Technical Note

Power Switching & Monitoring

Nominal current tolerated by core balance transformers according to the application

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1. Purpose of this Technical Note

The purpose of this Technical Note is to provide clarification on the maximum permissible nominal current level for core balance transformers (differential toroids) for various applications in TT, TNS and IT neutral systems.

2. Overview

When using our differential protection and monitoring solutions, there is always a question about the operational current flowing through the core balance transformers.

In our operating manuals, we specify a current that must not be exceeded depending on the diameter of the core balance transformer. In certain situations, this value is considered to be too low for the current drawn by the load from the low-voltage distribution boards.

This raises the question: "Is it allowed to exceed the nominal current stated in the operating manual?"

The answer is YES.

This value may be exceeded according to usage limits which we will discuss later in this document.

But first of all, we must first explain the background of this nominal current, which appears in our various documents.

3. The normative background

There is currently no standard specifically for core balance transformers. In order to qualify this type of measurement sensor, manufacturers of such devices refer to the IEC 60947-2 standard (and more precisely to appendix M).

Among the multitude of qualification trials, one of the tests required by the standard is to check that the differential system set with a minimum IΔn threshold does not trip spuriously during an engine start-up.

The IEC 60947-2 standard imposes an overload level of around 6xIn. Therefore, the manufacturers define a maximum rated current to safeguard the testing during the overload period.

This rated current, which is then correlated to the overload current, is the value that the manufacturers are obliged to include in their technical documentation.

As an example, and using the table below, the current flowing through the 120mm diameter core balance transformer (ΔIC Ø120mm) must be limited to 250A to ensure that the differential system will not trip at an overload of 1500A (6x250A) for a threshold of IΔn ≥ 300mA.

Rated operational current In	Max. cross-section per conductor	Core (toroid)	IΔn
36 A	6 mm ^{2}	ΔIC/ΔIP Ø 15	30 mA
65 A	25 mm ^{2}	ΔIC/ΔIP Ø 30	30 mA
85 A	50 mm ^{2}	ΔIC/ΔIP Ø 50	30 mA
160 A	95 mm ^{2}	ΔIC/ΔIP Ø 80	100 mA
250 A	240 mm ^{2}	ΔIC/ΔIP Ø 120	300 mA (ΔIP: 100)
400 A	2 x 185 mm ^{2}	ΔIC/ΔIP Ø 200	300 mA
630 A	2 x 240 mm ^{2}	ΔIC/ΔIP Ø 300	300 mA

Choice of core balance transformers depending on the power circuit and recommended value of IΔn min for high homopolar currents (according to 6xIn trials as per IEC 60947-2 Annex M)

4. Application reality

The value stated in the documentation is very useful when using differential systems in proximity to motors or even terminal circuits.

But what happens when our core balance transformers are used on the low-voltage distribution boards?

Remember that an overload is a current that is generated by the loads and in case of prolonged duration, it is the protection of this same load that will ensure its elimination without affecting the protection devices upstream.

An overload that is generated by the load will be considered as a lower value (or even non-existent) overload for the connections and the switchgear upstream of the fault.

It is difficult to assume an overload of 6xIn when core balance transformers are installed on the low-voltage distribution panels or switchboards. This is not realistic because the value to be considered will be lower.

The other point to remember concerns the IΔn threshold of the differential device. For implementations in proximity to the low voltage distribution panels or to switchboards, it is really rare to see settings at IΔn=30mA.

This is not impossible but the vast majority of settings fall within a threshold value of IΔn ≥ 100mA.

Since IEC 60947-2 focuses only on the motor starter, it is therefore necessary to adapt new verification criteria for core balance transformers installed on the low-voltage distribution panels or switchboards.

For this reason, Socomec has initiated a test procedure taking into account an overload level of around 3xIn, which is more in line with the application. These trials have enabled the nominal current flowing through the core balance transformer to be increased, but also enabled the sensitivity of the IΔn thresholds to be reviewed.

In effect, by limiting the overload current, the risk of spurious tripping has been reduced and therefore the sensitivity has been improved, and the threshold setting of the core balance transformer has been revised downwards.

Below are the results of our trial campaign.

As an example, and using the table below, the current flowing through the 120mm diameter core balance transformer (ΔIC Ø120mm) must be limited to 500A to ensure that the differential system will not trip at an overload of 1500A (3x500A) for a threshold of IΔn ≥ 300mA.

Rated operational current In	Max cross-section per conductor	Core (toroid)	IΔN at 1.5xIn	IΔN at 3xIn
72 A	6 mm^2	ΔIC/ΔIP Ø 15	30 mA	30 mA
130 A	25 mm^2	ΔIC/ΔIP Ø 30	30 mA	30 mA
170 A	50 mm^2	ΔIC/ΔIP Ø 50	30 mA	30 mA
320 A	95 mm^2	ΔIC/ΔIP Ø 80	30 mA	100 mA
500 A	240 mm^2	ΔIC/ΔIP Ø 120	100 mA	300 mA
800 A	2 x 185 mm^2	ΔIC/ΔIP Ø 200	100 mA	300 mA
1260 A	2 x 240 mm^2	ΔIC/ΔIP Ø 300	100 mA	300 mA

Choice of core balance transformers depending on the power circuit and recommended value of IΔn min for high homopolar currents (according to 3xIn trials as per IEC 60947-2 Annex M)

It should be noted that these new levels of performance do not affect in any way the compliance of the differential switchgear with the reference standards IEC 60755 and IEC62020 and are applicable in accordance with the implementation described in the operating instructions.

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