International Rectifier

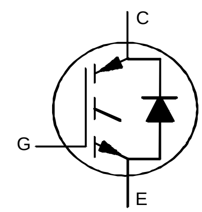
PD - 94388B

IRGP30B60KD-E

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Features

- Low $V_{CE\ (on)}$ Non Punch Through IGBT Technology.
- Low Diode V_F.
- 10µs Short Circuit Capability.
- Square RBSOA.
- Ultrasoft Diode Reverse Recovery Characteristics.
- Positive $V_{CE\ (on)}$ Temperature Coefficient.
- TO-247AD Package



n-channel

V_{CES} = 600V

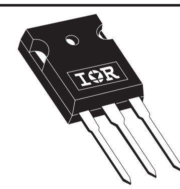
I_C = 30A, T_C=100°C

t_{sc} > 10µs, T_J=150°C

$V_{CE(on)}$ typ. = 1.95V

Benefits

- Benchmark Efficiency for Motor Control.
- Rugged Transient Performance.
- Low EMI.
- Excellent Current Sharing in Parallel Operation.



TO-247AD

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
I_C @ T_C = 25°C	Continuous Collector Current	60	A
I_C @ T_C = 100°C	Continuous Collector Current	30	
I_{CM}	Pulsed Collector Current	120	
I_{LM}	Clamped Inductive Load Current ①	120	
I_F @ T_C = 25°C	Diode Continuous Forward Current	60	
I_F @ T_C = 100°C	Diode Continuous Forward Current	30	
I_{FM}	Diode Maximum Forward Current	120	
V_{GE}	Gate-to-Emitter Voltage	±20	V
P_D @ T_C = 25°C	Maximum Power Dissipation	304	W
P_D @ T_C = 100°C	Maximum Power Dissipation	122	
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 (1.1N•m)	

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT	–––	–––	0.41	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode	–––	–––	1.32	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	–––	0.24	–––	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	–––	–––	40	
Wt	Weight	–––	6.0	–––	g

Electrical Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig.
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	V_{GE} = 0V, I_C = 500µA	
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.4	—	V/°C	V_{GE} = 0V, I_C = 1.0mA, (25°C-150°C)	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.95	2.35	V	I_C = 30A, V_{GE} = 15V	5,6,7
		—	2.40	2.75		I_C = 30A,V_{GE} = 15V, T_J = 150°C	9,10,11
$V_{GE(th)}$	Gate Threshold Voltage	3.5	4.5	5.5	V	V_{CE} = V_{GE}, I_C = 250µA	9,10,11
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	—	-10	—	mV/°C	V_{CE} = V_{GE}, I_C = 1.0mA, (25°C-150°C)	12
g_{fe}	Forward Transconductance	—	18	—	S	V_{CE} = 50V, I_C = 50A, PW=80µs	
I_{CES}	Zero Gate Voltage Collector Current	—	5.0	250	µA	V_{GE} = 0V, V_{CE} = 600V	
		—	1000	2000		V_{GE} = 0V, V_{CE} = 600V, T_J = 150°C	
V_{FM}	Diode Forward Voltage Drop	—	1.30	1.55	V	I_F = 30A	8
		—	1.25	1.50		I_F = 30A T_J = 150°C	
I_{GES}	Gate-to-Emitter Leakage Current	—	—	±100	nA	V_{GE} = ±20V	

Switching Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig.
Qg	Total Gate Charge (turn-on)	—	102	153	nC	I_C = 30A	23
Qge	Gate - Emitter Charge (turn-on)	—	14	21		V_{CC} = 400V	CT.1
Qgc	Gate - Collector Charge (turn-on)	—	44	66		V_{GE} = 15V	
E_{on}	Turn-On Switching Loss	—	350	620	µJ	I_C = 30A, V_{CC} = 400V	
E_{off}	Turn-Off Switching Loss	—	825	955		V_{GE} =15V, R_G = 10Ω, L=200µH,	CT.4
E_{tot}	Total Switching Loss	—	1175	1575		L_S = 150nH T_J = 25°C ②	
$t_{d(on)}$	Turn-On Delay Time	—	46	60	ns	I_C = 30A, V_{CC} = 400V	
t_r	Rise Time	—	28	39		V_{GE} = 15V, R_G = 10Ω L =200µH	CT.4
$t_{d(off)}$	Turn-Off Delay Time	—	185	200		L_S = 150nH, T_J = 25°C	
t_f	Fall Time	—	31	40			
E_{on}	Turn-On Switching Loss	—	635	1085	µJ	I_C = 30A, V_{CC} = 400V	CT.4
E_{off}	Turn-Off Switching Loss	—	1150	1350		V_{GE} = 15V,R_G = 10Ω, L =200µH	13,15
E_{tot}	Total Switching Loss	—	1785	2435		L_S = 150nH T_J = 150°C ②	WF1,WF2
$t_{d(on)}$	Turn-On Delay Time	—	46	60	ns	I_C = 30A, V_{CC} = 400V	CT.4
t_r	Rise Time	—	28	39		V_{GE} = 15V, R_G = 10Ω L =200µH	14,16
$t_{d(off)}$	Turn-Off Delay Time	—	205	235		L_S = 150nH, T_J = 150°C	WF1,WF2
t_f	Fall Time	—	32	42			
C_{ies}	Input Capacitance	—	1750	—	pF	V_{GE} = 0V	
C_{oes}	Output Capacitance	—	160	—		V_{CC} = 30V	22
C_{res}	Reverse Transfer Capacitance	—	60	—		f = 1.0MHz	
RBSOA	Reverse Bias Safe Operting Area	FULL SQUARE				T_J = 150°C, I_C = 120A, Vp =600V V_{CC} = 500V, V_{GE} = +15V to 0V, R_G=10Ω	4 CT.2
SCSOA	Short Circuit Safe Operting Area	10	—	—	µs	T_J = 150°C, Vp =600V, R_G = 10Ω V_{CC} = 360V, V_{GE} = +15V to 0V	CT.3 WF.4
Erec	Reverse Recovery energy of the diode	—	925	1165	µJ	T_J = 150°C	17,18,19
t_{rr}	Diode Reverse Recovery time	—	125	—	ns	V_{CC} = 400V, I_F = 30A, L = 200µH	20,21
I_{rr}	Diode Peak Reverse Recovery Current	—	43	48	A	V_{GE} = 15V,R_G = 10Ω, L_s = 150nH	CT.4,WF.3

Notes: ① V_{CC} = 80% (V_{CES}), V_{GE} = 15V, L = 28µH, R_G = 22Ω. ② Energy losses include "tail" and diode reverse recovery.

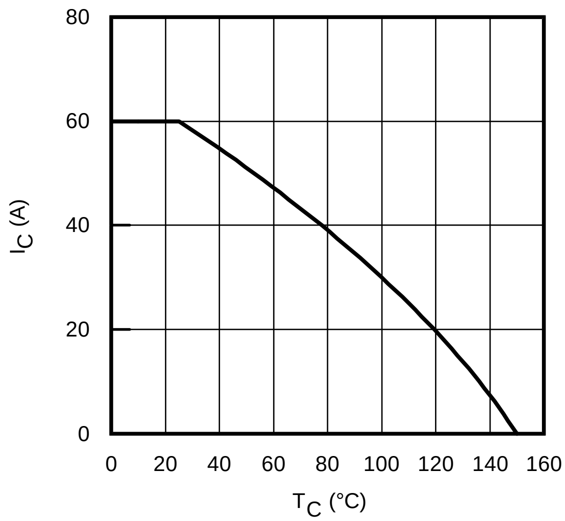


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

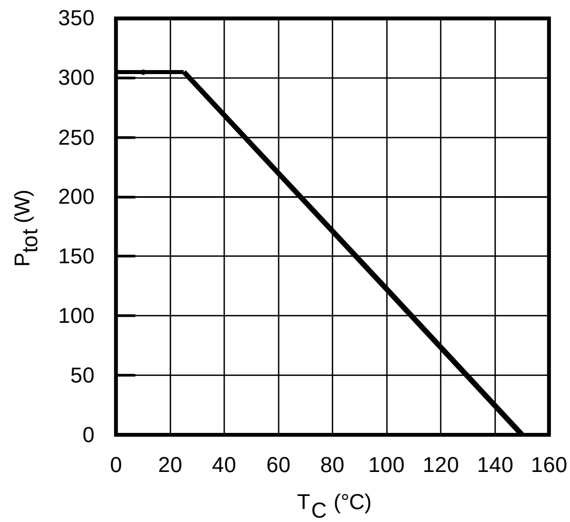


Fig. 2 - Power Dissipation vs. Case Temperature

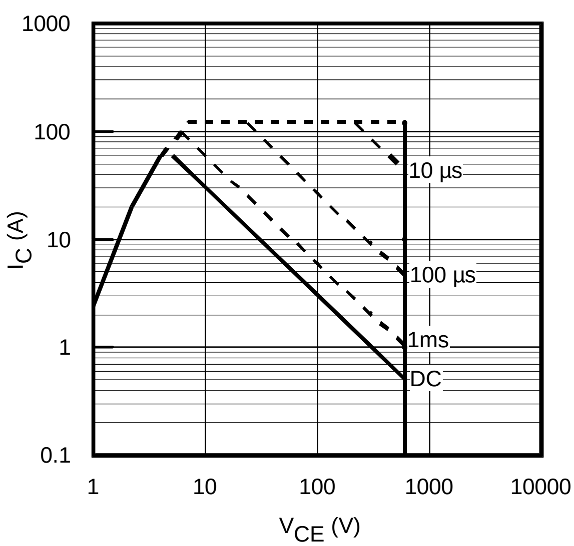


Fig. 3 - Forward SOA
T_C = 25°C; $T_J \leq$ 150°C

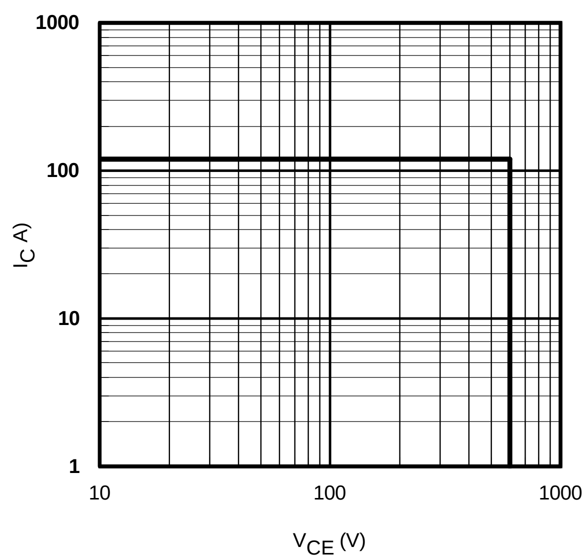


Fig. 4 - Reverse Bias SOA
T_J = 150°C; V_{GE} =15V

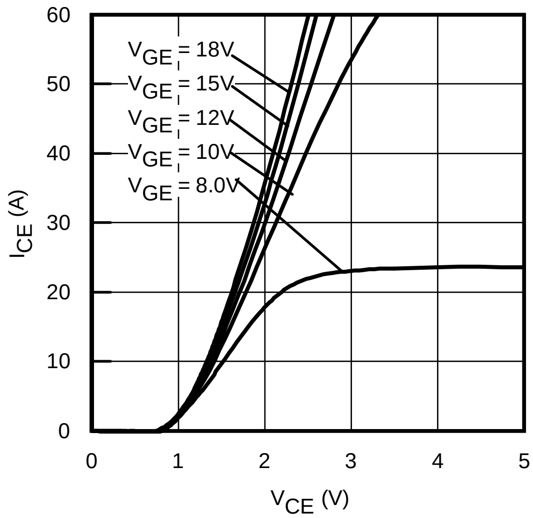


Fig. 5 - Typ. IGBT Output Characteristics
T_J = -40°C; tp = 80µs

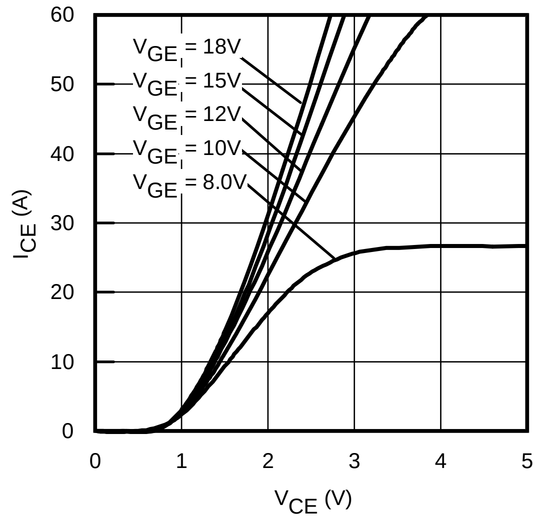


Fig. 6 - Typ. IGBT Output Characteristics
T_J = 25°C; tp = 80µs

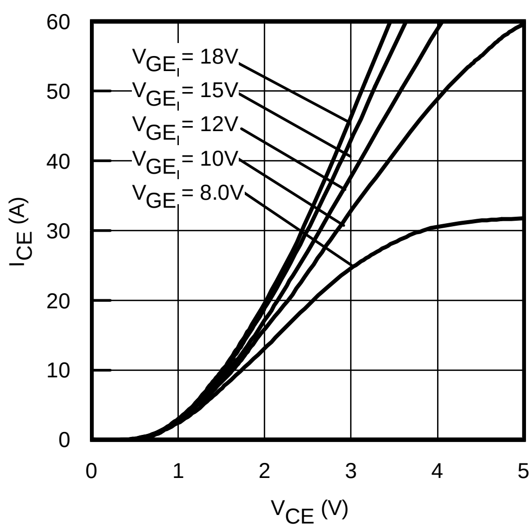


Fig. 7 - Typ. IGBT Output Characteristics
T_J = 150°C; tp = 80µs

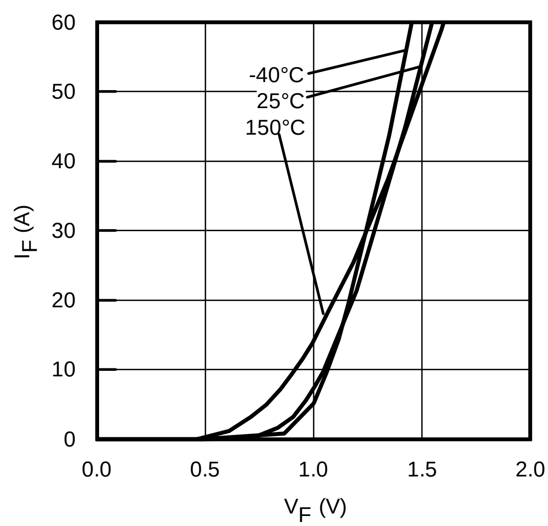


Fig. 8 - Typ. Diode Forward Characteristics
tp = 80µs

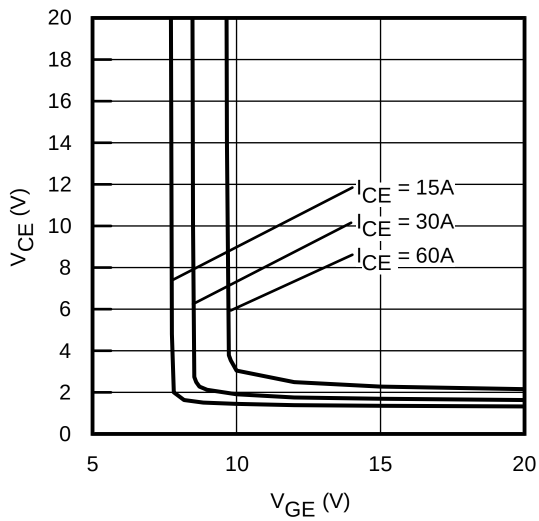


Fig. 9 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

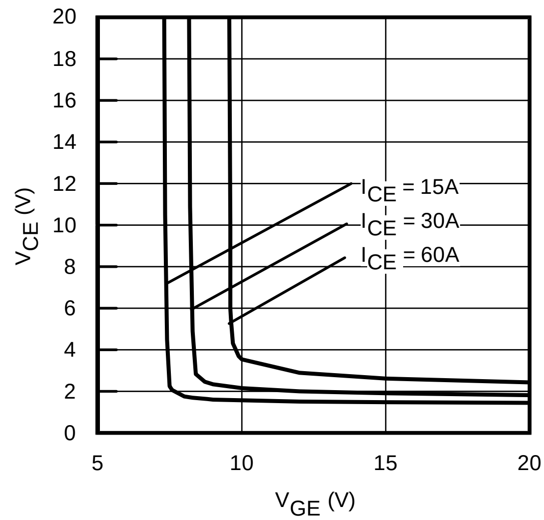


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

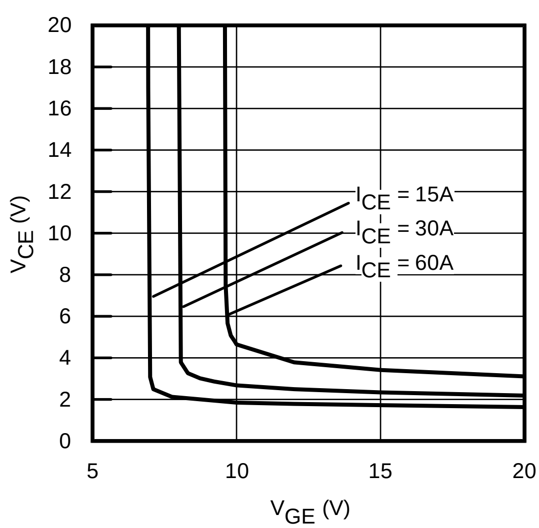


Fig. 11 - Typical V_{CE} vs. V_{GE}
T_J = 150°C

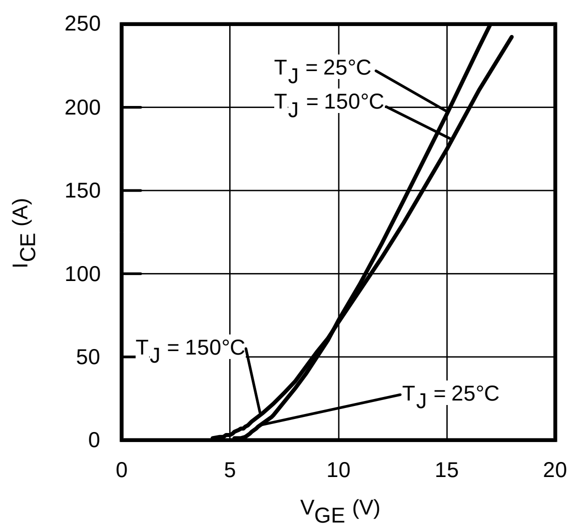


Fig. 12 - Typ. Transfer Characteristics
V_{CE} = 50V; tp = 10µs

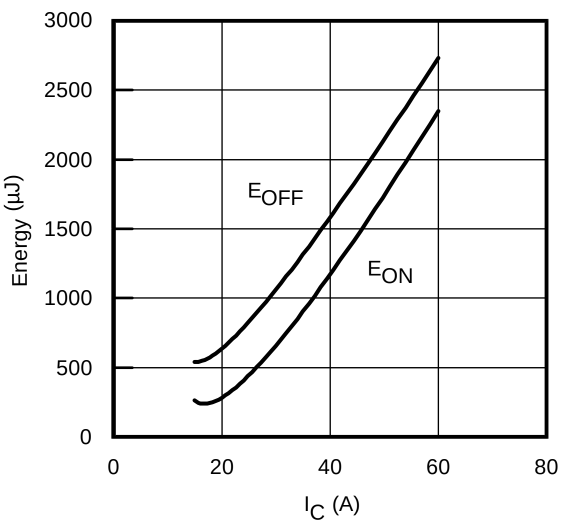


Fig. 13 - Typ. Energy Loss vs. I_C
T_J = 150°C; L = 200µH; V_{CE} = 400V
R_G = 10Ω; V_{GE} = 15V

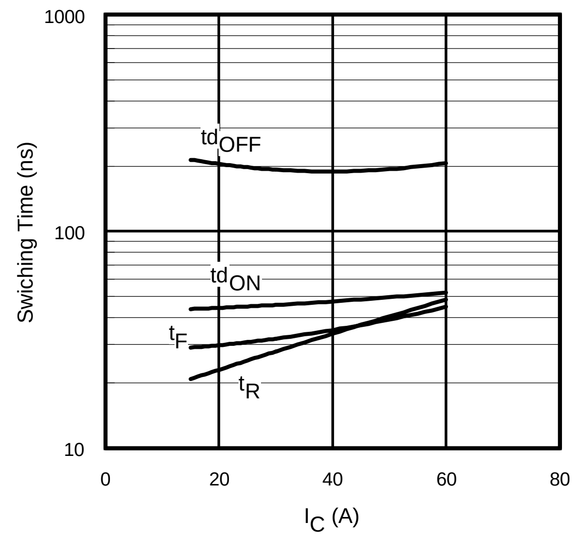


Fig. 14 - Typ. Switching Time vs. I_C
T_J = 150°C; L = 200µH; V_{CE} = 400V
R_G = 10Ω; V_{GE} = 15V

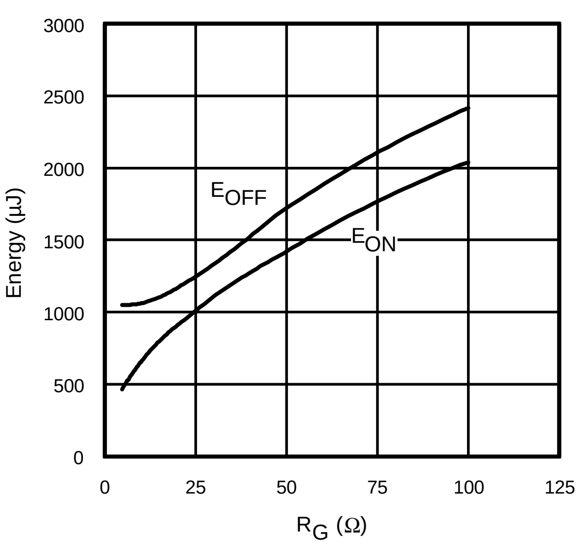


Fig. 15 - Typ. Energy Loss vs. R_G
T_J = 150°C; L = 200µH; V_{CE} = 400V
I_{CE} = 30A; V_{GE} = 15V

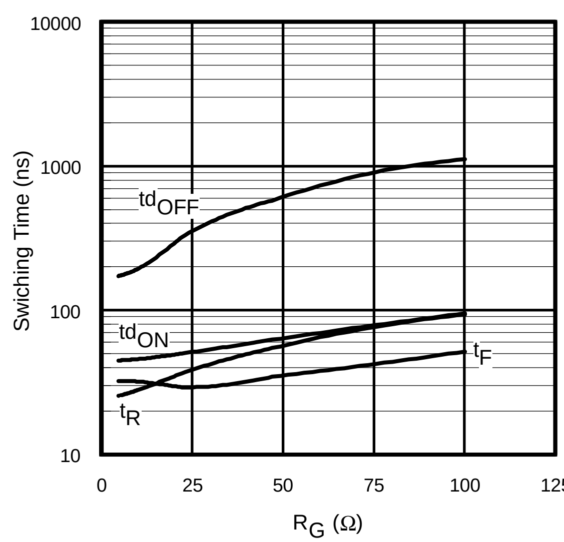


Fig. 16 - Typ. Switching Time vs. R_G
T_J = 150°C; L = 200µH; V_{CE} = 400V
I_{CE} = 30A; V_{GE} = 15V

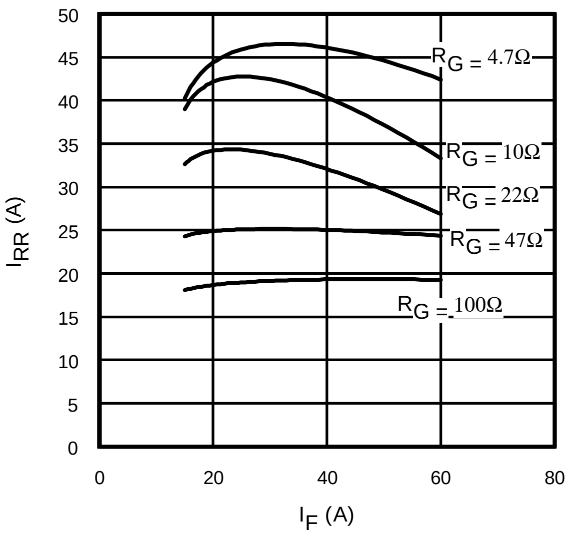


Fig. 17 - Typical Diode I_{RR} vs. I_F
T_J = 150°C

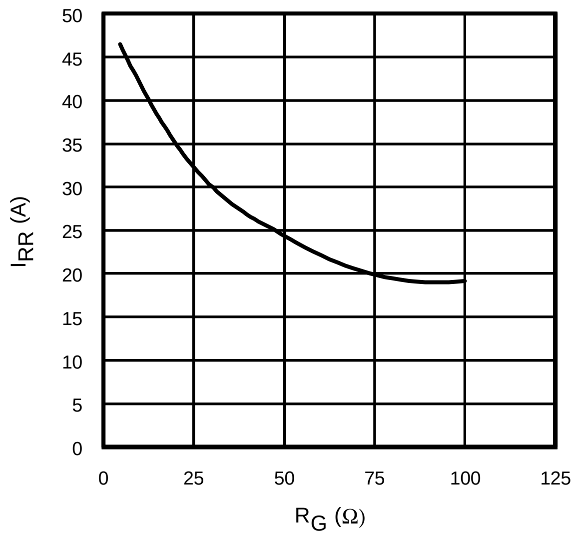


Fig. 18 - Typical Diode I_{RR} vs. R_G
T_J = 150°C; I_F = 30A

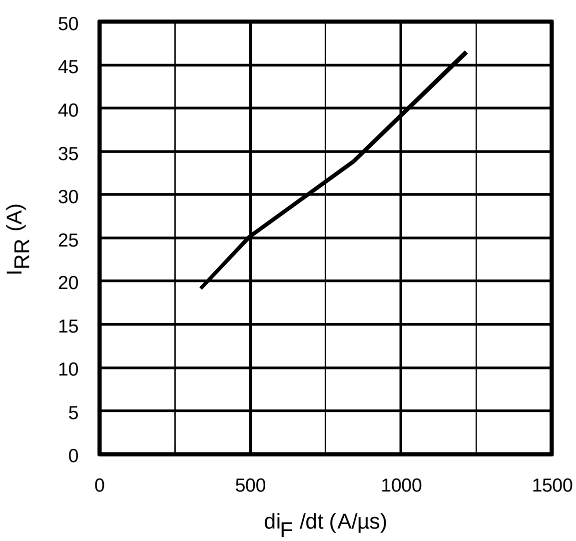


Fig. 19- Typical Diode I_{RR} vs. di_F/dt
V_{CC}= 400V; V_{GE}= 15V;
I_F= 30A; T_J = 150°C

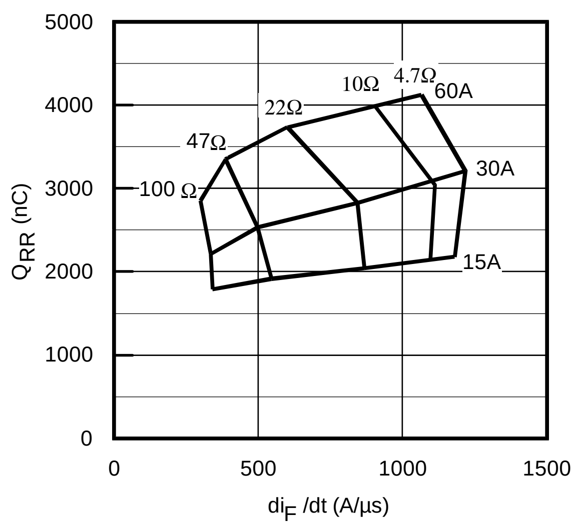


Fig. 20 - Typical Diode Q_{RR}
V_{CC}= 400V; V_{GE}= 15V;T_J = 150°C

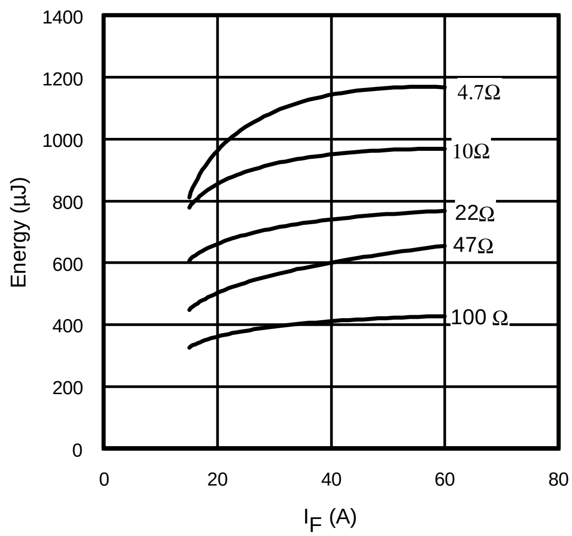


Fig. 21 - Typical Diode E_{RR} vs. I_F
T_J = 150°C

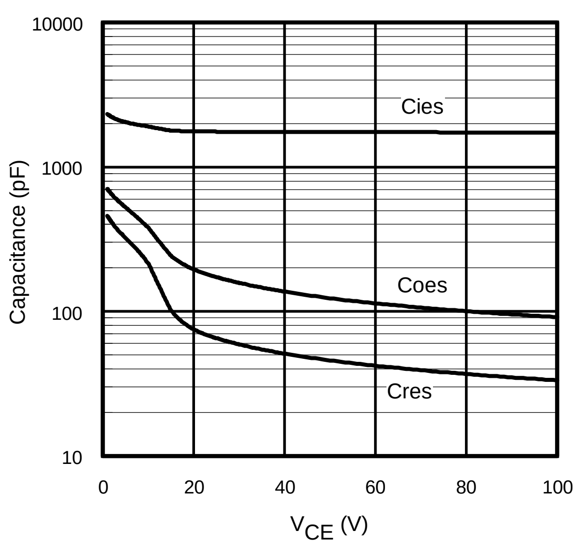


Fig. 22- Typ. Capacitance vs. V_{CE}
V_{GE}= 0V; f = 1MHz

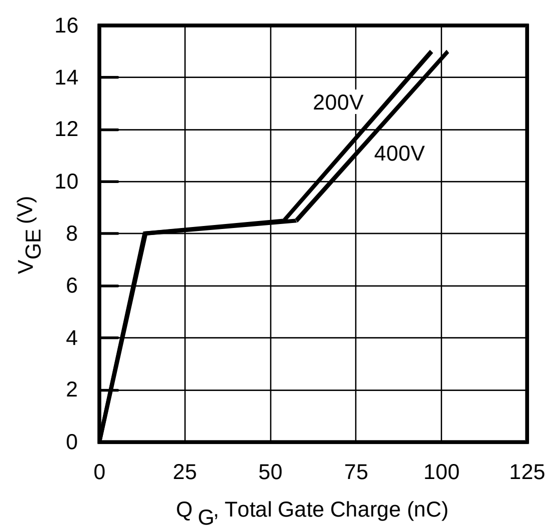


Fig. 23 - Typical Gate Charge vs. V_{GE}
I_{CE} = 30A; L = 600µH

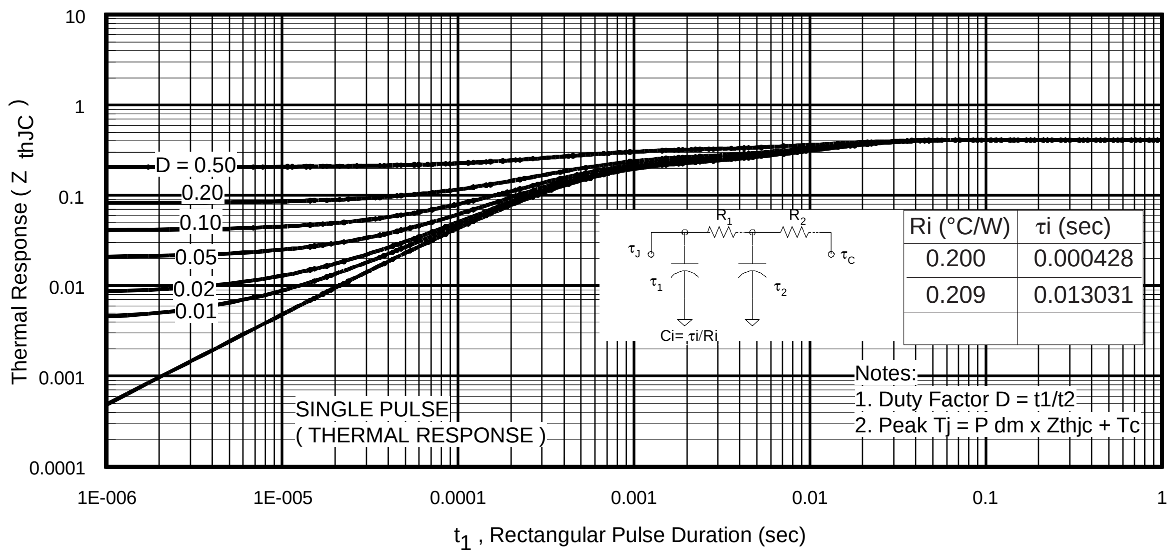


Fig 24. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

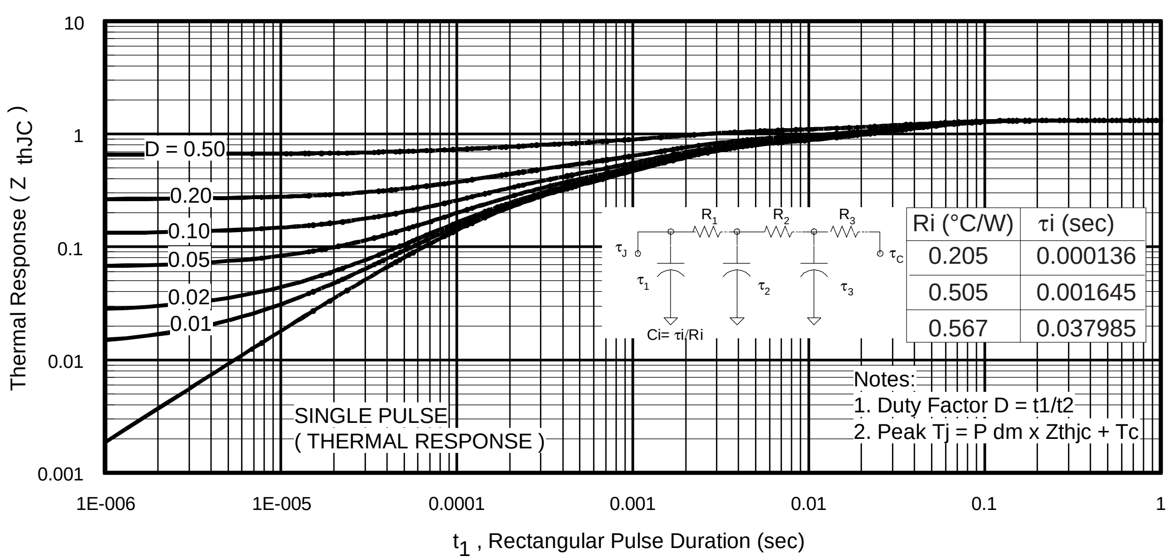


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

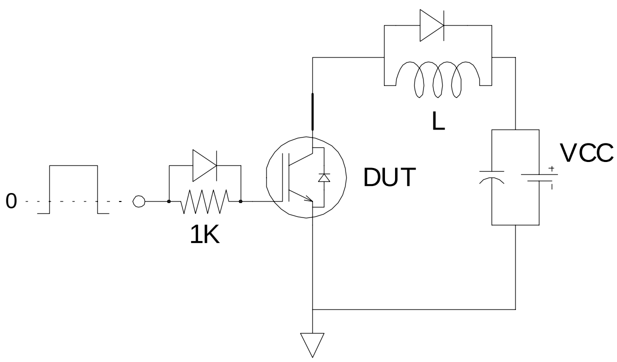


Fig.C.T.1 - Gate Charge Circuit (turn-off)

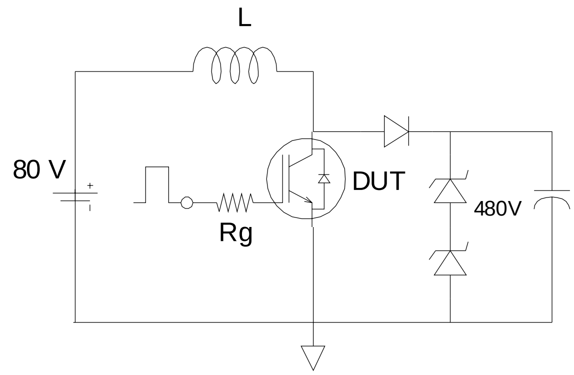


Fig.C.T.2 - RBSOA Circuit

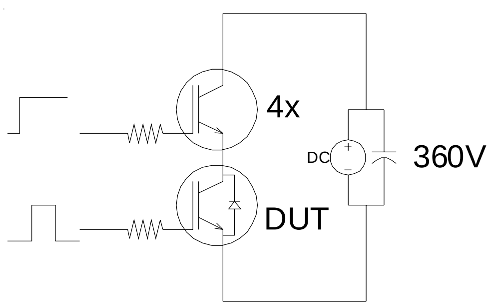


Fig.C.T.3 - S.C.SOA Circuit

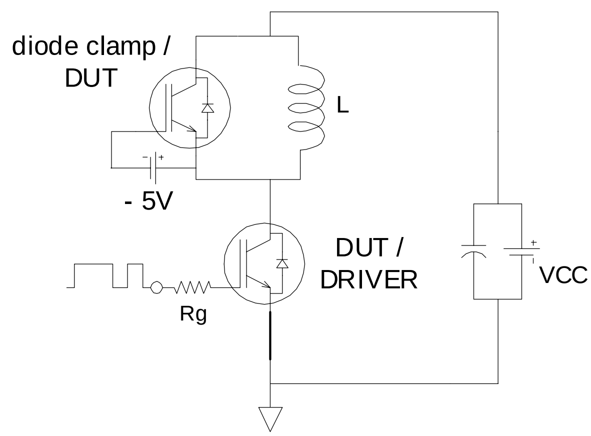


Fig.C.T.4 - Switching Loss Circuit

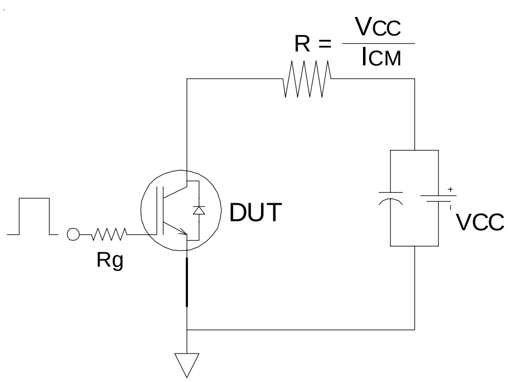


Fig.C.T.5 - Resistive Load Circuit

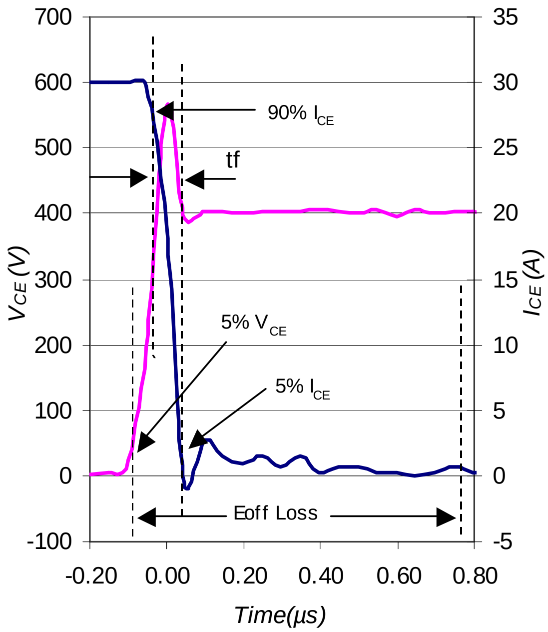


Fig. WF1- Typ. Turn-off Loss Waveform @ T_J = 150°C using Fig. CT.4

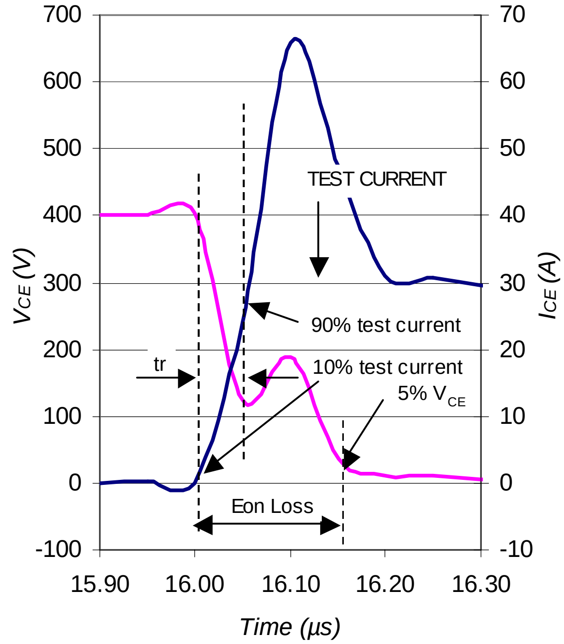


Fig. WF2- Typ. Turn-on Loss Waveform @ T_J = 150°C using Fig. CT.4

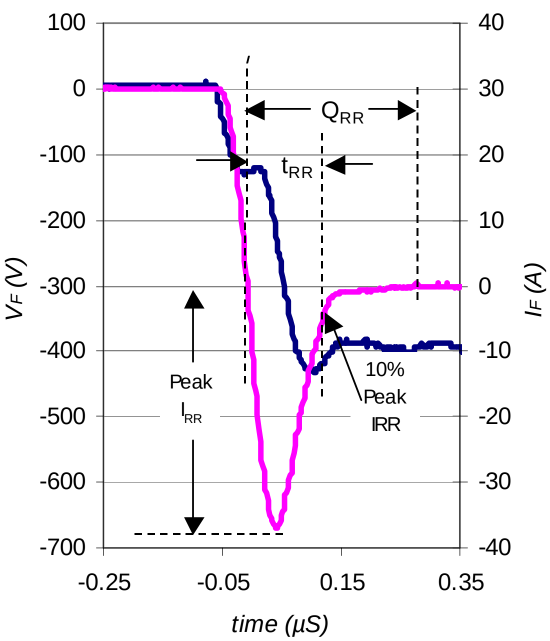


Fig. WF3- Typ. Diode Recovery Waveform @ T_J = 150°C using Fig. CT.4

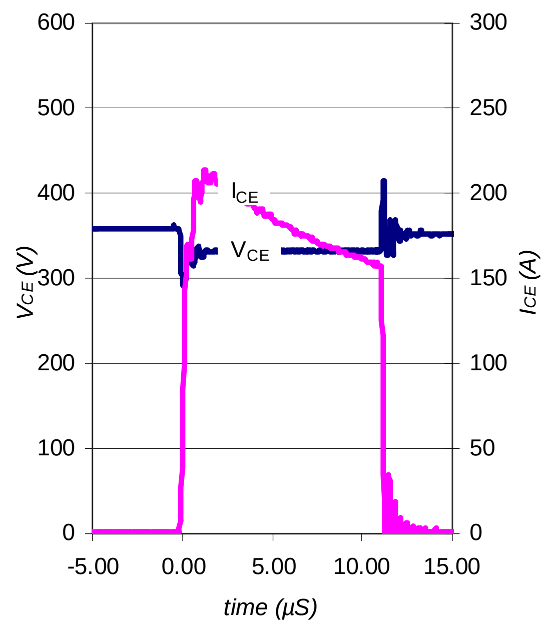
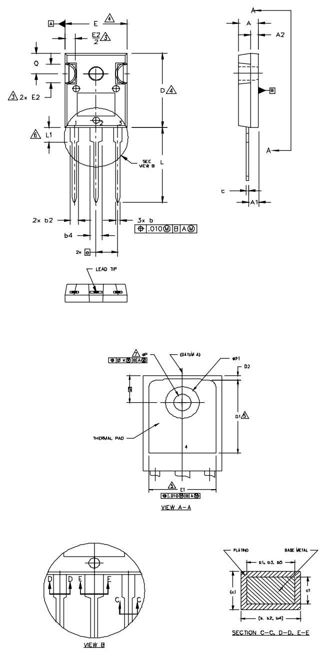


Fig. WF4- Typ. S.C Waveform @ T_C = 150°C using Fig. CT.3

TO-247AD Package Outline

Dimensions are shown in milimeters (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

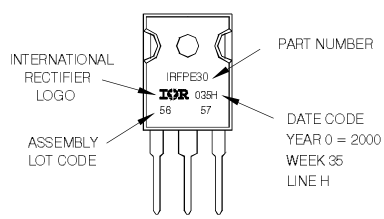
DIODES

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

TO-247AD Part Marking Information

EXAMPLE: THIS IS AN IRFPE30
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.

International
IOR Rectifier

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