

# Hybrid Field Stop Trench IGBT

## 650 V, 75 A, TO247

### AFGHL75T65SQDC

Using the novel field stop 4th generation IGBT technology and the 1.5th generation SiC Schottky Diode technology, AFGHL75T65SQDC offers the optimum performance with both low conduction and switching losses for high efficiency operations in various applications, especially totem pole bridgeless PFC and Inverter.

#### 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
- No Reverse Recovery/No Forward Recovery
- 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 Transient Gate-to-Emitter Voltage	$V_{GES}$	$\pm 20$ $\pm 30$	V
Collector Current (Note 1)	$I_C$	80 75	A
		@ $T_C = 25^\circ\text{C}$ @ $T_C = 100^\circ\text{C}$	
Pulsed Collector Current (Note 2)	$I_{LM}$	300	A
Pulsed Collector Current (Note 3)	$I_{CM}$	300	A
Diode Forward Current (Note 1)	$I_F$	35 20	A
		@ $T_C = 25^\circ\text{C}$ @ $T_C = 100^\circ\text{C}$	
Pulsed Diode Maximum Forward Current	$I_{FM}$	200	A
Maximum Power Dissipation	$P_D$	375 188	W
		@ $T_C = 25^\circ\text{C}$ @ $T_C = 100^\circ\text{C}$	
Operating Junction / Storage Temperature Range	$T_J$ , $T_{STG}$	-55 to +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.

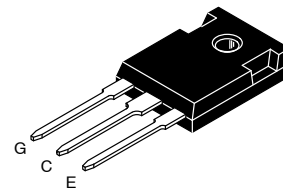
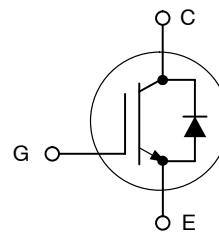
1. Value limited by bond wire
2.  $V_{CC} = 400\text{ V}$ ,  $V_{GE} = 15\text{ V}$ ,  $I_C = 300\text{ A}$ ,  $R_G = 15\ \Omega$ , Inductive Load, 100% of the Parts are Tested.
3. Repetitive Rating: pulse width limited by max. Junction temperature



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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  
 AFGHL75T65SQDC = Specific Device Code

#### ORDERING INFORMATION

Device	Package	Shipping
AFGHL75T65SQDC	TO-247-3L	30 Units / Rail

# AFGHL75T65SQDC

## 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-case, for Diode	$R_{\theta JC}$	1.55	$^{\circ}\text{C}/\text{W}$
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
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### OFF CHARACTERISTICS

Collector-emitter breakdown voltage, gate-emitter short-circuited	$V_{GE} = 0\text{ V},$ $I_C = 1\text{ mA}$	$BV_{CES}$	650	-	-	V
Temperature Coefficient of Breakdown Voltage	$V_{GE} = 0\text{ V},$ $I_C = 1\text{ mA}$	$\frac{\Delta BV_{CES}}{\Delta T_J}$	-	0.6	-	$\text{V}/^{\circ}\text{C}$
Collector-emitter cut-off current, gate-emitter short-circuited	$V_{GE} = 0\text{ V},$ $V_{CE} = 650\text{ V}$	$I_{CES}$	-	-	250	$\mu\text{A}$
Gate leakage current, collector-emitter short-circuited	$V_{GE} = 20\text{ V},$ $V_{CE} = 0\text{ V}$	$I_{GES}$	-	-	$\pm 400$	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	$V_{GE} = 15\text{ V}, I_C = 75\text{ A}$ $V_{GE} = 15\text{ V}, I_C = 75\text{ A}, T_J = 175^{\circ}\text{C}$	$V_{CE(sat)}$	-	1.6	2.1	V
			-	2.0	-	

### DYNAMIC CHARACTERISTICS

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

### SWITCHING CHARACTERISTICS, INDUCTIVE LOAD

Turn-on delay time	$T_C = 25^{\circ}\text{C},$ $V_{CC} = 400\text{ V},$ $I_C = 37.5\text{ A},$ $R_G = 4.7\ \Omega,$ $V_{GE} = 15\text{ V},$ Inductive Load	$t_{d(on)}$	-	22.4	-	ns
Rise time		$t_r$	-	19.2	-	
Turn-off delay time		$t_{d(off)}$	-	116.8	-	
Fall time		$t_f$	-	9.6	-	
Turn-on switching loss		$E_{on}$	-	0.48	-	mJ
Turn-off switching loss		$E_{off}$	-	0.24	-	
Total switching loss		$E_{ts}$	-	0.72	-	
Turn-on delay time	$T_C = 25^{\circ}\text{C},$ $V_{CC} = 400\text{ V},$ $I_C = 75\text{ A},$ $R_G = 4.7\ \Omega,$ $V_{GE} = 15\text{ V},$ Inductive Load	$t_{d(on)}$	-	24	-	ns
Rise time		$t_r$	-	49.6	-	
Turn-off delay time		$t_{d(off)}$	-	107.2	-	
Fall time		$t_f$	-	70.4	-	
Turn-on switching loss		$E_{on}$	-	1.68	-	mJ
Turn-off switching loss		$E_{off}$	-	1.11	-	
Total switching loss		$E_{ts}$	-	2.79	-	

# AFGHL75T65SQDC

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

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
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### SWITCHING CHARACTERISTICS, INDUCTIVE LOAD

Turn-on delay time	$T_C = 175^\circ\text{C}$ , $V_{CC} = 400\text{ V}$ , $I_C = 37.5\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GE} = 15\text{ V}$ , Inductive Load	$t_{d(on)}$	-	20.8	-	ns
Rise time		$t_r$	-	22.4	-	
Turn-off delay time		$t_{d(off)}$	-	130	-	
Fall time		$t_f$	-	9.6	-	
Turn-on switching loss		$E_{on}$	-	0.53	-	mJ
Turn-off switching loss		$E_{off}$	-	0.44	-	
Total switching loss		$E_{ts}$	-	0.98	-	
Turn-on delay time	$T_C = 175^\circ\text{C}$ , $V_{CC} = 400\text{ V}$ , $I_C = 75\text{ A}$ , $R_G = 4.7\ \Omega$ , $V_{GE} = 15\text{ V}$ , Inductive Load	$t_{d(on)}$	-	24	-	ns
Rise time		$t_r$	-	49.6	-	
Turn-off delay time		$t_{d(off)}$	-	118	-	
Fall time		$t_f$	-	78.4	-	
Turn-on switching loss		$E_{on}$	-	1.76	-	mJ
Turn-off switching loss		$E_{off}$	-	1.42	-	
Total switching loss		$E_{ts}$	-	3.19	-	

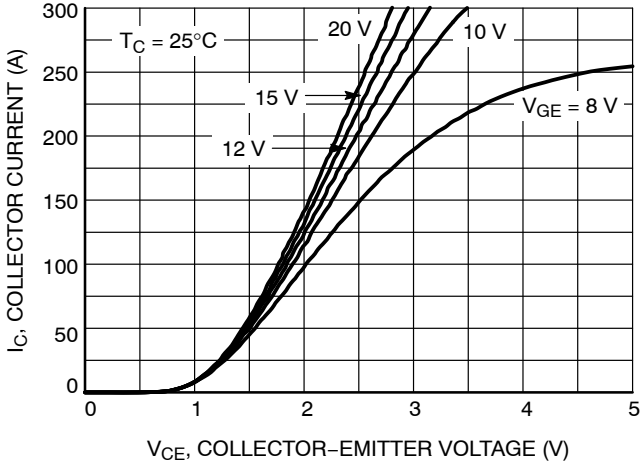
### DIODE CHARACTERISTICS

Forward Voltage	$I_F = 20\text{ A}$	$V_F$	-	1.45	1.75	V
	$I_F = 20\text{ A}, T_J = 175^\circ\text{C}$		-	1.80	-	
Total Capacitance	$V_R = 400\text{ V}, f = 1\text{ MHz}$	C	-	110	-	pF
	$V_R = 400\text{ V}, f = 1\text{ MHz}$		-	105	-	

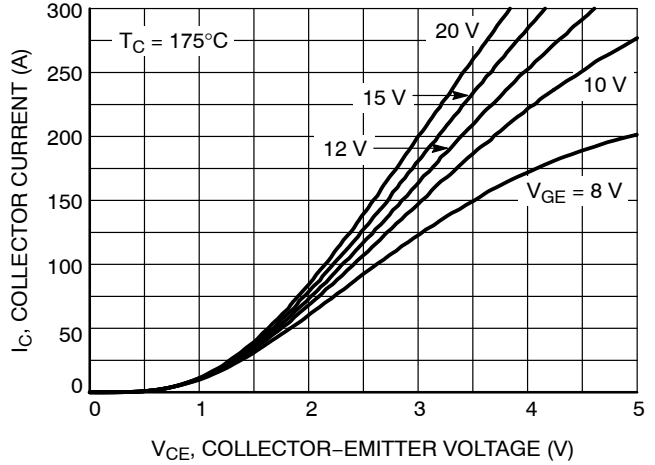
Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

# AFGHL75T65SQDC

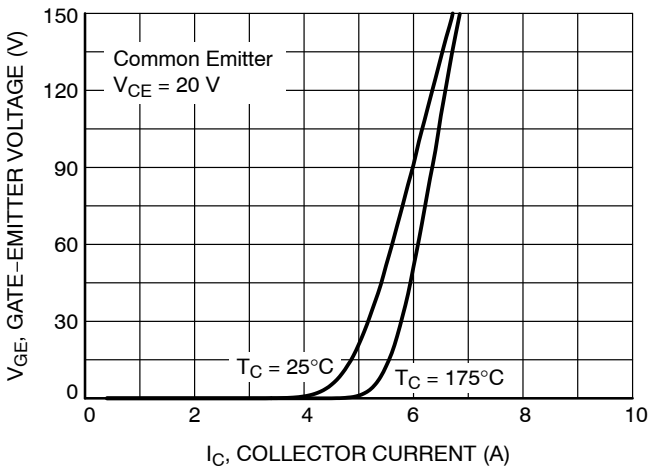
## TYPICAL CHARACTERISTICS



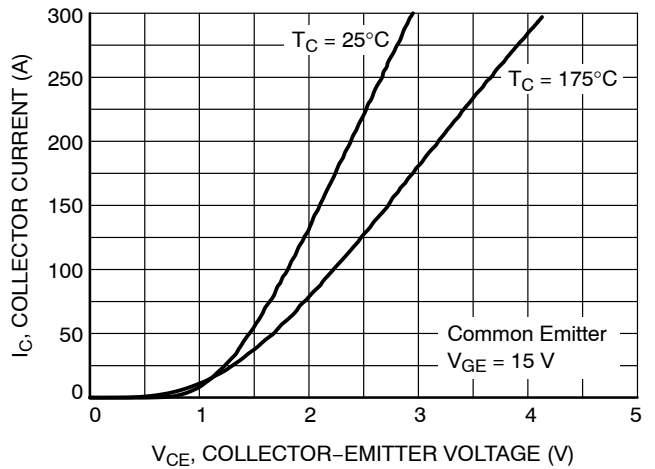
**Figure 1. Typical Output Characteristics**  
( $T_c = 25^\circ\text{C}$ )



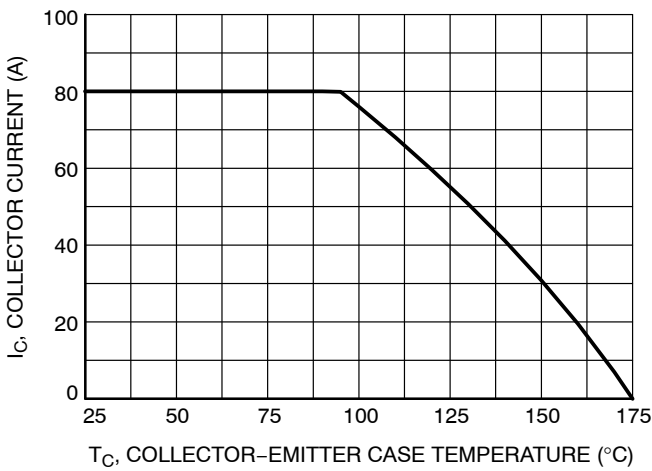
**Figure 2. Typical Output Characteristics**  
( $T_c = 175^\circ\text{C}$ )



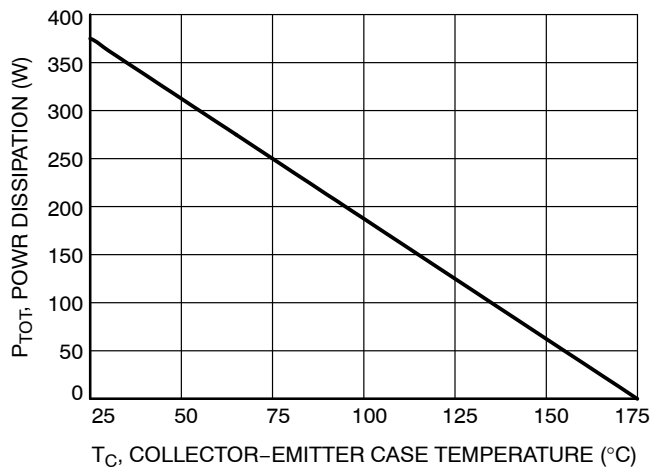
**Figure 3. Transfer Characteristics**



**Figure 4. Typical Saturation Voltage**  
**Characteristics**



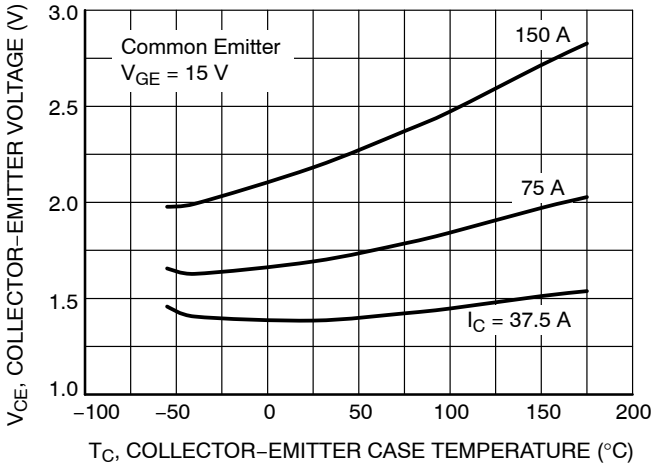
**Figure 5. Collector Current Derating**



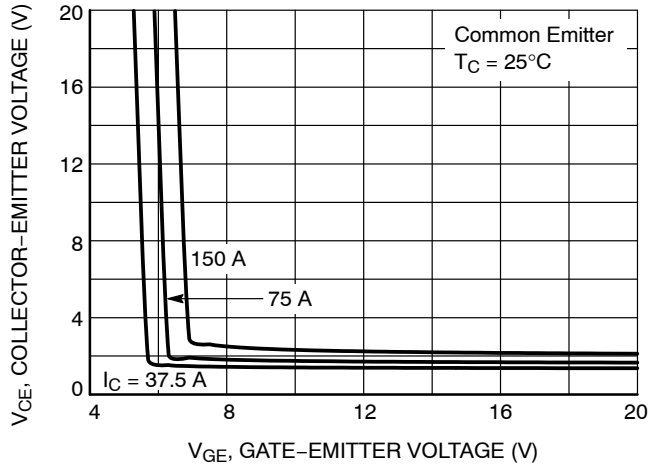
**Figure 6. Power Dissipation**

# AFGHL75T65SQDC

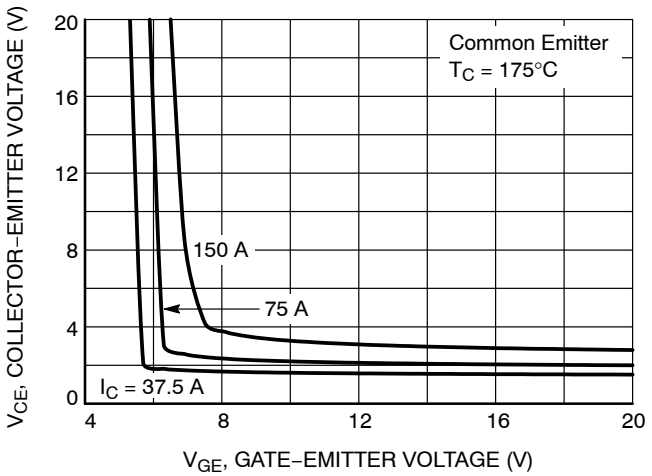
## TYPICAL CHARACTERISTICS



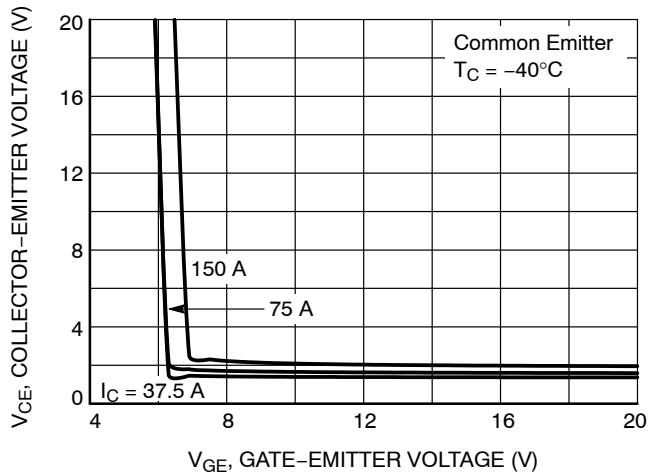
**Figure 7. Saturation Voltage vs. Case Temperature at Variant Current Level**



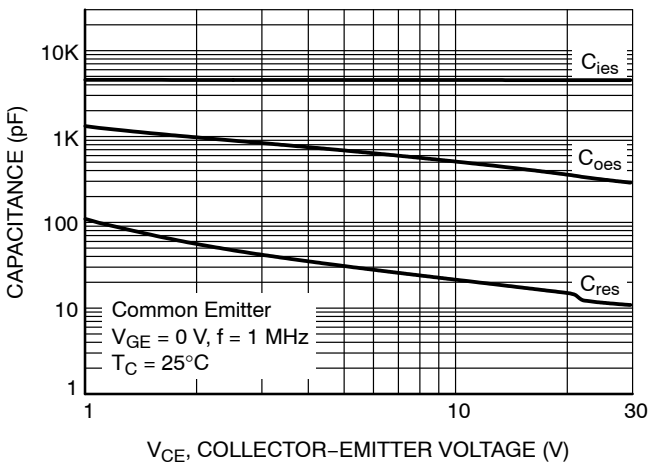
**Figure 8. Saturation Voltage vs. V<sub>GE</sub> (T<sub>C</sub> = 25°C)**



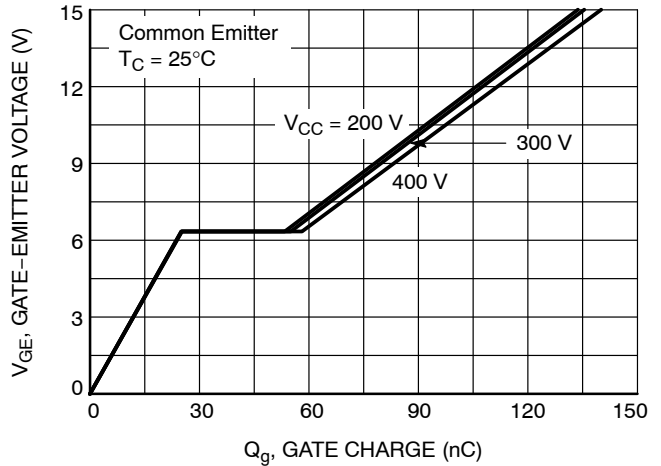
**Figure 9. Saturation Voltage vs. V<sub>GE</sub> (T<sub>C</sub> = 175°C)**



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



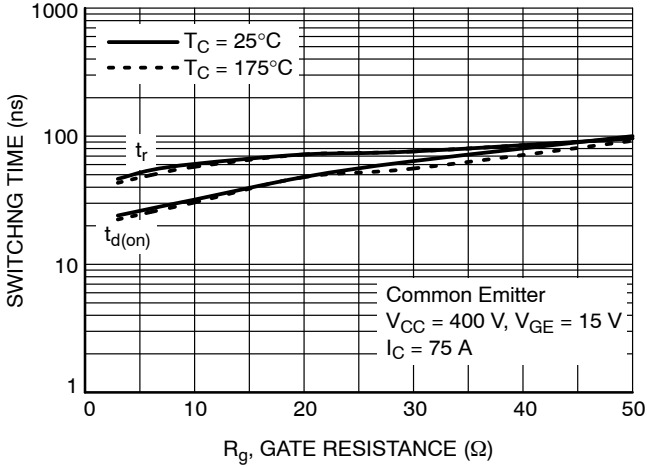
**Figure 11. Capacitance Characteristics**



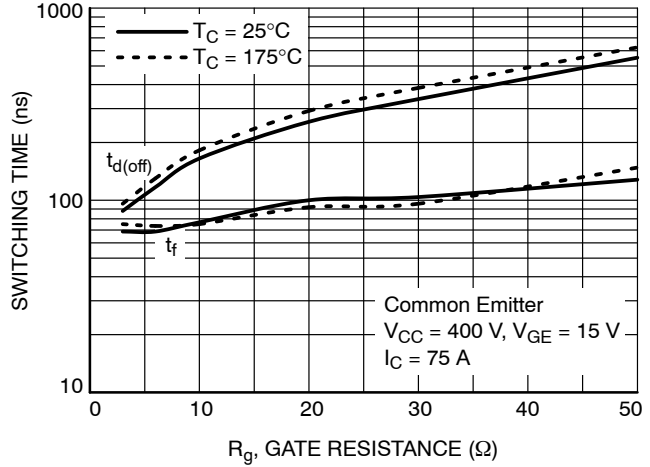
**Figure 12. Gate Charge Characteristic (T<sub>C</sub> = 25°C)**

# AFGHL75T65SQDC

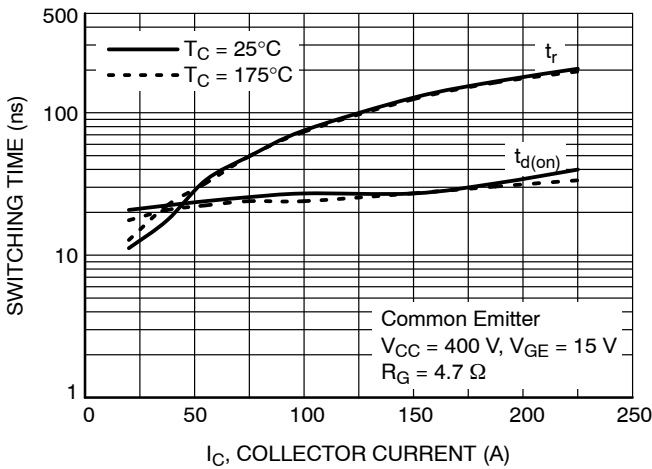
## TYPICAL CHARACTERISTICS



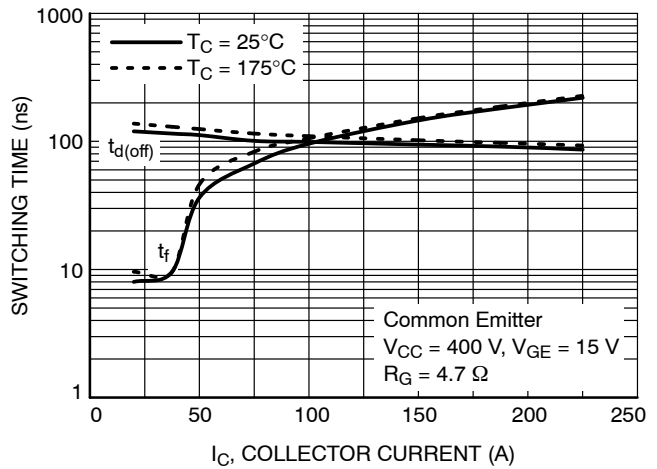
**Figure 13. Turn-On Characteristics vs. Gate Resistance**



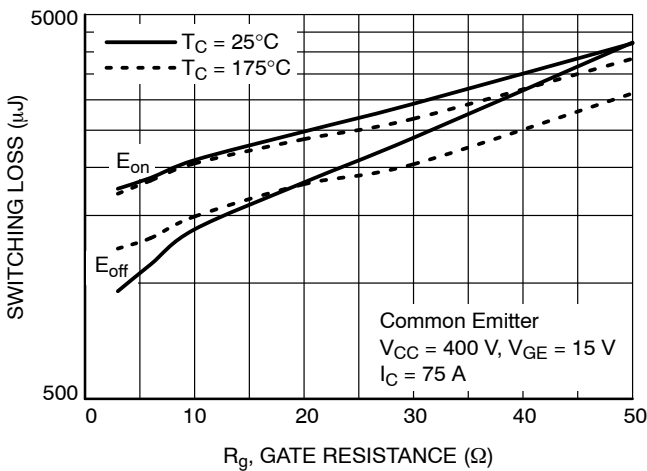
**Figure 14. Turn-Off Characteristics vs. Gate Resistance**



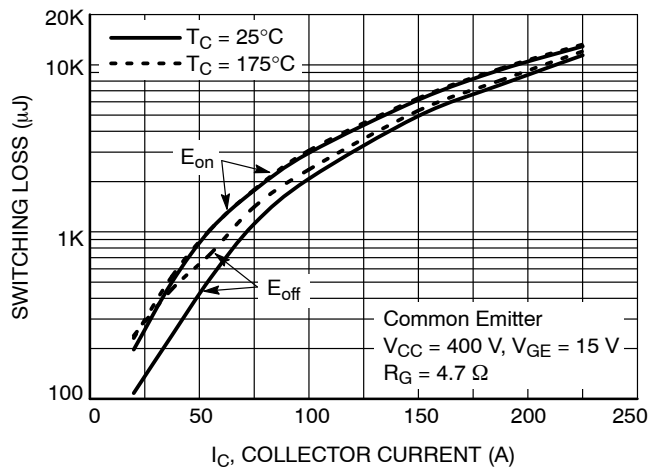
**Figure 15. Turn-On Characteristics vs. Collector Current**



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



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



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

# AFGHL75T65SQDC

## TYPICAL CHARACTERISTICS

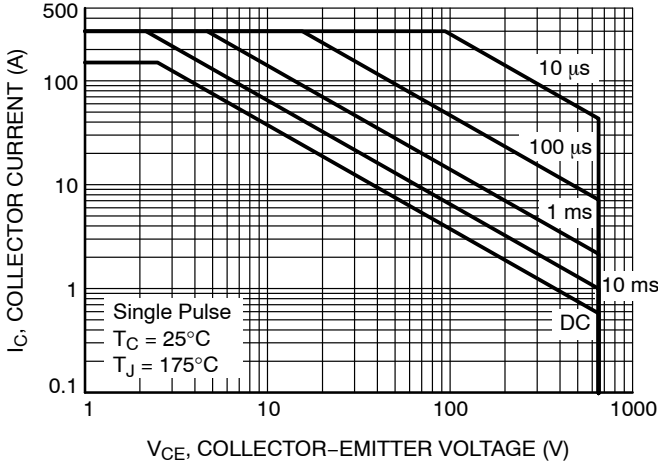


Figure 19. SOA Characteristics (FBSOA)

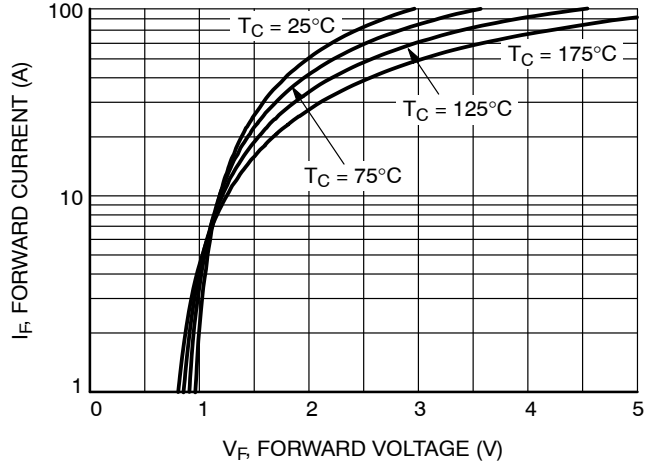


Figure 20. (Diode) Forward Characteristics vs. (Normal I-V)

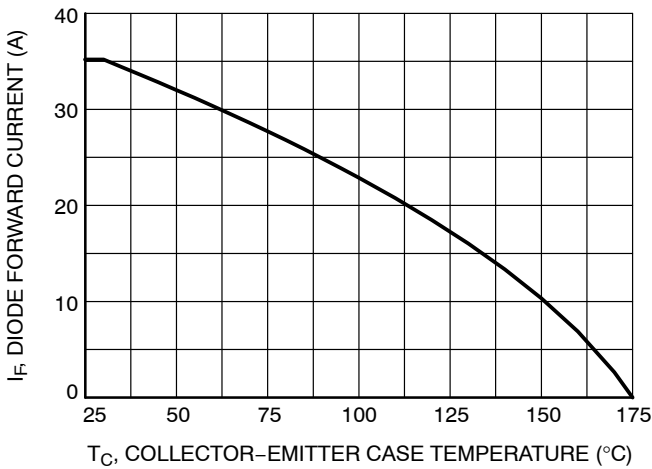


Figure 21. (Diode) Forward Current Derating

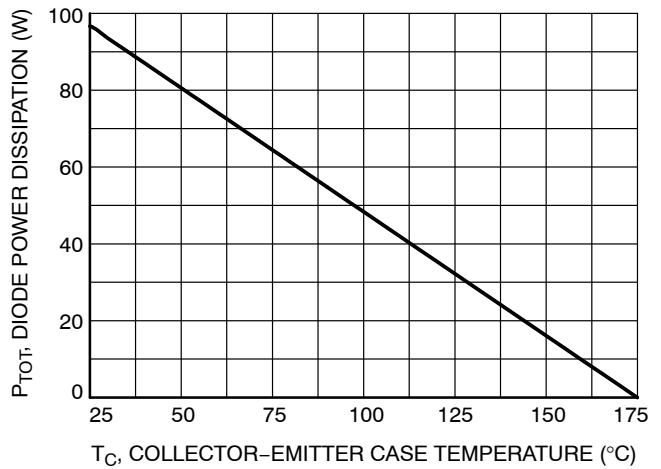


Figure 22. (Diode) Power Derating

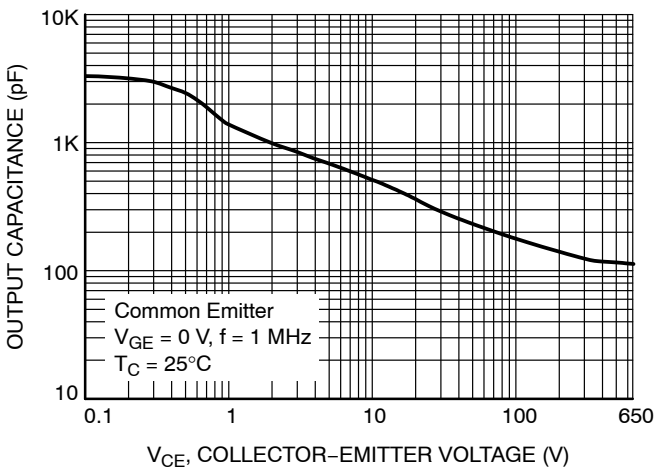


Figure 23. (Diode) Output Capacitance (Coes) vs. Reverse Voltage

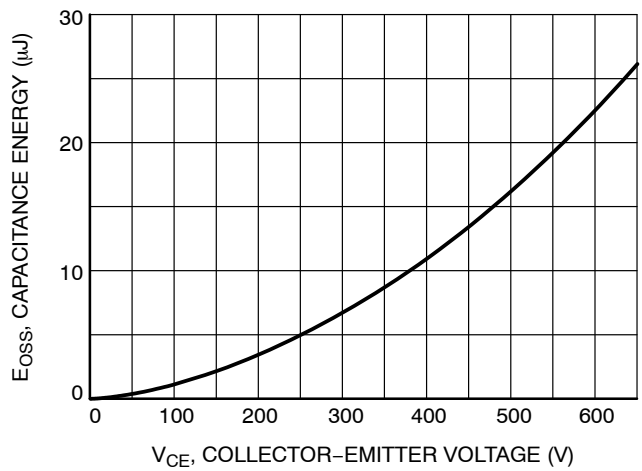


Figure 24. (Diode) Output Capacitance Stored Energy

# AFGHL75T65SQDC

## TYPICAL CHARACTERISTICS

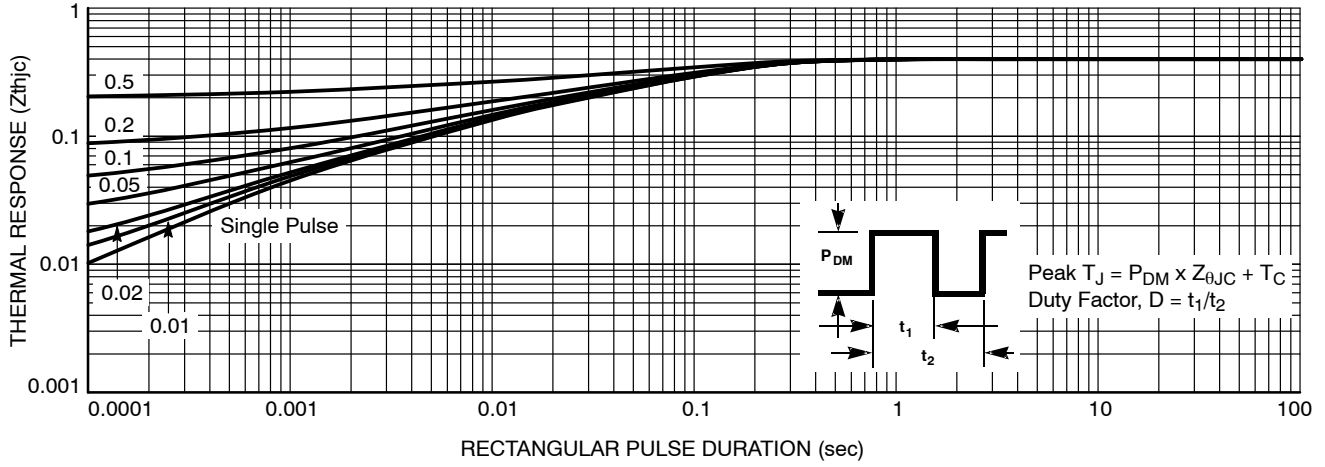


Figure 25. Transient Thermal Impedance of IGBT

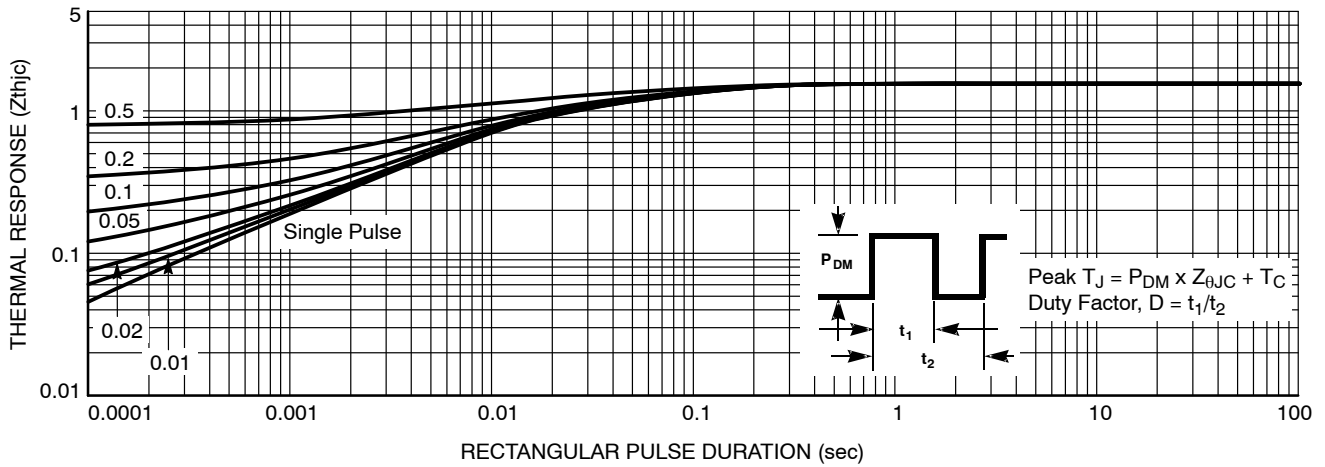


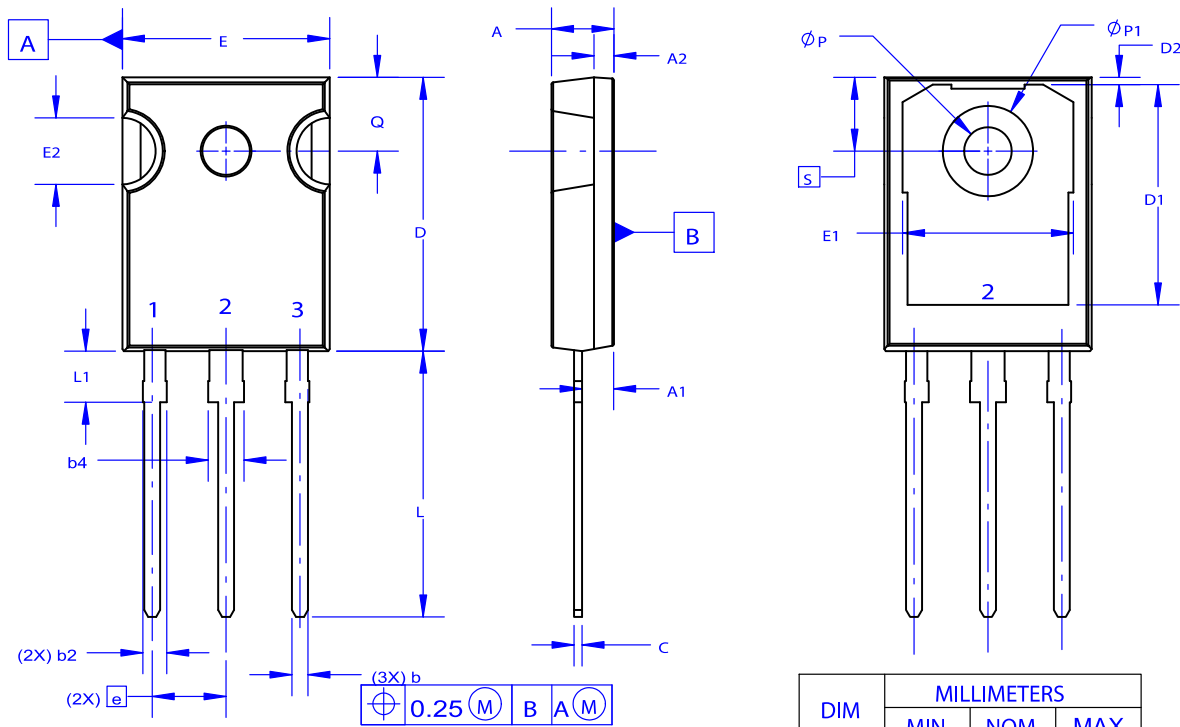
Figure 26. Transient Thermal Impedance of Diode



# AFGHL75T65SQDC

## 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

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