

1 Introduction

VDE-AR-N 4131 (Technical Connection Rule TCR HVDC) specifies new requirements for the controls of HVDC systems and DC-connected Power Park Modules (PPMs) with respect to dynamic frequency/active power behaviour and dynamic voltage control without reactive current specification.

The requirements and verification criteria for dynamic frequency/active power behaviour and the dynamic voltage control without reactive current specification shall take into account the results of system studies which are carried out by the relevant system operator and thereby fulfill the requirements of VDE-AR-N 4131 [1], 10.1.4 and 10.1.9.2.

To provide a framework for implementation in terms of specifications and conformity methods to any party involved in the network connection process, the general description given in the TCR HVDC is substantiated in this Guideline. This includes in particular further development of verification methods for the future grid forming behaviour of HVDC systems and DC-connected PPMs.

This Guideline indicates the requirements from the system perspective while respecting power and current rating of the HVDC system and DC-connected PPMs. In this regard, the following basic principles should be considered in the selection of the conformity verification method:

- This Guideline is not intended to specify any site specific control strategy and therefore does not provide with any provisions for technical implementation.
- The verification test criteria proposed here are to be adapted specifically for VSC MMC - HVDC technology.
- The network-stabilising effect of the respective system control must be ensured.

In order to provide examples, this Guideline presents an operating plan for conformity verification and gives test networks, scenarios and reference behaviour for the grid forming behaviour.

2 Scope

VDE-AR-N 4131 (TCR HVDC) specifies new requirements for controlling HVDC systems and DC-connected PPMs with respect to the dynamic frequency/active power behaviour (Clause 10.1.4) and the dynamic voltage control without reactive current specification (Chapter 10.1.9.2 and Clause 10.2.7).

This VDE FNN Guideline describes methods for verifying the dynamic frequency/active power behaviour (Clause 10.1.4) and the dynamic voltage control without reactive current specification (Clause 10.1.9.2 and Clause 10.2.7). Thus, it describes functional details for the specifications of VDE-AR-N 4131 regarding the grid forming behaviour of future HVDC systems and DC-connected PPMs. The corresponding dynamic performance is described with the aim to provide clear application-specific background information for the development and implementation of associated technical solutions without highlighting a particular technology. Suitable test networks, test scenarios and methods for specifying the reference behaviour and validity range for the purpose of verifying the conformity of grid forming behaviour are introduced. The annex provides the complete set of the simulation results. The latter is provided in the form of an exemplary verification of conformity with the requirements of VDE-AR-N 4131 in order to take into account at least the results obtained by the