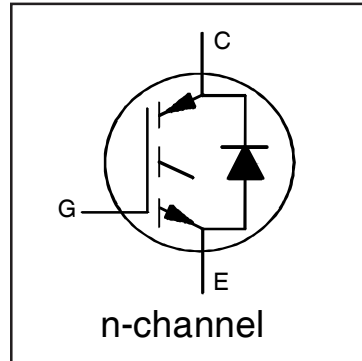


# IRGP4068DPbF IRGP4068D-EPbF

**INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRA-LOW VF DIODE  
FOR INDUCTION HEATING AND SOFT SWITCHING APPLICATIONS**

## Features

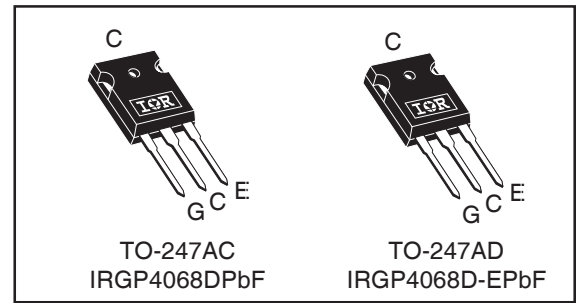
- Low  $V_{CE(ON)}$  Trench IGBT Technology
- Low Switching Losses
- Maximum Junction temperature 175 °C
- 5  $\mu$ S short circuit SOA
- Square RBSOA
- 100% of the parts tested for 4X rated current ( $I_{LM}$ )
- Positive  $V_{CE(ON)}$  Temperature co-efficient
- Ultra-low  $V_F$  Hyperfast Diode
- Tight parameter distribution
- Lead Free Package



$V_{CES} = 600V$
$I_C = 48A, T_C = 100^\circ C$
$t_{SC} \geq 5\mu s, T_{J(max)} = 175^\circ C$
$V_{CE(on)} \text{ typ.} = 1.65V$

## Benefits

- Device optimized for induction heating and soft switching applications
- High Efficiency due to Low  $V_{CE(on)}$ , Low Switching Losses and Ultra-low  $V_F$
- Rugged transient Performance for increased reliability
- Excellent Current sharing in parallel operation
- Low EMI



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

## Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	96	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	48	
$I_{CM}$	Pulse Collector Current	192	
$I_{LM}$	Clamped Inductive Load Current ①	192	
$I_F @ T_C = 160^\circ C$	Diode Continuous Forward Current	8.0	
$I_{FSM}$	Diode Non Repetitive Peak Surge Current @ $T_J = 25^\circ C$ ②	175	
$I_{FM}$	Diode Peak Repetitive Forward Current ②	16	V
$V_{GE}$	Continuous Gate-to-Emitter Voltage	$\pm 20$	
	Transient Gate-to-Emitter Voltage	$\pm 30$	
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	330	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	170	
$T_J$	Operating Junction and	-55 to +175	°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)	Thermal Resistance Junction-to-Case-(each IGBT)	—	—	0.45	°C/W
$R_{\theta JC}$ (Diode)	Thermal Resistance Junction-to-Case-(each Diode)	—	—	2.0	
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink (flat, greased surface)	—	0.24	—	
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (typical socket mount)	—	80	—	

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

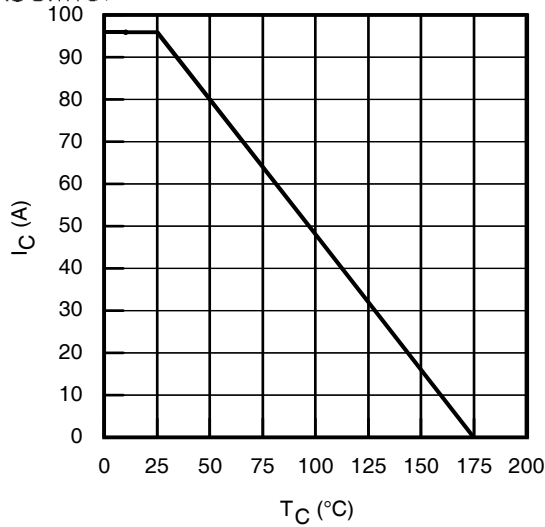
	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig
V <sub>(BR)CES</sub>	Collector-to-Emitter Breakdown Voltage	600	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 100μA ③	CT6
ΔV <sub>(BR)CES</sub> /ΔT <sub>J</sub>	Temperature Coeff. of Breakdown Voltage	—	0.30	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1mA (25°C-175°C)	CT6
V <sub>CE(on)</sub>	Collector-to-Emitter Saturation Voltage	—	1.65	2.14	V	I <sub>C</sub> = 48A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 25°C	4,5,6
		—	2.0	—		I <sub>C</sub> = 48A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 150°C	8,9,10
		—	2.05	—		I <sub>C</sub> = 48A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 175°C	
V <sub>GE(th)</sub>	Gate Threshold Voltage	4.0	—	6.5	V	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 1.4mA	8,9
ΔV <sub>GE(th)</sub> /ΔT <sub>J</sub>	Threshold Voltage temp. coefficient	—	-21	—	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 1.0mA (25°C - 175°C)	10,11
g <sub>fe</sub>	Forward Transconductance	—	32	—	S	V <sub>CE</sub> = 50V, I <sub>C</sub> = 48A, PW = 80μs	
I <sub>CES</sub>	Collector-to-Emitter Leakage Current	—	1.0	150	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V	
		—	450	1000		V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V, T <sub>J</sub> = 175°C	
V <sub>FM</sub>	Diode Forward Voltage Drop	—	0.96	1.05	V	I <sub>F</sub> = 8.0A	7
		—	0.81	0.86		I <sub>F</sub> = 8.0A, 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)

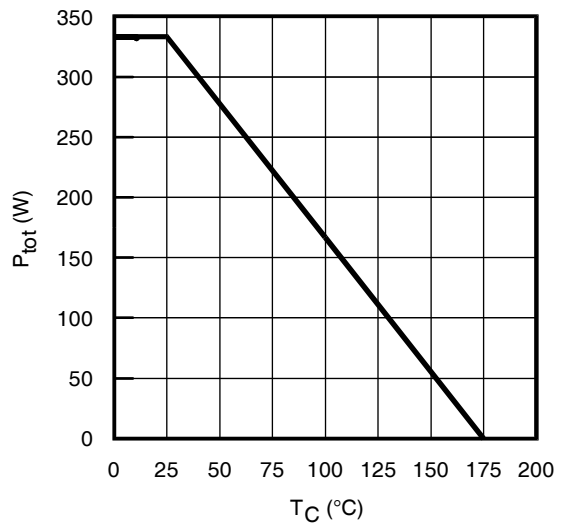
	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig
Q <sub>g</sub>	Total Gate Charge (turn-on)	—	95	140	nC	I <sub>C</sub> = 48A V <sub>GE</sub> = 15V V <sub>CC</sub> = 400V	18 CT1
Q <sub>ge</sub>	Gate-to-Emitter Charge (turn-on)	—	28	42			
Q <sub>gc</sub>	Gate-to-Collector Charge (turn-on)	—	35	53			
E <sub>off</sub>	Turn-Off Switching Loss	—	1275	1481	μJ	I <sub>C</sub> = 48A, V <sub>CC</sub> = 400V, V <sub>GE</sub> = 15V R <sub>G</sub> = 10Ω, L = 200μH, T <sub>J</sub> = 25°C Energy losses include tail	CT4
t <sub>d(off)</sub>	Turn-Off delay time	—	145	176	μJ	I <sub>C</sub> = 48A, V <sub>CC</sub> = 400V, V <sub>GE</sub> = 15V R <sub>G</sub> = 10Ω, L = 200μH, T <sub>J</sub> = 25°C	
t <sub>f</sub>	Fall time	—	35	46			
E <sub>off</sub>	Turn-Off Switching Loss	—	1585	—	μJ	I <sub>C</sub> = 48A, V <sub>CC</sub> = 400V, V <sub>GE</sub> = 15V R <sub>G</sub> = 10Ω, L = 200μH, T <sub>J</sub> = 175°C Energy losses include tail	CT4
t <sub>d(off)</sub>	Turn-Off delay time	—	165	—	μJ	I <sub>C</sub> = 48A, V <sub>CC</sub> = 400V, V <sub>GE</sub> = 15V R <sub>G</sub> =10Ω, L=200μH, T <sub>J</sub> = 175°C	WF1
t <sub>f</sub>	Fall time	—	45	—			
C <sub>ies</sub>	Input Capacitance	—	3025	—	pF	V <sub>GE</sub> = 0V V <sub>CC</sub> = 30V f = 1.0Mhz	17
C <sub>oes</sub>	Output Capacitance	—	245	—			
C <sub>res</sub>	Reverse Transfer Capacitance	—	90	—			
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T <sub>J</sub> = 175°C, I <sub>C</sub> = 192A V <sub>CC</sub> = 480V, V <sub>p</sub> = 600V R <sub>G</sub> = 10Ω, V <sub>GE</sub> = +15V to 0V	3 CT2
SCSOA	Short Circuit Safe Operating Area	5	—	—	μs	V <sub>CC</sub> = 400V, V <sub>p</sub> = 600V R <sub>G</sub> = 10Ω, V <sub>GE</sub> = +15V to 0V	16, CT3 WF2

### Notes:

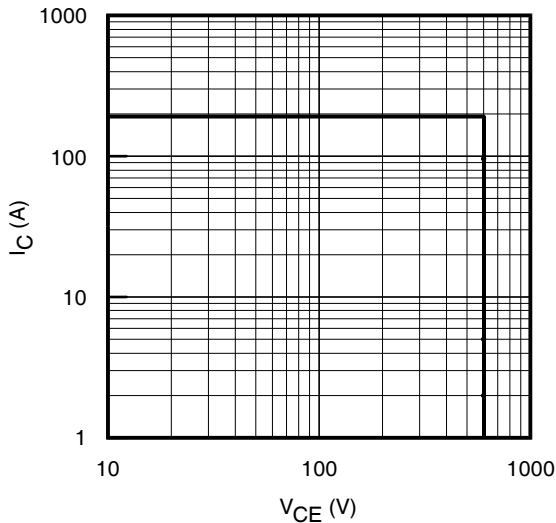
- ① V<sub>CC</sub> = 80% (V<sub>CES</sub>), V<sub>GE</sub> = 20V, L = 200μH, R<sub>G</sub> = 10Ω.
- ② Pulse width limited by max. junction temperature.
- ③ Refer to AN-1086 for guidelines for measuring V<sub>(BR)CES</sub> safely.



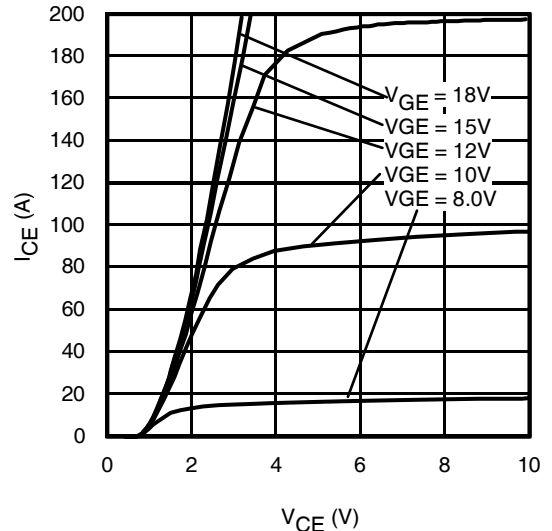
**Fig. 1** - Maximum DC Collector Current vs. Case Temperature



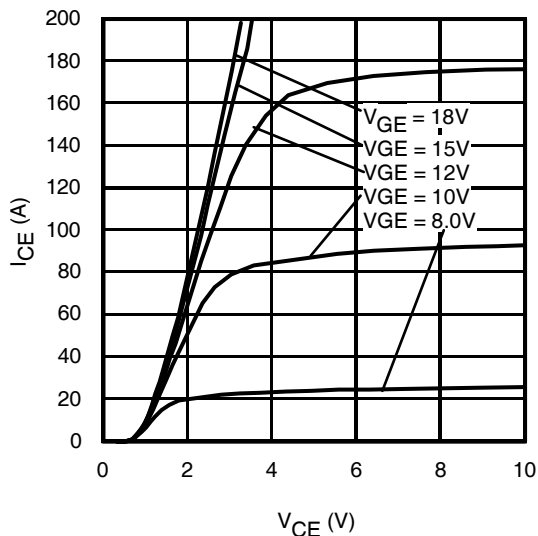
**Fig. 2** - Power Dissipation vs. Case Temperature



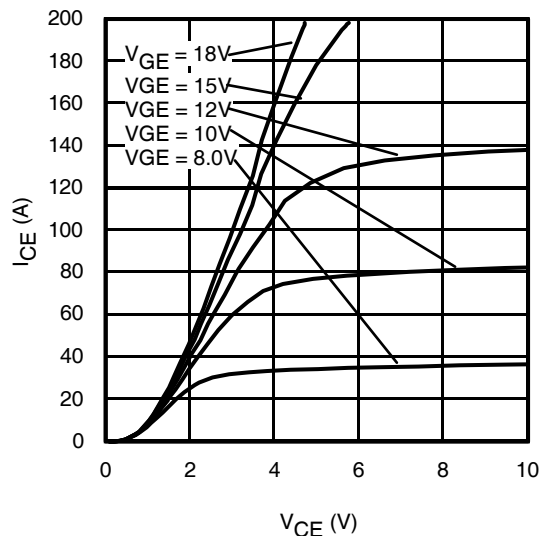
**Fig. 3** - Reverse Bias SOA  
 $T_J = 175^\circ\text{C}$ ;  $V_{GE} = 15\text{V}$



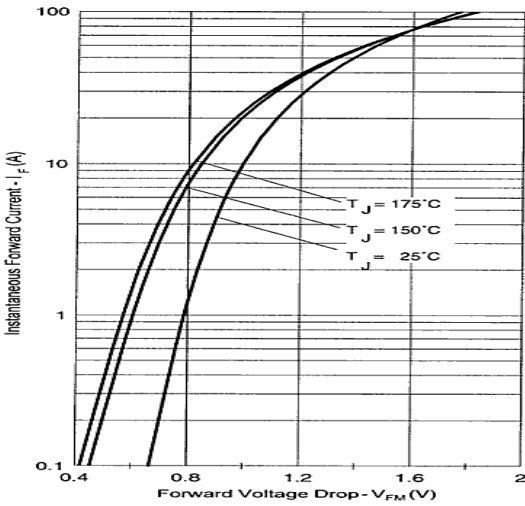
**Fig. 4** - Typ. IGBT Output Characteristics  
 $T_J = -40^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$



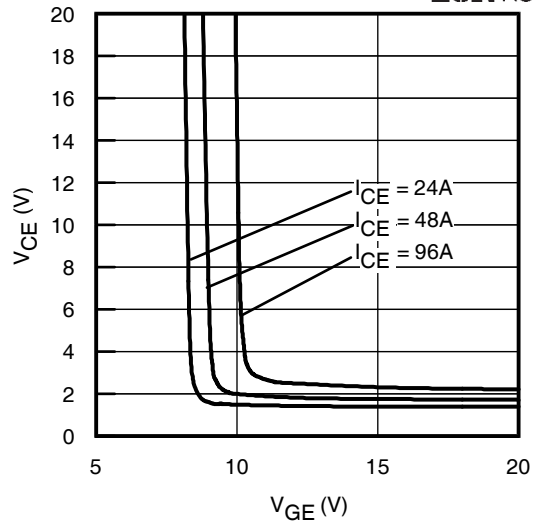
**Fig. 5** - Typ. IGBT Output Characteristics  
 $T_J = 25^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$



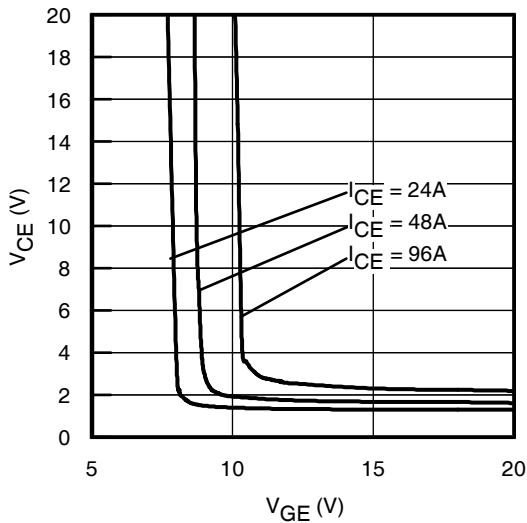
**Fig. 6** - Typ. IGBT Output Characteristics  
 $T_J = 175^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$



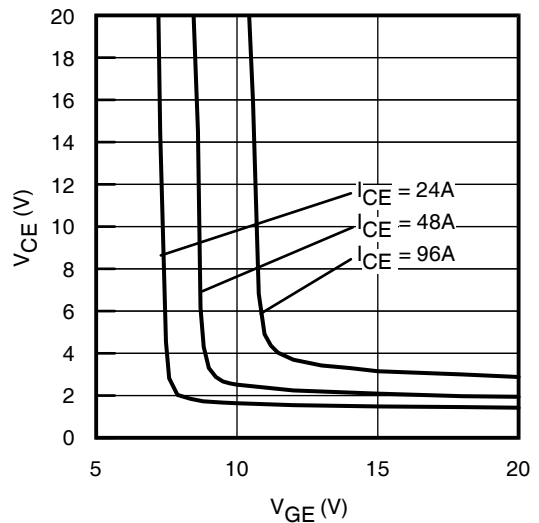
**Fig. 7** - Typ. Diode Forward Voltage Drop Characteristics



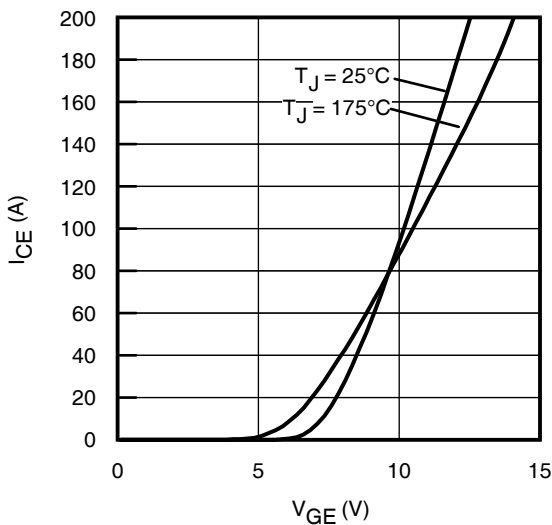
**Fig. 8** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = -40^\circ\text{C}$



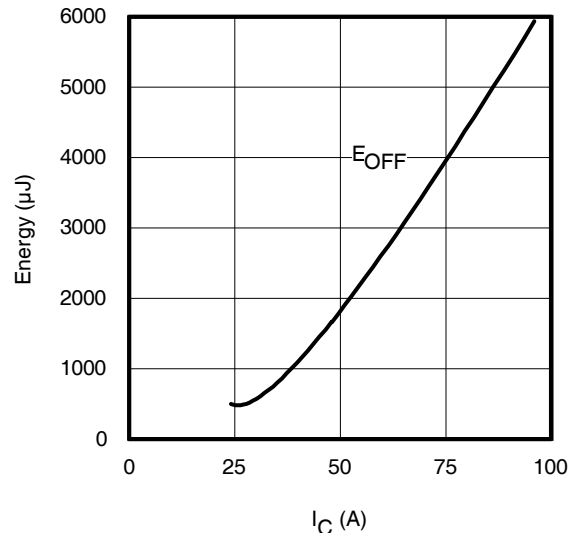
**Fig. 9** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 25^\circ\text{C}$



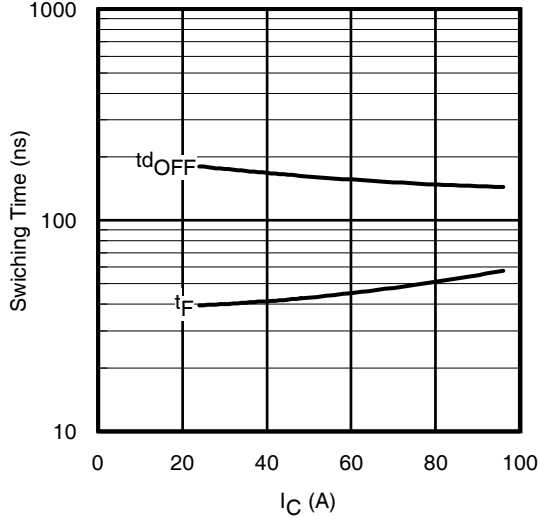
**Fig. 10** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 175^\circ\text{C}$



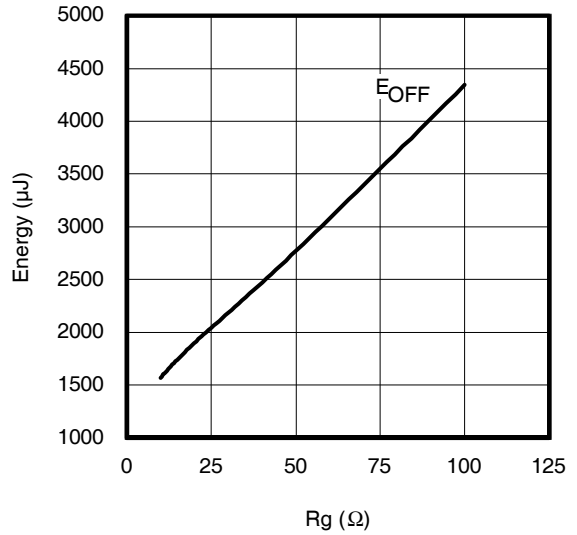
**Fig. 11** - Typ. Transfer Characteristics  
 $V_{CE} = 50\text{V}$ ;  $t_p = 10\mu\text{s}$



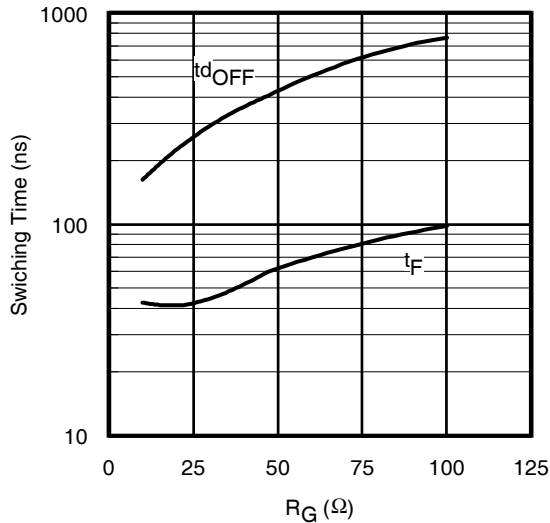
**Fig. 12** - Typ. Energy Loss vs.  $I_C$   
 $T_J = 175^\circ\text{C}$ ;  $L = 200\mu\text{H}$ ;  $V_{CE} = 400\text{V}$ ;  $R_G = 10\Omega$ ;  $V_{GE} = 15\text{V}$



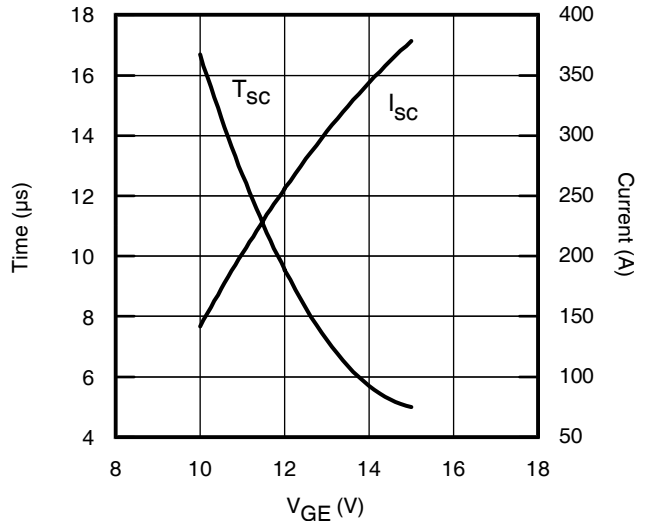
**Fig. 13 - Typ. Switching Time vs.  $I_C$**   
 $T_J = 175^\circ\text{C}$ ;  $L = 200\mu\text{H}$ ;  $V_{CE} = 400\text{V}$ ;  $R_G = 10\Omega$ ;  $V_{GE} = 15\text{V}$



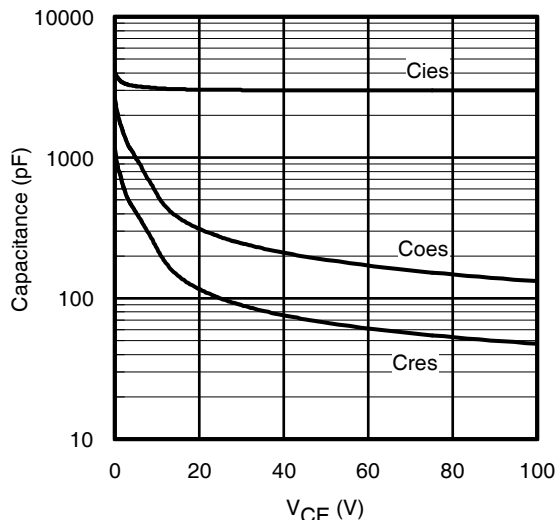
**Fig. 14 - Typ. Energy Loss vs.  $R_G$**   
 $T_J = 175^\circ\text{C}$ ;  $L = 200\mu\text{H}$ ;  $V_{CE} = 400\text{V}$ ;  $I_{CE} = 48\text{A}$ ;  $V_{GE} = 15\text{V}$



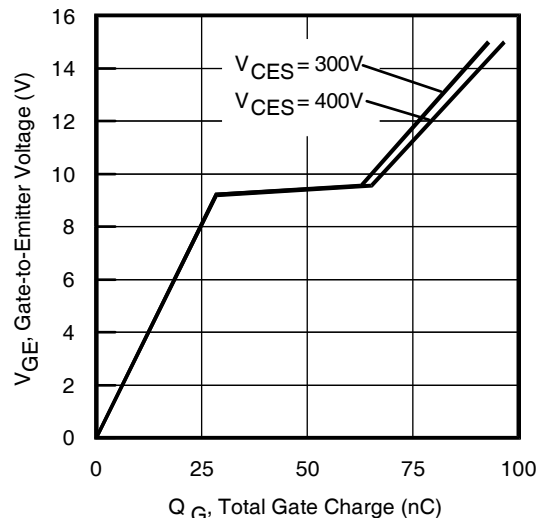
**Fig. 15 - Typ. Switching Time vs.  $R_G$**   
 $T_J = 175^\circ\text{C}$ ;  $L = 200\mu\text{H}$ ;  $V_{CE} = 400\text{V}$ ;  $I_{CE} = 48\text{A}$ ;  $V_{GE} = 15\text{V}$



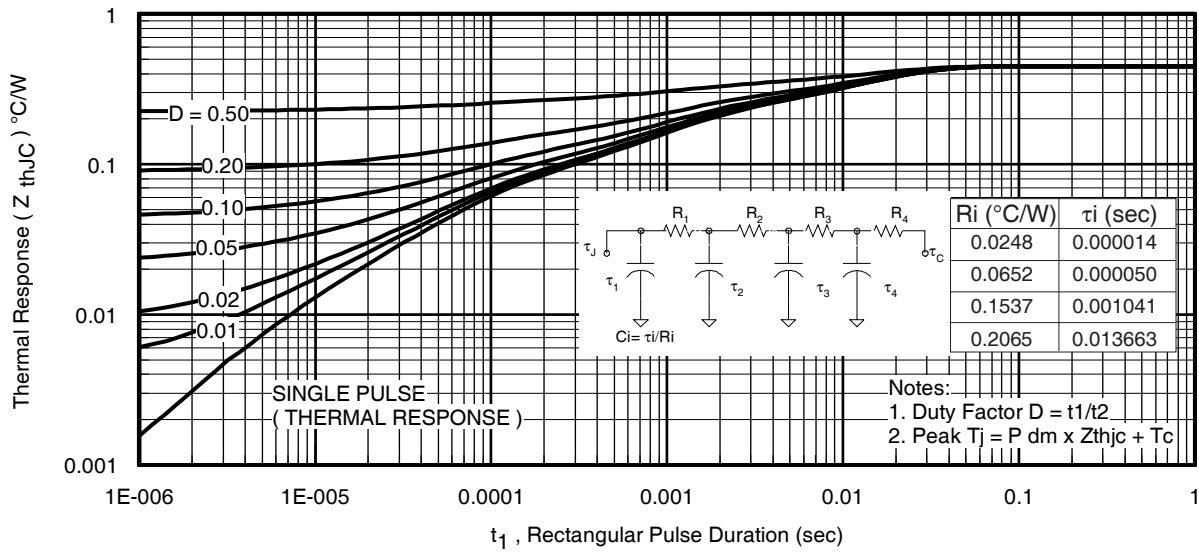
**Fig. 16 -  $V_{GE}$  vs. Short Circuit**  
 $V_{CC} = 400\text{V}$ ;  $T_C = 25^\circ\text{C}$



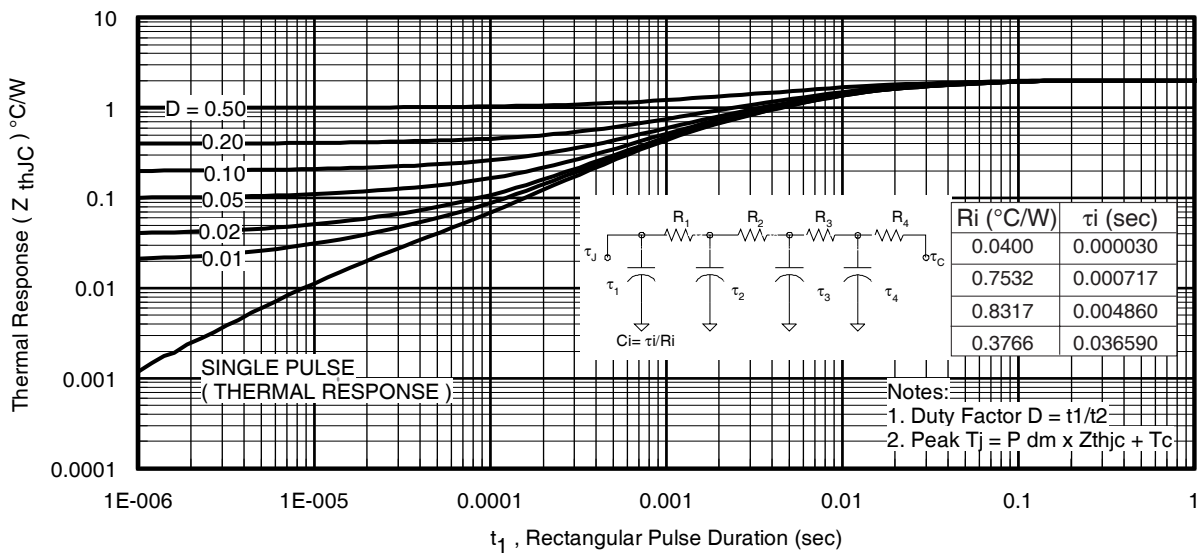
**Fig. 17 - Typ. Capacitance vs.  $V_{CE}$**   
 $V_{GE} = 0\text{V}$ ;  $f = 1\text{MHz}$



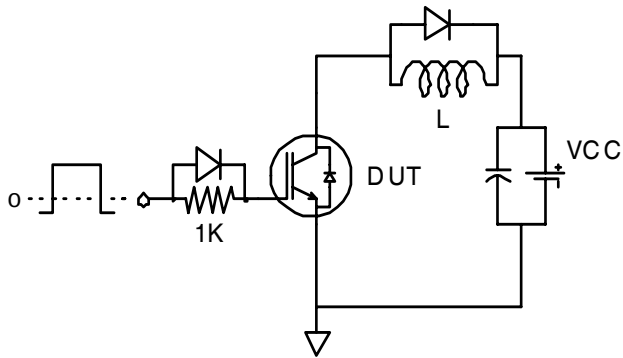
**Fig. 18 - Typical Gate Charge vs.  $V_{GE}$**   
 $I_{CE} = 48\text{A}$ ;  $L = 600\mu\text{H}$



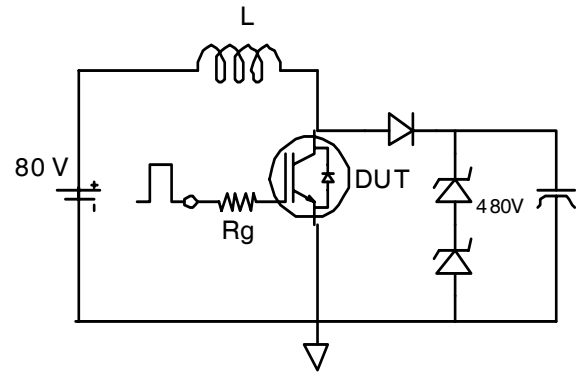
**Fig. 19.** Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)



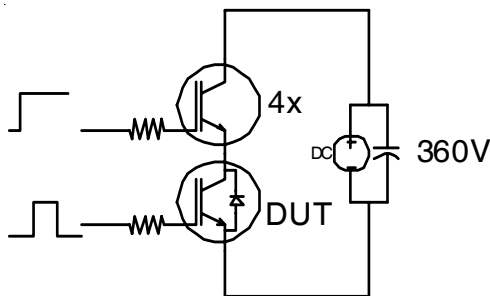
**Fig. 20.** Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)



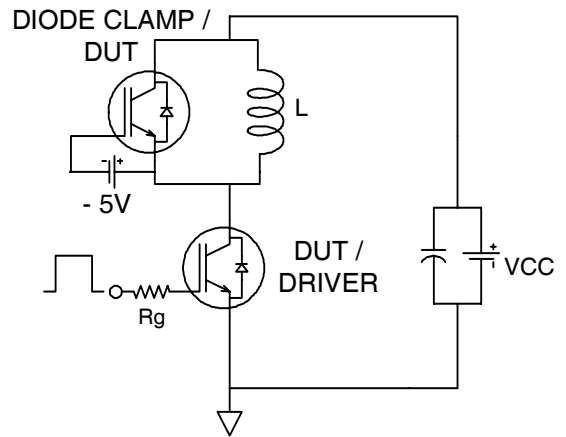
**Fig.C.T.1** - Gate Charge Circuit (turn-off)



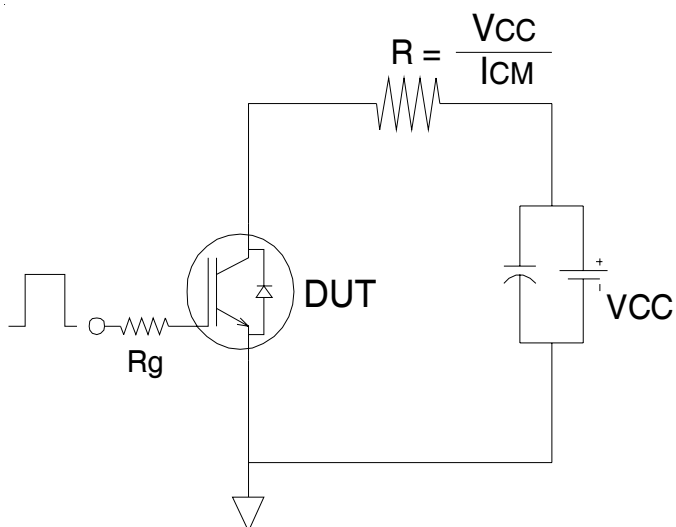
**Fig.C.T.2** - RBSOA Circuit



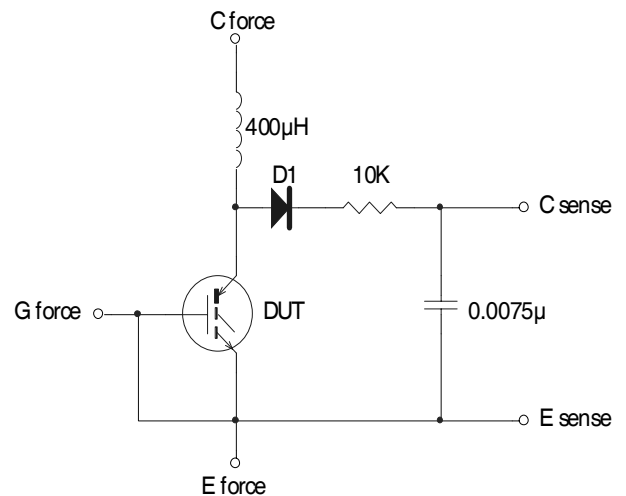
**Fig.C.T.3** - S.C. SOA Circuit



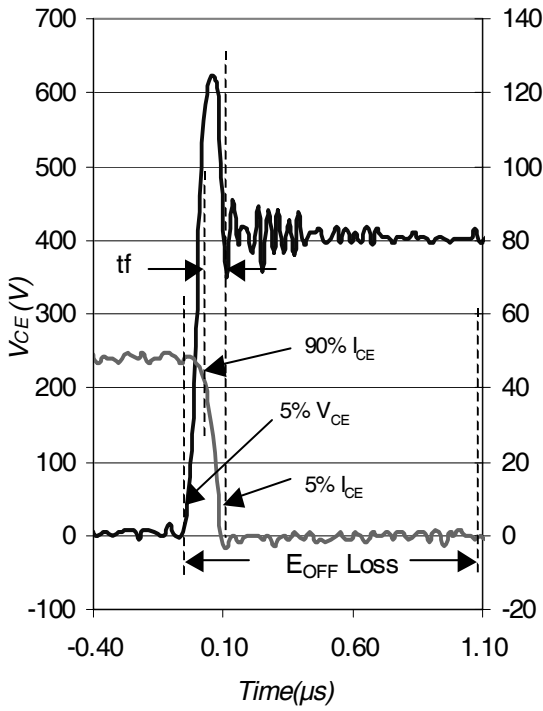
**Fig.C.T.4** - Switching Loss Circuit



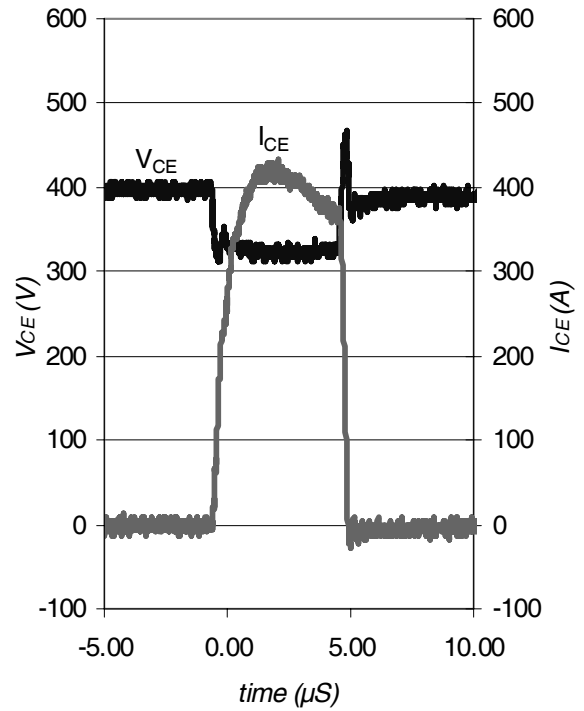
**Fig.C.T.5** - Resistive Load Circuit



**Fig.C.T.6** - BVCES Filter Circuit



**Fig. WF1** - Typ. Turn-off Loss Waveform  
@  $T_J = 175^\circ\text{C}$  using Fig. CT.4

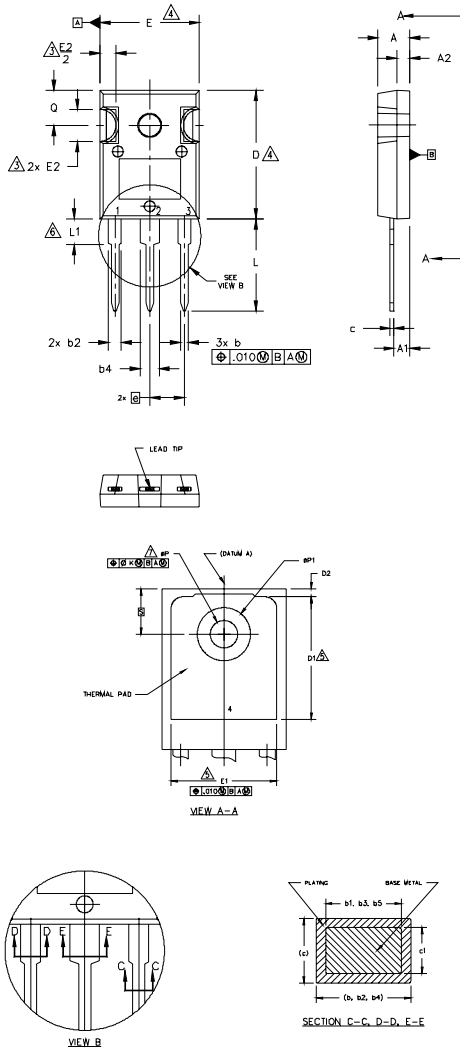


**Fig. WF2** - Typ. S.C. Waveform  
@  $T_J = 25^\circ\text{C}$  using Fig. CT.3



## 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. 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-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		
Øk	.010		0.25		
L	.559	.634	14.20	16.10	
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

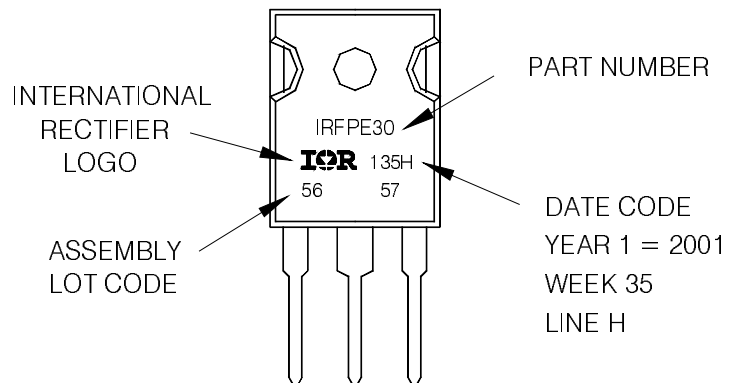
DIODES

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

## TO-247AC Part Marking Information

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"

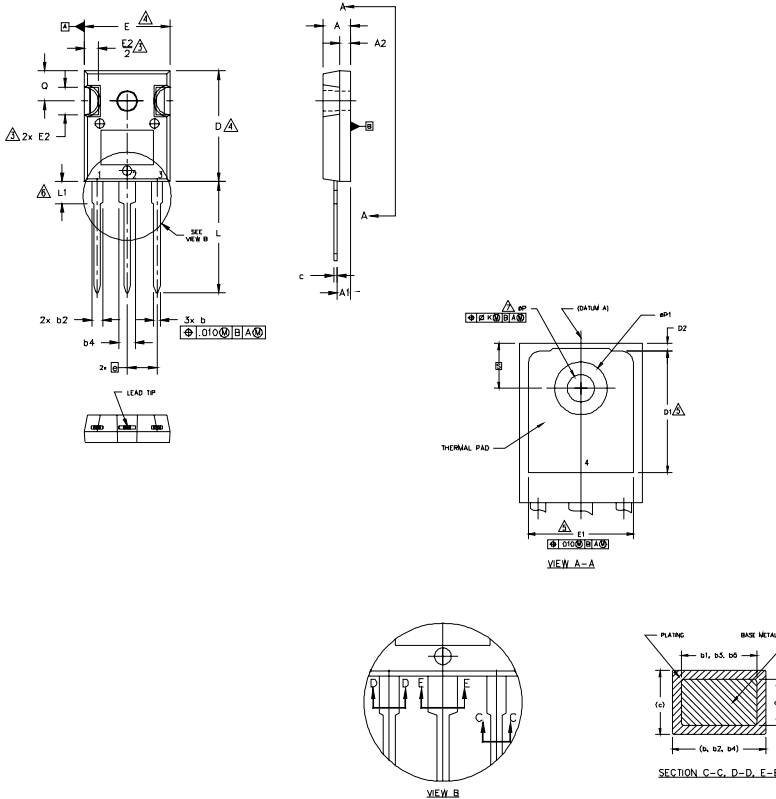


**TO-247AC package is not recommended for Surface Mount Application.**

# IRGP4068DPbF/IRGP4068D-EPbF

## 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. RP 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	.065	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		
PK	.010		0.25		
L	.780	.827	19.57	21.00	
L1	.146	.169	3.71	4.29	
RP	.140	.144	3.56	3.66	
RP1	-	.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

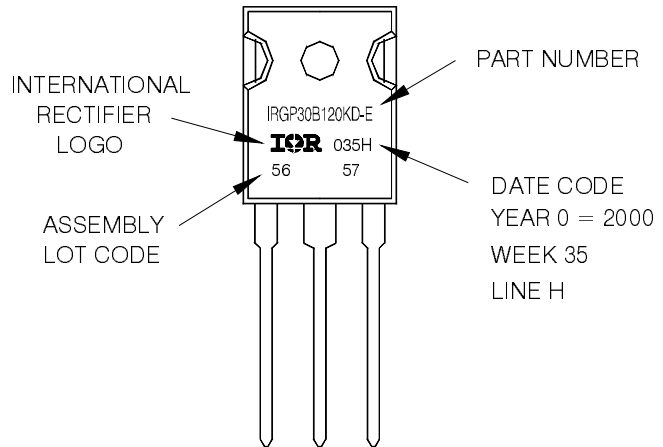
**DIODES**

- 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.**

Data and specifications subject to change without notice.  
This product has been designed and qualified for Industrial market.  
Qualification Standards can be found on IR's Web site.