Modelling and Simulation of Fractional Frequency Transmission for S of Power Systems

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ABSTRACT

The fractional frequency transmission system (FFTS) is a very promising long-distance transmission approach, which uses lower frequency (50/2 Hz, 50/3 Hz, 50/4 Hz) to reduce the electrical length of the ac power line, and thus, to increase its transmission capacity by several fold. The simulation uses the phase-controlled cyclo-converter as the frequency changer. The system step down the grid frequency of 50 Hz to 50/3 Hz etc. and being tested for the harmonics and distortion in the propagating wave. The same frequency will act as an input frequency to the WPDAN system. The transmission capabilities, transmission length, and resonant frequency have been tested and demonstrated.

1. Introduction

Increasing transmission distance and capacity is always the motivation to advance power industry technologies [1]. In the history of the ac transmission system, increasing distance and capacity mainly depends on raising voltage level of transmission lines. At present, the highest voltage level of the ac power transmission line in operation is 750 kV. To further upgrade, the voltage level encounters difficulties of material and environment issues. The high-voltage direct current (HVDC) transmission that has no stability limit problem once became another approach to increasing electricity transmission capacity. However, the current converters at two ends of HVDC are very expensive. In addition, up to now, the HVDC practices have been limited to the point-to-point transmission. It is still difficult to operate a multiterminal HVDC system. From 1982 to 2003, the total HVDC transmission capacity in the world was only 70 GW.

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Received 28 October 2022
Received in revised form 11 December 2022
Accepted 22 January 2023

The flexible ac transmission system (FACTS) has been used to improve power system performance and has become a very challenging research field. This paper introduces the experimental installation of FFTS and primary experiment results. The experiment uses the phase controlled cycloconverter as the frequency changer, stepping up 50/3 Hz electricity to 50 Hz and supplying it to the utility grid. Thus, a new FACTS device is successfully established in this paper and also illustrates that there is no essential difficulty to realize FFTS in engineering practice.

The AC electricity supplied by utilities has two basic parameters: voltage and frequency. After the transformer was invented, different voltage levels could be used flexibly in generating, transmitting, and consuming electricity to guarantee efficiency for different segments of the power system. In the history of electricity transmission, besides of 50–60 Hz, many frequencies were used, such as 25, 50/3, and 133 Hz. A 25-Hz electric system had been chosen as the winning design [5]. However, since 50–60 Hz was selected as the standard, changing frequency apparently became taboo. The reason for this might consist in that to transform frequency is more difficult than to transform voltage. As new materials and power electronic techniques continuously advance, different kinds of large-frequency changers are developed rapidly. This