

General Description

The silicon carbide power MOSFET utilizes Oriental-Semi's advanced technology to achieve low on-resistance, low gate charge, low Qrr and excellent thermal performance by exploiting innovative properties of wide bandgap materials. It is engineered to minimize conduction loss and provide superior switching performance almost independent of temperature.

The silicon carbide power MOSFET provides high reliability and extremely high efficiency. It is targeted to improve application performance in frequency, energy efficiency, reliability, system size and weight reduction.

Features

- High blocking voltage with low on-resistance
- High-speed switching with low capacitances
- IGBT-compatible driving voltage (15V for turn-on)
- Fast intrinsic diode with low reverse recovery (Qrr)
- Temperature independent turn-off switching losses
- Halogen free, RoHS compliant

Applications

- On-board charger/PFC
- EV motor drive
- High voltage DC/DC converters
- Switch mode power supplies

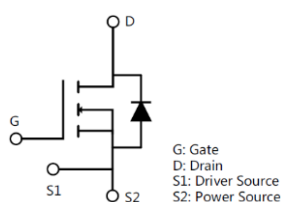
Key Performance Parameters

Parameter	Value	Unit
V_{DS}	650	V
I_D , pulse	142	A
$R_{DS(ON)}$, typ @ $V_{GS}=18V$	45	m Ω
Q_g	46	nC

Marking Information

Product Name	Package	Marking
OSQ65R045H4T2F_NB	TO247-4L-NL	OSQ65R045H4T2

Package & Pin Information



Absolute Maximum Ratings at $T_j=25^{\circ}\text{C}$ unless otherwise noted

Parameter	Symbol	Value	Unit
Drain-source voltage	V_{DS}	650	V
Gate-source voltage (max static)	V_{GS}	-8/+22	V
Gate-source voltage (recommended operating values)	V_{GS}	-4/+18	V
Continuous drain current ¹⁾ , $T_C=25^{\circ}\text{C}$	I_D	43	A
Continuous drain current ¹⁾ , $T_C=100^{\circ}\text{C}$		30	
Pulsed drain current ²⁾	$I_{D, \text{pulse}}$	142	A
Power dissipation ³⁾ , $T_C=25^{\circ}\text{C}$	P_D	166	W
Operation and storage temperature	T_{stg}, T_j	-55 to 175	$^{\circ}\text{C}$

Thermal Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit
Thermal resistance, junction-case	$R_{\theta JC}$		0.70	0.90	$^{\circ}\text{C/W}$
Thermal resistance, junction-ambient	$R_{\theta JA}$			62	$^{\circ}\text{C/W}$

Electrical Characteristics at $T_j=25^{\circ}\text{C}$ unless otherwise specified

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test condition
Drain-source breakdown voltage	BV_{DSS}	650			V	$V_{GS}=0\text{ V}, I_D=100\text{ }\mu\text{A}$
Gate threshold voltage	$V_{GS(th)}$	2.3	2.8	3.6	V	$V_{DS}=V_{GS}, I_D=5\text{ mA}$
Drain-source on-state resistance	$R_{DS(ON)}$		45	60	$\text{m}\Omega$	$V_{GS}=18\text{ V}, I_D=15\text{ A}$
			60			$V_{GS}=18\text{ V}, I_D=15\text{ A}, T_j=175^{\circ}\text{C}$
			60	79	$\text{m}\Omega$	$V_{GS}=15\text{ V}, I_D=15\text{ A}$
			70			$V_{GS}=15\text{ V}, I_D=15\text{ A}, T_j=175^{\circ}\text{C}$
Transconductance	g_{fs}		9		S	$V_{DS}=20\text{ V}, I_D=15\text{ A}$
Gate-source leakage current	I_{GSS}			± 100	nA	$V_{GS}=-8\sim 22\text{ V}$
Drain-source leakage current	I_{DSS}			100	μA	$V_{DS}=650\text{ V}, V_{GS}=0\text{ V}$
				500	μA	$V_{DS}=650\text{ V}, V_{GS}=0\text{ V}, T_j=175^{\circ}\text{C}$
Gate resistance	R_G		2.3		Ω	$f=1\text{ MHz}$, Open drain, $V_{AC}=25\text{ mV}$

Dynamic Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test condition
Input capacitance	C_{iss}		1200		pF	$V_{GS}=0\text{ V}$, $V_{DS}=400\text{ V}$, $f=1\text{ MHz}$, $V_{AC}=25\text{ mV}$
Output capacitance	C_{oss}		113		pF	
Reverse transfer capacitance	C_{rss}		4.3		pF	
C_{oss} stored energy	E_{oss}		10.6		μJ	
Turn-on delay time	$t_{d(on)}$		9.6		ns	$V_{GS}=-4/18\text{ V}$, $V_{DS}=400\text{ V}$, $R_G=5\ \Omega$, $I_D=15\text{ A}$, $L=120\ \mu\text{H}$, $T_j=25\text{ }^\circ\text{C}$
Rise time	t_r		8.5		ns	
Turn-off delay time	$t_{d(off)}$		17.4		ns	
Fall time	t_f		8.0		ns	
Turn-on switching energy	E_{on}		27		μJ	
Turn-off switching energy	E_{off}		10.8		μJ	
Turn-on switching energy	E_{on}		24.6		μJ	$V_{GS}=-4/18\text{ V}$, $V_{DS}=400\text{ V}$, $R_G=5\ \Omega$, $I_D=15\text{ A}$, $L=120\ \mu\text{H}$, $T_j=175\text{ }^\circ\text{C}$
Turn-off switching energy	E_{off}		11		μJ	

Gate Charge Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test condition
Total gate charge	Q_g		46		nC	$V_{GS}=-4/18\text{ V}$, $V_{DS}=400\text{ V}$, $I_D=15\text{ A}$
Gate-source charge	Q_{gs}		15.4		nC	
Gate-drain charge	Q_{gd}		9.5		nC	

Body Diode Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test condition
Diode forward voltage	V_{SD}		4.4		V	$I_S=15\text{ A}$, $V_{GS}=-4\text{ V}$, $T_J=25\text{ }^{\circ}\text{C}$
			3.9		V	$I_S=15\text{ A}$, $V_{GS}=-4\text{ V}$, $T_J=175\text{ }^{\circ}\text{C}$
Continuous diode forward current	I_S		43		A	$V_{GS}=-4\text{ V}$, $T_J=25\text{ }^{\circ}\text{C}$
Reverse recovery time	t_{rr}		12.5		ns	$V_{GS}=-4\text{ V}$, $V_R=400\text{ V}$, $I_S=15\text{ A}$, $di/dt=3000\text{ A}/\mu\text{s}$, $T_J=25\text{ }^{\circ}\text{C}$
Reverse recovery charge	Q_{rr}		122		nC	
Peak reverse recovery current	I_{rrm}		17.3		A	
Reverse recovery time	t_{rr}		18		ns	$V_{GS}=-4\text{ V}$, $V_R=400\text{ V}$, $I_S=15\text{ A}$, $di/dt=1000\text{ A}/\mu\text{s}$, $T_J=175\text{ }^{\circ}\text{C}$
Reverse recovery charge	Q_{rr}		85		nC	
Peak reverse recovery current	I_{rrm}		8.2		A	

Note

- 1) Calculated continuous current based on maximum allowable junction temperature.
- 2) Repetitive rating; pulse width limited by max. junction temperature.
- 3) P_d is based on max. junction temperature, using junction-case thermal resistance.

Electrical Characteristics Diagrams

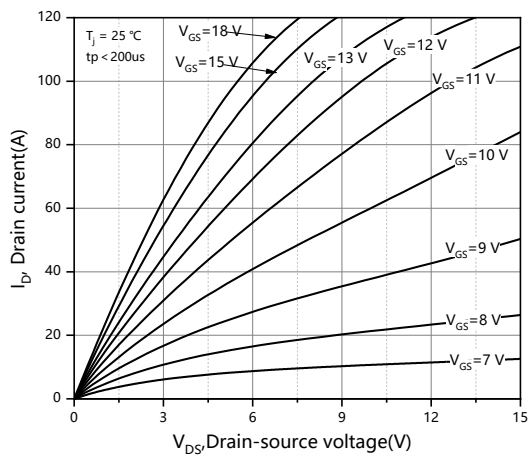


Figure 1. Output characteristics $T_j=25^{\circ}\text{C}$

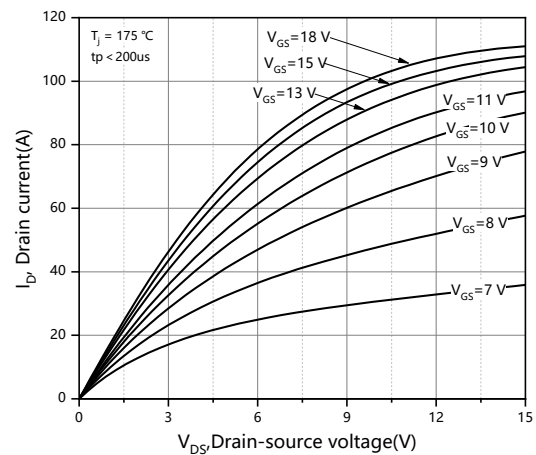


Figure 2. Output characteristics $T_j=175^{\circ}\text{C}$

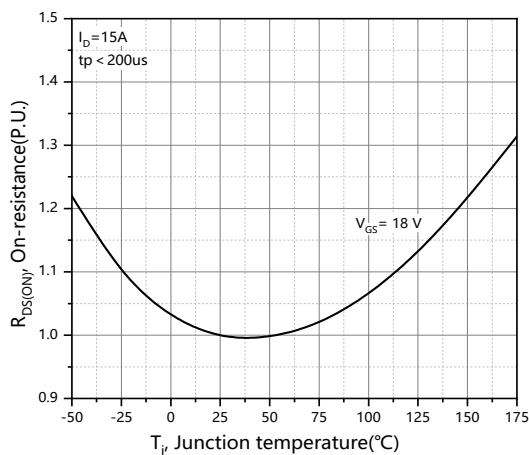


Figure 3. Normalized on-resistance vs. temperature

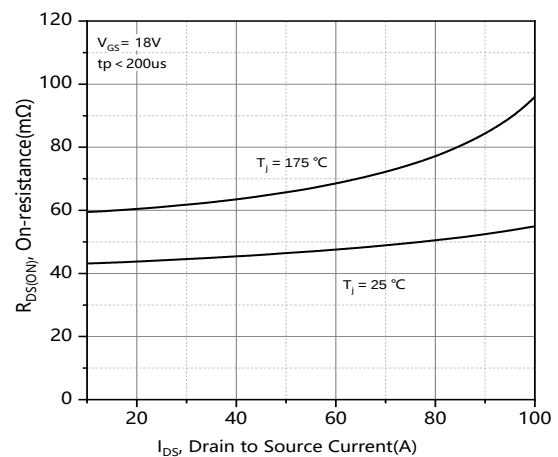


Figure 4. On-resistance vs. drain current for various temperatures

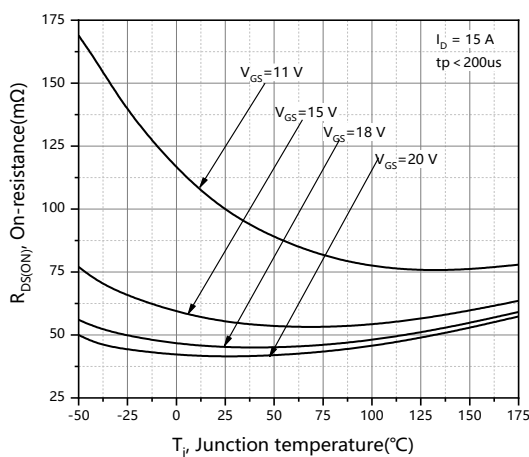


Figure 5. On-resistance vs. temperature for various gate voltage

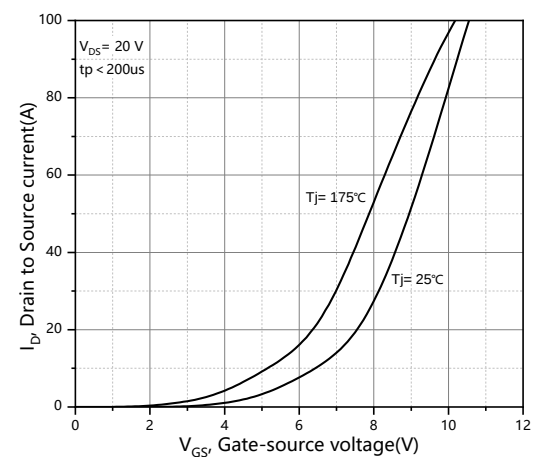


Figure 6. Transfer characteristic for various junction temperatures

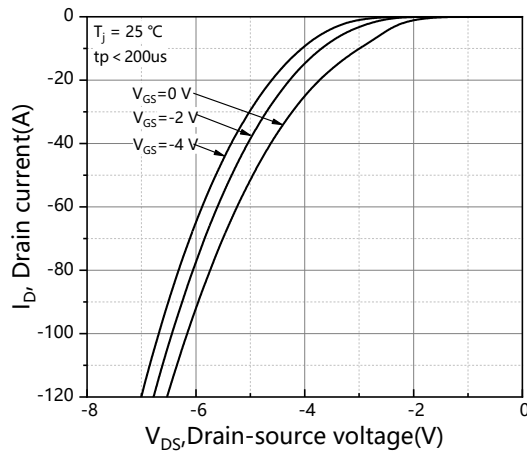


Figure 7. Body diode characteristic at $T_j = 25\text{ }^{\circ}\text{C}$

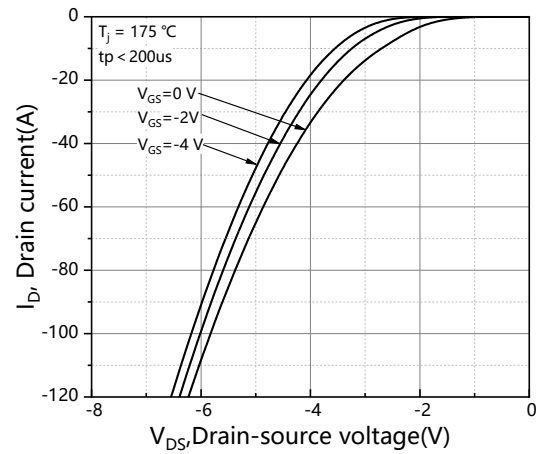


Figure 8. Body diode characteristic at $T_j = 175\text{ }^{\circ}\text{C}$

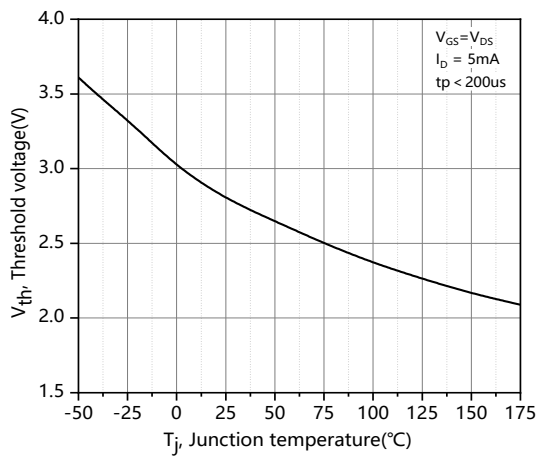


Figure 9. Threshold voltage vs. temperature

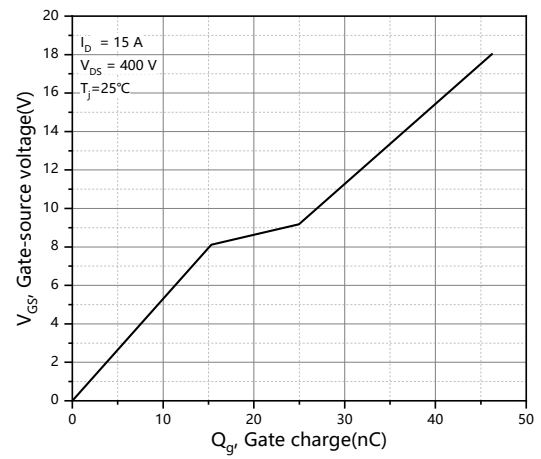
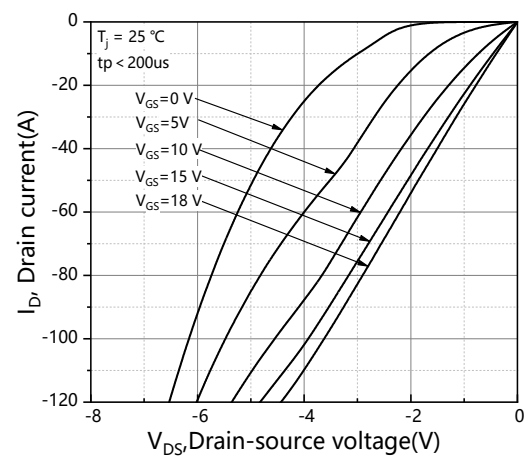
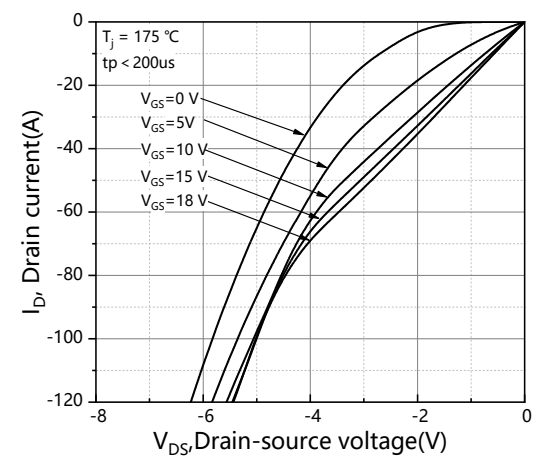


Figure 10. Gate charge characteristic



**Figure 11. 3rd quadrant characteristic
at $T_j = 25\text{ }^{\circ}\text{C}$**



**Figure 12. 3rd quadrant characteristic
at $T_j = 175\text{ }^{\circ}\text{C}$**

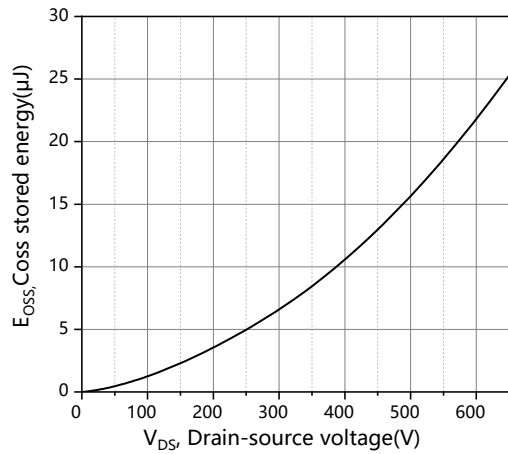


Figure 13. Output capacitor stored energy

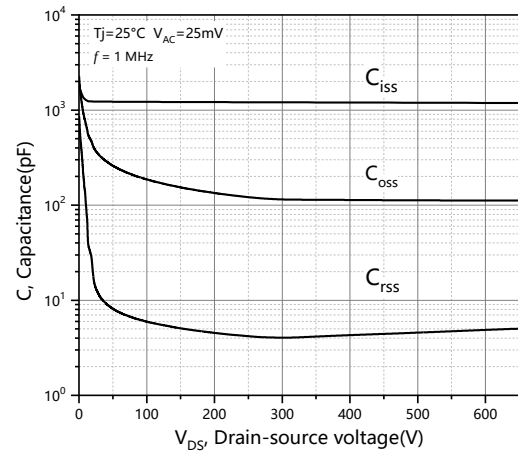
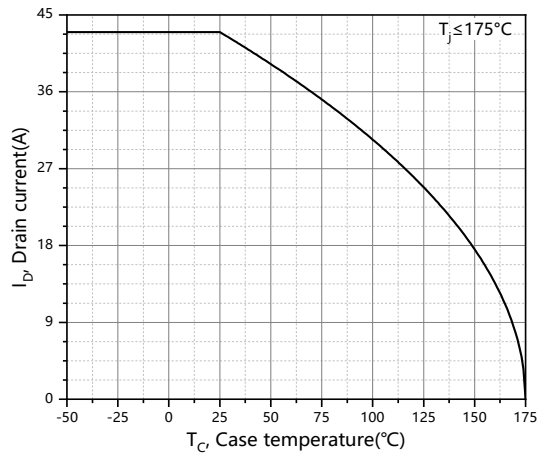
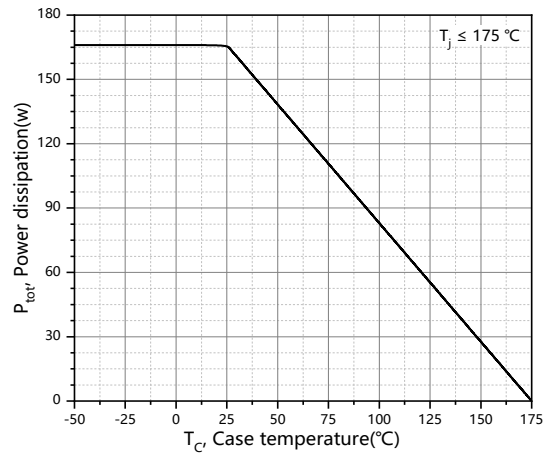


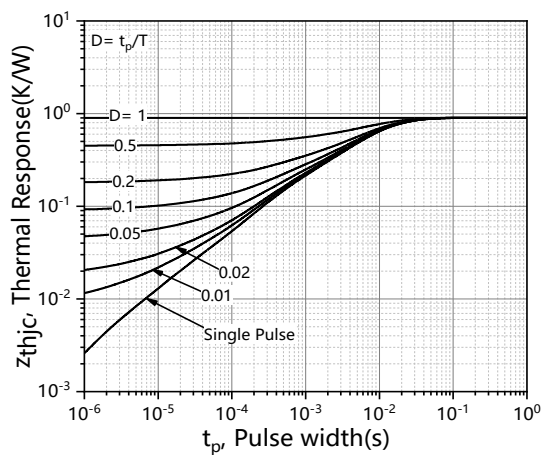
Figure 14. Capacitances vs. drain-source voltage



**Figure 15. Continuous drain current derating
vs.case temperature**



**Figure 16. Maximum power dissipation derating
vs.case temperature**



**Figure 17. Transient thermal impedance
(junction - case)**

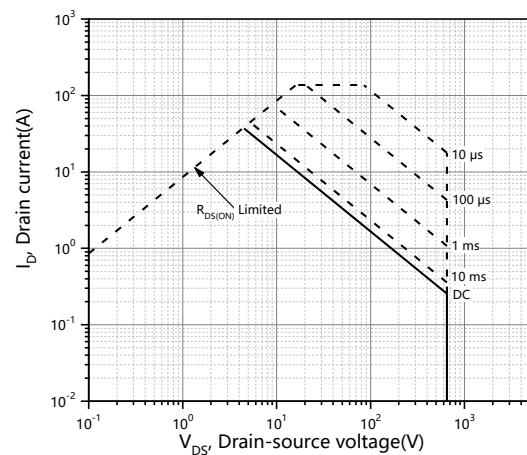


Figure 18. Safe operating area

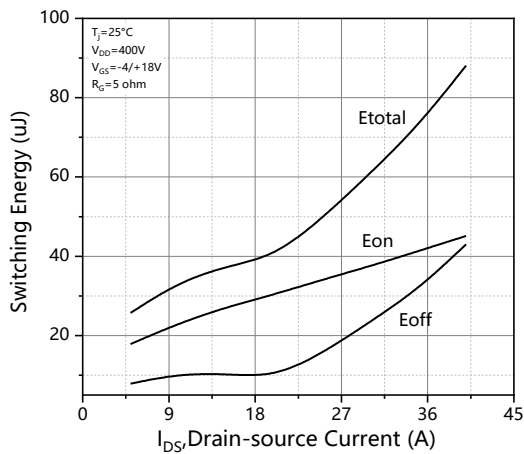


Figure 19. Clamped Inductive switching energy vs. drain current

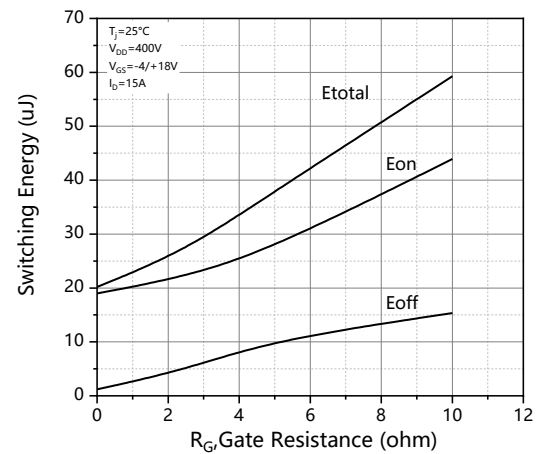


Figure 20. Clamped inductive switching energy vs. R_G

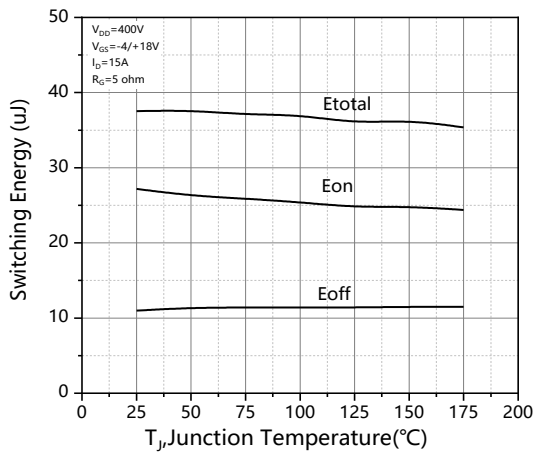


Figure 21. Clamped inductive switching energy vs. temperature

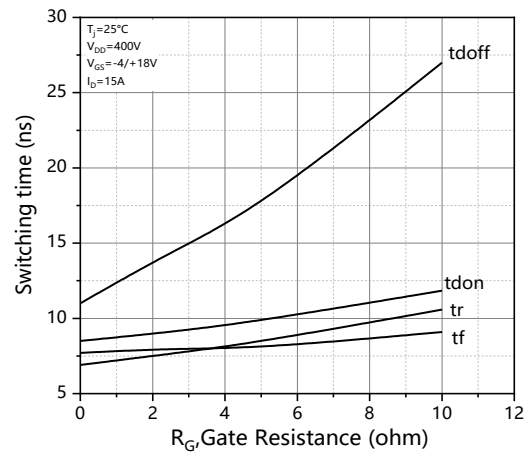
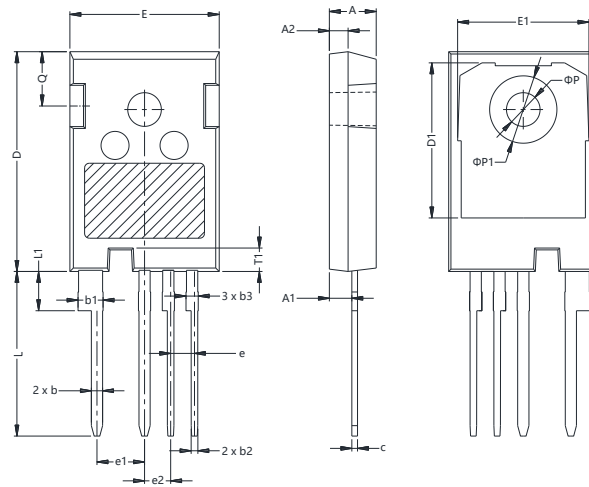


Figure 22. Switching times vs. R_G

Package Information



Symbol	mm		
	Min	Nom	Max
A	4.80	5.00	5.20
A1	2.21	2.41	2.61
A2	1.80	2.00	2.20
b	1.06	1.21	1.36
b1	2.33	2.63	2.93
b2	0.60	0.70	0.80
b3	1.07	1.30	1.60
c	0.51	0.61	0.75
D	23.30	23.45	23.60
D1	16.25	16.55	16.85
E	15.74	15.94	16.14
E1	13.72	14.02	14.32
T1	2.35	2.50	2.65
e	2.54BSC		
e1	5.08BSC		
e2	2.79BSC		
Q	5.49	5.79	6.09
L	17.27	17.57	17.87
L1	3.99	4.19	4.39
ΦP	3.40	3.60	3.80
ΦP1	7.19REP		

Version 1: TO247-4L_NL-P -package outline dimension

Ordering Information

Package Type	Units/ Tube	Tubes/ Inner Box	Units/ Inner Box	Inner Boxes/ Carton Box	Units/ Carton Box
TO247-4L-NL-P	30	11	330	6	1980

Product Information

Product	Package	Pb Free	RoHS	Halogen Free
OSQ65R045H4T2F_NB	TO247-4L_NL	yes	yes	yes

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