OPERATING MANUAL
(Original Operating Manual)

INTILION

INTILION | scalestac power
INTILION | scalestac power boost

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INTILION

AC-coupled lithium-ion battery storage system for indoor installation

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Contents

1 Introduction

This operating manual provides all the information needed for the smooth operation of the INTILION | scalestac battery storage system (hereafter referred to as the “battery storage system”).

The operating manual must be read, understood, and applied by all persons tasked with the assembly, commissioning, operation, maintenance, decommissioning and disassembly of the battery storage system. This applies in particular to the specified safety instructions.

After reading the operating manual, you will be able to

- commission the battery storage system
- operate the battery storage system in compliance with the safety standards
- properly maintain the battery storage system
- decommission and disassemble the battery storage system.

The generally applicable, statutory and other mandatory regulations relating to accident prevention and environmental protection valid in the country of use must also be observed in addition to the operating manual.

The operating manual must always be kept at the location where the battery storage system is installed.

1.1 Means of representation

Text that should be paid particular attention to and that constitutes instructions or a direct warning against hazards is indicated as follows in this operating manual:

1.1.1 Section-relevant warnings

Section-relevant warnings apply not only to a certain action, but to all actions within a section.

1.1.1.1 Structure

SIGNAL WORD

Symbol providing more details on a hazard

Hazard type and source

Possible consequence(s) of non-observation

– Measure(s) for risk prevention

1.1.1.2 Hazard levels

DANGER

Hazard with a high level of risk that, if not avoided, can lead to death or serious bodily injury.

WARNING

Hazard with a medium level of risk that, if not avoided, can lead to death or serious bodily injury.

CAUTION

Hazard with a low level of risk that, if not avoided, can lead to minor or moderate bodily injury.

NOTE

Hazard with a low level of risk that, if not avoided, can lead to material damage.

1.1.2 Embedded warnings

Incorporated warnings are directly integrated into certain actions.

Structure

SIGNAL WORD Hazard type and source

Possible consequences of non-observance, measures for preventing the hazard

Hazard levels

- **DANGER/WARNING/CAUTION**
- ***NOTE*** (without warning triangle, see section 1.1.1)

1.1.3 Other means of representation

The information symbol provides useful information.

– These markings are followed by lists.

• These markings are followed by text describing activities that need to be performed in the order in which they are listed.

" " Text in quotation marks constitutes references to other chapters or sections.

1.1.4 Symbols used in this manual

Particular hazards are indicated as follows in the form of warnings:

Warning of electrical voltage

This symbol warns of the risk to life due to dangerous electrical voltage.

Warning of the danger due to lithium-ion batteries

This symbol warns of potential hazards due to the use of lithium-ion batteries.

Unauthorized access prohibited

This symbol prohibits access to the indicated areas by unauthorised persons. Hazards cannot be recognised by unauthorised persons.

Observe manual

This symbol stipulates the observance of the operating manual and the safety instructions.

1.2 Warranty and liability

The obligations agreed upon in the delivery contract apply, along with the general terms and conditions and the delivery conditions of the battery storage system and the statutory regulations valid at the time the contract was concluded.

All information and specifications in this operating manual have been compiled taking into account the applicable standards and regulations, the current state of technology and our many years of knowledge and experience.

Warranty and liability claims for personal injury or material damage are excluded if they are due to one or several of the following causes:

- Improper use of the battery storage system or use other than the intended use
- Improper installation, commissioning, operation, and maintenance of the battery storage system
- Operation of the battery storage system with faulty safety devices or with improperly fitted or non-functioning safety and protective equipment
- Failure to observe the operating manual and the instructions in the operating manual with regard to the installation, commissioning, operation and maintenance of the battery storage system
- Use of non-qualified or untrained personnel
- Structural modifications to the battery storage system (conversions or other changes to the battery storage system must not be made without the prior written approval of INTILION AG. The battery storage system will lose its EU conformity in the event of any infringements)
- Incorrectly performed repairs

- The use of non-approved spare parts or the use of spare parts that do not meet the technically define requirements.
- Disaster situations, the infiltration of foreign bodies and force majeure

The time between the installation and commissioning of the battery storage system must not exceed three months.

We reserve the right to make technical changes as part of improvements to the usage properties and further development.

1.3 Guarantee

INTILION AG provides a five-year product guarantee for all components of the battery storage system, with the exception of the lithium-ion battery cells.

INTILION AG also provides a ten-year performance guarantee for the capacity of the lithium-ion battery cells. With the conclusion of this contract, INTILION AG guarantees that the remaining useful battery capacity does not fall below a relative minimum value for the specified battery capacity. The State of Health (SoH) (a classifying factor for the remaining useful capacity of a battery) is an indication of the ageing condition of the battery storage system.

Additional information and the conditions of the guarantee can be found in the separately provided document entitled “Guarantee conditions for the INTILION | scalestac storage system”.

1.4 Copyright protection

This operating manual is copyright-protected.

The release of the operating manual to third parties, reproductions of any type or form – including of extracts – and the processing and/or communication of the content of the manual is not permitted for purposes other than external purposes without the written approval of INTILION AG.

Infringements will lead to liability for damages. The right to make any further claims remains reserved.

1.5 Customer service

INTILION AG is part of the HOPPECKE Group. Our customer service team is available to provide you with any technical information you may require:

HOPPECKE Service Competence Center
Phone: +49 (0) 2963 61 591
Fax: +49 (0) 2963 61-543
Email: service@hoppecke.com

Our employees are also always interested in any information or feedback on your experiences with actual use that may be useful for us in improving our products.

2 Safety

Failing to observe the following safety instructions can have serious consequences.

DANGER

– Environmental damage due to escaping hazardous substances

– Failure of important assembly functions

– Danger to persons due to electrical, mechanical, or chemical influences

- Read the safety instructions and warnings in this section carefully before putting the battery storage system into operation.
- In addition to the instructions in this operating manual, make sure to also observe the general safety and accident-prevention regulations.

In addition to the instructions in this operating manual, the operator must also observe any existing national working, operating and safety regulations. Any existing internal site regulations must also be observed.

2.1 Intended use

The operational safety of the battery storage system is only guaranteed if it is used as intended.

INTILION | scalestac is an AC-coupled battery storage system and in grid-building operation, it is primarily suitable for the “behind-the-meter” application.

There are three important features that are worth mentioning for the behind-the-meter application:

- The system interacts with the energy meter at the operating company’s mains connection*
- The system optimises the load and energy flows within the operating company’s infrastructure
- The system does not provide any energy to the public power grid (in Germany: UCTE network) [1]

The battery storage system is not intended for any use other than that specified in this document.

NOTE

The battery storage system is designed for indoor use. INTILION AG offers alternative product solutions for outdoor use.

The intended use also includes

- Observation of all instructions in the operating manual
- Compliance with the inspection and maintenance intervals
- Use of consumables in accordance with the applicable safety regulations
- Compliance with the operating conditions

The technical specifications set out in the technical data must be complied with without exception.

Only ever use the battery storage system as intended in order to guarantee safe operation.

The operating company using the battery storage system and not the manufacturer is responsible for all personal injury and property damage arising from improper use.

[1] additional hardware required, please contact INTILION AG

2.1.1 Structural changes to the battery storage system

The design and the manufacturer acceptance are performed based on the German Product Safety Act (ProdSG). No modifications, additions or conversions may be made to the battery storage system without the prior written approval of INTILION AG.

The product will lose its EU conformity in the event of non-compliance. The manufacturer of the battery storage system is outside of the warranty and any warranty claims.

Components not in perfect condition must be reported to the HOPPECKE Service team immediately (see section 1.5). Continued use of the system is not permitted.

Only use original spare parts/wear parts/accessories. These parts have been specially designed for the battery storage system. If parts that are manufactured by third parties are used, it cannot be guaranteed that they have been designed and produced such that they can bear sufficient loads and comply with safety standards.

Parts and special equipment that are not supplied by INTILION AG are not approved for use on the battery storage system.

2.1.2 Foreseeable misuse

Any use that differs from or goes beyond the intended use of the battery storage system can lead to serious injury.

DANGER

- Do not operate the battery storage system in a potentially explosive environment.
- Only use the battery storage system as per the intended use.
- Do not charge or discharge the battery modules outside of the temperature range specified in section 3.6.
- Do not operate the battery modules outside of the operating conditions defined in the data sheet.

- Do not expose the lithium-ion cells of the battery storage system to ambient temperatures of above 40 °C or below 0° C. Compliance with the temperature specifications must be ensured during operation by a room air-conditioning system.
- Avoid short circuits.

2.2 Personnel requirements

Unauthorised persons are prohibited from working on the battery storage system. The operating manual must be observed.

DANGER

The battery storage system must only be installed, commissioned, operated, maintained, repaired, decommissioned and/or disassembled by persons who are qualified and/or trained in the performance of this work.

These persons must have completed an INTILION | scalestac product training session and must be familiar with and act in accordance with the operating manual. The relevant authorisations of the various personnel must be clearly defined.

The following qualifications are specified in the operating manual for different activity areas.

Personnel in training

Personnel in training, such as apprentices or temporary employees, are not familiar with all of the hazards that can occur when operating the battery storage system. Work must only be performed on the battery storage system under the supervision of trained or qualified personnel.

Trained personnel

Trained personnel have been instructed by the operating company or by qualified personnel on the tasks assigned to them and the potential hazards involved with improper conduct as part of a training session.

Qualified personnel

Qualified personnel are those who because of their training, knowledge and experience, coupled with knowledge of the applicable regulations, are in a position to perform the work assigned to them and to independently recognise and prevent potential hazards.

Specialised electricians

Specialised electricians are individuals who, because of their specialist training, knowledge and experience, coupled with knowledge of the applicable regulations, are in a position to perform work on electrical equipment and to independently recognise and prevent potential hazards.

Specialised electricians are specifically trained for the working environment in which they are employed, and they are also familiar with the relevant standards and regulations.

Specialised electrician with WLE certification

Only a specially trained specialised electrician is permitted to carry out work on live equipment (WLE work). Certification must be performed based on DGUV Rule 103-011/3.2.4 and VDE 0105-100 section 6.3.2.

2.2.1 Responsibilities

Incorrect use can result in serious personal injury and material damage.

Therefore, have all tasks performed by qualified personnel only.

– People are only permitted to be approved as personnel if they can be expected to perform their work reliably. No persons may work on the battery storage system if their response capability is impaired as a result of substances such as drugs, alcohol or medication.
– All persons who work on battery storage system must read the operating manual and provide their signature to confirm that they have understood the content.
– Personnel in training must initially only work on the battery storage system under the supervision of qualified personnel. Successfully completed training must be confirmed in writing.

The operating company is responsible for personnel training.

2.2.2 Obligations of personnel

All persons assigned with work on the battery storage system are obligated to do the following prior to starting work:

- Observe the basic requirements regarding occupational safety and accident prevention.
- Read and understand the safety instructions and warnings in this operating manual and confirm this by signature.

2.2.3 Unauthorised persons

Unauthorised persons who do not meet the qualification requirements for personnel will not be familiar with the hazards in the working area.

- Keep unauthorised persons away from the working area.
- If in doubt, approach persons in the working area and escort them out if necessary.
- Stop work if there are unauthorised persons in the working area.

2.2.4 Training

Personnel must receive regular training from the operating company (e. g. every six months). A log must be created after the completion of training (see Tab. 1 for an example).

Tab. 1: Training

Date	Name	Type of instruction	Training performed by	Signature

2.3 Personal protective equipment

Observe the signs affixed in the working area regarding personal protective equipment.

Irrespective of the workplace risk assessment, personal protective equipment must be worn when operating the battery storage system in order to keep health risks to a minimum.

- Always wear the necessary protective equipment when performing work.
- Do not wear any metallic watches, rings, chains, or other jewellery.

The symbols have the following meanings:

Wear protective clothing (isolating protective clothing)

Protective work clothing is closely fitting work clothing with a low tear-resistance, with narrow sleeves and no protruding parts. It is primarily intended for protection against being caught by moving product parts.
Isolating protective clothing is non-conductive and prevents the passage of electrical current when the wearer comes into contact with a live part.

Wear foot protection (isolating safety boots)

Wear non-slip safety boots to protect against heavy falling parts or slipping on smooth surfaces.
Specialised electricians require isolating shoes for carrying out work on live parts. When worn in combination with isolating protective clothing, these shoes are designed to protect the wearer from electric shock while also preventing current from flowing through the body and into the ground via the feet.

Wear hand protection (1000-V protective gloves)

Wear protective gloves to protect the hands from friction, abrasions, punctures or deep wounds, aggressive chemicals and from contact with hot surfaces or chemical substances.
Wear isolating (1000 V) protective gloves in accordance with EN 60903 or VDE 0682 Part 311 to protect the hands from dangerous electric shock when touching live parts.

Wear head protection (electrician's safety helmet)

Wear a safety helmet to protect against falling or flying parts.
Wear an electrician's safety helmet marked with 1000 V to protect against thermal impacts such as arcs and to protect against dangerous electric shock when touching live parts in accordance with DIN EN 50365.

Wear face protection (electrician's face protection)

Wear face protection to protect the eyes and face.
Wear electrician's face protection suitable for working on live equipment (WLE) to protect against potential electric arcs.

Wear ear protection

Wear hearing protection to protect against hearing damage.

Wear a harness

Use suitable fall protection (safety cable and harness) when working at heights.

Personal protective equipment must be provided by the operating company and must comply with the applicable requirements.

The national regulations and specifications from the workplace risk assessment must also be observed, along with any internal instructions from the operating company.

2.4 General safety information

- The battery storage system must only be commissioned, maintained, decommissioned and/or disassembled once this operating manual has been read.
- Only use the battery storage system as per the intended use (see section 0).
- Do not put the battery storage system into operation if there are other people in the danger zone.
- When operating the battery storage system, avoid any operation that might impair the safety of persons or the battery storage system.
- Never operate the battery storage system without the associated protective and safety devices. Never take the installed safety devices out of operation.
- If an alarm is triggered, maintain the maximum possible distance from the battery storage system and do not open the battery storage system. With indoor battery storage systems, leave the room and/or building immediately and warn any other persons in the room.
- Always keep the working area of the battery storage system clean and tidy in order to prevent hazards as a result of dirt or parts that have been left lying around.
- Keep the ventilation slots on the battery storage system open. Do not place any materials in front of the ventilation slots either from the inside or the outside.
- Do not exceed the technical performance data (see section 3.5.1).
- Keep all safety instructions and warnings on the product in a legible condition and replace them if necessary.
- Operation of and work on the battery storage system must only be performed by trained and qualified personnel (see section 0).
- Remote updates must only be performed under the supervision of a qualified person on site. The qualified person on site may act immediately in the event of an error (e. g. by carrying out a reboot or importing the old, runnable version).
- Take the battery storage system out of operation immediately in the event of malfunctions. Have the malfunctions rectified by appropriately trained specialists or by INTILION AG or the HOPPECKE Service team.
- Always store the operating manual in the location where the battery storage system is used. It must be ensured that all persons carrying out work on the battery storage system can access the operating manual at any time.

2.5 Safety measures for environmental protection

- For all work, make sure to comply with regulations on waste avoidance and proper waste recycling or disposal.
- During installation and maintenance work in particular, as well as during decommissioning, make sure that substances that are harmful to groundwater, such as grease, oils, coolants, cleaning fluids containing solvents etc. do not infiltrate the ground or get into the sewer system. These substances must be collected, stored and transported in suitable containers, and disposed of in accordance with national legal provisions.

2.6 Special warnings

2.6.1 Symbols used on the battery storage system

Warning of electrical voltage

This symbol warns of the risk to life due to dangerous electrical voltage. There is an immediate risk to life in the event of contact with live parts.

Warning of the danger due to lithium-ion batteries

This symbol warns of potential hazards due to the use of lithium-ion batteries.

Unauthorized access prohibited

This symbol prohibits access to the indicated areas by unauthorised persons. Hazards cannot be recognised by unauthorised persons.

No access for persons with pacemakers or defibrillator implants

This symbol prohibits the presence of persons with medical implants in the area of the battery storage system, as the electromagnetic fields risk causing devices such as pacemakers to malfunction.

No open flames; fire, open ignition sources and smoking are prohibited

This symbol prohibits fire, open flame and smoking in the area of the battery storage system.

Observe manual

This symbol stipulates the observance of the operating manual and the safety instructions.

Keep all safety instructions and warnings on the battery storage system in a legible condition. Replace the warnings as necessary.

2.6.2 Danger due to electrical energy

DANGER

There is a risk of electric shock when touching parts that are under voltage. This also poses a danger of secondary accidents as a result of shock (e. g. falls).

- Keep electrical components closed at all times.
- Only ever have work on the electrical equipment performed by specialised electricians with WLE certification and who have been specifically trained for working on electrical equipment and who are capable of recognising and avoiding dangers.
- Adhere to the five safety rules when working on the electrical equipment:
  1. Disconnect
  2. Secure against being switched back on
  3. Verify that the system is de-energised
  4. Connect to earth and short circuit
  5. Cover or partition off live parts

In order to ensure the safe performance of electrical work, the operating company can transfer its obligations over to a system manager (specialised electrician). The transfer of responsibility must be made in writing.

- Before working on the electrical equipment, de-energise the battery storage system and secure it against re-activation.

DANGER

There is a risk of electric shock when touching parts that are under voltage.

Because the system contains batteries that cannot be de-energised, life-threatening DC voltages are always present in some sub-areas of the system.

Each battery rack on the battery storage system can only be de-energised up to the output + and output - connections on the control box that is part of the battery management system on the mains side. The individual battery modules cannot be de-energised. There is always dangerous electrical voltage at the power connections on the battery modules and at the input + and input - connections on the control box.

- Work on the electrical equipment must only be performed by a responsible specialised electrician (e. g. industrial electrician) with WLE certification.
- The responsible specialist electrician must have completed an INTILION | scalestac product training session.
- Always use insulated tools (up to 1000 V) when working.
- Check the electrical equipment for defects such as loose connections or singed cables on a regular basis. Have any defects rectified immediately.
- Have the electrical equipment and local electrical operating equipment checked by a specialised electrician once a year or as per the stipulated intervals.
- Local electrical operating equipment refers to permanently installed operating equipment or operating equipment with no carrying device and with a weight that means that it cannot be easily moved. This also includes electrical operating equipment that is permanently attached on a temporary basis and that is operated via moving connection cables.
- At least every 6 months, have a specialised electrician check the portable electrical operating equipment, the connection cables with connectors and the extension and device-connection cables together with their connector systems where used.
- Portable operating equipment refers to equipment that can be moved when live in accordance with the type of equipment and its normal use. These include items such as electrical floor-cleaning machines.
- Check all the safety devices on the battery storage system for correct functioning on a regular basis.
- Damaged housings or cables must be repaired or replaced immediately and before switch-on.

2.6.3 Dangers due to lithium-ion batteries

DANGER

There is a considerable risk to health and life in the event of electric shocks at battery voltages higher than just 60 V. Lithium-ion batteries can produce a high short-circuit current even when they appear to be discharged.

In rare events, mechanical damage (e. g. impact), electrical faults (e. g. short circuit, deep discharge, overloading) or temperatures of over 70 C° (e. g. internal overheating) can cause emission of electrolytes or gas which may lead to fire.

Contact with the emitted electrolyte or gas can cause breathing difficulties, suffocation, or intoxication, or even cancer.

- The battery modules must only ever be handled by specialists. Always used insulated tools when working.
- Always wear protective work clothing and protective gloves when working on the battery modules.

- Only ever transport the battery modules in their original packaging or in packaging that corresponds to the applicable guidelines. Keep the packaging in a safe place.
- Do not heat up the battery modules beyond the maximum permissible temperature and do not burn them.
- Make sure that there are no external ignition sources.
- Do not short-circuit the battery modules and do not cause them any mechanical damage (do not pierce, deform, destroy etc.).

DANGER

- When handling suspicious battery modules (leaking contents, deformation, discolouration, dents etc.), wear protective work clothing and protective gloves and ensure sufficient ventilation. Do not breathe in any of the escaping gases.

- Cover the poles with masking tape to secure the damaged battery modules against short circuit.
- When packaging damaged battery modules, make sure that they are as hermetically sealed as possible, and surround with dry sand, calcium carbonate powder (CaCO3) or Vermiculite.
- Wherever possible, store damaged battery modules outside of buildings and in a shock-proof and fire-proof outer packaging. Use warning signs to mark and secure the storage location.

- Have the battery modules disposed of by a certified specialist company or by INTILION AG (see section 10).

In the event of contact with escaping electrolyte, proceed as follows:

- In the event of inhalation, move the affected person into the fresh air and leave in a resting position. Consult a doctor if larger quantities have been inhaled or in the event of irritation of the airways.
- In the event of contact with the skin, immediately rinse the area with water for at least 15 minutes. Consult a doctor in the event of persistent skin irritation.
- In the event of contact with the eyes, immediately rinse the eyes with water for at least 15 minutes and consult a doctor. Protect the other uninjured eye.
- In the event of swallowing, consult a doctor immediately. No not induce vomiting. Rinse the mouth and surrounding areas with water.

2.6.4 Dangers due to hot surfaces

WARNING

Contact with hot components may cause burns.

- Always wear protective work clothing and protective gloves when working near hot components.
- Allow components to cool down to ambient temperature before working on the battery storage system.

2.6.5 Dangers due to working at height

WARNING

When working on the product, there is a danger of falling from a great height, which can lead to fatal injuries.

- Use fall protection (e. g. safety cable and harness) when working at heights of over 1 m.
- If a harness is used as fall protection: Observe the rescue concept for people in harnesses. A person must not be left suspended in a harness for more than 15 minutes, as otherwise they could go into shock, with potentially fatal consequences.

Qualification for working at heights must be demonstrated.

2.6.6 Dangers due to noise

CAUTION

The sound pressure level in the working area can lead to lasting hearing damage in the event of long-term exposure.

- The operating company must provide ear protection for sound pressure levels of 80 dB(A) and over.
- Ear protection must be work at sound pressure levels of 85 dB(A) and over.

2.6.7 Dangers due to the use of incorrect spare parts

NOTE

Incorrect or faulty spare parts can lead to damage, malfunctions or total failure, and can also impair safety.

- Only use original spare parts.
- Procure spare parts from INTILION AG. (See section 1.5).

2.7 Safety and protective devices

- Make sure to cordon off the working area of the battery storage system.
- Always check that the safety and protective devices are all properly attached and fully functioning before switching on the battery storage system.
- For the delivery of sub-components, the protective devices must be attached by the operating company in accordance with the regulations.
- During operation, the safety and protective devices must not be bypassed, removed or otherwise rendered inoperative.
- Protective devices may only be removed following a standstill and only after the battery storage system has been secured against re-activation.
- Check all the safety devices on the battery storage system for correct functioning on a regular basis.

2.8 Information regarding emergencies

⚠ Preventative measures

- Always be prepared for accidents or fire.
- Keep first-aid equipment (first-aid kit, blankets etc.) to hand.
- Make sure that you are familiar with the accident-reporting, first-aid, fire-extinguishing and rescue facilities.
- Keep the access routes clear for rescue vehicles and mark them accordingly if necessary.

⚠ Measures in the event of accidents

- Rescue people from the danger zone.
- Perform resuscitation immediately if heart or breathing stops.
- In the event of personal injury, inform the first-aid officer and an emergency doctor or the emergency services immediately.
- Clear the access routes for rescue vehicles. If necessary, assign somebody with the task of briefing the emergency services.

2.9 Obligations of the operating company

The battery storage system is used in a commercial environment. The operating company of the battery storage system is therefore subject to the legal obligations regarding occupational safety.

In addition to the safety instructions in this operating manual, the safety, accident-prevention and environmental-protection regulations that apply in the field of application of the battery storage system must also be complied with. The following applies in particular in this regard:

– The operating company must ensure that the battery storage system is only used as intended (see section 0).
– The operating company must provide and indicate escape routes. The operating company must also ensure that escape routes are always kept clear.
– The operating company must provide the operating manual in the location where the battery storage system is used, making sure that it is always in a complete and legible condition.
– The operating company must clearly regulate and define the various responsibilities for commissioning, operation, maintenance, decommissioning and disassembly.
– The operating company must only allow people to work on the battery storage system who have reached the statutory minimum age limit.
– The operating company must only allow people to work on the battery storage system who have the appropriate qualifications and training.
– The operating company must ensure that all employees who work with the battery storage system have read and understood the operating manual.
It must also provide employees with regular documented training and must inform them of the associated dangers.

- The operating company must provide personnel with the personal protective equipment and make sure that it is used.
- The operating company must ensure that no work is carried out on the battery storage system by persons whose response capability is impaired as a result of substances such as drugs, alcohol or medication.
- The operating company must ensure that all employees who work with the battery storage system take sufficient breaks in order to rule out as far as possible any symptoms of fatigue or lack of concentration when working with the battery storage system.

The operating company is also responsible for ensuring that the battery storage system is always in a technically perfect condition. The following rules apply in this regard:

- The operating company must ensure that the maintenance intervals specified in this operating manual are complied with.
- The operating company must have all safety devices checked for correct functioning and completeness on a regular basis.
- The operating company must perform regular checks to establish that all of the safety instructions and warnings attached to the battery storage system are legible and permanently affixed.

2.10 Obligations of the system manager

The system manager is responsible for the safe performance of electrical work. The transfer of responsibility is performed in writing by the operating company.

The system manager must have read and understand the operating manual. He or she must consult the HOPPECKE Service Competence Center in the event of misunderstandings.

3 Description of the battery storage system

3.1 Functional description

The INTILION | scalestac is an AC-coupled battery storage system for use in industrial indoor applications.

In its basic configuration, the battery storage system has lithium-ion batteries with a nominal energy content of 154 kWh (scalestac power) or 123 kWh (scalestac power boost). Additional batteries can be used to increase the energy content to up to 616 kWh (scalestac power) or 369 kWh (scalestac power boost).

The output can be scaled up in 25 kVA steps from 25 kVA to 400 kVA by the parallel connection of bidirectional battery inverters (hereafter referred to as “inverters”).

The battery storage system can be controlled via the external Modbus interface and used in a range of different application areas. It consists of multiple control cabinets where various assemblies and components are integrated. Tab. 2 shows an overview of the scalable structure of the INTILION | scalestac.

Tab. 2: Scalable structure

Control cabinet	**Function**
Field 1 **INTILION Control Unit (ICU)**	AC connection field and control unit for the entire system
Field 2 **(Basic)** **Bidirectional inverter**	Power electronics with AC ←→ DC converter, with a system output of 25 kVA to 200 kVA
Field 3 **(optional)** **Bidirectional inverter**	Power electronics with AC ←→ DC converter, with a system output of 225 kVA to 400 kVA required in addition to field 2
Field 4 **INTILION Battery Unit (IBU)**	DC connection field and battery monitoring device
Field 5 **Battery**	*Basic* - battery A control cabinet with 154 kWh (scalestac power) or A control cabinet with 123 kWh (scalestac power boost)
	Expansion - battery Up to three additional control cabinets with a cumulative energy content of 308 kWh to 616 kWh (scalestac power) or Up to three additional control cabinets with a cumulative energy content of 246 kWh to 492 kWh (scalestac power boost)

Application fields include behind-the-meter use, where the device is used to optimise the private consumption of locally generated energy, in order to reduce load peaks in industrial environments or to buffer energy for electric vehicle charging stations.

The battery storage system must be controlled via the Modbus TCP/IP interface. This enables the integration into an energy management system (EMS) provided by a third party or by INTILION AG (additional hardware required). The INTILION Control Unit checks the external setpoint specifications for plausibility, thus making sure that the battery storage system always operates within the defined operating window.

A detailed description of the Modbus TCP/IP interface can be found in the document entitled “scalestac_Modbus_TCPIP_Interface.pdf”.

INTILION | scalestac contains an industrial PC (IPC) and an LTE router for remote access and data upload.

- Connect INTILION | scalestac to the internet using a network cable (CAT 6 or higher).
- Assign an IP address to the battery storage system.
- Enable the following ports for remote access and data upload:
  1194, 8883, 80 & 443.

Various safety features have been integrated into the system ex works to meet regulatory requirements. For example, the integrated power generation protection which is implemented by the Ziehl UFR-1001E grid and plant protection unit and the circuit breaker. The default configuration of the protection unit contains the settings as indicated in VDE-AR-N 4110.

3.2 Component layout

There are two categories of system parts in the battery storage system:

- The **primary technology** consists of the components that carry the energy flow, which are allocated to the system's power element. This consists of the battery, the AC and DC infrastructure and the inverter.
- The **secondary technology** consists of the control units and the system's safety and monitoring equipment. These are not directly involved in the storage and output of energy from an electrical installation perspective.

The following illustrations show the individual control cabinets for INTILION | scalestac.

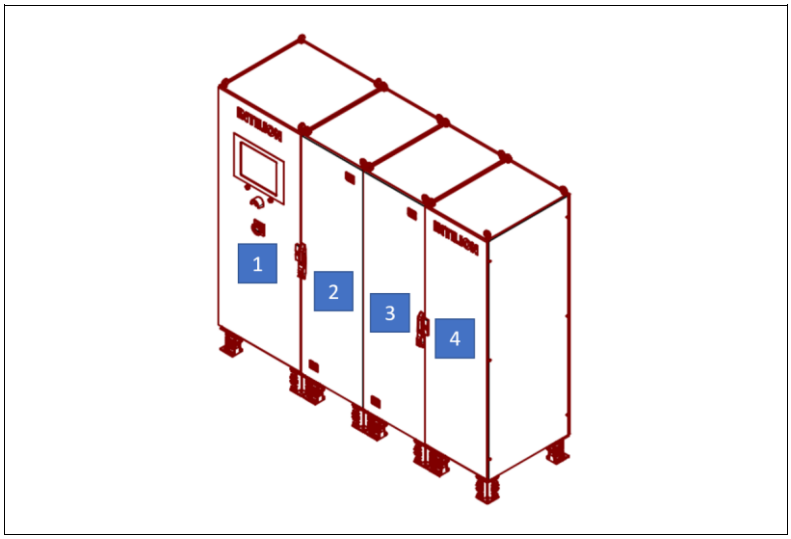

Fig. 1: fields 1, 2, 3 and 4

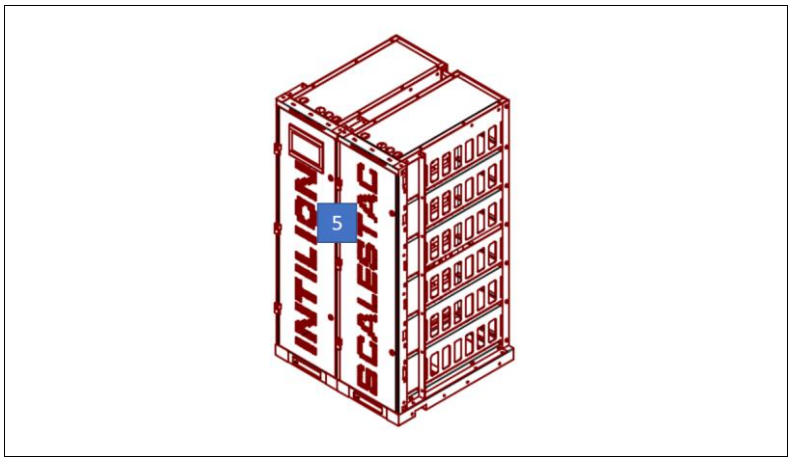

Fig. 2: field 5 (battery)

No.	Component	Comment
1	Field 1 INTILION Control Unit	AC connection and system control unit
2	Field 2 Inverter	Basic - bidirectional AC ←→ DC inverter
3	Field 3 Inverter	Extension - bidirectional AC ←→ DC inverter
4	Field 4 INTILION Battery Unit	DC connection and battery monitoring
5	Field 5 Battery	Battery

3.3 Primary technology – power element components

The primary technology consists of the lithium-ion batteries, the AC and DC infrastructure and the bidirectional inverter.

3.3.1 Field 5 – battery rack

As well as ensuring safe charging and discharging, the Narada battery system is also responsible for communicating with every individual battery module and logging all the data that is measured during operation. All information is firstly forwarded to the higher-level INTILION Battery Unit (IBU).

INTILION AG has purchased the lithium-ion-batteries as a storage system. The battery module consists of the serial-parallel 24S2P connection of 48 lithium-ion cells, which individually constitute the smallest electrochemical unit.

The battery modules are delivered ready-assembled and form the base unit of the storage system. In addition to the cells, they also contain the Battery Management Unit (BMU), which constitutes the first level of the Battery Management System (BMS) in the form of a module BMS. By default, ten of these base units are connected in series to form a battery rack (see **Fehler! Ungültiger Eigenverweis auf Textmarke.**).

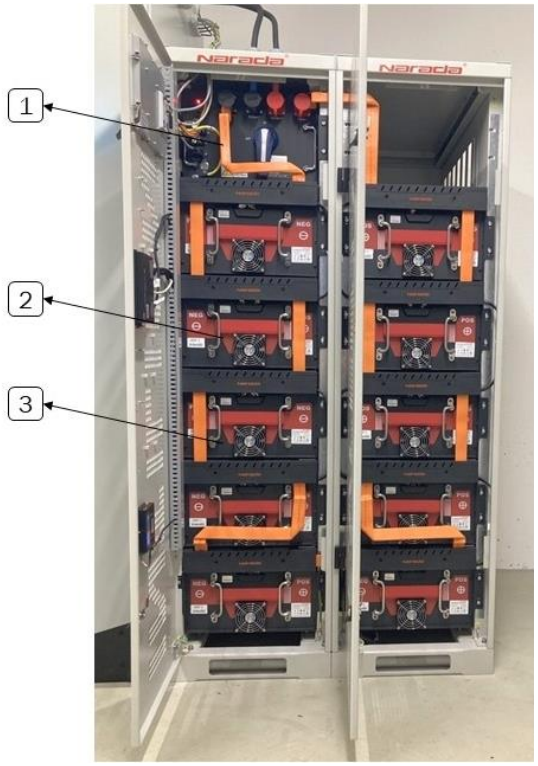

Fig. 3: Battery rack

1: Control box *2: Module type A* *3: Module type B*

In addition to the modules, each rack also contains a control box. From a battery perspective, this control box constitutes the system's first-level switching mechanism and safety device together with the installed main contactors and fuses (disconnector-fuse combination). A Battery Cluster Management Unit (BCU) integrated in the control box constitutes the second level of the BMS in the form of a rack BMS downstream from the module BMS. This BCU communicates with the BMUs via CAN and monitors current, voltage and temperature of all battery modules. All the acquired information is sent to the higher-level Battery Administration Management System (BAMS).

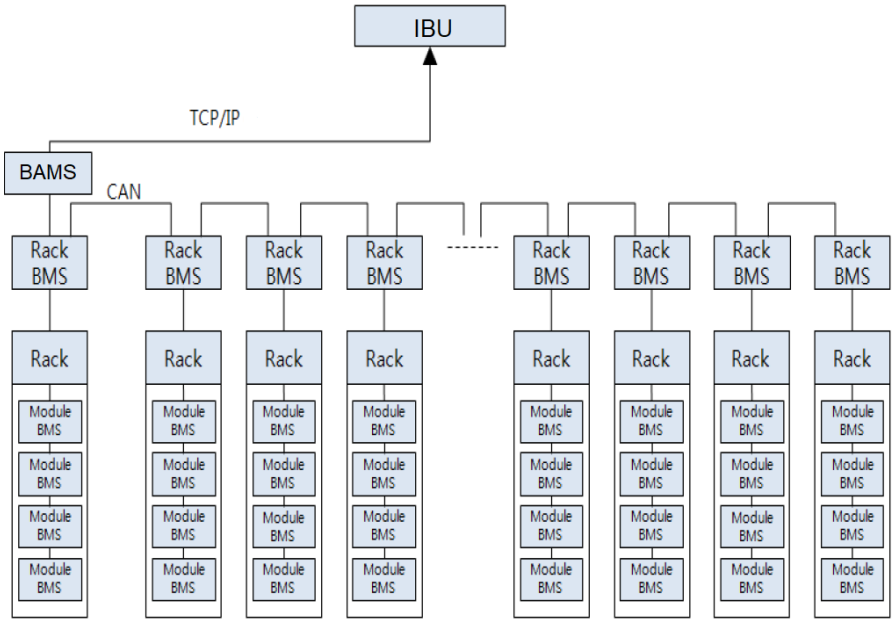

Fig. 1: Hierarchy of BMS

The BAMS is the third level of the BMS and consists of the Battery Administration Management Unit (BAU) and the Human Machine Interface (HMI). The BAMS enables communication with multiple BCUs when multiple battery racks are connected in parallel, as well as with other external devices.

In order to increase the energy content and the operating current, up to four (INTILION | scalestac power) or up to three (INTILION | scalestac power boost) form a battery bank. In this case, only one of the racks has a BAMS.

The battery bank, which constitutes the highest battery level, is controlled by the BAU and connected to the INTILION Battery Unit (IBU) by means of a TCP/IP connection. The BAU and the BCUs of the individual racks communicate via CAN bus.

3.3.2 DC infrastructure

The DC infrastructure includes the connection from the battery racks to the inverter via the DC distribution. Each battery rack is individually connected to the DC distribution via cable connections.

A total of up to four battery racks can be connected in parallel and fed to the DC distribution via a switch-disconnector, which disconnects the battery racks from the inverter. The inverter is connected to the DC distribution via copper busbar. Additionally, surge protection is integrated in the inverter and insulation monitoring in the battery system; the corresponding switch positions and fuse status (signalling switch) are polled by the INTILION Control Unit.

3.3.3 Field 2 and field 3 – inverter

The bidirectional battery inverter converts the battery's DC voltage into a three-phase 400 V AC voltage for the low-voltage distribution network and vice versa. It has an apparent power of up to 400 kVA.

3.4 Secondary technology – control and safety components

The secondary technology includes the control system, which is made up of the INTILION Control Unit (ICU) and the INTILION Battery Unit (IBU), and the safety circuit.

3.4.1 Field 1 – INTILION Control Unit (ICU)

Field 1 of the battery storage contains the following entities:

- AC circuit breaker / grid section switch
- grid and plant protection / PGU disengagement protection
- INTILION Control Unit (ICU)

The ICU is the main control unit for the battery storage system. It has the following tasks:

- Collecting operation data and controlling the IBU
- Controlling the inverter
- Displaying system values via the external communication interface
- Processing feedback contacts, emergency stop triggers and system status messages
- Supplying power to the IBU
- Transmitting the power setpoint for the inverter
- Controlling the AC circuit breaker

In addition to the ICU, field 1 also includes an integrated industrial PC (IPC) for remote access and the cloud connection of the battery storage system. It also contains surge protection for cable-related faults. All outputs are retrieved and monitored via signalling switches. The fuses, switches and protective devices are also incorporated in the DC distribution via the IBU in field 4. To maintain communication in case of network failure, a UPS buffers the control and safety components in the ICU with 24 V of DC power.

3.4.2 Field 4 – INTILION Battery Unit (IBU)

The INTILION Battery Unit (IBU) is controlled by the ICU.

The IBU activates and deactivates the batteries and also acts as a communication interface between the ICU and the Battery Administration Management Unit (BAU) via Modbus TCP/IP. This involves transferring data point lists and communication protocols from the batteries to the ICU via a standardised protocol. The IBU is also responsible for the auxiliary power supply of the battery racks and second-by-second data logging for upload to the INTILION Cloud.

3.4.3 Safety devices

INTILION | scalestac implements the safety functions at two independent levels.

At battery level, operational safety is guaranteed by the battery system concept of the manufacturer Narada. The BMS guarantees that operation takes place under the specified operating conditions for the cells regarding voltage current and temperature. If the threshold parameters are exceeded or not met, the control box performs a safety shut-off by opening the contactors.

At higher-level system level there is a second safety circuit, which triggers an emergency stop of the battery storage system, for example in case of an insulation failure. A push-lock switch is installed on the front of the control cabinet in field 1 (ICU) in order to trigger an emergency stop. All primary technology components are then switched off as well as the 400 VAC auxiliary voltage.

DANGER

There is a risk of electric shock when touching parts that are under voltage. Because the system contains batteries that cannot be de-energised, life-threatening DC voltages are always present in some sub-areas of the system.

Each battery rack on the battery storage system can only be de-energised up to the output + and output - connections on the control box that is part of the battery management system on the mains side. The individual battery modules cannot be de-energised. There is always dangerous electrical voltage at the power connections on the battery modules and at the input + and input - connections on the control box.

3.4.4 UPS for grid-forming operation

For grid-forming or stand-alone operation, an uninterruptible power supply (UPS) is required. In the switching time between grid-connected and grid-forming operation, the UPS supplies the batteries and the inverters. A UPS with two outputs is required.

- Connect the UPS for the batteries and inverters according to the single line diagram.

The control components are supplied by an integrated UPS. The power consumption during switching time is 125 W for one inverter. For every additional inverter, 25 W must be added. The battery racks need 150 W each.

INTILION AG recommends the following UPS: Effekta MCI 1000 incl. Effekta MCI Accubank AC8X103009XX300.

3.5 Operating modes

The battery storage system can be operated connected to the grid (default operation) and standalone (grid-forming operating).

The operating modes can be switched using either the Modbus interface or the dry contact (digital input – DI).

In standalone operation mode, the battery storage system autonomously sets up its own grid or synchronizes to the existing grid, respectively.

3.5.1 Grid-connected operation (GCO)

In default operation that is grid-connected, voltage and frequency are set by the public grid, and the current is impressed in order to generate the requested effective and reactive power.

The battery storage unit is designed for the following applications in this operating mode:

- External reference value setting
- Self-consumption optimization

The reference value can be externally set by the customer's or a third-party EMS, or by INTILION AG (additional hardware required). In this operation mode, the battery storage must be controlled via the Modbus TCP/IP interface.

For more information on grid-forming operation, see also section 8.4.

3.5.2 Grid-forming operation (GFO)

In grid-forming operation (also called islanding or stand-alone operation), voltage and frequency are formed by the battery storage system according to the pre-set reference values. The connected loads and generators set the resulting effective and reactive power in the stand-alone grid.

The dependencies of frequency f to effective power P and voltage U to reactive power Q result from the P-f characteristic and the Q-U characteristic.

For more information on grid-forming operation, see also section 8.4.

3.6 Technical specifications

3.6.1 INTILION | scalestac battery storage system

Tab. 3: Technical specifications – INTILION | scalestac battery storage system

INTILION | scalestac (battery storage system)		
	INTILION scalestac power (up to 1C)	INTILION scalestac power boost (up to 2C)
Technology	Lithium-ion, LFP (lithium iron phosphate)	
Configuration	Up to 4 racks/616 kWh	Up to 3 racks/369 kWh
Energy content (usable)	138.6 kWh/rack	110.7 kWh/rack
Voltage (nominal)	768 V	
Capacity (nominal)	200 Ah/rack	160 Ah/rack
Mains connection	400 V AC (3L, N, PE), 50 Hz	
Output, nominal	25...400 kVA	
Control cabinets field 1 to field 4 (system control unit and AC/DC power conversion)		
Dimensions (W x H x D)	Approx. 2000 (2600*) mm x 2200 mm x 800 (1000**) mm	
Weight	Approx. 800 kg/cabinet	
Housing	Indoor housing IP20	
Control cabinet field 5 (battery rack)		
Dimensions (W x H x D)	Approx. 1000 x 1800 x 940 mm³/rack	
Weight	Approx. 1715 kg/rack	Approx. 1487 kg/rack
Housing	Indoor housing IP20	

*With an output > 200 kVA

**Depth incl. wall clearance (only required with control cabinets field 1 to field 4)

Ambient conditions at the installation site (indoor)	
Ambient temperature during operation (permissible)	0 °C to +40 °C
Air humidity, non-condensing (max. permissible)	90 % rel. humidity

3.6.2 Battery modules

Tab. 4: Technical specifications – battery modules

Battery rack Narada	**768100154**	**76880123**
Configuration	10 battery modules connected in series	
Cell arrangement	2P240S	
Energy content (nominal)	154 kWh	123 kWh
Capacity (nominal)	200 Ah	160 Ah
Voltage (nominal)	768 V	
Voltage range	672...864 V	
Power (max. constant)	154 kW (1C)	246 kW (2C)
Dimensions (W x H x D) (approx.)	1000 x 1860 x 938 mm³	
Weight (approx.)	1715 kg	1487 kg

Battery module Narada	**76.8NESP200**	**76.8NESP160**
Cell arrangement	2P24S	
Energy content (nominal)	15.4 kWh	12.3 kWh
Capacity (nominal)	200 Ah	160 Ah
Voltage (nominal)	76.8 V	
Voltage range	67.2...86.4 V	
Power (max. constant)	15.4 kW (1C)	24.6 kW (2C)
Weight	133.5 kg	110.7 kg
Dimensions (W x H x D)	400 x 265 x 884 mm³	

(Battery) cell Narada	**FE105A**	**FE80B**
Technology	Lithium-ion, LFP (lithium iron phosphate)	
Energy content (nominal)	0.336 kWh	0.275 kWh
Capacity (nominal)	105 Ah	86 Ah
Voltage (nominal)	3.2 V	3.2 V
Voltage range	2.5 V - 3.8 V	2.5 V - 3.8 V
Power (max. constant)	0.336 kW (1C)	0.55 kW (2C)
Weight	2.3 kg	2.2 kg
Dimensions (W x H x D)	130 mm x 240 mm x 36 mm	

3.7 Protection technology

The battery storage system contains a voltage and frequency relay by the company Ziehl (model UFR1001E) in order to meet the requirements of the grid connection guidelines (VDE AR-N4105/VDE AR-N4110).

The grid decoupling relay UFR1001E monitors voltage and frequency in three-phase and AC networks. It meets the conditions for central grid and plant protection in accordance with VDE-AR-N 4105:2018-11 in decentralised power generating facilities for supplying the low-voltage distribution network. For VDE-AR-N 4105:2018-11, the corresponding parameters are stored in program 2, and the monitoring of the section switch and the protection of the parameters are adapted accordingly.

For supplying the medium-voltage network in accordance with VDE-AR-N 4110:2018-11, the UFR1001E is suitable for use as unit protection on the power generation units and as mid-stream decoupling protection. The default parameters for this application are stored in program 13.

Additional information on the device and its parameterisation can be found in the manufacturer's product documentation.

4 Transport and storage

The battery storage system is transported in accordance with the specifications and under the supervision of INTILION AG or by INTILION AG or by personnel who have been trained and assigned by a distribution partner.

NOTE

In order to guarantee the correct transportation and therefore functional safety of the battery storage system, the personnel must observe the instructions from INTILION AG or trained appointed personnel without fail!

The battery storage system is delivered to the customer by INTILION AG, by trained and appointed personnel or by an authorised transport company.

For information on changing the location of the battery storage system, please contact INTILION AG and observe the following information.

Battery modules

Only transport and store the battery modules in their original packaging or in packaging that corresponds to the applicable guidelines.

Symbols on the packaging must be observed. The battery modules must not be removed from their packaging until shortly before insertion into the battery racks.

Make sure that the battery modules are protected against the weather and against unauthorised access.

For longer storage periods or if the battery storage system is taken out of operation, there is a possibility of deep discharge of the battery modules. Make sure that the ambient temperature is in the range of 23°C° and that the SoC is between 20% and 30% at the start. Thereafter, measure the battery voltage every 6 months to check the condition of the battery modules.

No liability is accepted for damage that occurs due to incorrect storage.

5 Installation location requirements

For more information regarding the installation site requirements, please refer to the document “recommendation_installation-site_scalestac_EN_V2.pdf“.

6 Installation

The battery storage system is installed in accordance with the specifications and under the supervision of INTILION AG or by INTILION AG or by personnel who have been trained and assigned by a distribution partner.

NOTE

To guarantee the correct installation and therefore functional safety of the battery storage system, the contracted personnel must observe the instructions from INTILION AG or trained appointed personnel without fail!

The installation site of the battery storage system must be prepared before installation and the access road must be cleared to guarantee safe transportation of the components.

For more information, please see the installation manual.

7 Commissioning

The installation location must be prepared broom-clean for assembly. The access paths must be cleared of hindrances to ensure a safe transport of all components.

For commissioning of the battery storage system, the supply cable (400 VAC) must be provisioned at the building site. Internet access is also required.

The electricians on site must be informed of the maximum power for the factory acceptance test and the configuration parameters for the grid decoupling relay. The same applies to the grid code parameters for the inverters requested by the grid operator.

7.1 Settings in grid-connected operation

The “SoC backup” for grid-forming operation is the exact state of charge up to which energy can be provided in the applications of the grid-connected operation. If the storage system is switched into grid-forming operation, this ensures a minimum state of charge of the battery storage for the stand-alone grid. The application-spanning SoC backup can be set between 0 % and 100 %. The default value is 0 %.

In the “external reference value setting“ application, the battery storage is controlled by the Modbus interface. In the application self-consumption optimization, it runs in automatic mode.

SoC backup and application configuration are customized during commissioning.

7.1.1 External reference value setting

The “external reference value” application does not require customized settings, because the battery storage is controlled by an external energy management system or an up-stream control unit via Modbus TCP/IP interface.

Refer to “Modbus_TCPIP_Interface_scalestac_3.0.pdf” for more information on the Modbus commands.

Kommentiert [KE1]: QR-Code

7.2 Settings in grid-forming operation

The dependencies between effective power P and frequency f as well as reactive power Q and voltage U in grid-forming operation result from the slopes of the individual characteristic curves.

- The P-f characteristic describes the relation between effective power and frequency by its droop k_P. You can configure values between 0.1 % and 2 %. The default is 2 %.
- The Q-U characteristic curve describes the relation between reactive power and voltage by its droop) k_Q. You can configure values between 2 % and 10 %. The default is 5 %.

7.2.1 Example of P-f characteristic with default droop of 2 %:

The default characteristic curve has a frequency of 50 Hz, when in idle mode. The 2 % increase correlates to frequency and is reached when the battery storage operates with nominal effective power. Fig. 2 shows a sample characteristic of the INTILION | scalestac power. At a nominal effective power of ± 50 kW, the frequency will be between 49 Hz and 51 Hz.

The same relationship applies to voltage and reactive power indicated by the Q-U characteristic curve. In a stand-alone grid with 230 V (L-N voltage) and an increase of 5 %, the voltage will reach values between 218.5 V and 241.5 V with a nominal reactive power of ± 50 kvar (INTILION | scalestac power).

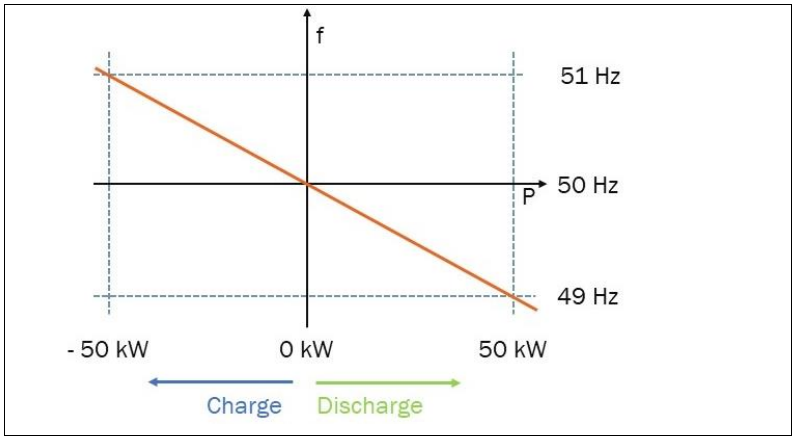

Fig. 2: Example of P-f characteristic of INTILION | scalestac

Refer to section 8.4 for more information on the characteristic curves and operating modes. Contact INTILION AG for further documentation regarding grid-forming operation.

8 Operation

The battery storage system is operated in automatic mode (default operation mode).

NOTE

It is usually only necessary to operate the battery storage system manually for servicing work, and this must only be performed in consultation with the INTILION AG.

8.1 Safety measures in normal operation

- The battery storage system must only be opened by persons who are qualified and/or trained in this operation (see section 0).
- There must be no unauthorised persons present in or around the battery storage system.
- No safety or protective devices may be removed or rendered non-functional.
- The battery storage system must only be operated within its specific performance limits.

WARNING

Risk to health due to electromagnetic radiation!

During operation, there is a risk to the health of persons with medical implants (e. g. pacemakers) as a result of electromagnetic radiation.

Persons with medical implants must not enter the installation space of the battery storage system.

8.2 General

For control and fault clearance, there are switches and signal lamps on the front of field 1:

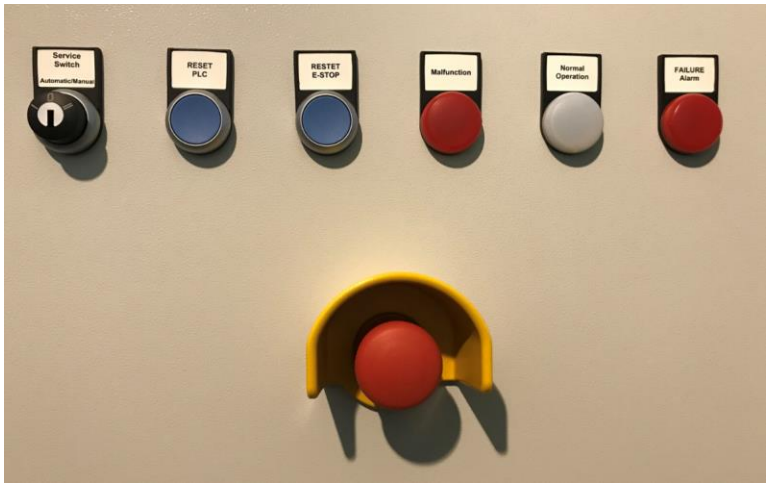

Fig. 4: Front of the ICU control cabinet

There are three signal lamps on the front of the ICU control cabinet.

The following system states are signalled by these lamps lighting up:

- "Malfunction": A warning message or error message is present
- "Normal operation": There are no system malfunctions
- "FAILURE alarm": Emergency stop circuit opened

The ICU also has an EMERGENCY STOP palm button. This switches off the battery storage system's power element on the DC side and the AC side by disconnecting the inverter from the battery circuit (DC) and from the mains connection (AC).

To reset the emergency stop, the palm button needs to be pulled out again and the "RESET E-STOP" button then pressed. The storage system is now switched to the ready-to-use state.

The "RESET PLC" button resets the PLC in the ICU.

8.3 Switching operating modes grid-connected and grid-forming

The operating modes grid-connected and grid-forming (see Fig. 3) can be switched using either the Modbus TCP/IP interface (see section 8.3.1) or the dry contact / digital input (see section 8.3.2).

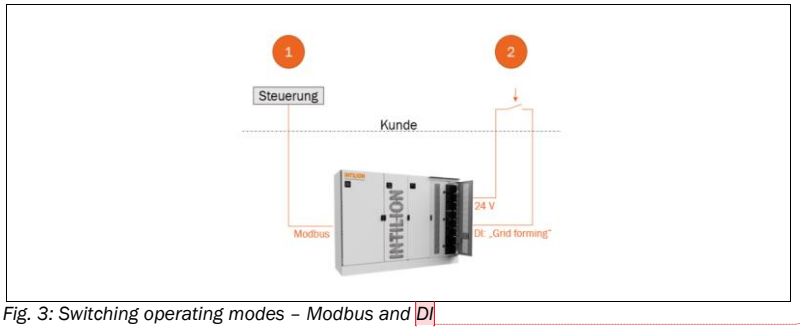

Fig. 3: Switching operating modes – Modbus and DI

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See section 7.1 for a description of the applications in grid-connected operation and their configuration.

In the initial state, the battery storage is in grid-connected mode (System State 50 – Run). The inverter is connected on the AC and DC side, the Control Box (BMS) contactor and power switch at the AC connection are closed.

During the operating mode switch, the BMS contactors always stay closed.

The system states and Modbus registers mentioned in this section can be found in the document Modbus_TCPIP_Interface_scalestac_3.0.pdf.

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NOTE

Star point handling in grid-forming operation

In grid-forming operation, the star point is emulated by the inverter and must be grounded by the customer. For more information, see VDE-AR-E 2510-2 code of practice.

See section **Fehler! Verweisquelle konnte nicht gefunden werden.** for a description of grid-connected operation.

8.3.1 Switching via Modbus TCP/IP

The Modbus interface in field 1 (=ScS-X21.8) enables switching between grid-connected and grid-forming operation.

8.3.1.1 Switching from grid-connected to grid-forming

In order to switch from system state 50 (grid-connected) to grid-forming, proceed as follows:

- Disconnect the battery storage from the public grid.

This may also occur due to power failure.

The inverter's power unit is disconnected from AC and DC. The contactors of the battery racks are opened, and the AC power switch stays closed.

- Send "60" to Modbus register 9000 to select grid-forming operation.

NOTE

Caution, danger of short circuit!

If the battery storage is not disconnected from the public grid, the stand-alone network of the battery storage can be shorted with the public grid as soon as it is re-powered.

- Protect the battery storage from re-powering of the public grid by disconnecting it from the public grid in grid-forming operation using a suitable device.

First, the AC power switch opens and the battery contactors close. Then, the inverter starts to build up the stand-alone network (DC and AC connection). Finally, the AC power switch closes and disconnects the stand-alone network at the power connection (system state 60 – gridforming).

8.3.1.2 Switching from grid-forming to grid-connected

In order to switch from system state 60 (grid-forming) to grid-connected, proceed as follows:

NOTE

Caution, danger of short circuit!

If the battery storage is not disconnected from the public grid, the stand-alone network of the battery storage can be shorted with the public grid as soon as it is re-powered.

- Protect the battery storage from re-powering of the public grid by disconnecting it from the public grid in grid-forming operation using a suitable device.
- Only re-connect the public grid for grid-connected operation when grid-forming operation has been stopped.
- Send "50" to Modbus register 9000 to select grid-connected operation.
- The inverter's power unit disconnects from AC and DC. The battery contactors and the AC power switch remain closed.
- Connect the public grid.

The public grid is now connected to the inverter's AC unit.

- Reset the grid decoupling relay in the ICU. It is possible to configure automatic error acknowledgement.

The system starts automatically. The battery contactors close, and the inverter connects both DC and AC (system state 50).

8.3.2 Switching via digital input

It is possible to switch between grid-connected operation and grid-forming operation using the dry contact (digital input – DI) at the customer interface:

DI connected	Grid-forming operation
DI disconnected	Grid-connected operation

- In order to switch the digital input, connect 24 V (=ScS-X3.5:1) with the “Gridforming“ input (=ScS-X3.5:2).

It is possible to switch operating modes via digital input automatically using for example a synchronisation relay (not included in the delivery).

8.3.2.1 Switching from grid-connected to grid-forming

In order to switch from system state 50 (grid-connected) to grid-forming, proceed as follows:

- Disconnect the battery storage from the public grid.

This may also occur due to power failure.

The inverter’s power unit is disconnected from AC and DC. The contactors of the battery racks are opened, and the AC power switch stays closed.

NOTE

Caution, danger of short circuit!

If the battery storage is not disconnected from the public grid, the stand-alone network of the battery storage can be shorted with the public grid as soon as it is re-powered.

- Protect the battery storage from re-powering of the public grid by disconnecting it from the public grid in grid-forming operation using a suitable device.

First, the AC power switch opens and the battery contactors close. Then, the battery contactors close, and the inverter starts to build up the stand-alone network (DC and AC connection). Finally, the AC power switch closes, and the stand-alone network is available at the power connection (system state 60 – gridforming).

In grid-forming operation, the DI must remain connected. As soon as the DI disconnects, grid-connection operation starts.

8.3.2.2 Switching from grid-forming to grid-connected

In order to switch from system state 60 (grid-forming) to grid-connected, proceed as follows:

NOTE

Caution, danger of short circuit!

If the battery storage is not disconnected from the public grid, the stand-alone network of the battery storage can be shorted with the public grid as soon as it is re-powered.

- Only re-connect the public grid for grid-connected operation when grid-forming operation has been stopped.
- Protect the battery storage from re-powering of the public grid by disconnecting it from the public grid in grid-forming operation using a suitable device.
- Disconnect the digital input in order to switch into grid-connected operation.

NOTE

Caution, danger of short circuit!

Protect the disconnected digital input against reconnection. Otherwise, in grid-connected operation, there is the danger of accidental connection of the digital input which would short-circuit the stand-alone network with the live public grid.

The inverter's power unit disconnects from AC and DC. The battery contactors open and the AC power switch remains closed.

- Connect to the public grid.

The public grid re-connects to the inverter's AC unit.

The system starts automatically. The battery contactors close and the inverter connects DC and AC (system state 50).

8.4 Management of grid-forming operation

8.4.1 Configuration options in grid-forming operation

In case of the default characteristic curve without offset, the frequency is 50 Hz, when in idle mode. The 2 % increase refers to frequency and is reached at nominal effective power of the battery storage. Fig. 4 shows an example of a characteristic curve of INTILION | scalestac power. At a nominal effective power of ± 50 kW a frequency of 49 Hz or 51 Hz, respectively, is reached.

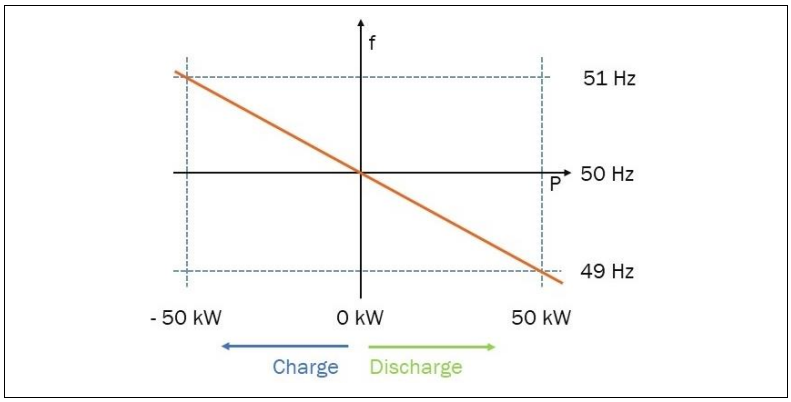

Fig. 4: Example of P-f characteristic of INTILION | scalestac power at 50 kW

In grid-forming operation, frequency and voltage can be actively managed and modified. This makes it possible to configure and control generation and load flows precisely, for example, throttling a photovoltaic inverter through frequency increase.

For more information on managing the grid-forming operation, contact INTILION AG to obtain a separate document.

8.4.2 Change of frequency (P-f characteristic)

In grid-forming operation, the nominal frequency changes depending on the momentary effective power according to the P-f characteristic curve configured during commissioning (see section 8.4.1).

The nominal frequency can be configured within a predefined range depending on the predefined reference frequency (Modbus register 9006). This causes an offset and thus an additive increase or decrease of the frequency change caused by the effective power. The P-f characteristic is shifted to left or right by a frequency offset (see Fig. 5).

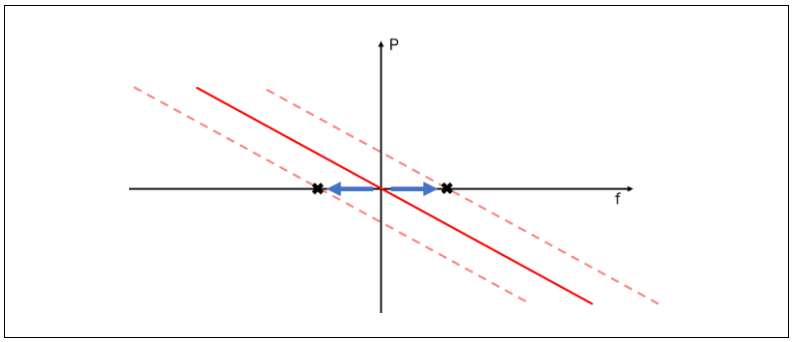

Fig. 5: P-f characteristic with frequency offset

In the same way, it is possible increase or decrease the frequency during operation by defining a nominal effective power value (Modbus register 9001; considered as offset in grid-forming operation) in addition to the effective power, which results from loads or generators. The P-f characteristic curve is shifted up and down by definition of a nominal effective power value (Fig. 6).

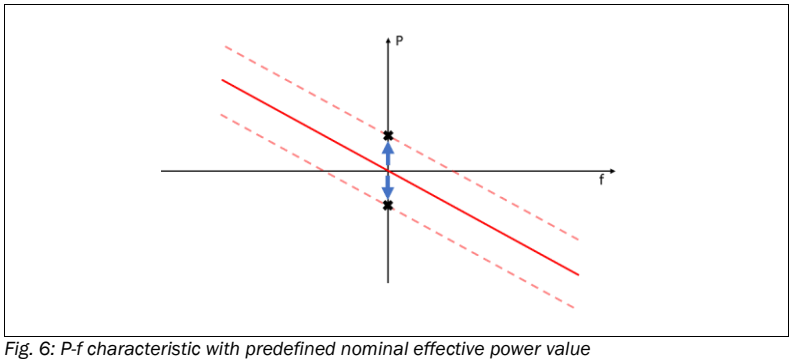

Fig. 6: P-f characteristic with predefined nominal effective power value

This makes it possible to synchronise to an external grid or to shift energy between two systems. Also, the behaviour of loads and generators can be actively modified.

8.4.3 Change of voltage (Q-U characteristic)

In grid-forming operation, the nominal voltage changes depending on the momentary reactive power according to the Q-U characteristic curve configured during commissioning (see section 8.4.1).

The nominal voltage can be configured within a predefined range depending on the predefined reference voltage (Modbus register 9005). This causes an offset and thus an additive increase or decrease of the voltage change caused by the reactive power.

In the same way, it is possible increase or decrease the voltage during operation by defining a nominal reactive power value (Modbus register 9002; considered as offset in grid-forming operation) in addition to the reactive power, which results from loads or generators.

Corresponding to the P-f characteristic curve from section **Fehler! Verweisquelle konnte nicht gefunden werden.**, the Q-U characteristic is shifted left and right due to a voltage offset and up and down due to the definition of a nominal reactive power value.

This makes it possible to stabilise the voltage and synchronise to an external grid.

9 Maintenance

The “Maintenance” section is currently being written and will be included in a later version of the operating manual.

10 Decommissioning and disposal

DANGER

There is a risk of electric shock when touching parts that are under voltage.

Because the system contains batteries that cannot be de-energised, life-threatening DC voltages are always present in some sub-areas of the system.

Each battery rack on the battery storage system can only be de-energised up to the output + and output - connections on the control box that is part of the battery management system on the mains side. The individual battery modules cannot be de-energised. There is always dangerous electrical voltage at the power connections on the battery modules and at the input + and input - connections on the control box.

– Only ever have work on the electrical equipment performed by specialised electricians with WLE certification and who have been specifically trained for working on electrical equipment and who are capable of recognising and avoiding dangers.

– Adhere to the five safety rules:

1. Disconnect
2. Secure against being switched back on
3. Verify that the system is de-energised
4. Connect to earth and short circuit
5. Cover or partition off live parts

10.1 Decommissioning

The battery system is deactivated. To this end, the communication cables and the high-current connectors are disconnected: no power output is possible following deactivation.

The battery storage system is decommissioned by the ICU.

- Turn the “Service Switch” on the ICU to the “0” position and press the emergency stop button to disconnect the inverter on the AC side and the DC side and to open the contactors in the battery racks.
- Secure the battery storage system against re-activation on the DC side by opening and securing the switch-disconnector in the DC distribution/IBU.
- Pressing the “main switch” on the ICU (see following illustration) deactivates the auxiliary voltage for the components and therefore the entire battery storage system.

Fig. 5: Main switch on the ICU

10.2 Disposal

INTILION AG is obligated to take back battery modules. INTILION AG will happily prepare a quote for you for the disposal of your battery modules.

- Have used battery modules disposed of by a certified specialist company or by INTILION AG.

11 Applicable documents

The following documents are attached to this operating manual in the form of appendices:

- EU Declaration of Conformity
- Overview wiring diagram for the INTILION | scalestac versions (energy, power, power boost)
- INTILION | scalestac technical data sheet
- Modbus TCP/IP Interface
- Commissioning log

12 Abbreviations

AC	Alternating current
BAMS	Battery administration management system
BAU	Battery administration unit
BBMS	Bank battery management system
BCU	Battery cluster management unit
BMS	Battery management system
BMU	Battery management unit
BPU	Battery protection unit
CAN	Controller area network
CCCV	Constant current constant voltage
DC	Direct current
DI	Digital input
DNS	Domain name system
EMS	energy management system
FCR	Frequency Containment Reserve
FLEPS	Fire limiter and environmental protection system
GCO	Grid-connected operation
GFO	Grid-forming operation (stand-alone)
HMI	Human machine interface
IBU	INTILION Battery Unit
ICU	INTILION Control Unit
IP	Ingress protection
IPC	Industrial PC
LTE	Long-term evolution
PFC	WAGO-branded PLC
PGU (EZE)	Power generation unit
PLC	Programmable logic controller
PPE (PSA)	Personal protective equipment
ProdSG	German Product Safety Act
RBMS	Rack battery management system
SoC	State of charge
SoH	State of health
TCP/IP	Transmission Control Protocol/Internet Protocol
UCS	Universal Configuration Software
UCTE	Union for the Co-ordination of Transmission of Electricity
UPS	Uninterruptable power supply

VDE	German electrotechnology association
WLE	Work on live equipment