Bidirectional Battery Charger (B2C)

Installation and operation manual
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1. INTRODUCTION

Dear customer, on behalf of CINERGIA team, thank you for the confidence placed in our company and for the purchase of this product. Please, read carefully this manual before using the equipment to get familiarized with it to obtain the maximum performance from it.

This document is intended for appropriately qualified personnel. Only personnel with the appropriate skills are allowed to perform the electrical connection and commissioning of the equipment.

The information in this documentation is not binding. CINERGIA reserves the right to make changes in part on in the whole at any time and without prior notice due to technical advance or product improvement.

1.1. Symbols used

**DANGER**: Indicates a hazardous situation which can result in death or serious injury and can cause important damage or destruction of the equipment or the property

**WARNING**: Indicates important information that must be taken into account to operate the equipment. Take the appropriate prevention measures.

**INFORMATION**: Information that is important but is not safety-relevant

1.2. Safety notes

Improper use of this equipment can cause both important personal injury and physical damage to the electrical power grid and the loads connected to it. Read this document carefully and follow all safety precautions at all times.

1.3. Quality and regulations

The equipment is based on a hardware designed, manufactured and commercialized in accordance with the standard EN ISO 9001 of Quality Management Systems. The marking shows the conformity to the EEC Directive by means of application of the following standards

- 2006/95/EC Low voltage directive.
- 2004/108/EC Electromagnetic Compatibility directive (EMC)

In accordance with the specifications of the harmonized standards:
• EN-IEC 62040-1. Uninterruptible power supply (UPS). Part 1-1: General and safety requirements for UPS’s used in accessible areas by end users.

• EN-IEC 60950-1. IT equipments. Safety. Part 1: General requirements.


The manufacturer responsibility is excluded in the event of any modification or intervention in the product by the customer’s side.


2. PRESENTATION

2.1. Introduction

The B2C is a Bidirectional Battery Charger, a power electronics equipment with the following main functionalities:

- It converts the AC input, of the main grid, in a controlled DC output by using an IGBT-based switching topology and DSP-based state-of-the-art digital control.
- It is based on CINERGIA’s DCPS, so it can be operated as:
  o Constant voltage output
  o Constant current output
  o Constant power output
- As a B2C it has a special operation mode for battery charging/discharging
- It is a bidirectional power source: energy can flow from the grid to the load or viceversa.
- The AC current consumed from the grid is sinusoidal (THD < 2%)
- The user can define the reactive power to be injected by the power supply and also choose between capacitive or inductive

The power range covered by the B2C power supplies goes from 6.75 to 160kW at the output. The parallelization of power supplies is possible to increase output power.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Rated Power</th>
<th>Rated Current</th>
<th>Rated Voltage</th>
<th>Dimensions (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kVA</td>
<td>kW (rms)</td>
<td>DC (per channel)</td>
<td>DC (total)</td>
</tr>
<tr>
<td>B2C7.5</td>
<td>7.5</td>
<td>6.75</td>
<td>10A</td>
<td>10A</td>
</tr>
<tr>
<td>B2C10</td>
<td>10</td>
<td>9</td>
<td>15A</td>
<td>15A</td>
</tr>
<tr>
<td>B2C15</td>
<td>15</td>
<td>13.5</td>
<td>20A</td>
<td>20A</td>
</tr>
<tr>
<td>B2C20</td>
<td>20</td>
<td>18</td>
<td>30A</td>
<td>25A</td>
</tr>
<tr>
<td>B2C30</td>
<td>30</td>
<td>27</td>
<td>40A</td>
<td>40A</td>
</tr>
<tr>
<td>B2C40</td>
<td>40</td>
<td>36</td>
<td>55A</td>
<td>50A</td>
</tr>
<tr>
<td>B2C50</td>
<td>50</td>
<td>45</td>
<td>70A</td>
<td>65A</td>
</tr>
<tr>
<td>B2C60</td>
<td>60</td>
<td>54</td>
<td>85A</td>
<td>80A</td>
</tr>
<tr>
<td>B2C80</td>
<td>80</td>
<td>72</td>
<td>115A</td>
<td>105A</td>
</tr>
<tr>
<td>B2C100</td>
<td>100</td>
<td>90</td>
<td>145A</td>
<td>130A</td>
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<tr>
<td>B2C120</td>
<td>120</td>
<td>108</td>
<td>175A</td>
<td>155A</td>
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<tr>
<td>B2C160</td>
<td>160</td>
<td>128</td>
<td>230A</td>
<td>185A</td>
</tr>
<tr>
<td>B2C200</td>
<td>200</td>
<td>160</td>
<td>290A</td>
<td>230A</td>
</tr>
</tbody>
</table>
## 2.2. Power supply features

<table>
<thead>
<tr>
<th>Magnitude</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>6.75kW-160kW</td>
</tr>
</tbody>
</table>

### Input

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Voltage</td>
<td>Rated 3x400V+Neutral+Earth</td>
</tr>
<tr>
<td>Voltage range</td>
<td>+15% / -20%</td>
</tr>
<tr>
<td>AC Current</td>
<td>2Arms - 290Arms</td>
</tr>
<tr>
<td>Frequency</td>
<td>50/60Hz</td>
</tr>
<tr>
<td>Power Factor</td>
<td>Controllable -1/1 (capacitive/inductive)</td>
</tr>
<tr>
<td>Efficiency</td>
<td>at full load &gt;92%</td>
</tr>
<tr>
<td>Overload</td>
<td>125% for 10 min / 150% for 60 s</td>
</tr>
</tbody>
</table>

### DC Outputs

| DC Current       | 3 independent channels 0-230A (per channel) |
| DC Current       | 1 parallelized channel 0-690A               |
| DC Voltage       | 0-750V                                     |
| Minimum voltage  | at rated power 220V                       |

### Modes of operation

<table>
<thead>
<tr>
<th>Mode</th>
<th>Range</th>
<th>Resolution</th>
<th>Ripple</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant Current (CC)</td>
<td>0-100%</td>
<td>&lt;±0.1%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Constant Voltage (CV)</td>
<td>0-100%</td>
<td>&lt;±0.1%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Constant Power (CP)</td>
<td>0-100%</td>
<td>&lt;±0.1%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Battery Charge (BC)</td>
<td>Combination of CC and CV modes to charge batteries</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### GENERAL

<table>
<thead>
<tr>
<th>Measurements</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage (Vrms) and Current (Irms)</td>
<td></td>
</tr>
<tr>
<td>Active and Reactive Input Power (P,Q)</td>
<td></td>
</tr>
<tr>
<td>Output Voltages (Vdc) and Currents (Idc)</td>
<td></td>
</tr>
<tr>
<td>Output Power</td>
<td></td>
</tr>
<tr>
<td>Temperatures</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>User interface</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2” Touchscreen</td>
<td></td>
</tr>
<tr>
<td>Control port: 3 analog inputs, 3 analog outputs, 5 digital inputs, 3 relay</td>
<td></td>
</tr>
<tr>
<td>Communication Protocols: Modbus/TCP</td>
<td></td>
</tr>
<tr>
<td>Communication Ports: Ethernet, RS485 (optional)</td>
<td></td>
</tr>
<tr>
<td>Customized communications for IEC61850, ERP or MATLAB* (optional)</td>
<td></td>
</tr>
</tbody>
</table>

| Humidity         | 10-90% (Absolute maximum, without condensation) |
| Temperature      | 5-40°C (Absolute maximum)                        |
| Refrigeration    | Forced air                                    |
| Protections      | Over Current, Over Shortcircuit, Over Temperature, Galvanic Isolation (optional) |

<table>
<thead>
<tr>
<th>Standards</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>EN-62040-1-2, EN-60950-1</td>
</tr>
<tr>
<td>EMC</td>
<td>EMC, EN-62040-2</td>
</tr>
</tbody>
</table>

Please note that items marked as optional shall be requested specifically at additional cost.
2.3. Operation and connection modes

The output of the power supply is formed by three channels referenced to a common negative channel. The power supply can be used in two different connection modes:

- **Independent channel**: each channel (U,V,W) is controlled independently. The setpoint and also the operation mode can be different for each channel.
- **Parallel channels**: the three channels are controlled by the control software as a unique channel to multiply the output current by 3. The setpoint and the operation mode are the same for all three channels. It is mandatory to shortcircuit by hardware the three output channels. All operation modes are available in this connection mode.

However, four operation modes are allowed:

- **Constant Voltage (CV)**: the output voltage is controlled to the setpoint value.
- **Constant Current (CC)**: the output current is controlled to the setpoint value.
- **Constant Power (CP)**: the output power is controlled to the setpoint value.
- **Battery Charge (BC)**: the output DC combines constant current and constant voltage modes to charge the battery in a IUoU charge mode.

2.4. Limits

The B2C output limits are defined by:

- **Maximum voltage**: 750V
- **Maximum current**: defined in the datasheet as *Rated Current DC (per channel)* or *Rated Current DC (total)*
- **Maximum power**: defined in the datasheet as *Rated Power (kW)*

For example, below the limits of a B2C160 power supply (with 750 V as maximum voltage) are shown:
2.5. Configuration and control of the power supply

The power supply can be interfaced by three means:

- **Local touchscreen**: a 3.2” colour local touchscreen panel can be used to configure, monitor and operate the power supply. See section *Local Touchscreen Control Panel* for further information.

- **Analog and digital inputs / outputs**: the power supply owns:
  - 5 optocoupled digital inputs
  - 3 relay outputs
  - 3 isolated analog inputs
  - 3 isolated analog outputs

- **Remote interface**: an Ethernet communication interface with protocol MODBUS/TCP can be used to configure, monitor and operate the power supply. By using HMI software application provided by CINERGIA, downloading of excel files is also possible.

2.6. Functional diagram

The diagram below is the conceptual functions blocks diagram of the power supply:

The main components of the diagram are the following (from grid side to load side):
- **Isolation transformer**: a 50/60Hz isolation transformer can be provided optionally in order to isolate the output channels. In this case, an isolation monitor can be integrated in the power supply to detect isolation faults too. This isolation transformer is mandatory if the power supply is to be used as a 4 quadrants equipment (by connecting the load between two output channels).

- **Input protections**: these protections include a thermal-magnetic circuit breaker and fuses. The connection of the power supply input with the grid is done by screw terminals. Please follow safety instructions in *Installation* section to connect the battery charger.

- **Input EMI filter**: an electromagnetic filter is integrated to fulfil electromagnetic compatibility regulations. The structure of the filter in question is the same as the one of the output EMI filter.

- **Input LCL filter**: the purpose of this filter is to reduce the current distortion at frequencies equal to or higher than switching frequency and thus reduce THD.

- **Active Rectifier**: a three-branch IGBT active front end is integrated in the equipment to consume/inject a sinusoidal current from/to the grid.

  The DC link voltage is set to 430V providing a regulation margin for fast transients at the output of the battery charger.

  The active rectifier has bidirectional power flow capability and the injected reactive power (grid side) can be defined by the customer.

- **DC/DC output converter**: a three-branch IGBT converter allows three buck-boost DC-DC conversions from the DC bus to each of the output channels. Each channel can be controlled independently or, by software, the three channels will share the same operation mode and setpoints.

- **Output LCL filter**: this filter reduces current distortion (caused by switching) at the output of the power supply.

- **Output EMI filter**: a high frequency common mode LC filter is used to reduce electromagnetic disturbances at the output of the battery charger.

- **Output protections**: the DC outputs are protected by fuses. A disconnector is provided to isolate the output from the load. Screw terminals are also integrated to connect the load. Please, follow safety instructions in *Installation* section to connect the power supply.
2.7. Principle of operation

Below, a technical diagram of the power supply is shown:

(Please note that earth protection cable is only connected to the cabinet chassis).

State-of-the-art digital control is used in all CINERGIA products. In the B2C case, the control system algorithms are computed in a dual core DSP-based hardware, designed by CINERGIA, allowing a multitask execution of the regulation systems for the Active Rectifier and the DC/DC output. This produces a fast transient response and high performance against load changes. A 12 bits analog to digital conversion, with digital processing, allows a high resolution output up to 0.1% with high stability too.

**Resonant control**

Control algorithms based on Resonant Control are used in the AC side. The regulation is structured in blocks resonating at a given frequency. Within the resonant frequency each block allows the suppression of gain and phase errors of the controlled magnitude: voltage, current, ...etc. Thanks to this, each harmonic can be controlled independently and thus it can be generated or suppressed, as needed.

**PID control**

The DC side control algorithm is based on a traditional PID controller which will be explained later.
3. INSTALLATION

3.1. Important safety instructions

As a device with class I protection against electric shocks, it is essential to install a protective earth wire (connect earth \[\text{\textbullet}\]). Connect the protection earth wire to the terminal (X5) before connecting the grid to the battery charger input.

All the electrical connections, including those for control (interface, remote control...etc.), shall be done with the switches in OFF position and with the mains supply disconnected (thermal-magnetic circuit breaker in OFF position too).

![Warning]

It must never be forgotten that the B2C is a power supply, so users must take all necessary precautions against direct or indirect contact.

Warning labels should be placed on all primary power switches installed in places far from the device to alert the electrical maintenance personnel of the presence of a voltage in the circuit up to 10 minutes after stopping the device.

In devices without isolation transformer, precautions must be taken as they are not isolated from the alternating input line, and there might be dangerous voltage between the battery terminals and the ground.

3.2. Equipment views

Electrical connections:

![Electrical Connections Diagram]

Local front panel:

![Local Front Panel Diagram]
Front view (with the door open):

Detailed view of the signal connectors:
General view (with the front door closed):

**Protection elements (Q*)**: 
- (Q1a) Input thermal-magnetic circuit breaker or disconnector according to power of the equipment.
- (Q2) Output disconnector.
- (Q3) Output fuses.

**Connection elements (X*)**: 
- (X1) Phase input terminal R.
- (X2) Phase input terminal S.
- (X3) Phase input terminal T.
- (X4) Neutral input terminal N.
- (X5) Earth connection terminal for main supply input (⚠).
- (X6) DC phase output terminal W.
- (X7) DC phase output terminal V.
- (X8) DC phase output terminal U.
- (X9) DC negative terminal N.
- (X10) Earth connection terminal for load or loads (⚠).
- (X11) DB9 connector for RS485 communications.
- **(X12)** Terminals for external Emergency Power Off (EPO) button.
- **(X13)** DB9 connector for CAN communications (input).
- **(X14)** DB9 connector for CAN communications (output).
- **(X15)** RJ45 connector for MODBUS interface.
- **(X16)** DE15 connector for digital inputs and outputs.
- **(X17)** DE15 connector for analogic inputs and outputs.

### 3.3. Equipment reception

#### 3.3.1. Unpacking and checking the content

On receiving the device, make sure that the power supply has not suffered any damage during the transportation. Otherwise, make all pertinent claims to the supplier or to CINERGIA.

The packing of the device consists of a wooden palette, a cardboard or wooden packaging (depending on the case), expanded polystyrene corner pieces, a polyethylene sleeve and bands; all recyclable materials. Therefore they should be disposed of according to current regulations. We recommend to keep the packaging in case its use is necessary in the future.

In order to unpack, cut the bands and remove the cardboard packaging with a vertical movement. In case of wooden packaging, remove it with the appropriate tools. Afterwards, remove the corner pieces and the plastic sleeve. At this point the equipment will be unpacked on the pallet. Please, use suitable tools to lower the power supply from the pallet.

After unpacking the equipment, check that the data in the nameplate (stuck on the inner part of the front door) correspond to those specified in the purchase order. Contact the supplier or CINERGIA in case of disconformity.

Keep the equipment in the original package if it will not be used in order to protect it from any possible mechanical damages, dust, dirt ...etc.

#### 3.3.2. Storage

The equipment shall be stored in a dry, ventilated place and protected against rain, water jets or chemical agents. It is advisable to keep the power supply into its original package, which has been designed to assure the maximum protection during the transport and storage.

**⚠️ Do not store the unit where the ambient temperature exceeds 40°C or falls below -20°C, as this may degrade the electrical characteristics of the batteries.**

#### 3.3.3. Transport to location

The equipment includes castors to facilitate its transport to its final location.

It is important to check previously if the weight of the power supply is appropriate for the site where it will be located.
It is also important to consider the most suitable means to place the power supply in its final location (floor, hoist, lift, stairs, etc).

3.3.4. Location

It is necessary to leave a minimum of 25 cm in the contour of the equipment for its ventilation. If possible, as shown in following figures, it is recommended to leave additional 75 cm to facilitate the operations of maintenance of the equipment or the interventions of the technical service in case of breakdown.
The equipment may be installed in any place as long as the safety and ventilation requirements are fulfilled.

The power supply includes 2 levelling elements located near the front castors, which serve to immobilize the unit once it is in place.

To adjust the level, open the front door of the cabinet and proceed as follows:

- By hand, loosen the levelling elements by turning them anticlockwise until they touch the floor, and then, using a spanner, continue loosening until the castors are raised off the floor by a maximum 0.5 cm.
- Close the door once more.
3.4. Connection

3.4.1. Earth protection

As a device with class I protection against electric shocks, it is essential to install a protective earth wire (connect earth △). Connect the protection earth wire to the terminal (X5) before connecting the grid to the B2C input.

On the other hand, connect the protection earth wire to the terminal (X10) before connecting the load to the battery charger output.

3.4.2. Input connection, terminals (X1 to X5)

Connect the grid cables R, S, T and N to the terminals (X1), (X2), (X3) and (X4) respectively. This connection must always be done according to the label placed under the input screw terminals.

In case of discrepancies between labelling and this manual instructions, the label information will always prevail.

3.4.3. Output connection, terminals (X6 to X10)

The equipment has 3 output channels (U, V and W) and a common negative return (N). Therefore, the load must be connected between the channels and the common negative return (phase-N):

- DC phase output terminal U (X8)
- DC phase output terminal V (X7)
- DC phase output terminal W (X6)
- DC negative terminal N (X9)

In case of discrepancies between labelling and this manual instructions, the label information will always prevail.

3.4.4. Emergency Power Off terminals (X12)

The equipment owns two terminals dedicated to external Emergency Power Off (EPO).

The EPO must act as a normally closed contact, and thus, there are two possible options for connection:

a) Connecting an external Emergency pushbutton to X12
b) Installing a cable bridge to close the circuit in terminal X12 (in case EPO is not desired)

If option a) is chosen, the procedure is as follows:

1. Emergency shutdown activation: the Emergency pushbutton must be set in the position in which it forces to open the circuit between the two terminals of X12.
2. Normal mode restoration: the Emergency pushbutton position must be inverted in order to close the circuit again between the two terminals of X12.
3.4.5. Communications

There are several connectors dedicated to communications, which are listed below:

- **Connector for RS485 communications (X11):** DB9 connector to be used when Modbus RS485 option is chosen.

- **Connectors for CAN communications (X13, X14):** DB9 connectors to be used when parallelization of battery chargers is needed (X13 works as input and X14 works as output).

- **Connector for MODBUS interface (X15):** RJ45 connector. A standard Ethernet cable must be connected between X15 and a Hub or a Router to communicate a remote PC with the battery charger.

3.4.6. Digital inputs and outputs

Digital inputs and outputs are gathered in X16. All of them are isolated and configurable.

Specifically, there are 5 digital inputs which operate at 24 V and 3 relay digital outputs.
3.4.7. Analog inputs and outputs

Analog inputs and outputs are gathered in X17.

The analog inputs of B2C are isolated and accept a voltage range from -10 to 10V. There are 3 analog inputs and, depending on the connection mode, there are two possible configurations for them:

- **Parallel channels**: the analog input Analog_In_1 is the reactive power command and the Analog_In_2 depends on the power supply operation mode.

- **Independent channels**: there is no reactive power command and each analog input corresponds to one phase. Their functionality depends on the power supply operation mode.

As it has been previously mentioned, an analog input can be configured as one magnitude (current, voltage...etc.) setpoint of a specific output channel. In this case, the magnitude in question of the output channel is proportional to the voltage of the respective analog input. For example, in independent current mode, for a 10 V analog input, the current of the respective output channel will be the maximum that the B2C withstands (see catalogue).

Regarding analog outputs, they are also isolated and accept a voltage range from 0 to 10 V. Analogously to inputs, there are 3 analog outputs and each one corresponds to one different output channel scaled magnitude.
4. OPERATION

4.1. Safety

Before operating the equipment, check that the Protective Earth is properly connected.

Check out the electrical installation in both sides (input and output) of the cabinet. All wires shall be connected and secured before proceeding to the power supply start-up.

4.2. State Machine

The operation of the power supply is based on 6 different states (square) and 5 transitions (rhombs). Each state defines the behaviour and possible operations of the power supply.
4.2.1. Initialization

During the initialization, the power supply control system checks the presence of all internal components, the embedded PC loads the operating system and the isolation detector runs a self-test.

No voltage is present at the DC bus and the IGBTs PWMs are completely stopped.

The transition from Initialization state brings the power supply to the Standby state as long as the emergency stop is deactivated (equipment armed) and the isolation detector performs a complete self-test successfully.

4.2.2. Standby

The Standby state keeps the power supply in low power mode until an Enable signal is received. While the power supply is in standby only the internal power supplies are energized. In particular, this means that there is no voltage in the DC link and no voltage/current is applied to the output of the power supply.

The transition from the Standby state is the Enable signal or, in case of errors, a Fault signal. The Enable signal will bring the State Machine to Precharge and eventually to the Ready state. If an error is detected the power supply will go into Alarm state.

4.2.3. Precharge

The Precharge is an internal transition state between Standby and Ready. During this state the DC link is gradually charged through resistors until the rated DC link voltage is reached. The transition will finish successfully as long as, in less than 10 seconds of precharge, the DC link has reached the specified voltage. Otherwise, the next state will be Alarm.

The Precharge state is only applicable to the grid side converter.

4.2.4. Ready

In the Ready state the power supply is ready to operate but no PWM signal is sent to IGBTs. The DC bus is charged to the rectified voltage and there is no voltage/current applied to the outputs.

The transition from Ready state can be the Run signal, the Not enable signal or, in case of errors, a Fault signal. When a Run signal is received the State Machine will evolve to the Run state. When a Not enable signal is received the State Machine puts the power supply on standby, thus discharging the DC link capacitors. If a fault is detected the power supply goes to Alarm state.

4.2.5. Run

In this state, the power supply is completely operational. Due to the power supply architecture, the grid side converter (Active Rectifier) will make the transition first while
stabilizes the DC link voltage. After that, the output side will measure the actual output state (voltage levels) and will start the control algorithms and PWM.

This state can evolve to Standby state when a Not enable signal is received, to Ready state when a Not run signal is received or to Alarm state if an error condition is detected.

Please, note that, while the power supply is in Run state, it is not possible to change the connection mode from independent channels to parallelized channels.

4.2.6. Alarm

In this state, the power supply is stopped and kept in a safe condition: the DC link is discharged and the PWM signals are stopped.

The Alarm state can be reached by any fault detected during the normal operation of the power supply, for instance, an emergency stop activation (see Alarms chapter for further detail).

The only possible transition from Alarm state is to Initialization state. Once in Alarm state a Reset signal is required from the customer after clearing the fault condition. If the fault condition has not been cleared the power supply state will be kept in Alarm (for example, when heatsink overheating has occurred and the temperature is still high).

4.3. Operation modes

The Bidirectional battery charger has 4 operation modes:

- **Constant Current mode (CC):** the power supply regulates the output current to the setpoint defined by the user.
- **Constant Voltage mode (CV):** the power supply regulates the output voltage to the setpoint defined by the user.
- **Constant Power mode (CP):** the power supply regulates the output power to the setpoint defined by the user.
- **Battery Charge mode (BC):** the power supply regulates the output current and voltage to charge a battery following the configuration profile defined by the user.

4.3.1. Current mode

The current mode is based on a PID controller with dynamic saturation limits which depend on the current limit configured. Find below the current regulation block diagram:
The user can configure:

- **Amplitude**: desired output current value.
- **Sign**: a positive sign represents a current sourced from the power supply. A negative sign represents a current sunk by the power supply.

![Current Control](image)

- **Setpoint limitation**: this limitation can be lower than the maximum power supply output current. It can be useful when the power supply is connected to batteries since they may have different current limits for charging and discharging and those limits may be lower than the maximum power supply current.

Depending on the loads connected, the voltage limitation may be useful too and is available in any mode.

![Charging Current](image)

**4.3.2. Voltage mode**

The voltage mode is based on a PID controller with dynamic saturation limits which depend on the current limit configured. The power supply will limit the output current in case of reaching the configured limit.
The user can configure:

- **Amplitude**: desired output voltage value.

- **Sign**: the output voltage between channels U,V,W is always positive with respect to N. No negative voltages can be set.

- **Setpoint limitation**: the maximum current may be controlled in this operation mode. The maximum available voltage will affect to the limit of the voltage setpoint given, but it will not be controlled. Therefore, in those applications where the load imposes a higher voltage than the maximum available, the power supply will trigger an overvoltage alarm.

### 4.3.3. Power mode

The power mode is implemented with a current PID. In this case, taking into account that the power equals to V·I, a linear controller may not be the optimum option to close this control loop. Consequently, in order to take advantage of the PID controller benefits, a linearization is made by dividing the power command by the output voltage of the power supply.
As in current mode case, the user can configure:

- **Amplitude**: desired output power value.
- **Sign**: a positive sign represents a current sourced from the power supply. A negative sign represents a current sunk by the power supply.
- **Setpoint limitation**: this limitation can be lower than the maximum power supply output current. It can be useful when the power supply is connected to batteries since they may have different current limits for charging and discharging and those limits may be lower than the maximum power supply current.

Depending on the loads connected, the voltage limitation may be useful too. However, there is no voltage control; only an alarm is triggered if the power supply voltage is beyond the limits set by the user.

### 4.3.4. Battery charge

The battery charge controller is based on an inner-loop current regulation and an outer-loop voltage regulation. This provides the power supply with the stability needed for controlling voltage and current during all the charging process.

The battery charge procedure has three states:

1. **Constant current phase**: the battery is charged at the constant current value configured by the user (recommended by the battery manufacturer) until a specified voltage is reached (the boost voltage or the equalizing voltage). The user can define this value in the HMI parameter *Recommended Charging Current*.
2. **Constant voltage phase:** in this phase the battery is charged at a constant voltage determined by CW (0: Boost Charge, 1: Equalizing Charge). As a consequence the charge current decreases at a rate imposed by the battery. The user can define the boost voltage value in the HMI parameter *Battery Boost Voltage* and the equalizing voltage in the parameter *Equalization Battery Voltage*.

3. **Floating charge phase:** a constant voltage is applied to compensate the battery self-discharge. Therefore, this phase allows to keep the battery fully charged without overcharging it. The user can define this value in the HMI parameter *Battery Floating Voltage*.

The current phase of the charging procedure is shown in *Battery Status Word* in the HMI:

<table>
<thead>
<tr>
<th>Battery Status Word</th>
<th>Cint I</th>
<th>Cint I</th>
<th>Cint I</th>
<th>Cint I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery Status Word</td>
<td>Cint I</td>
<td>Cint I</td>
<td>Cint I</td>
<td>Cint I</td>
</tr>
<tr>
<td>Battery Status Word</td>
<td>Boost</td>
<td>Boost</td>
<td>Boost</td>
<td>Boost</td>
</tr>
<tr>
<td>Battery Status Word</td>
<td>Full</td>
<td>Full</td>
<td>Full</td>
<td>Full</td>
</tr>
</tbody>
</table>

### 4.3.4.1. Boost Charge

Boost charging allows the quick charging of the batteries. A high voltage is applied to reach 80-90% of the battery capacity in a relatively short time.

The constant voltage phase is divided into 2 substates:

- **Boost:** the power supply raises the topping voltage in order to reduce the charging time. The transition occurs by time (*Max time in Boost*) or by reaching configured current value (*[A] for leaving boost mode*).

- **Full:** the power supply keeps the voltage at its recommended charging value. This state transition is also by time (*Max time in Full*) or it happens when a configured current is reached (*[A] for leaving full mode*).

The following diagram shows the whole process for Boost charging:
4.3.4.2. Equalizing Charge

Equalizing charge is an operation required for preventive maintenance of the battery system. This charge brings all cells to similar voltage levels. Please refer to the battery manufacturer technical sheet for recommended maintenance periods and voltages. Equalize the batteries at least every six months.

To equalize manually the batteries write “1” to CW for *equalization mode* while the power supply is in the constant current phase. The constant equalization voltage phase transition is by time (*Max time in Equalizing*) or by reaching the configured current value (*[A] for leaving equalizing mode*).

The following diagram shows the whole process of Equalizing charge:

![Equalizing Charge Diagram]

Please read carefully the instructions and safety manual of the battery manufacturer in order to configure correctly the voltage settings (float, boost, equalizing, etc...). Wrong settings may lead to battery damage and hazard.
4.3.5. Programmable limits

In constant current, constant voltage and constant power modes the maximum current and maximum voltage of the power supply can be limited too. The user can configure these values through the HMI:

![DCDC limits table]

**Current**

When the power supply reaches the configured value, the output current will be regulated to the limit defined. This limitation can be useful to protect a load with a maximum allowable current below the maximum current of CINERGIA power supply. For instance, to protect a battery against excessive discharge in constant current mode.

**Voltage**

The voltage protection differs from the current protection in that the output voltage will not be regulated. When the voltage reaches the maximum or minimum voltage defined by the user, an alarm will be triggered and the power supply will be stopped in alarm state (**DC Overvoltage** or **DC Undervoltage**).

4.4. Connection modes

As it has been previously mentioned, there are two different ways of connecting the power supply output:

- **Independent mode**: each output channel is connected to an independent load. In this way, the power supply could, for instance, charge three independent battery systems at the same time with different capacities, voltages, currents, etc.

  Please be sure that no electrical connection between the channels exists, i.e. that the loads are completely independent. Keep in mind that, if two channels are interconnected, a shortcircuit may appear in voltage based modes.

- **Parallel mode**: all three channels are connected in parallel to increase the maximum power supply output current. It is mandatory to shortcircuit by hardware the three output channels. All operation modes are available in this connection mode.

- **Four quadrant mode**: the four quadrant mode is a particular case of the independent mode in which the power supply may only be operated as a voltage source. In this case
the load is connected only between phases without any reference to the N phase. As far as the load has no reference to the negative phase, the connected phases may be charged at any potential (keep it in mind).

In order to operate the output phases, Cinergia recommends a start-up voltage of 200V for each connected phase. From this initial voltage, sum the desired setpoint divided by 2 to one phase and subtract the same value to the other phase.

Changing the polarity of the load implies switching the setpoint values in the phases.

Due to the blanking time of the IGBTs, it is not possible to operate in this mode with voltages near 0V.

Please remember to disconnect the equipment before modifying the connection mode.

4.5. Working with the equipment

Before powering the cabinet check step by step the following items (if the cabinet is powered for the first time, place the fuses in the fuseholder before proceeding):

- The power supply output must be disconnected:

- The grid side of the power supply is protected by a thermal-magnetic circuit breaker. Be sure that this breaker is switched off:
• Check that all wires are connected and secured before proceeding to the power supply start-up.

If these steps are validated the power supply is ready to be started.

4.5.1. Start-up

Switch on the thermal-magnetic circuit breaker of the grid side of the power supply. After switching it on, the power supply will initiate the start-up sequence. This sequence will activate the cabinet fans for one second and, if an internal isolation transformer is used, an internal relay for the transformer precharge will also be activated.

At this point the power supply will start the initialization process, as described before. During this time the embedded PC will load the operating system and the communications program. The isolation detector will also perform a self-test before being operative. The power supply will ignore any command during this process.

The Initialization state can last up to 15 seconds. If every step is completed successfully the power supply will move automatically to Standby state.

Summarizing, to put the equipment in Run state the user should follow step by step the next checklist:

1. Connect the mains.
2. Turn on the input thermal-magnetic circuit breaker.
3. Activate the cabinet output by switching the disconnector.
4. Deactivate the emergency stop (pull out the button). \((Initialization \rightarrow Standby)\)
5. Send the Enable signal. \((Standby \rightarrow Precharge \rightarrow Ready)\)
6. Select the connection mode between independent or parallel. This option cannot be undone while the power supply is running.
7. Select the operation mode. Please keep in mind that not all loads are compatible with all operation modes. For example, if the power supply is acting like a voltage source, do not connect any other voltage sources at the output.
8. Send the Run signal. \((Ready \rightarrow Run)\)

Please keep in mind that not all loads are compatible with all operation modes. If the power supply is operated as a voltage source, please do not connect any other voltage sources at the output. If the power supply is operated as a current source, please do not connect any other current sources at the output.
4.5.2. Stop

Once the equipment is running (Run state) it may be stopped in three ways:

4.5.2.1. Full stop

This type of stop is recommended if the electrical connections are to be modified or the power supply will be stopped for a long time.

When the power supply is running, special care must be taken. It is strongly recommended to follow the next steps:

1. Send the Not enable signal to the power supply (Run $\rightarrow$ Ready $\rightarrow$ Standby)
2. Press the emergency stop button (Standby $\rightarrow$ Alarm)
3. Disconnect the output disconnector
4. **Wait at least 60 seconds** (time to get discharged the internal DC link capacitors)
5. Disconnect the input thermal-magnetic circuit breaker

*Before manipulating the cables in the cabinet terminals, please check the voltages with a voltmeter to assure no voltage is present. The grid cable and the load must be completely unpowered before connecting or disconnecting the cables. The user must be sure that the input and output switches are both in OFF position.*

4.5.2.2. Standby stop

This type of stop is recommended if the power supply will be stopped during some hours. The DC link is discharged and therefore aging of the DC bus capacitors is prevented.

Send the Not enable signal to the power supply. If the user wants to lock the power supply in order to avoid an accidental start-up, press the emergency stop button, and keep it pressed.

For restarting operation, release the emergency stop button and send the Reset signal. After doing this, proceed as a standard start-up sending the Enable signal.

**NEVER** connect or disconnect the cables while the power supply in Standby state.

4.5.2.3. Ready

This type of stop is recommended if the power supply will be stopped for a short time. The DC link is kept charged and the power supply is ready to run.

When the power supply is running, the user may send the Not run signal at any time. This will stop the IGBT’s PWM signals but all internal parts will be kept powered. To restart operation, send the Run signal.
NEVER connect or disconnect the cables while the power supply is in Ready state.

4.5.3. Emergency stop

The emergency stop button may be pressed at any time bringing the power supply to the Alarm state. The emergency stop shall be only used when an emergency is detected. Please, avoid to stop the equipment with the emergency button as a “normal practice” since it will contribute to premature component aging. To lock the power supply and bring it to the Alarm state, follow the Full stop procedure.

The emergency stop unpowers all the electromechanical devices in the cabinet so the power supply is stopped by hardware assuring a full stop. The internal contactors will be open so no power will be present at the DC link or at the output of the power supply. Only the control boards, the embedded PC and the local touchscreen remain powered.

4.5.4. Accidental shut down

When the power supply is suddenly disconnected from the mains special care must be taken for restarting it. When the power supply is shut down with a charged DC link, some thermal protections of the internal power supplies will prevent its start-up.

When an accidental shutdown happens, disconnect the mains and wait for at least 2 minutes for powering the cabinet again.

4.5.5. Alarms

There are different sources of alarm in the power supply. The following table describes them and offers possible causes and solutions to the user.

<table>
<thead>
<tr>
<th>Code</th>
<th>Name</th>
<th>Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Watchdog</td>
<td>Internal microcontroller error.</td>
<td>If this alarm persists, contact Cinergia’s technical support.</td>
</tr>
<tr>
<td>2</td>
<td>Emergency sequence</td>
<td>The emergency stop button is activated or the EPO wire in no longer connected.</td>
<td>Unpress the emergency stop button or reconnect the EPO wire.</td>
</tr>
<tr>
<td>3</td>
<td>Drivers</td>
<td>IGBTs saturation protection has been activated. This alarm is triggered when there is a sudden overcurrent in the power</td>
<td>Contact Cinergia for technical support if this alarm persists. Check the equipment under test before restarting the power</td>
</tr>
<tr>
<td>No</td>
<td>Condition</td>
<td>Description</td>
<td>Action</td>
</tr>
<tr>
<td>----</td>
<td>-----------</td>
<td>-------------</td>
<td>--------</td>
</tr>
<tr>
<td>4</td>
<td>Precharge timeout</td>
<td>Internal error caused by a low voltage in mains.</td>
<td>Check the grid voltage.</td>
</tr>
<tr>
<td>5</td>
<td>Overload in precharge</td>
<td>Internal alarm caused by a shortcircuit.</td>
<td>Contact Cinergia for technical support.</td>
</tr>
<tr>
<td>6</td>
<td>Overvoltage in the DC link</td>
<td>The DC link voltage has exceeded its maximum value.</td>
<td>Reduce the DC output step transition time. Contact Cinergia for technical support if this alarm persists.</td>
</tr>
<tr>
<td>7</td>
<td>Undervoltage in the DC link</td>
<td>Undervoltage in the DC link caused by fast output transient.</td>
<td>Reduce the DC output step transition time. Contact Cinergia for technical support if this alarm persists.</td>
</tr>
<tr>
<td>8</td>
<td>Phase overvoltage</td>
<td>The voltage in the grid is too high.</td>
<td>Check the grid voltage.</td>
</tr>
<tr>
<td>9</td>
<td>Phase undervoltage</td>
<td>The voltage in the grid is too low.</td>
<td>Check the grid voltage.</td>
</tr>
<tr>
<td>10</td>
<td>DC Overcurrent</td>
<td>The output current has exceeded the configured limitation.</td>
<td>Check the output load.</td>
</tr>
<tr>
<td>11</td>
<td>Heatsink overtemperature</td>
<td>Overtemperature in the heatsink.</td>
<td>Check enough space exists between the power supply and the wall. There is insufficient air flow inside the power supply. Check that the fans are working correctly.</td>
</tr>
<tr>
<td>11</td>
<td>Sensor offset</td>
<td>Error caused by transducers malfunction.</td>
<td>Turn off the equipment, wait one minute, and turn it on again. This alarm can occur when the power supply is switched off accidentally under load. Otherwise, contact Cinergia for technical support.</td>
</tr>
<tr>
<td>12</td>
<td>No Heart Beat</td>
<td>Communication cable broken or control board failure.</td>
<td>Contact Cinergia in order to isolate the problem.</td>
</tr>
</tbody>
</table>
without response.

13 PLL error The frequency of the grid is too high or low. Check the grid frequency.

14 Mains lost There is no voltage on the grid (short interruption or voltage dip). Check the grid voltage.

15 Open loop The power supply has reached the maximum voltage in current or power operation mode. The load is not connected or its impedance is too high for the current setpoint.

16 Isolation The isolation detector has detected a fault in the galvanic isolation. Check if isolation fault disappears when the power supply has no load connected to the output. If it does, the isolation problem is in the load. If it does not, contact Cinergia.

17 Overload The power supply is working beyond its rated values. Check the parameters configured.

18 Shortcircuit The power supply has detected a shortcircuit in the equipment under test. Check the equipment under test impedance.

4.5.6. Alarms reset

The user shall follow the next steps for resetting the alarms:

- Press the emergency stop button.
- Send a Reset signal to the power supply.
- Send a Not enable and Not run signals (note: this step is done automatically when the user is interfacing the power supply by the LCD or by the software provided by Cinergia).
- Proceed as a standard start-up process by deactivating the emergency stop (pull out the button).

A Reset will be performed only in the case that the alarm source has been cleared. If the problem persists after resetting the power supply, a new alarm will be triggered.
5. LOCAL TOUCHSCREEN CONTROL PANEL

5.1. Basic functions

The LCD touchscreen main purpose is to provide the user with the necessary information about the battery pack and the power converters. Besides, the touchscreen allows the user to interact with the mother board and control multiple variables in regard to the DC power output of the power converters.

By means of the black bar in the upper side of the touchscreen, the user is constantly aware of the following variables:

- Control
- Mode
- State of the power converters

The rest of information can be found throughout the menus and submenus.

5.2. Menus and submenus

5.2.1. General

There are four main menus:

- Operational
- Battery pack
- Configuration
- Alarms

A description of each one can be found in the following points.
5.2.2. Operational

The main purpose of the Operational menu is, in case the LCD Control is activated, to allow the user to manage the power converters State Machine and to introduce current, voltage and both active and reactive power setpoints.

The user gets to read the following information as well:

- Connection mode
- Output voltage
- Output current
- Output active power
- Reactive power

**State Machine**

By means of the **ENABLE** and **RUN** buttons the user can manage the power converters State Machine as long as the Control variable is set to LCD.

- **ENABLE:** the function of this button depends on the power converters state:
  - **Standby State:** the **ENABLE** button is released. By pressing the **ENABLE** button the user orders the system to move to the Ready state.
  - **Ready & Run States:** the **ENABLE** button is pressed. By pressing the **ENABLE** button the user orders the system to disable the power converters.

  The **ENABLE** button has no effect in every other state.

- **RUN:** the function of this button depends on the power converters state:
  - **Ready State:** the **RUN** button is released. By pressing the **RUN** button the user orders the system to move to Run State.
  - **Run State:** the **RUN** button is pressed. By pressing the **RUN** button the user orders the system to return to Ready State.

  The **RUN** button has no effect in every other state.
**Commands**

The button *COMMANDS* allows the user to introduce different setpoints:

- Voltage setpoints
- Current setpoints
- Active power setpoints

Once again, this function is only permitted when the Control variable is set to LCD. Information about the different kinds of setpoints that the user can introduce through the touchscreen can be found below. When the *COMMANDS* button is pressed, the following keyboard will appear.

![Keyboard](image)

The kind of setpoint to introduce will depend on the operation mode (Constant Voltage, Constant Current, Constant Power or Charger) and the connection mode (Independent or Parallel). The procedure to send a setpoint consists of the following steps:

1. Press *COMMANDS* button.
2. Introduce the first setpoint and press *Enter*.
3. Introduce the second setpoint and press *Enter*.
4. Introduce the third setpoint and press *Enter*.
5. Press *SEND* button.

If the user needs to erase the current setpoint being edited, the *Cancel* button (grey one) sets it to zero.
In case the user wants to set a negative setpoint, this can be made by pressing the button +/-.

The Cancel button (green one) can be pressed anytime to return to the Operational menu without sending any setpoint.
**Voltage setpoint**
The user can introduce an independent voltage setpoint per every channel.

**Current setpoint**
The user can introduce an independent current setpoint per every channel.

**Active power setpoint**
The user can introduce an independent power setpoint per every channel.

**SET REACTIVE**
The SET REACTIVE button allows the user to introduce a global reactive power setpoint. The procedure to follow is the same as with the COMMANDS button. Regardless the current mode, the user is allowed to enter the desired reactive setpoint.

5.2.3. Battery Pack

The Battery Pack window is exclusively informative. By means of the scrolling buttons the user can change the current screen and thereby, the information to visualize.

![Battery Pack Window](image)

The user may check the following battery bank variables in the first screen:

- Charge stage
- Voltage
In the second screen the following variables are accessible:

- State of charge
- Battery errors

5.2.4. Configuration

The Configuration window provides the user with some helpful information about the following variables:

- Connection mode
- Mode
- Control

By means of the upper buttons shown, the user may manage these variables in case the current Control variable is set to LCD.
**Connection mode**

The following screen appears when the user presses the *Connection mode* button:

In case the Control variable is set to LCD, the user may change the current connection mode. Two types are available for the user to choose:

- Independent
- Parallel

Pressing the *BACK* button the user can return to the main Configuration window.

**Mode**

The following screen appears when the user presses the *Mode* button:

In case the Control variable is set to LCD, the user may change the current mode. Four types of mode are available for the user to choose:

- Constant V
- Constant C
- Constant P
- Charger
Pressing the *BACK* button the user can return to the main Configuration window.

**Control**

The following screen appears when the user presses the *Control* button:

![Control Screen](image)

In case the Control variable is set to LCD, the user may change the current control mode. Three types of control mode are available for the user to choose:

- LCD
- Modbus
- Analog input

Pressing the *BACK* button the user can return to the main Configuration window.

**5.2.5. Alarms**

The Alarms window displays information about the power converters alarms. Any existing alarm will appear in this window.

![Alarms Screen](image)

In case the user is willing to reset the system, the *RESET* button permits him to do so.
6. REMOTE COMMUNICATIONS

CINERGIA’s power supplies can be operated and supervised remotely through an Ethernet communications bus. An internal embedded PC, with CINERGIA’s proprietary software, allows the exchange of information between the internal CAN bus and the external Modbus TCP/IP (Ethernet). In this way, the customer can build specific HMI client software application while CINERGIA’s power supply acts as a Modbus TCP/IP server.

This Modbus TCP/IP slave has the following properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Function Codes:</strong></td>
<td>0x04: READ_INPUT_REGISTER</td>
</tr>
<tr>
<td></td>
<td>0x03: READ_HOLDING_REGISTER</td>
</tr>
<tr>
<td></td>
<td>0x10: WRITE_MULTIPLE_REGISTER (Note: only 2 registers Write is allowed)</td>
</tr>
<tr>
<td><strong>CRC</strong></td>
<td>Not used. Included in the TCP stack.</td>
</tr>
<tr>
<td><strong>Multiple connections</strong></td>
<td>Only one master at one time allowed. Additional connection requests might be delayed or even rejected.</td>
</tr>
<tr>
<td><strong>Idle connections</strong></td>
<td>Idle connections might be closed by the slave. However, the listen socket will force the master to keep the connection active, even when there is no active connection at all.</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>All variables are 32 bits long (2 registers). Their MODBUS addresses are 1 register long each one. All Read operations must start at the beginning of one variable, and must read an even number of registers. As for Write operations, ONLY 1 WRITE OPERATION OF 1 VARIABLE IS ALLOWED AT ONE TIME.</td>
</tr>
</tbody>
</table>

The memory map is as follows:
<table>
<thead>
<tr>
<th>Variable</th>
<th>MODBUS Address (dec)</th>
<th>Size</th>
<th>ACCESS</th>
<th>TYPE</th>
<th>MIN</th>
<th>MAX</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR_VRS</td>
<td>154</td>
<td>2</td>
<td>RO</td>
<td>IQ21</td>
<td>0</td>
<td>_IQ(440.0)</td>
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<td>AR_VST</td>
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<td>AR_VTR</td>
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<td>AR_IR</td>
<td>170</td>
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<td>AR_IS</td>
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<td>_IQ(-100.0)</td>
<td>_IQ(100.0)</td>
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<td>AR_IT</td>
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<td>_IQ(100.0)</td>
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<td>AR_FR</td>
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<td>_IQ(440)</td>
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<td>_IQ(440)</td>
<td>Frequency PhS</td>
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<td>IQ21</td>
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<td>_IQ(440)</td>
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<td>_IQ(175.0)</td>
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<td>AR_TEMPOUT</td>
<td>190</td>
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<td>_IQ(-10.0)</td>
<td>_IQ(175.0)</td>
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<td>AR_HOBDESCW</td>
<td>220</td>
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<td>226</td>
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<td>232</td>
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<td>_IQ10(-2000000)</td>
<td>_IQ10(2000000)</td>
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<td>_IQ10(2000000)</td>
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<td>AR_READQT</td>
<td>242</td>
<td>RO</td>
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<td>_IQ10(-2000000) _IQ10(2000000)     // Reactive Power T</td>
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<td>AR_SETQ0</td>
<td>256</td>
<td>RW</td>
<td>IQ10</td>
<td>_IQ10(-2000000) _IQ10(2000000)     // Reactive Power (Set-Point)</td>
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<tr>
<td>DCDC_VAB</td>
<td>296</td>
<td>RO</td>
<td>IQ21</td>
<td>0 _IQ(440.0)                       // Voltage PhA-PhB</td>
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<td>DCDC_VBC</td>
<td>298</td>
<td>RO</td>
<td>IQ21</td>
<td>0 _IQ(440.0)                       // Voltage PhB-PhC</td>
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<td>DCDC_VCA</td>
<td>300</td>
<td>RO</td>
<td>IQ21</td>
<td>0 _IQ(440.0)                       // Voltage PhC-PhA</td>
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<td>DCDC_VAN</td>
<td>304</td>
<td>RO</td>
<td>IQ21</td>
<td>0 _IQ(440.0)                       // Voltage PhA-NEG</td>
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<tr>
<td>DCDC_VBN</td>
<td>306</td>
<td>RO</td>
<td>IQ21</td>
<td>0 _IQ(440.0)                       // Voltage PhB-NEG</td>
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<td>IQ21</td>
<td>0 _IQ(440.0)                       // Voltage PhC-NEG</td>
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<td>DCDC_IA</td>
<td>312</td>
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<td>IQ21</td>
<td>_IQ(-100.0) _IQ(100.0)            // Current PhA</td>
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<td>DCDC_IB</td>
<td>314</td>
<td>RO</td>
<td>IQ21</td>
<td>_IQ(-100.0) _IQ(100.0)            // Current PhB</td>
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<tr>
<td>DCDC_IC</td>
<td>316</td>
<td>RO</td>
<td>IQ21</td>
<td>_IQ(-100.0) _IQ(100.0)            // Current PhC</td>
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<tr>
<td>DCDC_VDC</td>
<td>326</td>
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<td>IQ21</td>
<td>0 _IQ(850.0)                       // DC link Voltage</td>
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<tr>
<td>DCDC_TEMPOUT</td>
<td>332</td>
<td>RO</td>
<td>UINT32</td>
<td>0 0X7FFFFFFF                        // DCDC Errors Vector</td>
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<tr>
<td>DCDC_ERRORIRMS</td>
<td>340</td>
<td>RO</td>
<td>IQ21</td>
<td>0 _IQ(80.0)                        // Error limit RMS Current</td>
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<tr>
<td>DCDC_ERRORIPIC</td>
<td>344</td>
<td>RO</td>
<td>IQ21</td>
<td>_IQ(0) _IQ(100)                    // Error limit Peak Current</td>
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<td>DCDC_ERRORVAC</td>
<td>346</td>
<td>RO</td>
<td>IQ21</td>
<td>_IQ(0) _IQ(620)                    // Error limit Voltage Output</td>
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<td>DCDC_ERRORVDC</td>
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<td>RO</td>
<td>IQ21</td>
<td>_IQ(0) _IQ(800)                    // Error limit DC link voltage</td>
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<td>DCDC_ALARMIRMS</td>
<td>352</td>
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<td>IQ21</td>
<td>0 _IQ(70.0)                        // Alarm limit RMS current</td>
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<td>DCDC_ALARMIPIC</td>
<td>354</td>
<td>RO</td>
<td>IQ21</td>
<td>_IQ(0) _IQ(80)                     // Alarm limit Peak current</td>
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<td>DCDC_ALARMVAC</td>
<td>356</td>
<td>RO</td>
<td>IQ21</td>
<td>_IQ(0) _IQ(580)                    // Alarm limit Voltage Output</td>
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<td>DCDC_ALARMVDC</td>
<td>358</td>
<td>RO</td>
<td>IQ21</td>
<td>_IQ(0) _IQ(750)                    // Alarm limit DC link voltage</td>
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<tr>
<td>DCDC_HOBDESCW</td>
<td>362</td>
<td>RO</td>
<td>UINT32</td>
<td>0 0X7FFFFFFF                        // DCDC Control Word</td>
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<tr>
<td>DCDC_HOBDESSW</td>
<td>364</td>
<td>RO</td>
<td>UINT32</td>
<td>0 0X7FFFFFFF                        // DCDC Status Word</td>
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<td>DCDC_READPO</td>
<td>368</td>
<td>RO</td>
<td>IQ10</td>
<td>_IQ10(-2000000) _IQ10(2000000)     // Active Power global</td>
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<tr>
<td>DCDC_READPA</td>
<td>370</td>
<td>RO</td>
<td>IQ10</td>
<td>_IQ10(-2000000) _IQ10(2000000)     // Active Power A</td>
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</tr>
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<td>DCDC_READPB</td>
<td>372</td>
<td>RO</td>
<td>IQ10</td>
<td>_IQ10(-2000000) _IQ10(2000000)     // Active Power B</td>
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<td>374</td>
<td>2</td>
<td>RO</td>
<td>IQ10</td>
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<td>_IQ10(2000000)</td>
<td>// Active Power C</td>
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<td>2</td>
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<td>_IQ10(-2000000)</td>
<td>_IQ10(2000000)</td>
<td>// Active Power global (Set-Point)</td>
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<td>2</td>
<td>RW</td>
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<td>_IQ10(-2000000)</td>
<td>_IQ10(2000000)</td>
<td>// Active Power A (Set-Point)</td>
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<td>DCDC_SETPB</td>
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<td>2</td>
<td>RW</td>
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<td>_IQ10(2000000)</td>
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<td>_IQ10(2000000)</td>
<td>// Active Power C (Set-Point)</td>
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<td>DCDC_BATSTATUSWORDGL</td>
<td>410</td>
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<tr>
<td>DCDC_BATERROWORDGL</td>
<td>412</td>
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<td>RO</td>
<td>UINT32</td>
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<td>0X7FFFFFFF</td>
<td>// Battery Error Word (parallelized)</td>
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<tr>
<td>DCDC_ALARMBATGHGL</td>
<td>414</td>
<td>2</td>
<td>RW</td>
<td>IQ21</td>
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<td>0X7FFFFFFF</td>
<td>// Battery High Voltage Alarm (parallelized)</td>
</tr>
<tr>
<td>DCDC_ALARMBATLGL</td>
<td>416</td>
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<td>RW</td>
<td>IQ21</td>
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<td>0X7FFFFFFF</td>
<td>// Battery Low Voltage Alarm (parallelized)</td>
</tr>
<tr>
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<td>RW</td>
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<td>// Battery Max Charging Current Alarm (parallelized)</td>
</tr>
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<td>DCDC_ALARMBATMINCHGL</td>
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<td>RW</td>
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<td>0X7FFFFFFF</td>
<td>// Battery Max Discharging Current Alarm (parallelized)</td>
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<td>422</td>
<td>2</td>
<td>RW</td>
<td>IQ21</td>
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<td>0X7FFFFFFF</td>
<td>// Recommended charging current (parallelized)</td>
</tr>
<tr>
<td>DCDC_SETCHVGL</td>
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<td>2</td>
<td>RW</td>
<td>IQ21</td>
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<td>0X7FFFFFFF</td>
<td>// Equalization battery voltage (parallelized)</td>
</tr>
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<td>DCDC_FLOATINGVGL</td>
<td>426</td>
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<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>0X7FFFFFFF</td>
<td>// Floating voltage (parallelized)</td>
</tr>
<tr>
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<td>428</td>
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<td>RW</td>
<td>IQ10</td>
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<td>0X7FFFFFFF</td>
<td>// Battery capacity (parallelized)</td>
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<td>430</td>
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<td>UINT32</td>
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<td>0X7FFFFFFF</td>
<td>// Battery State of Charge (parallelized)</td>
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<td>0X7FFFFFFF</td>
<td>// Battery DC voltage measured (parallelized)</td>
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<td>434</td>
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<td>RO</td>
<td>UINT32</td>
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<td>0X7FFFFFFF</td>
<td>// Battery Drain Current measured (parallelized)</td>
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<td>436</td>
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<td>RO</td>
<td>IQ10</td>
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<td>0X7FFFFFFF</td>
<td>// Ah measured (parallelized)</td>
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<td>// Time measured (parallelized)</td>
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<td>442</td>
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<td>RO</td>
<td>UINT32</td>
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<td>// Battery Status Word A</td>
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<td>DCDC_BATERROWORDA</td>
<td>444</td>
<td>2</td>
<td>RO</td>
<td>UINT32</td>
<td>0</td>
<td>0X7FFFFFFF</td>
<td>// Battery Error Word A</td>
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<tr>
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<td>446</td>
<td>2</td>
<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>0X7FFFFFFF</td>
<td>// Battery High Voltage Alarm A</td>
</tr>
<tr>
<td>DCDC_ALARMBATLA</td>
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<td>RW</td>
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<td>// Battery Low Voltage Alarm A</td>
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<td>450</td>
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<td>RW</td>
<td>IQ21</td>
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<td>0X7FFFFFFF</td>
<td>// Battery Max Charging Current Alarm A</td>
</tr>
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<td>452</td>
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<td>RW</td>
<td>IQ21</td>
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<td>0X7FFFFFFF</td>
<td>// Battery Max Discharging Current Alarm A</td>
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<td>Bit Position</td>
<td>Read/Write</td>
<td>Data Type</td>
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<td>DCDC_SETCHIA</td>
<td>454</td>
<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>0x7fffffff // Recommended charging current A</td>
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</tr>
<tr>
<td>DCDC_SETCHVIA</td>
<td>456</td>
<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>0x7fffffff // Equalization battery voltage A</td>
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<tr>
<td>DCDC_FLOATINGVIA</td>
<td>458</td>
<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>0x7fffffff // Floating voltage A</td>
<td></td>
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<tr>
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<td>460</td>
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<td>IQ10</td>
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<td>0x7fffffff // Battery capacity A</td>
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<tr>
<td>DCDC_BATSOCA</td>
<td>462</td>
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<td>UINT32</td>
<td>0</td>
<td>0x7fffffff // Battery State of Charge A</td>
<td></td>
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</tr>
<tr>
<td>DCDC_BATVDCA</td>
<td>464</td>
<td>RO</td>
<td>UINT32</td>
<td>0</td>
<td>0x7fffffff // Battery DC voltage measured A</td>
<td></td>
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<tr>
<td>DCDC_BATIDCA</td>
<td>466</td>
<td>RO</td>
<td>UINT32</td>
<td>0</td>
<td>0x7fffffff // Battery Drain Current measured A</td>
<td></td>
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</tr>
<tr>
<td>DCDC_AHMEASUREDA</td>
<td>468</td>
<td>RO</td>
<td>IQ10</td>
<td>0</td>
<td>0x7fffffff // Ah measured A</td>
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<td></td>
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<td>RO</td>
<td>UINT32</td>
<td>0</td>
<td>0x7fffffff // Time measured A</td>
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<tr>
<td>DCDC_BATSTATUSWORDB</td>
<td>474</td>
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<td>0x7fffffff // Battery Status Word B</td>
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<td>DCDC_BATERROWORDB</td>
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<td>UINT32</td>
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<td>0x7fffffff // Battery Error Word B</td>
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<td>478</td>
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<td>IQ21</td>
<td>0</td>
<td>0x7fffffff // Battery High Voltage Alarm B</td>
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<td>IQ21</td>
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<td>0x7fffffff // Battery Low Voltage Alarm B</td>
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<td>DCDC_ALARMBATMAXCHB</td>
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<td>0x7fffffff // Battery Max Charging Current Alarm B</td>
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<td>DCDC_ALARMBATMINCHB</td>
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<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>0x7fffffff // Battery Max Discharging Current Alarm B</td>
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<td>DCDC_SETCHIB</td>
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<td>IQ21</td>
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<td>0x7fffffff // Recommended charging current B</td>
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<td>IQ21</td>
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<td>0x7fffffff // Equalization battery voltage B</td>
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<tr>
<td>DCDC_FLOATINGVBI</td>
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<td>RW</td>
<td>IQ21</td>
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<td>0x7fffffff // Floating voltage B</td>
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<tr>
<td>DCDC_SETCHP8</td>
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<td>IQ10</td>
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<td>0x7fffffff // Battery capacity B</td>
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<tr>
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<td>UINT32</td>
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<td>0x7fffffff // Battery State of Charge B</td>
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<td></td>
</tr>
<tr>
<td>DCDC_BATVDCCB</td>
<td>496</td>
<td>RO</td>
<td>UINT32</td>
<td>0</td>
<td>0x7fffffff // Battery DC voltage measured</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCDC_BATIDCCB</td>
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<td>UINT32</td>
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<td>0x7fffffff // Battery Drain Current measured B</td>
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<td>DCDC_AHMEASUREDB</td>
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<td>IQ10</td>
<td>0</td>
<td>0x7fffffff // Ah measured B</td>
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<td></td>
</tr>
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<td>DCDC_TIMEMEASUREDB</td>
<td>502</td>
<td>RO</td>
<td>UINT32</td>
<td>0</td>
<td>0x7fffffff // Time measured B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCDC_BATSTATUSWORDC</td>
<td>506</td>
<td>RO</td>
<td>UINT32</td>
<td>0</td>
<td>0x7fffffff // Battery Status Word C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCDC_BATERROWORDC</td>
<td>508</td>
<td>RO</td>
<td>UINT32</td>
<td>0</td>
<td>0x7fffffff // Battery Error Word C</td>
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<td></td>
</tr>
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<td>DCDC_ALARMBATHC</td>
<td>510</td>
<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>0x7fffffff // Battery High Voltage Alarm C</td>
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<td></td>
</tr>
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<td>Name</td>
<td>Type</td>
<td>Read/Write</td>
<td>IQ10/IQ21</td>
<td>Offset</td>
<td>Description</td>
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<td></td>
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<td>DCDC_ALARMBATL</td>
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<td>IQ21</td>
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<td>Battery Low Voltage Alarm C</td>
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<td></td>
</tr>
<tr>
<td>DCDC_ALARMBATMAXCHC</td>
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<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>Battery Max Charging Current Alarm C</td>
<td></td>
<td></td>
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<tr>
<td>DCDC_ALARMBATMINCHC</td>
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<td>RW</td>
<td>IQ21</td>
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<td>Battery Max Discharging Current Alarm C</td>
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<td>DCDC_SETCHIC</td>
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<td>IQ21</td>
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<td>Recommended charging current C</td>
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<td>Battery capacity C</td>
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<tr>
<td>DCDC_BATIDCC</td>
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<td>UINT32</td>
<td>0</td>
<td>Battery DC voltage measured C</td>
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<td></td>
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<td>Ah measured C</td>
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<td>RO</td>
<td>UINT32</td>
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<td>Time measured</td>
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<td></td>
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<tr>
<td>DCDC_DC_VOLTAGEGLOBAL</td>
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<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>Global DC voltage command</td>
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<td></td>
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<tr>
<td>DCDC_DC_VOLTAGEPHA</td>
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<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>Phase A voltage command</td>
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<td></td>
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<tr>
<td>DCDC_DC_VOLTAGEPHB</td>
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<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>Phase B voltage command</td>
<td></td>
<td></td>
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<tr>
<td>DCDC_DC_VOLTAGEPHC</td>
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<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>Phase C voltage command</td>
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<td>DCDC_AC_VOLTAGEGLOBAL</td>
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<td>RW</td>
<td>IQ21</td>
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<td>Global DC current command</td>
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<tr>
<td>DCDC_AC_VOLTAGEPHA</td>
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<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>Phase A current command</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCDC_AD_VOLTAGEPHB</td>
<td></td>
<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>Phase B current command</td>
<td></td>
<td></td>
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<tr>
<td>DCDC_AD_VOLTAGEPHC</td>
<td></td>
<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>Phase C current command</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCDC_MAXAGLOBAL</td>
<td></td>
<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>Current limit (Global)</td>
<td></td>
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<tr>
<td>DCDC_MAXAPHA</td>
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<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>Current limit (Phase A)</td>
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</tr>
<tr>
<td>DCDC_MAXAPHB</td>
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<td>IQ21</td>
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<td>Current limit (Phase B)</td>
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<td></td>
</tr>
<tr>
<td>DCDC_MAXAPHC</td>
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<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>Current limit (Phase C)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCDC_MAXVGLOBAL</td>
<td></td>
<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>Global DC maximum allowable voltage</td>
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<td></td>
</tr>
<tr>
<td>DCDC_MAXVPHA</td>
<td></td>
<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>Phase A maximum allowable voltage</td>
<td></td>
<td></td>
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<tr>
<td>DCDC_MAXVPHB</td>
<td></td>
<td>RW</td>
<td>IQ21</td>
<td>0</td>
<td>Phase B maximum allowable voltage</td>
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</tr>
</tbody>
</table>
### DCDC_MAXVPHC
- **Value:** 574
- **Type:** RW
- **Address:** IQ21
- **Value:** 0
- **Hex Value:** 0x7FFFFFFF
- **Description:** Phase C maximum allowable voltage

### DCDC_MINVGLOBAL
- **Value:** 578
- **Type:** RW
- **Address:** IQ21
- **Value:** 0
- **Hex Value:** 0x7FFFFFFF
- **Description:** Global DC minimum allowable voltage

### DCDC_MINVPH
- **Value:** 580
- **Type:** RW
- **Address:** IQ21
- **Value:** 0
- **Hex Value:** 0x7FFFFFFF
- **Description:** Phase A minimum allowable voltage

### DCDC_MINVPHB
- **Value:** 582
- **Type:** RW
- **Address:** IQ21
- **Value:** 0
- **Hex Value:** 0x7FFFFFFF
- **Description:** Phase B minimum allowable voltage

### DCDC_MINVPHC
- **Value:** 584
- **Type:** RW
- **Address:** IQ21
- **Value:** 0
- **Hex Value:** 0x7FFFFFFF
- **Description:** Phase C minimum allowable voltage

---

### The Bit Coded Variables descriptions are:

#### CONTROL WORD

<table>
<thead>
<tr>
<th>bits</th>
<th>31..12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8..5</th>
<th>4..3</th>
<th>2</th>
<th>1</th>
<th>0</th>
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</thead>
<tbody>
<tr>
<td>Definition</td>
<td>reserved</td>
<td>reserved</td>
<td>reserved</td>
<td>Connection mode</td>
<td>Function</td>
<td>LocalRemote</td>
<td>RunReady</td>
<td>Enable</td>
<td>Reset</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0: Independent 1: Parallel</td>
<td>0: Voltage 1: Icnt 2: Pcnt 3: Bat. Charge 4: Rsvd</td>
<td>0: Local 1: Modbus 2: External ADC</td>
<td>0: Ready</td>
<td>0: Disabled</td>
<td>1: Reset</td>
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</table>

#### STATUS WORD

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<th>bits</th>
<th>31..17</th>
<th>16</th>
<th>15</th>
<th>11</th>
<th>10..8</th>
<th>7..6</th>
<th>5</th>
<th>4</th>
<th>3..0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>reserved</td>
<td>reserved</td>
<td>reserved</td>
<td>Connection mode</td>
<td>Function</td>
<td>LocalRemote</td>
<td>RunReady</td>
<td>Enable</td>
<td>State Machine</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>0: Independent 1: Parallel</td>
<td>0: Voltage 1: Icnt 2: Pcnt 3: Bat. Charge 4: Rsvd</td>
<td>0: Local 1: Modbus 2: External ADC</td>
<td>0: Ready</td>
<td>0: Disabled</td>
<td>s_Init: 1 s_StandBy: 2 s_PreCharge: 3 s_Ready: 4 s_Run: 5 s_Alarm: 6 s_Calibration: 7</td>
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</table>
## ERRORS

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<th>Definition</th>
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<tr>
<td>7</td>
<td>Phase overvoltage</td>
</tr>
<tr>
<td></td>
<td>Overvoltage in phase</td>
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<tr>
<td></td>
<td>Mains lost</td>
</tr>
<tr>
<td></td>
<td>There is no voltage in the grid</td>
</tr>
<tr>
<td></td>
<td>31..26</td>
</tr>
<tr>
<td></td>
<td>reserved</td>
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</table>

<table>
<thead>
<tr>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>The power supply output is shortcircuited</td>
</tr>
<tr>
<td>BATTERY ERRORS</td>
</tr>
<tr>
<td>---------------</td>
</tr>
<tr>
<td>bits</td>
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<tr>
<td>Definition</td>
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<table>
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</tr>
</thead>
<tbody>
<tr>
<td>bits</td>
<td>31..10</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2..0</td>
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</tr>
<tr>
<td>Definition</td>
<td>reserved</td>
<td>reserved</td>
<td>reserved</td>
<td>reserved</td>
<td>reserved</td>
<td>reserved</td>
<td>reserved</td>
<td>Charge_Stage</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0:Constant Current</td>
<td>1:Boost</td>
<td>2:Full</td>
<td>3:Equ</td>
<td>4:Floating</td>
<td>5: No Bat Presence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6.1. IQ MANAGEMENT

Many of the parameters of this equipment are defined as IQ numbers (Texas Instruments nomenclature). An IQ number refers to a 32 bit signed fixed point number where the number of fractional bits is specified. For instance, IQ21 means that the number has 21 fractional bits, 10 integer bits and 1 bit is for the sign.

For the representation of the negative numbers:

\[ X_{\text{iq}} = X_{\text{float}} \cdot 2^n + 2^{32} \]

And for the positive numbers:

\[ X_{\text{iq}} = X_{\text{float}} \cdot 2^n \]

As an example, 1.4142 in IQ10 representation:

1.4142 \cdot 2^{10} = 1448.155

Below there is a C# sample code for the representation:

IQ10 functions:

```csharp
public double IQ10toFloat(double Var)
{
    if (Var > 2147483648) // if the value is bigger than 2^31 (positive)
    {
        Var = Var - 4294967296; // Var - 2^32
        Var = Var / 1024; // Var/(2^10)
    }
    else
    {
        Var = Var / 1024;
    }
    return Var;
}

public UInt32 FloatToIQ10(double Var)
{
    UInt32 Retorn=0;
    if (Var <0 ) // if negative
    {
        Var = (1024*Var) + 4294967296; // x*2^10 + 2^32
    }
    else
    {
        Var = Var * (1024);
    }
    Retorn = Convert.ToUInt32(Var); return Retorn;
}
```
IQ21 functions:

```csharp
public double IQ21toFloat(double Var)
{
    if (Var > 2147483648) //if the value is bigger than 2^31 (positive)
    {
        Var = Var - 4294967296; // Var - 2^32
        Var = Var / (2097152); // Var / (2^21)
    }
    else
    {
        Var = Var / (2097152); //Var/(2^21)
    }
    return Var;
}

public UInt32 FloatToIQ21(double Var)
{
    UInt32 Return = 0;
    if (Var < 0) // if negative
    {
        Var = (2097152 * Var) + 4294967296; // Var*2^21 + 2^32
    }
    else
    {
        Var = Var * (2097152); // Var*2^21
    }
    Return = Convert.ToUInt32(Var);
    return Return;
}
```
7. HUMAN MACHINE INTERFACE

CINERGIA delivers, within the scope of the supply, a Human Machine Interface software that communicates with the equipment using MODBUS protocol. This application is based on Windows 7/Windows XP. The software can be installed by executing Setup.exe file in Administrator Mode and following the instructions of the application.

The software is based in a Tab Dialog, so each tab has different uses:

- OPERATION
- SUPERVISION
- ALARM
- BATT CONFIGURATION
- I, V, P CONFIGURATION

7.1. Operation tab

A- Information about the status of the equipment and buttons to control it:

- **Enable / Disable**: the corresponding led shows whether the equipment is enabled or disabled.
- **Run / Ready**: the corresponding led shows whether the equipment is running or is ready for operation.
- **Reset**: it allows the user to reset all the alarms that have occurred and that have been previously announced.

B- Selection of the operating mode and information about the active one:

- **Current Control / Voltage Control / Power Control / Battery Charge**
- **Parallelized Outputs / Independent Outputs**
C- Connection parameters for the communications:

- IP of the equipment (192.168.55.204), port (502). This equipment has a fixed IP.
- Pooling time [ms] is the time to refresh all parameters. The minimum value recommended is 500 ms.
- Connect / Disconnect / Pause buttons

D- Information about the State Machine of the two converters of the equipment (Active Rectifier and DC/DC Output).

7.2. Supervision tab

A- Information about electrical parameters of both converters:

- Voltage, current, frequency, temperatures, active and reactive power.

B- Trend plots of voltage, current and power:

- Only one variable per plot is allowed at the same time.
- The refreshing time is defined by the pooling time, therefore it is not possible to detect fast transients of the variable.
7.3. Alarm tab

In this tab, the alarm status of each converter is shown.

7.4. Batt configuration tab

The behaviour of the equipment when operating in Battery Charging mode is configured through this tab:

A- Information about the electrical parameters for the Battery Charge operation mode. To update the data and change the configuration the *Send* button must be pressed.

B- Electrical limits for each phase when the power supply is in Constant Current, Voltage or Power mode. The information is sent to the equipment after pressing the *Send* button.
7.5.1, V, P configuration tab

A- Information and setpoints for the electrical parameters associated to the Current, Voltage and Power operating modes. By using the Send button the data is downloaded to the equipment.

B- Setpoint of the reactive power for the grid-tied Active Rectifier. The information is sent to the equipment after pressing the Send button.
8. WARRANTY AND MAINTENANCE

Fans and capacitors must be replaced at the end of their useful lifetime.

**Inside the equipment there are dangerous voltages and metallic parts at high temperatures even when the equipment is stopped. The direct contact may cause electrocutions and burns. All the operations must be done by authorized technical staff.**

8.1. Replacing the output fuses

**This operation must be performed by personnel experienced with electrical systems. The direct contact can cause electrocutions and burns.**

In order to replace the output fuses follow procedure below:

1. Stop the power supply following the instructions of FULL STOP
2. Turn the output switch-disconnector (Q2) to the OFF position
3. Open the fuse holder and replace the fuses

The battery fuses can only be replaced by ultrafast models type Gould aR 660V (14x51 or 22x58 mm, depending on the unit model) of the same dimensions and rating.

8.2. Fans

The useful lifetime of the fans used to cool the power circuits depends on the use and environment conditions. It is recommended their preventive replacement by authorized technical staff.

8.3. DC bus capacitors

The useful lifetime of the DC bus capacitors and those ones used in the input and output filtering depends on the use and the environment conditions. It is recommended their preventive replacement by authorized technical staff.

8.4. Warranty

CINERGIA warrants that the delivered equipment is free from any defect affecting the functioning thereof for a time period not exceeding one (1) year from the Ex Works delivery date. If a purchased CINERGIA product becomes defective because of a faulty component or manufacturing, at any time during its standard warranty period, CINERGIA shall provide one of the following solutions:

- On-site technical assistance;
- Product or component repair at CINERGIA’s premises.
• Replacement of the defective product or component;

The decision whether to perform the assistance on-site, to repair or replace the faulty product and/or component shall be taken in any case exclusively by CINERGIA.

8.5. Claim procedure

The warranty rights can be exercised during the validity of the warranty period and immediately upon detecting any abnormalities, except in the case of visible defects, in which case the claim shall be submitted within a maximum time of 7 days from the date of receipt of the equipment and always prior to their installation.

If defect of malfunction is detected, please proceed as follows:

• Immediately notify in writing CINERGIA by submitting a brief report describing the type of fault detected and all the data contained in the product data plate, attaching a copy of the purchase invoice/receipt. Such documentation shall be sent to the email address of the Sales Team (comercial@cinergia.coop).

• Upon receiving the documentation, CINERGIA will analyse it to decide whether the intervention required is covered by the warranty terms described herein.

• If the claim is covered by the warranty terms, CINERGIA shall provide on-site technical assistance or, alternatively, can request the shipping of the defective product and/or component to have it repaired at CINERGIA premises. At last, CINERGIA shall decide to send a replacement product and/or component. The faulty product and/or component shall be returned to CINERGIA. Any shipping damages attributable to improper packaging shall not be covered by warranty.

• Failure to return the replaced equipment within 10 (ten) standard days shall authorize CINERGIA to invoice the equipment supplied as replacement.

• In case the defect of the returned equipment is deemed not to be covered by the warranty, CINERGIA shall issue an invoice to the purchaser for the repair activity.

• If on arrival at CINERGIA’s premises the returned equipment is deemed to be in perfect operating conditions, CINERGIA shall be authorized to issue an invoice for all the costs resulting from its replacement (analysis and testing of the equipment and shipping costs).

• CINERGIA reserves the right to provide a different model of product and/or component to process the claims covered by the warranty terms, in case the original model and/or component is out of production.