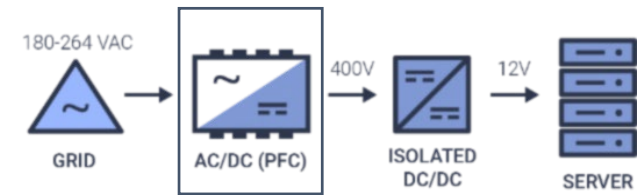


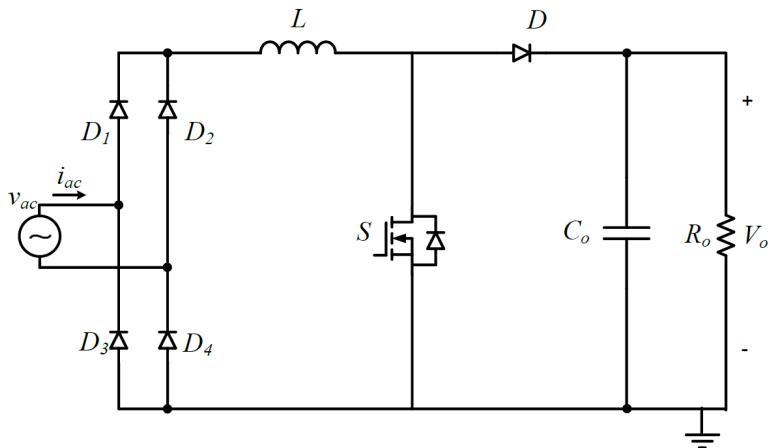
Silicon Carbide TOLL MOSFETs Enable High Efficiency and High Power Density in 3.6kW Totem-Pole PFC



TARGET PFC TOPOLOGIES OF SERVER SMPS

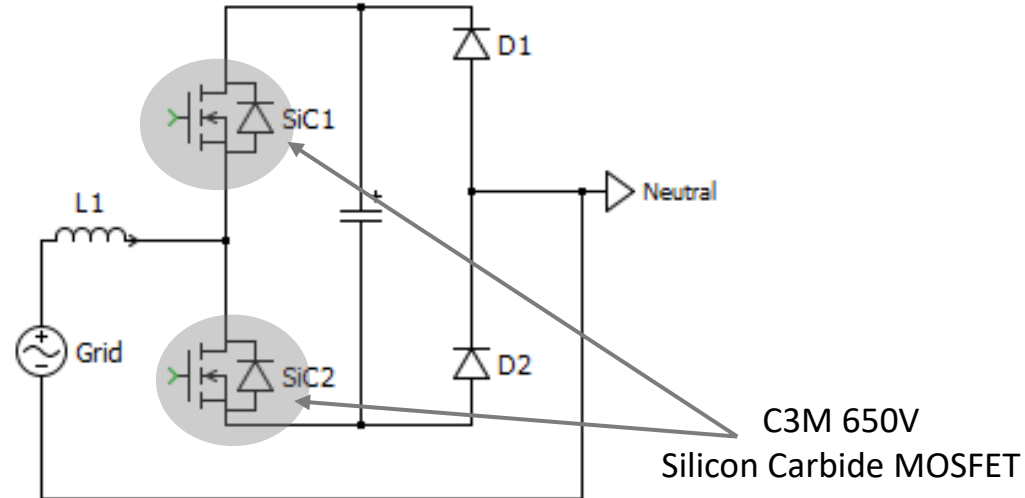


Traditional PFC Boost



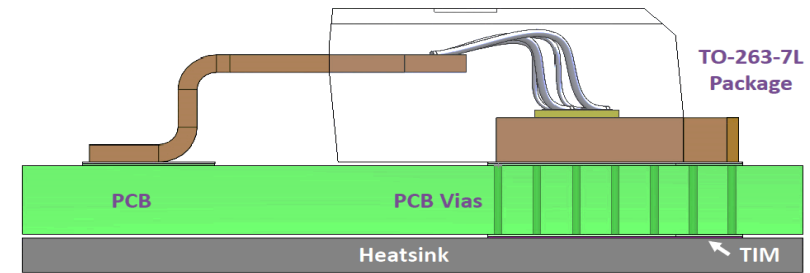
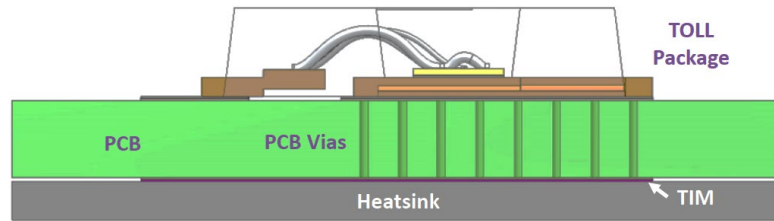
- Appropriate for low power server SMPS targeting lower 80 PLUS efficiency standards (e.g. Silver, Gold)
- Low VF, high reverse blocking voltage and zero reverse recovery of Wolfspeed C6D 650V Schottky enable high efficiency and high power density



Bridgeless Totem-Pole PFC



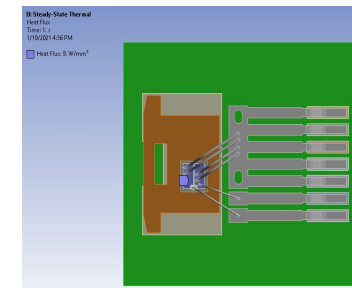
- For HF leg, Si-based MOSFET cannot be used due to slow reverse recovery of body diode
- SiC devices appropriate for high power server power SMPS
- Low Rds(on) over Temp., robust body diode and lower switching losses of Wolfspeed C3M 650V Silicon Carbide MOSFET enable high efficiency and high power density
- 80 PLUS® Platinum/Titanium efficiency standards can be achieved

SYSTEM LEVEL THERMAL PERFORMANCE OF TOLL VS TO-263-7L PACKAGE

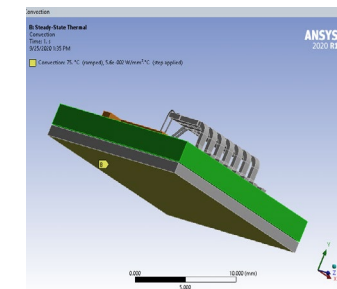


Thermal Performance		
Package	TOLL 	TO-263-7L 
T_{jmax} (°C)	152	175

Power – 28 W

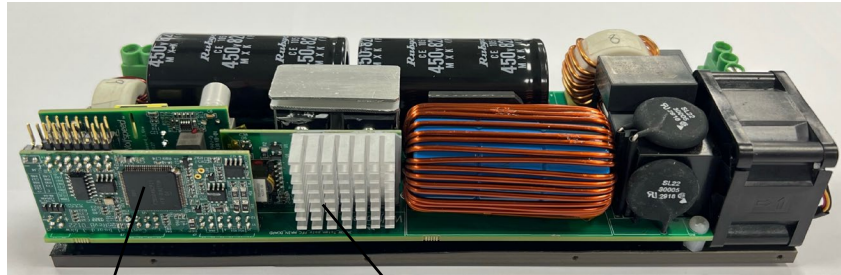


Convection
5000 W/m²K



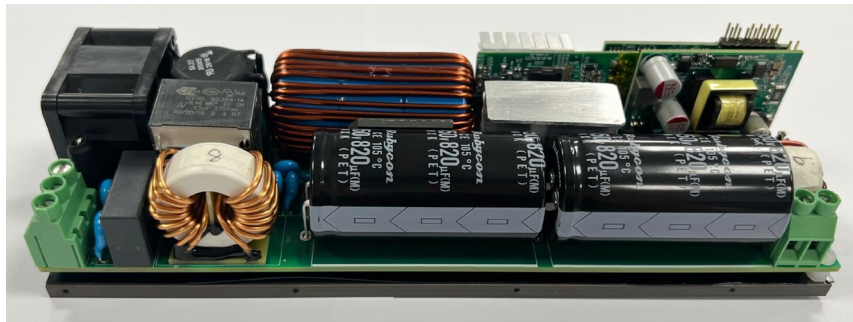
TOLL Package require less thermal management, granting cost, space, and weight benefits to the application.

WOLFSPEED 3.6KW TOTEM-POLE PFC WITH SILICON CARBIDE



Control card with TI DSP

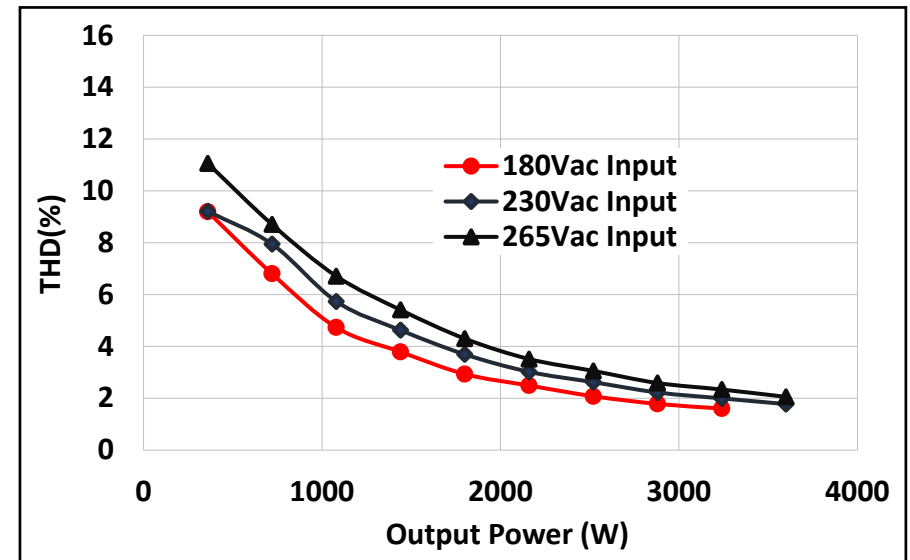
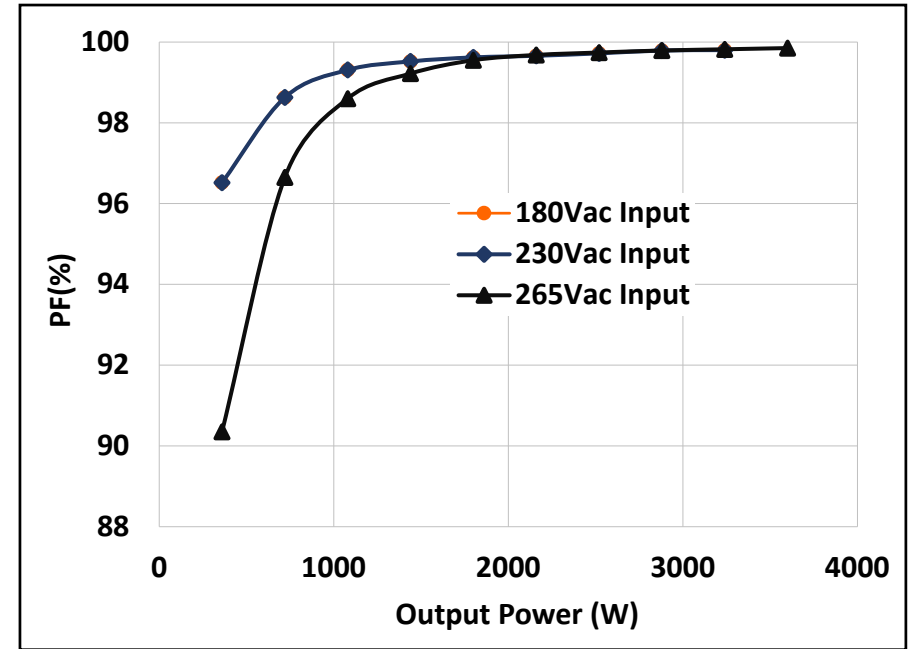
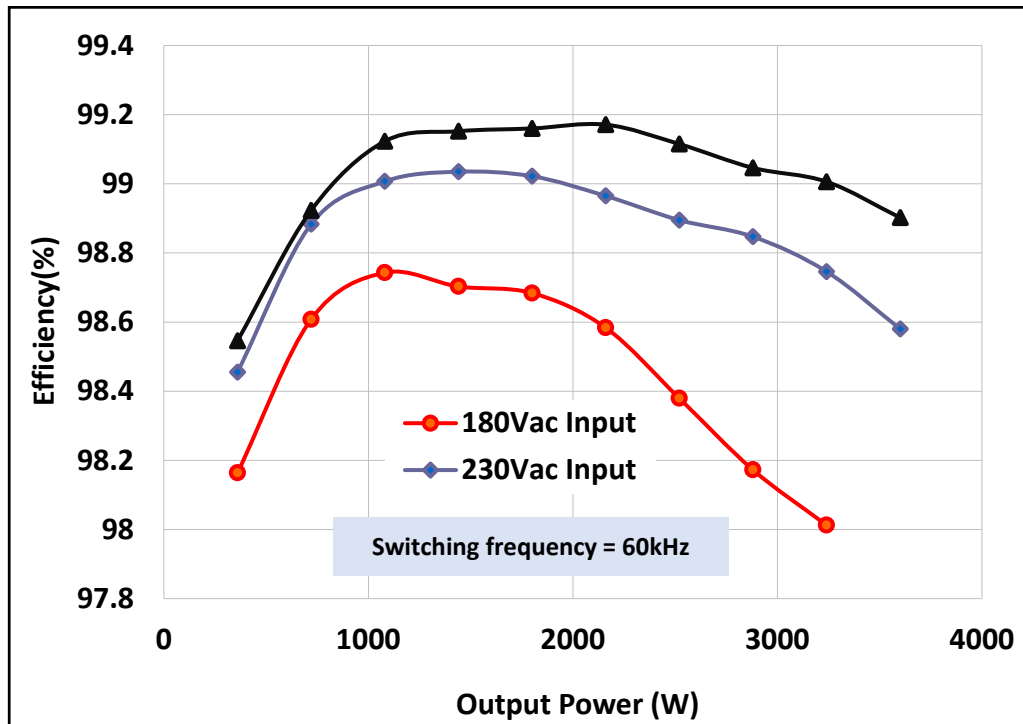
Daughter card with SiC MOSFETs C3M0045065L



Dimension: 220mmX73mmX40mm

Parameter	Value	Notes
Input Voltage V_{IN}	180-265 VAC RMS, 230V nominal	Power derating needed for low line
Output Voltage V_{OUT}	420 VDC max.	
Output Power P_{OUT}	3.6 kW max.	
Switching Frequency f_s	60kHz	
Peak Efficiency η	99%	
Silicon Carbide MOSFET	C3M0045065L – HF leg C3M0015065D – LF leg	TOLL package for HF Leg
Form Factor (W x H x L)	73mm x 40mm x 220mm	Power density: 92W/in ³
Operating Ambient Temperature T_a	-40°C to +45°C	Forced air cooling

TEST DATA



- Over 99% efficiency at half load and 98.6% efficiency at full load with Aux PS
- PF > 0.99 and THD < 2 at full load at 230V input

THERMAL RESULT (adhesive as TIM)

	Calculated Power loss (Watts)	Measured Case Temp (°C)	Calculated Junction Temp (°C)	Max. Junction Temperature (°C)	Derating Requirement (°C)	Comments
180Vac Input 400Vdc output 3600W						
High side MOSFET	13.38	82.5	94.27	175	135	Pass
Low side MOSFET	13.38	85	96.77	175	135	Pass
230Vac Input 400Vdc output 3600W (adhesive as TIM)						
High side MOSFET	8.24	63.5	70.75	175	135	Pass
Low side MOSFET	8.24	62	69.25	175	135	Pass

Balanced thermal

SUMMARY

- 80 Plus Platinum/Lot 9 efficiency standards require new topologies and advanced power devices to be used for server and data center power supplies
- A 3.6kW high-efficiency high-power-density Totem-pole PFC with 650V Wolfspeed TOLL package SiC power devices designed and tested to meet 80 Plus efficiency and OCP form factor requirement
- A peak efficiency of over 99% at half load and an efficiency of over 98.5% at full load achieved even with Aux PS
- TOLL package enabled small form factor PCB design with an ease in thermal management
- Thermal vias with high-performance adhesive proved to be a cost-effective thermal solution
- Design challenges and general design guidelines introduced in this work
- Wolfspeed 650 V Silicon Carbide power device in TOLL package has opened the door to high-efficient and high-power-density power supplies