



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student : Hrishikesan V M

Roll Number : 156102024

Programme of Study : Ph.D.

Thesis Title: Investigation on the Capabilities of Smart Transformer on Power Distribution Systems

Name of Thesis Supervisor(s) : Dr. Chandan Kumar

Thesis Submitted to the Department/ : Yes
Center

Date of completion of Thesis Viva-Voce : 09-04-2021
Exam

Key words for description of Thesis : Smart transformer (ST), solid-state transformer, voltage support
Work

SHORT ABSTRACT

The power distribution system is under major transformation due to the increased integration of renewable energy sources (RESs) and electric vehicles (EVs). Solid-state transformer (SST), which is a power electronic-based transformer, is gaining attraction in power distribution system. An SST with intelligent control integration is termed as a smart transformer (ST), and it can function as a central controller in distribution grid. Voltage variations are considered critical problem in the distribution system. This thesis proposes a method to coordinate the operation of ST LV converter and battery energy storage system (BESS) during MVAC grid voltage sag and swell. The coordinated operation improves the voltage support from ST with a lower-rated BESS. Further to the operation during voltage sag and swell, the load and generation hosting capability of a power distribution system is often restricted by the voltage limit violations. Along with the reactive power support, the ST with BESS integration has the capability to exchange the active power with the MVAC grid. This thesis proposes a sensitivity based ST and BESS sizing method to improve the load and generation hosting capacity of a distribution grid. The proposed method has the capability to achieve the desired hosting capability with active and reactive power support independently or with a flexible combination of both. Another aspect requiring immediate attention is the power management capability of a distribution system. This is important to achieve better reliability and operational flexibility. The MVDC based distribution systems are suitable for the establishing hybrid grids, and ST's MVDC links are capable of forming MVDC interconnections. An MVDC based meshed hybrid microgrid is proposed using ST and the operation is analyzed in different grid conditions. The performance of the system is compared with the existing topologies to show its advantages. In addition, the operation of this system with the integrated BESS is studied during adverse grid operating conditions. The peak loading, peak generation and MVAC voltage sag conditions are analyzed. The experimental prototype is built in the laboratory, and all the proposed methods are tested.