Installation and Operating Manual

LITHIUM STORAGE SYSTEM

TS-I HV 80

TESVOLT

THE ENERGY STORAGE EXPERTS

CONTENT

1 IMPORTANT INFORMATION ABOUT THIS MANUAL

1.1 SCOPE

This Installation and Operating Manual applies to the modular high-voltage battery storage system TESVOLT TS-I HV 80.

Read this Installation and Operating Manual thoroughly to ensure error-free and secure installation, initial commissioning and maintenance of the TESVOLT TS-I HV 80. Installation, initial commissioning and maintenance must be carried out by qualified and authorised specialists. Keep this Installation and Operating Manual and other applicable documents near the battery storage system. This Installation and Operating Manual must be accessible at all times to all persons involved in installation or maintenance.

This Installation and Operating Manual adopts and supplements information from the technical documentation for the integrated battery inverter TESVOLT PCS and is only valid in conjunction with the associated original manufacturer's documentation. TESVOLT assumes no responsibility for the accuracy and currency of the information adopted. This Installation and Operating Manual is in no way a replacement for the original manufacturer's documentation for the battery inverter and does not release installers, operators and maintenance personnel from their obligation to observe the original manufacturer's documentation for the battery inverter.

This Installation and Operating Manual applies to the Federal Republic of Germany only, without restriction. Please ensure that you adhere to the applicable local legal regulations and standards. The standards and legal regulations in other countries may contradict the specifications in this manual. In this case please contact the TESVOLT Service Line +49 (0) 3491 87 97 - 200 or contact us by email at service@tesvolt.com.

1.2 COMPONENTS OF THE BATTERY STORAGE SYSTEM TS-I HV 80

- Battery storage system TS HV 80 (Manufacturer: TESVOLT GmbH; product corresponds to a TS HV 70 with 16 battery modules)
- Inverter TESVOLT PCS (Manufacturer: Maschinenfabrik Reinhausen GmbH – hereinafter MR GmbH)
- TESVOLT Energy Manager (Software manufacturer: TESVOLT GmbH)

1.3 CONTENTS OF THE DOCUMENTATION/OTHER APPLICABLE DOCUMENTS

- Installation and Operating Manual TS-I HV 80 (this document)
- TESVOLT Energy Manager Installation and Operating Manual
- Application note "Application note for lithium storage system TS-I HV 80 – Are we ready to go off-grid?"
- Operating manual for GRIDCON® PCS (MR GmbH) software
- Operating manual for GRIDCON® PCS (MR GmbH) hardware

1.4 MEANING OF SYMBOLS

Symbols in the manual

This manual contains the following types of warnings and information:

DANGER! Warning notice indicating that electric shock may result if you fail to follow the instruction, even when the unit is disconnected from the utility grid, as a voltage-free state only occurs after a time delay.

DANGER! Warning notice indicating that death or serious injury may result if you fail to follow the instruction.

CAUTION! Warning notice indicating that injury may result if you fail to follow the instruction.

WARNING! Warning notice indicating that material damage may result if you fail to follow the instruction.

NOTE: This symbol indicates information relating to the use of the unit.

Symbols on the unit

The following types of warning, prohibition and mandatory symbols are also used on the unit:

CAUTION! RISK OF CHEMICAL BURNS

If the battery is damaged and a fault occurs, this may result in electrolyte escaping and the formation of hydrofluoric acid in small concentrations and quantities, among other effects. Contact with these liquids can lead to chemical burns.

- Do not subject the battery modules to violent impact.
- Do not open, disassemble or mechanically alter the battery modules.
- If there is contact with the electrolyte, rinse the affected area immediately with water and promptly seek medical advice/attention.

CAUTION! RISK OF EXPLOSION Improper handling or fire can cause lithium battery cells to ignite or explode and cause serious injuries.

- Do not install or operate the battery modules in explosive areas or in areas with high humidity.
- Store the battery modules in a dry area and within the temperature ranges specified in the data sheet.
- Do not open, drill through or drop the battery cells or modules.
- Do not expose the battery cells or modules to high temperatures.
- Do not throw the battery cells or modules into a fire.
- In case of fire, use CO_2 fire extinguishers if the fire comes from the battery. In case of fire in the vicinity of the battery, use an ABC fire extinguisher.
- Do not use defective or damaged battery modules.

CAUTION! HOT SURFACE

If there is a malfunction, components can become very hot and cause serious injury if touched.

- Switch the storage system off immediately if it is defective.
- Take particular care when handling the unit if malfunctions or defects become apparent.

NO OPEN FLAMES!

Handling open flames and sources of ignition in the immediate vicinity of the storage system is prohibited.

DO NOT INSERT OBJECTS INTO OPENINGS ON THE STORAGE SYSTEM'S CASING!

No objects, such as screwdrivers, may be inserted through openings in the casing of the storage system.

WEAR SAFETY GOGGLES!

Wear safety goggles when working on the unit.

FOLLOW THE MANUAL! It is imperative that you follow the Installation and Operating Manual when working on and operating the unit.

1.5 GENERAL SAFETY INFORMATION

DANGER! Failure to observe the safety information can result in danger to life.

Improper use can lead to fatal injuries. Any person tasked with working on the system must have read and understood this manual, particularly section "2 Safety" on page 10. **All safety information must be followed without fail.**

Everyone who works on the TESVOLT TS-I HV 80 must follow the specifications in this manual.

This manual cannot describe every conceivable situation. For this reason, the applicable standards and corresponding occupational health and safety regulations always take priority.

In addition, installation may also involve residual hazards under the following circumstances:

- Installation is not carried out properly.
- Installation is carried out by personnel who have not received the relevant training or instruction.
- The warnings and safety information in this manual are not followed.

1.6 DISCLAIMER

TESVOLT GmbH assumes no liability for personal injury, damage to property, damage to the product and follow-on damage attributable to the following causes:

- Non-compliance with this manual,
- Improper use of the product,
- Repairs, opening the cabinet and other actions performed on or with the product by unauthorised and/or unqualified personnel,
- Use of non-approved spare parts.

Unauthorised modifications or technical changes to the product are forbidden.

1.7 APPROPRIATE USE

The TESVOLT TS-I HV 80 is a modular lithium battery storage system with an integrated inverter. The components were built in accordance with the current state of the art in technology and product-specific standards.

The TESVOLT TS-I HV 80 is intended exclusively for operation with the integrated, bidirectional, three-phase inverter TESVOLT PCS. Any other use must be agreed with the manufacturer and, if necessary, with the local energy supply company.

The battery storage system may only be installed and operated in enclosed spaces. The TESVOLT TS-I HV 80 works in an ambient temperature range of 0°C to 40°C (battery inverter TESVOLT PCS) and at a maximum humidity of 85%. The battery cabinet may not be exposed to direct sunlight or placed directly beside sources of heat.

The battery cabinet may not be exposed to corrosive atmospheres.

When installing the battery storage system, ensure that it is standing on a sufficiently dry, horizontal and flat surface with sufficient load-bearing capacity.

The altitude of the installation location may not be higher than 2,000 m above sea level without approval in writing from the manufacturer. At installation locations higher than 1,000 m above sea level, the battery inverter will have an altitude-dependent decline in output power due to reduced system cooling. For further information, please refer to the operating manual for the GRIDCON® PCS hardware from MR GmbH.

In regions subject to flooding, care must be taken to ensure that the battery cabinet is installed in a suitably elevated location and is protected against contact with water.

According to IEC 62619, the battery storage system must be installed in a fire-proofed room. This room must be free from fire loads and must be equipped with an independent fire alarm unit in accordance with the locally applicable regulations and standards. The room must be separated by class T60 fire doors. Comparable fire protection requirements also apply to other openings in the room (e.g. windows).

The TS-I HV 80 must be secured against access by unauthorised persons, i.e. the cabinet door must be kept closed and locked. Operation is only permitted with the cabinet door closed. The key must only be accessible to authorised persons.

Interference with hardware and software is prohibited.

Adherence to the specifications in this Installation and Operating Manual also forms part of appropriate use.

The TESVOLT TS-I HV 80 may not be used:

- For mobile use on land or in the air (it may only be used on water in agreement with, and with the written consent of the manufacturer),
- For use with medical equipment,
- As a UPS system.

1.8 GUARANTEE

The current guarantee conditions can be downloaded from the internet by visiting **www.tesvolt.com**.

1.9 REQUIREMENTS FOR INSTALLERS

The locally applicable regulations and standards are to be adhered to for all work.

The installation of the TS-I HV 80 may only be carried out by qualified electricians who have the following qualifications:

- Training in dealing with hazards and risks associated with installing and operating electrical equipment, systems and batteries,
- Training in installing and commissioning electrical equipment,
- Knowledge of and compliance with the technical connection conditions, standards, guidelines, regulations and laws applicable for the location,
- Knowledge of handling lithium-ion batteries (transport, storage, disposal, sources of danger),
- Knowledge of and compliance with this document and other applicable documents (see "1.3 Contents of the documentation/other applicable documents" on page 6),
- Successful participation in **TESVOLT TS-I HV 80 certification training** (information about the training courses can be found at www.tesvolt.com; alternatively, please email academy@tesvolt.com).

2 SAFETY

The battery storage system TS-I HV 80 meets the requirements of IEC 61508 Parts 1 to 7 and corresponds to Safety Integrity Level (SIL) 1.

2.1 SAFETY RULES

To avoid damage to property and personal injury, follow these rules when working on live parts of the battery storage system:

1. Enable.
2. Secure against restarting.
3. Determine that there is no voltage.
4. Ground and short circuit.
5. Cover or shield adjacent live parts.

2.2 SAFETY INFORMATION

DANGER! Life-threatening electric shock from damaged components or short circuit

Bridging the battery terminals causes a short circuit that results in a flow of electrical current. A short circuit of this type should be avoided under all circumstances. For this reason, follow these instructions:

- Use insulated tools and insulated gloves.
- Do not place any tools or metal parts on inverter components, battery modules or the APU HV1000-S.
- Always remove watches, rings and other metal objects when working with the batteries.
- Do not install or operate the system in explosive areas or areas with high humidity.
- When working on the storage system, switch off all voltage supplies first to the charge controller, then to the battery, and ensure that they cannot be switched on again.

DANGER! Possible chemical burns and poisoning due to electrolyte or poisonous gases in case of damage to battery modules

During normal operation, no electrolyte can escape from the battery and no poisonous gases can form. Despite careful design, damage to the battery in the event of a fault can result in escaping electrolyte or small concentrations and quantities of toxic gases, organic solvent gases and hydrofluoric acid. For this reason, please follow these instructions:

- Do not expose the battery module to violent impacts.
- Do not open, disassemble or mechanically alter the battery module.

If there is contact with the electrolyte, rinse the affected area immediately with water and promptly seek medical advice.

DANGER! Improper handling can lead to life-threatening injuries.

Lithium battery cells can ignite if handled incorrectly. For this reason, ensure that you adhere to the following instructions for handing lithium battery cells:

- Do not install and operate the battery modules in potentially explosive or highly humid areas.
- Store the battery modules in a dry place and within the temperature ranges specified in the data sheet.

- Do not open, drill through or drop the battery cells or modules.
- Do not expose the battery cells or modules to high temperatures.
- Do not throw the battery cells or modules into a fire.
- In case of fire, use CO_2 fire extinguishers if the fire comes from the battery. In case of fire in the vicinity of the battery, use an ABC fire extinguisher.
- Do not use defective or damaged battery modules.

DANGER! Danger to life due to improper use of the battery storage system

Any use of the battery storage system beyond the intended use or any other type of use can result in considerable hazards and is therefore prohibited.

DANGER! Danger of death due to incorrect handling of the battery storage system

Incorrect handling of the battery storage system can lead to serious injury or even death. For this reason, any action that requires the battery cabinet to be opened may only be carried out by qualified electricians in accordance with the instructions in section “1.9 Requirements for installers” on page 9.

CAUTION! Danger from working on open current transformer circuits

It must be ensured that the secondary circuit of the current transformer is short-circuited before working on current transformer circuits. The current transformer circuit must never be operated when open under any circumstances, as this can lead to personal injury and damage to the device.

WARNING! Improper use can cause damage to the battery cells.

- Do not expose battery cells or modules to rain and do not immerse them in liquids.
- Do not expose battery cells to corrosive atmospheres (e.g. ammonia, salt).
- Do not use any other battery inverters apart from the TESVOLT PCS.
- Commission the battery storage system within **six months** of delivery at the latest.

3 PREPARATION

3.1 TOOLS REQUIRED

TOOL		USE
Torque wrench for 40 to 70 Nm with socket 10, 13 and long sockets 17 and 19 mm		Incl. TS HV 80: Tightening the grounding connections, TESVOLT PCS: Fastening the AC/DC connection cables
Socket wrench extension (recommended minimum length 200 mm)		TESVOLT PCS: AC power connections
Torque wrench for 6 to 10 Nm with slot-head screwdriver bit 6.5 x 1.2 and 10 and 13 mm sockets		Incl. TS HV 80: Tightening the grounding connections, TESVOLT PCS: Fastening the DC connection cables
TX 25/30 Torx screwdriver		Incl. TS HV 80: Fastening the baying connectors, TESVOLT PCS: removing the cover of the DC connection
PH1, PH3 cross-head screwdriver		TS HV 80: Ethernet switch grounding connection, fastening of the battery modules and the APU HV1000-S in the rack
Screwdriver 0.4 x 2.5		Connection to terminal blocks, e.g. TESVOLT Energy Manager
Crimping tool	35 mm² to 50 mm²	TS HV 80: For crimping the wire-end ferrules for the DC connecting cable
	As per the dimensioning of the connecting cables	TESVOLT PCS: For crimping the wire-end ferrules for the AC connecting cable
Voltmeter (min. 1,000 V_{DC})		TS HV 80: Measuring the power supply and battery voltages (up to 1,000 V_{DC}) and testing the battery modules' state of charge
Spanner, 19 mm		Optional TS HV 80: Lifting the cabinet cover, fitting the spacers
Box cutter		Removing the outer packaging

3.2 REQUIRED AIDS AND MATERIALS

AID/MATERIAL	USE
SD card:only tested SanDisk, 16 GB, HC, class 4. Purchase via TESVOLT is highly recommended!	Memory for parameters and programs for the TESVOLT PCS
Fastening material (screws and dowels)	Fastening the TESVOLT Backup Control Box (weight approx. 20 kg)

3.3 TRANSPORT TO THE END CUSTOMER

When transporting the battery inverter, follow the transport instructions in the original manufacturer's documentation "GRIDCON® PCS Hardware Operating Instructions" from the manufacturer MR GmbH.

Transport regulations for battery modules

All the requirements set down in the German Ordinance on the Transport of Dangerous Goods by Road, Rail and Inland Waterways (GGVSEB) and the European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR) must be adhered to.

- The battery modules may only be transported by the manufacturer or by a haulier engaged by the manufacturer. Should transport on public roads nevertheless be necessary, this may only be carried out by personnel who have received appropriate training and instruction. This instruction is to be documented and carried out periodically.
- Smoking is prohibited in the vehicle during the transport journey, and also in the immediate vicinity during loading and unloading.
- Two tested fire class D metal fire extinguishers (minimum capacity: 2 kg) and equipment for dangerous goods in accordance with the ADR are to be carried in the vehicle.
- The freight carrier is prohibited from opening the outer packaging of the battery module.

Transport regulations for cabinet and battery inverter

Please note that the base of the TESVOLT PCS must not be completely dismantled.

Only move the battery cabinet system with lifting gear approved for this purpose. Only use the transport lugs on the top of the cabinets as attachment points. When lifting, the cable angle of the slings must be at least 60°.

DANGER! Risk of injury due to improper transport in a vehicle Improper transport and/or inadequate transport locks can cause the load to slide or topple over, leading to injuries. Position the cabinet vertically and in such a way that it cannot slide around in the vehicle, and use securing straps to prevent it from toppling over and sliding.

CAUTION! Risk of injury due to tipping battery cabinet Individual components can weigh up to 820 kg. They may topple over when tilted, causing injury and damage. Ensure that the cabinets in particular are situated on a stable surface and that they are not tilted by loads or forces.

CAUTION! Risk of injury if safety shoes are not worn Injuries such as crushing injuries can occur due to the components' heavy self-weight when the battery cabinet and battery modules are being transported. All those involved in transport must therefore wear safety shoes with protective toe caps.

CAUTION! Please also follow the safety information in section "3.4 Transport at end-customer site" on page 13 below, especially when loading and unloading.

WARNING! Risk of damage to the battery storage system if transported improperly

The battery storage and inverter cabinets must only be transported upright. Please note that the components can be top-heavy. Non-observance of this instruction can lead to damage of the components.

WARNING! Risk of damage to the battery storage cabinet during transport with installed battery modules

The battery storage cabinet is not designed for transport with installed battery modules. Always transport battery modules and the battery storage cabinet separately. Never move a battery storage cabinet once fitted with battery modules, even by suspending it using a lifting device.

3.4 TRANSPORT AT END-CUSTOMER SITE

When transporting the battery inverter, follow the transport instructions in the original manufacturer's documentation "GRIDCON® PCS Hardware Operating Manual" from the manufacturer MR GmbH.

If possible, do not remove the transport packaging before reaching the final installation site. Before removing the transport protection, check for damage to the transport packaging and check the shock indicators on the outer packaging of the battery inverter. If these have been triggered, transport damage cannot be ruled out.

Please note that the base of the TESVOLT PCS must not be completely dismantled.

Check that the delivery is complete.

CAUTION! Risk of injury due to improper transport of the battery modules

Battery modules are heavy (36 kg) and may cause injury if they fall or slip. Ensure safe transport and use only suitable transport and lifting equipment.

CAUTION! Risk of injury due to tilting battery cabinet during transport

The cabinet weighs approx. 120 kg and may topple over if tilted, causing injuries or itself becoming damaged.

CAUTION! Risk of injury if safety shoes are not worn

Injuries such as crushing injuries can occur due to the components' heavy self-weight when the battery cabinet and battery modules are being transported. All those involved in transport must therefore wear safety shoes with protective toe caps.

CAUTION! Risk of injury from sharp edges and metal panels

During transport and installation of the unpacked battery storage cabinet or battery inverter cabinet, there is an increased risk of injury, especially on sharp-edged metal panels. All persons involved in transport and installation must therefore wear protective gloves.

WARNING! Risk of damage to the battery storage cabinet during transport with installed battery modules

The battery storage cabinet is not designed for transport with installed battery modules. Always transport battery modules and the battery storage cabinet separately. Never move a battery storage cabinet once fitted with battery modules, even by suspending it using a lifting device.

NOTE: TESVOLT PCS must be transported in an upright position

The battery inverter TESVOLT PCS may only be transported in an upright position. Please note that the battery inverter cabinet may be very top-heavy.

NOTE: Transport with at least two persons

The individual components of the TS-I HV 80 may weigh up to 820 kg and are therefore unsuitable for transport by one person. We recommend at least two people install the system. A lifting device is helpful for heavier elements, and for lighter components a dolly or hand truck is helpful. Take care not to damage the casing. **No more than five battery modules may be stored on top of each other.**

Figure 3.1 Permissible and impermissible storage positions of a packaged battery module

3.5 INSTALLATION LOCATION

Necessary prerequisites

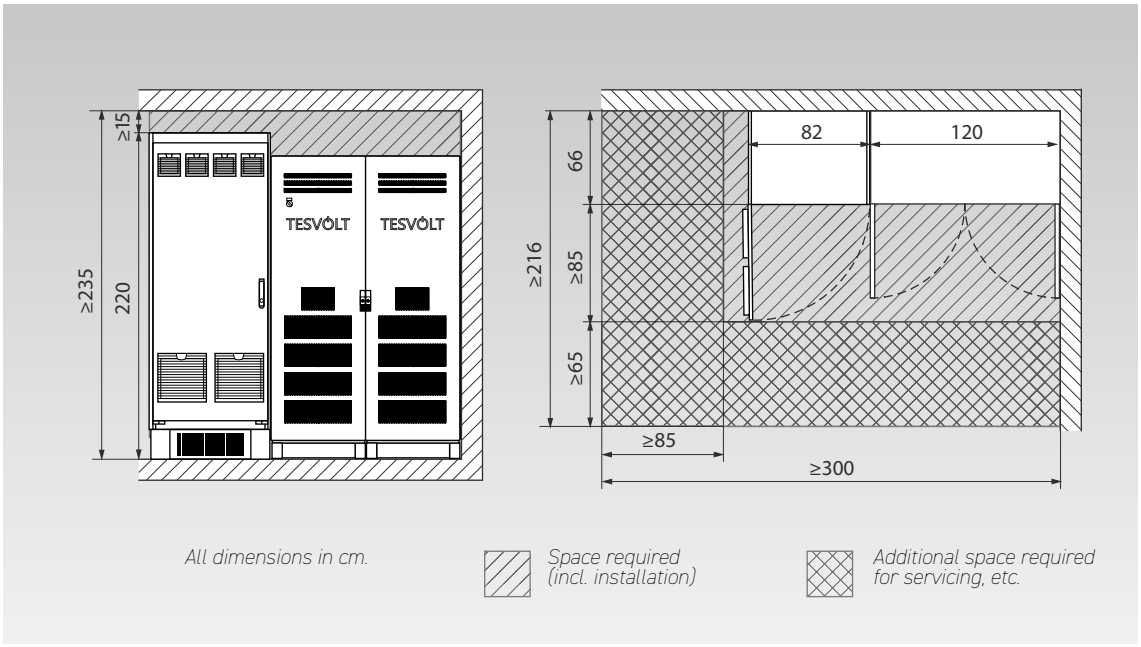
Section “1.7 Appropriate use” on page 8 lists all the necessary prerequisites and conditions for installing a TS-I HV 80.

When selecting the installation site, bear in mind transport routes and the necessary site clearance.

WARNING! Possible damage to the building due to static overload

The total weight of the battery storage system (battery inverter TESVOLT PCS and battery storage system TS HV 80) is 1,213 kg. Ensure that the installation location has sufficient load-bearing capacity. If in doubt, consult a structural engineer.

Dimensions TS-I HV 80

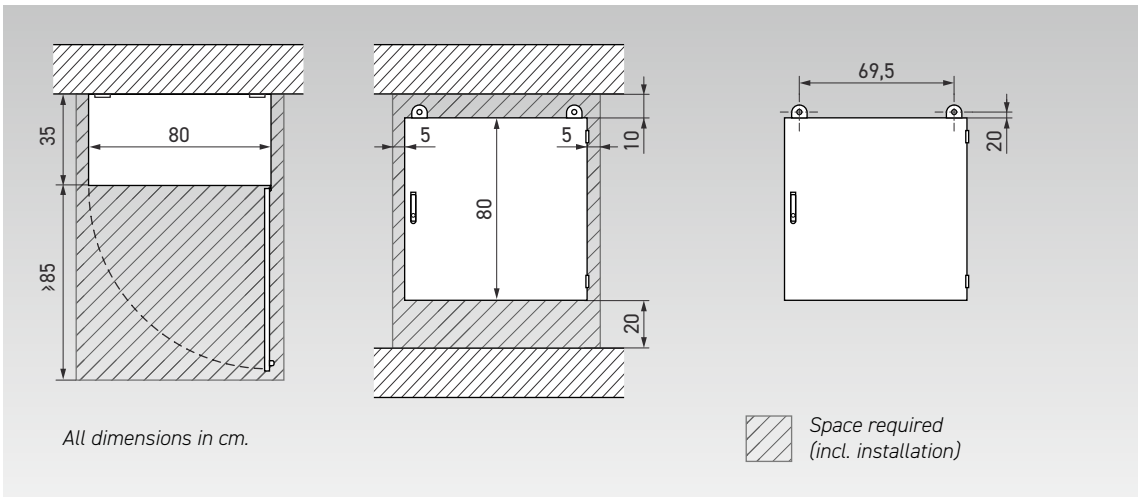


All dimensions in cm.

Space required (incl. installation)

Additional space required for servicing, etc.

Dimensions TESVOLT Backup Control Box



All dimensions in cm.

Space required (incl. installation)

4 TECHNICAL DATA

4.1 BATTERY STORAGE SYSTEM TS HV 80

The battery storage system TESVOLT TS-I HV 80 is equipped with the high-voltage lithium battery storage TS HV 80. The battery storage is modular and has 16 battery modules with a capacity of 4.8 kWh each.

Its advanced, cost-optimised design ensures unbeatable cost efficiency without compromising on quality and performance.

It is extremely robust and well suited to the hardest of tasks. High-end battery cells from the automotive industry and innovative technologies such as the Active Battery Optimizer make the TESVOLT TS HV 80 lithium battery storage system one of the most durable and flexible products on the market.

TECHNICAL DATA FOR BATTERY		
Energy for each TS HV 80 battery system (16 battery modules)		76 kWh
C-rate		1 C
Cell		Lithium NMC prismatic (Samsung SDI)
Max. charging/discharging current		94 A
Cell balancing		Active Battery Optimizer
Expected cycles at 100 % DoD | 70 % EoL | 23°C +/– 5°C 1 C/1 C		6000
Expected cycles at 100 % DoD | 70 % EoL | 23°C +/– 5°C 0.5 C/0.5 C		8000
Efficiency (battery)		Up to 98 %
Self-consumption (standby)		5 W (without battery inverter)
Operating voltage		761 to 930 V DC
Operating temperature		–10 to 50 °C
Humidity		0 to 85 % (non-condensing)
Altitude of installation site		< 2000 m above sea level
Dimensions (H x W x D)		1900 x 1200 x 600 mm
Certificates/standards	Cell	IEC 62619, UL 1642, UN 38.3
	Product	CE, UN 38.3, IEC 62619, IEC 61000-6-2/4/7, BattG 2006/66/EC
Guarantee		10-year performance guarantee, 5-year system guarantee
Recycling		TESVOLT offers a free take-back scheme for batteries from Germany
Total weight	(16 battery modules, 2 racks)	791 kg
	Weight per battery module | cabinet	34 kg | 120 kg
Protection class		IP 20
Battery specification as per DIN EN 62620:2015		IMP47/175/127/[14S]E/-20+60/90

4.2 BATTERY INVERTER TESVOLT PCS

The battery storage system TESVOLT TS-I HV 80 is equipped with the three-phase battery inverter TESVOLT PCS. It has a modular design and can be equipped with up to four inverter modules with 75 kW each.

Thanks to black start capability, permanent scalability and a power output of up to 300 kW, the battery storage system is ideally suited to the needs of trade and industry.

Thanks to the flexible TESVOLT energy management system and its high C-rate, the system can be used for a wide range of applications. Projects up to the megawatt range can be implemented with this unit.

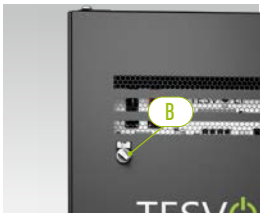
TECHNICAL DATA FOR THE BATTERY INVERTER								
Operating voltage AC	400/480 V +/–10%							
Grid frequency	50/60 Hz							
AC cable connection	Three-phase + PE, neutral conductor connection not required (grid grounding types: TN, TT, IT)							
	400 V				480 V			
Number of IPUs	1	2	3	4	1	2	3	4
Rated AC current	125 A	250 A	375 A	500 A	125 A	250 A	375 A	500 A
Rated active power	75 kW 85 kW*	150 kW 170 kW*	225 kW 255 kW*	300 kW 340 kW*	75 kW 100 kW*	150 kW 200 kW*	225 kW 300 kW*	300 kW 400 kW*
Rated apparent power	75 kVA 87 kVA*	150 kVA 173 kVA*	225 kVA 260 kVA*	300 kVA 346 kVA*	75 kVA 104 kVA*	150 kVA 208 kVA*	225 kVA 312 kVA*	300 kVA 416 kVA*
DC connection	Two-pin DC direct connection without DC/DC actuator							
DC voltage range	680 to 1,200 V_{DC}				840 to 1,200 V_{DC}			
Rated DC current	140 A	280 A	420 A	560 A	140 A	280 A	420 A	560 A
DC short-circuit current (< 1 s)	238 A	476 A	714 A	952 A	238 A	476 A	714 A	952 A
Weight (approx.)	390 kg	530 kg	670 kg	820 kg	390 kg	530 kg	670 kg	820 kg
Power loss	< 2.4% in typ. operation, < 0.5% in no-load operation, < 100 W in standby mode				< 2.1% in typ. operation, < 0.5% in no-load operation, < 100 W in standby mode			
Dimensions (H x W x D)	2200 x 820 x 660 mm							
Max. efficiency	97.8%							
Operating temperature	0 to 40°C (other temperatures on request)							
Temperature storage/transport	–20 to 70°C							
Max. relative humidity	95%							
Protection class	IP 20 (optional: IP 21 ... IP 54)							
Overvoltage category	CAT III, 1,000 V							
EMC class	EN 55011, class A1 (industrial environment)							
Communication	Ethernet TCP/IP (various fieldbus systems via optional Anybus module, e.g. Modbus TCP/IP)							
Inverter	Three-level IGBT with auxiliary voltage circuit (DC film capacitors)							
Certificates and permits	CE, EN 50178, EN 61439-1/2, EN 61000-6-2/4, EN 55011							
Topology	Transformer-free							
Communication	Modbus TCP/IP							

TECHNICAL DATA FOR THE BATTERY INVERTER	
Noise level	Max. 83 dB(A)

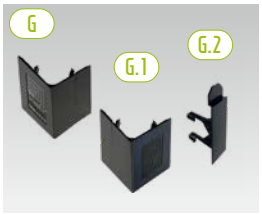
** Max. power limit of inverter. The power depends on the connected battery configuration. Please refer to the system configuration table in the data sheet for the output variants by number of connected batteries.*

5 BATTERY STORAGE SYSTEMTS HV 80

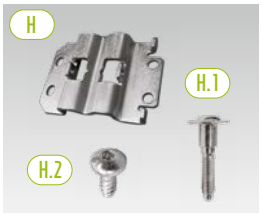
Cabinet halves



External switch

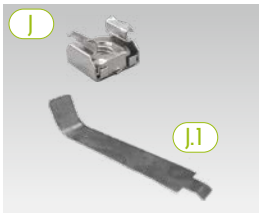


Base corner cover plate and connector



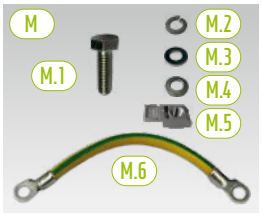
Baying connector with screws for fastening

Pan head screw with plastic washer



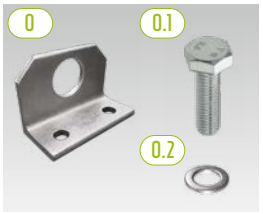
Cage nut with installation aid

Cable support clip
Ring screw



Cabinet grounding connection

Spacer with accessories for lifting the roof



Optional: combination bracket with fastening materials

5.1 TS HV 80 CABINET SCOPE OF DELIVERY

ITEM	NUMBER	DESCRIPTION
A	2	**Cabinet halves** (left/right)
B	1	**External switch** (pre-installed)
C	1	**Central grounding point** (pre-installed)
C.1	1	**Grounding point** (pre-installed)
D	1	**C-rail** (pre-installed)
E	1	**Connection cable for external switch** (pre-installed)
F	2	**Cable retention rail** (pre-installed, also referred to as "mounting rail")
G	4	**Base corner cover plates (right)**
G.1	4	└ **Base corner cover plates (left)**
G.2	2	└ **Connector for corner cover plates**
H	6	**Baying connector**
H.1	12	└ **M6 x 35 setscrew**
H.2	24	└ **5.5 x 13 pan head screw** (Torx TX25)
I	100	**M6 x 16 pan head screw** (cross-head)
I.1	100	**M6 plastic washer**
J	100	**M6 cage nut**
J.1	2	└ **Auxiliary tool for cage nuts**
K	2	**Cable retention clip** for C-rail (cable relief)
L	8	**Ring screw**
M	1	**Cabinet grounding connection set**
M.1	2	└ **M8 x 30 screw**
M.2	2	└ **M8 spring washer**
M.3	2	└ **M8 washer**
M.4	2	└ **M8 contact washer**
M.5	2	└ **M8 speed nut**
M.6	1	└ **Grounding cable**
N	8	**20 mm spacer**
N.1	8	└ **M6 x 16 countersunk screw** (Torx TX30)
N.2	8	└ **Cover cap**
N.3	8	└ **Plastic washer**
O	2	**Combined bracket** (optional – only for transporting the installed cabinet casing by crane, not including battery modules)
O.1	4	└ **M12 screw**
O.2	4	└ **M12 washer**

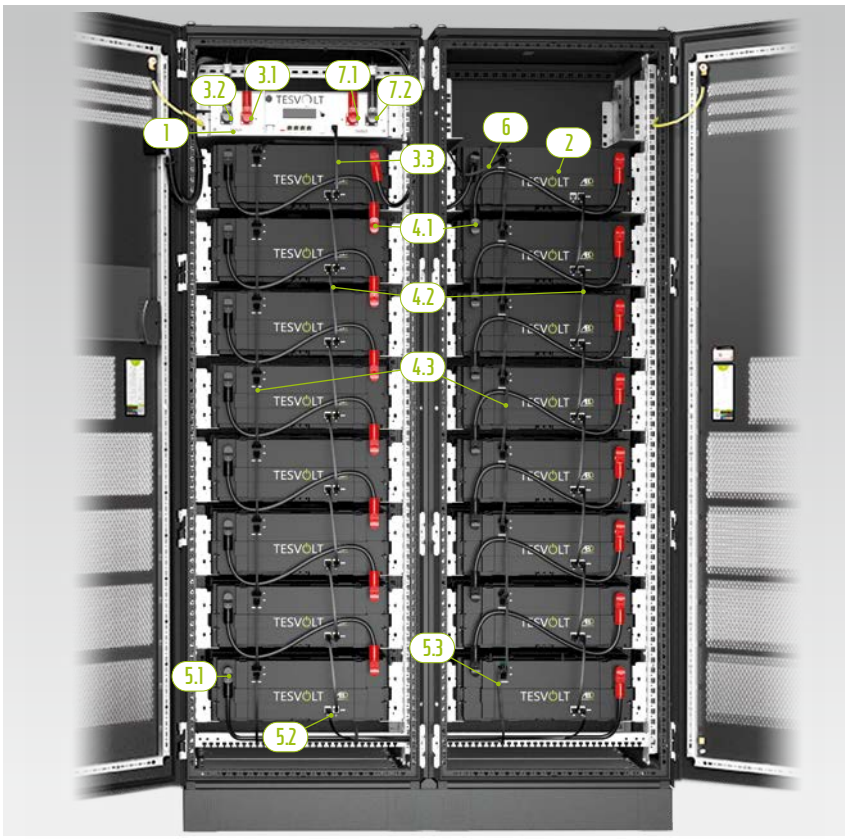
5.2 SETUP AND COMPONENTS

APU HV1000-S

Battery module incl. Active Battery Optimizer (ABO)

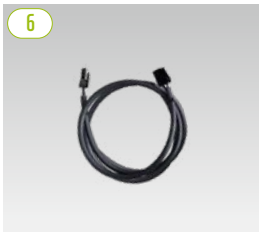
APU connector kit HV1000

Module connector kit TS HV 80



TS HV 80 Fully installed

Cabinet connector kit HV1000



Rack-balancing ring cable 0.75 m

DC connector kit APU to Bat INV/BatBreaker HV1000

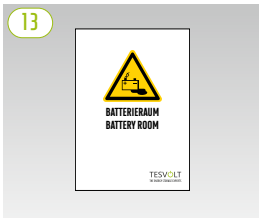
24 V power supply

Patch cable CAT 6 10.00 m

Type plate

Installation manual

TESVOLT USB drive

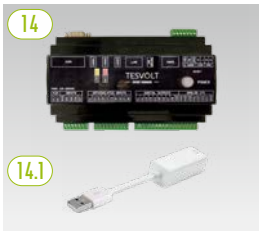


Battery room sticker

5.3 TS HV 80 SCOPE OF DELIVERY

ITEM	NUMBER	DESCRIPTION
1	1	**APU HV1000-S**
2	16	**Battery module 4.8-1C-HV1000** incl. Active Battery Optimizer (ABO)
3	1	**APU connector kit HV1000** from the APU HV1000-S to the 1st and 16th battery module
3.1	1	└ **DC connecting cable 0.95 m – 35 mm²** (rd to rd)
3.2	1	└ **1.15 m – 35 mm² DC connecting cable** (bk to bk)
3.3	1	└ **Patch CAT 6 0.30 m**
3.4	1	└ **0.70 m – 16 mm² APU grounding cable** (gn/yw) M 6 – M8
4	1	**Module connector kit TS HV 80**
4.1	14	└ **DC connecting cable 0.55 m – 35 mm²** (rd to bk)
4.2	14	└ **Patch CAT 6 0.30 m**
4.3	14	└ **Rack balancing 0.24 m**
5	1	**Cabinet connector kit HV1000**
5.1	1	└ **1.20 m – 35 mm² DC connecting cable** (rd to bk)
5.2	1	└ **Patch CAT 6 1.00 m**
5.3	1	└ **1.10 m rack balancing cable**
6	1	**0.75 m rack balancing ring cable**
7	1	**DC connector kit APU HV1000-S for Bat INV/BatBreaker HV1000**
7.1	1	└ **5.00 m – 35 mm² DC connecting cable**(red plug on one end)
7.2	1	└ **DC connecting cable 5.00 m – 35 mm²** (black plug on one end)
7.3	2	└ **35 mm² insulated wire-end ferrule**
7.4	1	└ **Patch cable CAT 6 5.00 m**
7.5	1	└ **5.00 m – 16 mm² M8 grounding cable** (gn/yw)
8	1	**24 V power supply**
9	2	**CAT 6 patch cable, 10.00 m**
10	2	**Type plate TS HV 70 (TS HV 80)**
11	1	**TESVOLT TS-I HV 80 Installation and Operating Manual**
12	1	**TESVOLT USB drive**
13	1	**Battery room sticker**

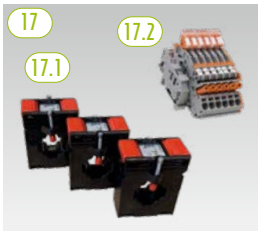
5.4 COMMUNICATION AND CONTROL COMPONENTS AND SCOPE OF DELIVERY



TESVOLT Energy Manager power supply and USB ethernet adapter

Ethernet switch 8 port, 24 V

Janitza power measurement



Transformer set

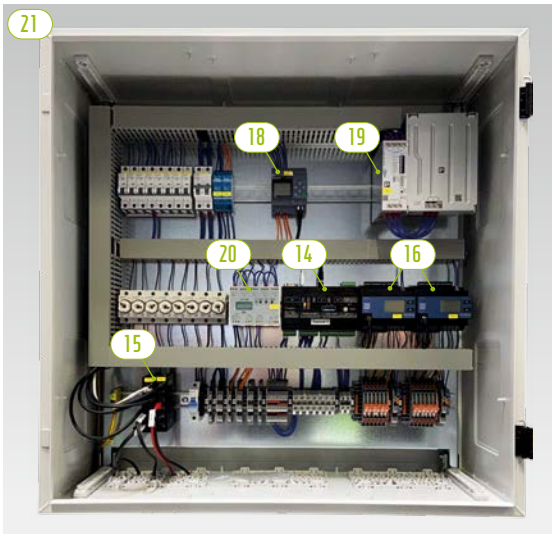
ITEM	NUMBER	DESCRIPTION
14	1	**TESVOLT Energy Manager**
14.1	1	└ **USB ethernet adapter**
15	2	**Ethernet switch 8-port, 24 V**
16	2	**Janitza power measurement UMG 604E-Pro, 24 V**
17	1	**Transformer set for Janitza power measurement UMG 604** ("TESVOLT PCS")
17.1	1	└ **Plug-in current transformer** (size depends on number of IPUs; see table in section "AC connection – cable cross-section, back-up fuses and transformer types" on page 50)
17.2	1	└ **Short circuit terminal block**

5.5 COMMUNICATION AND CONTROL COMPONENTS AND SCOPE OF DELIVERY OFF-GRID/BACK-UP POWER

SIEMENS Logo

UPS set 40 A

Synchronising, frequency and voltage control unit SYFU50

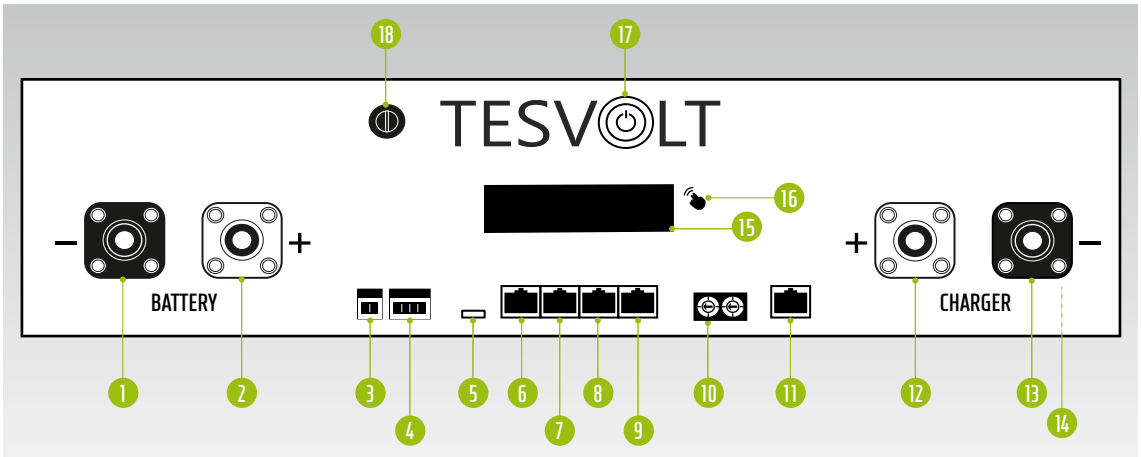


TESVOLT Backup Control Box with communication, measuring and control components

ITEM	NUMBER	DESCRIPTION
18	Optional	**SIEMENS Logo**
19	Optional	**UPS set 40 A**
20	Optional	**Synchronising, frequency and voltage control unit SYFU50**
21	Optional	**TESVOLT Backup Control Box**

NOTE: The components listed in the previous section "5.4 Communication and control components and scope of delivery" are also requiredfor off-grid systems. Together with the components listed in this section, they can either be used as part of the TESVOLT Backup Control Box or they can also be installed as individual components.

5.6 CONNECTIONS AND SETUP OF THE APU HV1000-S

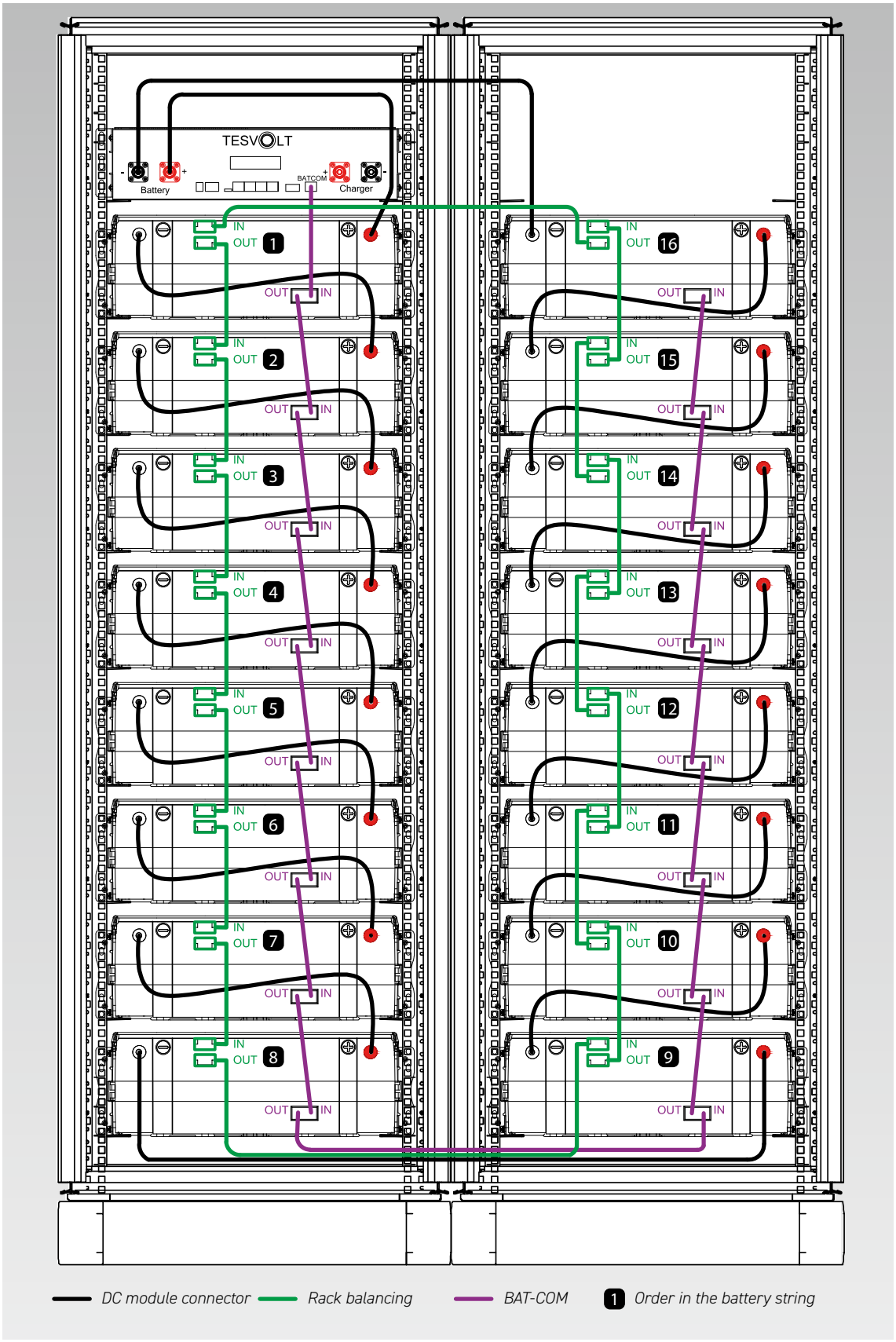


NO.	DESIGNATION	DESCRIPTION
1	BATTERY –	The battery's DC connection for the negative pole (black)
2	BATTERY +	The battery's DC connection for the positive pole (red)
3	EXT SWITCH	Connection of the external switch (B)
4	E-STOP	Four-pin plug for the optional connection of an emergency stop switch for quick shutdown (pre-installed with bridge on delivery)
5	TERM	CAN bus termination TERM must be activated (ON) for the first and last CAN bus subscribers.
6	CAN IN	APU HV1000-S master/slave communication (input)
7	CAN OUT	APU HV1000-S master/slave communication (output)
8	CAN SMA	Connection not used on the TS HV 80.
9	LAN	Modbus TCP/IP transmission for communication between battery and TESVOLT Energy Manager
10	ADDRESS	Further information can be found in the section "Overview of all addressing options" on page 87.
11	BAT-COM	Communication connection to the first battery module
12	CHARGER +	DC connection of the TESVOLT PCS for the positive pole (red)
13	CHARGER –	DC connection of the TESVOLT PCS for the negative pole (black)
14	GROUND	Grounding connection (M6 thread bolt on the rear of the unit)
15	DISPLAY	Display
16	MARKING	Marking for activating and changing the display by tapping
17	SWITCH	On/off switch for the battery
18	APU fuse (F1)	Fuse to protect the APU HV1000-S (2 AG fuse, 5 x 20 mm, time lag (T) according to DIN 41571-2, type: ESKA 521.020, 250 V_{AC}) Operation is not possible with a defective fuse.

5.7 CONNECTIONS AND SETUP OF THE BATTERY MODULE

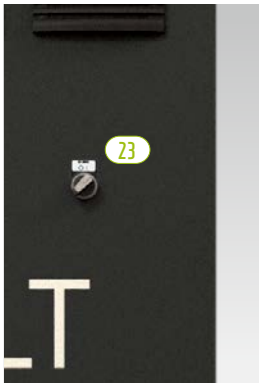
NO.	DESIGNATION	DESCRIPTION
19	– POLE	Battery negative pole (black)
20	+ POLE	Battery positive pole (red)
21	RACK BALANCING IN	Rack balancing (input)
22	RACK BALANCING OUT	Rack balancing (output)
23	BAT-COM OUT	Communication connection for battery module (output)
24	BAT-COM IN	Communication connection for battery module (input)

5.8 WIRING THE BATTERY MODULES



6 BATTERY INVERTER TESVOLT PCS

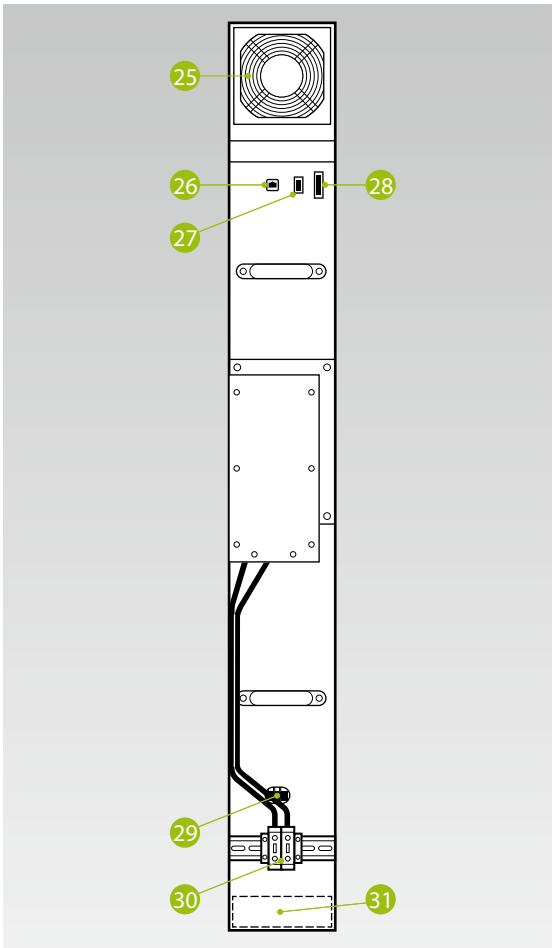
6.1 SETUP AND COMPONENTS



Main switch

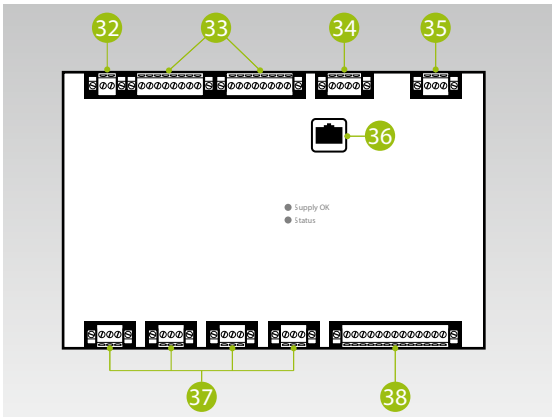
ITEM	NUMBER	DESCRIPTION
22	1	**Air filter** (air outlet)
23	1	**Main switch (S1)**
24	1	**Control computer CCU**
25	1 ... 4	**Inverter module IPU**
26	1	**AC connection**
27	1	**DC connection**
27	1	**NH switch disconnector for the inverter modules (Q1 ... Q4)**
29	1	**Control transformer 690/400/24 V**
30	1	**Measuring and input/output module MIO**
31	1	**24 V power supply**
32	1	**Air filter** (air inlet)
33	1	**Terminal strip**

6.2 CONNECTIONS AND SETUP OF INVERTER MODULE – IPU



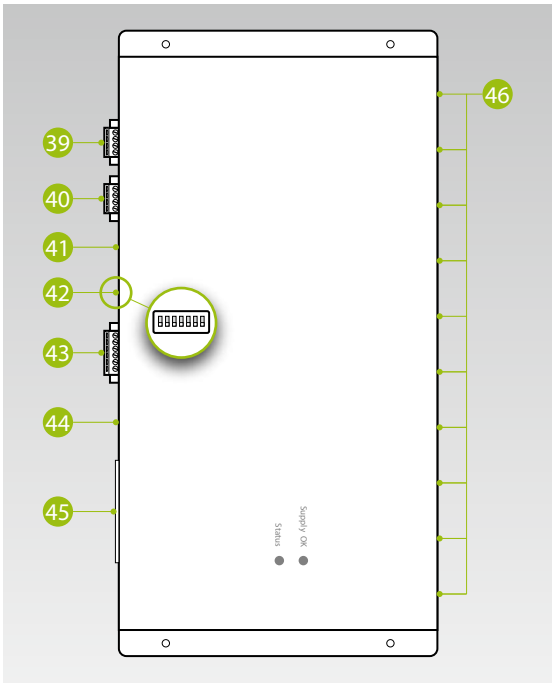
NO.	DESCRIPTION
25	Secondary fan 24 V_{DC}, replaceable
26	DSC connection (RJ45 CAT5 cable)
27	24 V_{DC} control voltage monitoring
28	24 V_{DC} control voltage, 10 A
29	Main contactor 24 V_{DC}, replaceable
30	DC link connections, 1,200 V_{DC}, 140 A
31	Primary fan 24 V_{DC}, replaceable

6.3 CONNECTIONS AND SETUP OF MEASURING AND INPUT/OUTPUT MODULE – MIO



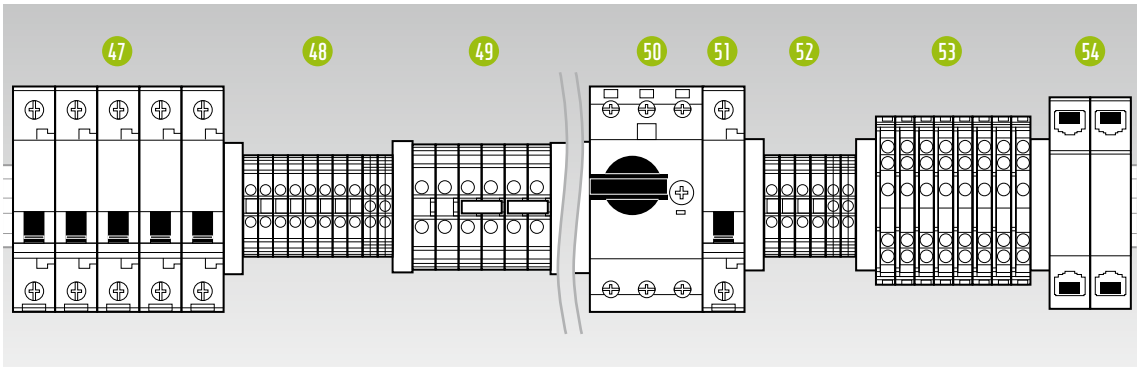
NO.	DESIGNATION
32	AC grid (measurement of utility grid frequency)
33	Galvanically isolated digital inputs and outputs 4x digital in, 4x digital out
34	Connection for an additional temperature measurement
35	24 V_{DC} control voltage
36	DSC connection (RJ45 CAT5 cable)
37	4 galvanically isolated, usable current inputs Measurement with high-precision A/D transformer Switchable: 1 A / 5 A Overload capacity: up to 100 A for 1 second
38	AC grid measurement voltage up to 1,000 V with high overvoltage resistance (CAT III)

6.4 CONNECTIONS AND SETUP OF THE CONTROL COMPUTER UNIT – CCU



NO.	DESIGNATION
39	X1 – 24 V_{DC} control voltage, 1 A
40	X2 – RS485 interface (exclusively for touch panel)
41	Ethernet connection (RJ45 CAT 5 cable)
42	DIP switch for X3
43	X3 – RS485 interface (configurable with DIP switch)
44	Slot for SD card
45	Anybus connection (RJ45 CAT 5 cable)
46	10 x DSC connection (connection to the IPUs, RJ45 CAT 5 cable)

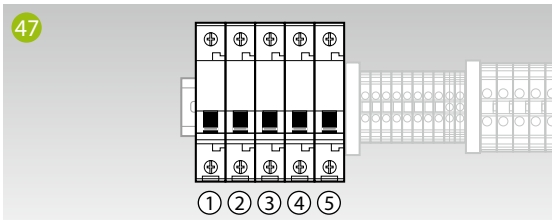
6.5 TERMINAL STRIP FOR BATTERY INVERTER TESVOLT PCS



NO.	DESIGNATION	DESCRIPTION
47	F21 ... F25	Circuit breaker
48	X5	Terminal blocks (no customer-side connection required)
49	X7	24 V tap for 24 V consumer
50	Q01	Circuit breaker, switches test voltage (for MIO) and control voltage (via control transformer)
51	F20	Circuit breaker 230 V power supply
52	X4	Terminal blocks (no customer-side connection required)
53	X6	Current transformer terminals
54	X10/X11	LAN 1 and LAN 2 ethernet connections

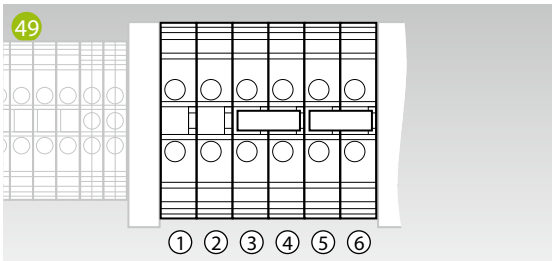
Description of the connections

Circuit breaker



1	F21 circuit breaker 24 V power supply CCU and MIO
2	F22 Circuit breaker 24 V power supply IPU pos. 1
3	F23 Circuit breaker 24 V power supply IPU pos. 2
4	F24 Circuit breaker 24 V power supply IPU pos. 3
5	F25 Circuit breaker 24 V power supply IPU pos. 4

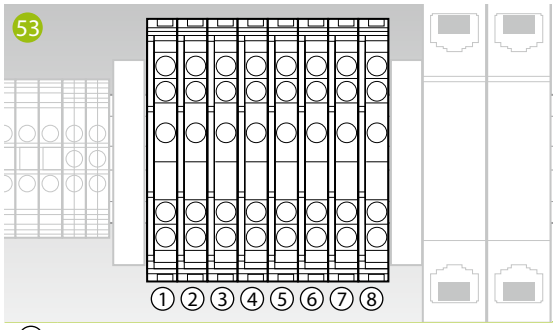
X7 terminal blocks



1	X7.1 Terminal blocks 24 V DC + OUT – to UPS*
2	X7.2 Terminal blocks 24 V DC – OUT – to UPS*
3	X7.3 Terminal blocks 24 V DC + IN – coming from UPS*
4	X7.4 Terminal blocks 24 V DC + OUT (for on-grid applications, provided that the 24 V consumers are to be supplied by the power supply unit in the TESVOLT PCS)
5	X7.5 Terminal blocks 24 V DC – IN – coming from UPS*
6	X7.6 Terminal blocks 24 V DC – OUT (for on-grid applications, if the 24 V loads are to be supplied by the power supply unit in the MR)

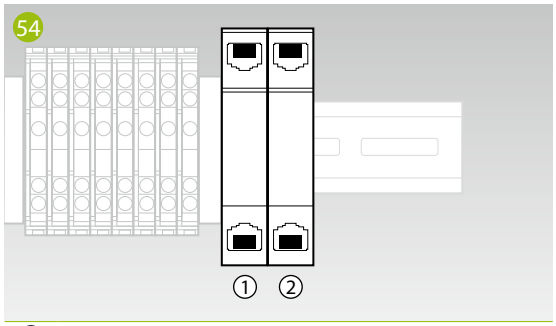
* only for back-up power/off-grid systems

X6 Current transformer terminals



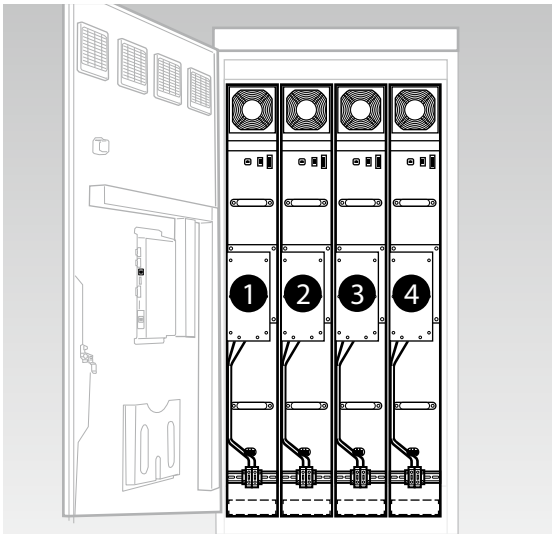
1	X6.1 Current transformer terminals/short circuit terminals k (L1)
2	X6.2 Current transformer terminals/short circuit terminals l (L1)
3	X6.3 Current transformer terminals/short circuit terminals k (L2)
4	X6.4 Current transformer terminals/short circuit terminals l (L2)
5	X6.5 Current transformer terminals/short circuit terminals k (L3)
6	X6.6 Current transformer terminals/short circuit terminals l (L3)
7	X6.7 not used
8	X6.8 not used

Ethernet coupling X10/X11



1	X10 Ethernet LAN 1 (local network)
2	X11 Anybus LAN 2 (dedicated Modbus network)

6.6 IPU POSITIONS AND ASSOCIATED CIRCUIT BREAKERS AND NH ISOLATORS



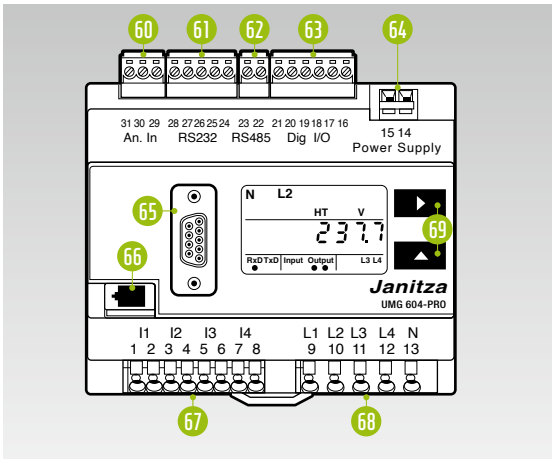
The installation position of the IPU determines the assignment of the associated NH isolators and circuit breakers. An overview is given in the following table.

POSITION.	NH ISOLATOR	CIRCUIT BREAKER
1	Q1	F22
2	Q2	F23
3	Q3	F24
4	Q4	F25

7 PERIPHERY

7.1 JANITZA POWER MEASUREMENT UMG 604

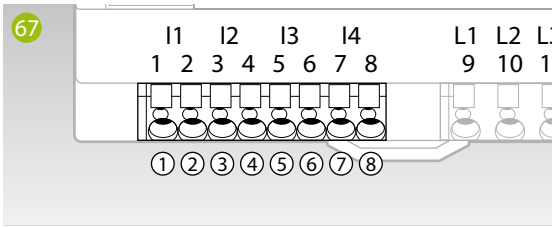
Connections and setup



NO.	DESIGNATION
60	Temperature measuring input
61	RS232 interface
62	RS485 interface
63	Digital inputs/outputs
64	24 V_{DC} supply voltage
65	Profibus interface (optional)
66	Ethernet interface
67	Current measuring inputs I1 ... I4
68	Voltage measuring inputs L1 ... L4
69	Operating buttons

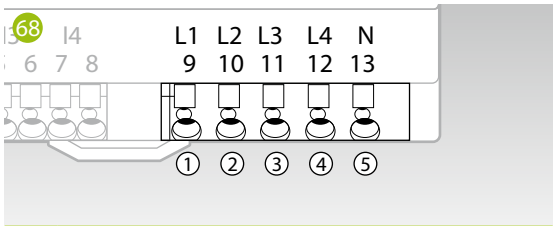
Description of the connections

Current measurement



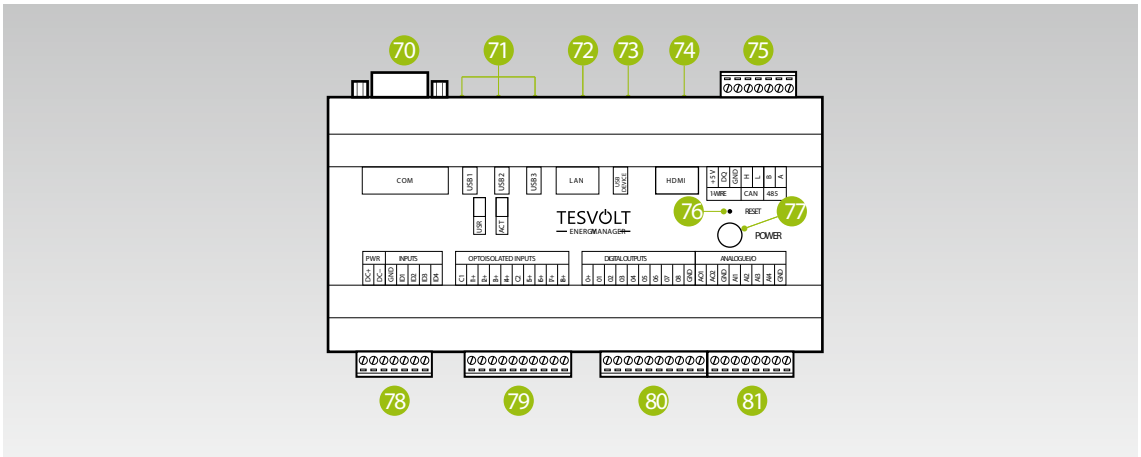
①	L1 k
②	L1 l
③	L2 k
④	L2 l
⑤	L3 k
⑥	L3 l
⑦	N k
⑧	N l

Voltage measurement



①	L1
②	L2
③	L3
④	L4
⑤	N

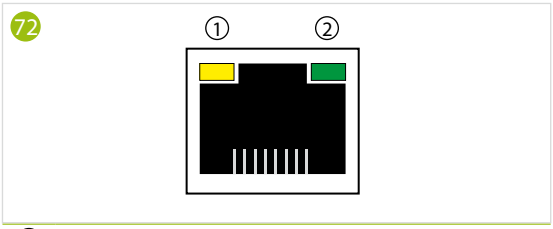
7.2 CONNECTIONS AND SETUP OF THE TESVOLT ENERGY MANAGER



NO.	DESIGNATION	DESCRIPTION
70	RS-232 (COM)	Service interface
71	USB 1 ... 3	2nd Ethernet, read heads, USB relays
72	LAN	Internet connection (Uplink LAN)
73	USB DEVICE	No function
74	HDMI	No function
75	1-WIRE/CAN/RS-485	Temperature and humidity sensors/CAN no function/Modbus RTU devices
76	RESET	Hardware reset (restart of the device)
77	POWER	On/off switch
78	PWR/INPUTS	24 V power supply/digital inputs – e.g. buttons or switches
79	OPTOISOLATED INPUTS	Optoisolated inputs – e.g. direct marketer interface, radio ripple control receivers, fault indicator contacts, NA box signals
80	DIGITAL OUTPUTS	Digital outputs – relays (e.g. for smart grid ready/heat pumps), NA box signals
81	ANALOGUE I/O	Analogue inputs/outputs – e.g. CHP, generator

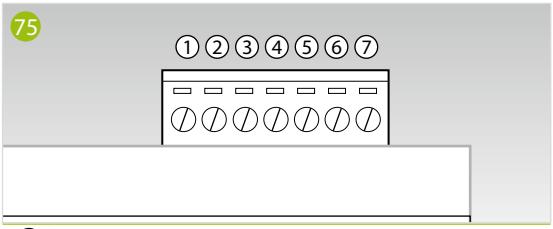
Description of the connections

LAN



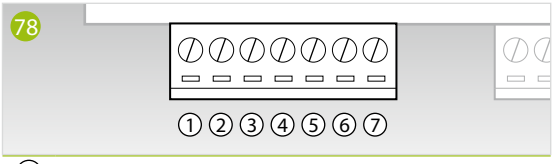
①	Activity LED – indicates network connection activity.
②	Link LED – indicates network connection status.

1-WIRE/CAN/RS-485

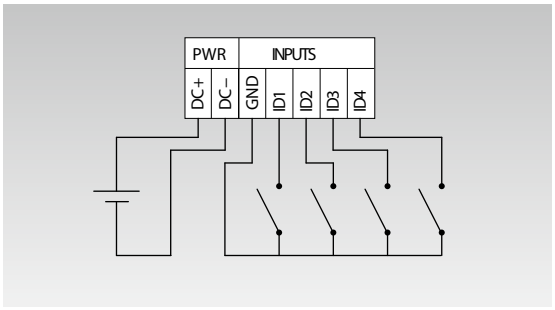


①	1-WIRE – +5 V
②	1-WIRE – DQ
③	1-WIRE/RS-485 – GND (also used for RS-485 connection)
④	CAN – H
⑤	CAN – L
⑥	RS-485 – B
⑦	RS-485 – A

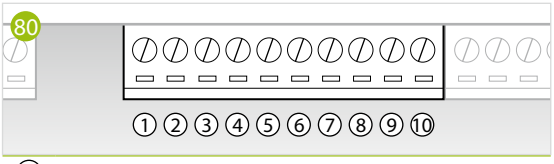
POWER/INPUTS



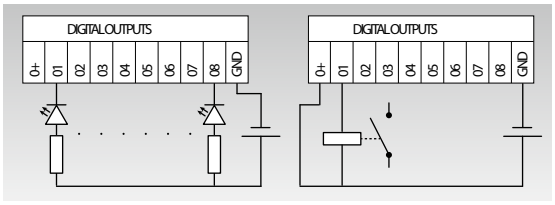
1	DC -
2	DC +
3	INPUTS - GND
4	INPUTS - ID1
5	INPUTS - ID2
6	INPUTS - ID3
7	INPUTS - ID4



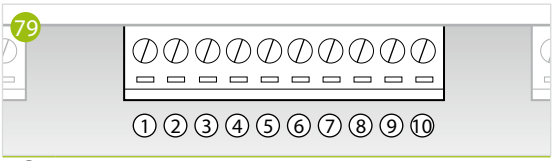
DIGITAL OUTPUTS



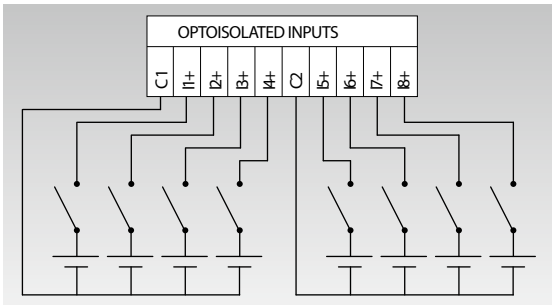
1	0+
2	01
3	02
4	03
5	04
6	05
7	06
8	07
9	08
10	GND



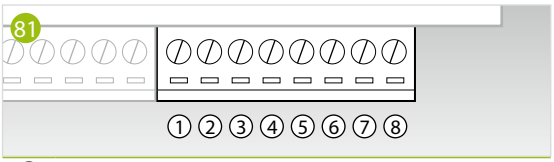
OPTOISOLATED INPUTS



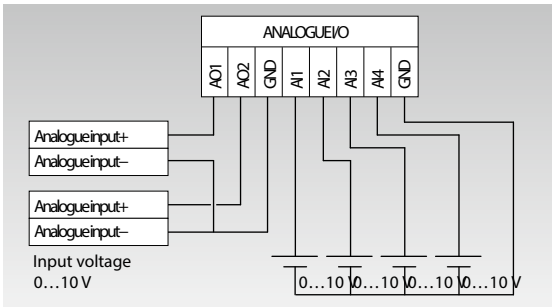
1	C1
2	I1+
3	I2+
4	I3+
5	I4+
6	C2
7	I5+
8	I6+
9	I7+
10	I8+



ANALOGUE I/O

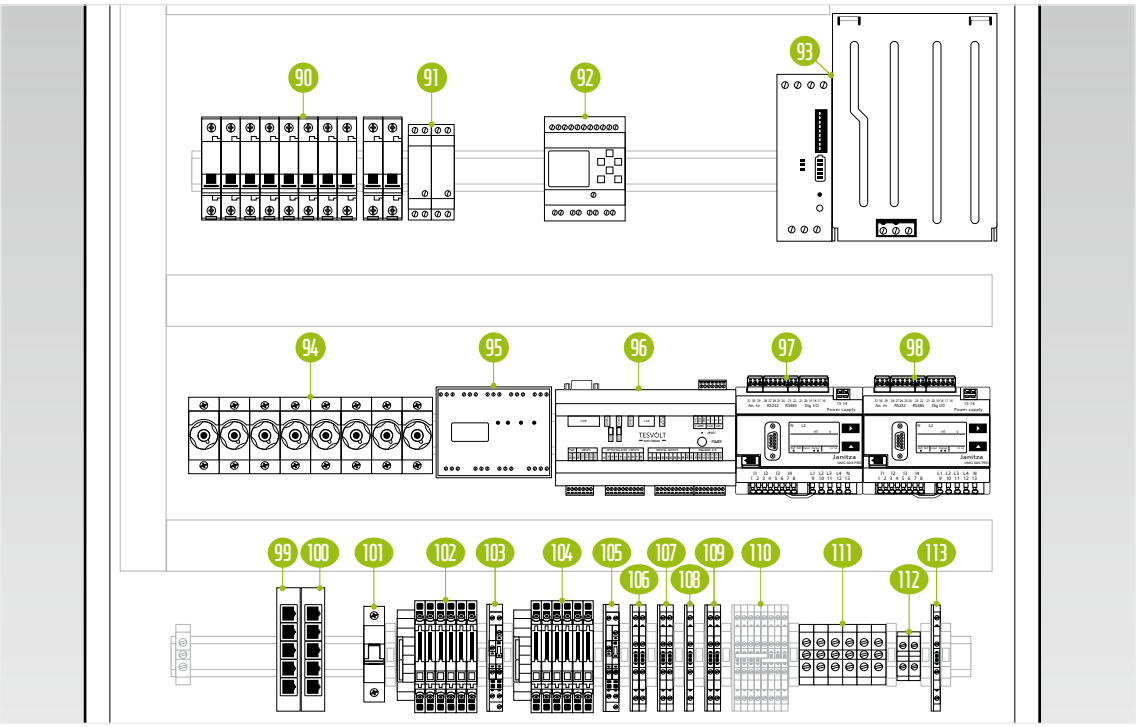


1	AO1
2	AO2
3	GND
4	AI1
5	AI2
6	AI3
7	AI4
8	GND



7.3 TESVOLT BACKUP CONTROL BOX

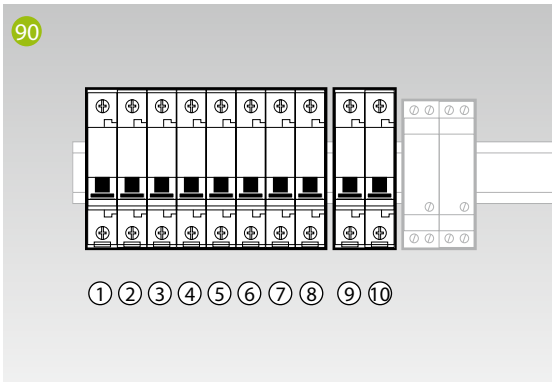
Components and setup



ITEM	DESIGNATION	DESCRIPTION
90	F1	Circuit breakers F1.1 ... F1.9 (uninterruptible 24 V power supply)
91	Q1	Auxiliary relay for SIEMENS Logo
92	K1	SIEMENS Logo, controls the grid disconnection switch
93	G1	UPS set 40 A for uninterruptible 24 V power supply
94	F2 ... F4	D01 screw fuses (fuse protection for voltage measurement)
95	K2	SYFU50 synchronising, frequency and voltage control unit (comparison of grid/off-grid parameters)
96	K3	TESVOLT Energy Manager
97	P1	Janitza power measurement UMG 604 (utility grid) – power measurement and multifunctional measuring device
98	P2	Janitza power measurement UMG 604 (TESVOLT PCS) – power measurement and multifunctional measuring device
99	K4	LAN 2 switch (Modbus) – dedicated Modbus network
100	K5	LAN 1 switch (local network) – linking with the local network or internet
101	F5	SYFU50 protection
102	X1	Terminals for current transformer at grid connection point; internally connected to power measurement (P1)
103	X2	Terminals for voltage tap at grid connection point; internally connected to power measurement (P1)
104	X3	Terminals for current transformer on the TESVOLT PCS; internally connected to power measurement (P2)
105	X4	Terminals for voltage tap on the TESVOLT PCS; internally connected to power measurement (P2)
106	X5	Measurement voltages on both sides of the grid disconnection switch; internally connected to SYFU50 (K2)
107	X6	Feedback on the actual switching state of the grid disconnection switch
108	X7	Feedback on the switching status of the NA protection relay
109	X8	Control of the coil of the grid isolator via the SIEMENS Logo controller (K1)
110	X9	Internal terminal – no customer-side connection
111	X10	Uninterruptible 24 V power supply for connection of the TESVOLT PCS
112	X11	24 V supply line (internal supply of the UPS)
113	X12	230 V power supply of the SYFU50 (K2)

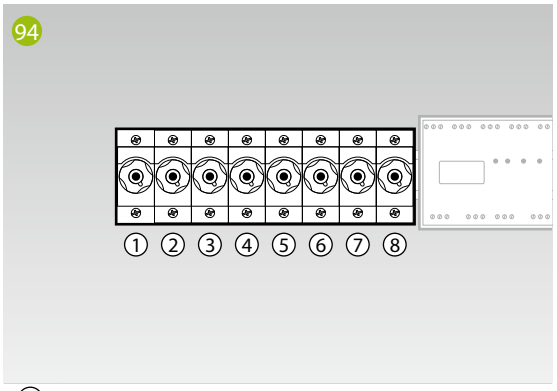
Description of the connections

Circuit breakers F 1.1 ... F 1.9



①	F 1.2 Fuse protection Janitza utility grid (P1) 97
②	F 1.3 Fuse protection Janitza TESVOLT PCS (P2) 98
③	F 1.4 Fuse protection Energy Manager (K3) 96
④	F 1.5 Free
⑤	F 1.6 Fuse protection Siemens Logo controller (K1) 92
⑥	F 1.7 Fuse protection LAN 2 switch, Modbus (K4) 99
⑦	F 1.8 Fuse protection LAN 1 switch, local network (K5) 100
⑧	F 1.9 24 V supply feedback contacts grid disconnection switch (X6.3, X6.4) 107
⑨	F 1.1 24 V main fuse/supply for TESVOLT PCS (X10) 111
⑩	F 1.1 24 V main fuse/supply for TESVOLT PCS (X10) 111

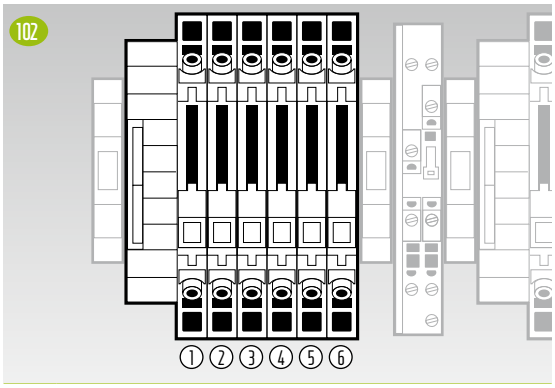
Screw fuses F2... F4



① ② ③	F2 Fuse protection voltage measurement Janitza utility grid (P1) 97 3 fuses (D01, 2 A)
④ ⑤ ⑥	F3 Fuse protection voltage measurement Janitza TESVOLT PCS (P2) 98, 3 fuses (D01, 2 A)
⑦ ⑧	F4 Fuse protection voltage measurement SYFU50 (K2) 95, 2 fuses (D01, 2 A)

X1 Current transformer grid connection point

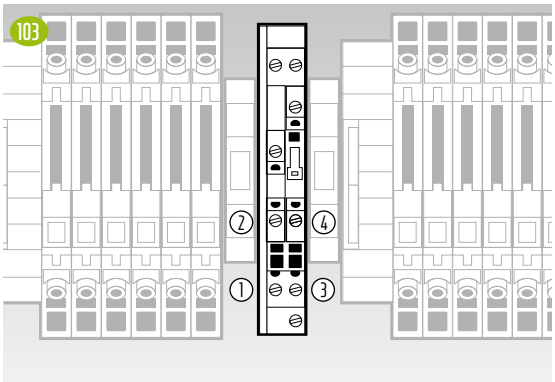
Internally connected to the transformer terminals of the Janitza UMG 604 power measurement at the grid connection point (P1) 97.



①	X1.1 Current transformer L1 k Janitza utility grid (P1) 97
②	X1.2 Current transformer L1 l Janitza utility grid (P1) 97
③	X1.3 Current transformer L2 k Janitza utility grid (P1) 97
④	X1.4 Current transformer L2 l Janitza utility grid (P1) 97
⑤	X1.5 Current transformer L3 k Janitza utility grid (P1) 97
⑥	X1.6 Current transformer L3 l Janitza utility grid (P1) 97

X2 Voltage tap grid connection point

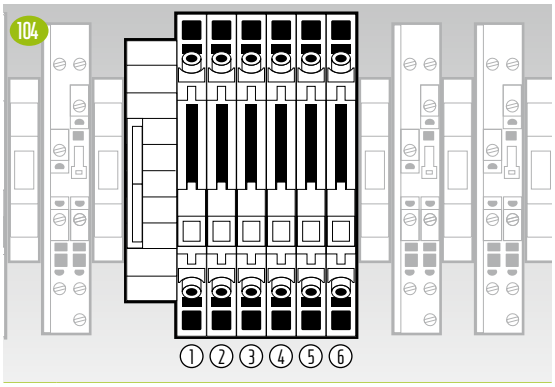
Internally connected to the Janitza UMG 604 power measurement at the grid connection point (P1) 97.



①	X2.1 Voltage L 1 Janitza utility grid (P1) 97
②	X2.2 Voltage L 2 Janitza utility grid (P1) 97
③	X2.3 Voltage L 3 Janitza utility grid (P1) 97
④	X2.4 Neutral conductor connection Janitza utility grid (P1) 97

X3 Current transformer TESVOLT PCS

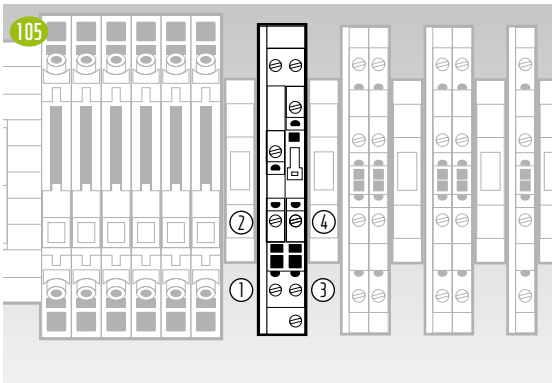
Internally connected to the transformer terminals of the Janitza UMG 604 power measurement at the TESVOLT PCS (P2) 98 .



1	X3.1 Current transformer L1 k Janitza TESVOLT PCS (P2) 98
2	X3.2 Current transformer L1 l Janitza TESVOLT PCS (P2) 98
3	X3.3 Current transformer L2 k Janitza TESVOLT PCS (P2) 98
4	X3.4 Current transformer L2 l Janitza TESVOLT PCS (P2) 98
5	X3.5 Current transformer L3 k Janitza TESVOLT PCS (P2) 98
6	X3.6 Current transformer L3 l Janitza TESVOLT PCS (P2) 98

X4 Voltage tap TESVOLT PCS

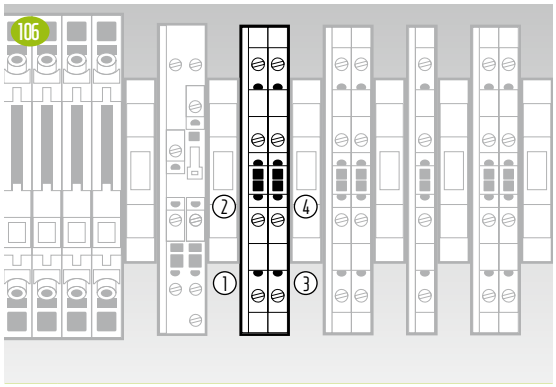
Internally connected to the Janitza UMG 604 power measurement at the TESVOLT PCS (P2) 98.



1	X4.1 Voltage L 1 Janitza TESVOLT PCS (P2) 98
2	X4.2 Voltage L 2 Janitza TESVOLT PCS (P2) 98
3	X4.3 Voltage L 3 Janitza TESVOLT PCS (P2) 98
4	X4.4 Neutral conductor connection TESVOLT PCS (P2) 98

X5 Voltage tap on both sides of the grid disconnection switch

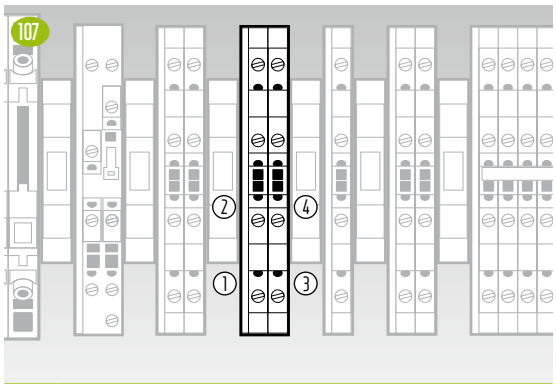
Internally connected to the synchroniser SYFU50 (K2) 95.



1	X5.1 Voltage N (customer side)
2	X5.2 Voltage L1 (customer side)
3	X5.3 Voltage N (utility grid side)
4	X5.4 Voltage L1 (utility grid side)

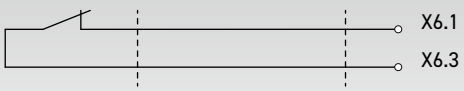
X6 Feedback on switching status of grid isolator

Internally connected to the TESVOLT Energy Manager (K3) 96.



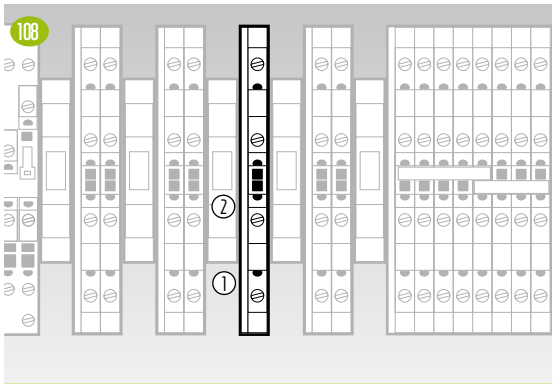
1	X6.1 Feedback on grid disconnection switch 1
2	X6.2 Feedback on grid disconnection switch 2 (optional if present)
3	X6.3 24 V power supply auxiliary contact grid disconnection switch 1
4	X6.4 24 V power supply auxiliary contact grid disconnection switch 2 (optional if present)

Feedback contact of the grid isolator (opener auxiliary contact)

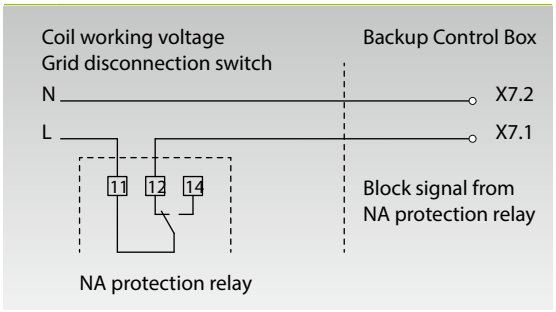


X7 Feedback on switching status of NA protection relay

Connected internally via coupling relay Q1.2 91 with the Siemens Logo controller (K1) 92 .

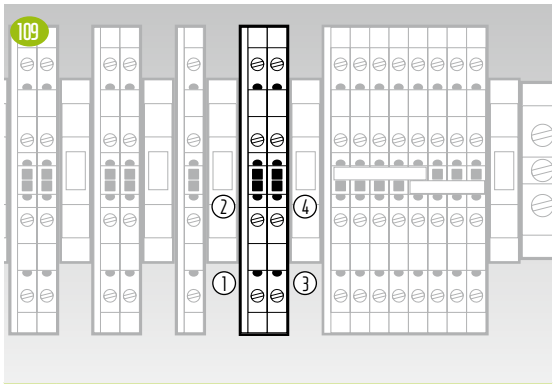


1	X7.1 NA protection relay NC contact
2	X7.2 Working voltage N

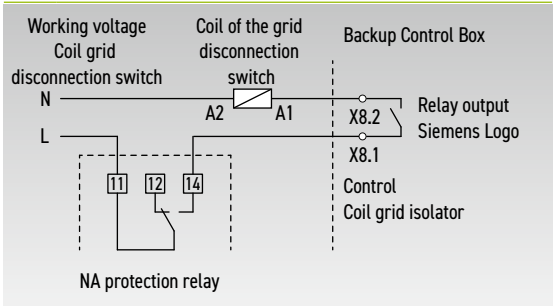


X8 Control of the coil of the grid isolator

Internally connected to the relay output of the SIEMENS Logo controller (K1) 92 .

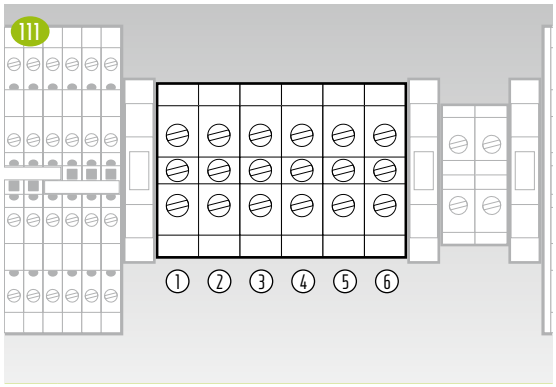


1	X8.1 NA protection relay NO contact 1
2	X8.2 Control of coil A1 of grid disconnection switch 1
3	X8.3 NA protection relay NO contact 2 (optional if present)
4	X8.4 Control of coil A1 of grid disconnection switch 2 (optional if present)



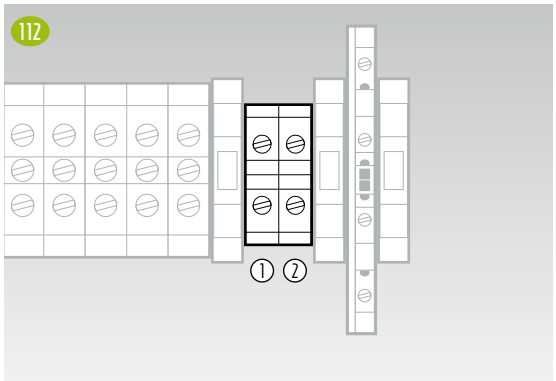
X10 Uninterruptible 24 V supply for connection of the inverter

The cable cross-section of the connection cable should be 10 mm² and with a max. length of 5 m.



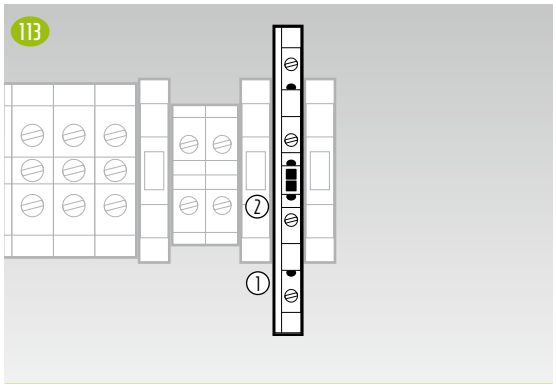
1	X10.1 24 V – UPS for connection of the TESVOLT PCS
2	X10.2 24 V – UPS for connection of the TESVOLT PCS
3	X10.3 24 V – UPS for connection of the TESVOLT PCS
4	X10.4 24 V+ UPS for connection of the TESVOLT PCS
5	X10.5 24 V+ UPS for connection of the TESVOLT PCS
6	X10.6 24 V+ UPS for connection of the TESVOLT PCS

X11 24 V supply line (internal supply UPS)



1	X11.1 24 V – supply line from the power supply unit of the TESVOLT PCS to the internal UPS 24 V power supply
2	X11.2 24 V + supply line from the power supply unit of the TESVOLT PCS to the internal UPS 24 V power supply

X12 230 V power supply SYFU50 (K2)



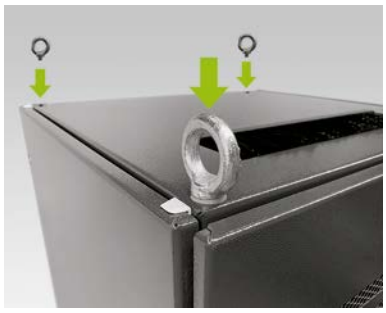
1	X12.1 Voltage L1 SYFU50 (K2) 95 (fuse-protected via F5 101)
2	X12.2 Voltage N SYFU50 (K2) 95

8 INSTALLATION AND CONNECTION OF TS HV 80

8.1 SETUP OF THE BATTERY CABINET

Remove the packaging and transport securing devices from the cabinet. The cabinet consists of two halves that are joined together once at the installation location.

1

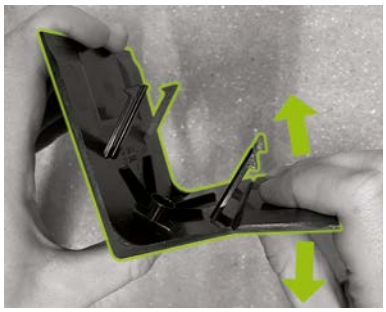


Optional: Install the ring screws: Install four ring screws at the four corners of the cabinet halves to transport the individual halves of the cabinet by crane. To do this, remove all the fastening screws from the cabinet covers and replace them with the ring screws (L).

2

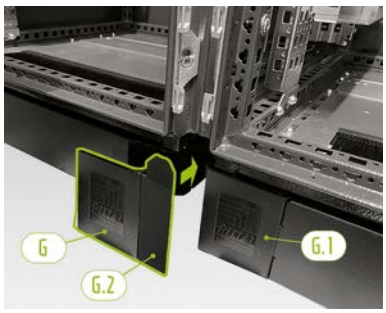
Transport the cabinet halves to the final installation location. It is essential that you observe the notes and specifications in section "3.4 Transport at end-customer site" on page 13.

3



Prepare a right base corner cover plate (G) (with the logo on the left leg) for fitting on the cabinet base. To do this, break the cover plate in half at the notch on the right leg. The narrow piece can be disposed of. Now use the two hooks of the connector for the base corner cover plate (G.2) to attach it to the shortened cover plate's short leg.

4

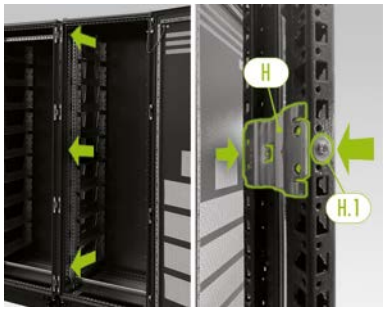


Now attach a left base corner cover plate (G.1) to the left corner at the front of the right half of the battery cabinet. Then you can attach the assembled cover plate to the right corner of the left half of the cabinet. Finally, fit the remaining base corner cover plates to the battery cabinet base's remaining corners.

5

Now remove the two cable retention rails (F) and reattach them below the bottom slide rails. Leave a hole free on the rack frame below the slide rails and install the cable retention rails. Use the old cage nuts (J) for this. You can use the auxiliary tool (J1) to remove and attach them.

6

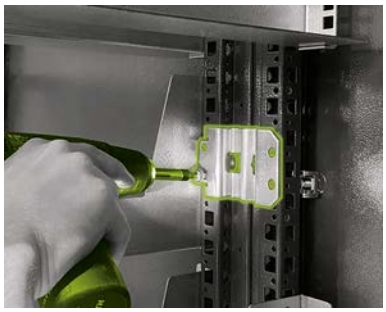


First of all, on the front of the cabinet, attach three baying connectors (H) to the central vertical cabinet profiles inside the cabinet at the top, middle and bottom. The baying connectors are affixed to the frame profiles with two setscrews (H.1) on each side from the right and left.

7

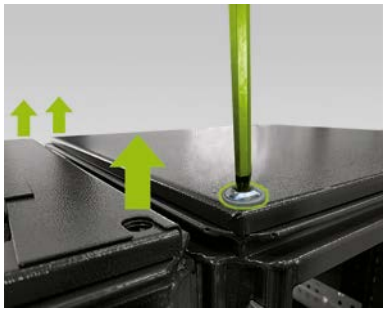
Now, fit the remaining three baying connectors (H) to the cabinet profiles at the rear of the cabinet at the same height as the front baying connectors already installed. When fitting the bottom baying connector, use the same process as for fitting on the front cabinet profiles. However, for the top and middle cabinet baying connectors, you must first remove the slide rail on one side in the fitting area.

8



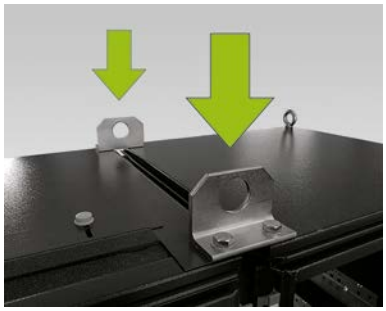
Then fasten the middle and the top cabinet baying connectors using the front holes and four screws (H.2). Then refit the relevant slide rail.

9



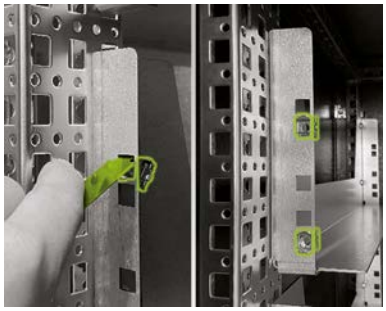
Optional: Installing the combined brackets: If you would like to transport the assembled cabinet (without the battery modules) by crane, two combined brackets (O) have to be fitted. To do this, remove the two fastening screws from the cabinet covers on each side of the two halves of the cabinet that are connected to one another (four screws in total).

10



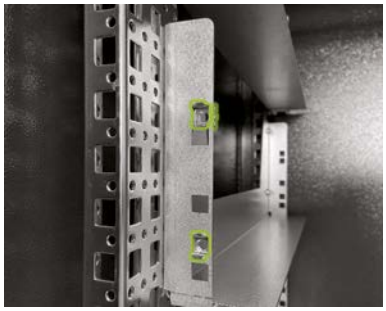
Optional: Installing the combined brackets: Install one combined bracket (O) each in place of the previously removed fastening screws in the cabinet covers. Fasten the combined brackets with two M12 x 40 screws (O.1) and washers (O.2) each.

11



Fit the cage nuts (J) for affixing the APU HV1000-S (1) in the slide rails using the auxiliary tool (J1). The APU HV1000-S uses the top slide rails in the left half of the cabinet. Distribute the cage nuts from bottom to top. Start at the bottom edge of the slide rails of the APU HV1000-S. Use the first opening and fit the first two cage nuts on both sides. Now, fit the remaining two cage nuts in the second opening in both slide rails from the top.

12

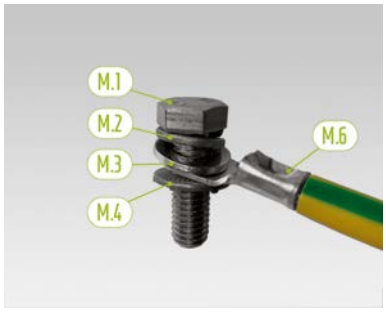


Now, fit the cage nuts (J) for fastening the battery modules (2) with the auxiliary tool (J1) (see "5.8 Wiring the battery modules" on page 24 for the positions of the battery modules). Distribute the cage nuts from bottom to top. Start at the bottom edge of the slide rail for the relevant battery module. Fit the first two cage nuts in the second opening on both sides from below, and fit the remaining two cage nuts in the top opening in the two slide rails.

13

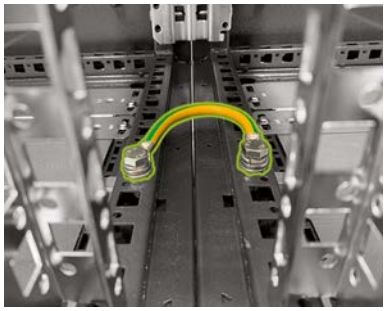
Fit the cabinet grounding connection set (M) to equalize the potential between the two halves of the cabinet. To do this, insert the speed nuts (M.5) from the side into the two middle cabinet profiles at the cabinet base. You are free to choose the position, but both speed nuts must be directly opposite each other.

14



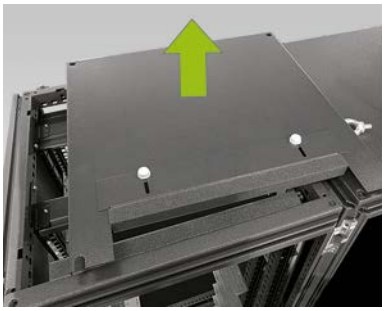
Now prepare the grounding cable (M.6) for installation. To do this, put an M8 spring washer (M.2), an M8 washer (M.3), the grounding cable's cable eyelet (M.6) and finally the M8 contact washer (M.4) onto the M8 screw (M.1). Ensure that the teeth of the M8 contact washer (M.4) are pointing downwards, towards the end of the screw.

15



Fit the prepared grounding cable (M.6) to the middle cabinet frame profiles using the pre-fitted speed nuts (M.5). Use a torque wrench with a tightening torque of 10 Nm.

16

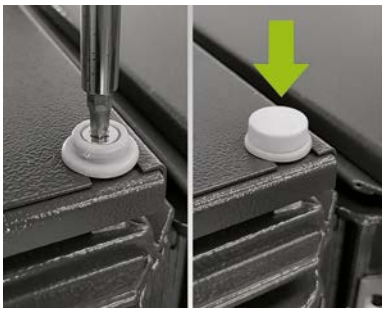


Optional: Lifting the cabinet covers for additional ventilation:
First of all, remove all the fastening screws, ring screws or combined brackets, then the two top cabinet covers.

17

Optional: Lifting the cabinet covers for additional ventilation:
Now screw four spacers (N) into the threaded holes of the ring screws on each half of the cabinet.

18



Optional: Lifting the cabinet covers for additional ventilation:
Then place the top cabinet cover on the spacers and fasten it with four M6 x 16 countersunk screws (N.1) (TX25) including plastic washers (N.3). Next fasten the cover caps (N.2) to the plastic washers.

19

Now attach the type plates (10) to the cabinet in the following positions: 1 x left-hand inside door and 1 x on the outside on a visible side panel.

8.2 INSTALLING THE COMPONENTS

DANGER! Life-threatening electric shock if grounding is insufficient or absent

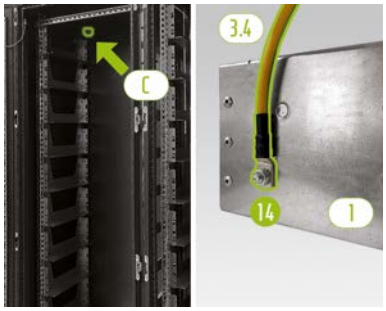
If a fault occurs on the unit, insufficient or absent grounding can cause damage to the unit, bringing with it the risk of a lethal electric shock.

1

First, ground the battery cabinet. To do this, connect the grounding cable (7.5) to the central grounding point (C) or the grounding point (C.1). First fasten the nut only loosely.

NOTE: Before installing the APU HV1000-S (1), note down its serial number in the "CS-S.FB.008.E.ENG_Commissioning_Protocol_TSiHV80" document, which can be found on the USB drive (12). The serial number can be found on a sticker on the underside of the APU HV1000-S. If the USB drive (12) is lost, contact the TESVOLT Service Line +49 (0) 3491 87 97 - 200 or write an email to service@tesvolt.com concerning the commissioning protocol.

2



The APU HV1000-S must be grounded. Using the grounding cable (3.4), connect the APU HV1000-S to the central grounding point (C). To do this, first place the grounding cable's M6 ring cable lug onto the grounding bolt 14 (on the back of the APU HV1000-S) with a tightening torque of 6 Nm.

3

Attach the end with the M8 ring cable lug to the central grounding point (C). Use a torque wrench with a tightening torque of 10 Nm.

For easier installation, temporarily place the APU HV1000-S on the slide rails of the first battery module during installation.

4

Insert the APU HV1000-S in the left half of the cabinet on the top slide rails. Use the enclosed M6 x 16 pan head screws (1) (cross-head) and plastic washers (1.1) to affix the APU HV1000-S to the pre-installed cage nuts.

5

The four-pin plug for the e-stop connection on the APU HV1000-S must be plugged in for operation. The APU HV1000-S will remain inactive without this plug. Further information about the e-stop can be found in the section "8.3 E-stop contact" on page 45.

6

All battery modules (2) of a TS HV 80 battery storage system must have exactly the same state of charge. So be sure to check the voltage of the battery modules before installation. The correct voltage for a battery module at installation is 50.0 +/– 0.1 V_{DC}. If you notice any deviation from this, please contact the TESVOLT Service Line +49 (0) 3491 8797-200.

7

Insert the first battery module into the slide rails below the APU HV1000-S. Affix it to the pre-fitted cage nuts using four M6 x 16 pan head screws (1) (cross-head) incl. plastic washers (1.1). Now fit the remaining modules in the left half of the cabinet.

8

As soon as the left half of the cabinet has been filled, install the battery modules in the right side. Start at the level of the top left module (the position at a level with the APU HV1000-S remains unoccupied). Affix the module to the pre-fitted cage nuts (J) with four M6 x 16 pan head screws (I) incl. washers (I.1). Then, place the next module below the one that has already been installed and fasten it as described. Continue until all the modules have been installed.

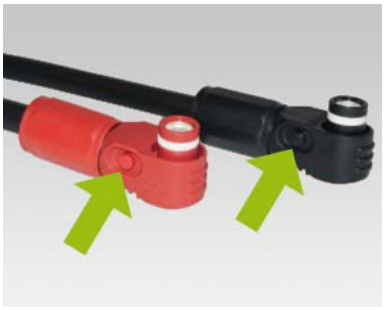
DANGER! Improper DC wiring can lead to life-threatening injuries
One or more of the battery modules will short circuit if the DC cables are connected incorrectly. This may cause components to become extremely hot and potentially ignite, which can lead to severe injuries.

- Ensure that wiring is carried out properly in accordance with section "5.8 Wiring the battery modules" on page 24.
- **Ensure that the plugs for the DC cables audibly snap into place when they are affixed.**

DANGER! Risk of death due to electric shock even before grid connection
The battery modules have a voltage of 50.0 +/– 0.1 V_{DC} when installed. When the DC connectors are installed, the voltage of the battery modules increases as they are connected in series. If all the modules are connected, parts of the unit carry an operating voltage of up to 930 V_{DC} before connection to the grid/commissioning. Touching the live components can lead to serious injury or even death. For this reason, ensure that you follow the relevant occupational safety regulations.

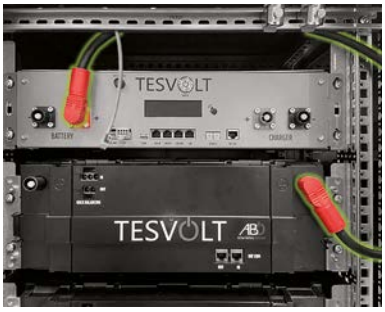
WARNING! Potential damage to the unit due to an incorrect DC connection
If the DC wiring is not carried out correctly, this may cause a short circuit and the battery modules will need to be replaced. In addition, damage to the APU HV1000-S can occur.

9



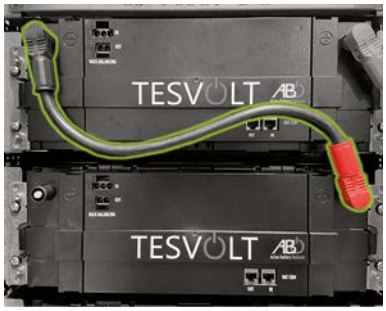
When installing the DC cabling, please note the following: **The plugs must audibly click into place.** The plugs can be unlocked by pressing the pushbutton on the side of the plug (see markings in the illustration).

10



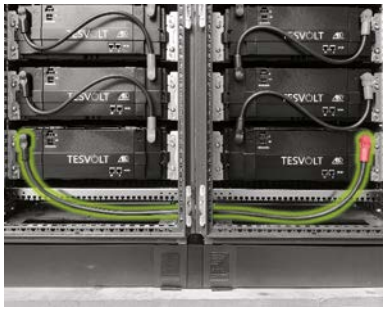
The battery modules on the TS HV80 are interconnected in series. The colours of the plugs must match the colours of the jacks on the battery module, i.e. red plug to red jack, for example. Start on the left side of the cabinet with the APU HV1000-S and the first battery module with the connecting cable (3.1).

11



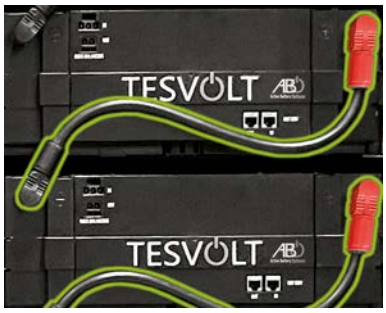
Then connect the remaining battery modules in this half of the cabinet with the DC connecting cables (4.1).

12



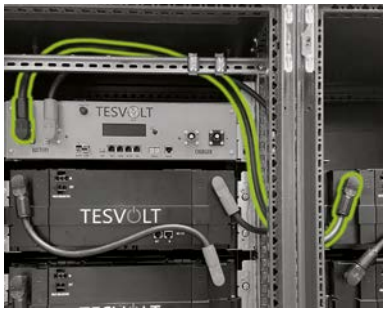
Connect the bottom two battery modules using the long DC connecting cable (5.1) from the cabinet connector set (5).

13



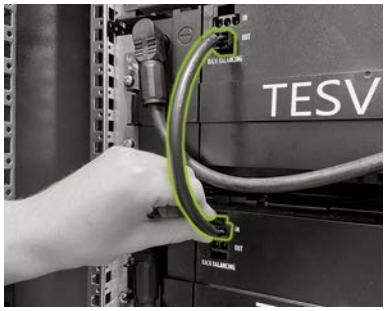
Install the remaining DC connecting cables (4.1) between the modules on the right side. Start with the bottom module.

14



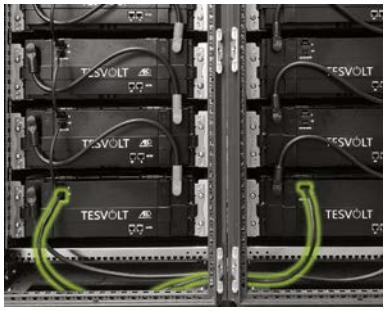
Connect the last module and the APU HV1000-S using the connecting cable (3.2). Make sure you follow the instructions in section “5.8 Wiring the battery modules” on page 24.

15



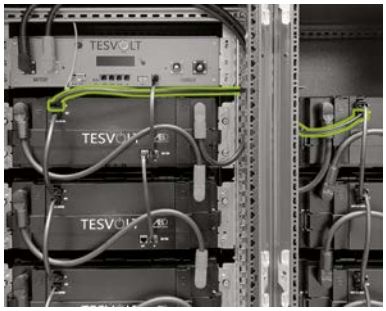
Connect the rack balancing “OUT” connection (22) of the first battery module below the APU HV1000-S to the rack balancing “IN” connection (21) of the next battery module down using a rack balancing module connector (4.3). Continue in this manner, connecting all the battery modules in the left half of the cabinet.

16



Use one of the 1.10 m long rack balancing connecting cables (5.3) to connect the bottom modules in the left and right halves of the cabinet.

17

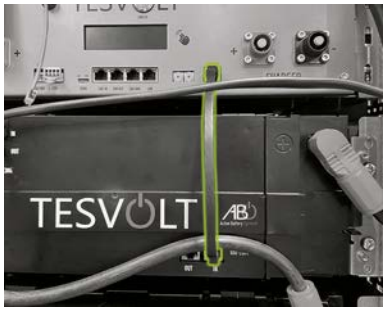


Now connect the remaining battery modules on the right side, starting from the bottom. Follow the instructions in section “5.8 Wiring the battery modules” on page 24.Finally, using the 0.75 m rack balancing cable (6), connect the rack balancing “OUT” connection of the top module on the right half of the cabinet to the rack balancing “IN” connection of the top module on the left side.

STOP

WARNING! Possible malfunction of the device due to faulty BAT-COM wiring
Incorrectly executed connection of the BAT-COM communication cable will lead to malfunctions in the operation of the battery. Ensure correct wiring in accordance with section “5.8 Wiring the battery modules” on page 24.

18

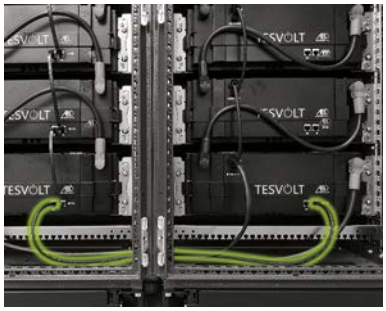


Connect the BAT-COM communication cable using the supplied patch cables (3.3) and (4.2). Connect the “BAT-COM” 11 connection of the APU HV1000-S and the BAT-COM “IN” connection of the battery module positioned below the APU HV1000-S using a patch cable (3.3). Then use a patch cable (4.2) to connect the same module’s BAT-COM “OUT” 23 connection to the next module’s BAT-COM “IN” 24 connection.

19

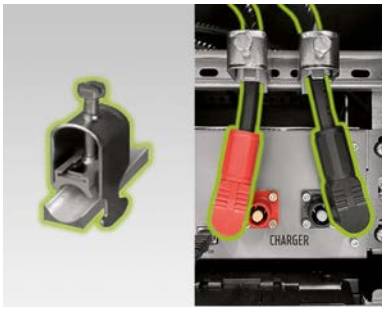
Connect the remaining battery modules in the left half of the cabinet in the same way using the patch cables (4.2).

20



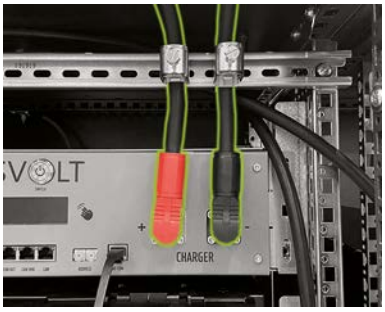
Establish the BAT-COM connection between the bottom battery modules using the longer patch cable (5.2). Next, connect the remaining modules in the right half of the cabinet, starting at the bottom and using the patch cables (4.2). The last battery module’s BAT-COM “OUT” connection remains open.

21



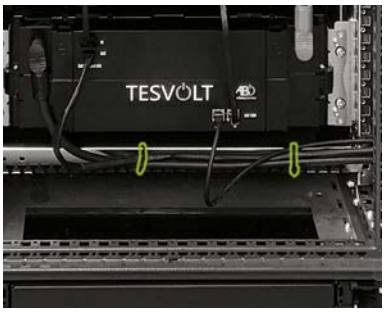
Now lay the DC cables (7.1)/(7.2) starting from the APU HV1000-S "CHARGER" 12/13 to the TESVOLT PCS. The red plug is intended for connection to the positive pole and the black plug for connection to the negative pole. Please note that the cable can only be shortened on the TESVOLT PCS side. To relieve the strain on the DC cables, install the two cable support clips (K) above the CHARGER connections of the APU HV1000-S (1) on the C-rail (D).

22



Only once connection of the TESVOLT PCS is complete, connect the DC cables (7.1) and (7.2) to the APU HV1000-S. **Please note that the plugs must audibly click into place.** Finally, fix the DC cables in the cable support clips (K).

23

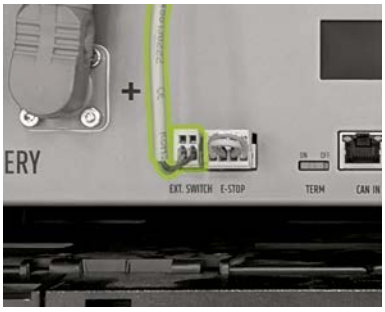


Fasten the cabinet connector cables in the bottom part of the cabinet to the cable retention rails (F) using cable ties. It is important to ensure while doing so that the cables are not crushed or damaged.

24

Only master/slave systems: Run the CAN bus wiring between the CAN OUT 7 and CAN IN connections 6 on the APUs of the storage systems in the master/slave configuration according to the specifications in section "16 Capacity expansion" on page 85 et seq. Use the patch cable(s) (7.4) from the delivery contents for the slave storage system.

25



Insert the plug of the connection cable (E) into the "EXT. SWITCH" connection 3 on the APU HV1000-S.

26

Finally, fill out the commissioning protocol. A blank copy of the form can be found on the USB drive (12). Also note down the serial numbers/factory number of the battery inverter and peripheral devices such as the TESVOLT Energy Manager. Send the completed commissioning protocol to service@tesvolt.com.

8.3 E-STOP CONTACT

The TS HV 80 has a quick shut-down (e-stop) function. The unit has a four-pin plug that is accessible from the outside for this purpose. This electrical connection can be connected to an external control system using the matching Wago 734-104 jack. If necessary, the external control system can switch off the unit as quickly as possible using a separate (i.e. completely independent) switching path. This shut-down is much faster than the normal shutdown process. The wiring connection may only be implemented using a dry contact.

STOP **WARNING! Possible damage to the device by using the e-stop**

The e-stop device is used to quickly shut down the system. As the battery storage system is not switched off properly when the e-stop is used, damage to the TS HV 80 can occur. For this reason, never use the e-stop to switch off the unit under normal circumstances.

STOP **WARNING! Possible damage to the APU HV1000-S or external components due to an unsuitable switching device**

The e-stop contact is at a voltage of 24 V_{DC} relative to the potential of the casing. This voltage is created from the battery voltage by the power supply unit in the APU HV1000-S. Connecting a non-floating switching device can result in damage to the APU HV1000-S and/or external components.

E-stop states

1. Contacts 1 and 4 as well as 2 and 3 of the Wago plug are connected, e.g. by an external relay; the e-stop is inactive and the APU HV1000-S is thus switched on.
2. Contacts 2 and 3 on the Wago plug are open, e.g. after activation of the external switch; the e-stop is active (this is shown on the APU HV1000-S display); the DC connection between the TESVOLT PCS and the TS HV 80 is interrupted.

Request to the external control system

Since the e-stop uses an internal voltage of 24 V_{DC} within the unit, external (relay) switching by means of a dry contact must be used for correct functioning. This switching can be adapted to match the requirements of the external control system. The possible wirings are shown in the figures below.

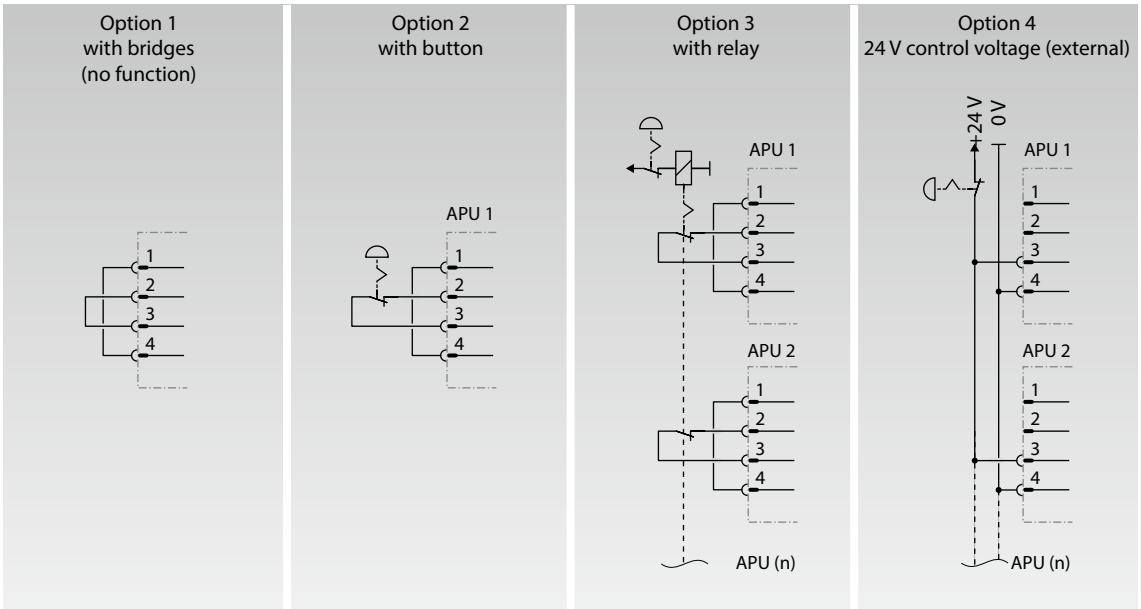


Figure 8.1 Different wiring options for the e-stop; options 3 and 4 are intended for use in systems with more than one APU HV1000-S.

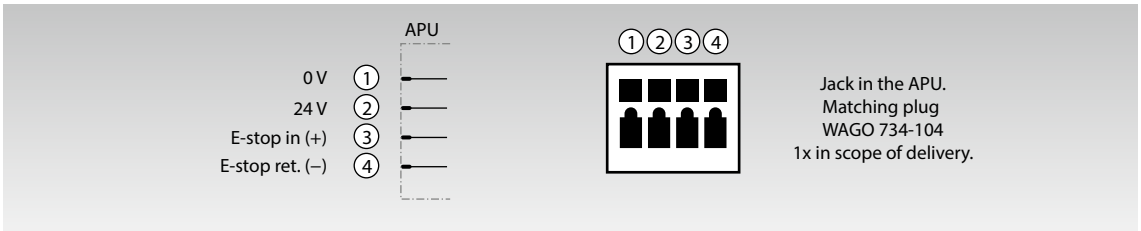


Figure 8.2 Assignment of the e-stop connection jack 4

NOTE: If you are not using the e-stop function, the bridged plug must be fitted to the e-stop connection 4 as the storage system will otherwise remain inactive!

E-stop connection 4 on the APU HV1000-S with Wago plug.

8.4 EXTERNAL 24 V POWER SUPPLY FOR THE APU HV1000-S

NOTE: If you want to operate the APU HV1000-S with an external 24 V power supply, please coordinate your intention beforehand with the TESVOLT Service Line +49 (0) 3491 87 97 - 200 or via service@tesvolt.com.

In the factory configuration, the APU HV1000-S is supplied with operating voltage by an internal power supply unit. If your planning requires an external 24 V supply, however, an adapted version of the APU HV1000-S can be supplied on request. Please coordinate your plans with TESVOLT Service in good time.

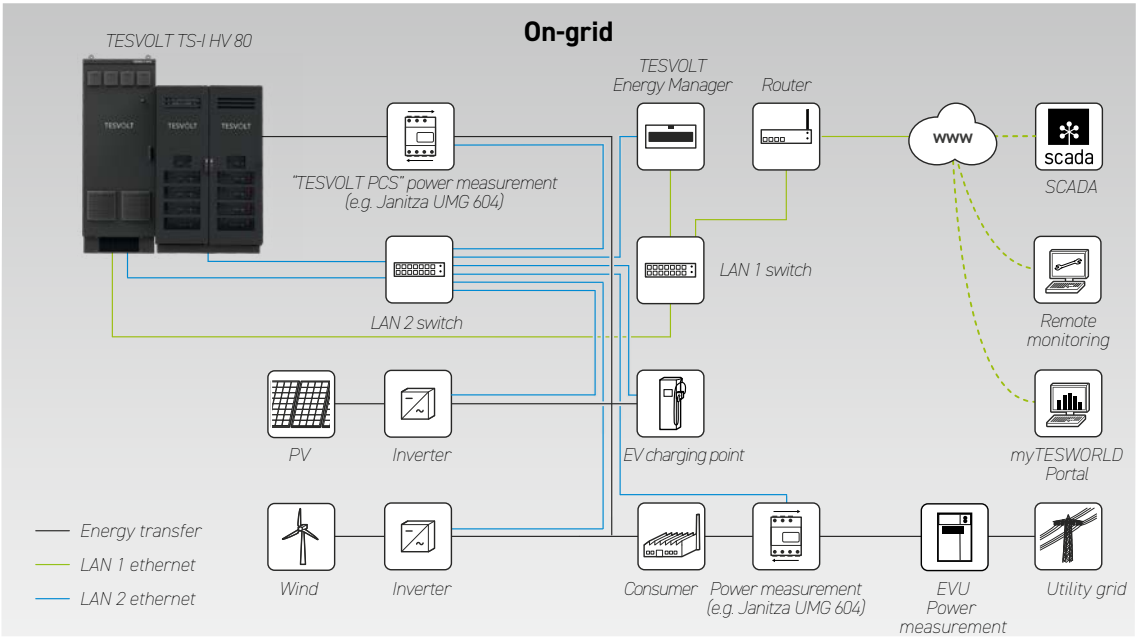
9 INSTALLATION AND CONNECTION OF TESVOLT PCS

WARNING! Possible damage to the TS HV 80 by additional consumers in the DC auxiliary circuit

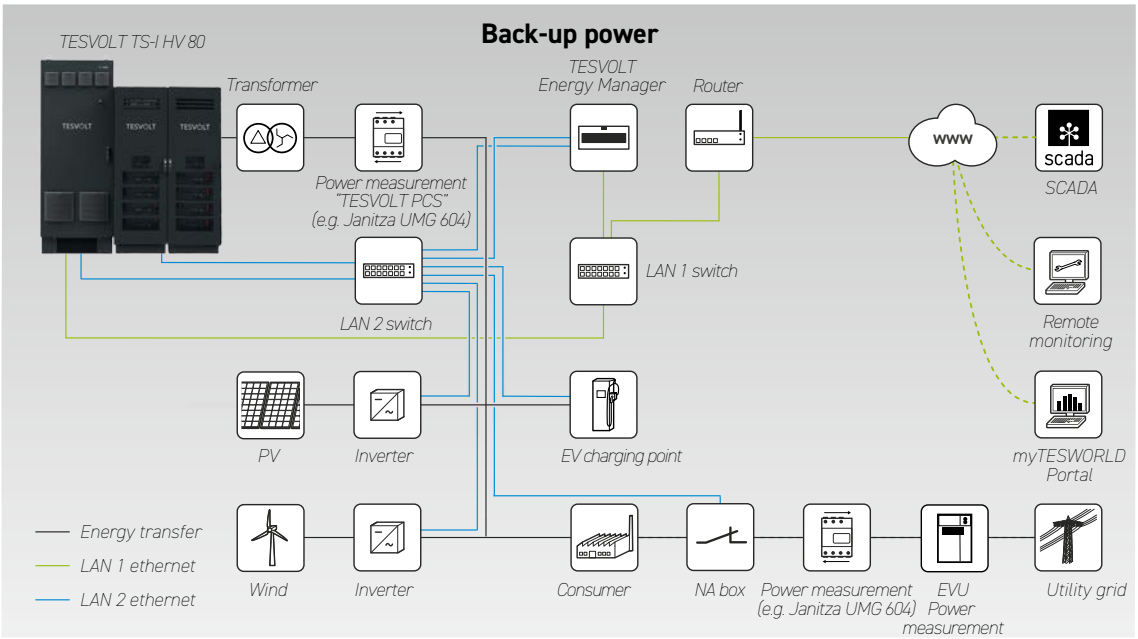
Always follow the instructions for connecting the TS HV 80 and TESVOLT PCS. For example, there must be no additional consumers or components planned for the DC auxiliary circuit between the battery and inverter. If you would like to make changes to the system setup, you must always consult with TESVOLT Service regarding your plans.

9.1 SYSTEM SETUP

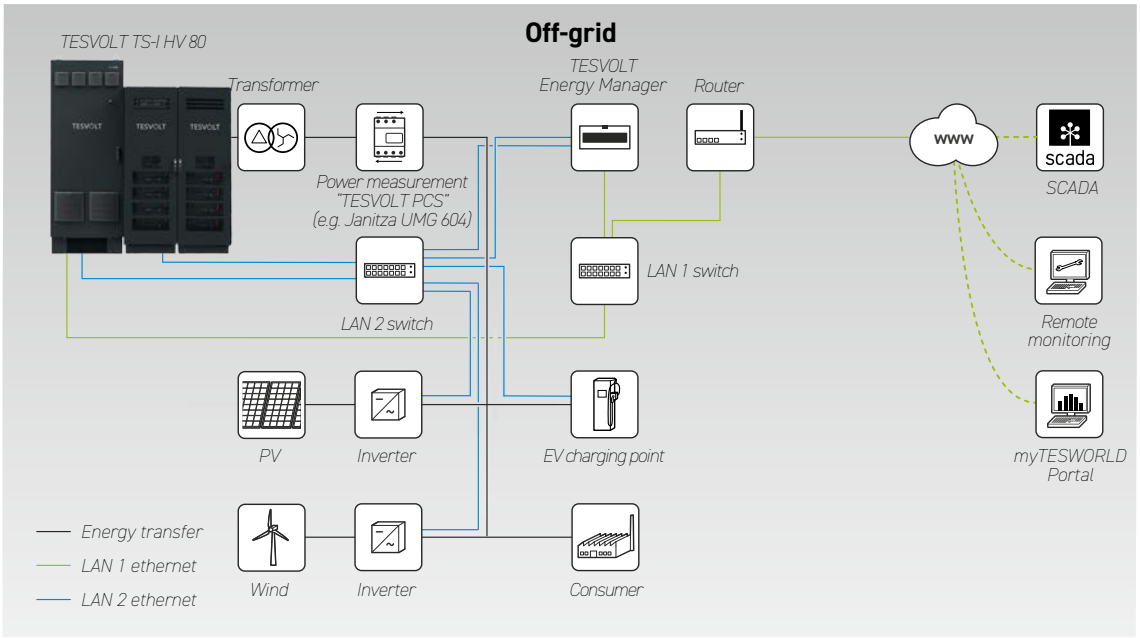
System setup for on-grid



System setup for back-up power



System setup for off-grid



9.2 TESVOLT PCS CONNECTION DIAGRAM

WARNING! Possible damage to the TS-I HV 80 if the installation requirements are not met

Before connecting the TESVOLT PCS, the installation of the battery storage system must be completely finished.

WARNING! Potential malfunctions due to improper laying of cables

Communication, measuring and control cables must always be kept separate from AC/DC cables, as otherwise electromagnetic interference can cause disturbances in data transmission and, as a result, malfunctions.

NOTE: The minimum cross section of the AC connection cables is determined by the respective VDE regulations.

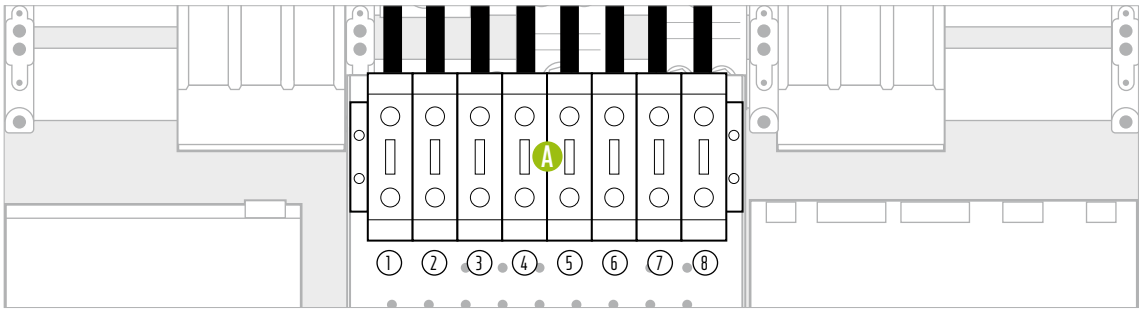


Figure 9.1 DC connector panel (covers the AC connection)

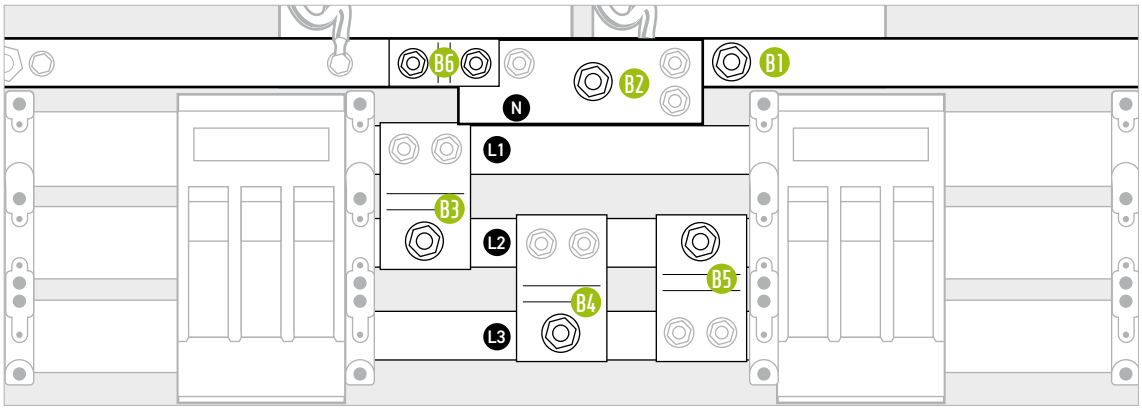


Figure 9.2 AC connector panel (behind the DC connections)

ITEM	DESIGNATION	TIGHTENING TORQUE	DESCRIPTION
A	DC connecting terminals	6–8 Nm	Battery connection: Conductor cross-section 35 to 50 mm² Note: If cables with fine or extra fine-wired conductors are used, wire-end ferrules should be used for the connection.
1	10+		
2	20+		
3	30+		
4	40+		
5	10–		
6	20–		
7	30–		
8	40–		
B1	AC connecting terminal PE	40 Nm	Connection to the in-house grid: Please refer to the following table for the conductor cross-section. Cable lugs must be used. **NOTE:** The AC terminals are covered by the DC connections and their bracket. Before the AC connection, they must be partially dismantled.
B2	AC connecting terminal N	70 Nm	
B3	AC connecting terminal L1		
B4	AC connecting terminal L2		
B5	AC connecting terminal L3		
B6	Bridge PE-N	40 Nm	**Only with TN-C-S grid grounding type:** The bridge B6 must be removed before installing the N conductor.

Assignment of the DC connecting terminals

NUMBER OF IPUS	IPU POSITION(S)	NUMBER TS HV 80	ASSIGNMENT OF DC CONNECTING TERMINALS (A)							
			10+	20+	30+	40+	10–	20–	30–	40–
1	2	1		1 x				1 x		
		2		1 x	1 x			1 x	1 x	
		3	1 x	1 x	1 x		1 x	1 x	1 x	
		4	1 x	1 x	1 x	1 x	1 x	1 x	1 x	1 x
		5	1 x	2 x	1 x	1 x	1 x	2 x	1 x	1 x
		6	1 x	2 x	2 x	1 x	1 x	2 x	2 x	1 x
		7	2 x	2 x	2 x	1 x	2 x	2 x	2 x	1 x
		8	2 x	2 x	2 x	2 x	2 x	2 x	2 x	2 x
2	2 | 3	2		1 x	1 x			1 x	1 x	
		3	1 x	1 x	1 x		1 x	1 x	1 x	
		4	1 x	1 x	1 x	1 x	1 x	1 x	1 x	1 x
		5	1 x	2 x	1 x	1 x	1 x	2 x	1 x	1 x
		6	1 x	2 x	2 x	1 x	1 x	2 x	2 x	1 x
		7	2 x	2 x	2 x	1 x	2 x	2 x	2 x	1 x
		8	2 x	2 x	2 x	2 x	2 x	2 x	2 x	2 x
3	1 | 2 | 3	3	1 x	1 x	1 x		1 x	1 x	1 x	
		4	1 x	1 x	1 x	1 x	1 x	1 x	1 x	1 x
		5	1 x	2 x	1 x	1 x	1 x	2 x	1 x	1 x
		6	1 x	2 x	2 x	1 x	1 x	2 x	2 x	1 x
		7	2 x	2 x	2 x	1 x	2 x	2 x	2 x	1 x
		8	2 x	2 x	2 x	2 x	2 x	2 x	2 x	2 x
4	1 | 2 | 3 | 4	4	1 x	1 x	1 x	1 x	1 x	1 x	1 x	1 x
		5	1 x	2 x	1 x	1 x	1 x	2 x	1 x	1 x
		6	1 x	2 x	2 x	1 x	1 x	2 x	2 x	1 x
		7	1 x	2 x	2 x	2 x	1 x	2 x	2 x	2 x
		8	2 x	2 x	2 x	2 x	2 x	2 x	2 x	2 x

AC connection – cable cross-section, back-up fuses and transformer types

NUMBER OF IPUS	OUTPUT [kW]	AC CURRENT [A]	RECOMMENDED BACK-UP FUSE [A]	RECOMMENDED CONDUCTOR CROSS-SECTION PER PHASE [mm²]	TRANSFORMER RATIO	ACCURACY CLASS
1	75	125	250	95	150/5 A	AC1
2	150	250	315	120	250/5 A	AC 1
3	225	375	450	2 x 120	400/5 A	AC 1
4	300	500	630	2 x 185	500/5 A	AC 1

9.3 INSTALLATION OF THE TESVOLT PCS

DANGER! Insufficient measures to establish and ensure the voltage-free state of the TESVOLT PCS can result in serious injuries or death

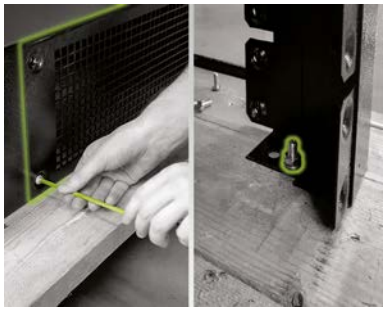
When fitting the AC grid connection to the TESVOLT PCS, the AC-side fuse switch disconnectors Q1 … Q4 (28) and the circuit breaker Q01 (47) must be open. If the TESVOLT PCS was previously in operation, a discharge time of 60 minutes must be observed to discharge the DC auxiliary circuit capacitor to harmless voltages (≤60 V_{DC}). External DC components must also be disconnected. The absence of voltage must be checked before work on the grid connection may be carried out.

STOP Please note that the base of the TESVOLT PCS must not be completely dismantled.

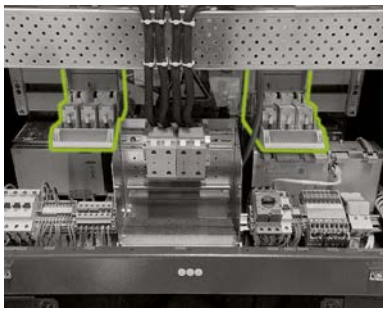
1 

Do not remove packaging before reaching the installation site. First check the shock sensor. If the sensor has triggered (red colouration in image, right), document the condition. Even without visible damage to the device, the delivery driver should confirm the triggered sensor in writing. Report the incident to TESVOLT Service. Transport the TESVOLT PCS to the final installation location. It is essential that you observe the notes and specifications in section "3.3 Preparation for installation" on page 9 as well as the "GRIDCON® PCS Hardware Operating Manual" from MR GmbH.

2 In case of transport by crane, you must first attach the ring screws provided. The bag with the ring screws is located (clearly visible) in the TESVOLT PCS. It is essential that you observe the notes and specifications in section "3.3 Transport to the end customer" on page 12 as well as the "GRIDCON® PCS Hardware Operating Manual" from MR GmbH.

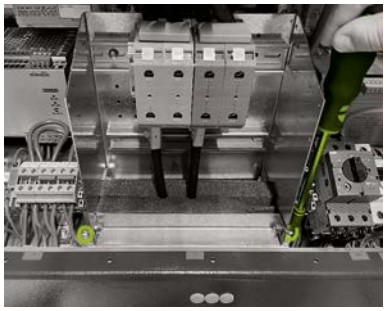
3 

To lift the TESVOLT PCS off the transport pallet, the screw connections on the four feet of the control cabinet must first be removed. To do this, remove the base cover plates on at least two opposite sides of the base (front/rear or right/left). This is done by removing the screws at the corners of the plates. Now loosen and remove the screws at the feet of the cabinet.

4 

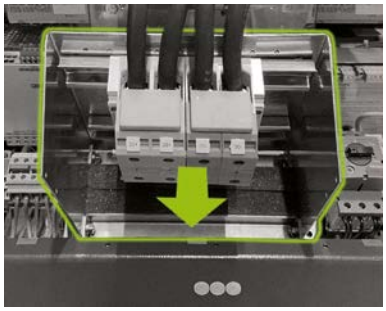
Before connecting, make sure that all fuse switch disconnectors Q1 … Q4 (28) are open (according to the number and positioning of the IPU) and switch S1 (23) is set to the "OFF" position.

5



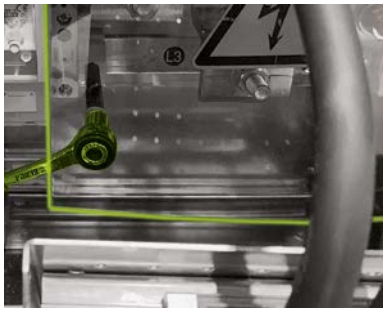
Loosen and remove the four screws that secure the DC connection bracket to the cabinet base.

6



When all fastening screws have been removed, move the DC connector bracket toward the front of the cabinet so that you have adequate clearance in front of the AC connections.

7

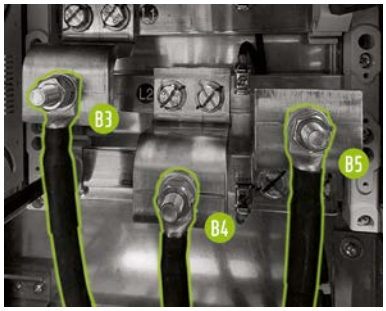


Now remove the touch guard above the AC connections (26). To do this, loosen the two M6 screws and remove the touch guard.

8

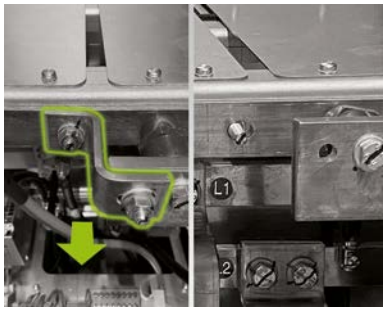
Open the cable inlet on the cabinet floor and insert all connecting cables into the cabinet.

9



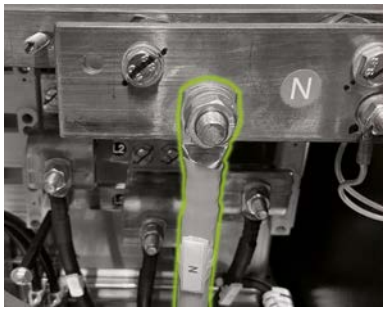
Now attach the AC connecting cables to the contact bolts B3 ... B5 of the busbars. Ensure that the phase conductors (L1 ... L3) are correctly assigned according to the markings on the busbars or section "9.2 TESVOLT PCS connection diagram" on page 49. The tightening torque is 70 Nm (secure the bolts against rotation using a spanner). Then reattach the touch guard. **Only with TN-C-S grid grounding type:** Please observe the following two installation steps before installing the touch guard.

10



Only with TN-C-S grid grounding type: Before installing the N conductor connection, remove the bridge B6 between the PE rail and N rail.

11



Only with TN-C-S grid grounding type: Now attach the N conductor to the N terminal B2. Use a torque wrench with a tightening torque of 70 Nm (secure the bolts against rotation using a spanner). To simplify installation, remove the cable retention rail (perforated plate). Finally, reinstall the touch guard over the AC connections and lastly the cable retention rail.

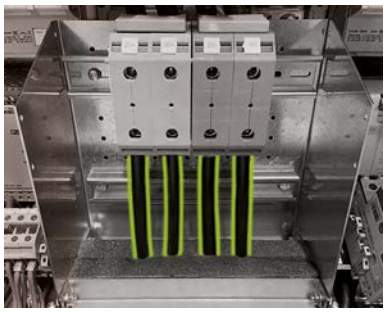
12

Now connect the grounding cable to the potential equalisation rail via the pre-assembled M10 or M12 contact bolts B1. This is located immediately to the right of the N rail. The tightening torque is 40 Nm for M10 connections and 70 Nm for M12 connections (use a spanner to prevent the bolts from turning when tightening).

13

Close the cable outlet again.

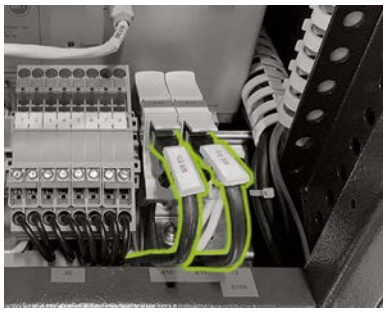
14



When installing the DC connection of the battery, make sure that the polarity is correct. The tightening torque is 6–8 Nm.

DANGER! The correct polarity of DC+ and DC– must be checked before switching on.

15



Connect the ethernet port 54 ① of the TESVOLT PCS with a network cable to connect the LAN 1 switch. Then connect a network cable to the Anybus port 54 ② of the TESVOLT PCS for the connection to the LAN 2 switch.

10 INSTALLATION AND CONNECTION OF THE PERIPHERALS OPERATED IN PARALLEL WITH THE GRID

DANGER! Risk of serious or fatal injury if safety instructions are disregarded

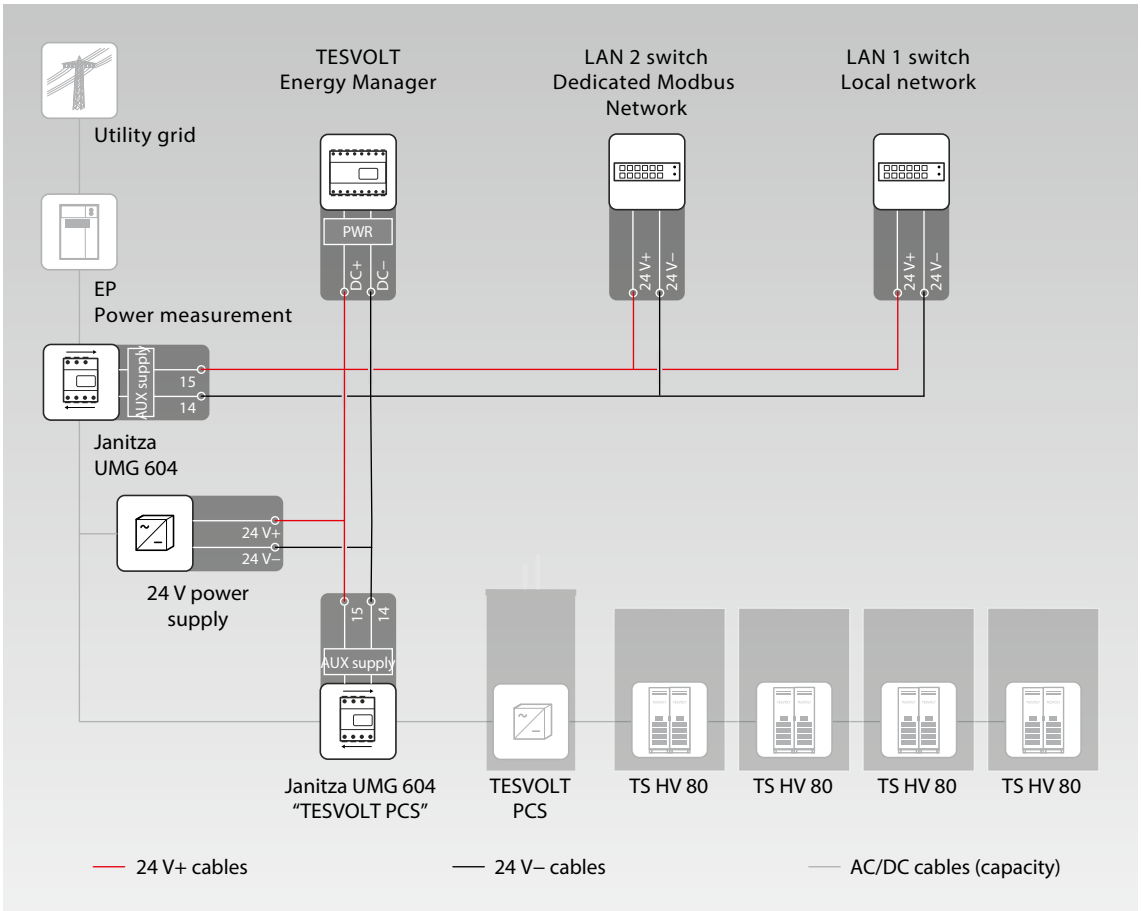
It is imperative that you observe the safety instructions in the original product documentation provided by the manufacturer of each respective component. Non-observance of these instructions can lead to serious injury or death.

NOTE: Please note that for all listed products whose manufacturer is not TESVOLT, only the product documentation of the respective manufacturer is binding. TESVOLT therefore does not guarantee the accuracy of the information on these products. Binding information can only be found in the valid product documentation for the respective product.

24 V power supply

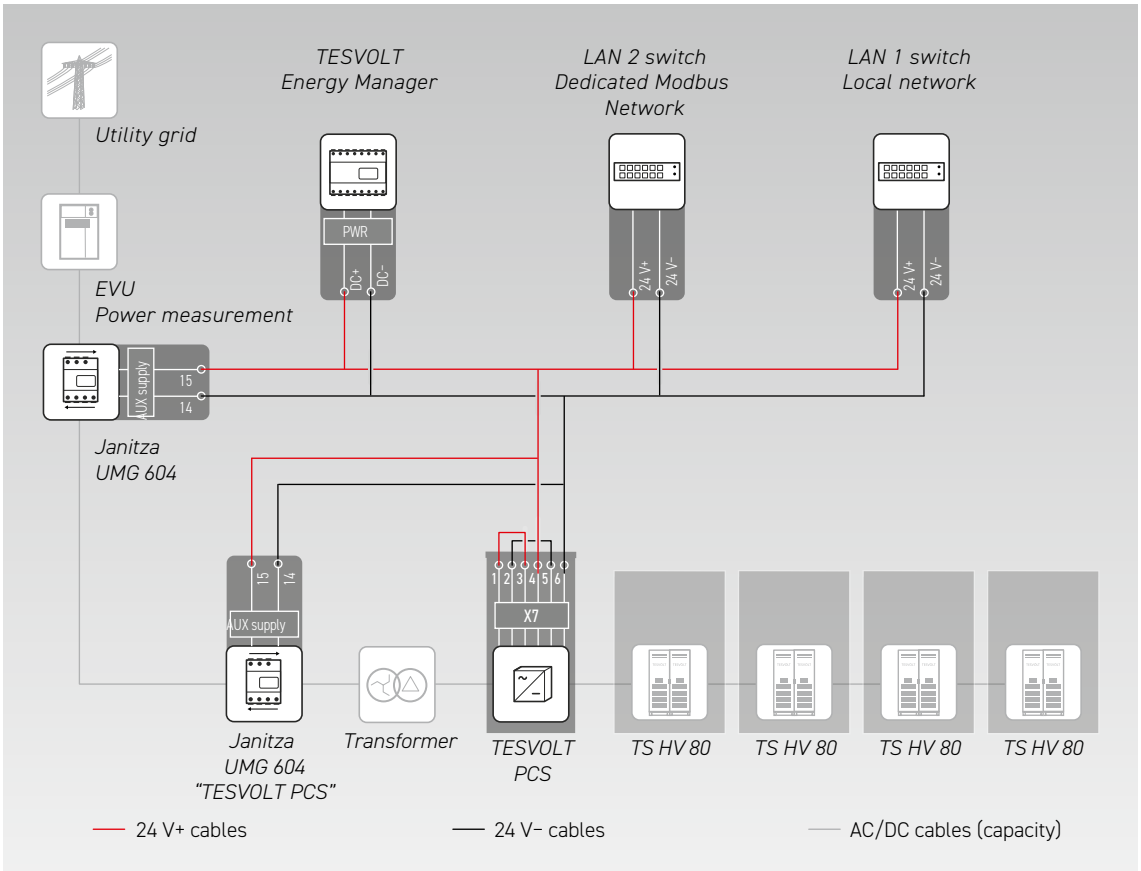
Variant 1 – on-grid: 24 V power supply via external power supply unit

If no back-up power functionality or off-grid use is required, the external 24 V power supply (8) included can be used to operate the peripheral devices. The device is installed in control cabinets or in small installation distributors on a 35 mm mounting rail according to DIN 43880.



Variant 2 – on-grid: 24 V power supply via TESVOLT PCS

The battery inverter TESVOLT PCS has an integrated 24 V power supply, which can be used to operate external devices. If the system is to be capable of providing back-up power at a later time, it is recommended that the external components be connected to the internal 24 V power supply in preparation. The 24 V supply voltage can be tapped on the TESVOLT PCS via the X7 terminals 49 ④/⑥.



Janitza power measurement

In a TS-I HV 80 system, at least two Janitza power measurement meters are used (see section "9.1 System setup" on page 47). One power measurement meter is placed at the grid connection point, the second one as close as possible to the TESVOLT PCS. Note that there must be no consumers between this power measurement meter and the TESVOLT PCS (except for the additional transformer in off-grid and back-up power systems). Note: only the transformers for the power measurement "TESVOLT PCS" are included in the scope of delivery. The transformers for the second power measurement meter must be provided by the customer.

1. Install the Janitza power measurement meters in a control cabinet or in small installation distributors on a 35 mm mounting rail. They can be installed in any position.
2. Connect the Janitza power measurement meters to the 24 V power supply via the terminal 64.
3. Equip the measuring inputs for voltage measurement with fuses and an isolator. Connect the measuring points for the voltage tap at the grid connection point and on the TESVOLT PCS via the terminal 68 of the Janitza power measurement meters.
4. Now connect the current transformers for current measurement to the Janitza power measurement meters via terminal 67 by way of a short-circuit device (short-circuit terminals). Also observe the information on terminal assignments in section "7.1 Janitza power measurement UMG 604" on page 29 as well as the specifications in the installation manual and the other product documentation for the Janitza UMG 604.

Current transformer connection to MIO (TESVOLT PCS)

Depending on the application (e.g. physical peak shaving), it may be necessary to minimise the response time of the inverter as much as possible. In these cases, the internal measuring and input/output device MIO (30) is used in the TESVOLT PCS.

The transformers required for current measurement (to be provided by the customer) are connected to terminal X6 (53) on the terminal strip (33) in the TESVOLT PCS (for assignments see "6.5 Terminal strip for battery inverter TESVOLT PCS" on page 27).

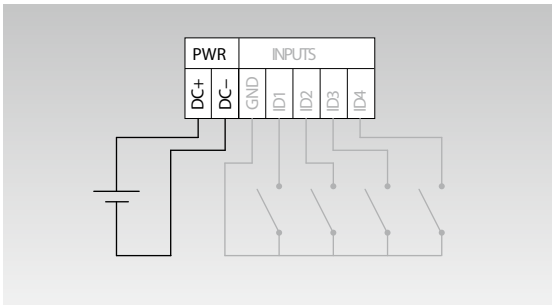
Ethernet switches (LAN 1 and LAN 2)

The devices are installed in control cabinets or in small installation distributors on a 35 mm mounting rail as per DIN 43880. They can be installed in any position. Connect the device to the 24 V power supply.

TESVOLT Energy Manager with USB ethernet adapter

1 Install the TESVOLT Energy Manager in a control cabinet or small installation distributor on a 35 mm mounting rail as per DIN 43880. They can be installed in any position. Note the installation dimensions shown in the illustration in section "3.3 Preparation for installation" on page 9 of the Installation and Operating Manual for the TESVOLT Energy Manager as well as the maximum cable lengths in the previous section.

2 Connect the TESVOLT Energy Manager to the 24 V power supply via its "PWR" connection (78). Ensure the supply line has a maximum 3 A fuse.

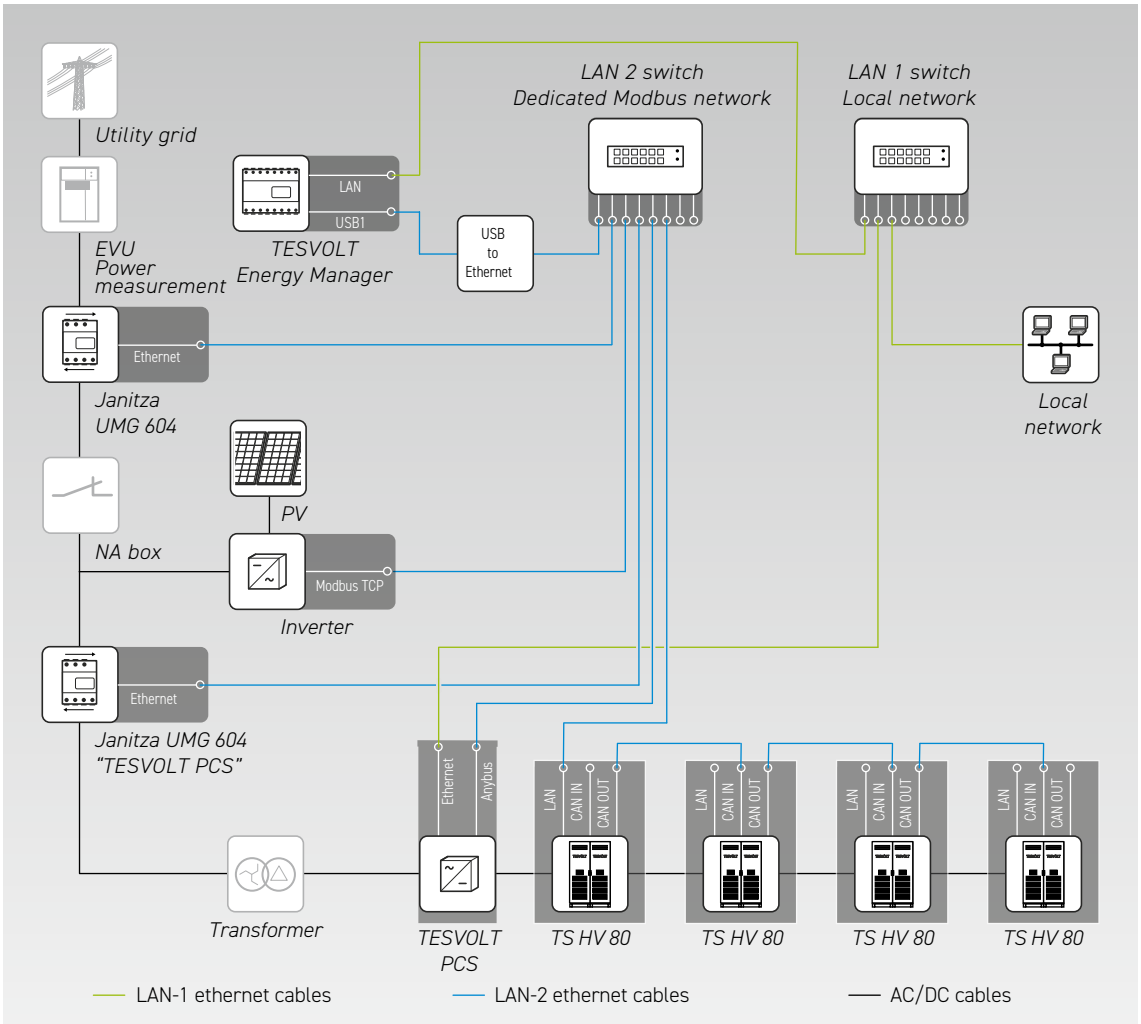


Current (at U = 24 V_{DC})	max. 210 mA
Operating voltage	24 V
Power	max. 5 W
Wire cross-section	0.5–1.5 mm², 28–16 AWG
Cable length	max. 3 m
Insulation stripping length	7 mm
Terminal tightening torque	0.2 Nm

3 Connect the LAN connection of the TESVOLT Energy Manager (72) to the internet connection using the LAN-1 switch. Connect the USB network adapter provided (14.1) to the USB-1 connection (71) and connect it to the LAN-2 switch (dedicated Modbus network). Please note the maximum cable length of 30 m. If units cannot be connected to the dedicated network (LAN 2), they can also be connected to the LAN 1 network. If you do not use a DHCP server as recommended, a fixed IP address must also be assigned to these units.

Establishing communication links

Connect the Modbus and network connections of all system components according to the following illustration.

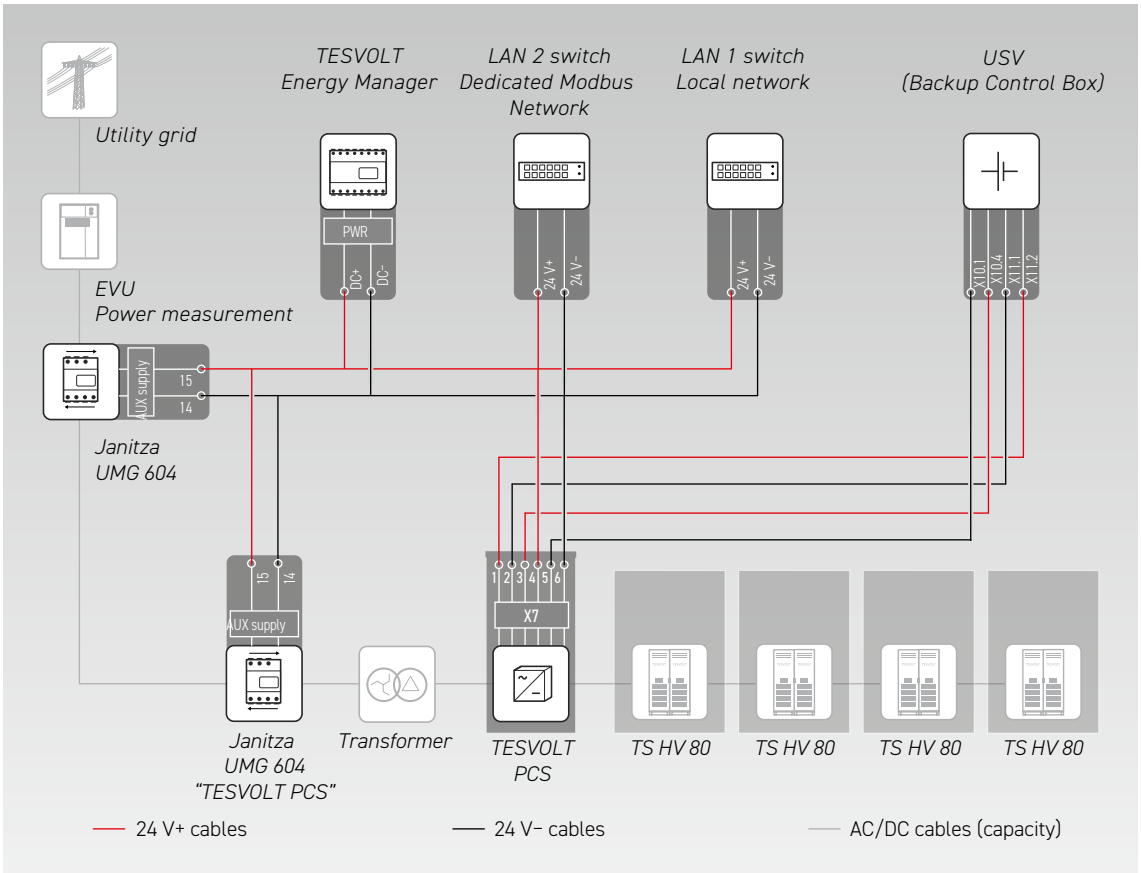


PORT NO.	LAN 1	LAN 2
1	Energy Manager [LAN]	Energy Manager [USB to ethernet/USB 1]
2	TESVOLT PCS [ethernet]	Janitza network connection [ethernet]
3	Local network [internet router]	PV inverter [Modbus TCP]
4	–	Janitza inverter [ethernet]
5	–	TESVOLT PCS [Anybus]
6	–	TS HV 80 Master [LAN]

11 INSTALLATION AND CONNECTION OF THE PERIPHERALS IN OFF-GRID OPERATION

For off-grid systems we recommend the use of a TESVOLT Backup Control Box. All communication, measuring and control components are already housed and pre-wired in it.

NOTE: When planning and installing off-grid systems, be sure to consult the TESVOLT Application Note "Application note for lithium storage system TS-I HV 80 – Are we ready to go off-grid?"



1 Install the TESVOLT Backup Control Box. Please also refer to section "Dimensions TESVOLT Backup Control Box" on page 15.

2 Now establish the network connections. To do this, connect the "ethernet" port X10 54 ① of the TESVOLT PCS with the LAN 1 switch (K5) 100 and the "Anybus" connection X11 54 ② with the LAN 2 switch (K4) 99. For systems with more than one storage system, establish the Modbus connections between the storage systems of the TS HV 80. Connect the storage system(s) to the LAN 2 switch (K4) 79. (See figure in section "Establishing communication links" on page 57). Finally, establish a connection between the LAN 1 switch (K5) 100 and the internet/local network.

3 Next, connect the supply voltage inputs and outputs of the TESVOLT PCS with the corresponding connections of the TESVOLT Backup Control Box (refer to the wiring diagram in this section and the terminal assignments according to sections "6.5 Terminal strip for battery inverter TESVOLT PCS" on page 27 and "7.3 TESVOLT Backup Control Box" on page 32).

4 Connect the measuring points for voltage tapping at the grid connection point to X2 103 and for the voltage tap on the TESVOLT PCS with X4 105 of the TESVOLT Backup Control Box. Then also connect the voltage taps on both sides of the grid disconnection switch with X5 106 .

5 Now connect the current transformers for current measurement to terminal X1 102 (P1, grid connection point) and terminal X3 104 (P2, TESVOLT PCS) of the TESVOLT Backup Control Box. Please also observe the information on terminal assignments in section "7.1 Janitza power measurement UMG 604" on page 29 as well as the specifications of the currently valid product documentation for the Janitza UMG 604.

6 Now connect the other components to the connections X6, X7 and X8 of the TESVOLT Backup Control Box. Observe the Application Note "Application note for lithium storage system TS-I HV 80 – Are we ready to go off-grid?" as well as the information on terminal assignments in section "7.3 TESVOLT Backup Control Box" on page 32.

12 COMMISSIONING

12.1 SEQUENCE OF SYSTEM COMMISSIONING

In order to avoid malfunctions, the individual system components must be put into operation in a certain order.

STEP	PROCEDURE	FURTHER INFORMATION
1	Commission TS HV 80	"12.2 Commissioning a single TS HV 80" on page 59 "12.3 Commissioning TS-HV-80 systems using the master/slave principle" on page 61
2	Commission TESVOLT PCS	"12.5 Commissioning the TESVOLT PCS" on page 64
3	Configure Janitza power measurement meters	Product documentation of the manufacturer
4	Commission consumers and producers such as PV inverters or electric charging stations	Product documentation of the manufacturers
5	Commission TESVOLT Energy Manager	"12.7 Commissioning the TESVOLT Energy Manager" on page 66
6	Configure the overall system with the TESVOLT Energy Manager	TESVOLT Energy Manager Operating and Installation Manual
7	Register your system in the myTESWORLD portal	TESVOLT Energy Manager Operating and Installation Manual
8	Fill out commissioning protocol	The template "CS-S.FB.008.E.ENG_Commissioning_Protocol_TSi-HV80" is located on the USB drive 12.

12.2 COMMISSIONING A SINGLE TS HV 80

STOP **WARNING! Possible damage to the battery due to incorrect configuration**

Incorrect configuration may damage the battery. The parameter settings influence the TESVOLT PCS's charging behaviour. For this reason, it is important to make the correct settings during commissioning.

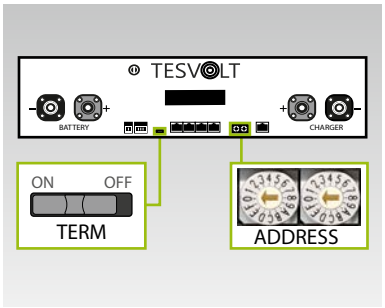
Prerequisites

The TESVOLT PCS and peripheral components were installed according to the specifications (installation/connection) of the respective manufacturers.

Procedure

1 Check the wiring between the TESVOLT PCS and TS HV 80.

2 Inspect the wiring of the components of the TS HV 80 in accordance with section “5.8 Wiring the battery modules” on page 24. If the wiring is correct, all live components will be protected against physical contact.

3 

Check and, if necessary, correct the settings for terminating and addressing the TS HV 80 “TERM” 5 and “ADDRESS” 10 on the APU HV1000-S.

TERM is to be set to “ON” when operating a single TS HV 80, and ADDRESS is to be set to “0” and “0”.

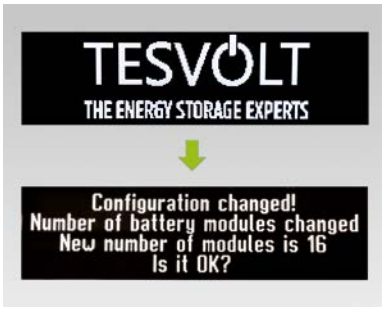
4 Switch on the external switch B on the outside of the cabinet door of the TS HV 80.

5 Press the On/off switch (“SWITCH”) 17 on the APU HV1000-S.

STOP **WARNING! Possible damage to the APU HV1000-S due to improper operation**

If you tap on the APU HV1000-S to activate it or confirm an action, you must note the following instructions to avoid damaging the APU HV1000-S:

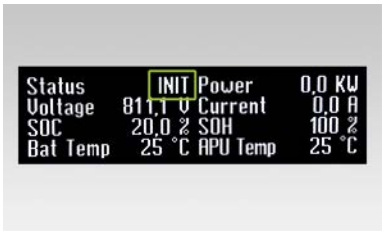
1. Do not use objects to tap the unit under any circumstances.
2. Tap gently with your fingers on the marking 16 to the right of the display on the casing. **Never tap on the display**.

6 

The number of detected battery modules (16) is shown on the display. Confirm the correct number by tapping twice on the marking 16 next to the display. If the displayed number of modules differs from the number actually present, shut down the device and check the BAT-COM wiring. If the fault continues to occur regardless, please contact the
TESVOLT Service Line +49 (0) 3491 87 97 - 200 or via email to service@tesvolt.com.

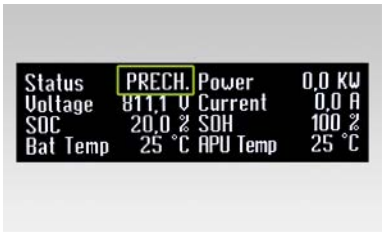
7 

Tap beside the display again to access the next menu item. You will now be shown the assigned IP address. It must begin with 192.168.29. ....

8 

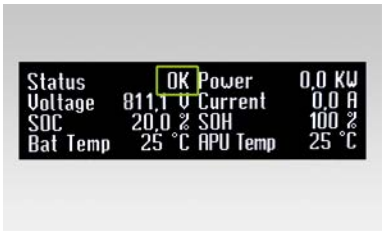
TS HV 80 switches to “INIT” mode and the on/off “SWITCH” 17 starts to flash.

9



Now start up the TESVOLT PCS and the TESVOLT Energy Manager (please refer to sections:"12.5 Commissioning the TESVOLT PCS" on page 64 et seq. and "12.7 Commissioning the TESVOLT Energy Manager" on page 66 et seq.). Once the commissioning process has been successfully completed, the TS HV 80 switches to precharge mode "PRECH".

10



After precharge mode, the on/off "SWITCH" 17 stays lit. "OK" appears as the status on the display of the APU HV1000-S. The TS HV 80 is now ready for operation.

NOTE: The display remains active for approximately two minutes and is then deactivated. It can be reactivated by tapping twice.

12.3 COMMISSIONING TS-HV-80 SYSTEMS USING THE MASTER/SLAVE PRINCIPLE

WARNING! Possible damage to the battery due to incorrect configuration

Incorrect configuration may damage the battery. The parameter settings influence the TESVOLT PCS's charging behaviour. For this reason, it is important to make the correct settings during commissioning.

Prerequisites

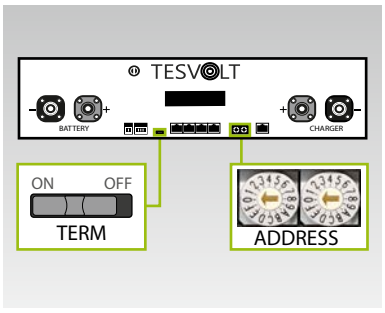
The TESVOLT PCS has been completely installed.

Procedure

1 Check the wiring of the TESVOLT PCS and TS HV 80.

2 Inspect the wiring of the components of the TS HV 80 in accordance with section "5.8 Wiring the battery modules" on page 24. If the wiring is correct, all live components will be protected against physical contact.

3



Now you can make the settings for terminating and addressing the TS HV 80 "TERM" 5 and "ADDRESS" 10 in accordance with section "Overview of all addressing options" on page 87 et. seq. In the case of master/slave systems, TERM 5 is to be set to "ON" for the APU HV1000-S of the master and the last storage system in the master/slave configuration. TERM 5 is to be set to "OFF" for all other slave APUs in the configuration.

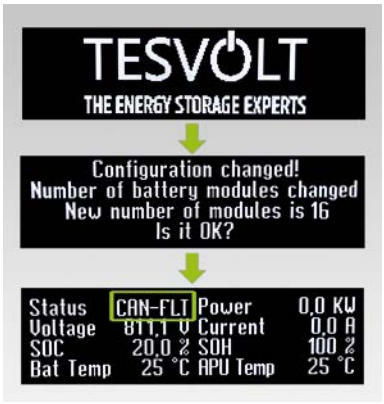
WARNING! Possible damage to the APU HV1000-S due to improper operation

If you tap on the APU HV1000-S to activate it or confirm an action, you must note the following instructions to avoid damaging the APU HV1000-S:

1. Do not use objects to tap the unit under any circumstances.
2. Tap gently with your fingers on the marking to the right of the display on the casing. **Never tap on the display**.

NOTE: The display remains active for approximately two minutes and is then deactivated. It can be reactivated by tapping twice.

4 You can now commission all the slave storage systems. Proceed in reverse order according to their position in the master/slave configuration. Start with the last slave of the master/slave configuration and first switch on the external switch B on the outside of the cabinet door and then the on/off "SWITCH" 17 on the APU HV1000-S.

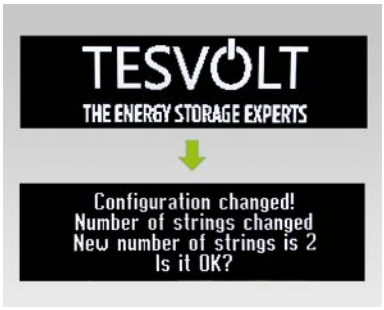
5 

The number of battery modules detected (16) is shown on the slave storage system's display. Confirm the number is correct by tapping twice on the marking 16 next to the display. If the displayed number of modules differs from the number actually present, shut down the TS HV 80 and check the BAT-COM wiring. If the fault continues to occur regardless, please contact service@tesvolt.com or the TESVOLT Service Line +49 (0) 3491 87 97 - 200. Once commissioning has been completed successfully, the status changes to "CAN-FLT".

6 Switch on the next slave storage system and proceed as described in steps 4 and 5, i.e. as for commissioning the first slave.

7 Once all of the slave storage systems have been commissioned, the master cabinet can be started. To do this, switch on the external switch B on the outside of the cabinet door.

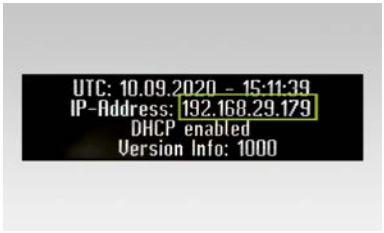
8 Now press the on/off "SWITCH" 17 on the corresponding APU HV1000-S.

9 

Unlike the slave APUs, the master initially requests the number of "strings". The number of strings corresponds to the number of storage systems in the master/slave configuration (e.g. master + slave 1 = 2 strings). Confirm the correct number by tapping twice next to the display. If there are deviations, check the CAN OUT → CAN IN cabling, the termination and the addressing. If the fault continues to occur regardless, please contact service@tesvolt.com or the TESVOLT Service Line +49 (0) 3491 87 97 - 200.

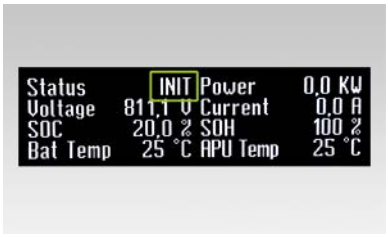
10 

The display of the master APU HV1000-S now shows the number of detected battery modules (16). Confirm the correct number by tapping twice. In case of deviations, shut down the TS HV 80 and check the BAT-COM cabling. If the fault continues to occur regardless, please contact service@tesvolt.com or the TESVOLT Service Line +49 (0) 3491 87 97 - 200.

11 

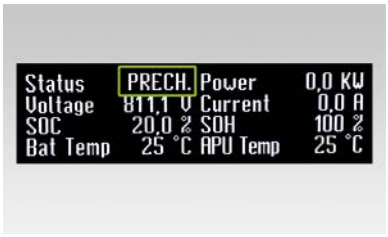
Tap beside the display again to access the next menu item. You will now be shown the assigned IP address. It must begin with 192.168.29. ....

12



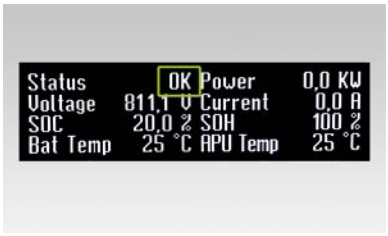
The TS HV 80 switches to "INIT" mode and the on/off "SWITCH" 17 starts to flash.

13



Now commission the TESVOLT PCS and the TESVOLT Energy Manager (please refer to sections:"12.5 Commissioning the TESVOLT PCS" on page 64 et seq. and "12.7 Commissioning the TESVOLT Energy Manager" on page 66 et seq.). Once the commissioning process has been successfully completed, all the TS HV 80 units switch to precharge mode "PRECH".

14



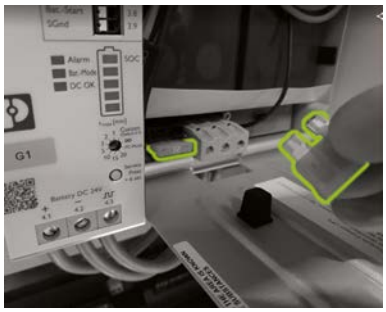
Once the precharging has completed successfully, the on/off switches "SWITCH" 17 on all APU HV1000-Ss in the master/slave configuration are permanently illuminated. "OK" appears as the status on the display of the APU HV1000-S. All the TS HV 80 units are now ready for operation.

12.4 COMMISSIONING OF THE TESVOLT BACKUP CONTROL BOX

Use of the TESVOLT Backup Control Box is optional for back-up power and off-grid systems.

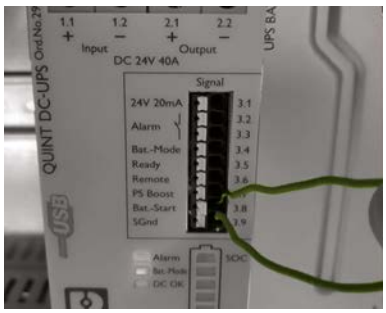
1 Insert 2 A screw fuses (D01) 94 in F2, F3 and F4.

2



First activate the UPS 93. First open the battery housing and insert two 25 A blade fuses into the slots provided.

3



Perform a cold start of the UPS 93. With the cold start function, the UPS can be started without an input supply voltage. The UPS is powered by energy from the connected battery, which also supplies the loads. The two signal terminals Bat.-Start (3.8) and SGnd (3.9) must be connected briefly. After initialisation, the UPS switches to battery mode.

4

Now switch on fuses F1.1 to F1.9 (90) of the TESVOLT Backup Control Box.

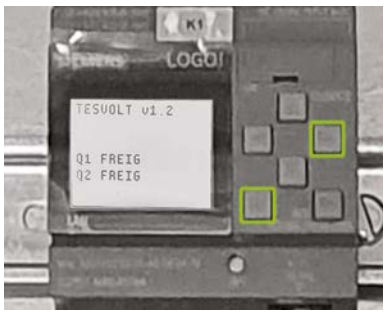
5

All 24 V components should now be supplied. Start up the components in the following order and according to the sections listed:
1. Janitza power measurements: "12.6 Commissioning the two Janitza power measurement meters" on page 65
2. TESVOLT Energy Manager: "12.7 Commissioning the TESVOLT Energy Manager" on page 66
3. Registration at myTESWORLD: "12.8 Registration in the myTESWORLD portal" on page 69.

6

The control program for the Siemens Logo (K1) (92) is already implemented in the factory configuration (recognisable by the display of "TESVOLT v1.2"). The display also indicates that both grid isolators are open ("Q1 OPEN"; "Q2 OPEN").

7



Now close the grid disconnection switches. This will apply voltage to the system. The basic prerequisite for this is that the TESVOLT PCS is inactive/idle and that no other off-grid system is formed (e.g. by way of a diesel generator), i.e. that the customer grid is voltage-free on the AC side. To close the grid disconnection switch, simultaneously press the (ESC) + (→) keys on the SIEMENS Logo (92) controller.

8

If the aforementioned conditions are met, the closing of the grid disconnection switch is enabled by the SIEMENS Logo (92) and the grid disconnection switches close. Now the mains voltage is applied to the system and on-grid operation can be started.

12.5 COMMISSIONING THE TESVOLT PCS

STOP

WARNING! Risk of damage to the TESVOLT PCS and other components in case of incorrect polarity

Before coupling for the first time, it is essential to check the correct polarity in the DC circuit. Incorrect polarity causes an uncontrolled discharge current to flow through the precharging resistors, which immediately and irreversibly damages them. It must also be taken into account that fuses or other overcurrent protection devices will not normally respond, as the charging current is limited by the resistors.

NOTE: Before commissioning, make sure that a right rotating field is present.

1. Check the wiring of the TESVOLT PCS (see the installation manual "9.3 Installation of the TESVOLT PCS" on page 51 et seq.).
2. Switch on the AC power supply for the TESVOLT PCS.
3. Close all existing fuse switch disconnectors Q1 ... Q4 (28) (the number corresponds to the number of IPUs).
4. Now close circuit breaker Q01 (50).
5. Check circuit breakers F20 ... F25 (47)/(51). F20 and F21 must be switched on, as well as the circuit breakers F22 ... F25 belonging to the existing IPUs. The installation position (1 ... 4) determines the assignment. F22 belongs to the IPU at installation position 1 (far left), F23 belongs to the IPU at installation position 2, and so forth. For example, if only two IPUs are installed on positions 2 and 3, then F23 and F24 must be closed. See also sections "6.5 Terminal strip for battery inverter TESVOLT PCS" on page 27 and "6.6 IPU positions and associated circuit breakers and NH isolators" on page 28.
6. 

Close the main switch S1 (23). First, the fans of the TESVOLT PCS are tested. After successful completion of the selftest, the upper "Supply OK" LED on the IPU(s) lights up green and the TESVOLT PCS is in operation.

12.6 COMMISSIONING THE TWO JANITZA POWER MEASUREMENT METERS

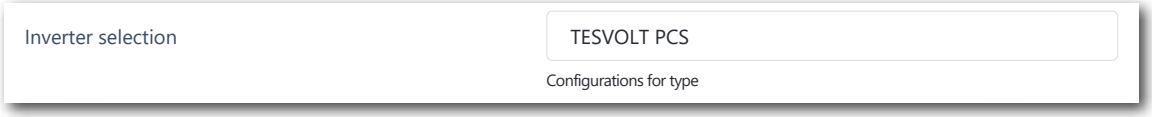
NOTE: If you should use a TESVOLT Backup Control Box, skip the following sections for the time being and continue the commissioning with section "12.4 Commissioning of the TESVOLT Backup Control Box" on page 63.

NOTE: Before commissioning the Janitza power measurement meters, please consult the manufacturer's documentation and, if appropriate, also use their "GridVis®" software to commission the device.

1. Switch on the fuses of the respective power measurement meter. The display becomes active and the startup process begins.
2. Select the programming mode on the device. By pressing buttons 1 and 2 simultaneously for about one second, you enter programming mode via the password query. If no display password has been programmed, you will be taken directly to the first programming menu.
3. Set the current and voltage transformer ratio (see the table in section "9.3 Installation of the TESVOLT PCS" on page 51). Please refer to the user manual of the Janitza UMG 604.
4. Now configure the ethernet connection. The device must be configured as a DHCP client. The TESVOLT Energy Manager acts as a DHCP server. The IP address assigned by the Energy Manager must begin with 192.168.29. .... Please refer to the user manual of the Janitza UMG 604.
5. Use the web interface of the Janitza power measurement meters to check the plausibility of the displayed values (positive values = drawn, negative values = feed-in). The main focus here is on avoiding incorrect installation of the transformers.

12.7 COMMISSIONING THE TESVOLT ENERGY MANAGER

1. Switch on the 24 V power supply.
2. Establish a connection with the TESVOLT Energy Manager, for example by connecting to the dedicated Modbus network (LAN 2) with your laptop.
3. Access the configuration interface of the Energy Manager via the IP address 192.168.29.254.
4. Now configure the ethernet connection: Settings → System settings → Network.
5. Now configure the utility grid transmission power measurement (e.g. Janitza UMG 604): Settings → Device configuration → Power measurement → Add power measurement status → "Select a model" → Janitza UMG 604
(The IP address of the Janitza assigned by the Energy Manager must begin with 192.168.29. … :502. Port 502 is the default value and can be changed if desired. The slave ID: Default value = 1 can optionally be changed in the configuration of the power measurement.) Then press "Save" and wait for 20 seconds.
6. Configure the power measurement "TESVOLT PCS" (e.g. Janitza UMG 604): Settings → Device configuration → Power measurement → Add power measurement status → "Select a model" → Janitza UMG 604. (The IP address assigned to the Janitza by the Energy Manager must begin with 192.168.29. … :502. Port 502 is the default value and can be changed if desired. The slave ID: Default value = 1 can optionally be changed in the configuration of the power measurement). Then press "Save" and wait for 20 seconds.
7. Configure the battery inverter (TESVOLT PCS): Settings → Device configuration → Inverter → Add inverter …



Select the inverter type

Select "Inverter active" and enter the Modbus TCP address of the inverter (default IP address: 192.168.29.210:502). It is stored on the SD card of the TESVOLT PCS (in operation in its slot 44 in the CCU – see "6.4 Connections and setup of the Control Computer Unit – CCU" on page 27) under CONFIGS → ANYBUS.TXT → modbus.tcp.ipaddress=192.168.29.210 and is also shown on a sticker on the CCU.

The default value is "0"

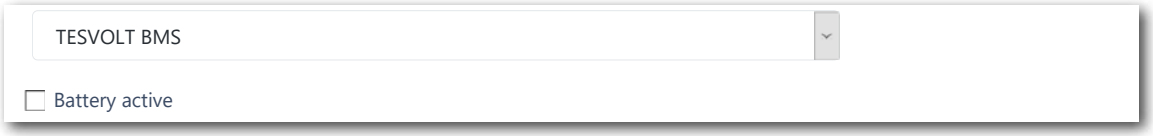
Trickle charging is charging the battery to compensate for its self-discharge. If the charge drops below the "Lower SOC limit for trickle charging", the storage system will charge up to the "Upper SOC limit for trickle charging" at a power level corresponding to the value set for the trickle charge. We recommend a value of 1,000 W.

Select 'Power limiter mode active' if the inverter is to limit the power via the MIO (e.g. physical peak shaving with control speed <1 ms).

Requires an entry only if “Power limiter mode active” has been selected.

Example 1) Lower power limit = 0, no feed-in i.e. zero feed-in.
Example 2) Lower power limit = –10,000 i.e. 10 kW feed-in is possible.

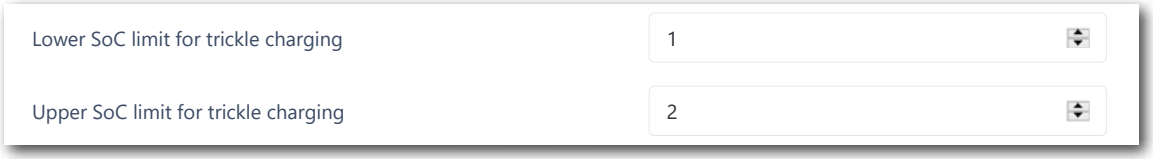
Example Upper power limit = 60,000 means peak shaving at 60 kW



Select “TESVOLT BMS”.

Enter the IP address of the master APU HV1000-S here. You can take the IP address from the display of the APU HV1000-S (2nd “page”, the IP address must start with 192.168.29. … :502).

The default value is “0”.“



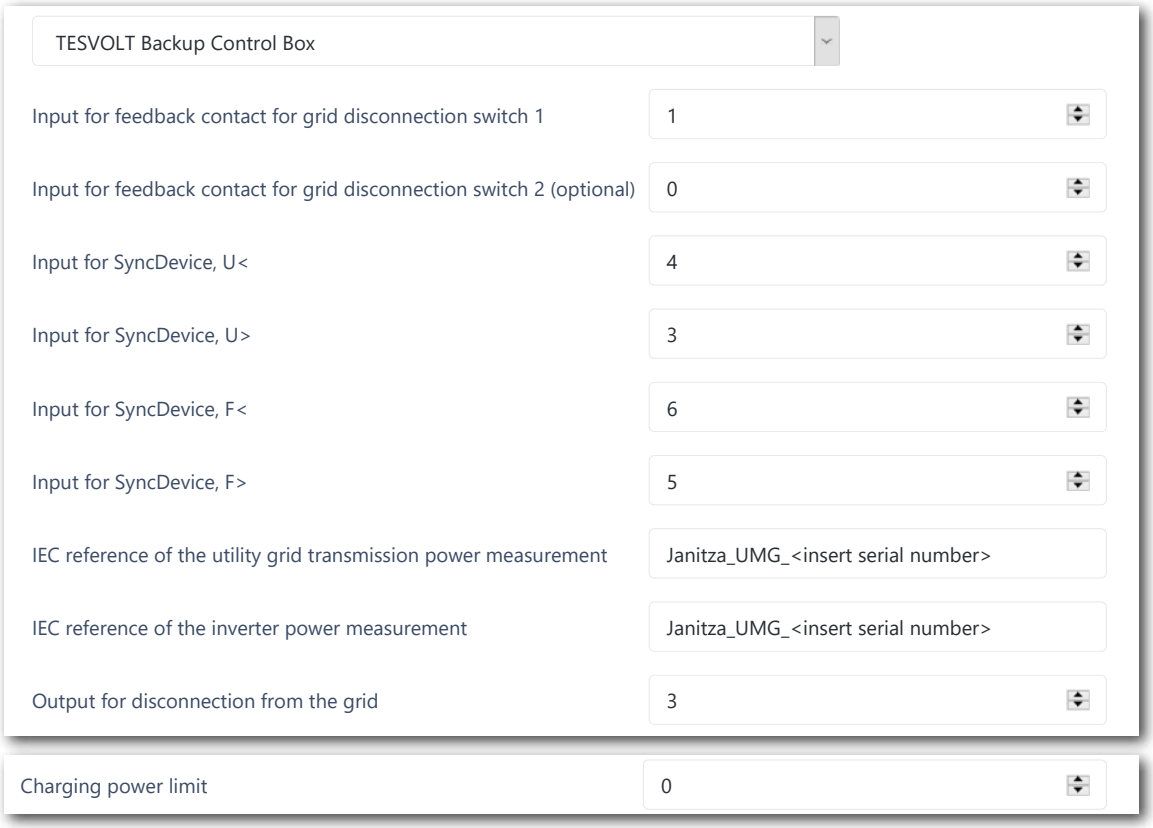
Lower SOC limit…” defines the lower threshold for the depth of discharge protection zone as a percentage of the charge status. At this value, the battery system recharges itself back to the upper limit at a power level corresponding to the value set for the trickle charge.

“Upper SOC limit…” defines the upper threshold for the depth of discharge protection zone as a percentage of the charge status. At this value, the battery system reverts to standby mode.

Individual configuration – particularly for back-up power and off-grid applications: we recommend the lower SOC limit is left at min. 1% and the upper limit is set at 5%.

Important: The value for the upper SOC limit must be greater than the lower SOC limit.

The following section only has to be configured if a TESVOLT Backup Control Box is used (e.g. in back-up power applications). If back-up power is not required, or a TESVOLT Backup Control Box has not been installed, the selection from the drop-down menu is left as: "TESVOLT Backup Control Box (optional)". You only need to change the entry for "Input feedback contact grid disconnection switch 2" if you are using more than one grid disconnection switch. If a second grid disconnection switch is installed, the value must be set to "2". The serial number for the power measurement meters, which must be entered under "IEC reference for power measurement..." can be retrieved from Settings → System settings → Device configuration → Power measurement → Power measurement status. Copy the value provided in the field "Logical device name" (or enter the following: "Janitza_UMG_"+serial number, e.g. "Janitza_UMG_70047343").



The maximum value for entering the active power per IPU is 86,000 W. If the full capacity can be used due to local specifications, 86,000 W (TESVOLT PCS charge limit) should be selected here. Example: 86,000 for 86 kW charge capacity limit.

The maximum value for entering the active power per IPU is 86,000 W. If the full capacity can be used due to local specifications, 86,000 W (TESVOLT PCS discharging power limit) should be selected here. Example: −86,000 for 86 kW discharge capacity limit.

This value is calculated automatically and does not have to be entered.

Enter the number of installed IPUs here.

Once you have correctly entered all the values and checked them again, click 'Save' and wait 20 seconds before continuing.

8 **Optional:** Configure the PV inverter: Settings → System settings → Device configuration → Inverters → "Select a model" and select the corresponding manufacturer and type.

12.8 REGISTRATION IN THE myTESWORLD PORTAL

1 To register in the myTESWORLD portal, go to mytesworld.tesvolt.com in your browser and register.

NOTE: Access to the engineer view is only available after unlocking by TESVOLT Service. For this, please contact service@tesvolt.com or the TESVOLT Service Line +49 (0) 3491 87 97 - 200 in good time.

2 After successful registration and unlocking of the engineer view by TESVOLT Service, log in to the myTESWORLD portal and switch to the engineer view.

3 Switch from the engineer view to the administration view and select "Set up a new EMS".

4 "Start setup" → Initialisation of a new EMS (name, user, description, time zone, distribution grid operator (optional), grid access point (optional) → Save

5 TESVOLT Energy Manager authentication: Enter the serial number of the TESVOLT Energy Manager to be registered.

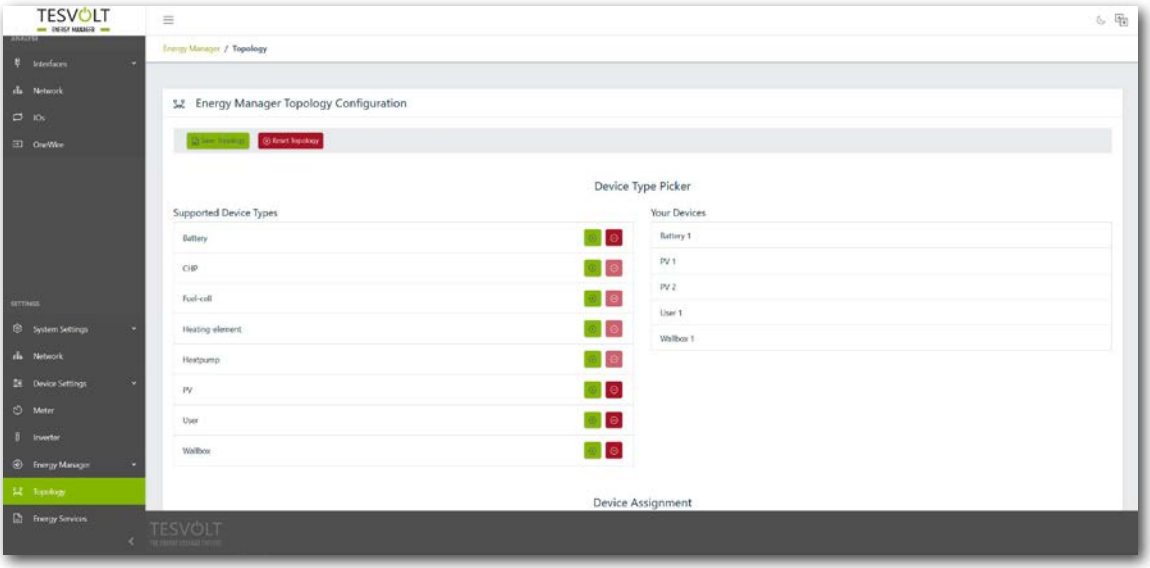
13 SETTING THE TOPOLOGY

13.1 PREPARATION

First, the TESVOLT Energy Manager must be made aware of what types of device, generator or consumer are present. To do this, "Supported device types" for the TESVOLT Energy Manager is displayed in the left-hand column. These must be transferred over to the right-hand column under "Your devices". Click the "+" symbol to do this. The relevant device is then automatically listed in the right-hand column.

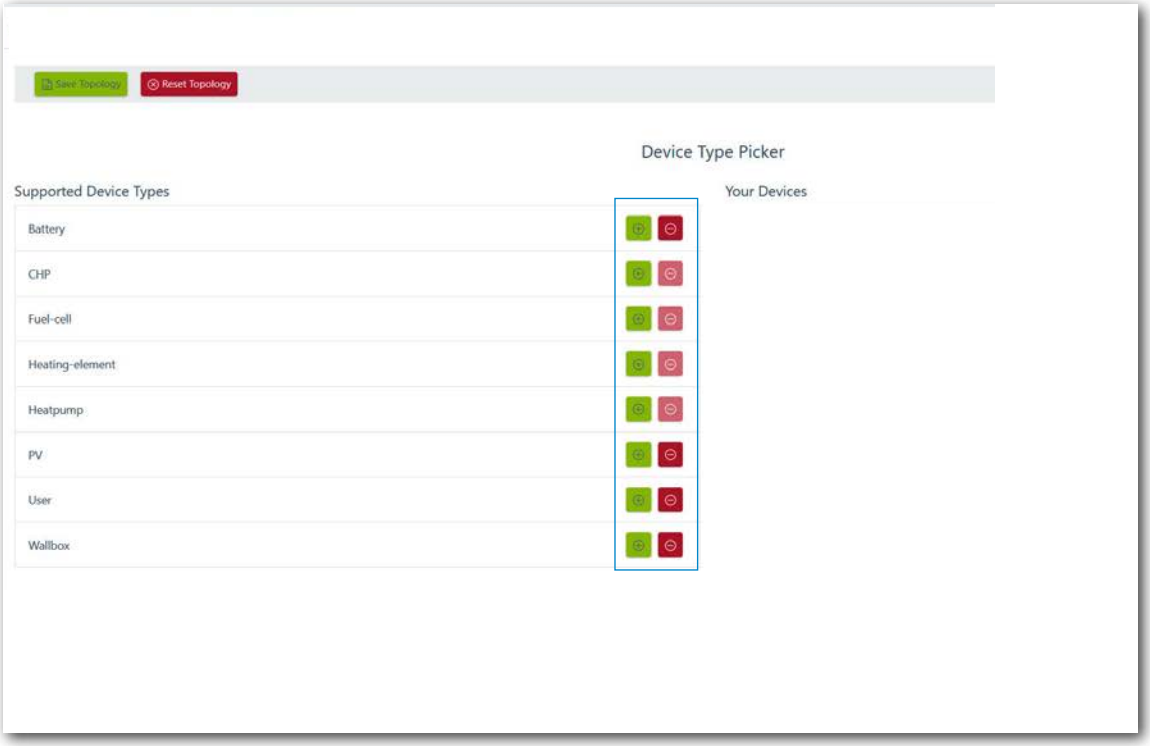
The installed power measurement meters must also be assigned in addition to the devices. With the TS-I HV 80 there are at least two power measurement meters (Janitza). One Janitza is installed at the utility grid transmission point and the other as close as possible to the TESVOLT PCS. Both power measurement meters must be assigned to the respective points.

1 Select Settings → Energy Manager → Topology. The next steps are first to select the devices in your system in the left-hand column “Supported device types” and add them to the “Device type selection”. They will then be listed in the right-hand column “Your devices”. Finally, the devices' links must be assigned in the “Device assignment” area.



13.2 CREATE DEVICES AND CONSUMERS

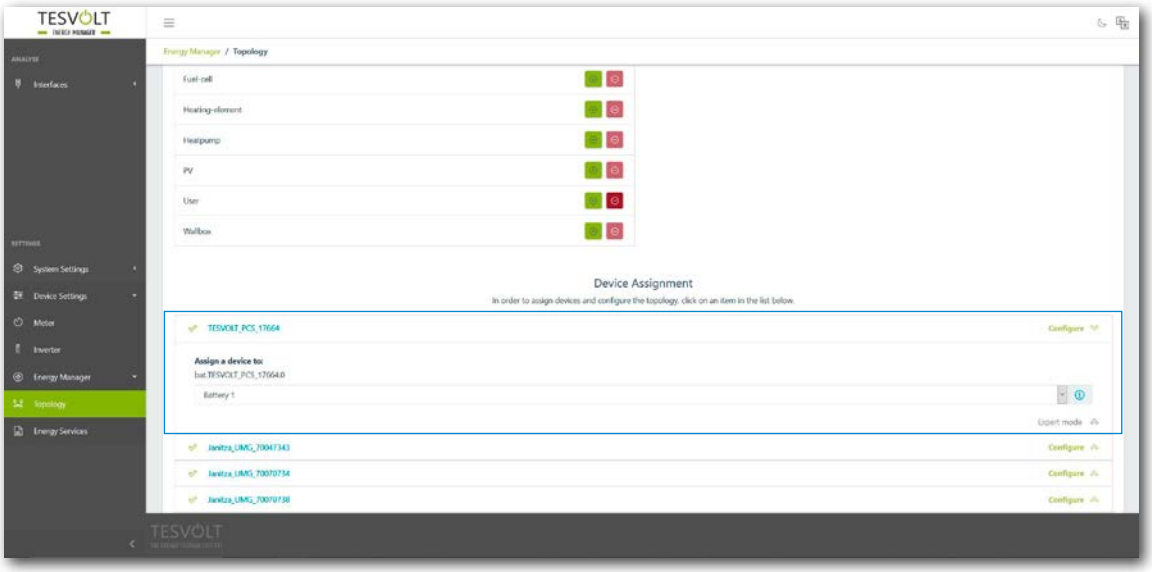
1 To create a battery, select Supported device types → Battery → “+”.
“Battery 1” will appear under “Your devices”.



2 Now create a device of the type PV Inverter – select Supported device types → PV → "+". "PV 1" will appear under "Your devices".

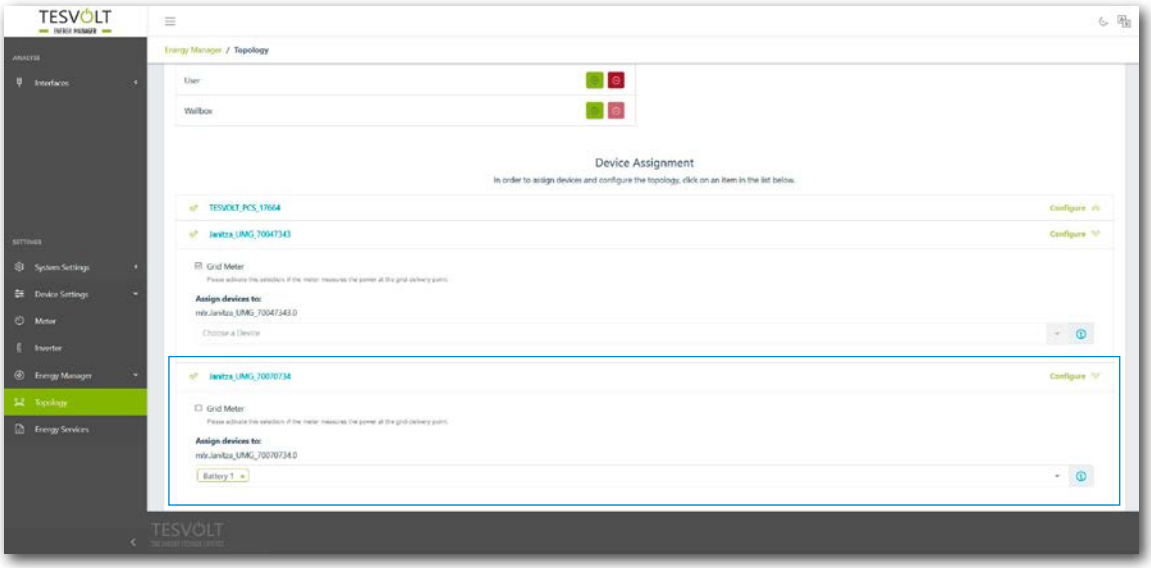
3 Now create the consumer(s). In this context, "consumers" are a specific load in the system. To do this, select Supported device types → Consumers → "+".
"Consumer 1" will appear under "Your devices".

4 The TESVOLT Energy Manager must be told what any power measurement meters are measuring (e.g. grid connection point) and what devices such as the TESVOLT PCS are controlling (e.g. battery 1). To do this, click on an entry in the list. Clicking will expand the entry. Click on the large selection field. This opens a drop-down menu with the devices you set up previously. Click on one of the devices to assign it. The warning icon at the start of the entry changes to a tick when assignment is successful and the colour changes from yellow to green (as does the colour of the content of the outer, right-hand column). Continue until you have added the appropriate link for all entries in the "Device assignment" list.



13.3 POWER MEASUREMENT CONFIGURATION

1 All the system's power measurement meters are shown in the "Device assignment" list. First, find the entry for the utility grid transmission point power measurement meter. Click on the list entry to open it. Select the square radio button next to "Utility grid transmission power measurement" by clicking on it.



2 Next, select and open the power measurement on the TESVOLT PCS from the list. This is shown as "mtr064841470104c5376dbe" in the above screenshot (the designation of the respective power measurement meter in your system will have a different name). The designation contains the serial number of the power measurement meter which can be used to assign the meter. Click on the field under the designation "Device assignment for:" and select the entry "Battery 1" by clicking on it.

3 Then, one after another, select and open any other power measurement meters present in the system. Click on the field labelled "Device selection". Click to select all devices which lie behind the relevant power measurement meter and which are being monitored by it.

14 ENERGY SERVICE SETTING

14.1 PREPARATION

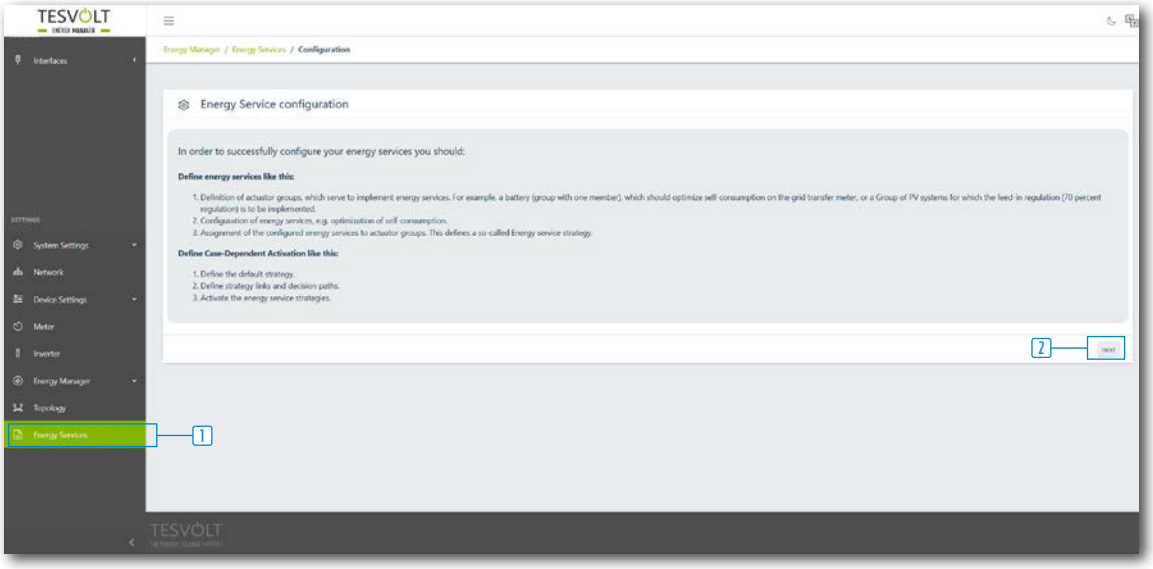
Energy service strategies are defined as follows:

- Definition of actuator groups which convert the energy service, e.g. a battery which performs self-consumption optimisation at the utility grid transmission power measurement, or a group of PV installations which requires 70% feed control.
- Configuration of energy services, e.g. self-consumption optimisation.
- Assignment of the configured energy services to actuator groups. This defines a so-called energy service strategy.

Activations are defined as follows, depending on circumstances: e.g. multi-use

1. Definition of standard strategy
2. Definition of strategy links and decision paths
3. Activation of energy service strategies

1 Select Settings → Energy manager → Energy service and click on “Next”.



14.2 STRATEGY DEFINITION

The strategies must first be defined. To this end, an energy service (e.g. self-consumption) is assigned to a so-called actuator group (e.g. the TESVOLT PCS) which implements the service.

The following energy services are available for selection:

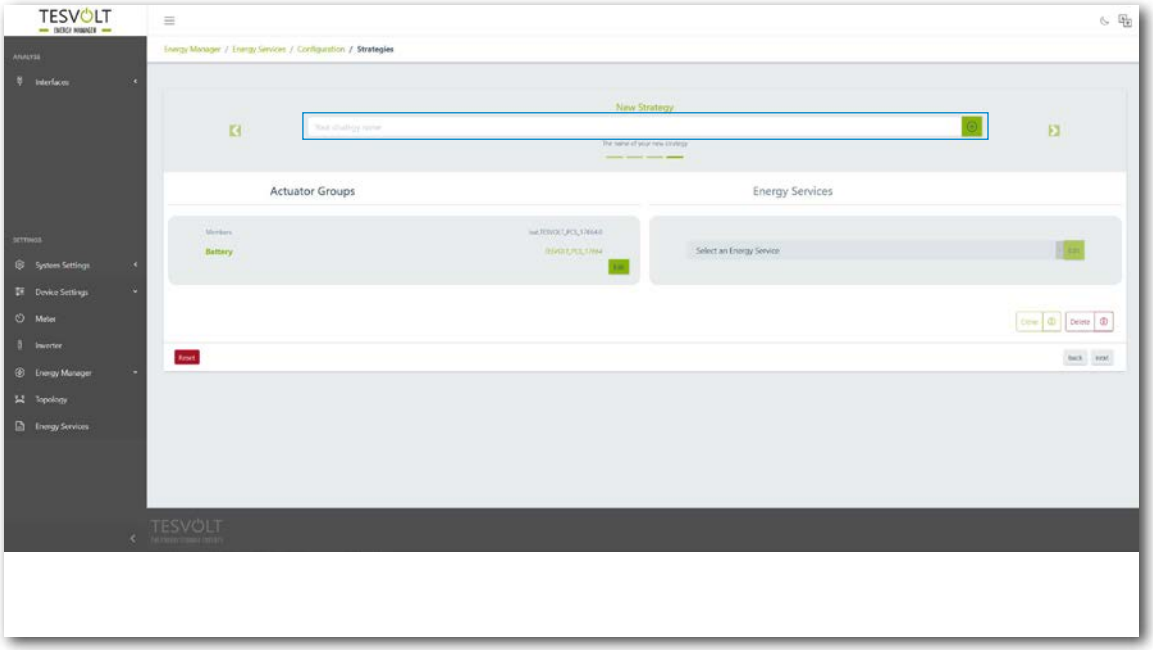
- Target output process (advanced, self-consumption, physical peak shaving, PV regulation)
- RLM peak shaving
- Forecast-based charging
- Off-grid.

Target output process – self-consumption

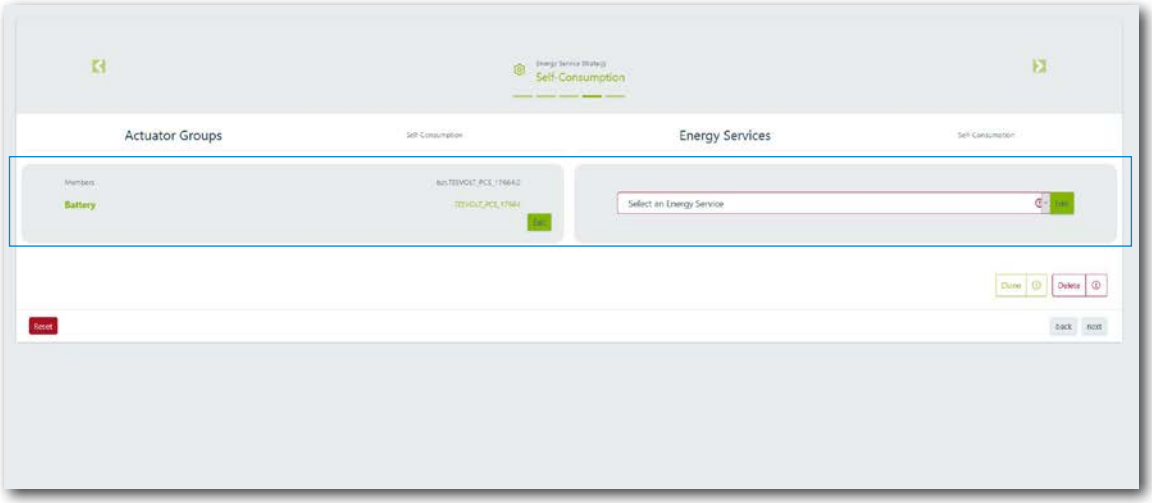
The "Target output process" function optimises the behaviour of the selected actuator group to a designated point.

A target output of 0 kW at the grid connection point is to be selected for self-consumption in order to consume as much renewable energy as possible and to reduce the electricity drawn from the public utility grid.

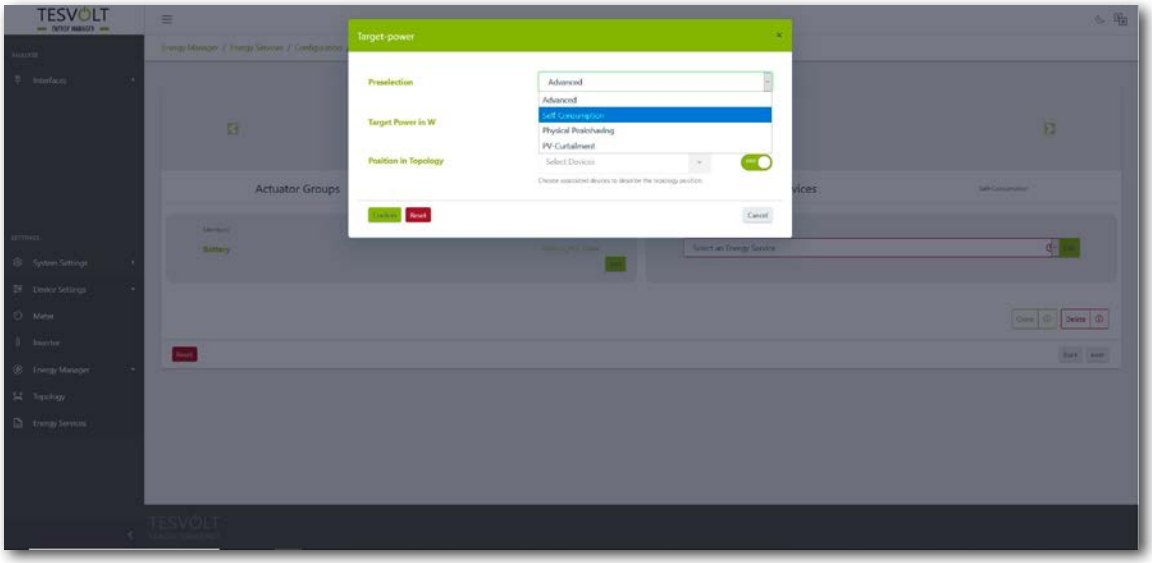
1 Create new strategy: to do this, enter a name for the strategy in the input field labelled "Your strategy name" (e.g. "Self-consumption") and then finally click on the "+" symbol to the right of the input field. You have now created a strategy called "Self-consumption".



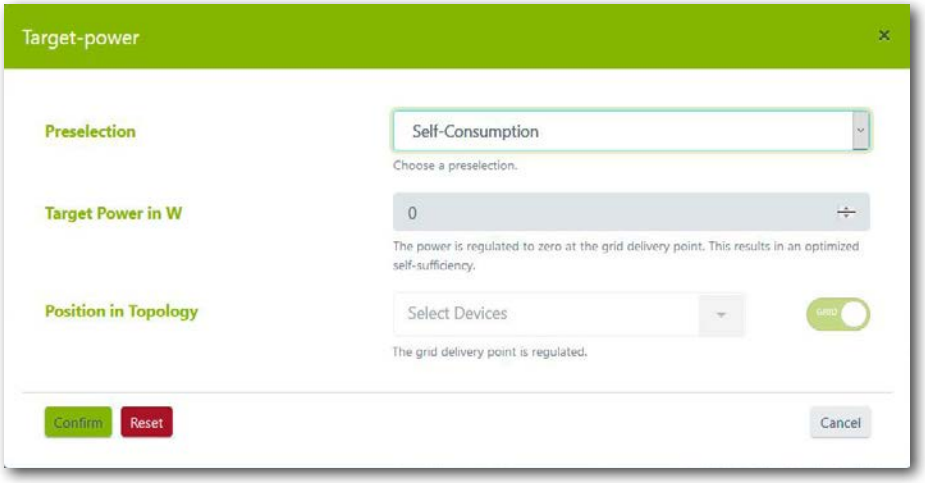
2 Now select the relevant actuator group to be configured. This example starts with “Battery”.



3 Now, under “Actuator groups”, select Battery → “Select energy service” → “Target output process” with the preselection “Self-consumption”.



4 The “target output in W” is preset to “0” in the “Target output process” dialogue box, which corresponds to 0 kW.A switch symbol is shown in “Position in topology”. This is always preset to “Utility grid on”. This means that the values from the utility grid transmission power measurement are applicable for regulation. Finally, click on “Confirm”. If you have several batteries to configure in your system, repeat the process from step 2 for each battery.



Target output process – physical peak shaving

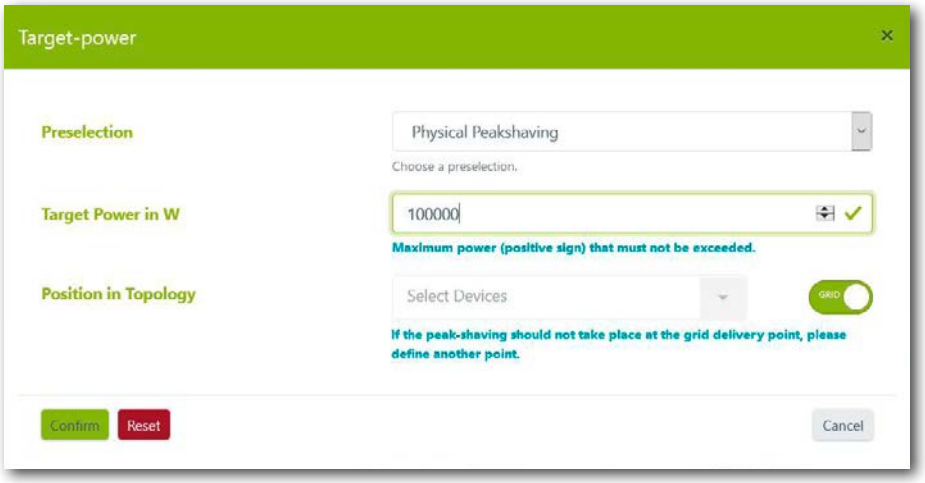
The “Target output process” function optimises the behaviour of the connected battery inverter to a designated point.

For physical peak shaving, the target output is a freely selectable output at the grid connection point. The selected value sets the maximum output drawn from the public utility grid. If this value is exceeded, the storage system discharges to cap the load peak.

1 Create a new strategy (as in section “Target output process – self-consumption” on page 74, step 1). Enter a new name for the strategy (e.g. “Physical peak shaving”) and then confirm your entry by clicking on the “+” symbol.

2 Then, under “Actuator groups”, select Battery → “Select energy service” → “Target output process” with the preselection “Physical peak shaving” under (see section “Target output process – self-consumption” on page 74, step 2 et seq.).

3 In the "Target output process" dialogue box, enter, for example, "100,000" for the "Target output in W", which corresponds to 100 kW. A switch symbol is shown in "Position in topology". This is always preset to "Utility grid on". This means that the values from the utility grid transmission power measurement are applicable for regulation. Finally, click on "Confirm". If you have several batteries to configure in your system, repeat the process from step 2 for each battery.



Target output process – PV installation active power limitation or zero feed-in

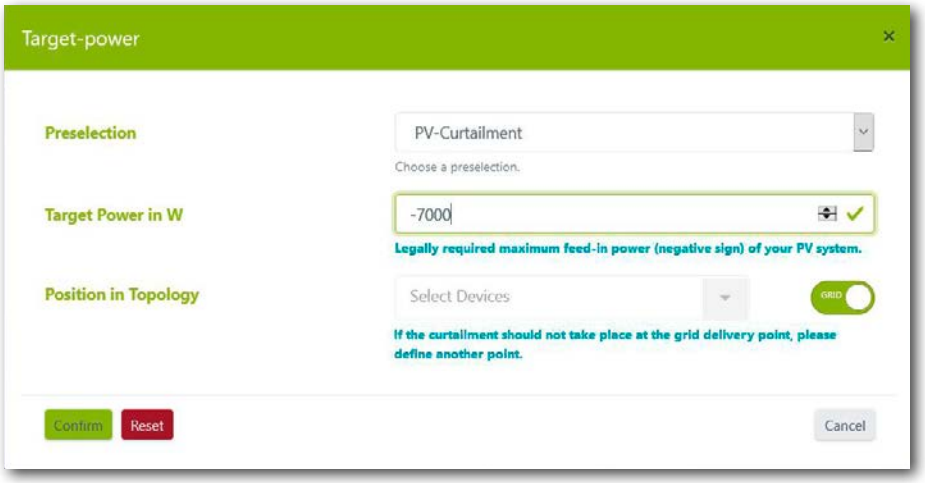
The "Target output process" function optimises the behaviour of the selected actuator group to a designated point.

For active power limitation of the photovoltaic installation, the target output is a freely selectable output at the grid connection point. The preset value fixes the maximum output which may be fed into the public utility grid. For zero feed-in, the value is 0 kW at the grid connection point.

1 Create a new strategy (as in section "Target output process – self-consumption" on page 74, step 1). Enter a new name for the strategy (e.g. "Active power limitation" or "Zero feed-in") and then confirm your entry by clicking on the "+" symbol.

2 Then, under "Actuator groups", select "PV installation" → "Select energy service" → "Target output process" with the preselection "PV limitation" (see section "Target output process – self-consumption" on page 74, step 2 et seq.).

3 In the “Target output process” dialogue box, enter, for example, “–7,000” for the “Target output in W”, which corresponds to feed-in of 7 kW (or 70% of a 10 kWp PV installation).A switch symbol is shown in “Position in topology”. This is always preset to “Utility grid on”. This means that the values from the utility grid transmission power measurement are applicable for regulation. Finally, click on “Confirm”. If you have several PV inverters to configure in your system, repeat the process from step 2 for each additional PV inverter.



Target output process – advanced

The “Target output process” function optimises the behaviour of the selected actuator group to a designated point.

The “Advanced” function allows freely selectable output and a freely selectable position in the topology. It would also be possible to configure the preset functions such as “Self-consumption” or “Physical peak shaving” at this point.

1 Create a new strategy (as in section “Target output process – self-consumption” on page 74, step 1). Enter a new name for the strategy (e.g. “Target output process – advanced”) and then confirm your entry by clicking on the “+” symbol.

2 Then, under “Actuator groups”, select “Battery” → “Select energy service” → “Target output process” with the preselection “Advanced” (see section “Target output process – self-consumption” on page 74, step 2 et seq.).

3 You can now enter any value for “Target output in W” in the “Target output process” dialogue box. A switch symbol is shown in “Position in topology”. The setting “Utility grid on” means that the values from the utility grid transmission power measurement are applicable for regulation. You can also adjust this setting. At this point, select all devices which are downstream of the point at which you wish to apply the entered output process. Finally, click on “Confirm”. If you have several batteries to configure in your system, repeat the process from step 2 for each additional battery.

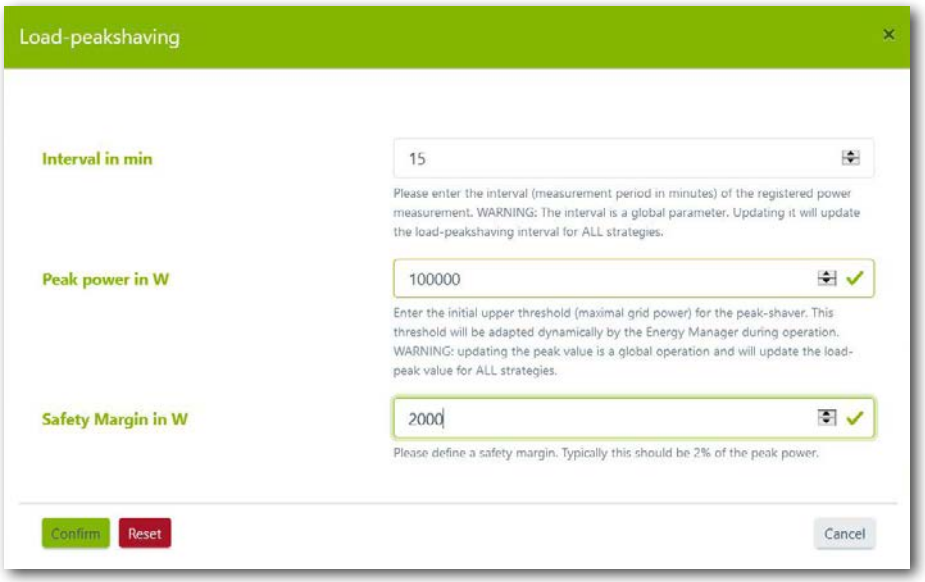
RLM peak shaving

The "RLM peak shaving" function optimises the behaviour of the connected battery storage system on the grid connection point. Unlike physical peak shaving, a freely selectable time period is considered here during which the average drawn output from the public utility grid may not exceed a specific value. In Germany, the interval for RLM peak shaving is 15 minutes.

1 Create a new strategy (as in section "Target output process – self-consumption" on page 74, step 1). Enter a new name for the strategy (e.g. "RLM peak shaving") and then confirm your entry by clicking on the "+" symbol.

2 Then, under "Actuator groups", select "Battery" → "Select energy service" → "RLM peak shaving" (see section "Target output process – self-consumption" on page 74, step 2 et seq.).

3 For Germany, enter "15" for "Interval in min" in the "RLM peak shaving" dialogue box.For "Peak shaving in W", enter the value for the maximum power drawn (e.g. 100,000 for 100 kW). Finally, click on "Confirm". If you have several batteries to configure in your system, repeat the process from step 2 for each additional battery.



Forecast-based charging

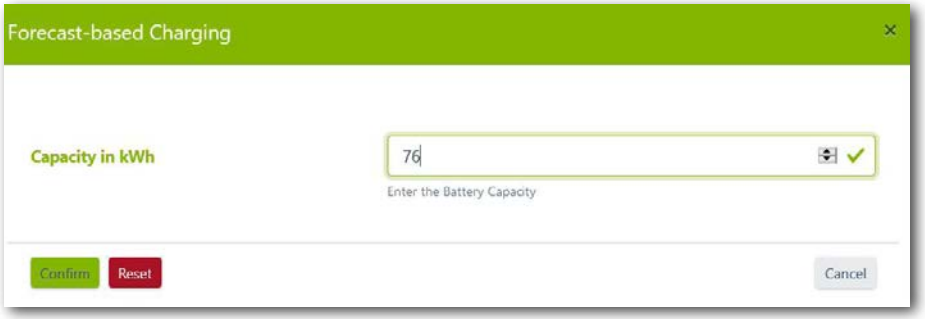
Intelligent charging and discharging of the battery is set up using the "Forecast-based charging" function.

The TESVOLT Energy Manager automatically controls the charging and discharging of the battery such that curtailment of the PV installation is kept to a minimum. The Energy Manager has a smart way of doing this, namely by determining the forecast PV output from local meteorological data. The Energy Manager therefore always knows how much energy is available at what point in time.

1 Create a new strategy (as in section "Target output process – self-consumption" on page 74, step 1). Enter a new name for the strategy (e.g. "Forecast-based charging") and then confirm by clicking on the "+" symbol.

2 Then, under "Actuator groups", select "Battery" → "Select energy service" → "Forecast-based charging" (see section "Target output process – self-consumption" on page 74, step 2 et seq.).

3 Enter 76 kWh for "Battery capacity" in the "Forecast-based charging" dialogue box. Finally, click on "Confirm". If you have several batteries to configure in your system, repeat the process from step 2 for each additional battery.



Off-grid

1 Create a new strategy (as in section "Target output process – self-consumption" on page 74, step 1). Enter a new name for the strategy (e.g. "Disconnection from the grid") and then confirm your entry by clicking on the "+" symbol.

2 Then, under "Actuator groups", select "Battery" → "Select energy service" → "Off-grid" and then "Disconnection from the grid" (see section "Target output process – self-consumption" on page 74, step 2 et seq.). Finally, click on "Confirm". If you have several batteries to configure in your system, repeat this step for each additional battery.

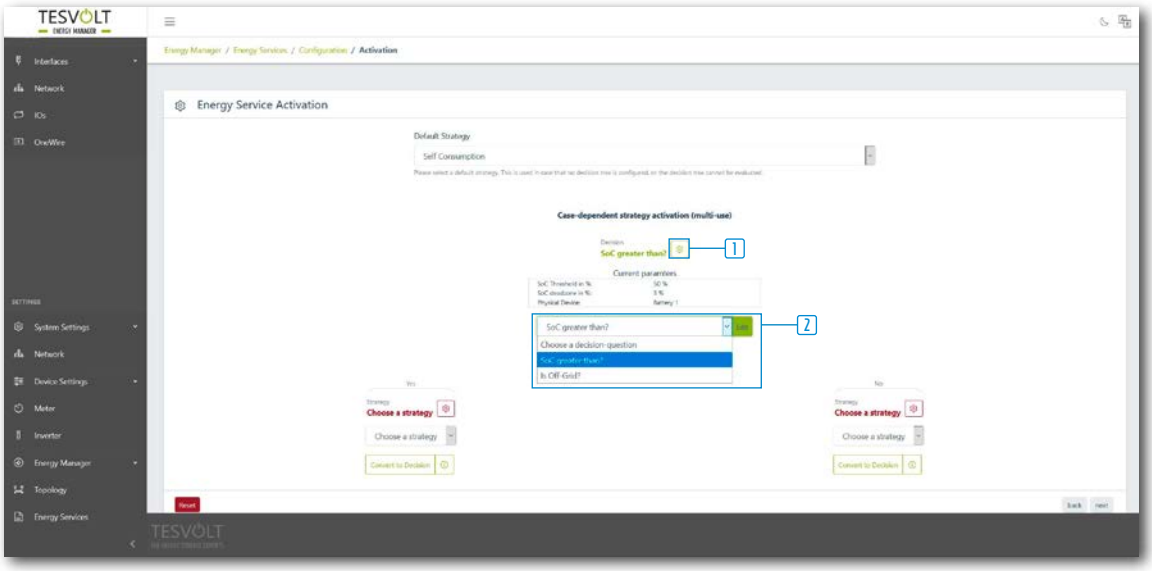
14.3 DEFINITION OF STRATEGY LINKS AND DECISION PATHS

The TESVOLT Energy Manager allows the above strategies to be linked to each other in order to meet more complex requirements or to maximise energy cost savings. For example, self-consumption and physical peak shaving could be combined to enable further energy cost savings. Furthermore, the back-up power functionality can also be combined with existing strategies to bridge power outages.

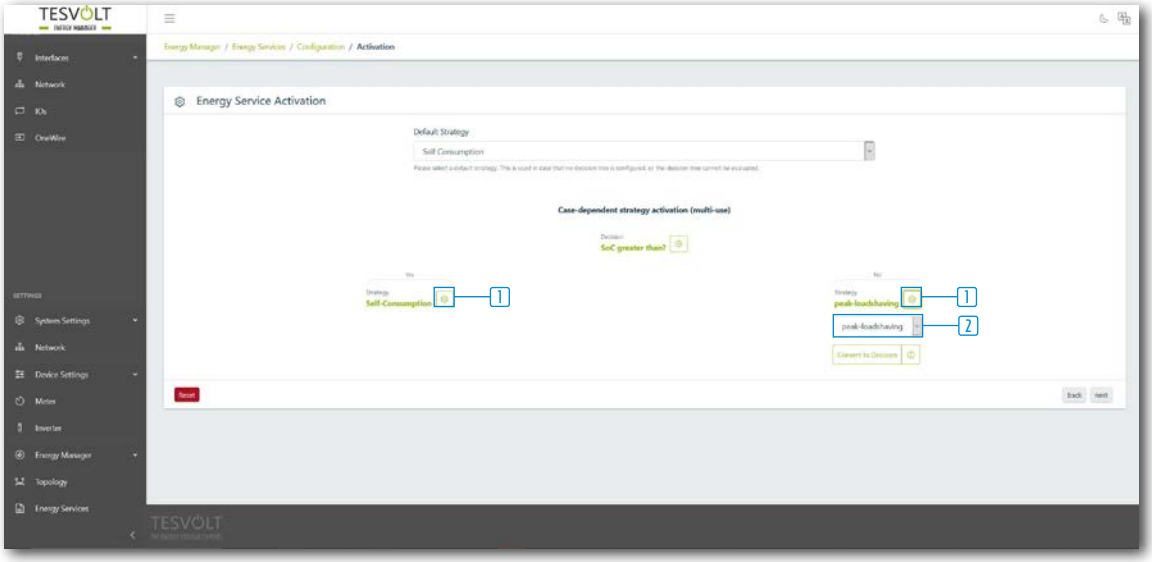
A decision tree is configured for this, in which one of two strategies is implemented based on an evaluation of a decision query. During operation, the TESVOLT Energy Manager continuously checks whether or not the decision criteria are being met. If the decision condition is fulfilled (e.g. a grid failure in the case of a "Disconnection from the grid" decision, or a charge level that exceeds the set threshold in the case of "SoC greater than"), the strategy under "Yes" is applied. If it is not met, the other strategy is executed.

A further decision query can also be configured instead of a strategy. In this case, a new evaluation of another decision query would be carried out instead of implementing a strategy, and only then would one of two strategies be executed. You can also replace these strategies with one or two decisions, and so on.

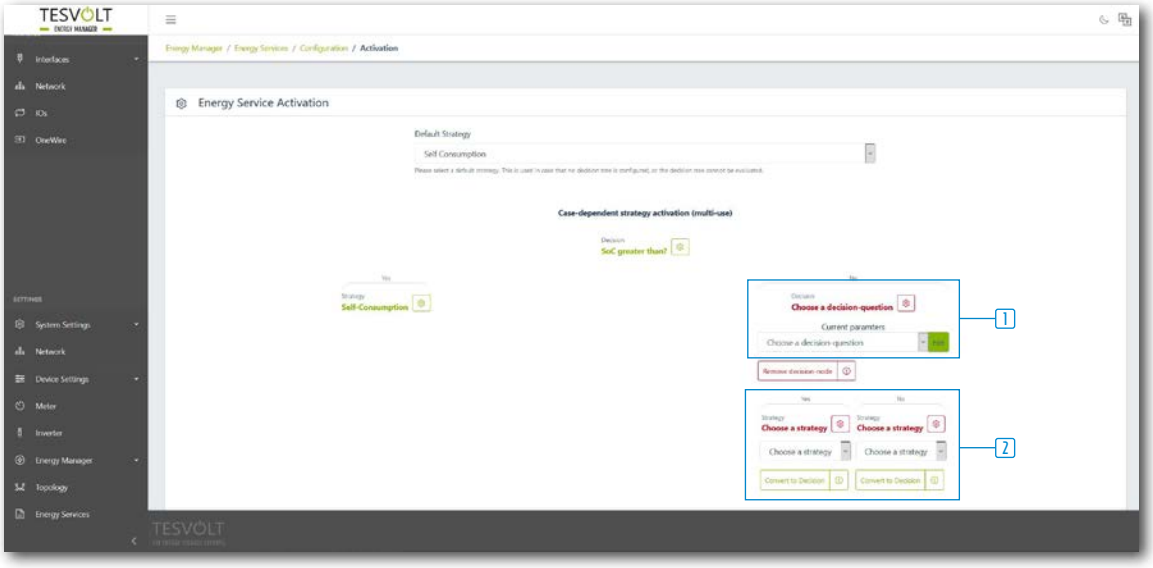
1 To configure the decision tree, first click on the setting buttons to the right next to the name of the decision. Then, select the required decision query (e.g. “SoC greater than”). To configure the decision node, click the “Edit” button to the right of the decision name.



2 Then, first click on the setting buttons to the right of the strategy’s name. Select the desired strategies.



3 If you want to insert another decision instead of a strategy, click on "Switch to decision". Configure the new decision node and then the two new strategies. If you want to remove a decision node, click on "Delete decision node".



15 DECOMMISSIONING

DANGER! Danger of death due to electric shock after shutdown

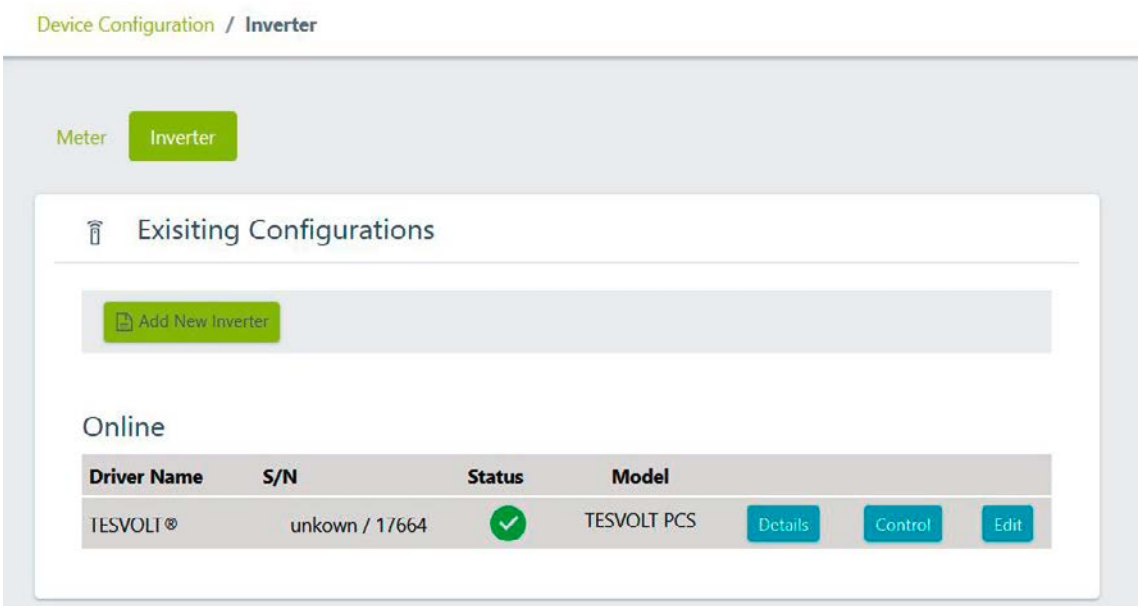
Large parts of the battery storage system are still under full voltage even after decommissioning, meaning there is a risk of serious injury or death if operators touch live parts of the storage system.

DANGER! Risk of injury due to electric shock after decommissioning

Discharging of the battery inverter's capacitors can take several minutes even after switching off. Wait 60 minutes after switching off until the system is largely voltage-free as the capacitors in the inverter take several minutes to discharge. Alternatively, check the DC voltage and do not proceed until the voltage is ≤ 60 V_{DC} so that a fatal electric shock can no longer occur if live parts in the DC auxiliary circuit are touched.

15.1 DECOMMISSIONING THE BATTERY INVERTER TESVOLT PCS

1



To do this, use a LAN-2 network connection to call up the configuration interface of the TESVOLT Energy Manager via the IP address 192.168.29.254, or use the customer-specific IP address via a LAN 1 network connection.

2

Reduce the power of the TESVOLT PCS to 0 kW: Go to Settings → Device configuration → Functional inverter configuration → TESVOLT PCS → Control → and select "activate strStop".

The TESVOLT Energy Manager then reduces the power of the TESVOLT PCS down to 0 kW and gives the command to the APU HV1000-S to disconnect from the DC path. Wait until the audible opening of the contactors in the APU HV1000-S is heard.

3 Switch off the battery inverter via the main switch S1 (23).

4 Open circuit breaker F20 ... F25 47/51.

5 Switch circuit breaker Q01 50 to 0 ("Off").

6 Open NH switch disconnector Q1 ... Q4 (28). The battery inverter is now out of operation.

7 Open the AC power supply for the TESVOLT PCS.

15.2 DECOMMISSIONING THE BATTERY STORAGE SYSTEM TS HV 80

1 First switch off the battery storage system via the external switch (B) on the outside of the cabinet door and then via the on/off "SWITCH" 17 on the APU HV1000-S. The green LED must go out. **For systems with multiple TS HV 80 units, each APU HV1000-S must be switched off.**

2 On the APU HV1000-S, disconnect the DC connecting cables (7.1) and (7.2) from the CHARGER 12 / 13 DC connections.

3 Wait 60 minutes until the system is largely voltage-free as the capacitors in the inverter take several minutes to discharge. Alternatively, check the DC voltage and do not continue until the voltage ≤ is 60 V_{DC}.

16 CAPACITY EXPANSION

WARNING! Possible damage to the device and/or battery inverter if the unit is extended by different capacities.

If you would like to use multiple TS HV 80 battery storage systems on one TESVOLT PCS battery inverter, it is essential that they all have the same capacity and the same state of charge. When battery storage systems are connected in parallel, the APUs may not be operated as independent masters and must always be installed in master-slave systems.

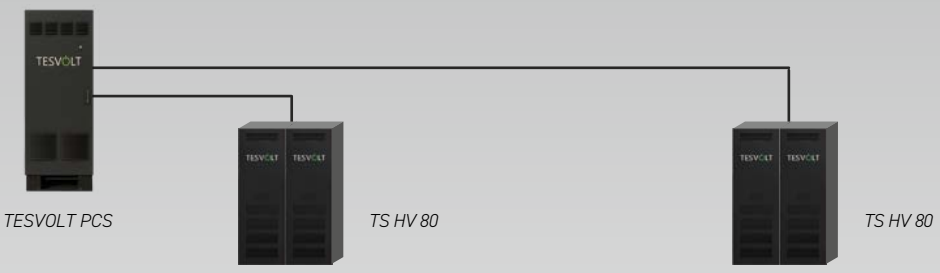
NOTE: Up to eight TS HV 80 units can be connected in parallel per TESVOLT PCS using the master/slave principle.

WARNING! Possible damage to the TS HV 80 if the expansion battery modules and original battery modules have different states of charge.

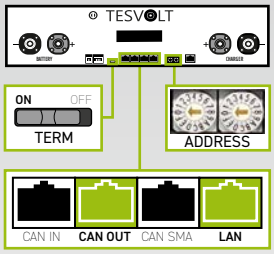
If a battery module is installed in a TS HV 80 battery storage system and this module's state of charge differs from that of the battery modules already present, this can cause damage to the battery modules or to the APU HV1000-S.

1. The new battery modules are supplied with a state of charge (SoC) of approx. 20%. Before you integrate a new battery module into an existing battery system, the existing system must be brought to the same voltage level. First check the state of charge of the new battery modules by carrying out a voltage measurement; this must be exactly 50.0 +/– 0.1 V_{DC}. If there are deviations, please contact the TESVOLT Service Line +49 (0) 3491 87 97 - 200 or service@tesvolt.com.
2. Adjust the voltage of the original battery modules of the TS HV 80 so that it matches the voltage of the new battery modules exactly. To do this, use the TESVOLT Energy Manager and call up the interface. **Manual charging:** Go to Device configuration → Inverter and select the configured TESVOLT PCS → Edit → Set the upper SoC limit for trickle charging to 20%. The trickle charge [W] determines the power with which the TESVOLT PCS charges, up to a state of charge of 20%. **Manual discharge:** To do this, activate loads such that feed-in to the public utility grid is prevented, and switch the TS-I HV 80 off at a state of charge of 20%.
3. Decommission the TS-I HV 80 in accordance with section "15 Decommissioning" on page 83.
4. Install the new TS HV 80 according to chapters "8 Installation and connection of TS HV 80" on page 36 and "9 Installation and connection of TESVOLT PCS" on page 47.
5. You can recommission the storage system in accordance with chapter "12 Commissioning" on page 59. Note that settings such as "Upper SoC limit for trickle charging" are restored to their original state.

System with 1 master and 1 slave

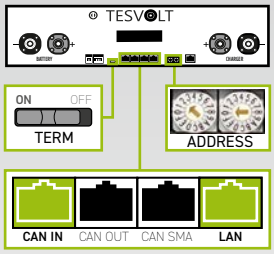


Master



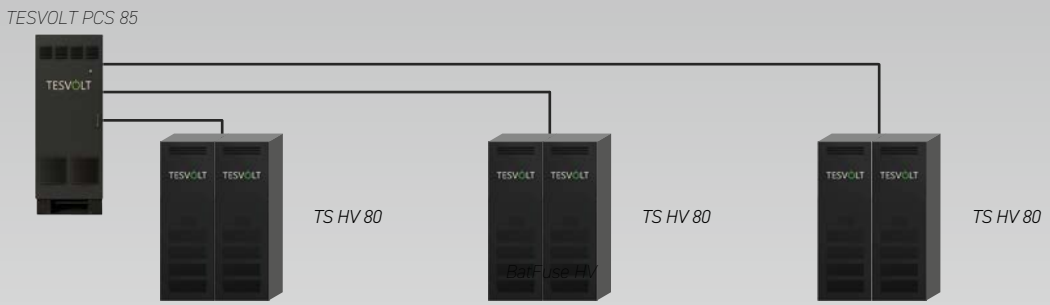
APU configuration master	
TERM:	ON
ADDRESS:	0/0
CAN OUT	> CAN IN Slave 1
LAN	> SWITCH LAN 2

Slave 1

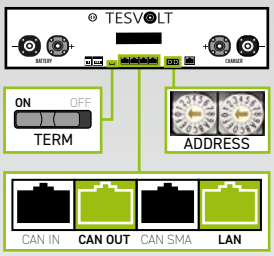


APU configuration slave 1	
TERM:	ON
ADDRESS:	2/0
CAN IN	> CAN OUT Master
LAN	> Optional LAN 1

System with 1 master and 2 slaves

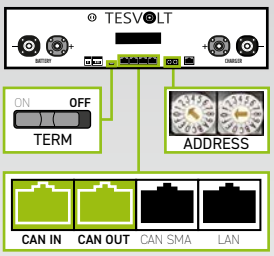


Master



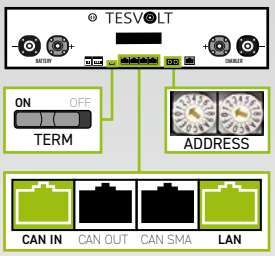
APU configuration master	
TERM:	ON
ADDRESS:	0/0
CAN OUT	> CAN IN Slave 1
LAN	> SWITCH LAN 2

Slave 1



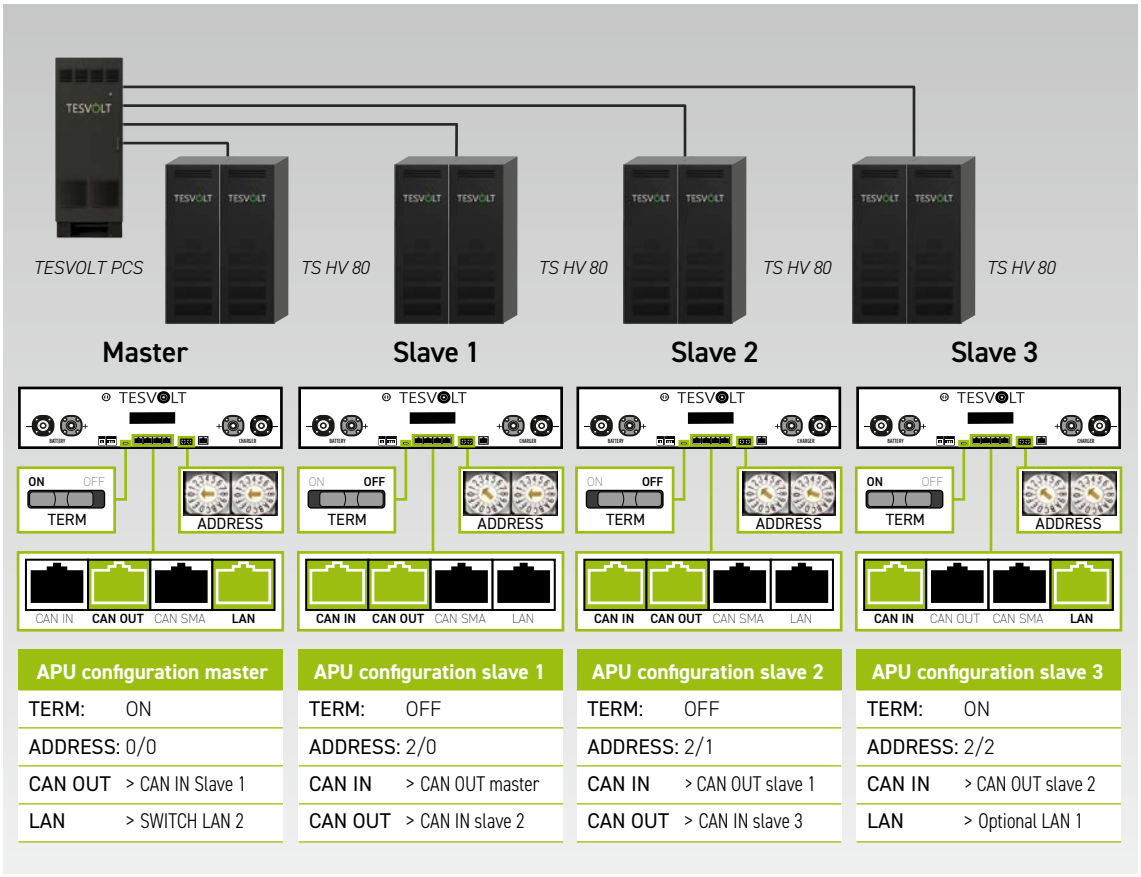
APU configuration slave 1	
TERM:	OFF
ADDRESS:	2/0
CAN IN	> CAN OUT master
CAN OUT	> CAN IN slave 2

Slave 2



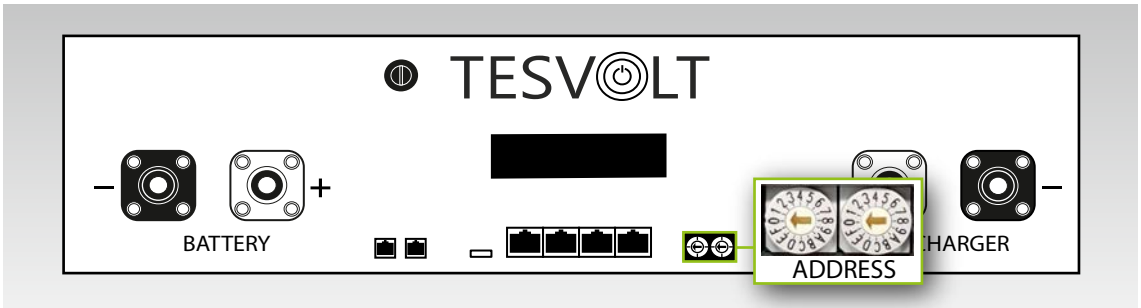
APU configuration slave 2	
TERM:	ON
ADDRESS:	2/1
CAN IN	> CAN OUT slave 1
LAN	> Optional LAN 1

System with 1 master and 3 slaves



APU configuration master		APU configuration slave 1		APU configuration slave 2		APU configuration slave 3	
TERM:	ON	TERM:	OFF	TERM:	OFF	TERM:	ON
ADDRESS:	0/0	ADDRESS:	2/0	ADDRESS:	2/1	ADDRESS:	2/2
CAN OUT	> CAN IN Slave 1	CAN IN	> CAN OUT master	CAN IN	> CAN OUT slave 1	CAN IN	> CAN OUT slave 2
LAN	> SWITCH LAN 2	CAN OUT	> CAN IN slave 2	CAN OUT	> CAN IN slave 3	LAN	> Optional LAN 1

Overview of all addressing options



Set the address selector on the APU HV1000-S to match the configuration and data in the table below.

LEFT SELECTOR	RIGHT SELECTOR	DESIGNATION
0	0	Master 1
2	0	Slave 1
2	1	Slave 2
2	2	Slave 3
2	3	Slave 4
2	4	Slave 5
2	5	Slave 6
2	6	Slave 7

17 TESVOLT BATMON BATTERY MONITORING SOFTWARE

17.1 VIEWS AND FUNCTIONS

TESVOLT BatMon is a piece of software that can be used to analyse and visualise batteries right down to the cell level.

NOTE: The software can be found on the supplied TESVOLT USB drive (12) and must be installed in a writable directory on the "C:" drive, for start-up. The installation path suggested by the installation program must not be changed.

To get a closer look at a battery using BatMon, the service laptop's LAN connection must be connected to the LAN-2 switch (see also "9.1 System setup" on page 47).

After installation, launch the file "BatMon.exe". Tick all the boxes in the firewall query about full access to the network. The "System" menu item at the bottom of the BatMon interface includes a "Communication Port" button. The serial number and IP address of the master APU HV1000-S must be selected here under "Select APU" (this information can be found on a sticker on the underside of the APU HV1000-S casing).

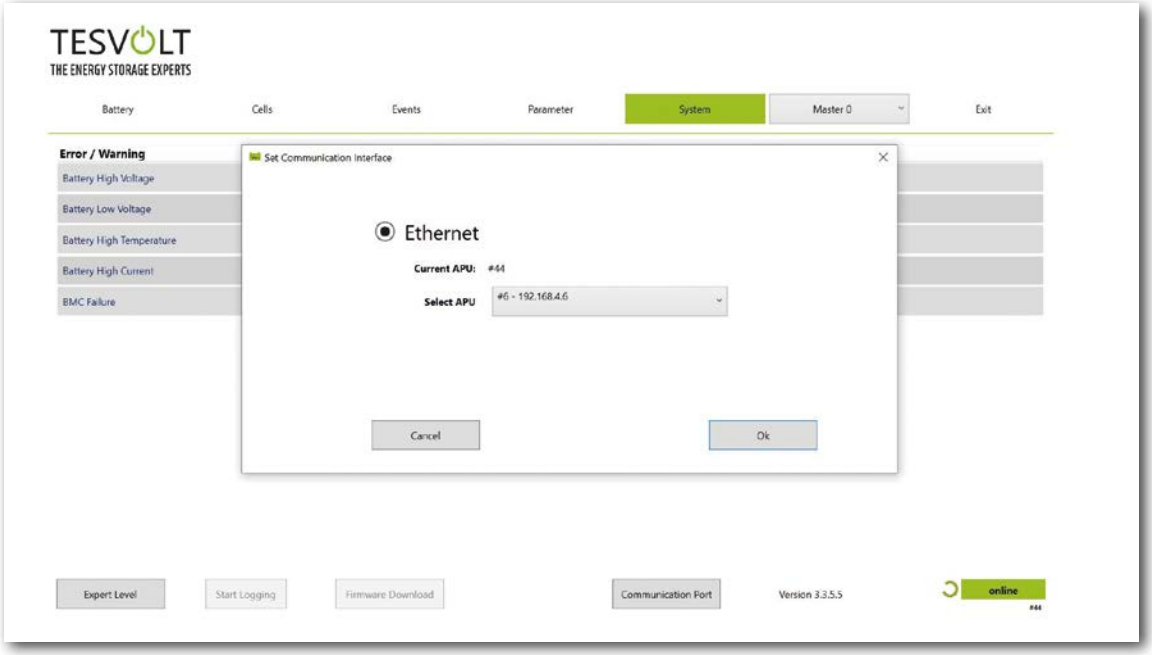


Figure 17.1 Screen for setting the network configuration

NOTE: If the configuration is correct and the battery is successfully connected, a continuous green circle and the "online" icon will appear in the bottom right-hand corner of the BatMon interface.

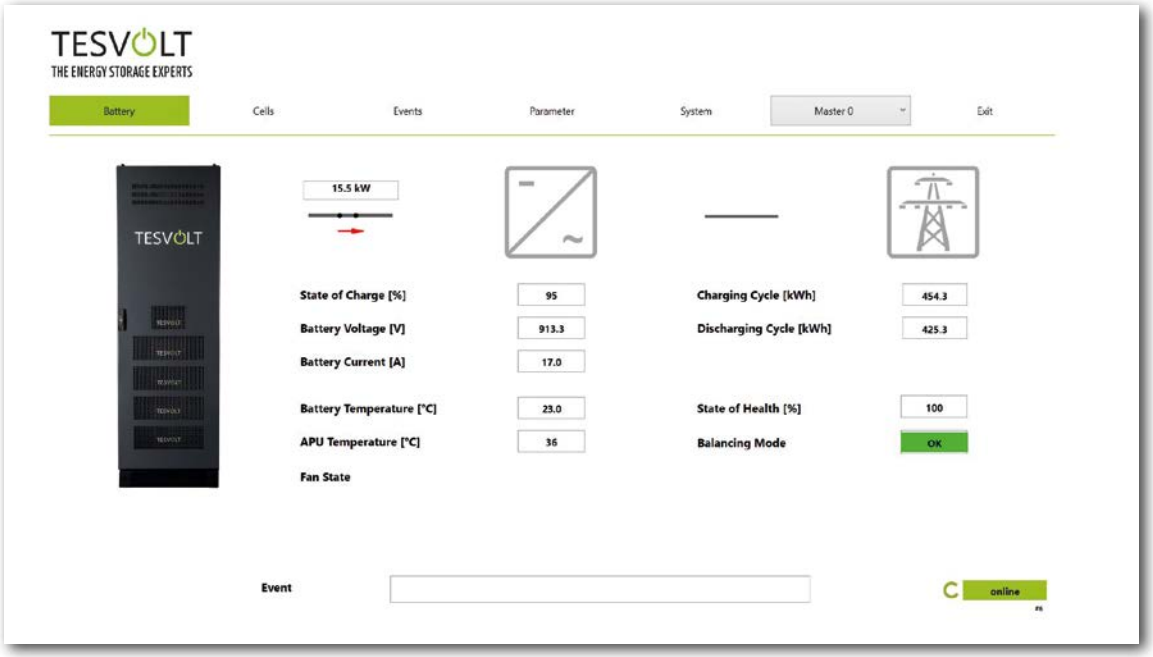


Figure 17.2 "Battery" screen

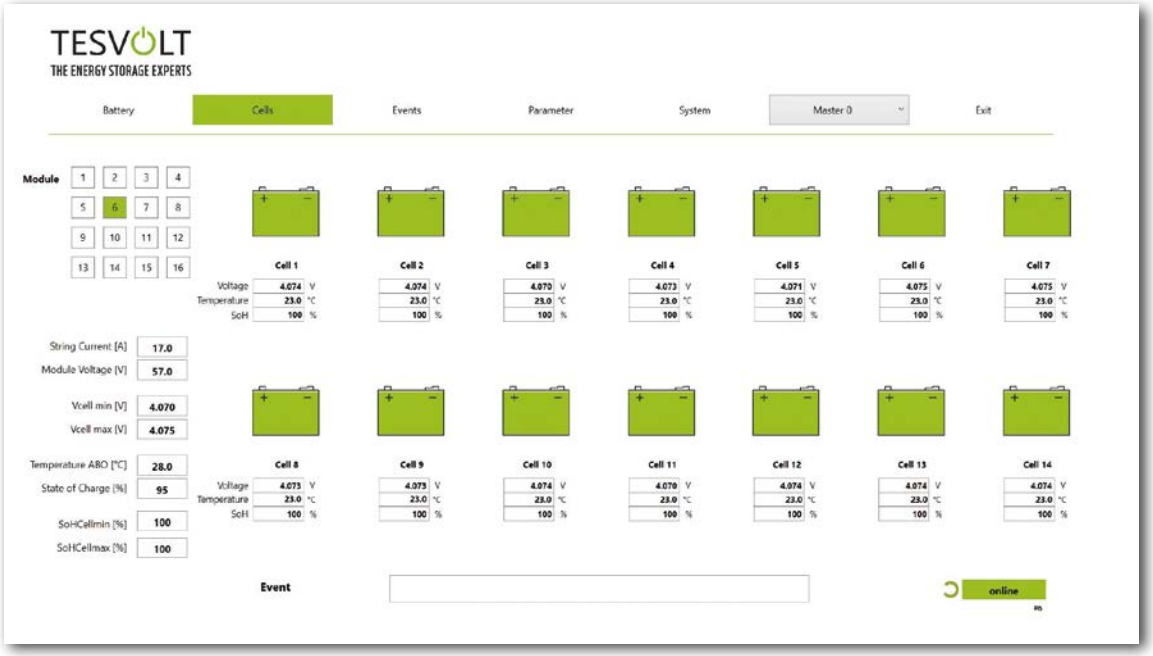


Figure 17.3 "Cells" screen

17.2 MENU STRUCTURE

The battery parameters highlighted in green in the table are password-protected. As these parameters directly affect the battery, only certified specialists are permitted to configure these parameters. You will receive the password directly from TESVOLT Service on request.

BATTERY	CELLS	EVENTS	PARAMETERS	SYSTEM	SELECTION
Charging/discharging power	Cell voltage	Event logbook	Battery parameters	Current errors	Master
Battery voltage	Cell temperature	Clear events	Load default	BatMon version	Slave
Charging/discharging current	SoC (cell)	Save events (as PDF)	Save default	Expert level	
Battery temperature	SoH (cell)		Reset APU	Start logging	
Balancing mode	Module voltage			Firmware download	
Charging cycle (kWh)	Charging/discharging power			Communication port	
Discharging cycle (kWh)	ABO temperature				
SoC (state of charge)					
SoH (state of health)					
Warning time		Displayed	Expert settings	Functions	
APU temperature		Data	Only with password		

17.3 THE MOST IMPORTANT CELL PARAMETERS

SoC – state of charge

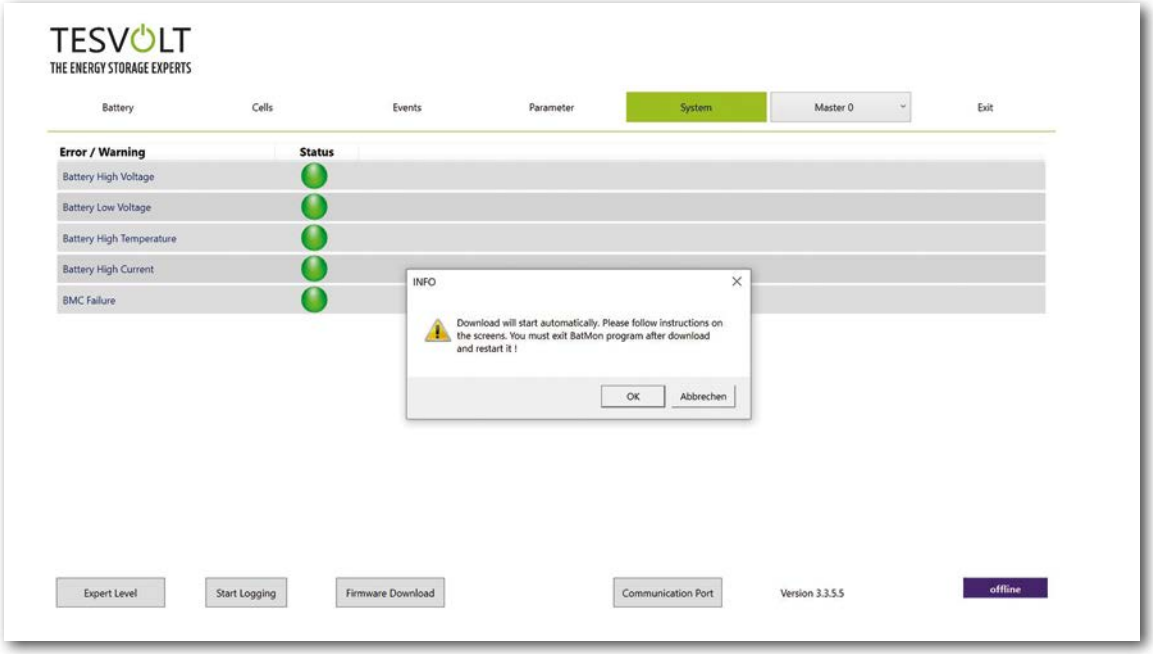
This value indicates the percentage to which the battery has been charged. 100% refers to a fully charged battery. The APU HV1000-S can use the parameters to determine the state of charge of a cell or battery module, and to stop the charging process if necessary. This prevents overcharging. The software also has the same function for the discharge process to prevent unnecessary strain on cells. Battery limit states define the points at which the system stops charging and discharging.

SoH – state of health

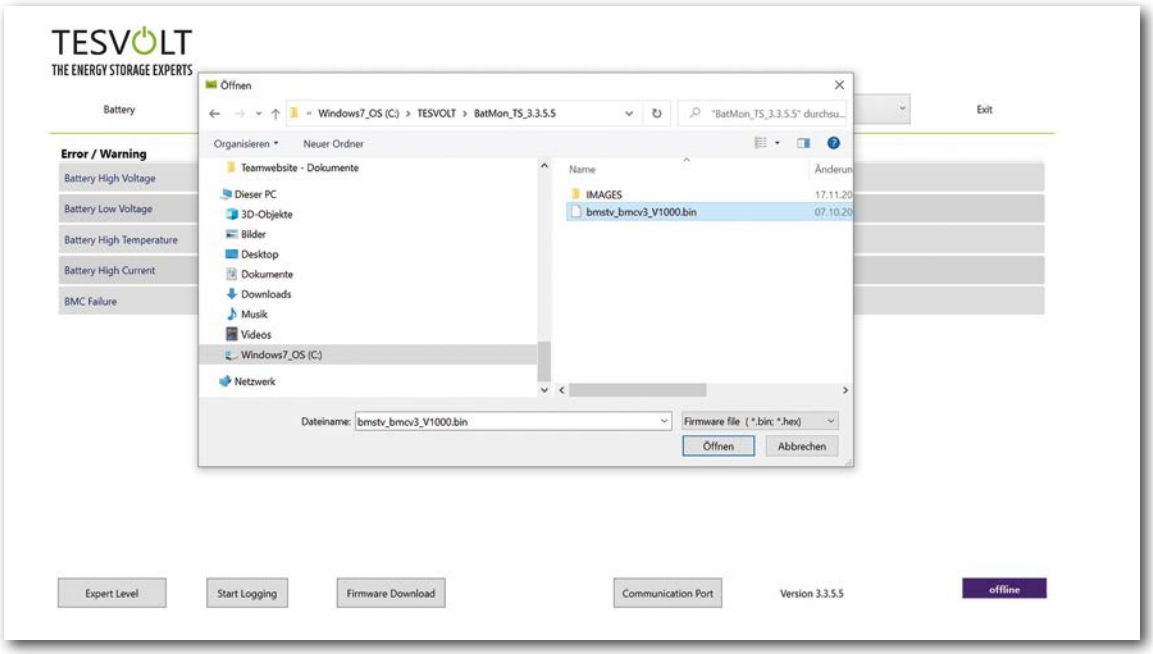
This value indicates a cell's health. Precise monitoring allows the system to detect performance differences between individual cells and thus detect damaged/defective cells. Depending on the seriousness of the fault, disconnection between the APU HV1000-S and inverter or switching off of the battery storage system may occur.

18 FIRMWARE UPDATE

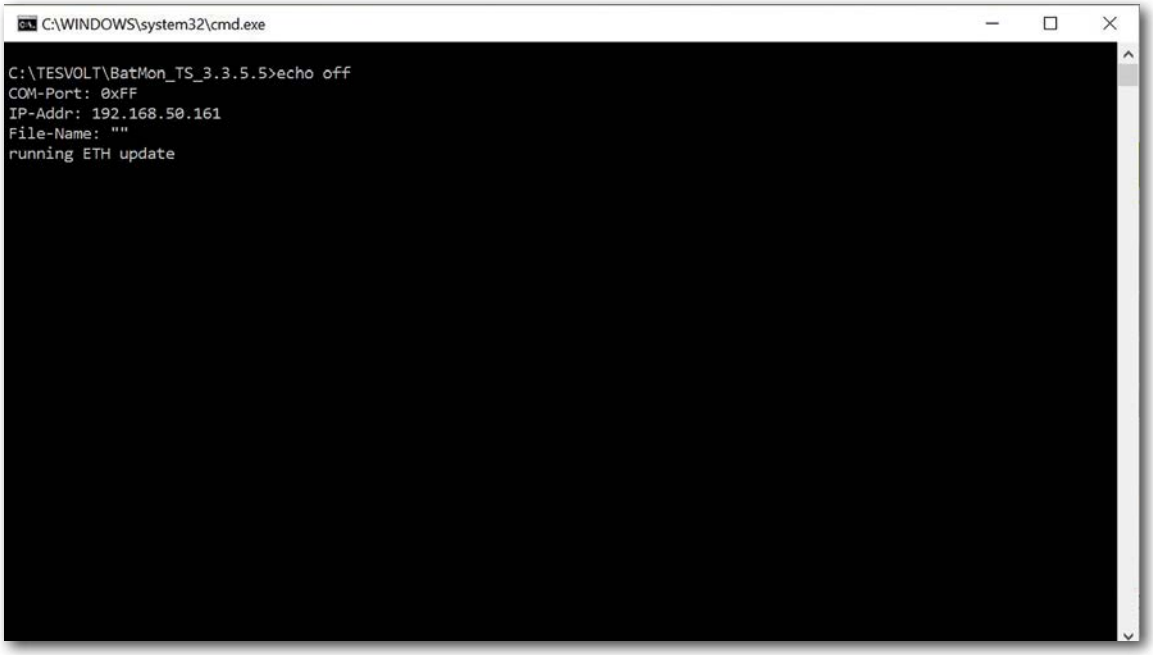
If required, the firmware update is installed via BatMon in coordination with TESVOLT Service. To do this, you have to enter the password in the Expert Level on the "System" page in BatMon. This can only be done in coordination with TESVOLT Service.



The latest firmware can then be downloaded with the "Firmware download" button on the "System" tab.



In the window that opens, select the firmware file (.bin) and confirm the selection by clicking on "Open".



Next, the update window opens. The update may take up to one minute. Afterwards, BatMon must be restarted.

19 FAULT AND WARNING MESSAGES ON THE TS HV 80

There are different types of messages as follows:

- Information (I): Status information, no error
- Warning (W): The system continues to run (possibly with limitations).
- Error (F): The system will shut down.

ID	TYPE	MESSAGE	DESCRIPTION	ERROR HANDLING
102	I	I102 Reset	Restart of the APU	After 5 unsuccessful restart attempts the APU HV1000-S goes into "sleep mode". In this case: Shut down the system. Contact TESVOLT Service.
104	F	F104 Current sensing error	Faulty current measurement	Shut down the system. Contact TESVOLT Service.
106	I	I106 E-stop	E-stop has been activated/deactivated.	If the e-stop signal is continuous: Check e-stop wiring and correct if necessary. Shut down the system. Contact TESVOLT Service.
110	I	I110 Precharge	APU HV1000-S starts precharging of the battery inverter.	–
121	F	F121 Parameter fault	A parameter value is outside the safe range.	Load default parameters. Perform a restart. Warning! Customer-specific parameters will be overwritten.
122	I	I122 Event buffer cleared	The message memory has been erased.	–
123	I	I123 Default parameters loaded	The default parameter values have been loaded.	To restore customer-specific parameter settings, contact TESVOLT Service.
201	F	F201 IsoSPI connection timeout	The communication between the APU HV1000-S and battery modules is interrupted.	Check the BAT-COM wiring. Shut down the system. Contact TESVOLT Service.
202	W	W202 Master/Slave communication timeout	Communication between the APUs in the master/slave configuration is faulty.	Check the master/slave configuration (addressing, termination). Check the communication links between APUs.
205	F	F205 No. Modules master/slave not consistent	A slave shows a different number of modules than the master.	Check the BAT-COM cabling and the system configuration. After this, start the systems individually and check the displayed number of modules in each case.
206	F	F206 Balancing selftest (startup) failed	The ABO selftest failed.	Perform a restart. If the error occurs more than once: Shut down the system. Contact TESVOLT Service.
207	F	F207 Module configuration fault	Different number of configured and communicating battery modules	Perform a restart. Perform reconfiguration. If the error continues to occur: Shut down the system. Contact TESVOLT Service.
208	F	F208 I_String1 offset fault	An implausible current value has been measured.	Perform a restart. If the error continues to occur: Shut down the system. Contact TESVOLT Service.
209	F	F209 Cell configuration fault	Voltage detected at an ABO measuring channel to which no battery cell should be connected	Perform a restart. If the error continues to occur: Shut down the system. Contact TESVOLT Service.
211	F	F211 Difference V_String/V_ext too high	Difference between external and internal voltage measurement too high.	Perform a restart. Check module configuration and correct if necessary. If the error continues to occur: Shut down the system. Contact TESVOLT Service.
212	F	F212 Reverse polarity detected V_ext	A negative voltage has been measured at the output.	Check power wiring for the system. If the error continues to occur: Shut down the system. Contact TESVOLT Service.

ID	TYPE	MESSAGE	DESCRIPTION	ERROR HANDLING
213	F	F213 Contactor fault	Contactor is defective.	Contact TESVOLT Service immediately! Switch off the system. Disconnect the battery inverter from the utility grid. If possible, switch DC switch on battery inverter to O.
214	F	F214 Reference voltage fault	Hardware error detected	Shut down the system. Contact TESVOLT Service.
215	W	W215 High temperature difference (module) warning	An excessive temperature difference within a battery module was measured.	The system enables the regular power again as soon as the temperature difference is within the permissible range. In case of repeated, continuous occurrence, check for external sources of heat or cold.
216	W	W216 High temperature difference (string) warning	An excessive temperature difference within a battery string was measured.	The system enables the regular power again as soon as the temperature difference is within the permissible range. In case of repeated, continuous occurrence, check for external sources of heat or cold.
217	F	F217 Balancing selftest fault	ABO selftest failed	Perform a restart. If a hardware defect occurs, a corresponding error message is shown.
218	F	F218 Temperature NTC open wire	Contact error in the temperature line	Shut down the system. Contact TESVOLT Service.
219	F	F219 Temperature NTC short circuit	Contact error in the temperature line	Shut down the system. Contact TESVOLT Service.
220	F	F220 LTC Diagnostics: Open wire	Contact error between ABO and battery cell	Shut down the system. Contact TESVOLT Service.
221	F	F221 LTC diagnostic fault: Category 1	Internal ABO error	Perform a restart. If the error continues to occur: Shut down the system. Contact TESVOLT Service.
222	F	F222 LTC diagnostic fault: Category 2	Internal ABO error	Perform a restart. If the error continues to occur: Shut down the system. Contact TESVOLT Service.
223	F	F223 LTC diagnostic fault: Sum of cell fault	Internal ABO error	Perform a restart. If the error continues to occur: Shut down the system. Contact TESVOLT Service.
301	F	F301 ABO board temperature max	The temperature of the ABO board is too high. The system will be disconnected and balancing switched off.	Let the system cool down and restart. If the error occurs frequently: Shut down the system. Contact TESVOLT Service.
305	F	F305 Balancer temperature high	The temperature of the balancer of an ABO board is too high.	If the error occurs frequently: Shut down the system. Contact TESVOLT Service.
310	W	W310 Contactor EOL warning	The lifespan of the contactors will soon be reached.	Maintenance/replacement of the contactors will soon be necessary. Contact TESVOLT Service.
311	W	W311 Contactor EOL OC warning	The end of the contactors' lifespan due to overcurrent shutdowns will soon be reached.	Maintenance/replacement of the contactors will soon be necessary. Contact TESVOLT Service.
360	F	F360 Contactor EOL reached	The end of the contactors' lifespan has been reached.	Maintenance/replacement of the contactors is required. Contact TESVOLT Service.
361	F	F361 Contactor EOL OC reached	The end of the contactors' lifespan due to overcurrent shutdowns has been reached.	Maintenance/replacement of the contactors is required. Contact TESVOLT Service.
701	I	I701 External heartbeat timeout	No heartbeat signal via the Modbus interface for more than 15 minutes.	Check the network connection and configuration.
911	F	F911 Permanent system lock	The system was operated outside of specifications and was shut down for safety reasons. SYS LOCK appears on the display.	This error cannot be acknowledged. An on-site inspection of the system by TESVOLT Service is required. Shut down the system. Contact TESVOLT Service.

ID	TYPE	MESSAGE	DESCRIPTION	ERROR HANDLING
921	F	F921 Cell max voltage	Overvoltage in a battery cell	Contact TESVOLT Service.
922	F	F922 Cell min voltage	Undervoltage in a battery cell	Contact TESVOLT Service.
923	F	F923 Battery max temperature	The upper temperature limit of a battery cell has been exceeded.	Shut down the system and let it cool down to at least 25°C. Check the wiring of the battery modules and the ventilation of the battery storage system. Perform a restart.
924	F	F924 Battery min temperature	The temperature has fallen below the lower limit of a battery cell.	Shut down the system and increase the ambient temperature to at least 5°C. Perform a restart.
927	F	F927 Battery high current (I_MAX)	Overcurrent shutdown. This error is automatically acknowledged three times.	If the error occurs frequently: Shut down the system. Contact TESVOLT Service.
928	F	F928 Hardware safety block / HW high current	Hardware overcurrent shutdown. This error is automatically acknowledged three times.	If the error occurs frequently: Shut down the system. Contact TESVOLT Service.
931	F	F931 Dynamic cell imbalance fault	Dynamic cell imbalance detected. This may indicate a defective battery cell.	Perform a restart. If the error continues to occur: Shut down the system. Contact TESVOLT Service.
932	F	F932 Static cell imbalance fault	Static cell imbalance detected. This may indicate a defective battery cell.	Perform a restart. If the error continues to occur: Shut down the system. Contact TESVOLT Service.
933	F	F933 APU HV1000-S Temperature max	The temperature limit value of the APU HV1000-S has been reached.	Allow the system to cool down. The system will then reconnect automatically. If the error continues to occur: Shut down the system. Contact TESVOLT Service.
934	F	F934 Precharge fault	Precharge error. This error is automatically acknowledged twice.	If the third attempt also fails: Check power wiring for incorrect polarity. If no error is found: Shut down the system. Contact TESVOLT Service.
935	F	F935 Battery EOL reached	The end of the lifespan of a module has been reached (end of life).	Shut down the system. Contact TESVOLT Service.
937	W	W937 Cell high voltage	Overvoltage in one battery cell in the battery module	If the error continues to occur: Shut down the system. Contact TESVOLT Service. If the error continues to occur: Shut down the system. Contact TESVOLT Service.
938	W	W938 Cell low voltage	Undervoltage in one battery cell in the battery module	If the error continues to occur: Shut down the system. Contact TESVOLT Service. If the error continues to occur: Shut down the system. Contact TESVOLT Service.
939	W	W939 Battery high temperature	Warning: The temperature of a battery cell is too high. The permissible charge and discharge current is limited.	If the error occurs frequently: Check the wiring of the battery modules and the ventilation of the battery storage system.
940	W	W940 Battery low temperature	Warning: The temperature of a cell is too low. The permissible charge and discharge current is limited.	If possible, increase the ambient temperature to at least 5°C.
943	F	F943 Battery high current (temperature derating)	Excessive current	Restart the system. If the error continues to occur: Shut down the system. Contact TESVOLT Service.
947	W	W947 Dynamic cell imbalance warning	Dynamic cell imbalance. This may indicate defective battery cells.	If the warning occurs more frequently: Shut down the system. Contact TESVOLT Service.
948	W	W948 Static cell imbalance warning	Static cell imbalance	If the warning continues to occur: Shut down the system. Contact TESVOLT Service.
949	W	W949 APU HV1000-S temperature high	APU temperature too high. The system power will be limited to 50%.	If the warning occurs more frequently:

ID	TYPE	MESSAGE	DESCRIPTION	ERROR HANDLING
951	W	W951 Battery EOL warning	The end of the battery lifespan will soon be reached.	Contact TESVOLT Service.
972	F	F972 Isolation fault	Isolation fault in the DC line (excessive differential current measured)	Check the grounding of the battery cabinet and APU HV1000-Sas well as the wiring. If no error is detected: Shut down the system. Contact TESVOLT Service.
973	F	F973 Isolation sensor selftest fault	The differential current sensor has a fault.	Shut down the system. Contact TESVOLT Service.
974	F	F974 Isolation sensor selftest fault (offset)	The differential current sensor has a fault.	Shut down the system. Contact TESVOLT Service.

NOTE: For further assistance or in the event of persistent faults, please email service@tesvolt.com or contact the TESVOLT Service Line +49 (0) 3491 87 97 - 200.

20 MAINTENANCE

WARNING! Possible damage to the unit and/or battery inverter if it is not decommissioned correctly

Before carrying out maintenance work, ensure that the TS-I HV 80 is decommissioned in accordance with the specifications in section "15 Decommissioning" on page 83.

NOTE: When cleaning and maintaining the TESVOLT PCS battery inverter, always follow the specifications and instructions in the technical documentation from the manufacturer MR GmbH.

NOTE: The locally applicable regulations and standards are to be adhered to for all maintenance work.

The TESVOLT USB drive (12) contains the template of a maintenance log which you can use as an aid.

20.1 MAINTENANCE OF THE BATTERY STORAGE SYSTEM TS HV 80

The lithium cells used by TESVOLT for the TS HV 80 are low-maintenance. However, to ensure safe operation, all plug connections must be inspected and, if necessary, pressed back into place by qualified specialists at least once a year.

The following checks or maintenance work must be carried out once a year:

- General visual inspection
- Check all screwed electrical connections: Check the tightening torque with the values specified in the following table. Loose connections must be retightened to the specified torque.

CONNECTION	TIGHTENING TORQUE
APU grounding	6 Nm
Central grounding point	10 Nm

- Check the SoC, SoH, cell voltages and temperatures of the battery modules for irregularities using the BatMon software.
- Switch the TS HV 80 off and on again once a year.

NOTE: Take a screenshot of the "Battery" and "Cell" page of each battery module and archive them together with all events as a PDF.

If you would like to clean the battery cabinet, please use a dry cleaning cloth. Ensure that no moisture comes into contact with the battery connections. Do not use solvents of any kind.

20.2 MAINTENANCE OF THE BATTERY INVERTER TESVOLT PCS

To ensure a long service life of the system, regular maintenance work according to the maintenance schedule is required. In addition, regular cleaning of the filter system is necessary.

These checks should be carried out annually:

- General visual inspection
- Check spare parts and accessories for completeness and perfect condition.
- Check overcurrent protection devices for tripping and tight fit.
- Check fan for proper functioning and clean if necessary. Fans must be replaced every 2–3 years under extreme conditions (continuous operation at maximum temperature and power) and every 5 years under moderate operating conditions.

- Check of all screwed electrical connections: Check the tightening torque with the values specified in the following table. Loose connections must be retightened to the specified torque.

CONNECTION	TIGHTENING TORQUE
AC connections M10	40 Nm
AC connections M12	70 Nm
DC connections	6–8 Nm

- Clean the ventilation openings of the compensation cabinet, check the filter mats (if present) and replace them if necessary
- Check the functions and put the system back into operation.

If defects are found, the cause must be determined and the affected components replaced. Dust in the control cabinet must be removed in a suitable manner.

NOTE: If the system is installed in a polluted environment, maintenance and cleaning work must be carried out at shorter intervals.

21 STORAGE

To ensure a long battery life, the storage temperature should be kept in a range between –20°C and 50°C and the cells should be cycled at least every six months. To minimise self-discharge during longer storage periods, the DC connection cables should be removed from the "BATTERY" connections 1/2 of the APU HV1000-S. This interrupts the power supply of the 24 V power supply installed in the APU HV1000-S and prevents discharge of the battery.

22 DISPOSAL

22.1 DISPOSAL OF THE BATTERY STORAGE SYSTEM TS HV 80

TESVOLT battery modules installed in Germany are integrated into the free GRS take-back system.

For disposal, please contact the TESVOLT Service Line +49 (0) 3491 87 97 - 200 or email service@tesvolt.com. Further information can be found at http://www.en.grs-batterien.de/index/.

The batteries may only be disposed of in accordance with the disposal regulations for used batteries applicable at the time of disposal. Immediately decommission any damaged batteries and please contact your installer or sales partner first before disposal. Ensure that the battery is not subjected to moisture or direct sunlight. Ensure quick removal by your installer or TESVOLT.

1. Do not dispose of batteries and rechargeable batteries in household waste! Please note that you are legally obliged to return used batteries and rechargeable batteries.
2. Used batteries may contain pollutants that can damage the environment or harm your health if they are not stored or disposed of properly.
3. Batteries also contain important raw materials such as iron, zinc, manganese, copper, cobalt or nickel and can be recycled.

Further information can be found at https://www.tesvolt.com/en/products/recycling.html

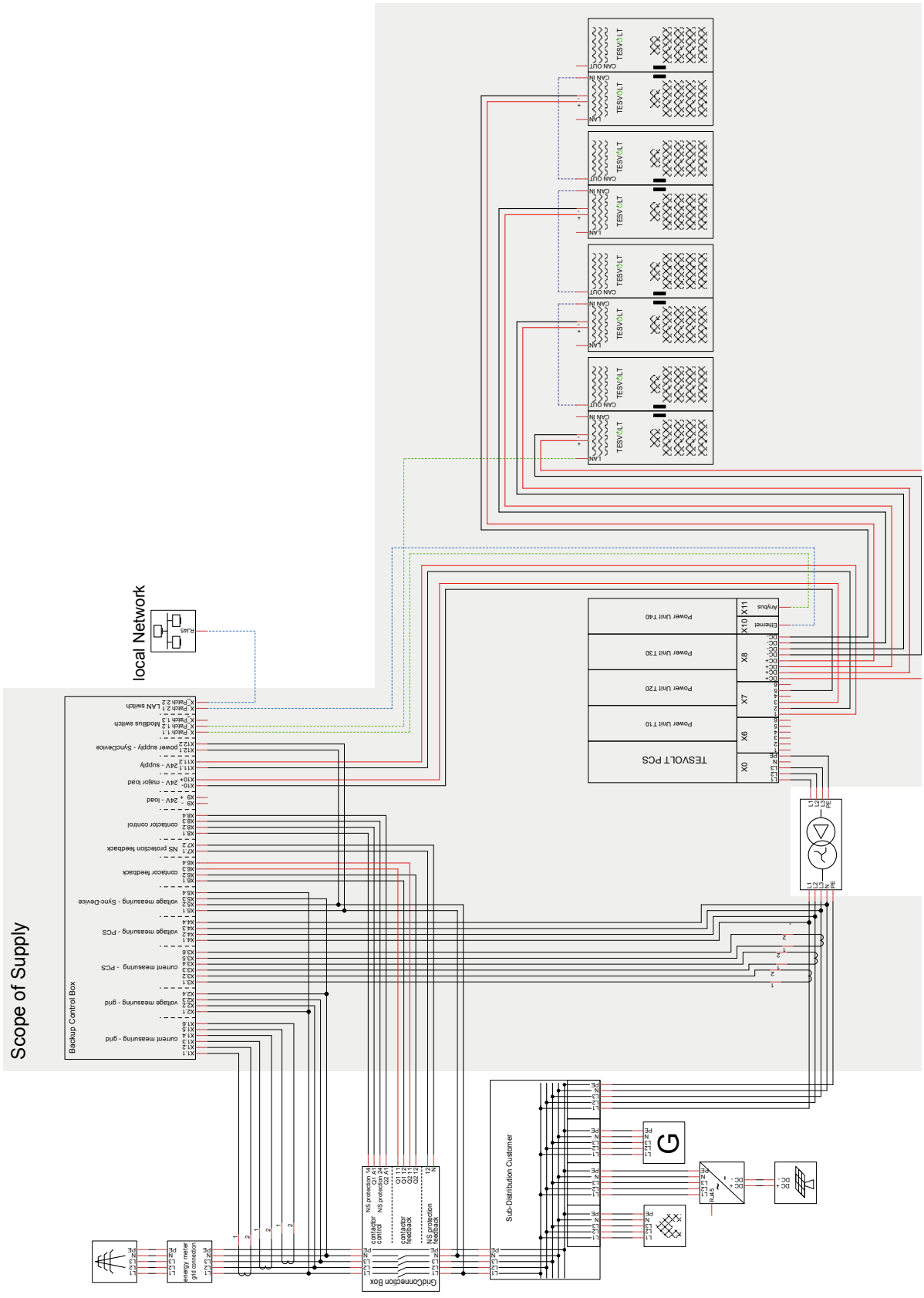
Do not dispose of batteries in household waste!

22.2 DISPOSAL OF THE BATTERY INVERTER TESVOLT PCS

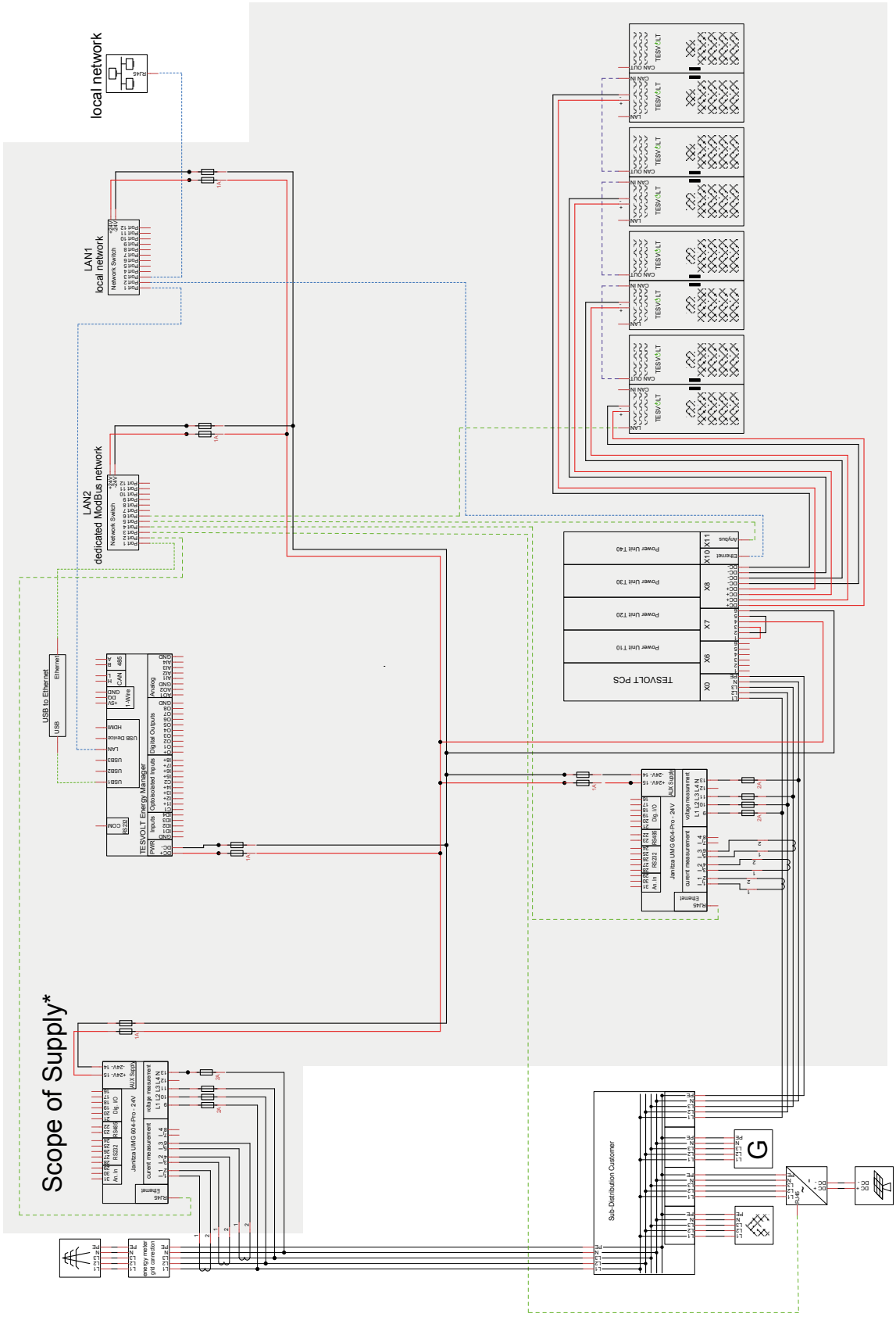
Separate the existing raw materials of the system according to disposal type and material. Copper-containing components such as busbars and cables can be recycled. Equipment such as contactors, fuses, capacitors, controllers and terminals must be disposed of as electronic scrap. These components must not be disposed of in household waste, as they may contain small amounts of heavy metals due to leaded solder or halogen compounds as well as PVC. The casing and mounting plates of the system can be recycled as metal scrap.

23 APPENDIX

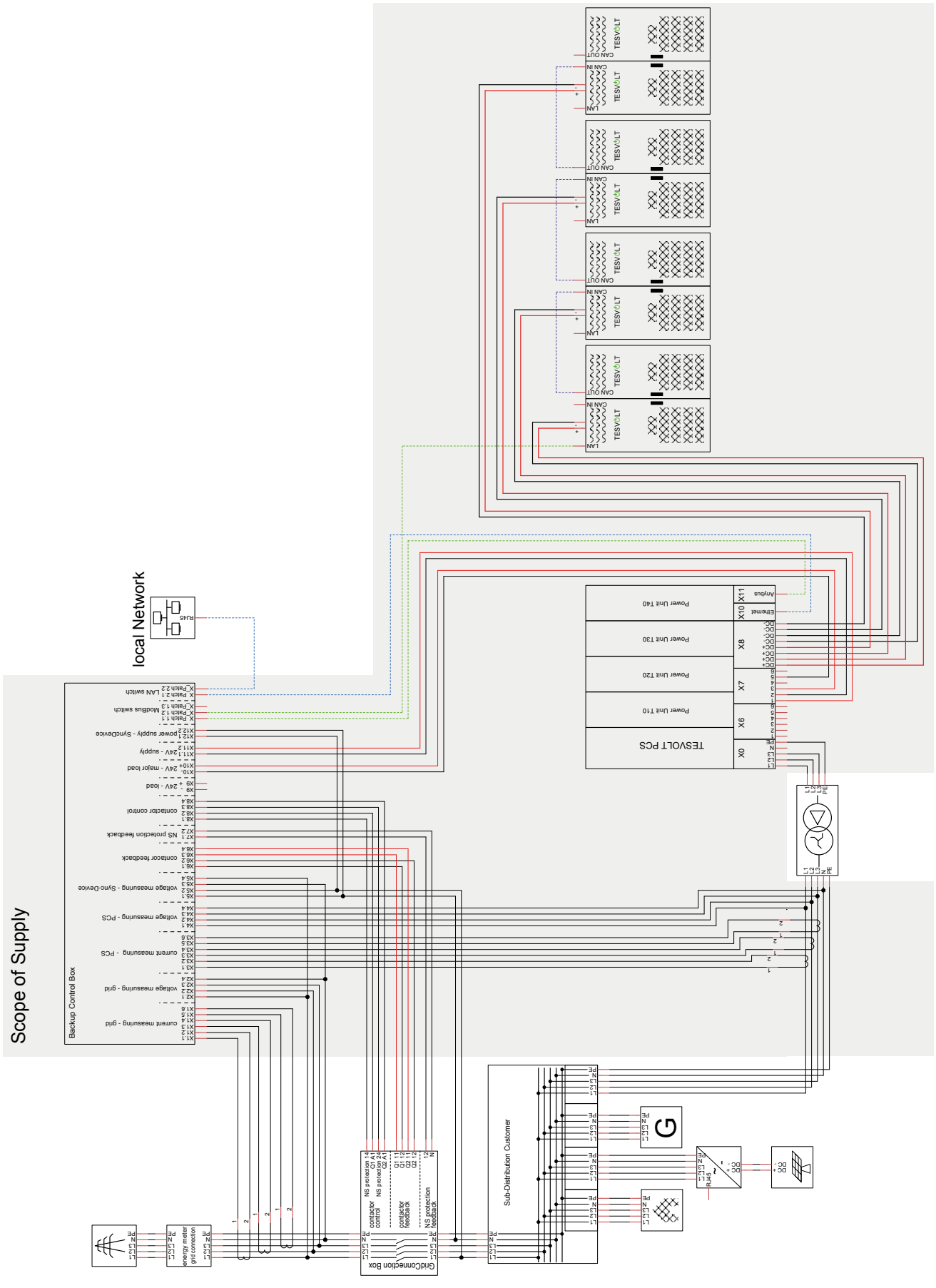
23.1 CIRCUIT DIAGRAM FOR ON-GRID SYSTEM WITH EXTERNAL 24 V SUPPLY



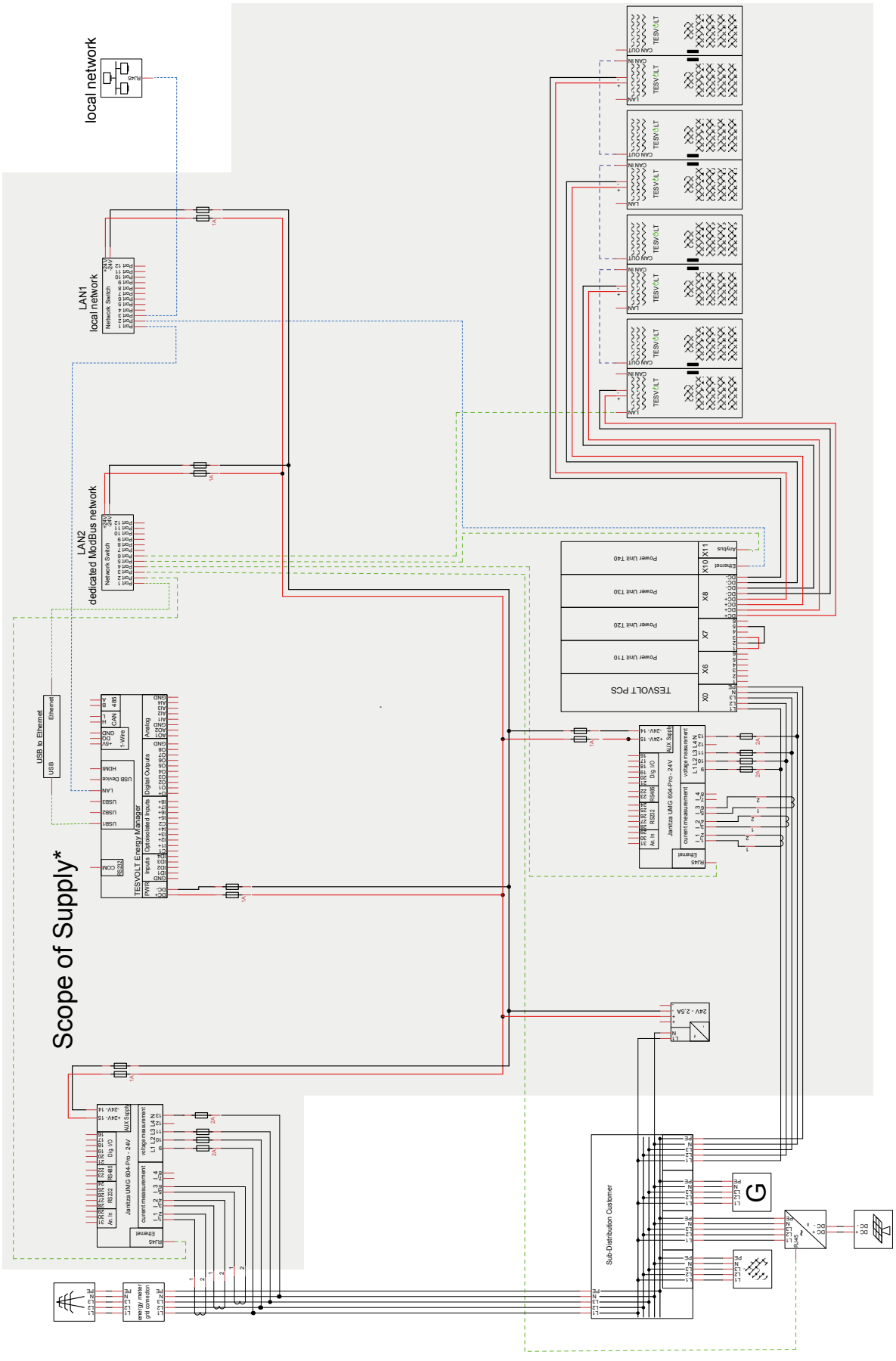
23.2 CIRCUIT DIAGRAM FOR ON-GRID SYSTEM WITH 24 V SUPPLY VIA TESVOLT PCS



23.3 CIRCUIT DIAGRAM FOR OFF-GRID SYSTEM WITH TESVOLT BACKUP CONTROL BOX



23.4 CIRCUIT DIAGRAM FOR OFF-GRID SYSTEM (FREE CONFIGURATION)



24 LEGAL NOTICE

TESVOLT TS-I HV 80 Lithium Battery Storage System Installation and Operating Manual

Last revised: 07/2021

Subject to technical changes.

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