CINERGIA’s Grid Emulators are programmable Voltage Sources designed to create stable AC grids as well as electrical disturbances. Based on a Regenerative and Bidirectional power hardware it is a key device for testing Renewable Energy Sources (PV, WT, CHP) and grid connected devices.

Key features

- **Bidirectional and Regenerative**
- **Clean grid current:** THDi < 3% and PF > 0.98
- **13 models from 6.75kW to 160kW**
- **Parallelization of units to increase the power**
- **Voltage Range:** up to 277Vrms (295Vrms with HV)
- **3 versions:** AC only, Power Amplifier for PHIL, AC/DC
- **Generation of Worldwide electrical grids:** 3-phase/1-phase/split phase/Multichannel
- **Independent phase configuration of:** voltage rms, phase angle, frequency and harmonics
- **Generation of disturbances:** harmonics, interharmonics, subharmonics, voltage dips, frequency variation, flicker
- **Disturbance Generation Editor compatible with IEC, LVRT, SEMI-F47, CBEMA test standards**

<table>
<thead>
<tr>
<th>Intuitive User Interface Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modbus/Ethernet Open protocol, Labview drivers</td>
</tr>
</tbody>
</table>

Highlights

**Efficiency and Flexibility**

GE+ units efficiently converts AC to AC with Regenerative capability. The system has been specially designed to bring a high level of flexibility to testing featuring independent configuration of each output phase: magnitude, phase, frequency, harmonics, ramps, voltage dip rise/fall along with a comprehensive set of alarms and limits for EUT protection.

**Harmonics Generation**

The PLUS series comes with an improved control of harmonics based on resonant controllers. The fundamental frequency is individually set on each phase and the user can control, for each phase, the multiple harmonics up to the 15th and one free harmonic to create sub/inter/high frequency harmonics up to the 50th.

**High-Resolution and Dynamics**

The fully-digital DSP-based control system is based on a 300kHz oversampling of the currents and voltages. This data is processed to provide high-resolution and low-noise measurements enabling the Proportional-Resonant Controllers to produce accurate outputs and fast transients.

**Smooth Integration**

All models integrate the electrical protections, terminal blocks, local touchscreen, analogue and digital I/O, local emergency stop pushbutton as well as input/output emergency signals for the general interlock system. Interfacing remotely a unit is simple by using the Modbus Ethernet connection (open protocol), User Interface Software and Labview drivers supplied.
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 is a three-leg Inverter which allows for the generation and control of three independent AC voltages with programmable amplitude, phase angle, frequency and harmonic content by using state of the art digital Proportional-Resonant controllers.

**Block diagram**

**Local Interface**

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

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.
Software Interface

The User Interface (UI) software has been carefully designed for an intuitive use while providing access to the more advanced functionalities and performances required to match the test necessities. The Grid Emulator has specific panels to configure independently the output voltage waveform, the transition ramps and the distortion of each phase. The Disturbance Generation Editor has been developed to create, save and import specific test profiles compatible with IEC, SEMI-F47, LVRT, etc. The user can also program the Alarms and Limits of the converter and save them to an EEPROM (password protected).

AC Operation

In this panel 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 GE+ uses resonant controllers to accurately create the programmed harmonic content. Each phase can be independently parameterized with a fundamental frequency, all multiple harmonics (up to the 15th) and one free harmonic (up to the 50th). Waveforms can be saved and imported in csv files and launched in a sequence.

Disturbance Generation

A powerful yet intuitive Editor allows generating and configuring voltage dips, frequency variation and flicker both manually or in a step sequence. Specific profiles can be saved in csv files, modified, and reused by importing an existing csv file.
Range and 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% (7.5kVA), ≥ 91% (15 to 30), ≥ 92% (40 to 200)

Output side (EUT side)

Terminals
Number: 4 (3 phases + 1 neutral)
Configuration
Independent: 4Q, independent setpoints per phase
Parallel: 4Q, global setpoints for all phases
Multichannel: 4Q, independent start/stop, alarm status and setpoints per phase (note: multichannel is an option for ≥ 80kVA)
Voltage
Peak: ±400V phase-neutral
Range: 0 N to 277Vrms phase-neutral (295Vrms with HV option)
0 N 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): < 1ms (10% to 90% at a step to Vrated)
Ripple(6) (peak-peak): < 0.55% of FS(3)
Phase Angle
Range: 0 to 360°
Resolution: 0.01°
Frequency
Fundamental Frequency Range: 10 to 100Hz
Small Signal Bandwidth: up to 5000Hz(7)
Resolution: 10mHz (1mHz upon request)
Harmonics
Range: up to 50th
15 independent harmonics per phase:
14 fixed frequency multiple of f0: 2,3,4,5,6,7,8,9,10,11,12,13,14,15
1 free programmable frequency from 0.1 to 50 times f0
Harmonics content: V·f < 46000 (with current derating)
Setpoint Accuracy(4): same as voltage accuracy
Transient Time(5): < 2ms (10% to 90% at a step change)

All specifications are subject to change without notice.
(1) The recommended minimum setpoint for long-term use is 20Vrms
(2) Effective resolution measured with a 400ms window
(3) FS Range of voltage is 800V
(4) FS Range of current is 2 [4 - listed] (see models table)
(5) FS Range of power is 2 [2000] - [4000] (see models table)
(6) FS Range of power is 2 [2000] - [4000] - [4000]
(7) FS Range of power is 2 [2000] - [4000] - [4000]
(8) FS Range of power is 2 [2000] - [4000] - [4000]
(9) FS Range of power is 2 [2000] - [4000] - [4000]
(10) Rated power figures are given at 20˚C. See (9) for admissible Overloads

Modes of operation

Version AC-only
CV: AC-only Programmable Voltage Source

Version Power Amplifier
CV: AC or DC Programmable Voltage Source
Power Amplifier
Optional: DC current/power/resistance, BatTest, BatEmu, PVEmu

Version AC/DC
CV: AC or DC Programmable Voltage Source
Power Amplifier
DC current/power/resistance, Battery Test
Optional: Battery Emulation, PV Panel Emulation
All versions: AC Disturbance Generation Mode, Automated testing from .csv file

Protections
Overvoltage (peak, rms), Overcurrent (peak, rms), Overload(2)
Shortcircuit, Emergency Stop, Watchdog, Heart Beat, Output Contactor
Alarms and Limits are user configurable and can be saved in a password protected EEPROM

Measurements(8)
Grid Voltage (rms), Current (rms), Power (P,Q) and Frequency
Output Voltage (rms), Current (rms), Power (P,Q) and Frequency
Heatsink Temperatures (x2) and DC Link Voltage
Datalogging available through FTP connection

User Interface
Local Control (4.3” Touchscreen panel)
Isolated Digital IO port: 6 inputs, 4 outputs
Isolated Analogue IO port: 6 inputs, 6 outputs
Interlock IO port: 1 input, 1 output
Emergency Stop pushbutton
Remote Control port:
LAN Ethernet with Open Modbus-TCP protocol
RS485, RS232, CANbus (optionals)
Software:
Graphical User Interface for Windows 7/10
LabView drivers and basic Labview interface example

Ambient
Operating temperature(9), 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 EN-50178
Safety EN-60950-1 EN-62040-1-2
EMC EN-62040-2

(1) Measured with the rated resistive load and high-dynamics controllers configuration
(2) Consult us for lower voltage/current ripple requirements
(7) The maximum output voltage depends on frequency following V·f < 46000
(8) Accuracy of measurements is ±0.1% of FS for rms voltage, ±0.2% of FS for rms current, ±0.5% of FS for active power (valid only above 10% of FS)
(9) Rated power figures are given at 20°C. See (9) for admissible Overloads
## Models

### GE+ (AC only version)

<table>
<thead>
<tr>
<th>Model</th>
<th>Version</th>
<th>AC Power</th>
<th>DC Power</th>
<th>AC Current</th>
<th>DC Current</th>
<th>Weight</th>
<th>Dimensions (DxWxH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GE+7.5</td>
<td>vAC</td>
<td>7.5 kW</td>
<td>-</td>
<td>11A / 33A</td>
<td>-</td>
<td>150 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+10</td>
<td>vAC</td>
<td>10 kW</td>
<td>-</td>
<td>15A / 45A</td>
<td>-</td>
<td>150 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+15</td>
<td>vAC</td>
<td>15 kW</td>
<td>-</td>
<td>22A / 66A</td>
<td>-</td>
<td>150 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+20</td>
<td>vAC</td>
<td>20 kW</td>
<td>-</td>
<td>29A / 87A</td>
<td>-</td>
<td>150 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+30</td>
<td>vAC</td>
<td>27 kW</td>
<td>-</td>
<td>40A / 120A</td>
<td>-</td>
<td>150 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+40</td>
<td>vAC</td>
<td>40 kW</td>
<td>-</td>
<td>58A / 174A</td>
<td>-</td>
<td>185 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+50</td>
<td>vAC</td>
<td>50 kW</td>
<td>-</td>
<td>73A / 219A</td>
<td>-</td>
<td>185 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+60</td>
<td>vAC</td>
<td>54 kW</td>
<td>-</td>
<td>82A / 240A</td>
<td>-</td>
<td>185 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+80</td>
<td>vAC</td>
<td>80 kW</td>
<td>-</td>
<td>116A / 348A</td>
<td>-</td>
<td>265 kg</td>
<td>880x590x1320 mm</td>
</tr>
<tr>
<td>GE+100</td>
<td>vAC</td>
<td>100 kW</td>
<td>-</td>
<td>145A / 435A</td>
<td>-</td>
<td>290 kg</td>
<td>880x590x1320 mm</td>
</tr>
<tr>
<td>GE+120</td>
<td>vAC</td>
<td>108 kW</td>
<td>-</td>
<td>157A / 471A</td>
<td>-</td>
<td>290 kg</td>
<td>880x590x1320 mm</td>
</tr>
<tr>
<td>GE+160</td>
<td>vAC</td>
<td>145 kW</td>
<td>-</td>
<td>211A / 633A</td>
<td>-</td>
<td>540 kg</td>
<td>850x900x2000 mm</td>
</tr>
<tr>
<td>GE+200</td>
<td>vAC</td>
<td>160 kW</td>
<td>-</td>
<td>232A / 696A</td>
<td>-</td>
<td>550 kg</td>
<td>850x900x2000 mm</td>
</tr>
</tbody>
</table>

### GE+ (Power Amplifier version)

<table>
<thead>
<tr>
<th>Model</th>
<th>Version</th>
<th>AC Power</th>
<th>DC Power</th>
<th>AC Current</th>
<th>DC Current</th>
<th>Weight</th>
<th>Dimensions (DxWxH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GE+7.5</td>
<td>vPA-V</td>
<td>7.5 kW</td>
<td>3.75 kW</td>
<td>11A / 33A</td>
<td>5A / 15A</td>
<td>155 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+10</td>
<td>vPA-V</td>
<td>10 kW</td>
<td>5 kW</td>
<td>15A / 45A</td>
<td>7.5A / 22.5A</td>
<td>155 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+15</td>
<td>vPA-V</td>
<td>15 kW</td>
<td>7.5 kW</td>
<td>22A / 66A</td>
<td>10A / 30A</td>
<td>155 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+20</td>
<td>vPA-V</td>
<td>20 kW</td>
<td>10 kW</td>
<td>29A / 87A</td>
<td>12.5A / 37.5A</td>
<td>155 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+30</td>
<td>vPA-V</td>
<td>27 kW</td>
<td>13.5 kW</td>
<td>40A / 120A</td>
<td>15A / 45A</td>
<td>155 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+40</td>
<td>vPA-V</td>
<td>40 kW</td>
<td>20 kW</td>
<td>58A / 174A</td>
<td>20A / 60A</td>
<td>190 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+50</td>
<td>vPA-V</td>
<td>50 kW</td>
<td>25 kW</td>
<td>73A / 219A</td>
<td>25A / 75A</td>
<td>190 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+60</td>
<td>vPA-V</td>
<td>54 kW</td>
<td>27 kW</td>
<td>80A / 240A</td>
<td>28.5A / 85.5A</td>
<td>190 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+80</td>
<td>vPA-V</td>
<td>80 kW</td>
<td>40 kW</td>
<td>116A / 348A</td>
<td>52.5A / 157.5A</td>
<td>270 kg</td>
<td>880x590x1320 mm</td>
</tr>
<tr>
<td>GE+100</td>
<td>vPA-V</td>
<td>100 kW</td>
<td>50 kW</td>
<td>145A / 435A</td>
<td>65A / 195A</td>
<td>295 kg</td>
<td>880x590x1320 mm</td>
</tr>
<tr>
<td>GE+120</td>
<td>vPA-V</td>
<td>108 kW</td>
<td>54 kW</td>
<td>157A / 471A</td>
<td>65A / 195A</td>
<td>295 kg</td>
<td>880x590x1320 mm</td>
</tr>
<tr>
<td>GE+160</td>
<td>vPA-V</td>
<td>145 kW</td>
<td>72.5 kW</td>
<td>211A / 633A</td>
<td>77.5A / 232.5</td>
<td>545 kg</td>
<td>850x900x2000 mm</td>
</tr>
<tr>
<td>GE+200</td>
<td>vPA-V</td>
<td>160 kW</td>
<td>80 kW</td>
<td>232A / 696A</td>
<td>92.5A / 277.5A</td>
<td>555 kg</td>
<td>850x900x2000 mm</td>
</tr>
</tbody>
</table>

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**Notes:**
- Admissible overloads are the following: 125% of rated value during 10 minutes, 150% of rated value during 1 minute, 200% of rated value during 2s.
- Overload levels can be configured by the user (to values below the factory ones) and saved in an EEPROM (password protected).
- The user can configure different admissible overload levels for power sourcing and power absorbing.

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**AC Overcurrents:**
- Admissible AC Overcurrents are the following: 125% during 10 minutes, 150% during 1 minute, 200% during 2s.
- Admissible Peak Overcurrent is 3 times the rated current (to allow a crest factor of 3).
- Overload levels can be configured by the user (to values below the factory ones) and saved in an EEPROM (password protected).

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**DC Overcurrent:**
- Admissible DC Overcurrent is the following: 110% during 1 minute.
Models

GE+ (AC/DC version)

<table>
<thead>
<tr>
<th>Model</th>
<th>Version</th>
<th>AC Power Rated</th>
<th>DC Power Rated</th>
<th>AC Current Rated RMS</th>
<th>DC Current Rated DC</th>
<th>Weight</th>
<th>Dimensions D x W x H (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GE+7.5</td>
<td>vAC/DC</td>
<td>7.5 kW</td>
<td>7.5 kW</td>
<td>11A / 33A</td>
<td>±10A / ±30A</td>
<td>155 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+10</td>
<td>vAC/DC</td>
<td>10 kW</td>
<td>10 kW</td>
<td>15A / 45A</td>
<td>±15A / ±45A</td>
<td>155 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+15</td>
<td>vAC/DC</td>
<td>15 kW</td>
<td>15 kW</td>
<td>22A / 66A</td>
<td>±20A / ±60A</td>
<td>155 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+20</td>
<td>vAC/DC</td>
<td>20 kW</td>
<td>20 kW</td>
<td>29A / 87A</td>
<td>±25A / ±75A</td>
<td>155 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+30</td>
<td>vAC/DC</td>
<td>27 kW</td>
<td>27 kW</td>
<td>40A / 120A</td>
<td>±30A / ±90A</td>
<td>155 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+40</td>
<td>vAC/DC</td>
<td>40 kW</td>
<td>40 kW</td>
<td>58A / 174A</td>
<td>±40A / ±120A</td>
<td>190 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+50</td>
<td>vAC/DC</td>
<td>50 kW</td>
<td>50 kW</td>
<td>73A / 219A</td>
<td>±50A / ±150A</td>
<td>190 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+60</td>
<td>vAC/DC</td>
<td>54 kW</td>
<td>54 kW</td>
<td>80A / 240A</td>
<td>±57A / ±171A</td>
<td>190 kg</td>
<td>770x450x1100 mm</td>
</tr>
<tr>
<td>GE+80</td>
<td>vAC/DC</td>
<td>80 kW</td>
<td>80 kW</td>
<td>116A / 348A</td>
<td>±105A / ±315A</td>
<td>270 kg</td>
<td>880x590x1320 mm</td>
</tr>
<tr>
<td>GE+100</td>
<td>vAC/DC</td>
<td>100 kW</td>
<td>100 kW</td>
<td>145A / 435A</td>
<td>±130A / ±390A</td>
<td>295 kg</td>
<td>880x590x1320 mm</td>
</tr>
<tr>
<td>GE+120</td>
<td>vAC/DC</td>
<td>108 kW</td>
<td>108 kW</td>
<td>157A / 471A</td>
<td>±130A / ±390A</td>
<td>295 kg</td>
<td>880x590x1320 mm</td>
</tr>
<tr>
<td>GE+160</td>
<td>vAC/DC</td>
<td>145 kW</td>
<td>145 kW</td>
<td>211A / 633A</td>
<td>±155A / ±465A</td>
<td>545 kg</td>
<td>850x900x2000 mm</td>
</tr>
<tr>
<td>GE+200</td>
<td>vAC/DC</td>
<td>160 kW</td>
<td>160 kW</td>
<td>232A / 696A</td>
<td>±185A / ±555A</td>
<td>555 kg</td>
<td>850x900x2000 mm</td>
</tr>
</tbody>
</table>

Galvanic Isolation (optional)

<table>
<thead>
<tr>
<th>Model</th>
<th>WEIGHT</th>
<th>DIMENSIONS D x W x H (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT7.5i</td>
<td>14.5</td>
<td>Inside the cabinet</td>
</tr>
<tr>
<td>IT10i</td>
<td>14.5</td>
<td>Inside the cabinet</td>
</tr>
<tr>
<td>IT15i</td>
<td>14.5</td>
<td>Inside the cabinet</td>
</tr>
<tr>
<td>IT20i</td>
<td>19.5</td>
<td>Inside the cabinet</td>
</tr>
<tr>
<td>IT30i</td>
<td>17.4</td>
<td>Inside the cabinet</td>
</tr>
<tr>
<td>IT30e</td>
<td>17.4</td>
<td>595x415x708</td>
</tr>
<tr>
<td>IT40e</td>
<td>21.7</td>
<td>789x490x865</td>
</tr>
<tr>
<td>IT50e</td>
<td>28.0</td>
<td>789x490x865</td>
</tr>
<tr>
<td>IT60e</td>
<td>38.1</td>
<td>789x490x865</td>
</tr>
<tr>
<td>IT80e</td>
<td>43.5</td>
<td>964x684x1252</td>
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<tr>
<td>IT100e</td>
<td>45.8</td>
<td>964x684x1252</td>
</tr>
<tr>
<td>IT120e</td>
<td>51.4</td>
<td>964x684x1252</td>
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<tr>
<td>IT160e</td>
<td>61.2</td>
<td>964x684x1252</td>
</tr>
<tr>
<td>IT200e</td>
<td>75.3</td>
<td>1192x744x1430</td>
</tr>
</tbody>
</table>

Options

Galvanic Isolation
- Multichannel mode (included in all models from 7.5 to 60, both included)
- 30kHz Switching Frequency (only available for models 15, 20 and 30. Power is derated to 7.5, 7.5 and 10kW respectively)
- Isolation monitor / Anti-islanding monitor
- High Voltage (HV)
- RS485, RS232, CAN
- Battery Emulation, PV Panel Emulation (only available for Power Amplifier and AC/DC versions)