



# THE DATASHEET OF AUIRG4PH50S



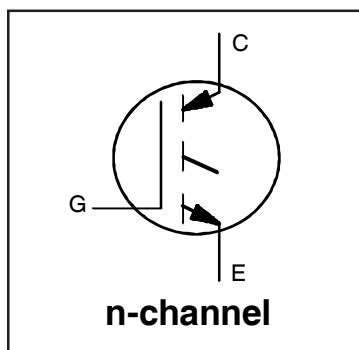
**INSULATED GATE BIPOLAR TRANSISTOR**

**Features**

- Standard: Optimized for minimum saturation voltage and low operating frequencies (< 1kHz)
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency
- Industry standard TO-247AC package
- Lead-Free
- Automotive Qualified \*

**Benefits**

- Generation 4 IGBT's offer highest efficiency available
- IGBT's optimized for specified application conditions



$V_{CES} = 1200V$   
 $I_C = 81A @ T_C = 100^{\circ}C$   
 $V_{CE(on)} \text{ typ.} = 1.47V @ 33A$



TO-247AC

<b>G</b>	<b>C</b>	<b>E</b>
Gate	Collector	Emitter

Base part number	Package Type	Standard Pack		Complete Part Number
		Form	Quantity	
AUIRG4PH50S	TO-247AC	Tube	25	AUIRG4PH50S

**Absolute Maximum Ratings**

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only; and functional operation of the device at these or any other condition beyond those indicated in the specifications is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability. The thermal resistance and power dissipation ratings are measured under board mounted and still air conditions. Ambient temperature ( $T_A$ ) is  $25^{\circ}C$ , unless otherwise specified.

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	1200	V
$I_C @ T_C = 25^{\circ}C$	Continuous Collector Current	141 <sup>⑤</sup>	A
$I_C @ T_C = 100^{\circ}C$	Continuous Collector Current	81	
$I_{CM}$	Pulse Collector Current, $V_{GE} = 15V$ ②	99	
$I_{LM}$	Clamped Inductive Load Current, $V_{GE} = 20V$ ①	99	
$V_{GE}$	Continuous Gate-to-Emitter Voltage	$\pm 20$	V
	Transient Gate-to-Emitter Voltage	$\pm 30$	
$P_D @ T_C = 25^{\circ}C$	Maximum Power Dissipation	543	W
$P_D @ T_C = 100^{\circ}C$	Maximum Power Dissipation	217	
$T_J$	Operating Junction and	-55 to +150	$^{\circ}C$
$T_{STG}$	Storage Temperature Range		
	Soldering Temperature, for 10 sec. (1.6mm from case)	300	
	Mounting Torque, 6-32 or M3 Screw	10 lbf-in (1.1N-m)	

**Thermal Resistance**

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$ (IGBT)	Thermal Resistance Junction-to-Case (IGBT) ④	—	—	0.23	$^{\circ}C/W$
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink (flat, greased surface)	—	0.24	—	
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	—	40	—	

\*Qualification standards can be found at <http://www.irf.com/>

**Electrical Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)**

	Parameter	Min.	Typ.	Max.	Units	Conditions
V <sub>(BR)CES</sub>	Collector-to-Emitter Breakdown Voltage	1200	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 250μA ③
ΔV <sub>(BR)CES</sub> /ΔT <sub>J</sub>	Temperature Coeff. of Breakdown Voltage	—	1.2	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1mA (25°C-150°C) ③
V <sub>CE(on)</sub>	Collector-to-Emitter Saturation Voltage	—	1.47	1.7	V	I <sub>C</sub> = 33A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 25°C
		—	1.55	—		I <sub>C</sub> = 33A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 150°C
V <sub>GE(th)</sub>	Gate Threshold Voltage	3.0	—	6.0	V	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA
ΔV <sub>GE(th)</sub> /ΔT <sub>J</sub>	Threshold Voltage temp. coefficient	—	-11	—	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA (25°C - 150°C)
g <sub>fe</sub>	Forward Transconductance	—	30	—	S	V <sub>CE</sub> = 50V, I <sub>C</sub> = 33A, PW = 20μs
I <sub>CES</sub>	Collector-to-Emitter Leakage Current	—	—	250	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 1200V, T <sub>J</sub> = 25°C
		—	—	1000		V <sub>GE</sub> = 0V, V <sub>CE</sub> = 1200V, T <sub>J</sub> = 150°C
I <sub>GES</sub>	Gate-to-Emitter Leakage Current	—	—	±100	nA	V <sub>GE</sub> = ±20V

**Switching Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)**

	Parameter	Min.	Typ.	Max.	Units	Conditions
Q <sub>g</sub>	Total Gate Charge (turn-on)	—	151	227	nC	I <sub>C</sub> = 33A V <sub>GE</sub> = 15V V <sub>CC</sub> = 600V
Q <sub>ge</sub>	Gate-to-Emitter Charge (turn-on)	—	26	39		
Q <sub>gc</sub>	Gate-to-Collector Charge (turn-on)	—	62	93		
E <sub>off</sub>	Turn-Off Switching Loss	—	15	16	mJ	I <sub>C</sub> = 33A, V <sub>CC</sub> = 600V, V <sub>GE</sub> = 15V R <sub>G</sub> = 5Ω, L = 400μH, T <sub>J</sub> = 25°C Energy losses include tail
t <sub>d(off)</sub>	Turn-Off delay time	—	485	616	ns	I <sub>C</sub> = 33A, V <sub>CC</sub> = 600V, V <sub>GE</sub> = 15V R <sub>G</sub> = 5Ω, L = 400μH, T <sub>J</sub> = 25°C
t <sub>f</sub>	Fall time	—	1193	1371		
E <sub>off</sub>	Turn-Off Switching Loss	—	29	—	mJ	I <sub>C</sub> = 33A, V <sub>CC</sub> = 600V, V <sub>GE</sub> = 15V R <sub>G</sub> = 5Ω, L = 400μH, T <sub>J</sub> = 150°C Energy losses include tail
t <sub>d(off)</sub>	Turn-Off delay time	—	689	—	ns	I <sub>C</sub> = 33A, V <sub>CC</sub> = 600V, V <sub>GE</sub> = 15V R <sub>G</sub> = 5Ω, L = 400μH, T <sub>J</sub> = 150°C
t <sub>f</sub>	Fall time	—	2462	—		
C <sub>ies</sub>	Input Capacitance	—	3804	—	pF	V <sub>GE</sub> = 0V V <sub>CC</sub> = 30V f = 1.0Mhz
C <sub>oes</sub>	Output Capacitance	—	161	—		
C <sub>res</sub>	Reverse Transfer Capacitance	—	31	—		
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T <sub>J</sub> = 150°C, I <sub>C</sub> = 99A V <sub>CC</sub> = 960V, V <sub>p</sub> ≤ 1200V R <sub>G</sub> = 5Ω, V <sub>GE</sub> = +20V to 0V

**Notes:**

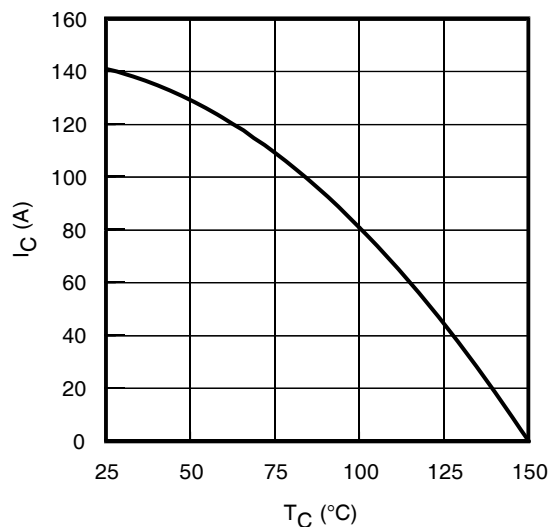
- ① V<sub>CC</sub> = 80% (V<sub>CES</sub>), V<sub>GE</sub> = 20V, L = 400μH, R<sub>G</sub> = 50Ω.
- ② Pulse width limited by max. junction temperature.
- ③ Refer to AN-1086 for guidelines for measuring V<sub>(BR)CES</sub> safely.
- ④ R<sub>θ</sub> is measured at T<sub>J</sub> of approximately 90°C.
- ⑤ Calculated continuous current based on maximum allowable junction temperature. Bond wire current limit is 78A. Note that current limitations arising from heating of the device leads may occur with some lead mounting arrangements.

**Qualification Information<sup>†</sup>**

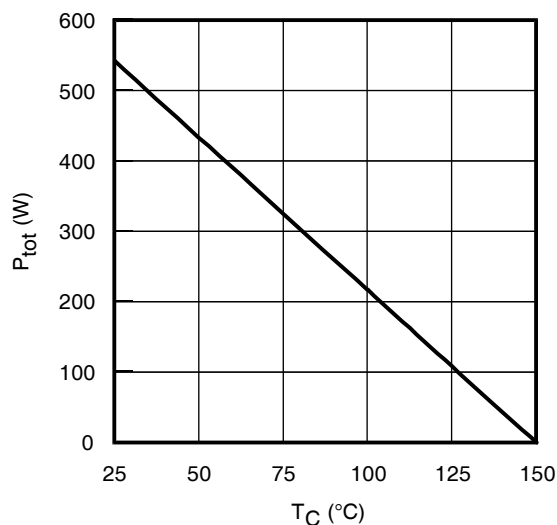
<b>Qualification Level</b>		Automotive (per AEC-Q101) <sup>††</sup>	
		This part number(s) passed Automotive qualification. IR's Industrial and Consumer qualification level is granted by extension of the higher Automotive level.	
<b>Moisture Sensitivity Level</b>		TO-247AC	N/A
<b>ESD</b>	Machine Model	Class M3 AEC-Q101-002	
	Human Body Model	Class H2 AEC-Q101-001	
	Charged Device Model	Class C4 AEC-Q101-005	
<b>RoHS Compliant</b>		Yes	

<sup>†</sup> Qualification standards can be found at International Rectifier's web site: <http://www.irf.com/>

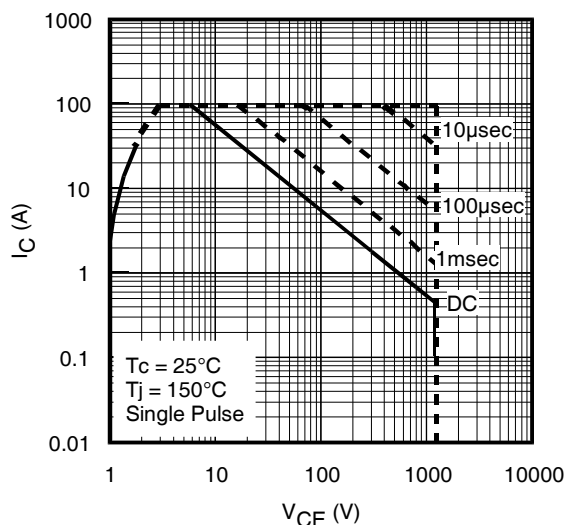
<sup>††</sup> Highest passing voltage.



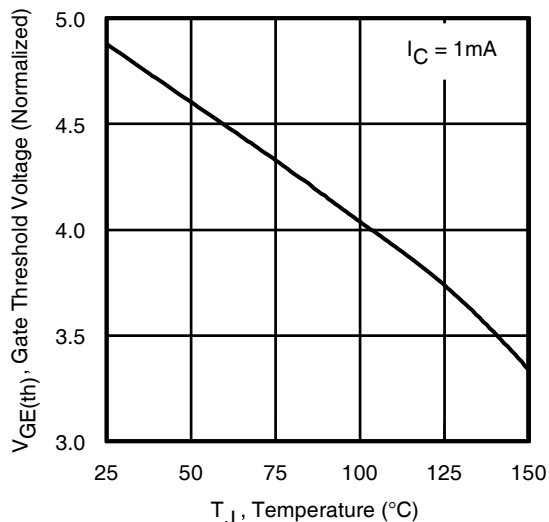
**Fig. 1** - Maximum DC Collector Current vs. Case Temperature



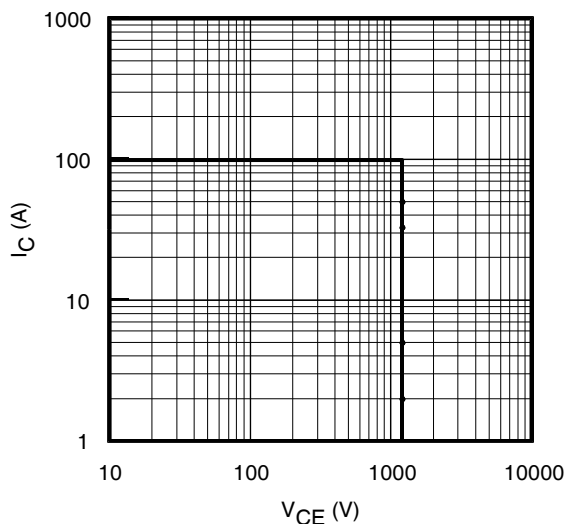
**Fig. 2** - Power Dissipation vs. Case Temperature



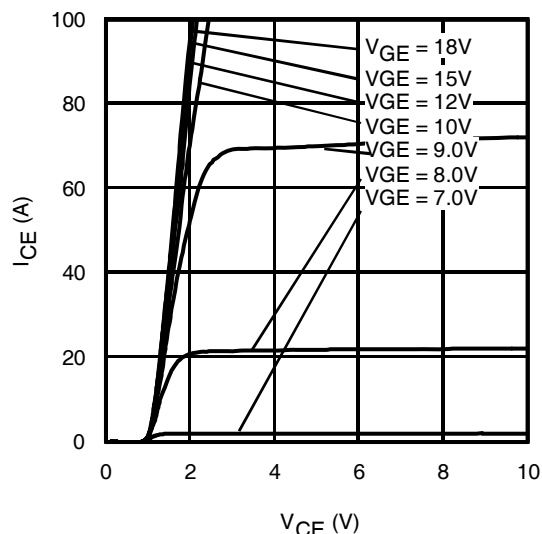
**Fig. 3** - Forward SOA  
 $T_C = 25^\circ\text{C}$ ,  $T_J \leq 150^\circ\text{C}$ ;  $V_{GE} = 15\text{V}$



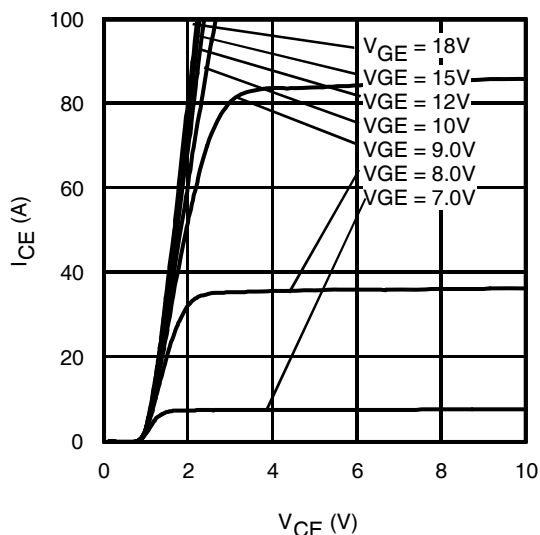
**Fig. 4** - Typical Gate Threshold Voltage (Normalized) vs. Junction Temperature



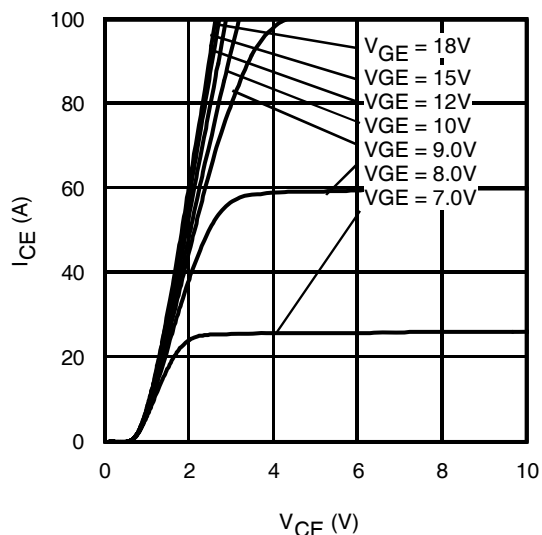
**Fig. 5** - Reverse Bias SOA  
 $T_J = 150^\circ\text{C}$ ;  $V_{GE} = 20\text{V}$



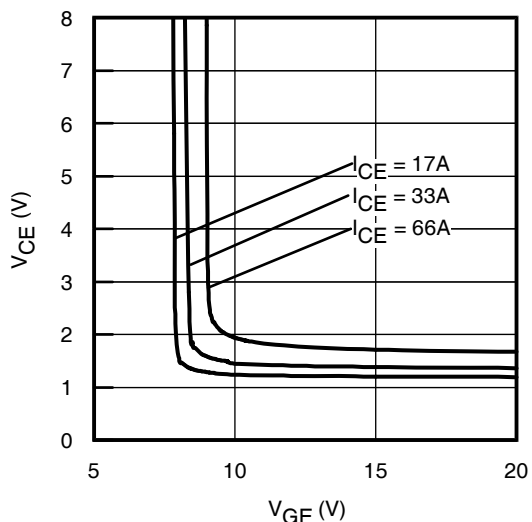
**Fig. 6** - Typ. IGBT Output Characteristics  
 $T_J = -40^\circ\text{C}$ ;  $t_p = 20\mu\text{s}$



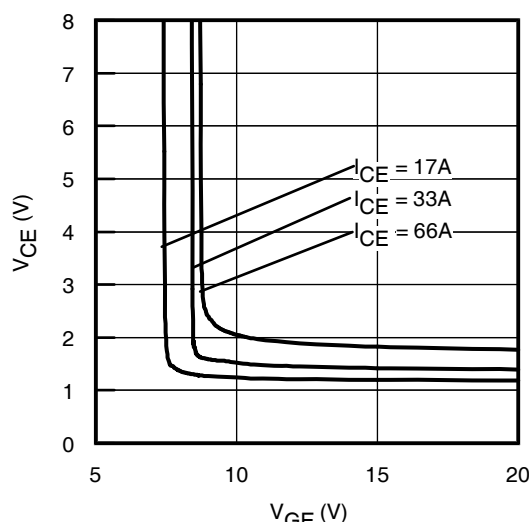
**Fig. 7 - Typ. IGBT Output Characteristics**  
 $T_J = 25^\circ\text{C}$ ;  $t_p = 20\mu\text{s}$



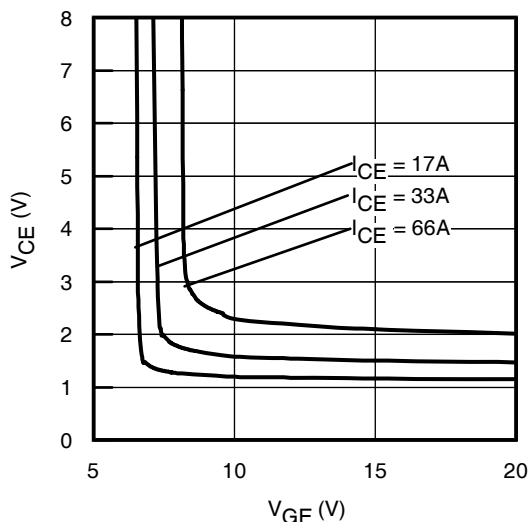
**Fig. 8 - Typ. IGBT Output Characteristics**  
 $T_J = 150^\circ\text{C}$ ;  $t_p = 20\mu\text{s}$



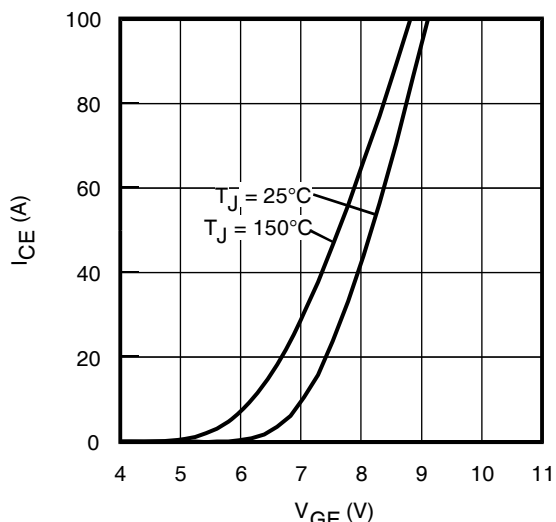
**Fig. 9 - Typical  $V_{CE}$  vs.  $V_{GE}$**   
 $T_J = -40^\circ\text{C}$



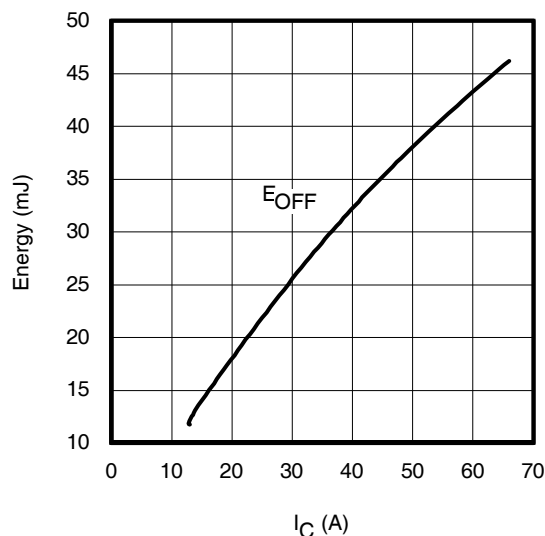
**Fig. 10 - Typical  $V_{CE}$  vs.  $V_{GE}$**   
 $T_J = 25^\circ\text{C}$



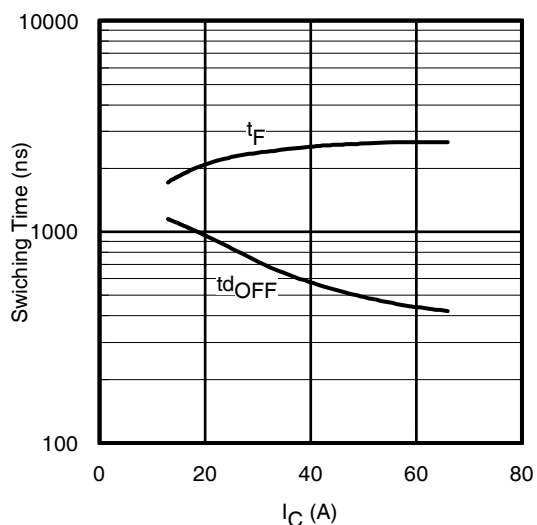
**Fig. 11 - Typical  $V_{CE}$  vs.  $V_{GE}$**   
 $T_J = 150^\circ\text{C}$



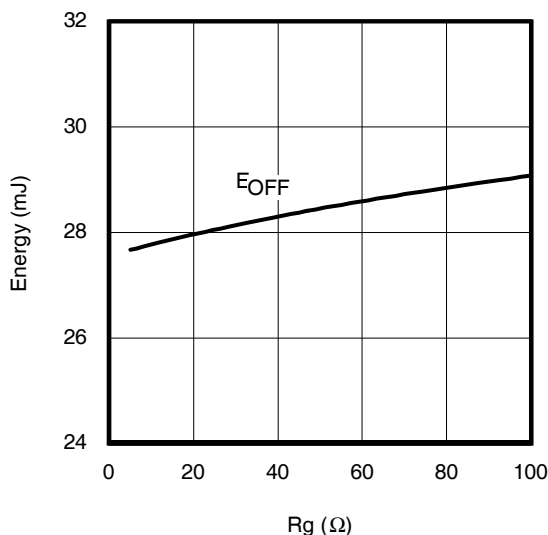
**Fig. 12- Typ. Transfer Characteristics**  
 $V_{CE} = 50\text{V}$ ;  $t_p = 20\mu\text{s}$



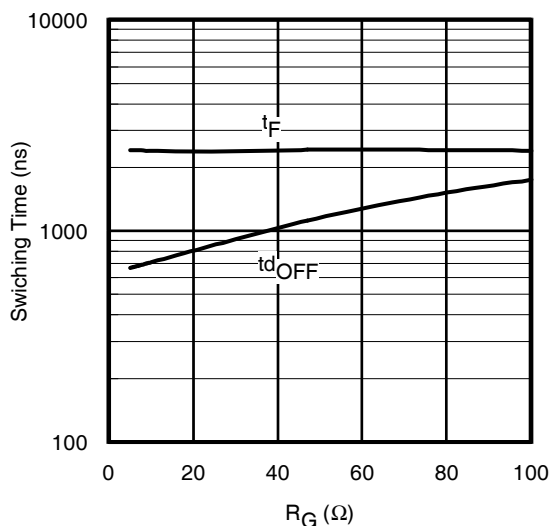
**Fig. 13 - Typ. Energy Loss vs.  $I_C$**   
 $T_J = 150^\circ\text{C}$ ;  $L = 400\mu\text{H}$ ;  $V_{CE} = 600\text{V}$ ,  $R_G = 5\Omega$ ;  $V_{GE} = 15\text{V}$



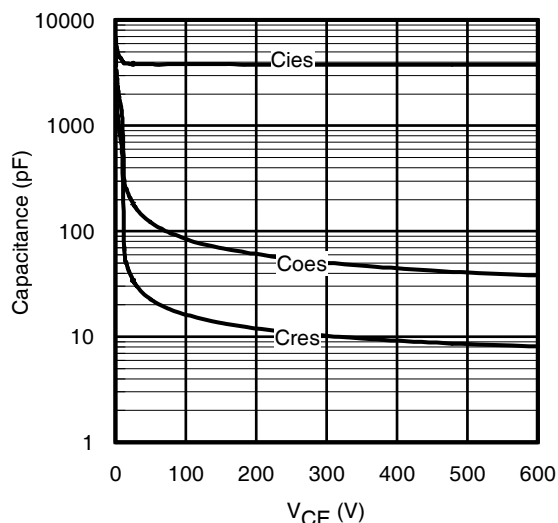
**Fig. 14 - Typ. Switching Time vs.  $I_C$**   
 $T_J = 150^\circ\text{C}$ ;  $L = 400\mu\text{H}$ ;  $V_{CE} = 600\text{V}$ ,  $R_G = 5\Omega$ ;  $V_{GE} = 15\text{V}$



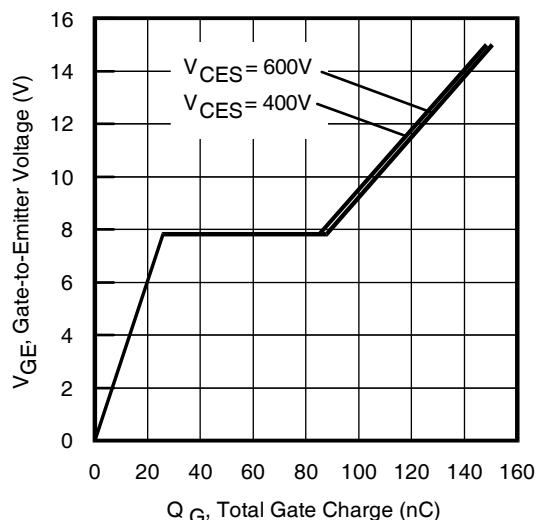
**Fig. 15 - Typ. Energy Loss vs.  $R_G$**   
 $T_J = 150^\circ\text{C}$ ;  $L = 400\mu\text{H}$ ;  $V_{CE} = 600\text{V}$ ,  $I_{CE} = 33\text{A}$ ;  $V_{GE} = 15\text{V}$



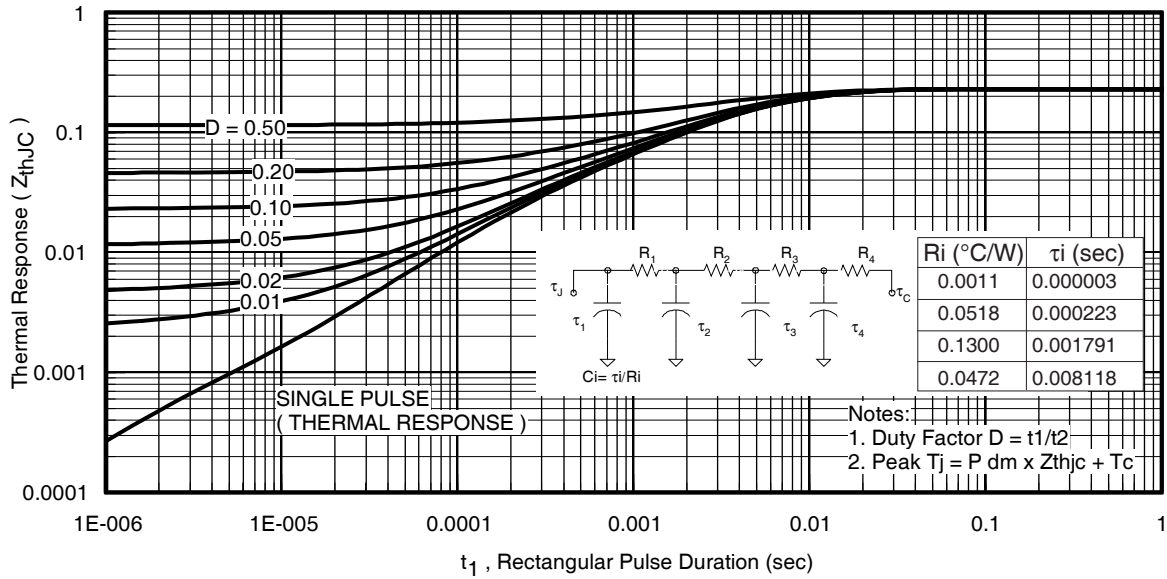
**Fig. 16 - Typ. Switching Time vs.  $R_G$**   
 $T_J = 150^\circ\text{C}$ ;  $L = 400\mu\text{H}$ ;  $V_{CE} = 600\text{V}$ ,  $I_{CE} = 33\text{A}$ ;  $V_{GE} = 15\text{V}$



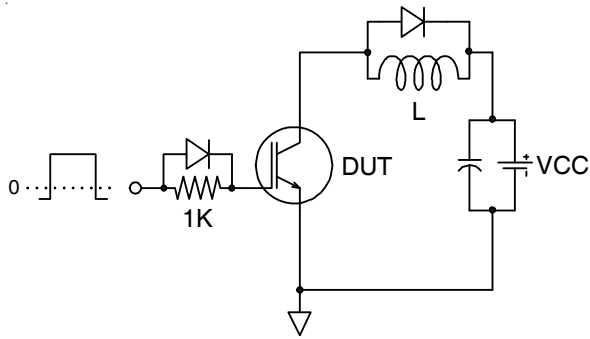
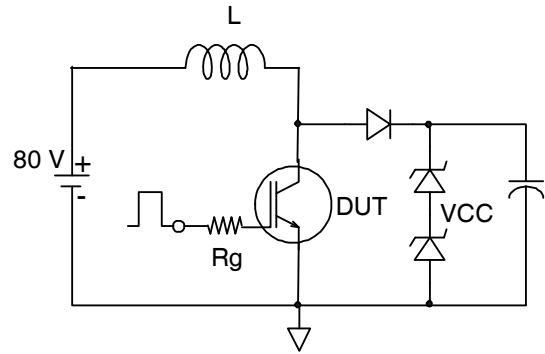
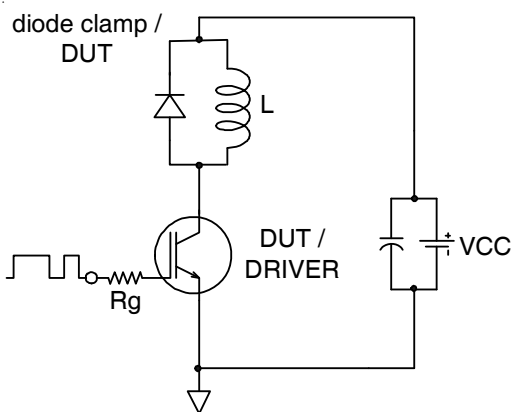
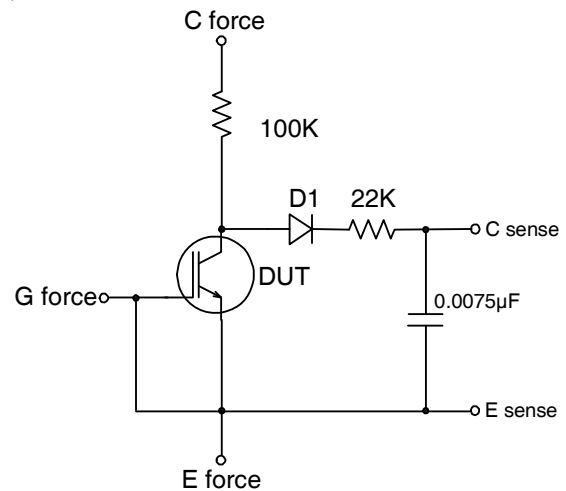
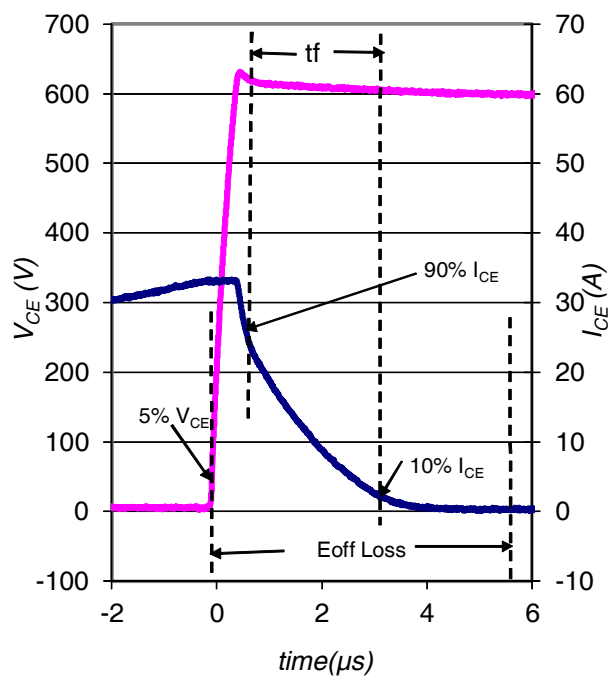
**Fig. 17 - Typ. Capacitance vs.  $V_{CE}$**   
 $V_{GE} = 0\text{V}$ ;  $f = 1\text{MHz}$



**Fig. 18 - Typical Gate Charge vs.  $V_{GE}$**   
 $I_{CE} = 33\text{A}$ ;  $L = 2.0\text{mH}$

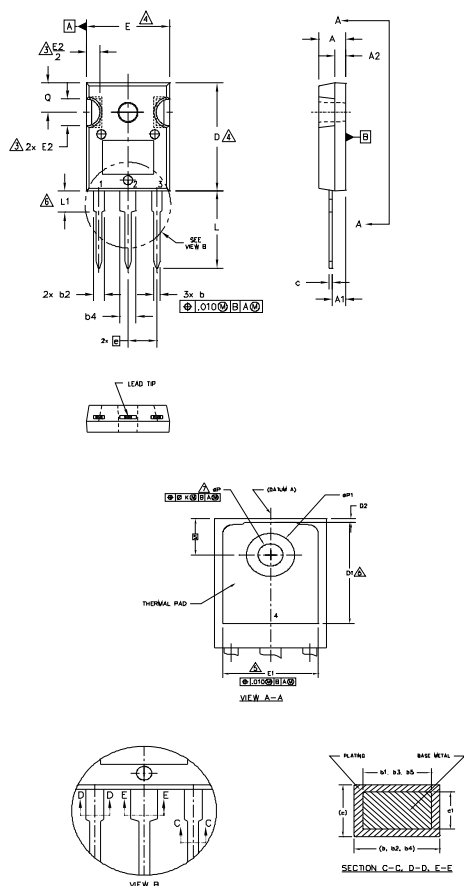


**Fig 19.** Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)


**Fig.C.T.1 - Gate Charge Circuit (turn-off)**

**Fig.C.T.2 - RBSOA Circuit**

**Fig.C.T.3 - Switching Loss Circuit**

**Fig.C.T.4 - BVCES Filter Circuit**

**Fig. WF1 - Typ. Turn-off Loss Waveform**  
 @ T<sub>J</sub> = 150°C using Fig. CT.3

## TO-247AC Package Outline

Dimensions are shown in millimeters (inches)



**NOTES:**

1. DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M 1994.
2. DIMENSIONS ARE SHOWN IN INCHES.
3. CONTOUR OF SLOT OPTIONAL.
4. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
5. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS D1 & E1.
6. LEAD FINISH UNCONTROLLED IN L1.
7.  $\phi P$  TO HAVE A MAXIMUM DRAFT ANGLE OF 1.5 ° TO THE TOP OF THE PART WITH A MAXIMUM HOLE DIAMETER OF .154 INCH.
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-247AC .

SYMBOL	DIMENSIONS				NOTES
	INCHES		MILLIMETERS		
	MIN.	MAX.	MIN.	MAX.	
A	.183	.209	4.65	5.31	
A1	.087	.102	2.21	2.59	
A2	.059	.098	1.50	2.49	
b	.039	.055	0.99	1.40	
b1	.039	.053	0.99	1.35	
b2	.065	.094	1.65	2.39	
b3	.065	.092	1.65	2.34	
b4	.102	.135	2.59	3.43	
b5	.102	.133	2.59	3.38	
c	.015	.035	0.38	0.89	
c1	.015	.033	0.38	0.84	
D	.776	.815	19.71	20.70	4
D1	.515	-	13.08	-	5
D2	.020	.053	0.51	1.35	
E	.602	.625	15.29	15.87	4
E1	.530	-	13.46	-	
E2	.178	.216	4.52	5.49	
e	.215 BSC		5.46 BSC		
$\phi k$	.010		0.25		
L	.559	.634	14.20	16.10	
L1	.146	.169	3.71	4.29	
$\phi P$	.140	.144	3.56	3.66	
$\phi P1$	-	.291	-	7.39	
Q	.209	.224	5.31	5.69	
S	.217 BSC		5.51 BSC		

LEAD ASSIGNMENTS

HEXFEE

- 1.- GATE
- 2.- DRAIN
- 3.- SOURCE
- 4.- DRAIN

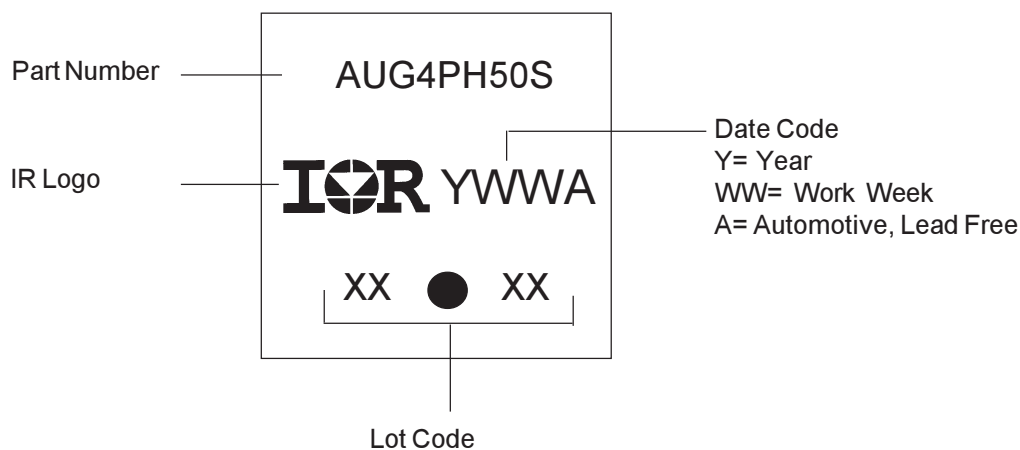
IGBTs, CoPACK

- 1.- GATE
- 2.- COLLECTOR
- 3.- EMITTER
- 4.- COLLECTOR

DIODES

- 1.- ANODE/OPEN
- 2.- CATHODE
- 3.- ANODE

## TO-247AC Part Marking Information



Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/>

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For technical support, please contact IR's Technical Assistance Center

<http://www.irf.com/technical-info/>

### WORLD HEADQUARTERS:

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Tel: (310) 252-7105

**Revision History**

Date	Comments
7/8/2014	<ul style="list-style-type: none"> <li>• Updated datasheet based on new template and retest data.</li> </ul>
7/11/2014	<ul style="list-style-type: none"> <li>• Removed <math>I_C</math> Nominal current on page 1.</li> <li>• Updated typo on switch time test condition from "25C" to "150C" on page 2.</li> </ul>
1/9/2015	<ul style="list-style-type: none"> <li>• Corrected typo on <math>V_{(BR)CES}</math> test condition from "100<math>\mu</math>A" to "250<math>\mu</math>A" on page 2.</li> <li>• Corrected typo on <math>V_{GE(TH)}</math> test condition from "1mA" to "250<math>\mu</math>A" on page 2.</li> </ul>
3/2/2015	<ul style="list-style-type: none"> <li>• Removed <math>I_{CES} = 2\mu</math>A @ <math>V_{CE} = 10</math>V on page 2.</li> </ul>

## Looking for pricing, stock, or lifecycle information?

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-  Obsolete Management
-  Cost Control Management
-  Shortage Management
-  Alternative Solution
-  Excess Inventory Management