

# Transient Stability Analysis of Distributed Generation Connected with Distribution Network

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**Abstract**—The transient stability problem of distributed generation (DG) has become one of the constraints for the local distribution network. In this paper, DG connected to the distribution network are divided into DGs based on synchronous generator interface, induction generator interface and inverter interface according to the different DG interface type, and the mathematical models of DGs are established based on different interface types. Then through the simulation on the typical test system infinite bus system, the paper analyzes the transient process and the corresponding fault critical clearing time of DGs under the various fault conditions. Finally on the basis of the transient stability analysis of DGs in pure inverter corresponding structure for DGs based on different interface types to improve transient stability.

**Index Terms**—distributed generation, transient stability, synchronous generator, induction generator, inverter, fault critical clearing time

## I. INTRODUCTION

The rapid development of distributed power generation technology makes DGs play a more and more important role in the power system [1]. They can be divided into DGs with synchronous generator interface, induction generator interface and inverter interface according to the different interface types. DGs connected with the grid make distribution network change from single power supplying and few loop to multi power supplying and multi loop, which will certainly affect transient stability of distribution network.

Current standards on the interconnection between DGs and the grid require to remove DGs after the occurrence of the fault without considering the transient process. Along with the problem arisen, the paper studies the dynamic characteristics of DGs and analyzes the ability to withstand faults after the occurrence of the fault [2], which provides the basis for the transient response of DGs after fault occur and provides the guidance for the protection of the distribution network with DGs. The research on the transient stability of DGs is not much currently. In [3], the influence of distributed power is analyzed on the transient stability of distribution network.

In [4], the transient stability of DGs based on induction generator interface is studied and several measures are proposed to enhance the transient stability of induction generator. In [5], the transient stability of inverter-grid with a variety of DGs is studied under different control strategies. In [6], the transient process of DGs distributed power in inverter-grid is analyzed through the simulation, but transient stability analysis of inverter based distributed power does not involve.

This paper studies the transient stability of DGs based on different interface types, and establishes the mathematical model. Then through the simulation on the typical test system infinite network, it analyzes the transient process and the corresponding fault critical clearing time of DGs under the various fault conditions, and discusses the related physical parameters. Finally, the corresponding measures are put forward to improve transient stability.

## II. DGs MODEL CLASSIFICATION BY THEIR INTERFACE TYPES

There are many kinds of DGs, according to the different interfaces, they can be divided into DGs with synchronous generator interface, induction generator interface and inverter interface. The interface types of common distributed generators are as shown in Table 1.

TABLE I. THE INTERFACE TYPES OF COMMON DISTRIBUTION GENERATOR

Distributed generation	Interface type
Wind power generation	Inverter Induction generator
Small hydro-power	Synchronous generator
Photovoltaic cells	Inverter
Micro-turbine	Synchronous generator
Small wind	Inverter
Hydro	Inverter
Fuel cell	Inverter
Hydro energy	Synchronous generator Inverter

### A. Synchronous Generator Model

Synchronous generator is common power generation equipment in the traditional power system. The speed is fixed to be same as power magnetic field by changing the excitation magnetic field, the terminal voltage and active power of synchronous generator can be controlled. In the dg coordinated system, after switching

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