Application Notes

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Dielectric Test Setup

Requirements

1.Impedance analyzer of desired frequency range.
2.Sample Holder for desired specimen bulk pellet, thick film or thin film.
3.Temperature control Furnace for desired Temperature Range.
4.Dielectric measurement software
5.Standard test specimen
6.Desktop PC/Laptop

Introduction

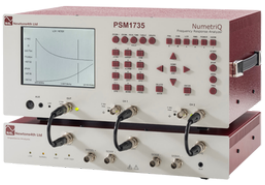
The system designed by us studies various dielectric properties above using a highly advanced Dielectric Measurement Test system and software. The complete system comprises a measurement unit and related temperature accessories for bulk and thick test specimens. The techniques are well defined by our team of experts which makes the system versatile.

Models Available for Dielectric Measurement System

PSM1700/1735

PSM3750

LCR Active Head Impedance Analysis

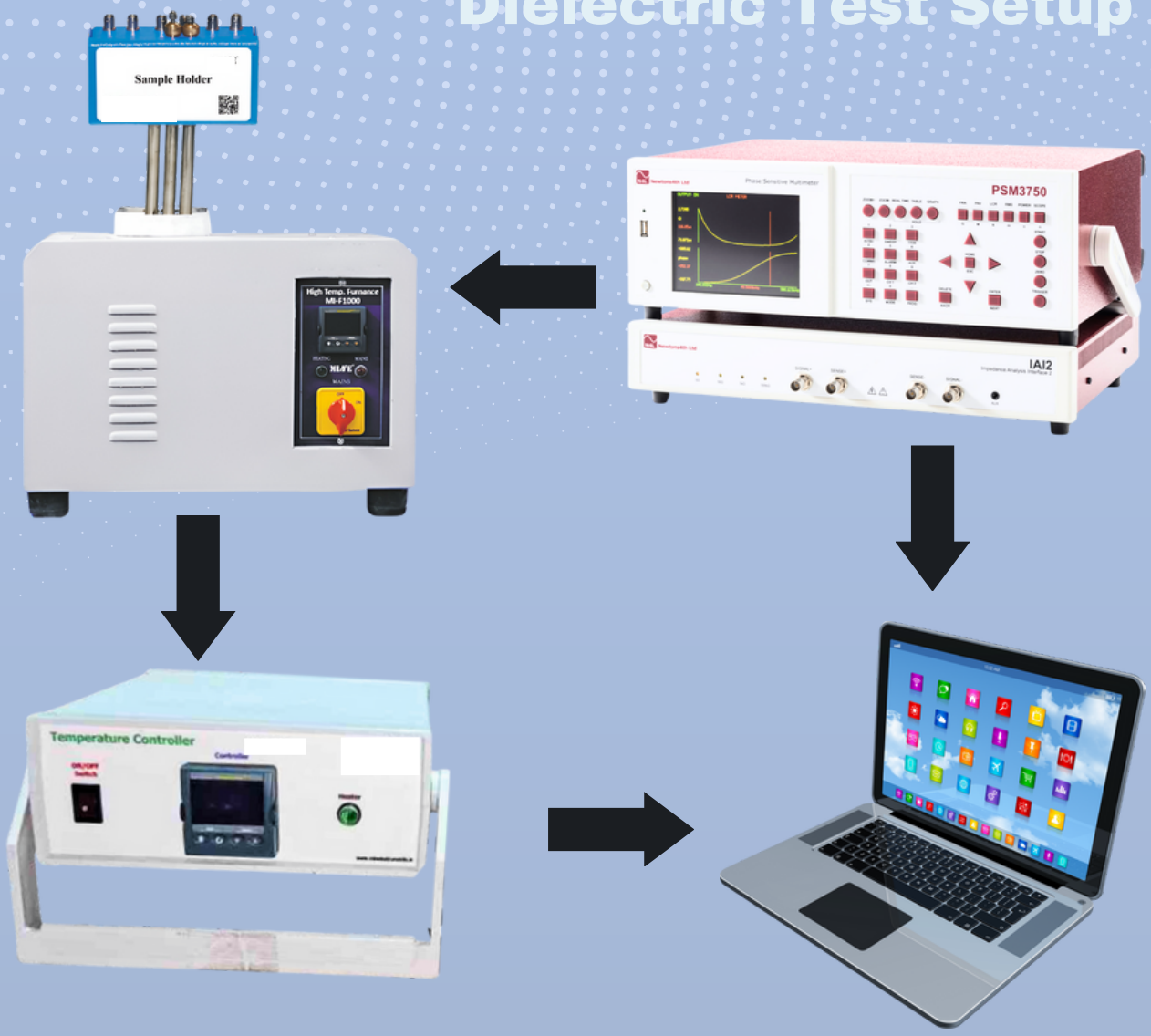


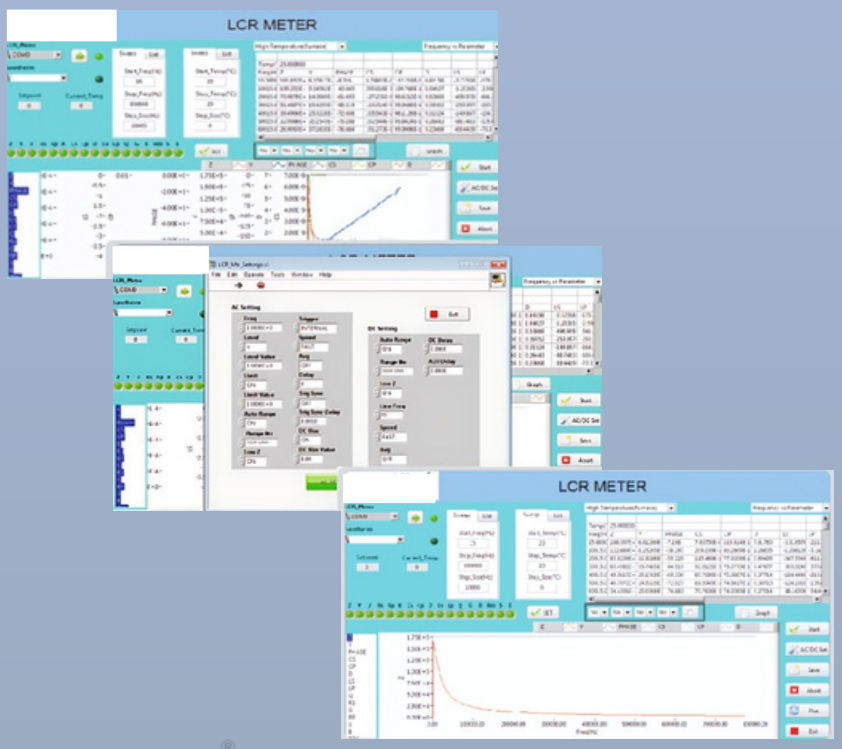
IAI Impedance Analyzer

IAI2 Impedance Analyzer

Basic Accuracy	0.2%	0.1%	0.1%
Phase Accuracy	0.05°	0.05°	0.05°
Frequency Range	10uHz ~ 5MHz	10uHz ~ 35MHz (PSM1700 - 1MHz)	10uHz ~ 50MHz

Dielectric Test Setup





Variable Temperature LN2 Cryostat MI-LN2

- 103K to 325K operating temperature range
- Unique thermal link variable temp. Easiest to use.
- High Temperature stability , fast thermal response
- 800ml liquid nitrogen reservoir
- 50ohm high power control heater installed on sample mount
- 4 BNC feed through
- Nitrogen fill and vent port
- Thermal link adjuster with vary-power thermal link insert
- Copper style sample holder
- PT-100 Platinum temperature sensor installed on sample mount
- Material : Stainless Steel & Aluminum

Temperature Controller

Range:

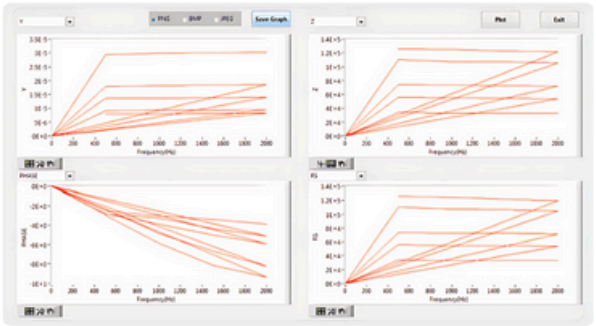
A. 96K – 273K

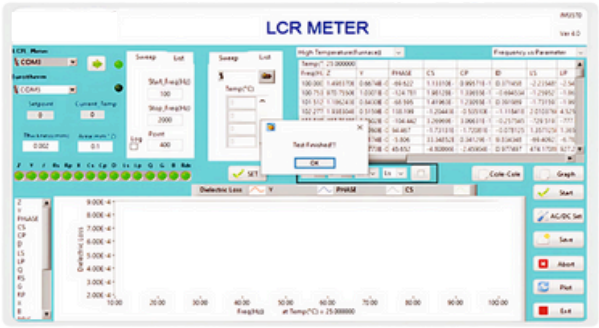
B. RT – 873K

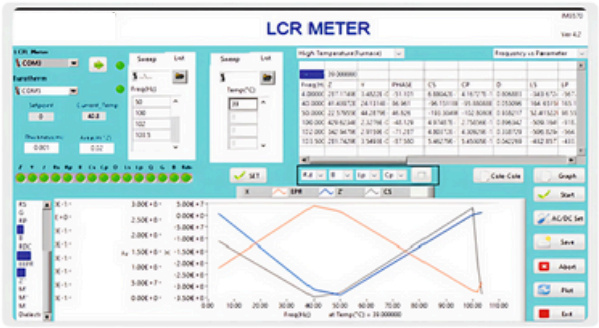
C. RT – 1073K

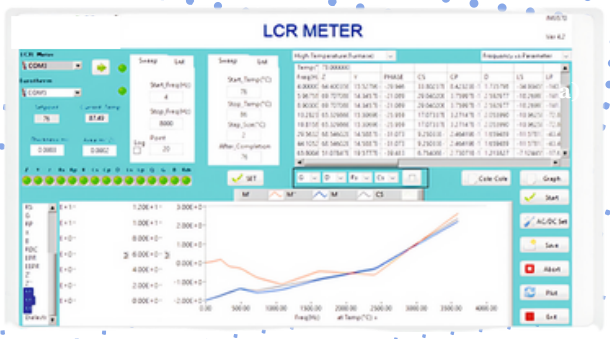
D. RT – 500K

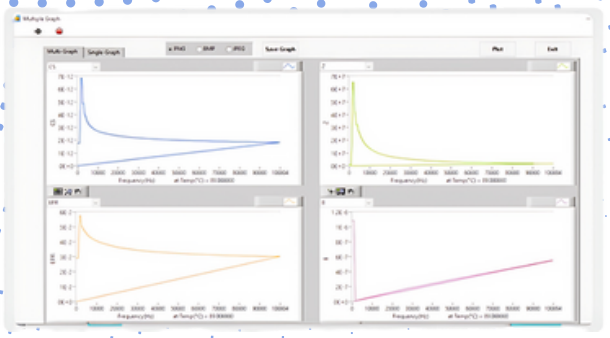
Software











- In this model test are performed from room temperature to1073-degree Kelvin. The sample is firstly inserted into the sampleholder assembly. The assembly is closed.
- The whole assembly is then inserted into abox furnace. The temperature of the test specimen is monitored andcontrolled using a temperature controller. The dielectric measurement system software will now start acquiringthe data of theselected
- parameters in desired frequency range. This is done by using a standard LCR/Impedance analyser at every step of temperature rise. For accurate rise of temperature measurements, two numbers of thermocouples areinstalled in the whole
- assembly. One of them is closed to the specimen. The test specimen must be coated with silver/gold/platinum pastedepending upon the test temperature.
-

List of deliverables

1.Impedance analyzer
2.Sample holder assembly
3.Furnace RT to 1073-degree Kelvin
4.Sample holder stand
5.Temperature controller
6.Software
7.Interconnecting cables
8.Manual

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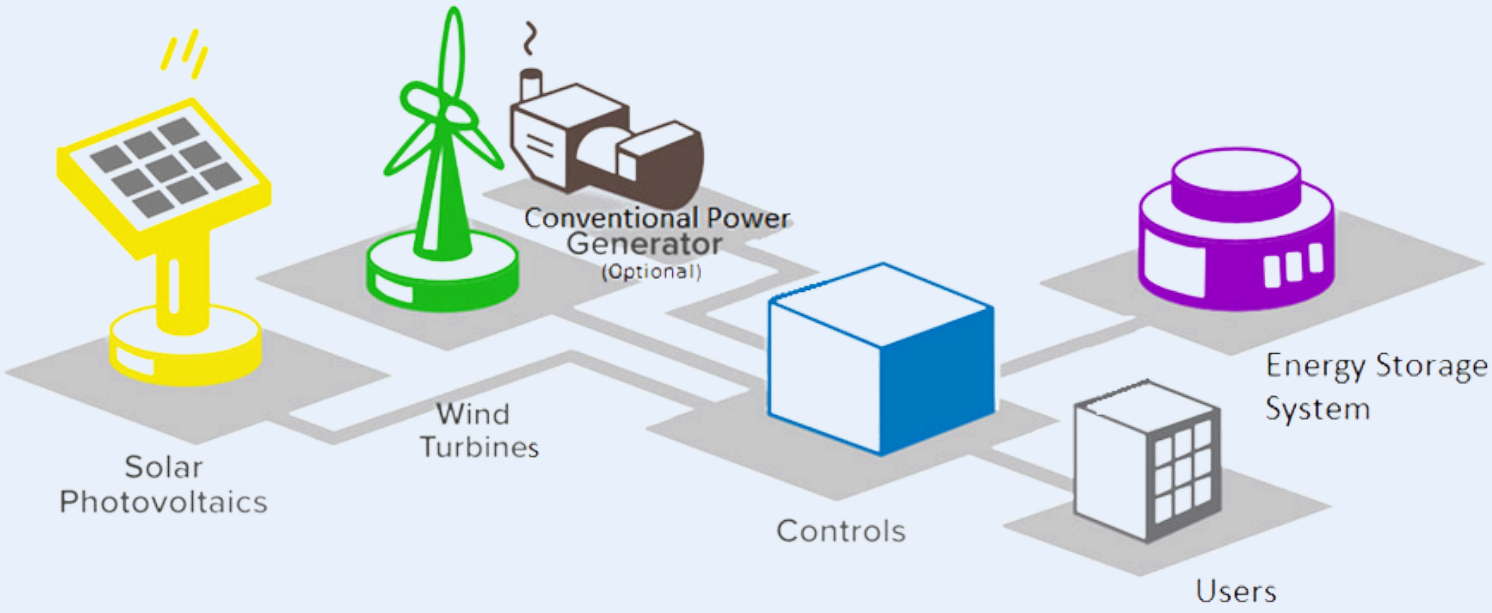
Micro Grid Test Bed



HIL - Microgrid Testbed

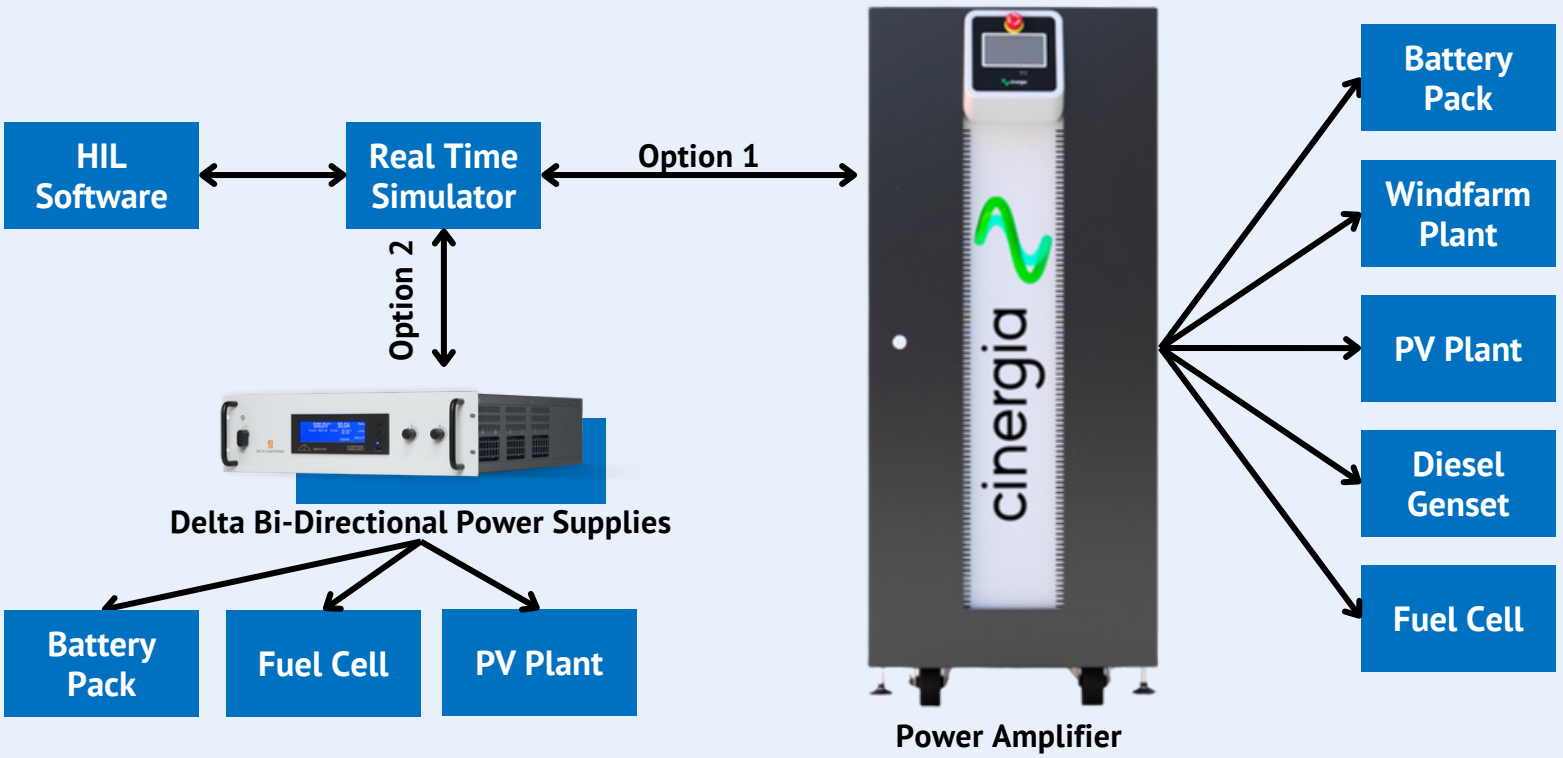
A Microgrid Testbed is a collection of HIL devices with integrated protection relays, microgrid controllers and controllers of solar inverters, battery inverters, diesel gensets, fuel cells, etc.

How does the C-HIL Microgrid Testbed Work?

The main purpose of the Microgrid Testbed is to comprehensively test and validate primary and secondary control, communications and protection under all operating conditions including faults in both the islanded and grid connected mode.
Moreover, Microgrid Testbed can perform all its tests and generate its test reports in the fully automatic mode, thus boosting the productivity and improving test coverage even further.

What is P-HIL Microgrid Testbed?

Adding high-bandwidth power amplifiers makes it possible to test grid connected converters and their interaction with the virtual grid components by establishing a high-speed high-fidelity feedback loop with the main Microgrid Testbed, enabling a 360° testing of any power electronics device.



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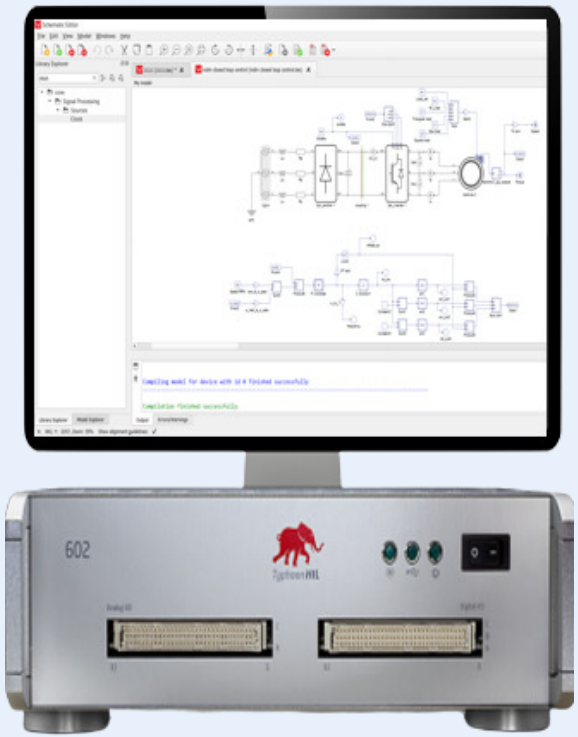
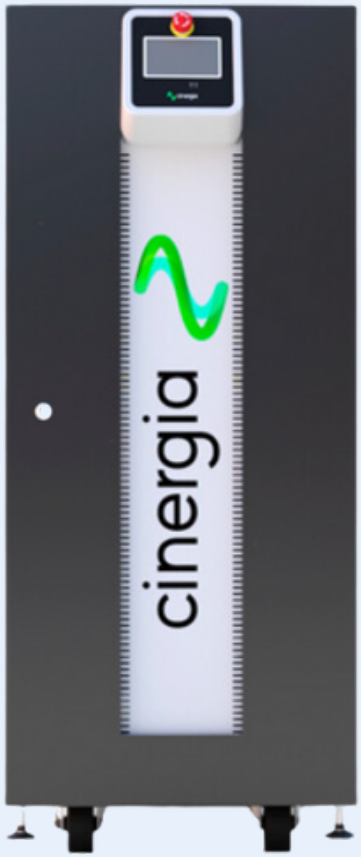
Hardware-in-loop (HIL)



Real Time Simulator



Power Amplifier

Battery Pack

3 Phase Motor

Solar Invertor

Load

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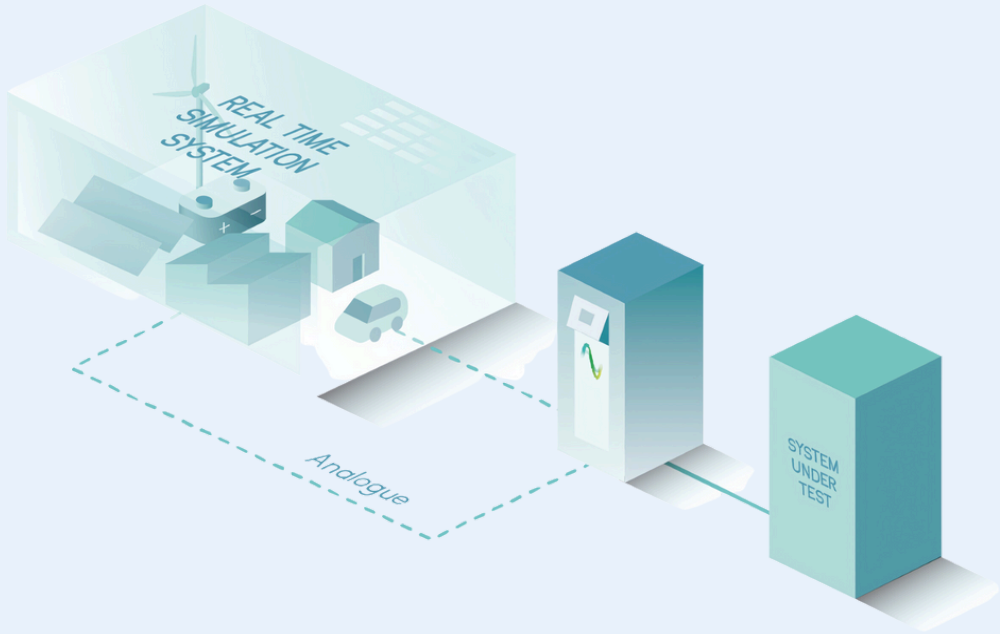
cinergia

Power HiL

Real Time Simulation and Power Converters are converging into the field known as Power Hardware in the Loop (PHiL). In these kind of applications, a real world system is simulated on a real-time basis and then emulated: converted in real voltage, current and power. This emulation is performed by a power converter that transforms the reference signal generated by the real time simulator into a voltage or current waveform. A power converter used in such a way is generally known as a power amplifier.



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POWER AMPLIFIER MODELS

Models

GE&EL+ vAC/DC

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&EL+ 7.5 vAC/DC	7.5 kW	11 A / 33A	7.5 kW	±10A / ±30A	155 kg	770 x 450 x 1100 mm
GE&EL+ 10 vAC/DC	10 kW	15 A / 45 A	10 kW	±15A / ±45A	155 kg	770 x 450 x 1100 mm
GE&EL+ 15 vAC/DC	15 kW	22 A / 66 A	15 kW	±20A / ±60A	155 kg	770 x 450 x 1100 mm
GE&EL+ 20 vAC/DC	20 kW	29 A / 87 A	20 kW	±25A / ±75A	155 kg	770 x 450 x 1100 mm
GE&EL+ 30 vAC/DC	27 kW	40 A / 120 A	27 kW	±30A / ±90A	155 kg	770 x 450 x 1100 mm
GE&EL+ 40 vAC/DC	40 kW	58 A / 174 A	40 kW	±40A / ±120A	200 kg	770 x 450 x 1100 mm
GE&EL+ 50 vAC/DC	50 kW	73 A / 219 A	50 kW	±50A / ±150A	200 kg	770 x 450 x 1100 mm
GE&EL+ 60 vAC/DC	54 kW	80 A / 240 A	54 kW	±57A / ±171A	200 kg	770 x 450 x 1100 mm
GE&EL+ 80 vAC/DC	80 kW	116 A / -	80 kW	±105A / ±315A	400 kg	880 x 875 x 1320 mm
GE&EL+ 100 vAC/DC	100 kW	145 A / -	100 kW	±130A / ±390A	400 kg	880 x 875 x 1320 mm
GE&EL+ 120 vAC/DC	108 kW	157 A / -	108 kW	±130A / ±390A	400 kg	880 x 875 x 1320 mm
GE&EL+ 160 vAC/DC	145 kW	211 A / -	145 kW	±155A / ±465A	680 kg	850 x 900 x 2000 mm
GE&EL+ 200 vAC/DC	160 kW	232 A / -	160 kW	±185A / ±555A	680 kg	850 x 900 x 2000 mm

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SM15K SERIES

High efficiency | Bidirectional | Flex output | Web interface | Plug and play interfaces

Unit	SM70-CP-450	SM210-CP-150	SM500-CP-90	SM1000-CP-45	SM1500-CP-30
Voltage	0 - 70 V	0 - 210 V	0 - 500 V	0 - 1000 V	0 - 1500 V
Current	-450 - 450 A	-150 - 150 A	-90 - 90 A	-45 - 45 A	-30 - 30 A
VI Curve					

Bi-directional constant power

The SM15K Series comprises power supplies with excellent efficiency, stability, and flexibility. Thanks to the constant power output, one power supply can cover up to five ranges of traditional power supplies with a rectangular VI-curve.

As standard, the SM15K series can be controlled via the front, web interface, or Ethernet. This connectivity can be expanded at any time by our interface cards.

Features

- Flexible output provided by constant power characteristics
- Excellent dynamic response to load changes
- EMC surpasses CE requirements: low emission and high immunity
- Designed for long life at full power
- Protected against all overload and short circuit conditions
- Low audible noise due to temperature controlled cooling fans
- Power Regeneration Technology
- Modular Master/Slave with use of interface card and output assembly kit
- All-digital control to adapt regulation to load type
- Automatic coarse and fine adjusting buttons
- Symmetrically providing and sinking 15 kW of power
- Operation on a wide range of 3 phase AC input voltages
- Efficient power conversion, at least 95 % efficiency at full power
- Master-Slave mode operation with up to 60 units and 900 kW output power
- Configuration and use via menu-driven display and web interface

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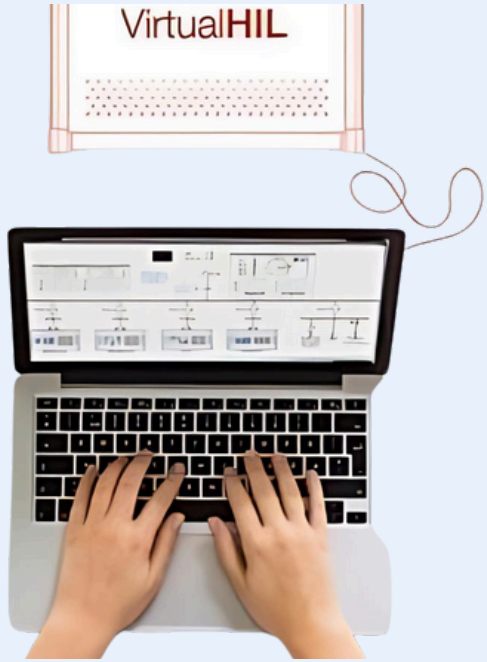
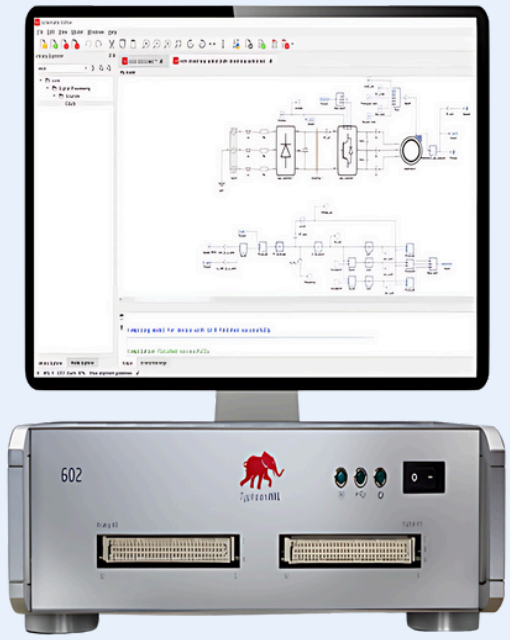
REAL TIME SIMULATOR





OFF Line Simulation

Real-Time Simulation

1. Model-in-loop (MIL)
2. Software-in-loop (SIL)

Microgrid Testbed Configurations

Recommended configurations	BASIC	PRO	ULTRA
Simulation capacity	up to 24 DERs, time-step down to 200/500ns to 450 busses (3 phase) time-step down to 10µs	up to 40 DERs time-step down to 200/500ns up to 750 busses (3 phase) time-step down to 10µs)	up to 80 DERs time-step down to 200/500ns up up to 1500 busses (3 phase) time-step down to 10µs
Analog I/O	288 channels MSPS sample rate 16 bit resolution 1% accuracy LV +/- 10V LC +/- 50 mA	480 channels 1 MSPS sample rate 16 bit resolution 1% accuracy LV +/- 10V HV +/- 350V four quadrant LC +/- 50 mA MC +/- 500 mA HC +/- 3A four quadrant	960 channels1 1 MSPS sample rate 16 bit resolution 1% accuracy LV +/- 10V HV user defined LC +/- 50 mA MC user defined HC user defined
Digital I/O	384 channels 20ns DI sampling resolution 7ns resolution PWM modulators	640 channels 20ns DI sampling resolution 7ns resolution PWM modulators	1280 channels 20ns DI sampling resolution 7ns resolution PWM modulators
Connectivity	USB, Ethernet/IP, CAN, RS232, Time Synchronization		
Supported Protocols	Variable Ethernet Exchange, Modbus, IEC61850, User Defined		

Typhoon HIL Products:

Typhoon HIL Simulators

Typhoon HIL 4-Series

Typhoon HIL 404

4 FPGA cores

Typhoon HIL 6-Series

Typhoon HIL 604

Typhoon HIL 606

8 FPGA cores

Typhoon HIL M-Series

Consisting Many Typhoon HIL Devices, Controllers and sensing devices

Product Specifications (Typhoon HIL 4/6 Series)

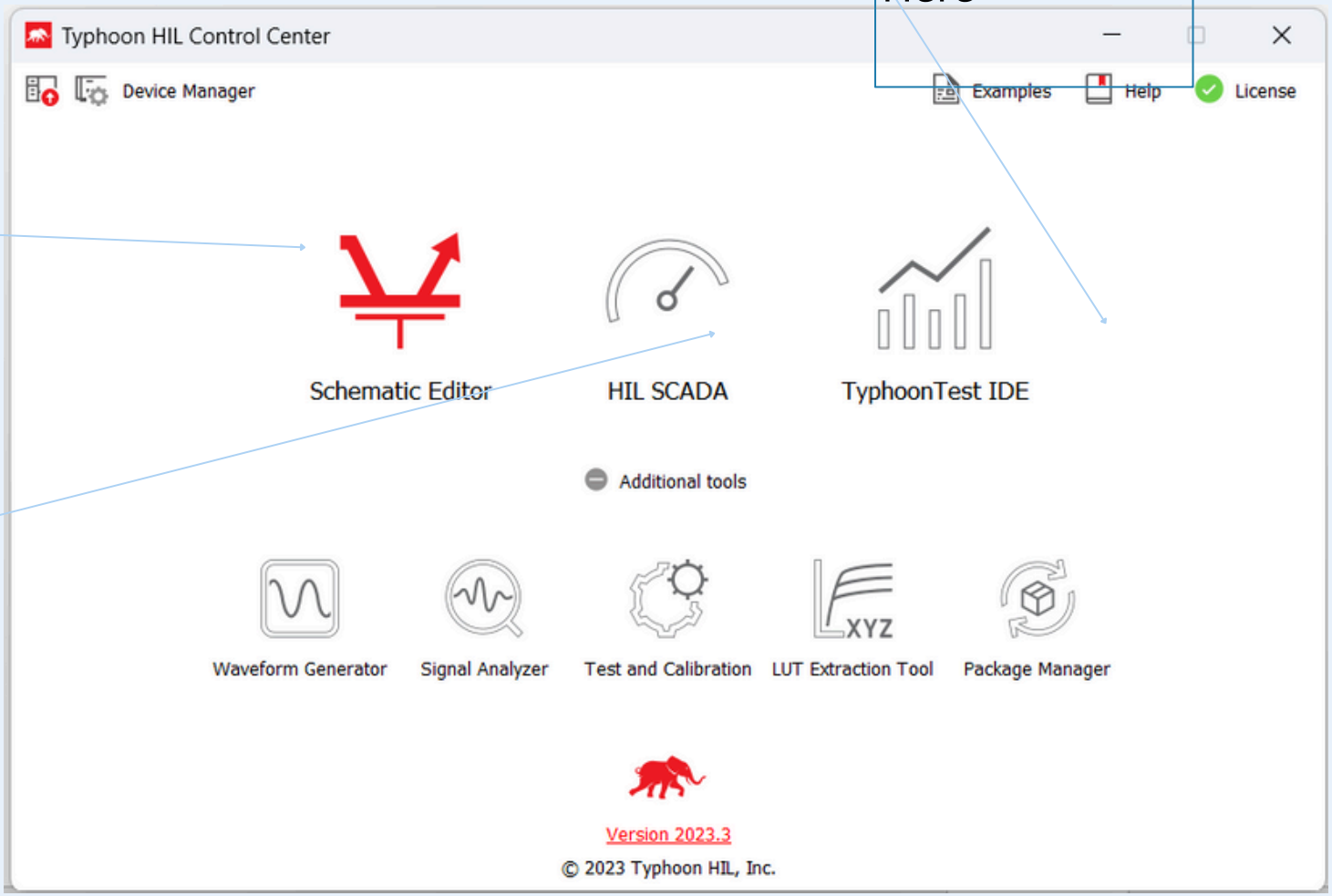
S.No.	Properties	Typhoon HIL 404	Typhoon HIL 604	Typhoon HIL 606
1	Main Processor	4 core FPGA (Xilinx) Processor	8 core FPGA (Xilinx) Processor	8 core FPGA (Xilinx) Processor
2	CPU Co-processors	2 ARM CPU Processors	2 ARM CPU Processors	2 ARM CPU Processors
3	Detailed Converter models (1ph/3ph)	12/04	24/08	24/08
4	Simulation time step up to	0.2 us	0.5 us	0.2 us
5	PWM Switching Frequency up to	400 kHz	400 kHz	500 kHz
6	Resolution	16 bit	16 bit	16 bit
7	Analog I/O per unit	16/16	32/64	32/64
8	Digital I/O per unit	32/32	64/64	64/64
9	Connectivity	USB, Ethernet, CAN ,RS232 SFP, GPIO, JTAG	USB, Ethernet, CAN ,RS232 SFP, GPIO, JTAG, Time synchronization (PPS & IRIG-B)	USB, Ethernet, CAN ,RS232 SFP, GPIO, JTAG, Time synchronization (PPS & IRIG-B), EtherCAT
11	Paralleling	04	16	16

Typhoon HIL Software

Perform Test automation Here

Simulate Your model Here

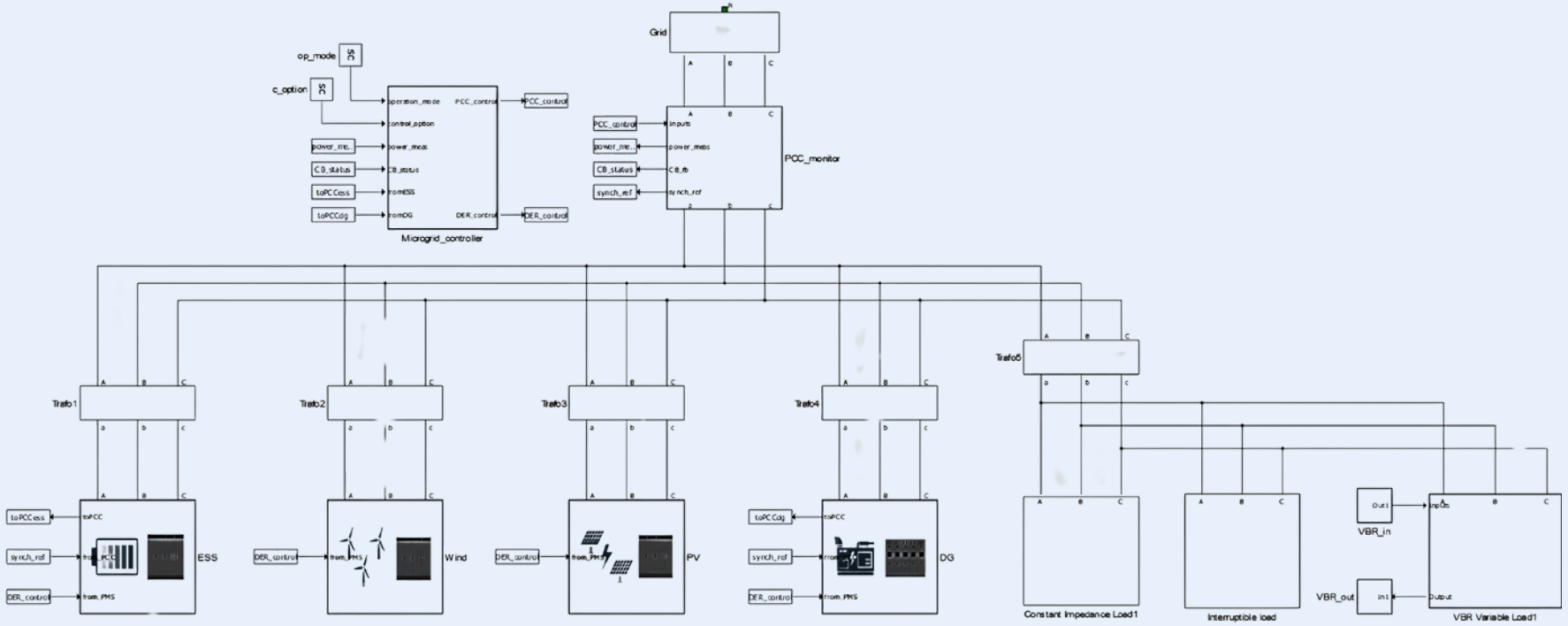
Monitor or Observe Your model Here



Micro Grid Toolbox

The Microgrid Toolbox is designed to provide you with realistic component-level building blocks that can be easily used for system-level modeling and real-time microgrid controller (MC) testing.

The microgrid model consists of four DERs (an Energy Storage System (ESS), a Wind Plant, a PV Plant, and a Diesel Genset (DG)) and three types of loads (a constant load, an interruptible load, and a variable load), all connected to the same point of common coupling (PCC).



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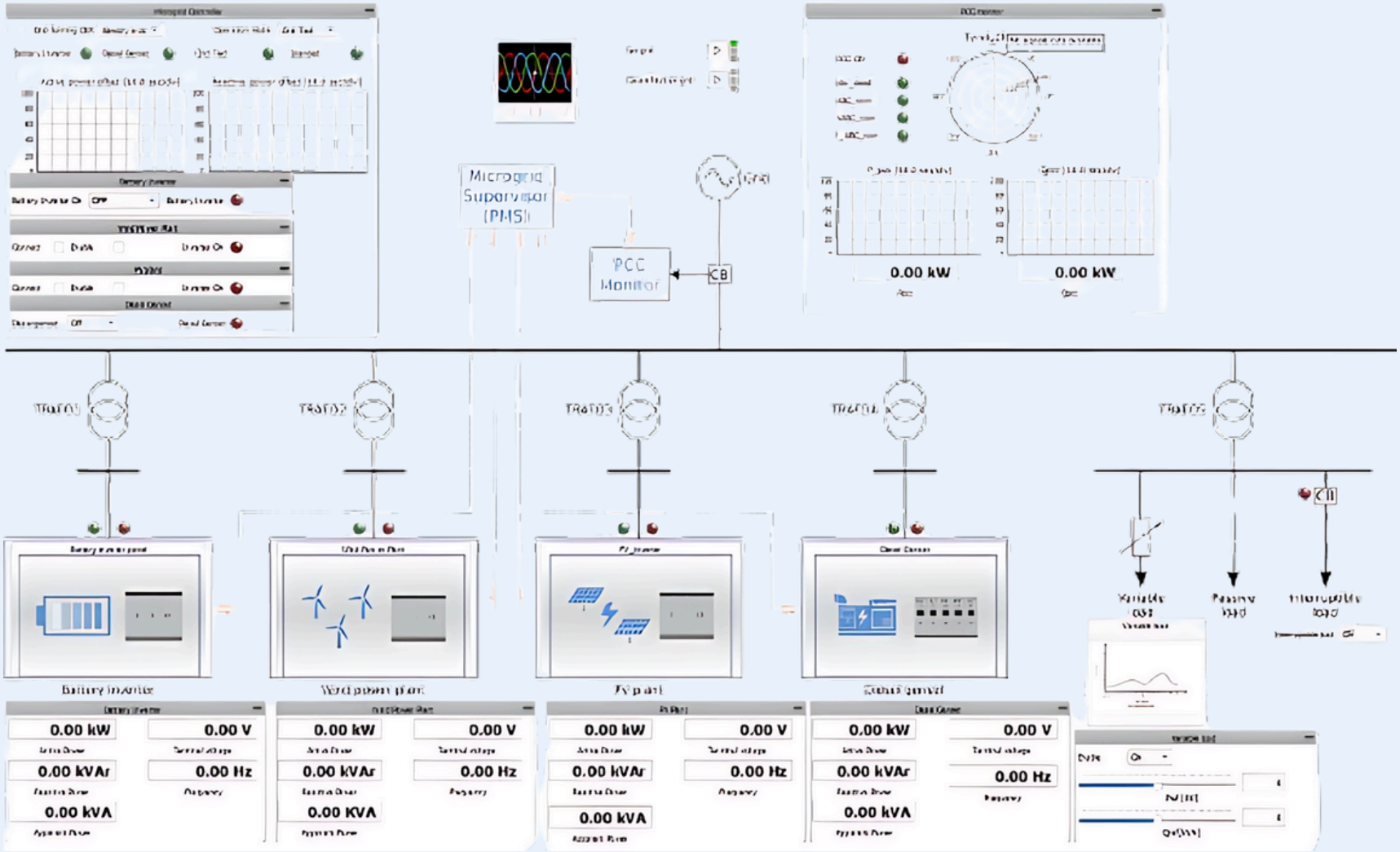
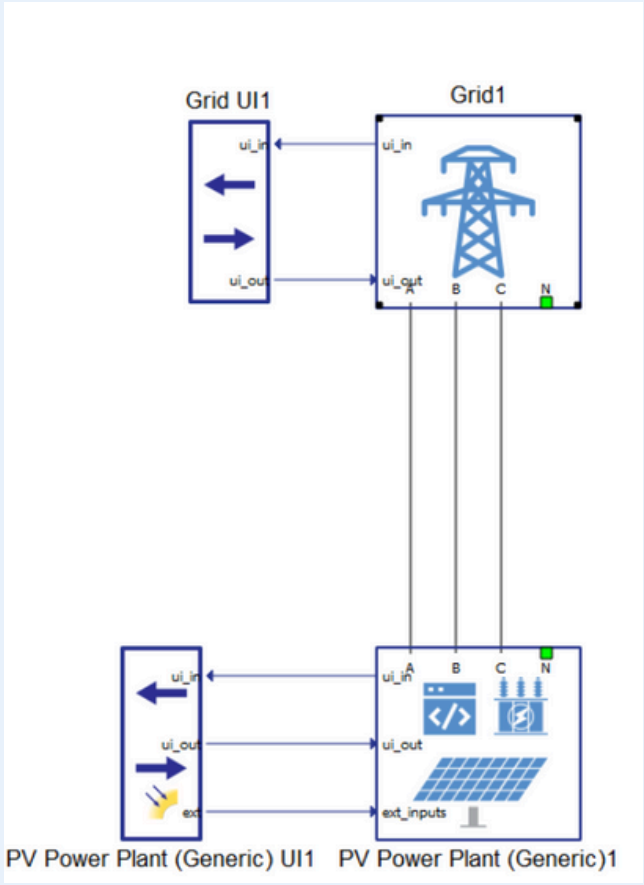
This application comes with a pre-built SCADA panel shown in Figure . It offers the most essential user interface elements (widgets) to monitor and interact with the simulation at runtime, allowing you to further customize it according to your needs.



Generic PV plant

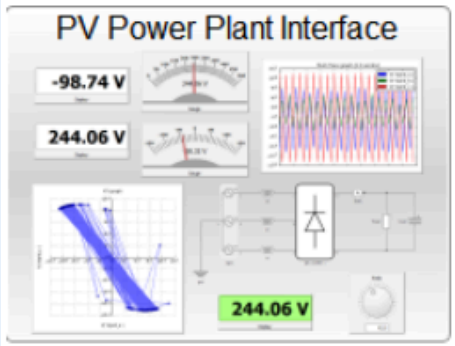


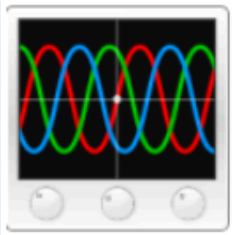
PV Power Plant (Generic)

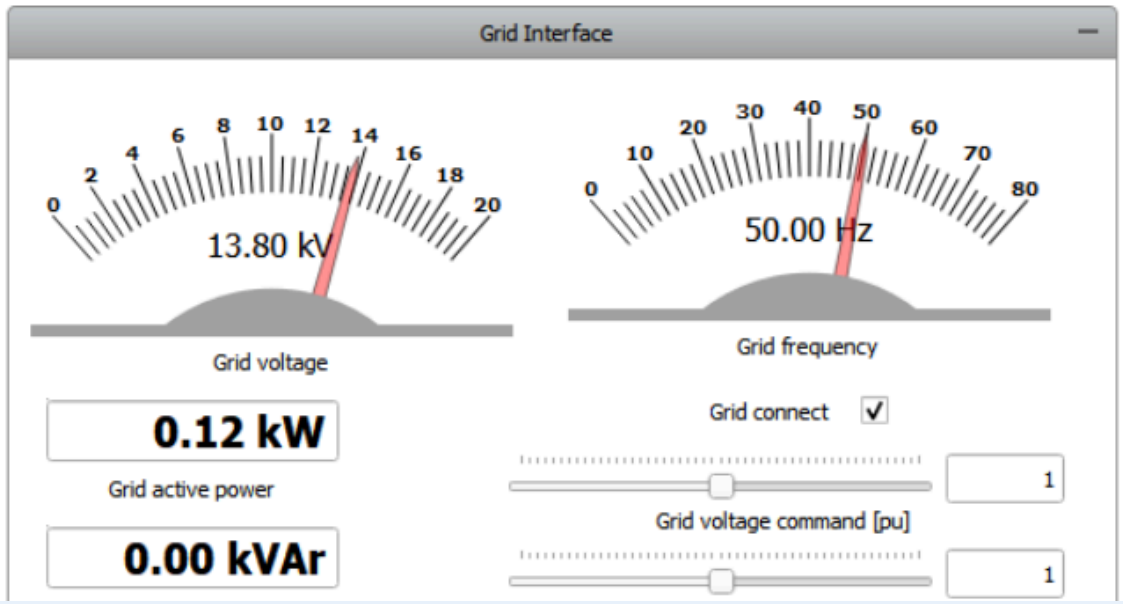
PV Power Plant Generic Model
Inputs and outputs are defined in the corresponding "PV Power Plant (Generic) UI" subsystem.

General	PV	Conv. Extras	Grid Extras

Nominal active power:	250e3	W
Nominal apparent power:	p.sqrt(2.0)*250e3	VA
Nominal converter line voltage:	400	V
Nominal grid line voltage:	13.8e3	V
Nominal frequency:	50	Hz







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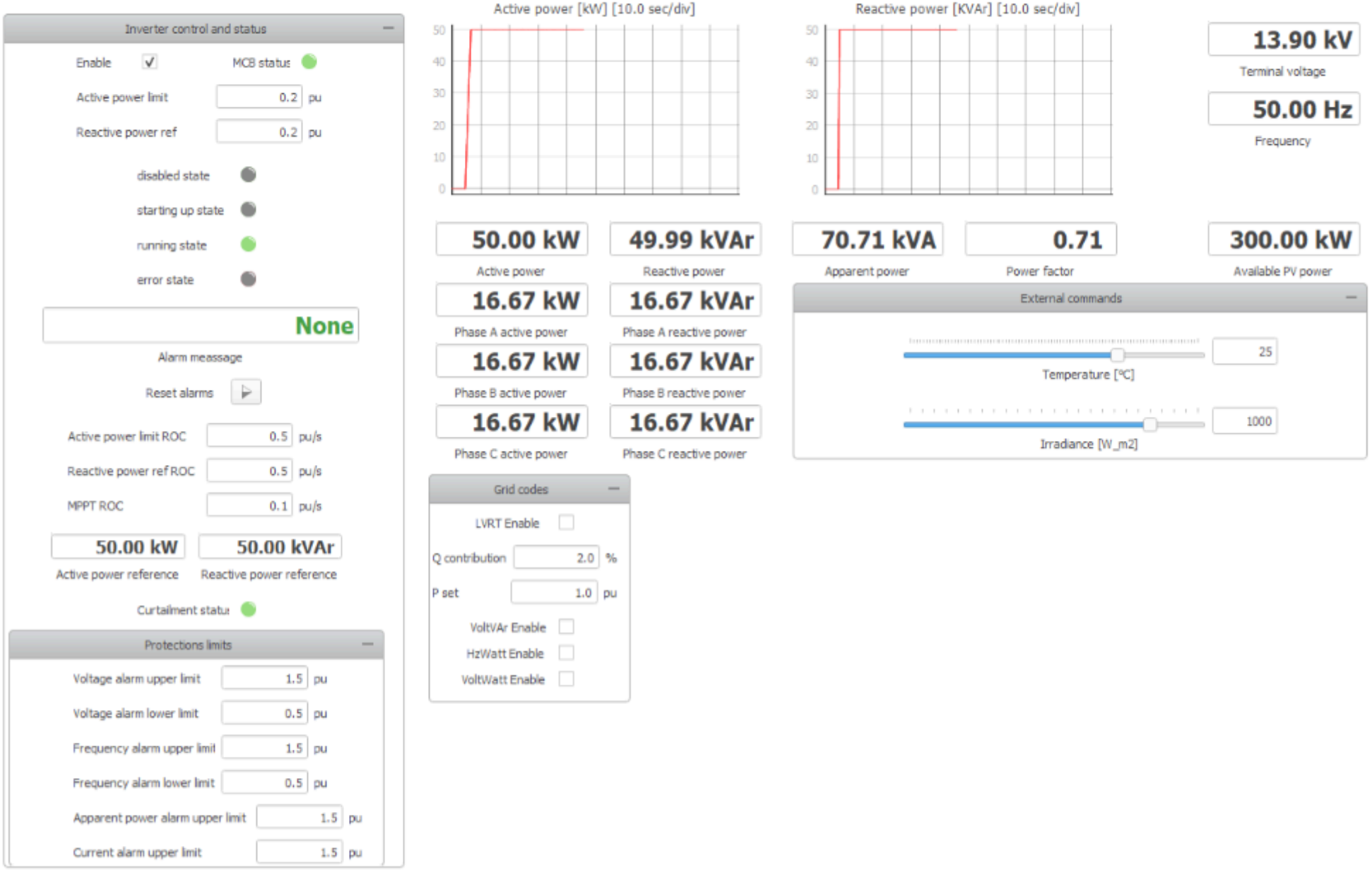
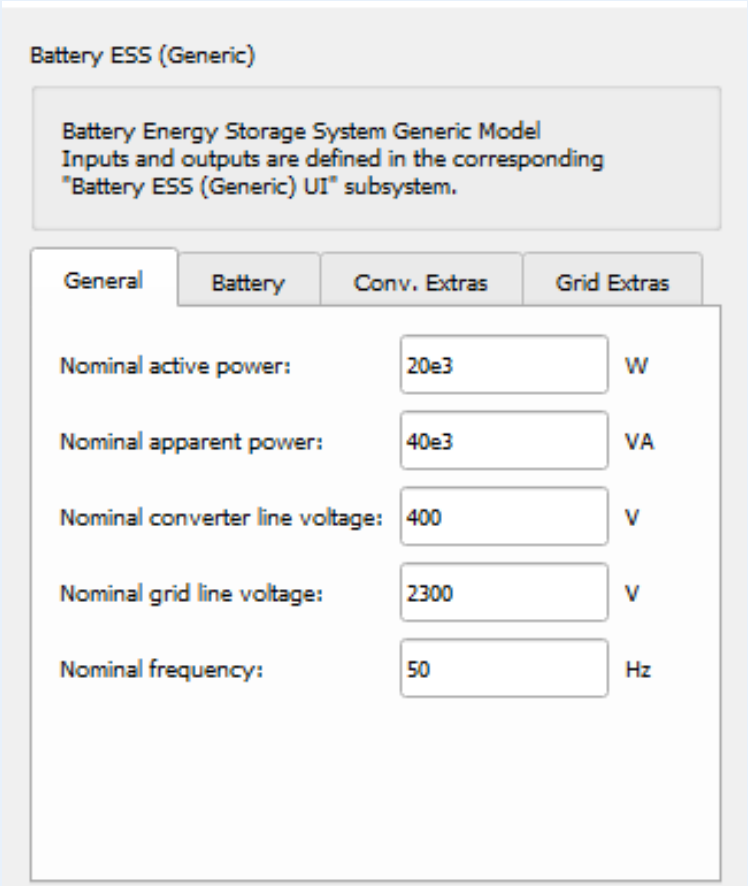
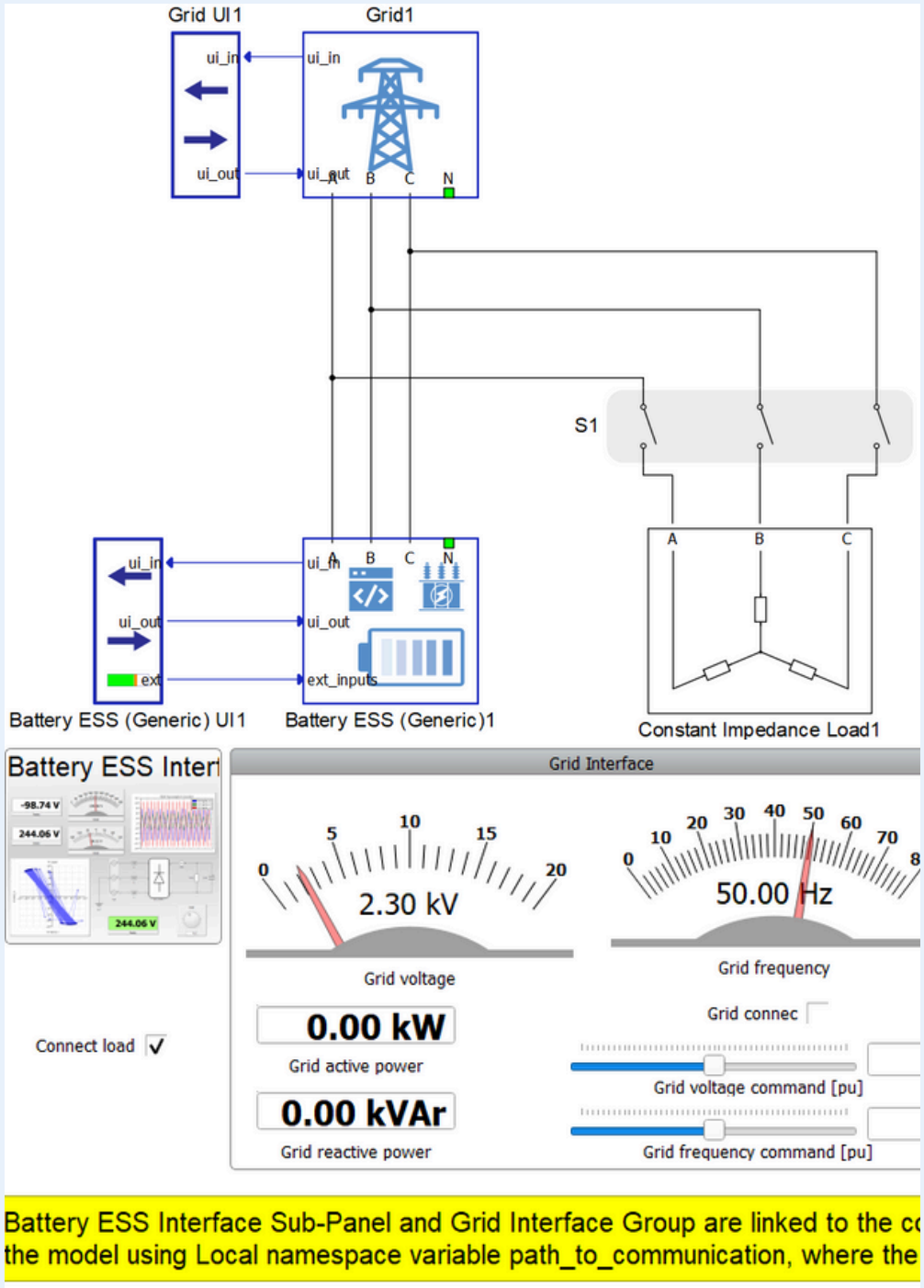
PV Power Plant Interface



Generic battery

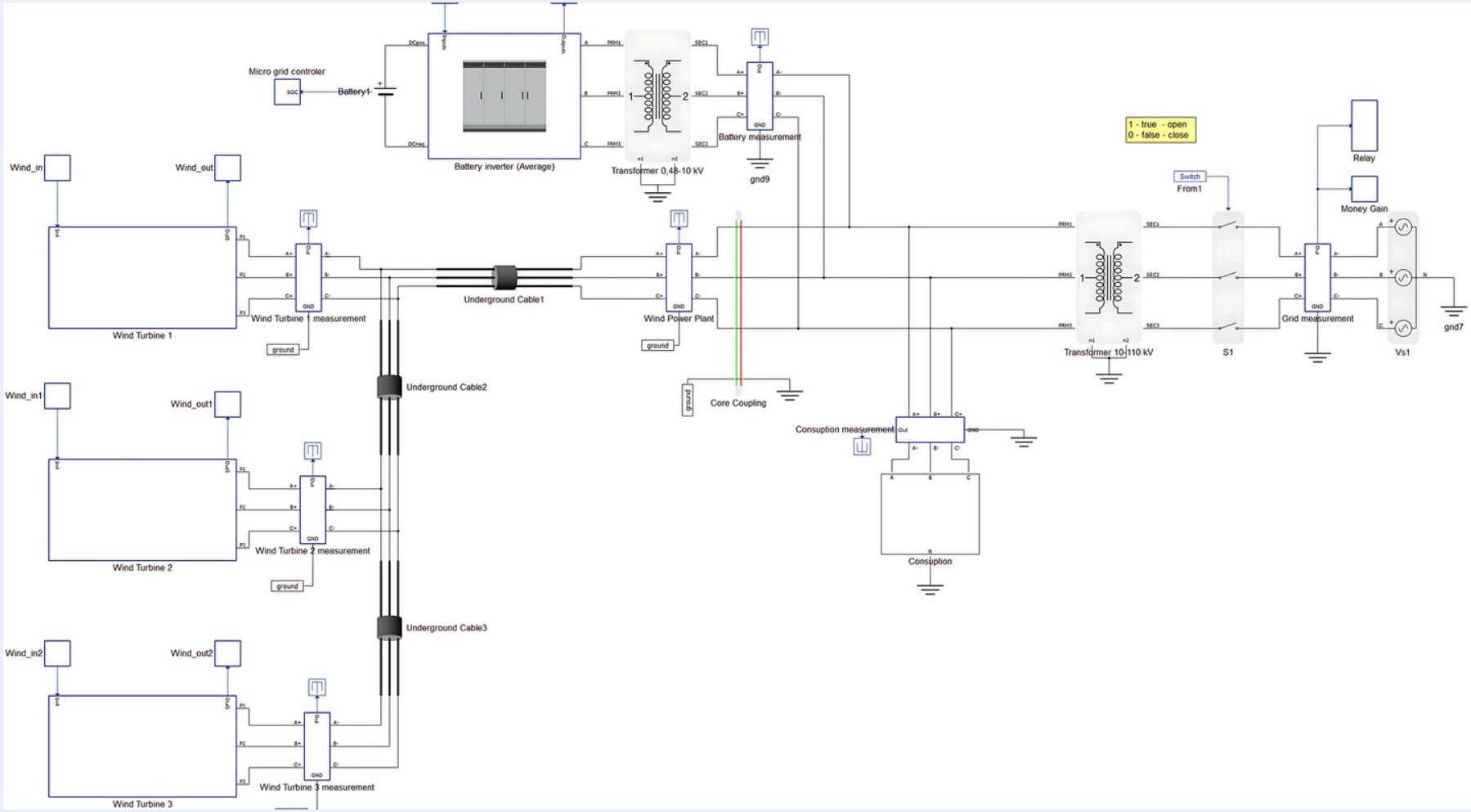
The model consists of a Battery EES (Generic) connected to the Grid with corresponding UI components and a passive load that can be connected or disconnected.



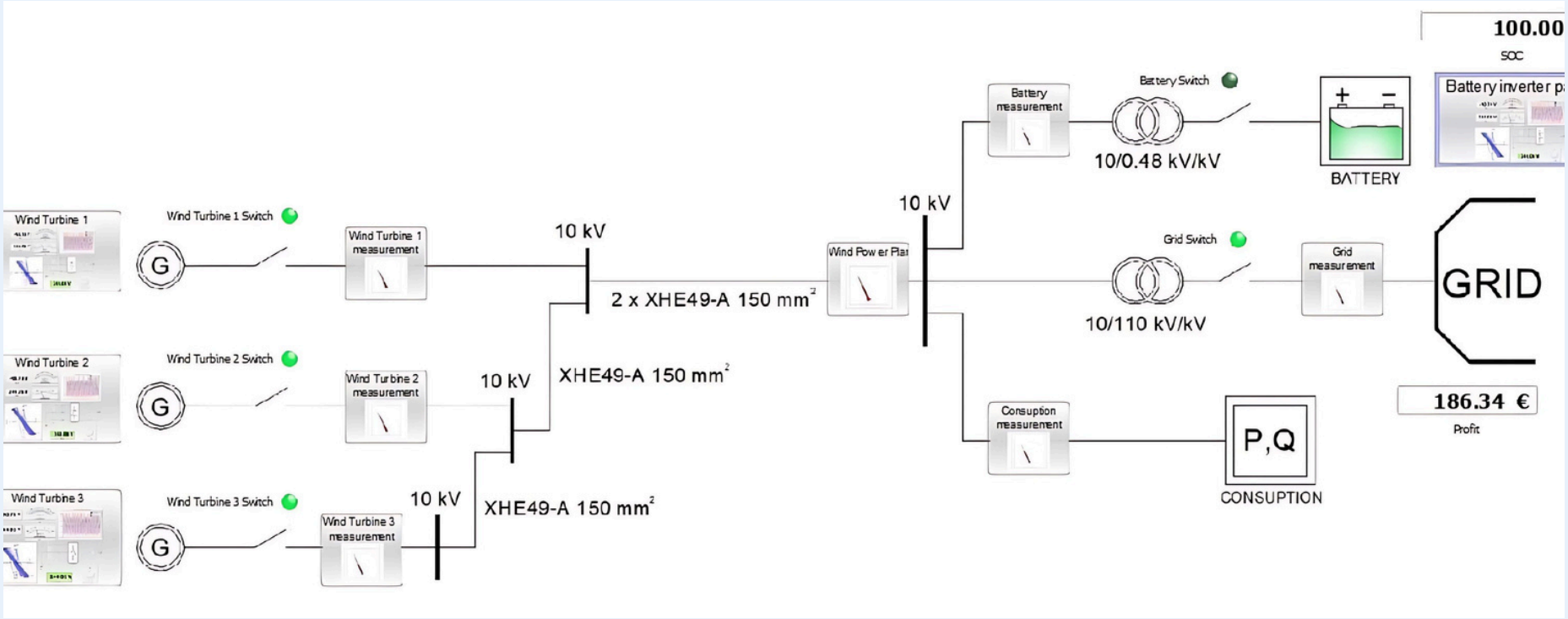


Microgrid powered by a wind farm

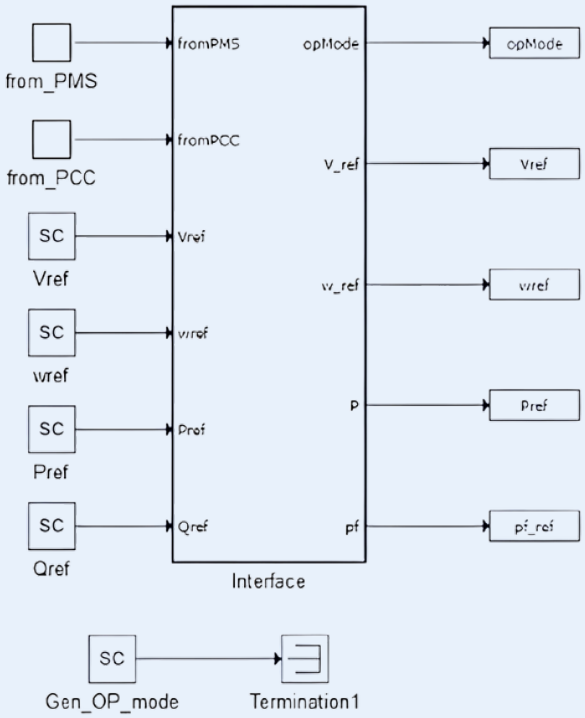
The microgrid model features a wind farm consisting of three wind turbines, with each turbine block consisting of a generator, transformer, inverter, control unit, and a switch.

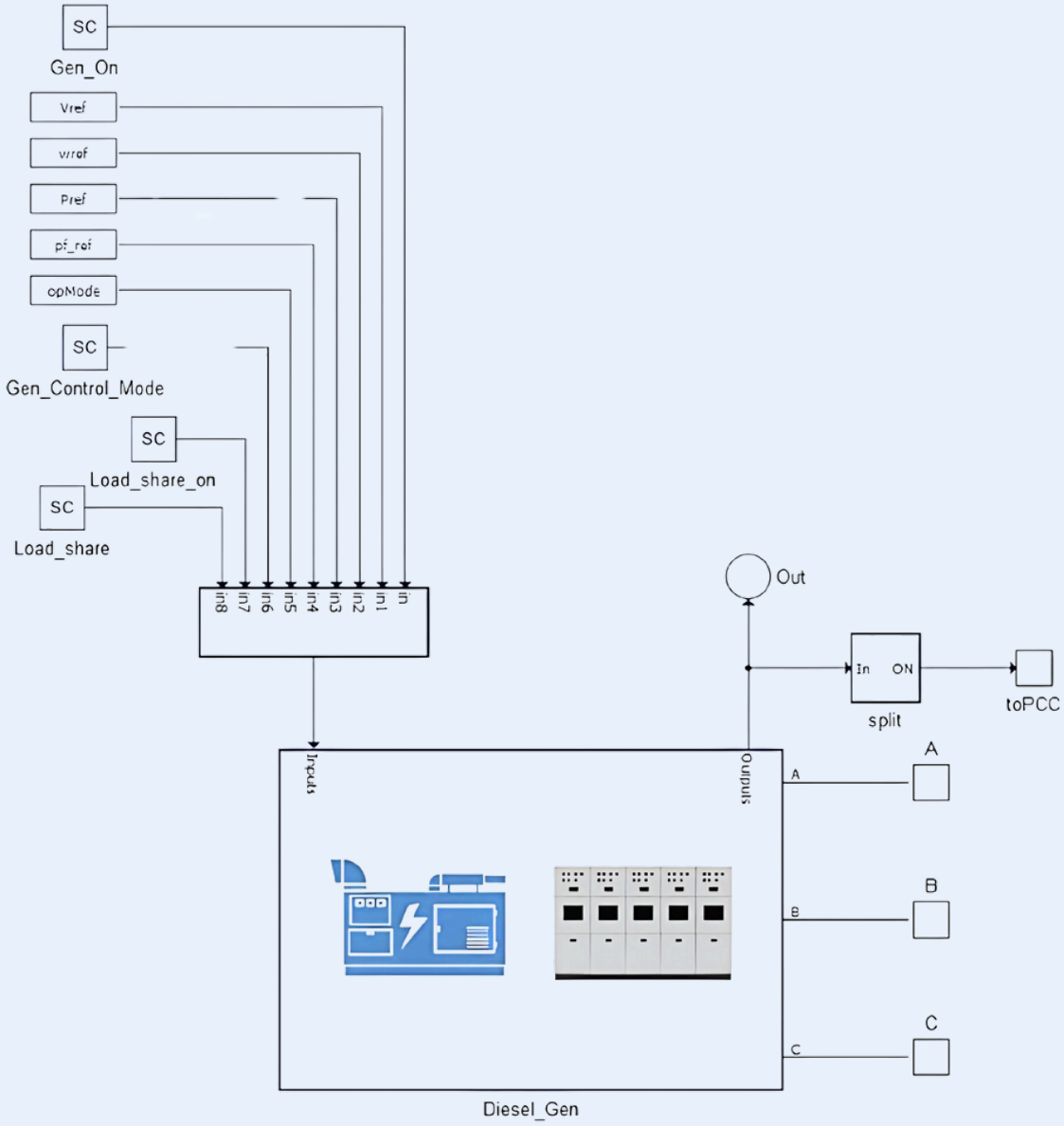


Application comes with a pre-built SCADA panel Figure. The panel offers most essential user interface elements (widgets) to monitor and interact with the simulation in runtime. You can customize it freely to fit your needs.



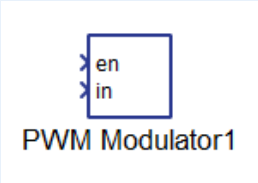
Diesel genset with a microgrid controller interface





Analog IOs and Digital IOs in Typhoon HIL

- Digital IOs Voltage levels: 0-5V, 16 bit
- Analog IOs Voltage Levels: +-10V, at 0.3mV Resolution,



PWM Modulator from library 'core'

Multi-channel PWM modulator with a symmetrical triangular carrier from 100 Hz up to 500 KHz and dead time generator. PWM modulator is based on a dedicated hardware unit and operates at the device's clock frequency.
Component outputs are available in digital signal map and can be individually routed to any of device's digital outputs at full time resolution.

General | Extras

Carrier:	Triangle	
Operation mode:	Fixed carrier frequency	
Carrier frequency (Hz):	10000.0	Hz
Phase operation mode:	Fixed carrier phase offset	
Carrier phase offset:	0.0	deg
Number of channels:	1	
Dead time period:	5e-6	s
Reference signal [min, max]:	[-1.0, 1.0]	Load mode: on min
Execution rate:	inherit	

Help | OK | Cancel

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POWER HIL (P-HIL)

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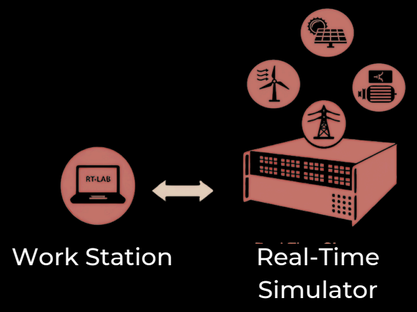
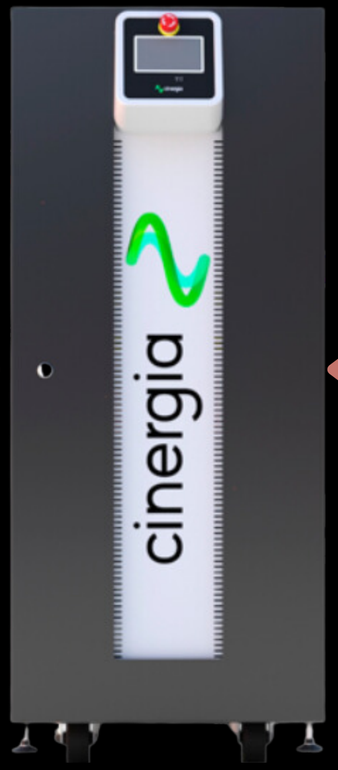
HARDWARE-IN-THE-LOOP

(LOW-POWER INTERFACE CASES)

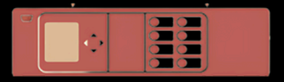
HIL or CIL (Controller-in-the-Loop) simulation is a real-time plant model (grid …) interfaced to a piece of hardware under test usually with low-power signal interfaces.



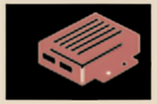
Real- Time Simulator



Power Amplifier



Relay with IEC 61850 …
Or +- 10V inputs



Motor drive
PV, Wind gen

HVDC
FACTS
uGRID

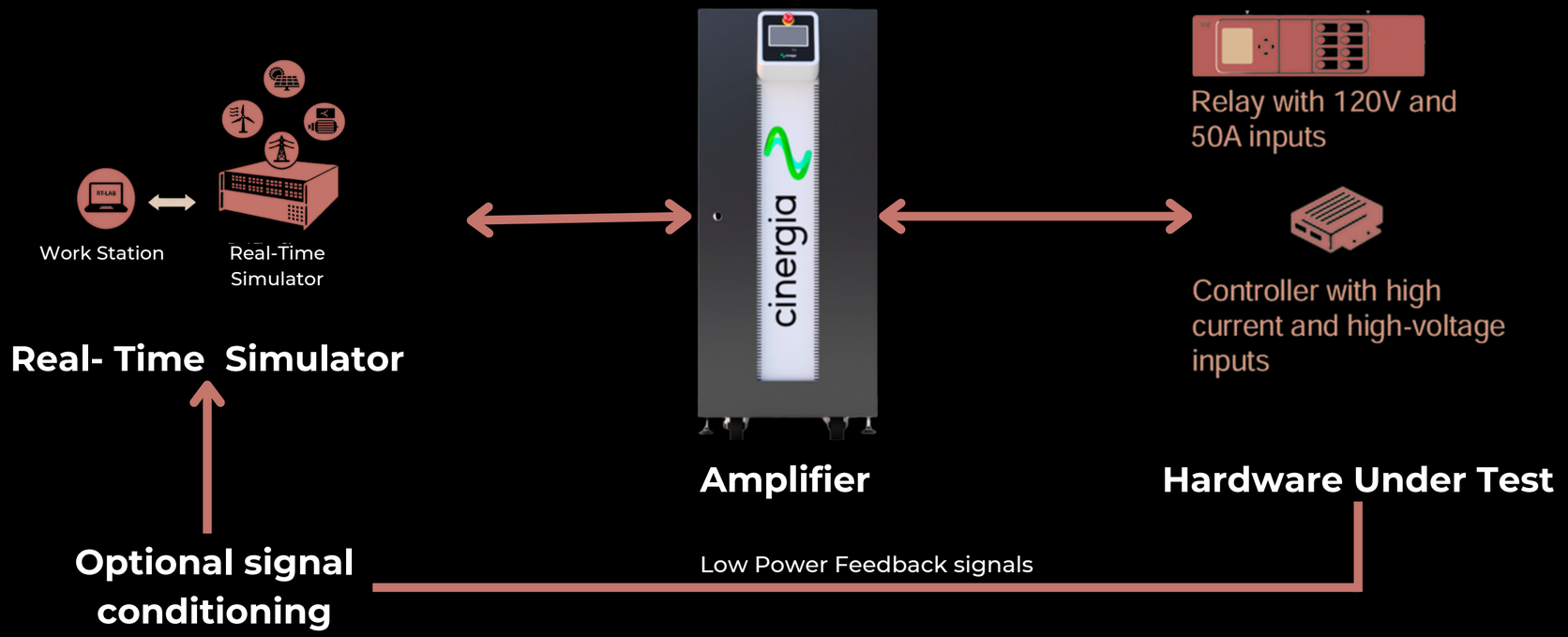
SCADA (SPS)

Hardware Under Test

HARDWARE-IN-THE-LOOP

(HIGH-POWER INTERFACE CASES)

In some cases, high-voltage and high current interfaces are required.



High-voltage, high-current, high-frequency and high-accuracy amplifiers are required to interface with some controllers and protection systems. The power rating is relatively low and the amplifier load does not influence the simulation.

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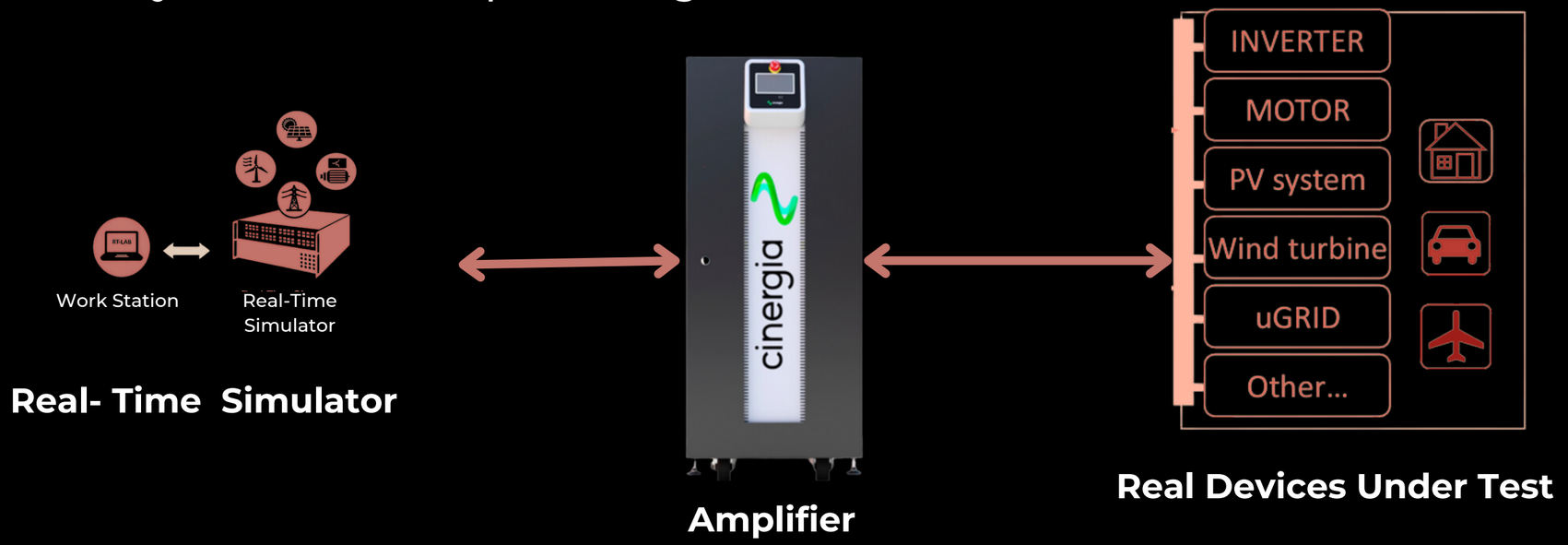
POWER HARDWARE-IN-THE-LOOP

PHIL simulation is the integrated simulation of a complete system with one part simulated numerically and the other part using real devices.



The amplifier must have the capability to feed the device under test and to absorb power generated by the devices.

The amplifier loads will influence the global simulation.

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POWER HARDWARE-IN-THE-LOOP (BENEFITS)

High-fidelity real-time power electronics and power system plant models combined with a quality amplifier can match the performance of a dynamometer or analog bench to achieve a 90% confidence-level that the system will perform as expected.

- **PHIL allows developers to test a wider range of characteristics than analog benches or dynos with less maintenance and setup time.**

Allowing robustness of the hardware under test over a wider variation of parameters, characteristics and faults.

- **In addition to interacting with the hardware, PHIL simulators are often used to simulate communication networks (CAN,DNP3, ARINC, 61850, others).**

Allowing Integration of multiple protocols/systems into a single system.

- **A PHIL simulator creates a robust, flexible, versatile, and reliable system.**

Allowing multiple experiments for multiple programs or research.

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PHIL APPLICATIONS

Grid Applications

- Grid Emulator
- Grid Load
- PV-Inverter Emulation
- Wind-Generator Emulation
- Grid Inverter Emulation

Microgrid Applications

- Motor Applications
- Motor / Generator Emulator
- Drive Inverter Emulator
- Frequency Inverter Emulator

Aerospace / Military

- 400 Hz Supply Grid Emulator
- DC-Supply Emulation
- 400 Hz Aerospace Device Emulator
- AC-DC Coupling Emulator

Automotive Applications

Electrical Drive Train Emulation

- Battery Emulator
- Drive Inverter Emulator
- Motor Emulator

evehicle applications

- eVehicle Charging Station Emulator
- Test Bench for Charging

Transportation

- Supply Grid Emulator
- Machine Emulator
- Inverter Emulator
- Electrical Drive-Train Emulation

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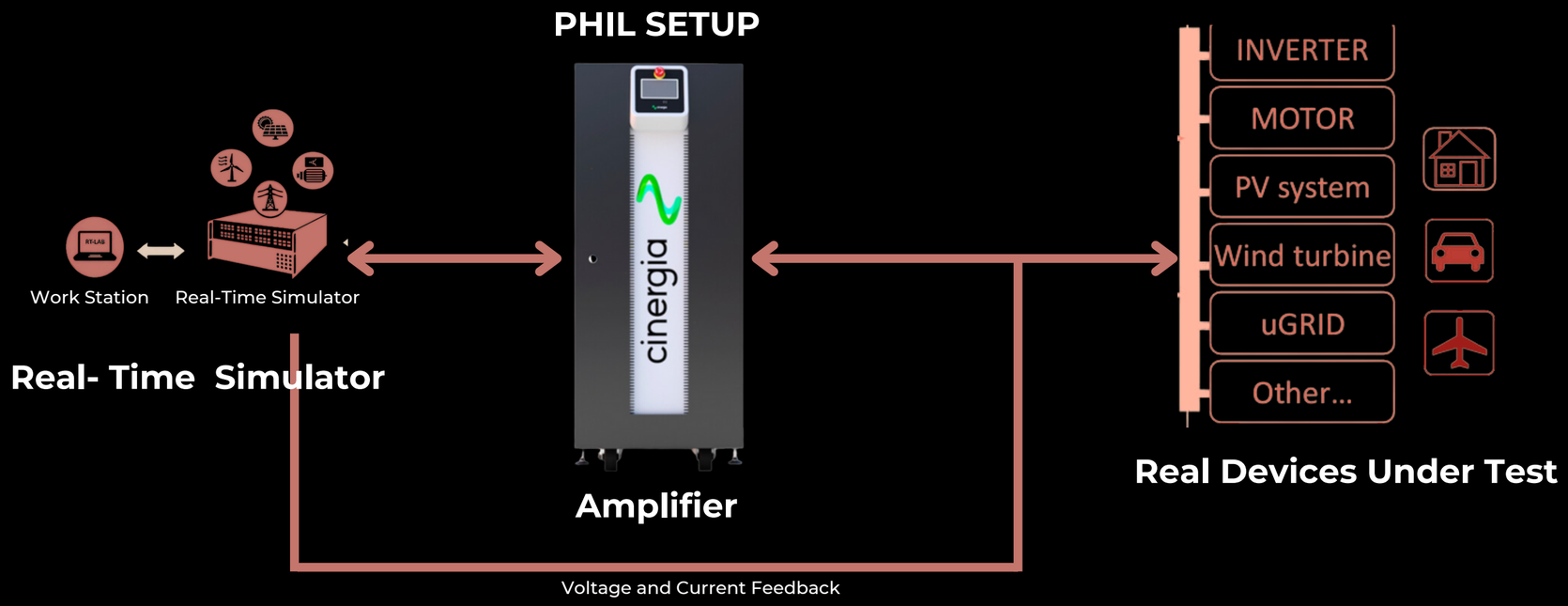
POWER HARDWARE-IN-THE-LOOP
AMPLIFIERS

For PHIL applications, simulators can be delivered with standard or custom amplifiers that meet the most demanding requirements with

- **Scalability: few hundred watts to Megawatt**
- **2Q (power generation) and 4Q mode (generation and absorption)**
- **High accuracy, low distortion and low phase lag**
- **Low or high bandwidth depending on the applications**



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APPLICATION VS AMPLIFIER TYPES

2Q Amplifier Generates Power :

- When simulating PV cells
- When simulating fuel-cells
- When output is connected to passive resistive loads (power factor close to 1)
- When output is connected to relays or controller with high-current inputs (HIL mode)

4Q Amplifier Generates and Absorbs Power:

- When driving active loads (ex. : motor/generator)
- When emulating a grid
- When emulating a load
- When emulating a battery (energy supply and charging mode)
- When connected to capacitive or inductive loads (low power factor)

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APPLICATION VS AMPLIFIER TYPES

AC AMPLIFIER: (monophase or triphase):

- When emulating a grid(4Q)
- When emulating AC motors(4Q)
- When connected to AC motors(4Q)
- When connected to AC/DC converters(4Q)
- When simulating a DC/AC controller(4Q)

DC AMPLIFIER:

- When simulating PV-cells(2Q)
- When simulating fuel-cells(2Q)
- When connected to DC/AC controllers(4Q)
- When simulating an AC/DC controllers(4Q)
- When simulating and/or connected to a battery(4Q)

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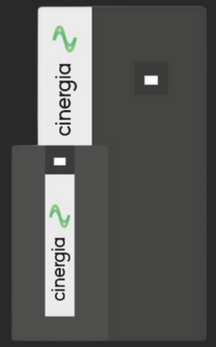
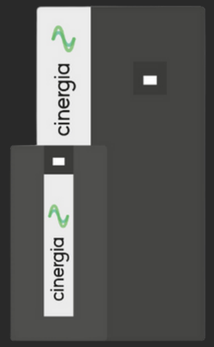
PRODUCTS THAT CAN BE USED FOR PHIL

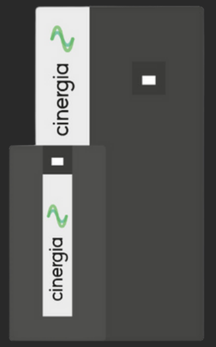
GE&ELvAC/DC
The All-Terrain AC/DC Regenerative Converter



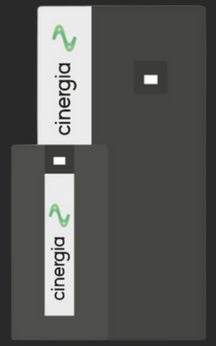
GE&EL+ vAC
The All-in-one AC Regenerative Converter



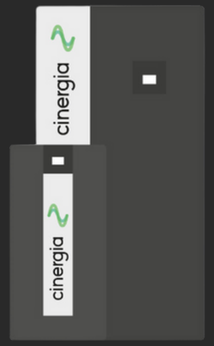
GE+ vAC/DC Full
Regenerative AC/DC Grid Simulator



EL+ vAC/DC Full
Regenerative AC/DC Electronic Load



B2C+
Regenerative DC Converter



GE&EL+ vAC/DC SiC
The All-Terrain AC/DC Regenerative Converter with Silicon Carbide Technology

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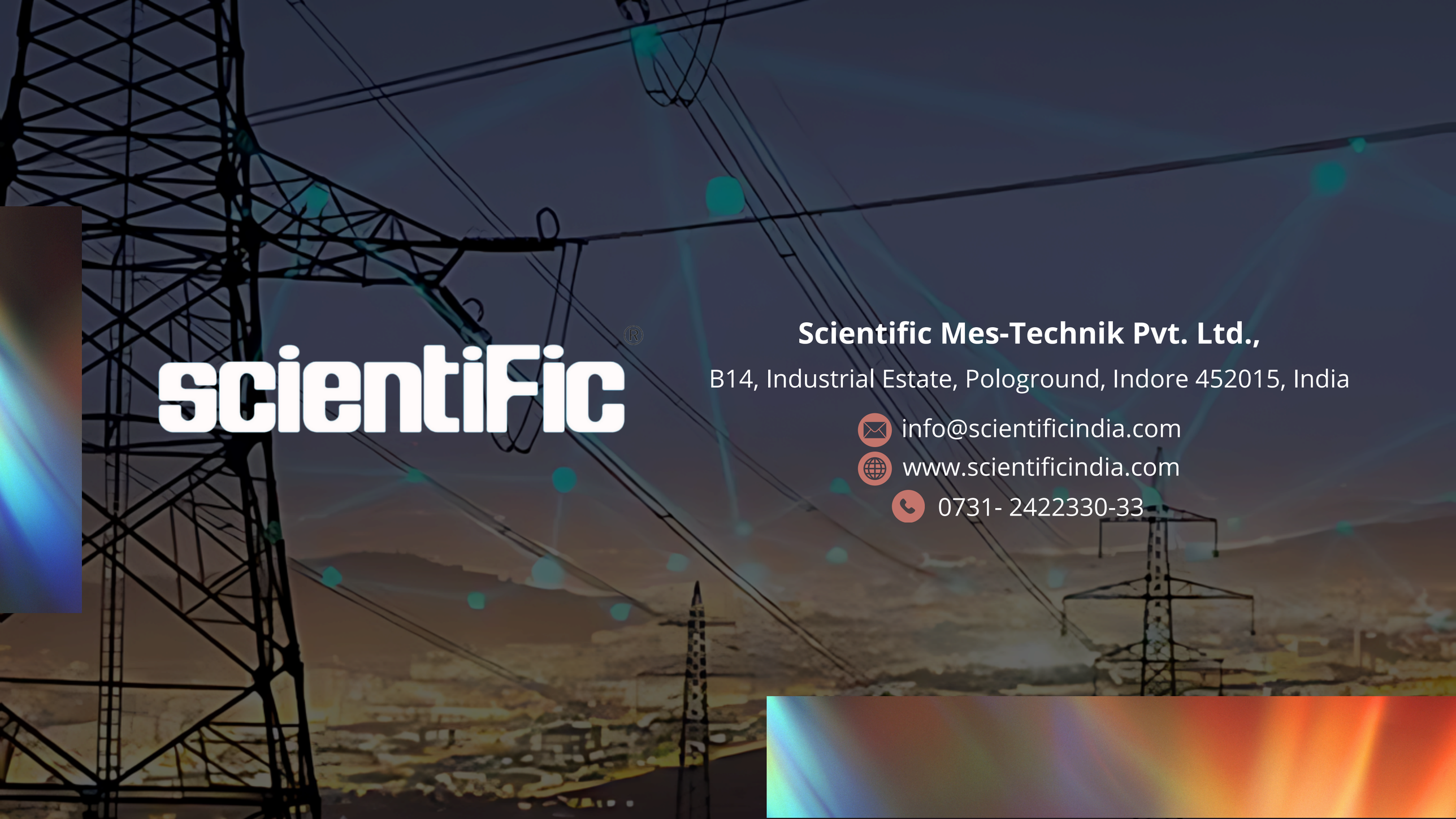
POWER RATINGS
GE+ VHIL

Reference	AC Power	AC Current	DC Power	DC Current	Weight	Dimensions
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



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