Via della Solidarietà n°2/1
40056 VALSAMOGGIA (Loc. Crespellano)
BOLOGNA ITALY

Edition 22/12/2017

Pulsed Power Supply 2 kA 300 V
User Manual

Compiled by:	Checked by:	Approved by:
Luca Bondesan Filippo Gherdovich	Sandro Maria Tenconi	Giuseppe Taddia

THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM - A DIVISION OF - ENERGY TECHNOLOGY SRL.

EDITIONS

Date	
20/12/2017	Emission

LIST OF EFFECTIVE PAGES

From page 1 to page 93

THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM - A DIVISION OF - ENERGY TECHNOLOGY SRL.

IMPORTANT: READ THIS DOCUMENT

Before proceeding to the operations of installation, commissioning, operation, maintenance or disposal, carefully read this entire document.

Symbols used in this manual

Icon	Description	Note
	CAUTION	*advisory that performing some action may lead to consequences that are unwanted or undefined*
	WARNING	*advisory that performing some action may lead to serious or dangerous consequences*
	NOTE	*helpful hints and other information that may assist the user by emphasizing or supplementing important points of the main text*
	Electrical Hazard	

Symbols used on the equipment

Icon	Description	Note
	ATTENTION! Dangerous Voltage	*warning label showing places where voltage levels can cause physical damage and/or damage to equipment*
	ATTENTION! Danger (generic)	*warning label advising the operator to take precautions to avoid injury or system damage. When this symbol is marked on a component refer to the documentation*
	ATTENTION! Hot Surface	*warning label showing places where surfaces which typically reach high temperatures are present*
	GROUND	*indicates points connected to the power supply's chassis*

THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM - A DIVISION OF - ENERGY TECHNOLOGY SRL.

SAFETY INFORMATION

Extreme caution should be exercised when working with this equipment; it is normally used or connected to circuits that operate at dangerous voltages and can be fatal.

This document contains important safety information that you must follow when installing and using the apparatus.

Misuse of the equipment or lack of care in applying safety procedures and prescriptions specified in this document, may result in a hazard.

Avoid contact with voltage or current sources.



WARNING

For no reason the protections and the safety devices must be removed.

COPYRIGHT © 2017 of OCEM – ENERGY TECHNOLOGY

All rights reserved. No part of this publication may be reproduced, distributed, or transmitted in any form or by any means without the prior written permission of the publisher. It constitutes a part of the furniture; its content is confidentially shared between the publisher and the customer of the equipment and cannot be revealed to other except for the safe use and the maintenance of the equipment. The content may be changed by the publisher without in advance notice; the publisher will not be responsible for errors potentially present in this document or for consequences deriving by the use of it.

THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM - A DIVISION OF - ENERGY TECHNOLOGY SRL.

INDEX

1 INTRODUCTION 12
1.1 LIMITED PRODUCT WARRANTY 12
1.2 ADVICE FOR IDLE PERIOD 12
1.3 PERSONAL PROTECTIVE EQUIPMENT (PPE) 13
1.4 OPERATION ON THE EQUIPMENT – SKILLS 13
1.5 REANIMATION 14
1.6 OUT OF SERVICE 14
1.7 SCOPE 14
1.8 NORMATIVE REFERENCES 14
2 TECHNICAL SPECIFICATION 15
2.1 TECHNICAL SPECIFICATIONS 15
2.2 POWER SUPPLY TECHNICAL SPECIFICATIONS 15
3 EQUIPMENT DESCRIPTION 17
3.1 OVERVIEW 17
3.1.1 General 17
3.1.2 STRUCTURE AND LAYOUT 18
3.2 Danger areas 19
3.2.1 Low-Voltage hazard 20
3.2.2 Residual energy hazard 21
3.2.3 Mechanical hazard 22
3.2.4 Thermal hazard 23
3.3 ELECTRICAL LAYOUT 24
3.4 MAIN PARTS DESCRIPTION 25
3.4.1 Supercapacitor modules 25
3.4.2 Series configuration (SUPERCAPACITORS) 26
3.4.3 Parallel configuration (SUPERCAPACITORS) 27
3.4.4 ENERGY RECOVERY configuration (diode D0) 28
3.4.5 FAST RAMP configuration (diode D0) 29
3.4.6 Polypropylene capacitors 30
3.4.7 Discharging resistors 30
3.4.8 H Bridge IGBT Converter 31
3.4.9 Panel PC (TOUCHSCREEN) 31
4 PACKING AND SHIPPING 32
4.1 PACKING 32
4.1.1 WEIGHT AND DIMENSIONS 33

THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM - A DIVISION OF - ENERGY TECHNOLOGY SRL.

4.2 SHIPPING 33
4.2.1 Shock 33
4.2.2 Vibration 34
4.2.3 Extreme climate conditions 34
4.3 SUPERCAPACITORS - HAZARDS IDENTIFICATION 34
4.3.1 First Aid information 35
4.3.2 Ecological Toxicity, Environmental Fate and Transport 35
4.4 UNPACKING 36
4.5 PACKAGING RECYCLING 36
5 POSITIONING AND INSTALLATION 37
5.1 WEIGHT AND DIMENSIONS 37
5.2 LIFTING AND MOVING 38
5.2.1 Lifting cabinet using provided eyebolts 39
5.2.2 Moving cabinet using wheels 40
5.3 POSITIONING 40
5.4 INSTALLATION 41
5.4.1 Earthing cable 41
5.4.2 Output cable 41
5.4.3 Input Plugs 42
5.4.4 External signals 43
5.5 EARTH CONTINUITY TEST 44
5.6 SAFETY INTERLOCK TEST 44
5.7 EXTERNAL I/O TEST 45
5.8 DISCHARGING PROCEDURE TEST 45
6 PERSONNEL SAFETY SYSTEM 46
6.1 OVERVIEW 46
6.2 SAFETY COMPONENTS 46
6.2.1 Grounding 46
6.2.2 Circuits breakers and contactors 47
6.2.3 Safety Interlocks 48
6.3 SAFETY PROCEDURES 48
6.3.1 Safety capacitor discharging and access to the cabinet 48
6.3.2 Complete supercapacitor discharging 49
6.3.3 Emergency stop 50
7 OPERATION 51
7.1 HOW TO READ THIS CHAPTER 51

THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM - A DIVISION OF - ENERGY TECHNOLOGY SRL.

7.2 INTERFACES OVERVIEW 51
7.3 REFERENCES 53
7.3.1 PAGE LAYOUT 53
7.3.2 LOGIN 57
7.3.3 STATUS 58
7.3.3.1 CHARGER STATUS 60
7.3.3.2 INTERLOCKS 61
7.3.4 SETTINGS 62
7.3.4.1 SIMPLE PULSE PARAMETER 64
7.3.4.2 ARBITRARY WAVEFORM PARAMETER 65
7.3.5 ADVANCED SETTINGS 66
7.3.5.1 OPERATION MODE SELECTION 66
7.3.5.2 Change of SUPER USER PASSWORD 67
7.4 INSTRUCTIONS 68
7.4.1 Authentication 68
7.4.2 User Log-off 69
7.4.3 Alarm Reset 70
7.4.4 App stopping and exit 71
7.4.5 Remote control enabling 72
7.4.6 Automatic discharge 74
7.4.7 First starting 76
7.4.8 Normal operation 83
7.4.9 Reconnecting Internal PSs 86
8 ALARM AND TROUBLESHOOTING 88
8.1 ALARM LIST 88
8.2 ALARM TROUBLESHOOTING 89
9 MAINTENANCE AND SPARE PARTS 90
9.1 PREVENTIVE MAINTENANCE 90
9.2 RESIDUAL CURRENT CIRCUIT BREAKERS TEST 91
9.3 SPARE PARTS 91
9.4 LONG TERM STORAGE 91
10 GLOSSARY AND ABBREVIATIONS 93

THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM - A DIVISION OF - ENERGY TECHNOLOGY SRL.

INDEX OF FIGURES

Figure 1 - Power supply diagram 17
Figure 2 - SCPS Front view and rear view 18
Figure 3- Low-Voltage hazard 20
Figure 4 - Residual Energy hazard 21
Figure 5 - Mechanical hazard 22
Figure 6- Thermal hazard 23
Figure 7- Line 1 Electrical Layout (POWER+AUX UPS) 24
Figure 8- Supercapacitors Modules Series configuration 26
Figure 9- Supercapacitors Modules Parallel configuration 27
Figure 10- D0 layout in energy recovery configuration 28
Figure 11- D0 layout in fast ramp configuration 29
Figure 12- Polypropylene capacitors 30
Figure 13 - Discharging resistors 30
Figure 14 - IGBT converter 31
Figure 15 - Panel PC and electronics 31
Figure 16 - Shipping unit 32
Figure 17 - Shipping descriptive marks 33
Figure 18 - SCPS front and rear view 37
Figure 19 - Cabinet lifting (eyebolts) 39
Figure 20 - Input and Output connections 40
Figure 21 - Grounding bar 41
Figure 22 - Output cable connection 41
Figure 23 - Input power connections 42
Figure 24 - X2A External signals connection 43
Figure 25 - Safety interlocks 44
Figure 26 - Circuit breakers and contactors 47
Figure 27 - HMI status page 49
Figure 28 - HMI page layout 53
Figure 29 - HMI: Login page 57
Figure 30 - HMI_ Status page 58
Figure 31 - HMI: Charger status page 60
Figure 32 - HMI: Interlocks status page 61
Figure 33 - HMI: Setting page 62
Figure 34 - HMI: Status page - waveform graph 63
Figure 35 - HMI: Simple Pulse parameters settings 64
Figure 36 - HMI: Arbitrary Waveform parameters settings 65
Figure 37 - HMI Arbitrary waveform graph (example) 66
Figure 38 - HMI: advanced settings 66
Figure 39 - HMI: user authentication (login page) 68
Figure 40 - HMI: authenticated user log-off (login page) 69
Figure 41 - HMI alarm reset (login page) 70
Figure 42 - HMI: off sequence (login page) 71
Figure 43 - HMI: remote control enabling (setting page) 72
Figure 44 - HMI: remote control enabled - equipment ready (setting page) 73
Figure 45 - HMI: remote control enabled (status page) 73
Figure 46- Entering the sleep mode (HMI Login page) 74
Figure 47- Resuming from sleep mode (HMI status page) 75
Figure 48 - Input configuration setting 76

THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM - A DIVISION OF - ENERGY TECHNOLOGY SRL.

Figure 49 - Capacitors discharging (before doors opening) 76
Figure 50 - Main circuit breakers (Q1, Q2, Q3, Q4) 77
Figure 51 - HMI login page (login page) 77
Figure 52 - Discharging switch: normal operation 78
Figure 53 - Internal PSs connection (HMI status page) 79
Figure 54 - Operating mode change (HMI advanced settings page) 80
Figure 55 - SCPS ready (HMI Status page) 81
Figure 56 - output waveform setting (HMI Simple Pulse parameters page) 81
Figure 57 - Output waveform settings (HMI setting page) 82
Figure 58 - Normal operation diagram 83
Figure 59 - HMI Starting the system 84
Figure 60 - HMI Triggering 85
Figure 61 - HMI stop feeding current to the load 85
Figure 62 - HMI trying to reconnect internal PSs to PC 86
Figure 63 - HMI internal PSs reconnection to PC in progress 86
Figure 64 - HMI internal PSs reconnection to PC succeeded 87

THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM - A DIVISION OF - ENERGY TECHNOLOGY SRL.

INDEX OF TABLES

Table 1: Shipping unit weight and dimensions 33
Table 2: Dimensions 37
Table 3: Weights 37
Table 4: External signals connectors 43
Table 5: Test of Digital Interlock signals from internal connections 45
Table 6: Test of Digital signals from external connections 45
Table 7: Capacitors discharging test procedure 45
Table 8: Grounding safety components 46
Table 9: Circuit breakers and contactors 47
Table 10: Safety Interlocks 48
Table 11: Operation: Structure of the chapter 51
Table 12: User Interface components 51
Table 13: State description (normal operation) 83
Table 14: Alarm list 88
Table 15: Spare parts list 91

THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM - A DIVISION OF - ENERGY TECHNOLOGY SRL.

LIST OF REFERENCES

Reference	Description
078.5307.0	Pulsed Power Supply 2000A 300VDC diagram

THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM - A DIVISION OF - ENERGY TECHNOLOGY SRL.

1 INTRODUCTION

1.1 LIMITED PRODUCT WARRANTY

THE FOLLOWING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, WHETHER EXPRESS, IMPLIED OR STATUTORY, INCLUDING, BUT NOT BY WAY OF LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

OCEM warrants to each original Buyer of Products manufactured by the Company that such Products are at the time of delivery to the Buyer, free of material and workmanship defects, provided that no warranty is made with respect to:

(a) Any Product, which has been repaired or altered in such a way, in Company's judgment, as to affect the Product adversely;

(b) Any Product, which has, in Company's judgment, been subject to negligence, accident or improper storage;

(c) Any Product which has not been operated and maintained in accordance with normal practice and in conformity with recommendations and published specification of Company; and, OCEM's obligation under this warranty is limited to use reasonable efforts to repair or, at its option, replace, during normal working hours at the facility of the Company, any Product which in its judgment proved not to be as warranted within the applicable warranty period.

All costs of transportation of Products claimed not to be warranted and of those repaired or replaced, to or from the facility of the Company shall be borne by Purchaser. Company may require the return of any Product claimed not to be as warranted to its facility, transportation prepaid by Purchaser, to establish a claim under this warranty. The cost of labour for the installation of a repaired or replaced Product shall be borne by Purchaser. Replacement parts provided under the terms of this warranty are warranted for the remainder of the warranty period of the Products upon which they are installed to the same extent as if such parts were original components thereof. Warranty services provided under the Agreement do not assure uninterrupted operations of Products; Company does not assume any liability for damages caused by any delays involving warranty service.

1.2 ADVICE FOR IDLE PERIOD

OCEM recommends that the unit does not remain idle for a long time: some of the electronic components inside may suffer long no working period.



CAUTION
In case of long time storage and/or not fed, some caution may be required at reactivation to avoid damages. Noncompliance with this prescription will void the WARRANTY.

The unit must not remain idle for a period longer than 12 months. This value considers standard storage / no working conditions: if higher temperature (i.e. more than 40 °C, but below 65 °) or other particular ambient conditions apply, the value reduces to 6 months. It is mandatory that the unit works at nominal output voltage for at least 2 hours for each period. This operation must be reported in written, with date and signature of the operator.

This applies either for the first installation and turn-on, or if the units must remain not working for a long period after installation.

THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM - A DIVISION OF - ENERGY TECHNOLOGY SRL.

If for any reason the 12 months limit is expired, it is MANDATORY to not operate the unit and to ask to the OCEM technical service. For further details, refer to 9.4 LONG TERM STORAGE page 91.

1.3 PERSONAL PROTECTIVE EQUIPMENT (PPE)

To prevent or mitigate serious job-related illness or injury employees should:

- Properly wear PPE
- Attend training sessions on PPE
- Care for, clean and maintain PPE
- Inform a supervisor of the need to repair or replace PPE.

To ensure the greatest possible protection for employees in the workplace, and to establish and maintain a safe and healthful work environment, employers are responsible for periodically reviewing, updating and evaluating the effectiveness of the PPE program.

In addition to PPE, electric power workers often use Insulating Protective Equipment (IPE) to provide workers protection from accidentally contacting energized conductors. Electrical hazards faced on the job include being exposed to energized parts, electric arcs or flashes.



WARNING

For the correct choice of PPE: internal voltage inside the system and at its output connection arise a maximum value of $400V_{DC}$.

1.4 OPERATION ON THE EQUIPMENT – SKILLS

Operation on the equipment and access to its internal parts shall be done by experienced personnel, adequately trained and aware of the risks related to electricity and high voltages.

Safety rules shall be adopted when operating on the equipment and also on cables and other apparatus connected to it.



WARNING

DO NOT OPERATE ON ENERGIZED CIRCUITS

Do not carry out any operation on the converter or on apparatus connected to it when the circuits or the energy storage devices are energized.



WARNING

WHEN HANDLING AND SERVICING THIS EQUIPMENT, OBSERVE PRECAUTIONS FOR LOW VOLTAGE EQUIPMENT ($V_{MAX} \leq 1kV$) WITH HIGH ENERGY STORED.

Before any access, inspection or intervention, be sure to have switched-off the unit, opened the main circuit breaker and removed the supply to the unit (by opening the circuit breaker/switch on the distribution board at the beginning of the supply line).

Then wait discharge time (at least 15 minute) and check for voltage presence before accessing.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

All the main safety procedures include with the PCSC are presented in the following (see 6.3 SAFETY PROCEDURES page 48) . The procedure must be integrated according to facility safety procedures.

1.5 REANIMATION

The maintenance staff must be aware of the risks related to mechanical movement and electricity, criteria to prevent the risk of mechanic impact and electric shock and resuscitation techniques.

1.6 OUT OF SERVICE

In case of dismantling, decommissioning, destruction, disposal, the user shall follow all the required precautions for component and material elimination, according to local rules and applicable law.

1.7 SCOPE

This document concerns thePulsed Power Supply 2 kA 300 V User Manual. This Manual contains all essential information for the user to face the equipment.

Chapter 2 and 3 present some introductory information to the technical characteristics of the equipment.

Chapter 4 and 5 presents the instructions on how to pack, shipping, manage and install the system.

Chapter 6 and 7 present the operative instruction to make working the equipment. Before any operations, it is necessary to read and understand the content of Chapter 6, related to safety for the operators.

Chapter 8 and 9 refer to management of alarm conditions, maintenance and other not frequent procedures.

1.8 NORMATIVE REFERENCES

The electrical equipment provided by OCEM are designed and built following the document *ENEA "SPECIFICHE TECNICHE - Fornitura e collaudo di un alimentatore basato sulla tecnologia dei supercondensatori per l'esperimento PROTO-SPHERA"*, ed. 2016, [OCEM ES-ST-0122], and the related general and common specifications.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

2 TECHNICAL SPECIFICATION

2.1 TECHNICAL SPECIFICATIONS

MAIN POWER INPUT SPECS			Note:
Supply	230 V ± 5 %	V_{AC}	*P+N+GND*
Operating frequency	50	Hz	
Max input current	10	A_{rms}	
Input cable connection	VDE IEC 60320 C14		*Fuse protected*

AUXILIARY POWER INPUT (UNINTERRUPTIBLE) SPECS			Note:
Supply	230 V ± 5 %	V_{AC}	*P+N+GND*
Operating frequency	50	Hz	
Max input current	10	A_{rms}	
Input cable connection	VDE IEC 60320 C14		*Fuse protected*

MECHANICAL SPECS			Note:
Weight		550	Kg
Dimensions	*length*	600	mm
	depth	1200	mm
	height	192	mm
Protection degree		IP 55	

EXTERNAL INFLUENCES		Note:
Environmental temperature	-15 ÷ +40	°C	
Max working humidity	95	%	*non condensing*
Storage temperature	-40 ÷ +60	°C	
Altitude	< 1000 m		
Degree of pollution	degree 2		*non conductive pollution occurs (see IEC 60664 1)*

2.2 POWER SUPPLY TECHNICAL SPECIFICATIONS

SUPERCAPACITORS MODULE SPECS			Note:
Product Name	BMOD0165 P048 C01		*Maxwell Technologies*
Rated Capacitance	165	F	
Maximum ESR_{DC}	6.0	mΩ	
Rated Voltage	48	V_{DC}	
Stored Energy	**53**	**Wh**	

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

SUPERCAPACITORS MODULE SPECS			Note:
Abs. Maximum Current	1900	A	
Operating Temperature	[-40÷ +65]	°C	
Storage Temperature	[-40 ÷ +70]	°C	
Weight	14.2	kg	
Size	418 x 194 x 179	mm	
Environmental Protection	IP 65		

ELECTROLYTIC CAPACITORS SPECS			Note:
Product Name	FX22W153BFM6		*Hitachi*
Rated Capacitance	15	mF	
Maximum ESR_{DC}	7.0	mΩ	
Rated Voltage	450	V_{DC}	
Weight	2.35	kg	
Size	90 x 236(h)	mm	

POLYPROPYLENE CAPACITORS SPECS			Note:
Product Name	416.86.1480		*Ducati Energia*
Rated Capacitance	8	mF	
Maximum ESR_{DC}	< 0.3	mΩ	
Rated Voltage	800	V_{DC}	
Weight	18	kg	
Size	150 x 460 x 240(h)	mm	

OUTPUT SPECS			Note:
Max. Output voltage	± 300	V_{DC}	
Output current	2000	A	
Output power	50	kW	*1.5 sec*
Duty Cycle (Max)	1.5/300	s/s	
Output connection	BUSBAR		*copper busbar*

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

3 EQUIPMENT DESCRIPTION

3.1 OVERVIEW

3.1.1 GENERAL

A single cabinet, accessible through front doors, composes the Super Capacitor Power Supply.

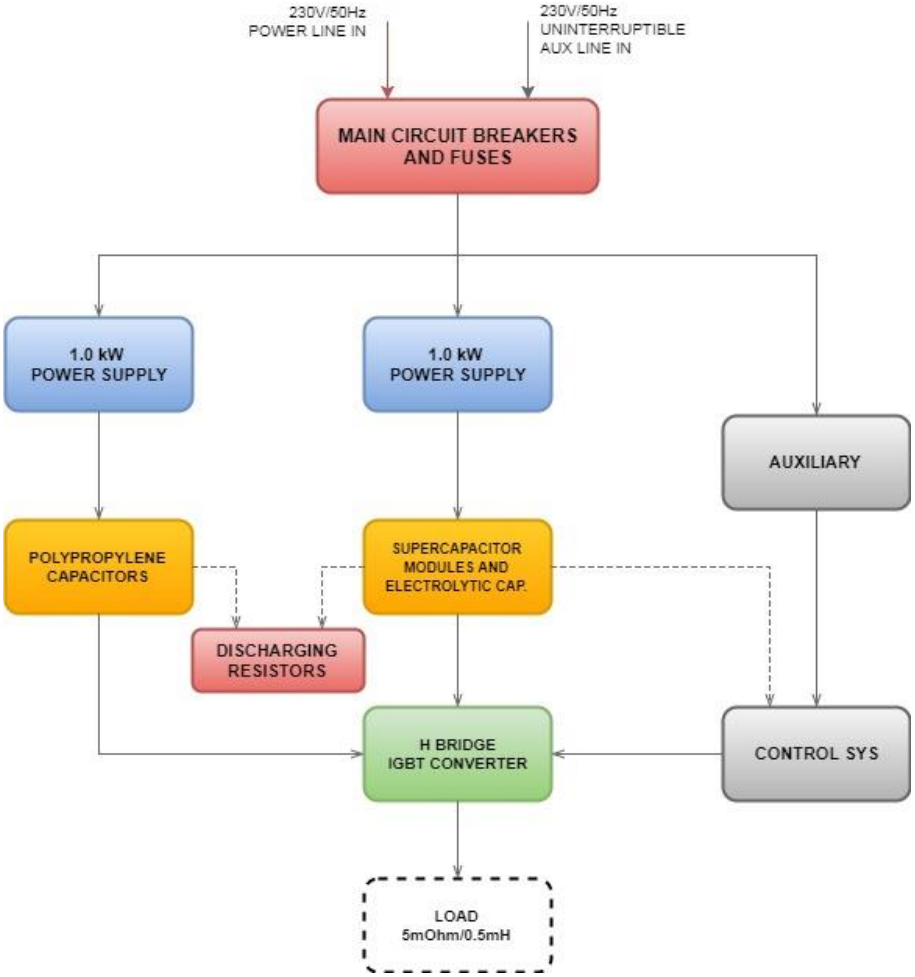


Figure 1 - Power supply diagram

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

3.1.2 STRUCTURE AND LAYOUT

SCPS front view and rear view:

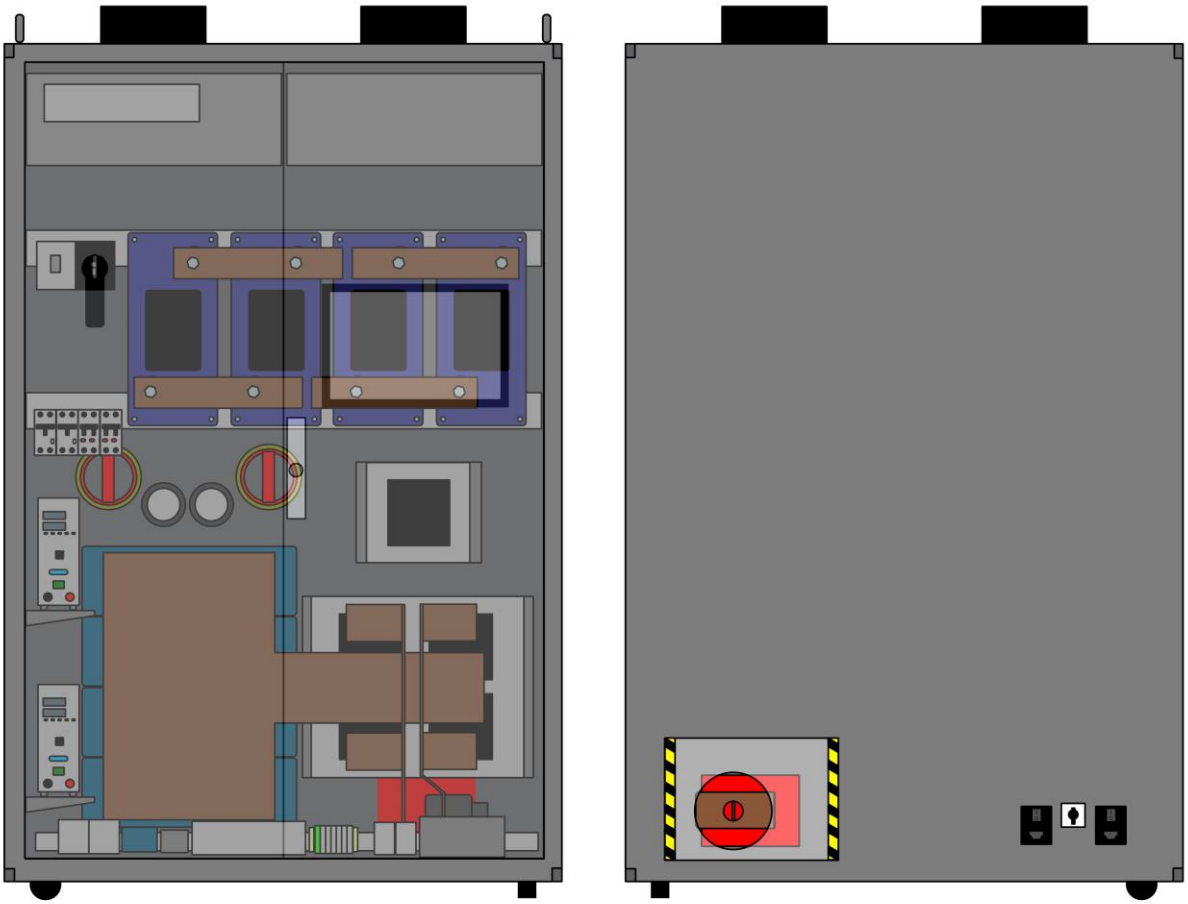


Figure 2 - SCPS Front view and rear view

The cabinet contains:

- Supercapacitor modules;
- Electrolytic capacitors;
- IGBT converters;
- Polypropylene capacitors;
- Protection, command and control system.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

3.2 DANGER AREAS

The equipment is designed to mitigate the likelihood of injuries from electro-mechanical hazard.



WARNING

Residual risks are still present even if all possible safety measures have been applied.

The equipment has safety devices built in (metallic grounded enclosures, door switches, grounding devices, measurement equipment) to protect workers during normal operations. However, during maintenance or repairs (expert users only), these devices may have to be removed or by-passed.

Before maintenance or repairs each energy source of the system has to be excluded to protect an individual from hazardous energy. A tag should be placed on each energy-isolating device, indicating that the energy device is not to be operated until removal of the lock and the tag. Follow safety instruction before to proceed to discharge the electrical energy from the system.



WARNING

Verify that the power line is properly locked out and tagged before beginning any maintenance or repair.

Electrical risks are still present due to energy storage inside the cabinet.

Some danger risk areas are mainly characterizing the equipment:

- Low-Voltage area risk: during maintenance, protecting device and guard should be removed and worker can reach potential hazardous parts of the system affected by Low-Voltage line distribution;
- Residual energy area risk: during operation the PS stores energy mainly in capacitors (more than 50 V_{DC}, up to 96 V_{DC} on each component); during maintenance, worker can reach parts of the system affected by Residual energy risk;
- Mechanical risk: a risk deriving by removable parts and fall of heavy items is present;
- Thermal risk: the internal equipment, and mainly transformer, other magnetic components and heatsinks, work at medium-high temperature (more than 60 °C); a burn hazard because of hot surfaces is present for the worker during maintenance.

The following shows a graphical map of these areas.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

3.2.1 LOW-VOLTAGE HAZARD

Low-Voltage hazards is present inside the cabinet, in particular behind the transparent removable panel.

WARNING

Some electrical component of the protection, command and control system of the equipment can be live even when front doors are open.

Be sure to de-energize completely the equipment before operating on the internal components of the equipment. Electrical risk are still present due to high energy storage in some of the component.

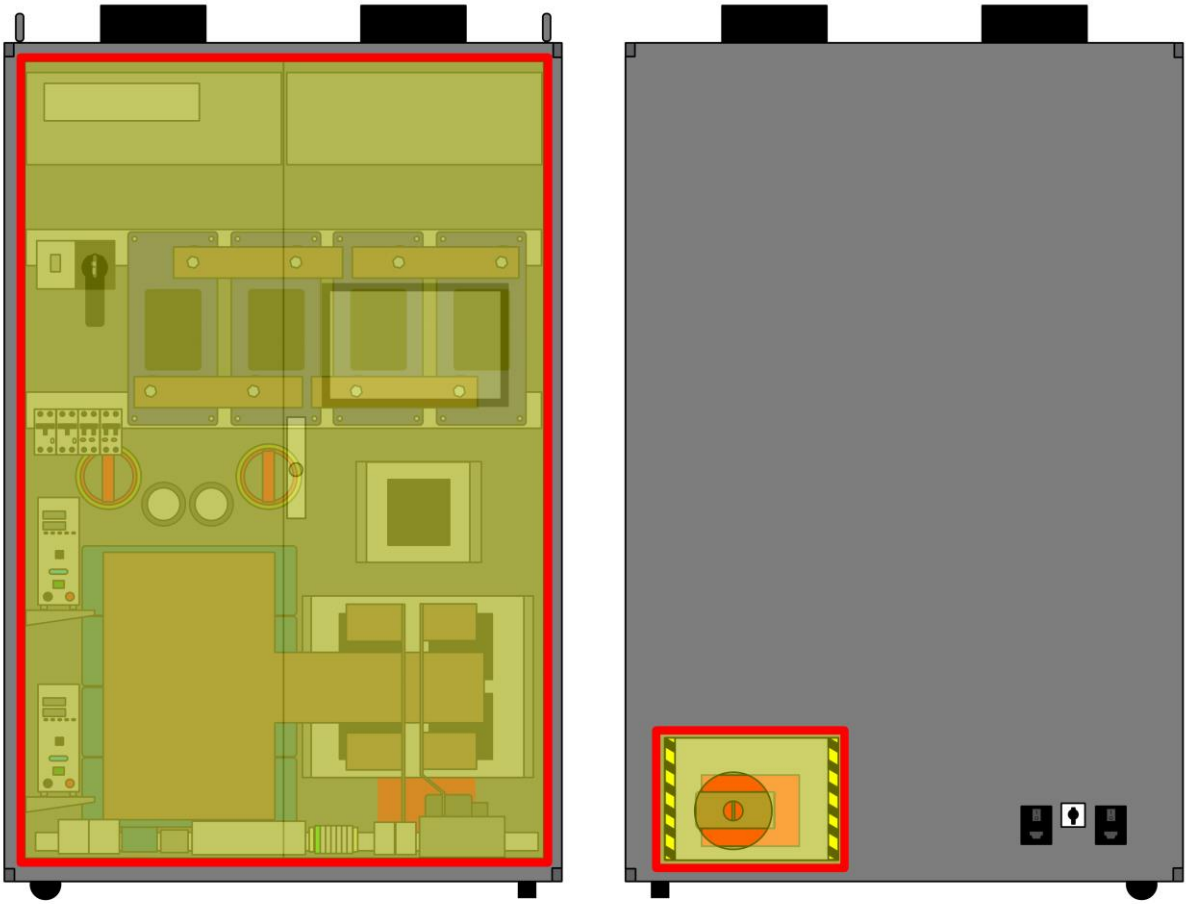


Figure 3- Low-Voltage hazard

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

3.2.2 RESIDUAL ENERGY HAZARD

Residual electrical energies can be very dangerous: follow safety shut down procedure and safety instruction before to proceed opening the cabinet doors and operating on the internal components. Moreover, consider that also after the normal discharging period some parts may store residual energy: apply any caution, as minimum state of art procedures to face each of these components.

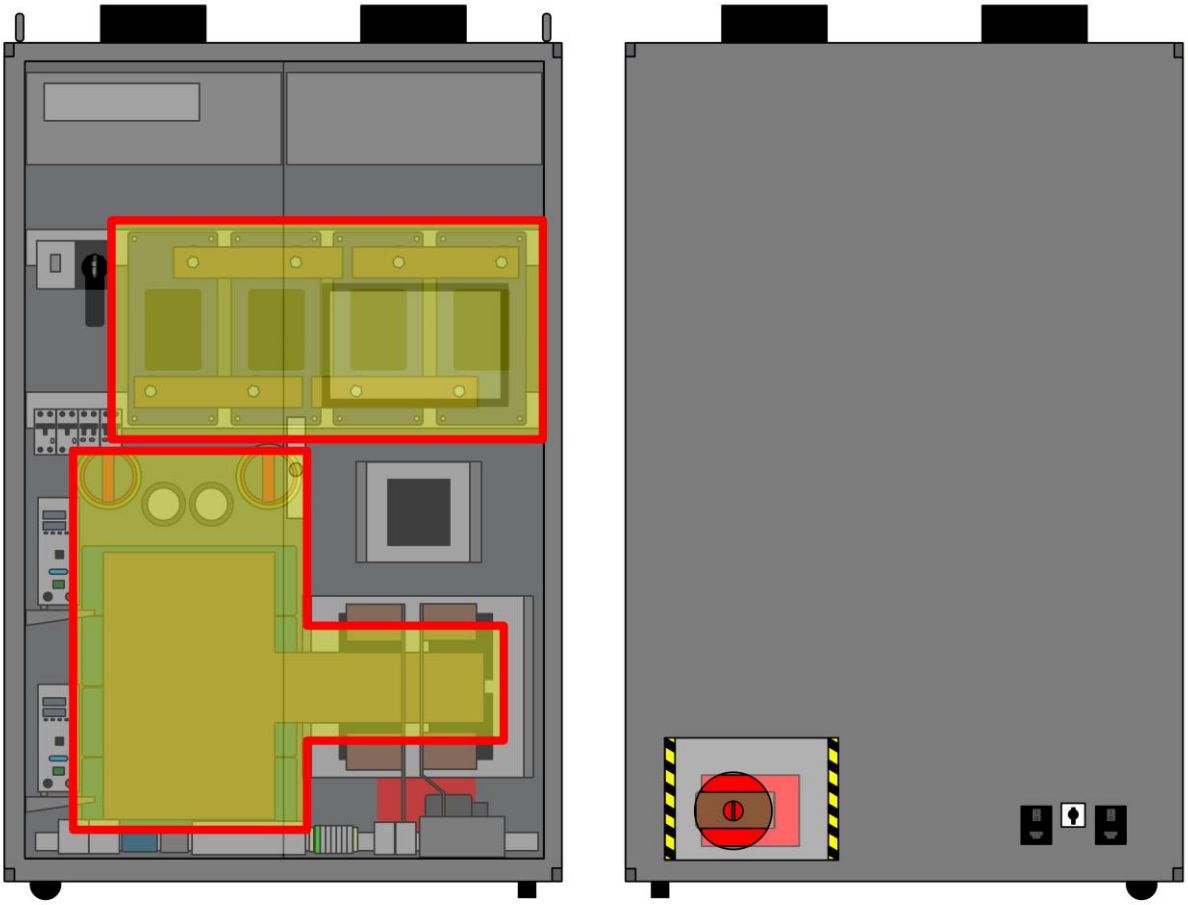


Figure 4 - Residual Energy hazard

Residual energy hazard is primarily localized in the following areas:

- Supercapacitor modules;
- Electrolytic and Polypropylene capacitors.

When operator open the cabinet, discharging switch should be switched to "capacitor discharge" position.

WARNING

In normal operation the equipment takes from 10 (series connection) to 20 (parallel connection) minutes to discharge the module: do not access cabinet before complete discharge.

In any case, test the residual voltage with external meter before manage the module: the residual energy could be not correctly managed in case of failure of some sub-system or in case of general damage of the PS.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

3.2.3 MECHANICAL HAZARD

In this paragraph we will consider only the hazards concerning mass and stability of the components installed inside the equipment: in particular, are considered components falling under the effect of their own weight.

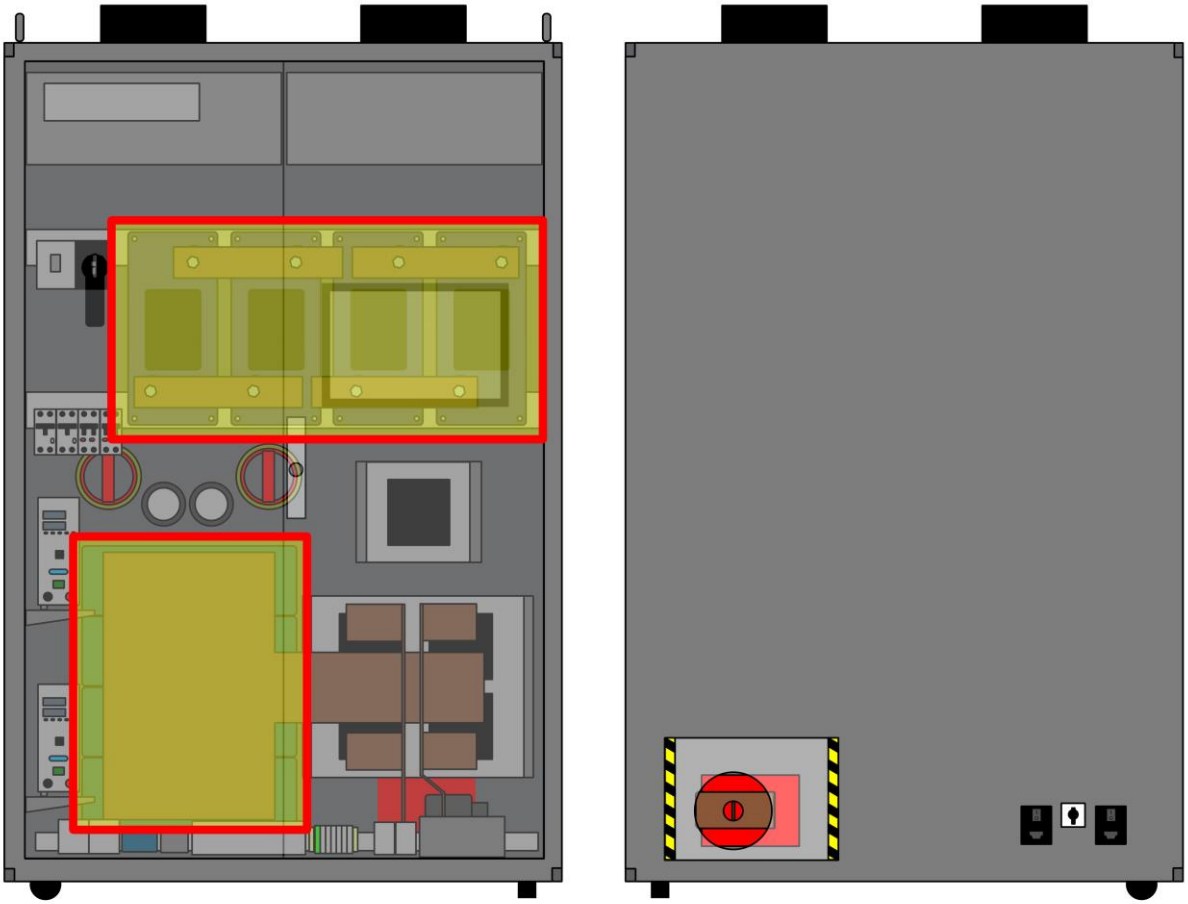


Figure 5 - Mechanical hazard

Mechanical hazard is primarily localized in the following areas:

- Supercapacitor modules;
- Polypropylene capacitors.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

3.2.4 THERMAL HAZARD

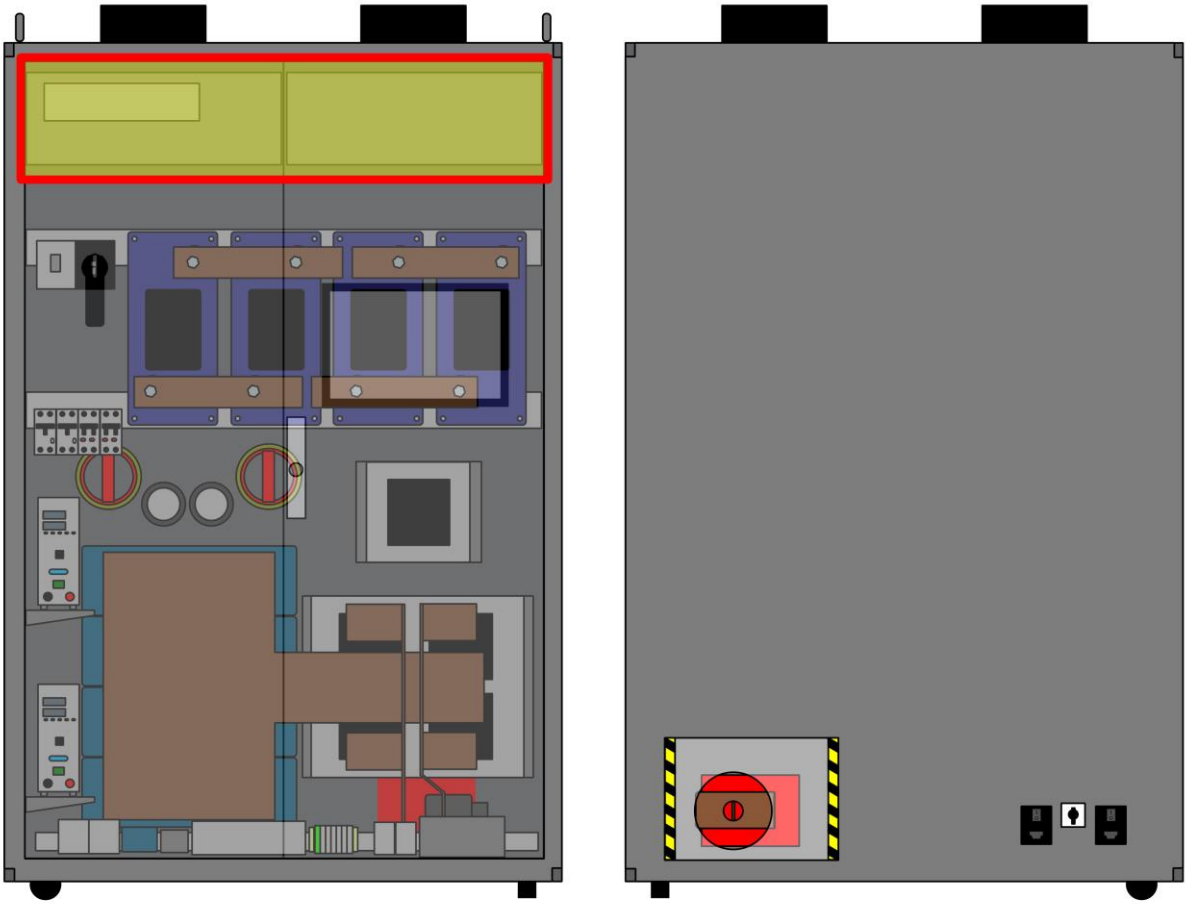


Figure 6- Thermal hazard

Thermal hazard is primarily localized in the following areas:

- Discharging Resistors.

WARNING

Under normal condition, some heatsinks and magnetic components may increase their temperature up to 65 °C and more. In case of failure, higher temperature can be detected.

Do not disassembly Discharging Resistor frames. Adopt protective PPE and check the temperatures with external measure system in case of doubt to face the risk of thermal shock for operators.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

3.3 ELECTRICAL LAYOUT

There are 2 separated feeding circuits for the PS:

- Line 1: 230 VAC / 50 Hz (VDE IEC 60320 C13/C14) feeding power circuits;
- Line 2: 230 VAC / 50 Hz (VDE IEC 60320 C13/C14) uninterruptible feeding auxiliary circuits.

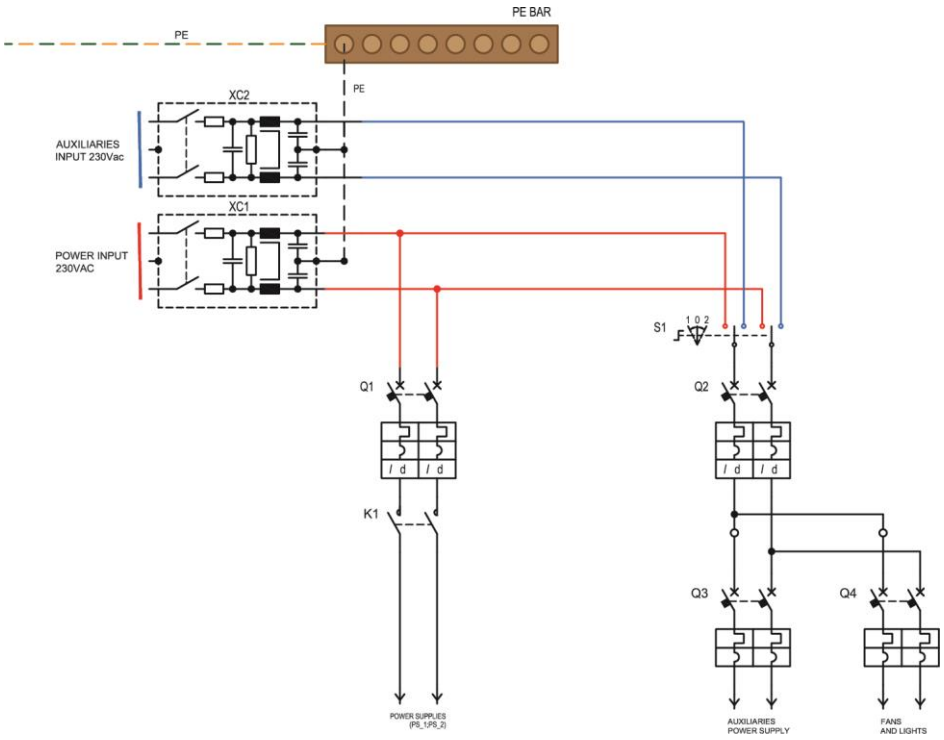


Figure 7- Line 1 Electrical Layout (POWER+AUX UPS)

WARNING

Auxiliary line should be protected against power fails. A UPS that provides emergency power to the equipment when the mains power fails is highly recommended, particularly 3000 VA/230 V_{AC}.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

3.4 MAIN PARTS DESCRIPTION

3.4.1 SUPERCAPACITOR MODULES



WARNING

ENERGY AND VOLTAGE HAZARD

Never touch the power terminals as the module can be charged and cause fatal electrical shocks. Always verify that the module is fully discharged before manipulating the module.

A fully discharged module may “bounce back” if it is stored without a shorting wire connected to the + and – terminals. This bounce back can be as much as 6 V for the 48 V module and is enough to cause dangerous electrical shocks.

Supercapacitors are utilized as temporary energy sources where immediate power availability may be difficult. Supercapacitor modules are used as the primary power source for applications requiring power for only short periods of time; it is acceptable to allow short charging time before use.

Prior to removal from the system, cable removal, or any other handling ensure that the energy storage module is completely discharged in a safe manner. The stored energy and the voltage levels may be lethal if mishandling occurs. Maintenance should only be conducted by trained personnel on discharged modules.



WARNING

When fully charged the stored energy on supercapacitors may exceed 760 kJ.

Before operating on a Supercapacitor module (e.g. SUPERCAPs configuration change) follow safety instruction to access the cabinet (see 6.3SAFETY PROCEDURES page 48) and to discharging supercapacitors modules. **NEVER TOUCH THE POWER TERMINALS AS THE MODULE CAN STORE ENERGY TO AVOID FATAL SHOCK.**

Using a voltmeter, measure voltage between the two power terminal: if the voltage is under 2 V. The module is now safe for handling. Leave the shorting wire connected at all times until the power cables are connected.



WARNING

Do not leave any spare parts or tools inside the cabinet after maintenance.

The output terminals of the module consist of internally threaded aluminum posts connected directly to a bus bar. The power supply is equipped with 2 blocks made by 2 supercapacitors modules each one. SCPS can operate in two different configurations:

- [C1A||C1B] and [C2A||C2B] in series: output range [0 ÷ 96 V]
- [C1A||C1B] and [C2A||C2B] in parallel: output range [0 ÷ 48 V]

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

3.4.2 SERIES CONFIGURATION (SUPERCAPACITORS)

To configure the Supercapacitors in SERIES CONFIGURATION:

- remove, if necessary, the copper bars PB6 and PB7, and install the bar PB5 as in the following Figure, using the bolts supplied. The tightening torque for the bolts is 20 Nm on positive terminals and 30 Nm on negative terminals.

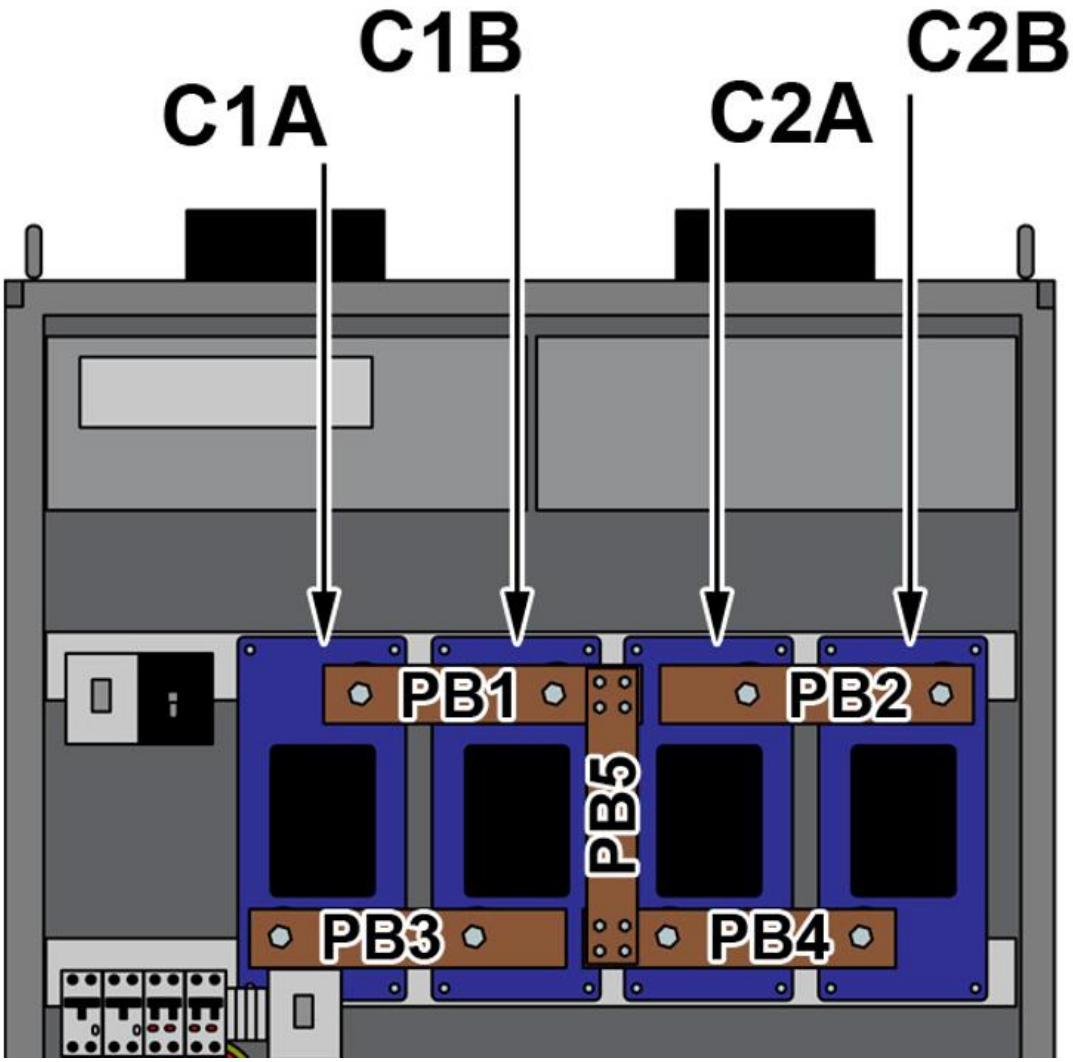


Figure 8- Supercapacitors Modules Series configuration

WARNING

Do not leave any spare parts or tools inside the cabinet after maintenance.

WARNING

To avoid damages, don't use bolts different from the ones supplied, and respect the prescribed tightening torque.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

3.4.3 PARALLEL CONFIGURATION (SUPERCAPACITORS)

To configure the Supercapacitors in PARALLEL CONFIGURATION:

- remove, if necessary, the copper bars PB5 and install the copper bar PB6 and PB7 as in the following Figure, using the bolts supplied. The tightening torque for the bolts is 20 Nm on positive terminals and 30 Nm on negative terminals.

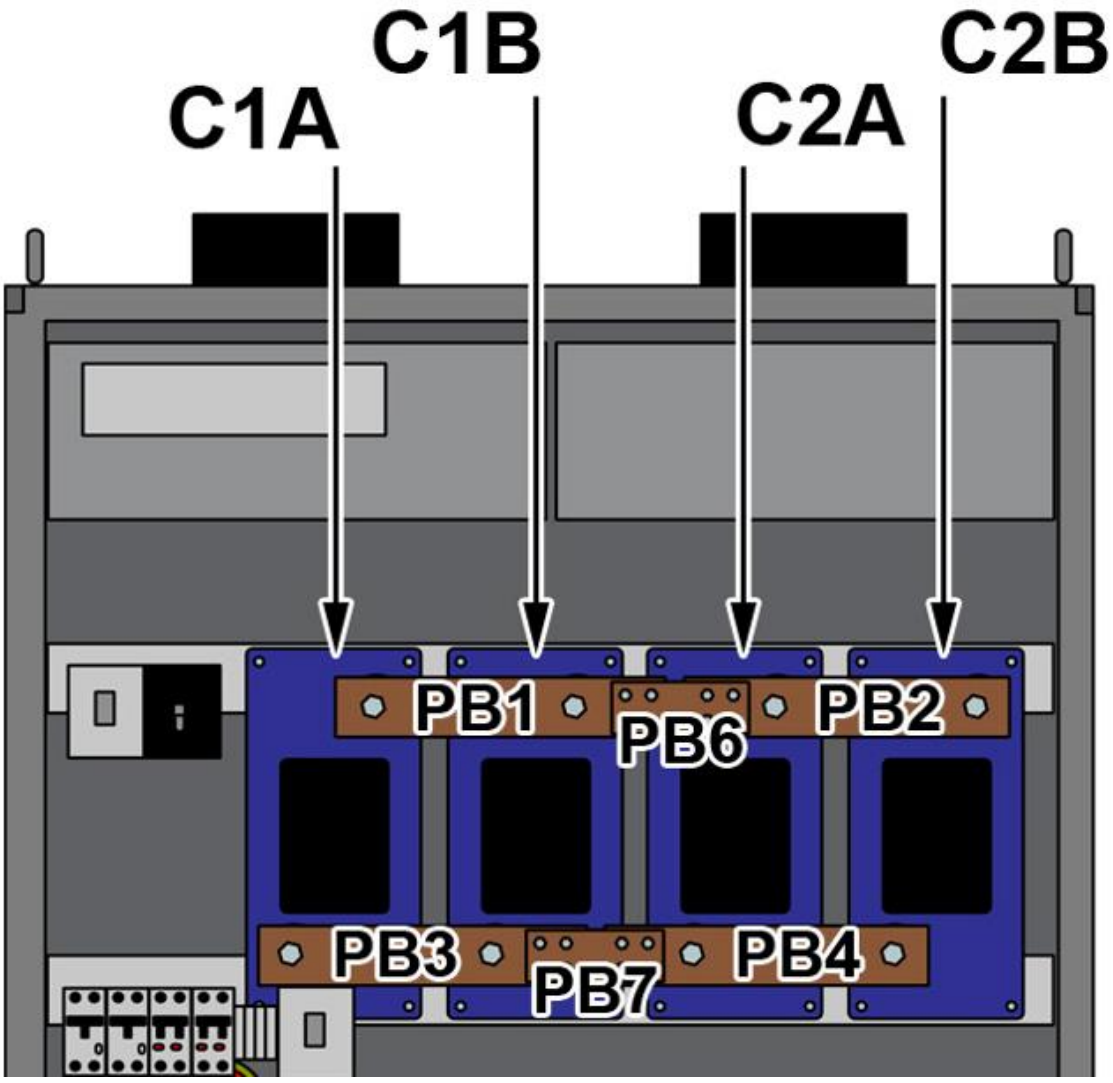


Figure 9- Supercapacitors Modules Parallel configuration

WARNING

Do not leave any spare parts or tools inside the cabinet after maintenance.

WARNING

To avoid damages, don't use bolts different from the ones supplied, and respect the prescribed tightening torque.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

3.4.4 ENERGY RECOVERY CONFIGURATION (DIODE D0)

Diode D0 decouples the supercapacitor bank from the polypropylene capacitors bank. In energy recovery configuration diode D0 is bypassed. In this modality:

- during current rump-down, the power supply recovers the energy from the load inductance into the supercapacitors
- both supercapacitors and polypropylene capacitors banks are fed by PS_1 power supply only.

To configure the unit in ENERGY RECOVERY MODE:

- install the supplied tin-plated slab to "shortcircuit" the four diode terminals, as in the following Figure (under copper bar), using the four bolts supplied. The tightening torque for the bolts A, B, C, D is 10 Nm.
- set the equipment in ENERGY RECOVERY mode (see 7.3.5 ADVANCED SETTINGS page 66)

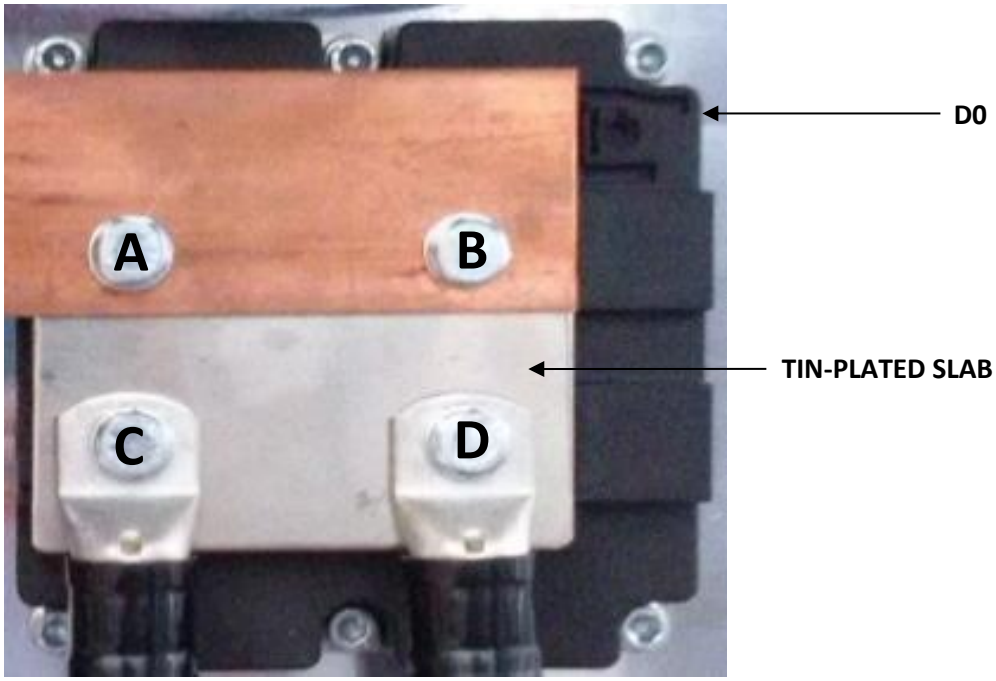


Figure 10- D0 layout in energy recovery configuration

Warning 1: to avoid damages, don't use bolts different from the ones supplied, and respect the prescribed tightening torque.

Warning 2: verify correspondence between software setting and hardware configuration (slab application), equipment is susceptible of damage in case of wrong settings.

WARNING

Pay close attention: equipment is susceptible of damage.

The operator is responsible of the correspondence between physical configuration (presence or absence of the slab) and the correct settings of the corresponding control parameter. The physical configuration is not detected by the control.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

3.4.5 FAST RAMP CONFIGURATION (DIODE D0)

In fast ramp configuration diode D0 is NOT bypassed; it decouples the supercapacitor bank from the polypropylene capacitors bank. In this modality:

- during current rump-down, the power supply recovers partially the energy from the load inductance into the polypropylene capacitors
- supercapacitors and polypropylene capacitors banks are fed respectively by PS_1 and PS_2 power supplies.

To configure the unit in ENERGY RECOVERY MODE:

- remove the tin-plated slab as in the following Figure
- sett the equipment in FAST RAMP mode (see 7.3.5 ADVANCED SETTINGS page 66)



Figure 11- D0 layout in fast ramp configuration

Warning 1: to avoid damages, don't use bolts different from the ones supplied, and respect the prescribed tightening torque.

Warning 2: verify correspondence between software setting and hardware configuration (slab application), equipment is susceptible of damage in case of wrong settings.

WARNING

Pay close attention: equipment is susceptible of damage.

The operator is responsible of the correspondence between physical configuration (presence or absence of the slab) and the correct settings of the corresponding control parameter. The physical configuration is not detected by the control.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

3.4.6 POLYPROPYLENE CAPACITORS

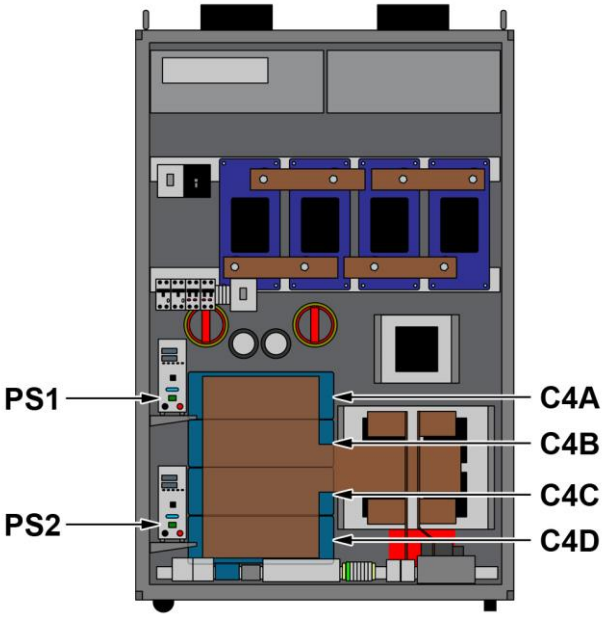


Figure 12- Polypropylene capacitors

3.4.7 DISCHARGING RESISTORS

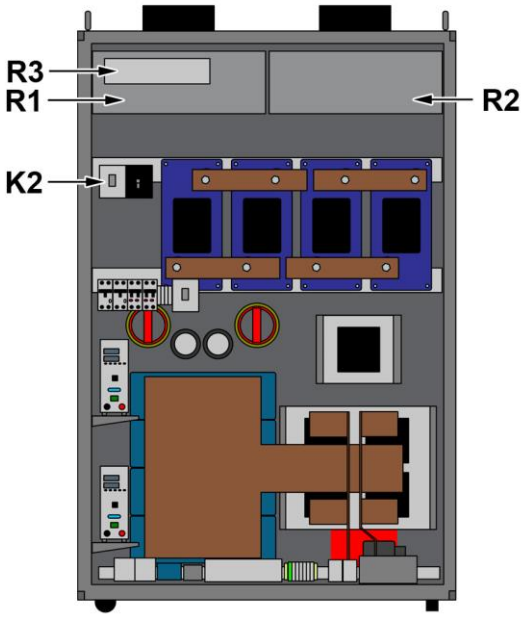


Figure 13 - Discharging resistors

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

3.4.8 H BRIDGE IGBT CONVERTER

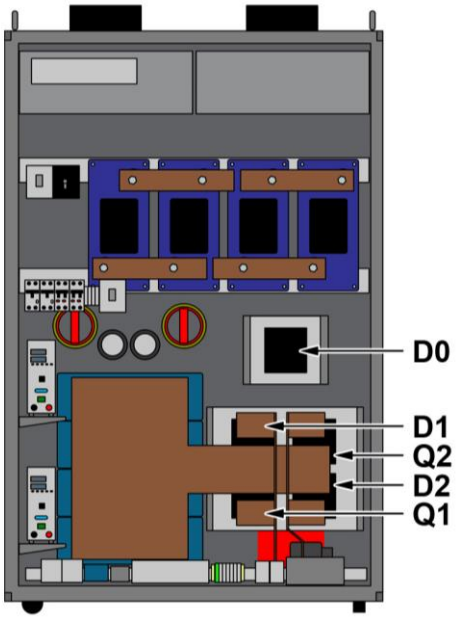


Figure 14 - IGBT converter

3.4.9 PANEL PC (TOUCHSCREEN)

The panel PC (touchscreen) is installed on the front right door.

NOTE

All the electronic components and the electronics boards are placed inside a metal box shielding electromagnetic fields, to avoid or reduce significantly electromagnetic interferences and radiations.

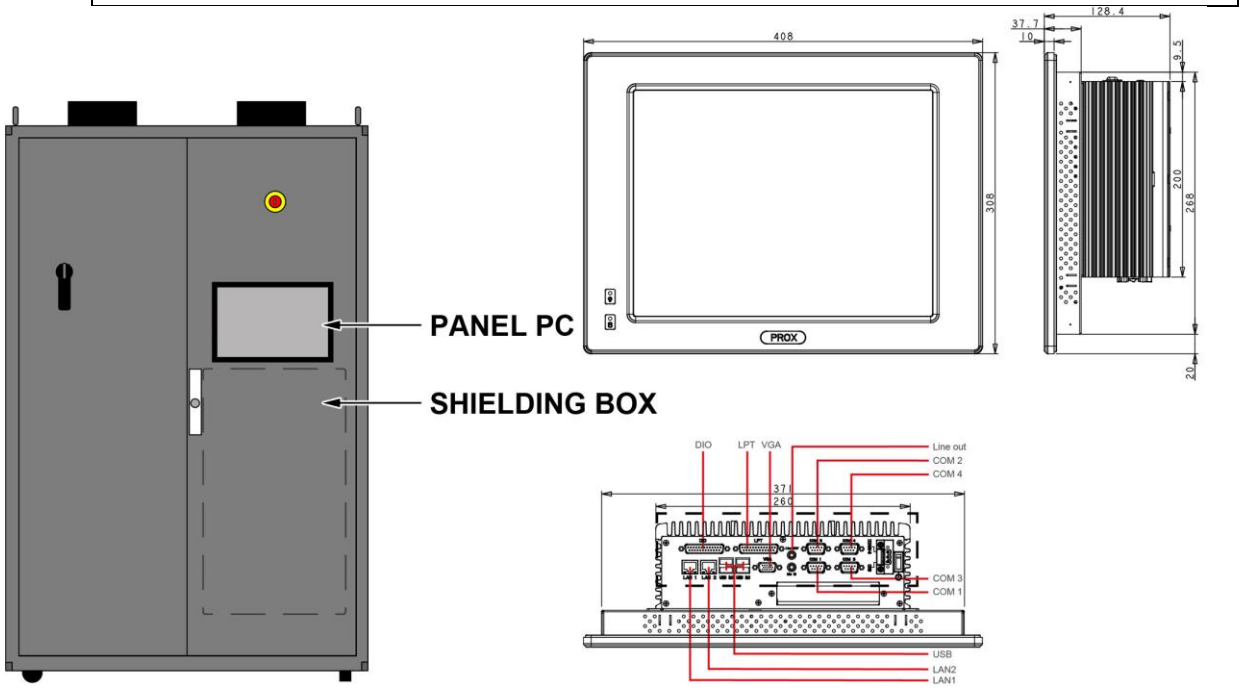


Figure 15 - Panel PC and electronics

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

4 PACKING AND SHIPPING

4.1 PACKING

Standard wood pallet, wood blocking and protective shell are used for packing.

WARNING

Place the cabinet on blocking wood components. Check carefully that cabinet rests on wooden support system and wheels do not remain in contact with the pallet: accidentally wheel contacts can cause exceeding stresses and the equipment could be damaged during transportation.

The blocking should be placed tightly against the object to keep it in the right position during all transportation and handling. Following a general rule, blocking requires a minimum of two fasteners in each end to prevent pivoting and maintain adequate strength.

WARNING

Protect output busbar during transport. Check carefully that the output busbar (in the lower part of the rear side) is placed inside the pallet area. Output busbar must be adequately protected against impacts to avoid damages during transportation.

WARNING

Provide adequate protection for the panel PC display during transportation. Shocks and collisions in this area may result in panel PC destruction.



Figure 16 - Shipping unit

A stretch-wrap can be added for granting an additional protection against corrosion, humidity and liquids.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

Use descriptive marks or labels to identify shipping technical specification. For example “This End Up”, “Do Not Stack,” “Fragile” and “Handle With Care” or simply Up Arrow Label to display the preferred orientation during shipping and handling.

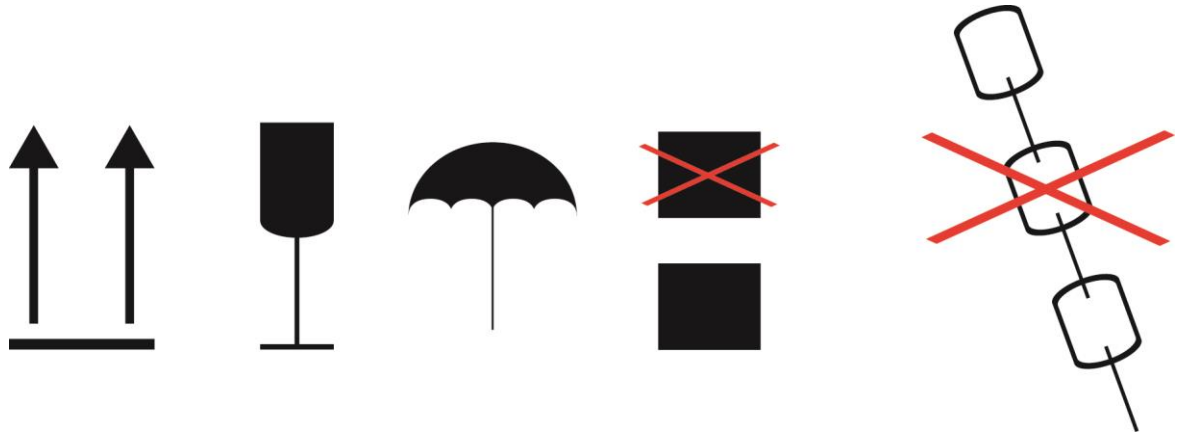


Figure 17 - Shipping descriptive marks

NOTE

Warning stickers should be placed on the outside of wooden crate in the upper part of the box on each side of the package to assist operator during handling.

4.1.1 WEIGHT AND DIMENSIONS

Table 1 summarizes the dimensions and weight of the shipping units:

Shipping unit	Dimensions [mm] L x D x H	Weight [kg]
Cabinet	1200 x 800 x ~2600	~600

Table 1: Shipping unit weight and dimensions

4.2 SHIPPING

All shipping unit must be labeled or marked with the most important information: routing information (including consignee and consignor addresses), weight information (total weight and center of gravity must be visible from each side to assist operator during handling), additional information (preferred orientation, descriptive marks,…)

During shipping, the equipment will move through different places and room, and it will face some hazards and in particular: shock, vibration and extreme climate conditions.

4.2.1 SHOCK

Accidentally, an impact (dropping, striking or falling) can create shock, which may cause fatigue or damage to the packaging and their contents.

Other types of impacts can occur during forklift handling: impacts with pallets and other freight shipments, impacts with fork lift blades as freight packages bounce during handling and impacts as freight packages are loaded into (or unloaded) from trailers, trucks, freight containers, racks or carts during sorting or transportation.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

4.2.2 VIBRATION

Mechanical handling induces a low level of vibration into freight packages as the freight packages bounce on the pallet or directly on the forklift blades during transit. In-transit motions subject freight packages to many levels of vibration over different durations of time.

Truckload (and trailer on flatbed railcar) will subject the freight packages too much higher amplitudes; the duration could reach up to several days.

Vibration can result in damage including scuffing, abrasion, loosening of fasteners and closures, freight package or freight product fatigue and failure.

4.2.3 EXTREME CLIMATE CONDITIONS

Environmental conditions can cause damage due to effects of temperatures and humidity if carrier vehicles are not conditioned (most of the cases). In this case, packages will be exposed to extreme temperature and humidity conditions even if placed inside a vehicle.

4.3 SUPERCAPACITORS - HAZARDS IDENTIFICATION

Supercapacitor is a manufactured electronic product that contains primarily non-hazardous materials, including metal and plastic. Supercapacitors are sealed, metal containers (steel or aluminum), which enclose layers of activated carbon that is saturated with an electrolyte solution. The electrolyte solution contains a quaternary salt compound (tetraethylammoniumtetrafluoroborate EINECS 207-055-1) dissolved in the solvent acetonitrile (EINECS 200-835-2). The assembled layers of activated carbon are inserted into an outer metal container and are saturated with the above electrolyte solution and then are sealed and stored in an electrically uncharged state. Further precautions should be taken to avoid rupture or overheating the sealed metal containers.



NOTE

Hazardous Ingredients according to Regulation (EC) No. 1272/2008:

- acetonitrile (EINECS 200-835-2) - Classification: Flam. Liq. 2; Acute Tox. 4; Eye Irrit. 2; H225; H302; H332; H312; H319 (concentration 20%-30%);
- tetraethylammoniumtetrafluoroborate (EINECS 207-055-1) - Classification: Acute Tox. 4; Skin Irrit. 2; Eye Irrit. 2; STOT SE 3; H302; H332; H312; H315; H319; H335 (concentration 5%-15%).



WARNING

During transportation the contents of the supercapacitors should to remain sealed in the outer shell and they should be kept uncharged: persons handling these products will avoid most of the risks associated with hazardous components of the electrolyte.

Emergency responders must wear the proper personal protective equipment (and have appropriate fire-suppression equipment) suitable for the situation to which they are responding. Appropriate precautions should be taken in the event of a container rupture under emergency conditions including fire.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

4.3.1 FIRST AID INFORMATION

Damaged module may release electrolyte containing acetonitrile and TEABF4. Acetonitrile is moderately toxic by inhalation and/or skin absorption. If necessary, physicians should refer to Toxicological Information in the event there is a severe inhalation, skin contact or ingestion exposure to the electrolyte solution. Under these circumstances, take a copy of this SDS to the physician or health care professional with the exposed individual.



NOTE

If necessary, in case of emergency eliminate exposure and treat symptoms.

First-aid measures applicable to contamination with the electrolyte solution are as follows:

SKIN EXPOSURE: If skin exposure to electrolyte occurs, flush contaminated area liberally with water. Seek medical attention if any adverse effects occur after flushing.

EYE EXPOSURE: If liquid, vapors or fumes from the electrolyte contained in this product contaminate the eyes, rinse eyes under gently running water. Use sufficient force to open eyelids and then "roll" eyes while flushing. Minimum flushing is for 20 minutes. **Seek medical attention.**

INHALATION: If vapors or fumes from the electrolyte contained in this product are inhaled, remove exposed person to fresh air. **If necessary, use artificial respiration to support vital functions and seek medical attention.**

INGESTION: In the unlikely event that the electrolyte contained in this product is swallowed, CALL PHYSICIAN OR POISON CONTROL CENTER FOR MOST CURRENT INFORMATION. If professional advice is not available, **DO NOT INDUCE VOMITING**. Never induce vomiting or give diluents (milk or water) to someone who is unconscious, having convulsions, or unable to swallow. If victim is convulsing, maintain an open airway and obtain immediate medical attention.

ELECTRIC SHOCK: Victim should not be touched if a connection to the product still exists. Once the victim is no longer in contact with the device and if electric shock from the device has resulted in cessation of breathing, immediately begin cardiopulmonary resuscitation (CPR). If no person that is trained in CPR is available, obtain immediate medical advice on how to perform CPR. If the heart has stopped, a qualified person should begin CPR. Immediate medical attention should be sought while attempts to revive the victim are ongoing. If an automatic external defibrillator (AED) is available, immediately begin treatment with AED.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: No medical conditions are known to be aggravated by exposure to this product.

4.3.2 ECOLOGICAL TOXICITY, ENVIRONMENTAL FATE AND TRANSPORT

This product is not expected to decompose in the environment. The following environmental data are available for components of the electrolyte solution.

Acetonitrile is expected to have high mobility in soil and to adsorb weakly to soils as predicted by its KOC value. Removal occurs primarily by volatilization and leaching into groundwater. Volatilization from moist soil surfaces is expected to be an important fate process. Acetonitrile has a vapor pressure of 88.8 mm Hg and would be expected to volatilize from dry soil surfaces. Volatilization from surface waters is slow due to the high water solubility, moderate vapor pressure, and low Henry's law constant. The water solubility of acetonitrile suggests that dissolution into clouds and raindrops may occur leading to possible removal in rainfall.

The metal and plastic case of this product will persist in the environment for extended periods of time. The following information is available for the acetonitrile component of the electrolyte solution.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

If released to air, acetonitrile will exist solely as a vapor in the ambient atmosphere. Vapor-phase acetonitrile will be degraded in the atmosphere by reaction with photochemically produced hydroxyl radicals and ozone. The half-life for the reaction with hydroxyl radicals ranges from 0.6 to 20 days. The half-life for the reaction with ozone is somewhat slower and ranges from 54 to 76.4 days. Acetonitrile is not expected to be susceptible to direct photolysis by sunlight as it absorbs light only in the far UV region.

Acetonitrile is removed from soil by microbial degradation. Nocardiarhodochrus LL100-21 and Aeromonas sp. BN 7013 isolated from soils are capable of utilizing acetonitrile as a sole carbon and nitrogen source. The chemical is enzymatically hydrolyzed by a strain of the fungus Fusariumsolani. Evaporation and leaching are also important in removing acetonitrile from soils. Biodegradation studies of acetonitrile with mixed cultures of microorganisms from activated sludge and sewage show that degradation proceeds slowly without acclimatization of microorganisms.

If released into water, acetonitrile is not expected to adsorb to suspended solids and sediment based upon its KOC value. Acetonitrile is removed from water by biodegradation, with decomposition occurring about five times faster following acclimation of the microorganisms. Degradation occurs by corynebacteriumnitrilophilus isolated from activated sludge. Enzymatic hydrolysis is accomplished by Pseudomonas sp. capable of utilizing acetonitrile as a sole carbon source. Although slow, loss by volatilization may become more important in shallow waters. Volatilization from water surfaces is expected to be an important fate process based upon this compound's Henry's Law constant. Hydrolysis is not expected to be an important environmental fate process since this compound lacks functional groups that hydrolyze under environmental conditions.

The release of a significant amount of electrolyte solution to an aquatic environment is unlikely. Acetonitrile has low acute toxicity to aquatic organisms; toxicity values are greater than 1,000 mg/L. Available data suggests that TEABF4 is toxic to aquatic ecosystems. Additionally, quaternary ammonium compounds generally are aquatic toxins, and boron compounds tend to be toxic to aquatic organisms, particularly invertebrates. Do not allow TEABF4 residues to enter storm drains or waterways.

4.4 UNPACKING

Move the shipping pallet to a firm, level surface in an open area.

Unpack carefully and check for damage caused during transport: damaged parts pose a risk to the operational safety.

Save pallet, angle brackets and box for later use, or dispose of it properly according to local regulations.



NOTE

If possible, keep the original packaging during the whole warranty period, in order to:

- properly repack the equipment, in case of need;
- move the equipment to another facility.

4.5 PACKAGING RECYCLING

The wooden crate and the whole packaging protect the equipment from transport damage. The materials for the packaging has been selected taking into account the environment and the disposal technique. They can therefore be recycled.



Please dispose of the packaging material, which are no longer necessary, to collection points at the dedicated areas for the recycling operations.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

5 POSITIONING AND INSTALLATION

5.1 WEIGHT AND DIMENSIONS

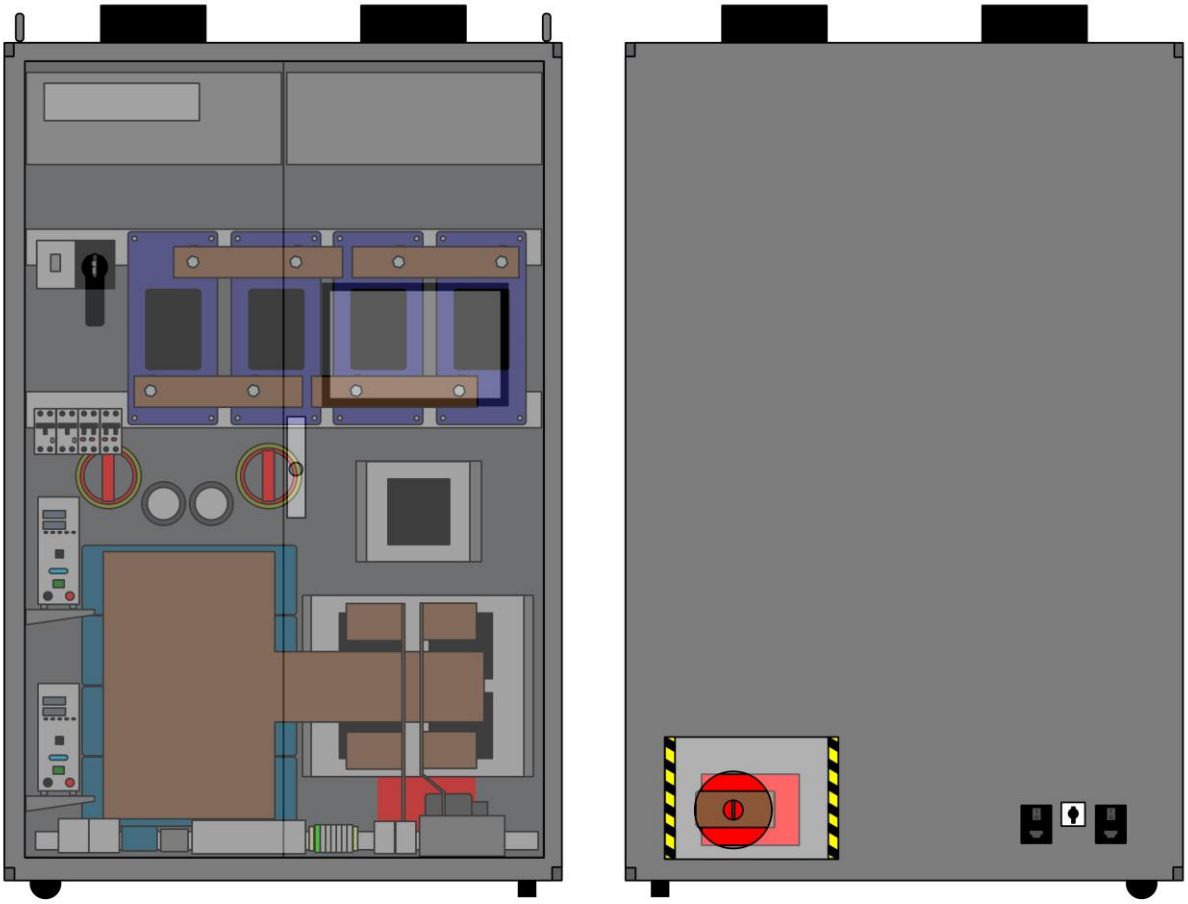


Figure 18 - SCPS front and rear view

Table 2summarizes the dimensions of the equipment; Table 3 presents the weights:

Module	Dimensions [mm] L x D x H
Cabinet	1200 x 600 x 1921

Table 2: Dimensions

Module	Component	Weight [kg]	Surface [m^2]
Cabinet	Cabinet, circuit, cabling and others	550	0.72

Table 3: Weights

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

5.2 LIFTING AND MOVING



WARNING

To minimize the risk of serious injury or damage, do not lift or move the enclosure by any means than the ones shown in following section.



WARNING

During lifting and moving the equipment, wear appropriate PPEs and follow the facility safety procedures.

Before starting to move the equipment, isolate a restricted area using perimeter markings. No worker should be inside the lifting or moving area during the operation. Make sure that the route is clear of all obstruction.



NOTE

Floor must be levelled and flat enough to place the equipment and provide a suitable support for the intended operation. **Do not proceed if floor hasn't been correctly levelled.**

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

5.2.1 LIFTING CABINET USING PROVIDED EYEBOLTS

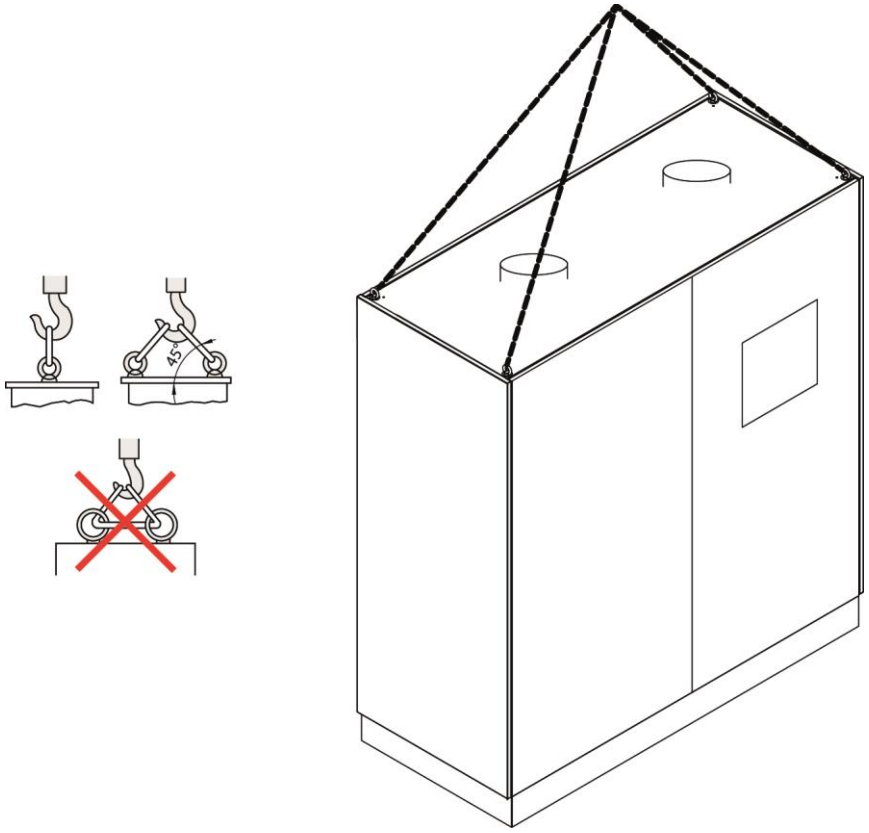


Figure 19 - Cabinet lifting (eyebolts)

- Attach rigging to eye bolts over the rooftop, always maintaining the 45° maximum angle. Use slings with adequate load-rated hooks or shackles.

WARNING

Ensure that rigging is sufficient to safely handle any of these loads. See Table 3.

Ensure that the load rating of the lifting device is sufficient to handle the equipment.

- Slightly lift the lifting device to keep some tension to the rigging. Adjust their lengths to compensate for any unequal weight distribution of the load and to support the cabinet in an upright position.

WARNING

To avoid severe personal injury or death, workers should be kept away from the load and never be under or near the load, while it is being lifted or suspended. Workers should never be next to rigging under tension.

- Carefully lift and move the equipment next to the installation position avoiding bump or shock.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

5.2.2 MOVING CABINET USING WHEELS

WARNING

Check that the ground upon which cabinet will stand is level and solid.

Push the cabinet to the installation position, avoiding bumps or shocks.

When the cabinet is in the installation position, secure the rear wheels from rolling away.

5.3 POSITIONING

NOTE

The cabinets are supplied with some components not installed.

The reactivation is a phase of commissioning; it requires expert personnel. During installation all the components must be remounted.

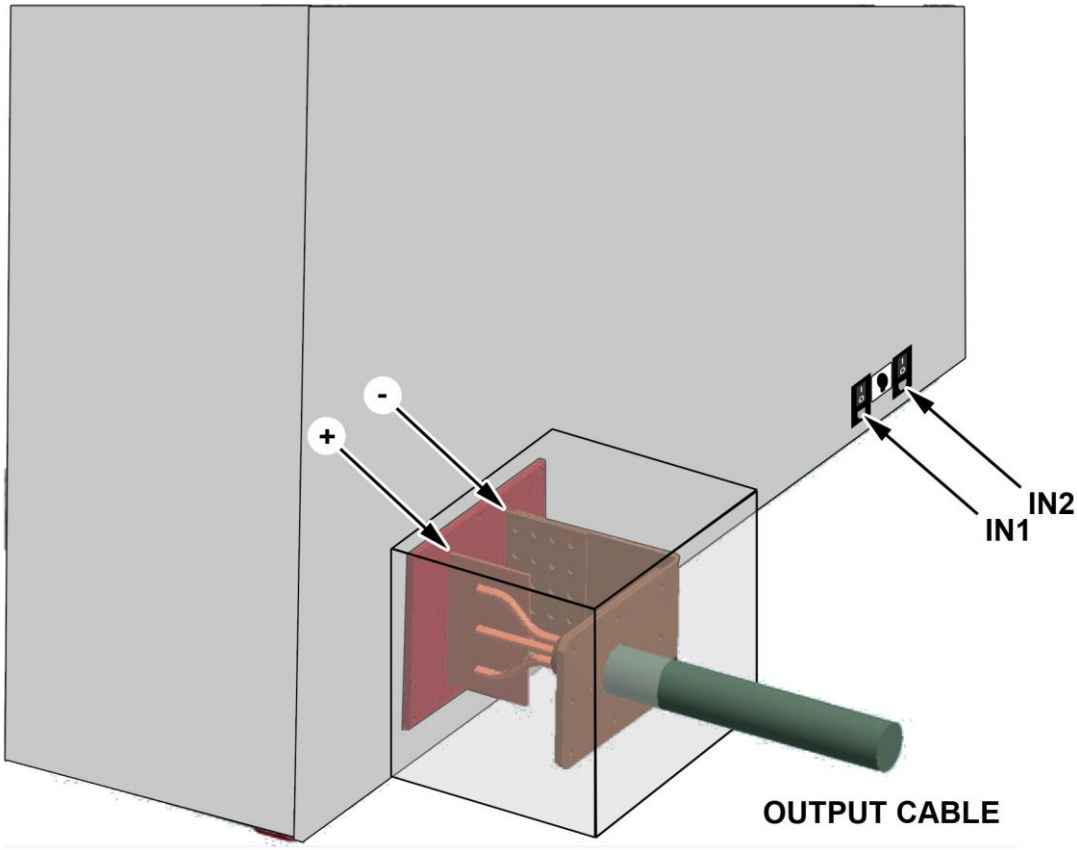


Figure 20 - Input and Output connections

Move the cabinet to the installation position and lock wheels.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

5.4 INSTALLATION

5.4.1 EARTHING CABLE

Connect the grounding cable (minimum: 16mm^2) to the earth copper bar.

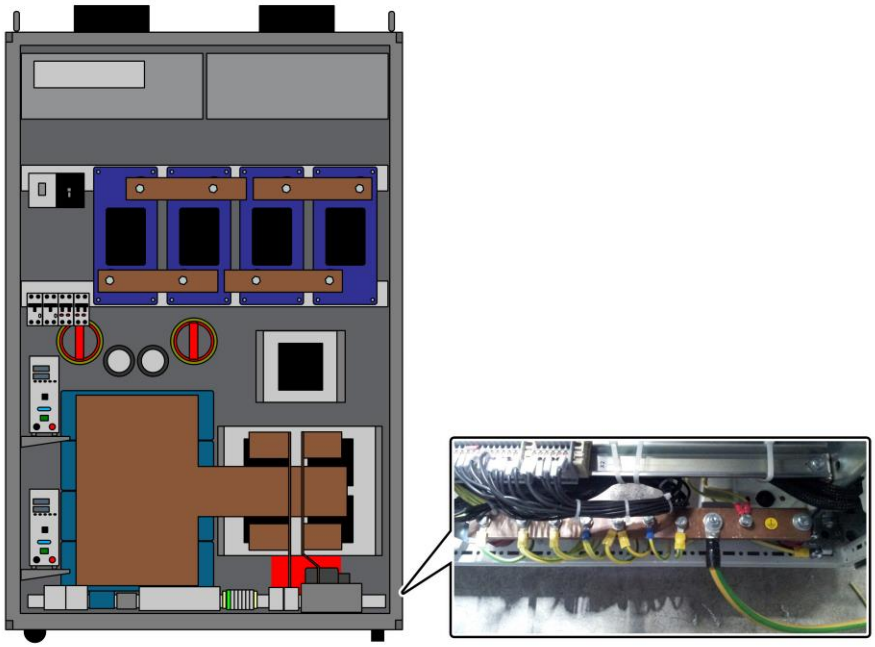


Figure 21 - Grounding bar

5.4.2 OUTPUT CABLE

Connect the load coaxial line to the output busbar, placed in the rear of the cabinet. Tight the fastener applying the specific torque. Place transparent protection and fix it on the structure.



Figure 22 - Output cable connection

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

5.4.3 INPUT PLUGS

Insert INPUT 1 power cord (main power). Insert INPUT 2 power cord (uninterruptible auxiliary power).



Figure 23 - Input power connections

Set in-feed configuration using rotating switch:

0. No power supplies connected to mains

1. Power and control (auxiliaries) both connected to left socket (NOT RECOMMENDED)

2. Power connected to left socket, auxiliaries connected to right socket (for example external UPS).

WARNING

To avoid severe personal injury or death, and damages to the equipment, execute a full electrical disconnection of the equipment before any mechanical operation or movement on the cabinets.

WARNING

Always perform, in case of mounting, the external connections as last operation or, in case dismounting, as first. Assure that any power source from the main or energy stored in the load is discharged before any operation.

If necessary, connect all the protective conductor on the cabinets (all the basements, the doors, metallic structures …).

WARNING

All exposed conductive parts shall be connected to the protective grounding circuit. Each protective conductor connecting point has been marked or labelled as such using the symbol IEC 60417 5019.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

All the grounding cables prepared by the supplier, marked with green/yellow, must be connected at this phase. If no dismantling of doors or other parts of the cabinet has been operated during the moving, at least the grounding bars inside each cabinet require a connection. They must be all connected to the PE bar inside Feed-in cabinet.

5.4.4 EXTERNAL SIGNALS

Connect the external signals (24 V_{DC}) to the terminal X2A placed in the lower part of the cabinet. Tight the fastener applying the specific torque.

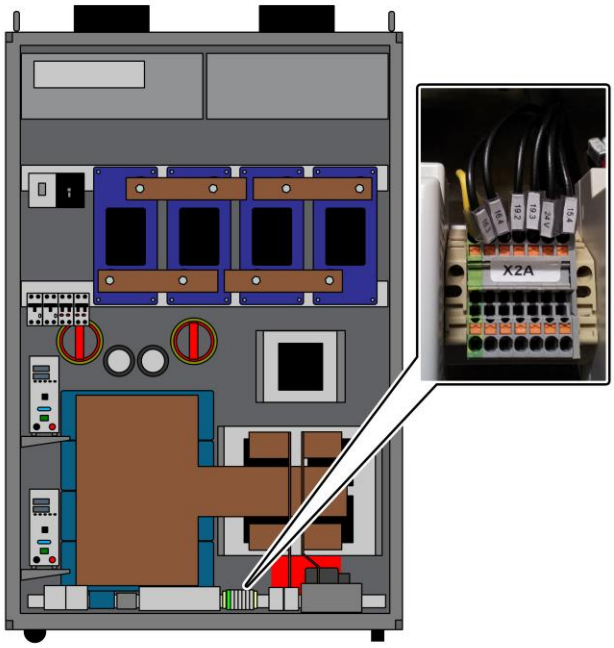


Figure 24 - X2A External signals connection

CONN/PLUG	Description	Note
16.3	External trigger	*External contact NO*
16.4	External trigger	*External contact NO*
11.8	External interlock	*External contact NC*
15.4	External interlock	*External contact NC*
19.2	Interlock activated	*Internal contact NC*
19.3	Interlock activated	*Internal contact NC*

Table 4: External signals connectors

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

5.5 EARTH CONTINUITY TEST

This test verifies that the different exposed conductive parts of the assembly are effectively connected to the protective circuit and their resistance between the incoming protective conductor and the relevant exposed conductive part does not exceed 0.1 Ω.

Verification is realized employing a resistance tester capable of driving a current of at least 10 A ac or dc into an impedance of 0.1 Ω between the points of the resistance measurement (EN 60204-11).

NOTE

All the points subject to verification have to pass the test according to the instrument applied.

5.6 SAFETY INTERLOCK TEST

This test verifies the correct functionality of each HSI interlock:

- Emergency push-button S2
- External Interlock

The test consists of operation on each interlock and verification of the power supplies shutdown. The effective response of the system should be checked during the test.

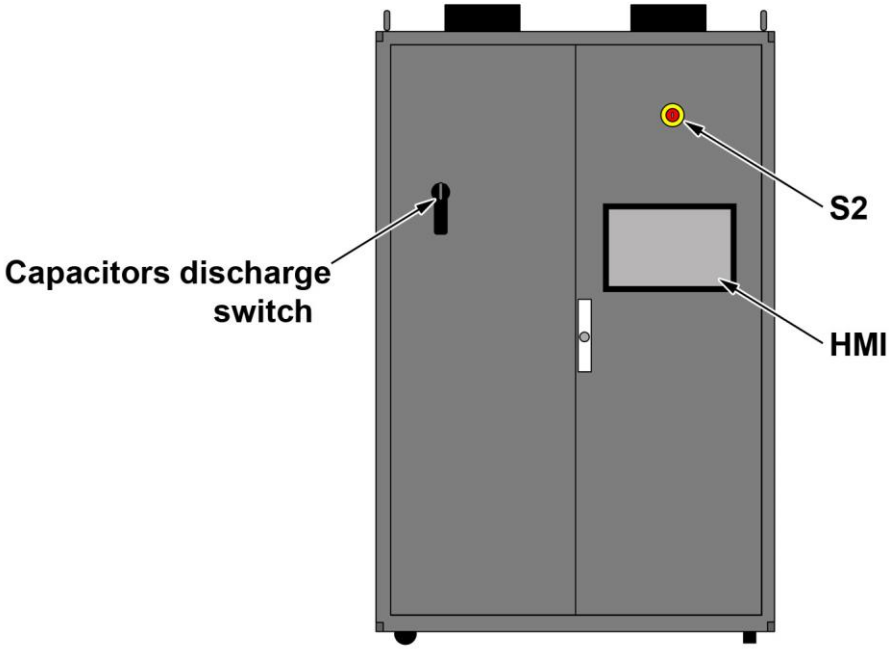


Figure 25 - Safety interlocks

All the hardwire safety chains need to be verified.

NOTE

The test consists of operation on each interlock and verification of the power supplies shutdown. All the signals must be correctly working to assure a correct protection level.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

Digital interlock

	Interlock Identifier	Test procedure	React
Emergency button	S2	*Button pressing*	*PS_1, PS_2 shutdown*
External Interlock	X2A (pins 5-6)	*Contact opening*	*PS_1, PS_2 shutdown*
Door switch	DSW1	*Door opening*	*PS_1, PS_2 shutdown*

Table 5: Test of Digital Interlock signals from internal connections

5.7 EXTERNAL I/O TEST

This test verifies all the external interconnections and the external interlocks.

Generally, the interlock signals from the field are realized activating/de-activating the signal:

- By means of disconnection on the terminal
- By means of action on the actuator

The test is passed when interlock is activated and checking that control system reacts properly.

Interlock Identifier	HMI Alarm Message	Test procedure
External trigger		*Contact closing*

Table 6: Test of Digital signals from external connections

5.8 DISCHARGING PROCEDURE TEST

This test verifies the discharging procedure to open the cabinet doors under safety conditions.

At start time: the equipment is normally operating, the capacitors are fully charged, the discharging switch is in normal operation position.

Code	Description	Expected result
DCH.01	Try to open front door	*Is not possible to open the door when discharging switch is in normal operation position.*
DCH.02	Move Discharging Switch to Capacitor discharging position	*Residual energy discharges through the Discharging resistance (Check actual energy level stored in capacitors through HMI)*
DCH.03	Try to open the door	*Is now possible to open the door. Capacitors are still protected from accessing by transparent fixed protection.*
DCH.04	Wait for 5 minutes and check actual energy level stored in capacitors through HMI.	*Residual voltage stored in in capacitors and supercapacitors is now under the danger level and equipment could be switched off and locked-out to remove internal protection.* ***But be aware that the energy stored in supercapacitors is still very high.*** *Wait at least 20 minutes before operating on power connections*

Table 7: Capacitors discharging test procedure

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

6 PERSONNEL SAFETY SYSTEM

6.1 OVERVIEW

The Personnel Safety System is the set of the countermeasures that impede the personnel to get injuries during normal operation, inspection, maintenance, repairing and test of the equipment.

It makes use of a sum of active and passive protection measures:

- Grounding, physical segregation and interlocks avoid direct contact with live parts
- Fast shutdown and de-energizing strategy permits to safely react to abnormal events.

In this chapter we describe:

- Safety components of the Personal Safety System
- Safety procedures to safely operate the equipment
- Emergency procedures to minimize health hazards

We assume that operator is familiar at least with industrial PLC and HMI systems, electric equipment, high-power /high-voltage electronic converter. Above all, we assume that he has at least some knowledge of the structure of the equipment.

It is extremely important that safe working practices are maintained when conducting high-voltage testing. Safe working procedures must be implemented to accepted standards.



WARNING

Before getting in touch with potentially live parts, the user MUST discharge possible stored energy.

6.2 SAFETY COMPONENTS

6.2.1 GROUNDING

As required by regulations, a cable of proper size connect to ground each metallic cabinet and each metallic part of the internal frames. The procedure of Earth continuity Test (see 5.5EARTH CONTINUITY TEST page 44) performs the test of the grounding resistance.

Code	Description	Note
GND	Ground bar	

Table 8: Grounding safety components

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

6.2.2 CIRCUITS BREAKERS AND CONTACTORS

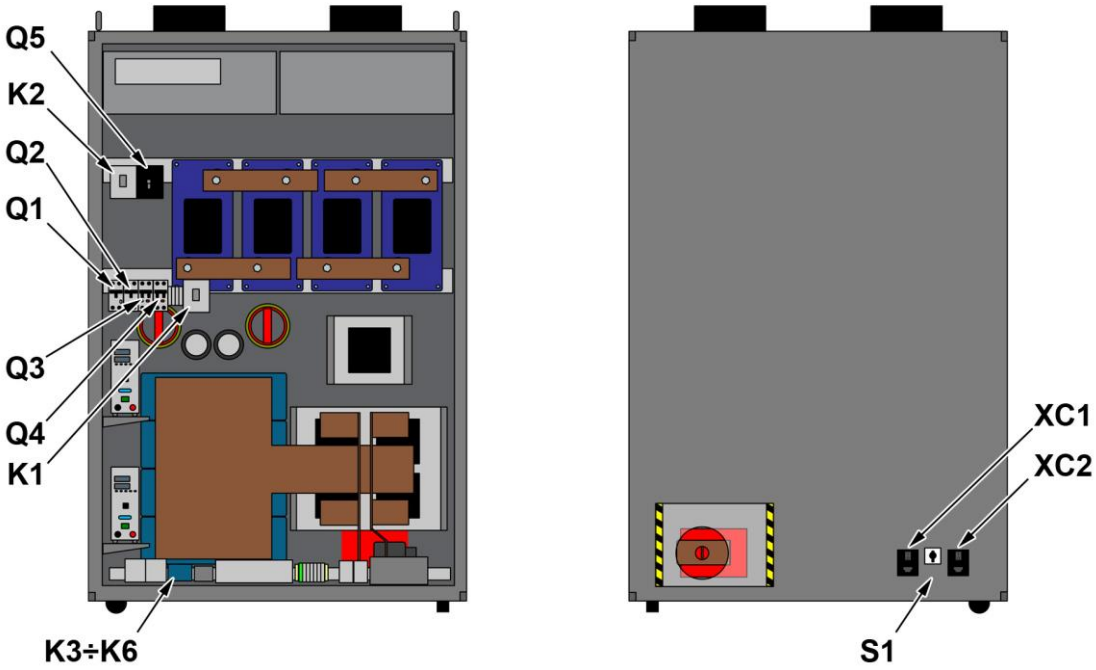


Figure 26 - Circuit breakers and contactors

Code	Description	Note
XC1	Line In 1 (main power) breaker	*VDE plug (access without need of opening the cabinet)*
XC2	Line In 2 (uninterruptible aux power) breaker	*VDE plug (access without need of opening the cabinet)*
S1	Line In configuration selector	*(access without need of opening the cabinet)*
Q1	Main Power Supplies (PS_1, PS_2)	*Residual Current Circuit Breaker with Over Current Protection*
Q2	Main Aux	*Residual Current Circuit Breaker with Over Current Protection*
Q3	Auxiliaries Power Supplies	*Automatic current breaker*
Q4	Fans and Lights	*automatic current breaker*
Q5	Capacitors discharging switch	*Manual (access without need of opening the cabinet)*
K1	Power Supplies (PS_1, PS_2)	*contactors*
K2	Capacitor Discharge (R1, R2, R3)	*contactors*

Table 9: Circuit breakers and contactors

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

6.2.3 SAFETY INTERLOCKS

Code	Description	Note
S2	Red Emergency Pushbutton	*Internal Safety Interlock*
EXT	External interlock	*External Safety Interlock (X2A)*

Table 10: Safety Interlocks



NOTE

A broken wire or a disconnected connector will lead to the intervention of the safety system.

6.3 SAFETY PROCEDURES

The safety procedures permit to the worker a safe access to the PS, reducing the risk connected with intervention inside the cabinet or at its output.



WARNING

The application of safety procedures is mandatory, but does not completely reduces the risks: it is always necessary to apply all the safety procedures required by facility facing an equipment of this type (HIGH ENERGY STORED).

The access procedure assure that the operator will work inside the equipment only when the control electronic detects no voltage on the PS. Included in the access procedure, the safety discharging procedure discharges the energy stored in the capacitors.

The emergency stop gives to any user the possibility of shutdown the equipment in case of emergency, requiring a fast stop.

6.3.1 SAFETY CAPACITOR DISCHARGING AND ACCESS TO THE CABINET

Rotate Discharging Switch to Capacitor discharging position: capacitor energy is dissipated through discharging resistance.



NOTE

The Panel PC can operate also when front doors are open: be sure to de-energized completely the equipment and lock-out each infeed power line before removing internal protection.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

Check actual energy level stored in capacitors through HMI.

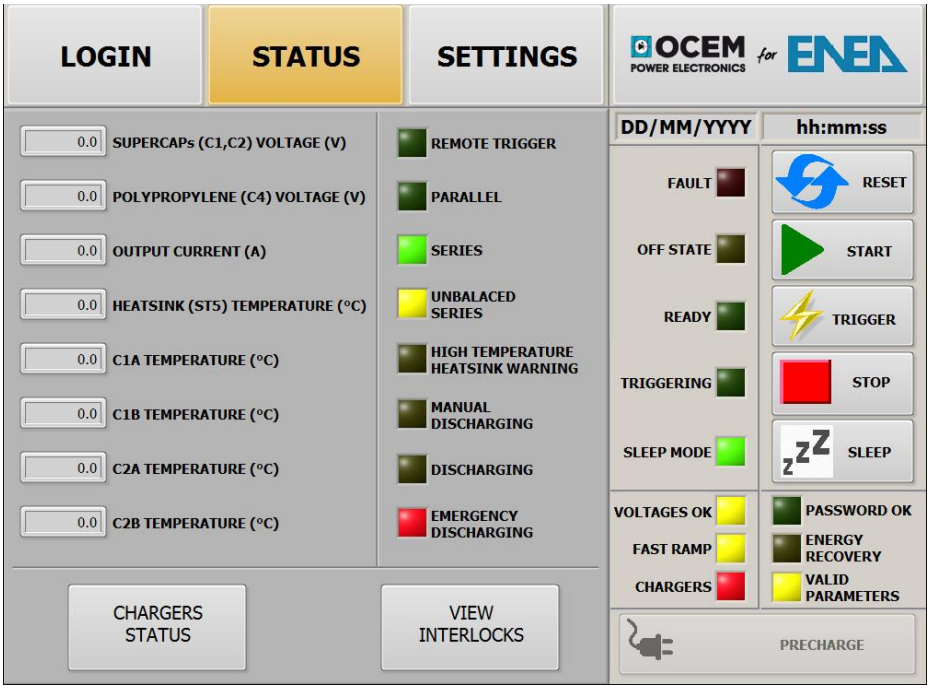


Figure 27 - HMI status page

Wait for complete discharge of the capacitors module before removing internal protection.

WARNING

Some electrical component of the protection, command and control system of the equipment can be live even when front doors are open.

Be sure to de-energize completely the equipment before operating on the internal components of the equipment. Electrical risk are still present due to high energy storage in some of the component.

6.3.2 COMPLETE SUPERCAPACITOR DISCHARGING

WARNING

HIGH VOLTAGE HAZARD

Never touch the power terminals as the module can be charged and cause fatal electrical shocks. Always verify that the module is fully discharged before manipulating the module.

A fully discharged module may “bounce back” if it is stored without a shorting wire connected to the + and – terminals. This bounce back can be as much as 6 V for the 48 V module and is enough to cause dangerous electrical shocks.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

Before operating on a Supercapacitor module (e.g. SUPERCAPs configuration change):

- Follow safety instruction to access the cabinet, and in particular rotate discharging switch to manual discharging position and verify, after some minutes, supercapacitors modules voltage values through HMI.
- De-energize completely the equipment and lock-out all energy sources.
- Remove internal protection panel to access the connection bar.
- Using a voltmeter, measure voltage between the two power terminal: if the voltage is above 2 V, wait for the modules complete discharge. NEVER TOUCH THE POWER TERMINALS AS THE MODULE CAN STORE ENERGY TO AVOID FATAL SHOCK.

The module is now safe for handling.

6.3.3 EMERGENCY STOP

The remote control may require an emergency stop of the plant, in case of important system failure.

In case of such an event the power distribution line of the whole plant will be completely shutdown, in order to permit the intervention of the rescue personnel. The PS is required to be safe for the rescue personnel that will intervene in such a case.

The safety of the PS is obtained by an HMI stop and implementing an automatic shutdown after some seconds.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

7 OPERATION

7.1 HOW TO READ THIS CHAPTER

This chapter describes how to operate equipment safely. It is organized in different sections as follows:

Paragraph	Description
Overview	It gives the general information about the human interfaces of the equipment.
References	It provides a quick guide to the content of the human interface
Instructions: how to operate with the equipment	It gives a task oriented description of how the equipment operates and of interactions with normal and expert users

Table 11: Operation: Structure of the chapter

We assume that operator is familiar at least with industrial PLC and HMI systems, electric equipment, high voltage / high energy / high power electronic converter. Above all, we assume that he has at least some knowledge of the structure of the equipment.

Three different kinds of user will face the equipment:

Normal users can only **read** the data, as they are supposed to be facing the equipment for tasks not specifically related to high-power.

Expert users can **perform advanced operations** (log in required); we assume that they have additional competences in high voltage / high energy / high power.

Super users can **perform reserved operations** (log in required); we assume that they have additional competences in high voltage / high energy / high power. Moreover, they must have a deep knowledge of the equipment before performing interventions inside it.

7.2 INTERFACES OVERVIEW

A developed graphic user interface allows the operator to visualize status and measurement data of the equipment, and to operate on the system. The PSCS needs an uninterruptible line in to assure safe shutdown in case of voltage blackout. An industrial electronic based on Siemens IPC and touch screen shows the remaining information. Its configuration is:

Item	Description	Reference
PANEL PC	ARCHMI-817	
CPU	Intel Celeron N2930 (1.83GHz) CPU	

Table 12: User Interface components



NOTE

The software is subject to significant changes among different versions; this manual may be only partially applicable in case of version deviating by the referred one.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

The power converter can be controlled locally and permits remote triggering.

Through local HMI operator can:

- read the current state of the machine;
- read the real-time current and voltage system values
- analyze the alarm status
- set target parameters (expert user only)
- select local mode operation (expert user only)
- operate step-by-step manual start-up of the system (expert user only)

In the following there is a description of the interfaces content (reference) and of the principal operations (instructions) related with the equipment.



NOTE

Some operations are not instantaneous and they can require at least some tens of seconds. Pressing two keys at once (or within very short time) is not supported and can generate unwanted results: **be sure to wait system response before proceeding. Do not issue too many commands at the same time to the equipment.**

In such case, the system considers only the key that was pressed first and implements the associated functions and operations. The key pressed second is ignored.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

7.3 REFERENCES

The following paragraphs present the structure of the page and the principal elements of each section, the meaning of the buttons and indicators.

NOTE

A Normal User (no password required) may access only to the informative and general pages. Inside them, only expert personnel may operate some of the functions.

7.3.1 PAGE LAYOUT

The user interface provides a set of pages to supervise the equipment. In each page some elements are in fixed position, and only the active page changes to visualize the requested data, parameters and/or commands.

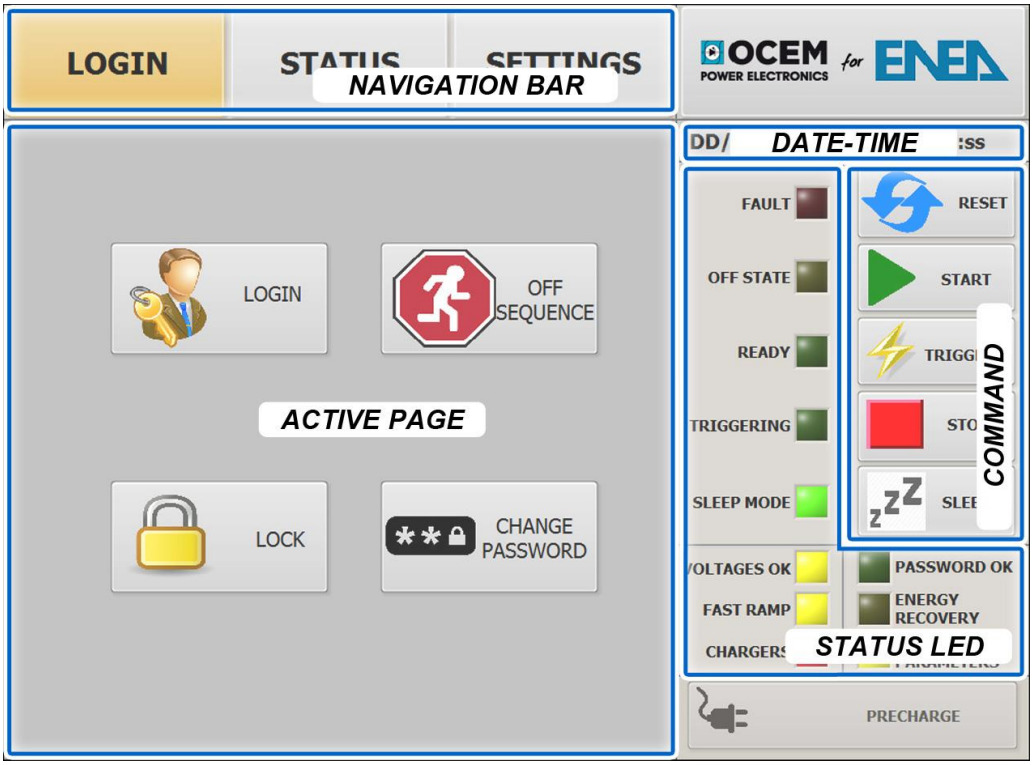


Figure 28 - HMI page layout

User can select the destination page using navigation bar, always present in the upper part of the screen. Each button navigate to different pages; when page is active, background turns color:

PAGE Gray
Tap on the button to visualize the page

PAGE Yellow
The page is currently displayed in the active page frame

The date-time area shows current date and time.

DD/MM/YYYY **hh:mm:ss** Date and time are shown in dd/mm/yyyy hh:mm:ss format.

The upper group of status LEDs permit the user to visualize a set of important information about the equipment current status:

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

- **FAULT**: when one or more fault/error are activated, system stops and wait for a reset.



LED OFF
System is normally operating



LED ON (flashing red)
One or more alarm are activated

- **OFF STATE**;



LED OFF
System is not currently in OFF State



LED ON (yellow)
OFF State is active

- **READY**;



LED OFF
System is not currently in Ready state



LED ON (green)
Ready state is active

- **TRIGGERING**: system commands to supply energy to the load;



LED OFF
System is not currently in Triggering state



LED ON (green)
Triggering state is active

- **SLEEP MODE**: automatic discharge procedure is operating;



LED OFF
System is not currently in Sleep mode



LED ON (green)
Sleep mode is active

The other group of status LEDs permit the user to visualize a set of important information about relevant parameters and values of current status:

- **VOLTAGES OK**;



LED OFF (yellow)
Set-point values are not reached



LED ON (green)
Actual voltage values reach set-point values



NOTE

Voltages OK turns green when (all conditions required):

- Supercapacitors (C1,C2) Voltage reaches 35 V;
- Polypropylene capacitors (C4) Voltage reaches 150 V.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

- **PASSWORD OK**: some function require user authentication;


LED OFF
Normal user active


LED ON (green)
Authentication completed and advanced function are active

- **FAST RAMP**;


LED OFF
System is operating in Energy recovery mode.


LED ON (yellow)
Fast ramp mode is active

- **ENERGY RECOVERY MODE**;


LED OFF
System is operating in Fast ramp mode


LED ON (flashing yellow)
Energy recovery mode is active

- **CHARGERS**: connection status of internal PSs and capacitors modules;


LED ON (red)
One or more connections need to be restored


LED ON (green)
Connections are available and normally operating

- **VALID PARAMETERS**: actual configuration check;


LED ON (yellow)
Configuration is not complete - triggering disabled


LED ON (green)
Configuration is complete

The button on the right of the screen permit the user to operate command on the system (operator should be authenticated).



RESET BUTTON
Tap on the button to reset alarms
(Password required)



TRIGGER
Tap on the button to command energy transfer to load
(Password required)



START
Tap on the button to start the system.
(Password required)



STOP
Tap on the button to stop the system.
(Password required)

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.



SLEEP MODE
Tap on the button to command the system energy discharging *sleep mode*.
(Password required)



WAKE UP
Tap on the button to command the system to wake up from discharging mode.
(Password required)

NOTE

When operator selects a function which requires authentication, Insert login password page is displayed before proceeding.

A button, in the bottom-left corner, control internal PSs power feeding to capacitors (PRECHARGE status and command):



PRECHARGING NOT POSSIBLE
Some operating mode don't need pre-charging function: button is disabled.



PRECHARGING POSSIBLE AND NOT ACTIVATED
Internal PSs don't feed energy to capacitors (tap to activate).



PRECHARGING ACTIVATED
Internal PSs feed energy to capacitors (tap to deactivate).

NOTE

Polypropylene capacitors (C4) normally reach pre-charging target value in a few seconds.
Supercapacitors (C1, C2) pre-charging can require many minutes.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

7.3.2 LOGIN

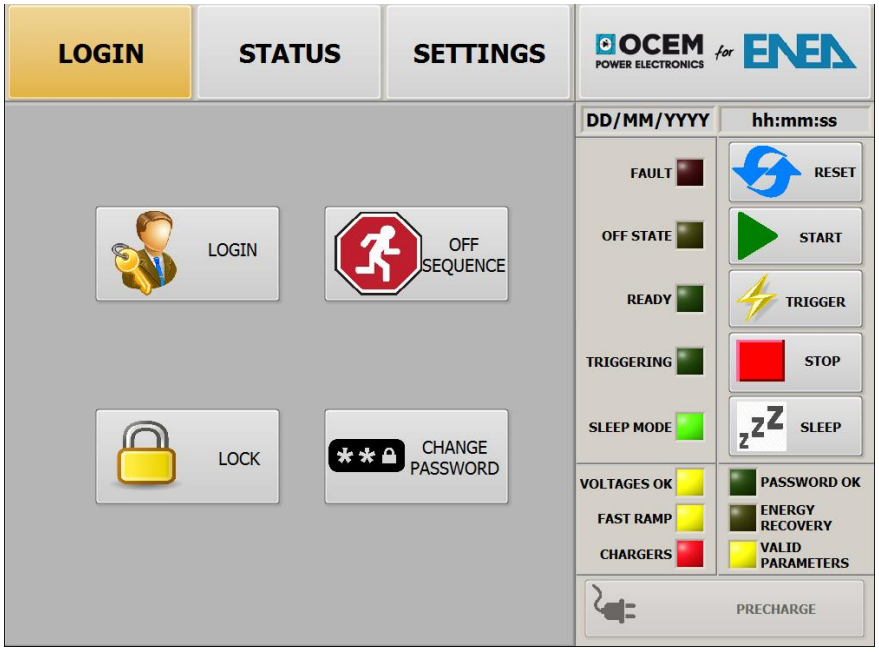


Figure 29 - HMI: Login page

Operator has to login to access reserved operation. The login page permits the operator to authenticate.



LOGIN BUTTON
Tap on the button to insert password and authenticate as expert user



LOCK BUTTON
Tap on the button to logout. When displayed, the operator is authenticated (Password ok LED is on)

Operator, when authenticated (Password ok LED is on), can command system exit and power off/reboot of the IPC.



OFF SEQUENCE BUTTON
Tap on the button to stop the software and exit (application quitting doesn't affect control logic).

When necessary, operator can change authentication password.



CHANGE PASSWORD
Tap on the button to access password change page.



NOTE

Authentication password must contain only numeric characters [0-9] and it should be maximum 10 characters long.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

7.3.3 STATUS

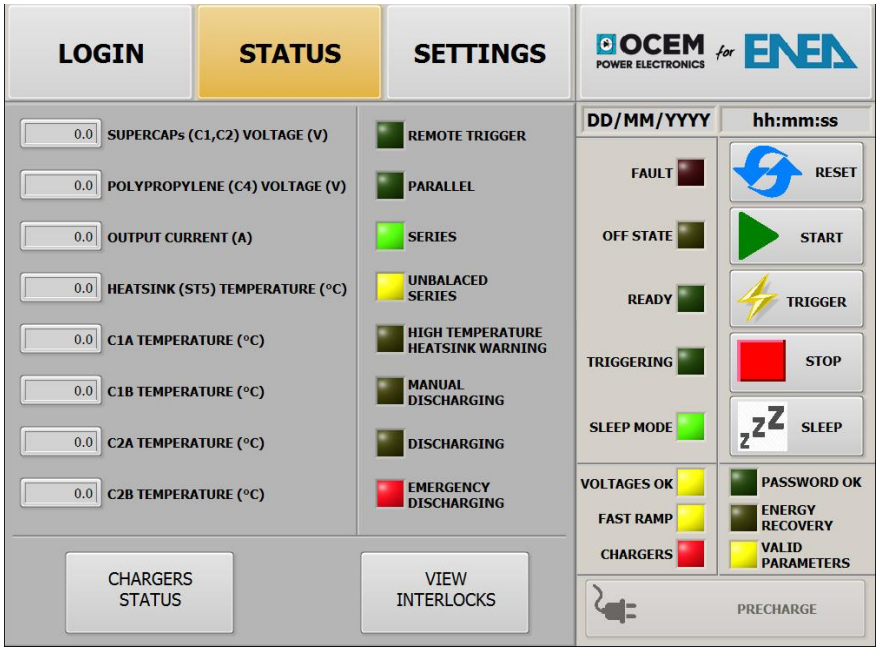


Figure 30 - HMI_ Status page

Operator can read the most important data of the system in the Status page:

- Supercapacitor modules C1 and C2 total voltage (expressed in Volts);
- Polypropylene C4 voltage (expressed in Volts);
- Output current (expressed in Amperes);
- Diode ST5 heatsink temperature (expressed in degrees Celsius)
- Supercapacitor modules C1A, C1B, C2A and C2B temperatures (expressed in degrees Celsius)

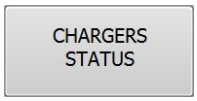
A set of led shows the current status, alarm/warning condition and current temperature condition.

REMOTE TRIGGER		LED OFF Remote triggering is not active		LED ON (green) Remote triggering is active
PARALLEL (SUPERCAPs electrical configuration)		LED OFF SERIES configuration is active		LED ON (green) PARALLEL configuration is active
SERIES (SUPERCAPs electrical configuration)		LED OFF PARALLEL configuration is active		LED ON (green) SERIES configuration is active
UNBALANCED SERIES (warning VC1 vs. VC2: ΔV:[50%($V_{SUPERCAPs}$) ± 2V])		LED OFF SUPERCAPs series is correctly balanced		LED ON (yellow) SUPERCAPs series is unbalanced

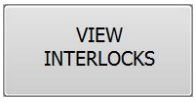
THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

HIGH TEMPERATURE HEATSINK WARNING (T_{WARN} = 50 °C)		LED OFF diode heatsink temperature is within normal operation range		LED ON (yellow) diode heatsink temperature is over limit
MANUAL DISCHARGING (Capacitor discharging switch Q5)		LED OFF Capacitor discharging switch is in Normal operation position		LED ON (yellow) Capacitor discharging switch is in Capacitor discharge position: manual capacitors discharge in progress
DISCHARGING (Sleep mode)		LED OFF Sleep mode is not active		LED ON (yellow) Sleep mode is active: automatic capacitors discharge in progress
EMERGENCY DISCHARGE (fault alarm)		LED OFF No fault alarm is detected.		LED ON (red) Fault alarm is detected: emergency supercapacitors discharge activated

Operator can access the advanced status page:



CHARGER STATUS
Tap on the button to access the charger status page.



VIEW INTERLOCKS
Tap on the button to access the alarm interlocks page

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

7.3.3.1 CHARGER STATUS

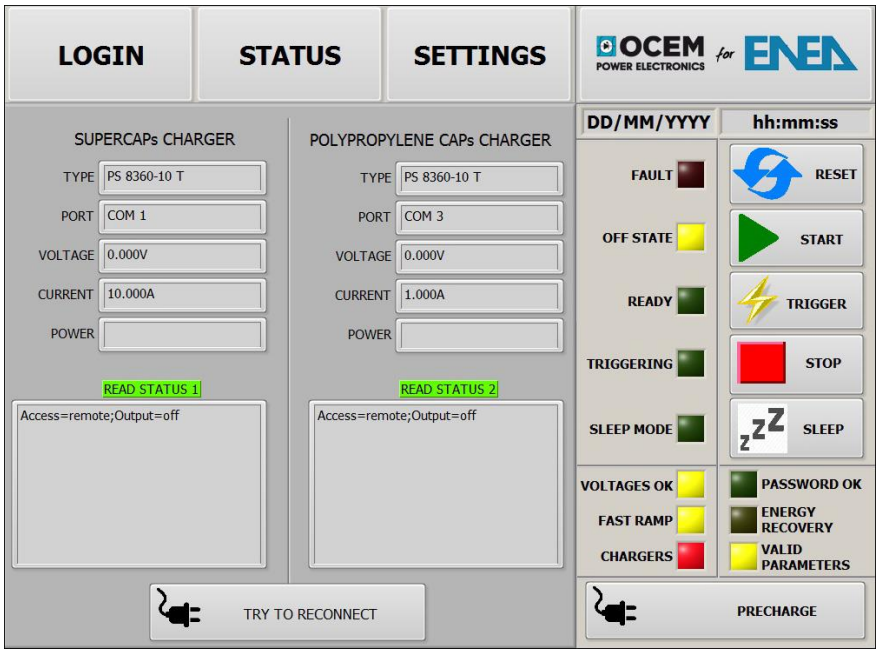


Figure 31 - HMI: Charger status page

In this page operator can read capacitors charging information: on the left Supercapacitors modules Charger PS status; on the right Polypropylene capacitors charger PS.

- TYPE: Power Supply product code;
- PORT: COM port selected for PS data communications with Panel PC;
- VOLTAGE: PS Output Voltage set-point;
- CURRENT: PS Maximum output Current;
- POWER: PS Output power (if correctly set);

NOTE

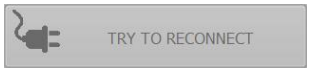
Maximum output Current value accepted for Supercapacitors modules Charger is 10 A; maximum output Current value accepted for Polypropylene Capacitors Charger is 1 A. Maximum output Power accepted is 1 kW.

READ STATUS data field contains a subset of PS operating information:

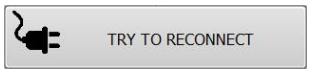
- Access=remote: PS is remotely connected through local COM port;
- Output=on: PS is feeding energy to capacitors;
- Output=off: PS is not feeding energy to capacitors.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

A button, in the bottom of active page frame, check internal connection trying to reconnect PS/PSs to Pane PC (if necessary):



TRY TO RECONNECT (not available)
No need to trying to reconnect: button is disabled.



TRY TO RECONNECT
At least one connection is lost: tap on the button to try re-establish communication between each PS and the PC.



RECONNECTING IN PROGRESS (WAIT PERIOD)
System is checking internal connections: HMI is temporarily disabled, waiting for system response at the end of the attempt to reconnect PSs to PC.

7.3.3.2 INTERLOCKS

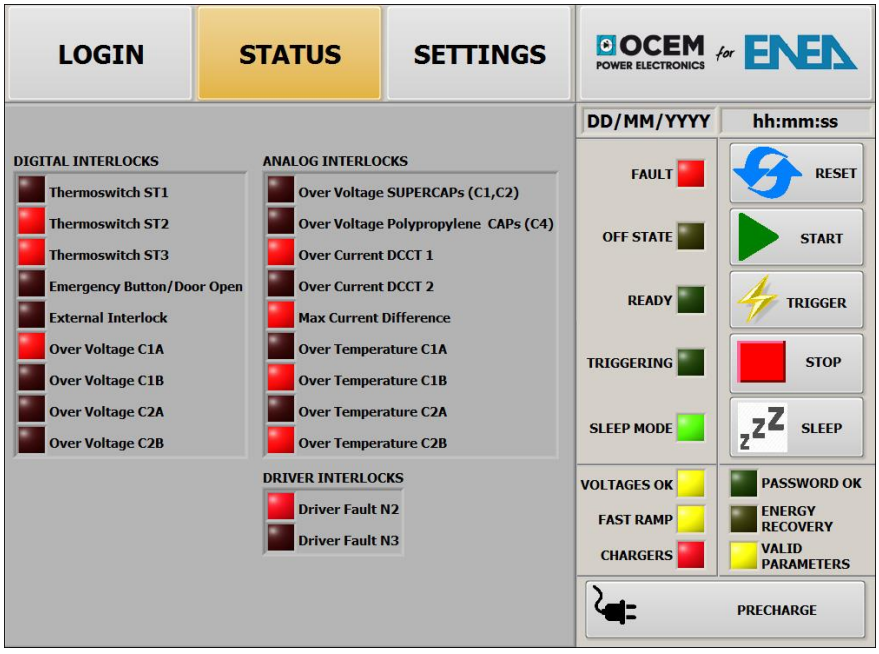


Figure 32 - HMI: Interlocks status page

This page shows different lists of interlocks alarm:

- Digital Interlocks
- Analog Interlocks
- IGBT Drivers Interlocks

ALARM STATUS



LED OFF
No alarm is detected.



LED ON (red flashing *1 s*)
Alarm is detected.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

7.3.4 SETTINGS

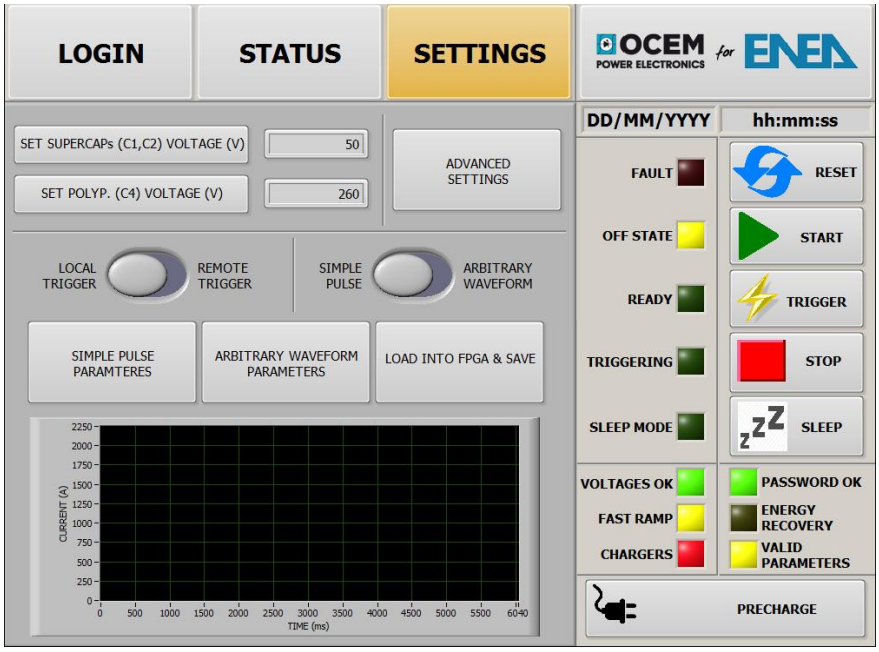


Figure 33 - HMI: Setting page

In this page authenticated operator can set the parameter and set-point values of the system.



SET SUPERCAPACITORS (C1,C2) VOLTAGE (V)
Tap to enter a new set-point value for Supercapacitors Modules Voltage.



SET POLYPROPYLENE (C4) VOLTAGE (V)
Tap to enter a new set-point value for Polypropylene Capacitor Voltage (Fast Ramp mode is active.



SET POLYPROPYLENE (C4) VOLTAGE (V) (not available)
Polypropylene Capacitors Voltage set-point cannot be changed (Energy recovery mode is active)



NOTE

Supercapacitors (C1, C2) Voltage can be set as follow:

- PARALLEL CONFIGURATION: 0 – 48 V
- SERIES CONFIGURATION: 0 – 96 V

Polypropylene capacitor (C4) can be set as follow: 0 – 300 V

Supercapacitors Voltage MUST be lower than Polypropylene capacitors Voltage.

When operator tap on value, a keyboard appears and operator can set a new set-point and confirm.

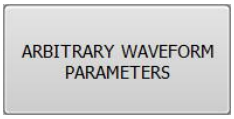
THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

Authenticated operator can set all the output current pulse parameter:

- LOCAL TRIGGER/REMOTE TRIGGER: local operator/remote operator can command triggering;
- PULSE WAVEFORM: operator can select the output current waveform (simple pulse or arbitrary waveform).



SIMPLE PULSE PARAMETERS
Tap to enter a new value for Simple Pulse Parameters.



ARBITRARY WAVEFORM PARAMETERS
Tap to enter a new value for Arbitrary Waveform Parameters.



LOAD INTO FPGA & SAVE (if available)
Tap to save selected impulse to FPGA. After saving, the selected output can be visualize in the graph below.



LOAD INTO FPGA & SAVE (not available)
When it isn't necessary, LOAD &SAVE button is disabled.

When operator tap on value, a keyboard appears and operator can set a new set-point and press OK. Confirm actual configuration by pressing Load into FPGA & Save button: now current values are stored in the control logic and output current waveform is display in the graph.

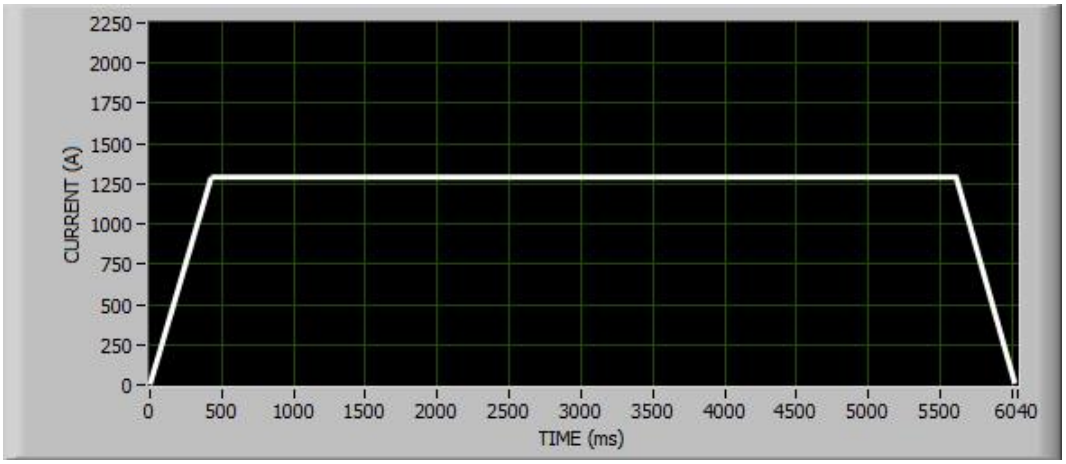


Figure 34 - HMI: Status page - waveform graph

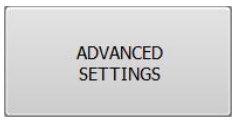


NOTE

The waveform graph shows the last saved waveform (the next one that can be triggered).

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

Authenticated operator can set advanced setting parameters:



ADVANCED SETTINGS

Tap to enter advanced settings: select operation mode and change super-user password.

7.3.4.1 SIMPLE PULSE PARAMETER

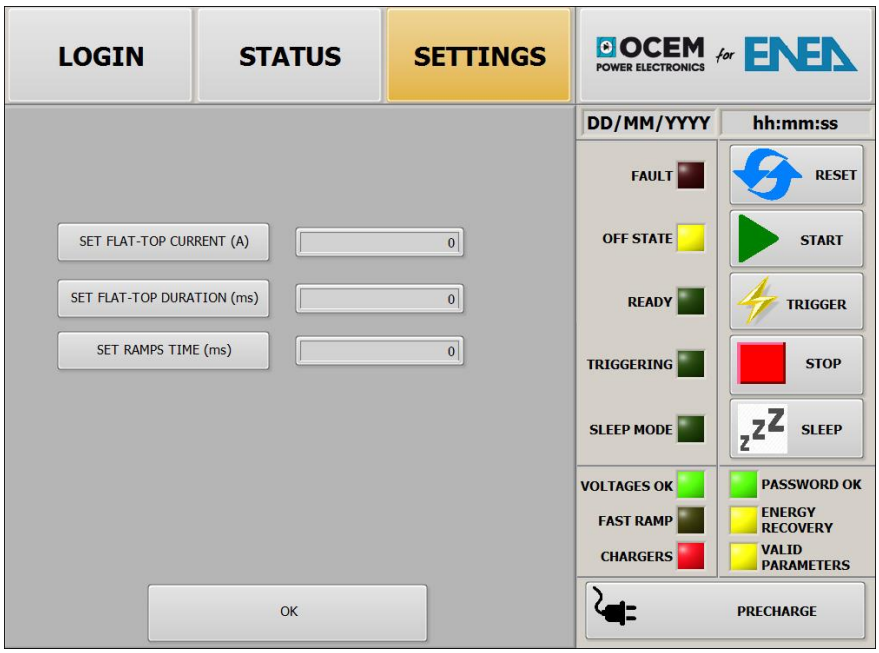


Figure 35 - HMI: Simple Pulse parameters settings

In this page authenticated operator can set the Simple Pulse parameter:

- SET FLAT-TOP CURRENT (A): set the high current level of the pulse;
- SET FLAT-TOP DURANTION (ms): set the width of the high current level;
- SET RAMPS TIME (ms): set the duration of ramp current function [zero to high level and high level to zero].



NOTE

Both current and time values shall be integer.

Confirm the entering data by tapping on OK button.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

7.3.4.2 ARBITRARY WAVEFORM PARAMETER

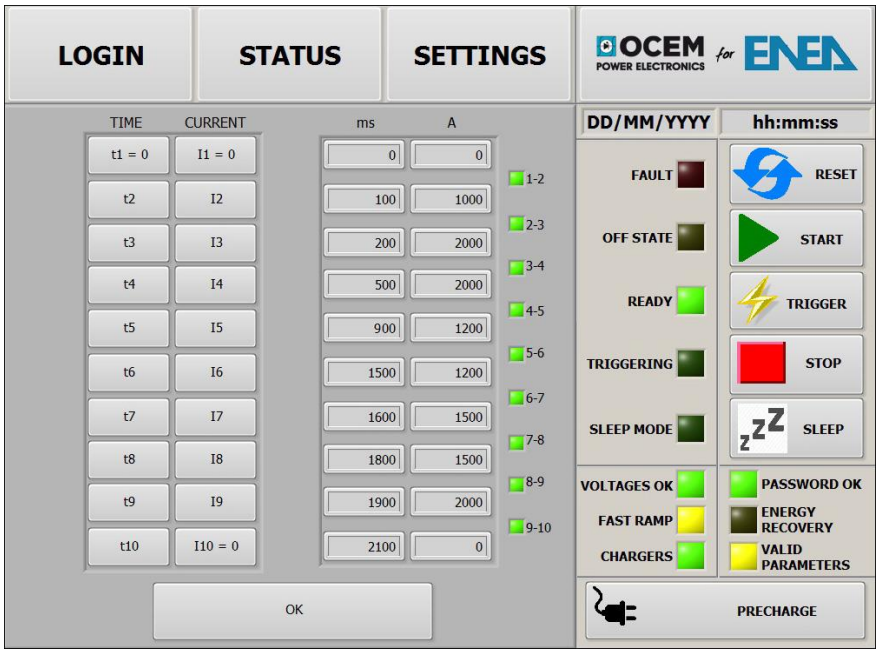


Figure 36 - HMI: Arbitrary Waveform parameters settings

In this page authenticated operator can set the Arbitrary Waveform parameter.

The equipment can generate an arbitrary waveform defined by a subset of data points (at maximum 10, setting duration and current values) defining a polygonal curve:

- (t1, I1): first point cannot be changed and it is always set to [0 ms, 0 A];
- (tn, In): set time and current value of the (n-1)-th segment;
- (t10, I10): set the duration of the last segment; current value cannot be changed and it is always set to 0 A.



NOTE

All figures shall be integer. **If not, the waveform cannot be loaded into FPGA and saved**.

Each value MUST respect following rules:

- $t_{n+1} > t_n$
- $\frac{(I_{n+1}-I_n)}{(t_{n+1}-t_n)}$ shall be an integer
- $t_{n+1} - t_n \geq 5ms$

If Energy Recovery mode is selected, entered values MUST respect also the following condition:

- $\frac{(I_{n+1}-I_n)}{(t_{n+1}-t_n)} \leq \frac{V_{supercaps}}{0.525mH}$

Confirm the entering data by tapping on OK button.

Confirm actual configuration by pressing Load into FPGA & Save button: now current values are stored in the control logic and output current waveform is display in the graph.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

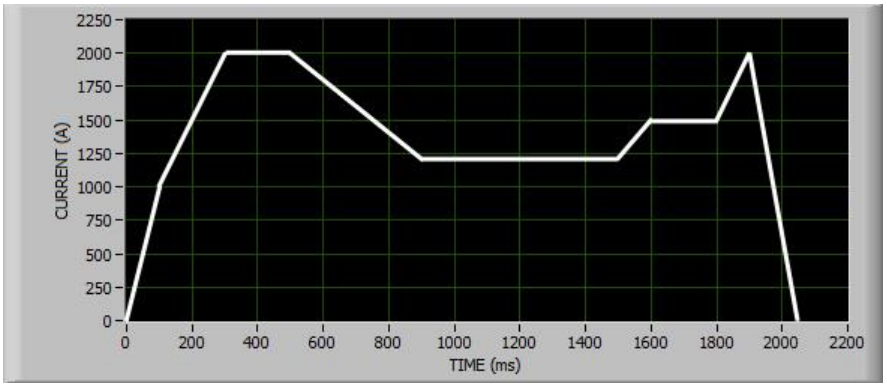


Figure 37 - HMI Arbitrary waveform graph (example)

7.3.5 ADVANCED SETTINGS

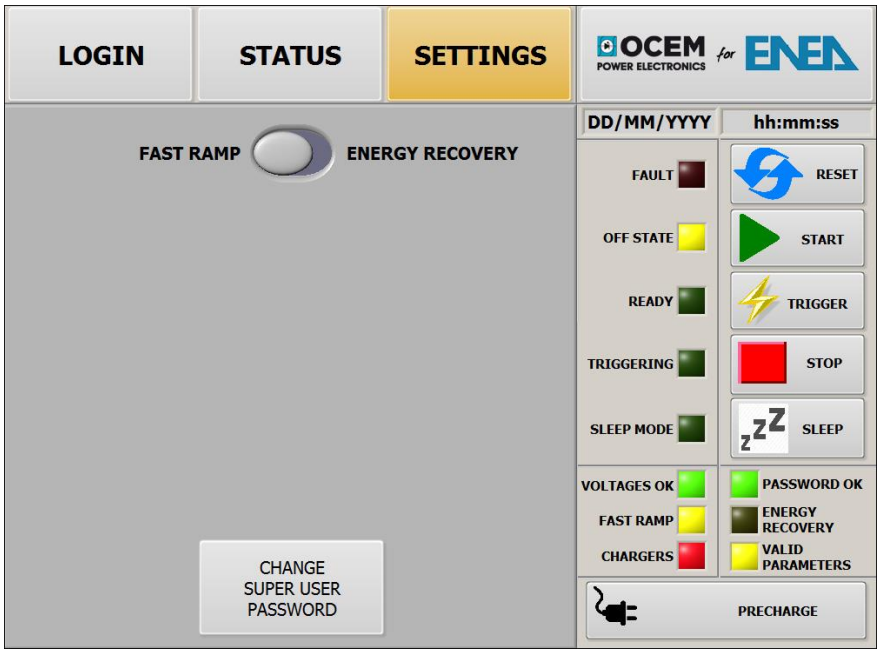


Figure 38 - HMI: advanced settings

In this page two operations are possible:

7.3.5.1 OPERATION MODE SELECTION

In this page authenticated operator can select the operation mode: FAST RAMP or ENERGY RECOVERY. When Fast Ramp Mode is selected, Fast Ramp LED is on; when Energy Recovery Mode is selected, Energy Recovery LED is on.

IMPORTANT: the operation selected MUST correspond to the hardware configuration of diode D0. Before making any change, please read carefully 3.4.5 FAST RAMP configuration and

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

ENERGY RECOVERY configuration page 29.

7.3.5.2 Change of SUPER USER PASSWORD

If necessary, authenticated operator can set a new Super User password.



WARNING

Pay close attention: equipment is susceptible of damage.

The operator is responsible of the correspondence between physical configuration (presence or absence of the slab on D0) and the correct settings of the corresponding control parameter. The physical configuration is not detected by the control.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

7.4 INSTRUCTIONS

7.4.1 AUTHENTICATION

When operator tries to access advanced operation user must be authenticated.

Login page appears and system waits for password entering.

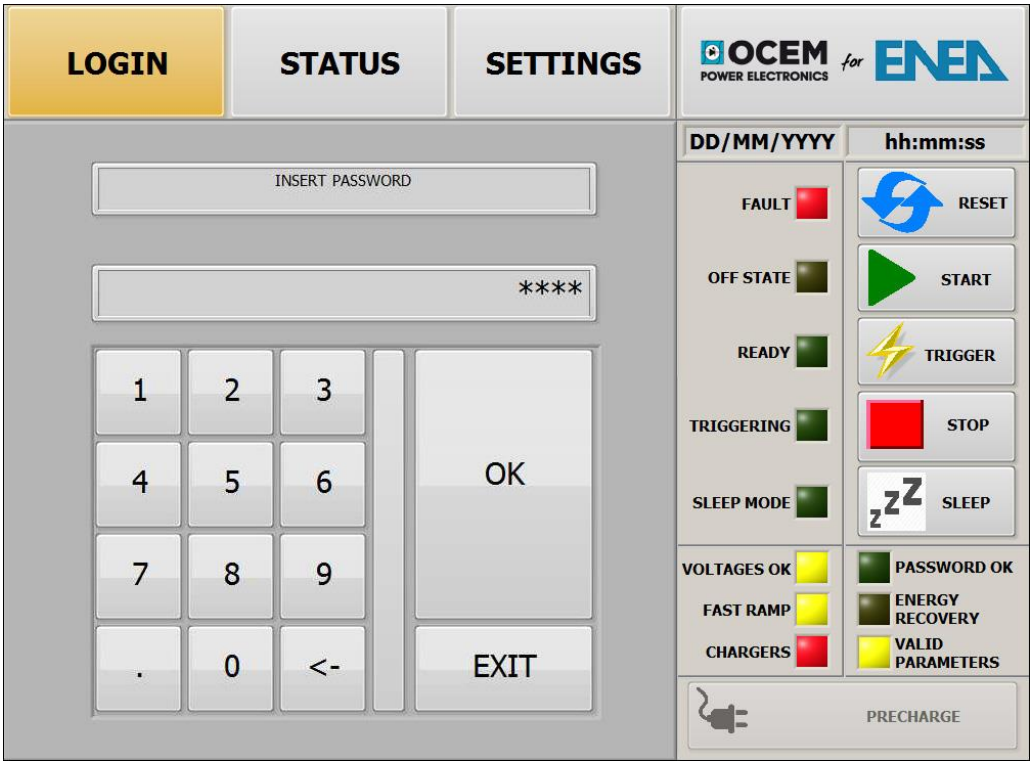


Figure 39 - HMI: user authentication (login page)

Enter password and press CONFIRM. If password is correct, password ok LED turns on (green) and user can access advanced functions.

NOTE

The system will take memory of authentication and it will require for a new log-in only after many minutes of inactivity.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

7.4.2 USER LOG-OFF

When authentication user needs to log-off the system, can tap on LOCK button in the Login page.

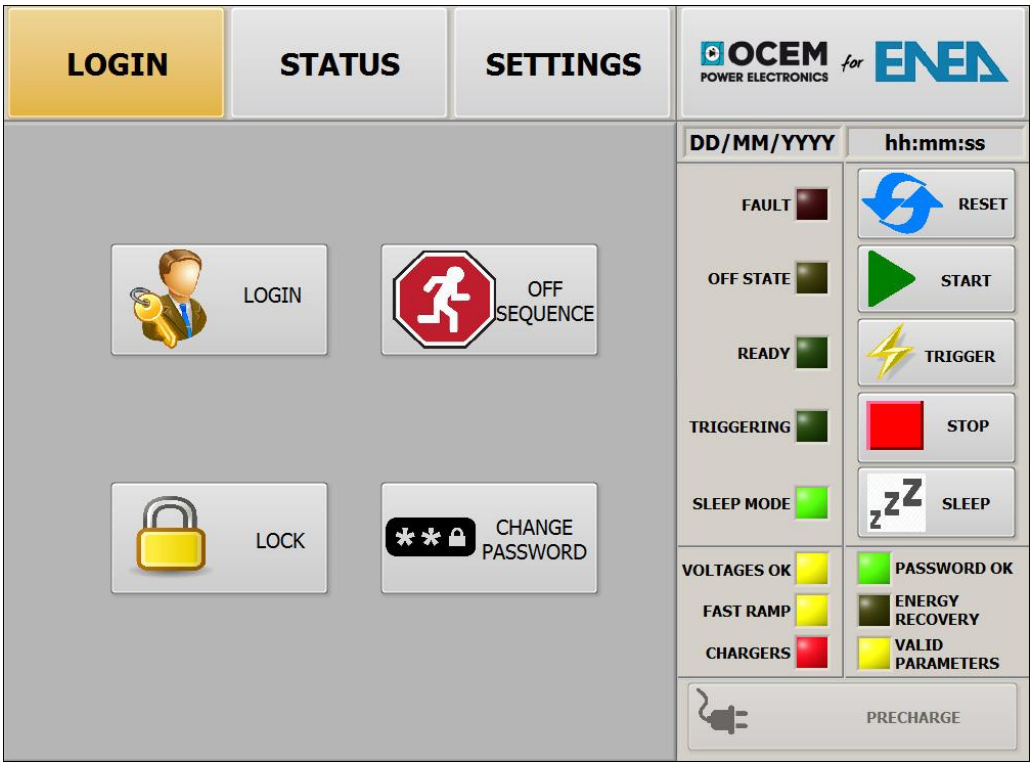
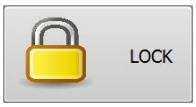


Figure 40 - HMI: authenticated user log-off (login page)

When operator tap on the Lock button, authenticated user is disconnected.



The system switches to normal user mode and all the advanced function will not be available until a new log-in procedure.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

7.4.3 ALARM RESET

When an alarm is detected, the system is automatically led to the FAULT status. The equipment stops and waits for manual operator intervention.

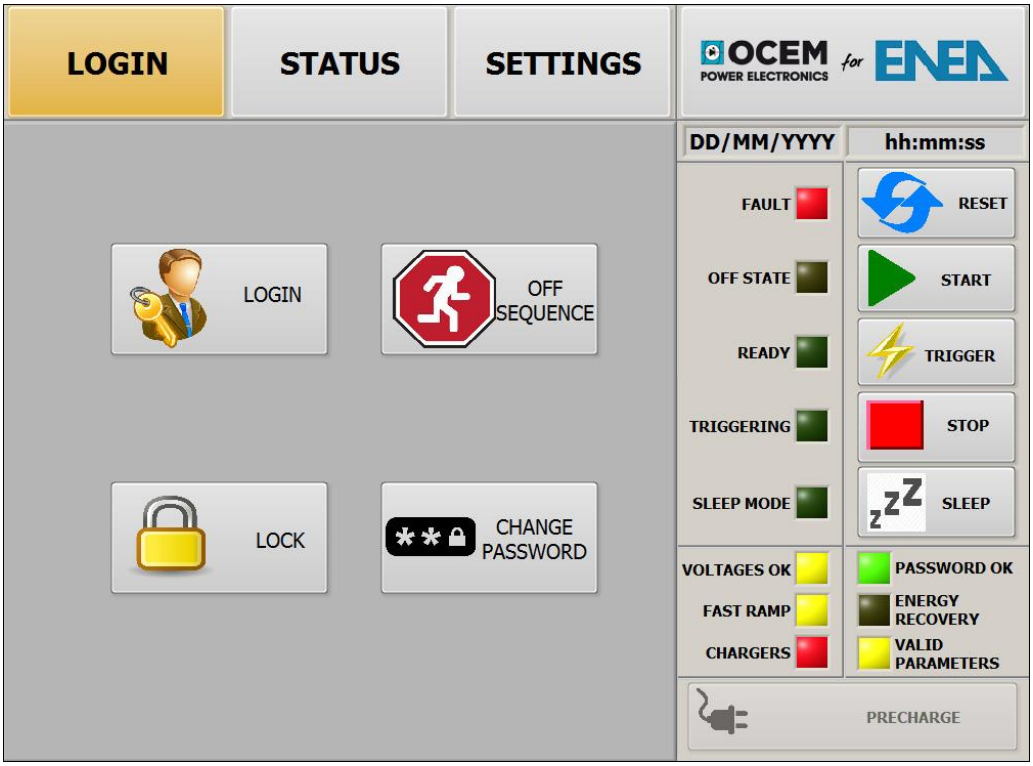


Figure 41 - HMI alarm reset (login page)

- **Check alarm:** HMI display all the information to identify the problem has occurred;
- **Remove the cause of fault:** check alarm list and solve the problem (see 8.1ALARM LIST page 88) removing the cause of fault;
- **Reset:** press reset button and wait for system response. When all faults have been resolved, equipment returns to OFF status, ready to a new start-up procedure.



NOTE

A persistent fault causes system stops in FAULT state. Check the alarm again and repeat all the steps.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

7.4.4 APP STOPPING AND EXIT

NOTE

If necessary, expert user can exit system application and reboot the system (IPC). Control Logic remains active.

When authentication user needs to reset the system, can tap on OFF SEQUENCE button in the Login page.

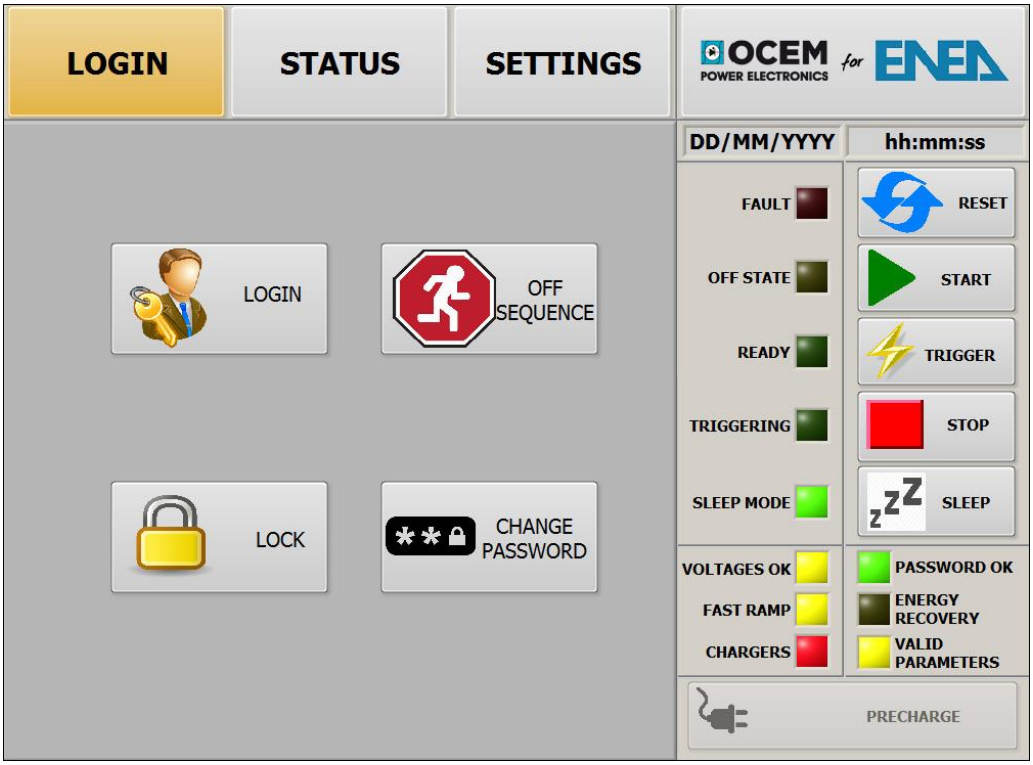


Figure 42 - HMI: off sequence (login page)

When operator tap on the OFF SEQUENCE button, application software becomes closed and user can access the operating system of the IPC.



The computer can now be rebooted or quitted.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

7.4.5 REMOTE CONTROL ENABLING

The operator can enable remote control to allow central control unit to operate on the equipment.

WARNING

To avoid a dangerous condition, before changing control mode, press STOP button and wait for the system switching to OFF STATE.

Drag the slider TRIGGER button to select remote control.



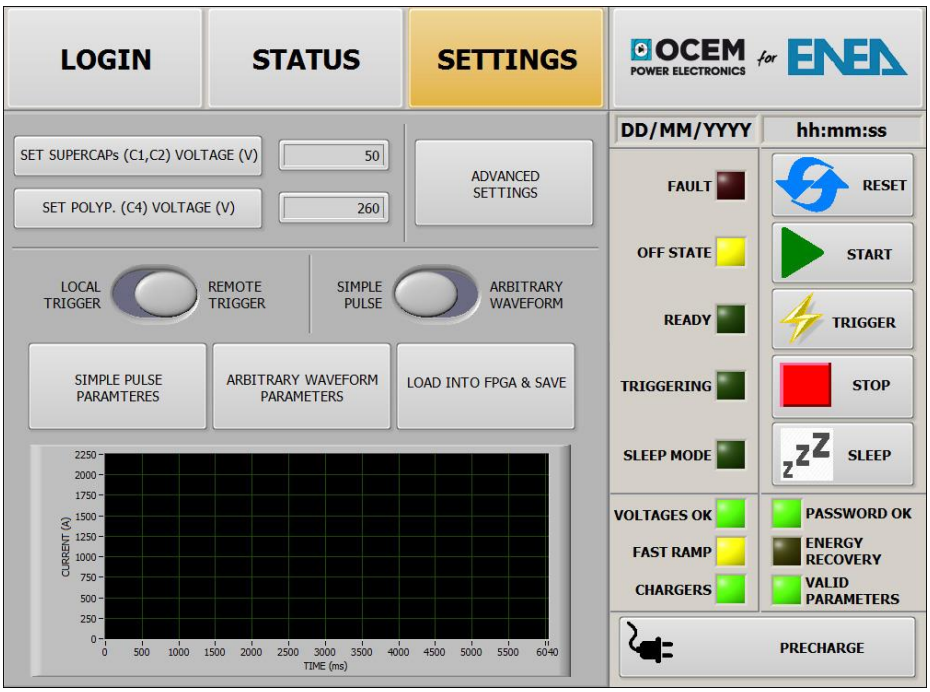


Figure 43 - HMI: remote control enabling (setting page)

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

Before returning to the central control unit (where remote triggering control is located) switch the system in READY status.

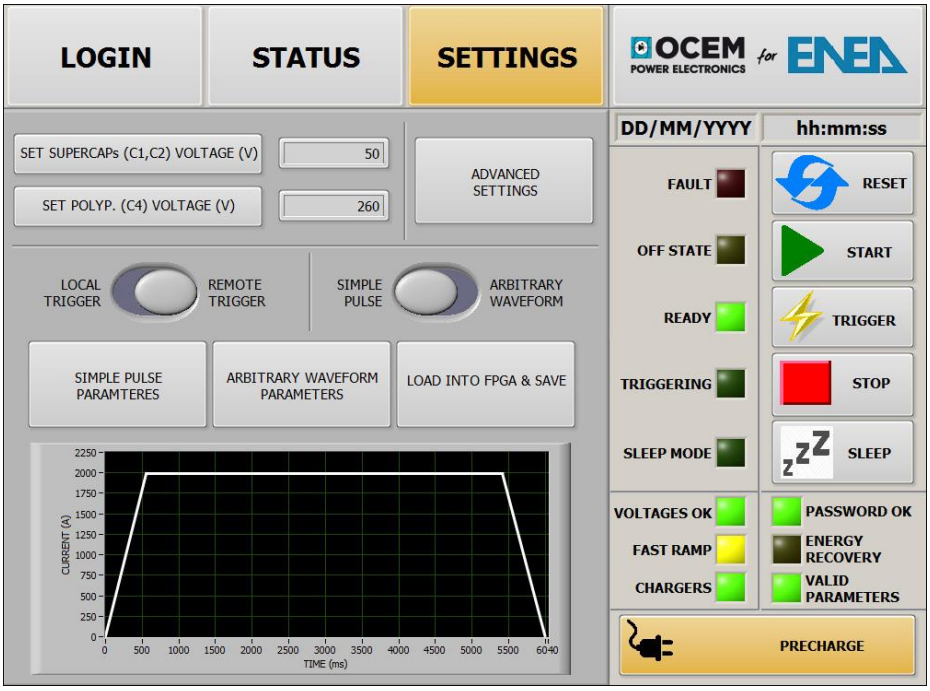


Figure 44 - HMI: remote control enabled - equipment ready (setting page)

When remote control is enabled, Remote Trigger LED in Status page turns on (green).

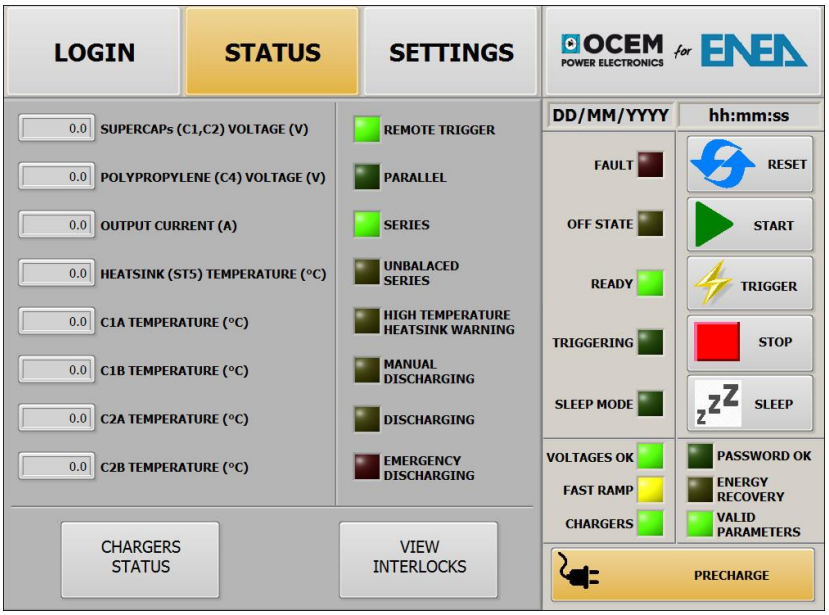


Figure 45 - HMI: remote control enabled (status page)

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

7.4.6 AUTOMATIC DISCHARGE

When the system is in READY or in OFF status, operator can command automatic discharge:

Tap on the button to command the system energy discharging sleep mode.

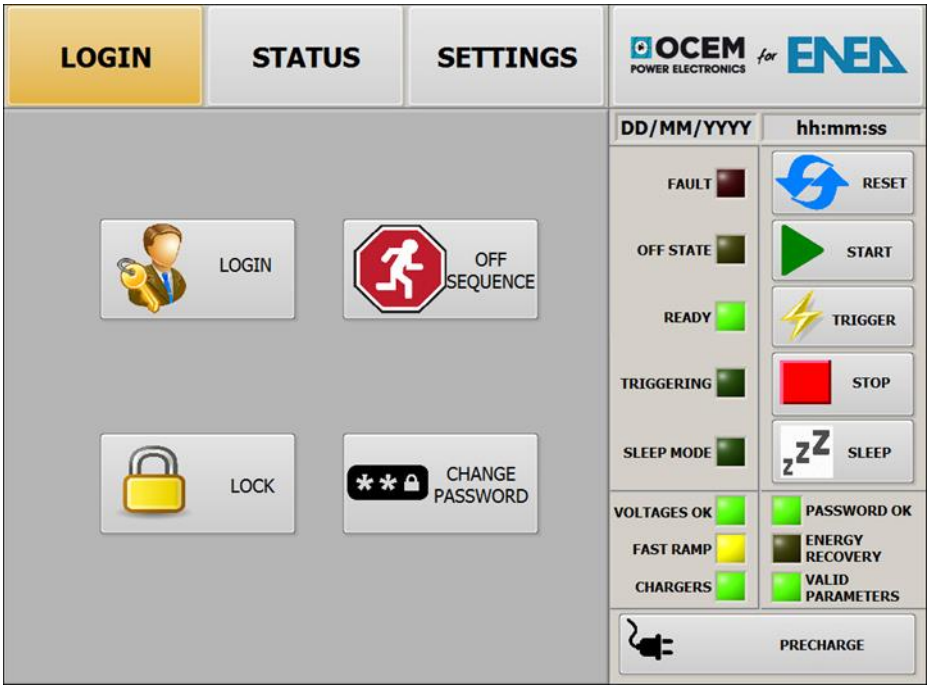


Figure 46- Entering the sleep mode (HMI Login page)

Supercapacitors will be discharged: only when Supercapacitor (C1, C2) Voltage reaches 45 V (if series connected) or 25 V (if parallel connected), discharge is suspended. During capacitors discharge, Discharging LED in Status page turns on.

WARNING

To obtain Supercapacitors complete discharge, rotate Capacitor discharging switch to discharging position.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

If necessary, operator can resume the system from sleep mode pushing WAKE UP button.

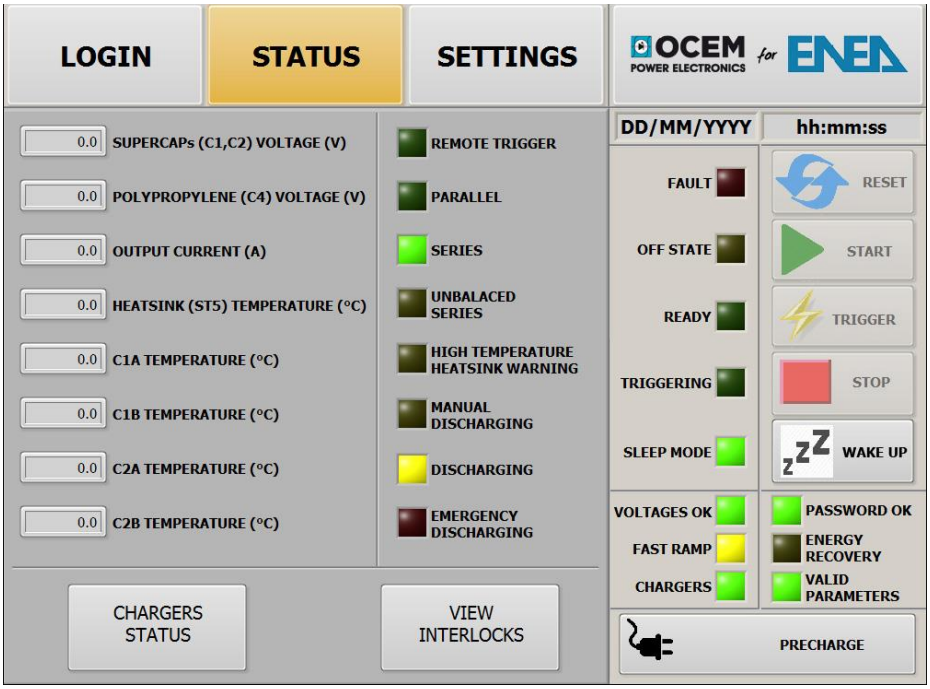


Figure 47- Resuming from sleep mode (HMI status page)

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

7.4.7 FIRST STARTING

Follow installation instructions (see 1.4 Installation, page 5) and execute test procedures (EARTH CONTINUITY TEST, SAFETY INTERLOCK TEST, EXTERNAL I/O TEST, DISCHARGING PROCEDURE TEST).

Set in-feed configuration using rotating switch:

0. No power supplies connected to mains
1. Power and control(auxiliaries) both connected to left socket (NOT RECOMMENDED)
2. Power connected to left socket, auxiliaries connected to right socket (UPS).



Figure 48 - Input configuration setting

Rotate Discharging Switch to Capacitor discharging position: capacitor energy is dissipated through discharging resistance.

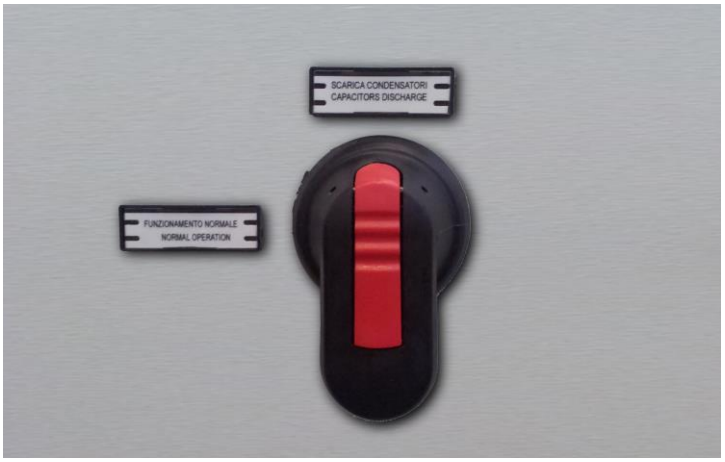


Figure 49 - Capacitors discharging (before doors opening)

Open Cabinet front doors and close main circuit breakers: Q1, Q2, Q3, Q4.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

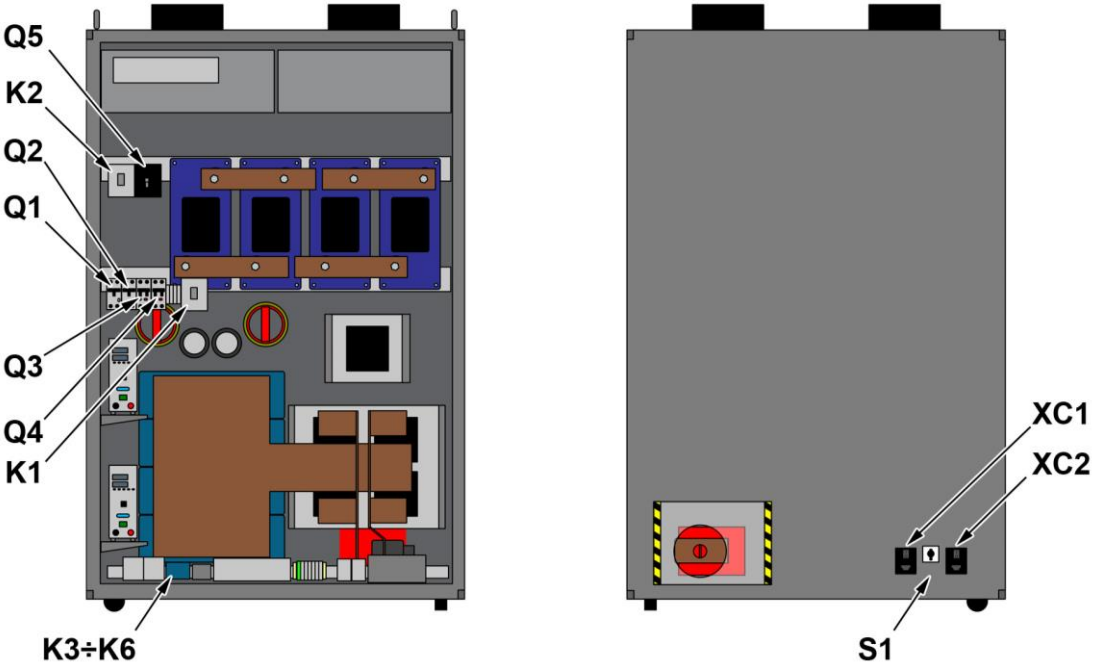


Figure 50 - Main circuit breakers (Q1, Q2, Q3, Q4)

NOTE

The Panel PC and control logic is now correctly energized. Wait for system starting. Main power is now available to internal distribution system.

Close cabinet front doors and wait for system starting. When ready, Login page appears:

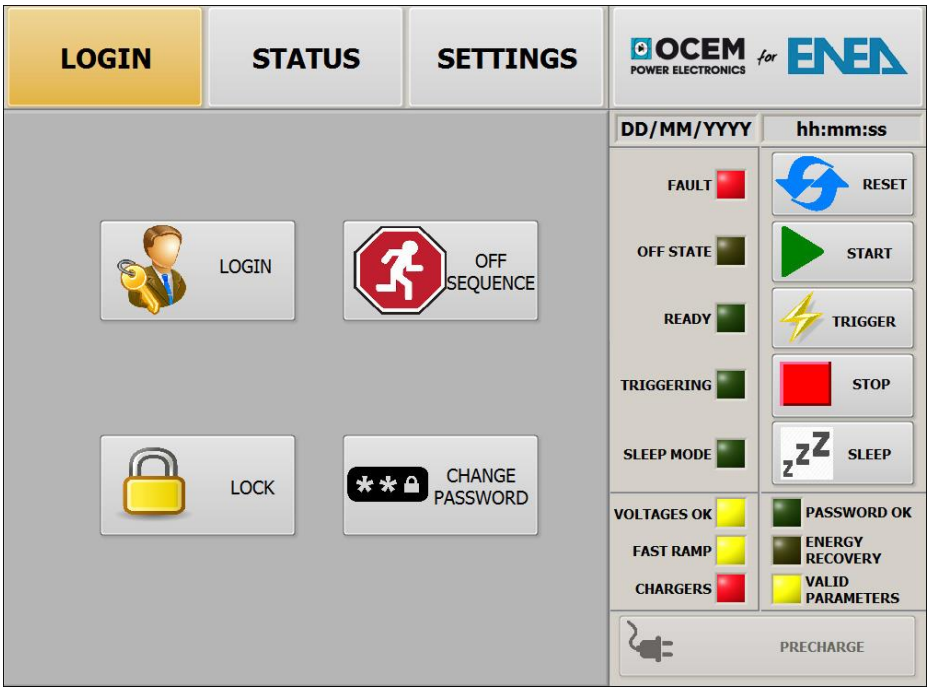


Figure 51 - HMI login page (login page)

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

Fault LED is on:

LED ON (flashing red)
System is in fault state
and waits for first starting

Follow authentication instructions (see7.4.1 Authentication page 68) and log in to the system.

NOTE

First starting default password is: **1234**. You can change your password at any time in LOGIN page by pressing CHANGE PASSWORD button.

If password is correct, password ok LED turns on (green):

LED ON (green)
Authentication completed
and advanced function
are active

Rotate Discharging Switch to Normal operation position.

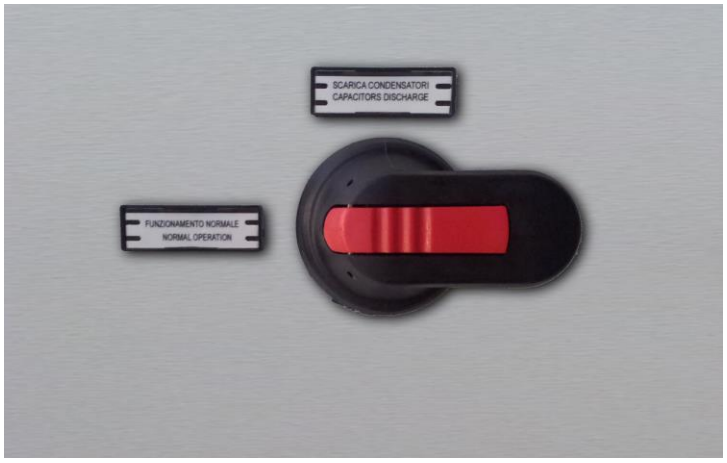


Figure 52 - Discharging switch: normal operation

Press reset button and wait for system response. When all faults have been resolved, equipment switch to OFF status.



NOTE

A persistent fault causes system stop in FAULT state. Check the alarm again and repeat all the steps.

Access to STATUS page and verify all the information data. If necessary, wait up to 15 seconds to check internal PSs connection status.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

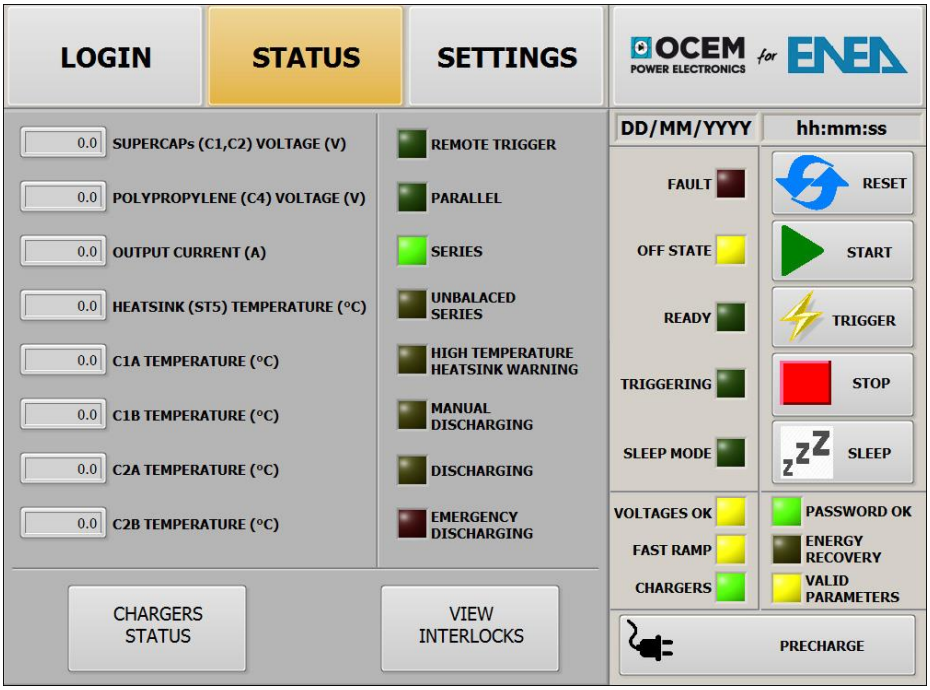


Figure 53 - Internal PSs connection (HMI status page)

If internal PSs connection is OK, Chargers LED turns green:

LED ON (red)
One or more connections need to be restored (see7.4.9 Reconnecting Internal PSs page 86)

LED ON (green)
Connections are available and normally operating

Verify currently active operating mode reading carefully following chapters before proceedings:

- 3.4.2 Series configuration (SUPERCAPACITORS),
- 3.4.3 Parallel configuration (SUPERCAPACITORS),
- 3.4.4ENERGY RECOVERY configuration (diode D0),
- 3.4.5FAST RAMP configuration (diode D0)

If necessary, change operating mode (see 7.3.5 ADVANCED SETTINGS page 66) through the dedicated slide button in advanced setting page (super user password required).

NOTE

First starting default super user password is: **9876**. You can change your super user password at any time in Advanced settings page by pressing CHANGE SUPER USER PASSWORD button.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

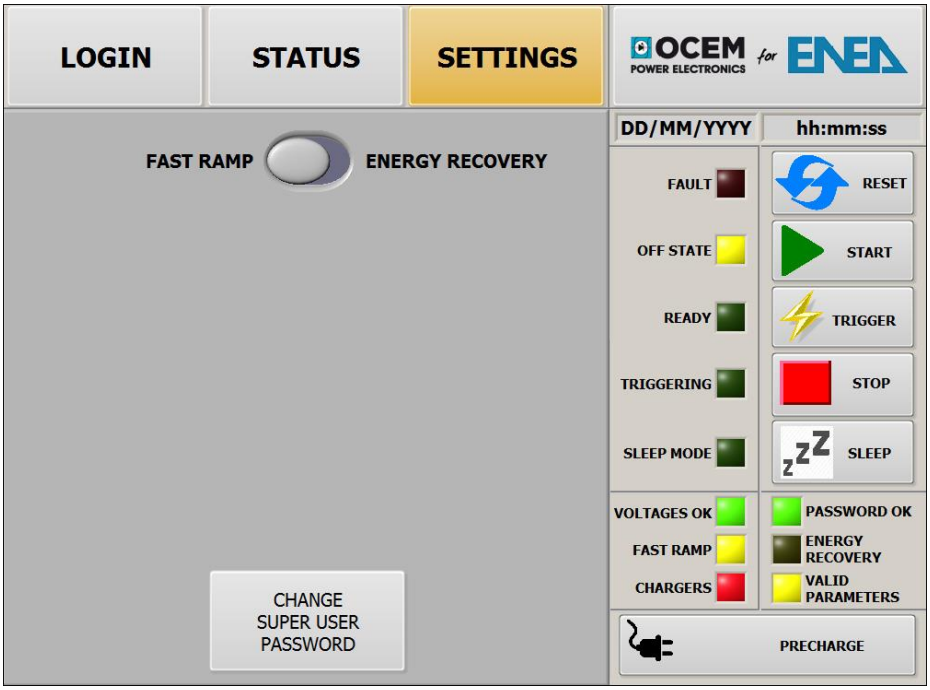


Figure 54 - Operating mode change (HMI advanced settings page)

Access to SETTING page and set all the parameters correctly (Supercapacitors voltage, Polypropylene capacitors voltage).

NOTE

Supercapacitors (C1, C2) Voltage can be set as follow:

- PARALLEL CONFIGURATION: 0 – 48 V
- SERIES CONFIGURATION: 0 – 96 V

Polypropylene capacitor (C4) can be set as follow: 0 – 300 V

Supercapacitors Voltage MUST be lower or equal than Polypropylene Capacitors Voltage.

If settings parameters are correct, capacitors pre-charging is now possible and PRECHARGE button change color:



PRECHARGING POSSIBLE AND NOT ACTIVATED
Internal PSs don't feed energy to capacitors (tap to activate).

Press PRECHARGE button to start capacitors pre-charging.



PRECHARGING POSSIBLE AND ACTIVATED
Internal PSs feed energy to capacitors (tap to deactivate).

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

NOTE

Polypropylene capacitors (C4) normally reach pre-charging target value in a few seconds. Supercapacitors (C1, C2) pre-charging can require many minutes.

When pre-charging value are correct, operator can press START button and command the system to switch to READY status.

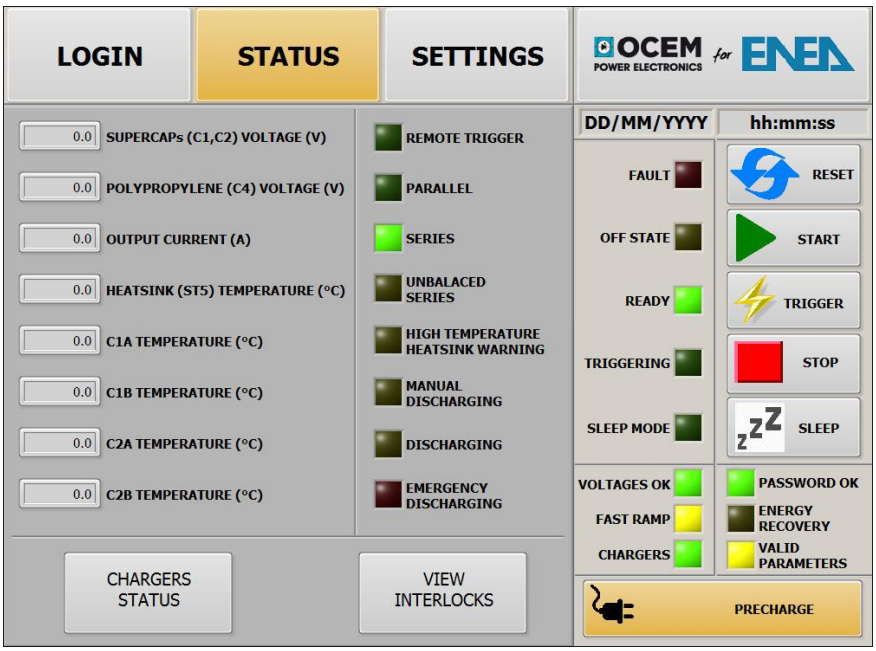


Figure 55 - SCPS ready (HMI Status page)

Access SIMPLE PULSE PARAMETER SETTING page to set all output current waveform parameters:

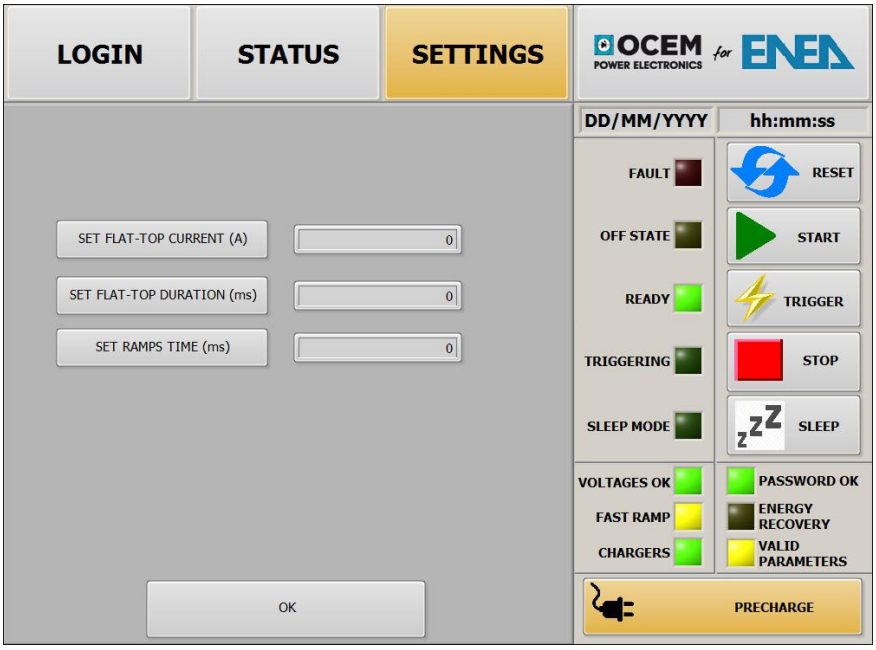


Figure 56 - output waveform setting (HMI Simple Pulse parameters page)

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

Insert for each parameter the desired value and then press OK button.

Confirm actual configuration by pressing Load into FPGA & Save button: now current values are stored in the control logic and output current waveform is display in the graph.

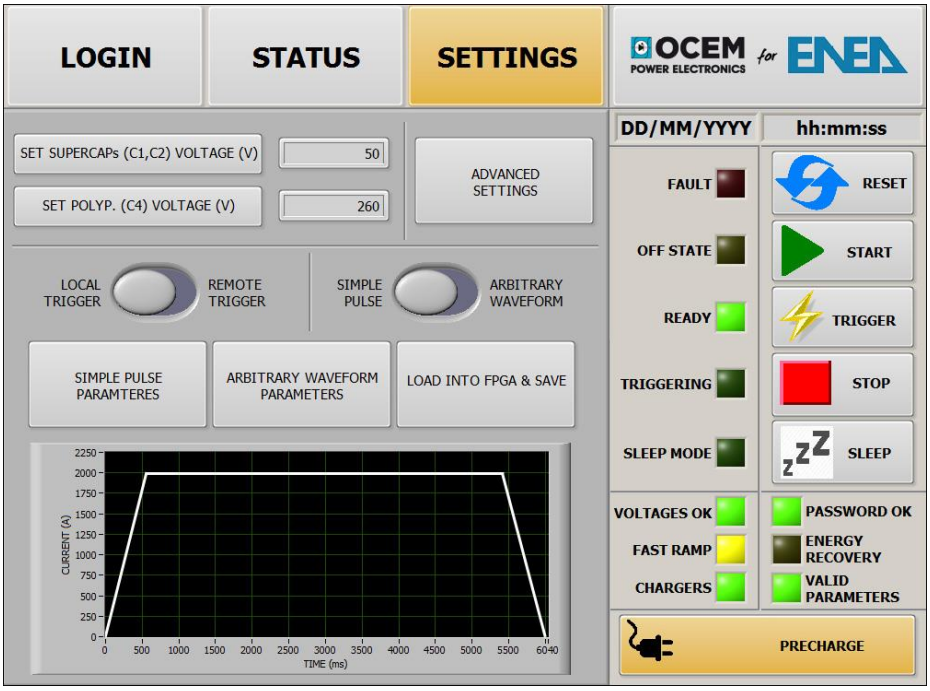


Figure 57 - Output waveform settings (HMI setting page)

Operator can now command the system to feed current to the load: when ready, press TRIGGER button.

WARNING

Before proceeding to trigger, verify that load is properly connected.

NOTE

When triggering, a sibilant sound is produced by semiconductor switching.

When the output current pulse ends, systems switch to READY status and waits for capacitors pre-charging before allowing the operator to command the next output current pulse.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

7.4.8 NORMAL OPERATION

In normal operation, the system can perform a sequence of action to change current status and operate the requested commands.

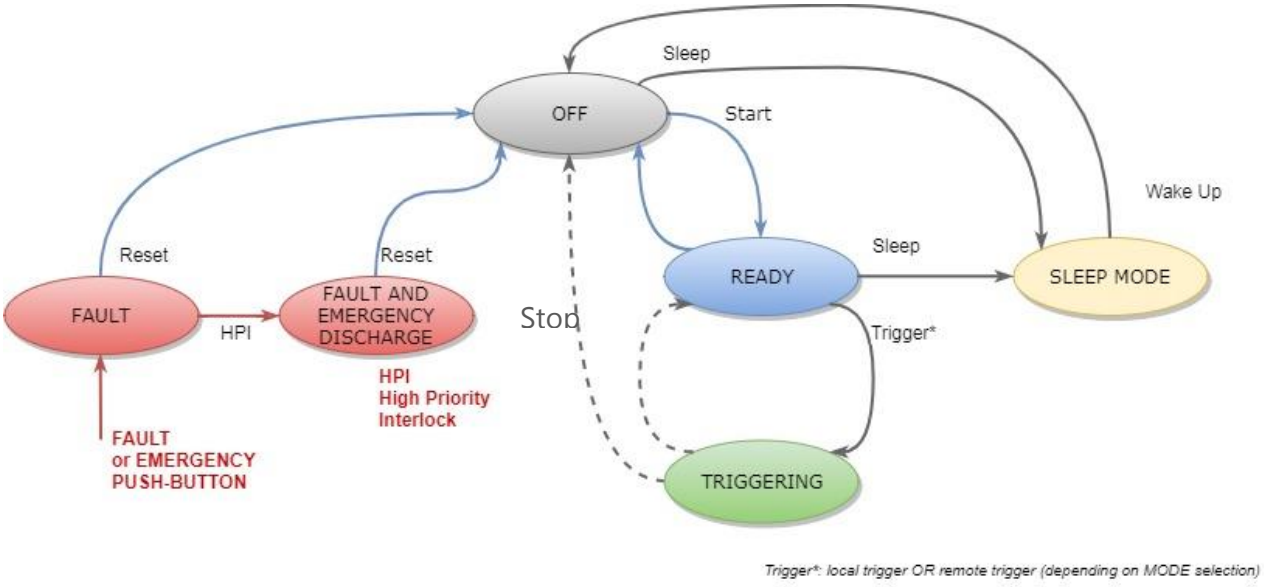


Figure 58 - Normal operation diagram

STATUS	Description	Note
OFF	The system waits for a Start command (password required).	
READY	Capacitors are fully charged and system is ready to operate. The system waits for a Trigger command (password required)	
TRIGGERING	System supplies current (selected waveform) to the load, and then capacitors are recharged.	
SLEEP MODE	The equipment discharge automatically the energy stored on the capacitors.	
FAULT	If one or more fault/error are activated, system stops and wait for a reset.	
FAULT AND EMERGENCY DISCHARGE	HPI (High Priority Interlock) active: system stop and capacitors are automatically discharged (emergency discharge)	

Table 13: State description (normal operation)

In normal operation, authenticated user can operate on the equipment.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

NOTE

Some operations are not instantaneous and they can require at least some tens of seconds. Pressing two keys at once (or within very short time) is not supported and can generate unwanted results: **be sure to wait system response before proceeding. Do not issue too many commands at the same time to the equipment.**

In such case, the system considers only the key that was pressed first and implements the associated functions and operations. The key pressed second is ignored.

When system is off, operator can command PRECHARGE to feed energy to capacitors (PRECHARGE button turns yellow). System enter in a waiting time (when Capacitors are fully charged, Voltages OK LED turns green).

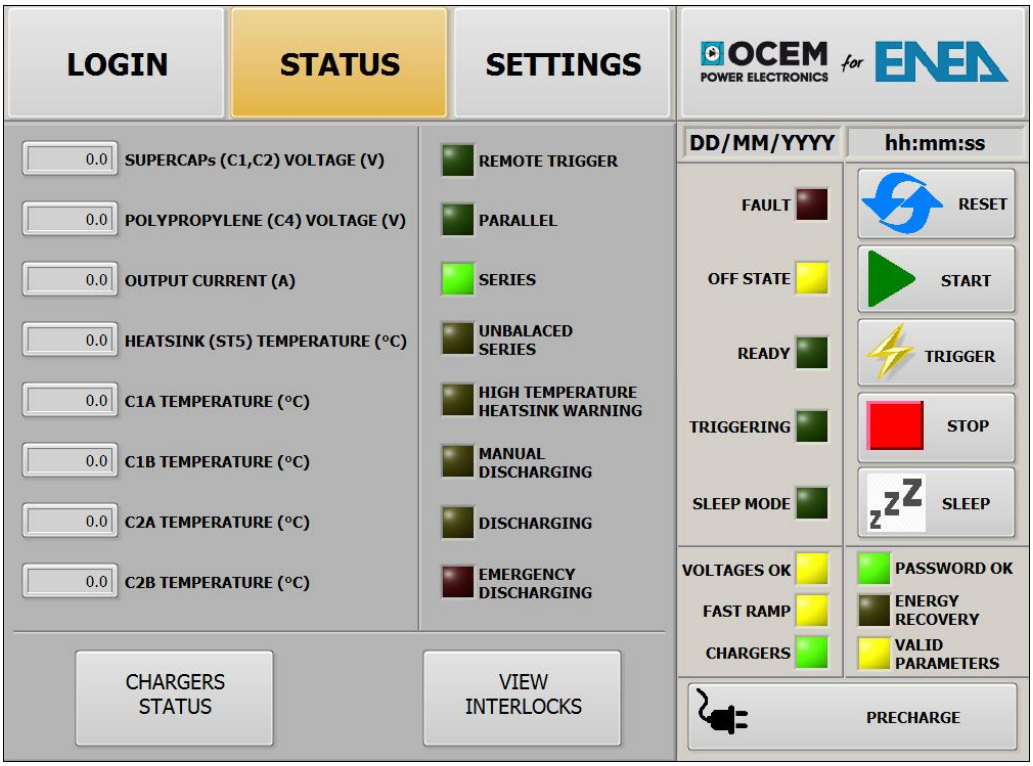


Figure 59 - HMI Starting the system

Authenticated operator can command START and when system reach READY status OFF STATE LED turns off, and READY LED turns on.

NOTE

Some operations are not instantaneous and they can require at least some tens of seconds.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

The equipment is now ready to supply current to the load.

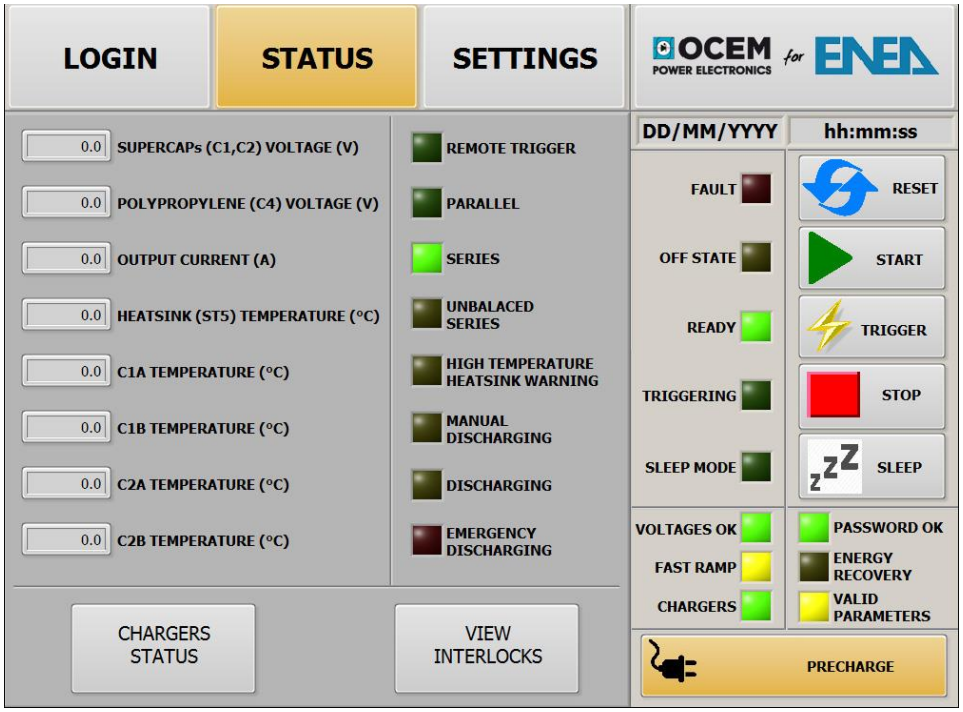


Figure 60 - HMI Triggering

To feed the load authenticated operator has to tap on TRIGGER button. The system enters in TRIGGERING status and, at the end of the current waveform selected, wait for capacitor charging and returns in READY status.

To stop the system, operator can tap on STOP button: the system returns in OFF STATE maintaining all the energy stored in capacitors.

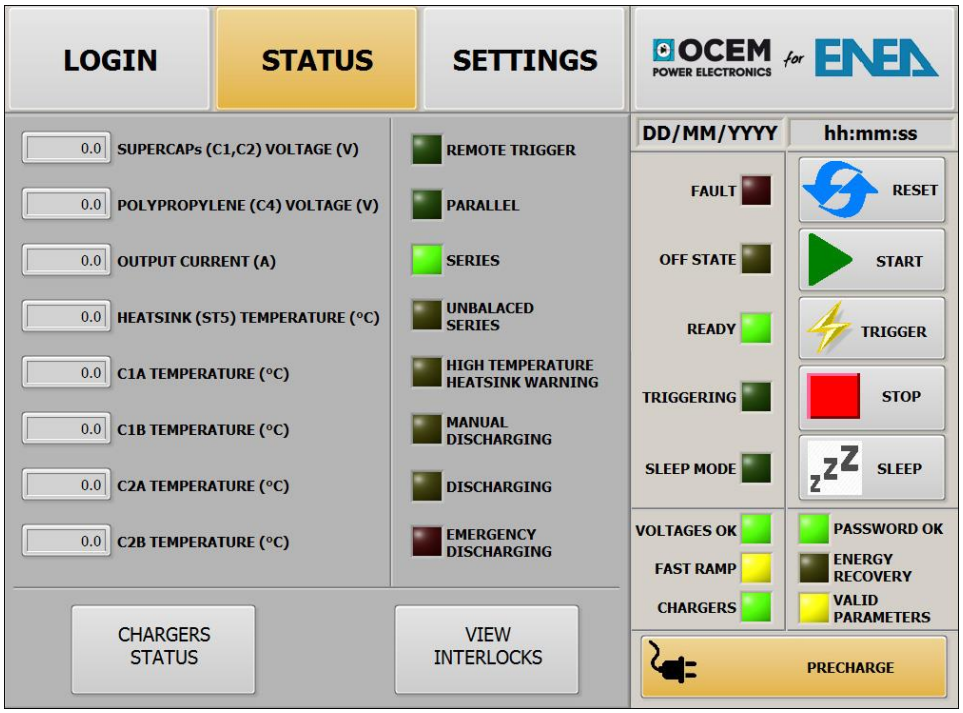


Figure 61 - HMI stop feeding current to the load

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

To stop the system and discharge automatically the energy stored in capacitors, authenticated operator can command the system to enter in SLEEP MODE.

7.4.9 RECONNECTING INTERNAL PSS

When Internal power supplies cannot correctly communicate to the PC, CHARGERS LED turns RED.

Operator should try to reconnect the PSs, by tapping the corresponding button in Charger Status page.

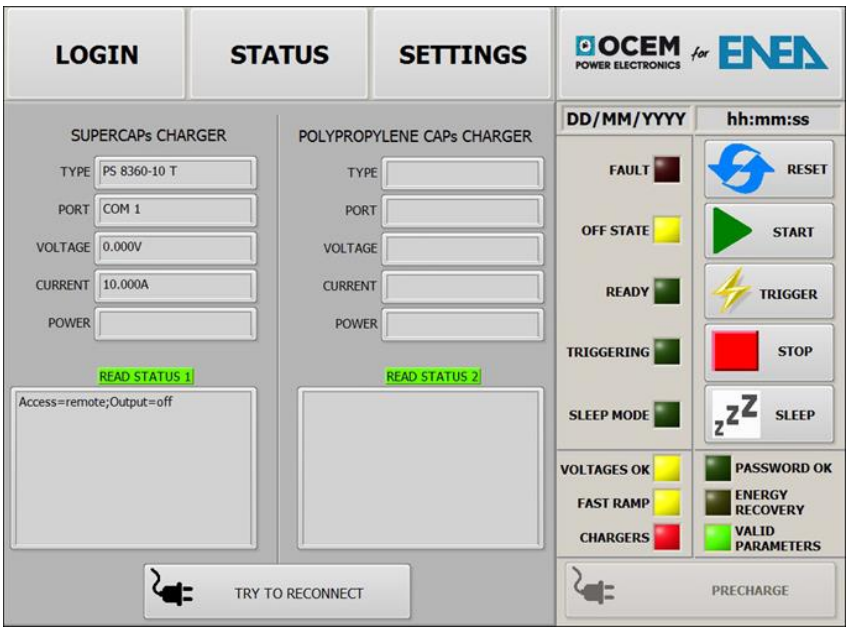


Figure 62 - HMI trying to reconnect internal PSs to PC

Trying to reconnect normally requires only a few seconds (Try to reconnect button turns yellow during this waiting time): while reconnection procedure is in progress, the interface is temporarily disable and operator must wait for the system response.

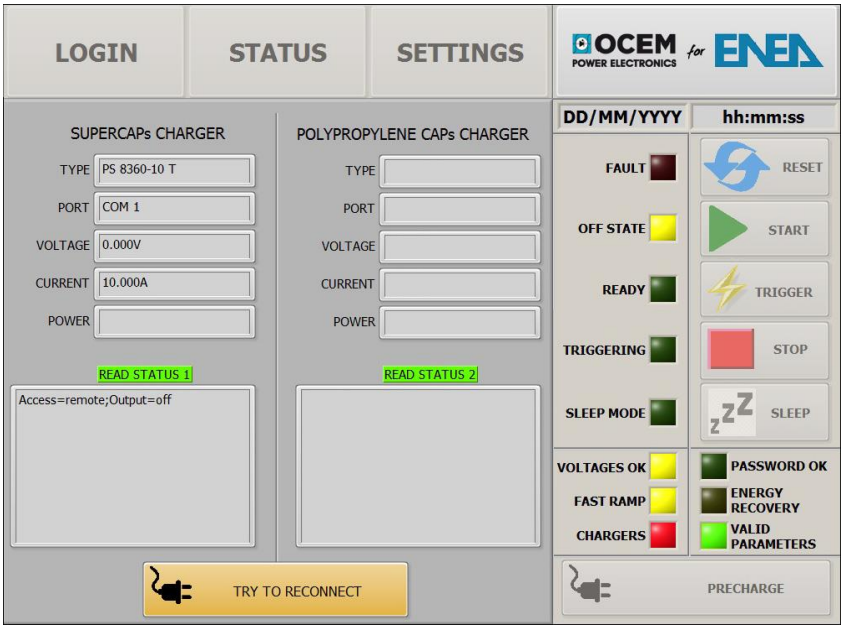


Figure 63 - HMI internal PSs reconnection to PC in progress

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

If reconnection is successful, system can be now normally started and operated.

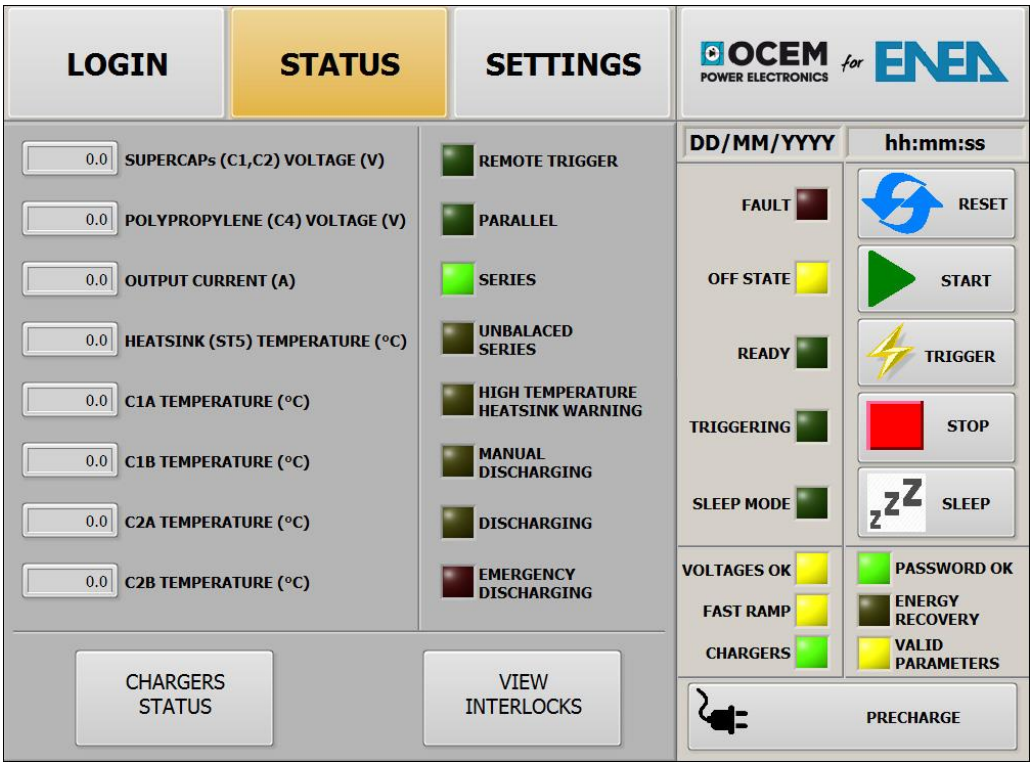


Figure 64 - HMI internal PSs reconnection to PC succeeded

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

8 ALARM AND TROUBLESHOOTING

8.1 ALARM LIST

Each part composing the PSCS, as presented in the HMI design, generates its messages: the alarm list considers this organization of the messages. The message texts are collected in the STATUS page of HMI (see 7.3.3 STATUS page 58).

In the following there is a summary of all the alarms and messages generated component by component, sort by alphabetic order.

Message Text	Description
Thermoswitch ST1	opens if T_heatsink > 55 °C
Thermoswitch ST2	opens if T_heatsink > 55 °C
Thermoswitch ST3	opens if T_heatsink > 55 °C
Thermoswitch ST4	closes if T_amb > 60 °C
Emergency button/Door Open	Emergency push-button pressed/Cubicle door open
External Interlock	Stop request from remote control
Over Voltage C1A	Module voltage > 51 V
Over Voltage C1B	Module voltage > 51 V
Over Voltage C2A	Module voltage > 51 V
Over Voltage C2B	Module voltage > 51 V
Over Voltage SUPERCAPs (C1,C2)	DCVT1 > 100 V
Over Voltage Polypropylene CAPs (C4)	DCVT3 > 360 V
Over Current DCCT 1	DCCT1 > 2200 V
Over Current DCCT 2	I_{LOAD} > 2300 A
Max Current Difference	|DCCT1 - DCCT2| > 500 A
Over Temperature C1A	Module Internal Temp > 65 °C
Over Temperature C1B	Module Internal Temp > 65 °C
Over Temperature C2A	Module Internal Temp > 65 °C
Over Temperature C2B	Module Internal Temp > 65 °C
Driver Fault N2	IGBT N2 driver power supply out of tolerance or N2 driver faulty
Driver Fault N3	IGBT N3 driver power supply out of tolerance or N3 driver faulty

Table 14: Alarm list

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

8.2 ALARM TROUBLESHOOTING

Any case of system malfunction detected by the controller activates one or more alarm condition. Before reactivating the PS through reset procedure (see 7.4.3 Alarm Reset page 70), it is important that the user has a good knowledge of the causes of the problem and an high confidence that the reactivation does not create a danger for person.



WARNING

Any failure must be carefully detected and registered; underestimating alarm messages can provoke dangerous effects.

The following procedure suggests a good troubleshooting approach:

1. Take a note of alarm messages, time of the event, all the information catch by PLC, all the surrounding conditions.
2. According to the alarm messages and signals, localize the components or subsystems involved. In many situations, more than one alarm messages occur simultaneously, but normally one of the subsystem mainly effects on the situation.
3. Check for the external conditions to detect eventual failure or error; many alarms detected by the PSCS are a reaction to external event. For instance, normally over-current is due to external arc or short circuit.
4. Check that all the output connections are safe and in order to start again the operations.
5. In case of residual doubt, or if the alarms highlight a probable internal problem, following the grounding procedure and with care against possible residual risks, check that are not visible facts related to probable damage of the system.
6. In case of failure detection, change the involved part or adopt other final solution.
7. Only when the situation and the alarm sequence are clear, restart the PS operation following the reset procedure (see 7.4.3 Alarm Reset page 70). Be careful against the possibility that the alarm condition appears again, especially if the event has not been completely clarified and solved.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

9 MAINTENANCE AND SPARE PARTS

9.1 PREVENTIVE MAINTENANCE



WARNING

For no reason the protections and the safety devices must be removed.



WARNING

DO NOT OPERATE ON ENERGIZED CIRCUITS

Do not carry out any operation on the converter or on apparatus connected to it when the circuits are energized.

To reduce the probability of failure and to mitigate the consequences of failure of equipment it is necessary to maintain equipment and facilities in satisfactory operating condition.



NOTE

The respect of scheduled maintenance is recommended to ensure that the equipment is operates correctly during the whole life cycle.



WARNING

During maintenance the equipment has to be POWERED OFF and DE-ENERGIZED; the main circuit breakers which supply the equipment must be all OPEN.

In order to ensure the safety of operations during all the time, it is recommended to:

- delimit the operating area
- place notices on each electrical cabinet to avoid unwanted re-energization of the equipment

A common maintenance procedure starts with a continuous check of the equipment conditions, at least one time each month:

- visual inspection that no damage evidence is present inside the cabinet: no burning mark, no rest of breakage may be present inside
- no damage on the internal cabling nor on the output connection may be present
- no abnormal pollution is admitted inside the cabinets: a cleaned area will mitigate the risk related to high voltage and arcs
- all the fans of the cabinet must be visually verified
- the unit is required to work with all the subcomponents powered at nominal voltage at least 2 hours every 12 months under standard ambient conditions

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

9.2 RESIDUAL CURRENT CIRCUIT BREAKERS TEST

For the functional test the switch must be in the ON position and the test pushbutton has to be pressed.

Remember to press the test button regularly and at least every six months. The RCCB should trip. If this does not happen, an expert operator should be alerted immediately because the system safety has been reduced.

9.3 SPARE PARTS

The following tables present a list of principal spare parts.

Ref	Description	Suggested quantity	OCEM code
C1A, C1B **C2A, C2B**	Supercapacitor module Maxwell Technologies BMOD0165 P048 C01	1	CECWT0001
C3A, C3B	Electrolytic capacitor HITACHI FX33W26BFM6	1	530.0424
C4A, C4B **C4C, C4D**	Polypropylene capacitor Ducati Energia 416.86.1480	1	CECXT0002
D0, D1 **D2, D3**	Diode Infineon DD1200S12H4	1	CEDDT0001
Q1, Q2	IGBT Infineon FZ2400R12HP4	1	CEIBT0001
N2, N3	F255 - IGBT driver board	1	150.4121
(Fuse in VDE plug)	Retarded 250V/16A fuse Siba 70 007 65/16A	1 set	CEFU00001
K4, K5	Relay module Finder 48.31.7.024.050	1	CERLT0006
K3, K6	Relay module Finder 48.52.7.024.050SPA	1	CERLT0008
K2	Contactor LOVATO 11BF6500	1	472.0228

Table 15: Spare parts list

9.4 LONG TERM STORAGE

A long idle period may impact some of the internal components of the equipment: in general, it is preferable avoid a stop longer than 12 months. If this is the case, please refer to OCEM to reactivate the system in a safe way: OCEM will evaluate the best restart sequence according to the present situation at that moment.

In any case, it is very important to assure stable storage conditions: no exposure to aggressive atmosphere or to outdoor conditions; storage at controlled temperatures, in the range [-40, +60] °C, and non-condensing humidity; avoidance of mechanical or thermal shocks; protection from dirt conditions.

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.



WARNING

After a long idle time, some of the components, like battery or electrolytic capacitors, require a special test or re-start procedure. Unusual degradation may also affect some electrical or mechanical components. These effects may result in DANGEROUS SITUATIONS and require expert intervention.

Here is a summary of the checks at the first start after long storage:

- Integrity of mechanical structures, absence of corrosion signs or other alterations;
- Tightening of screws and nuts;
- Internal cable connections, according to the electrical schemes;
- Other checks of visual inspection;
- Cleaning of the entire system, to avoid that dirt may impact on isolation;
- Execution of isolation test;
- After disconnection of all the internal power supplies (anode, screen and control grids, filaments), checking of the low voltage distribution and components;
- Integrity of interlock and other safety related circuits;
- Checking of the software version and of parameters retention;
- Individual test (powering and checking them in steady state conditions);
- Test of each module (powering and checking their functionality) out of the equipment. To complete this task, it is preferable to ask OCEM for a specific test equipment and procedure;
- Test of the overall system, on dummy or light load, performing a step by step sequence and carefully checking the result
- Test of the machine protection functionalities (short circuit protection, machine protection interlocks, …)

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.

10 GLOSSARY AND ABBREVIATIONS

C

- **Caution:** *advisory that performing some action may lead to consequences that are unwanted or undefined.*

D

- **DCCT:** *Direct Current Current Transducer*
- **DCVT:** *Direct Current Voltage Transducer*

H

- **HMI:** *Human Machine Interface*
- **HPI:** *High Priority Interlock*

I

- **Instruction:** *access to information to use the equipment in performing tasks.*
- **INTLK:** *Interlock*

M

- **MCE:** *Control Electronic Module*
- **MCB:** *Main Circuit Breaker*
- **Note:** *helpful hints and other information that may assist the user by emphasizing or supplementing important points of the main text.*

N

- **Note:** *helpful hints and other information*

P

- **PPE:** *Personal Protective Equipment*
- **PS:** *Power Supply unit*
- **PSCS:** *Power Supply and PLC Control System*
- **PSs:** *Power Supplies*

R

- **Reference:** *quick access to specific information for users who are familiar with the equipment functions and basic principles.*

S

- **SI:** *Safety Interlock*

U

- **UPS:** *Uninterruptible power supply*
- **User:** *person who employs equipment to perform a task. (see also: Expert and Normal).*

W

- **Warning:** *advisory that performing some action may lead to serious or dangerous consequences.*

THIS COPY IS NOT SIGNED SINCE IT IS FILED AND DELIVERED BY MEANS OF THE AUTOMATIC KNOWLEDGE MANAGEMENT SYSTEM (IT CAN BE SIGNED ON REQUEST). THIS DOCUMENT AND THE DATA CONTAINED HERE IN, IS PROPRIETARY PROPERTY AND SHALL NOT BE DUPLICATED, USED OR DISCLOSED – IN WHOLE OR IN PART – FOR ANY PURPOSE WITHOUT WRITTEN CONSENT OF OCEM – EnergyTechnology.