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The Implementation of the Low Voltage Ride-Through Curve on the Protection System of a Wind Power Plant

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Abstract. This paper presents the implementation of the low voltage ride-through (LVRT) curve in two commercial numerical relays, assessing the features and limitations of each protection device. The LVRT curve is defined in grid codes of several countries, especially those who already have or are planning a high share of wind power in their electric power systems. The functionality of the wind turbine grid protection system is tested in a power system using the PSCAD/EMTDC simulation tool. The fault ride through capability curve applied in the test system is as defined in the Brazilian grid code and the protection system responses evaluated at the point of common coupling of the wind power plant when the power network is under symmetrical and unsymmetrical faults. The biggest challenge to adhere the system operator requirements is to ensure the highest conformity to the defined LVRT curve, because most relays only gives you the option of tuning in discrete time intervals.

Key words

Low voltage ride-through, Numerical relays, Wind power plant, Doubly-fed induction generator.

1. Introduction

As the wind power plants increase in size and command a larger share of supply portfolio, they are required to stay operational and not disconnect from the grid supporting the grid with reactive power during and after voltage sags [1]. Such requirements are known as Fault Ride-Through (FRT) or Low Voltage Ride-Through (LVRT) capability. Low voltage ride-through is a condition required to the wind generators when the voltage in the grid is temporarily reduced due to a fault or large load change in the grid. The voltage may be reduced in one, two or all the three phases of the ac grid. The required low voltage ride-through (LVRT) behavior is defined in grid codes issued by the grid operators in order to maintain high availability and system stability, reducing the risk of voltage collapse [2,3,4]. LVRT enhances this feature by keeping wind farms online by feeding reactive power during system events. Until now it is common that wind turbines have a single response to these momentary voltage drops: they trip offline, protecting their functions until the grid recovers.

In order to the wind power plants to attend the fault ride-through requirements besides providing the wind generator with appropriate technology it is necessary that the system protection be able to accomplish the task accordingly.

This paper aims to present the evaluation from the implementation of the LVRT curve in two numerical relays from different manufacturers. The features of the relays and the LVRT curve achieved are discussed. The functionality of the wind turbine grid protection system is tested in a simplified power system using the PSCAD/EMTDC simulation tool. The protection levels and the disconnection times of the wind power plant are defined according to the Brazilian grid code. Simulation results are presented and discussed.

The paper is organized in the following way: section 2 defines the low-voltage ride-through curve; section 3 presents the procedures to implement the LVRT in two relays of different brands; in section 4 simulation tests are performed in a simplified system with wind turbine taking into consideration the LVRT requirements in the system protection, and finally the conclusion are given in section 5.