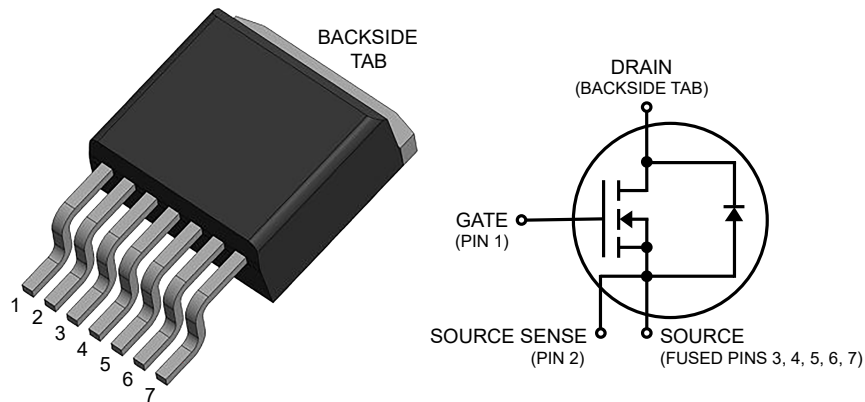


## Product Overview

1200V, 180 mΩ typical at  $V_{GS} = 20V$ , 207 mΩ typical at  $V_{GS} = 18V$ , Silicon Carbide (SiC) N-Channel MOSFET, TO-263 7-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
$V_{DSS}$	Drain source voltage	1200	V
$I_D$	Continuous drain current at $T_C = 25\text{ }^\circ\text{C}$	21	A
	Continuous drain current at $T_C = 100\text{ }^\circ\text{C}$	15	
$I_{DM}$	Pulsed drain current <sup>1</sup>	54	
$V_{GS}$	Gate-source voltage	23 to -10	V
	Transient gate-source voltage	25 to -12	
$P_D$	Total power dissipation at $T_C = 25\text{ }^\circ\text{C}$	146	W
	Linear derating factor	0.97	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	—	0.79	1.03	$^\circ\text{C}/\text{W}$
$T_J$	Operating junction temperature	-55	—	175	$^\circ\text{C}$
$T_{STG}$	Storage temperature	-55	—	150	
—	Reflow temperature	—	—	260	$^\circ\text{C}$
Wt	Package weight	—	1.42	—	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 <sup>1</sup>	$V_{GS} = 20\text{V}, I_D = 8\text{A}$	—	180	225	$\text{m}\Omega$
		$V_{GS} = 18\text{V}, I_D = 8\text{A}$	—	207	—	
$V_{GS(th)}$	Gate-source threshold voltage	$V_{GS} = V_{DS}, I_D = 500\text{ }\mu\text{A}$	1.9	3.0	5.0	V
$I_{DSS}$	Zero gate voltage drain current	$V_{DS} = 1200\text{V}, V_{GS} = 0\text{V}$	—	0.1	25	$\mu\text{A}$
		$V_{DS} = 1200\text{V}, V_{GS} = 0\text{V}, T_J = 175\text{ }^\circ\text{C}$	—	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.  $T_J = 25\text{ }^\circ\text{C}$  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	$V_{GS} = 0\text{V}$	—	481	—	pF
$C_{RSS}$	Reverse transfer capacitance	$V_{DD} = 1200\text{V}$	—	4.0	—	
$C_{OSS}$	Output capacitance	$V_{AC} = 25\text{ mV}$ $f = 200\text{ kHz}$	—	47	—	
$Q_G$	Total gate charge	$V_{GS} = -5\text{V}/20\text{V}$	—	36	—	nC
$Q_{GS}$	Gate-source charge	$V_{DD} = 800\text{V}$	—	11	—	
$Q_{GD}$	Gate-drain charge	$I_D = 8\text{A}$	—	10	—	
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 850\text{V}$	—	19	—	ns
$t_r$	Voltage rise time	$V_{GS} = -5\text{V}/20\text{V}$	—	15	—	
$t_{d(off)}$	Turn-off delay time	$I_D = 10\text{A}$	—	25	—	
$t_f$	Voltage fall time	$R_{G(ext)} = 32\Omega$	—	12	—	
$E_{on}$	Turn-on switching energy	Freewheeling diode = MSC180SMA120SA ( $V_{GS} = -5\text{V}$ ); reference <a href="#">Figure 1-19</a>	—	215	—	$\mu\text{J}$
$E_{off}$	Turn-off switching energy		—	19	—	
ESR	Gate equivalent series resistance	$f = 1\text{ MHz}$ , 25 mV, drain short	—	3.15	—	$\Omega$
SCWT	Short circuit withstand time	$V_{DS} = 960\text{V}$ , $V_{GS} = 20\text{V}$	—	3.0	—	$\mu\text{s}$
$E_{AS}$	Avalanche energy, single pulse	$I_D = 8\text{A}$	—	100	—	mJ

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

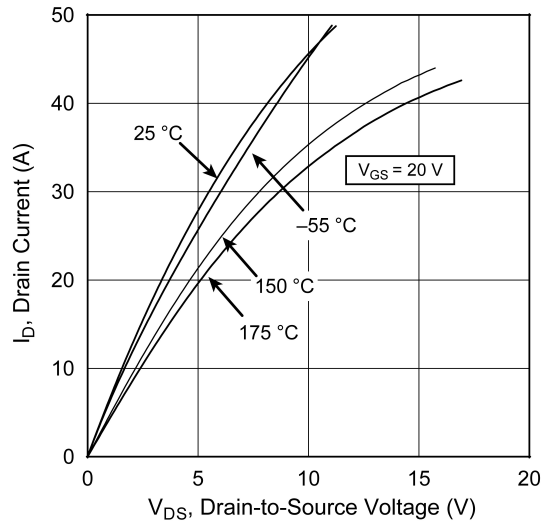
**Table 1-5. Body Diode Characteristics**

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$V_{SD}$	Diode forward voltage	$I_{SD} = 8\text{A}$ , $V_{GS} = 0\text{V}$	—	3.9	—	V
		$I_{SD} = 8\text{A}$ , $V_{GS} = -5\text{V}$	—	4.0	5.0	
$t_{rr}$	Reverse recovery time	$I_{SD} = 10\text{A}$ , $V_{GS} = -5\text{V}$ , Drive $R_G = 32\Omega$ , $V_{DD} = 850\text{V}$ , $di/dt = -2200\text{ A}/\mu\text{s}$	—	26	—	ns
$Q_{rr}$	Reverse recovery charge		—	137	—	nC
$I_{RRM}$	Reverse recovery current		—	13	—	A

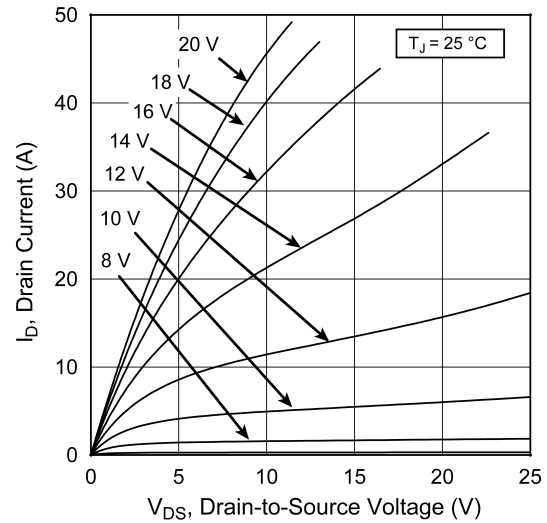
### 1.3 Typical Performance Curves

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

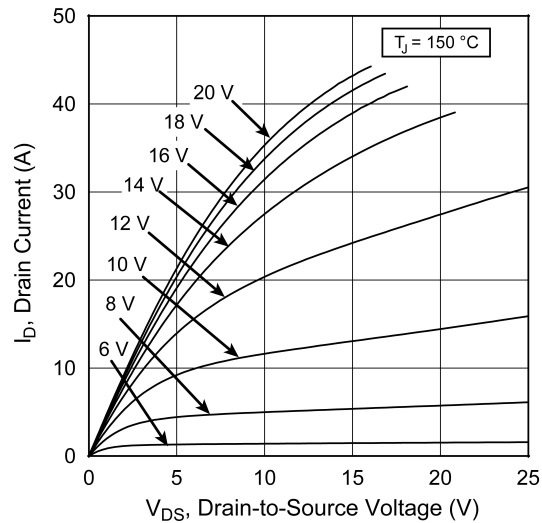
**Figure 1-1.** Drain Current vs.  $V_{DS}$  at  $T_J$



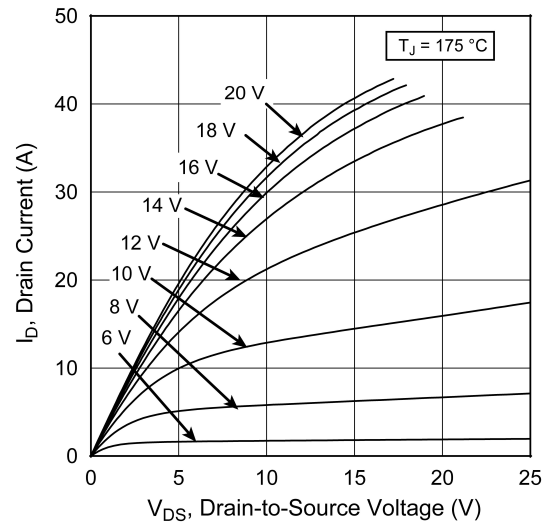
**Figure 1-2.** Drain Current vs.  $V_{DS}$  at  $V_{GS}$



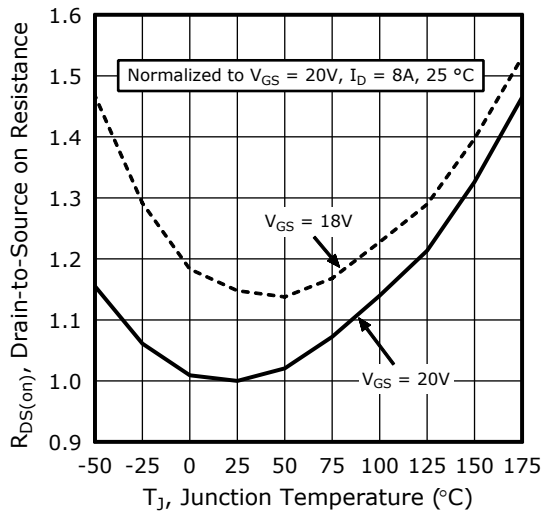
**Figure 1-3.** Drain Current vs.  $V_{DS}$  at  $V_{GS}$



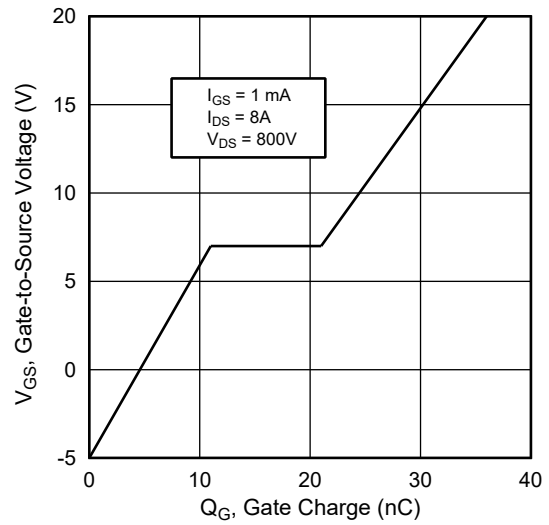
**Figure 1-4.** Drain Current vs.  $V_{DS}$  at  $V_{GS}$



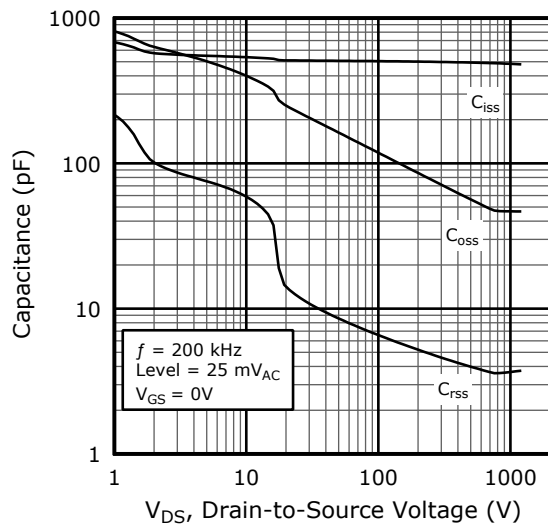
**Figure 1-5.**  $R_{DS(on)}$  vs. Junction Temperature



**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

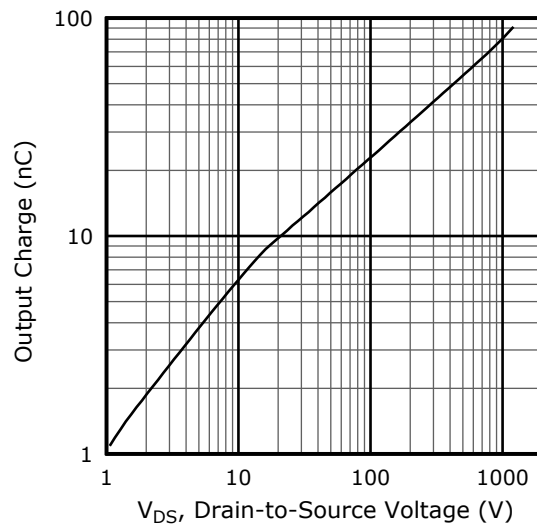


Figure 1-9. Output Stored Energy vs.  $V_{DS}$

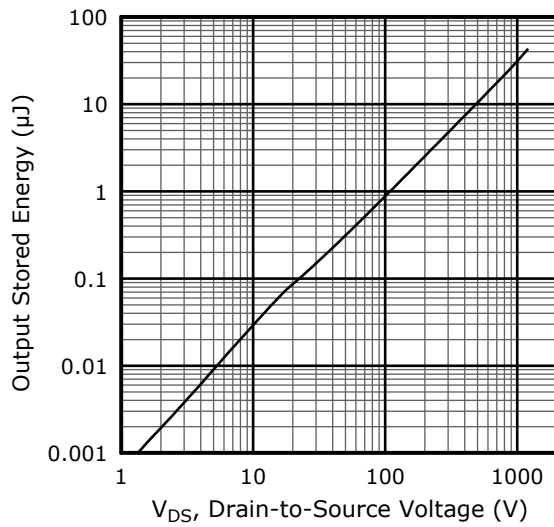


Figure 1-10.  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction

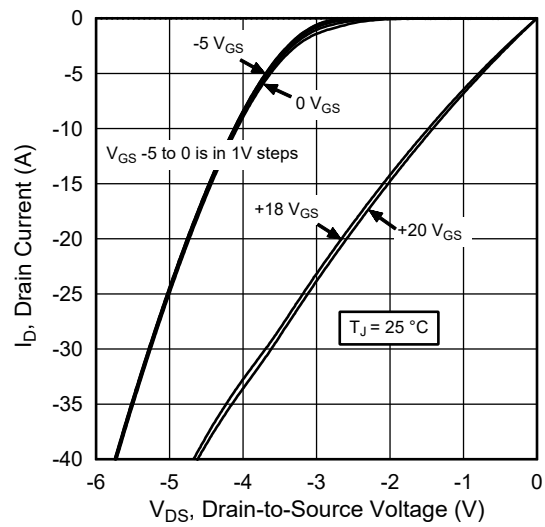


Figure 1-11.  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction

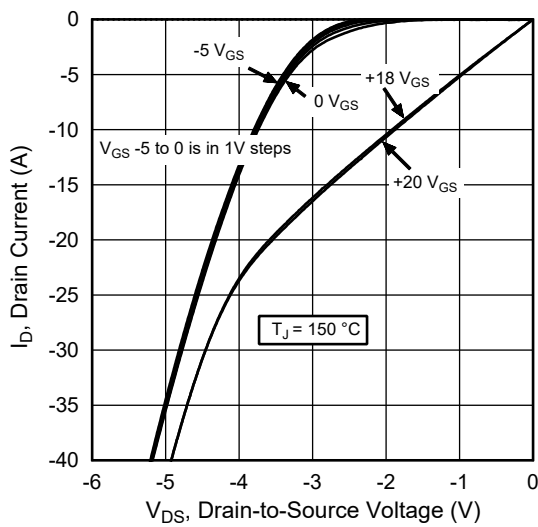


Figure 1-12. Switching Energy  $E_{on}$  vs.  $V_{DS}$  &  $I_D$

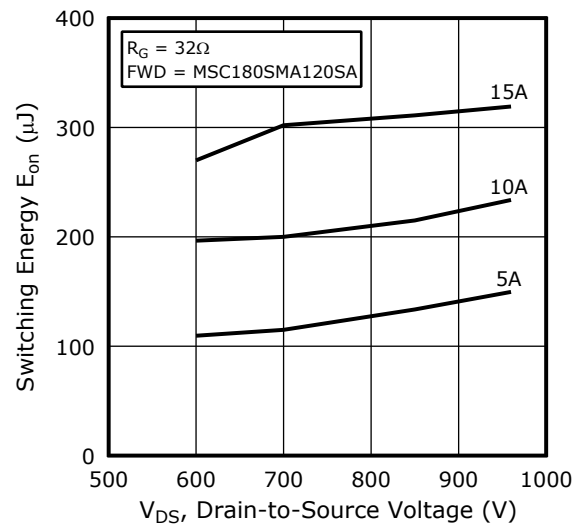


Figure 1-13. Switching Energy  $E_{off}$  vs.  $V_{DS}$  &  $I_D$

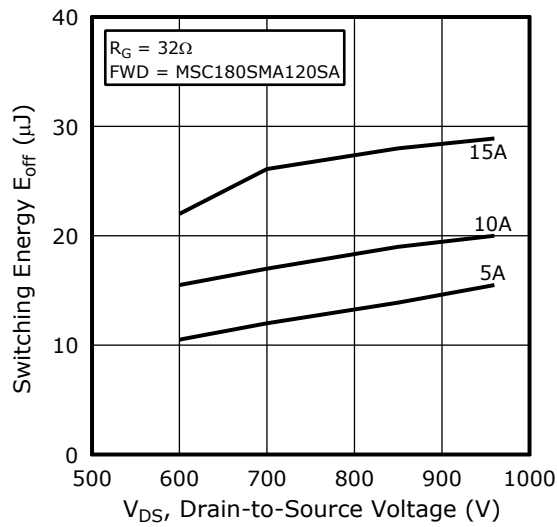


Figure 1-14. Switching Energy vs.  $R_G$

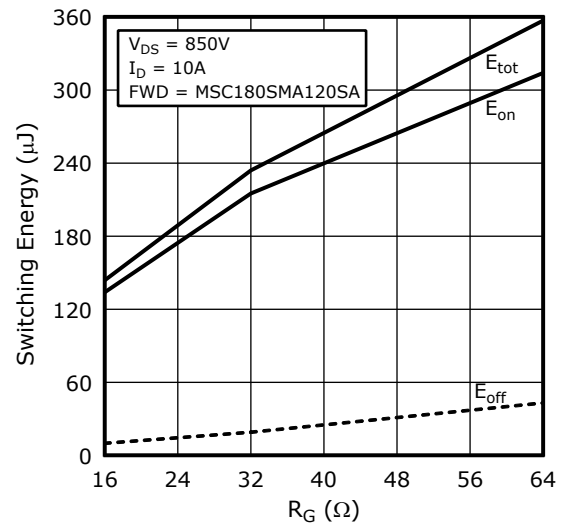


Figure 1-15. Switching Energy vs. Junction Temperature

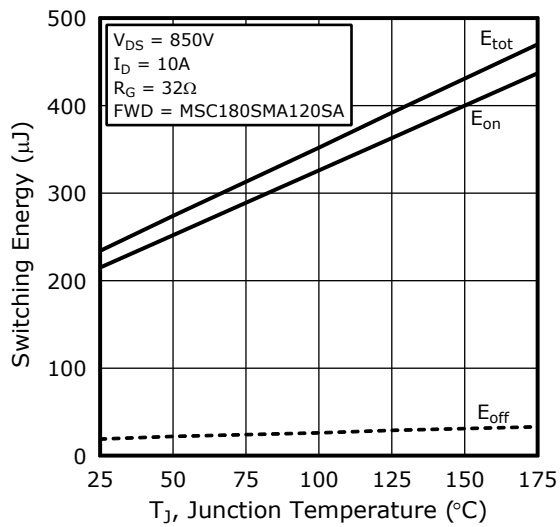


Figure 1-16. Threshold Voltage vs. Junction Temperature

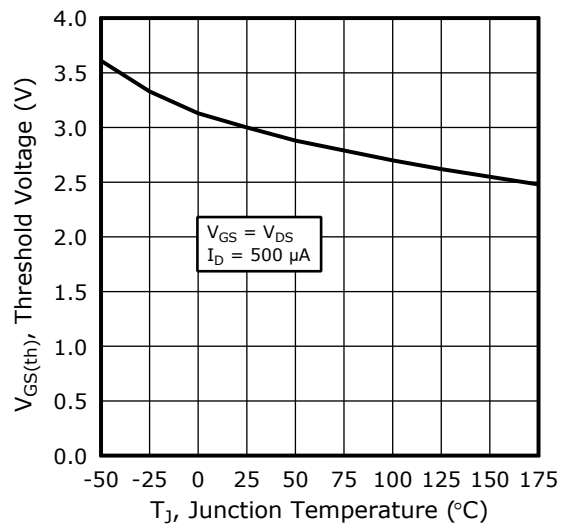


Figure 1-17. Forward Safe Operating Area

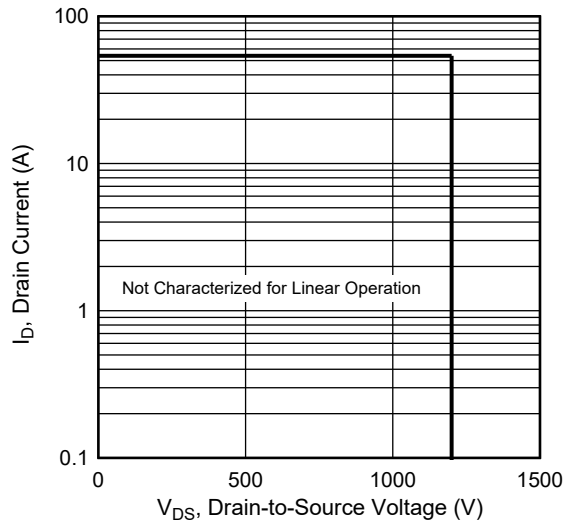
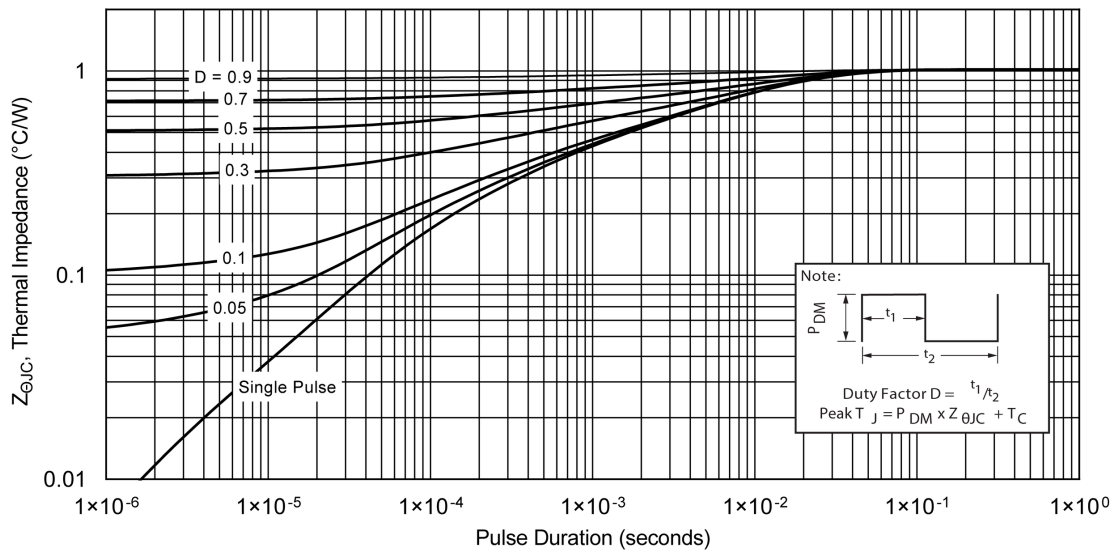
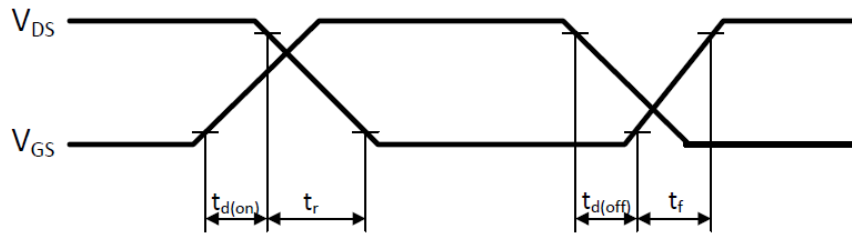


Figure 1-18. Maximum Transient Thermal Impedance



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

Figure 1-19. Switching Waveform



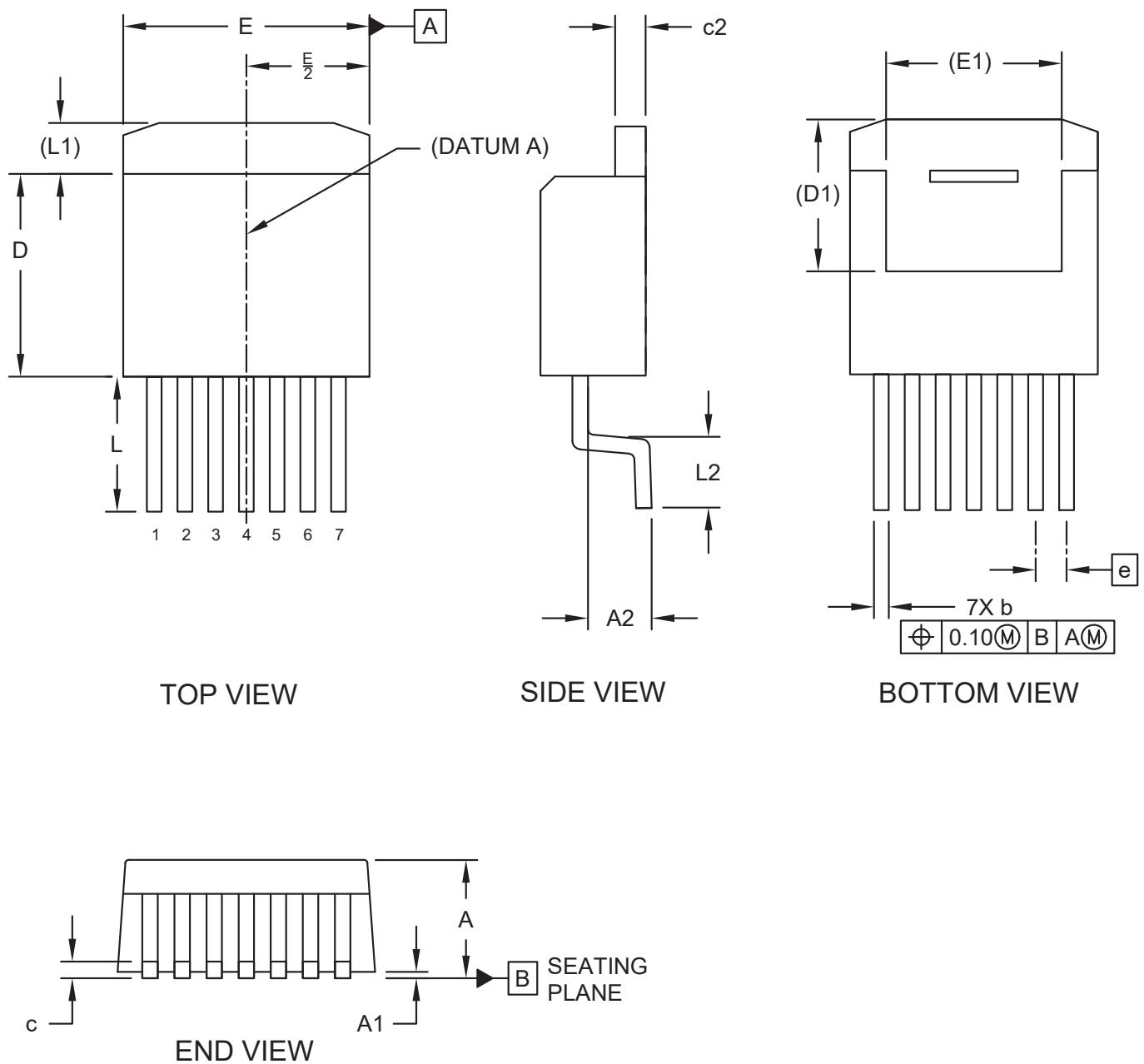
## 2. Package Specification

This section shows the package specification of this device.

### 2.1 Package Outline Drawing

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

Figure 2-1. Package Outline Drawing



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

**Table 2-1. TO-263 7-Lead Dimensions**

Symbol	Description	Min. (mm)	Nom. (mm)	Max. (mm)
N	Number of leads	7		
e	Pitch	1.27 BSC		
A	Overall height	4.29	4.42	4.57
A1	Seating plane height	0.00	—	0.25
A2	Seating plane to lead	2.49	2.59	2.69
b	Lead width	0.51	0.61	0.71
c	Lead thickness	0.33	0.48	0.66
c2	Thermal pad thickness	1.17	1.30	1.40
L	Lead length	4.85	5.59	6.32
L1	Tab length	2.49 REF		
L2	Foot length	2.31	2.49	2.69
D	Molded body length	8.84	8.97	10.80
D1	Thermal pad length	6.25 REF		
E	Total width	10.13	10.19	10.24
E1	Thermal pad width	6.78	7.21	7.67

**Notes:**

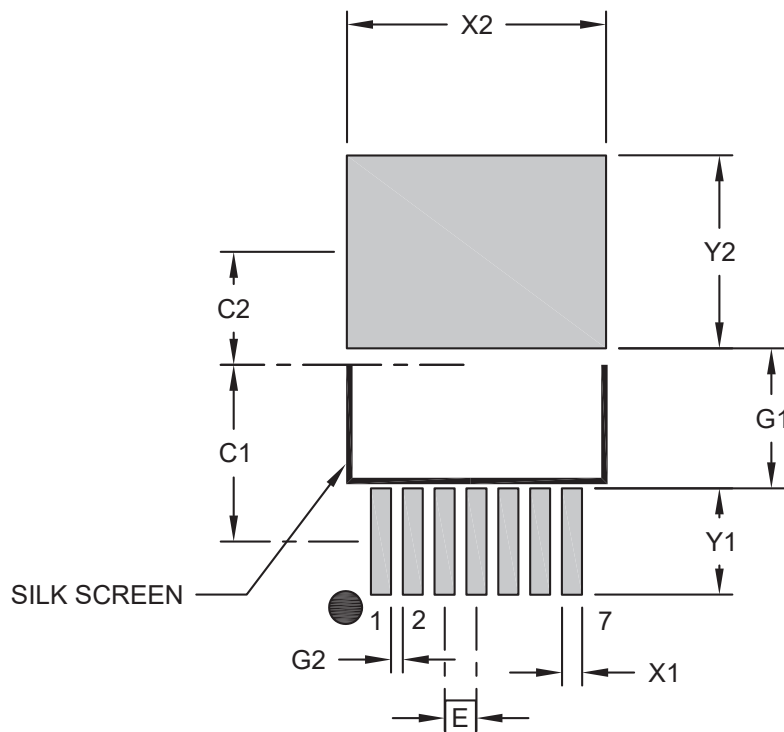
Dimensioning and tolerancing per ASME Y14.5M.

- BSC: Basic dimension. Theoretically exact value shown without tolerances.
- REF: Reference dimension, usually without tolerance, for information purposes only.

## 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	—	—	10.34
Y2	Center pad length	—	—	7.70
C1	Contact pad spacing	—	6.81	—
C2	Contact pad spacing	—	5.05	—
X1	Contact pad width (X7)	—	—	0.79
Y1	Contact pad length (X7)	—	—	4.24
G1	Contact pad to center pad (X7)	5.66	—	—
G2	Contact pad to contact pad (X6)	0.46	—	—

**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
B	07/2024	The following changes are made in this revision of the document: <ul style="list-style-type: none"><li>• Updated values in <a href="#">Table 1-1</a>, <a href="#">Table 1-4</a>, and <a href="#">Table 1-5</a>.</li><li>• Updated values for <math>R_{DS(on)}</math>, <math>V_{GS(th)}</math>, and <math>I_{DSS}</math> in <a href="#">Table 1-3</a>.</li><li>• Updated <a href="#">1.3. Typical Performance Curves</a> and <a href="#">2.1. Package Outline Drawing</a>.</li><li>• Added <a href="#">2.2. Recommended Land Pattern</a>.</li></ul>
A	11/2022	Document created.

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