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**Silicon Carbide N-Channel Power MOSFET**

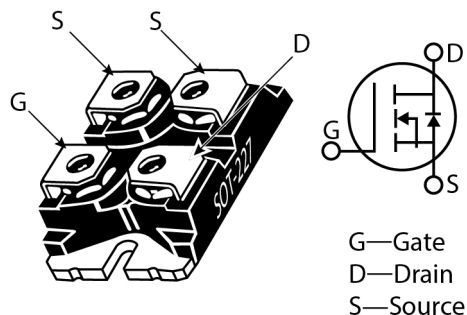
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**Product Overview**

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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,  $T_{J(max)} = 175\text{ }^{\circ}\text{C}$
- 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 $T_C = 25\text{ }^\circ\text{C}$	31	A
	Continuous drain current at $T_C = 100\text{ }^\circ\text{C}$	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 $T_C = 25\text{ }^\circ\text{C}$	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	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.  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise specified.

# MSC080SMA120J

## Device Specifications

**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	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		mV/ $^{\circ}\text{C}$
$I_{DSS}$	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	$V_{GS} = 0\text{ V}, V_{DD} = 1000\text{ V}$		838		pF
$C_{rss}$	Reverse transfer capacitance	$V_{AC} = 25\text{ mV}, f = 1\text{ MHz}$		9		
$C_{oss}$	Output capacitance			84		
$Q_g$	Total gate charge	$V_{GS} = -5\text{ V}/20\text{ V}, V_{DD} = 800\text{ V}$		64		nC
$Q_{gs}$	Gate-source charge	$I_D = 15\text{ A}$		12		
$Q_{gd}$	Gate-drain charge			19		

# MSC080SMA120J

## Device Specifications

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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	
$E_{off}$	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		mJ

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

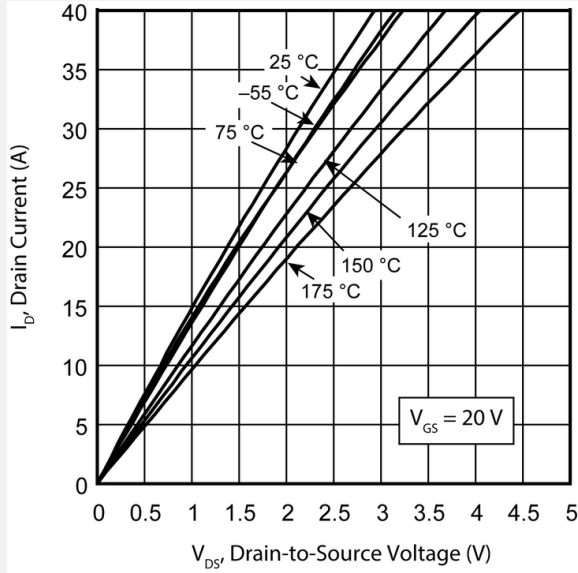
**Table 1-5. Body Diode Characteristics**

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		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		nC
$I_{RRM}$	Reverse recovery current			6.5		A

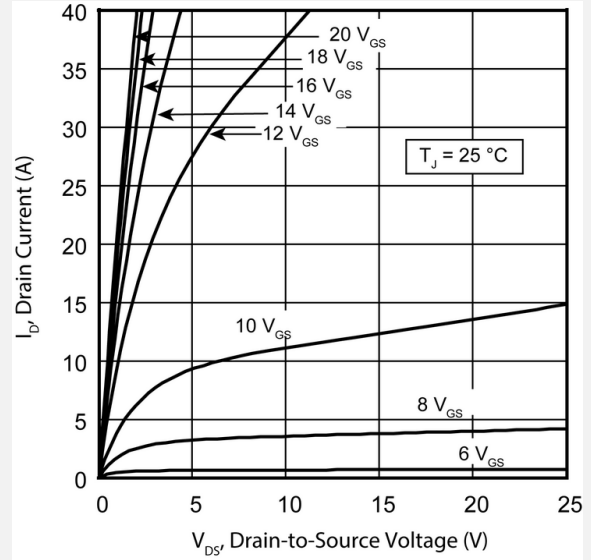
### 1.3 Typical Performance Curves

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

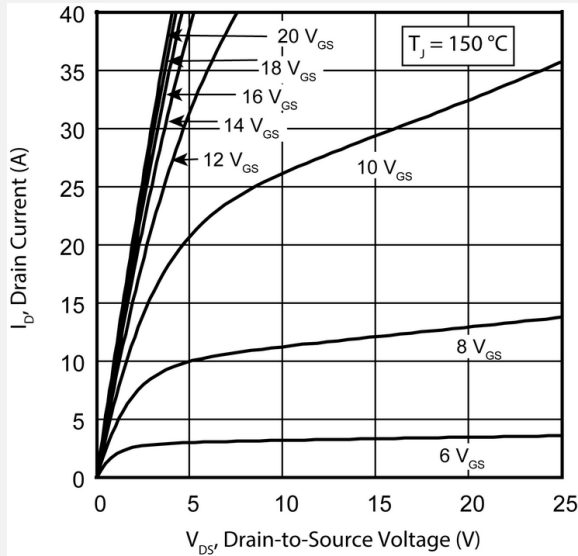
**Figure 1-1. Drain Current vs.  $V_{DS}$  at  $T_J$**



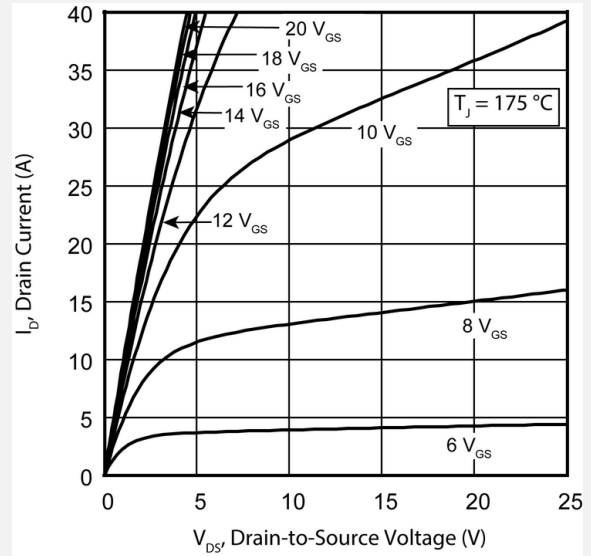
**Figure 1-2. Drain Current vs.  $V_{DS}$  at  $V_{GS}$**



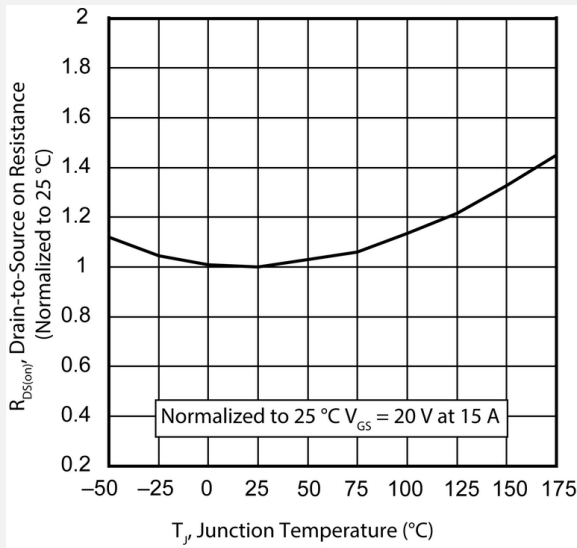
**Figure 1-3. Drain Current vs.  $V_{DS}$  at  $V_{GS}$**



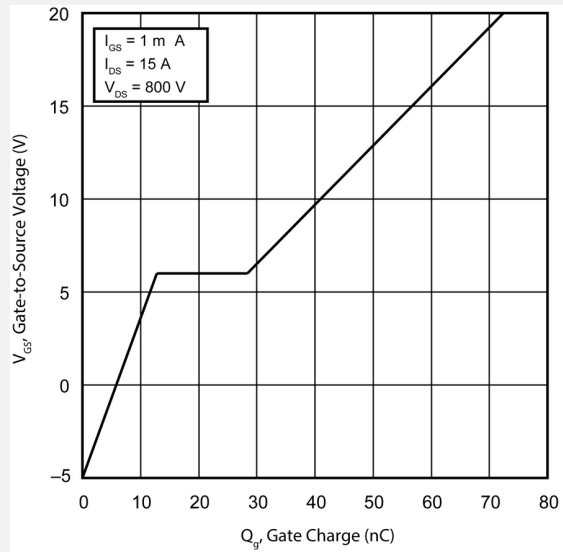
**Figure 1-4. Drain Current vs.  $V_{DS}$  at  $V_{GS}$**



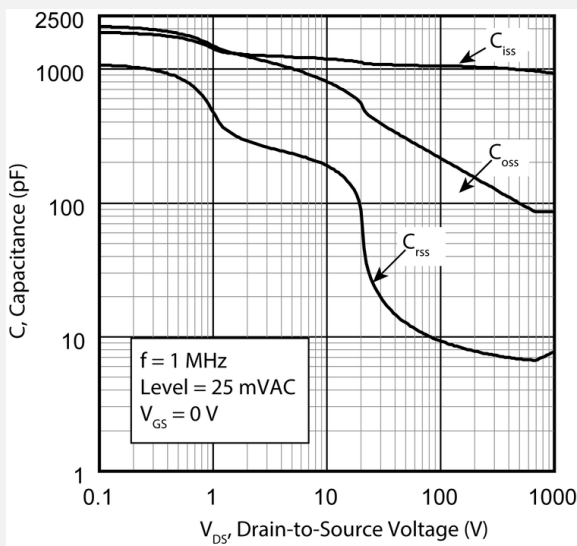
**Figure 1-5.  $R_{DS(on)}$  vs. Junction Temperature**



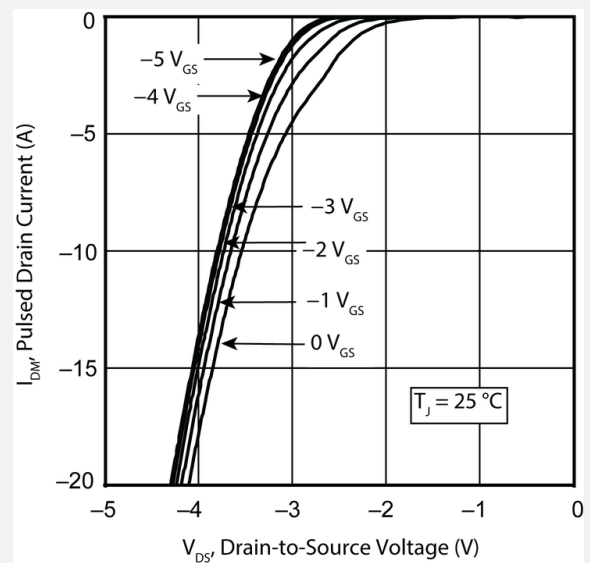
**Figure 1-6. Gate Charge Characteristics**



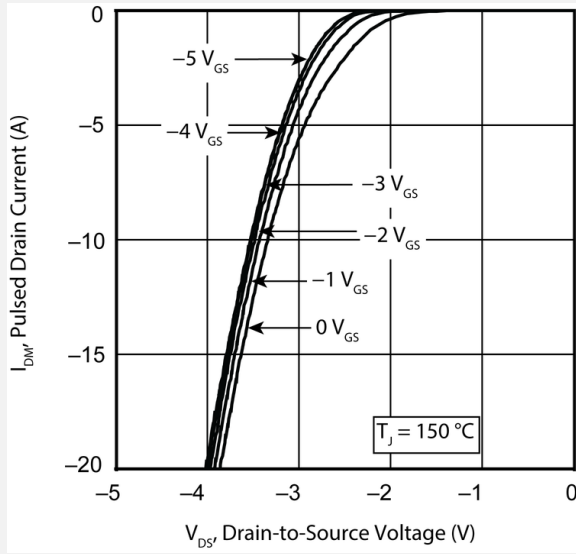
**Figure 1-7. Capacitance vs. Drain-to-Source Voltage**



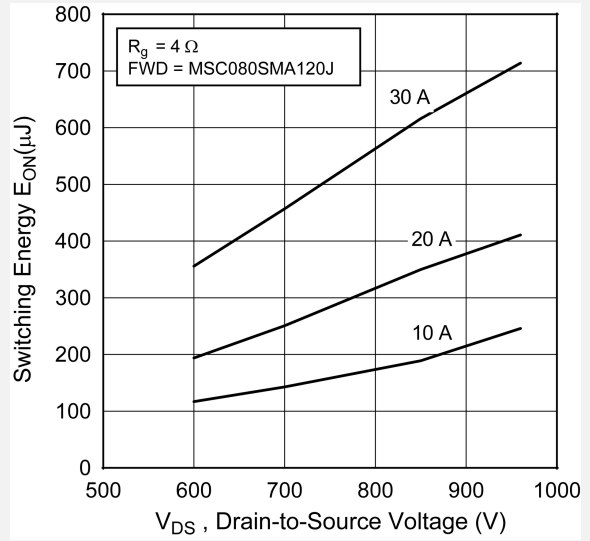
**Figure 1-8.  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction**



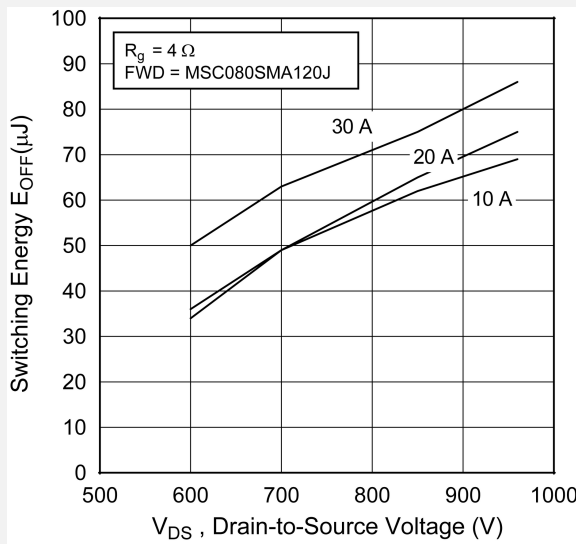
**Figure 1-9.  $I_{D(r)}$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction**



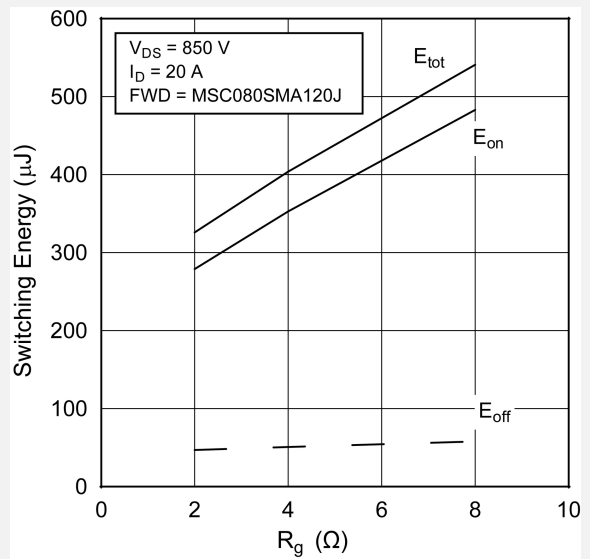
**Figure 1-10. Switching Energy  $E_{on}$  vs.  $V_{DS}$  &  $I_D$**



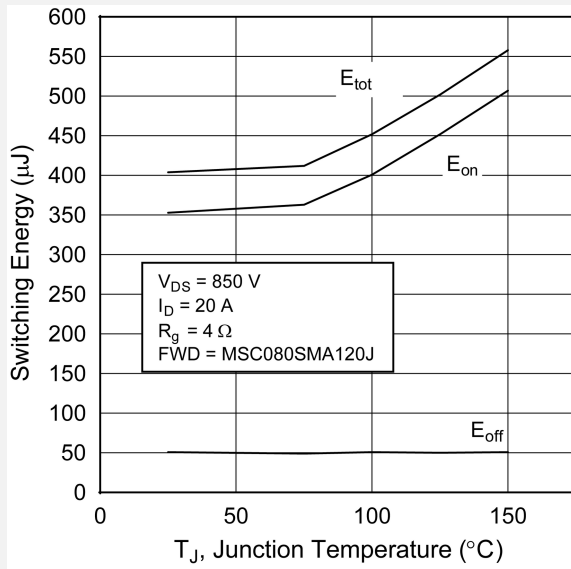
**Figure 1-11. Switching Energy  $E_{off}$  vs.  $V_{DS}$  &  $I_D$**



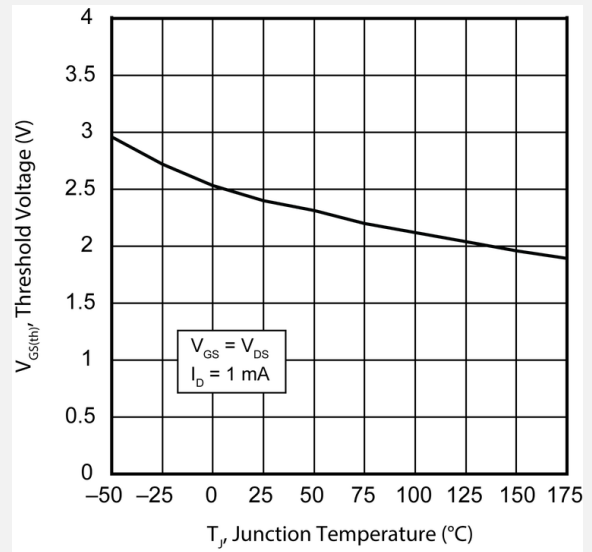
**Figure 1-12. Switching Energy vs.  $R_g$**



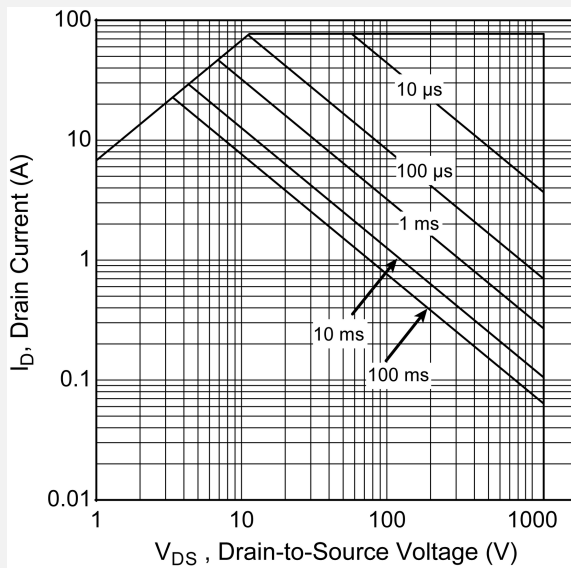
**Figure 1-13. Switching Energy vs. Temperature**



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

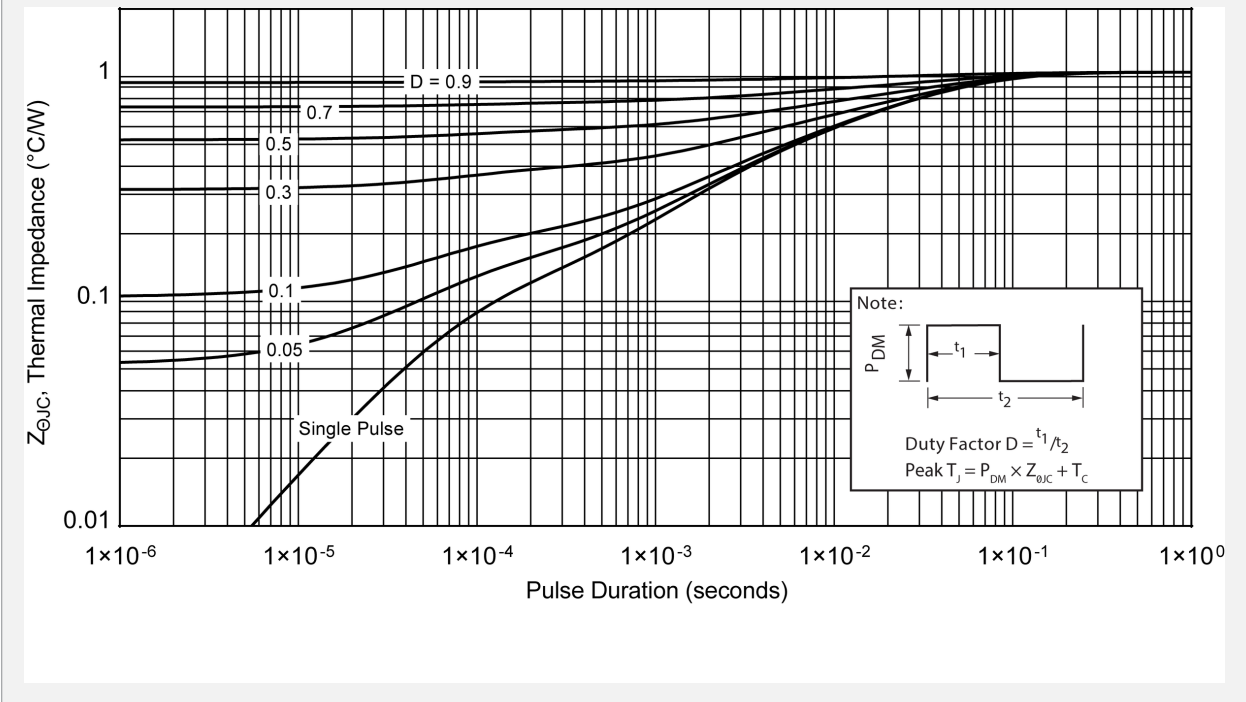


**Figure 1-15. Forward Safe Operating Area**



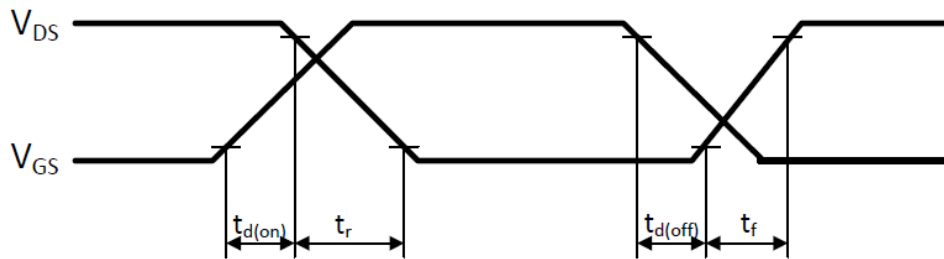


**Figure 1-16. Maximum Transient Thermal Impedance**



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

**Figure 1-17. Switching Waveform**



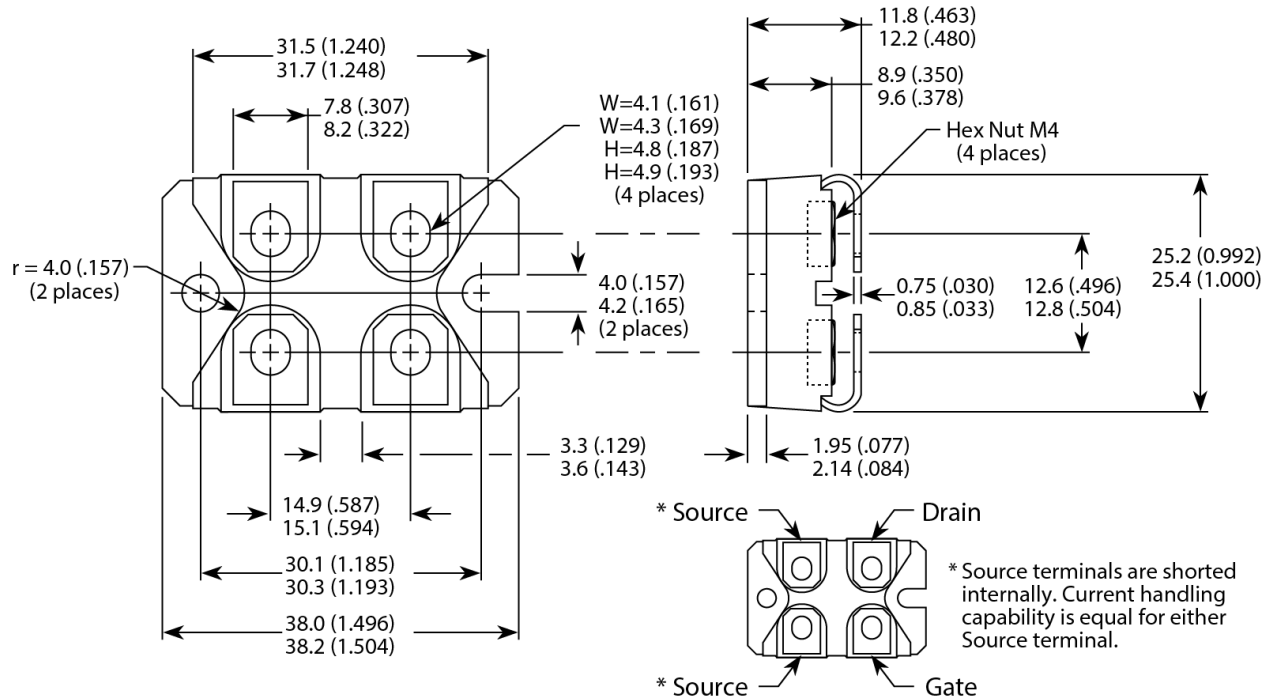
## 2. Package Specification

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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ISBN: 978-1-5224-8673-2

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