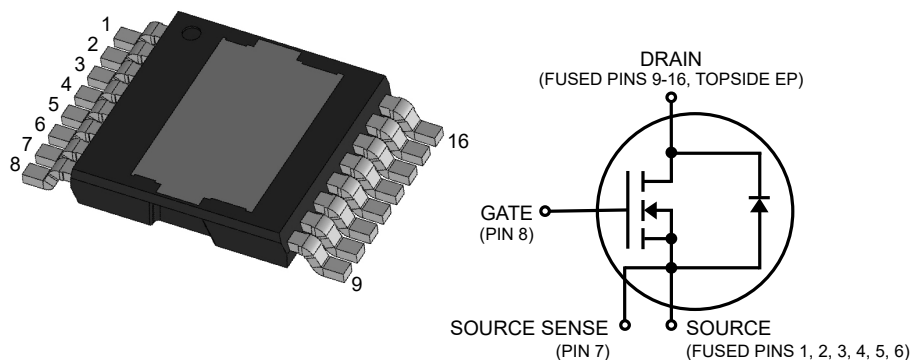


## Product Overview

700V, 60 mΩ typical at  $V_{GS} = 20V$ , 68 mΩ typical at  $V_{GS} = 18V$ , Silicon Carbide (SiC) N-Channel MOSFET, Power Surface Mount Top-Side Cooled (PSMT) 16-lead with a source sense.



## 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
- RoHS compliant

## 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

## 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

# 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 |
|----------|-----------------------------------------------------------------|-----------|------|
| $V_{DS}$ | Drain source voltage                                            | 700       | V    |
| $I_D$    | Continuous drain current at $T_C = 25\text{ }^{\circ}\text{C}$  | 48        | A    |
|          | Continuous drain current at $T_C = 100\text{ }^{\circ}\text{C}$ | 34        |      |
| $I_{DM}$ | Pulsed drain current <sup>1</sup>                               | 188       |      |
| $V_{GS}$ | Gate-source voltage                                             | 23 to -10 | V    |
|          | Transient gate-source voltage                                   | 25 to -12 |      |
| $P_D$    | Total power dissipation at $T_C = 25\text{ }^{\circ}\text{C}$   | 215       | W    |
|          | Linear derating factor                                          | 1.43      |      |

**Note:**

1. Repetitive rating: pulse width and case temperature are limited by the 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 | —    | 0.54 | 0.70 | $^{\circ}\text{C}/\text{W}$ |
| $T_J$           | Operating junction temperature      | -55  | —    | 175  | $^{\circ}\text{C}$          |
| $T_{STG}$       | Storage temperature                 | -55  | —    | 150  |                             |
| —               | Reflow temperature                  | —    | —    | 260  | $^{\circ}\text{C}$          |
| Wt              | Package weight                      | —    | 0.83 | —    | g                           |

ESD practices should comply with JESD-625.

## 1.2 Electrical Performance

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

**Table 1-3.** Static Characteristics

| Symbol       | Characteristic                          | Test Conditions                                                               | Min. | Typ. | Max.      | Unit             |
|--------------|-----------------------------------------|-------------------------------------------------------------------------------|------|------|-----------|------------------|
| $V_{(BR)DS}$ | Drain-source breakdown voltage          | $V_{GS} = 0\text{V}, I_D = 100\text{ }\mu\text{A}$                            | 700  | —    | —         | V                |
| $R_{DS(on)}$ | Drain-source on resistance <sup>1</sup> | $V_{GS} = 20\text{V}, I_D = 20\text{A}$                                       | —    | 60   | 75        | $\text{m}\Omega$ |
|              |                                         | $V_{GS} = 18\text{V}, I_D = 20\text{A}$                                       | —    | 68   | —         |                  |
| $V_{GS(th)}$ | Gate-source threshold voltage           | $V_{GS} = V_{DS}, I_D = 1\text{ mA}$                                          | 1.9  | 3.0  | 5.0       | V                |
| $I_{DSS}$    | Zero gate voltage drain current         | $V_{DS} = 700\text{V}, V_{GS} = 0\text{V}$                                    | —    | 0.1  | 25        | $\mu\text{A}$    |
|              |                                         | $V_{DS} = 700\text{V}, V_{GS} = 0\text{V}, T_J = 175\text{ }^{\circ}\text{C}$ | —    | 1.5  | —         |                  |
| $I_{GSS}$    | Gate-source leakage current             | $V_{GS} = 20\text{V}/-10\text{V}$                                             | —    | —    | $\pm 100$ | nA               |

**Note:**

1. Pulse test: pulse width  $< 380\text{ }\mu\text{s}$ , 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% tested, at the recommended operating  $V_{GS} = 20\text{V}/-5\text{V}$ .

**Table 1-4. Dynamic Characteristics**

| Symbol       | Characteristic                    | Test Conditions                                                                                            | Min. | Typ. | Max. | Unit          |
|--------------|-----------------------------------|------------------------------------------------------------------------------------------------------------|------|------|------|---------------|
| $C_{iss}$    | Input capacitance                 | $V_{GS} = 0\text{V}$                                                                                       | —    | 1160 | —    | pF            |
| $C_{rss}$    | Reverse transfer capacitance      | $V_{DD} = 700\text{V}$                                                                                     | —    | 10   | —    |               |
| $C_{oss}$    | Output capacitance                | $V_{AC} = 25\text{ mV}$<br>$f = 200\text{ kHz}$                                                            | —    | 132  | —    |               |
| $Q_G$        | Total gate charge                 | $V_{GS} = -5\text{V}/20\text{V}$                                                                           | —    | 56   | —    | nC            |
| $Q_{GS}$     | Gate-source charge                | $V_{DD} = 470\text{V}$                                                                                     | —    | 15   | —    |               |
| $Q_{GD}$     | Gate-drain charge                 | $I_D = 20\text{A}$                                                                                         | —    | 9.0  | —    |               |
| $t_{d(on)}$  | Turn-on delay time                | $V_{DD} = 470\text{V}$                                                                                     | —    | 10   | —    | ns            |
| $t_r$        | Voltage rise time                 | $V_{GS} = -5\text{V}/20\text{V}$                                                                           | —    | 7.0  | —    |               |
| $t_{d(off)}$ | Turn-off delay time               | $I_D = 20\text{A}$                                                                                         | —    | 19   | —    |               |
| $t_f$        | Voltage fall time                 | $R_{G(ext)} = 4\Omega$                                                                                     | —    | 7.0  | —    |               |
| $E_{on}$     | Turn-on switching energy          | Freewheeling diode =<br>MSC060SMA070SC ( $V_{GS} = -5\text{V}$ );<br>reference <a href="#">Figure 1-19</a> | —    | 92   | —    | $\mu\text{J}$ |
| $E_{off}$    | Turn-off switching energy         |                                                                                                            | —    | 11   | —    |               |
| ESR          | Gate equivalent series resistance | $f = 1\text{ MHz}$ , 25 mV, drain short                                                                    | —    | 2.6  | —    | $\Omega$      |
| SCWT         | Short circuit withstand time      | $V_{DS} = 560\text{V}$ , $V_{GS} = 20\text{V}$                                                             | —    | 3.0  | —    | $\mu\text{s}$ |
| $E_{AS}$     | Avalanche energy, single pulse    | $I_D = 20\text{A}$                                                                                         | —    | 1100 | —    | mJ            |

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% tested.

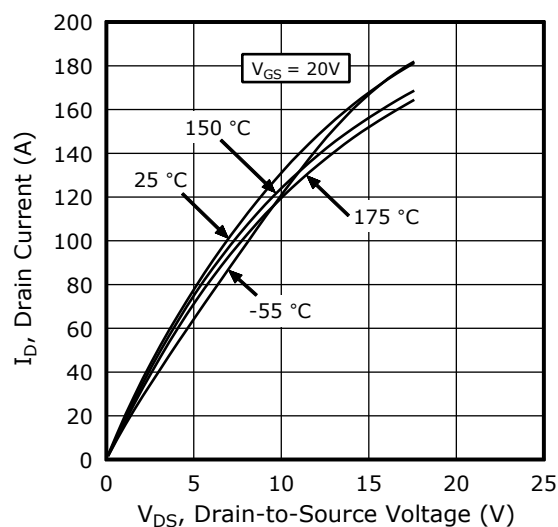
**Table 1-5. Body Diode Characteristics**

| Symbol    | Characteristic           | Test Conditions                                                                                                                       | Min. | Typ. | Max. | Unit |
|-----------|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------|------|------|------|------|
| $V_{SD}$  | Diode forward voltage    | $I_{SD} = 20\text{A}$ , $V_{GS} = 0\text{V}$                                                                                          | —    | 3.7  | —    | V    |
|           |                          | $I_{SD} = 20\text{A}$ , $V_{GS} = -5\text{V}$                                                                                         | —    | 3.9  | 5.0  |      |
| $t_{rr}$  | Reverse recovery time    | $I_{SD} = 20\text{A}$ , $V_{GS} = -5\text{V}$ , Drive $R_G = 8\Omega$ , $V_{DD} = 470\text{V}$ , $dI/dt = -8000\text{ A}/\mu\text{s}$ | —    | 10   | —    | ns   |
| $Q_{rr}$  | Reverse recovery charge  |                                                                                                                                       | —    | 336  | —    | nC   |
| $I_{RRM}$ | Reverse recovery current |                                                                                                                                       | —    | 54   | —    | A    |

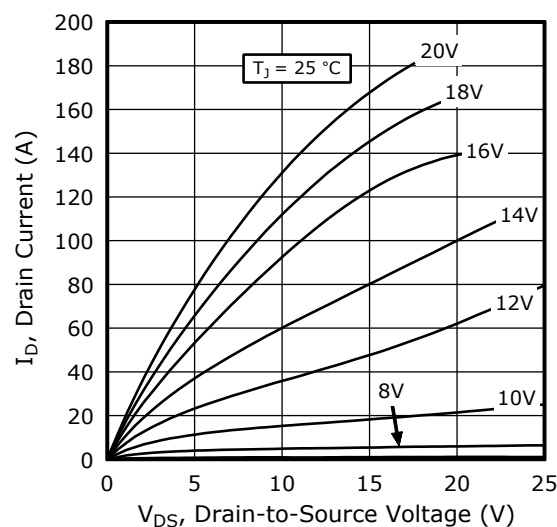
## 1.3 Typical Performance Curves

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

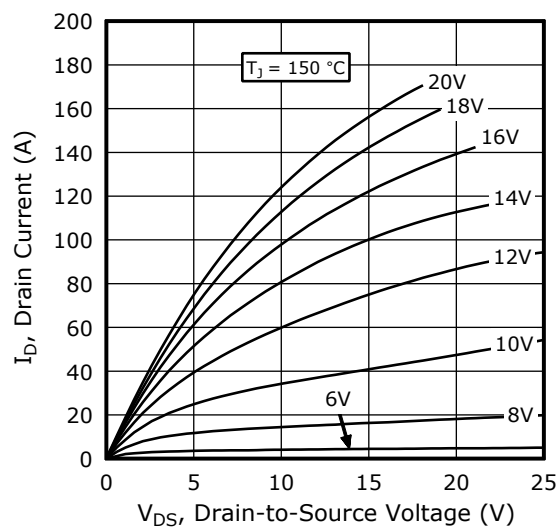
**Figure 1-1.** Drain Current vs.  $V_{DS}$  at  $T_J$



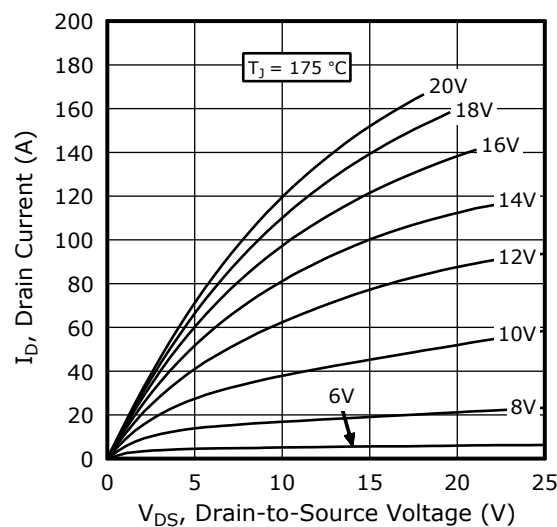
**Figure 1-2.** Drain Current vs.  $V_{DS}$  at  $V_{GS}$



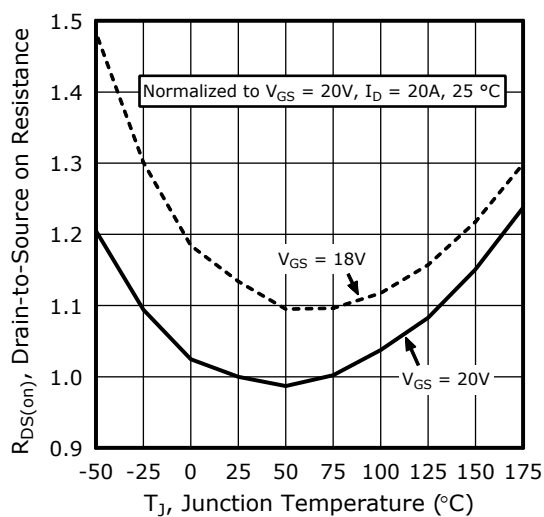
**Figure 1-3.** Drain Current vs.  $V_{DS}$  at  $V_{GS}$



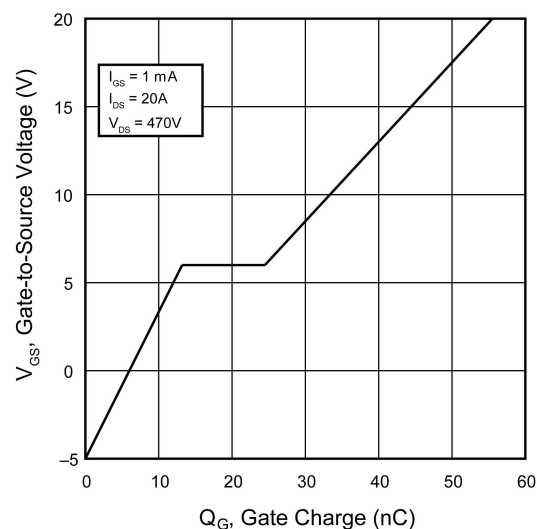
**Figure 1-4.** Drain Current vs.  $V_{DS}$  at  $V_{GS}$



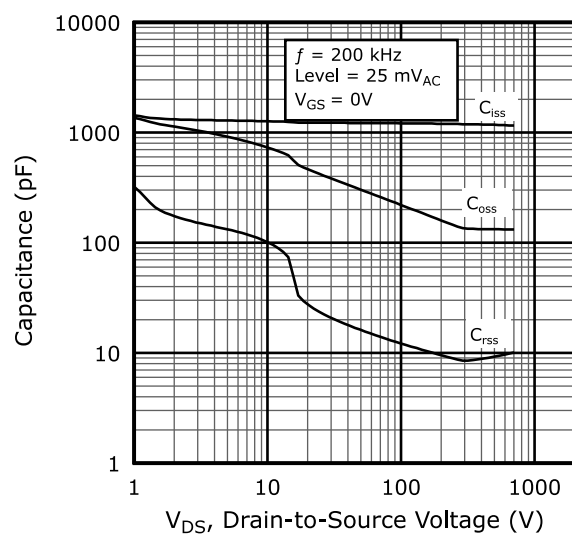
**Figure 1-5.**  $R_{DS(on)}$  vs. Junction Temperature



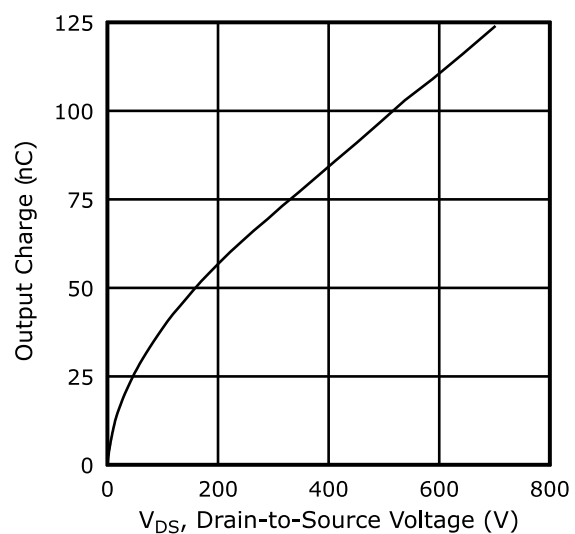
**Figure 1-6.** Gate Charge Characteristics



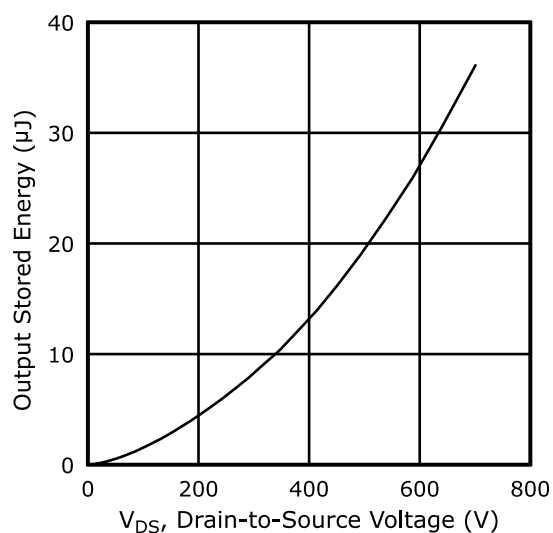
**Figure 1-7.** Capacitance vs. Drain-to-Source Voltage



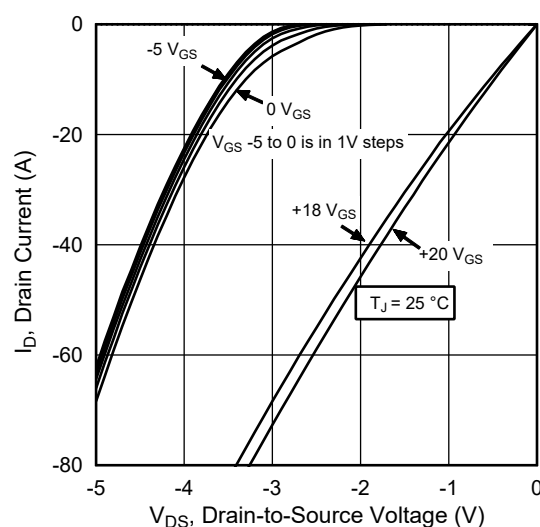
**Figure 1-8.** Output Charge vs. Drain-to-Source Voltage



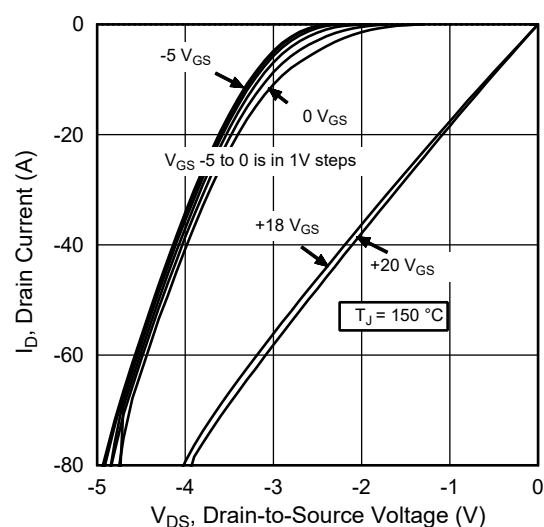
**Figure 1-9.** Output Stored Energy vs.  $V_{DS}$



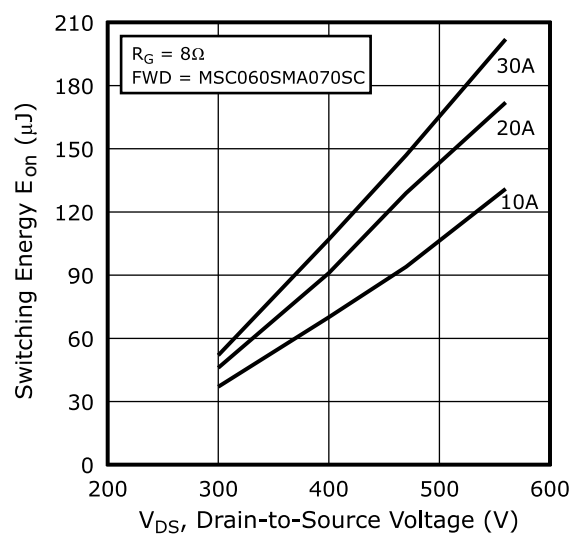
**Figure 1-10.**  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction



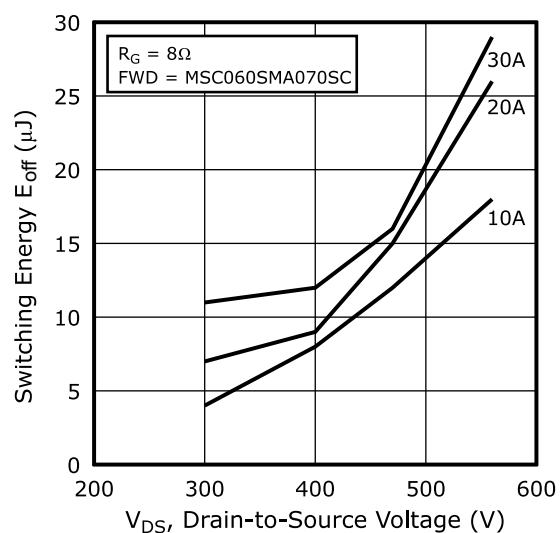
**Figure 1-11.**  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction



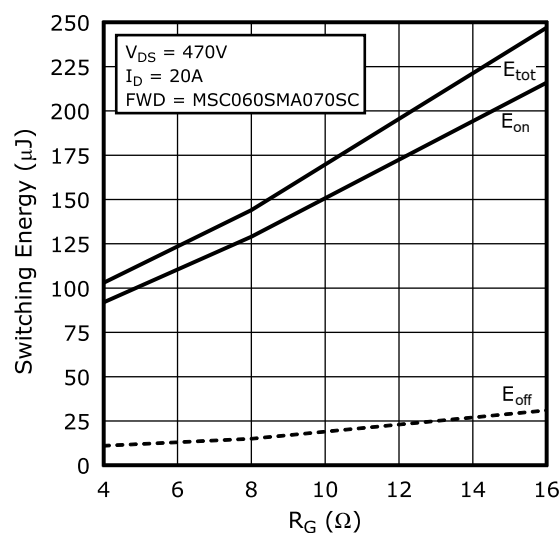
**Figure 1-12.** Switching Energy  $E_{on}$  vs.  $V_{DS}$  &  $I_D$



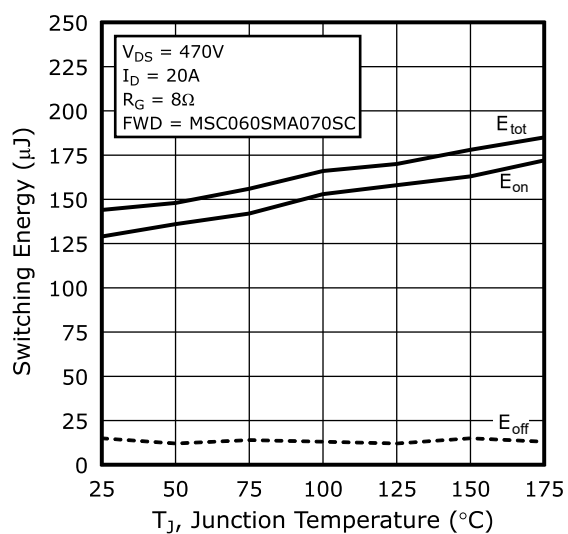
**Figure 1-13. Switching Energy  $E_{off}$  vs.  $V_{DS}$  &  $I_D$**



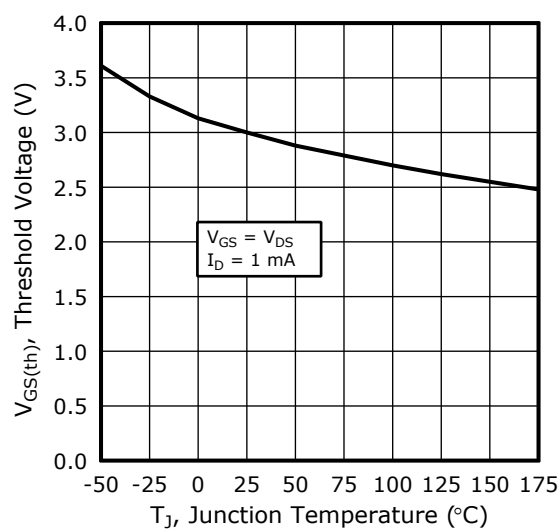
**Figure 1-14. Switching Energy vs.  $R_G$**



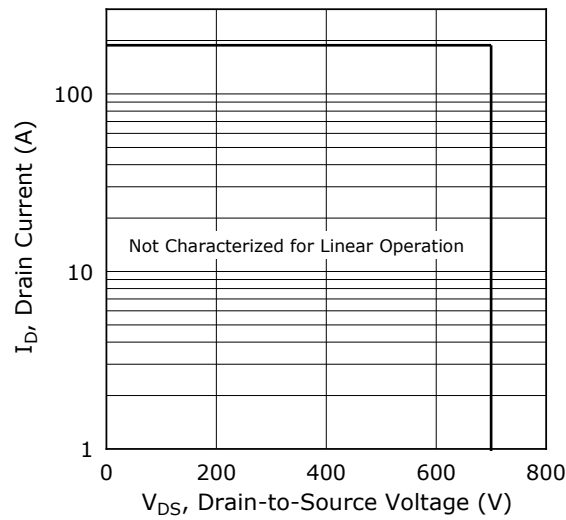
**Figure 1-15. Switching Energy vs. Junction Temperature**



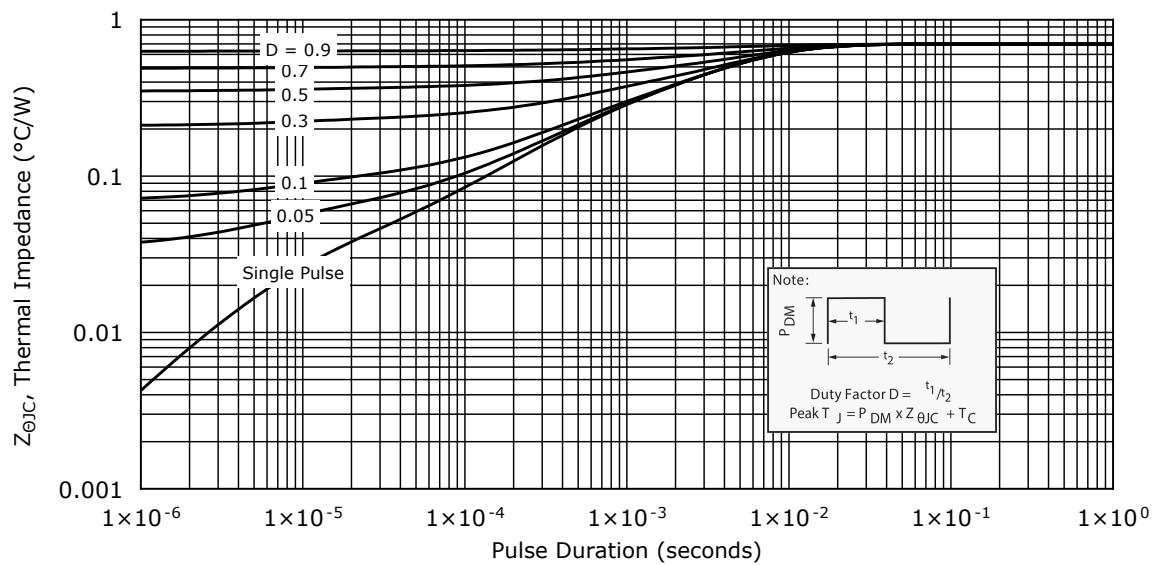
**Figure 1-16. Threshold Voltage vs. Junction Temperature**



**Figure 1-17. Forward Safe Operating Area**

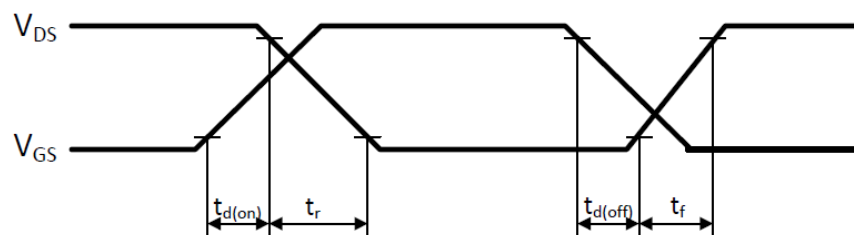


**Figure 1-18. Maximum Transient Thermal Impedance**



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

**Figure 1-19. Switching Waveform**



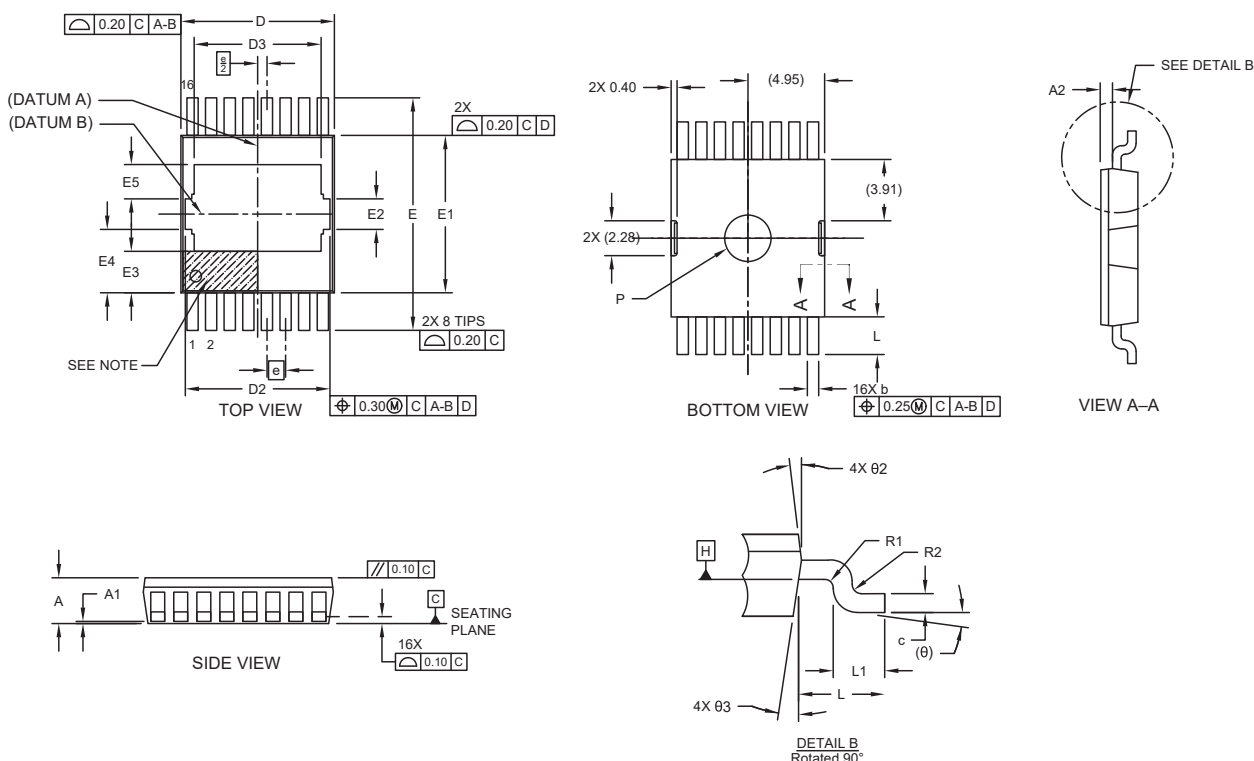
## 2. Package Specification

This section shows the package specification of this device.

### 2.1 Package Outline Drawing

The following figure illustrates the PSMT-16L package outline of this device.

**Figure 2-1. Package Outline Drawing**



The following table shows the PSMT-16L dimensions and should be used in conjunction with the package outline drawing.

**Table 2-1. PSMT-16L Dimensions**

| Symbol | Description               | Min. (mm) | Nom. (mm) | Max. (mm) |
|--------|---------------------------|-----------|-----------|-----------|
| N      | Number of terminals       | 16        |           |           |
| e      | Pitch                     | 1.20 BSC  |           |           |
| A      | Overall height            | 2.20      | —         | 2.35      |
| A1     | Standoff                  | 0.01      | —         | 0.11      |
| A2     | Leadframe to mold top     | 0.56      | —         | 0.96      |
| D      | Overall length            | 9.70      | 9.90      | 10.10     |
| D2     | Heat slug length with tab | 9.26      | —         | 9.66      |
| D3     | Heat slug length          | 8.10      | —         | 8.50      |
| E      | Overall width             | 14.80     | 15.00     | 15.20     |
| E1     | Molded package width      | 10.00     | —         | 10.30     |
| E2     | Heat slug tab             | 1.80      | —         | 2.20      |
| E3     | Heat slug to body edge    | 2.42      | —         | 2.82      |
| E4     | Body edge to tab          | 3.85      | —         | 4.25      |

.....continued

| Symbol | Description        | Min. (mm) | Nom. (mm) | Max. (mm) |
|--------|--------------------|-----------|-----------|-----------|
| E5     | Heat slug to tab   | 2.04      | —         | 2.44      |
| b      | Terminal width     | 0.60      | —         | 0.85      |
| c      | Terminal thickness | 0.45      | —         | 0.65      |
| L      | Terminal length    | 2.25      | —         | 2.65      |
| L1     | Footprint          | 1.30      | —         | 1.70      |
| R1     | Lead bend radius   | 0.07      | —         | —         |
| R2     |                    |           |           |           |
| θ      | Lead angle         | (4°) REF  |           |           |
| θ2     | Mold draft angle   | 4°        | —         | 10°       |
| θ3     |                    |           |           |           |
| P      | Ejector mark       | 2.90      | —         | 3.10      |

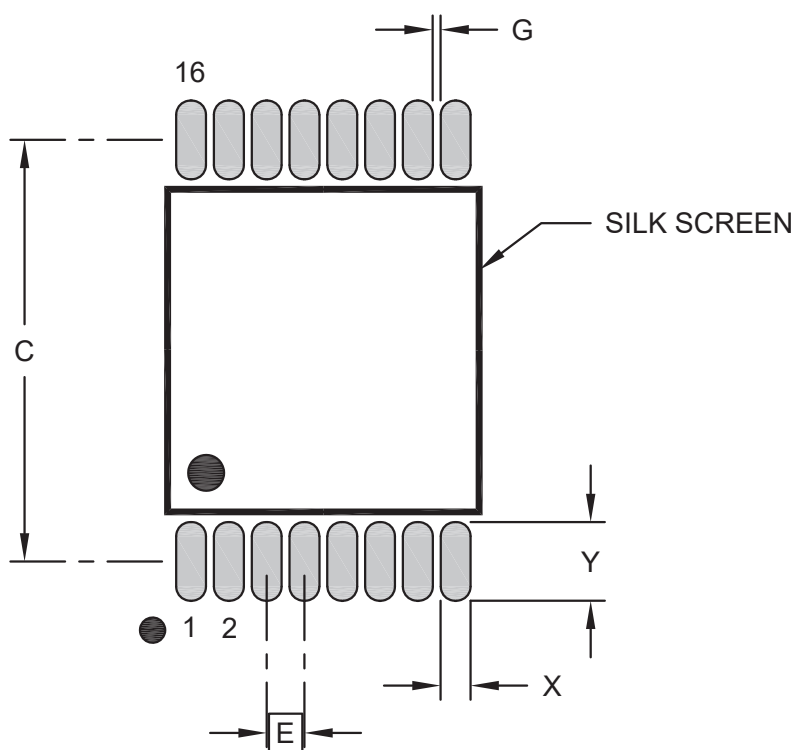
**Notes:**

- Pin 1 visual index feature may vary, but must be located within the hatched area.
- Dimensioning and tolerancing per ASME Y14.5M.
  - BSC: Basic dimension. Theoretically exact value shown without tolerances.
  - REF: Reference dimension, usually without tolerance, for information purposes only.

## 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              | 1.20 BSC  |           |           |
| X      | Contact pad width (X16)    | —         | —         | 0.95      |
| Y      | Contact pad length (X16)   | —         | —         | 2.50      |
| C      | Contact pad spacing        | —         | 13.40     | —         |
| G      | Contact pad to contact pad | 0.25      | —         | —         |

**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.

### 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        | 07/2024 | Initial revision |

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