

Fast IGBT and Diode technologies achieve Platinum Efficiency Standard in commercial SMPS applications.



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The TRENCHSTOP™_{smps} consists of a drastic improvement of Infineon's Trench Field Stop (TRENCHSTOP™) concept, aiming to reduce simultaneously switching and conduction losses. The gate design is optimized for fast switching applications like SMPS. Below an exemplary product matrix:

Configuration	TRENCHSTOP™ _{smps} High Speed	TRENCHSTOP™ _{smps} Fast
Co-Pack with Rapid 1 anti-parallel diode	IPW40N65HFD	IPW40N65FFD
Single IGBT	IPW40N65H	IPW40N65F

- High Speed "H": plug and play replacement of existing MOSFET or IGBT, best fit in PFC with Si ultrafast boost diode.
- Fast "F": highest efficiency achievable. Optimized performance in PCB design with low stray inductance. Best fit with SiC Schottky boost diode in PFC. Needs driver stage with split R_g.

The following table shows a parametric comparison with a commercial 650V Superjunction MOSFET. The energy E_{oss} stored in the output capacitance C_{oss} as well as gate charge Q_g are drastically reduced. The equivalent body diode is much faster. C_{oss} and Q_g are responsible for the losses in the Output capacitance and gate driver losses.

$$P_{Coss} = 1/2 C_{oss} \times V_{ce}^2$$

$$P_{dr} = V_{ge} \times Q_g \times f_{sw}$$

Comparison of 40A "F" with commercial Superjunction MOS of equivalent rating

Parameter	650V SJ MOS	TRENCHSTOP™ _{smps} IPW40N65F	Unit
R _{(on)eq, typ. @ T_c=25°C}	63	65	mΩ
ID,pulse @ 25°C	150	120	A/μs
E _{oss} @ 400V	13	3	μJ
Q _{g,typ}	170	95	nC
Q _{rr}	19	0.6	μC
T _{rr}	730	18	Ns
I _{rrm}	50	5.6	A

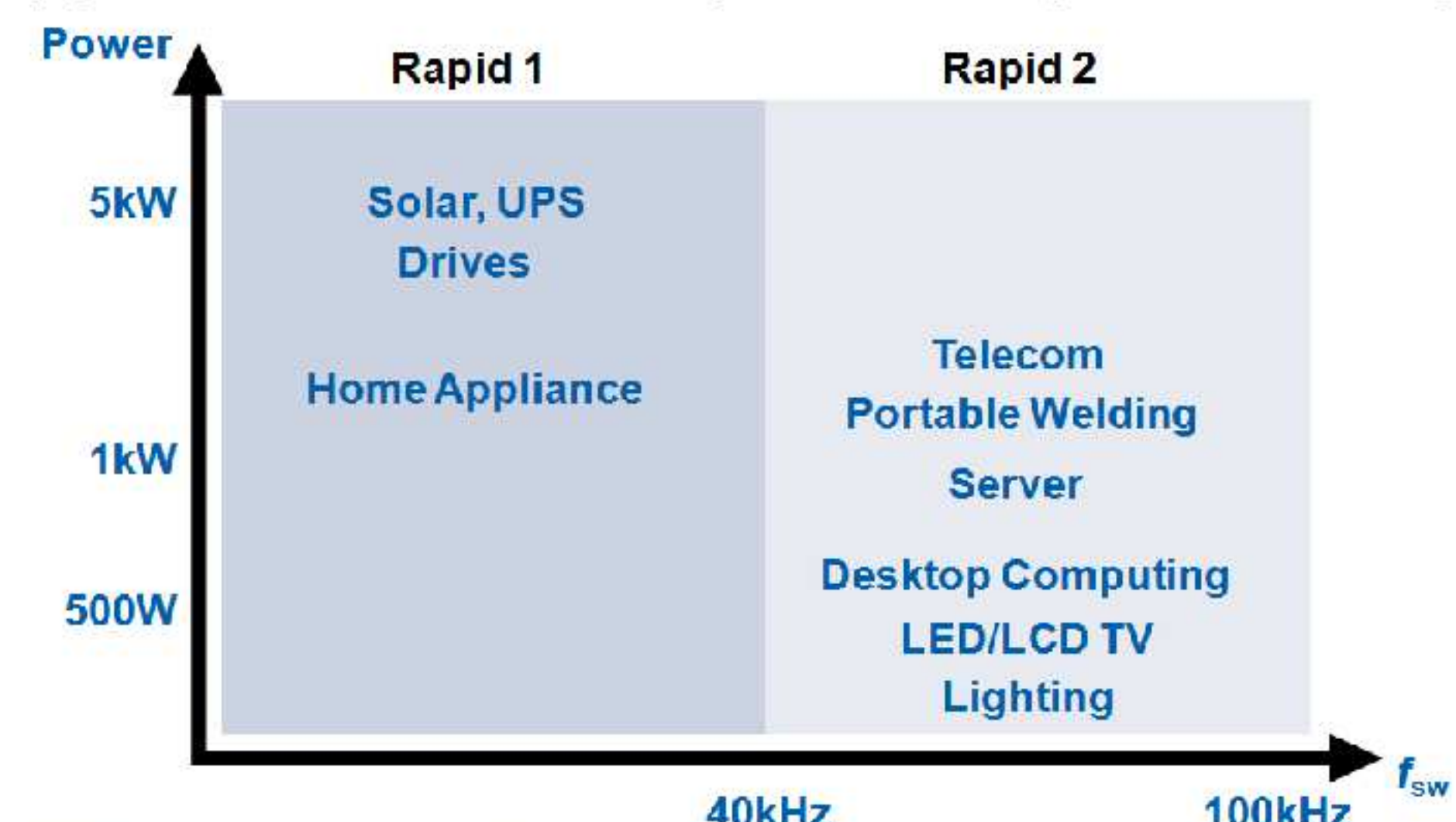
Datasheet conditions are slightly different for the two devices

This provides several application benefits in different topologies:

- High light load & High Line efficiency in hard switching topologies
- Reduced size of resonant Inductor L_r in soft switching topologies (ZVS Phase Shift)
- Reduced gate driver losses
- Turn-on and turn-off delay time reduction in bridge configuration at short duty cycles for improved modulation accuracy.

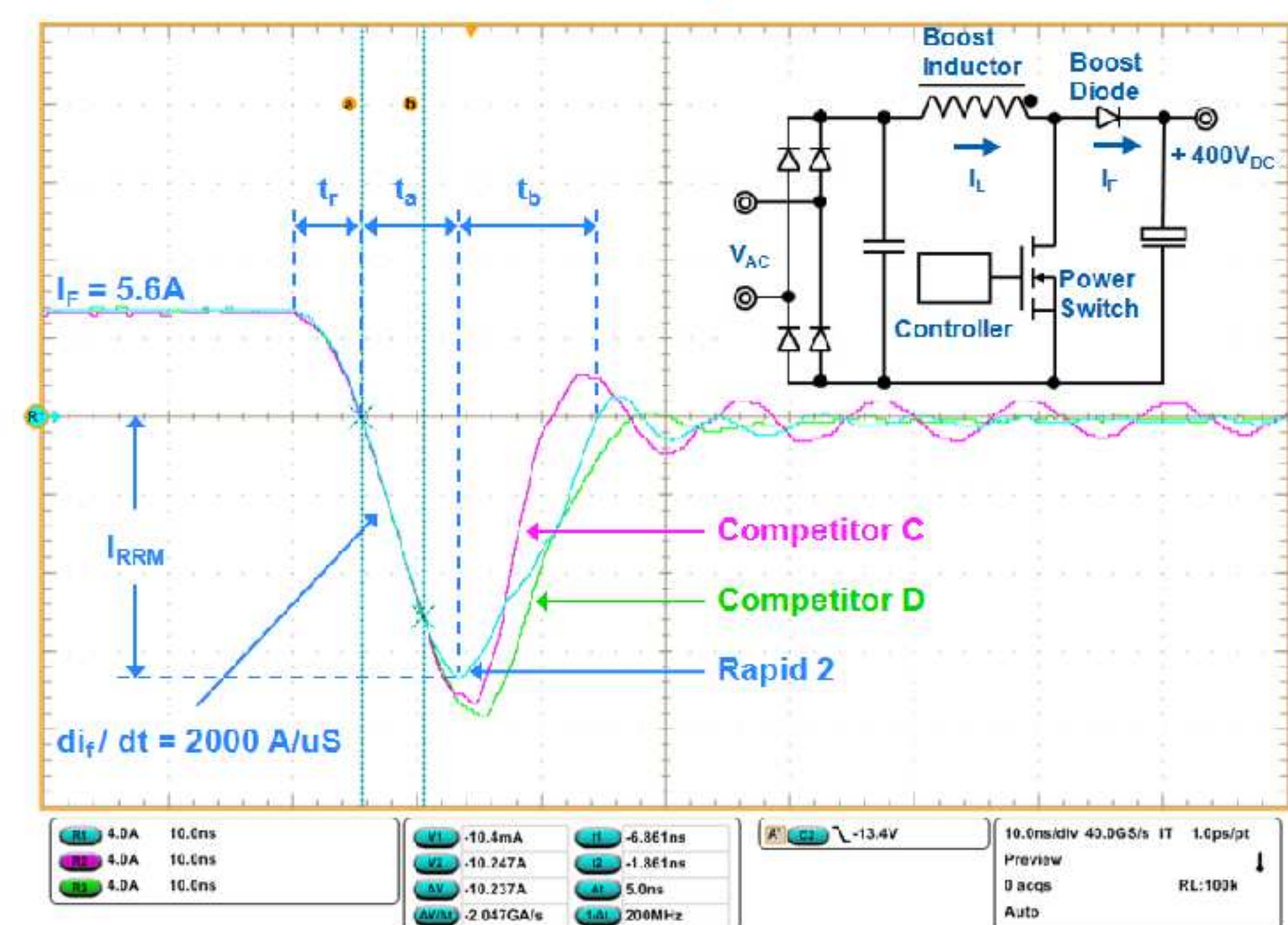
The Rapid Diode is developed to address the following applications:

Application Landscape for Rapid 1 & Rapid 2



Driven in PFC at high di/dt of 2000 A/us, the Rapid 2 shows the lowest I_{RRM} and the highest softness factor S among competitors. This translates in reduced stress on the switch that shows the lowest turn-on Energy E_{on}. Moreover a stable temperature behavior of electrical parameters is observed:

Boost Diode Reverse Recovery Waveforms and Test Circuit



Relative variation of switching parameters as a function of temperature

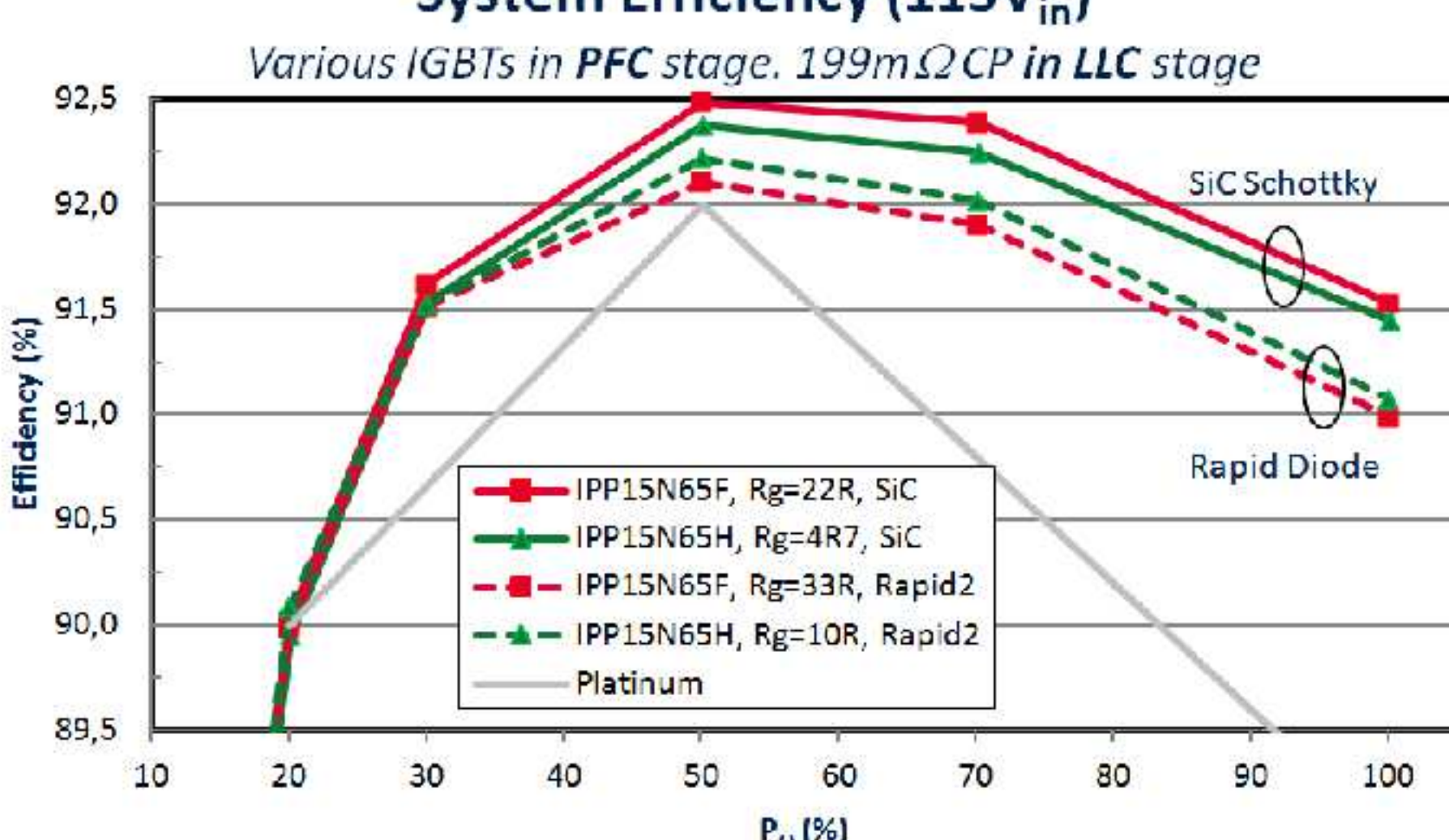
Device	Relative Value at T _c =125°C		
	t _{rr}	Q _{rr}	I _{rrm}
Rapid 2	= 0.9 x t _{rr,25°C}	= 2.2 x Q _{rr,25°C}	= 1.5 x I _{rrm,25°C}
Competitor C	n.a.	= 4.0 x Q _{rr,25°C}	= 2.5 x I _{rrm,25°C}
Competitor D	= 2.1 x t _{rr,25°C}	= 3.3 x Q _{rr,25°C}	= 1.5 x I _{rrm,25°C}

Extracted from datasheet, conditions differ for different devices

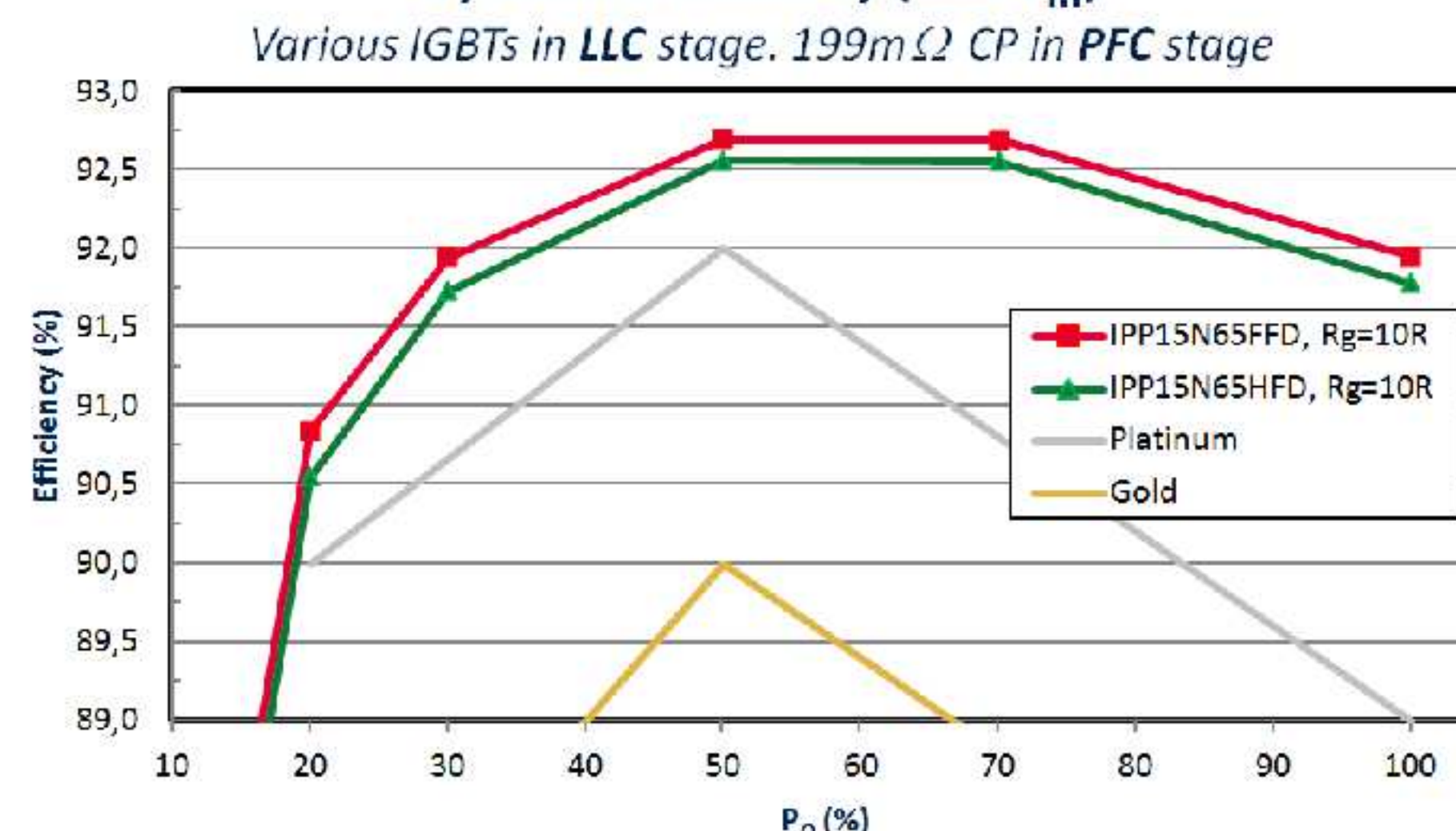
Advantages/Benefits:

- Soft switching and low I_{RRM}
→ Reduced E_{on} for IGBT → low EMI, Low R_{g,on}
- Stable temperature behavior of electrical parameters
→ increased reliability
- Diode robustness in ZVS Phase Shift when Rapid Diode is co-packed with IGBTs

System Efficiency (115V_{in})



System Efficiency (115V_{in})



The performance of the TRENCHSTOP™_{smps} and Rapid Diode is verified on a 300W Platinum Silver Box reference design from Infineon, having in the original configuration 199mΩ CoolMOS™ CP in the LLC converter and PFC stage, along with 6A SiC Boost PFC Diode. The platinum efficiency rating can be fully met with IGBTs in the LLC stage, and marginally met with IGBTs in the PFC stage.