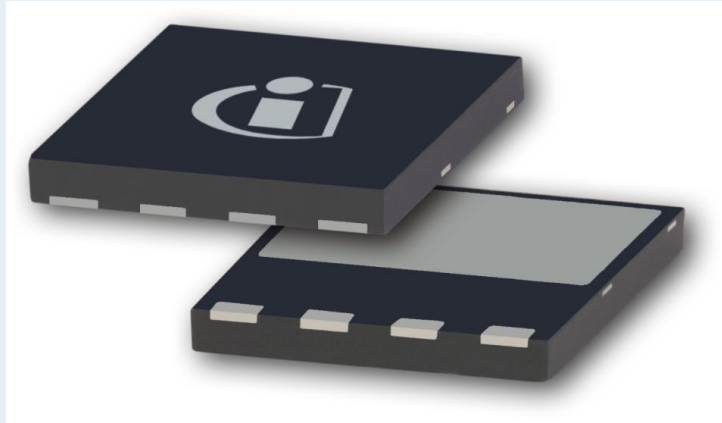


ThinPAK 8x8



New High Voltage SMD-Package

**April 2010
Version 1.0**

Page 1 of 34

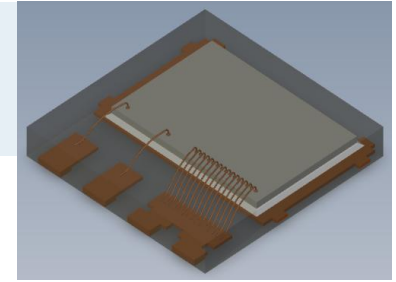


INNOSCIENCE EXHIBIT 1016

Content

- Introduction
- Package Specification
- Thermal Concept
- Application Test Conditions
- Impact on Efficiency and EMI
- Switching behaviour
- Portfolio and Target Applications
- Standardization
- Summary

ThinPAK 8x8 - Introduction



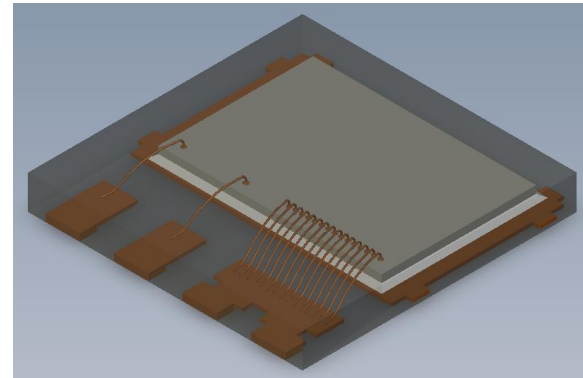
- What is it ?
 - A new leadless SMD package for HV MOSFETs
 - It is very small
 - Footprint of only 64mm² (vs. 150mm² for the D2PAK)
 - Low profile with only 1mm height (vs. 4.4mm for the D2PAK)
 - It has benchmark low parasitic inductances
- Why is it needed ?
 - Fast switching HV silicon performance is increasingly limited by the parasitics of through-hole and conventional SMD packages
- What benefits is the ThinPAK 8x8 package bringing ?
 - Provides improved performance and switching behavior (ease-of-use, EMI, reliability)
 - Enables end-products with higher power density

Content

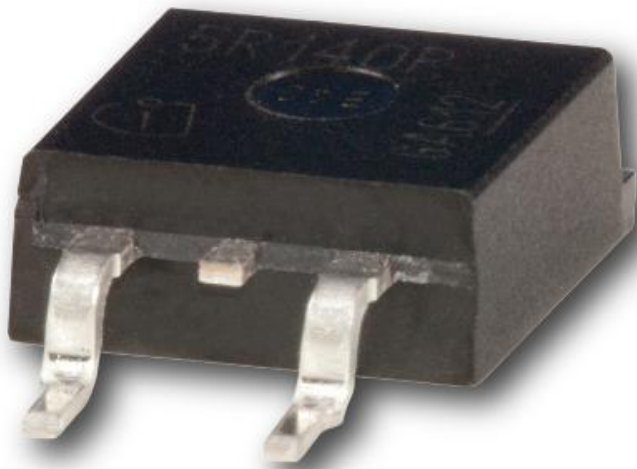
- Introduction
- Package Specification
- Thermal Concept
- Application Test Conditions
- Impact on Efficiency and EMI
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Package specification

- SMD package - leadless
- Height: 1 mm package height
- Footprint smaller than D2PAK ($8 \times 8 \text{ mm}^2$)
- R_{dson} -> similar to D²PAK / TO220
- Creepage distance: 2.7 mm
- Low Parasitics (package inductivity, package resistance)
- Double sided cooling (optional)
- Soldering: wave and reflow
- Green mold compound



ThinPAK 8x8 versus D²PAK



10 x 15 x 4.4 mm³

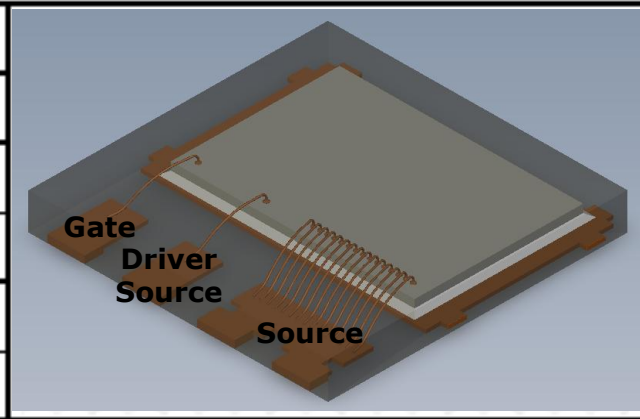


8 x 8 x 1 mm³

60 % footprint reduction - 80% height reduction - 90% Volume reduction

Package parasitics of ThinPAK 8x8

IPY60R199CP_L5023C - 10 Wirebonds				
		DC	100 MHz	200 MHz
Gate	R (mΩ)	64.2	97.9	138.4
	L (nH)	4.99	4.26	4.26
Source	R (mΩ)	6	10.3	14.6
	L (nH)	1.83	1.58	1.58

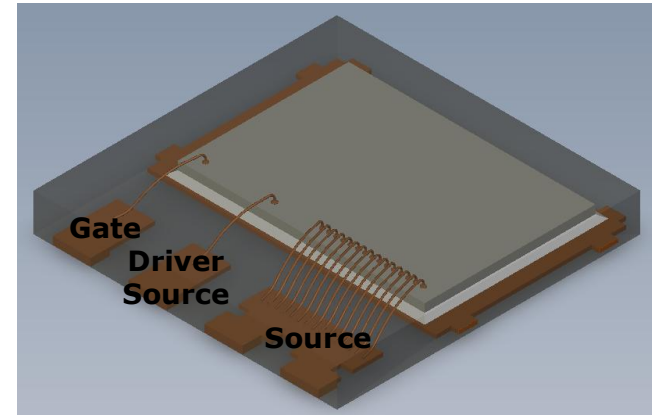


Lowest parasitic inductance available for HV-MOS

Gate driving circuit opportunity

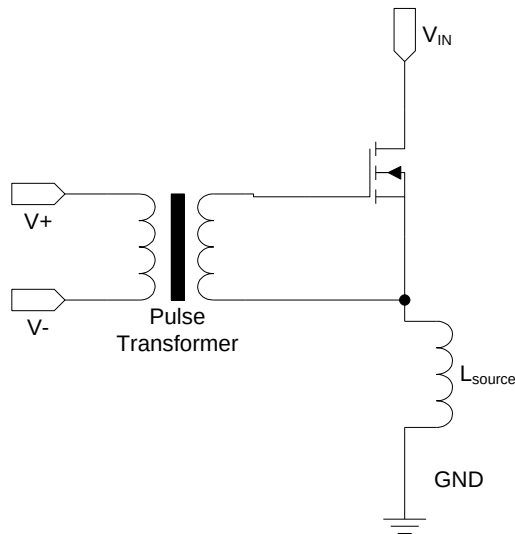
- Separate source connection for driver
 - Negligible influence of the di/dt of the switched current
 - Driver is able to provide a constant turn-on / turn-off voltage

- Optimum performance can be achieved with
 - Pulse transformer (primary side – main converter stage)
 - Gate driving IC with separate power and signal GND

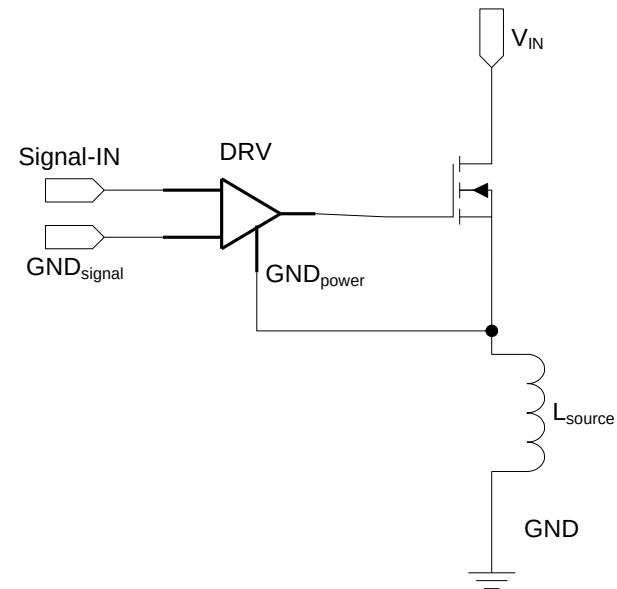


Gate driving circuit opportunity

■ Pulse transformer



■ Driver with separated ground



Minimizing influence of the source inductance possible

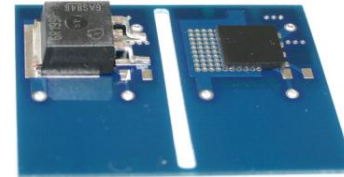
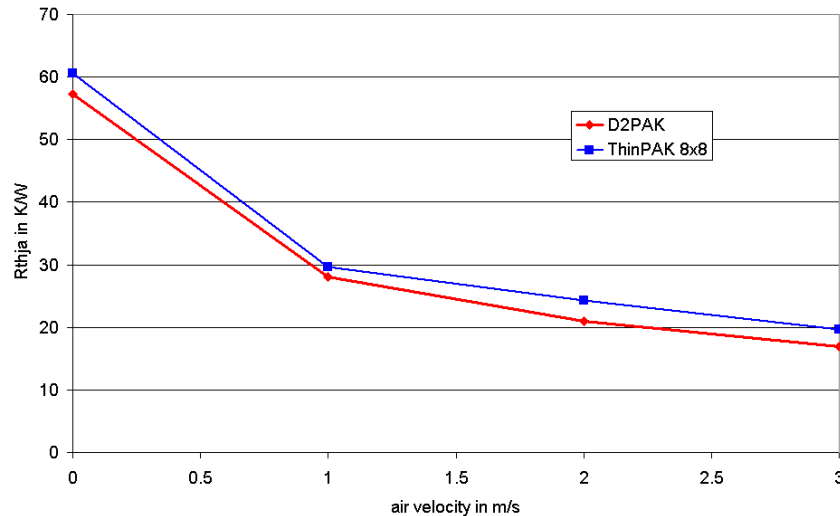
Content

- Introduction
- Package Specification
- Thermal Concept
- Application Test Conditions
- Impact on Efficiency and EMI
- Switching behaviour
- Portfolio and Target Applications
- Standardization
- Summary

Thermal Resistance: Comparison D²PAK vs. ThinPAK 8x8



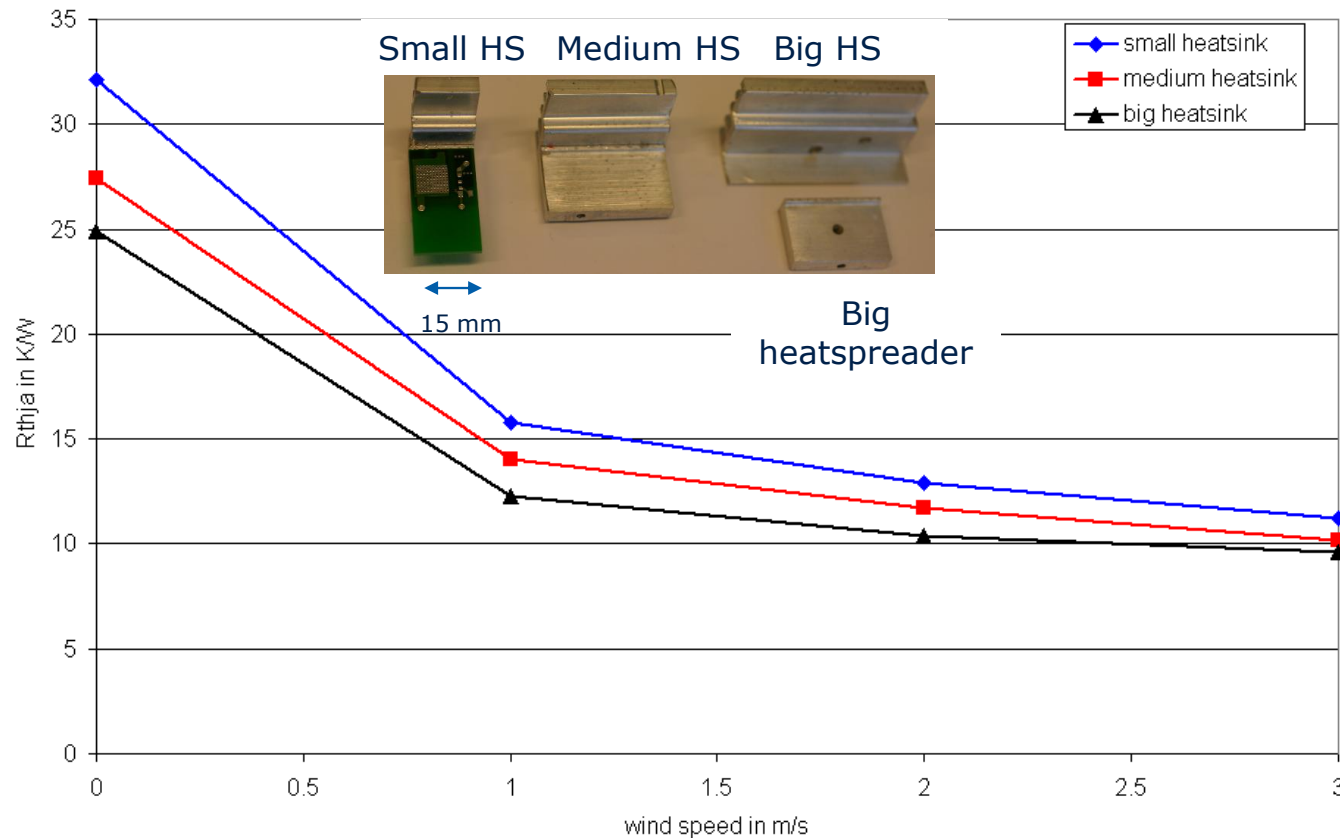
■ R_{th} Junction to Ambient



■ R_{th} - Datasheet values

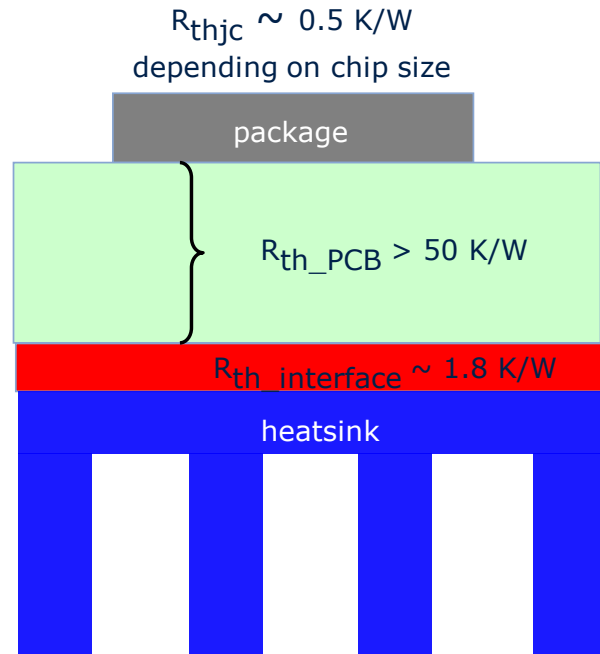
Product	IPB60R199CP – D ² PAK	IPL60R199CP – ThinPAK 8x8
R_{th-JC}	0,9 K/W	0,9 K/W
R_{th-JA}	40 K/W	42 K/W

Thermal measurement R_{thja} Big heatspreader + different heatsink sizes

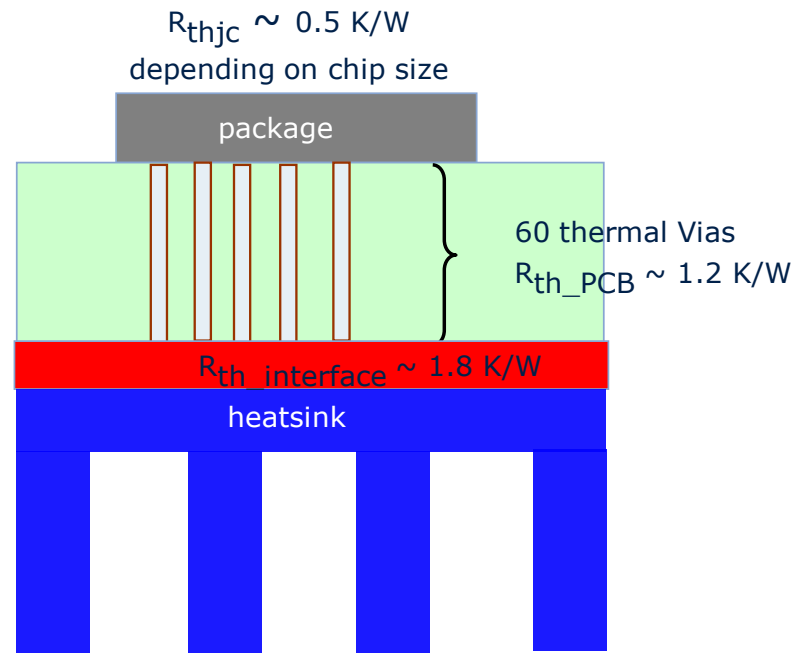


Up to 7W power handling capability in typical applications

Thermal system



$R_{th_j_to\ heatsink} > 52 \text{ K/W}$
(without heatsink)



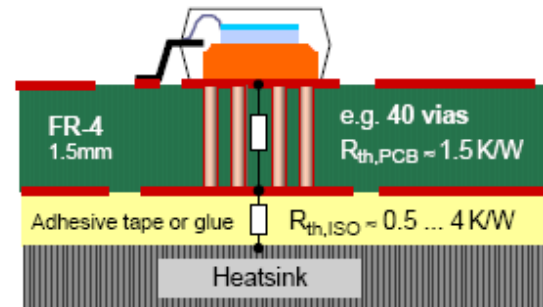
$R_{th_j_to\ heatsink} \sim 3.5 \text{ K/W}$
(without heatsink)

Use thermal vias to greatly reduce the thermal board resistance

Thermal PCB available solutions

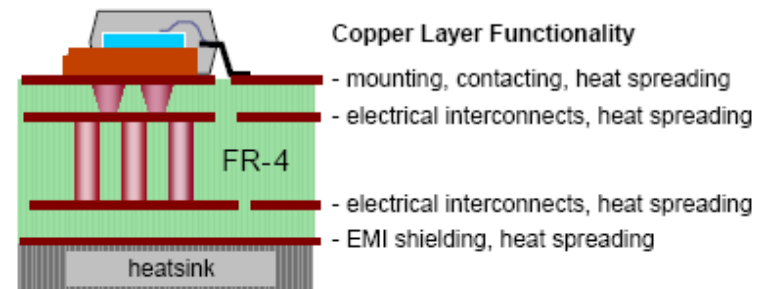
■ 2 layer PCB

- Thermal vias for thermal coupling to heatsink



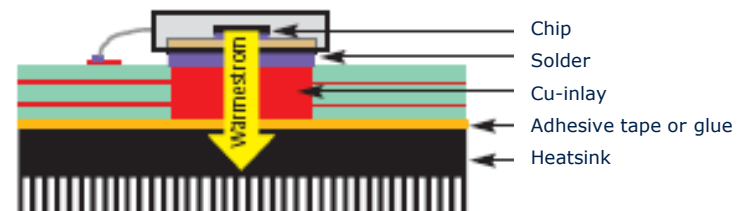
■ Multi layer PCB

- Shifted thermal vias with heat spreading layer and EMI-shielding



■ PCB with Cu-inlay

- Cu-Inlay for high thermal conductivity

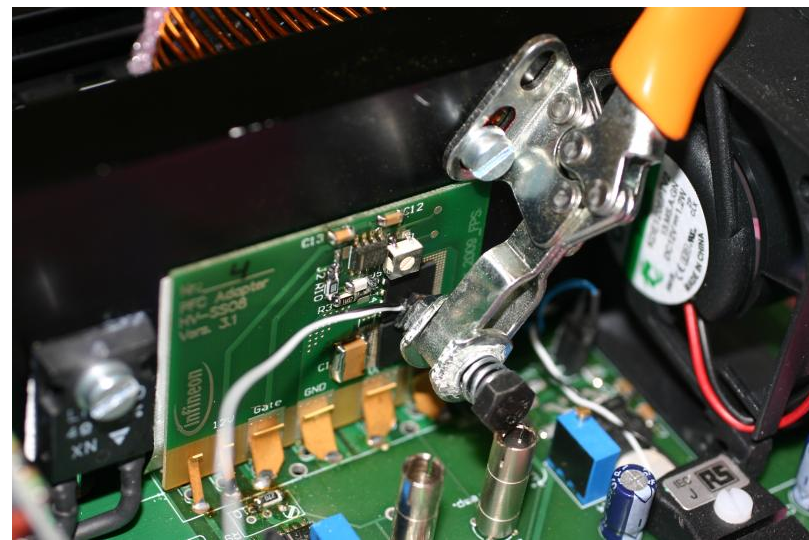
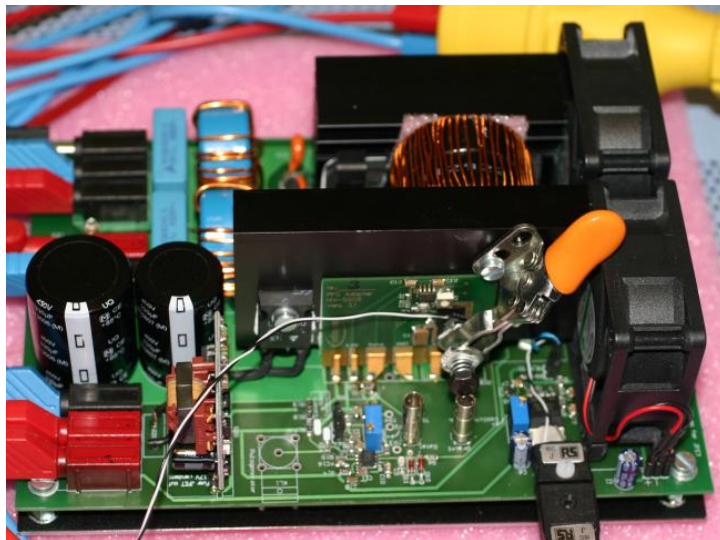


Content

- Introduction
- Package Specification
- Thermal Concept
- Application Test Conditions
- Impact on Efficiency and EMI
- Switching behaviour
- Portfolio and Target Applications
- Standardization
- Summary

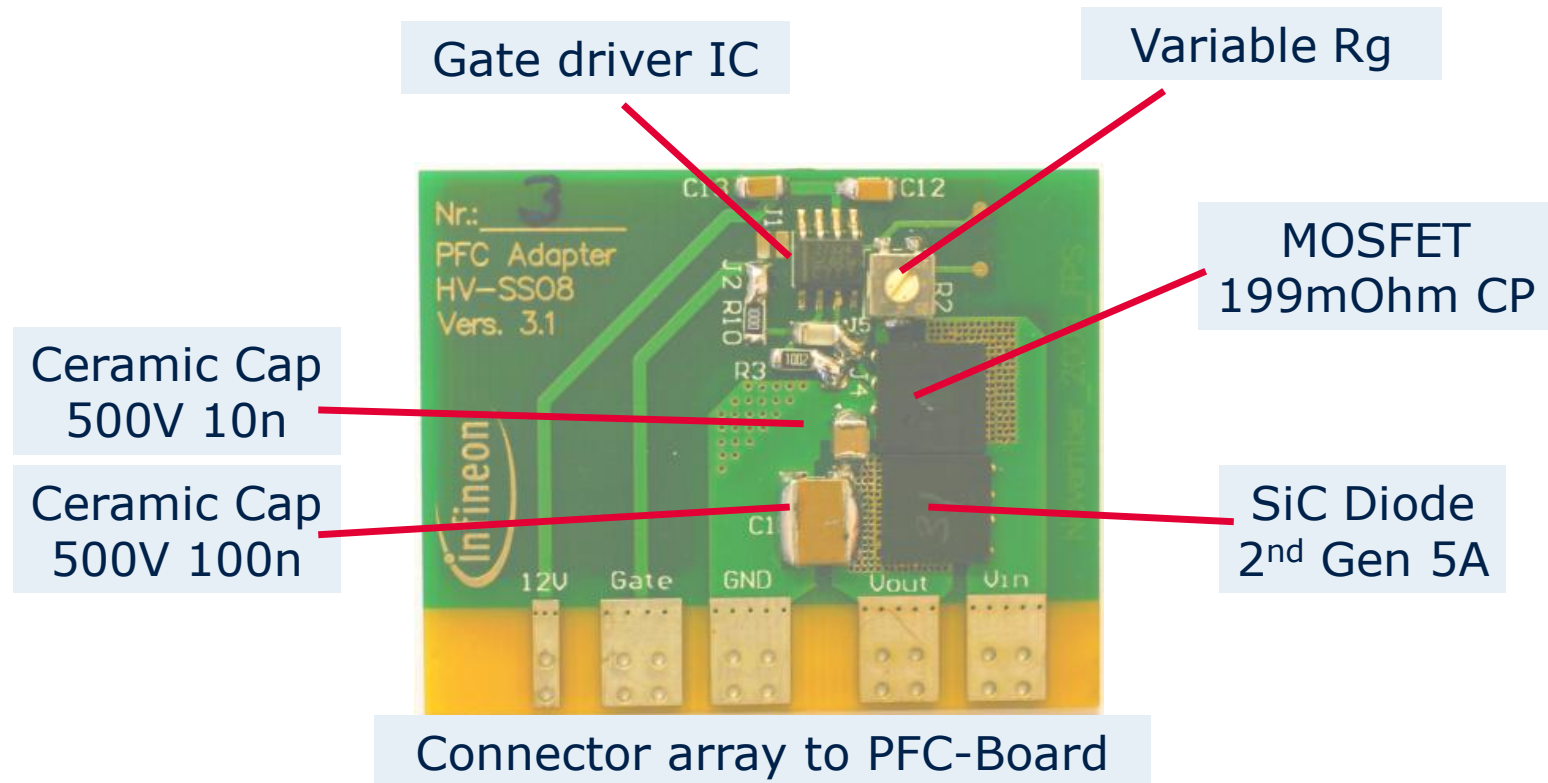
Application Test Conditions

Application	CCM PFC
Max Output Power (W)	300W
PFC Controller	ICE2PCS01G
PFC Diode	5A SiC
Heatsink Temperature	60°C
PCB	PFC Adapter Board_2

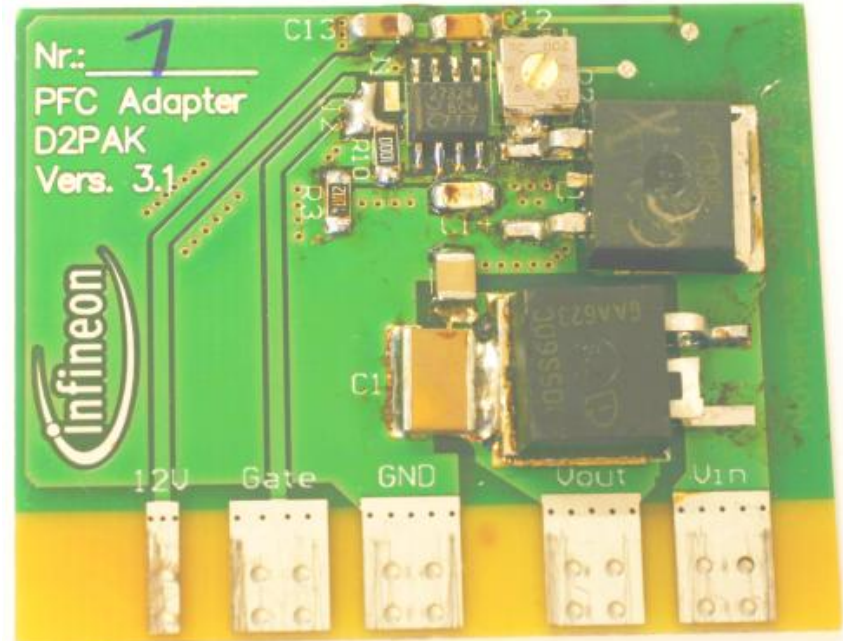
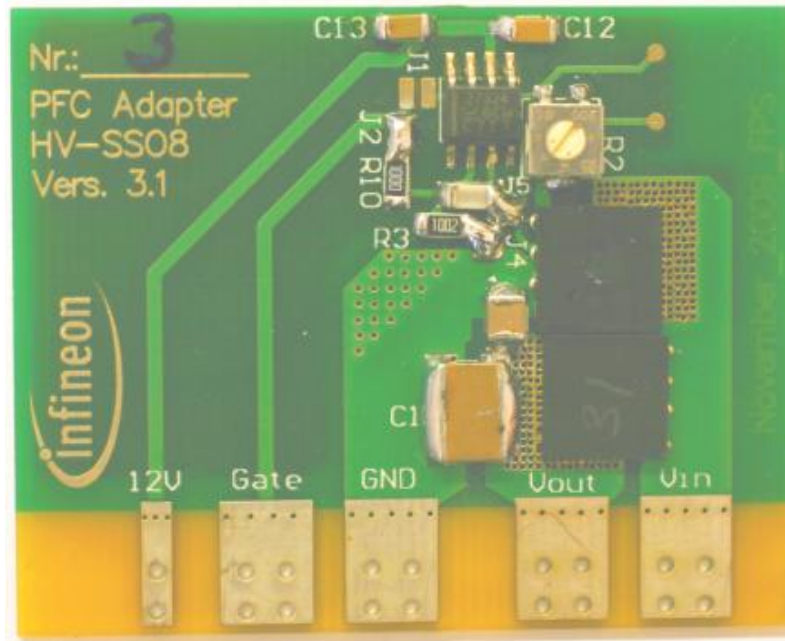


Application Test Condition

■ ThinPAK 8x8 adapter PCB for PFC stage

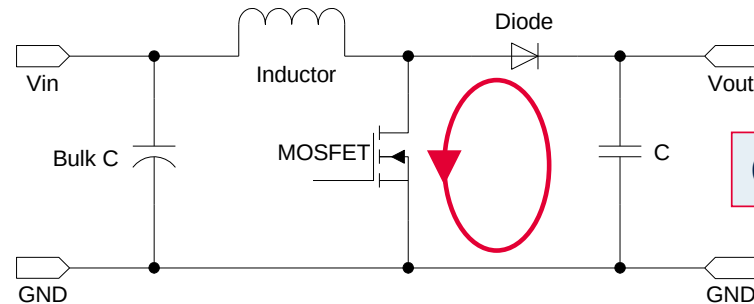


ThinPAK 8x8 vs. D²PAK

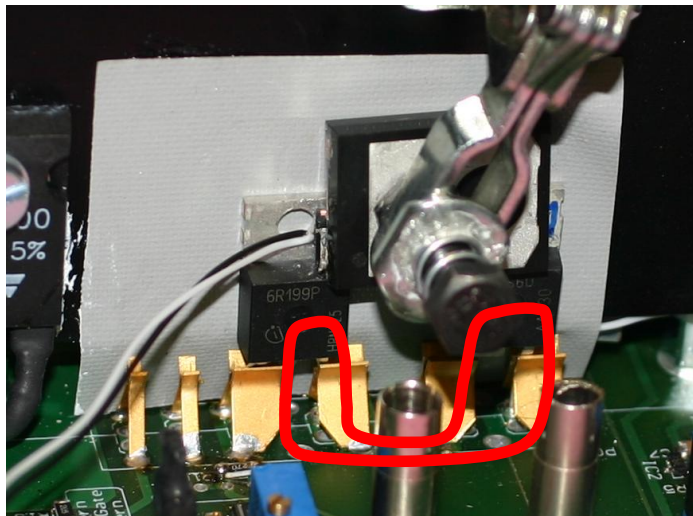


Application Test Condition

Improved commutation loop compared to TO220



Commutation loop



Big loop
2x TO220 + main PCB



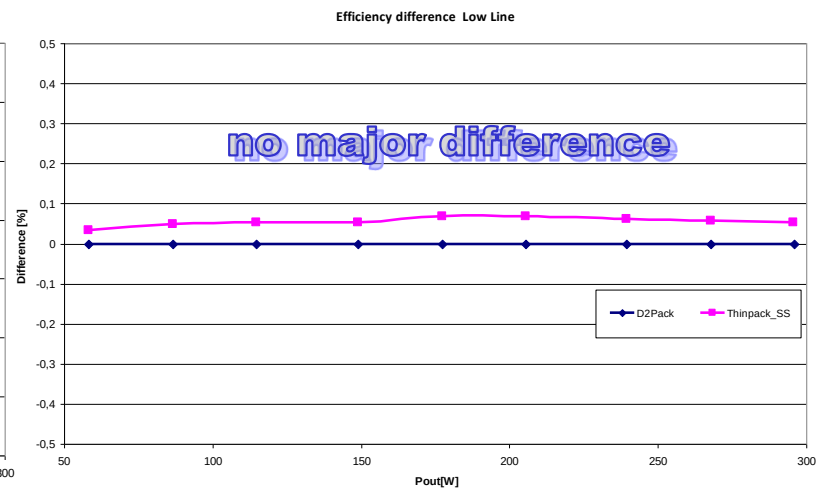
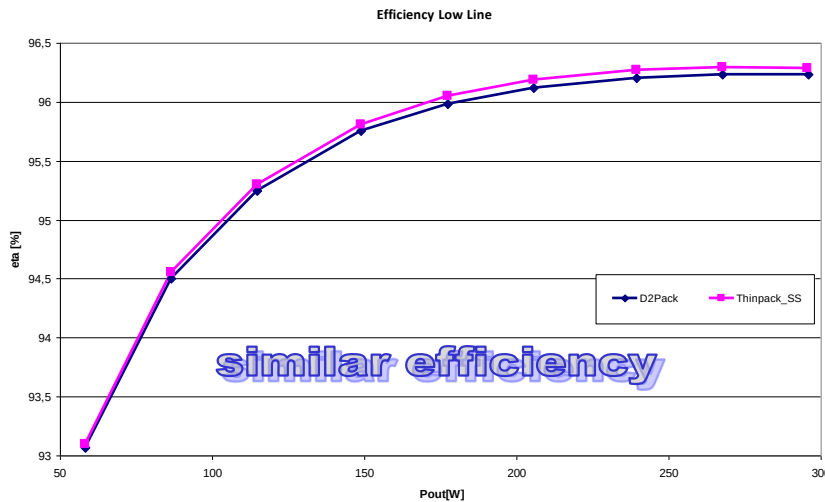
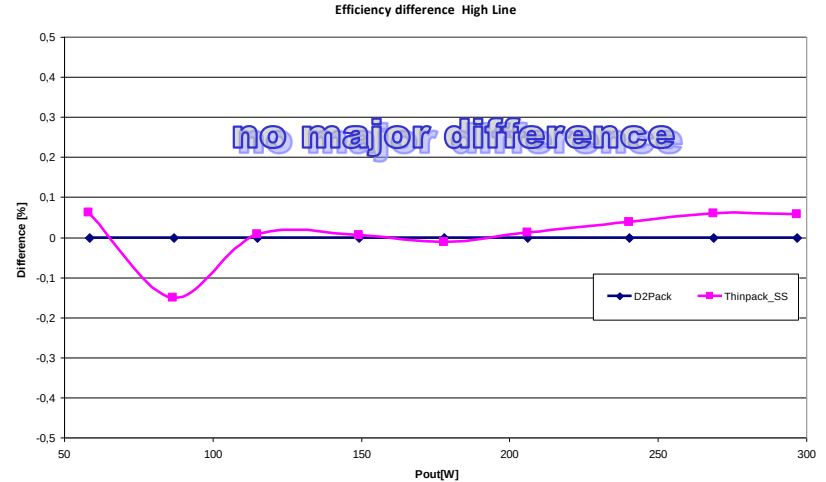
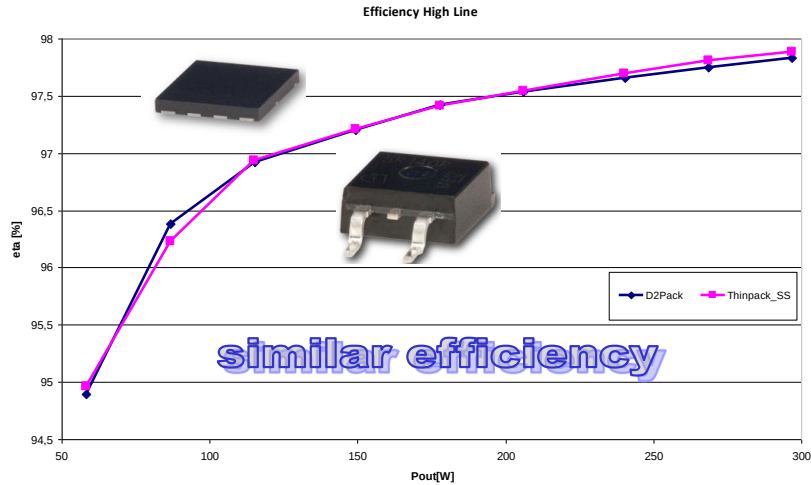
Smallest loop
2x ThinPAK 8x8

Content

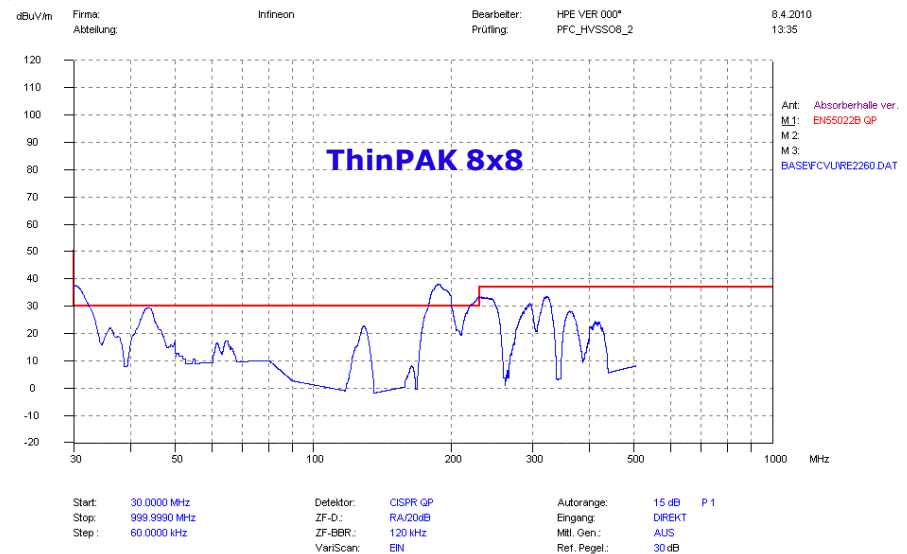
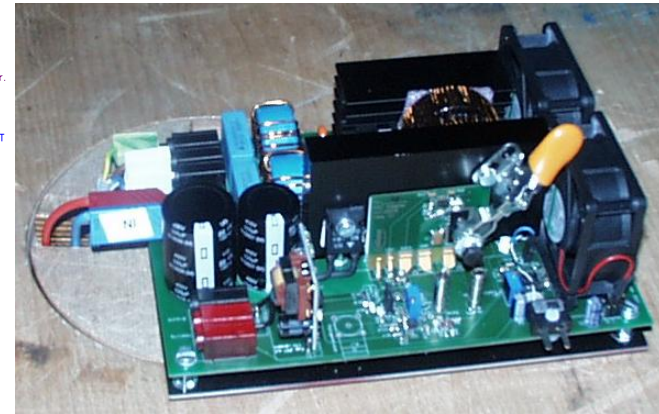
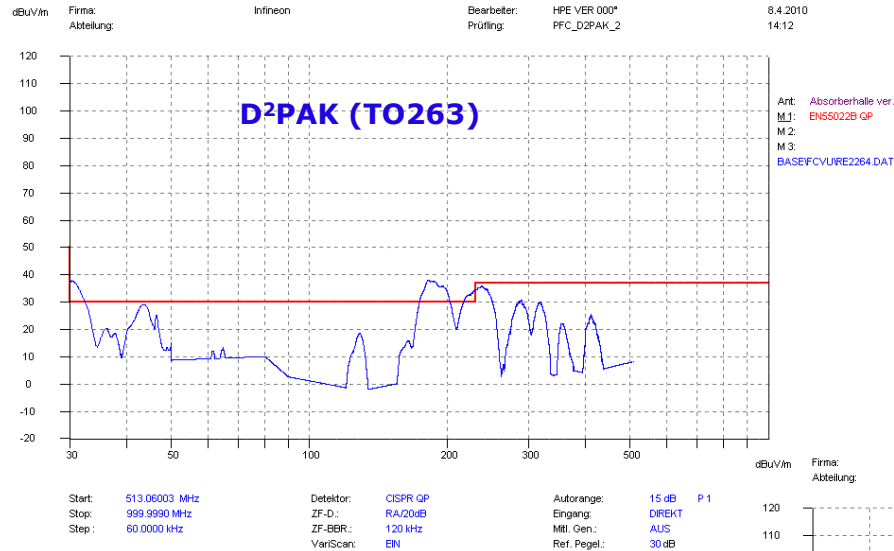
- Introduction
- Package Specification
- Thermal Concept
- Application Test Conditions
- Impact on Efficiency and EMI
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- Summary

Efficiency comparison D²PAK vs. ThinPAK 8x8

600V 199mOhm CP; 130kHz; 15 Ohm R_g; CCM; 60°C



EMI Measurement 200W; 15 Ohm Rg, 130kHz



similar behaviour

Content

- Introduction
- Package Specification
- Thermal Concept
- Application Test Conditions
- Impact on Efficiency and EMI
- Switching behaviour
- Portfolio and Target Applications
- Standardization
- Summary

Turn on: Waveform - Comparison

TO263 (D²PAK)

ThinPAK 8x8



V_{GS}
 V_{Bulk}
 I_{Choke}
 V_{DS}

Highly reduced ringing at gate when using ThinPAK 8x8

Turn off: Waveform – Comparison

TO263 (D²PAK)

ThinPAK 8x8



V_{GS}
V_{Bulk}
I_{Choke}
V_{DS}

Highly reduced ringing at gate when using ThinPAK 8x8

Waveforms – 50ms AC line drop out



V_{GS}
 V_{Bulk}
 I_{Choke}
 V_{DS}

Content

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- Summary

Initial Portfolio: 600V CoolMOS CP

Part Number	Maximum Ratings		$R_{DS(ON)}$ (mOhm)		
	V_{DSS} (V)	I_D (A)	Typ.	Max.	Q_g (nC) typ.
IPL60R199CP	600	16	180	199	32
IPL60R299CP	600	11	270	299	22
IPL60R385CP	600	9	350	385	17

- Further portfolio extensions are in development for market introduction in H2 2010

Target applications and topologies

■ Target applications:

□ Server (Computing, Telecom)

- └ CCM PFC, ITTF

□ High power density applications (e.g.: UPS)

□ Ultra slim adapter

- └ Quasi-resonant Fly-back

□ Lamp ballast HID applications

- └ DCM PFC

■ Daughter board use is a „new“ way to increase power density in compactness driven designs and target applications

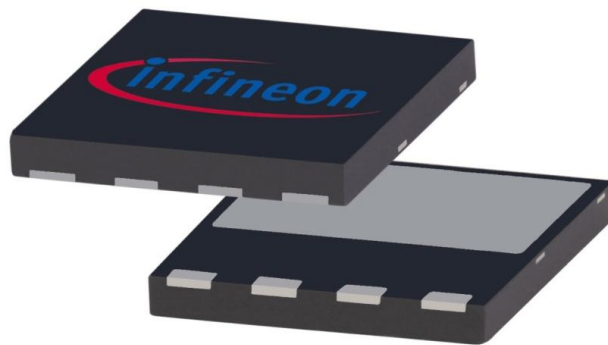
Content

- Introduction
- Package Specification
- Thermal Concept
- Application Test Conditions
- Impact on Efficiency and EMI
- Switching behaviour
- Portfolio and Target Applications
- Standardization
- Summary

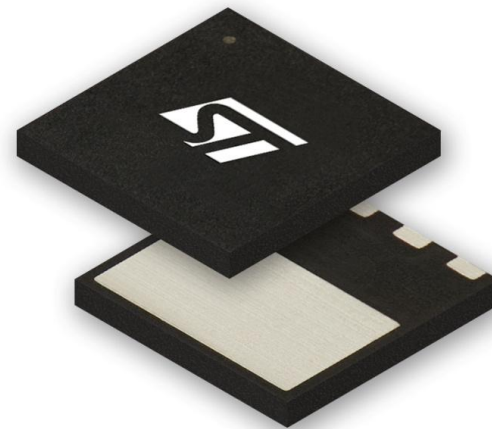
Standardization is key in today's market

■ Infineon & ST

- Package footprint is supported by two major global power semiconductor suppliers



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ThinPAK 8x8

PowerFLAT™ 8x8 HV

Content

- Introduction
- Package Specification
- Thermal Concept
- Application Test Conditions
- Impact on Efficiency and EMI
- Switching behaviour
- Portfolio and Target Applications
- Standardization
- Summary

Summary of Advantages

- Leadless SMD approach enables highest power density designs
 - Small footprint (64 mm² vs. 150 mm² for D²PAK)
 - Low profile package (1.0 mm vs. 4.4 mm for D²PAK)
- Highly improved commutation loop (MOSFET, Diode, Cap)
 - Lowest stray inductances leads to lower V_{DS} overshoots
- Small Drain area
 - Smaller capacitive coupling of the Drain to the heat sink compared to TO220
- Lowest L_{source} (2 nH vs. 6 nH for D²PAK)
 - Separate driver source connection
 - Cleaner Waveforms, Easy to use for fast switching MOSFETs
 - Less tendency for dynamic re-turn-on or re-turn-off
 - Much easier for paralleling in high current applications

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