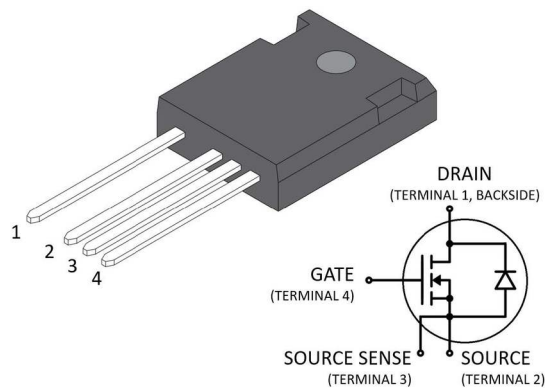# MSC400SMA330B4

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.

DRAIN
(TERMINAL 1, BACKSIDE)

GATE
(TERMINAL 4)

SOURCE SENSE
(TERMINAL 3)

SOURCE
(TERMINAL 2)

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 °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 °C	11	A
	Continuous drain current at T_C = 100 °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 °C	131	W
	Linear derating factor	1.05	W/°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	°C/W
T_J	Operating junction temperature	−55		150	°C
T_{STG}	Storage temperature	−55		150	°C
T_L	Soldering temperature for 10 seconds (1.6 mm from case)			300	°C
	Mounting torque, 6-32 or M3 screw			10	lbf-in
				1.1	N-m
Wt	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 °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 V, I_D = 100 µA	3300			V
$R_{DS(on)}$	Drain-source on resistance[1]	V_{GS} = 20 V, I_D = 5 A		416	520	mΩ

..........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	μA
		$V_{DS} = 3300$ 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 μs, 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		μJ
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 Rg = 16 Ω, $V_{GS} = -5$ V, dI/dt = –7900 A/μs		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.
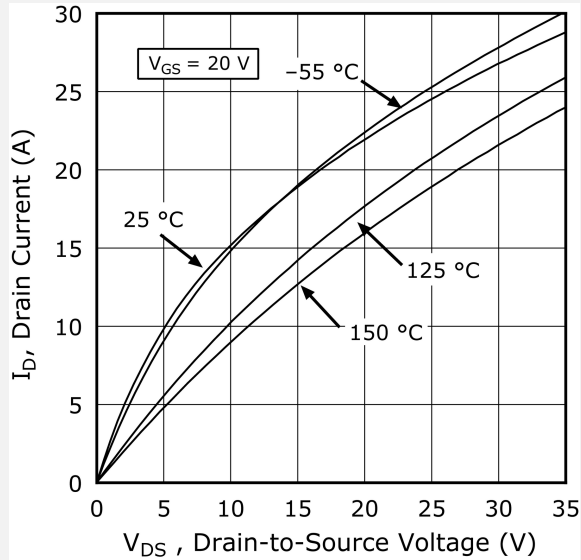
Figure 1-1. Drain Current vs. V_{DS} at T_J
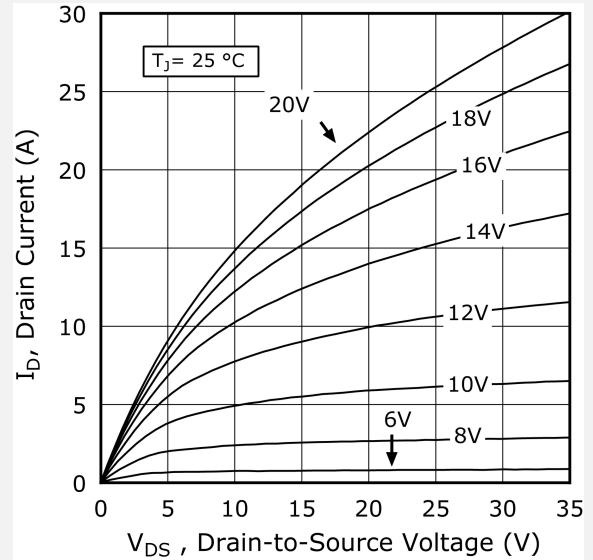

Figure 1-2. Drain Current vs. V_{DS} at V_{GS}
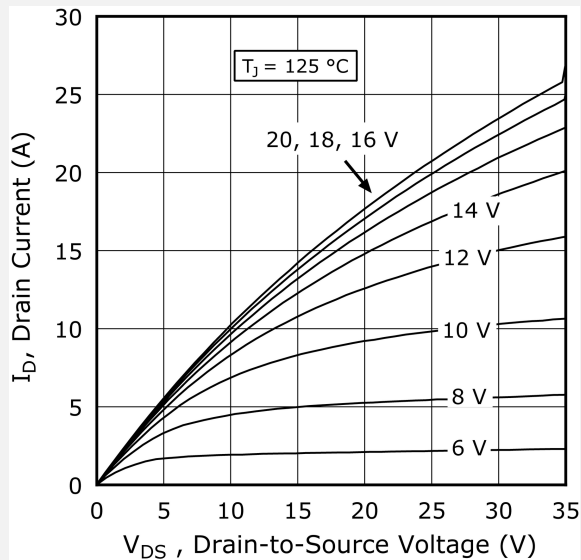

Figure 1-3. Drain Current vs. V_{DS} at V_{GS}

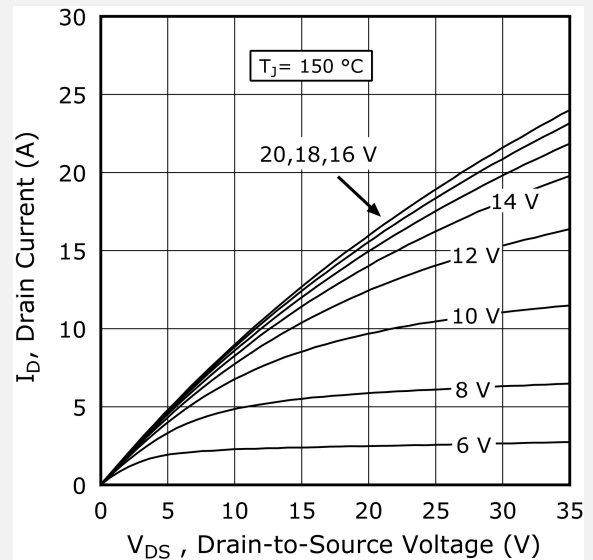**Figure 1-4. Drain Current vs. V_{DS} at V_{GS}**

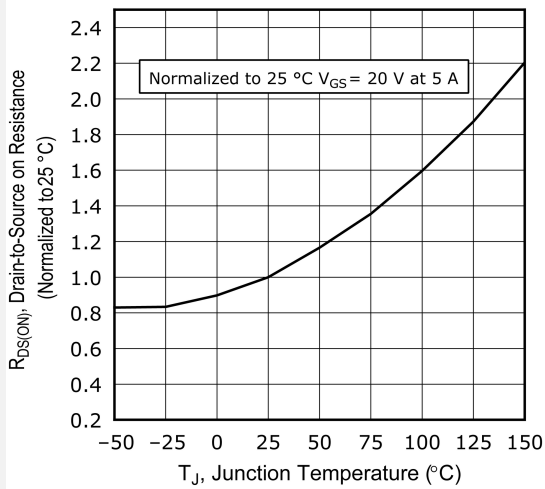**Figure 1-5. R_DS(on) vs. Junction Temperature**

Normalized to 25 °C V_GS = 20 V at 5 A

R_DS(ON), Drain-to-Source on Resistance (Normalized to 25 °C) vs. T_J, Junction Temperature (°C)

Figure 1-6. Gate Charge Characteristics

I_DS = 5 A
V_DS = 2600 V

V_GS, Gate-to-Source Voltage vs. Q_G, Gate Charge (nC)
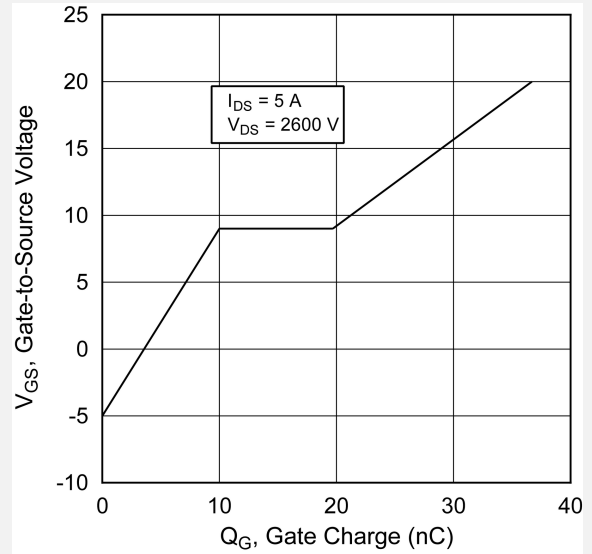
Figure 1-7. Capacitance vs. Drain-to-Source Voltage

Ciss
Coss
Crss

f = 200 KHz
Level = 25 mV_AC
V_GS = 0 V

C, Capacitance (pF) vs. V_DS, Drain-to-Source Voltage (V)
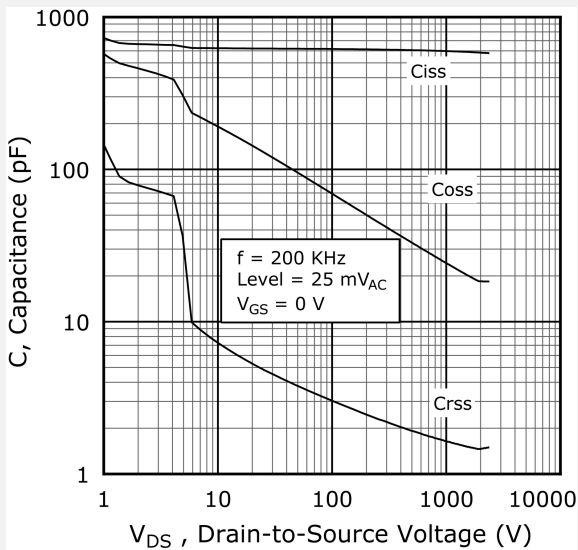
Figure 1-8. I_D vs. V_DS 3rd Quadrant Conduction

−5 V_GS
0 V_GS
V_GS −5 to 0 is in 1 V steps
+18 V_GS
+20 V_GS
T_J = 25 °C

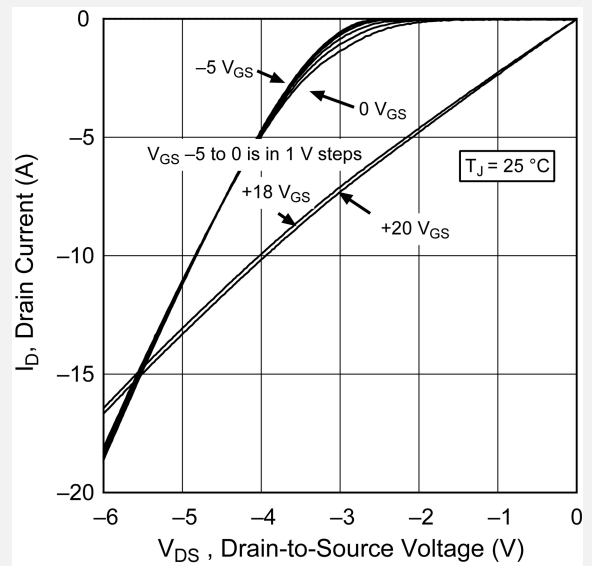I_D, Drain Current (A) vs. V_DS, Drain-to-Source Voltage (V)

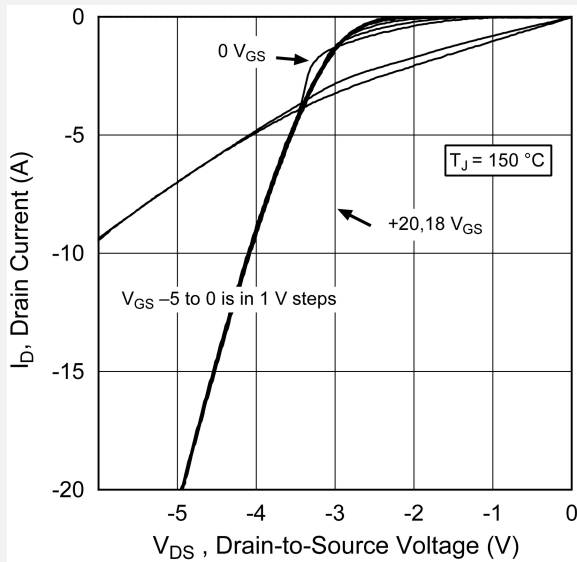**Figure 1-9. I$_D$ vs. V$_{DS}$ 3rd Quadrant Conduction**

Figure 1-10. Switching Energy Eon vs. V$_{DS}$ & I$_D$
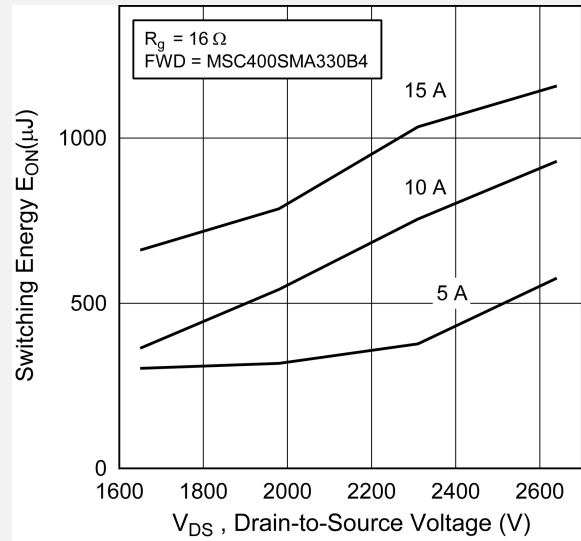

Figure 1-11. Switching Energy Eoff vs. V$_{DS}$ & I$_D$
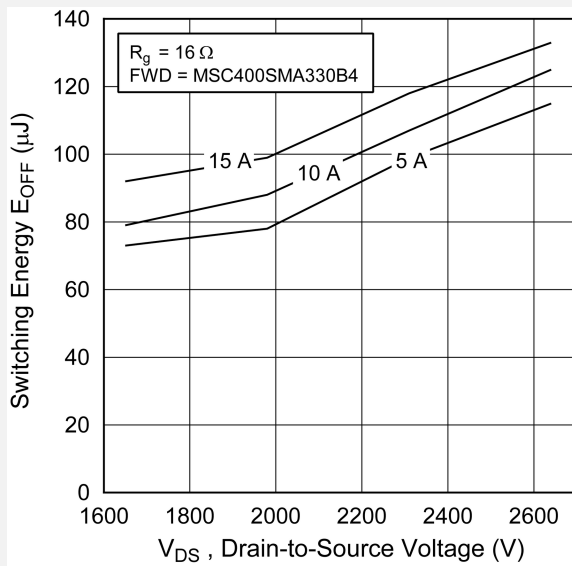

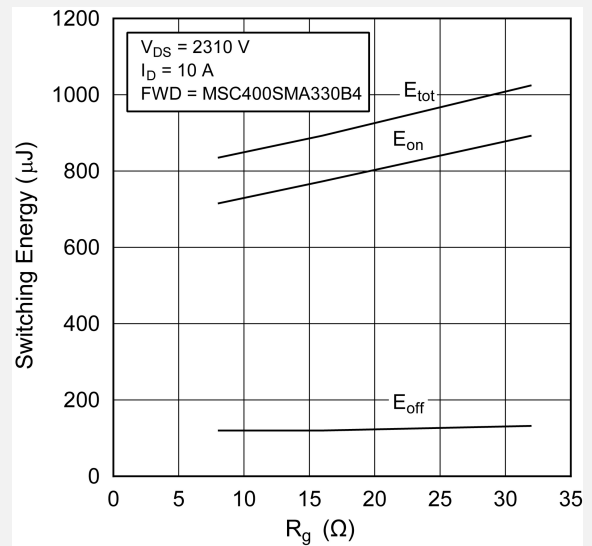**Figure 1-12. Switching Energy vs. Rg**

Figure 1-13. Switching Energy vs. Temperature
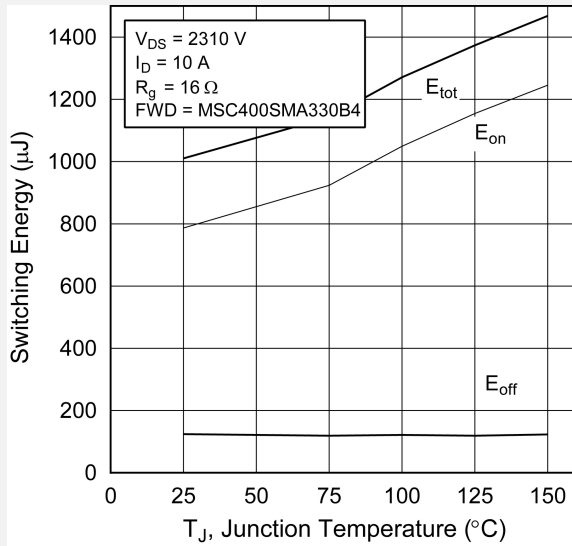

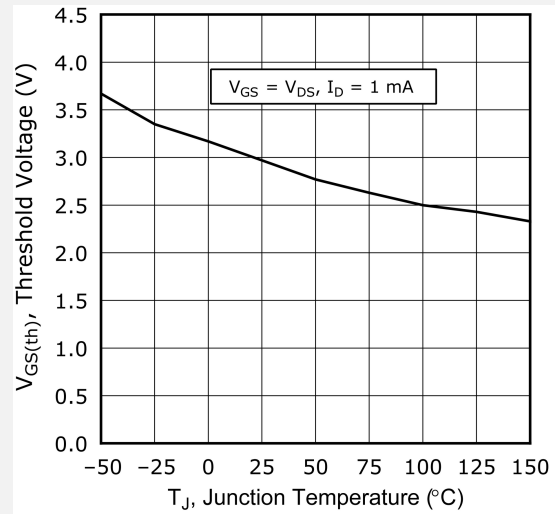**Figure 1-14. Threshold Voltage vs. Junction Temp.**

Figure 1-15. Forward Safe Operating Area
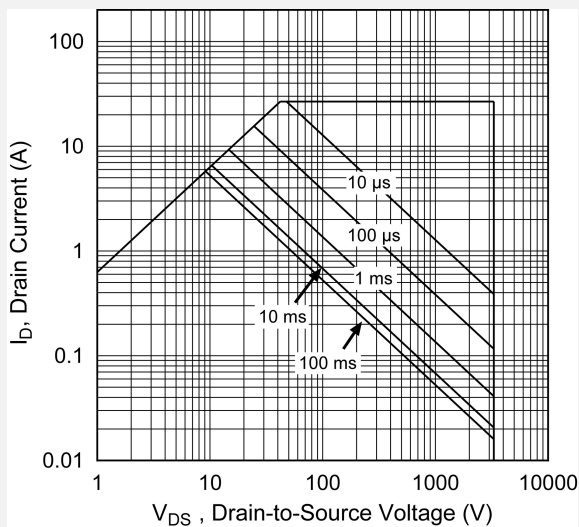
Figure 1-16. Maximum Transient Thermal Impedance
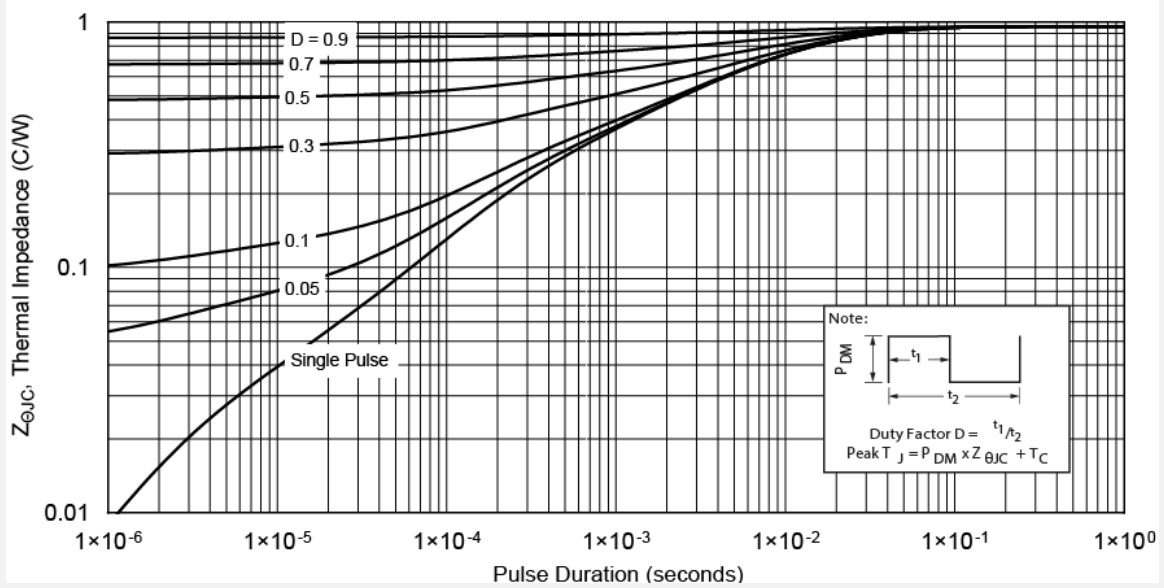
The following figure shows the switching waveform diagram of the MSC400SMA330B4 device.

Figure 1-17. Switching Waveform
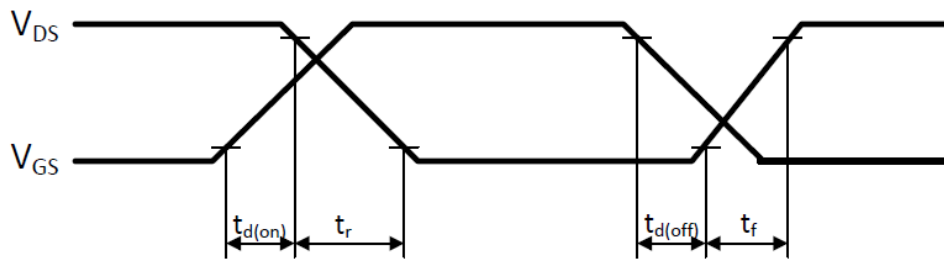
2. Package Specification

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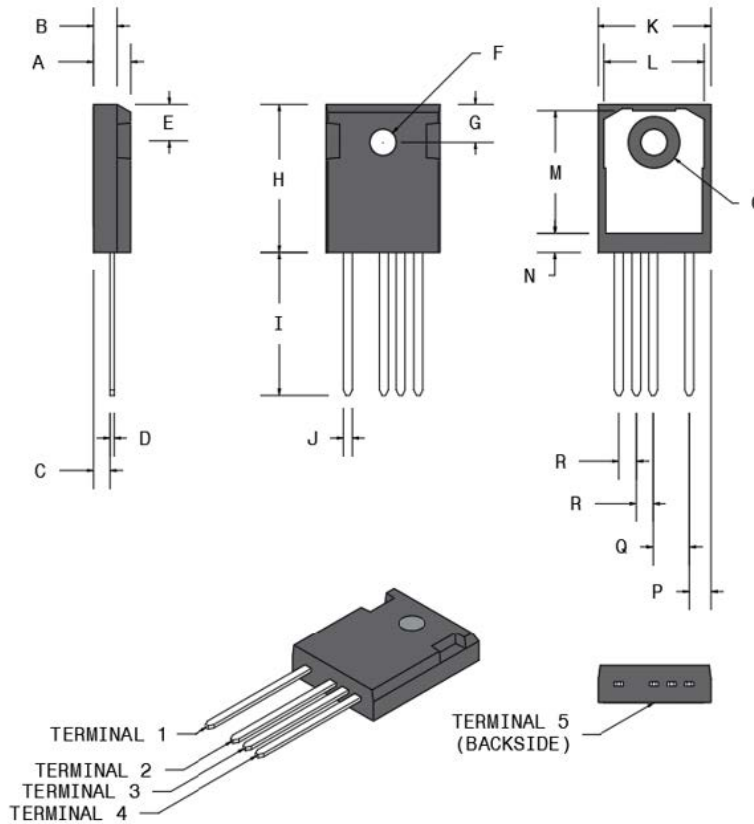
The following table shows the TO-247-4L dimensions and should be used in conjunction with the package outline drawing.

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

Symbol	Min (mm)	Max (mm)	Min (in.)	Max (in.)
..........continued				
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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