1200V, 45 mΩ N-Channel mSiC™ MOSFET

MSC045SMB120B4N

Product Overview

1200V, 45 mΩ typical at V_{GS} = 18V, 56 mΩ typical at V_{GS} = 15V, Silicon Carbide (SiC) N-Channel MOSFET, TO-247 notched 4-lead with a source sense.

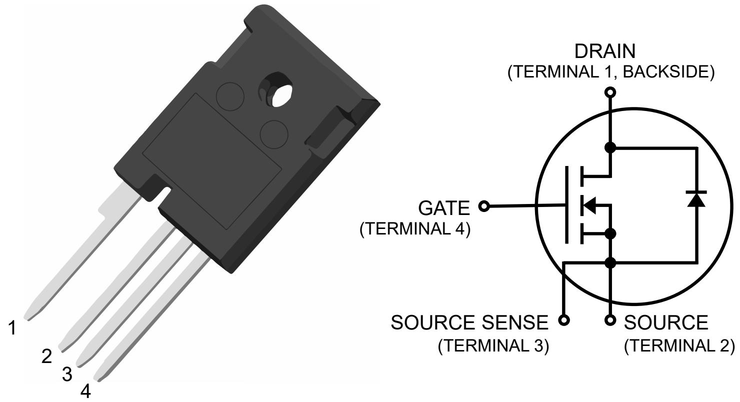


Table 1. Ordering Information

Catalog Part Number (CPN)	Package	Packing Media (Qty.)	Qualification
MSC045SMB120B4N	TO-247 notched 4-lead	Tube (30)	Industrial
MSC045SMB120B4NVAO	TO-247 notched 4-lead	Tube (30)	AEC-Q101

Features

- 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 (100% UIS production tested)
- Creepage distance (Typ. > 8 mm)
- RoHS compliant

Applications

- Photovoltaic (PV) inverter, converter, and industrial motor drives
- Smart grid transmission and distribution
- Induction heating and welding
- Hybrid Electric Vehicle (HEV) powertrain and Electric Vehicle (EV) charger
- Power supply and distribution

Benefits

- High efficiency to enable lighter and 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

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	1200	V
I_D	Continuous drain current at T_C = 25 °C	49	A
	Continuous drain current at T_C = 100 °C	35	
I_{DM}	Pulsed drain current[1]	108	
V_{GS}	Gate-source voltage	21/–10	V
	Transient gate-source voltage	23/–12	
	Recommended turn-on gate-source voltage	15 to 18	
	Recommended turn-off gate-source voltage	–5	
P_D	Total power dissipation at T_C = 25 °C	237	W
	Linear derating factor	1.5	W/°C

Note:

1. Repetitive rating: Pulse width and case temperature are limited by the maximum junction temperature.

1.2. Thermal and Mechanical Characteristics

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	—	0.49	0.63	°C/W
T_J	Operating junction temperature	–55	—	175	°C
T_{STG}	Storage temperature	–55	—	175	
T_L	Lead temperature for 10 seconds	—	—	300	°C
τ_M	Mounting torque, M3 screw for heat sink attachment (requires 1, not included)	—	0.8	—	N·m
Wt	Package weight	—	6.2	—	g

ESD practices should comply with JESD-625.

1.3. Electrical Performance

The following table shows the static characteristics of this device at 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} = 0V, I_D = 100 µA	1200	—	—	V
$R_{DS(on)}$	Drain-source on resistance[1]	V_{GS} = 18V, I_D = 10A	—	45	60	mΩ
		V_{GS} = 15V, I_D = 10A	—	56	—	
		V_{GS} = 18V, I_D = 10A, T_J = 175 °C	—	74	—	

Table 1-3. Static Characteristics (continued)

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$V_{GS(th)}$	Gate-source threshold voltage	$V_{GS} = V_{DS}$, $I_D = 1.0$ mA	1.9	3.0	5.0	V
		$V_{DS} = 960V$, $I_D = 1.0$ mA	1.65	—	—	
I_{DSS}	Zero gate voltage drain current	$V_{DS} = 1200V$, $V_{GS} = 0V$	—	0.03	5.3	μA
		$V_{DS} = 1200V$, $V_{GS} = 0V$, $T_J = 175$ °C	—	0.46	—	
I_{GSS}	Gate-source leakage current	$V_{GS} = 21V/–10V$	—	—	±100	nA

Note:

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

The following table shows the dynamic characteristics of the device at $T_J = 25$ °C unless otherwise specified.

Table 1-4. Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{GS} = 0V$, $V_{DD} = 1000V$, $V_{AC} = 25$ mV, $f = 100$ kHz	—	1480	—	pF
C_{rss}	Reverse transfer capacitance		—	5.0	—	
C_{oss}	Output capacitance		—	70	—	
Q_G	Total gate charge	$V_{GS} = 18V/–5V$, $V_{DD} = 800V$, $I_D = 10A$	—	61	—	nC
Q_{GS}	Gate-source charge		—	18	—	
Q_{GD}	Gate-drain charge		—	10	—	
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 850V$, $V_{GS} = 18V/–5V$, $I_D = 30$, $R_G = 8Ω$, Freewheeling diode = MSC045SMB120B4N ($V_{GS} = –5V$); reference Figure 1-19	—	14	—	ns
t_r	Rise time		—	12	—	
$t_{d(off)}$	Turn-off delay time		—	20	—	
t_f	Fall time		—	8	—	
E_{on}	Turn-on switching energy		—	296	—	μJ
E_{off}	Turn-off switching energy		—	123	—	
ESR	Gate equivalent series resistance	f = 1 MHz, 25 mV, drain-to-source short	—	1.05	—	Ω
SCWT	Short circuit withstand time	$V_{DS} = 960V$, $V_{GS} = 18V/0V$, $R_G = 20Ω$	—	2	—	μs
E_{AS}	Avalanche energy, single pulse	$I_D = 2.8A$, 100% UIS production tested	580	—	—	mJ
$E_{AS\ CHAR}$		$I_D = 12A$, last typical pass	—	1500	—	

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

Table 1-5. Body Diode Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
V_{SD}	Diode forward voltage	$I_{SD} = 10A$, $V_{GS} = 0V$	—	3.5	—	V
		$I_{SD} = 10A$, $V_{GS} = –5V$	—	3.9	5.0	
t_{rr}	Reverse recovery time	$I_{SD} = 30A$, $V_{GS} = –5V$, Drive $R_G = 8Ω$, $V_{DD} = 850V$, dI/dt = –9200 A/μs	—	9	—	ns
Q_{rr}	Reverse recovery charge		—	180	—	nC
I_{RRM}	Reverse recovery current		—	31	—	A

1.4. Typical Performance Curves

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

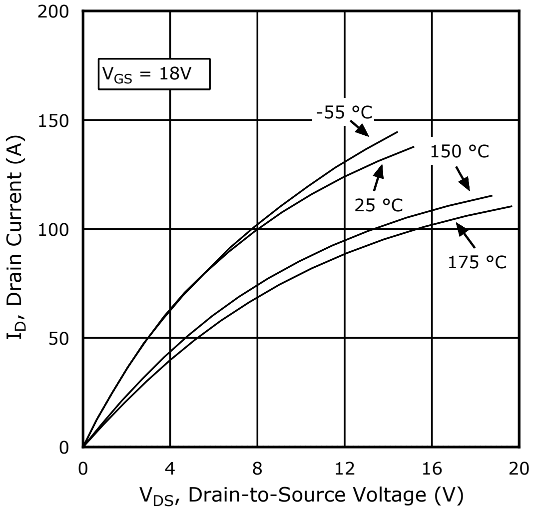


Figure 1-2. Drain Current vs. V_{DS} at V_{GS}

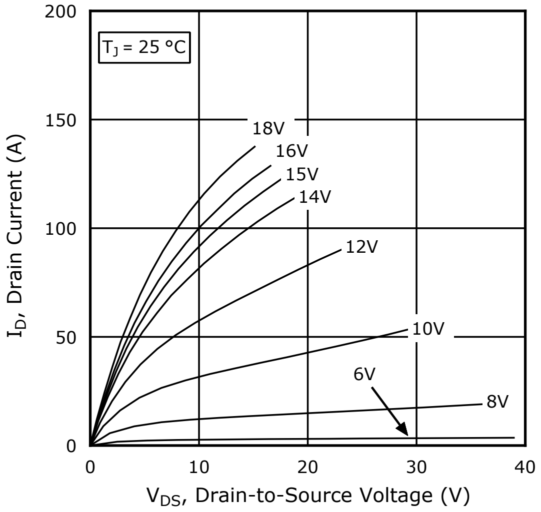


Figure 1-3. Drain Current vs. V_{DS} at V_{GS}

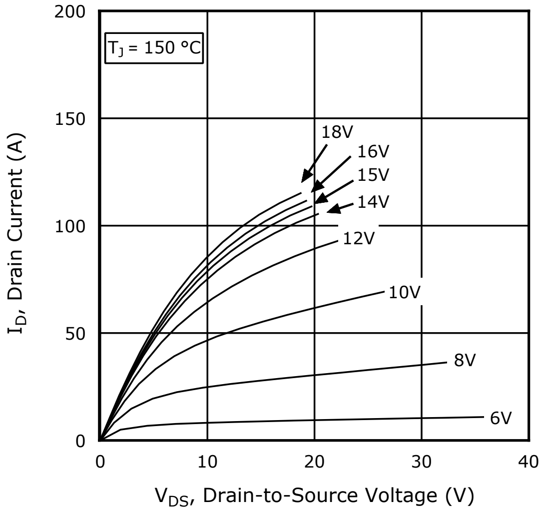


Figure 1-4. Drain Current vs. V_{DS} at V_{GS}

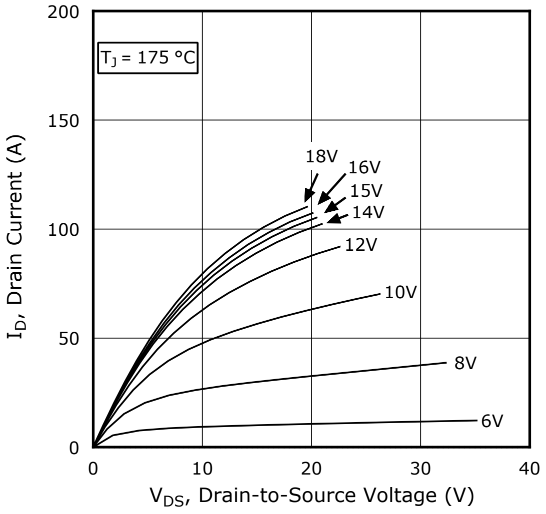


Figure 1-5. I_D vs. V_{DS} 3rd Quadrant Conduction

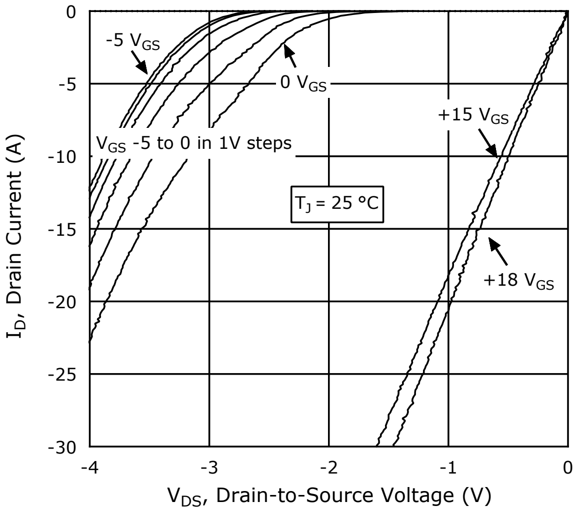


Figure 1-6. I_D vs. V_{DS} 3rd Quadrant Conduction

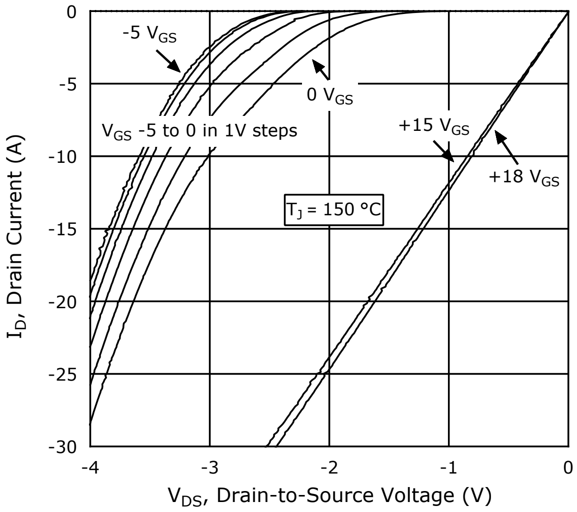


Figure 1-7. $R_{DS(on)}$ vs. Junction Temperature

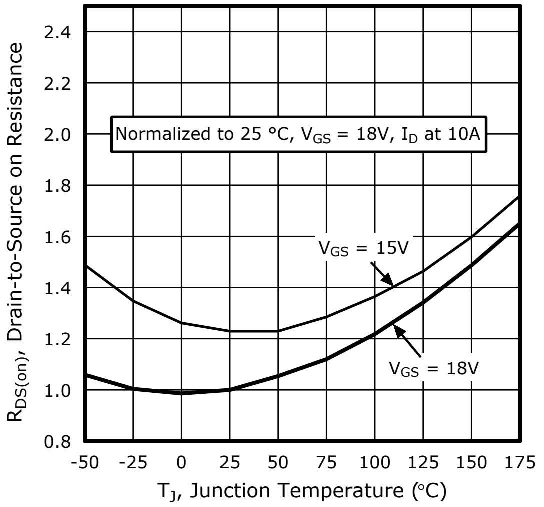


Figure 1-8. Gate Charge Characteristics

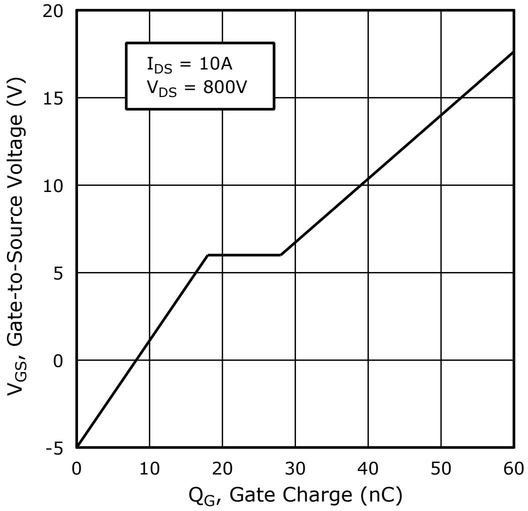


Figure 1-9. Capacitance vs. Drain-to-Source Voltage

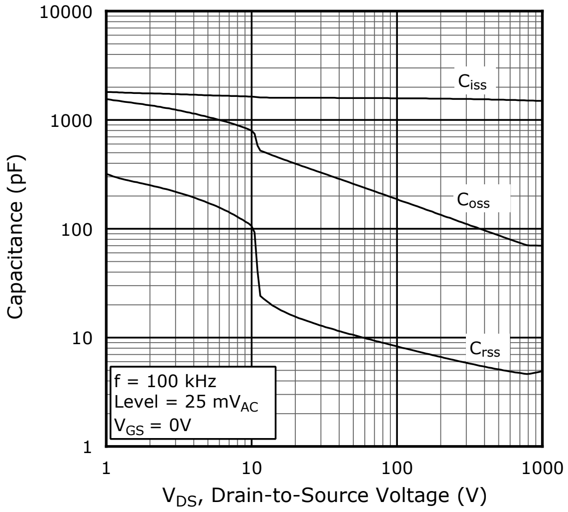


Figure 1-10. Q_{oss} vs. Drain-to-Source Voltage

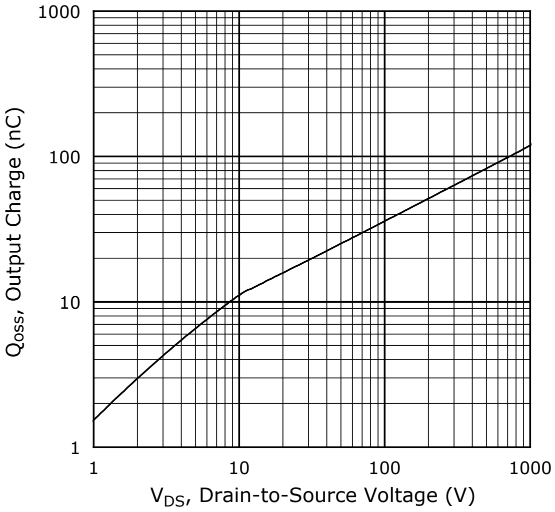


Figure 1-11. E_{oss} vs. Drain-to-Source Voltage

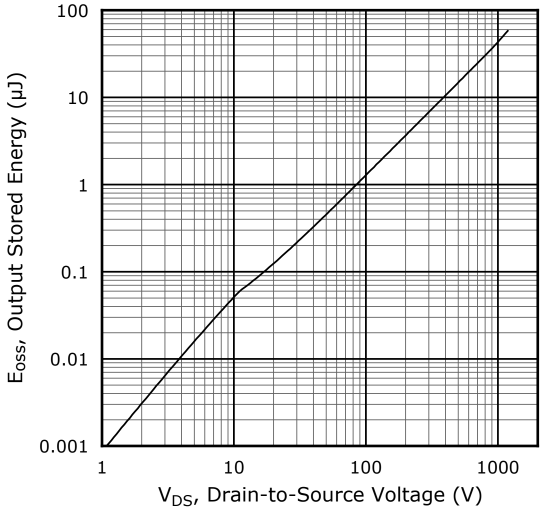


Figure 1-12. Switching Energy vs. V_{DS} & I_D

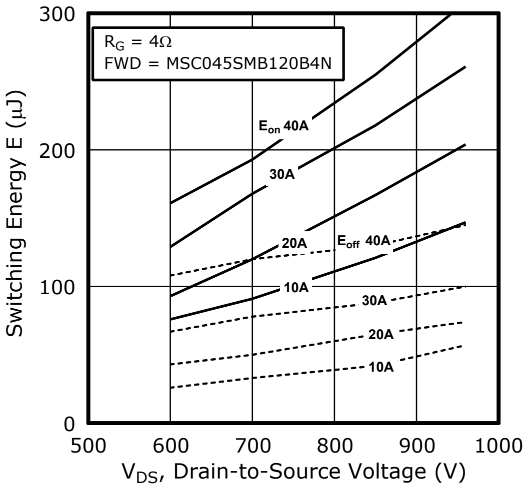


Figure 1-13. Switching Energy vs. V_{DS} & I_D

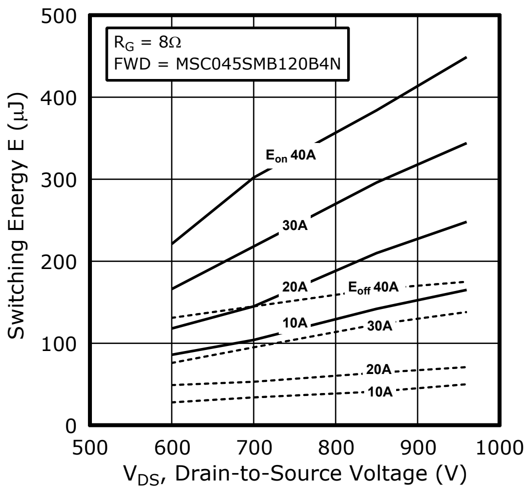


Figure 1-14. Switching Energy vs. V_{DS} & I_D

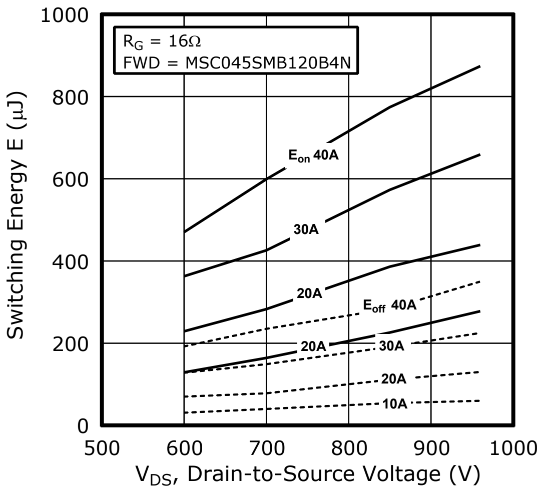


Figure 1-15. Switching Energy vs. Junction Temperature

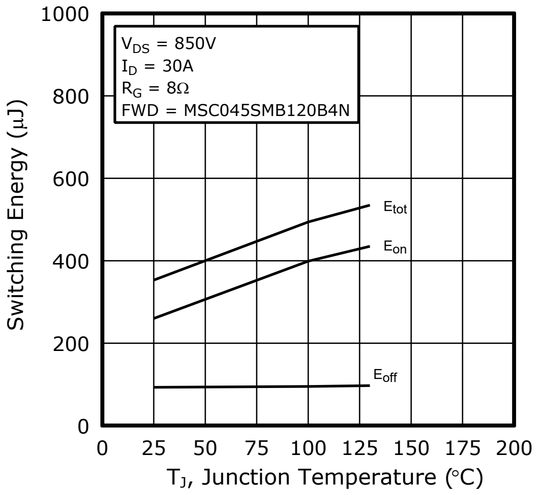


Figure 1-16. Threshold Voltage vs. Junction Temperature

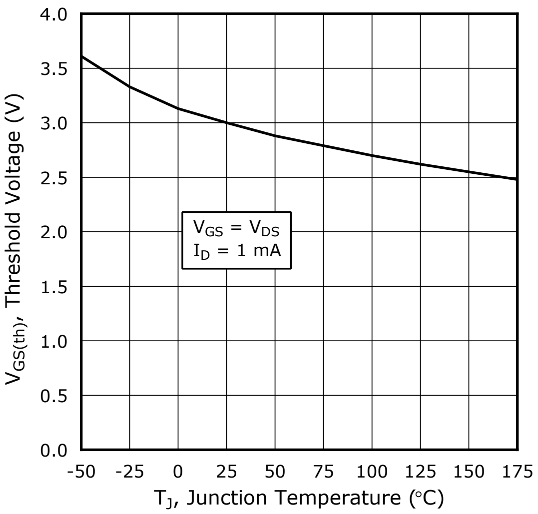


Figure 1-17. Forward Safe Operating Area

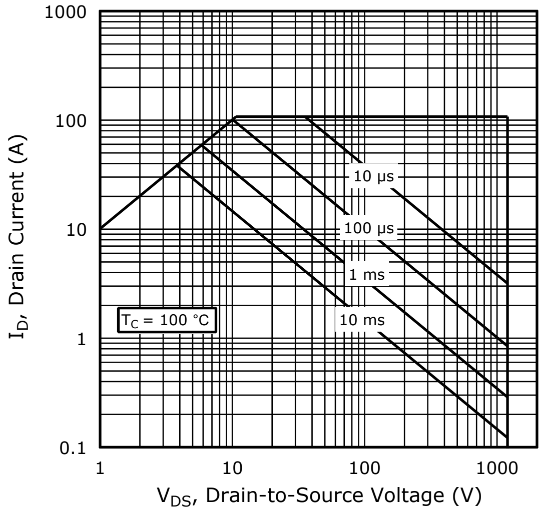
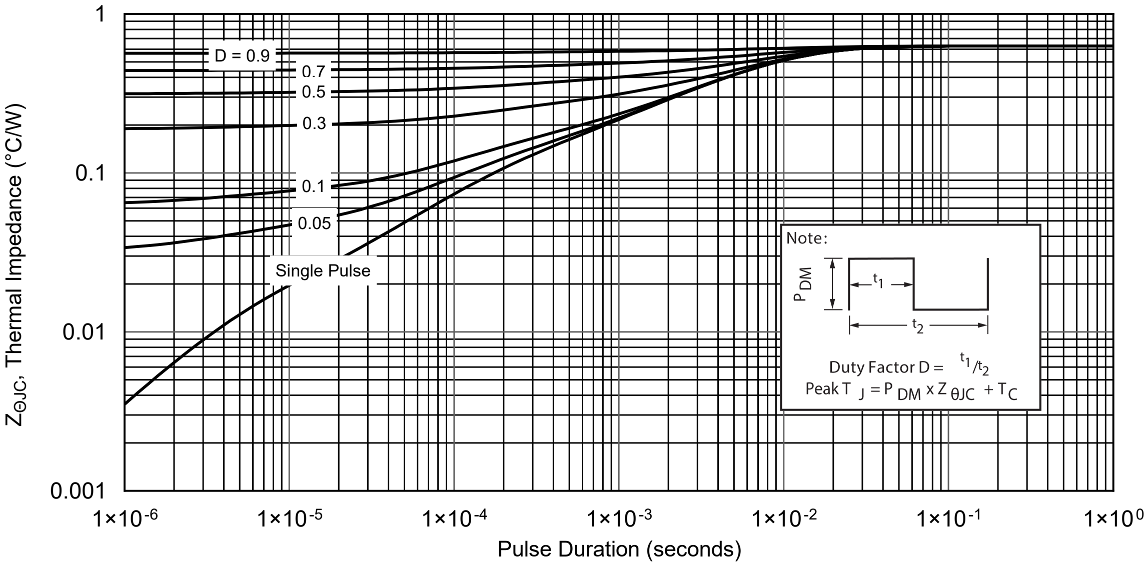
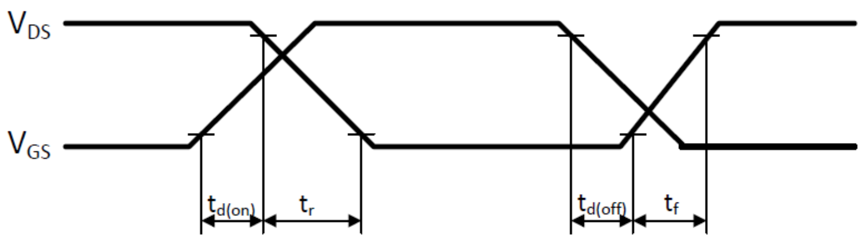


Figure 1-18. Maximum Transient Thermal Impedance



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

Figure 1-19. Switching Waveform



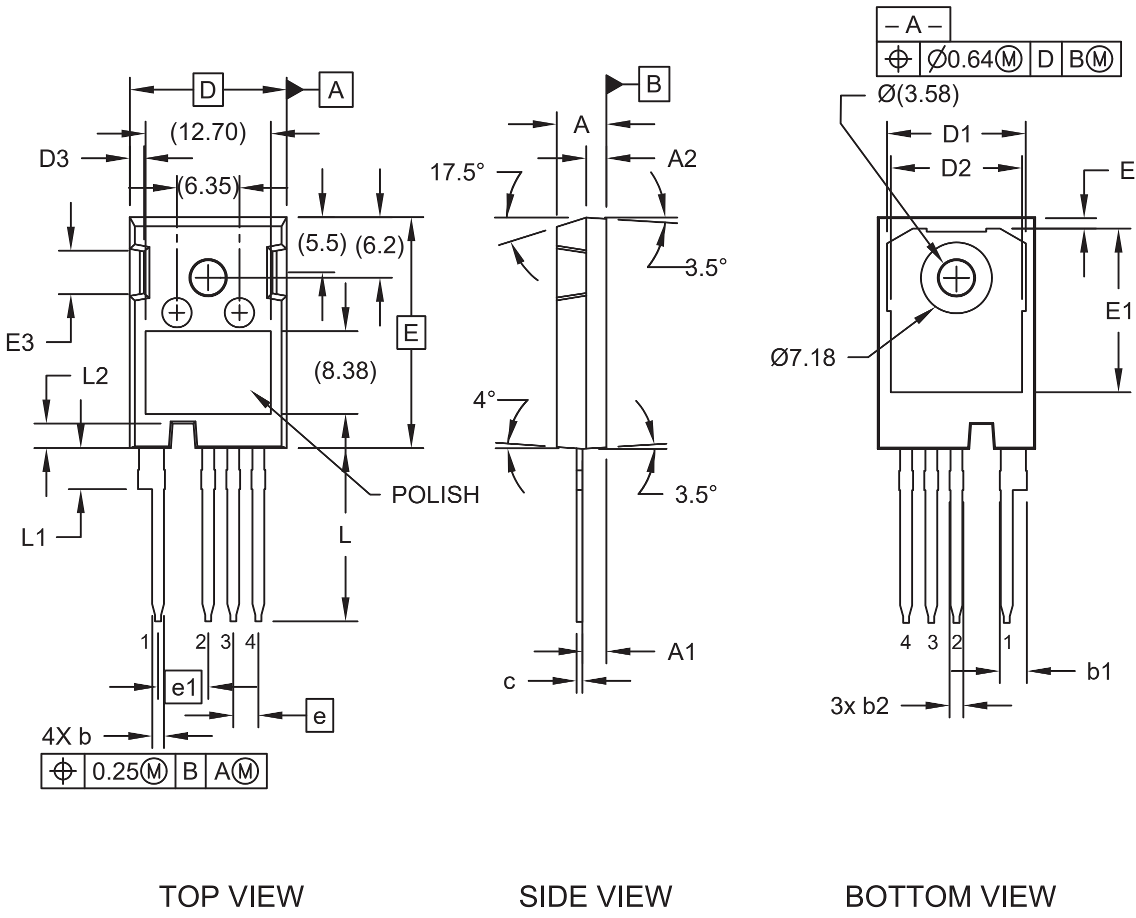
2. Package Specification

This section shows the package specification of this device.

2.1. Package Outline Drawing

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

Figure 2-1. Package Outline Drawing



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

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

Symbol	Description	Min. (mm)	Nom. (mm)	Max. (mm)
N	Number of terminals	4		
e	Pitch	2.54 BSC		
e1		5.08 BSC		
A	Overall height	4.83	5.02	5.21
A1	Standoff	2.29	2.41	2.54
A2	Exposed pad thickness	1.91	2.03	2.16
c	Terminal thickness	0.55	0.60	0.68
D	Overall length	15.75	15.94	16.13

Table 2-1. TO-247 Notched-4L Dimensions (continued)

Symbol	Description	Min. (mm)	Nom. (mm)	Max. (mm)
D1	Exposed pad length	13.10	13.62	14.15
D2		12.38	12.90	13.43
D3	Cutout length	1.00	1.45	1.90
E	Overall width	23.30	23.45	23.60
E1	Exposed pad width	16.25	16.95	17.65
E2	Exposed pad gap to edge	0.95	1.10	1.25
E3	Cutout width	3.68	4.39	5.10
b	Terminal width	1.07	1.20	1.33
b1	Terminal shoulder width (X1)	2.39	2.66	2.94
b2	Terminal shoulder width (X3)	1.07	1.33	1.60
L	Terminal length	17.31	17.56	17.82
L1	Terminal shoulder length	3.97	4.17	4.37
L2	Notch depth	2.35	2.50	2.65

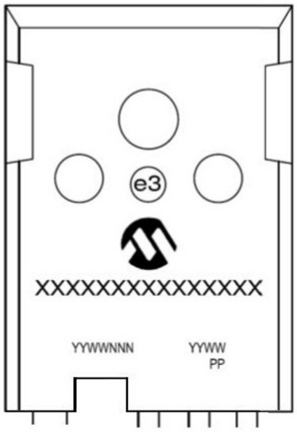
Note:
Dimensioning and tolerancing per ASME Y14.5M.

- BSC: Basic dimension. Theoretically exact value shown without tolerances.

2.2. Product Marking Information

The following figure shows the product marking information of this device.

Figure 2-2. Product Marking Information



Marking	Marking Identifier	Description
XXXXXXXXXX	Catalog Part Number (CPN)	This is the unique catalog number for the finished device. **Note:** For automotive-grade device, the VAO identifier is not shown.
YYWWNNN	Traceability code	A unique identifier assigned by Microchip to track and verify the manufacturing history of the device.
YYWW	Date code	A four-digit number which reflects the year and work week of manufacturing. It is the first four digits of the traceability code.
PP	Country of origin	Two-character code per ISO 3166-1-Alpha-2, indicating the manufacturing country.
e3	ROHS category (Lead finish code)	This code specifies the type of finish applied to the device's leads. **Note:** e3 indicates a 100% Matte Tin (Sn) finish.

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
B	12/2025	Added $R_{DS(on)}$ value at 175 °C in Table 1-3.
A	07/2025	Initial revision

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