B-Board PRO
EMBEDDABLE CONTROLLER

"The B-Board PRO is an advanced controller designed for series-manufactured products."
Accurate simulations are guaranteed, thanks to a perfect functional equivalence between B-Box RCP and B-Board PRO, as well as to a precise modeling of the discrete-time control during simulation.

Instant switchover between simulation and experimentation is possible in just one click. This allows to move very quickly to the lab, or even work iteratively to improve the simulation model.

Early experimentation is possible, thanks to the software-independent protections of the B-Box RCP. This enables to identify potential challenges early and mitigate implementation risks.

No controller tuning is ever needed thanks to the seamless transition between the simulation and the real world. The same also applies between B-Box RCP and B-Board PRO, which are 100% bitfile-compatible.
FROM THE LAB TO THE FIELD!
MIGRATE EASILY TO B-BOARD PRO

What if you could simply take the result of your research and put it into an affordable controller, directly embedded inside your own products?

DEVELOPMENT PHASE
- Flexible hardware
- Rapid control validation

PRODUCTION PHASE
- Cost-optimized hardware
- Pre-validated control

FULL BITFILE COMPATIBILITY!

B-Box RCP
Prototyping controller

The exact compatibility between B-Box RCP and B-Board PRO allows to benefit from the increased flexibility of the prototyping controller during developments, while using a lower-cost product-embeddable variant during series production.

MAINTENANCE
LET US TAKE CARE OF THE MAINTENANCE OF YOUR CONTROL SOLUTION!

Digital control electronics suffer from a shorter life cycle than their associated power stages. This may be challenging for companies that have limited resources devoted to their maintenance. The same remark also holds to the software development tools. Relying on imperix’s solutions avoids this burden and guarantees to work with up-to-date hardware and software at all times, for both prototyping and embeddable solutions. Thanks to a strict abstraction from the hardware resources and strong retro-compatibility guidelines, imperix also guarantees that any control code will still work on future equipment.
DEVICE DESCRIPTION

The B-Board PRO is a small piggy-back board meant to be assembled within a larger control system. It embeds the essential and application-independent part of a converter controller, hence without extensive signal conditioning.

SMALL FORM FACTOR

Despite its numerous I/Os, the B-Board PRO measures only 86x124 mm. This is small enough to be assembled in most industrial control systems. It also fits within a headroom of 22 mm only!

TAILOR-MADE KERNEL

The B-Board PRO embeds a special operating system, tailored for hard real-time applications with very low latency. This OS simultaneously combines a high level of safety and a very low overhead.

SFP INTERCONNECT

Imperix proprietary RealSync technology offers unrivalled communication performance, including:

- High data bandwidth (5 Gbps)
- Intrinsic synchronization
- Ultra-low latency
- Up to 64 units (B-Board PRO or B-Box RCP)

ANALOG-TO-DIGITAL CONVERTERS

Data acquisition is supported by two LTC2324, offering:

- 8 full-differential channels
- Up to 2Msps operation
- 16 bits resolution
- Simultaneous sampling

FLEXIBLE POWER SUPPLY

B-Board PRO is compatible with 5-15V DC input voltages

- Single power supply
- Wide input range 5-15VDC
- Low power (15W max)

XILINX ZYNQ 7030

B-Board PRO is based on a high-performance System-on-Chip (SoC), offering:

- 2x ARM Cores 1GHz
- 1GB DDR3
- 125K Kintex-grade FPGA
BITFILE COMPATIBILITY
The B-Board PRO is guaranteed to work exactly the same way as the B-Box RCP, with the exact same performance. In fact, the very same bitfile can be used on both devices.

PROCESSING POWER
The B-Board PRO is exactly as powerful as the B-Box RCP. Indeed, with its dual-core 1GHz processor, it features outstanding performance, especially for an embedded controller.

BOARD-TO-BOARD SIGNALS
Digital signals, including
- 16x PWM outputs (3V3)
- 16x Digital inputs (3V3)
- 16x Digital outputs (3V3)
- 36x Bidirectional user I/O straight from/to the FPGA
- 16x PWM outputs (1V8)
- 16x Fault inputs (1V8)

Communication signals, including
- 1x Gigabit Ethernet
- 1x USB 2.0 OTG
- 2x Quad SPI
- 1x JTAG output
- 1x GTX lane
- 4x Fault inputs

Analog signals, including
- 8x Full-differential inputs
KEY SPECIFICATIONS

<table>
<thead>
<tr>
<th>System on chip</th>
<th>Zynq XC7Z030-3FBG676E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>ARM Cortex A9 1 GHz 1GB DDR3 x2</td>
</tr>
<tr>
<td>FPGAs</td>
<td>Kintex 7 125K (user programmable) x1</td>
</tr>
<tr>
<td>Analog inputs</td>
<td>16bits @ 2Msps x8</td>
</tr>
<tr>
<td>PWM outputs</td>
<td>Electrical (PWM lanes 0-15, 1.8V) x16 Electrical (PWM lanes 16-31, 3.3V) x16</td>
</tr>
<tr>
<td>User I/Os (high-speed)</td>
<td>Electrical (3.3V) x36</td>
</tr>
<tr>
<td>Digital outputs</td>
<td>Electrical (3.3V) x16</td>
</tr>
<tr>
<td>Digital inputs</td>
<td>Electrical (3.3V) x16</td>
</tr>
<tr>
<td>Fault inputs</td>
<td>Electrical (3.3V/5.0V) x16 Electrical interlock x1</td>
</tr>
<tr>
<td>Encoder inputs</td>
<td>3pins (A,B,Z), shared with GPI x2</td>
</tr>
<tr>
<td>Communication</td>
<td>Ethernet 1 Gbps SFP+ 5 Gbps USB 2.0 (computer) x1</td>
</tr>
</tbody>
</table>

EXTENSIVE CONNECTIVITY

The B-Board PRO is ready for the most demanding needs and has been specially designed with low- to mid-volume, complex applications in mind.

With its high number of digital I/Os, there’s plenty of extension margin. The application scope is thus mostly defined by the available analog inputs.

When needed, hierarchized or distributed control systems can also be implemented, similarly to B-Box RCP, so that the total number of usable I/O becomes practically boundless (512 analog in and 2048 PWM outputs).

A COST-COMPETITIVE CONTROLLER, EQUIVALENT TO B-BOX RCP!

The B-Board PRO possesses most of the features of the B-Box RCP, except the configurable analog front end and its own software-independent protection thresholds.

It is meant to be a cost-optimized equivalent system for embedded applications, fully cross-compatible with its bigger and more flexible variant.
FEATURES AND BENEFITS

INTEGRATED WITH SIMULINK™

The B-Board PRO can be programmed using either C/C++ or directly from simulation software, such as MATLAB® Simulink™. Thanks to a fully automated code generation toolchain, just one single click is all it needs to fully program the device!

With Simulink, the provided blockset also embeds simulation models so that the system behaviour can be accurately simulated and tuned before run-time. Then, everything truly works from the first test!

USER-PROGRAMMABLE FPGA

Absolutely no expertise in FPGA-based development is needed to work with the B-Board, as it operates readily with a highly flexible and highly configurable FPGA firmware.

Nevertheless, for the most advanced users who require to alter the FPGA code, the B-Board allows to do so. In this case, dedicated areas are provided, with straightforward integration within the existing DSP software kernel.

HIGH PROCESSING POWER

The B-Board PRO uses a dual-core processor. One core is dedicated to the execution of the closed-loop control tasks (bare metal, dedicated kernel), the other one to the system supervision and monitoring (linux). Most tasks are also shifted in FPGA.

This results in the full dedication of a fast floating-point processor core to real-time control tasks, with best-in-class performance, ranging up to 200kHz closed-loop control frequencies.

QUICK INTEGRATION

In addition to being 100% compatible with B-Box RCP, the B-Board PRO benefits from the same software environment and tools. It can be programmed from Simulink™ and controlled from BB Control too!

Overall, most of the specific integration efforts are only those related to the mechanical aspects, as well as the signal conditioning and protection, which are often tailored to the application anyway.
Imperix RealSync™ technology

PERFECT SYNCHRONIZATION
Imperix’s patent-pending RealSync™ technology guarantees an unrivaled synchronization accuracy across multiple units, down to ±2.0 ns! This is achieved through advanced clock dissemination through the optical fibers, enabling multiple B-Boxes to operate as if they were one single unit!

HIGH-SPEED COMMUNICATION
The 5 Gbps SFP+ links can be configured to form a tree-shaped network, achieving superior data bandwidth and lower latency over daisy-chain or ring topologies. This guarantees sub-microsecond data transfers in many configurations with up to 8 controllers!

MAXIMUM I/O CAPABILITIES

<table>
<thead>
<tr>
<th>Component</th>
<th>Single (1 unit)</th>
<th>Stacked (64 units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog inputs</td>
<td>8x</td>
<td>512x</td>
</tr>
<tr>
<td>PWM outputs</td>
<td>32x</td>
<td>2048x</td>
</tr>
<tr>
<td>General-Purpose digital Outputs (GPO)</td>
<td>16x</td>
<td>1024x</td>
</tr>
<tr>
<td>General-Purpose digital Inputs (GPI)</td>
<td>16x</td>
<td>1024x</td>
</tr>
</tbody>
</table>

The synchronization between B-Boards is achieved without the user even knowing it! The guaranteed accuracy is ±2.0 ns.

Ultra-low latency is achieved even with a high number of ADC or PWM channels. This allows closed-loop control frequencies up to 200 kHz.
PROGRAMMING
Software Development Kits (SDK)

ACG SDK
The Automated Code Generation (ACG) SDK enables engineers to program B-Box RCP and B-Board PRO controllers directly from MATLAB™ Simulink™. The provided toolchain handles fully automated code generation, compilation and upload, in just one click.

In addition, the SDK contains simulation models of each controller peripheral, so that the exact system behavior can be simulated – and hence easily anticipated – before code is generated.

C/C++ SDK
The C/C++ SDK provides a direct way to implement converter control techniques without requiring any simulation software. This approach also offers superior performance and flexibility over automatically-generated code.

The SDK contains extensive libraries, specifically developed to make the coding experience as simple as possible, while granting users direct access to each and every system parameter.

FEATURE
ACG SDK C/C++ SDK
BBOS operating system ✔ ✔
Blockset for Simulink™ ✔ ☐
C/C++ coding environment ☐ ✔
BB Control monitoring software ✔ ☒
Code examples ✔ ✔
User-editable FPGA area ✔ ✔
Multi B-Box operation (I/O extension) ✔ ✔

* Requires a valid MATLAB™ license issued by MathWorks™ and the following toolboxes: Embedded Coder, MATLAB™ Coder and Simulink™ Coder.

MULTIPLE HARDWARE
The very same software can be used for programming either the B-Box RCP or the B-Board PRO. Besides, thanks to the strict equivalence between both devices, user-level control software is also guaranteed to behave identically.

OPEN FRAMEWORK
Imperix SDKs beeing only a set of tools, engineers remain in complete control of their control software. Everything can be tuned or edited down to the duty cycle! Furthermore, the FPGA firmware can also be modified for even more flexibility.

SOFTWARE FOR EVERYONE
Irrespective of the level of expertise or field of use, the very same software can be used for teaching purposes, R&D activities or industrial applications. Everything is kept simple, allowing to accelerate any development.
Evaluation kit
CARRIER MODULE FOR B-BOARD PRO

The Evaluation kit allows to quickly assess the tremendous capabilities of the B-Board PRO, right from the top of your desk.

CONTENT

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation board</td>
<td>Carrier board</td>
<td>x1</td>
</tr>
<tr>
<td>B-Board PRO</td>
<td>Embeddable controller</td>
<td>x1</td>
</tr>
<tr>
<td>RJ45 cable</td>
<td></td>
<td>x1</td>
</tr>
<tr>
<td>Power supply</td>
<td>20W / 12V adapter</td>
<td>x1</td>
</tr>
<tr>
<td>Quick start guide</td>
<td></td>
<td>x1</td>
</tr>
</tbody>
</table>

PRODUCT DESCRIPTION

The Evaluation kit enables development engineers to power up the B-Board PRO and get the first signals out of it within few minutes. It notably contains an easy-to-use carrier board that gives instant access to most analog and digital signals, normally located on the bottom of the B-Board PRO.

The kit also contains suitable documentation and getting-started examples as to best support a rapid evaluation of the hardware and software capabilities, featuring the very same performance as the larger B-Box RCP system.

Choose your Software Development Kits (SDK)

ACG SDK
C/C++ SDK
CARRIER BOARD SIGNALS

<table>
<thead>
<tr>
<th>Count</th>
<th>Type</th>
<th>Description</th>
<th>Connector</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>x8</td>
<td>Analog inputs</td>
<td>Full-differential inputs, 16bits</td>
<td>Phoenix 3.5mm (1989023)</td>
<td>± 5V</td>
</tr>
<tr>
<td>x4</td>
<td>Analog outputs</td>
<td>16bits, single-ended</td>
<td>Phoenix 3.5mm (1989023)</td>
<td>± 5V</td>
</tr>
<tr>
<td>x4</td>
<td>Fault inputs</td>
<td>Electrical</td>
<td>2.54 mm header</td>
<td>3.3V</td>
</tr>
<tr>
<td>x1</td>
<td>Communication</td>
<td>Ethernet, device programming and monitoring RJ45 socket</td>
<td></td>
<td></td>
</tr>
<tr>
<td>x16</td>
<td>PWM outputs</td>
<td>Dedicated modulators, 4 different time bases</td>
<td>Phoenix 3.5mm (1989023)</td>
<td>3.3V</td>
</tr>
<tr>
<td>x8</td>
<td>Digital outputs</td>
<td></td>
<td>2.54 mm header</td>
<td>3.3V</td>
</tr>
<tr>
<td>x8</td>
<td>Digital inputs</td>
<td></td>
<td>2.54 mm header</td>
<td>3.3V</td>
</tr>
<tr>
<td>x36</td>
<td>User configurable I/Os</td>
<td>Direct to FPGA, bidirectional</td>
<td>2.54 mm header</td>
<td>3.3V</td>
</tr>
</tbody>
</table>