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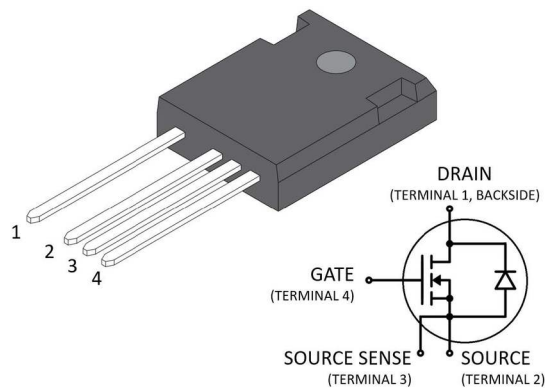
**3300 V, 400 mΩ SiC N-Channel Power MOSFET**

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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 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 <sup>1</sup>	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 <sup>1</sup>	$V_{GS} = 20\text{ V}, I_D = 5\text{ A}$		416	520	m $\Omega$

# MSC400SMA330B4

## Device Specifications

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Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$V_{GS(th)}$	Gate-source threshold voltage	$V_{GS} = V_{DS}, I_D = 1 \text{ mA}$	1.9	2.97		V
$I_{DSS}$	Zero gate voltage drain current	$V_{DS} = 3300 \text{ V}, V_{GS} = 0 \text{ V}$			100	$\mu\text{A}$
		$V_{DS} = 3300 \text{ V}, V_{GS} = 0 \text{ V}, T_J = 125 \text{ }^\circ\text{C}$			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 MSC400SMA330B4 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	$V_{GS} = 0 \text{ V}$ $V_{DD} = 2400 \text{ V}$		579		pF
$C_{rSS}$	Reverse transfer capacitance	$V_{AC} = 25 \text{ mV}$		2		
$C_{oss}$	Output capacitance	$f = 200 \text{ kHz}$		18		
$Q_g$	Total gate charge	$V_{DD} = 2600 \text{ V}$ $V_{GS} = -5 \text{ V}/20 \text{ V}$		37		nC
$Q_{gs}$	Gate-source charge	$I_D = 5 \text{ A}$		10		
$Q_{gd}$	Gate-drain charge			10		
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 2310 \text{ V}$		16		ns
$t_r$	Voltage rise time	$V_{GS} = -5 \text{ V}/20 \text{ V}$		8		
$t_{d(off)}$	Turn-off delay time	$I_D = 10 \text{ A}$		16		
$t_f$	Voltage fall time	$R_{g(ext)} = 16 \text{ } \Omega$		20		
$E_{on}$	Turn-on switching energy	Freewheeling diode = MSC400SMA330B4 ( $V_{GS} = -5$ V) (reference Fig. 1-17)		750		$\mu\text{J}$
$E_{off}$	Turn-off switching energy			120		
ESR	Gate equivalent series resistance	$f = 1 \text{ MHz}, 25 \text{ mV}, \text{ drain short}$		3.7		$\Omega$

The following table shows the body diode characteristics of the MSC400SMA330B4 device.  $T_J = 25 \text{ }^\circ\text{C}$  unless otherwise specified.

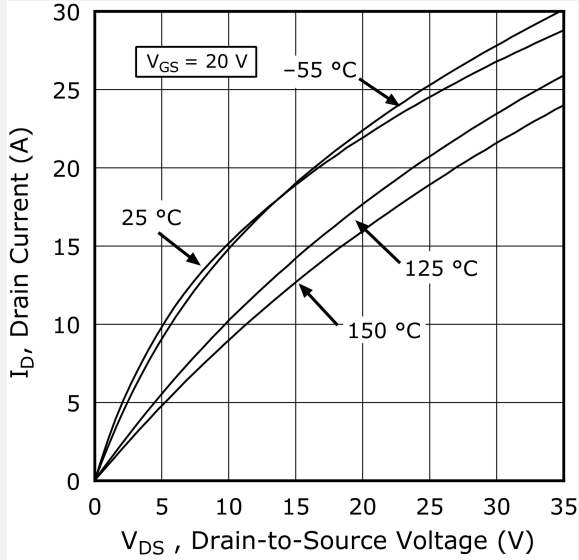
**Table 1-5. Body Diode Characteristics**

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

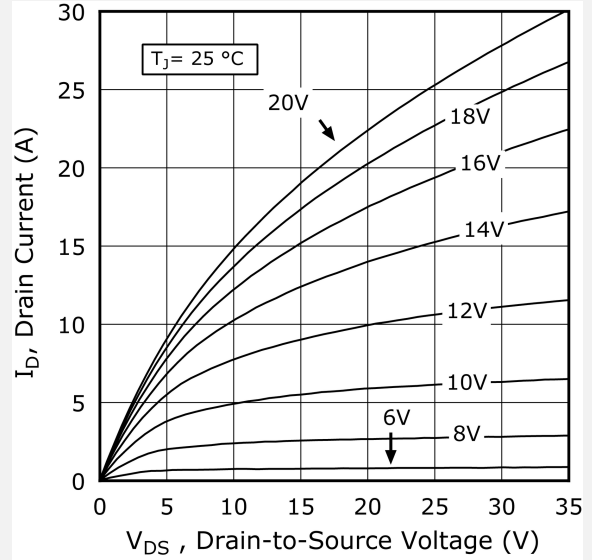
### 1.3 Typical Performance Curves

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

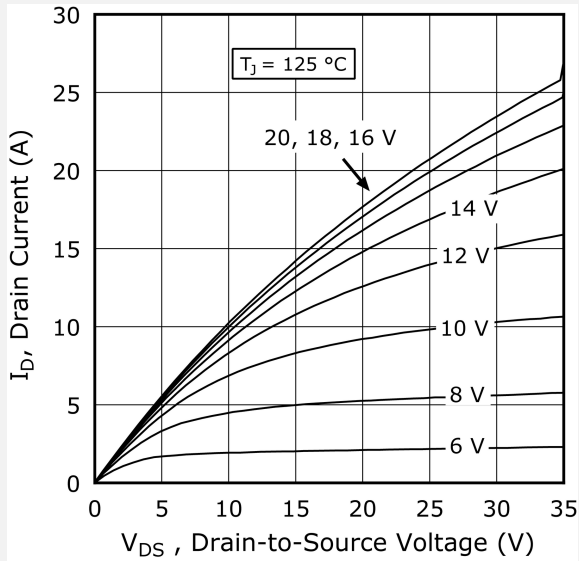
**Figure 1-1. Drain Current vs.  $V_{DS}$  at  $T_J$**



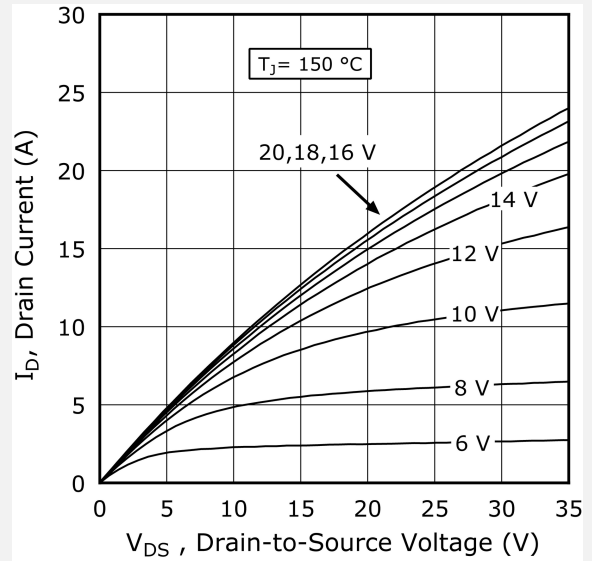
**Figure 1-2. Drain Current vs.  $V_{DS}$  at  $V_{GS}$**



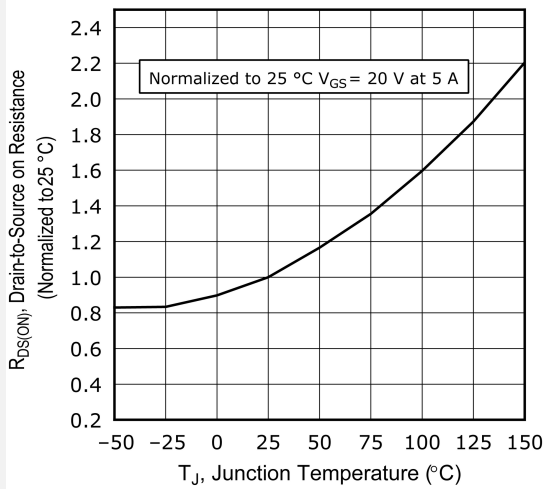
**Figure 1-3. Drain Current vs.  $V_{DS}$  at  $V_{GS}$**



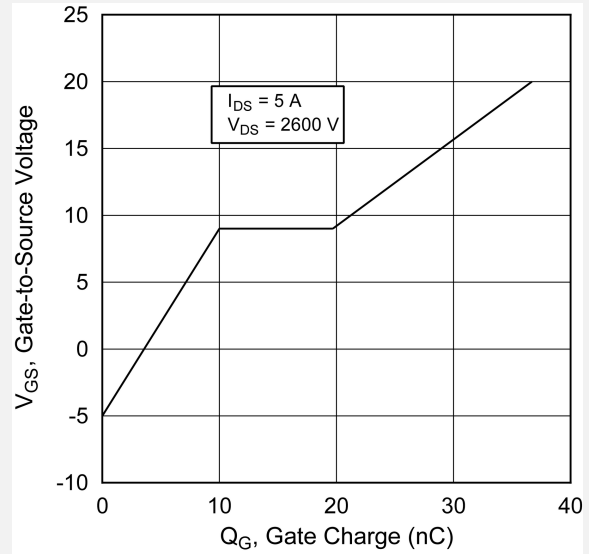
**Figure 1-4. Drain Current vs.  $V_{DS}$  at  $V_{GS}$**



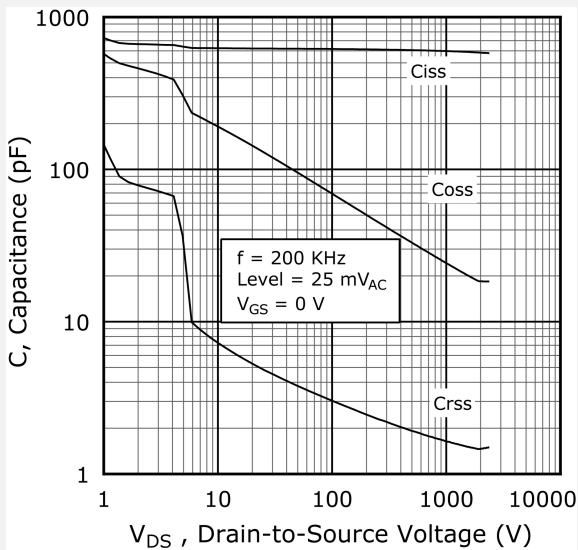
**Figure 1-5.  $R_{DS(on)}$  vs. Junction Temperature**



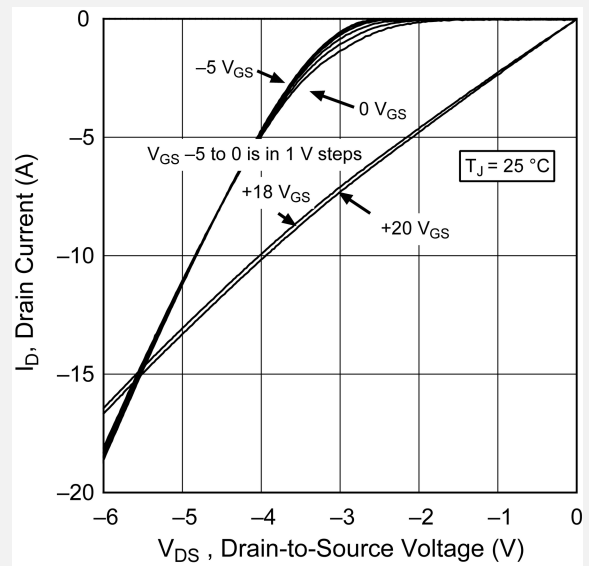
**Figure 1-6. Gate Charge Characteristics**



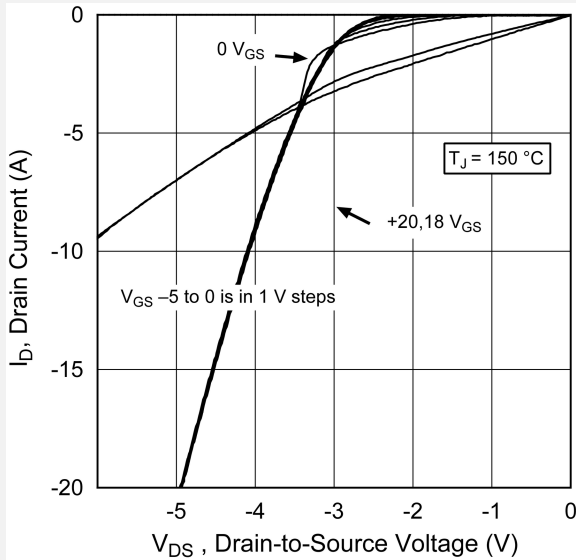
**Figure 1-7. Capacitance vs. Drain-to-Source Voltage**



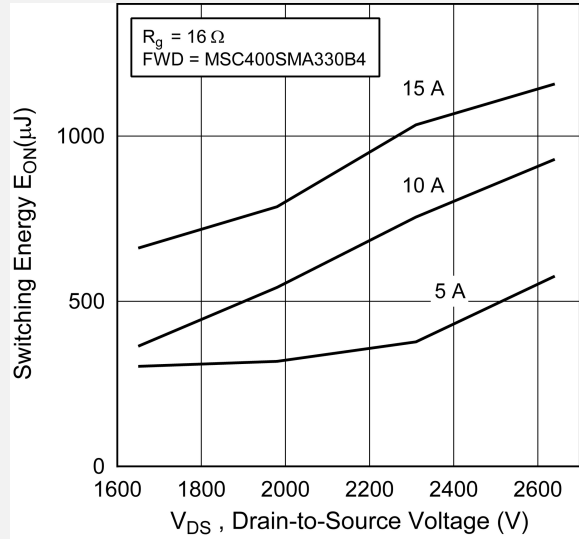
**Figure 1-8.  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction**



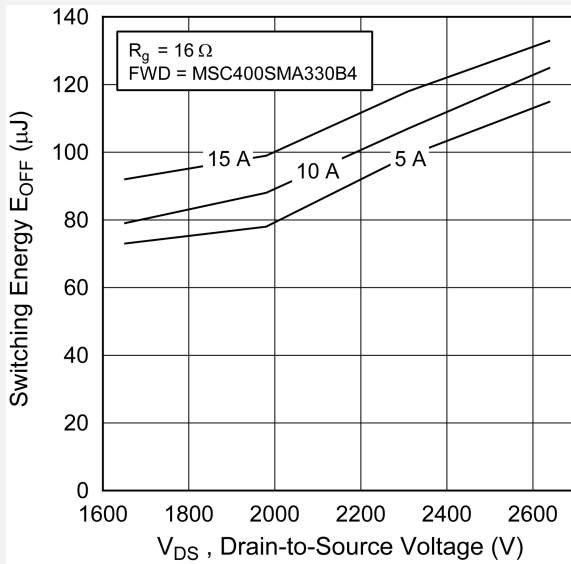
**Figure 1-9.  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction**



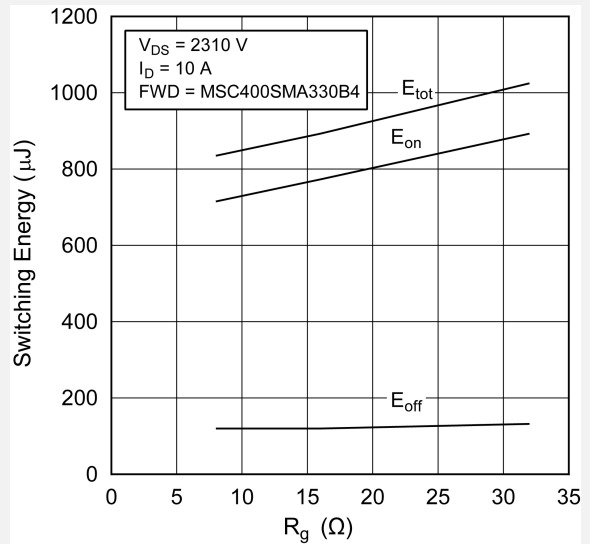
**Figure 1-10. Switching Energy  $E_{on}$  vs.  $V_{DS}$  &  $I_D$**



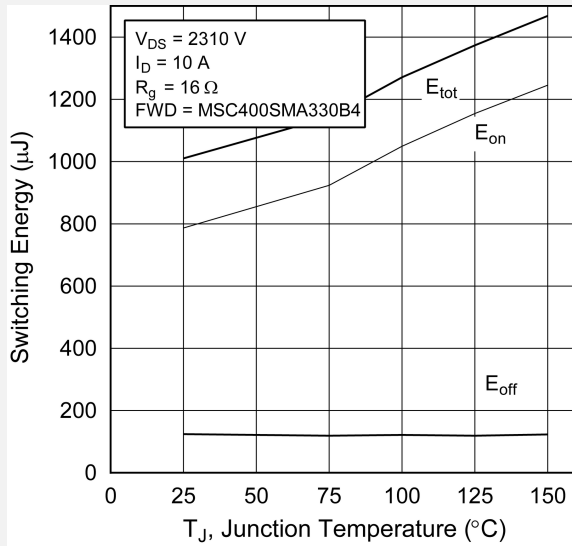
**Figure 1-11. Switching Energy  $E_{off}$  vs.  $V_{DS}$  &  $I_D$**



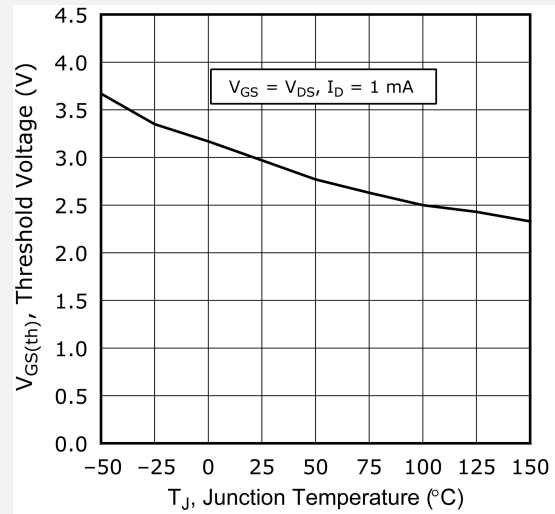
**Figure 1-12. Switching Energy vs.  $R_g$**



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



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



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

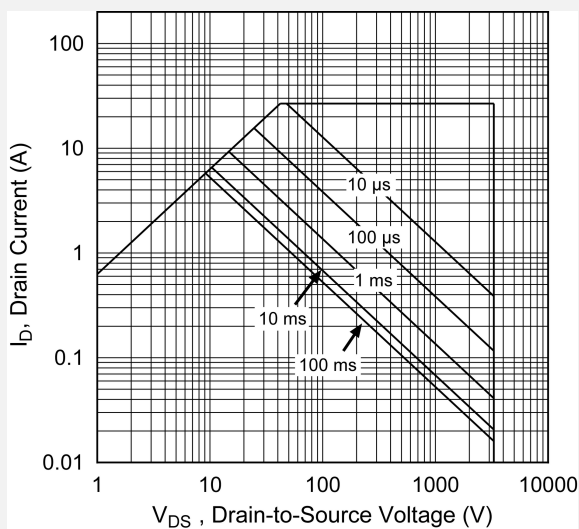
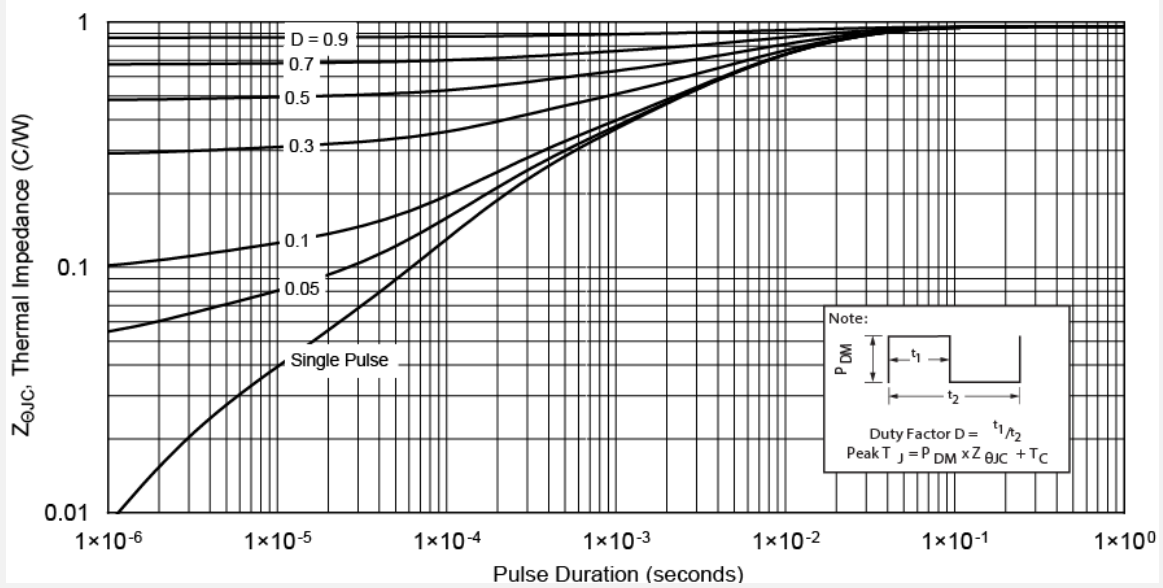
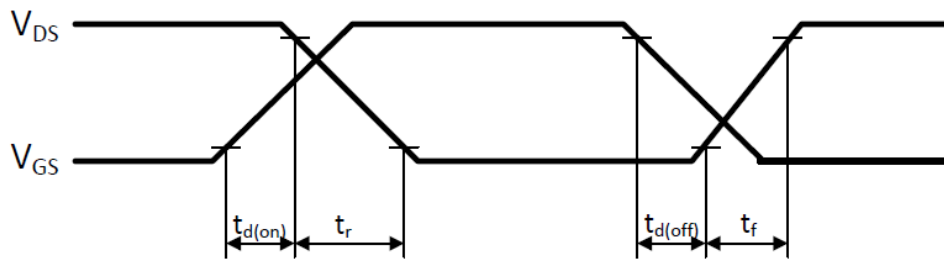


Figure 1-16. Maximum Transient Thermal Impedance



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

Figure 1-17. Switching Waveform





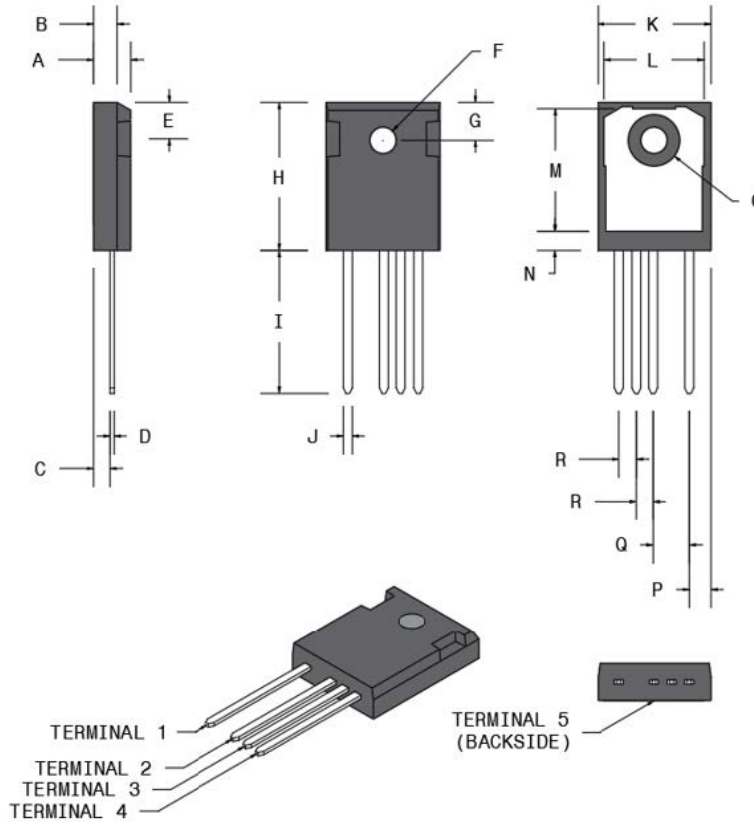
## 2. Package Specification

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**

<b>Revision</b>	<b>Date</b>	<b>Description</b>
A	02/2022	Document created.

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