CORE BALANCE
EARTH LEAKAGE PROTECTION

By Sten Maraldo, Stemar Electrical Products

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With the introduction of sensitive Earth Leakage Protection features on most common electronic motor protection relays and the availability of specifically designed sensitive earth leakage relays. It is often forgotten that the current sensor (Core Balance CT) has the critical duty of sensing accurately the existence of very small earth fault currents.

The Current Transformer in addition must be able to differentiate these faults within very complex electromagnetic environment that exist in modern switchgear designs (heavy current carrying busbars or adjacent current carrying conductors); further the current transformer has the onerous requirement of meeting Australian Standards tests. The voltage output requirements of the transformer vary from relay to relay and more specifically is dependent on the primary earth fault current setting requirement.

EARTH CURRENT SETTING

It has been common practice to specify the class of the current transformer in line with AS1675 specifying reference voltages at varing accuracy limit factors, this however does not ensure that the transformer will have sufficient voltage output at the required operating level – i.e. a current transformer specified with an accuracy limit factor of 5 will ensure that it has the required output at 5 times rated current, however, if the earth current setting is 20% of rated current then it is essential that the transformer has the required voltage output at this level; if the characteristics of the magnetic material in the core would be linear then this would not represent a problem, however, the majority of magnetic materials have the charecterictics of an inverse knee point at very low values of exciting current, it is for this reason that the design must be checked at all the possible desired operating level settings.
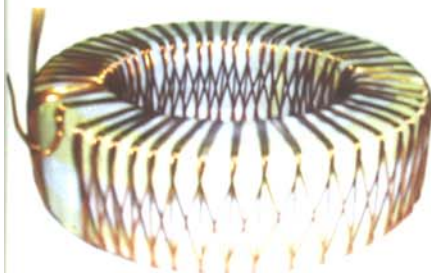
The design must be such, however, that not only must it satisfy the burden requirements of the relay but it must also address the problems of:
• Symmetry of installation of conductors
• Effect of adjacent electromagnetic forces

Conductors not symmetrically installed within the window of the transformer could easily cause non uniform magnetic fields across the CT. Adjacent electromagnetic forces also influence the magnetic field so regardless of the source, the influence of external flux must be reduced if correct CT operation is to be achieved. If external influences are not reduced or eliminated it is possible that local core saturation can occur resulting in non-cancelling voltages appearing across the secondary of the CT and these voltages can be high enough to result in nuisance tripping of the relay.

REGRESSIVE WINDING METHOD

An established solution is the utilisation of a regressive winding method in winding the CT; this was first invented by Steen later refined by Goss. This system does not completely neutralise fluxes set up in the core by external fields so it is essential to also address this problem.

SCREENING SOLUTION

A solution which has provided excellent results is the total screening of winding and cores with flux liners; essentially these can consist of a concentric buffer of low permeability material on the internal diameter of the CT and MS screens on the other sides.

Having given due consideration to all the above a design has been developed by Stemar Electrical in Sydney that provides a solution to the above problems. Essentially the transformer developed consists of a torodial core, a regressive winding and flux liners - all enclosed into a DMC plastic shell and encapsulated in resin so as to provide the mechanical characteristics normally required in mining applications.

FIELD USAGE

This design has now been adopted by at least two relay suppliers who prior to accepting design carried out a number of tests including tests by Londonderry Testing Laboratories.