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Voltage Stability of Power Systems

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Contents

Voltage Stability of Power Systems

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ABSTRACT

Voltage stability of a power system refers to its ability to maintain an acceptable level of bus voltages following a disturbance. With heavier loading and increasing penetration of renewable energy sources, voltage stability has become a very important concern in modern power systems. This monograph discusses different types of voltage stability problems based on their time-scales and the size of the disturbances. The basic concepts of voltage stability are explained with the help of a simple two-bus power system. Commonly used methods for voltage stability assessment are also discussed. Online monitoring of voltage stability is a prerequisite for taking any control actions to enhance the voltage stability of a system. Techniques for real-time monitoring of voltage stability using synchronized measurements from phasor measurement units are discussed.

The voltage stability of a system strongly depends on the characteristics of its loads. The impact of different types of static load models on long-term voltage stability of a system is investigated. In the event of ongoing voltage instability or potential voltage instability problems, corrective or preventive control actions are taken. Some of the commonly used control actions are discussed. The monograph also briefly highlights the impact of renewable energy-based

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converter interfaced generations on the voltage stability of power systems.

1

Introduction

At any point in time, a power system operating condition should be stable, meeting various operational criteria, and it should also be secure in the event of any credible contingency. Present-day power systems are being operated closer to their stability limits due to economic and environmental constraints. Maintaining a stable and secure operation of a power system is therefore a very important and challenging issue. Voltage instability has been given much attention by power system researchers and planner and is regarded as one of the major causes of power system instability. Voltage instability phenomena are the ones in which the receiving end voltage decreases well below its normal value and does not come back even after setting restoring mechanisms such as VAR compensators, or continues to oscillate for lack of damping against the disturbances. Voltage collapse is the process by which the voltage falls to a low, unacceptable value as a result of an avalanche of events accompanying voltage instability [15], [16]. Once associated with weak systems and long lines, voltage problems are a source of concern in highly developed networks also, as a result of heavier loading.

There have been several incidents of voltage instability in power systems [10]. Voltage instability was one of the major reasons behind the Western Interconnection voltage collapse on August 10, 1996 in the USA [18]. This blackout affected over 7.5 million people across 14 states, and parts of Canada and Mexico. A series of cascading line failures and inadequate reactive power support led to a voltage collapse. Voltage instability was partly responsible for the August 14, 2003 blackout in the USA and Canada [7]. Reactive power deficiency and voltage instability were the key factors behind the France-Italy blackout on September 28, 2003 [8]. Voltage instability also played a role in the southern Brazil blackout on March 11, 1999 [10].

The main factors causing voltage instability in a power system are now well explored and understood [6], [11], [12], [15], [16]. A brief introduction to the basic concepts of voltage stability, its classification, commonly used methods of assessment, and related control actions are presented in this monograph.

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