cinergia

ePLUS Family units

EXTERNAL OPERATION: DIGITAL AND ANALOGUE INPUTS & OUTPUTS

Revision number	Document changes	Date
A00	Creation	September 20
A01	Update information	November 20
B00	New DO functionality	November 20
B01	Table values modified in AC	December 20

CONTENT

1. GENERAL

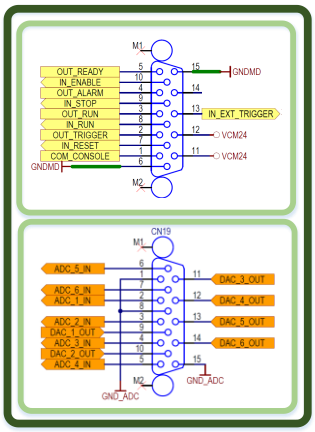
The purpose of this manual is to provide the necessary information to use the Cinergia converter with the external digital and analogue inputs and outputs.

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

This manual is valid for the ePLUS Standard platform units.

If your unit has *specific requirements or has some customization*, please ask for your valid specific manual. This manual will not be useful for you.

DIGITAL AND ANALOGUE SIGNALS



The equipment can be controlled using digitals and analogue signals: the digitals are used for controlling the status of the equipment (Standby, Alarm, Ready and Run) whereas the analogue signals allows the user to set output values sending the corresponding setpoints. To sum, with these signals it is possible to control the basics of the equipment.

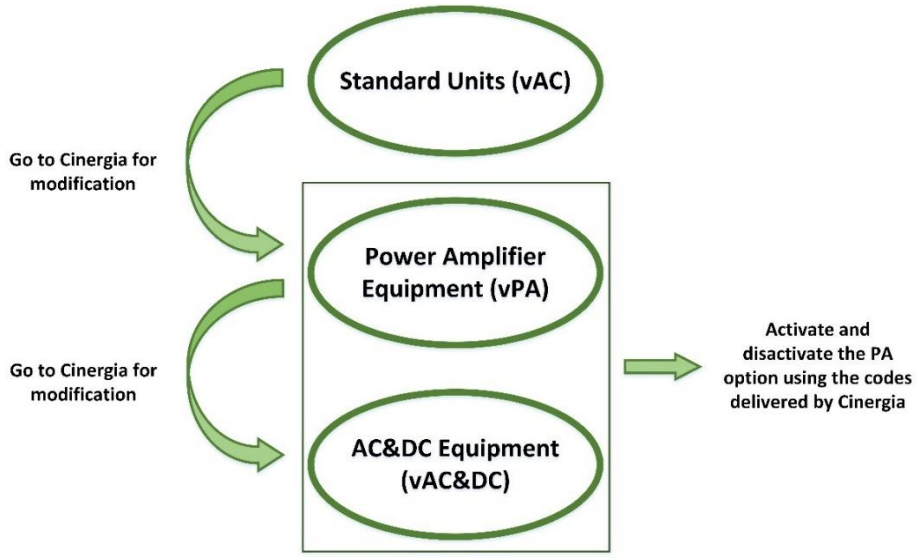
Please be sure to carefully read the description of the Cinergia converter types described below to fully understand the functionalities of your equipment.

It is important to identify the 3 types of equipment that Cinergia has when talking about the Power Amplifier optional:

1. **Standard Units (vAC).** The converter does not allow the possibility of Power Amplifier, but the analogue inputs and outputs can be used as it is explained in this manual.
2. **Power Amplifier Equipment (vPA or vHIL).** The user can activate or disactivate the option Power Amplifier. With the PA disactivated, the analogue inputs and outputs behave as the standard units. Activating and disactivating the functionality PA is done with the codes delivered by Cinergia.
3. **AC&DC Equipment (vACDC).** The user can activate or disactivate the option Power Amplifier. With the PA disactivated, the analogue inputs and outputs behave as the standard units. Activating and disactivating the functionality PA is done with the codes delivered by Cinergia.

The procedure to introduce the delivered codes is explained in the chapter *4. POWER AMPLIFIER*.

Upgrading the converter to add functionalities means that the equipment must go to Cinergia for the modifications. But the PA optional in the Power Amplifier Equipment and AC&DC Equipment is activated or disable by the delivered codes as the following schematic sums:



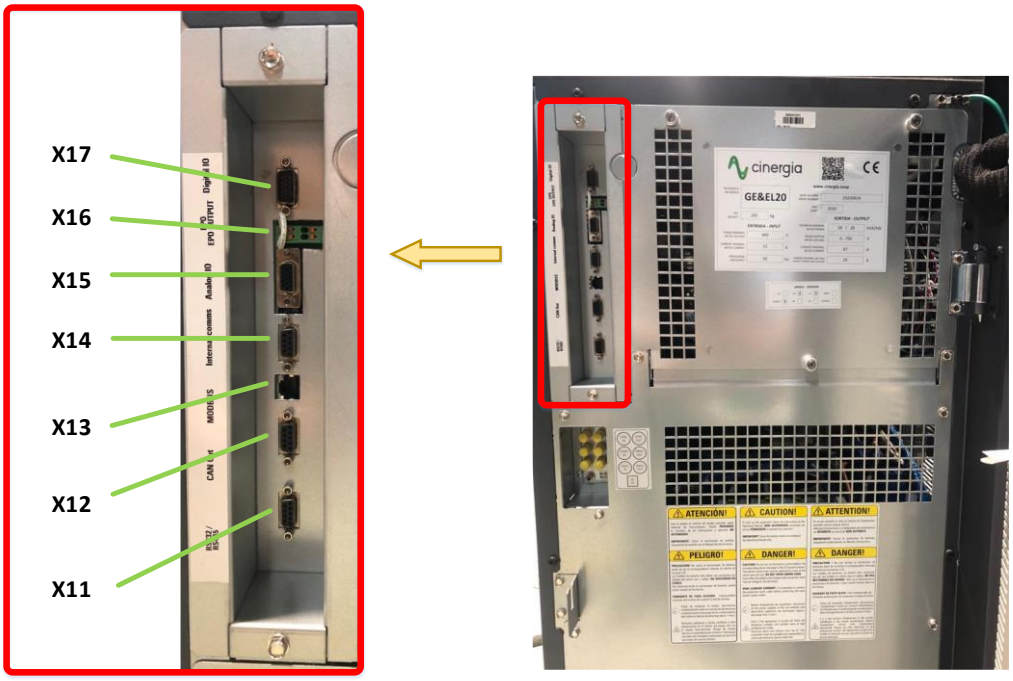
It is important for the user to have this manual nearby and familiarize with it to operate efficiently with the converter.

This document tries to be easy to understand, created with schematics and real pictures of the equipment.

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

2. DIGITAL INPUTS AND OUTPUTS (X17)

Digital inputs and outputs are gathered in **X17.** All of them are isolated and located in the front of the equipment:



Specifically, there are **6** digital inputs which operate at **24V** and **4** digital outputs. On the standard units, both digital inputs and outputs are referenced to **GNDMD** (pins 6 and 15 of the **X17**).

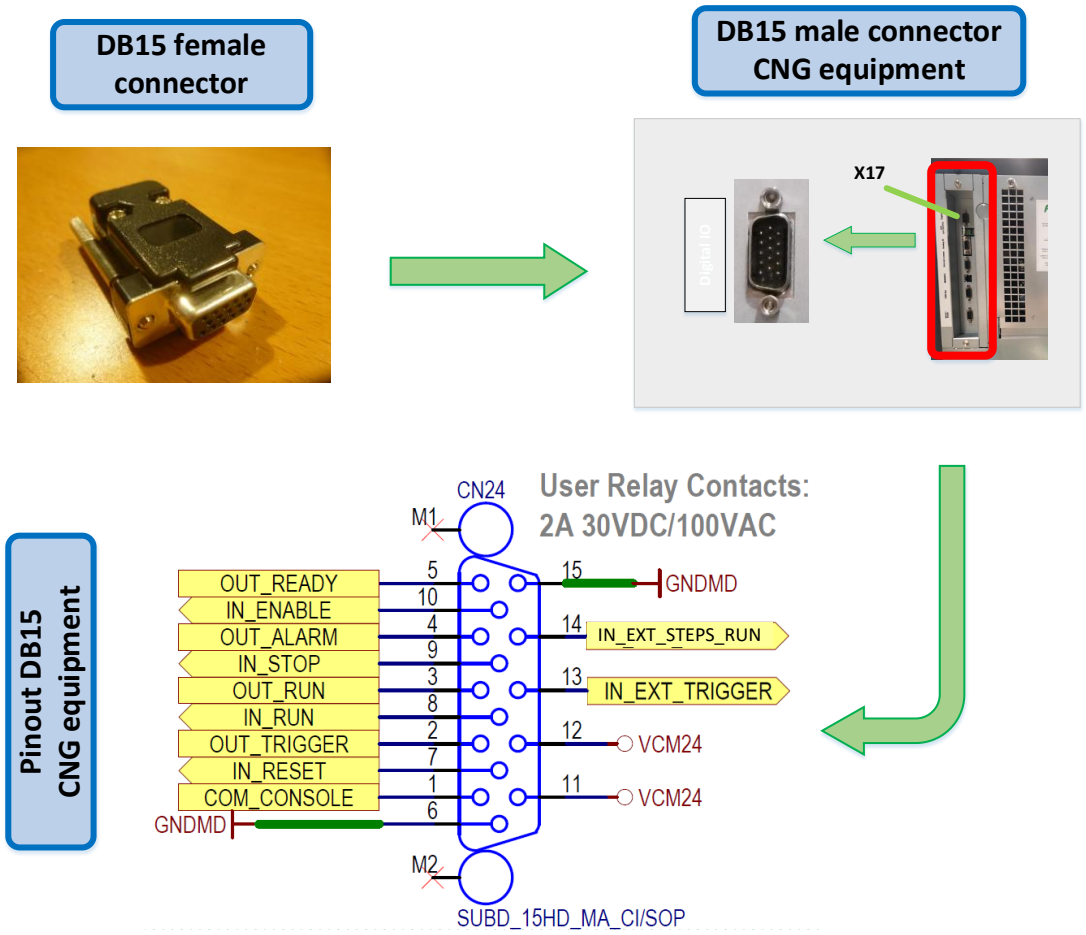
On the standard units, the output digitals are powered by the internal power supply at 24VDC. The maximum current allowed are 100mA on relay outputs and 5mA on optocoupler outputs.

There is an OPTIONAL to power the digitals output through an external power supply. The maximum voltage allowed on this power supply is 24V in DC or 230V in AC. In that case the maximum current allowed is 2A. ***Please, contact with Cinergia if this optional is required in your units.***

If the customer requires a specific functionality on the input and output digital signals, please contact with Cinergia before manufacturing the unit.

If the customer requires a specific voltage range for the output digital signals, please contact with Cinergia before manufacturing the unit otherwise the output digital signals are powered with the internal power supply.

The following scheme shows the connector with the pinout of the DB15 for the digital inputs and outputs (X17):



Please note that the connector for digital inputs and outputs of the equipment is a *SUBD_15HD_MA_CI/SOP, MALE CONNECTOR*. The necessary connector to use it is the *SUBD_15HD_FA_CI/SOP, FEMALE CONNECTOR*.

The maximum allowed input voltage is 24VDC (referenced to GNDMD). On the Standard unit, the digital outputs voltage are 24VDC (referenced to GNDMD). The maximum allowed output current is 100mA or 5mA (depending on the type of output. Please see table below). Applying an upper voltage or current can make irreversible damage to the equipment.

Please read the table below to know the electrical features of the digital signals in all cases:

	Digital Signal	Electrical features	
		Standard unit Using internal power supply	**OPTIONAL POWER unit** Using external power supply
INPUT	*IN_ENABLE* *IN_RUN* *IN_RESET* *IN_STOP*	**0** to **24VDC** (using the **VCM24** or using external power supply) (referenced to **GNDMD**)	**0** to **24VDC** (using the **VCM24** or using external power supply) (referenced to **GNDMD**)
	IN_EXT_TRIGGER *IN_EXT_STEPS_RUN*		
OUTPUT	*OUT_READY (relay)* *OUT_RUN (relay)* *OUT_ALARM (relay)*	**100mA** - 0 to 24VDC (referenced to **GNDMD**)	**2A** - 0 to **24VDC** or **230VAC** (using **COM_CONSOLE**)
	OUT_TRIGGER (opto)	**5mA** - 0 to 24VDC - **VCM24** (referenced to **GNDMD**)	**5mA** - 0 to **24VDC** - **VCM24** (referenced to **GNDMD**)
POWER	*COM_CONSOLE* *(ONLY output relay)*	**NOT USED - NC**	**2A** - **24VDC** or **230VAC** (Power supply)

On a Standard Unit, the list of each digital functionality is the following:

INPUT (referenced to the GNDMD - PIN 6 or 15):

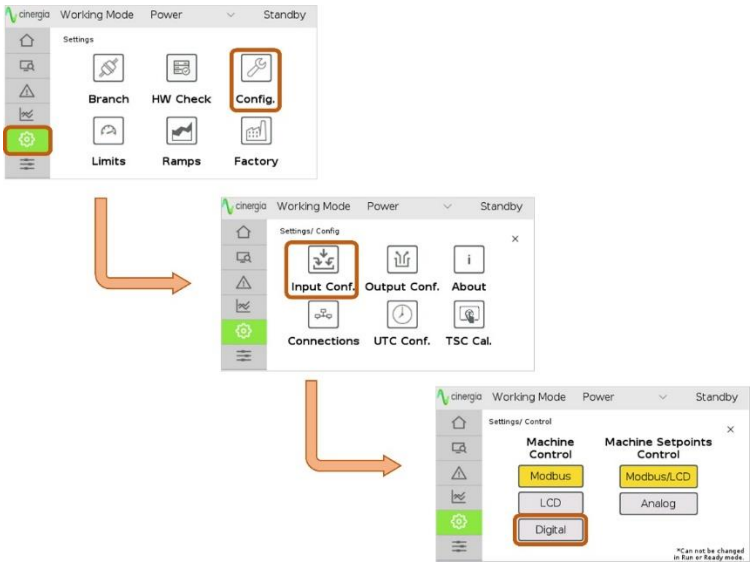
- **PIN 7:** IN_RESET - INPUT RESET. Makes a RESET to the equipment.
- **PIN 8:** IN_RUN - INPUT RUN/READY. Changes from RUN to READY and vice versa.
- **PIN 9**: IN_STOP - INPUT STOP. Makes the equipment go to READY if it is in RUN state during all the time that this digital input is enabled.
- **PIN 10:** IN_ENABLE - INPUT ENABLE/DISABLE. Changes from ENABLE to DISABLE and vice versa.
- **PIN 13:** IN_EXT_TRIGGER - TRIGGER CONFIG. Applies the setpoint sent to the converter.
- **PIN 14:** IN_EXT_STEPS_RUN. Executes the activated STEP file on the converter.

OUTPUT (referenced to the GNDMD - PIN 6 or 15):

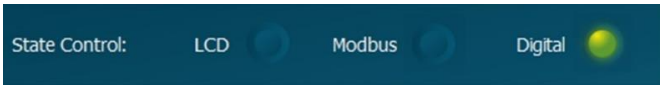
- **PIN 2:** OUT_TRIGGER - OUTPUT TRIGGER. The output will turn on when the TRIGGER CONFIG is sent. When the equipment applies a setpoint, the *Trigger Out* is active (24VDC) during 100ms.
- **PIN 3:** OUT_RUN - RUN LED. The output will turn on (24VDC) when the equipment is in RUN state.
- **PIN 4:** OUT_ALARM - ALARM LED. The output will turn on (24VDC) when the equipment is in ALARM state.
- **PIN 5:** OUT_READY - READY LED. The output will turn on (24VDC) when the equipment is in READY and RUN state.

2.1. Digital Inputs

To control the Cinergia converter with the digital inputs, it is necessary to activate them through the LCD touchscreen following these steps:



When the digital control is enabled, there will appear the indicator in the Operation tab of the interface:

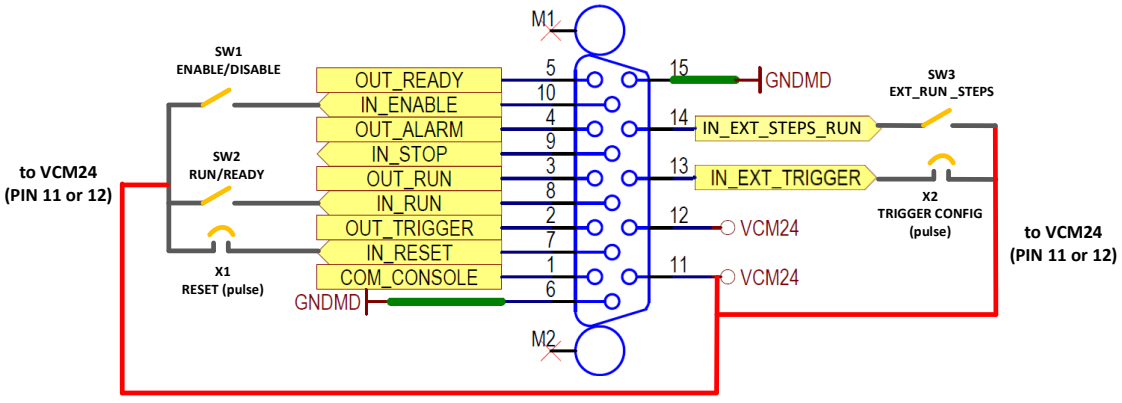


Digital inputs can be supplied with an external power supply or using the internal one **VCM24**, located in the pins 11 and 12 (they are the same point). Both cases, internal or external power supply, must use the same reference, which is **GNDMD**, located in the pins 6 and 15 (they are the same point as well).

2.1.1. Digital Inputs Voltage Power Supply (Standard and customized units)

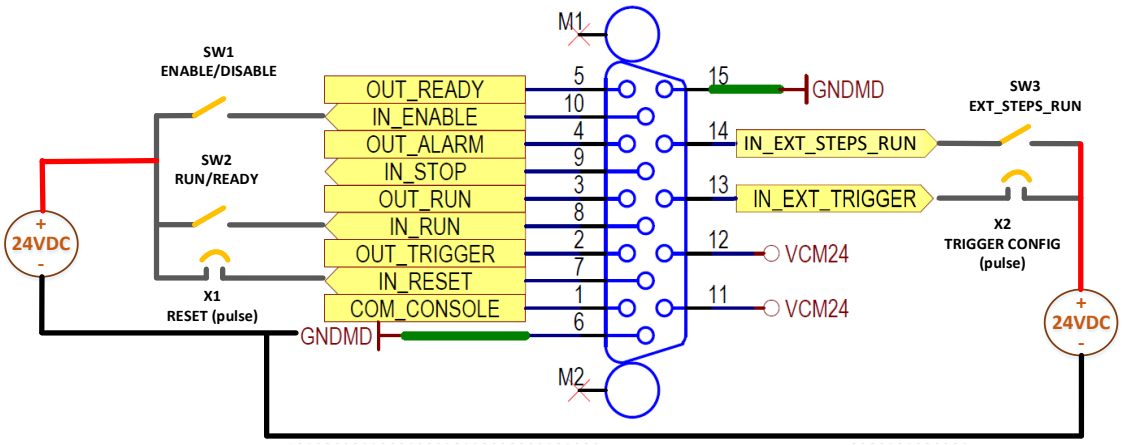
2.1.1.1. Internal voltage supply

The following image illustrates the necessary circuit to control the Cinergia equipment with the digital inputs using the internal voltage supply that the unit provides:



2.1.1.2. External voltage supply

And the following image illustrates the necessary circuit to control the Cinergia equipment with the digital inputs using an external voltage supply:



*External voltage source power supply **24VDC**. Pins 11 and 12 NOT used. GNDMD pins 6 and 15*

2.1.2. Equipment Status inputs digital signals

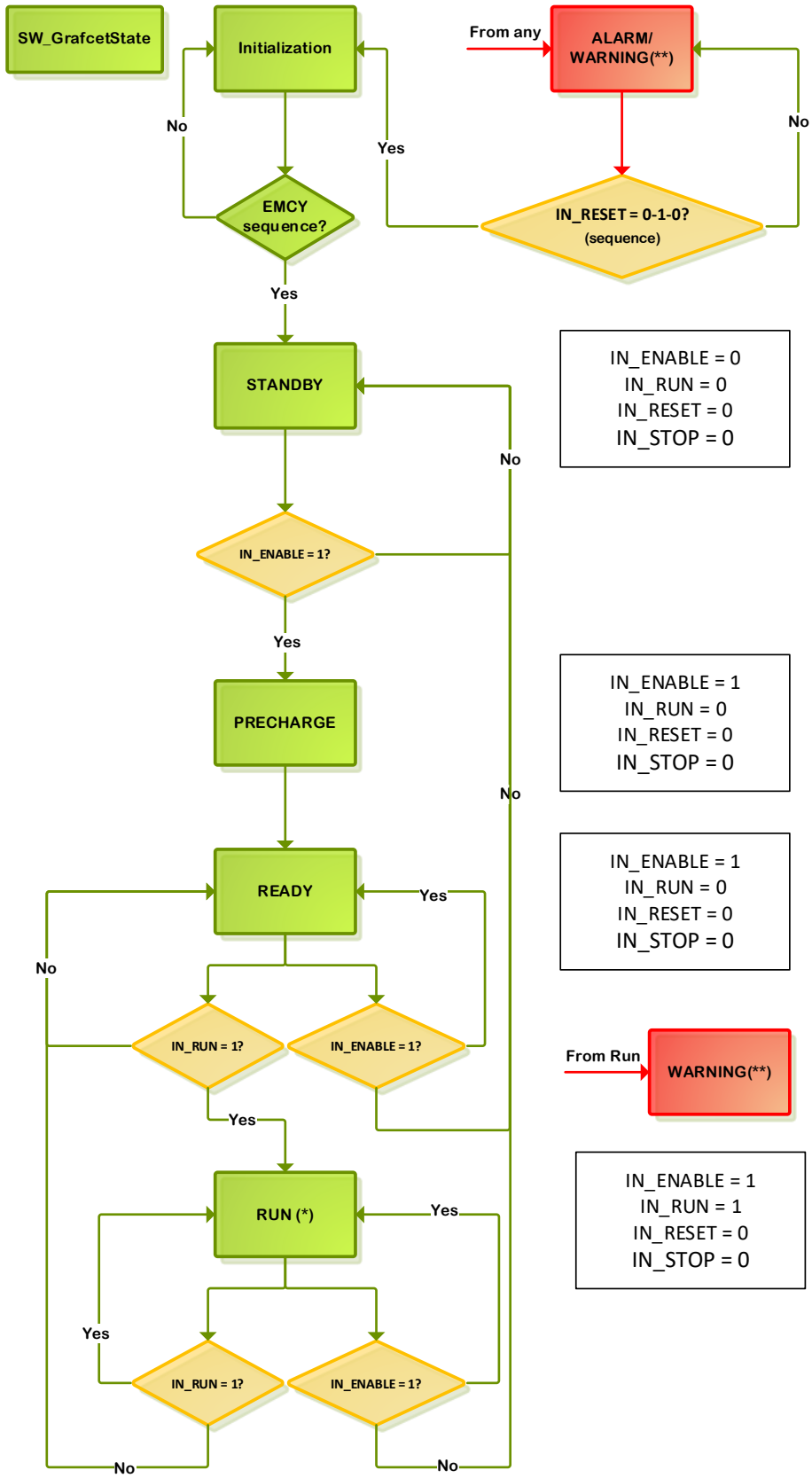
These signals will control the evolution or transition in the state machine of the equipment. In both cases (internal and external power supply), it is necessary 2 independent switches and 3 independent push buttons, detailed below (marked in orange in the pictures above):

Switch SW1	***IN_ENABLE*** *ENABLE/DISABLE*	0 = disable 1 = enable
Switch SW2	***IN_RUN*** *RUN/READY*	0 = ready 1 = run
Push button X1	***IN_RESET***	0 – 1 – 0 means reset
Push button X2	***IN_TRIGGER***	0 – 1 – 0 means apply setpoint
Push button X3	***IN_STOP***	during 1 goes to Ready
Switch SW3	***IN_EXT_STEPS_RUN***	0 = no function 1 = RUN activated step file

The following table detail the relation of each digital input signals and the transition on the state machine:

Digital INPUTS	Action	State machine transition
IN_ENABLE = 1	Enable	Standby → Precharge → Ready
IN_ENABLE = 0	Disable	Ready/Run → Standby
IN_RUN = 1	Run	Ready → Run
IN_RUN = 0	Ready	Run → Ready
IN_RESET = 0-1-0	Reset	Alarm → Initialization → Standby
IN_TRIGGER = 0-1-0	Trigger_config	Apply the setpoint send to the unit
IN_STOP	Stops	Run → Ready during pulsed

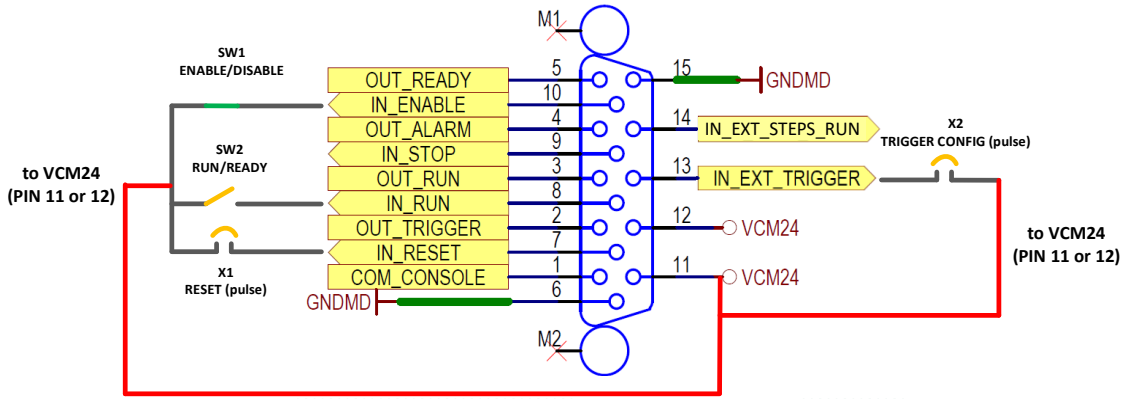
Please, find attached the description of the state machine of the Cinergia units. In this case, the operation of the unit is made by digital input signals (marked in orange):

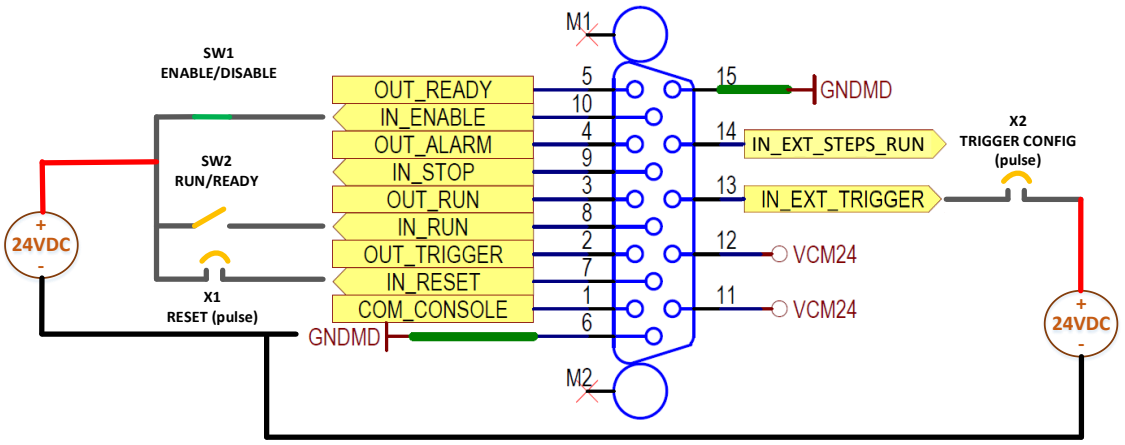


On the pictures below, internal or external voltage source power supply diagram connection is shown. Please, take into account if your setup requires an internal or external voltage source power supply.

The following diagrams shows how the digital input signal must be sent. First, the IN_ENABLE must be powered and waiting for the precharge done, after that the IN_RUN could be powered:

2.1.2.1. IN_ENABLE - Enable/Disable (PIN 10 DB15, X17)

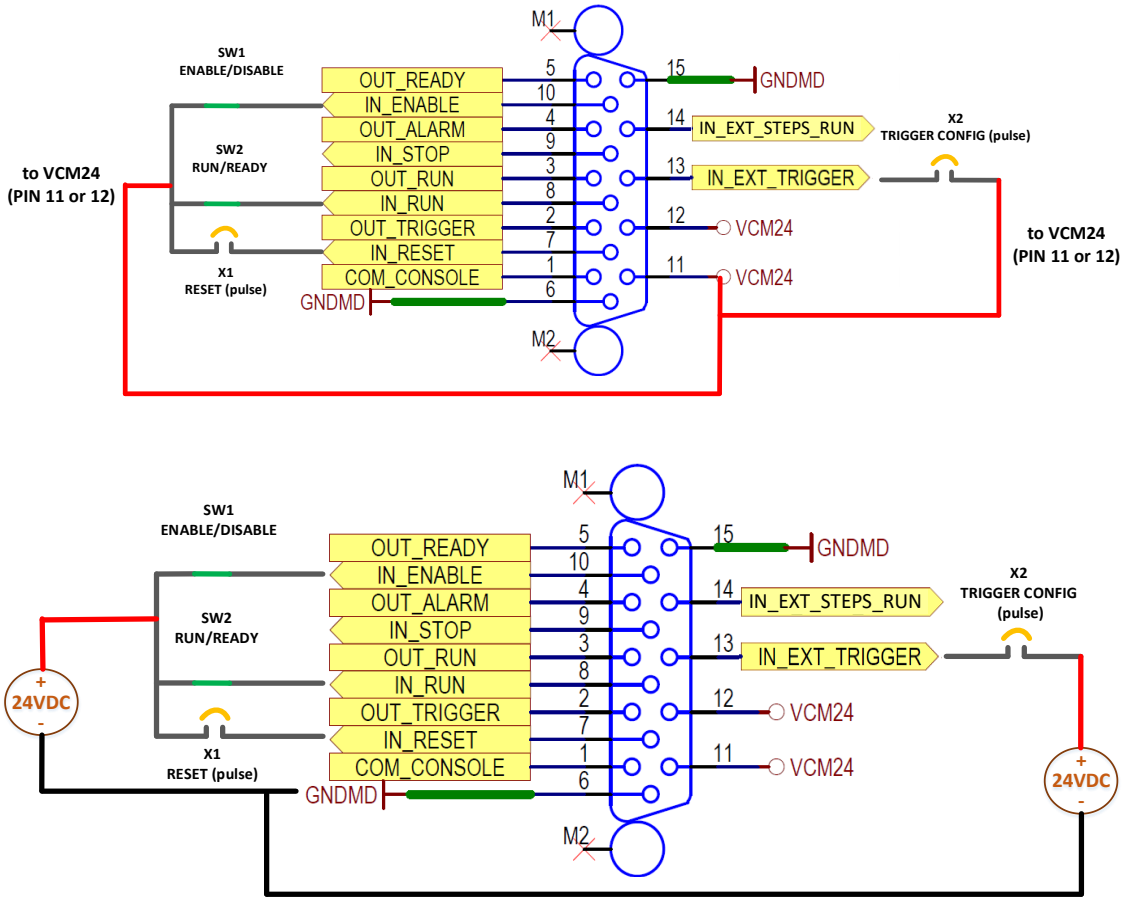




The switch *SW1 IN_ENABLE* input goes from *Standby* to *Ready* going through *Precharge state*. The functionality of this digital input is the same or equivalent as the ***CW_ENABLEDISABLE*** Modbus register.

If the equipment is not in *Standby*, sending a "1" with this switch will not cause any effect. A "0" will make the converter to remain or go to *Standby*.

2.1.2.2. IN_RUN - Run/Ready (PIN 18 DB15, X17)



A "1" in this switch *SW2 IN_RUN* allows the converter to go from *Ready* to *Run.* But this transition will be done only if the *SW1 IN_ENABLE* sends a "1". The functionality of this digital input is the same or equivalent as the ***CW_RUNREADY*** Modbus register.

If the switch *SW1 IN_ENABLE* is not sending a "1", the switch *SW2 IN_RUN* will not cause any effect in the converter because the equipment needs to be in *Ready* state to change to *Run*.
A "0" in this switch *SW2* makes the converter to remain or go to *Ready* state.

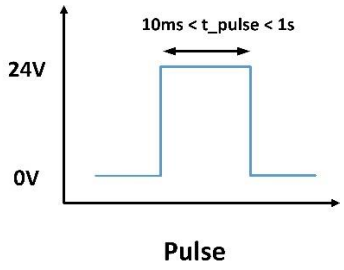
Sending a "1" in the IN_RUN (PIN 8) will not cause any effect if there is a "0" in the IN_ENABLE (PIN 10).

2.1.3. Control input digital signals

These digital signals can be sent with a push button because they are only pulse signals:

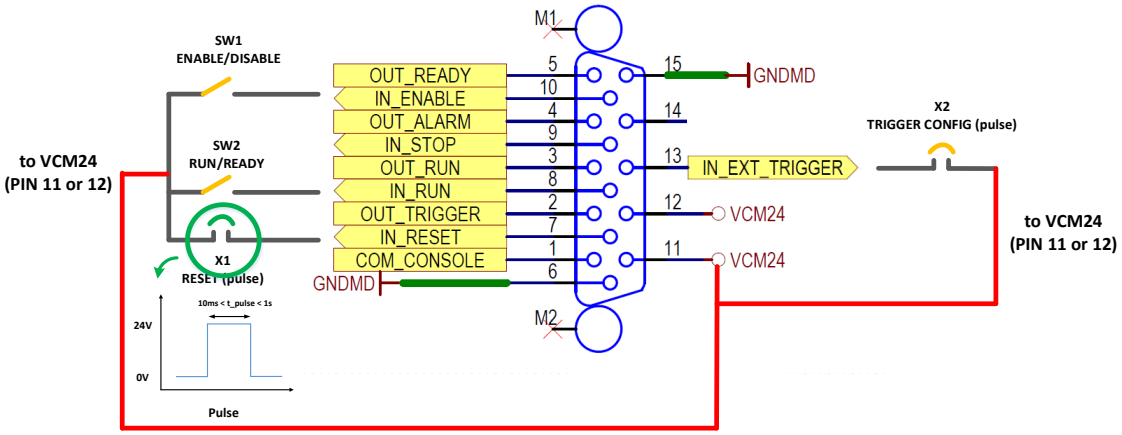
Push Button	*X1 RESET*	Pulse:
	X2 TRIGGER CONFIG	10ms < t_{pulse} < 1s
	X3 STOP	10ms < t_{pulse}

These signals are made with a push button that must have a minimum pulse of 10ms and a maximum of 1s:



The digital STOP signal has no time limit. It can be higher than 1 second.

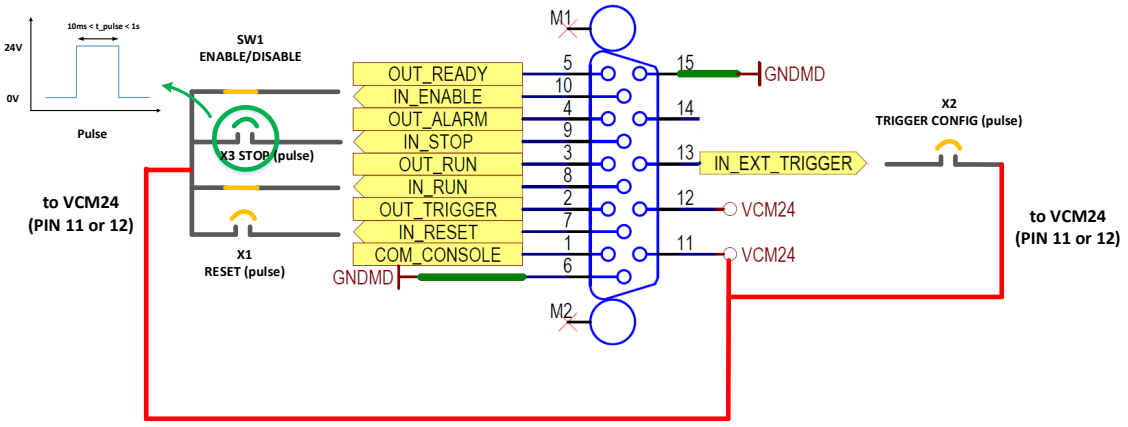
2.1.3.1. IN_RESET - Reset (PIN 7 DB15, X17)



This digital input signal *X1* makes a reset to the equipment ONLY in case of being in Alarm state. The functionality of this digital input is the same or equivalent as the ***CW_RESET*** Modbus register.

If the alarm persists, the converter will remain in alarm state. If the equipment is not in Alarm state, any action on this input, will not cause any effect.

2.1.3.2. IN_STOP - Stop (PIN 9 DB15, X17)

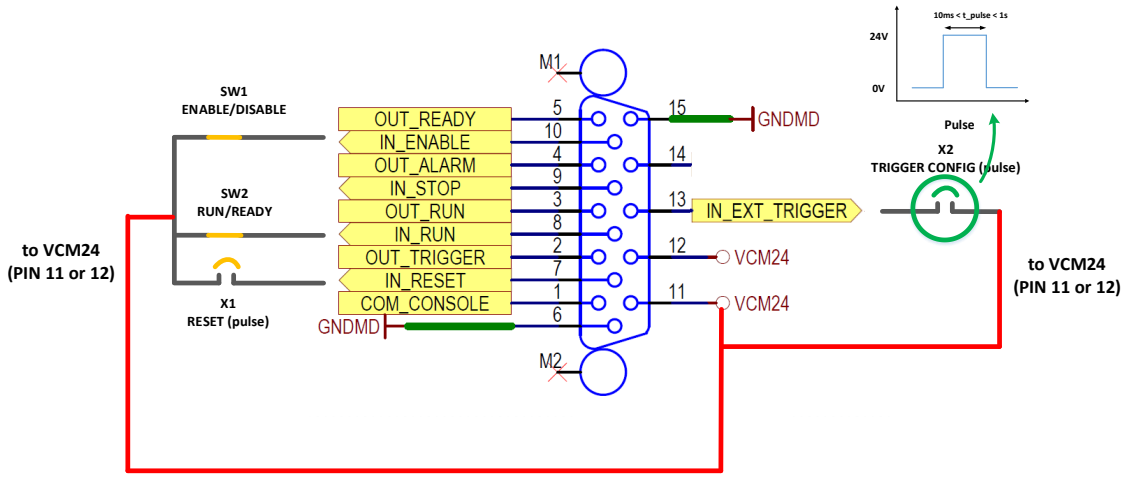


This digital input signal *X3* makes the equipment go to READY state ONLY if the equipment is in RUN. The equipment will remain in READY while this digital input is high (24V). The functionality of this digital input is the same or equivalent as the ***CW_RUNREADY*** Modbus register.

When the converter is in RUN, this signal will always be *IN_STOP* = 0V. If the equipment is running and it is sent this digital input (*IN_STOP* = 1, that means applying 24VDC), the converter will go to ready during all the time that *IN_STOP* is active. When the unit goes to RUN again, any setpoint must be send again.

If *IN_STOP* = 1 but the converter was not in RUN state, it will not cause any effect.

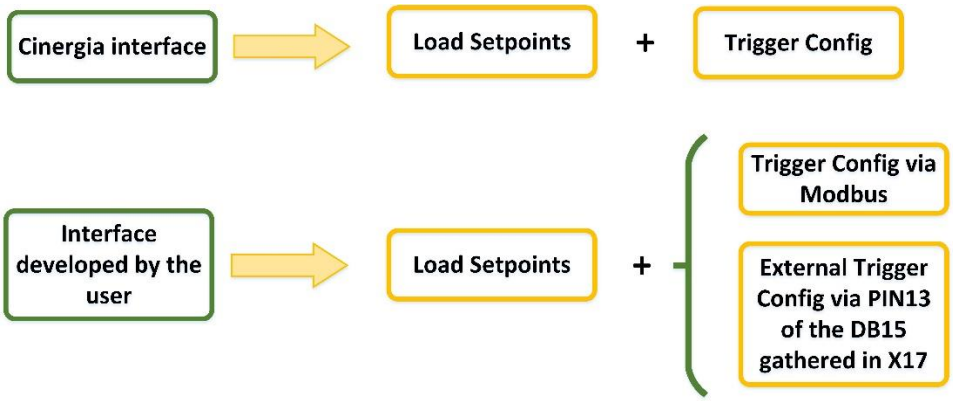
2.1.3.3. IN_TRIGGER - Trigger Config (PIN 13 DB15, X17)



This digital input signal *X2* applies at the output of the unit the setpoints sent. The functionality of this digital input is the same or equivalent as the ***Trigger_config*** Modbus register.

For example, if the user makes its own interface and load the setpoints in the corresponding Modbus address, these setpoints will be applied when the *IN_EXT_TRIGGER* = 1 or *Trigger Config* is sent.

With the interface delivered by Cinergia, when the user presses the *Send* button, the selected setpoints are loaded in the corresponding Modbus address and the *Trigger Config* is sent. The result of this sequence is that the setpoints are applied at the output of the equipment. Another possibility is that the user develops its own interface and decides to send the setpoints with the external *Trigger Config*. So, developing the interface open two possibilities: send the setpoints by sending the *Trigger Config* via Modbus register or by sending it via Digital input through the PIN 13 of the X17:



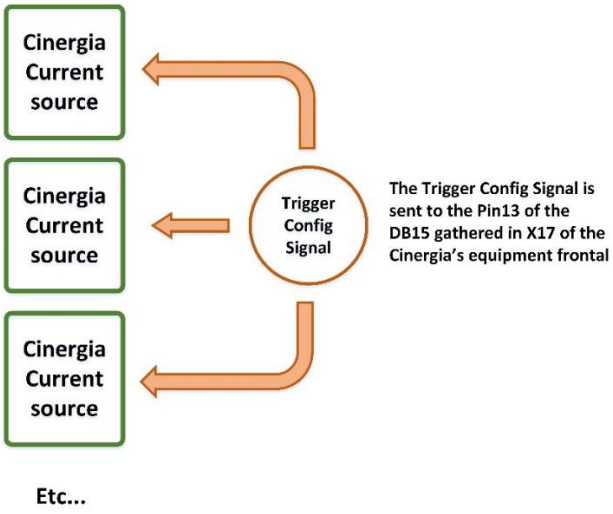
If there are no new setpoints to be applied at the corresponding Modbus address, the equipment will not change values at the output of the converter even though the *Trigger Config* is sent.

2.1.3.4. IN_TRIGGER - Trigger Config example of use

Trigger Config can be used, for example, to send simultaneous trigger signals to different Cinergia equipment with the external digital input.

This example is NOT valid for Cinergia voltage source in parallel.

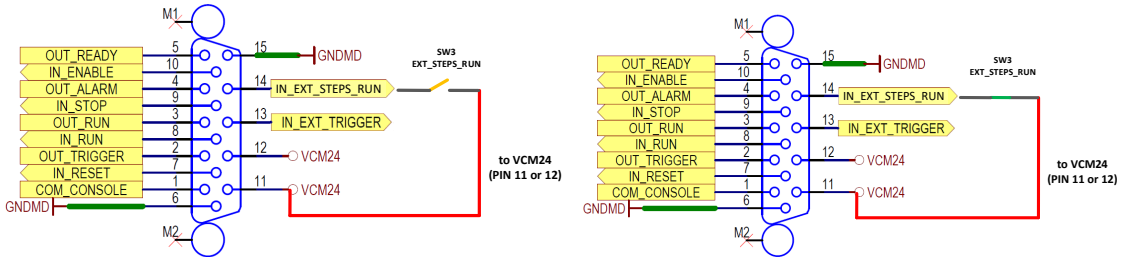
The following schematic illustrates the example. With one digital signal, all the units will apply the new setpoint at the output at the same time:



The result of this example can be seen in the following image, where the trigger is sent to 2 different Cinergia AC Electronic Load and, with the oscilloscope, displayed the current of the same phase of each converter:

Image of current of two different EL units loading the same setpoint using the Digital signal IN_EXT_TRIGGER.

2.1.3.5. IN_EXT_STEPS_RUN – Run STEPS file (PIN 14 DB15, X17)



The switch ***SW3*** *EXT_STEPS_RUN* input indicates to the unit start RUNNING the activated Step file. If no Step file is activated, this action will not have any response from the unit. The functionality of this digital input is the START running of the Steps file, it is equivalent to the RUN on the Steps Tab from Interface.

Take into account that the minimum time for this digital input to be detected by the unit is 10ms.

While this input is in “1”, once the Step file is finished, the unit will start it again. So, if the input remains to “1”, it is the same functionality as the Repeat cycle configured by interface. The Step file will be reproduced all the time, until the input goes to “0”.

While the input is in “1”, the Steps file will be reproducing all the time. One stops, will start again. If the input goes to “0”, the Steps file will stop once the last test from the Steps file is finished.

2.2. Digital Outputs

2.2.1. Standard units

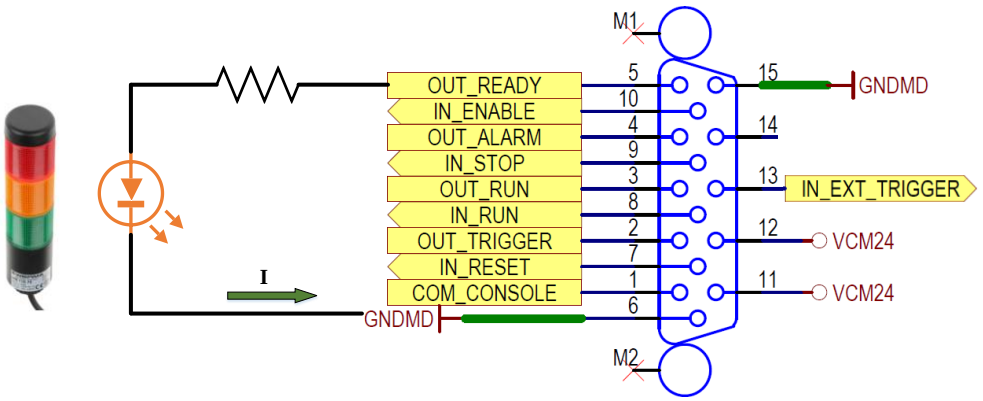
On the standard units, the output digitals are powered by the internal power supply at 24VDC. The maximum current allowed are 100mA on relay outputs and 5mA on optocoupler outputs. There are 4 digital outputs referenced to **GNDMD**.

They are already configured by Cinergia as the following:

- **PIN 2:** OUT_TRIGGER - OUTPUT TRIGGER. The output will be active when the equipment applies a setpoint. When the equipment applies a setpoint, the *Trigger Out* is active (24VDC) during 100ms. When the equipment applies any Steps sequence the *Trigger Out* is active (24V) during all the time these steps are applying.
  This output is an optocoupler output, so only 5mA is allowed. The voltage range is going to 0V to 24VDC.
- **PIN 3:** OUT_RUN - RUN LED. The output will be active (24VDC) when the equipment is in RUN state.
  This output is a relay output, so only 100mA is allowed. The voltage range is going to 0V to 24VDC.
- **PIN 4:** OUT_ALARM - ALARM LED. The output will be active (24VDC) when the equipment is in ALARM state.
  This output is a relay output, so only 100mA is allowed. The voltage range is going to 0V to 24VDC.
- **PIN 5:** OUT_READY - READY LED. The output will be active (24VDC) when the equipment is in READY and RUN state.
  This output is a relay output, so only 100mA is allowed. The voltage range is going to 0V to 24VDC.

2.2.1.1. Examples RELAY digital output

The following schematic details the connection that must be done when using the digital outputs of the Cinergia converter. As an example, the LED in connected at the output of the OUT_READY digital output, but will be the same for the OUT_RUN and OUT_ALARM digital outputs:



Digital output Ready *connected to a LED.*

Please note that the use of a resistance to limit the current supplied by the unit is necessary.

The output voltage of the digital output is 24V.

The maximum accepted current *I* is 100mA on relay outputs.

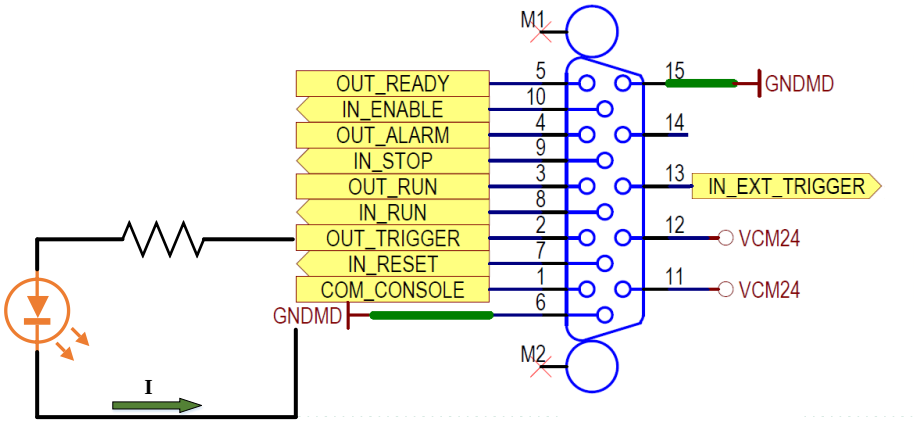
In the schematic above, the LED (OUT_READY) will be lighting when the equipment is in Ready and Run state.

In case of to install another LED at the output of the OUT_ALARM digital output, the LED will be lighting when the equipment is in Alarm state.

In case of to install another LED at the output of the OUT_RUN digital output, the LED will be lighting when the equipment is in Run state.

2.2.1.2. Example OPTOCOUPLER digital output

The next example illustrates how the digital output trigger must be connected:



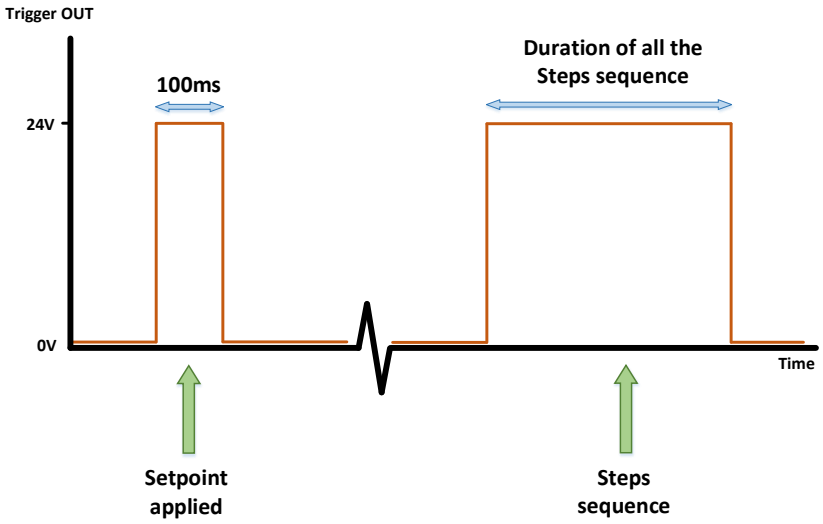
Digital output Trigger *connected to a LED.*

Please note that the use of a resistance to limit the current supplied by the unit is necessary.

The output voltage of the digital output is 24V.

The maximum accepted current *I* is 5mA in optocoupler outputs.

In the schematic above, the LED (OUT_TRIGGER) will be lighting when the equipment applies a setpoint (during 100ms) and when the equipment applies any steps sequence:



2.2.2. Customized units (OPTIONAL)

There is an optional to power the RELAY digital outputs through an external power supply. The maximum voltage allowed on this external power supply is 24V in DC or 230V in AC. In that case the maximum current allowed is 2A. The optocoupler output will be powered by an internal power supply and the maximum current allowed is 5mA. This optocoupler output is referenced to the **GNDMD**.

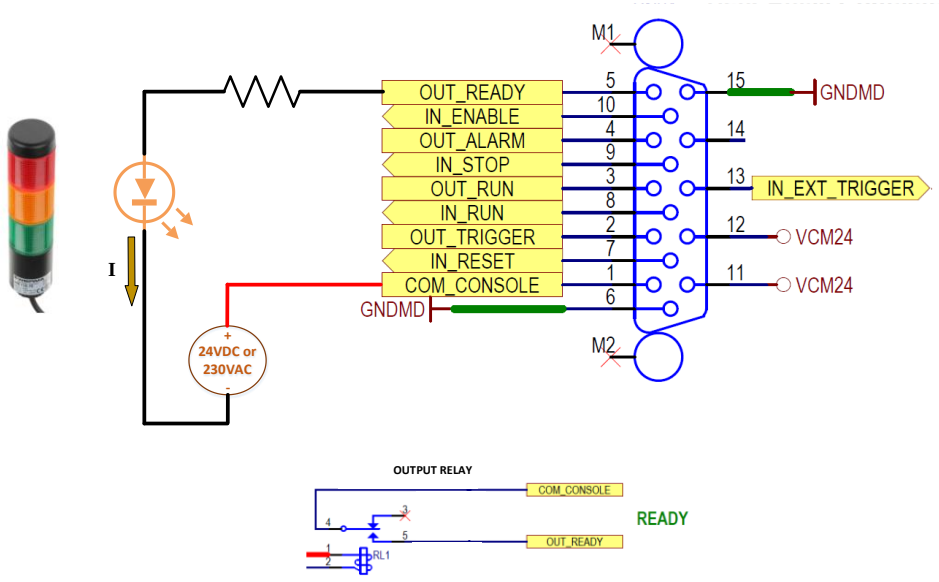
Please, contact with Cinergia if this optional is required in your units.

They are already configured by Cinergia as the following:

- **PIN 2:** OUT_TRIGGER - OUTPUT TRIGGER. The output will be active when the equipment applies a setpoint. When the equipment applies a setpoint, the *Trigger Out* is active (24VDC) during 100ms. When the equipment applies any Steps sequence the *Trigger Out* is active (24V) during all the time these steps are applying.
  This output is an optocoupler output, so only 5mA is allowed. The voltage range is going to 0V to 24VDC.
- **PIN 3:** OUT_RUN - RUN LED. The output will be active (24VDC or 230VAC) when the equipment is in RUN state.
  This output is a relay output, so 2A is allowed. The voltage range is going to 0V to 24VDC or 230VAC, depends on the customer setup.
- **PIN 4:** OUT_ALARM - ALARM LED. The output will be active (24VDC or 230VAC) when the equipment is in ALARM state.
  This output is a relay output, so 2A is allowed. The voltage range is going to 0V to 24VDC or 230VAC, depends on the customer setup.
- **PIN 5:** OUT_READY - READY LED. The output will be active (24VDC or 230VAC) when the equipment is in READY and RUN state.
  This output is a relay output, so 2A is allowed. The voltage range is going to 0V to 24VDC or 230VAC, depends on the customer setup.

2.2.2.1. Examples RELAY digital output

The following schematic details the connection that must be done when using the digital outputs of the Cinergia converter:



Digital output Ready *connected to a LED.*

Please note that the use of a resistance to limit the current supplied by the unit is necessary.

The output voltage range of the digital output is 24VDC or 230VAC.

The maximum accepted current *I* is 2A on relay outputs.

In the schematic above, the LED (OUT_READY) will be lighting when the equipment is in Ready and Run state.

The same structure must be reproduced for the OUT_ALARM and OUT_RUN.

In case of to install another LED at the output of the OUT_ALARM digital output, the LED will be lighting when the equipment is in Alarm state.

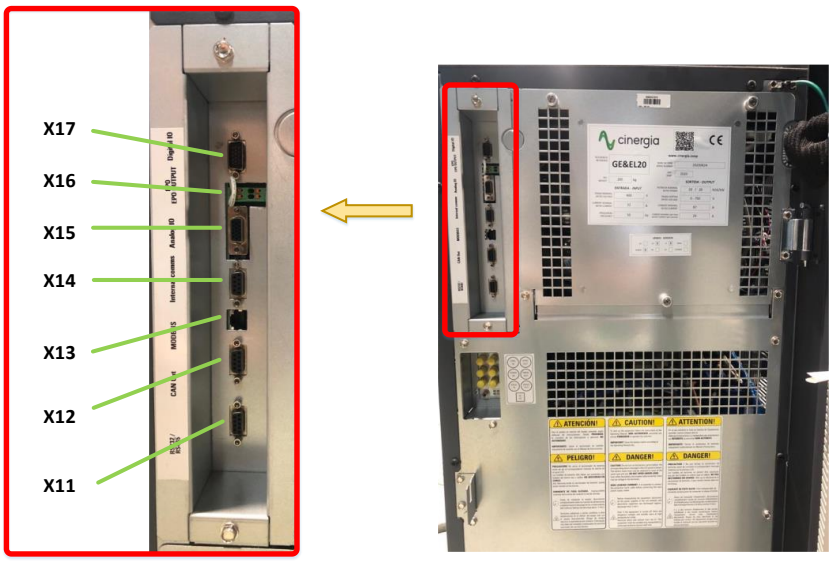
In case of to install another LED at the output of the OUT_RUN digital output, the LED will be lighting when the equipment is in Run state.

2.2.2.2. Example OPTOCOUPLER digital output

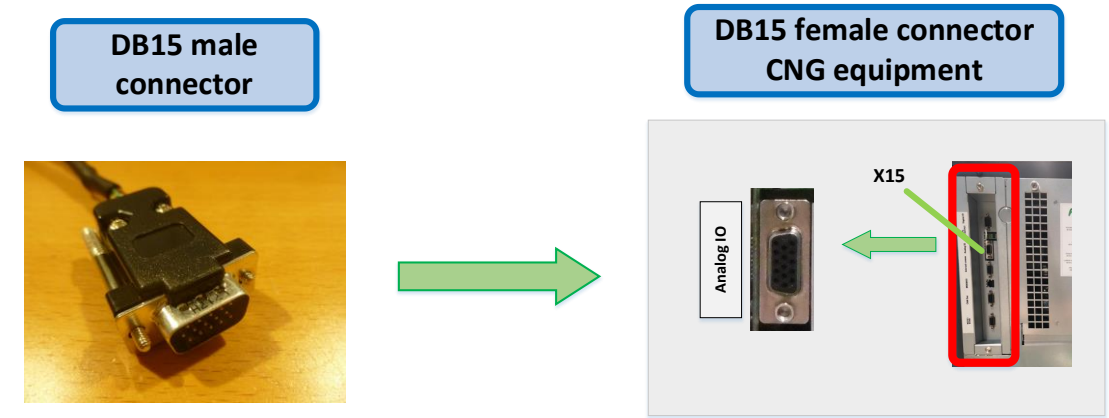
In this case, the schematic will be the same of explained on chapter 2.2.1.2.

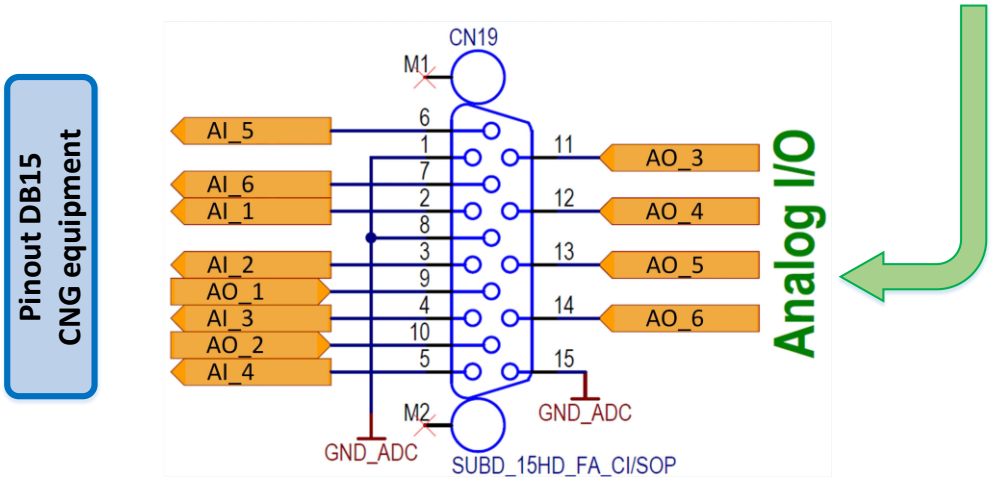
3. ANALOG INPUTS AND OUTPUTS (X15)

Analogue inputs and outputs are gathered in **X15.** All of them are isolated and located in the front of the equipment:



The equipment contains **6** analogue inputs and **6** analogue outputs which are gathered in **X15** with a *SUBD_15HD_FA_CI/SOP* connector and the pinout is the following:





Please read the table below about the pinout of the X15 connector:

X15 CNG EQUIPMENT PINOUT	Analogue signal	PIN DB15
ANALOGUE INPUT	AI_1	2
	AI_2	3
	AI_3	4
	AI_4	5
	AI_5	6
	AI_6	7
ANALOGUE OUTPUT	AO_1	9
	AO_2	10
	AO_3	11
	AO_4	12
	AO_5	13
	AO_6	14
GND		1, 8, 15

Please note that the connector for analog inputs and outputs of the equipment is *a SUBD_15HD_FA_CI/SOP, FEMALE CONNECTOR*. The necessary connector to use it is the *SUBD_15HD_MA_CI/SOP, MALE CONNECTOR*.

The analogue inputs accept a voltage range from -10V to +10V and the analogue output delivers a voltage range from -10V to +10V. Both input and output are referenced to GND_ADC; pin 1, 8 and 15. Applying an upper voltage or current can make irreversible damage to the equipment. Applying any voltage at the analogue output pins can make irreversible damage to the equipment.

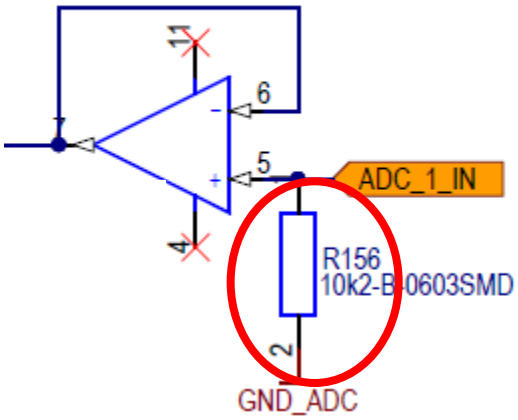
The analogue inputs and outputs of the unit are isolated.

3.1. Analogue Circuit

The analogue circuit at the output of the communication board (board reference: 702B) from the unit is as shown in the following diagrams.

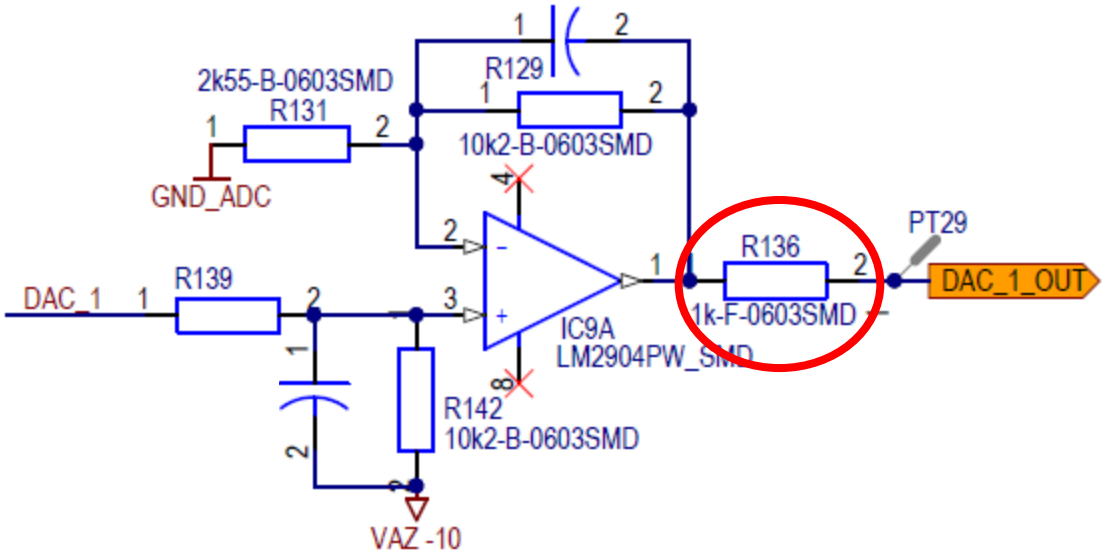
3.1.1. Analogue Input (AI) circuit

The analogue input (AI) circuit has a 10k resistor at the input of the circuit connected to GND (marked in red R156), the user has to take into account this point when the analogue inputs will be used. Please find the analogue input circuit below:



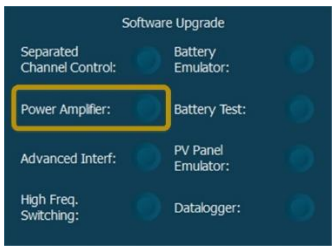
3.1.2. Analogue Output (AO) circuit

The analogue output (AO) circuit has a 1k resistor at the output of the circuit (marked in read R136), the user must take into account this point when the analogue outputs will be used. Please find the analogue output circuit below:



3.2. Standard Unit

Standard units are the ones with the Power Amplifier option DISABLED. In the ABOUT tab of the interface, the user can see if this optional is ACTIVATED if the LED just beside the option is lighting or no. Be sure that the Power Amplifier LED is disabled:



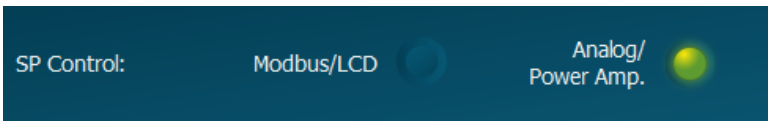
The setpoint that the unit will apply at the output will be the **RMS value** of the voltage range. The functionality of this digital input is the same or equivalent as the ***SETPOINT*** *sent by* Modbus register.

3.2.1. Analogue Inputs (AI) values

The maximum accepted values in the X15 are +10V and -10V. This range represents at the output the Max_limit and Min_limit of each variable. Please, read carefully this section to avoid any damage.

The equipment has 6 analogues inputs to send SETPOINT values to the equipment. The configuration of this control mode must be done through the local control LCD touchscreen:

When the analog setpoint control is enabled, there will appear the indicator in the Operation tab of the interface:



3.2.1.1. AC mode

To operate in analogue setpoint mode, the user must know the voltage value to apply on each analogue to operate. To know which is the corresponding range of each setpoint in AC mode, please take into account the values on the *Limits* tab of the Cinergia interface for each parameter (voltage, current, power and frequency):

The values of this tab (*Limits tab*) are the maximum and the minimum that the equipment can accept as a setpoint when the analogue input is also the maximum (±10V).

NOTE: For example, in voltage source, a 10V applied on the analogue input corresponds to 277Vac at the output of the unit, the Max.Voltage value. Remember that, in case of AC current, Cinergia equipment can deliver a 200% of the rated value for 2 seconds. So, to apply the rated current, the user must apply ±5V on each analogue input. Applying 10V, the unit will sink/source a setpoint of two times the rated current (2xRated current).

The analog input channel used in this mode are:

X15 CNG EQUIPMENT PINOUT	Analogue signal	Phase	PIN DB15
ANALOGUE INPUT	AI_1	SP_U	2
	AI_2	SP_U	3
	AI_3	SP_V	4
	AI_4	SP_V	5
	AI_5	SP_W	6
	AI_6	SP_W	7
GND			1, 8, 15

In Analogue mode, the setpoint or value represented by the unit is in RMS

The values of this *Limits* tab are the reference that the equipment will use to calculate the maximum allowed setpoint. These values depend on the power and the features of the unit.

The following table contains all the possible analogue inputs for Cinergia equipment in AC mode.

The MINIMUM and MAXIMUM of the following table are the numbers shown on the *Limits* tab.

Listed below are the equivalence table on AC mode:

AC MODE						-10V	0V	10V
MODE				ANALOG	VARIABLE	MINIMUM	MEDIUM	MAXIMUM
Voltage source	**3CHANNEL**	**Bipolar**	**AC**	AI_1	Voltage U RMS setpoint	*not used*	*0*	*max voltage AC*
				AI_2	Phase angle U	*-359º*	*0*	*359º*
				AI_3	Voltage V RMS setpoint	*not used*	*0*	*max voltage AC*
				AI_4	Phase angle V	*-359º -120º*	*-120º*	*359º -120º*
				AI_5	Voltage W RMS setpoint	*not used*	*0*	*max voltage AC*
				AI_6	Phase angle W	*-359º -240º*	*-240º*	*359º -240º*
Current source	**3CHANNEL**	**Bipolar**	**AC**	AI_1	Current U RMS setpoint	*min current AC (-2xIrated)*	*0*	*max current AC (2xIrated)*
				AI_2	Phase angle U	*-90º*	*0*	*90º*
				AI_3	Current V RMS setpoint	*min current AC (-2xIrated)*	*0*	*max current AC (2xIrated)*
				AI_4	Phase angle V	*-90º*	*0*	*90º*
				AI_5	Current W RMS setpoint	*min current AC (-2xIrated)*	*0*	*max current AC (2xIrated)*
				AI_6	Phase angle W	*-90º*	*0*	*90º*
Power source	**3CHANNEL**	**Bipolar**	**AC**	AI_1	Active power U	*min power (-2xPrated)*	*0*	*max power (2xPrated)*
				AI_2	Reactive power U	*min power (-2xPrated)*	*0*	*max power (2xPrated)*
				AI_3	Active power V	*min power (-2xPrated)*	*0*	*max power (2xPrated)*
				AI_4	Reactive power V	*min power (-2xPrated)*	*0*	*max power (2xPrated)*
				AI_5	Active power W	*min power (-2xPrated)*	*0*	*max power (2xPrated)*
				AI_6	Reactive power W	*min power (-2xPrated)*	*0*	*max power (2xPrated)*

Impedance	**3CHANNEL**	**Bipolar**	**AC**	AI_1	Resistance U	*not used*	*10000*	*0*
				AI_2	Inductance U	*not used*	*10000*	*0*
				AI_3	Resistance V	*not used*	*10000*	*0*
				AI_4	Inductance V	*not used*	*10000*	*0*
				AI_5	Resistance W	*not used*	*10000*	*0*
				AI_6	Inductance W	*not used*	*10000*	*0*
Voltage source	**1CHANNEL**	**Bipolar**	**AC**	AI_1	Voltage Global RMS setpoint	*not used*	*0*	*max voltage AC*
				AI_2	Phase angle Global	*-359º*	*0*	*359º*

** Noted that in 1Channel mode, only the analog input 1 and 2 is used. The other 4 analog inputs have no effect.*

If the user changes any limit values from the Limit Tab (*CINEINA* interface), the table above and the maximum and minimum values corresponding to the ±10V must be recalculated.

3.2.1.2. Setpoint Example in AC mode

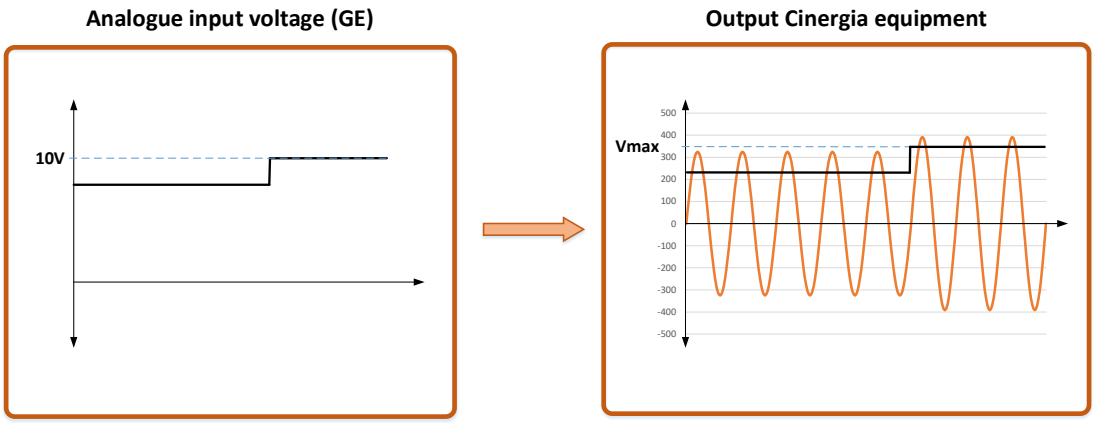
The following tables exemplify how the analogue input works.

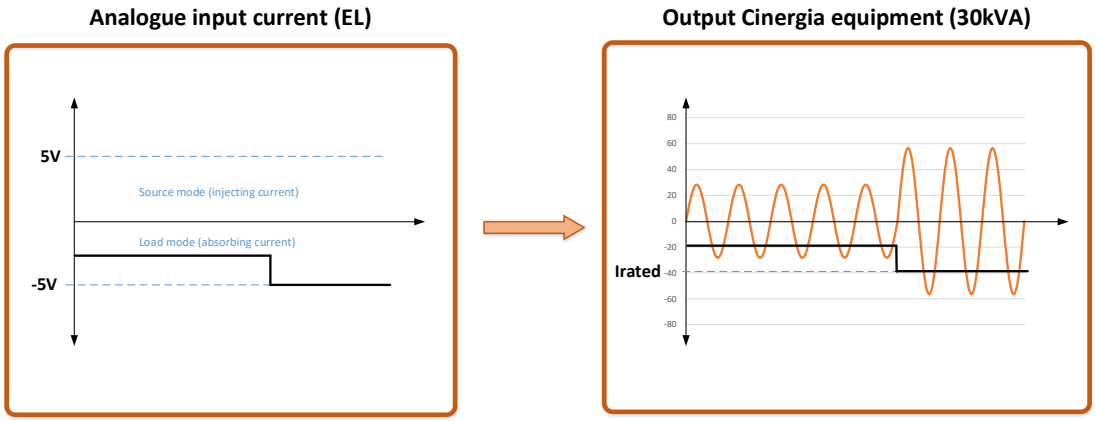
The first example, the converter is working in Current AC mode and has a limit of 40A. When the user introduced 5V in the analogue input 1, the equipment's output phase U will apply a setpoint of 20A:

10V (analogue limit)	→	40A (converter limit)
5V	→	x

$$x = \frac{5 \cdot 40}{10} = 20A$$

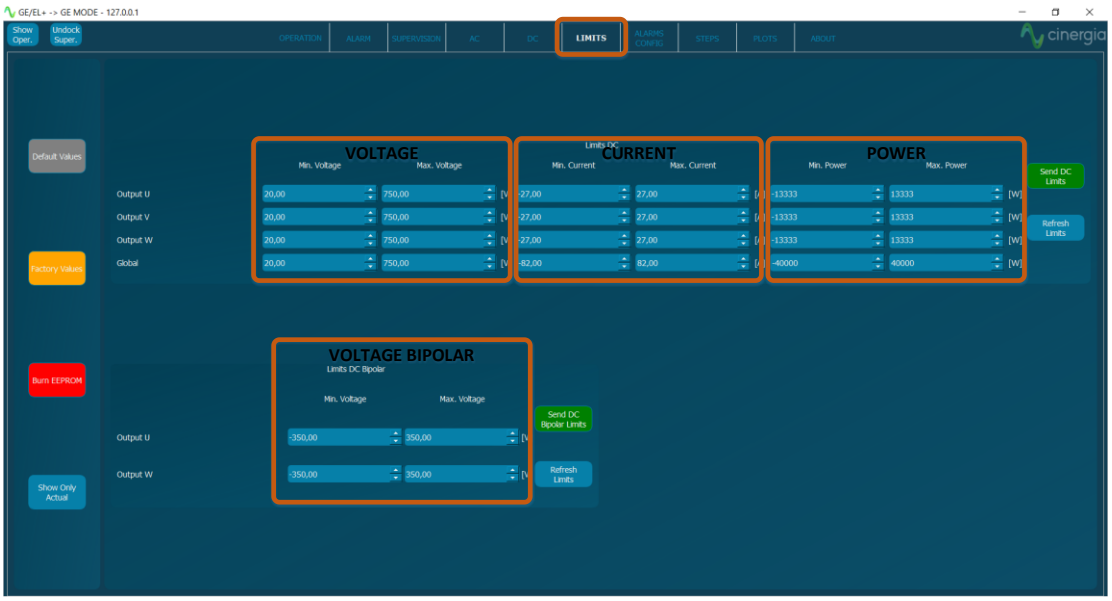
Examples for an equipment of GE and EL units:





3.2.1.3. DC mode

To operate in analogue setpoint mode, the user must know the voltage value to apply on each analogue to operate. To know which is the corresponding range of each setpoint in DC mode, please take into account the values on the *Limits* tab of the Cinergia interface for each parameter (voltage, current and power):



The values of this tab (*Limits tab*) are the maximum and the minimum that the equipment can accept as a setpoint when the analogue input is also the maximum (±10V).

NOTE: For example, in voltage source, a 10V applied on the analogue input corresponds to 750Vdc at the output of the unit, the Max.Voltage value. Take into account, in case of DC current, Cinergia equipment can deliver a 110% of the rated value for 1 minute. So, to apply the rated current, the user must apply ±9.09V on each analogue input. Applying 10V, the unit will sink/source a setpoint of 1.1xRated current.

The values of this *Limits* tab are the reference that the equipment will use to calculate the maximum allowed setpoint.

The following table contains all the possible analogue inputs for all Cinergia equipment in DC mode.

The MINIMUM and MAXIMUM of the following table are the numbers displayed on the *Limits* tab.

The analog input channel used in this mode are:

X15 CNG EQUIPMENT PINOUT	Analogue signal	Phase	PIN DB15
ANALOGUE INPUT	AI_1	SP_U	2
	AI_2	SP_V	3
	AI_3	SP_W	4
GND			1, 8, 15

Equipment in DC ALWAYS works as *Power Amplifier* option this means that the setpoint send by analogue input is the REALTIME value represented by the unit at its output.

When Voltage or Current mode is configured on the Analog input channels the value to the unit is a REALTIME setpoint.

Listed below are the equivalence table on DC mode:

DC MODE

MODE				ANALOG	VARIABLE	-10V MINIMUM	0V MEDIUM	10V MAXIMUM
Voltage source	**3CHANNEL**	**Unipolar**	**DC**	AI_1	Voltage U DC setpoint	*not used*	*0*	*max voltage DC*
				AI_2	Voltage V DC setpoint	*not used*	*0*	*max voltage DC*
				AI_3	Voltage W DC setpoint	*not used*	*0*	*max voltage DC*
Current source	**3CHANNEL**	**Unipolar**	**DC**	AI_1	Current U DC setpoint	*min current DC (-1.1xIrated)*	*0*	*max current DC (1.1xIrated)*
				AI_2	Current V DC setpoint	*min current DC (-1.1xIrated)*	*0*	*max current DC (1.1xIrated)*
				AI_3	Current W DC setpoint	*min current DC (-1.1xIrated)*	*0*	*max current DC (1.1xIrated)*
Power source	**3CHANNEL**	**Unipolar**	**DC**	AI_1	Power U DC setpoint	*min power (-2xPrated)*	*0*	*max power (2xPrated)*
				AI_2	Power V DC setpoint	*min power (-2xPrated)*	*0*	*max power (2xPrated)*
				AI_3	Power W DC setpoint	*min power (-2xPrated)*	*0*	*max power (2xPrated)*
Impedance	**3CHANNEL**	**Unipolar**	**DC**	AI_1	Impedance U DC setpoint	*not used*	*10000*	*0*
				AI_2	Impedance V DC setpoint	*not used*	*10000*	*0*
				AI_3	Impedance W DC setpoint	*not used*	*10000*	*0*
Voltage source	**1CHANNEL**	**Unipolar**	**DC**	AI_1	Voltage DC setpoint	*not used*	*0*	*max voltage DC*
Current source	**1CHANNEL**	**Unipolar**	**DC**	AI_1	Current DC setpoint	*min current DC (-1.1xIrated)*	*0*	*max current DC (1.1xIrated)*
Power source	**1CHANNEL**	**Unipolar**	**DC**	AI_1	Power DC setpoint	*min power (-2xPrated)*	*0*	*max power (2xPrated)*
Current source	**1CHANNEL**	**Unipolar**	**DC**	AI_1	Resistance	*not used*	*10000*	*0*

Voltage source	**3CHANNEL**	**Bipolar**	**DC**	AI_1	Voltage U DC bipolar setpoint	*min bipolar voltage*	*0*	*max bipolar voltage*
				AI_3	Voltage W DC bipolar setpoint	*min bipolar voltage*	*0*	*max bipolar voltage*
Current source	**3CHANNEL**	**Bipolar**	**DC**	AI_1	Current U DC bipolar setpoint	*min current DC (-1.1xIrated)*	*0*	*max current DC (1.1xIrated)*
				AI_3	Voltage W DC bipolar setpoint	*min current DC (-1.1xIrated)*	*0*	*max current DC (1.1xIrated)*
Power source	**3CHANNEL**	**Bipolar**	**DC**	AI_1	Power U DC bipolar setpoint	*min power (-2xPrated)*	*0*	*max power (2xPrated)*
				AI_3	Power W DC bipolar setpoint	*min power (-2xPrated)*	*0*	*max power (2xPrated)*
Impedance	**3CHANNEL**	**Bipolar**	**DC**	AI_1	Resistance U DC bipolar setpoint	*not used*	*10000*	*0*
				AI_3	Resistance W DC bipolar setpoint	*not used*	*10000*	*0*

** Noted that in 1Channel mode, only the analog input 1 is used. The other 2 analog inputs have no effect.*
In Bipolar mode, only the analog 1 and 3 are used. The analog 2 have no effect.

If the user changes any limit values from the Limit Tab (*Cineina* interface), the table above and the maximum and minimum values corresponding to the ±10V must be recalculated.

3.2.1.4. Setpoint Example in DC mode

The following tables exemplify how the analogue input works.

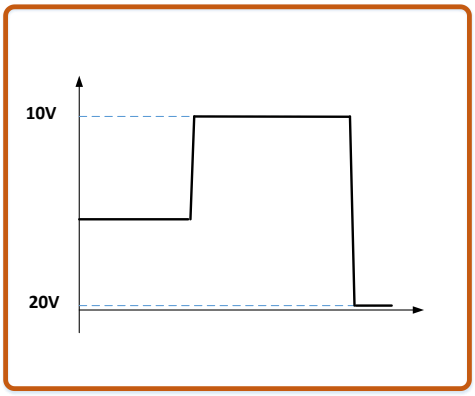
The first example, the converter is working in Voltage DC mode and has a limit of 750V. When the user introduced 5V in the analogue input 1, the equipment's output phase U will apply a setpoint of 375V:

10V (analogue limit)	→	750V (converter limit)
5V	→	x

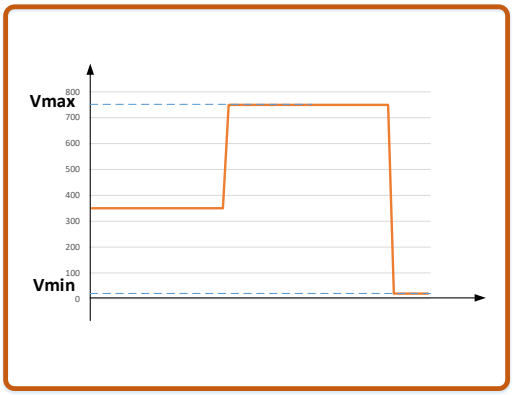
$$x = \frac{5 \cdot 750}{10} = 375V$$

Examples for an equipment of 30kVA in Unipolar mode:

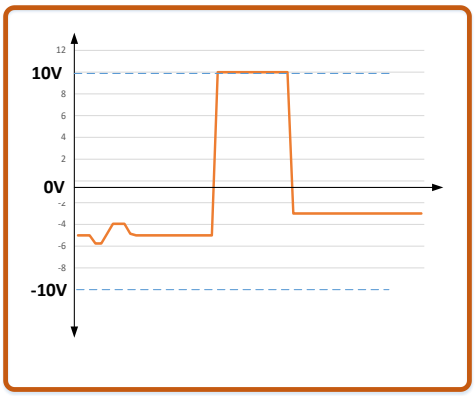
Analogue input voltage (DC)



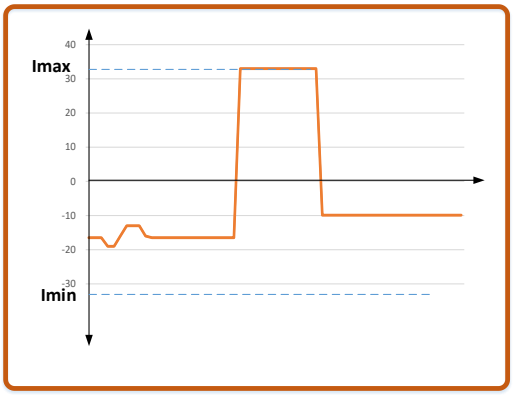
Output Cinergia equipment



Analogue input current (DC)



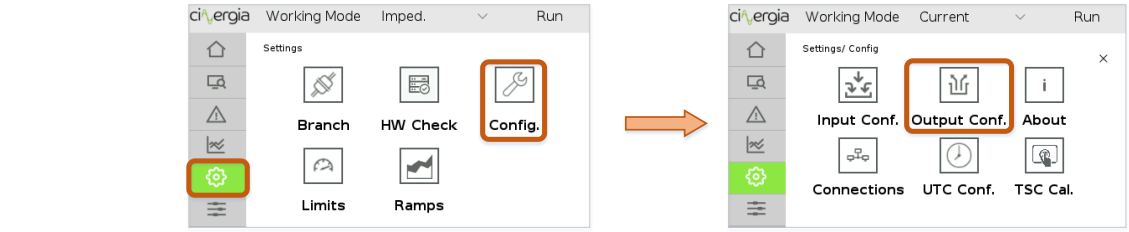
Output Cinergia equipment (30kVA)

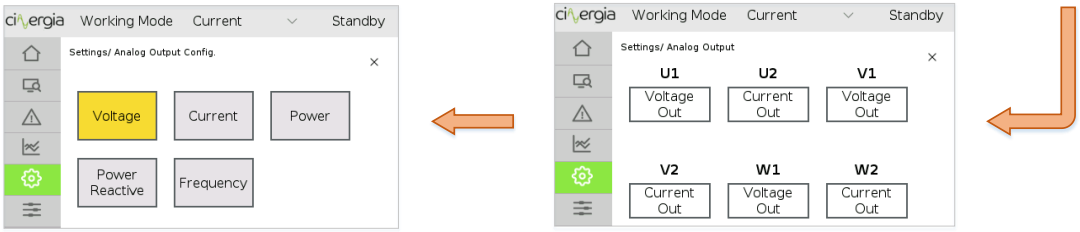


3.2.2. Analogue Outputs (AO)

The maximum accepted values in the X15 are +10V and -10V. This range represents at the output the Max_limit and Min_limit of each variable. Please, read carefully this section to avoid any damage.

The analogue output signals could be used to read some internal variables of the unit. There are two analogue output assigned to each output phase, U, V and W. This means that Output **AO_1** and **AO_2** are used to reproduce two variables related with phase U. Each output analogue is configurable by the user through the local control LCD touchscreen. There will be different analogue measures to read depending on the operation mode of the equipment AC or DC:





The available analogue outputs will change depending on the Cinergia equipment

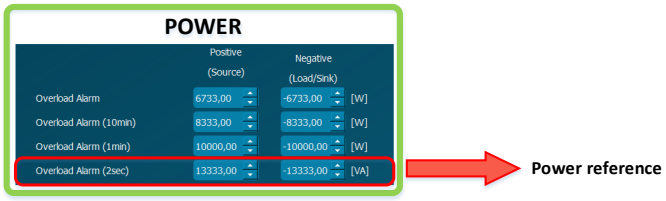
By pressing any of the 6 analogue outputs, the user will be able to select which is the parameter to appear outside

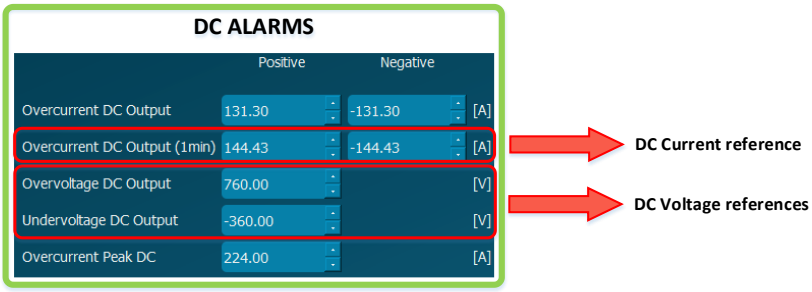
The analogue output used in this mode are:

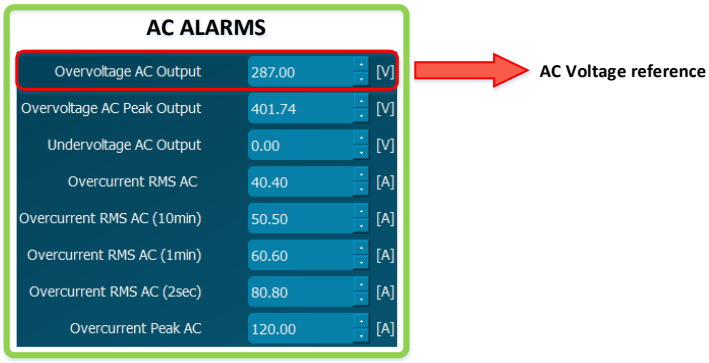
X15 CNG EQUIPMENT PINOUT	Analogue signal	Related to Phase	PIN DB15
ANALOGUE OUTPUT	AO_1	U	9
	AO_2	U	10
	AO_3	V	11
	AO_4	V	12
	AO_5	W	13
	AO_6	W	14
GND			1, 8, 15

To understand the value at the analogue output that the equipment is showing, please check at the *Alarms Config* tab of the Cinergia interface. These values are the references of the analogue output:

The values of this *Alarm Config* tab are the reference (total range) that the equipment will use to calculate the according value at the analogue output.

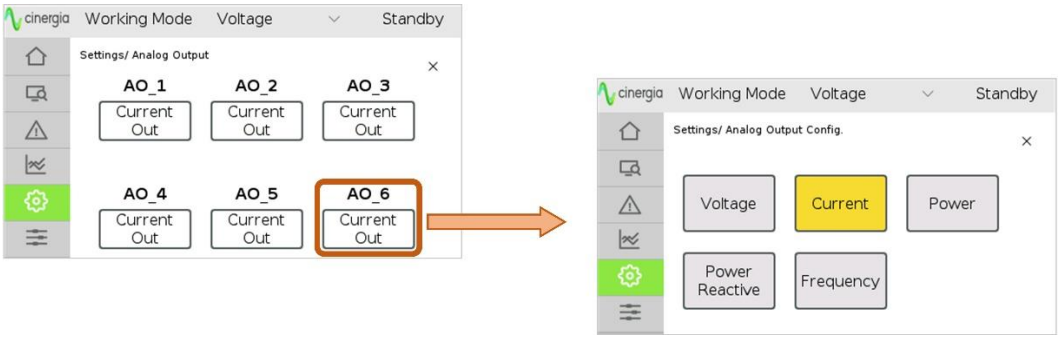






3.2.2.1. AC mode

In AC, the LCD touchscreen will have these variables to represent:



- Voltage
- Current
- Power (Active power)
- Power Reactive
- Frequency

Each analogue output can be configured by 5 internal variables (of each channel) described above.

The analogue output used in this mode are:

X15 CNG EQUIPMENT PINOUT	Analogue signal	Phase	PIN DB15
ANALOGUE OUTPUT	AO_1	U	9
	AO_2	U	10
	AO_3	V	11
	AO_4	V	12
	AO_5	W	13
	AO_6	W	14
GND			1, 8, 15

Take into account that each output channel can be configured in 5 different options: Voltage, Current, Active Power, Reactive Power and Frequency. This means that for each phase (phase U, phase V and phase W) the user can configure and represent two different parameters at the same time.

Equipment in AC working without the *Power Amplifier* option activated, when Voltage and Current is configured on the Analog output channels the value returned by the unit is an RMS value.

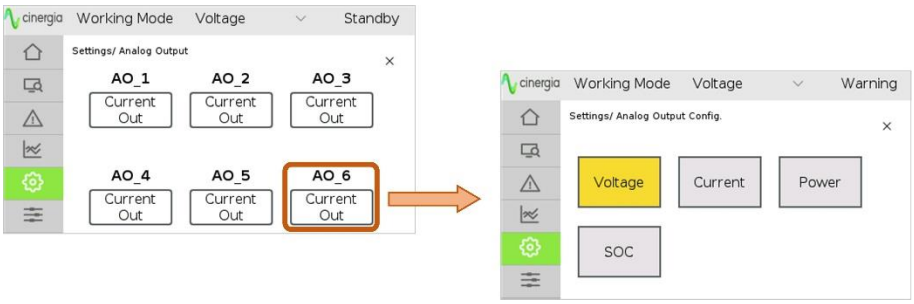
The following table illustrates the range or the equivalences between the real value at the output of the converter and the corresponding value on the analogue output:

Description	Minimum (-10V)	0V	Maximum (10V)
Voltage [V]	*not used*	0	Overvoltage AC Output
Current [A]	*not used*	0	Overcurrent RMS AC (2sec)
Power [W] **Power Reactive [VAr]**	Negative Alarm Overload (2sec)	0	Positive Alarm Overload (2sec)
Frequency [Hz]	*Min frequency (Limits tab)*	0	Max frequency (*Limits tab*)

The values on the table above are located in the *ALARMS CONFIG* tab on the interface.
Only in case of the frequency variable, the *Min frequency* and *Max frequency* parameters are present in the *Limits* tab.

3.2.2.2. DC mode

In DC, the LCD touchscreen will have these possibilities to choose:



- Voltage
- Current
- Power
- SOC (State of Charge). This parameter is only useful when the equipment is in battery mode

Equipment in DC ALWAYS works as in *Power Amplifier* option this means that the setpoint send by analogue input is the REALTIME value represented by the unit at its output.

When Voltage or Current mode is configured on the Analog input channels the value to the unit is a REALTIME setpoint.

The analogue output used in this mode are:

X15 CNG EQUIPMENT PINOUT	Analogue signal	Phase	PIN DB15
ANALOGUE OUTPUT	AO_1	U	9
	AO_2	U	10
	AO_3	V	11
	AO_4	V	12
	AO_5	W	13
	AO_6	W	14
GND			1, 8, 15

Take into account that each output channel can be configured in 4 different options: Voltage, Current, Power and SOC (only in case of Battery Emulator optional). This means that for each phase (phase U, phase V and phase W) the user can configure and represent two different parameters at the same time.

The following table illustrates the range or the equivalences between the real value at the output of the converter and the corresponding value on the analogue output. The range and configuration are shown on the following table:

Description	Minimum (-10V)	0V	Maximum (10V)
Voltage unipolar [V]	*not used*	0	Overvoltage DC Output
Current [A]	Overcurrent DC Output (1 min)	0	Overcurrent DC Output (1 min)
Power [W]	Alarm Overload (1 min)	0	Alarm Overload (1 min)
SOC [%]	*not used*	0	100
Description	**Minimum (-5V)**	**0V**	**Maximum (5V)**
Voltage bipolar	Undervoltage DC Output [V]	0V	Overvoltage DC Output

The values on the table above are located in the *ALARMS CONFIG* tab on the interface.

3.2.2.3. Output analogue examples in DC mode

The following tables exemplify how the analogue output is calculated.

The first example, the converter is working in Voltage DC mode and has an alarm of $760V_{DC}$. When the setpoint is $250V_{DC}$, the analogue output is $3.29V_{DC}$ due to:

$760V_{DC}$ (converter alarm) → $10V_{DC}$ (analogue limit)

$250V_{DC}$ → x

$$x = \frac{250 \cdot 10}{760} = 3.29V_{DC}$$

Examples for an equipment of 30kVA:

CNG 30				
Equipment mode	***Alarms Config* tab**		**Equipment output**	**Analogue output (X15)**
	Min	**Max**		
Voltage DC	$-360V_{DC}$	$760V_{DC}$	$250V_{DC}$	$3.29V_{DC}$
Current DC	$33.00A_{RMS}$		$30A_{RMS}$	$9.09V_{DC}$
Power DC	-18000W	18000W	8500W	$4.72V_{DC}$

3.3. vPA or vHIL units

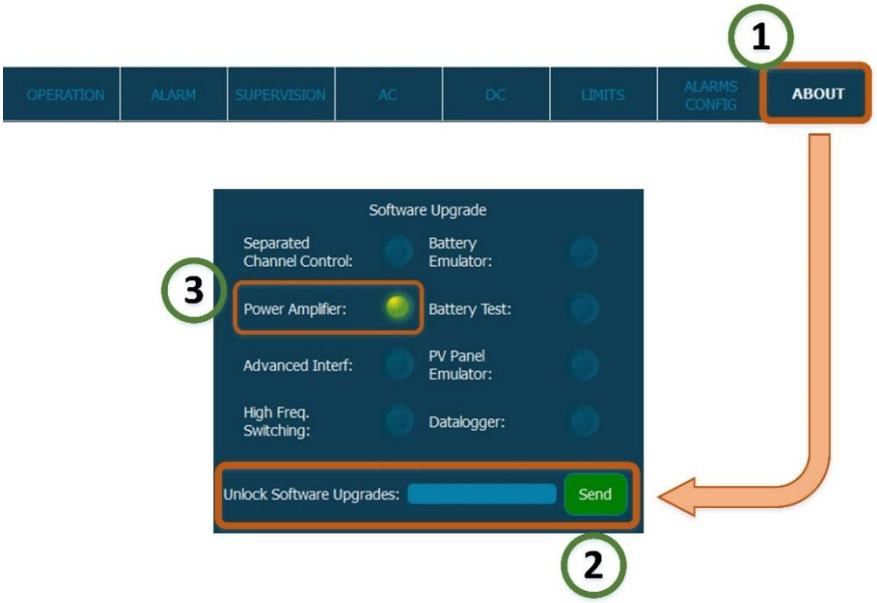
The Units version Power Amplifier (vPA), Hardware in a Loop (vHIL) or bought with the Power Amplifier Optional are provided with the code to activate or disable the Power Amplifier mode for free. Cinergia provides the code to activate or disable this functionality.
This means that the customer will choose when to enable or not this function.

Please, read on *Chapter 4* to learn more about this function.

4. POWER AMPLIFIER MODE (OPTIONAL)

To activate this optional, contact Cinergia to get the upgrade code. Upgrading it has an additional cost.

The delivered code must be introduced in the *Unlock extra* reserved space and, afterwards, press the button *Send* (number **2** in the figure below) in the *About* tab. When the Power Amplifier is activated, the LED beside the option (**3** in the figure below) is shining:



When Cinergia send the activation code, it also sends the disactivating code. The user can activate or disactivate this optional using this procedure described above.

The optional *Power Amplifier* is operated in AC mode and DC mode. For the DC mode, it is not needed to introduce the code, the unit is always working on analog input continues value.

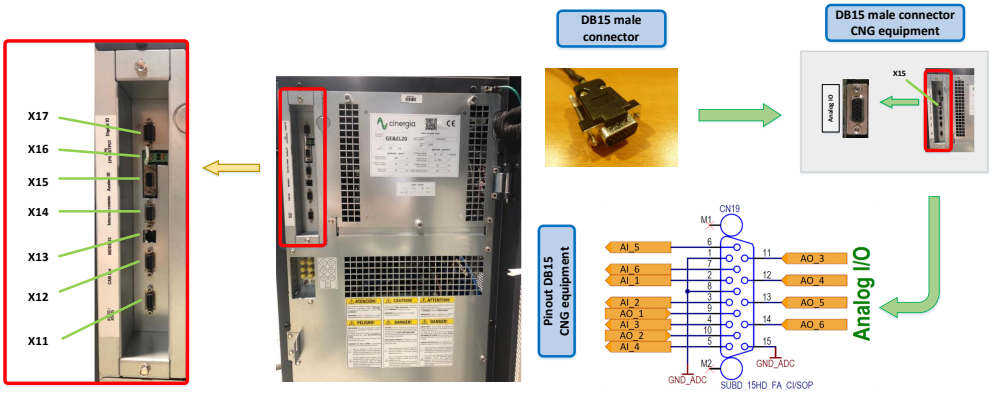
X15 CNG EQUIPMENT PINOUT	Analogue signal	Phase	PIN DB15
ANALOGUE INPUT	AI_1	SP_U	2
	AI_2	SP_V	3
	AI_3	SP_W	4
ANALOGUE OUTPUT	AO_1	V_U	9
	AO_2	V_V	10
	AO_3	V_W	11
	AO_4	I_U	12
	AO_5	I_V	13
	AO_6	I_W	14
GND			1, 8, 15

4.1. Quick operation Power Amplifier

This chapter describes the procedure to operate the unit In Power Amplifier mode.

To activate this Optional, contact Cinergia to get the upgrade code. Upgrading it has an additional cost.

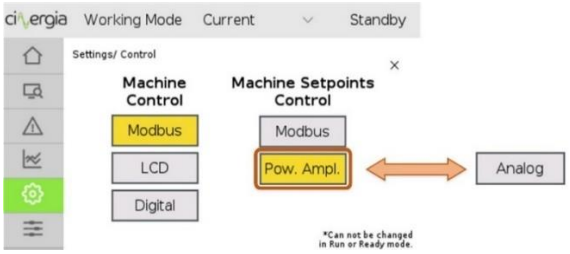
Analogue inputs and outputs are located in **X15.** All of them are isolated and located in the front of the equipment:



Please be sure to read carefully all the information provided with the Cinergia converter types to fully understand the functionalities of your equipment.

The analogue inputs accept a voltage range from -10V to +10V and the analogue output delivers a voltage range from -10V to +10V. Both input and output are referenced to GND_ADC; pin 1, 8 and 15. Applying an upper voltage or current can make irreversible damage to the equipment. Applying any voltage at the analogue output pins can make irreversible damage to the equipment.

A. **STEP 1**: Connect to the unit through Modbus using the Cinergia Interface provided.
B. **STEP 2**: Go to *About* tab. The unit must be in *Stand By* or *Alarm* status.
C. **STEP 3**: The delivered code must be introduced in the *Unlock extra* reserved space and, afterwards, press the button *Send* (number **2** in the figure above). When the Power Amplifier is activated, the LED beside the option (**3** in the figure above) is shining.
D. **STEP 4**: The user must configure the Power Amplifier mode by the LCD. Go to the setting tab from the LCD and press Power Amplifier on Setpoints control as picture below:



The unit is ready to be controlled by Analogue inputs in Power Amplifier mode.

4.2. Analogue Inputs (AI) in AC mode

The maximum admitted voltage to the analogue input signals is $20V_{pp}$ (±10V).

Please read the Chapter 3.1 Analogue Circuit before operating the unit in Power Amplifier.

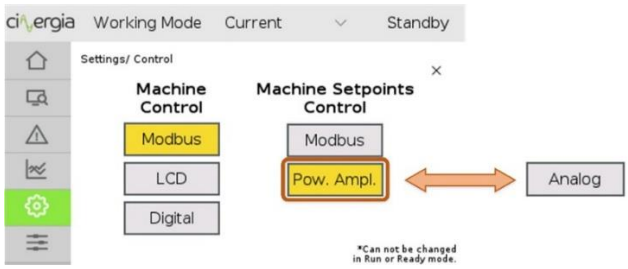
Cinergia equipment with the optional *Power Amplifier* enabled reproduces the analog input waveform signal from the analog input to the output of the Cinergia equipment in Realtime. The output is the instant value instead of the calculated RMS value as mentioned on previous chapter. For example, if the user needs a triangle waveform in the output of the Cinergia equipment, the input in the analogue PIN must be a triangle waveform as well. Please see some examples below.

In case of AC mode:

- In case of **Voltage source (GE)**, the SP will be the ***REALTIME*** *voltage value*, and
- in case of **Current Source (EL)**, the SP will be the ***REALTIME*** *current value*.

Equipment in DC ALWAYS works as in *Power Amplifier* option.

When the equipment has the optional *Power Amplifier* the LDC touchscreen will change the *Machine Setpoints Control* in the *Settings* / *Control* tab and will display *Pow. Ampl.* instead of *Analog*:



The analogue INPUT used in this mode are shown on the following table. The other three analogue input channels are not used. Each analogue input corresponds on one phase.

X15 CNG EQUIPMENT PINOUT	Analogue signal	Phase	PIN DB15
ANALOGUE INPUT	AI_1	SP_U	2
	AI_2	SP_V	3
	AI_3	SP_W	4
GND			1, 8, 15

The maximum admitted voltage to the analogue input signals is $20V_{pp}$ (±10V).

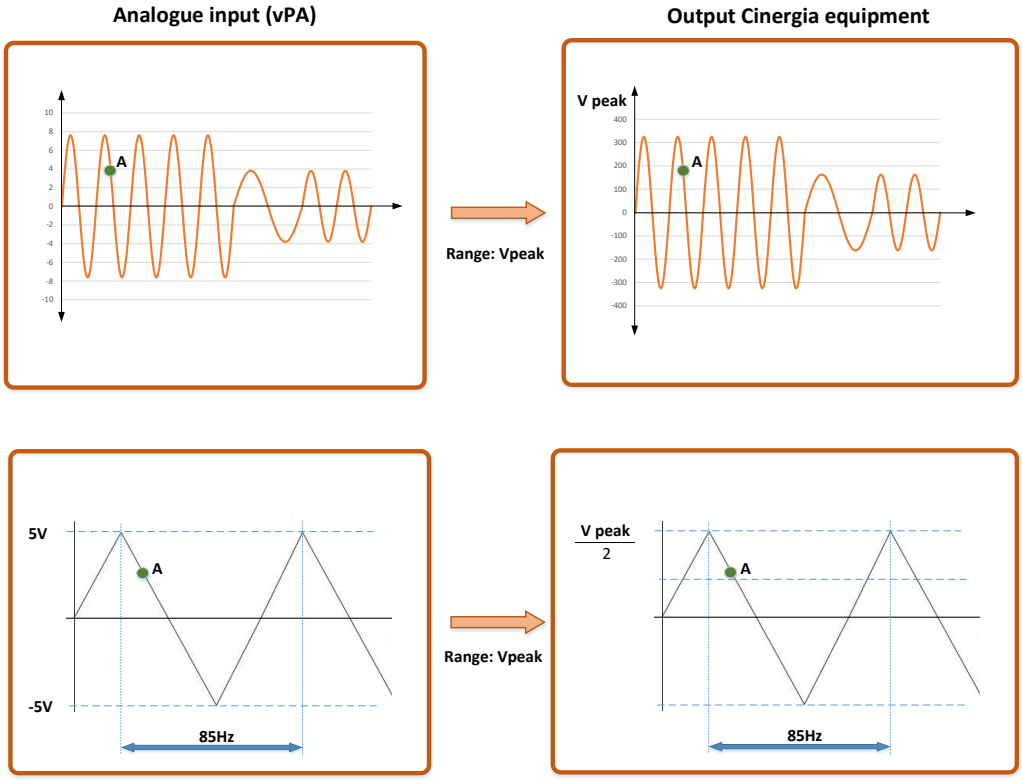
4.2.1. Grid Emulator (GE) or Voltage Source case

A GE will generate a voltage proportional to the input with the frequency and waveform of it.

The maximum admitted voltage to the analogue input signals is $20V_{pp}$ (±10V).

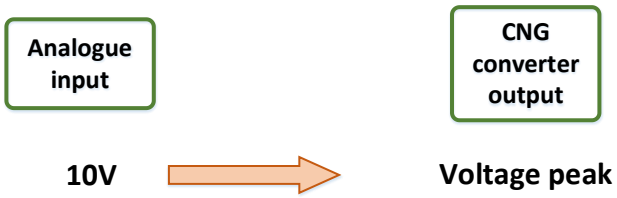
To initialize a Grid Emulator, it is necessary to be introducing a reference (through the AI 1, 2 and 3 from the X15) in all channels when it goes to RUN state. Afterwards, the setpoints can go down to 0. The reason of that is because the GE will apply a frequency at the output with a certain value of voltage, which can be small.

The following image illustrates two examples of power amplifier waveform:

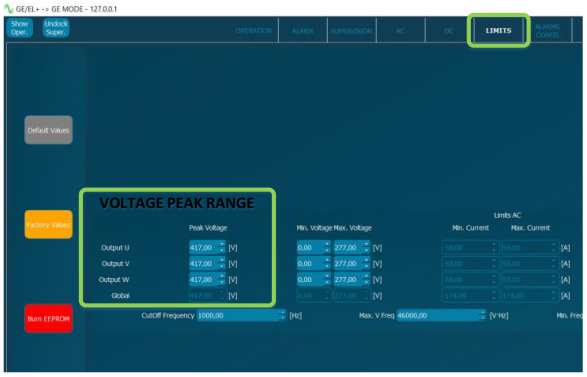


It is important to remember that the Power amplifier option calculates the instant value of the waveform: the point A in each left graph corresponds with the point A of the right graph.

To calculate which will the output be, the only required parameter is the limit value (Vpeak). So, it is important to say that both examples above are calculated with a maximum limit of the voltage peak that the unit can reproduce. It is also explained that the voltage limit in the input of the analogue PIN is $10V_{pk}$. The following equivalence is the one required to make the calculations:



The user must take in mind that the correct value is the V_{pk}, the voltage peak. This value is a parameter that the user can find in *LIMIT TAB* of the Cinergia interface.



The analogue INPUT channel used in this mode are:

X15 CNG EQUIPMENT PINOUT	Analogue signal	Phase	PIN DB15
ANALOGUE INPUT	AI_1	V_SP_U	2
	AI_2	V_SP_V	3
	AI_3	V_SP_W	4
GND			1, 8, 15

The used inputs for the power amplifier in GE mode option are the following, representing the voltage setpoint:

ANALOG	PHASE	RANG max.
AI_1 (PIN 2)	V_SP_U	20V_{PP} **(±10V)** Voltage setpoint
AI_2 (PIN 3)	V_SP_V	
AI_3 (PIN 4)	V_SP_W	

If the GE is working in 1 channel mode, the voltage limit that the converter will use is the global one, which is also in the LIMITS tab in the interface and the LCD touchscreen. The calculations will be the same but using the global limit. The factory value for the global voltage limit is the same than the values for each channel

In 1 channel mode, the setpoint will be delivered using the Analogue Input 1, located in the PIN 2 of the DB15 (X15). The other 2 analogue input has no effect.

The maximum allowed voltage value to be introduced in the **X15** for the power amplifier option is 20V_{PP} **(±10V)**, which corresponds to the maximum output range of the converter. The Power

Amplifier will use the voltage peak limit of the equipment to calculate the output range in voltage. In voltage, the **range or limit used is Voltage Peak limit** value located on LIMITS TAB.

For a Grid Emulator, the factory limit of the voltage is 427,19V (with no High Voltage optional), but if the user changes this limit, the Power Amplifier range will use the new value to calculate the setpoint and the output.

4.2.1.1. Grid Emulator (GE) example

A GE will generate a voltage proportional to the input with the frequency and waveform of it.

To initialize a Grid Emulator, it is necessary to be introducing a reference (through the AI 1, 2 and 3 from the X15) in all channels when it goes to RUN state. Afterwards, the setpoints can go down to 0. The reason of that is because the GE will apply a frequency at the output with a certain value of voltage, which can be small.

On the example diagram shown on the section above, in the first example, as the input sinusoidal has 7,6V_{pk}, the output will be

$$\frac{7{,}6V_{pk} \cdot Voltage\ peak\ value}{10V_{pk}} = 325\ V_{pk} \rightarrow 230V_{RMS}$$

In the second example, the triangular wave has 5V_{pk} , this means that the voltage peak value at the output will be $\frac{Voltage\ peak\ value}{2}$.

Noted: In case of 1 channel mode, the limit will be found in the *Limits* tab of the interface, located in the *Global* line.

4.2.2. Electronic Load (EL) or Current source case

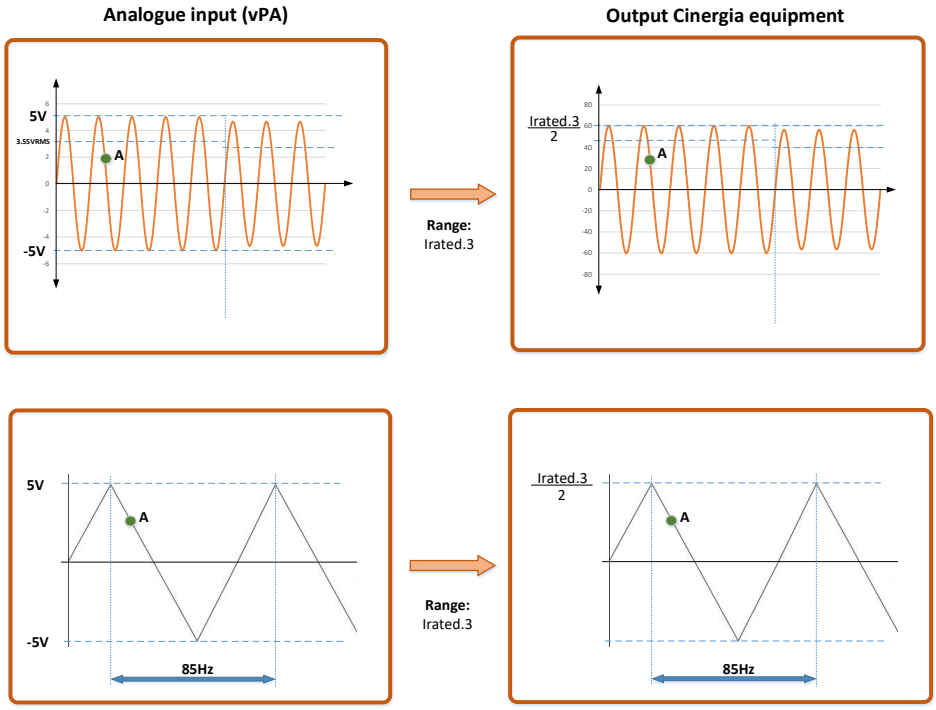
An EL will generate a current proportional to the input with the frequency and waveform introduced on each input analog channel per channel.

The maximum admitted voltage to the analogue input signals is $20V_{pp}$ (±10V).

To initialize an Electronic Load, it is necessary to be introducing a reference (through the AI 1, 2 and 3 from the X15) in all channels when it goes to RUN state. Afterwards, the setpoints can go down to 0. The reason of that is because the EL will apply a frequency at the output with a certain value of voltage, which can be small.

To operate any Electronic Load Cinergia Unit in Power Amplifier mode, it is needed that the external device that is generating the waveform connected to the input analogue channels close the control loop to be assure that the EL is consuming in phase to the voltage, same phase and frequency. The unit is only amplifying the waveform at the analogue input to the real output.

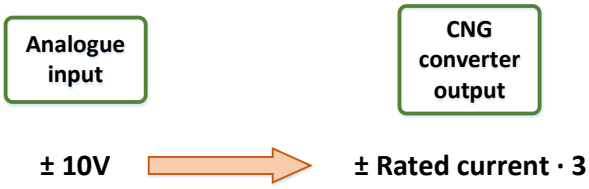
The following image illustrates two examples of power amplifier waveform for a EL30:



It is important to remember that the Power amplifier option calculates the instant value of the waveform: the point A in each left graph corresponds with the point A of the right graph.

The user must calculate which will the output be, the only required parameter is know the rated current, and the total range of the output is three time the rated current as crest factor 3. So, it is important to say that both examples above are calculated with a **current 3 crest factor** (as

EL30, this value is $120A$). It is also explained that the voltage limit in the input of the analogue PIN is 10V. The following equivalence is the one required to make all the calculations:



Please note that the rated current of the equipment is in A_{RMS}. This value cannot be modified by the user, so the range is all the time the same, in current.

The analogue INPUT channel used in this mode are:

X15 CNG EQUIPMENT PINOUT	Analogue signal	Phase	PIN DB15
ANALOGUE INPUT	AI_1	I_SP_U	2
	AI_2	I_SP_V	3
	AI_3	I_SP_W	4
GND			1, 8, 15

The used inputs for the power amplifier in EL option are the following, representing the current setpoint:

ANALOG	PHASE	RANG max.
AI_1 (PIN 2)	I_SP_U	**$20V_{PP}$ (±10V)** Current setpoint
AI_2 (PIN 3)	I_SP_V	
AI_3 (PIN 4)	I_SP_W	

The maximum allowed voltage value to be introduced in the **X15** for the power amplifier option is $20V_{PP}$ **(±10V)**, which corresponds to the maximum output range of the converter. The Power Amplifier will use the rated current of the equipment to calculate the output range in current. In current, the **range or limit used is three times rated current**.

In case of Electronic Load (EL), the used limit is the three times (CF = 3) of the rated current that the EL can hold current. For example, in case of an EL30, the nominal output current is 40A, so the range value will be $\pm 120A\ peak$.

To operate any Electronic Load Cinergia Unit in Power Amplifier mode, it is needed that the external device that is generating the waveform connected to the input analogue channels close the control loop to be assure that the EL is consuming in phase to the voltage, same phase and frequency. The unit is only amplifying the waveform at the analogue input to the real output.

4.2.2.1. Electronic Load (EL) example

An EL will generate a current proportional to the input with the frequency and waveform of it.

On the example diagram shown on the section above, if the EL is a 30kVA unit, in the first example, as the input sinusoidal has $5V_{pk}$, the output will be:

$$\frac{5V_{pk} \cdot Irated \cdot 3}{10V_{pk}} = 60A_{pk}$$

In the second example, the triangular wave has the same peak current.

Please note that the EL does not have parallel mode

4.3. Analogue Inputs (AI) in DC mode

Please, read the chapter 3.2.1.3. for more information.

4.4. Analogue Outputs (AO) in AC mode

In Power Amplifier, there are 6 analog output available. The analogue outputs cannot be modified: they are fixed for all type of units in AC and are returning the Realtime value of the measures of voltage and current of each channel (6 measures in total). The first 3-analog output (AO_1, AO_2, AO_3) return the voltage at the output of the unit of each phase U, V and W and the last 3-analog output (AO_4, AO_5, AO_6), the current.

X15 CNG EQUIPMENT PINOUT	Analogue signal	Phase	PIN DB15
ANALOGUE OUTPUT	AO_1	V_U	9
	AO_2	V_V	10
	AO_3	V_W	11
	AO_4	I_U	12
	AO_5	I_V	13
	AO_6	I_W	14
GND			1, 8, 15

The maximum voltage returned by the unit on the analogue output is $20V_{pp}$ (±10V).

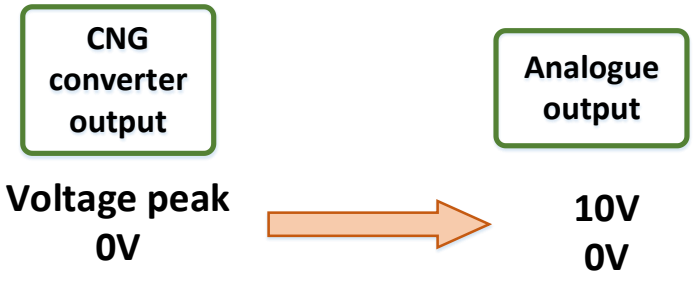
Please read the Chapter 3.1 Analogue Circuit before operating the unit in Power Amplifier.

The output analog voltage has the same maximum values as the analog input voltages, so the ±10V corresponds to the maximum voltage or current that the device can withstand, according to the limits that the equipment has in that moment. But it is possible that the equipment applies some restriction depending on the configuration of the limits, that's why the user must pay attention to the value of the converter limits.

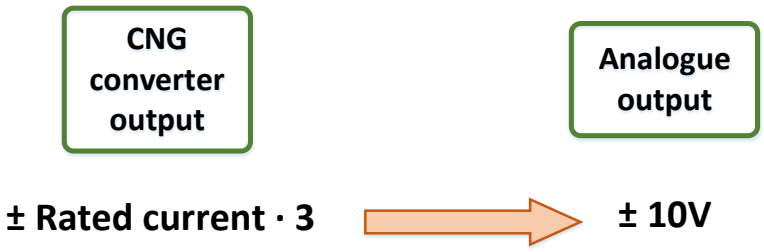
So, if there is no restriction and the unit is working properly the values applied on the analogue input channels will be the same as the unit is returned or shown in the corresponds analogue output channels.

The equivalence will be:

On channels (AO_1, AO_2, AO_3) reproducing the **voltage** at the output of the unit:



On channels (AO_5, AO_6, AO_7) reproducing the **current** at the output of the unit:



4.5. Analogue Outputs (AO) in DC mode

Please, read the chapter 3.2.2.2. for more information.

5. ABOUT

In case of any doubt or issues with your converter, please make a screenshot of the ABOUT TAB once the unit is properly connected and send it to Cinergia.

In case of issues with the converter, please make a screenshot of the ABOUT TAB and send it to Cinergia. The user must connect to the equipment to be sure that the interface tab charges all the internal parameters of the unit.

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t. 93 486 43 58

Please, don't hesitate to contact on support@cinergia.coop our technical support team in case of any doubt or question.