https://doi.org/10.46335/IJIES.2026.11.4.3 e-ISSN: 2456-3463
Vol. 11, No. 4, 2026, PP. 16-18

International Journal of Innovations in Engineering and Science, www.ijies.net

Design and Simulation of Fault Current Limiter in Distribution Line for Compensating Voltage Sag

Ashish Bhimate[1], Prof. Diksha Khare[2], Prof. Rajendra Bhombe[3], Prof. Saurabh Bagade[4]

[1]*Students of Department of Electrical Engineering Guru Nanak Institute of Engineering & Technology, Nagpur*

[2]*Assistant Professor Department Guru Nanak Institute of Engineering & Technology, Nagpur*
[3]*Assistant Professor& Head of Electrical Engineering Department of Electrical Engineering Guru Nanak Institute of Engineering & Technology, Nagpur*

[4]*Assistant Professor Department Guru Nanak Institute of Engineering & Technology, Nagpur*

asshbhimte@gmail.com

***Received on**: 11 March, 2026* ***Revised on**: 13 April, 2026* ***Published on**: 16 April, 2026*

***Abstract –** A high potential fault current levels in power grid is not a new approach, and should eventually exceed, the limitation of short-circuit-current would be existed protection devices. Different to pricey system upgrades of protection devices, Fault Current Limiters (FCL's) gives an additional cost efficient solutions to forestall recent protection devices and different instrumentality on the system from being broken by excessive fault currents. Evaluation of short circuit faults may usually the origin of voltage sags at a purpose of common coupling point (PCC) during a power network, the extent of the voltage sag is proportional to the short current level, reducing the fault current level at intervals the networks will scale back voltage sags throughout faults and defend sensitive loads that are interfaced to a similar PCC. The planned structure prevents voltage sag and counter balance the phase-angle of the PCC once fault prevalence. As a result, different feeders which are interlinked to the sub-station PCC can have attentive power quality. During this paper a high performance 3-phase fault current electrical model is planned. A Matlab/Simulink model is developed and simulation results are conferred.*

***Keywords-** Fault current limiter (FCL), point of common coupling (PCC), power quality (PQ), semiconductor switch, total harmonic distortion (THD), and voltage sag*

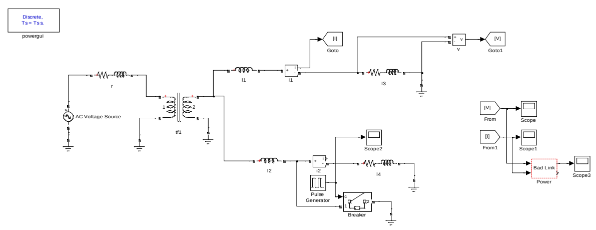
INTRODUCTION

Voltage sag is one of the most frequent and significant power quality issues affecting contemporary electrical distribution systems. It commonly arises from short-circuit faults, abrupt load variations, motor starting, and switching operations. Even brief voltage sags can cause severe disturbances, leading to malfunction or shutdown of sensitive industrial equipment such as programmable logic controllers (PLCs), variable-speed drives, robotics, and automated manufacturing systems. As industries increasingly rely on electronics-based and power-electronic-driven processes, their tolerance for voltage variations has diminished considerably. Consequently, maintaining voltage stability has become a major operational challenge for distribution utilities. Fault Current Limiters (FCLs) have gained attention as an effective solution not only for restricting excessive fault currents but also for enhancing system stability during transient conditions. Conventional protection devices—such as circuit breakers, relays, and fuses—are essential for fault isolation but are not designed to mitigate voltage sags. In contrast, FCLs introduce dynamic impedance during fault events, thereby reducing fault current magnitude and minimizing the severity and duration of voltage sag.

https://doi.org/10.46335/IJIES.2026.11.4.3 e-ISSN: 2456-3463
Vol. 11, No. 4, 2026, PP. 16-18

Their fast response, automatic operation, and negligible impact on normal system performance make them highly suitable for modern power distribution networks.

Over the years, several FCL technologies have been developed, including Superconducting Fault Current Limiters (SFCLs), Solid-State Fault Current Limiters (SSFCLs), resistive and inductive types, and hybrid FCL structures. Each exhibits unique advantages in terms of speed, reliability, cost-effectiveness, and application feasibility. SFCLs, for instance, offer ultra-fast response and low losses, while SSFCLs provide high controllability and compact design, making them particularly suitable for smart grid integration. As distribution networks continue to evolve with the increasing adoption of renewable energy sources, electric vehicle charging stations, and distributed generation, challenges related to fault current levels and voltage stability are intensifying. Renewable-dominated grids often experience bidirectional power flow and fluctuating voltage profiles, amplifying the need for advanced protection and voltage support mechanisms. This has further strengthened the demand for innovative FCL technologies capable of enhancing grid resilience and voltage regulation.



This review paper aims to present a comprehensive assessment of FCL technologies, focusing on their operating principles, characteristics, and effectiveness in mitigating voltage sag in distribution systems. It also examines recent developments, practical challenges, and emerging trends in the field. By evaluating the capabilities and limitations of various FCL configurations, this paper provides valuable insights for researchers, system engineers, and utility planners seeking effective solutions to improve voltage stability and overall power quality in modern distribution networks.

METHOLOGY

AResearch Objective

Design and simulation of FCL for the compensation of power quality problems to make the distribution system more efficient using MATLAB software.

- Main objective of project to eliminate the power quality problem in single phase and three phase line
- To minimize the sag using FCL in single phase and three phase line
- To Reduce Total Harmonic Distortion
- No power loss at fault conditions;

Proposed System

- Implementing a single phase and three phase line without FCL.,
- Implementation of Fault current limiter
- Implementation will be the desirable operation of the system for undesirable conditions for example Sag mitigation and harmonics reduction..
- Simulation of the model can be done in MATLAB software.Evaluation of the performance.

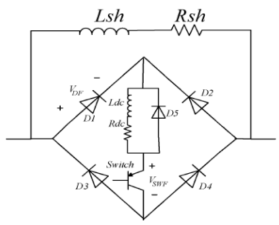


Fig 1 Proposed FCL technology

The Role of Simulation in Design

Electrical power systems are combinations of electrical circuits and electromechanical devices like motors and generators. Engineers working in this discipline are constantly improving the performance of the systems. Requirements for drastically increased efficiency have forced power system designers to use power electronic devices and sophisticated control system concepts that tax traditional analysis tools and techniques. Further complicating the analyst's role is the fact that the system is often so nonlinear that the only way to understand it is through simulation.

Land-based power generation from hydroelectric, steam, or other devices is not the only use of power systems. A common attribute of these systems is their use of power electronics and control systems to achieve their performance objectives.

Sim Power Systems software is a modern design tool that allows scientists and engineers to rapidly and easily

https://doi.org/10.46335/IJIES.2026.11.4.3 **e-ISSN: 2456-3463**
Vol. 11, No. 4, 2026, PP. 16-18

International Journal of Innovations in Engineering and Science, www.ijies.net

build models that simulate power systems. It uses the Simulink environment, allowing you to build a model using simple click and drag procedures. Not only can you draw the circuit topology rapidly, but your analysis of the circuit can include its interactions with mechanical, thermal, control, and other disciplines. This is possible because all the electrical parts of the simulation interact with the extensive Simulink modeling library. Since Simulink uses the MATLAB® computational engine, designers can also use MATLAB toolboxes and Simulink blocksets. SimPower Systems software belongs to the Physical Modeling product family and uses similar block and connection line interface.

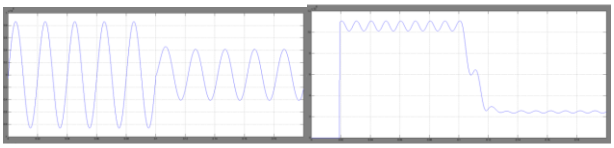


Fig 7 andFig 8 show simulation result of singl phase line withought and with FCL
It is show that withought

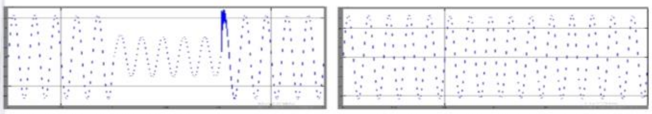


Fig. 7 PCC Voltage without FCL

Fig. 9 PCC Voltage with the Proposed FCL

It is show that for duration of 0.1 To 0.2 sag produce in the system withought FCL above waweform sag compsated using FCLwhich is shown in above fig

CONCLUSION

Proposed system single phase and three phase fault will be create due which voltage deep accures in the system . this power quality problem will be mitigate using Fault cuurent limiter. In this paper, voltage sag compensation, phase-angle jump mitigation, and fault current limiting operation were analyzed. The designed FCL is capable of mitigating voltage sag and phase-angle jump to acceptable levels. By using the semiconductor switch in the dc current path instead of two numbers of Thyristors at the bridge branches, the FCL will have high speed and consequently, the dc reactor value is reduced to a lower value. In addition, the dc voltage source placed in the FCL structure reduces its THD and ac losses in normal operation. In general, this type of FCL, with the simple control circuit and low cost, is useful for the voltage-quality improvement because of voltage sag and phase-angle jump mitigating and low harmonic distortion in distribution systems. In addition to that three phase power systems are developed with and without the FCL as well as their behaviors are also observed

REFERENCES

[1] *IHye-Rim Kim, Seong-Eun Yanung-Duck Yu, Heesun Kim, WooSeok Kim, Kijun Park, Ok-Bae Hyun,Byeong-Mo Yang, Jungwook Sim, and Young-Geun Kim, "Installation and Testing of SFCLs," IEEE Trans. Appl. Supercond , vol. 22, no. 3, June 2020.*

[2] *M. Firouzi, G.B.Gharehpetian, and M. Pishvaie, "Proposed New Structure for Fault Current Limiting and Power Quality Improving Functions," International Conference on Renewable Energies and Power Quality (ICREPQ'10) Granada (Spain), 23rd to 25th March, 2019.*

[3] *N. Ertugrul, A. M. Gargoom, and W. L. Soong, ''Automatic classification and characterization of power quality events,'' IEEE Trans. Power Del., vol. 23, no. 4, pp. 2417---2425, Oct. 2019.*

[4] *Steven M. Blair, Campbell D. Booth, Nand K. Singh, and Graeme M. Burt, "Analysis of Energy Dissipation in Resistive Superconducting Fault-Current Limiters for Optimal Power System Performance," IEEE Trans. Appl. Supercond , vol. 21, no. 4, August 2020.*

[5] *M. Brenna, R. Faranda, and E. Tironi, ''A new proposal for power quality and custom power improvement: Open UPQC,'' IEEE Trans. Power Del., vol. 24, no. 4, pp. 2107---2116, Oct. 2020.*

[6] *W. M. Fei, Y. Zhang, and Z. Lü, 'Novel bridge-type FCL based on self turnoff devices for three-phase power systems,'' IEEE Trans. Power Del., vol. 23, no. 4, pp. 2068---2078, Oct. 2018.*

[7] *E. Babaei, M. F. Kangarlu, and M. Sabahi, ''Mitigation of voltage disturbances using dynamic voltage restorer based on direct converters,''IEEE Trans. Power Del., vol. 25, no. 4, pp. 2676---2683, Oct. 2017.*

[8] *M. Moradlou and H. R. Karshenas, ''Design strategy for optimum ratingselection of interline DVR,'' IEEE Trans. Power Del., vol. 26, no. 1, pp. 242---249, Jan. 2016.*

[9] *L. Chen, Y. Tang, Z. Li, L. Ren, J. Shi, and S. Cheng, ''Current limiting characteristics of a novel flux-coupling type superconducting fault current limiter,'' IEEE Trans. Appl. Supercond., vol. 20, no. 3, pp. 1143---1146, Jun. 2010.*

[10] *S. Quaia and F. Tosato, ''Reducing voltage sags through fault current limitation,'' IEEE Trans. Power Del., vol. 16, no. 1, pp. 12---17, Jan. 2018.*