



Verification of compliance with the requirements of VDE-AR-N 4105 for bidirectional charging of electric vehicles

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Foreword

This document is the responsibility of the Working Group 'Generation systems on the low-voltage network' of the Forum for Network Technology and Network Operation in the VDE (VDE FNN) under the Steering Committee 'System Issues and Network Codes'.

This VDE FNN Guideline describes the verification of compliance with the technical requirements of VDE-AR-N 4105 for the bidirectional charging of electric vehicles. The requirements in this guideline correspond to the current state of technology and standardization.

1 Scope of application

This FNN Guideline describes different ways of complying with the requirements of VDE-AR-N 4105 for bidirectional charging of electric vehicles.

The aim of the specifications in this guideline is to enable a process suitable for mass implementation of the requirements. The network operator and the installer may still agree specific conditions for a particular project or network connection point.

Note: the specifications of this guideline shall be reviewed and, if necessary, updated after the new revision of the European Network Code Requirements for Generators (NC RfG) enters into force. Similarly, the requirements in this guideline shall be reviewed and, if necessary, updated to take into account new technological developments, findings, and operating experience with bidirectional charging of electric vehicles (EV) and EV supply equipments (EVSE).

2 Normative references

DIN EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

DIN EN ISO/IEC 17065, *Conformity assessments – Requirements for bodies certifying products, processes and services*

VDE-AR-N 4105, *Generators connected to the low-voltage distribution network - Technical requirements for the connection to and parallel operation with low-voltage distribution networks*

NELEV, *Ordinance on the Verification of Electrotechnical Characteristics of Energy Systems (Elektrotechnische-Eigenschaften-Nachweis-Verordnung - NELEV)*

3 Definitions and abbreviations

3.1 Abbreviations

BPT	Bidirectional power transfer
EV	Electric vehicle
EVSE	Supply equipment for an electric vehicle
NC RfG	European Network Code Requirements for Generators (NC RfG)
NS protection	Network and system protection
OBC	Onboard charger
PGU	Power-generating unit (ge: Erzeugungseinheit – EZE)
TCC	Technical Connection Conditions (ge: Technische Anschlussbedingungen – TAB)
ZEREZ	Central register for unit and component certificates

3.2 Definitions

Certificate

document confirming the compliance of a product with specified requirements
[SOURCE: IEC 426-04-23, modified: shortened and limited to products]

Electric vehicle (EV) with bidirectional power transfer (BPT) capability

electric vehicle providing dedicated functions to transfer electric energy between an EV supply equipment with BPT capability and the traction battery

Note 1 to entry: also referred to as the mobile part in this guideline.

Electric vehicle supply equipment (EVSE) with bidirectional power transfer (BPT) capability

equipment providing dedicated functions for the transfer of electric energy between an electrical installation, that is connected to the electrical power supply network, and an electric vehicle (EV)

Note 1 to entry: also referred to as the stationary part in this guideline.

Network operator

operator of the general electrical power supply network

Power-generating unit (PGU)

single unit for the generating electrical energy

Qualified communication

transfer of parameters by the EV supply equipment with BPT capability to the EV with BPT capability and verification of the capability to operate as required on a specific network connection point

System with bidirectional power transfer (BPT) capability

combination of EVSE and EV both with BPT capability

System operator

person having the overall responsibility for the safe operation of the customer installation and setting rules and boundary conditions of the organisation

4 Principles for verification in accordance with VDE-AR-N 4105

Compliance with minimum technical requirements shall be verified for power-generating unit (PGU) and storage connecting to the electrical power supply network. The following requirements apply to **PGU that are considered to be self-contained units**:

1. System operators shall prove to the relevant network operator that the minimum technical requirements are met (NELEV).
2. The certificate shall be issued by a certification body accredited according to DIN EN ISO/IEC 17065 on the basis of an examination of the requirements by a testing laboratory accredited according to DIN EN ISO/IEC 17025 (NELEV).
3. Together with the registration for the network connection, the connection owner shall submit the certificates (VDE-AR-N 4105) to the network operator.
4. The manufacturer of a PGU shall provide the certificates.
5. The certificates refer to the PGU as a self-contained unit and therefore shall include all required verification modules.

The certificates include an unit certificate and a certificate for network and system protection (NS protection).

5 Verification for a system with BPT capability

The particularity of bidirectional charging is that the system combines an EVSE (stationary part) with BPT capability and a EV (mobile part) with BPT capability which means that at least part of the system is mobile and may therefore be changed at any time by the system operator or a third party.

The technical design of the system with BPT capability and the compliance process shall ensure that systems with BPT capability (EV and EVSE) meet the requirements of VDE-AR-N 4105 and that reverse power transfer into the electrical power supply network is carried out as specified in this guideline.

The required verification of the technical capability (fulfillment of all requirements VDE-AR-N 4105) of the system with BPT capability shall be performed by the EVSE with BPT capability (stationary part). This part is permanently connected to the electrical power supply network and thus shall be parameterized by the installer in accordance with the requirements of VDE-AR-N 4105 and the specifications from the TCC of the relevant network operator.

While the redundant fulfillment of the requirements of VDE-AR-N 4105 by the EV with BPT capability and by the EVSE with BPT capability is permissible, reverse power transfer is prohibited if the system does not fully comply with the requirements of VDE-AR-N 4105 and this guideline.

In relation to the relevant principles for verification in accordance with VDE AR N 4105 (as mentioned in Section 4), the following requirements apply to **PGU that are considered as distributed units (stationary and mobile parts) and constitute a system with BPT capability**:

1. Applies without changes.
2. Applies without changes.
3. The unit and component certificates shall be registered in the ZEREZ database.
4. The manufacturer of a PGU shall register a certificate issued by a certification body in the ZEREZ database. In practice, the certification body may also do this on behalf of the manufacturer.
5. The certificates refer to the PGU. The PGU is divided into a stationary and a mobile part. Depending on the concept of the technical implementation (assignment of functions), the PGU is distributed accordingly. If functions requiring certification are located in the mobile part, additional verification modules are required as follows:
 - A If the stationary part complies with the requirements of VDE-AR-N 4105 and specifications from the TCC of the relevant network operator, then it shall also fulfill the verification modules related to the required properties (as specified in the requirements). Proof of certification shall be provided once during installation and define the implementation concept. The certificate shall be registered in the ZEREZ database.
 - B If the mobile part complies with the requirements of VDE-AR-N 4105 and specifications from the TCC of the relevant network operator, then it shall also fulfill the verification modules in relation to the required properties (as specified in the requirements). Proof of certification shall be provided once when the inverter type is placed on the market. The certificate shall be registered in the ZEREZ database.
 - C The technical capability of the mobile part shall be verified before each reverse power transfer process. This represents an additional verification module for the stationary part which contains a verification through qualified communication (implemented in the EVSE with BPT capability) and checks the capability of the mobile part to operate as required on the specific network connection point.

Note: proof of compliance with the requirements of the mobile part before each reverse power transfer process via a digital vehicle certificate is deferred until appropriate certificate management systems have been defined, which includes test certificates for the stationary part and their management.

6 Technical requirements to a system with BPT capability

6.1 Illustration of the requirements according to VDE-AR-N 4105 and DIN VDE V 0124-100 (VDE V 0124-100):2020-06

1. Proof of permissible network disturbances
2. Proof of symmetry behaviour of inverters
3. Proof of behaviour of the PGU on the electrical power supply network
4. Proof of network and system protection (NS protection)
5. Connection conditions and synchronization
6. Proof of dynamic network support
7. Proof of $P_{AV,E}$ monitoring
8. Immunity against voltage and frequency events
9. Verification of the technical capability for reverse power transfer

In accordance with VDE-AR-N 4105, if the use of the PGU is restricted to systems with centralised NS protection, the NS protection certification in accordance with DIN VDE V 0124-100 (VDE V 0124-100):2020-06, Section 5.5, is not required for NS protection integrated into the PGU. This shall be indicated in the documentation from the manufacturer.

The implementation of a centralized NS protection is not covered in this guideline.

6.2 Verification of compliance of a system with BPT capability with DC connection between EV and EVSE

Since all functions relevant for certification in the system with BPT capability with DC connection between stationary and mobile part are provided by the stationary part, verification module A (as specified in Section 5 of this guideline) shall be provided for all required functions according to VDE-AR-N 4105 and the requirements of the TCC of the relevant network operator.

6.3 Verification of compliance of a system with BPT capability with AC connection between EV and EVSE

For systems with BPT capability with an AC connection between stationary and mobile part, a clear assignment of functions according to Table 1 is required to ensure the independent certification of mobile and stationary part required according to “ACER Recommendation 03-2023 Annex 1 to RfG 2.0”. Verification modules as defined in Section 5, Table 1 apply accordingly.

In addition to the assignment of functions specified for independent certification of EV and EVSE in Table 1, certification of a closed system is allowed with deviations to the assignment of functions in Table 1. In this case the following aspects shall be considered:

1. The reverse power transfer functionality shall not be possible when replacing either the EVSE or the EV with an EV/EVSE that is not part of the certified closed system with BPT capability.
2. The modification of a certified function on the EVSE and/or EV (e.g. through a software update) requires recertification of the closed system.
3. The EV and EVSE certified as a closed system shall not interfere with or influence other standardized equipment (e.g. central NS protection).

Table 1: Implementation of requirements for systems with BPT capability with an AC connection between EV and EVSE

The following legend applies for Table 1:

N/A	Not applicable
A	Verification module A (requirements according to Section 5.5.A apply)
B	Verification module B (requirements according to Section 5.5.B apply)
C	Verification module C (requirements according to Section 5.5.C apply)

Requirement	Property-related verification		
	Realization in the mobile part	Realization in the stationary part	Comment
Verification of permissible network disturbances (5.2, DIN VDE V 0124-100 (VDE V 0124-100):2020-06)			
5.2.2 Rapid voltage changes	N/A	N/A	Inverter without relevant starting currents. No technical relevance.
5.2.3 Flicker	B	N/A	Compliance with the product family standards (IEC 61000-3-x, x = 2,3,11,12) required in the test standard for devices < 75 A is covered by the vehicle homologation regulation ECE R10 ED6 for charging operation. The reverse power mode is currently being introduced in the EMC standard for the OBC with the same limit values.
5.2.4 Harmonics and interharmonics	B	N/A	
5.2.5 Commutation dips	N/A	N/A	This test is only required for network-commutated converters. (EV/charging device = network-parallel converter with PLL)
5.2.6 Direct current injection	B + C	N/A	
Verification of the symmetry behavior of inverters (5.3, DIN VDE V 0124-100 (VDE V 0124-100):2020-06)			
5.3.2 Test from three-phase converters	N/A	N/A	Compliance with VDE-ARN 4100:2019- 04, Section 5.5, is ensured by the symmetry device integrated in the charging device.
5.3.3 Symmetrical operation with a symmetry device	N/A	A	
Proof of behavior of the PGU on the electrical power supply network (5.4, DIN VDE V 0124-100 (VDE V 0124-100):2020-06)			
5.4.2 Measurement of active and reactive power range	N/A	N/A	
5.4.3 Active power reduction on setpoint	B + C	N/A	
5.4.4 Active power feed-in of PGU at overfrequency	B + C	N/A	
5.4.5 Active power feed-in of storage units at overfrequency	B + C	N/A	
5.4.6 Active power feed-in of PGU at underfrequency	B + C	N/A	
5.4.7 Active power feed-in of storage units at underfrequency	B + C	N/A	

5.4.8 Static voltage support / provision of reactive power	B + C	N/A	
5.4.8 Provision of reactive power at overfrequency	B + C	N/A	
5.4.8 Provision of reactive power at underfrequency	B + C	N/A	
Proof of NS protection (5.5, DIN VDE V 0124-100 (VDE V 0124-100):2020-06)			
5.5.2 NS protection	N/A	N/A	
5.5.3 Centralized NS protection	N/A	N/A	
5.5.4 Integrated NS protection	N/A	A	
5.5.5 Documentation	N/A	A	
5.5.6 Interface switch	N/A	A	
5.5.7 Protective devices and protection settings	N/A	A	
5.5.9 Structural characteristics of the NS protection	N/A	A	
5.5.10 Islanding detection	N/A	A	
Connection conditions and synchronization (5.6, DIN VDE V 0124-100 (VDE V 0124-100):2020-06)			
5.6 Connection	N/A	A	Connection only in EVSE possible, because the EVSE will not close the interface switch without authorization. Classified as a protective function, since connection via interface switch is required.
5.6. Synchronization	N/A	A	Current ramp through setpoint specification of EVSE.
Proof the $P_{AV,E}$ monitoring (5.7, DIN VDE V 0124-100 (VDE V 0124-100):2020-06)			
5.7 Proof of $P_{AV,E}$ - monitoring	N/A	N/A	Relevant at the network connection point.
Proof the dynamic grid support (5.8, DIN VDE V 0124-100 (VDE V 0124-100):2020-06)			
5.8 Verification of the dynamic network support	B + C	N/A	
Immunity against voltage and frequency events			
Voltage dips and short interruptions	B	A	EV and EVSE shall comply with immunity requirements. The pass criteria is different in both cases.
Frequency change	B	A	
Harmonics and interharmonics	B	A	
Verification of the technical capability for reverse power transfer			
Proof of technical capability	N/A	A	

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