

Product Overview

1200V, 31 mΩ typical at $V_{GS} = 18V$, 38 mΩ typical at $V_{GS} = 15V$, Silicon Carbide (SiC) N-Channel MOSFET, TO-247 notched 4-lead with a source sense.

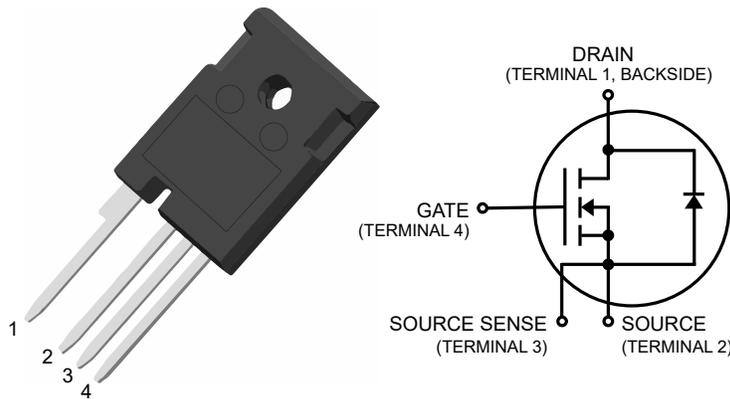


Table 1. Ordering Information

| Catalog Part Number (CPN) | Package | Packing Media (Qty.) | Qualification |
|---------------------------|-----------------------|----------------------|---------------|
| MSC031SMC120B4N | TO-247 notched 4-lead | Tube (30) | Industrial |
| MSC031SMC120B4NVAO | 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, $T_{J(max)} = 175\text{ °C}$
- Fast and reliable body diode
- Superior avalanche ruggedness (100% UIS production tested)
- Creepage distance (Typ. > 8 mm)
- MC option integrates gate resistor for improved stability
- 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 $T_C = 25\text{ }^\circ\text{C}$ | 72 | A |
| | Continuous drain current at $T_C = 100\text{ }^\circ\text{C}$ | 51 | |
| I_{DM} | Pulsed drain current ¹ | 161 | |
| V_{GS} | Gate-source voltage | 21 to -10 | V |
| | Transient gate-source voltage | 23 to -12 | |
| P_D | Total power dissipation at $T_C = 25\text{ }^\circ\text{C}$ | 362 | W |
| | Linear derating factor | 2.44 | 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 | — | 0.32 | 0.41 | $^\circ\text{C}/\text{W}$ |
| T_J | Operating junction temperature | -55 | — | 175 | $^\circ\text{C}$ |
| T_{STG} | Storage temperature | -55 | — | 175 | |
| T_L | Lead temperature for 10 seconds | — | — | 300 | $^\circ\text{C}$ |
| 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. $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified. Recommended operating $V_{GS} = 18\text{V}/-5\text{V}$.

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 | $V_{GS} = 18\text{V}, I_D = 15\text{A}$ | — | 31 | 42 | m Ω |
| | | $V_{GS} = 15\text{V}, I_D = 15\text{A}$ | — | 38 | — | |
| $V_{GS(th)}$ | Gate-source threshold voltage | $V_{GS} = V_{DS}, I_D = 1.7\text{ mA}$ | 1.9 | 3.0 | 5.0 | V |
| | | $V_{DS} = 960\text{V}, I_D = 1.7\text{ mA}$ | 1.65 | — | — | |
| I_{DSS} | Zero gate voltage drain current | $V_{DS} = 1200\text{V}, V_{GS} = 0\text{V}$ | — | 0.05 | 7.5 | μA |
| | | $V_{DS} = 1200\text{V}, V_{GS} = 0\text{V}, T_J = 175\text{ }^\circ\text{C}$ | — | 0.77 | — | |

Table 1-3. Static Characteristics (continued)

| Symbol | Characteristic | Test Conditions | Min. | Typ. | Max. | Unit |
|-----------|-----------------------------|---------------------|------|------|------|------|
| I_{GSS} | Gate-source leakage current | $V_{GS} = 18V/-10V$ | — | — | ±100 | nA |

Note:

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

The following table shows the dynamic characteristics of this device. $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified. The dynamic characteristics are characterized, not 100% production tested.

Table 1-4. Dynamic Characteristics

| Symbol | Characteristic | Test Conditions | Min. | Typ. | Max. | Unit | |
|----------------------|-----------------------------------|---|------|------|------|----------|---------|
| C_{iss} | Input capacitance | $V_{GS} = 0V, V_{DD} = 1000V, V_{AC} = 25\text{ mV}, f = 100\text{ kHz}$ | — | 2080 | — | pF | |
| C_{rSS} | Reverse transfer capacitance | | — | 8 | — | | |
| C_{oss} | Output capacitance | | — | 109 | — | | |
| Q_G | Total gate charge | $V_{GS} = 18V/-5V, V_{DD} = 850V, I_D = 20A$ | — | 70 | — | nC | |
| Q_{GS} | Gate-source charge | | — | 24 | — | | |
| Q_{GD} | Gate-drain charge | | — | 13 | — | | |
| $t_{d(on)}$ | Turn-on delay time | $V_{DD} = 850V, V_{GS} = 18V/-5V, I_D = 40A, R_G = 4\Omega,$ Freewheeling diode = MSC031SMC120B4N ($V_{GS} = -5V$); reference Figure 1-19 | — | 18 | — | ns | |
| t_r | Rise time | | — | 16 | — | | |
| $t_{d(off)}$ | Turn-off delay time | | — | 30 | — | | |
| t_f | Fall time | | — | 13 | — | | |
| E_{on} | Turn-on switching energy | | — | 598 | — | | μ J |
| E_{off} | Turn-off switching energy | | — | 187 | — | | |
| ESR | Gate equivalent series resistance | $f = 1\text{ MHz}, 25\text{ mV}, \text{ drain short}$ | — | 4.1 | — | Ω | |
| SCWT | Short circuit withstand time | $V_{DS} = 850V, V_{GS} = 18V$ | — | 2 | — | μ s | |
| E_{AS} | Avalanche energy, single pulse | $I_D = 3.75A, 100\% \text{ UIS production tested}$ | 960 | — | — | mJ | |
| $E_{AS\text{ CHAR}}$ | | $I_D = 10A$ | — | 2190 | — | | |

The following table shows the body diode characteristics of this device. $T_J = 25\text{ }^\circ\text{C}$ unless otherwise specified. The body diode reverse recovery is characterized, not 100% production tested.

Table 1-5. Body Diode Characteristics

| Symbol | Characteristic | Test Conditions | Min. | Typ. | Max. | Unit |
|-----------|--------------------------|--|------|------|------|------|
| V_{SD} | Diode forward voltage | $I_{SD} = 15A, V_{GS} = 0V$ | — | 3.5 | — | V |
| | | $I_{SD} = 15A, V_{GS} = -5V$ | — | 3.9 | 5.0 | |
| t_{rr} | Reverse recovery time | $I_{SD} = 40A, V_{GS} = -5V, \text{ Drive } R_G = 4\Omega, V_{DD} = 850V, \text{ di}/\text{dt} = -7200\text{ A}/\mu\text{s}$ | — | 13 | — | ns |
| Q_{rr} | Reverse recovery charge | | — | 296 | — | nC |
| I_{RRM} | Reverse recovery current | | — | 41 | — | A |

1.4. Typical Performance Curves

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

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

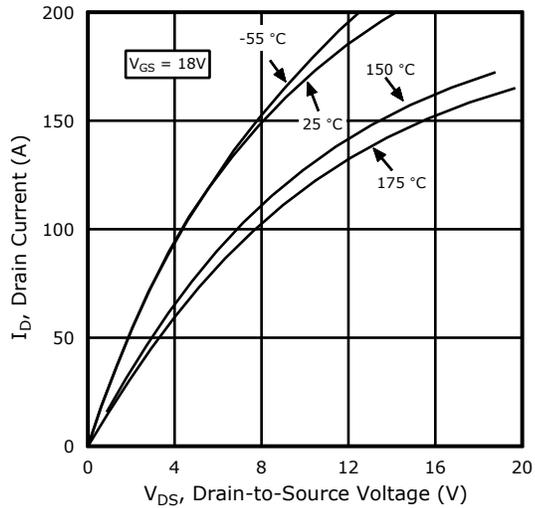


Figure 1-2. Drain Current vs. V_{DS} at V_{GS}

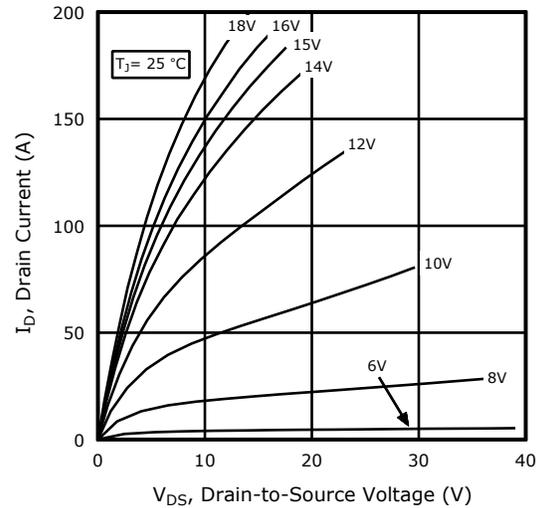


Figure 1-3. Drain Current vs. V_{DS} at V_{GS}

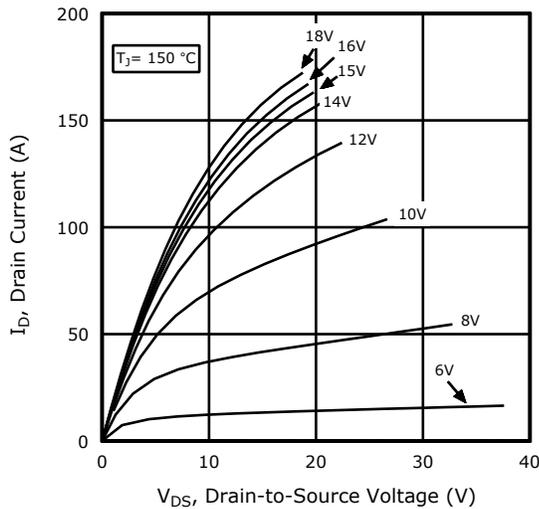


Figure 1-4. Drain Current vs. V_{DS} at V_{GS}

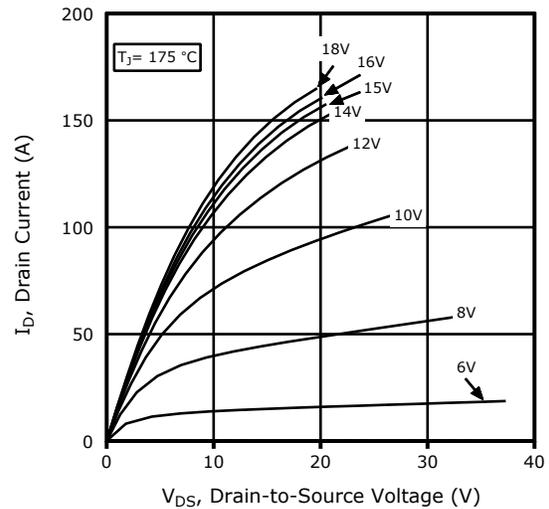


Figure 1-5. I_D vs. V_{DS} 3rd Quadrant Conduction

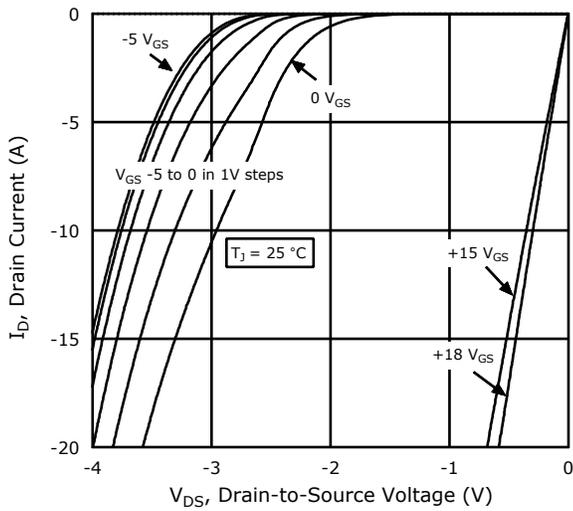


Figure 1-6. I_D vs. V_{DS} 3rd Quadrant Conduction

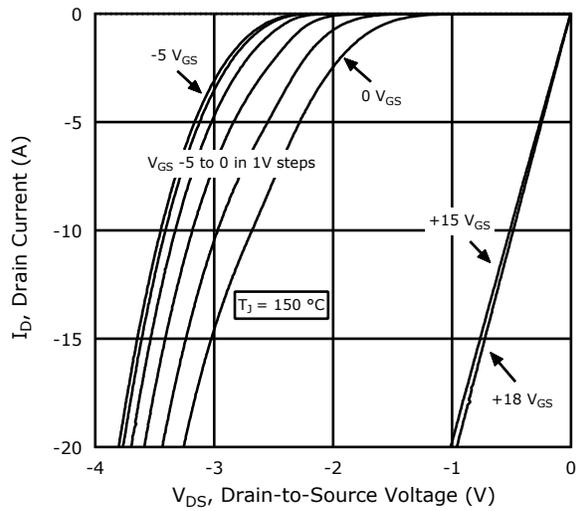


Figure 1-7. $R_{DS(on)}$ vs. Junction Temperature

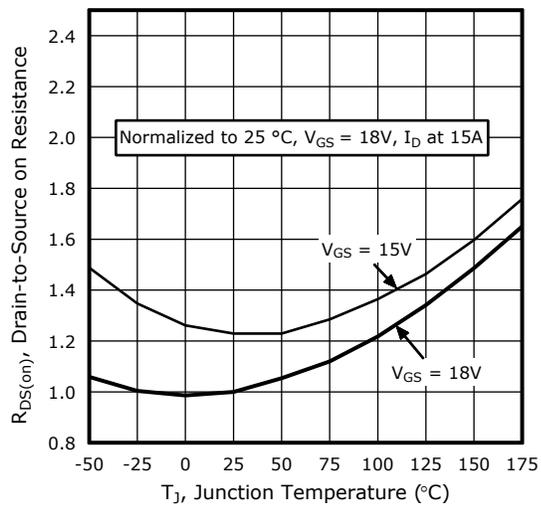


Figure 1-8. Gate Charge Characteristics

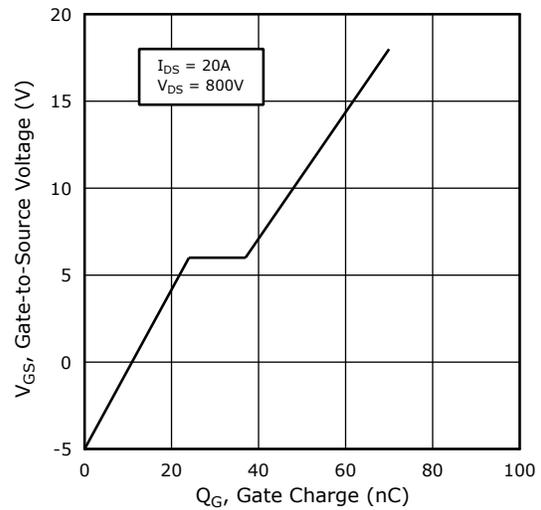


Figure 1-9. Capacitance vs. Drain-to-Source Voltage

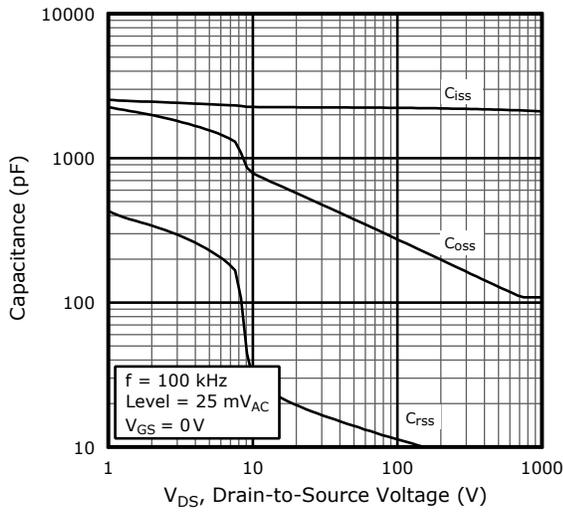


Figure 1-10. Q_{oss} vs. Drain-to-Source Voltage

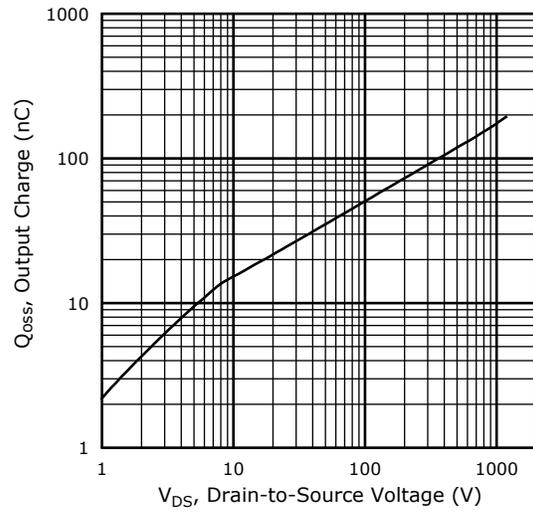


Figure 1-11. E_{oss} vs. Drain-to-Source Voltage

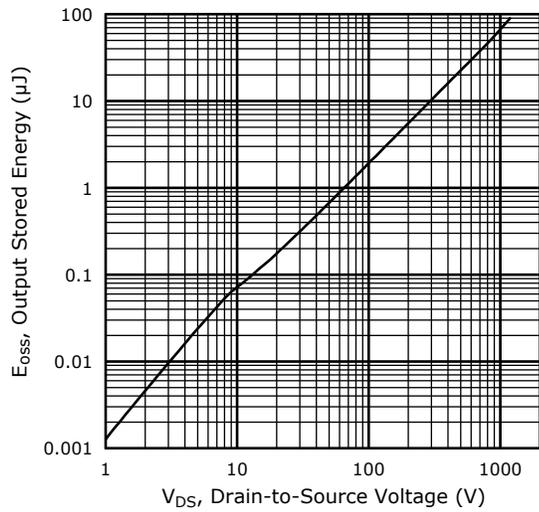


Figure 1-12. Switching Energy vs. V_{DS} & I_D

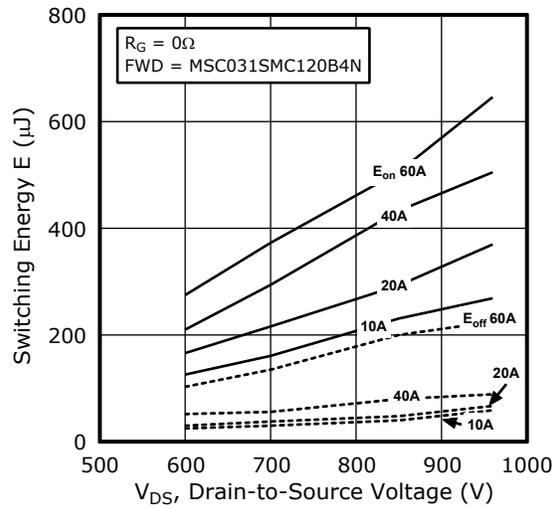


Figure 1-13. Switching Energy vs. V_{DS} & I_D

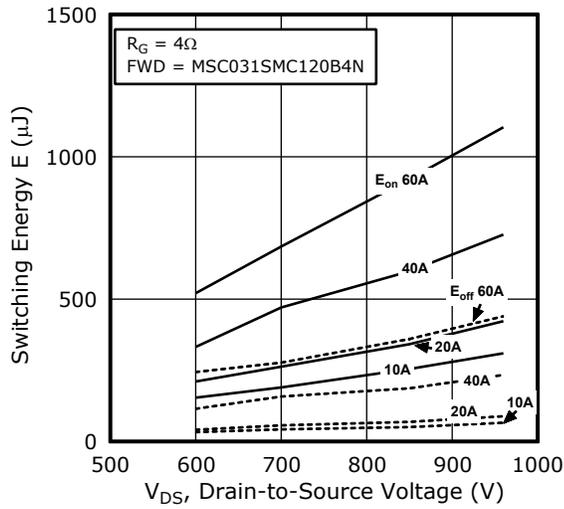


Figure 1-14. Switching Energy vs. V_{DS} & I_D

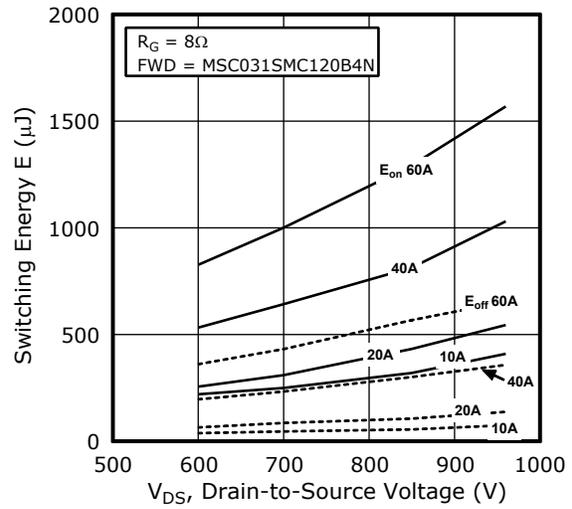


Figure 1-15. Switching Energy vs. Junction Temperature

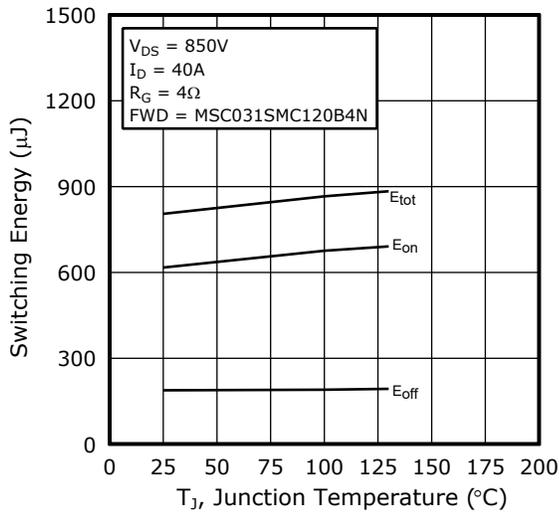


Figure 1-16. Threshold Voltage vs. Junction Temperature

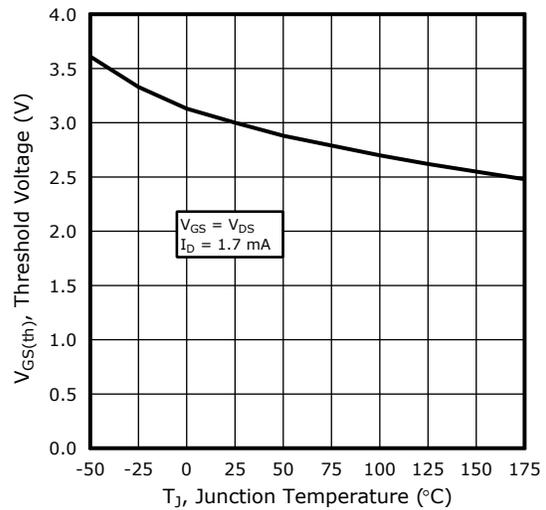


Figure 1-17. Forward Safe Operating Area

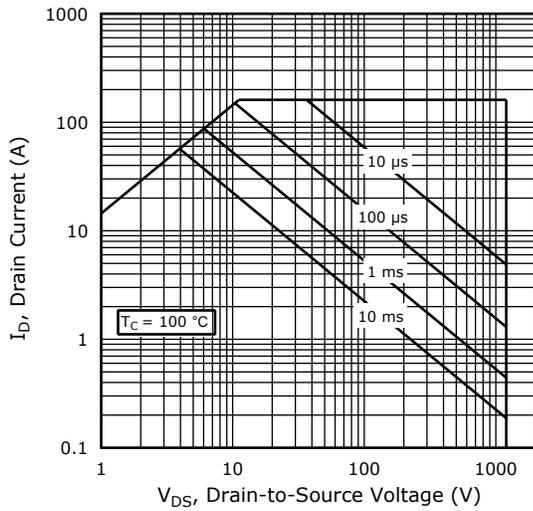
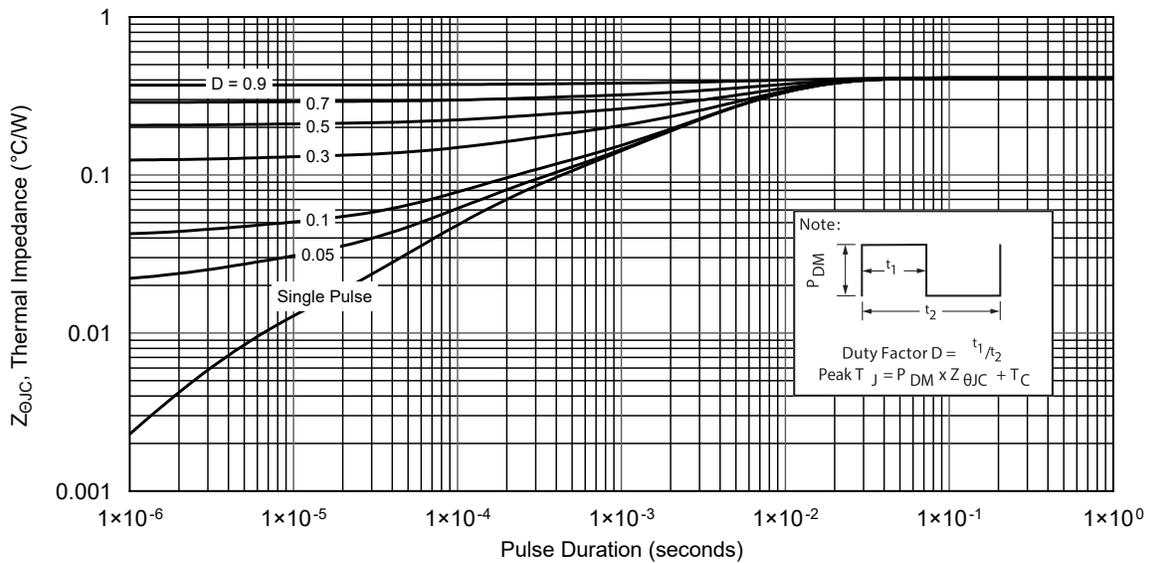
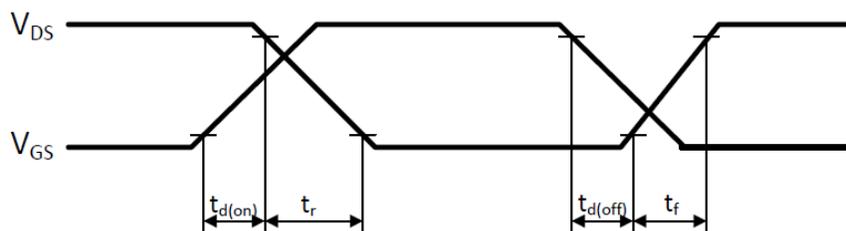


Figure 1-18. Maximum Transient Thermal Impedance



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

Figure 1-19. Switching Waveform



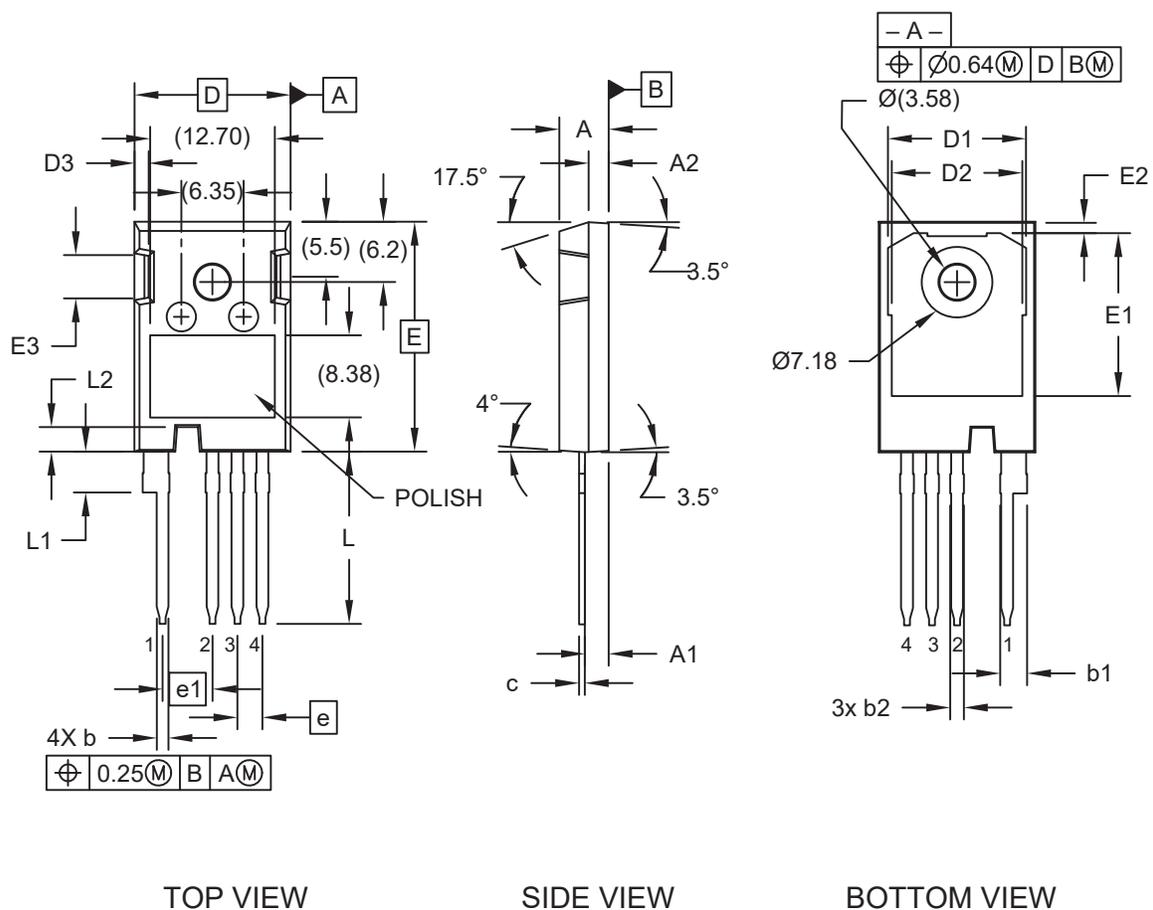
2. Package Specification

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 |

| 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:

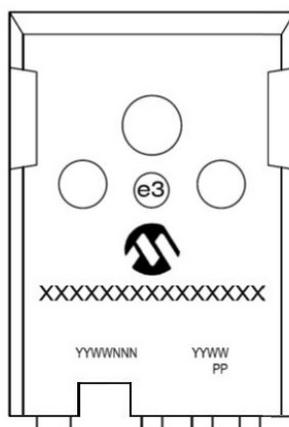
Dimensioning and tolerancing per ASME Y14.5M.

- 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. |
| YYWNNN | 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 |
|----------|---------|------------------|
| A | 07/2025 | Initial revision |

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