

1200V, 20 mΩ N-Channel mSiC™ MOSFET
MSC020SMB120SD



Product Overview

1200V, 20 mΩ typical at $V_{GS} = 18V$, 24 mΩ typical at $V_{GS} = 15V$, Silicon Carbide (SiC) N-Channel MOSFET, TO-263 7-lead XL with a source sense.

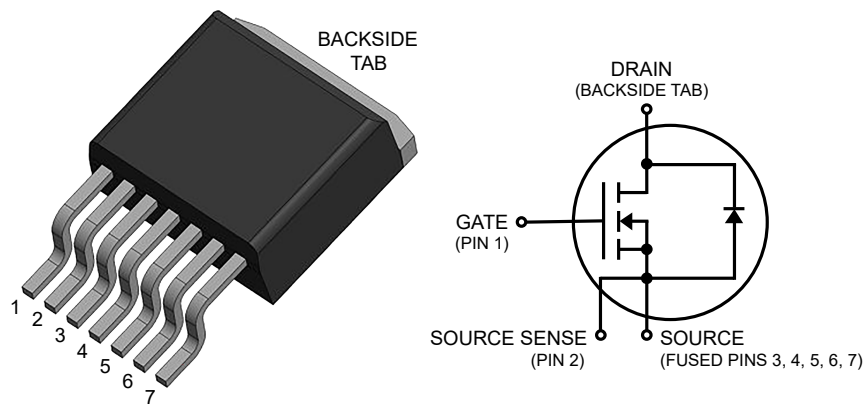


Table 1. Ordering Information

Catalog Part Number (CPN)	Package	Packing Media (Qty.)	Qualification
MSC020SMB120SDT/R	TO-263 7-lead XL	Tape and Reel (800)	Industrial
MSC020SMB120SDT/RM		Mini Tape and Reel (100)	
MSC020SMB120SDT/RVAO	TO-263 7-lead XL	Tape and Reel (800)	AEC-Q101
MSC020SMB120SDT/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, $T_{J(max)} = 175\text{ }^{\circ}\text{C}$
- 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

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 $T_C = 25\text{ }^{\circ}\text{C}$	97	A
	Continuous drain current at $T_C = 100\text{ }^{\circ}\text{C}$	68	
I_{DM}	Pulsed drain current ¹	243	
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 $T_C = 25\text{ }^{\circ}\text{C}$	416	W
	Linear derating factor	2.78	W/ $^{\circ}\text{C}$

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	—	0.28	0.36	$^{\circ}\text{C}/\text{W}$
T_J	Operating junction temperature	-55	—	175	$^{\circ}\text{C}$
T_{STG}	Storage temperature	-55	—	175	
—	Reflow temperature	—	—	260	$^{\circ}\text{C}$
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 $T_J = 25\text{ }^{\circ}\text{C}$ unless otherwise specified.

Table 1-3. Static Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{V}, I_D = 100\text{ }\mu\text{A}$	1200	—	—	V
$R_{DS(on)}$	Drain-source on resistance ¹	$V_{GS} = 18\text{V}, I_D = 23\text{A}$	—	20	27	m Ω
		$V_{GS} = 15\text{V}, I_D = 23\text{A}$	—	24	—	
		$V_{GS} = 18\text{V}, I_D = 23\text{A}, T_J = 175\text{ }^{\circ}\text{C}$	—	33	—	
$V_{GS(th)}$	Gate-source threshold voltage	$V_{GS} = V_{DS}, I_D = 2.5\text{ mA}$	1.9	3.0	5.0	V
		$V_{DS} = 960\text{V}, I_D = 2.5\text{ mA}$	1.5	—	—	

Table 1-3. Static Characteristics (continued)

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
I_{DSS}	Zero gate voltage drain current	$V_{DS} = 1200V, V_{GS} = 0V$	—	0.6	11.3	μA
		$V_{DS} = 1200V, V_{GS} = 0V, T_J = 175\text{ }^{\circ}C$	—	0.9	—	
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 $T_J = 25\text{ }^{\circ}C$ unless otherwise specified.

Table 1-4. Dynamic Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	$V_{GS} = 0V, V_{DD} = 1000V, V_{AC} = 25\text{ mV},$ $f = 100\text{ kHz}$	—	3314	—	pF
C_{rss}	Reverse transfer capacitance		—	11	—	
C_{oss}	Output capacitance		—	152	—	
Q_G	Total gate charge	$V_{GS} = 18V/-5V, V_{DD} = 800V, I_D = 30A$	—	136	—	nC
Q_{GS}	Gate-source charge		—	39	—	
Q_{GD}	Gate-drain charge		—	23	—	
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 850V, V_{GS} = 18V/-5V, I_D = 40A, R_G = 4\Omega,$ Freewheeling diode = MSC020SMB120SD ($V_{GS} = -5V$); reference Figure 1-19	—	18	—	ns
t_r	Rise time		—	14	—	
$t_{d(off)}$	Turn-off delay time		—	31	—	
t_f	Fall time		—	9	—	
E_{on}	Turn-on switching energy		—	500	—	μJ
E_{off}	Turn-off switching energy		—	121	—	
ESR	Gate equivalent series resistance	$f = 1\text{ MHz}, 25\text{ mV},$ drain-to-source short	—	1.0	—	Ω
SCWT	Short circuit withstand time	$V_{DS} = 960V, V_{GS} = 18V/0V, R_G = 20\Omega$	—	2	—	μs
E_{AS}	Avalanche energy, single pulse	$I_D = 5.6A, 100\%$ UIS production tested	1400	—	—	mJ
$E_{AS\text{ CHAR}}$		$I_D = 24A,$ last typical pass	—	3000	—	

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

Table 1-5. Body Diode Characteristics

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
V_{SD}	Diode forward voltage	$I_{SD} = 23A, V_{GS} = 0V$	—	3.1	—	V
		$I_{SD} = 23A, V_{GS} = -5V$	—	3.9	5.0	
t_{rr}	Reverse recovery time	$I_{SD} = 40A, V_{GS} = -5V,$ Drive $R_G = 4\Omega, V_{DD} = 850V,$ $di/dt = -9600\text{ A}/\mu s$	—	12	—	ns
Q_{rr}	Reverse recovery charge		—	337	—	nC
I_{RRM}	Reverse recovery current		—	50	—	A

1.4. Typical Performance Curves

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

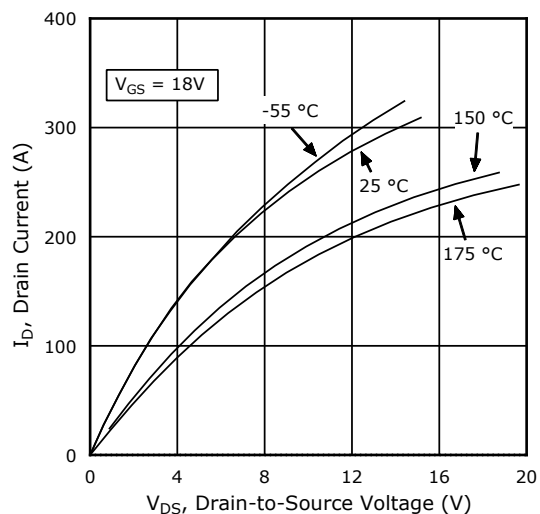


Figure 1-2. Drain Current vs. V_{DS} at V_{GS}

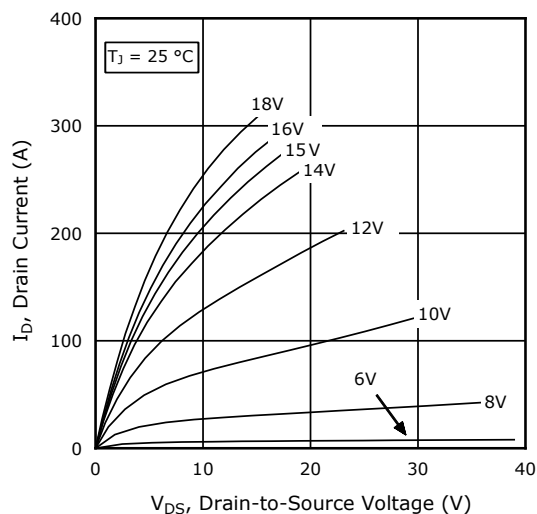


Figure 1-3. Drain Current vs. V_{DS} at V_{GS}

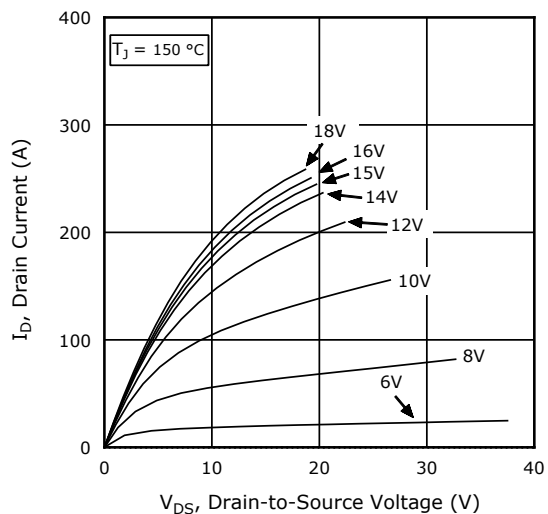


Figure 1-4. Drain Current vs. V_{DS} at V_{GS}

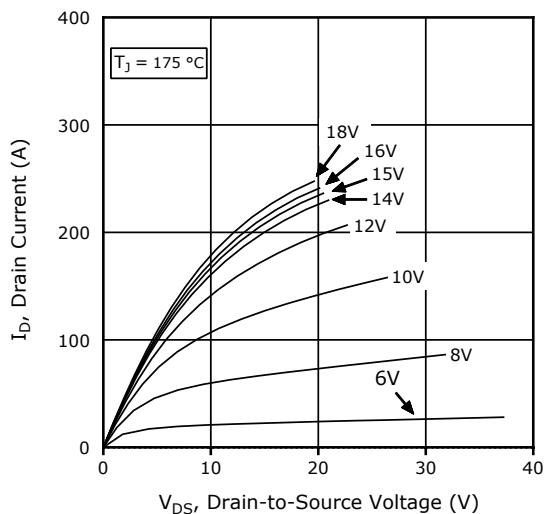


Figure 1-5. I_D vs. V_{DS} 3rd Quadrant Conduction

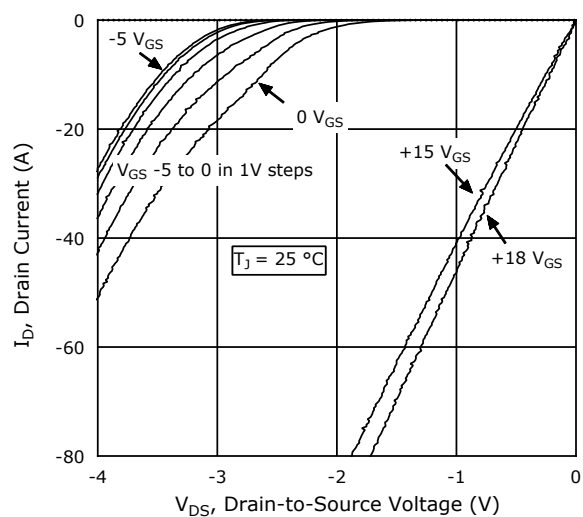


Figure 1-6. I_D vs. V_{DS} 3rd Quadrant Conduction

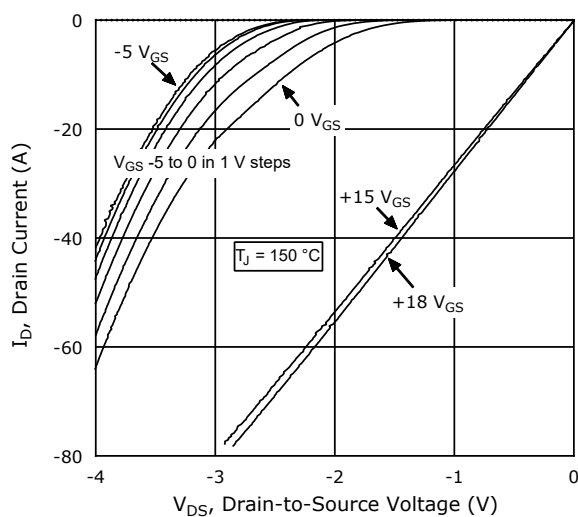


Figure 1-7. $R_{DS(on)}$ vs. Junction Temperature

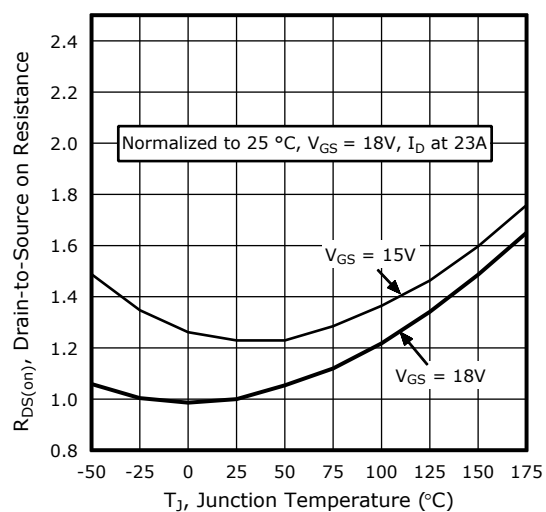


Figure 1-8. Gate Charge Characteristics

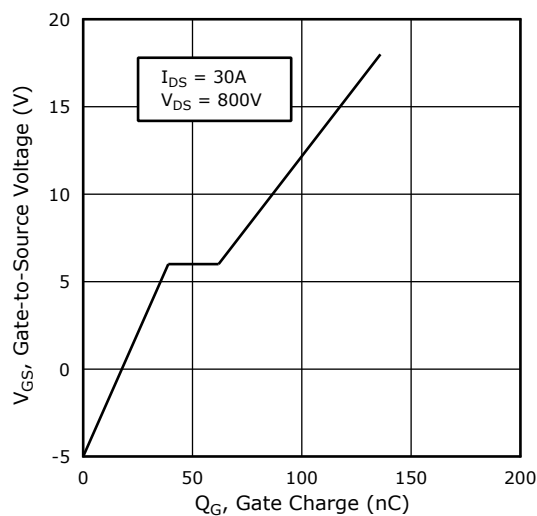


Figure 1-9. Capacitance vs. Drain-to-Source Voltage

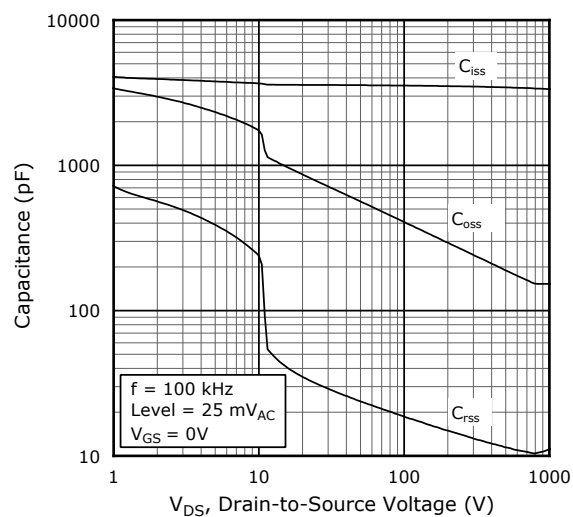


Figure 1-10. Q_{oss} vs. Drain-to-Source Voltage

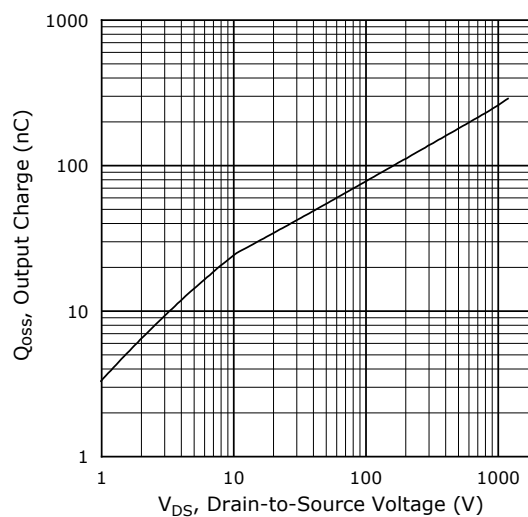


Figure 1-11. E_{oss} vs. Drain-to-Source Voltage

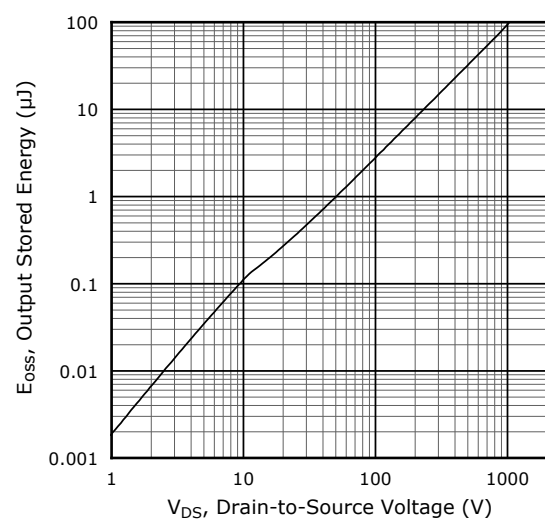


Figure 1-12. Switching Energy vs. V_{DS} & I_D

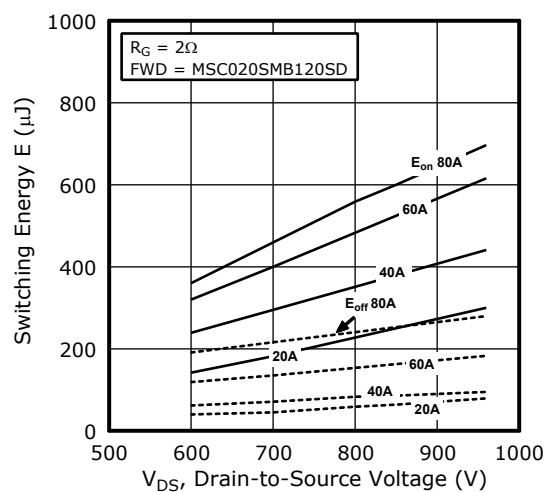


Figure 1-13. Switching Energy vs. V_{DS} & I_D

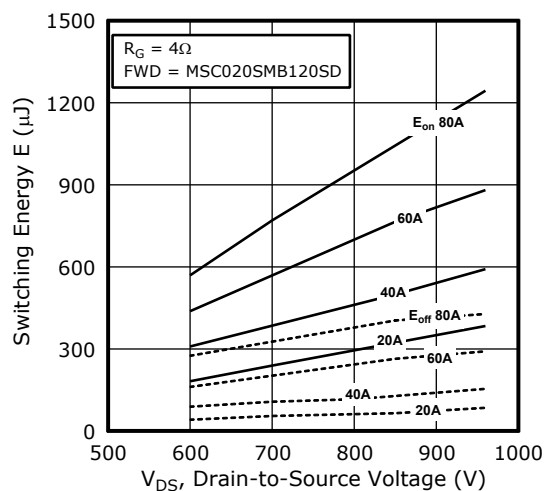


Figure 1-14. Switching Energy vs. V_{DS} & I_D

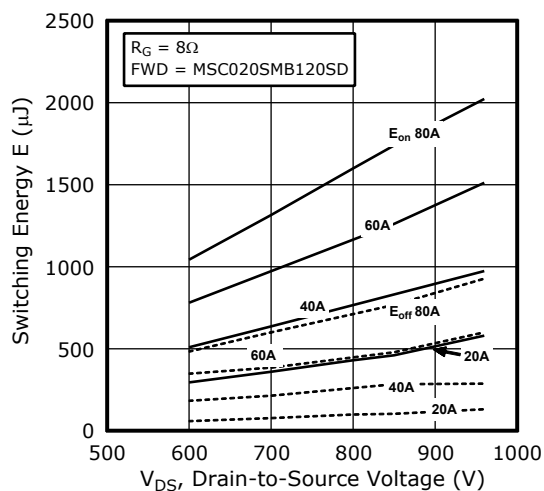


Figure 1-15. Switching Energy vs. Junction Temperature

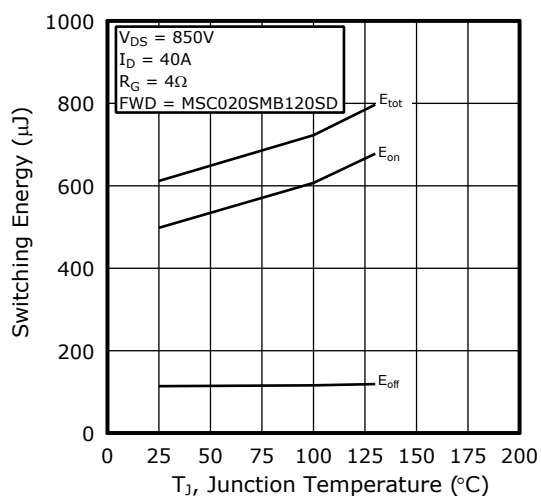


Figure 1-16. Threshold Voltage vs. Junction Temperature

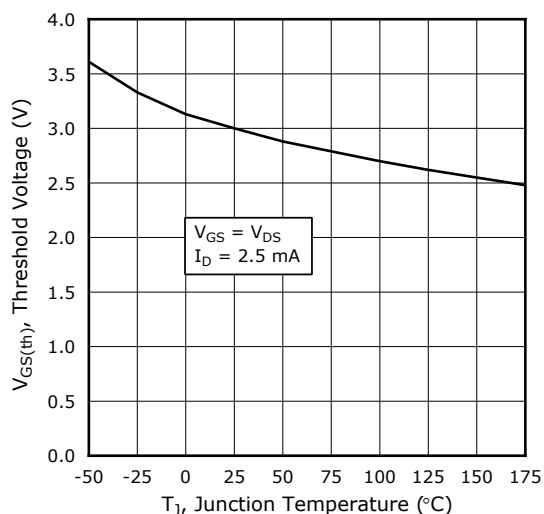


Figure 1-17. Forward Safe Operating Area

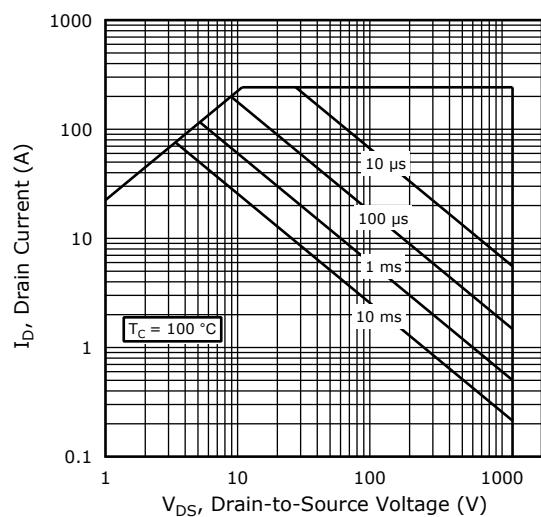
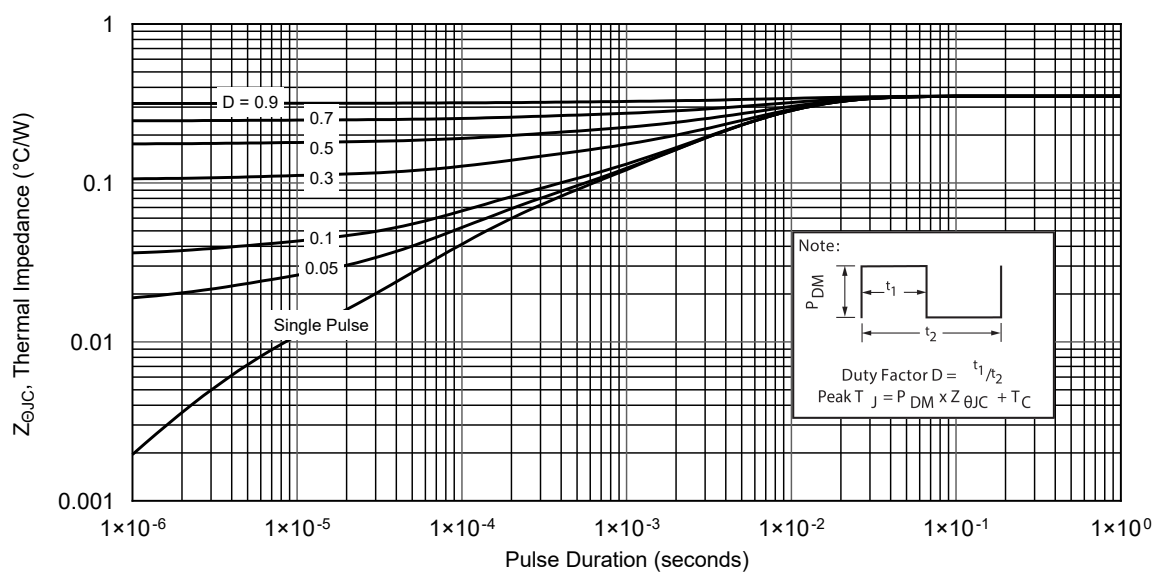
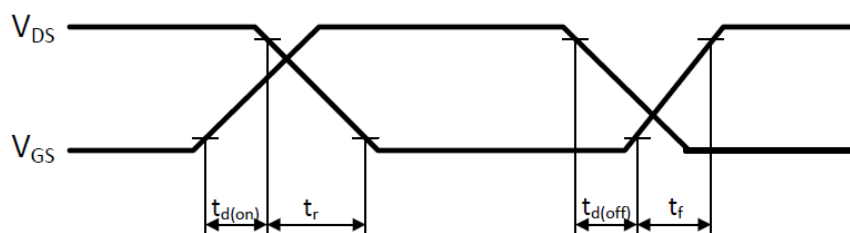


Figure 1-18. Maximum Transient Thermal Impedance



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

Figure 1-19. Switching Waveform



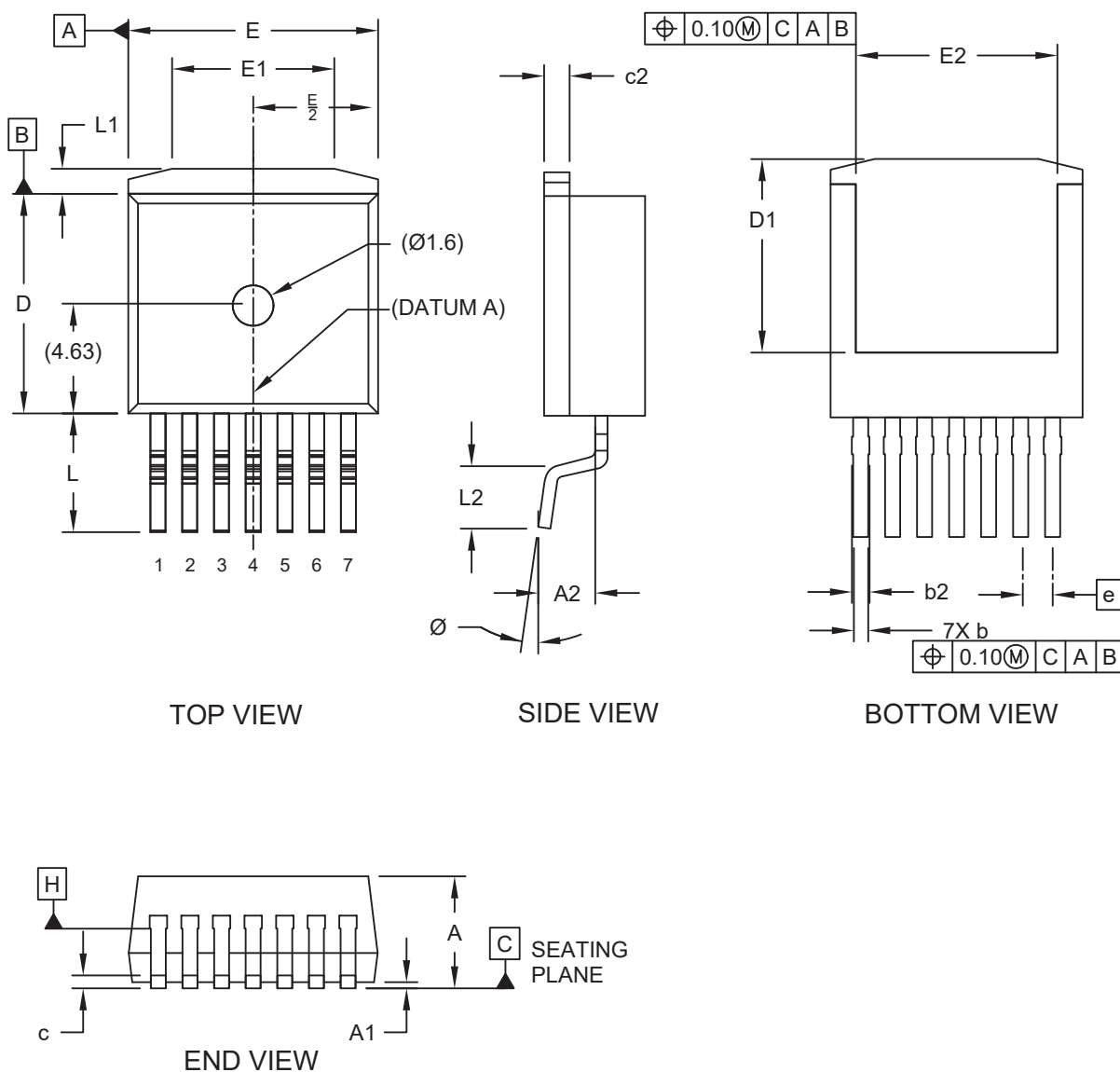
2. Package Specification

This section shows the package specification of this device.

2.1. Package Outline Drawing

The following figure illustrates the TO-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	

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°

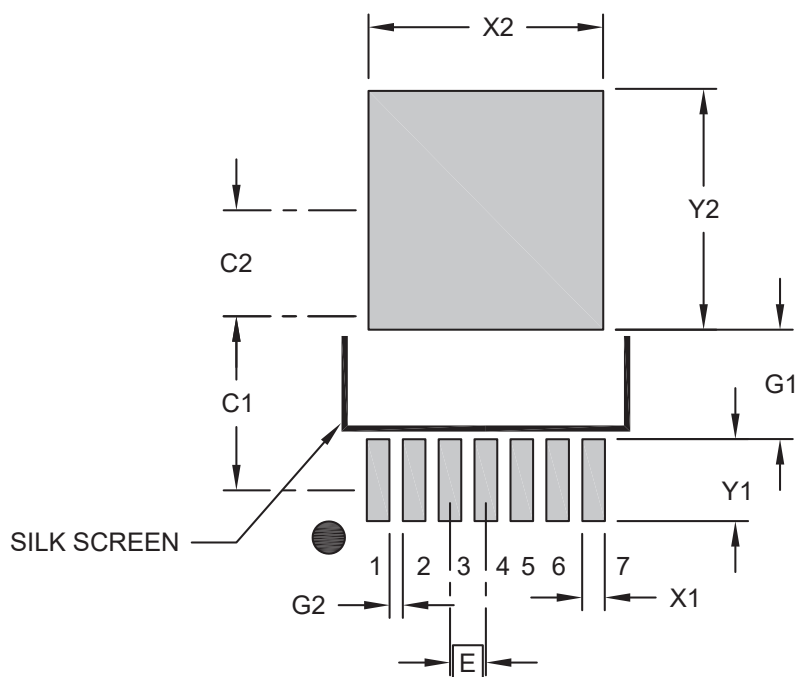
Note: Dimensioning and tolerancing per ASME Y14.5M.

- 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.

Table 2-2. Recommended Land Pattern Dimensions

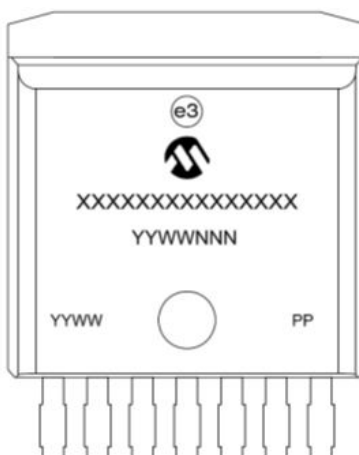
Symbol	Description	Min. (mm)	Nom. (mm)	Max. (mm)
E	Contact pitch	1.27 BSC		
X2	Center pad width	—	—	8.30
Y2	Center pad length	—	—	8.45
C1	Contact pad spacing	—	6.45	—
C2	Contact pad spacing	—	4.30	—
X1	Contact pad width (X7)	—	—	0.80
Y1	Contact pad length (X7)	—	—	2.90
G1	Contact pad to center pad (X7)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

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	The following changes are made in this revision of the document: • Updated data sheet type from advance information to final data sheet. • Added $R_{DS(on)}$ value at 175 °C in Table 1-3. • Updated Figure 1-7.
A	01/2025	Initial revision (advance information)

Microchip Information

Trademarks

The “Microchip” name and logo, the “M” logo, and other names, logos, and brands are registered and unregistered trademarks of Microchip Technology Incorporated or its affiliates and/or subsidiaries in the United States and/or other countries (“Microchip Trademarks”). Information regarding Microchip Trademarks can be found at <https://www.microchip.com/en-us/about/legal-information/microchip-trademarks>.

ISBN: 979-8-3371-2475-9

Legal Notice

This publication and the information herein may be used only with Microchip products, including to design, test, and integrate Microchip products with your application. Use of this information in any other manner violates these terms. Information regarding device applications is provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. Contact your local Microchip sales office for additional support or, obtain additional support at www.microchip.com/en-us/support/design-help/client-support-services.

THIS INFORMATION IS PROVIDED BY MICROCHIP “AS IS”. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE, OR WARRANTIES RELATED TO ITS CONDITION, QUALITY, OR PERFORMANCE.

IN NO EVENT WILL MICROCHIP BE LIABLE FOR ANY INDIRECT, SPECIAL, PUNITIVE, INCIDENTAL, OR CONSEQUENTIAL LOSS, DAMAGE, COST, OR EXPENSE OF ANY KIND WHATSOEVER RELATED TO THE INFORMATION OR ITS USE, HOWEVER CAUSED, EVEN IF MICROCHIP HAS BEEN ADVISED OF THE POSSIBILITY OR THE DAMAGES ARE FORESEEABLE. TO THE FULLEST EXTENT ALLOWED BY LAW, MICROCHIP’S TOTAL LIABILITY ON ALL CLAIMS IN ANY WAY RELATED TO THE INFORMATION OR ITS USE WILL NOT EXCEED THE AMOUNT OF FEES, IF ANY, THAT YOU HAVE PAID DIRECTLY TO MICROCHIP FOR THE INFORMATION.

Use of Microchip devices in life support and/or safety applications is entirely at the buyer’s risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

Microchip Devices Code Protection Feature

Note the following details of the code protection feature on Microchip products:

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is secure when used in the intended manner, within operating specifications, and under normal conditions.
- Microchip values and aggressively protects its intellectual property rights. Attempts to breach the code protection features of Microchip products are strictly prohibited and may violate the Digital Millennium Copyright Act.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of its code. Code protection does not mean that we are guaranteeing the product is “unbreakable”. Code protection is constantly evolving. Microchip is committed to continuously improving the code protection features of our products.