



GE&EL+ vAC/DC ePLUS

The All-Terrain AC/DC Regenerative Converter

The GE/EL+ vAC/DC is the most complete and versatile converter in the regenerative energy testing market. The whole CINERGIA's catalogue in a single unit. A Grid Emulator (GE), an Electronic Load (EL) and a DC Bidirectional (B2C). This All-Terrain converter is suitable for the majority of test applications in the field of Renewable Energies, Smartgrids, Batteries and Electrical Vehicles.

Key features



Bidirectional and Regenerative
Clean grid current: THDi < 3% and PF > 0.98
Same power in DC and AC

Operation Modes:

- Complete DC Load/Source
- Full 4Q AC Grid Emulator
- Power Amplifier for Power HiL
- Full 4Q AC Electronic Load
- Battery Emulation and Testing
- PV Panel Emulation

Modbus/Ethernet Open protocol, Labview drivers

What's new

MASTER/SLAVE CONNECTION

up to 8 units using a fiber optics link to increase power/voltage capabilities:

- GE mode: can be connected in parallel
- EL mode: can be connected in parallel
- B2C: can be connected in parallel, or serial or serial/parallel

IMPROVED CONTROL

30kHz closed control loop frequency with 300kHz oversampling technique

MORE HARMONICS

50 per phase with 21 free-harmonics, in AC models

DELTA LOAD

added to the star connection, for the EL mode in AC

SELECTABLE SLEW RATE FOR DC

for the fastest transients and highest stability

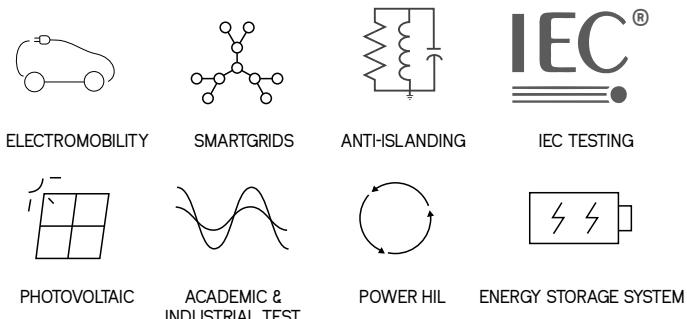
OPTIMIZED RLC MODE

RMS or instantaneous RLC model for anti-islanding test

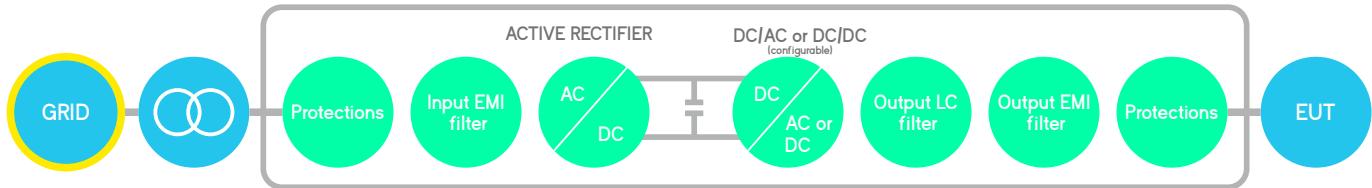


ePLUS keeps the robustness, ratings and all the functionalities of the PLUS platform and adds the new features described in this datasheet

Main Applications



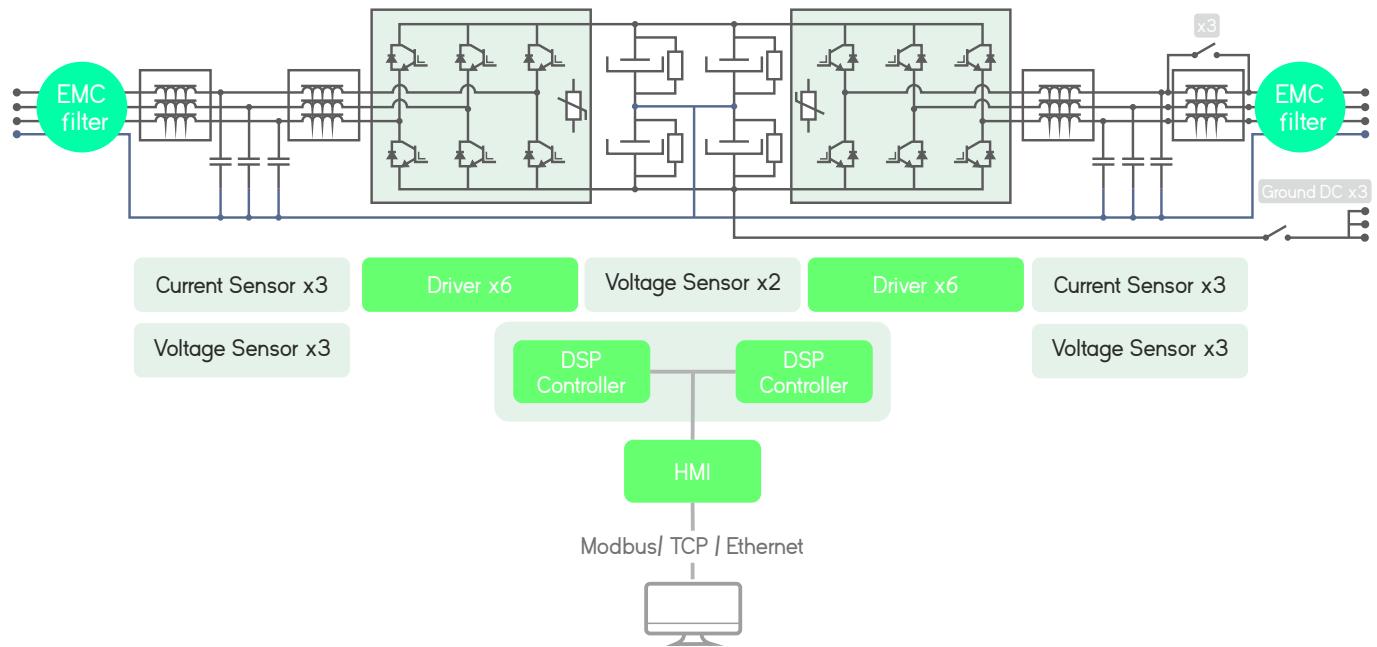
Bidirectional and Regenerative Hardware



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 IO 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

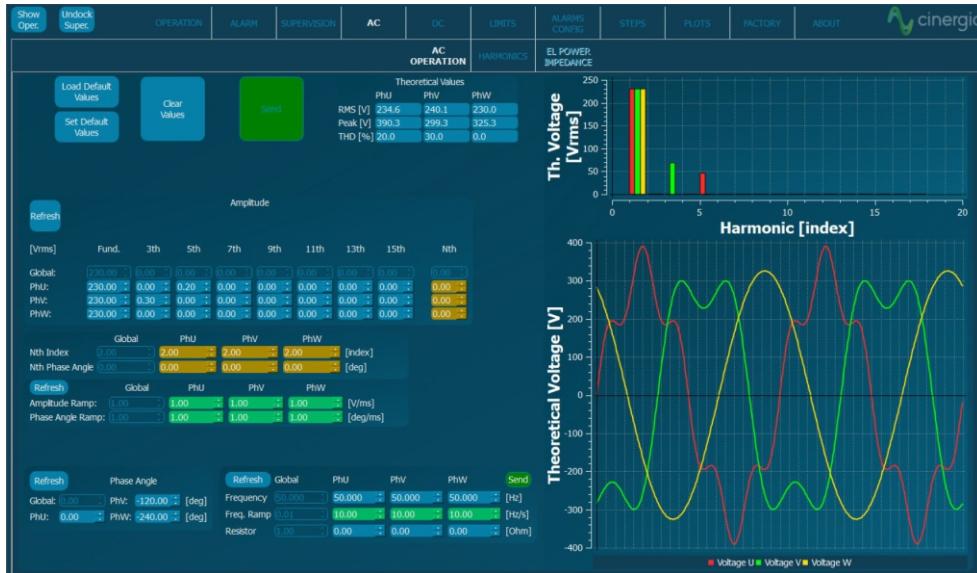
The units integrate a local Emergency Stop pushbutton and two signals (input + output) to be connected to the laboratory interlock system. Additionally, the digital outputs can be interfaced to safety tower lights.

Master/Slave

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

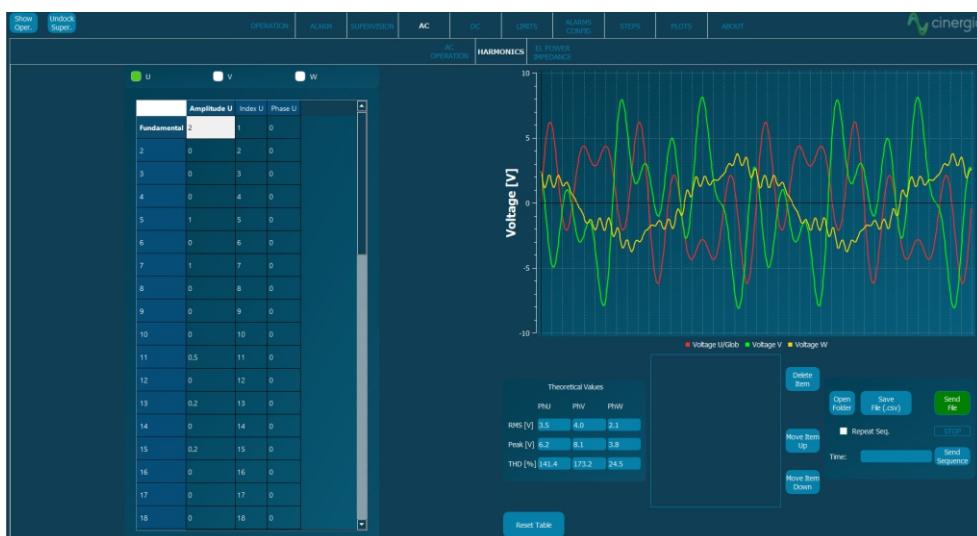


Software Interface in GE+ and EL+ modes



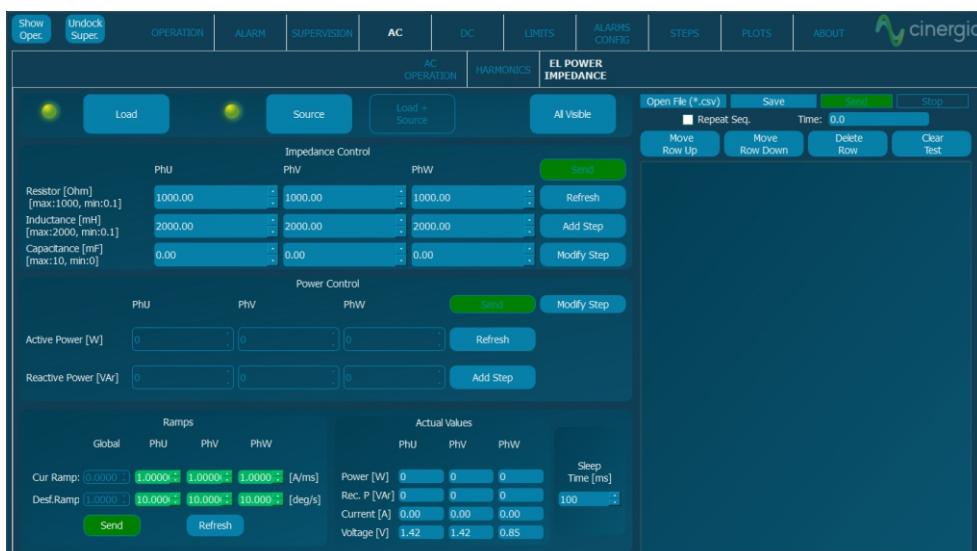
AC Operation

From this panel, the user can set all AC parameters. Each phase can be independently configured: RMS voltage (GE+) or current (EL+) 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

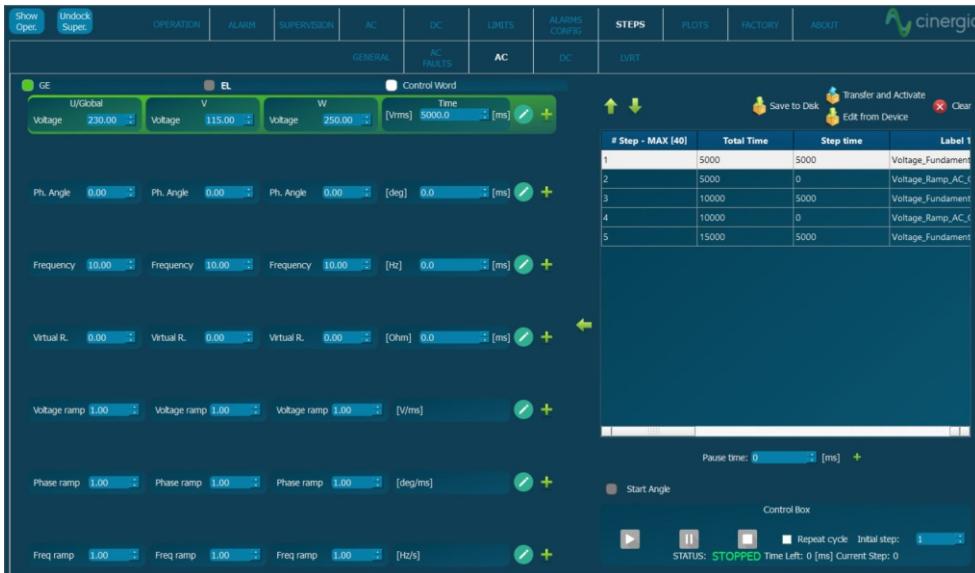
The device can control simultaneously the magnitude of the first 50 harmonics and 20 free harmonic per phase. These free ones allows the generation of sub-harmonics, inter-harmonics and high frequency harmonics up to the 50th, setting both the magnitude and phase delay.



Power and Impedance Control

This mode is only available in EL+ configuration. 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.

Advanced AC Software Applications



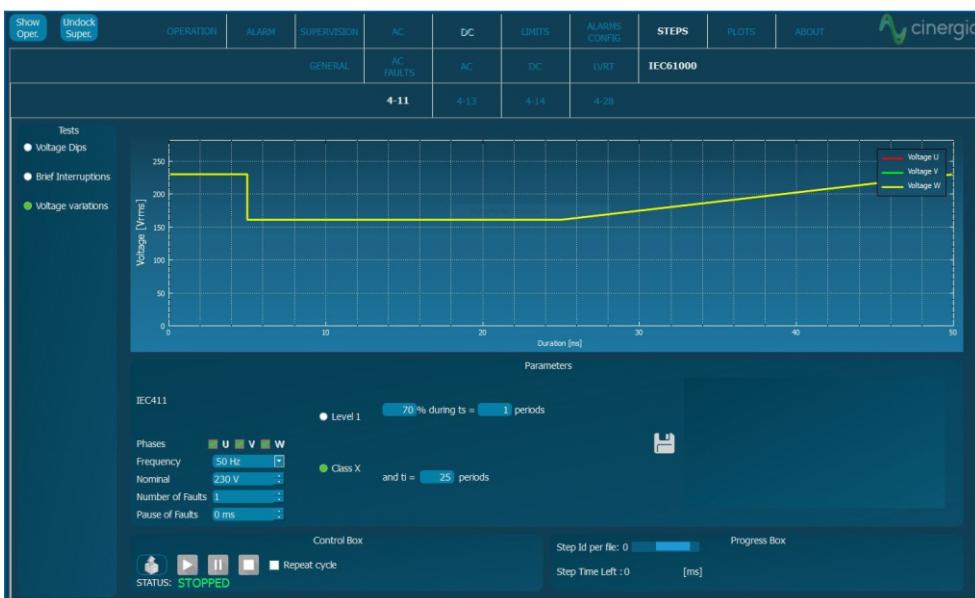
Steps Mode

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 voltage dips, frequency variation, flicker and LVRT. Specific profiles can be saved in .csv files, modified, and reused by importing an existing one. The LVRT page have predetermined profiles for different countries.



Option IEC Testing

The last version of software includes a library supporting IEC compatible 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

Software Interface in DC

	Min. Voltage	Max. Voltage	Min. Current	Max. Current
Output U	20,00	750,00	0,00	33,00
Output V	20,00	750,00	0,00	33,00
Output W	20,00	750,00	0,00	33,00
Global	20,00	750,00	-99,00	99,00

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.

Step	1	2	3	4	5	6	7	8
1	Voltage	Voltage	Voltage	100	10	10	10	1
2	Current	Resist...	Current	100	10	10	1	1
3	Power	Power	Current	100	20...	20...	10	1
4	Power	Voltage	Current	100	20...	10	10	1
5	Resist...	Voltage	Current	100	10	10	1	1
6	Voltage	Resist...	Current	100	10	10	1	1

Sequence

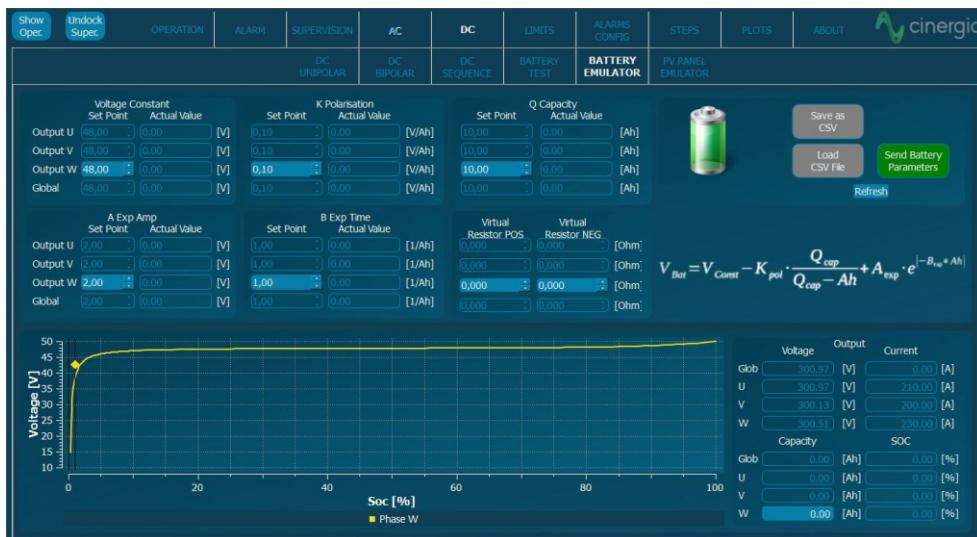
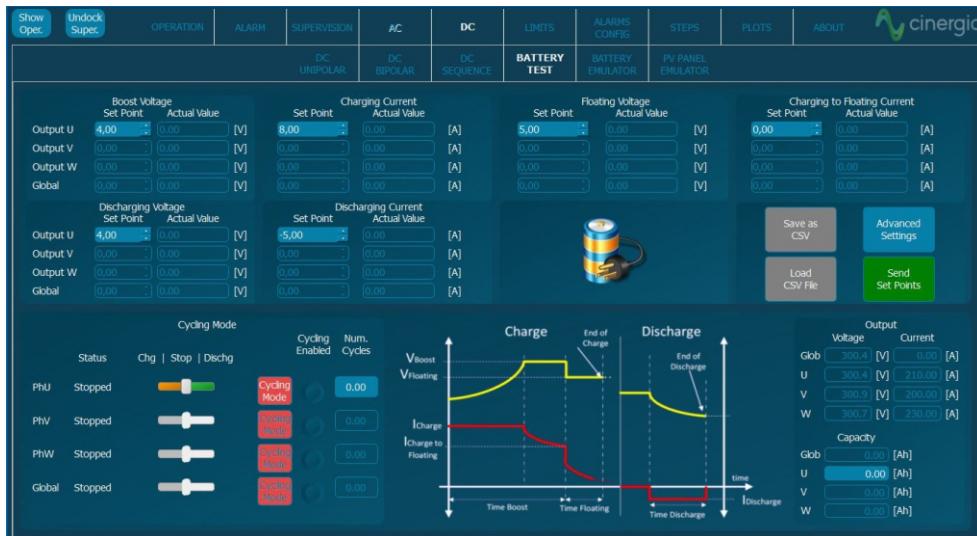
The User Interface Software integrates a Sequence Editor to create automatic test sequences, save them for future use and import them in .csv files.

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.

Advanced DC Applications



GE&EL+ vAC/DC Range & Specifications

Input side (GRID side)	<p>AC Voltage Rated: 3x400Vrms + Neutral + Earth Range: +15% / -20%</p> <p>Rated AC Current Depends on model (see Wiring Manual)</p> <p>Frequency 48-62Hz</p> <p>Current Harmonic Distortion THDi < 3% at rated power</p> <p>Current Power factor PF > 0.98 at rated power</p> <p>Efficiency ≥ 89% (7.5 & 10), ≥ 91% (15 to 30), ≥ 92% (40 to 200)</p>
Output side in DC (EUT side)	<p>Terminals Number: 6 (3 positive + 3 negative)</p> <p>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)</p> <p>Voltage Mode (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 Vrated) Ripple⁽⁷⁾ (peak-peak): < 0.55% of FS⁽³⁾</p> <p>Current Mode (CC) Range: from 0 to ± 110% of Irated (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 Irated) Ripple⁽⁷⁾ (peak-peak): < 0.7% of FS⁽³⁾</p> <p>Power Mode (CP) Range: from 0 to ± 200%⁽⁸⁾ of Prated (see models table) Derived current setpoint: Psetpoint / Vmeasured 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 Prated)</p> <p>Resistance Mode (CR) Range: from 0.1 to 1000 Ohm Derived current: Vmeasured / Rsetpoint Setpoint Resolution: 0.01 Ohm Setpoint Accuracy⁽⁴⁾: ± 0.2% of FS⁽³⁾ Transient Time⁽⁵⁾: < 2ms (10% to 90% at a step to Rrated))</p>

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 $\geq 80\text{kVA}$)

Output side in GE-AC

Voltage Mode (CV)

Peak: $\pm 400\text{V}$ 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⁾: $< \pm 0.1\%$ of FS⁽³⁾

Transient Time⁽⁵⁾: < 1.5ms (10% to 90% at a step to Vrated)

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: $V \cdot f < 46000$ (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°

Output side in EL-AC

Admissible Voltage

Connection: 1-phase, 3-phase star or 3-phase delta

Maximum: $\pm 400\text{V}$ peak

Range: 10-100Hz

35⁽¹⁾ to 277Vrms phase-neutral (295Vrms with HV option)

35⁽¹⁾ to 480Vrms phase-phase (510Vrms with HV option)

> 100Hz: maximum rms voltage follows $V \cdot f < 46000$

Frequency: 10 to 400Hz

Current Mode (CC)

Range: from 0 to $\pm 200\%$ ⁽⁸⁾ of Irated (see models table)

Setpoint Resolution: 10mAmps

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

Setpoint Accuracy⁽⁴⁾: < $\pm 0.2\%$ of FS⁽³⁾

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

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

Phase Angle ($\cos \phi$)

Range: -90 to 90° in Sink / Source

Resolution: 0.01°

Enhanced Harmonics

Range: up to 50th

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⁽⁴⁾: same as current accuracy

Small Signal Bandwidth: up to 5000Hz⁽⁹⁾

Transient Time⁽⁵⁾: < 2ms (10% to 90% at a step change)

Power Mode (CP / CS)

Range: from 0 to $\pm 200\%$ ⁽⁸⁾ of Prated (see models table)

Derived current setpoint: calculated from $|S|$ and $\Phi(S)$

Setpoint Resolution: 1W, 1VA

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

Setpoint Accuracy⁽⁴⁾: $\pm 0.4\%$ of FS⁽³⁾

Transient Time⁽⁵⁾: < 2.5ms (10% to 90% at a step to Prated)

Impedance Mode (CZ)

Enhanced

Calculation method configurable (rms, instantaneous)

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

Derived current/phase setpoint: calculated from $|Z|$ and $\Phi(Z)$

Setpoint Resolution: 0.01 Ohm/mH/mF

Setpoint Accuracy⁽⁴⁾: see current accuracy

Transient Time⁽⁵⁾: < 2.5ms (10% to 90% at a step to Rated)

Operation Modes	DC
	Programmable Voltage (CV) Programmable Current (CC) Programmable Power (CP) Programmable Resistance (CR) Power Amplifier (HiL) Steps Optional Battery Testing (BTest)(charge/discharge/cycling) Optional Battery Emulation (Bemu) Optional PV Panel Emulation (PVEmu)
AC	Programmable Voltage (CV)(only in GE+) Programmable Current (CC)(only in EL+) Programmable Power (CP / CS)(only in EL+) Programmable Impedance (CZ)(only in EL+) Power Amplifier (HiL) Steps Optional LVRT, IEC 61000 -4-11, 4-13, 4-14, 4-28
	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
Enhanced	Remote Control Port
	LAN Ethernet with Open Modbus-TCP protocol RS485(option), CAN and RS232 (using external gateway)
Software	Master/Slave operation
	Graphical User Interface for Windows 7/10 LabView drivers and open Labview interface example Connection: fiber optics link (x6) Configuration: from software user interface/MODBUS up to 8 units: AC: parallel DC: parallel, serial or serial-parallel
	

Protections

Overvoltage (peak, rms), Overcurrent (peak, rms), Overload
Shortcircuit, Emergency Stop, Watchdog, Heart Beat, Output
Contactor, 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,Q) and Frequency
Output Voltage (rms, avg), Current (rms, avg), Power (P,Q) 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 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
- Multichannel 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
- Low current ripple inductance (included in all models ≤54kW, optional for models ≥80kW)
- 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
- Battery Emulation
- Battery Test
- PV Panel Emulation
- 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 2·3 · Irated [(see models table)]

FS Range of power is 2·1·200% · Prated [(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&EL+ vAC/DC

Reference	AC Power Rated ⁽⁹⁾	DC Power Rated ⁽⁹⁾	AC Current Rated ⁽⁹⁾ RMS 3 channels / 1 channel	DC Current Rated ⁽⁹⁾ RMS 3 channels / 1 channel	Weight (kg)	Dimensions DxWxH (mm)
GE&EL+7.5 vAC/DC	7.5kW	7.5kW	11A / 33A	±10A / ±30A	155 kg	770x450x1100 mm
GE&EL+10 vAC/DC	10kW	10kW	15A / 45A	±15A / ±45A	155 kg	770x450x1100 mm
GE&EL+15 vAC/DC	15kW	15kW	22A / 66A	±20A / ±60A	155 kg	770x450x1100 mm
GE&EL+20 vAC/DC	20kW	20kW	29A / 87A	±25A / ±75A	155 kg	770x450x1100 mm
GE&EL+30 vAC/DC	27kW	27kW	40A / 120A	±30A / ±90A	155 kg	770x450x1100 mm
GE&EL+40 vAC/DC	40kW	40kW	58A / 174A	±40A / ±120A	190kg	770x450x1100 mm
GE&EL+50 vAC/DC	50kW	50kW	73A / 219A	±50A / ±150A	190kg	770x450x1100 mm
GE&EL+60 vAC/DC	54kW	54kW	80A / 240A	±57A / ±171A	190kg	770x450x1100 mm
GE&EL+80 vAC/DC	80kW	80kW	116A / -	±105A / ±315A	270kg	880x875x1320 mm
GE&EL+100 vAC/DC	100kW	100kW	145A / -	±130A / ±390A	295kg	880x875x1320 mm
GE&EL+120 vAC/DC	108kW	108kW	157A / -	±130A / ±390A	295kg	880x875x1320 mm
GE&EL+160 vAC/DC	145kW	145kW	211A / -	±155A / ±465A	545kg	850x900x2000 mm
GE&EL+200 vAC/DC	160kW	160kW	232A / -	±185A / ±555A	555kg	850x900x2000 mm

All specifications are subject to change without notice.

Galvanic Isolation (optional)

Circuit Breaker Recommended	Weight (kg)	Circuit Breaker Recommended		Weight (kg)	Dimensions DxWxH (mm)
		IT 30e	Type D - 80A		
IT 7.5i	Type C - 25A	145 kg	IT 40e	Type D - 100A	217 kg
IT 10i	Type C - 25A	145 kg	IT 50e	Type D - 125A	280 kg
IT 15i	Type C - 32A	145 kg	IT 60e	Type D - 160A	381 kg
IT 20i	Type C - 40A	145 kg	IT 80e	Type D - 200A	435 kg
IT 30i	Type C - 50A	195 kg	IT 100e	Type D - 250A	458 kg
* IT 40i	Type C - 63A	195 kg	IT 120e	Type D - 315A	514 kg
* IT 50i	Type C - 83A	195 kg	IT 160e	Type D - 400A	612 kg
			IT 200e	Type D - 500A	753 kg

* In the IT40i and IT50i models the size of the cabinet increases to a total of 770x835x1100mm. The others keep the original size.



Configuration Modes

- GE+ AC
- EL+ 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 EL

- 3 channels
- 1 channel

* For 1-channel configuration contact us.

Channel Configuration in DC

- 3 channels
- 1 channel
- Bipolar
- Unipolar

CINERGIA, Regenerative Power Electronics Solutions

- Grid Emulators AC, DC, AC/DC
- Electronic Loads, AC, DC, AC/DC, HF (360-900Hz)
- Bidireccional DC, Battery Emulators, PV Panel Emulators

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