Fault location in High Voltage Multi-terminal dc networks using Gaussian Process

Rounak Meyur, University of Virginia, Bhaskar Mitra, Idaho National Laboratory

Abstract:

With the push to incorporate renewable energy where the generation centers are located far-off from the load centers and through the development of ac-dc conversion technology using power electronics high voltage dc (HVdc) transmission technology has found prominence for large distance power transmission. Modular multi-level converter (MMC) technology has found its prominence as HVdc converters due to its advantages of high modularity, high efficiency, low switching frequency and low harmonics [1]. Fast and efficient methods to isolate the network under dc faults have been widely studied and investigated, after successful isolation, it is essential to determine the exact fault location. Fault location techniques for MMC-HVdc are classified into time domain and frequency domain analysis.

Time domain analysis methods are achieved through single ended or double ended measurements. Single ended measurements estimate the fault location by capturing the difference in time of the incident and reflected wave of the traveling wave generated by the fault [2]. Reflected waves are weak and thus this method tends to provide inaccurate results. Dual ended methods utilize measurements at both ends to determine the fault location through the difference of arrival time of the incident wave at both ends. Robust communication infrastructure and expensive equipment’s are required to incorporate time-stamped measurements for accurate fault location. Frequency domain methods for fault location derive an analytical relationship between the fault dominant frequency and location. Using such methods, it is difficult to locate faults happening close to the measurement terminals [3].

In this paper we propose a novel data-driven approach for fault location in multi-terminal HVdc networks based on gaussian time-series.

References

[1] B. Mitra, S. Debnath, & B. Chowdhury (2021). Adaptive Threshold-Based Zonal Isolation of Faults in a Multiterminal DC Using Local Measurements. *IEEE Systems Journal*.

[2] M. Ando, E. O. Schweitzer, and R. A. Baker, “Development and field-data evaluation of single-end fault locator for two-terminal HVDV transmission lines-part 2: Algorithm and evaluation,” IEEE Trans. Power App. Syst., vol. PAS-104, no. 12, pp. 3531–3537, Dec. 1985.

[3] Z. He, K. Liao, X. Li, S. Lin, J. Yang, and R. Mai, “Natural frequency-based line fault location in HVDC lines,” IEEE Trans. Power Del., vol. 29, no. 2, pp. 851–859, Apr. 2014.