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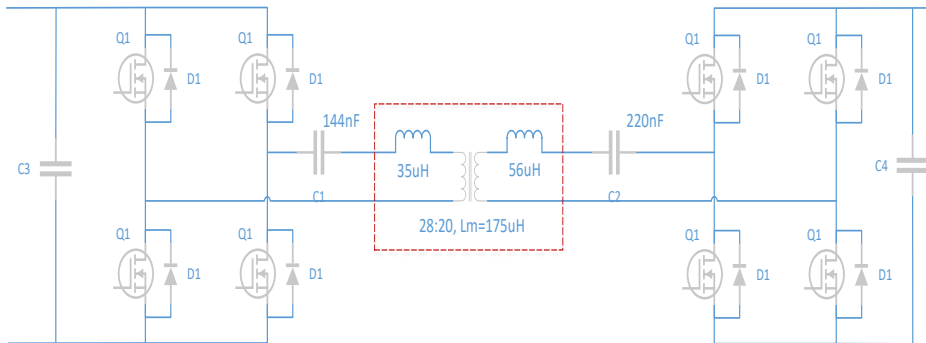
# Bi-directional DC-DC converter with 1200 V & 1700 V SiC MOSFETs

Infineon's virtual show 2020



# Bi-directional DC-DC converter evaluation board with CoolSiC™ IMZ120R030M1H & IMBF170R1K0M1

## Schematic



Parameter	Minimum	Nominal	Maximum	Unit
Rated power		10		KW
Bus voltage	700	750	800	V
HV voltage	550		800	V
Bus current range	0		15	A
HV current range	0		20	A
DC/DC frequency	40 K	100 K	200 K	Hz

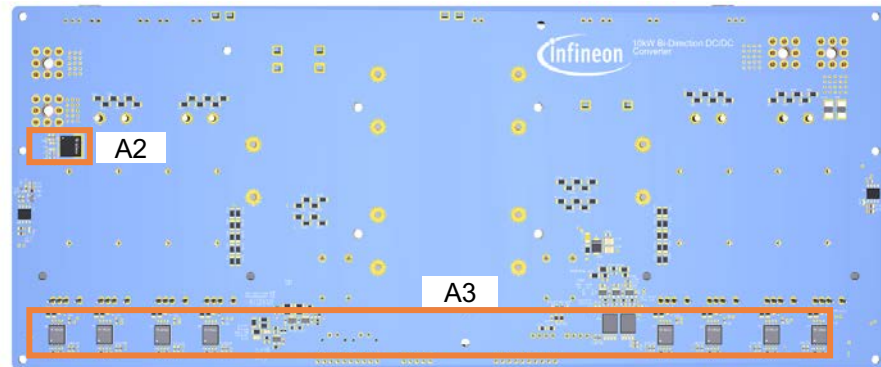
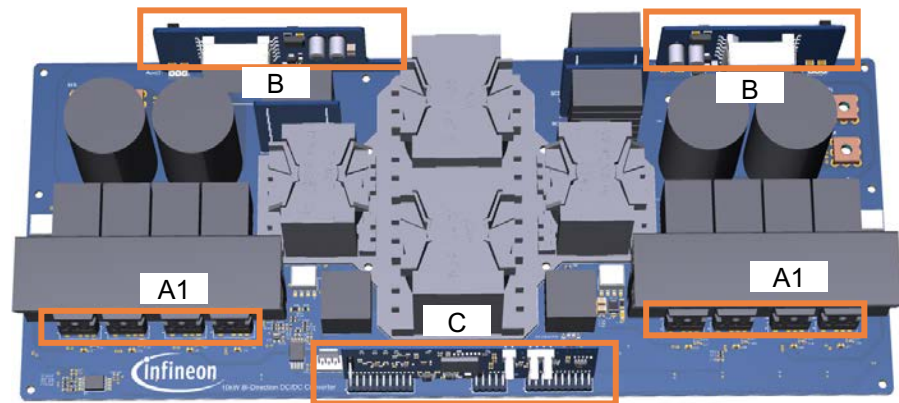
## System features

- › High efficiency: 98.8%
- › SiC MOSFETs guarantee high performance
- › Small auxiliary power board with 1700 V SiC MOSFETs
- › Total solution from Infineon with SiC MOSFETs, driver IC, XMC™ controller, current sensor, communication chip, security chip, RAM (from Cypress)
- › Support for Wi-Fi module communication
- › User-friendly GUI debug window

# Bi-directional DC-DC converter evaluation board

## Total system solution from Infineon

No.	Functional groups
<b>A</b>	<b>Mainboard</b>
A1	Power stage: 1200 V SiC MOSFET TO-247, 4-pin IMZ120R030M1H×8
A2	Driver circuit: 1ED isolated high-creepage driver IC 1EDC60H12AH×8
A3	Current sensor: High-precision coreless current sensor TLI4971×1
<b>B</b>	<b>Auxiliary power supply ×2</b>
B1	Power stage: 1700 V CoolSiC™ MOS D <sup>2</sup> PAK-7L IMBF170R1K0M1 ×2
B2	Flyback controller: ICE5QSAG×2
<b>C</b>	<b>Control board</b>
C1	Microcontroller: XMC4400-F100k512 BA
C2	Communication chip: TLE9251VSJ
C3	Security chip: SLS32AIA010MH
C4	Voltage regulator: IFX1763XEJV50
C5	MOSFETs: 2N7002
C6	Linear voltage regulator IC: IFX1117MEV33
C7	256-Kbit (32 K × 8) serial (SPI) F-RAM: FM25V02A



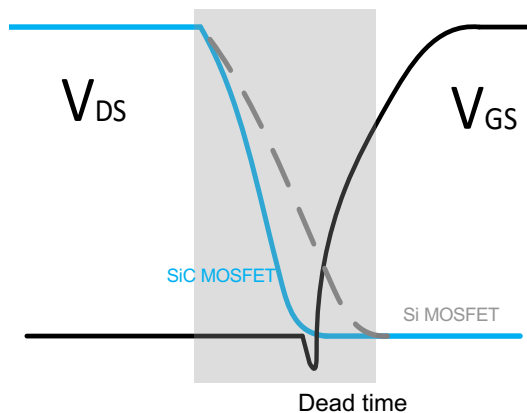
# Bi-directional DC-DC converter evaluation board

## 1200 V CoolSiC™ MOSFET

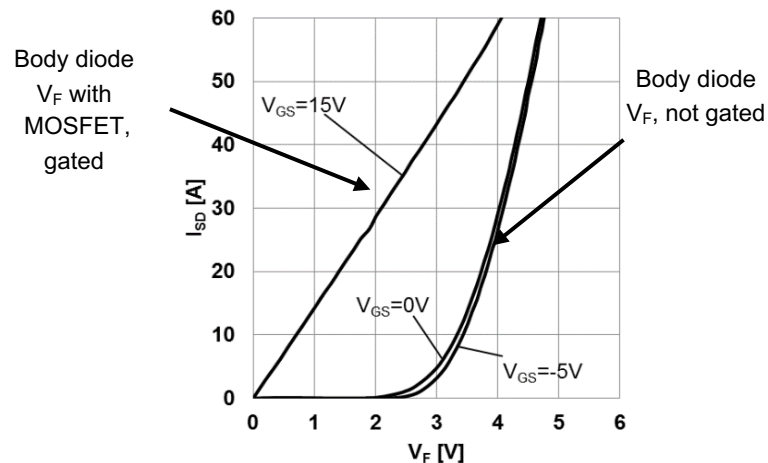
### Bi-directional converters benefit from 1200 V CoolSiC™ MOSFETs:

- Easy to achieve bi-directional charging function
- Smaller  $C_{oss}$  means less dead time is required to reduce losses during transient period
- Body diode  $V_F$  without knee voltage when gated to reduce conducting losses

### Dead time reduction by using CoolSiC™ MOSFET



### Loss reduction due to gate body diode



# Bi-directional DC-DC converter evaluation board

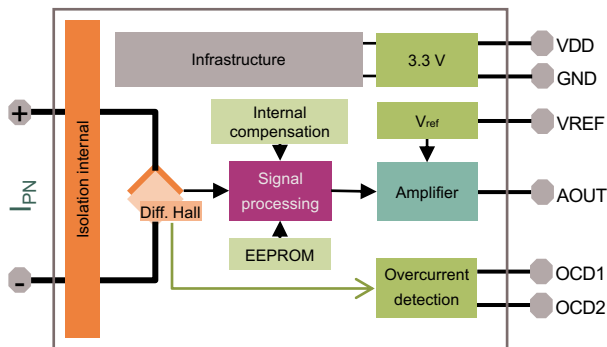
## XENSIV™ current sensor TLI4971 for industrial applications



### Product characteristics

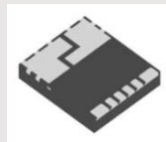
- › High-precision current sensor for bi-directional AC and DC measurements with robustness to stray fields
- › Pre-calibrated for a measurement range up to 120 A
- › High accuracy over temperature and lifetime due to internal compensation
- › Analog output with high bandwidth (120 kHz) for fast response time
- › Two fast overcurrent detection outputs (<1  $\mu$ s)
- › Integrated primary conductor (current rail) with very low insertion resistance
- › Galvanic isolation due to contactless magnetic sensing principle
- › Variant with UL certification available

### Block diagram



### Package

PG-TISON-8 with integrated current rail



### Value

Improved system performance

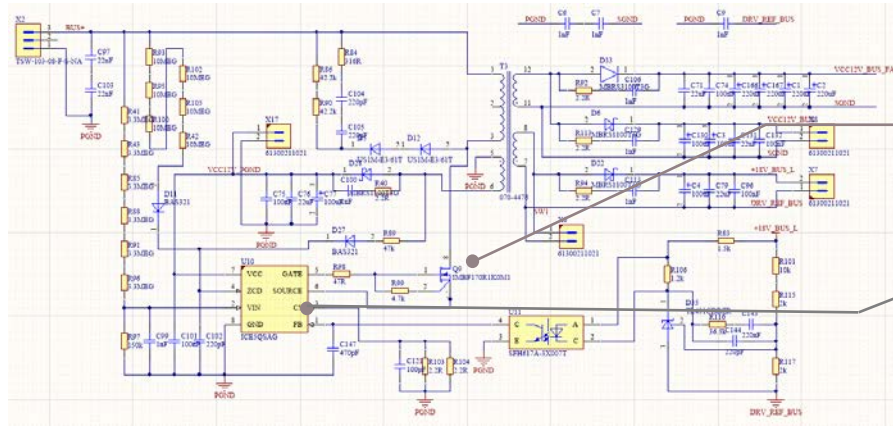
Simplified layout, reduced design risk

Support of upcoming power technologies

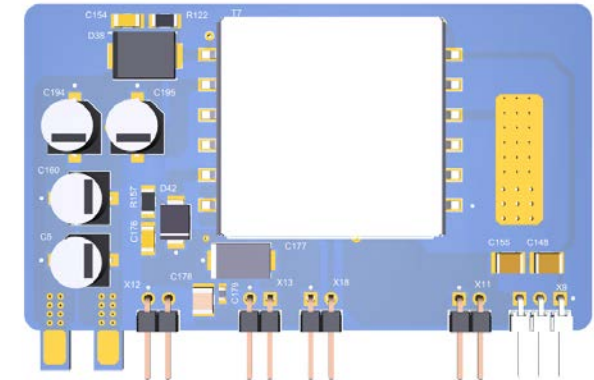
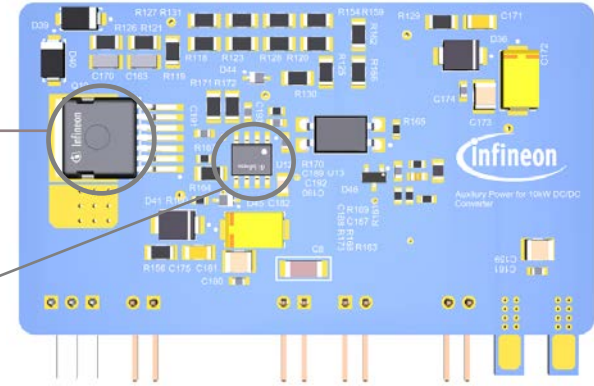
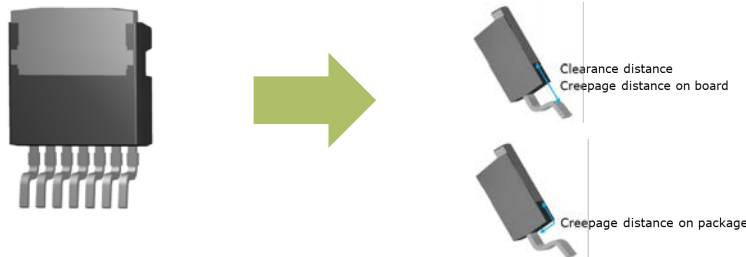
Space and cost savings

# Auxiliary power board

## 1700 V CoolSiC™ MOSFET in D2PAK-7L package with high creepage



- Directly driven with flyback controller, no gate driver needed!
- Extended creepage distance > 7 mm, reduced board isolation effort





# Bi-directional DC-DC converter control board

## XMC4400-F100k512 microcontroller



### Peripherals for power conversion applications

HRPWM

ERU

CCU8/4

ADC

ARM® Cortex®  
M4F

COMP

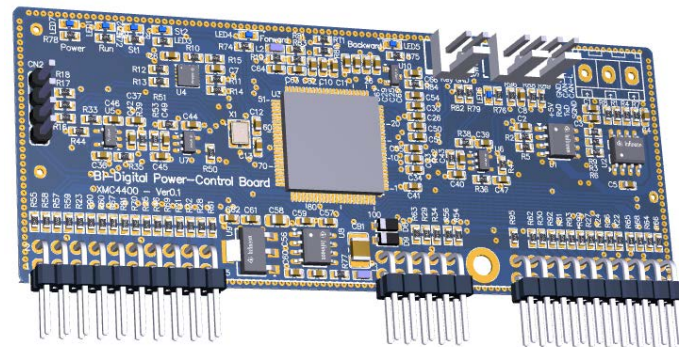
### Key features

High resolution PWM (150 ps)

Smart analog comparators

Fast and flexible ADC and timers

Extended temp. range (up to  $T_A$  125 °C )



### Customer benefits

Regulate voltages/current with higher accuracy

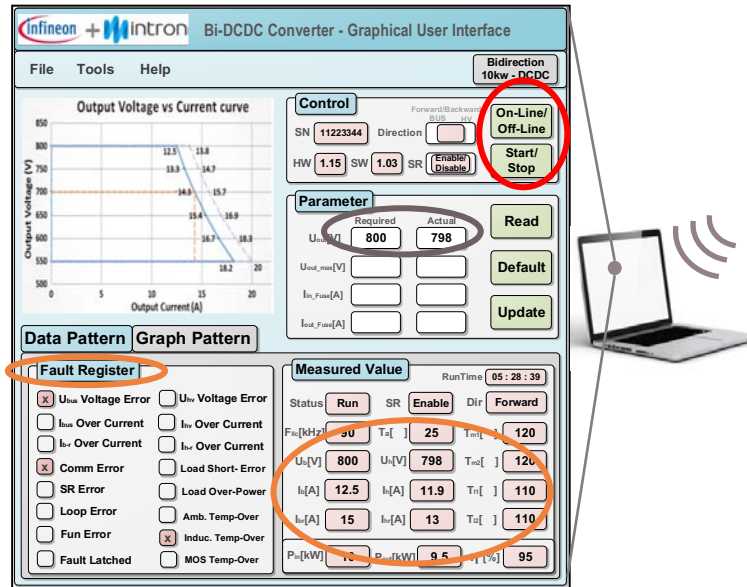
Analog comparators with smart features such as slope compensation

Permit complex PWM patterns and sophisticated measure sequences

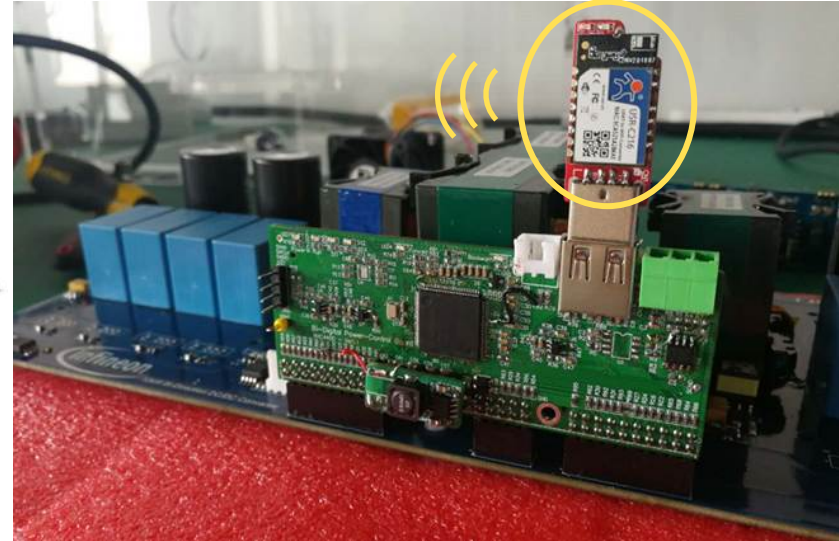
Adaptability to a more hostile work environment

# User interface software

## Demo GUI and XMC 4400 industrial microcontroller



Example: Set parameters for evaluation board through Wi-Fi module



Microcontroller is based on XMC4400, with a Wi-Fi module with wireless connection to the computer:

- › Set start & stop, set the direction forward or backward
- › Set output voltage and current
- › Read out voltage, current and temperature
- › Check the converter status



# CoolSiC™ MOSFETs in DC-DC converter

## Higher efficiency

- › CoolSiC™ MOSFETs with smaller  $C_{oss}$  reduce transient losses
- › TO247, 4-pin package reduces switching losses
- › 1700 V CoolSiC™ MOSFETs enable high efficiency in auxiliary power board

## High reliability

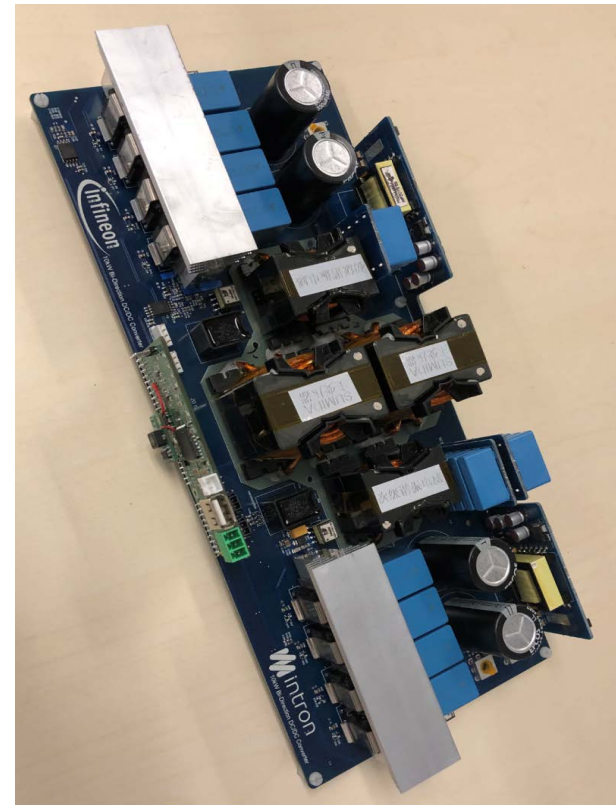
- › 1700 V CoolSiC™ MOSFET in D<sup>2</sup>PAK-7L offers high creepage

## High power density



- › Compact system design, reduced size and weight

## Easy of use

- › IED driver IC combined with CoolSiC™ MOSFETs reduce the design effort
- › Controller drives 1700 V CoolSiC™ MOSFETs directly



# 1200 V – 1700 V CoolSiC™ MOSFET portfolio and upcoming products

	$R_{DS(on)}$ [mΩ]	TO-247 3 	TO-247 4 	D <sup>2</sup> PAK-7L  	D <sup>2</sup> PAK-7L extended creepage  
1200 V	30	IMW120R030M1H	IMZ120R030M1H	IMBG120R030M1H	
	45	IMW120R045M1	IMZ120R045M1	IMBG120R045M1H	
	60	IMW120R060M1H	IMZ120R060M1H	IMBG120R060M1H	
	90	IMW120R90M1H	IMZ120R090M1H	IMBG120R090M1H	
	140	IMW120R140M1H	IMZ120R140M1H	IMBG120R140M1H	
	220	IMW120R220M1H	IMZ120R220M1H	IMBG120R220M1H	
	350	IMW120R350M1H	IMZ120R350M1H	IMBG120R350M1H	
1700 V	450				IMBF170R450M1
	650				IMBF170R650M1
	1000				IMBF170R1K0M1

# Summary



CoolSiC™ solutions

As reliable as Si power transistors from Infineon

Outstanding performance and best ease of use

Comprehensive portfolio – all in mass production

This is the revolution you can rely on!

For more product information, please visit

**Webpage:** [www.infineon.com/coolbic-mosfet](http://www.infineon.com/coolbic-mosfet)

**Forum:** [www.infineonforums.com/forums/34-Silicon-Carbide-\(SiC\)-Forum](http://www.infineonforums.com/forums/34-Silicon-Carbide-(SiC)-Forum)

# Find the right product for the right application

More information is available on Infineon website:

[www.infineon.com/coolpic-mosfet](http://www.infineon.com/coolpic-mosfet)

[www.infineon.com/tools](http://www.infineon.com/tools)

## Application learning

**Block diagrams**  
**Online information**

## System understanding

**Digital prototyping**  
**Online simulation tools**

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