USER MANUAL

VFCT

Very Fast Current Transformer

Rev. 1.0

bergoz INSTRUMENTATION

More than 40 years of experience recognized in the world of particle accelerators

Record of updates

Version	Date	Updates performed
1.0	04/2025	Initial release

DISTRIBUTORS

U.S.A.

GMW Associates
www.gmw.com
sales@gmw.com

Japan

Hayashi-Repic Co., Ltd.
www.h-repic.co.jp
sales@h-repic.co.jp

India

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

China

Beijing Conveyi Limited
www.conveyi.com
sales@conveyi.com

South Korea

Seyoung Co., Ltd
www.seyoungsys.com
apark@seyoungsys.com

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INITIAL INSPECTION

It is recommended that the shipment be inspected immediately upon delivery. If it is damaged in any way, contact Bergoz Instrumentation or your local distributor. The content of the shipment should be compared to the items listed on the invoice. Any discrepancy should be notified to Bergoz Instrumentation or its local distributor immediately. Unless promptly notified, Bergoz Instrumentation will not be responsible for such discrepancies.

WARRANTY

Bergoz Instrumentation warrants its beam current monitors to operate within specifications under normal use for a period of 60 months from the date of shipment. Spares, repairs and replacement parts are warranted for 90 days. In exercising this warranty, Bergoz Instrumentation will repair, or at its option, replace any product returned to Bergoz Instrumentation or its local distributor within the warranty period, provided that the warrantor's examination discloses that the product is defective due to workmanship or materials and that the defect has not been caused by misuse, disassembly, neglect, use of faulty part, accident or abnormal conditions, repair made by the customer, or operations. Damages caused by ionizing radiations are specifically excluded from the warranty. Bergoz Instrumentation and its local distributors shall not be responsible for any consequential, incidental or special damages.

ASSISTANCE

Assistance in installation, use or calibration of Bergoz Instrumentation beam current monitors is available from Bergoz Instrumentation, 01630 Saint Genis Pouilly, France. It is recommended to send a detailed description of the problem by email to info@bergoz.com.

SERVICE PROCEDURE

Products requiring maintenance should be returned to Bergoz Instrumentation or its local distributor: The purchaser/customer must ask for a RMA (Return Material Authorization) number to Bergoz Instrumentation or its local distributor before return of goods. Bergoz Instrumentation will repair or replace any product under warranty at no charge.

For products in need of repair after the warranty period, Bergoz Instrumentation will assess the technical issue and send a quote to the purchaser/customer. The purchaser/customer must provide a purchase order before repairs can be initiated. Bergoz Instrumentation can issue fixed price quotations for most repairs.

RETURN PROCEDURE

All products returned for repair should include a detailed description of the defect or failure as well as name, phone number and email of a contact person to allow further inquiry. Contact Bergoz Instrumentation or your local distributor to determine where to return the product. Returns must be notified by email prior to shipment.

The shipment of a product under warranty or out of warranty back to the factory is paid by the user/customer, including the customs fees. The return of this repaired product under warranty back to the customer is paid by Bergoz Instrumentation.

Return of product out of warranty should be made prepaid or will be invoiced. Bergoz Instrumentation will not accept freight-collect shipments. Shipments should be made via UPS, FedEx or DHL. Within Europe, the transportation services offered by the national Post Offices can be used. The delivery charges or customs clearance charges arising from the use of other carriers will be charged to the customer.

SAFETY INSTRUCTIONS

The Toroid sensor contains materials such as cobalt and iron. Those materials may become radioactive when exposed to high energy particle beams. Follow applicable radiation-safety procedures when the Toroid sensor must be handled.

GENERAL DESCRIPTION

The VFCT is a passive device. It contains no active electronics. It has a rise time as low as 120 ps, corresponding to 3 GHz upper frequency cutoff (-3 dB).

The differential output signal is provided by two SMA connectors which must be measured using 50Ω termination. They can either be measured using two oscilloscope or digitizer channels. Or by attaching a balun and measuring the balun output on one oscilloscope or digitizer channel. When measuring the two signals separately, the difference of the obtained waveforms must be calculated. In any case, exact timing of the two VFCT output signals must be maintained.

The VFCT is available as in-flange models only. That means, it is embedded in a pair of flanges. Flanges are Conflat with usual inner diameters.

These current transformers are UHV compatible at least to 1e-9 mbar. Soap or alcohol cleaning before installation is however recommended. To reach pressure down to 1e-11 mbar, adequate pumping and prior cleaning, e.g. plasma, are required.

Current transformer temperature should never exceed 100°C (212°F) at any time during bake out or operation.

Current transformer wall current break (“gap”) is a ceramic ring (Al2O3 99.7%) brazed onto two Kovar transition sleeves.
Standard models are made from AISI 304 steel, AISI 316LN is available on option.

In-flange VFCT part numbers follow below syntax:

In-flange VFCT	
-CFx”-	x” is the CF flanges OD [inch]
-xx.x-	xx.x is the sensor ID [mm]
-xx-	xx is the sensor axial length [mm]
-UHV-	UHV: Sensor UHV compatible with brazed ceramic wall current break; - As delivered down to 1e-9 mbar - After adequate cleaning down to 1e-11 mbar
-xx.x	xx.x is the sensitivity of the sensor [V/A]
Example: VFCT-CF6”-34.9-40-UHV-1.0	
Options for In-flange VFCT	
-316LN-	In-flange VFCT sensor in AISI316LN instead of 304

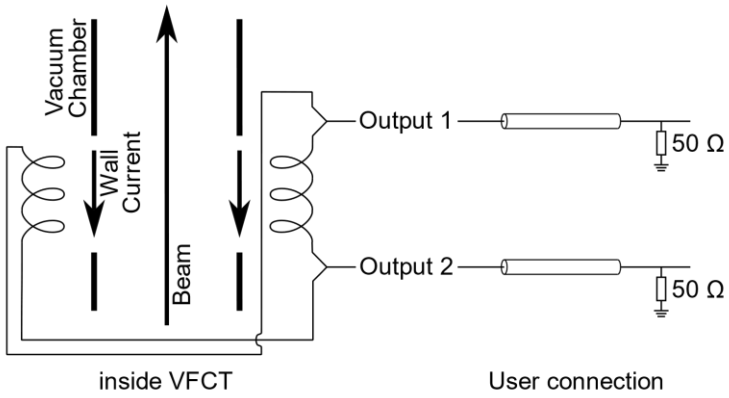
VFCT main advantages

- The VFCT displays the beam current with a minimum of distortion up to very high frequency. It is therefore, primarily, an instrument to be used with an oscilloscope.
- Very low ringing when it is properly installed (See: "Installation on the vacuum chamber" in this manual).

VFCT limitations

- The VFCT, like all transformers, differentiates the signal. Compared to other current transformers, its lower cut-off frequency is high. Strong output signal droop shall be expected, if observed pulses are longer than a few 10 nanoseconds.
- Eddy current losses can heat up VFCT ceramic break or its interior parts. This may lead to malfunction if power losses are excessive.

OPERATING PRINCIPLE



VFCT CHARACTERISTICS

VFCT bandwidth is limited by a lower and an upper cutoff frequency.

Lower cutoff frequency

The droop is equal to

$$D = 2\pi f_{low}$$

Where
D [1/s] is the droop
f_{low} [Hz] is the lower cutoff frequency (-3dB)

The droop is also equal to

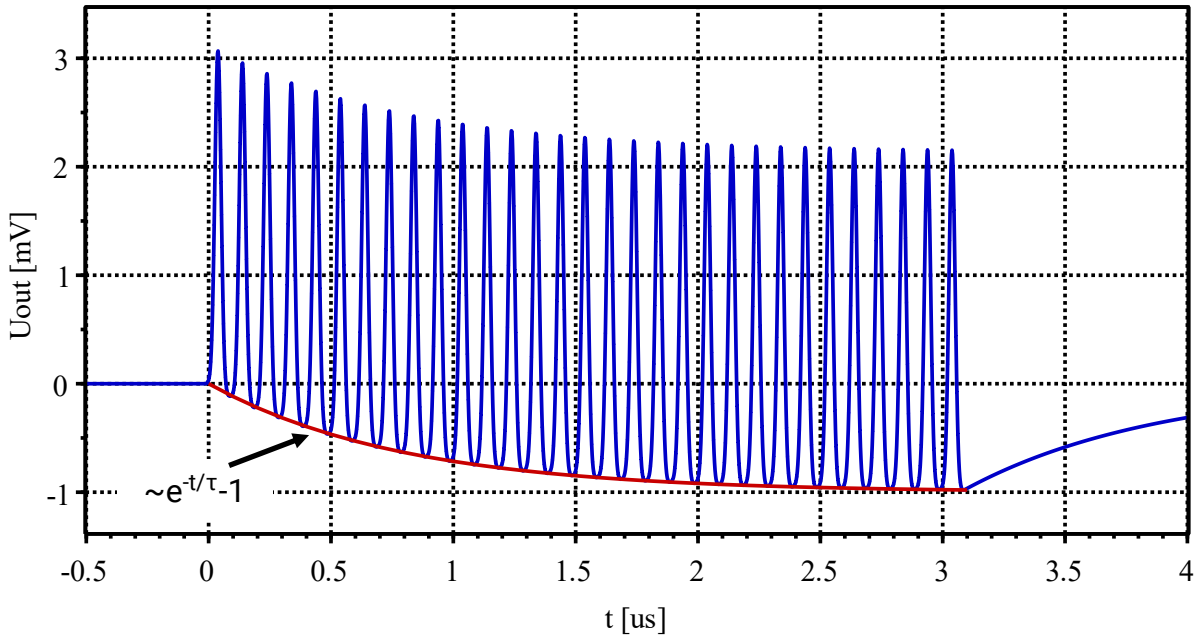
$$D = \frac{1}{\tau}$$

Where
τ [s] is the differentiating time constant

The differentiating time constant describes how fast the output signal will decay after being excited by a step:

$$U_{out}(t) = U_{out,0}\, e^{-t/\tau}$$

Example of VFCT output signal droop:
Observe on the plot below the effect of a transformer's lower cutoff frequency, i.e., its droop.



Upper cutoff frequency

The upper cutoff frequency (-3dB) is the consequence of a complex combination of elements:

a) The eddy currents which are developing inside transformer cores.

b) The parasitic capacitance of the transformer wire windings, e.g., the capacitance between adjacent turns, between wire and core, between wire and outer shell.

c) The wire inductance.

Finally, the necessary impedance adaptation between the transformer winding source impedance, the 50 ohm output connector and the cable further limits the bandwidth.

SPECIFICATIONS

Sensitivity (nominal)	1.0	V/A
Rise time (typ.)	120	ps
Droop (typ.)	<0.13	%/ns
Upper cutoff frequency -3dB (typ.)	3	GHz
Lower cutoff frequency -3dB (typ.)	200	kHz
L/R time constant (typ.)	800	ns

ELECTRICAL CONNECTIONS

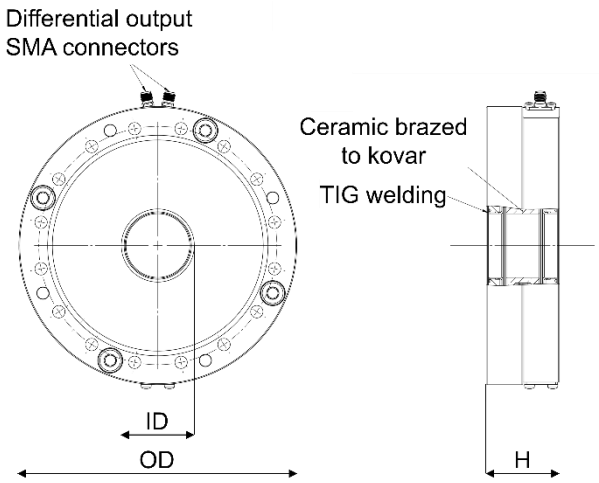
VFCTs are equipped with two SMA jack connectors with PTFE dielectric.

OUTPUT SIGNAL POLARITY

The VFCT is bipolar.
Arrows are printed on the outer surface of the sensor. Charges (positive) crossing the aperture in the direction of the arrow give positive outputs. For example, an electron beam (= negative charge) passing in the direction of the arrow yields a negative output.

MECHANICAL DIMENSIONS AND DRAWINGS

In-flange models



In-flange VFCT sensor order code	Flange OD (inch)	Pipe OD (inch)	Mating flange	VFCT ID (mm)	VFCT H (mm)
VFCT-CF6"-34.9-40-UHV-xx	6”	1.5"	DN/NW100CF	34.9	40.0

For other diameters please ask Bergoz Instrumentation.

Drawings

Drawings in .pdf can be found on our website:
www.bergoz.com :: VFCT :: Downloads :: Technical drawings
Dimensions missing on the website can be obtained asking info@bergoz.com

INSTALLATION

In-flange models

In-flange model mechanical parts are in direct electrical contact with the vacuum chamber. Its output connector body and, hence, the coaxial cable shield are also in direct electrical contact with the vacuum chamber. It is therefore important to equip every segment of the coaxial cable with common mode filters to mitigate ground loops. A cable segment is any section of cable between two grounded connectors or bulkheads, for example through a grounded patch panel.

In-flange VFCT bolts must be tightened at the recommended torque according to the flange type, but not beyond.

Common mode filters

To improve EMI rejection common mode filters should be installed at both ends of each cable segment. Each filter shall comprise a MnZn ferrite core for high frequency >500 MHz rejection, and an iron-based nanocrystalline core with soft B-H loop for low frequency rejection.

VFCT RADIATION RESISTANCE

VFCTs contain materials which may be damaged by ionizing radiation. They are listed hereafter:

Organic and radiation-sensitive materials used in the VFCT sensor[1]:

Component	*Material*	*Radiation resistance*
Wiring insulation	Polyester 1350 tape	10^6 Gy
	Fiber glass	> 10^8 Gy
	with rubber adhesive	> 10^6 Gy
Stress absorbent	Silicon rubber tape SIR	5 x 10^5 Gy
	Silicon rubber SIR	2 x 10^5 Gy
Connector dielectric	PTFE “Teflon”	< 10^3 Gy

The above radiation resistance values are indicative only. They do not imply any guarantee of whatever nature from the manufacturer.
The manufacturer specifically declines any responsibility for any damage, direct or consequential, caused by ionizing radiations.

[1] *Source: Compilation of Radiation Damage Test Data, H.Schönbacher et al.,*
CERN 79-04: http://cds.cern.ch/record/133188/files/CERN-HS-RP-038-YR-PARTI.pdf?version=1
CERN 79-08: http://cds.cern.ch/record/141784/files/CERN-HS-RP-093.pdf?version=1
CERN 82-10: http://cds.cern.ch/record/141784/files/CERN-HS-RP-093.pdf?version=1
CERN 89-12: http://cds.cern.ch/record/205520/files/CERN-89-12.pdf?version=1

More information and latest manuals revisions can be found on our website

www.bergoz.com

If you have any questions, feel free to contact us by e-mail

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