

Contents

1	Introduction	1
2	Scope	1
3	Abbreviations and terms	2
4	Requirements from the system perspective	2
5	Grid forming relevant design parameters of HVDC systems and DC-connected PPMs	3
6	Application-specific guidelines	4
6.1	General	4
6.2	HVDC systems	5
6.3	DC-connected PPMs	5
7	Test network, verification method and reference behaviour for HVDC systems and DC-connected PPMs	5
7.1	Test networks	5
7.2	Definition of test scenarios	8
7.2.1	Phase angle step in network voltage	9
7.2.2	Phase angle step followed by linear frequency change	9
7.2.3	Voltage magnitude step in the network	10
7.2.4	Presence of a negative-sequence component in the network	10
7.2.5	Presence of harmonics in the network	11
7.2.6	Presence of subharmonics in the network	11
7.2.7	Change in the network impedance	12
7.2.8	Islanding with DUT and active load	12
7.2.9	Islanding with 2 DUT and active load	13
7.2.10	Change in the network impedance with 2 parallel DUT	13
7.3	Reference behaviour	14
7.3.1	Procedure	14
7.3.2	DC-connected PPMs and HVDC systems with options of energy compensation from independent energy sources	15
8	Summary and prospect	26
9	Bibliography	27
A.	Annex	28
A.I.	Verification procedure – Application-specific guidelines	28
A.I.A.	Required DUT behaviour for evaluation of grid forming control behaviour (high-level control requirements)	28

A.I.B. Specification of a load under grid forming control (feed-in)	29
A.I.C. Definition of measurement variables	35
A.II. Comparison of verification procedures.....	35
A.II.A. Introduction	35
A.II.B. Time curve up to the first peak and of the settled state.....	36
A.II.C. Continuous envelope based on the simulation model with actual topology.....	38
A.II.D. Comparison.....	44
A.III. Examples of reference time varying curves with controlled voltage source	89