

# 3300 W 54 V bi-directional phase-shift full-bridge with 600 V CoolMOS™ CFD7 and XMC™

EVAL\_3K3W\_BIDI\_PSFB

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# General description

## Introduction

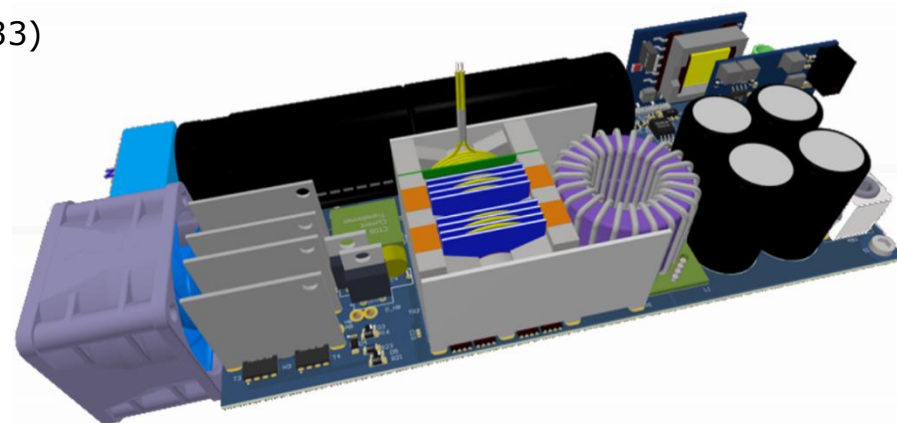
This Infineon evaluation board (EVAL\_3K3W\_BIDI\_PSF) represents a complete system solution for a 3300 W telecom or battery charging DC-DC converter, which achieves 98 percent efficiency peak. The DC-DC converter comprises a ZVS PSFB with bi-directional capability (patent pending).

To achieve the high efficiency results the evaluation board features several Infineon components:

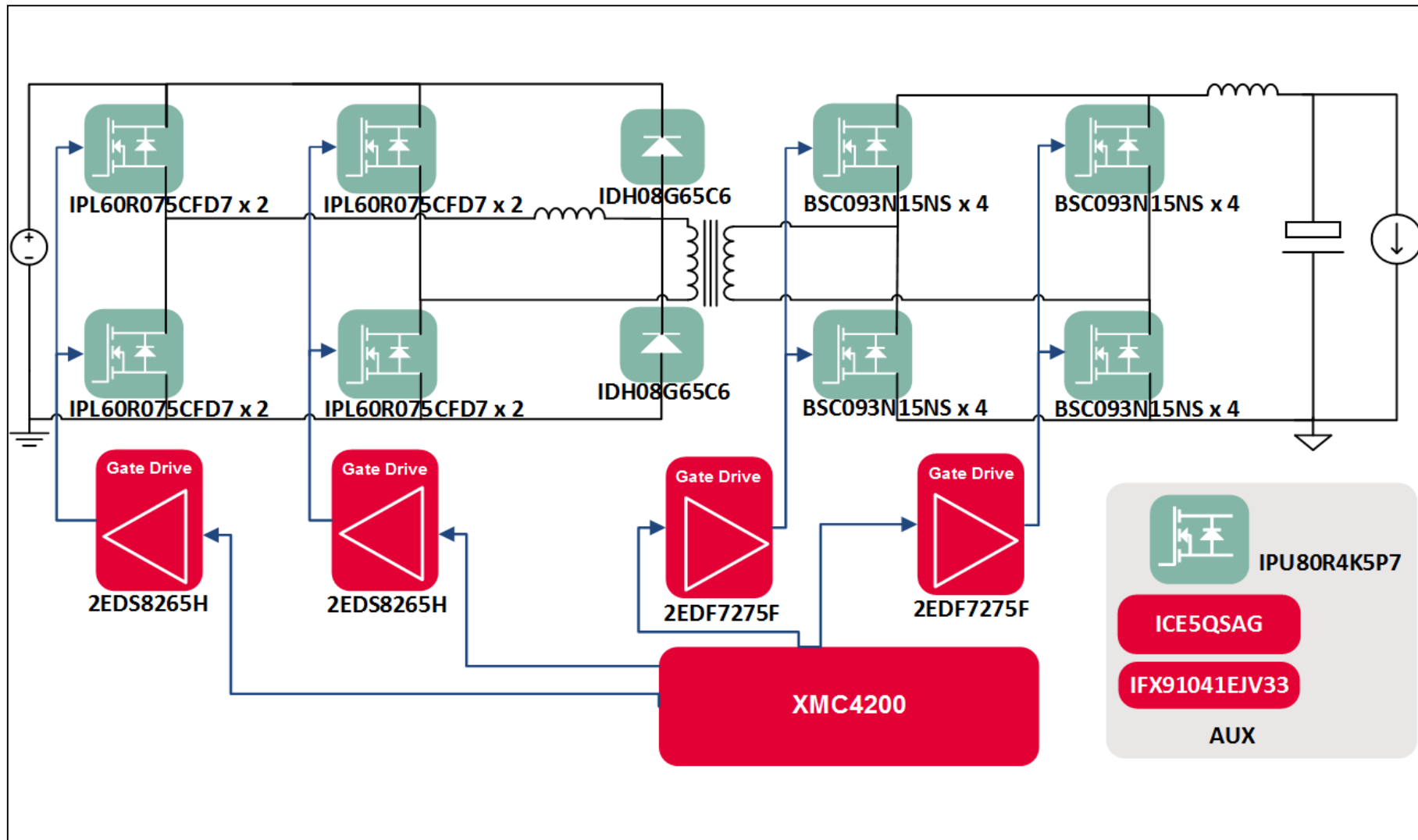
- › 75 mΩ 600 V CoolMOS™ CFD7 (IPL60R075CFD7) in the high voltage (HV) bridge
- › 9.3 mΩ OptiMOS™ 5 150 V in Super SO-8 package (BSC093N15NS5) in the low voltage (LV) bridge
- › EiceDRIVER™ gate driver IC (2EDS8265H safety isolated and 2EDF7275F functional isolated)
- › XMC™ microcontroller for control implementation (XMC4200-F64k256 BA)
- › Quasi-resonant flyback controller (ICE5QSAG) with external 800 V CoolMOS™ P7 4.5 Ω (IPU80R4K5P7)
- › CoolSiC™ Schottky diode 650V G6 (IDH08G65C6)
- › Medium power Schottky diode (BAT165)
- › DC-DC step-down voltage regulator (IFX91041EJV33)

## Board parametrics:

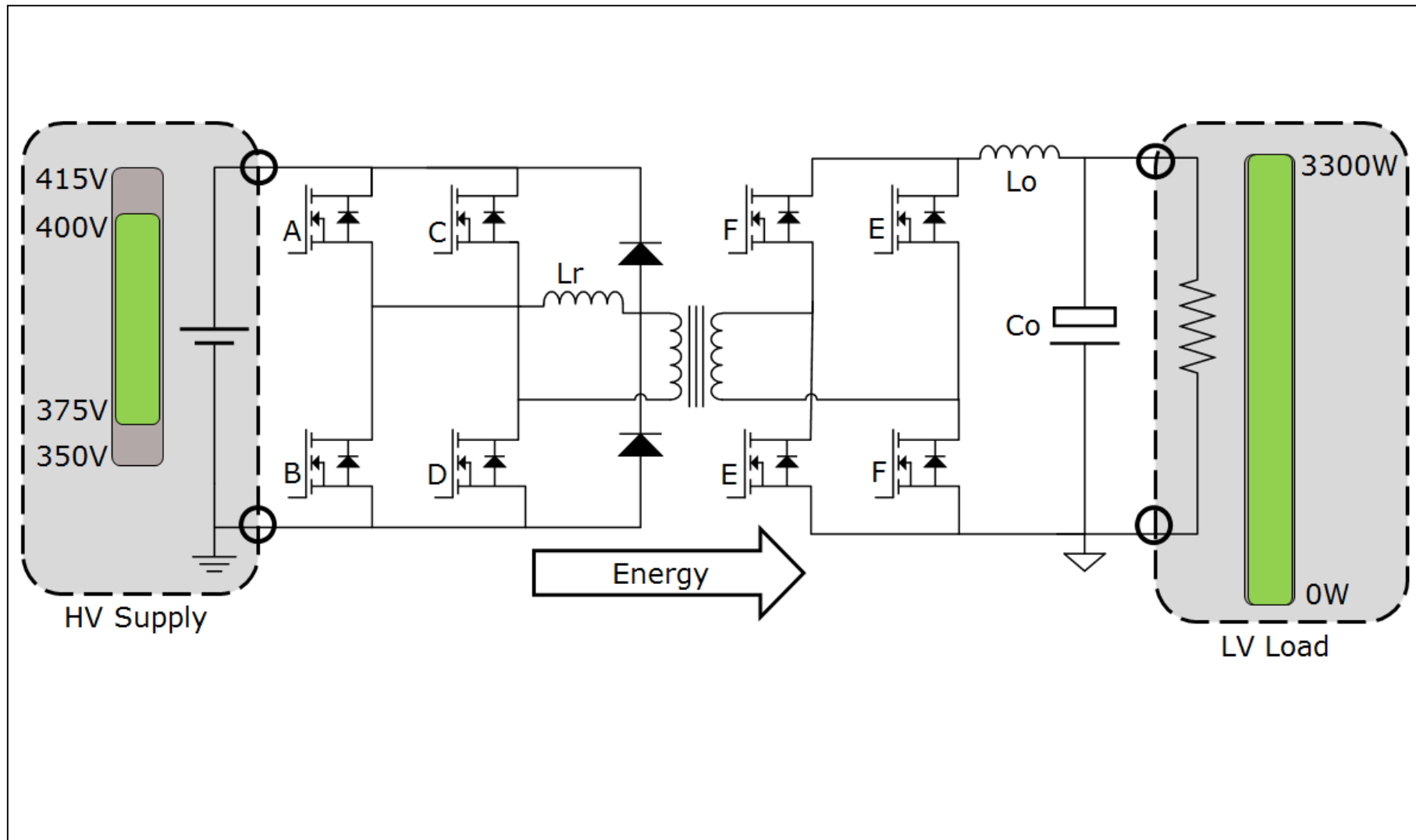
- › Input voltage: 350 V<sub>DC</sub> – 415 V<sub>DC</sub>
- › Output voltage: 60 V<sub>DC</sub> – 40 V<sub>DC</sub>
- › Output power: 3300 W
- › Switching frequency: 100 kHz
- › Peak efficiency: 98%



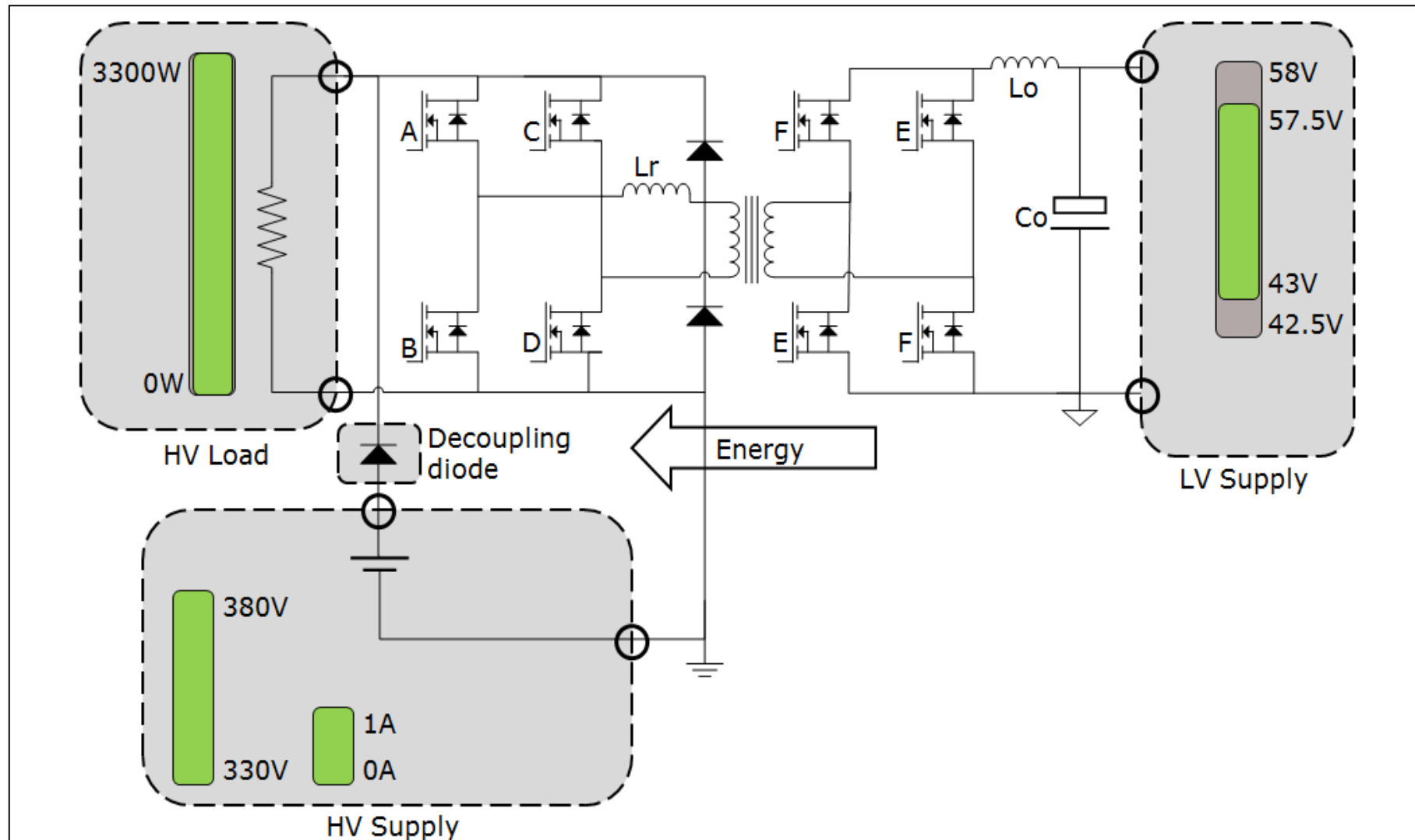
# Simplified diagram



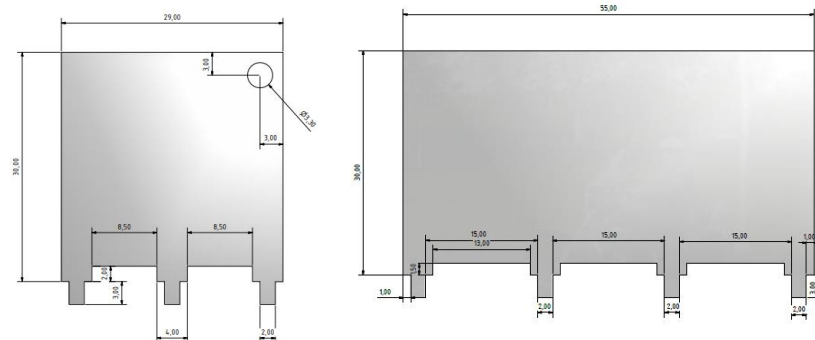
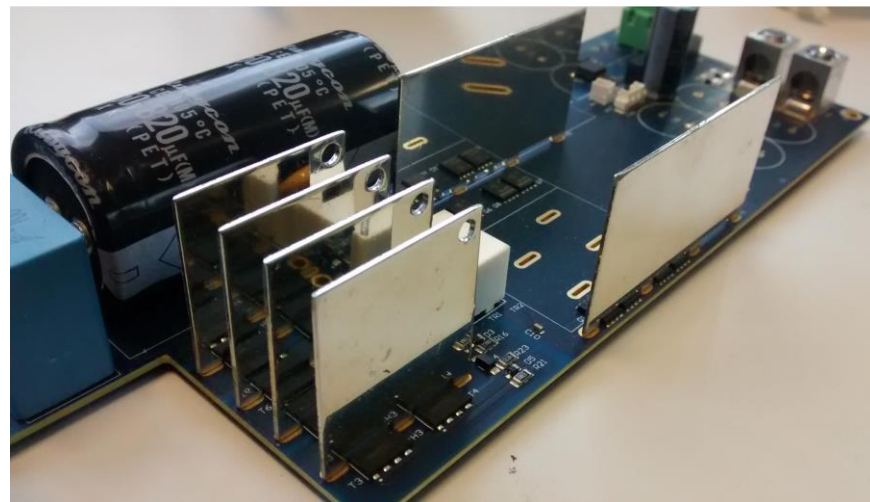
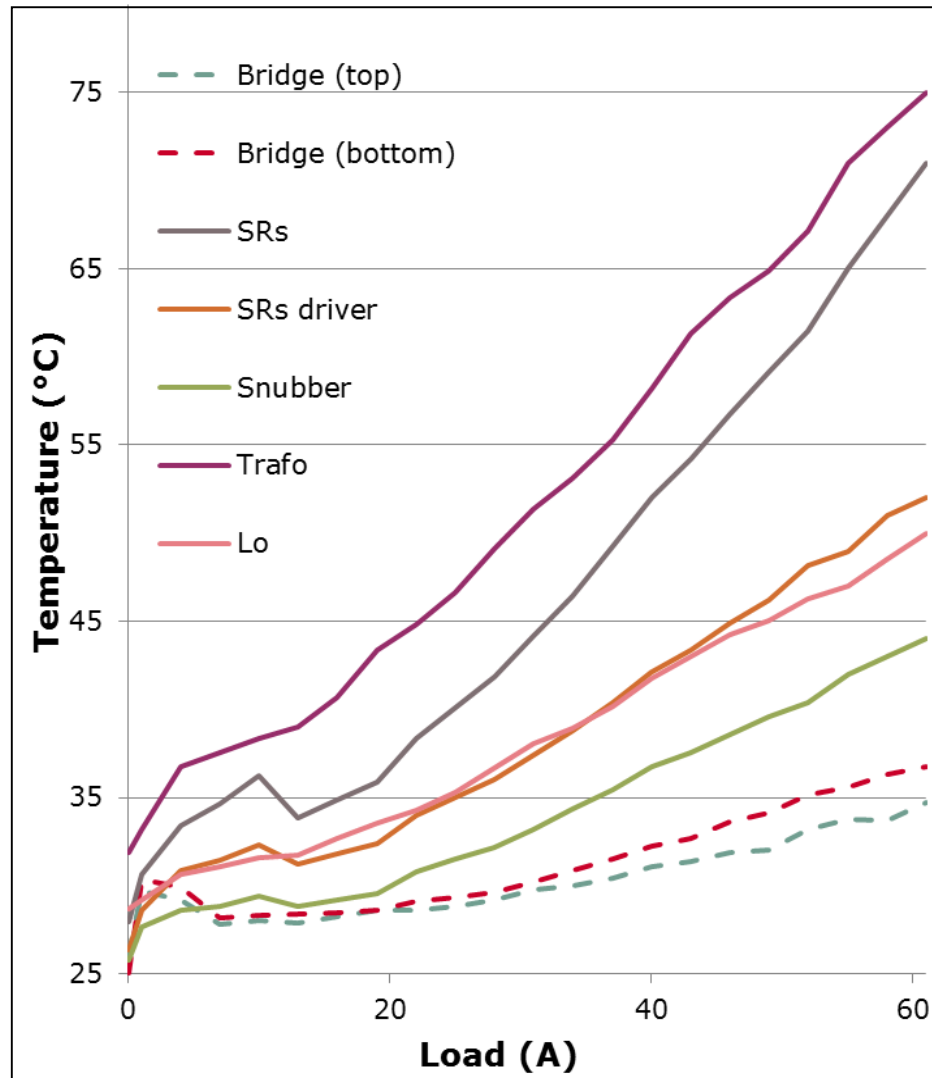
# Buck operation



# Boost operation

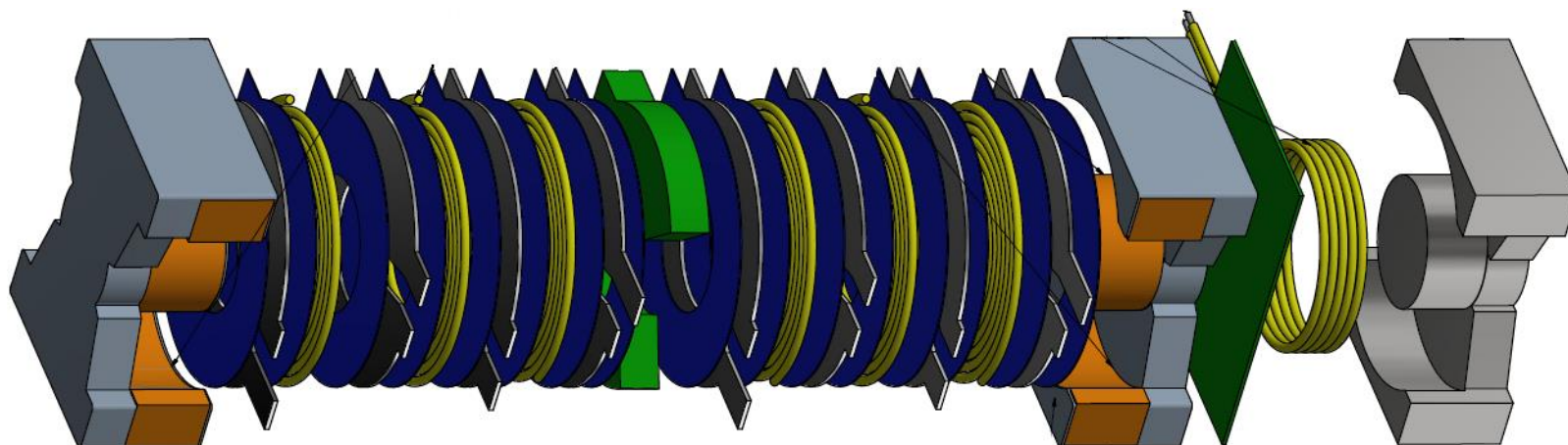
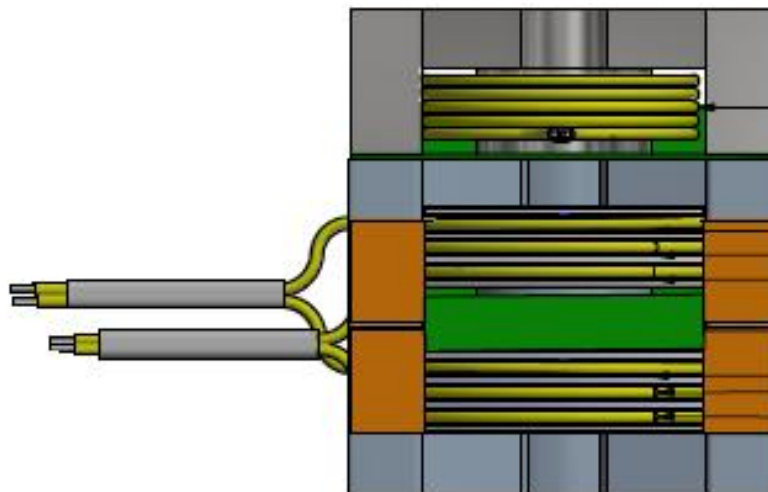


# Innovative cooling for SMD devices

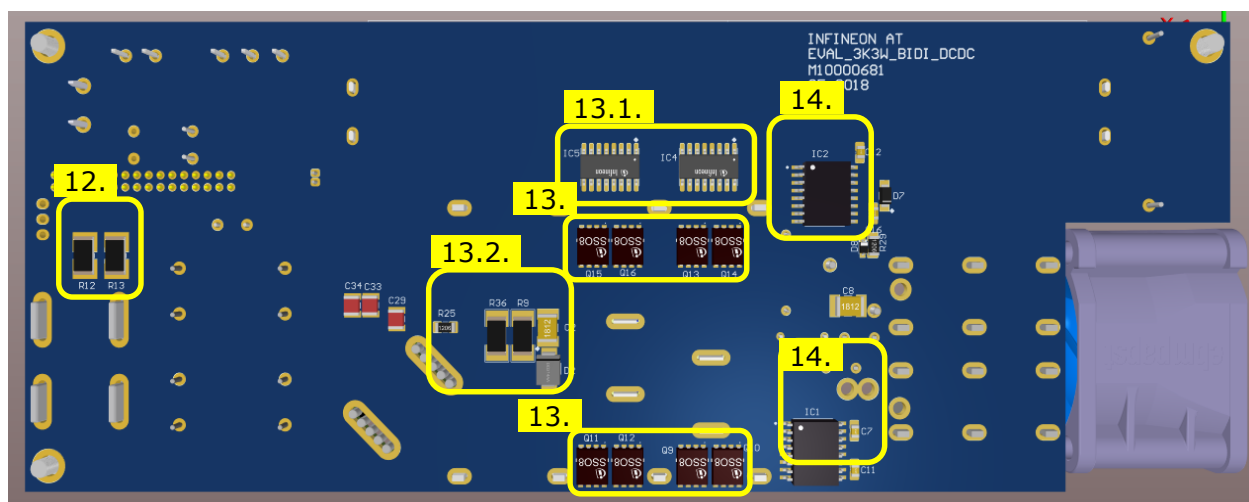
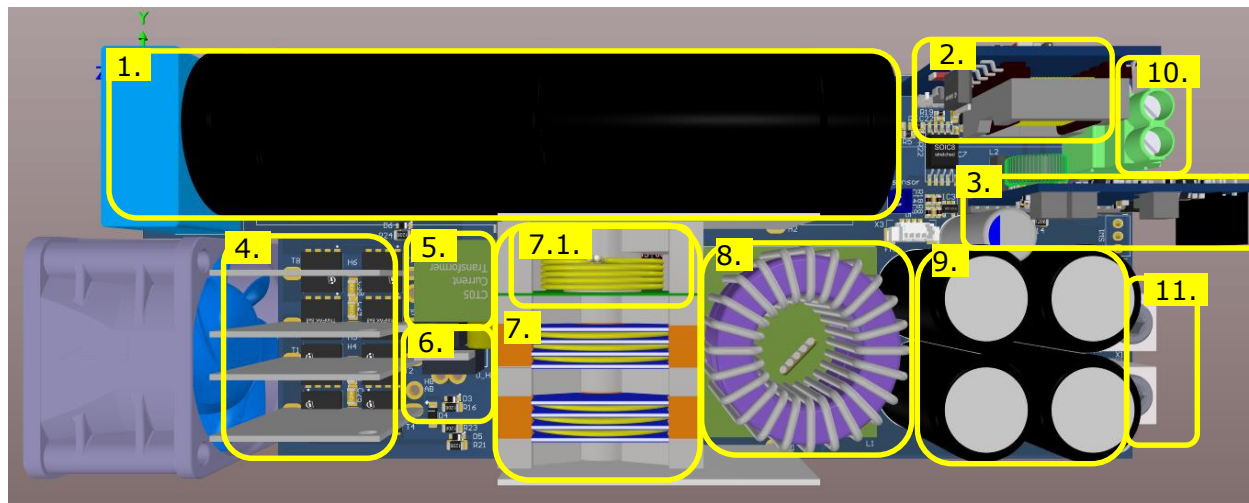


# Stacked magnetic structure

Item	Value	Manufacturer
<b>Lm</b>	650 $\mu$ H	ICE
<b>Lr</b>	11 $\mu$ H	ICE
<b>Transformer core</b>	PQ35 / 28	DMR95 DMGC
<b>Lr core</b>	PQI35 / 23	DMR95 DMGC
<b>Primary wire</b>	7 x 0.3 mm Litz	Furukawa
<b>Lr wire</b>	120 x 0.1 mm Litz	
<b>Secondary wire</b>	0.5 mm copper plate	



# Board distribution



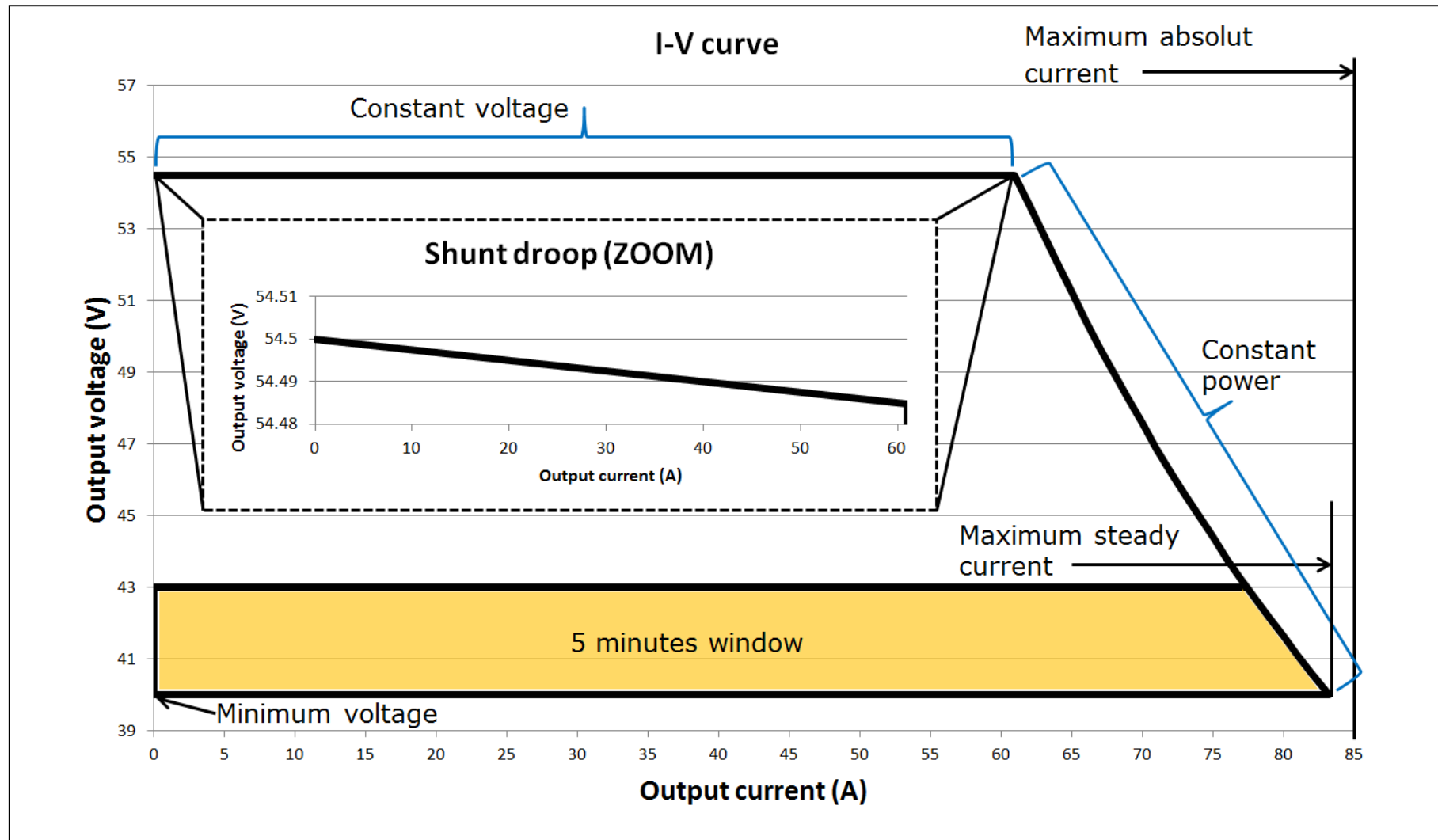
## Functional blocks

1. HV Bulk
2. Bias supply
3. Control card
4. HV bridge
5. C. Sence
6. C. Diodes
7. Maintransformer
  - 7.1. LR
8. Output choke
9. Output capacitor
10. Input connector
11. Output connector
12. Output shunt
13. Synchronous Rectification
  - 13.1. Functional isolated Driver (SR)
  - 13.2. Snubber (SR)
14. Reinforced isolated Drivers (Bridge)

\*SR - Synchronous Rectification



# Buck operation current-voltage curve



# User interface

The screenshot displays the Infineon SMPS software interface for a PSFB 3300W converter. The interface is organized into several functional areas:

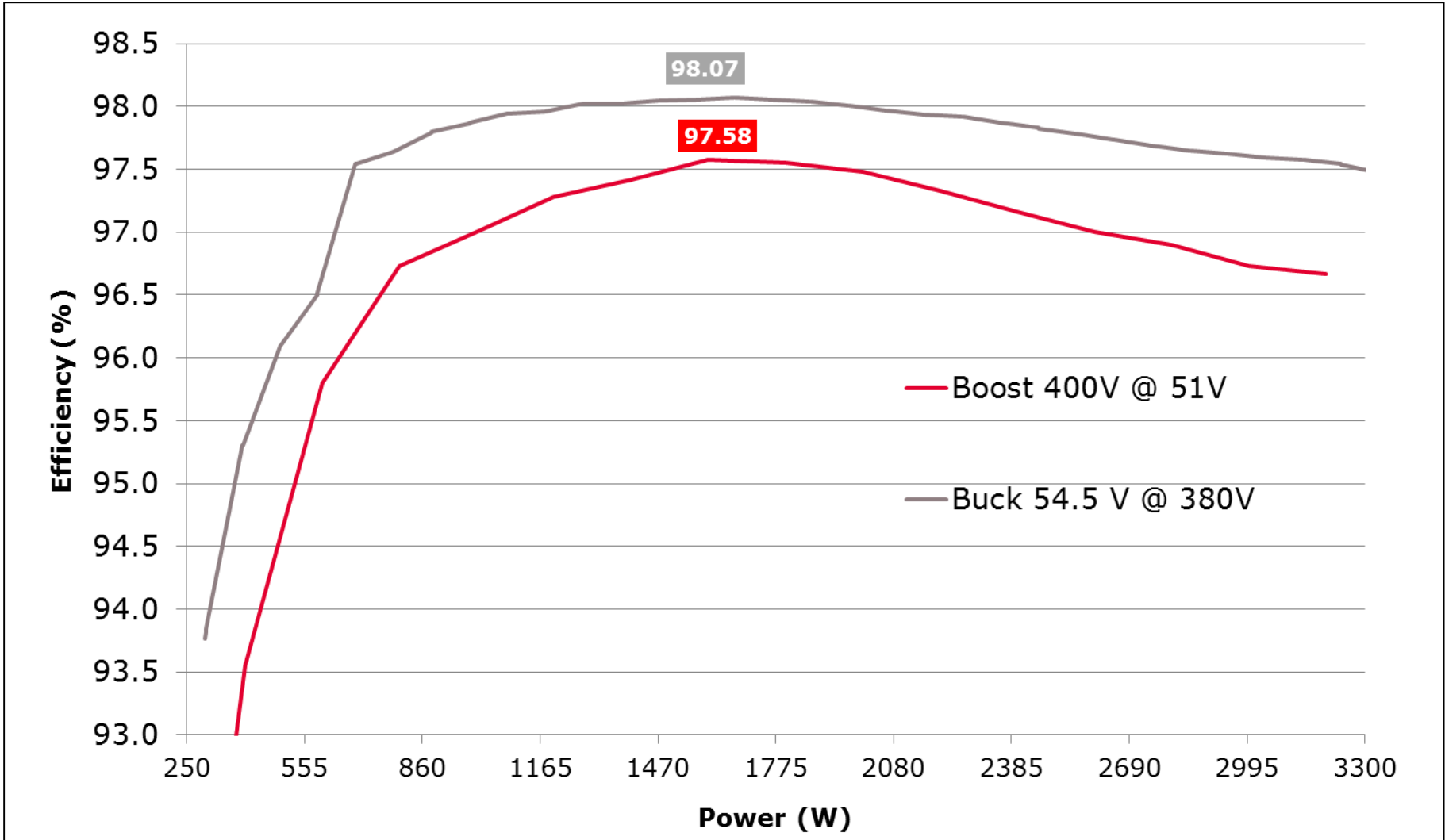
- Header:** Shows 'Infineon SMPS', 'Board:', 'Converter: PSFB 3300W', and 'Soft Version: 1.0'.
- VOLTAGES:** Includes 'Output voltage: 13878 ADC units' and 'Brown in voltage: 9991 ADC units'.
- BRIDGE:** Features 'Buck' and 'Boost' modes. Parameters include 'Dead time AB: 337.5 ns', 'Dead time CD: 400 ns', 'AB factor: 0.005', 'CD factor: 0.006', and 'Current ratio: 10 power of 2'.
- SYNCHRONOUS:** Parameters include 'ON DCM delay: 62.5 ns', 'ON delay: 50 ns', 'OFF delay: 250 ns', 'ON factor: 0.000', 'OFF factor: 0.006', 'DCM limit: 280 ADC units', and 'SYNC OFF limit: 280 ADC units'.
- BURST:** Parameters include 'BURST stop: 39%', 'BURST low thr.: 49%', 'BURST high thr.: 59%', 'MIN phase: 20%', 'BURST phase: 20%', 'BURST skip cyc.: 50 pulses', 'BURST length: 50 pulses', and 'BURST frq.: 1.00 kHz'.
- CONTROL:** Includes 'ON/OFF' buttons, a 'Warning' icon, and 'Receive', 'Send', 'Store' buttons.
- STATUS/FAULTS:** Shows 'ENABLED', 'SOFT START', 'BURST', 'SYNC\_MODE\_2 UV/OV', 'SYNC\_MODE\_1 FAN FAIL', 'SYNC\_DIODES', 'OVERTEMP', 'BOOST', and 'TEMP. WARNING'.
- PROTECTIONS:** Includes 'Soft start', 'Input UVLO', and 'Fan detection' checkboxes, along with a warning icon.
- Diagram:** A schematic diagram of the PSFB converter circuit, showing the HV Load (3300W/3200W), HV Supply (380V/330V), and LV Supply (58V/57.5V/43V/42.5V).
- Bottom Panel:** Displays 'H V' and 'L V' input/output parameters (Current, Voltage, Power) and 'TEMPERATURE' (NTC, Ambient) with sliders and status indicators.
- Footer:** Shows 'Adapter plugged-in and ON (COM11)' and the Infineon logo.

# Summary of specifications

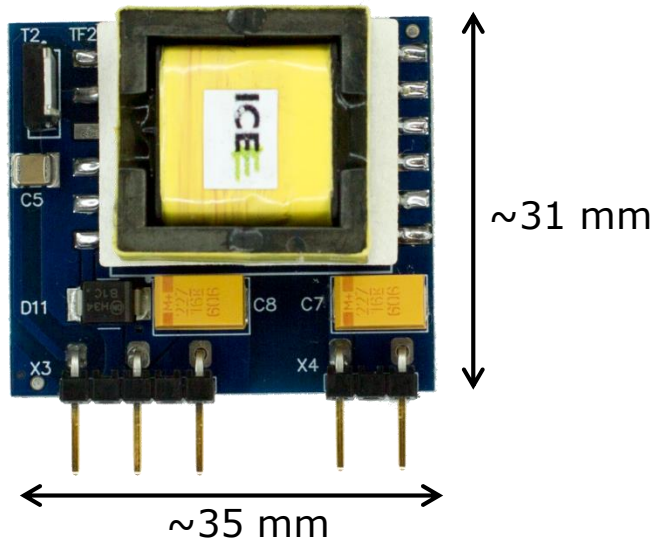
Test	Conditions	Specification
<b>Efficiency test</b>	380 V input, 54.5 V output	$\eta_{pk} = 98\%$ at 1500 W (50% load)
<b>Output voltage</b>		60 V – 40 V
<b>Steady-state <math>V_{out}</math> ripple</b>	380 V input, 54.5 V output	$ \Delta V_{out} $ less than 200 mV <sub>pk-pk</sub>
<b>Brown-out</b>		370 V on – 350 V off 415 V off – 390 V on
<b>Load transient</b>	5 A ↔ 31 A, 0.5 A/ $\mu$ s	$ \Delta V_{out} $ less than 450 mV <sub>pk</sub>
	31 A ↔ 61 A, 0.5 A/ $\mu$ s	
<b>OCP</b>	5 min. at 77 A - 83 A	Shut down and resume after 5 min.
	1 ms at 83 -85 A	
	20 $\mu$ s at 85 A	Shut down and latch
	Output terminals in short-circuit	Detection within switching cycle Shut down and latch

# Efficiency

## Bias and fan included



# Bias board KIT\_6W\_12V\_P7\_950V



Ordering code:  
KIT\_6W\_12V\_P7\_950V

## Board components

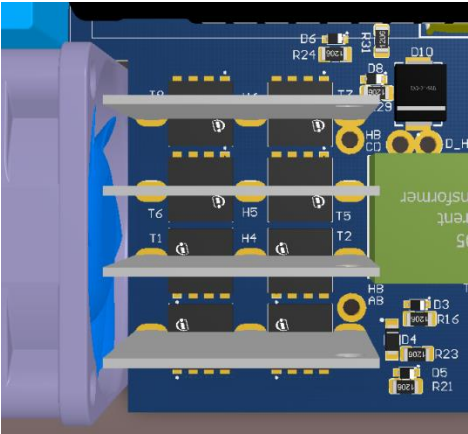
- › CoolSET™ standalone controller (ICE5QSAG)
- › 950 V CoolMOS™ P7 SJ MOSFET (IPU95R3K7P7)

## Board specifications

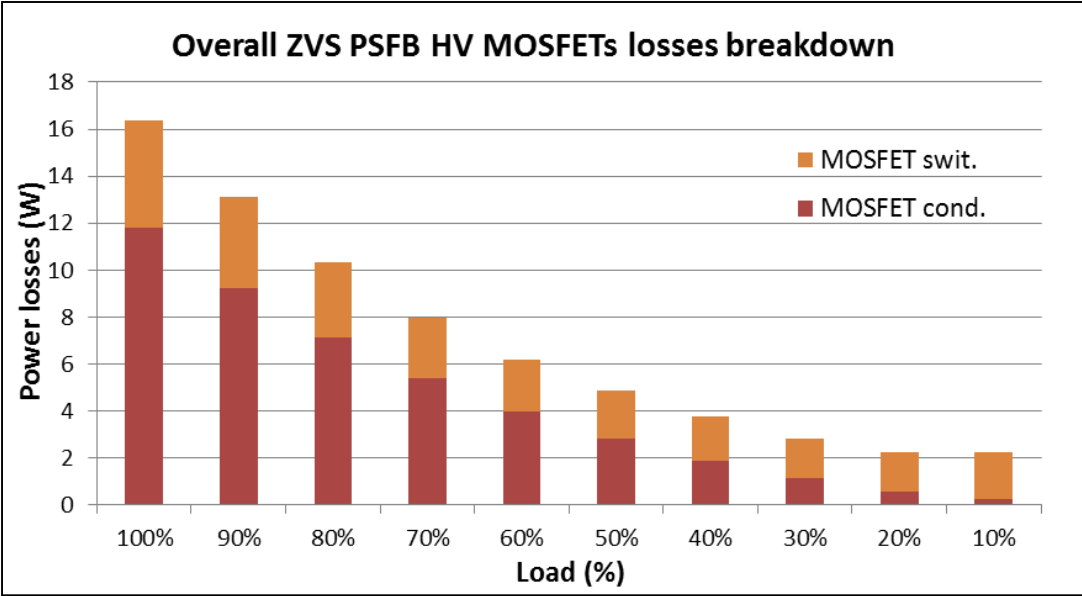
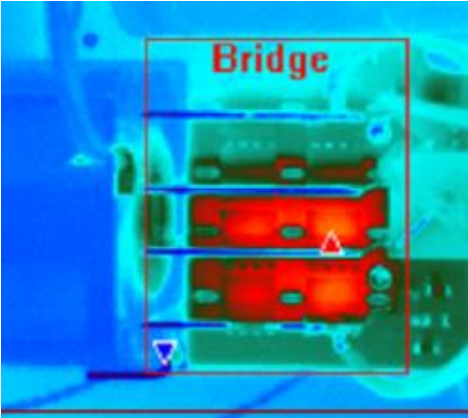
- › Input voltage:  $90 V_{DC} - 400 V_{DC}$
- › Output voltage:  $12 V_{DC}$  (prim. and sec. side)
- › Output power max.: 6 W (prim. + sec. side)

Auxiliary supply solution featuring off-line SMPS current mode controller IC with an 950 V CoolMOS™ SJ MOSFET

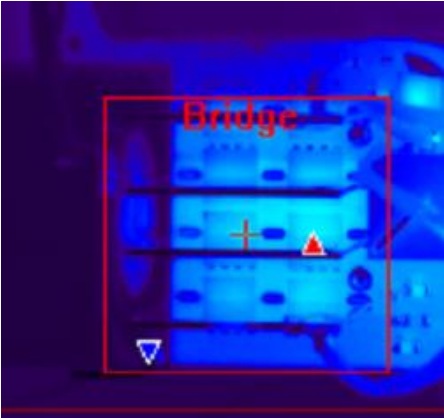
# 600 V CoolMOS™ CFD7 (IPL60R075CFD7) HV bridge MOSFETs



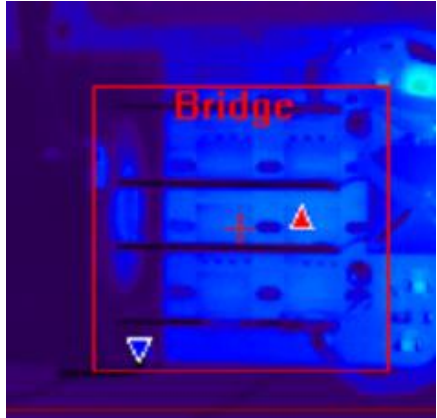
**36°C @ 1A**



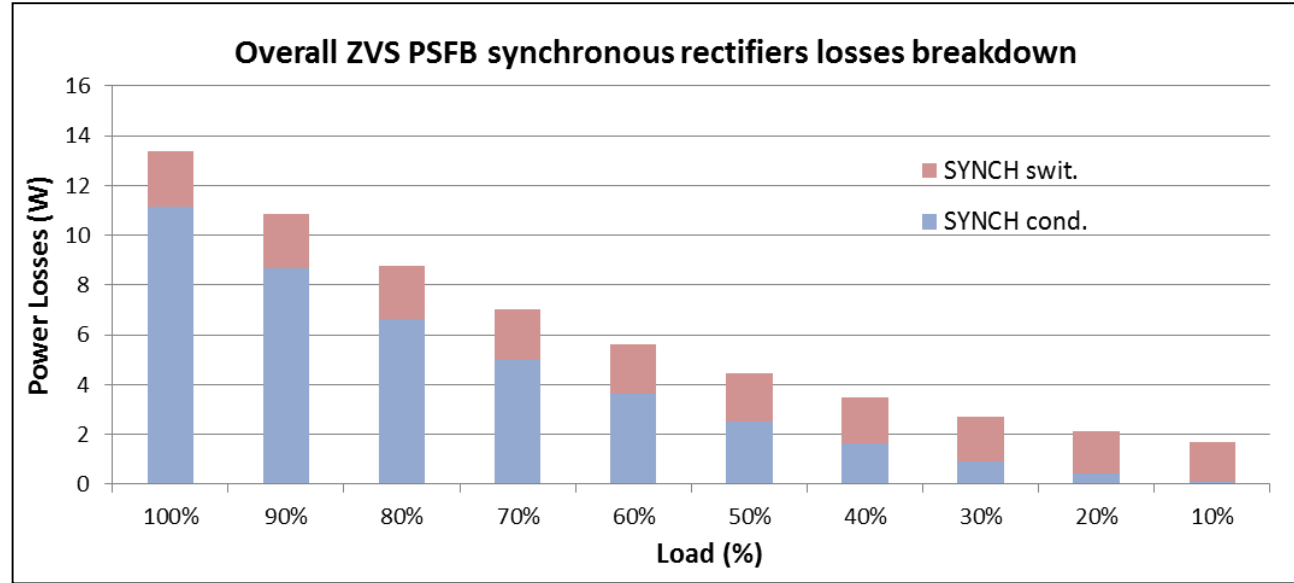
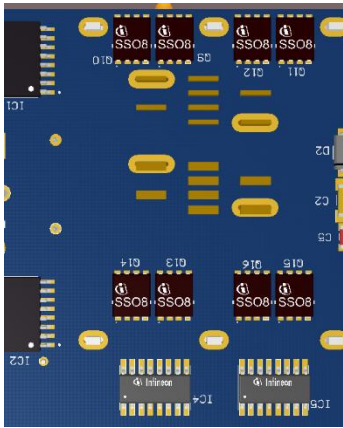
**34°C @ 34A**



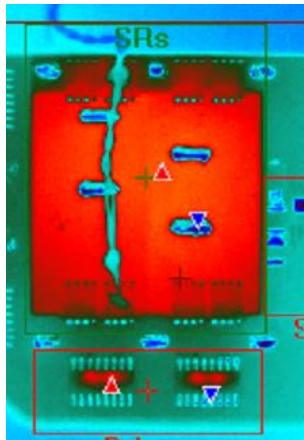
**43°C @ 61A**



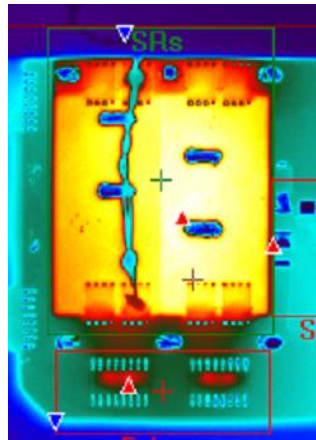
# OptiMOS™ 5 150 V (BSC093N15NS) SR bridge MOSFETs



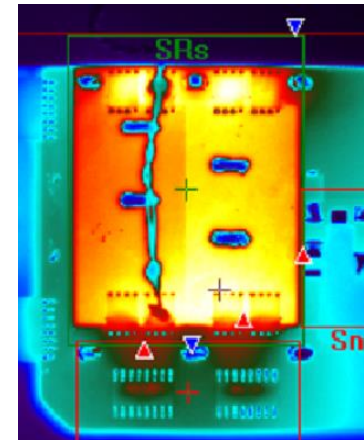
**33°C @ 1A**



**53°C @ 34A**

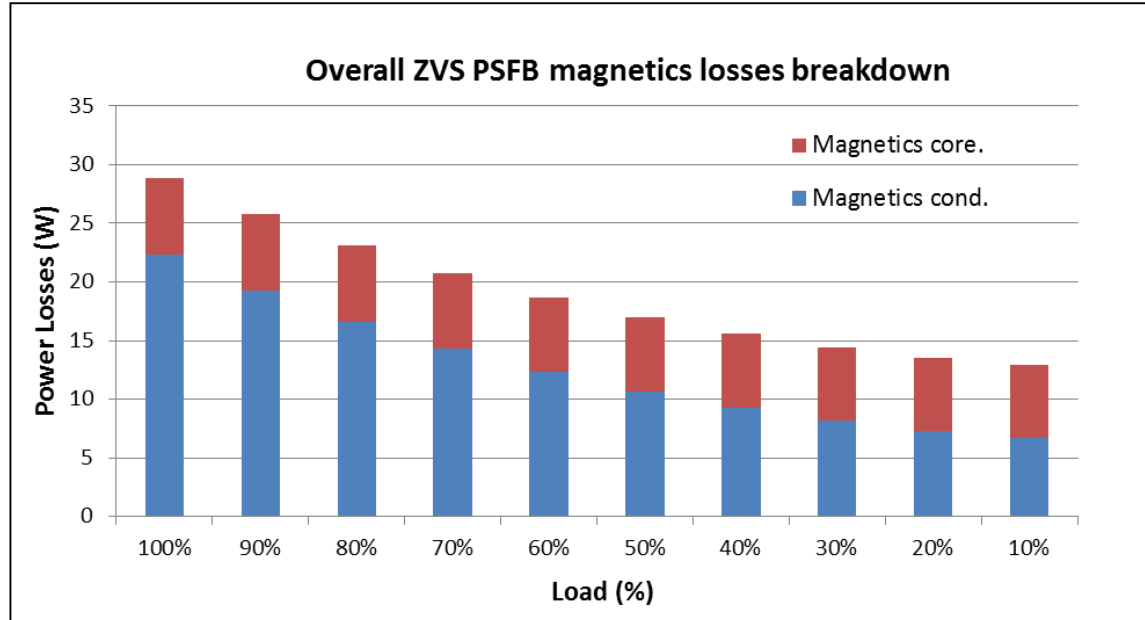
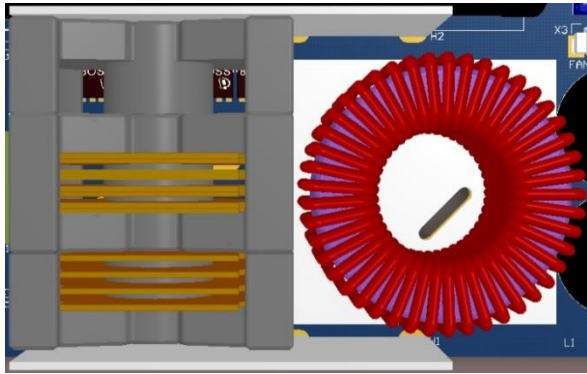


**76°C @ 61A**

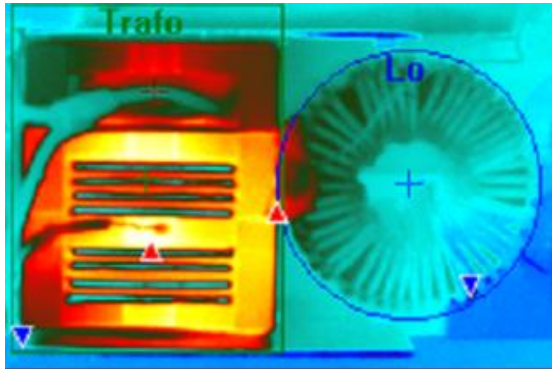




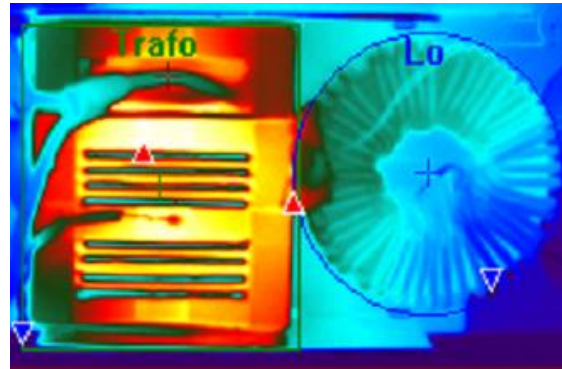
# Magnetics: Transformer, resonant inductance and output choke



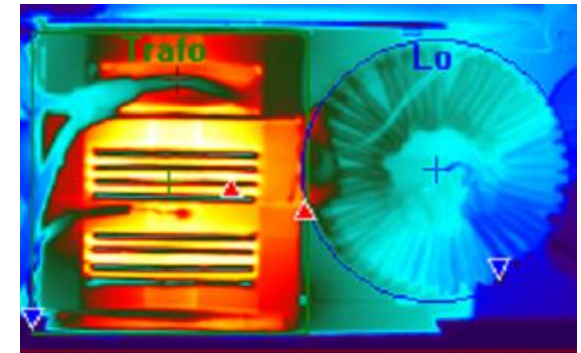
**39°C @ 1A    36°C @ 1A**



**70°C @ 34A    58°C @ 34A**



**86°C @ 61A    68°C @ 61A**





# Summary

- › The trend in the field of switched mode power supplies (SMPS) in the last years moves towards the increase of power density with an optimized cost. In order to achieve this higher power density, high efficiency is a key parameter since heat dissipation must be minimized
- › The 3300 W DC-DC converter evaluation board developed with Infineon semiconductors, is a good example of how to achieve high efficiency level and high power density in telecom and battery charging applications
- › Fully resonant topologies, like LLC, are traditionally considered best possible solution for high power, high voltage DC-DC converters. The EVAL\_3K3W\_BIDI\_PSFb demonstrates PSFB topology can achieve similar or equal levels of performance
- › Unlike the bi-directional operation in other resonant topologies, the proposed bi-directional operation of PSFB in EVAL\_3K3W\_BIDI\_PSFb does not constrain the design, does not have any impact on efficiency nor requires any additional components
- › This telecom or battery charging DC-DC converter allows as well the implementation and test of future Infineon devices and technologies



## Technical Material

- > Application Notes
- > Simulation Models
- > Datasheets

> [EVAL\\_3K3W\\_BIDI\\_PSF](#)

## Evaluation Boards

- > Evaluation Boards
- > Demoboards
- > Reference Designs

> [www.infineon.com/evaluationboards](http://www.infineon.com/evaluationboards)

## Videos

- > Technical Videos
- > Product Information Videos

> [www.infineon.com/mediacenter](http://www.infineon.com/mediacenter)

# Support Online tools and services



The screenshot shows the Infineon website header with the following elements:

- Infineon logo
- Navigation menu: Products, Applications, **Tools** (highlighted with a red box and number 3), About Infineon, Careers
- Utility menu: **Newsletter** (highlighted with a red box and number 1), Contact, **Where to Buy** (highlighted with a red box and number 2), English, Login
- Search bar with a magnifying glass icon
- Main content area: A large image of a city skyline at night with the word "Lighting" overlaid. Below the image is a text snippet: "New LED controller enables low-wattage luminaire designs August 26th 17:00 CEST" and a "Register Now!" button with a right arrow.
- Left and right navigation arrows on the main content area.
- Bottom navigation dots.

- 1 **Subscribe to Newsletter**
- 2 **Where to Buy**
- 3 **Tools, Finders and Selectors**
- 4 **Support**

- Products
- Applications
- Tools
- **Support** (highlighted with a red box and number 4)
- Technology

- **Power**
- Automotive System IC
- ESD & EMI
- Microcontroller
- RF & Wireless Control
- Security IC
- Sensor
- Smart Card IC
- Interface
- Transistor & Diode

- Power Overview
- Power MOSFET
- IGBT
- Smart Low-Side & High-Side Switches
- Linear Voltage Regulator
- DC-DC Converter
- LED Driver | Lighting ICs
- Silicon Carbide (SiC)
- High Power Thyristors & Diodes
- Motor Control & Gate Driver
- AC-DC Supply



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