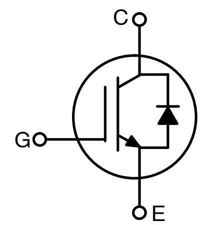
# IGBT - Field Stop

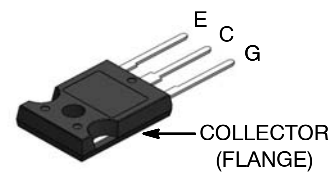
## 600 V, 60 A

# FGH60N60SFDTU-F085

**ON Semiconductor®**

www.onsemi.com




**TO−247−3LD**
**CASE 340CK**

### Description

Using Novel Field Stop IGBT Technology, ON Semiconductor's new series of Field Stop IGBTs offer the optimum performance for Automotive Chargers, Inverter, and other applications where low conduction and switching losses are essential.

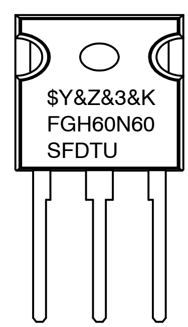
### Features

- High Current Capability
- Low Saturation Voltage: $V_{CE(sat)}$ = 2.2 V @ $I_C$ = 60 A
- High Input Impedance
- Fast Switching
- Qualified to Automotive Requirements of AEC−Q101
- This Device is Pb−Free and is RoHS Compliant

### Applications

- Automotive chargers, Converters, High Voltage Auxiliaries
- Inverters, PFC, UPS

### MARKING DIAGRAM




| | |
|---|---|
| $Y | = ON Semiconductor Logo |
| &Z | = Assembly Plant Code |
| &3 | = Numeric Date Code |
| &K | = Lot Code |
| FGH60N60SFDTU | = Specific Device Code |

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

## ABSOLUTE MAXIMUM RATINGS ($T_C$ = 25°C unless otherwise noted)

| Description | | Symbol | Ratings | Unit |
|---|---|---|---|---|
| Collector to Emitter Voltage | | $V_{CES}$ | 600 | V |
| Gate to Emitter Voltage | | $V_{GES}$ | ±20 | V |
| Transient Gate−to−Emitter Voltage | | | ±30 | V |
| Collector Current | $T_C$ = 25°C | $I_C$ | 120 | A |
| | $T_C$ = 100°C | | 60 | A |
| Pulsed Collector Current | $T_C$ = 25°C | $I_{CM}$ (Note 1) | 180 | A |
| Maximum Power Dissipation | $T_C$ = 25°C | $P_D$ | 378 | W |
| | $T_C$ = 100°C | | 151 | W |
| Operating Junction Temperature | | $T_J$ | −55 to +150 | °C |
| Storage Temperature Range | | $T_{stg}$ | −55 to +150 | °C |
| Maximum Lead Temp. for Soldering Purposes, 1/8” from Case for 5 Seconds | | $T_L$ | 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. Repetitive test, Pulse width limited by max. junction temperature.

## THERMAL CHARACTERISTICS

| Parameter | Symbol | Typ | Unit |
|---|---|---|---|
| Thermal Resistance, Junction to Case | $R_{\theta JC}$(IGBT) | 0.33 | °C/W |
| Thermal Resistance, Junction to Case | $R_{\theta JC}$(Diode) | 1.1 | °C/W |
| Thermal Resistance, Junction to Ambient | $R_{\theta JA}$ | 40 | °C/W |

## PACKAGE MARKING AND ORDERING INFORMATION

| Part Number | Top Mark | Package | Packing Method | Reel Size | Tape Width | Quantity |
|---|---|---|---|---|---|---|
| FGH60N60SFDTU−F085 | FGH60N60SFDTU | TO−247 | Tube | N/A | N/A | 30 |

## ELECTRICAL CHARACTERISTICS OF THE IGBT ($T_C$ = 25°C unless otherwise noted)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | |
| Collector to Emitter Breakdown Voltage | $BV_{CES}$ | $V_{GE}$ = 0 V, $I_C$ = 250 μA | 600 | – | – | V |
| Temperature Coefficient of Breakdown Voltage | $\Delta BV_{CES}/\Delta T_J$ | $V_{GE}$ = 0 V, $I_C$ = 250 μA | – | 0.4 | – | V/°C |
| Collector Cut−Off Current | $I_{CES}$ | $V_{CE}$ = $V_{CES}$, $V_{GE}$ = 0 V | – | – | 250 | μA |
| G−E Leakage Current | $I_{GES}$ | $V_{GE}$ = $V_{GES}$, $V_{CE}$ = 0 V | – | – | ±400 | nA |
| **ON CHARACTERISTICs** | | | | | | |
| G−E Threshold Voltage | $V_{GE(th)}$ | $I_C$ = 250 μA, $V_{CE}$ = $V_{GE}$ | 4.0 | 5.1 | 6.6 | V |
| Collector to Emitter Saturation Voltage | $V_{CE(sat)}$ | $I_C$ = 60 A, $V_{GE}$ = 15 V | – | 2.2 | 2.9 | V |
| | | $I_C$ = 60 A, $V_{GE}$ = 15 V, $T_C$ = 125°C | – | 2.4 | – | V |

**ELECTRICAL CHARACTERISTICS OF THE IGBT** ($T_C$ = 25°C unless otherwise noted) (continued)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **DYNAMIC CHARACTERISTICS** | | | | | | |
| Input Capacitance | $C_{ies}$ | $V_{CE}$ = 30 V, $V_{GE}$ = 0 V, f = 1 MHz | – | 2940 | – | pF |
| Output Capacitance | $C_{oes}$ | | – | 310 | – | pF |
| Reverse Transfer Capacitance | $C_{res}$ | | – | 100 | – | pF |
| **SWITCHING CHARACTERISTICS** | | | | | | |
| Turn−On Delay Time | $t_{d(on)}$ | $V_{CC}$ = 400 V, $I_C$ = 60 A, $R_G$ = 5 Ω, $V_{GE}$ = 15 V, Inductive Load, $T_C$ = 25°C | – | 26 | – | ns |
| Rise Time | $t_r$ | | – | 54 | – | ns |
| Turn−Off Delay Time | $t_{d(off)}$ | | – | 134 | – | ns |
| Fall Time | $t_f$ | | – | 18 | 62 | ns |
| Turn−On Switching Loss | $E_{on}$ | | – | 1.97 | – | mJ |
| Turn−Off Switching Loss | $E_{off}$ | | – | 0.57 | – | mJ |
| Total Switching Loss | $E_{ts}$ | | | 2.54 | – | mJ |
| Turn−On Delay Time | $t_{d(on)}$ | $V_{CC}$ = 400 V, $I_C$ = 60 A, $R_G$ = 5 Ω, $V_{GE}$ = 15 V, Inductive Load, $T_C$ = 125°C | – | 26 | – | ns |
| Rise Time | $t_r$ | | – | 50 | – | ns |
| Turn−Off Delay Time | $t_{d(off)}$ | | – | 142 | – | ns |
| Fall Time | $t_f$ | | – | 24 | – | ns |
| Turn−On Switching Loss | $E_{on}$ | | – | 2.5 | – | mJ |
| Turn−Off Switching Loss | $E_{off}$ | | – | 0.8 | – | mJ |
| Total Switching Loss | $E_{ts}$ | | – | 3.2 | – | mJ |
| Total Gate Charge | $Q_g$ | $V_{CE}$ = 400 V, $I_C$ = 60 A, $V_{GE}$ = 15 V | – | 188 | – | nC |
| Gate to Emitter Charge | $Q_{ge}$ | | – | 21 | – | nC |
| Gate to Collector Charge | $Q_{gc}$ | | – | 98 | – | nC |

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

| Symbol | Parameter | Test Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{FM}$ | Diode Forward Voltage | $I_F$ = 30 A | $T_C$ = 25°C | – | 1.9 | 2.6 | V |
| | | | $T_C$ = 125°C | – | 1.7 | – | |
| $t_{rr}$ | Diode Reverse Recovery Time | $I_F$ = 30 A, $di_F/dt$ = 200 A/µs | $T_C$ = 25°C | – | 55 | – | ns |
| | | | $T_C$ = 125°C | – | 204 | – | |
| $Q_{rr}$ | Diode Reverse Recovery Charge | | $T_C$ = 25°C | – | 125 | – | nC |
| | | | $T_C$ = 125°C | – | 895 | – | |

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 PERFORMANCE CHARACTERISTICS

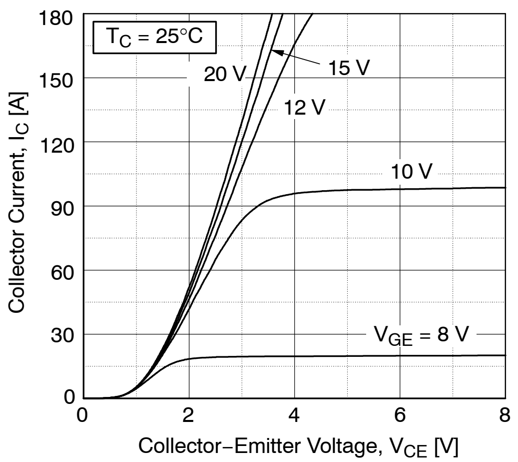



**Figure 1. Typical Output Characteristics**

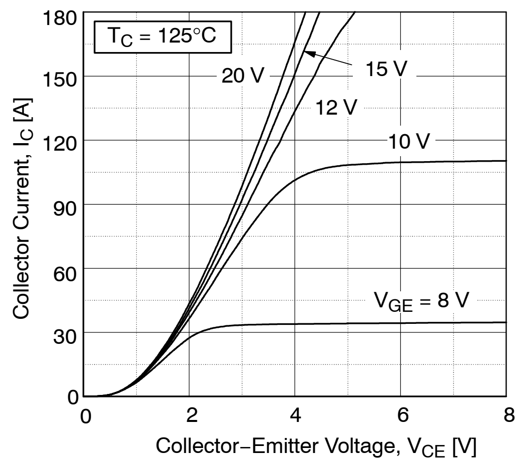



**Figure 2. Typical Output Characteristics**

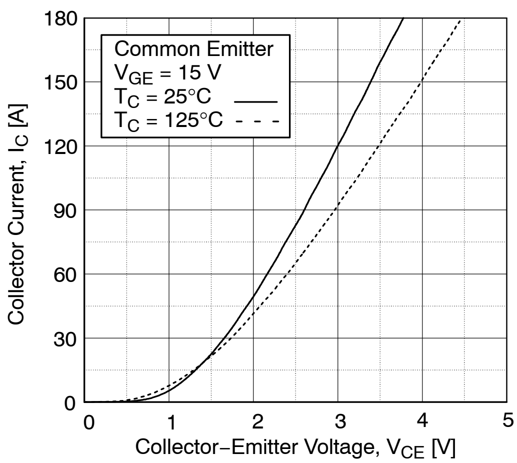



**Figure 3. Typical Saturation Voltage Characteristics**

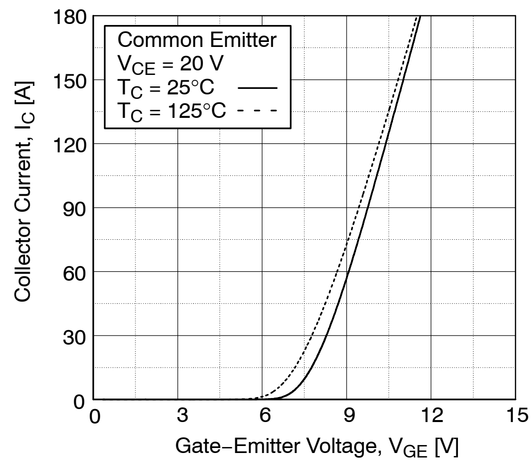



**Figure 4. Transfer Characteristics**

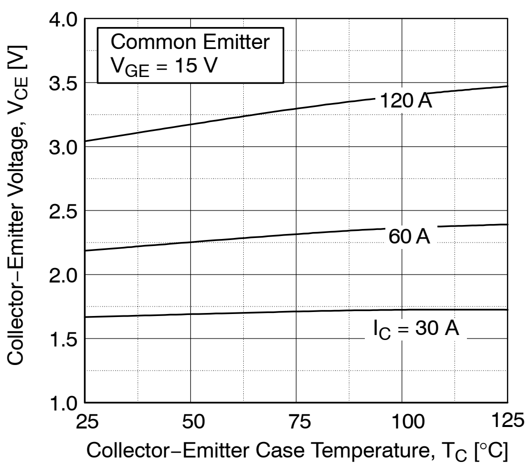



**Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level**

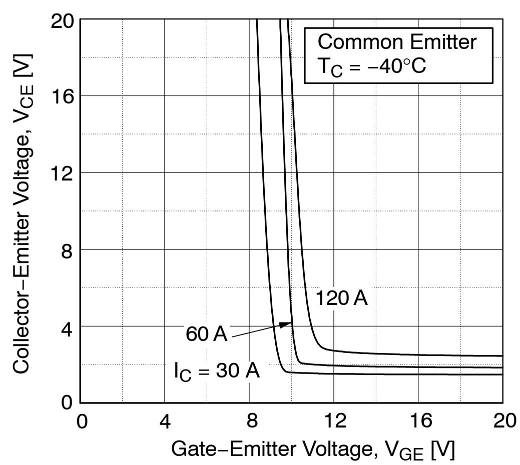



**Figure 6. Saturation Voltage vs $V_{GE}$**

## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

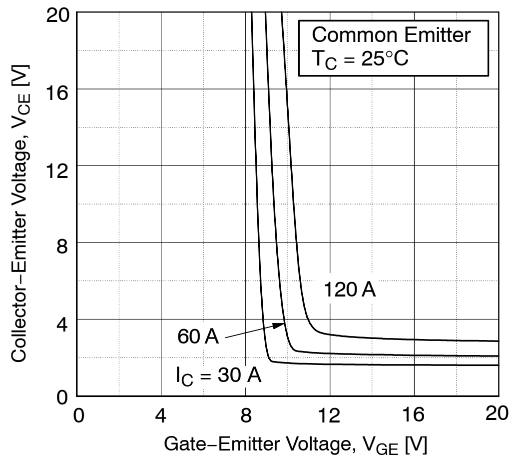



**Figure 7. Saturation Voltage vs. $V_{GE}$**

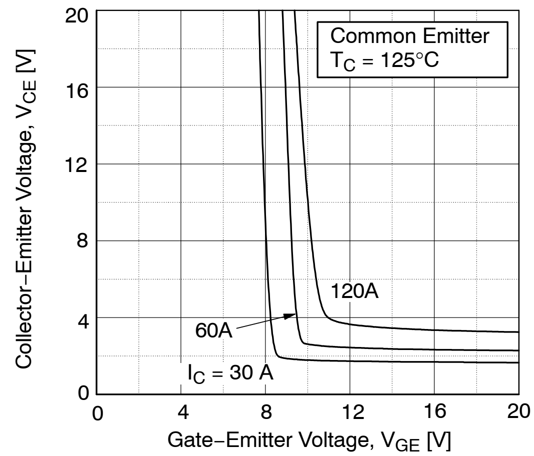



**Figure 8. Saturation Voltage vs. $V_{GE}$**

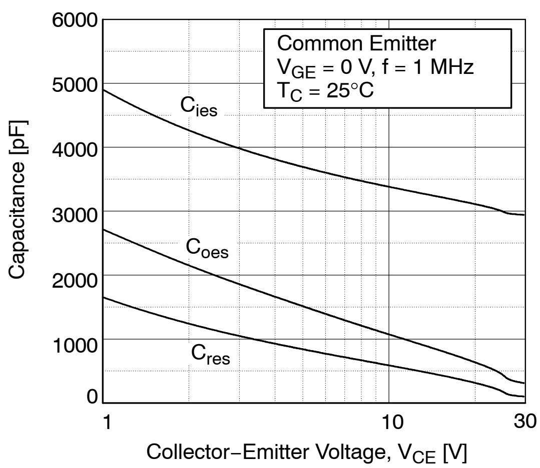



**Figure 9. Capacitance Characteristics**

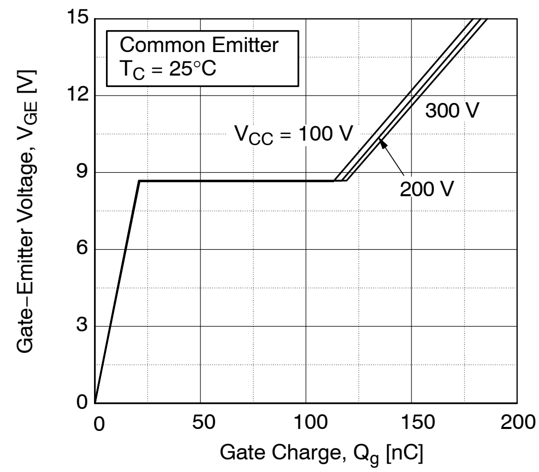



**Figure 10. Gate Charge Characteristics**

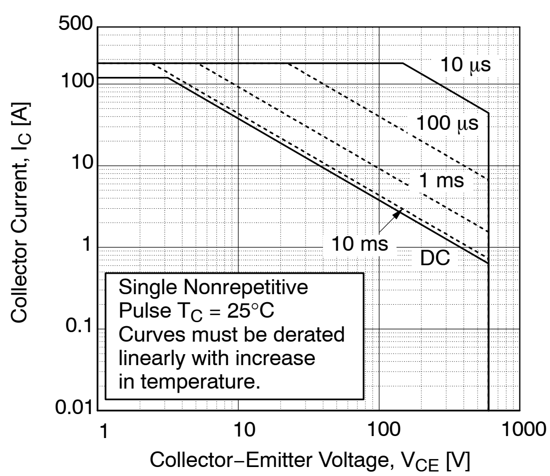



**Figure 11. SOA Characteristics**

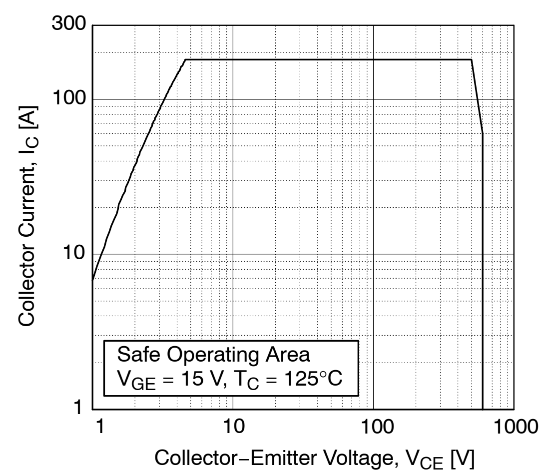



**Figure 12. Turn−Off Switching SOA Characteristics**

## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

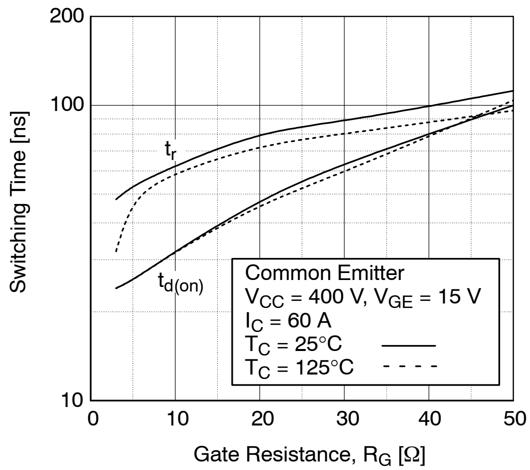



**Figure 13. Turn−On Characteristics vs. Gate Resistance**

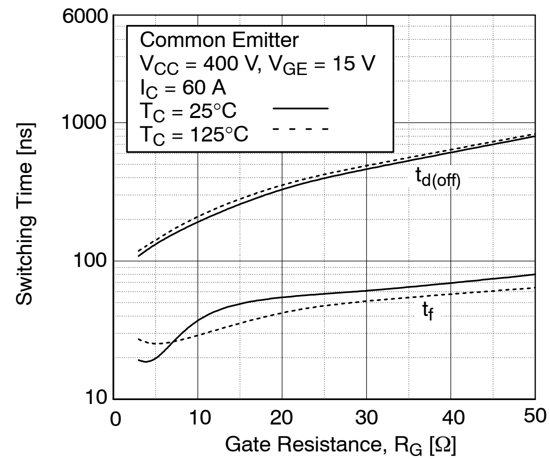



**Figure 14. Turn−Off Characteristics vs. Gate Resistance**

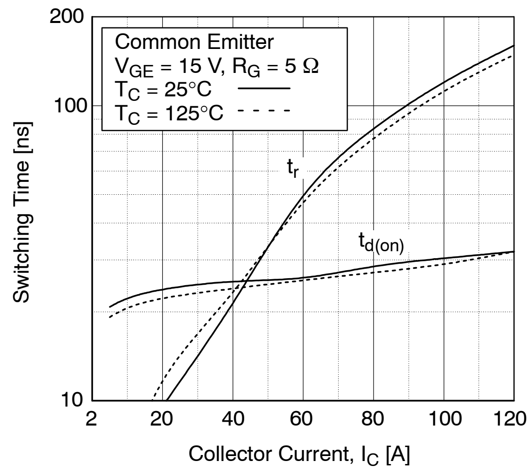



**Figure 15. Turn−On Characteristics vs. Collector Current**

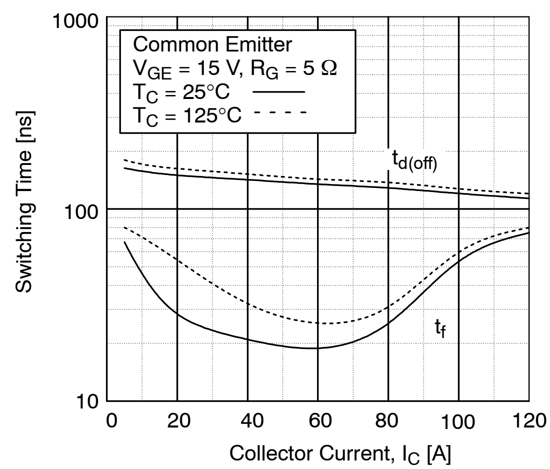



**Figure 16. Turn−Off Characteristics vs. Collector Current**

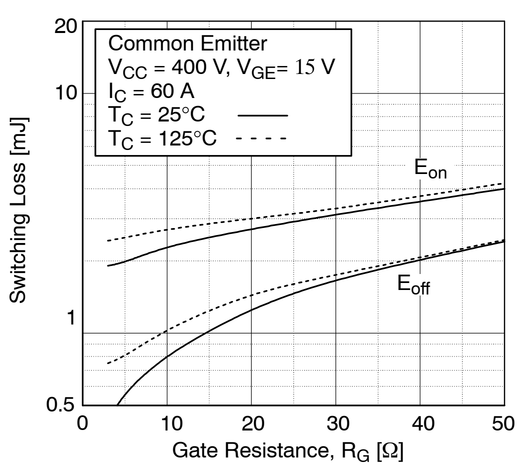



**Figure 17. Switching Loss vs. Gate Resistance**

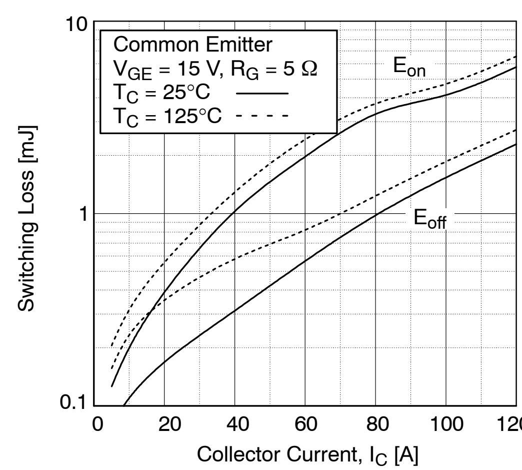



**Figure 18. Switching Loss vs. Collector Current**

## TYPICAL PERFORMANCE CHARACTERISTICS (continued)

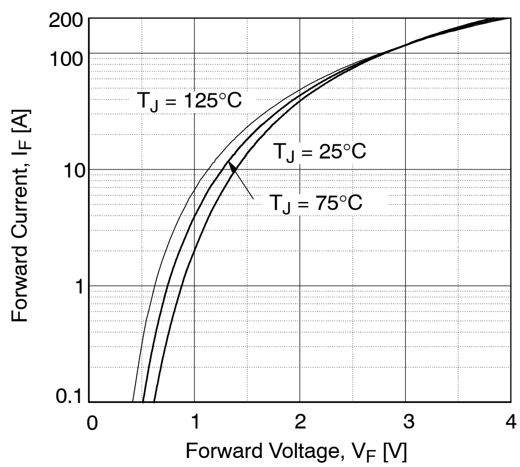



**Figure 19. Forward Characteristics**

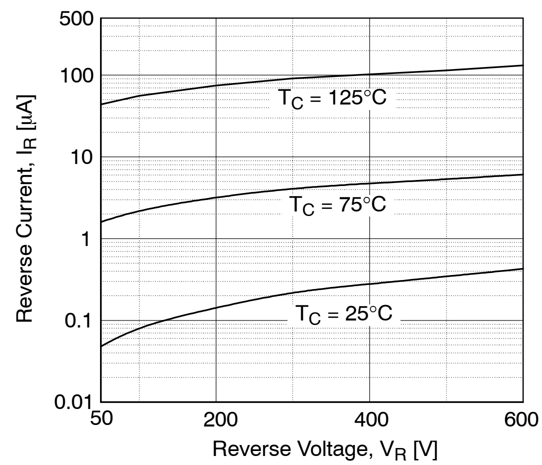



**Figure 20. Reverse Current**

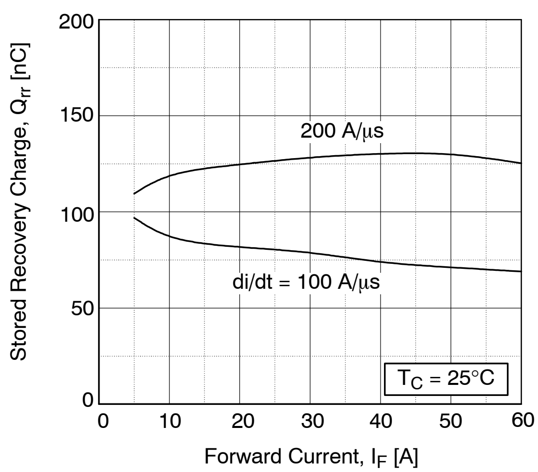



**Figure 21. Stored Charge**

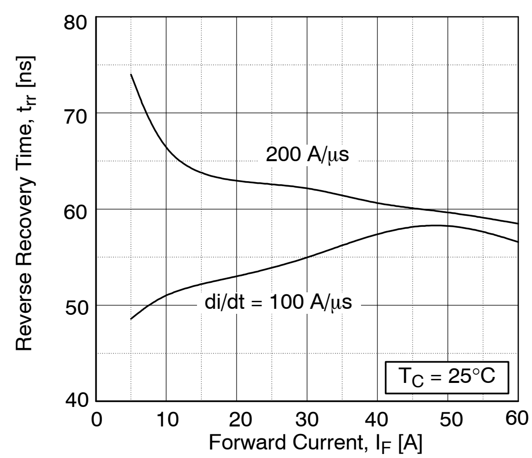



**Figure 22. Reverse Recovery Time**

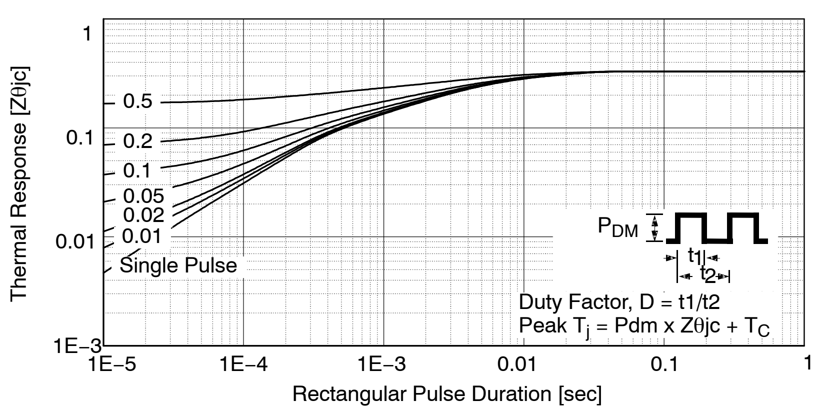
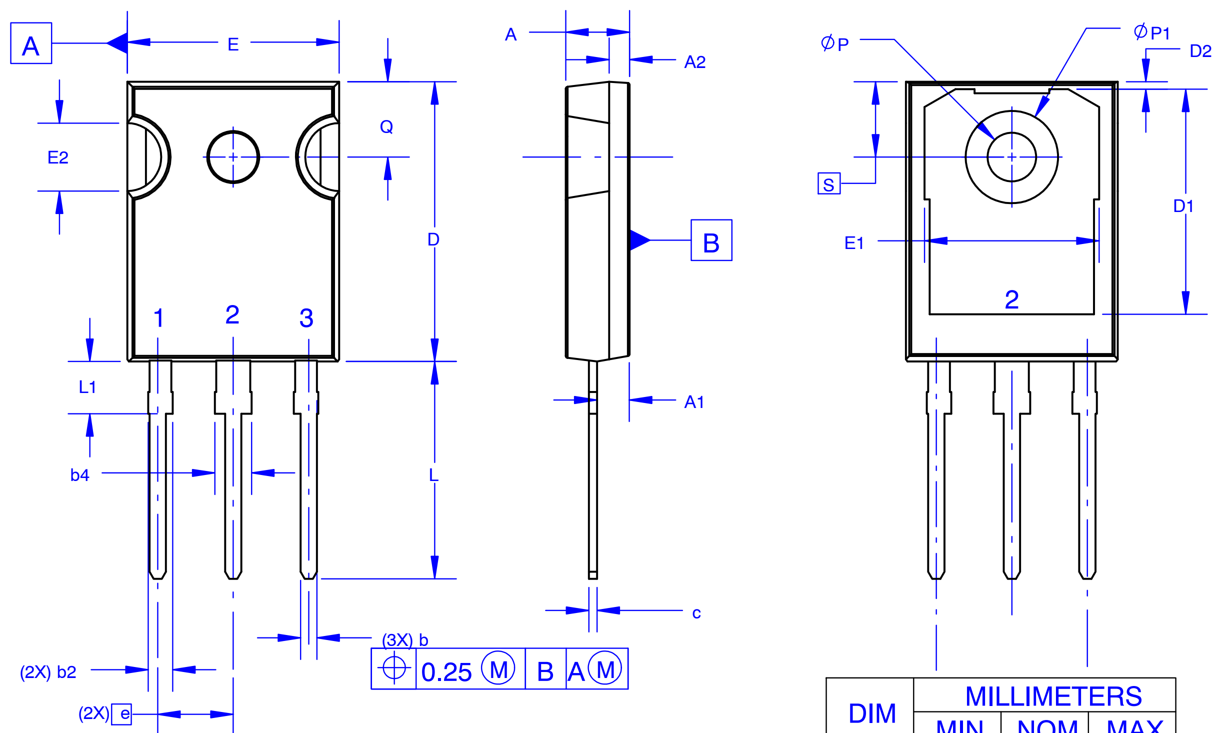



**Figure 23. Transient Thermal Impedance of IGBT**

## TO−247−3LD SHORT LEAD
CASE 340CK
ISSUE A

DATE 31 JAN 2019




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.

| 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 |
| 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 |
| D | 20.32 | 20.57 | 20.82 |
| D1 | 13.08 | ~ | ~ |
| D2 | 0.51 | 0.93 | 1.35 |
| E | 15.37 | 15.62 | 15.87 |
| E1 | 12.81 | ~ | ~ |
| E2 | 4.96 | 5.08 | 5.20 |
| e | ~ | 5.56 | ~ |
| L | 15.75 | 16.00 | 16.25 |
| L1 | 3.69 | 3.81 | 3.93 |
| ØP | 3.51 | 3.58 | 3.65 |
| ØP1 | 6.60 | 6.80 | 7.00 |
| Q | 5.34 | 5.46 | 5.58 |
| S | 5.34 | 5.46 | 5.58 |

### GENERIC MARKING DIAGRAM*

AYWWZZ
XXXXXXX
XXXXXXX
∘

XXXX = Specific Device Code
A = Assembly Location
Y = Year
WW = Work Week
ZZ = Assembly Lot Code

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “▪”, may or may not be present. Some products may not follow the Generic Marking.

| | | |
|---|---|---|
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| **DESCRIPTION:** | **TO−247−3LD SHORT LEAD** | **PAGE 1 OF 1** |

## PUBLICATION ORDERING INFORMATION

**LITERATURE FULFILLMENT**:
**Email Requests to:** orderlit@onsemi.com

**onsemi Website:** www.onsemi.com

**TECHNICAL SUPPORT**
**North American Technical Support:**
Voice Mail: 1 800−282−9855 Toll Free USA/Canada
Phone: 011 421 33 790 2910

**Europe, Middle East and Africa Technical Support:**
Phone: 00421 33 790 2910
For additional information, please contact your local Sales Representative

◊