# IGBT - Power, Co-PAK N-Channel, Field Stop IV, MQ (Medium Speed), TO247-4L

## 650 V, 1.45 V, 50 A

# FGH4L50T65MQDC50

Using the novel field stop 4th generation IGBT technology and generation 1.5 SiC Schottky Diode technology in TO−247 4−lead package, FGH4L50T65MQDC50 offers the optimum performance with both low conduction and switching losses for high−efficiency operations in various applications, especially totem pole bridgeless PFC and Inverter.

**Features**

- Positive Temperature Coefficient for Easy Parallel Operation
- High Current Capability
- 100% of the Parts are Tested for $I_{LM}$ (Note 2)
- Smooth and Optimized Switching
- Low Saturation Voltage: $V_{CE(Sat)}$ = 1.45 V (Typ.) @ $I_C$ = 50 A
- No Reverse Recovery / No Forward Recovery
- Tight Parameter Distribution
- RoHS Compliant

**Applications**

- Charging Station (EVSE)
- Solar Inverter
- UPS, ESS
- PFC, Converters

**MAXIMUM RATINGS** ($T_J$ = 25°C unless otherwise noted)

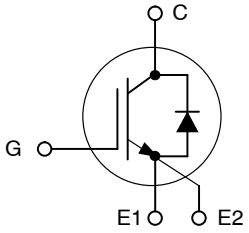
| Parameter | | Symbol | Value | Unit |
|---|---|---|---|---|
| Collector−to−Emitter Voltage | | $V_{CES}$ | 650 | V |
| Gate−to−Emitter Voltage | | $V_{GES}$ | ±20 | |
| Transient Gate−to−Emitter Voltage ($t_p$ < 0.5 μs, D < 0.001) | | | ±30 | |
| Collector Current | $T_C$ = 25°C (Note 1) | $I_C$ | 100 | A |
| | $T_C$ = 100°C | | 50 | |
| Power Dissipation | $T_C$ = 25°C | $P_D$ | 246 | W |
| | $T_C$ = 100°C | | 123 | |
| Pulsed Collector Current | $T_C$ = 25°C (Note 2) | $I_{LM}$ | 200 | A |
| | $T_C$ = 25°C (Note 3) | $I_{CM}$ | 200 | |
| Diode Forward Current | $T_C$ = 25°C (Note 1) | $I_F$ | 60 | A |
| | $T_C$ = 100°C | | 50 | |
| Pulsed Diode Maximum Forward Current | $T_C$ = 25°C | $I_{FM}$ | 200 | A |
| Operating Junction and Storage Temperature Range | | $T_J$, $T_{STG}$ | −55 to +175 | °C |
| Maximum Lead Temp. for Soldering Purposes (1/8″ from case for 5 s) | | $T_L$ | 260 | °C |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

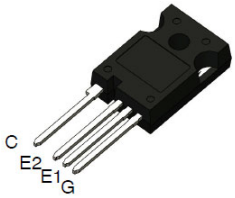
1. Value limit by bond wire
2. $V_{CC}$ = 400 V, $V_{GE}$ = 15 V, $I_C$ = 200 A, Inductive Load, 100% tested
3. Repetitive rating: pulse width limited by max. junction temperature

| $BV_{CES}$ | $V_{CE(sat)}$ | $I_C$ |
|---|---|---|
| 650 V | 1.45 V | 50 A |

**PIN CONNECTIONS**

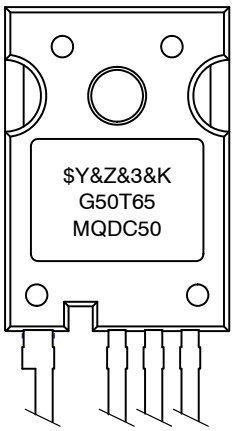



E1: Kelvin Emitter
E2: Power Emitter




**TO−247−4LD**
**CASE 340CJ**

**MARKING DIAGRAM**




$Y = **onsemi** Logo
&Z = Assembly Plant Code
&3 = 3−Digit Date Code
&K = 2−Digit Lot Traceability Code
G50T65MQDC50 = Specific Device Code

**ORDERING INFORMATION**

| Device | Package | Shipping |
|---|---|---|
| FGH4L50T65MQDC50 | TO−247 −4LD | 30 Units / Tube |

## THERMAL CHARACTERISTICS

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Thermal Resistance Junction−to−Case, for IGBT | $R_{\theta JC}$ | 0.61 | °C/W |
| Thermal Resistance Junction−to−Case, for Diode | $R_{\theta JCD}$ | 0.70 | |
| Thermal Resistance junction−to−Ambient | $R_{\theta JA}$ | 40 | |

## ELECTRICAL CHARACTERISTICS ($T_J$ = 25°C unless otherwise noted)

| Parameter | Test Conditions | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | |
| Collector−emitter Breakdown Voltage, Gate−emitter Short−circuited | $V_{GE}$ = 0 V, $I_C$ = 1 mA | $BV_{CES}$ | 650 | – | – | V |
| Temperature Coefficient of Breakdown Voltage | $V_{GE}$ = 0 V, $I_C$ = 1 mA | $\frac{\Delta BV_{CES}}{\Delta T_J}$ | – | 0.5 | – | V/°C |
| Collector−emitter Cut−off Current, Gate−emitter Short−circuited | $V_{GE}$ = 0 V, $V_{CE}$ = 650 V | $I_{CES}$ | – | – | 250 | μA |
| Gate Leakage Current, Collector−emitter Short−circuited | $V_{GE}$ = 20 V, $V_{CE}$ = 0 V | $I_{GES}$ | – | – | ±400 | nA |
| **ON CHARACTERISTICS** | | | | | | |
| Gate−emitter Threshold Voltage | $V_{GE}$ = $V_{CE}$, $I_C$ = 50 mA | $V_{GE(th)}$ | 3.0 | 4.5 | 6.0 | V |
| Collector−emitter Saturation Voltage | $V_{GE}$ = 15 V, $I_C$ = 50 A, $T_J$ = 25°C | $V_{CE(sat)}$ | – | 1.45 | 1.8 | V |
| | $V_{GE}$ = 15 V, $I_C$ = 50 A, $T_J$ = 175°C | | – | 1.65 | – | |
| **DYNAMIC CHARACTERISTICS** | | | | | | |
| Input Capacitance | $V_{CE}$ = 30 V, $V_{GE}$ = 0 V, f = 1 MHz | $C_{ies}$ | – | 3340 | – | pF |
| Output Capacitance | | $C_{oes}$ | – | 630 | – | |
| Reverse Transfer Capacitance | | $C_{res}$ | – | 10 | – | |
| Gate Charge Total | $V_{CE}$ = 400 V, $I_C$ = 50 A, $V_{GE}$ = 15 V | $Q_g$ | – | 102 | – | nC |
| Gate−to−emitter Charge | | $Q_{ge}$ | – | 19 | – | |
| Gate−to−collector Charge | | $Q_{gc}$ | – | 25 | – | |
| **SWITCHING CHARACTERISTICS, INDUCTIVE LOAD** | | | | | | |
| Turn−on Delay Time | $T_J$ = 25°C, $V_{CC}$ = 400 V, $I_C$ = 25 A, $R_G$ = 15 Ω, $V_{GE}$ = 15 V, Inductive Load | $t_{d(on)}$ | – | 27 | – | ns |
| Rise Time | | $t_r$ | – | 10 | – | |
| Turn−off Delay Time | | $t_{d(off)}$ | – | 181 | – | |
| Fall Time | | $t_f$ | – | 21 | – | |
| Turn−on Switching Loss | | $E_{on}$ | – | 0.24 | – | mJ |
| Turn−off Switching Loss | | $E_{off}$ | – | 0.31 | – | |
| Total Switching Loss | | $E_{ts}$ | – | 0.55 | – | |
| Turn−on Delay Time | $T_J$ = 25°C, $V_{CC}$ = 400 V, $I_C$ = 50 A, $R_G$ = 15 Ω, $V_{GE}$ = 15 V, Inductive Load | $t_{d(on)}$ | – | 29 | – | ns |
| Rise Time | | $t_r$ | – | 21 | – | |
| Turn−off Delay Time | | $t_{d(off)}$ | – | 173 | – | |
| Fall Time | | $t_f$ | – | 18 | – | |
| Turn−on Switching Loss | | $E_{on}$ | – | 0.54 | – | mJ |
| Turn−off Switching Loss | | $E_{off}$ | – | 0.59 | – | |
| Total Switching Loss | | $E_{ts}$ | – | 1.13 | – | |

**ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise noted)

| Parameter | Test Conditions | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **SWITCHING CHARACTERISTICS, INDUCTIVE LOAD** | | | | | | |
| Turn−on Delay Time | $T_J$ = 175°C, $V_{CC}$ = 400 V, $I_C$ = 25 A, $R_G$ = 15 Ω, $V_{GE}$ = 15 V, Inductive Load | $t_{d(on)}$ | − | 24 | − | ns |
| Rise Time | | $t_r$ | − | 11 | − | |
| Turn−off Delay Time | | $t_{d(off)}$ | − | 197 | − | |
| Fall Time | | $t_f$ | − | 24 | − | |
| Turn−on Switching Loss | | $E_{on}$ | − | 0.31 | − | mJ |
| Turn−off Switching Loss | | $E_{off}$ | − | 0.51 | − | |
| Total Switching Loss | | $E_{ts}$ | − | 0.82 | − | |
| Turn−on Delay Time | $T_J$ = 175°C, $V_{CC}$ = 400 V, $I_C$ = 50 A, $R_G$ = 15 Ω, $V_{GE}$ = 15 V, Inductive Load | $t_{d(on)}$ | − | 26 | − | ns |
| Rise Time | | $t_r$ | − | 27 | − | |
| Turn−off Delay Time | | $t_{d(off)}$ | − | 186 | − | |
| Fall Time | | $t_f$ | − | 26 | − | |
| Turn−on Switching Loss | | $E_{on}$ | − | 0.74 | − | mJ |
| Turn−off Switching Loss | | $E_{off}$ | − | 0.97 | − | |
| Total Switching Loss | | $E_{ts}$ | − | 1.71 | − | |
| **DIODE CHARACTERISTICS** | | | | | | |
| Diode Forward Voltage | $I_F$ = 50 A, $T_J$ = 25°C | $V_F$ | − | 1.46 | 1.7 | V |
| | $I_F$ = 50 A, $T_J$ = 175°C | | − | 1.83 | − | |
| Total Capacitance | $V_R$ = 400 V, f = 1 MHz, $T_J$ = 25°C | C | − | 210 | − | pF |
| | $V_R$ = 600 V, f = 1 MHz, $T_J$ = 25°C | | − | 202 | − | |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

## TYPICAL CHARACTERISTICS

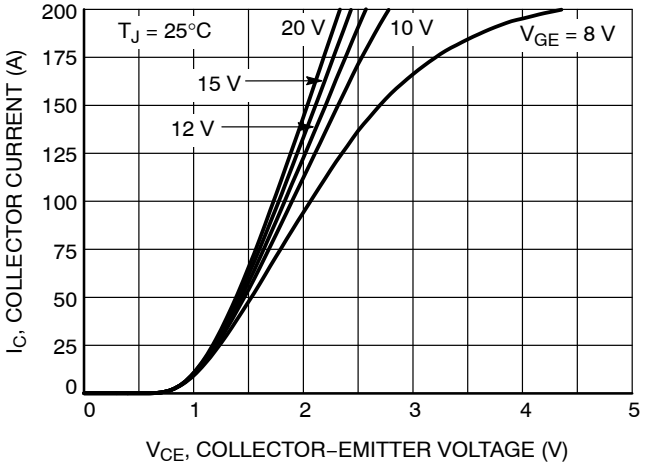



**Figure 1. Typical Output Characteristics**

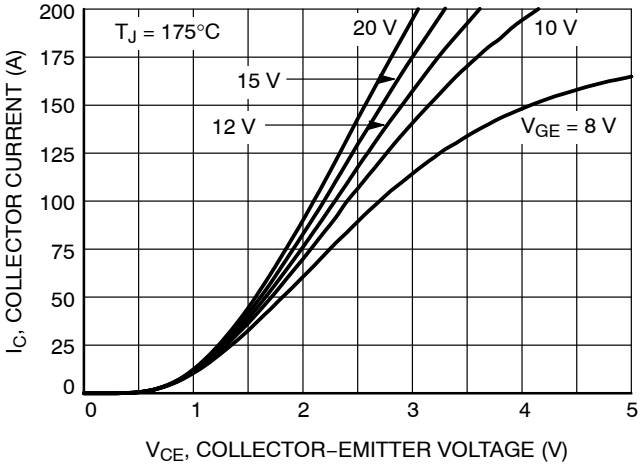



**Figure 2. Typical Output Characteristics**

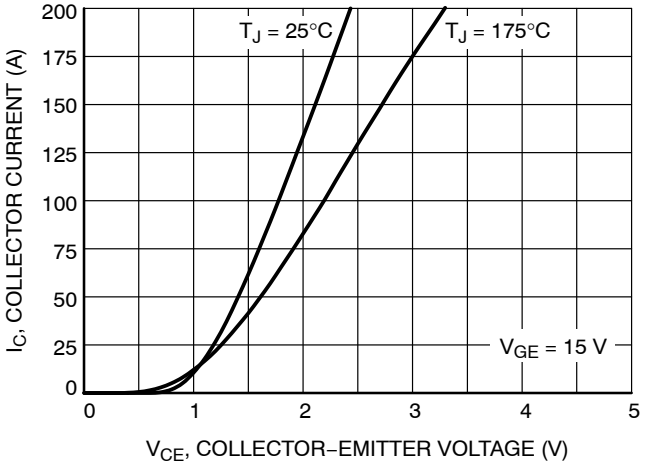



**Figure 3. Typical Output Characteristics**

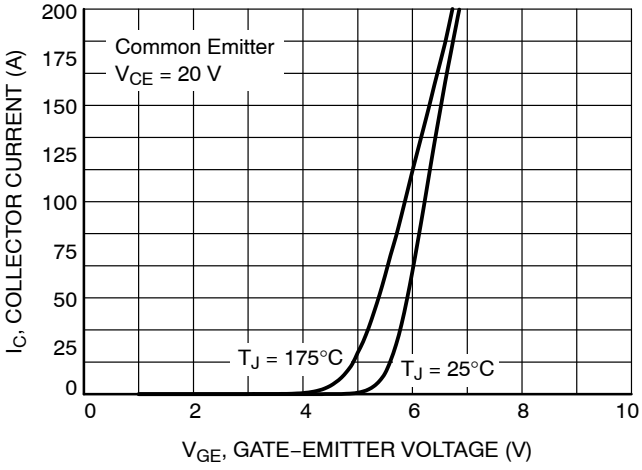



**Figure 4. Transfer Characteristics**

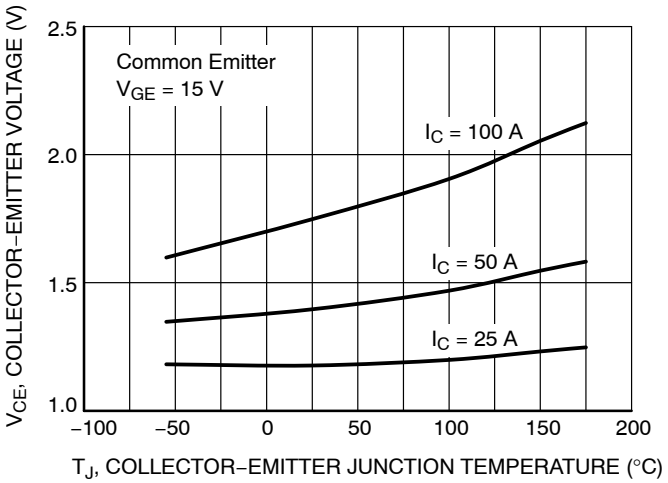



**Figure 5. Saturation Voltage vs. Junction Temperature at Variant Current Level**

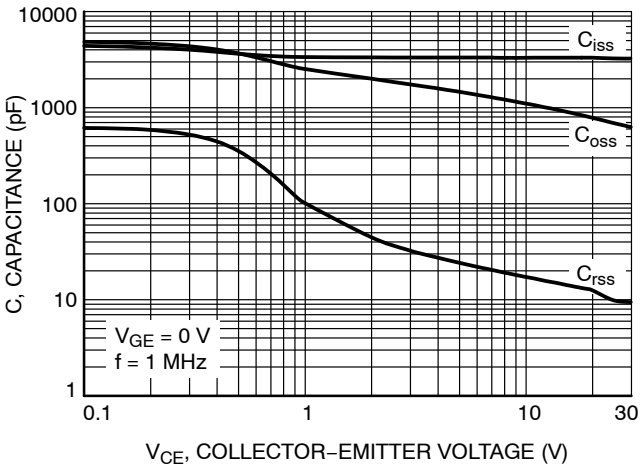



**Figure 6. Capacitance Variation**

## TYPICAL CHARACTERISTICS

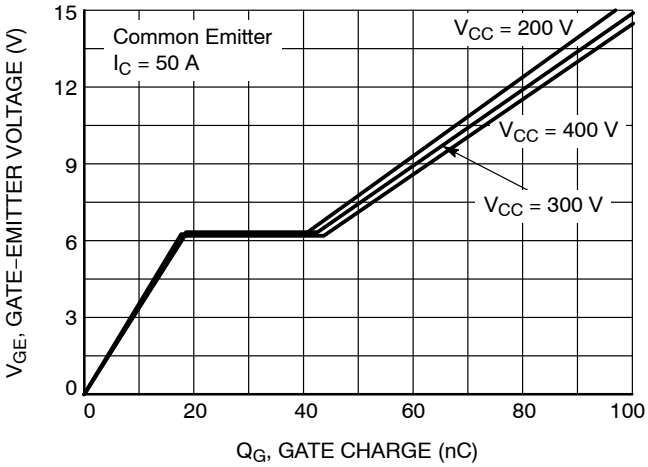



**Figure 7. Gate Charge Characteristics**

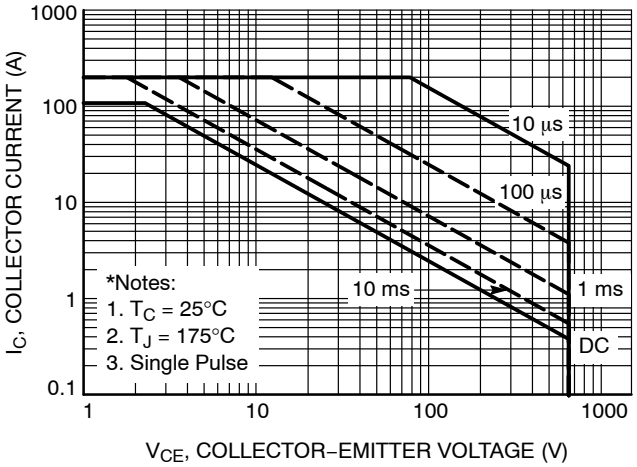



**Figure 8. SOA Characteristics**

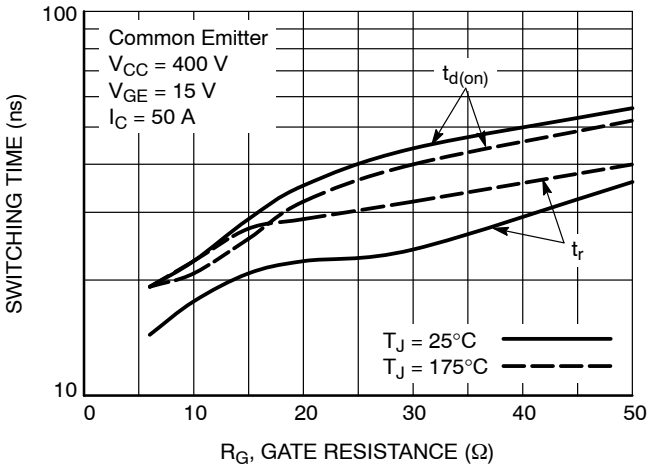



**Figure 9. Turn−On Characteristics vs. Gate Resistance**

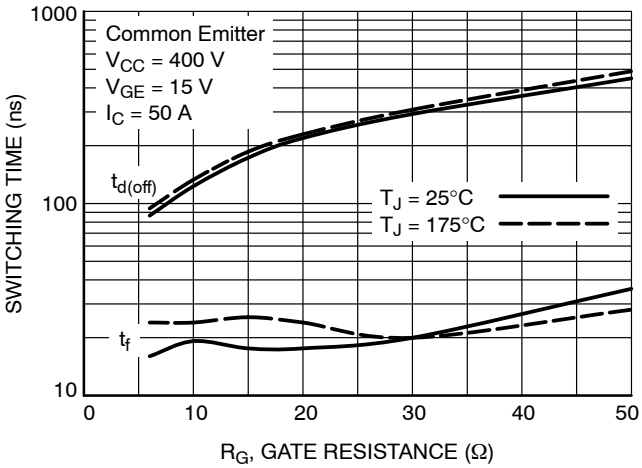



**Figure 10. Turn−Off Characteristics vs. Gate Resistance**

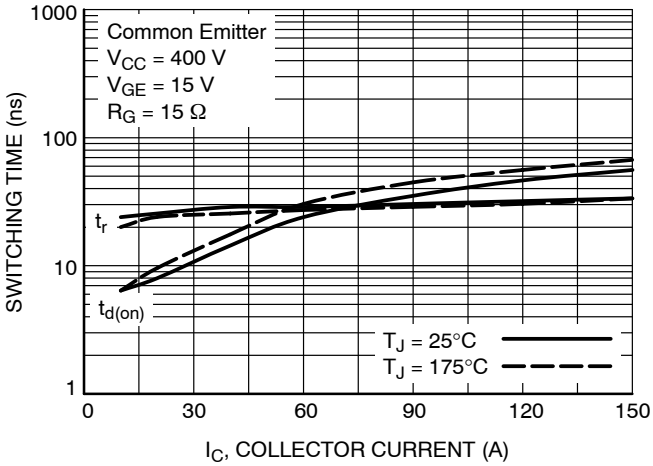



**Figure 11. Turn−on Characteristics vs. Collector Current**

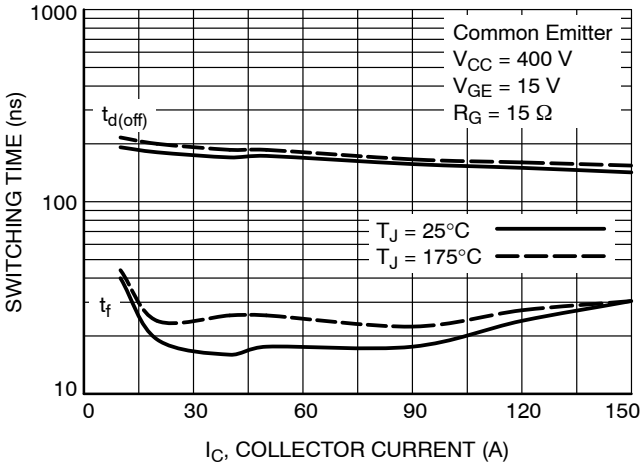



**Figure 12. Turn−off Characteristics vs. Collector Current**

## TYPICAL CHARACTERISTICS

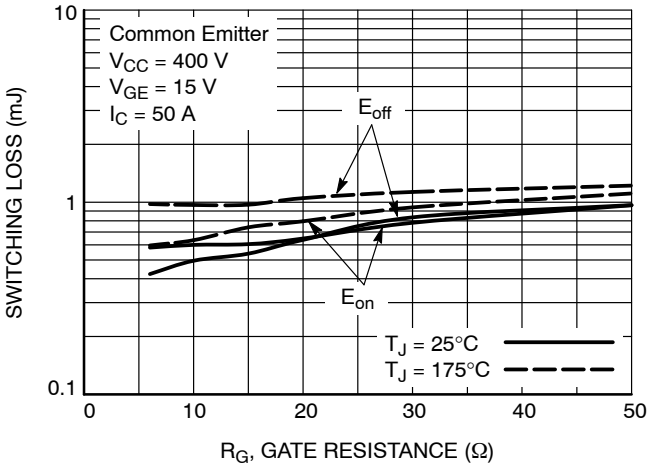



**Figure 13. Switching Loss vs. Gate Resistance**

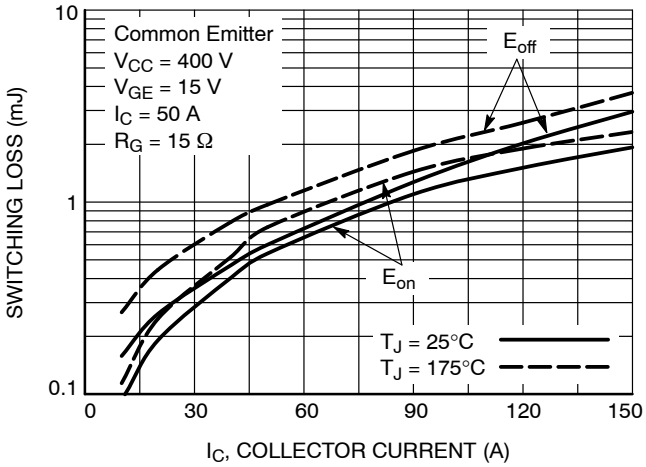



**Figure 14. Switching Loss vs. Collector Current**

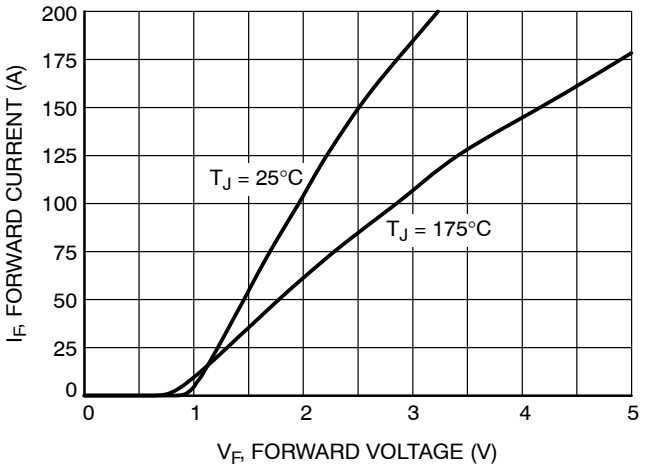



**Figure 15. Forward Diode Characteristics**

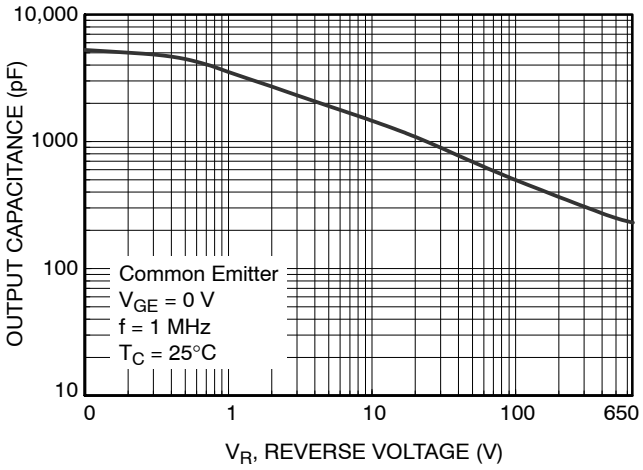



**Figure 16. (Diode) Output Capacitance (Coes) vs. Reverse Voltage**

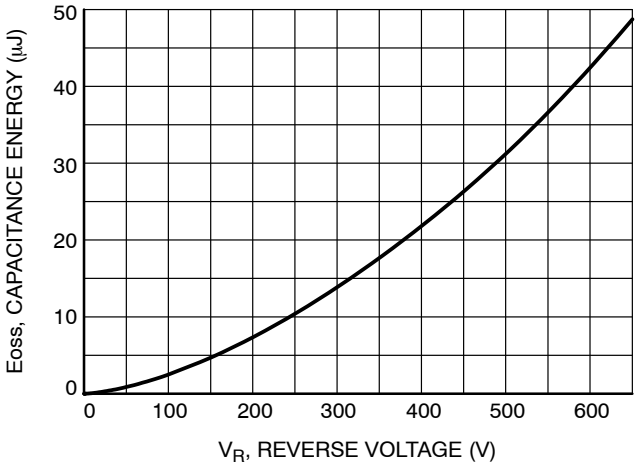



**Figure 17. Output Capacitance Stored Energy**

## TYPICAL CHARACTERISTICS

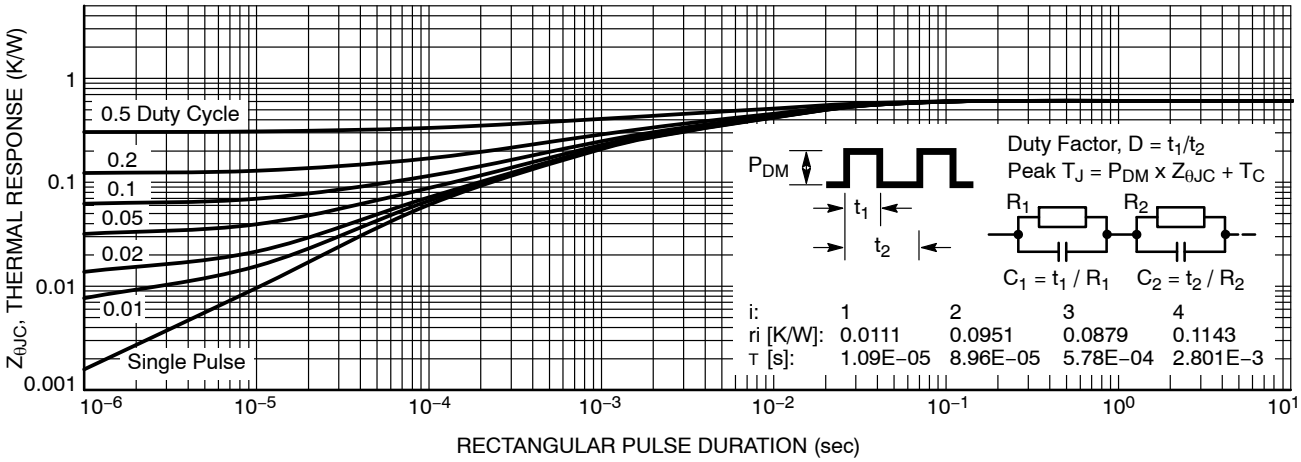



**Figure 18. Transient Thermal Impedance of IGBT**

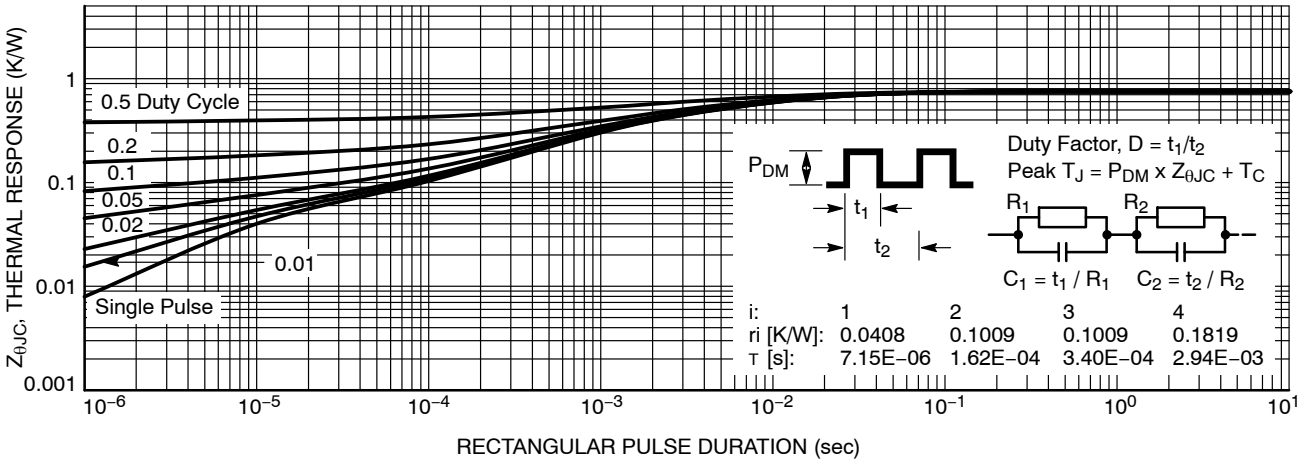


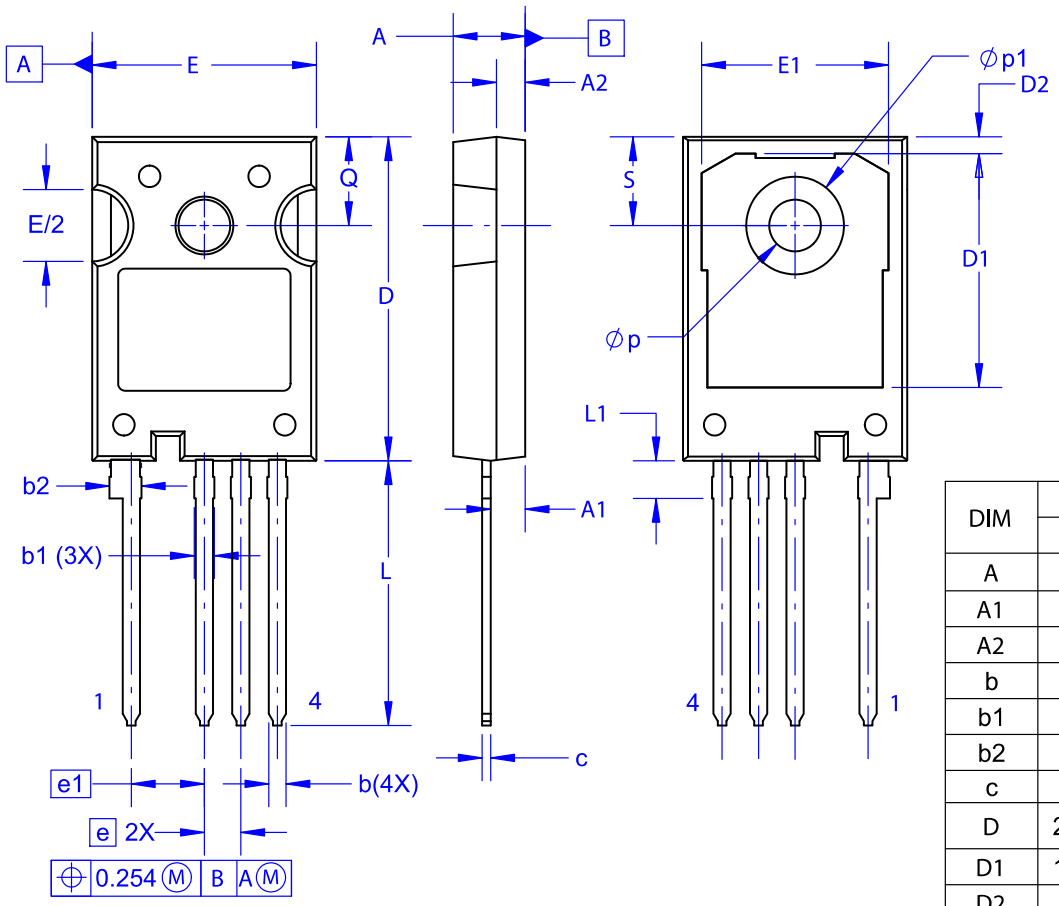

**Figure 19. Transient Thermal Impedance of Diode**

# MECHANICAL CASE OUTLINE
## PACKAGE DIMENSIONS

ON Semiconductor®

**TO−247−4LD**
CASE 340CJ
ISSUE A

DATE 16 SEP 2019




| DIM | MILLIMETERS | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 4.80 | 5.00 | 5.20 |
| A1 | 2.10 | 2.40 | 2.70 |
| A2 | 1.80 | 2.00 | 2.20 |
| b | 1.07 | 1.20 | 1.33 |
| b1 | 1.20 | 1.40 | 1.60 |
| b2 | 2.02 | 2.22 | 2.42 |
| c | 0.50 | 0.60 | 0.70 |
| D | 22.34 | 22.54 | 22.74 |
| D1 | 16.00 | 16.25 | 16.50 |
| D2 | 0.97 | 1.17 | 1.37 |
| e | 2.54 BSC | | |
| e1 | 5.08 BSC | | |
| E | 15.40 | 15.60 | 15.80 |
| E1 | 12.80 | 13.00 | 13.20 |
| E/2 | 4.80 | 5.00 | 5.20 |
| L | 18.22 | 18.42 | 18.62 |
| L1 | 2.42 | 2.62 | 2.82 |
| p | 3.40 | 3.60 | 3.80 |
| p1 | 6.60 | 6.80 | 7.00 |
| Q | 5.97 | 6.17 | 6.37 |
| S | 5.97 | 6.17 | 6.37 |

NOTES:

A. NO INDUSTRY STANDARD APPLIES TO THIS PACKAGE.
B. DIMENSIONS ARE EXCLUSIVE OF BURRS,MOLD FLASH,AND TIE BAR EXTRUSIONS.
C. ALL DIMENSIONS ARE IN MILLIMETERS.
D. DRAWING CONFORMS TO ASME Y14.5-2009.

| | | |
|---|---|---|
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| **DESCRIPTION:** | **TO−247−4LD** | **PAGE 1 OF 1** |

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