# E3M0160120J2

## Silicon Carbide Power MOSFET
E-Series Automotive
N-Channel Enhancement Mode

## Features

- 3rd generation SiC MOSFET technology
- Optimized package with separate driver source pin
- 4.7mm of creepage distance between drain and source
- High blocking voltage with low on-resistance
- High-speed switching with low capacitances
- Fast intrinsic diode with low reverse recovery ($Q_{rr}$)
- Halogen free, RoHS compliant
- Automotive Qualified (AEC-Q101) and PPAP Capable

## Benefits

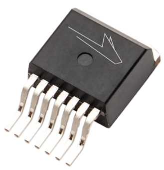
- Reduce switching losses and minimize gate ringing
- Higher system efficiency
- Reduce cooling requirements
- Increase power density
- Increase system switching frequency

## Typical Applications

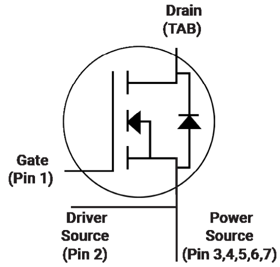
- Motor Control
- EV Battery Chargers
- High Voltage DC/DC Converters

## Package

Tab
Drain



1 2 3 4 5 6 7




| Part Number | Package | Marking |
|---|---|---|
| E3M0160120J2 | TO-263-7XL | E3M0160120J2 |

## Maximum Ratings ($T_C$ = 25 ˚C unless otherwise specified)

| Symbol | Parameter | | Value | Unit | Note |
|---|---|---|---|---|---|
| $V_{DSmax}$ | Drain - Source Voltage | | 1200 | V | |
| $V_{GSmax}$ | Gate - Source Voltage | | -8/+19 | V | Note: 1 |
| $I_D$ | Continuous Drain Current, $V_{GS}$ = 15 V | $T_C$ = 25˚C | 18 | A | Fig. 19 Note: 2 |
| | | $T_C$ = 100˚C | 14 | | |
| $I_{D(pulse)}$ | Pulsed Drain Current, Pulse width $t_P$ limited by $T_{jmax}$ | | 34 | A | Fig. 22 |
| $P_D$ | Power Dissipation, $T_C$=25˚C, $T_J$ = 175 ˚C | | 104 | W | Fig. 20 Note: 2 |
| $T_J$ , $T_{stg}$ | Operating Junction and Storage Temperature | | -55 to +175 | ˚C | |
| $T_L$ | Solder Temperature, 1.6mm (0.063”) from case for 10s | | 260 | ˚C | |

Note (1): Recommended turn off / turn on gate voltage $V_{GS}$ - 4V...0V / +15V
Note (2): Verified by design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## Electrical Characteristics ($T_C$ = 25˚C unless otherwise specified)

| Symbol | Parameter | Min. | Typ. | Max. | Unit | Test Conditions | Note |
|---|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-Source Breakdown Voltage | 1200 | | | V | $V_{GS}$ = 0 V, $I_D$ = 100 μA | |
| $V_{GS(th)}$ | Gate Threshold Voltage | 1.8 | 2.8 | 3.8 | V | $V_{DS}$ = $V_{GS}$, $I_D$ = 2.33 mA | Fig. 11 |
| | | | 2.2 | | V | $V_{DS}$ = $V_{GS}$, $I_D$ = 2.33 mA, $T_J$ = 175ºC | |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | | 1 | 50 | μA | $V_{DS}$ = 1200 V, $V_{GS}$ = 0 V | |
| $I_{GSS}$ | Gate-Source Leakage Current | | 10 | 250 | nA | $V_{GS}$ = 15 V, $V_{DS}$ = 0 V | |
| $R_{DS(on)}$ | Drain-Source On-State Resistance | | 159 | 208 | mΩ | $V_{GS}$ = 15 V, $I_D$ = 8.5 A | Fig. 4, 5, 6 |
| | | | 280 | | | $V_{GS}$ = 15 V, $I_D$ = 8.5 A, $T_J$ = 175ºC | |
| $g_{fs}$ | Transconductance | | 4.9 | | S | $V_{DS}$= 20 V, $I_{DS}$= 8.5 A | Fig. 7 |
| | | | 4.6 | | | $V_{DS}$= 20 V, $I_{DS}$= 8.5 A, $T_J$ = 175ºC | |
| $C_{iss}$ | Input Capacitance | | 730 | | pF | $V_{GS}$ = 0 V, $V_{DS}$ = 0V to 1000 V<br>f = 1 MHz<br>$V_{AC}$ = 25 mV | Fig. 17, 18 |
| $C_{oss}$ | Output Capacitance | | 31 | | | | |
| $C_{rss}$ | Reverse Transfer Capacitance | | 2 | | | | |
| $E_{oss}$ | $C_{oss}$ Stored Energy | | 17 | | μJ | $V_{DS}$= 1000 V, f = 1 MHz | Fig. 16 |
| $C_{o(er)}$ | Effective Output Capacitance (Energy Related) | | 36 | | pF | $V_{GS}$ = 0 V, $V_{DS}$ = 0 to 800V | Note: 3 |
| $C_{o(tr)}$ | Effective Output Capacitance (Time Related) | | 55 | | pF | | |
| $E_{ON}$ | Turn-On Switching Energy (Body Diode FWD) | | 151 | | μJ | $V_{DS}$= 800 V, $V_{GS}$= -4 V/15 V, $I_D$= 8.5 A,<br>$R_{G(ext)}$ = 2.5 Ω, L= 404 μH, $T_J$ = 175ºC<br>FWD = Internal Body Diode | Fig. 26, 28 |
| $E_{OFF}$ | Turn-Off Switching Energy (Body Diode FWD) | | 8 | | | | |
| $t_{d(on)}$ | Turn-On Delay Time | | 7 | | ns | $V_{DD}$ = 800 V, $V_{GS}$ = -4 V/15 V, $I_D$ = 8.5 A,<br>$R_{G(ext)}$ = 2.5 Ω, L= 404 μH, $T_J$ = 175ºC<br>Timing relative to $V_{DS}$<br>Inductive load | Fig. 27, 28 |
| $t_r$ | Rise Time | | 9 | | | | |
| $t_{d(off)}$ | Turn-Off Delay Time | | 12 | | | | |
| $t_f$ | Fall Time | | 11 | | | | |
| $R_{G(int)}$ | Internal Gate Resistance | | 5.1 | | Ω | f = 1 MHz | |
| $Q_{gs}$ | Gate to Source Charge | | 11 | | nC | $V_{DS}$ = 800 V, $V_{GS}$ = -4 V/15 V<br>$I_D$ = 8.5 A<br>Per IEC60747-8-4 pg 21 | Fig. 12 |
| $Q_{gd}$ | Gate to Drain Charge | | 10 | | | | |
| $Q_g$ | Total Gate Charge | | 28 | | | | |

Note (3): $C_{o(er)}$, a lumped capacitance that gives same stored energy as Coss while Vds is rising from 0 to 800V
$C_{o(tr)}$, a lumped capacitance that gives same charging time as Coss while Vds is rising from 0 to 800V

## Reverse Diode Characteristics ($T_C$ = 25˚C unless otherwise specified)

| Symbol | Parameter | Typ. | Max. | Unit | Test Conditions | Note |
|---|---|---|---|---|---|---|
| $V_{SD}$ | Diode Forward Voltage | 4.8 | | V | $V_{GS}$ = -4 V, $I_{SD}$ = 4.25 A, $T_J$ = 25 °C | Fig. 8, 9, 10 |
| | | 4.2 | | V | $V_{GS}$ = -4 V, $I_{SD}$ = 4.25 A, $T_J$ = 175 °C | |
| $I_S$ | Continuous Diode Forward Current | | 17 | A | $V_{GS}$ = -4 V, $T_C$ = 25˚C | |
| $I_{S, pulse}$ | Diode pulse Current | | 34 | A | $V_{GS}$ = -4 V, pulse width $t_P$ limited by $T_{jmax}$ | |
| $t_{rr}$ | Reverse Recover time | 8 | | ns | $V_{GS}$ = -4 V, $I_{SD}$ = 8.5 A, $V_R$ = 800 V<br>$di_F/dt$ = 6820 A/µs, $T_J$ = 25 °C | |
| $Q_{rr}$ | Reverse Recovery Charge | 111 | | nC | | |
| $I_{rrm}$ | Peak Reverse Recovery Current | 25 | | A | | |
| $t_{rr}$ | Reverse Recover time | 10 | | ns | $V_{GS}$ = -4 V, $I_{SD}$ = 8.5 A, $V_R$ = 800 V<br>$di_F/dt$ = 2230 A/µs, $T_J$ = 25 °C | |
| $Q_{rr}$ | Reverse Recovery Charge | 42 | | nC | | |
| $I_{rrm}$ | Peak Reverse Recovery Current | 8 | | A | | |

## Thermal Characteristics

| Symbol | Parameter | Typ. | Max. | Unit | Test Conditions | Note |
|---|---|---|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance from Junction to Case | 1.11 | 1.44 | °C/W | | Fig. 21 |

## Typical Performance

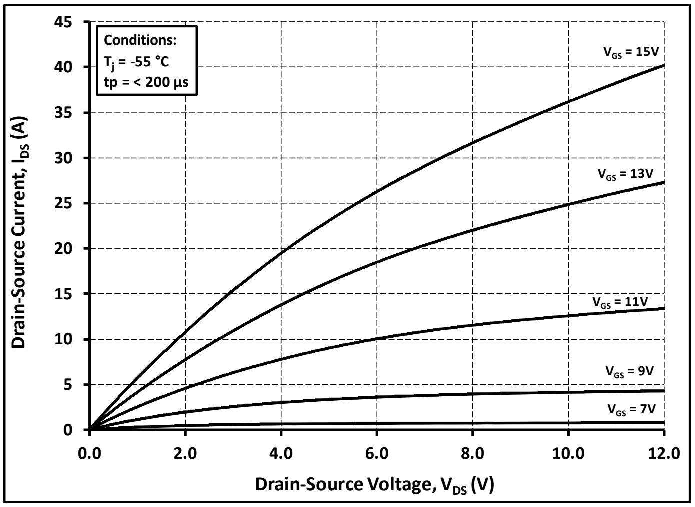


Figure 1. Output Characteristics $T_J$ = -55 °C

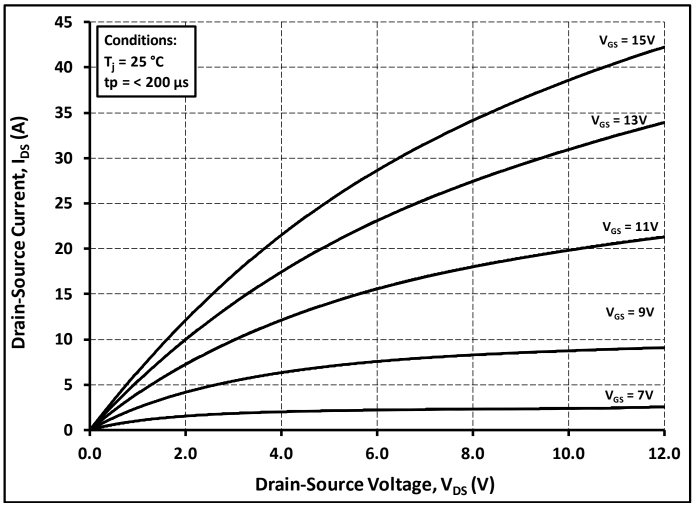


Figure 2. Output Characteristics $T_J$ = 25 °C

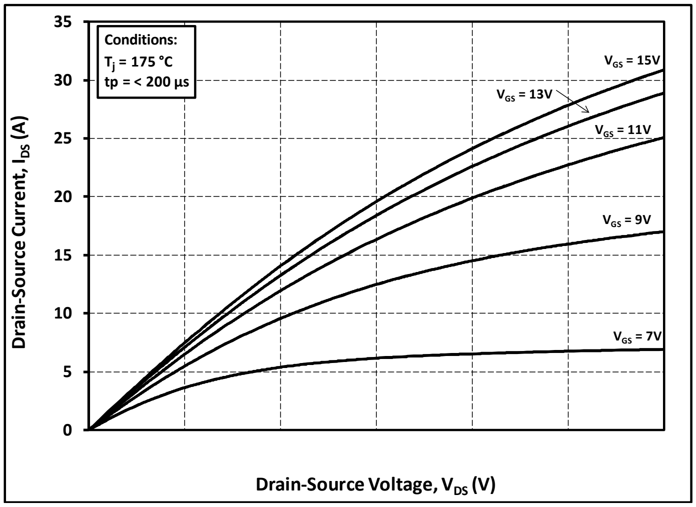


Figure 3. Output Characteristics $T_J$ = 175 °C

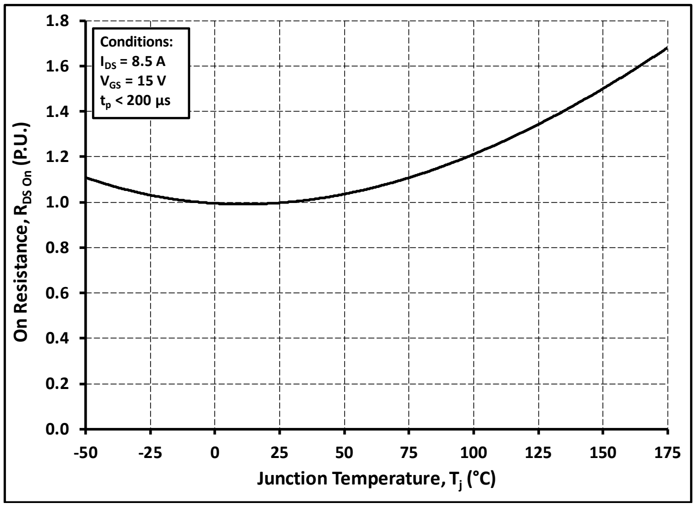


Figure 4. Normalized On-Resistance vs. Temperature

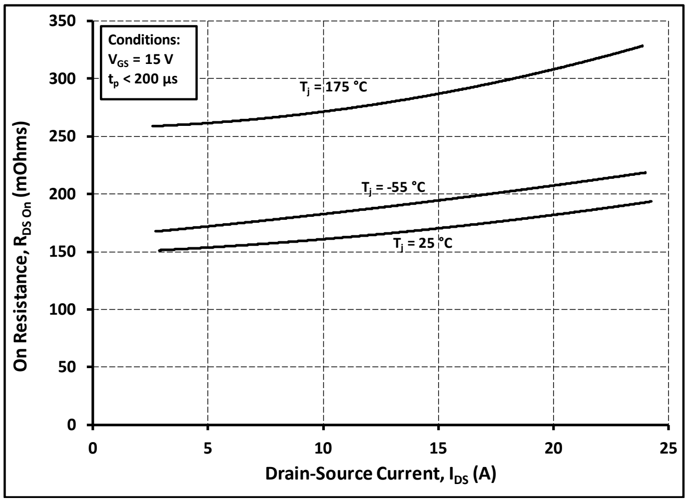


Figure 5. On-Resistance vs. Drain Current
For Various Temperatures

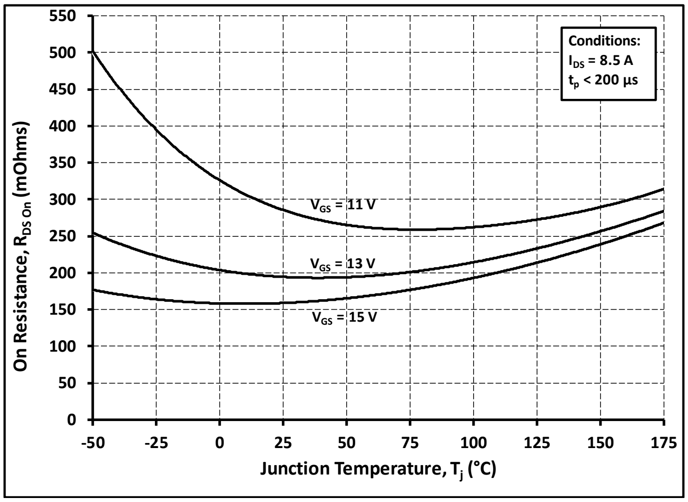


Figure 6. On-Resistance vs. Temperature
For Various Gate Voltage

## Typical Performance

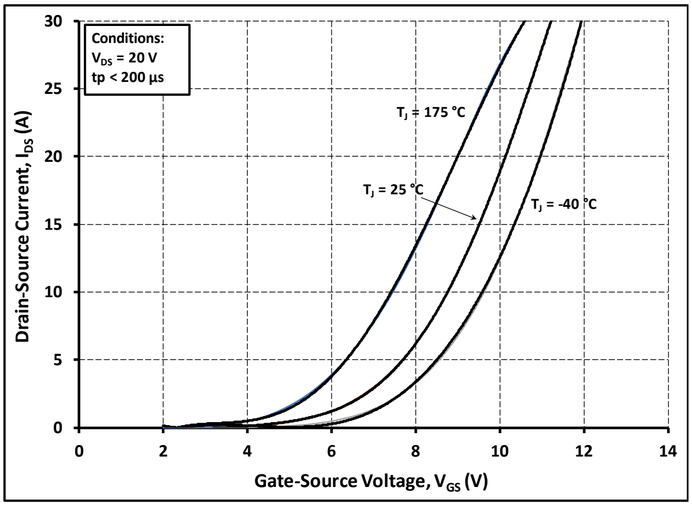


Figure 7. Transfer Characteristic for Various Junction Temperatures

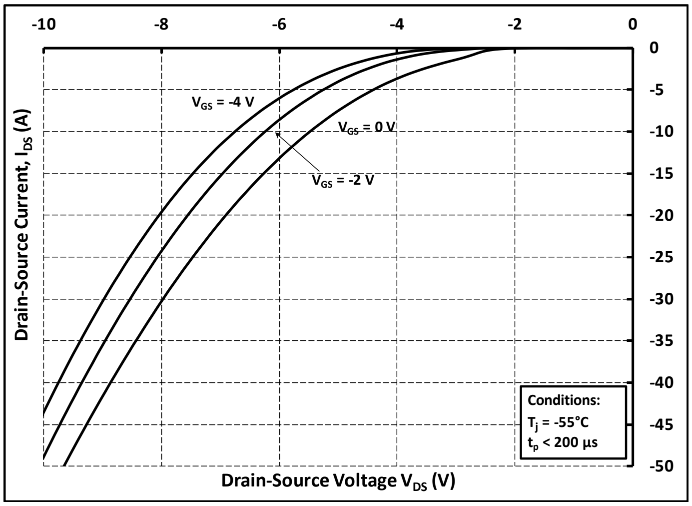


Figure 8. Body Diode Characteristic at -55 °C

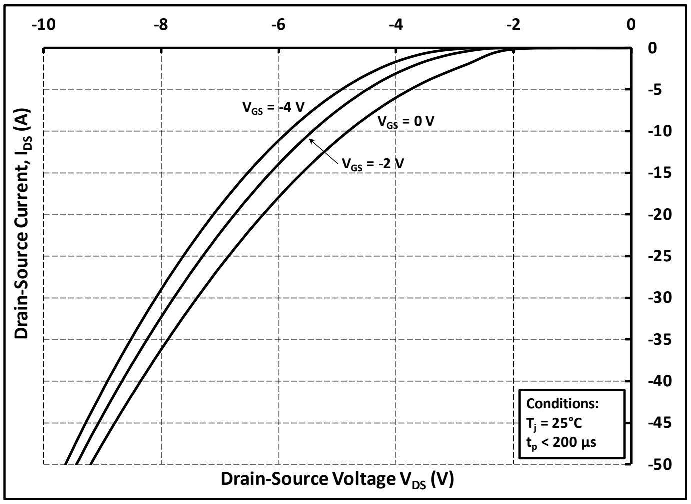


Figure 9. Body Diode Characteristic at 25 °C

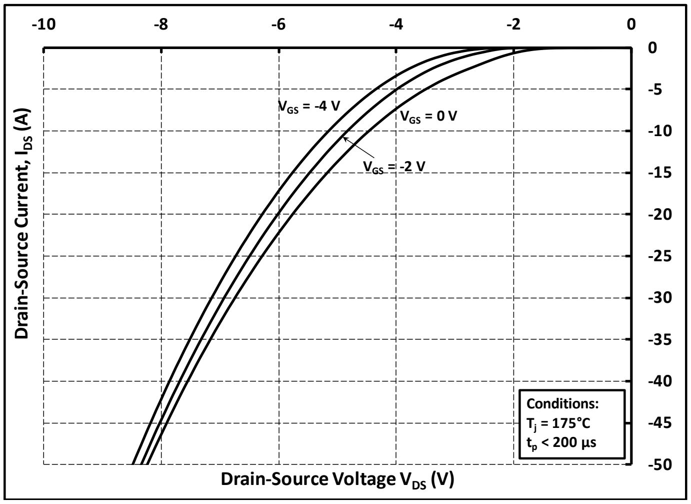


Figure 10. Body Diode Characteristic at 175 °C

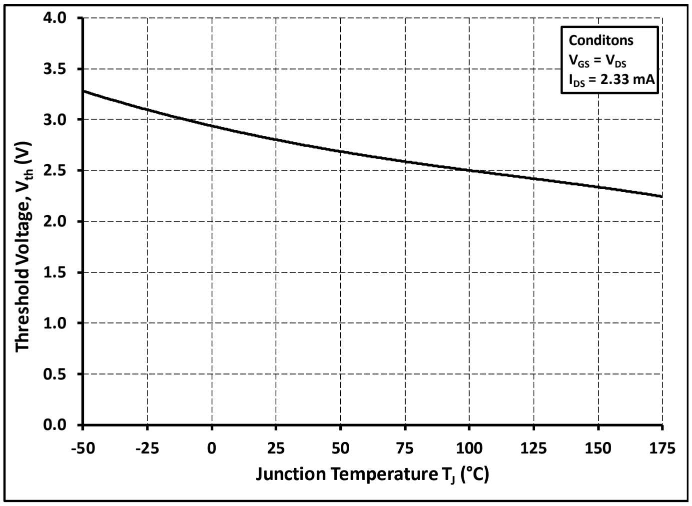


Figure 11. Threshold Voltage vs. Temperature

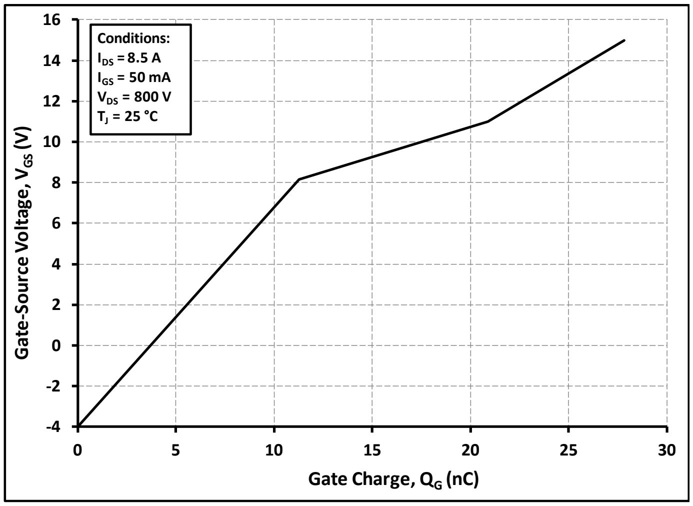


Figure 12. Gate Charge Characteristics

## Typical Performance

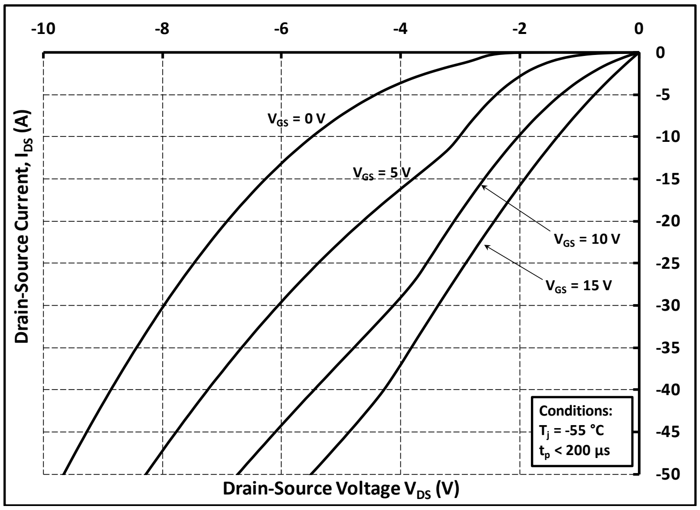


Figure 13. 3rd Quadrant Characteristic at -55 °C

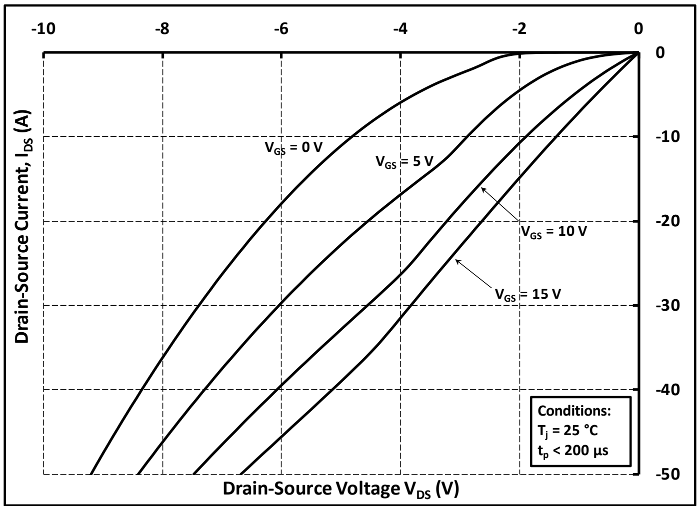


Figure 14. 3rd Quadrant Characteristic at 25 °C

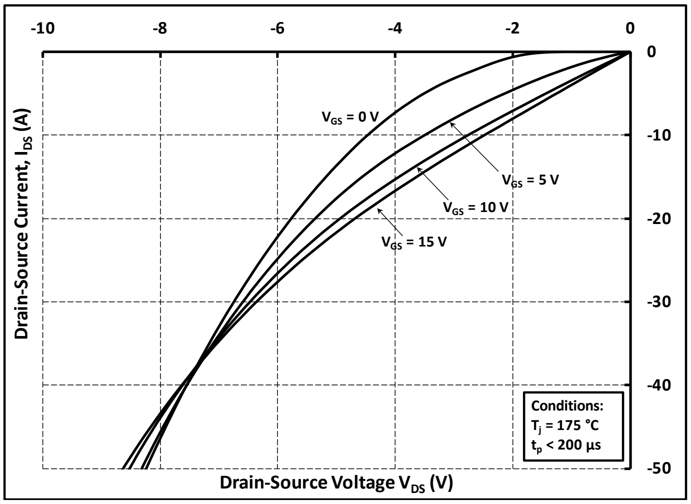


Figure 15. 3rd Quadrant Characteristic at 175 °C

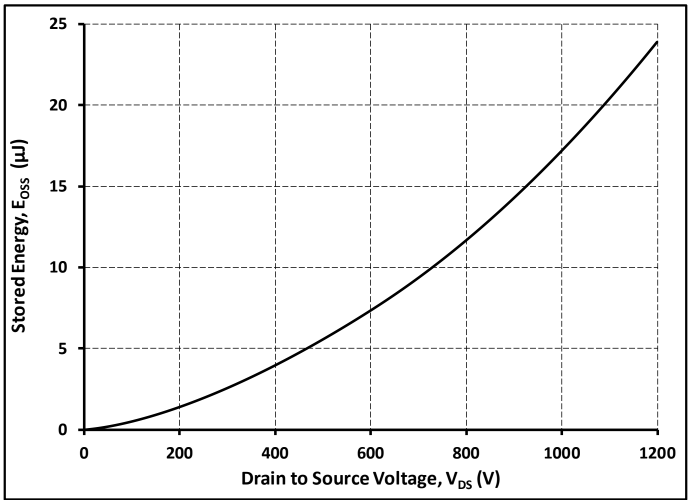


Figure 16. Output Capacitor Stored Energy

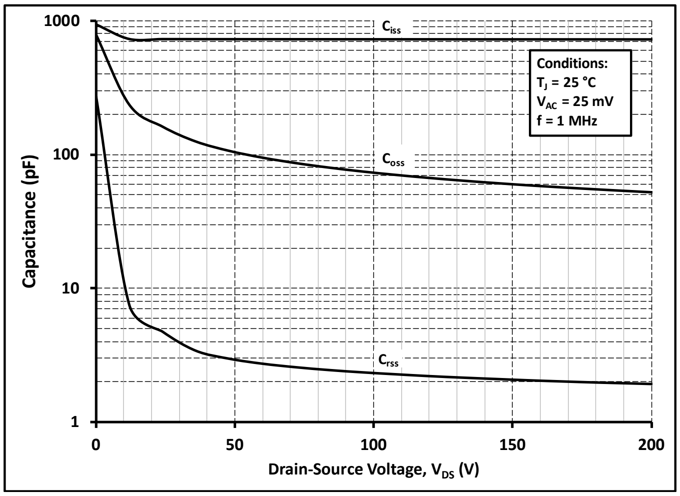


Figure 17. Capacitances vs. Drain-Source Voltage (0 - 200V)

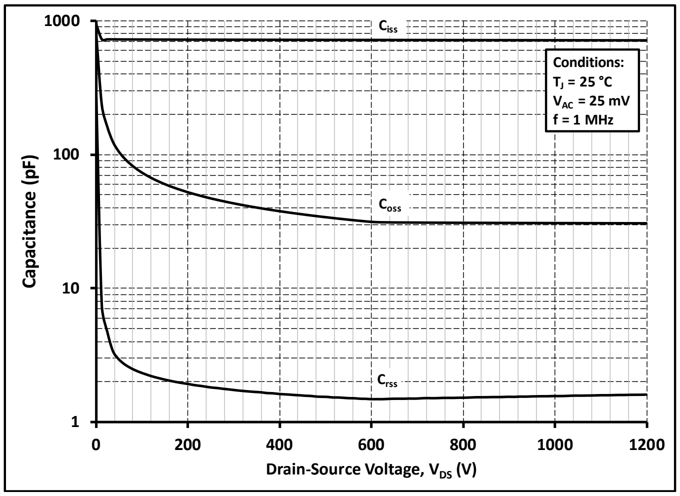


Figure 18. Capacitances vs. Drain-Source Voltage (0 - 1200V)

## Typical Performance

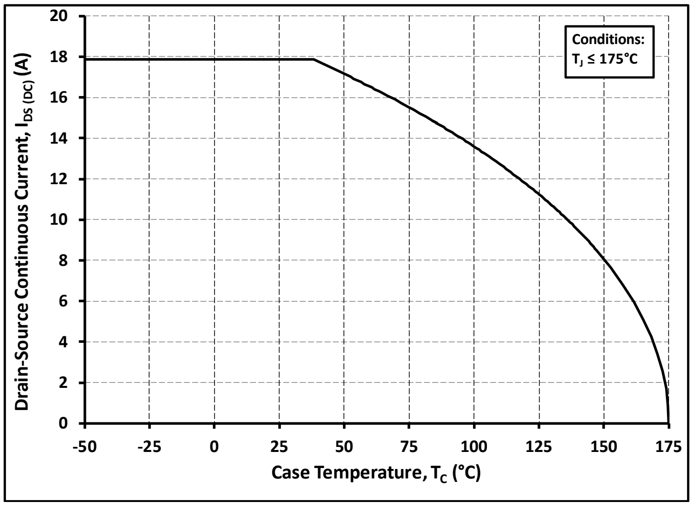


Figure 19. Continuous Drain Current Derating vs. Case Temperature

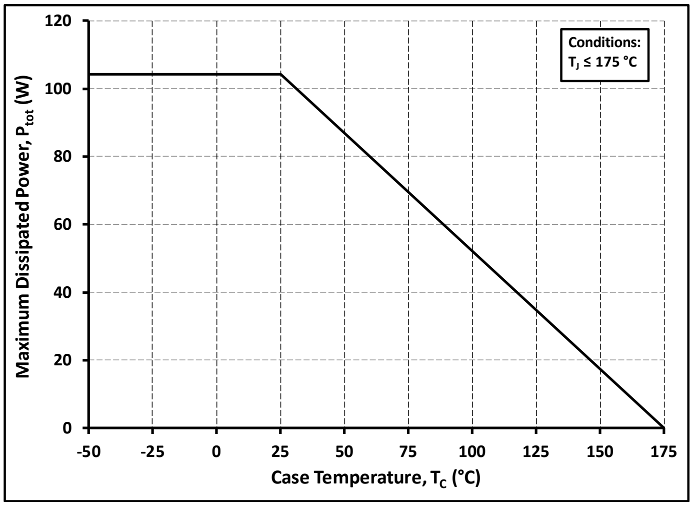


Figure 20. Maximum Power Dissipation Derating vs. Case Temperature

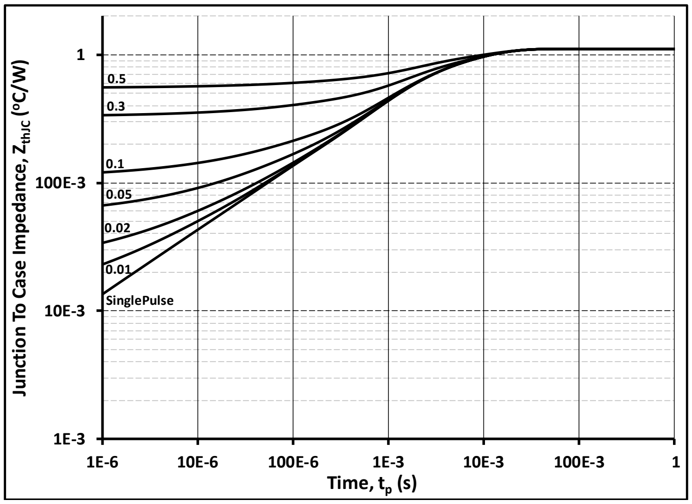


Figure 21. Transient Thermal Impedance (Junction - Case)

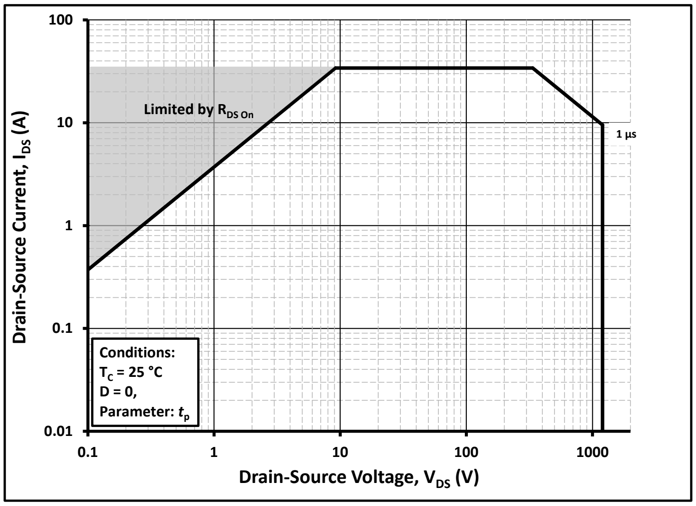


Figure 22. Safe Operating Area

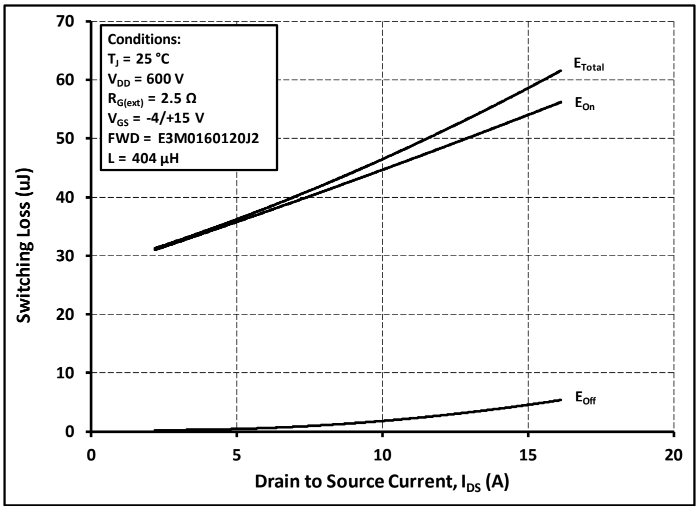


Figure 23. Clamped Inductive Switching Energy vs. Drain Current ($V_{DD}$ = 600V)

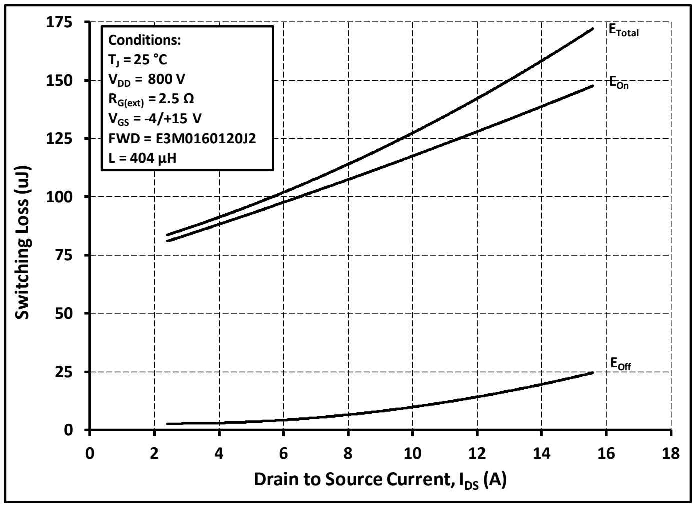


Figure 24. Clamped Inductive Switching Energy vs. Drain Current ($V_{DD}$ = 800V)

## Typical Performance

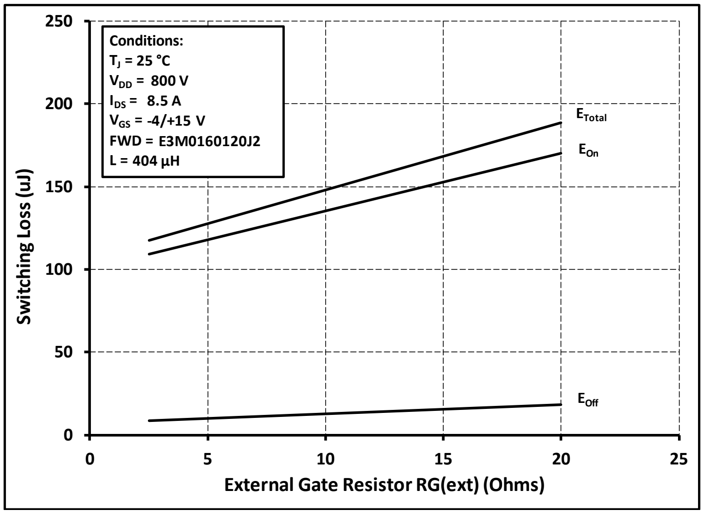


Figure 25. Clamped Inductive Switching Energy vs. $R_{G(ext)}$

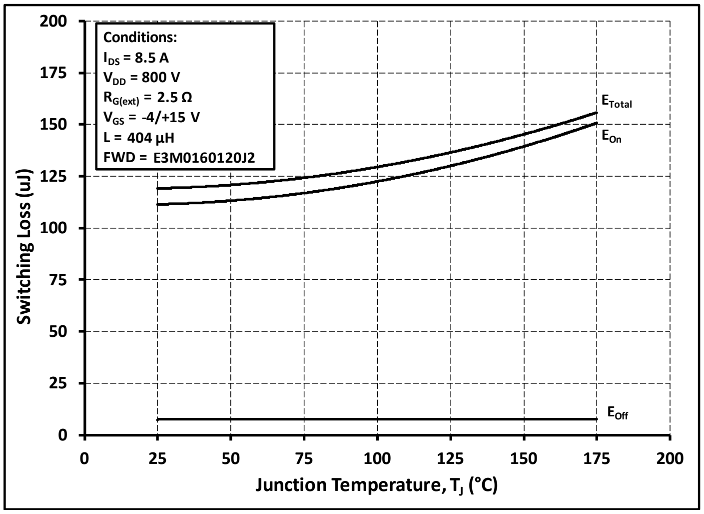


Figure 26. Clamped Inductive Switching Energy vs. Temperature

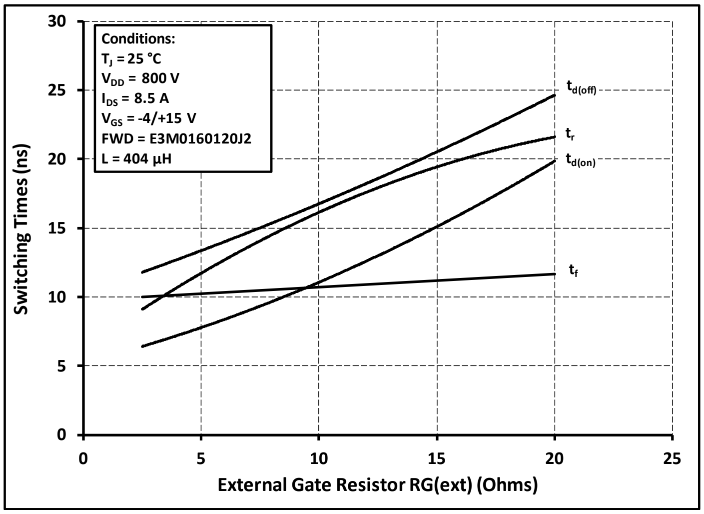


Figure 27. Switching Times vs. $R_{G(ext)}$

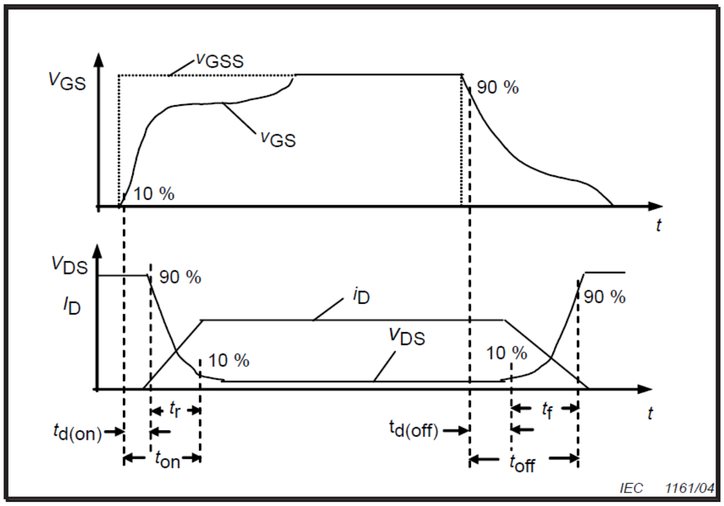


Figure 28. Switching Times Definition

## Test Circuit Schematic

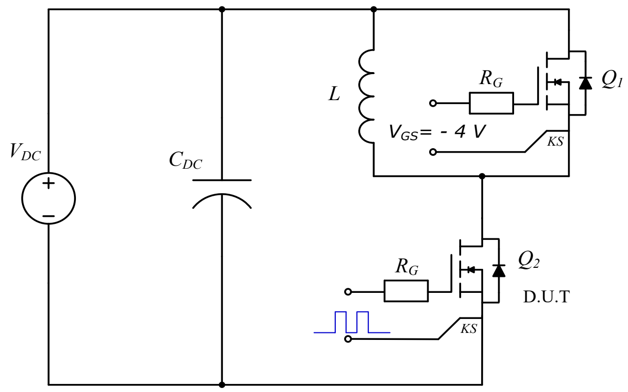


Figure 29. Clamped Inductive Switching Waveform Test Circuit


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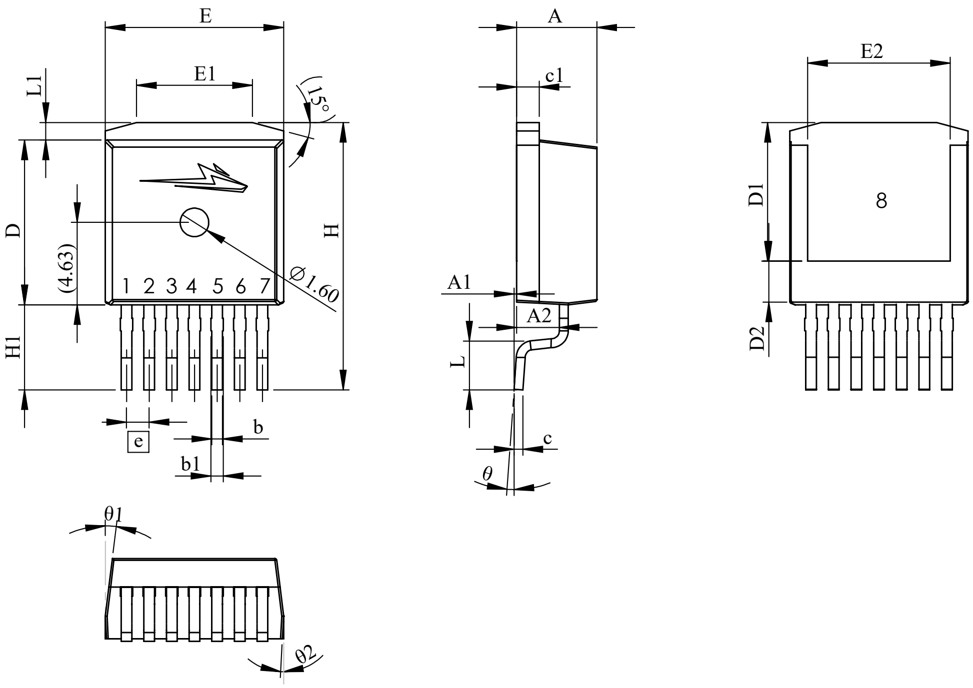
## Package Dimensions




| SYMBOL | MIN (mm) | MAX (mm) |
|---|---|---|
| A | 4.30 | 4.70 |
| A1 | 0.00 | 0.25 |
| A2 | 2.20 | 2.60 |
| b | 0.52 | 0.72 |
| b1 | 0.60 | 0.80 |
| c | 0.42 | 0.62 |
| c1 | 1.07 | 1.47 |
| D | 9.05 | 9.45 |
| D1 | 7.58 | 7.98 |
| D2 | 2.05 | 2.45 |
| E | 9.80 | 10.20 |
| E1 | 6.30 | 6.97 |
| E2 | 7.80 | 8.20 |
| e | 1.27 BSC | |
| H | 14.87 | 15.27 |
| H1 | 4.55 | 4.95 |
| L | 2.48 | 2.88 |
| L1 | 0.87 | 1.27 |
| θ | 0° | 8° |
| θ1 | 4° | 10° |
| θ2 | 0° | 6° |

| | |
|---|---|
| 1 | GATE |
| 2 | KELVIN |
| 3 | SOURCE |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | DRAIN |

NOTE
1. ALL METAL SURFACES ARE TIN PLATED (MATTE), EXCEPT AREA OF CUT.
2. DIMENSIONING & TOLERANCING CONFORM TO ASME Y14.5M-1994.
3. ALL DIMENSIONS ARE LISTED IN MILLIMETERS. ANGLES ARE IN DEGREES.
4. PACKAGE BURR FLASH SIZE (0.5 mm) IS NOT INCLUDED IN THE DIMENSIONS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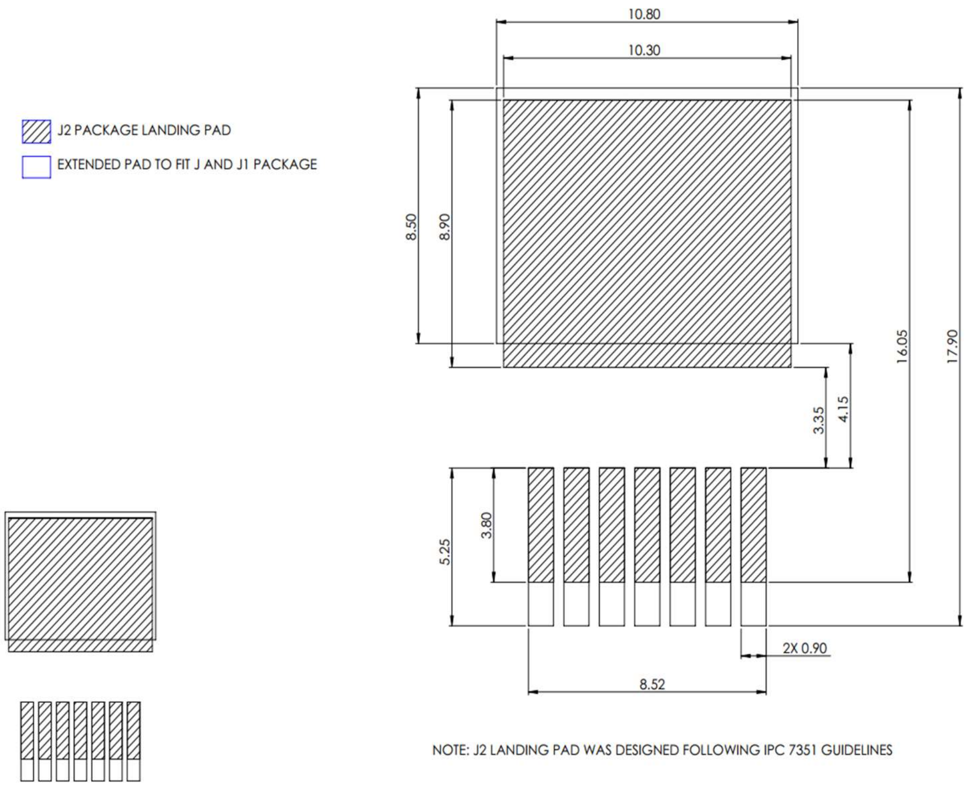
## Recommended Solder Pad Layout

All dimensions in mm



## Revision history

| Document Version | Date of release | Descriptiion of changes |
|---|---|---|
| 1.0 | December 2023 | Initial release |
| 2 | January - 2025 | Legal Disclaimer Updated |
| 3 | June - 2025 | Removed $V_{AC}$ from $R_{G(int)}$ test condition<br>Updated Fig 22 |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