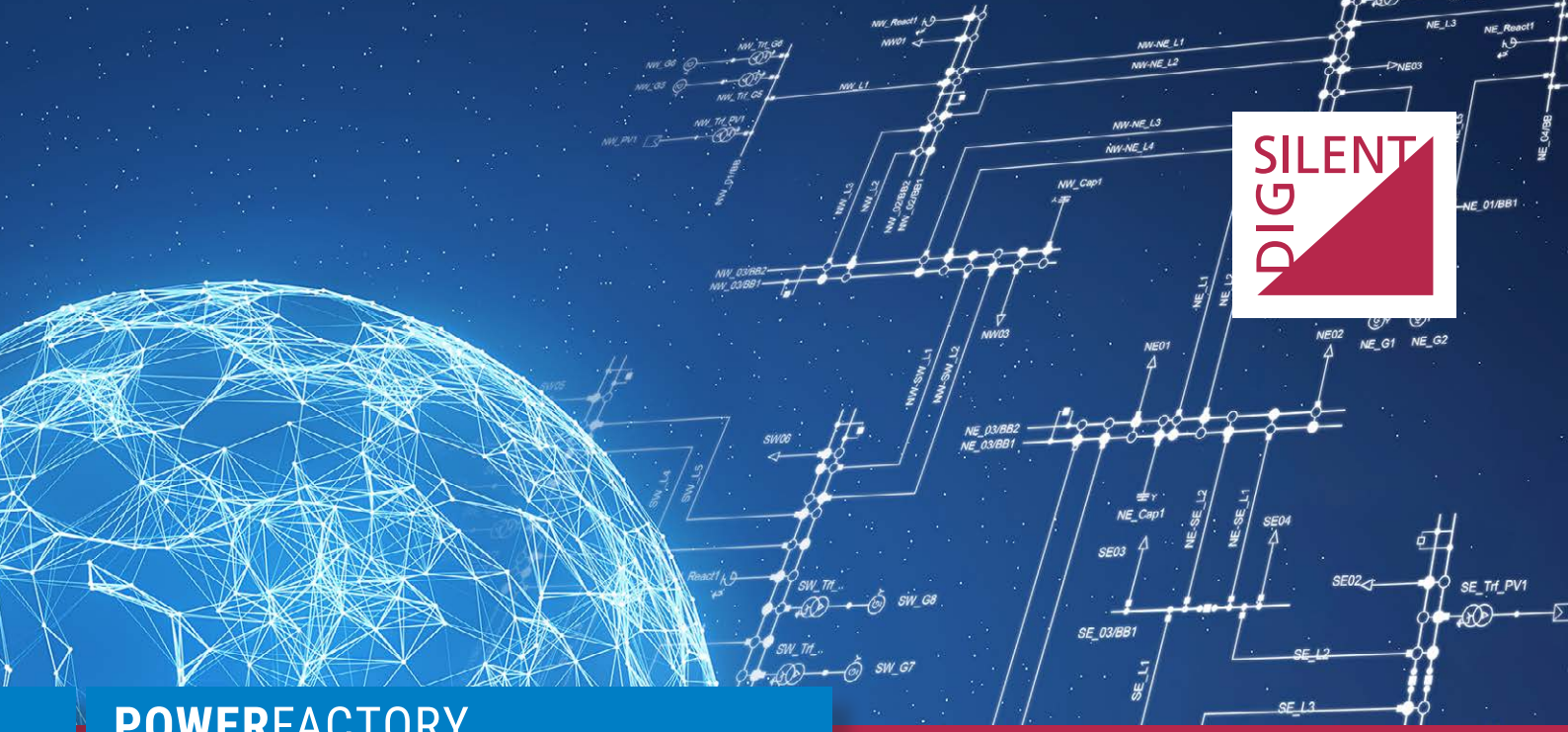

POWERFACTORY

PowerFactory 2021

Technical Reference

Connection Request

ElmConreq

PF2021

POWER SYSTEM SOLUTIONS

MADE IN GERMANY

Publisher:
DIgSILENT GmbH
Heinrich-Hertz-Straße 9
72810 Gomaringen / Germany
Tel.: +49 (0) 7072-9168-0
Fax: +49 (0) 7072-9168-88
info@digsilent.de

Please visit our homepage at:
https://www.digsilent.de

December 1, 2020
PowerFactory 2021
Revision 1

Contents

1 General Description **1**

2 D-A-CH-CZ **2**

2.1 Installation 2

2.2 Voltage changes and flicker 2

2.3 Voltage unbalance 3

2.4 Harmonics 4

2.5 Commutation notches 5

2.6 Interharmonic voltages 5

3 BDEW, 4th Supplement **6**

3.1 Power plant definition 6

3.2 Sudden voltage changes and flicker 6

3.3 Harmonics and interharmonics 6

3.4 Commutation notches 7

3.5 Short-circuit current 7

4 VDE-AR-N 4105 (2011 and 2018) **8**

4.1 Power plant definition 8

4.2 Minimum short-circuit power 8

4.3 Rapid voltage changes and flicker 8

4.4 Unbalance 9

4.5 Harmonics and interharmonics 9

4.6 Commutation notches 9

4.7 Short-circuit current 10

5 VDE-AR-N 4110 (2018) **11**

5.1 Installation definition 11

5.2 Minimum short-circuit power 11

5.3 Sudden voltage changes 11

5.4 Flicker 12

5.5 Harmonics, interharmonics and supraharmonics 12
5.6 Commutation notches 12
5.7 Short-circuit current 13

6 References **14**

1 General Description

For power quality assessment, *PowerFactory* offers a Connection Request Assessment command (*ComConreq*) and corresponding element (*ElmConreq*). The connection request element (*ElmConreq*) is used to model planned connections of generating stations and/or loads for new connectees. The Connection Request Assessment command (described in the User Manual), in conjunction with the Connection Request element, facilitates the execution of a power quality assessment according to the *Method* selected in the command.

The following points are important to note:

- The setting in the command determines the dialog page (*ElmConreq*) from which the infeed will be taken for other calculations such as load flow, short-circuit, etc.; or it will use the first ticked option in the *ElmConreq*.
- All output window messages issued should be noted.
- The connection request element is *only* intended for use in conjunction with the Connection Request command and the calculations that it carries out; i.e. balanced load flow and short-circuit according to DIN EN 60909-0 (VDE 0102).

2 D-A-CH-CZ

The selection of *D-A-CH-CZ* as the *Method* in the Connection Request Assessment command carries out a power quality assessment according to [1]. The associated input data for the connection request element is described in this section.

2.1 Installation

- ***Power consuming installation (load).***
- ***Power generating station.***
- ***Connected load, Sa (kVA).***
- ***Name.*** An arbitrary name used to describe the generating unit/s in this row of the table.
- ***Type.*** The type of generating unit.
- ***Qty.*** The number of generating unit/s in this row of the table.
- ***Rated voltage, Ur (kV)*** The rated voltage of the generating unit/s in this row of the table.
- ***SrE (MVA).*** The rated apparent power of the generating unit/s in this row of the table.
- ***cos(phiE).*** The power factor of the generating unit/s in this row of the table.
- ***PnG (MW).*** The rated active power of the generating unit/s in this row of the table.
- ***p0.2 (pu).*** Instantaneous value.
- ***p60 (pu).*** 1-minute mean value.
- ***p600 (pu).*** 10-minute mean value.
- ***SrEtot.*** Specifies which value to use in the calculation of SrEtot. If *N/A* is selected, a value of 1 will be used.
- ***cos(phiA).*** The power factor of the generating station.

2.2 Voltage changes and flicker

2.2.0.1 Loads

- ***Input mode.*** Selection of mode of data input.
- ***Apparent power change, dSa.*** Apparent power change (kVA) for devices and installations, relevant to the assessment of network disturbances.
- ***Angle, phi.*** The angle (degrees) of the installation of the network user.
- ***Displacement factor, cos(phi).*** The quotient of the active power and the apparent power, relative to the fundamental voltage and current.
- ***Active power change, dPa.*** Active power change (kW) for devices and installations, relevant to the assessment of network disturbances.
- ***Reactive power change, dQa.*** Reactive power change (kvar) for devices and installations, relevant to the assessment of network disturbances.

- ***Rated voltage, Ur.*** The rated voltage (V) of the motor. Applicable only when *Input Mode* is set to *Motor Data*.
- ***Rated current, Ir.*** The rated current (A) of the motor. Applicable only when *Input Mode* is set to *Motor Data*.
- ***Starting current ratio, Ia/Ir.*** The ratio of the motor starting current (A) to the motor rated current (A). Valid range is [3-8]. Applicable only when *Input Mode* is set to *Motor Data*.
- ***Load technology.*** The type of connection of the user installation (3PH, 1PH PH-PH, 1PH).
- ***Transformer characteristic number.*** The transformer characteristic number.
- ***Repetition rate.*** The repetition rate (1/min). *PowerFactory* uses the Pst=1 curve (see [1]) for the calculation of flicker, and therefore supports repetition rates ¡= 1800/min.
- ***Shape factor.*** The shape factor. Used for the conversion of special shapes of voltage change characteristics into flicker-equivalent voltage jumps. The shape factor is considered in the calculation of the short- and long-term flicker severity, and in the calculation of the flicker impression time.

2.2.0.2 Generating units

- ***Handle as.*** For the purpose of voltage change and flicker calculations, specifies whether the units should be handled as wind turbine generators (WTGs).
- ***Flk. Coeff. (TypFlicker).*** Selection of *Flicker* type in which to specify flicker data for the generating unit/s in this row of the table. This data should only include maximum values.
- ***Ia (kA).*** The rated current of the generating unit/s in this row of the table.
- ***phi_f (deg).*** Flicker-relevant angle.
- ***phi_a (deg).*** Starting angle.
- ***r (1/min).*** Repetition rate.
- ***SrEtot.*** Specify which value to use in the calculation of SrEtot. If *N/A* is selected, a value of 1 will be used.
- ***SrEmax.*** Specify which value to use in the calculation of SrEmax. If *N/A* is selected, a value of 1 will be used.

2.3 Voltage unbalance

2.3.0.3 Loads

- ***Load technology.*** The type of connection of the user installation (3PH, 1PH PH-PH, 1PH).
- ***Pre-existing voltage unbalance level in entire grid.*** The voltage unbalance level (%) pre-existing in the network under assessment. Relevant to HV networks only.
- ***Pre-existing two-phase installations in entire grid.*** Should be ticked if there are pre-existing two-phase installations in the network under assessment. Relevant to HV networks only.

2.3.0.4 Generating units

- ***Technology.*** The type of connection (3PH or 1PH) of the generating unit/s in this row of the table.
- ***Phase.*** The phase to which the generating unit/s are connected.

2.4 Harmonics

This input data applies to both loads and generating units. It should be noted that Harmonics will only be assessed for generating units whose *Type* on the *Installation* subpage is set to *Generator with converter*.

- ***Input of device data: According to groups.*** Device data used for calculation of the harmonic load. Input according to Groups defined in [1] and [4].
- ***Input of device Data: According to total harmonic distortion (THDi).*** Device data used for calculation of the harmonic load. Input according to total harmonic distortion is automatically classified into corresponding Groups (as defined in [1] and [4]) and displayed as read-only data in the table.
- ***Type.*** Device type (load or generating unit/s).
- ***Maximum connectible power of all consumer installations.*** Used in the calculation of harmonic current emission limits and subsequently, THDiA. Relevant to HV networks only.
- ***Simultaneity factor.*** Used in the calculation of harmonic current emission limits and subsequently, THDiA. Relevant to HV networks only.
- ***Network level factor.*** Used in the calculation of allowable harmonic voltages, and subsequently, for the calculation of *general* harmonic current emission limits and THDiA. Relevant to HV networks only.
- ***System capacitance.*** Used in the calculation of the first parallel resonance point. Input is in units of uF and must already consider length. If not specified, and option *calculated* is selected, *PowerFactory* will calculate the capacitance considering all lines/cables and purely capacitive shunts connected at the same voltage level as the PCC. Relevant to HV networks only.
- ***Automatic detection of supply transformers.*** If ticked, *PowerFactory* will search for all supply transformers using the criterion that they are connected between the voltage level of the PCC and a higher voltage level. If this option is left unticked, the user may specify the supply transformers in the table provided. Relevant to HV networks only.
- ***Supply transformers.*** User-specified supply transformers. These must be connected between the same voltage level as the PCC and a higher voltage level. Relevant to HV networks only.
- ***SNHS.*** Assumed (or indicative) network power of the HV network. This is the sum of the rated power of all supply transformers. Relevant to HV networks only.

2.5 Commutation notches

This input data applies to both loads and generating units.

- ***Converter rated power.*** Rated power of the converter (kVA). Used in the calculation of the commutation reactance short-circuit voltage.
- ***Number of pulses.*** Number of pulses of converter. Used in the calculation of the commutation reactance short-circuit voltage.
- ***Worst-case converter angle.*** Worst-case angle of the converter (degrees). Used in the calculation of the commutation reactance short-circuit voltage. Relevant to HV networks only.

2.6 Interharmonic voltages

- ***Input of interharmonics for entire installation: Harmonic voltages (spectral lines.)*** Table of interharmonic voltage magnitudes, defined according to spectral lines. Harmonic frequencies must be entered in ascending order.
- ***Input of interharmonics for entire installation: Harmonic current injections (spectral lines).*** Table of interharmonic current injections, defined according to spectral lines. Harmonic frequencies must be entered in ascending order.
- ***Input of interharmonics for entire installation: Harmonic voltages (groups).*** Table of interharmonic voltage magnitudes, defined according to groups.
- ***Input of interharmonics for entire installation: Harmonic current injections (groups).*** Table of interharmonic current injections, defined according to groups.
- ***Devices (HV Networks only).*** List of devices which create interharmonics. The harmonic load content is calculated as either: the sum of the nominal powers of all identical units; or, the nominal power of the highest-rated (power) unit. Relevant to HV networks only.
- ***Converter power (Devices and installations).*** Used to calculate the ratio of short-circuit power to converter power. Relevant to LV and MV networks only.
- ***Ripple control frequency.*** The frequency of the ripple control (Hz).
- ***Converter type: frequency converter.***
- ***Converter type: Pulse-width modulated rectifier.***

3 BDEW, 4th Supplement

The selection of *BDEW, 4th Supplement* as the *Method* in the Connection Request Assessment command carries out a power quality assessment according to [2]. The associated input data for the connection request element is described in this section.

3.1 Power plant definition

- ***Name.*** An arbitrary name used to describe the generating unit/s in this row of the table.
- ***Type.*** The type of generating unit.
- ***Qty.*** The number of generating unit/s in this row of the table.
- ***Rated voltage, Ur (kV).*** The rated voltage of the generating unit/s in this row of the table.
- ***SrE (MVA)*** The rated apparent power of the generating unit/s in this row of the table.
- ***PEmax (MW)*** The rated active power of the generating unit/s in this row of the table. The plant infeed for load flow purposes uses *PEmax* and *Minimum power factor, lambda*.
- ***Junction point*** The user-specified junction point.
- ***Minimum power factor, lambda.*** The minimum power factor at the junction point.

3.2 Sudden voltage changes and flicker

Identical units should be defined in a single table row.

- ***WTG***: Tick this option if the generating unit/s should be treated as wind turbine generators. The assessment then uses equation (B.2-5) or (B.2-6) from [2].
- ***Flk. Coeff. (TypFlicker)*** Selection of *Flicker* type in which to specify flicker data for the generating unit/s in this row of the table. This data should only include maximum values.
- ***Assess*** Use either ku or ki for assessment.
- ***kimax*** Switched current factor.
- ***Ia (kA)*** Starting current of the generating unit/s in this row of the table.
- ***InG (kA)*** Nominal current of the generating unit/s in this row of the table.

3.3 Harmonics and interharmonics

- ***Harmonic currents (TypHmccur).*** Selection of *Harmonic Current Source* type in which to specify harmonics data for the generating unit/s in this row of the table.
- ***Summation*** Method to use for summation of harmonic currents emitted by the generating unit/s in this row of the table.
- ***Total connectible power, Sgesamt (MVA).*** Used in the calculation of harmonic current emission limits.
- ***Apparent connection power, SA (MVA).*** Used in the calculation of harmonic current emission limits.
- ***Ripple control frequency (Hz).*** The frequency of the ripple control.

3.4 Commutation notches

- ***Converter rated power (kVA).*** Rated power of the converter. Used in the calculation of the commutation reactance short-circuit voltage.
- ***Number of pulses.*** Number of pulses of converter. Used in the calculation of the commutation reactance short-circuit voltage.

3.5 Short-circuit current

The short-circuit current should be input for the voltage level of the individual units.

- ***Short-circuit current (kA).*** The short-circuit current contribution of each generating unit in this row of the table.
- ***Rated current (kA).*** The rated current of each generating unit in this row of the table.
- ***Factor.*** The factor (specified by BDEW or VDE as appropriate) applying to each generating unit in this row of the table.

4 VDE-AR-N 4105 (2011 and 2018)

The selection of *VDE-AR-N 4105* as the *Method* in the Connection Request Assessment command carries out a power quality assessment according to [3] or [6], depending on the *Year* selected in the command. The associated input data for the connection request element is described in this section.

4.1 Power plant definition

As for BDEW (please refer to Section 3.1).

The following inputs are only relevant to the 2018 edition [6]:

- ***Supply transformer or network infeed***: A single supply transformer (or external grid equivalent) used for various assessments. Some assessments (i.e. minimum short-circuit power, commutation notches and harmonics) may not be possible without this being specified.
- ***Storage: Type 1 and Storage: Type 2***: Selection of generator *Type* in the table.

4.2 Minimum short-circuit power

It should be noted that the method used to calculate the short-circuit power (*SkV*) is the same for both the 2011 and 2018 editions. This page and its inputs are only relevant to the 2018 edition [6]:

- ***Type-1 generation at voltage level:*** The user-defined list of type-1 generators that are to be considered in the calculation of the limit for the minimum short-circuit power at the supply transformer bus. Elements that are valid inclusion are synchronous generators (*ElmSym*), external grids (*ElmXnet*), static generators (*ElmGenstat*) and connection requests (*ElmConreq*).
- ***Type-1 generation at junction point:*** The user-defined list of type-1 generators that are to be considered in the calculation of the limit for the minimum short-circuit power at the junction point. Elements that are valid inclusion are synchronous generators (*ElmSym*), external grids (*ElmXnet*), static generators (*ElmGenstat*) and connection requests (*ElmConreq*).

4.3 Rapid voltage changes and flicker

As for BDEW (please refer to Section 3.2). For the sudden voltage change of the individual units, the following additional inputs are available (only relevant to the 2018 edition [6]:

- ***Switching freq.:*** The frequency of switching operations as defined in [5] (“Tabelle 3”, 2nd column).
- ***Minimum interval:*** The minimum interval between switching operations as defined in [5] (“Tabelle 3”, 3rd column).

For the assessment of flicker, the following additional inputs are available (only relevant to the 2018 edition [6]:

- ***SA_B:*** Used in conjunction with the supply transformer rated power for calculation of the demand factor, kB.
- ***SA_E:*** Used in conjunction with the supply transformer rated power for calculation of the generation factor, kE.
- ***SA_S:*** Used in conjunction with the supply transformer rated power for calculation of the storage factor, kS.
- ***Apparent connection power, SA (MVA)***: Used in the calculation of flicker limits.
- ***Simultaneity factor:*** Has a default value of '1'.

For the assessment of flicker, identical units should be defined in a single table row.

4.4 Unbalance

- ***Technology.*** The type of connection (3PH or 1PH) of the generating unit/s in this row of the table.
- ***Phase.*** The phase to which the generating unit/s are connected.

4.5 Harmonics and interharmonics

As for BDEW (please refer to Section 3.3). The assessment is undertaken assuming that $I_A > 75$ A. The following additional inputs are required for assessment according to the 2018 edition [6]:

- ***Resonance factor for harmonics:*** Used for the calculation of harmonic current limits. Has a default value of '1.5' or can be user-defined. Please note that this factor will be used for harmonic orders h$\leq$19; and set to kv=1 for harmonic orders h$>$19.
- ***Resonance factor for interharmonics:*** Used for the calculation of interharmonic current limits as defined in Section 5.4.4.4 of [5].
- ***Resonance factor for supraharmonics:*** Used for the calculation of supraharmonic current limits as defined in Section 5.4.4.4 of [5].
- ***SA_B:*** Used in conjunction with the supply transformer rated power for calculation of the demand factor, kB.
- ***SA_E:*** Used in conjunction with the supply transformer rated power for calculation of the generation factor, kE.
- ***SA_S:*** Used in conjunction with the supply transformer rated power for calculation of the storage factor, kS.
- ***Neutral wire:*** Considered when calculating supraharmonic limits (application of scaling factor defined in Section 5.4.4.4 of [5]).

4.6 Commutation notches

As for BDEW (please refer to Section 3.4).

4.7 Short-circuit current

As for BDEW (please refer to Section 3.5).

5 VDE-AR-N 4110 (2018)

The selection of *VDE-AR-N 4110 (2018)* as the *Method* in the Connection Request Assessment command carries out a power quality assessment according to [7]. The associated input data for the connection request element is described in this section.

5.1 Installation definition

As for BDEW (please refer to Section 3.1). The following additional input is required:

- ***Supply transformer or network infeed***: A single supply transformer (or external grid equivalent) used for various assessments. Some assessments (i.e. minimum short-circuit power, commutation notches and harmonics) may not be possible without this being specified.

5.2 Minimum short-circuit power

The following inputs are required:

- ***Type-1 generation at voltage level:*** The user-defined list of type-1 generators that are to be considered in the calculation of the limit for the minimum short-circuit power at the supply transformer bus. Elements that are valid inclusion are synchronous generators (*ElmSym*), external grids (*ElmXnet*), static generators (*ElmGenstat*) and connection requests (*ElmConreq*).
- ***Type-1 generation at junction point:*** The user-defined list of type-1 generators that are to be considered in the calculation of the limit for the minimum short-circuit power at the junction point. Elements that are valid inclusion are synchronous generators (*ElmSym*), external grids (*ElmXnet*), static generators (*ElmGenstat*) and connection requests (*ElmConreq*).

For the assessment of the minimum short-circuit power at the supply transformer bus, all downstream (MV and LV) generation (and load) is outaged and a 3-phase short-circuit (minimum short-circuit currents) according to DIN EN 60909-0 (VDE 0102) is calculated. The resistances of lines and cables are considered at 20 degrees Celsius.

For the assessment of the minimum short-circuit power at the junction point, all MV (and LV) generation (and load) is outaged and a 3-phase short-circuit (minimum short-circuit currents) according to DIN EN 60909-0 (VDE 0102) is calculated. The resistances of lines and cables are considered at 20 degrees Celsius.

5.3 Sudden voltage changes

As for BDEW (please refer to Section 3.2). For loads, the inputs are as defined for D-A-CH-CZ (please refer to Section 2.2). For the sudden voltage change of the individual units, the following additional inputs are available:

- ***Switching freq.:*** The frequency of switching operations as defined in [7] (“Tabelle 2”, 2nd column).

- ***Minimum interval:*** The minimum interval between switching operations as defined in [7] ("Tabelle 2", 3rd column).

It should be noted that the sudden voltage change of the individual units is calculated directly at the junction point set in the connection request element.

5.4 Flicker

As for BDEW (please refer to Section 3.2). For the calculation of the short-term flicker (Pst) for loads, inputs are as defined for D-A-CH-CZ. Please refer to Section 2.2. The following additional inputs are required:

- ***SA_B:*** Used in conjunction with the supply transformer rated power for calculation of the demand factor, kB.
- ***SA_E:*** Used in conjunction with the supply transformer rated power for calculation of the generation factor, kE.
- ***SA_S:*** Used in conjunction with the supply transformer rated power for calculation of the storage factor, kS.
- ***Simultaneity factor:*** Has a default value of '1'.

For the assessment of flicker, identical units should be defined in a single table row.

5.5 Harmonics, interharmonics and supraharmonics

As for BDEW (please refer to Section 3.3). Please refer to definitions of duplicate inputs on the Flicker subpage in Section 5.4. The following additional inputs are required:

- ***Apparent connection power, SA (MVA).*** Used in the calculation of harmonic current emission limits. For VDE4110, this is automatically calculated and considers the in-service status of each unit in the plant.
- ***Resonance factor for harmonics:*** Used for the calculation of harmonic current limits as defined in Section 5.4.4 of [7]. Has a default value of '1.5' or can be user-defined. Please note that this factor will be used for harmonic orders $h \leq 19$; and set to kv=1 for harmonic orders $h > 19$.
- ***Resonance factor for interharmonics:*** Used for the calculation of interharmonic current limits as defined in Section 5.4.4 of [7].
- ***Resonance factor for supraharmonics:*** Used for the calculation of supraharmonic current limits as defined in Section 5.4.4 of [7].

5.6 Commutation notches

As for BDEW (please refer to Section 3.4).

5.7 Short-circuit current

Inputs are as described for BDEW (please refer to Section 3.5), however it must be noted that **the short-circuit current should be input for the voltage level of the point of connection (PoC) of the plant**. The short-circuit contribution is considered for generating/storage units.

6 References

[1] Technical Rules for the Assessment of Network Disturbances, 2007.

[2] Regelungen und Uebergangsfristen fuer bestimmte Anforderungen in Ergaenzung zur technischen Richtlinie - Erzeugungsanlagen am Mittelspannungsnetz - Richtlinie fuer Anschluss und Parallelbetrieb von Erzeugungsanlagen am Niederspannungsnetz, 2008.

[3] VDE-AR-N 4105: Technische Mindestanforderungen fuer Anschluss und Parallelbetrieb von Erzeugungsanlagen am Niederspannungsnetz (Generators connected to the low-voltage distribution network - Technical requirements for the connection to and parallel operation with low-voltage distribution networks), 2011.

[4] Technical Rules for the Assessment of Network Disturbances - HV Extension (Ergaenzungsdokument zur Beurteilung von Anlagen fuer den Anschluss an Hochspannungsverteilernetze), 2012.

[5] VDE-AR-N 4100: Technische Regeln fuer den Anschluss von Kundenanlagen an das Niederspannungsnetz und deren Betrieb (TAR Niederspannung) (Technical rules for the connection and operation of customer installations to the low voltage network (tar low voltage)), 2018.

[6] VDE-AR-N 4105: Technische Mindestanforderungen fuer Anschluss und Parallelbetrieb von Erzeugungsanlagen am Niederspannungsnetz (Generators connected to the low-voltage distribution network - Technical requirements for the connection to and parallel operation with low-voltage distribution networks), 2018.

[7] VDE-AR-N 4110: Technische Regeln fr den Anschluss von Kundenanlagen an das Mittelspannungsnetz und deren Betrieb (TAR Mittelspannung) (Technical requirements for the connection and operation of customer installations to the medium voltage network (TAR medium voltage)), 2018.