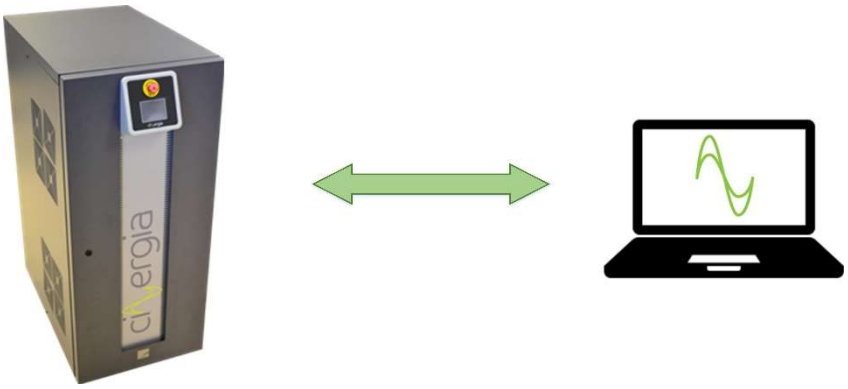
Electronic Load (EL+ AC) Human Machine Interface

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.



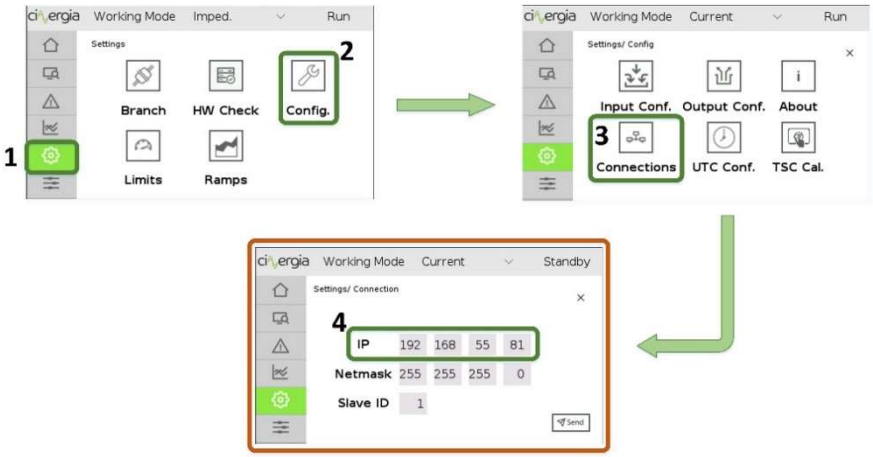
This manual is valid for the following versions:

1.511, 1.512

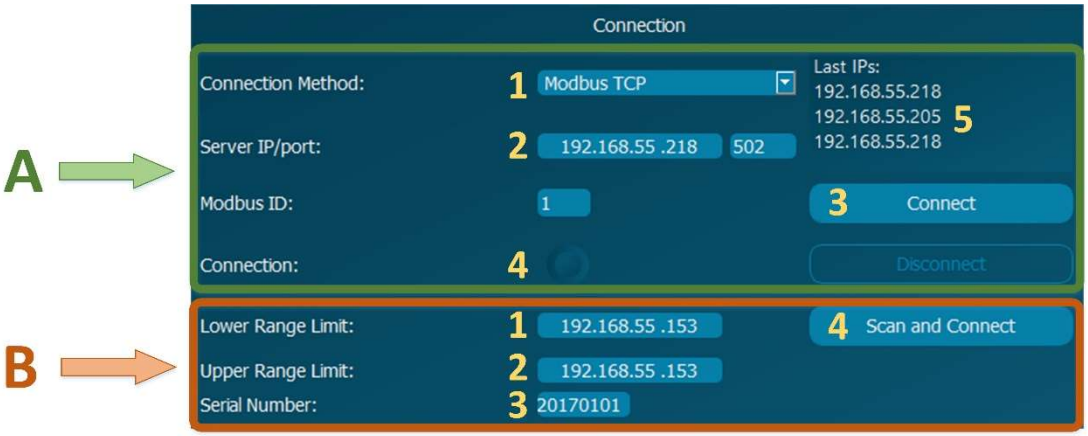
2. HUMAN MACHINE INTERFACE

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

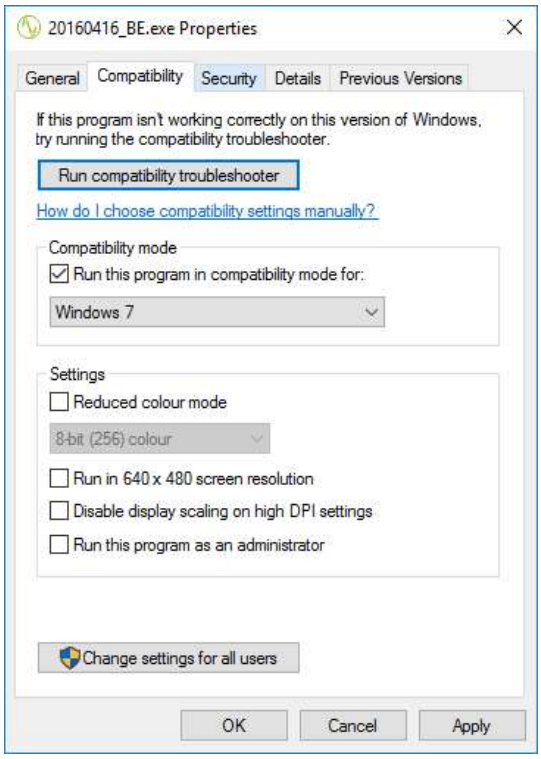
B- Known the serial number of the equipment and the range of IPs that the equipment is located. The serial number is written in the front of the equipment with the specification data. If the equipment has a serial number such as 20170101-1, the number to introduce must be without the hyphen: 201701011. 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.

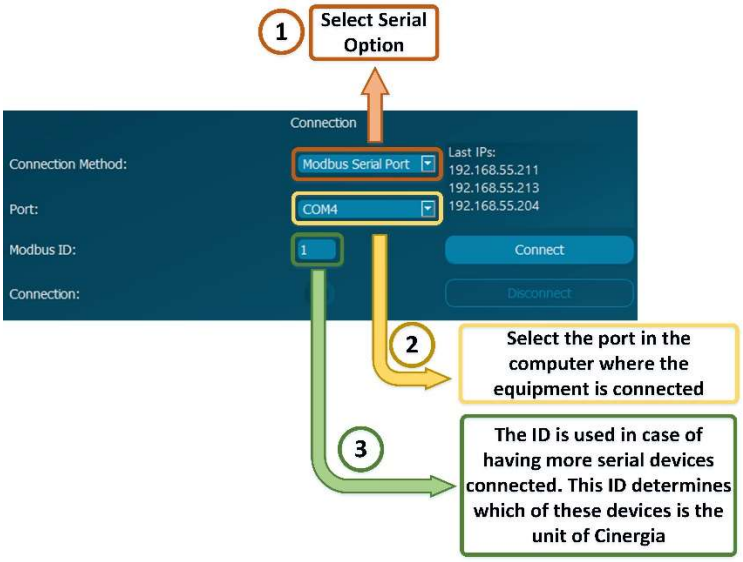
If there is an error when trying to run CINERGIA application, please check the compatibility mode of your computer. For instance, in a Windows 7 computer, right click CINERGIA application → *Properties*; go to *Compatibility* panel and check the box *Run this program in compatibility mode*; and select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



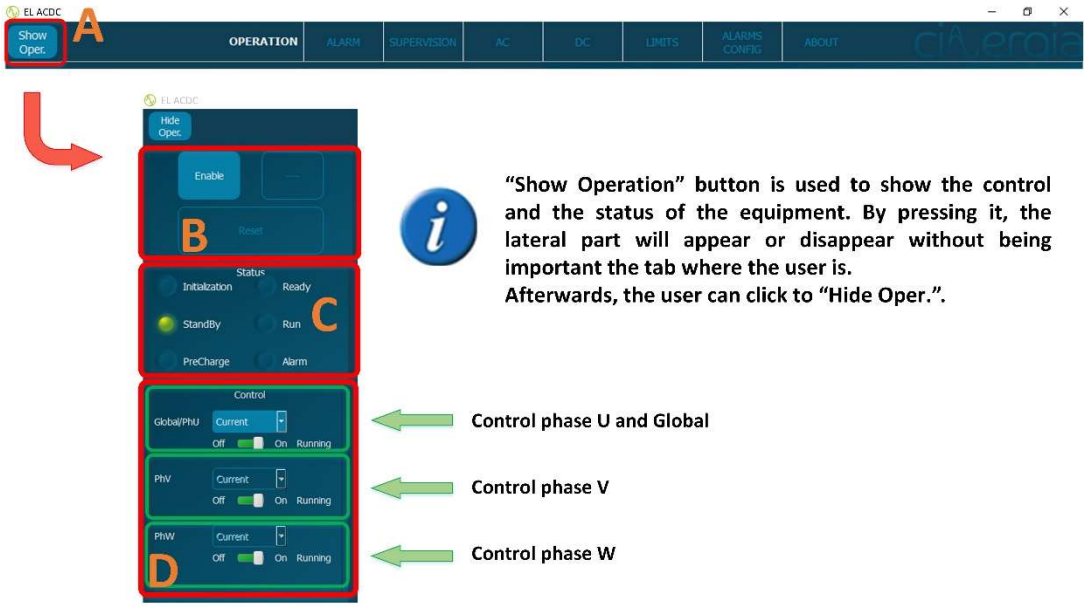
The interface delivered by Cinergia has a correct visualization with screens configured with a minimal resolution of 1366x768 (16:9)

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 BUTTON



- **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 EL allows current control.
    - In DC , the EL 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.

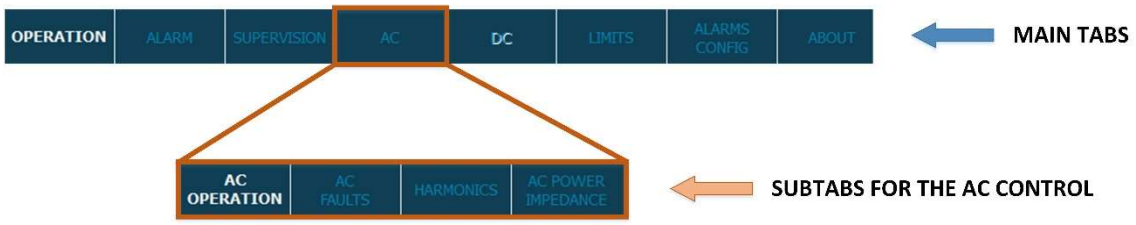
To select the mode unified or separate, please read the chapter **3** part D.

Independent control 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

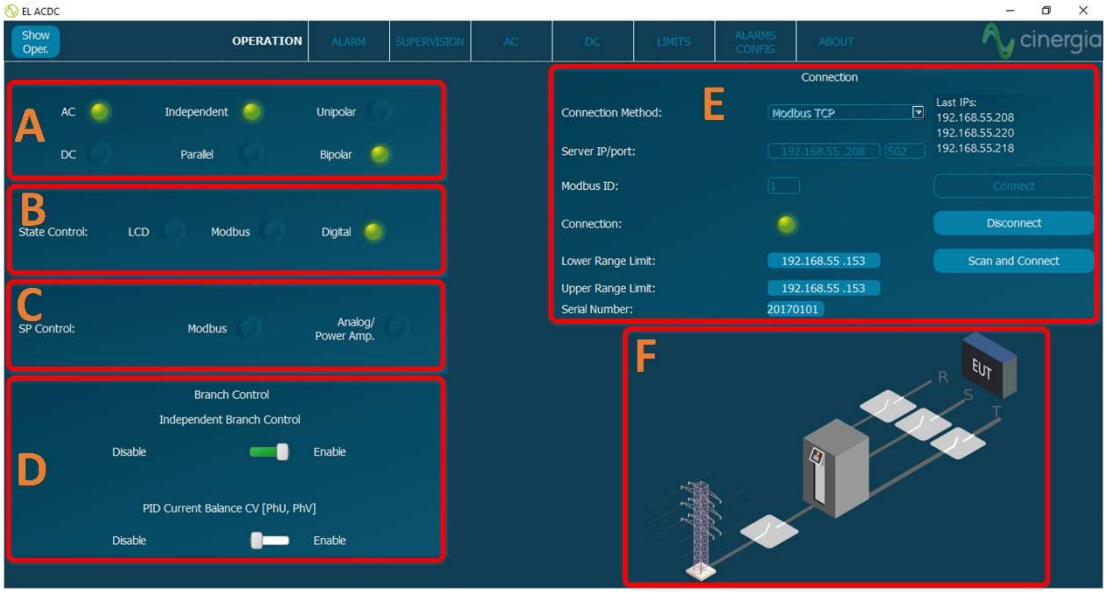
To create a friendly navigation of the interface, Cinergia has designed a Tab Dialog distribution, in which each tab has one of the following purposes:



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



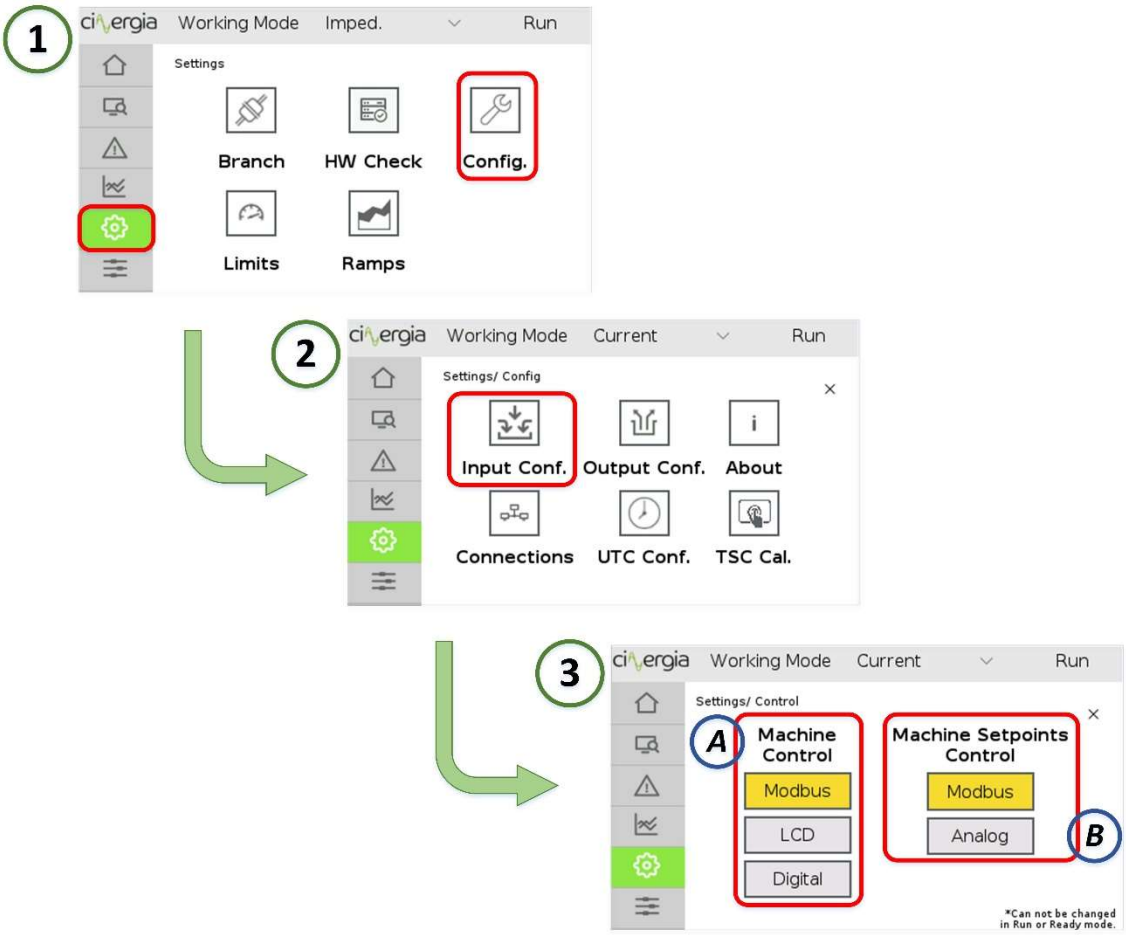
- **A:** Connection mode. Informs about the connection:
  - AC Independent Bipolar (note that AC unipolar is not allowed)

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:
  - <u>LCD:</u> control from LCD screen.
  - <u>Modbus:</u> control using Modbus Ethernet (IP) or serial port.
  - <u>Digital:</u> control with digital/analogue control.

  The selection of the control mode is set throw the LCD touchscreen (please see figure below)
- **C:** Informs about which is the equipment's setpoint control:
  - <u>Modbus:</u> the setpoint is sent via Modbus (interface)
  - <u>Analogue / Power Amplifier:</u> the setpoint is sent with an analogue signal. There is also the possibility to us the converter as a power amplifier (optional).

  The following figure explains how to change the control mode throw 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: 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.

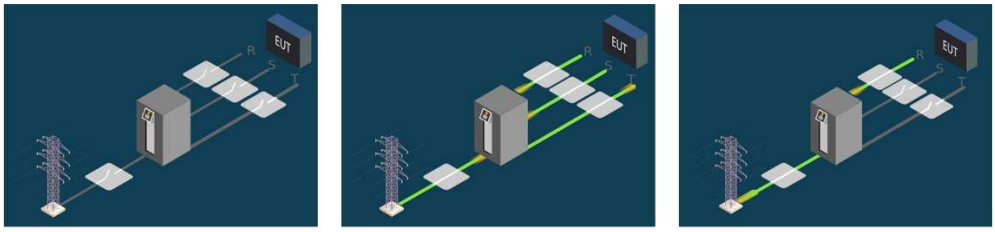
If the equipment is working with separated branches, the user can activate a PID control between the phases U and V which balances the current passing through them.

- **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.



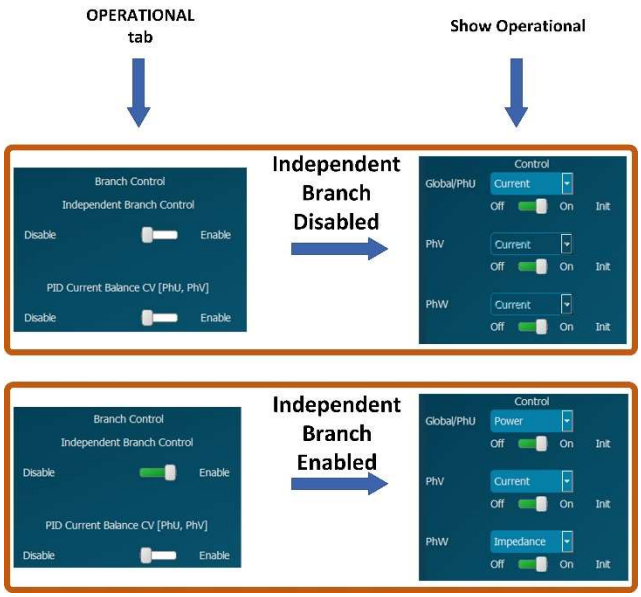
EQUIPMENT NOT RUNNING | EQUIPMENT WITH ALL 3 PHASES RUNNING | EQUIPMENT WITH U PHASE RUNNING (only with separate mode)

4.1.1. Independent Branch Control (OPTIONAL)

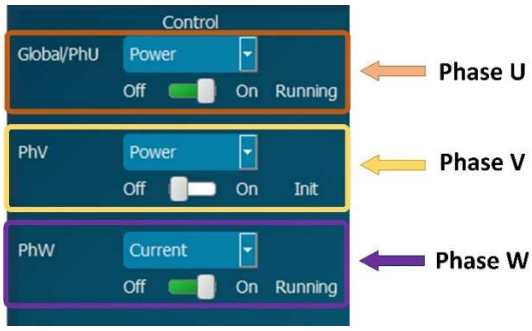
This optional allows the user to control each branch (U, V and W) separately, which means that the phases can be in a different status (*Initialization*, *Running*, *Warning* or *Alarmed*) and a different control mode (*Voltage*, *Current*, *Power* or *Impedance*).

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

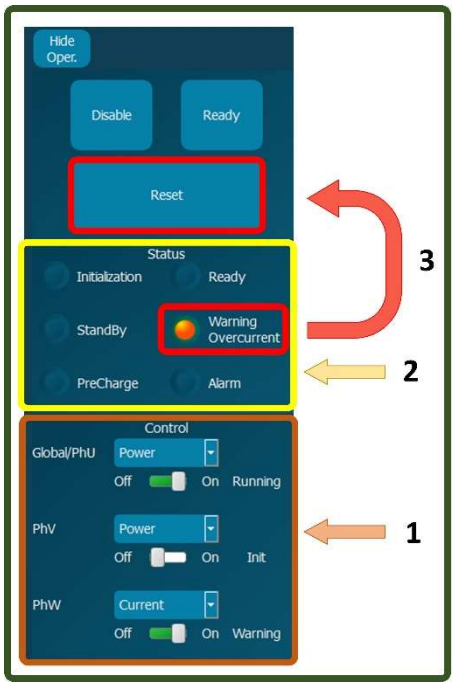
To activate or disactivate this mode, go to the Operation tab and select the control with the slider:



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:

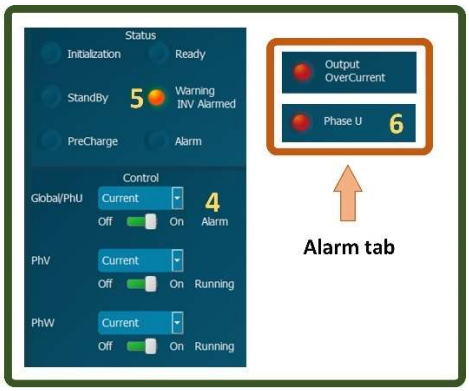


1- It is visible how the 3 phases are in a different control mode: PhU and PhV are in Power mode whereas PhW is in Current mode. Also, the status per phase is different and it is indicated next to them (Running, Initialization and Warning).

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 un frozen 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:



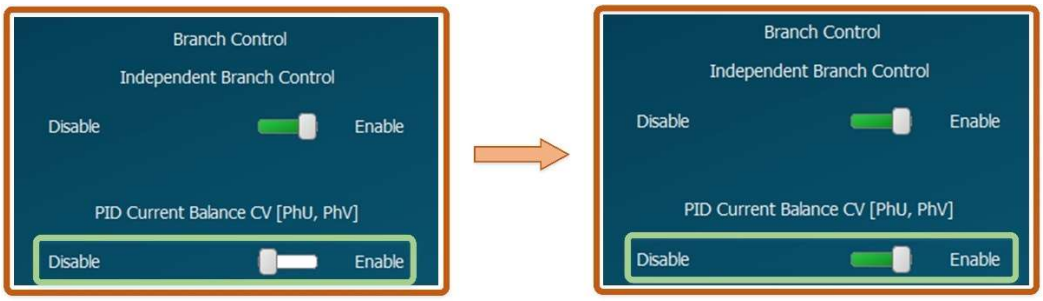
1- The interface notices that phase U is in *Warning* state for some reason.
2- This reason results to be an *Overcurrent*, that is why it appears the Warning LED.
3- In the *Alarm* tab, the *Output OverCurrent* and *Phase U*. Please note that all phases of the converter is still running.
4- Phase U 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 Slide* button:

1. Press *Show Slide* 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. AC

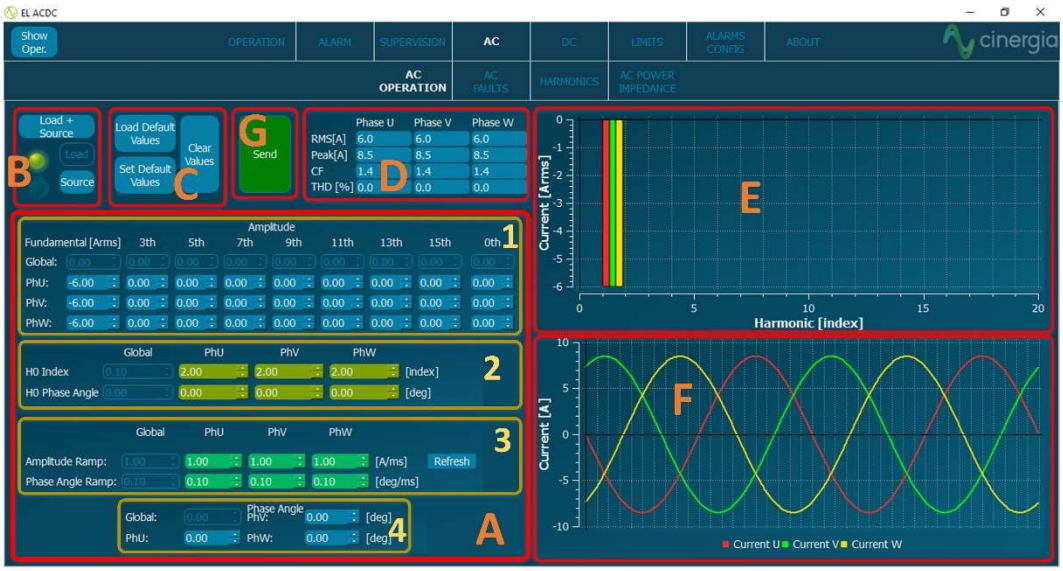
This tab contains all the subtabs concerning the AC mode: *AC Operation*, *AC Faults*, *Harmonics* and *AC Power Impedance*.

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. AC Operation

This subtab allows the user to send all the AC parameters to control the Cinergia converter in AC mode: current setpoints, harmonics, phase angles and ramps. It is also possible to define the converter as a load or as a source.

The 2 buttons *Load* and *Source* described in the following chapter is used only for helping the user to understand whereas the equipment is delivering or injecting current. It can be important, for example, if the EUT connected in the output only allows one kind of current (injected or delivered). These buttons do not make changes in the Cinergia equipment but only in the interface. If the button pressed is *Load*, for example, the interface will allow negative current setpoints.



- **A:** Part of the subtab to introduce all the parameters to be sent to the converter.
  1. Set the fundamental amplitude of the current setpoint in the first column. The other 8 columns are for the harmonics setpoints. The units for the first column are amperes, whereas the other columns are a percentage of the first column. From the 3th until the 9th harmonic, the percentage can go from 0% to 100% (0 to ±1), the 11th harmonic can go from 0% to 50% (0 to ±0.5), whereas 13th to 15th can reach 20% (0 to ±0.2).
     Please note that there is a column at the end with a harmonic "0". This parameter allows to introduce a harmonic where the user requires. It is explained in the chapter **4.4.1.1** of this manual.

If the equipment is in parallel, the only available setpoints to introduce are in the first row and are common for all 3 phases (parallel mode).

2. Control of the position the harmonic "0". The position means the index, which places the harmonic in the desired position within the rang 0.1 to 50, and the phase angle, that means the angle that this harmonic will has referenced at himself. This phase angle can go from -360º to 360º. Further information is found in the chapter 4.4.1.1 of this manual.
3. Ramps section. It controls the softer or faster change of the setpoints of amplitude (fundamental and harmonics) and phase angles. If the equipment is in parallel mode, the ramps are controlled only in the first column.
   Refresh button is for load the default values, which are *1V/ms* and *10deg/ms*.
4. Set the phase angle for each phase in concordance with the voltage of the same phase. For example, the first channel will be synchronized with the voltage that the equipment has in the U (delivered by an external voltage source), and the phase angle will set the angle between the voltage and the current of that channel. The maximum and the minimum are 90º and -90º.

If the user introduces a parameter which is out of the converter limits, the interface will not allow to send it. Please read the manual to know which are the limits of the converter.

- **B:** Define if the converter must behave as a load or as a source. When it is in *Load* mode (absorbing current), the only setpoints available are negative whereas when the converter is in *Source* mode (delivering current), the setpoints must be positive.
- **C:** The 3 buttons are used to help the user saving time by remembering default values of the parts **1** and **3** described above from window **A** (ramps cannot be saved). They can be established by pressing *Set Default Values* and it will save the actual parameters. After pressing this button, the user can use *Load Default values* to refresh them again. *Clear Values* will set to 0 all the numbers.
- **D:** Information part. Meanwhile the user is introducing the setpoints, the theoretical values (RMS, peak, crest factor and the total harmonic distortion) are being calculated and displayed.
- **E:** Information part. Graphs are being drawn meanwhile entering the data in the **A** part. From left to right, the values of fundamental and harmonic setpoints are being displayed.
- **F:** Information part. Graphs are being drawn meanwhile entering the data in the **A** part. This is a waveform graph and it is the same that will appear on any oscilloscope connected to the output of the converter.
- **G:** Once all the values of the parts described above are correct, the user must press *Send*. This shall be done in Run state, otherwise the setpoints will not appear in the output.

4.4.1.1. Harmonic 0

This harmonic can work as a joker and be placed in every desired part of the "index" graph displayed in part **D** of the AC OPERATION tab. It will add its value to the present value selected on the part **A1**. So, for example, if the fundamental value is 10A and the value of this H0 harmonic is 0.5 with the index 1 (which means fundamental), this phase will be increased 50%: 10+0.5·100=15A (this operation is 10A + 50% of 10A). If the value was -0.5, the operation would be: 10-0.5·10=5A. The following two images illustrates these operations:

1. It is defined a fundamental amplitude of the phase U of 10A
2. A H0 (joker harmonic) is set up to 0.5 (50%)
3. The position of the H0 harmonic is 1, which means that is the same of the fundamental
4. It is drawn both graphics: the harmonic index and the waveform
5. The theoretical values are clear: 10A of fundamental with +50% of itself has a RMS result value of 15A.
6. If the H0 was -0.5 instead of 0.5, the result would be 5ARMS as it can be seen in the theoretical values and the index graph, where -5A are drawn below the 10A of the fundamental.

4.4.2. AC Faults

Current faults must be executed over an existing grid, so it is important to have a grid in the input and the output of the converter (it will appear in the supervision tab). As the converter is an electronic load, it is required a voltage source connected to the output before any current setpoint (fault or not) is applied.

- **A:** Selection of the fault. By selecting each fault, the corresponding part is going to be illuminated. Please note that *Frequency Variation* is never illuminated because the Electronic Load cannot modify the frequency: each phase is adapting to its reading voltage.
- **B:** Current Dip and Over/Under Current configurations. Introduce the percentage of the current and the angle of each phase. Note that 0% means 0A and 50% is the half of the actual current. A *Delta Angle* of Xº means that the current of that phase will remain all the fault with that phase angle between the current and the voltage of that channel. There are also ramps for the current and the angles. The buttons *Add Step* and *Config Step* are explained at the point **H** of this chapter.
  The following images illustrate the same current dip with different *Delta angle* (the channels are U-yellow, V-green and W-purple):

Fault duration

Delta angle = 0º

Fault duration

Delta angle = 90º

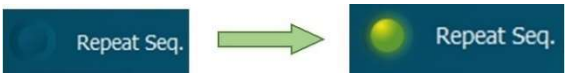
- **C:** Frequency Variation configurations is not available in the Electronic Load converter of Cinergia because it adapts its frequency to the one that reads in the output. For example, if the Electronic Load is connected to a voltage source that delivers a grid with 70Hz, the current of the converter will synchronize with it and it will appear a current with 70Hz. The range of the frequency is 10 to 400Hz and the maximum value of the current is adapting depending on the frequency.
- **D:** Flicker configurations. It will introduce an over/under current modulated by the introduced frequency. The minimum and maximum values for current and frequency are, respectively, 0%, 50% and 0.01Hz, 20Hz. For example, when the current percentage is 20%, the current reaches the actual value of current A_{RMS} ± 20%. The value of frequency represents the frequency of the modulated wave. The ramps FadeIn and FadeOut represent the %/ms of the change. The buttons *Add Step* and *Config Step* are explained at the point **H** of this chapter.
- **E:** Add pauses in between faults when creating a fault sequence. The minimum recommended Step Time (pause) is 200ms.
- **F:** Create a current grid at the beginning to add faults on it or modify an existing grid in between faults. The parameters to introduce are the RMS current, the angle and ramps for all three elements of each phase. The buttons *Add Step* and *Config Step* are explained

at the point **H** of this chapter. Remember that to set the current values, it is important to have a voltage source connected to the output of the converter.

- **G:** General configurations of the fault. Set the duration of any fault and the starting angle referenced at the U channel. By pressing "Execute Single Fault" the selected fault will start with the sent parameters. The buttons *Add Step* and *Config Step* are explained at the point **H** of this chapter.

In windows **B**, **C**, **D**, **E** and **F** there are the buttons "*Add Step*" and "*Config Step*". They are used to add or modify points in the sequence created in the window **H**:

- **H:** 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.

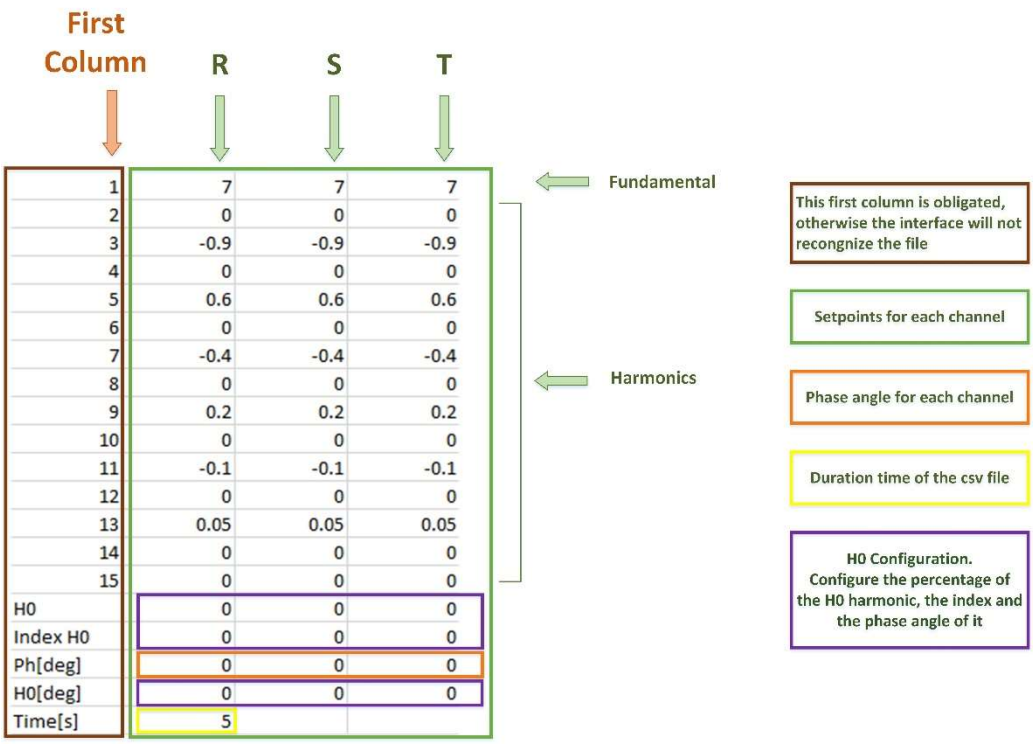
Remember to introduce a minimum recommended Sleep (pause) of 200ms in between faults. The following figure shows an example of a sequence created via interface.

Before introducing any fault, remember to emulate a grid.

4.4.3. Harmonics

The *Harmonics* tab allows the user to send *.csv* (coma separated value) files. The *.csv* files can be created and saved, loaded or modified and saved by the interface.
All the files can be executed as a sequence.

- **A:** This table shows all the values that refer to the configuration of the harmonics and it is distributed in the following way:



The user can write the desired values on this table of the interface to create a harmonic file to be sent or saved as it is explained in the point **E** of this chapter.

- **B:** Meanwhile the user is introducing the values for the harmonics in table **A**, the index graph is refreshing at the same time. Remember that the index graph has the fundamental (with its full value) at the left part and the harmonics (with its percentage value, positive or negative, referenced to the fundamental).

- **C:** This graph is behaving as the one before (**B**), but it draws the waveform showing how the harmonics will look like when the user uses an oscilloscope in the output (EUT side).

- **D:** Theoretical values are very useful to know which is the maximum output voltage, as well as the peak, the crest factor and the total harmonic distortion (THD).

- **E:** Open, save or send *.csv* files with the following buttons
    - *Open Folder*. Open a folder of the computer with *.csv* files in it. The files will be shown in window **F**.
    - *Save File (.csv)*. This button allows to save a created harmonic in **A** window or to modify an existing opened file.
    - *Send File*. The created file in **A** or the opened and selected file in **F** will be sent by pressing this button. To sum, the sent file will be the one shown in **A**, **B**, **C** and **D**.
    - *Send Sequence*. The user can send a sequence instead of a unique file. The file sequence to execute will be the one with the harmonic files in **F** window that the user has opened.
    - *Repeat Sequence*. By pressing this button, the LED right beside it will be illuminated and it will indicate that the sequence is going to start again when it is finished.
    - *Time*. It shows the time in seconds that the actual file will last until it goes to the next file.
    - *STOP*. The user can stop the sequence any time, but the equipment will stay in the actual file. This button is not a button to stop the converter but the sequence.

- **F:** This window will show the name and the location of the file that the user opens from the button *Open Folder* of part **E**. it is possible to select (double click) one file and the characteristics of it will be shown in windows **A**, **B**, **C** and **D**. To create the order of the sequence, click the file and move it up or down with the buttons *Move Item Up* and *Move Item Down*.

When the user creates a .csv file with excel or a text editor, it is important to write in the first column, as in the example above, the number of the fundamental and harmonic (from 1 to 15) and the words *Desf* and *Time [s]*

Each file is a state so, to create a sequence, different files must be created and saved in the same folder. From the interface, the user can visualize all the files of this folder, send each file into the converter or perform the sequence.

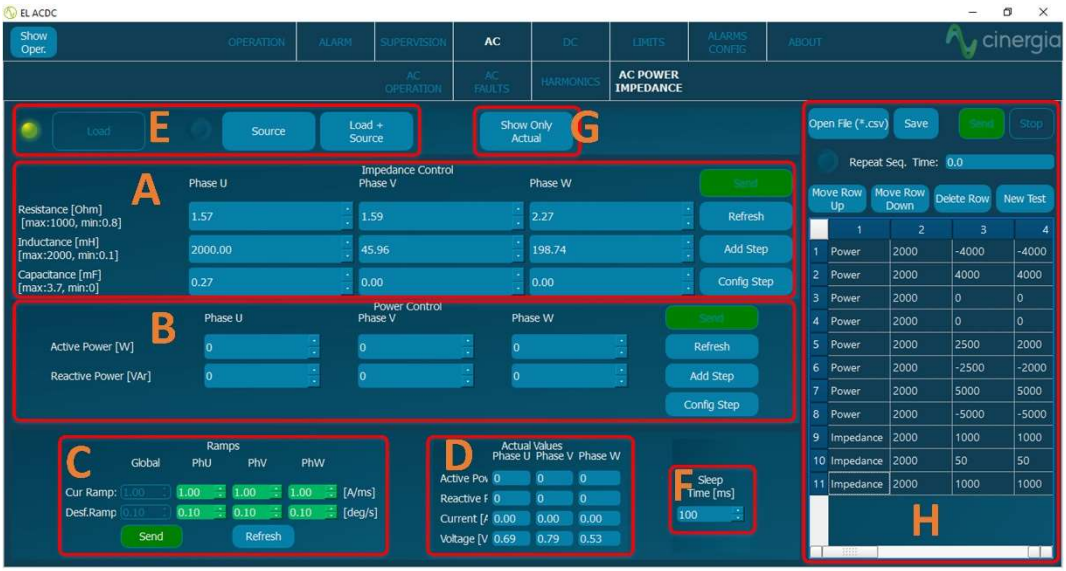
The same example of *csv* file explained above with *excel* is shown in the following image with a text editor. Please note that the columns are separated with comas and the decimal points are points.

```
1, 7,7,7
2, 0,0,0
3, -0.9,-0.9,-0.9
4, 0,0,0
5, 0.6,0.6,0.6
6, 0,0,0
7, -0.4,-0.4,-0.4
8, 0,0,0
9, 0.2,0.2,0.2
10, 0,0,0
11, -0.1,-0.1,-0.1
12, 0,0,0
13, 0.05,0.05,0.05
14, 0,0,0
15, 0,0,0
H0, 0,0,0
Index H0, 0,0,0
Ph[deg], 0,0,0
H0[deg], 0,0,0
Time[s], 5
```

4.4.4. AC Power Impedance

Set the setpoints values for impedance and power. As it is AC current, the impedance is composed by resistance, inductance and capacitance and the power by active and reactive. This tab also allows to create sequence with combinations of these two working modes.

The 2 buttons *Load* and *Source* described in the following chapter is used only for helping the user to understand whereas the equipment is delivering or injecting current. It can be important, for example, if the EUT connected in the output only allows one kind of current (injected or delivered). These buttons do not make changes in the Cinergia equipment but only in the interface. If the button pressed is *Load*, for example, the interface will allow negative power setpoints. Please note that in Impedance mode, the only mode that make sense is *Load*.



- **A:** Impedance control. When the equipment is in impedance mode (the mode is selected in the button *Show Operation* explained in the chapter 3 part D of this manual) this part will be illuminated, and the user will be able to introduce the impedance setpoints. Each

column is for each phase and the rows are for the resistance, inductance and capacitance setpoints respectively. Once the parameters are ready, press *Send*. If the converter is in impedance mode and configured as a source, the equipment will not send the setpoints, so it is important that the converter is in load state (windows **E**) when it is in impedance mode.
The button *Refresh* will make appear the internal values of the equipment in that moment. *Add Step* and *Config Step* are explained in the part **F** of this chapter.

- **B:** Power control. When the equipment is in power mode (the mode is selected in the button *Show Operation* explained in the chapter 3 part D of this manual) this part will be illuminated, and the user will be able to introduce the power setpoints. Each column is for each phase and the rows are for the active and reactive power setpoints respectively. Once the parameters are ready, press *Send*.
The button *Refresh* will make appear the internal values of the equipment in that moment. *Add Step* and *Config Step* are explained in the part **F** of this chapter.

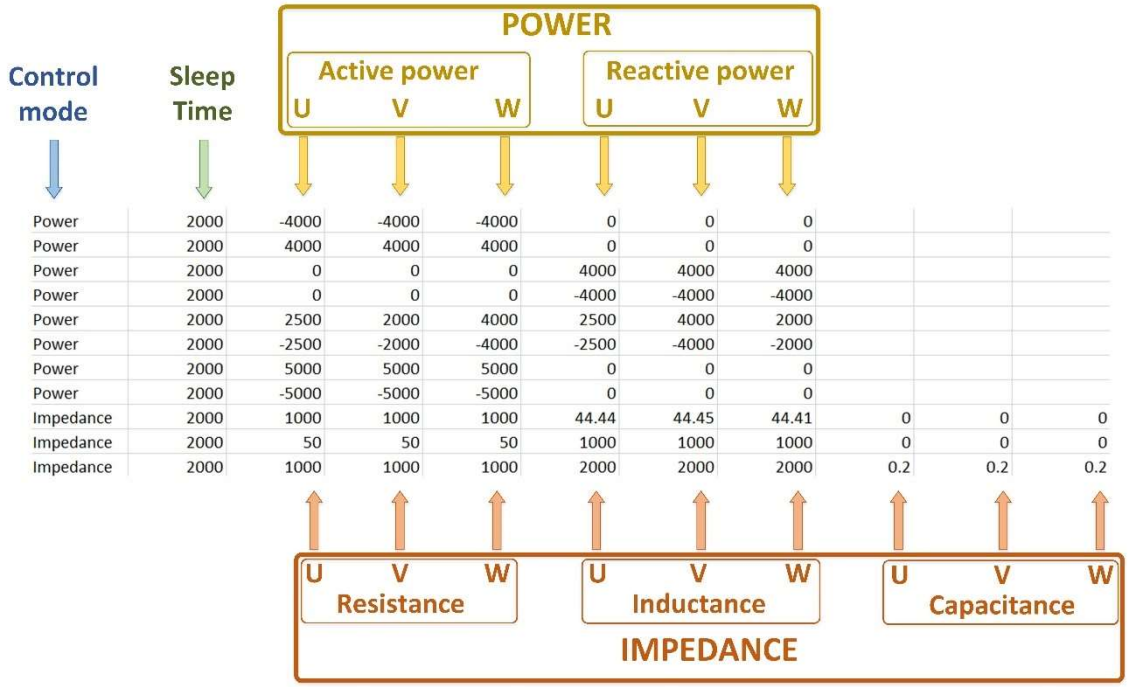
If the user introduces a parameter which is out of the converter limits, the interface will not allow to send it. Please read the manual to know which are the limits of the converter.

- **C:** Ramps section. Set the ramps for the current and the phase angle. This ramp values are the same than the ramps explained in the chapter **4.4.1** A part 3.
- **D:** Information part. Meanwhile the user is introducing the setpoints, the theoretical values (Active Power, Reactive Power, Current and Voltage) are being calculated and displayed.
- **E:** Define if the converter must behave as a load or as a source. When it is in *Load* mode (absorbing current), the only setpoints available are negative whereas when the converter is in *Source* mode (delivering current), the setpoints must be positive. The button *All Visible* allows the user to see and write the parameters of parts **A**, **B** and **C**. It is useful to create the sequences explained in the following part **G**.
- **F:** The Sleep Time is the configurable time that the sequence will use to remain in a row of setpoints. It is explained in the part **H**.
- **G:** *Show Only Actual* button helps to visualise all window or freeze the not used part. So, for example, if the equipment is working in Impedance mode, the Power window will be frozen, but if this button is pressed, all parts will be unfrozen. It is useful when the user wants to create a sequence with the different modes.

In windows **A** and **B** there are the buttons "*Add Step*" and "*Config Step*". They are used to add or modify points in the sequence created in the window **H**:

- **H:** Create or load an impedance and/or power sequence. Each row contains the parameters of the setpoint and to add them it is necessary to introduce the desired values to the windows **A** or **B** and press *Add Step*. To modify a row, proceed exactly the same as if introducing another row but instead of *Add Step* press *Config Step*. It is important to select the row that the user want to modify before pressing the button.
Once the sequence is ready, press *Send* and there's the possibility of repeating it by pressing *Repeat Sequence*. The button *Stop* allows to stop the execution in any moment. The user can also open a created sequence using the button *Open File (*.csv)*. It is also possible to save the test created in the interface by pressing *Save*, and it is important to save it as a *.csv* file.

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:



Power	2000	-4000	-4000	-4000	0	0	0			
Power	2000	4000	4000	4000	0	0	0			
Power	2000	0	0	0	4000	4000	4000			
Power	2000	0	0	0	-4000	-4000	-4000			
Power	2000	2500	2000	4000	2500	4000	2000			
Power	2000	-2500	-2000	-4000	-2500	-4000	-2000			
Power	2000	5000	5000	5000	0	0	0			
Power	2000	-5000	-5000	-5000	0	0	0			
Impedance	2000	1000	1000	1000	44.44	44.45	44.41	0	0	0
Impedance	2000	50	50	50	1000	1000	1000	0	0	0
Impedance	2000	1000	1000	1000	2000	2000	2000	0.2	0.2	0.2

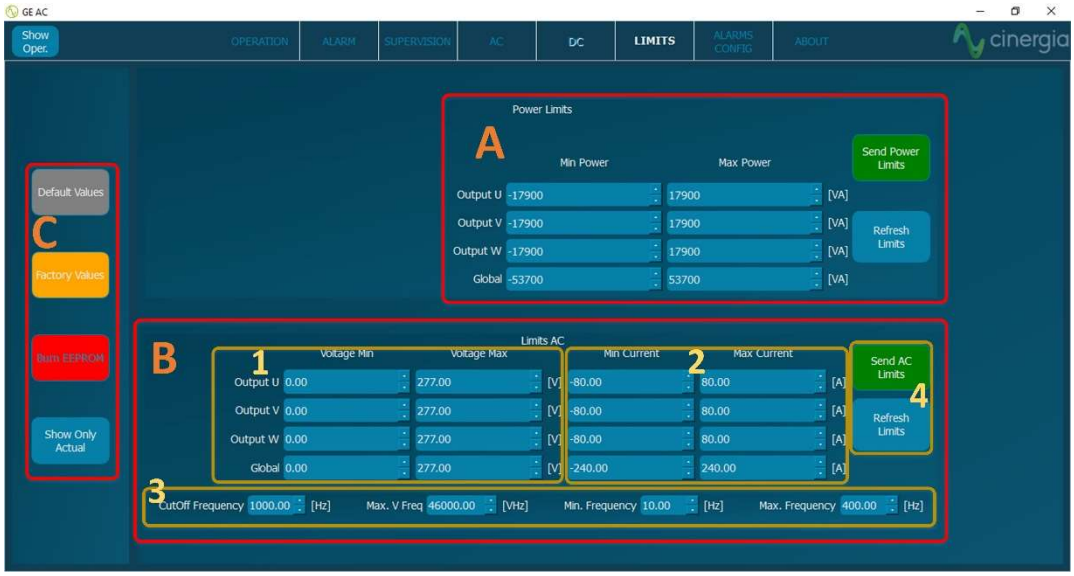
Please note that each row is a state of the sequence.

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.

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.



- **A:** Power Limits. The user can set the maximum and minimum limits for each phase. Once the limits are ready, press *Send Power Limits*. By pressing *Refresh Limits*, the converter will deliver the actual limit values.

  If the user introduces limit values higher the accepted ones, the converter will set the maximum allowed values. By pressing *Refresh Limits*, the user will know which are the values of the converter in that moment.

- **B:** Voltage and current limits section.
  1. Voltage limits. The user can set the maximum and minimum limits for each phase.
  2. Current limits. The user can set the maximum and minimum limits for each phase. These current limits are used in current mode (positive and negative) and in power mode (positive but not negative).

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

  3. Set the limits for the frequency parameters.
  4. Once the limits are ready, press *Send AC Limits*. When the user presses *Refresh Limits*, the converter will return the actual limit values. This last button is useful to realise if the introduced limits are higher that the allowed ones.

If the equipment is in RUN mode with a value that is outside the range of the new introduced limits, it will change the actual setpoint. For example, if the converter is in current mode with a value of 20A and the user introduces (and sends) a limit of 15A, the equipment will go to 15A 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.

- **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*.
    - *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.
    - *All Visible.* This button unfreeze 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 of each window (A and B) are pressed.

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.

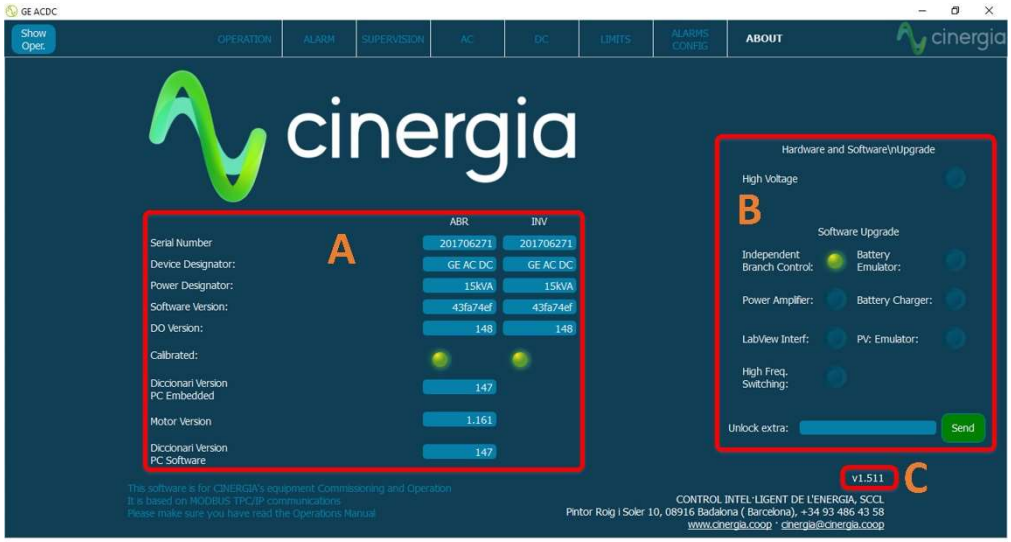
Depending on the connection mode of the equipment (AC or DC), this tab will automatically change and the parameters that will appear will be the ones according to the mode.

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

- **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 AC alarms and once the values are ready press *Send AC 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*.
    - *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.
    - *Ask Password.* A popup message will appear asking the password. This allows to burn eeprom.

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.



- **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.