ABSTRACT

Power or Energy is one of the important components that contributes towards the growth of a nation. Currently, the load demand is met through fossil fuel-based generations. The adverse effects of fossil fuel-based generation are that they degrade the environment with greenhouse gases and causes a serious threat to climate in terms of global warming. In this context, United Nations Development Programme has also emphasized the importance of Renewable Energy Sources (RES) in providing affordable and clean energy in their sustainable development goals.

Integration of RES systems pose a threat to operation and control of traditional power systems. Issues related to integration of RES in the transmission grid are as follows.

- Distance protection schemes are deployed for the protection of transmission lines. With integration of RES, the impedance read by the distance relays gets altered and leads to maloperation of distance relays.
- For enhancing power transfer capability of transmission lines, series compensation capacitors are generally deployed. Interaction of control circuitry of converters of RES with the series compensation capacitor triggers undamped power oscillations that grows rapidly, leading to tripping of transmission infrastructure.

Some of the issues related to integration of RES in distribution grid are

- Islanding detection
- Power quality issues etc.,

The currently available SCADA based grid monitoring system is not reliable as the SCADA system lacks dynamic visibility of various events happening on the power grid. In this research, synchrophasor are widely deployed to overcome the issues related to grid integration of large-scale RES. As a preliminary work, Synchrophasor or Phasor Measurement Unit (PMU) is modelled, simulated and implemented through hardware components in MATLAB and LabVIEW environments. The developed laboratory scale PMU is also validated against IEEE c37.118 standards.

Research work on algorithm development for islanding detection using micro-synchrophasor is proposed. Three islanding and non-islanding scenarios (ISs and NISs) are proposed and the effectiveness of the algorithm on the above scenarios are tested. The proposed method outperforms on the above metrics and detects the islanding condition within 14 ms.

In the second research contribution, a protection scheme based on modified impedance relay settings is proposed to overcome the effects of series compensation on the distance relay characteristics. With the new adaptive setting, the distance relays can perform effectively without maloperation, since the effects of series compensation impedance are incorporated in the adaptive algorithm for distance protection.

In the third research contribution a Generic 12-bus transmission test network with scenarios for simulation of sub-synchronous oscillations are carried out in MATLAB environment and oscillation detection tool is modelled and developed in LabVIEW environment. The hardware implementation of the same is carried out in LabVIEW platform. With the developed hardware, sub-synchronous frequencies can be detected earlier and adverse effects of power oscillations on the oscillatory stability can be averted. Thus, PMUs are evolving as a vital sensing and measurement module for the monitoring and protection of power grids with renewable energy sources.