# GE+ vHiL ePlus

Regenerative AC/DC Grid Emulator

cinergia

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 Amplifi er 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.
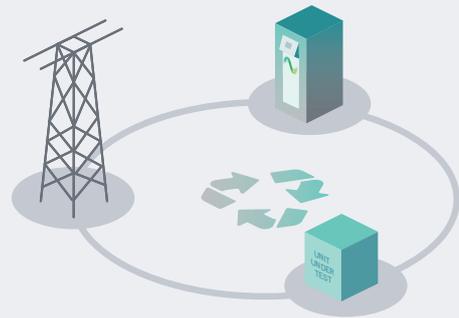
Main Applications

| Electromobility | Smart Grids | Academic & RCP | IEC Testing | Photovoltaic | Industrial Test | Power HiL | Energy Storage System |
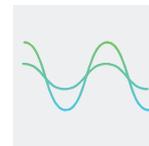
Bidirectional and Regenerative

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

CV — AC

CV CC CP CR — DC
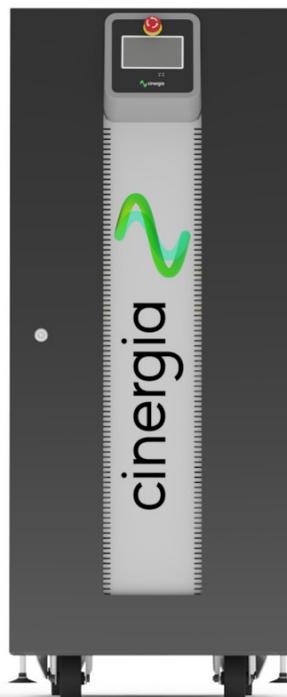
Same Power in DC and AC

Generation of Disturbances
harmonics, interharmonics, subharmonics, voltage dips frequency variaton, 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
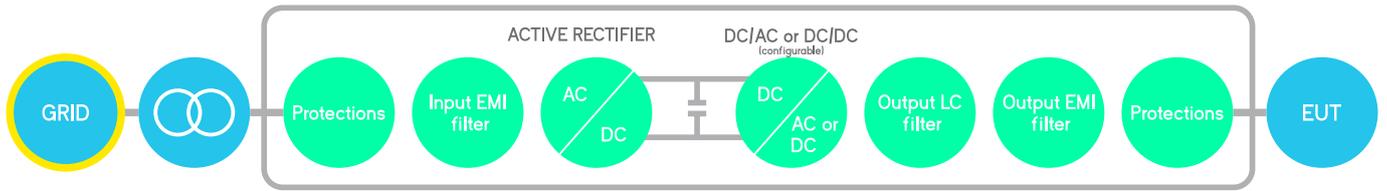
The hardware platform is based on a Back-to-Back power conversion topology, formed by two IGBT-based power stages. The grid side stage is an Active Rectifi er which produces clean sinusoidal currents with very low harmonic distortion and power factor close to one.

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 control lers. In DC, the three independent buck-boost bidirectional legs enable the separated control of three different DC voltages or currents.

Block Diagram

Modbus/ TCP / Ethernet
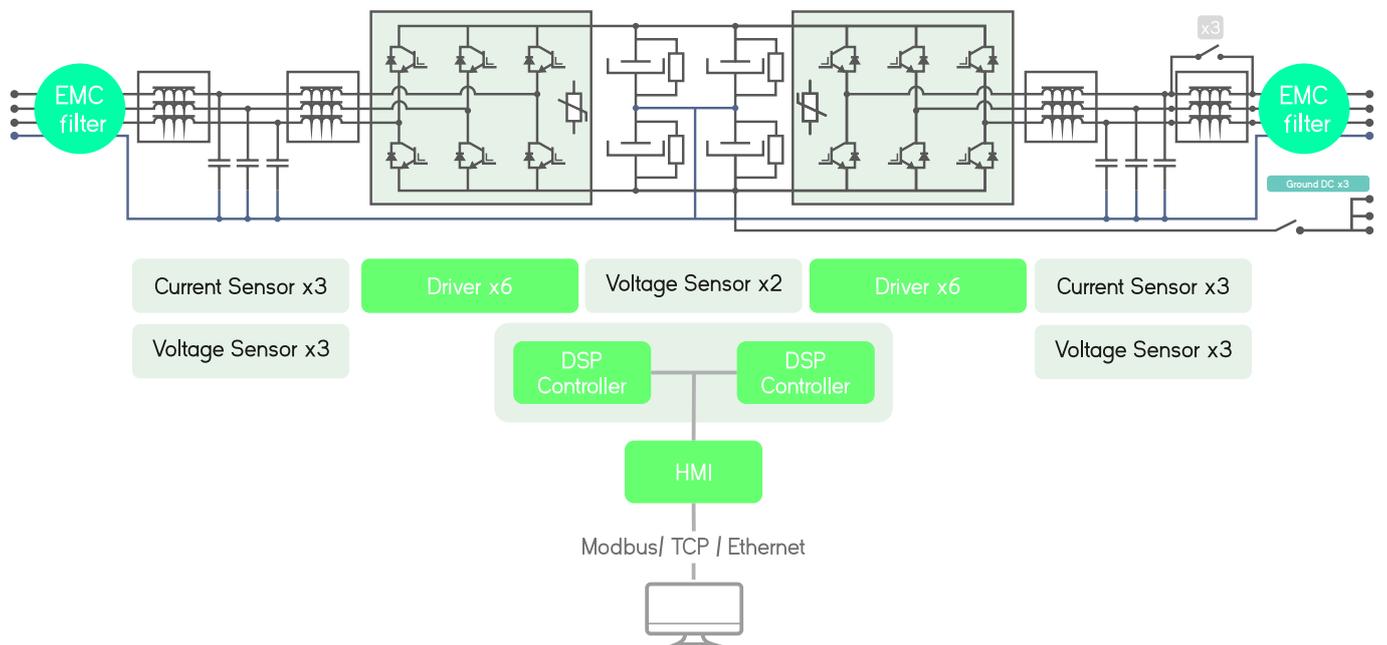
Local Interface

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.

GE vHiL ePlus

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.
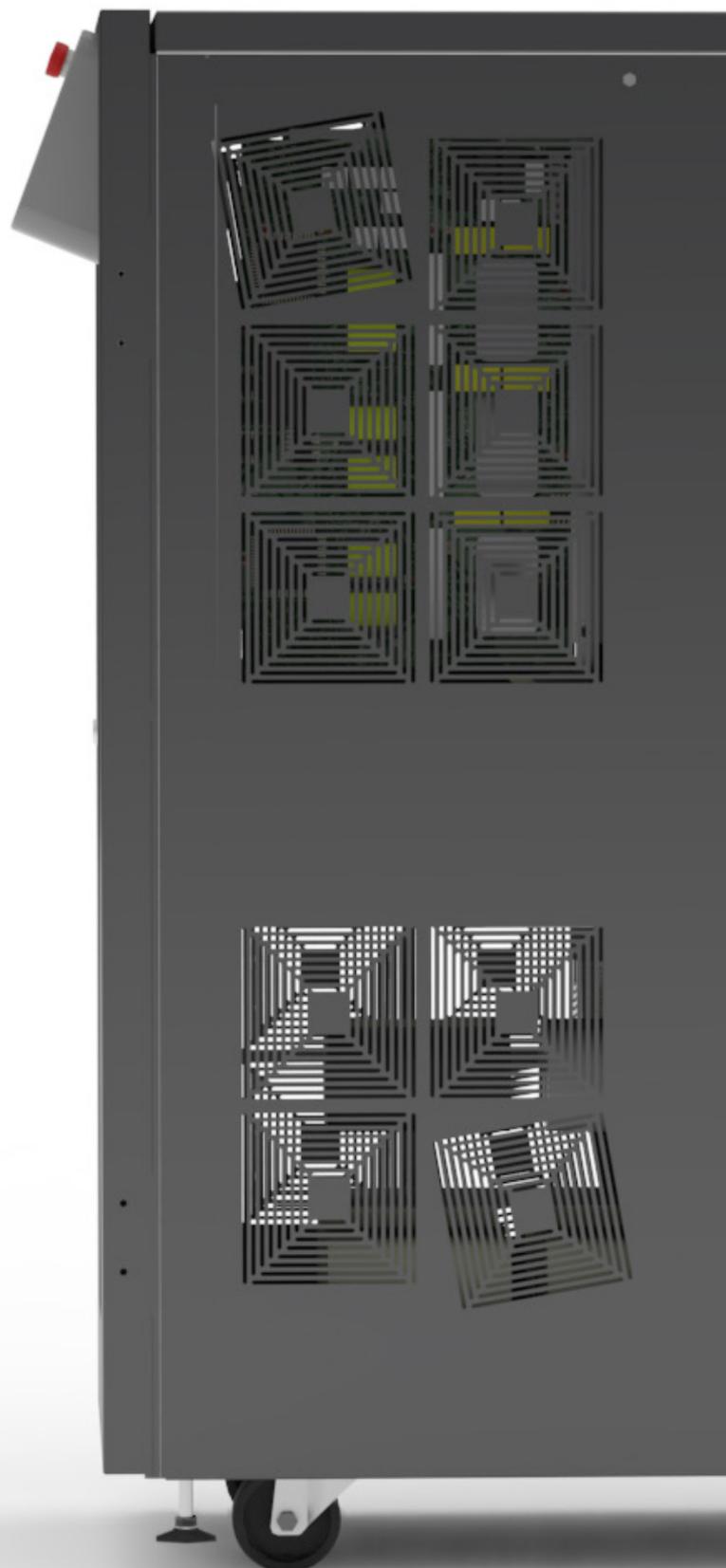
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ePlus

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.
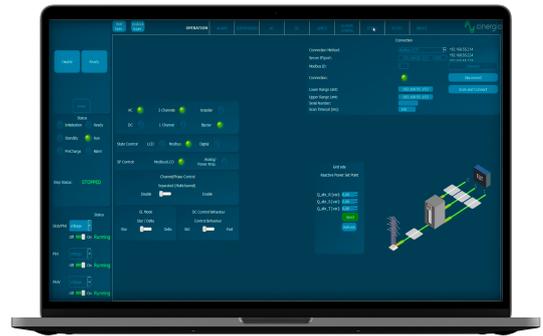
GE Modes

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 simultaneosly 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 funcionality. 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 pre-defined 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 def ined in the standards are preloaded in the software for a user friendly execution and edition. Currently the following standards are available:

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

*It is mainly intended for pre-compliance testing. Contact us for futher 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 paramters 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.
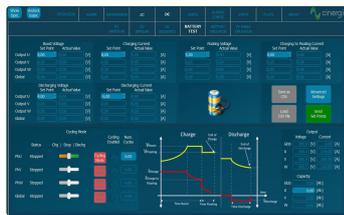
Battery Emulation

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: LiIon, NiMH, NiCd, Pb, Flux, etc.
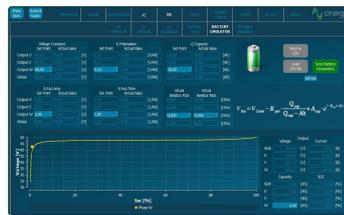
PV Panel Emulation

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

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[1] to 750V (800V with High Voltage option)
        4Q: 0 to +350V / 0 to -350 (+ rail / 0 / - rail, Bipolar configuration)
Setpoint Resolution: 10mV
Effective Resolution[2]: < 0.05% of FS[3]
Setpoint Accuracy[4]: ± 0.1% of FS[3]
Transient Time[5]: < 1ms (10% to 90% at a step to V_{rated})
Ripple[7] (peak-peak): < 0.55% of FS[3]

Current Mode (CC)
Range: from 0 to ± 110% of I_{rated} (see models table)
Setpoint Resolution: 10mA
Effective Resolution[2]: < 0.05% of FS[3] (< 0.1% models 7.5 & 10)
Setpoint Accuracy[4]: ± 0.2% of FS[3]
Transient Time[5]: < 1ms (10% to 90% at a step to I_{rated})
Ripple[7] (peak-peak): < 0.7% of FS[3]

Power Mode (CP)
Range: from 0 to ± 200%[8] of P_{rated} (see models table)
Derived current setpoint: $P_{setpoint}$ / $V_{measured}$
Setpoint Resolution: 1W
Effective Resolution[2]: < 0.1% of FS[3] (< 0.25% models 7.5 & 10)
Setpoint Accuracy[4]: ± 0.4% of FS[3]
Transient Time[5]: < 2.5ms (10% to 90% at a step to P_{rated})

Resistance Mode (CR)
Range: from 0.1 to 1000 Ohm
Derived current: $V_{measured}$ / $R_{setpoint}$
Setpoint Resolution: 0.01 Ohm
Setpoint Accuracy[4]: ± 0.2% of FS[3]
Transient Time[5]: < 2ms (10% to 90% at a step to R_{rated})

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 GE-AC

Voltage Mode (CV)
Peak: ± 400V phase-neutral
Range: $0^{(1)}$ to 277Vrms phase-neutral (295Vrms with HV option)
        $0^{(1)}$ to 480Vrms phase-phase (510Vrms with HV option)
THDv: < 0.1% rated linear load at 230Vrms, 50/60Hz
        < 0.9% rated non linear load CF=3 at 230Vrms, 50/60Hz
Setpoint Resolution: 10mVrms
Effective Resolution[2]: < 0.05% of FS[3]
Setpoint Accuracy[4]: < ± 0.1% of FS[3]
Transient Time[5]: < 1.5ms (10% to 90% at a step to V_{rated})
Ripple[7] (peak-peak): < 0.55% of FS[3]

`Enhanced` **Harmonics**
Range: up to 50th (at 50/60 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·f < 46000 (with current derating)
Setpoint Accuracy[4]: same as voltage accuracy
Small Signal Bandwidth: up to 5000Hz[9]
Transient Time[5]: < 2ms (10% to 90% at a step change)

Frequency
Fundamental Frequency Range: 10 to 100Hz (up to 400Hz option)
Small Signal Bandwidth: up to 5000Hz[9]
Resolution: 1mHz

Phase Angle
Range: 0 to 360°
Resolution: 0.01°

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

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

`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

Emergency Stop
pushbutton

4.3"

Touchscreen panel
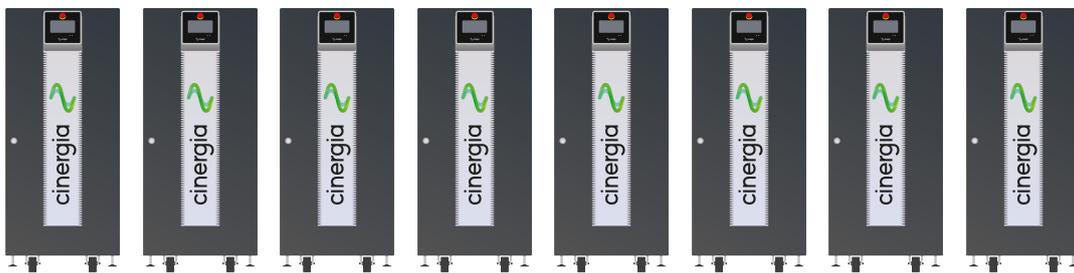
Size and Weight

Models 7.5 to 60 kW

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

770 mm

450 mm

1100 mm
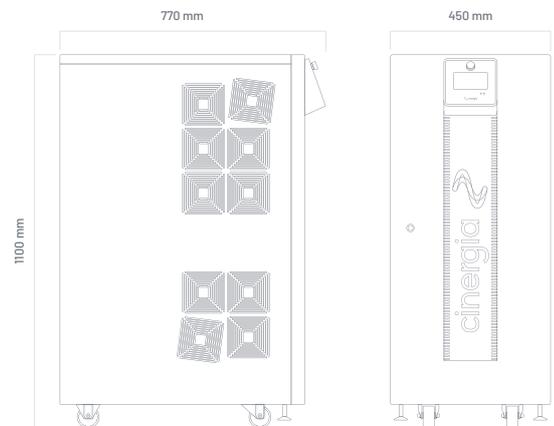
Models 80 to 120 kW

Height
1320 mm
Width
590 mm
Depth
870 mm
Weight
320 kg

870 mm

590 mm

1320 mm
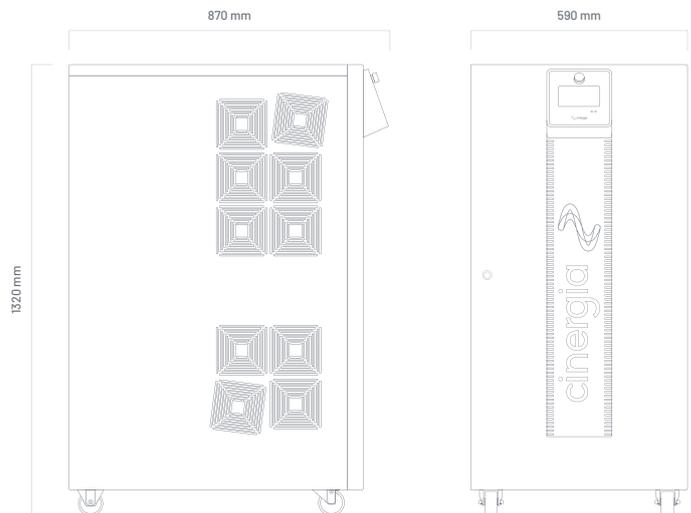
Models 160 & 200 kW

Height
2000 mm

Width
900 mm

Depth
850 mm

Weight
680 kg

850 mm

900 mm

2000 mm
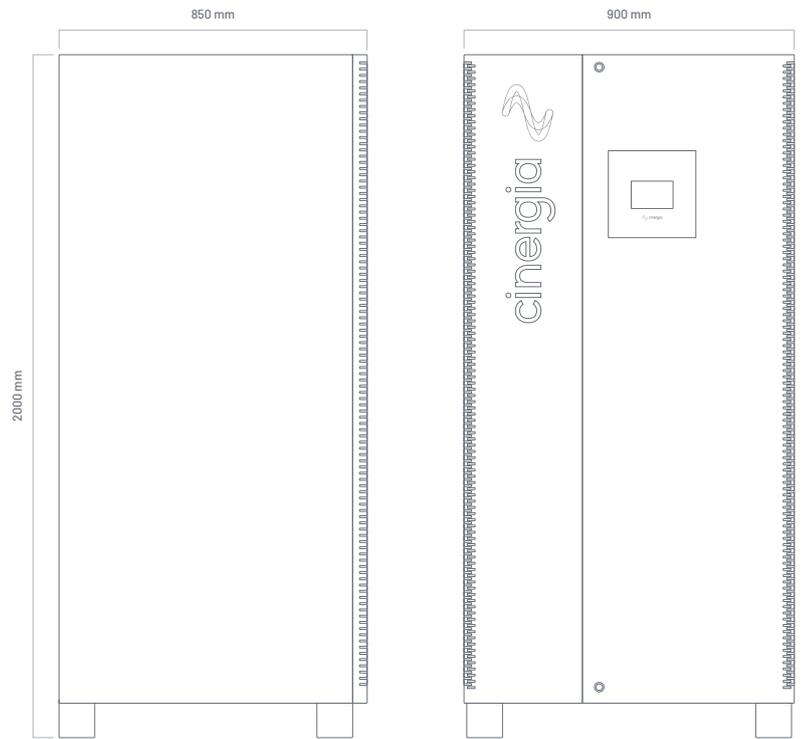
Connections

Fiber Optics

Digital IO

EPO EPO Output

Analogue IO

Internal Comms

Modbus

CAN Out

RS323 / RS485
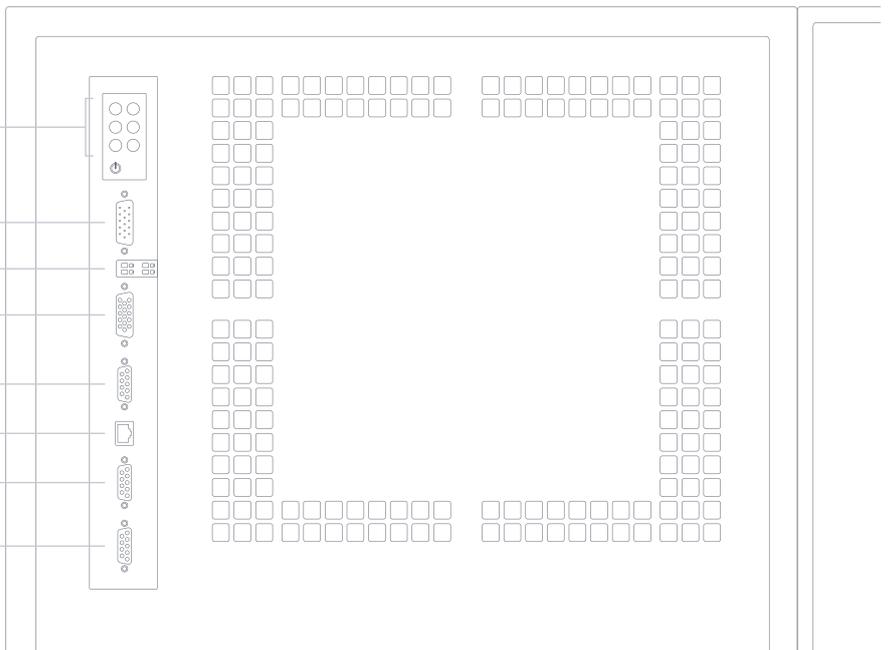
The distribution of the connectors may change depending on the models

Selectors

Output EUT SIDE

Bipolar / Unipolar Mode

AC Input GRID SIDE

1 Channel / 3 Channel Mode

AC / DC Mode
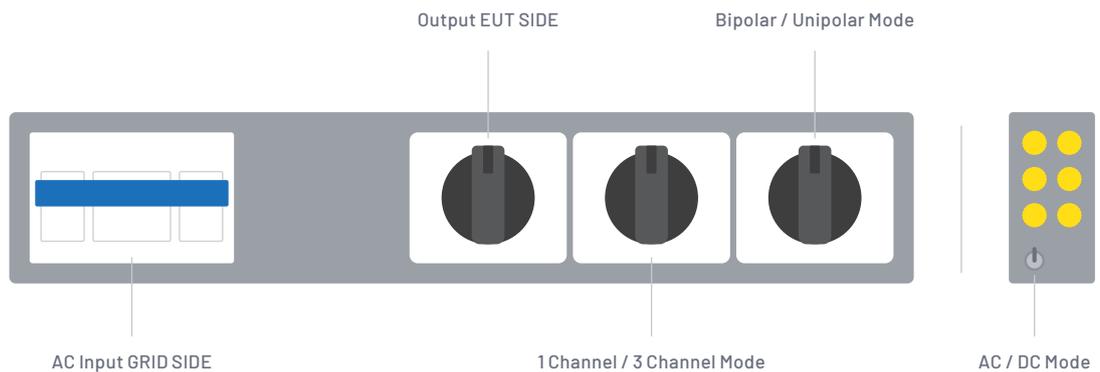
The type of selectors and their location may change depending on the models

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[8] : 5-40°C
Relative Humidity: up to 95%, non-condensing
Cooling: Forced air
Acoustic noise at Im: < 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:

- 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)

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·f < 46000

Models

GE+ vHiL

Reference	AC Power Rated[9]	AC Current Rated[9] RMS 3 channels / 1 channel	DC Power Rated[9]	DC Current Rated[9] RMS 3 channels / 1 channel	Weight (kg)	Dimensions DxWxH (mm)
GE+ 7.5 vHiL	7.5 kW	11 A / 33A	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
IT 7.5i	Type C - 25 A	145 kg
IT 10i	Type C - 25 A	145 kg
IT 15i	Type C - 32 A	145 kg
IT 20i	Type C - 40 A	145 kg
IT 30i	Type C - 50 A	195 kg
IT 40i*	Type C - 63 A	195 kg
IT 50i*	Type C - 83 A	195 kg

Inside the cabinet

*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
IT 30e	Type D - 80 A	174 kg	595 x 415 x 708 mm
IT 40e	Type D - 100 A	217 kg	725 x 525 x 773 mm
IT 50e	Type D - 125 A	280 kg	725 x 525 x 773 mm
IT 60e	Type D - 160 A	381 kg	875 x 600 x 900 mm
IT 80e	Type D - 200 A	435 kg	875 x 600 x 900 mm
IT 100e	Type D - 250 A	458 kg	875 x 600 x 900 mm
IT 120e	Type D - 315 A	514 kg	875 x 600 x 900 mm
IT 160e	Type D - 400 A	612 kg	964 x 648 x 1252 mm
IT 200e	Type D - 500 A	753 kg	1192 x 744 x 1430 mm

In external cabinet IP20

Configuration Modes

| GE+ AC | PHiL DC | PHiL AC | DC |

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. |

Channel Configuration in DC

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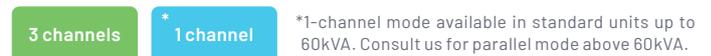
Regenerative Power Electronic Solutions