OXYGEN

VOLTAGE SAG COMPENSATOR

USER'S MANUAL
MAT303 August 2021

Annexed:

SCHEMATICS

CONFORMITY DECLARATION

The Manufacturer,

ORTEA SpA
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Tel.: ++39 02 95917800 Fax: ++39 02 95917801
www.ortea.com - ortea@ortea.com

under its own responsibility

DECLARES

that the products:

3-PHASE VOLTAGE SAG COMPENSATOR

identified with the name:

OXYGEN (code SCXxxxxxxxCxxxx)

provided that they are installed, maintained and used for the purpose for which they have been designed and built according to good professional practice and in conformity with the Manufacturer's instructions,

COMPLY

with the requirements contained in the CE EUROPEAN DIRECTIVES:

- **2014/30/EU (EMC DIRECTIVE)**
- **2014/35/EU (LOW VOLTAGE DIRECTIVE)**
- **2011/65/EU (ROHS RECAST)**

as complying with the relevant parts of the Harmonised Standards:

- **EN 61439-1 (LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES. PART 1: GENERAL RULES)**
- **EN 61439-2 (LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR ASSEMBLIES. PART 2: POWER SWITCHGEAR AND CONTROLGEAR ASSEMBLIES)**
- **EN 55011 (INDUSTRIAL, SCIENTIFIC AND MEDICAL EQUIPMENT. RADIO-FREQUENCY DISTURBANCE CHARACTERISTICS. LIMITS AND METHODS OF MEASUREMENT)**
- **EN 61000-6-2 (ELECTROMAGNETIC COMPATIBILITY (EMC) GENERIC STANDARDS)**

The Manufacturer also

DECLARES

that the units are built with suitable quality components and that the manufacturing process is constantly verified in accordance with the Quality Control Plans which the Company applies in compliance with the **ISO9001:2015** Standard.
The Company's commitment towards environmental issues and safety at work matters is guaranteed by the certification of the Management System according to the ISO14001:2015 and **ISO45001:2018** Standards.

The General Sales Conditions, which include the warranty terms, can be downloaded either via the QR code or from the website www.next.ortea.com

1 INTRODUCTION

This Manual contains the information necessary to ensure correct operation of the unit, efficient maintenance program, avoidance of incorrect use and safety for the personnel involved with the unit performance. The sag compensator described in this manual must be used exclusively for the purpose for which they have been designed and manufactured. Installation must be done according to the instructions provided with this handbook. Any other use has to be considered as inappropriate and therefore dangerous. The Manufacturer shall not to be held liable for any damage to people and belongings due to incorrect use or installation. In case of doubt and for any other necessity, please contact the nearest authorised Service Centre. This Manual is as an integral part to the unit and the instructions therein must be carefully followed. File this manual and all the attached documentation for further consultation in a place available and known to the user and the maintenance personnel and keep it for the entire life of the unit.

1.1 INFORMATION PROPERTY

This Manual (including any attached document) is covered by copyright and the Manufacturer maintains all the reserved rights. It is compulsory to inform the Manufacturer's Head Office and ask for authorisation before proceeding with any release or reproduction. The Manufacturer shall not be held liable or responsible in any way for unauthorised copies, alterations or additions to the text or to the illustrated parts of this document. Any modification involving company logo, certification symbols, names and official data is strictly forbidden. In order to obtain better performance, the product described in this handbook can be altered at any date and without prior notice.

⚠ ***WARNING*** *INFORMATION AND INSTRUCTIONS PROVIDED BY THIS MANUAL ADD TO AND NEITHER REPLACE NOR AMEND ANY STANDARDS, REGULATIONS, DECREES, DIRECTIVES OR LAWS CONCERNING ENVIRONMENTAL AND SAFETY AT WORK AWARENESS ENFORCED BOTH INTERNATIONALLY AND IN THE COUNTRY OF INSTALLATION.*

1.2 DEFINITIONS

⚠ ***DANGER***	***MESSAGE RELEVANT TO POSSIBLE OR PROBABLE HAZARDOUS SITUATIONS WHICH MIGHT INDUCE SERIOUS OR EVEN FATAL HARM IF IGNORED OR NEGLECTED***
⚠ ***WARNING***	*MESSAGE RELEVANT TO POTENTIALLY HAZARDOUS SITUATIONS WHICH MIGHT INDUCE MINOR INJURIES IF IGNORED OR NEGLECTED. THE SAME SIGNAL CAN BE USED TO HIGHLIGHT HAZARDS WHICH MIGHT CAUSE DAMAGE TO THE UNIT OR TO POINT OUT IMPORTANT INFORMATION*
Note	*Additional information to understand the unit operation better*
UI	User Interface
CAN	Controller Area Network: multicast serial communication bus used to connect different electronic control units (ECU)
AAD	Audible Alarm Device: siren or other device producing a sound when the unit is in error condition
SAG or DIP	Temporary reduction of units' RMS input voltage, beyond continuous stabilisation limit.
OVV	Temporary rise of units' input voltage, beyond continuous stabilisation limit
ACB	Air Circuit Breaker
MCCB	Moulded Case Circuit Breaker
MCB	Mini Circuit Breaker

Note *In this document, the words line and phase will be used as synonyms when there is no ambiguity in their usage.*

2 ENVIRONMENTAL NOTE

Note *Units weighing more than 2000kg do not enter the scope of the 2012/19/EU WEEE Directive (Waste of Electric and Electronic Equipment) as they can be identified as large fixed industrial equipment. Nevertheless, although they do not bear the relevant symbol on their nameplates, it is recommendable to follow the Directive's guidelines concerning a responsible disposal at the end of their working life.*

With reference to the 2012/19/EU WEEE Directive (Waste of electric and electronic equipment), please be aware that the products described in this manual have been produced after August 13th 2015. When applicable, the WEEE symbol (beside) on the product label and / or accompanying documents means that used electrical and electronic equipment must not be mixed with general household or municipal waste. At the end of their useful life, these products must be disposed of via suitable channels. Please refer to the current legislation in force in the Country of installation. Professional users in the European Union must contact their dealer or supplier for further information. The symbol is only valid in the European Union (EU). For disposal in countries outside of the European Union please contact the local authorities or dealer and ask for the correct method of disposal. Disposing of this product correctly will help save valuable resources and prevent any potential negative effects on human health and the environment, which could otherwise arise from inappropriate waste handling. The product does not contain CFCs, HCFCs, asbestos, fuel, PCB, PCT, liquids or gaseous substances. Please recycle the packaging materials (cardboard and/or wood). At the end of the service, before disposing of the unit, remove the nameplate and make the appliance unusable by cutting the internal connections.

3 HEALTH & SAFETY

3.1 NOTES FOR THE OPERATOR

⚠ ***DANGER*** ***THE VOLTAGE INSIDE THE EQUIPMENT IS DANGEROUS. ACCESS TO THE COMPONENTS FOR INSTALLATION, SETTING, INSPECTION AND MAINTENANCE MUST BE GRANTED ONLY TO QUALIFIED PERSONNEL IN CHARGE OF IT AND INFORMED OF THE RELEVANT RISKS. BEFORE STARTING ANY OPERATION, DISCONNECT THE UNIT FROM THE MAINS.***

The following safety general instructions are based on experience and common sense, but cannot describe or foresee all the possible situations. Basic safety procedures must be continuously applied and known by whoever operates on the unit. In order to ensure full knowledge of properties and characteristics of the unit, this Manual must be read and comprehended by those who supervise, maintain and run the unit.

- Check that the unit is always properly earthed.
- Warn anybody who might be in the vicinity before energizing the unit.
- Always operate in good lighting.
- Do not allow unauthorized personnel to operate on the unit for no reason whatsoever.
- Always use suitable safety means such as isolating tools and footboards, isolating gloves, etc.
- NEVER operate the unit without the provided protections against accidental contact, unless specifically indicated in the maintenance instructions in this Manual. However, controls and maintenance routines that require the protections to be removed shall be under the User's full responsibility.
- Do not climb on top of the enclosure.
- Do not accumulate goods around or above the enclosure.

The unit is housed in an enclosure with screwed-in panels. In normal working conditions, the unit operates with the enclosure completely closed and cannot be accessed without opening the cubicle with specific means. The protection against direct contact is therefore inherently obtained. Any anomaly or alarm indication must be promptly signalled.

3.2 NOTES FOR MAINTENANCE

⚠ ***DANGER*** ***BEFORE ANY MAINTENANCE OR REPAIRING ROUTINE, DISCONNECT THE UNIT BY OPENING THE UPSTREAM GENERAL BREAKER AND LOCK IT WITH A PADLOCK, THE KEYS OF WHICH MUST BE KEPT BY THE MAINTENANCE SUPERVISOR UNTIL THE END OF THE PROCEDURE.***

- Do not perform maintenance while the unit is working. Only setting or checking operations through the provided instrumentation are allowed.
- Whenever possible, do not use hands instead of suitable tools to work on the unit.
- Do not use bars, cables, plates or internal components as support or handhold.
- Check that mechanical and electrical connections are properly tightened at the end of the maintenance routine.
- Do not remove, alter or damage nameplates, warnings of any identification tags or labels.
- Before re-energising, always restore the protection that might have been removed for maintenance.

In case of doubts on the operational features or on the necessary maintenance procedures, please contact the Manufacturer or an authorised Service Centre.

Tampering on the unit relieves the Manufacturer from any responsibilities and makes the User solely responsible towards the competent bodies concerning accident prevention. The Manufacturer disclaims all responsibility for:

- failure to follow the specified instructions
- modification (even slight) performed on the unit resulting in altering its operational features
- failure to comply with the health and safety at work measures
- use of not original spare parts (unless specifically authorized by the Manufacturer)

During maintenance and repairing procedures, the enclosure is likely to be open. Consequently, some residual dangers persist, due to the impossibility of eliminating the sources as implicit in the working procedures.

DANGER	INDICATIONS
CRUSHING	Handling the unit must be done exclusively by means of the tools described in the relevant chapter. Handling and lifting operations must be carried out by skilled and trained personnel only.
ELECTROCUTION	During normal working operation, the danger does not exist. Carry out maintenance routines only after having disconnected the unit. Should it be necessary to test an energized unit, segregate the area so that only skilled personnel can operate, still in compliance with all the health and safety requirements set forth by the Rules and Regulations enforced in the Country of installation.
FIRE	Open the upstream interrupting device and use CO_2 fire extinguishers. Do not use water to extinguish fire.
HUMAN ERROR	Installation, start-up, setting, inspection, maintenance and repairing operations must be carried out by skilled, qualified and authorized personnel only, informed of the relevant risks. Read this Manual carefully and thoroughly before operating on the unit. Altering its configuration or replacing one or more of its parts without the Manufacturer's authorization is strictly forbidden.
FAILURE TO CARRY OUT MAINTENANCE	Carry out the maintenance routine as prescribed in this Manual. The Manufacturer shall not be held liable in any way for damage to people and belongings caused by failure in performing maintenance on the unit.
LACK OF INFORMATION	While carrying out the maintenance routine, ensure that the unit cannot be energised without the maintainer's awareness. To this purpose, padlock the upstream interrupting device and affix warning signs.

3.3 BEHAVIOUR

The personnel dealing with the unit shall operate strictly in conformity with the requirements set forth by the health and safety at work Rules and Regulations enforced in the Country of installation. Provided that everything is carried out according to the instructions in this Manual, the unit is designed in order to work and be maintained without risks for people or the environment. The sag compensator is an automatic equipment that does not require manoeuvring or command drives.

However, personnel dealing with it must be aware of its characteristics, functioning features, signals and alarm indications, maintenance routines and troubleshooting procedures. The full comprehension of this Manual is therefore critical.

⚠ ***DANGER*** *TAMPERING AND/OR UNAUTHORISED REPLACEMENT OF ONE OR MORE COMPONENTS, USING ACCESSORIES, TOOLS OR MATERIAL NOT RECOMMENDED AND/OR NOT APPROVED BY THE MANUFACTURER MIGHT BE DANGEROUS AND CAUSE ACCIDENTS. SAID ACTIONS RELIEVE THE MANUFACTURER FROM ANY CIVIL AND/OR PENAL RESPONSIBILITIES.*

3.3.1 Correct behaviour

The User is protected against the risks related to the unit operation. The correct use allows for fully and safely exploiting its performance and can be obtained by:

- following the instructions provided by this use and maintenance Manual
- paying attention to the provided warnings and danger indications
- respecting the recommended maintenance frequency and keeping a record of the performed interventions
- disconnecting the unit in case of inspection, maintenance or repairing routines
- using suitable PPEs (Personal Protective Equipment) when dealing with the unit
- promptly informing the supervisor about operating anomalies (suspected malfunctioning, incorrect operation or failure; excessive noise; etc.) and if necessary putting the unit out of order.

3.3.2 Incorrect behaviour

Any use that contrasts with what stated above and any of the operations listed below can be defined as 'incorrect':

- arbitrary alteration of the working parameters. Should changes be required, please contact the Manufacturer or an authorized Service Centre
- use of improper of unsuitable energy sources
- unit operated by insufficiently trained personnel
- failure to comply with the maintenance instructions or incorrect maintenance
- use of unsuitable or unauthorized not original spare parts
- alteration of the safety devices and/or unit tampering
- performance of inspection, maintenance or repairing routines without disconnecting the unit

⚠ ***WARNING*** *THE MANUFACTURER SHALL NOT BE HELD LIABLE DUE TO ANY DAMAGE TO PEOPLE AND BELONGINGS ARISING FROM INCORRECT USE AS ABOVE DEFINED.*

The microprocessor-based control system detects data and anomalies, generating several alarms displayed by means of the external control panel. The alarms are generally accompanied by an acoustic signal.

⚠ ***WARNING*** *EXCLUDING OR BYPASSING IN ANY WAY THE ALARMS IS STRICTLY FORBIDDEN. THE MANUFACTURER DISCLAIMS ALL RESPONSIBILITY ON THE UNIT SAFETY IN CASE OF FAILURE TO RESPECT SAID BAN.*

3.4 PERSONAL PROTECTIVE EQUIPMENT (PPE)

While dealing with the unit, the user must have and use suitable PPEs, in conformity with the safety requirements enforced in the Country of installation and with the relevant European Directives (89/656/EEC and 89/686/EEC). The Manufacturer strongly recommends dressing suitably, avoiding clothes that might be caught up, wide sleeves, synthetic material, scarves and ties. Necklaces, bracelets, metallic wristwatches and similar object should also be avoided. In the table below, the recommended PPEs are listed:

		USER	MAINTAINER	DANGER	CONSEQUENCE
	SAFETY SHOES	✹	✹	Bumping, tripping, slipping, crushing limbs	Bruises, abrasions, cuts, sprains, dislocations, fractures
	SAFETY GLOVES	✹	✹	Contact with sharp surfaces or edges	Bruises, abrasions, cuts
	SAFETY DIELECTRIC GLOVES		✹	Contact with live parts when testing an energized unit	Electrocution
	HELMET		✹	Bumps to the head in case of suspended loads or work inside the enclosure	Bruises, abrasions, cuts, concussion, fractures
	VISOR/GLASSES		✹	Contact with liquids and projectile	Eye injury, eyesight loss or limitation
	ANTI-ARC VISOR		✹	Contact with projectile and radiation from electric arc	Eye injury, eyesight loss or limitation
	GENERIC ANTI-DUST MASK		✹	Particulate and/or dust inhalation	Respiratory disorders

⚠ ***WARNING*** *A VISITOR CAN APPROACH A WORKING UNIT ONLY IF THE LATTER IS COMPLETELY CLOSED. SHOULD THE INTERNAL COMPONENTS BE SHOWN, REGARDLESS OF THE PROTECTION AGAINST ACCIDENTAL CONTACT, THE UNIT WILL HAVE TO BE SWITCHED OFF. OTHERWISE, THE VISITOR SHALL BE MAINTAINED AT A SAFETY DISTANCE BY MEANS OF PHYSICAL BARRIERS.*

4 HANDLING

4.1 PACKAGING

The units can be packaged either in cardboard boxes strapped to a pallet and wound in plastic film or in a wooden crate with seaworthy vacuum bag. Each unit is provided with a label indicating nominal data, consignee data and purchasing order details. The package bears the usual pictograms (; ;) and, in case of wooden crate, the indication of the lifting points for chains or fork-lift trucks. With cardboard box packaging, anti-shock and anti-tilting indicators are also affixed.

4.2 RECEPTION

At reception, check the integrity of the packaging and the absence of evident damage occurred during transport. If the unit does not require immediate installation, store it with its original packaging. Once the good condition of the delivery has been established, unpack the unit and check it. In the unlikely event of damage, DO NOT CONNECT the unit and notify the Manufacturer in writing immediately.

4.3 DOCUMENTATION

The unit is accompanied by a set of documents positioned in a pocket inside one of the front doors (usually the one bearing the display). The set includes User's manual and relevant annexes, schematics and test report.

4.4 STORAGE

Should the unit be stored, ensure that it is kept sheltered from rain or snow, excessive humidity, adverse climatic conditions (atmospheric pollution, saline atmosphere, parasites, etc.) at a temperature between -25°C and +60°C and relative humidity lower than 95% (not condensing)..

4.5 MOVING THE UNIT

⚠ ***WARNING*** *THE UNIT MUST BE KEPT IN VERTICAL POSITION, AS INDICATED ON THE PACKAGING. LAYING IT DOWN INTO HORIZONTAL POSITION MIGHT SERIOUSLY DAMAGE THE INTERNAL COMPONENTS, ALTER THE MECHANICAL STABILITY AND COMPROMISE THE FUNCTIONALITY.*

Unloading and moving operations are under the User's responsibility. Take the utmost care in order to avoid damage to whoever might be around the unit, to the unit itself and to belongings or other equipment on the installation site. Unloading and moving operations can be performed via cranes fitted with chains or lifting brackets or fork-lift trucks. The lifting devices must be suitable to the unit weight, in good conditions and regularly checked and maintained. If required by the weight distribution inside the cabinet (which might not be balanced), the lifting points are highlighted by means of stickers (black arrow on yellow field).

⚠ ***DANGER*** ***HANDLING OPERATIONS MUST BE CARRIED OUT ONLY BY AUTHORISED, SUITABLY TRAINED PERSONNEL PROVIDED WITH THE NECESSARY PERSONAL PROTECTIVE EQUIPMENT (PPE). ALWAYS OPERATE IN CONFORMITY WITH THE SAFETY AT WORK RULES AND REGULATIONS ENFORCED IN THE COUNTRY OF INSTALLATION AND WITH THE INSTRUCTION MANUALS OF THE TOOLS USED. THE MANUFACTURER SHALL NOT BE HELD LIABLE FOR ANY DAMAGE THAT MIGHT OCCUR TO PEOPLE OR BELONGINGS DUE TO FAILURE IN COMPLYING WITH WHAT STATED ABOVE DURING UNLOADING AND MOVING OPERATIONS.***

5 DESCRIPTION

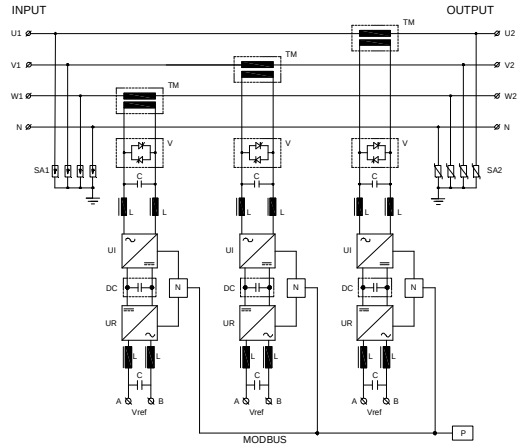
Please refer to the attached Data Sheet for a complete list of the technical characteristics. The present handbook deals only with the standard units. If optional devices such as by-pass switch, circuit breakers, etc. are provided, please refer to the attached relevant technical sheets. The unit's main features are:

- Voltage regulation based on IGBT static switches (double-conversion technology)
- Independent stabilisation on each single phase
- Output voltage accuracy: ± 0.5%
- Regulation speed: < 3ms
- Admitted load range: 0 – 100%
- Admitted overload: 150% for 1min at nominal input voltage
- No output voltage harmonic distortion introduced
- Insensitivity to the load power factor

5.1 MAIN COMPONENTS AND WORKING PRINCIPLE

- three-single-phase 'buck/boost' transformers adding or subtracting the voltage necessary to compensate for the mains fluctuation
- three conversion units (AC/DC rectifier and DC/AC inverter)
  - Rectifier = it converts the phase to neutral voltage of the AC mains into DC voltage by means of a fully-controlled IGBT bridge. The rectifier is sized in order to supply the inverter at full load.
  - Inverter = it converts the DC voltage coming from the rectifier into AC voltage, stabilised in amplitude. The inverter uses the same IGBT technology as the rectifier.
- three IGBT microprocessor-based electronic control boards running the system in terms of regulation and alarm management. They compare the output voltage value to the set one: if a difference is detected, they generate the compensation necessary to bring back the output voltage to the nominal value (provided that said difference falls in the working range).
- touchscreen display

A representation of the system is shown in the picture below. The control circuit compares the output voltage value to the adjusted one. When the percentage variation is too high, the control drives the double conversion regulators. By doing so setting and supplied the voltage to the buck/boost transformer primary winding. Being the secondary voltage of the buck/boost transformer in phase or in opposition to the supply, the voltage drawn from the regulator is added or subtracted to the mains voltage, thus compensating its variations with response time in milliseconds.

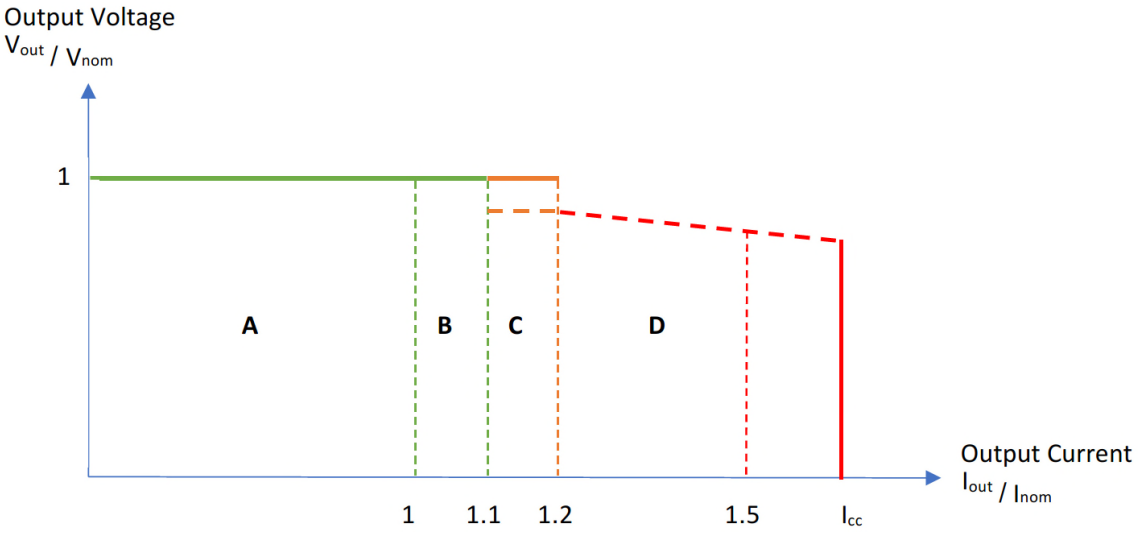


SA1	class I SPD
TM	Buck/boost transformer
V	Thyristor-based protection
UR	AC/DC rectifier
UI	DC/AC inverter
DC	DC bus
L	Commutating reactor
C	Filtering capacitor
N	Control card
P	User interface (touchscreen display)
SA2	class II SPD

***Note**. Depending on the unit's rating and configuration, the converters can be supplied either a phase-to-neutral voltage or a phase-to-phase voltage at terminals A-B.*

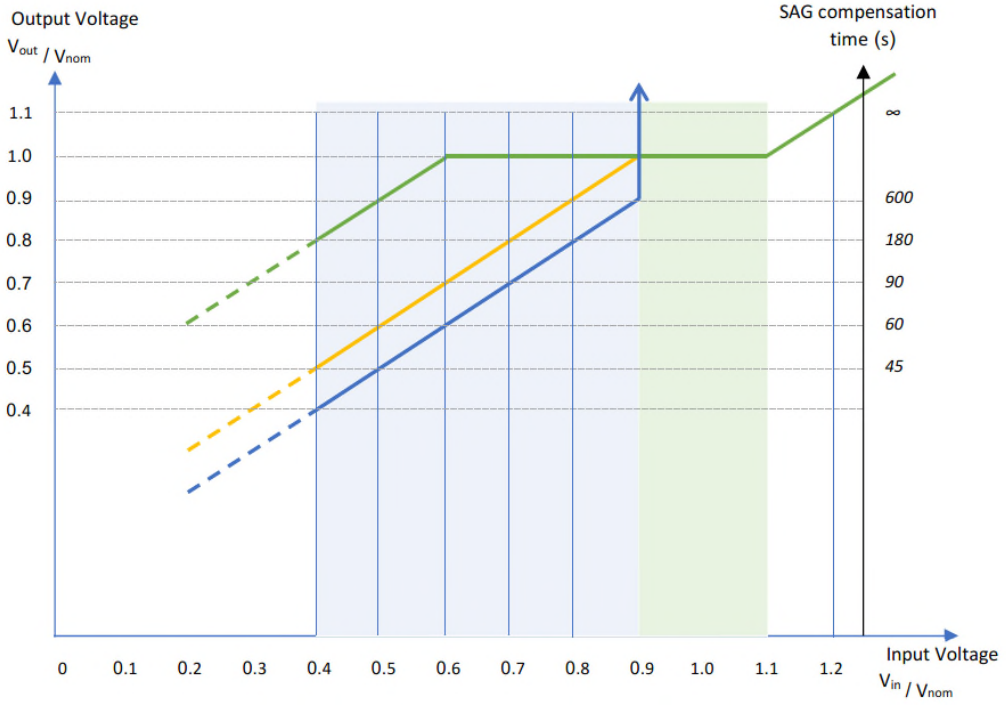
The remote communication can be obtained via a TCP MODBUS® protocol or a Client application that enables the remote reproduction of the control panel on a PC connected to it by means of an Ethernet network.

5.2 OPERATING CURVES



Area A	regular operation
Area B	admitted overload
Area C:	admitted overload for 60s maximum; once this time has elapsed, the unit switches to e-bypass mode and $V_{out} = V_{in}$ (dashed line) until I_{out} drops below $1.1 \cdot I_{nom}$
Area D	the unit switches immediately to e-bypass mode and Vout = Vin (dashed line) until I_{out} drops below $1.1 \cdot I_{nom}$

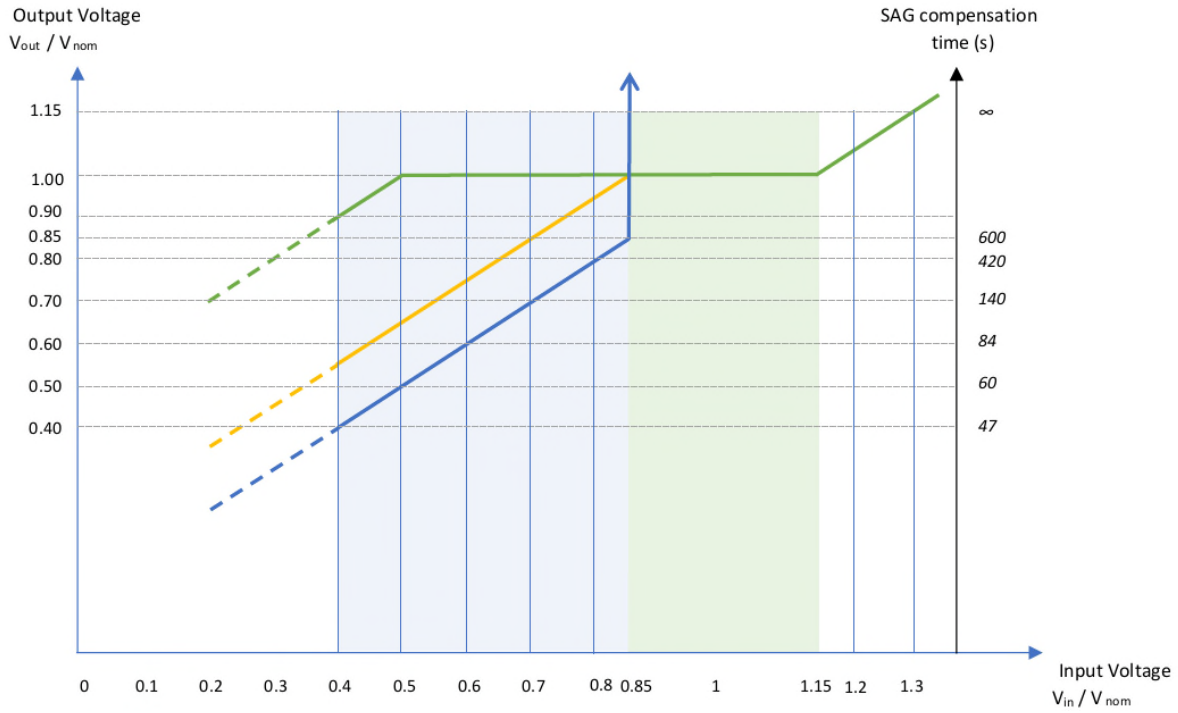
5.2.1 Compensating range: ±10/-40%



0 ≤ Vin/Vnom < 0.4	undefined behaviour zone; behaviour depends on the grid's characteristics – dashed lines
0.4 ≤ Vin/Vnom < 0.9	SAG compensation zone; full compensation time depends on the SAG depth. If the SAG persists for longer than a given time (60s @ V_{in}=60%V_{nom}) the unit behaviour switches from green solid line to orange solid line
0.9 ≤ Vin/Vnom ≤ 1.1	voltage stabilisation zone; any input variation is compensated for an indefinite time
Vin/Vnom > 1.1	SWELL mitigation zone; input voltage is decreased by 10%V_{nom}
Blue solid line	SAG full compensation maximum time[1] at a given input voltage

[1]: maximum cumulated time in a 600s period

5.2.2 Compensating range: ±15/-50%



0 ≤ Vin/Vnom < 0.4	undefined behaviour zone; behaviour depends on the grid's characteristics – dashed lines
0.4 ≤ Vin/Vnom < 0.85	SAG compensation zone; full compensation time depends on the SAG depth. If the SAG persists for longer than a given time (60s @ V_{in}=50%V_{nom}) the unit behaviour switches from green solid line to orange solid line
0.85 ≤ Vin/Vnom ≤ 1.15	voltage stabilisation zone; any input variation is compensated for an indefinite time
Vin/Vnom > 1.15	SWELL mitigation zone; input voltage is decreased by 15%V_{nom}
Blue solid line	SAG full compensation maximum time[1] at a given input voltage

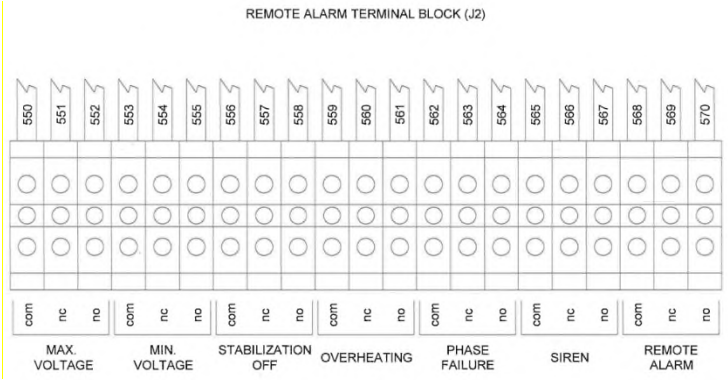
1: maximum cumulated time in a 600s period

5.3 PROTECTIONS

PROTECTION AGAINST	IN CASE OF	ACHIEVED THROUGH	EFFECT
OUTPUT SHORT-CIRCUIT	Load failure	Thyristor driver board	The buck/boost transformer is short-circuited and the compensating section is excluded; Unit supply cut off
OVERHEATING	Temperature on the IGBT heatsink > 65°C	Thermal probe and electronic bypass	Stabilisation off (V_{in} = V_{out}).
ANOMALOUS VOLTAGE IN THE DC BUS	DC bus voltage higher than set reference value	DC voltage sensing board	Unit is switched off by the control logic to avoid filter capacitors damage or explosion
IGBT SATURATION	IGBT short circuit	Desaturation detection circuit (IGBT driver board)	Unit is switched off by control logic
OVERVOLTAGE	Lightning	Input Class I SPDs	Overvoltage discharged to ground
OVERVOLTAGE	Transients & spikes	Output Class II SPDs	Overvoltage discharged to ground

5.3.1 Outputs available to the user

The alarm signal can be transferred to a remote position via the terminals included in the J1 auxiliary terminal block. The contacts are potential free and isolated between each other.



The following table lists a brief description of each alarm. The NO acronym means *normally open*, while NC means normally closed. Please pay attention to the alarm condition and check whether the contact is open or closed when the alarm is on.

TERMINAL	DESCRIPTION
MAX VOLTAGE ALARM	NO contact is *closed* on alarm, opened when everything is working correctly. Typically, the contact will close when the output voltage rises above the allowed threshold and will open when the output voltage falls below said threshold.
MIN VOLTAGE ALARM	NO contact is *closed* on alarm, opened when everything is working correctly. Typically, the contact will close when the output voltage falls below the allowed threshold and will open when the output voltage rises above said threshold.
STABILISATION OFF ALARM	NO contact is *closed* each time the unit is in a state in which the stabilisation function is off (internal bypass is on, unit in error or in idle state). Please note that it is possible to have stabilisation off signal even if output voltage is at its nominal value – input voltage is at nominal value and unit has internal bypass on.
OVERHEATING ALARM	NO contact is *closed* each time the unit detects a temperature on heatsinks higher than 65°C (150°F); the contact is then opened when temperature drops below 60°C (140°F)
PHASE FAILURE ALARM	NO contact is *open* on alarm, closed when everything is working correctly. Typically, the contact is open on unit power up and, after an initial check, it will be closed. An open contact can indicate one of the following cases: • A phase failure – input phase-to-neutral voltage less than $70V_{AC}$ • A phase rotation problem • The unit is not yet powered up
SIREN ALARM	NO contact is *closed* on alarm condition, open if everything is working correctly.
REMOTE ALARM	NO contact is *closed* on alarm condition, open if everything is working correctly.

6 INSTALLATION & COMMISSIONING

⚠ ***DANGER*** ***DO NOT CONNECT IN PARALLEL TO EACH OTHER TWO OR MORE SAG COMPENSATORS OUTPUT LINES.***

6.1 SITE CHOICE

The installation site must comply with the basic requirements listed below:

- unless otherwise agreed upon, the ambient temperature must fall in the -20/+40°C range
- unless otherwise agreed upon, the maximum installation altitude is 1000mt a.s.l.
- the floor or surface must be flat and able to withstand the unit's weight;
- the installation room dimensions and the airing system must ensure that the generated heat can be disposed of, otherwise, a cooling system must be arranged (see also the chapter on ventilation);
- the lighting system must be suitable for normal operating and maintenance routines;
- the ground circuit must comply with the relevant applicable rules and regulations;

If not previously arranged during the contracting phases, the unit must not be commissioned in case of:

- corrosive, explosive or flammable atmosphere;
- presence of conductive dust in the environment;
- proximity to radiation sources;
- possibility of floods.

Avoid direct heat and contact with liquid, flammable or corrosive materials.

Do not clog the cabinet air outlets and leave 150-200mm clearance to allow for the air to circulate.

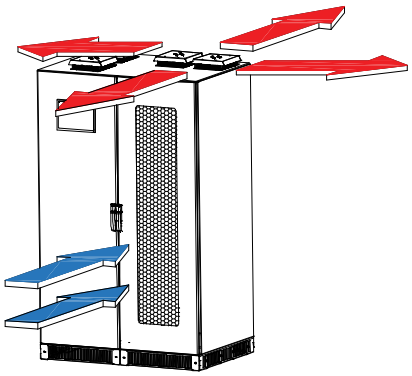
Check that anti fire devices are available in the area.

6.2 COOLING AIRFLOW AND CIRCULATION

6.2.1 Standard Units

The cooling air enters the unit through the base air inlets and the grills located on the front door and exits from the top through the hooded fans mounted on the cabinet roof.

Being the ambient colder than the cabinet inner environment, the air is sucked in through the base and the grids and conveyed inside. Only by ensuring this operating mode and an airflow rate adequate to the sag compensator in hands, the correct separation between cold and hot areas can be maintained and the proper operation of the unit guaranteed.



6.2.2 Special Units

On customer request, it is sometime possible that the cabinet enclosing the sag compensator is not provided with standard openings for cold air input and hot air output (for example, in case of sealed units for harsh environmental condition equipped with coolers, or units for outdoor usage). In these cases, please refer to the unit specifications and annexed schematics for layout details.

6.3 ELECTRICAL CONNECTION

⚠ ***DANGER*** ***THE SAG COMPENSATOR IS NOT AND MUST NOT BE USED AS A PROTECTING DEVICE FOR NEITHER THE PLANT NOR THE LOADS. THE ELECTRICAL CONNECTION MUST BE CARRIED OUT BY TRAINED AND QUALIFIED PERSONNEL, AWARE OF THE INVOLVED RISKS. ALWAYS USE SUITABLE TOOLS AND PERSONAL PROTECTIVE EQUIPMENT (PPE). THE OPERATIONS MUST BE CARRIED OUT IN CONFORMITY WITH THE RULES AND REGULATIONS ENFORCED IN THE COUNTRY OF INSTALLATION.***

Please refer to the annexed schematics for details on the connections.

6.3.1 Supply

The supplying line must comply with the technical data specified in the nameplate. The unit is not protected against short-circuit or overload. In compliance with the safety regulations in force, the installation should take place in a system fitted with:

- an interrupting device with capacity referred to the maximum input current upstream the unit
- an interrupting device with capacity referred to the output current downstream the unit

The above-mentioned protections are not included with the standard unit and must be part of the supplying line.

6.3.2 Connections

Note *The cross-section value of the cables/bars for the connection to mains and load falls entirely under the installer's responsibility. The Manufacturer shall not be held liable for any damage that might occur to people or belongings due to an incorrect choice.*

Open the cubicle and locate main parts and connection points. Remove the accidental contact protections. Prepare the connection cables/bars with regard to the nominal current and make them go through the openings prepared on purpose. The very first operation is to connect the earth wire to the terminal identified by PE, GRD or ⏚.

⚠ ***DANGER*** ***THE EARTH CONDUCTOR MUST NEVER BE ELECTRICALLY INTERRUPTED NEITHER INSIDE NOR OUTSIDE THE UNIT.***

The earth wire cross-section must be chosen in conformity to the regulations in force. Therefore, depending on the phase cable cross-section, the earth wire cross-section should respect the values in the table below:

PHASE CABLE CROSS-SECTION S [mm^2]	EARTH WIRE MIN CROSS-SECTION [mm^2]
$S \leq 16$	S
$16 < S \leq 35$	16
$35 < S \leq 400$	S/2
$400 < S \leq 800$	200
$S > 800$	S/4

Note *If the application of this data determines a not standardised cross-section, the nearest larger one should be chosen.*

⚠ ***WARNING*** *FOR THE CORRECT OPERATION OF THE- SAG COMPENSATOR, THE NEUTRAL WIRE MUST BE AVAILABLE AND CONNECTED TO THE RELEVANT TERMINALS.*

Connect the unit to mains and load, trying to avoid kinks and accidental contact between the cables and the electric components. Make the connections respecting the indications written on the terminations.

⚠ ***WARNING*** *BE SURE THAT PHASE AND NEUTRAL WIRES ARE CONNECTED TO THE RELEVANT TERMINALS. SWAPPING THE INPUT CONNECTION WITH THE OUTPUT ONE COULD CAUSE SERIOUS DAMAGE.*

Check the tightness of the connections and carefully close the cabinet.

7 ELECTRONIC BOARDS

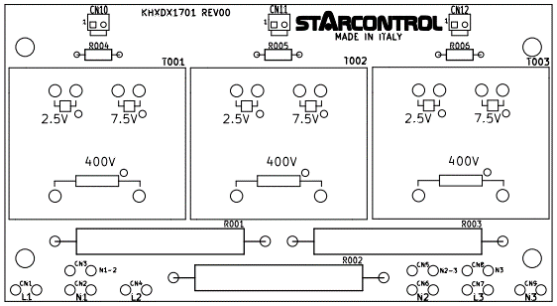
For each board a sketch of the board and a table of main connectors are shown. Maintainers can use the information provided in this chapter to perform some measurements or checks, following the Service instructions, in order to deal with troubleshooting.

DANGER ***ACCESS TO THE INTERNAL COMPONENTS FOR INSTALLATION, SETTING, INSPECTION AND MAINTENANCE MUST BE GRANTED ONLY TO QUALIFIED PERSONNEL IN CHARGE OF IT AND INFORMED OF THE RELEVANT RISKS. ANY INTERVENTION MUST BE CARRIED OUT IN COMPLIANCE WITH THE HABITUAL RULES ON PERSONAL SAFETY AND USE OF ADEQUATE PROTECTIVE TOOLS.***

7.1 AC VOLTAGE SENSING BOARD KHXDX1701

The board hosts the voltage sensing transformers (TV) used for the reading of a single phase:

- Input voltage, line-to-neutral
- Booster secondary winding voltage
- Output voltage, line-to-neutral

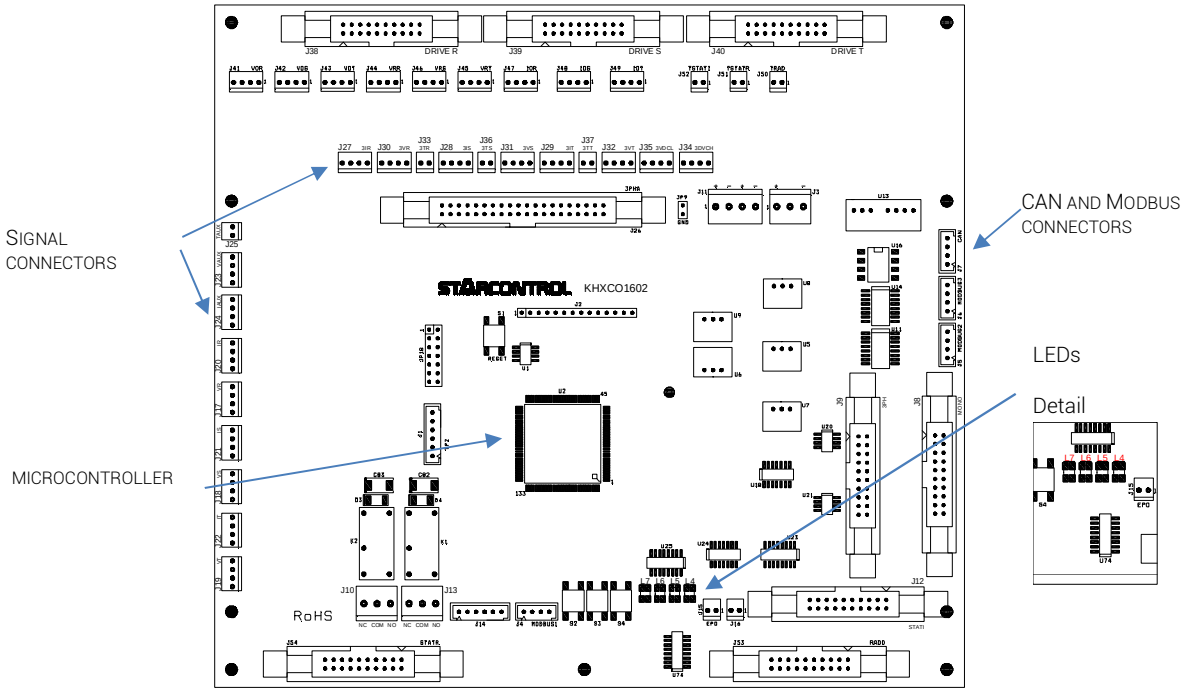


CONNECTOR	DESCRIPTION
CN10	Input voltage signal (V_{in}/40); connected to controller board
CN11	Output voltage signal (V_{out}/40); connected to controller board
CN12	Booster voltage signal ($V_{booster}$/40); connected to controller board
CN1-CN2	Input voltage V_{in} (≤500V_{AC}); connected to input phase-to-neutral voltage
CN4-CN6	Output voltage V_{out} (≤500V_{AC}); connected to output phase-to-neutral voltage
CN7-CN9	Booster voltage $V_{booster}$ (≤500V_{AC}); connected to input/output phase voltage

7.2 CONTROLLER BOARD KHXC01601

The controller board is the heart of the sag compensator. It hosts the microcontroller unit that, by analysing the input voltage and current signals, generates the IGBT driving signals in order to generate the booster voltage to be added or subtracted to the input voltage to keep the output at the desired level. The board:

- manages measurement of electrical parameters
- performs software execution
- handles the set and the clear of alarms
- signals, by mean of 4 LEDs, the actual state of software execution
- handles communication toward the user interface (UI) panel and other single-phase controller boards; communication includes Modbus and CAN

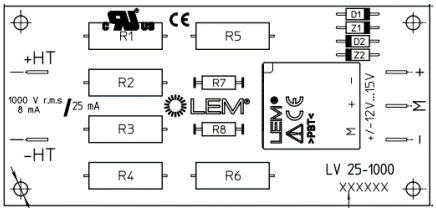


LED	COLOUR	DESCRIPTION
L4	Green	Pre-charge contactor close
	Orange	Pre-charge contactor close and running fans
	Red	Running fans
L5	Red	Init
	Orange	Start AD converter micro
	Blinking orange (1Hz)	Waiting
	Blinking green (2Hz)	Start pre-charge
	Blinking green & red (5Hz)	Check value dc voltage and contactor is closed
	Blinking green (1Hz)	Start stabiliser
	Blinking red (5Hz)	Overload and bypass
	Blinking green (0.25Hz)	Board and stabiliser test mode
	Blinking red & orange (5Hz)	Error
L6	Blinking green (1Hz)	Start software
L7	Green	Power supply

CONNECTOR	DESCRIPTION
J1	Synchronous Serial Interface, to KHSF01701/CN2
J3	Power supply, 24V_{DC}
J5	Modbus RTU, 9600bps, 8-n-1
J6	Modbus RTU, 9600bps, 8-n-1
J7	CAN
J8	Rectifier's IGBT driving signals
J9/J38	Inverter's IGBT driving signals
J12	Thyristor's driving signals, to KHXC01604/CN1
J17	Phase-to-Neutral input voltage signal (max 14V_{AC-RMS})
J18	Phase-to-Neutral output voltage signal (max 14V_{AC-RMS})
J19	Transformer booster voltage signal (max 14V_{AC-RMS}) – secondary winding
J23	Phase-to-Phase output voltage signal (max 14V_{AC-RMS}) – rectifier power supply
J25	Temperature NTC sensor
J33	Temperature NTC sensor
J36	Temperature NTC sensor
J37	Temperature NTC sensor
J27	Inverter's current (1V/100A, 1V/200A depending on unit configuration)
J28	Rectifier's current (1V/100A, 1V/200A depending on unit configuration)
J29	Unit's input current (4.1V_{RMS}/1000A_{RMS}, 4.1V_{RMS}/5000A_{RMS} depending on unit configuration), from KHXC01604/[CN600 | CN601]
J34	DC-Bus voltage signal (2.5V/1000V)

7.3 DC VOLTAGE SENSING BOARD 6HDS504

This board is used to measure the DC-Bus voltage. It hosts an insulated voltage transducer to provide galvanic separation between the primary – exposed to voltages up to 1000V_{DC}, and the secondary side.



CONNECTOR	DESCRIPTION
+HT	Positive terminal DC voltage to be measured (max 1000V between +HT and -HT)
-HT	Negative terminal DC voltage to be measured (max 1000V between +HT and -HT)
-	Secondary side power supply (-15V_{DC}), to be provided
M	Measure signal, scale 25mA/1000V (measured toward power supply GND)
+	Secondary side power supply (+15V_{DC}), to be provided

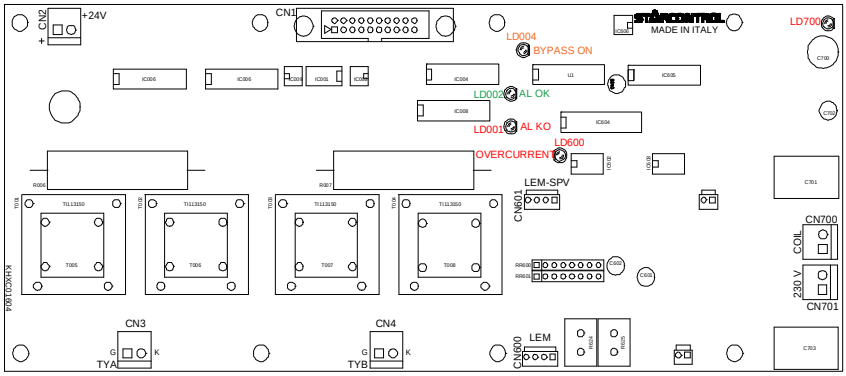
7.4 THYRISTOR DRIVER BOARD KHXC01604

Each phase regulator is equipped with a thyristor used to short circuit the transformer booster primary side.
The main usages of said thyristor are:

- Short circuit the primary side when unit is or is going into internal bypass mode (also indicated as e-Bypass);
- Short circuit the primary side to avoid hazardous overvoltage when a short circuit happens on the output; in this condition

the booster transformer works in a reverse mode, feeding to the primary side the unit's input voltage multiplied by the turn ratio. This phenomenon, if not handled, can cause DC-Bus voltage increase and, in worst cases, serious damage to DC-Bus capacitors.

Thyristor driving signals are provided by mean of a board capable to rapidly switch on the device.



LED	COLOUR	DESCRIPTION
LD001	Red	Incorrect board power supply
LD002	Green	Correct board power supply
LD004	Yellow	Bypass ON
LD600	Red	Input phase overcurrent
LD700	Red	Phase-to-neutral input voltage (190V_{AC} to 260V_{AC}) presence

CONNECTOR	DESCRIPTION
CN1	Thyristor's driving signals, from KHXC01601/J12
CN2	Power supply, 24V_{DC}
CN3-CN4	Thyristor driving signals
CN600	Input phase TA current transformer (up to 5000A/1A transformer ratio)
CN601	Input phase current signal (1A/5000A)
CN700	Primary side booster transformer short circuit contactor, power supply
CN701	Phase-to-neutral input voltage (190V_{AC} to 260V_{AC})

7.5 I/O EXPANDER BOARD KHSF01701

This board provides input and output lines to:

- Detect relevant events in the stabiliser (doors opening, circuit breaker position, on/off humidity sensors, etc.);
- Signal to external devices relevant events (stabilisation off, drive a siren, min/max voltage alarm, etc.)

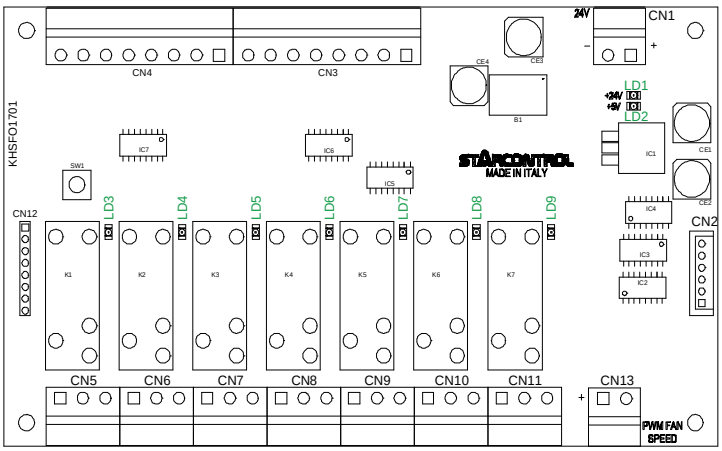
Inputs have to be provided via potential free contacts. The board provides up to 7 inputs.

Please refer to the unit specifications and annexed schematics for the meaning of a particular input signal.

Outputs are provided via potential free contacts. Each output foresees the NO (normally open) and the NC (normally closed) contact. The board provides up to 7 outputs.

Please refer to the unit specifications and annexed schematics for the meaning of a particular output signal.

NOTE *Please note that in the figure below, connector's pin #1 is identified by a square pad.*



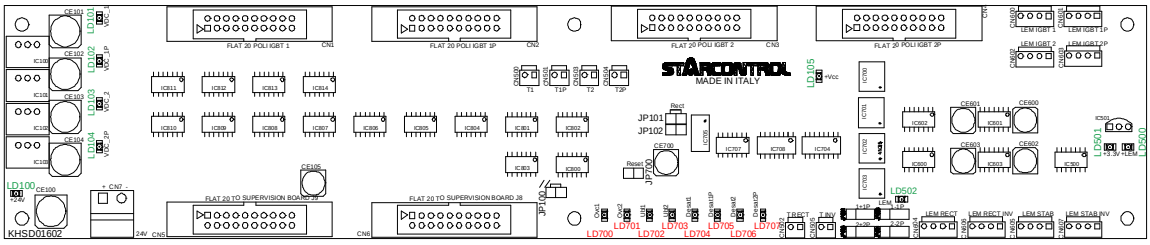
LED	COLOUR	DESCRIPTION
LD1	Green	Power supply, 24V_{DC}
LD2	Green	Power supply, 5V_{DC}
LD3	Green	K1 relay activated
LD4	Green	K2 relay activated

LED	COLOUR	DESCRIPTION
LD5	Green	K3 relay activated
LD6	Green	K4 relay activated
LD7	Green	K5 relay activated
LD8	Green	K6 relay activated
LD9	Green	K7 relay activated
LD10	Green	Input I1 active
LD11	Green	Input I2 active
LD12	Green	Input I3 active
LD13	Green	Input I4 active
LD14	Green	Input I5 active
LD15	Green	Input I6 active
LD16	Green	Input I7 active

CONNECTOR	DESCRIPTION
CN1	Power supply, $24V_{DC}$
CN2	Synchronous Serial Interface, from KHXC01604/J1
CN5	K1 relay contacts (1: common; 2: NC; 3: NO)
CN6	K2 relay contacts (1: common; 2: NC; 3: NO)
CN7	K3 relay contacts (1: common; 2: NC; 3: NO)
CN8	K4 relay contacts (1: common; 2: NC; 3: NO)
CN9	K5 relay contacts (1: common; 2: NC; 3: NO)
CN10	K6 relay contacts (1: common; 2: NC; 3: NO)
CN11	K7 relay contacts (1: common; 2: NC; 3: NO)
CN13	Fan speed (10V, [0, ..., 100%] PWM, ~200Hz)
CN3: [1, 2]	Input I1
CN3: [3, 4]	Input I2
CN3: [5, 6]	Input I3
CN3: [7, 8]	Input I4
CN4: [1, 2]	Input I5
CN4: [3, 4]	Input I6
CN4: [5, 6]	Input I7
CN4: [7, 8]	Insulated $12V_{DC}$, 10mA output (7: +12V; 8: 0V)

7.6 IGBT CONTROL BOARD KHSD01602

This board takes in input the PWM generated by control software and transform it into IGBTs driving signals, taking care of dead-time generation. At present time, 2 board revisions co-exist, sharing the same functionalities and connectors and differing only in few hardware details. To distinguish a revision from another please check the label reported near CN7, $24V_{DC}$ power supply: it should be REV01 or REV02.



The board is capable of driving up to 4 IGBTs, named ***IGBT$_1$***, ***IGBT$_{1P}$***, ***IGBT$_2$***, and ***IGBT$_{2P}$***.
These IGBTs can be driven to obtain different hardware configuration, reported hereafter:

a. 4 IGBTs to obtain a single H bridge configuration to double the IGBTs current; in this case ***IGBT$_1$*** and ***IGBT$_{1P}$*** are driven in parallel with a given signal, ***IGBT$_2$*** and ***IGBT$_{2P}$*** are driven in parallel with a complementary signal. With this configuration it is possible to obtain an inverter (DC/AC converter) *or* a rectifier (AC/DC converter) with maximum allowed current double than IGBT maximum current. Only a PWM signal is requested from control board with this configuration.
b. 4 IGBTs to obtain a double H bridge configuration; in this case, each couple ***IGBT$_1$***/***IGBT$_{1P}$*** and ***IGBT$_2$***/***IGBT$_{2P}$*** is driven with a signal and its complementary one. With this configuration it is possible to obtain an inverter (DC/AC converter) *and* a rectifier (AC/DC converter) with maximum allowed current equals to IGBT maximum current. Two independent PWM signals are requested from control board with this configuration.

When the configuration is that depicted at point a. the board also handles IGBTs *overcurrent* – the total amount of current feeded by the two IGBTs working in parallel must be lower than a given threshold, and *current unbalance* – the difference of current feeded by the each one of the two IGBTs working in parallel should not exceed a given threshold. When the configuration is that depicted at point b. the board handles only IGBTs *overcurrent*.

When a potentially dangerous condition arise, the IGBTs driving signals are set to rest level – typically this means that IGBTs open, and an alarm signal is sent to control board.
The board handles also DESAT and IGBTs short circuit conditions signalled by IGBTs driver board 2SP0320x2Ax.

LED	COLOUR	DESCRIPTION
LD100	Green	Power supply, $24V_{DC}$
LD101	Green	Power supply ($15V_{DC}$, 1A) for $IGBT_1$ driver board
LD102	Green	Power supply ($15V_{DC}$, 1A) for $IGBT_{1P}$ driver board
LD103	Green	Power supply ($15V_{DC}$, 1A) for $IGBT_2$ driver board
LD104	Green	Power supply ($15V_{DC}$, 1A) for $IGBT_{2P}$ driver board
LD105	Green	Power supply, $15V_{DC}$ (carried by flat cables)
LD106 *(REV02)*	Green	Power supply $-15V_{DC}$ (generated on-board)
LD500	Green	Power supply $+15V_{DC}$ (carried by 4 pole cables used for current sensors)
LD501	Green	Power supply, $3.3V_{DC}$
LD502	Green	Power supply $-15V_{DC}$ (carried by 4 pole cables used for current sensors)
LD700 Ovc1	Red	Overcurrent condition occurred on $IGBT_1$ and $IGBT_{1P}$
LD701 Ovc2	Red	Overcurrent condition occurred on $IGBT_2$ and $IGBT_{2P}$
LD702 Ubl1	Red	Current unbalance occurred between $IGBT_1$ and $IGBT_{1P}$ This signal is raised only when board is used in configuration depicted at previous point a.
LD703 Ubl2	Red	Current unbalance occurred between $IGBT_2$ and $IGBT_{2P}$ This signal is raised only when board is used in configuration depicted at previous point a.
LD704 Desat1	Red	DESAT or short circuit condition occurred on $IGBT_1$
LD705 Desat1P	Red	DESAT or short circuit condition occurred on $IGBT_{1P}$
LD706 Desat2	Red	DESAT or short circuit condition occurred on $IGBT_2$
LD707 Desat2P	Red	DESAT or short circuit condition occurred on $IGBT_{2P}$

CONNECTOR	DESCRIPTION
CN1	$IGBT_1$ driver board 2SP0320x2Ax power supply, driving signals, and alarm feedback
CN2	$IGBT_{1P}$ driver board 2SP0320x2Ax power supply, driving signals, and alarm feedback
CN3	$IGBT_2$ driver board 2SP0320x2Ax power supply, driving signals, and alarm feedback
CN4	$IGBT_{2P}$ driver board 2SP0320x2Ax power supply, driving signals, and alarm feedback
CN5	Inverter's IGBT driving signals, from KHXC01601
CN6	Rectifier's IGBT driving signals, from KHXC01601
CN7	Power supply, $24V_{DC}$
CN500	Temperature NTC sensor, from NTC sensor
CN501	Temperature NTC sensor, from NTC sensor
CN502	Temperature NTC sensor, $\boldsymbol{max(t_{CN500}, t_{CN501})}$, to KHXC01601
CN503	Temperature NTC sensor, from NTC sensor
CN504	Temperature NTC sensor, from NTC sensor
CN505	Temperature NTC sensor, $\boldsymbol{max(t_{CN503}, t_{CN504})}$, to KHXC01601
CN600	$IGBT_1$ current sensor (1V/100A)
CN601	$IGBT_{1P}$ current sensor (1V/100A)
CN602	$IGBT_2$ current sensor (1V/100A)
CN603	$IGBT_{2P}$ current sensor (1V/100A)
CN604 Rect	Not used
CN605 Stab	Not used
CN606 Rect Inv	Rectifier's current (1V/200A), to KHXC01601
CN607 Stab Inv	Inverter's current (1V/200A), to KHXC01601

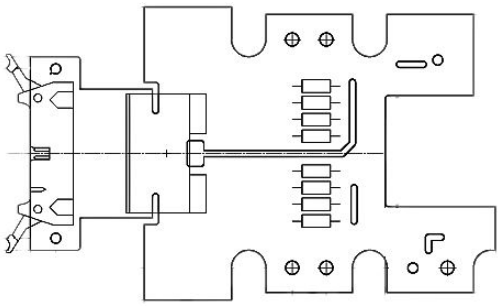
In the table below, to indicate a jumper's state the following graphical convention is adopted:
- two black squares (■■) indicate the presence of a jumper
- two white squares (□□) indicate the absence of a jumper
- if a two positions jumper is present, □■■ means that the right side is short circuited, ■■□ means that the left side is short circuited, □□□ means that no jumper is present.

⚠ ***WARNING*** *IN ORDER TO POSITION THE JUMPERS CORRECTLY, PLEASE LOOK AT THE BOARD SKETCHED ABOVE.*

JUMPER	STATUS	DESCRIPTION
JP100	■■	The board is working in configuration depicted at point b.
	□□	The board is working in configuration depicted at point a.
JP101 JP102	■■ ■■	The board is working in configuration depicted at point a.; driving signals from KHXC01601 arrive through a flat cable connected in CN6 connector
	□□ □□	The board is working in configuration depicted at point a.; driving signals from KHXC01601 arrive through a flat cable connected in CN5 connector or The board is working in configuration depicted at point b.; driving signals from KHXC01601 arrive through flat cables connected in CN5 and CN6 connectors
JP600 JP601	■■□ ■■□	The board is working in configuration depicted at point a.; current unbalancing hardware is active
	□■■ □■■	The board is working in configuration depicted at point b.; current unbalancing hardware is not active
JP602 JP603	■■□ ■■□	The board is working in configuration depicted at point a.; overcurrent detection hardware works on each couple of IGBTs. Ovc1 indicates a problem on $IGBT_1/IGBT_{1P}$, Ovc2 indicates a problem on $IGBT_2/IGBT_{2P}$
	□■■ □■■	The board is working in configuration depicted at point b. Ovc1 indicates a problem on $IGBT_1/IGBT_{1P}$ – inverter, Ovc2 indicates a problem on $IGBT_2/IGBT_{2P}$ - rectifier

7.7 IGBT DRIVER BOARD 2SP0320X2AX

This plug-and-play driver board is a compact dual-channel intelligent gate driver designed for ***PrimePACK™3*** 1200V IGBT modules. The board is assembled on the IGBT and connected to the IGBT control board KHSD01602 by means of a 20-conductor twisted flat cable.



8 USER INTERFACE ('UI')

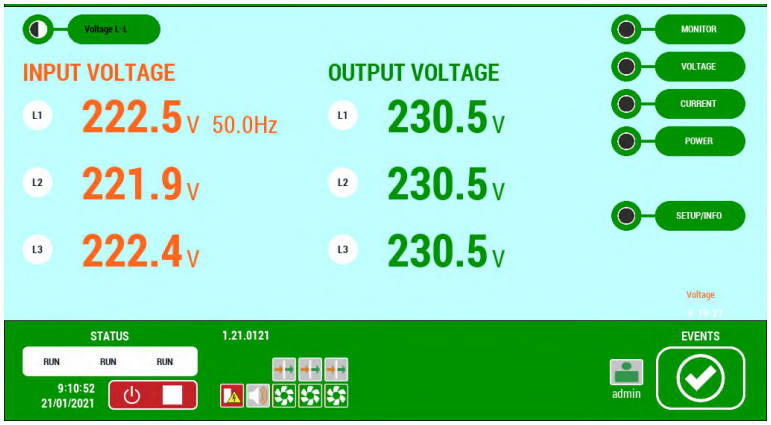
This chapter provides with an overview of the user interface organisation and with instructions on how to interact/setup the unit. The user interface allows for:

- easy setup of the sag compensator;
- monitoring of measured current and voltage values;
- logging the events during the sag compensator operation
- switching on/off the sag compensator

Note *UI and electronic boards inside the unit are not measurement instruments. Therefore, reported values are to be intended as indicative and not as absolute, even if they tend to be close to reality. If the user needs to perform precision measurements, the unit must be fitted with a suitable measuring device.*

8.1 UI PANEL ELEMENTS AND STRUCTURE

The UI panel schematic representation and the element identification are reported in the following figure.



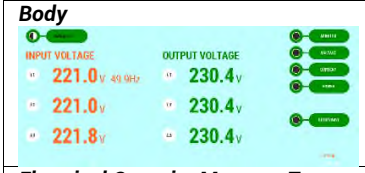
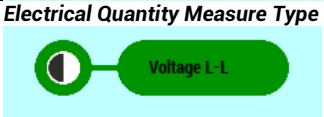
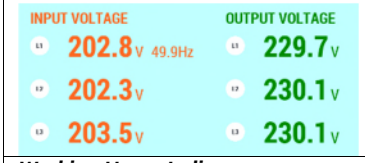
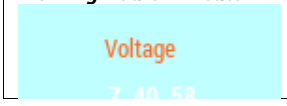
Three main areas can be identified:

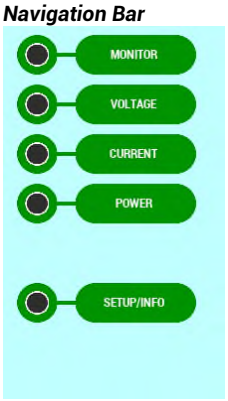
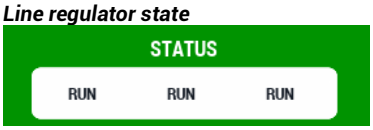
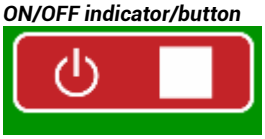
- a header showing manufacturer and unit family name;
- a body showing the information related to the electrical quantities of interest or a unit overview;
- a footer showing the information related to the unit status, date and time, and the ON/OFF button;

Header and footer are always visible, while the body content depends on the user's selection.

⚠ ***WARNING*** *THE SCREENSHOTS SHOWN IN THIS MANUAL ARE INTENDED ONLY TO MAKE IT EASIER TO UNDERSTAND THE TOPICS ON THE UI AND TO OPERATE THE UNIT. THEREFORE, THEY MAY NOT CORRESPOND IN WHOLE OR IN PART TO ANY REAL SCREEN THAT WILL APPEAR ON THE MACHINE'S USER INTERFACE AND/OR MAY REPORT INFORMATION THAT MAY NOT ACTUALLY BE AVAILABLE ON THE USER'S MACHINE, FOR INSTANCE BECAUSE NOT PROVIDED FOR THE SPECIFIC MACHINE MODEL OR BECAUSE AVAILABLE ONLY AS OPTIONS.*

The main elements of UI are listed in the table below:

ELEMENT	DESCRIPTION
Header	It shows *manufacturer* and *unit family* name.
Body 	It shows electrical quantities measurement or units' overview, depending upon user selection.
Electrical Quantity Measure Type 	For some kind of electrical quantities, the user can select the type of measure to be displayed (*line-to-line* or *line-to-neutral* for voltage). Typically, electrical quantities measures are expressed in ***RMS*** values, unless otherwise indicated. The reported label indicates what the user will get by pressing the given button.
Electrical Quantities Measures/Unit overview 	Depending on the selected page, UI shows the electrical quantities measures. Typically, on the left and right side respectively input and output related measures are indicated. A suitable text label will identify input and output measures; furthermore, input related quantities are shown in orange, while output related quantities are shown in green.
Working Hours Indicator 	This indicator shows the unit ON time.

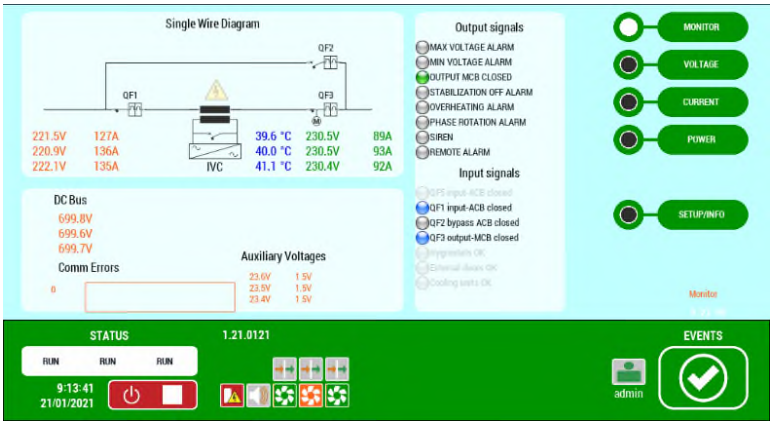
ELEMENT	DESCRIPTION
Navigation Bar 	Buttons in the Navigation Bar allows the user to navigate between different pages, each one reporting a given set of information. • MONITOR: this page shows the unit's *single wire diagram*, with actual state of **QF_x** switches, a synoptic of main digital IOs state available in the unit, input/output voltages and currents, and regulators heatsink temperature. • VOLTAGE: this page shows the unit's input and output measured voltages; user can select a line-to-line or a line-to-neutral measure by means of button 21. • CURRENT: this page shows the unit's input and output measured currents. • POWER: this page shows the unit's input and output powers, efficiency and *cos(φ)* for each phase; user can select ***kW*** (*active power*), ***kVA*** (*apparent power*), and ***kvar*** (*reactive power*) measure by means of button 21. • SETUP/INFO: this page allows the user to perform a set of setup/maintenance operations, detailed later in the chapter. • EVT HISTORY: this page allows the user to scroll the events history. This navigation button is visible only in the active alarm page, detailed later in the chapter. The pressed button is highlighted with respect to the others and the condition is held until another button is pressed instead.
Footer 	It shows relevant information about the unit current state.
Line regulator state 	This indicator shows the actual state for each line regulator. Allowed values are: • **INIT**: the unit has just started up; initial checks are performed. • **IDLE**: the unit is waiting for the ***ON*** command or for a consensus to start (external contact, hygrostats, a door to be closed, etc.). • **PRECHARGE.1**: the unit received all needed consensus, then it started DC bus charge operation; this operation can last from seconds to minutes, depending on the power of line regulators installed in the unit. • **PRECHARGE.2**: the unit completed successfully the DC bus charge operation. • **RUN**: the unit is stabilising the output voltage and performing all runtime checks related to currents and voltages. • **BYPASS**: the unit is in *internal* bypass mode. • **OVERLOAD**: the unit detected an overload and is waiting for the transient to end. • **ERROR**: the unit detected an abnormal condition and stopped all operations; the inverters are switched off and the internal bypass is activated to provide load with the available input voltage. • **TEST MODE**: the unit is in test mode; this mode can be activated only by a remote agent connected via Modbus RTU.
Date/Time indicator 	This indicator shows unit current time and date.
ON/OFF indicator/button 	This control allows the user to switch the unit on or off. When the unit is off, the button looks like this:  ; if the user pushes the button, a start command is issued to the unit. When the unit is on, or the unit is still off (charging the DC bus), but a start command has been issued, the button changes to:  ; if the user pushes the button, a stop command is issued to the unit and all the running operations (DC bus charging, stabilisation, etc.) are terminated. Please refer to chapter §8.3 for more details about start-up and shutdown procedure.
Hazardous Voltage Indicator 	This indicator warns the user about the presence, inside the unit, of a voltage exceeding $50V_{DC}/30V_{AC}$.  : potentially hazardous voltage detected; DO NOT OPERATE INSIDE THE UNIT.  : it is safe to operate inside the unit; however, only the authorized personnel is allowed to operate inside the unit.
Audible Alarm Indicator 	***Audible Alarm Indicator*** This indicator shows whether the **audible alarm device (AAD)** is enabled or not.  : **AAD** is enabled; if the unit goes into an error condition, a sound is produced.  : **AAD** is disabled; if the unit goes into an error condition, no sound is produced.

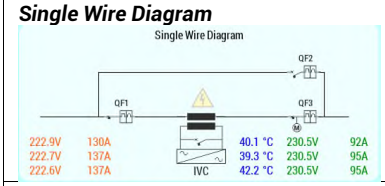
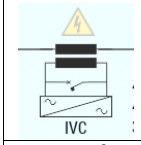
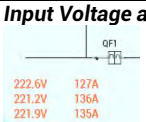
ELEMENT	DESCRIPTION
Event Severity Summary Indicator/Button 	This indicator shows, at any time, the maximum severity of currently active events. Icons that can be shown are:  ***Normal Operation***: no events or normal operation events are active  ***Warning***: events that might degrade the unit performance or that represent a potential source of problems (doors open, SAG or OVV in progress, internal bypass active, etc.). Typically, no user intervention is required; the unit will go back to normal operation when the triggering event ends.  ***Critical***: events that caused termination of unit operations (inverter trip due to IGBTs overcurrent or current unbalance, DC bus overvoltage, etc.). When a critical event occurs, the unit stops the inverters and activates internal bypass. The user can try to *reset* the unit by means of the UI and to restore normal operation. This operation is detailed later in this chapter. By pressing the indicator, the user can view the active alarm page to check which event, or events, caused the change in the indicator.
Fans Status Indicators 	These indicators show, one for each line regulator, the fans actual status. Typically, the represented icon is  ; when the unit is operating, the internal temperature can change and the automatic regulation system adapts the fans speed to keep IGBTs temperature at 50°C (122°F) or less. Depending on the fans speed, an orange band will appear, starting from the left. When the icon is completely orange,  , that fan is running at full speed.
Bypass/Stabilisation Indicator 	These indicators show the internal bypass status:  : internal bypass is active; booster primary side is short circuited.  : internal bypass is not active and line regulator is stabilising output voltage.

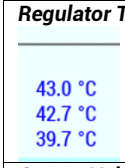
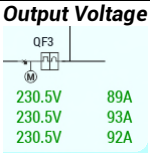
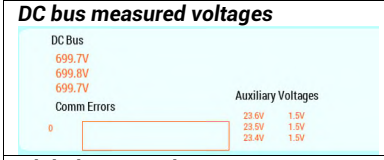
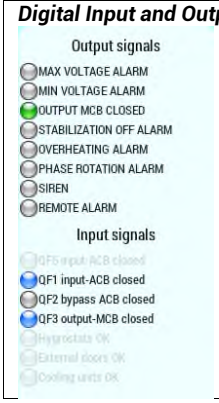
8.2 UI PAGES

When the UI panel is powered, the UI software is executed. The default page that appears is the Voltage page. Then user can select a different page by pushing the related button in the ***Navigation Bar***. A brief overview of all available pages is reported in the following.

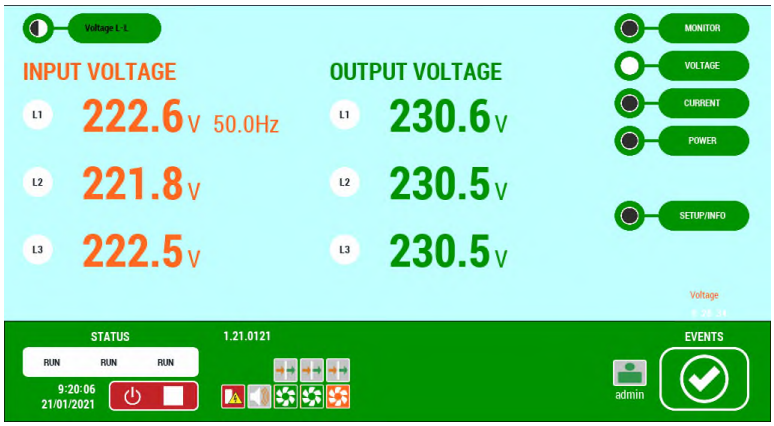
8.2.1 Monitor page



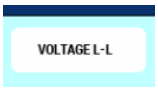
ELEMENT	DESCRIPTION
Single Wire Diagram 	It shows the unit single wire diagram, input/output measured voltage and current, **QF_x ACB** status (open or close) and internal bypass status. It also details the highest temperature detected on each line regulator and warns about the presence of potentially hazardous voltage inside the unit.
Hazardous Voltage Indicator 	This indicator warns the user about the presence of voltage exceeding $50V_{DC}/30V_{AC}$ inside the unit.
Input Voltage and Current Measures 	For each line, input voltage and current are displayed.

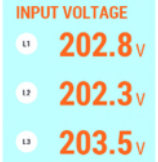
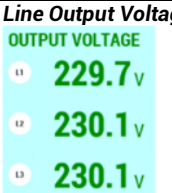
ELEMENT	DESCRIPTION
Regulator Temperatures 	For each line regulator, highest measured temperature is displayed.
Output Voltage and Current Measures 	For each line, output voltage and current are displayed.
DC bus measured voltages 	For each line regulator, DC bus voltage is displayed.
Digital Input and Output Status 	Digital input and output current status. An input/output indicator ON means that the condition described by the text label is met.

8.2.2 Voltage page



The information provided in this page is related to input (in orange) and output (in green) voltage. They can be shown as *line-to-neutral* or as *line-to-line*. The user can select the preferred mode by pushing the button.

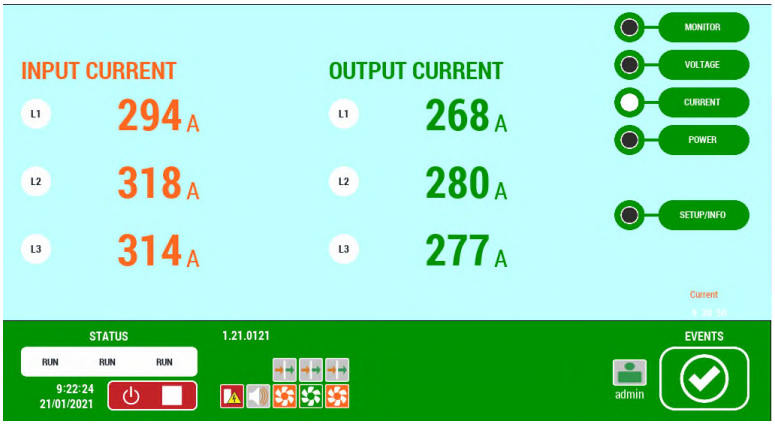


ELEMENT	DESCRIPTION
Line Input Voltages 	These indicators show, for each input line, the actual measured voltage. Reported measure can be either *line-to-neutral* (default) or *line-to-line*, depending on the selection.
Input / Output Line Frequency 	This indicator shows the detected/measured input line frequency. Since the unit does not affect the frequency, this value is referred both to input and output.
Line Output Voltages 	These indicators show, for each output line, the actual measured voltage. Reported measure can be either *line-to-neutral* (default) or *line-to-line*, depending on the selection.

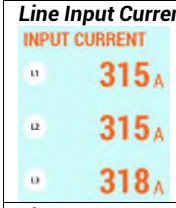
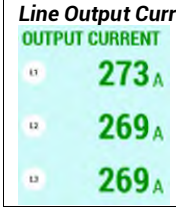
Note. *The user's selection affects both input and output measures, so it is not possible to show input voltages as line-to-neutral and output voltages as line-to-line, or vice versa.*

⚠ ***WARNING*** *THE USER'S SELECTION IS NOT STORED IN PERMANENT WAY. IF THE UI PANEL IS POWERED OFF AND THEN ON, THE VOLTAGE PAGE WILL SHOW LINE-TO-NEUTRAL MEASURES.*

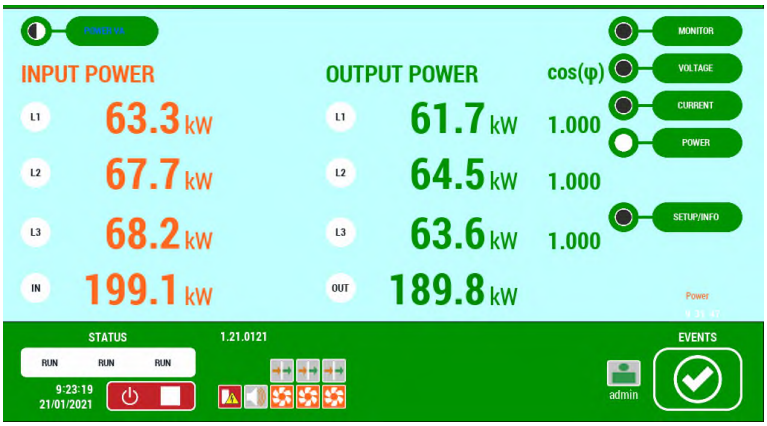
8.2.3 Current page



The information provided in this page is related to input (in orange) and output (in green) currents.

ELEMENT	DESCRIPTION
Line Input Currents 	These indicators show, for each input line, the actual measured current.
Line Output Currents 	These indicators show, for each output line, the actual measured current.

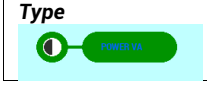
8.2.4 Power page

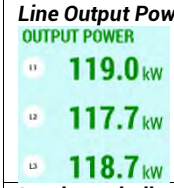
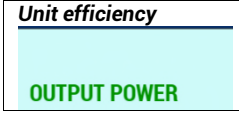


The information provided in this page is related to input (in orange) and output (in green) power. It is possible to select the view related to *active*, *reactive*, or *apparent* power by pushing the relevant key.

For each output line the *cos(φ)* – or *power factor PF* - indication is available.

Note *The unit efficiency η, calculated as ratio between output and input active power, can be also reported. However, depending on the unit configuration, the efficiency indicator might not be shown.*

ELEMENT	DESCRIPTION
Electrical Quantity Measure Type 	***Electrical Quantity Measure Type*** This control allows the user to select the kind of power to show in the page. It is possible to select between active - kW, apparent - kVA, and reactive – kvar – power.

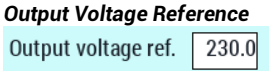
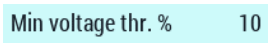
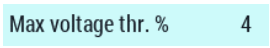
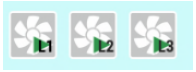
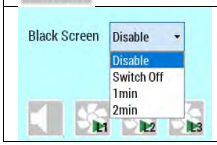
ELEMENT	DESCRIPTION
Line Input Power 	These indicators show, for each input line, the actual measured power. Displayed power type depends on the selection.
Line Output Power 	These indicators show, for each output line, the actual measured power.
Load type indicators 	These indicators show, for each input and output line, the actual load behaviour or, in other words, if the load is predominantly inductive (***RL***) or capacitive (***RC***). If no icon is shown, the load is purely resistive. These indicators are shown only if the displayed power type is reactive.
cos(φ) or Power Factor indicators 	These indicators show, for each output line, the actual calculated ***cos(φ)*** – or ***power factor***.
Unit efficiency 	When present, the efficiency indicator appears in the area above the output parameters.

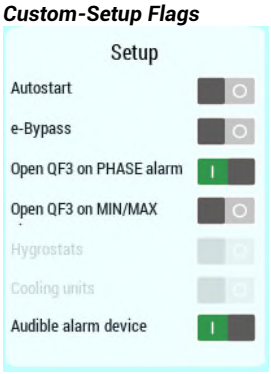
8.2.5 Setup/Info page

In this page, the user can:

- setup unit date and time;
- perform fans test for each line regulator;
- open or put in automatic mode output-ACB;
- activate or deactivate *internal* bypass;
- reset unit from error condition;
- change output voltage reference – within continuous stabilisation range;
- setup flags to customise unit behaviour (opening output-ACB when output voltage goes beyond a given limit, auto restart the unit after a blackout occurred, etc.)
- manage the "switch off time" of the display

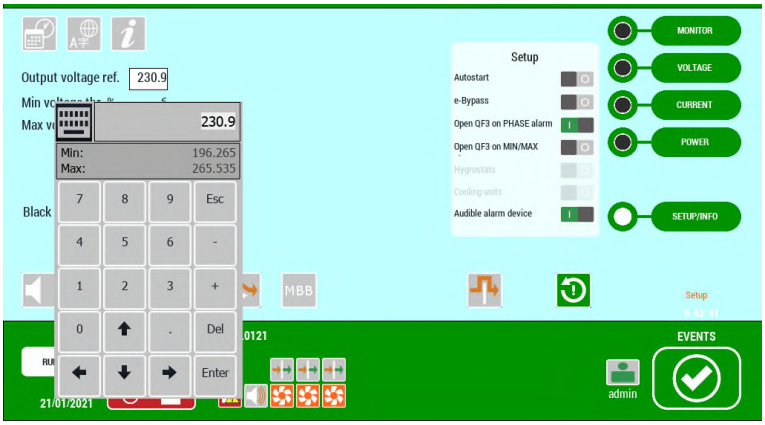
ELEMENT	DESCRIPTION
Date and Time Setup 	By pressing this button, a pop-up window to setup date and time is shown. Please refer to §8.2.5.1 on how to setup date and time.
Language and locale Setup 	By pressing this button, a pop-up window to setup user interface locale is shown. Please refer to §8.2.5.2 on how to setup current locale.

ELEMENT	DESCRIPTION
Output Voltage Reference 	This indicator shows the actual output voltage set point; an authorized user can change the set point at any time, simply by clicking the voltage value. Once clicked the voltage value, a numeric keypad (see figure below this table) will appear on the screen for typing in the new reference value. Please note that only values inside the continuous stabilisation range are allowed; values outside that range are not allowed.
Minimum Voltage Alarm Threshold 	This indicator shows the actual minimum voltage alarm threshold; if the actual output voltage drops below the value: $V_{out} = (1 - Minimum\_Voltage\_Alarm\_Threshold) \times V_{out\text{-}nominal}$ an alarm signal is raised. For example. if the nominal reference voltage is $230V_{L\text{-}N}$ and the threshold value is 10%, the alarm is raised if the actual output voltage drops below the value $(1 - 0.10) \times 230 = 207,0V$
Maximum Voltage Alarm Threshold 	This indicator shows the actual maximum voltage alarm threshold; if the actual output voltage raises above the value: $Vout = (1 + Maximum\_Voltage\_Alarm\_Threshold) \times Vout\text{-}nominal$ an alarm signal is raised. For example. if the nominal reference voltage is $230V_{L\text{-}N}$ and the threshold value is 4%, the alarm is raised if actual output voltage raises above the value $(1 + 0.04) \times 230 = 239,2V$
Output ACB management mode 	This button allows the user to switch between forced opening and automatic mode. The represented icon is what the user will get when the button is pressed, the request is processed and the icon changed.  : output ACB opens, without regards of output voltage;  : depending on the setup flags, the output ACB can open when the output voltage goes beyond a given limit; the output ACB status is handled automatically through the control software. If a hardware device, for example a key-switch, is used for driving the output ACB, the hardware device has a higher priority and prevails over the software.
Fans Test 	These buttons allow the user to run or terminate a fans test, independently for each line regulator. To start the test, the user can push the  button corresponding to the line to test. Once the button is pushed, the fans are started at the maximum speed and the button changes to  . If the user pushes the button again, the test is terminated. If the user does not push the button to terminate the test, this is automatically terminated after 3 minutes.
Audible Alarm Device enable/disable 	This button allows the user to enable or disable the *audible alarm device* (AAD).  : disables the *audible alarm device*. If an audible alarm is active, it will be silenced immediately.  : enables the *audible alarm device*. If an audible alarm is active, a sound will be immediately emitted. AAD is enabled by default. Actual status of AAD is available through the indicator in the status bar.
Reset 	This button allows the user to reset from an error condition that drove the unit into **ERROR** status. The unit is reset and returns back to **IDLE** status. If the ***AutoStart*** function is enabled, the unit will start up automatically without any further intervention.
Bypass/Stabilisation mode 	This button allows the user to switch from stabilisation mode to internal bypass and vice versa.  : activates the internal bypass, also known as ***e-Bypass***  : activates the stabilisation mode
Make Before Break 	If present, this button allows the user to switch from bypass to unit output if the unit is provided with ***Make Before Break*** function and output breaker is provided with spring load motor.
	With this choice it is possible to manage the inactivity switch off of the panel. "Disable" means that the panel stay always on; "Switch Off" produce an immediate Switch off of the display; Other options define inactivity switch off time.

ELEMENT	DESCRIPTION
Custom-Setup Flags 	These switches allow the user to customize some unit behaviours, such as: • Auto start: if ON, commands the unit to start automatically after a complete power off or a blackout; the default factory value is OFF. • e-Bypass: if ON, commands the unit to switch to internal bypass mode. • Open QF3 on alarm: if ON, commands the unit to open QF3 ACB when the output voltage rises or drops beyond a given tolerance band. Depending on the unit configuration, this option could or could not be present or be working (for example , the unit is not fitted with motorized output ACBs) • Open QF3 on phase sequence Alarm: if ON, commands the unit to open QF3 ACB when Input phase sequence is incorrect. • Hygrostats: if ON, the unit will not start if the relative humidity inside the unit itself is higher than a given threshold. If the relative humidity rises while the machine is working, a relevant alarm is signalled. • Cooling Units: if ON, the unit will check the cooling units alarm contact and report if any alarm condition arises during the unit operations. • Audible Alarm Device: if ON, the unit will produce a sound if a severe alarm condition arises; if OFF no sound will be produced and the alarm condition will be signalled only through the UI. Values set by the user are retained across power off cycles. The only exception is the Audible Alarm Device, always reset to ON state.

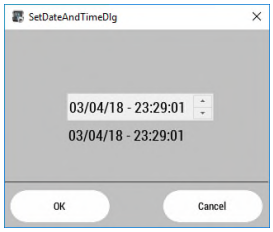
Note *Status of AAD is always reset to default – enable - when unit is powered off and then on.*

⚠ ***WARNING*** *IF THE RESET BUTTON WORKS BUT THE UNIT FALLS BACK REPEATEDLY INTO ERROR STATE, CONTACT THE SERVICE DEPT.*



8.2.5.1 Date and Time Setup

The dialog window allows the user to setup the system date and time. To setup any of the reported fields, click on the item to modify, then click on the UP or on the DOWN arrow to change the selected value. Once the date and time have been set, click the OK button to confirm.



8.2.5.2 Language Setup

The dialog allows the user to setup the system language. Click on the flag representing the language to apply. Once clicked, the UI localization is immediately performed. Then click the Close button to dismiss the dialog.

8.2.5.3 AVC/Admin operations

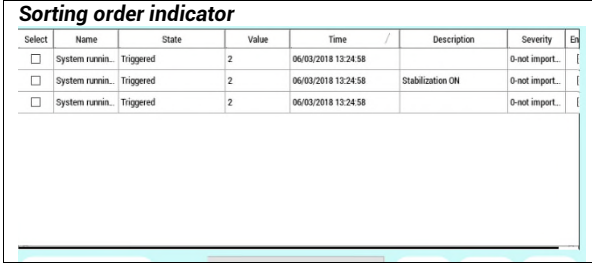
When the panel starts up the HMI runs in AVC mode. That means that not all the commands in setup page are available. To enable a full control of the system a user switch must be executed. On the left of the Events button, there is one of the following icons:

By pressing it, the user switch is made available. Contact the system administrator for the password.
The following Setups are available only in admin mode:

- Make before brake

- Reset
- Bypass
- Autostart
- Enable Bypass
- Open QF3 on PHASE Alarm
- Open QF3 on Min/Max
- Enable Hygrostats
- Enable Cooling Units
- Voltage Reference
- Min Voltage threshold
- Max Voltage threshold

8.2.6 Active Events page

ELEMENT	DESCRIPTION
Sorting order indicator 	Ascending (△); if sorted by Time, oldest event at the top Descending (▽); if sorted by Time, newest event at the top

It shows any event triggered by the unit. An event can be in one of the following conditions:

- ***Triggered***: the event has been detected by the unit and is still active
- ***Not Triggered***: the event has not been detected by the unit
- ***Triggered Not Acked***: the event has been detected by the unit; user didn't acknowledge it yet
- ***Not Triggered Not Acked***: the event previously triggered has ended; user didn't acknowledge it yet
- ***Triggered Acked***: the event has been detected by the unit; user acknowledged it

The table below lists all the events that can be triggered by the unit.

EVENT	DESCRIPTION	SEVERITY
System Up (*)	Regulator's control on	0
System running (*)	Regulator stabilising	0
Bypass On (*)	Regulator in bypass mode; booster primary side short circuited by thyristor	1
Sag in progress (*)	Input voltage below the continuous stabilisation range	1
Output Overload (*)	Output current beyond 110% of the nominal value	3
Thermal Overload (*)	Regulator exceeded the foreseen duty cycle	3
Output maximum voltage (*)	Output voltage beyond the admitted tolerance range - upper bound	3
Output minimum voltage (*)	Output voltage beyond the admitted tolerance range - lower bound	3
Rectifier IGBT Overtemperature (*)	Overtemperature on the rectifier module; this event is triggered only on units with 2 power modules for each line, one for the rectifier one for the stabiliser.	4
Stabiliser IGBT Overtemperature (*)	Overtemperature on the stabiliser module; this event is triggered also in case of rectifier module overtemperature in units having one power module per line (two IGBTs working as rectifier, two IGBTs working as stabiliser).	4
Input voltage too low (*)	Input voltage too low to start unit up.	1
Input voltage too high (*)	Input voltage too high to start unit up.	1
Phase sequence (*)	Input phase sequence not correct	5
Phase loss (*)	Input voltage below $50V_{AC}$	5
DC bus overvoltage (*)	Regulator experienced an overvoltage on DC bus	6

EVENT	DESCRIPTION	SEVERITY
Output short circuit (*)	Regulator senses an output current beyond highest foreseen limit	6
System switch off	Switch off command received	1
E2PROM default configuration (*)	Regulator loaded default configuration from on board E²PROM database	1
E2PROM write error (*)	Regulator failed to write a configuration change to on board E²PROM database	2
E2PROM read error (*)	Regulator failed to read configuration from on board E²PROM database	2
E2PROM fault (*)	Regulator unspecified on board E²PROM database failure	2
DC bus pre-charge fail (*)	Regulator experienced a DC bus pre-charge failure; typically, this means that DC voltage didn't reached the predefined level in the foreseen time limit	6
FANs malfunction (*)	Regulator fans not working properly	4
Vaux 24V (*)	Regulator auxiliary voltage not correct (lower than 22V or higher than 27V)	6
Pre-charge contactor failure (*)	Regulator detected an unexpected drop on DC bus voltage while unit is working	6
OVV in progress (*)	Regulator detected an input voltage higher than continuous stabilisation range	1
Inverter TRIP (*)	Regulator hardware detected a stabiliser or rectifier inverter TRIP	6
External doors opened	Only for units with external doors: unit doors open	2
Hygrostat	Only for units with hygrostat sensors: humidity inside the unit too high	3
Cooling unit(s)	Malfunctioning of one or more cooling units (only when fitted)	4
Delta-Star voltage mismatch(*)	Phase-to-Phase Voltage does not match Phase-to-Neutral voltage	6
DC bus precharge timeout expired (*)	Rectifier start command not received in predefined time frame	6
DC bus target voltage fail (*)	DC bus working voltage not reached	6
DC bus target timeout (*)	Stabilizer start command not received in predefined time frame	6
System REST (*)	RESeT command received	4
Precharge relay stuck-at (*)	Precharge relay locked in NC position	5
Precharge relay mismatch	Precharge relay state mismatch	5

(*) = for each phase

Please note that, depending on the specific unit, not all events might be triggered. Each event is characterized by a ***severity level*** (from 0 to 2: low severity; from 2 to 4: medium severity; greater than 4: high severity), which identifies the impact on the unit performance; medium severity level denotes a degrading in unit performance, high severity level denotes a complete degradation or loss of unit performance.

If no event or a low severity level event is triggered, the indication is  .

If a medium severity level event is triggered, the indication is  .

If a high severity level event is triggered, the indication is  .

The Indicator changes dynamically while the unit is operating, depending on what events are active at the moment. Events can be sorted by **Time**, **Name**, **Description**, etc., simply by pressing the relevant column header. The sorted column will show △ or ▽ , indicating ascending or descending ordering criteria.

If an event causes the system to stop, when the Autostart function is enabled, the device tries to restart autonomously. The restart system algorithm tries a restart after a defined time interval. For each stop event, a defined number of attempts is set. If the issue persists, no more tries are performed. The following table lists events associated with autostart function, number of attempts and delay.

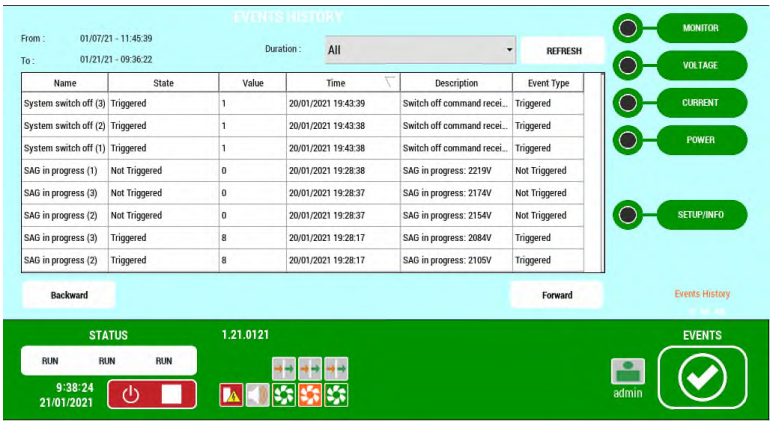
EVENT	RETRIES	TIME [SEC]
Phase loss	5	30
DC bus pre-charge fail	5	45
DC bus precharge timeout expired	5	45
DC bus target voltage fail	3	30
DC bus target timeout	5	30
Inverter TRIP	5	30
Pre-charge contactor failure	5	30
Vaux 24V	5	15
Phase sequence	5	30
Delta-Star voltage mismatch	5	30
Precharge relay stuck-at (*)	1	
Precharge relay mismatch	1	
Output short circuit	3	180
DC bus overvoltage	3	60

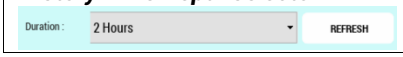
The active event list can be saved on a “comma separated variables” file using an USB key. The following icons show if the USB key is inserted

When the USB key is in, press the following button to start data copy

During the copying activity, the hand icon signals to wait the end of the job  . The following two thumb icons give feedback whether the activity was successful or failed.

8.2.7 Event History page



ELEMENT	DESCRIPTION
Sorting order indicator 	Ascending (△); if sorted by Time, oldest event at the top Descending (▽); if sorted by Time, newest event at the top
History Time Depth selector 	Allows the selection of history time depth, so only the events in the selected interval are shown; it can be useful when searching for events occurred in a given time interval.

In this page the user can view the events occurred in the selected time interval. The main use of this page is to examine the list of events to check the root cause of a problem in the unit. Please refer to the troubleshooting section for more information about how to handle an abnormal situation.

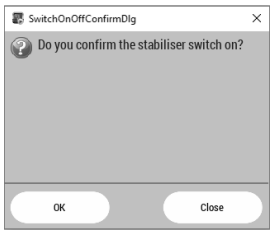
8.3 START-UP & SHUTDOWN

DANGER ***THE START-UP AND SHUTDOWN ROUTINES MUST BE CARRIED OUT BY TRAINED AND QUALIFIED PERSONNEL, AWARE OF THE INVOLVED RISKS. ALWAYS USE SUITABLE TOOLS AND PERSONAL PROTECTIVE EQUIPMENT (PPE). THE OPERATIONS MUST BE CARRIED OUT IN CONFORMITY WITH THE RULES AND REGULATIONS ENFORCED IN THE COUNTRY OF INSTALLATION.***

8.3.1 Turn ON

Before starting-up, it is recommendable to check whether haulage and long permanence in a warehouse might have affected the unit. If clear signs of dust, dirt or rust can be detected, follow the instruction given in the 'Maintenance' chapter concerning how to clean the components. Should the stabiliser being fitted with a maintenance manual bypass line, please refer to the relevant technical note attached to this manual.
Once the above electrical connections and the all check have been made, the internal safety screens have been repositioned, and the doors of the cabinet have been closed, the unit can be started. Follow these steps:

- Close the QF1 input breaker, if present;
- Check that control boards, if possible, and UI panel are energised;
- Wait until the UI panel completes the start-up procedure;
- On the UI panel, click the Monitor button in the navigation bar then, depending upon unit configuration:
  - check that the DC-Bus voltage has increased to approximately 1.3 times the line-to-line input voltage
  - check that the DC-Bus voltage is close to 0
- If the Monitor page does not appear, call support and request assistance;
- Click on the ON/OFF button  ;
- Confirm the requested operation in the dialog window that will appear:



Once the operation has been confirmed the unit will start working in few seconds, and the ON/OFF button will change from to . Please check, in the Voltage or in the Monitor page that input and output parameters comply with the rated ones and output voltage regulation is steady.

⚠ ***WARNING*** *TO AVOID UNIT MANUAL SWITCH ON, EACH TIME A BLACK-OUT OCCURS, PLEASE GO TO THE SETUP PAGE AND TURN ON AUTOSTART FEATURE.*

8.3.2 Turn OFF

To turn off the unit:

- Click on the ON/OFF button ;
- Confirm the requested operation in the dialog window that will appear:

Once the operation has been confirmed the unit will stop working in few seconds, and the ON/OFF button will change from to . When the unit is off, the internal bypass – e-Bypass, is active to guarantee that input and output voltages are equal.
To secure the unit, open any input breaker, if present, then wait at least 20 minutes to allow for all the internal capacitors to discharge; DC-Bus voltage can be checked in the Monitor page. Always make sure there is no dangerous voltage by measuring instrument.

8.4 MAKE BEFORE BREAK - MBB

⚠ ***WARNING*** *THE MAKE BEFORE BREAK ROUTINES MUST BE CARRIED OUT BY TRAINED AND QUALIFIED PERSONNEL, AWARE OF THE INVOLVED RISKS. FAILING OR NOT COMPLYING WITH THE INSTRUCTIONS THEREIN COULD CAUSE DAMAGE TO THE UNIT AND INJURIES TO PEOPLE. PLEASE CHECK THE TECHNICAL DOCUMENTATION SUPPLIED WITH THE UNIT TO VERIFY IF THE MBB OPTION IS AVAILABLE.*

The main purpose of the MBB function is to allows the switch between unit regulated output and mains – and vice versa – without interrupting the output voltage. To carry out these routines, different scenarios must be taken into account, depending on the type of bypass and output circuit breakers adopted.
Please check the scenario that applies to the provided unit configuration and follow the relevant instructions.

8.4.1 Scenario #1: Manual Bypass Circuit Breaker, Manual Output Circuit Breaker

8.4.1.1 From bypass to regulated output

Initial condition is **QF2** bypass breaker closed and **QF3** output breaker open. To switch from bypass to regulated output:

a. put the unit in IDLE or internal BYPASS state; please refer to §8.3.2 on how to put the unit in IDLE state, refer to §8.2.5 on how to activate internal bypass or e-Bypass
b. check the **Line regulator state** - see §8.1 – to verify if the unit has reached the desired target state
c. close the **QF3** output breaker
d. open the **QF2** bypass breaker
e. put the unit in RUN state by switching it on or exiting the internal bypass state; please refer to §8.3.1 on how to switch the unit on, refer to §8.2.5 on how to deactivate internal bypass or e-Bypass

8.4.1.2 From regulated output to bypass

Initial condition is **QF2** bypass breaker open and **QF3** output breaker closed. To switch from regulated output to bypass:

a. put the unit in IDLE or internal BYPASS state; please refer to §8.3.2 on how to put the unit in IDLE state, refer to §8.2.5 on how to activate internal bypass or e-Bypass
b. check the **Line regulator state** - see §8.1 – to verify if the unit reached the desired target state
c. close the **QF2** bypass breaker
d. open the **QF3** output breaker
e. put the unit in RUN state by switching it on or exiting the internal bypass state; please refer to §8.3.1 on how to switch the unit on, refer to §8.2.5 on how to deactivate internal bypass or e-Bypass

8.4.2 Scenario #2: Manual Bypass Circuit Breaker, Motorised Output Circuit Breaker

8.4.2.1 From bypass to regulated output

Initial condition is **QF2** bypass breaker closed and **QF3** output breaker open. To switch from bypass to regulated output:

a. put the unit in IDLE or internal BYPASS state; please refer to §8.3.2 on how to put the unit in IDLE state, refer to §8.2.5 on how to activate internal bypass or e-Bypass
b. check the **Line regulator state** - see §8.1 – to verify if the unit reached the desired target state

c. switch to the SETUP/INFO page
d. push the MBB button
e. wait until the unit control software closes the **QF_3** output breaker
f. open the **QF_2** bypass breaker
g. put the unit in RUN state by switching it on or exiting the internal bypass state; please refer to §8.3.1 on how to switch the unit on, refer to §8.2.5 on how to deactivate internal bypass or e-Bypass

8.4.2.2 From regulated output to bypass

Initial condition is **QF_2** bypass breaker open and **QF_3** output breaker closed. To switch from regulated output to bypass:

a. put the unit in IDLE or internal BYPASS state; please refer to §8.3.2 on how to put the unit in IDLE state, refer to §8.2.5 on how to activate internal bypass or e-Bypass
b. check the **Line regulator state** - see §Errore. L'origine riferimento non è stata trovata. – to verify if the unit reached the desired target state
c. close the **QF_2** bypass breaker
d. open the **QF_3** output breaker
e. put the unit in RUN state by switching it on or exiting the internal bypass state; please refer to §8.3.1 on how to switch the unit on, refer to §8.2.5 on how to deactivate internal bypass or e-Bypass

8.5 MODBUS TCP AVAILABLE TAGS

The unit exposes a few Modbus tags for remote monitoring purposes.
Such tags can be read through a Modbus TCP connection, by connecting a remote computer to the unit operator panel via an Ethernet cable. The exported tags are listed in the table below:

SLAVE/REGISTER/TYPE	VARIABLE	DESCRIPTION
1, HREG 400000, short	Vin L1	L1 phase input voltage, phase to neutral – tenth of Volt
1, HREG 400001, short	Vin L2	L2 phase input voltage, phase to neutral – tenth of Volt
1, HREG 400002, short	Vin L3	L3 phase input voltage, phase to neutral – tenth of Volt
1, HREG 400003, short	Iin L1	L1 phase input current – Amps
1, HREG 400004, short	Iin L2	L2 phase input current – Amps
1, HREG 400005, short	Iin L3	L3 phase input current – Amps
1, HREG 400006, short	Vout L1	L1 phase output voltage, phase to neutral – tenth of Volt
1, HREG 400007, short	Vout L2	L1 phase output voltage, phase to neutral – tenth of Volt
1, HREG 400008, short	Vout L3	L1 phase output voltage, phase to neutral – tenth of Volt
1, HREG 400009, short	Iout L1	L1 phase output current – Amps
1, HREG 400010, short	Iout L2	L2 phase output current – Amps
1, HREG 400011, short	Iout L3	L3 phase output current – Amps
1, HREG 401000, short	Alarm1-1	L1 phase alarm bitmap, word 1
1, HREG 401001, short	Alarm1-2	L1 phase alarm bitmap, word 2
1, HREG 401002, short	Alarm1-3	L1 phase alarm bitmap, word 3
1, HREG 401003, short	Alarm2-1	L2 phase alarm bitmap, word 1
1, HREG 401004, short	Alarm2-2	L2 phase alarm bitmap, word 2
1, HREG 401005, short	Alarm2-3	L2 phase alarm bitmap, word 3
1, HREG 401006, short	Alarm3-1	L3 phase alarm bitmap, word 1
1, HREG 401007, short	Alarm3-2	L3 phase alarm bitmap, word 2
1, HREG 401008, short	Alarm3-3	L3 phase alarm bitmap, word 3

WORD #	BIT #	DESCRIPTION
1	0	Line regulator powered on
1	1	Line regulator stabilising
1	2	Line regulator in e-bypass mode
1	3	Line input voltage below the 10% of the nominal voltage
1	4	Line output current beyond 120% of the nominal value
1	5	Line regulator exceeded the foreseen duty cycle
1	6	Line output voltage beyond the admitted tolerance range – maximum voltage
1	7	Line output voltage beyond the admitted tolerance range – minimum voltage
1	8	Rectifier module experiencing an overtemperature
1	9	Stabiliser module experiencing an overtemperature
1	10	Input voltage too low to start unit up
1	11	Input voltage too high to start unit up
1	12	Input phase sequence not correct
1	13	Input voltage below 50VAC
1	14	Line regulator experienced an overvoltage on DC bus

WORD #	BIT #	DESCRIPTION
1	15	Line regulator senses an output current beyond highest foreseen limit
2	0	Line regulator powered off – via operator panel
2	1	Line regulator loaded default configuration from on board E²PROM database
2	2	Line regulator failed to write a configuration change to on board E²PROM database
2	3	Line regulator failed to read configuration from on board E²PROM database
2	4	Line regulator unspecified on board E²PROM database failure
2	5	Line regulator experienced a DC bus pre-charge failure; typically, this means that DC voltage didn't reached the predefined level in the foreseen time limit
2	6	Line regulator fans not working properly
2	7	Line regulator auxiliary voltage not correct – lower than 22V or higher than 27V
2	8	Line regulator detected an unexpected drop on DC bus voltage while unit were working
2	9	Line regulator detected an input voltage higher than 10% of nominal voltage
2	10	Line regulator hardware detected a stabiliser or rectifier inverter TRIP/overcurrent/desaturation
2	11	*Only for units with external doors*: Unit doors open
2	12	*Only for units with hygrostat sensors*: Humidity inside the unit too high
2	13	*Only for units equipped with cooling units*: One or more cooling units not working properly
2	14	Phase-to-Neutral and Phase-to-Phase voltages don't match
2	15	Line regulator experienced a DC bus pre-charge failure; typically, this means that rectifier start command has not been received in the foreseen time limit
3	0	Line regulator experienced a DC bus pre-charge failure; typically, this means that rectifier started but was not able to get predefined target voltage
3	1	Line regulator experienced a DC bus pre-charge failure; typically, this means that inverter start command has not been received in the foreseen time limit
3	2	Line regulator received a reset command
3	3	-
3	4	-
3	5	-
3	6	-
3	7	-
3	8	-
3	9	-
3	10	-
3	11	-
3	12	-
3	13	-
3	14	-
3	15	-

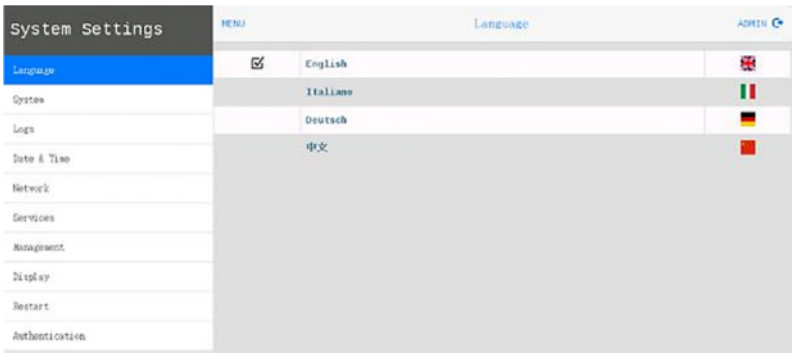
8.5.1 How to setup operator panel TCP/IP address, subnet mask and gateway

The operator panel default configuration is with DHCP feature enabled.
In such case, if a DHCP server is available on the network, the IP address will be assigned automatically by the server.
If no DHCP server is available on the network, the operator panel assigns itself an IP Address into range 169.254.x.x with subnet mask 255.255.0.0.
IP address can also be assigned manually by disabling the DHCP feature.
To perform this operation, please follow the steps detailed hereafter:

1. click and hold an empty area on the screen
2. release after 3 seconds and a popup menu will appear:

3. Click on the ***Show system settings*** menu item
4. After a few seconds, the screen will switch from application to system settings; the operator panel should look as

follows:



5. Click ***Network*** in the left menu
6. Click the ***Network Interface*** header to show the current network setting
7. Click the ***Edit*** key in the upper right side of the screen to change the current setting
8. Turn off the DHCP feature and setup the desired Host name, IP address, Subnet mask and default Gateway
9. Click the ***Save*** key in the upper right side of the screen to save the new setting
10. If the left menu disappeared after having executed the operations listed at item no. 5, please click the ***Menu*** key in the upper part of the screen
11. Click the ***Exit*** in the left menu. Please scroll the page if this entry is not visible

9 MAINTENANCE

DANGER ***ACCESS TO THE INTERNAL COMPONENTS FOR INSTALLATION, SETTING, INSPECTION AND MAINTENANCE MUST BE GRANTED ONLY TO QUALIFIED PERSONNEL IN CHARGE OF IT AND INFORMED OF THE RELEVANT RISKS. ANY INTERVENTION MUST BE CARRIED OUT IN COMPLIANCE WITH THE HABITUAL RULES ON PERSONAL SAFETY AND USE OF ADEQUATE PROTECTIVE TOOLS.***

In order to ensure the performance throughout its life, the unit must undergo a simple but regular maintenance scheduling. The recommended frequency is 12 months, but the maintenance routine ought to be more frequent should it be required by other factors such as polluted environment or heavy-duty cycle. Conforming to the recommended maintenance program ensures the correct functioning, thus preventing potentially dangerous failures.

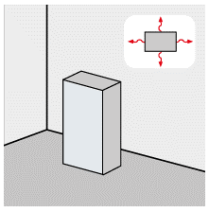
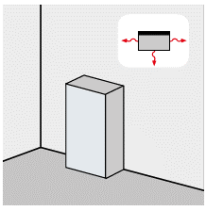
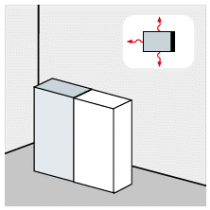
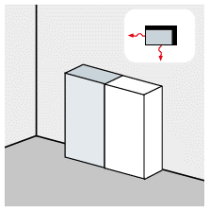
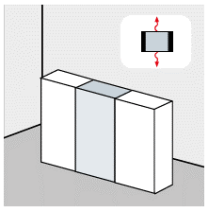
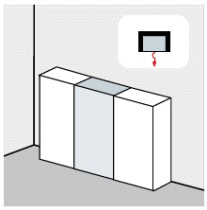
DANGER ***EVERY MAINTENANCE OPERATION MUST BE DONE WHILE THE UNIT IS DISCONNECTED FROM THE MAINS.***

WARNING. *ONCE THE UNIT HAS BEEN SWITCHED OFF, A RESIDUAL DANGEROUS VOLTAGE COULD STILL BE PRESENT INSIDE THE CONVERTING MODULES AND ON THE DC TERMINALS. THIS IS DUE TO THE ELECTROLYTIC CAPACITORS THAT STAY CHARGED FOR A LIMITED AMOUNT OF TIME. BEFORE INTERVENING ON THE UNIT, MAKE SURE THAT SAID VOLTAGE IS DECREASED TO A LEVEL < 60VDC.*

Before proceeding with the maintenance routine, check that the upstream interrupting device (disconnecting switch or circuit breaker) is open. Put on the unit a sign indicating the ***out of order*** condition. Be sure that only the personnel necessary to the maintenance operations is dealing with the unit. The tables below resume the maintenance program:

9.1 CONDITIONS FOR MAINTENANCE

Maintenance activities can be performed only if clearances are ensured around the unit.
Beside the front (which is presumed to be clear), at least another side must be available. The possible configurations are:

	**4 clear sides** Best configuration to perform maintenance.
	**Front and sides clear.** Maintenance possible (provided that the clearance be at least 800mm).
	**Front, rear and 1 side clear.** Maintenance possible if at least 800mm are available at the rear and the side.
	**Front and 1 side clear.** Maintenance possible provided that: 1. clearance at the side is at least 800mm 2. the internal configuration allows access from the clear sides. For more information, please contact the after-sale Service).
	**Front and rear clear.** Maintenance possible (but potentially difficult) if at least 800mm are available at the rear.
	**Only the front is clear.** Maintenance impossible. The unit must be moved. Please contact the after-sale Service to agree on how to proceed.

9.2 MAINTENANCE ACTIVITIES

9.2.1 Generalities

WHAT TO DO	HOW	WHY
Clean the components removing dust, dirt and rust	Vacuum cleaner	Dust accumulation may limit the cooling airflow and cause overheating. Rust may compromise the dielectric properties of materials and components.
Check that the electrical connections are tight	Tightening tools	Improper electrical connections may cause localised overheating and consequent major failure of the unit
Clean the air inlets at the base of the enclosure	Vacuum cleaner	Dust accumulation may limit the cooling airflow and cause overheating.

9.2.2 Roof fans

Please note that roof fans could or could not be present depending on unit configuration.

WHAT TO DO	HOW	WHY
Check that the airflow coming out from the fan hoods is regular. Keep the air outlets and the fans clean.	Vacuum cleaner	Dust accumulation may limit the cooling airflow and cause overheating.
If necessary, replace defective fans. ***WARNING.*** *THE FANS ARE CONTROLLED BY THE CONTROL CARD. BEFORE PROCEEDING WITH THE REPLACEMENT, CHECK THE TEMPERATURE THRESHOLD THAT DETERMINES THE ACTIVATION.*	• disconnect the fan plug; • unscrew and remove the hood from the roof; • replace the defective fan with an original spare one; • connect the fan plug; • re-position the turret on the roof	Failure of one or more fans may compromise the air circulation inside the enclosure.

9.2.3 Electronic boards

WHAT TO DO	HOW	WHY
Remove the suspended dust	Vacuum cleaner	Dust accumulation may cause damage.
Check power	See on board power on indicators, typically LEDs	Diagnostic problems

9.2.4 Conversion units

WHAT TO DO	HOW	WHY
Check that the fan airflow is regular. Clean units and fans from dust	Vacuum cleaner	Dust accumulation may limit the cooling airflow and cause overheating.
If necessary, replace defective fans. ***WARNING.*** *THE FANS ARE CONTROLLED BY THE CONTROL CARD. BEFORE PROCEEDING WITH THE REPLACEMENT, CHECK THE TEMPERATURE THRESHOLD THAT DETERMINES THE ACTIVATION.*	• unscrew the diagnostic and power cables; • remove the power module (if necessary); • unscrew and remove the fan module; • replace the defective fan with an original spare one; • re-position power module (if necessary); • screw the diagnostic and power cables	Failure of one or more fans may compromise the air circulation inside the enclosure.
Check that the electrical connections are tight	Tightening tools	Improper electrical connections may cause localised overheating and consequent major failure of the unit
Clean the air inlets at the front of the enclosure	Vacuum cleaner	Dust accumulation may limit the cooling airflow and cause overheating.

10 TROUBLESHOOTING & ASSISTANCE

⚠ ***DANGER*** ***ACCESS TO THE INTERNAL COMPONENTS MUST BE GRANTED ONLY TO QUALIFIED, TRAINED PERSONNEL IN CHARGE OF IT. ANY OPERATION THAT MIGHT REQUIRE THE UNIT TO BE ENERGISED MUST BE CARRIED OUT IN COMPLIANCE WITH THE HABITUAL RULES CONCERNING PERSONAL SAFETY AND THE USE OF ADEQUATE PROTECTIVE TOOLS.***

In case of anomalies or failure of any component, check that all the instructions given in this manual have been followed. Interventions must be requested out promptly as soon as the issue arises in order to avoid an aggravation of the problem and the involvement of other components.

IN CASE OF (INDICATION IN THE EVENT PAGE)	**EVENT DESCRIPTION**	**ACTION**
Sag in progress (…)	Input voltage decreased beyond the continuous stabilisation range.	Wait for the transient event to finish
Output Overload (…)	Output current beyond 150% of the nominal value.	Check the load connected to the unit and decrease it if higher than nominal
Thermal Overload (…)	The input sag is lasting beyond the maximum 100% coverage maximum allowed time; for example, if input remaining voltage is 50% and this input voltage sag lasts more than 60s.	Wait for the transient event to finish
Output maximum voltage (…)	Input voltage is increasing to a level that causes an output stabilised voltage increase beyond the admitted tolerance.	Wait for the transient event to finish.
Output minimum voltage (…)	Input voltage is decreasing to a level that causes an output stabilised voltage decrease beyond the admitted tolerance.	Wait for the transient event to finish.
Rectifier IGBT Overtemperature (…)	Rectifier module is overheating; this event is triggered only on units with 2 power modules for each line, one for the rectifier one for the stabiliser.	Check the load connected to the unit and decrease it if higher than nominal.
Stabiliser IGBT Overtemperature (…)	Stabiliser module is overheating; this event is triggered also if the rectifier module is experiencing overtemperature on units with one power module per line – two IGBTs working as rectifier, two IGBTs working as stabiliser.	Check the load connected to the unit and decrease it if higher than nominal
Input voltage too low (…)	Input voltage on one or more lines too low to start the unit up; input voltage should be within the continuous stabilisation range to avoid high inrush currents.	Wait for the transient event to finish, then try to restart the unit. Check input voltage in the Voltage page. If input voltage is correct (measured by the user via a measuring instrument) and the problem persists, please contact the Service Dept.
Input voltage too high (…)	Input voltage on one or more lines too high to start the unit up; input voltage should be within the continuous stabilisation range to avoid high inrush currents.	Wait for the transient event to finish, then try to restart the unit. Check input voltage in the Voltage page. If input voltage is correct (measured by the user via a measuring instrument) and the problem persists, please contact the Service Dept.
Phase sequence (…)	Input phase sequence incorrect.	Check the input phase sequence and, if necessary, adjust the cable connections to ensure the correct sequence
Phase loss (…)	Input voltage on one or more lines below $50V_{AC}$	Check the input voltage on the indicated line, remove any short circuit condition if present, and then check the input voltage in the Voltage page. If the input voltage is correct (measured by the user via a measuring instrument) and the problem persists, please contact the Service Dept.
DC bus overvoltage (…)	Line regulator sensed a DC bus overvoltage.	Check in the Monitor page that DC bus voltage is lower than $700V_{DC}$, then perform a unit reset (Setup page) and start up the unit again. If the problem persists, please contact the Service Dept.
Output short circuit (…)	Line regulator sensed an output current beyond highest foreseen limit.	Check the load connected to the unit and decrease it if higher than nominal. Check if any load connected to the unit could have an inrush current higher than the unit maximum current. If the problem persists, please contact the Service Dept.
ADC zero trim failed (…)	Software failed to set a zero point for Analog-to-Digital conversion stage.	Please contact the Service Dept.
E2PROM default configuration (…)	Software failed to load the configuration from on-board persistent memory and the default configuration has been applied.	Setup the modification to the default configuration. If the problem persists, please contact the Service Dept.

IN CASE OF (INDICATION IN THE EVENT PAGE)	EVENT DESCRIPTION	ACTION
E2PROM write error (…)	Software failed to write a configuration change to the on-board persistent memory.	Try saving a new configuration change. If the problem persists, please contact the Service Dept.
E2PROM read error (…)	Software failed to read configuration data from the on-board persistent memory.	Try saving a new configuration change. If the problem persists, please contact the Service Dept.
DC bus pre-charge failure (…)	Line regulator experienced a DC bus pre-charge failure; typically, this means that DC voltage did not reach the predefined level in the foreseen time limit.	Sometime, due to capacitors and pre-charge resistors tolerances, pre-charge phase can last more than expected. In the Monitor page check that DC-Bus voltage reached a level not so far from ($V_{line\text{-}to\text{-}line\_RMS}$ × 1.3), then perform a unit reset (Setup page) and start up the unit again. If previous check of DC-Bus voltage failed, for example, voltage is hundred Volts far from the previously defined level, please contact the Service Dept. and avoid any attempt to restart unit.
FANs malfunction (…)	Line regulator fans not working properly.	Perform suggested maintenance. If the problem persists, please contact the Service Dept.
Vaux 24V (…)	Line regulator auxiliary voltage not correct – lower than 22V or higher than 27V.	Please contact the Service Dept.
Pre-charge contactor failure (…)	Software detected an unexpected drop on DC-Bus voltage while unit is working.	Please contact the Service Dept.
Swell in progress (…)	Line regulator detected an input voltage higher than continuous stabilisation range.	Wait for the transient event to finish
Inverter TRIP (…)	Line regulator hardware detected a stabiliser or rectifier inverter TRIP. Inverter TRIPs are generated also during normal working conditions when load connection can cause large inrush currents. In this latter case the error is automatically recovered by unit and simply logged into Event Log.	If possible, please check the driver board signalling LEDs, then perform a unit reset (Setup page) and start up the unit again. If the problem persists, please contact the Service Dept.
External doors open *Only for units with external doors designed for harsh conditions or outdoor locations*	Unit doors open.	If the doors are closed please check if the switches are working properly. If the doors are open, close them firmly, then acknowledge the event in the Active Events page.
Hygrostat *Only for units with hygrostat sensors*	Relative humidity inside the unit too high.	If the doors are open, close them firmly, then acknowledge the event in the Active Events page. If the problem persists check if the HVAC subsystem (cooling units) is working properly. Please contact the Service Dept. if needed.
Cooling unit(s) *Only for units equipped with cooling units*	One or more cooling units not working properly; unit can perform in a degraded way.	Check the cooling units according to the relevant user manual; contact the Service Dept .for support.

For any queries (including the request for spare parts) please contact the nearest authorised Service facility or the Manufacturer's Service Dept. always mentioning type and factory code of the unit, serial number and Purchasing Order or Invoice Number.

MAINTENANCE RECORD

⚠ ***DANGER*** ***ACCESS TO THE INTERNAL COMPONENTS FOR INSTALLATION, SETTING, INSPECTION AND MAINTENANCE MUST BE GRANTED ONLY TO QUALIFIED PERSONNEL IN CHARGE OF IT AND INFORMED OF THE RELEVANT RISKS. ANY INTERVENTION MUST BE CARRIED OUT IN COMPLIANCE WITH THE HABITUAL RULES ON PERSONAL SAFETY AND USE OF ADEQUATE PROTECTIVE TOOLS.***

FOR A DESCRIPTION OF THE MAINTENANCE PROCEDURES AND FREQUENCY, PLEASE REFER TO THE RELEVANT SECTION IN THE USER'S MANUAL.
IN CASE OF ABNORMAL SITUATIONS (SUCH AS POLLUTING OR AGGRESSIVE ENVIRONMENT, HEAVY DUTY CYCLE, ETC.) THE MAINTENANCE FREQUENCY OUGHT TO BE INCREASED ACCORDINGLY.

NOMINAL DATA			
TYPE	**CODE**	**SERIAL NUMBER**	**RATING**

ORDINARY MAINTENANCE		
CLEANLINESS	1	GENERAL
	2	VENTILATION AIR INLET
CHECK	3	MECHANICAL FIXTURES
	4	ELECTRICAL CONNECTIONS
	5	FAN OPERATION

RECORD (TICK THE RELEVANT BOX)							
1	**2**	**3**	**4**	**5**	**COMPANY**	**DATE**	**SIGNATURE**

EXTRAORDINARY MAINTENANCE			
DESCRIPTION	**COMPANY**	**DATE**	**SIGNATURE**

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