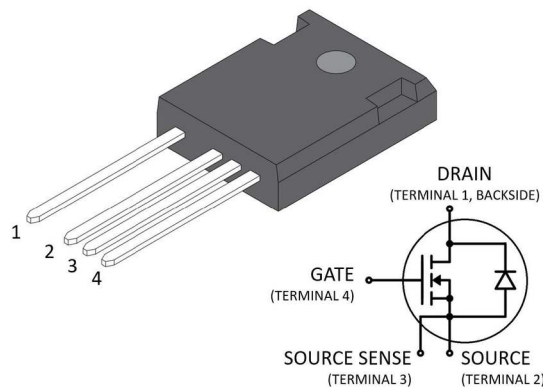

3300 V, 400 mΩ SiC N-Channel Power MOSFET

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 MSC400SMA330B4 device is a 3300 V, 400 mΩ SiC MOSFET in a TO-247 4-lead package with a source sense.

**Features**

The following are key features of the MSC400SMA330B4 device:

- Low capacitances and low gate charge
- Fast switching speed due to low internal gate resistance (ESR)
- Stable operation at high junction temperature, $T_{J(max)} = 150\text{ }^{\circ}\text{C}$
- Fast and reliable body diode
- Superior avalanche ruggedness
- RoHS compliant

Benefits

The following are benefits of the MSC400SMA330B4 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 MSC400SMA330B4 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 MSC400SMA330B4 device.

1.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings of the MSC400SMA330B4 device.

Table 1-1. Absolute Maximum Ratings

Symbol	Parameter	Ratings	Unit
V_{DSS}	Drain source voltage	3300	V
I_D	Continuous drain current at $T_C = 25\text{ }^\circ\text{C}$	11	A
	Continuous drain current at $T_C = 100\text{ }^\circ\text{C}$	7	
I_{DM}	Pulsed drain current ¹	27	
V_{GS}	Gate-source voltage	23 to -10	V
P_D	Total power dissipation at $T_C = 25\text{ }^\circ\text{C}$	131	W
	Linear derating factor	1.05	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 MSC400SMA330B4 device.

Table 1-2. Thermal and Mechanical Characteristics

Symbol	Characteristic/Test Conditions	Min	Typ	Max	Unit
$R_{\theta JC}$	Junction-to-case thermal resistance		0.64	0.96	$^\circ\text{C}/\text{W}$
T_J	Operating junction temperature	-55		150	$^\circ\text{C}$
T_{STG}	Storage temperature	-55		150	$^\circ\text{C}$
T_L	Soldering temperature for 10 seconds (1.6 mm from case)			300	$^\circ\text{C}$
	Mounting torque, 6-32 or M3 screw			10	lbf-in
				1.1	N-m
W_t	Package weight		0.22		oz
			6.2		g

1.2 Electrical Performance

The following table shows the static characteristics of the MSC400SMA330B4 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	$V_{GS} = 0\text{ V}, I_D = 100\text{ }\mu\text{A}$	3300			V
$R_{DS(on)}$	Drain-source on resistance ¹	$V_{GS} = 20\text{ V}, I_D = 5\text{ A}$		416	520	m Ω

MSC400SMA330B4

Device Specifications

.....continued

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$V_{GS(th)}$	Gate-source threshold voltage	$V_{GS} = V_{DS}$, $I_D = 1$ mA	1.9	2.97		V
I_{DSS}	Zero gate voltage drain current	$V_{DS} = 3300$ V, $V_{GS} = 0$ V			100	μ A
		$V_{DS} = 3300$ V, $V_{GS} = 0$ V, $T_J = 125$ °C			500	
I_{GSS}	Gate-source leakage current	$V_{GS} = 20$ V/–10 V			± 100	nA

Note:

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

The following table shows the dynamic characteristics of the MSC400SMA330B4 device. $T_J = 25$ °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 $V_{DD} = 2400$ V		579		pF
C_{rSS}	Reverse transfer capacitance	$V_{AC} = 25$ mV		2		
C_{oss}	Output capacitance	$f = 200$ kHz		18		
Q_g	Total gate charge	$V_{DD} = 2600$ V $V_{GS} = -5$ V/20 V		37		nC
Q_{gs}	Gate-source charge	$I_D = 5$ A		10		
Q_{gd}	Gate-drain charge			10		
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 2310$ V		16		ns
t_r	Voltage rise time	$V_{GS} = -5$ V/20 V		8		
$t_{d(off)}$	Turn-off delay time	$I_D = 10$ A		16		
t_f	Voltage fall time	$R_{g(ext)} = 16$ Ω		20		
E_{on}	Turn-on switching energy	Freewheeling diode = MSC400SMA330B4 ($V_{GS} = -5$ V) (reference Fig. 1-17)		750		μ J
E_{off}	Turn-off switching energy			120		
ESR	Gate equivalent series resistance	$f = 1$ MHz, 25 mV, drain short		3.7		Ω

The following table shows the body diode characteristics of the MSC400SMA330B4 device. $T_J = 25$ °C unless otherwise specified.

Table 1-5. Body Diode Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
V_{SD}	Diode forward voltage	$I_{SD} = 5$ A, $V_{GS} = 0$ V		4.0		V
		$I_{SD} = 5$ A, $V_{GS} = -5$ V		4.0		
t_{rr}	Reverse recovery time	$I_{SD} = 10$ A, $V_{DD} = 2310$ V, Drive $R_g = 16$ Ω , $V_{GS} = -5$ V, $di/dt = -7900$ A/ μ s		14		ns
Q_{rr}	Reverse recovery charge			175		nC
I_{RRM}	Reverse recovery current				32	

1.3 Typical Performance Curves

This section shows the typical performance curves of the MSC400SMA330B4 device.

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

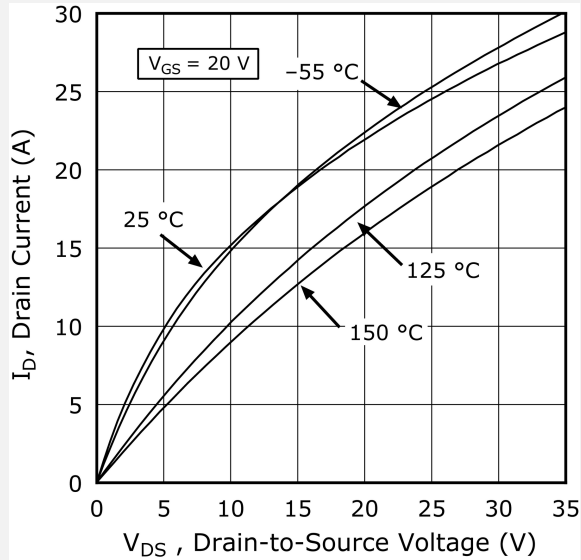


Figure 1-2. Drain Current vs. V_{DS} at V_{GS}

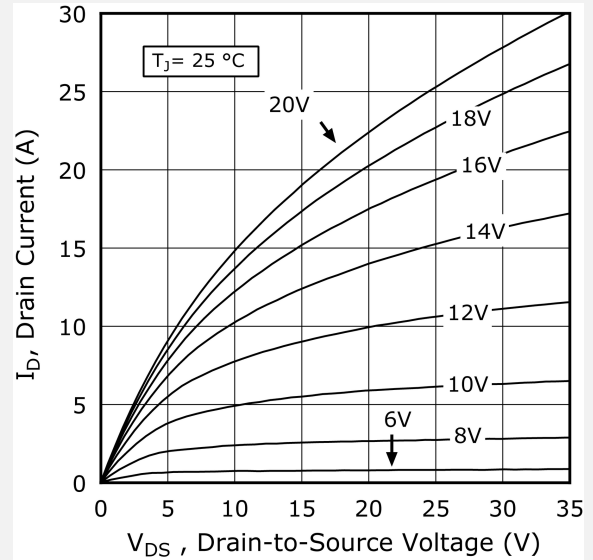


Figure 1-3. Drain Current vs. V_{DS} at V_{GS}

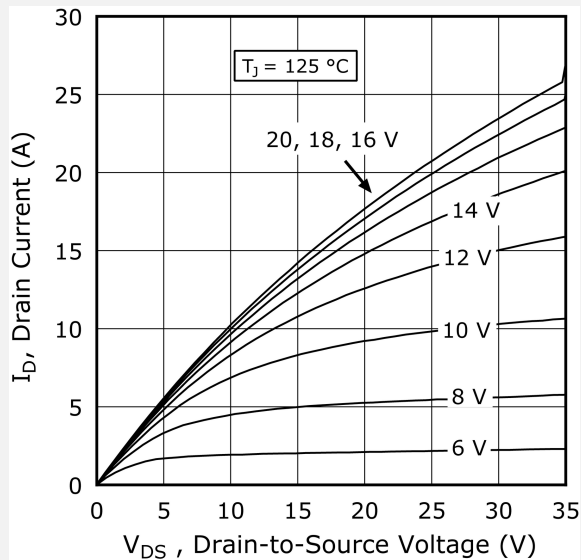


Figure 1-4. Drain Current vs. V_{DS} at V_{GS}

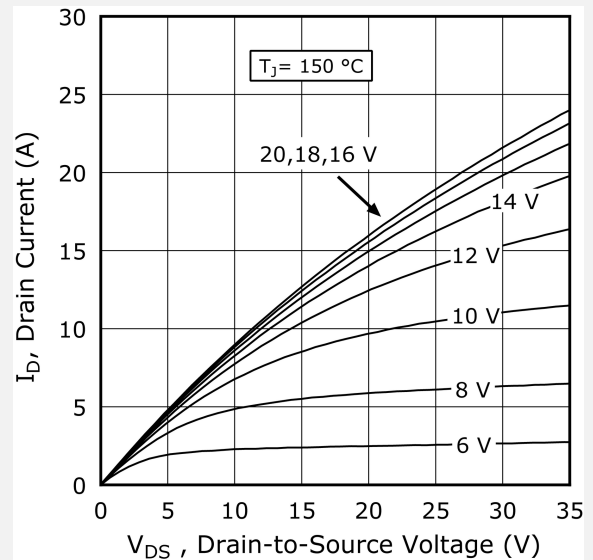


Figure 1-5. $R_{DS(on)}$ vs. Junction Temperature

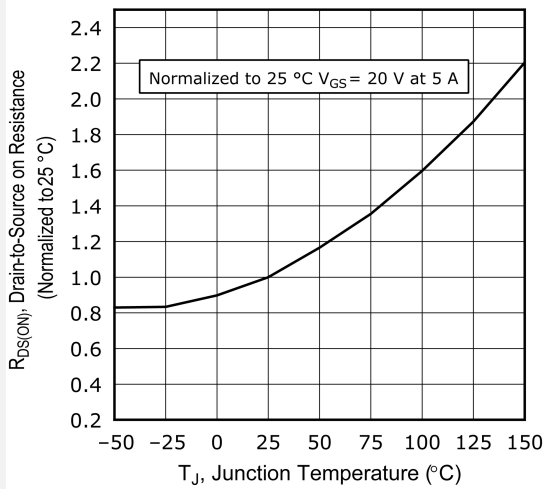


Figure 1-6. Gate Charge Characteristics

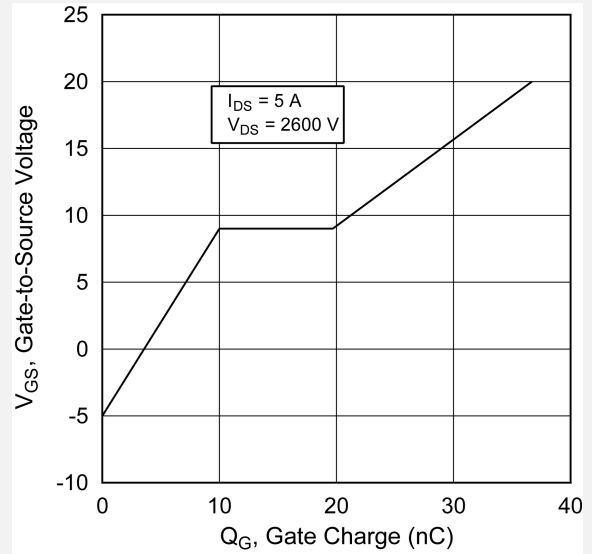


Figure 1-7. Capacitance vs. Drain-to-Source Voltage

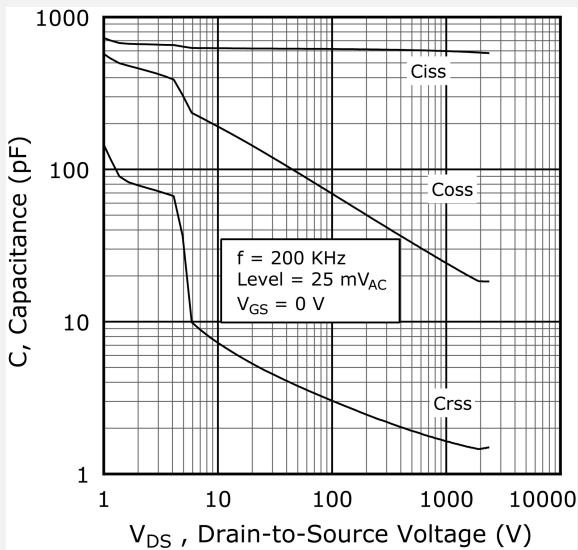


Figure 1-8. I_D vs. V_{DS} 3rd Quadrant Conduction

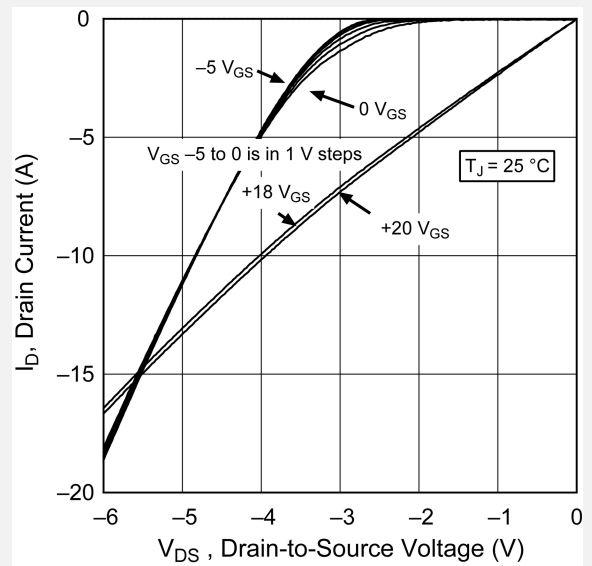


Figure 1-9. I_D vs. V_{DS} 3rd Quadrant Conduction

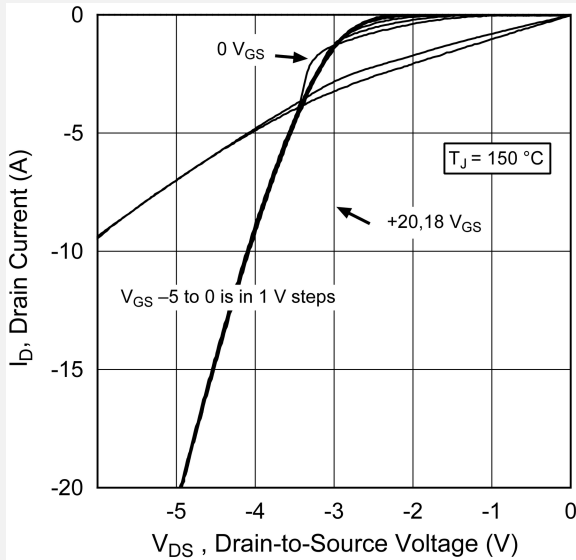


Figure 1-10. Switching Energy E_{on} vs. V_{DS} & I_D

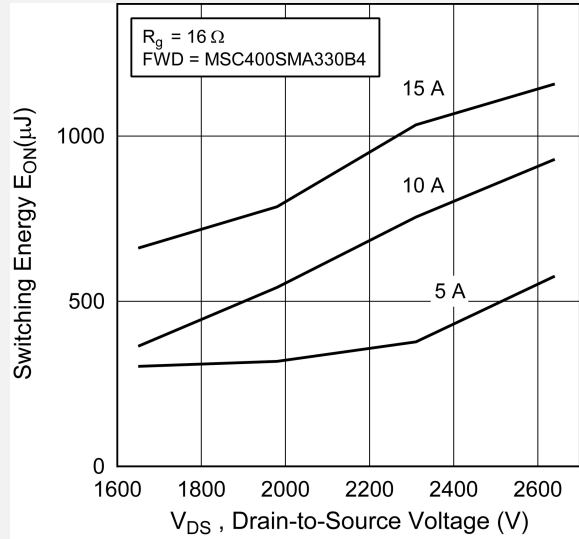


Figure 1-11. Switching Energy E_{off} vs. V_{DS} & I_D

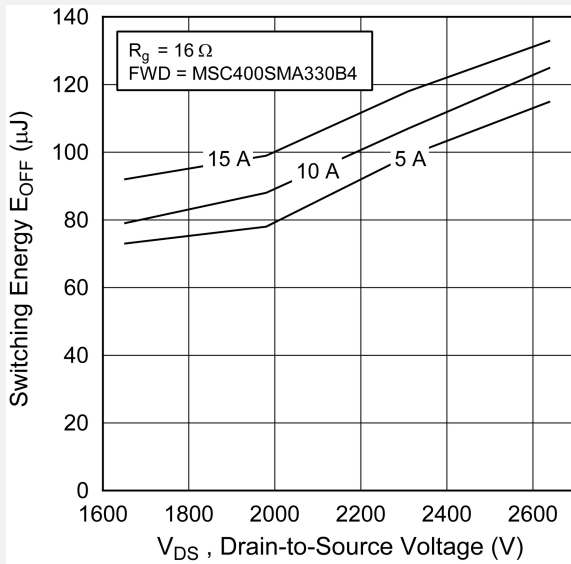


Figure 1-12. Switching Energy vs. R_g

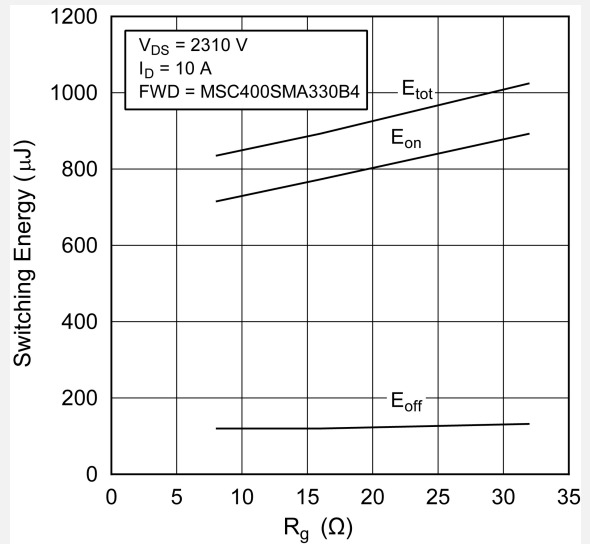


Figure 1-13. Switching Energy vs. Temperature

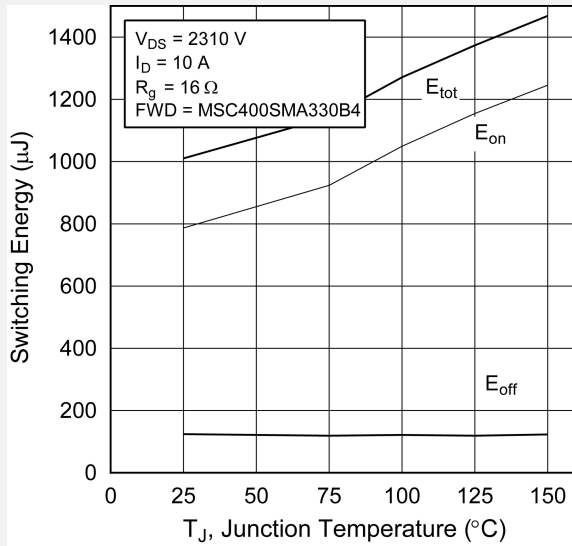


Figure 1-14. Threshold Voltage vs. Junction Temp.

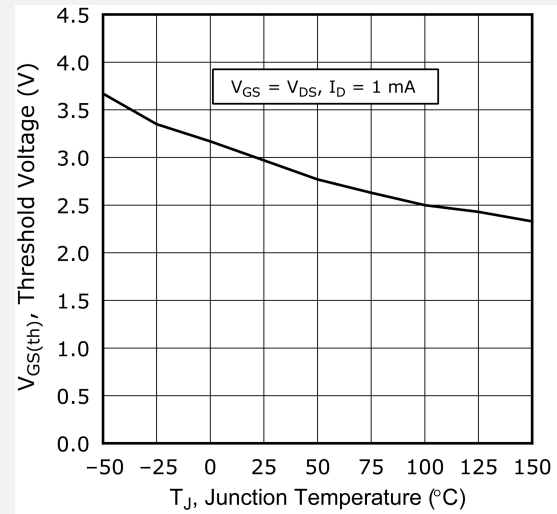


Figure 1-15. Forward Safe Operating Area

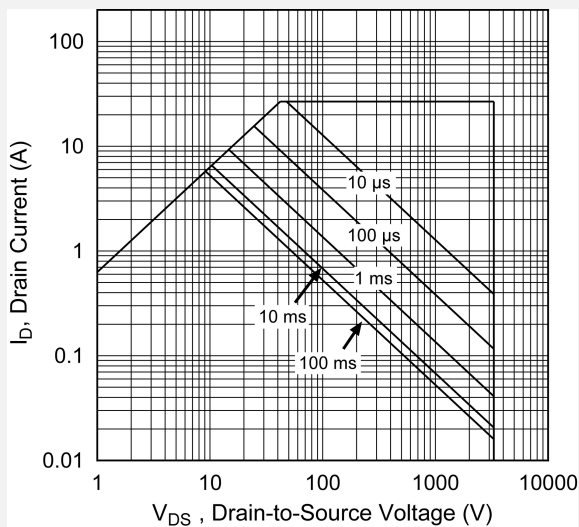
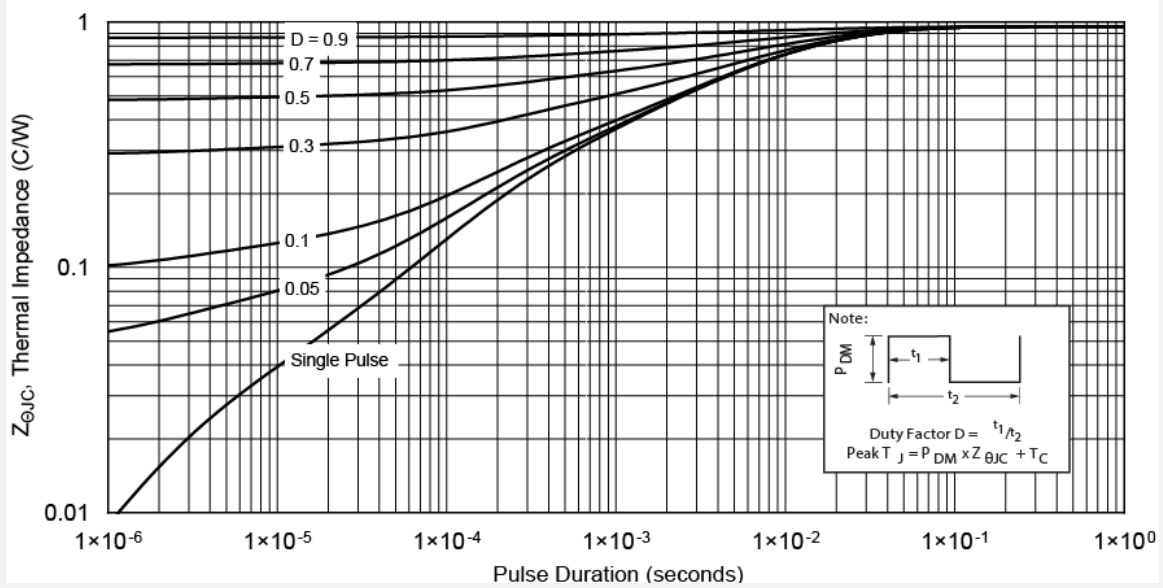
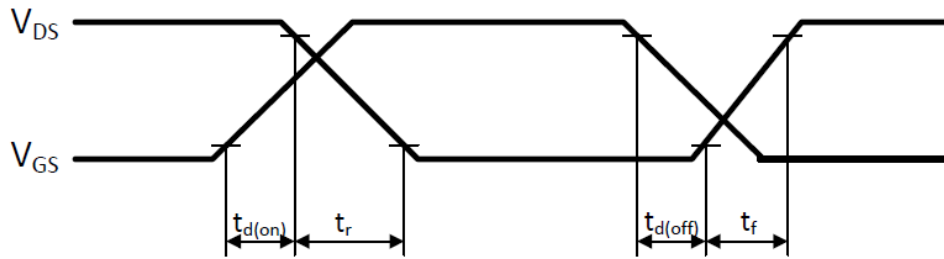


Figure 1-16. Maximum Transient Thermal Impedance



The following figure shows the switching waveform diagram of the MSC400SMA330B4 device.

Figure 1-17. Switching Waveform



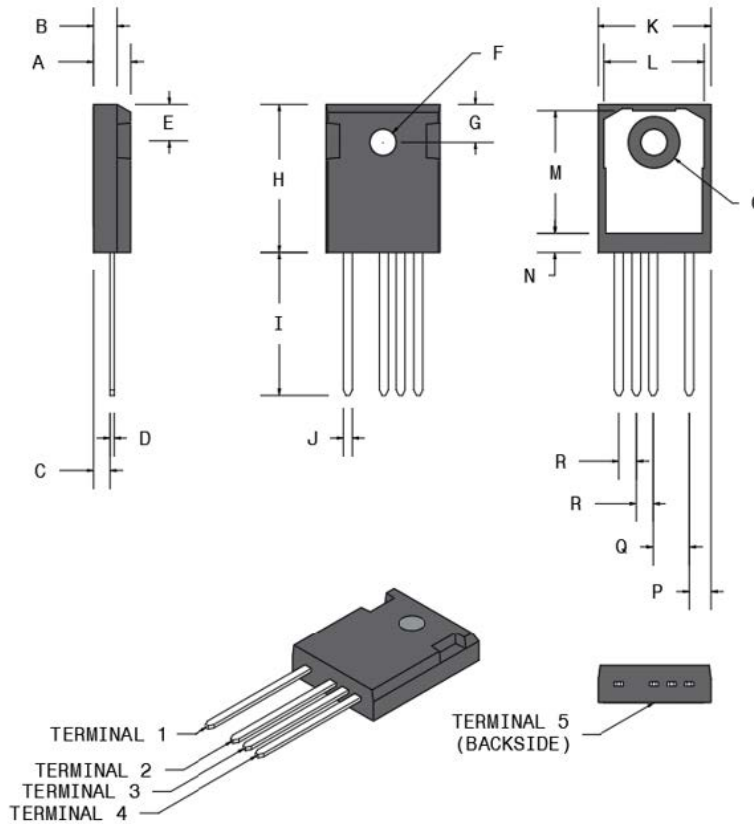
2. Package Specification

This section shows the package specification of the MSC400SMA330B4 device.

2.1 Package Outline Drawing

The following figure illustrates the TO-247-4L package outline of the MSC400SMA330B4 device.

Figure 2-1. Package Outline Drawing



The following table shows the TO-247-4L dimensions and should be used in conjunction with the package outline drawing.

Table 2-1. TO-247-4L Dimensions

Symbol	Min (mm)	Max (mm)	Min (in.)	Max (in.)
A	4.90	5.17	0.193	0.204
B	1.85	2.11	0.073	0.083
C	2.25	2.51	0.089	0.099
D	0.55	0.68	0.022	0.027
E	5.49	5.74	0.216	0.226
F	3.56	3.66	0.140	0.144
G	6.15 BSC		0.242 BSC	
H	20.83	21.08	0.820	0.830

MSC400SMA330B4

Package Specification

.....continued				
Symbol	Min (mm)	Max (mm)	Min (in.)	Max (in.)
I	19.81	20.32	0.780	0.800
J	1.07	1.33	0.042	0.052
K	15.77	16.03	0.621	0.631
L	13.89	14.15	0.547	0.557
M	16.25	16.85	0.640	0.663
N	2.00	2.75	0.079	0.108
O	7.10	7.50	0.280	0.295
P	2.87 BSC		0.113 BSC	
Q	5.08 BSC		0.200 BSC	
R	2.54 BSC		0.100 BSC	
Terminal 1	Drain			
Terminal 2	Source			
Terminal 3	Source sense			
Terminal 4	Gate			
Terminal 5	Drain			

3. Revision History

Table 3-1. Revision History

Revision	Date	Description
A	02/2022	Document created.

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