INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INSTRUMENT TRANSFORMERS –

Part 2: Additional requirements for current transformers

INTERPRETATION SHEET 1

This interpretation sheet has been prepared by IEC Technical Committee 38: Instrument transformers.

The text of this interpretation sheet is based on the following documents:

DISH	Report on voting
38/687/DISH	38/692/RVDISH

Full information on the voting for the approval of this interpretation sheet can be found in the report on voting indicated in the above table.

5.6.201.3 Limits of ratio error (ε) and phase displacement for measuring current transformers

BACKGROUND:

Subclause 5.6.201.3 states the following:

...For all classes, the burden shall have a power-factor of 0,8 lagging except that, when the burden is less than 5 VA, a power-factor of 1,0 shall be used, with a minimum value of 1 VA.

QUESTION:

How shall this sentence be interpreted when the rated output is above 5 VA, but the test burden for the test at 25 % of the rated output is below 5 VA?

For example, when testing a current transformer with a rated output of 10 VA, the test burden at 25 % of the rated output is 2,5 VA. Shall this test burden be at power factor 1,0 or 0,8?

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INTERPRETATION:

The "burden" mentioned in the above-stated sentence of 5.6.201.3 is to be understood as the "test burden" and therefore in the proposed example the test at 2,5 VA has to be carried out at power factor 1,0.

Rationale: The sentence under discussion is about the burden connected to the current transformer during the accuracy test. This is the understanding of manufacturers, metrological institutes and test laboratories.

This is also reflected in the commercially available test burdens used for accuracy testing of current transformers. These burdens have the possibility to choose values of 5 VA and above with a power factor of 0,8 and values below 5 VA with a power factor of 1,0. The minimum test burden is 1 VA.

For the above-mentioned reasons, it is logical to conclude that:

- the power factor value is 0,8 for test burdens of 5 VA and above,
- the power factor value is 1,0 for test burdens of less than 5 VA,
- 1 VA is the minimum value for the rated output, as well as for the test burden.

Some users need to compare accuracy measurements at 25 % and 100 % of the rated output with the same power factor of 0,8. The best way of doing this is a measurement. If this is not possible, the following method shows a possibility to calculate the ratio error and phase displacement at power factor 0,8 based on a measurement performed with power factor 1,0 for a given test burden [1][1] [2]. This interpretation sheet does not make a statement about the inaccuracies of this method.

$$\varepsilon_{0,8} = \varepsilon_0 \left[1-(R+0{,}8B)/(R+B)\right] + \frac{0{,}6B\Delta\varphi_0}{(R+B)} + \left[(R+0{,}8B)\varepsilon_1 - 0{,}6B\Delta\varphi_1\right]/(R+B) \qquad (1)$$

$$\Delta\varphi_{0,8} = \Delta\varphi_0 \left[1-(R+0{,}8B)/(R+B)\right] - \frac{0{,}6B\varepsilon_0}{(R+B)} + \left[(R+0{,}8B)\Delta\varphi_1 + 0{,}6B\varepsilon_1\right]/(R+B) \qquad (2)$$

where

$\varepsilon_{0,8}$ calculated ratio error (in percent) at test burden with power factor 0,8;

$\Delta\varphi_{0,8}$ calculated phase displacement (in centiradians) at test burden with power factor 0,8;

ε_0 extrapolated ratio error (in percent) at zero total burden;

$\Delta\varphi_0$ extrapolated phase displacement (in centiradians) at zero total burden;

ε_1 measured ratio error (in percent) at test burden with power factor 1,0;

$\Delta\varphi_1$ measured phase displacement (in centiradians) at test burden with power factor 1,0;

R secondary winding resistance (in ohms) at ambient temperature;

B test burden (in ohms) with power factor 1,0.

[1] Numbers in square brackets refer to the Bibliography.

In order to estimate the ratio error and phase displacement at zero total burden, two measurements must be made at two different test burdens, both with power factor 1,0, followed by a linear extrapolation to zero total burden. Note that the total burden is equal to the external burden (B) plus the internal burden (R).

Where it is known that the current transformer is manufactured without any turns compensation, the errors at zero total burden may be assumed to be zero and the Formulas (1) and (2) may be simplified to the following:

$$\varepsilon_{0,8} = \left[\left(R + 0{,}8B\right)\varepsilon_1 - 0{,}6B\Delta\varphi_1\right] / \left(R + B\right) \tag{3}$$

$$\Delta\varphi_{0,8} = \left[\left(R + 0{,}8B\right)\Delta\varphi_1 + 0{,}6B\varepsilon_1\right] / \left(R + B\right) \tag{4}$$

NOTE 1 The secondary winding resistance may be taken as the value measured in DC.

NOTE 2 For the calculation according to the above formula, all phase displacements are in centiradians. Phase displacements in minutes require a conversion to centiradians (1 minute = 0,029 1 centiradian).

Bibliography

[1] POKORNY, P. Conversion of current transformer errors at unity power factor burden, to 0,8 power factor-equivalent, MAPAN – *Journal of Metrology Society of India*, Vol. 24, No. 1, 2009, pp 3-8

[2] Australian Standard AS 60044-1:2007, *Instrument transformers – Part 1: Current transformers*