Electromagnetic Simulation of Split-Core Current Transformer for Medium Voltage Applications

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Abstract

In electric distribution network, current and voltage measurement for metering, monitoring, and protection & control applications is done via instrument transformers (current and voltage transformers). These measurement devices are deployed during the construction phase of the electric network. However, it is necessary from time to time to replace these devices due to failure or upgrade. Utility companies preferred to replace these devices without any power interruption. For the very same reason, this project focus to develop a clamp-on current instrument transformer with split ferromagnetic cores which can be easily installed around the primary conductor without service disconnection.

The design is focus to have the low voltage output that is proportional to the current input and, having a very low energy output, minimizes safety concerns associated with open circuited leads on an energized current transformer. The electromagnetic design is performed in COMSOL Multiphysics using AC/DC Module. The Magnetic Fields physics is coupled with Electrical Circuit interface to perform the FEA & Circuit co-simulation. Since, the split-core transformer is design for accuracy class of 1% (maximum error <1%) for the entire operating range, the optimal shape of the split core is investigated through EM simulation.

The simulation was performed for three different core cross-sections. The EM simulation is performed in the Frequency Domain at 60Hz for wide range of input currents (60A to 4000A) in a single phase configuration and also in 3-phase configurations with each phase separated by 8[in]. The number of turns, wire size, bobbin configuration (angle width), bobbin placements etc. was investigated through various Parametric Sweep studies for each of these parameters. The output voltage remain linearly proportional to the input current throughout this operating range as the magnetic core is never saturates due to the two air-gaps in the design. The optimal bobbin angle width was found when bobbin is placed next to the air-gaps (on either side) will have the minimum cross-talk (interference) from the other conductor (with & without current transformer in it).

Figures used in the abstract

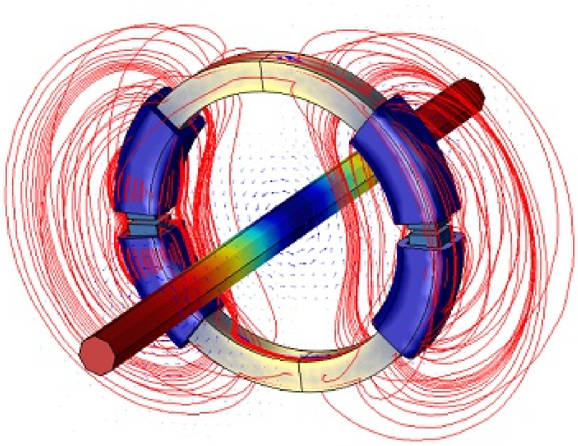

Figure 1: EM model of CT showing magnetic flux in core and current density in primary conductor & coils.