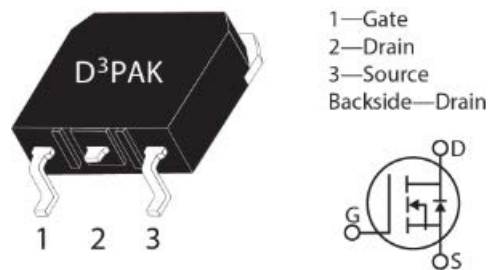

Silicon Carbide N-Channel Power MOSFET

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 MSC180SMA120S device is a 1200 V, 180 mΩ SiC MOSFET in a TO-268 (D3PAK) package.

**Features**

The following are key features of the MSC180SMA120S 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

Benefits

The following are benefits of the MSC180SMA120S 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 MSC180SMA120S 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 MSC180SMA120S device..

1.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings of the MSC180SMA120S 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 ¹	40	
V_{GS}	Gate-source voltage	23 to -10	V
P_D	Total power dissipation at $T_C = 25\text{ }^{\circ}\text{C}$	125	W
	Linear derating factor	0.85	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 MSC180SMA120S 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	1.18	$^{\circ}\text{C}/\text{W}$
T_J	Operating junction temperature	-55		175	$^{\circ}\text{C}$
T_{STG}	Storage temperature	-55		150	$^{\circ}\text{C}$
T_L	Soldering temperature for 10 seconds (1.6 mm from case)			300	$^{\circ}\text{C}$
Wt	Package weight		0.14		oz
			4.0		g

1.2 Electrical Performance

The following table shows the static characteristics of the MSC180SMA120S 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 ¹	$V_{GS} = 20\text{ V}$, $I_D = 8\text{ A}$		180	225	m Ω
$V_{GS(th)}$	Gate-source threshold voltage	$V_{GS} = V_{DS}$, $I_D = 500\text{ }\mu\text{A}$	1.9	3.26		V

.....continued

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$\Delta V_{GS(th)}/\Delta T_J$	Threshold voltage coefficient	$V_{GS} = V_{DS}$, $I_D = 500 \mu A$		-5.8		mV/°C
I_{DSS}	Zero gate voltage drain current	$V_{DS} = 1200 V$, $V_{GS} = 0 V$			100	μA
		$V_{DS} = 1200 V$, $V_{GS} = 0 V$, $T_J = 125^\circ C$			500	
I_{GSS}	Gate-source leakage current	$V_{GS} = 20 V/-10 V$			± 100	nA

Note:

1. Pulse test: pulse width < 380 μs , duty cycle < 2%.

The following table shows the dynamic characteristics of the MSC180SMA120S device. $T_J = 25^\circ C$ unless otherwise specified.

Table 1-4. Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
C_{iss}	Input capacitance	$V_{GS} = 0 V$, $V_{DD} = 1000 V$, $V_{AC} = 25 mV$, $f = 1 MHz$		510		pF
C_{rss}	Reverse transfer capacitance			4		
C_{oss}	Output capacitance			45		
Q_g	Total gate charge	$V_{GS} = -5 V/20 V$, $V_{DD} = 800 V$, $I_D = 40 A$		34		nC
Q_{gs}	Gate-source charge			10		
Q_{gd}	Gate-drain charge			9		
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 800 V$, $V_{GS} = -5 V/20 V$, $I_D = 10 A$, $R_{g(ext)} = 8.0 \Omega$, Freewheeling diode = MSC180SMA120S ($V_{GS} = -5 V$)				ns
t_r	Voltage rise time					
$t_{d(off)}$	Turn-off delay time					
t_f	Voltage fall time					
E_{on}	Turn-on switching energy			210		μJ
E_{off}	Turn-off switching energy			23		
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 800 V$, $V_{GS} = -5 V/20 V$, $I_D = 10 A$, $R_{g(ext)} = 8.0 \Omega$, Freewheeling diode = MSC010SDA120B				ns
t_r	Voltage rise time					
$t_{d(off)}$	Turn-off delay time					
t_f	Voltage fall time					
E_{on}	Turn-on switching energy			170		μJ
E_{off}	Turn-off switching energy			23		
ESR	Equivalent series resistance	$f = 1 MHz$, 25 mV, drain short		3.29		Ω
SCWT	Short circuit withstand time	$V_{DS} = 960 V$, $V_{GS} = 20 V$				μs
E_{AS}	Avalanche energy, single pulse	$V_{DS} = 150 V$, $I_D = 30 A$				mJ

The following table shows the body diode characteristics of the MSC180SMA120S device. $T_J = 25^\circ\text{C}$ unless otherwise specified.

Table 1-5. Body Diode Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
V_{SD}	Diode forward voltage	$I_{SD} = 0\text{ V}, V_{GS} = 0\text{ V}$		3.81		V
		$I_{SD} = 0\text{ V}, V_{GS} = -5\text{ V}$		3.96		
t_{rr}	Reverse recovery time	$I_{SD} = 10\text{ A}, V_{GS} = -5\text{ V}, V_{DD} = 800\text{ V}, dl/dt = -1120\text{ A}/\mu\text{s}, \text{Drive } R_g = 8\ \Omega$		28		ns
Q_{rr}	Reverse recovery charge			88		nC
I_{RRM}	Reverse recovery current			4.2		A

1.3 Typical Performance Curves

This section shows the typical performance curves of the MSC180SMA120S device.

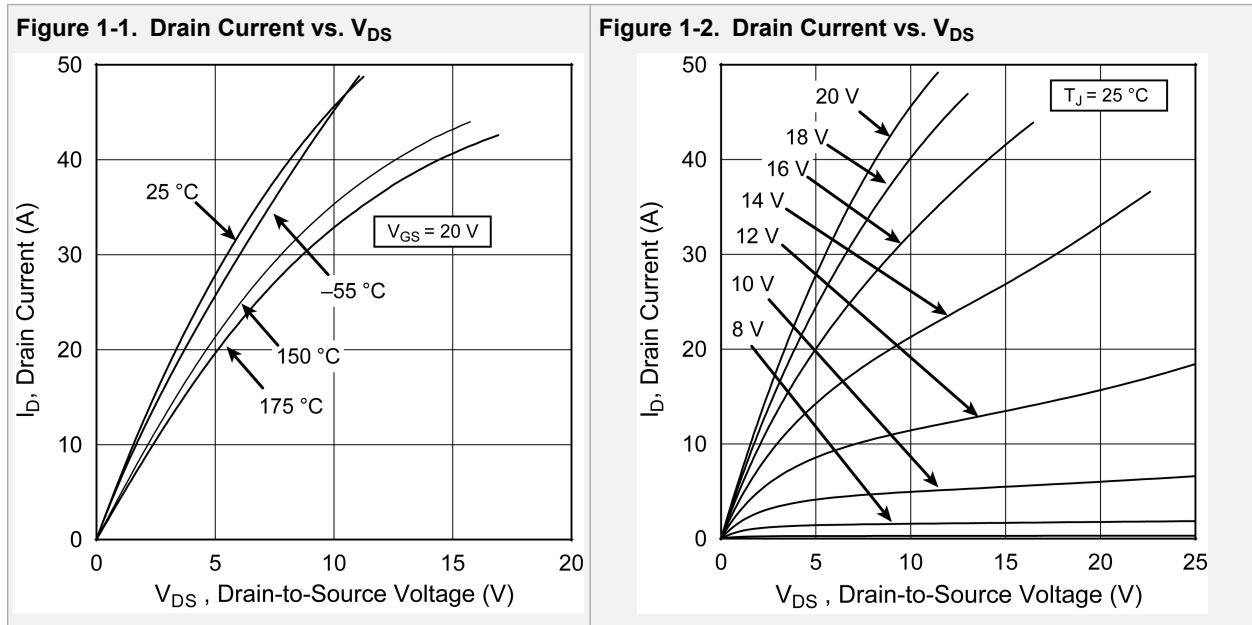


Figure 1-3. Drain Current vs. V_{DS}

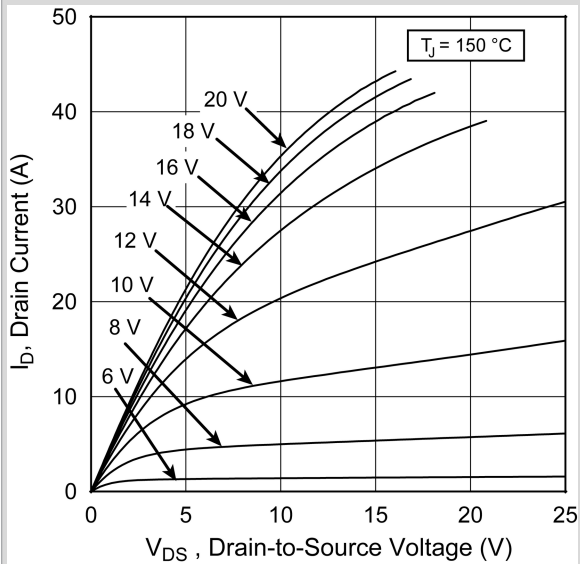


Figure 1-4. Drain Current vs. V_{DS}

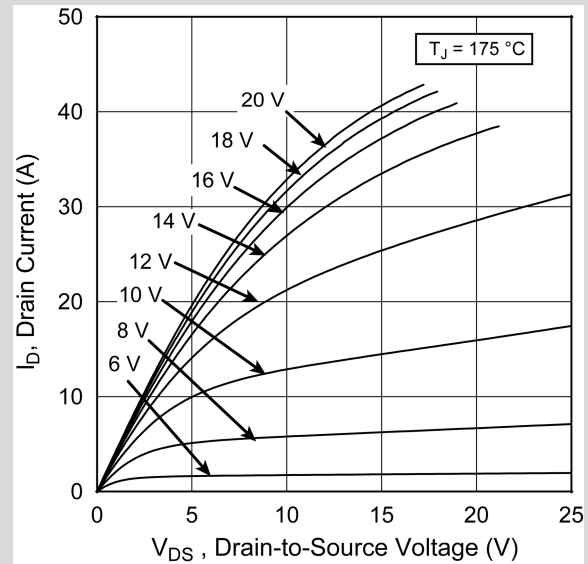


Figure 1-5. $R_{DS(on)}$ vs. Junction Temperature

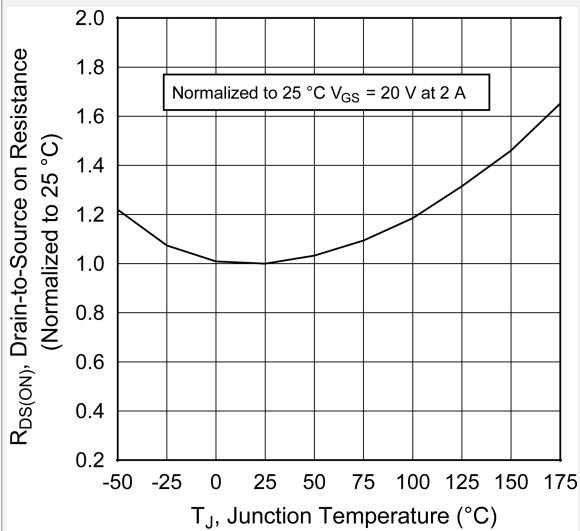


Figure 1-6. Gate Charge Characteristics

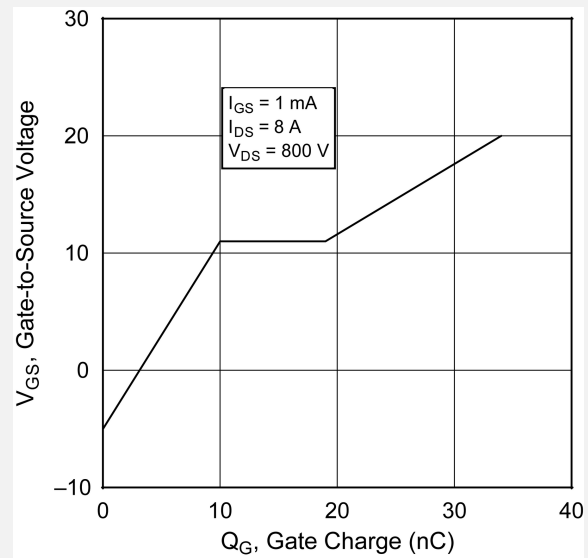


Figure 1-7. Capacitance vs. Drain-to-Source Voltage

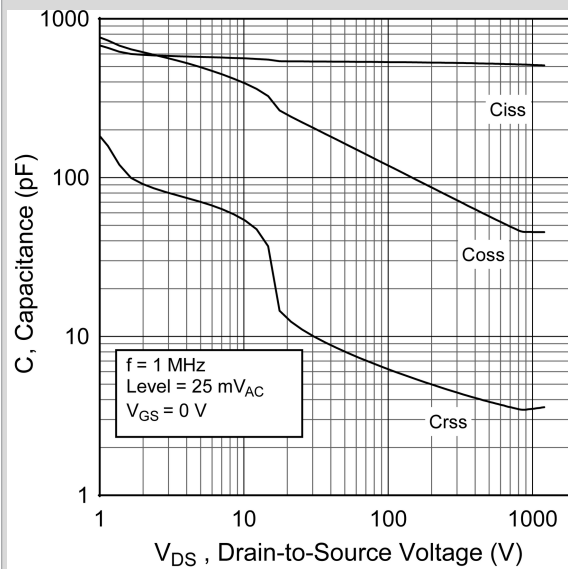


Figure 1-8. I_D vs. V_{DS} 3rd Quadrant Conduction

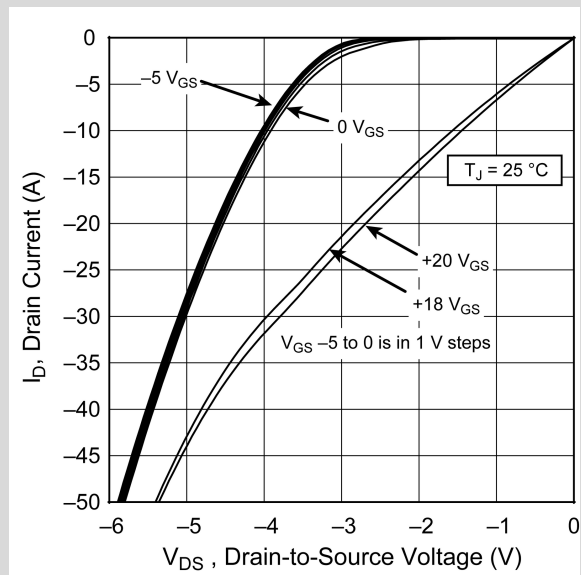


Figure 1-9. I_D vs. V_{DS} 3rd Quadrant Conduction

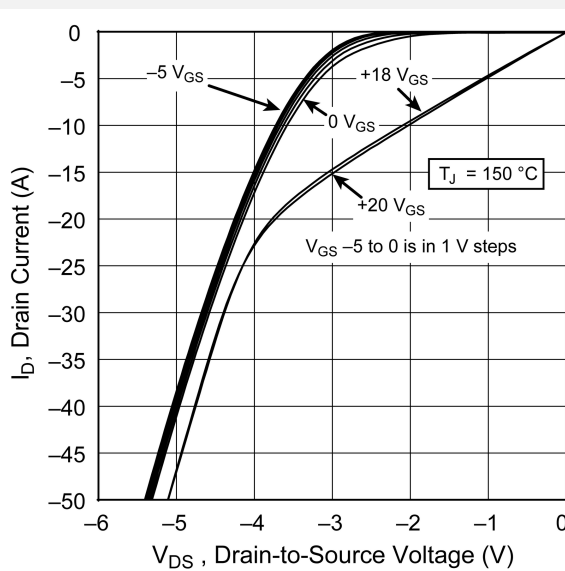
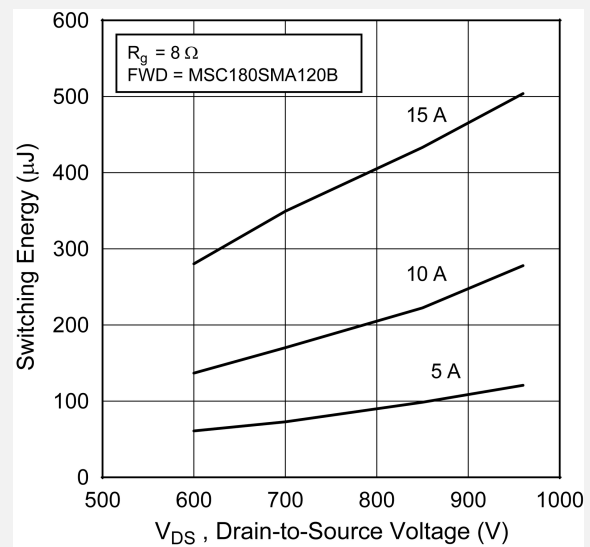


Figure 1-10. Switching Energy E_{on} vs. V_{DS} & I_D



MSC180SMA120S

Device Specifications

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

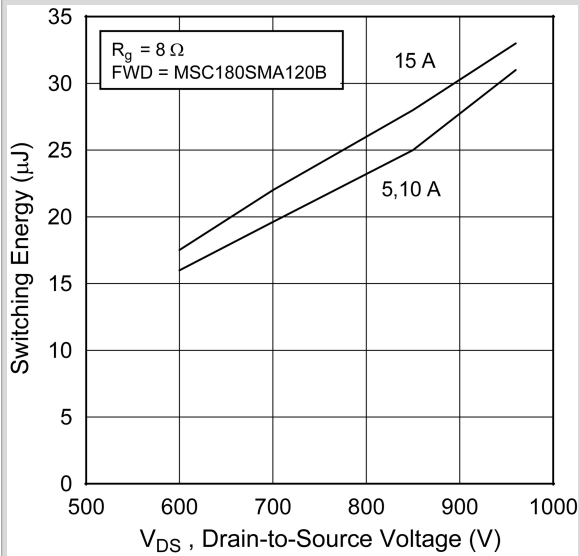


Figure 1-12. Switching Energy vs. R_g

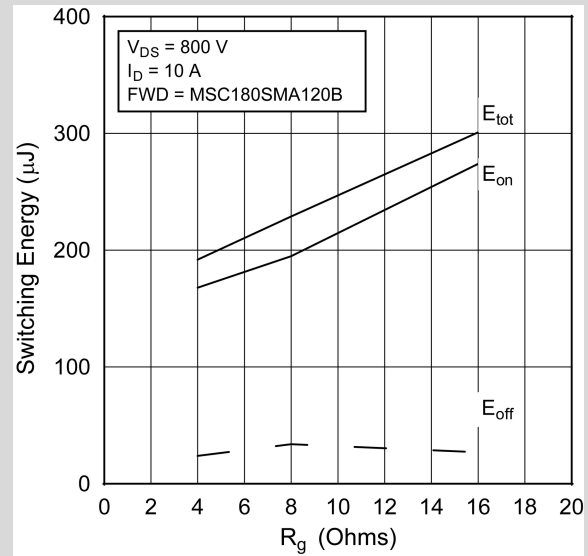


Figure 1-13. Switching Energy vs. Temperature

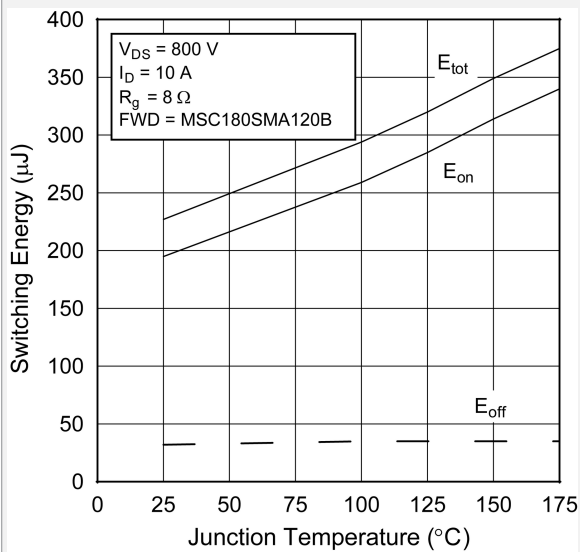


Figure 1-14. Switching Energy E_{on} vs. V_{DS} & I_D

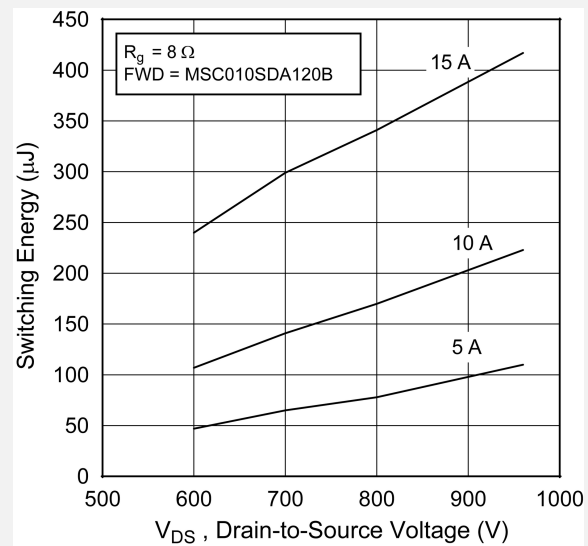


Figure 1-15. Switching Energy E_{off} vs. V_{DS} & I_D

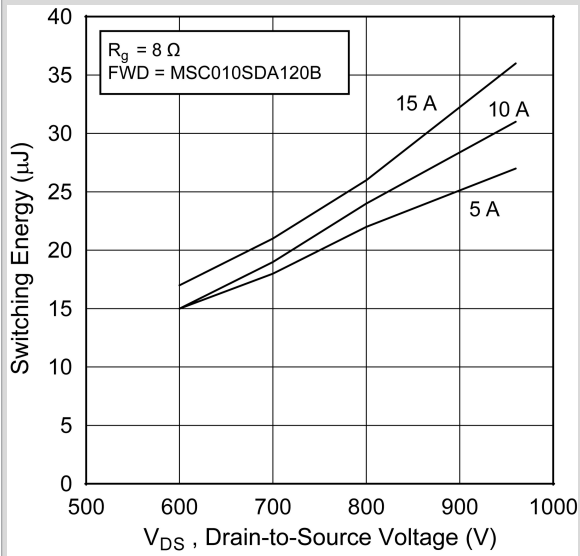


Figure 1-16. Switching Energy vs. R_g

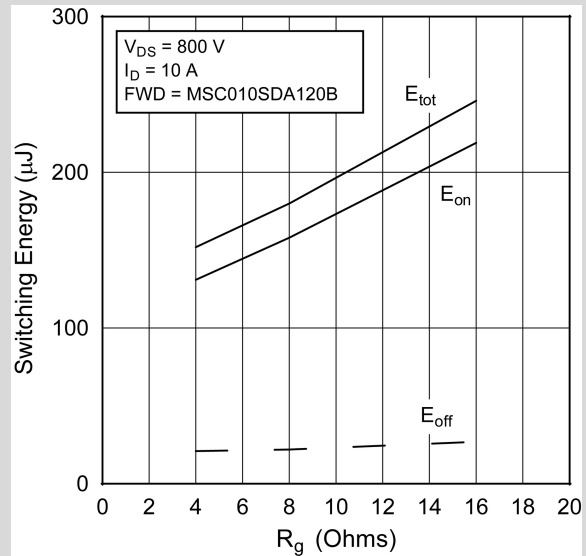


Figure 1-17. Threshold Voltage vs. Junction Temp.

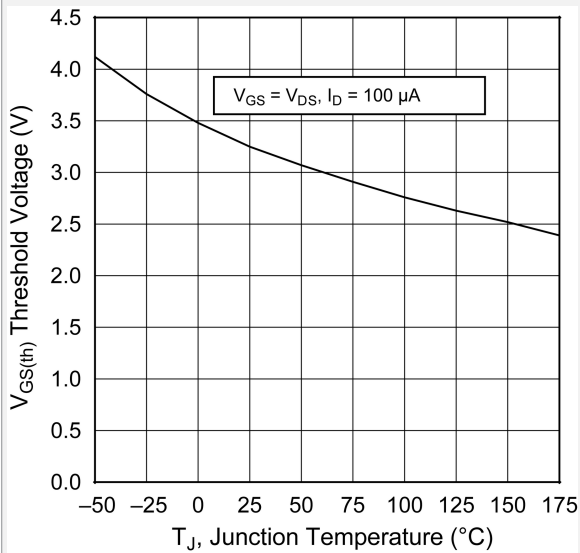


Figure 1-18. Forward Safe Operating Area

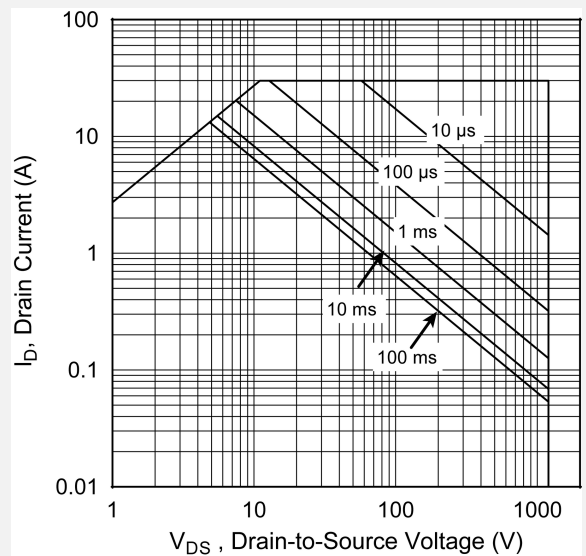
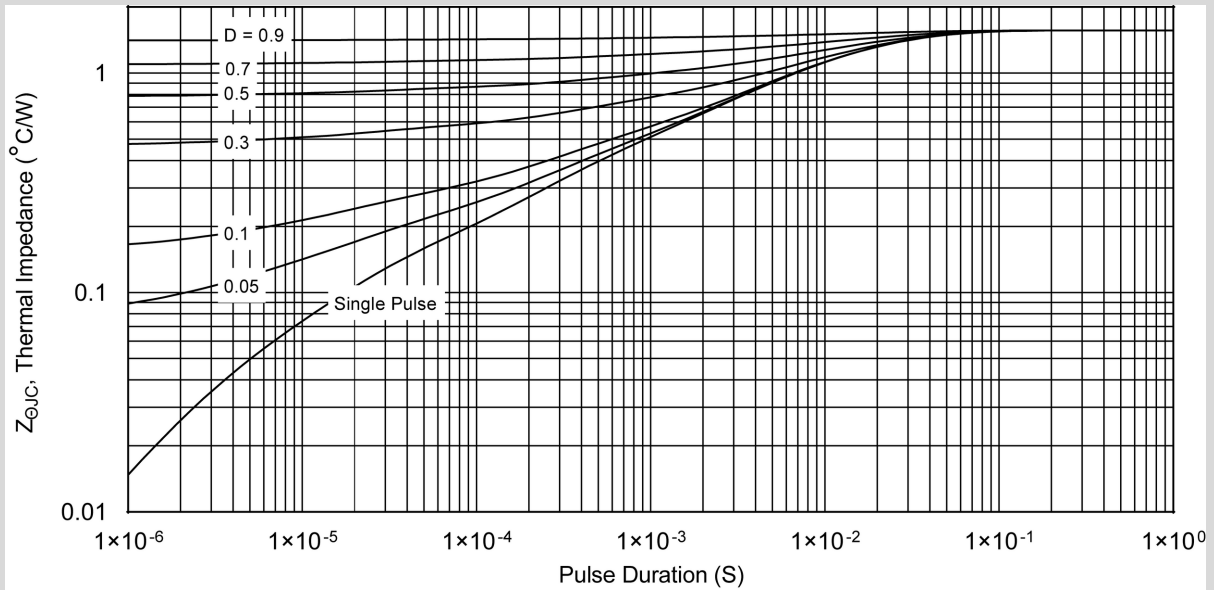
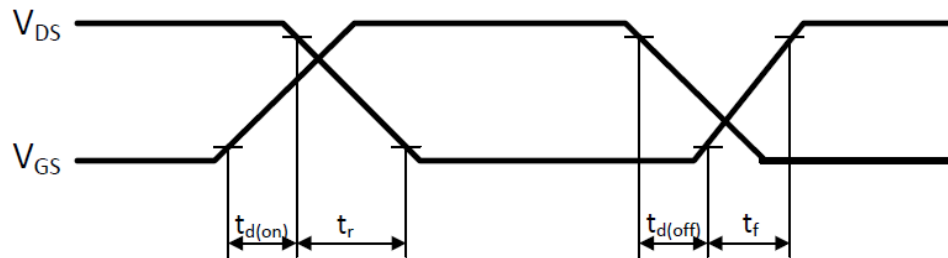


Figure 1-19. Maximum Transient Thermal Impedance



The following figure shows the switching waveform diagram of the MSC180SMA120S device.

Figure 1-20. Switching Waveform



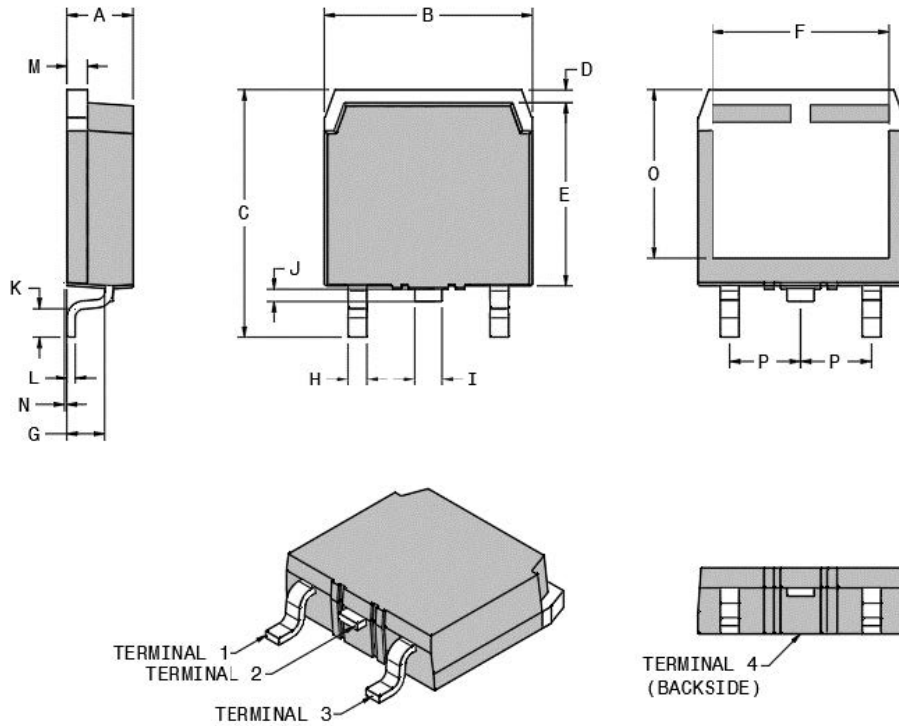
2. Package Specification

This section shows the package specification of the MSC180SMA120S device.

2.1 Package Outline Drawing

The following figure illustrates the TO-268 package outline of the MSC180SMA120S device.

Figure 2-1. Package Outline Drawing



The following table shows the TO-268 dimensions and should be used in conjunction with the package outline drawing.

Table 2-1. TO-268 Dimensions

Symbol	Min (mm)	Max (mm)	Min (in.)	Max (in.)
A	4.90	5.10	0.193	0.201
B	15.85	16.20	0.624	0.638
C	18.70	19.10	0.736	0.752
D	1.00	1.025	0.039	0.049
E	13.80	14.00	0.543	0.551
F	13.30	13.60	0.524	0.535
G	2.70	2.90	0.106	0.114
H	1.15	1.45	0.045	0.057
I	1.95	2.21	0.077	0.087

MSC180SMA120S

Package Specification

.....continued				
Symbol	Min (mm)	Max (mm)	Min (in.)	Max (in.)
J	0.94	1.40	0.037	0.055
K	2.40	2.70	0.094	0.106
L	0.40	0.60	0.016	0.024
M	1.45	1.60	0.057	0.063
N	0.00	0.018	0.00	0.007
O	12.40	12.70	0.488	0.500
P	5.45 BSC (nom.)		0.215 BSC (nom.)	
Terminal 1	Gate			
Terminal 2	Drain			
Terminal 3	Source			
Terminal 4	Drain			

3. Revision History

Table 3-1. Revision History

Revision	Date	Description
A	03/2021	Document created.

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