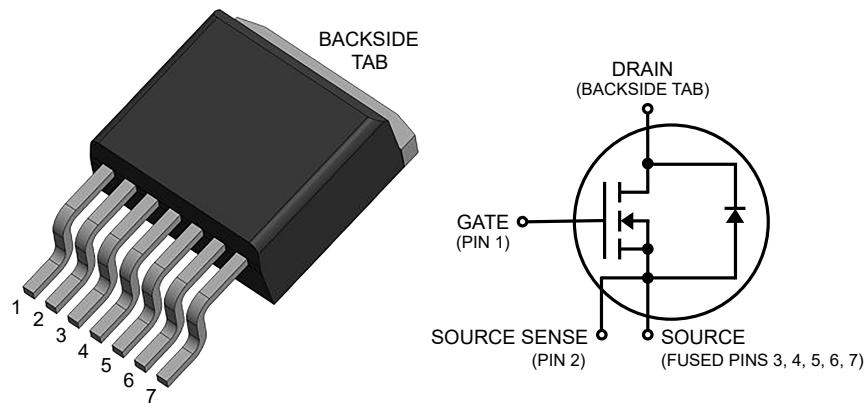


## Product Overview

700V, 60 mΩ typical at  $V_{GS} = 20V$ , 68 mΩ typical at  $V_{GS} = 18V$ , Silicon Carbide (SiC) N-Channel MOSFET, TO-263 7-lead XL with a source sense.



## Features

- AEC-Q101 qualified option available
- 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
$V_{DSS}$	Drain source voltage	700	V
$I_D$	Continuous drain current at $T_C = 25^\circ\text{C}$	51	A
	Continuous drain current at $T_C = 100^\circ\text{C}$	36	
$I_{DM}$	Pulsed drain current <sup>1</sup>	188	
$V_{GS}$	Gate-source voltage	23 to -10	V
	Transient gate-source voltage	25 to -12	
$P_D$	Total power dissipation at $T_C = 25^\circ\text{C}$	240	W
	Linear derating factor	1.6	

**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	—	0.48	0.62	$^\circ\text{C}/\text{W}$
$T_J$	Operating junction temperature	-55	—	175	$^\circ\text{C}$
$T_{STG}$	Storage temperature	-55	—	175	
—	Reflow temperature	—	—	260	$^\circ\text{C}$
Wt	Package weight	—	1.6	—	g

ESD practices should comply with JESD-625.

### 1.2 Electrical Performance

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

**Table 1-3.** Static Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{V}$ , $I_D = 100\text{ }\mu\text{A}$	700	—	—	V
$R_{DS(on)}$	Drain-source on resistance <sup>1</sup>	$V_{GS} = 20\text{V}$ , $I_D = 20\text{A}$	—	60	75	$\text{m}\Omega$
		$V_{GS} = 18\text{V}$ , $I_D = 20\text{A}$	—	68	—	
$V_{GS(th)}$	Gate-source threshold voltage	$V_{GS} = V_{DS}$ , $I_D = 1\text{ mA}$	1.9	3.0	5.0	V
$I_{DSS}$	Zero gate voltage drain current	$V_{DS} = 700\text{V}$ , $V_{GS} = 0\text{V}$	—	0.1	25	$\mu\text{A}$
		$V_{DS} = 700\text{V}$ , $V_{GS} = 0\text{V}$ , $T_J = 175^\circ\text{C}$	—	1.5	—	
$I_{GSS}$	Gate-source leakage current	$V_{GS} = 20\text{V}/-10\text{V}$	—	—	$\pm 100$	nA

**Note:**

1. Pulse test: pulse width < 380  $\mu\text{s}$ , 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	$V_{GS} = 0\text{V}$ $V_{DD} = 700\text{V}$ $V_{AC} = 25\text{ mV}$ $f = 200\text{ kHz}$	—	1160	—	pF
$C_{rss}$	Reverse transfer capacitance		—	10	—	
$C_{oss}$	Output capacitance		—	132	—	
$Q_G$	Total gate charge	$V_{GS} = -5\text{V}/20\text{V}$ $V_{DD} = 470\text{V}$ $I_D = 20\text{A}$	—	56	—	nC
$Q_{GS}$	Gate-source charge		—	15	—	
$Q_{GD}$	Gate-drain charge		—	9.0	—	
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 470\text{V}$ $V_{GS} = -5\text{V}/20\text{V}$ $I_D = 20\text{A}$ $R_{G(ext)} = 4\Omega$	—	10	—	ns
$t_r$	Voltage rise time		—	7.0	—	
$t_{d(off)}$	Turn-off delay time		—	19	—	
$t_f$	Voltage fall time		—	7.0	—	
$E_{on}$	Turn-on switching energy	Freewheeling diode = MSC060SMA070SD ( $V_{GS} = -5\text{V}$ ); reference <a href="#">Figure 1-19</a>	—	92	—	$\mu\text{J}$
$E_{off}$	Turn-off switching energy		—	11	—	
ESR	Gate equivalent series resistance	$f = 1\text{ MHz}, 25\text{ mV}, \text{drain short}$	—	2.6	—	$\Omega$
SCWT	Short circuit withstand time	$V_{DS} = 560\text{V}, V_{GS} = 20\text{V}$	—	3.0	—	$\mu\text{s}$
$E_{AS}$	Avalanche energy, single pulse	$I_D = 20\text{A}$	—	1100	—	$\text{mJ}$

The following table shows the body diode characteristics of this device.  $T_J = 25^\circ\text{C}$  unless otherwise specified. The body diode reverse recovery is characterized, not 100% tested.

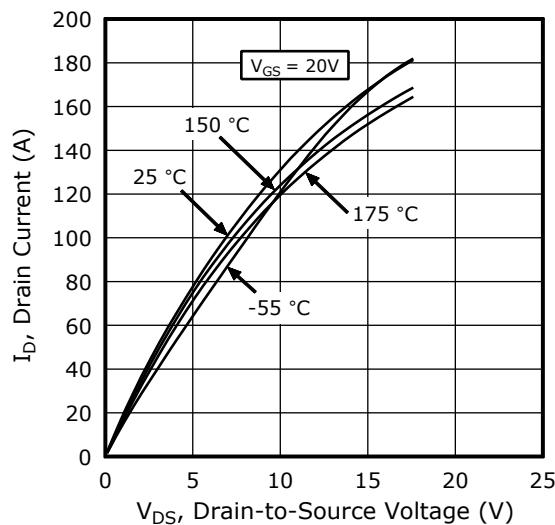
**Table 1-5.** Body Diode Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$V_{SD}$	Diode forward voltage	$I_{SD} = 20\text{A}, V_{GS} = 0\text{V}$	—	3.7	—	V
		$I_{SD} = 20\text{A}, V_{GS} = -5\text{V}$	—	3.9	5.0	
$t_{rr}$	Reverse recovery time	$I_{SD} = 20\text{A}, V_{GS} = -5\text{V}, \text{Drive } R_G = 8\Omega, V_{DD} = 470\text{V}, dI/dt = -8000\text{ A}/\mu\text{s}$	—	10	—	ns
$Q_{rr}$	Reverse recovery charge		—	336	—	
$I_{RRM}$	Reverse recovery current		—	54	—	

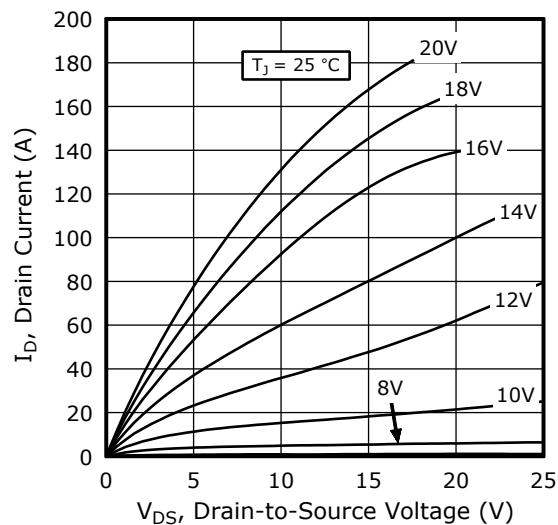
### 1.3 Typical Performance Curves

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

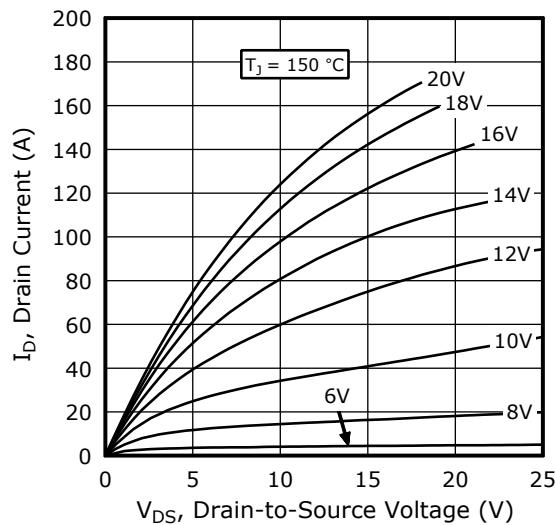
**Figure 1-1.** Drain Current vs.  $V_{DS}$  at  $T_J$



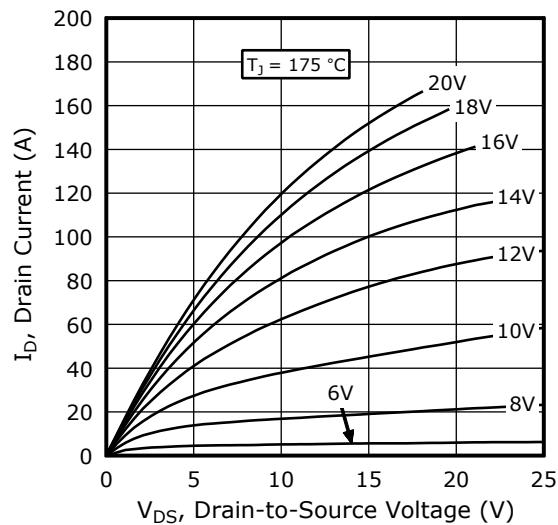
**Figure 1-2.** Drain Current vs.  $V_{DS}$  at  $V_{GS}$



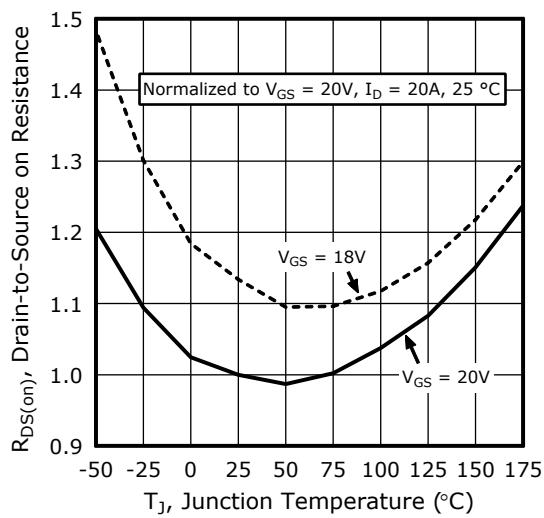
**Figure 1-3.** Drain Current vs.  $V_{DS}$  at  $V_{GS}$



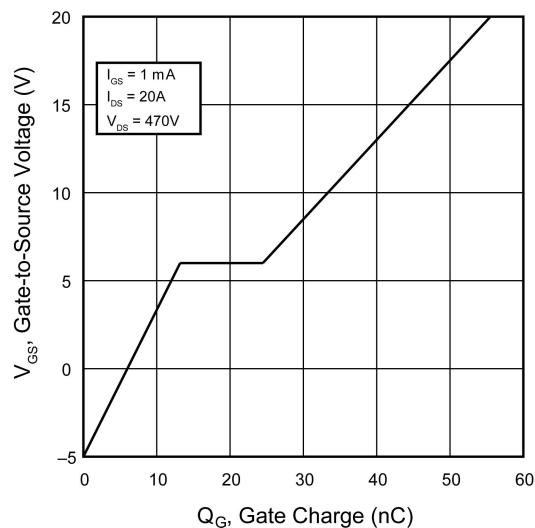
**Figure 1-4.** Drain Current vs.  $V_{DS}$  at  $V_{GS}$



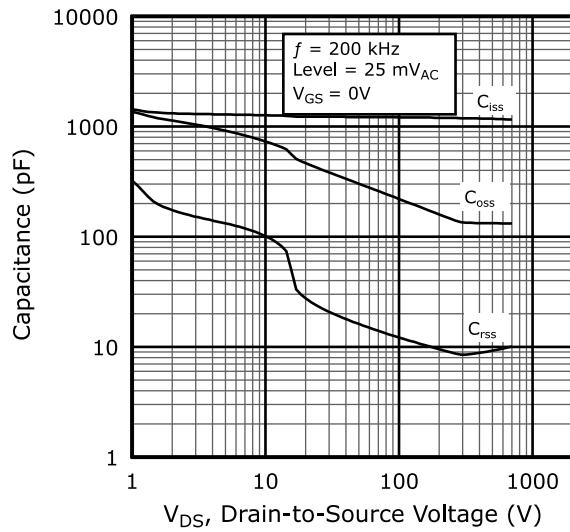
**Figure 1-5.  $R_{DS(on)}$  vs. Junction Temperature**



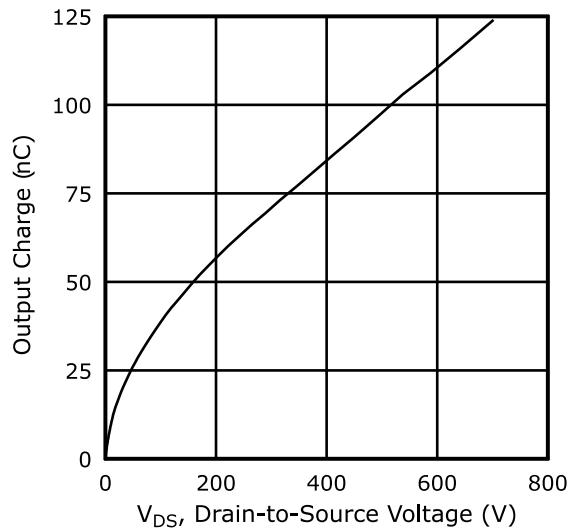
**Figure 1-6. Gate Charge Characteristics**



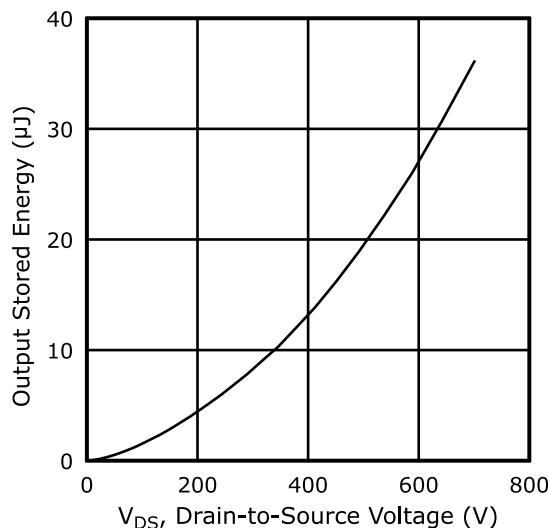
**Figure 1-7. Capacitance vs. Drain-to-Source Voltage**



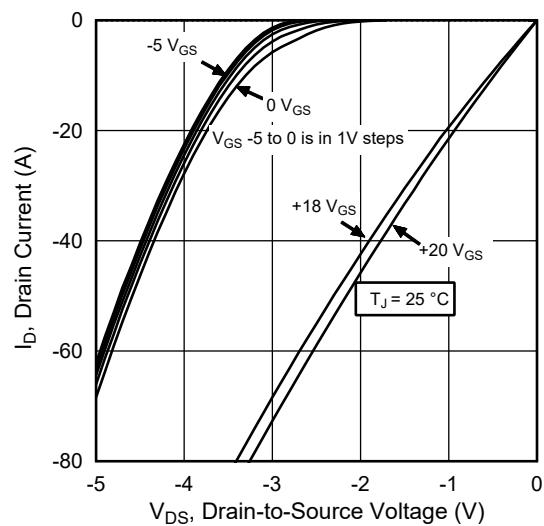
**Figure 1-8. Output Charge vs. Drain-to-Source Voltage**



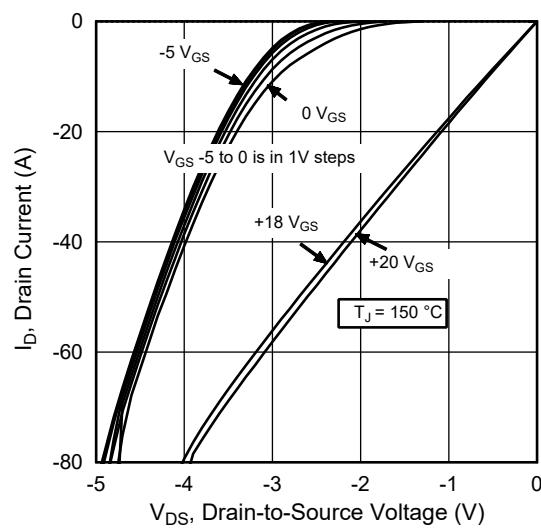
**Figure 1-9.** Output Stored Energy vs.  $V_{DS}$



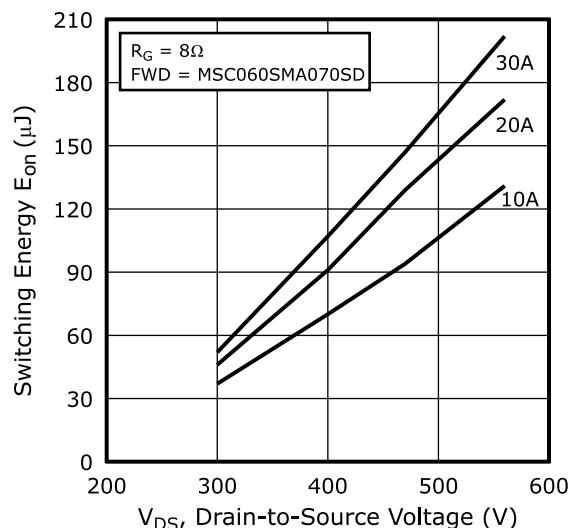
**Figure 1-10.**  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction



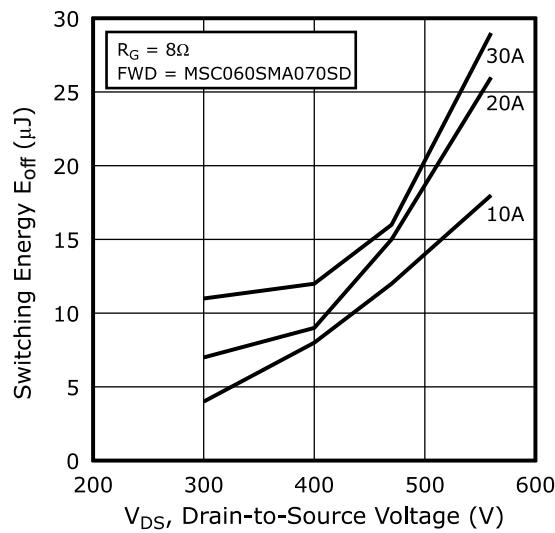
**Figure 1-11.**  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction



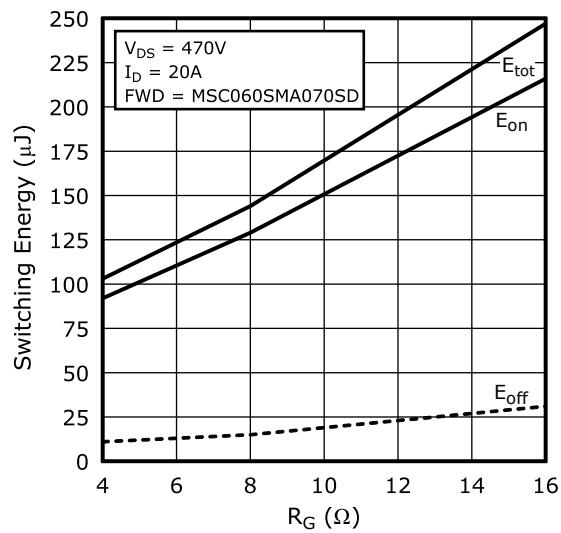
**Figure 1-12.** Switching Energy  $E_{on}$  vs.  $V_{DS}$  &  $I_D$



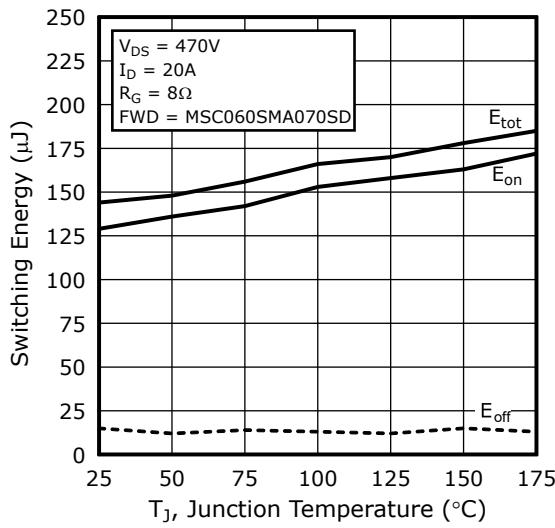
**Figure 1-13.** Switching Energy  $E_{off}$  vs.  $V_{DS}$  &  $I_D$



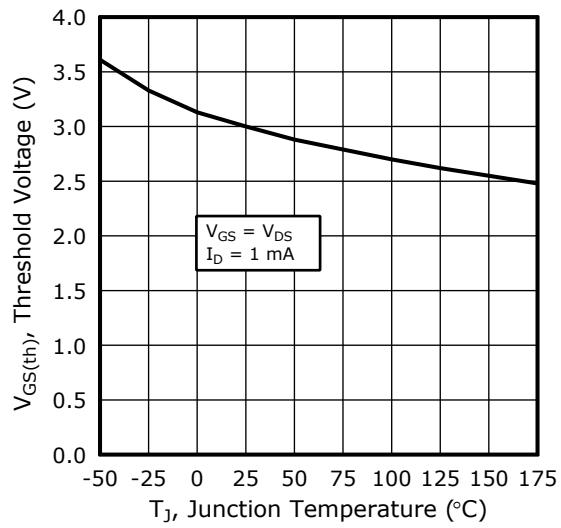
**Figure 1-14.** Switching Energy vs.  $R_G$



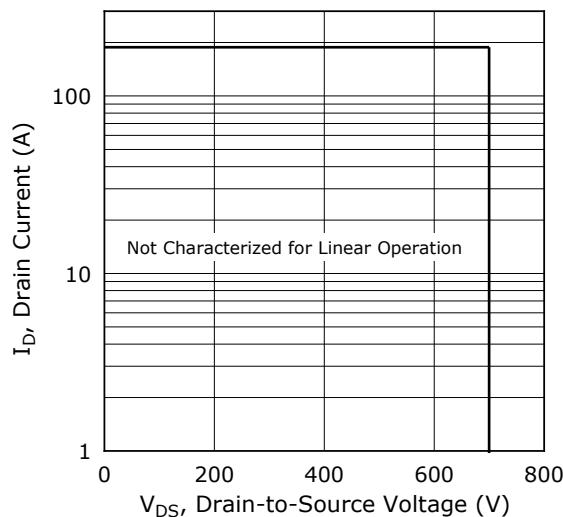
**Figure 1-15.** Switching Energy vs. Junction Temperature



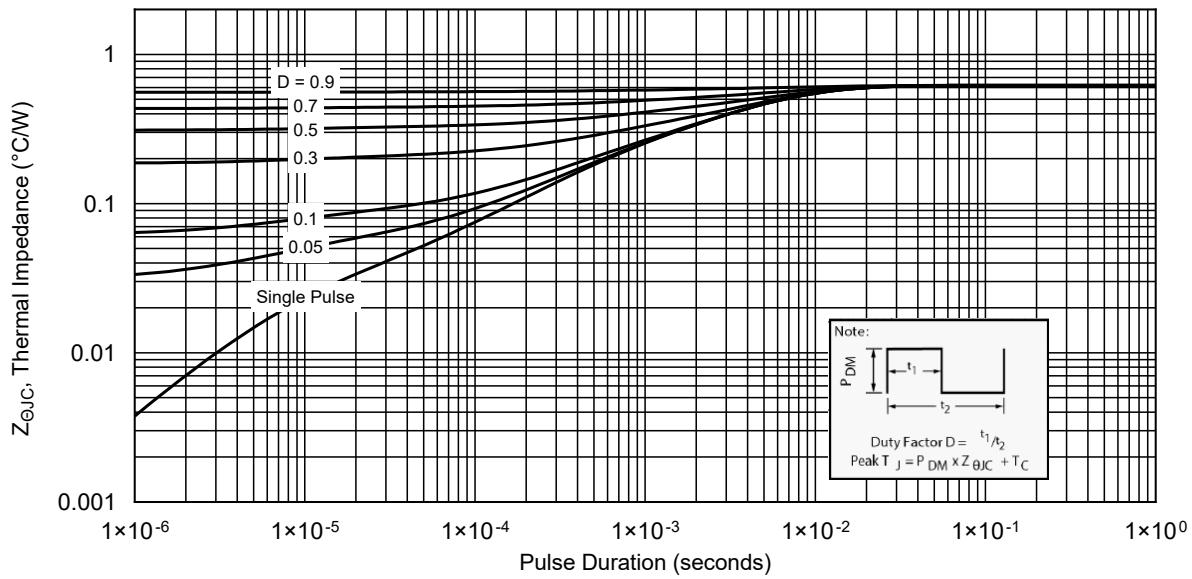
**Figure 1-16.** Threshold Voltage vs. Junction Temperature



**Figure 1-17.** Forward Safe Operating Area

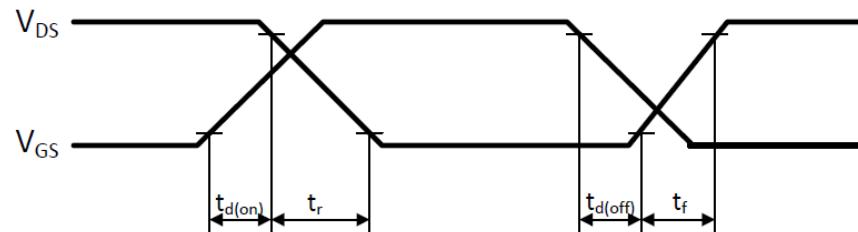


**Figure 1-18.** Maximum Transient Thermal Impedance



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

**Figure 1-19.** Switching Waveform



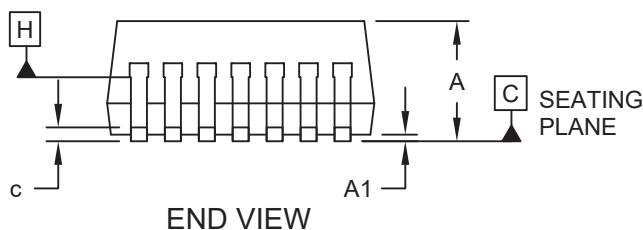
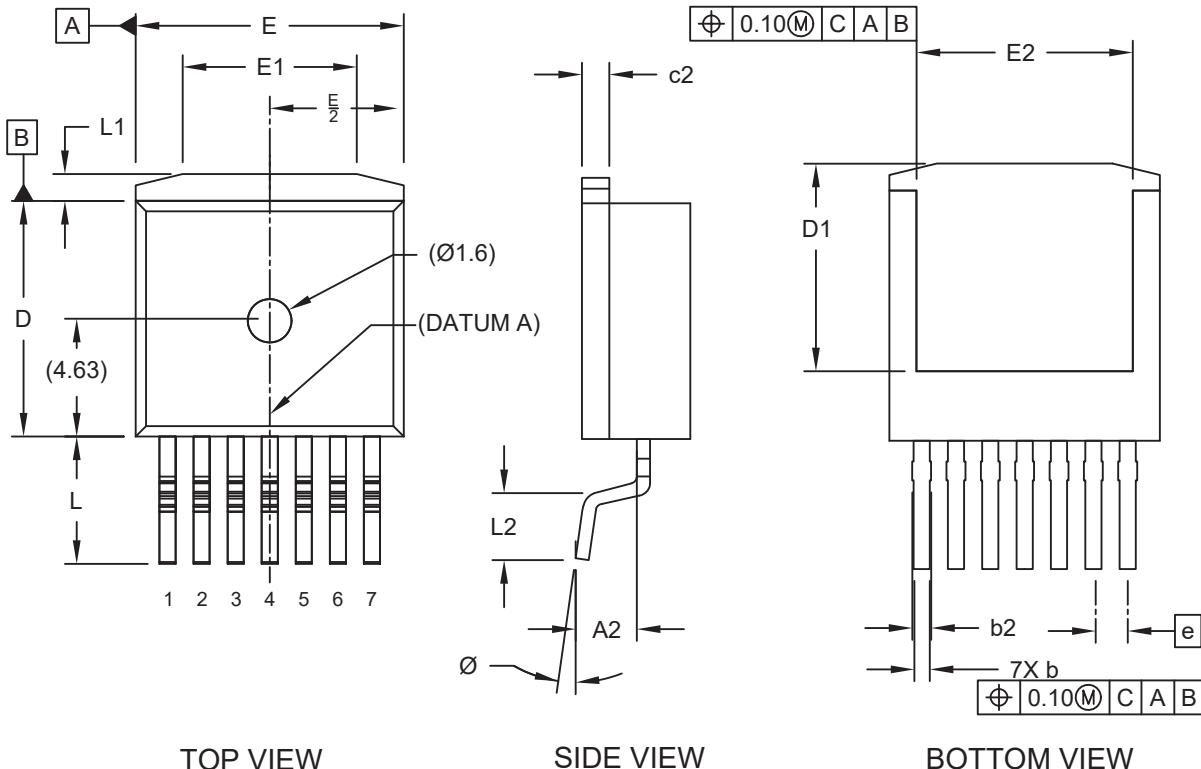
## 2. Package Specification

This section shows the package specification of this device.

### 2.1 Package Outline Drawing

The following figure illustrates the TO-263-7L XL package outline of this device.

**Figure 2-1. Package Outline Drawing**



The following table shows the TO-263-7L XL dimensions and should be used in conjunction with the package outline drawing.

**Table 2-1. TO-263-7L XL Dimensions**

Symbol	Description	Min. (mm)	Max. (mm)
N	Number of leads	7	
e	Pitch	1.27 BSC	

.....continued

Symbol	Description	Min. (mm)	Max. (mm)
A	Overall height	4.30	4.70
A1	Seating plane height	—	0.25
A2	Seating plane to lead	2.20	2.60
b	Lead width	0.52	0.72
b1		0.60	0.80
c	Lead thickness	0.42	0.62
c2	Thermal pad thickness	1.07	1.47
L	Lead length	4.55	4.95
L1	Tab length	0.87	1.27
L2	Foot length	2.48	2.88
D	Molded body length	9.05	9.45
D1	Thermal pad length	7.58	7.98
E	Total width	9.80	10.20
E1	Thermal pad width step back	6.30	6.70
E2	Thermal pad width	7.80	8.20
Ø	Lead foot angle	0°	8°

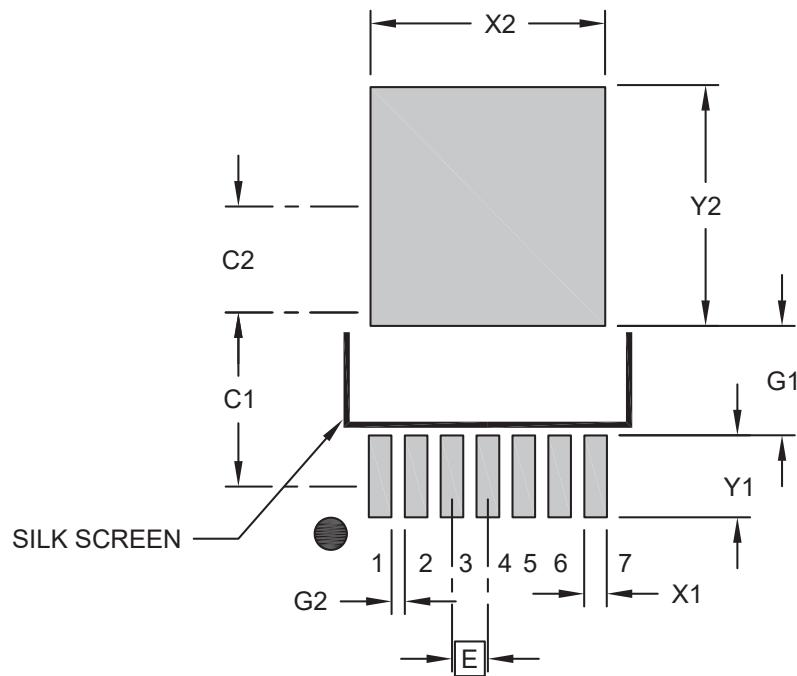
**Note:** Dimensioning and tolerancing per ASME Y14.5M.

- BSC: Basic dimension. Theoretically exact value shown without tolerances.

## 2.2 Recommended Land Pattern

The following figure illustrates the recommended land pattern of this device.

**Figure 2-2.** Recommended Land Pattern



The following table shows the recommended land pattern dimensions.

**Table 2-2.** Recommended Land Pattern Dimensions

Symbol	Description	Min. (mm)	Nom. (mm)	Max. (mm)
E	Contact pitch	1.27 BSC		
X2	Center pad width	—	—	8.30
Y2	Center pad length	—	—	8.45
C1	Contact pad spacing	—	6.45	—
C2	Contact pad spacing	—	4.30	—
X1	Contact pad width (X7)	—	—	0.80
Y1	Contact pad length (X7)	—	—	2.90
G1	Contact pad to center pad (X7)	3.88	—	—
G2	Contact pad to contact pad (X6)	0.47	—	—

**Notes:**

- Dimensioning and tolerancing per ASME Y14.5M.
  - BSC: Basic dimension. Theoretically exact value shown without tolerances.
- For best soldering results, thermal vias, if used, should be filled or tented to avoid solder loss during reflow process.

### 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	07/2024	Added <a href="#">2.2. Recommended Land Pattern</a> .
B	05/2024	Updated <a href="#">Figure 1-5</a> .
A	04/2024	Initial revision

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