



ON Semiconductor®

# FGD3N60LSD IGBT

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## Features

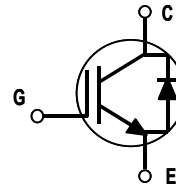
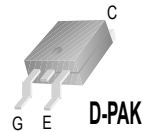
- High Current Capability
- Very Low Saturation Voltage :  $V_{CE(sat)} = 1.2\text{ V @ } I_C = 3\text{ A}$
- High Input Impedance

## Applications

- HID Lamp Applications
- Piezo Fuel Injection Applications

## Description

ON Semiconductor's Insulated Gate Bipolar Transistors (IGBTs) provide very low conduction losses. The device is designed for applications where very low On-Voltage Drop is a required feature.



## Absolute Maximum Ratings

| Symbol      | Description   | FGD3N60LSD  | Units |
|-------------|---|-------------|-------|
| $V_{CES}$   | Collector-Emitter Voltage   | 600         | V     |
| $V_{GES}$   | Gate-Emitter Voltage  | $\pm 25$    | V     |
| $I_C$       | Collector Current @ $T_C = 25^\circ\text{C}$                            | 6           | A     |
|             | Collector Current @ $T_C = 100^\circ\text{C}$                           | 3           | A     |
| $I_{CM(1)}$ | Pulsed Collector Current (1)  | 25          | A     |
| $I_F$       | Diode Continuous Forward Current @ $T_C = 100^\circ\text{C}$            | 3           | A     |
| $I_{FM}$    | Diode Maximum Forward Current   | 25          | A     |
| $P_D$       | Maximum Power Dissipation @ $T_C = 25^\circ\text{C}$                    | 40          | W     |
|             | Derating Factor   | 0.32        | W/°C  |
| $T_J$       | Operating Junction Temperature  | -55 to +150 | °C    |
| $T_{stg}$   | Storage Temperature Range   | -55 to +150 | °C    |
| $T_L$       | Maximum Lead Temp. for Soldering Purposes, 1/8" from Case for 5 Seconds | 250         | °C    |

Notes :

(1) Repetitive rating : Pulse width limited by max. junction temperature

## Thermal Characteristics

| Symbol                 | Parameter   | Typ. | Max. | Units |
|------------------------|---|------|------|-------|
| $R_{\theta JC}$ (IGBT) | Thermal Resistance, Junction-to-Case                    | --   | 3.1  | °C/W  |
| $R_{\theta JA}$        | Thermal Resistance, Junction-to-Ambient (PCB Mount) (2) | --   | 100  | °C/W  |

Notes :

(2) Mounted on 1" square PCB (FR4 or G-10 Material)

## Package Marking and Ordering Information

| Device Marking | Device       | Package | Reel Size | Tape Width | Quantity |
|----------------|--------------|---------|-----------|------------|----------|
| FGD3N60LSD     | FGD3N60LSDTM | D-PAK   | 380mm     | 16mm       | 2500     |

## Electrical Characteristics of the IGBT T<sub>C</sub> = 25°C unless otherwise noted

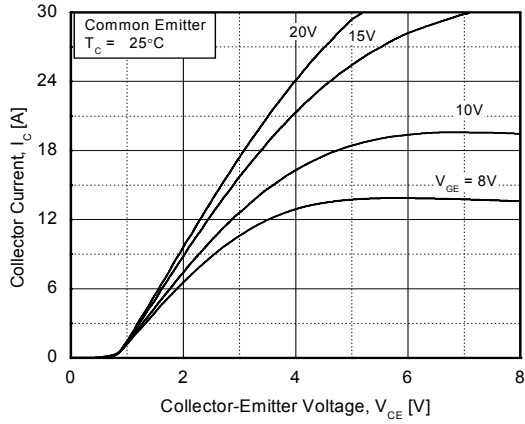
| Symbol                               | Parameter                                    | Test Conditions   | Min. | Typ. | Max.      | Units   |
|--------------------------------------|--|---|------|------|-----------|---------|
| <b>Off Characteristics</b>           |  |   |      |      |           |         |
| $BV_{CES}$                           | Collector-Emitter Breakdown Voltage          | $V_{GE} = 0V, I_C = 250\mu A$   | 600  | --   | --        | V       |
| $\frac{\Delta BV_{CES}}{\Delta T_J}$ | Temperature Coefficient of Breakdown Voltage | $V_{GE} = 0V, I_C = 1mA$  | --   | 0.6  | --        | V/°C    |
| $I_{CES}$                            | Collector Cut-Off Current                    | $V_{CE} = V_{CES}, V_{GE} = 0V$   | --   | --   | 250       | $\mu A$ |
| $I_{GES}$                            | G-E Leakage Current                          | $V_{GE} = V_{GES}, V_{CE} = 0V$   | --   | --   | $\pm 100$ | nA      |
| <b>On Characteristics</b>            |  |   |      |      |           |         |
| $V_{GE(th)}$                         | G-E Threshold Voltage                        | $I_C = 3mA, V_{CE} = V_{GE}$  | 2.5  | 3.2  | 5.0       | V       |
| $V_{CE(sat)}$                        | Collector to Emitter Saturation Voltage      | $I_C = 3A, V_{GE} = 10V$  | --   | 1.2  | 1.5       | V       |
|                                      |  | $I_C = 6A, V_{GE} = 10V$  | --   | 1.8  | --        | V       |
| <b>Dynamic Characteristics</b>       |  |   |      |      |           |         |
| $C_{ies}$                            | Input Capacitance                            | $V_{CE} = 25V, V_{GE} = 0V,$<br>$f = 1MHz$  | --   | 185  | --        | pF      |
| $C_{oes}$                            | Output Capacitance                           |   | --   | 20   | --        | pF      |
| $C_{res}$                            | Reverse Transfer Capacitance                 |   | --   | 5.5  | --        | pF      |
| <b>Switching Characteristics</b>     |  |   |      |      |           |         |
| $t_{d(on)}$                          | Turn-On Delay Time                           | $V_{CC} = 480V, I_C = 3A,$<br>$R_G = 470\Omega, V_{GE} = 10V,$<br>Inductive Load, $T_C = 25^\circ C$  | --   | 40   | --        | ns      |
| $t_r$                                | Rise Time                                    |   | --   | 40   | --        | ns      |
| $t_{d(off)}$                         | Turn-Off Delay Time                          |   | --   | 600  | --        | ns      |
| $t_f$                                | Fall Time                                    |   | --   | 600  | --        | ns      |
| $E_{on}$                             | Turn-On Switching Loss                       |   | --   | 250  | --        | $\mu J$ |
| $E_{off}$                            | Turn-Off Switching Loss                      |   | --   | 1.00 | --        | mJ      |
| $E_{ts}$                             | Total Switching Loss                         |   | --   | 1.25 | --        | mJ      |
| $t_{d(on)}$                          | Turn-On Delay Time                           | $V_{CC} = 480V, I_C = 3A,$<br>$R_G = 470\Omega, V_{GE} = 10V,$<br>Inductive Load, $T_C = 125^\circ C$ | --   | 40   | --        | ns      |
| $t_r$                                | Rise Time                                    |   | --   | 45   | --        | ns      |
| $t_{d(off)}$                         | Turn-Off Delay Time                          |   | --   | 620  | --        | ns      |
| $t_f$                                | Fall Time                                    |   | --   | 800  | --        | ns      |
| $E_{on}$                             | Turn-On Switching Loss                       |   | --   | 300  | --        | $\mu J$ |
| $E_{off}$                            | Turn-Off Switching Loss                      |   | --   | 1.9  | --        | mJ      |
| $E_{ts}$                             | Total Switching Loss                         |   | --   | 2.2  | --        | mJ      |
| $Q_g$                                | Total Gate Charge                            | $V_{CE} = 480V, I_C = 3A,$<br>$V_{GE} = 10V$  | --   | 12.5 | --        | nC      |
| $Q_{ge}$                             | Gate-Emitter Charge                          |   | --   | 2.8  | --        | nC      |
| $Q_{gc}$                             | Gate-Collector Charge                        |   | --   | 4.9  | --        | nC      |
| $L_e$                                | Internal Emitter Inductance                  | Measured 5mm from PKG   | --   | 7.5  | --        | nH      |

**Electrical Characteristics of DIODE**  $T_C = 25^\circ\text{C}$  unless otherwise noted

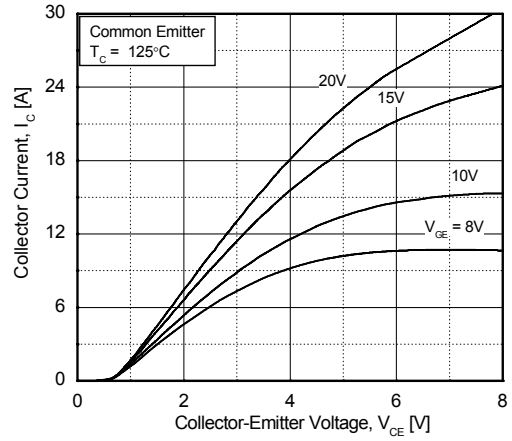
| Symbol   | Parameter                           | Test Conditions                                  | Min.                      | Typ. | Max. | Units |    |
|----------|-------------------------------------|--|---------------------------|------|------|-------|----|
| $V_{FM}$ | Diode Forward Voltage               | $I_F = 3A$                                       | $T_C = 25^\circ\text{C}$  | --   | 1.5  | 1.9   | V  |
|          |                                     |  | $T_C = 100^\circ\text{C}$ | --   | 1.55 | --    |    |
| $t_{rr}$ | Diode Reverse Recovery Time         | $I_F = 3A,$<br>$di/dt = 100A/us$<br>$V_R = 200V$ | $T_C = 25^\circ\text{C}$  | --   | 234  | --    | ns |
|          |                                     |  | $T_C = 100^\circ\text{C}$ | --   | --   | --    |    |
| $I_{rr}$ | Diode Peak Reverse Recovery Current | $I_F = 3A,$<br>$di/dt = 100A/us$<br>$V_R = 200V$ | $T_C = 25^\circ\text{C}$  | --   | 2.64 | --    | A  |
|          |                                     |  | $T_C = 100^\circ\text{C}$ | --   | --   | --    |    |
| $Q_{rr}$ | Diode Reverse Recovery Charge       | $I_F = 3A,$<br>$di/dt = 100A/us$<br>$V_R = 200V$ | $T_C = 25^\circ\text{C}$  | --   | 309  | --    | nC |
|          |                                     |  | $T_C = 100^\circ\text{C}$ | --   | --   | --    |    |

## Typical Performance Characteristics

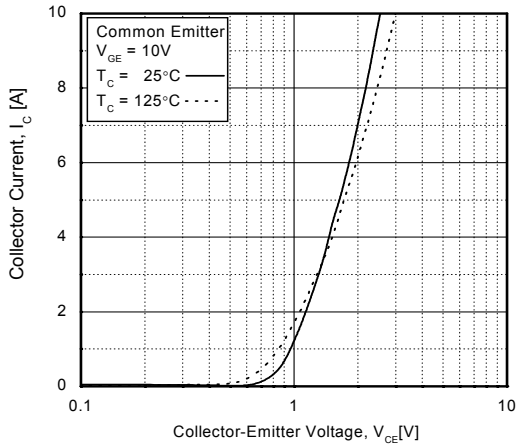
**Figure 1. Typical Output Characteristics**



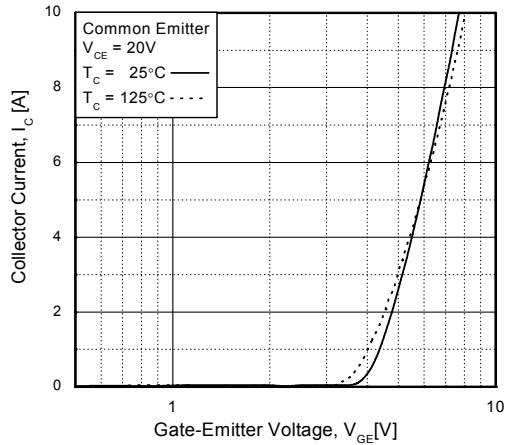
**Figure 2. Typical Output Characteristics**



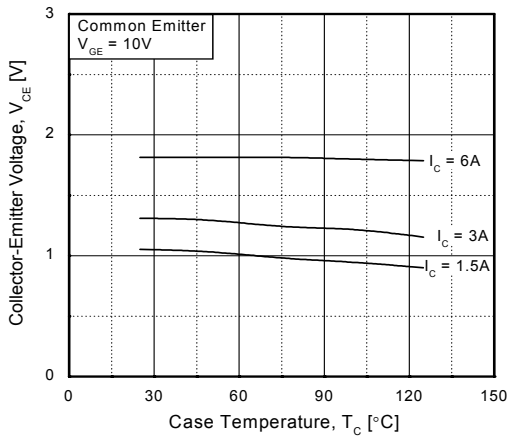
**Figure 3. Typical Output Characteristics**



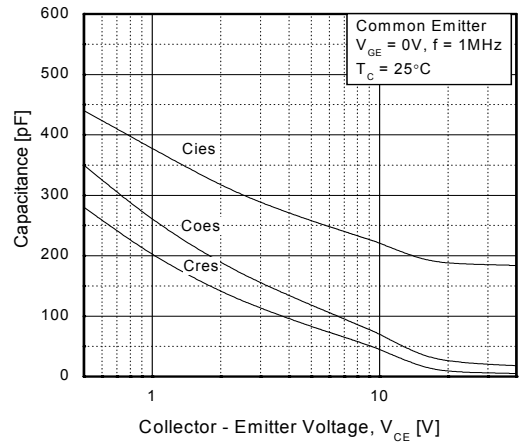
**Figure 4. Transfer Characteristics**



**Figure 5. Saturation Voltage vs. Case**

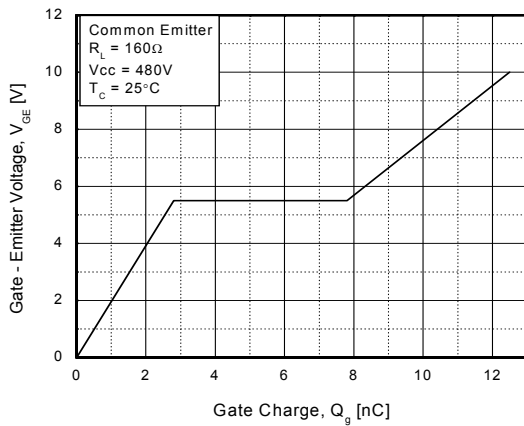


**Figure 6. Capacitance Characteristics**

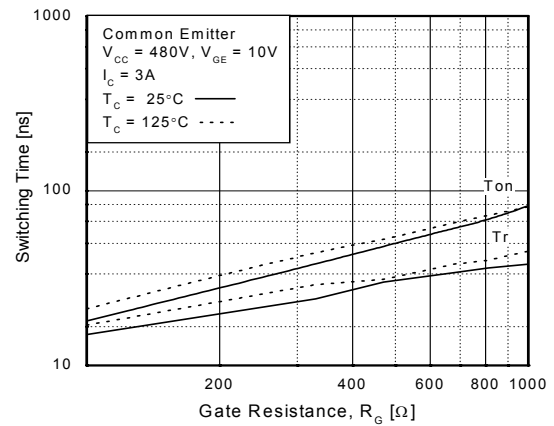


## Typical Performance Characteristics (Continued)

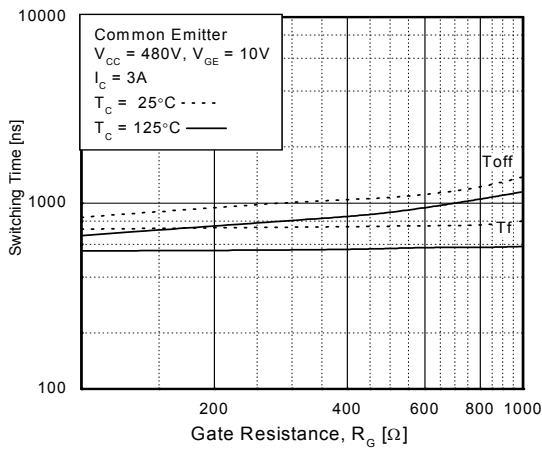
**Figure 7. Gate Charge**



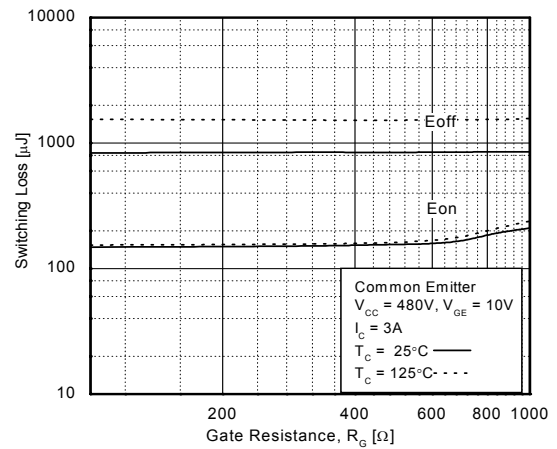
**Figure 8. Turn-On Characteristics vs. Gate Resistance**



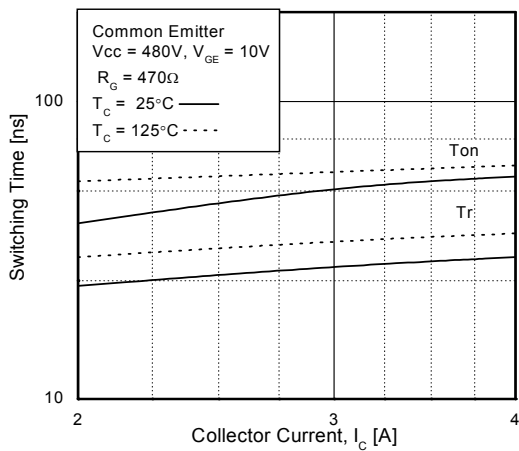
**Figure 9. Turn-Off Characteristics vs. Gate Resistance**



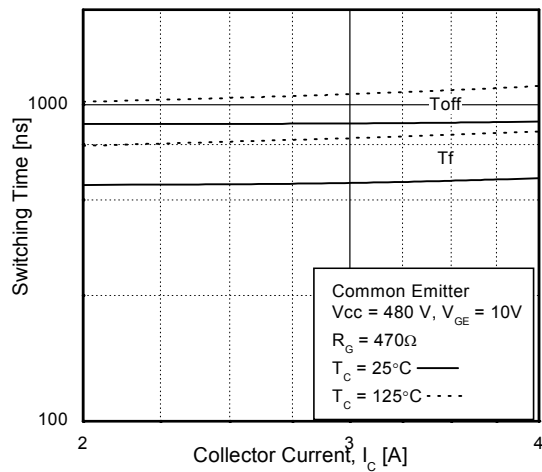
**Figure 10. Switching Loss vs. Gate Resistance**



**Figure 11. Turn-On Characteristics vs. Collector Current**

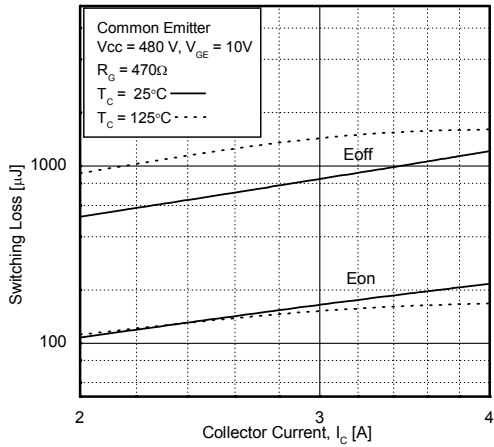


**Figure 12. Turn-Off Characteristics vs. Collector Current**

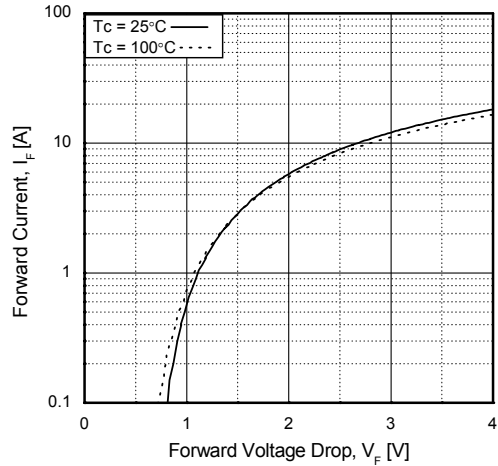


**Typical Performance Characteristics** (Continued)

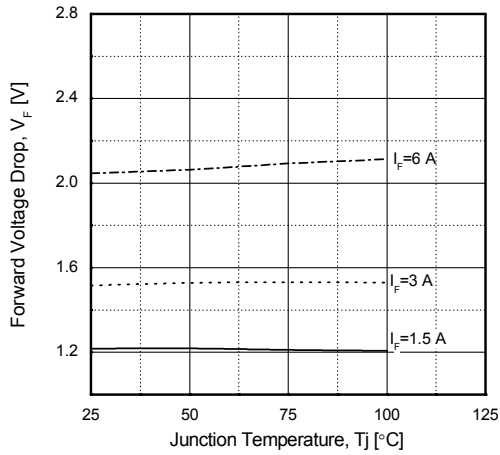
**Figure 13. Switching Loss vs. Collector Current**



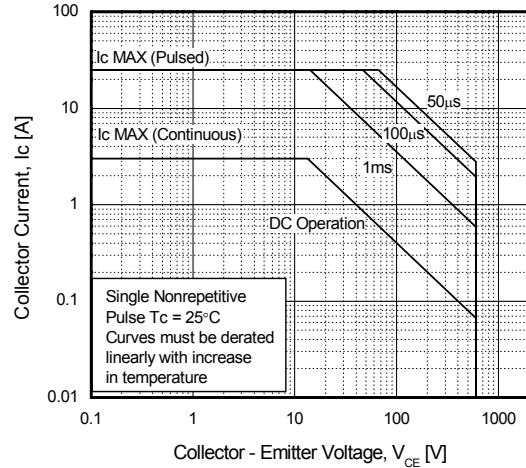
**Figure 14. Forward Characteristics**



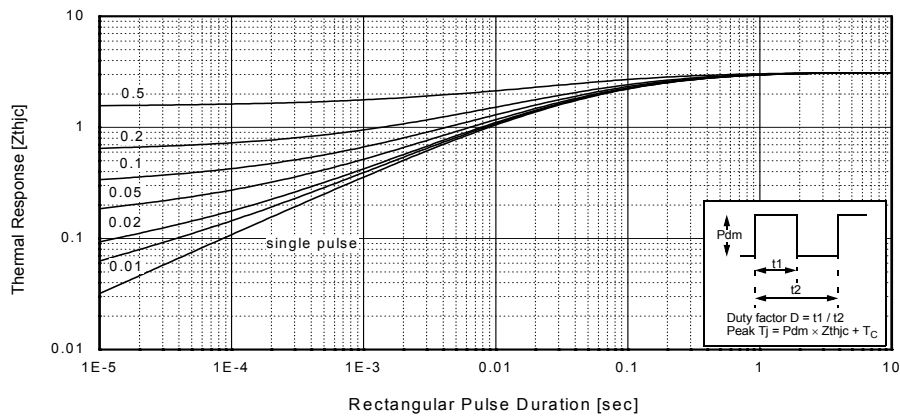
**Figure 15. Forward Voltage Drop Vs Tj**



**Figure 16. SOA Characteristics**

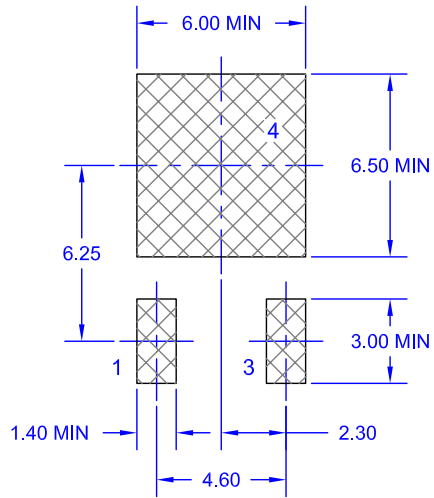
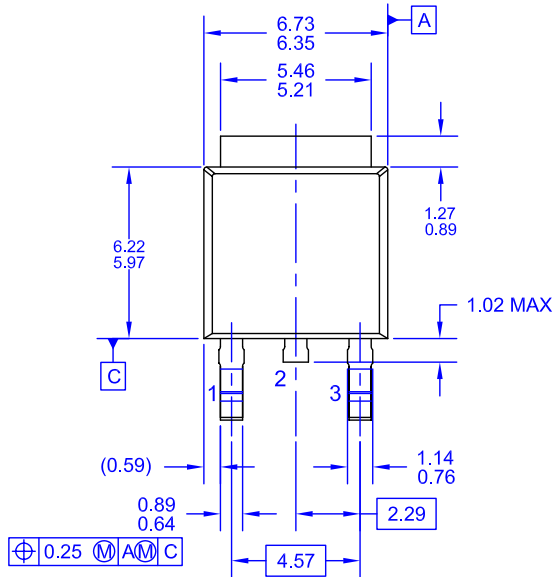


**Figure 17. Transient Thermal Impedance of IGBT**

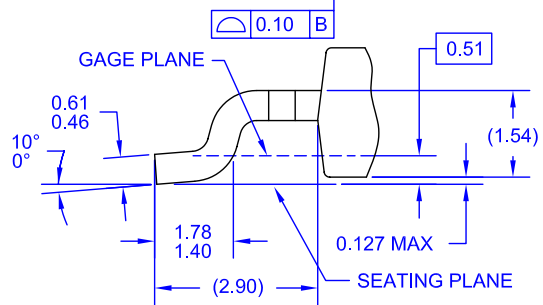
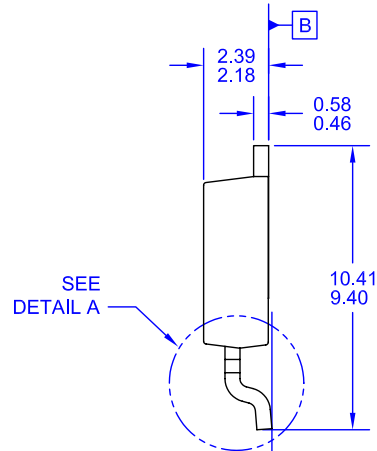
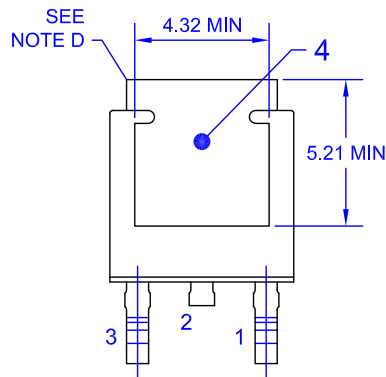


# Mechanical Dimensions

## D-PAK



LAND PATTERN RECOMMENDATION



- NOTES: UNLESS OTHERWISE SPECIFIED
- A) THIS PACKAGE CONFORMS TO JEDEC, TO-252, ISSUE C, VARIATION AA.
  - B) ALL DIMENSIONS ARE IN MILLIMETERS.
  - C) DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.
  - D) HEAT SINK TOP EDGE COULD BE IN CHAMFERED CORNERS OR EDGE PROTRUSION.
  - E) PRESENCE OF TRIMMED CENTER LEAD IS OPTIONAL.
  - F) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR EXTRUSIONS.
  - G) LAND PATTERN RECOMMENDATION IS BASED ON IPC7351A STD TO220P1003X238-3N.
  - H) DRAWING NUMBER AND REVISION: MKT-TO252A03REV8

Dimensions in Millimeters

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