Available online at www.sciencedirect.com

ScienceDirect

Procedia Technology 21 (2015) 498 – 506

Procedia Technology

SMART GRID Technologies, August 6-8, 2015

Non-contact Current Measurement in Power Transmission Lines

Kruphalan Tamil Selva[a*] , Olof A. Forsberg[b], Daniel Merkoulova[b] , Fatemeh Ghasemifard[b], Nathaniel Taylor[b], Martin Norgren[b]

[a]Amrita Vishwa Vidyapeetham,Coimbatore-641112, India
[b]KTH Royal Institute of Technology, Sweden

Abstract

This project deals with the technique of measurement of current in power transmission lines without the need for actual contact with the wires. Magnetic fields emitted by the wires are sensed using hall-effect based magnetic field sensors. Signals from these sensors are utilized for computing or 'reconstructing' the currents. Algorithms are developed in Matlab to facilitate the computation process. The algorithm also considers the challenge of interference due to Earth's magnetic field and stray magnetic fields. The study is performed on a scaled down model of a three phase three wire power transmission line configuration. This technology is aimed at improving the flexibility and portability of present day current measurement technology related to power transmission lines. They can be used as a secondary or temporary measurement system to complement measurements from the current transformers (CT) or be installed in places where CTs are absent. As the measurement system will be completely isolated from the power lines, they possess numerous advantages.

Peer-review under responsibility of Amrita School of Engineering, Amrita Vishwa Vidyapeetham University

*Keywords:*current transformer; power transmission line; non-contact measurement

1. Introduction

To study a physical process or perform any experiment, measurements are very crucial. It is no doubt that measurement techniques in themselves are a wide area of study. But measurements often depend on operating on the variable of interest directly and end up disturbing the process in one way or the other. The disturbance is often sufficiently small that it can be overlooked or compensated, e.g. energy meters used for recording the power consumed by a circuit, themselves consume energy from that circuit for their operation.

* Corresponding author. Tel.: 919894622344
E-mail address: krupha.ee.93@gmail.com

Peer-review under responsibility of Amrita School of Engineering, Amrita Vishwa Vidyapeetham University
doi:10.1016/j.protcy.2015.10.034

With measurements involving currents, the branch that contains the measurement equipment needs to be altered when they are removed or added to the circuit.When the measurement technique is made non-intrusive in a way that they can be removed or added onto the process, it simply offers greater flexibility and obviates the need to operate on the whole process to work on the measurement instruments.

1.1. Non-Contact Current Measurement

Non-contact current measurement techniques have been in use for quite a while. The general working principle is to measure the magnetic field that is a resultant of the current flow in a branch (of a circuit) and analyze it to estimate the current that would have given rise to it. These techniques are generally employed for circuits operating in relatively low powers. Current transducers are employed for the measurement. Ampere's circuital law is the basic working principle. It generally involves ‘clamping’ around the conductor and reading effective magnetic field, with voltage proportional to the field being produced as output. These are called Clamp-On probes. There is a definitive need to place a closed loop of conductor around the wire of interest to measure the current. It is a fairly prevalent technology and a reliable one. While there are current-clamps that can measure hundreds or thousands of amperes, it is fairly impractical to use them on wires in systems that have such currents. This should not be confused with numerous strands of wires with small current that give rise to apparent high current. Unless carefully chosen protective equipment is in place (either worn by the person or the circuitry is well isolated from direct contact), it is often hazardous to be in proximity to such circuitry even when it is at “low voltage” (<1000 V). At high voltage it becomes increasingly hard to install such sensors without isolating the system, and the sensors need to withstand the high voltage during operating. A classic example for this scenario is the power transmission lines. Occasions can arise wherein, there might be a need to measure currents in them by non-contact method. When such high voltage (and high current) lines are to be measured for their currents by conventional contact method, it becomes a challenge.

1.2. Current measurement in Power Transmission Lines

Today, current transformers (CT) are employed for measuring currents in power lines. They are very much sufficient and reliable for regular (and steady state) operating conditions of the power transmission lines. But during faulty conditions, the cores of the transformers can easily saturate and give erroneous readings. Currents in the line can often get distorted due to non-linear loading. Hence, spikes, surges, sags in current are events that can occur often. It is then important to capture such transients for various analysis pertaining to the power system. Conventional measurements of current (or voltage) in a power system involve sensors with parts that operate at the high voltage of the system’s conductors. These typically require isolation of the system for their installation and maintenance, and if they also have parts that operate and ground potential then they become additional points in the system where insulation failure may happen.

1.3. Scope of the work

The proposed non-contact current measurement technique aims at intervening at this point. The study is aimed at tapping magnetic fields in open space at a point and compute currents that gave raise to them. There will be no need for forming a closed loop around the wires as in clamping. The necessity to go in proximity to the wires for the clamping is obviated. This means that one can stay at the very bottom, between power transmission line towers and with pointing of magnetic probes in open air, one can very well estimate the currents in them. This can contribute in providing a great amount of distance between electrical work personnel and the wires when he or she needs to measure currents manually. This very distance can bring great advantages. As opposed to a CT, the field sensors (here, hall-effect based sensor is used [1]) are light and very small in size that they can fit in one’s palms. Therefore, high portability, flexibility and mobility in measurement on an as-when-required basis can be expected. The proposed non-current measurement technique can complement the existing CTs for a more comprehensive measurement involving the sturdiness provided by a CT and the extensive information regarding transients provided