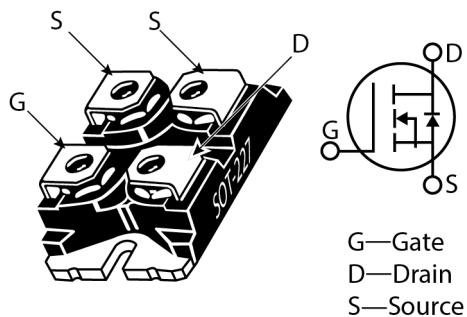


## Silicon Carbide N-Channel Power MOSFET

### Product Overview

The silicon carbide (SiC) power MOSFET product line from Microsemi increases the performance over silicon MOSFET and silicon IGBT solutions while lowering the total cost of ownership for high-voltage applications. The MSC080SMA120J device is a 1200 V, 80 mΩ SiC MOSFET in an SOT-227 package.



### Features

The following are key features of the MSC080SMA120J device:

- Low capacitances and low gate charge
- Fast switching speed due to low internal gate resistance (ESR)
- Stable operation at high junction temperature,  $T_{J(\max)} = 175^\circ\text{C}$
- Fast and reliable body diode
- Superior avalanche ruggedness
- RoHS compliant
- Isolated voltage to 2500 V

### Benefits

The following are benefits of the MSC080SMA120J device:

- High efficiency to enable lighter, 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

The MSC080SMA120J device is designed for the following applications:

- PV inverter, converter, and industrial motor drives
- Smart grid transmission and distribution
- Induction heating and welding
- H/EV powertrain and EV charger
- Power supply and distribution

## 1. Device Specifications

This section shows the specifications of the MSC080SMA120J device.

### 1.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings of the MSC080SMA120J device.

**Table 1-1. Absolute Maximum Ratings**

Symbol	Parameter	Ratings	Unit
$V_{DSS}$	Drain source voltage	1200	V
$I_D$	Continuous drain current at $T_C = 25^\circ\text{C}$	31	A
	Continuous drain current at $T_C = 100^\circ\text{C}$	22	
$I_{DM}$	Pulsed drain current <sup>1</sup>	77	
$V_{GS}$	Gate-source voltage	23 to -10	V
$P_D$	Total power dissipation at $T_C = 25^\circ\text{C}$	143	W
	Linear derating factor	0.95	W/ $^\circ\text{C}$

**Note:**

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

The following table shows the thermal and mechanical characteristics of the MSC080SMA120J device.

**Table 1-2. Thermal and Mechanical Characteristics**

Symbol	Characteristic/Test Conditions	Min	Typ	Max	Unit
$R_{\theta JC}$	Junction-to-case thermal resistance		0.70	1.05	$^\circ\text{C}/\text{W}$
$T_J$	Operating junction temperature	-55		175	$^\circ\text{C}$
$T_{STG}$	Storage temperature	-55		150	
$T_L$	Soldering temperature for 10 seconds (1.6 mm from case)			300	
$V_{ISOLATION}$	RMS voltage (50 Hz–60 Hz sinusoidal waveform from terminals to mounting base for 1 minute)	2500			V
	Mounting torque, M4 screw			10	$\text{lbf-in}$
				1.1	N-m
Wt	Package weight		1.03		oz
			29.2		g

### 1.2 Electrical Performance

The following table shows the static characteristics of the MSC080SMA120J 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	$V_{GS} = 0 \text{ V}$ , $I_D = 100 \mu\text{A}$	1200			V
$R_{DS(on)}$	Drain-source on resistance <sup>1</sup>	$V_{GS} = 20 \text{ V}$ , $I_D = 15 \text{ A}$		80	100	$\text{m}\Omega$
$V_{GS(th)}$	Gate-source threshold voltage	$V_{GS} = V_{DS}$ , $I_D = 1 \text{ mA}$	1.9	2.8		V
$\Delta V_{GS(th)}/\Delta T_J$	Threshold voltage coefficient	$V_{GS} = V_{DS}$ , $I_D = 1 \text{ mA}$		-4.5		$\text{mV}/\text{C}$
$I_{DSS}$	Zero gate voltage drain current	$V_{DS} = 1200 \text{ V}$ , $V_{GS} = 0 \text{ V}$			100	$\mu\text{A}$
		$V_{DS} = 1200 \text{ V}$ , $T_J = 125 \text{ }^\circ\text{C}$ , $V_{GS} = 0 \text{ V}$			500	
$I_{GSS}$	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 the MSC080SMA120J device.  $T_J = 25 \text{ }^\circ\text{C}$  unless otherwise specified.

**Table 1-4. Dynamic Characteristics**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$C_{iss}$	Input capacitance	$V_{GS} = 0 \text{ V}$ , $V_{DD} = 1000 \text{ V}$ $V_{AC} = 25 \text{ mV}$ , $f = 1 \text{ MHz}$		838		pF
$C_{rss}$	Reverse transfer capacitance			9		
$C_{oss}$	Output capacitance			84		
$Q_g$	Total gate charge	$V_{GS} = -5 \text{ V}/20 \text{ V}$ , $V_{DD} = 800 \text{ V}$ $I_D = 15 \text{ A}$		64		nC
$Q_{gs}$	Gate-source charge			12		
$Q_{gd}$	Gate-drain charge			19		

.....continued

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 850 \text{ V}$ , $V_{GS} = -5 \text{ V}/20 \text{ V}$ $I_D = 20 \text{ A}$ , $R_{g(ext)} = 4 \Omega$		14		ns
$t_r$	Voltage rise time	Freewheeling diode = MSC080SMA120J ( $V_{GS} = -5\text{V}$ ) (reference Fig. 1-17)		14		
$t_{d(off)}$	Turn-off delay time			19		
$t_f$	Voltage fall time			13		
$E_{on}$	Turn-on switching energy			350		$\mu\text{J}$
$E_{off}$	Turn-off switching energy			65		
ESR	Equivalent series resistance	$f = 1 \text{ MHz}$ , 25 mV, drain short		1.9		$\Omega$
SCWT	Short circuit withstand time	$V_{DS} = 960 \text{ V}$ , $V_{GS} = 20 \text{ V}$		3		$\mu\text{s}$
$E_{AS}$	Avalanche energy, single pulse	$V_{DS} = 150 \text{ V}$ , $I_D = 15 \text{ A}$		1000		$\text{mJ}$

The following table shows the body diode characteristics of the MSC080SMA120J device.  $T_J = 25 \text{ }^\circ\text{C}$  unless otherwise specified.

Table 1-5. Body Diode Characteristics

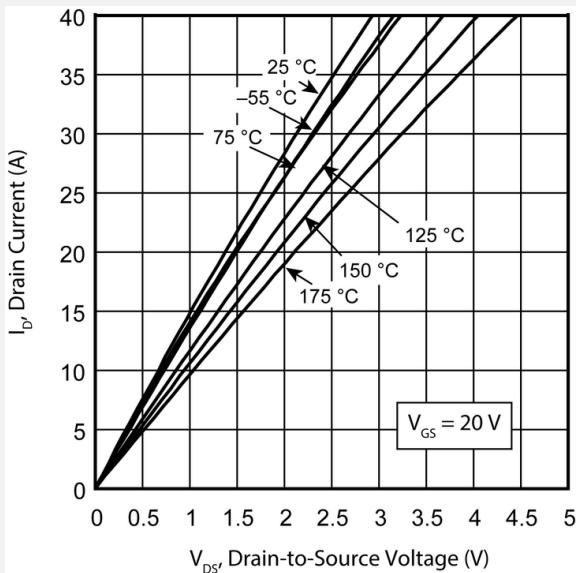
Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$V_{SD}$	Diode forward voltage	$I_{SD} = 15 \text{ A}$ , $V_{GS} = 0 \text{ V}$		4.0		$\text{V}$
		$I_{SD} = 15 \text{ A}$ , $V_{GS} = -5 \text{ V}$		4.2		
$t_{rr}$	Reverse recovery time	$I_{SD} = 15 \text{ A}$ , $V_{GS} = -5 \text{ V}$		34		ns
$Q_{rr}$	Reverse recovery charge	$V_{DD} = 800 \text{ V}$ , $dI/dt = -1000 \text{ A}/\mu\text{s}$		200		$\text{nC}$
$I_{RRM}$	Reverse recovery current			6.5		A

## 1.3

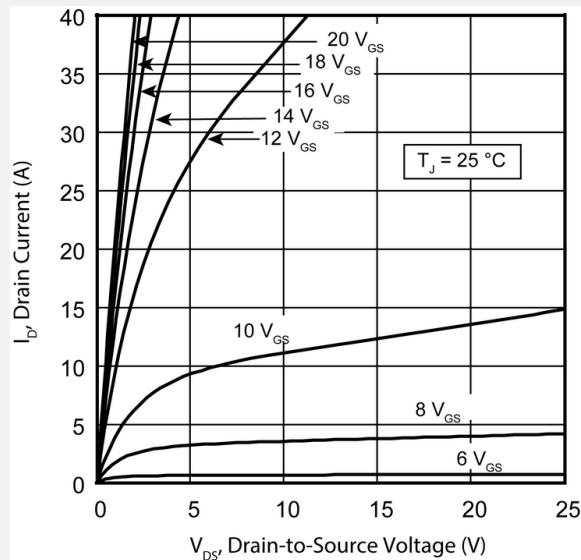
## Typical Performance Curves

This section shows the typical performance curves of the MSC080SMA120J device.

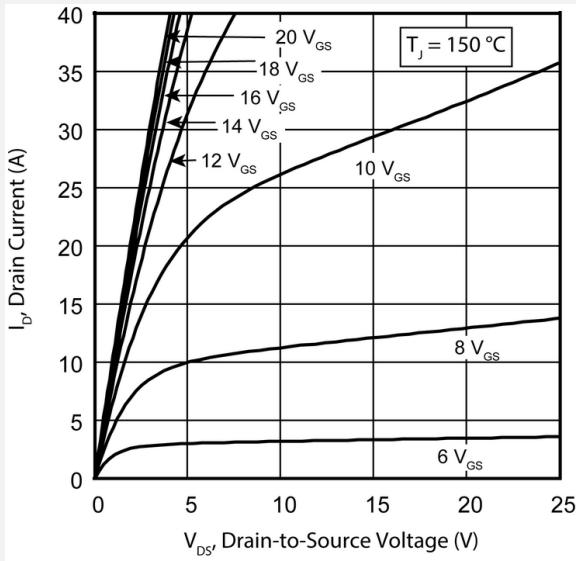
**Figure 1-1. Drain Current vs.  $V_{DS}$  at  $T_J$**



**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  $V_{GS}$**

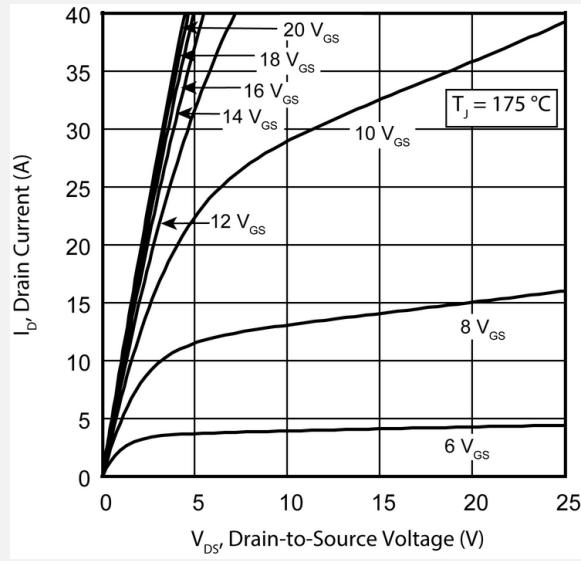


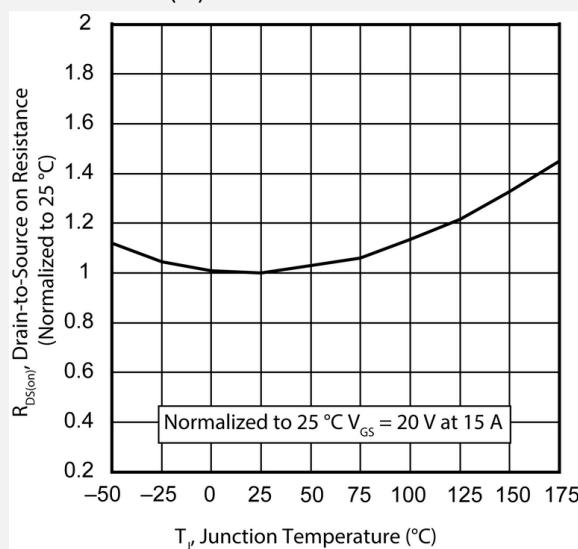
Figure 1-5.  $R_{DS(on)}$  vs. Junction Temperature

Figure 1-6. Gate Charge Characteristics

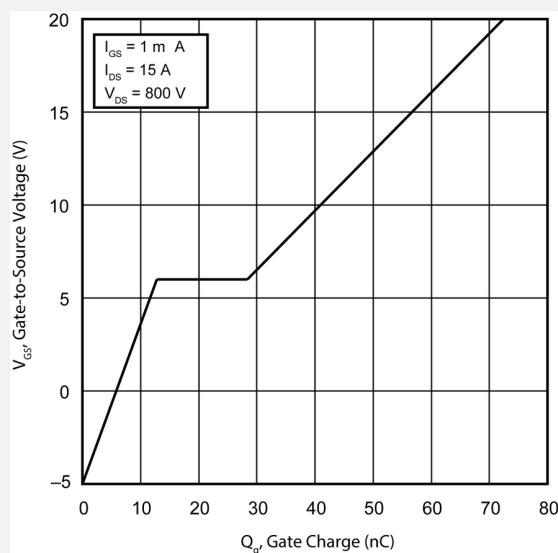
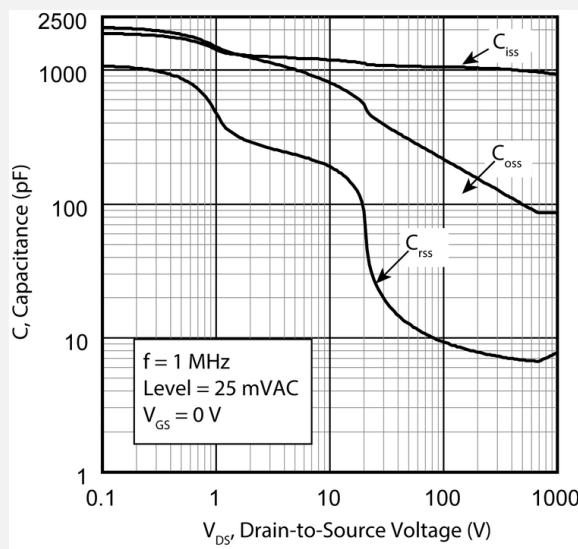
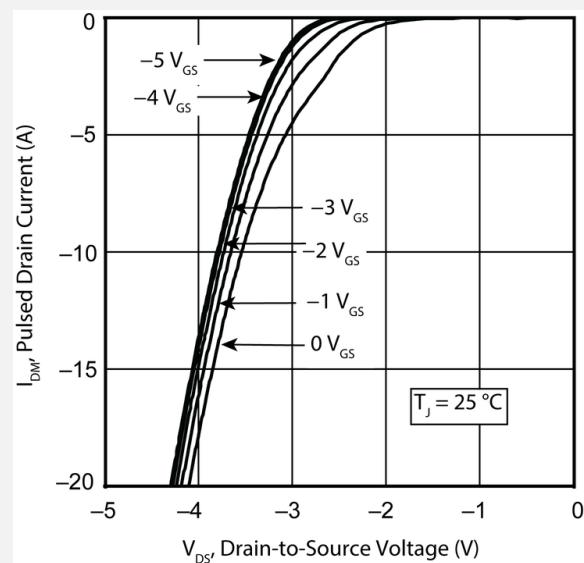


Figure 1-7. Capacitance vs. Drain-to-Source Voltage

Figure 1-8.  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction

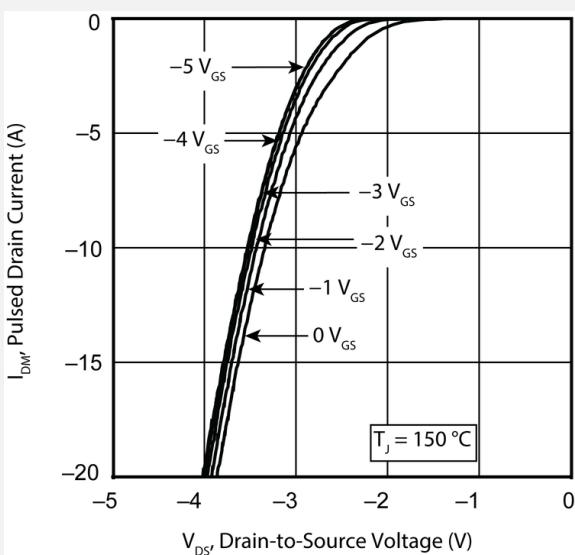
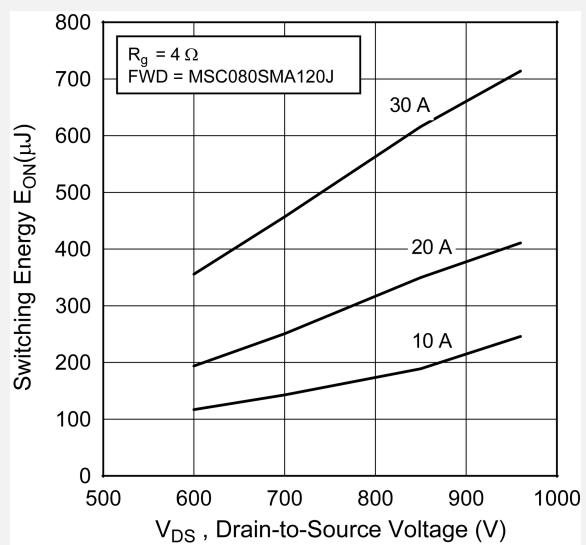
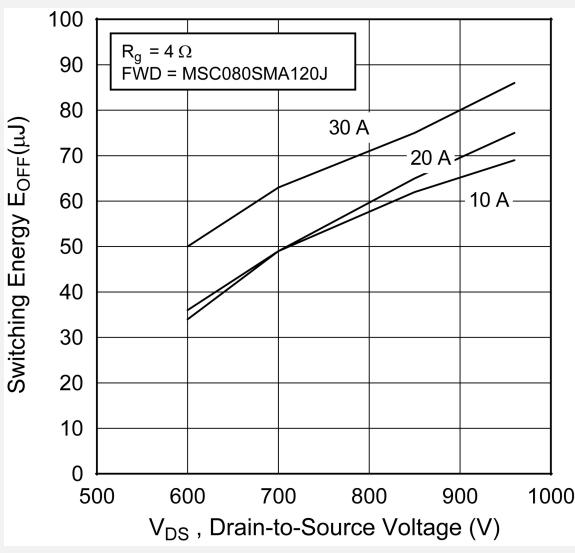
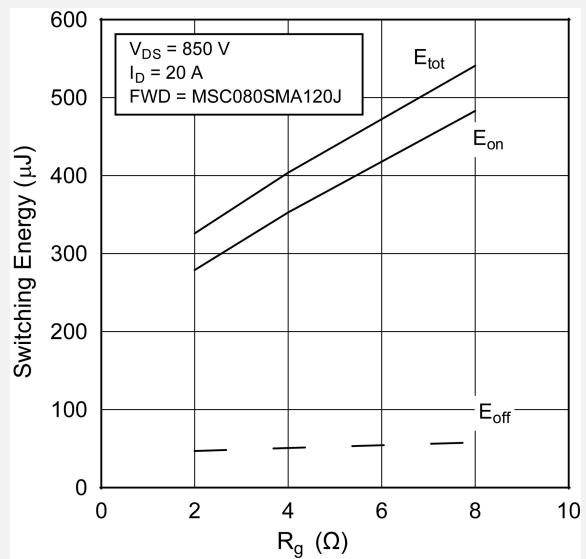
**Figure 1-9.  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction****Figure 1-10. Switching Energy  $E_{on}$  vs.  $V_{DS}$  &  $I_D$** **Figure 1-11. Switching Energy  $E_{off}$  vs.  $V_{DS}$  &  $I_D$** **Figure 1-12. Switching Energy vs.  $R_g$** 

Figure 1-13. Switching Energy vs. Temperature

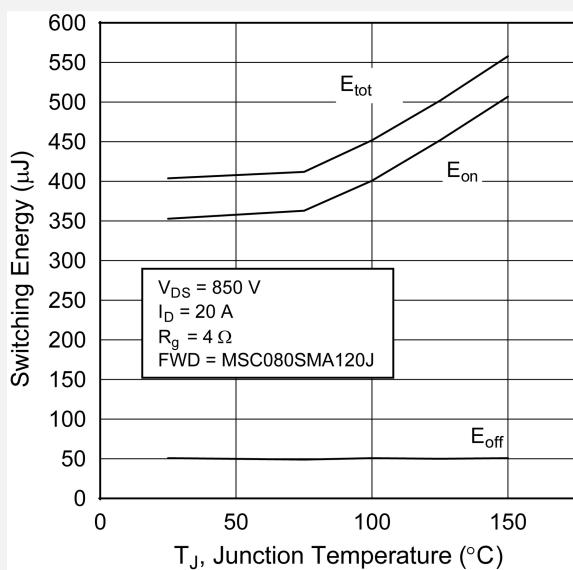


Figure 1-14. Threshold Voltage vs. Junction Temp.

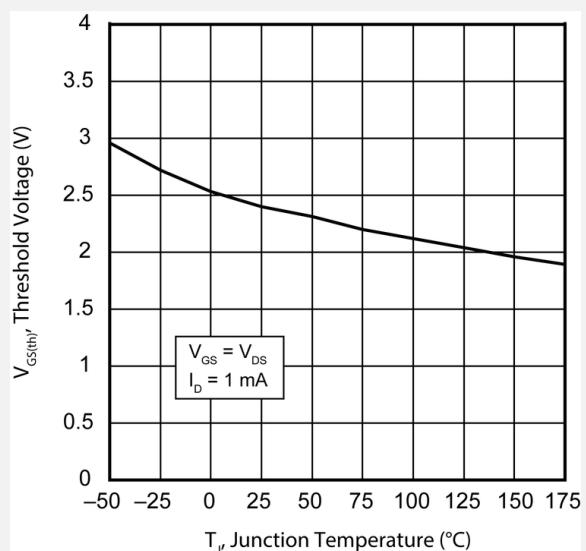
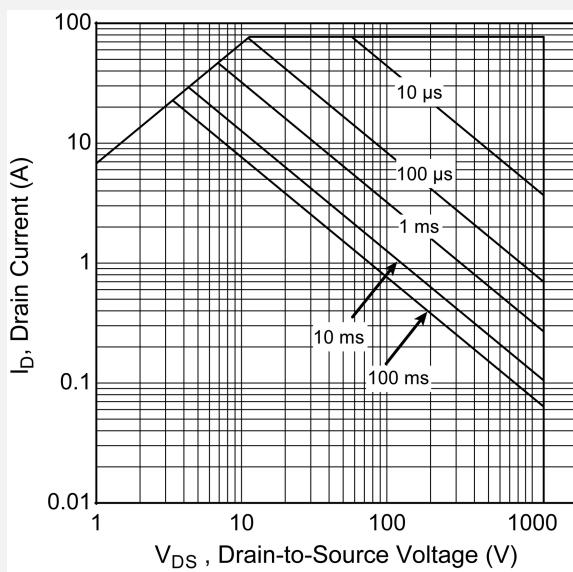
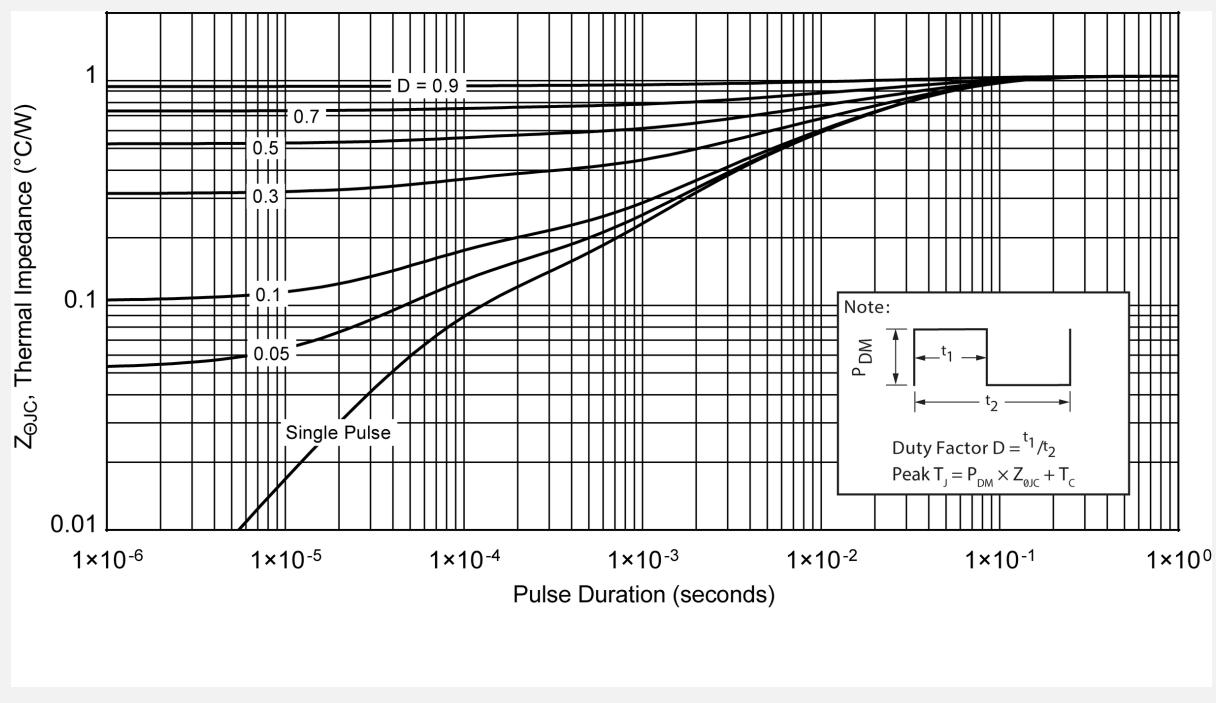
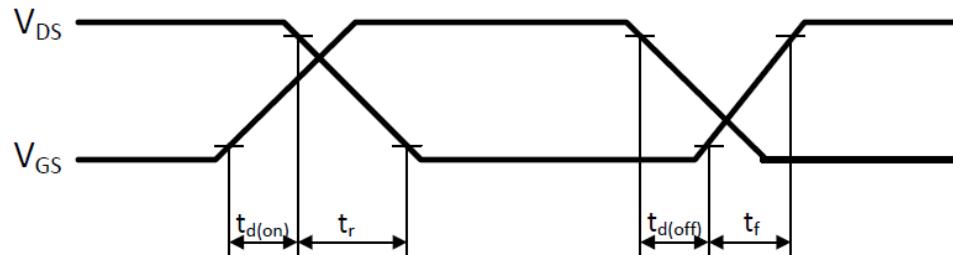


Figure 1-15. Forward Safe Operating Area



**Figure 1-16. Maximum Transient Thermal Impedance**

The following figure shows the switching waveform diagram of the MSC080SMA120J device.

**Figure 1-17. Switching Waveform**

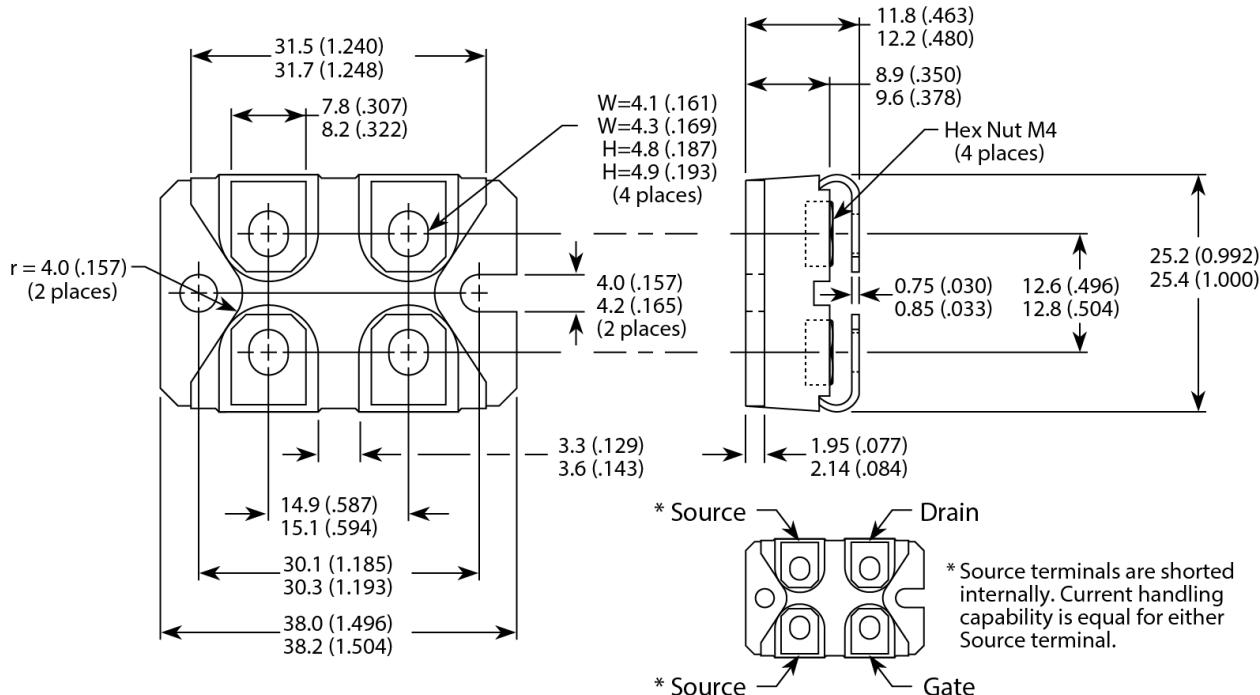
## 2. Package Specification

This section shows the package specification of the MSC080SMA120J device.

### 2.1 Package Outline Drawing

The following figure illustrates the SOT-227 package outline of the MSC080SMA120J device. The dimensions in the figure below are in millimeters and (inches).

Figure 2-1. Package Outline Drawing



### 3. Revision History

**Table 3-1. Revision History**

Revision	Date	Description
A	06/2021	Document migrated from Microsemi template to Microchip template; Assigned Microchip literature number DS-00004138A, which replaces the previous Microsemi literature number 050-7767.
Initial release (Microsemi Revision A)	02/2020	Document created.

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