

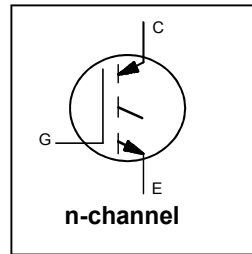
**Insulated Gate Bipolar Transistor**

**Features**

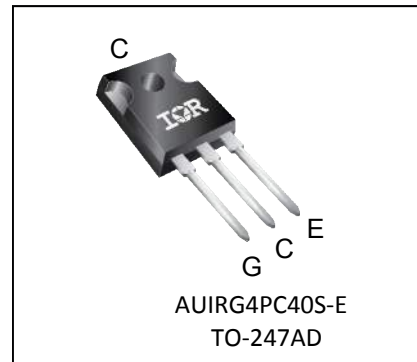
- Standard: Optimized for minimum saturation voltage and low operating frequencies (< 1kHz)
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency than Generation 3
- Industry standard TO-247AD package
- Lead-Free
- Automotive Qualified\*

**Benefits**

- Generation 4 IGBT's offer highest efficiency available
- IGBT's optimized for specified application conditions
- Designed to be a "drop-in" replacement for equivalent industry-standard Generation 3 IR IGBT's



$V_{CES} = 600V$
$V_{CE(ON)} \text{ typ.} = 1.32V$
@ $V_{GE} = 15V, I_C = 31A$



G	C	E
Gate	Collector	Emitter

Base part number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
AUIRG4PC40S-E	TO-247AD	Tube	25	AUIRG4PC40S-E

**Absolute Maximum Ratings**

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	60	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	31	
$I_{CM}$	Pulse Collector Current ①	120	
$I_{LM}$	Clamped Inductive Load Current ②	120	
$V_{GE}$	Continuous Gate-to-Emitter Voltage	$\pm 20$	V
$E_{ARV}$	Reverse Voltage Avalanche Energy ③	15	
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	160	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	65	
$T_J$ $T_{STG}$	Operating Junction and Storage Temperature Range	-55 to +150	C
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	
	Mounting Torque, 6-32 or M3 Screw	10 lbf-in (1.1 N-m)	

**Thermal Resistance**

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Thermal Resistance Junction-to-Case	—	0.77	$^\circ C/W$
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink (flat, greased surface)	0.24	—	
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (typical socket mount)	—	40	
Wt	Weight	6 (0.21)	—	g (oz)

\* Qualification standard can be found at [http:// www.irf.com/](http://www.irf.com/)

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

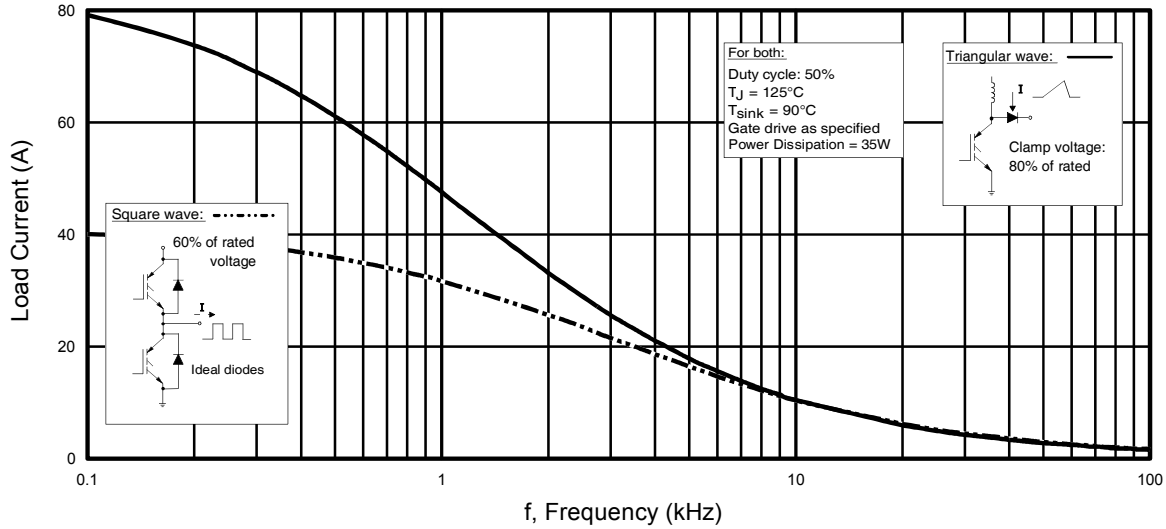
	Parameter	Min.	Typ.	Max.	Units	Conditions
V <sub>(BR)CES</sub>	Collector-to-Emitter Breakdown Voltage	600	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 250μA
V <sub>(BR)ECS</sub>	Emitter-to-Collector Breakdown Voltage ④	18	—	—		V <sub>GE</sub> = 0V, I <sub>C</sub> = 1.0A
ΔV <sub>(BR)CES</sub> /ΔT <sub>J</sub>	Temperature Coeff. of Breakdown Voltage	—	0.75	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1mA
V <sub>CE(on)</sub>	Collector-to-Emitter Saturation Voltage	—	1.32	1.5	V	I <sub>C</sub> = 31A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 25°C
		—	1.68	—		I <sub>C</sub> = 60A, V <sub>GE</sub> = 15V, See Fig. 2,5
		—	1.32	—		I <sub>C</sub> = 31A, 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 Temperature Coeff.	—	-9.3	—	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA
g <sub>fe</sub>	Forward Transconductance⑤	12	21	—	S	V <sub>CE</sub> = 100V, I <sub>C</sub> = 31A
I <sub>CES</sub>	Collector-to-Emitter Leakage Current	—	—	250	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V
		—	—	2.0		V <sub>GE</sub> = 0V, V <sub>CE</sub> = 10V, T <sub>J</sub> = 25°C
		—	—	1000		V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V, 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)**

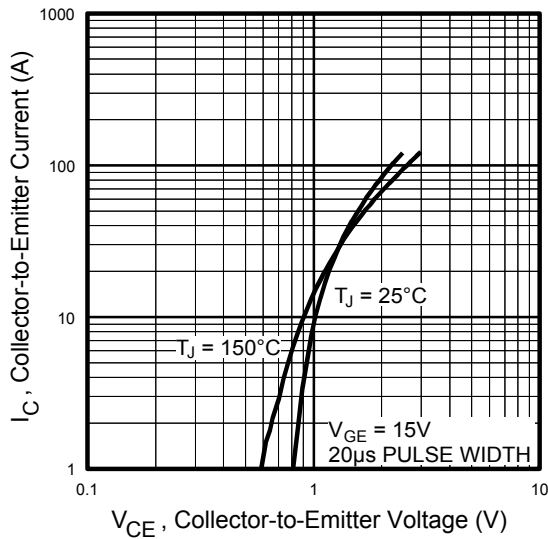
	Parameter	Min.	Typ.	Max	Units	Conditions
Q <sub>g</sub>	Total Gate Charge (turn-on)	—	100	150	nC	I <sub>C</sub> = 31A V <sub>GE</sub> = 15V V <sub>CC</sub> = 400V See Fig.8
Q <sub>ge</sub>	Gate-to-Emitter Charge (turn-on)	—	14	21		
Q <sub>gc</sub>	Gate-to-Collector Charge (turn-on)	—	34	51		
t <sub>d(on)</sub>	Turn-On delay time	—	22	—	ns	I <sub>C</sub> = 31A, V <sub>CC</sub> = 480V, V <sub>GE</sub> =15V R <sub>G</sub> = 10Ω, T <sub>J</sub> = 25°C Energy losses include "tail"
t <sub>r</sub>	Rise time	—	18	—		
t <sub>d(off)</sub>	Turn-Off delay time	—	650	980		
t <sub>f</sub>	Fall time	—	380	570		
E <sub>on</sub>	Turn-On Switching Loss	—	0.45	—	mJ	See Fig. 10, 11, 13, 14
E <sub>off</sub>	Turn-Off Switching Loss	—	6.5	—		
E <sub>ts</sub>	Total Switching Loss	—	6.95	9.9		
t <sub>d(on)</sub>	Turn-On delay time	—	23	—	ns	I <sub>C</sub> = 31A, V <sub>CC</sub> = 480V, V <sub>GE</sub> =15V R <sub>G</sub> = 10Ω, T <sub>J</sub> = 150°C Energy losses include "tail"
t <sub>r</sub>	Rise time	—	21	—		
t <sub>d(off)</sub>	Turn-Off delay time	—	1000	—		
t <sub>f</sub>	Fall time	—	940	—		
E <sub>ts</sub>	Total Switching Loss	—	12	—	mJ	See Fig. 13, 14
L <sub>E</sub>	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package
C <sub>ies</sub>	Input Capacitance	—	2200	—	pF	V <sub>GE</sub> = 0V V <sub>CC</sub> = 30V f = 1.0Mhz See Fig. 7
C <sub>oes</sub>	Output Capacitance	—	140	—		
C <sub>res</sub>	Reverse Transfer Capacitance	—	26	—		

**Notes:**

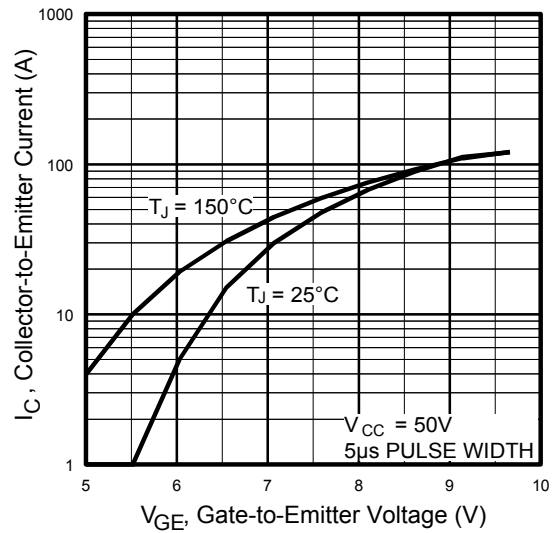
- ① Repetitive rating; V<sub>GE</sub> = 20V, pulse width limited by max. junction temperature. ( See fig. 13b )
- ② V<sub>CC</sub> = 80%(V<sub>CES</sub>), V<sub>GE</sub> = 20V, L = 10μH, R<sub>G</sub> = 10Ω, (See fig. 13a)
- ③ Repetitive rating; pulse width limited by maximum junction temperature.
- ④ Pulse width ≤ 80μs; duty factor ≤ 0.1%.
- ⑤ Pulse width 5.0μs, single shot.



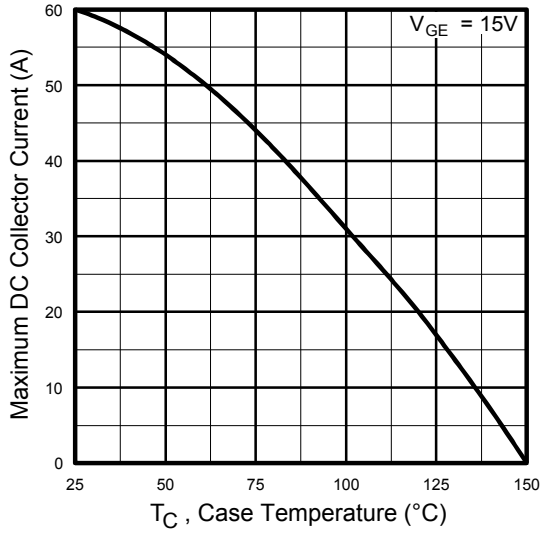
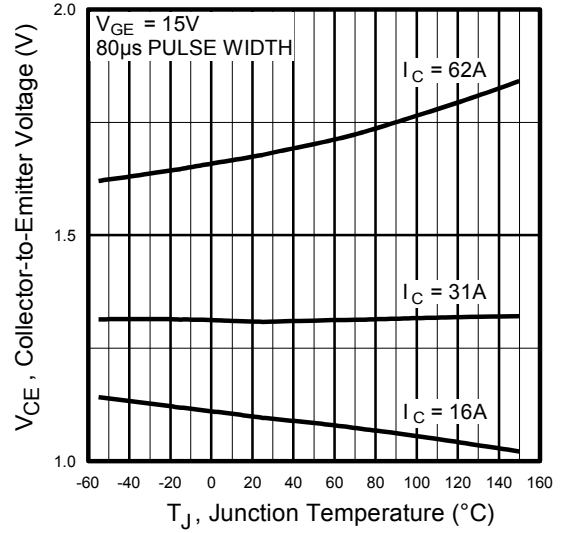
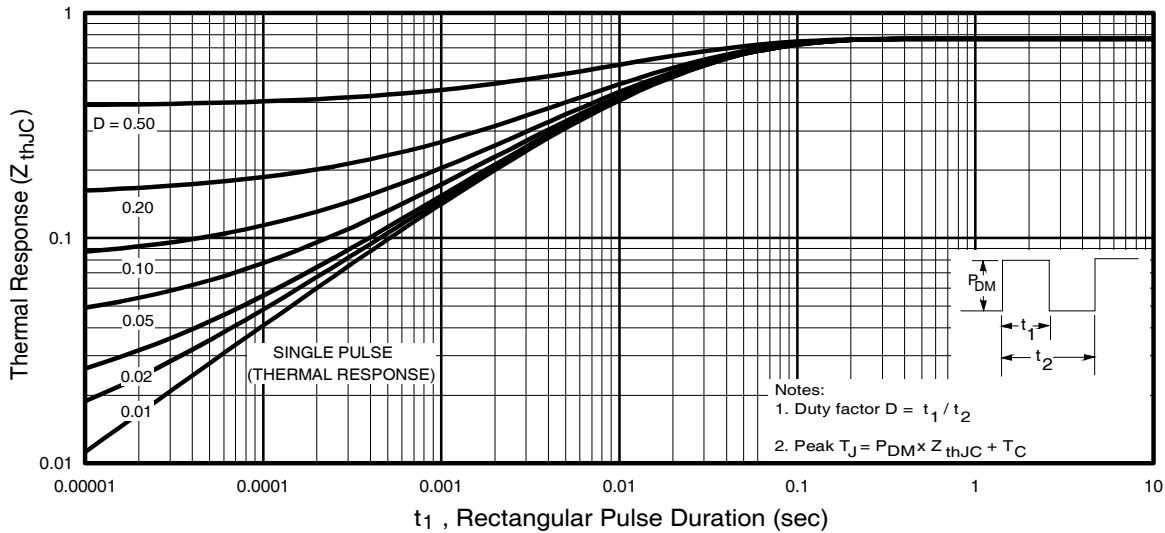
**Fig. 1 - Typical Load Current vs. Frequency**  
 (For square wave,  $I = I_{RMS}$  of fundamental; for triangular wave,  $I = I_{PK}$ )

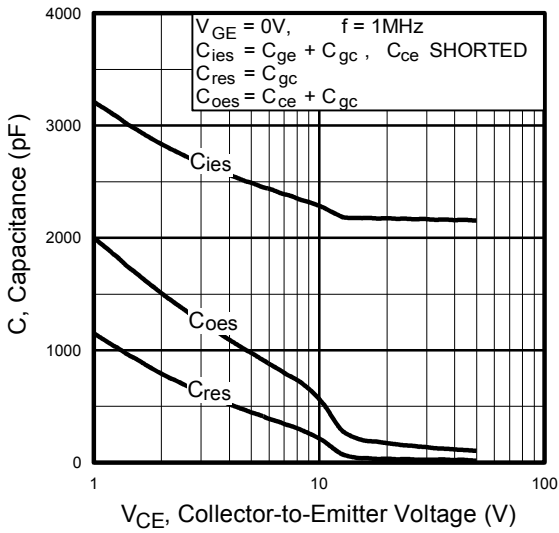


**Fig. 2 - Typical Output Characteristics**

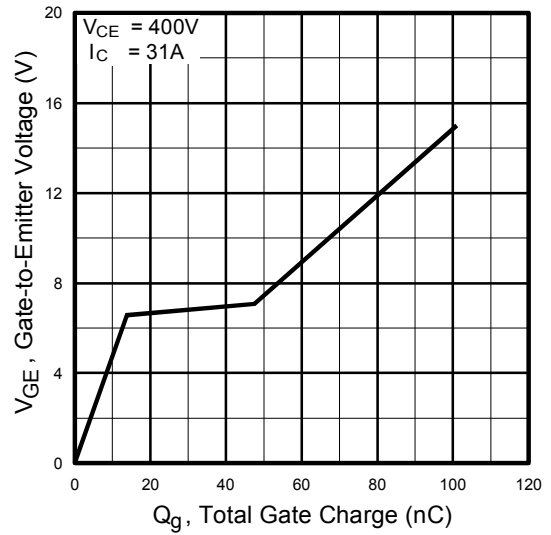


**Fig. 3 - Typical Transfer Characteristics**

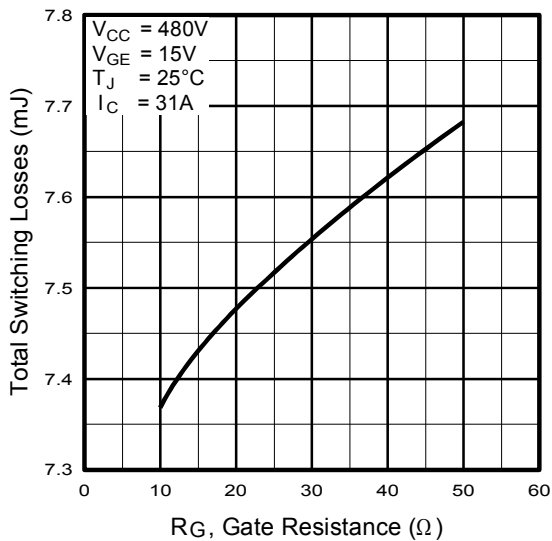

**Fig. 4 - Maximum Collector Current vs. Case Temperature**

**Fig. 5 - Collector-to-Emitter Voltage vs. Junction Temperature**

**Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case**



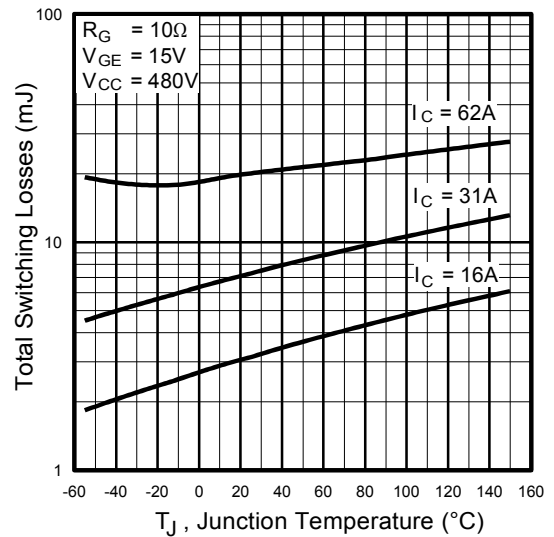
**Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage**



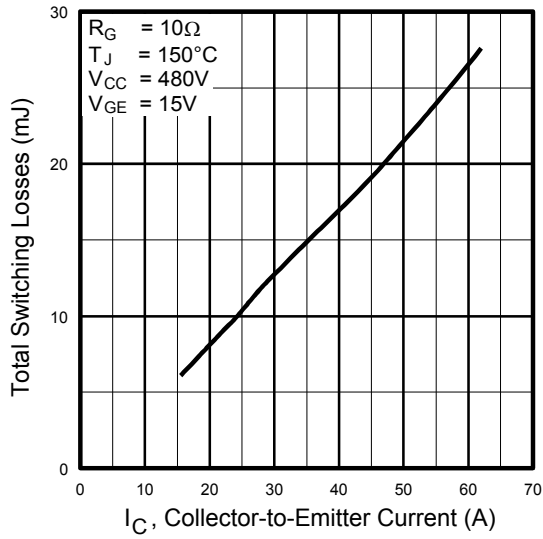
**Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage**



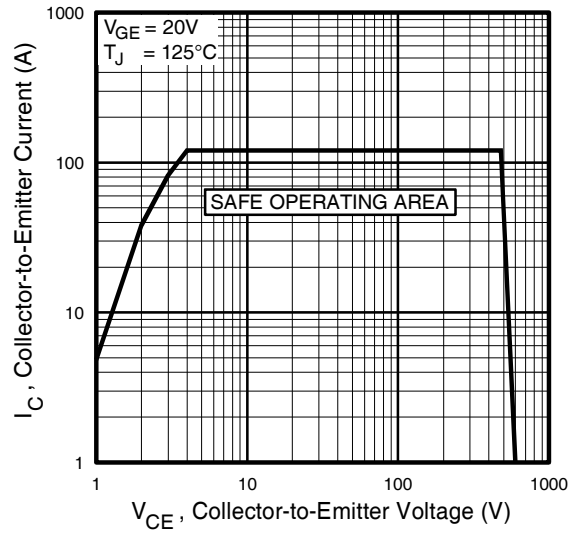
**Fig. 9 - Typical Switching Losses vs. Gate Resistance**



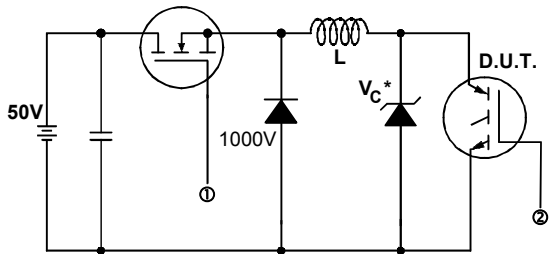
**Fig. 10 - Typical Switching Losses vs. Junction Temperature**



**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current

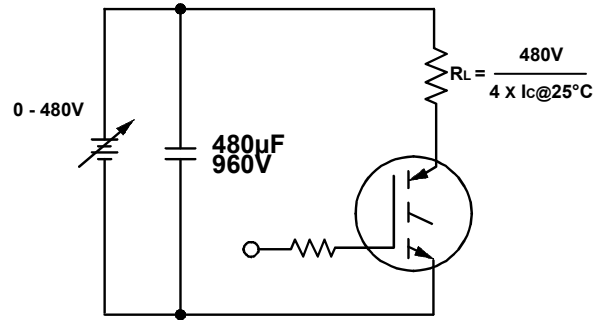


**Fig. 12** - Turn-Off SOA

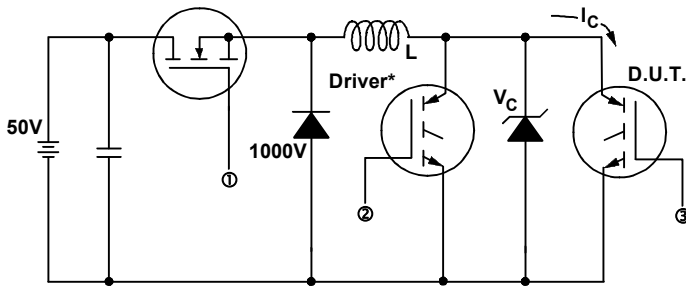


\* Driver same type as D.U.T.;  $V_c = 80\%$  of  $V_{ce(max)}$   
 \* Note: Due to the 50V power supply, pulse width and inductor will increase to obtain rated  $I_d$ .

**Fig. 13a** - Clamped Inductive Load Test Circuit

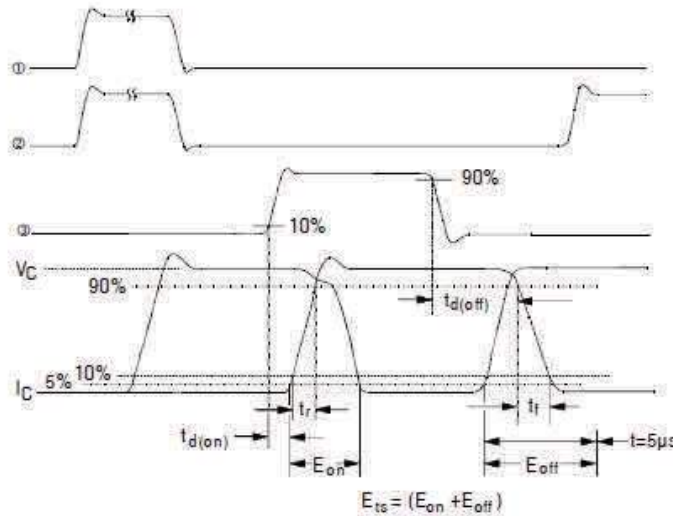


**Fig. 13b** - Pulsed Collector Current Test Circuit



\* Driver same type as D.U.T.,  $V_c = 480V$

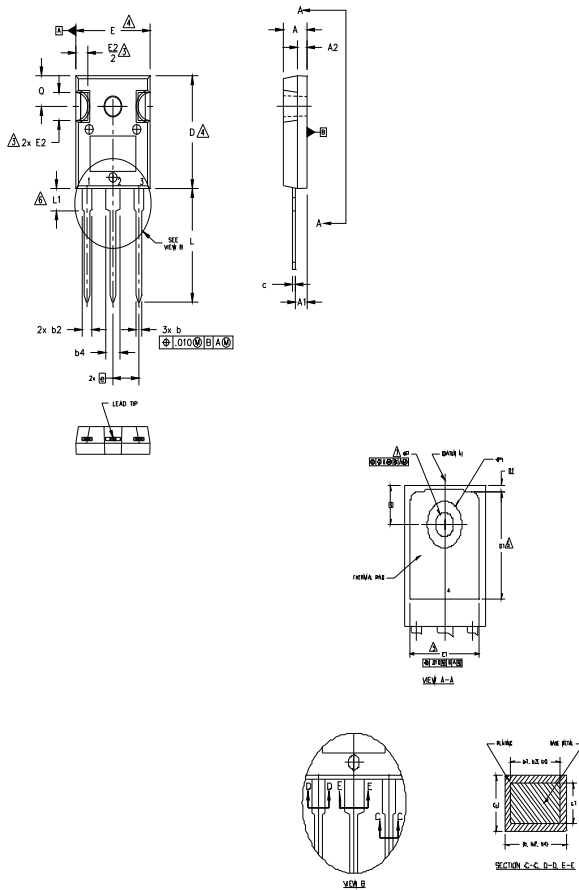
**Fig. 14a** - Switching Loss Test Circuit



**Fig. 14b** - Switching Loss Waveforms

# TO-247AD 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. ØP 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-247AD.

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	.056	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	.036	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		5.48 BSC		
Øk	.010		0.25		
L	.780	.827	19.57	21.00	
L1	.146	.169	3.71	4.29	
ØP	.140	.144	3.56	3.66	
ØP1	-	.291	-	7.39	
Q	.209	.224	5.31	5.69	
S	.217 BSC		5.51 BSC		

LEAD ASSIGNMENTS

HEXFET

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

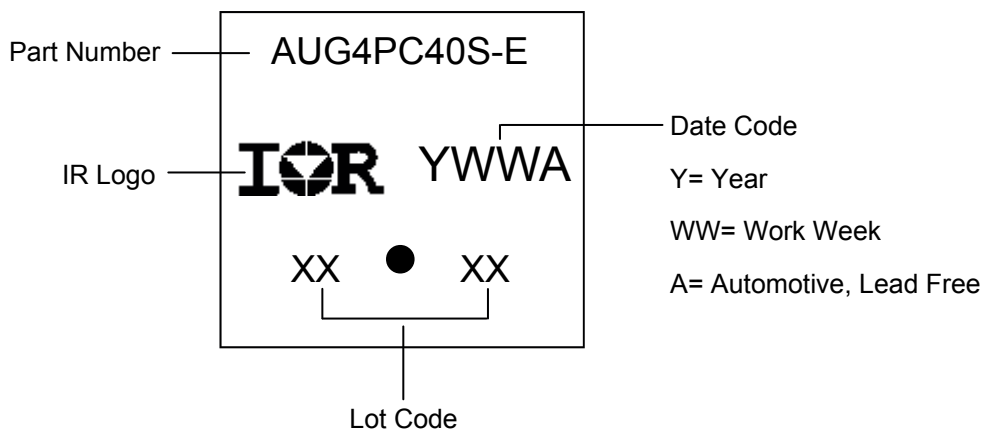
IGBTs, CoPACK

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

DIODES

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

## TO-247AD Part Marking Information



TO-247AD package is not recommended for Surface Mount Application.

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



**Qualification Information†**

<b>Qualification Level</b>		Automotive (per AEC-Q101) ††	
		Comments: 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-247AD	N/A
<b>ESD</b>	Human Body Model	Class H1C (+/- 2000V) AEC-Q101-001	
	Charged Device Model	Class C5 (+/- 2000V) AEC-Q101-005	
<b>RoHS Compliant</b>		Yes	

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

†† Exceptions to AEC-Q101 requirements are noted in the qualification report.

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