



# EL+ vHF ePlus

Avionics | Regenerative High Frequency Electronic Load



CINERGIA has developed a line of Regenerative Electronic Load products capable of working in a frequency range of 360 to 900Hz. It was designed to simulate the different loads that can be found in the aircraft.

The testing of aircraft generators with variable frequency is an added difficulty. Since the regulations require a constant value of  $\cos \phi$ , this implies the need to vary the magnitude of the inductance during the test. Through passive elements, the cost can be very high, and we obtain discrete results.

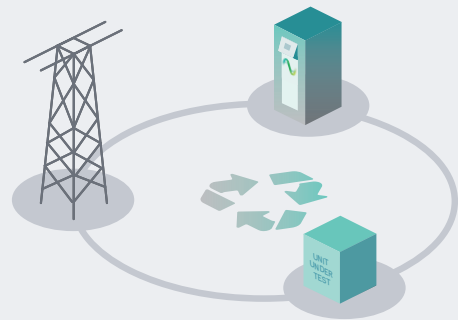
CINERGIA's electronics loads are the best tools for this type of tests. Their easy-to-use software allows us to control all the parameters and adjust the magnitude of the current required in the test. Its Bidirectional and Regenerative Hardware based on a back-to-back power conversion topology also allows energy and power saving.



## Regenerative Technology

Thanks to our bi-directional topology, the HF Electronic Load Converter are regenerative, resulting in a reduction of both the consumed energy during the tests and the power required from the electrical installation.

This technology allows us to work in both directions, as power generators or offering a consumption for the realization of all types of tests.



## Bidirectional and Regenerative

### Clean grid current

THDi <3% and PF > 0.98

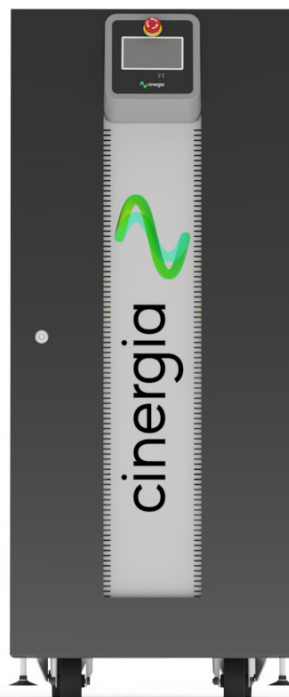
### 5 Models

from 15kVA to 50kVA

### Parallelization of units to increase the power

### Independent phase configuration of

rms current, phase angle, generation of fast transients ("Current Dips")



## High Frequency range

360-900 Hz

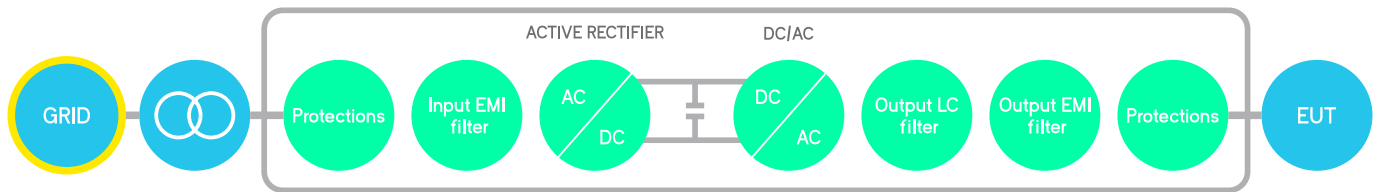
## Emulation of grid connected devices

Loads absorbing energy from grid  
Generators injecting energy to the grid  
Programmable Active/Reactive consumption  
Non-linear currents up to CF of 3

## Intuitive User Interface

## Modbus/Ethernet Open protocol, Labview drivers

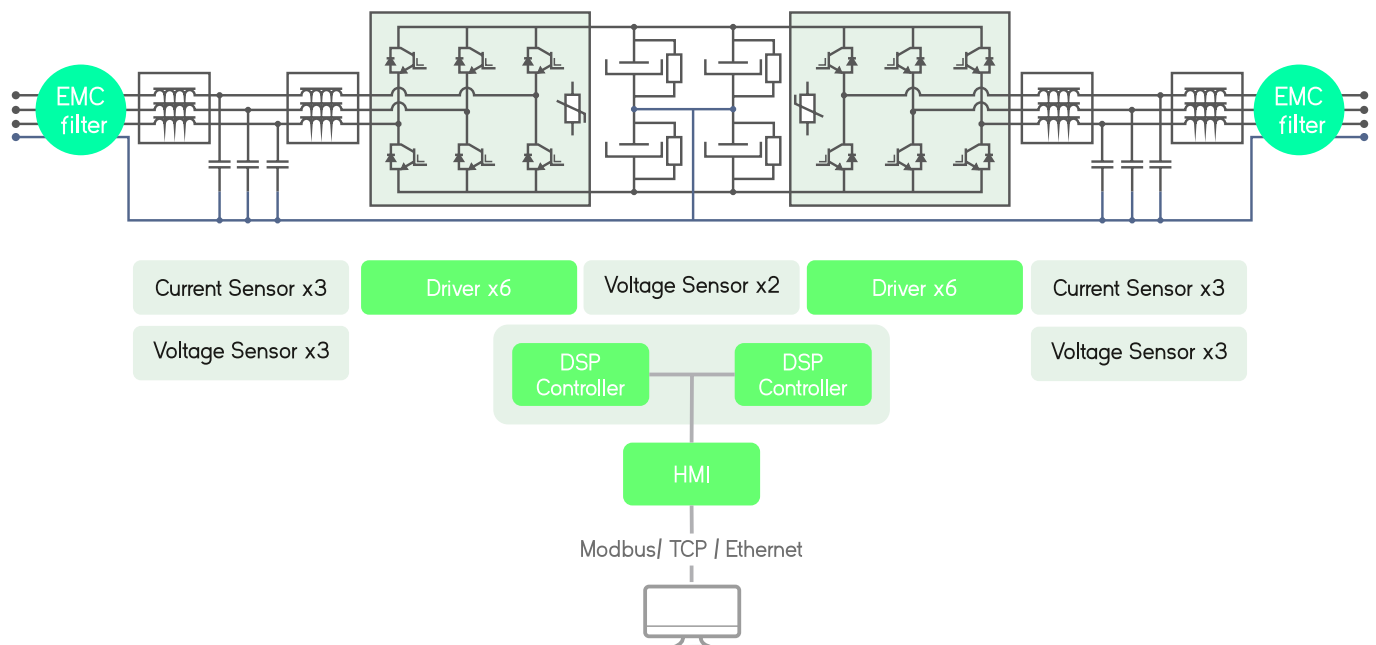
# Bidirectional and Regenerative Hardware



The hardware platform is based on a Back-to-Back power conversion topology, formed by two IGBT-based power stages. The grid side stage is an Active Rectifier which produces clean sinusoidal currents with very low harmonic distortion and power factor close to one.

The EUT side stage can be configured for AC voltage source or AC current source or DC output. In AC, voltage/current are controlled by using state of the art digital Proportional-Resonant controllers. In DC, the three independent buck-boost bidirectional legs enable the separated control of three different DC voltages or currents.

## Block Diagram



## Local Interface

### Analogue and Digital 10 ports

The isolated digital and analogue inputs/outputs permit the connection of the unit to External Controllers and Power Hardware in the Loop systems (option).

### 4.3" Touchscreen

Allows the local parameterization and command of the device, configuration of the communications link, plots the main signals and enables the local datalogging.

### Safety First

The units integrate a local Emergency Stop pushbutton and two signals (input+ output) to be connected to the laboratory interlock system. Additionally, the digital outputs can be interfaced to safety tower lights.

### Master/Slave

ePLUS is a modular platform enabling the master/slave connection of units with equal power.



# Better than ever, the enhanced **Plus** family



## What's better

### MASTER/SLAVE CONNECTION

by using a fiber optics link to increase power/voltage capabilities:

GE in AC: can be connected in parallel

EL in AC: can be connected in parallel

B2C: can be connected in parallel, or series or both

### FASTER

30kHz control loop frequency

### MORE HARMONICS

50 per phase with 20 free-harmonics

### DELTA LOAD

for the EL in AC mode

### ADJUSTABLE DC TRANSIENT

controllers to improve stability of the system

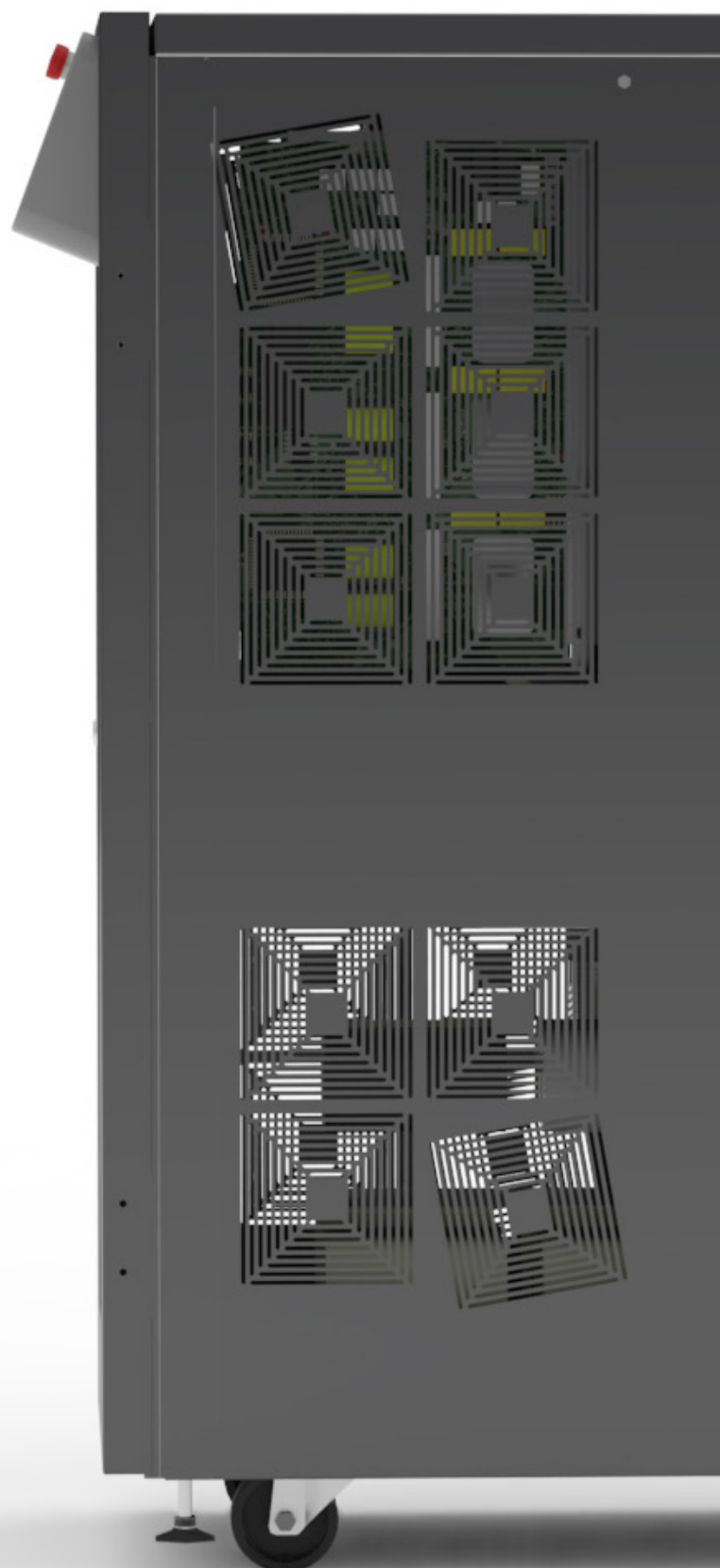
### OPTIMIZED RMS CALCULATION

for PV inverters anti-islanding test

### SAME ELECTRICAL RATINGS

#### and SAME BANDWIDTH

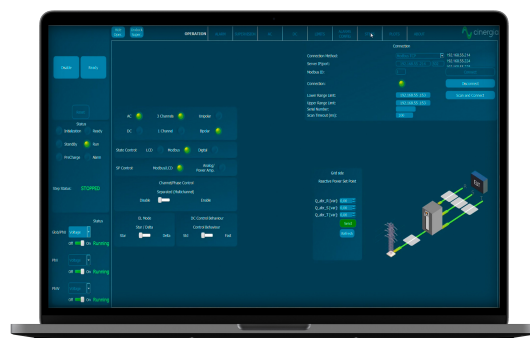
because the power platform does not change so robustness and ratings remain the same.



# Software



The user interface used by CINERGIA devices has been developed by our R&D team, to offer total control of the device, with a comfortable and intuitive design. This allows us to take full advantage of the capabilities of the device, as well as the programming and execution of standardized or self-created tests.



## EL Modes



### AC Operation

From this panel, the user can set all AC parameters. Each phase can be independently configured: RMS current magnitude, phase delay, harmonics content, free-frequency harmonic and transition ramps. A plot shows the expected real-time waveform, the FFT representation and the numeric data: RMS, peak, CF and THD.



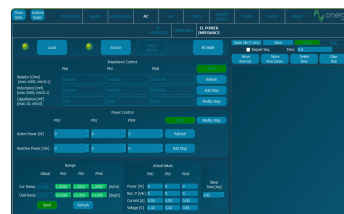
### Harmonics

The device can control simultaneously the magnitude of the first 15 harmonics and one free harmonic per phase. The free one allows the generation of sub-harmonics, inter-harmonics and high frequency harmonics up to the 50th, setting both the magnitude and phase delay.



### Power and Impedance Control

In Power mode, the active and reactive power of each phase is independently controlled. In Impedance mode, the device emulates an RLC load allowing to parameterize resistance, inductance and capacitance per phase making this device suitable for Anti-Islanding test of grid converters.

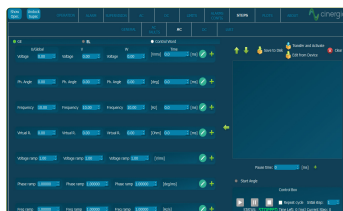


## AC



### Steps Mode

One of the most remarkable novelties of the new software is the steps functionality. Step test files are saved and executed by the DSP allowing deterministic timing with a resolution of 66µs. The user gains access to all registers of the device to create complex test sequences which run directly in the converter without the need of an external computer.



### Disturbance Generation

The steps mode includes predefined easy-to-use test panels. The AC faults panel is a powerful yet intuitive editor which allows generating and configuring flicker. Specific profiles can be saved in .csv files, modified, and reused by importing an existing one.



### Linear & Non-Linear Emulation

The capacity to emulate linear and non-linear loads in one of the main features of the 4Q Electronic Load. Through our intuitive control software, the magnitude of harmonics can be set and different types of loads can be generated.



# EL+ vHF Range & Specifications

---

## Input side (GRID side)

### AC Voltage

Rated: 3x400Vrms +Neutral+ Earth

Range: +15% / -20%

### Rated AC Current

Depends on model (see Wiring Manual)

### Frequency

48-62Hz

### Current Harmonic Distortion

THDi < 3% at rated power

### Current Power Factor

PF > 0.98 at rated power

### Efficiency

≥ 89% (7.5 & 10), ≥ 91% (15 to 30), ≥ 92% (40 to 200)

---

## Output side in AC (EUT side)

### Terminals

Number: 4 (3 phases + 1 neutral)

### Configuration of Channels

3 channels: 4Q, independent setpoints per phase

1 channel: 4Q, global setpoints for all phases (only in GE+)

Multichannel: 4Q, independent start/stop, alarm status and setpoints per phase (note: multichannel is an option for ≥ 80kVA)

---

## Output side in EL-HF

### Admissible Voltage

Connection: 1-phase, 3-phase star (consult us for 3-phase delta)

Maximum: ± 400V peak

Range: 360-900Hz

35<sup>(1)</sup> to 277Vrms phase-neutral (295Vrms with HV option)

35<sup>(1)</sup> to 480Vrms phase-phase (510Vrms with HV option)

Frequency: 360 to 900Hz

### Current Mode (CC)

Range: from 0 to ± 200%<sup>(8)</sup> of  $I_{rated}$  (see models table)

Setpoint Resolution: 10mA<sub>rms</sub>

Effective Resolution<sup>(2)</sup>: < 0.05% of FS<sup>(3)</sup> (< 0.1% models 7.5 & 10)

Setpoint Accuracy<sup>(4)</sup>: < ± 0.2% of FS<sup>(3)</sup>

Transient Time<sup>(5)</sup>: < 1.5ms (10% to 90% at a step transient)

Ripple<sup>(7)</sup> (peak-peak): < 0.7% of FS<sup>(3)</sup> (with Low Ripple Inductor option)

### Phase Angle (cos φ)

Range: -90 to 90° in Sink / Source

Resolution: 0.01°

### Harmonics

Open-loop generation of harmonics (consult us)

### Power Mode (CP / CS)

Range: from 0 to ± 200%<sup>(8)</sup> of  $P_{rated}$  (see models table)

Derived current setpoint: calculated from ISI and φ(S)

Setpoint Resolution: 1W, 1VA

Effective Resolution<sup>(2)</sup>: < 0.1% of FS<sup>(3)</sup> (< 0.25% models 7.5 & 10)

Setpoint Accuracy<sup>(4)</sup>: ± 0.4% of FS<sup>(3)</sup>

Transient Time<sup>(5)</sup>: < 2.5ms (10% to 90% at a step to  $P_{rated}$ )

### Impedance Mode (CZ)

Range: from 0.8 to 1000 Ohm, 0.1 to 2000mH, 0 to 3.7mF

Derived current/phase setpoint: calculated from IZI and φ(Z)

Setpoint Resolution: 0.01 Ohm/mH/mF

Setpoint Accuracy<sup>(4)</sup>: see current accuracy

Transient Time<sup>(5)</sup>: < 2.5ms (10% to 90% at a step to  $R_{rated}$ )

---

## Operation Modes

**HF**  
Programmable Current (CC)  
Programmable Power (CP / CS)  
Programmable Impedance (CZ)  
Steps

## Overload/ Overcurrent

Admissible AC overcurrent: 125% of rated value during 10 minutes, 150% during 1 minute, 200% during 2 seconds  
Admissible overloads: 125% of rated value during 10 minutes, 150% during 1 minute, 200% during 2 seconds

## User Interface

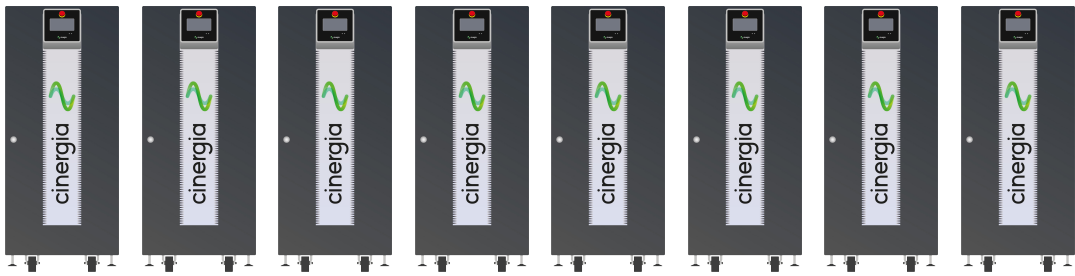
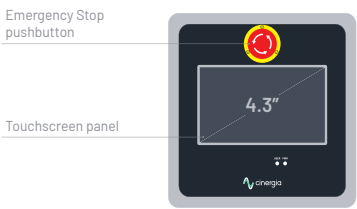
**Local Control (4.3" Touchscreen panel)**  
Isolated Digital port: 6 inputs, 4 outputs  
Isolated Analogue port: 6 inputs (rms setpoints or power amplifier), 6 outputs (rms readback or real-time readback)  
Interlock port: 1 NC Input, 1 NO Output  
Emergency Stop pushbutton

**Remote Control Port**  
LAN Ethernet with Open Modbus-TCP protocol  
RS485 (option), CAN and RS232 (using external gateway)

**Software**  
Graphical User Interface for Windows 7/10  
LabView drivers and open Labview interface example

Enhanced

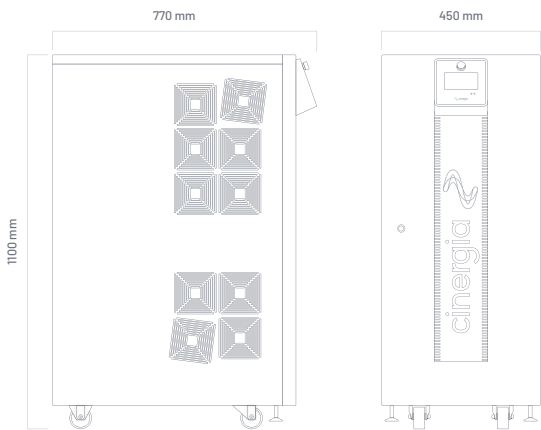
**Master/Slave Operation**  
Connection: fiber optics link (x6)  
Configuration: from software user interface/MODBUS up to 8 units:  
AC: Parallel  
DC: Parallel, serial or serial-parallel



## Size and Weight

### Models 7.5 to 60

**Height**  
1100 mm  
**Width**  
450 mm  
**Depth**  
770 mm  
**Weight**  
200 kg



# Connections

Fiber Optics

Digital IO

EPO EPO Output

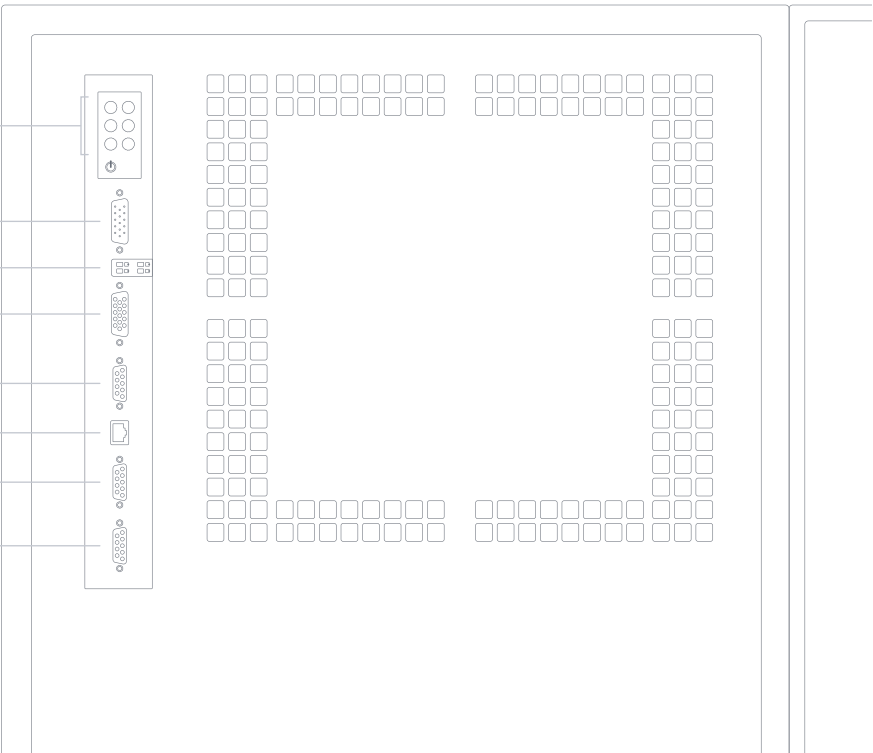
Analogue IO

Internal Comms

Modbus

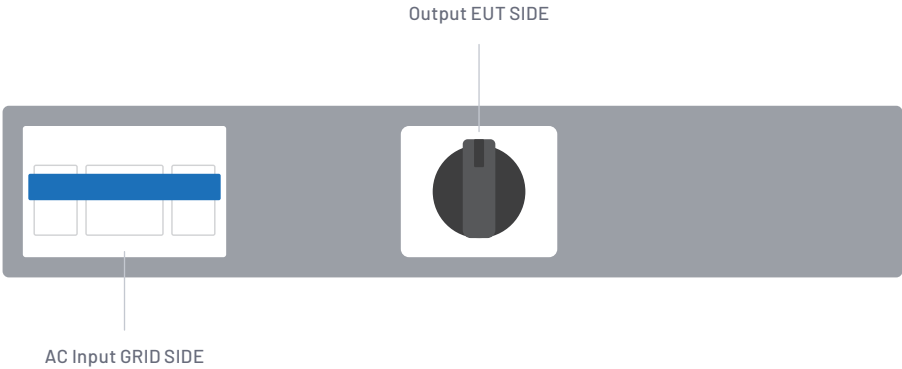
CAN Out

RS323 / RS485



The distribution of the connectors may change depending on the models

# Selectors



The type of selectors and their location may change depending on the models

# Protections

Overvoltage (peak, rms), Overcurrent (peak, rms), Overload  
Shortcircuit, Emergency Stop, Watchdog, Heart Beat, Output  
Contactar, Wrong Configuration  
Alarms and Limits are user configurable and can be saved in a  
password protected EEPROM

# Mesurements (6)

Grid Voltage (rms), Current (rms), Power (P,O) and Frequency  
Output Voltage (rms, avg), Current (rms, avg), Power (P,O) and Frequency  
Heatsink Temperatures (x2) and DC Link Voltage  
Datalogging available through FTP connection

# Ambient

Operating temperature<sup>(8)</sup> : 5-40°C  
Relative Humidity: up to 95%, non-condensing  
Cooling: Forced air  
Acoustic noise at 1m: < 52dB(A)(7.5 to 60), < 65dB(A)(80 to 120), < 70dB(A)(160 and 200)

---

## Standards

CE Marking  
Operation and Safety: EN-50178, EN-62040-1  
EMC: EN-62040-2  
RoHS

---

All specifications are subject to change without notice.

## Options

Choose your options:

- Galvanic Isolation
- Three channel mode: allows different operation mode start/stop/reset per channel
- 30kHz Switching Frequency: only available for models 15 (derated to 7.5kW), 20 (derated to 7.5kW) and 30 (derated to 10kW)
- Isolation monitor (advised for IT systems)
- High Frequency 360 - 900 Hz
- Anti-islanding monitor (only advised in net injection to the grid and following local regulations)
- High Voltage (HV): voltage up to 295Vrms phase-neutral in AC up to 800V in DC
- RS485

---

All specifications are subject to change without notice.

1. Minimum voltage setpoint is 0V in DC. The recommended minimum setpoint for long-term use is 20Vrms in AC and 20V in DC,
2. Effective resolution measured with a 400ms window
3. FS Range of voltage is 800V (with High Voltage option)  
FS Range of current is  $2 \cdot 13 \cdot I_{rated}$  (see models table)  
FS Range of power is  $2 \cdot 1200\% \cdot P_{rated}$  (see models table)
4. Accuracies are valid for settings above 10% of FS
5. Measured with the rated resistive load and high-dynamics controllers configuration.
6. Accuracy of measurements is  $\pm 0.1\%$  of FS for rms voltage,  $\pm 0.2\%$  of FS for rms current,  $\pm 0.4\%$  of FS for active power (valid only above 10% of FS)
7. Consult us for lower voltage/current ripple requirements
8. Rated power figures are given at 20 °C
9. The maximum output voltage depends on frequency following  $V \cdot f < 46000$



# Models

## EL+ vHF

Reference	AC Power Rated <sup>(9)</sup>	AC Current Rated <sup>(9)</sup> RMS 3 channels / 1 channel	DC Power Rated <sup>(9)</sup>	DC Current Rated <sup>(9)</sup> RMS 3 channels / 1 channel	Weight (kg) (lbs)	Dimensions DxWxH (mm) (inch)
EL+15 vHF	15 kW	20 A / 60 A	-	-	155 kg 341.71 lbs	770 x 450 x 1100 mm 30.31 x 17.71 x 43.30 "
EL+20 vHF	20 kW	26 A / 78 A	-	-		
EL+30 vHF	27 kW	40 A / 120 A	-	-		
EL+40 vHF	40 kW	52 A / 156 A	-	-	200 kg	
EL+50 vHF	50 kW	65 A / 195 A	-	-	440.92 lbs	

All specifications are subject to change without notice.  
For EL mode is not available a physical 3 channel/1 channel switch. To work in a single phase mode, it's necessary to introduce a monophasic grid at the output.

## Galvanic Isolation

Circuit Breaker Recommended		Weight (kg) (lbs)
Inside the cabinet	IT 7.5i Type C - 25 A	145 kg 319.67 lbs
	IT 10i Type C - 25 A	
	IT 15i Type C - 32 A	
	IT 20i Type C - 40 A	
	IT 30i Type C - 50 A	195 kg 429.90 lbs
	IT 40i* Type C - 63 A	
	IT 50i* Type C - 83 A	

\*In the IT 40i and IT 50i models the size of the cabinet increases to a total of 770 x 835 x 1100 mm (27.55 x 32.87 x 43.31"). The others keep the original size.

Circuit Breaker Recommended		Weight (kg) (lbs)	Dimensions D x W x H (mm) (inch)
In external cabinet IP20	IT 30e Type D - 80 A	174 kg 383.60 lbs	595 x 415 x 708 mm 23.42 x 16.33 x 27.87 "
	IT 40e Type D - 100 A	217 kg 478.40 lbs	725 x 525 x 773 mm 28.54 x 20.67 x 30.43 "
	IT 50e Type D - 125 A	280 kg 617.29 lbs	
	IT 60e Type D - 160 A	381 kg 839.96 lbs	875 x 600 x 900 mm 34.44 x 23.62 x 35.43 "
	IT 80e Type D - 200 A	435 kg 959.01 lbs	
	IT 100e Type D - 250 A	458 kg 1009.72 lbs	
	IT 120e Type D - 315 A	514 kg 1133.18 lbs	
	IT 160e Type D - 400 A	612 kg 1349.23 lbs	964 x 648 x 1252 mm 37.95 x 25.51 x 49.29 "
	IT 200e Type D - 500 A	753 kg 1660.10 lbs	1192 x 744 x 1430 mm 46.92 x 29.29 x 56.29 "

## Configuration Modes

EL+ AC

Master / Slave

Parallel

in AC modes (GE & EL)

Parallel

Serial

Serial Parallel

in DC mode

## Channel Configuration in EL

3 channels	* 1 channel	*For 1-channel configuration contact us.
------------	-------------	--

## Channel Configuration in DC

3 channels	1 channel	Bipolar	Unipolar
------------	-----------	---------	----------

## Regenerative Power Electronic Solutions