



Bidirectional Battery Charger (B2C+) Human Machine Interface



Regenerative Power Converters

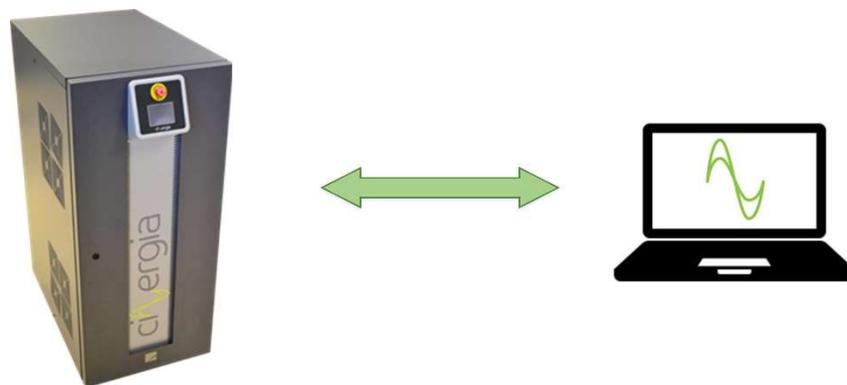
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1. GENERAL

The purpose of this manual is to provide information to use the Cinergia converter with all its different functionalities. It is important for the user to have this manual nearby and familiarize with it to operate efficiently with the converter.

This document tries to be easy to understand, created with schematics and real pictures of the equipment with parts marked with letters and numbers which you can find the explanation just below the picture.

Cinergia is in constant development to deliver always the best service to you, so it is possible to find some discrepancy between this manual and the real converter itself. Don't hesitate to contact us and ask for the latest version of the documentation.



This manual is valid for the following versions:

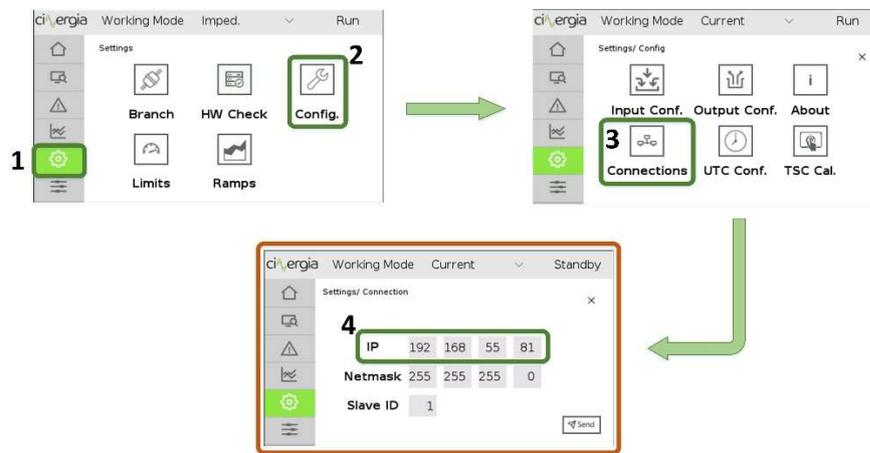


2. HUMAN MACHINE INTERFACE

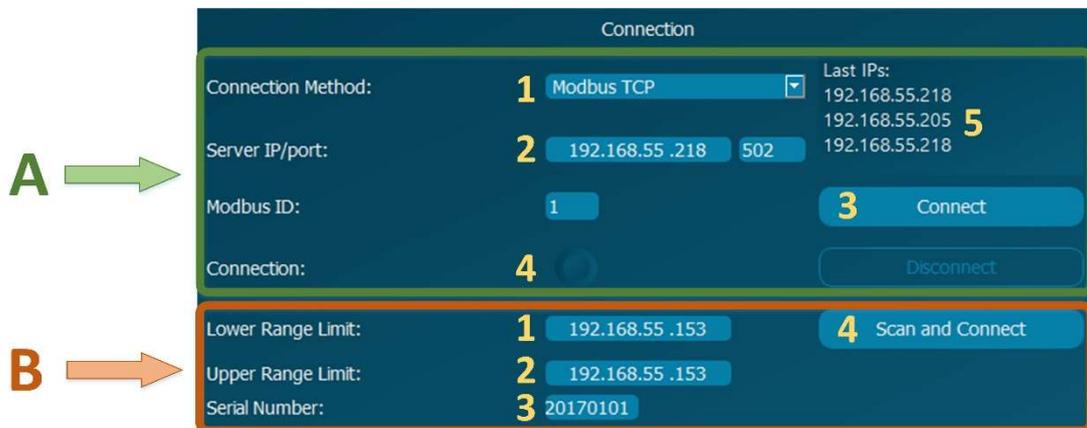
CINERGIA delivers, within the scope of the supply, a Human Machine Interface software that communicates with the equipment using MODBUS protocol. This application is compatible on Windows 10/Windows 7/Windows XP. The software can be installed by executing Setup.exe file in Administrator Mode and following the instructions of the application.

To connect Cinergia units to a PC, follow these steps:

- Connect a standard RJ45 Ethernet cable to terminal X13. The unit can be connected directly either to a computer or to a router (wired or wireless). If the CINERGIA unit is connected through a router, several computers could be connected to the unit at the same time.
- Check the IP address of CINERGIA unit in the LCD Touchscreen following these steps:



- Check the computer's Ethernet configuration panel and make sure that both the computer and the CINERGIA unit are in the same subnetwork. For instance, if the CINERGIA unit IP address is 192.168.55.81 the computer Ethernet configuration shall be:
 - a) Computer IP address: 192.168.55.XXX (XXX can be any address different from 81 and different from any other device in the same network)
 - b) Subnet mask: 255.255.255.0
 - c) Gateway and DNS configuration are not needed for a connection with a CINERGIA unit
- Run the graphical user interface delivered by CINERGIA, write the IP address of the unit to be connected and press the Connect button.



There are two different ways to connect the unit to the PC via Modbus TCP:

- A-** Known the IP address of the equipment. This IP address is displayed in the LCD touchscreen as it is explained in the LCD touchscreen schematic displayed above.
 - 1- Define the connection (Modbus TCP)
 - 2- Introduce the IP address
 - 3- Press Connect
 - 4- Once the equipment is connected, the LED will indicate it
 - 5- There is a register of 3 IPs which the interface has connected to the equipment
- B-** Known the serial number of the equipment and the range of IPs that the equipment is located. The serial number is written in the front of the equipment with the specification data. If the equipment has a serial number such as 20170101-1, the number to introduce must be without the hyphen: 201701011. This method is useful when the user, for example, does not know the exact IP of the equipment but knows that the range of IPs is, for example, from 192.168.55.150 to 192.168.55.250
 - 1- Introduce the lower IP range
 - 2- Introduce the upper IP range
 - 3- Introduce the serial number (without hyphen)
 - 4- Press *Scan and Connect*. It may last a few seconds to scan all the IPs

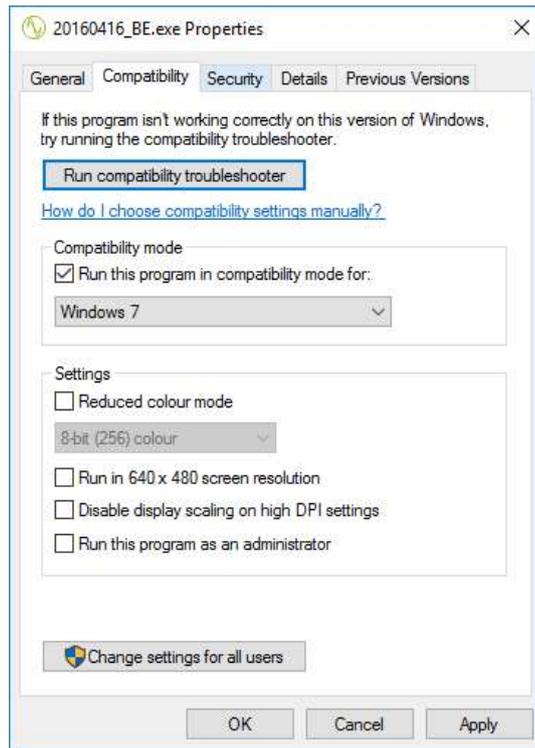


If there is an error when trying to run Cinergia application, please check the compatibility mode of your computer. For instance, in a Windows 7 computer, right click CINERGIA application → Properties; go to Compatibility panel and check the box Run this program in compatibility mode; and select the operating system of your computer.



The document *Connecting CNG+ units to a PC v3* details how to connect the equipment. Please read this document to make sure that the parameters are introduced properly.

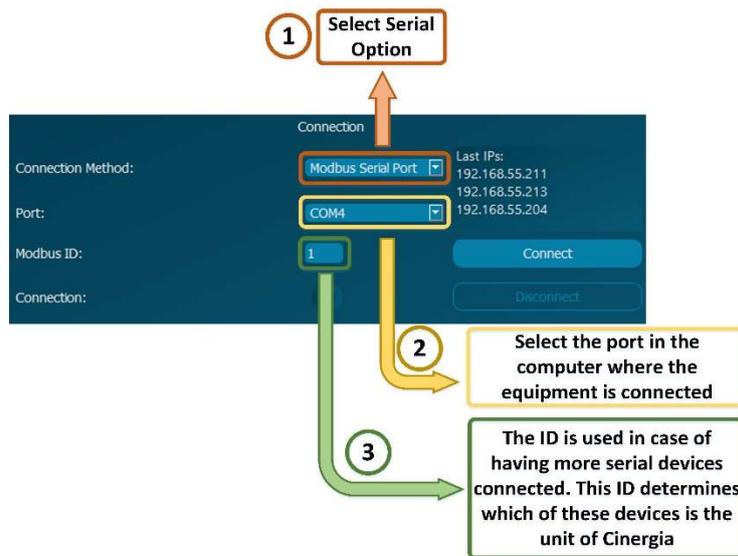
If there is an error when trying to run CINERGIA application, please check the compatibility mode of your computer. For instance, in a Windows 7 computer, right click CINERGIA application → Properties; go to Compatibility panel and check the box *Run this program in compatibility mode*; and select the operating system of your computer. For instance, for a Windows 7 computer:



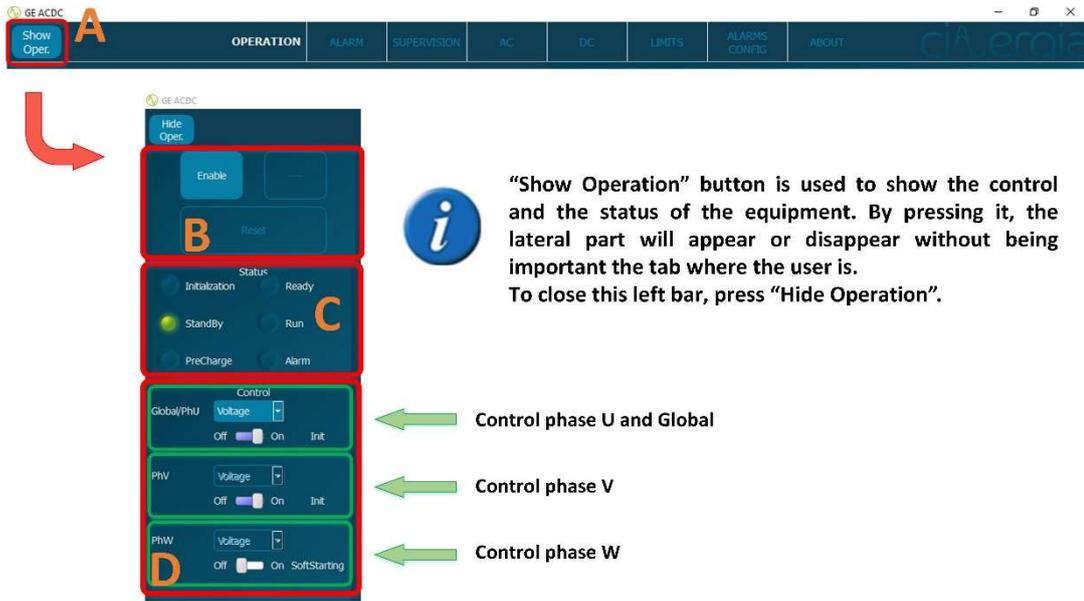
The interface delivered by Cinergia has a correct visualization with screens configured with a minimal resolution of 1366x768 (16:9)

2.1. Optional Communications

There is an optional which is to connect the CNG unit using series connection (RS485, RS232) or CAN protocol and it has an additional cost.



3. SHOW OPERATIONAL BUTON



A "Show Oper." button

B Control buttons: Enable, Disable, Run, Ready, Reset

C Status indicators: Initialization, StandBy, Run, PreCharge, Alarm

D Control phase buttons: Global/PhU, PhV, PhW (Voltage, On, Init)

Control phase U and Global

Control phase V

Control phase W

i "Show Operation" button is used to show the control and the status of the equipment. By pressing it, the lateral part will appear or disappear without being important the tab where the user is. To close this left bar, press "Hide Operation".

- **A:** "Show Oper." button. It allows the user to see the lateral part of the interface with the control and the status of the converter. It is useful to have a wider view of every tab of the interface.
- **B:** Control the status of the equipment with the buttons:
 - Enable / Disable. *Enable* button turns the equipment into Ready state. *Disable* button turns the equipment into Standby state.
 - Run / Ready. *Run* button turns the equipment into Run state. *Ready* button turns the equipment into Ready state.
 - Reset. *Reset* button turns the equipment into Standby state.



Before going to Run state, please be sure that all the connections between the EUT and the Cinergia equipment are ready.

- **C:** Information about of Active Rectifier and Inverter status:
 - Initialization. The converter control system checks the presence of all internal components and the embedded PC loads the operating system.
 - Standby. Keeps the converter in low power mode until an Enable signal is received. There is no voltage in the DC link and no voltage/current is applied to the output of the converter.
 - Precharge. 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.
 - Ready. The converter is ready to operate but no PWM signal is sent to IGBTs. The DC link is charged to the rectified voltage and there is no voltage/current applied to the outputs.
 - Run. The converter is completely operational: the inverter starts the control algorithms and PWM. Setpoints can be sent.
 - Alarm. The converter has an alarm and the user can visualize it in the *Alarm* tab.

| Button | State transitions |
|---------|----------------------------------|
| Enable | Standby → Ready |
| Disable | Ready/Run → Standby |
| Run | Ready → Run |
| Ready | Run → Ready |
| Reset | Alarm → Initialization → Standby |

- **D:** Choose the control mode (Voltage, Current, Power or Impedance mode). The converter can change the control mode in any state.
 - In AC, the GE allows voltage control.
 - In DC, the GE allows voltage, current, power and impedance control.

The user can unify the channels or can work with them independently by enabling or disabling this option (which is an optional and has an additional cost):

The channels can work Unified/Disable Independent Control Branch (run all phases in the same run button) or Separate/Enable Independent Control Branch (run each phase with a separate run button).

- Unified: once the equipment is in run state, the user can control all three phases together by activating them using the slider *Off/On* in the Global part. When the slider is in *On* position, the IGBTs start commuting.
- Independent: once the equipment is in run state, the user can control the phases one by one by activating them with their own slider shown in the picture above.

To select the mode unified or separate, please read the chapter ¡Error! No se encuentra el origen de la referencia. part D.



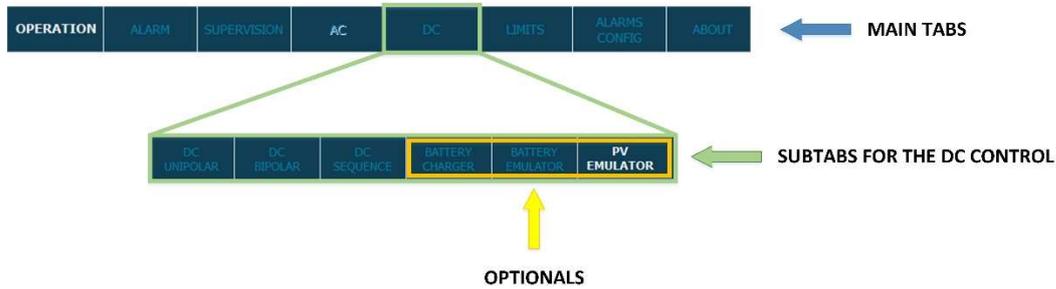
Separate mode is optional, and it has an additional cost.



In Current, Power or Impedance mode, the equipment controls current and it requires a voltage source connected in the output of the Cinergia equipment. The voltage source must be the first to be turned on. Once the Cinergia converter reads the voltage in the inverter, the Run state can be applied.

4. DISTRIBUTION OF THE INTERFACE

To create a friendly navigation of the interface, Cinergia has designed a Tab Dialog distribution, in which each tab has one of the following purposes:



Please note that the DC subtabs contains 3 OPTIONAL: *Battery Charger*, *Battery Emulator* and *PV Emulator*. These OPTIONAL are an upgrade of the converter and have an additional cost. The subtabs will appear if the option is enabled.

Further information of each kind of tab can be found in the following sections.



If there is any discrepancy between this document and the manual, the information of the present document will prevail.

4.1. Operation



- **A:** Connection mode. Informs about the connection:
 - DC Independent/Parallel Unipolar
 - DC Independent Bipolar (note that parallel bipolar is not allowed)



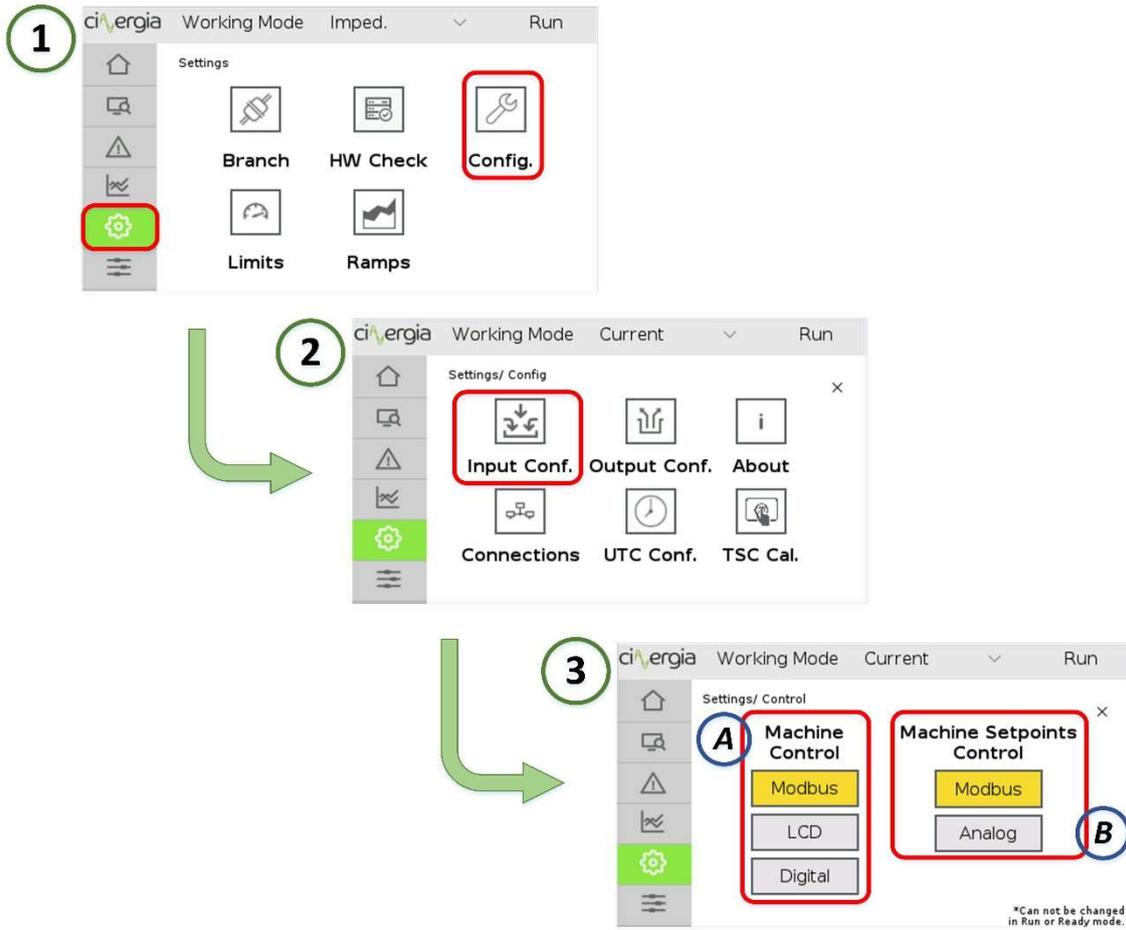
The connection mode can only be modified by changing the switches in the front panel. Please read the document Operation Modes for more information.

- **B:** Informs about which is the equipment's state control:
 - LCD: control from LCD screen.
 - Modbus: control using Modbus Ethernet (IP) or serial port.
 - Digital: control with digital/analogue control.

The selection of the control mode is set through the LCD touchscreen (please see figure below)

- **C:** Informs about which is the equipment's setpoint control:
 - Modbus: the setpoint is sent via Modbus (interface)
 - Analogue / Power Amplifier: the setpoint is sent with an analogue signal. There is also the possibility to use the converter as a power amplifier (optional).

The following figure explains how to change the control mode through the LCD touchscreen.



Follow the steps **1**, **2** and **3** of the above picture to reach the LCD touchscreen submenu that enables the configuration of the *Machine Control* and *Setpoints Control*. Once the user is in the third step, **A** part is for the *Machine Control* (*Enable, Disable, Run, Ready* and *Reset*) and **B** part is for the setpoints (the equipment will send the setpoints only in Run state).

Please note that the machine state and the setpoints control are independent.



It is not possible to change the control when the equipment is in RUN state.

D: Independent Branch control (Optional). The user can unify the channels or can work with them independently by enabling or disabling this option (which is an optional and has an additional cost):

The channels can work Unified/Disable Independent Control Branch (run all phases in the same run button) or Separate/Enable Independent Control Branch (run each phase with a separate run button).

- Unified: once the equipment is in run state, the user can control all three phases together by activating them using the slider *Off/On* in the Global part. When the slider is in *On* position, the IGBTs start commuting.
- Independent: once the equipment is in run state, the user can control the phases one by one by activating them with their own slider shown in the picture above.

If the equipment is working with separated branches, the user can activate a PID control between the phases U and V which balances the current passing through them.

For more information of this optional, read chapter 4.1.1. *Independent Branch Control* of this manual.

- **E:** Connection settings. The converter can be connected to the interface using the following methods:
 - Modbus TCP. Uses Modbus protocol and the port 502. Connect a RJ45 ethernet cable to the terminal X15.
 - TCP Socket. Uses an internal Cinergia protocol and the port 8989. Connect a RJ45 ethernet cable to the terminal X15.
 - Modbus Serial Port. Uses RS485 or RS232 protocol. Connect a DB9 cable to the terminal X11.

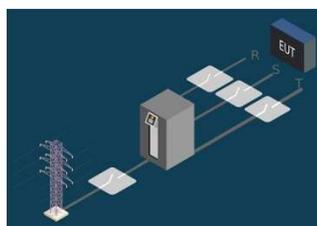
There is another possibility to connect to a Cinergia equipment, which is introduce an IP range and the serial number. This option is useful if there are different units connected to the same subnet. The serial number of the equipment is written in the front panel, opening the door. This number must be introduced in the interface without separate the numbers.



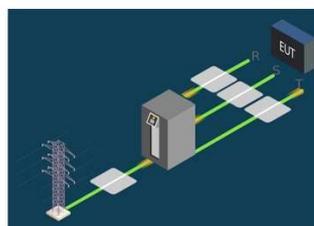
Both *Modbus TCP* and *TCP Socket* can be connected via router or direct to the computer. *Modbus Serial Port* must be connected directly to the computer. For more information please read the document *Connecting CINERGIA units to a PC*.

Once the configuration is selected, press *Connect*.

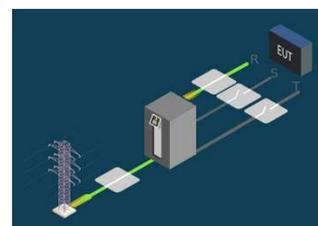
- **F:** graphical state of the converter. The figure indicates whereas the equipment is running (and which phase) or not.



**EQUIPMENT NOT
RUNNING**



**EQUIPMENT WITH ALL
3 PHASES RUNNING**



**EQUIPMENT WITH U
PHASE RUNNING
(only with separate
mode)**

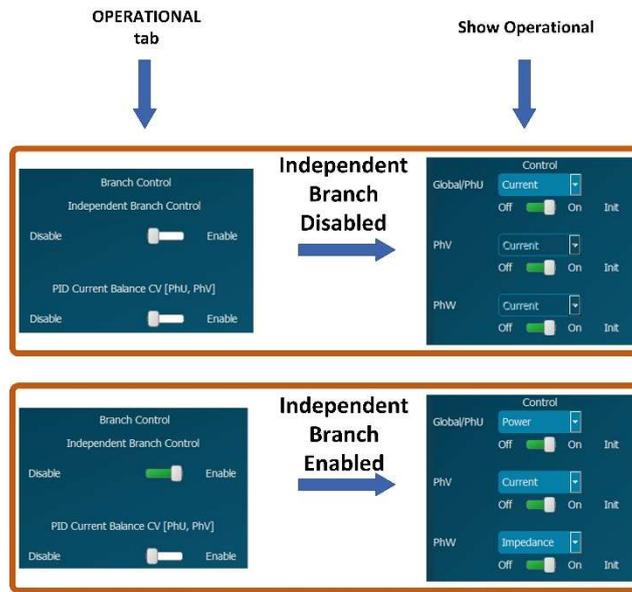
4.1.1. Independent Branch Control (OPTIONAL)

This optional allows the user to control each branch (U, V and W) separately, which means that the phases can be in a different status (*Initialization, Running, Warning or Alarmed*) and a different control mode (*Voltage, Current, Power or Impedance*).



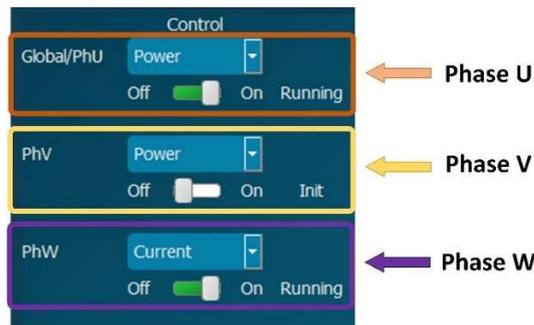
Independent Branch Control is possible in AC or in DC Cinergia converters in exception of the AC Grid Emulator.

To activate or deactivate this mode, go to the Operation tab and select the control with the slider:



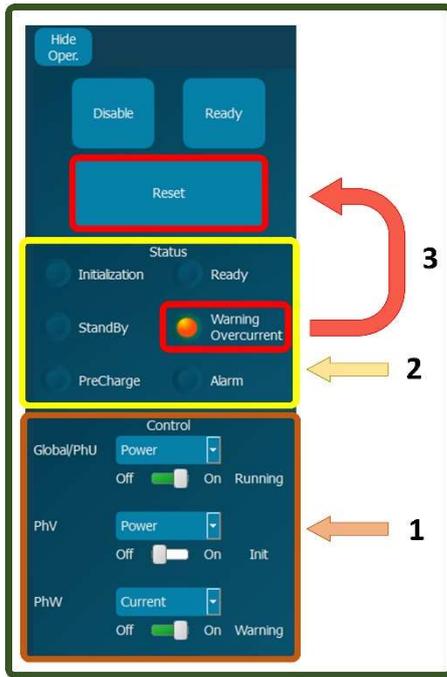
Once the mode is activated, the phases will be unfrozen, and the user will be able to control them separately.

The image below illustrates the independent control branch:



Each phase has the selector of the mode and a slider to make the channel go to *Run* or *Initialization* state. In the image above, for example, the only phase that is not in *Run* state is the V.

It is possible to get only one channel alarmed and continue working and it will be indicated in the Status and the Alarm tab of the converter. So, each phase is treated independently, as the following image illustrates:



- 1- It is visible how the 3 phases are in a different control mode: PhU and PhV are in Power mode whereas PhW is in Current mode. Also, the status per phase is different and it is indicated next to them (Running, Initialization and Warning).
- 2- As the phase W is in Warning state, the status of the converter indicates that there is an overcurrent
- 3- The Warning state makes the *Reset* button to be unfrozen and the user will be able to press it in case of Alarm.

As an example, there is a sequence below of an equipment that has an overcurrent in phase U:



- 1- The interface notices that phase U is in *Warning* state for some reason.
- 2- This reason results to be an *Overcurrent*, that is why it appears the Warning LED.
- 3- In the *Alarm* tab, the *Output OverCurrent* and *Phase U*. Please note that all phases of the converter is still running.
- 4- Phase U has gone to *Alarm* state, so it is not working. However, the other channels are running.
- 5- The status indicates that there is some alarm in the inverter.
- 6- The indicated alarms are *Output OverCurrent* and *Phase U*, but this time the LED is red instead of orange, which means that the output contactor is open, and this phase is not working. The *Reset* button will make this channel to work again.

During all this example, the channels V and W have not stop working.

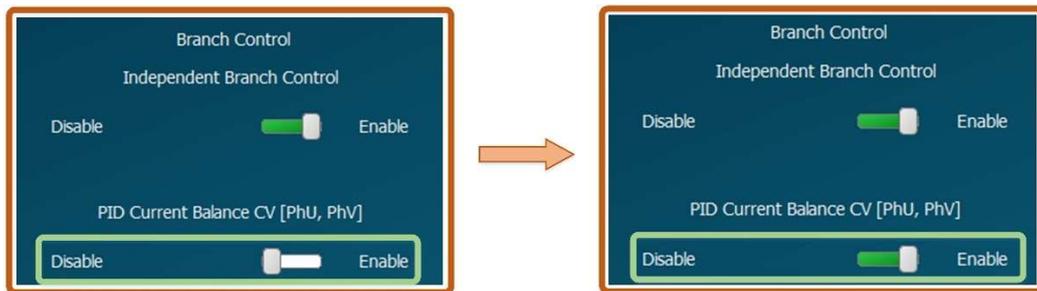


If the converter has DC OPTIONAL (*Battery Emulator*, *Battery Charger* or *PV Emulator*), each channel can also work as one of these possibilities independently.

4.1.1.1. Enable "PID Current Balance CV [PhU, PhV]"

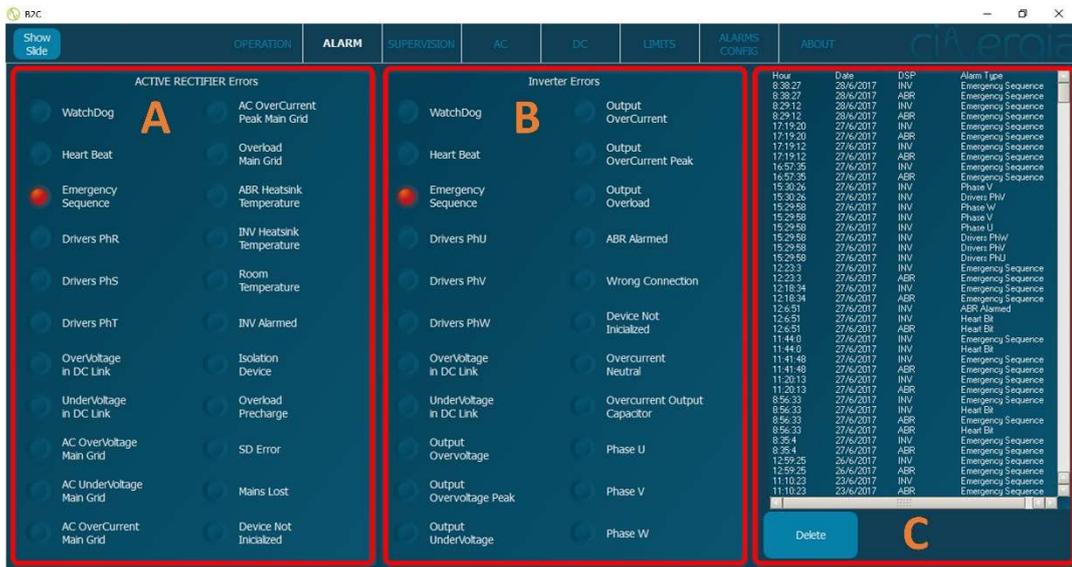
In case of require the phases U and V in parallel as sources of the same circuit, it is recommended to enable the PID Current Balance to get the desired current flowing through each branch. Otherwise it is possible that there flow more or maybe less current that the one desired for each channel due to the parallelization of them.

To use this function, it is required to join the channels U and V with a cable. It is almost the same as activate the parallel switch of the equipment with the difference that this case needs to parallelization of only the first two channels.



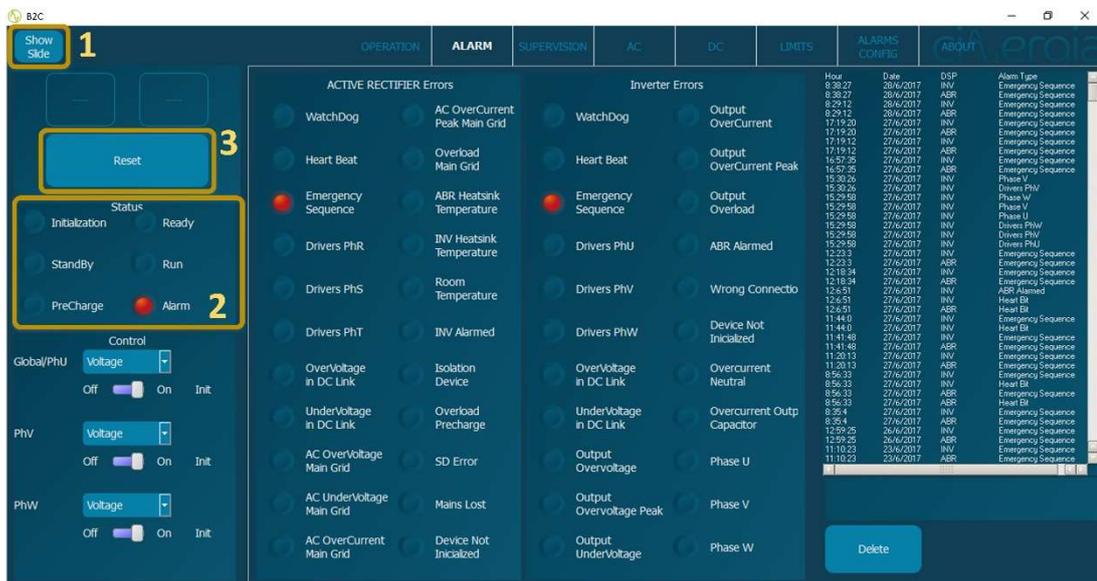
4.2. Alarm

In this tab, the alarms of each converter (active rectifier and inverter) are shown. When there is an alarm, the light turns into red.



- **A:** Active Rectifier alarms.
- **B:** Inverter alarms.
- **C:** Alarms history. It can be deleted using the password.

To reset the equipment, press the *Reset* button using the *Show Oper.* button:



1. Press *Show Oper.* to see the status of the equipment and the reset button.
2. When the equipment has any alarm, it is reflected in the status.
3. Press *Reset* to reach the standby state (no alarms).

4.3. Supervision

The supervision is an informative tab is where the user is able can see all the values of the converter.

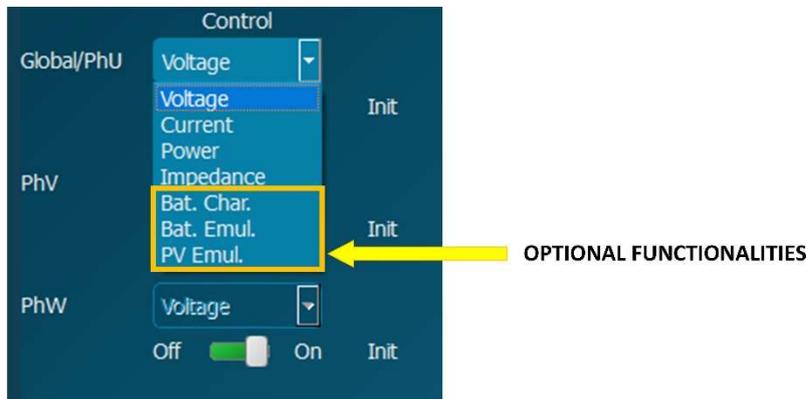


- **A:** Information about the parameters of the input (grid side):
 - Voltage
 - Current
 - Active power
 - Reactive power
 - Frequency
 - Temperature
 - Voltage DC link
- **B:** Information about the parameters of the output (EUT side):
 - Voltage
 - Current
 - Active power
 - Reactive power
 - Frequency
 - Temperature
- **C:** Current trend plots:
 - It displays 3 variables per graph. The first one is for voltage, the second one for current and the third for power. Due to a long refreshing time, it is not possible to detect fast current transients of the variables.
 1. The user can set the maximum and the minimum for the vertical axes or can use the Auto Scale, which will adjust the graph with the maximum and minimum displayed at the current time. This configuration is able for all three graphs.
 2. The number of points are all the points that will be displayed in the graphs. If the number is high the time is going to be longer whereas it is going to be displayed a short period of time with a low number of points. This value is common for all 3 graphs.

4.4. DC

This tab contains all the subtabs concerning the DC mode: DC Unipolar, DC Bipolar and DC Sequence.

Apart from the standard functionalities of the equipment, there are 3 DC OPTIONAL in the converter: *Battery Charger*, *Battery Emulator* and *PV Emulator*. These tab functions will appear when the optional is activated, as well as the new functionalities in the *Show Operational* part:



These 3 functionalities require an upgrade and has an additional cost.



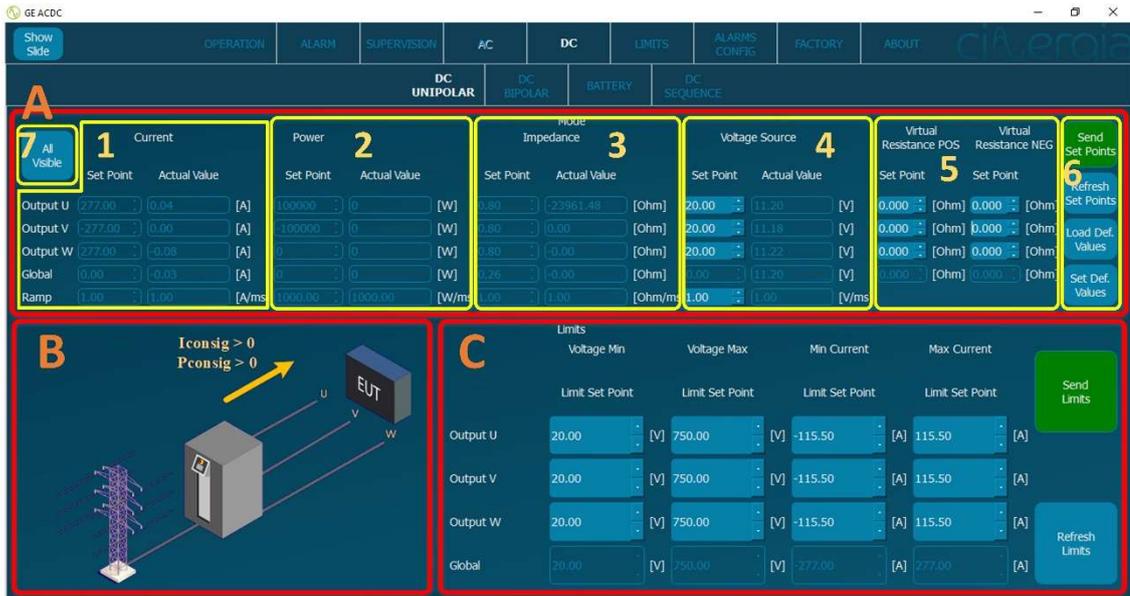
Remember that the *Show Slide* button is available in all the tabs. It is useful to hide the control operation of the converter to have a wider view of the working tab.

4.4.1. DC Unipolar

This subtab allows the user to send all the DC parameters to control the Cinergia converter in unipolar connection: current, power, impedance, voltage setpoints, virtual resistances and limits.



Please read the *Operation Modes* document to know more about how to connect the equipment in unipolar.



- **A:** Part of the subtab to introduce all the setpoints to be sent to the converter. The interface will illuminate the parts where the values can be introduced depending on the connection mode (independent or parallel) and the control mode (current, power, impedance or voltage).
 1. Set the current setpoints to be sent and its ramp. The allowed maximum and minimum values are \pm *rated current* and the ramps go from 0 to 1000A/ms.
 2. Set the power setpoints to be sent and its ramp. The allowed maximum and minimum values are \pm *rated power* and the ramps go from 0 to 1000W/ms.
 3. Set the impedance setpoints to be sent and its ramp. The allowed maximum and minimum values are 1000 and 0.8 Ω , but the minimum value in the global case (parallel) is 0.26 Ω . The ramps go from 0 to 1000 Ω /ms. The user must calculate the appropriate value or resistance to get the desired current.
 4. Set the voltage setpoints to be sent and its ramp. The allowed maximum and minimum values are 750 and 20V. The ramps go from 0 to 1000V/ms.



All setpoints windows have the actual value right beside them. In this way, the user can know it without being necessary the supervision tab.

5. Set the resistance value to create a voltage drop. It is configurable for each channel and for independent and parallel mode. The difference between the positive (POS) resistance and the negative (NEG) resistance is that each one will work depending on the sign of the flowing current. The maximum and minimum values are 1 and 0 Ω . Please note that it is a virtual resistance. It means that there is any physical resistance introduced in the equipment.
6. Once all the setpoints are ready, the user must press *Send Set Points* button and it will send only the setpoints of the actual control mode (the illuminated part). For example, if the equipment is in voltage mode, when the voltage setpoints are ready and the user press *Send Set Points*, the voltage values are sent whereas the current, power and impedance values are not sent.

The other buttons are useful to save time when typing setpoints:

- a. Refresh Set Points: it will refresh the setpoints with the actual value of setpoints showed in the *actual value* windows (beside the setpoints). But if the equipment is controlling power, for example, the *actual value* of power is not being sent to the *set point* on the left.

- b. Load Set Points: the interface saves values as default and the user can set which are this default numbers in the following point c.
 - c. Set Default values: introduce the desired values and press this button. Then these values are going to appear again by pressing the button b.
7. *All Visible* button un freeze all setpoints windows whatever it is the control mode. In this situation, if it is sent by pressing *Send Set Points*, for example, a power setpoint being in current mode, the equipment will not set this power setpoints. This button is useful to set the default setpoints of the equipment.
- **B:** The graph explains which is the direction of the current and power according to the setpoints.
 - **C:** The equipment has its rated values and limits itself, but the user can set another limit (lower than the factory ones). The factory limits are the followings:

| | Minimum | Maximum |
|---------|-----------------------|-------------------|
| Voltage | 0V | 750V |
| Current | - (rated value + 10%) | rated value + 10% |

These limits above are default values and will be the ones initialized when turning on the equipment, but they can be modified and another limit can be chosen as default. Please read the chapter 4.5. *Limits* for more information. The interface will freeze and unfreeze the available part to write limits depending on the connection mode (independent or parallel).



Remember that the limits introduced by the user must be lower than the factory ones. If a higher or lower limit is sent, the interface will show and send the maximum or minimum of the equipment

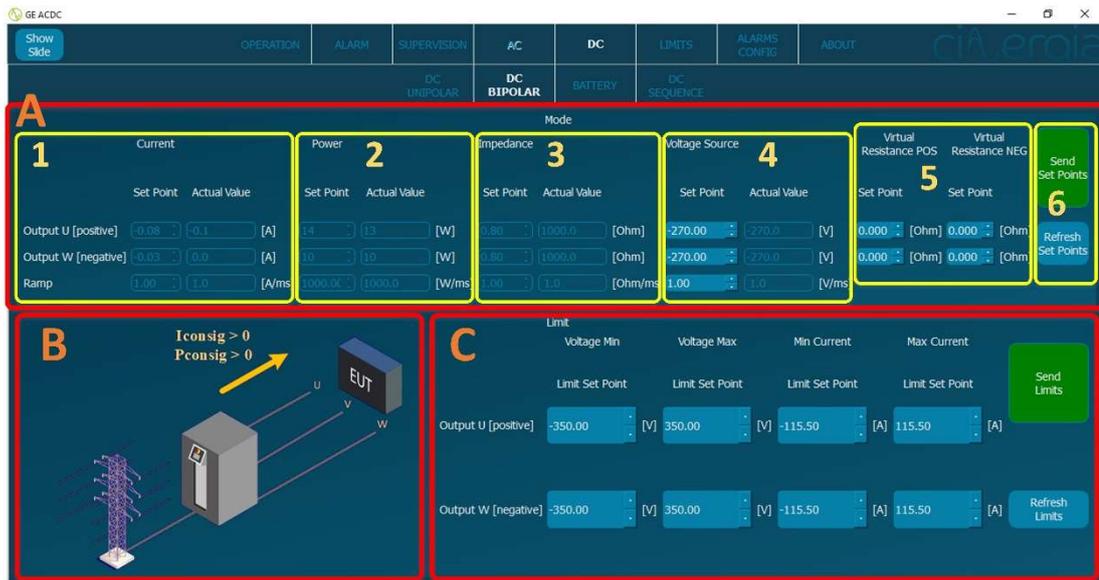
Once the limits are ready, press *Send Limits*. The button *Refresh Limits* will show in the windows the limits that the equipment has in that moment. When the converter is switched off and on again, these limits will be erased and substituted for the factory ones. It is possible to save limits in the equipment in the EEPROM memory, but a password is required (explained in the chapter 1.6. *Limits* of this manual).

4.4.2. DC Bipolar

This subtab allows the user to send all the DC parameters to control the Cinergia converter in bipolar connection: current, power, impedance, voltage setpoints, virtual resistances and limits.



Please read the *Operation Modes* document to know more about how to connect the equipment in bipolar.



- **A:** Part of the subtab to introduce all the setpoints to be sent to the converter. The interface will illuminate the parts where the values can be introduced depending on the control mode (current, power, impedance or voltage).
 1. Set the current setpoints to be sent and its ramp. The allowed maximum and minimum values are \pm *rated current* and the ramps go from 0 to 1000A/ms.
 2. Set the power setpoints to be sent and its ramp. The allowed maximum and minimum values are \pm *rated power* and the ramps go from 0 to 1000W/ms.
 3. Set the impedance setpoints to be sent and its ramp. The allowed maximum and minimum values are 1000 and 0.8 Ω . The ramps go from 0 to 1000 Ω /ms. The user must calculate the appropriate value or resistance to get the desired current.



The converter is controlling channels U and W and both are referred to channel V. If the current setpoints of phases U and W add up to the limits of V channel, the equipment will go to alarm. In the supervision tab, the user can see which is the current and the power flowing through V phase.

4. Set the voltage setpoints to be sent and its ramp. The allowed maximum and minimum values are 750 and 20V. The ramps go from 0 to 1000V/ms.



All setpoints windows have the actual value right beside them. In this way, the user can know it without being necessary the supervision tab.

5. Set the resistance value to create a voltage drop. It is configurable for each channel. The difference between the positive (POS) resistance and the negative (NEG) resistance is that each one will work depending on the sign of the flowing current. The maximum and minimum values are 1 and 0 Ω .
Please note that it is a virtual resistance. It means that there is any physical resistance introduced in the equipment.
6. Once all the setpoints are ready, the user must press *Send Set Points* button and it will send only the setpoints of the actual control mode (the illuminated part).
For example, if the equipment is in voltage mode, when the voltage setpoints are ready and the user press *Send Set Points*, the voltage values are sent whereas the current, power and impedance values are not sent. Refresh Set Points button will refresh the setpoints with the actual value of setpoints showed in the *actual value*

windows (beside the setpoints). But if the equipment is controlling power, for example, the *actual value* of power is not being sent to the *set point* on the left.

- **B:** The graph explains which is the direction of the current and power according to the setpoints.
- **C:** The equipment has its rated values and limits itself, but the user can set another limit (lower than the factory ones). The factory limits are the followings:

| | Minimum | Maximum |
|----------------|-----------------------|-------------------|
| Voltage | -350V | 350V |
| Current | - (rated value + 10%) | rated value + 10% |

These limits above are default values and will be the ones initialized when turning on the equipment, but they can be modified and another limit can be chosen as default. Please read the chapter 4.5. *Limits* for more information.



Remember that the limits introduced by the user must be lower than the factory ones. If a higher or lower limit is sent, the interface will show and send the maximum or minimum of the equipment

Once the limits are ready, press *Send Limits*. The button *Refresh Limits* will show in the windows the limits that the equipment has in that moment.

When the converter is switched off and on again, these limits will be erased and substituted for the factory ones. It is possible to save limits in the equipment in the EEPROM memory, but a password is required (explained in the chapter 1.6. *Limits* of this manual).

4.4.3. DC Sequence

The converter can execute sequences created by the user. These sequences can be made in the interface or in an external program and saved as a CSV (Coma Separated Values) file. This chapter explains how to create this file/sequence through the interface.

| | 1 | 2 | 3 | 4 | 5 |
|-------------|------|-------|-------|--------|---|
| 1 Voltage | 100 | 50 | 100 | 150 | |
| 2 Current | 1500 | -10 | 5 | 10 | |
| 3 Power | 2000 | 60000 | 20000 | -20000 | |
| 4 Impedance | 3000 | 50 | 60 | 70 | |

- **A:** Part of the subtab to introduce all the values that will conform the sequence. This can be multiple, which means that the equipment can be in voltage, current, power or impedance mode in the same sequence.



When the equipment is in current, power or impedance mode is controlling current, which means that a voltage source is required. The logical DC sequence is the one with the same type of control: voltage or current. It is recommended to create two types of DC sequences: one with voltage mode and one with current, power and impedance mode.

The sequence is configured with rows and each row is one step of the sequence. The parts 1, 2, 3 and 4 of A contain two buttons: *Add Step* and *Config Step*. They are used to add or modify rows in the sequence.

1. Voltage setpoints configuration where the user can introduce values for the global configuration (parallel), channel U, V and W and the ramp.
2. Current setpoints configuration where the user can introduce values for the global configuration (parallel), channel U, V and W and the ramp.
3. Power setpoints configuration where the user can introduce values for the global configuration (parallel), channel U, V and W and the ramp.
4. Impedance setpoints configuration where the user can introduce values for the global configuration (parallel), channel U, V and W and the ramp.
5. Pauses. It is necessary to add a *Sleep* in between rows. This will determinate the duration of the setpoints. When configuring the parts 1, 2, 3 and 4, it is also necessary to determinate the time that this row will last using this *Sleep Time*. When an *Add Step* or a *Config Step* button is pressed, the *Sleep Time* will be added on the row. Please note that it is configured in milliseconds.



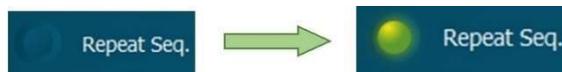
The minimum recommended value for a *Sleep* is 200ms.

The maximum and minimum values to be introduced in the parts **1**, **2**, **3** and **4** depend on the rated values of the equipment or the limits introduced by the user (chapter 4.5. *Limits*).

To add or modify a row of the sequence follow the steps:

- *Add Step*: press this button once the parameters are introduced and the values will appear the row in window B.
 - *Config Step*: if there is any row of windows B that the user needs to modify, double click directly to it in B and the values of that row will appear in the corresponding part of A. For example, if the user makes a double click in a row of B which is of power mode, the values of that row will appear in the part A3. Then, the values can be modified in A3 and when the correct parameters are introduced press *Config Step*. It will change the values of that selected row in B with the new parameters introduced in A3.
- **B:** This part shows all the rows that configure the sequence. It allows to operate with the rows, but no with the values of them. This window contains the following buttons:
 - *Move Row Up/Down*. Select a row and press these buttons to move a row up or down.
 - *Execute Sequence*. Once the sequence is ready, press this button and the converter will start the sequence.

- *Open test.* Another way to create a sequence instead of using the interface is building it with an external programme and save it as a CSV file. This button allows to open one of these files. The explanation of how to create this CSV file is in the manual of the equipment.
- *New test.* This button will erase all the rows to begin a new sequence.
- *Stop sequence.* When the sequence is running, and the user needs it to be stopped, this button will do it and the setpoints will remain in the row of the actual sequence.
- *Save test.* There is the possibility to save the created sequence. By pressing this button, the user will save the existent sequence in the B window in a CSV file in the desired location and name.
- *Delete row.* If the user requires to delete a row, click to it and press this button. It will disappear from the sequence.
- *Repeat test.* The sequence can be repeated by pressing the LED showed in the following figure:



When the LED is illuminated the sequence will start again when it arrives at the last row.

- *Time to next step.* This indicator will show how many seconds the actual row will last and start the next one.
- *Current row.* This indicator will show the number of the actual row.

The resulting .csv file after saving the sequence can be modified in a program (such as Excel). The user can also create the sequence from the beginning. This file must follow this pattern and can be as long as the user desires:

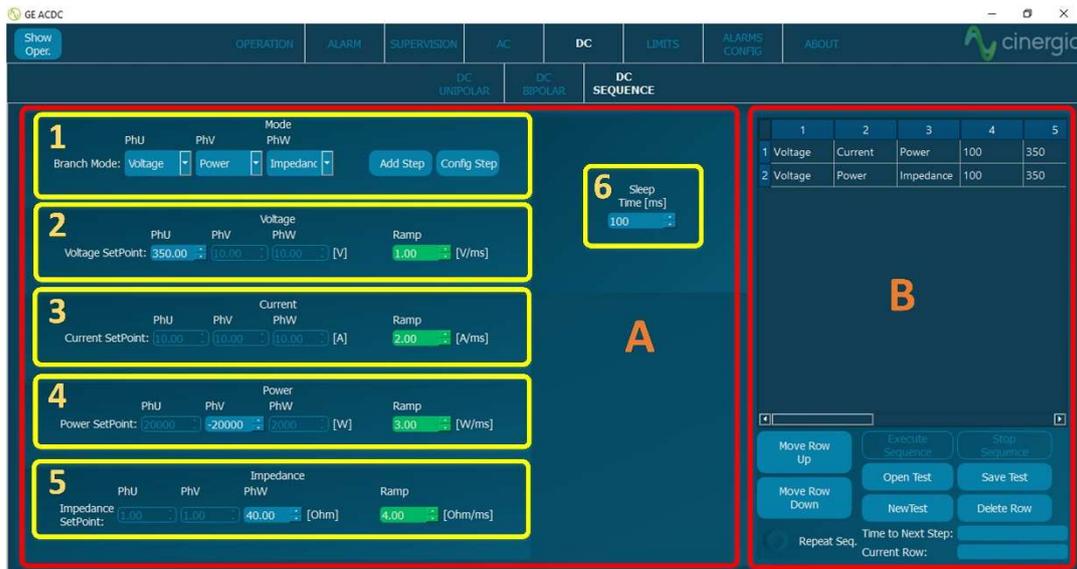
| Control mode | Sleep Time | Setpoint Global | Setpoint U | Setpoint V | Setpoint W | Ramp |
|--------------|------------|-----------------|------------|------------|------------|------|
| Voltage | 100 | 50 | 100 | 150 | 200 | 1 |
| Current | 1500 | -10 | 5 | 10 | 15 | 0.01 |
| Power | 2000 | 60000 | 20000 | -20000 | 3000 | 3 |
| Impedance | 3000 | 50 | 60 | 70 | 80 | 4 |

4.4.3.1. DC Sequence with independent branch control

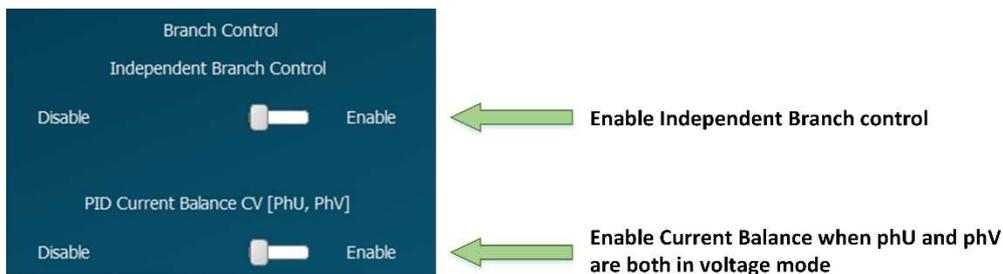
Equipment with independent branch control optional enabled can create another type of DC Sequence due to the more possibilities that the converter has.



Remember that independent branch control is an optional and has an additional cost.



To enable the independent branch control, go to the Operation tab and move the corresponding slider:



It is possible to configure the outputs with different modes, but it is known that two voltage sources together in parallel are not compatible. Cinergia converter can be configured with two voltage sources (phU and phV) at the same time, but it is necessary to enable the PID Current Balance with the corresponding slider.

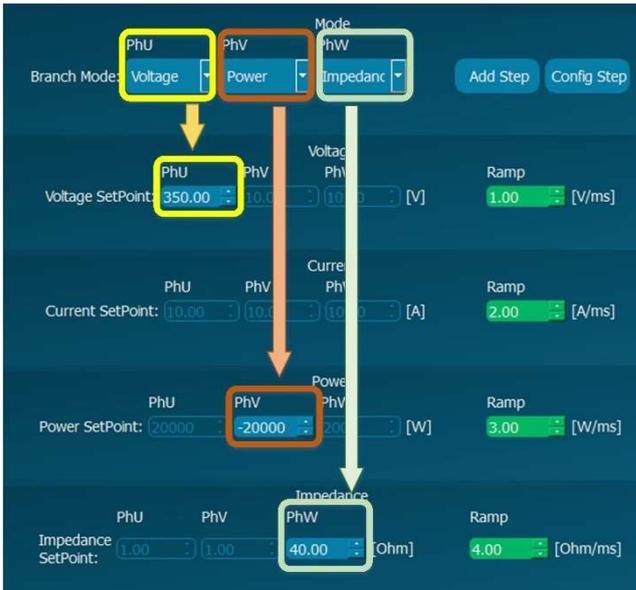


For more information about the independent control branch, please read the chapter 4.1.1. *Independent Branch Control* of this manual

- **A:** Part of the subtab to introduce all the values that will conform the sequence. This can be multiple, which means that the equipment can be in voltage, current, power or impedance mode in the same sequence.

The sequence is configured with rows and each row is one step of the sequence.

1. Define the control mode of each branch and by selecting the modes, the corresponding parts of 2, 3, 4 and 5 will be illuminated. As an example, the screenshot above has the branches configured as Voltage (phU), Power (phU) and Impedance (phW) and the setpoints must be introduced in the corresponding part:



Current setpoint is not available in this case because there is any branch with this mode

This part also contains two buttons: *Add Step* and *Config Step*. They are used to add or modify rows in the sequence.

2. Voltage setpoints configuration where the user can introduce values for the global configuration (parallel), channel U, V and W and the ramp.
3. Current setpoints configuration where the user can introduce values for the global configuration (parallel), channel U, V and W and the ramp.
4. Power setpoints configuration where the user can introduce values for the global configuration (parallel), channel U, V and W and the ramp.
5. Impedance setpoints configuration where the user can introduce values for the global configuration (parallel), channel U, V and W and the ramp.
6. Pauses. It is necessary to add a *Sleep* in between rows. This will determinate the duration of the setpoints. When configuring the parts 1, 2, 3 and 4, it is also necessary to determinate the time that this row will last using this *Sleep Time*. When an *Add Step* or a *Config Step* button is pressed, the *Sleep Time* will be added on the row. Please note that it is configured in milliseconds.



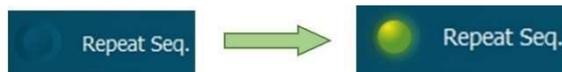
The minimum recommended value for a *Sleep* is 200ms.

The maximum and minimum values to be introduced in the parts **2**, **3**, **4** and **5** depend on the rated values of the equipment or the limits introduced by the user (chapter 4.5. *Limits*).

To add or modify a row of the sequence follow the steps:

- *Add Step*: press this button once the parameters are introduced and the values will appear the row in window B.
- *Config Step*: if there is any row of windows B that the user needs to modify, double click directly to it in B and the values of that row will appear in the corresponding part of A. For example, if the user makes a double click in a row of B which is of current mode, the values of that row will appear in the part A3. Then, the values can be modified in A3 and when the correct parameters are introduced press *Config Step*. It will change the values of that selected row in B with the new parameters introduced in A3.

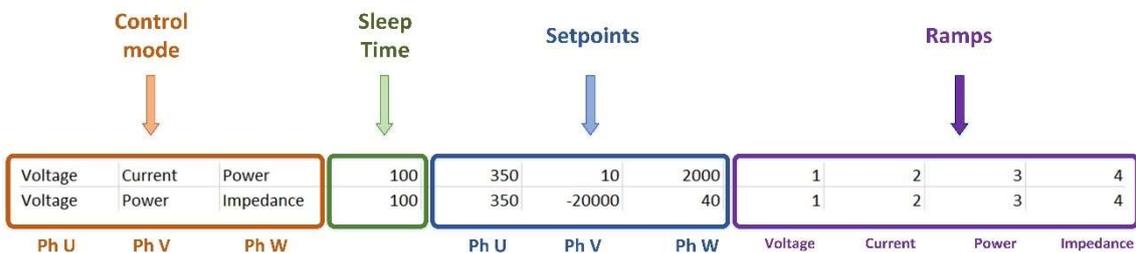
- **B:** This part shows all the rows that configure the sequence. It allows to operate with the rows, but no with the values of them. This window contains the following buttons:
 - *Move Row Up/Down.* Select a row and press these buttons to move a row up or down.
 - *Execute Sequence.* Once the sequence is ready, press this button and the converter will start the sequence.
 - *Open test.* Another way to create a sequence instead of using the interface is building it with an external programme and save it as a CSV file. This button allows to open one of these files. The explanation of how to create this CSV file is in the manual of the equipment.
 - *New test.* This button will erase all the rows to begin a new sequence.
 - *Stop sequence.* When the sequence is running, and the user needs it to be stopped, this button will do it and the setpoints will remain in the row of the actual sequence.
 - *Save test.* There is the possibility to save the created sequence. By pressing this button, the user will save the existent sequence in the B window in a CSV file in the desired location and name.
 - *Delete row.* If the user requires to delete a row, click to it and press this button. It will disappear from the sequence.
 - *Repeat test.* The sequence can be repeated by pressing the LED showed in the following figure:



When the LED is illuminated the sequence will start again when it arrives at the last row.

- *Time to next step.* This indicator will show how many seconds the actual row will last and start the next one.
- *Current row.* This indicator will show the number of the actual row.

The DC sequence with independent control branch is possible such as the sequence without independent branch explained in the chapter before. But there are differences between one .csv file and another. The pattern to follow when creating a .csv file with the independent control branch is the following:



Please note that in the first row, for example, the impedance is not used, and it means that the ramp that affects this parameter makes no effect to this row (the “4” at the end of the row). Whereas in the second row, the current does not appear, so the value “2” of the ramp at the end of the row is not used.

4.4.4. Battery charger (OPTIONAL)

The equipment is prepared to charge and discharge batteries and create cycles to test them. The user must introduce the basic parameters (maximum and minimum voltage and current of the battery...) and the converter will start charging, discharging or both. Remember that it is possible to work with 3 independent power supplies (independent unipolar connection), 2 independent power supplies (independent bipolar connection) or 1 power supply (parallel unipolar connection).

The interface will make visible or not the parts to introduce the parameters depending on the connection mode. If the user selects independent unipolar mode (3 power supplies), the Human Machine Interface will make visible 3 channels and it will be possible to test 3 different batteries with different characteristics each one.

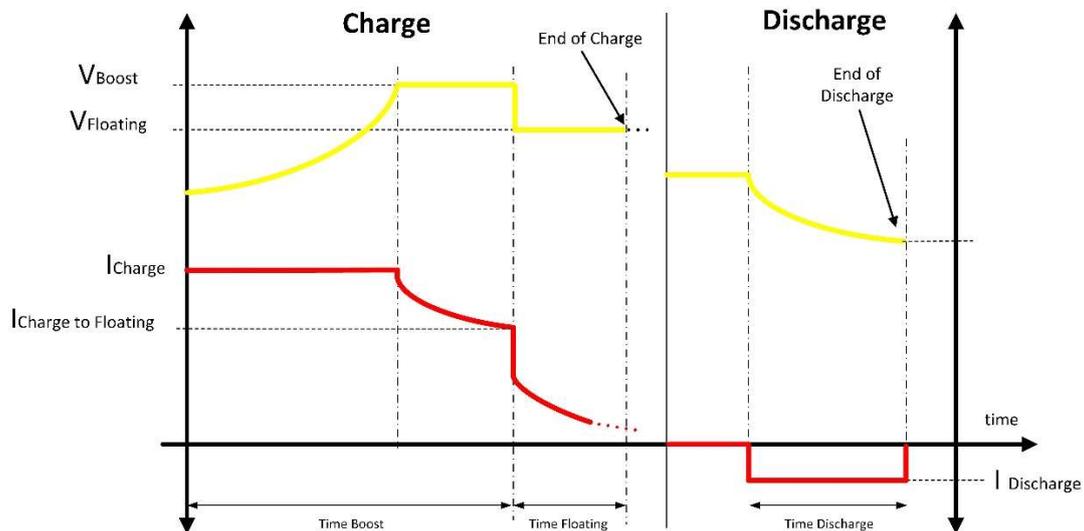


- **A:** Window where all the battery parameters can be introduced.
 1. **Boost Voltage.** Maximum voltage of the battery. The equipment will charge the battery until it reaches this voltage.
 2. **Charging Current.** Maximum accepted input current of the battery. The higher the current is, the faster will be charged the EUT, but be sure that this parameter is lower than the maximum current accepted of the battery.
 3. **Floating Voltage.** Once the battery has reached the boosting voltage (the maximum voltage), the converter will make the EUT to remain in the floating voltage which is lower than the *boost voltage*.
 4. **Charging to Floating Current.** To make the battery remain in the *floating voltage* some current must flow inside the it, otherwise it would lose voltage. Once this current reaches the introduced value, the equipment will start discharging the battery.
 5. **Discharging Voltage.** It is the minimum voltage where the converter will make the battery reach. A lower voltage than the one accepted for the EUT would make it irreversible damages in the battery.
 6. **Discharging Current.** The Cinergia equipment will discharge the battery until the *discharging voltage* with this current. It is the only parameter that must be negative. If the user introduces a value which is higher than the one accepted for the EUT, it would make irreversible damages in the battery.



Please be sure that all parameters are appropriate for the battery where the Cinergia converter is connected. For example, an over current or voltage can make irreversible damages to the EUT.

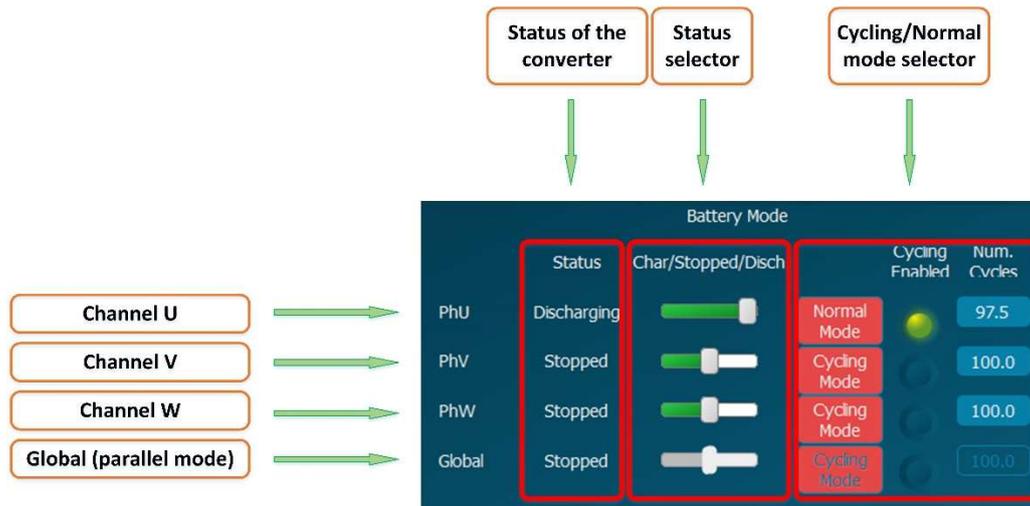
There is a figure in the part **B** that illustrates all that parts above mentioned:



7. Control buttons:

- Save to CSV.** All the introduced parameters above (from 1 to 6) can be saved and named in a .csv file so it won't be necessary to remember and reintroduce the parameters of a test.
- Load CSV file.** To load the parameters saved before, press this button and look for the file in the computer. It is important that this file is saved in .csv format.
- Advanced Settings.** Apart from these basic settings described above, the converter can control the battery with some other parameters which make the regulation of the EUT much more realistic. The description of these parameters is in the document *Battery advanced settings v2*.
- Send Set Points.** This button will introduce the parameters of the parts 1 to 6 inside the Cinergia equipment, but it won't start charging or discharging the equipment until it is in *Run* state.

- **B:** As it is explained before, this figure shows all the parameters of **A**.
- **C:** This window controls the status of the converter. The allowed status is *Charging*, *Discharging* and *Stopped*. The detail of this window is in the following image:



- *Status of the converter.* It is an indicator that shows the status in the actual moment.
- *Status selector.* The user must select the status by moving the slider right or left (right goes to discharge and left to charge. The slider in the middle means Stop). If the status is *Stopped*, the equipment won't start charging nor discharging. If the connected battery is discharged and the user select *Disch*, the Cinergia equipment will go to alarm state. It happens the same when the battery is charged and the user select to charge it.
- *Cycling selector.* In this part of the window, the user can enable the cycling mode of the equipment. If the cycling mode is selected, the corresponding LED is illuminated. To go back to normal mode, press again the red button *Normal Mode*.
It is also possible to determinate the number of cycles that the equipment will make to the EUT. To introduce the number of cycle, write it directly in the blue space of this window and press *Intro*. Once all the cycles are completed, the equipment will stop automatically.

All these operations can be done for each channel as the figure shows. The first row is for the U channel, the second for the V, the third for the W and the last for the parallel mode (global).

- **D:** This window contains indicators of the voltage and current for each channel. It also has another parameter to be introduced in the converter: the amps per hour of the battery. This value must be negative and is the value that indicates the capacity of the battery. For example, if the battery has a capacity of 100Ah, it means that can deliver 10A during 10h or 1A during 100h and so on. To introduce this parameter, write it to the corresponding blue window depending on the channel to be introduced and press intro in the keyboard.



To make the equipment work with a battery, the user must follow this order: with the equipment in *Ready* state, introduce and send all the parameters (from 1 to 6 described above and the send button of 7). Once the parameters are sent, run the Cinergia converter and it will start charging or discharging the battery depending on the selected mode chose in windows C (for each channel). If the selected mode is *Stop*, the converter will not start sending any current.

Please, read the *Battery charger optional* document for more Information.

4.4.5. Battery emulator (OPTIONAL)

Equipment with DC output can have the optional Battery Emulator. To activate it, contact Cinergia to get the upgrade code.

In this function mode, the power converter can emulate any kind of battery.

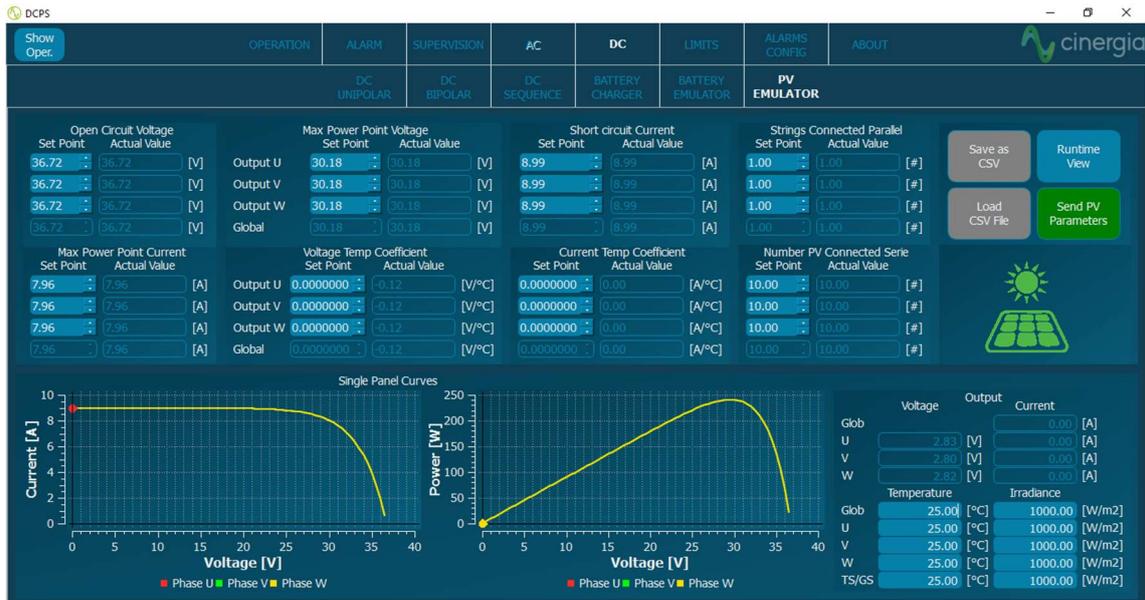


Please, read the *Battery emulator optional* document for more Information.

4.4.6. PV emulator (OPTIONAL)

Equipment with DC output can have the optional PV Emulator (Photo Voltaic Emulator). To activate it, contact Cinergia to get the upgrade code.

In this function mode, the power converter is emulating a photovoltaic solar panel.



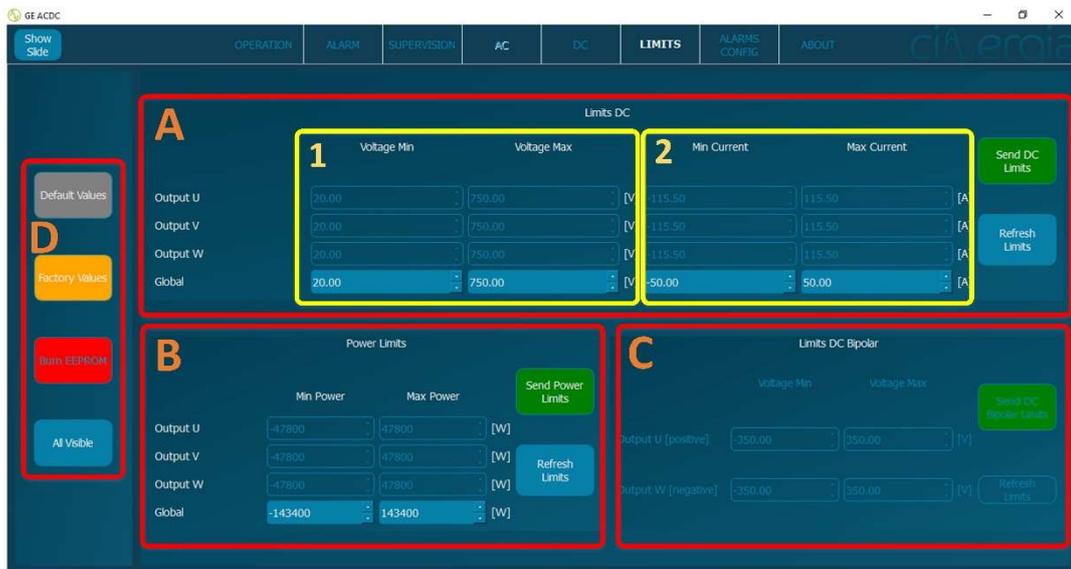
Please, read the *PV emulator optional* document for more Information.

4.5.Limits

The user can define the limits of the equipment in this tab. The converter has its own factory limits, but it is possible to introduce new ones.



The condition for these new limits is that they must be lower (in case of maximum limits) or higher (in case of minimum limits) than the factory ones, otherwise the equipment will introduce the factory limits.



The interface will freeze or unfreeze (illuminate) the available parts where the user can introduce the parameters depending on the connection mode (parallel or independent).

- **A:** Voltage and current limits section.
 1. Voltage limits. The user can set the maximum and minimum limits for each phase (independent connection) or for the global (parallel connection). Please note that the maximum voltage is the same if the equipment is in parallel or independent.
 2. Current limits. The user can set the maximum and minimum limits for each phase (independent connection) or for the global (parallel connection). The current in parallel mode is 3 times the current for each channel in independent connection.

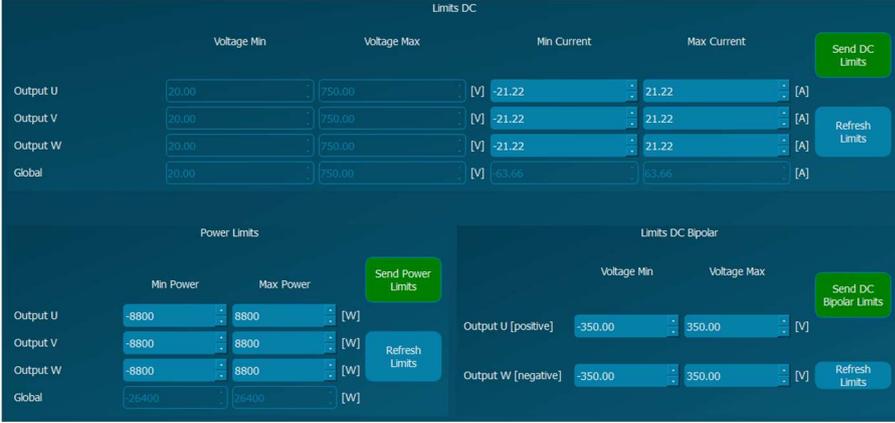


The minimum and maximum upper and lower current limits are, respectively, 1A and -1A

- **B:** Power limits. The user can set the maximum and minimum limits for each phase (independent connection) or for the global (parallel connection). The power in parallel mode is 3 times the power for each channel in independent connection.
- **C:** Bipolar limits. This part of the tab will be illuminated when the equipment is in bipolar connection. The maximum voltage in unipolar is 750V whereas that in bipolar is $\pm 350V$. This is the reason that bipolar connection is required a new part to send voltage limits

(current limits are the same than in unipolar). The user can introduce new voltage limits as long as they are lower, in case of maximum limits, or higher, in case of minimum limits, than the factory one.

This tab in bipolar connection is the following:



The screenshot shows the 'Limits DC' tab with the following data:

| | Voltage Min | Voltage Max | Min Current | Max Current |
|----------|-------------|-------------|-------------|-------------|
| Output U | 20.00 | 750.00 | [V] -21.22 | 21.22 [A] |
| Output V | 20.00 | 750.00 | [V] -21.22 | 21.22 [A] |
| Output W | 20.00 | 750.00 | [V] -21.22 | 21.22 [A] |
| Global | 20.00 | 750.00 | [V] 63.66 | 63.66 [A] |

The 'Power Limits' section shows:

| | Min Power | Max Power |
|----------|-----------|-----------|
| Output U | -8800 [W] | 8800 [W] |
| Output V | -8800 [W] | 8800 [W] |
| Output W | -8800 [W] | 8800 [W] |
| Global | 26400 [W] | 26400 [W] |

The 'Limits DC Bipolar' section shows:

| | Voltage Min | Voltage Max |
|---------------------|-------------|-------------|
| Output U [positive] | -350.00 [V] | 350.00 [V] |
| Output W [negative] | -350.00 [V] | 350.00 [V] |

Each part (A, B and C) has two different buttons explained in the following lines. It is important that, for example, voltage limits must be sent, the buttons to use are the ones in the A part.

- *Send DC Limits.* Once all the limits are introduced in the corresponding part, press this button and the parameters will be sent to the converter.
- *Refresh Limits.* This button will show the limits values that are in the converter in that moment.



If the equipment is in RUN mode with a value that is outside the new introduced limits, it will change the actual setpoint. For example, if the converter is in voltage mode with a value of 500V and the user introduces (and sends) a limit of 300V, the equipment will go to 300V and remain there. If the limit is only introduced in one channel, it is going to be that channel the one which go to that limit.

- **D:** These buttons allow the user to operate with the values of the limits.
 - *Default Values.* The user can define default values that will remember the equipment as long as it is switched on and lower than the *Factory Values*.
 - *All Visible.* This button unfreezes all the windows so that the user can set the *Default Values*. Remember that the limits are not introduced to the equipment until *Send Limits* buttons on each window (A, B and C) are pressed.
 - *Factory Values.* The equipment has its own factory values depending on the rated power. This button will make these parameters appear in the visible windows.
 - *Burn EEPROM.* To save the sent values to the equipment and make it remember them even it is switched off, the EEPROM can be burnt. This step requires a password.



When the converter is switched off and on again, these limits will be erased and substituted for the factory ones. It is possible to save limits in the equipment in the EEPROM memory, but a password is required

4.6. Alarms Configuration

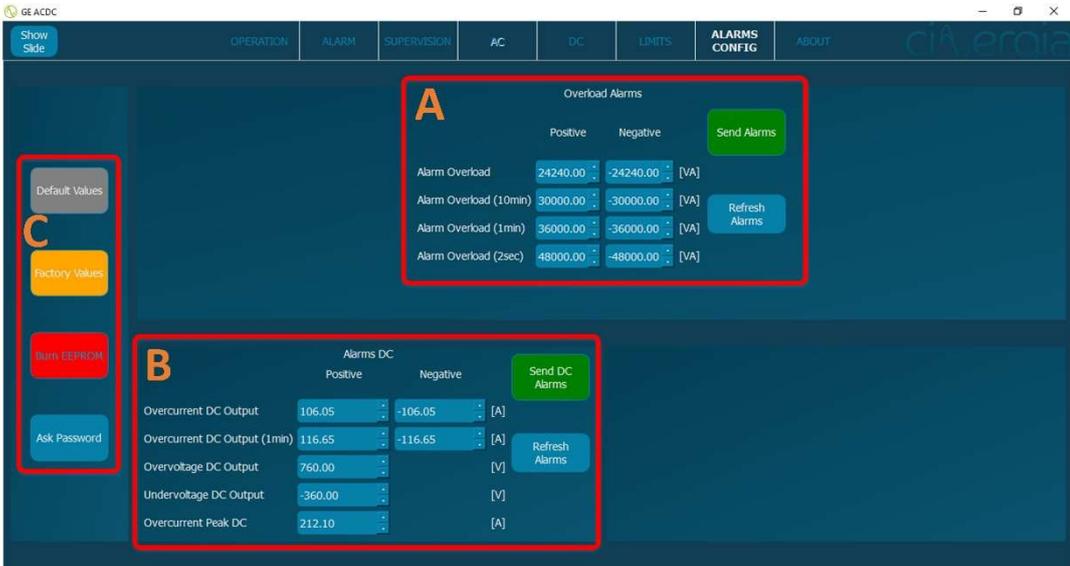
This tab sets the alarms of the equipment. The difference between *Limit* and *Alarm* is that the equipment can work during a certain time above the limits, but if there is some value that goes further than some alarm parameter, the equipment will go to alarm state.



Depending on the connection mode of the equipment (AC or DC), this tab will automatically change and the parameters that will appear will be the ones according to the mode.



The minimum and maximum upper and lower current alarms are, respectively, 1A and -1A



| | Positive | Negative | |
|------------------------|----------|-----------|------|
| Alarm Overload | 24240.00 | -24240.00 | [VA] |
| Alarm Overload (10min) | 30000.00 | -30000.00 | [VA] |
| Alarm Overload (1min) | 36000.00 | -36000.00 | [VA] |
| Alarm Overload (2sec) | 48000.00 | -48000.00 | [VA] |

| | Positive | Negative | |
|------------------------------|----------|----------|-----|
| Overcurrent DC Output | 106.05 | -106.05 | [A] |
| Overcurrent DC Output (1min) | 116.65 | -116.65 | [A] |
| Overvoltage DC Output | 760.00 | | [V] |
| Undervoltage DC Output | -360.00 | | [V] |
| Overcurrent Peak DC | 212.10 | | [A] |

- **A:** Set the overload alarms and once the values are ready press *Send Alarms* button. If the user presses *Refresh Alarms*, the parameters that the converter has in that moment will appear in the window.
- **B:** Set the DC alarms and once the values are ready press *Send DC Alarms* button. If the user presses *Refresh Alarms*, the parameters that the converter has in that moment will appear in the window.
- **C:** These buttons allow the user to operate with the values of the limits.
 - *Default Values*. The user can define default values that will remember the equipment as long as it is switched on and lower than the *Factory Values*.
 - *All Visible*. This button unfreezes all the windows so that the user can set the *Default Values*. Remember that the limits are not introduced to the equipment until *Send Limits* buttons on each window (A, B and C) are pressed.
 - *Factory Values*. The equipment has its own factory values depending on the rated power. This button will make these parameters appear in the visible windows.

Burn EEPROM. To save the sent values to the equipment and make it remember them even it is switched off, the EEPROM can be burnt. This step requires a password.

4.7. About

This tab shows the characteristics of the equipment. It is very important to get acquainted with this tab because in case of problems with the equipment, CINERGIA will require this information to success with the reparation.



| | ABR | INV |
|-----------------------------------|--------------------------|--------------------------|
| Serial Number | 201706271 | 201706271 |
| Device Designator: | GE AC DG | GE AC DG |
| Power Designator: | 15kVA | 15kVA |
| Software Version: | 43fa74ef | 43fa74ef |
| DO Version: | 148 | 148 |
| Calibrated: | <input type="checkbox"/> | <input type="checkbox"/> |
| Dictionary Version PC Embedded | 147 | |
| Motor Version | 1.161 | |
| Dictionary Version PC Software | 147 | |

Hardware and Software Upgrade

High Voltage:

B Software Upgrade

Independent Branch Control: Battery Emulator:

Power Amplifier: Battery Charger:

LabView Interf: PV: Emulator:

High Freq. Switching:

Unlock extra:

C v1.511

This software is for CINERGIA's equipment Commissioning and Operation
It is based on NIOMIA'S TCP/IP communications
Please make sure you have read the Operator's Manual

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- **A:** Basic description parameters of the equipment. This basic information will be very useful to Cinergia in case of problems with the equipment. If this happens, please make a screenshot of this tab.
- **B:** Optional of the converter. By entering the password delivered by Cinergia, it is possible to unblock the available optional of the equipment. The OPTIONAL will be indicated with a LED so, for example, in the figure above the only activated optional is the *Independent Branch Control*. It has an additional cost. In case to get the activation code, introduce it, press *Send* and do not get any result, please make a screenshot of this tab to send it to Cinergia.
- **C:** Interface version. This information will also be useful to Cinergia in case of problems.



In case of problems with the converter, please make a screenshot of this tab and send it to Cinergia.