

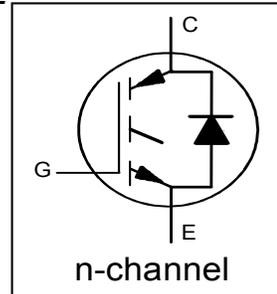
**INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRA-LOW VF DIODE  
FOR INDUCTION HEATING AND SOFT SWITCHING APPLICATIONS**

**Features**

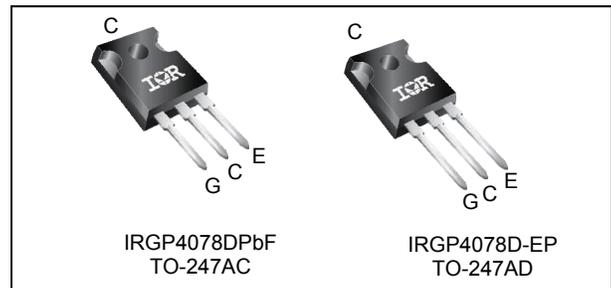
- Low  $V_{CE(ON)}$  Trench IGBT Technology
- Low Switching Losses
- Maximum Junction temperature 175°C
- 5  $\mu$ s short circuit SOA
- Square RBSOA
- 100% of the parts tested for  $I_{LM}$ ①
- Positive  $V_{CE(ON)}$  Temperature co-efficient
- Ultra-low VF Hyperfast Diode
- Tight parameter distribution

**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



$V_{CES} = 600V$
$I_C = 50A, T_C = 100^\circ C$
$T_{J(MAX)} = 175^\circ C$
$V_{CE(ON)} \text{ typ.} = 1.9V$



G	C	E
Gate	Collector	Emitter

Base part number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
IRGP4078DPbF	TO-247AC	Tube	25	IRGP4078DPbF
IRGP4078D-EPbF	TO-247AD	Tube	25	IRGP4078D-EPbF

**Absolute Maximum Ratings**

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	74	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	50	
$I_{CM}$	Pulse Collector Current, $V_{GE} = 15V$	150	
$I_{LM}$	Clamped Inductive Load Current, $V_{GE} = 20V$ ①	200	
$I_F @ T_C = 25^\circ C$	Diode Continuous Forward Current	44	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	25	
$I_{FSM} @ T_C = 25^\circ C$	Diode Non Repetitive Peak Surge Current @ $T_J = 25^\circ C$ ② ⑥	120	
$I_{FRM} @ T_C = 100^\circ C$	Diode Repetitive Peak Forward Current at $t_p = 10\mu s$ ② ④	79	
$V_{GE}$	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	278	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	139	
$T_J$	Operating Junction and	-55 to +175	°C
$T_{STG}$	Storage Temperature Range		
	Soldering Temperature, for 10 sec.		
	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)	—	—	0.54	°C/W
$R_{\theta JC}$ (Diode)	Thermal Resistance Junction-to-Case-(each Diode)	—	—	2.55	
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink (flat, greased surface)	—	0.24	—	
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (typical socket mount)	—	—	40	

**Electrical Characteristics @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)**

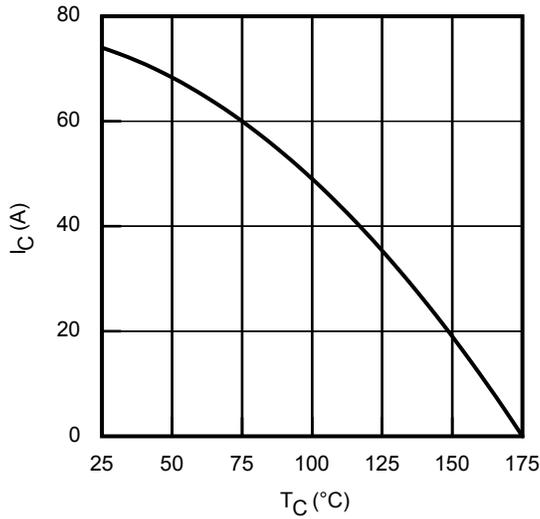
	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	$V_{GE} = 0V, I_C = 100\mu A$ ③
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.45	—	V/°C	$V_{GE} = 0V, I_C = 1mA$ (25°C-175°C)
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.9	2.2	V	$I_C = 50A, V_{GE} = 15V, T_J = 25^\circ\text{C}$
		—	2.5	—		$I_C = 50A, V_{GE} = 15V, T_J = 150^\circ\text{C}$
		—	2.6	—		$I_C = 50A, V_{GE} = 15V, T_J = 175^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	$V_{CE} = V_{GE}, I_C = 1.0mA$
$g_{fe}$	Forward Transconductance	—	26	—	S	$V_{CE} = 50V, I_C = 50A, PW = 20\mu s$
$I_{CES}$	Collector-to-Emitter Leakage Current	—	1.0	80	$\mu A$	$V_{GE} = 0V, V_{CE} = 600V$
		—	600	—		$V_{GE} = 0V, V_{CE} = 600V, T_J = 175^\circ\text{C}$
$V_{FM}$	Diode Forward Voltage Drop	—	1.17	1.30	V	$I_F = 25A$
		—	1.06	—		$I_F = 25A, T_J = 175^\circ\text{C}$
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{GE} = \pm 20V$

**Switching Characteristics @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)**

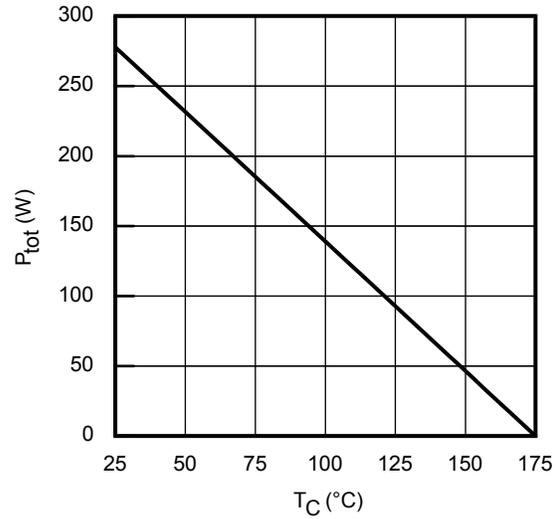
	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge (turn-on)	—	61	92	nC	$I_C = 50A$ $V_{GE} = 15V$ $V_{CC} = 300V$
$Q_{ge}$	Gate-to-Emitter Charge (turn-on)	—	20	30		
$Q_{gc}$	Gate-to-Collector Charge (turn-on)	—	22	33		
$E_{off}$	Turn-Off Switching Loss	—	1.1	1.4	mJ	$I_C = 50A, V_{CC} = 400V, V_{GE} = 15V$ $R_G = 10\Omega, L = 210\mu H, T_J = 25^\circ\text{C}$
$t_{d(off)}$	Turn-Off delay time	—	116	—	ns	Energy losses include tail & diode reverse recovery
$t_f$	Fall time	—	33	—		
$E_{off}$	Turn-Off Switching Loss	—	1.5	—	mJ	$I_C = 50A, V_{CC} = 400V, V_{GE} = 15V$ $R_G = 10\Omega, L = 210\mu H, T_J = 175^\circ\text{C}$
$t_{d(off)}$	Turn-Off delay time	—	113	—	ns	Energy losses include tail & diode reverse recovery
$t_f$	Fall time	—	54	—		
$C_{ies}$	Input Capacitance	—	2105	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0MHz$
$C_{oes}$	Output Capacitance	—	131	—		
$C_{res}$	Reverse Transfer Capacitance	—	59	—		
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 175^\circ\text{C}, I_C = 200A$ $V_{CC} = 480V, V_p \leq 600V$ $R_g = 10\Omega, V_{GE} = +20V$ to 0V
SCSOA	Short Circuit Safe Operating Area	5	—	—	$\mu s$	$V_{CC} = 400V, V_p \leq 600V$ $R_g = 10\Omega, V_{GE} = +15V$ to 0V

**Notes:**

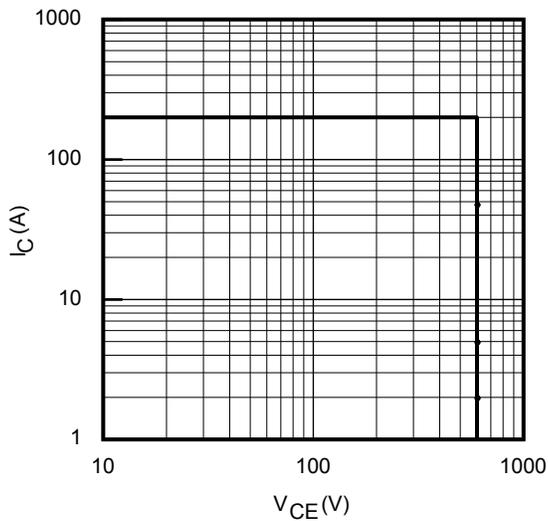
- ①  $V_{CC} = 80\% (V_{CES}), V_{GE} = 20V, L = 23\mu H, R_G = 10\Omega$ .
- ② Pulse width limited by max. junction temperature.
- ③ Refer to AN-1086 for guidelines for measuring  $V_{(BR)CES}$  safely.
- ④  $f_{sw} = 20KHz$ , refer to figure 19.
- ⑤  $R_{\theta}$  is measured at  $T_J$  of approximately  $90^\circ\text{C}$ .
- ⑥ Sinusoidal half wave,  $t = 10ms$ .



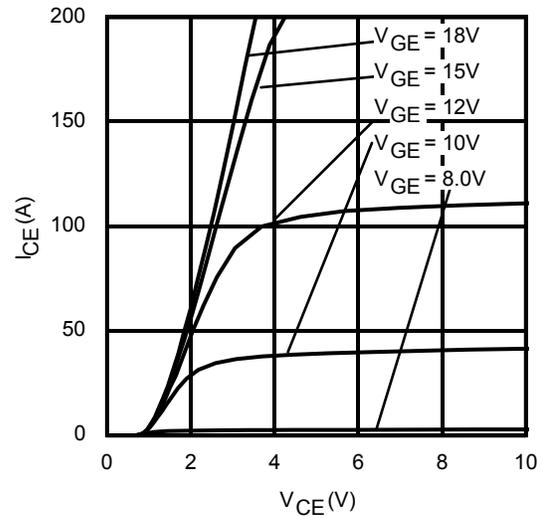
**Fig. 1** - Maximum DC Collector Current vs. Case Temperature



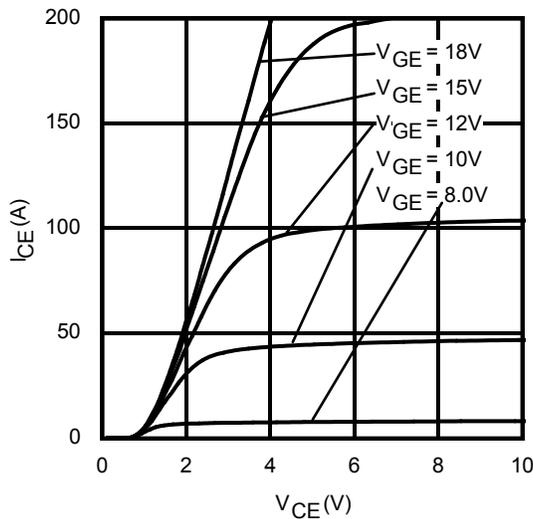
**Fig. 2** - Power Dissipation vs. Case Temperature



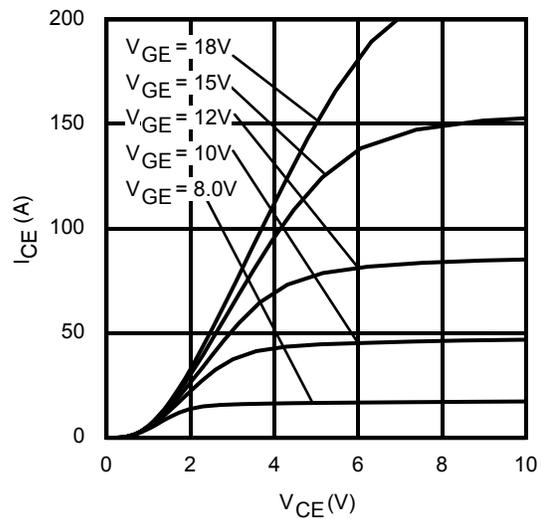
**Fig. 3** - Reverse Bias SOA  
 $T_J = 150^\circ\text{C}$ ;  $V_{GE} = 20\text{V}$



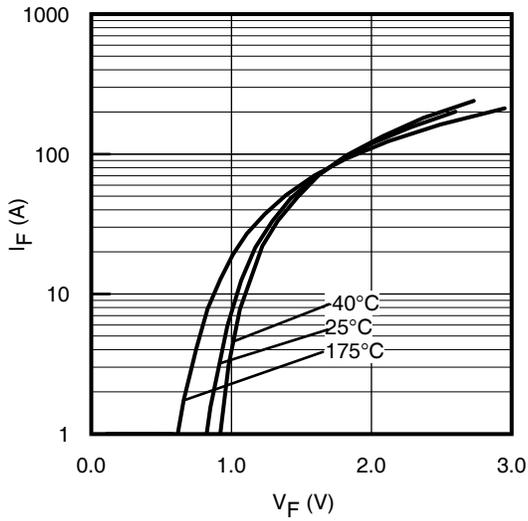
**Fig. 4** - Typ. IGBT Output Characteristics  
 $T_J = -40^\circ\text{C}$ ;  $t_p = 20\mu\text{s}$



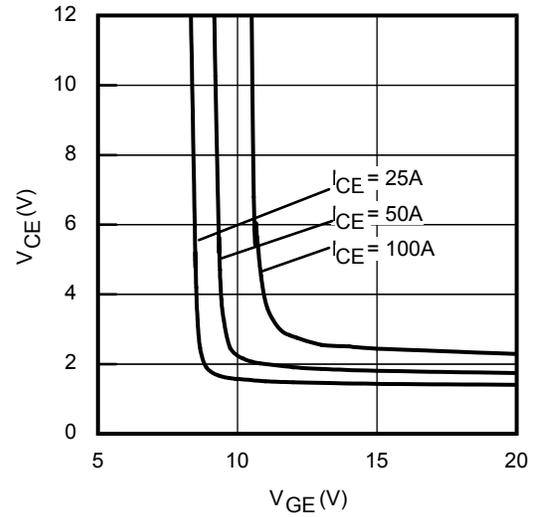
**Fig. 5** - Typ. IGBT Output Characteristics  
 $T_J = 25^\circ\text{C}$ ;  $t_p = 20\mu\text{s}$



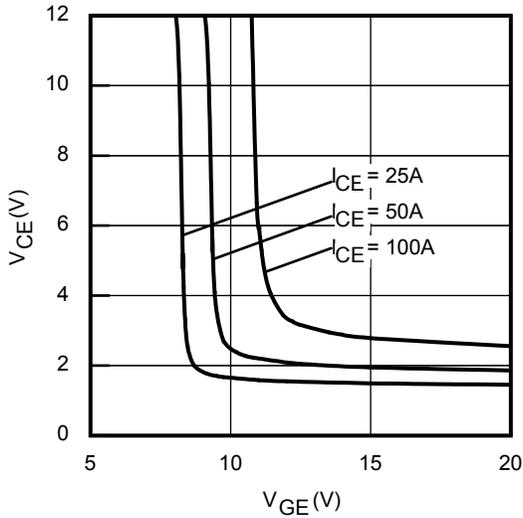
**Fig. 6** - Typ. IGBT Output Characteristics  
 $T_J = 175^\circ\text{C}$ ;  $t_p = 20\mu\text{s}$



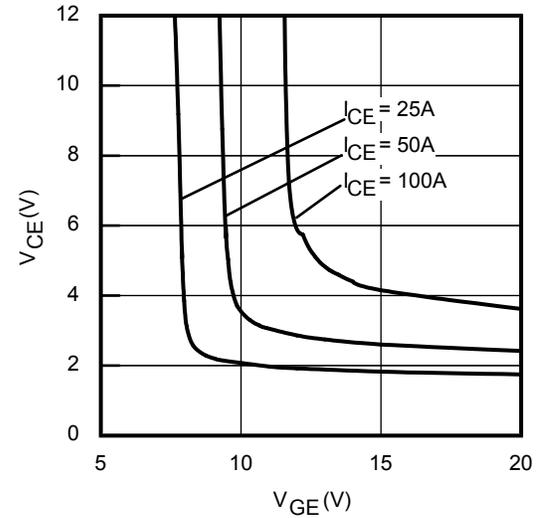
**Fig. 7** - Typ. Diode Forward Voltage Drop Characteristics



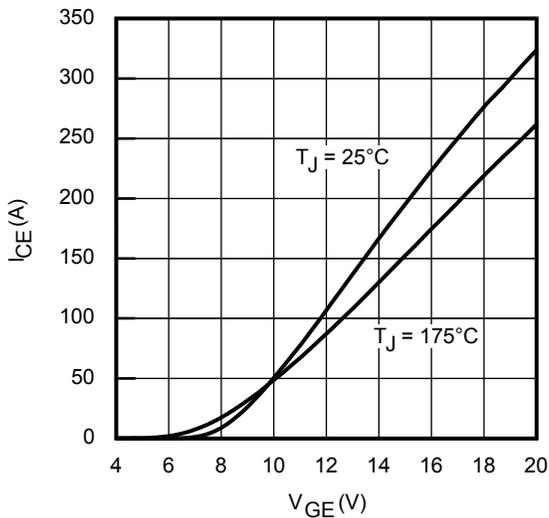
**Fig. 8** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = -40^\circ\text{C}$



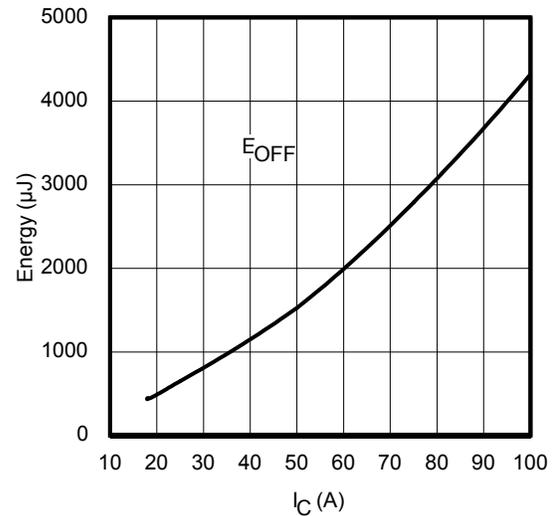
**Fig. 9** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 25^\circ\text{C}$



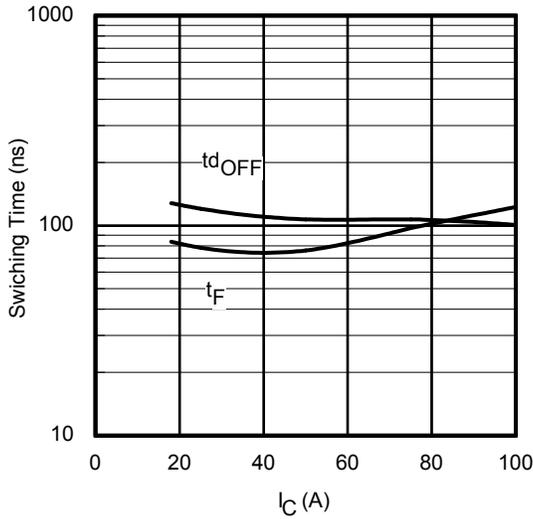
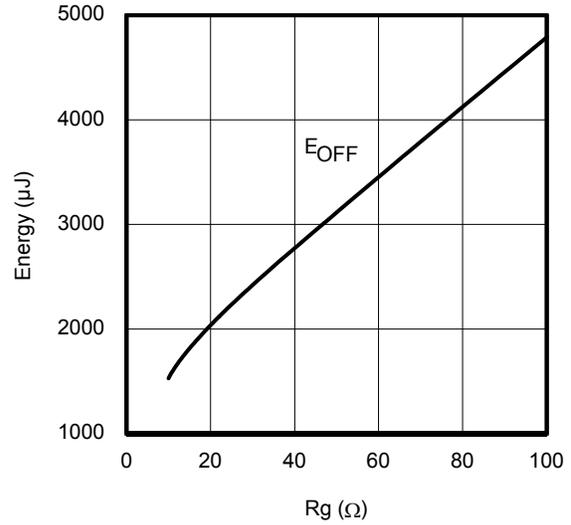
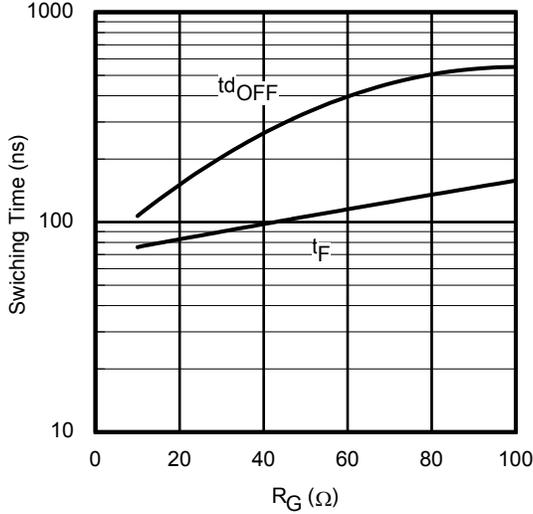
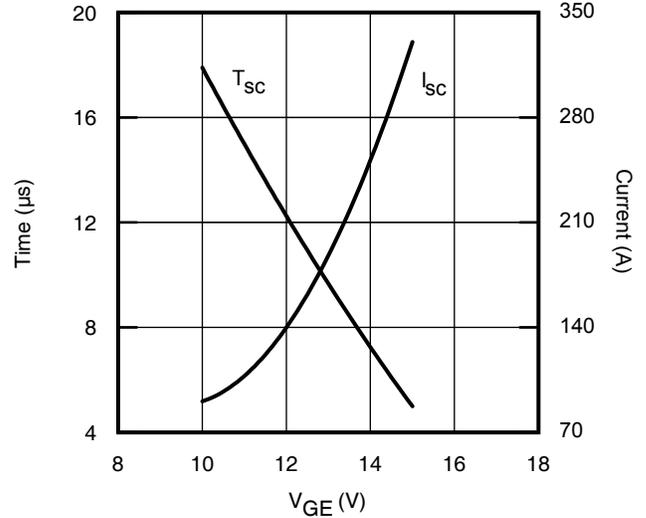
**Fig. 10** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 175^\circ\text{C}$

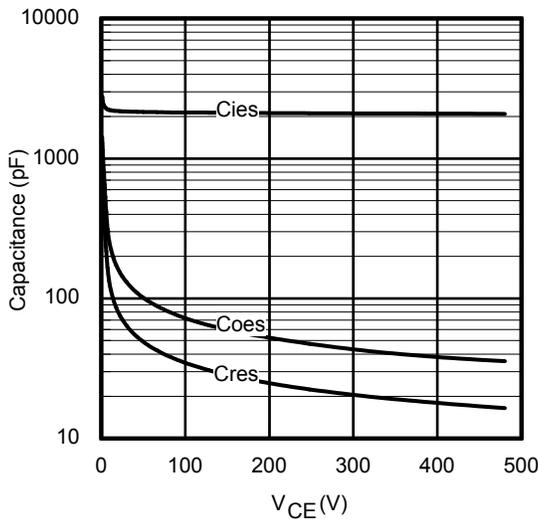
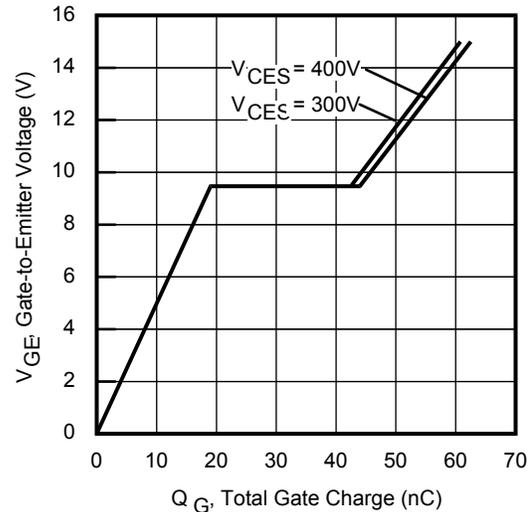


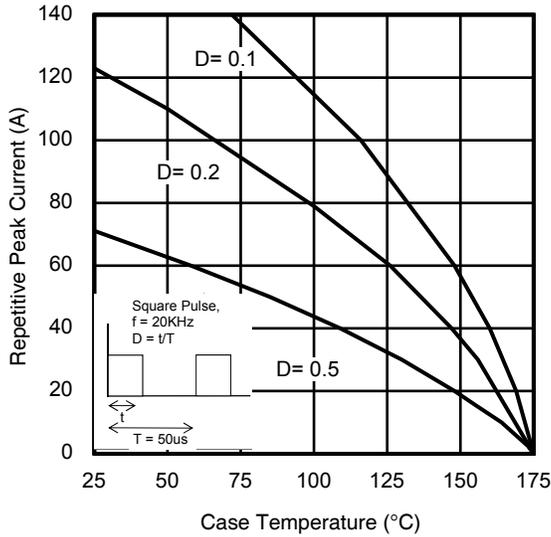
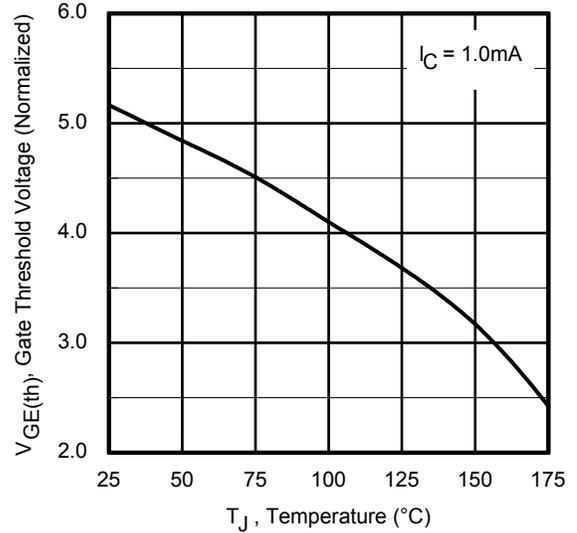
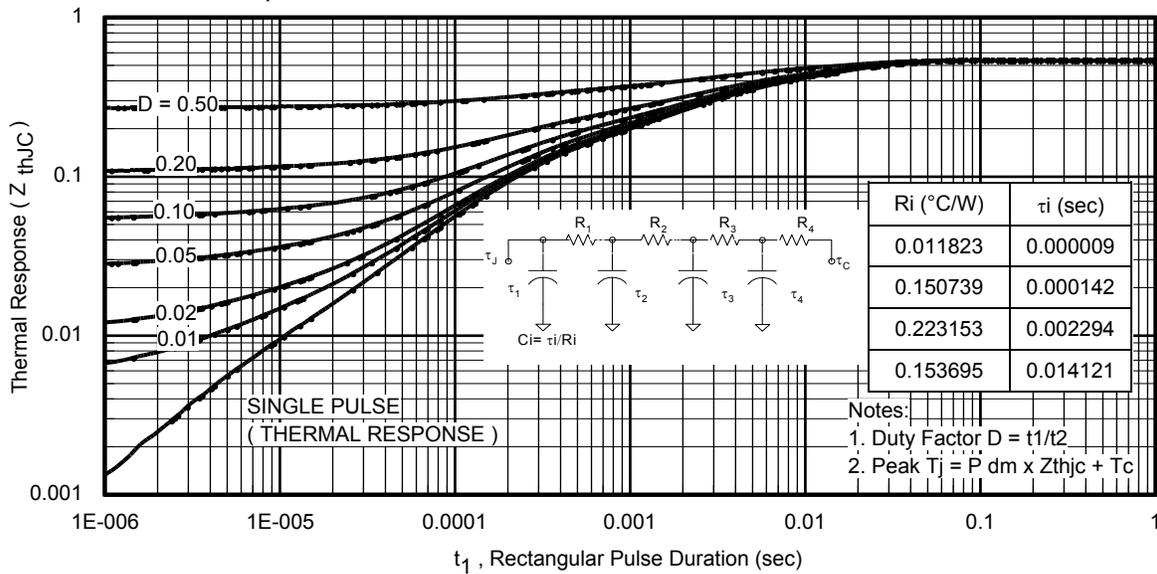
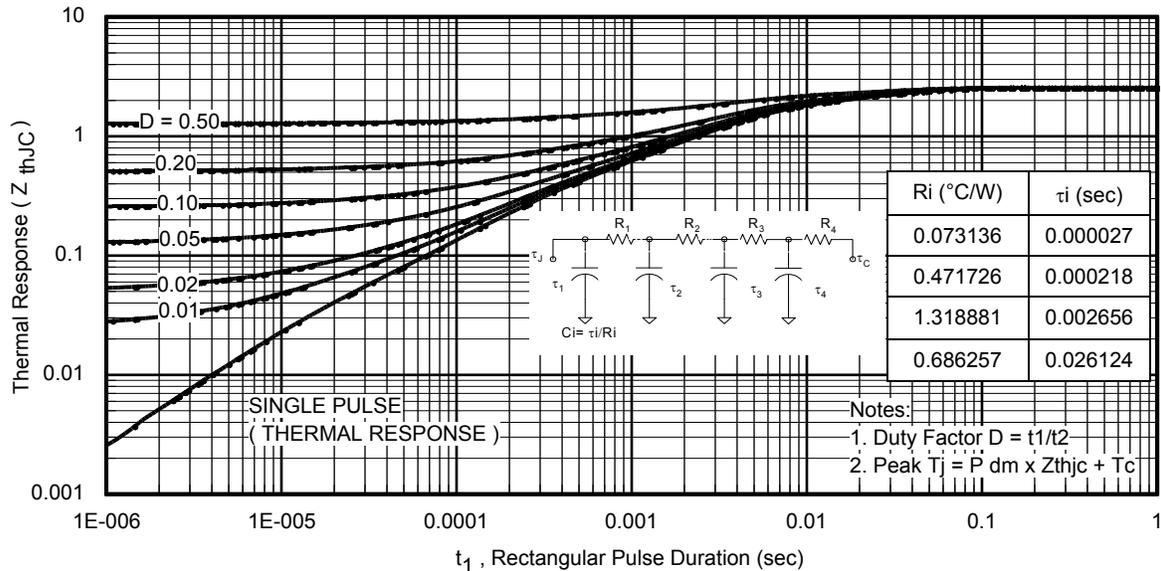
**Fig. 11** - Typ. Transfer Characteristics  
 $V_{CE} = 50\text{V}$ ;  $t_p = 20\mu\text{s}$

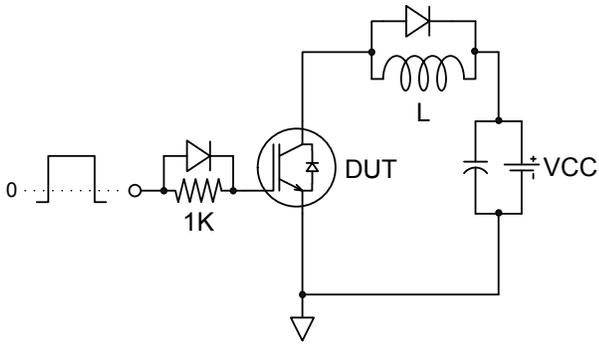
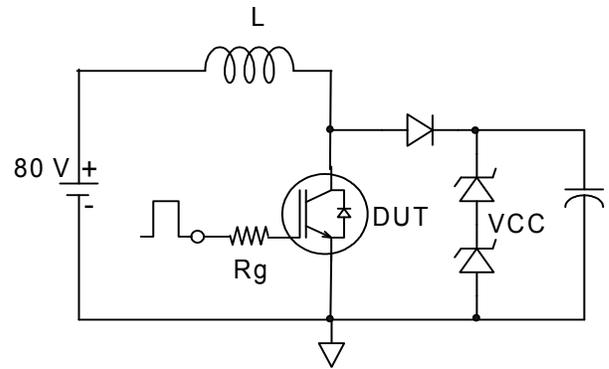
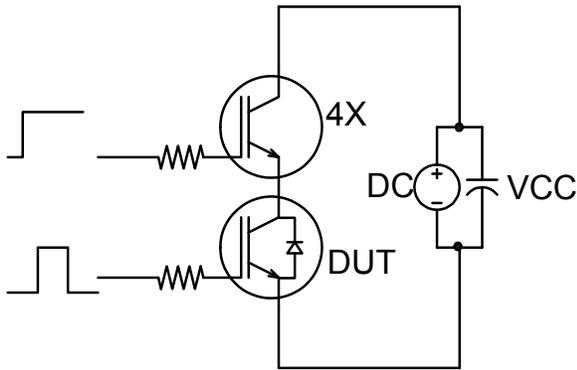
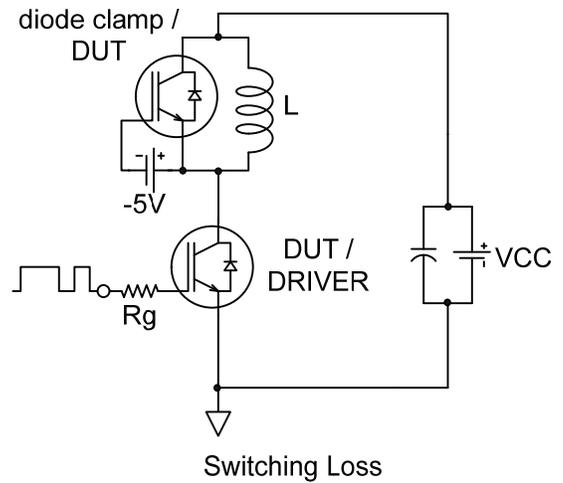
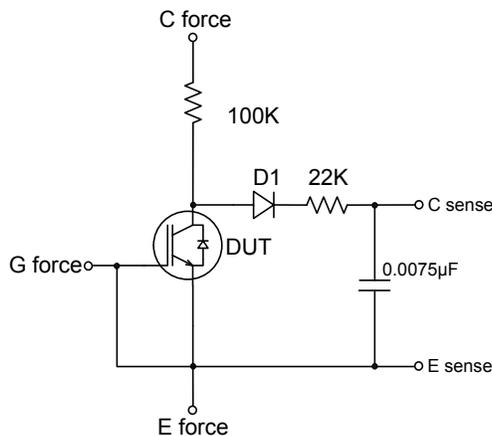


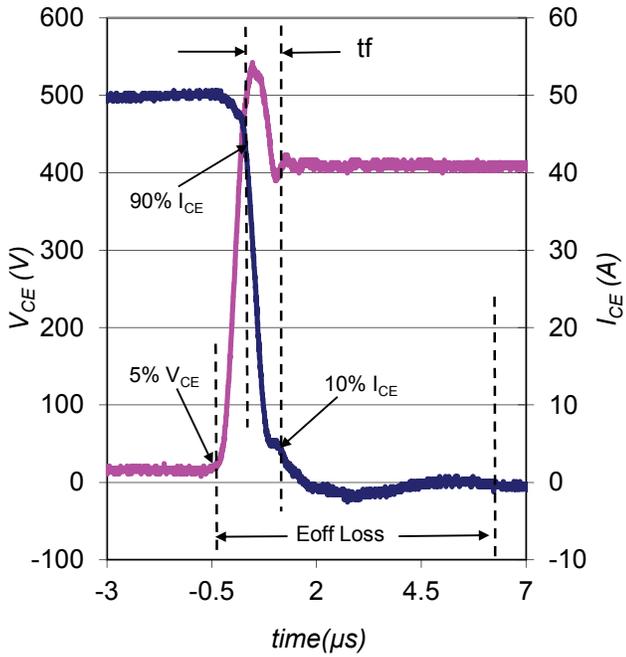
**Fig. 12** - Typ. Energy Loss vs.  $I_C$   
 $T_J = 175^\circ\text{C}$ ;  $L = 210\text{mH}$ ;  $V_{CE} = 400\text{V}$ ;  $R_G = 10\Omega$ ;  $V_{GE} = 15\text{V}$


**Fig. 13** - Typ. Switching Time vs.  $I_C$ 
 $T_J = 175^\circ\text{C}; L = 210\text{mH}; V_{CE} = 400\text{V}, R_G = 10\Omega; V_{GE} = 15\text{V}$ 

**Fig. 14** - Typ. Energy Loss vs.  $R_G$ 
 $T_J = 175^\circ\text{C}; L = 210\text{mH}; V_{CE} = 400\text{V}, I_{CE} = 50\text{A}; V_{GE} = 15\text{V}$ 

**Fig. 15** - Typ. Switching Time vs.  $R_G$ 
 $T_J = 175^\circ\text{C}; L = 210\text{mH}; V_{CE} = 400\text{V}, I_{CE} = 50\text{A}; V_{GE} = 15\text{V}$ 

**Fig. 16** -  $V_{GE}$  vs. Short Circuit

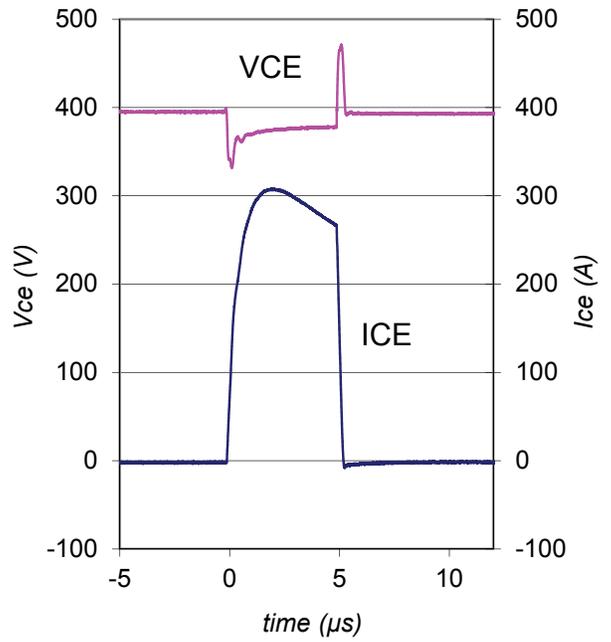
 $V_{CC} = 400\text{V}; T_C = 25^\circ\text{C}$ 

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

**Fig. 18** - Typical Gate Charge vs.  $V_{GE}$ 
 $I_{CE} = 50\text{A}$


**Fig. 19** - Maximum Diode Repetitive Forward Peak Current vs. Case Temperature

**Fig. 20** - Typical Gate Threshold Voltage (Normalized) vs. Junction Temperature

**Fig 21.** Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

**Fig 22.** 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 - BVCEs Filter Circuit**



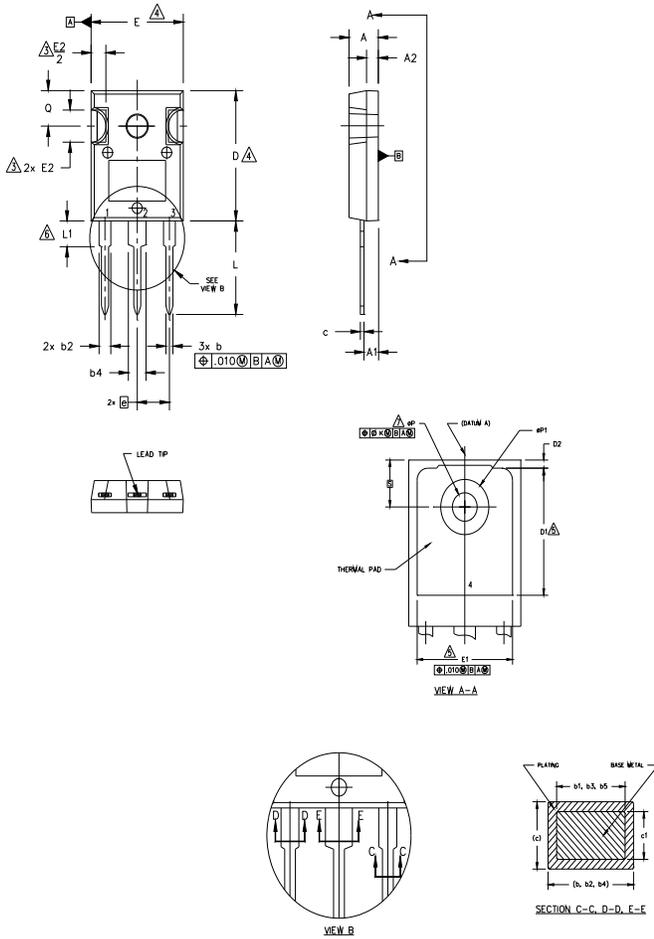
**Fig. WF1** - Typ. Turn-off Loss Waveform @  $T_J = 175^\circ C$  using Fig. CT.4



**Fig. WF2** - Typ. S.C. Waveform @  $T_J = 25^\circ C$  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**

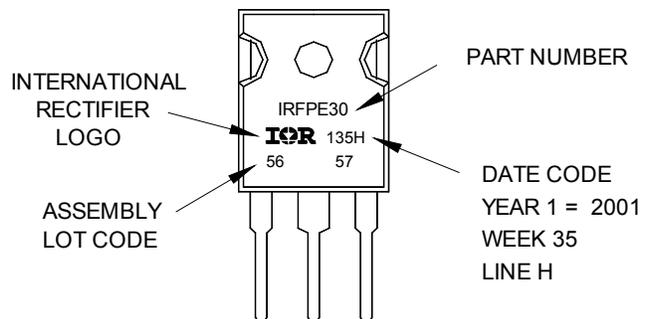
- 1.- ANODE/OPEN
- 2.- CATHODE
- 3.- ANODE

# TO-247AC Part Marking Information

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"

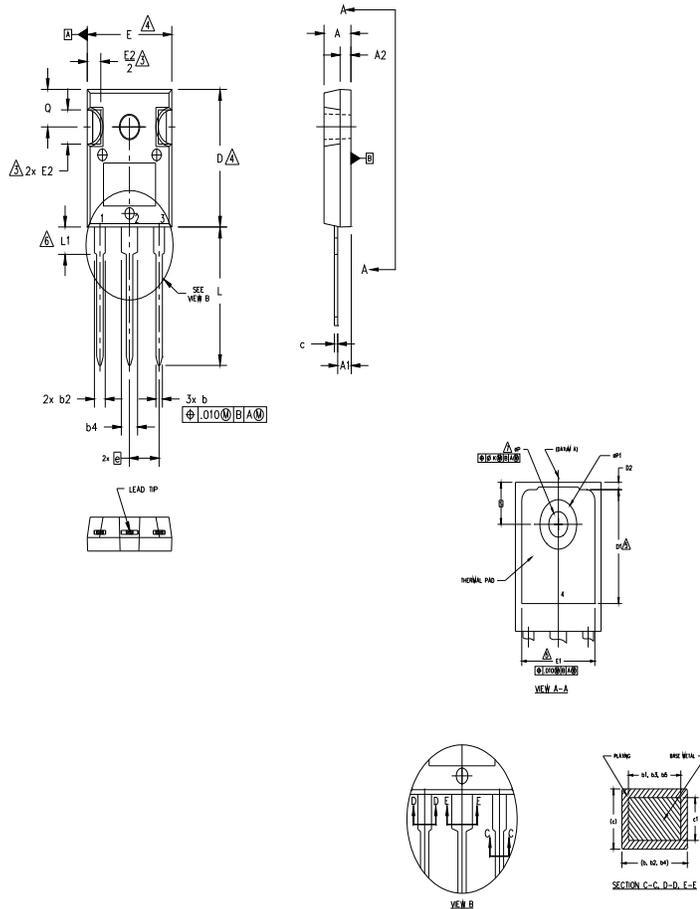


TO-247AC package is not recommended for Surface Mount Application.

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	
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	.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

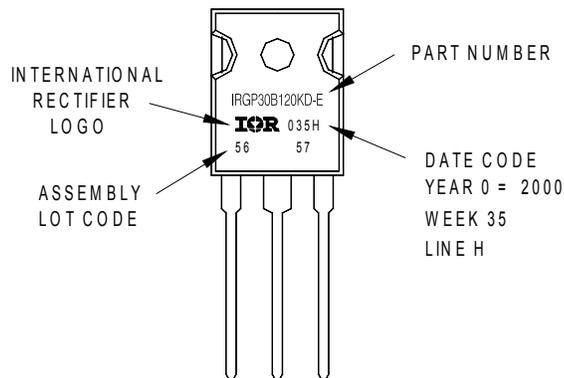
DIODES

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

## TO-247AD Part Marking Information

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 <sup>†</sup> (per JEDEC JESD47F) <sup>††</sup>	
<b>Moisture Sensitivity Level</b>	TO-247AC	N/A
	TO-247AD	N/A
<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.

**Revision History**

Date	Comment
7/17/2014	• Corrected from “I <sub>NOMINAL</sub> = 50A” to “I <sub>C</sub> = 50A, T <sub>C</sub> = 100C” on page1

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