

Design

The air-insulated design intended for installation indoors has vacuum-impregnated windings, the double-loop core consisting of a pair of high-grade C cores (small air-gap = low magnetizing current = small current error). The core and coils are held in two vertical frames, attached to which is the strong terminal block with protective wire clip, the terminals being arranged in two rows. A separate terminal marked with the earth symbol is used as the earthing point. It is bonded to the core and frames, either for protective purposes, or for earthing the start of the primary or secondary winding when the star connection is employed. Due to their vertical design the transformers occupy very little floor space and a group of three forms a very compact assembly.

Special features

- Several thousand transformation ratios are obtainable for differential protection or general duties
- Low internal consumption, hence good transformation properties
- Overrated windings (small current density)
- C cores of very high quality
- Strong terminals with protective wire clip, capable of accommodating wires up to 16 mm² cross-section, and one earthing terminal
- Generally applicable for rated outputs up to 75 VA
- To correct for mistakes, the connections of the c.t. can be changed over after installation

Electrical details

Overcurrent characteristic and consumption

The overcurrent factor (or current limit factor) "n" is inversely proportional to the sum of the connected load and the internal consumption of the secondary. If the connected load is negligible—as applies to BBC differential relays consuming only 0.1–0.3 VA—the overcurrent factor, i.e. the transformation characteristic of the transformer, is determined solely by its secondary consumption. The universal c.t. for differential protection are therefore designed for a very low secondary consumption. Their copper cross-section is up to three times the value required for minimum thermal capacity. The decisive influence of the internal consumption may be illustrated by the following example.

Considering a c.t. type WI 23 D 5 rated 4.78/1 A, 4 VA in class 5 P 20, 50 Hz, having an overcurrent factor n of approx. 105/(S + 0.5) and a secondary consumption of 0.5 VA, a differential relay is connected having a consumption of 0.1 VA. This the resultant overcurrent factor is 105/(0.1 + 0.5) = approx. 175. If the internal consumption were 5 VA, a value which could quite easily be permitted from the thermal aspect, the value of n would decrease from 175 to 105/(0.1 + 5) = approx. 20. In the same manner the low total consumption (primary + secondary) also exerts a favourable influence on the main c.t.

The universal c.t. WI 23 D ensure that the protective scheme functions reliably even under difficult circumstances, such when heavy, asymmetrical fault currents have to be reproduced, where the d.c. component of the

fault current imposes added requirements in the linearity of the c.t.

Rated output

Regardless of the actual power required by the differential protection, these transformers are designed for a rated output of 4 VA in class 5 P 20 and are tested accordingly. The maximum possible outputs in class 5 P 20, depending on the frequency and secondary current as well as the conversion formula for the effective relationship between the connected load and overcurrent factor, can be found under the heading "Technical details". For general applications the c.t. illustrated in Fig. 2 and 3 may be employed for outputs up to 65 VA at cos β = 0.8 or 75 VA at cos β = 1.

Testing

The routine tests performed on each c.t. on conclusion of series-manufacture include the following:

- A check of the measuring accuracy (current and phase error) at 4 VA, 50 Hz, connected A–M/a–e, i.e. with rated transformation ratio of 1.2/0.577 A for type WI 23 D 5 and with 0.24/0.577 A for type WI 23 D 1. All the primary and secondary turns are included in this test connection, thus guaranteeing that all ratios quoted are correct.
- A check of the overcurrent characteristic (4 VA, class 5 P 20, 50 Hz) at all four secondary rated currents, by control of the secondary exciting current.
- A polarity check.
- A voltage test at 4 kV, 50 Hz for 1 minute, applied between primary and secondary, and between each and earth.

Further tests and acceptance tests can only be performed as extras and will be charged for accordingly, provided the testing facilities are available. Since they are bound to delay delivery, they should be avoided where possible.

Changeover facilities

If the transformation ratio has to be altered after the c.t. have been installed, either because wrong information was given beforehand or because the main c.t. have meanwhile been changed, there is no need to order new intermediate c.t.'s. The connection of the universal c.t.'s can be changed over.

Overload capacity

Primary

Type	WI 23 D 5	WI 23 D 1
Rated current I_{1N} [A]	8–4.56	2.16–1.2
Max. curr. I_{1max} [A]	8.11	3.05
		1.63
		1.02
		0.546

Secondary (both types)

Rated current I_{2N} [A]	5	2.89	1	0.577
Max. curr. I_{2max} [A]	9.3	4.43	3.04	1.3

The maximum permissible currents that can be carried continuously at a given ratio (I_{1N}/I_{2N}) are worked out by determining the overload capacity (I_{max}/I_N) for both primary and secondary. The smaller of the two values then indicates which side of the c.t. and which current limits the overload capacity of the transformer as a whole.

Examples:

Type	Ratio $\frac{I_{1N}}{I_{2N}}$ [A]	Overload capacity I_{max}/I_N [A] = $x \cdot I_N$	Limited by [A]	Cont. perm. max. currents [A]
WI 23 D 5	$\frac{3.14}{5}$	$\frac{6.6}{9.3} \cdot 14 = 2.1$ $\frac{9.3}{5} = 1.86$	sec. 9.3	$\frac{5.84}{9.3}$
WI 23 D 1	$\frac{0.49}{1}$	$\frac{1.02}{3.04} \cdot 0.49 = 2.08$ $\frac{3.04}{1} = 3.04$	prim. 1.02	$\frac{1.02}{2.08}$