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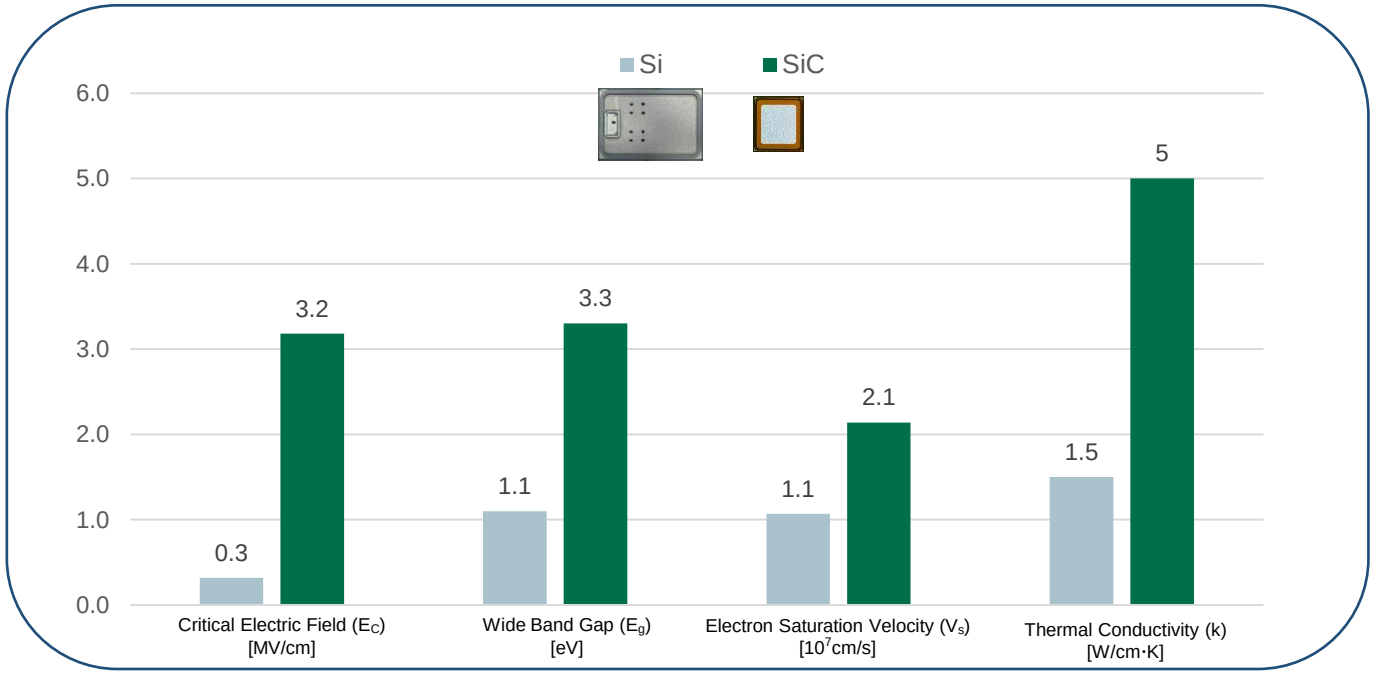
Masters of Power Solution

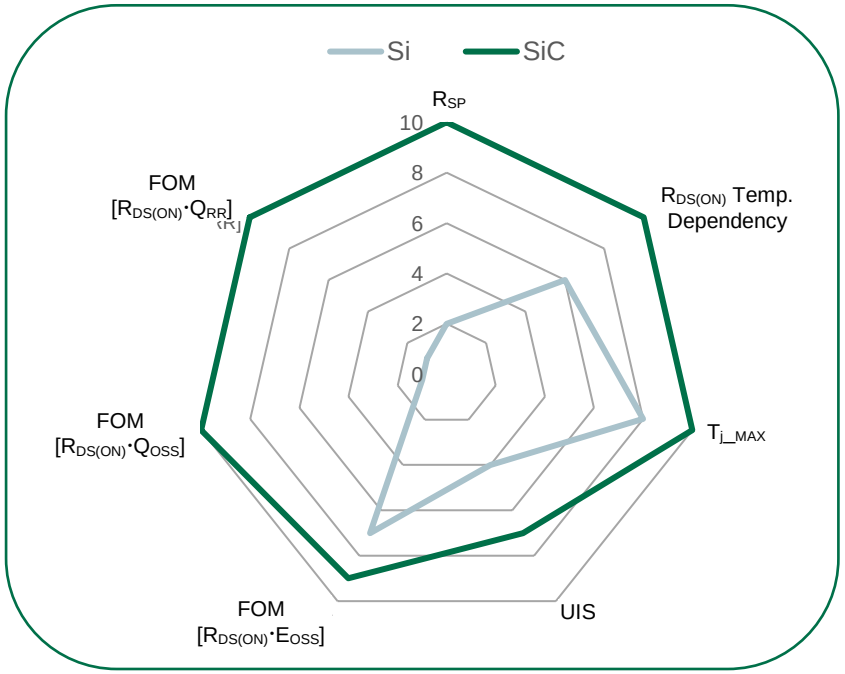
eSiC MOSFET Selection Guide 2022

Advanced Power Master Semiconductor's Silicon Carbide Technology

www.powermastersemi.com

Advantages of Silicon Carbide (SiC) as a Power Devices



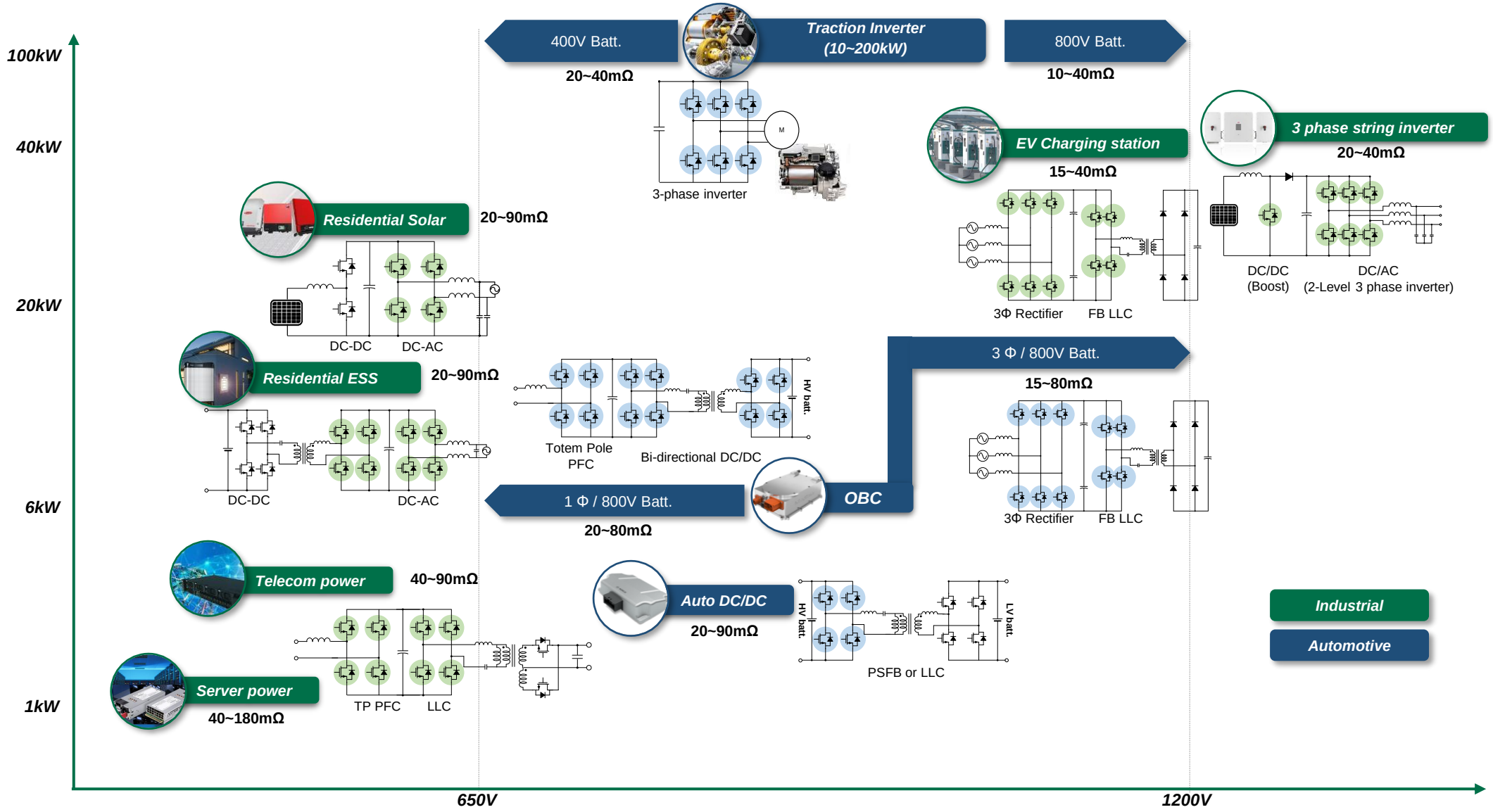


Device	• Higher BV_{DSS} • Lower R_{SP}	• Low Switching Losses
Application	• Higher system Efficiency • Higher Frequency Operation • Smaller Passive Components	Fewer Cooling

System

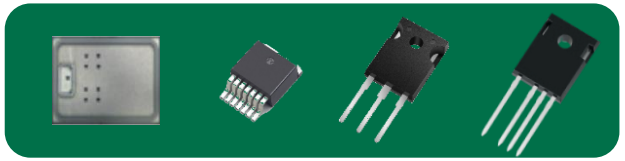
- **Higher efficiency**
- **Smaller Size**
- **Lighter Weight**
- **Lower System Cost**

eSiC MOSFET's Target Applications & Topologies



eSiC MOSFET Product Portfolio

1200V SiC MOSFET



21 / 30 / 40 / 60 / 80mΩ
Die : 5 Parts / Package : 15 Parts

xEV

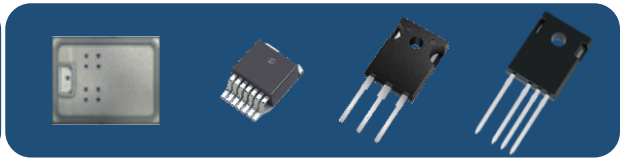
Solar Inverter

EV Charging Pole

UPS

Industrial Motors

650V SiC MOSFET



18 / 27 / 48 / 72 / 107mΩ
Die : 5 Parts / Package : 15 Parts

TV&LED lighting

xEV

Telecom/Server (w.UPS)

Solar Inverter

EV Charging Pole

Industrial Motors

Product Differentiation

High Efficiency
(for Non-motor control)

High Ruggedness (SCWT)
(for Motor control)

1200V eSiC MOSFET - Features & Benefits

Power Master Semiconductor's advanced eSiC MOSFET provides design flexibility for high system efficiency, higher switching frequency for system size reduction with higher reliability thanks to its extremely low switching losses, low FOM [Q_G x $R_{DS(ON)}$], no reverse recovery losses of body diode and high ruggedness.

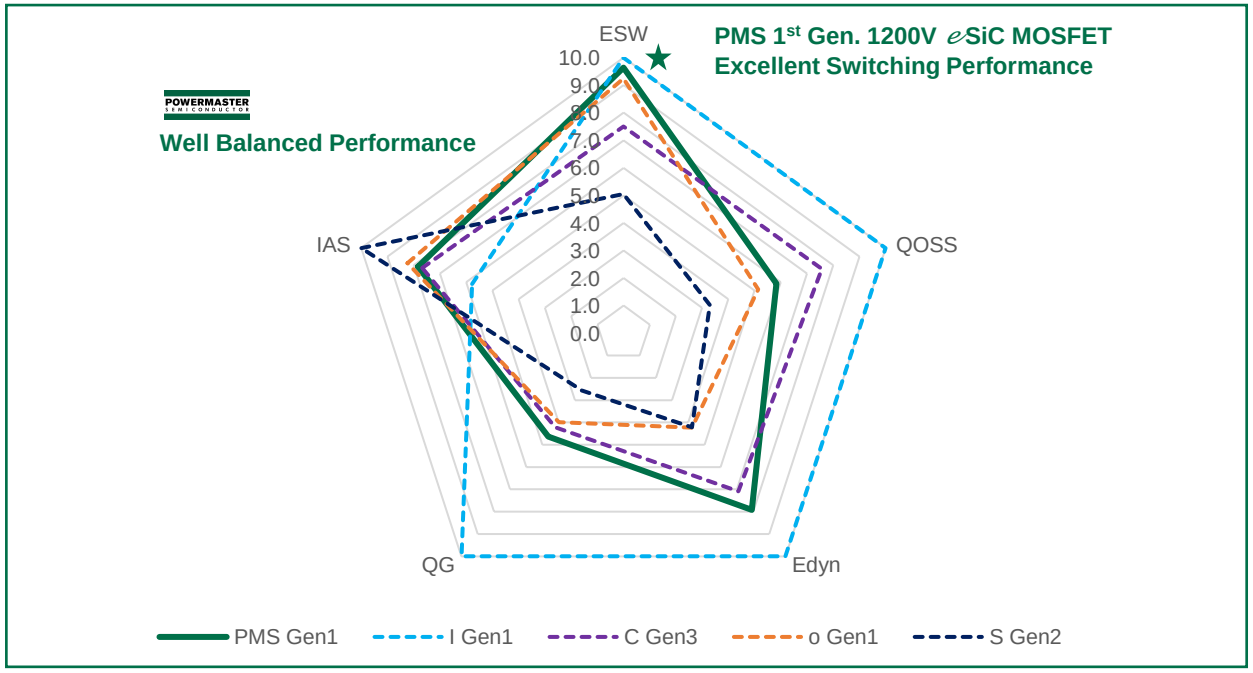
Features

- Extremely low switching losses
- Low FOM ; Q_G x $R_{DS(on)}$
- Fast intrinsic diode
- Robust Avalanche Capability

System Benefits

- Higher system efficiency
- Higher frequency applicability
- Increased power density
- Higher system reliability
- Reduced cooling effort

Performamnce Benchmark



Target Applications

1200V / 40mΩ eSiC MOSFET - Switching Performance

PCW120N40M1vs. Competitors

PMS eSiC MOSFET shows well balanced performance against major Players

I_D=40A	Best ←					→ Worst
Eon [uJ]	PMS / Comp. C PCW120N40M1 943		Comp. S 947	Comp. I 950	Comp. O 1073	Comp. R 1267
Eoff [uJ]	PMS PCW120N40M1 203	Comp. C 207	Comp. I 238	Comp. O 244	Comp. S SCTW60N120G2 314	Comp. R 513
Total SW Losses [uJ]	PMS PCW120N40M1 1147	Comp. C 1150	Comp. I 1188	Comp. S 1261	Comp. O 1317	Comp. R 1780
Peak Vds [V]	Comp. R 1008	PMS / Comp. C / Comp. O PCW120N40M1 1024			Comp. S 1027	Comp. I 1028
Negative Vgs [V]	PMS PCW120N40M1 - 5.8	Comp. I / Comp. O - 6.4		Comp. C - 6.6	Comp. R - 6.8	Comp. S - 8.0

1200V / 40mΩ *e*SiC MOSFET Switching Losses

PCW120N40M1vs. Competitors

Excellent switching performance

	5A	10A	20A	30A	40A	50A
Comp. C	188	268	431	752	1150	1636
PCW120N40M1	193	271	434	753	1147	1627
Comp. I	190	268	434	768	1188	1711
Comp. O	214	303	489	858	1317	1878
Comp. S	199	283	459	819	1261	1838
Comp. R_G3	230	361	690	1197	1780	2512
Comp. R_G4	164	240	414	710	1091	1627

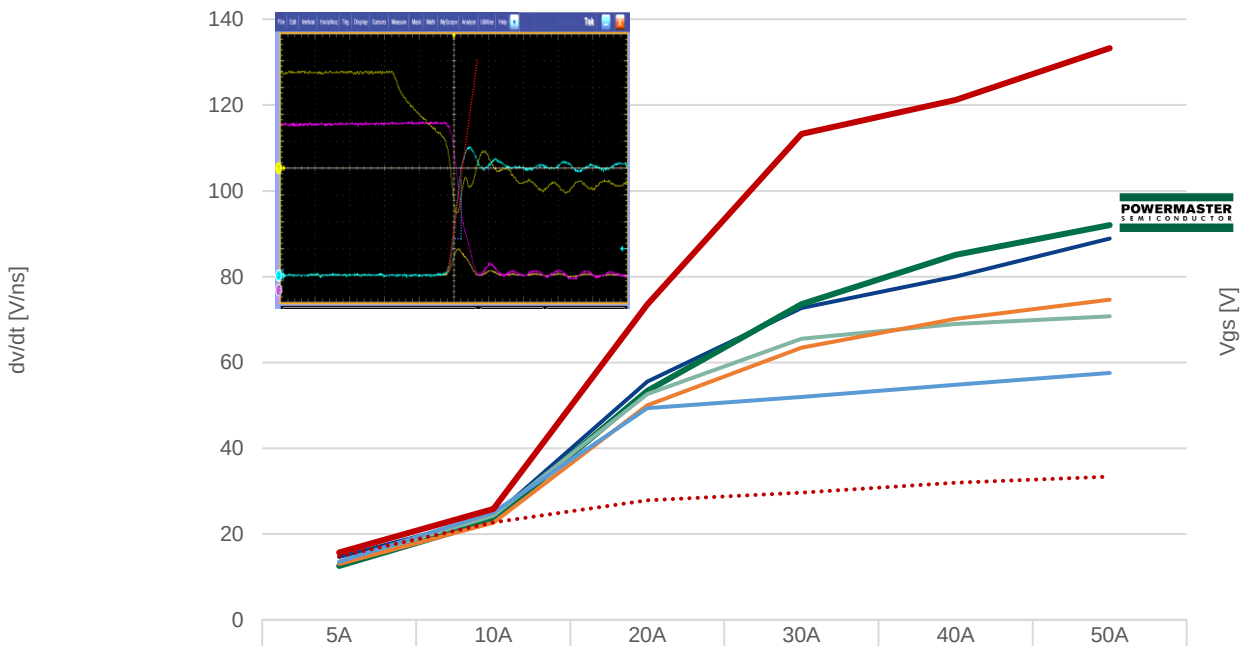
- Note
  * V_{DD}=800V, R_G=2Ω, V_{GS}= -3V~18V, I_D=10A, 20A, FWD=PCH120S10D1(1200V/10A

1200V / 40mΩ *e*SiC MOSFET Switching Noise

PCW120N40M1vs. Competitors

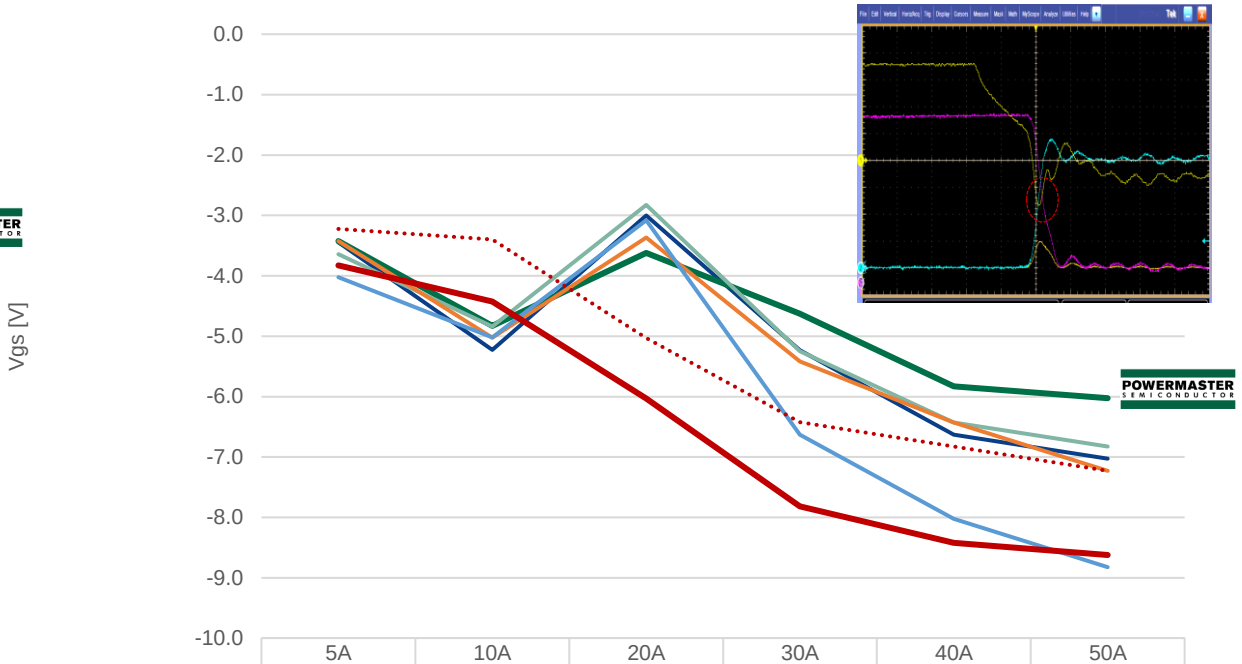
Lower Switching Noise

dv/dt



	5A	10A	20A	30A	40A	50A
Comp. C	15	24	56	73	80	89
PCW120N40M1	13	23	53	74	85	92
Comp. I	14	24	53	66	69	71
Comp. O	13	23	50	63	70	75
Comp. S	14	25	49	52	55	58
Comp. R_G3	15	23	28	30	32	33
Comp. R_G4	16	26	74	113	121	133

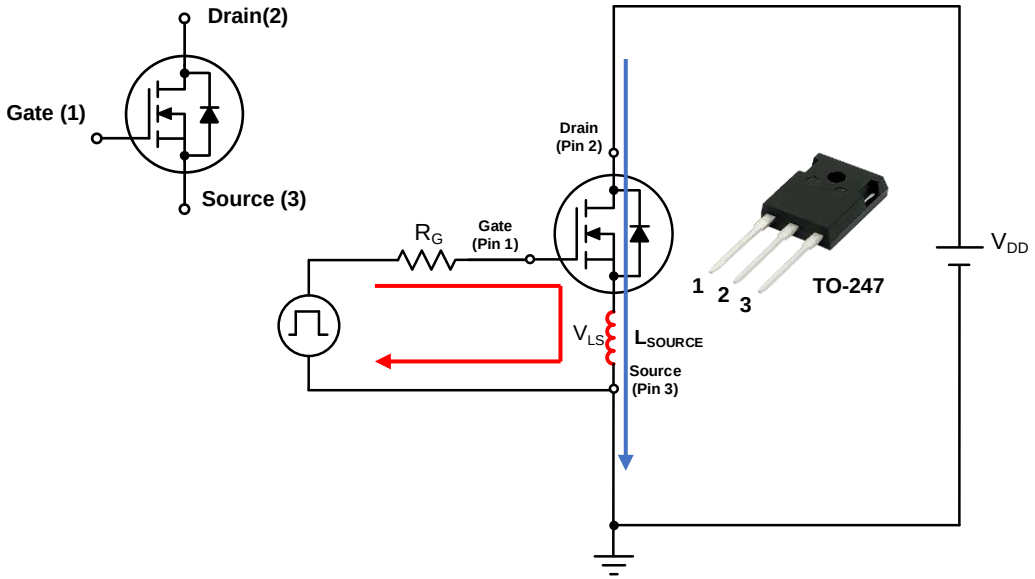
Negative V_{GS} peak at turn-off

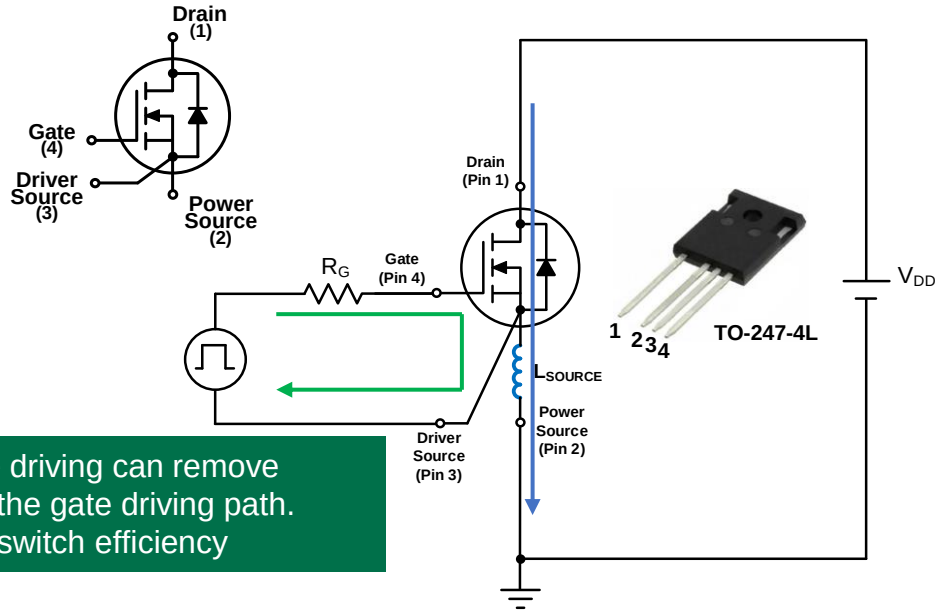


	5A	10A	20A	30A	40A	50A
Comp. C	-3.4	-5.2	-3.0	-5.2	-6.6	-7.0
PCW120N40M1	-3.4	-4.8	-3.6	-4.6	-5.8	-6.0
Comp. I	-3.6	-4.8	-2.8	-5.2	-6.4	-6.8
Comp. O	-3.4	-5.0	-3.4	-5.4	-6.4	-7.2
Comp. S	-4.0	-5.0	-3.1	-6.6	-8.0	-8.8
Comp. R_G3	-3.2	-3.4	-5.0	-6.4	-6.8	-7.2
Comp. R_G4	-4	-4	-6	-8	-8	-9

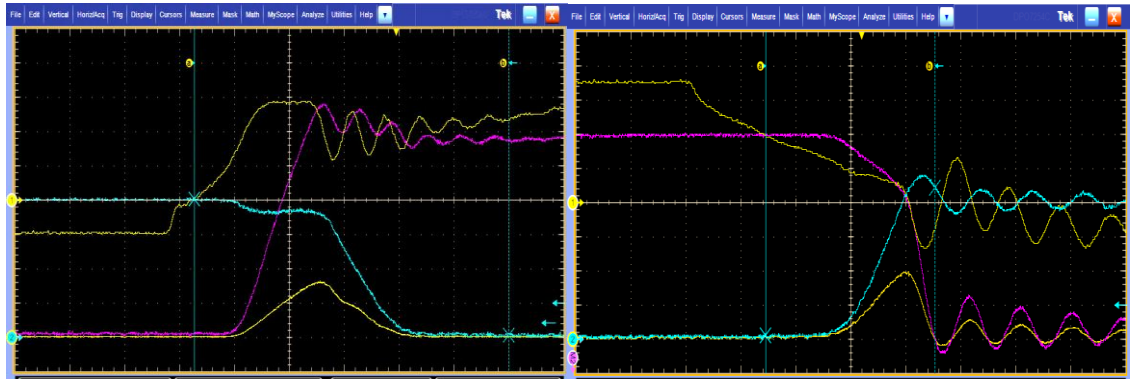
- Note
  * V_{DD}=800V, R_G=2Ω, V_{GS}= -3V~18V, I_D=10A, 20A, FWD=PCH120S10D1(1200V/10A

TO-247-4L Kelvin Source Package' Benefits

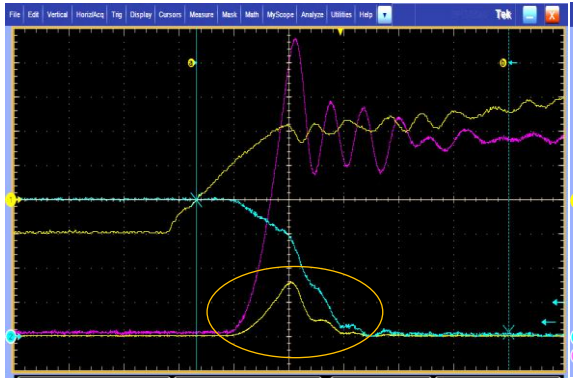




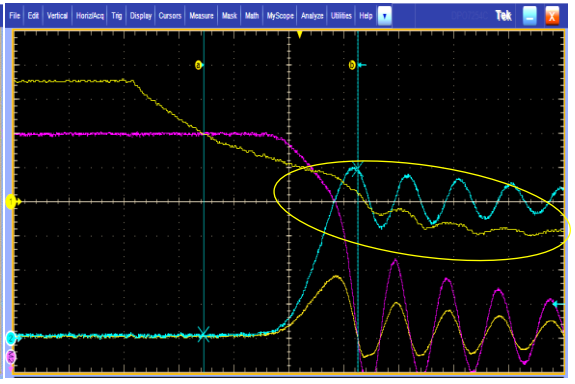
Kelvin source driving can remove L_{SOURCE} into the gate driving path.
→ Increases switch efficiency



Lower switching losses @ Turn-on



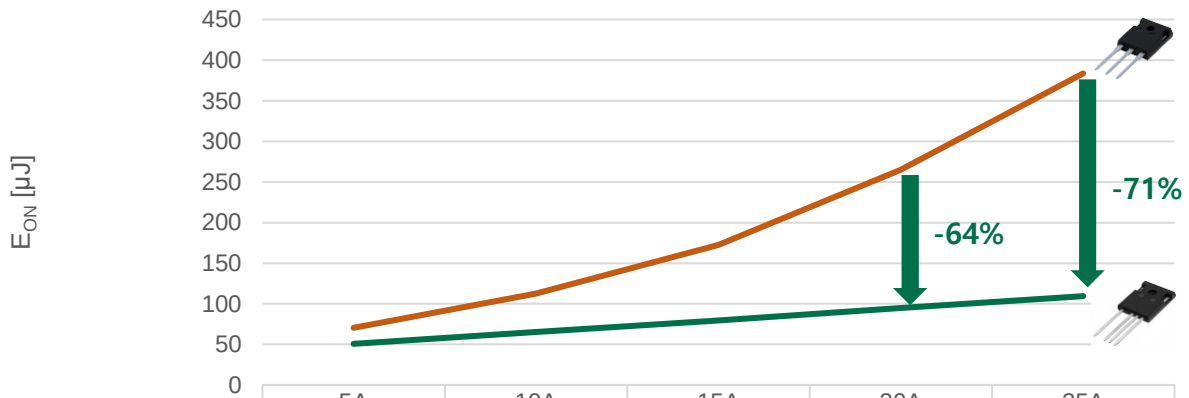
Lower gate noise @ Turn-off



Reduced Switching Loss by TO-247-4L Package

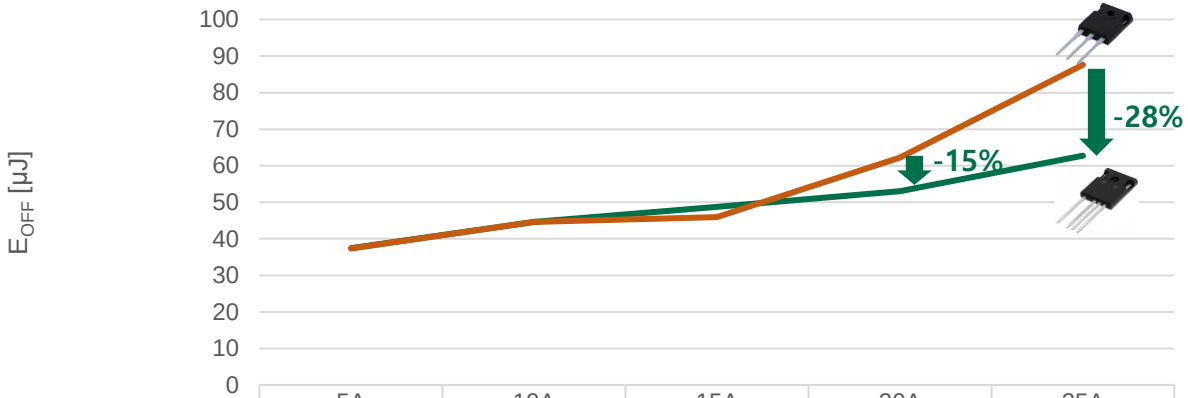
Switching Losses can be significantly improved !!

Turn-on Loss



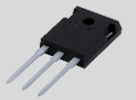
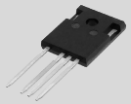
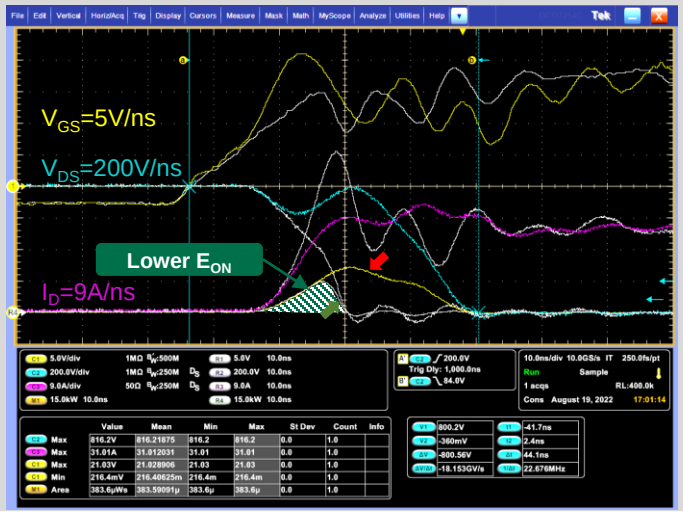
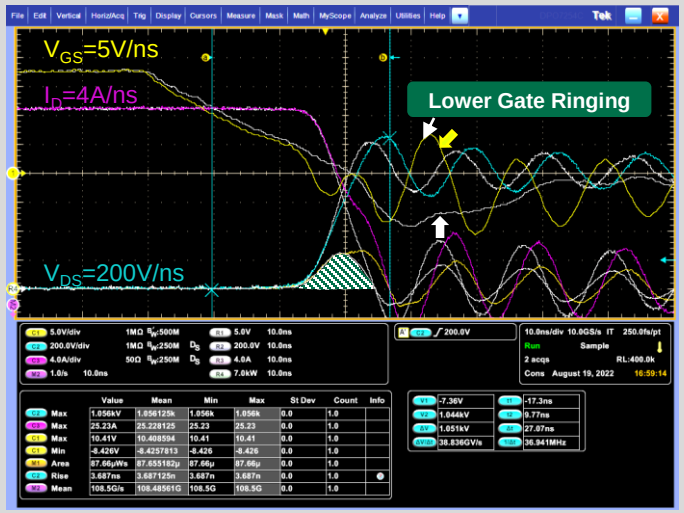
	5A	10A	15A	20A	25A
PCZ120N80M1	51	65	79	95	110
PCW120N80M1	70	112	172	265	384

Turn-off Loss



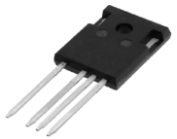
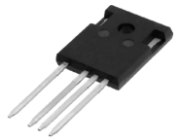
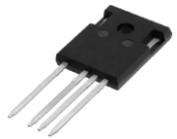
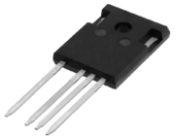
	5A	10A	15A	20A	25A
PCZ120N80M1	37	45	49	53	63
PCW120N80M1	37	45	46	62	88

Color : TO-247 3L White : TO-247 4L

TO-247 4L Benefits	Turn-on	Turn-off
 Lower E_{ON} / Lower Gate Ringing 		

1200V / 80mΩ *e*SiC MOSFET Benchmark

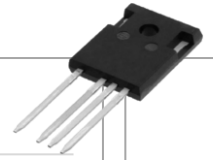
PCZ120N80M1vs. Competitors

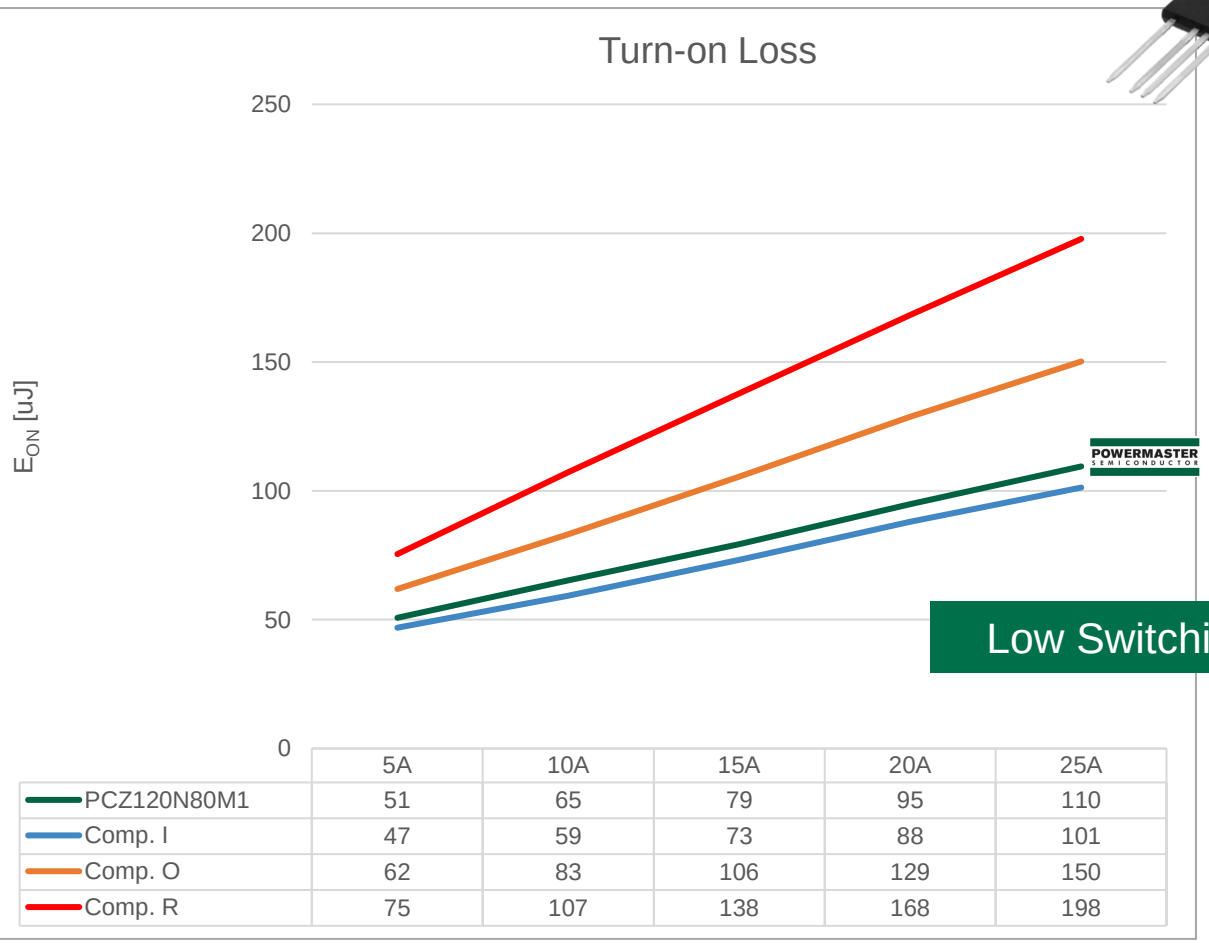





	PCZ120N80M1	Comp. I	Comp. O	Comp. R
BV_{DSS} [V]	1200	1200	1200	1200
I_D [A]	30	26	29	31
V_{GS_op} [V]	-5 / +18	0 / +18	-5 / +20	0 / +18
V_{GS_max} [V]	-10 / +22	-7 / +23	-15 / +25	-4 / +22
I_{GSS} [nA]	±100 (-10V / 22V)	±100 (-7V / 23V)	±1000 (-15V / 25V)	±100 (-4V / 22V)
$R_{DS(on)}$ [mΩ] (typ) / (max)	80 / 104	90 / 125	80 / 110	80 / 104
V_{TH} [V]	2.0 / 3.0 / 4.5	3.5 / 4.5 / 5.7	1.8 / 2.75 / 4.3	2.7 / - / 5.6
Int. R_G [Ω]	4.0	9.0	1.7	12.0
V_{SD} [V]	4.1	4.1	3.7	3.2
Q_G [nC]	52	21	56	60
E_{ON} [µJ] @ I_D=20A, R_G=2Ω	95	88	129	168
E_{OFF} [µJ] @ I_D=20A, R_G=2Ω	53	40	60	117

1200V / 80mΩ *e*SiC MOSFET Switching Losses

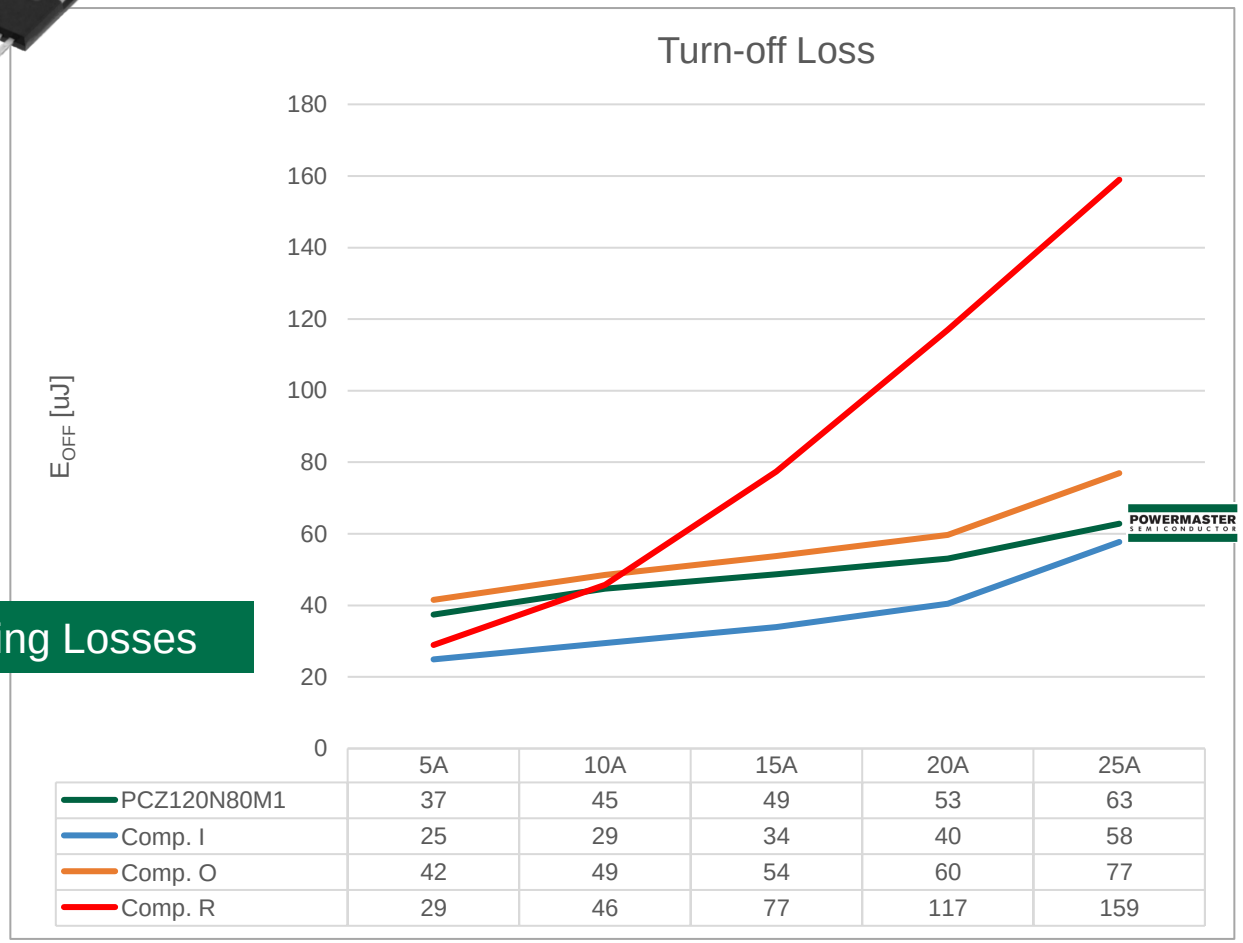
PCZ120N80M1vs. Competitors





	5A	10A	15A	20A	25A
PCZ120N80M1	51	65	79	95	110
Comp. I	47	59	73	88	101
Comp. O	62	83	106	129	150
Comp. R	75	107	138	168	198

Low Switching Losses



	5A	10A	15A	20A	25A
PCZ120N80M1	37	45	49	53	63
Comp. I	25	29	34	40	58
Comp. O	42	49	54	60	77
Comp. R	29	46	77	117	159

* Test condition : V_{DD}=800V, V_{GS}=-3V/+18V, FWD=PCH120S10D1, R_G=2Ω

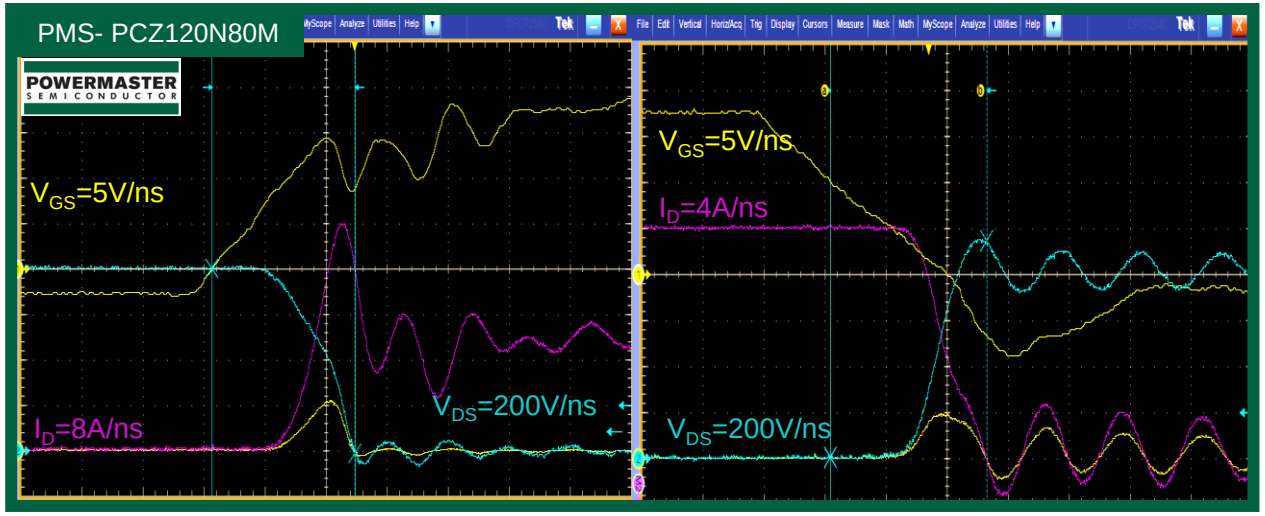
1200V / 80mΩ *e*SiC MOSFET Switching Performance

PCZ120N80M1vs. Competitors

Turn-on | Turn-off

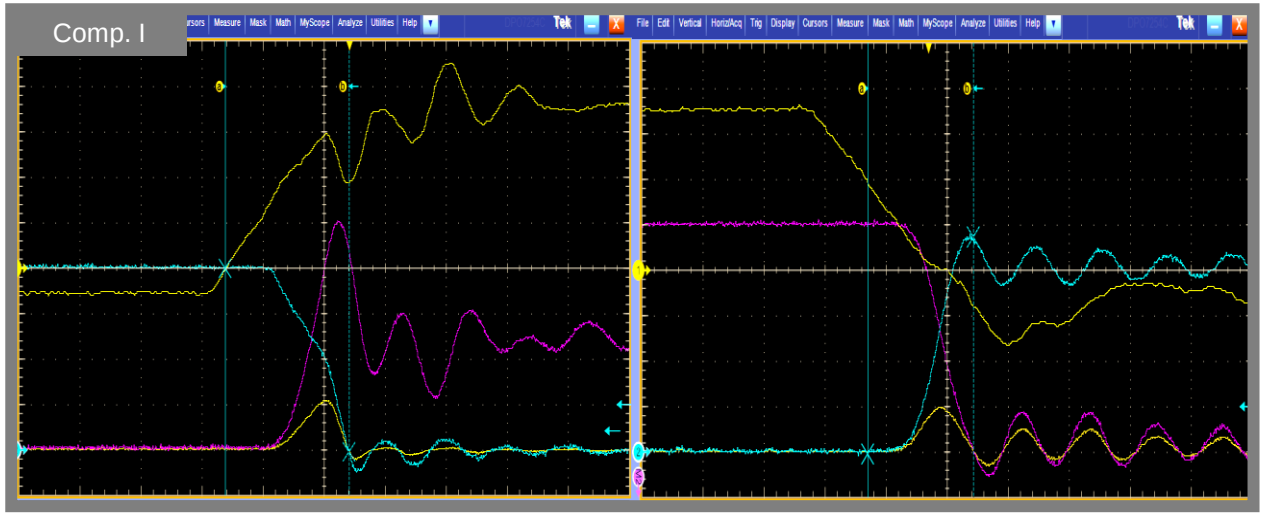
PMS- PCZ120N80M

POWERMASTER SEMICONDUCTOR



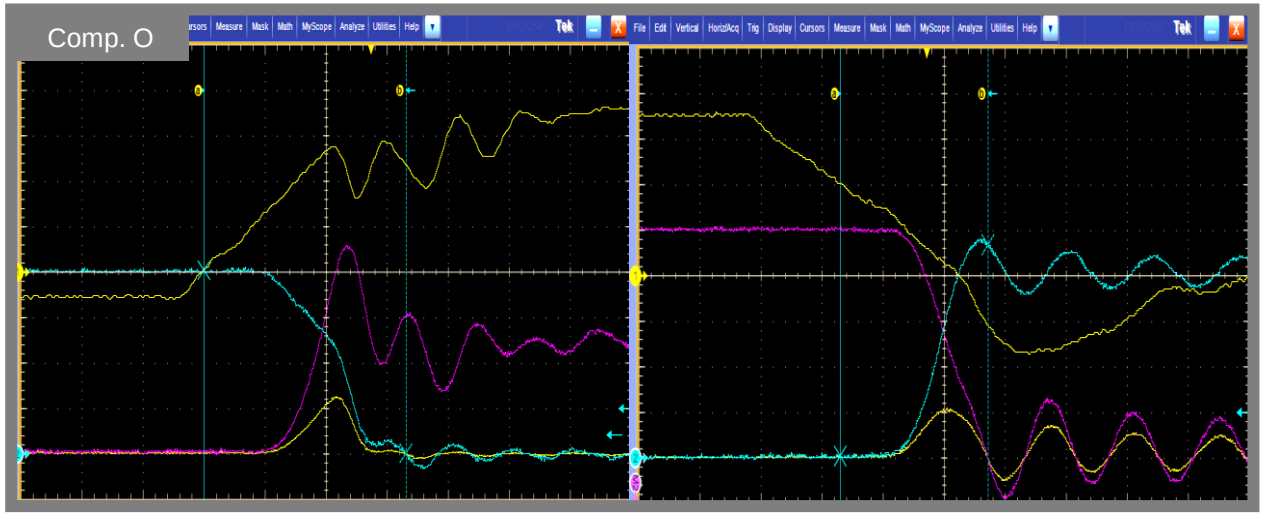
Turn-on | Turn-off

Comp. I



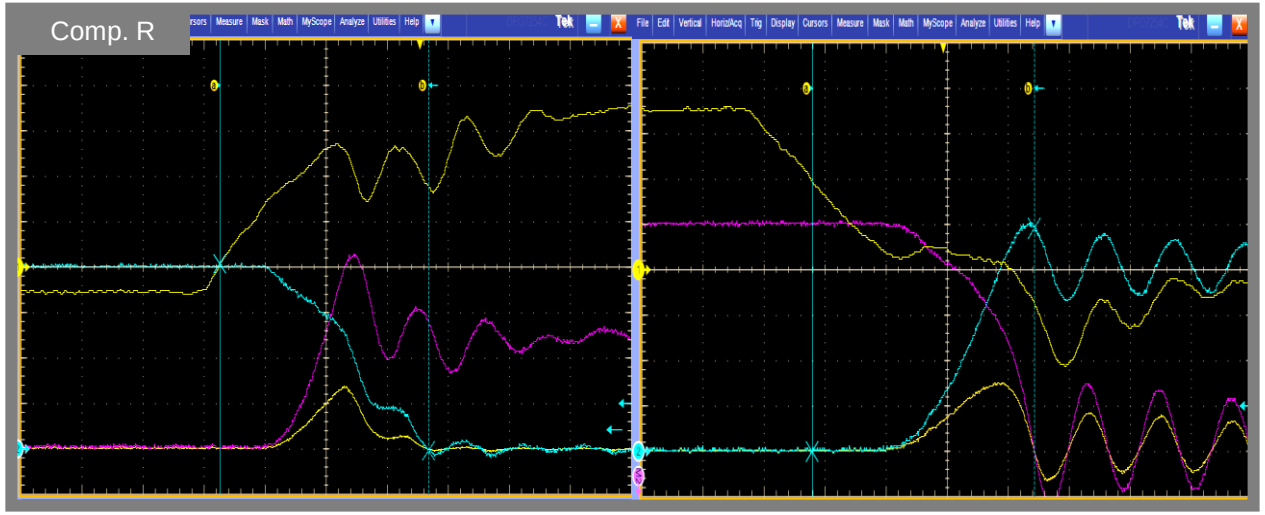
Turn-on | Turn-off

Comp. O



Turn-on | Turn-off

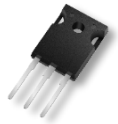
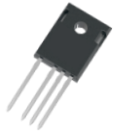
Comp. R



650V / 1200V *e*SiC MOSFET Portfolio

650V *e*SiC MOSFET Lineup

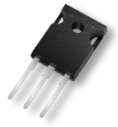
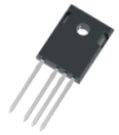
Solar | Server / Telecom | UPS | EV Charger | xEV(OBC)

PKG / $R_{DS(ON)\_typ}$	Die	D2PAK 7L	TO-247 3L	TO-247 4L
				
18mΩ	*PCO65N18M1	*PCBF65N18M1(-A)	*PCW65N18M1(-A)	*PCZ65N18M1(-A)
27mΩ	*PCO65N27M1	*PCBF65N27M1(-A)	*PCW65N27M1(-A)	*PCZ65N27M1(-A)
48mΩ	*PCO65N48M1	*PCBF65N48M1(-A)	*PCW65N48M1(-A)	*PCZ65N48M1(-A)
72mΩ	*PCO65N72M1	*PCBF65N72M1(-A)	*PCW65N72M1(-A)	*PCZ65N72M1(-A)
107mΩ	*PCO65N107M1	*PCBF65N107M1(-A)	*PCW65N107M1(-A)	*PCZ65N107M1(-A)

* Coming soon (-A : Automotive Grade)

1200V *e*SiC MOSFET Lineup

Solar | UPS | EV Charger | xEV(OBC)

PKG / $R_{DS(ON)\_typ}$	Die	D2PAK 7L	TO-247 3L	TO-247 4L
				
21mΩ	PCO120N21M1	*PCBF120N21M1(-A)	PCW120N21M1(-A)	PCZ120N21M1(-A)
30mΩ	*PCO120N30M1	*PCBF120N30M1(-A)	*PCW120N30M1(-A)	*PCZ120N30M1(-A)
40mΩ	PCO120N40M1	*PCBF120N40M1(-A)	PCW120N40M1(-A)	PCZ120N40M1(-A)
60mΩ	*PCO120N60M1	*PCBF120N60M1(-A)	*PCW120N60M1(-A)	*PCZ120N60M1(-A)
80mΩ	PCO120N80M1	*PCBF120N80M1(-A)	PCW120N80M1(-A)	PCZ120N80M1(-A)

* Coming soon (-A : Automotive Grade)

eSiC MOSFET – Nomenclature

P C P 120 N 60 M1 - A

MOSFET / Grade

- - A : Automotive Grade
- None : Industrial Grade

MOSFET / Generation

- M1 : Gen1 (High Efficiency) , M1R : Gen1 (High Ruggedness)
- M2 : Gen2 (High Efficiency) , M2R : Gen2 (High Ruggedness)

$R_{DS(ON)}$ Typ [mΩ]

Channel Polarity

Voltage Rating (x10)

Package

- B : D2-PAK 2L
- BF : D2-PAK 7L
- W : TO-247 3L
- Z : TO-247 4L
- P : TO-220 3L
- O : Wafer (Unsawn)
- OS : Wafer (Sawn)

SiC Technology

PMS Semiconductor

Important Notice

POWERMASTER
SEMICONDUCTOR

Masters of Power Solution

Experience Power Master's leading edge products and superb application engineers' design support at fair price

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