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# Field Stop Trench IGBT

## 650 V, 75 A, TO247

### AFGHL75T65SQ

Using the novel field stop 4th generation IGBT technology, AFGHL75T65SQ offers the optimum performance with both low conduction and switching losses for high efficiency operations in various applications, which does not require reverse recovery specification.

#### Features

- Maximum Junction Temperature:  $T_J = 175^\circ\text{C}$
- Positive Temperature Co-efficient for Easy Parallel Operating
- High Current Capability
- Low Saturation Voltage:  $V_{CE(Sat)} = 1.6\text{ V (Typ.) @ } I_C = 75\text{ A}$
- 100% of the Parts are Tested for  $I_{LM}$  (Note 2)
- Fast Switching
- Tight Parameter Distribution
- AEC-Q101 Qualified and PPAP Capable

#### Typical Applications

- Automotive
- On & Off Board Chargers
- DC-DC Converters
- PFC
- Industrial Inverter

#### MAXIMUM RATINGS

| Rating   | Symbol               | Value   | Unit             |
|--|----------------------|---|------------------|
| Collector-to-Emitter Voltage   | $V_{CES}$            | 650   | V                |
| Gate-to-Emitter Voltage<br>Transient Gate-to-Emitter Voltage             | $V_{GES}$            | $\pm 20$<br>$\pm 30$                                      | V                |
| Collector Current (Note 1)   | $I_C$                | 80<br>75  | A                |
|  |                      | @ $T_C = 25^\circ\text{C}$<br>@ $T_C = 100^\circ\text{C}$ |                  |
| Pulsed Collector Current (Note 2)  | $I_{LM}$             | 300   | A                |
| Pulsed Collector Current (Note 3)  | $I_{CM}$             | 300   | A                |
| Maximum Power Dissipation  | $P_D$                | 375<br>188  | W                |
|  |                      | @ $T_C = 25^\circ\text{C}$<br>@ $T_C = 100^\circ\text{C}$ |                  |
| Operating Junction / Storage Temperature Range                           | $T_J$ ,<br>$T_{STG}$ | -55 to<br>+175  | $^\circ\text{C}$ |
| Maximum Lead Temp. for Soldering Purposes, 1/8" from case for 10 seconds | $T_L$                | 265   | $^\circ\text{C}$ |

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.

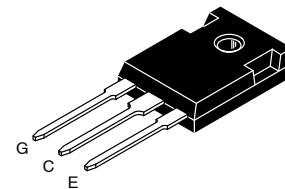
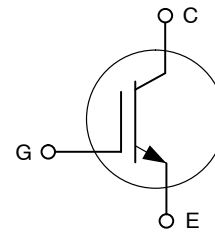
1. Value limited by bond wire
2.  $V_{CC} = 400\text{ V}$ ,  $V_{GE} = 15\text{ V}$ ,  $I_C = 300\text{ A}$ ,  $R_G = 15\ \Omega$ , Inductive Load, 100% of the Parts are Tested.
3. Repetitive Rating: pulse width limited by max. Junction temperature



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75 A, 650 V  
 $V_{CESat} = 1.6\text{ V (Typ.)}$



TO-247-3LD  
CASE 340CX

#### MARKING DIAGRAM



- A = Assembly Location
- YWW = 3-Digit Date Code
- ZZ = 2-Digit Lot Traceability Code
- AFGHL75T65SQ = Specific Device Code

#### ORDERING INFORMATION

| Device       | Package   | Shipping        |
|--------------|-----------|-----------------|
| AFGHL75T65SQ | TO-247-3L | 30 Units / Rail |

# AFGHL75T65SQ

## THERMAL CHARACTERISTICS

| Rating  | Symbol          | Max | Unit                        |
|---|-----------------|-----|-----------------------------|
| Thermal resistance junction-to-case, for IGBT | $R_{\theta JC}$ | 0.4 | $^{\circ}\text{C}/\text{W}$ |
| Thermal resistance junction-to-ambient        | $R_{\theta JA}$ | 40  | $^{\circ}\text{C}/\text{W}$ |

## ELECTRICAL CHARACTERISTICS ( $T_J = 25^{\circ}\text{C}$ unless otherwise noted)

| Parameter | Test Conditions | Symbol | Min | Typ | Max | Unit |
|-----------|-----------------|--------|-----|-----|-----|------|
|-----------|-----------------|--------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|   |  |                                      |     |     |           |                             |
|---|--|--------------------------------------|-----|-----|-----------|-----------------------------|
| Collector-emitter breakdown voltage, gate-emitter short-circuited | $V_{GE} = 0\text{ V}$ ,<br>$I_C = 1\text{ mA}$     | $BV_{CES}$                           | 650 | -   | -         | V                           |
| Temperature Coefficient of Breakdown Voltage                      | $V_{GE} = 0\text{ V}$ ,<br>$I_C = 1\text{ mA}$     | $\frac{\Delta BV_{CES}}{\Delta T_J}$ | -   | 0.6 | -         | $\text{V}/^{\circ}\text{C}$ |
| Collector-emitter cut-off current, gate-emitter short-circuited   | $V_{GE} = 0\text{ V}$ ,<br>$V_{CE} = 650\text{ V}$ | $I_{CES}$                            | -   | -   | 250       | $\mu\text{A}$               |
| Gate leakage current, collector-emitter short-circuited           | $V_{GE} = 20\text{ V}$ ,<br>$V_{CE} = 0\text{ V}$  | $I_{GES}$                            | -   | -   | $\pm 400$ | nA                          |

### ON CHARACTERISTICS

|                                      |  |               |     |     |     |   |
|--------------------------------------|--|---------------|-----|-----|-----|---|
| Gate-emitter threshold voltage       | $V_{GE} = V_{CE}$ , $I_C = 75\text{ mA}$   | $V_{GE(th)}$  | 3.4 | 4.9 | 6.4 | V |
| Collector-emitter saturation voltage | $V_{GE} = 15\text{ V}$ , $I_C = 75\text{ A}$<br>$V_{GE} = 15\text{ V}$ , $I_C = 75\text{ A}$ , $T_J = 175^{\circ}\text{C}$ | $V_{CE(sat)}$ | -   | 1.6 | 2.1 | V |
|                                      |  |               | -   | 2.0 | -   |   |

### DYNAMIC CHARACTERISTICS

|                              |  |           |   |       |   |    |
|------------------------------|--|-----------|---|-------|---|----|
| Input capacitance            | $V_{CE} = 30\text{ V}$ ,<br>$V_{GE} = 0\text{ V}$ ,<br>$f = 1\text{ MHz}$    | $C_{ies}$ | - | 4574  | - | pF |
| Output capacitance           |  | $C_{oes}$ | - | 289.4 | - |    |
| Reverse transfer capacitance |  | $C_{res}$ | - | 11.2  | - |    |
| Gate charge total            | $V_{CE} = 400\text{ V}$ ,<br>$I_C = 75\text{ A}$ ,<br>$V_{GE} = 15\text{ V}$ | $Q_g$     | - | 139   | - | nC |
| Gate-to-emitter charge       |  | $Q_{ge}$  | - | 25    | - |    |
| Gate-to-collector charge     |  | $Q_{gc}$  | - | 33    | - |    |

### SWITCHING CHARACTERISTICS, INDUCTIVE LOAD

|                         |   |              |   |      |   |    |
|-------------------------|---|--------------|---|------|---|----|
| Turn-on delay time      | $T_C = 25^{\circ}\text{C}$ ,<br>$V_{CC} = 400\text{ V}$ ,<br>$I_C = 37.5\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ ,<br>$V_{GE} = 15\text{ V}$ ,<br>Inductive Load<br>Energy losses include "tail" and diode reverse recovery. Diode from AFGHL75T65SQD. | $t_{d(on)}$  | - | 23   | - | ns |
| Rise time               |   | $t_r$        | - | 17   | - |    |
| Turn-off delay time     |   | $t_{d(off)}$ | - | 112  | - |    |
| Fall time               |   | $t_f$        | - | 8    | - |    |
| Turn-on switching loss  |   | $E_{on}$     | - | 0.61 | - | mJ |
| Turn-off switching loss |   | $E_{off}$    | - | 0.21 | - |    |
| Total switching loss    |   | $E_{ts}$     | - | 0.82 | - |    |
| Turn-on delay time      | $T_C = 25^{\circ}\text{C}$ ,<br>$V_{CC} = 400\text{ V}$ ,<br>$I_C = 75\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ ,<br>$V_{GE} = 15\text{ V}$ ,<br>Inductive Load<br>Energy losses include "tail" and diode reverse recovery. Diode from AFGHL75T65SQD.   | $t_{d(on)}$  | - | 25   | - | ns |
| Rise time               |   | $t_r$        | - | 46   | - |    |
| Turn-off delay time     |   | $t_{d(off)}$ | - | 106  | - |    |
| Fall time               |   | $t_f$        | - | 67   | - |    |
| Turn-on switching loss  |   | $E_{on}$     | - | 1.86 | - | mJ |
| Turn-off switching loss |   | $E_{off}$    | - | 1.13 | - |    |
| Total switching loss    |   | $E_{ts}$     | - | 2.99 | - |    |

# AFGHL75T65SQ

## ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

| Parameter | Test Conditions | Symbol | Min | Typ | Max | Unit |
|-----------|-----------------|--------|-----|-----|-----|------|
|-----------|-----------------|--------|-----|-----|-----|------|

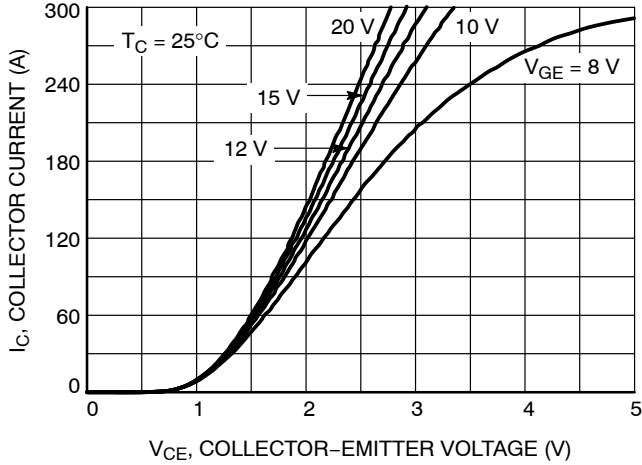
### SWITCHING CHARACTERISTICS, INDUCTIVE LOAD

|                         |  |              |   |      |   |    |
|-------------------------|--|--------------|---|------|---|----|
| Turn-on delay time      | $T_C = 175^\circ\text{C}$ ,<br>$V_{CC} = 400\text{ V}$ ,<br>$I_C = 37.5\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ ,<br>$V_{GE} = 15\text{ V}$ ,<br>Inductive Load<br>Energy losses include "tail" and diode reverse recovery. Diode from AFGHL75T65SQD. | $t_{d(on)}$  | - | 21   | - | ns |
| Rise time               |  | $t_r$        | - | 19   | - |    |
| Turn-off delay time     |  | $t_{d(off)}$ | - | 126  | - |    |
| Fall time               |  | $t_f$        | - | 7    | - |    |
| Turn-on switching loss  |  | $E_{on}$     | - | 1.20 | - | mJ |
| Turn-off switching loss |  | $E_{off}$    | - | 0.41 | - |    |
| Total switching loss    |  | $E_{ts}$     | - | 1.61 | - |    |
| Turn-on delay time      | $T_C = 175^\circ\text{C}$ ,<br>$V_{CC} = 400\text{ V}$ ,<br>$I_C = 75\text{ A}$ ,<br>$R_G = 4.7\ \Omega$ ,<br>$V_{GE} = 15\text{ V}$ ,<br>Inductive Load<br>Energy losses include "tail" and diode reverse recovery. Diode from AFGHL75T65SQD.   | $t_{d(on)}$  | - | 24   | - | ns |
| Rise time               |  | $t_r$        | - | 46   | - |    |
| Turn-off delay time     |  | $t_{d(off)}$ | - | 115  | - |    |
| Fall time               |  | $t_f$        | - | 72   | - |    |
| Turn-on switching loss  |  | $E_{on}$     | - | 2.84 | - | mJ |
| Turn-off switching loss |  | $E_{off}$    | - | 1.35 | - |    |
| Total switching loss    |  | $E_{ts}$     | - | 4.20 | - |    |

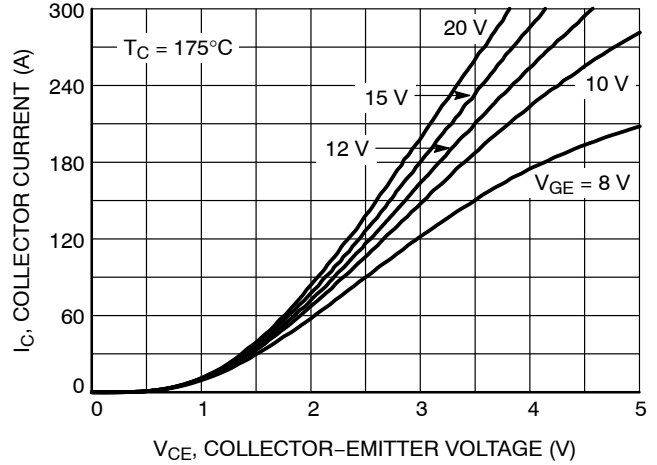
Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

# AFGHL75T65SQ

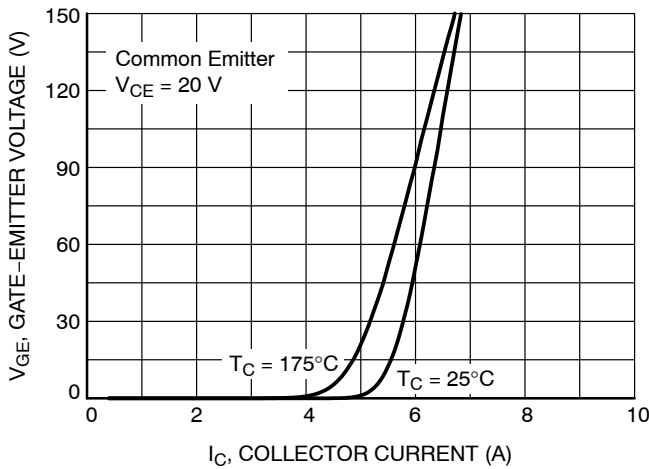
## TYPICAL CHARACTERISTICS



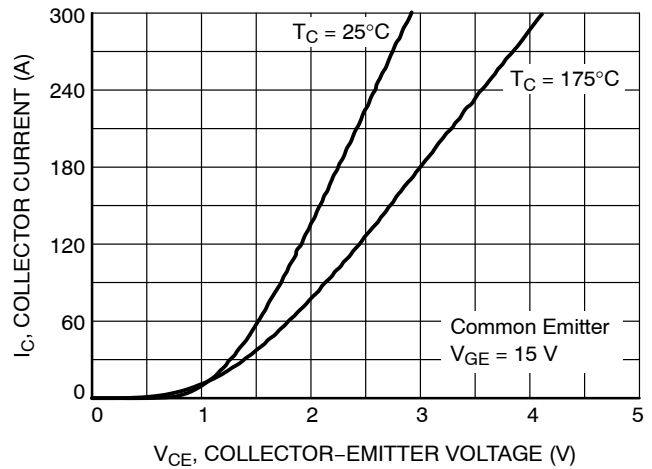
**Figure 1. Typical Output Characteristics**  
( $T_c = 25^\circ\text{C}$ )



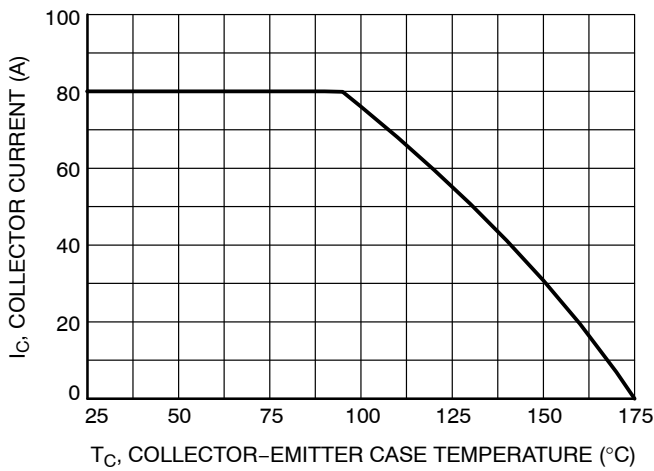
**Figure 2. Typical Output Characteristics**  
( $T_c = 175^\circ\text{C}$ )



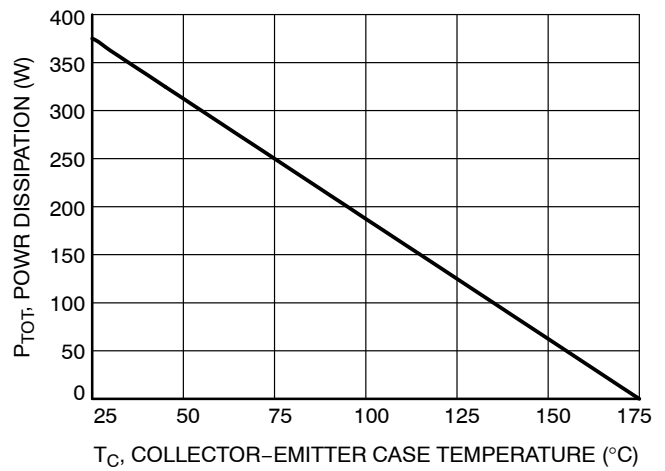
**Figure 3. Transfer Characteristics**



**Figure 4. Typical Saturation Voltage Characteristics**



**Figure 5. Collector Current Derating**



**Figure 6. Power Dissipation**

TYPICAL CHARACTERISTICS

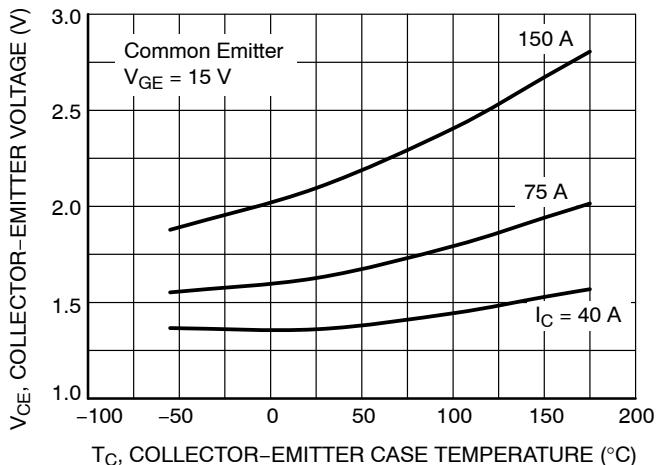


Figure 7. Saturation Voltage vs. Case Temperature at Variant Current Level

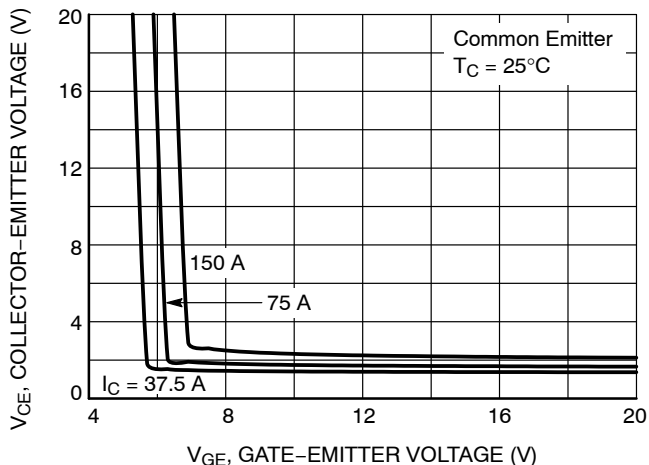


Figure 8. Saturation Voltage vs. V<sub>GE</sub> (T<sub>C</sub> = 25°C)

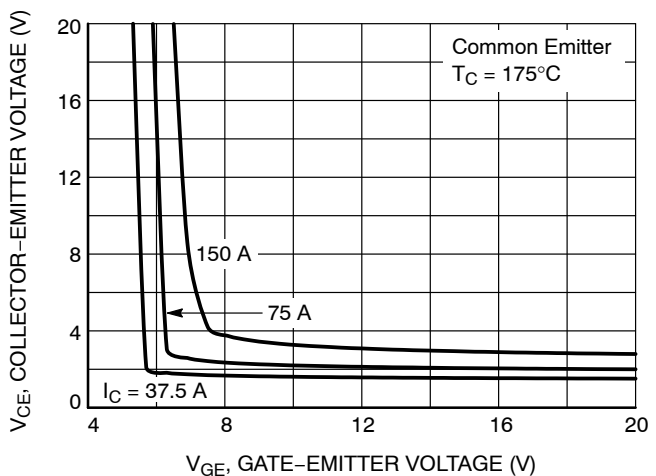


Figure 9. Saturation Voltage vs. V<sub>GE</sub> (T<sub>C</sub> = 175°C)

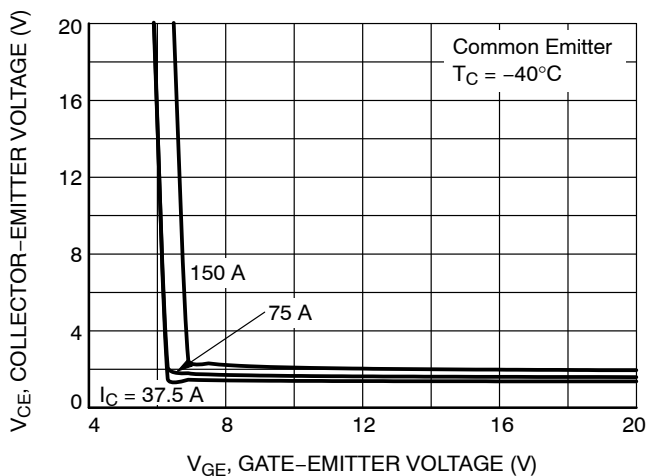


Figure 10. Saturation Voltage vs. V<sub>GE</sub> (T<sub>C</sub> = -40°C)

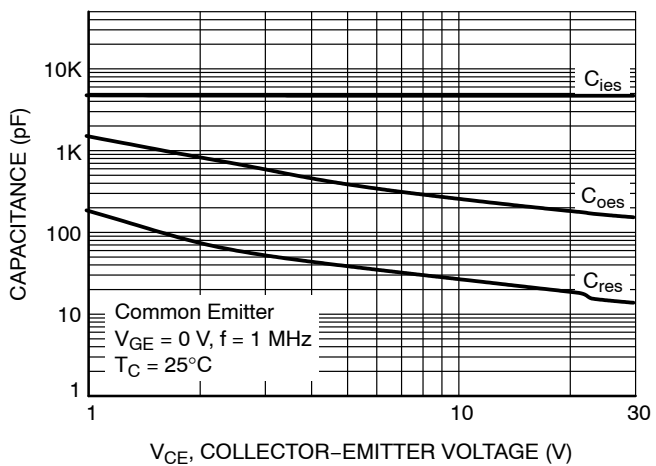


Figure 11. Capacitance Characteristics

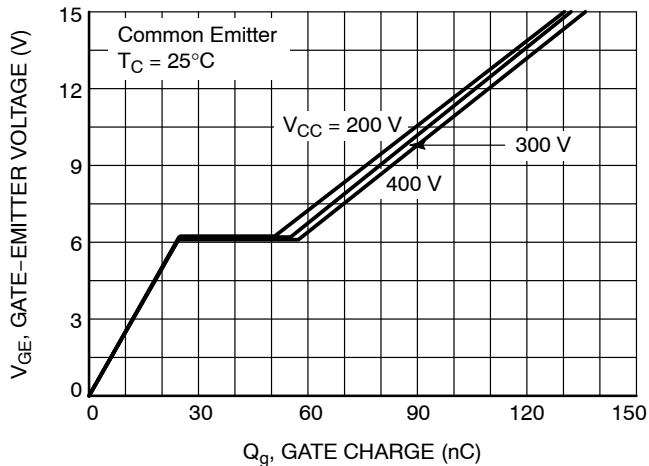


Figure 12. Gate Charge Characteristic (T<sub>C</sub> = 25°C)

TYPICAL CHARACTERISTICS

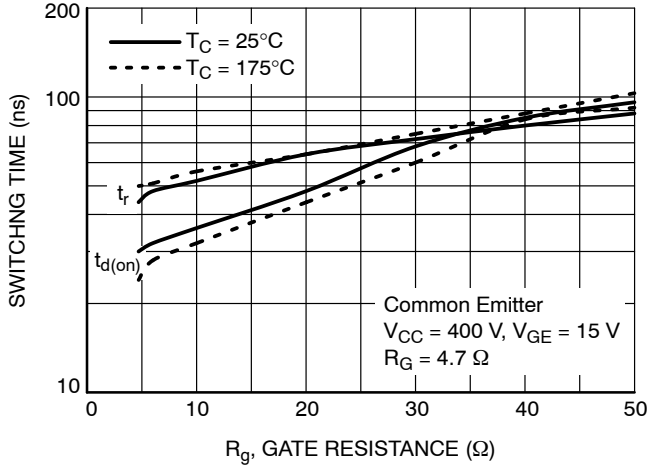


Figure 13. Turn-On Characteristics vs. Gate Resistance

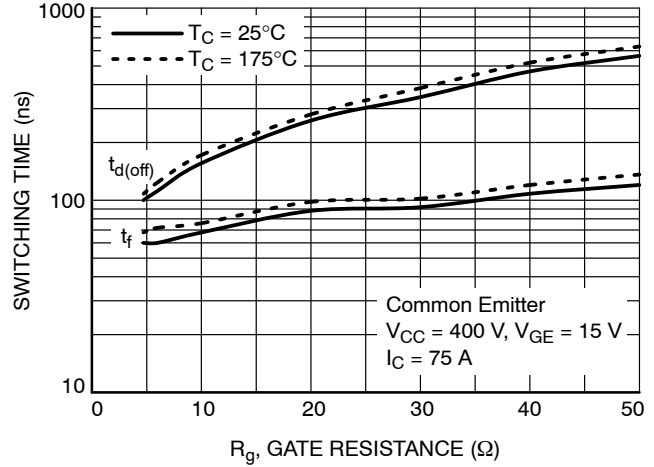


Figure 14. Turn-Off Characteristics vs. Gate Resistance

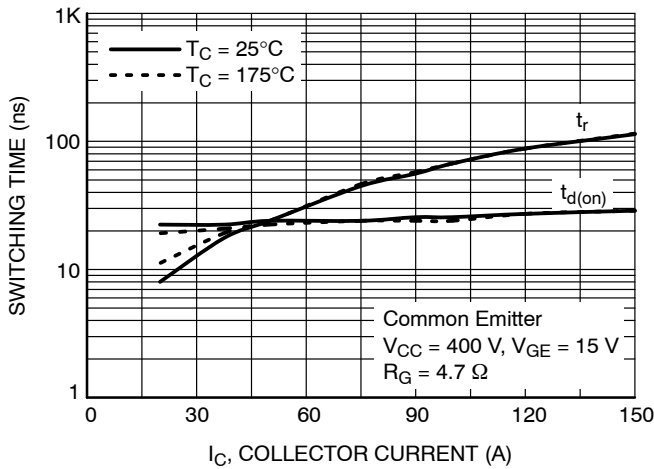


Figure 15. Turn-On Characteristics vs. Collector Current

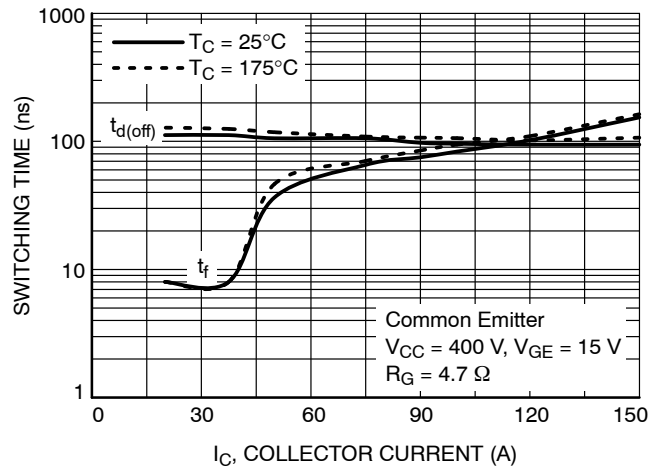


Figure 16. Turn-Off Characteristics vs. Collector Current

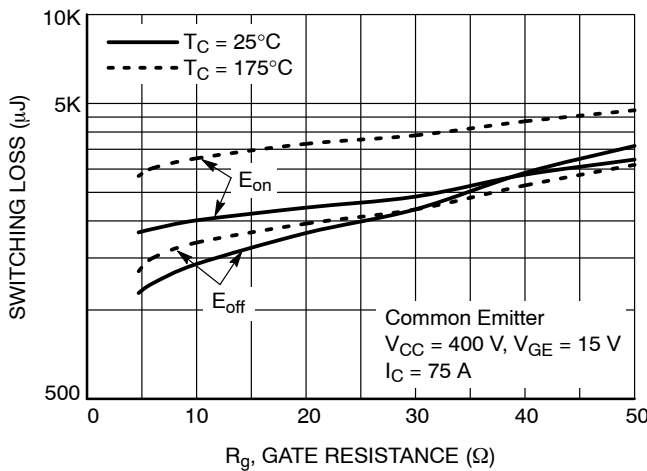


Figure 17. Switching Loss vs. Gate Resistance

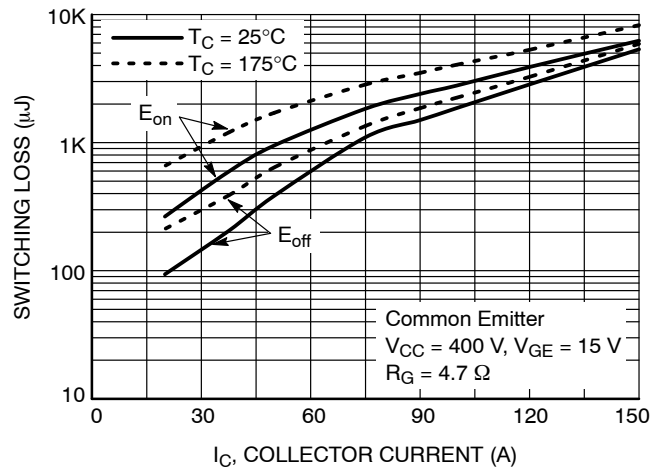


Figure 18. Switching Loss vs. Collector Current

# AFGHL75T65SQ

## TYPICAL CHARACTERISTICS

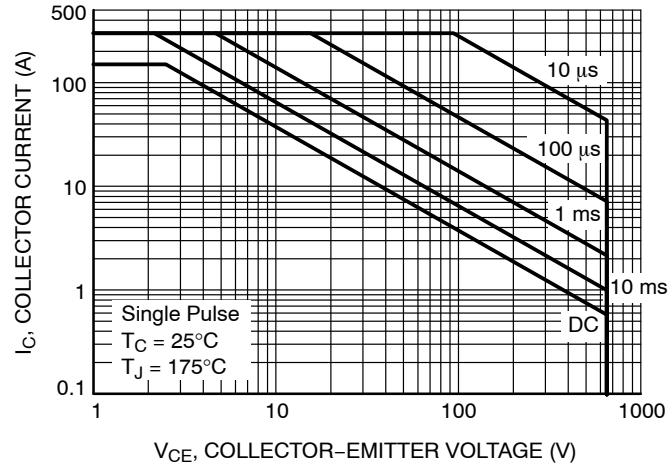


Figure 19. SOA Characteristics (FBSOA)

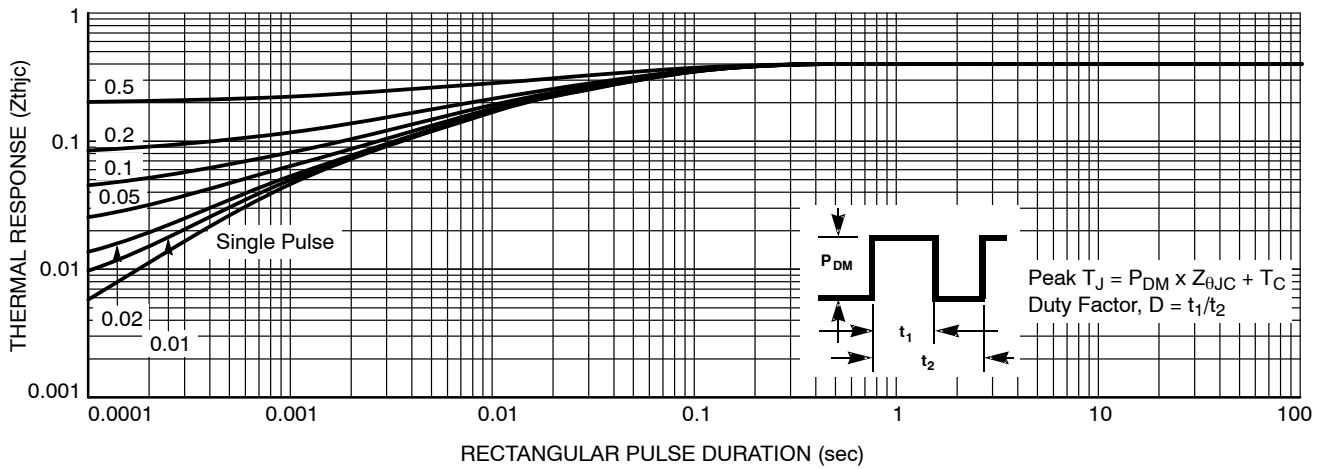


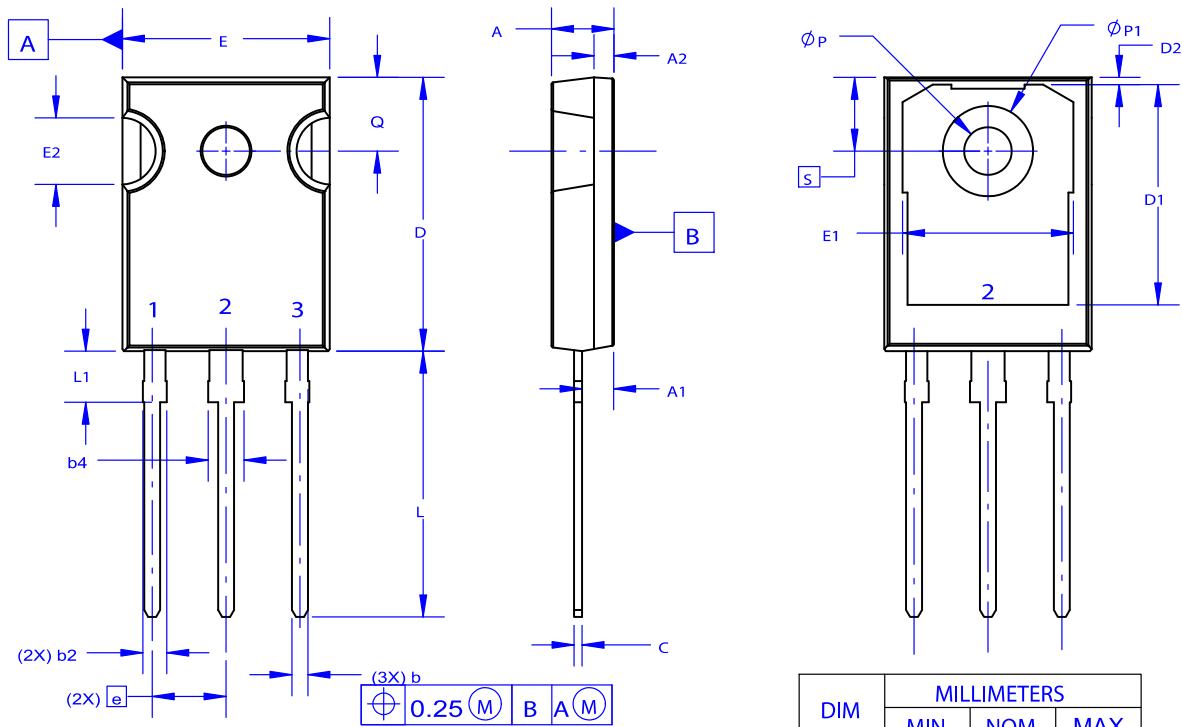
Figure 20. Transient Thermal Impedance of IGBT



# AFGHL75T65SQ

## PACKAGE DIMENSIONS

TO-247-3LD  
CASE 340CX  
ISSUE O




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  |
| phi P  | 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       | ~     | ~     |
| phi P1 | 6.60        | 6.80  | 7.00  |

# AFGHL75T65SQ

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