Susceptibility of Current Transformer Measurements Due to Pulsed Currents

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***Abstract*—The use of more energy efficient solutions and products contribute to the increased use of non-linear equipment, for example in households. Inherent to the switching nature of such equipment, the currents show a pulsed behavior with high peak values and fast rising slopes. Consequently, this increases the conducted emission and many electromagnetic interference problems have been reported. When analysing such problems the accurate reconstruction of a current waveform is of importance. For this, suitable current sensing elements are needed, of which the current transformer is a widely used sensing principle. However, this paper presents the susceptibility of current transformers when measuring pulsed currents that are represented by square-wave signals. As a consequence the measured current does not represent the actual current accurately.**

***Index Terms*—Current sensing, current transformer, electromagnetic interference, non-linear, pulsed currents.**

I. Objective

The adoption of more energy efficient products has contributed to the increased use of non-linear equipment in households. This has increased the conducted emission and resulted in many electromagnetic interference (EMI) problems [1]. When analysing such problems the accurate reconstruction of a current waveform is of importance. For this, suitable current sensing elements are needed, of which the current transformer (CT) is a widely used sensing principle. Therefore, this paper aims to analyse the response of CTs with pulsed currents.

II. Methodology

The schematic of the current sensing method as used by a CT is shown in Fig. 1. Where L_e represents magnetization behavior of the core the and R_s the secondary winding resistance [2]. In order to avoid effects of the transimpedance amplifier (TIA) on the response of the CT its behavior is mimicked by using the equivalent resistance of the TIA, R_eq. The response of the CT is simulated and measured when supplied with a 50% duty cycle square-wave at mains frequency (50 Hz) to represent a pulsed interference current.

III. Results and Conclusion

Fig. 2 shows the response of the CT as a result of simulations and measurements. When the square-wave has a constant value, the response of the CT drops exponentially, because of its inability to measure dc. This behavior is also called droop and earlier discussed in [3]. The droop is determined by the time constant of the circuit, $\tau = L_\mathrm{e}/(R_\mathrm{s}+R_\mathrm{eq})$.

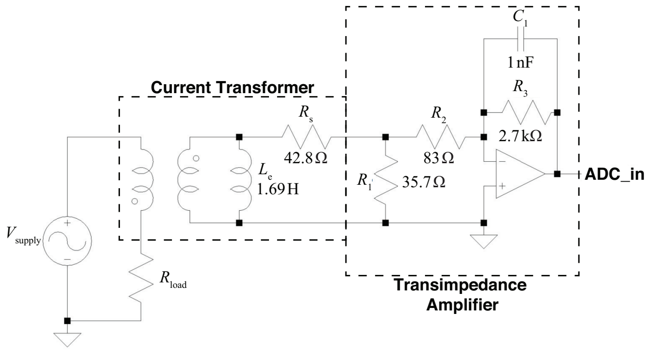

Fig. 1. Schematic of the current sensing method used by the CT.

The simulation result shows that R_eq mimics the behavior of the TIA correctly. Furthermore, the measurement and simulation results are in accordance with each other.

In conclusion, the results show that the CT principle is susceptible to square-wave signals due to its inability to measure non-varying currents. As a consequence the measured current does not represent the actual current accurately.

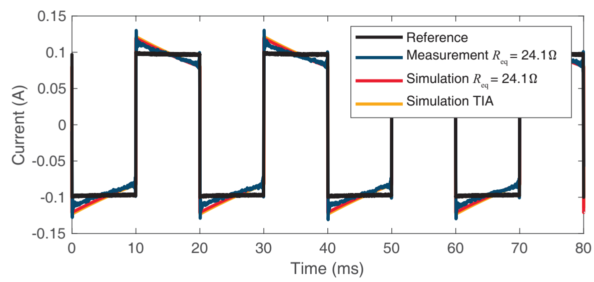

Fig. 2. Measured and simulated response of the current transformer for a 50% duty cycle square-wave.

References

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