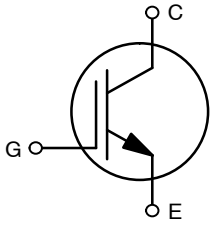
# Field Stop Trench IGBT

## 40 A, 650 V

# AFGHL40T65SQ

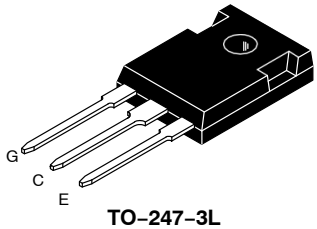
**40 A, 650 V**
**$V_{CESat}$ = 1.6 V**

Using the novel field stop 4th generation high speed IGBT technology. AFGHL40T65SQ which is AEC Q101 qualified offers the optimum performance for both hard and soft switching topology in automotive application. It is a stand−alone IGBT.




### Features

- AEC−Q101 Qualified
- Maximum Junction Temperature: $T_J$ = 175°C
- Positive Temperature Co−efficient for Easy Parallel Operating
- High Current Capability
- Low Saturation Voltage: $V_{CE(Sat)}$ = 1.6 V (Typ.) @ $I_C$ = 40 A
- 100% of the Parts are Tested for $I_{LM}$ (Note 2)
- Fast Switching
- Tight Parameter Distribution
- RoHS Compliant

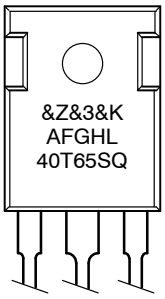



**TO−247−3L**
**CASE 340CX**

### Typical Applications

- Automotive HEV−EV Onboard Chargers
- Automotive HEV−EV DC−DC Converters
- Totem Pole Bridgeless PFC
- PTC

### MARKING DIAGRAM




&Z = Assembly Plant Code
&3 = 3−Digit Date Code
&K = 2−Digit Lot Traceability Code
AFGHL40T65SQ = Specific Device Code

### MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Collector−to−Emitter Voltage | $V_{CES}$ | 650 | V |
| Gate−to−Emitter Voltage<br>Transient Gate−to−Emitter Voltage | $V_{GES}$ | ±20<br>±30 | V |
| Collector Current (Note 1) @ $T_C$ = 25°C<br>@ $T_C$ = 100°C | $I_C$ | 80<br>40 | A |
| Pulsed Collector Current (Note 2) | $I_{LM}$ | 160 | A |
| Pulsed Collector Current (Note 3) | $I_{CM}$ | 160 | A |
| Maximum Power Dissipation @ $T_C$ = 25°C<br>@ $T_C$ = 100°C | $P_D$ | 239<br>119 | W |
| Operating Junction / Storage Temperature Range | $T_J$, $T_{STG}$ | −55 to +175 | °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. Value limit by bond wire
2. $V_{CC}$ = 400 V, $V_{GE}$ = 15 V, $I_C$ = 160 A, $R_G$ = 15 Ω, Inductive Load
3. Repetitive Rating: pulse width limited by max. Junction temperature

### ORDERING INFORMATION

| Device | Package | Shipping |
|---|---|---|
| AFGHL40T65SQ | TO−247−3L | 30 Units / Rail |

## THERMAL CHARACTERISTICS

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Thermal resistance junction−to−case, for IGBT | $R_{\theta JC}$ | 0.63 | °C/W |
| Thermal resistance junction−to−ambient | $R_{\theta JA}$ | 40 | °C/W |

## 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 | $\frac{\Delta BV_{CES}}{\Delta T_J}$ | – | 0.6 | – | 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 CHARACTERISTICS** | | | | | | |
| Gate−emitter threshold voltage | $V_{GE}$ = $V_{CE}$, $I_C$ = 40 mA | $V_{GE(th)}$ | 3.4 | 4.9 | 6.4 | 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 | $V_{CE(sat)}$ | –<br>– | 1.6<br>1.95 | 2.1<br>– | V |
| **DYNAMIC CHARACTERISTICS** | | | | | | |
| Input capacitance | $V_{CE}$ = 30 V, $V_{GE}$ = 0 V, f = 1 MHz | $C_{ies}$ | – | 2312 | – | pF |
| Output capacitance | | $C_{oes}$ | – | 30 | – | |
| Reverse transfer capacitance | | $C_{res}$ | – | 8 | – | |
| Gate charge total | $V_{CE}$ = 400 V, $I_C$ = 40 A, $V_{GE}$ = 15 V | $Q_g$ | – | 68 | – | nC |
| Gate−to−emitter charge | | $Q_{ge}$ | – | 13 | – | |
| Gate−to−collector charge | | $Q_{gc}$ | – | 16 | – | |
| **SWITCHING CHARACTERISTICS, INDUCTIVE LOAD** | | | | | | |
| Turn−on delay time | $T_C$ = 25°C, $V_{CC}$ = 400 V, $I_C$ = 20 A, $R_G$ = 6 Ω, $V_{GE}$ = 15 V, Inductive Load, FWD: AFGHL40T65SQD | $t_{d(on)}$ | – | 15 | – | ns |
| Rise time | | $t_r$ | – | 10 | – | |
| Turn−off delay time | | $t_{d(off)}$ | – | 70 | – | |
| Fall time | | $t_f$ | – | 3 | – | |
| Turn−on switching loss | | $E_{on}$ | – | 0.25 | – | mJ |
| Turn−off switching loss | | $E_{off}$ | – | 0.09 | – | |
| Total switching loss | | $E_{ts}$ | – | 0.34 | – | |
| Turn−on delay time | $T_C$ = 25°C, $V_{CC}$ = 400 V, $I_C$ = 40 A, $R_G$ = 6 Ω, $V_{GE}$ = 15 V, Inductive Load, FWD: AFGHL40T65SQD | $t_{d(on)}$ | – | 17 | – | ns |
| Rise time | | $t_r$ | – | 22 | – | |
| Turn−off delay time | | $t_{d(off)}$ | – | 67 | – | |
| Fall time | | $t_f$ | – | 31 | – | |
| Turn−on switching loss | | $E_{on}$ | – | 0.75 | – | mJ |
| Turn−off switching loss | | $E_{off}$ | – | 0.29 | – | |
| Total switching loss | | $E_{ts}$ | – | 1.04 | – | |

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

| Parameter | Test Conditions | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **SWITCHING CHARACTERISTICS, INDUCTIVE LOAD** | | | | | | |
| Turn−on delay time | $T_J$ = 175°C, $V_{CC}$ = 400 V, $I_C$ = 20 A, $R_G$ = 6 Ω, $V_{GE}$ = 15 V, Inductive Load, FWD: AFGHL40T65SQD | $t_{d(on)}$ | − | 14 | − | ns |
| Rise time | | $t_r$ | − | 12 | − | |
| Turn−off delay time | | $t_{d(off)}$ | − | 81 | − | |
| Fall time | | $t_f$ | − | 7 | − | |
| Turn−on switching loss | | $E_{on}$ | − | 0.46 | − | mJ |
| Turn−off switching loss | | $E_{off}$ | − | 0.22 | − | |
| Total switching loss | | $E_{ts}$ | − | 0.68 | − | |
| Turn−on delay time | $T_J$ = 175°C, $V_{CC}$ = 400 V, $I_C$ = 40 A, $R_G$ = 6 Ω, $V_{GE}$ = 15 V, Inductive Load, FWD: AFGHL40T65SQD | $t_{d(on)}$ | − | 16 | − | ns |
| Rise time | | $t_r$ | − | 25 | − | |
| Turn−off delay time | | $t_{d(off)}$ | − | 75 | − | |
| Fall time | | $t_f$ | − | 38 | − | |
| Turn−on switching loss | | $E_{on}$ | − | 1.06 | − | mJ |
| Turn−off switching loss | | $E_{off}$ | − | 0.47 | − | |
| Total switching loss | | $E_{ts}$ | − | 1.53 | − | |

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

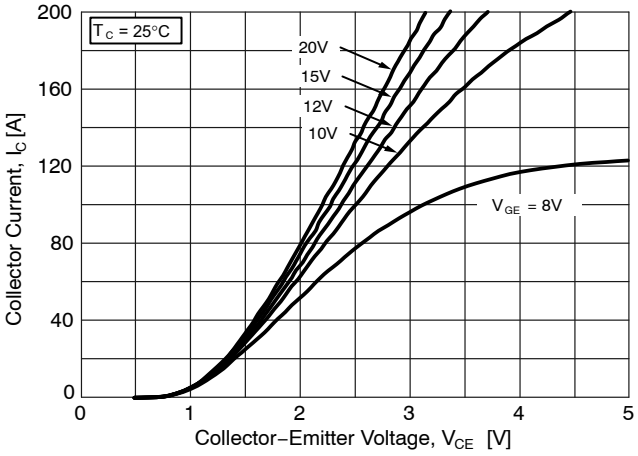



**Figure 1. Typical Output Characteristics**

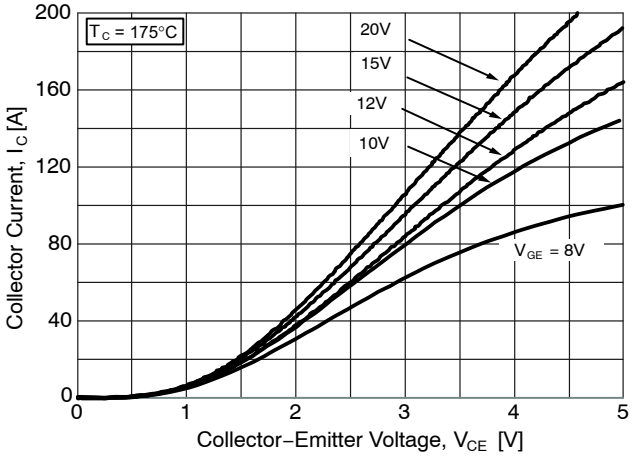



**Figure 2. Typical Output Characteristics**

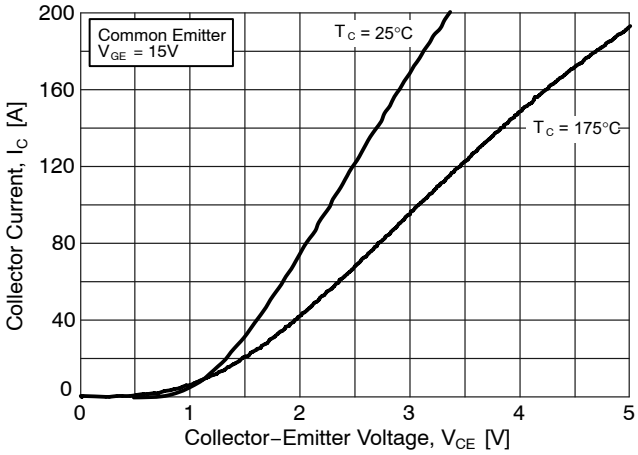



**Figure 3. Typical Saturation Voltage**

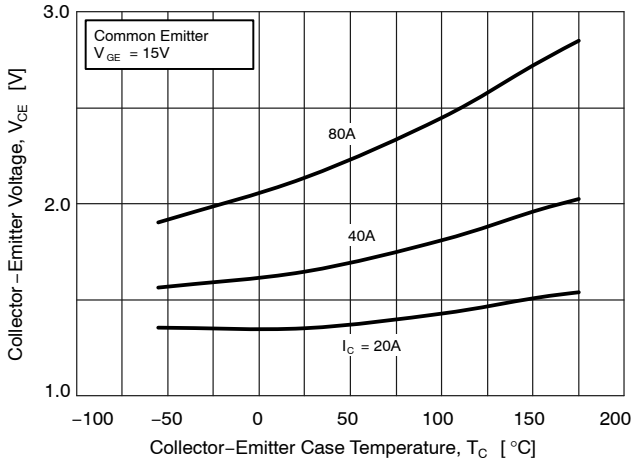



**Figure 4. Saturation Voltage vs. Case Temperature**

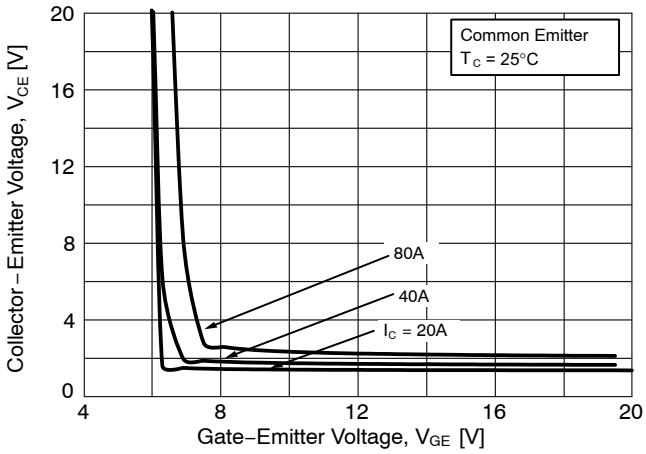



**Figure 5. Saturation Voltage vs. $V_{GE}$**

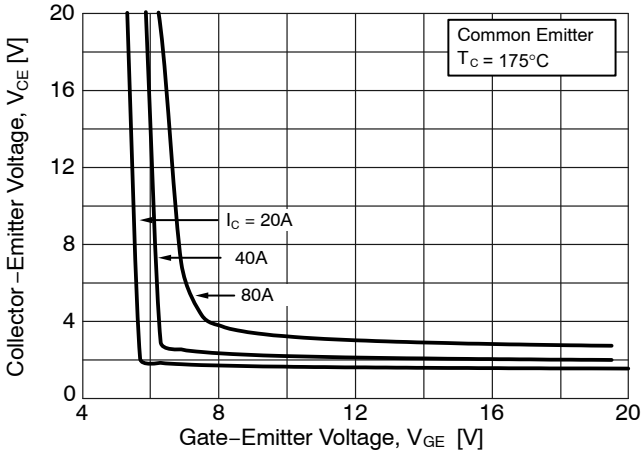



**Figure 6. Saturation Voltage vs. $V_{GE}$**

## TYPICAL CHARACTERISTICS

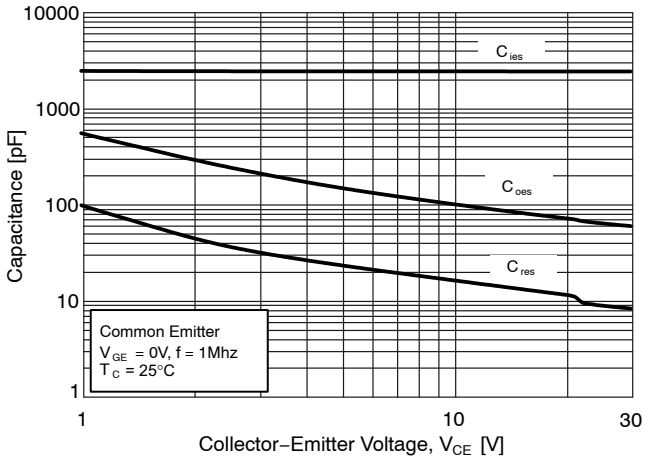



**Figure 7. Capacitance Characteristics**

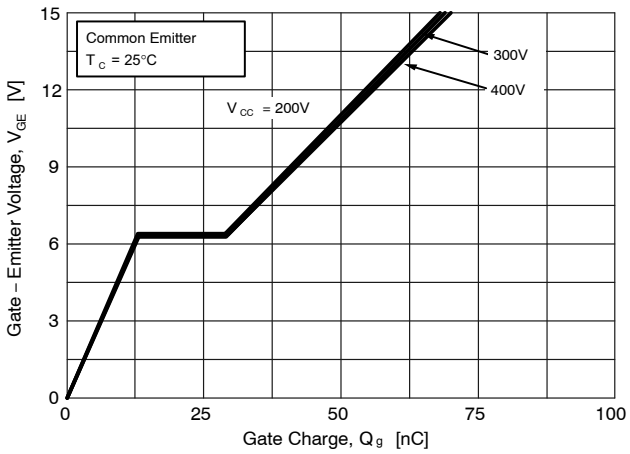



**Figure 8. Gate Charge**

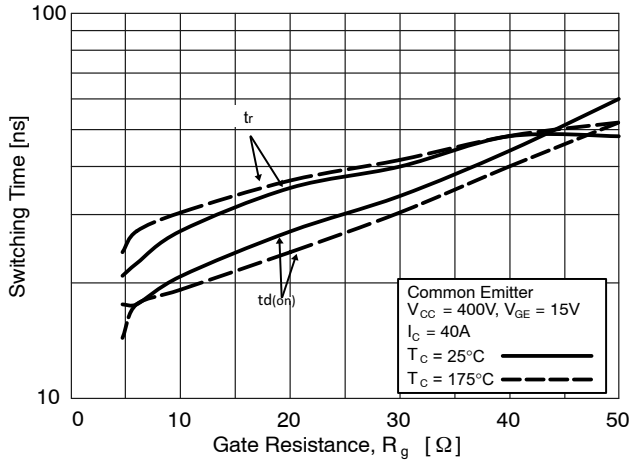



**Figure 9. Turn−On Characteristics vs. Gate Resistance**

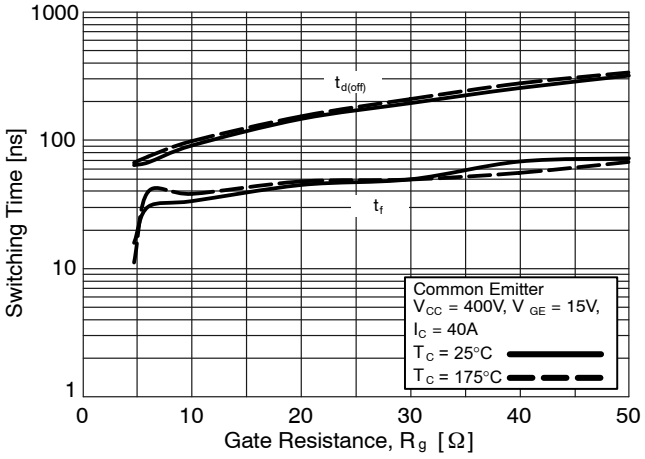



**Figure 10. Turn−Off Characteristics vs. Gate Resistance**

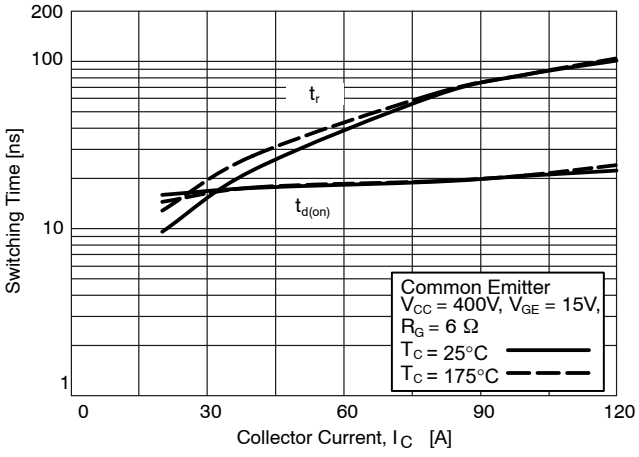



**Figure 11. Turn−On Characteristics vs. Collector Current**

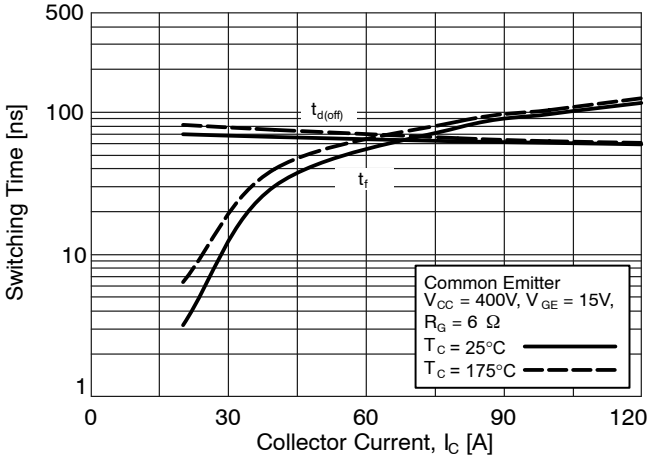



**Figure 12. Turn−Off Characteristics vs. Collector Current**

## TYPICAL CHARACTERISTICS

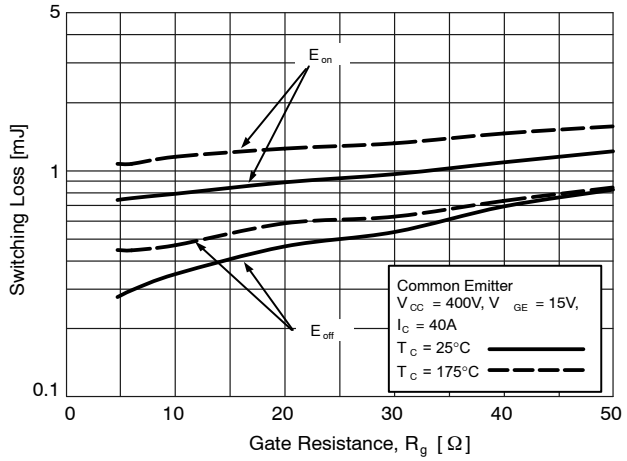



**Figure 13. Switching Loss vs. Gate Resistance**

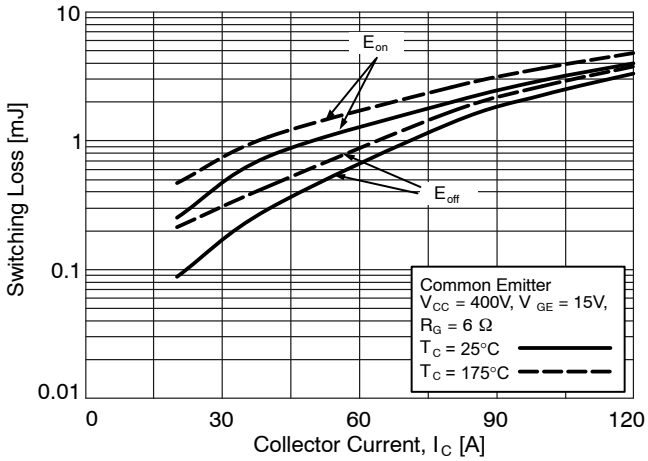



**Figure 14. Switching Loss vs. Collector Current**

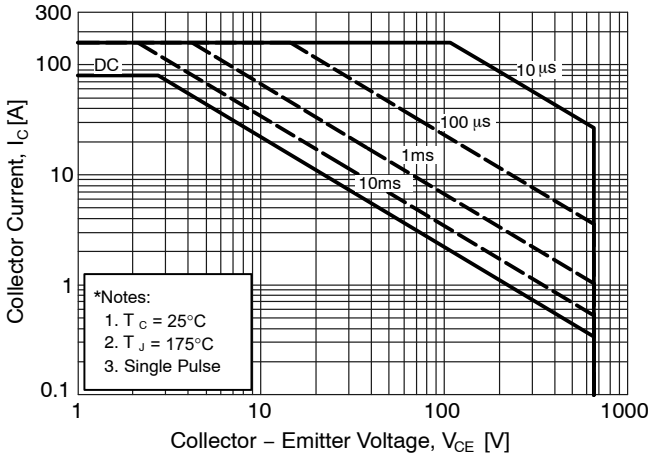



**Figure 15. SOA Characteristics**

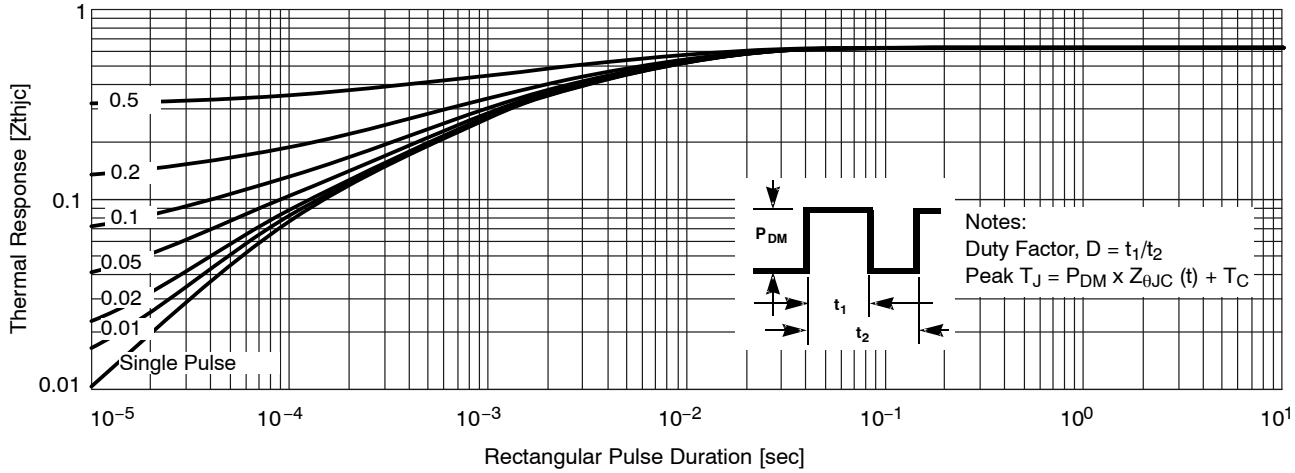
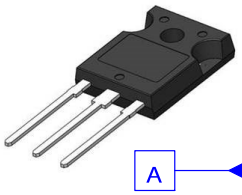
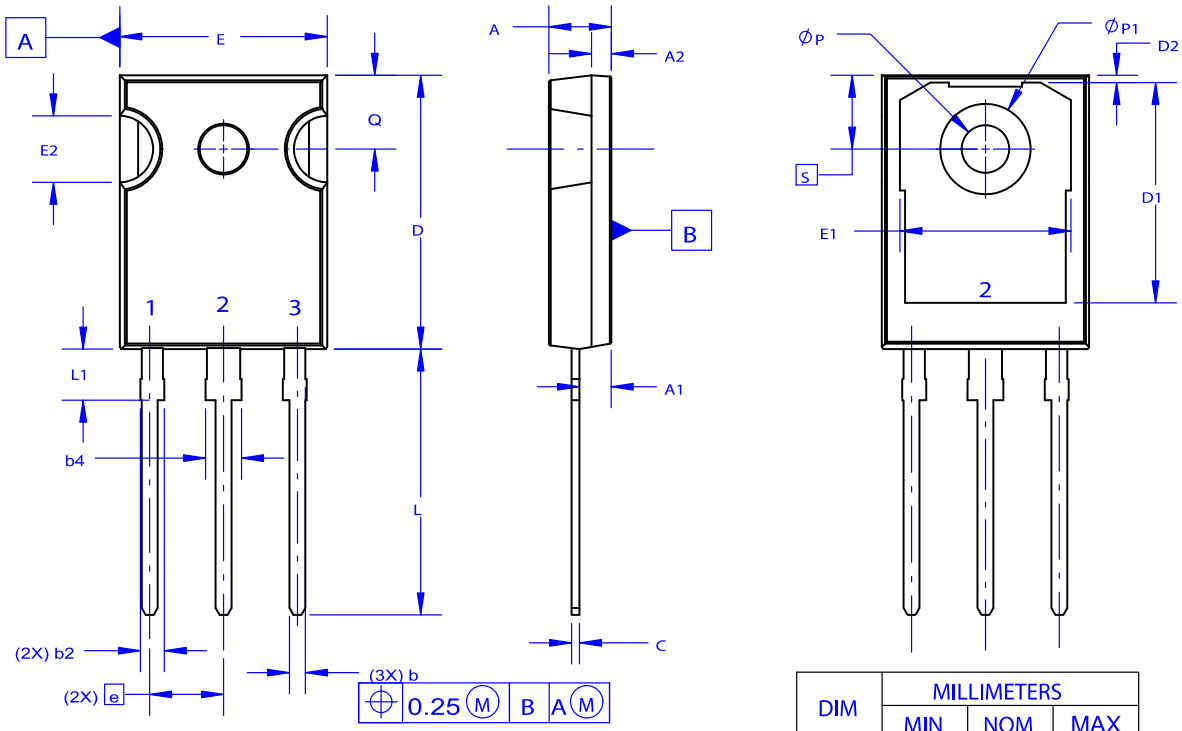



**Figure 16. transient Thermal Impedance of IGBT**

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

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