

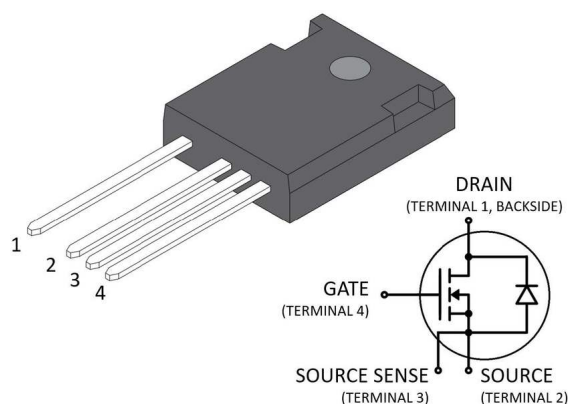
1200V, 17 mΩ N-Channel mSiC™ MOSFET

MSC017SMA120B4



Product Overview

1200V, 17 mΩ typical at 20 V_{GS}, 19 mΩ typical at 18 V_{GS}, Silicon Carbide (SiC) N-Channel MOSFET, TO-247 4-lead with a source sense.



Features

- Low capacitances and low gate charge
- Fast switching speed due to low internal gate resistance (ESR)
- Stable operation at high junction temperature, $T_{J(max)} = 175\text{ }^{\circ}\text{C}$
- Fast and reliable body diode
- Superior avalanche ruggedness
- RoHS compliant

Benefits

- High efficiency to enable lighter and more compact system
- Simple to drive and easy to parallel
- Improved thermal capabilities and lower switching losses
- Eliminates the need for external freewheeling diode
- Lower system cost of ownership

Applications

- Photovoltaic (PV) inverter, converter, and industrial motor drives
- Smart grid transmission and distribution
- Induction heating and welding
- Hybrid Electric Vehicle (HEV) powertrain and Electric Vehicle (EV) charger
- Power supply and distribution

1. Device Specifications

This section shows the specifications of this device.

1.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings of this device.

Table 1-1. Absolute Maximum Ratings

Symbol	Parameter	Ratings	Unit
V_{DSS}	Drain source voltage	1200	V
I_D	Continuous drain current at $T_C = 25\text{ }^{\circ}\text{C}$	119	A
	Continuous drain current at $T_C = 100\text{ }^{\circ}\text{C}$	84	
I_{DM}	Pulsed drain current ¹	280	
V_{GS}	Gate-source voltage	23 to -10	V
	Transient gate-source voltage	25 to -12	
P_D	Total power dissipation at $T_C = 25\text{ }^{\circ}\text{C}$	577	W
	Linear derating factor	3.84	W/ $^{\circ}\text{C}$

Note:

1. Repetitive rating: pulse width and case temperature are limited by the maximum junction temperature.

The following table shows the thermal and mechanical characteristics of this device.

Table 1-2. Thermal and Mechanical Characteristics

Symbol	Characteristic/Test Conditions	Min.	Typ.	Max.	Unit
$R_{\theta JC}$	Junction-to-case thermal resistance	—	0.20	0.26	$^{\circ}\text{C}/\text{W}$
T_J	Operating junction temperature	-55	—	175	$^{\circ}\text{C}$
T_{STG}	Storage temperature	-55	—	150	
T_L	Lead temperature for 10 seconds	—	—	300	$^{\circ}\text{C}$
—	Mounting torque, 6-32 or M3 screw	—	—	10	lbf.in
		—	—	1.1	N.m
W_t	Package weight	—	0.22	—	oz
		—	6.2	—	g

ESD practices should comply with JESD-625.

1.2 Electrical Performance

The following table shows the static characteristics of this device. $T_J = 25\text{ }^{\circ}\text{C}$ unless otherwise specified.

Table 1-3. Static Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{V}$, $I_D = 100\text{ }\mu\text{A}$	1200	—	—	V
$R_{DS(on)}$	Drain-source on resistance ¹	$V_{GS} = 20\text{V}$, $I_D = 40\text{A}$	—	17	22	$\text{m}\Omega$
		$V_{GS} = 18\text{V}$, $I_D = 40\text{A}$	—	19	—	
$V_{GS(th)}$	Gate-source threshold voltage	$V_{GS} = V_{DS}$, $I_D = 4.5\text{ mA}$	1.9	3	—	V
I_{DSS}	Zero gate voltage drain current	$V_{DS} = 1200\text{V}$, $V_{GS} = 0\text{V}$	—	0.3	40	μA
		$V_{DS} = 1200\text{V}$, $V_{GS} = 0\text{V}$, $T_J = 175\text{ }^{\circ}\text{C}$	—	3.5	—	
I_{GSS}	Gate-source leakage current	$V_{GS} = 20\text{V}/-10\text{V}$	—	—	± 100	nA

Note:

1. Pulse test: pulse width < 380 μ s, duty cycle < 2%.

The following table shows the dynamic characteristics of this device. $T_J = 25^\circ\text{C}$ unless otherwise specified. The dynamic characteristics are characterized, not 100% tested, at the recommended operating $V_{GS} = 20\text{V}/-5\text{V}$.

Table 1-4. Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{GS} = 0\text{V}$	—	4960	—	pF
C_{rss}	Reverse transfer capacitance	$V_{DD} = 1000\text{V}$	—	18	—	
C_{oss}	Output capacitance	$V_{AC} = 25\text{ mV}$ $f = 200\text{ KHz}$	—	263	—	
Q_g	Total gate charge	$V_{GS} = -5\text{V}/20\text{V}$	—	249	—	nC
Q_{gs}	Gate-source charge	$V_{DD} = 800\text{V}$	—	63	—	
Q_{gd}	Gate-drain charge	$I_D = 40\text{A}$	—	32	—	
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 800\text{V}$	—	29	—	ns
t_f	Voltage rise time	$V_{GS} = -5\text{V}/20\text{V}$	—	18	—	
$t_{d(off)}$	Turn-off delay time	$I_D = 50\text{A}$	—	51	—	
t_r	Voltage fall time	$R_{g(ext)} = 4\Omega$	—	13	—	
E_{on}	Turn-on switching energy	Freewheeling diode = MSC017SMA120B4 ($V_{GS} = -5\text{V}$); reference Figure 1-18	—	684	—	μ J
E_{off}	Turn-off switching energy		—	195	—	
ESR	Gate equivalent series resistance	$f = 1\text{ MHz}$, 25 mV, drain short	—	0.71	—	Ω
SCWT	Short circuit withstand time	$V_{DS} = 960\text{V}$, $V_{GS} = 20\text{V}$	—	3	—	μ s
E_{AS}	Avalanche energy, single pulse	$I_D = 40\text{A}$	—	3500	—	mJ

The following table shows the body diode characteristics of this device. $T_J = 25^\circ\text{C}$ unless otherwise specified.

Table 1-5. Body Diode Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
V_{SD}	Diode forward voltage	$I_{SD} = 40\text{A}$, $V_{GS} = 0\text{V}$	—	3.5	—	V
		$I_{SD} = 40\text{A}$, $V_{GS} = -5\text{V}$	—	3.9	—	
t_{rr}	Reverse recovery time	$I_{SD} = 50\text{A}$, $V_{GS} = -5\text{V}$, Drive $R_g = 4\Omega$, $V_{DD} = 800\text{V}$, $dI/dt = -8000\text{ A}/\mu\text{s}$	—	17	—	ns
Q_{rr}	Reverse recovery charge		—	678	—	nC
I_{RRM}	Reverse recovery current		—	64	—	A

1.3 Typical Performance Curves

Data for performance curves are characterized, not 100% tested.

Figure 1-1. Drain Current vs. V_{DS} at T_J

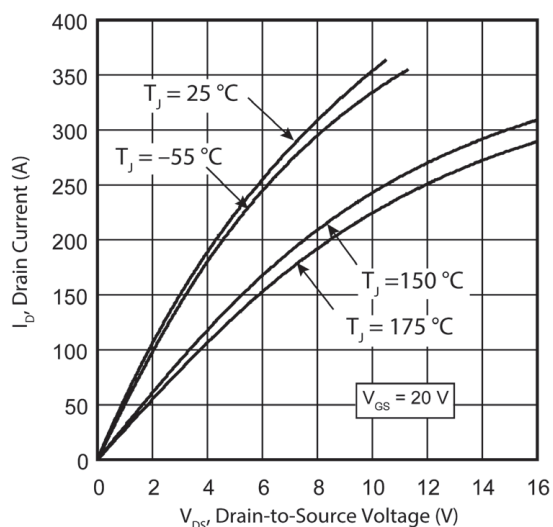


Figure 1-2. Drain Current vs. V_{DS} at V_{GS}

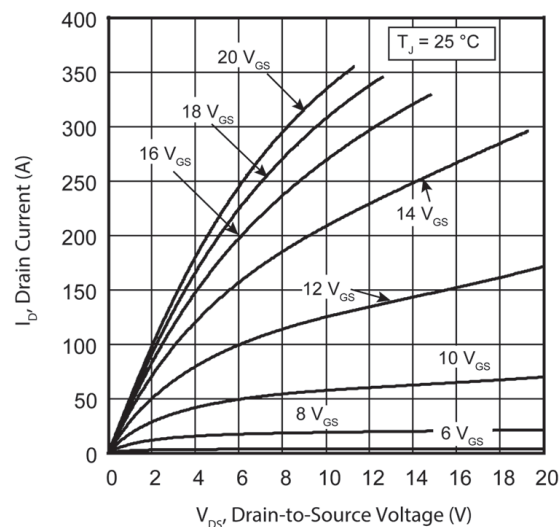


Figure 1-3. Drain Current vs. V_{DS} at V_{GS}

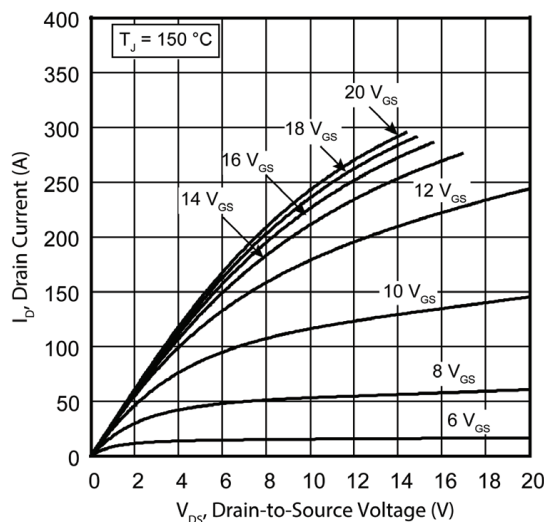


Figure 1-4. Drain Current vs. V_{DS} at V_{GS}

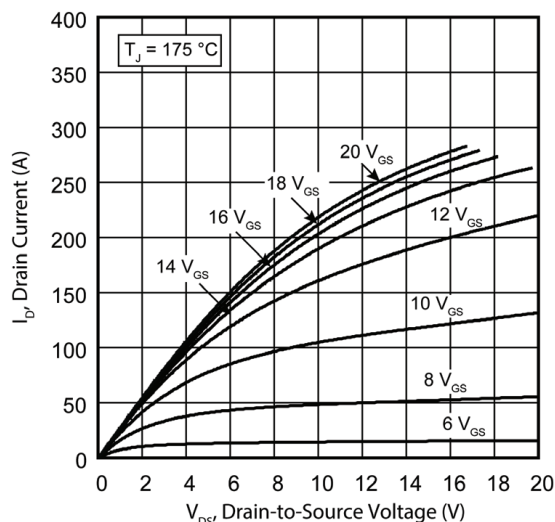


Figure 1-5. $R_{DS(on)}$ vs. Junction Temperature

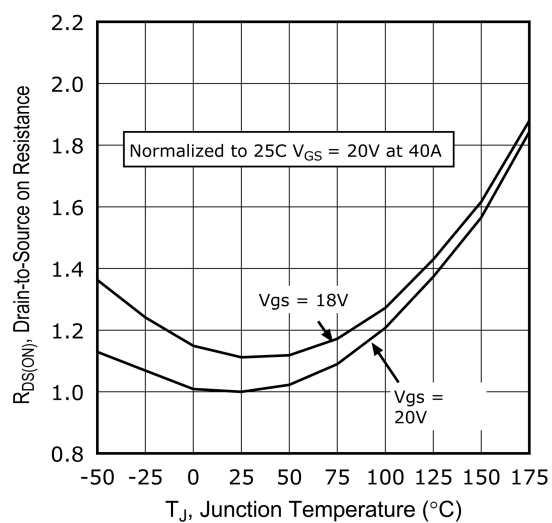


Figure 1-6. Gate Charge Characteristics

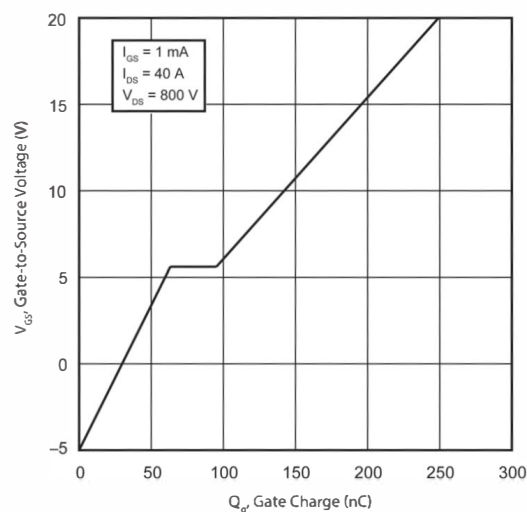


Figure 1-7. Capacitance vs. Drain-to-Source Voltage

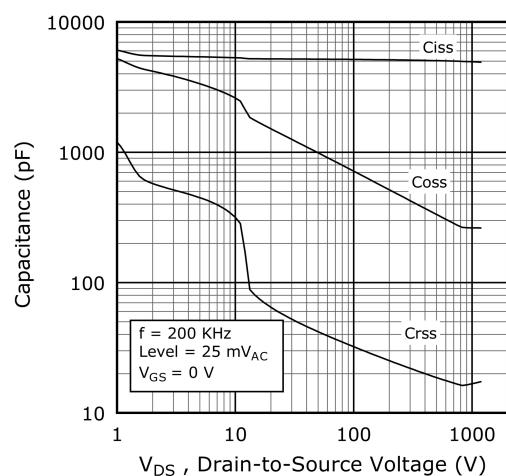


Figure 1-8. Output Charge vs. Drain-to-Source Voltage

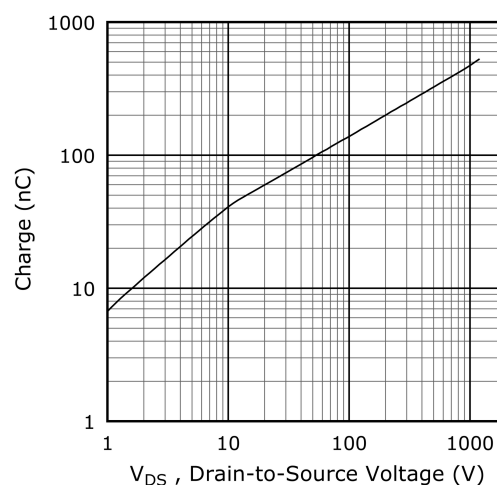


Figure 1-9. I_D vs. V_{DS} 3rd Quadrant Conduction

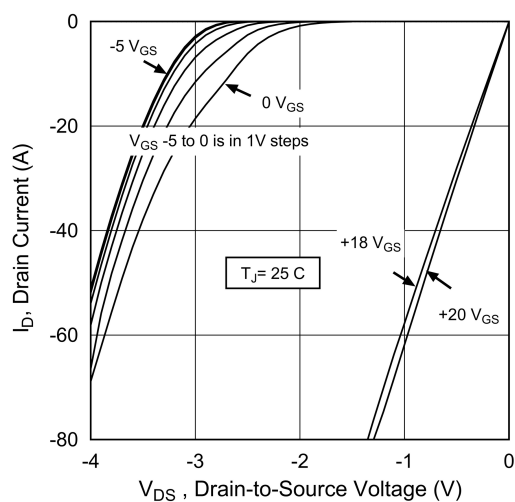


Figure 1-10. I_D vs. V_{DS} 3rd Quadrant Conduction

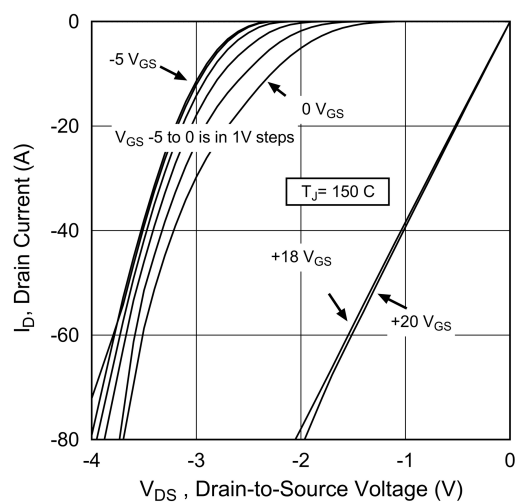


Figure 1-11. Switching Energy E_{on} vs. V_{DS} & I_D

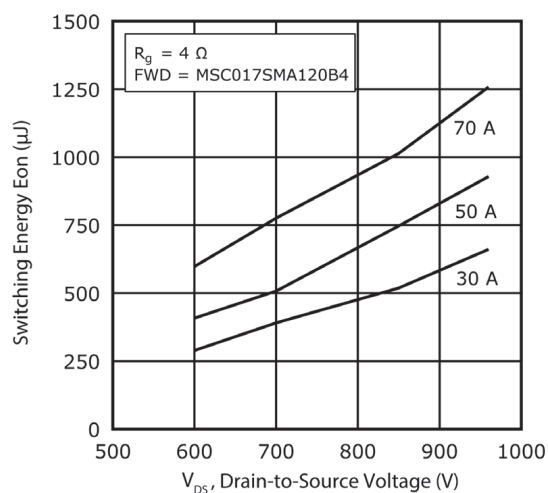


Figure 1-12. Switching Energy E_{off} vs. V_{DS} & I_D

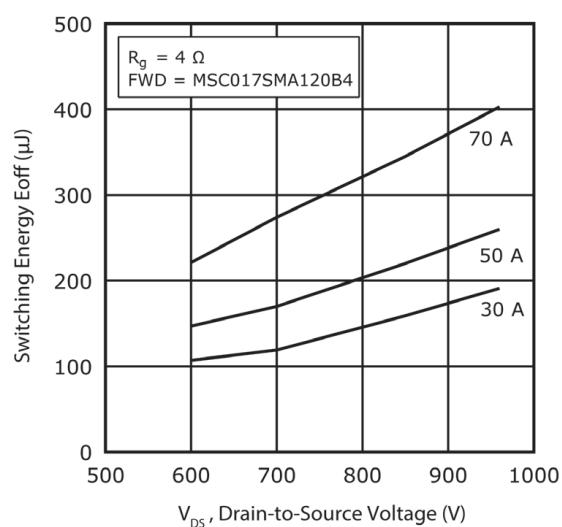


Figure 1-13. Switching Energy vs. R_g

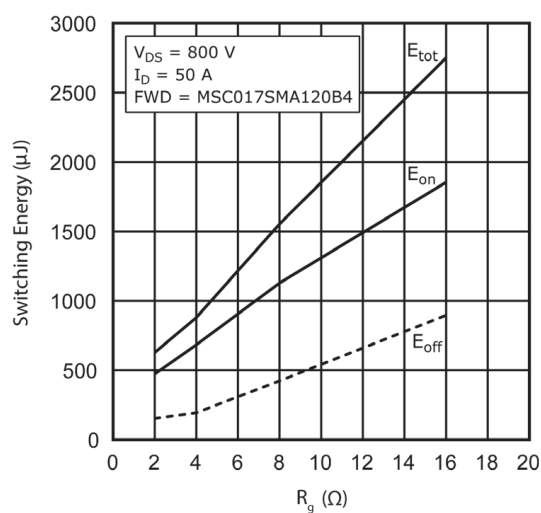


Figure 1-14. Switching Energy vs. Junction Temperature

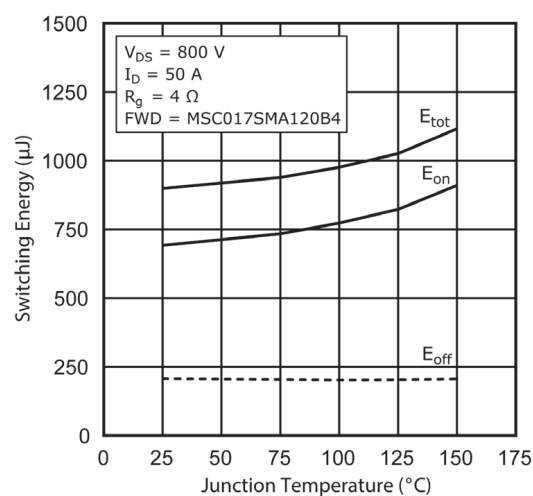


Figure 1-15. Threshold Voltage vs. Junction Temperature

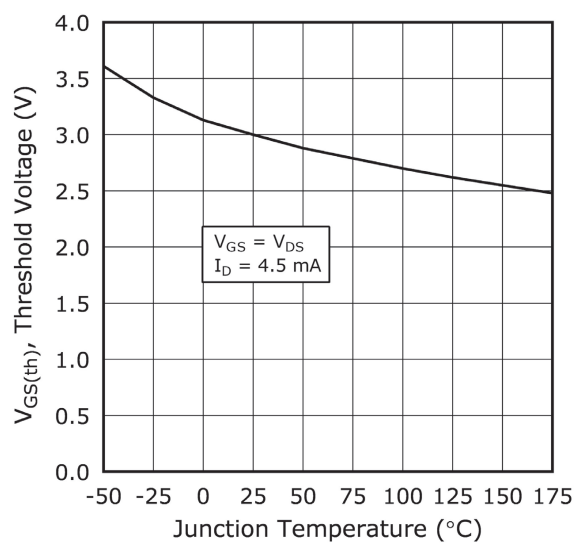


Figure 1-16. Forward Safe Operating Area

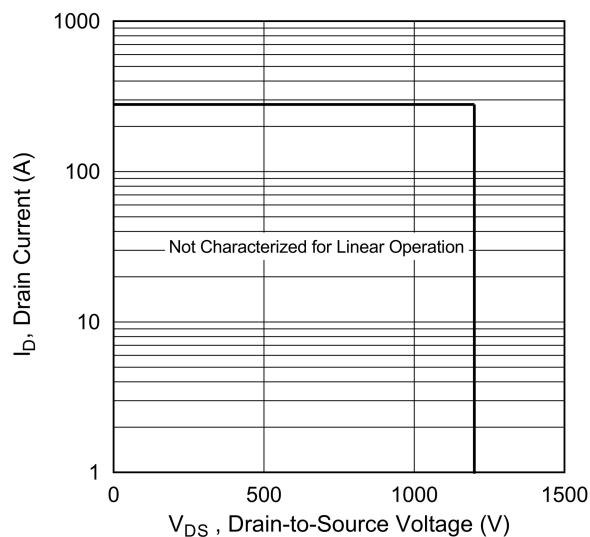
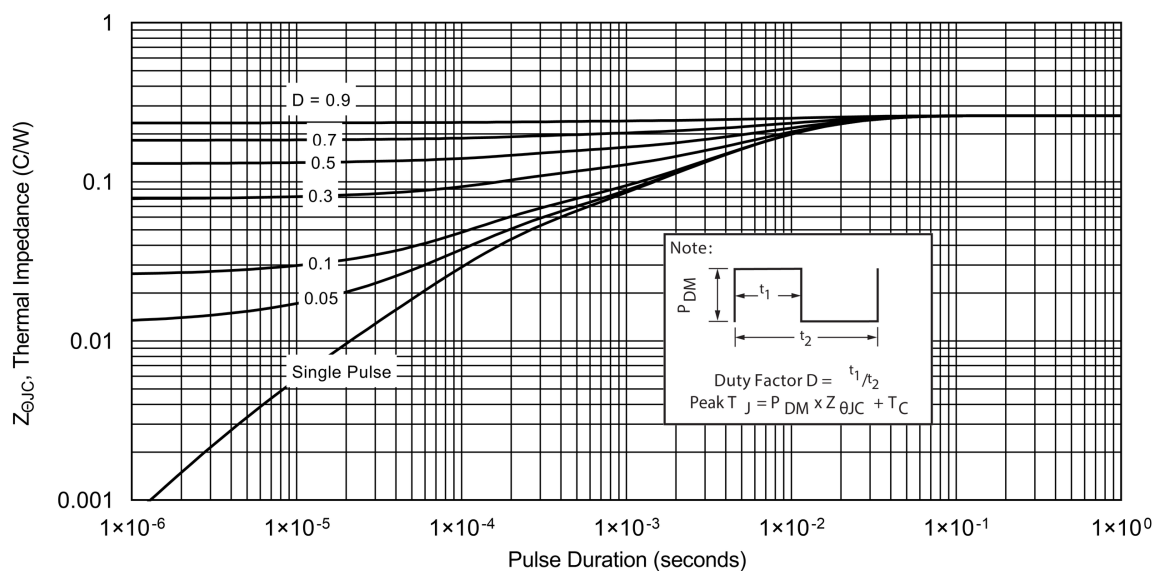
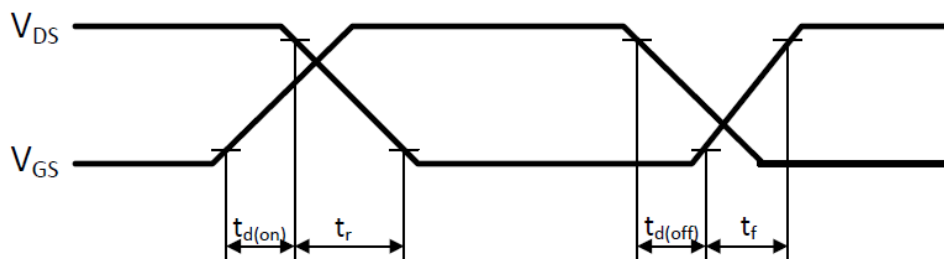


Figure 1-17. Maximum Transient Thermal Impedance



The following figure shows the switching waveform diagram of this device.

Figure 1-18. Switching Waveform



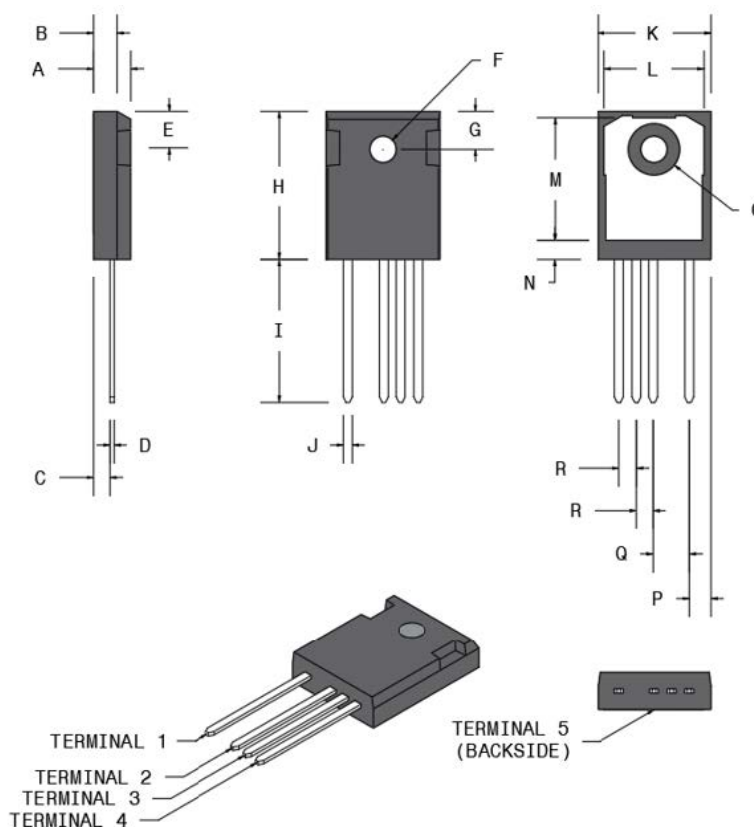
2. Package Specification

This section shows the package specification of this device.

2.1 Package Outline Drawing

The following figure illustrates the TO-247-4L package outline of this device.

Figure 2-1. Package Outline Drawing



The following table shows the TO-247-4L dimensions and should be used in conjunction with the package outline drawing.

Table 2-1. TO-247-4L Dimensions

Symbol	Min. (mm)	Max. (mm)	Min. (in.)	Max. (in.)
A	4.90	5.17	0.193	0.204
B	1.85	2.11	0.073	0.083
C	2.25	2.51	0.089	0.099
D	0.55	0.68	0.022	0.027
E	5.49	5.74	0.216	0.226
F	3.56	3.66	0.140	0.144
G	6.15 BSC		0.242 BSC	
H	20.83	21.08	0.820	0.830
I	19.81	20.32	0.780	0.800
J	1.07	1.33	0.042	0.052
K	15.77	16.03	0.621	0.631

.....continued

Symbol	Min. (mm)	Max. (mm)	Min. (in.)	Max. (in.)
L	13.89	14.15	0.547	0.557
M	16.25	16.85	0.640	0.663
N	2.00	2.75	0.079	0.108
O	7.10	7.50	0.280	0.295
P	2.87 BSC		0.113 BSC	
Q	5.08 BSC		0.200 BSC	
R	2.54 BSC		0.100 BSC	
Terminal 1	Drain			
Terminal 2	Source			
Terminal 3	Source sense			
Terminal 4	Gate			
Terminal 5	Drain			

3. Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

Table 3-1. Revision History

Revision	Date	Description
A	09/2023	The following changes are made in this revision of the document: • Document migrated from Microsemi template to Microchip template; Assigned Microchip literature number DS-00005089A, which replaces the previous Microsemi literature number 050-7777. • Added Figure 1-8. • Updated Figure 1-9, Figure 1-10 and Figure 1-15.
Initial release (Microsemi Revision A and B)	09/2020–11/2020	Initial releases.

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