1200V, 40 mΩ N-Channel mSiC™ MOSFET

MSC040SMB120SD

Product Overview

1200V, 40 mΩ typical at V_{GS} = 18V, 49 mΩ typical at V_{GS} = 15V, Silicon Carbide (SiC) N-Channel MOSFET, TO-263 7-lead XL with a source sense.

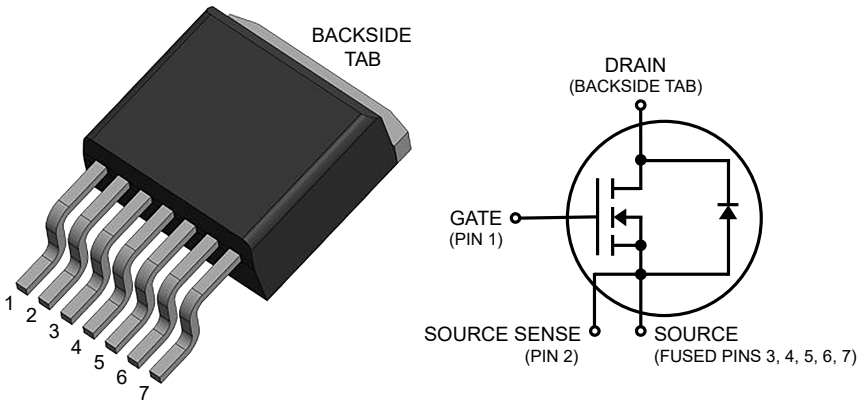

Table 1. Ordering Information

Catalog Part Number (CPN)	Package	Packing Media (Qty.)	Qualification
MSC040SMB120SDT/R	TO-263 7-lead XL	Tape and Reel (800)	Industrial
MSC040SMB120SDT/RM		Mini Tape and Reel (100)	
MSC040SMB120SDT/RVAO	TO-263 7-lead XL	Tape and Reel (800)	AEC-Q101
MSC040SMB120SDT/RMVAO		Mini Tape and Reel (100)	

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)
- 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

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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	1200	V
I_D	Continuous drain current at T_C = 25 °C	54	A
	Continuous drain current at T_C = 100 °C	38	
I_{DM}	Pulsed drain current[1]	122	
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	256	W
	Linear derating factor	1.6	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	—	0.45	0.59	°C/W
T_J	Operating junction temperature	–55	—	175	°C
T_{STG}	Storage temperature	–55	—	175	
—	Reflow temperature	—	—	260	°C
Wt	Package weight	—	1.6	—	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 = 11A	—	40	53	mΩ
		V_{GS} = 15V, I_D = 11A	—	49	—	
		V_{GS} = 18V, I_D = 11A, T_J = 175 °C	—	66	—	
$V_{GS(th)}$	Gate-source threshold voltage	V_{GS} = V_{DS}, I_D = 1.5 mA	1.9	3.0	5.0	V
		V_{DS} = 960V, I_D = 1.5 mA	1.5	—	—	

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Table 1-3. Static Characteristics (continued)

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
I_{DSS}	Zero gate voltage drain current	V_{DS} = 1200V, V_{GS} = 0V	—	0.04	5.3	µA
		V_{DS} = 1200V, V_{GS} = 0V, T_J = 175 °C	—	0.5	—	
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, ƒ = 100 kHz	—	1669	—	pF
C_{rss}	Reverse transfer capacitance		—	6.0	—	
C_{oss}	Output capacitance		—	78	—	
Q_G	Total gate charge	V_{GS} = 18V/–5V, V_{DD} = 800V, I_D = 11A	—	69	—	nC
Q_{GS}	Gate-source charge		—	20	—	
Q_{GD}	Gate-drain charge		—	11	—	
$t_{d(on)}$	Turn-on delay time	V_{DD} = 820V, V_{GS} = 18V/–5V, I_D = 30A, R_G = 8Ω, Freewheeling diode = MSC040SMB120SD (V_{GS} = –5V); reference Figure 1-19	—	16	—	ns
t_r	Rise time		—	14	—	
$t_{d(off)}$	Turn-off delay time		—	24	—	
t_f	Fall time		—	10	—	
E_{on}	Turn-on switching energy		—	337	—	µJ
E_{off}	Turn-off switching energy		—	99	—	
ESR	Gate equivalent series resistance	f = 1 MHz, 25 mV, drain-to-source short	—	1.03	—	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 = 3A, 100% UIS production tested	700	—	—	mJ
$E_{AS\ CHAR}$		I_D = 13A, last typical pass	—	1575	—	

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} = 11A, V_{GS} = 0V	—	3.5	—	V
		I_{SD} = 11A, V_{GS} = –5V	—	3.9	5.0	
t_{rr}	Reverse recovery time	I_{SD} = 30A, V_{GS} = –5V, Drive R_G = 8Ω, V_{DD} = 820V, dI/dt = –8400 A/µs	—	10	—	ns
Q_{rr}	Reverse recovery charge		—	184	—	nC
I_{RRM}	Reverse recovery current		—	31	—	A

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1.4. Typical Performance Curves

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

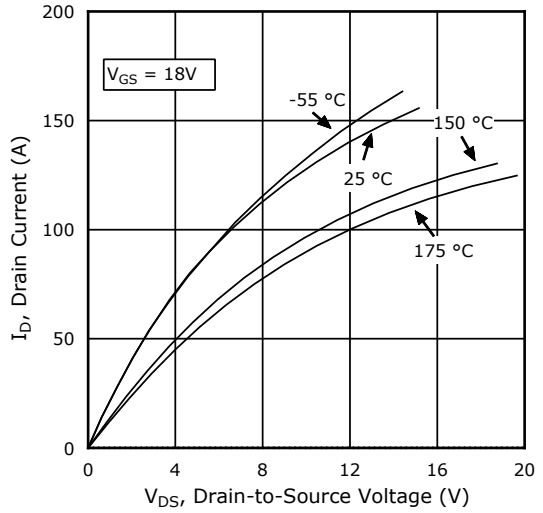

Figure 1-2. Drain Current vs. V_{DS} at V_{GS}

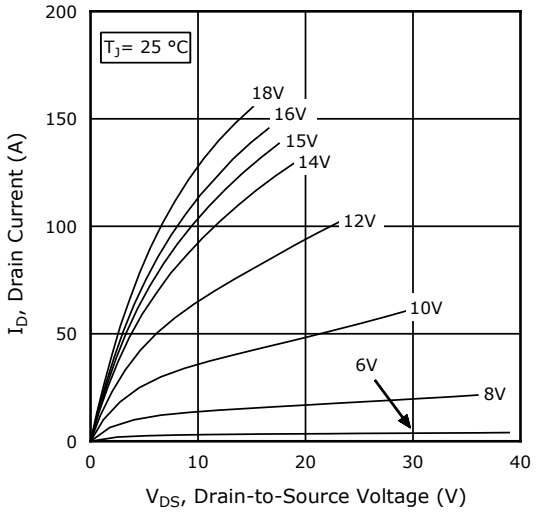

Figure 1-3. Drain Current vs. V_{DS} at V_{GS}

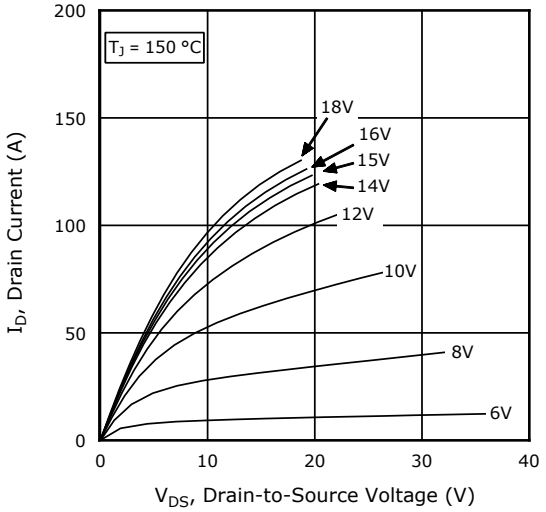

Figure 1-4. Drain Current vs. V_{DS} at V_{GS}

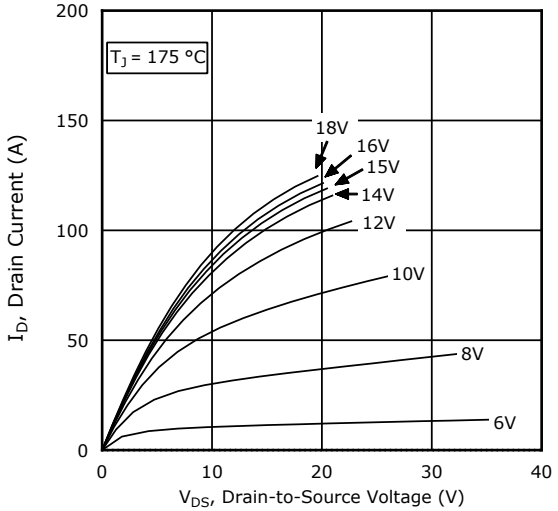

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Figure 1-5. I_D vs. V_{DS} 3rd Quadrant Conduction

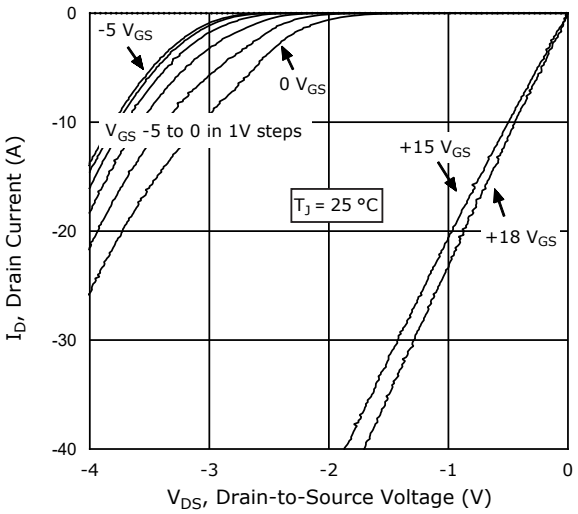

Figure 1-6. I_D vs. V_{DS} 3rd Quadrant Conduction

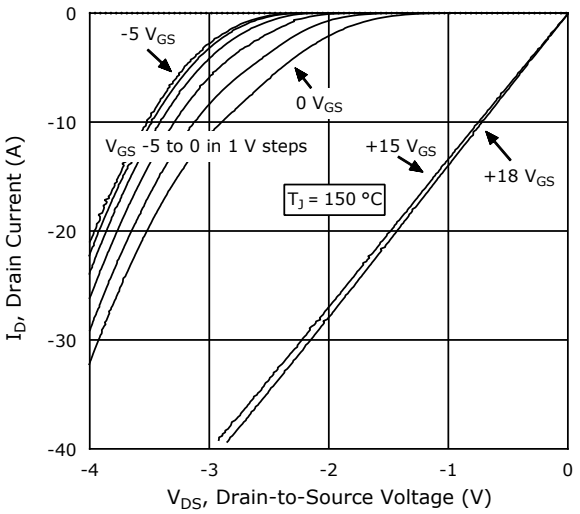

Figure 1-7. $R_{DS(on)}$ vs. Junction Temperature

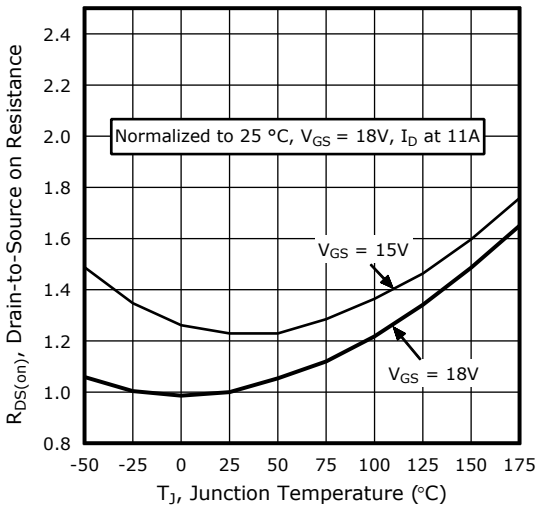

Figure 1-8. Gate Charge Characteristics

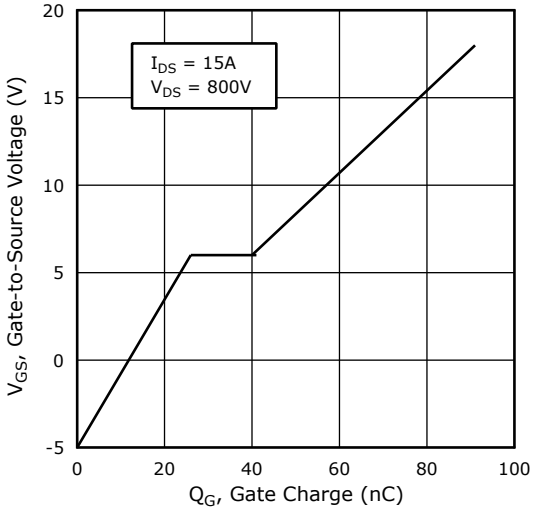

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Figure 1-9. Capacitance vs. Drain-to-Source Voltage

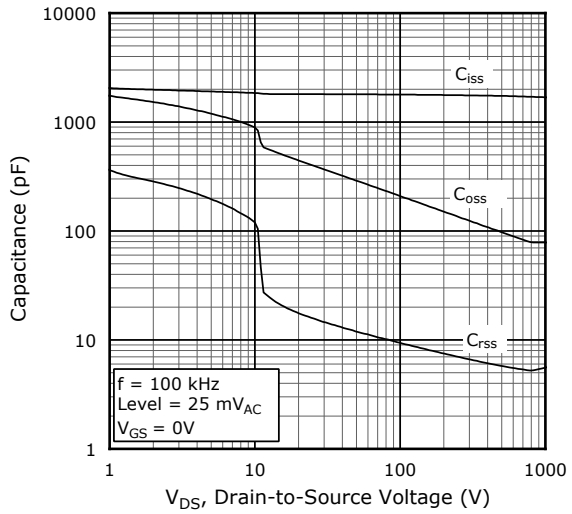

Figure 1-10. Q_{oss} vs. Drain-to-Source Voltage

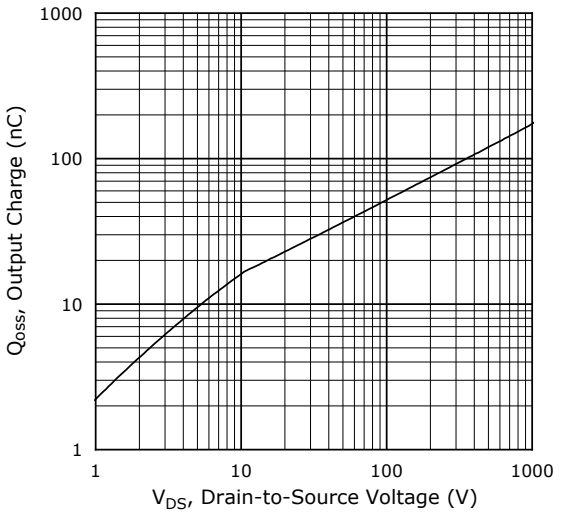

Figure 1-11. E_{oss} vs. Drain-to-Source Voltage

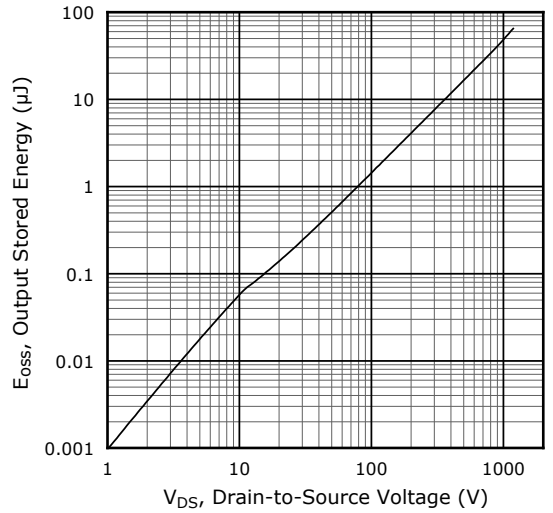

Figure 1-12. Switching Energy vs. V_{DS} & I_D

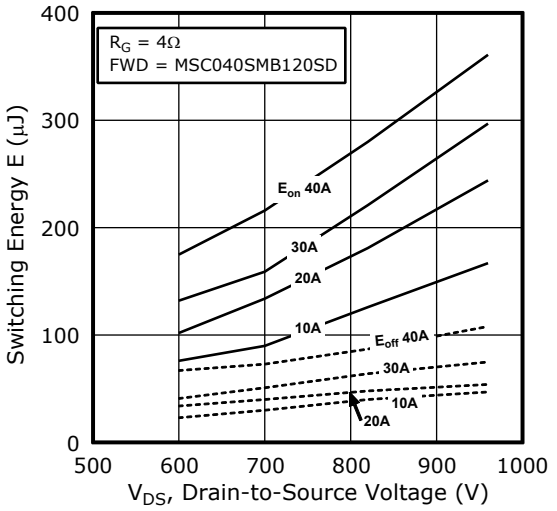

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Figure 1-13. Switching Energy vs. V_{DS} & I_D

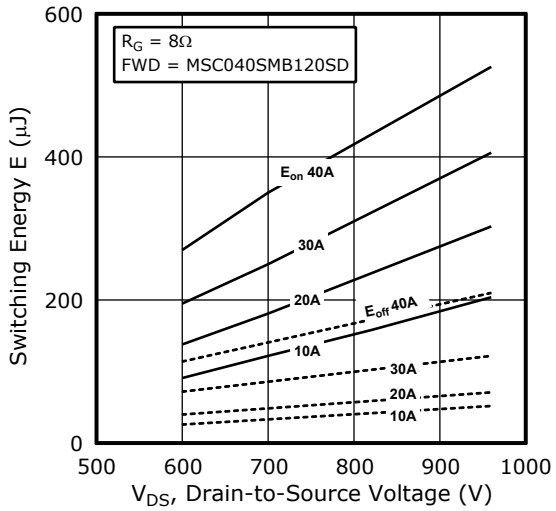

Figure 1-14. Switching Energy vs. V_{DS} & I_D

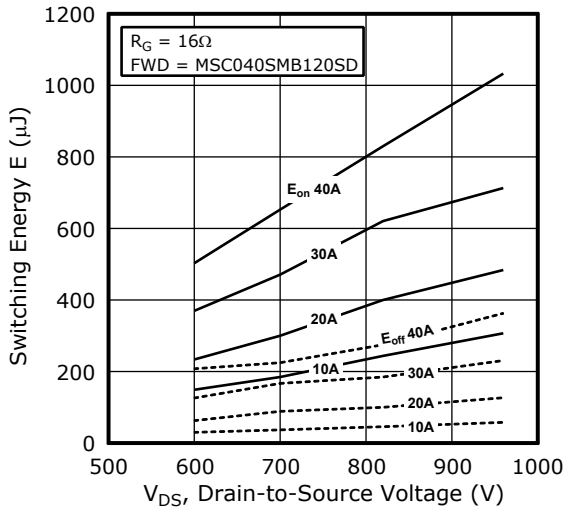

Figure 1-15. Switching Energy vs. Junction Temperature

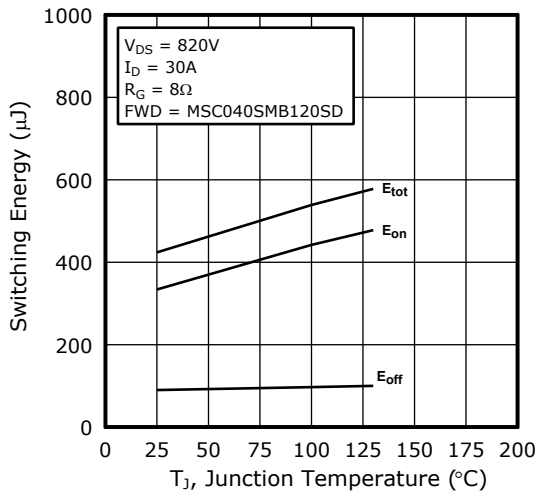

Figure 1-16. Threshold Voltage vs. Junction Temperature

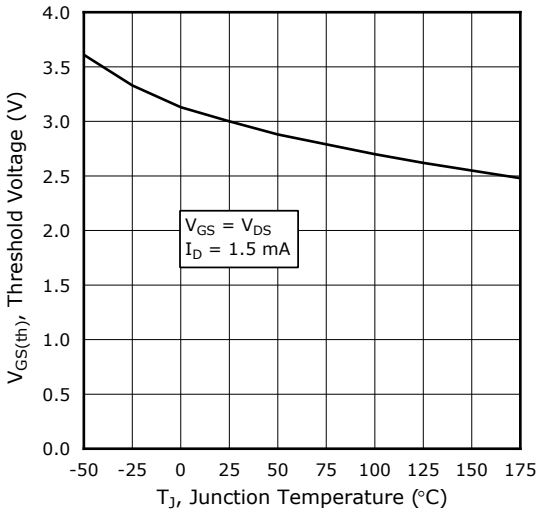

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Figure 1-17. Forward Safe Operating Area

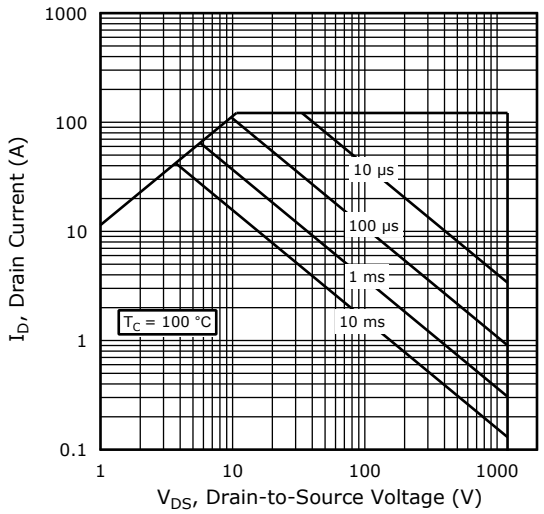
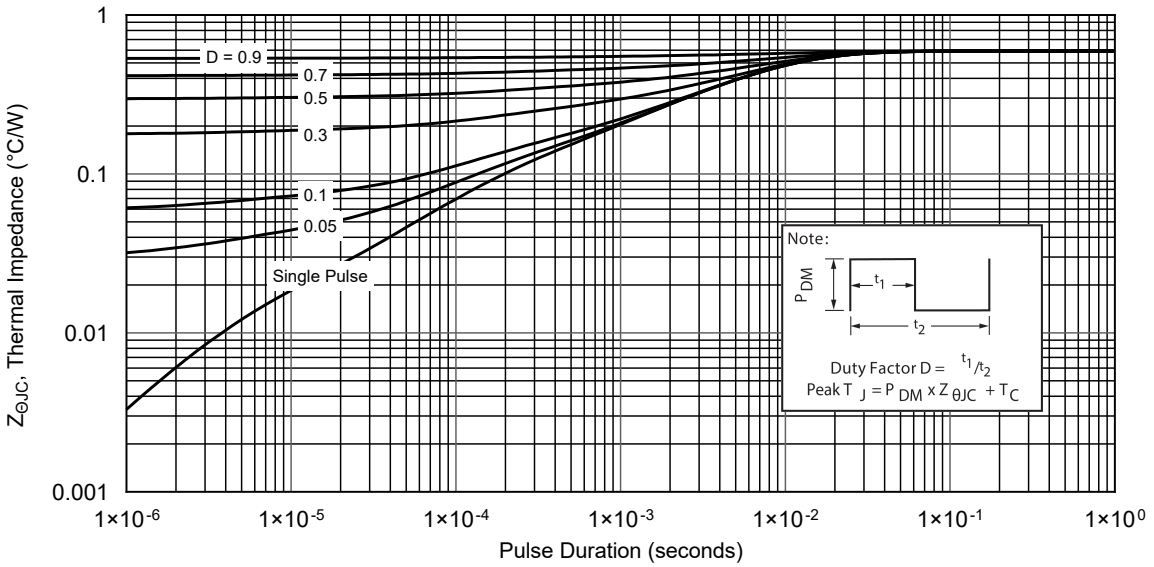
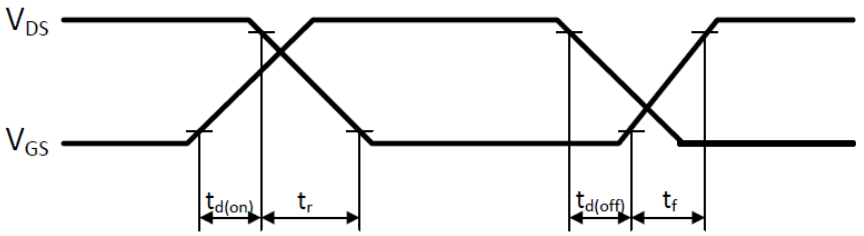


Figure 1-18. Maximum Transient Thermal Impedance



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

Figure 1-19. Switching Waveform



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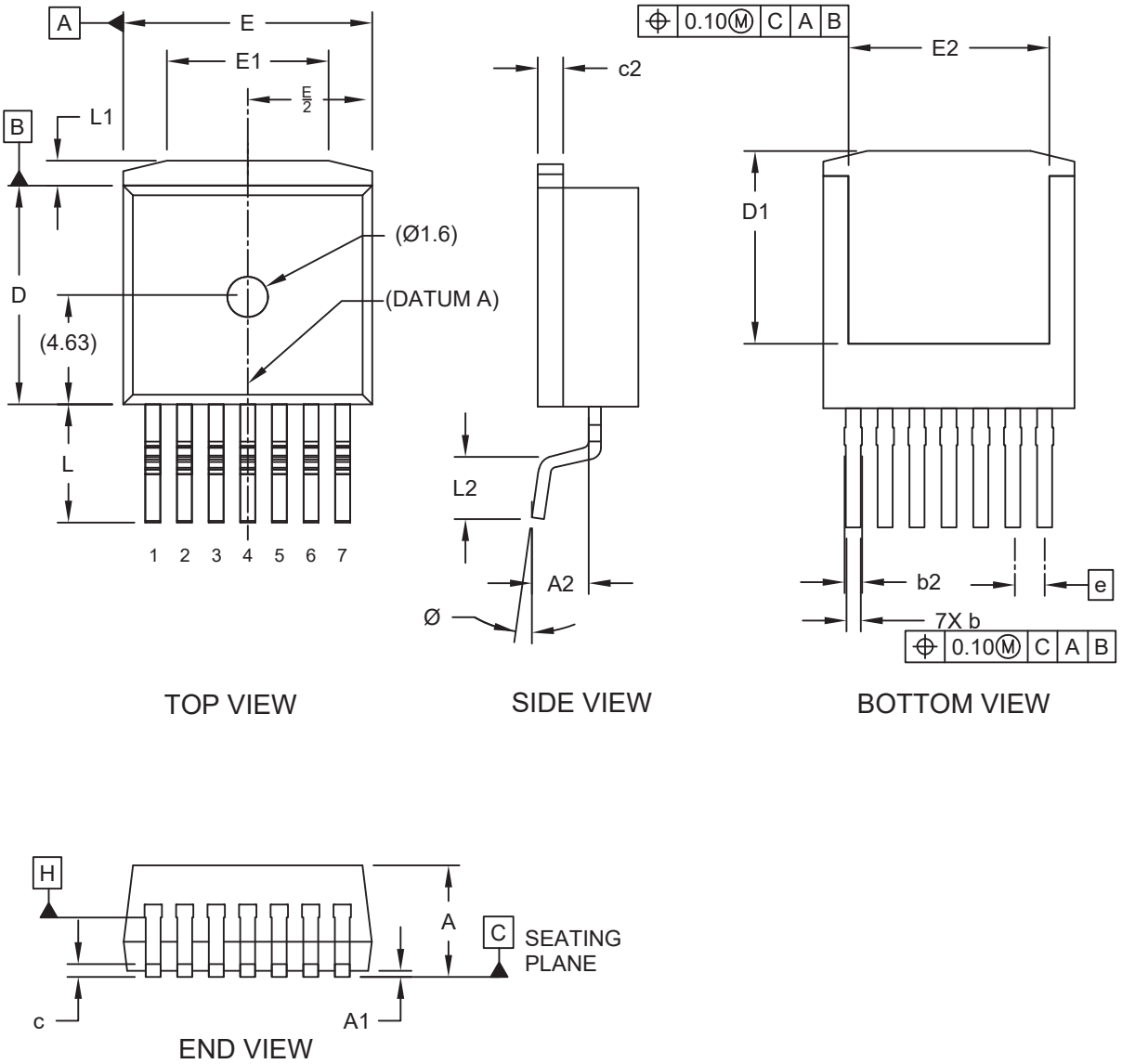
2. Package Specification

This section shows the package specification of this device.

2.1. Package Outline Drawing

The following figure illustrates the TO-263-7L XL package outline of this device.

Figure 2-1. Package Outline Drawing



The following table shows the TO-263-7L XL dimensions and should be used in conjunction with the package outline drawing.

Table 2-1. TO-263-7L XL Dimensions

Symbol	Description	Min. (mm)	Max. (mm)
N	Number of leads	7	
e	Pitch	1.27 BSC	

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Table 2-1. TO-263-7L XL Dimensions (continued)

Symbol	Description	Min. (mm)	Max. (mm)
A	Overall height	4.30	4.70
A1	Seating plane height	—	0.25
A2	Seating plane to lead	2.20	2.60
b	Lead width	0.52	0.72
b1		0.60	0.80
c	Lead thickness	0.42	0.62
c2	Thermal pad thickness	1.07	1.47
L	Lead length	4.55	4.95
L1	Tab length	0.87	1.27
L2	Foot length	2.48	2.88
D	Molded body length	9.05	9.45
D1	Thermal pad length	7.58	7.98
E	Total width	9.80	10.20
E1	Thermal pad width step back	6.30	6.70
E2	Thermal pad width	7.80	8.20
Ø	Lead foot angle	0°	8°

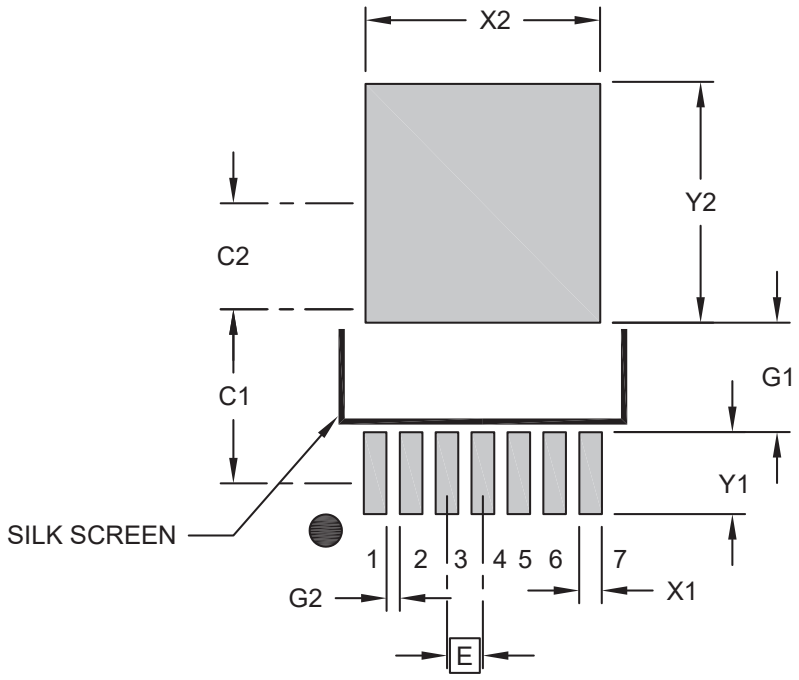
Note: Dimensioning and tolerancing per ASME Y14.5M.

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

2.2. Recommended Land Pattern

The following figure illustrates the recommended land pattern of this device.

Figure 2-2. Recommended Land Pattern



The following table shows the recommended land pattern dimensions.

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Table 2-2. Recommended Land Pattern Dimensions

Symbol	Description	Min. (mm)	Nom. (mm)	Max. (mm)
E	Contact pitch	1.27 BSC		
X2	Center pad width	—	—	8.30
Y2	Center pad length	—	—	8.45
C1	Contact pad spacing	—	6.45	—
C2	Contact pad spacing	—	4.30	—
X1	Contact pad width (X7)	—	—	0.80
Y1	Contact pad length (X7)	—	—	2.90
G1	Contact pad to center pad (X7)	3.88	—	—
G2	Contact pad to contact pad (X6)	0.47	—	—

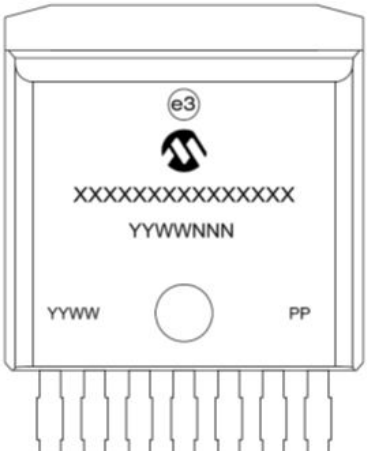
Notes:

- Dimensioning and tolerancing per ASME Y14.5M.
  - BSC: Basic dimension. Theoretically exact value shown without tolerances.
- For best soldering results, thermal vias, if used, should be filled or tented to avoid solder loss during reflow process.

2.3. Product Marking Information

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

Figure 2-3. 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.

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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	12/2025	Initial revision

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