Comparative Analysis of Power and Thermal Performance in SiC MOSFET SMD Packages: X.PAK, QDPAK & D²PAK-7

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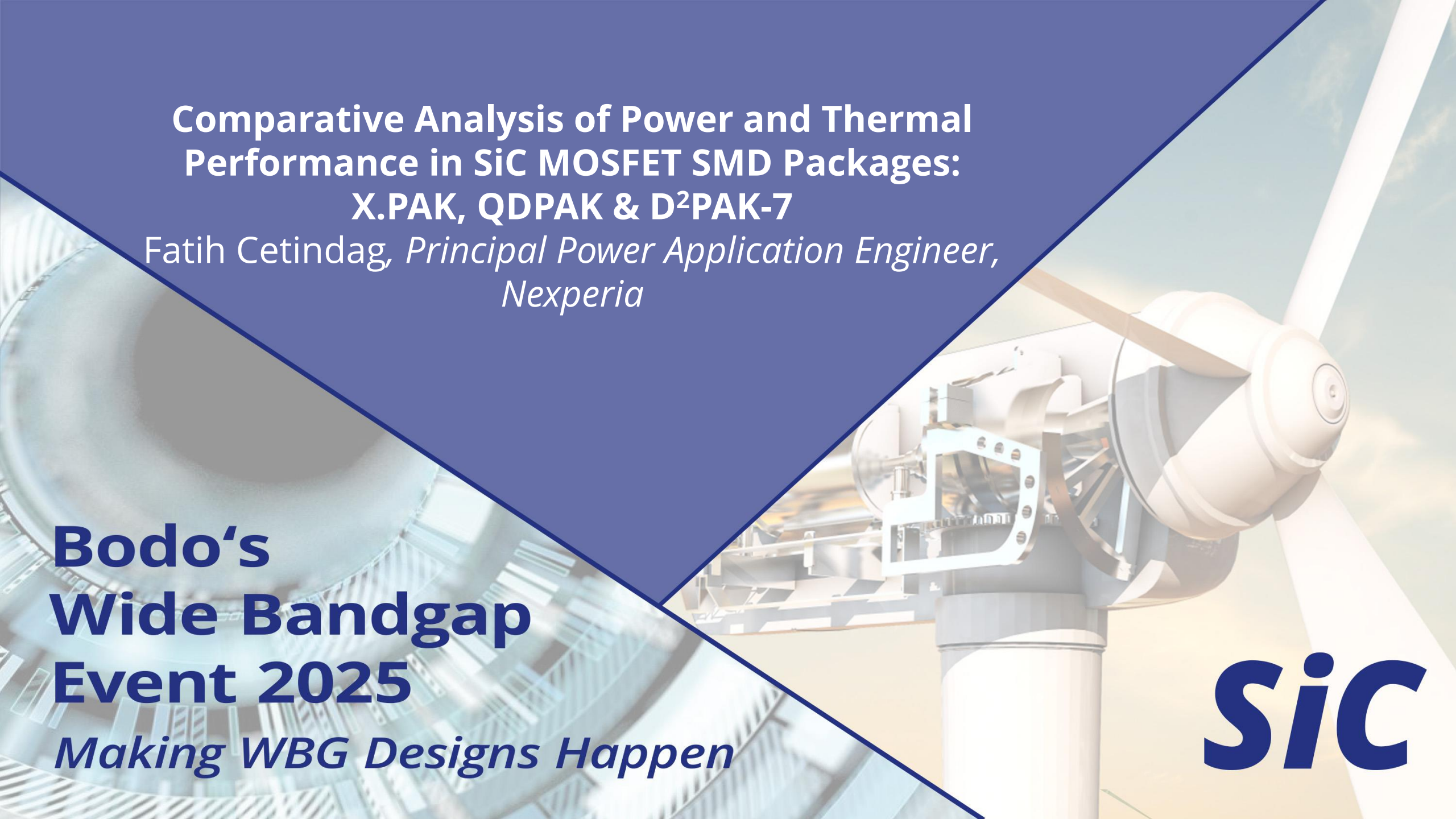
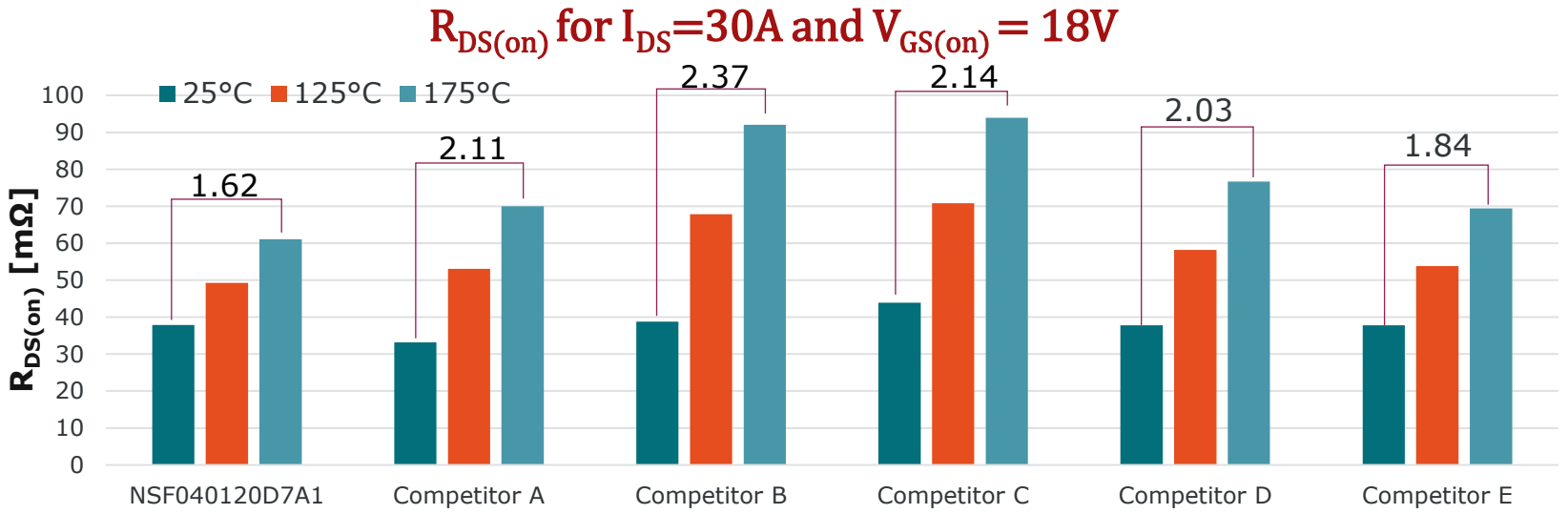


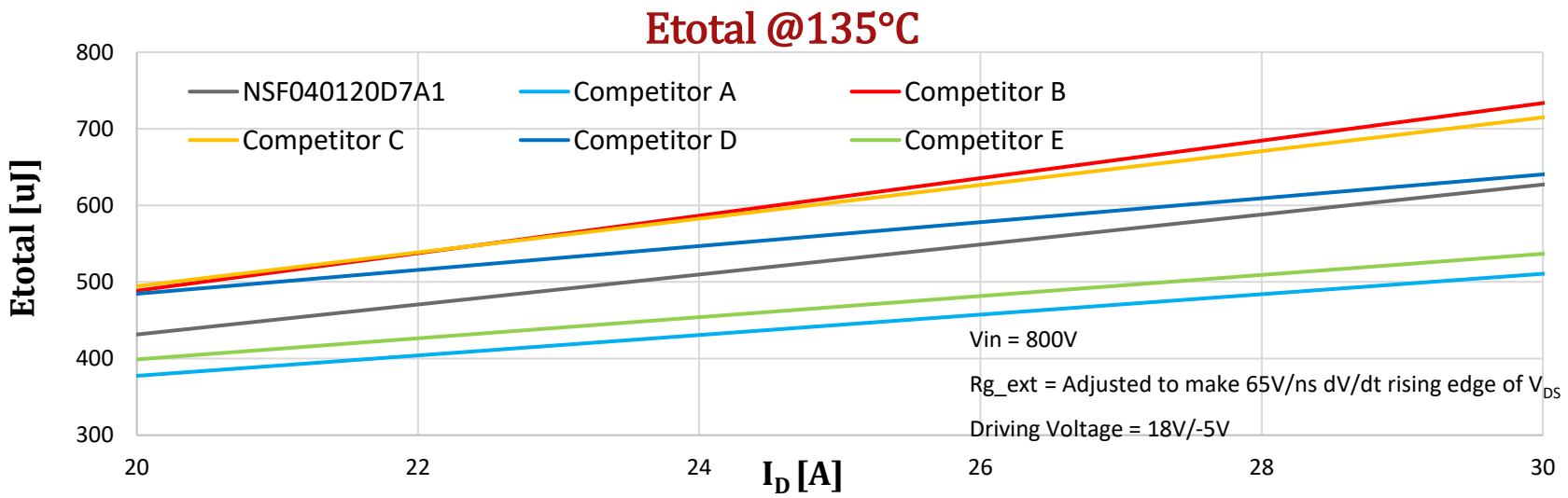
Bodo's Wide Bandgap Event 2025

Making WBG Designs Happen

SiC

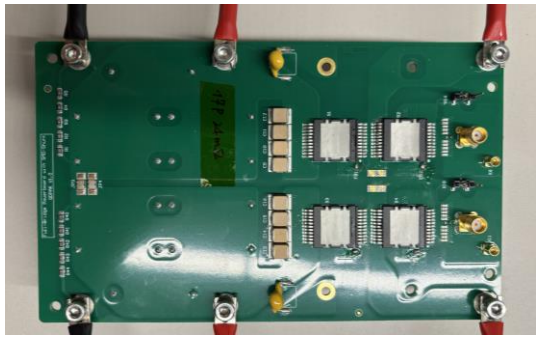
D²PAK-7 Benchmarking | Important Parameters



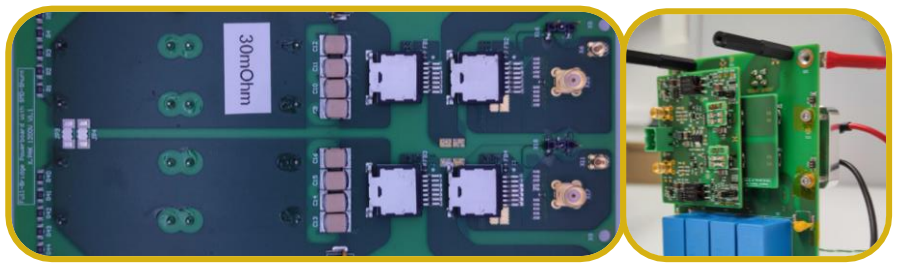


Fixed duty cycle DC/DC buck V_{DC}=800V | Measurement Set-up

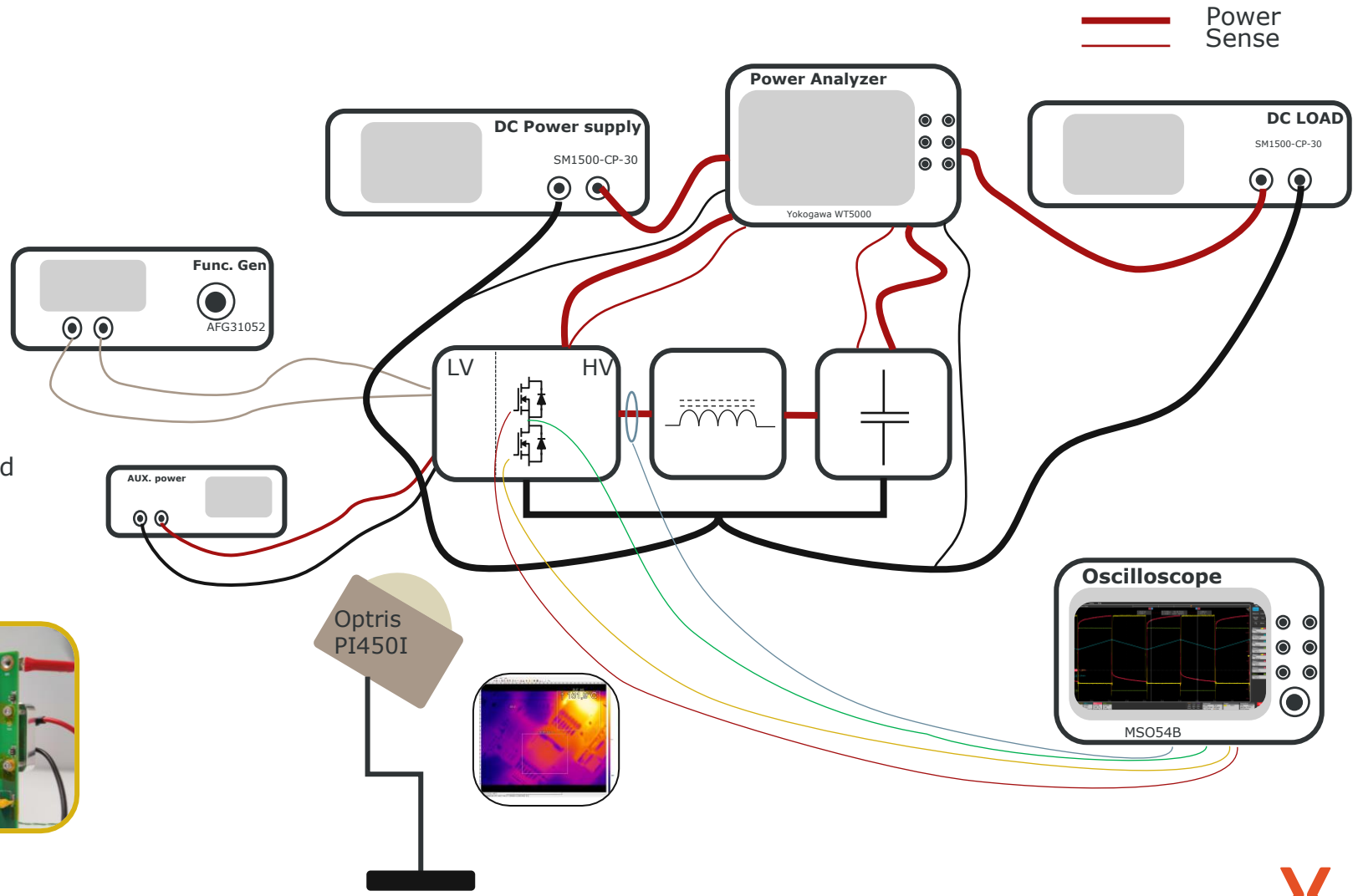
LV HV NEVB-HB-NSFD7-A0



QDPAK Eval Board

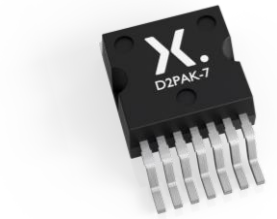


NEVB-XPAK-NSF-A0



D²PAK-7 Benchmarking | Continuous Operation Tests | Buck Converter Configuration

Vin=800V
fsw = 64kHz
Duty cycle = 48.5%
T_dead = 230ns
L = ~600µH
Cout = 30 µF
Tcoolant = 25°C
Rg_ext = 65V/ns rising slew rate V_{DS} @ 20A & 25°C
Driving Voltage = 18V/-5V
Test stop condition = Tcase,top ~ 160°C

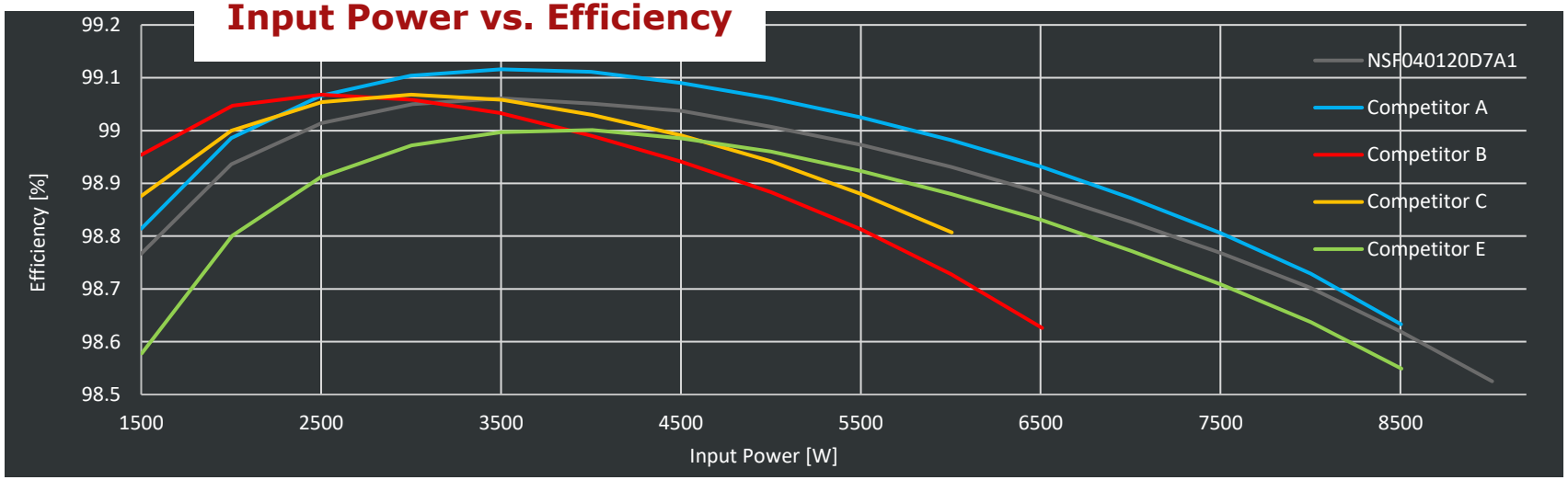


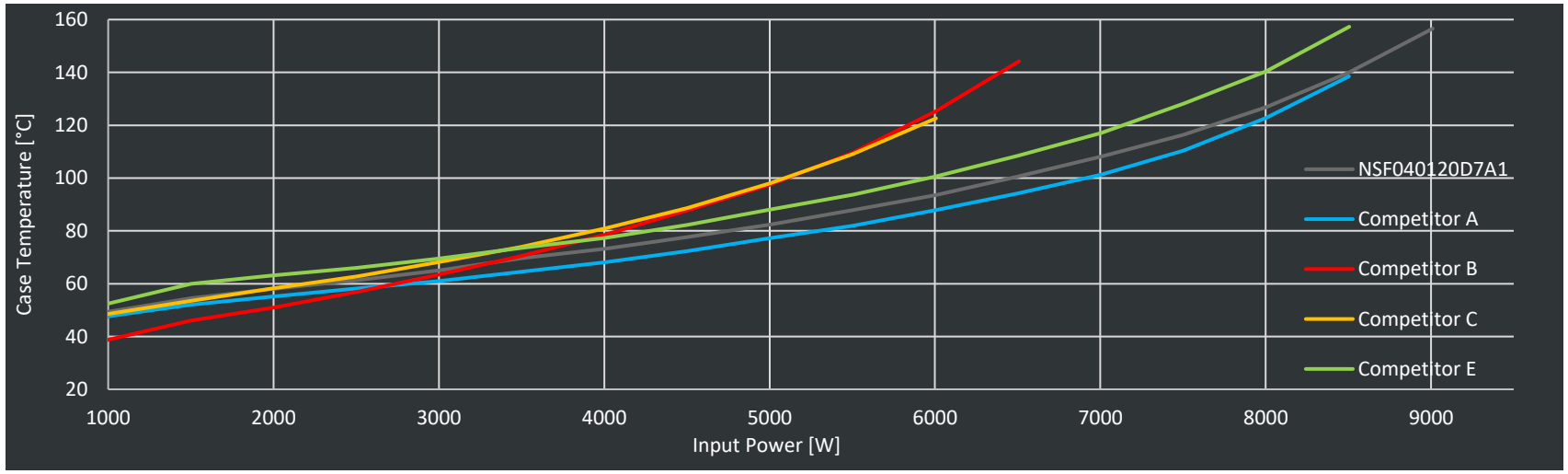
https://copilot.microsoft.com/

Tweaking $R_{g,ext}$ values to achieve same dv/dt = Putting the same engine into a sports car & a daily usage car

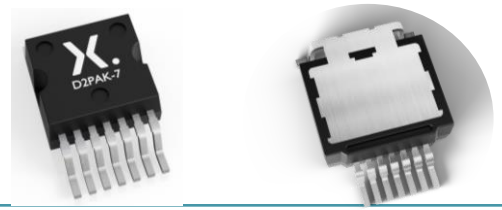
Partially true - but there are some constraints for high dv/dt:

- EMC
- Parasitic Turn-On
- Overvoltage stress (high dv/dt → high overshoot)
- Gate driver IC capabilities (typical CMTI ranges 50 V/ns – 200 V/ns)

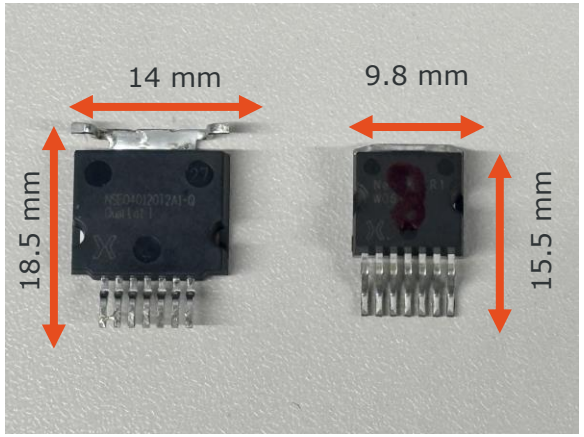


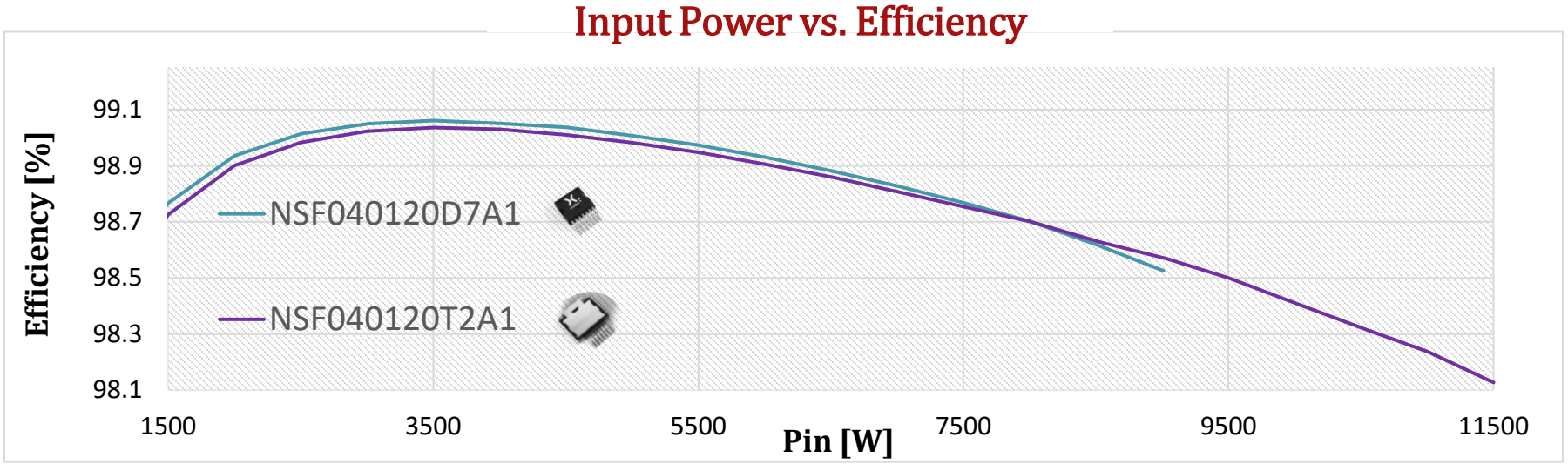


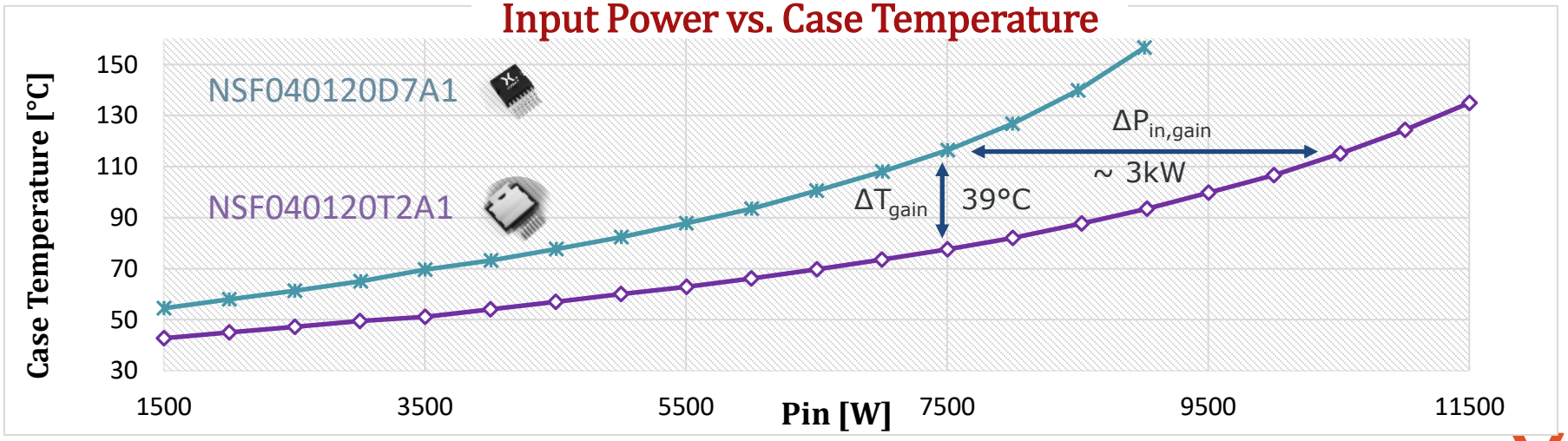
D²PAK-7 vs. X.PAK | Continuous Operation Tests | Buck Converter Configuration



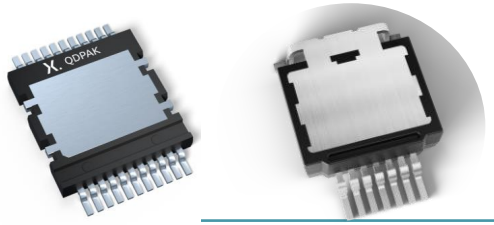
Vin=800V
fsw = 64kHz
Duty cycle = 48.5%
T_dead = 230ns
L = ~600µH
Cout = 30 µF
Tcoolant = 25°C
Rg_ext = 4.7 Ω
Driving Voltage = 18V/-5V
Test stop condition = Tcase,top ~ 150°C



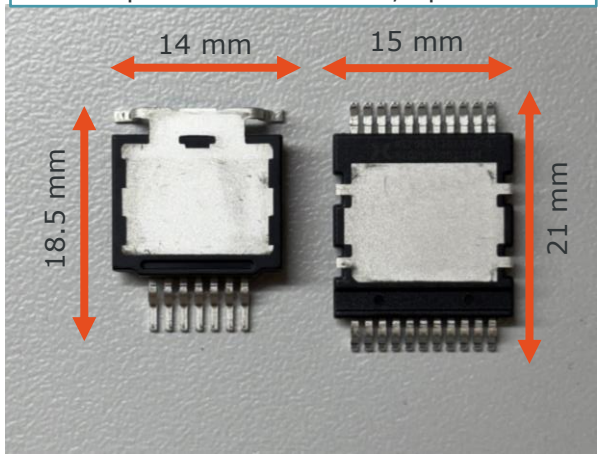


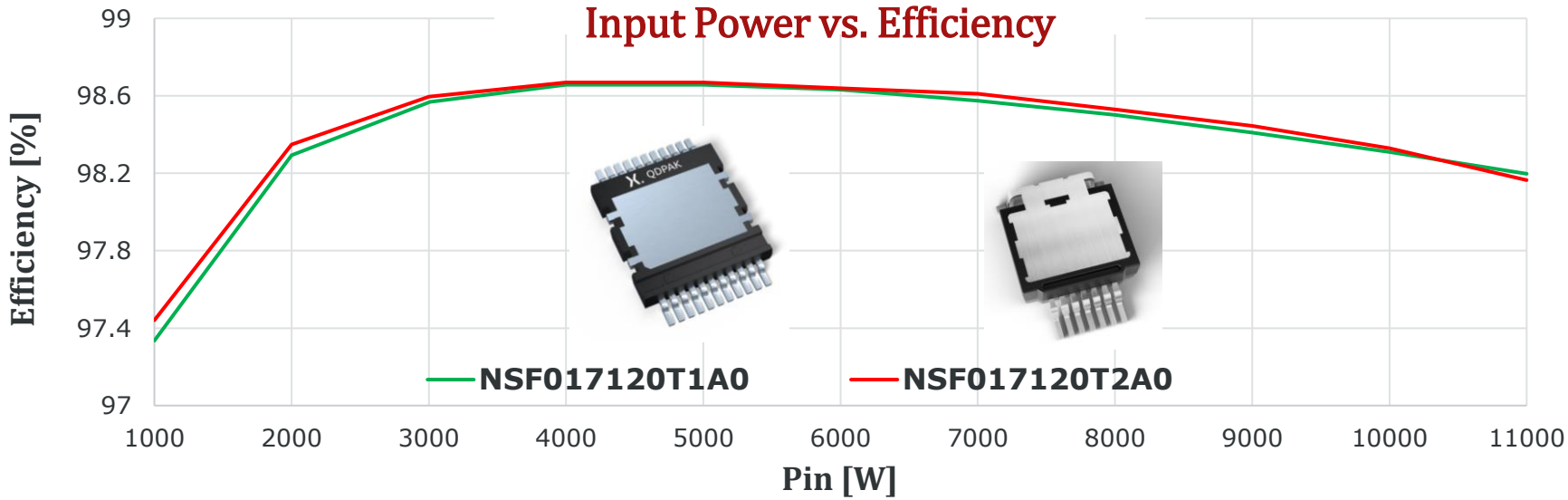


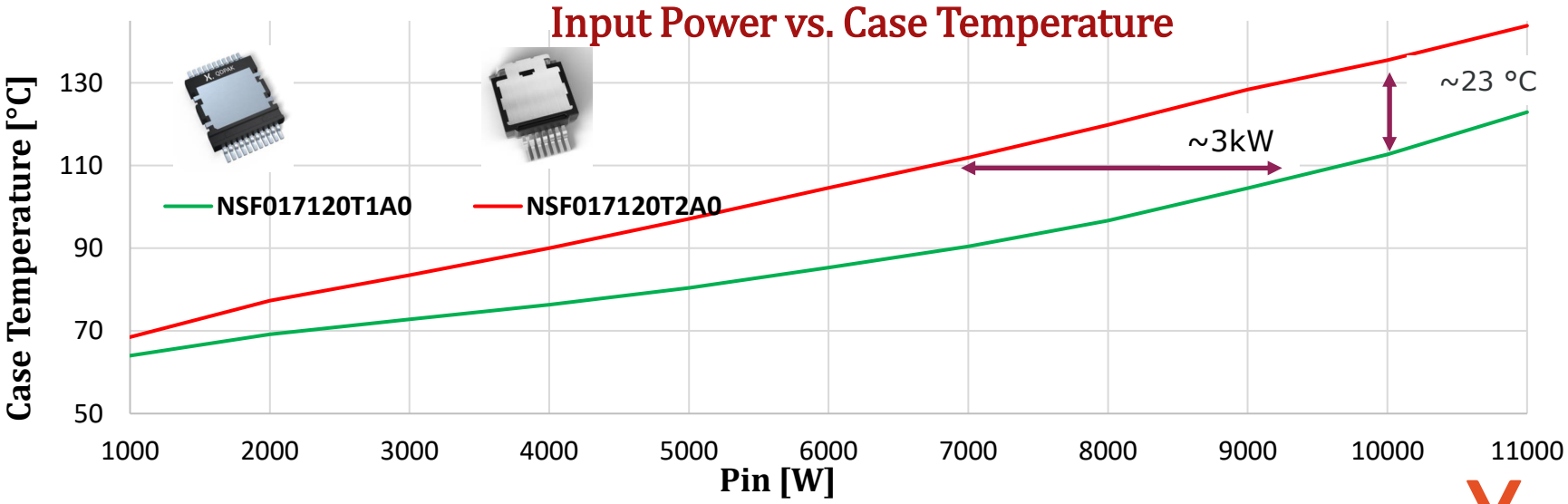
X.PAK vs. QDPAK | Continuous Operation Tests | Buck Converter Configuration



Vin=800V
fsw = 64kHz
Duty cycle = 48.5%
T_dead = 230ns
L = ~600µH
Cout = 30 µF
Tcoolant = 25°C
Rg_ext = 4.7 Ω
Driving Voltage = 18V/-5V
Test stop condition = Tcase,top ~ 150°C

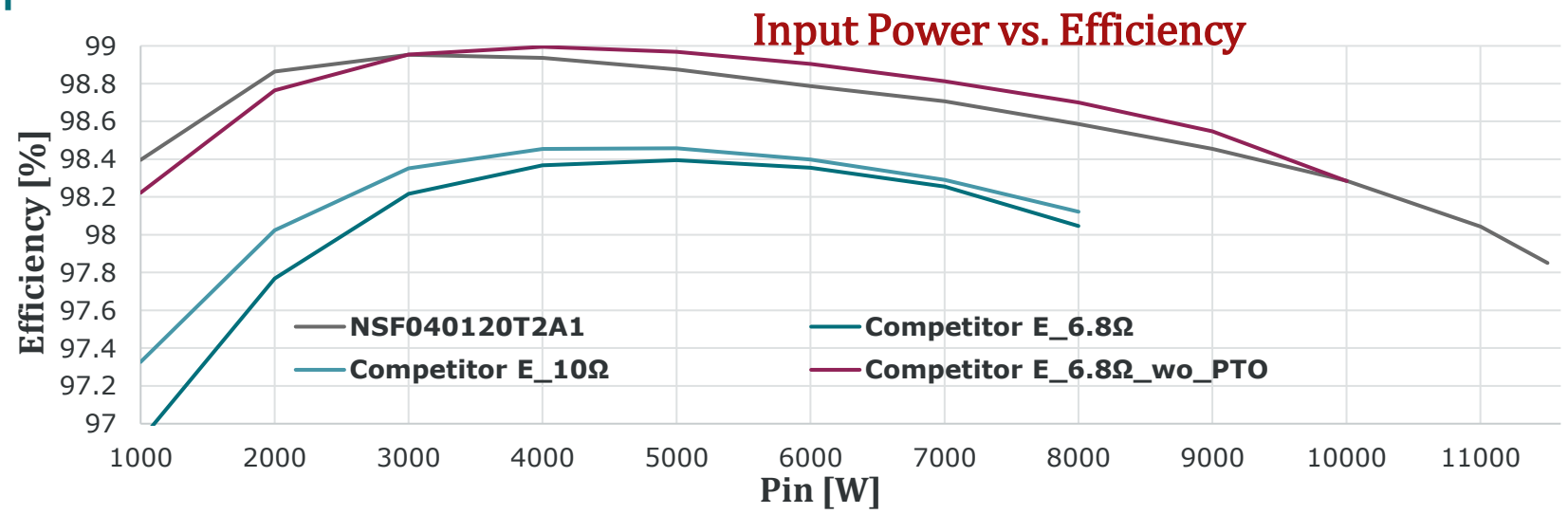


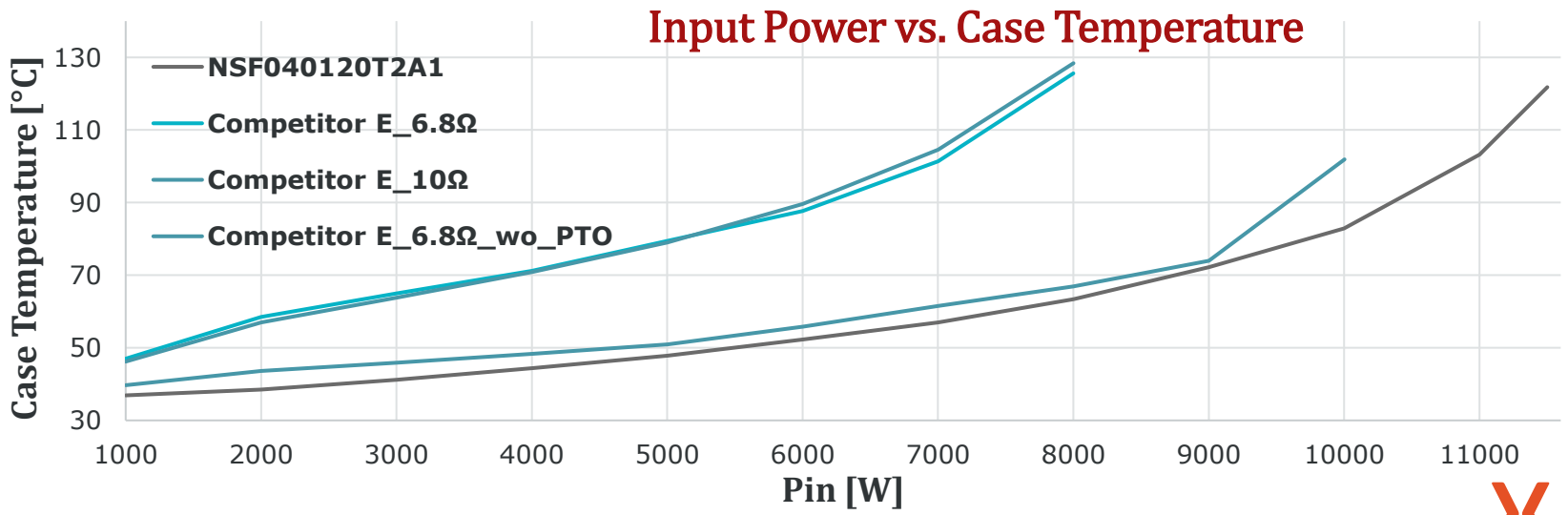




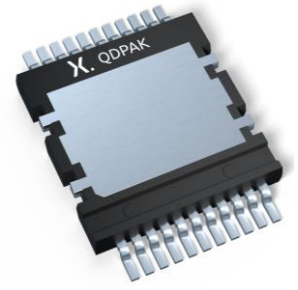
Nexperia vs. Competitor (X.PAK) | Continuous Operation Tests | Buck Converter Configuration

Vin=800V
fsw = 64kHz
Duty cycle = 50%
T_dead = 230ns
L = ~600µH
Cout = 30 µF
Tcoolant = 25°C
Rg_ext = Adjusted to have similar dV/dt of Vds
Driving Voltage = 18V/-5V
Test stop condition = Reaching HV power supply limit

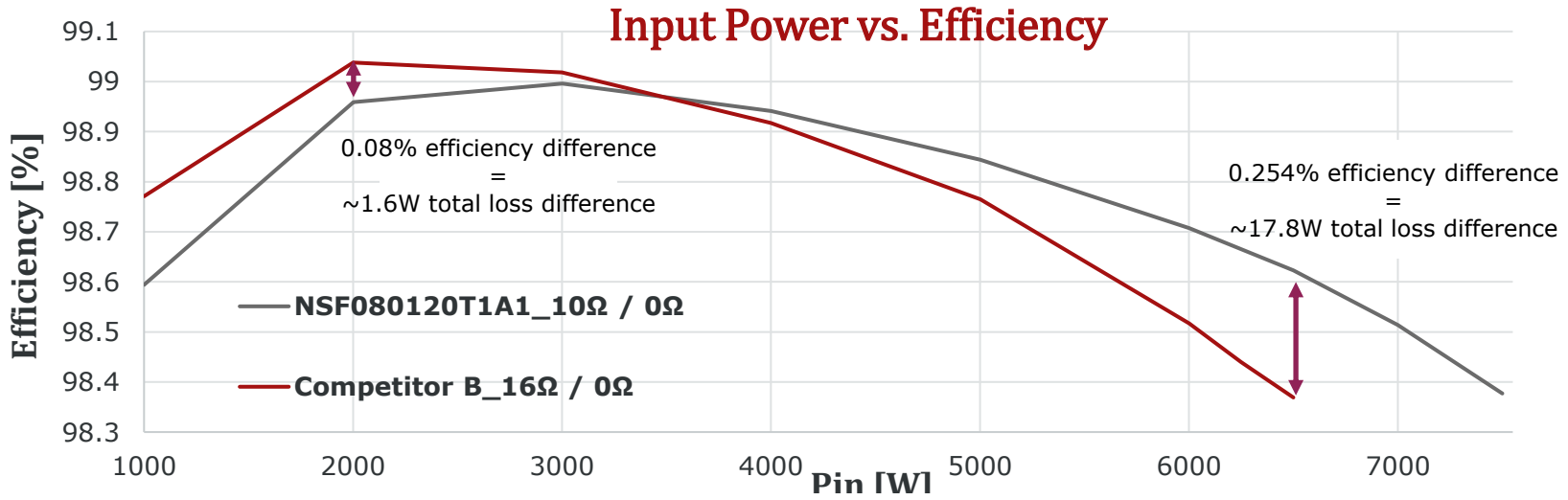


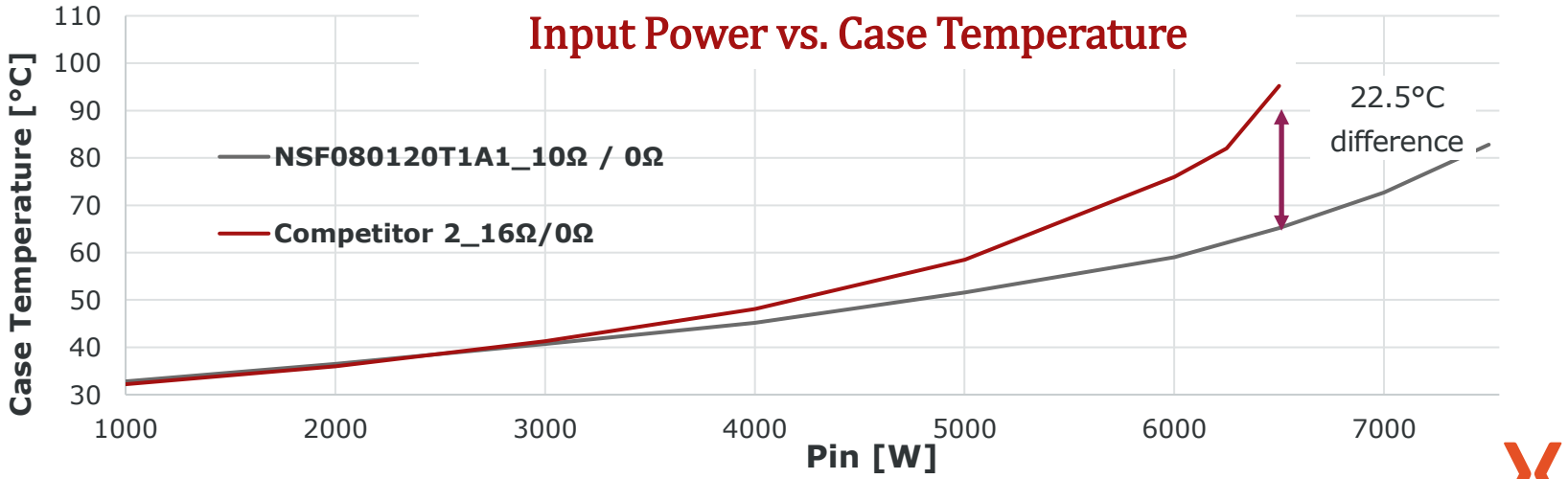


Nexperia vs. Competitor (QDPAK) | Continuous Operation Tests | Buck Converter Configuration



Vin=800V
fsw = 70kHz
Duty cycle = 50%
T_dead = 230ns
$C_{gs\_external}$ = 1nF
L = ~600µH
Cout = 30 µF
Tcoolant = 25°C
Rg_ext = Adjusted to have similar dV/dt of Vds
Driving Voltage = 18V/0V
Test stop condition = Reaching 7.5 kW input power





SiC MOSFETs | 1200V Portfolio for established packages

Qualification	$R_{DS(on)}$ (mΩ) @18V V_{GS}	$R_{DS(on)}$ (mΩ) @15V V_{GS}	Through hole technology		Surface mount technology	
			TO-247-3	TO-247-4	TO-263-7	Top side cooling*
Industrial	**17**	22		NSF017120L4A0	NSF017120C7A0	NSF017120T1A0 NSF017120T2A0
	22	30		NSF022120L4A0	NSF022120D7A0	NSF022120T1A0/ NSF022120T2A0
	30	**40**	NSF030120L3A0/ NSF040120L3A0	NSF030120L4A0/ NSF040120L4A0	NSF030120D7A0/ NSF040120D7A0	NSF030120T1A0 NSF030120T2A0
	40	55		NSF040120L4A1	NSF040120D7A1	NSF040120T1A1 NSF040120T2A1
	60	**80**	NSF060120L3A0/ NSF080120L3A0	NSF060120L4A0/ NSF080120L4A0	NSF060120D7A0/ NSF080120D7A0	NSF060120T1A0/ NSF060120T2A0
	80	100		NSF080120L4A1	NSF080120D7A1	NSF080120T1A1/ NSF080120T2A1
Automotive	**17**	22		NSF017120L4A0-Q	NSF017120C7A0-Q	NSF017120T1A0-Q/ NSF017120T2A0-Q
	22	30		NSF022120L4A0-Q	NSF022120D7A0-Q	NSF022120T1A0-Q/ NSF022120T2A0-Q
	30	**40**		NSF030120L4A0-Q	NSF030120D7A0-Q	NSF030120T1A0-Q/ NSF030120T2A0-Q
	40	55		NSF040120L4A1-Q	NSF040120D7A1-Q	NSF040120T1A1-Q/ NSF040120T2A1-Q
	60	**80**		NSF060120L4A0-Q	NSF060120D7A0-Q	NSF060120T1A0-Q/ NSF060120T2A0-Q
	80	100		NSF080120L4A1-Q	NSF080120D7A1-Q	NSF080120T1A1-Q/ NSF080120T2A1-Q

*QDPAK  / X.PAK 

● Released/Mass production ● Coming soon ● On roadmap ● Considered