imperix

Modular power solutions

PROTOTYPING EQUIPMENT FOR POWER ELECTRONICS

"
Experiment on downscaled prototypes, while facing all the challenges of advanced converter control in realistic conditions

HIGH PERFORMANCE CONTROL
DEVELOPMENT AND TESTING

SOLUTIONS OVERVIEW

Speeding up power converter development and testing

OUR PROMISE

imperix products provide solutions for accelerating power converter research and development.

- Our blocksets for Simulink and PLECS enable the accurate simulation and pre-tuning of control algorithms.
- Test benches can be quickly assembled thanks to plug-and-play interfaces between our power modules and the controllers.
- Switching from a simulation environment to a real prototype can be done quickly, using multiple iterations if needed.
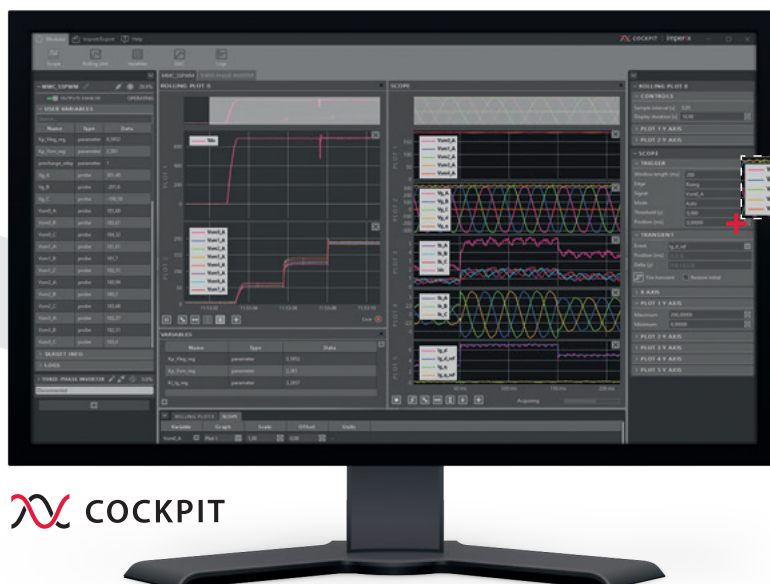
1 Run an offline simulation
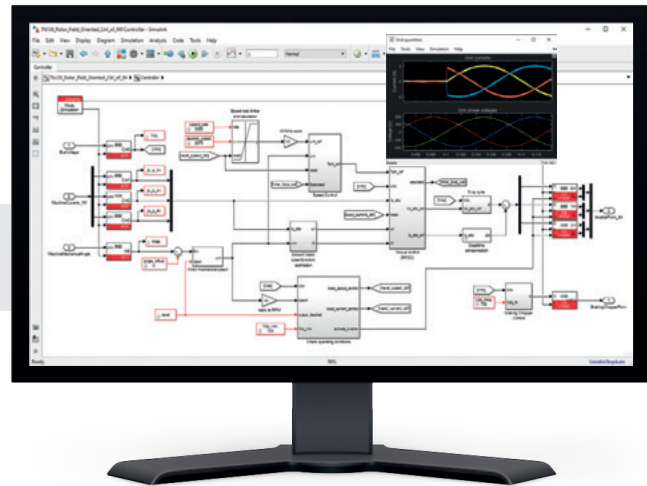
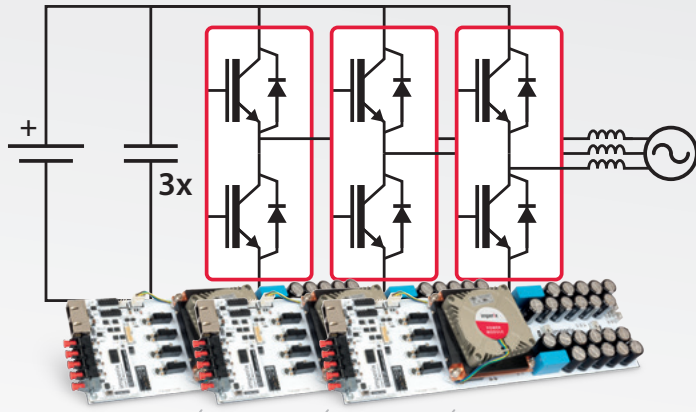
3 Generate the runtime code automatically

4 Operate the system and export results

⋈ COCKPIT

2

Build an
experimental setup

Optical fibers

Analog signals (RJ45 cables)

5

Efficiently document
your work

POWER CONVERTERS MADE OF STANDARD MODULES

Imperix power modules are building blocks for the rapid implementation of power converter prototypes. They are designed for use in research laboratories, where they facilitate the rapid development and experimental validation of various control techniques.

Accelerated control testing

Downscaled converter prototypes are often used to validate developments that were previously conducted using simulations. To this end, imperix modules are of great help as they can be quickly assembled and connected to imperix controllers.

Unlimited topologies

Thanks to the various internal topologies of the power modules and the multiple integration options, there are virtually no limitations to the range of power converters that can be implemented.

Modularity for scalability

The current and voltage ratings of the modules have been carefully selected to fit most laboratory environments. However, modules can also be used in parallel to increase the current rating, or in series (multilevel converters) to increase the blocking voltage. In both cases, systems up to about 100kW can be easily built using imperix modules.

POWER EQUIPMENT

A broad choice of building blocks for various types of applications

SEMICONDUCTOR POWER MODULES

The power electronic building blocks are the cornerstone of imperix power solutions. They are available as standalone products, or already integrated in racks or even complete systems. Although they embed no intelligence, they possess useful sensors and protections, to be used in coordination with a separate controller.
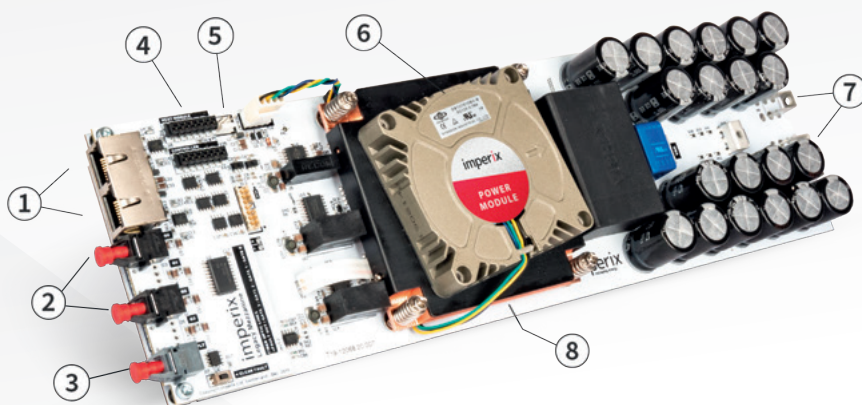
EMBEDDED FUNCTIONS

1 - V/I Sensors outputs (analog)
2 - Gate drivers inputs (optical)
3 - Fault feedback output
4 - Board-to-board link
5 - Power supply (5/12 V)
6 - Cooling fan (120 W)
7 - DC link power terminals
8 - Power switches (2x SiC MOSFETs)

PEB 8024 / 8038 SiC HALF-BRIDGE

- 800 V / 24 A or 800 V / 38 A
- Up to 8 kVA per module, up to 200 kHz f_{SW}
- Switching- (8024) or conduction-optmized (8038)
- V + I measurements, onboard protections

PEH 2015 / 4010 IGBT FULL-BRIDGE
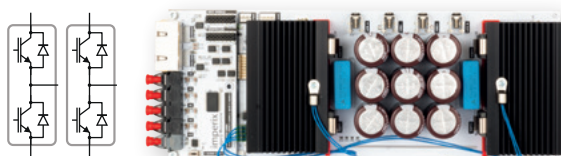
- 200 V / 15 A or 400 V / 10 A
- Up to 400 W per module, fanless design
- Usable in full- or half-bridge mode
- V + I measurements, onboard protections

PEB 4050 IGBT HALF-BRIDGE

- 400 V / 50 A
- Up to 8 kVA per module
- Up to 50 kHz hard switching
- V + I measurements, onboard protections

PEN 8018 NPC PHASE-LEG
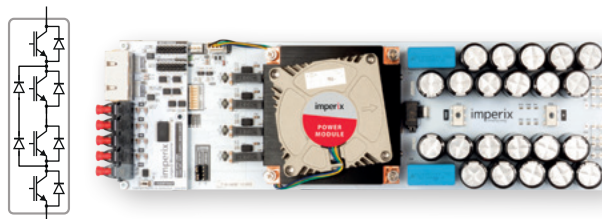
- 800 V / 18 A
- Up to 5 kVA per module
- Three-level NPC topology (I-type phase-leg)
- V + I measurements, onboard protections

MECHANICAL INTEGRATION OPTIONS

3U x 19'' CHASSIS

4U x 19'' ENCLOSURE

Imperix power modules are designed for easy assembly within 19" racks and cabinets. This offers an effective way to build reconfigurable systems.

Two rack-mounting options are possible: open chassis (left) for handy and affordable mounting, or closed racks (right) for sleeker and safer configurations.

ACCESSORIES
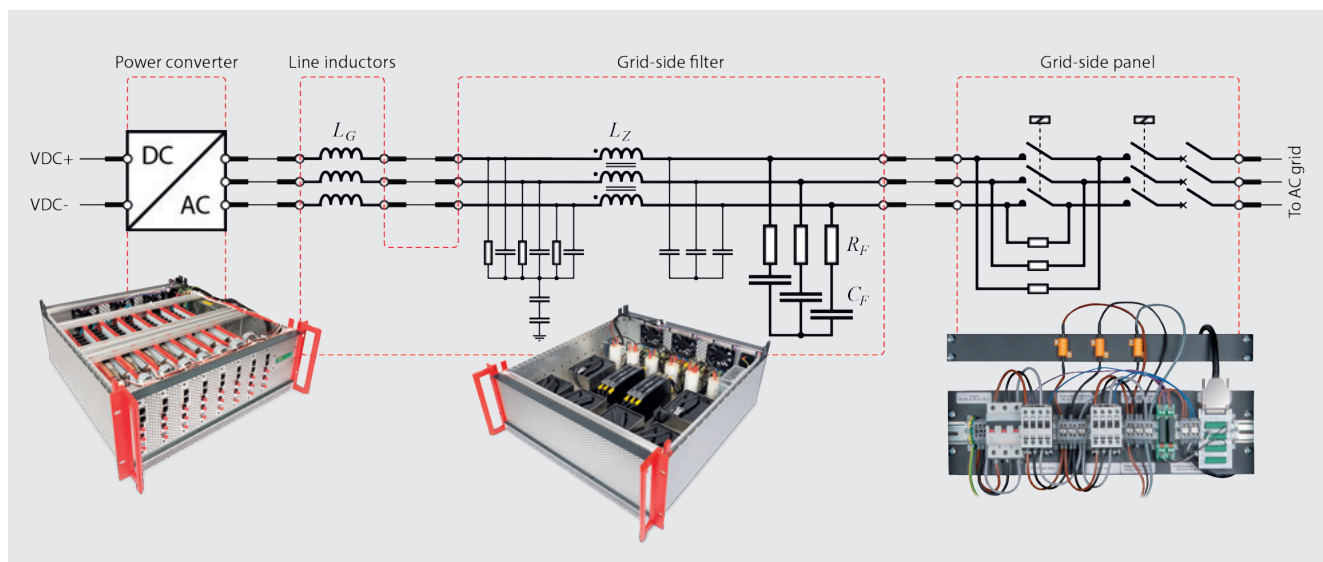
PASSIVE FILTERS

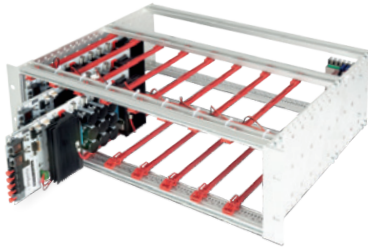The Passive Filters Box contains essential components for interfacing power converters with various types of loads. It is ideally suited for AC grid connection, but its versatility extends to DC or single-phase applications.

ELECTROTECHNICS

To enable safe connection of the power converter to the AC grid, the Grid Connection Panel provides the essential electromechanical components for protection, proper DC bus pre-charging, and controlled connection after synchronization.

SENSORS

In situation where measurements outside of the power modules are required, external voltage and current sensors are available. These sensors easily connect to imperix controllers, ensuring quick and simple setup.

WIRING SERVICES

The majority of power electronics applications can be covered with standard pre-configured bundles. For specific customer needs, imperix also provides tailored wiring and integration services, facilitating the commissioning of the system.
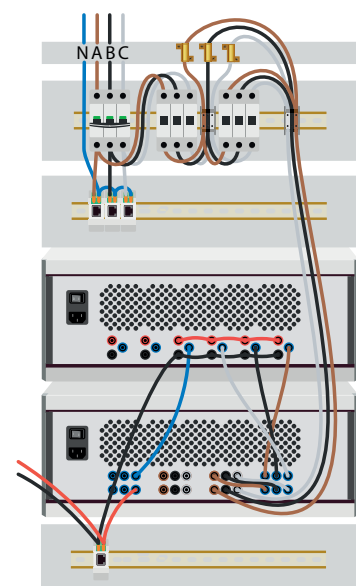
APPLICATIONS EXAMPLES

Flexible configurations for a broad range of needs and budgets

PV INVERTER

Grid-tied central inverter for photovoltaic application
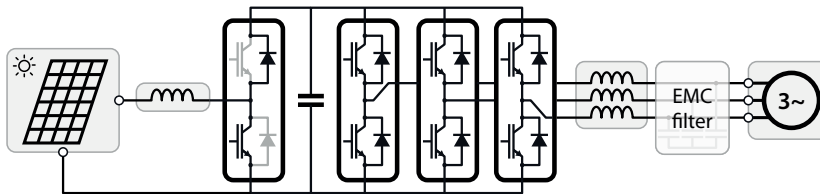
Research topics

- Cascaded voltage control
- MPPT algorithm
- PLL implementation
- Vector current control
- Grid voltage forming
- Islanding detection / prevention
- Inertia emulation

Work with a **real PV** panel and improve the realism of your setup!

Measure **real power** flows and evaluate efficiency!
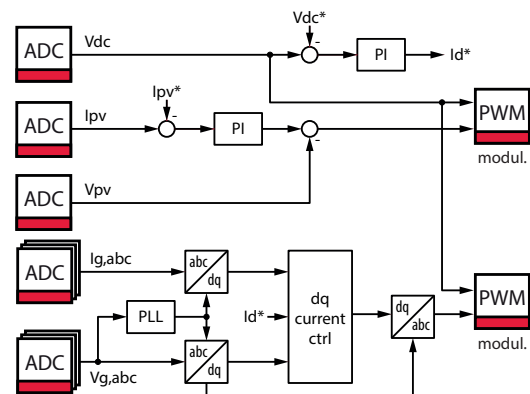
BATTERY CHARGER

Single-phase inverter with isolated DC/DC converter
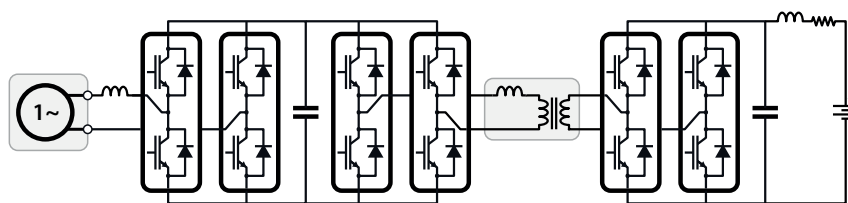
Research topics

- Modulation for DAB
- PR control
- Fictive axis emulation (FAE)
- Battery charging strategy
- BMS development
- Transformer design

Work with a **real** transformer and **real** batteries!

Measure **real power** flows and evaluate efficiency!

KITS & BUNDLES

Flexible configurations for a broad range of needs and budgets

STARTER KIT

* HARDWARE + SOFTWARE

- Desktop converter controller (B-Box Micro)
- Control development tools for Simulink and PLECS (ACG SDK)
- 4x phase-leg modules (PEB8038)
- 4x voltage sensors

————————————— OPTIONS —————

- Different power modules

LITE KIT

* HARDWARE + SOFTWARE

- Programmable controller (B-Box RCP)
- Control development tools for Simulink and PLECS (ACG SDK)
- 6x phase-leg modules (PEB8038)
- 6x voltage sensors

————————————— OPTIONS —————

- Different power inverter modules

INVERTER KIT

* HARDWARE + SOFTWARE

- Programmable inverter (TPI8032)
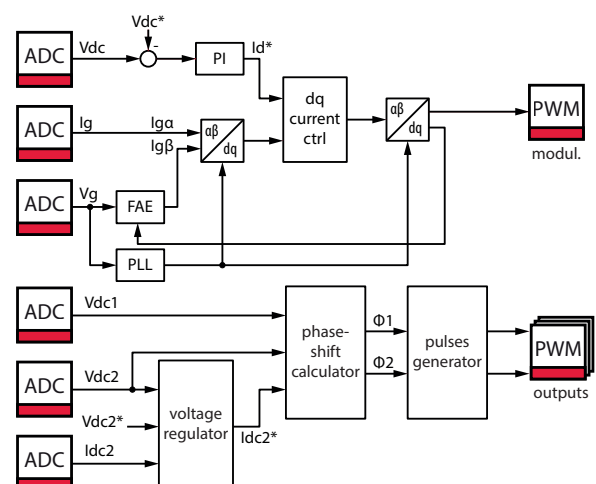- Control development tools for Simulink and PLECS (ACG SDK)
- Bidirectional DC power supply (800V, 6kW)

————————————— OPTIONS —————

- 12kW or 18kW bidirectional DC power supply
- Isolation transformer

POWER ELECTRONICS BUNDLE

* HARDWARE + SOFTWARE

- Programmable controller (B-Box RCP)
- Control development tools for Simulink and PLECS (ACG SDK)
- 6x phase-leg modules (PEB8038)
- Passives filters box
- Grid-side panel
- 6x voltage sensors
- 4x current sensors

————————————— OPTIONS —————

- Phase-leg modules (PEB4050) for 110VAC operation
- Fast-switching modules (PEB8024) for up to 200 kHz switching frequency

MMC BUNDLE

* HARDWARE + SOFTWARE

- 3x Programmable controller (B-Box RCP)
- Software tools for Simulink and PLECS
- 24x full bridge submodule (PEH2015)
- 6x inductors
- Grid-side panel
- 4x voltage sensors
- 6x current sensors

————————————— OPTIONS —————

- Phase-leg modules (PEB4050) for increased power

MOTOR TESTBENCH

* HARDWARE + SOFTWARE

- Programmable controller (B-Box RCP)
- Software tools for Simulink and PLECS
- Motor Interface for B-Box RCP
- 6x phase-leg modules (PEB8038)
- DC source
- Induction machine (Motor Testbench)
- Synchronous machine (Motor Testbench)

————————————— OPTIONS —————

- NPC modules (PEN8018) for three-level converters

ELECTRIC MOTOR DRIVE BUNDLE

A turnkey test bench for flexible motor control validation

B-BOX RCP CONTROLLERS

- 16x analog inputs, 16x fiber optic outputs, 8/8x digital I/O, CAN
- Hardware protections
- 1 GHz dual-core processor
- Up to 500 kHz sampling

POWER CONVERTER(S)

- Reconfigurable topology
- 6x half-bridge power modules

MOTOR INTERFACE

- 8x position sensor interfaces
- 2x temperature sensor interfaces
- 1x torque sensor interface
- 1x 24V brake command

REVERSIBLE DC SOURCE

- Up to 800V
- Up to 25A

SYNCHRONOUS MACHINE

- Permanent magnet design
- 4kW nominal power
- 400V / 1800rpm
- 1x temperature sensor
- 1x resolver
- 1x brake

INDUCTION MACHINE

- Squirrel cage design
- 4kW nominal power
- 380V / 50Hz or 460V / 60Hz
- 1x temperature sensor

With two coupled motors, it is often convenient to have one device under study, while the other one is controlled to emulate the environment (such as road, wind, and recover energy).

Since the two machines are of different types, it may also be interesting to swap roles so that the changes brought to the control algorithms can be compared and evaluated.

In order to compare the mechanical and electrical quantities, the provided torque and speed sensors may be useful. This also applies when working on estimators or sensorless techniques.

MODULAR MULTILEVEL CONVERTER BUNDLE

A modular multilevel converter at the size of the laboratory

GRID CONNECTION PANEL

- 1x 10A (type C) circuit breaker (3-phase)
- 1x Controllable relay (3-phase)
- 3x Precharge resistors (47ohm), with 1x bypass relay
- 2x Auxiliary solid-state relays
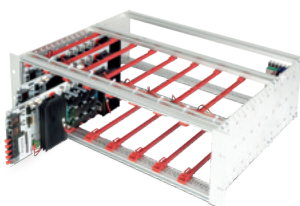- 1x VHDCI adapter and cable

B-BOX RCP CONTROLLERS

- 16x analog inputs, 16x fiber optic outputs, 8/8x digital I/O, CAN
- Hardware protections
- 1 GHz dual-core processor
- Up to 500 kHz sampling

AC VOLTAGE SENSORS

ARM CURRENTS SENSORS

POWER MODULES

- Reconfigurable topology
- 3x open chassis with 24x PEH2015

ARM INDUCTORS

- 6x inductors (2.4mH, 20A)

PEH modules can be (re)configured either as half bridges or full bridges by a simple change of connections. This enables using the MMC bundle for direct AC/AC converters, or working on DC faults blocking.

The same equipment can be used for prototyping solid state transformers or other similar topologies based on cascaded H bridges. Multilevel STATCOMs are one of such examples.

Variants of the MMC bundle can be built upon request, such as using optical interfaces for a larger number of fibers, or involving PEB4050 modules for higher power ratings.

ALL-IN-ONE PROGRAMMABLE INVERTER

The reliable support for grid-connected converter testing

TPI8032 – POWER AND CONTROL COMBINED

The programmable inverter is an all-in-one system combining a 22 kW DC/AC power stage and the same high-performance controller as in the B-Box RCP in a compact chassis.

Thanks to the tight integration between the control and power stages, users benefit from a fully ready and easy-to-use solution for prototyping with grid-tie converters.

POWER CONNECTIVITY
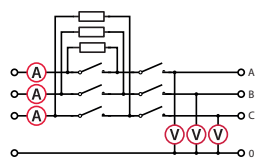
Includes all the necessary equipment for the safe and seamless connection to the three-phase AC grid.
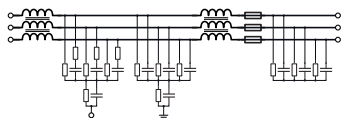
- AC precharge circuit
- 3x voltage sensors
- 3x current sensors

SIGNAL CONNECTIVITY

Digital and analog I/Os are available at the rear of the enclosure to extend the capabilities of the programmable inverter.
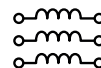
- 8x GPOs
- 8x GPIs
- 4x Analog inputs
- CAN communication
- Electrical interlock

EMC FILTERS

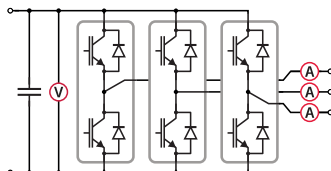Reduces the electromagnetic interferences generated on the AC side of the converter.

MAIN INDUCTORS

The main inductors are essential to the current control.
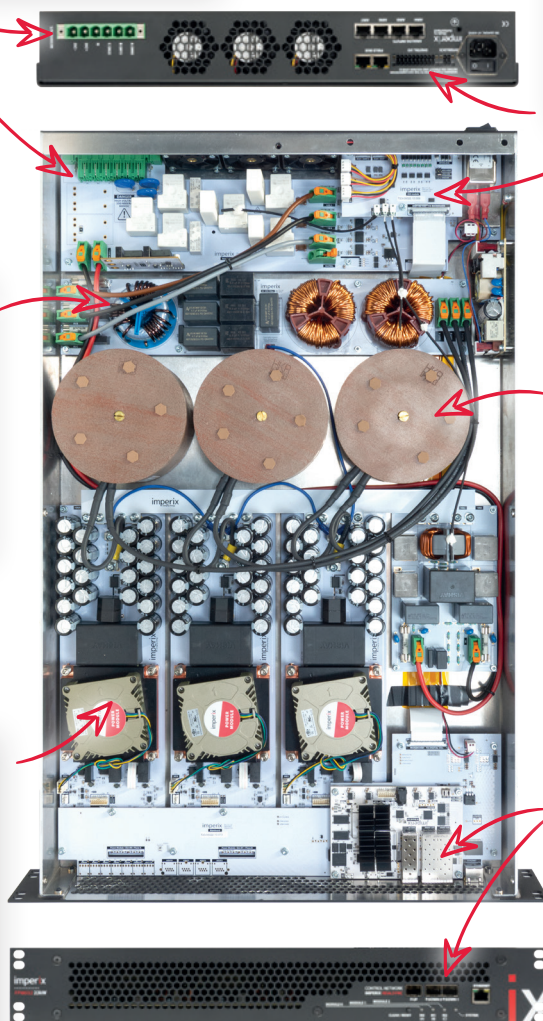
- 3x 1mH/32A

POWER MODULES

The inverter uses three half-bridges with a common DC bus.

- Up to 800 VDC
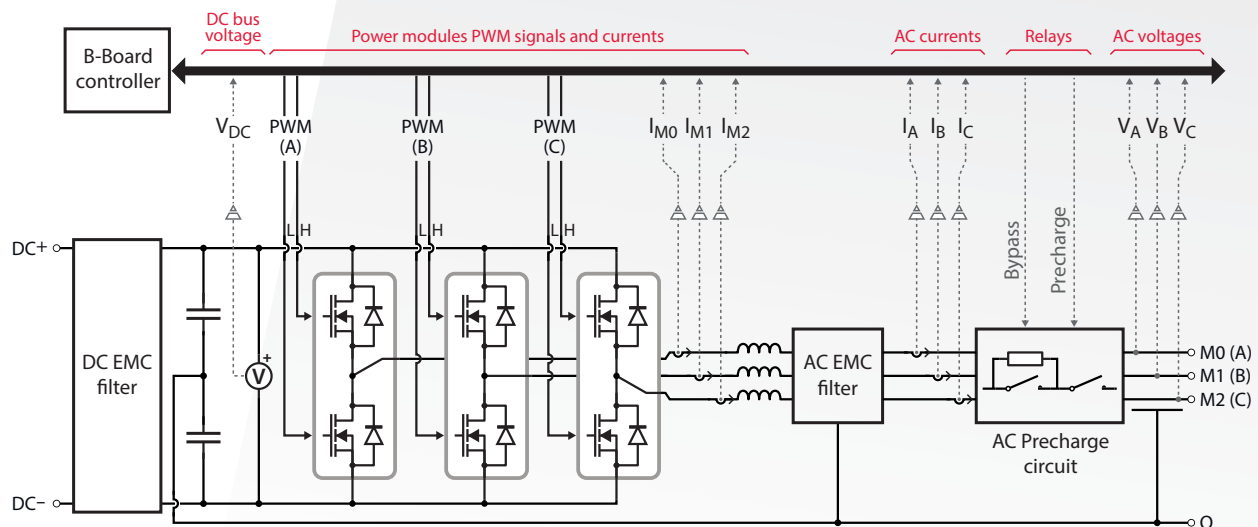- Up to 32 A (RMS) at 50 kHz
- SiC MOSFETs

EMBEDDED CONTROLLER

The B-Board PRO brings the exact same capabilities to the TPI8032 as on the B-Box family of controllers.

- Fast control execution
- Automated code generation
- Offline simulation and tuning
- User-editable FPGA area

READY FOR THE GRID

LC AND EMC FILTERS

Thanks to a comprehensive filtering solution, the TPI8032 ensures excellent power quality, with sinusoidal output voltages and currents, compliant with the CISPR11 EMC standard.

AC PRECHARGE CIRCUIT

The precharge of the DC bus can be fully automated. Furthermore, the relay control is implemented such that inadequate connection and uncontrollable currents flows are prevented.

SOA PROTECTIONS

FPGA-based protections ensure that the safe operating area (SOA) is respected at all times, and safely block the power stage in case of hazardous behavior, including during fast transients.

INTEGRATING DISTRIBUTED ENERGY RESOURCES
INTO A SMART GRID

RESEARCH TOPIC EXAMPLES

- Droop control
- Virtual inertia
- Low voltage ride-through
- Anti-islanding
- Frequency-watt control
- Volt/VAR curves
- Synchrophasor estimation
- Virtual power plant
- Decentralized control
- Load shifting
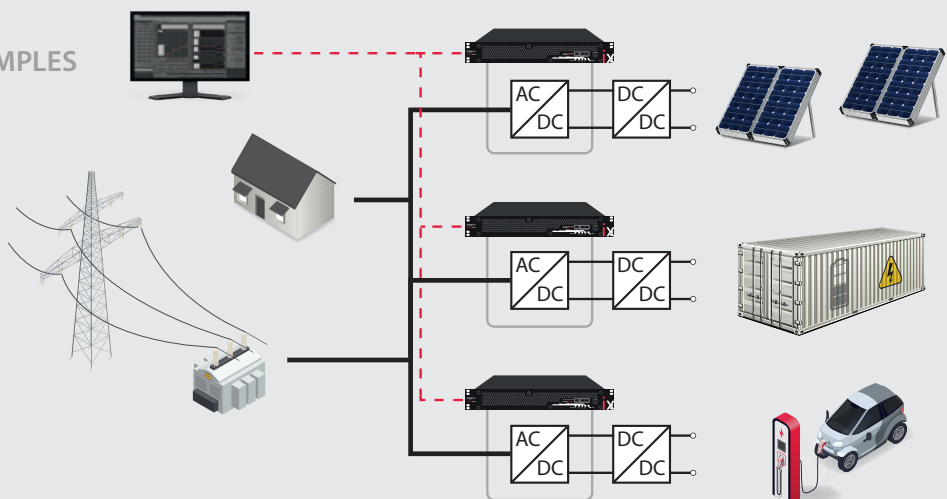
APPLICATION EXAMPLES

The knowledge base gathers numerous technical articles as well as product-related documentation, which is available free of charge.

imperix.com/doc/

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