650V 23mΩ SiC MOSFET

Features:

- High blocking voltage with low Rds(on)
- High frequency operation with low capacitance
- Simple to drive with -4V/+18V gate
- Robust body diode with low Qrr
- 100% avalanche tested

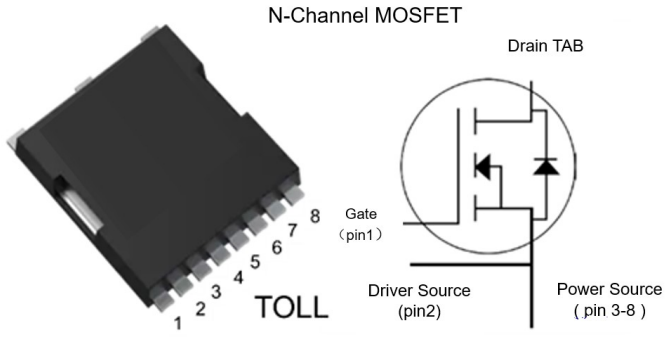
Benefits

- Superior robustness and system reliability
- Higher system efficiency
- Easier paralleling without thermal runaway
- Capable of high temperature application
- Faster and more efficient switching

Applications:

- Server Power
- EV/HEV charging station
- Energy storage and battery charging
- High performance DC-DC converters
- On-board charge
- Battery management system

Circuit Diagram



Key Performance and Package Parameters

Type	V_{DS}	$R_{DS(ON)}$	I_D@25°C	I_D@100°C	Marking	Package
PH023S065JNC	650V	23mΩ	94A	66A	PH023S065JNC	TOLL

Absolute Maximum Ratings(T_C=25°C unless otherwise specified)

Parameter	Symbols	Conditions	Value	Unit
Drain - source voltage	$V_{DS(max)}$	V_{GS}=0V, I_D=100μA	650	V
Gate - source voltage	$V_{GS(max)}$	AC (f>1Hz, duty cycle<1%, pulse width<200ns)	-9 / +23	V
Gate – source voltage	$V_{GS(op)}$	Recommend operation	-4 / +18	V
Continuous drain current (limited by $T_{J,max}$)	I_D	V_{GS} =18V, T_C=25°C V_{GS} =18V, T_C=100°C	94 66	A
Pulsed drain current	$I_{D(pulse)}$	T_C=25°C	215	A
Total power dissipation	P_D	T_C=25°C	326	W
Operating junction temperature	T_J		-55 to 175	°C
Storage temperature	T_{STG}		-55 to 175	°C
Soldering temperature	T_L		260	°C
Avalanche capability, single pulse*	I_{AV}	V_{DD}=100V, V_{GS}=10V, L=2mH	35	A
Avalanche capability, single pulse**	E_{AV}	V_{DD}=100V, V_{GS}=10V, L=2mH	1225	mJ

*100% tested in 60% rating
**100% tested in 36% rating

Electrical Characteristics at T_C= 25°C (unless otherwise specified)

Parameter	Symbols	Conditions	Value			Unit
			Min	Typ	Max	
Drain-source breakdown voltage	$V_{(BR)DSS}$	V_{GS}=0V, I_D=100μA	650	-	-	V
Gate threshold voltage	$V_{GS(th)}$	V_{DS}=V_{GS},I_D=10mA	2.6	3.0	4.2	V
		V_{DS}=V_{GS},I_D=10mA, T_J=150°C	-	2.3	-	
		V_{DS}=V_{GS},I_D=10mA, T_J=175°C	-	2.2	-	V
Zero gate voltage drain current	I_{DSS}	V_{DS}=650V, V_{GS}= 0V	0	0.5	60	uA
		V_{DS}=650V, V_{GS}= 0V,T_J=175°C	0	5	200	
Gate-source leakage current	I_{GSS}	V_{GS}=18V, V_{DS}=0V	0	5	100	nA
Gate-source leakage current	I_{GSS}	V_{GS}=-4V, V_{DS}=0V	-100	-5	0	nA
Drain-source on-state resistance	$R_{DS(on)}$	V_{GS}=18V, I_D=30A	-	23	29	mΩ
		V_{GS}=18V, I_D=30A, T_J=175°C	-	28	-	
Transconductance	gfs	V_{DS}=20V, I_D=30A	-	24	-	S
		V_{DS}=20V, I_D=30A, T_J=175°C	-	22	-	S
Input capacitance	C_{iss}	V_{DS}=400V, V_{GS}=0V f=1MHZ, V_{AC}=25mV	-	2420	-	pF
Output capacitance	C_{oss}		-	189	-	pF
Reverse transfer capacitance	C_{rss}		-	8	-	pF
Coss stored energy	E_{oss}		-	18	-	μJ
Turn-on switching energy	E_{ON}	V_{DS}=400V, V_{GS}= -4V/18V I_D=30A, $R_{G(ext)}$=2Ω, L=200μH	-	28	-	μJ
Turn-off switching energy	E_{OFF}		-	27	-	μJ
Turn-on delay time	td(on)	V_{DS}=400V, V_{GS}=-4V/18V I_D=30A, $R_{G(ext)}$=2Ω, L=200μH	-	13	-	ns
Rise time	tr		-	12	-	ns
Turn-off delaytime	td(off)		-	27	-	ns
Fall time	tf		-	5	-	ns
Total gate charge	Q_g	V_{DS}=400V, V_{GS}=-4V/18V I_D= 30A	-	113	-	nC
Gate-source charge	Q_{gs}		-	32	-	nC
Gate-drain charge	Q_{gd}		-	46	-	nC
Internal gate input resistance	$R_{g(int)}$	f=1MHZ, I_D= 0A	-	1.2	-	Ω

***Turn-off with -4V gate bias is highlyrecommended

Reverse Diode Characteristics at T_C= 25°C (unless otherwise specified)

Parameter	Symbols	Conditions	Value			Unit
			Min	Typ	Max	
Diode Forward Voltage	V_{SD}	V_{GS}=0V, I_{SD}=20A,T_J=25°C	-	3.2	-	V
Diode Forward Voltage	V_{SD}	V_{GS}=0V, I_{SD}=20A,T_J=175°C	-	2.9	-	V
Continuous diode forward current	Is	V_{GS}=-4V, T_J=25°C	-	60	-	A
Reverse recovery time	trr	V_{GS}=-4V, I_{SD}=30A,V_R=400V, $R_{G(ext)}$=20Ω, L=200μH dif/dt=1420A/us	-	20	-	ns
Reverse recovery charge	Q_{rr}		-	238	-	nC
Peak reverse recovery current	I_{rrm}		-	20	-	A

Thermal Characteristics

Parameter	Symbols	Conditions	Value			Unit
			Min	Typ	Max	
Thermal resistance	$R_{th(j-c)}$	Junction to case	-	0.46	0.55	°C/W

Typical Characteristics

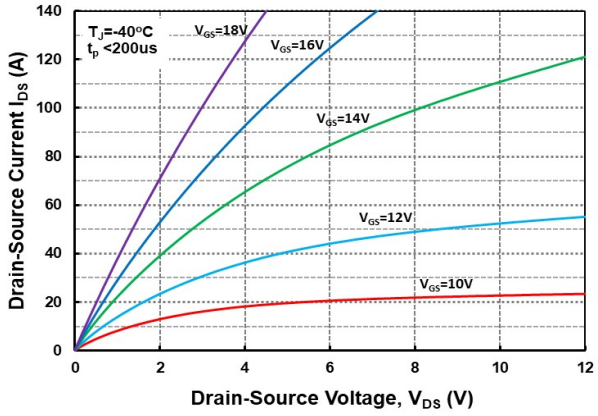


Figure 1: OutputCharacteristics,TJ=-40°C

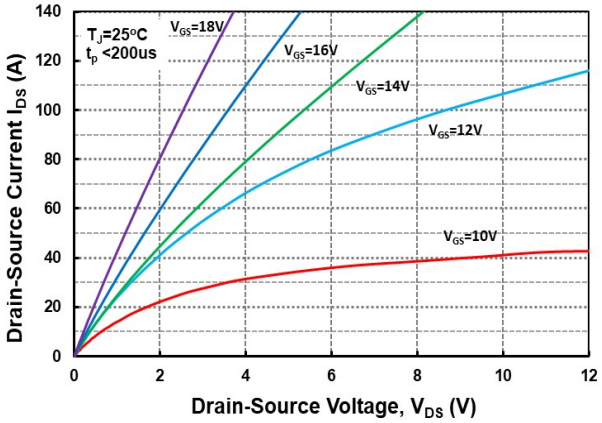


Figure 2: Output Characteristics, TJ=25°C

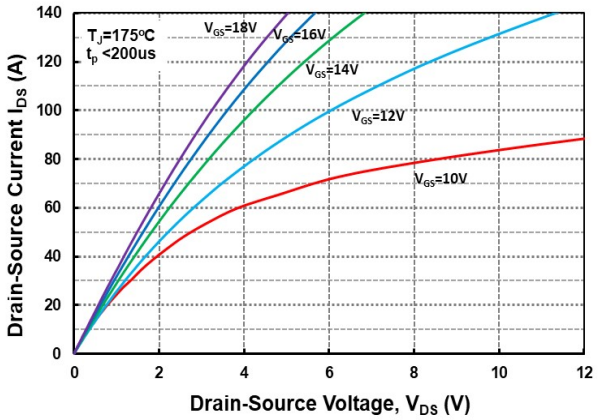


Figure 3: OutputCharacteristics,TJ=175°C

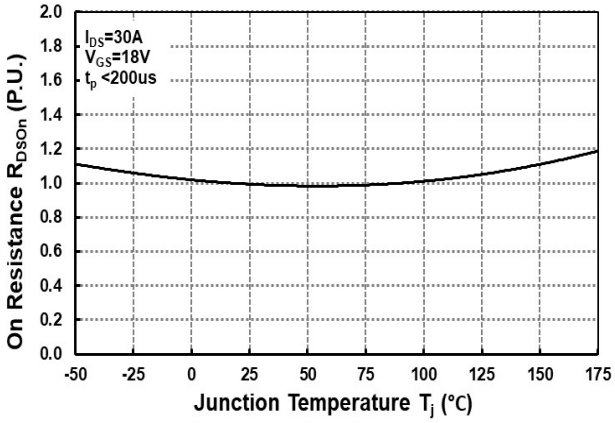


Figure 4: Normalized On-Resistance vs.Temperature

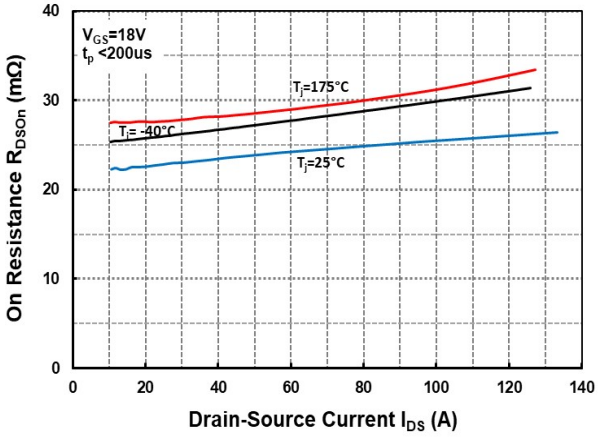


Figure 5: On-Resistance vs. Drain Current for Various Temperatures

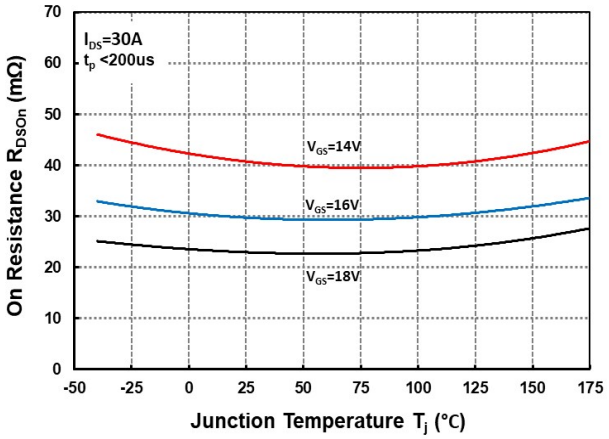


Figure 6: On-Resistance vs.Temperature for Various Gate Voltage

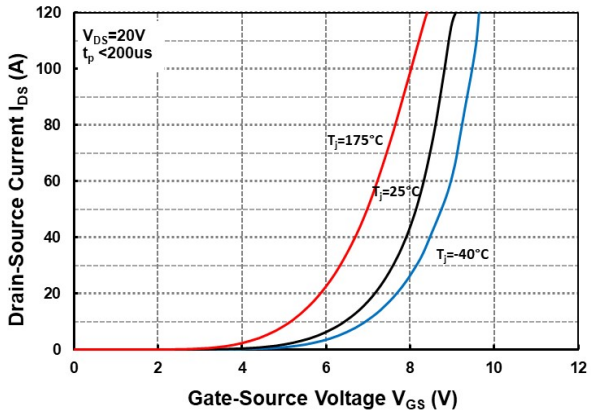


Figure 7: Transfer Characteristic for Various Junction Temperatures

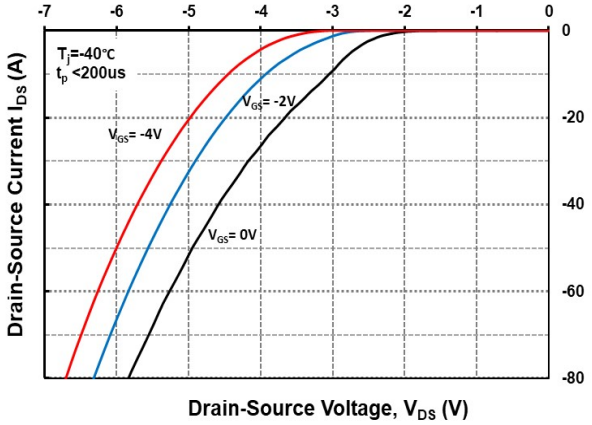


Figure 8: Body Diode Characteristics @ -40°C

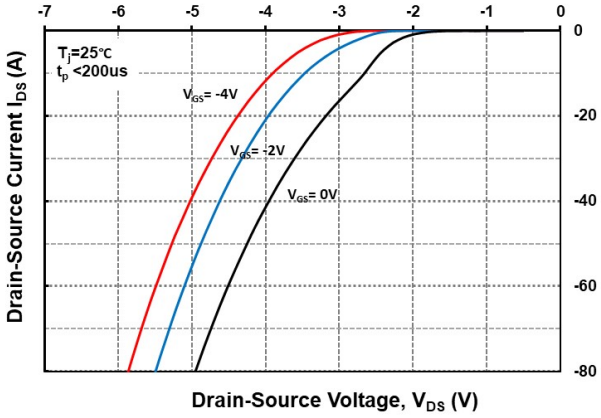


Figure 9: Body Diode Characteristics @ 25°C

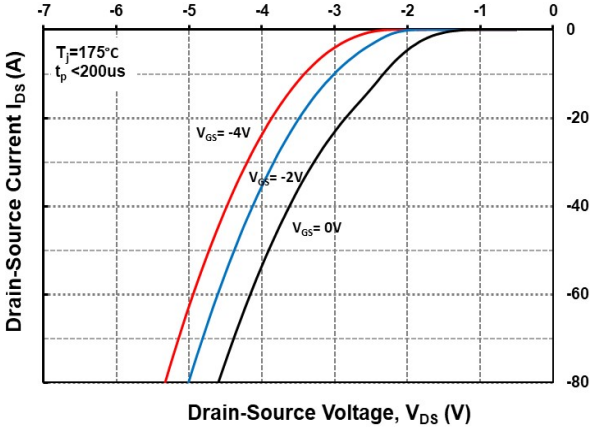


Figure 10: Body Diode Characteristics @ 175°C

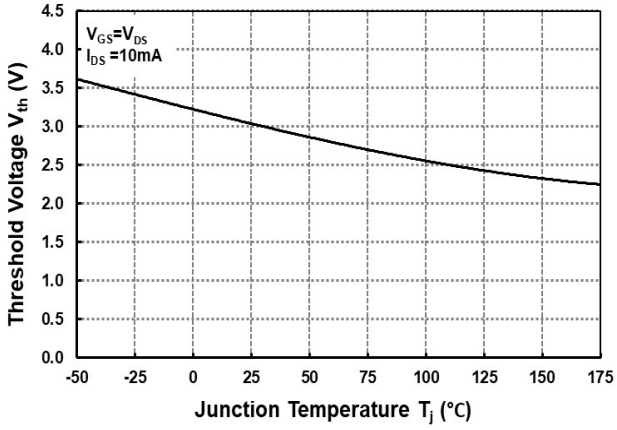


Figure 11: Threshold Voltage vs.Temperature

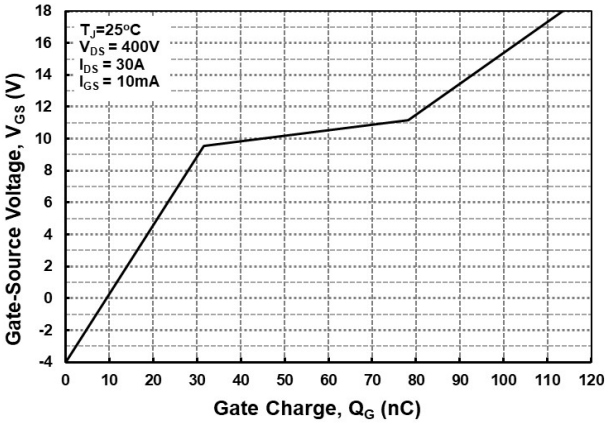


Figure 12: Gate Charge Characteristics

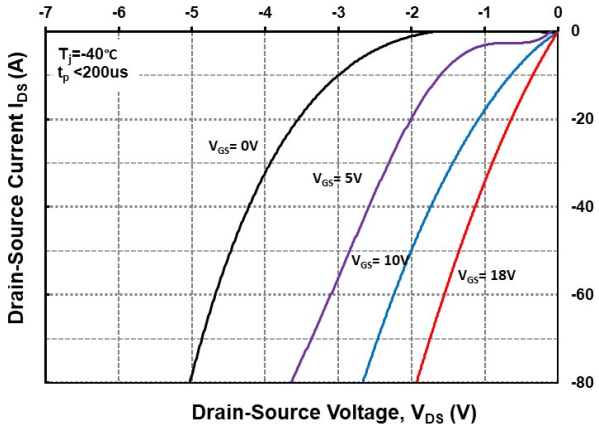


Figure 13: 3rd Quadrant Characteristics @ -40°C

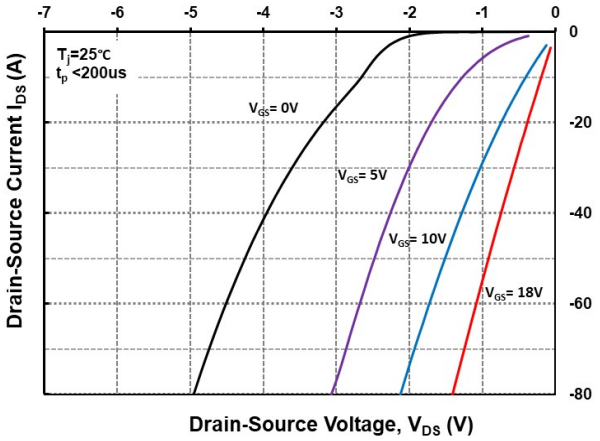


Figure 14: 3rd Quadrant Characteristics @ 25°C

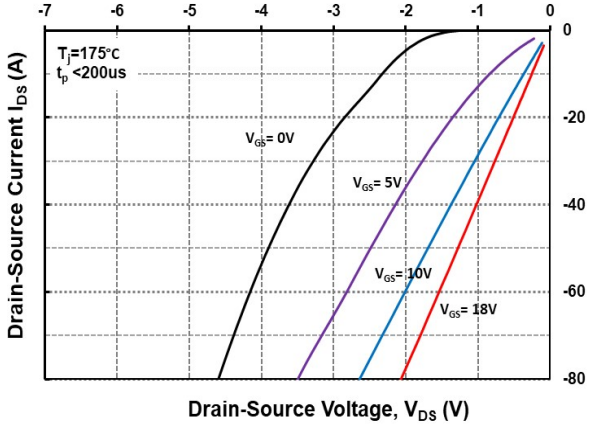


Figure 15: 3rd Quadrant Characteristics @175°C

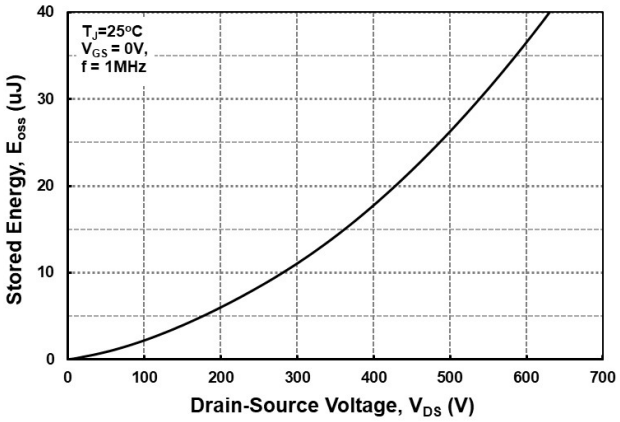


Figure 16: Output Capacitor Stored Energy

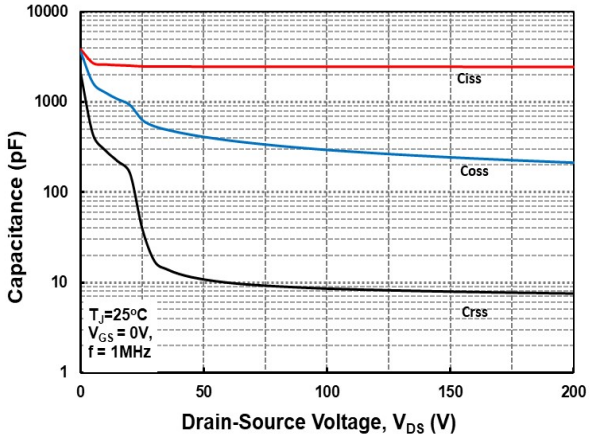


Figure 17: Capacitances vs. Drain-Source Voltage (0-200V)

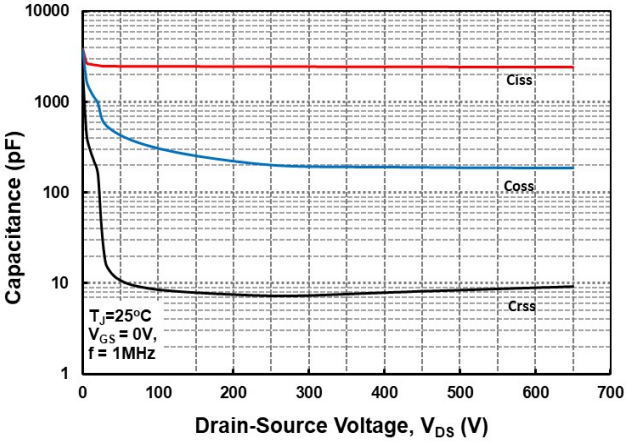


Figure 18: Capacitances vs. Drain-Source Voltage (0-650V)

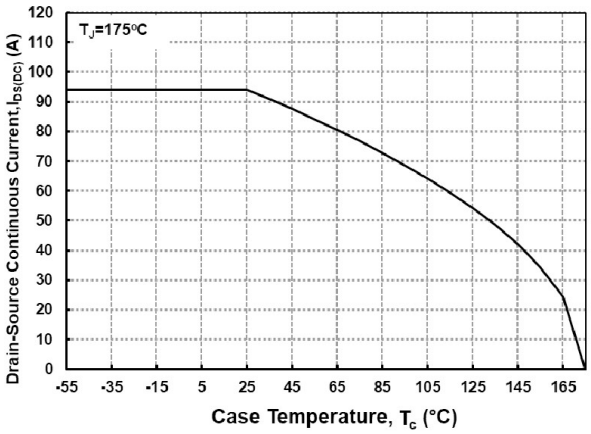


Figure 19: Continuous Drain Current Derating vs. Case Temperature

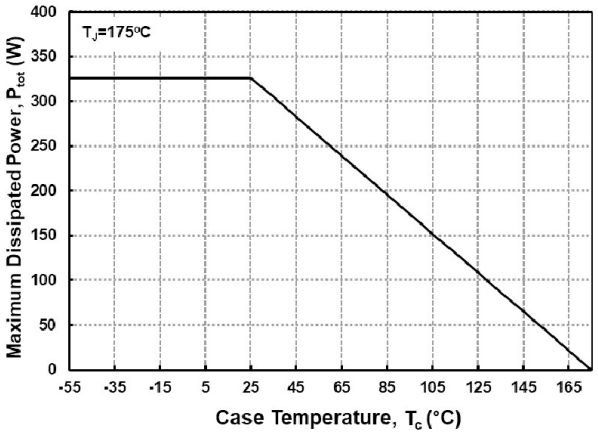


Figure 20: Maximum Power Dissipation Derating vs. Case Temperature

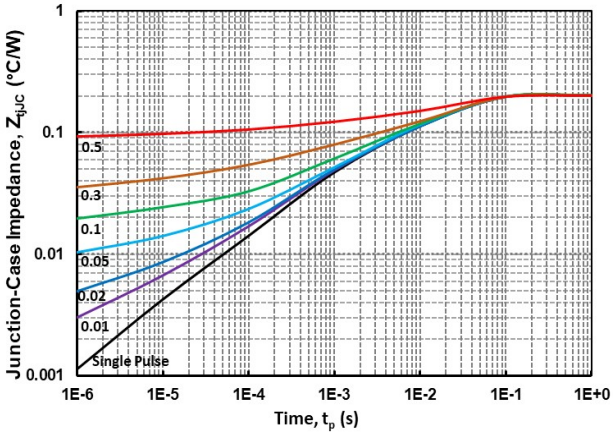


Figure 21: Transient ThermalImpedance (Junction - Case)

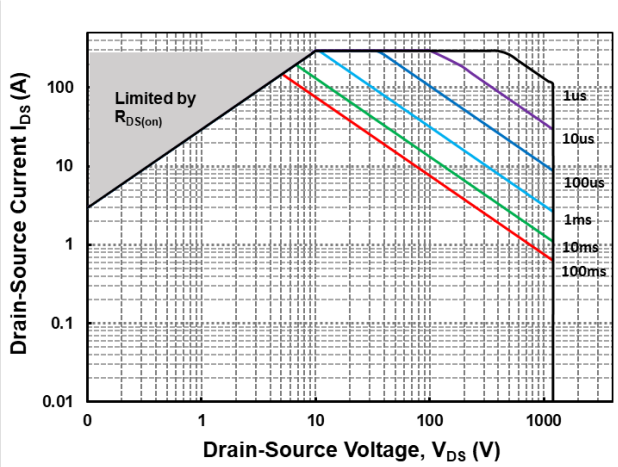


Figure 22: Safe Operating Area

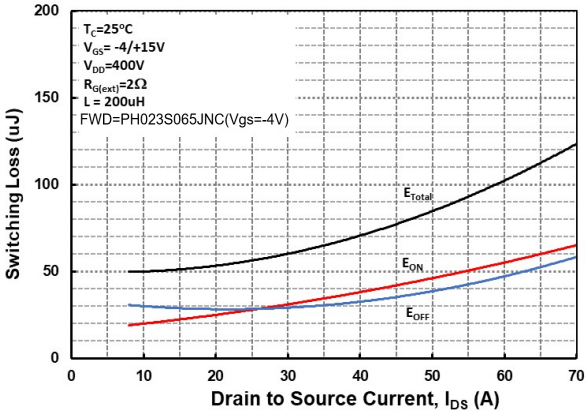


Figure 23: Clamped inductive Switching Energy vs Drain Current (V_{DD}= 400V)

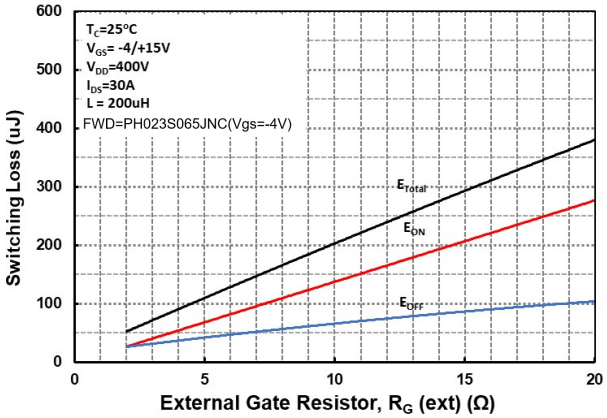


Figure 24: Clamped inductive Switching Energy vs External Gate Resistor $R_{G(ext)}$

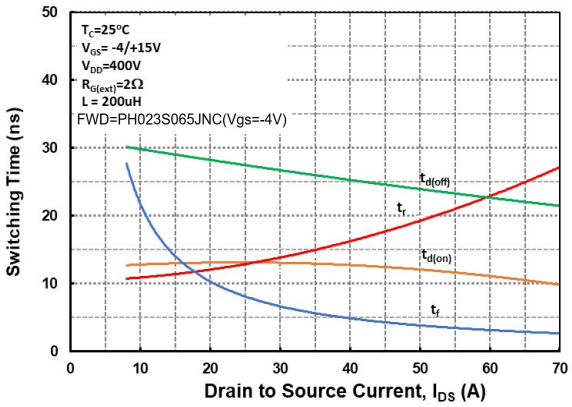


Figure 25: Switching Times vs Drain Current(V_{DD}=400V)

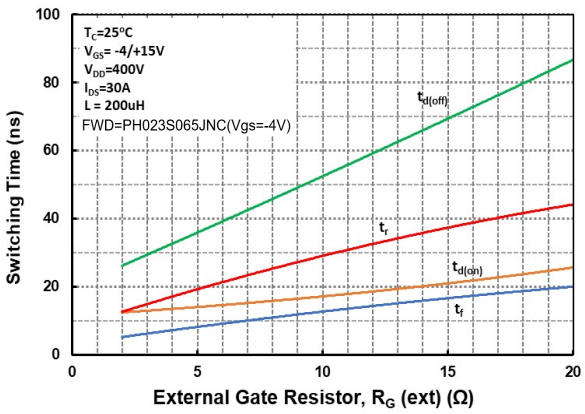
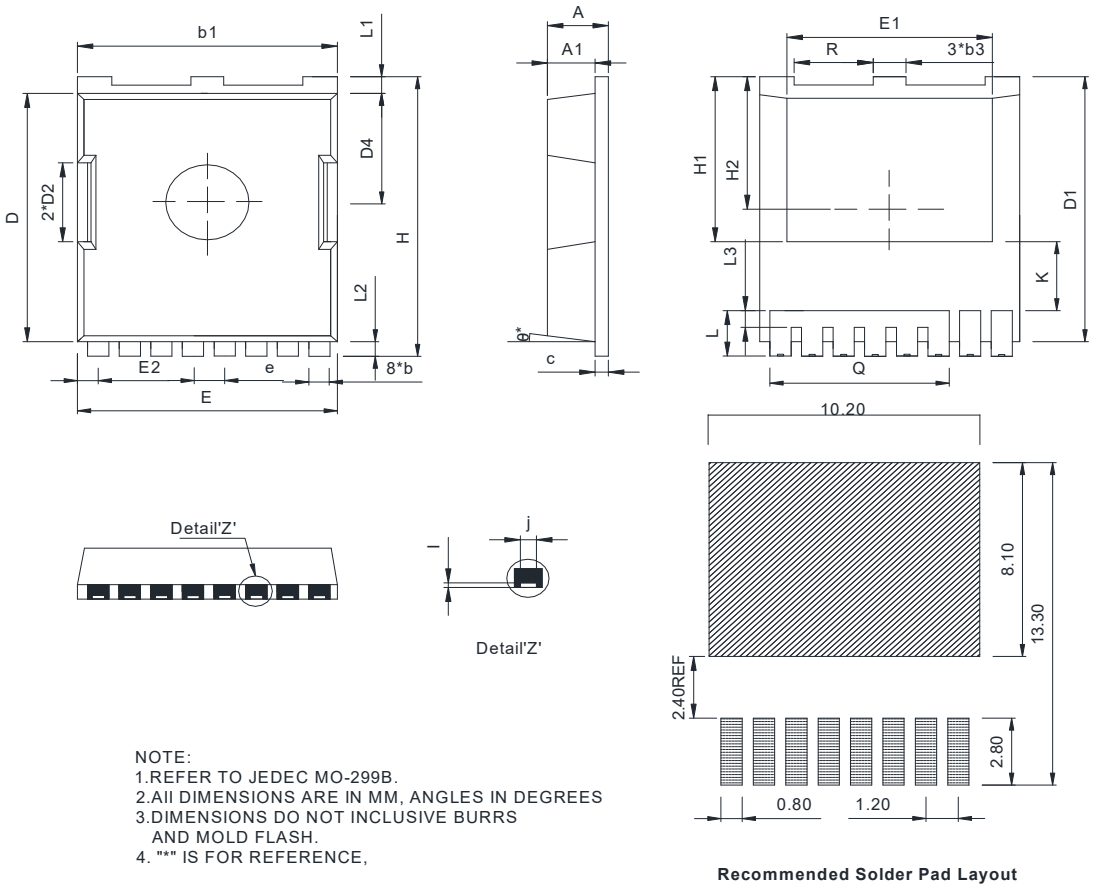


Figure 26: Switching Times vs External Gate Resistor $R_{G(ext)}$

Package Dimensions



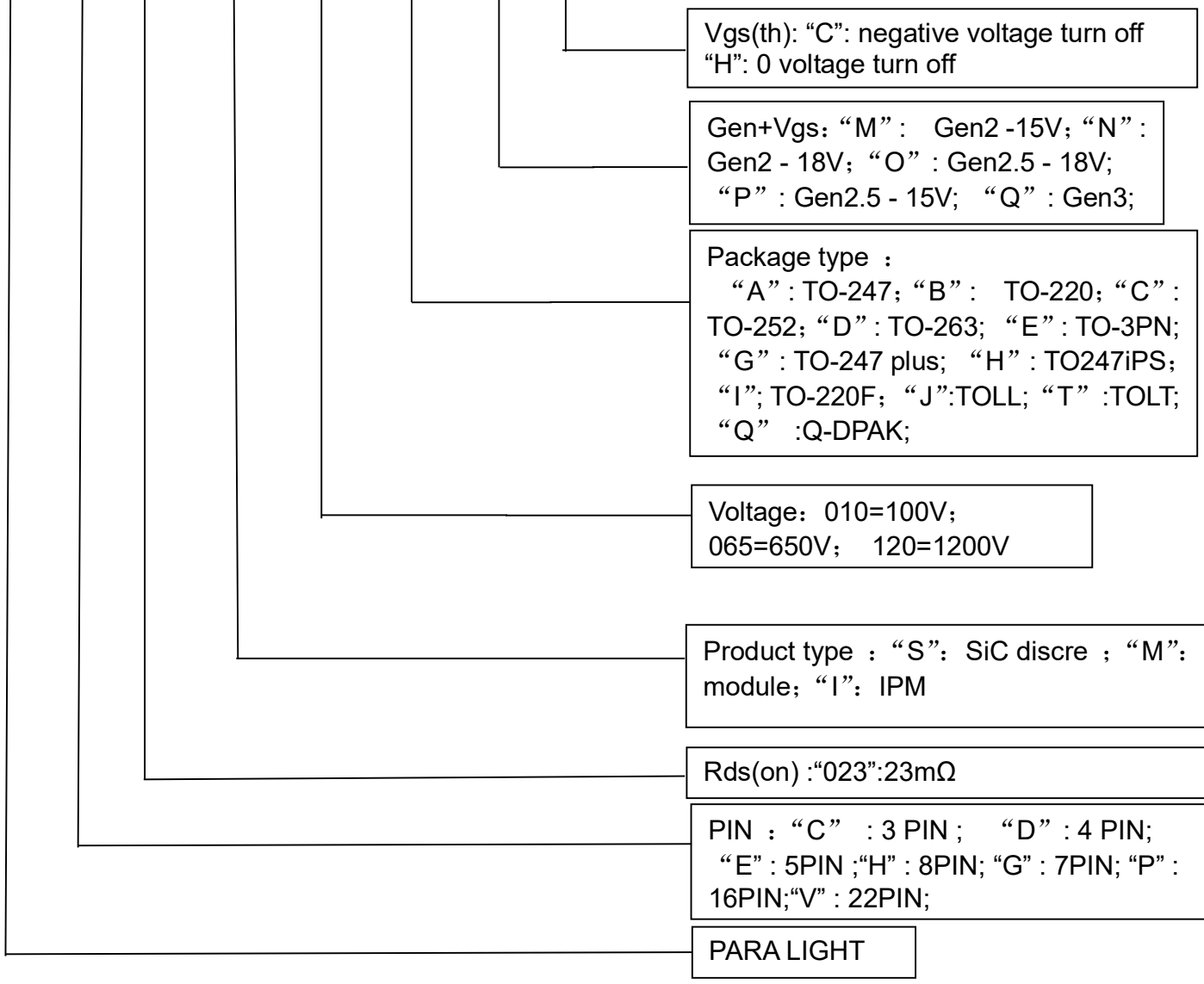
Recommended Solder Pad Layout

NOTE:
1.REFER TO JEDEC MO-299B.
2.All DIMENSIONS ARE IN MM, ANGLES IN DEGREES
3.DIMENSIONS DO NOT INCLUSIVE BURRS AND MOLD FLASH.
4. "*" IS FOR REFERENCE,

Common dimensions(mm)							
Symbol	**Min**	**Typ**	**Max**	**Symbol**	**Min**	**Typ**	**Max**
A	2.20	2.30	2.40	H	11.58	11.68	11.78
A1	1.70	1.80	1.90	H1	6.95BSC		
b	0.70	0.80	0.90	H2	5.89BSC		
b1	9.70	9.80	9.90	I	0.10REF.		
b3	1.10	1.20	1.30	j	0.46REF.		
c	0.40	0.50	0.60	K	2.80REF.		
D	10.28	10.38	10.48	L	1.40	1.90	2.10
D1	10.98	11.08	11.18	L1	0.60	0.70	0.80
D2	3.20	3.30	3.40	L2	0.50	0.60	0.70
D4	4.45	4.55	4.65	L3	0.30	0.70	0.80
E	9.80	9.90	10.00	N	8		
E1	8.00	8.10	8.20	Q	6.80REF.		
E2	0.60	0.70	0.80	R	3.00	3.10	3.20
e	1.20BSC			θ	10° REF.		

PART NO. SYSTEM :

P H 023 S 065 J N C



Revision history

Document revision history

Date	Version	Changes
2025.07.12	A / 0	First release.
2025.10.31	A / 1	Error correction.
2025.12.22	A / 2	Version Upgrade.