

**INSULATED GATE BIPOLAR TRANSISTOR**

**Features**

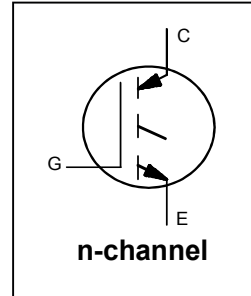
- Low  $V_{CE(ON)}$  trench IGBT technology
- Low switching losses
- Square RBSOA
- 100% of the parts tested for  $I_{LM}$ ①
- Positive  $V_{CE(ON)}$  temperature co-efficient
- Tight parameter distribution
- Lead-free package

**Benefits**

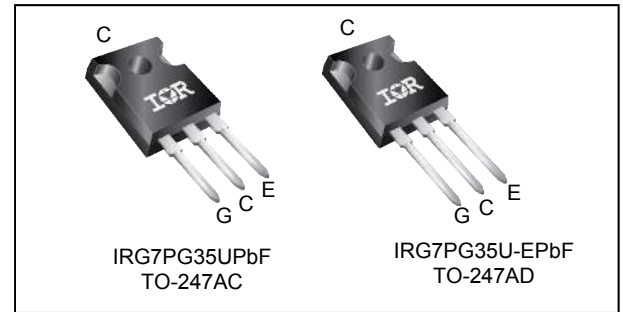
- High efficiency in a wide range of applications
- Suitable for a wide range of switching frequencies due to low  $V_{CE(on)}$  and low switching losses
- Rugged transient performance for increased reliability
- Excellent current sharing in parallel operation

**Applications**

- U.P.S.
- Welding
- Solar Inverter
- Induction heating



$V_{CES} = 1000V$
$I_C = 35A, T_C = 100^\circ C$
$T_{J(MAX)} = 175^\circ C$
$V_{CE(ON)} \text{ typ.} = 1.9V @ I_C = 20A$



G	C	E
Gate	Collector	Emitter

Base part number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
IRG7PG35UPbF	TO-247AC	Tube	25	IRG7PG35UPbF
IRG7PG35U-EPbF	TO-247AD	Tube	25	IRG7PG35U-EPbF

**Absolute Maximum Ratings**

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	1000	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current (Silicon Limited)	55	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current (Silicon Limited)	35	
$I_{CM}$	Pulse Collector Current, $V_{GE} = 15V$ ②	60	
$I_{LM}$	Clamped Inductive Load Current, $V_{GE} = 20V$ ①	80	
$V_{GE}$	Continuous Gate-to-Emitter Voltage	$\pm 30$	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	210	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	105	
$T_J$	Operating Junction and	-55 to +175	$^\circ C$
$T_{STG}$	Storage Temperature Range		
	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	Min.	Typ.	Max.	Units
$R_{\theta JC}$ (IGBT)	Junction-to-Case (IGBT) ④	—	—	0.70	$^\circ C/W$
$R_{\theta CS}$	Case-to-Sink (flat, greased surface)	—	0.24	—	
$R_{\theta JA}$	Junction-to-Ambient (typical socket mount)	—	—	40	

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

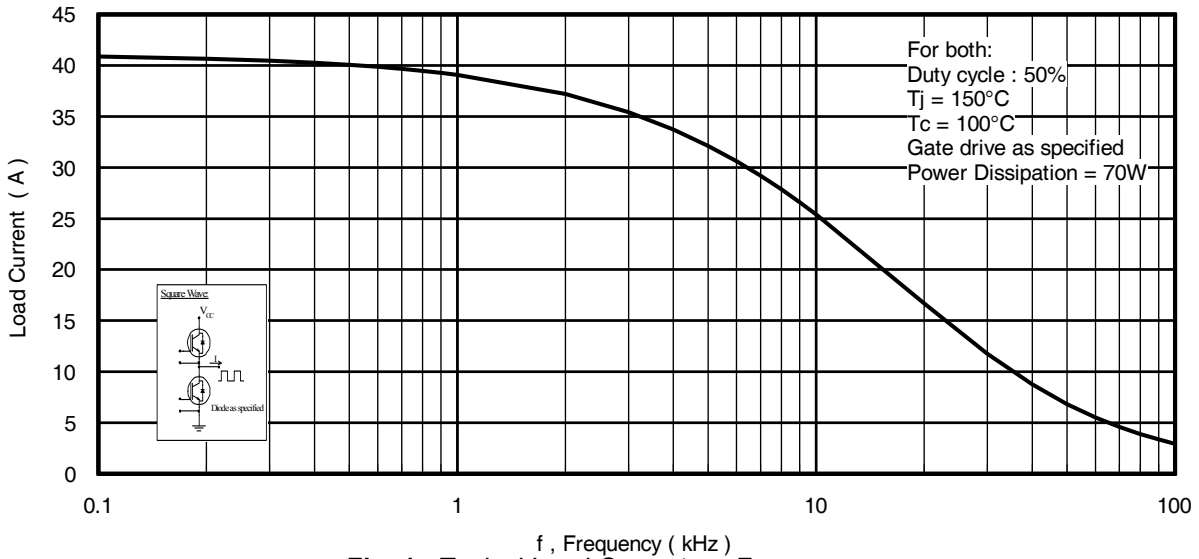
	Parameter	Min.	Typ.	Max.	Units	Conditions
V <sub>(BR)CES</sub>	Collector-to-Emitter Breakdown Voltage	1000	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 100μA ③
ΔV <sub>(BR)CES</sub> /ΔT <sub>J</sub>	Temperature Coeff. of Breakdown Voltage	—	1.2	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1.0mA (25°C-150°C)
V <sub>CE(on)</sub>	Collector-to-Emitter Saturation Voltage	—	1.9	2.2	V	I <sub>C</sub> = 20A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 25°C
		—	2.3	—		I <sub>C</sub> = 20A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 150°C
		—	2.4	—		I <sub>C</sub> = 20A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 175°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> = 600μA
ΔV <sub>GE(th)</sub> /ΔT <sub>J</sub>	Gate Threshold Voltage temp coefficient.	—	-16	—	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 600μA (25°C-150°C)
g <sub>fe</sub>	Forward Transconductance	—	22	—	S	V <sub>CE</sub> = 50V, I <sub>C</sub> = 20A, PW = 30μs
I <sub>CES</sub>	Collector-to-Emitter Leakage Current	—	2.0	100	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 1000V
		—	2000	—		V <sub>GE</sub> = 0V, V <sub>CE</sub> = 1000V, T <sub>J</sub> = 175°C
I <sub>GES</sub>	Gate-to-Emitter Leakage Current	—	—	±100	nA	V <sub>GE</sub> = ±30V

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

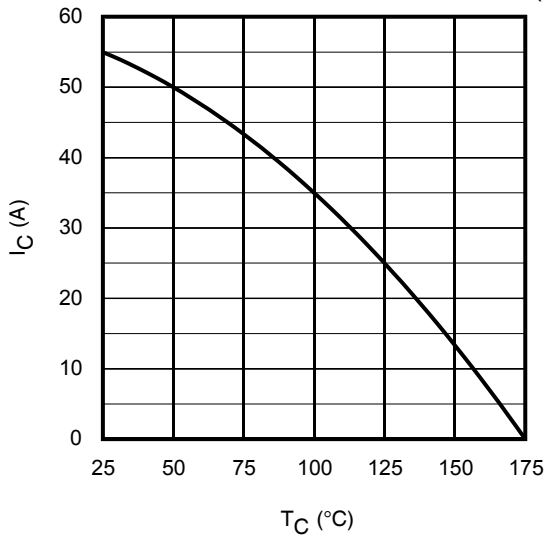
	Parameter	Min.	Typ.	Max.	Units	Conditions
Q <sub>g</sub>	Total Gate Charge	—	85	—	nC	I <sub>C</sub> = 20A V <sub>GE</sub> = 15V V <sub>CC</sub> = 600V
Q <sub>ge</sub>	Gate-to-Emitter Charge	—	15	—		
Q <sub>gc</sub>	Gate-to-Collector Charge	—	35	—		
E <sub>on</sub>	Turn-On Switching Loss	—	1060	—	μJ	I <sub>C</sub> = 20A, V <sub>CC</sub> = 600V, V <sub>GE</sub> = 15V R <sub>G</sub> = 10Ω, L = 200μH, T <sub>J</sub> = 25°C Energy losses include tail & diode reverse recovery
E <sub>off</sub>	Turn-Off Switching Loss	—	620	—		
E <sub>total</sub>	Total Switching Loss	—	1680	—		
t <sub>d(on)</sub>	Turn-On delay time	—	30	—	ns	Diode clamp the same as IRG7PH35UDPbF
t <sub>r</sub>	Rise time	—	15	—		
t <sub>d(off)</sub>	Turn-Off delay time	—	160	—		
t <sub>f</sub>	Fall time	—	80	—		
E <sub>on</sub>	Turn-On Switching Loss	—	1880	—	μJ	I <sub>C</sub> = 20A, V <sub>CC</sub> = 600V, V <sub>GE</sub> = 15V R <sub>G</sub> = 10Ω, L = 200μH, T <sub>J</sub> = 175°C Energy losses include tail & diode reverse recovery
E <sub>off</sub>	Turn-Off Switching Loss	—	1140	—		
E <sub>total</sub>	Total Switching Loss	—	3020	—		
t <sub>d(on)</sub>	Turn-On delay time	—	25	—	ns	Diode clamp the same as IRG7PH35UDPbF
t <sub>r</sub>	Rise time	—	20	—		
t <sub>d(off)</sub>	Turn-Off delay time	—	200	—		
t <sub>f</sub>	Fall time	—	200	—		
C <sub>ies</sub>	Input Capacitance	—	1940	—	pF	V <sub>GE</sub> = 0V V <sub>CC</sub> = 30V f = 1.0Mhz
C <sub>oes</sub>	Output Capacitance	—	60	—		
C <sub>res</sub>	Reverse Transfer Capacitance	—	40	—		
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T <sub>J</sub> = 175°C, I <sub>C</sub> = 80A V <sub>CC</sub> = 800V, V <sub>p</sub> ≤ 1000V R <sub>G</sub> = 10Ω, V <sub>GE</sub> = +20V to 0V

**Notes:**

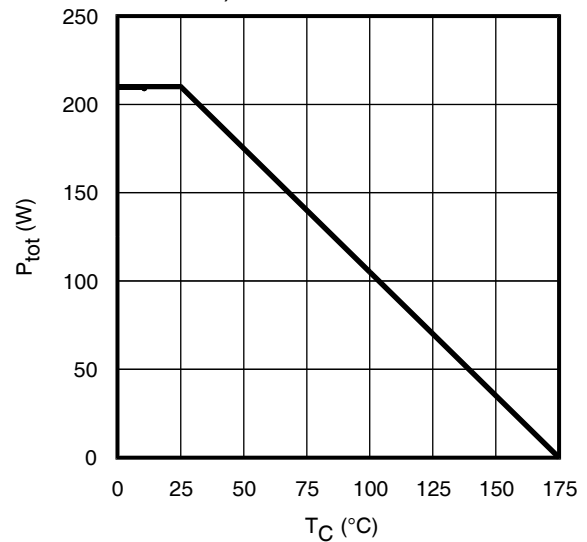
- ① V<sub>CC</sub> = 80% (V<sub>CES</sub>), V<sub>GE</sub> = 20V, R<sub>G</sub> = 10Ω.
- ② Pulse width limited by max. junction temperature.
- ③ Refer to AN-1086 for guidelines for measuring V<sub>(BR)CES</sub> safely.
- ④ R<sub>θ</sub> is measured at T<sub>J</sub> of approximately 90°C.



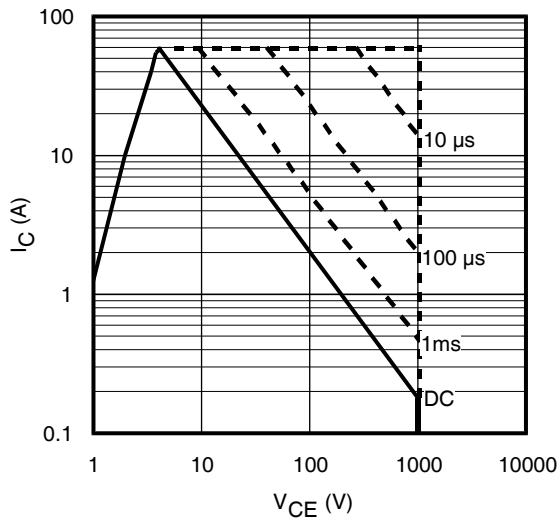
**Fig. 1 - Typical Load Current vs. Frequency**  
 (Load Current =  $I_{RMS}$  of fundamental)



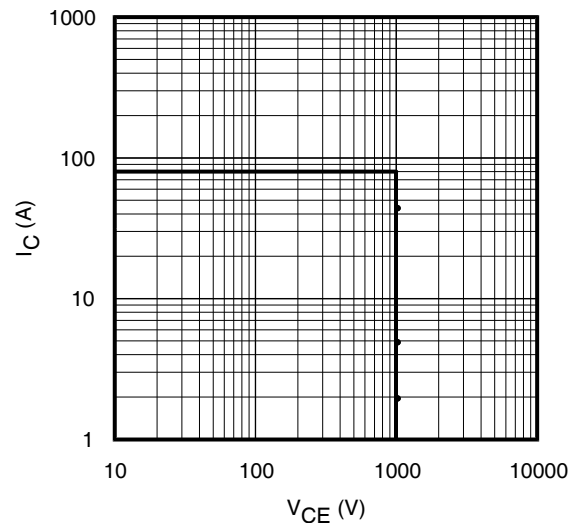
**Fig. 2 - Maximum DC Collector Current vs. Case Temperature**



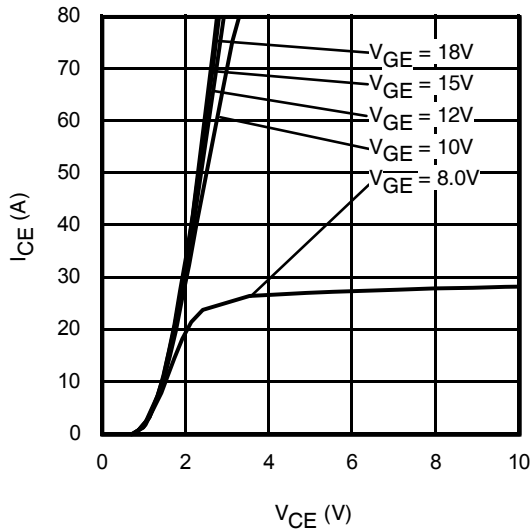
**Fig. 3 - Power Dissipation vs. Case Temperature**



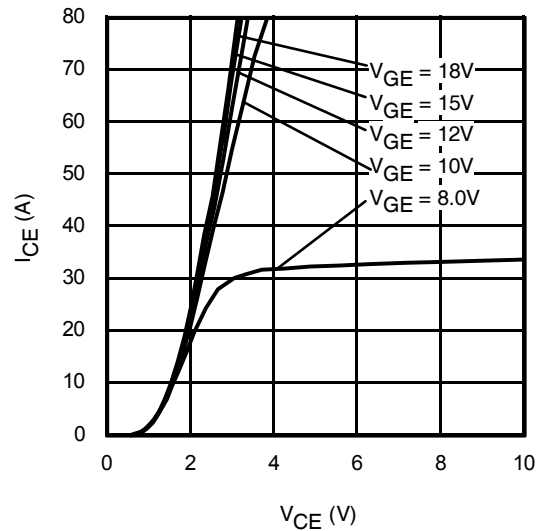
**Fig. 4 - Forward SOA**  
 $T_c = 25^\circ\text{C}$ ,  $T_j \leq 175^\circ\text{C}$ ;  $V_{GE} = 15\text{V}$



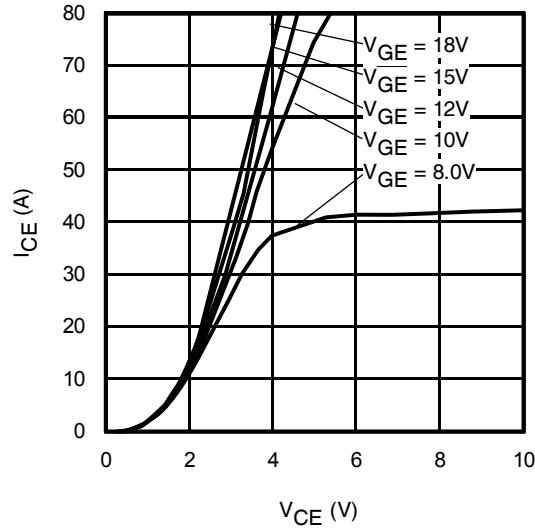
**Fig. 5 - Reverse Bias SOA**  
 $T_j = 175^\circ\text{C}$ ;  $V_{GE} = 20\text{V}$



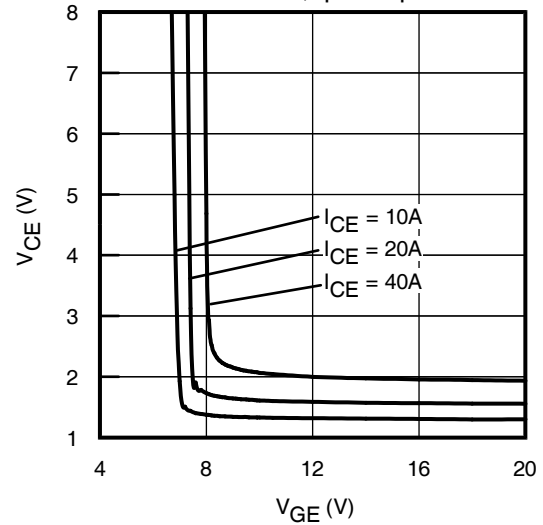
**Fig. 6 - Typ. IGBT Output Characteristics**  
 $T_J = -40^\circ\text{C}$ ;  $t_p = 30\mu\text{s}$



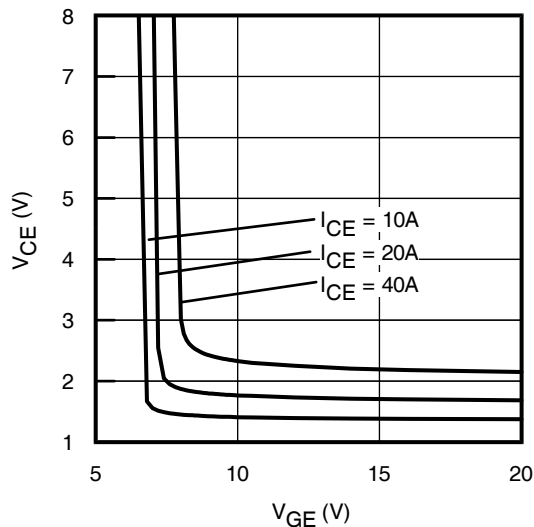
**Fig. 7 - Typ. IGBT Output Characteristics**  
 $T_J = 25^\circ\text{C}$ ;  $t_p = 30\mu\text{s}$



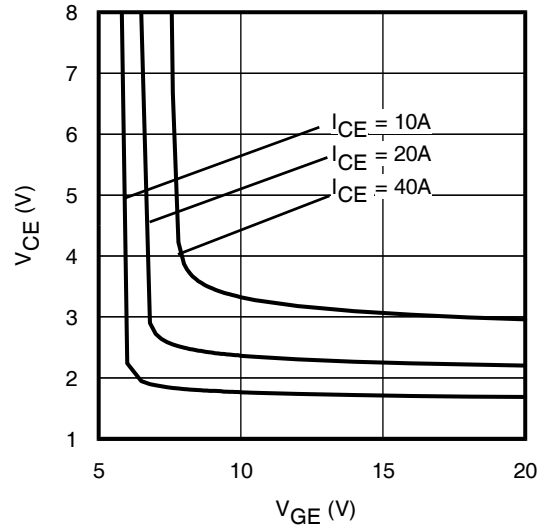
**Fig. 8 - Typ. IGBT Output Characteristics**  
 $T_J = 175^\circ\text{C}$ ;  $t_p = 30\mu\text{s}$



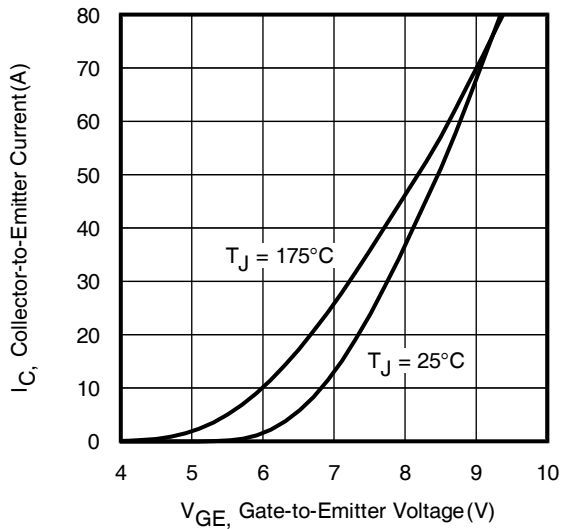
**Fig. 9 - Typical  $V_{CE}$  vs.  $V_{GE}$**   
 $T_J = -40^\circ\text{C}$



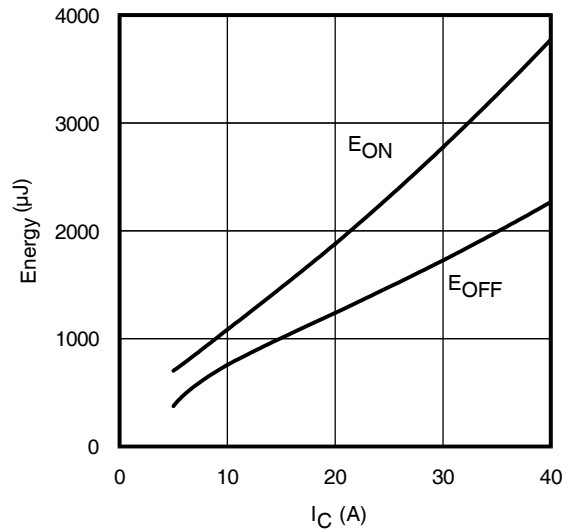
**Fig. 10 - Typical  $V_{CE}$  vs.  $V_{GE}$**   
 $T_J = 25^\circ\text{C}$



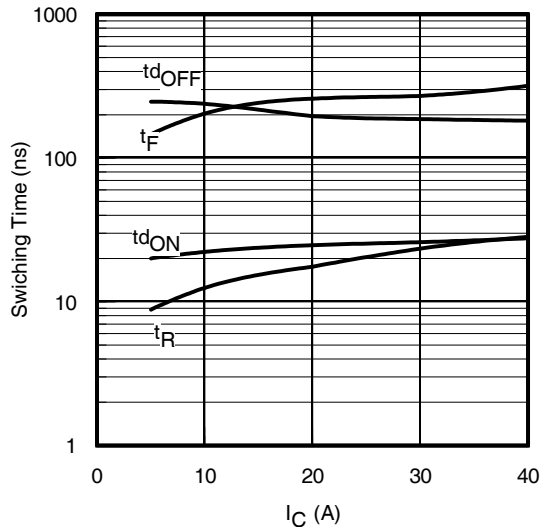
**Fig. 11 - Typical  $V_{CE}$  vs.  $V_{GE}$**   
 $T_J = 175^\circ\text{C}$



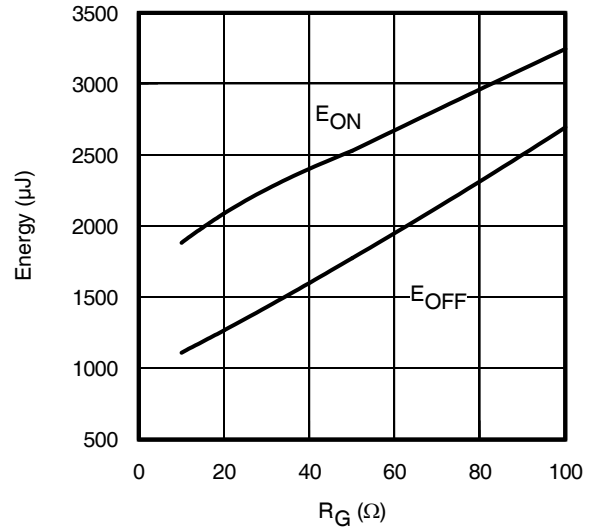
**Fig. 12 - Typ. Transfer Characteristics**  
 $V_{CE} = 50V$ ;  $t_p = 30\mu s$



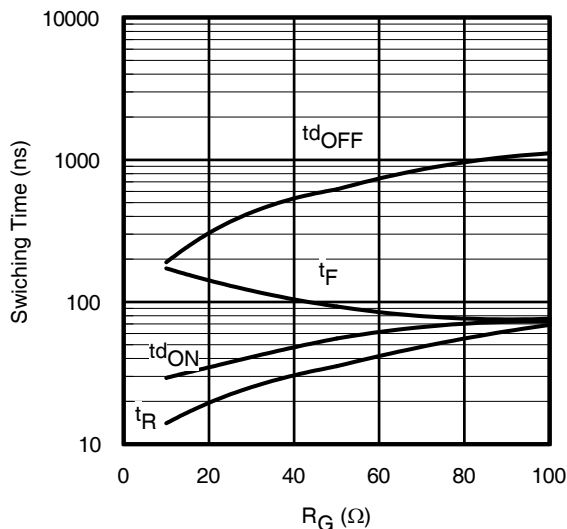
**Fig. 13 - Typ. Energy Loss vs.  $I_C$**   
 $T_J = 175^\circ C$ ;  $L = 680\mu H$ ;  $V_{CE} = 600V$ ,  $R_G = 10\Omega$ ;  $V_{GE} = 15V$



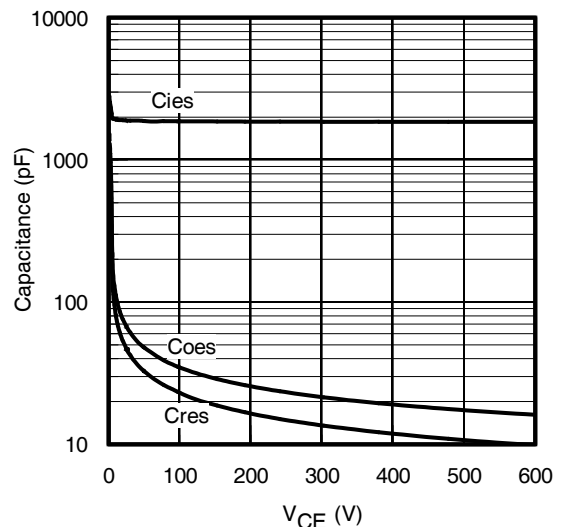
**Fig. 14 - Typ. Switching Time vs.  $I_C$**   
 $T_J = 175^\circ C$ ;  $L = 680\mu H$ ;  $V_{CE} = 600V$ ,  $R_G = 10\Omega$ ;  $V_{GE} = 15V$



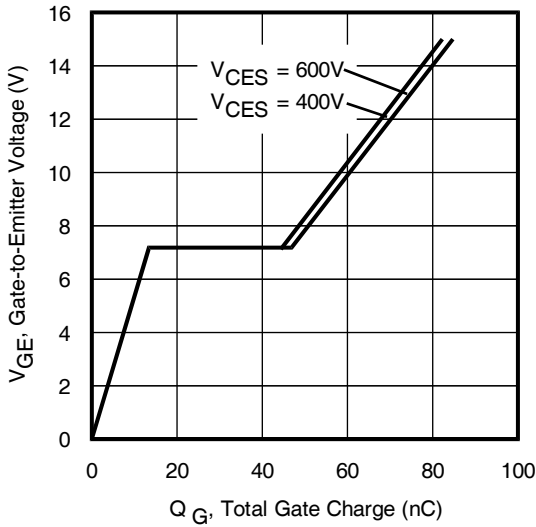
**Fig. 15 - Typ. Energy Loss vs.  $R_G$**   
 $T_J = 175^\circ C$ ;  $L = 680\mu H$ ;  $V_{CE} = 600V$ ,  $I_{CE} = 20A$ ;  $V_{GE} = 15V$



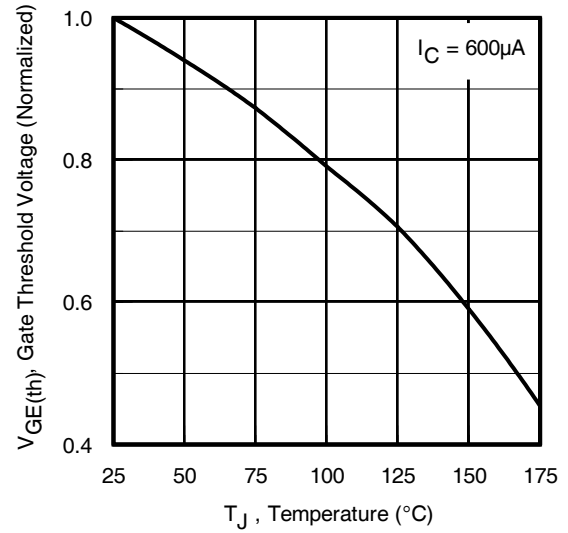
**Fig. 16 - Typ. Switching Time vs.  $R_G$**   
 $T_J = 175^\circ C$ ;  $L = 680\mu H$ ;  $V_{CE} = 600V$ ,  $I_{CE} = 20A$ ;  $V_{GE} = 15V$



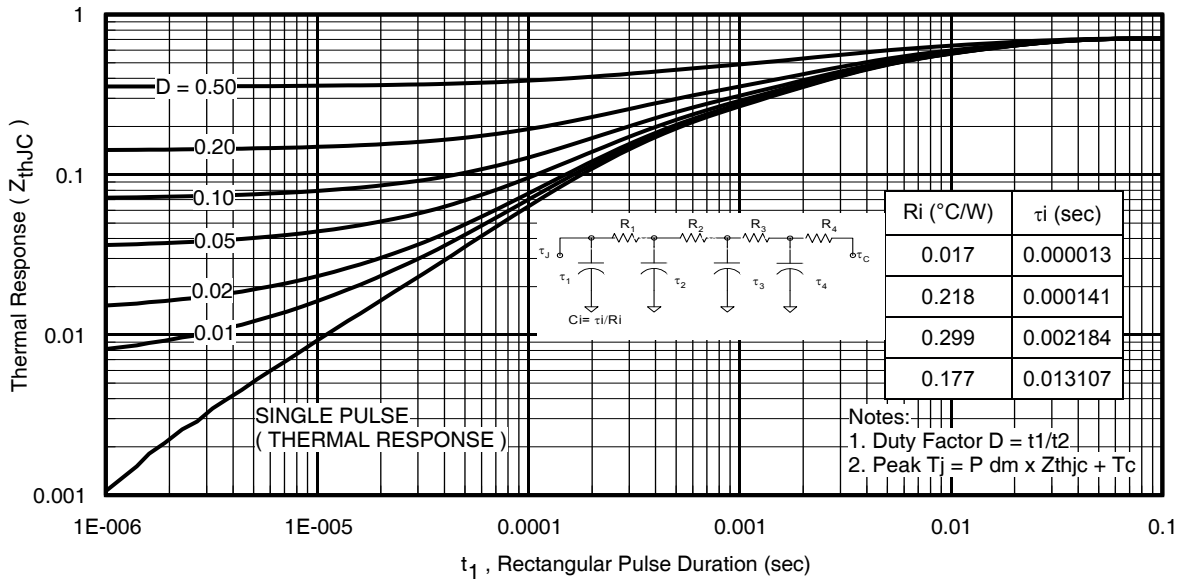
**Fig. 17 - Typ. Capacitance vs.  $V_{CE}$**   
 $V_{GE} = 0V$ ;  $f = 1MHz$



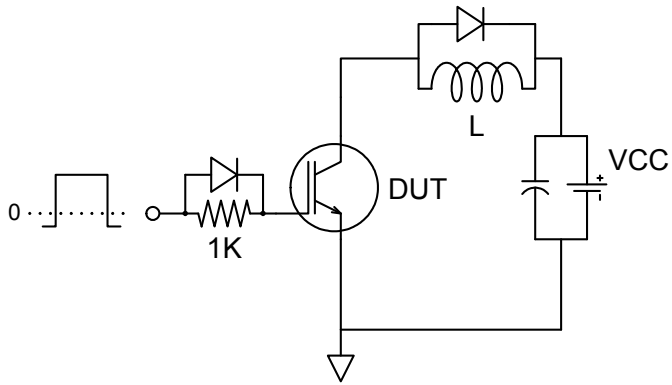
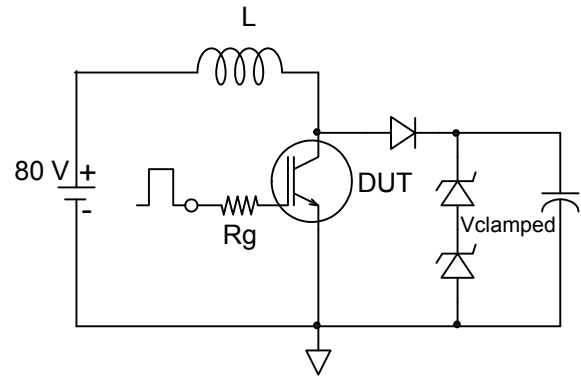
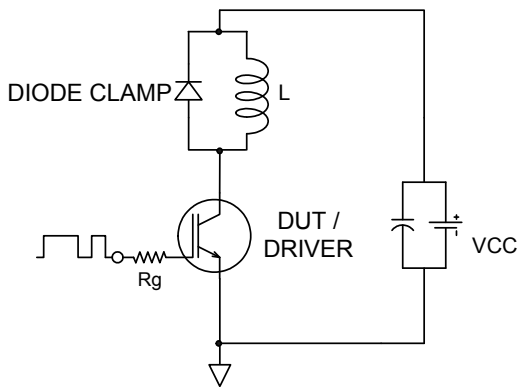
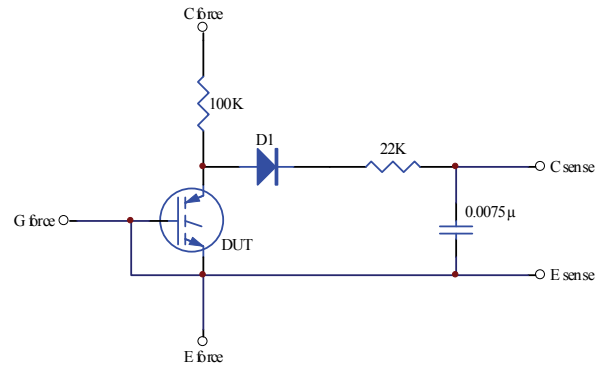
**Fig. 18** - Typical Gate Charge vs.  $V_{GE}$   
 $I_{CE} = 20A$

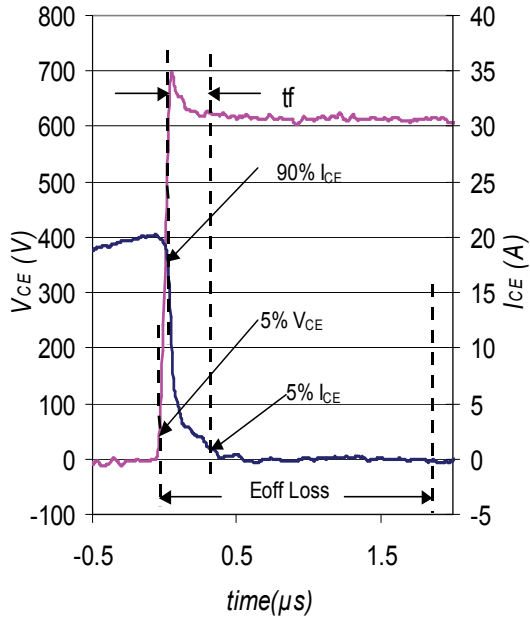


**Fig. 19** - Typical Gate Threshold Voltage (Normalized) vs. Junction Temperature

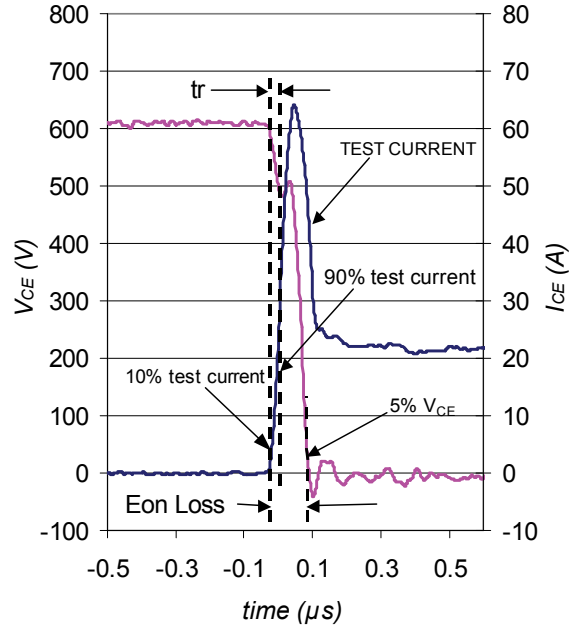


**Fig. 20** - Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)


**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  
@  $T_J = 175^\circ\text{C}$  using Fig. CT.3

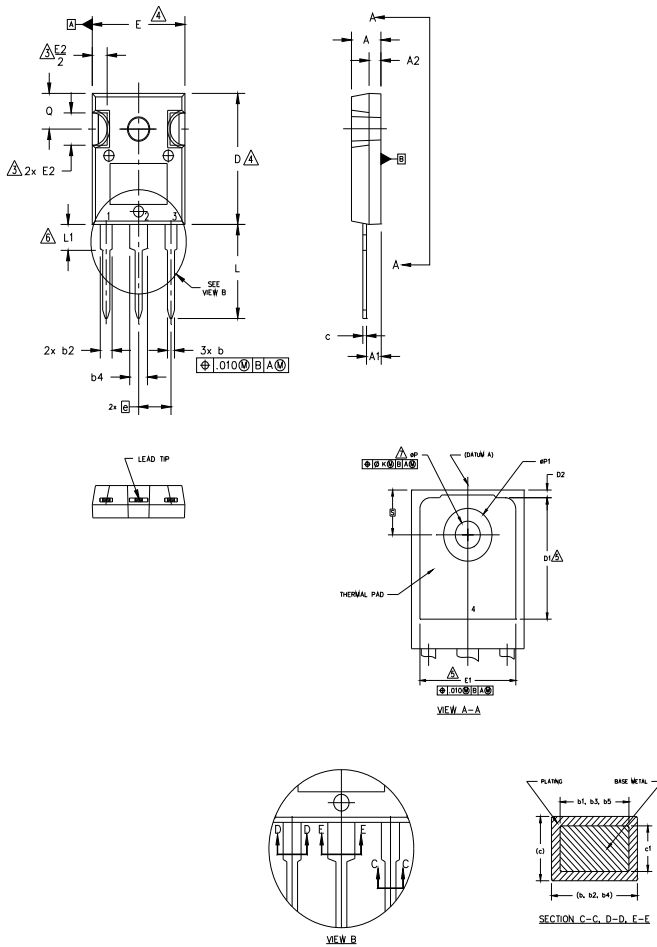


**Fig. WF2** - Typ. Turn-on Loss Waveform  
@  $T_J = 175^\circ\text{C}$  using Fig. CT.3



## 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**

**HEXFET**

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

**IGBTs, CoPACK**

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

**DIODES**

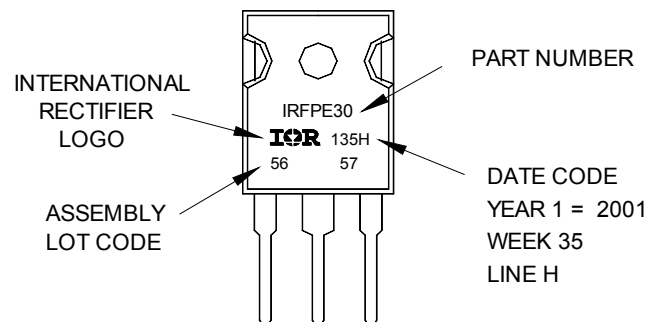
- 1.- ANODE/OPEN
- 2.- CATHODE
- 3.- ANODE

## TO-247AC Part Marking Information

Notes: This part marking information applies to devices produced after 02/26/2001

EXAMPLE: THIS IS AN IRFPE30  
WITH ASSEMBLY  
LOT CODE 5657  
ASSEMBLED ON WW 35, 2001  
IN THE ASSEMBLY LINE "H"

Note: "P" in assembly line position indicates "Lead-Free"

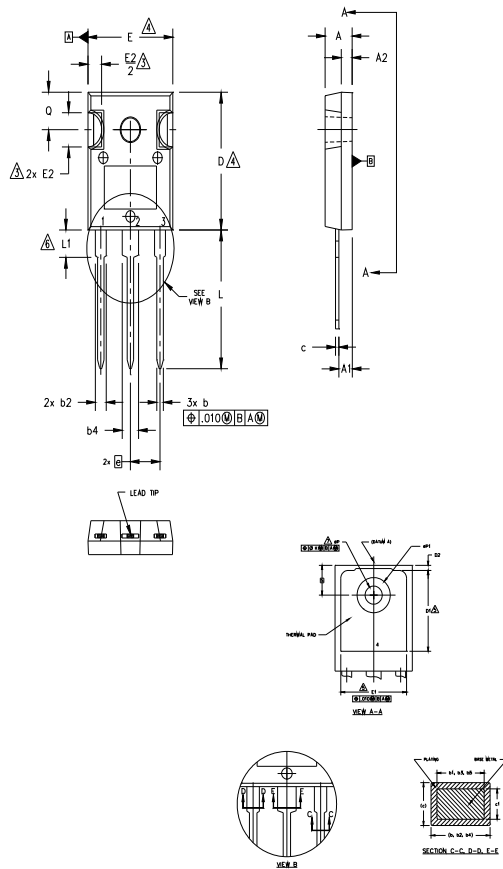


TO-247AC package is not recommended for Surface Mount Application.

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

## 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	.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	4
E	.602	.625	15.29	15.87	
E1	.530	-	13.46	-	
E2	.178	.216	4.52	5.49	
e	.215 BSC		5.46 BSC		
Øk	.010		0.25		
L	.780	.827	19.57	21.00	
L1	.146	.169	3.71	4.29	
ØP1	.140	.144	3.56	3.66	
ØP	-	.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

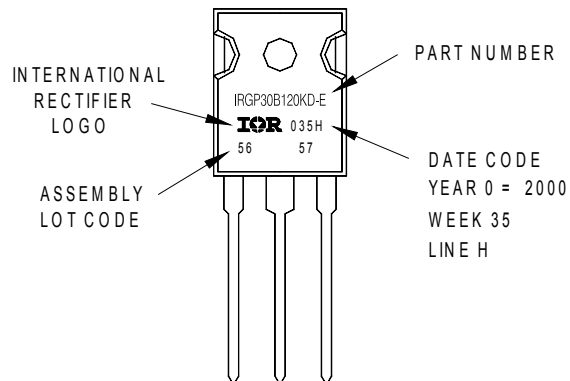
**DIODES**

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

## TO-247AD Part Marking Information

EXAMPLE: THIS IS AN IRGP30B120KD-E  
WITH ASSEMBLY  
LOT CODE 5657  
ASSEMBLED ON WW 35, 2000  
IN THE ASSEMBLY LINE "H"

Note: "P" in assembly line position  
indicates "Lead-Free"



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<sup>†</sup>**

<b>Qualification Level</b>	Industrial	
<b>Moisture Sensitivity Level</b>	TO-247AC	N/A
	TO-247AD	
<b>RoHS Compliant</b>	Yes	

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

†† Applicable version of JEDEC standard at the time of product release.