	1.5V = half of radius for orthogonal pickups 1.0V = half of radius for rotated pickups
X and Y noise	For CW beam: <200µVrms, e.g. 2µm rms in a 40-mm pickup aperture For macropulse and single bunch: <7mVrms, e.g. 70um rms in a 40-mm pickup aperture
Intensity dependence	On center: Negligible Off-center: <3% gain error
Temperature drift	6E-4 of aperture per degree, e.g. 25µm/K in a 40-mm pickup aperture
ADC trigger output	When X and Y ready: positive or negative edge
Power supply	+ 15V, <500 mA; – 15V, <500 mA includes power for front-ends

Order codes

S-FEFA/xxxMHz	Front-end Filter / Amplifier Operating frequency xxxMHz One unit for each pickup electrode
S-BPM	S-band / L-band plug-in module

On-board factory-installed options:

S-BPM-SH	Sample and Hold on X and Y outputs
S-BPM-TRG	Beam Trigger, built-in
S-BPM-SUM	Sum of log (A,B,C,D)

Accessories:

BPM-RFC/xx	RF-chassis, ≤16 stations 19” rack-mountable 3U-high EMI-RFI-shielded chassis for 100~245V 50~60Hz mains power
BPM-KIT	Table-top test kit 100~245V 50~60Hz powered kit Pickup inputs on SMAs Outputs on BNCs and DB15
BPM-XTD	Module extender card
BPM-SERV/RF	RF service module Passive module. Brings the pickup signals from the back connectors to front panel BNCs

Packaging

S-BPM module is 3U-high x 160mm shielded Euromodule; 20-mm wide.
Interchangeable / plug-compatible with other Bergoz Instrumentation’s BPM modules. S-BPM can be installed in same chassis as LR-BPM, BB-BPM and MX-BPM for mixed application.

BB-BPM – BaseBand BPM Electronics

For cancer therapy synchrotrons
Tracks the beam during energy ramp

Optimized for proton/carbon beams
Handles >70dB beam intensity range
Up to 40dB additional gain preamplifier

BB-BPM module was originally developed by A. Kalinin and redesigned by S. Artinian. It is based on Robert E. Shafer's original concept.

The BaseBand BPM is a log amplifier-based beam position monitor. It operates up to 25MHz.

Output signals are analog voltages:
X&Y narrowband outputs for close orbit measurement
X&Y wideband outputs for machine study, to see orbit changes or instabilities during the ramp

Cable length matching not required: pickup signals don't need to be in phase

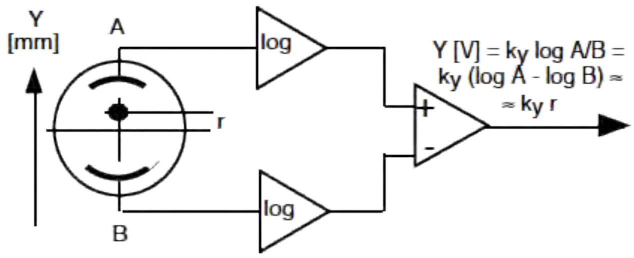
To prevent noise pickup by way of ground loops:
- The front-end amplifiers and filters are powered via their RF output coaxial cables
- The front-end amplifiers gain is controlled by fiber optic signals

Front-end Filter and Amplifier BB-BPM-FEFA

Four BB-BPM-FEFA are required for each BB-BPM plug-in module, one per pickup.
BB-BPM-FEFA has been specifically developed to measure low intensity ion beams. It is best to install it very close to the stripline or shoebox pickups to minimize capacitive loading.
Control of BB-BPM-FEFA gain is done by FO fiber optics, one per front-end amplifier.
A single control FO can be daisy-chained to all front-end amplifiers. The FO signal is under user's control.
The user must provide FO with a high level to switch the gain from 0dB to nominal value.

Operating principle

Based on the pioneering work of Robert E. Shafer at Los Alamos Laboratory, the Log-Ratio BPM derives beam position from logarithm of the ratio of opposite pickup signals: Log(A/B).
Position measured by this method is more linear, over a wider range, than difference-over-sum.



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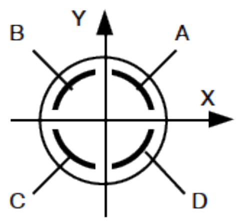

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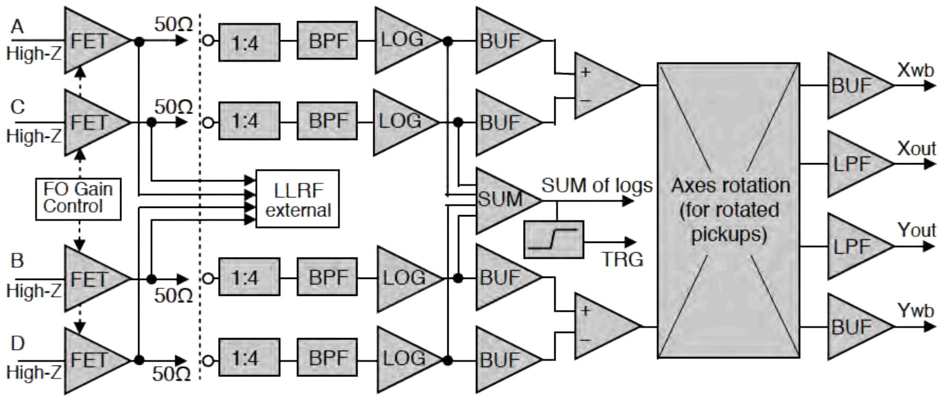
BB-BPM – BaseBand BPM Electronics

Block diagram



Specifications

	BB-BPM-FEFA Amplifier and filter	BB-BPM Log-Ratio processor
Input intensity range	0dB or +40dB switchable gain	>70dB continuous gain
Frequency range	200kHz - ≤25MHz	200kHz - ≤25MHz
Input signal	High impedance 2.5Vmax	-70dBm - +5dBm
Input noise floor	25nV/√Hz	<-70dBm
Controls	Gain control by FO Daisy chain	N/A
Power supply max	+15V, 1.5W supplied by BB-BPM	±15V, 9W includes supply to BB-BPM-FEFA
Output to external LLRF	50Ω unity gain pickup image	None
Outputs	When measured in 50**Ω** load or 100**Ω** differential load	When measured in high-impedance load
X & Y Narrowband for close orbit on front panel DB9	-2V…0…+2V 0V on center 25MHz bandwidth	-5V…0…+5V 0V on center 25MHz bandwidth
X & Y Wideband for machine study on front panel DB9	-2V…0…+2V 0V on center 25MHz bandwidth	-5V…0…+5V 0V on center 25MHz bandwidth
X&Y gains Orthogonal PU	0.75V for ½ radius	1.5V for ½ radius
X&Y gains Rotated PU	0.5V for ½ radius	1.0V for ½ radius
Output noise rms for input >1mV	<0.1% of pickup radius, e.g. 100µm in 100mm radius	<1% of pickup radius, e.g. 100µm in 100mm radius
Linearity error As % of pickup radius	On-center <0.1% e.g. 100µm in 100mm radius	Off-center <1% e.g. 100µm in 100mm radius
Temperature drift as % of pickup radius	300 ppm/K e.g. 30µm/K in 100mm radius	

Order codes

BB-BPM-E	Eurocard format 100 x 160mm, 20mm wide to be plugged into one BPM-RFC chassis station. May be mixed with LR-BPM-E and MX-BPM-E in same chassis
BB-BPM-FEFA/xxdB	W40mm, L80mm, H22mm front-end Filter and amplifier with F.O. selectable gain 0dB or xxdB. Features four 3-mm mounting holes.
BPM-RFC/xx	19"x3U RF-shielded chassis with xx wired stations (power-limited to up to 8 stations) AC mains 90-245Vac, 50/60Hz
Accessories:	
BPM-Cxx	SMA-SMA coaxial cable with PTFE connector dielectric, xx meters
BPM-RHCxx	Radiation-tolerant SMA-SMA coaxial Radox cable with PEEK connector dielectric, xx meters
BPM-KIT	Table-top test kit for one XX-BPM-E, with SMA inputrs and BNC output
BPM-XTD	Module extender card
BPM-SERV/RF	RF service module Passive module. Brings the pickup signals from the back connectors to front panel BNCs

DISTRIBUTORS

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VWM – Vibrating Wire Monitor

Beam transverse profile and position Beam Halo measurement

Fixed or moving sensor for protons, ions, electrons, photons, neutrons:

Electron beam scan in vacuum
- 20 MeV electrons
- 70pA wire-intercepted current resolution

Proton beam scan in vacuum
- 15 GeV protons
- 3pA wire-intercepted current resolution

Photon beam scan in vacuum
- 14 keV photon mean energy
- 1.4E+7 ph/s wire-intercepted flux resolution

Photon beam scan in air
- 100 keV photon mean energy
- 3E+13 ph/s wire-intercepted flux resolution

Specifications

Frequency resolution		<0.01Hz
Thermal resolution per wire material		
Stainless steel SS		0.3mK
Bronze B		0.6mK
Tungsten W		1.0mK
Deposited heat power resolution		
	In vacuum	In air
Stainless steel SS	7E-9 W	1E-6 W
Bronze B	5E-8 W	2.6E-6 W
Tungsten W	3E-7 W	5.4E-6 W
Response time	In vacuum	In air
Stainless steel SS	20s	0.23s
Bronze B	9s	0.21s
Tungsten W	2s	0.16s

Order codes

VWM-S-1W-A__mm	Sensor, 1 wire, __mm free aperture Possible apertures: 5, 20, 40, 60mm
-SS	Stainless steel wire
-B	Bronze wire
-W	Tungsten wire
VWM-FEE	Front-end electronics for 2 wires
VWM-RFC	Chassis housing up to 6 boards
VWM-2WB	Board supporting 2 wires
VWM-RJC/xx	RJ45 cable Cat.5, max 50m

VWM was developed on the basis of Suren Arutunian Vibrating Wire Scanner.
Dr. Arutunian received the Faraday Cup 2008 for this innovation

VWM system components

- VWM 1-wire Sensor
- Twisted pair cable from Sensor to Front-End Electronics
- Front-End Electronics box, each supports 2 Sensors
- Front-end to chassis RJ45 cable, up to 50 meters
- Chassis, can support up to 6 Front-End Electronics

DISTRIBUTORS

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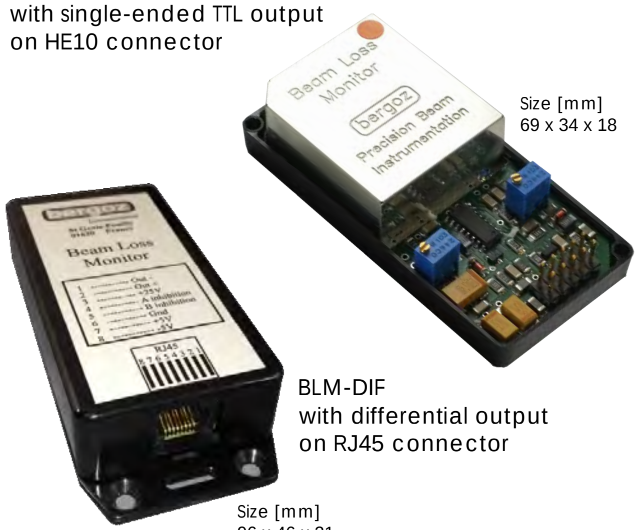
BLM – Beam Loss Monitor

BLM-SE
with single-ended TTL output
on HE10 connector



Size [mm]
69 x 34 x 18

BLM-DIF
with differential output
on RJ45 connector

Size [mm]
96 x 46 x 21

K. Wittenburg was awarded the Faraday Cup in 2000 for the design of the PIN photodiode Beam Loss Monitor and its implementation at HERA. Bergoz Instrumentation was granted a license by DESY to use Wittenburg's original development.

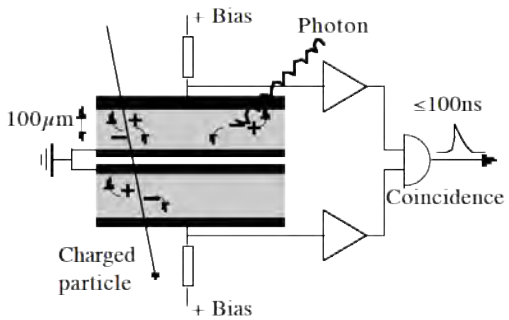
Largest dynamic range
Lowest cost of any BLM

This Beam Loss Monitor (BLM) is a new approach to measure and localize beam losses.
Very small size and low unit cost make it possible to monitor all locations where beam loss is predicted.
Vacuum quality around the storage ring can be measured based on BLM count rate.
Two PIN-photodiodes mounted face-to-face detect charged particles. Coincidence counting make it insensitive to synchrotron radiation photons.
Spurious count very low: < 1 count in 10 s
Up to 10MHz counting: dynamic range > 1E8
Recovers 100 ns after a hit
Choice of detector solid angle: Large PIN-diodes can be user installed.
Output is a TTL compatible pulse: easy counting
Tested successfully up to 1 MGray for hardness.

Specifications

Single particle detection efficiency	>30%
PIN-photodiode surface	7.34 mm^2
Spurious count rate	<0.1Hz
Maximum count rate	>10MHz
Count rate @ 6kGray/yr SR photons	≈ 100 Hz
Same with 3cm lead shielding	≈ 1Hz
Output	positive TTL 50Ω pulse
Cable driving capability	>200m RG213
Output female connector	10-pin HE10
Power supply	+5V <50mA; 45mA typ.
	–5V <80mA; 72mA typ.
	+24V <10mA; 4mA typ.

Operating principle



The charged particle crosses both PIN diodes, causing a coincidence.
Synchrotron radiation photons, if stopped by either PIN-diode, do not cause a coincidence.

Order codes

BLM-SE	BLM with single-ended output
BLM-DIF	BLM with differential output

DISTRIBUTORS

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