

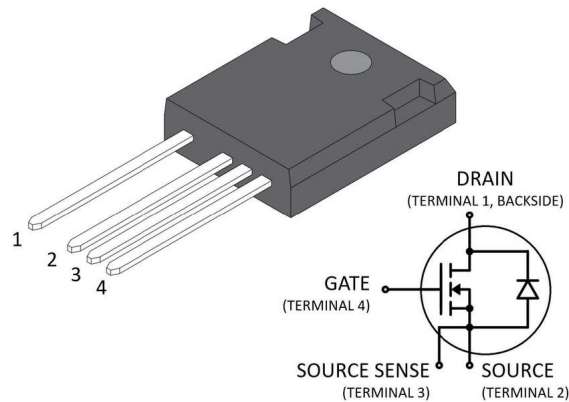
# 700V, 15 mΩ N-Channel mSiC™ MOSFET

## MSC015SMA070B4



## Product Overview

700V, 15 mΩ typical at 20 V<sub>GS</sub>, 18 mΩ typical at 18 V<sub>GS</sub>, 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,  $T_{J(max)} = 175\text{ °C}$
- 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 <sub>DSS</sub>	Drain source voltage	700	V
I <sub>D</sub>	Continuous drain current at T <sub>C</sub> = 25 °C	149	A
	Continuous drain current at T <sub>C</sub> = 100 °C	106	
I <sub>DM</sub>	Pulsed drain current <sup>1</sup>	350	
V <sub>GS</sub>	Gate-source voltage	23 to -10	V
	Transient gate-source voltage	25 to -12	
P <sub>D</sub>	Total power dissipation at T <sub>C</sub> = 25 °C	524	W
	Linear derating factor	3.4	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 <sub>θJC</sub>	Junction-to-case thermal resistance	—	0.22	0.29	°C/W
T <sub>J</sub>	Operating junction temperature	-55	—	175	°C
T <sub>STG</sub>	Storage temperature	-55	—	150	°C
T <sub>L</sub>	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 shows the static characteristics of this device. T<sub>J</sub> = 25 °C unless otherwise specified.

**Table 1-3.** Static Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
V <sub>(BR)DSS</sub>	Drain-source breakdown voltage	V <sub>GS</sub> = 0V, I <sub>D</sub> = 100 μA	700	—	—	V
R <sub>DS(on)</sub>	Drain-source on resistance <sup>1</sup>	V <sub>GS</sub> = 20V, I <sub>D</sub> = 40A	—	15	19	mΩ
		V <sub>GS</sub> = 18V, I <sub>D</sub> = 40A	—	18	—	
V <sub>GS(th)</sub>	Gate-source threshold voltage	V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 4 mA	1.9	3.0	—	V
I <sub>DSS</sub>	Zero gate voltage drain current	V <sub>DS</sub> = 700V, V <sub>GS</sub> = 0V	—	0.3	40	μA
		V <sub>DS</sub> = 700V, V <sub>GS</sub> = 0V, T <sub>J</sub> = 175 °C	—	3.5	—	
I <sub>GSS</sub>	Gate-source leakage current	V <sub>GS</sub> = 20V/-10V	—	—	±100	nA

**Note:**

1. Pulse test: pulse width < 380  $\mu$ s, duty cycle < 2%.

The following table shows the dynamic characteristics of this device.  $T_J = 25\text{ }^\circ\text{C}$  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	$V_{GS} = 0\text{V}$	—	4500	—	pF
$C_{rss}$	Reverse transfer capacitance	$V_{DD} = 700\text{V}$	—	44	—	
$C_{oss}$	Output capacitance	$V_{AC} = 25\text{ mV}$ $f = 200\text{ kHz}$	—	510	—	
$Q_g$	Total gate charge	$V_{GS} = -5\text{V}/20\text{V}$	—	215	—	nC
$Q_{gs}$	Gate-source charge	$V_{DD} = 470\text{V}$	—	58	—	
$Q_{gd}$	Gate-drain charge	$I_D = 40\text{A}$	—	35	—	
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 470\text{V}$	—	27	—	ns
$t_r$	Voltage rise time	$V_{GS} = -5\text{V}/20\text{V}$	—	22	—	
$t_{d(off)}$	Turn-off delay time	$I_D = 40\text{A}$	—	40	—	
$t_f$	Voltage fall time	$R_{g(ext)} = 4\Omega$	—	12	—	
$E_{on}$	Turn-on switching energy	Freewheeling diode = MSC015SMA070B4 ( $V_{GS} = -5\text{V}$ ); reference <a href="#">Figure 1-18</a>	—	413	—	$\mu$ J
$E_{off}$	Turn-off switching energy		—	89	—	
ESR	Gate equivalent series resistance	$f = 1\text{ MHz}$ , 25 mV, drain short	—	0.69	—	$\Omega$
SCWT	Short circuit withstand time	$V_{DS} = 560\text{V}$ , $V_{GS} = 20\text{V}$	—	3	—	$\mu$ s
$E_{AS}$	Avalanche energy, single pulse	$I_D = 40\text{A}$	—	4400	—	mJ

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

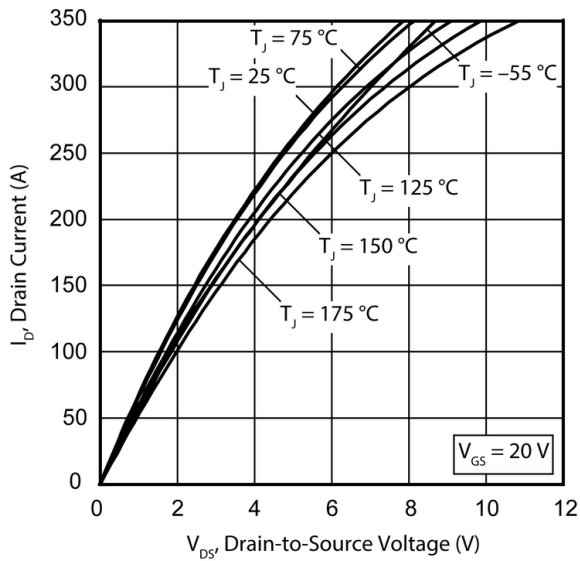
**Table 1-5. Body Diode Characteristics**

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$V_{SD}$	Diode forward voltage	$I_{SD} = 40\text{A}$ , $V_{GS} = 0\text{V}$	—	3.4	—	V
		$I_{SD} = 40\text{A}$ , $V_{GS} = -5\text{V}$	—	3.8	—	
$t_{rr}$	Reverse recovery time	$I_{SD} = 40\text{A}$ , $V_{GS} = -5\text{V}$ , $V_{DD} = 470\text{V}$ , $di/dt = -1200\text{ A}/\mu\text{s}$	—	40	—	ns
$Q_{rr}$	Reverse recovery charge		—	495	—	nC
$I_{RRM}$	Reverse recovery current		—	19	—	A

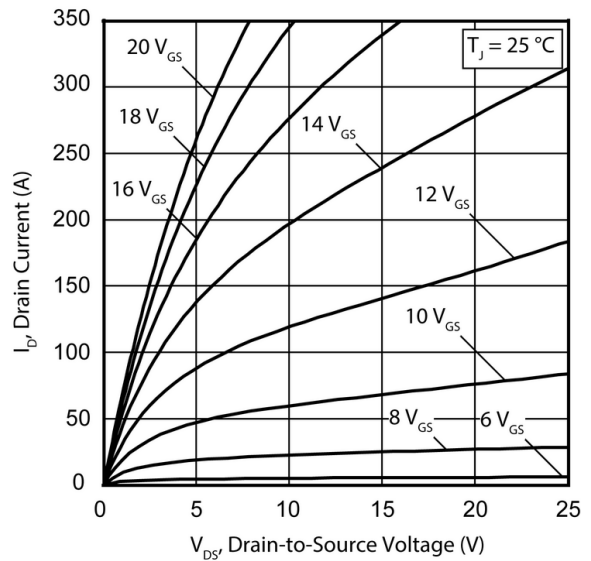
### 1.3 Typical Performance Curves

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

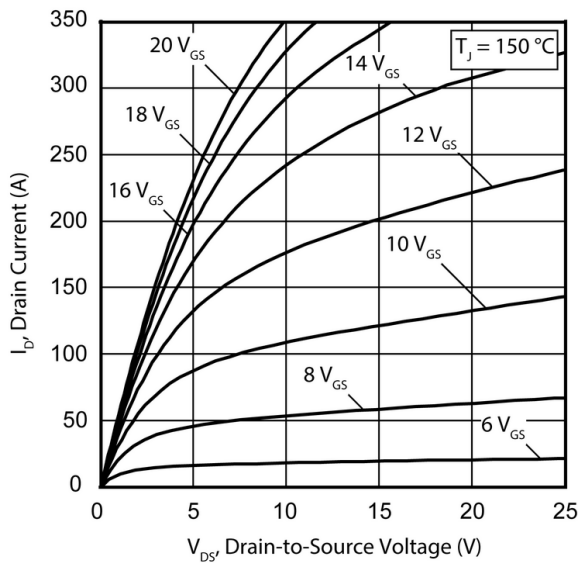
**Figure 1-1.** Drain Current vs.  $V_{DS}$  at  $T_J$



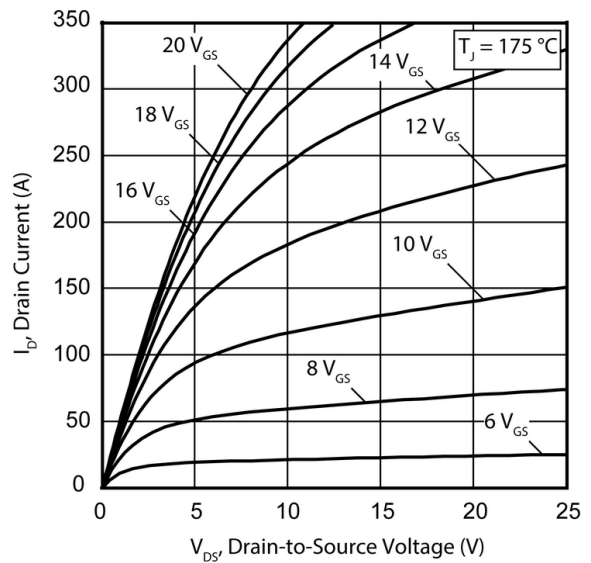
**Figure 1-2.** Drain Current vs.  $V_{DS}$  at  $V_{GS}$



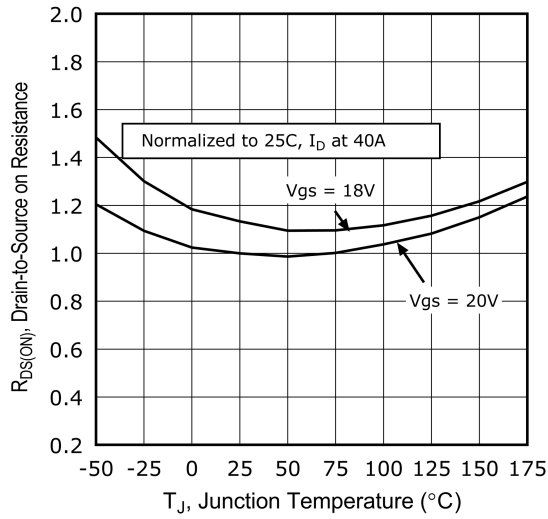
**Figure 1-3.** Drain Current vs.  $V_{DS}$  at  $V_{GS}$



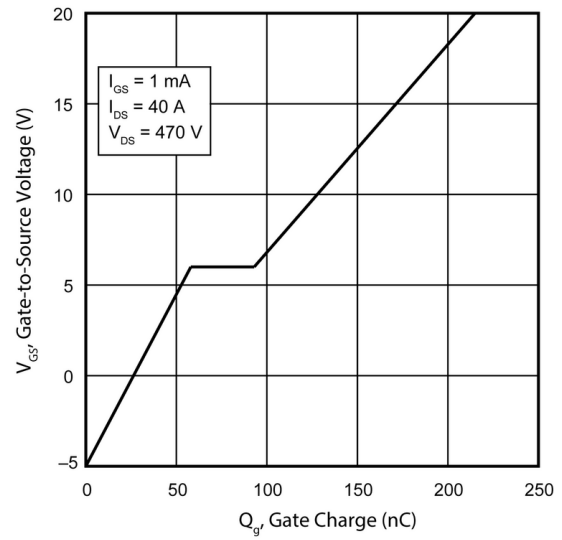
**Figure 1-4.** Drain Current vs.  $V_{DS}$  at  $V_{GS}$



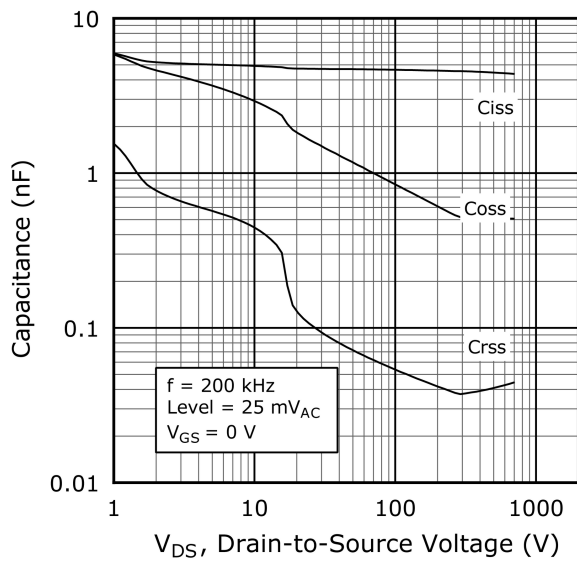
**Figure 1-5.**  $R_{DS(on)}$  vs. Junction Temperature



**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

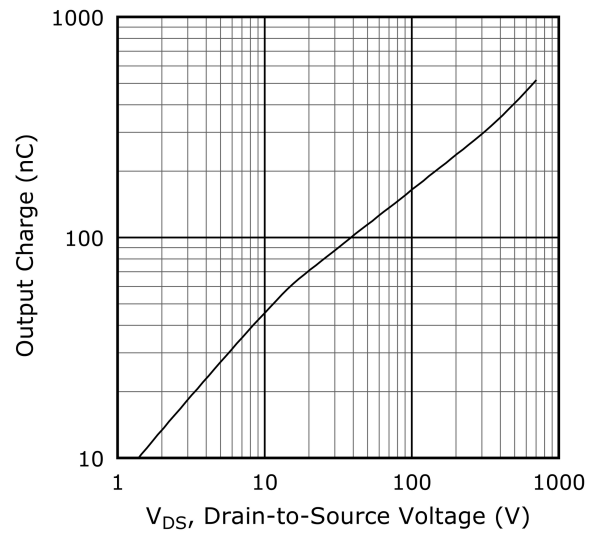


Figure 1-9.  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction

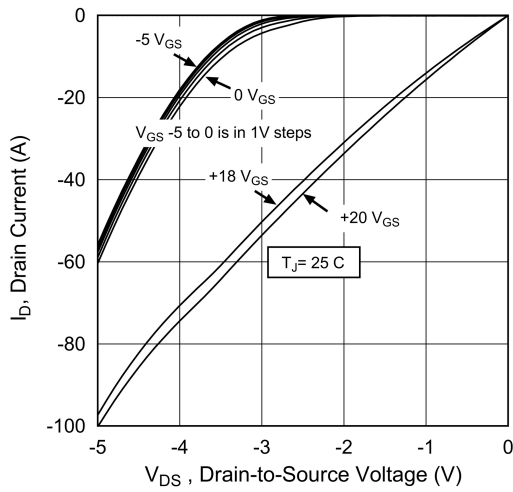


Figure 1-10.  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction

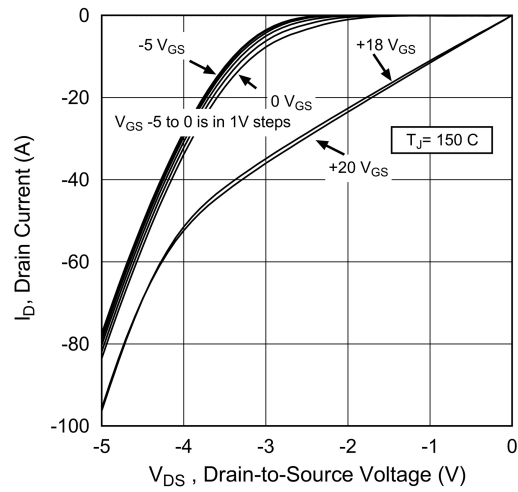


Figure 1-11. Switching Energy  $E_{on}$  vs.  $V_{DS}$  &  $I_D$

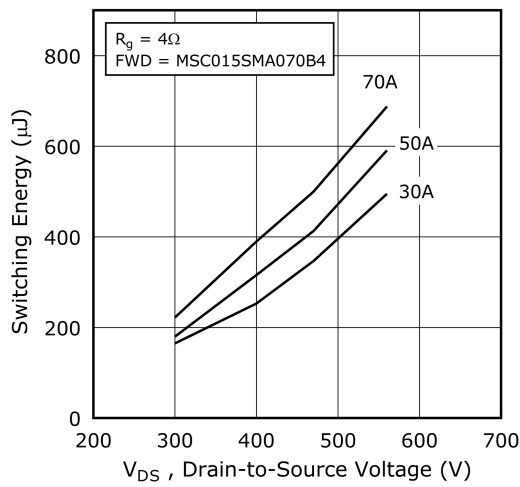


Figure 1-12. Switching Energy  $E_{off}$  vs.  $V_{DS}$  &  $I_D$

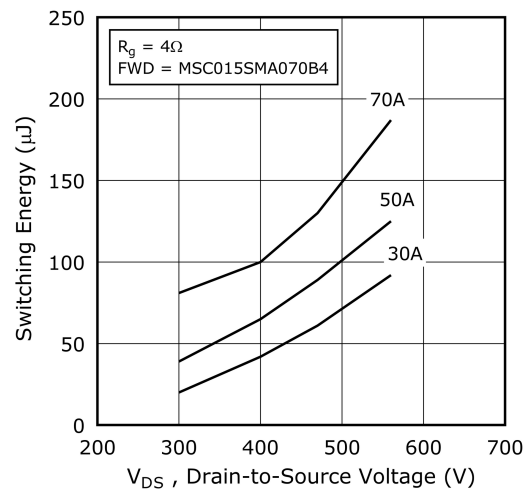


Figure 1-13. Switching Energy vs.  $R_g$

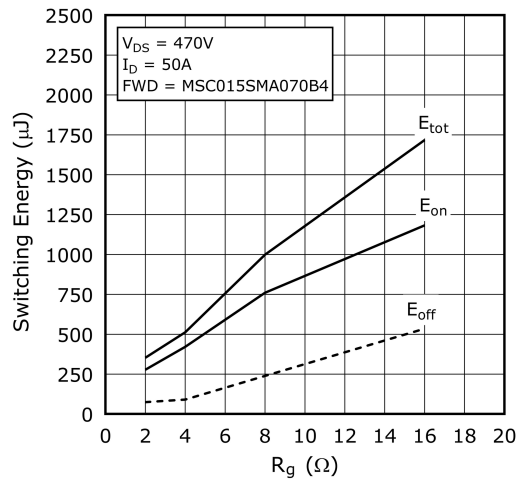


Figure 1-14. Switching Energy vs. Junction Temperature

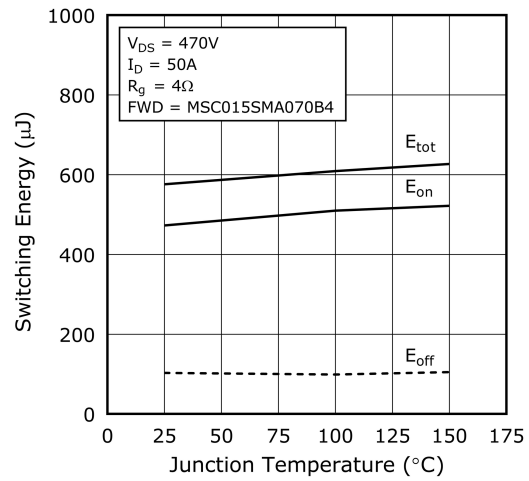


Figure 1-15. Threshold Voltage vs. Junction Temperature

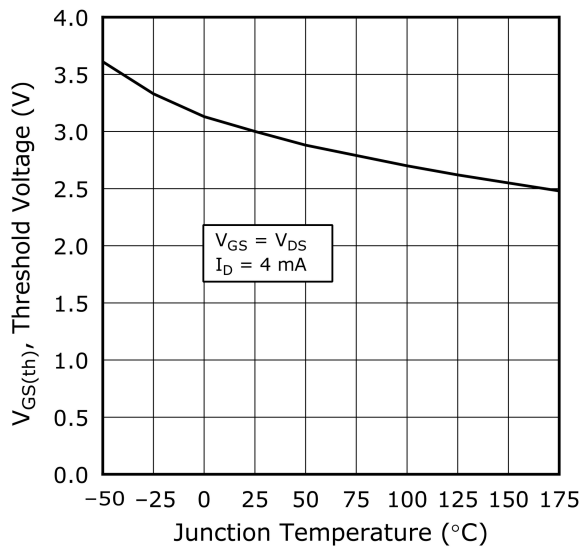


Figure 1-16. Forward Safe Operating Area

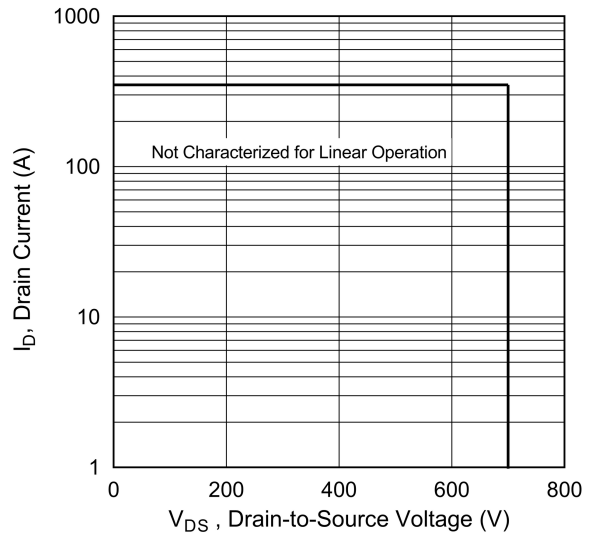
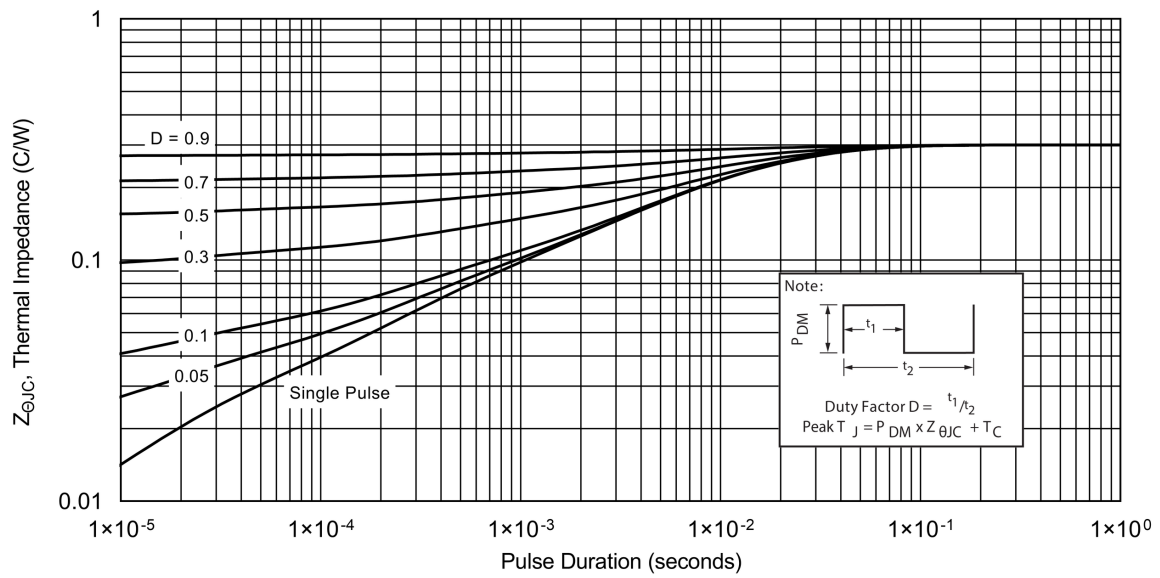
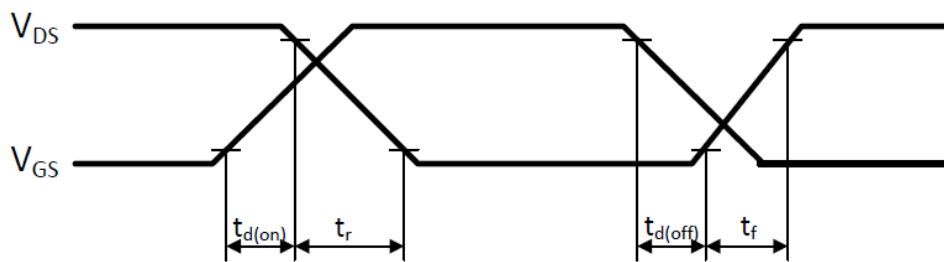


Figure 1-17. Maximum Transient Thermal Impedance



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

Figure 1-18. Switching Waveform



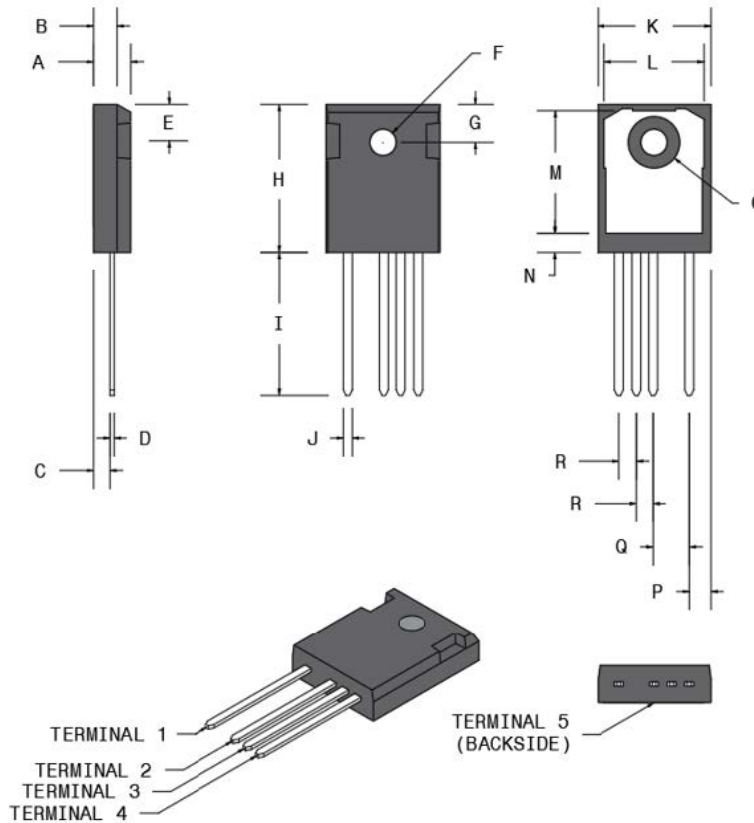
## 2. Package Specification

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 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

.....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
B	09/2023	The following changes are made in this revision of the document: <ul style="list-style-type: none"><li>• Updated the maximum value for the lead temperature in the <a href="#">Table 1-2</a>.</li><li>• Added <a href="#">Figure 1-8</a>, <a href="#">Figure 1-9</a>, <a href="#">Figure 1-10</a>, and <a href="#">Figure 1-18</a>.</li><li>• Updated <a href="#">Figure 1-5</a> and <a href="#">Figure 1-16</a>.</li></ul>
A	05/2023	Document migrated from Microsemi template to Microchip template; Assigned Microchip literature number DS-00004986A, which replaces the previous Microsemi literature number 050-7764.
Initial release (Microsemi Revision A)	12/2019	Document created.

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