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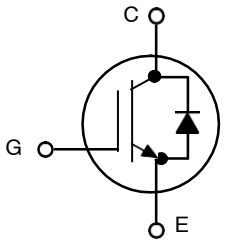
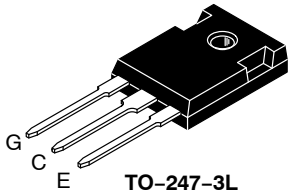
# Field Stop Trench IGBT

## 40 A, 650 V

# AFGHL40T65SPD

| $V_{CES}$ | $E_{on}$ | $V_{CE(Sat)}$ |
|---|---|---|
| 650 V | 1.16 mJ | 1.85 V |




**TO−247−3L**
**CASE 340CX**

### Description

Using the novel field stop 3rd generation IGBT technology, AFGHL40T65SPD offers the optimum performance with both low conduction loss and switching loss for a high efficiency operation in various applications, which provides 50 V higher blocking voltage and rugged high current switching reliability.

Meanwhile, this part also offers and advantage of outstanding performance in parallel operation.

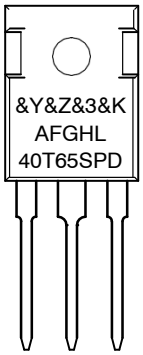
### Features

- AEC−Q101 Qualified
- Low Saturation Voltage: $V_{CE(Sat)}$ = 1.85 V (Typ.) @ $I_C$ = 40 A
- 100% Of The Part Are Dynamically Tested (Note 1)
- Short Circuit Ruggedness > 5 μS @ 25°C
- Maximum Junction Temperature: $T_J$ = 175°C
- Fast Switching
- Tight Parameter Distribution
- Positive Temperature Co−efficient for Easy Parallel Operating
- Co−Packed With Soft And Fast Recovery Diode

### Typical Applications

- On−board Charger
- Air Conditioner Compressor
- PTC Heater
- Motor Drivers
- Other Automotive Power−Train Applications

### MARKING DIAGRAM




| | |
|---|---|
| $Y | = **onsemi** Logo |
| &Z | = Assembly Plant Code |
| &3 | = 3−Digit Data code |
| &K | = 2−Digit Lot Traceability code |
| AFGHL40T65SPD | = Specific Device Code |

### ORDERING INFORMATION

| Device | Package | Shipping |
|---|---|---|
| AFGHL40T65SPD | TO−247−3L | 30 Units / Rail |

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**ABSOLUTE MAXIMUM RATINGS** ($T_C$ = 25°C, Unless otherwise noted)

| Symbol | Description | Ratings | Units |
|---|---|---|---|
| $V_{CES}$ | Collector to Emitter Voltage | 650 | V |
| $V_{GES}$ | Gate to Emitter Voltage | ±20 | V |
| | Transient Gate to Emitter Voltage | ±30 | V |
| $I_C$ | Collector Current @ $T_C$ = 25°C | 80 | A |
| | Collector Current @ $T_C$ = 100°C | 40 | |
| $I_{CM}$ | Pulsed Collector Current (Note 2) | 120 | A |
| $I_F$ | Diode Forward Current @ $T_C$ = 25°C | 40 | A |
| | Diode Forward Current @ $T_C$ = 100°C | 20 | |
| $I_{FM}$ | Pulsed Diode Maximum Forward Current (Note 2) | 120 | A |
| $P_D$ | Maximum Power Dissipation @ $T_C$ = 25°C | 267 | W |
| | Maximum Power Dissipation @ $T_C$ = 100°C | 134 | |
| SCWT | Short Circuit Withstand Time @ $T_C$ = 25°C | 5 | μs |
| $T_J$ | Operating Junction Temperature | −55 to +175 | °C |
| $T_{stg}$ | Storage Temperature Range | −55 to +175 | °C |
| $T_L$ | Maximum Lead Temp. For soldering Purposes, ⅛” from case for 5 seconds | 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. $V_{CC}$ = 400 V, $V_{GE}$ = 15 V, $I_C$ = 120 A, $R_G$ = 20 Ω, Inductive Load.
2. Repetitive rating: pulse width limited by max. Junction temperature.

**THERMAL CHARACTERISTICS**

| Symbol | Rating | Max. | Units |
|---|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance Junction to Case, for IGBT | 0.43 | °C/W |
| $R_{\theta JC}$ | Thermal Resistance Junction to Case, for Diode | 1.69 | °C/W |
| $R_{\theta JA}$ | Thermal Resistance Junction to Ambient | 40 | °C/W |

**ELECTRICAL CHARACTERISTICS** ($T_C$ = 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, $I_C$ = 1mA | BVCES | 650 | – | – | V |
| Temperature Coefficient of Breakdown Voltage | $V_{GE}$ = 0 V, $I_C$ = 1mA | | – | 0.6 | – | V/°C |
| Collector−emitter Cut−off Current, Gate−emitter Short−circuited | $V_{GE}$ = 0 V, $V_{CE}$ = 650 V<br>$V_{GE}$ = 0 V, $V_{CE}$ = 650 V, $T_J$ = 175°C | ICES | –<br>– | –<br>750 | 250<br>– | μA |
| Gate Leakage Current, Collector−emitter Short−circuited | $V_{GE}$ = 20 V, $V_{CE}$ = 0 V | IGES | – | – | ±400 | nA |
| **ON CHARACTERISTICS** | | | | | | |
| Gate−emitter Threshold Voltage | $V_{GE}$ = $V_{CE}$, $I_C$ = 40 mA | VGE(th) | 4.0 | 5.0 | 7.5 | V |
| Collector−emitter Saturation Voltage | $V_{GE}$ = 15 V, $I_C$ = 40 A<br>$V_{GE}$ = 15 V, $I_C$ = 40 A, $T_J$ = 175°C | VCE(sat) | 1.4<br>– | 1.85<br>2.51 | 2.4<br>– | V |
| **DYNAMIC CHARACTERISTICS** | | | | | | |
| Input Capacitance | $V_{CE}$ = 30 V, $V_{GE}$ = 0 V, f = 1 MHz | Cies | – | 1518 | – | pF |
| Output Capacitance | | Coes | – | 91 | – | |
| Reverse Transfer Capacitance | | Cres | – | 15 | – | |
| Gate Charge Total | $V_{CE}$ = 400 V, $I_C$ = 40 V, $V_{GE}$ = 15 V | $Q_g$ | – | 36 | – | nC |
| Gate to Emitter Charge | | Qge | – | 11 | – | |
| Gate to Collector Charge | | Qgc | – | 12 | – | |
| **SWITCHING CHARACTERISTICS** | | | | | | |
| Turn−on Delay Time | $T_C$ = 25°C<br>$V_{CC}$ = 400 V, $I_C$ = 40 A<br>Rg = 6 Ω<br>$V_{GE}$ = 15 V<br>Inductive Load, $T_C$ = 25°C | td(on) | – | 18 | – | ns |
| Rise Time | | $t_r$ | – | 42 | – | |
| Turn−off Delay Time | | td(off) | – | 35 | – | |
| Fall Time | | $t_f$ | – | 10 | – | |
| Turn−on Switching Loss | | Eon | – | 1.16 | – | mJ |
| Turn−off Switching Loss | | Eoff | – | 0.27 | – | |
| Total Switching Loss | | Ets | – | 1.43 | – | |
| Turn−on Delay Time | $T_C$ = 175°C<br>$V_{CC}$ = 400 V, $I_C$ = 40 A<br>Rg = 6 Ω<br>$V_{GE}$ = 15 V<br>Inductive Load | td(on) | – | 16 | – | ns |
| Rise Time | | $t_r$ | – | 40 | – | |
| Turn−off Delay Time | | td(off) | – | 37 | – | |
| Fall Time | | $t_f$ | – | 11 | – | |
| Turn−on Switching Loss | | Eon | – | 1.59 | – | mJ |
| Turn−off Switching Loss | | Eoff | – | 0.42 | – | |
| Total Switching Loss | | Ets | – | 2.01 | – | |
| **DIODE CHARACTERISTICS** | | | | | | |
| Forward Voltage | $I_F$ = 20 A<br>$I_F$ = 20 A, $T_J$ = 175°C | $V_F$ | 1.4<br>– | 2.2<br>1.9 | 2.7<br>– | V |
| Reverse Recovery Time | $T_J$ = 25°C<br>$I_F$ = 20 A, $di_F/dt$ = 200 A/μs | trr | – | 35 | – | ns |
| Reverse Recovery Charge | | Qrr | – | 58 | – | μC |
| Reverse Recovery Time | $T_J$ = 175°C<br>$I_F$ = 20 A, $di_F/dt$ = 200 A/μs | trr | – | 214 | – | ns |
| Reverse Recovery Charge | | Qrr | – | 776 | – | μC |
| Reverse Recovery Energy | | Erec | – | 51 | – | μJ |

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

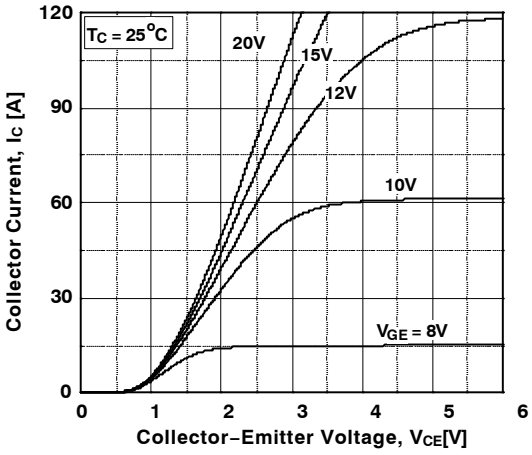



**Figure 1. Typical Output Characteristics**

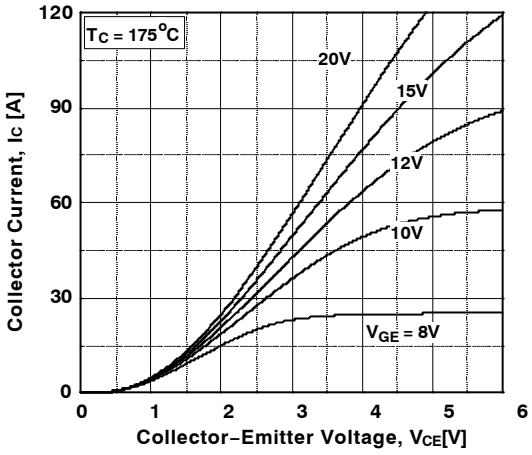



**Figure 2. Typical Output Characteristics**

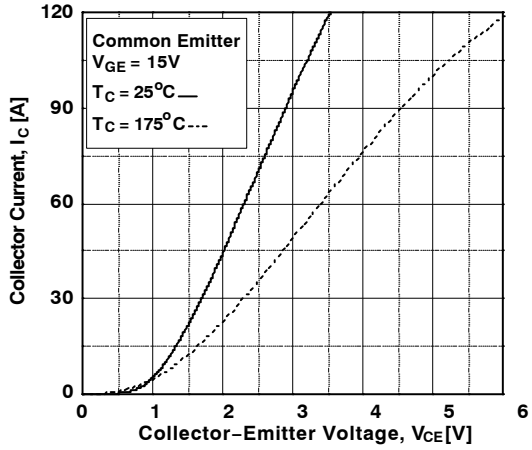



**Figure 3. Typical Saturation Voltage Characteristics**

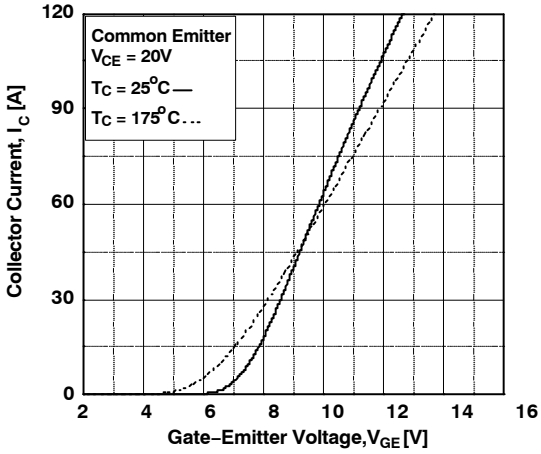



**Figure 4. Transfer Characteristics**

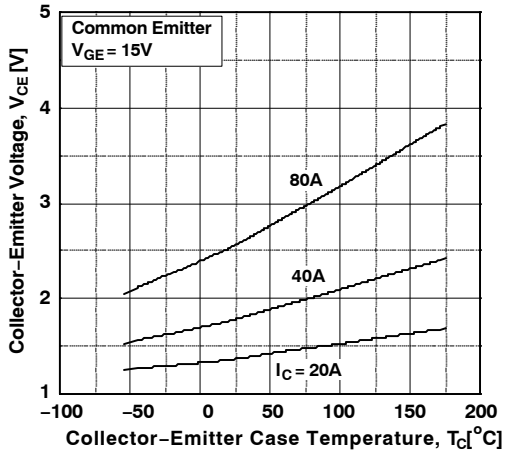



**Figure 5. Saturation Voltage vs. Case Temperature at Variant Current Level**

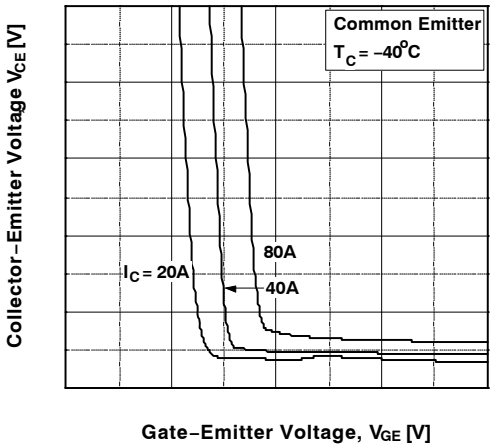



**Figure 6. Saturation Voltage vs. $V_{GE}$**

## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

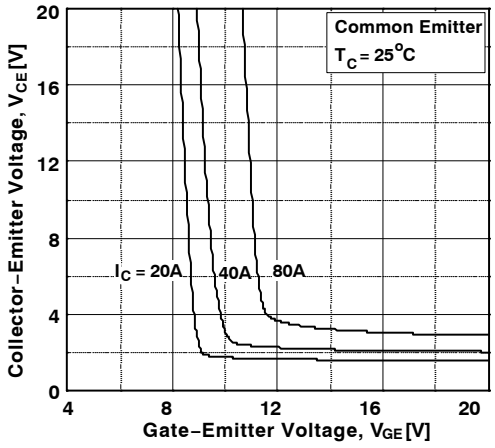



Figure 7. Saturation Voltage vs. $V_{GE}$

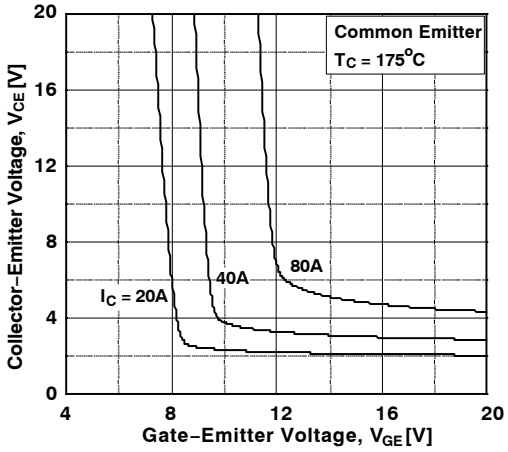



Figure 8. Saturation Voltage vs. $V_{GE}$

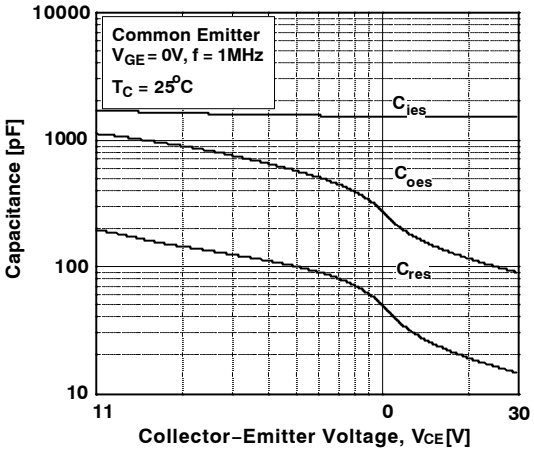



Figure 9. Capacitance Characteristics

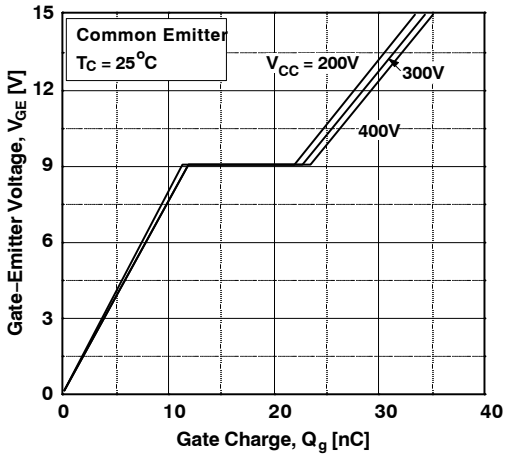



Figure 10. Gate charge Characteristics

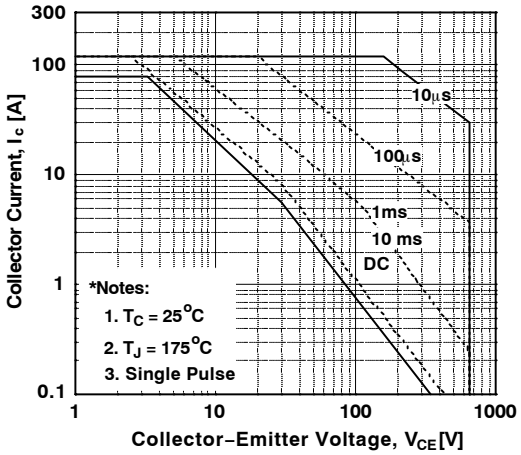



Figure 11. SOA Characteristics

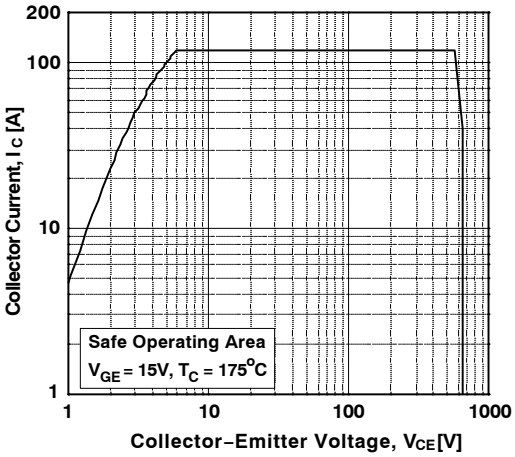



Figure 12. Turn off Switching SOA Characteristics

## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

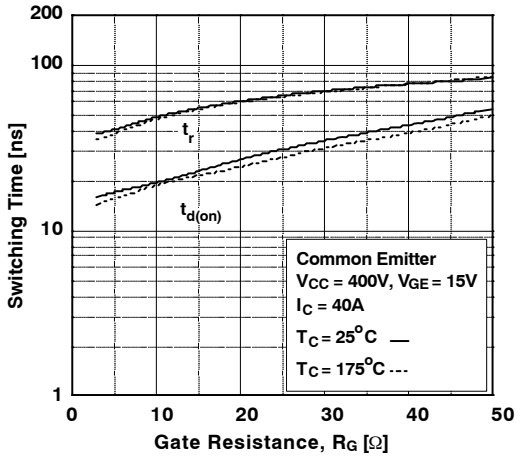



**Figure 13. Turn−on Characteristics vs. Gate Resistance**

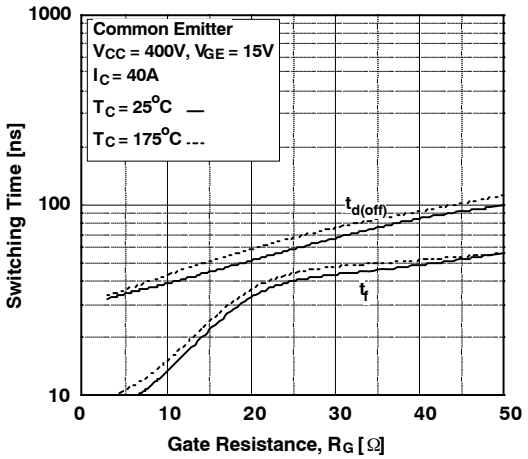



**Figure 14. Turn−off Characteristics vs. Gate Resistance**

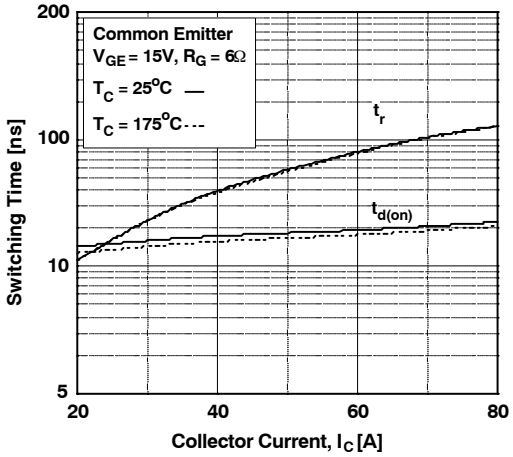



**Figure 15. Turn−on Characteristics vs. Collector Current**

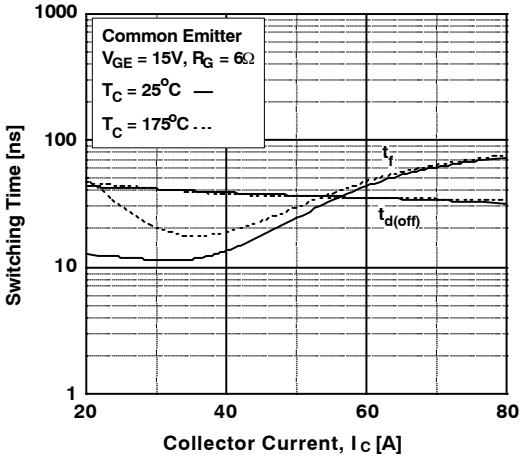



**Figure 16. Turn−off Characteristics vs. Collector Current**

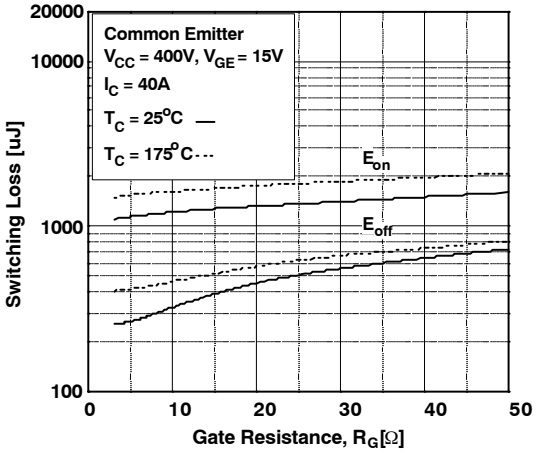



**Figure 17. Switching Loss vs Gate Resistance**

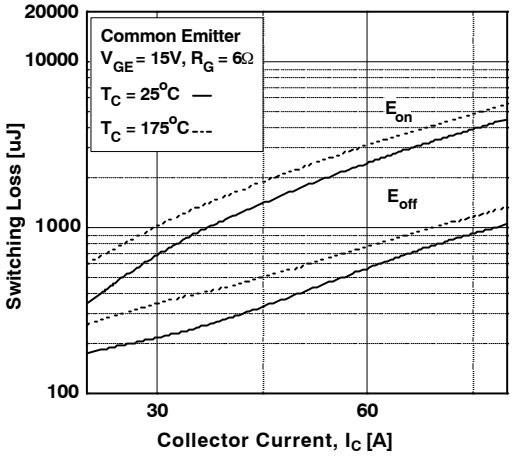



**Figure 18. Switching Loss vs Collector Current**

## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

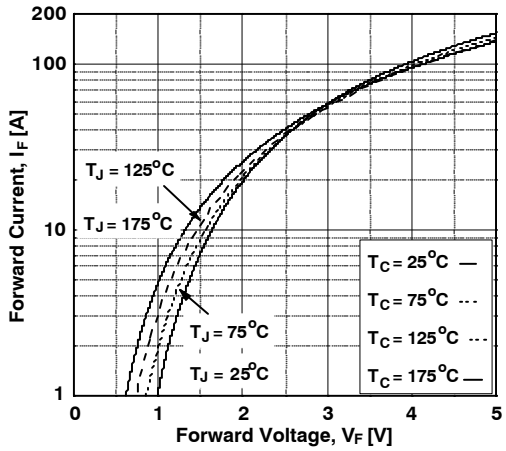



Figure 19. Forward Characteristics

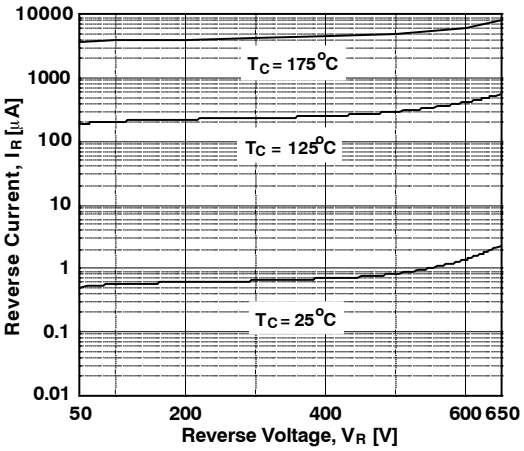



Figure 20. Reverse Current

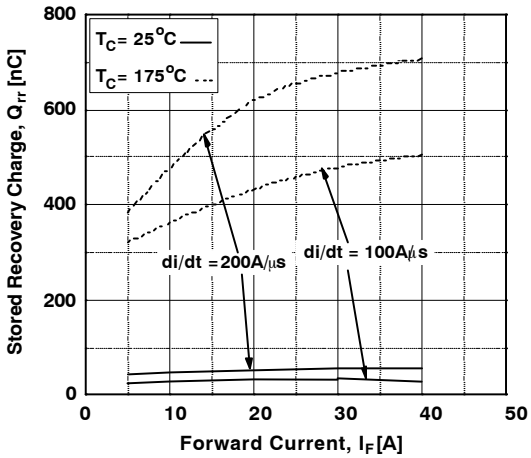



Figure 21. Stored Charge

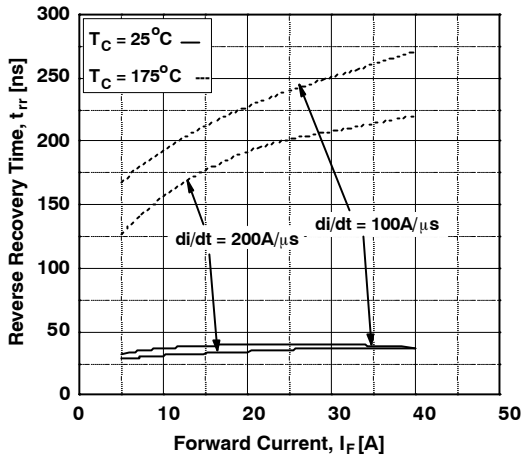



Figure 22. Reverse Recovery Time

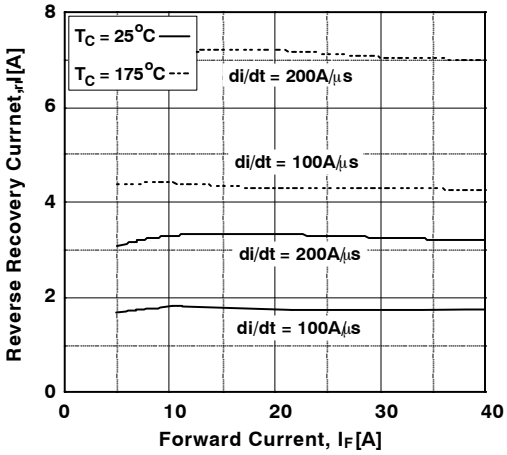



Figure 23. Reverse Recovery Current

## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

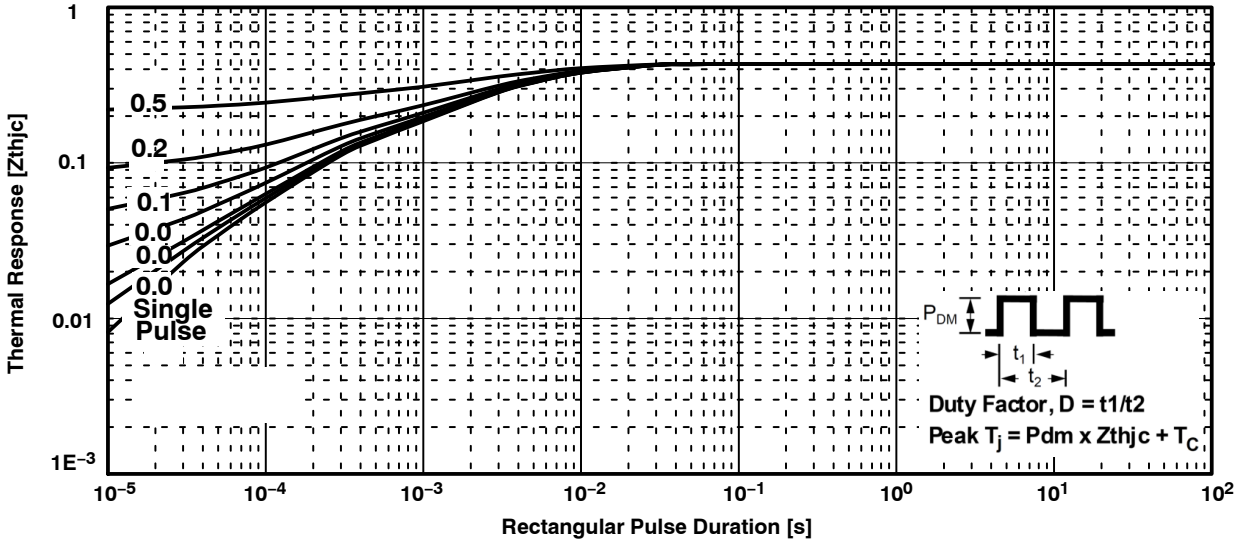



**Figure 24. Transient Thermal Impedance of IGBT**

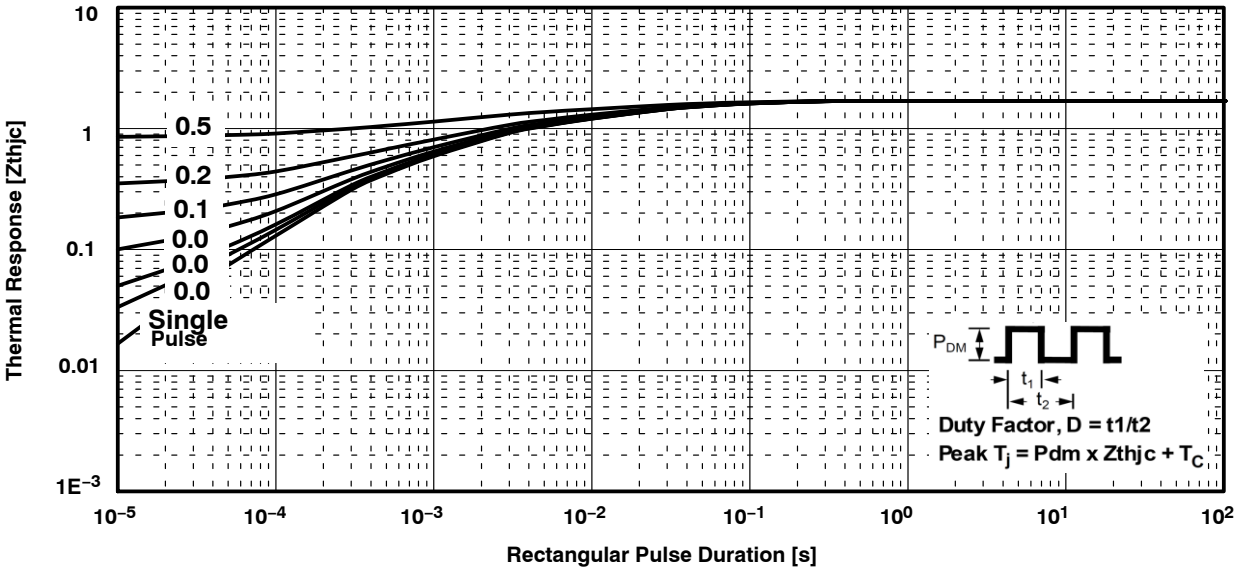
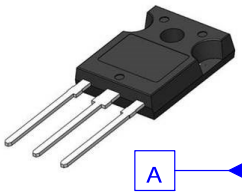
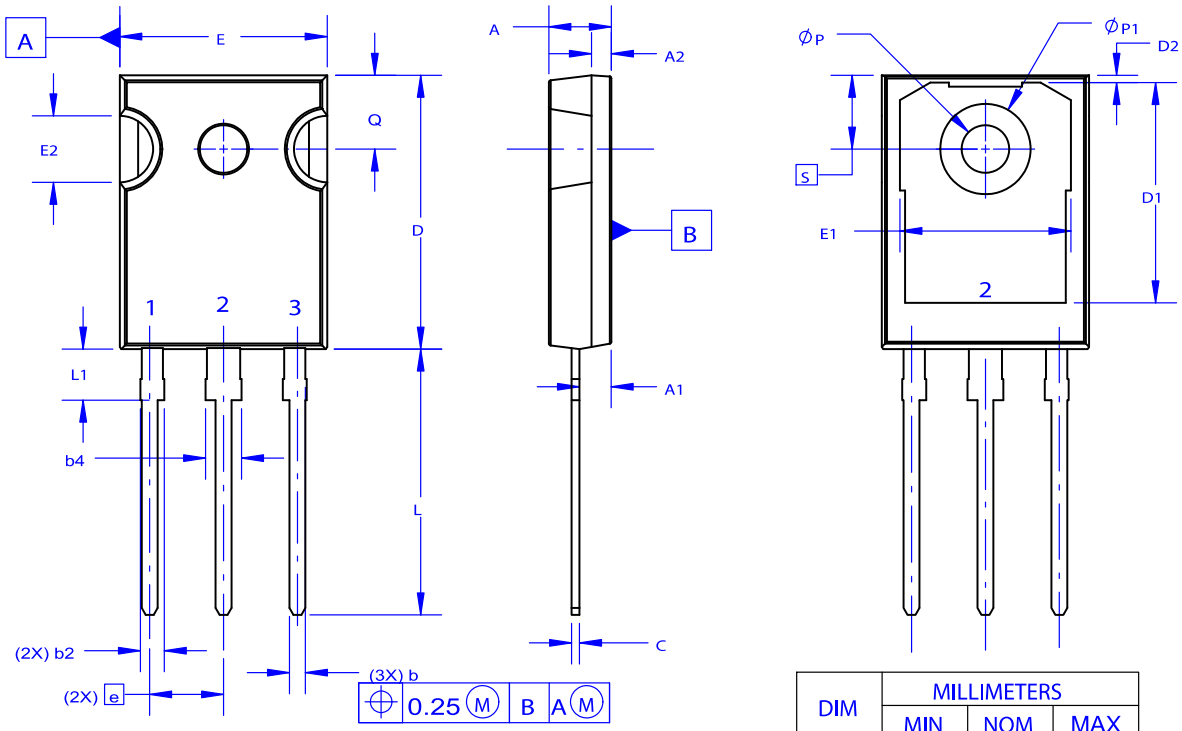



**Figure 25. Transient Thermal Impedance of Diode**

**TO−247−3LD**
CASE 340CX
ISSUE A

DATE 06 JUL 2020






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 |
| 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 |

## GENERIC MARKING DIAGRAM*


XXXXX = Specific Device Code
A = Assembly Location
Y = Year
WW = Work Week
G = Pb−Free Package

*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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