imperix

BoomBox control platform

The ultimate solution for fast and reliable development and testing

BOOMBOX RAPID CONTROL

The ultimate solution for fast and

DEDICATED OPERATING SYSTEM

» Up to 200 kHz sampling and operation
» Real time supervision

SCALABLE DESIGN

» Stackable up to 6 units
» Native synchronization

EASY PROGRAMMING

» Programmable in C/C++ or with Simulink™
» Power electronics libraries

SCALABLE DESIGN

In order to adjust swiftly to varying needs and systems of various complexity, several BoomBoxes cas be used together in a modular fashion. When needed, up to 6 units can be stacked together, hence extending the number of I/Os up to 96!

In any case, all inputs and PWM outputs remain fully synchronized down to few hundreds of nanoseconds. As such, operating a multi-BoomBox configuration is just as simple as using one unit only.

DEDICATED OPERATING SYSTEM

Simple is beautiful is the guideline behind the BoomBox's operating system! It contains just what is needed to control your converter, including protection, communication and real-time supervision.

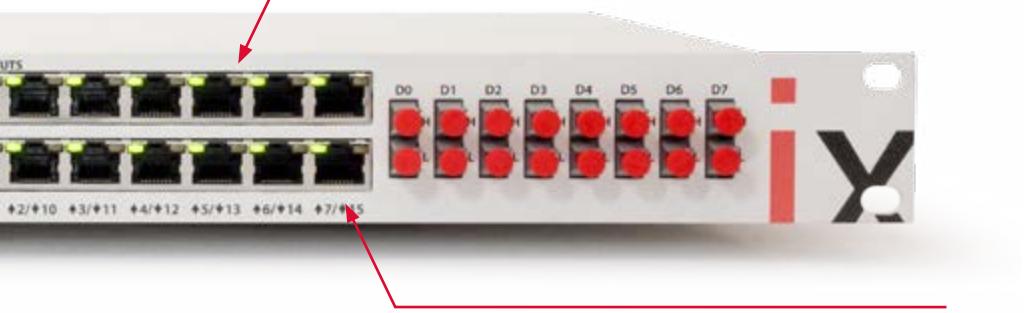
By avoiding the usual burden of conventional operating systems, control and interrupt frequencies up to several tens of kHz can be achieved, which brings high performance controls within everyone's reach, including for the most complex converter topologies.

L PROTOTYPING PLATFORM

reliable development and testing

SOFTWARE-INDEPENDENT PROTECTIONS

» Programmable safety thresholds on all inputs
» Microsecond-scale response time



TAILORED INTERFACES

» Optical outputs (PWM or direct)
» Flexible analog inputs
» High-Z full diff. or Low-Z single-ended
» Programmable gains
» Configurable low-pass filters (+ bypass)
» Excellent EMI performance

TAILORED INTERFACES

With its flexible front-end, the BoomBox can adapt to almost any sensor. All channels possess programmable gains and filters and can be configured to low- or high-impedance with single-ended or differential signalling. Together with shielded twisted-pair RJ45 cables, this also guarantees excellent EMI performance.

Configuration parameters can also be instantly saved and restored, hence allowing to move from one application to another within minutes.

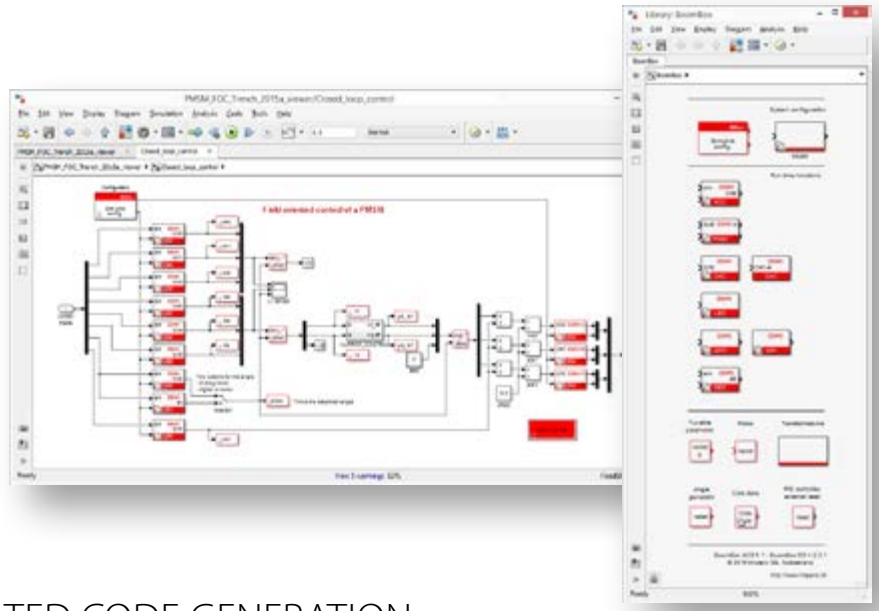
INDEPENDENT PROTECTIONS

The BoomBox possesses software-independent protections that block every output in case of any error within a few microseconds.

This mechanism is often essential when the control software is not yet entirely stable, and allows to move quickly from computer-based simulation to real applications. Working concurrently between the lab and the office becomes possible in order to improve both the simulation model and the converter prototype.

SIMPLE PROGRAMMING

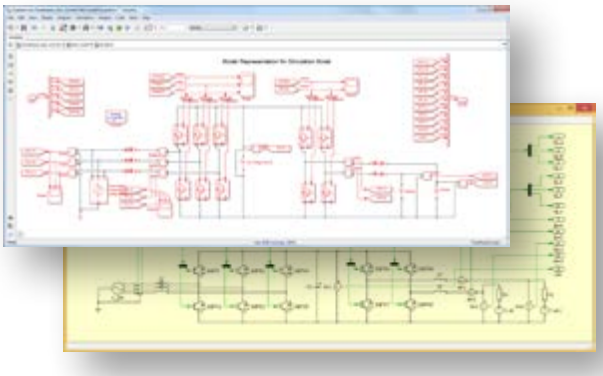
Efficient workflows for designing your control software



AUTOMATED CODE GENERATION

Once your control has been successfully tested and validated in simulation, all you need is to click on one button to generate executable code, compile it and upload it into the BoomBox!

In this process, every function block is instantly translated into control code, without the need for any other software. Hence, validating advanced control implementations has truly become a child's play.



SIMULINK-BASED ™ SIMULATION

With the BoomBox blockset for Simulink,™ drawing your converter control can be done very easily. Relying on the capabilities of PLECS™ or SimPowerSystems,™ you will also be able to run a realistic PC-based simulation of your converter, including its control.

Such a high-fidelity model guarantees a seamless transition from the PC-based simulation to the actual hardware, without the need to re-tune any controller.

ADVANCED C/C++ CODING

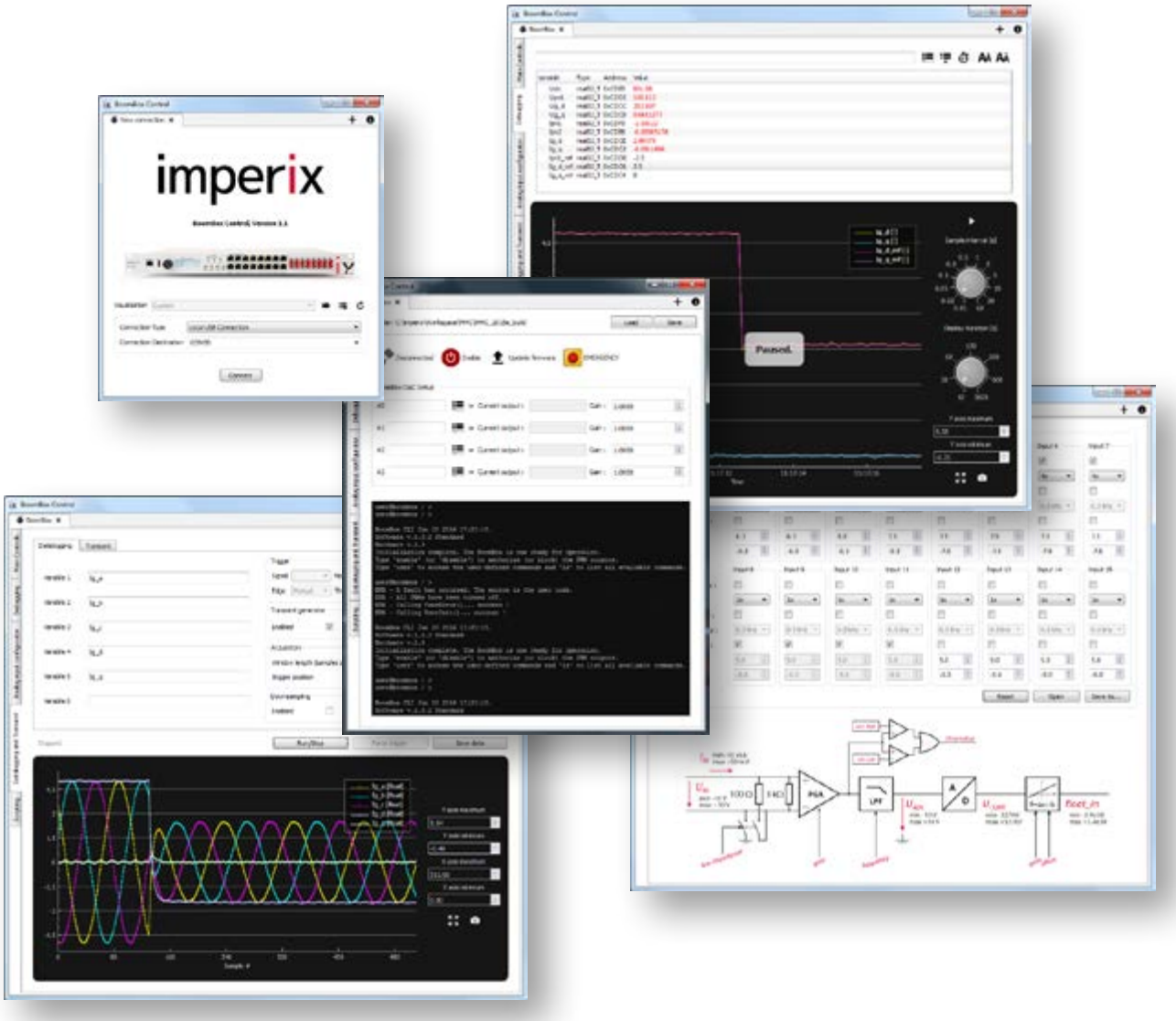
C/C++ programming provides a quick way to begin coding a converter control without requiring any additional software. The BoomBox is shipped with code examples, software libraries and helper functions to provide a better and faster coding experience.

For advanced users and complex projects, C/C++ is a must, thanks to its flexibility and the best overall performance.

Automated Code Generation requires MatLab™ Simulink™ Coder and Embedded Coder R2015a or newer.

REAL TIME MONITORING

A direct and transparent access to your control software in real time



GENERATE AND EXPLOIT MEANINGFUL RESULTS

Each system is shipped with *BoomBox Control*, which is a graphical Windows™-based software, enabling the user to monitor, control as well as display various data from the BoomBox control platform.

No matter if you are debugging a new control code or if the control platform is running in standalone mode, all you need is to connect your BoomBox to your PC to immediately get hands on all internal variables and measurements, and start tuning your control.

The remote access is always granted, even while your converter is actually switching, without impeding on the real time execution of the code. *BoomBox Control* therefore provides a quick and convenient pathway to debugging, tuning and datalogging.

At each capture, the software allows to export all your meaningful measurements and results within seconds, directly into you preferred software for post-processing (MatLab™, Excel™, Octave, etc.).

OPERATING PRINCIPLES

The basics of an advanced control platform

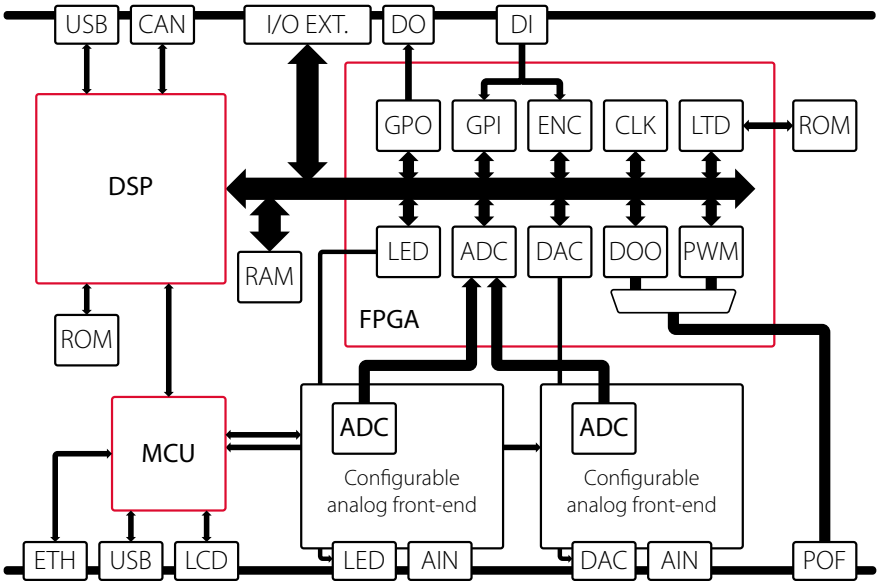
DSP + FPGA CO-PROCESSING

With the BoomBox, all you need to do is to download your control code into the DSP. The resident peripherals in the FPGA (such as modulators, encoder interface, analog I/O blocs, etc.) are pre-configured to offer you a high performance and reliable behavior in a easy-to-use fashion. This approach also guarantees that the most time-sensitive tasks are handled with care and that the DSP can be almost exclusively dedicated to the execution of your control.

HARDWARE INDEPENDENCY

Thanks to the architecture of the BoomBox's operating system, your control code is virtually independent from the hardware that executes it.

As such, while the components of the BoomBox will follow the hardware evolution – featuring increasing performance – you can make sure that a control created on a BoomBox will keep working on a BoomBox, no matter how long after, or the evolution of the supporting hardware.



CONSISTENT TIMINGS

The BoomBox distinguishes from similar prototyping controllers by its clear and solid management of time. All time-sensitive aspects can be precisely clocked on one of the four available time bases, including sampling, modulation and interrupt-based control routines.

This guarantees a complete control over the sampling instant, or the relative phase of any PWM channel, making synchronous sampling very easy to implement.

STANDALONE OPERATION

While the BoomBox is ideal for rapid control development and testing in a laboratory environment, nothing prevents it from being later used in the field, typically during pilot phases or small pre-series.

Indeed, the BoomBox can always run as a standalone unit, independently from any computer. It also embeds the necessary connectivity for remote control and logging, through CAN or Ethernet.

APPLICATION EXAMPLES

A broad range of systems that can be ideally served

RENEWABLES AND STORAGE

Whether you are working on new converter topologies or on innovative control schemes, the flexibility of the BoomBox will help you get faster results on real hardware. In case you don't have your own hardware yet, a few power modules from imperix is all you need to set up quickly the converter(s) of your dreams.

VARIABLE-SPEED DRIVES

Drives are certainly the most widespread application of power converters, which are ideally served by the BoomBox, thanks to its encoder inputs, CAN interface and high I/O count. As such, you are ideally equipped to accelerate the development of modern control strategies such as sensorless or split drivetrains.

MICROGRID-TIED CONVERTERS

With the BoomBox, you are never limited to the implementation of conventional control techniques. You can always fearlessly experiment any novel approach and test it, during steady state, or during islanding and grid synchronization procedures. The software-independant protections of the BoomBox are here to keep you and your hardware safe, at all times !

MODULAR CONVERTERS

With stacked controllers, up to 96 gating signals and 96 measurements can be handled by perfectly synchronized devices, as if you had only one BoomBox. This makes it perfectly suited for the implementation and validation of various control strategies on modular converters. Besides, you can always opt-in for FPGA code edition for the most demanding implementations.

COMPLEMENTARY ELEMENTS

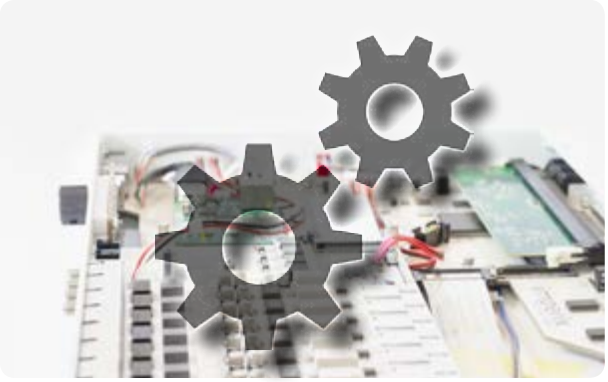
Everything you need to work efficiently in the laboratory

DIN RAIL-MOUNTABLE SENSORS

When plug-and-play measurements are required, our voltage or current sensors provide direct compatibility with the BoomBox. Ranging up to 50 A_{RMS} and 800 V_{DC}, these sensors can be easily mounted on 35 mm DIN rails and can be directly powered by the BoomBox.

FPGA-BASED IP BLOCKS

Advanced firmware blocks are also available for special FPGA implementations, typically featuring space-vector modulators or voltage balancing algorithms for multi-level converters. In special cases, it is also possible to grant access to a fully editable FPGA code.



INTERFACES TO HIL EMULATORS

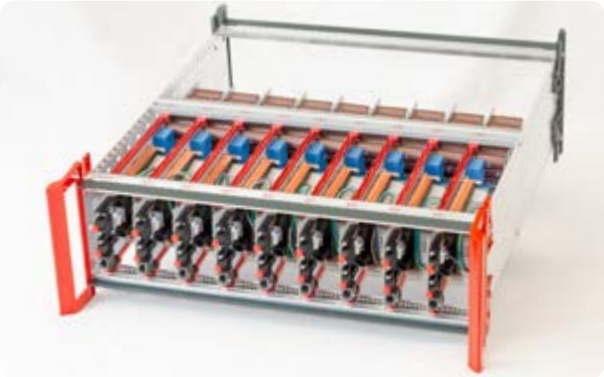
HIL emulators offer easy means to validate your control under harsh transient or fault conditions, which are sometime impractical to (re)create in the lab.

Using the BoomBox's interfaces for OPAL-RT, Typhoon, or other HIL devices, your control can hence be fully tested on a HIL emulator, before all cables are simply swapped to the real converter.

PLUG&PLAY POWER MODULES

Imperix offers power modules that are directly compatible with the BoomBox. Available with different cell topologies and ratings, these modules can be easily assembled in series or in parallel, similarly to LEGOs.™

Furthermore, finished assemblies can also be ordered, including temperature monitoring (LCD), precharge circuits, passives, additional cooling etc.



VERSIONS AND AVAILABILITY

The right system for every need

A SCALABLE SYSTEM FOR VARIABLE NEEDS

With just one unique hardware, the BoomBox prototyping controller provides an unrivalled flexibility and ability, so that it can be reused in multiple research and development projects.

From teaching purposes to industrial-grade converter implementation, each use-case is covered by one of the three versions of the BoomBox software package.

For applications requiring a large number of inputs and outputs such as multilevel converters, boxes can be stacked, hence forming a centralized control system with numerous inputs and outputs.

Finally, the software package can be upgraded at anytime, even temporarily. Free software updates and E-mail support are provided for two years.

Feature	Hardware	Standard	Expert
BoomBox hardware	✔	✔	✔
Embedded operating system	◑	✔	✔
C/C++ programming libraries	◑	✔	✔
BoomBox Control utility software	✔	✔	✔
Operation in I/O extension mode, up to 6 BoomBoxes			✔
FPGA access (integration of custom code)			★
Simulink blockset for the automated programming of the BoomBox *(1'200.-/yr or 4900.- CHF lifetime license, 3 computers)*	★	★	★
Hardware	CHF 8'400.-	CHF 8'400.-	CHF 8'400.-
Software	free	CHF 3'100.-	CHF 5'200.-

✔ = Base feature
★ = Option
◑ = Limited feature: *Without software license (standard or expert), only the first 8 analog inputs / 8 digital outputs are usable and the sampling frequency is limited below 5 kHz.*

VAT and other sales taxes may apply extra. Prices vary depending on the country.
Prices are valid for 2017.

PERFORMANCE SPECIFICATIONS

Key characteristics of the BoomBox control control platform

ANALOG INPUTS

Characteristic	Test conditions	Min.	Typ.	Max.	Unit
Resolution			16		bits
Noise floor	G=1, differential input mode, no filter		0.8	1.7	LSB (rms)
Large signal bandwidth	-3dB, without any filter	200	208		kHz
Sampling rate	All channels simultaneously	0.001		375	ksps
Sampling jitter	All channels, same BoomBox		±2.1		ns
	All channels, across several BoomBoxes		±120	±280	ns
Input voltage range	Differential mode		±10.0		V
	Common mode		±11.2		V
Maximum tolerable input voltage	On any pin		±56		V
Input impedance	High Z mode / full differential input	2.99	3	3.01	kΩ
			2.2		nF
	Low Z mode / single ended input	99	100	101	Ω
			2.2		nF
CMRR (differential input mode only)	G = 2, 0Hz - 200kHz	>65	>72		dB
	G= 2, 1.5Mhz	>42	>48		dB
	G= 2, >10Mhz	>70	>75		dB
Total gain error (uncalibrated)	DC, 3kΩ differential input mode		±0.8	±1.5	%
	DC, 100Ω single-ended input mode		±1.4	±1.8	%
Gain stability	0 - 85°C		±0.12	±0.25	%
Offset (uncalibrated)	G=1, without filter (other gains are better)		±3.6	±15.3	LSB
	G=1, with filter on	+16.4	+20.0	+23.6	LSB
Offset stability	0 - 85°C, without filter		±2.1	±4.3	LSB
	0 - 85°C, with filter on		±5.3	±9.3	LSB
Programmable LPF group delay	0Hz - 1.5x cut-off frequency	38	40	43	µs
A/D conversion time	all channels simultaneously			1.25	µs
A/D converter to FPGA tranfer time				1.38	µs
Programmable safety threshold range	Any channel	-10.0		+10.0	V
Programmable safety threshold accuracy		±10 % m.v. ±100 mV			
Programmable safety threshold response time			2.8	4.0	µs
Embedded power supply voltage			±15		V
Maximum embedded power supply current	per channel, short-circuit protected		150		mA
	all channels		1500		mA

ANALOG OUTPUTS

Characteristic	Test conditions	Min.	Typ.	Max.	Unit
Resolution			16		bits
Output voltage range			±5.0		V
Maximum tolerable output current	Short-circuit protected	±15	±29		mA
Gain error	0 - 85°C		±1.1		%
Offset			±0.2		mV
Settling time	After end of DSP interrupt, 25-75% output range		6.5		µs

PERFORMANCE SPECIFICATIONS

Key characteristics of the BoomBox control control platform

MAIN DSP

Characteristic	Test conditions	Min.	Typ.	Max.	Unit
Processor type	• *Texas Instruments TMS320C28346 / 300 Mhz / 32 bits* • *300 MIPS (floating point)*				
Memory	• *DSP : 2 Mbits RAM* • *256 Mbits NOR Flash*				
A/D acquisition delay	*FPGA to end of GetADC(), one channel*		*1.9*		*µs*
	FPGA to end of all GetADC(), sixteen channels		*6.7*		*µs*
User-available CPU time	*At 20 ksps*		*89*		*%*

PWM OUTPUTS

Characteristic	Test conditions	Min.	Typ.	Max.	Unit
Counter resolution			*33.3*		*ns*
Counter depth			*16*		*bits*
Carrier types	*1) Triangle* *2) Inverted triangle* *3) Sawtooth* *4) Inverted sawtooth*				
Output modes (signal coding)	*1) High + low (complimentary with dead-time)* *2) PWM + enable signal* *3) Direct output (bypass of the modulator, similar to a conventional digital output)*				
Dead-time	*Between H and L signals of the same pair*	*0*		*8.53*	*ms*
Duty-cycle	*Linear region, 0.1% dead-time*	*0.2*		*99.8*	*%*
	Complete range, glitch-less operation	*0.0*		*100.0*	*%*
Jitter	*At the optical signals, any pair, same BoomBox*		*±30*	*±36*	*ns*
	At the optical signals, any pair, across BoomBoxes		*±120*	*±280*	*ns*
Ratio control to switching frequency (prescaler)		*1/256*	*1*	*256*	
Optical fiber type	*POF 650 nm*				

GENERAL-PURPOSE INPUTS / OUTPUTS

Characteristic	Test conditions	Min.	Typ.	Max.	Unit
Logic level			*5.0*		*V*
Maximum tolerable input voltage	*Inputs only*	*7.0*	*20*		*V*
Maximum tolerable output current	*Outputs only*		*±25*		*mA*
Usable signal frequency range		*0*		*200*	*kHz*
Pin-to-pin jitter	*Same BoomBox*		*±3.2*		*ns*
	Across several BoomBoxes		*±120*	*±280*	*ns*

ENCODER INPUTS

Characteristic	Test conditions	Min.	Typ.	Max.	Unit
Logic level	*Same connector as digital inputs.*		*5.0*		*V*
Maximum tolerable input voltage	*Same connector as digital inputs.*	*7.0*	*20*		*V*
Input signals	• *Channel 1: A, B and Z (Z is optional)* • *Channel 2: A, B and Z (Z is optional)* • *Channels 1+2 : A, $\overline{A}$, B, $\overline{B}$, Z, $\overline{Z}$ ($\overline{Z}$ are optional)*				
Sampling options	*Either synchronized with ADC, or independent*				
PPR frequency	*Quadruple rate operation*	*0*		*200*	*kHz*

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