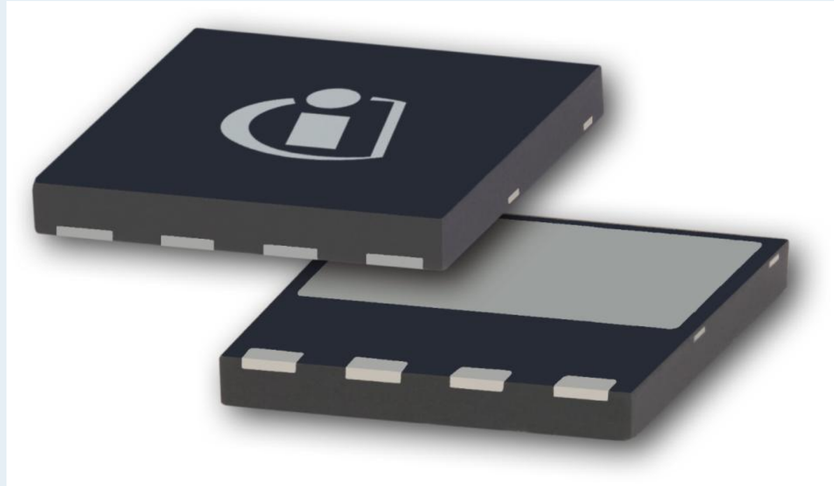
# ThinPAK 8x8



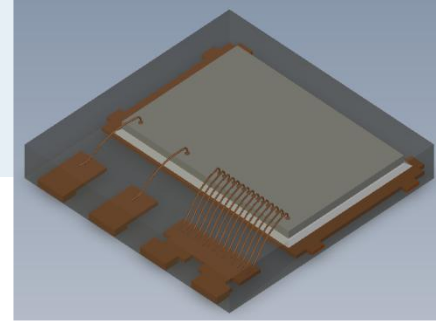
# New High Voltage SMD-Package

April 2010
Version 1.0

# 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 $64mm^2$ (vs. $150mm^2$ 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

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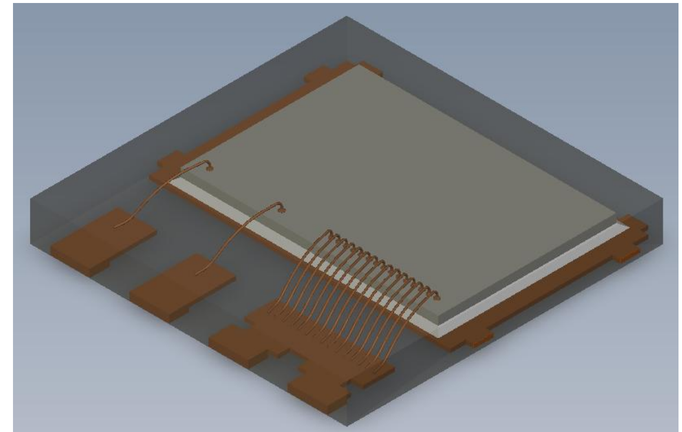
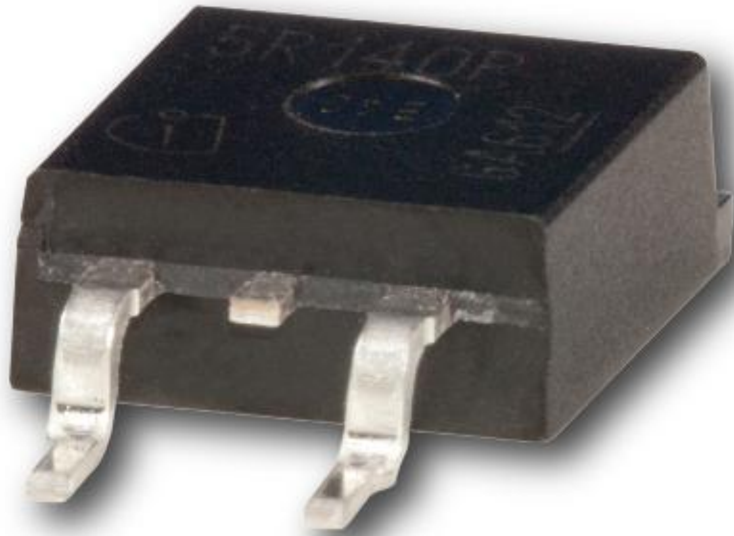
# Package specification

- SMD package - leadless
- Height: 1 mm package height
- Footprint smaller than D2PAK (8 x 8 $mm^2$)
- Rdson -> similar to $D^2PAK$ / 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



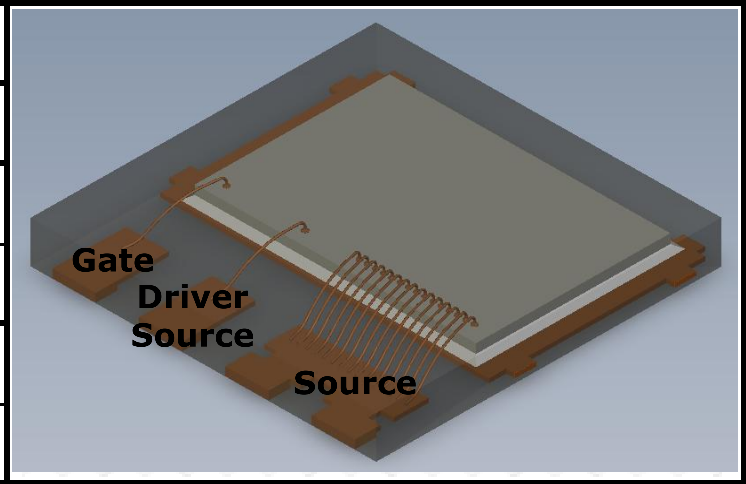
10 x 15 x 4.4 mm³

8 x 8 x 1 mm³

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

# Package parasitics of ThinPAK 8x8

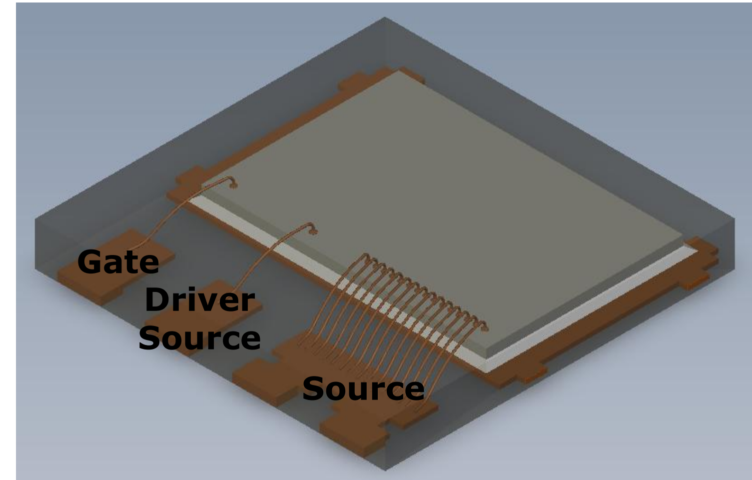
| IPY60R199CP_L5023C - 10 Wirebonds | | | | |
|---|---|---|---|---|
| | | DC | 100 MHz | 200 MHz |
| Gate | R (mΩ) | 64.2 | 97.9 | 138.4 |
| | L (nH) | 4.99 | 4.26 | 4.26 |
| Source | R (mΩ) | 6 | 10.3 | 14.6 |
| | L (nH) | 1.83 | 1.58 | 1.58 |




**Lowest parasitic inductance available for HV-MOS**

# Gate driving circuit opportunity

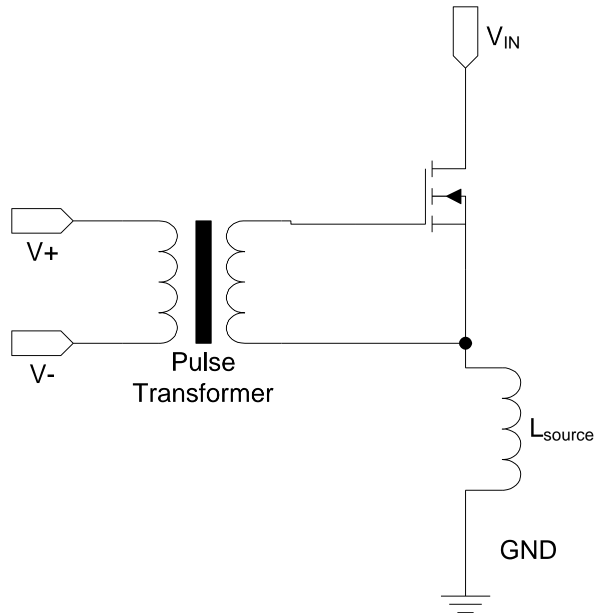
- Separate source connection for driver
  - Negligible influence of the di/dt of the switched current
  - Driver is able to provide a constant turn-on / turn-off voltage



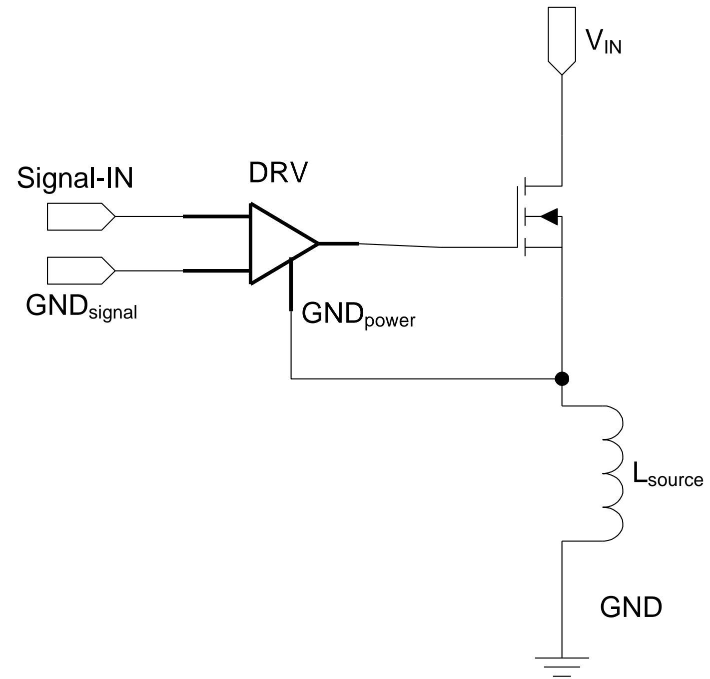

- Optimum performance can be achieved with
  - Pulse transformer (primary side – main converter stage)
  - Gate driving IC with separate power and signal GND

# Gate driving circuit opportunity

- Pulse transformer




- Driver with separated ground




Minimizing influence of the source inductance possible

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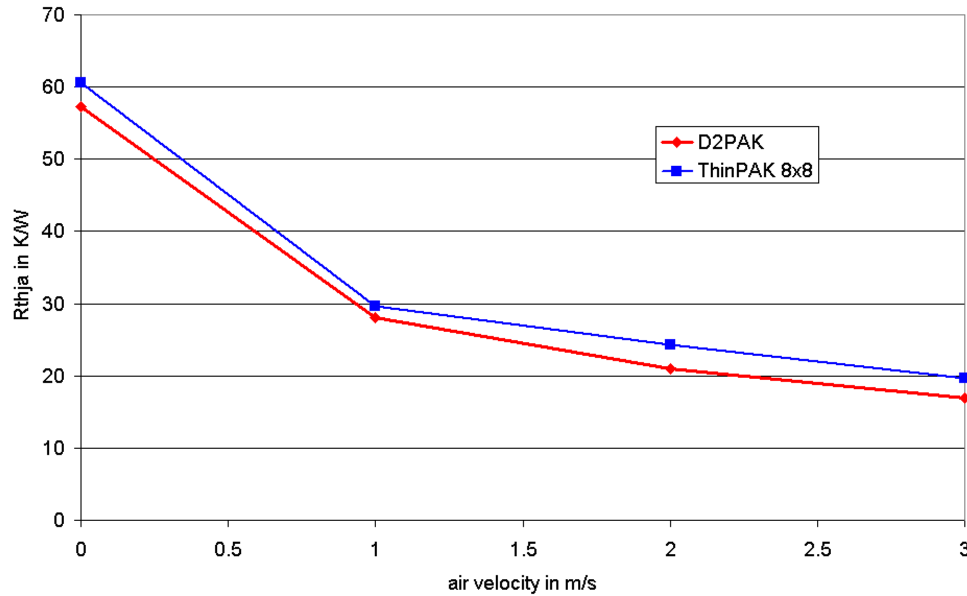
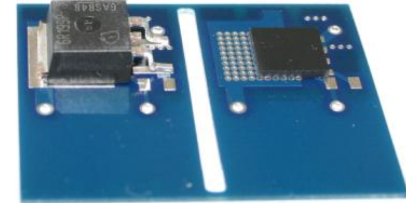
# Thermal Resistance: Comparison D²PAK vs. ThinPAK 8x8

## $R_{th}$ Junction to Ambient

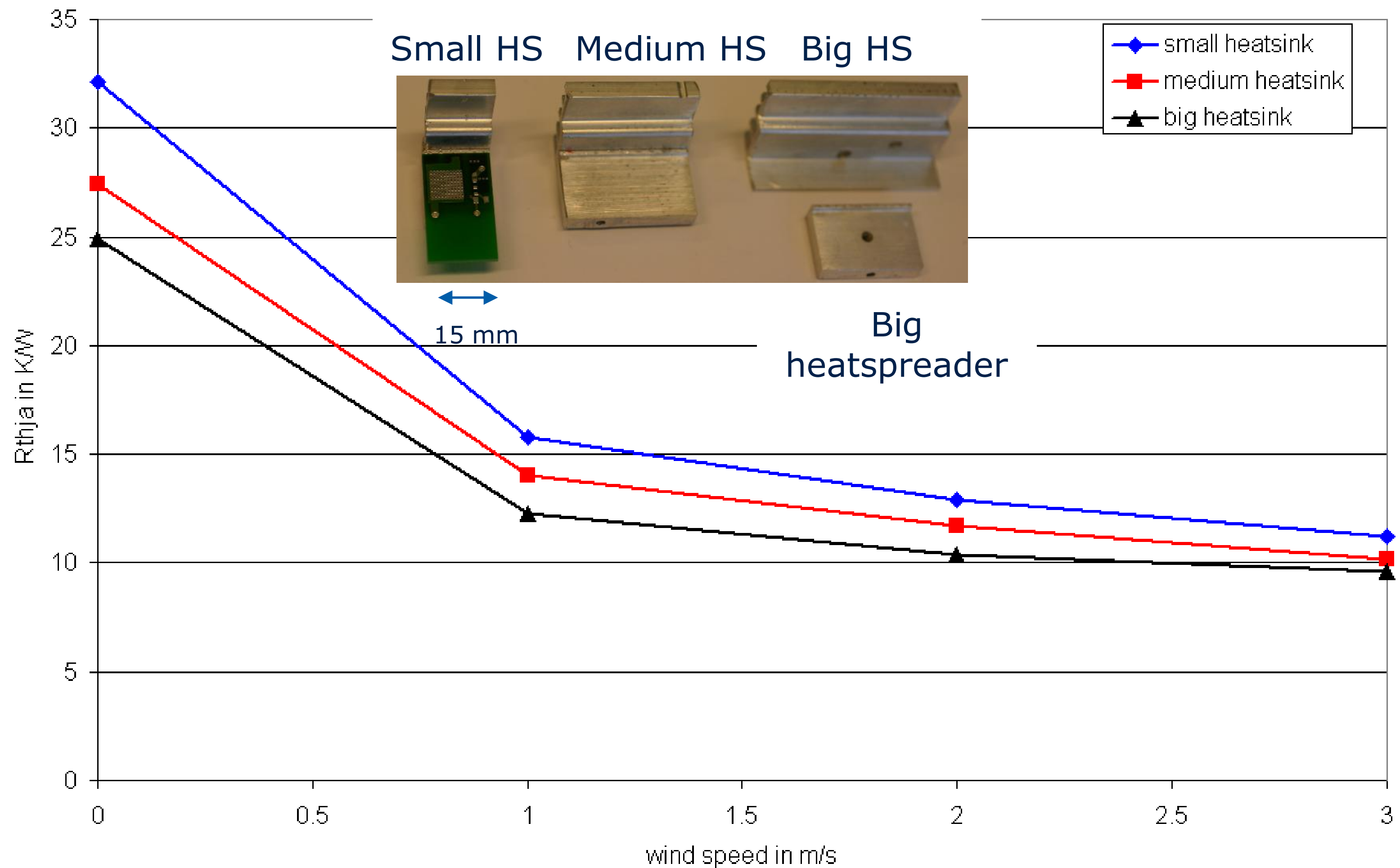


## Rth- Datasheet values

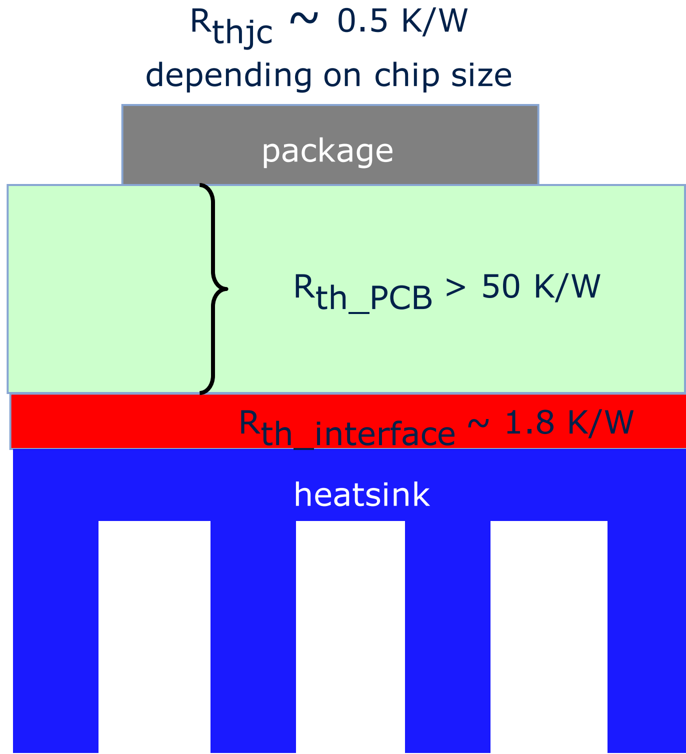
| Product | IPB60R199CP – D²PAK | IPL60R199CP – ThinPAK 8x8 |
|---|---|---|
| $R_{th\text{-}JC}$ | 0,9 K/W | 0,9 K/W |
| $R_{th\text{-}JA}$ | 40 K/W | 42 K/W |

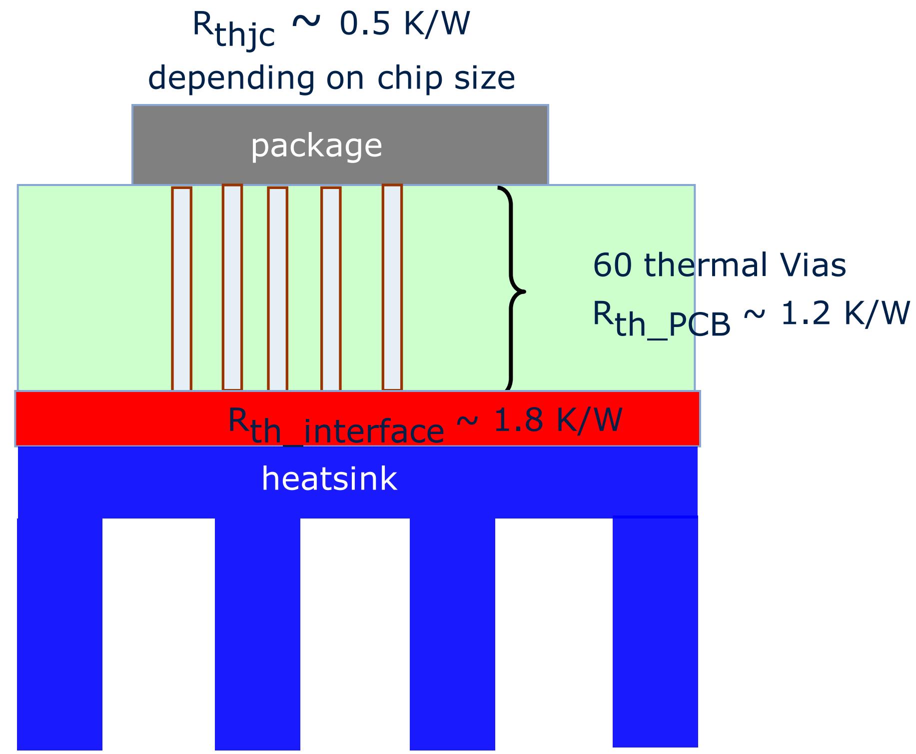
# Thermal measurement Rthja
# Big heatspreader + different heatsink sizes




**Up to 7W power handling capability in typical applications**

# Thermal system



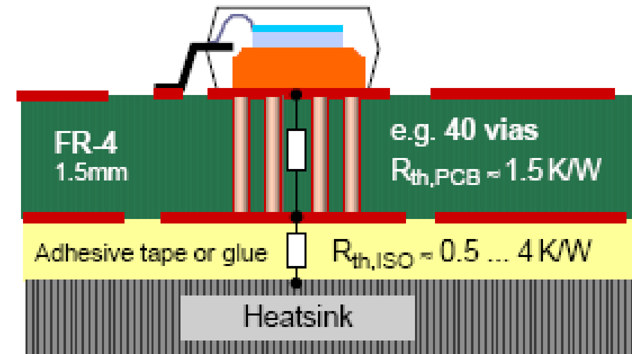

$Rth_{j_to\ heatsink} > 52$ K/W
(without heatsink)

$Rth_{j_to\ heatsink} \sim 3.5$ K/W
(without heatsink)

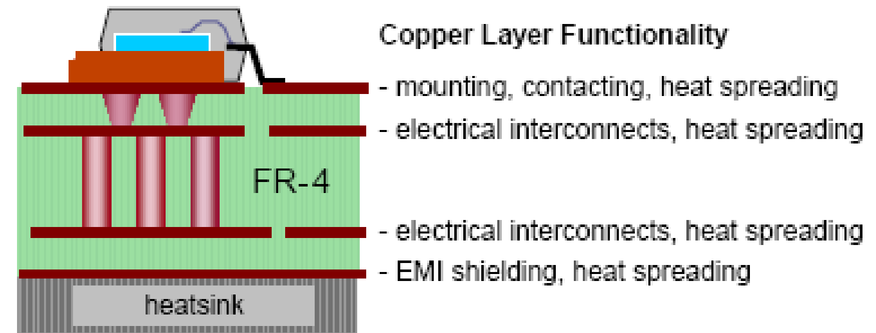
**Use thermal vias to greatly reduce the thermal board resistance**

# Thermal PCB available solutions

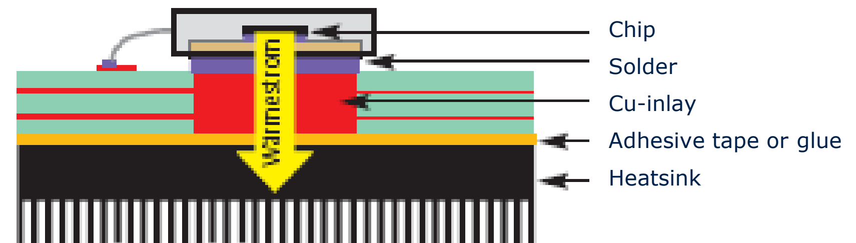
- 2 layer PCB
  - Thermal vias for thermal coupling to heatsink




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




- PCB with Cu-inlay
  - Cu-Inlay for high thermal conductivity



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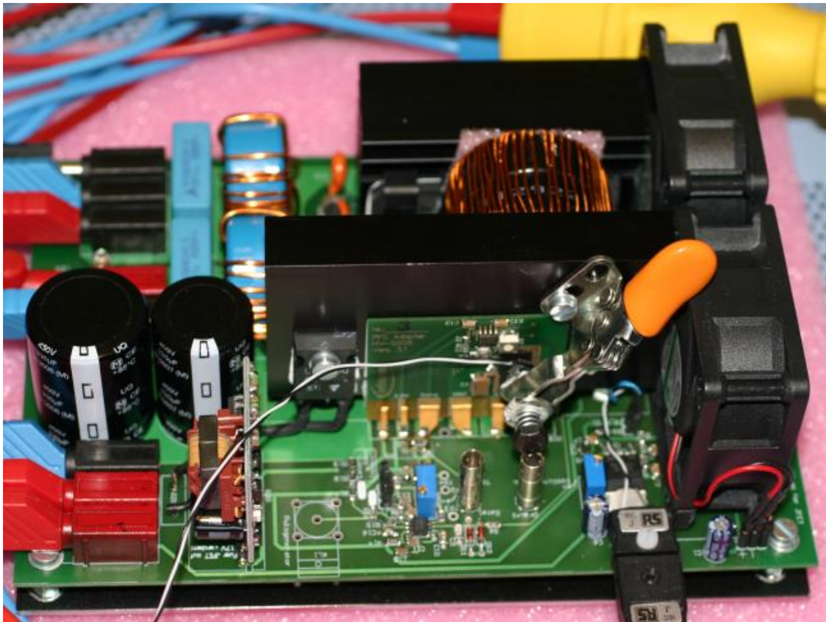
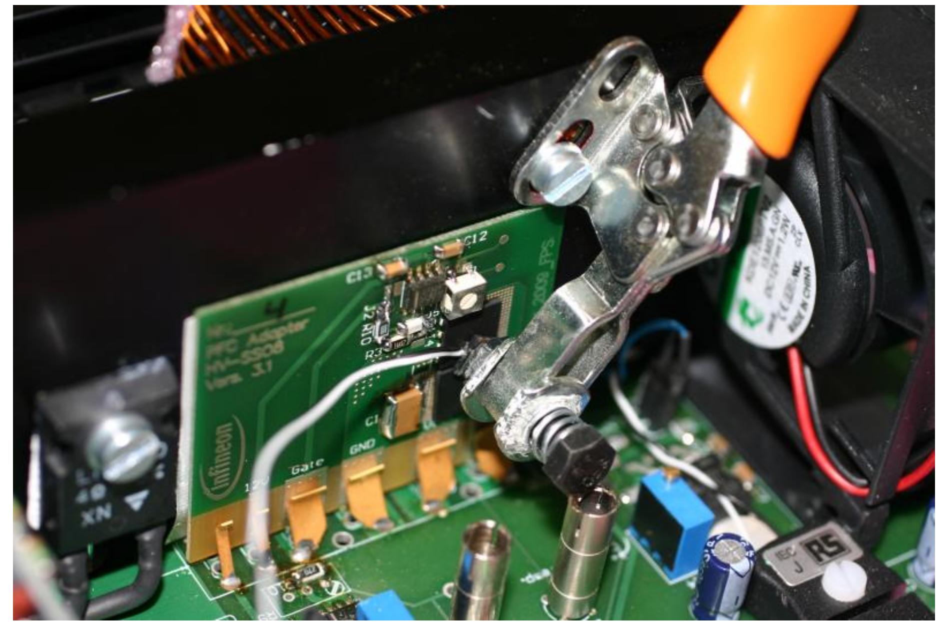
# Application Test Conditions

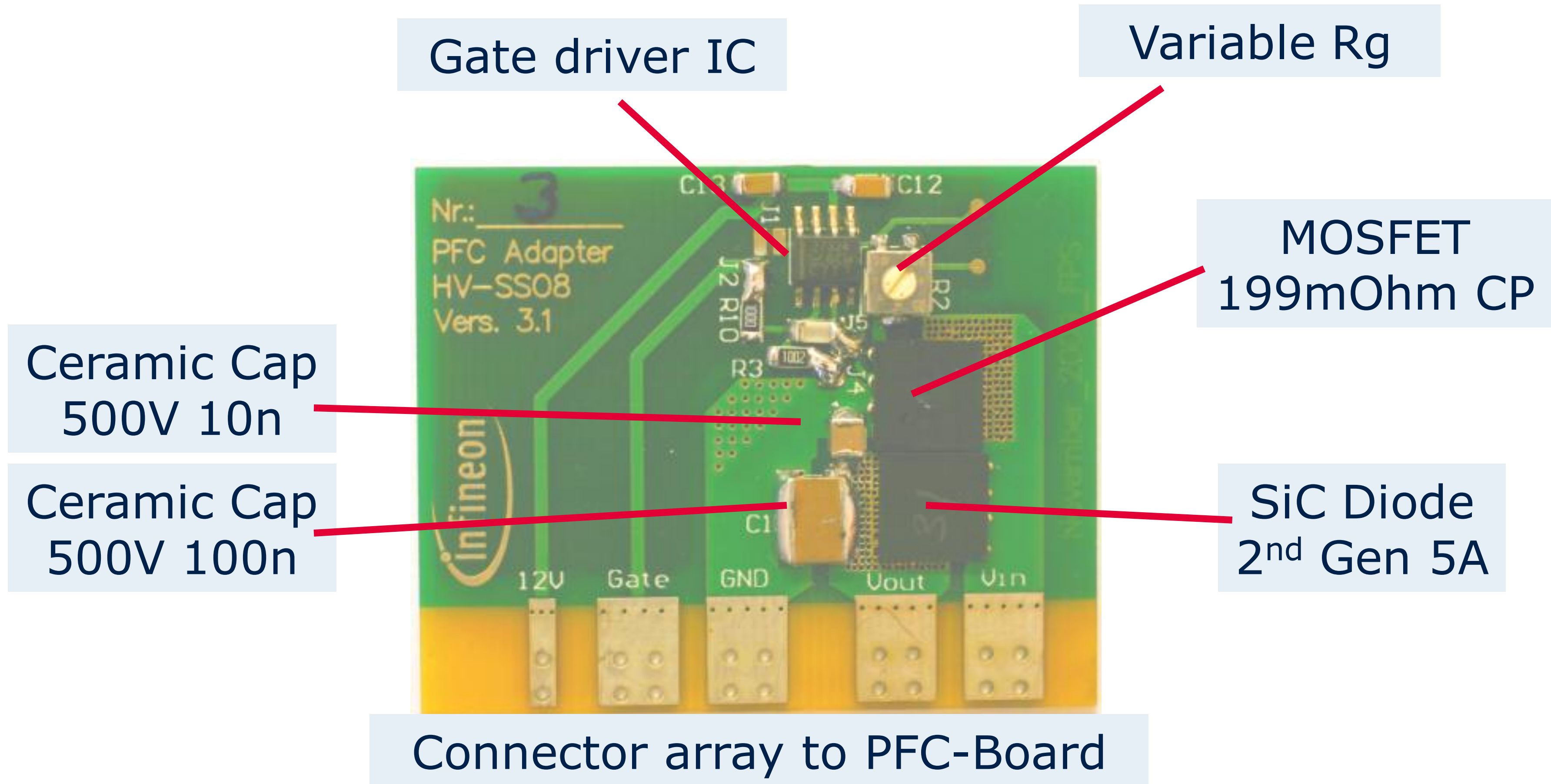
| Application | CCM PFC |
|---|---|
| **Max Output Power (W)** | 300W |
| **PFC Controller** | ICE2PCS01G |
| **PFC Diode** | 5A SiC |
| **Heatsink Temperature** | 60$^{o}$C |
| **PCB** | PFC Adapter Board_2 |



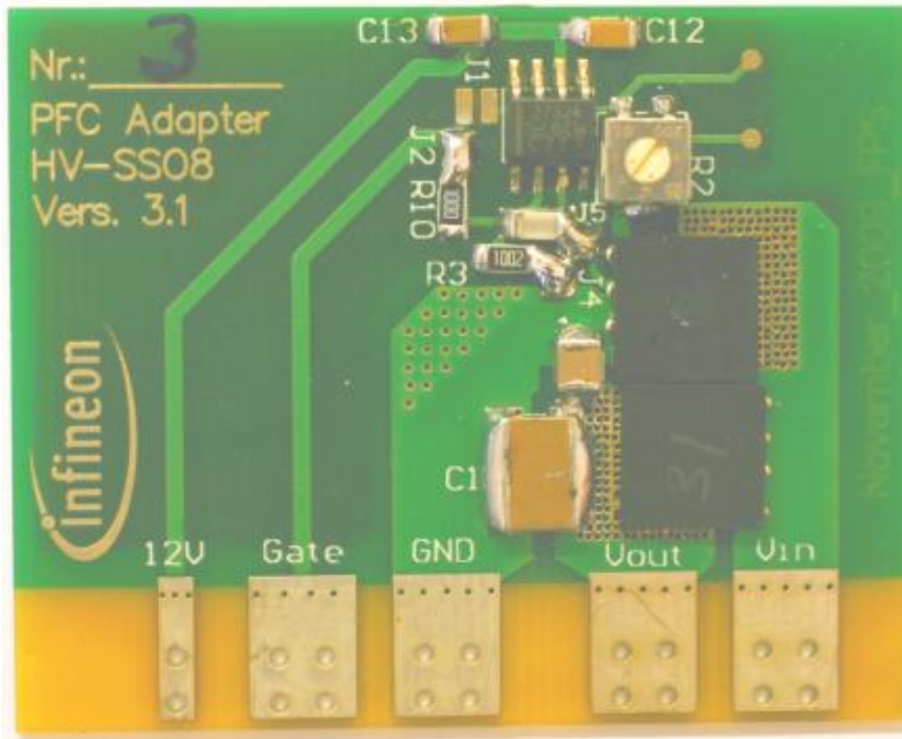


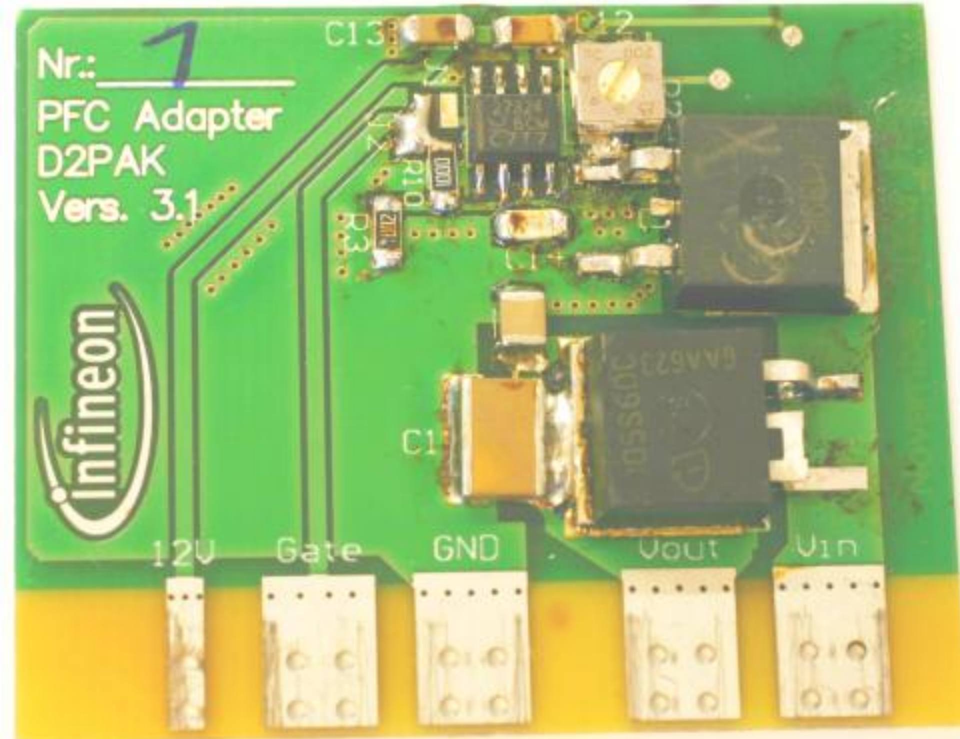
# Application Test Condition

- ThinPAK 8x8 adapter PCB for PFC stage

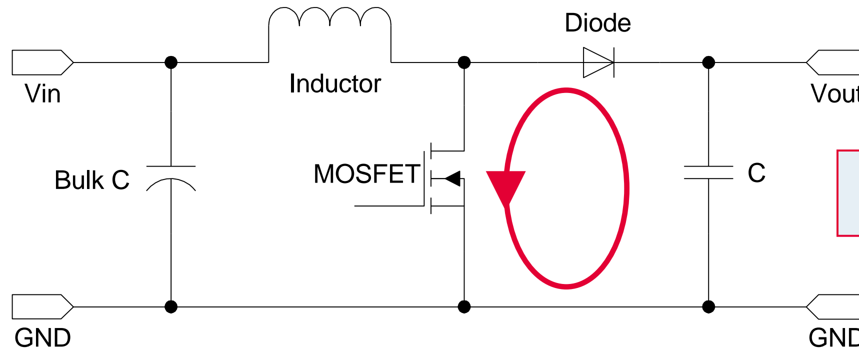


# ThinPAK 8x8 vs. $D^2$PAK

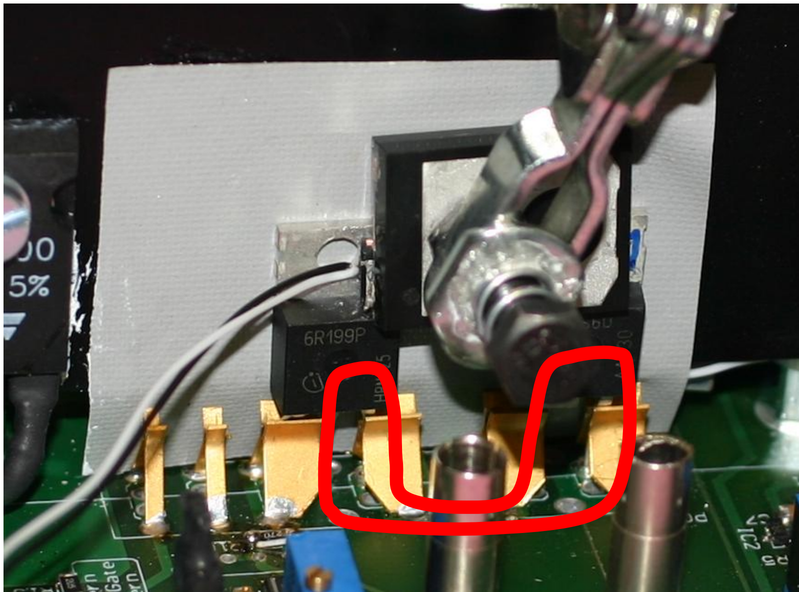


# Application Test Condition
# Improved commutation loop compared to TO220




Commutation loop



Big loop
2x TO220 + main PCB

Smallest loop
2x ThinPAK 8x8

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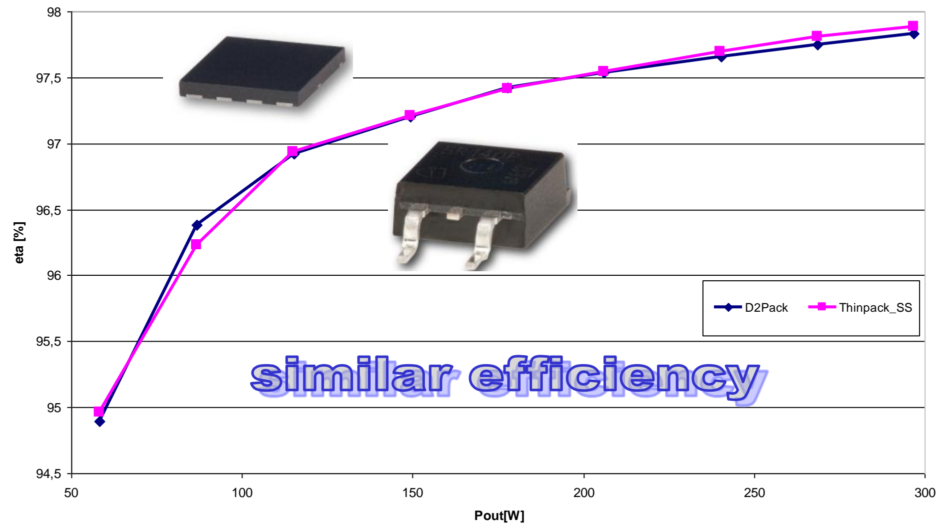
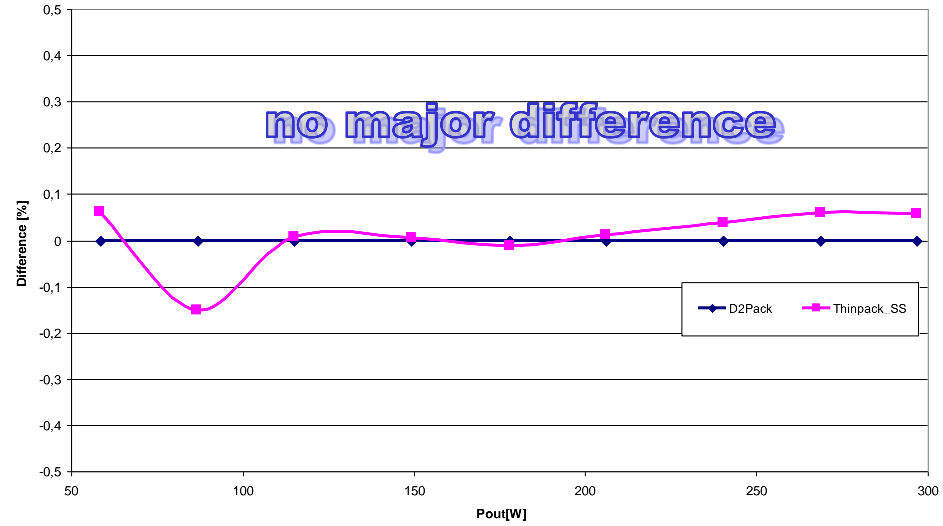
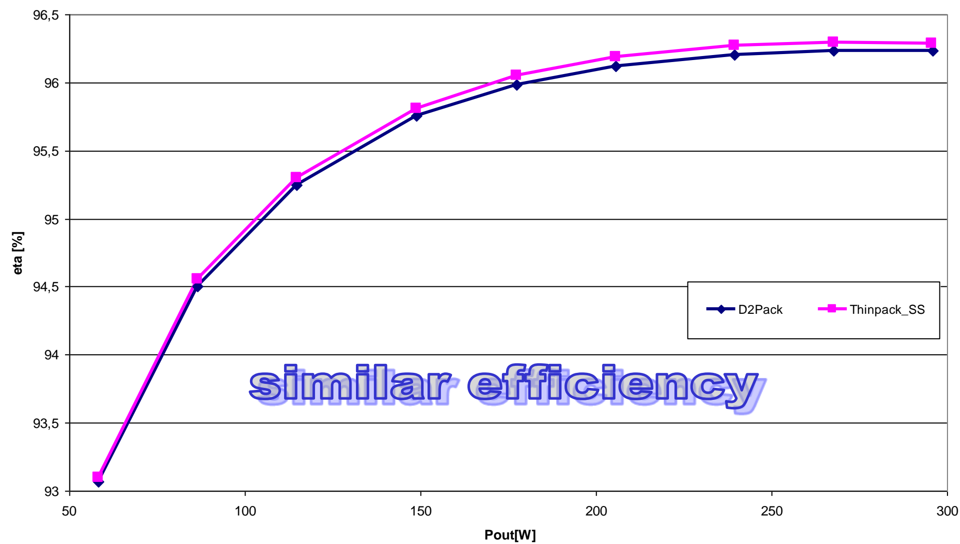
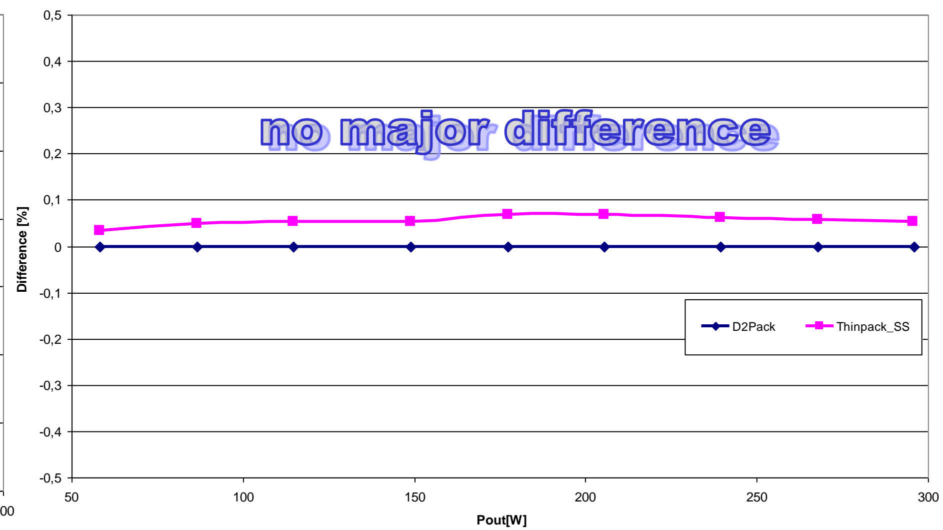
# Efficiency comparison $D^2$PAK vs. ThinPAK 8x8

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

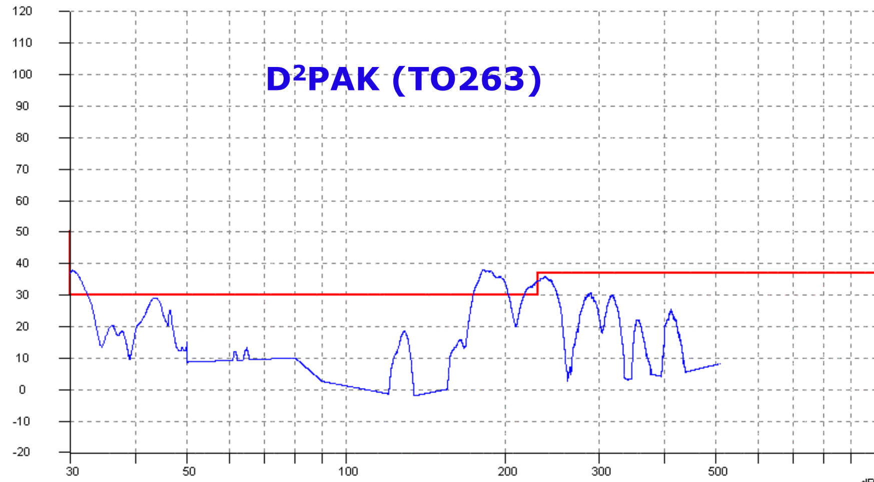


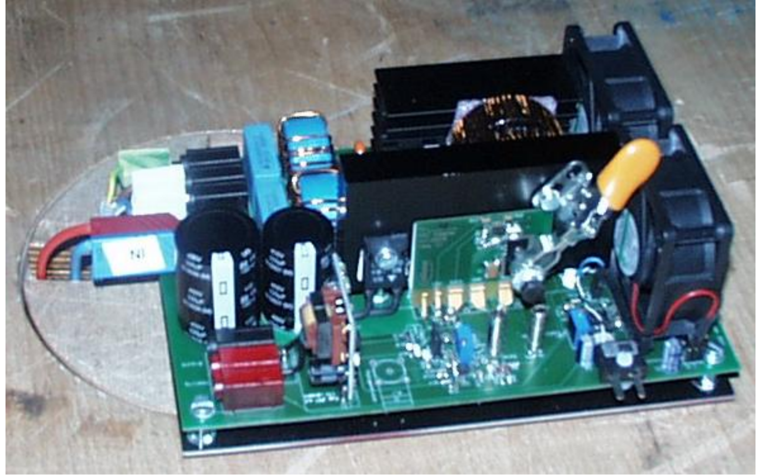
# EMI Measurement 200W; 15 Ohm Rg, 130kHz




Start: 513.06003 MHz
Stop: 999.9990 MHz
Step : 60.0000 kHz

Detektor: CISPR QP
ZF-D.: RA/20dB
ZF-BBR.: 120 kHz
VariScan: EIN

Autorange: 15 dB P 1
Eingang: DIREKT
Mitl. Gen.: AUS
Ref. Pegel.: 30 dB



**similar behaviour**

Start: 30.0000 MHz
Stop: 999.9990 MHz
Step : 60.0000 kHz

Detektor: CISPR QP
ZF-D.: RA/20dB
ZF-BBR.: 120 kHz
VariScan: EIN

Autorange: 15 dB P 1
Eingang: DIREKT
Mitl. Gen.: AUS
Ref. Pegel.: 30 dB

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# Turn on: Waveform - Comparison

TO263 ($D^2PAK$)

ThinPAK 8x8

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

Highly reduced ringing at gate when using ThinPAK 8x8

# Turn off: Waveform – Comparison

TO263 ($D^2PAK$)

ThinPAK 8x8

$V_{Gs}$
$V_{Bulk}$
$I_{Choke}$
$V_{DS}$

Highly reduced ringing at gate when using ThinPAK 8x8

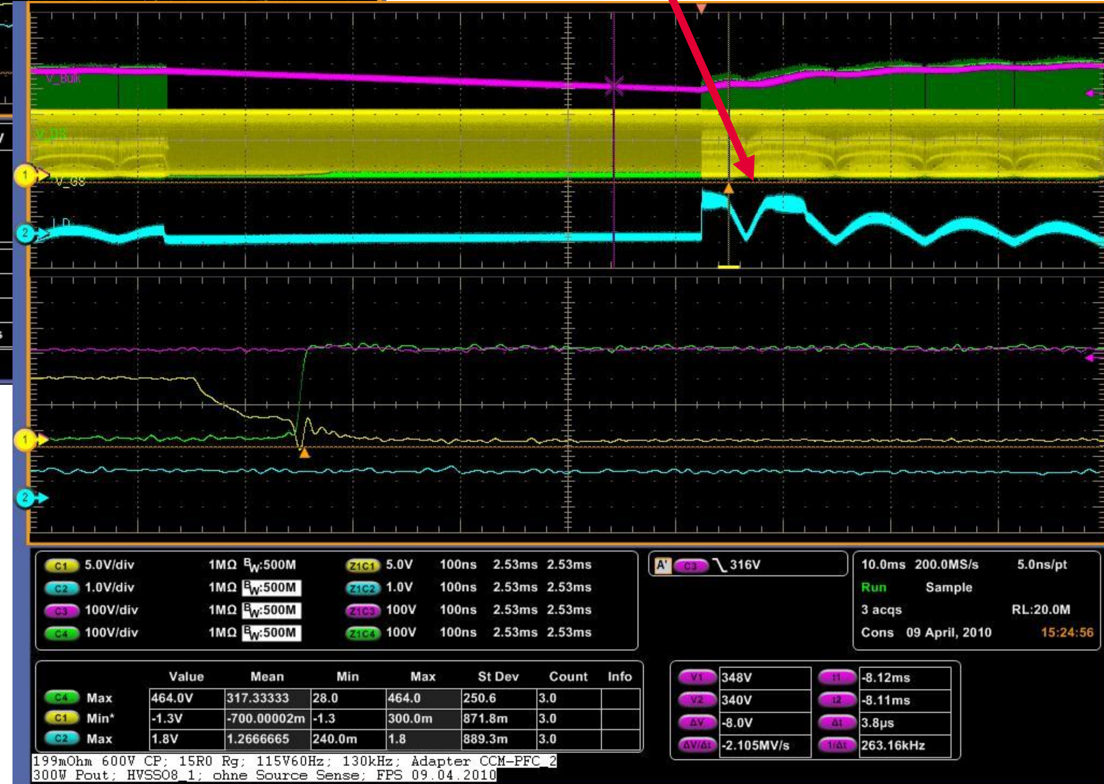
# Waveforms – 50ms AC line drop out

Up to -12V on $V_{GS}$

TO263 (DPAK)

Up to -1,3V on $V_{GS}$

ThinPAK 8x8




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

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# Initial Portfolio: 600V CoolMOS CP

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

- Further portfolio extentions 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

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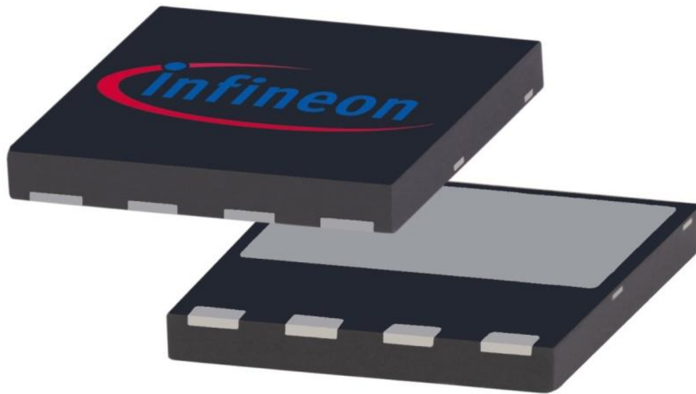
# Standardization is key in today´s market

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

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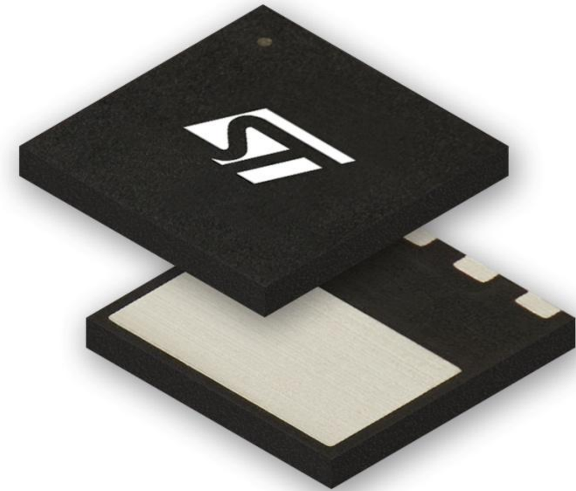

**ThinPAK 8x8** **PowerFLAT™ 8x8 HV**

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# Summary of Advantages

- Leadless SMD approach enables highest power density designs
  - Small footprint (64 mm² vs. 150 mm² for $D^2PAK$)
  - Low profile package (1.0 mm vs. 4.4 mm for $D^2PAK$)

- 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 $D^2PAK$)
  - 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

Infineon

ENERGY EFFICIENCY
COMMUNICATIONS
SECURITY

Innovative semiconductor solutions for energy efficiency, communications and security.