

Smart high-voltage separable T-Connectors up to 72 kV with integrated voltage and partial discharge detection

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ABSTRACT

In offshore wind farms, a strong trend towards growing installed energy capacity is visible. With its increasing wind park size and related raising voltage over time. Hence the installation is becoming even more critical to achieve long lasting connections. Therefore the impact of the installation quality by maintaining a short installation time becomes crucial. At this, the latest separable T-Connector technology as they are being used at today's 66 kV voltage level offshore wind farms is shown but also special attention is paid to the integrated monitoring capabilities. In this respect, specifically relevant parameters such as voltage and partial discharge detection are evaluated and subsequently measured test result of this new solution are shown and the paper is finalized by an evaluation of how such kind of solution may reduce any outage time of offshore wind farms.

KEYWORDS

High-voltage, offshore wind farm, monitoring, partial discharge measurement, smart cable accessories.

INTRODUCTION

The standard voltage level for an offshore wind park inter-array grid was 33 kV but since the capacity of wind turbines is already in the range of 12 GW and higher values are to be expected, new offshore wind projects are using a voltage level of 66 kV for inter-array connections of new offshore wind projects. This voltage level is not the end and already developments towards the 145 kV voltage class can be seen.

Those steps towards higher voltage levels are a result of the requirement for economic power transmission of the generated electric energy. But with the higher energy and voltage, the factors' reliability and asset management are becoming more important which leads to technically higher sophisticated solutions which do not only provide easy to use connection technologies but also measurement functionalities at the same time. In this paper such a solution for 66 kV offshore cable systems and their integrated voltage and partial discharge detection system is shown.

CABLE CONNECTIONS IN WIND TURBINES

Today's wind farms are using 66 kV cable systems due to the high electrical power to be submitted. For those cable systems today two connection systems are existing: The outer cone and the inner cone system.

The inner cone system consist of an insulator and the corresponding plug-in termination which is plugged into the insulator, hence sitting inside of the insulator. Whereas the outer cone system, which also consists of an insulator and pluggable connector, is setup the other way round: At this,

the pluggable termination sits on top of the bushing. This type of pluggable termination has a symmetric design (two connection areas – at the front but also at the back) so that it allows to plug another termination into the first one. This characteristic shape of this separable connector gave it also its characteristic name "T-Connector".

Those high-voltage cable accessories are usually being used for the cable connections inside of a wind turbine (see figure 1) which could be, depending on the wind turbine design, between:

- the different individual wind towers (array cables)
- the turbine and the electrical network (dropper cable)
- the transition piece and tower



Fig. 1: Typical windturbine with 66 kV cable systems

Typically this is the connection/interface between the electrical apparatus and the cable system. Those cable systems are either pre-installed cable assemblies which are connected in the wind turbine as one piece alternatively the different components (cable + high voltage cable accessory) are individually installed.

But in both cases there is always manual work included which makes it necessary to have an easy to be installable system in order to reduce installation issues to an minimum. But at the same time is there a big pressure to reduce the time for installation to an minimum as this time is very costly. Hence those connections points are critical for the performance and reliability of the complete electrical system [1].

SEPARABLE T-CONNECTORS FOR 72 KV

Today, a lot of wind farms are and will operate at 66/72 kV and use for the connection of the cable system the outer cone bushing type F in accordance to EN 50673. This