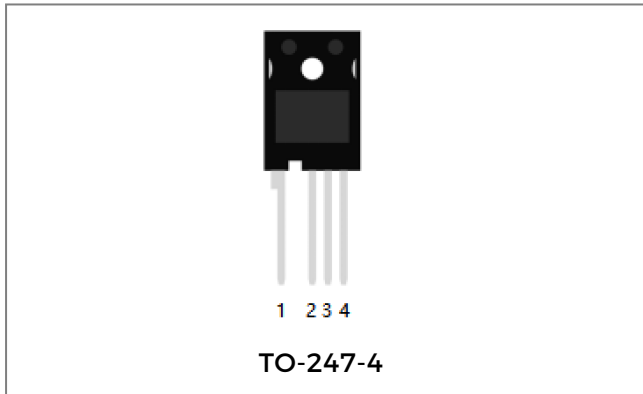


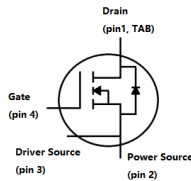
## S4M0040120K Silicon Carbide Power MOSFET



### Features

- Positive temperature characteristics, easy to parallel.
- Low on-resistance typ.  $R_{DS(on)} = 40 \text{ m}\Omega$ .
- Fast switching speed and low switching losses.
- Very fast and robust intrinsic body diode.
- Process of non-bright tin electroplatin.
- "-A" is an AEC-Q101 qualified device.

### Circuit Diagram



### Applications

- EV Fast Charging Modules
- EV On Board Chargers
- Solar Inverters
- Online UPS/Industrial UPS
- SMPS (Switch Mode Power Supplies)
- DC-DC Converters
- ESS (Energy Storage Systems)

### Maximum Ratings( $T_C = 25^\circ\text{C}$ unless otherwise specified)

Characteristics	Symbol	Conditions	Min.	Typ.	Max.	Units	Note
Drain - Source Voltage	$V_{DSmax}$	$V_{GS} = 0 \text{ V}, I_D = 100 \mu\text{A}$			1200	V	
Gate - Source Voltage (dynamic)	$V_{GSmax}$	AC ( $f > 1 \text{ Hz}$ )	-10		+22	V	
Gate - Source Voltage (static)	$V_{GSop}$	Static		-4 / +18		V	[1]
Continuous Drain Current	$I_D$	$V_{GS} = 18 \text{ V}, T_C = 25^\circ\text{C}$			57	A	
		$V_{GS} = 18 \text{ V}, T_C = 100^\circ\text{C}$			41	A	
Pulsed Drain Current	$I_{D(pulse)}$	Pulse width $t_p$ limited by $T_{jmax}$			147	A	
Power Dissipation	$P_D$	$T_C = 25^\circ\text{C}$			338	W	

[1] Recommended turn off gate voltage is -4 V. Recommended turn on gate voltage is 18 V. Do not use with VGSON < 12 V.

**Electrical Characteristics:**

Characteristics	Symbol	Conditions	Min.	Typ.	Max.	Units
Drain Source Breakdown Voltage	$V_{(BR)DSS}$	$V_{GS} = 0\text{ V}, I_D = 100\ \mu\text{A}$	1200			V
Gate Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 10.6\ \text{mA}$	2	2.8	4	V
		$V_{DS} = V_{GS}, I_D = 10.6\ \text{mA}, T_J = 175\ ^\circ\text{C}$		1.9		V
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = 1200\text{V}, V_{GS} = 0\ \text{V}$			100	$\mu\text{A}$
Gate Source Leakage Current	$I_{GSS}$	$V_{GS} = 18\ \text{V}, V_{DS} = 0\ \text{V}$			250	nA
Drain Source On-State Resistance	$R_{DS(on)}$	$V_{GS} = 18\ \text{V}, I_D = 28.6\ \text{A}$		40	52	m $\Omega$
		$V_{GS} = 18\ \text{V}, I_D = 28.6\ \text{A}, T_J = 175\ ^\circ\text{C}$		66		m $\Omega$
Transconductance	$g_{fs}$	$V_{DS} = 20\ \text{V}, I_{DS} = 28.6\ \text{A}$		14		S
		$V_{DS} = 20\ \text{V}, I_{DS} = 28.6\ \text{A}, T_J = 175\ ^\circ\text{C}$		13		S
Input Capacitance	$C_{ISS}$	$V_{GS} = 0\ \text{V}$		1337		pF
Output Capacitance	$C_{OSS}$	$V_{DS} = 1200\text{V}$		76		
Reverse Transfer Capacitance	$C_{RSS}$	$V_{AC} = 25\ \text{mV}$		1.5		
COSS Stored Energy	$E_{OSS}$	$f = 1\ \text{MHz}$		63		
Turn-On Switching Energy	$E_{ON}$	$V_{DS} = 800\ \text{V}, V_{GS} = -4 / 18\ \text{V}$		92		$\mu\text{J}$
Turn-Off Switching Energy	$E_{OFF}$	$I_D = 28.6\ \text{A}, R_{G(ext)} = 2.5\ \Omega, L = 99\ \mu\text{H}$		70		
Turn-On Delay Time	$t_{d(on)}$	$V_{DS} = 800\ \text{V}, V_{GS} = -4 / 18\ \text{V}$		7.6		ns
Rise Time	$t_r$	$I_D = 28.6\ \text{A}, R_{G(ext)} = 2.5\ \Omega$		9.0		
Turn-Off Delay Time	$t_{d(off)}$	Inductive Load Timing relative to		12.9		
Fall Time	$t_f$	$V_{DS}$ Per IEC60747-8-4 pg 83		6.4		
Internal Gate Resistance	$R_{G(int)}$	$f = 1\ \text{MHz}, AC = 25\ \text{mV}$		1.5		$\Omega$
Gate to Source Charge	$Q_{gs}$	$V_{DS} = 800\ \text{V}, V_{GS} = -4 / 18\ \text{V}$		14		nC
Gate to Drain Charge	$Q_{gd}$	$I_D = 28.6\ \text{A}$		10		
Total Gate Charge	$Q_g$	Per IEC60747-8-4 pg 21		48		

**Reverse Diode Characteristics (T<sub>A</sub> = 25 °C, unless otherwise specified)**

Characteristics	Symbol	Conditions	Typ.	Max.	Units
Diode Forward Voltage	V <sub>SD</sub>	V <sub>GS</sub> = -4 V, I <sub>SD</sub> = 14.3 A	3.9		V
	V <sub>SD</sub>	V <sub>GS</sub> = -4 V, I <sub>SD</sub> = 14.3 A, T <sub>J</sub> = 175 °C	3.4		V
Reverse Recovery Time	t <sub>rr</sub>	V <sub>GS</sub> = -4 V, I <sub>SD</sub> = 28.6 A, T <sub>J</sub> = 25 °C	14		ns
Reverse Recovery Charge	Q <sub>rr</sub>	V <sub>R</sub> = 800 V	207		nC
Peak Reverse Recovery Current	I <sub>mm</sub>	dif / dt = 2000 A / μs	17		A

**Thermal-Mechanical Specifications**

Characteristics	Symbol	Condition	Specification	Units
Junction Temperature	T <sub>J</sub>	-	-55 to +175	°C
Storage Temperature	T <sub>stg</sub>	-	-55 to +175	°C
Typical Thermal Resistance Junction to Case	R <sub>θJC</sub>		0.44	°C /W

**Ordering Information**

Device	Package	Shipping
S4M0040120K	TO-247-4	30 pcs/tube

**Marking Diagram**



Where XXXXX is YYWWL

- S4M = Device Type
- 0040 = RDS(on)
- 120 = Reverse Voltage (1200V)
- K = Package
- SSG = SSC
- YY = Year
- WW = Week
- L = Lot Number

Cautions: Molding resin  
Epoxy resin UL94V-0

**Ratings and Characteristics Curves**

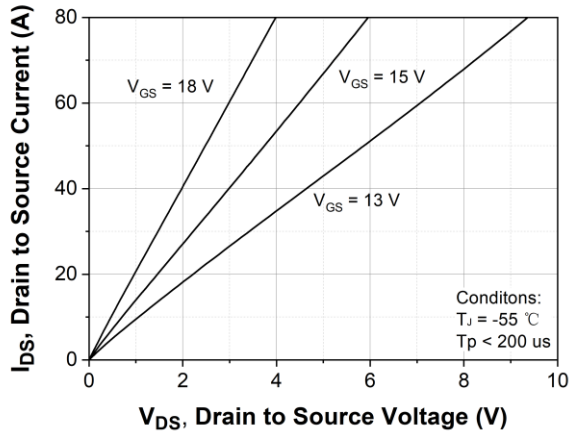


Figure 1. Output Characteristics  $T_J = -55\text{ }^\circ\text{C}$

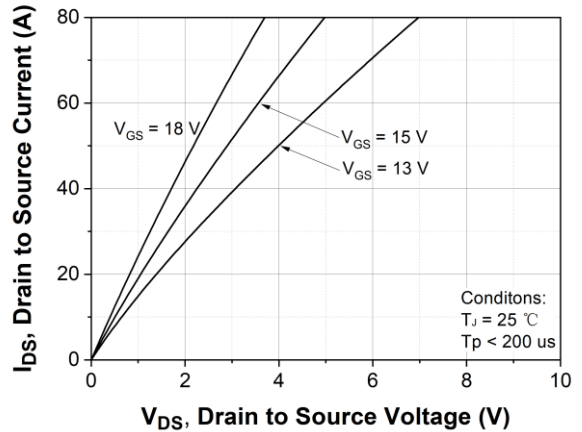


Figure 2. Output Characteristics  $T_J = 25\text{ }^\circ\text{C}$

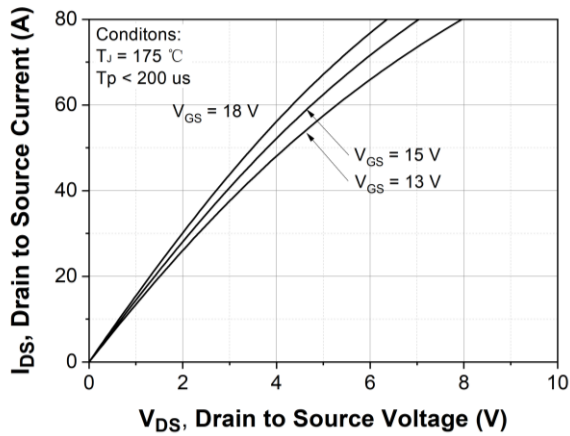


Figure 3. Output Characteristics  $T_J = 175\text{ }^\circ\text{C}$

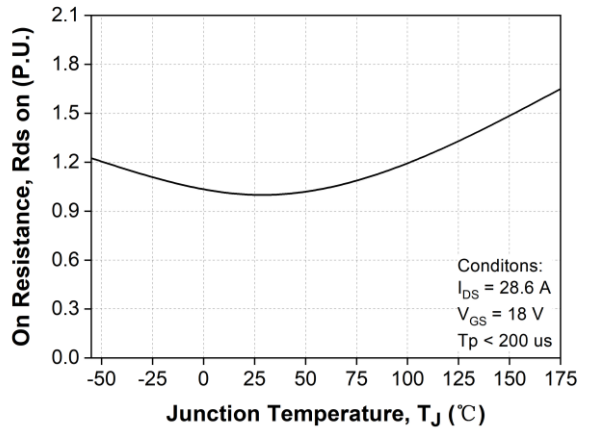


Figure 4. Normalized On-Resistance vs. Temperature

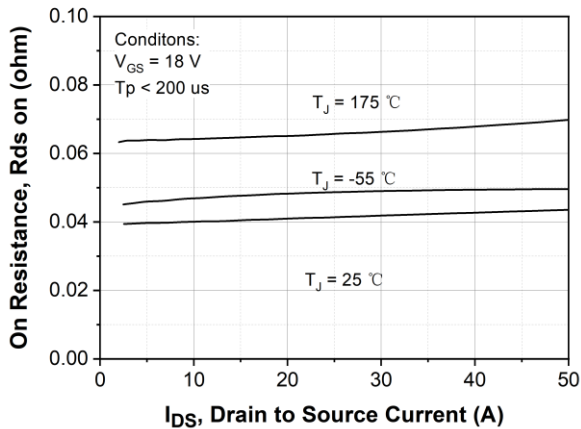


Figure 5. On-Resistance vs. Drain Current For Various Temperatures

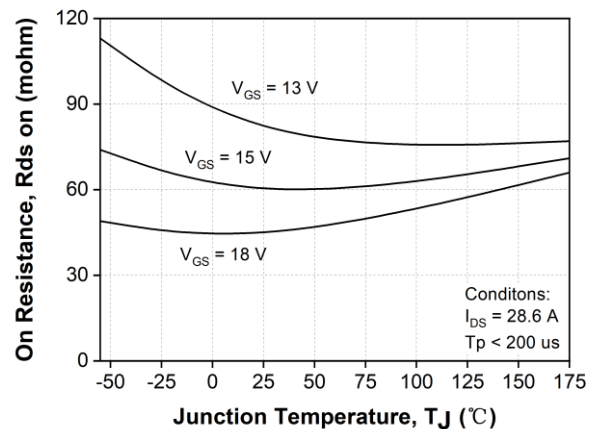


Figure 6. On-Resistance vs. Temperature For Various Gate Voltage

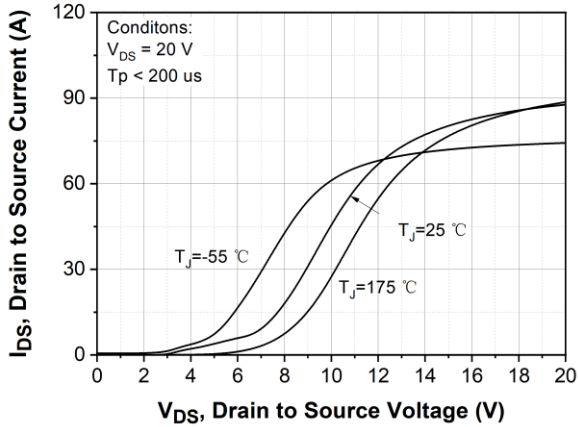


Figure 7. Transfer Characteristic for Various Junction Temperatures

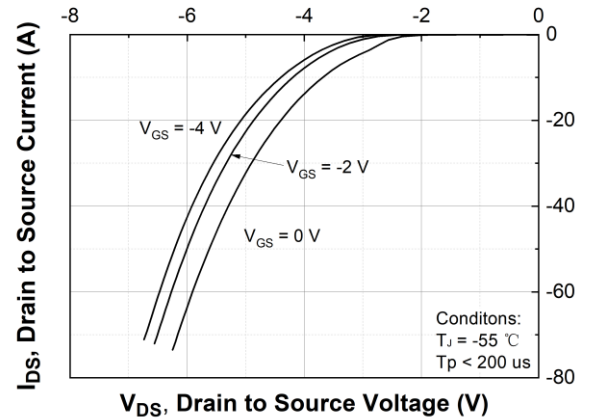


Figure 8. Body Diode Characteristic at  $T_J = -55^\circ\text{C}$

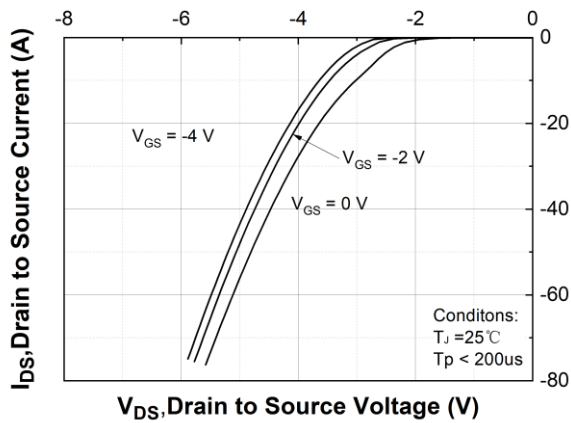


Figure 9. Body Diode Characteristic at  $T_J = 25^\circ\text{C}$

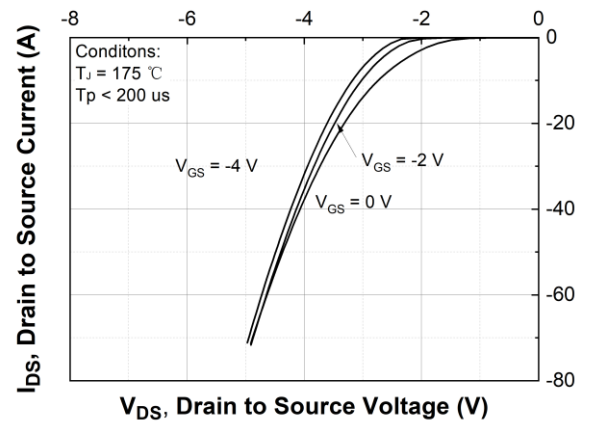


Figure 10. Body Diode Characteristic at  $T_J = 175^\circ\text{C}$

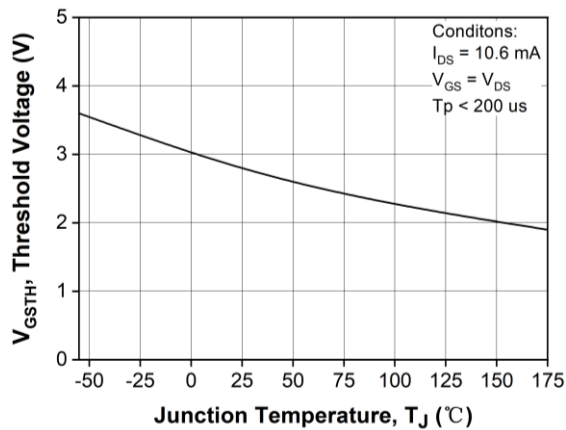


Figure 11. Threshold Voltage vs. Temperature

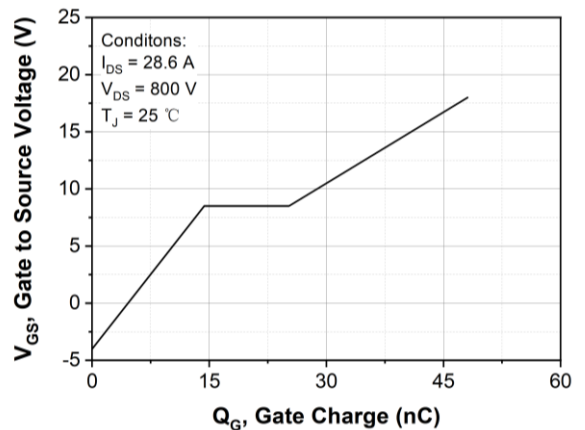


Figure 12. Gate Charge Characteristic

Technical Data  
Data Sheet N3207, Rev.-

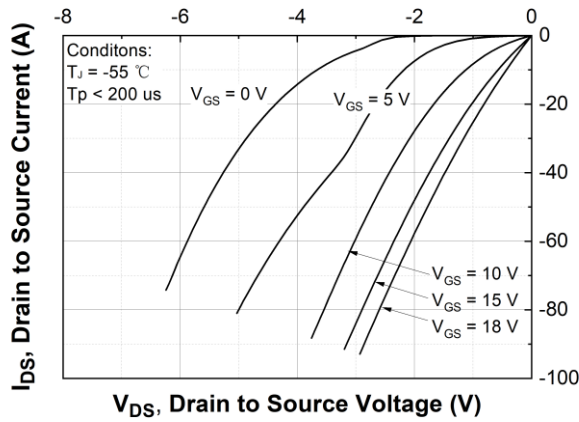


Figure 13. 3rd Quadrant Characteristic at  $T_j = -55$  °C

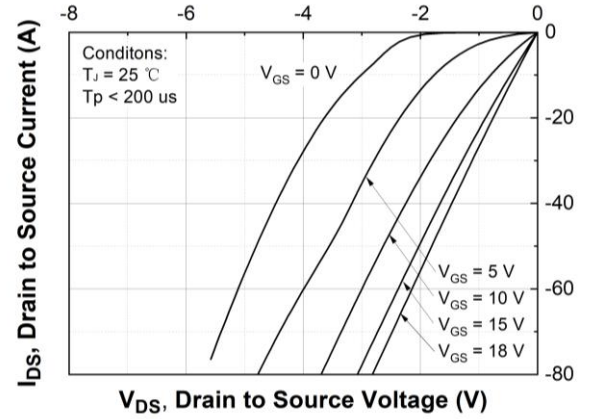


Figure 14. 3rd Quadrant Characteristic at  $T_j = 25$  °C

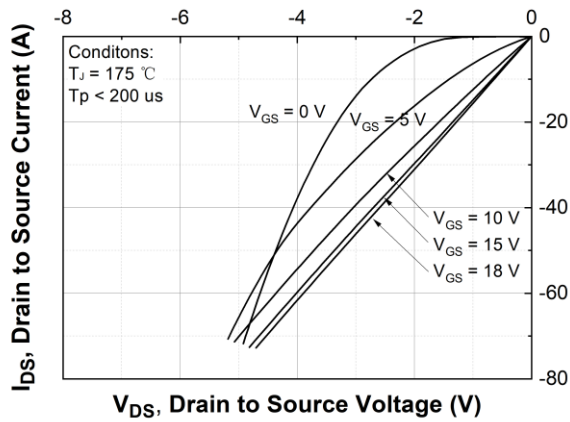


Figure 15. 3rd Quadrant Characteristic at  $T_j = 175$  °C

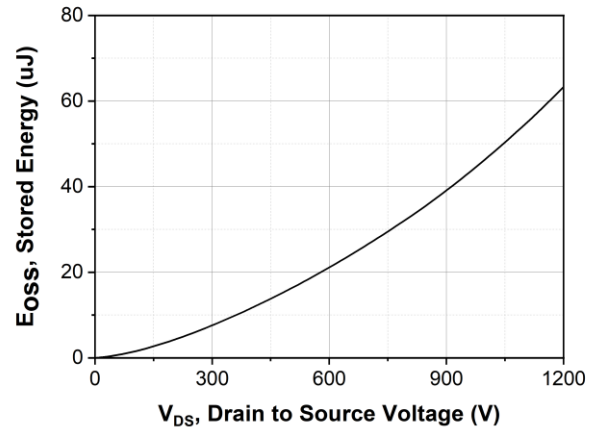


Figure 16. Output Capacitor Stored Energy

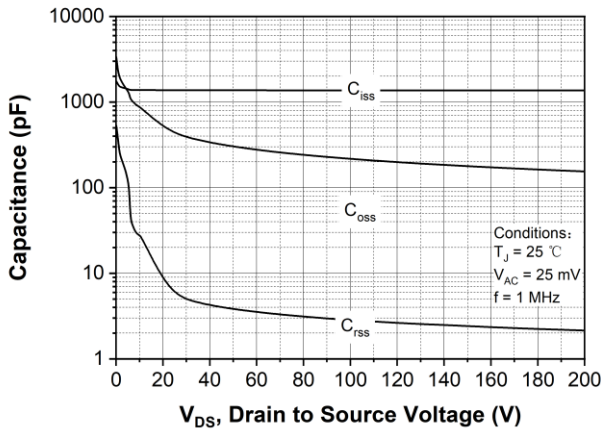


Figure 17. Capacitances vs. Drain-Source Voltage (0 - 200 V)

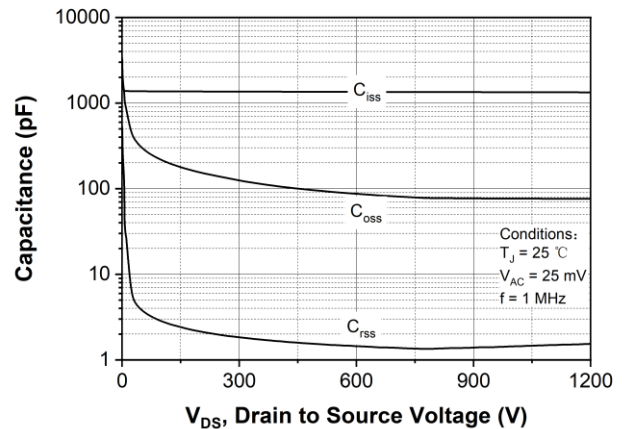


Figure 18. Capacitances vs. Drain-Source Voltage (0 - 1200V)

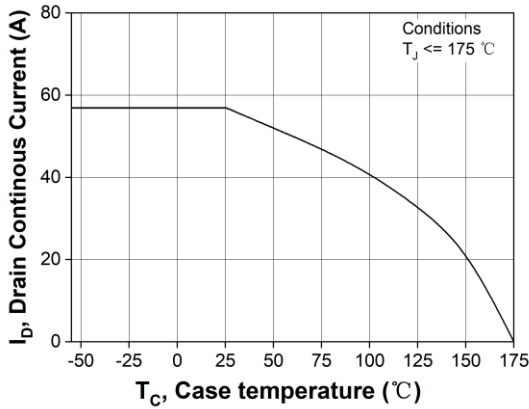


Figure 19. Continuous Drain Current Derating vs. Case Temperature

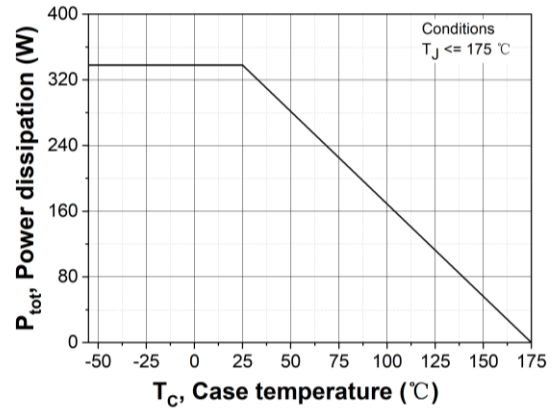


Figure 20. Maximum Power Dissipation Derating vs. Case Temperature

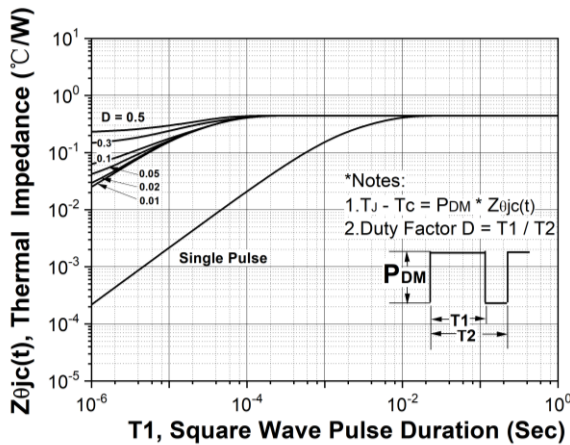


Figure 21. Transient Thermal Impedance (Junction - Case)

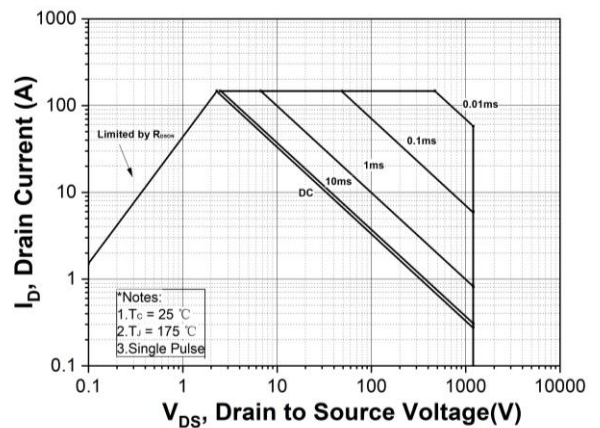


Figure 22. Safe Operating Area

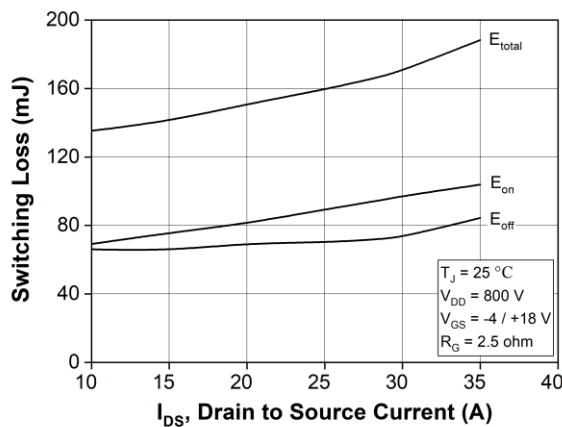


Figure 23. Clamped Inductive Switching Energy vs. Drain Current ( $V_{DD} = 800V$ )

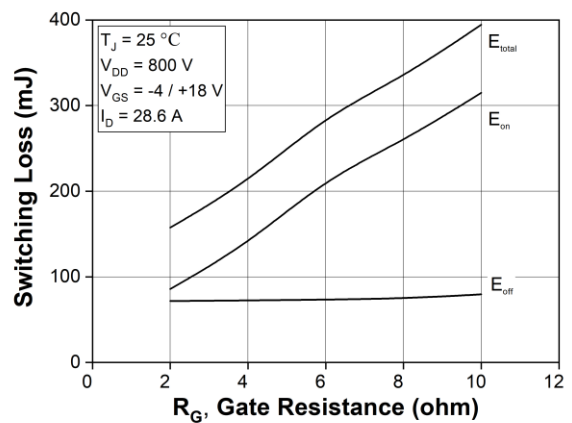


Figure 24. Clamped Inductive Switching Energy vs.  $R_{G(ext)}$

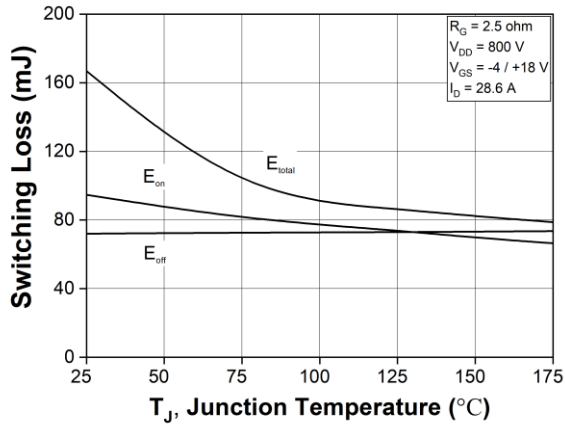


Figure 25. Clamped Inductive Switching Energy vs. Temperature

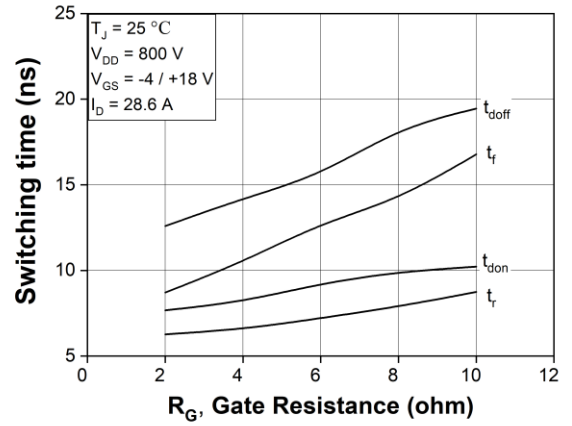
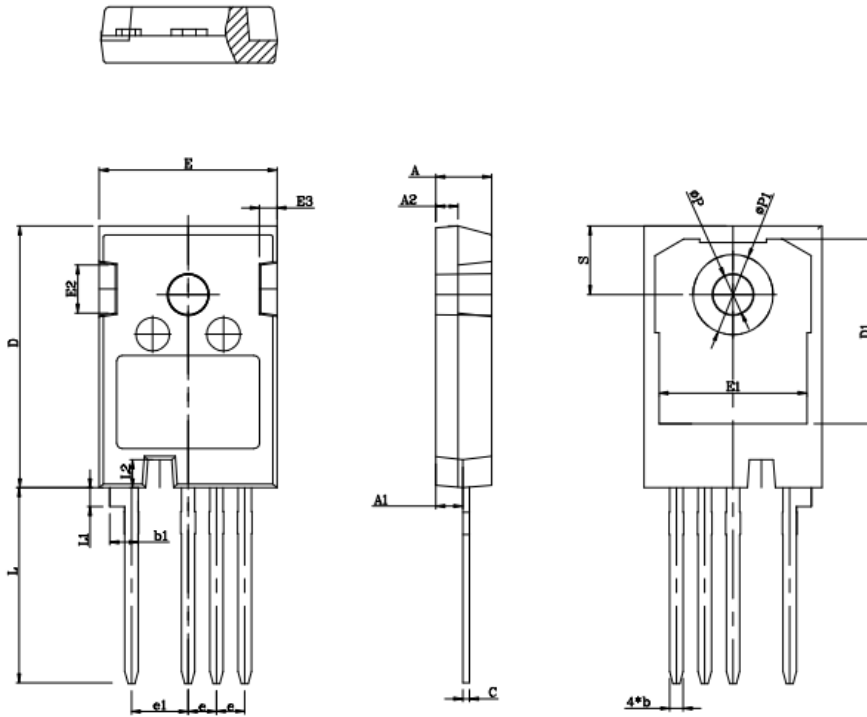


Figure 26. Switching Times vs. R<sub>G(ext)</sub>

**Mechanical Dimensions TO-247-4**



SYMBOL	mm		
	Min	Nom	Max
A	4.80	5.00	5.20
A1	2.23	2.41	2.59
A2	1.85	2.00	2.15
b	1.11	1.21	1.36
b1	2.35	2.55	2.75
c	0.51	0.61	0.75
D	23.30	23.45	23.60
D1	16.25	16.55	16.85
E	15.75	15.94	16.10
E1	13.00	13.26	13.43
E2	4.00	4.30	4.60
E3	1.15	1.45	1.75
e		2.54BSC	
e1		5.08BSC	
L	17.31	17.47	17.82
L1	1.50	1.70	1.90
ØP	3.51	3.60	3.65
ØP1	7.08	7.19	7.30
S		6.15BSC	

The outline from different package houses may have slight differences. So the outline above is just schematic. The dimensions are controlled per specifications.



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