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# Preliminary prototype confirmation

<b>Manufacturer / Applicant</b>	<b>LE-System</b> NT Building, Oi 1-47-1, Shinagawa-ku, Tokio 140-0014 Japan
<b>Product type</b>	<b>Power Conversion System</b>
<b>Model</b>	<b>LE-FEBS 200</b>
<b>Specifications</b>	Nominal apparent power 200 kVA Nominal active power 200 kW Nominal voltage 400 V (3L+PE) Nominal frequency 50 Hz
<b>Description</b>	Storage system with power electronic converter for feeding power generated by battery modules into the public AC grid (discharging operation mode, PGU) or draw energy from the public AC grid to charge the battery (charging operation mode, Load).
<b>Standards</b>	<b>VDE-AR-N 4110:2023-09</b> Technical requirements for the connection and operation of customer installations to the medium voltage network (TAR medium voltage) <b>VDE-AR-N 4120:2018-11 + A1:2024-04</b> Technical requirements for the connection and operation of customer installations to the high voltage network (TAR high voltage) <b>FGW TG8 Rev. 10:2025-07</b> Certification of the Electrical Characteristics of Power Generating Units, Systems and Storage Systems as well as their Components on the Grid

This preliminary prototype certificate confirms that the above-mentioned PGUs are prototypes according to VDE-AR-N 4110/VDE AR-N 4120 and FGW TG 8: The PGU are characterized by major technical developments or innovations (see Annex 1 and Annex 3).

It is also confirmed that the general ability of the PGU to fulfil the requirements of the VDE-AR-N 4110/VDE AR-N 4120 based on manufacturer data of the electrical properties of the PGUs (see Annex 2). It is expected that in the scope of a certification the requirements of Annex A of the FGW TG8 will be fulfilled.

## Restriction

A test terminal strip must be installed separately if necessary.

**Commission of the first power generating unit prototype in Germany**      Date of commission not confirmed

“This Document is an English translation of the original certificate in German language with number U26-0264”

**Project number:** 202600450

**Certification program:** NSOP-0032-DEU-ZE-ES-V10

**Confirmation number:** U26-0264

**Date of issue:** 2026-03-18



## Certification body

Georg LORITZ  
Lab Supervisor Energy Systems

## Accreditation



Accredited certification body by Deutsche Akkreditierungsstelle GmbH (DAkKS) according to ISO/IEC 17065. The accreditation is valid only for the scope listed in the annex of the accreditation certificate D-ZE-12024-01-00. The Deutsche Akkreditierungsstelle GmbH (DAkKS) is signatory of the multilateral arrangements of EA, ILAC and IAF for mutual recognition.

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## Annex to preliminary prototype confirmation U26-0264

### Description of the revisioning of the preliminary prototype confirmation U26-0264

Rev. 0	First issue
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**Annex 1**

This certificate confirms that the mentioned power generating unit (PGU) according to FGW TR 8 is a prototype. For this purpose, the PGU is described below, and the main technical developments or innovations are presented.

After commissioning the first unit of the specified type, the certification body must be notified of the commissioning date. The preliminary prototype confirmation is then replaced by a prototype confirmation, which is valid for 2 years after the notified commissioning date. After that, the unit must have a valid unit certificate.

**FGW TG 8**

Requirements	Comment / Verdict
<b>2.12 Equipment prototypes</b>	
<b>2.12.1 Prototype regulation</b>	
<p>A prototype is the first piece of equipment of a type displaying fundamental technical developments or innovations, and all additional pieces of equipment of this type commissioned within two years of commissioning the first piece of equipment of this type</p> <p>The regulation and periods for equipment prototypes in a PGS can be found in the GCR.</p>	<p>Considered (Annex 3).</p> <p>Considered. according to VDE-AR-N 4110/VDE AR-N 4120 applies: for production plants with production units of the same prototype, the plant certificate and the declaration of conformity must be submitted within one year after the first prototype has received a unit certificate</p>
<b>2.12.2 Prototype declaration</b>	
<p>The prerequisite for a certification body issuing a prototype confirmation is a manufacturer's declaration regarding the following points:</p> <ul style="list-style-type: none"> <li>• statement on the partial or complete conformity with one or more GCR;</li> <li>• declaration that this relates to a substantial technical development or innovation</li> </ul>	<p>Considered (Annex 3)</p> <p>Considered (Annex 3)</p>
<ul style="list-style-type: none"> <li>• the identification of differences to any existing and previously certified equipment;</li> </ul>	<p>Considered (Annex 3).</p>
<ul style="list-style-type: none"> <li>• additional technical data corresponding to the requirements or the relevant GCR.</li> </ul> <p>Substantial technical developments and innovations are usually present if components or software versions have been modified such that the electrical behaviour of the generation unit on the grid has significantly changed or an equivalent electrical behaviour has been achieved through a different technical development and innovation.</p> <p>Based on the manufacturer's declarations submitted regarding the prototype, the certification body will assess whether this is a technical development and certifies this in the form of a prototype confirmation.</p> <p>The certification body must clearly identify in the prototype confirmation that the prototype would fundamentally be able to meet the requirements of the relevant GCR in terms of electrical characteristics and functions of the operating equipment. The requirements of the GCR for the test scope for the prototype confirmation must be taken into account (to the extent present).</p>	<p>Considered (see Annex 3, Annex 4).</p> <p>Since the product is intended to achieve unit certification in accordance with VDE-AR- N 4110/VDE AR-N 4120 and no certification has yet been obtained, the software version used is a significant technical development/innovation.</p> <p>Considered (see Annex 3)</p> <p>Considered (see Annex 3)</p>



**Annex 2**

This certificate confirms that the named generating unit (PGU) is able to meet the requirements for the electrical properties of a generating unit according to VDE-AR-N 4110/VDE AR-N 4120. For this purpose, the conformity of the electrical properties of the PGU with the requirements of the VDE-AR-N 4110/VDE AR-N 4120 is verified as described below:

Type of equipment	EZE			Component		
	Photovoltaic (PV)	Storage	ORC	EZA-Regler	Component circuits	Interface protection
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Note</b>	The following points 1), 2) and 4) are to be applied			The following points 1), 2), 3) and 4) are to be applied		

VDE-AR-N 4110 / 4120		
BV-No	Requirements	Comment / Verdict
<b>12 Regulation for prototypes</b>		
1)	<p>A prototype is the first power generating unit of a type presenting substantial technological developments or innovations and all other power generating units of this type put into operation within two years after the commissioning of the first power generating unit of this type.</p> <p>NOTE 1 This definition corresponds to the term's definition given in SDLWindV [1]. There is no relation to the term "pilot wind turbine" (de: Pilotwindenergieanlage) used in the EEG [6].</p> <p>Technological developments and innovations are generally considered to be substantial where components or software versions are changed so that the electrical behaviour of the power generating unit at the network changes significantly and a unit certification of this new type is required.</p>	Considered (see Annex 3).
2)	<p>For the prototype of a power generating unit the requirements of this VDE application guide apply. For these prototypes, a prototype confirmation, in which the certification body confirms a substantial technological development or innovation based on a manufacturer declaration, is sufficient, instead of the unit certificate, for a period of two years after commissioning of the first power generating unit prototype in Germany. The certification body shall also check and set out reproducibly in the prototype confirmation, whether the prototype is generally capable of meeting the requirements of this VDE application guide for the electrical properties of the power generating unit. This is based on an electrical properties data sheet prepared by the manufacturer of the power generating unit.</p> <p>For prototypes commissioned before 2019-04-27, the above-mentioned period starts 2019-04-27.</p>	Considered.
3)	<p>For components within the power generating plant, for which a component certificate is required, the prototype regulation can be applied in analogy</p>	Not applicable.



**Annex 2**

<b>BV-No</b>	<b>Requirements</b>	<b>Comment / Verdict</b>
4)	<p>In order to allow the certification body to carry out the required plausibility test, the data sheet of the power generating unit shall contain at least the following information:</p> <ul style="list-style-type: none"> <li>- electrical data (nominal and rated quantities);</li> <li>- schematic overview circuit diagram of the power generating unit with all relevant components;</li> <li>- operating ranges of the power generating unit: <ul style="list-style-type: none"> <li>• limits in quasi-steady-state operation,</li> <li>• reactive power adjustment range,</li> <li>• FRT limit curve (U/t diagram);</li> </ul> </li> <li>- protection functions with setting ranges: <ul style="list-style-type: none"> <li>• decoupling protection,</li> <li>• self-protection;</li> </ul> </li> <li>- active power control: <ul style="list-style-type: none"> <li>• power/frequency behaviour,</li> <li>• active power gradient;</li> </ul> </li> <li>- reactive power control:</li> <li>- dynamic reactive current feed-in: <ul style="list-style-type: none"> <li>• basic functionality;</li> </ul> </li> <li>- declaration of the manufacturer stating that the power generating unit has been designed so that the requirements of this application guide for the power generating unit can be complied with</li> </ul> <p>At the latest after expiry of the above-mentioned period, a unit certificate is required.</p> <p>NOTE 2 If the unit certificate is available prior to expiry of the two-year term after commissioning the first power generating unit of this type, it can still be a prototype.</p>	<p>Considered.</p> <p>Data from the manufacturer are available (see Annex 3 – Annex 4).</p> <p>Results of the plausibility check see the following table.</p>
<b>Plausibility test</b>		
a)	Electrical data (nominal and rated quantities)	Fulfilled (see Annex 4)
b)	schematic overview circuit diagram of the power generating unit with all relevant components;	Fulfilled (see Annex 3)
c)	operating ranges of the power generating unit: <ul style="list-style-type: none"> <li>• limits in quasi-steady-state operation,</li> <li>• reactive power adjustment range,</li> <li>• FRT limit curve (U/t diagram);</li> </ul>	Fulfilled (see Annex 3)
d)	protection functions with setting ranges: <ul style="list-style-type: none"> <li>• decoupling protection,</li> <li>• self-protection</li> </ul>	<p>Fulfilled (see Annex 3) under the following condition:</p> <p>The PGU does not provide a test terminal for on-site testing. A test terminal must be installed on plant level.</p>
e)	active power control: <ul style="list-style-type: none"> <li>• power/frequency behaviour,</li> <li>• active power gradient;</li> </ul>	Fulfilled (see Annex 3)
f)	Reactive power control	Fulfilled (see Annex 3)
g)	dynamic reactive current feed-in: <ul style="list-style-type: none"> <li>• basic functionality</li> </ul>	Fulfilled (see Annex 3)
h)	Declaration of the manufacturer stating that the power generating unit has been designed so that the requirements of this application guide for the power generating unit can be complied with	Fulfilled (see Annex 3)



Annex 3

Manufacturer's declaration for prototype, Functional description of the types

Ö

## Herstellereklärung

### Manufacturer's Declaration

LE-System, NT Building, Oi 1-47-1, Shinagawa-ku, Tokio 140-0014, Japan

Stromumwandlungssystem

Power Conversion System

Version	1.0	Autor
For LE System	05.02.2026	Weirong Zhang (张卫荣)
For Certification	22.01.2026	Dr. Frank Wieland

Die Stromerzeugungseinheit LE-FEBS 200 kann die Anforderungen der VDE-AR-N 4105/4110/4120 an die elektrischen Eigenschaften der Stromerzeugungseinheiten erfüllen.

*The power generation unit LE-FEBS 200 is capable of meeting the electrical property requirements of the VDE-AR-N 4105/4110/4120 standards. This means they comply with the relevant regulations for grid connection and operation.*

#### 1. Beschreibung:

Es handelt es sich um ein Notstromversorgungsprojekt, das an das Stromnetz angeschlossen oder netzunabhängig betrieben werden kann. Das Projekt nutzt zwei mobile Energiespeicher-Systemcontainer von LE-System mit unterschiedlichen Gesamteingangs- und -Ausgangsleistungen wie z.B. von 2,5 MW und einer Speichersystemkapazität von 5,2 MWh. Es kann aufgeladen werden, wenn ausreichend Strom vorhanden ist, und als Notstromversorgung verwendet werden, wenn Strom benötigt wird, um wirtschaftliche Verluste durch Stromprobleme zu vermeiden.

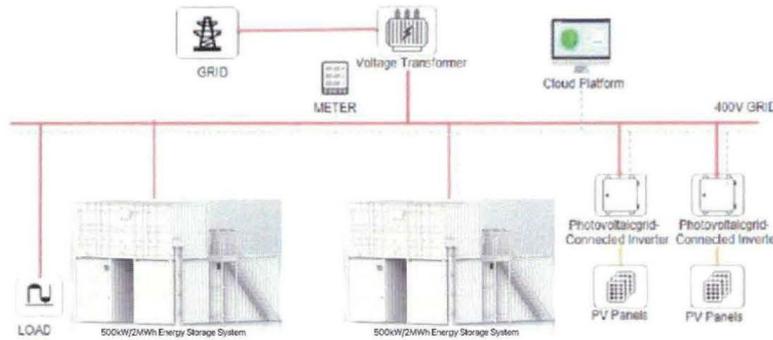
Die Systemarchitektur ist wie folgt.

Bei dieser Lösung handelt es sich um ein integriertes AC/DC-Containersystem zur Energiespeicherung von RS ENERGYSHANDONG CO., LTD. Das Produkt verfügt über ein begehbare Redoxflowdesign mit einem hohen Grad an Systemintegration und erfüllt die Anforderungen für einen sicheren, zuverlässigen und langfristigen Betrieb des Energiespeichersystems. Das integrierte System weist eine höhere Gesamtstabilität auf, ist bequem zu bauen und zu installieren und kann direkt an den Netzpunkt oder das Booster-System angeschlossen werden.

*This project is an emergency power supply system that can operate either connected to the power grid or independently from it. The project uses two mobile energy-storage system containers from RS ENERGYSHANDONG CO.,LTD, each with different total input and output capacities, for example 2.5 MW, and an energy-storage capacity of 5.2 MWh. The system can be charged when sufficient electricity is available and used as an emergency power source when electricity is needed, helping to avoid economic losses caused by power supply issues.*

*The solution is an integrated AC/DC container-based energy-storage system from LE-System. The product features a walk-in redox-flow design with a high degree of system integration and meets the requirements for safe, reliable, and long-term operation of the energy-storage system. The integrated system offers higher overall stability, is easy to construct and install, and can be connected directly to the grid connection point or to a booster system.*

Fig: Blockbild



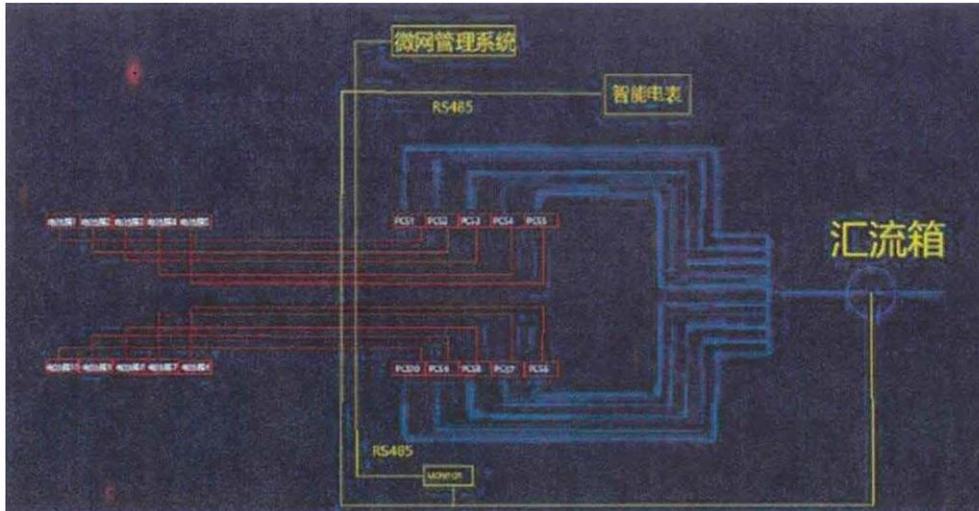
**2. Typen der Stromwandler siehe Anhang 1**

**See attachment 1 for the types of current transformers**

**3. Typenschild:  
Nameplates**

	
Name:	LE Battery System Container
Model:	PS3-500-D
Serial Number	49-558966545587511
<b>DC Data</b>	
Voltage Range(V)	312.0 - 483.6
Max. DC Current(A)	1602.0
Rated DC Power(KW)	500.0
<b>General Data</b>	
Dimension(W*H*D)(mm)	Power Module ( x 1 ) 6800 x 2850 x 2700 Capacity Module ( x 2 ) 9700 x 2850 x 3350
Weight(T):	Power Module ( x 1 ) 23 Capacity Module ( x 2 ) 75
Protective Class	I
Ingress Protection Rating	IP54
Operating Temperature (°C)	-35 ~ 45
Global Support Hotline:	RS TECHNOLOGY
Web:	www.LESYS-IP/ENGLISH www.JunLeMa.com
Business Cooperation:	RS Energy/WREEC
After Sales Service:	JunLeMa GmbH
Add:	Alsterdorfer Straße 15, 22299 Hamburg Phone: +49 40 7163 4393

Fig: Aufbau



**4. Schutzparameter: Die LE-Produkte erfüllen die folgenden Anforderungen**

*Protection Parameter: The LE products meet the following requirements*

Interface protection settings:			
Parameter	Setting range	Setting step	Default value
OV1 protection value OV-G-V1	1.00Un...1.30Un	0.001Un	1.10Un
OV1 protection time OVGV1-T	0.01s...180s	0.01s	100ms
OV2 protection value OV-G-V2	1.00Un...1.30Un	0.001Un	1.25Un
OV2 protection time OVGV2-T	10ms...100ms	0.01s	100ms
UV1 protection value UN-G-V1	0.10Un...1.00Un	0.001Un	0.80Un
UV1 protection time UNGV1-T	0.01s ...2.4s	0.01s	1.0s
UV2 protection value UN-G-V2	0.10Un...1.00Un	0.001Un	0.45Un
UV2 protection time UNGV2-T	10ms ...800ms	0.01s	300ms
OF1 protection value OV-G-F1	50.0Hz...55.0Hz	0.01Hz	51.5Hz
OF1 protection time OVGF1T	0.01s ...5s	0.01s	100ms
OF2 protection value OV-G-F2	50.0Hz...55.0Hz	0.01Hz	52.5Hz
OF2 protection time OVGF2T	10ms...100ms	0.01s	100ms
UF1 protection value UN-G-F1	45.0Hz...50.0Hz	0.01Hz	47.5Hz
UF1 protection time UNGF1T	10ms...100ms	0.01s	100ms

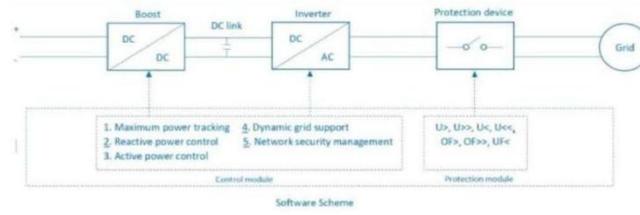
**5. PQ diagram:**

X3-FTH-80K								
P [p.u.]	Direction	Qmax [p.u.]						
		85 % U <sub>N</sub>	90 % U <sub>N</sub>	95 % U <sub>N</sub>	100 % U <sub>N</sub>	105 % U <sub>N</sub>	110 % U <sub>N</sub>	115 % U <sub>N</sub>
0	Underexcited	-0.600	-0.600	-0.600	-0.600	-0.600	-0.600	-0.600
	Overexcited	0.600	0.600	0.600	0.600	0.600	0.600	0.600
0.1	Underexcited	-0.600	-0.600	-0.600	-0.600	-0.600	-0.600	-0.600
	Overexcited	0.600	0.600	0.600	0.600	0.600	0.600	0.600
0.2	Underexcited	-0.600	-0.600	-0.600	-0.600	-0.600	-0.600	-0.600
	Overexcited	0.600	0.600	0.600	0.600	0.600	0.600	0.600
0.3	Underexcited	-0.600	-0.600	-0.600	-0.600	-0.600	-0.600	-0.600
	Overexcited	0.600	0.600	0.600	0.600	0.600	0.600	0.600
0.4	Underexcited	-0.600	-0.600	-0.600	-0.600	-0.600	-0.600	-0.600
	Overexcited	0.600	0.600	0.600	0.600	0.600	0.600	0.600
0.5	Underexcited	-0.600	-0.600	-0.600	-0.600	-0.600	-0.600	-0.600
	Overexcited	0.600	0.600	0.600	0.600	0.600	0.600	0.600
0.6	Underexcited	-0.600	-0.600	-0.600	-0.600	-0.600	-0.600	-0.600
	Overexcited	0.600	0.600	0.600	0.600	0.600	0.600	0.600
0.7	Underexcited	-0.600	-0.600	-0.600	-0.600	-0.600	-0.600	-0.600
	Overexcited	0.600	0.600	0.600	0.600	0.600	0.600	0.600
0.8	Underexcited	-0.485	-0.584	-0.600	-0.600	-0.600	-0.600	-0.600
	Overexcited	0.485	0.584	0.600	0.600	0.600	0.600	0.600
0.9	Underexcited	-0.255	-0.414	-0.532	-0.600	-0.600	-0.600	-0.600
	Overexcited	0.255	0.414	0.532	0.600	0.600	0.600	0.600
1.0	Underexcited	0.000	0.000	-0.305	-0.458	-0.458	-0.458	-0.458
	Overexcited	0.000	0.000	0.305	0.458	0.458	0.458	0.458
1.1	Underexcited	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Overexcited	0.000	0.000	0.000	0.000	0.000	0.000	0.000

**6. Kommunikationsfunktion des bidirektionalen Energiespeicherconverters**

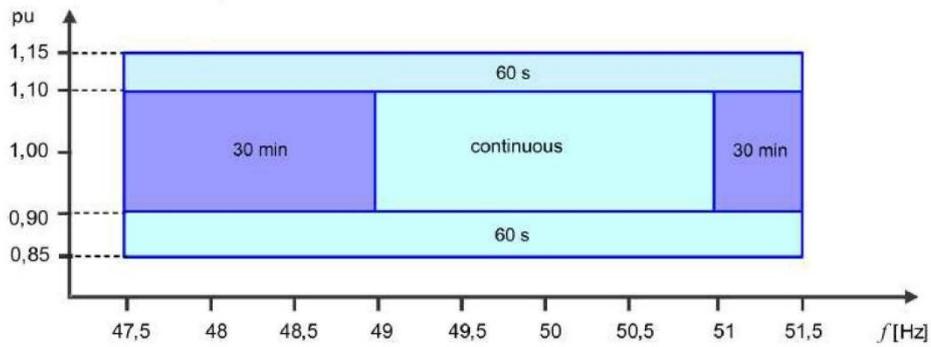
Der bidirektionale Energiespeicher-Wechselrichter verfügt über mindestens eine unabhängige RS485-Kommunikationsschnittstelle und eine unabhängige CAN-Kommunikationsschnittstelle zur Kommunikation mit dem BMS. Der bidirektionale Energiespeicher-Wechselrichter (PCS) tauscht hauptsächlich Informationen mit dem lokalen Überwachungssystem aus. Der bidirektionale Energiespeicher-Wechselrichter sendet seinen eigenen Betriebsstatus an das lokale Überwachungssystem und den Überwachungshintergrund und kann vom Hintergrund ausgegebene Befehle und Sollwerte empfangen. Gleichzeitig kann es BMS-Systeminformationen zum Schutz der Batterie empfangen.

*The bidirectional energy storage inverter is equipped with at least one independent RS485 communication interface and one independent CAN communication interface to communicate with the Battery Management System (BMS). Its main function is to exchange information with the local monitoring system. The inverter sends its operational status and background information to the monitoring system, and it can also receive commands and setpoints issued by the system to adjust its operation accordingly. Additionally, it can receive BMS system information to help protect the battery. This communication capability ensures that the energy storage system operates efficiently and safely.*

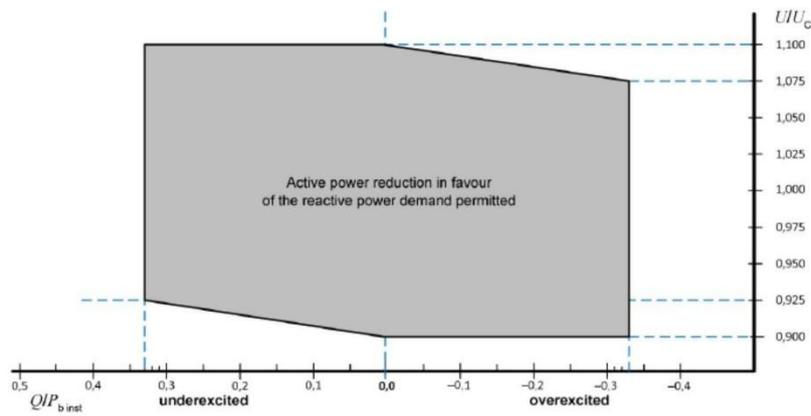


**7. Die folgenden Kurven und Vorgaben der VDE-AR-N 4105, 4110 und 4120 werden eingehalten**

*The following curves and specifications of VDE-AR-N 4105, 4110 and 4120 are adhered to.*



VDE-AR-N 4110:2023-09 (en)



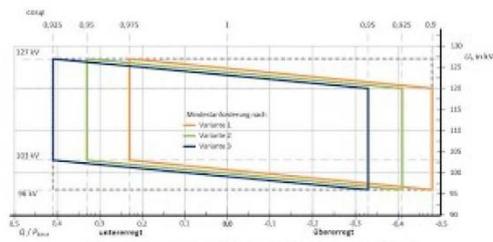
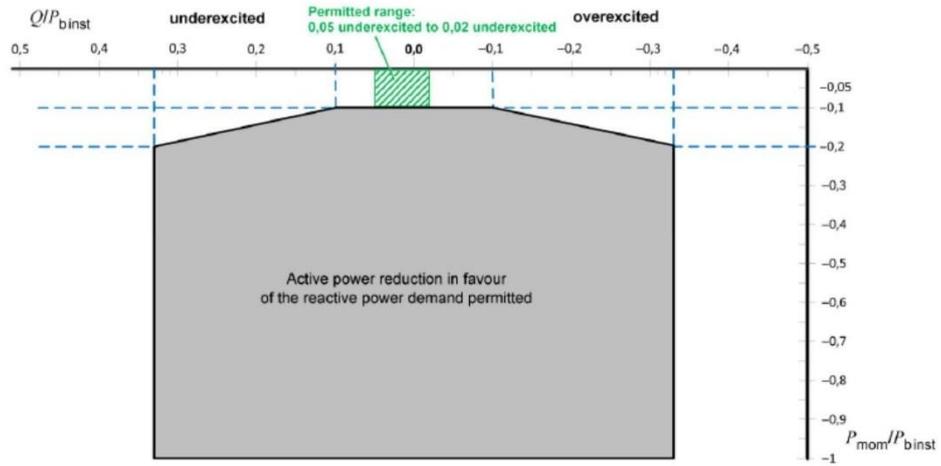


Bild 4 – Varianten der Anforderungen an Erzeugungsanlagen an die Blindleistungsbereitstellung am Netzanschlusspunkt

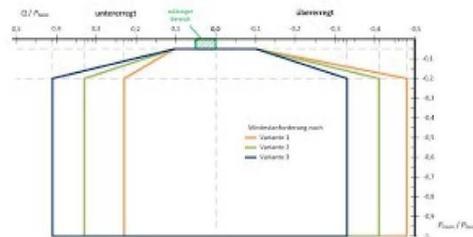
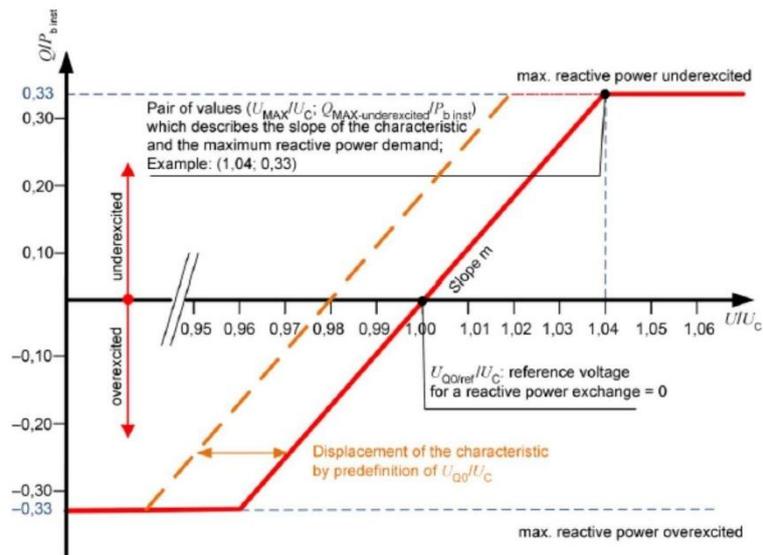
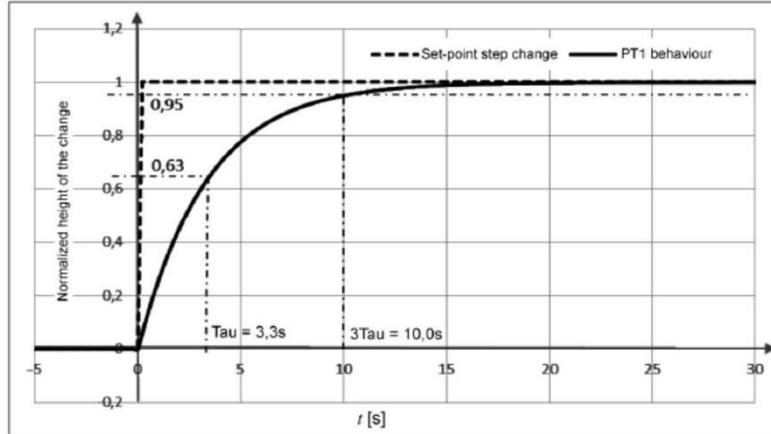
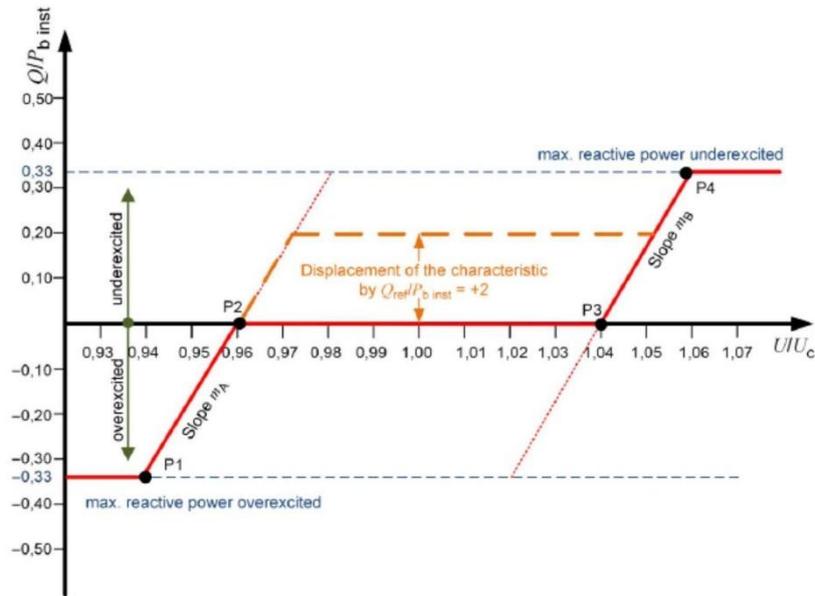
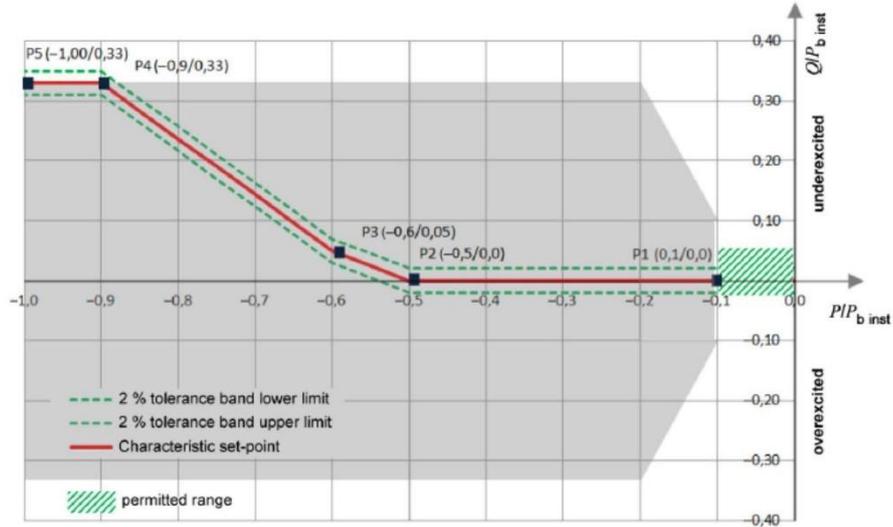
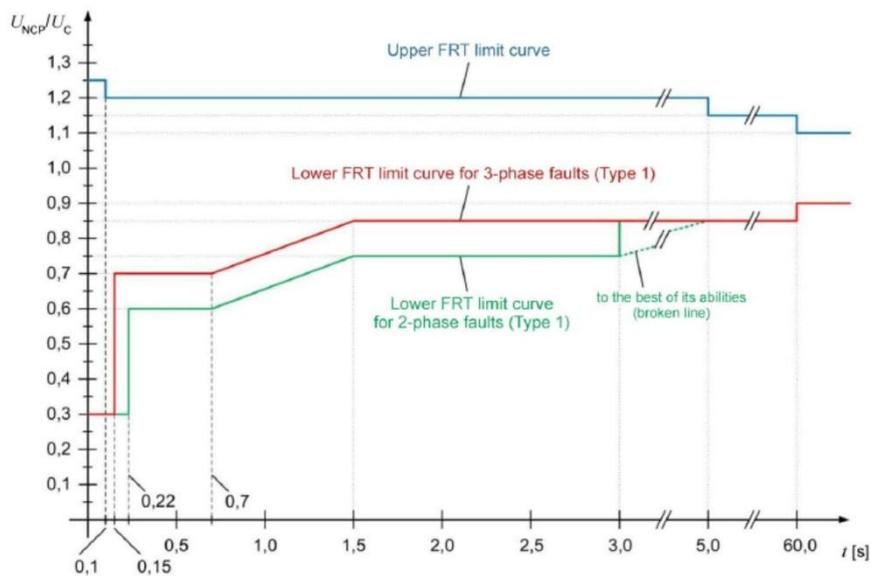
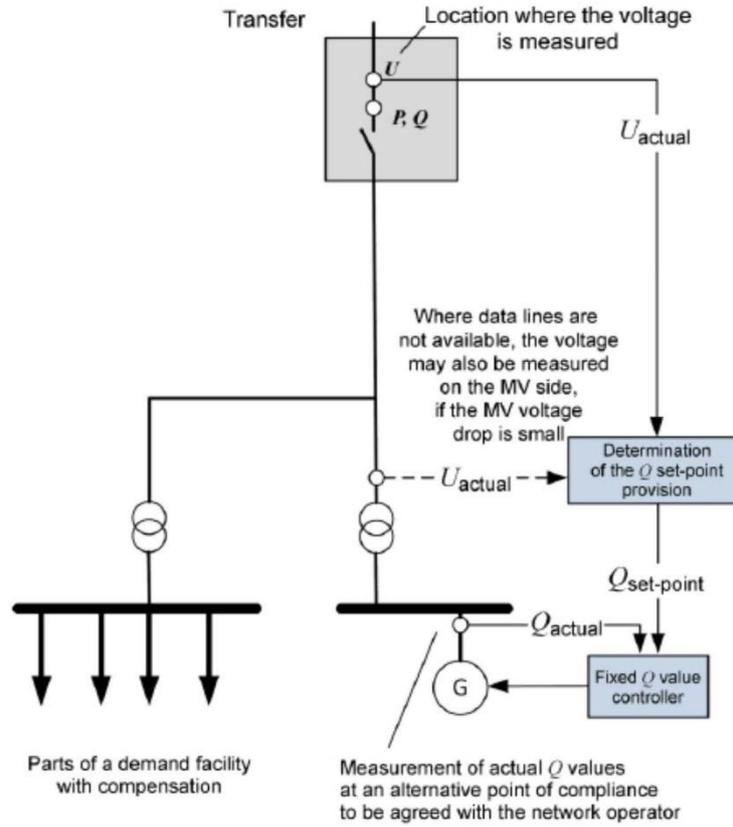
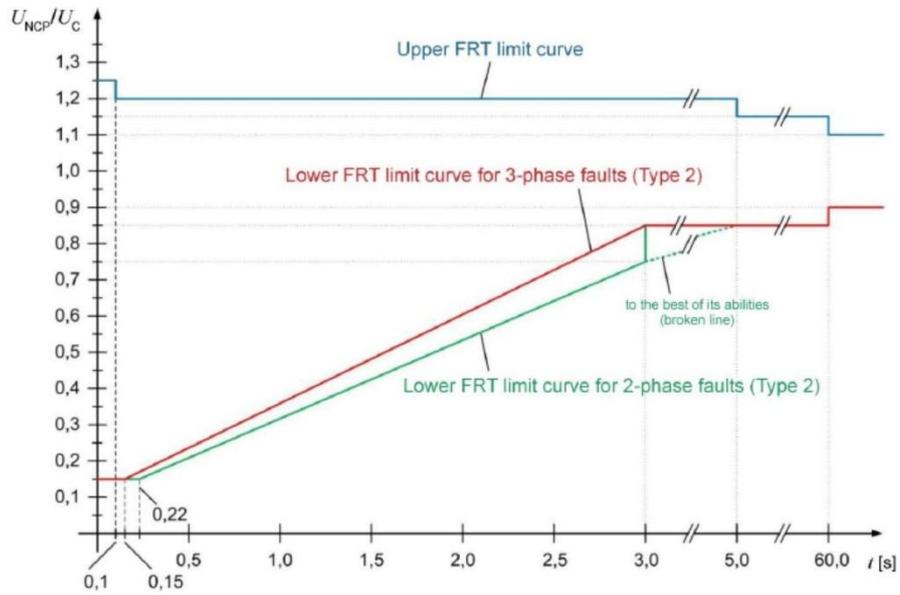


Bild 5 – Varianten der PQ-Diagramme der Erzeugungsanlage am Netzanschlusspunkt im Verbrauchszählpfeilsystem

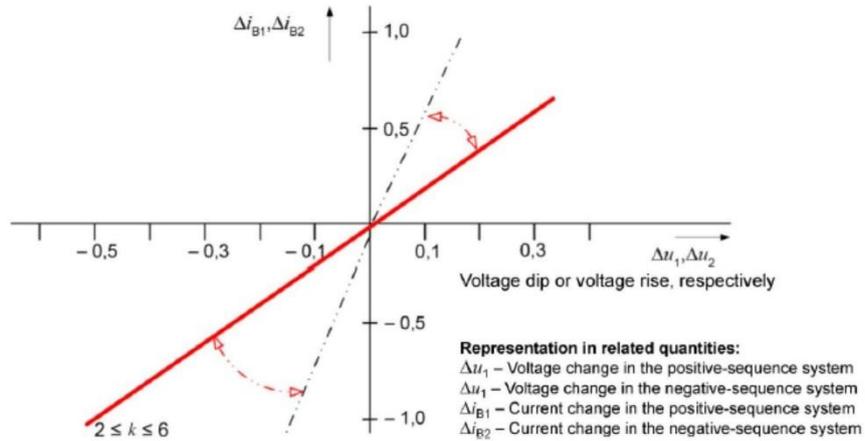


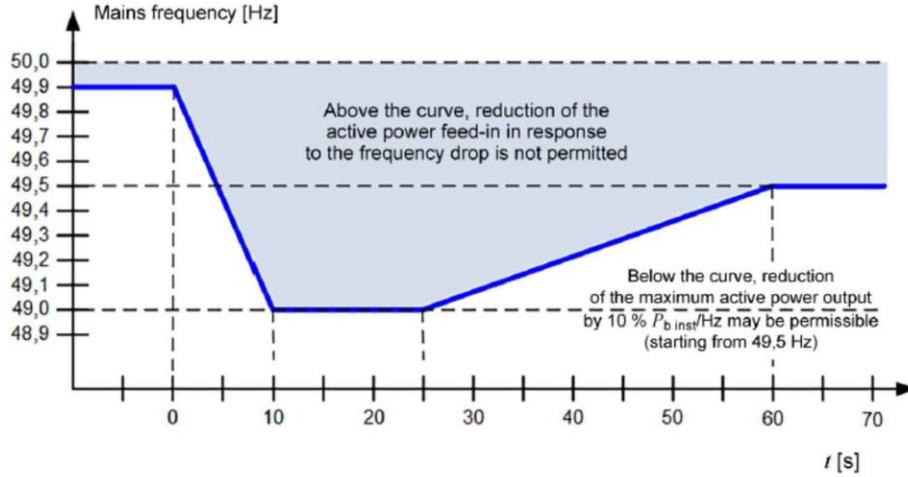






Required additional reactive current





		Type 1	Type 2	
		Power generating plants, storage units, and controllable appliances	Power generating plants and controllable appliances	Storage units
Uprating	Step response time in the event of a frequency reduction in the range of 49,8 Hz to 47,5 Hz	$\leq 5$ min for a $\Delta P \leq 20\%$ of $P_{b\ inst}$	$\leq 10$ s for a $\Delta P \leq 50\%$ of $P_{b\ inst}$	$\leq 1$ s for a $\Delta P \leq 100\%$ of $P_{b\ inst}$
	Step response time in the event of a frequency reduction in the range of 51,5 Hz to 50,2 Hz	$\leq 5$ min for a $\Delta P \leq 20\%$ of $P_{b\ inst}$ <sup>a</sup>		
	Settling time	$\leq 6$ min	$\leq 30$ s	$\leq 10$ s
Power reduction	Step response time in the event of a frequency rise in the range of 50,2 Hz to 51,5 Hz	$\leq 8$ s for a $\Delta P \leq 45\%$ of $P_{b\ inst}$	$\leq 2$ s for a $\Delta P \leq 50\%$ of $P_{b\ inst}$	$\leq 1$ s for a $\Delta P \leq 100\%$ of $P_{b\ inst}$
	Step response time in the event of a frequency rise in the range of 47,5 Hz to 49,8 Hz			
	Settling time	$\leq 30$ s	$\leq 20$ s	$\leq 10$ s

<sup>a</sup> If the power has previously been reduced for overfrequency without adjusting the primary process (e.g. combustion capacity), then the subsequent uprating has to be done considerably quicker.

Response the reactive current fulfill:

- a) Anschwingzeit:  $T_{\text{ein},90\%} \leq 30$  ms;  
 b) Einschwingzeit:  $T_{\text{ein},\Delta x} \leq 60$  ms.

Dynamic network support			
Parameter	Setting range	Setting step	Default value
Operation Mode	Full support / Zero current	--	Full support
K factor <i>VRT_K1, VRT_K2</i>	2...6	0.5	4
Entry threshold <i>StaticVL, StaticVH</i>	Upper bond: 0.8...1.0Un <i>StaticVH</i> Lower bond: 1.0...1.2Un <i>StaticVL</i>	0.01Un	Upper bond: 1.1Un <i>StaticVH</i> Lower bond: 0.9Un <i>StaticVL</i>

Function	Protection setting range	Recommended protection set values	
Rise-in-voltage protection $U >>$	1,00 to 1,30 $u_n$	1,20 $U_c$	300 ms
Rise-in-voltage protection $U >$	1,00 to 1,30 $u_n$	1,10 $U_c$ <sup>a</sup>	180 s
Voltage reduction protection $U <$	0,10 to 1,00 $u_n$	0,80 $U_c$	2,7 s
$QU$ protection ( $Q \rightarrow$ and $U <$ )	0,70 to 1,00 $u_n$	0,85 $U_c$	500 ms

<sup>a</sup> With a view to compliance with the voltage quality, values in excess of 1,1  $U_c$  should not be set.

Network event	Residual voltage in relation to $U_{1\text{min}}$	Duration [ms]	Interruption time
Double fault	$\leq 0,3$	140 ms to 160 ms	0,3 s to 2 s
	$\leq 0,3$	550 ms to 600 ms	20 s to 30 s
Standard fault	$\leq 0,3$	950 ms to 1 050 ms	20 s to 30 s
Double fault	$\leq 0,3$	140 ms to 160 ms	0,3 s to 2 s
	$\leq 0,3$	950 ms to 1 050 ms	

Die Vorgaben der VDE-AR-N 4105, 4110 und 4120 werden vollständig erfüllt.

*The requirements of VDE-AR-N 4105, 4110 and 4120 are fully met.*

## 8. Quasi-stationärer Betrieb quasi-steady-state operation

Während des quasi-stationären Betriebs sollen die Kraftwerke in der Lage sein, sich mit dem Verteilnetz zu verbinden und dort gemäß den Vorgaben in Abbildung 4 zu arbeiten. Das gilt für den gesamten Frequenzbereich von 47,5 Hz bis 51,5 Hz sowie für Spannungen im Bereich von 85 % bis 115 % der Nennspannung ( $U_c$ ) auf der Netzanschlusspunkts. Der quasi-stationäre Betrieb ist dabei definiert durch eine Spannungsänderung von weniger als 5 %  $U_c$  pro Minute und eine Frequenzänderung von weniger als 0,5 % der Nennfrequenz ( $f_n$ ) pro Minute.

*During quasi-steady-state operation, the power generating plants shall be able to operate linked to the distribution network in compliance with the minimum time requirements given in Figure 4 over the full frequency range of 47,5 Hz to 51,5 Hz and for voltages in the range of 85 %  $U_c$  to 115 %  $U_c$  (r.m.s. values of the phase-to-phase voltage) at the network connection*

point. The quasi-steady-state operation is defined by a voltage gradient of 5 % Uc/min and a frequency gradient of 0,5 % fn/min.

## 9. Q(U) Kennlinie

*Q(U) characteristic*

Reactive power-voltage character curve Q(U)			
Parameter	Setting range	Setting step	Default value
Reactive power node (Q1-Q4)	Q1: 0...0.6Pn Q2: -0.6Pn...0.6Pn Q3: -0.6Pn...0.6Pn Q4: -0.6Pn...0	0.01Pn	Q1: 0.44Pn Q2: 0 Q3: 0 Q4: -0.44Pn
Voltage node (Voltage1-Voltage4)	Voltage1: 0.93Un...1.00Un Voltage2: 0.95Un...1.00Un Voltage3: 1.00Un...1.05Un Voltage4: 1.00Un...1.07Un	0.01Un	Voltage1: 0.96Un Voltage2: 1.00Un Voltage3: 1.00Un Voltage4: 1.04Un
Settling time 3Tau	6s...60s	1s	10s

## 10. Q(P) Kennlinie

*Q(P) characteristic*

Character curve Q(P)			
Parameter	Setting range	Setting step	Default value
Reactive Power Node (Q1-Q5)	Q1: -0.6Pn...0.6Pn Q2: -0.6Pn...0.6Pn Q3: -0.6Pn...0.6Pn Q4: -0.6Pn...0.6Pn Q5: -0.6Pn...0.6Pn	0.01Pn	Q1: 0 Q2: 0 Q3: -0.05Pn Q4: -0.33Pn Q5: -0.33Pn
Active Power Node (P1-P5)	P1: 0...1.0Pn P2: 0...1.0Pn P3: 0...1.0Pn P4: 0...1.0Pn P5: 0...1.0Pn	0.1Pn	P1: 0 P2: 0.5Pn P3: 0.6Pn P4: 0.9Pn P5: 1.0Pn
Settling time 3Tau	6s...60s	1s	10s

**c. Fixed Q**

Fixed Q			
Parameter	Setting range	Setting step	Default value
Reactive power Q <i>React. Power</i>	-0.6Pn...0.6Pn	0.01Pn	Q=0
Reactive power Q in com loss condition	--	--	last set-point received
Settling time <i>3Tau</i>	6s...60s	1s	10s

If communication with plant controller or network operator interrupted over 1min, the reactive power maintain the last set-point received.

**d. Fixed cosφ**

Fixed cosφ			
Parameter	Setting range	Setting step	Default value
Displacement factor <i>Power Factor</i>	0.80ue...0.80oe	0.005	1.00
Displacement factor in com loss condition	--	--	last set-point received
Settling time <i>3Tau</i>	6s...60s	1s	10s

If communication with plant controller or network operator interrupted over 1min, the reactive power maintain the last set-point received.

**11. PGU**

Das PGU wurde so ausgelegt, dass die Anforderungen der VDE-AR-N 4105, VDE-AR-N 4110 und VDE-AR-N 4120 für die Erzeugungseinheit erfüllt werden können. Der Prototyp stellt eine wesentliche technische Weiterentwicklung bzw. Innovation dar.

*The PGU have been designed so that the requirements of VDE-AR-N 4105, VDE-AR-N 4110 and VDE-AR-N 4120 for the power generating unit can be complied with. The prototype is an essential technical advancement or innovation.*

数字签字盖章 Weirong ZHANG 张卫荣 CSC 2026年2月10日星期二



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**Annex 4**

**Electrical Data**



Technical Requirements for 200kW Flow Battery Energy Storage PCS

Cabinet

1. Functions:

The PCS performs bidirectional power conversion for a vanadium redox flow battery (VRFB) energy storage system. Together with the DC/DC converter, it forms a two-stage power conversion architecture, supporting battery module operation within a voltage range of 192-297.6V under bipolar operation. The AC interface of the PCS supports 400V/380V grid-connected operation. Under normal operating conditions, the DC bus between the PCS and the DC/DC converter is established by the DC/DC unit, enabling standard four-quadrant active and reactive power control. During 0V start-up and pre-charge, the DC bus between the PCS and the DC/DC converter is established by the PCS, with the PCS drawing power from the AC side.

2. Basic Parameters:

<b>200kW Energy Storage Converter</b>		
<b>Applicable Condition: Grid-connected operation mode</b>		
DC Side Parameters	Maximum DC Power (kW)	220 (continuous)
	Rated DC Power (kW)	200
	Maximum DC Current (A)	1146A
	Voltage Regulation Accuracy	≤2%
	Current Regulation Accuracy	0.5% (above 20% load)
	DC Current Ripple	≤5%
	DC Voltage Operating Range (V)	192-297.6V
	Number of DC Inputs	2
AC Side Parameters	Interface Type	Circuit breaker protection
	Maximum Output Power (kW)	220 (continuous)
	Rated Power (kW)	200
	AC Connection Mode	AC 400V, 3L+PE
	Isolation Method	High-frequency/External power-frequency transformer
Grid-Connected Operation Parameters	Power Factor	-1 ~ +1
	Interface Type	Circuit Breaker
	Rated Grid Voltage (V)	AC 400V
	Permissible Grid Voltage (V)	±15%
	Rated Grid Frequency (Hz)	50Hz
	Permissible Grid Frequency (Hz±%)	±2.5
	Total Harmonic Distortion of Current (%)	≤3%
	Power Factor	≥98%
	Charge/Discharge Switching Time (ms)	100
	Efficiency (%)	98%
	Permissible Ambient Temperature (°C)	-20~50
	Permissible Relative Humidity (%)	0~95%
	Noise Level (dB)	≤70
	Maximum Dimensions (W*D*H) (mm)	(1100*800*2000)



General Parameters	Weight (kg)	/
	Protection Rating	IP21–Drip and Condensation Protection
	Cooling Method	Forced Air Cooling (Provides Cooling Power and Airflow Requirements, Coordinated with Container Air Duct and Fan Design)
	Altitude (m)	Below 1000 m; above 1000 m, derated operation is required, derating curve provided
	Cabinet Access	Front Double Doors, Front Maintenance
	Insulation Resistance (MΩ)	Insulation Resistance $\geq 10$ MΩ for Both AC and DC Sides, Equipped with Insulation Monitoring Device
	DC Energy Metering Accuracy	DC Power, Daily Charge/Discharge Energy, Cumulative Charge/Discharge Energy, Accuracy: $\pm 5\%$
	AC Energy Metering Accuracy	Bidirectional Active and Reactive Power, Daily Charge/Discharge Energy, Cumulative Charge/Discharge Energy, Accuracy: $\pm 5\%$
	Cable Entry/Exit Method	Bottom Entry and Exit, Cable Connection
	Auxiliary Power Supply Mode	AC/DC Side Self-Powered or Optional External Power Supply (External Supply Requires Specified Power)
	Dry Contact	1. Charge/Discharge Enable 2. Full-Power Discharge Start A 3. Full-Power Discharge Start B
Communication Interface	RJ45	
Display and Communication	Human-Machine Interface	Touchscreen, Equipped with Local Display, Control, and Monitoring Functions for Standalone Charge/Discharge Operation
	Communication Protocol	MODBUS TCP (Dual AB Network Ports for EMS Communication)
Charge/Discharge Mode	Charging	Constant Voltage, Constant Current, Constant Power
	Discharging	Constant Voltage, Constant Current, Constant Power (Active + Reactive Power)
	Grid-connected Operation	P/Q control mode
	Grid-connected/Off-grid Switching Operation	/
Protection Functions	High and Low Voltage Ride-Through	Provide High-Voltage (Low-Voltage) Ride-Through Report for Charge (Discharge)
	Current Protection	Overcurrent, Short-Circuit Protection, etc. on AC and DC Sides
	Voltage Protection	Overvoltage and Undervoltage Protection, etc. on AC and DC Sides
	Frequency Protection	Overfrequency and Underfrequency Protection of the Grid in Grid-Connected Operating
	Anti-Islanding Protection	/
	Insulation Monitoring	Online Insulation Monitoring and Leakage Protection on AC and DC Sides



	Other Protection Functions	Overtemperature, Communication Failure, Voltage Unbalance, Phase, and Polarity Protections

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