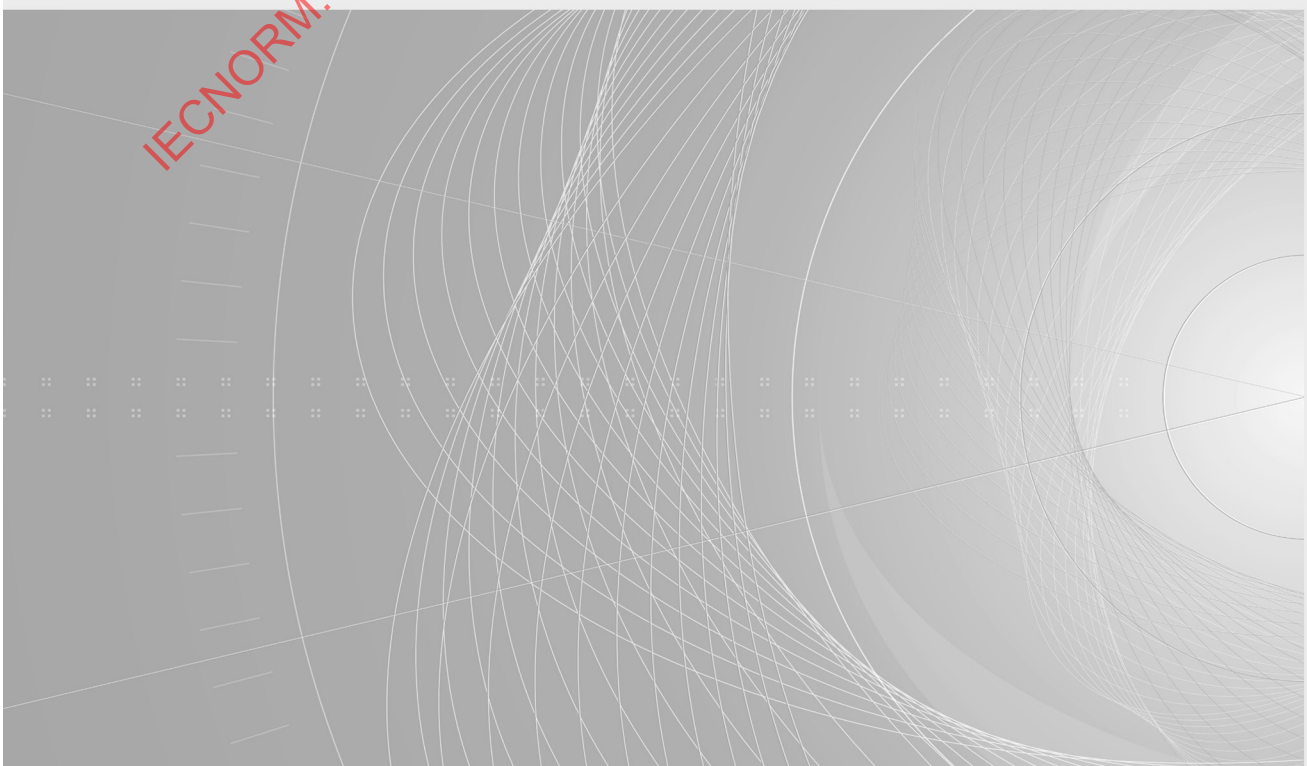
IEC TS 62786-3

Edition 1.0 2023-11

TECHNICAL SPECIFICATION

Distributed energy resources connection with the grid – Part 3: Additional requirements for stationary battery energy storage system



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colour inside

Distributed energy resources connection with the grid – Part 3: Additional requirements for stationary battery energy storage system

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Part 3: Additional requirements for stationary battery energy storage system

FOREWORD

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IEC TS 62786-3 has been prepared by IEC Technical Committee 8: System aspects of electrical energy supply. It is a Technical Specification.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
8/1663/DTS	8/1680/RVDTS

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Specification is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 62786 series, published under the general title *Distributed energy resources connection with the grid*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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DISTRIBUTED ENERGY RESOURCES CONNECTION WITH THE GRID –

Part 3: Additional requirements for stationary battery energy storage system

1 Scope

This part of IEC 62786, which is a Technical Specification, provides principles and technical requirements for interconnection of distributed Battery Energy Storage System (BESS) to the distribution network. It applies to the design, operation and testing of BESS interconnected to distribution networks. It includes the additional requirements for BESS, such as connection scheme, choice of switchgear, normal operating range, immunity to disturbance, active power response to frequency deviation, reactive power response to voltage variations and voltage changes, EMC and power quality, interface protection, connection and start to generate electric power, active power management, monitoring, control and communication, and grid-connected tests.

The stationary BESSs considered within the scope of this document include electrical forms such as lead-acid, lithium-ion, liquid flow and sodium-sulfur batteries, interconnected to medium voltage (MV) or low voltage (LV) distribution networks via bidirectional DC to AC power converters. This document will specify active and reactive power response and grid-connected testing for distributed BESS, as a supplement for IEC TS 62786-1:2023.

This document specifies interface requirements for connection of distributed BESS with the distribution network operating at a nominal frequency of 50 Hz or 60 Hz.

NOTE Mobile electrical energy storage devices (e.g., electrical vehicles) are under consideration for future editions.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC TS 62786-1:2023, *Distributed energy resources connection with the grid – Part 1: General requirements*

IEC TS 62898-2: *Microgrids – Part 2: Guidelines for operation*

3 Terms and definitions, abbreviated terms and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 62786-1:2023 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
battery energy storage system
BESS
electrical energy storage system with an accumulation subsystem based on batteries with secondary cells

Note 1 to entry: A battery energy storage system includes a flow battery energy system.

3.1.2
battery storage subsystem
BSS
BESS subsystem, comprising at least one battery energy storage unit, where energy is stored in the battery

Note 1 to entry: Generally, the battery storage subsystem is connected to the power conversion subsystem that performs the necessary power conversion to electrical energy; however, in some cases, a power converter can be embedded in the battery storage subsystem.

3.1.3
charging mode
operating mode during a required time in which the BESS is supplied with electrical energy from the POC in a controllable way

3.1.4
charging regulation time
time interval from the time when the BESS receives the control signal or when the grid parameter changes in a way to trigger the system response to the time when the power deviation is controlled within a specified percentage of the set point value after charging power firstly reaches to the set point value

3.1.5
charging response time
time interval from the time when the BESS receives the control signal or the grid parameter changes in a way to trigger the system response to the time when the charging power firstly reaches the set point value

3.1.6
charging to discharging transition time
under normal operation conditions, time when the BESS transits from a specified percentage of rated power charging mode to a specified percentage of rated power discharging mode

3.1.7
discharging mode
operating mode during a required time in which the BESS supplies electrical energy to the POC in a controllable way

3.1.8
discharging to charging transition time
under normal operation conditions, time when the BESS transits from a specified percentage of rated power discharging mode to a specified percentage of rated power charging mode

3.1.9
discharging regulation time
time interval from the time when the BESS receives the control signal or the grid parameter changes in a way to trigger the system response to the time when the power deviation is controlled within a specified percentage of the set point value after discharging power reaches to the set point value

3.1.10
discharging response time
time interval from the time when the BESS receives the control signal or the grid parameter changes in a way to trigger the system response to the time when the discharging power firstly reaches the set point value

3.1.11
interconnection interface
single device or a collection of multiple devices connecting the BESS with the grid, which includes the interface switchgear, interface control, interface protection, interface communication, auxiliary subsystem etc.

Note 1 to entry: Figure 1 gives an example of interconnection interface between BESS and distribution network.

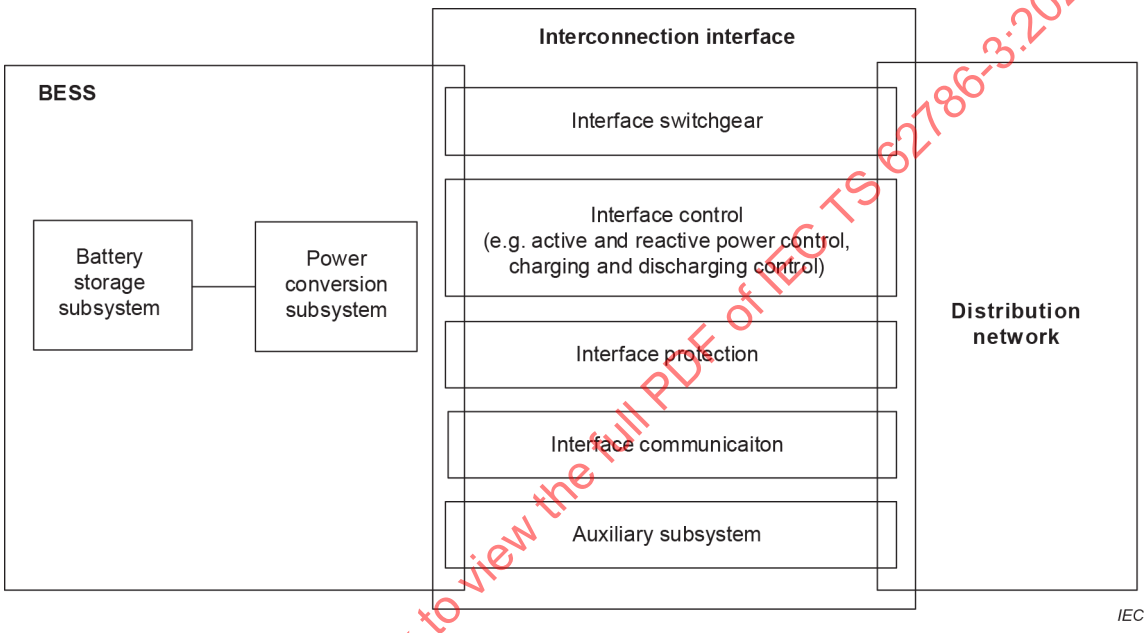

Figure 1 – Example of the interconnection interface concept

3.1.12
power conversion subsystem
subsystem generally connected to the battery storage subsystem and to the POC through the interconnection interface, which converts power bi-directionally between the battery storage subsystem and AC power system

[SOURCE: IEC 62933-1:2018, 5.2.2, modified − The definition has been rewritten and the Note to entry removed.]

3.1.13
rated power charging response time
special state of charging response time, which refers to the time interval from the time when the BESS receives the control signal in standby mode to the time when the charging power firstly reaches the rated power

3.1.14
rated power charging regulation time
special state of charging regulation time, which refers to the time interval from the time when the BESS receives the control signal in standby mode to the time when the power deviation is controlled within a specified percentage of the rated power after charging power firstly reaches the rated power

3.1.15
secondary battery
assembly of battery cell(s) which can include associated safety and control circuits and case/enclosure, ready for use as a source of electrical energy characterized by its voltage, size, terminal arrangement, capacity and rate capability

Note 1 to entry: This includes single cell batteries.

[SOURCE: IEC 62485-2:2010, 3.5, modified − The definition has been rewritten.]

3.1.16
standby mode
operation mode of the BESS that connected to the POC without any intentional power flow and providing for immediate operation upon demand

[SOURCE: IEC 62933-1:2018, 6.1.7, modified − The definition has been rewritten.]

3.1.17
state of charge
SOC
ratio between the available energy from a battery storage subsystem and the actual energy capacity, typically expressed as a percentage

[SOURCE: IEC 62933-1:2018, 6.2.4, modified – "EES system" has been replaced by "battery storage system".]

3.1.18
stationary battery
secondary battery which is designed for service in a fixed location and is not habitually moved from place to place during the operating life

Note 1 to entry: It is permanently connected to the DC power supply (fixed installation) or part of a complete battery storage system.

[SOURCE: IEC 62485-2:2010, 3.8, modified – "or part of a complete battery storage system" has been added and the second sentence has been changed to a Note to entry.]

3.2 Abbreviated terms and symbols

3.2.1 Abbreviated terms

BESS	battery energy storage system
BSS	battery storage subsystem
DER	distributed energy resources
DSO	distributed system operator
EMC	electromagnetic compatibility
OVRT	over voltage ride through
POC	point of connection
ROCOF	rate of change of frequency
SO	system operator
SOC	state of charge
UVRT	under voltage ride through

3.2.2 Symbols

F	operating frequency

f_{dz1} under frequency dead zone value

f_{dz2} over frequency dead zone value

f_{max1} upper threshold of continuous operation frequency range

f_{max2} upper threshold of limited operation frequency range

f_{min1} lower threshold of continuous operation frequency range

f_{min2} lower threshold of limited operation frequency range

f_N nominal frequency of distribution network

P active power

P_N nominal active power output of the BESS

ΔP active power output change in response to the frequency deviation

$\Delta P'$ active power output change in response to the voltage deviation

$P_{th\text{-}apc}$ power threshold for active power control

$P_{th\text{-}fd}$ power threshold for frequency deviation

$P_{th\text{-}rps}$ power threshold for reactive power support

$P_{th\text{-}vd}$ apparent power threshold for voltage deviation

$P_{th\text{-}vwm}$ power threshold for volt-watt mode

P_0 initial value of the BESS active power output

P_1 initial value of the BESS active power output

Q reactive power

s active power droop

T_{cf1} maximum permitted charging time value when $f_{min2} \leq f < f_{min1}$

T_{cf2} maximum permitted charging time value when $f > f_{max2}$

T_{cf3} maximum permitted charging time value when $f < f_{min2}$

T_{df1} maximum permitted discharging time value when $f_{max1} < f \leq f_{max2}$

T_{df2} maximum permitted discharging time value when $f < f_{min2}$

T_{df3} maximum permitted discharging time value when $f > f_{max2}$

T_{f1} minimum operating time value based on operating frequency

U operating voltage in RMS value at POC

U_{max1} upper threshold of continuous operation voltage range

U_{max2} upper threshold of limited operation voltage range

U_{min1} lower threshold of continuous operation voltage range

U_{min2} lower threshold of limited operation voltage range

T_{u1} minimum operating time value based on voltage at POC

T_{u2} disconnection allowed time based on voltage at POC

4 Requirements for distributed BESS

4.1 General

The requirements of Clause 4 apply during normal operation of the BESS units and do not apply in case of maintenance or units out of operation. The provisions in IEC TS 62786-1:2023 for DER are applicable for the BESS in discharging mode. The BESS should have the same characteristics (output voltage, frequency, etc.), unless stated otherwise in the clauses of this document.

4.2 Connection scheme

IEC TS 62786-1:2023, 4.2 shall be applied.

4.3 Choice of switchgear

4.3.1 General

IEC TS 62786-1:2023, 4.3.1 shall be applied.

4.3.2 Interface switch

IEC TS 62786-1:2023, 4.3.2 shall be applied.

4.4 Normal operating range

4.4.1 General

IEC TS 62786-1—, 4.4.1 shall be applied.

4.4.2 Operating frequency range

The BESS with a rated power exceeding the power threshold for frequency deviation $P_{\text{th-fd}}$, (see Annex C), as defined by individual countries, shall be able to operate until the interface protection trips. The BESS shall be able to operate in the frequency ranges, for the duration and minimum requirements as specified in Table 1.

Table 1 – Operating frequency requirements of BESS

Frequency	BESS actions required
$f > f_{\text{max2}}$	Instantaneous disconnection permitted, the BESS can operate in charging mode for a certain amount of time, which is defined by T_{cf2}. The BESS can operate in discharging mode for a certain amount of time, which is defined by T_{df3}.
$f_{\text{max1}} < f \leq f_{\text{max2}}$	Operate for a minimum amount of time, which is defined as T_{f1}. The duration of discharging operation should not exceed a certain amount of time, which is defined by T_{df1}. Charging operation is permitted continuously.
$f_{\text{min1}} \leq f \leq f_{\text{max1}}$	Continuous operation with no specific restriction associated with the frequency of POC.
$f_{\text{min2}} \leq f < f_{\text{min1}}$	Operate for a minimum amount of time which is defined by T_{f1}. The duration of charging operation should not exceed a certain amount of time, which is defined by T_{cf1}. Discharging is permitted continuously.

$f < f_{min2}$	Instantaneous disconnection permitted, the BESS can operate in discharging mode for a certain amount of time which is defined by T_{df2}. The BESS can operate in charging mode for a certain amount of time, which is defined by T_{cf3}.

The recommended range values of f_{min1}, f_{min2}, f_{max1}, f_{max2}, T_{f1}, T_{cf1}, T_{cf2}, T_{cf3}, T_{df1}, T_{df2}, and T_{df3} are specified in Annex A.

4.4.3 Operating voltage range

The BESS interconnection with LV and MV distribution network with a capacity above a certain level of apparent power $P_{th\text{-}vd,}$ (see Annex C), as defined by individual countries, shall be able to withstand voltage deviations in accordance with those specified in Table 2.

Table 2 – Operating voltage requirements of BESS with LV distribution network

Voltage at POC	BESS actions required
$U > U_{max2}$	Disconnection allowed after time T_{u2}
$U_{max1} < U \leq U_{max2}$	Operate for a minimum time T_{u1}
$U_{min1} \leq U \leq U_{max1}$	Continuous operation with no specific restriction associated with the voltage of POC
$U_{min2} \leq U < U_{min1}$	Operate for a minimum time T_{u1}
$U < U_{min2}$	Disconnection allowed after time T_{u2}

The recommended range values of U_{min1}, U_{min2}, U_{max1}, U_{max2}, T_{u1} and T_{u2} in Table 2 are specified in Annex B.

4.5 Immunity to disturbances

4.5.1 General

IEC TS 62786-1:2023, 4.5.1 shall be applied.

4.5.2 Rate of change of frequency (ROCOF) immunity

IEC TS 62786-1:2023, 4.5.2 shall be applied.

4.5.3 Under voltage ride through (UVRT) requirements

IEC TS 62786-1:2023, 4.5.3 shall be applied.

4.5.4 Over voltage ride through (OVRT) requirements

IEC TS 62786-:—, 4.5.4 shall be applied.

4.5.5 Rapid phase angle change immunity

IEC TS 62786-1:2023, 4.5.5 shall be applied.

4.6 Active power response to frequency deviation

4.6.1 General

Depending on local system requirements, the BESS connected to MV and those connected to LV network with a rated power exceeding $P_{\text{th-apc}}$ (see Annex C) shall have active power control in response to frequency variations. $P_{\text{th-apc}}$ is a kW threshold defined by each individual country.

The BESS shall be able to activate active power control in response to under frequency at a programmable frequency threshold f_{dz1} and to over frequency at a programmable frequency threshold f_{dz2}. The active power output change in response to the frequency deviation can be expressed as Formula (1):

$$\Delta P = \begin{cases} \frac{1}{s} \cdot \frac{f_{\text{dz1}} - f}{f_{\text{N}}} \cdot P_{\text{N}} & f < f_{\text{dz1}} \\ 0 & f_{\text{dz1}} \le f \le f_{\text{dz2}} \\ \frac{1}{s} \cdot \frac{f_{\text{dz2}} - f}{f_{\text{N}}} \cdot P_{\text{N}} & f > f_{\text{dz2}} \end{cases} \quad (1)$$

where

f_{N} is the nominal frequency of the network;

P_{N} is the nominal active power output of the BESS;

ΔP is the active power output change of the BESS in response to the frequency deviation;

s is the active power droop.

Figure 2 shows typical curves of active power response to frequency deviation for the BESS under operating frequency range considering charging and discharging modes.

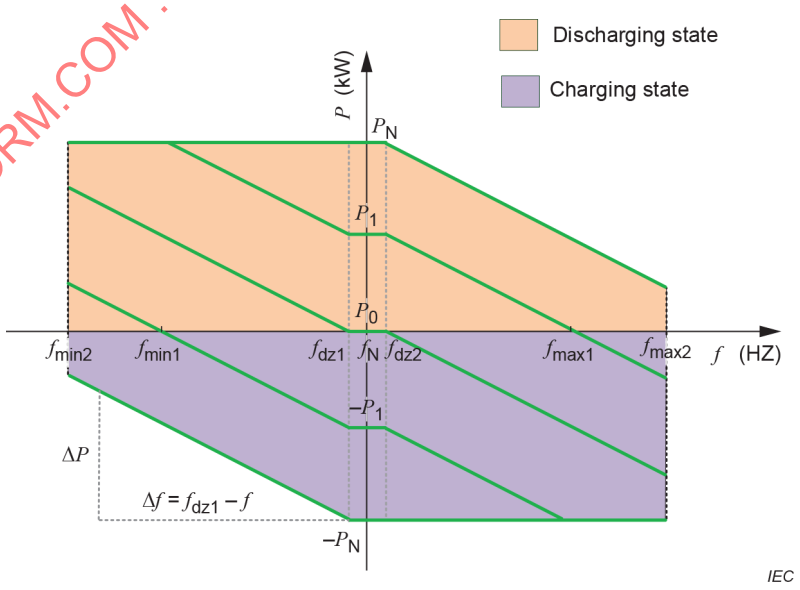

Figure 2 – Typical power-frequency response curve for BESS charging and discharging modes under operating frequency range

In Figure 2, P_0 is in the standby mode and P_1 indicates a discharging initial value of the BESS active power output before the frequency change exceeds the dead zone ($f_{dz1} \leq f \leq f_{dz2}$).

When the network frequency is within the frequency dead zone, the active power output of the BESS should remain the initial value. When the network frequency exceeds the frequency dead zone with Δf, the BESS should regulate the active power output with ΔP following a droop curve like the one shown in Figure 2.

The BESS shall be able to adjust charging or discharging active power in response to frequency deviation as fast as technically feasible.

For utility transmission line short circuit failure or large generator drop out, system frequency change happens with extensive high speed. To support the stabilization action of synchronous generators with quick draw out of their rotational energy in passive manner, power electronic based DER can draw out active power with high speed.

In that case, when the power system ROCOF is observed larger than the threshold, the power converters react to discharge active power with droop function of frequency, or in a stepwise manner to reduce ROCOF of the system, which is called a 'synthetic inertia function' and is utilized in case the function is required by local codes or SOs, or if it is required according to the stipulations of the agreement between the BESS system owner and SO (system operator).

NOTE 1 The negative value of P_1 represents the charging active power and the positive value of P_1 represents the discharging active power.

NOTE 2 The frequency dead zone is defined by the system operator.

NOTE 3 The maximum value of charging response time and charging regulation time are determined by the DSO.

NOTE 4 The maximum value of the discharging response time and discharging regulation time are determined by the DSO.

NOTE 5 The maximum value of charging to discharging transition time and discharging to charging transition time are determined by the DSO.

4.6.2 Active power response to over frequency

As shown in Figure 2, if the network frequency exceeds f_{dz2} when the BESS is in discharging mode with discharging power of P_1, the BESS shall decrease its discharging power following the droop with ΔP, which can be expressed as $P_1 - \Delta P$.

With decreasing of discharging active power from a certain value, the BESS can enter charging mode from discharging mode to support the network frequency.

If the network frequency exceeds f_{dz2} when the BESS is in charging mode with charging power of $-P_1$, the BESS shall increase its charging power following the droop with ΔP, which can be expressed as $-P_1 - \Delta P$. The charging active power of the BESS shall be limited by $-P_N$ if it reaches the rated value of $-P_N$. In order to prevent any other risk of injury or damage to the equipment, a reduction of charging power is permitted.

4.6.3 Active power response to underfrequency

As shown in Figure 2, if the network frequency goes below f_{dz1} and the BESS is in charging mode with charging power of $-P_1$, the BESS shall decrease its charging power following the droop with ΔP, which can be expressed as $-P_1 + \Delta P$.

With decreasing of charging active power from a certain value, the BESS can enter discharging mode from charging mode to support the network frequency.

If the network frequency is under f_{dz1} when the BESS is in discharging mode with discharging power of P_1, the BESS shall increase its discharging power following the droop with ΔP, which can be expressed as $P_1+\Delta P$. The discharging active power of the BESS shall be limited by P_N if it reaches the rated value of P_N. In order to prevent any other risk of injury or damage to the equipment, a reduction of discharging power is permitted.

4.7 Power response to voltage changes

4.7.1 General

When the contribution to voltage support is required by the DSO, the BESS shall be designed to have the capability of managing reactive power according to the requirements of 4.7.

4.7.2 Voltage support by reactive power

The BESS connected to MV network and those connected to LV network with a rated power exceeding $P_{th\text{-}rps}$ (see Annex C) should be able to manage reactive power to maintain the power factor at POC as required by DSO. $P_{th\text{-}rps}$ is a kW threshold defined by each individual country.

The BESS shall be able to deliver the reactive power requirements stipulated by DSO. Figure 3 gives an example of reactive power support capability range of the BESS.

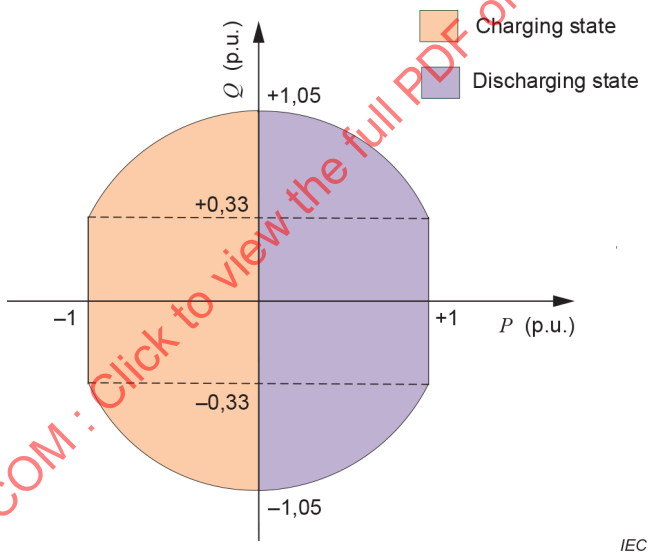

Figure 3 – Example of reactive power capability range of BESS in per unit at nominal voltage

4.7.3 Reactive power control modes

IEC TS 62786-1:2023, 4.7.3 shall be applied.

4.7.4 Voltage related active power control

The BESS connected to MV network and those connected to LV network with a rated power exceeding $P_{th\text{-}vwm}$ (see Annex C) should have capability to regulate the active power output in response to a voltage variation. The final implemented logic can be chosen by the DSO. Nevertheless, this logic shall not cause step changes or oscillations in the active power output. $P_{th\text{-}vwm}$ is a kW threshold defined by each individual country.

Figure 4 shows typical curves of voltage related active power regulation of the BESS. $\Delta P'$ is the active power output change of the BESS in response to the voltage deviation.

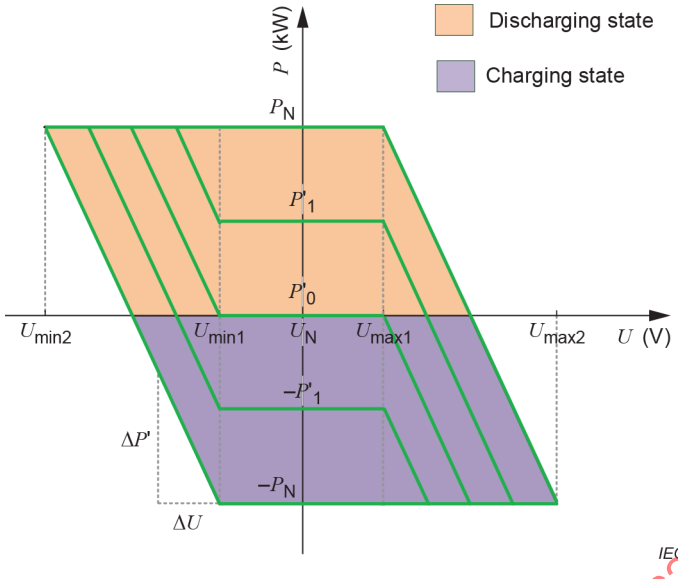

Figure 4 – Typical voltage related active power regulation of BESS

The BESS shall decrease its discharging power by $\Delta P'$ which follows the droop in Figure 4, if it is in discharging mode and the voltage of POC exceeds U_{max1} with ΔU. The BESS shall increase its charging power by $\Delta P'$ which follows the droop in Figure 4, if the BESS is in charging mode and the voltage of POC exceeds U_{max1} with ΔU.

The BESS shall decrease its charging power by $\Delta P'$ which follows the droop in Figure 4, if it is in charging mode and the voltage of POC under U_{min1} with ΔU. The BESS shall increase its discharging power by $\Delta P'$ which follows the droop in Figure 4, if it is in discharging mode and the voltage of POC under U_{min1} with ΔU.

The BESS can go from discharge mode to charging mode, or from charge mode to discharge mode to support the voltage of POC. When the BESS output power reaches the rated value, the BESS output shall be limited to the rated value as shown in Figure 4.

NOTE 1 When the frequency and voltage exceed their respective dead zone at the same time, the priority of active power control in response to frequency and voltage are selected according to the DSO requirement.

NOTE 2 In the situation where multiple BESS are connected, the setting of the regulation curve and response time to voltage variation is studied by SO, avoiding a risk of circulating power or oscillations of power. This power regulation can be combined with priority control of voltage related reactive power regulation.

4.7.5 Voltage related reactive power response

IEC TS 62786-1:2023, 4.7.5 shall be applied.

4.7.6 Additional reactive current requirements on BESS

IEC TS 62786-1:2023, 4.7.6 shall be applied.

4.8 EMC and power quality

4.8.1 General

IEC TS 62786-1:2023, 4.8.1 shall be applied.

4.8.2 Direct current (DC) injection

IEC TS 62786-1:2023, 4.8.2 shall be applied.

4.9 Interface protection

4.9.1 General

IEC TS 62786-1:2023, 4.9.1 shall be applied except the directional current protection requirement.

4.9.2 Requirements on voltage and frequency protection

IEC TS 62786-1:2023, 4.9.2 shall be applied.

4.9.3 Means to detect islanding situation

IEC TS 62786-1:2023, 4.9.3 shall be applied.

4.9.4 Digital input to the interface protection

IEC TS 62786-1:2023, 4.9.4 shall be applied.

4.10 Connection and starting to generate electrical power

4.10.1 General

IEC TS 62786-1:2023, 4.10.1 shall be applied.

4.10.2 Connection of BESS

IEC TS 62786-1: —, 4.10.2 shall be applied if the BESS can be considered as "synchronous-type DER".

4.10.3 Auto reclose of distribution lines

IEC TS 62786-1: —, 4.10.3 shall be applied.

4.10.4 Black start capability and intentional islanding control

According to IEC TS 62898-2, black start capability of the BESS refers to startup of an electric power system from a blackout through the BESS. Intentional islanding control either refers to the procedure to recover from power system network outage or to the independent operation of a local network apart from the main power system.

The BESS shall have black start and intentional islanding control capability if it is required according to the stipulations of the agreement between the BESS system owner and DSO. Transition between utility interactive operation and intentional islanding operation can be seamless or with short time suspending, that transition shall not cause major disturbances by short circuit or step phase jump.

4.11 Ceasing and reduction of active power on set point

For the BESS, the discharging active power output shall be able to reduce to a negative value by entering into charging mode. The rate of charging and discharging active power and the variation of active power should not exceed the value determined by the DSO.

4.12 Remote information exchange

4.12.1 General

IEC TS 62786-1: —, 4.12.1 shall be applied.

4.12.2 Monitoring and control

In addition to IEC TS 62786-1: —, the information provided by the BESS to the system operator should include following:

– charging status or discharging status;
– SOC (state of charge).

4.12.3 Communication

IEC TS 62786-1: —, 4.12.3 shall be applied.

5 Conformance tests

IEC TS 62786-1: —, Clause 5 shall be applied.

Annex A
(normative)

Operating frequency range

This annex specifies recommended continuous and limited operating frequency ranges under which the BESS with a rated power exceeding $P_{\text{th-fd}}$, as defined by individual countries, shall be able to withstand frequency deviations. Table A.1 gives the continuous operating frequency range, Table A.2 gives the limited operating frequency range, Table A.3 gives the limited charging/discharging time.

Table A.1 – Continuous operating frequency range

Frequency of power system Hz	f_{min1} Hz	f_{max1} Hz
50	48,50 to 49,85	50,15 to 51,00
60	58,00 to 59,90	60,2 to 61,5
NOTE It is possible that some countries do not specify the f_{min1}, f_{max1} value.		

Table A.2 – Limited operating frequency range

Frequency of power system Hz	f_{min2} Hz	f_{max2} Hz
50	47,00 to 49,80	50,20 to 52,00
60	56,50 to 59,80	60,30 to 62,50

Table A.3 – Limited charging/discharging time

T_{f1}	T_{cf1}	T_{cf2}	T_{cf3}	T_{df1}	T_{df2}	T_{df3}
2 s to 90 min	0 s~90 min	0~90 min	0~15 min	0 s~90 min	0~90 min	0~15 min

NOTE For Table A.3, in some countries, the maximum duration of operation does not exist. T_{cf1}, T_{cf2}, T_{cf3}, T_{df1}, T_{df2} and T_{df3} are set to infinite values.

Annex B
(normative)

Operating voltage range

This annex specifies recommended continuous and limited operating POC voltage ranges under which the BESS with a rated power exceeding $P_{\text{th-vd}}$, as defined by individual countries, shall withstand voltage deviations. Table B.1 gives the continuous operating POC voltage range, Table B.2 gives the limited operating voltage range.

Table B.1 – Continuous operating POC voltage range

U_{min1} in per unit	U_{max1} in per unit
0,9	1,1
NOTE It is possible that some countries do not specify U_{min1} and U_{max1} values.	

Table B.2 – Limited operating voltage range

U_{min2} in per unit	U_{max2} in per unit	T_{u1} in seconds	T_{u2} in seconds
0,85 to 0,9	1,1 to 1,2	10,0 to 180,0	0,0

NOTE For Table B.1 and Table B.2, $U_{\text{min2}} \leq U_{\text{min1}} < U_{\text{max1}} \leq U_{\text{max2}}$.