# Field Stop Trench IGBT 650 V, 50 A

# FGHL50T65MQD

Field stop 4th generation mid speed IGBT technology and full current rated copak Diode technology.

### Features

- Maximum Junction Temperature: $T_J$ = 175°C
- Positive Temperature Co−efficient for Easy Parallel Operating
- High Current Capability
- Low Saturation Voltage: $V_{CE(sat)}$ = 1.45 V (Typ.) @ $I_C$ = 50 A
- 100% of the Parts are Tested for $I_{LM}$ (Note 2)
- Smooth & Optimized Switching
- Tight Parameter Distribution
- RoHS Compliant

### Typical Applications

- Solar Inverter
- UPS, ESS
- PFC, Converters

### MAXIMUM RATINGS

| Parameter | | Symbol | Value | Unit |
|---|---|---|---|---|
| Collector−to−Emitter Voltage | | $V_{CES}$ | 650 | V |
| Gate−to−Emitter Voltage | | $V_{GES}$ | ±20 | V |
| Transient Gate−to−Emitter Voltage | | $V_{GES}$ | ±30 | V |
| Collector Current (Note 1) | $T_C$ = 25°C | $I_C$ | 80 | A |
| | $T_C$ = 100°C | | 50 | |
| Pulsed Collector Current (Note 2) | | $I_{LM}$ | 200 | A |
| Pulsed Collector Current (Note 3) | | $I_{CM}$ | 200 | A |
| Diode Forward Current (Note 1) | $T_C$ = 25°C | $I_F$ | 55 | A |
| | $T_C$ = 65°C | | 40 | |
| Pulsed Diode Maximum Forward Current | | $I_{FM}$ | 200 | A |
| Maximum Power Dissipation | $T_C$ = 25°C | $P_D$ | 268 | W |
| | $T_C$ = 100°C | | 134 | |
| Operating Junction and Storage Temperature Range | | $T_J$, $T_{stg}$ | −55 to +175 | °C |
| Maximum Lead Temperature for Soldering Purposes (1/8″ from case for 5 s) | | $T_L$ | 300 | °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, $R_G$ = 14 Ω, Inductive Load, 100% Tested
3. Repetitive rating: Pulse width limited by max. junction temperature

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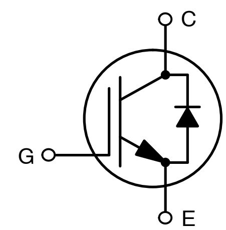
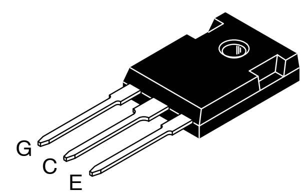
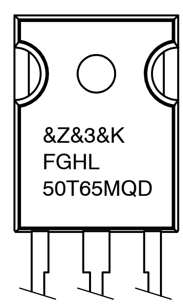
| $BV_{CES}$ | $V_{CE(sat)}$ TYP | $I_C$ MAX |
|---|---|---|
| 650 V | 1.45 V | 50 A |




**TO−247 LONG LEADS**
**CASE 340CX**

### MARKING DIAGRAM




| | |
|---|---|
| &Z | = Assembly Plant Code |
| &3 | = 3−Digit Date Code |
| &K | = 2−Digit Lot Traceability Code |
| FGHL50T65MQD | = Specific Device Code |

### ORDERING INFORMATION

| Device | Package | Shipping |
|---|---|---|
| FGHL50T65MQD | TO−247−3L | 30 Units / Rail |

**Table 1. THERMAL CHARACTERISTICS**

| Parameter | Symbol | Value | Unit |
|---|---|---|---|
| Thermal Resistance Junction−to−Case, for IGBT | $R_{\theta JC}$ | 0.56 | °C/W |
| Thermal Resistance Junction−to−Case, for Diode | $R_{\theta JC}$ | 1.07 | |
| Thermal Resistance Junction−to−Ambient | $R_{\theta JA}$ | 40 | |

**Table 2. ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise specified)

| Parameter | Test Conditions | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **OFF CHARACTERISTIC** | | | | | | |
| 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 | $\Delta BV_{CES}/\Delta T_J$ | – | 0.6 | – | 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 CHARACTERISTIC** | | | | | | |
| 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<br>$V_{GE}$ = 15 V, $I_C$ = 50 A, $T_J$ = 175°C | $V_{CE(sat)}$ | –<br>– | 1.45<br>1.77 | 1.8<br>– | V |
| **DYNAMIC CHARACTERISTIC** | | | | | | |
| Input capacitance | $V_{CE}$ = 30 V, $V_{GE}$ = 0 V, f = 1 MHz | $C_{ies}$ | – | 3226 | – | pF |
| Output capacitance | | $C_{oes}$ | – | 85 | – | |
| Reverse transfer capacitance | | $C_{res}$ | – | 10 | – | |
| Gate charge total | $V_{CE}$ = 400 V, $I_C$ = 50 A, $V_{GE}$ = 15 V | $Q_g$ | – | 94 | – | nC |
| Gate−to−Emitter charge | | $Q_{ge}$ | – | 17 | – | |
| Gate−to−Collector charge | | $Q_{gc}$ | – | 22 | – | |
| **SWITCHING CHARACTERISTIC, INDUCTIVE LOAD** | | | | | | |
| Turn−on delay time | $T_C$ = 25°C<br>$V_{CC}$ = 400 V, $I_C$ = 25 A<br>$R_G$ = 10 Ω<br>$V_{GE}$ = 15 V<br>Inductive Load | $t_{d(on)}$ | – | 21 | – | ns |
| Rise time | | $t_r$ | – | 15 | – | |
| Turn−off delay time | | $t_{d(off)}$ | – | 128 | – | |
| Fall time | | $t_f$ | – | 50 | – | |
| Turn−on switching loss | | $E_{on}$ | – | 0.41 | – | mJ |
| Turn−off switching loss | | $E_{off}$ | – | 0.31 | – | |
| Total switching loss | | $E_{ts}$ | – | 0.72 | – | |
| Turn−on delay time | $T_C$ = 25°C<br>$V_{CC}$ = 400 V, $I_C$ = 50 A<br>$R_G$ = 10 Ω<br>$V_{GE}$ = 15 V<br>Inductive Load | $t_{d(on)}$ | – | 23 | – | ns |
| Rise time | | $t_r$ | – | 34 | – | |
| Turn−off delay time | | $t_{d(off)}$ | – | 120 | – | |
| Fall time | | $t_f$ | – | 46 | – | |
| Turn−on switching loss | | $E_{on}$ | – | 1.05 | – | mJ |
| Turn−off switching loss | | $E_{off}$ | – | 0.70 | – | |
| Total switching loss | | $E_{ts}$ | – | 1.75 | – | |

**Table 2. ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise specified) (continued)

| Parameter | Test Conditions | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **SWITCHING CHARACTERISTIC, INDUCTIVE LOAD** | | | | | | |
| Turn−on delay time | $T_C$ = 175°C<br>$V_{CC}$ = 400 V, $I_C$ = 25 A<br>$R_G$ = 10 Ω<br>$V_{GE}$ = 15 V<br>Inductive Load | $t_{d(on)}$ | – | 20 | – | ns |
| Rise time | | $t_r$ | – | 17 | – | |
| Turn−off delay time | | $t_{d(off)}$ | – | 146 | – | |
| Fall time | | $t_f$ | – | 75 | – | |
| Turn−on switching loss | | $E_{on}$ | – | 0.75 | – | mJ |
| Turn−off switching loss | | $E_{off}$ | – | 0.53 | – | |
| Total switching loss | | $E_{ts}$ | – | 1.28 | – | |
| Turn−on delay time | $T_C$ = 175°C<br>$V_{CC}$ = 400 V, $I_C$ = 50 A<br>$R_G$ = 10 Ω<br>$V_{GE}$ = 15 V<br>Inductive Load | $t_{d(on)}$ | – | 22 | – | ns |
| Rise time | | $t_r$ | – | 36 | – | |
| Turn−off delay time | | $t_{d(off)}$ | – | 130 | – | |
| Fall time | | $t_f$ | – | 58 | – | |
| Turn−on switching loss | | $E_{on}$ | – | 1.63 | – | mJ |
| Turn−off switching loss | | $E_{off}$ | – | 0.94 | – | |
| Total switching loss | | $E_{ts}$ | – | 2.57 | – | |
| **DIODE CHARACTERISTIC** | | | | | | |
| Diode Forward Voltage | $I_F$ = 50 A, $T_C$ = 25°C<br>$I_F$ = 50 A, $T_C$ = 175°C | $V_{FM}$ | –<br>– | 2.45<br>2.2 | 2.75<br>– | V |
| Reverse Recovery Energy | $I_F$ = 50 A, $dI_F/dt$ = 200 A/μs, $T_C$ = 175°C | $E_{rec}$ | – | 57 | – | μJ |
| Diode Reverse Recovery Time | $I_F$ = 50 A, $dI_F/dt$ = 200 A/μs, $T_C$ = 25°C<br>$I_F$ = 50 A, $dI_F/dt$ = 200 A/μs, $T_C$ = 175°C | $T_{rr}$ | – | 32<br>202 | – | ns |
| Diode Reverse Recovery Charge | $I_F$ = 50 A, $dI_F/dt$ = 200 A/μs, $T_C$ = 25°C<br>$I_F$ = 50 A, $dI_F/dt$ = 200 A/μs, $T_C$ = 175°C | $Q_{rr}$ | – | 46<br>814 | – | nC |

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

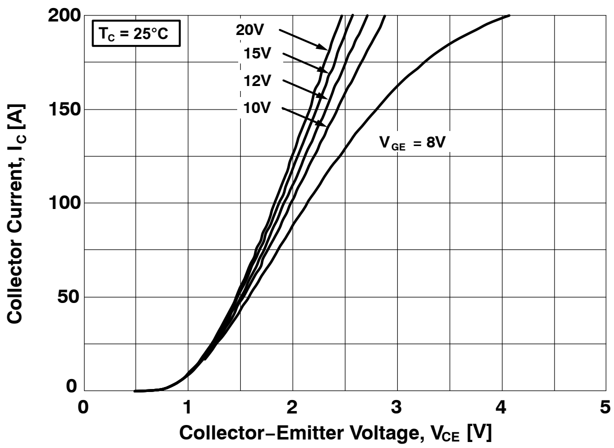



**Figure 1. Typical Output Characteristics ($T_J$ = 25°C)**

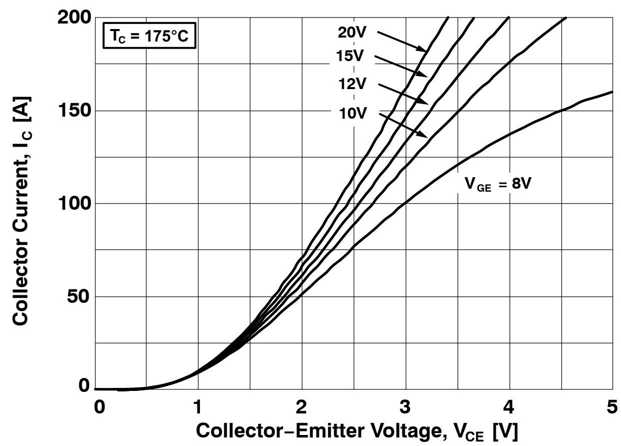



**Figure 2. Typical Output Characteristics ($T_J$ = 175°C)**

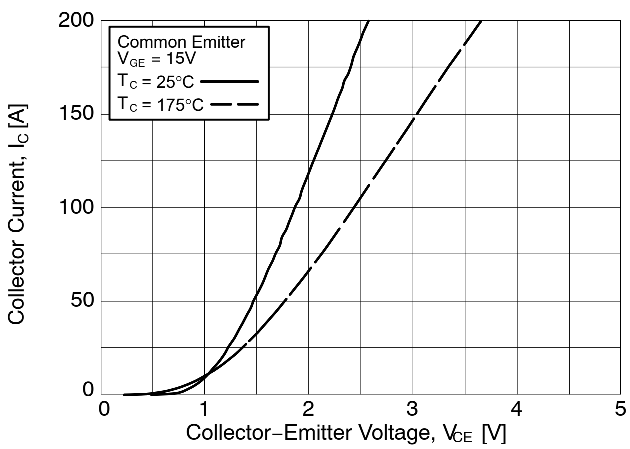



**Figure 3. Typical Saturation Voltage Characteristics**

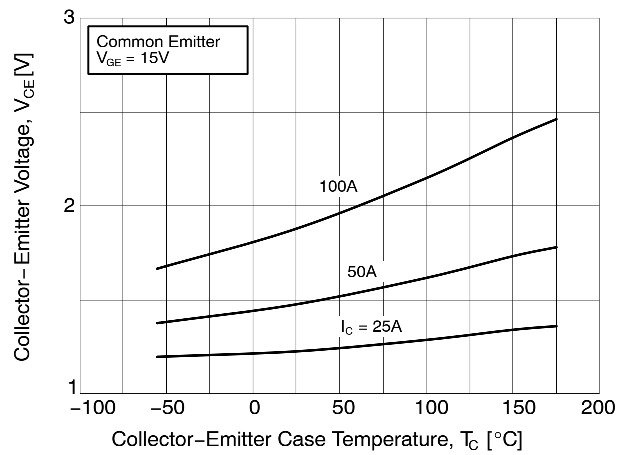



**Figure 4. Saturation Voltage vs. Case Temperature at Variant Current Level**

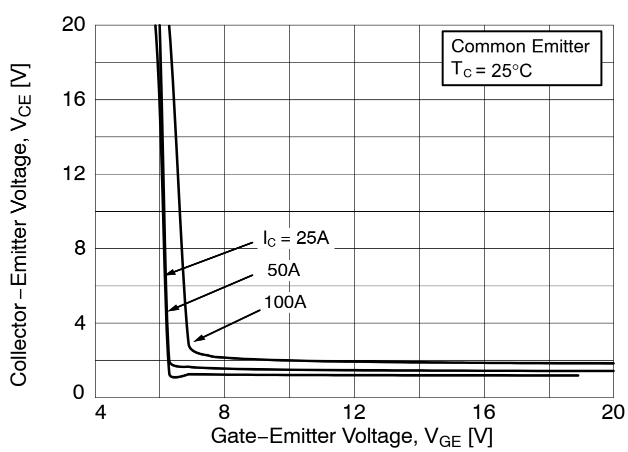



**Figure 5. Saturation Voltage vs. $V_{GE}$ ($T_J$ = 25°C)**

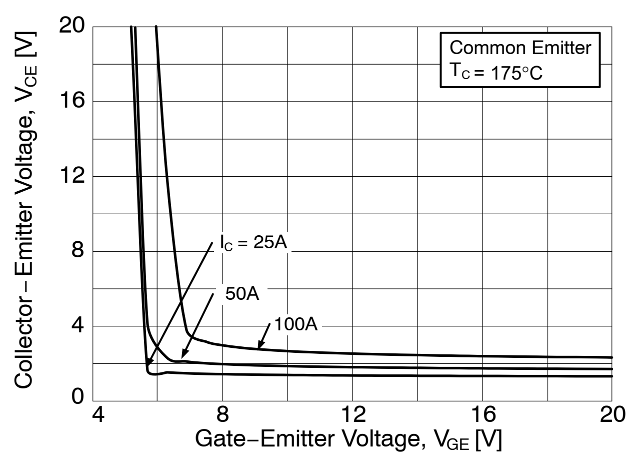



**Figure 6. Saturation Voltage vs. $V_{GE}$ ($T_J$ = 175°C)**

## TYPICAL CHARACTERISTICS (continued)

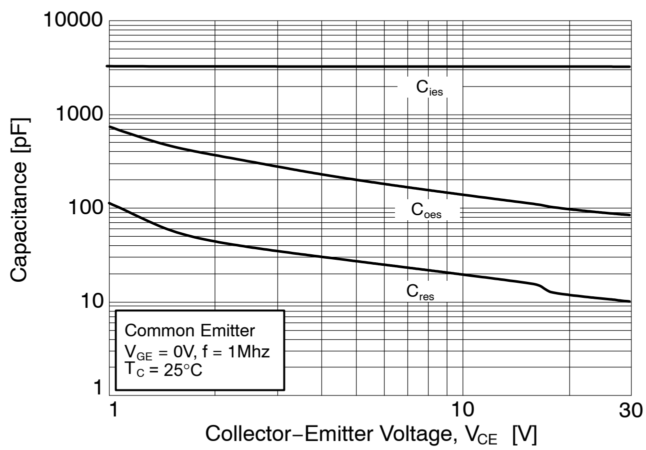



**Figure 7. Capacitance Characteristics**

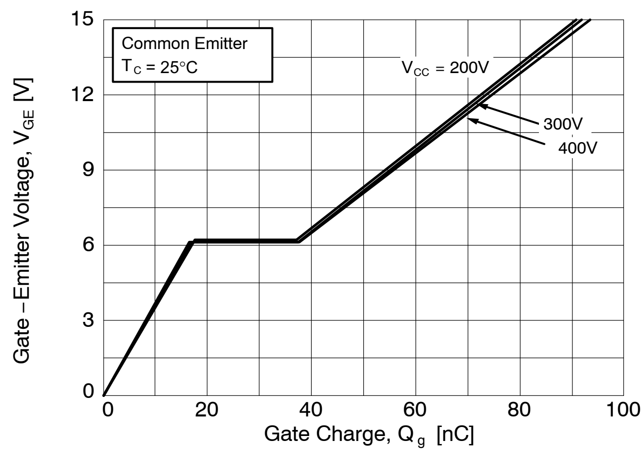



**Figure 8. Gate Charge Characteristics**

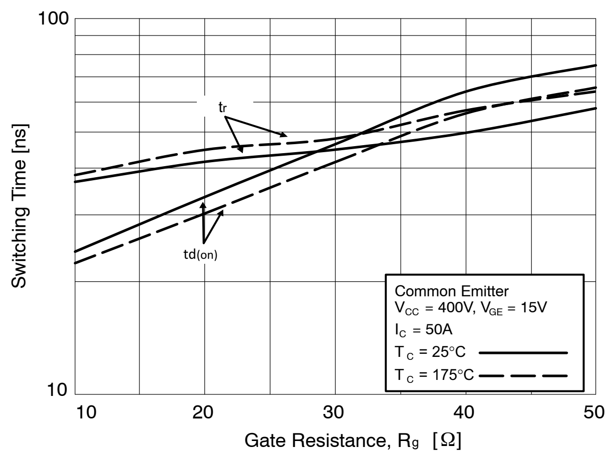



**Figure 9. Turn−On Characteristics vs. Gate Resistance**

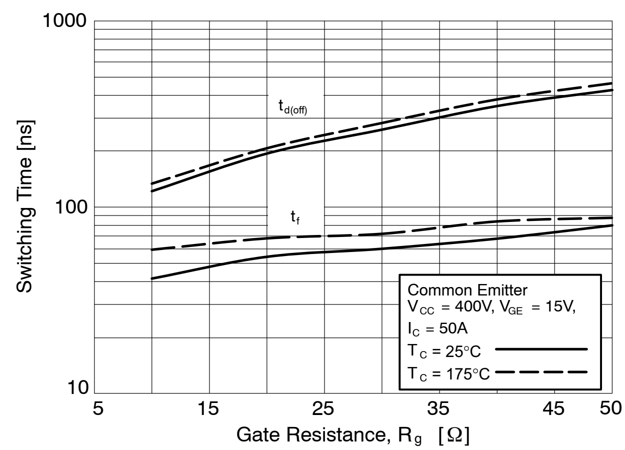



**Figure 10. Turn−Off Characteristics vs. Gate Resistance**

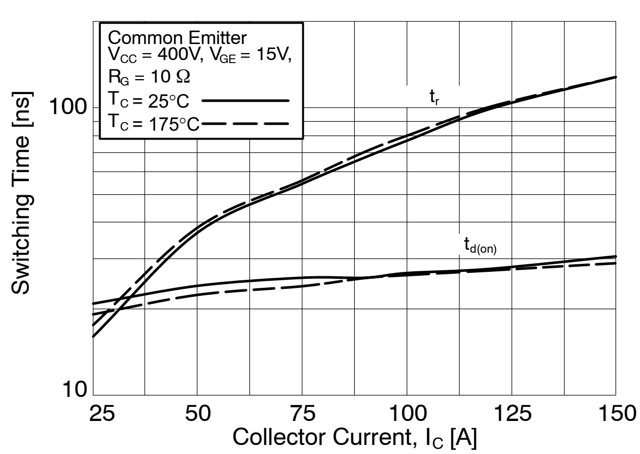



**Figure 11. Turn−On Characteristics vs. Collector Current**

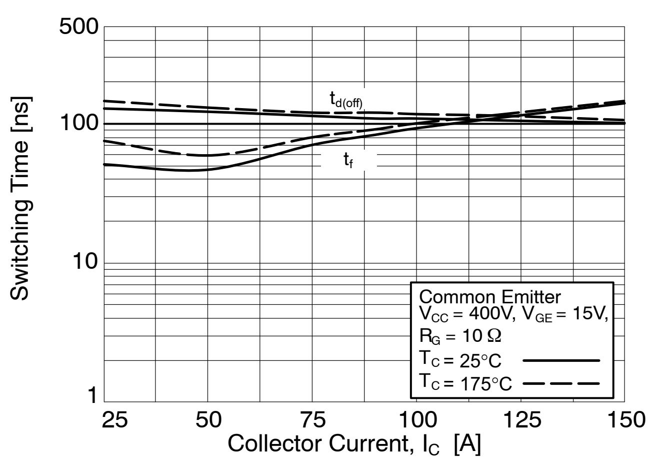



**Figure 12. Turn−Off Characteristics vs. Collector Current**

## TYPICAL CHARACTERISTICS (continued)

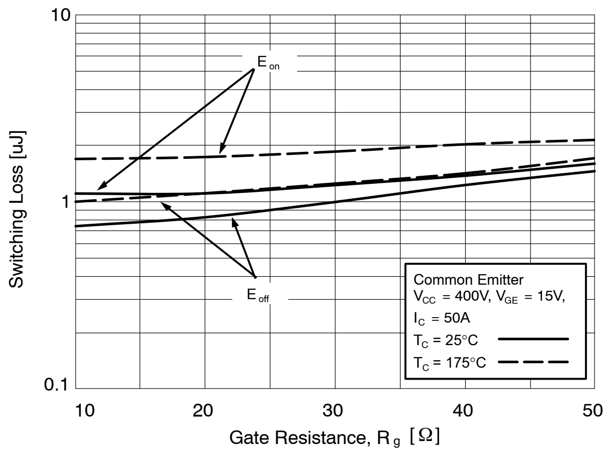



**Figure 13. Switching Loss vs. Gate Resistance**

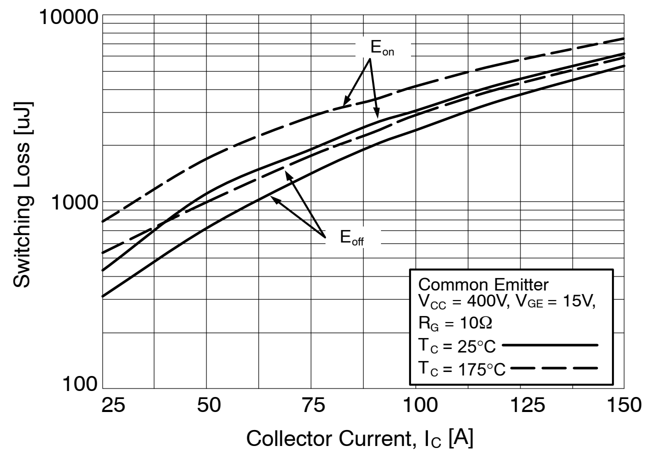



**Figure 14. Switching Loss vs. Collector Current**

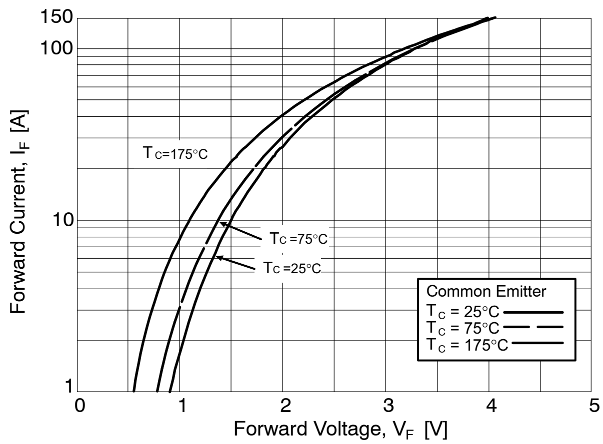



**Figure 15. Forward Characteristics**

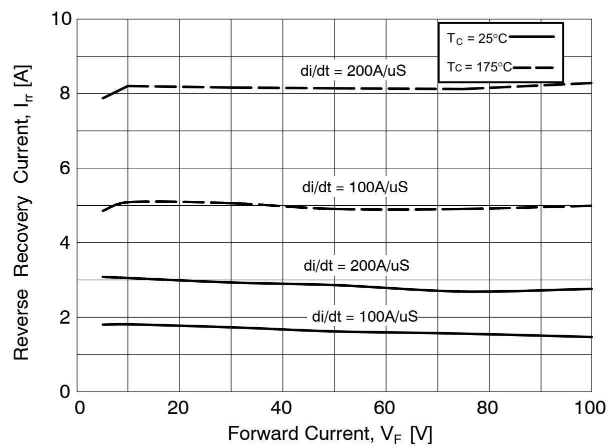



**Figure 16. Reverse Recovery Current**

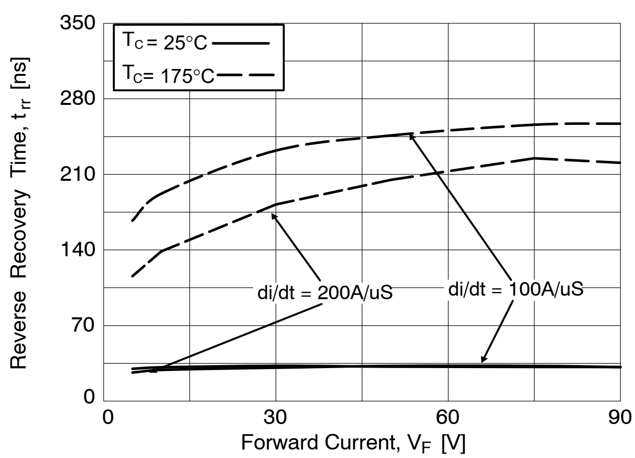



**Figure 17. Reverse Recovery Time**

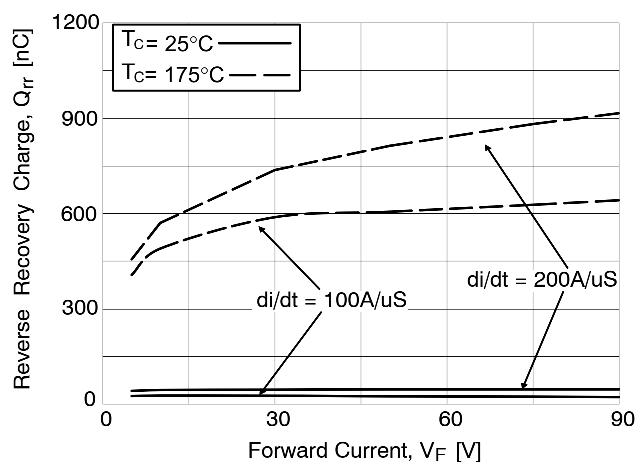



**Figure 18. Stored Charge**

## TYPICAL CHARACTERISTICS (continued)

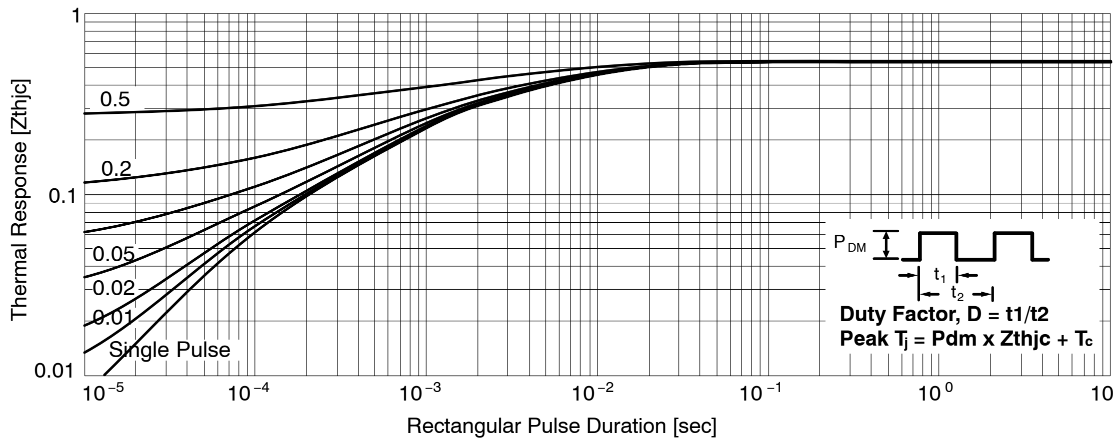



**Figure 19. Transient Thermal Impedance of IGBT**

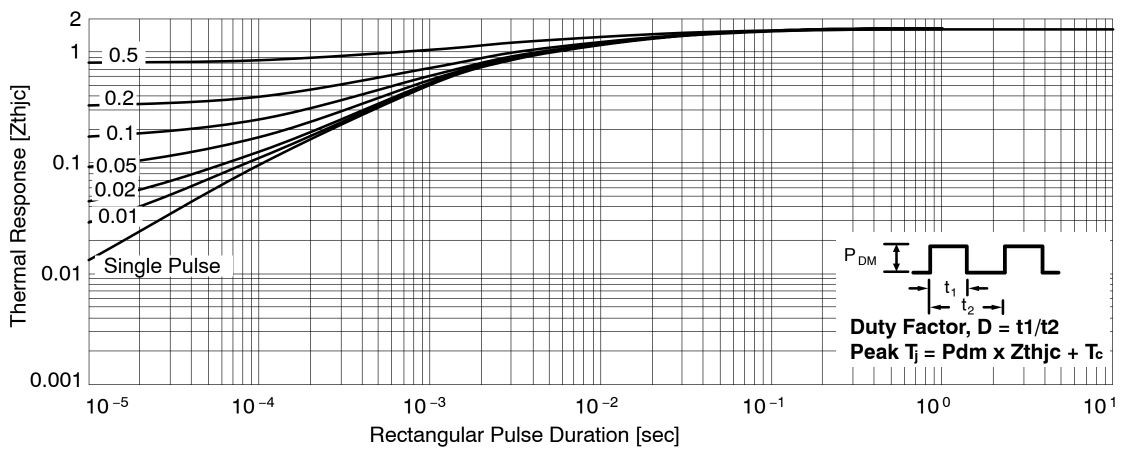
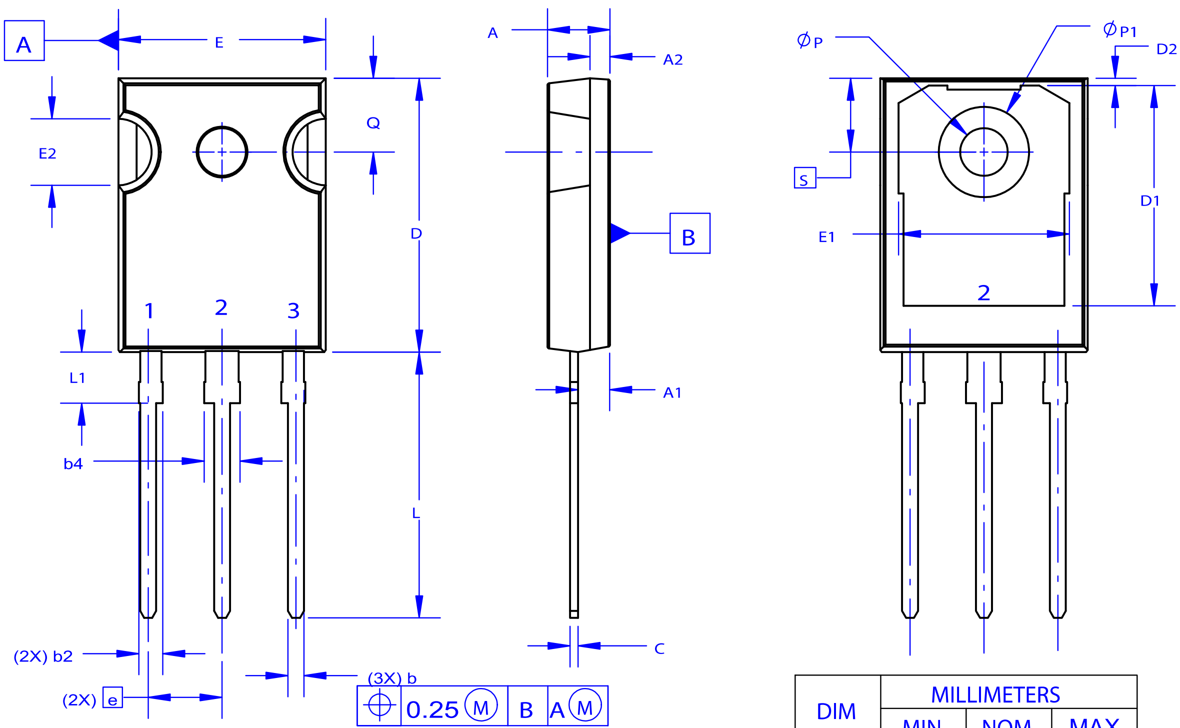



**Figure 20. Transient Thermal Impedance of Diode**

## PACKAGE DIMENSIONS

**TO−247−3LD**
CASE 340CX
ISSUE O




| DIM | MILLIMETERS | | |
|---|---|---|---|
| | MIN | NOM | MAX |
| A | 4.58 | 4.70 | 4.82 |
| A1 | 2.20 | 2.40 | 2.60 |
| A2 | 1.40 | 1.50 | 1.60 |
| D | 20.32 | 20.57 | 20.82 |
| E | 15.37 | 15.62 | 15.87 |
| E2 | 4.96 | 5.08 | 5.20 |
| e | ~ | 5.56 | ~ |
| L | 19.75 | 20.00 | 20.25 |
| L1 | 3.69 | 3.81 | 3.93 |
| ØP | 3.51 | 3.58 | 3.65 |
| Q | 5.34 | 5.46 | 5.58 |
| S | 5.34 | 5.46 | 5.58 |
| b | 1.17 | 1.26 | 1.35 |
| b2 | 1.53 | 1.65 | 1.77 |
| b4 | 2.42 | 2.54 | 2.66 |
| c | 0.51 | 0.61 | 0.71 |
| D1 | 13.08 | ~ | ~ |
| D2 | 0.51 | 0.93 | 1.35 |
| E1 | 12.81 | ~ | ~ |
| ØP1 | 6.60 | 6.80 | 7.00 |

NOTES: UNLESS OTHERWISE SPECIFIED.

A. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS.
B. ALL DIMENSIONS ARE IN MILLIMETERS.
C. DRAWING CONFORMS TO ASME Y14.5 - 2009.
D. DIMENSION A1 TO BE MEASURED IN THE REGION DEFINED BY L1.
E. LEAD FINISH IS UNCONTROLLED IN THE REGION DEFINED BY L1.

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