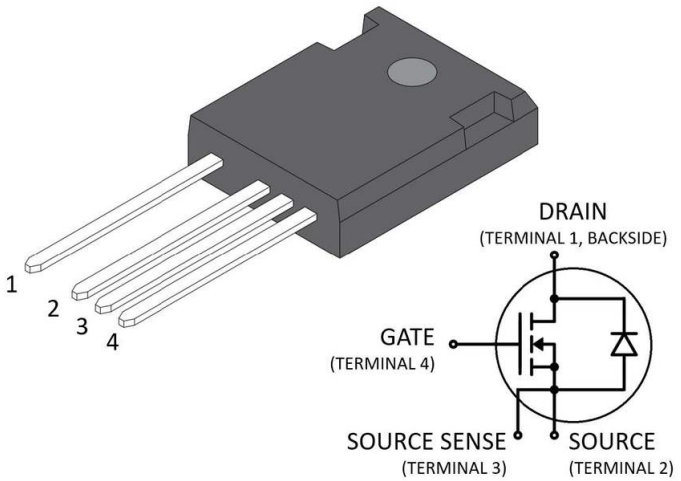
1200V, 80 mΩ N-Channel mSiC™ MOSFET

MSC080SMA120B4

Product Overview

1200V, 80 mΩ typical at 20 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 °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

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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 °C	40	A
	Continuous drain current at T_C = 100 °C	28	
I_{DM}	Pulsed drain current[1]	90	
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 °C	231	W
	Linear derating factor	1.54	W/°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	—	0.50	0.65	°C/W
T_J	Operating junction temperature	–55	—	175	°C
T_{STG}	Storage temperature	–55	—	150	°C
T_L	Lead temperature for 10 seconds	—	—	300	°C
—	Mounting torque, 6-32 or M3 screw	—	—	10	lbf.in
		—	—	1.1	N.m
Wt	Package weight	—	0.22	—	oz
		—	6.2	—	g

ESD practices should comply with JESD-625.

1.2 Electrical Performance

The following table lists the static characteristics of this device. T_J = 25 °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} = 0V, I_D = 100 µA	1200	—	—	V
$R_{DS(on)}$	Drain-source on resistance[1]	V_{GS} = 20V, I_D = 15A	—	80	100	mΩ
$V_{GS(th)}$	Gate-source threshold voltage	V_{GS} = V_{DS}, I_D = 1 mA	1.9	3.0	4.5	V
I_{DSS}	Zero gate voltage drain current	V_{DS} = 1200V, V_{GS} = 0V	—	0.2	100	µA
		V_{DS} = 1200V, V_{GS} = 0V, T_J = 175 °C	—	2	—	
I_{GSS}	Gate-source leakage current	V_{GS} = 20V/–10V	—	—	±100	nA

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Note:

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

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

Table 1-4. Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{GS} = 0V V_{DD} = 1000V V_{AC} = 25 mV f = 200 kHz	—	1100	—	pF
C_{rss}	Reverse transfer capacitance		—	6.2	—	
C_{oss}	Output capacitance		—	91	—	
Q_g	Total gate charge	V_{GS} = –5V/20V V_{DD} = 800V I_D = 15A	—	64	—	nC
Q_{gs}	Gate-source charge		—	12	—	
Q_{gd}	Gate-drain charge		—	19	—	
$t_{d(on)}$	Turn-on delay time	V_{DD} = 850V V_{GS} = –5V/20V I_D = 20A $R_{g(ext)}$ = 8Ω Freewheeling diode = MSC080SMA120B4 (V_{GS} = –5V); reference Figure 1-17	—	13	—	ns
t_r	Voltage rise time		—	11	—	
$t_{d(off)}$	Turn-off delay time		—	22	—	
t_f	Voltage fall time		—	12	—	
E_{on}	Turn-on switching energy		—	469	—	µJ
E_{off}	Turn-off switching energy		—	47	—	
ESR	Gate equivalent series resistance	f = 1 MHz, 25 mV, drain short	—	1.9	—	Ω
SWCT	Short circuit withstand time	V_{DS} = 960V, V_{GS} = 20V	—	3	—	µs
E_{AS}	Avalanche energy, single pulse	V_{DS} = 150V, I_D = 15A	—	100	—	mJ

The following table shows the body diode characteristics of this device. T_J = 25 °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} = 15A, V_{GS} = 0V	—	3.7	—	V
		I_{SD} = 15A, V_{GS} = –5V	—	3.9	—	
t_{rr}	Reverse recovery time	I_{SD} = 20A, V_{DD} = 850V, V_{GS} = –5V, dI/dt = –1000 A/µs, Drive Rg = 8Ω	—	12	—	ns
Q_{rr}	Reverse recovery charge		—	416	—	nC
I_{RRM}	Reverse recovery current		—	59	—	A

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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

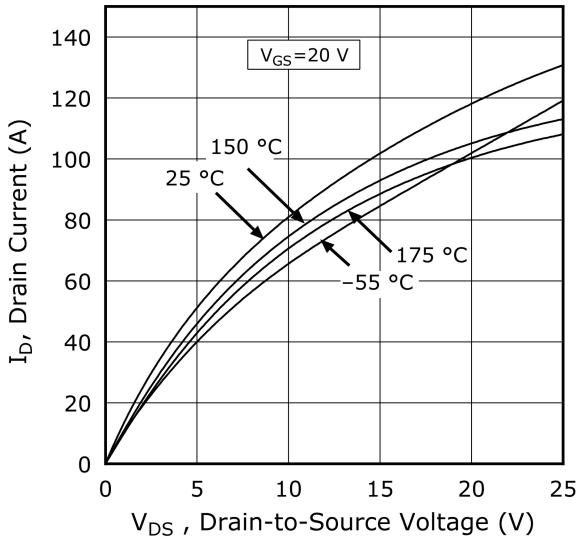

Figure 1-2. Drain Current vs. V_{DS} at V_{GS}

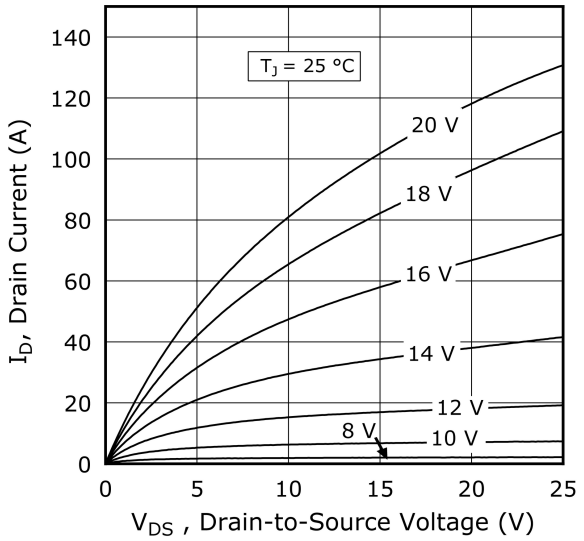

Figure 1-3. Drain Current vs. V_{DS} at V_{GS}

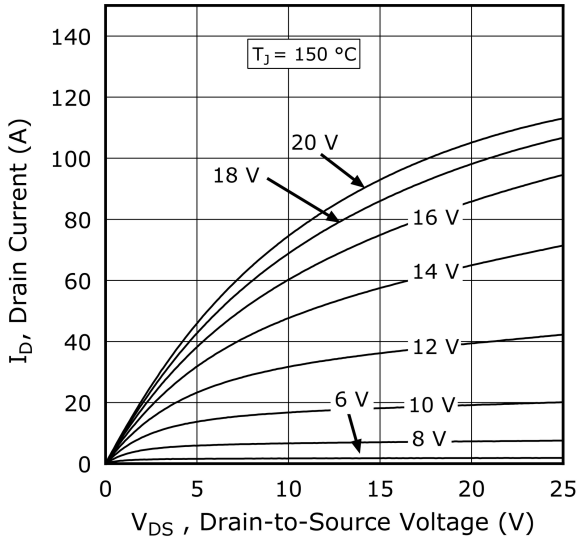

Figure 1-4. Drain Current vs. V_{DS} at V_{GS}

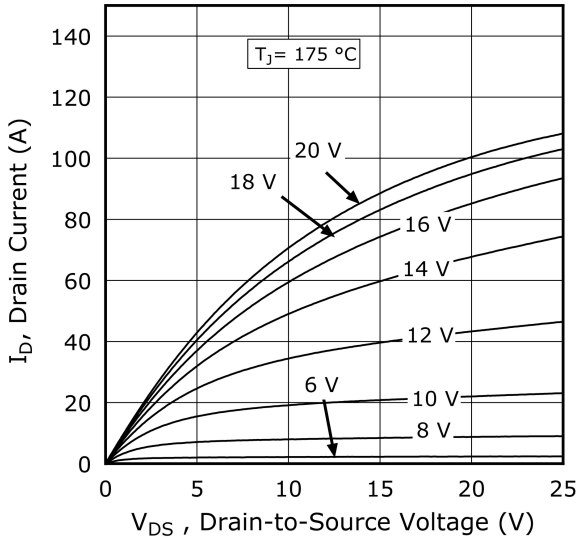

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Figure 1-5. $R_{DS(on)}$ vs. Junction Temperature

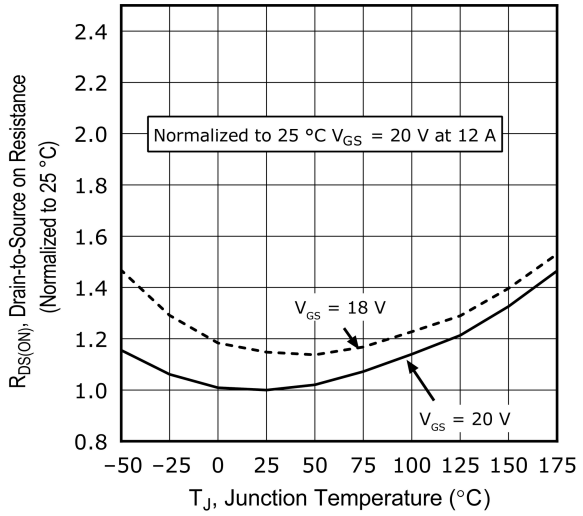

Figure 1-6. Gate Charge Characteristics

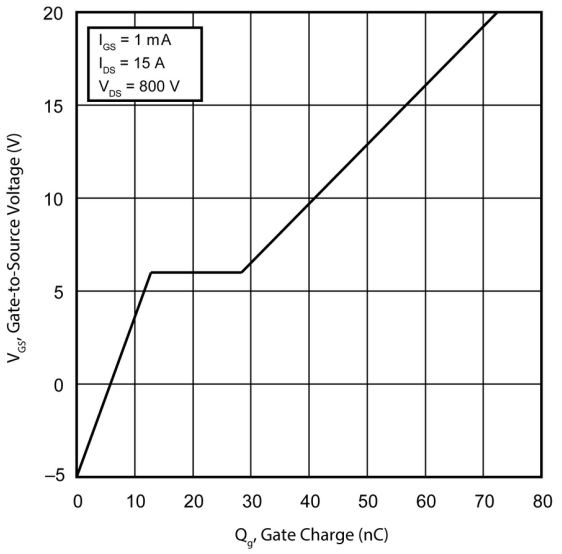

Figure 1-7. Capacitance vs. Drain-to-Source Voltage

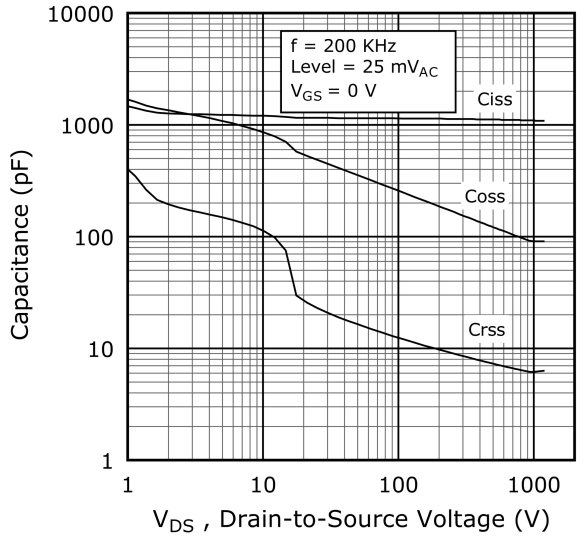

Figure 1-8. I_D vs. V_{DS} 3rd Quadrant Conduction

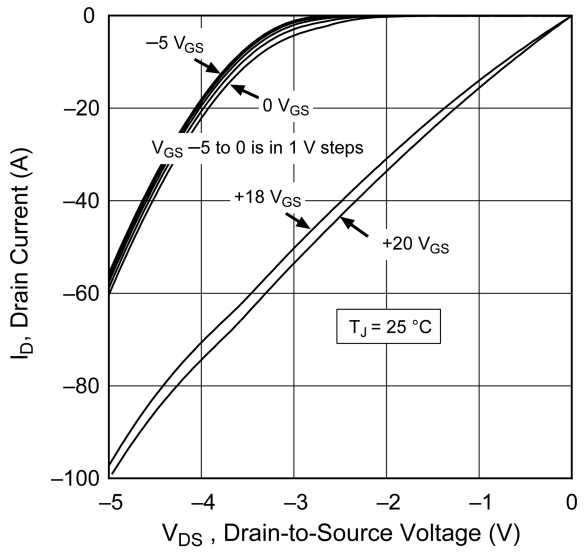

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Figure 1-9. I_D vs. V_{DS} 3rd Quadrant Conduction

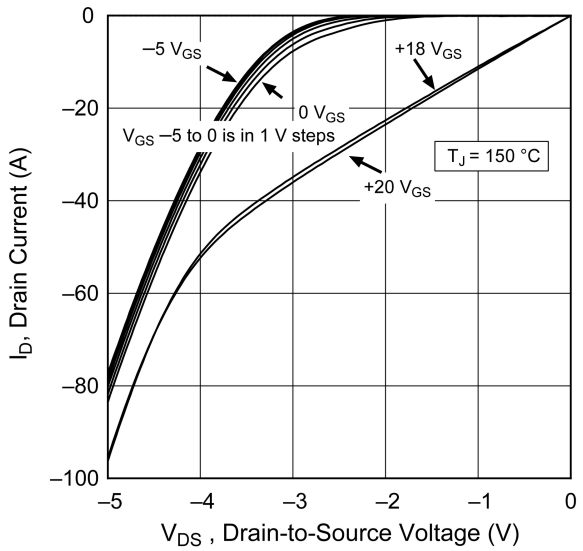

Figure 1-10. Switching Energy E_{on} vs. V_{DS} & I_D

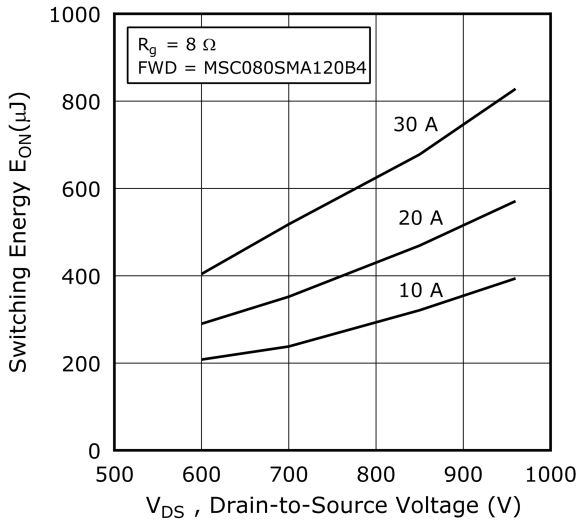

Figure 1-11. Switching Energy E_{off} vs. V_{DS} & I_D

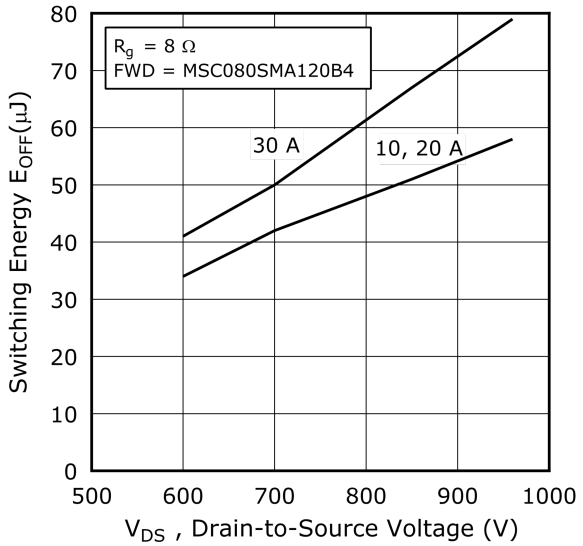

Figure 1-12. Switching Energy vs. R_g

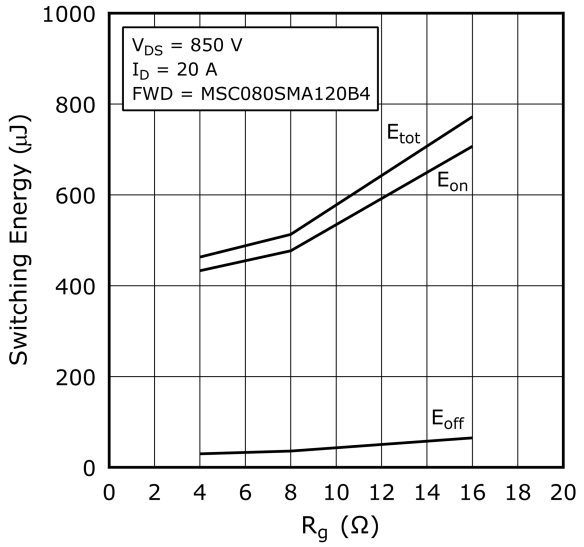

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Figure 1-13. Switching Energy vs. Junction Temperature

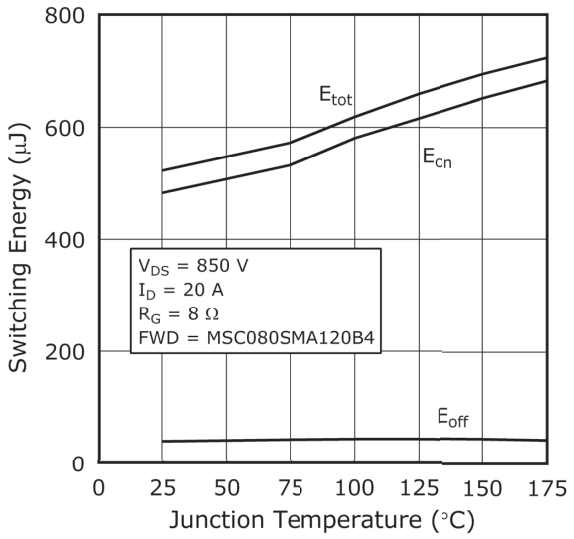

Figure 1-14. Threshold Voltage vs. Junction Temperature

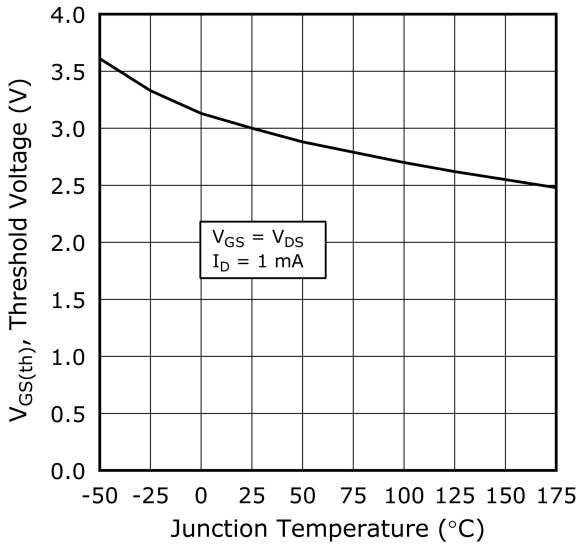

Figure 1-15. Forward Safe Operating Area

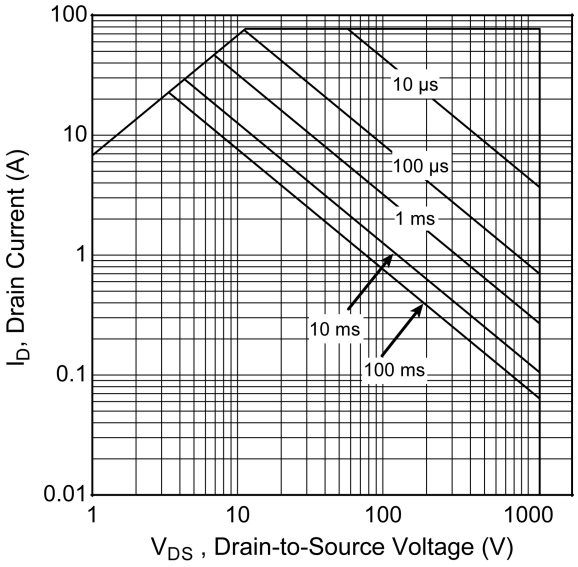

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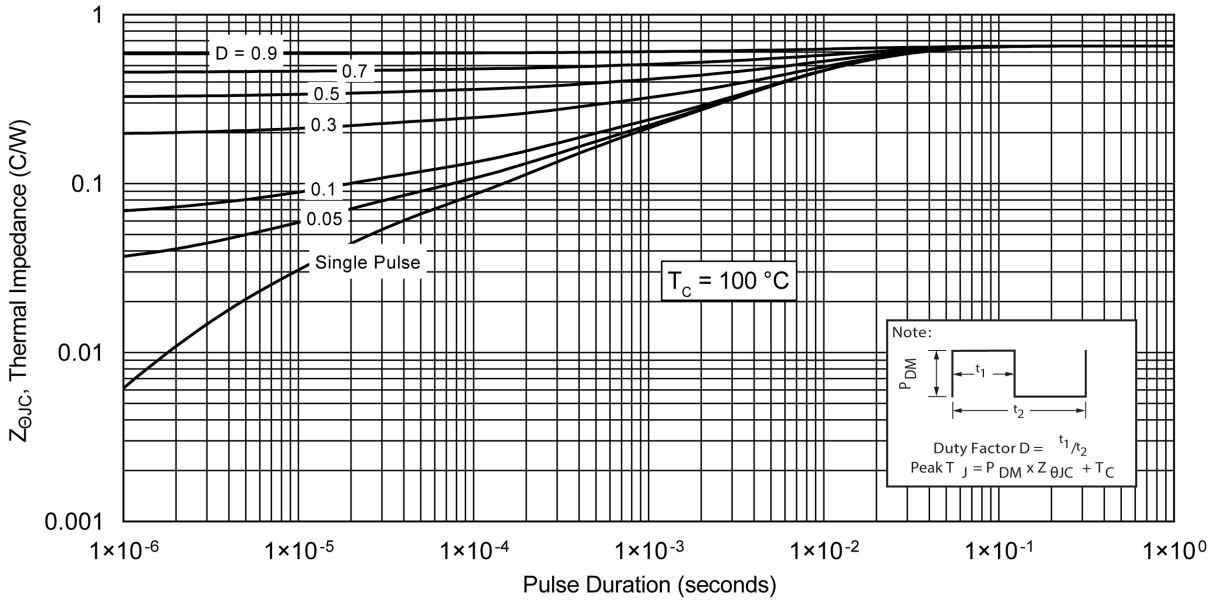
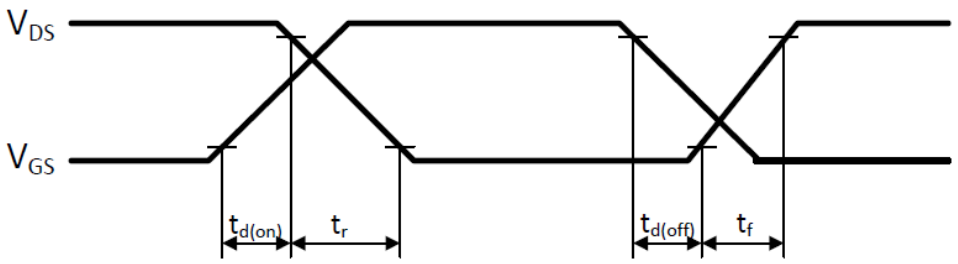
Figure 1-16. Maximum Transient Thermal Impedance



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

Figure 1-17. Switching Waveform



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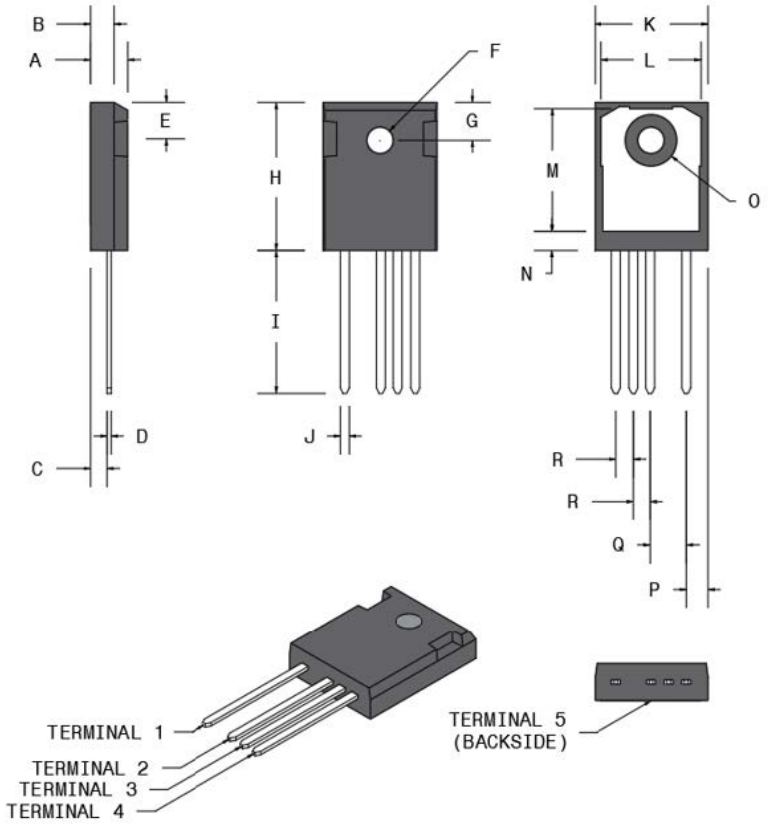
2. Package Specification

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 must 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

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.....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			

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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
C	08/2023	The following changes are made in this revision of the document: • Updated typical value for zero gate voltage drain current in Table 1-3. • Updated typical values for diode forward voltage in Table 1-5. • Updated Figure 1-7 and Figure 1-13.
B	12/2022	• Updated values in Table 1-4. • Updated values in Table 1-3. • Updated Figure 1-14.
A	08/2022	Document migrated from Microsemi template to Microchip template; Assigned Microchip literature number DS-00004673A, which replaces the previous Microsemi literature number 050-7755.
Initial release (Microsemi Revision A)	09/2019	Document created.

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