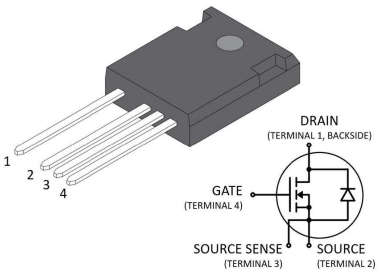
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700 V, 15 mΩ SiC N-Channel Power MOSFET

MSC015SMA070B4

Product Overview

700 V, 15 mΩ typical at 20 V_{GS}, 18 mΩ typical at 18 V_{GS}, TO-247 4-lead with a source sense



Features

The following are key features of this 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 °C
- Fast and reliable body diode
- Superior avalanche ruggedness
- RoHS compliant

Benefits

The following are benefits of this 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

This 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

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1. Device Specifications

This section shows the specifications of this device.

1.1 Absolute Maximum Ratings

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

Table 1-1. Absolute Maximum Ratings

Symbol	Parameter	Ratings	Unit
V_{DSS}	Drain source voltage	700	V
I_D	Continuous drain current at T_C = 25 °C	149	A
	Continuous drain current at T_C = 100 °C	106	
I_{DM}	Pulsed drain current[1]	350	
V_{GS}	Gate-source voltage	23 to –10	V
	Transient gate-source voltage	25 to –12	
P_D	Total power dissipation at T_C = 25 °C	524	W
	Linear derating factor	3.4	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 this device.

Table 1-2. Thermal and Mechanical Characteristics

Symbol	Characteristic/Test Conditions	Min	Typ	Max	Unit
$R_{\theta JC}$	Junction-to-case thermal resistance		0.22	0.29	°C/W
T_J	Operating junction temperature	–55		175	°C
T_{STG}	Storage temperature	–55		150	°C
T_L	Lead temperature for 10 seconds			260	°C
	Mounting torque, 6-32 or M3 screw			10	lbf-in
				1.1	N-m
Wt	Package weight		0.22		oz
			6.2		g

ESD practices should comply with JESD-625.

1.2 Electrical Performance

The following table shows the static characteristics of this 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	700			V
$R_{DS(on)}$	Drain-source on resistance[1]	V_{GS} = 20 V, I_D = 40 A		15	19	mΩ
		V_{GS} = 18 V, I_D = 40 A		18		
$V_{GS(th)}$	Gate-source threshold voltage	V_{GS} = V_{DS}, I_D = 4 mA	1.9	3.0		V
I_{DSS}	Zero gate voltage drain current	V_{DS} = 700 V, V_{GS} = 0 V		0.3	40	µA
		V_{DS} = 700 V, V_{GS} = 0 V, T_J = 175 °C		3.5		
I_{GSS}	Gate-source leakage current	V_{GS} = 20 V/–10 V			±100	nA

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Note:

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

The following table shows the dynamic characteristics of this device. T_J = 25 °C unless otherwise specified. The dynamic characteristics are characterized, not 100% tested, at the recommended operating V_{GS} +20 V, –5 V.

Table 1-4. Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
C_{iss}	Input capacitance	V_{GS} = 0 V, V_{DD} = 700 V, V_{AC} = 25 mV, ƒ = 200 kHz		4500		pF
C_{rss}	Reverse transfer capacitance			44		
C_{oss}	Output capacitance			510		
Q_g	Total gate charge	V_{GS} = –5 V/20 V, V_{DD} = 470 V, I_D = 40 A		215		nC
Q_{gs}	Gate-source charge			58		
Q_{gd}	Gate-drain charge			35		
$t_{d(on)}$	Turn-on delay time	V_{DD} = 470 V, V_{GS} = –5 V/20 V, I_D = 40 A, $R_{g(ext)}$ = 4 Ω, Freewheeling diode = MSC015SMA070B4 (V_{GS} = –5 V) (reference Figure 1-18)		27		ns
t_r	Voltage rise time			22		
$t_{d(off)}$	Turn-off delay time			40		
t_f	Voltage fall time			12		
E_{on}	Turn-on switching energy			413		µJ
E_{off}	Turn-off switching energy			89		
ESR	Gate equivalent series resistance	f = 1 MHz, 25 mV, drain short		0.69		Ω
SCWT	Short circuit withstand time	V_{DS} = 560 V, V_{GS} = 20 V		3		µs
E_{AS}	Avalanche energy, single pulse	I_D = 40 A		4400		mJ

The following table shows the body diode characteristics of this 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} = 40 A, V_{GS} = 0 V		3.4		V
		I_{SD} = 40 A, V_{GS} = –5 V		3.8		
t_{rr}	Reverse recovery time	I_{SD} = 40 A, V_{GS} = –5 V, V_{DD} = 470 V, dI/dt = –1200 A/µs		40		ns
Q_{rr}	Reverse recovery charge			495		nC
I_{RRM}	Reverse recovery current			19		A

1.3 Typical Performance Curves

Data for performance curves are characterized, not 100% tested.

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

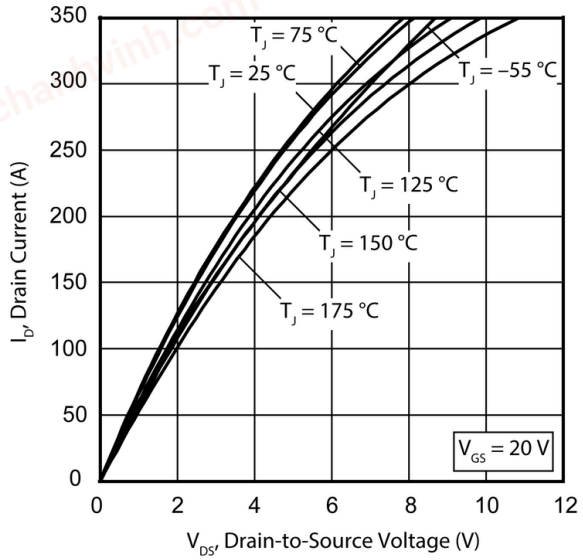


Figure 1-2. Drain Current vs. V_{DS} at V_{GS}

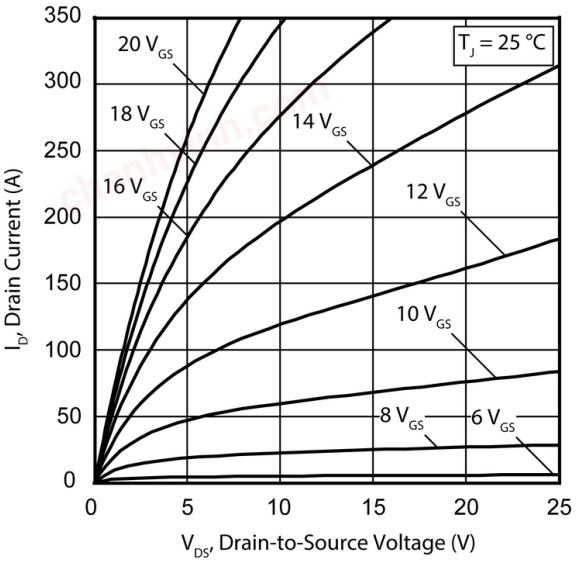


Figure 1-3. Drain Current vs. V_{DS} at V_{GS}

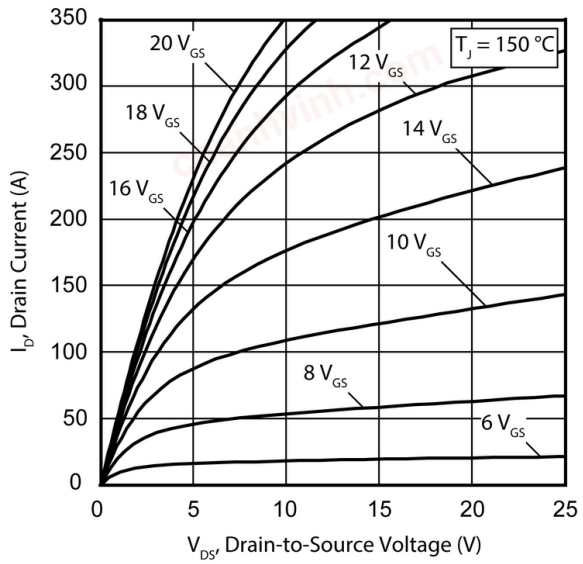
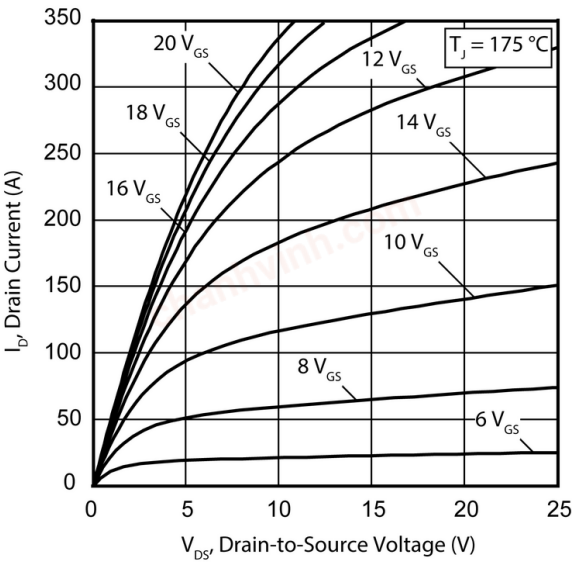


Figure 1-4. Drain Current vs. V_{DS} at V_{GS}



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

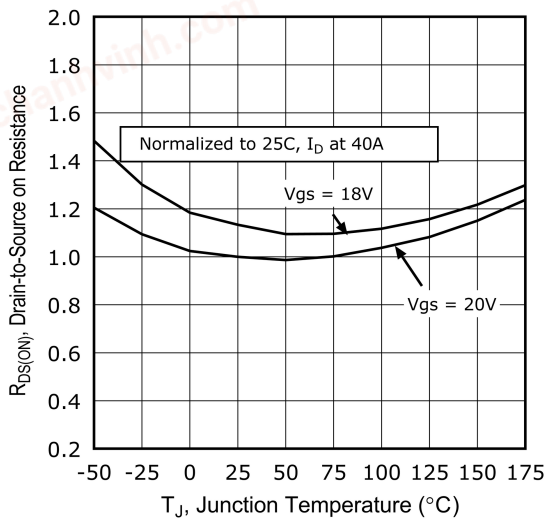


Figure 1-6. Gate Charge Characteristics

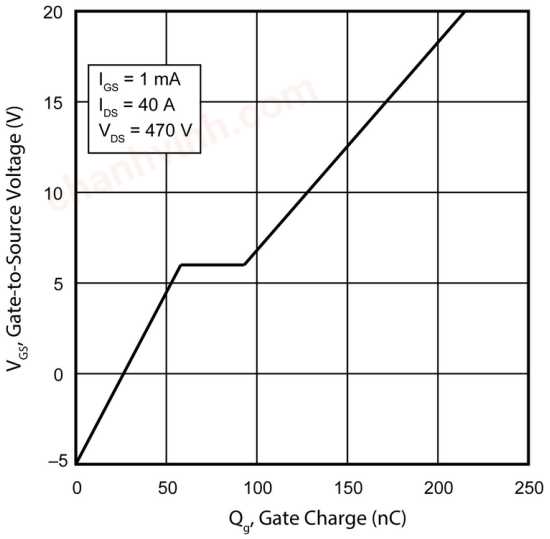


Figure 1-7. Capacitance vs. Drain-to-Source Voltage

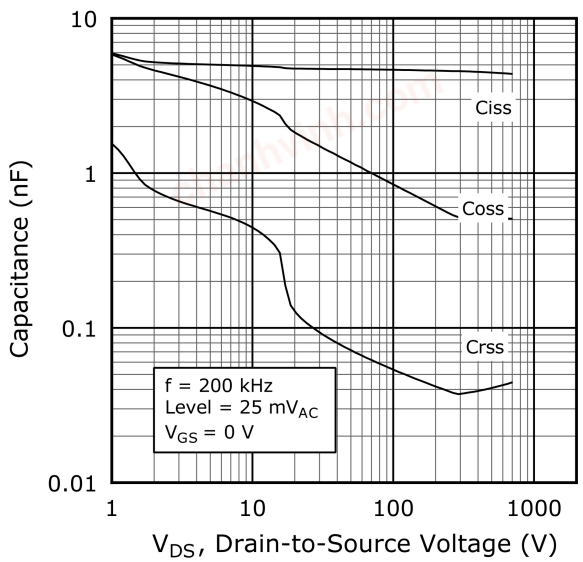
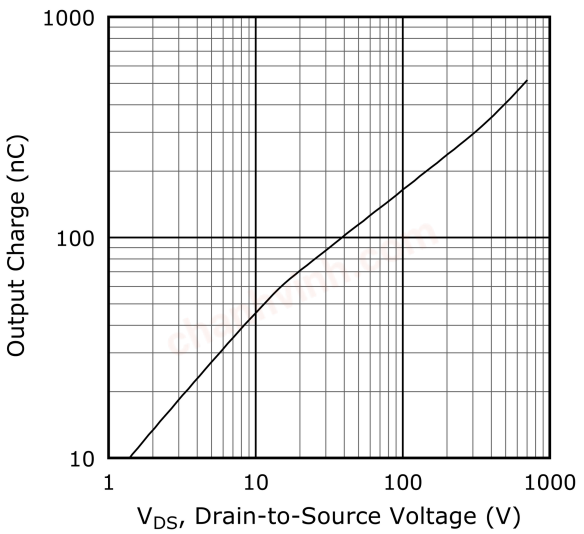


Figure 1-8. Output Charge vs. Drain-to-Source Voltage



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

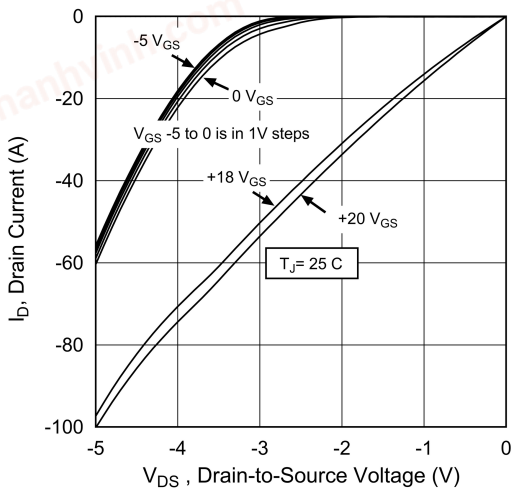


Figure 1-10. I_D vs. V_{DS} 3rd Quadrant Conduction

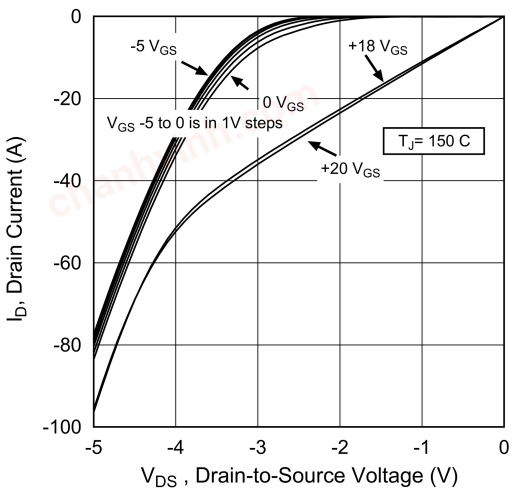


Figure 1-11. Switching Energy Eon vs. V_{DS} & I_D

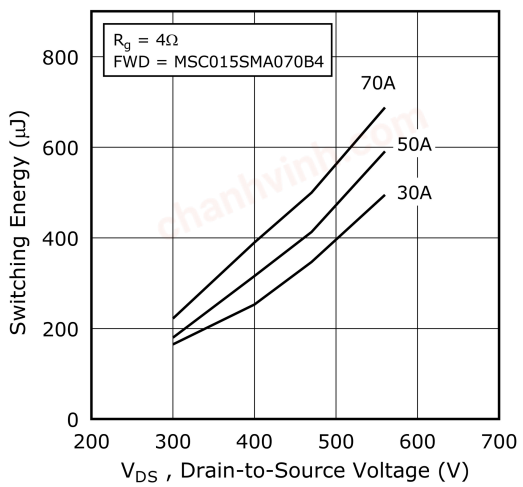
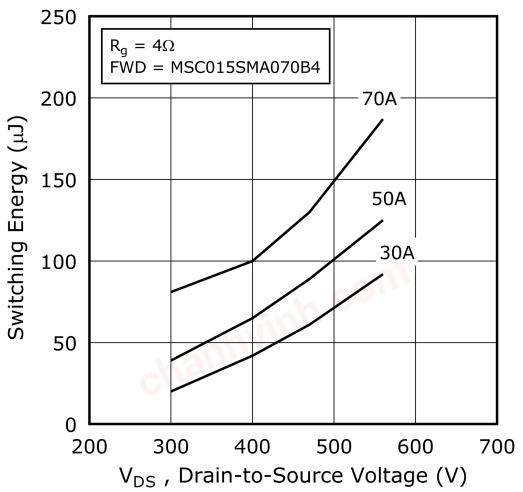


Figure 1-12. Switching Energy Eoff vs. V_{DS} & I_D



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Figure 1-13. Switching Energy vs. R_g

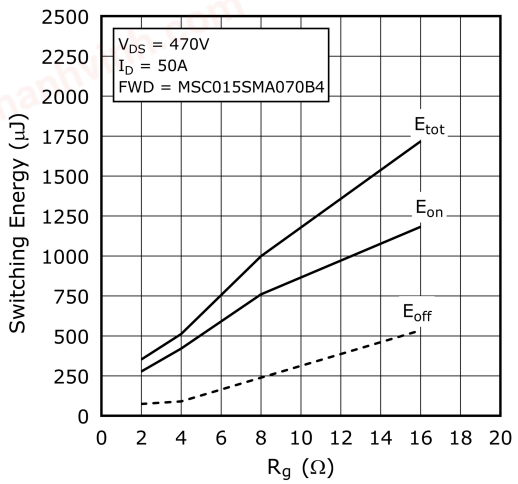


Figure 1-14. Switching Energy vs. Junction Temperature

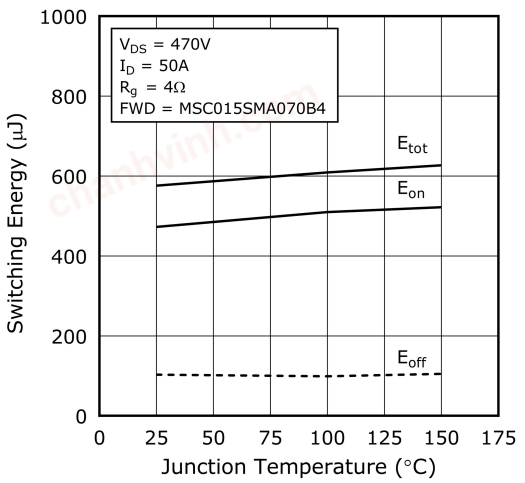


Figure 1-15. Threshold Voltage vs. Junction Temperature

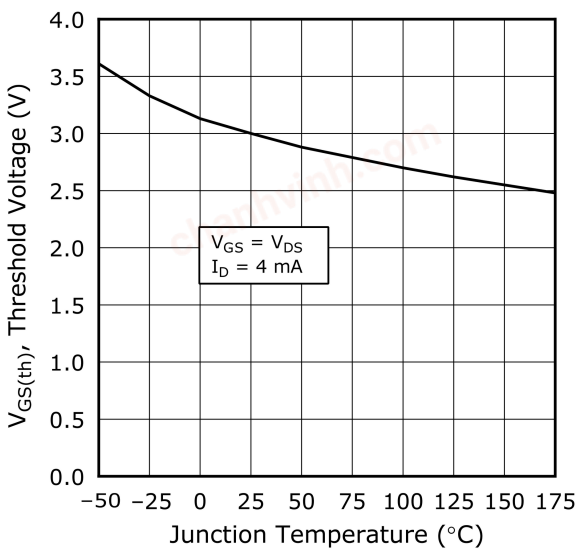
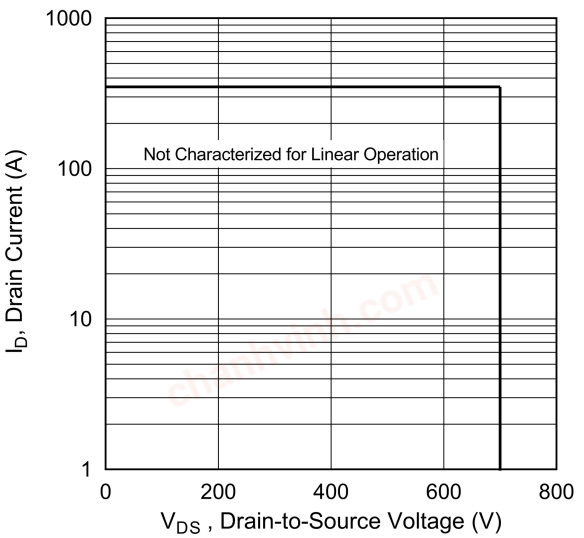


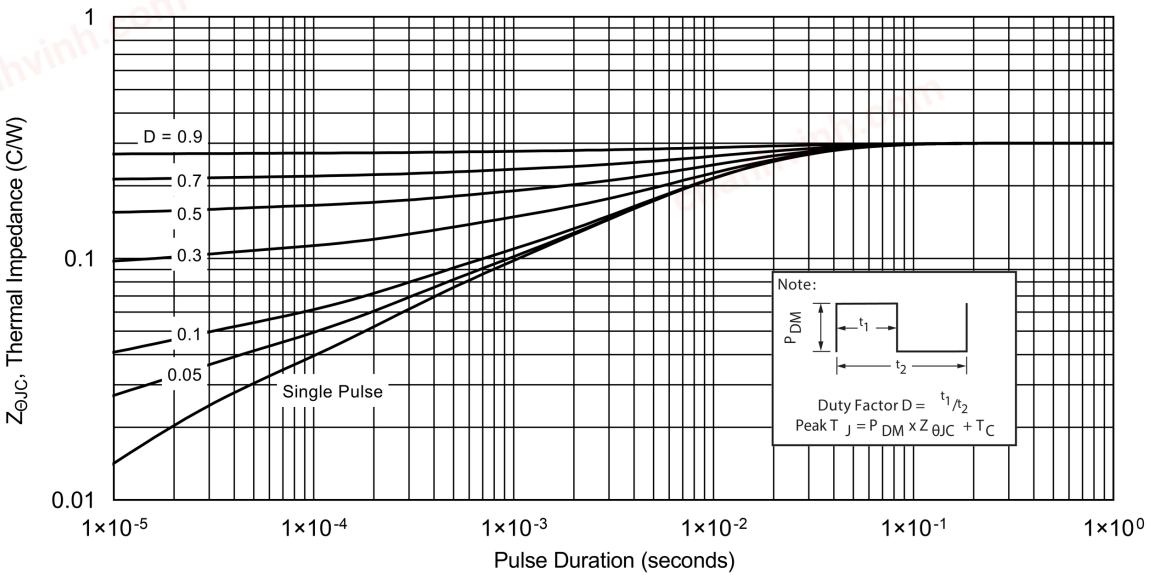
Figure 1-16. Forward Safe Operating Area



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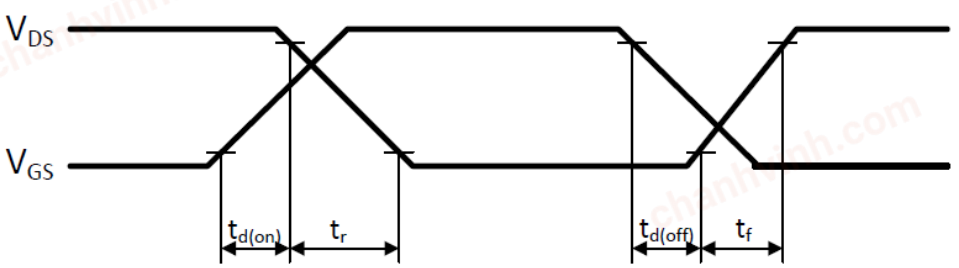
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Figure 1-17. Maximum Transient Thermal Impedance



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

Figure 1-18. Switching Waveform



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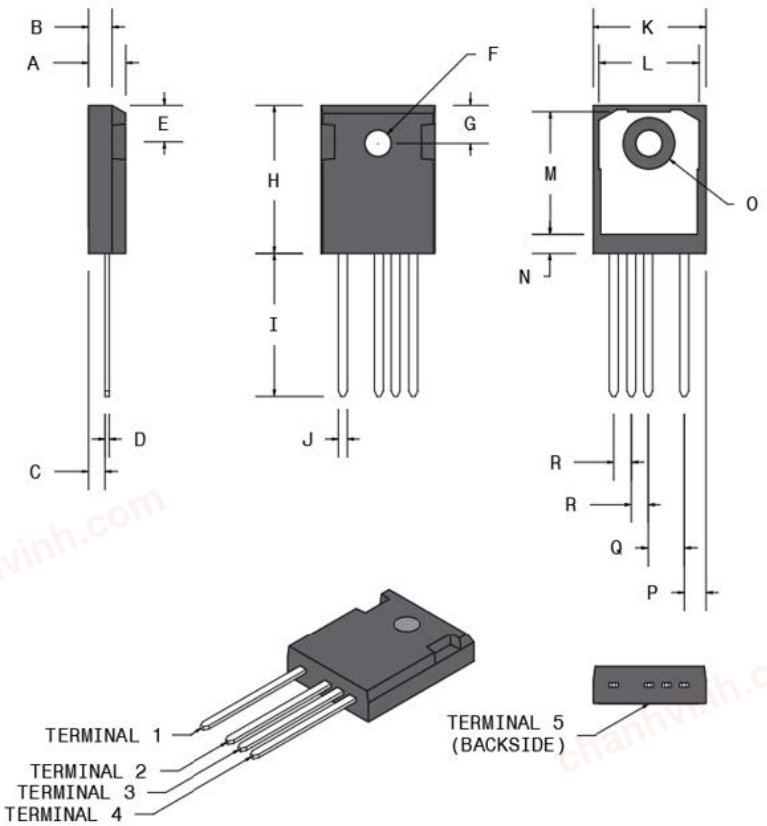
2. Package Specification

This section shows the package specification of this device.

2.1 Package Outline Drawing

The following figure illustrates the TO-247-4L package outline of this 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
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

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

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3. Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

Table 3-1. Revision History

Revision	Date	Description
A	05/2023	Document migrated from Microsemi template to Microchip template; Assigned Microchip literature number DS-00004986A,which replaces the previous Microsemi literature number 050-7764.
Initial release (Microsemi Revision A)	12/2019	Document created.

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