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Broadband current transformer with variable sensitivity depending on the frequency of the measured signal

Patent application : A/00929 / 28.11.2016
Applicant : ICMET - National Institute for Research, Development and Testing in Electrical Engineering

Inventors : Marinescu Andrei, Dumbravă Ionel, Mandache Lucian

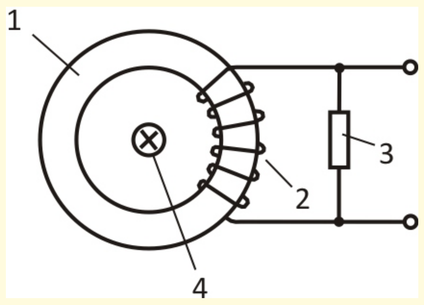
DESCRIPTION

The patent application refers to achieving a broadband current transformer whose sensitivity may change automatically depending on the frequency of the measured current, able to operate in a wideband of frequencies from a few Hz to tens of MHz.

The classical broadband current transformer (TCBL) is done on a magnetic toroidal core, where the primary winding is a conductor through which the mixed curent to be measured flows, placed on the axis of the toroid, while the secondary winding is a distributed coil closed on a resistor.

The magnetic flux density is much higher at low frequencies than at high frequencies, so that for a given TCBL with closed magnetic circuit, the ratio of the amplitude of the high frequency current and the low frequency current may bevery high, between 100 and 1000. The patent solve this disadvantage.

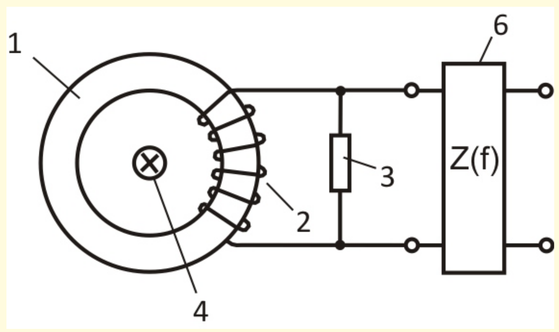
The classical TCBL



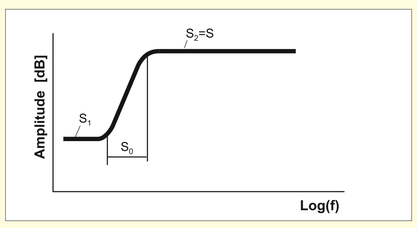
1 - magnetic circuit;
2 - the secondary winding;
3 - integrated load resistor;
4 - the primary winding.

Schematic representation of a classic TCBL with magnetic toroidal core and secondary winding closed on a low-value resistor load.

Proposed broadband current transformer

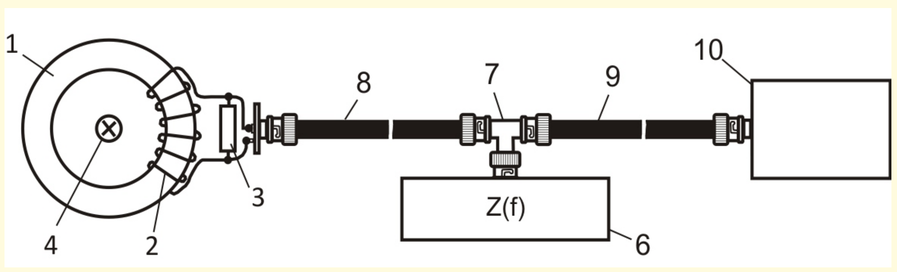


TCBL realized with a variable-frequency impedance Z(f) mounted in parallel with the load resistance.



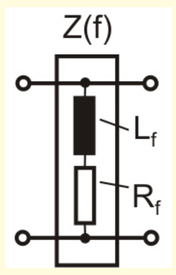
Frequency characteristic of TCBL with Z(f)

The achievement of constructive assembly TCBL with Z(f)



6 - variable-frequency impedance
7 - BNC T - adapter
8, 9 - coaxial measuring cable
10 - measuring instrument

Impedance Z(f) is a passive series circuit type R-L.

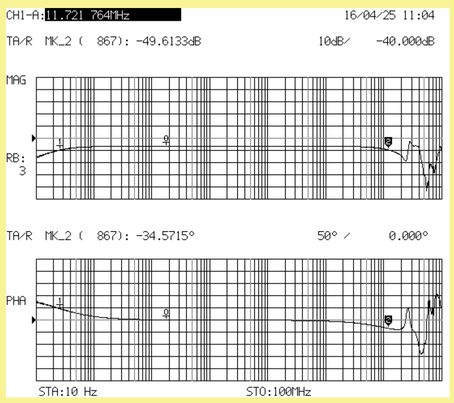


The impedance Z(f) is so dimensioned that at low frequencies the circuit behaves as a resistor R_f in parallel with the load resistor of TCBL which leads to a reduction of the magnetic induction in the circuit. Follows an increase of 20 dB/decade of equivalent impedance up to the cutoff frequency f_t when inductance reactance L_f becomes so large that it no longer affects the load resistance of TCBL, so TCBL sensitivity remains the nominal.

The frequency characteristics of TCBL

Without Z(f)

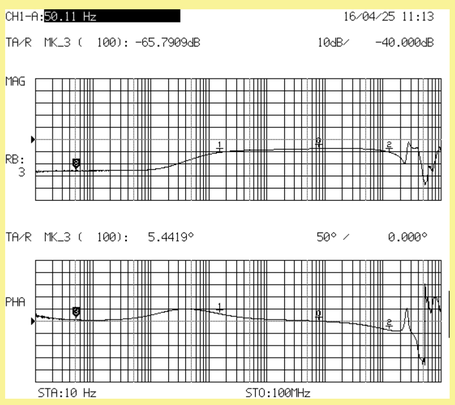
BW = 25 Hz - 11.7 MHz
S = 0.21 V/A



With Z(f)

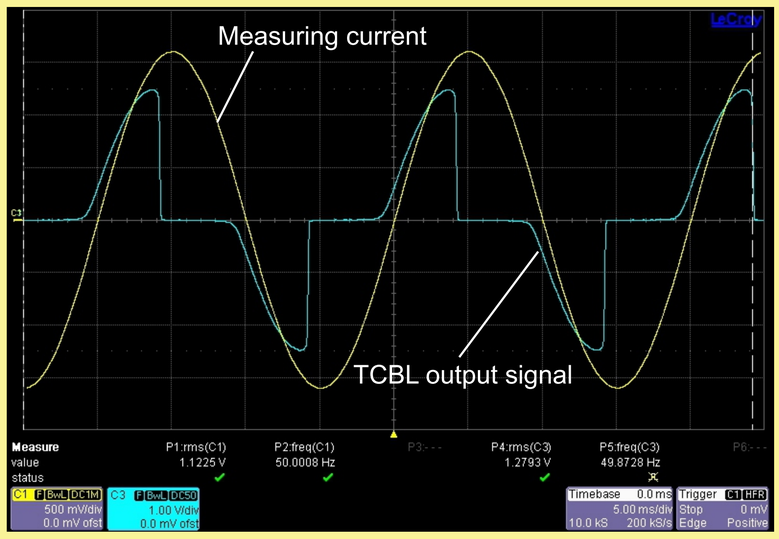
BW =15 kHz - 12.7 MHz
S = 0.21 V/A

BW =10 - 500 Hz
S = 0.02 V/A

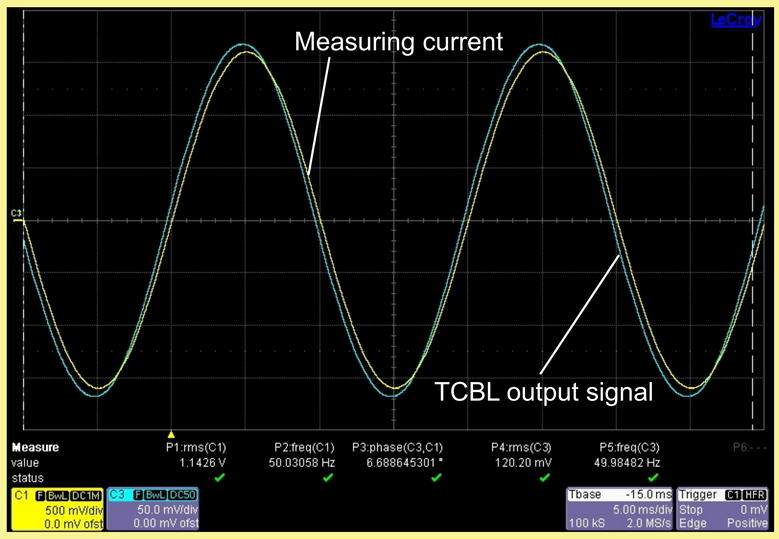


Time domain example

Without Z(f) *



With Z(f) *



* AC 50 Hz, 11 A from 5500A Fluke calibrator

TCBL data:

- Magnetic core: nanocrystalline strip;
- Secondary winding: n = 40 turns;
- Load resistance: R_2 = 9.97 Ohm;
- Max. RMS current at 50 Hz = 4 A.

Applications

Measurement of mixed High AC currents with HF currents (Pulse & CW) for:

- Power inverters;
- CM & NM filters;
- Partial discharges in power capacitors and cables.