Available online at www.sciencedirect.com

ScienceDirect

Materials Today: Proceedings 5 (2018) 758–764

materialstoday: PROCEEDINGS

www.materialstoday.com/proceedings

PMME 2016

Optimum Placement of Fault Current Limiter in 11 kV Distribution System☆

P Sridhar[a], V Purna Chandra Rao[b], B P Singh[a,b]*

[a]Department of Electrical and Electronics Engineering, Institute of Aeronautical Engineering, Hyderabad, INDIA
[b]Lords Institute of Technology and Science, Hyderabad, INDIA
[a,b]Department of Electrical and Electronics Engineering, (Rtd. GM, BHEL,) St. Martins Engineering College, Hyderabad, INDIA

Abstract

Presently a number of radial distribution systems are in operation supplying power to utilities. Due to rapid growth of loads in a distribution system and more network connections, high current flows in the event of short circuit faults in the system. In such cases, the relay co-ordination is disturbed and hence the equipment like circuit breakers needs to be replaced with enhanced ratings. So that relay can handle the new operating currents which are often expensive retrofit costs. In order to mitigate the consequences of huge fault currents in a system a Fault Current Limiter (FCL) is proposed and discussed in this paper. FCLs can be fixed in a power system to enable circuit breakers to operate within their operating range. This paper proposes the application of deterministic method of establishing the optimal placement of FCL in a distribution system. An IEEE 6 bus system has been considered for fault analysis and placement of FCL to reduce the impact of fault.

Selection and Peer-review under responsibility of International Conference on Processing of Materials, Minerals and Energy (July 29th – 30th) 2016, Ongole, Andhra Pradesh, India.

*Keywords:*Fault Current Limiter; IEEE 6 bus system; Optimum location; Distribution system

* Corresponding author. Tel.: 99487 50050; fax: 0-88860-23000.
*E-mail address:*Sridharp35@gmail.com

2214-7853
Selection and Peer-review under responsibility of International Conference on Processing of Materials, Minerals and Energy (July 29th – 30th) 2016, Ongole, Andhra Pradesh, India.

1. Introduction

Expeditious development of the power system network has caused the fault levels of the system to increase accordingly. Levels of fault currents in many situations have increased more than the withstand capability of the existing distribution system apparatus. Several connected lines / feeders and loads not only increase the fault current but also increase the rated continuous operating current level of circuit breaker. It causes issues related to stability, reliability, security of power system dynamics. These parameters have negative effect on the system performance. The fault current can be restricted to an acceptable value and hence the voltage dips at PCC of the power system network with effective placement of FCL [1, 2, 3].

The common Power Quality (PQ) issues today are harmonic distortions, low power factor, voltage sags. Voltage sags/dips are the most crucial power quality concern, caused by a fault within the customers' facility or a utility system with a high commercial loss. Thus it causes disturbance to the end user. The utilization of power semiconductor technology (FACTS) has been introduced for enhancing power system dynamics with versatile advanced control methods in transmission / distribution networks [4]. The main demerits of FACTS devices are more expensive to provide smooth outcome, large size and more complex to implement. Implementation of this simple technology discussed is this work is the utilization of principle of FCL. Performance evaluation of power system transient stability improvement with a reliable operation, maximization of the power transfer capability of the power system network while using FCL operating under current and or voltage controlled mode have been discussed in literature [5, 6, 7]. Several topologies are introduced and examined for applicability. It is observed that a single switch voltage controlled FCL has ideal characteristics as listed as follows:

- Normal power loss as FCL offers Zero/Low Impedance in the normal operating region
- Recovery speed is very high hence fast appearance of impedance in a faulty section
- Controllability of FCL is quite good and is well coordinated with the existing protection devices, in terms of timing the current magnitude
- FCL provideseconomical alternatives to costly upgrades of the conductors and protection devices on a system or distribution power
- Compact in size

Normally, FCLs are employed in the power system network where interrupting devices are not capable of interrupting the fault current at the earliest. The placement of FCL has certain advantages in the system. These are

- Probability of increasing the distribution sources
- Improvement in power capability of the system
- Mitigating the sags at PCC in a system
- Improving the system stability and
- Improving the system reliability and security.

In radial power systems, the placement of FCL is not difficult, but in loop power system, FCL placement becomes much more complex when more than one location that has high fault current problems is involved. In such a system, short-circuit currents could come from many directions and are not easily blocked by a single FCL. Therefore, from distribution system operation and planning point of view, a technique that can choose optimum number and locations for FCL placement becomes necessary. For this purpose, rectifier-type superconducting FCL models are included in short circuit current analysis and a method to find FCL locations suitable for short-circuit current reduction is proposed.

2. Network Simulation and Data preparation

In order to obtain location for FCL placement, an algorithm is developed and is used in association with Electro Magnetic Transient Program (EMTP). The basic structure of FCL is as shown in Fig.1. L_{sh} and $R_{sh}$is the shunt branch elements, D1 to D4 are the diodes, D5 is a freewheeling diode. L_{dc} and R_{dc} are the DC reactor impedance and IGBT switch.