

# GE+ vHiL ePlus

Regenerative AC/DC Grid Emulator



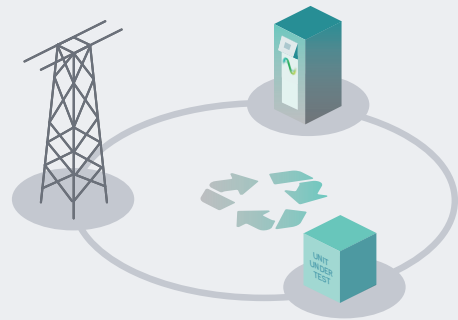
The GE+ vHiL is CINERGIA's Voltage Source optimized in performance and price for Power Hardware in the Loop applications. This version keeps the software and functionalities of CINERGIA's GE+ vAC and it includes Power Amplifier functions to interface with Real Time Control Systems.



## Regenerative Technology

Thanks to our bi-directional topology, the AC/DC Grid Emulator 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.



## Main Applications



Electromobility



Smart Grids



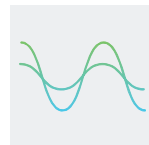
Academic & RCP



IEC Testing



Photovoltaic



Industrial Test



Power HiL



Energy Storage System

## Bidirectional and Regenerative

### Clean grid current

THDi <3% and PF > 0.98

### 13 Models

from 7.5kW to 160kW

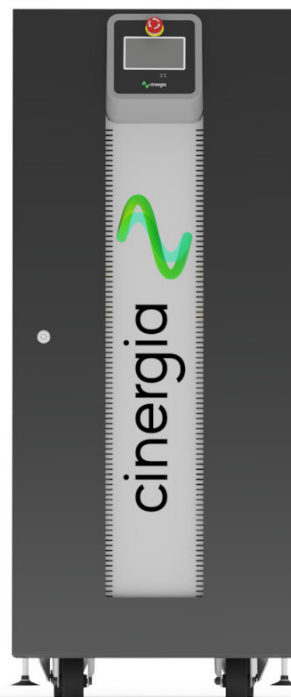
### Parallelization of units to increase the power

### Generation of Worldwide Electrical Grids

3-phase/ 1-phase/ split phase/ Multichannel

### Independent Phase Configuration of

voltage rms, phase angle, frequency and harmonics



## Same Power in DC and AC

### Generation of Disturbances

harmonics, interharmonics, subharmonics, voltage dips frequency variation, flicker

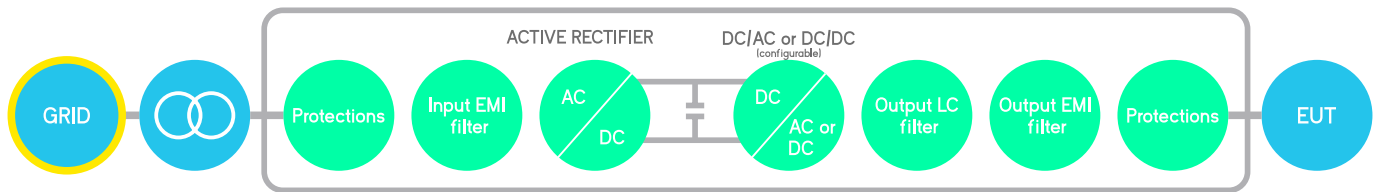
### Disturbance Generation Editor

compatible with IEC, LVRT, SEMI-F47, CBEMA test standards

### Intuitive User Interface

### Modbus/Ethernet Open protocol, Labview drivers

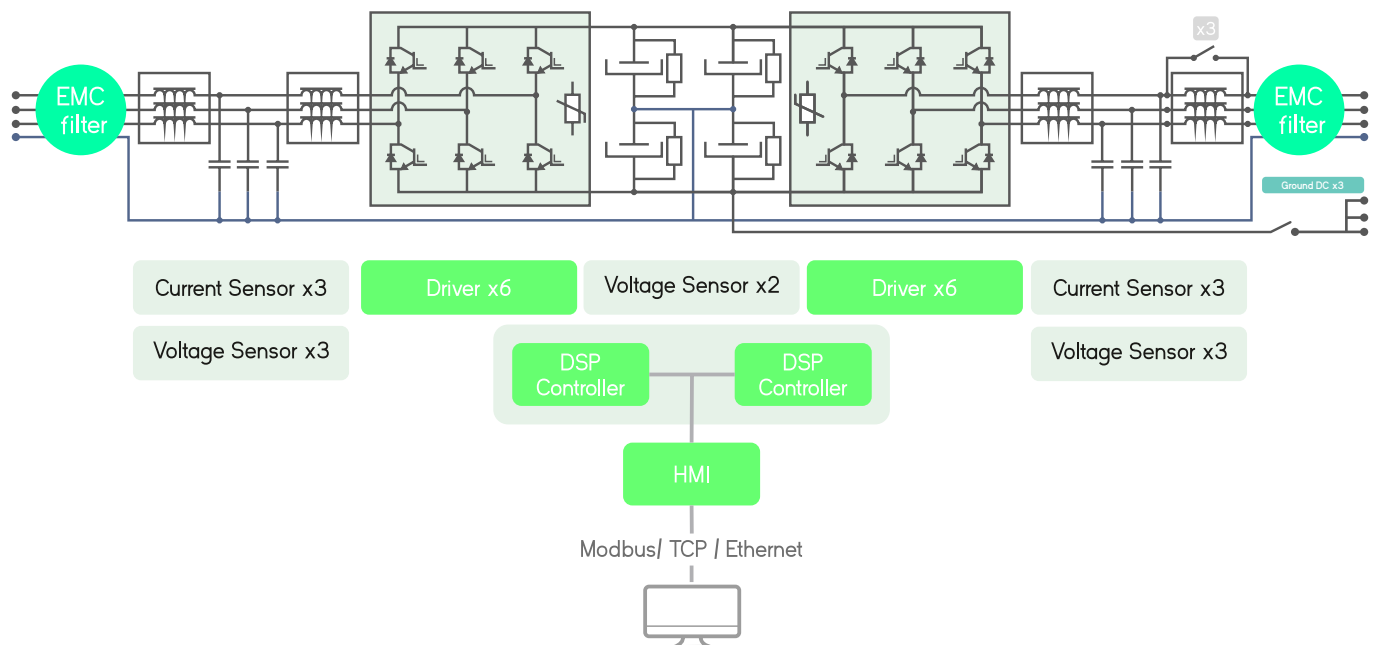
# Bidirectional and Regenerative Hardware



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

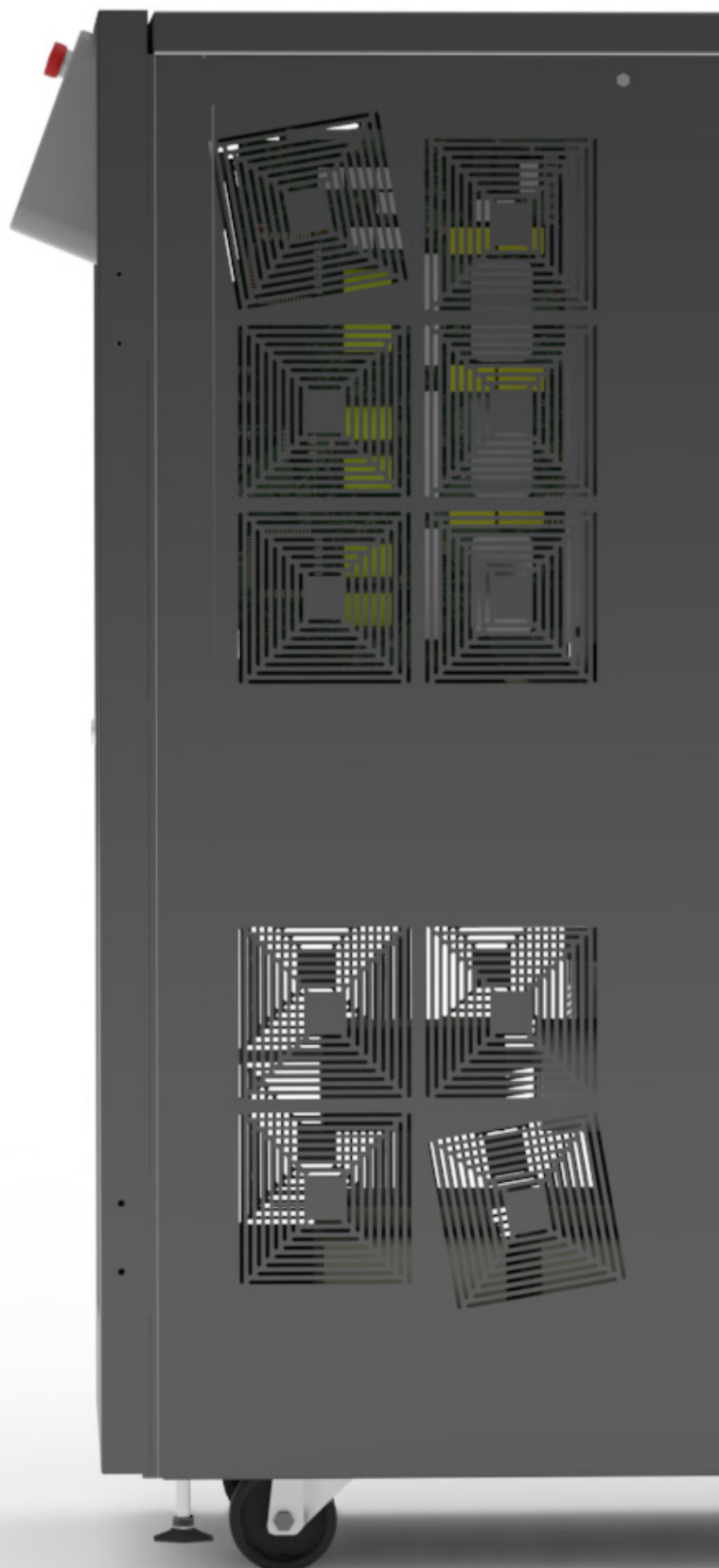
### OPTIMIZED RMS CALCULATION

for PV inverters anti-islanding test

### SAME ELECTRICAL RATINGS

#### and SAME BANDWIDTH

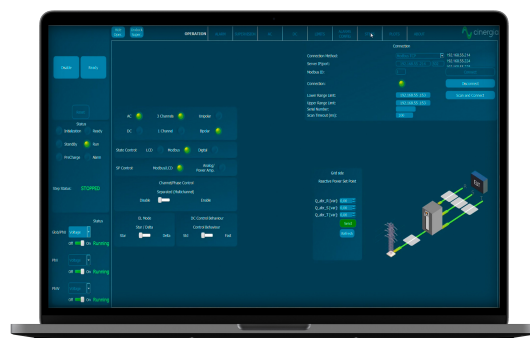
because the power platform does not change so robustness and ratings remain the same.



# 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.



## GE 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.



### Parallel Mode

The device can be controlled in parallel mode where all phases are short-circuited internally. This mode it's suitable for single-phase applications. To increase the total power of the solution, the device can be connected in parallel\* with multiple devices.

\*For this connection contact us.

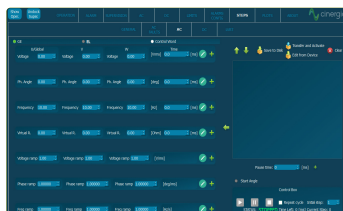


## AC



### 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.



### IEC Testing

Optional

The last version of software includes a library supporting IEC standard for pre-compliance tests. The profiles defined in the standards are preloaded in the software for a user friendly execution and edition. Currently the following standards are available:

- IEC61000-4/11
- IEC61000-4/13
- IEC61000-4/14
- IEC61000-4/28

\*It is mainly intended for pre-compliance testing. Contact us for further information.



## DC



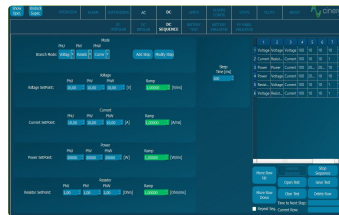
### DC Operation

This panel allows the user to access all DC setpoints and limits. Thanks to the unique Multichannel feature, each phase can have a different Operation Mode: voltage, current, power, resistance and advanced DC applications. Transition ramps, voltage and current limits can be modified. The limits for sink and source operation are different for safer testing, specially in battery applications.



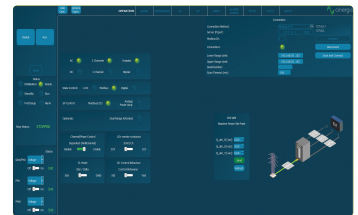
### Sequence

The User Interface Software integrates a Sequence Editor to create automatic test sequences, save them for future use and import them in .csv files. A smart datalogger can be activated from the LCD of the unit to record automatically the resulting voltage and current measurements with a time resolution of 400 ms.



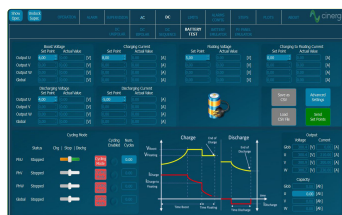
### Multichannel

Enabling the Separated Channel Control converts the device in three functionally independent DC Bidirectional Power Supplies, sharing the common negative rail. Each channel can have a different status (ON, OFF, Warning, Alarm), Operation Mode (see Range and Specifications table), Setpoint, Ramp and Limits.



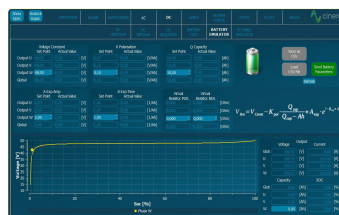
### Battery Pack Tester

This functionality enables the user to precisely control the charge, discharge and cycling of a Battery. Basic parameters include the charge/discharge current, fast charge and floating voltages while Advanced parameters add Energy (Ah) and Time as transition conditions. Profiles for each Battery technology can be saved and imported in .CSV files.



### Battery Emulation

The B2C+ integrates a mathematical model to emulate the voltage behaviour of a real battery pack. The output voltage will change as a function of the SOC and Current. By configuring the provided parameters, the voltage profile can be adjusted to match different technologies: Lilon, NiMH, NiCd, Pb, Flux, etc.



### PV Panel Emulation

The PV Panel model is based on the single-diode equivalent circuit of a PV cell and the series-parallel connection of cells to form a panel. A Runtime functionality allows the simulation of a complete day by launching different irradiance and temperature setpoints from a .csv file, enabling the user burn-in and functional tests of PV Inverters.



# GE+ vHiL Range & Specifications

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## 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 DC (EUT side)

### Terminals

Number: 4 (3 phases + 1 neutral)

### Configuration of Channels

Unipolar 3-channels 2Q, independent setpoints per channel

Unipolar 1-channel 2Q, one global setpoint for all channels

Multichannel: 2Q, independent start/stop, operation mode and setpoints per channel (note: multichannel is an option for ≥ 80kVA)

Bipolar (4Q two independent setpoints)

### Voltage (CV)

Range: 2Q: 20<sup>(1)</sup> to 750V (800V with High Voltage option)

4Q: 0 to +350V / 0 to -350 (+ rail / 0 / - rail, Bipolar configuration)

Setpoint Resolution: 10mV

Effective Resolution<sup>(2)</sup>: < 0.05% of FS<sup>(3)</sup>

Setpoint Accuracy<sup>(4)</sup>: ± 0.1% of FS<sup>(3)</sup>

Transient Time<sup>(5)</sup>: < 1ms (10% to 90% at a step to V<sub>rated</sub>)

Ripple<sup>(7)</sup> (peak-peak): < 0.55% of FS<sup>(3)</sup>

### Current Mode (CC)

Range: from 0 to ± 110% of I<sub>rated</sub> (see models table)

Setpoint Resolution: 10mA

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>: < 1ms (10% to 90% at a step to I<sub>rated</sub>)

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

### Power Mode (CP)

Range: from 0 to ± 200%<sup>(8)</sup> of P<sub>rated</sub> (see models table)

Derived current setpoint: P<sub>setpoint</sub> / V<sub>measured</sub>

Setpoint Resolution: 1W

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<sub>rated</sub>)

### Resistance Mode (CR)

Range: from 0.1 to 1000 Ohm

Derived current: V<sub>measured</sub> / R<sub>setpoint</sub>

Setpoint Resolution: 0.01 Ohm

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

Transient Time<sup>(5)</sup>: < 2ms (10% to 90% at a step to R<sub>rated</sub>)

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## 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  $\geq 80\text{kVA}$ )

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## Output side in GE-AC

### Voltage Mode (CV)

Peak:  $\pm 400\text{V}$  phase-neutral

Range:  $0^{(1)}$  to  $277\text{Vrms}$  phase-neutral ( $295\text{Vrms}$  with HV option)  
 $0^{(1)}$  to  $480\text{Vrms}$  phase-phase ( $510\text{Vrms}$  with HV option)

THDv:  $< 0.1\%$  rated linear load at  $230\text{Vrms}$ ,  $50/60\text{Hz}$   
 $< 0.9\%$  rated non linear load  $\text{CF}=3$  at  $230\text{Vrms}$ ,  $50/60\text{Hz}$

Setpoint Resolution:  $10\text{mVrms}$

Effective Resolution<sup>(2)</sup>:  $< 0.05\%$  of  $\text{FS}^{(3)}$

Setpoint Accuracy<sup>(4)</sup>:  $< \pm 0.1\%$  of  $\text{FS}^{(3)}$

Transient Time<sup>(5)</sup>:  $< 1.5\text{ms}$  ( $10\%$  to  $90\%$  at a step to  $V_{\text{rated}}$ )

Ripple<sup>(7)</sup> (peak-peak):  $< 0.55\%$  of  $\text{FS}^{(3)}$

Enhanced

### Harmonics

Range: up to 50th (at  $50/60\text{Hz}$  fundamental)

50 independent harmonics per phase:

20 free programmable frequency and phase from  $0.1$  to  $50$  times  $f_0$

30 fixed frequency

Harmonics content:  $V \cdot f < 46000$  (with current derating)

Setpoint Accuracy<sup>(4)</sup>: same as voltage accuracy

Small Signal Bandwidth: up to  $5000\text{Hz}^{(9)}$

Transient Time<sup>(5)</sup>:  $< 2\text{ms}$  ( $10\%$  to  $90\%$  at a step change)

### Frequency

Fundamental Frequency Range:  $10$  to  $100\text{Hz}$  (up to  $400\text{Hz}$  option)

Small Signal Bandwidth: up to  $5000\text{Hz}^{(9)}$

Resolution:  $1\text{mHz}$

### Phase Angle

Range:  $0$  to  $360^\circ$

Resolution:  $0.01^\circ$

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## Operation Modes

### DC

Programmable Voltage (CV)

Power Amplifier (HiL)

Steps

Optional Programmable Current (CC)

Optional Programmable Power (CP)

Optional Programmable Resistance (CR)

Optional Battery Testing (BTest) (charge/discharge/cycling)

Optional Battery Emulation (BEmu)

Optional PV Panel Emulation (PVEmu)

### AC

Programmable Voltage (CV)

Power Amplifier (HiL)

Steps

Optional LVRT, IEC 61000 -4-11, 4-13, 4-14, 4-28

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## Overload/ Overcurrent

Admissible DC overcurrent is:  $110\%$  of rated value during  $1$  minute

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)

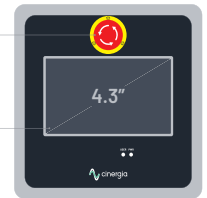
### Software

Graphical User Interface for Windows 7/10

LabView drivers and open Labview interface example

Emergency Stop  
pushbutton

Touchscreen panel



Enhanced

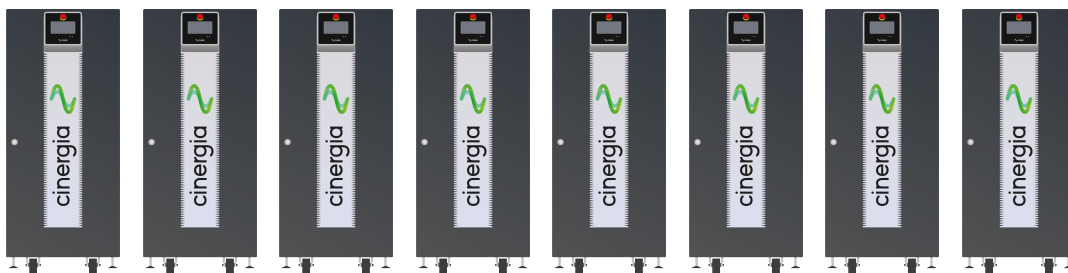
### Master/Slave Operation

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 kW

#### Height

1100 mm

#### Width

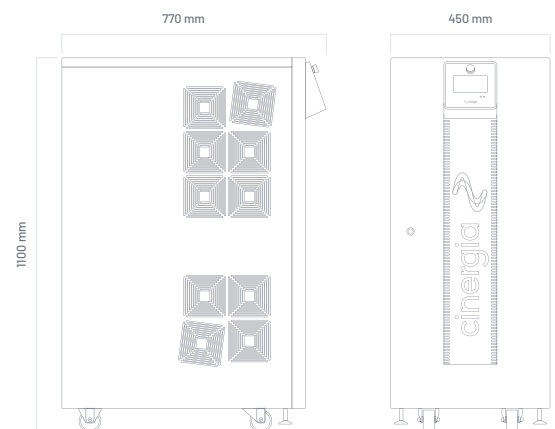
450 mm

#### Depth

770 mm

#### Weight

200 kg



### Models 80 to 120 kW

#### Height

1320 mm

#### Width

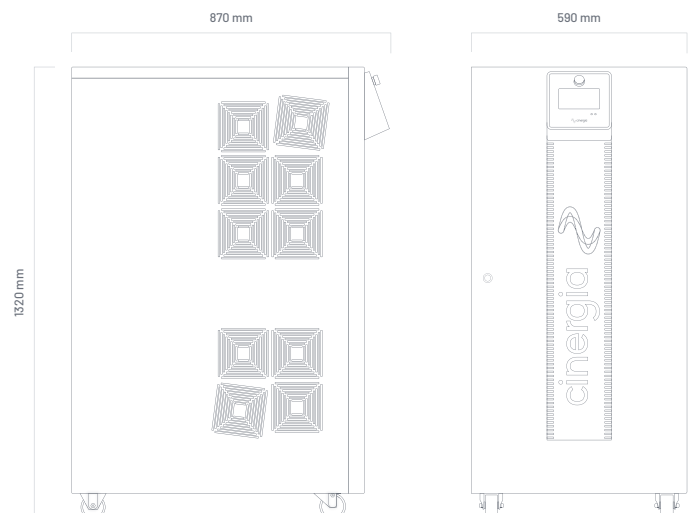
590 mm

#### Depth

870 mm

#### Weight

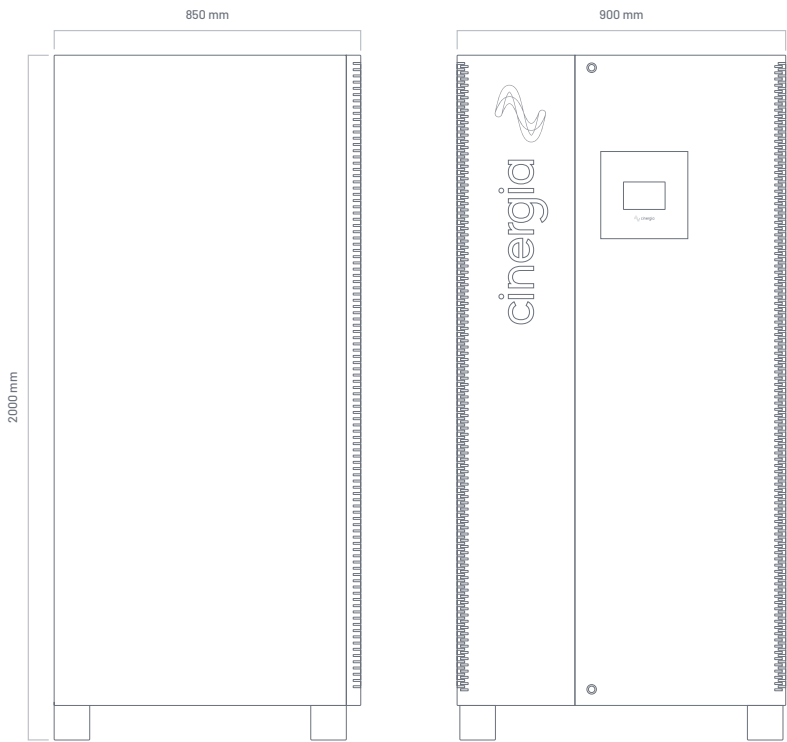
320 kg





Models 160 & 200 kW

- Height  
2000 mm
- Width  
900 mm
- Depth  
850 mm
- Weight  
680 kg



Connections

Fiber Optics

Digital IO

EPO EPO Output

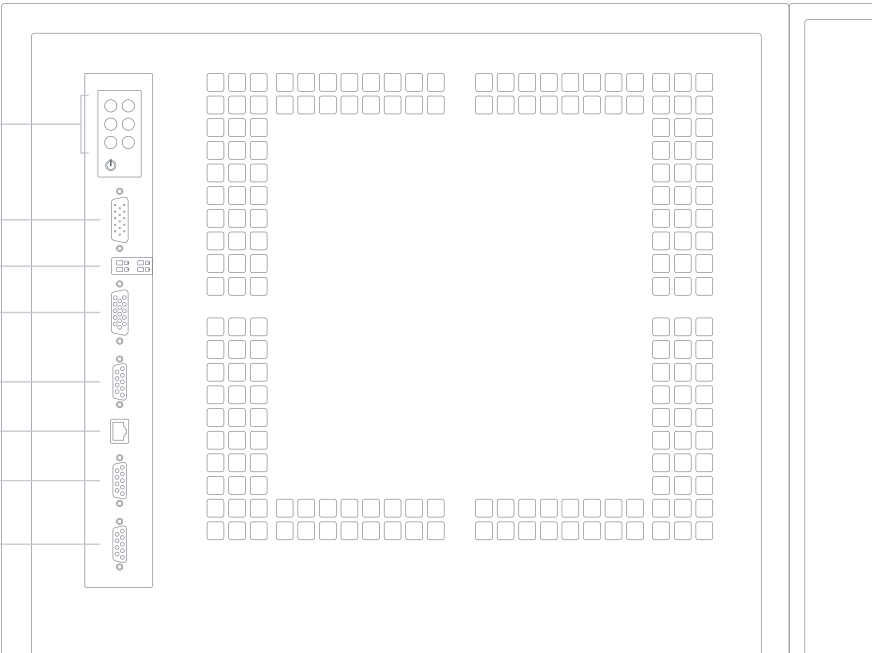
Analogue IO

Internal Comms

Modbus

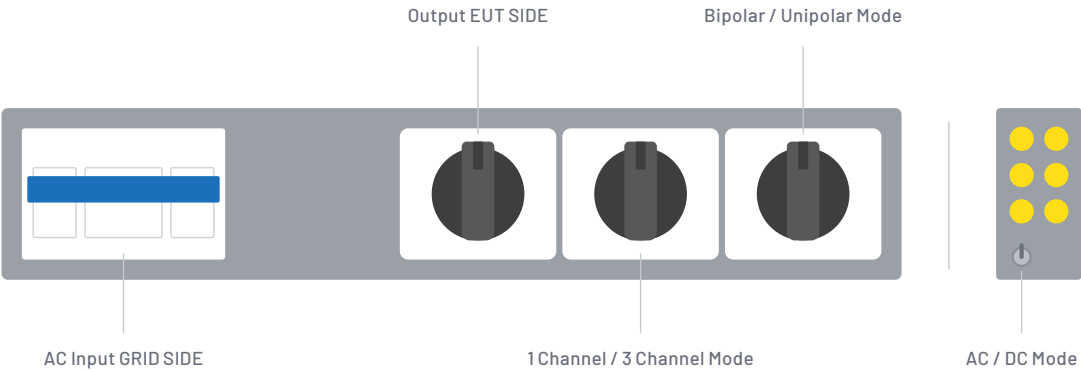
CAN Out

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

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## 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

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## Mesurements <sup>(6)</sup>

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

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## Ambient

Operating temperature<sup>(9)</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)

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## Standards

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

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All specifications are subject to change without notice.

## Options

Choose your options:

- Three channel mode: allows different operation mode start/stop/reset per channel (included in all models from 7.5 to 60, both included)
- 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)
- Low voltage ripple capacitance
- 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
- Battery Emulation
- Battery Test
- PV Panel Emulation
- CC, CP and CR
- Predefined Tests: LVRT, IEC 61000-4-11, 4-13, 4-14, 4-28 (consult us for specific Test)
- External gateway for RS232, CAN and others (consult us for specific gateway)

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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 2-13 · Irated I (see models table)  
FS Range of power is 2-1200% · Prated I (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 ±0.1% of FS for rms voltage, ±0.2% of FS for rms current, ±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

## GE+ vHiL

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)	Dimensions DxWxH (mm)
GE+ 7.5 vHiL	7.5 kW	11 A / 33 A	3.75 kW	±5 A / ±15 A	155 kg	770 x 450 x 1100 mm
GE+ 10 vHiL	10 kW	15 A / 45 A	5 kW	±7.5 A / ±22.5 A	155 kg	770 x 450 x 1100 mm
GE+ 15 vHiL	15 kW	22 A / 66 A	7.5 kW	±10 A / ±30 A	155 kg	770 x 450 x 1100 mm
GE+ 20 vHiL	20 kW	29 A / 87 A	10 kW	±12.5 A / ±37.5 A	155 kg	770 x 450 x 1100 mm
GE+ 30 vHiL	27 kW	40 A / 120 A	13.5 kW	±15 A / ±45 A	155 kg	770 x 450 x 1100 mm
GE+ 40 vHiL	40 kW	58 A / 174 A	20 kW	±20 A / ±60 A	200 kg	770 x 450 x 1100 mm
GE+ 50 vHiL	50 kW	73 A / 219 A	25 kW	±25 A / ±75 A	200 kg	770 x 450 x 1100 mm
GE+ 60 vHiL	54 kW	80 A / 240 A	27 kW	±28.5 A / ±85.5 A	200 kg	770 x 450 x 1100 mm
GE+ 80 vHiL	80 kW	116 A / -	40 kW	±52.5 A / ±157.5 A	320 kg	870 x 590 x 1320 mm
GE+ 100 vHiL	100 kW	145 A / -	50 kW	±65 A / ±195 A	320 kg	870 x 590 x 1320 mm
GE+ 120 vHiL	108 kW	157 A / -	54 kW	±65 A / ±195 A	320 kg	870 x 590 x 1320 mm
GE+ 160 vHiL	145 kW	211 A / -	72.5 kW	±77.5 A / ±232.5 A	680 kg	850 x 900 x 2000 mm
GE+ 200 vHiL	160 kW	232 A / -	80 kW	±92.5 A / ±277.5 A	680 kg	850 x 900 x 2000 mm

All specifications are subject to change without notice.

## Galvanic Isolation

	Circuit Breaker Recommended	Weight
Inside the cabinet	IT 7.5i	Type C - 25 A
	IT 10i	Type C - 25 A
	IT 15i	Type C - 32 A
	IT 20i	Type C - 40 A
	IT 30i	Type C - 50 A
	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. The others keep the original size.

	Circuit Breaker Recommended	Weight	Dimensions D x W x H
In external cabinet IP20	IT 30e	Type D - 80 A	174 kg
	IT 40e	Type D - 100 A	217 kg
	IT 50e	Type D - 125 A	280 kg
	IT 60e	Type D - 160 A	381 kg
	IT 80e	Type D - 200 A	435 kg
	IT 100e	Type D - 250 A	458 kg
	IT 120e	Type D - 315 A	514 kg
	IT 160e	Type D - 400 A	612 kg
	IT 200e	Type D - 500 A	753 kg

## Configuration Modes

GE+ AC	PHiL DC	PHiL AC	DC
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## Master / Slave

Parallel	in AC modes (GE & EL)		
Parallel	Serial	Serial Parallel	in DC mode

## Channel Configuration in GE

3 channels	* 1 channel	*1-channel mode available in standard units up to 60kVA. Consult us for parallel mode above 60kVA.
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## Channel Configuration in DC

3 channels	1 channel	Bipolar	Unipolar
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## Regenerative Power Electronic Solutions



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