GE+ Grid Emulator

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

Key features

Bidirectional and Regenerative
Clean grid current: THDi < 3% and PF > 0.98

13 models from 6.75kW to 160kW
Parallel operation 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

Intuitive User Interface Software
Modbus/Ethernet Open protocol, Labview drivers

Highlights

Efficiency and Flexibility

GE+ units efficiently convert 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.

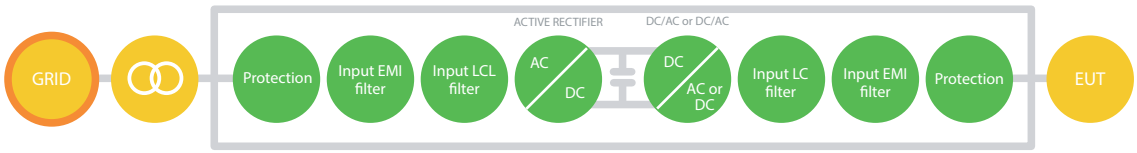
High-Resolution and Dynamics

The fully-digital DSP-based control system is based on oversampling of the currents and voltages at 300kHz. 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 electrical protections, terminal blocks, local touchscreen, analog and digital I/O, local emergency stop pushbutton, as well as input & output emergency signals for an interlock system. Interfacing remotely to a unit is simple by using the Modbus Ethernet connection (open protocol), User Interface Software and Labview drivers supplied.

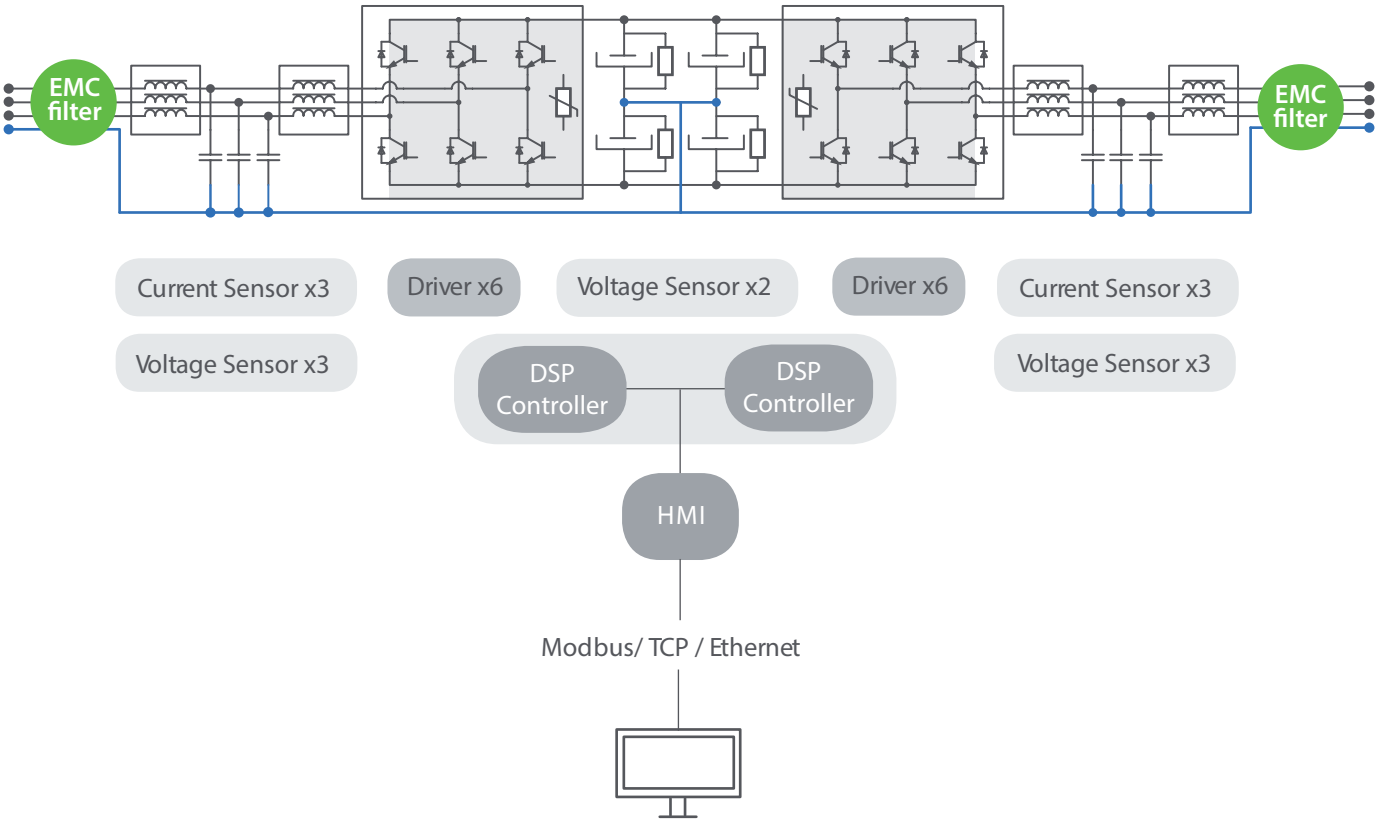
Bidirectional and Regenerative Hardware



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 a power factor close to one.

The EUT side stage is a three-legged Inverter which allows for the generation and control of three independent AC voltages with programmable amplitude, phase angle, frequency and harmonic content using state of the art digital Proportional-Resonant controllers.

Block diagram



Local Interface

Analogue and Digital IO port

The isolated digital and analog inputs & outputs permit the connection of the unit to External Controllers and (optional) Power Hardware in the Loop (PHIL) systems

4.3" Touchscreen

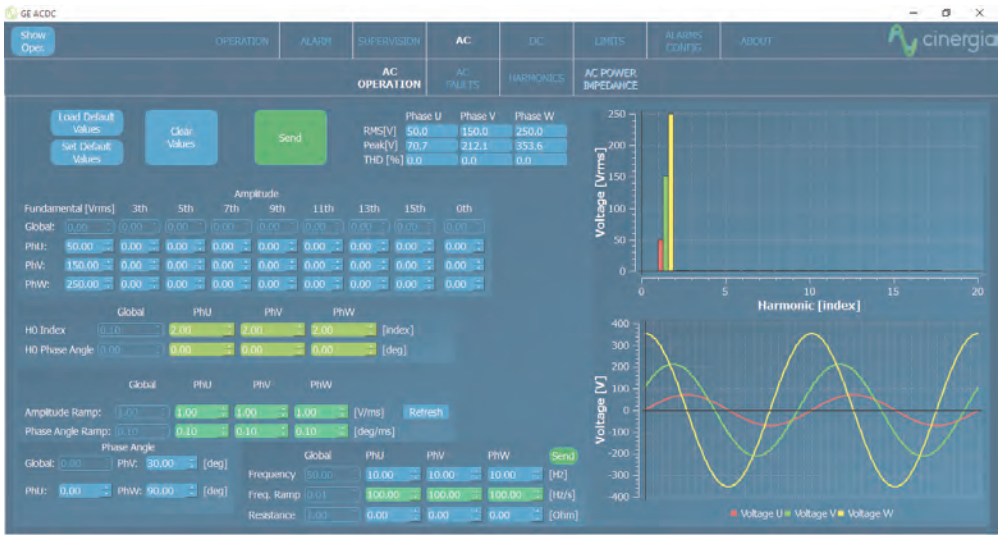
Allows programming and control of the unit, configuration of the communications link, plots the main signals and enables local logging of data

Safety First

All units integrate a local Emergency Stop push button and two signals (input + output) for connection to a safety interlock system. Additionally, the digital outputs can be interfaced to safety tower lights as needed

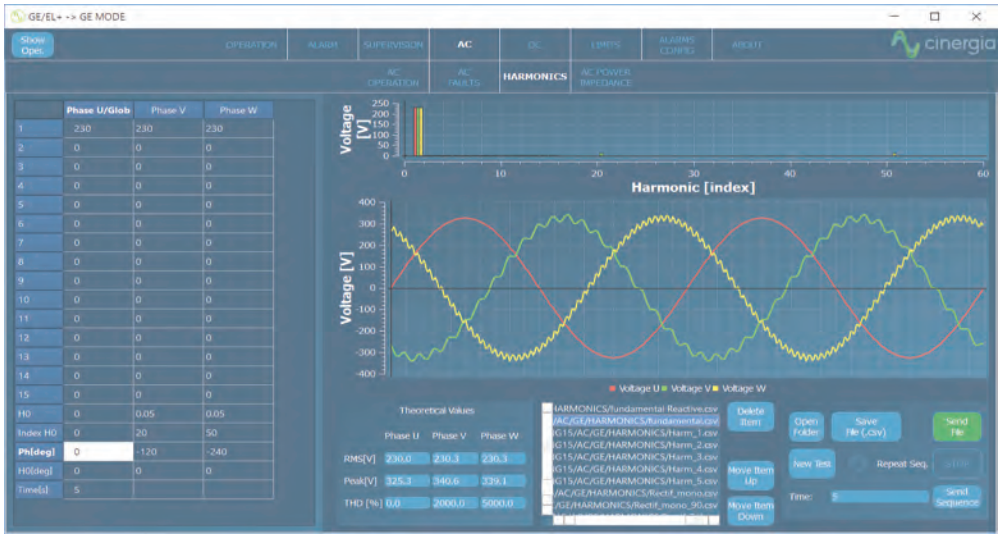
Software Interface

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 variations 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 specifcations

Input side (GRID side)

AC Voltage

Rated: Models < 40kW: 3x208V or 3x480V + N + E (US grid)
Models 40kW and up: 3x400Vrms + N + E + External coupling transformer with 3x208V and 3x480V taps

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 (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[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]: < 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 possible upon request)

Harmonics

Range: up to 50th

15 independent harmonics per phase:

14 fixed frequency multiple of f_0: 2,3,4,5,6,7,8,9,10,11,1,2,13,14,15

1 free programmable frequency from 0.1 to 50 times f_0

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)

Modes of operation

Version AC-only

CV: AC-only Programmable Voltage Source

Version HIL / AC/DC Lite

CV: AC or DC Programmable Voltage Source for HIL applications

Optional: DC current/power/resistance, BatTest, BatEmu, PVEmu

Version AC/DC

AC mode: CV: AC or DC Programmable Voltage Source includes HIL Mode

DC modes: CV, CC, CR, CP, Battery Test

Optional: Battery Emulation, PV Panel Emulation

All versions: AC Disturbance Generation Mode, Automated testing from .csv file

Protections

Overvoltage (peak, rms), Overcurrent[10,11] (peak, rms), Overload[9]

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 Analog 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

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
FS Range of current is 2·| 3 · Irated | (see models table)
FS Range of power is 2·| 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) 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, ±0.4% of FS for active power (valid only above 10% of FS)

(9) Rated power figures are given at 20°C. See (10) for permissible Overloads

Models

GE+ (AC only version)

Model	Version	AC Power Rated [9]	DC Power Rated [9]	AC Current Rated [10] RMS Per phase / Global	DC Current Rated [11] DC Per phase / Global	Weight lbs / kg	Dimensions (DxWxH) inches / mm
GE+7.5	vAC	7.5 kW	-	11A / 33A	-	331/150	30.3x17.7x43.3/770x450x1100
GE+10	vAC	10 kW	-	15A / 45A	-	331/150	30.3x17.7x43.3/770x450x1100
GE+15	vAC	15 kW	-	22A / 66A	-	331/150	30.3x17.7x43.3/770x450x1100
GE+20	vAC	20 kW	-	29A / 87A	-	331/150	30.3x17.7x43.3/770x450x1100
GE+30	vAC	27 kW	-	40A / 120A	-	331/150	30.3x17.7x43.3/770x450x1100
GE+40	vAC	40 kW	-	58A / 174A	-	408/185	30.3x17.7x43.3/770x450x1100
GE+50	vAC	50 kW	-	73A / 219A	-	408/185	30.3x17.7x43.3/770x450x1100
GE+60	vAC	54 kW	-	80A / 240A	-	408/185	30.3x17.7x43.3/770x450x1100
GE+80	vAC	80 kW	-	116A / 348A	-	584/265	34.6x22.2x52.0/880x590x1320
GE+100	vAC	100 kW	-	145A / 435A	-	639/290	34.6x22.2x52.0/880x590x1320
GE+120	vAC	108 kW	-	157A / 471A	-	639/290	34.6x22.2x52.0/880x590x1320
GE+160	vAC	145 kW	-	211A / 633A	-	1190/540	33.5x35.4x78.7/850x900x2000
GE+200	vAC	160 kW	-	232A / 696A	-	1213/550	33.5x35.4x78.7/850x900x2000

All specifications are subject to change without notice.

GE+ (AC/DC Full version)

Model	Version	AC Power Rated [9]	DC Power Rated [9]	AC Current Rated [10] RMS Per phase / Global	DC Current Rated [11] DC Per phase / Global	Weight lbs / kg	Dimensions (DxWxH) inches / mm
GE+7.5	vAC/DC	7.5 kW	7.5 kW	11A / 33A	±10A / ±30A	342/155	30.3x17.7x43.3/770x450x1100
GE+10	vAC/DC	10 kW	10 kW	15A / 45A	±15A / ±45A	342/155	30.3x17.7x43.3/770x450x1100
GE+15	vAC/DC	15 kW	15 kW	22A / 66A	±20A / ±60A	342/155	30.3x17.7x43.3/770x450x1100
GE+20	vAC/DC	20 kW	20 kW	29A / 87A	±25A / ±75A	342/155	30.3x17.7x43.3/770x450x1100
GE+30	vAC/DC	27 kW	27 kW	40A / 120A	±30A / ±90A	342/155	30.3x17.7x43.3/770x450x1100
GE+40	vAC/DC	40 kW	40 kW	58A / 174A	±40A / ±120A	419/190	30.3x17.7x43.3/770x450x1100
GE+50	vAC/DC	50 kW	50 kW	73A / 219A	±50A / ±150A	419/190	30.3x17.7x43.3/770x450x1100
GE+60	vAC/DC	54 kW	54 kW	80A / 240A	±57A / ±171A	419/190	30.3x17.7x43.3/770x450x1100
GE+80	vAC/DC	80 kW	80 kW	116A / 348A	±105A / ±315A	595/270	34.6x22.2x52.0/880x590x1320
GE+100	vAC/DC	100 kW	100 kW	145A / 435A	±130A / ±390A	650/295	34.6x22.2x52.0/880x590x1320
GE+120	vAC/DC	108 kW	108 kW	157A / 471A	±130A / ±390A	650/295	34.6x22.2x52.0/880x590x1320
GE+160	vAC/DC	145 kW	145 kW	211A / 633A	±155A / ±465A	1202/545	33.5x35.4x78.7/850x900x2000
GE+200	vAC/DC	160 kW	160 kW	232A / 696A	±185A / ±555A	1224/555	33.5x35.4x78.7/850x900x2000

All specifications are subject to change without notice.

Product Version Explained:

- GE+ vAC: AC Ouput Mode. No DC or HIL support
- GE+ vAC/DC Full (vAC/DC): Full featured version. Can be used also in PHIL applications using power amplifier mode. Combines GE+ vAC and a B2C+ in one single unit. Power in DC mode is the same as power in AC mode (no derating). Operation modes: AC: CV | DC:CV, CC, CR, CP and optionally Battery Testing, Battery Emulation and PV Panel Emulation
- GE+ vHIL (vAC/DC Lite): Unit optimized for for PHIL applications. Includes the power amplifier mode. Power in DC mode is 50% of power in AC mode. Operation modes: CV standard, other modes optional.

(10) Permissible 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 a EEPROM (password protected)
The user can configure different admissible overload levels for power sourcing and power absorbing

(11) Permissible AC Overcurrents are the following: 125% during 10 minutes, 150% during 1 minute, 200% during 2s
Permissible 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 a EEPROM (password protected)

(12) Permissible DC Overcurrent is the following: 110% during 1 minute

Models

GE+ (vHIL - Hardware In Loop / AC/DC Lite version)

Model	Version	AC Power Rated [9]	DC Power Rated [9]	AC Current Rated [10] RMS Per phase / Global	DC Current Rated [11] DC Per phase / Global	Weight lbs / kg	Dimensions (DxWxH) inches / mm
GE+7.5	vHIL	7.5 kW	3.75 kW	11A / 33A	5A / 15A	342/155	30.3x17.7x43.3/770x450x1100
GE+10	vHIL	10 kW	5 kW	15A / 45A	7.5A / 22.5A	342/155	30.3x17.7x43.3/770x450x1100
GE+15	vHIL	15 kW	7.5 kW	22A / 66A	10A / 30A	342/155	30.3x17.7x43.3/770x450x1100
GE+20	vHIL	20 kW	10 kW	29A / 87A	12.5A / 37.5A	342/155	30.3x17.7x43.3/770x450x1100
GE+30	vHIL	27 kW	13.5 kW	40A / 120A	15A / 45A	342/155	30.3x17.7x43.3/770x450x1100
GE+40	vHIL	40 kW	20 kW	58A / 174A	20A / 60A	419/190	30.3x17.7x43.3/770x450x1100
GE+50	vHIL	50 kW	25 kW	73A / 219A	25A / 75A	419/190	30.3x17.7x43.3/770x450x1100
GE+60	vHIL	54 kW	27 kW	80A / 240A	28.5A / 85.5A	419/190	30.3x17.7x43.3/770x450x1100
GE+80	vHIL	80 kW	40 kW	116A / 348A	52.5A / 157.5A	595/270	34.6x22.2x52.0/880x590x1320
GE+100	vHIL	100 kW	50 kW	145A / 435A	65A / 195A	650/295	34.6x22.2x52.0/880x590x1320
GE+120	vHIL	108 kW	54 kW	157A / 471A	65A / 195A	650/295	34.6x22.2x52.0/880x590x1320
GE+160	vHIL	145 kW	72.5 kW	211A / 633A	77.5A / 232.5	1202/545	33.5x35.4x78.7/850x900x2000
GE+200	vHIL	160 kW	80 kW	232A / 696A	92.5A / 277.5A	1224/555	33.5x35.4x78.7/850x900x2000

All specifications are subject to change without notice.

Galvanic Isolation *(Required for US Grid Connection)*

Model		Weight lbs / kg	Dimensions (DxHxW) (inch/mm)
IT7.5i	Type C - 25A	320/145	Inside the cabinet
IT10i	Type C - 25A	320/145	Inside the cabinet
IT15i	Type C - 32A	320/145	Inside the cabinet
IT20i	Type C - 40A	320/145	Inside the cabinet
IT30i	Type C - 50A	430/195	Inside the cabinet
IT60e	Type D - 160A	840/381	31.0x19.3x34.1/789x490x865
IT120e	Type D - 315A	1133/514	38.0x26.9x49.3/964x684x1252
IT200e	Type D - 500A	1660/753	46.9x29.3x56.3/1192x744x1430

Note: 'i' stands for internal transformer, 'e' stands for external transformer (delivered in a stand-alone cabinet IP23)
For internal transformers, specify 208Vac or 480Vac grid connection when ordering.
External transformers provide tap for either 208Vac or 480Vac US Grid Connect.

All specifications are subject to change without notice.

Options

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)

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