

Your design consideration – our wide bandgap expertise



인피니언 전력반도체 솔루션
가상부스에 오신 걸 환영합니다!

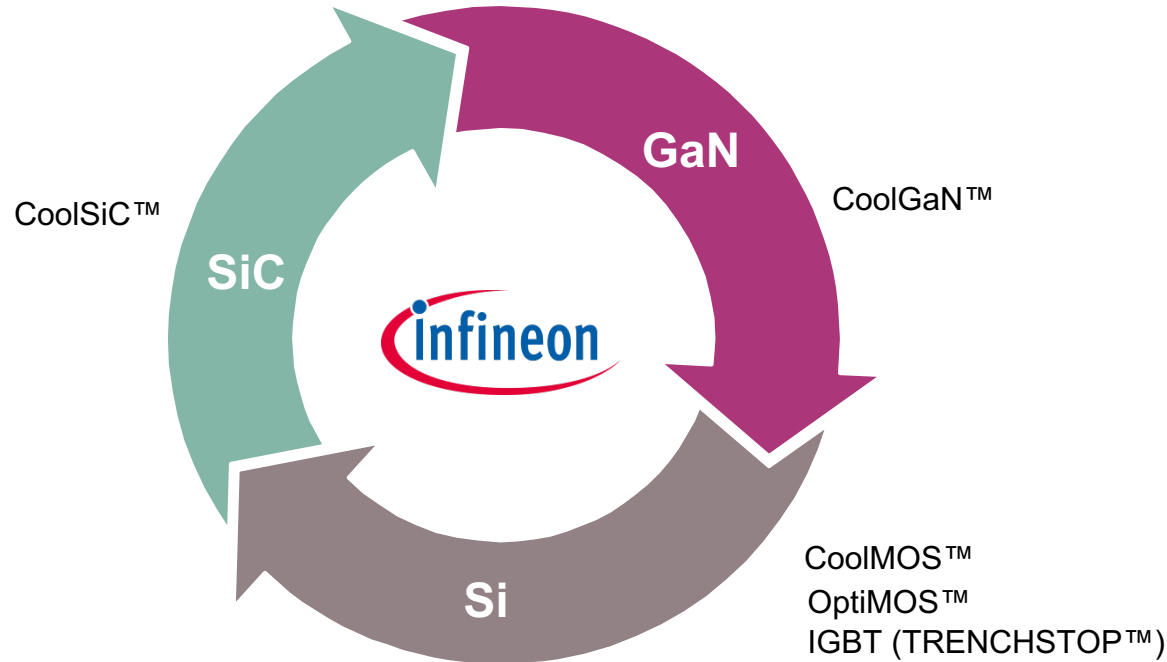


Si, SiC and GaN

Infineon masters all power technologies...

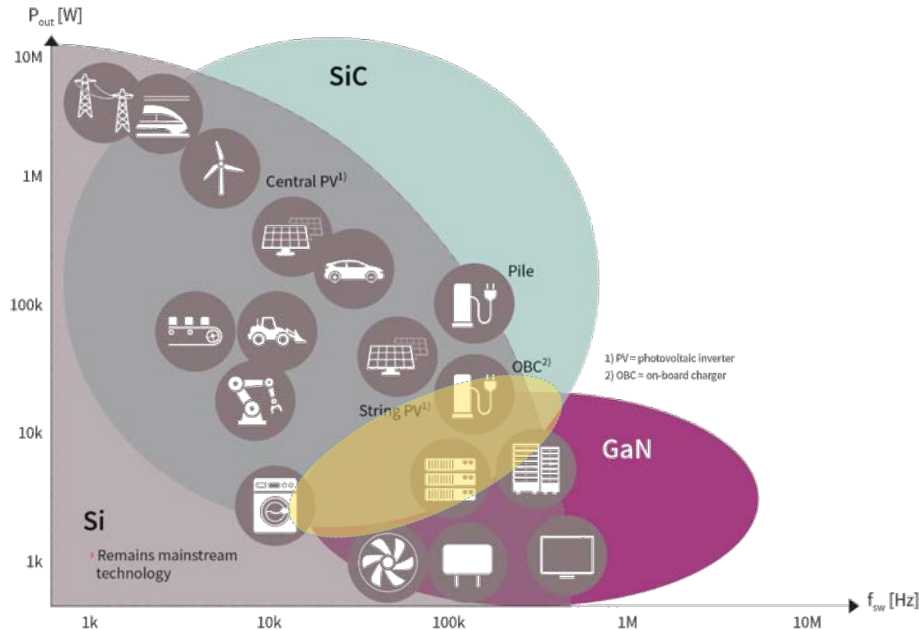


...and is the trusted advisor for all of them



Si, SiC and GaN

Overall positioning of the 3 technologies



Silicon (Si)

- › Targeting around 25 V – 1.7 kV
- › Main stream technology
- › Suitable across all power ranges

Silicon carbide (SiC)

- › Targeting around 650 V – 3.3 kV
- › High power – high switching frequency

Gallium Nitride (GaN)

- › Targeting around 80 V – 650 V
- › Medium power – highest switching frequency

600 V/650 V segment

CoolMOS™, CoolSiC™ and CoolGaN™ coexists. Depending on requirements, they have different value proposition in applications such as: Datacenter and telecom SMPS, Industrial SMPS, solar inverters, energy storage, UPS, battery formation, motor drives, EV charging plus automotive applications like OBC (on-oard charger)

600 V/650 V CoolMOS™, CoolSiC™ and CoolGaN™

The key benefits positioning summary



CoolMOS™

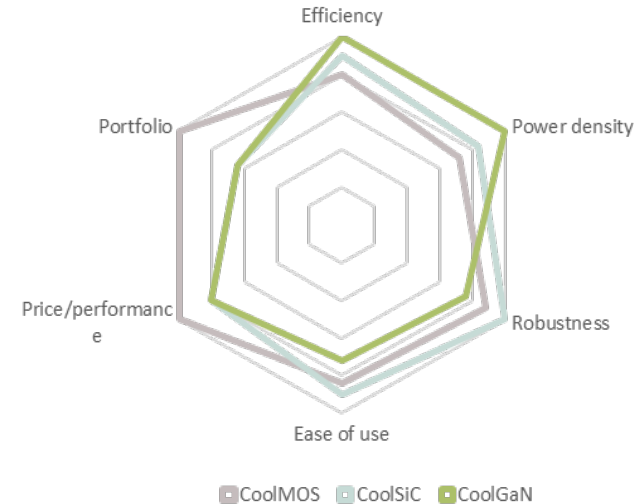
- › Meets most of application requirements, keeping cost/performance benefit
- › Meets most of the density requirements
- › Largest SJ MOSFET portfolio on the market
- › Mature, stable, well established

CoolSiC™

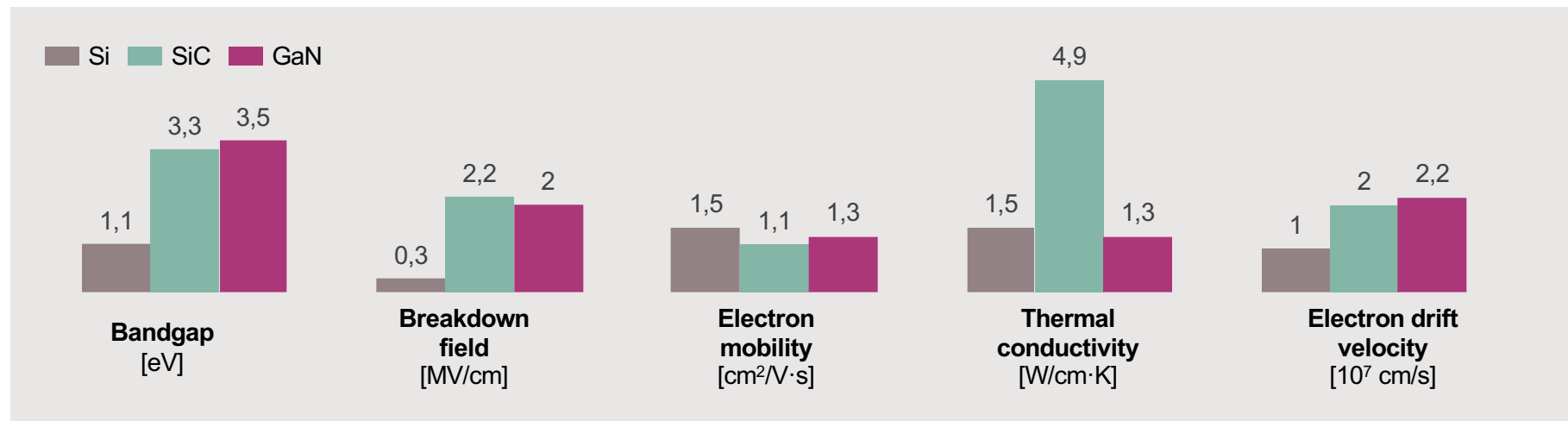
- › High performance combined with ruggedness and ease of use
- › High reliability especially with high temperature and in harsh environments
- › Switching frequency: up to 300kHz with little efficiency deterioration
- › Smaller system size
- › Enable topologies with hard commutation
- › Bi-directional topologies

CoolGaN™

- › Highest efficiency at the highest frequency. Switching frequency: up to 1Mhz with little efficiency deterioration
- › Smallest system size
- › Enables system integration
- › Enable topologies with hard commutation
- › Bi-directional topologies



Si, SiC and GaN show different material properties



The wide bandgap of GaN and SiC....

...enables higher breakdown fields...

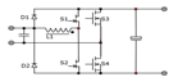
...allowing for strong minituarization of devices and significant improvements of figures of merit (FOM) for power switches...

600V/650V CoolMOS™, CoolSiC™ and CoolGaN™

FOMs analysis

DEVICE	$V_{(BR)DSS}$ [V]	$R_{DS(on)} \cdot Q_{rr}$ [mΩ * μC]	$R_{DS(on)} \cdot E_{oss}$ [mΩ * μJ]	$R_{DS(on)} \cdot Q_g$ [mΩ * nC]	$R_{DS(on)} \cdot Q_{os}$ [mΩ * μC]
CoolMOS™ 7	600	100%	100%	100%	100%
CoolMOS™ 7 – fast diode	600	10%	104%	108%	104%
CoolGaN™ Gen 1	600	0%	84%	6%	13%
CoolSiC™ Gen 1	650	2%	133%	41%	21%

Allows WBG usage in topologies with repetitive hard commutation (e.g. CCM totem-pole PFC) → BOM savings for highest efficiency

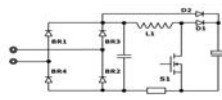


CCM PFC totem-pole



SiC/GaN in servers, OBC

Minimum switching losses in hard switching topologies (e.g. classic boost PFC) → higher efficiency with GaN



Classic Boost PFC

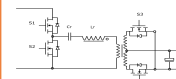
Si for best cost – performance ratio

Reduced driving losses especially at light-load conditions. Allows WBG to reach higher efficiency at increased frequency → power density increase (weight & size reduction).



high power density
e.g. GaN for chargers

Enables better soft-switching (e.g. half-bridge LLC), where WBG leads to higher efficiency combined with high frequencies



Half-Bridge LLC

SiC and GaN
e.g. in telecom

Both SiC and GaN allow an easier way than Si to top efficiency

The 3 products have similar behaviour in hard switching topologies like classic PFC

For power density, SiC is better than Si but the champion is GaN

SiC and GaN are both better than Si to reach both high efficiency and high density

SiC, GaN and Si Positioning – summary

	CoolMOS™	CoolSiC™	CoolGaN™
Efficiency	★★★★☆	★★★★★	★★★★★
Frequency	★★★★☆	★★★★★	★★★★★
Power Density	★★★★☆	★★★★★	★★★★★
Efficiency at max power density	★★★☆☆	★★★★☆	★★★★★
Robustness	★★★★☆	★★★★★	★★★☆☆
High temperature operations	★★★★☆	★★★★★	★★★★☆
Fit for bi-directional topologies	★★★☆☆	★★★★☆	★★★★★
Ease of use	★★★★☆	★★★★★	★★★★☆
Price performance(1)	★★★★★	★★★☆☆	★★★☆☆
Portfolio granularity	★★★★★	★★★☆☆	★★★☆☆

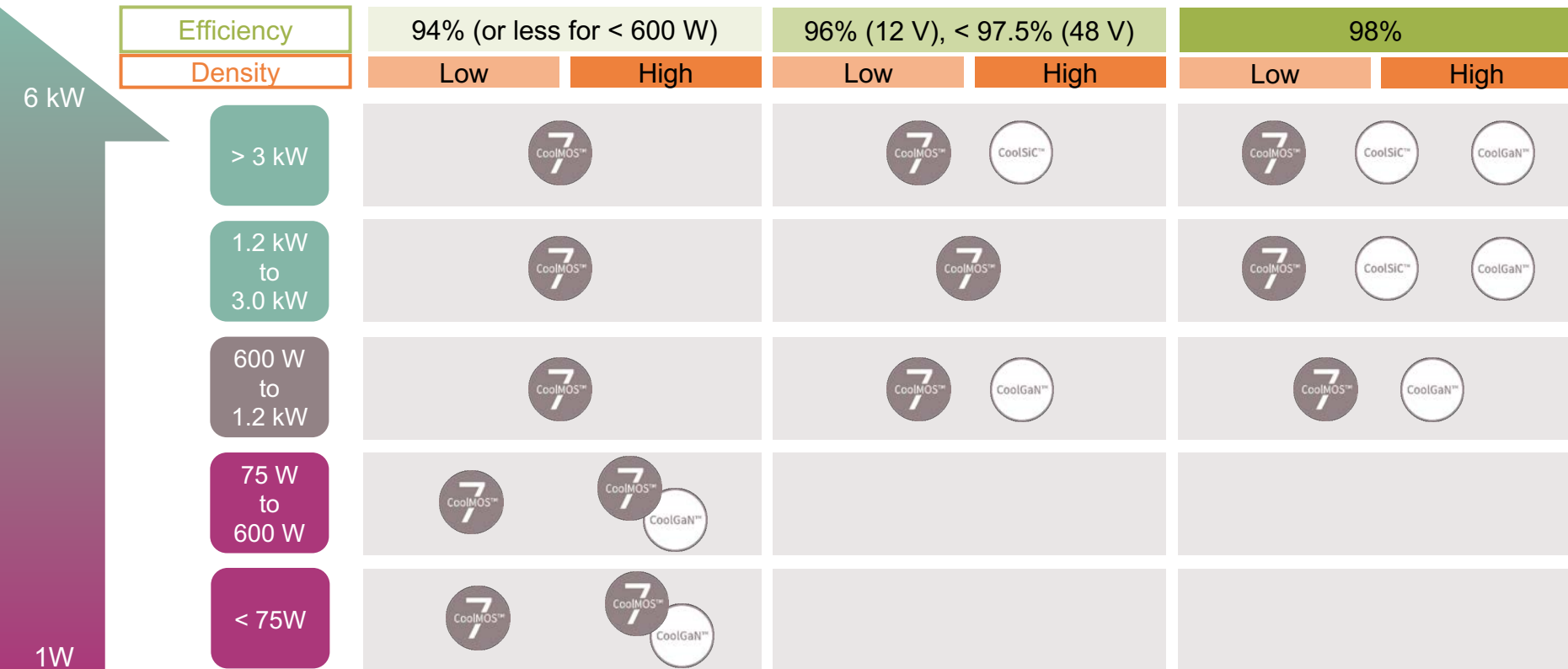
(1) Price performance depends largely on application and efficiency targets

(1) can use 35% less Ron

(2) can use 25% less Ron

(3) EMI, Coss clamping...

Example of positioning in SMPS with 600 V / 650 V Si, SiC & GaN



Applications and positioning per value drivers

	Energy efficiency	Power Density	BOM Savings	Bidirectional Capability	Weight Reduction	OPBX reduction	Higher Reliability and/or Harsh Environments	High temperature	System Simplification Ease of Use	High Current Operations
SMPS Datacenter	GaN or SiC	GaN	GaN or SiC			GaN or SiC			SiC	
SMPS Telecom Rectifier	GaN or SiC	GaN	GaN or SiC		GaN	GaN or SiC	SiC	SiC	SiC	
SMPS 5G Small Cell Outdoor			GaN or SiC		GaN or SiC		SiC	SiC		
SMPS Industrial	GaN or SiC			GaN or SiC	GaN		SiC	SiC		
Solar PV inverters incl. ESS		GaN or SiC		GaN or SiC	GaN		SiC	SiC	SiC	
UPS				GaN or SiC			SiC		SiC	SiC
EV Charging	SiC ⁽¹⁾	SiC ⁽¹⁾		GaN or SiC			SiC	SiC	SiC	SiC
Ultra-High Density Chargers and Adapters		GaN (int.)	GaN (int.)		GaN (int.)				GaN (int.)	
Automotive OBC	GaN or SiC	GaN or SiC		GaN or SiC	GaN or SiC		SiC		SiC	

2.5 kW totem pole PFC with CoolGaN™ HEMT

EVAL_2500W_PFC_GAN_A

Demo Board Information

Input voltage:	85 – 265 V _{AC}
Output Voltage:	390 V
Output power	2500 W
Topology:	totem pole PFC
Sw. Frequency:	65 kHz
Efficiency:	Flat efficiency >99% over wide load range



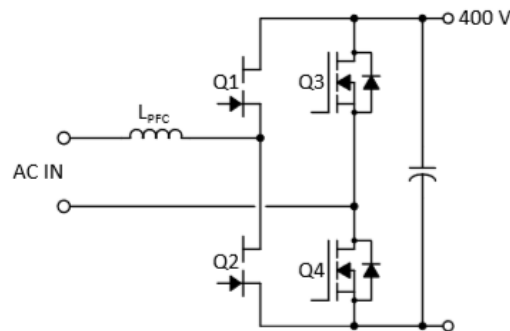
220 mm x 72 mm x 48 mm

[www.infineon.com/ EVAL-2500W-PFC-GAN-A](http://www.infineon.com/EVAL-2500W-PFC-GAN-A)

IFX components

HV Devices:	2x IGO60R070D1 2x IPT60R033C7 2x IPW60R17C7
Driver:	2x 1EDI20N12AF 1x 2EDN7524F 2x 1EDI60N12AF
Schootky Diode:	1x BAT165, 1x Bat54C
Control IC:	1x ICE2QR2280G, 1x ICE3PCS01G
Voltage regulator:	1x TLE4264-2G
N-CH MOSFET:	1 x BSS138N

Schematic Overview



2400W Active Bridge PFC Demoboard EVAL_2K4W_ACT_BRD_S7

Demo Board Information

Input voltage: 90 – 265 V_{AC}
Output Voltage: 390 V_{DC} (nom)
Output power: 2400 W
Topology: boost full bridge
non-isolated PFC single phase
Sw. Frequency: 65 kHz
Efficiency: 98.6% (max)



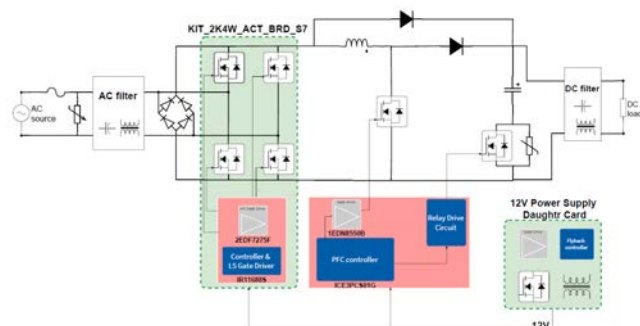
130 mm x 90 mm x 45 mm

www.infineon.com/EVAL-2K4W-ACT-BRD-S7

IFX components

HV Devices: 1x IPT60R022S7
1x IPZ60R040C7
Diode: 1x IDH12G65C6
Driver: 1x 1EDN8550B
Voltage regulator: 1x BAT165
Controller: 1x ICE3PCS01G

Schematic Overview

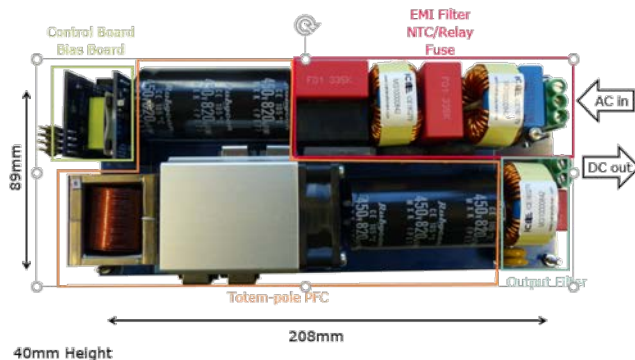


Bidirectional ACDC board with SiC MOSFET

3.3 kW BIDI CCM Totem Pole PFC

Demo Board Information

Input voltage: 176-265 V_{AC}
Output voltage: 400 V_{DC}
Output power: 3300 W
PF > 0.95 from 20% load
Target Efficiency: 99% at 50% load
Power Density ~72 W/inch³

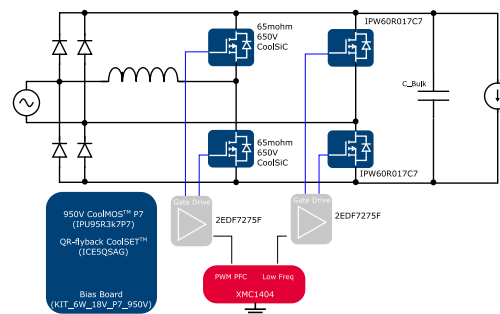


www.infineon.com/EVAL-3K3W-TP-PFC-SIC

IFX components

HV Devices: 2x 65m Ω 650V CoolSiC™
2x IPW60R17C7
Driver: 2x 2EDF7275F
Controller: 1x XMC1404-F064X0200
QR-Flyback: 1x ICE5QSAG,
1x IPU95R3k7P7

Schematic Overview



1.6 kW Titanium Efficiency HD AC/DC PSU for Server

EVAL_1K6W_PSU_G7_DD

Demo Board Information

Input voltage:	176 – 265 V _{AC}
Output Voltage:	12.2 V _{DC}
Output power	1600 W
Topology:	CCM PFC bi-directional half-bridge
Sw. Frequency:	PFC: 65 kHz LLC: 160 kHz
Peak Efficiency:	96%



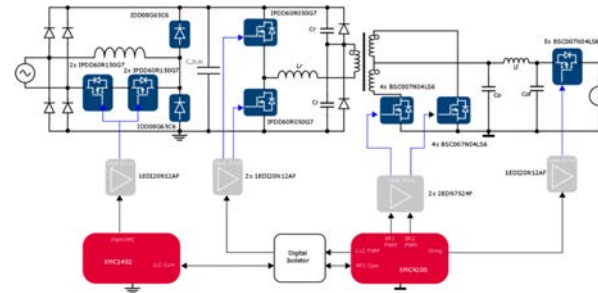
200 mm x 70 mm x 40 mm

www.infineon.com/EVAL-1K6W-PSU-G7-DD

IFX components

Driver:	2x 2EDN7524F, 5x 1EDI20N12AF
Controller:	1x ICE2QR2280G,
Microcontroller:	1x MC1402Q040X0128AAUMA 1, 1x XMC4200-F64K256AB
Voltage regulator:	1x IFX1117ME V33
MOSFET:	13x BSC007N04LS6 2x IPDD60R050G7, 4x IPDD60R150G7, 2x IDDD08G65C6
Diode:	4x BAT165, 4x BAT54-04

Schematic Overview



3.3 kW bidirectional Full-bridge DCDC EVAL_3K3W_BIDI_PSF

Demo Board Information

Input voltage: 350 V_{DC} ~ 415 V_{DC}
Output voltage: 40 V_{DC} ~ 60 V_{DC}
Output power: 3300 W
Efficiency: 98% peak

- › Bidirectional mode
- › Novel integrated magnetics concept
- › Novel SMD cooling concept



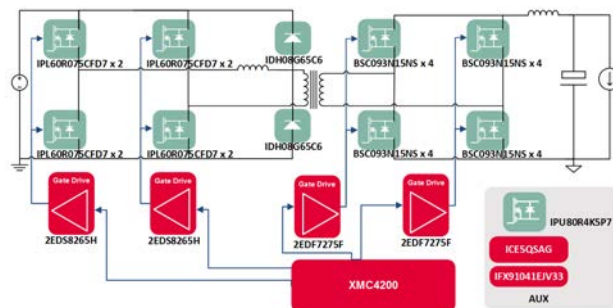
208 mm x 83 mm x 44 mm

www.infineon.com/EVAL-3K3W-BIDI-PSFB

IFX components

HV Devices: 8x IPL60R075CFD7 (75 mΩ, 600 V)
LV Devices: 16x BSC093N15NS5 (9.3 mΩ, 150 V)
Driver: 2x 2EDS8265H (4A/8A source/sink)
2x 2EDF7275F (4A/8A source/sink)
Schottky Diode: 2x IDH08G65C6 (650 V)
4x BAT165 (40 V)
Controller: XMC4200-F64K256AB
AUX: ICE5QSAG CoolSET™
IPU80R4K5P7 (4.5Ω, 800 V)

Schematic Overview





Part of your life. Part of tomorrow.