

# Parametric Current Transformer

The Parametric Current Transformer (PCT) is an instrument designed for the non-destructive measurement of charged particle beam currents.

Full scale ranges are true bipolar. They can be from  $\pm 1$  mA to  $\pm 10$  A with resolution down to  $0.2 \mu\text{A}$ .

The frequency response is from DC up to 100kHz.

The very large dynamic range ( $2 \times 10^7$ ) makes it the ideal beam current monitor for particle accelerators.

It is also particularly suitable for high resolution measurement of electric currents when galvanic insulation up to high voltages is required.

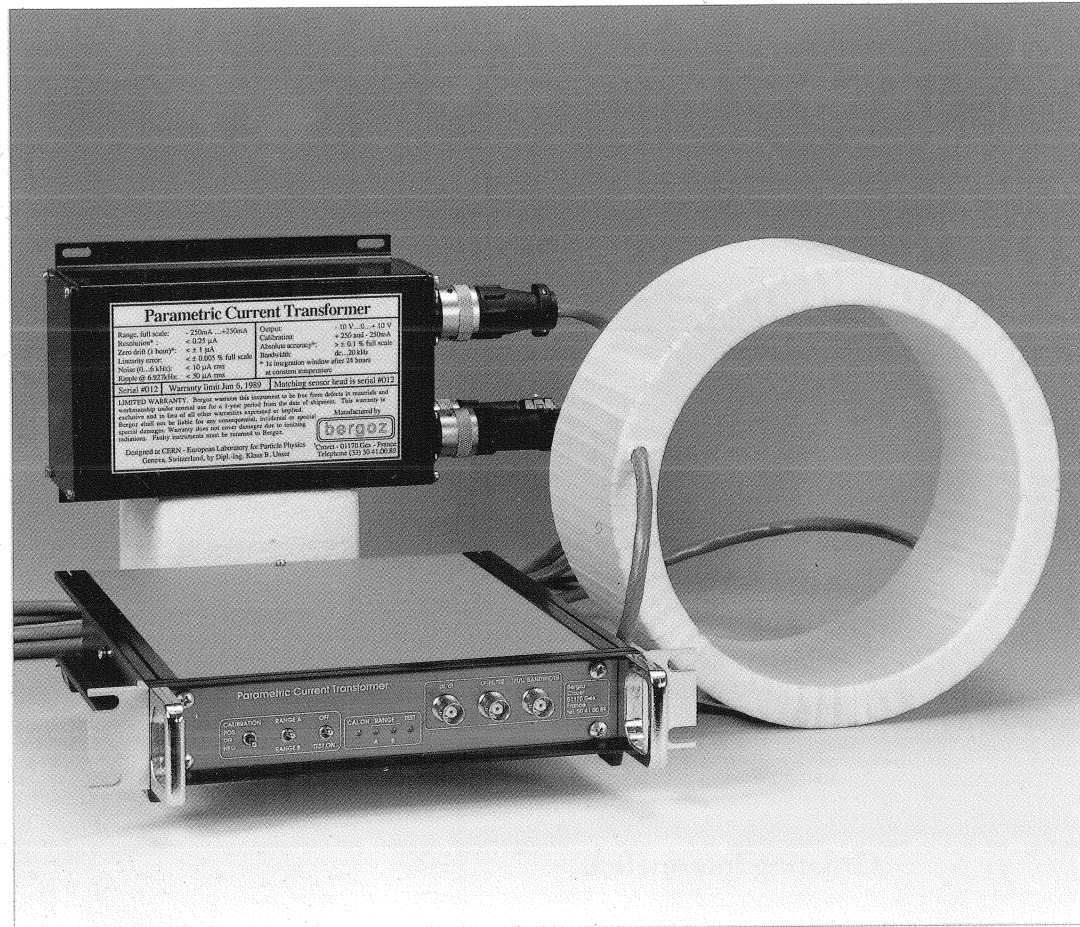


Photo Bugey

The PCT consists of a light-weight toroidal sensor with a large circular aperture. The associated electronic circuits are located in a small box within 2 to 5 meters of cable distance.

The measurement principle is based on a very precise compensation of the magnetic field created by the beam current. In a typical installation, the vacuum chamber passes thru the aperture of the toroid sensor. An insulating gap is included in the vacuum chamber to interrupt the wall currents. The PCT is not sensitive to the position of the beam.

The PCT incorporates the latest available technology in respect to

magnetic materials, electronics design and manufacturing techniques.

Dramatic performance improvements are obtained with the PCT as compared to those obtained with DC Current Transformers (DCCT) of older design. These improvements are the results of significant technological advances in three areas:

- A new circuit concept for high resolution, high linearity and large frequency range which drastically reduces the required magnetic core's cross section.
- The use of high-sensitivity cores made out of thin ribbons of  $(\text{CoFe})_{70}(\text{MoSiB})_{30}$  amorphous magnetic alloy which features higher

electrical resistivity and permeability at high frequency.

- A proprietary new manufacturing process to improve the characteristics and stability of these cores.

The PCT achieves simultaneously very high dc sensitivity and extended high frequency response by combining an active current transformer and a magnetic parametric amplifier in a common feedback loop.

The magnetic parametric amplifier consists of a magnetic modulator and a synchronous demodulator. Very low Barkhausen noise and excellent dc stability is obtained by driving the modulator magnetic cores in an avalanche mode with high peak currents.

## Specifications

Full scale range	from 10mA to 1A, to be specified
Resolution (1s integration)	< 5 $\mu\text{A}$ rms
Linearity error	< $\pm 0.01\%$ $\pm$ zero error
Zero drift (1 hour)	< $\pm 10\ \mu\text{A}$ rms
Long term dc zero drift	< $\pm 30\ \mu\text{A}/\text{month}$
Small signal bandwidth	dc ... 20 kHz
Output, direct	- 10 V to + 10 V, true bipolar
Direct output slew rate	> 0.1 V / $\mu\text{s}$
Lowpass output < 100 Hz	- 10 V to + 10 V
Output di/dt	- 5 V to + 5 V
di/dt output sensitivity	- 10 V/Vs <sup>-1</sup>
Built-in calibration source	$\pm 80\%$ of full scale
Absolute accuracy	> $\pm 0.1\%$
Beam position dependance	< 0.1 $\mu\text{A}$ over 50% of inner $\emptyset$
Sensitivity to external magnetic fields	< 1 $\mu\text{A}/\text{G}$ (axial) < 100 $\mu\text{A}/\text{G}$ (radial)
Power requirements	100/120/230V, 50/60Hz, 15 VA
Dimensions	225 mm max outer diameter 175 mm min inner diameter 102 mm max height (axial)

## Options

Additional scale range (two ranges in total)  
Extended bandwidth (dc to 100 kHz)  
Extended scale range (beyond 1 A, up to 10 A)  
High resolution (1 $\mu\text{A}$  rms at 1 sec integration)  
Very high resolution (500 nA rms at 1 sec integration)  
Front-end to output cable up to 300m total length  
Rad Hard Sensor

## Ordering Information

PCT- Specify full scale (e.g. 25mA)  
Specify mains voltage (e.g. 120 Vac)  
Includes:  
Toroidal sensor head with 3-meter cable set  
Two front-end electronics matching their sensor (one as spare)  
Two output electronics (one as spare)  
One 2.5m length front-end to output cable

### Options

Specify each option :  
Additional scale range, specify value  
Extended bandwidth  
Extended scale range  
High resolution or Very high resolution  
Long cable, specify length in meters  
Rad hard sensor

Users of the Parametric Current Transformers find the high resolution of this instrument extremely useful for tuning their machines and monitoring beam lifetime. In many cases, the PCT has become the primary instrument for beam tuning. This requires a PCT with a very high resolution; high enough to observe very small changes in the beam current.

PCTs are already installed or being installed on many accelerators: CESR at Cornell, LEP at CERN, TSR at Heidelberg, the JET collaboration at Culham, ChalkRiver/Laboratories in Ontario, HERA in Hamburg, CEBAF in Newport News, ADONE in Frascati, BEPC in Beijing, COSY in Jülich, ELETTRA Sincrotrone Trieste, ELSA at the Bonn University, the Loma Linda Cancer Therapy Center in California, AGS in Brookhaven, AmPS of NIFHEF-K in Amsterdam, ASTRID in Århus, CRYRING in Stockholm, The GANIL cyclotron in Caen, Indiana University, ESRF in Grenoble., SRRC at Hsinchu in Taiwan, LSU at Maxwell Labs, ALS in Berkeley, TRISTAN and Photon Factory at KEK, COSY in Berlin.

## Distributors

**U.S.A. :** GMW  
P.O. Box 2578  
Redwood City, CA 94064, U.S.A.  
Fax : 415 - 368 - 0816  
Tel : 415 - 368 - 4884

**Japan :** REPIC Corporation  
28-3 Kita Otsuka, 1-Chome  
Toshima-ku, Tokyo 170, Japan  
Fax : 03 - 3918 - 5741  
Tel : 03 - 3918 - 5110

## Manufacturer

BERGOZ  
01170 Crozet, France  
Fax : 33 - 50.41.01.99  
Tel : 33 - 50.41.00.89

The Parametric Current Transformer was developed in collaboration with Klaus Unser at CERN, the European Particle Physics Laboratory in Geneva.

The logo for bergoz, featuring the word "bergoz" in a bold, lowercase, sans-serif font. The text is white and is enclosed within a white rectangular border with rounded corners, all set against a black background.