600 V CoolMOS™ P7 for high power SMPS

Tamara Krappinger

July 2017

Agenda

1. 600 V CoolMOS™ P7 positioning and overview
2. Efficiency – application tests and benchmarking
3. Ease of use
4. Portfolio granularity
5. Summary & support material

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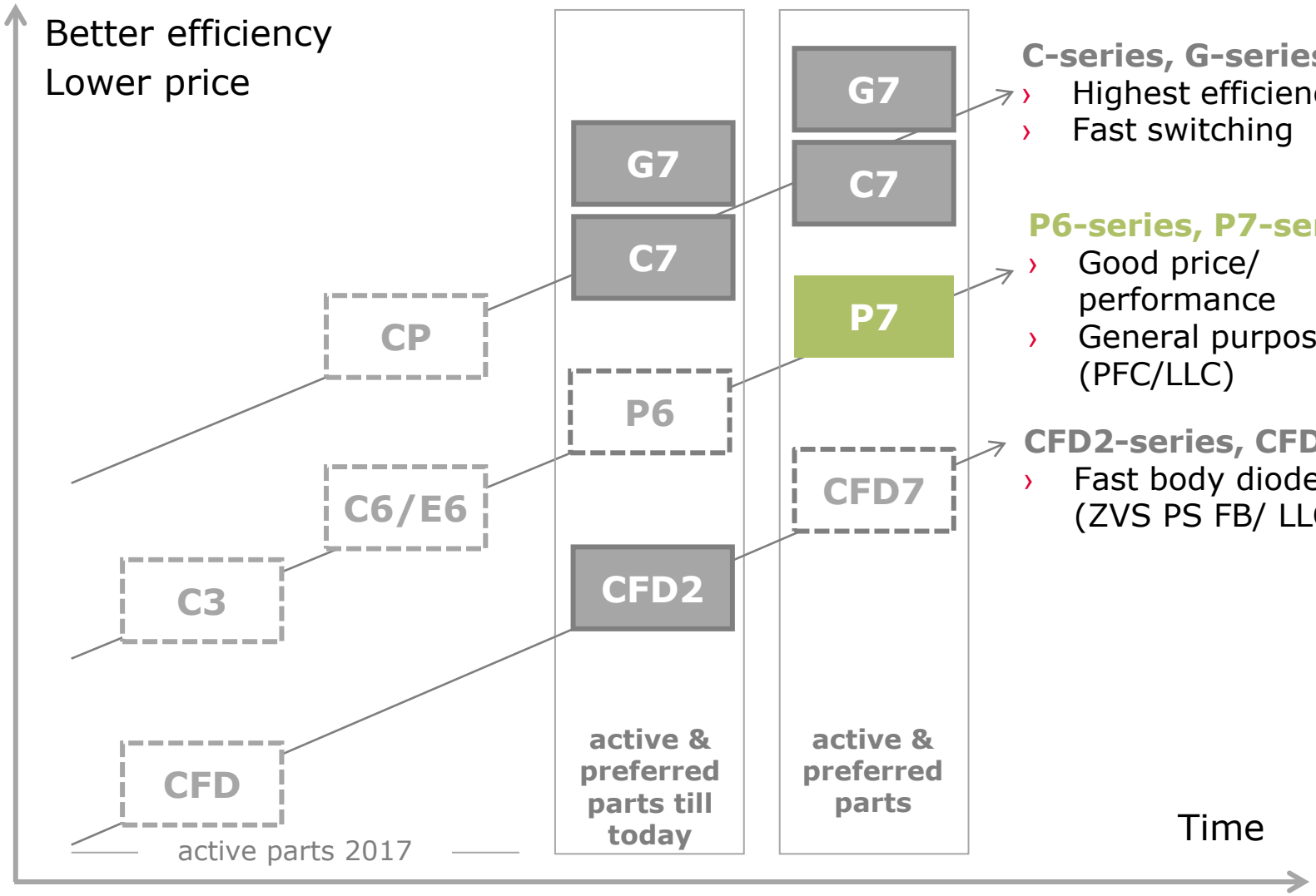
CoolMOS™ positioning within the high power SMPS market



C-series, G-series
- Highest efficiency
- Fast switching

P6-series, P7-series
- Good price/ performance
- General purpose (PFC/LLC)

CFD2-series, CFD7-series
- Fast body diode (ZVS PS FB/ LLC)

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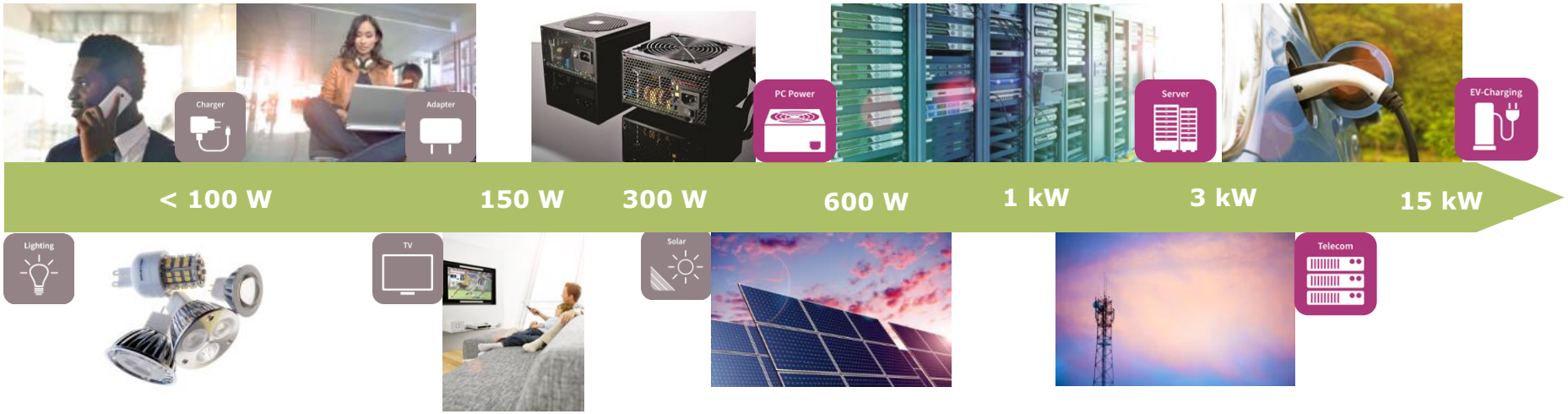
600 V CoolMOS™ P7 spans the power range from 100 W-15 kW …

… addressing a wide range of applications



Flyback

Hard switching topologies like PFC

Soft switching topologies like LLC

600 V CoolMOS™ P7 is suitable for a **wide range of applications and power classes** and can be used in **hard switching** as well as in **soft switching topologies**.

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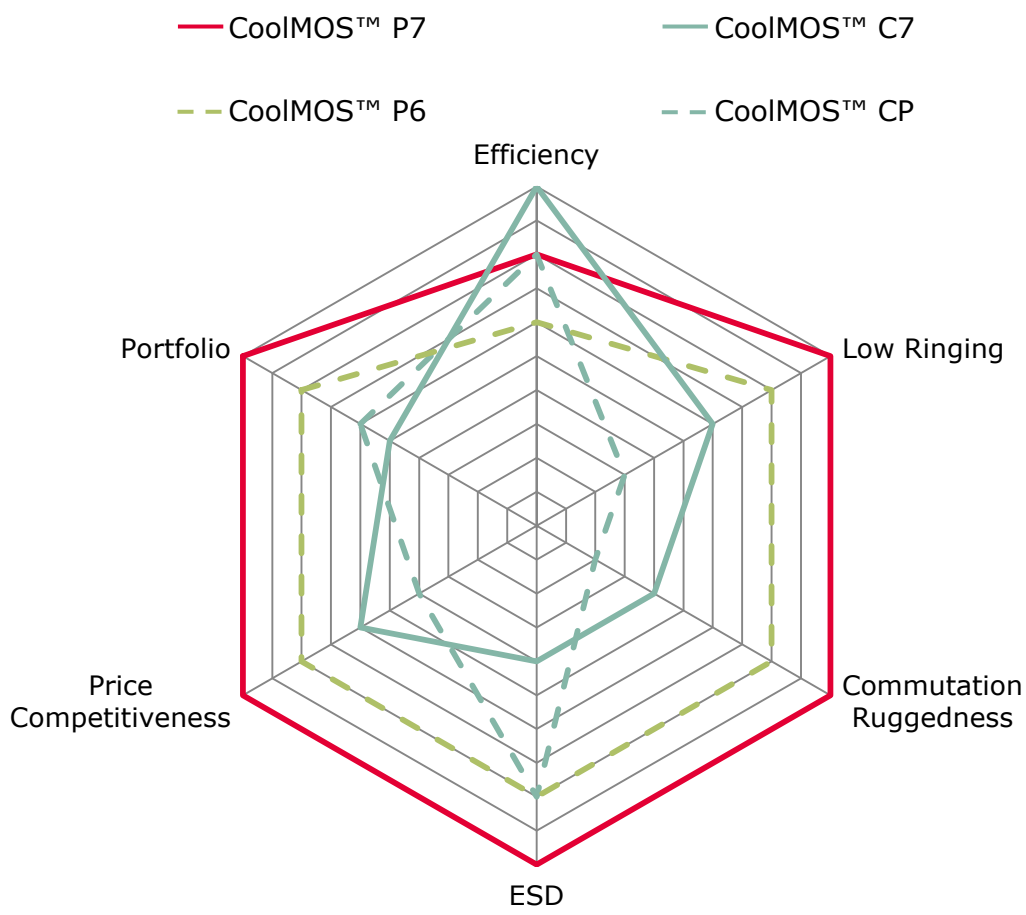
600 V CoolMOS™ P7 – the most well balanced high voltage MOSFET in key dimensions



- Most rounded technology of all CoolMOS™ families
- Perfect combination of:
  - high efficiency
  - excellent ease-of-use
  - competitive price and
  - outstanding portfolio granularity

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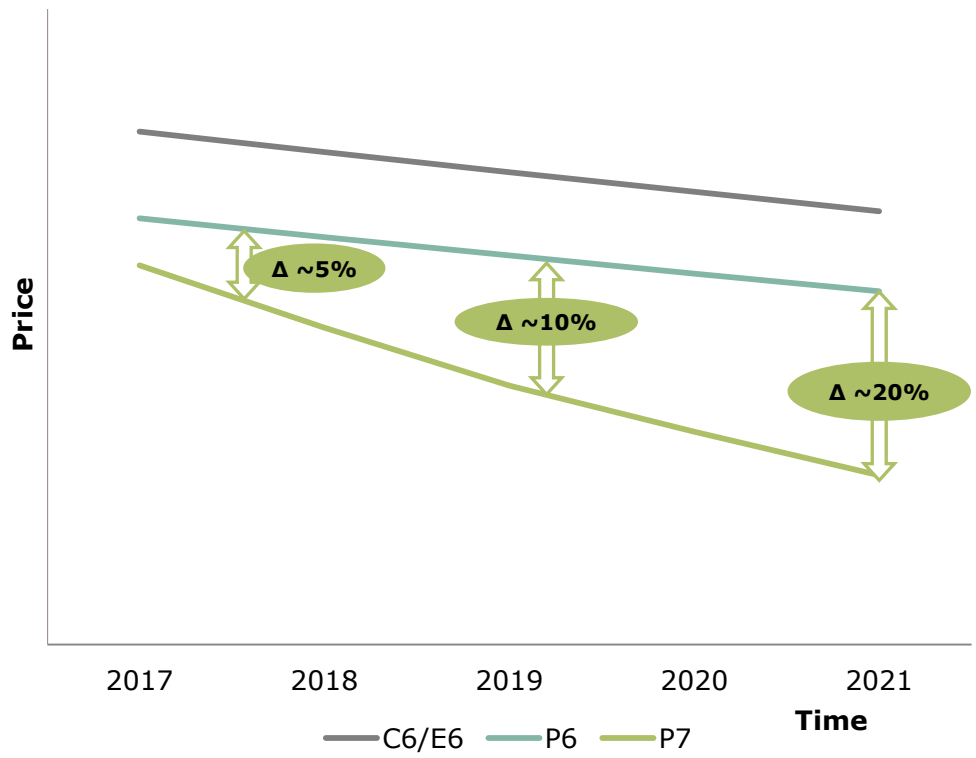
600 V CoolMOS™ P7 combines high performance with state of the art ease-of-use …

… at best price/performance ratio



600 V CoolMOS™ P7 commercial aspects

600 V CoolMOS™ P7

- comes along with the best balanced price/performance ratio
- offers most competitive **long term price roadmap** compared to previous CoolMOS™ families

Remark:

The given indications are based on standard prices by considering high volumes (>>500 kpcs/yr)

Single price points can differ from this indication

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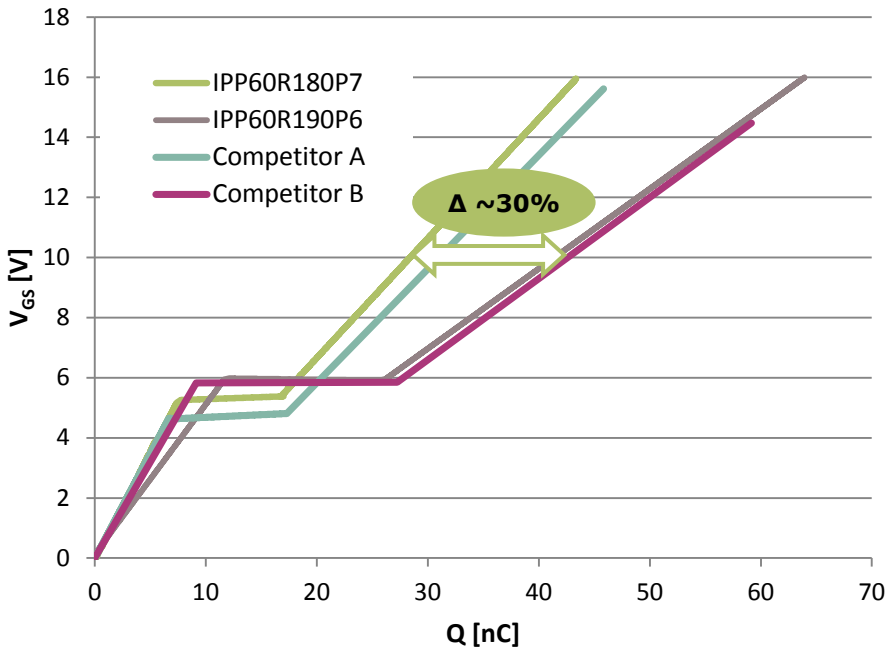
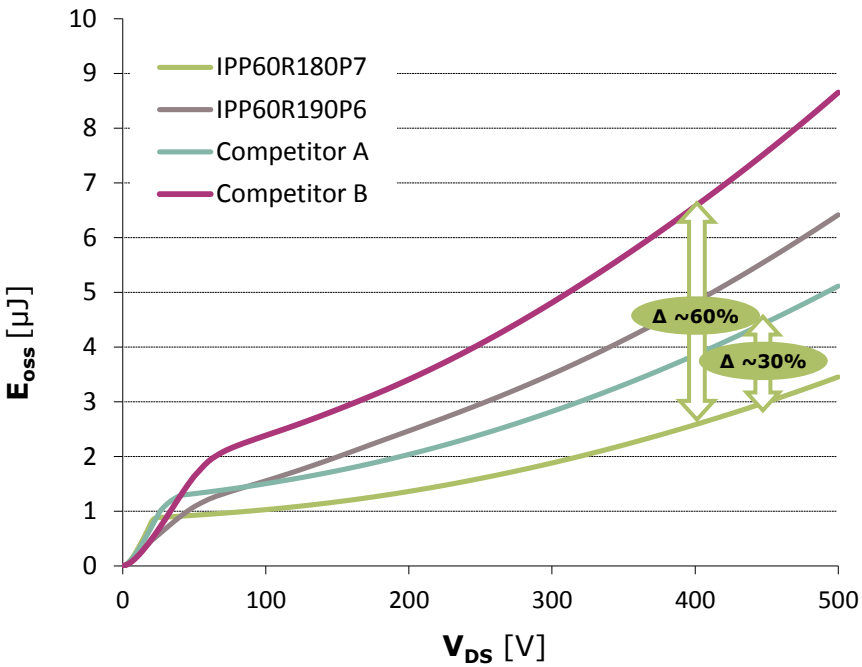
600 V CoolMOS™ P7 offers significant reduction of driving and switching losses

1 Driving losses (Q_G)



2 Switching losses (E_{oss})



600 V CoolMOS™ P7 offers

- ~30% reduced gate charge over competition at 10 V
- between 30% and 60% lower E_{oss} than competition at 400 V

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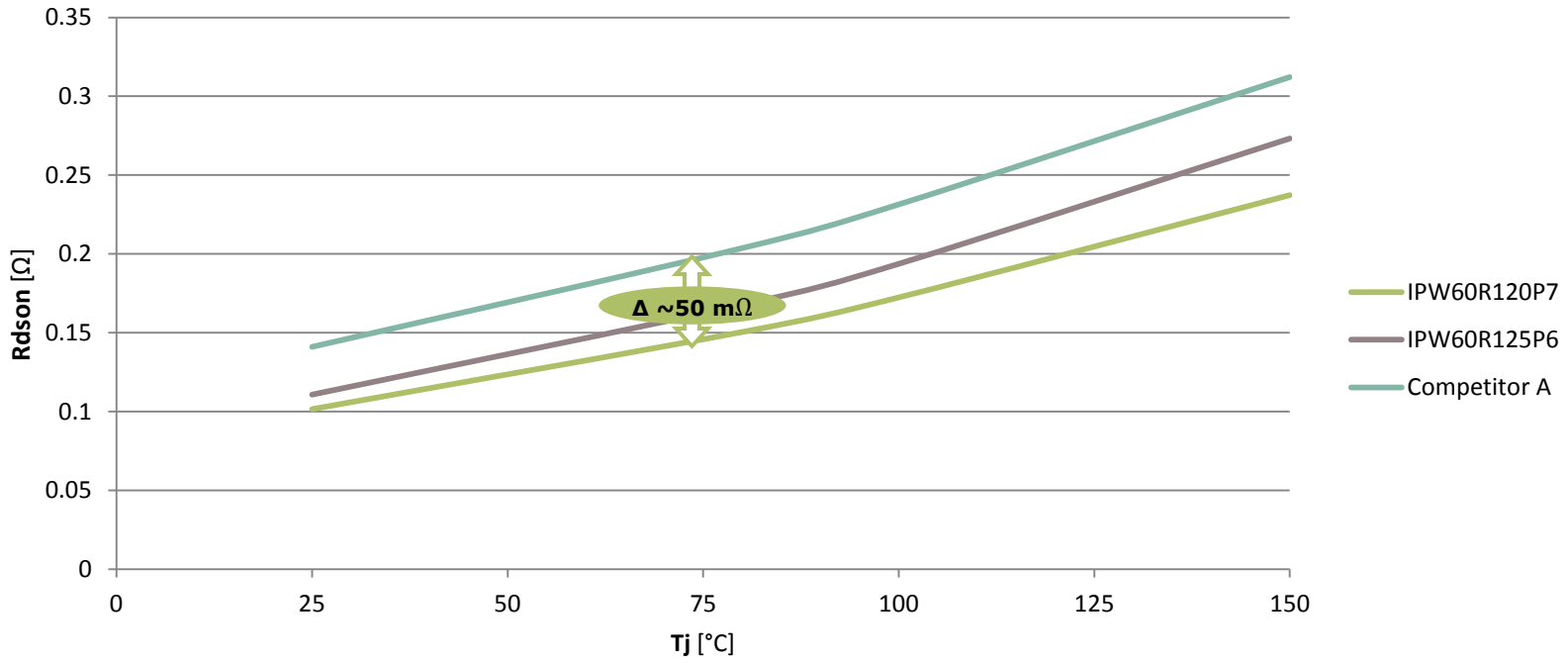
600 V CoolMOS™ P7 offers significant reduction of conduction losses

Rdson[Ω] at 10 A over Tj [°C]



CoolMOS™ P7 600 V offers a lower typical $R_{DS(on)}$ than competitor offerings leading to a reduction of conduction losses

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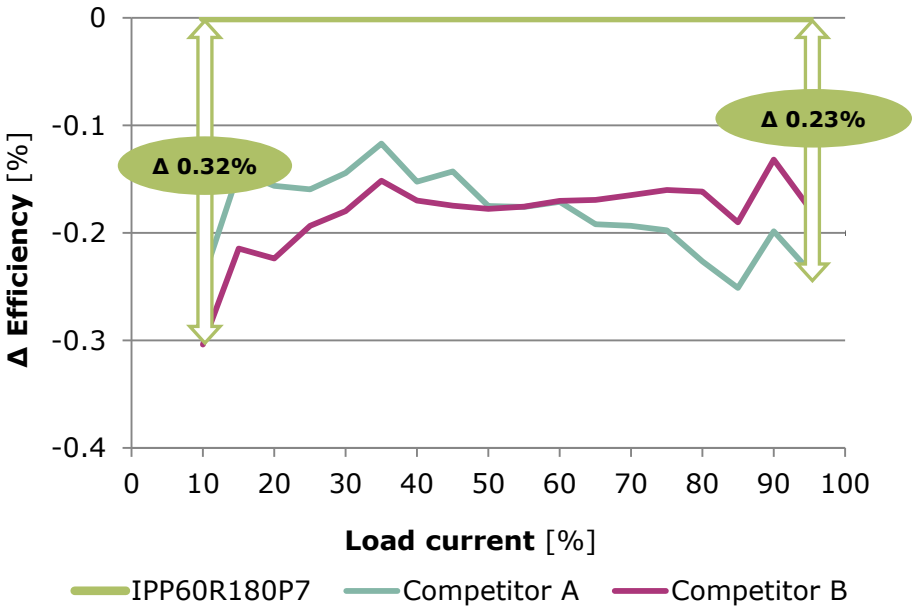
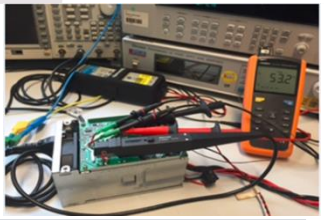
600 V CoolMOS™ P7 application test and benchmarking - 240 W PC power in PFC

1 Efficiency measurement

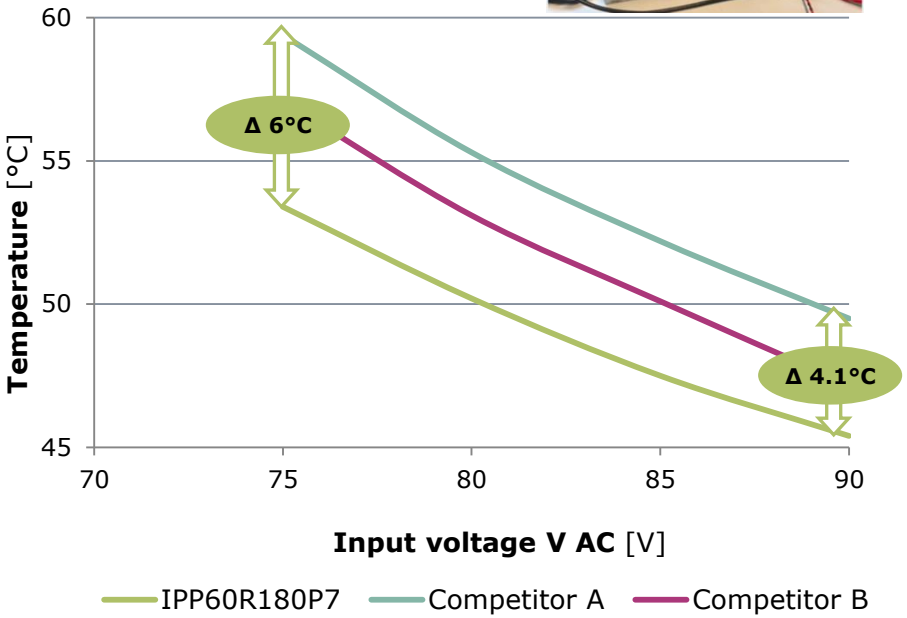
Delta efficiency @ 90 V_{AC}, 65 kHz



2 Brown out test



MOSFET temperature over V_{AC}



600 V CoolMOS™ P7 offers

- efficiency benefits up to 0.32% at low line
- passes brown out test with up to 6°C lower temperature compared to competition

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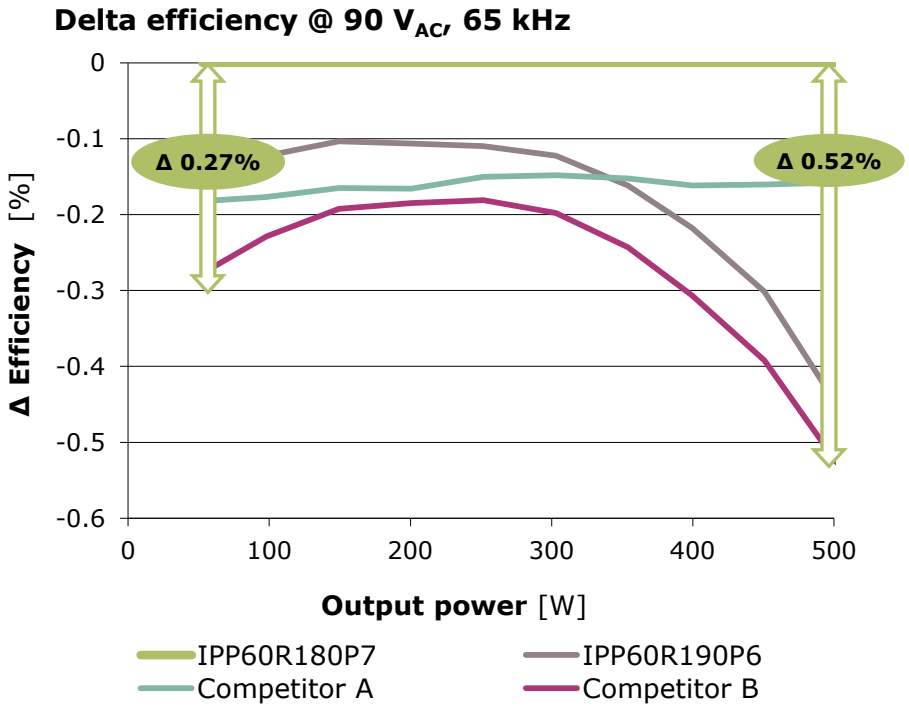
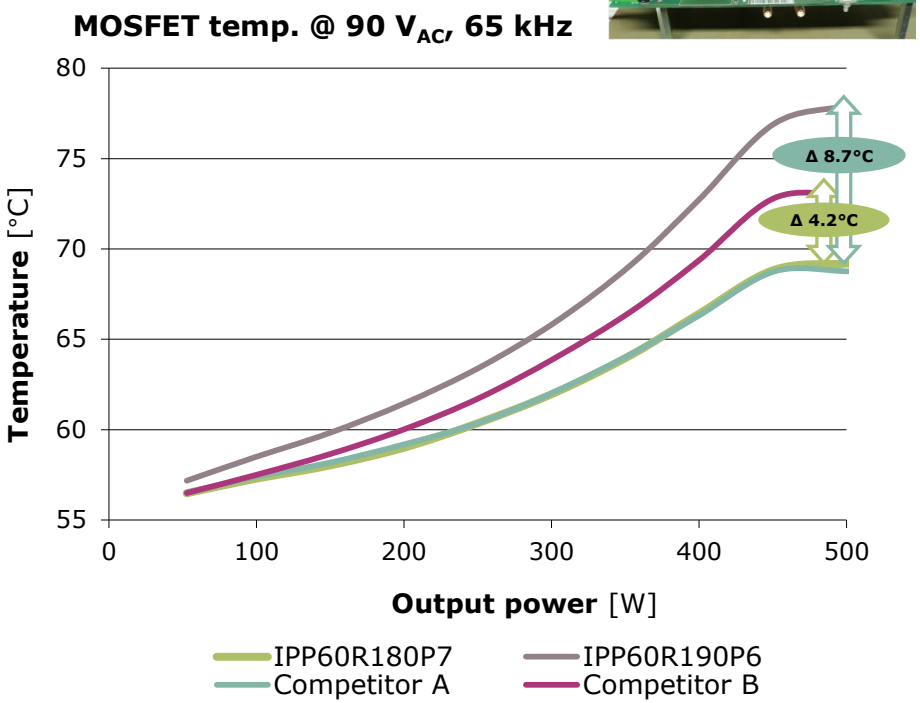
600 V CoolMOS™ P7 application test and benchmarking - 500 W in PFC

1 Efficiency measurement



2 Thermal measurement



600 V CoolMOS™ P7 offers

- efficiency benefits up to 0.52% at low line
- 8.7°C better thermals compared to CoolMOS™ P6
- up to 4.2°C better temperature than competition

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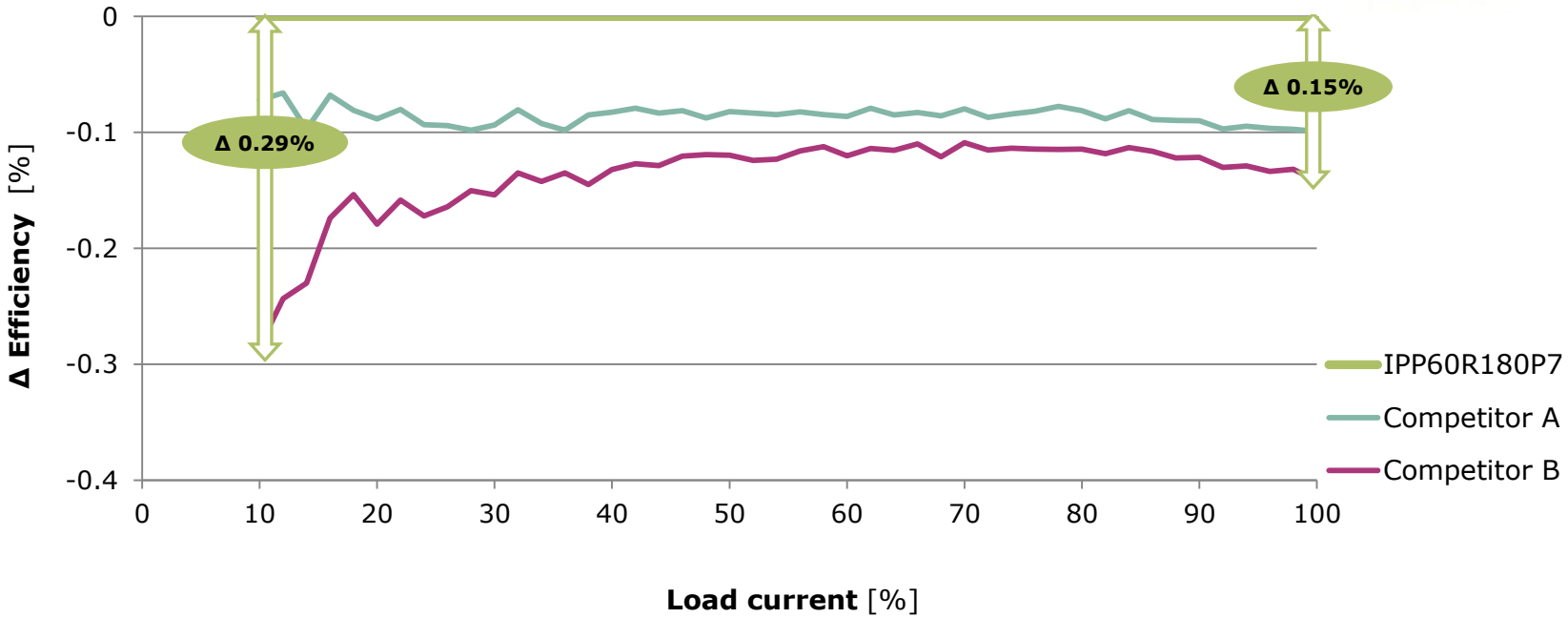
600 V CoolMOS™ P7 application test and benchmarking - 600 W in LLC

Delta efficiency measurement @ 150 kHz



600 V CoolMOS™ P7 offers efficiency benefits up to 0.29% compared to competition over the whole load range

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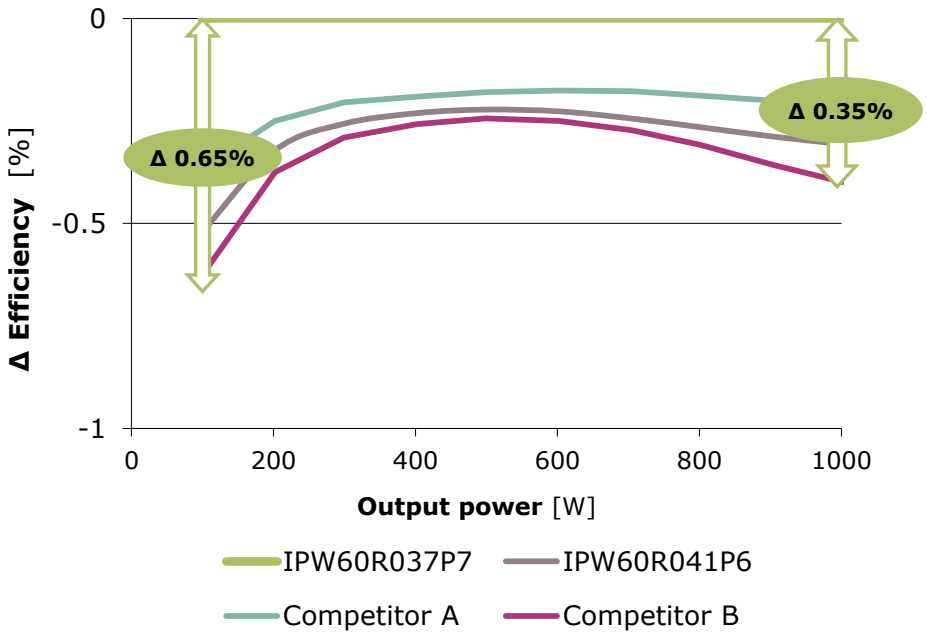
600 V CoolMOS™ P7 application test and benchmarking - 3 kW in PFC

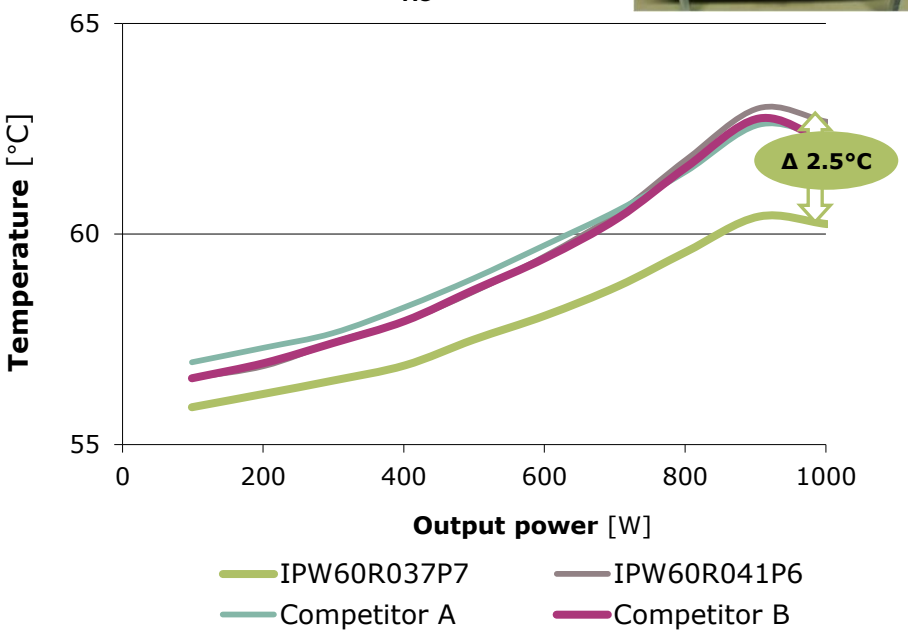
1 Efficiency measurement

Delta efficiency @ 90 V_{AC}, 65 kHz



2 Thermal measurement

MOSFET temp. @ 90 V_{AC}, 65 kHz



600 V CoolMOS™ P7 offers

- efficiency benefits up to 0.65% compared to competition
- lowest temperate increase and outperforms competition by offering thermal benefits of up to 2.5°C

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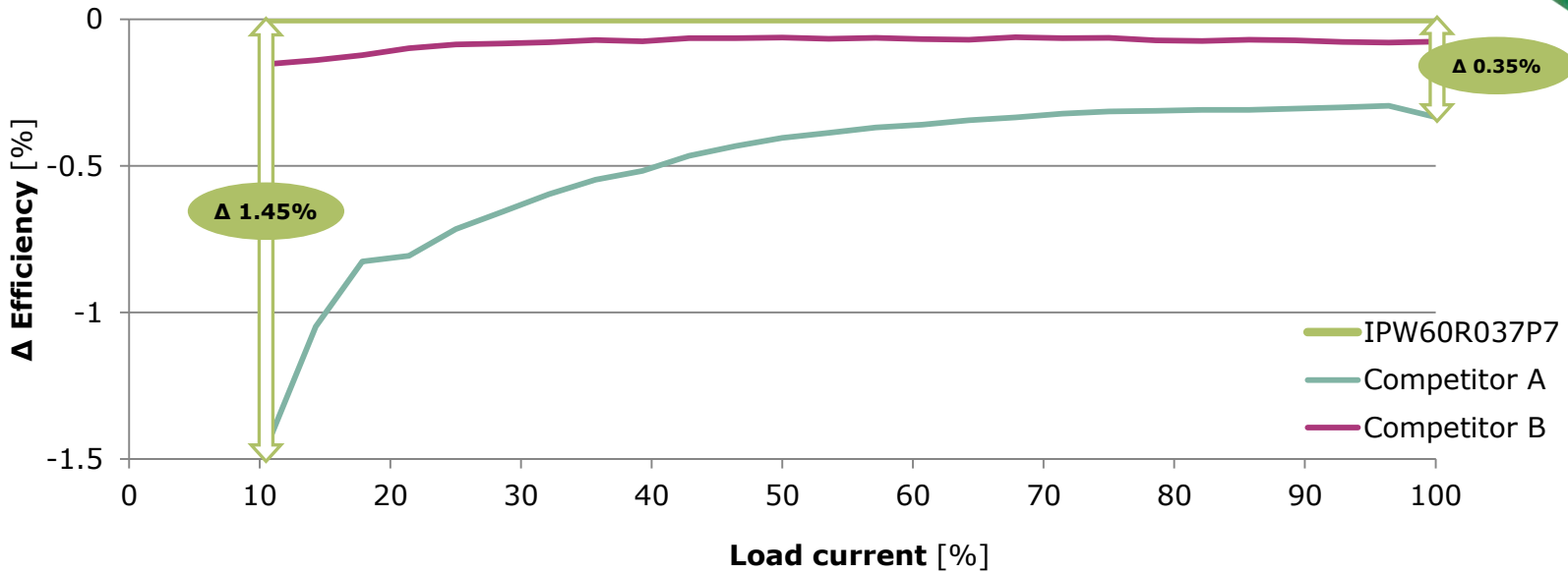
600 V CoolMOS™ P7 application test and benchmarking - 3 kW in LLC

Delta efficiency @ 200 kHz



600 V CoolMOS™ P7 offers efficiency benefits of up to 1.45% compared to competition

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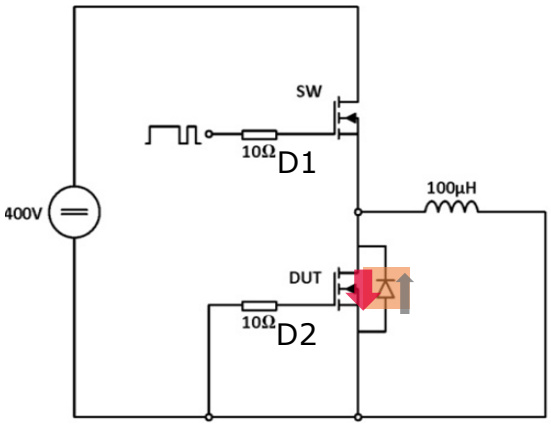
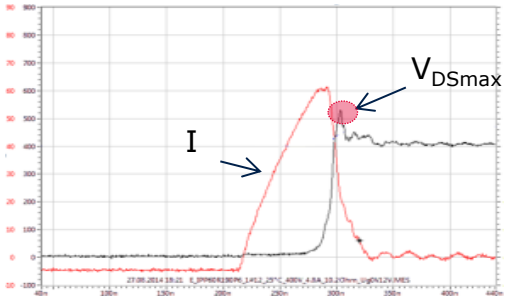
600 V CoolMOS™ P7 offers a robust body diode making it suitable for LLC topology

Body diode hard commutation challenge in LLC

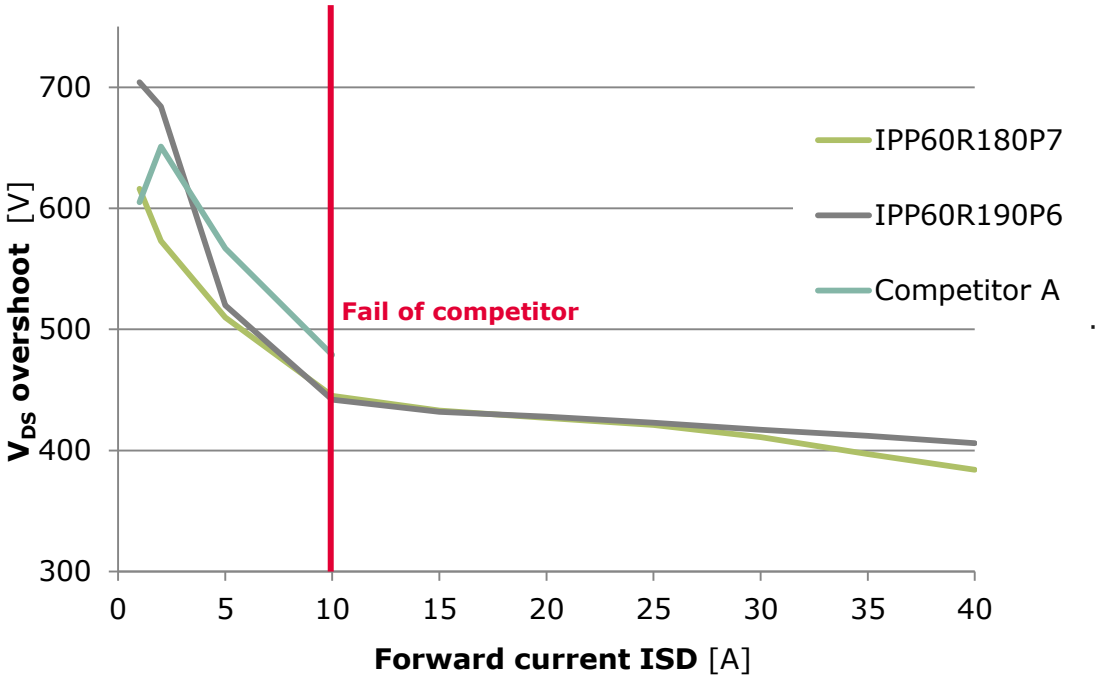


Body diode hard commutation



- Body diode of D2 is not fully off before D1 turns on
- High di/dt and voltage over-shoot significantly stress D2

Body diode hard commutation of 180 mΩ device @ $R_{g,}$=1.8 Ω, V_{GS} =13 V



600 V CoolMOS™ P7

- offers a rugged body diode capable to withstand hard commutation conditions up to 2.5 times higher than nominal ID
- offers a smooth wavefom and a reduced V_{DSmax}

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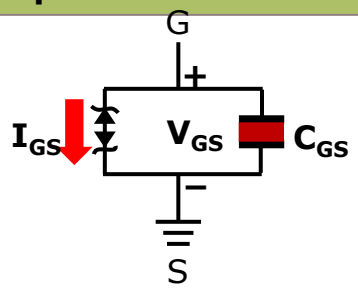
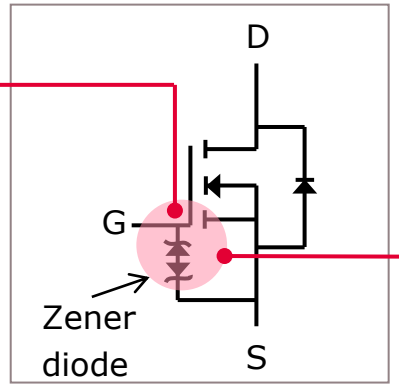
CoolMOS™ P7 integrated ESD protection reduces ESD related failures

ESD protection mechanism



During ESD event:

- V_{GS} is clamped by Zener diode
- I_{GS} flows through Zener diode
- Thus protect gate oxide



Customer benefits

- Better assembling yield thus less cost
- Less field failure rate
- Higher quality and better reputation

600 V CoolMOS™ P7 offers an **ESD robustness** of > 2 kV (HBM Class 2)

- 100 mΩ–600 mΩ due to integrated Zener diode
- <100 mΩ ensured by chip size

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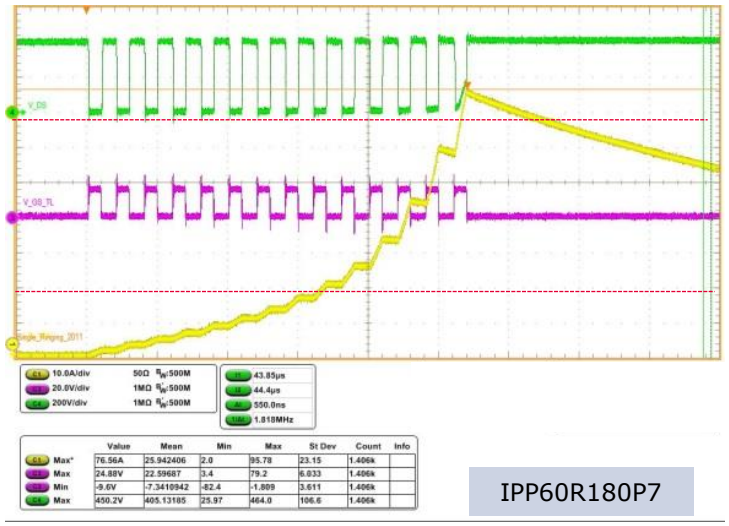
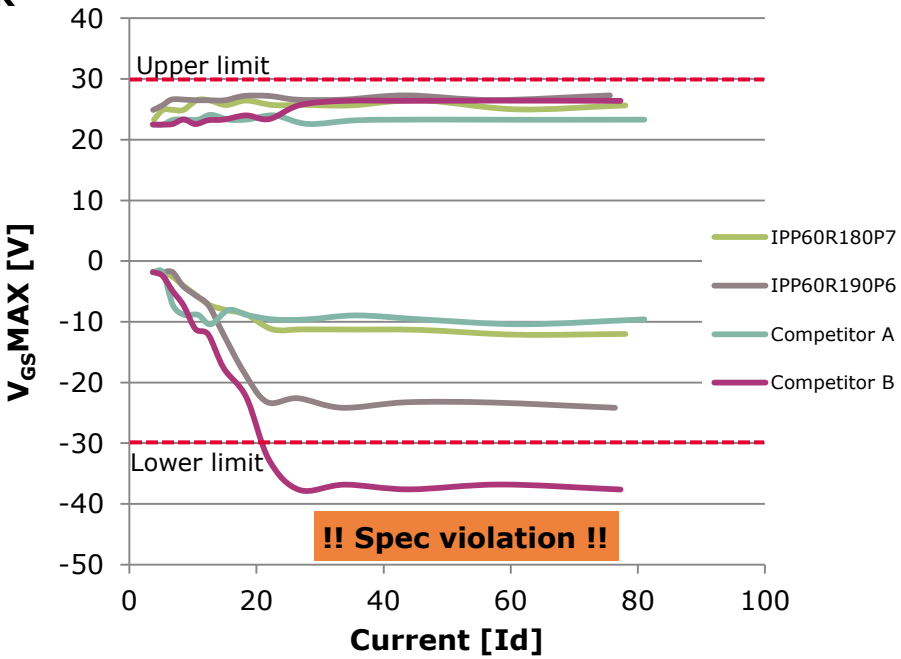
600 V CoolMOS™ P7 is optimized for low ringing to allow for design-in flexibility

Ringing evaluation in a PFC

@ worst case conditions 7.2. pF C_{GD} and 0.5 R





600 V CoolMOS™ P7 offers

- an excellent ringing margin before hurting +/-30 V datasheet limit
- improved ringing behavior than previous CoolMOS™ technologies
- optimized balance between efficiency and ease of use

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600 V CoolMOS™ P7 planned portfolio

$R_{DS(ON)}$ [mΩ] Max.	DPAK	D²PAK	ThinPAK 8x8	TO220 FullPAK	TO220	TO220 FP WC	TO247	TO247-4	SOT223
Industrial Grade									
600	IPD60R600P7			IPA60R600P7	IPP60R600P7				
360/365	IPD60R360P7	IPB60R360P7	IPL60R365P7	IPA60R360P7	IPP60R360P7				
280/285	IPD60R280P7	IPB60R280P7	IPL60R285P7	IPA60R280P7	IPP60R280P7				
180/185	IPD60R180P7	IPB60R180P7	IPL60R185P7	IPA60R180P7	IPP60R180P7		IPW60R180P7	IPZ60R180P7	
120/125		IPB60R120P7	IPL60R125P7	IPA60R120P7	IPP60R120P7		IPW60R120P7	IPZ60R120P7	
99/104		IPB60R099P7	IPL60R105P7	IPA60R099P7	IPP60R099P7		IPW60R099P7	IPZ60R099P7	
80		IPB60R080P7	IPL60R085P7	IPA60R080P7	IPP60R080P7		IPW60R080P7	IPZ60R080P7	
60/65		IPB60R060P7	IPL60R065P7	IPA60R060P7	IPP60R060P7		IPW60R060P7	IPZ60R060P7	
37							IPW60R037P7	IPZ60R037P7	
Standard Grade									
600	IPD60R600P7S			IPA60R600P7S		IPAW60R600P7S			IPN60R600P7S
360/365	IPD60R360P7S			IPA60R360P7S		IPAW60R360P7S			IPN60R360P7S
280/285	IPD60R280P7S			IPA60R280P7S		IPAW60R280P7S			
180/185	IPD60R180P7S			IPA60R180P7S		IPAW60R180P7S			

Released

Coming until end of 2017

- Large $R_{DS(on)}$ and package variety
- Offering through hole and SMD packages
- Suitable for a wide variety of applications and power ranges

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600 V CoolMOS™ P7 offers the optimized balance between high efficiency and ease of use

Best-fit performance for target markets

- Significant reduction of switching losses
  - -50% E_{oss}
  - -30% Q_G
  - -20% turn off losses
- Up to 5°C lower MOSFET temperature
- Lower $R_{DS(on)}$ per package (TO-220, ThinPAK)
- Enabling smaller form factors

State of the art ease of use

- Very low ringing tendency
- Smooth switching waveforms
- Outstanding body diode ruggedness
- Excellent ESD robustness >2 kV (HBM)

Best-in-class commercial aspects

- Best-in-class price performance ratio
- 60 parts in 9 different packages
- $R_{DS(on)}$ granularity from 37 to 600 mΩ
- Available in industrial and standard grade packages
- Suitable for a wide variety of applications and power ranges

600 V CoolMOS™ P7 – a universal high voltage MOSFET for a large range of use cases

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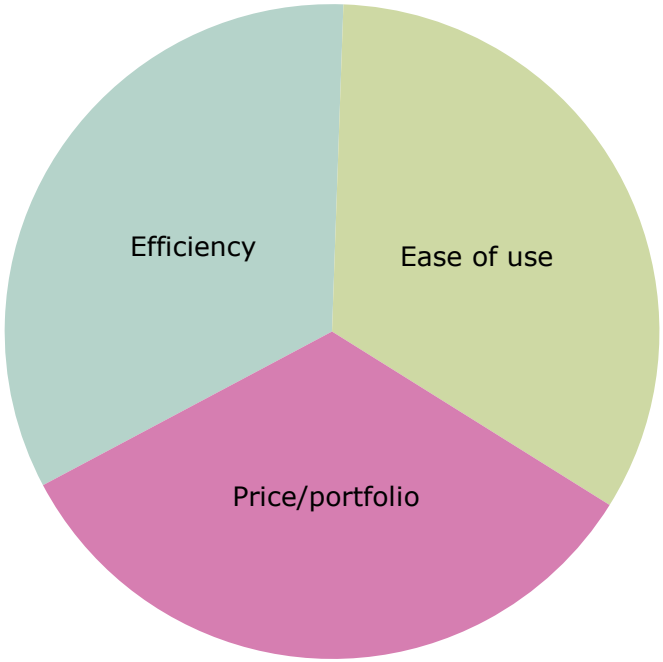
600 V CoolMOS™ P7 – Infineon's best balanced CoolMOS™ technology



Resulting from 17 years of superjunction MOSFET innovation 600 V CoolMOS™ P7 is **Infineon's most rounded CoolMOS™ technology** offering the optimized balance between performance, ease of use, price and portfolio granularity

2001	2004	2005	2009	2011	2012	2013	2014	2015	2017
C3	CFD	CP	C6/E6	CFD2	CE 500 V	C7 650 V P6	CE 600/650/800 V	C7 600 V	**P7 600 V**

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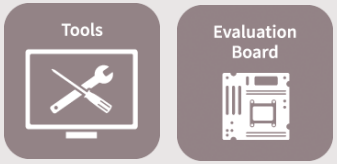
Support material

Collaterals and brochures

- Product Briefs
- Selection Guides
- Application Brochures
- Presentations
- Press Releases, Ads

Technical material



- Application Notes
- Technical Articles
- Simulation Models
- Datasheets, MCDS Files
- PCB Design Data

Videos

- Technical Videos
- Product Information Videos

- www.infineon.com/p7
- Drive your CoolMOS™ to best performance with a cool EiceDRIVER™

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