

INSULATED GATE BIPOLAR TRANSISTOR

IRG7PH46UPbF IRG7PH46U-EP

Features

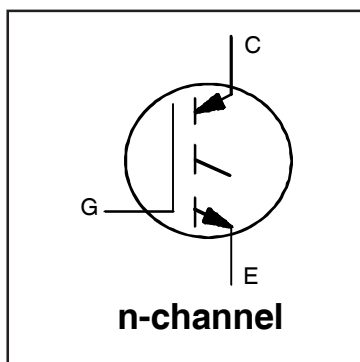
- Low $V_{CE(ON)}$ trench IGBT technology
- Low switching losses
- Maximum junction temperature 175 °C
- Square RBSOA
- 100% of the parts tested for I_{LM}
- Positive $V_{CE(ON)}$ temperature co-efficient
- Tight parameter distribution
- Lead-Free

Benefits

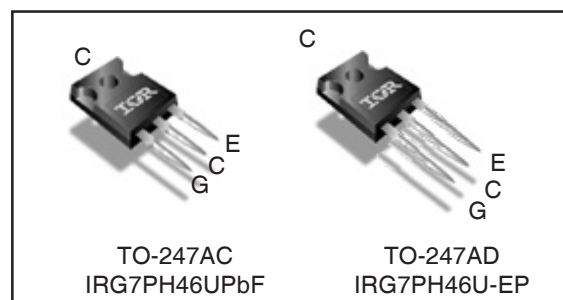
- High efficiency in a wide range of applications
- Suitable for a wide range of switching frequencies due to low $V_{CE(ON)}$ and low switching losses
- Rugged transient performance for increased reliability
- Excellent current sharing in parallel operation

Applications

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



$V_{CES} = 1200V$
$I_C = 75A, T_C = 100^\circ C$
$T_{J(max)} = 175^\circ C$
$V_{CE(on)} \text{ typ.} = 1.7V$



G	C	E
Gate	Collector	Emitter

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	1200	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current (Silicon Limited)	130③	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current (Silicon Limited)	75	
$I_{NOMINAL}$	Nominal Current	40	
I_{CM}	Pulse Collector Current, $V_{GE} = 20V$	160	
I_{LM}	Clamped Inductive Load Current, $V_{GE} = 20V$ ①	160	
V_{GE}	Continuous Gate-to-Emitter Voltage	± 30	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	469	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	234	
T_J	Operating Junction and	-55 to +175	$^\circ C$
T_{STG}	Storage Temperature Range		
	Soldering Temperature, for 10 sec.		
	Mounting Torque, 6-32 or M3 Screw		

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$ (IGBT)	Thermal Resistance Junction-to-Case-(each IGBT) TO-247AC ④	—	—	0.32	$^\circ C/W$
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink (flat, greased surface) ④	—	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	1200	—	—	V	$V_{GE} = 0V, I_C = 100\mu A$ ③
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	1.2	—	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 1mA$ (25 $^\circ\text{C}$ -150 $^\circ\text{C}$) ③
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.7	2.0	V	$I_C = 40A, V_{GE} = 15V, T_J = 25^\circ\text{C}$ ②
		—	2.0	—		$I_C = 40A, V_{GE} = 15V, T_J = 150^\circ\text{C}$ ②
		—	2.1	—		$I_C = 40A, V_{GE} = 15V, T_J = 175^\circ\text{C}$ ②
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	6.0	V	$V_{CE} = V_{GE}, I_C = 1.6mA$
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-15	—	mV/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 1.6mA$ (25 $^\circ\text{C}$ - 175 $^\circ\text{C}$)
g_{fe}	Forward Transconductance	—	60	—	S	$V_{CE} = 50V, I_C = 40A, PW = 20\mu s$
I_{CES}	Collector-to-Emitter Leakage Current	—	1	100	μA	$V_{GE} = 0V, V_{CE} = 1200V$
		—	1170	—		$V_{GE} = 0V, V_{CE} = 1200V, T_J = 175^\circ\text{C}$
I_{GES}	Gate-to-Emitter Leakage Current	—	—	± 200	nA	$V_{GE} = \pm 30V$

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

	Parameter	Min.	Typ.	Max.	Units	Conditions
Q_g	Total Gate Charge (turn-on)	—	220	320	nC	$I_C = 40A$ ②
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	30	50		$V_{GE} = 15V$
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	85	130		$V_{CC} = 600V$
E_{on}	Turn-On Switching Loss	—	2560	3460	μJ	$I_C = 40A, V_{CC} = 600V, V_{GE} = 15V$ ②
E_{off}	Turn-Off Switching Loss	—	1780	2660		$R_G = 10\Omega, L = 200\mu H, T_J = 25^\circ\text{C}$
E_{total}	Total Switching Loss	—	4340	6120		Energy losses include tail & diode reverse recovery
$t_{d(on)}$	Turn-On delay time	—	45	65	ns	Diode clamp the same as IRG7PH46UDPbF
t_r	Rise time	—	40	55		
$t_{d(off)}$	Turn-Off delay time	—	410	445		
t_f	Fall time	—	45	65		
E_{on}	Turn-On Switching Loss	—	3950	—	μJ	$I_C = 40A, V_{CC} = 600V, V_{GE} = 15V$ ②
E_{off}	Turn-Off Switching Loss	—	3020	—		$R_G = 10\Omega, L = 200\mu H, T_J = 175^\circ\text{C}$
E_{total}	Total Switching Loss	—	6970	—		Energy losses include tail & diode reverse recovery
$t_{d(on)}$	Turn-On delay time	—	40	—	ns	Diode clamp the same as IRG7PH46UDPbF
t_r	Rise time	—	40	—		
$t_{d(off)}$	Turn-Off delay time	—	480	—		
t_f	Fall time	—	220	—		
C_{ies}	Input Capacitance	—	4820	—	pF	$V_{GE} = 0V$
C_{oes}	Output Capacitance	—	150	—		$V_{CC} = 30V$
C_{res}	Reverse Transfer Capacitance	—	110	—		$f = 1.0MHz$
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$I_C = 160A$ $V_{CC} = 960V, V_p = 1200V$ $R_g = 10\Omega, V_{GE} = +20V$ to $0V, T_J = 175^\circ\text{C}$

Notes:

- ① $V_{CC} = 80\% (V_{CES}), V_{GE} = 20V, L = 25\mu H, R_G = 50\Omega$
- ② Pulse width $\leq 400\mu s$; duty cycle $\leq 2\%$.
- ③ Refer to AN-1086 for guidelines for measuring $V_{(BR)CES}$ safely.
- ④ R_g is measured at T_J of approximately 90 $^\circ\text{C}$.
- ⑤ Calculated continuous current based on maximum allowable junction temperature. Bond wire current limit is 117A. Note that current limitations arising from heating of the device leads may occur with some lead mounting arrangements.

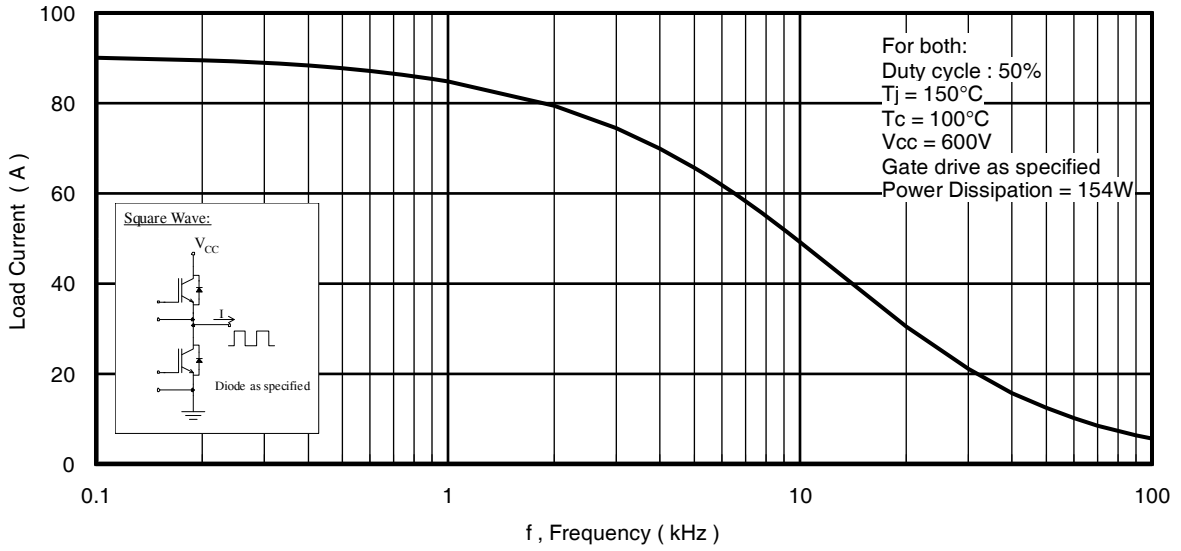


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

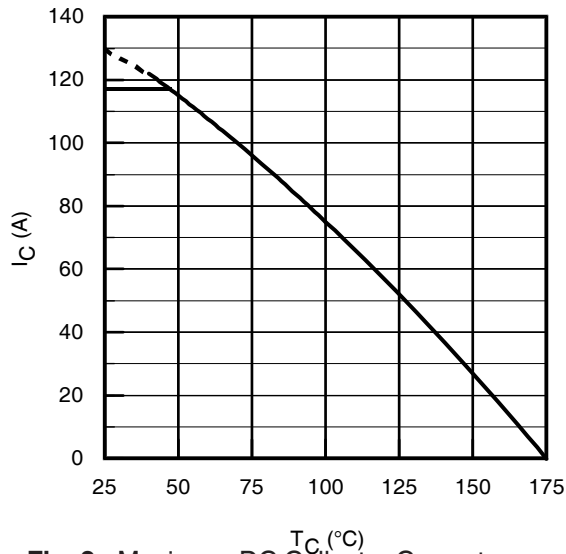


Fig. 2 - Maximum DC Collector Current vs. Case Temperature

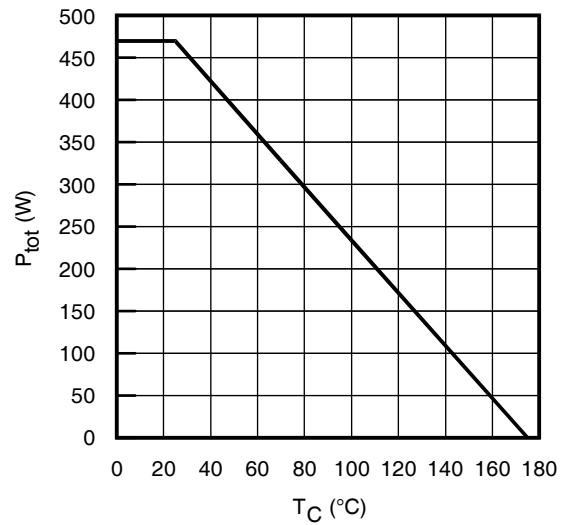


Fig. 3 - Power Dissipation vs. Case Temperature

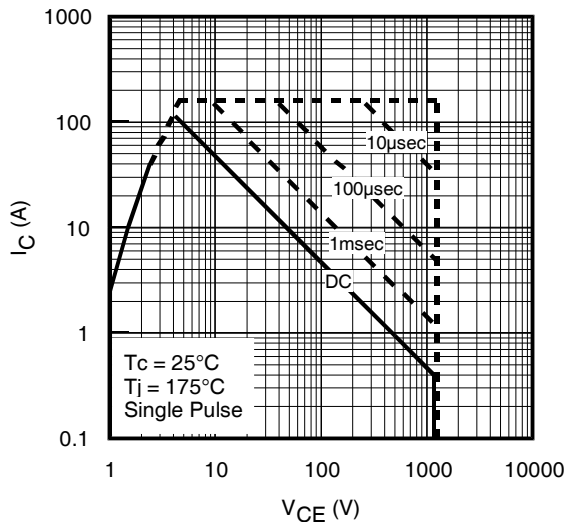


Fig. 4 - Forward SOA
 $T_C = 25^{\circ}\text{C}$, $T_J \leq 175^{\circ}\text{C}$; $V_{GE} = 15\text{V}$

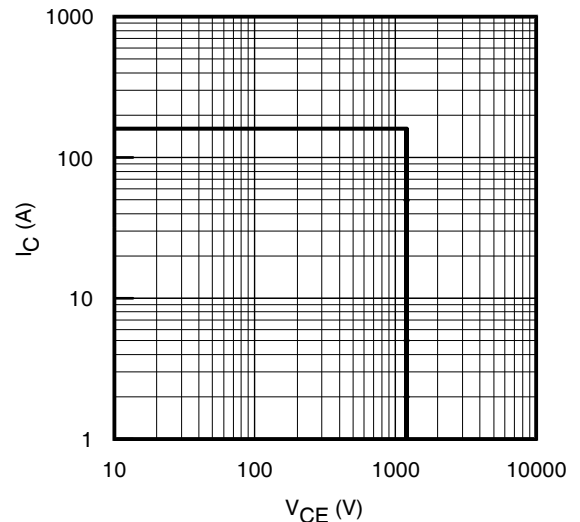


Fig. 5 - Reverse Bias SOA
 $T_J = 175^{\circ}\text{C}$; $V_{GE} = 20\text{V}$

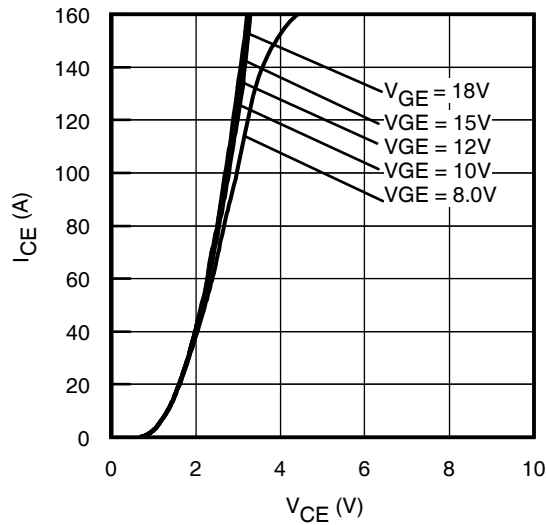


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = -40^{\circ}\text{C}$; $t_p = 20\mu\text{s}$

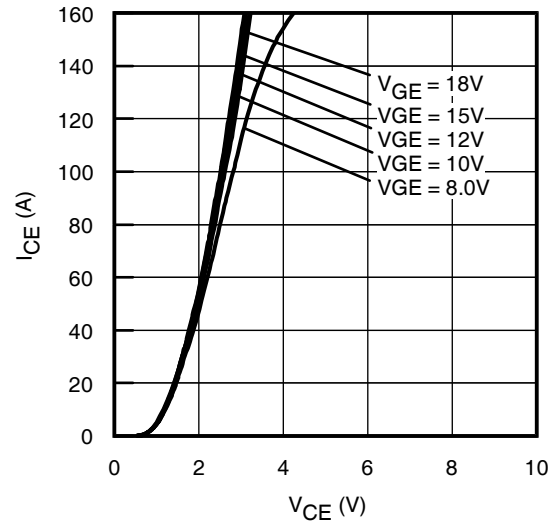


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 25^{\circ}\text{C}$; $t_p = 20\mu\text{s}$

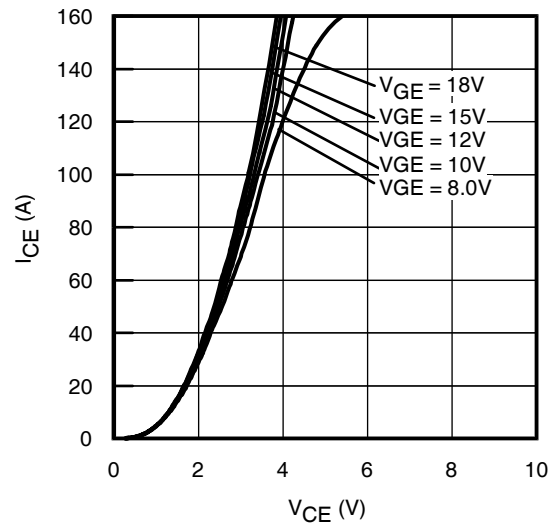


Fig. 8 - Typ. IGBT Output Characteristics
 $T_J = 175^{\circ}\text{C}$; $t_p = 20\mu\text{s}$

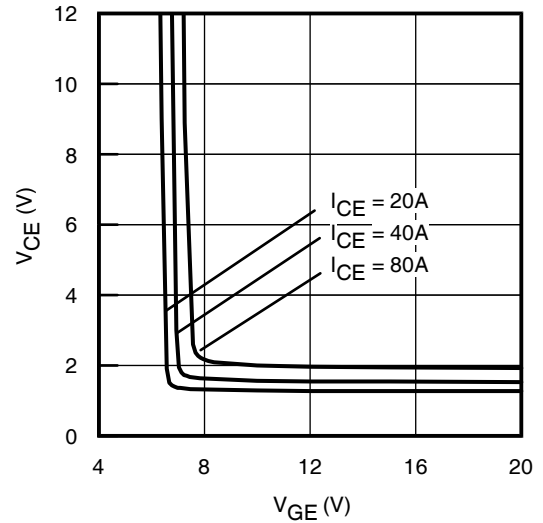


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^{\circ}\text{C}$

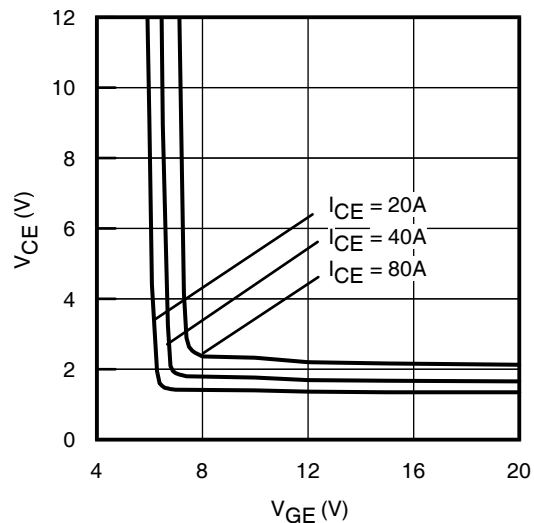


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^{\circ}\text{C}$

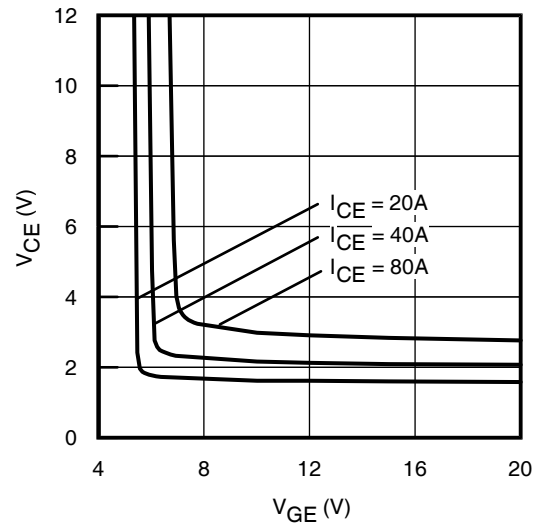


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 175^{\circ}\text{C}$

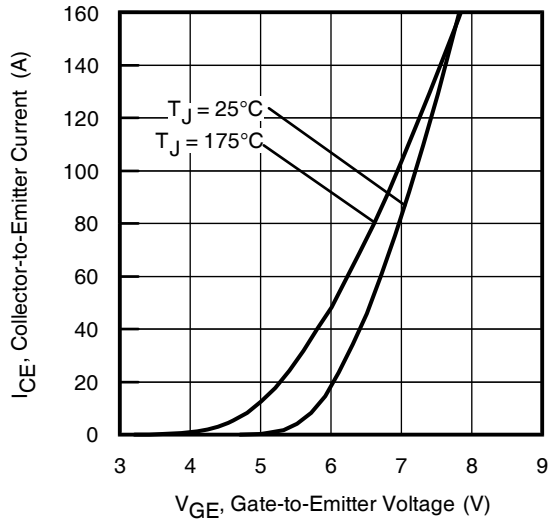


Fig. 12 - Typ. Transfer Characteristics
 $V_{CE} = 50V$; $t_p = 20\mu s$

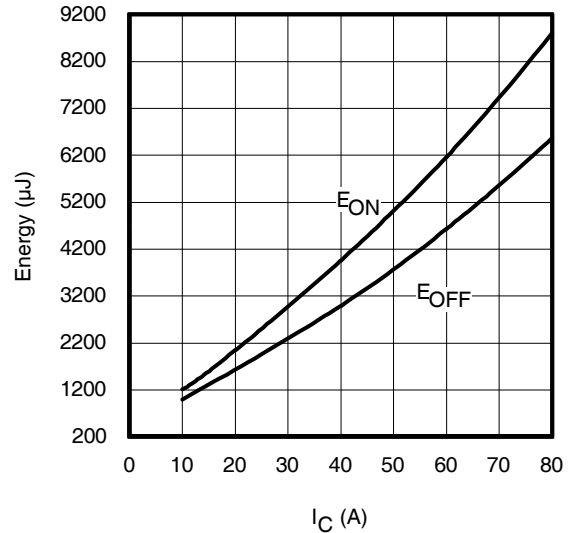


Fig. 13 - Typ. Energy Loss vs. I_C
 $T_J = 175^\circ C$; $L = 200\mu H$; $V_{CE} = 600V$; $R_G = 10\Omega$; $V_{GE} = 15V$

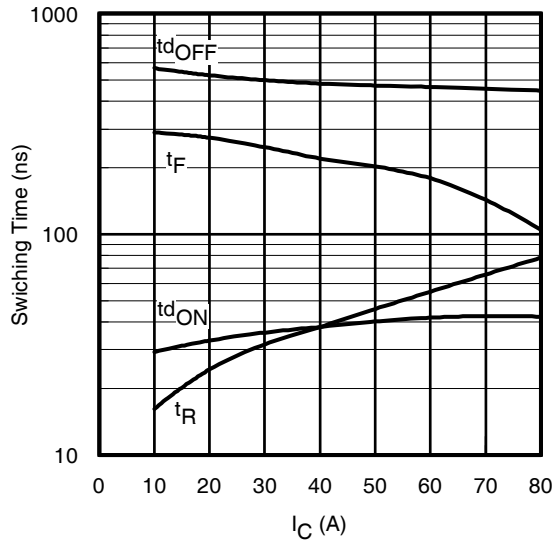


Fig. 14 - Typ. Switching Time vs. I_C
 $T_J = 175^\circ C$; $L = 200\mu H$; $V_{CE} = 600V$; $R_G = 10\Omega$; $V_{GE} = 15V$

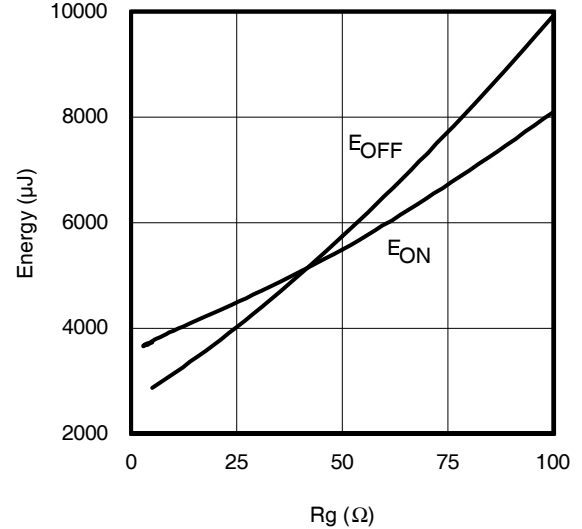


Fig. 15 - Typ. Energy Loss vs. R_G
 $T_J = 175^\circ C$; $L = 200\mu H$; $V_{CE} = 600V$; $I_{CE} = 40A$; $V_{GE} = 15V$

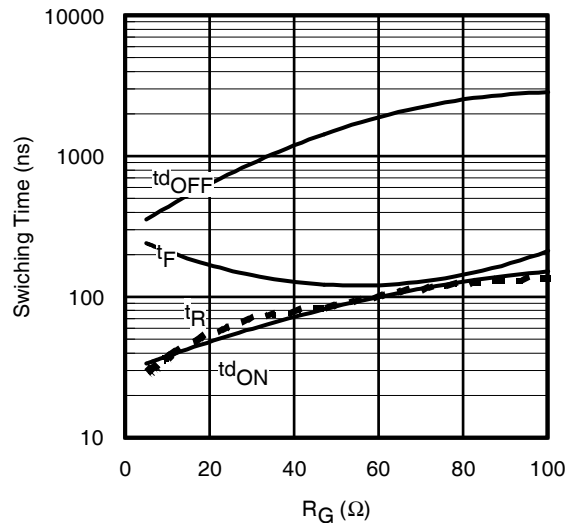


Fig. 16 - Typ. Switching Time vs. R_G
 $T_J = 175^\circ C$; $L = 200\mu H$; $V_{CE} = 600V$; $I_{CE} = 40A$; $V_{GE} = 15V$

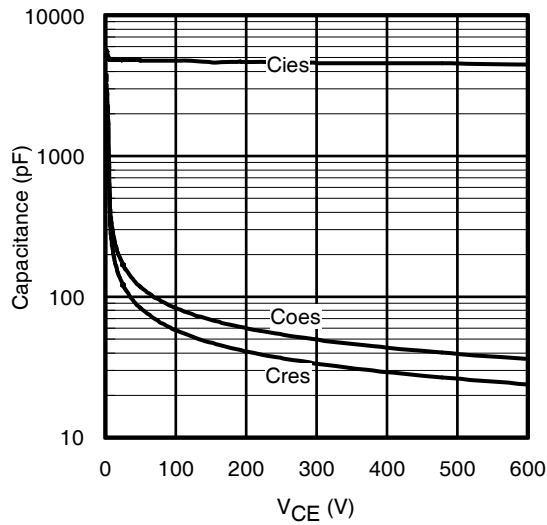


Fig. 17 - Typ. Capacitance vs. V_{CE}
 $V_{GE} = 0V$; $f = 1MHz$

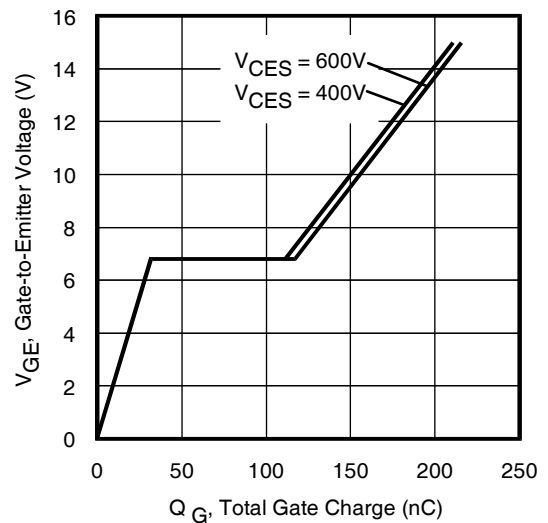


Fig. 18- Typical Gate Charge vs. V_{GE}
 $I_{CE} = 40A$; $L = 2.4mH$

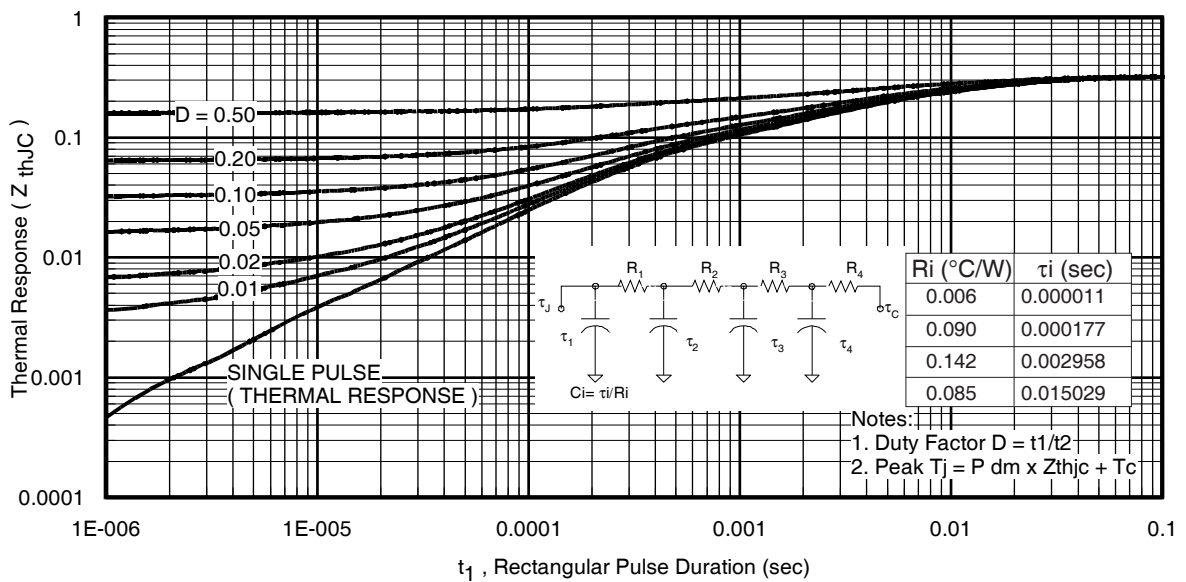


Fig 19. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT) TO-247AC

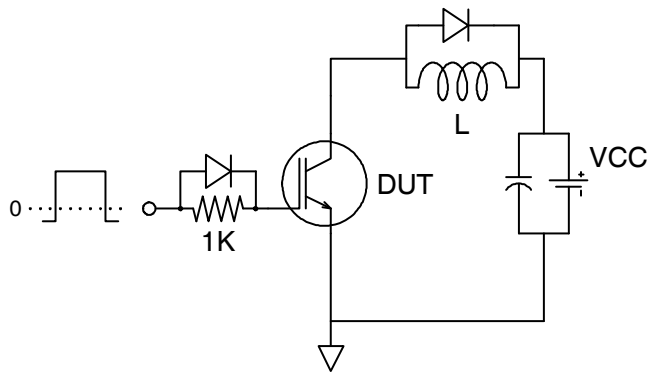


Fig.C.T.1 - Gate Charge Circuit (turn-off)

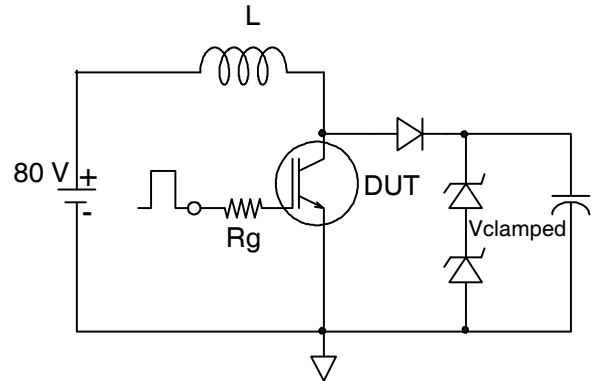


Fig.C.T.2 - RBSOA Circuit

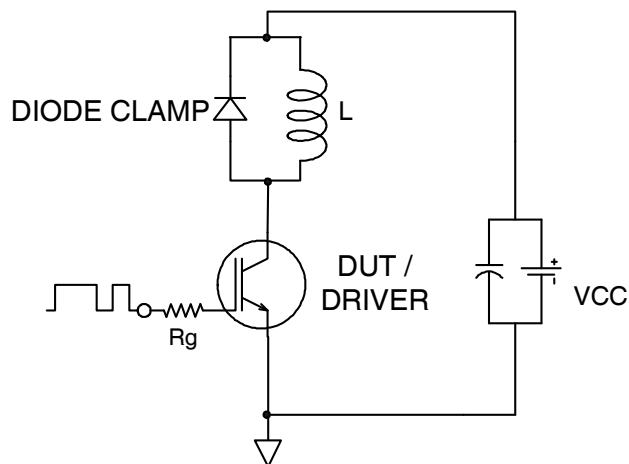


Fig.C.T.3 - Switching Loss Circuit

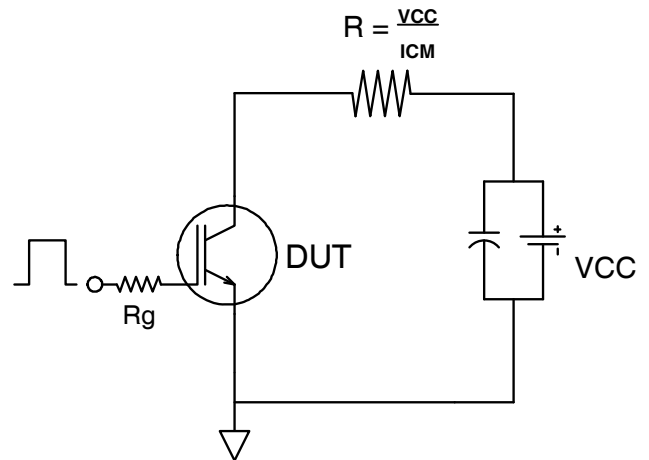


Fig.C.T.4 - Resistive Load Circuit

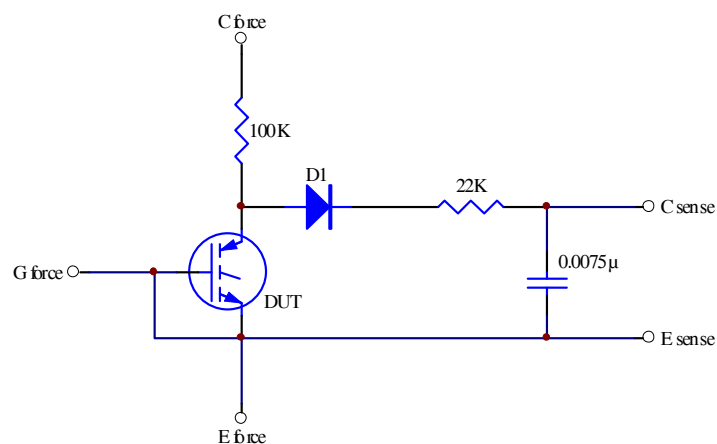


Fig.C.T.5 - BVCES Filter Circuit

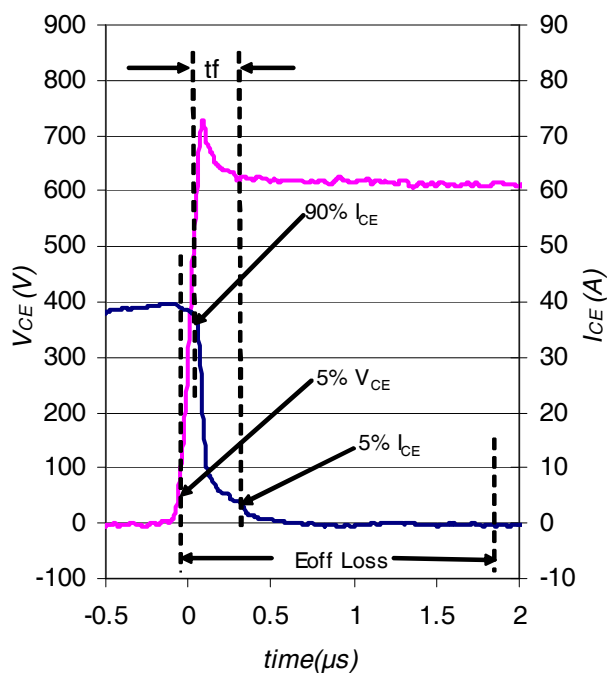


Fig. WF1 - Typ. Turn-off Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

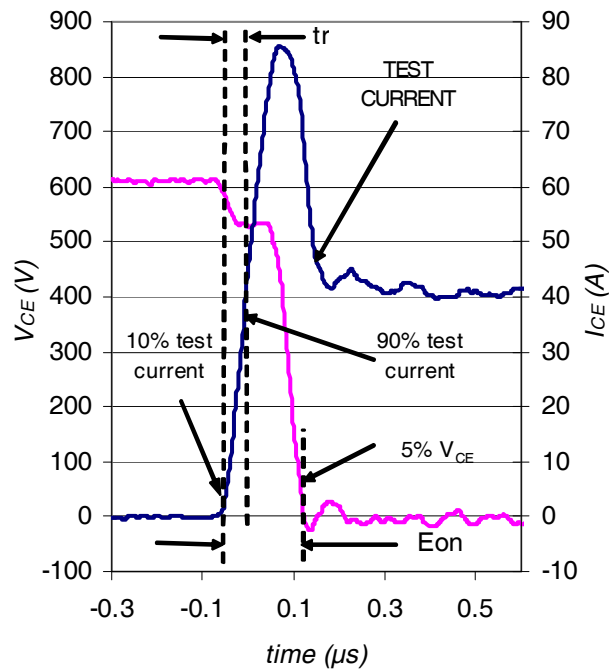
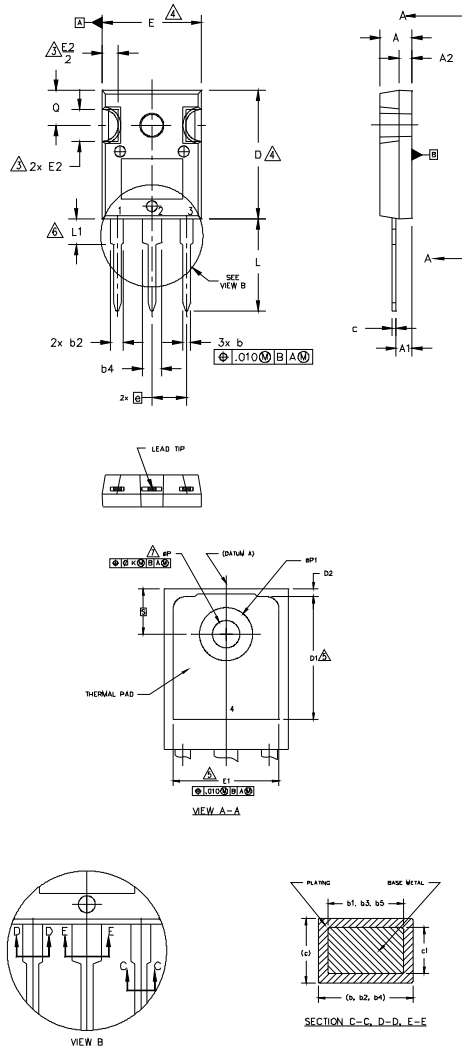


Fig. WF2 - Typ. Turn-on Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

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.
- B. 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	4
D	.776	.815	19.71	20.70	
D1	.515	—	13.08	—	
D2	.020	.053	0.51	1.35	5
E	.602	.625	15.29	15.87	
E1	.530	—	13.46	—	
E2	.178	.216	4.52	5.49	4
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

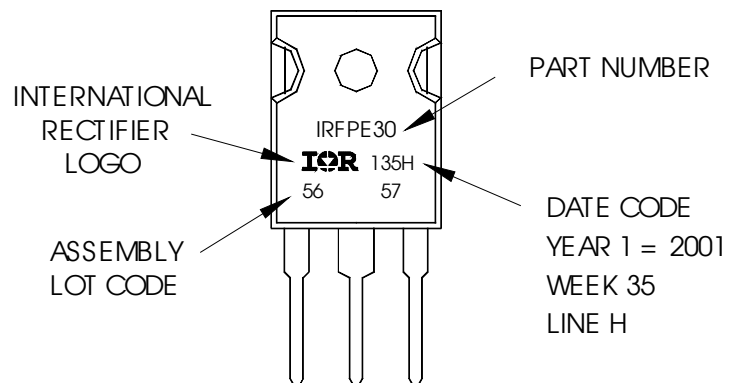
DIODES

- 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"

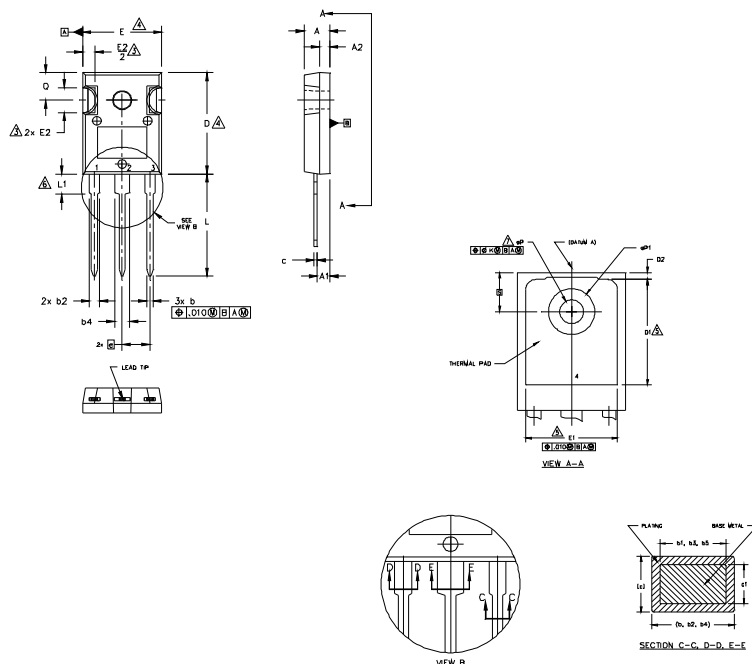


TO-247AC package is not recommended for Surface Mount Application.

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.
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6. LEAD FINISH UNCONTROLLED IN L1.
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8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-247AD.

SYMBOL	DIMENSIONS				NOTE
	INCHES		MILLIMETERS		
	MIN.	MAX.	MIN.	MAX.	
A	.183	.209	4.65	5.31	4
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	4
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	5
D	.776	.815	19.71	20.70	
D1	.515	—	13.08	—	
D2	.020	.053	0.51	1.35	
E	.502	.625	12.99	15.87	
E1	—	—	13.46	—	4
E2	.178	.216	4.52	5.49	
e	.215 BSC		5.46 BSC		
ek	.010		0.25		
L	.780	.827	19.57	21.00	
L1	.186	.169	3.71	4.29	4
L	.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

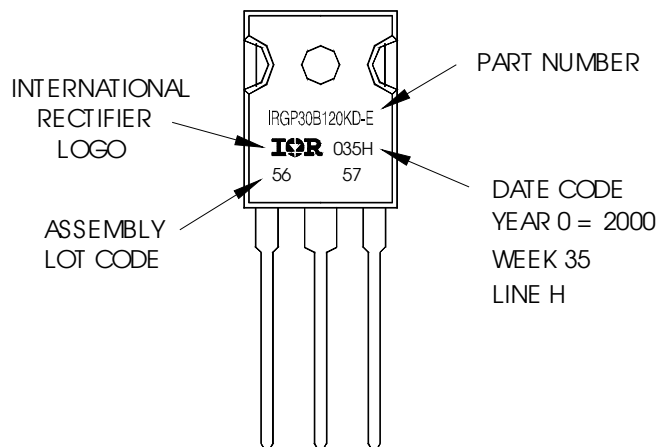
DIODES

- 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/>

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.

Mouser Electronics

Authorized Distributor

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