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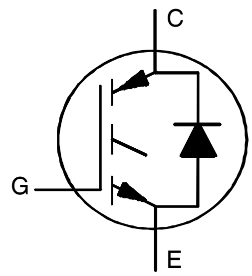
International
IOR Rectifier

IRG7PH46UDPbF
IRG7PH46UD-EP

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

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
- Ultra fast soft recovery co-pak diode
- Tight parameter distribution
- Lead-Free



n-channel

V_{CES} = 1200V

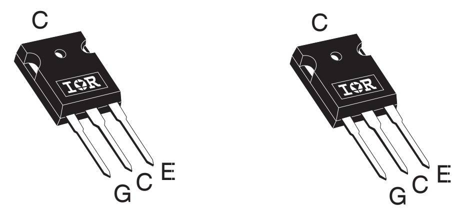
$I_{NOMINAL}$ = 40A

$T_{J(max)}$ = 150°C

$V_{CE(on)}$ typ. = 1.7V

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



TO-247AC IRG7PH46UDPbF

TO-247AD IRG7PH46UD-EP

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°C	Continuous Collector Current (Silicon Limited)	108	A
I_C @ T_C = 100°C	Continuous Collector Current (Silicon Limited)	57	
$I_{NOMINAL}$	Nominal Current	40	
I_{CM}	Pulse Collector Current, V_{GE} = 20V	160	
I_{LM}	Clamped Inductive Load Current, V_{GE} = 20V ①	160	
I_F @ T_C = 25°C	Diode Continous Forward Current	108	
I_F @ T_C = 100°C	Diode Continous Forward Current	57	
I_{FM}	Diode Maximum Forward Current ②	160	
V_{GE}	Continuous Gate-to-Emitter Voltage	±30	V
P_D @ T_C = 25°C	Maximum Power Dissipation	390	W
P_D @ T_C = 100°C	Maximum Power Dissipation	156	
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 (1.1 N·m)	

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$ (IGBT)	Thermal Resistance Junction-to-Case-(each IGBT) ④	–––	–––	0.32	°C/W
$R_{\theta JC}$ (Diode)	Thermal Resistance Junction-to-Case-(each Diode) ④	–––	–––	0.66	
$R_{\theta CS}$	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°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 = 100μA ③
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	1.2	—	V/°C	V_{GE} = 0V, I_C = 1.0mA (25°C-150°C)
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.7	2.0	V	I_C = 40A, V_{GE} = 15V, T_J = 25°C
		—	2.0	—		I_C = 40A, V_{GE} = 15V, T_J = 150°C
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	6.0	V	V_{CE} = V_{GE}, I_C = 1.6mA
$\Delta V_{GE(th)}/\Delta TJ$	Threshold Voltage temp. coefficient	—	-13	—	mV/°C	V_{CE} = V_{GE}, I_C = 1.6mA (25°C - 150°C)
gfe	Forward Transconductance	—	50	—	S	V_{CE} = 50V, I_C = 40A, PW = 20μs
I_{CES}	Collector-to-Emitter Leakage Current	—	1.5	100	μA	V_{GE} = 0V, V_{CE} = 1200V
		—	2.0	—	mA	V_{GE} = 0V, V_{CE} = 1200V, T_J = 150°C
V_{FM}	Diode Forward Voltage Drop	—	3.1	4.8	V	I_F = 40A
		—	3.0	—		I_F = 40A, T_J = 150°C
I_{GES}	Gate-to-Emitter Leakage Current	—	—	±200	nA	V_{GE} = ±30V

Switching Characteristics @ T_J = 25°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	—	2610	3515	μJ	I_C = 40A, V_{CC} = 600V, V_{GE} = 15V ⑤
E_{off}	Turn-Off Switching Loss	—	1845	2725		R_G = 10Ω, L = 200μH, T_J = 25°C
E_{total}	Total Switching Loss	—	4455	6240		Energy losses include tail & diode reverse recovery
$t_{d(on)}$	Turn-On delay time	—	45	60	ns	
t_r	Rise time	—	40	60		
$t_{d(off)}$	Turn-Off delay time	—	410	450		
t_f	Fall time	—	45	60		
E_{on}	Turn-On Switching Loss	—	3790	—	μJ	I_C = 40A, V_{CC} = 600V, V_{GE}=15V ⑤
E_{off}	Turn-Off Switching Loss	—	2905	—		R_G=10Ω, L=200μH, T_J = 150°C
E_{total}	Total Switching Loss	—	6695	—		Energy losses include tail & diode reverse recovery
$t_{d(on)}$	Turn-On delay time	—	40	—	ns	
t_r	Rise time	—	40	—		
$t_{d(off)}$	Turn-Off delay time	—	480	—		
t_f	Fall time	—	200	—		
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				T_J = 150°C, I_C = 160A V_{CC} = 960V, Vp ≤1200V Rg = 10Ω, V_{GE} = +20V to 0V
Erec	Reverse Recovery Energy of the Diode	—	1130	—	μJ	T_J = 150°C
t_{rr}	Diode Reverse Recovery Time	—	140	—	ns	V_{CC} = 600V, I_F = 40A
I_{rr}	Peak Reverse Recovery Current	—	40	—	A	Rg = 10Ω, L =1.0mH

Notes:

① V_{CC} = 80% (V_{CES}), V_{GE} = 20V, L = 200μH, R_G = 10Ω.
② Pulse width limited by max. junction temperature.
③ Refer to AN-1086 for guidelines for measuring $V_{(BR)CES}$ safely.
④ R_θ is measured at T_J of approximately 90°C.
⑤ Values influenced by parasitic L and C of the test circuit.

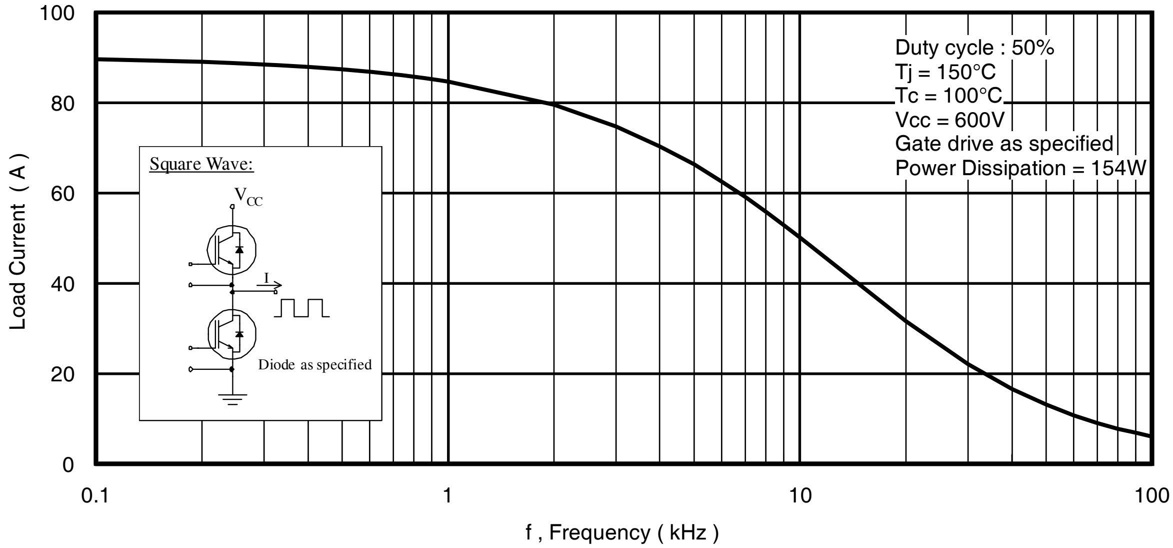


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

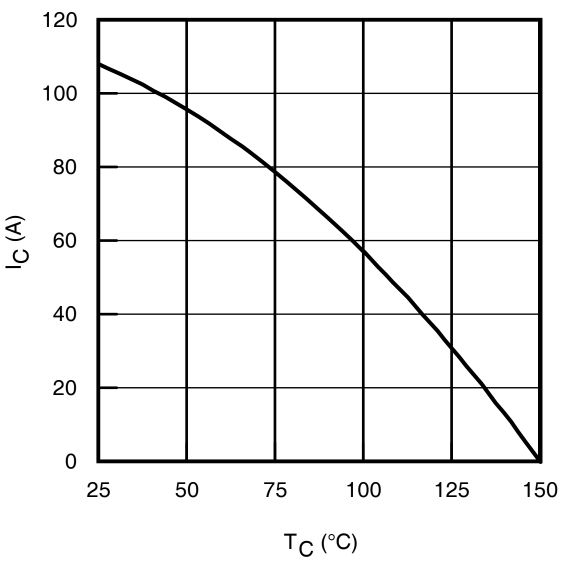


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

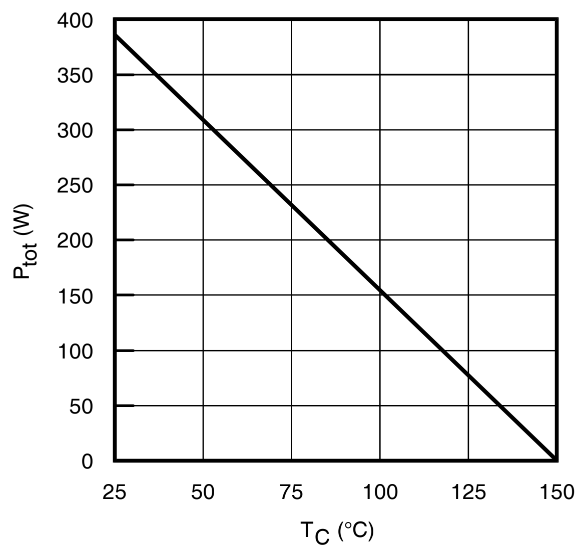


Fig. 2 - Power Dissipation vs. Case Temperature

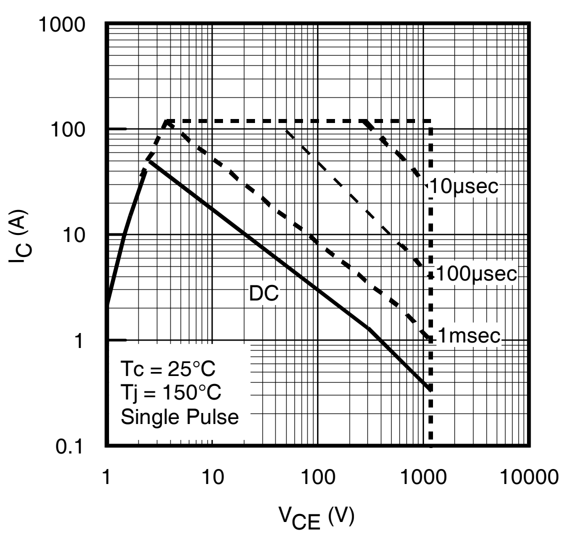


Fig. 3 - Forward SOA
T_C = 25°C, $T_J \leq$ 150°C; V_{GE} =15V

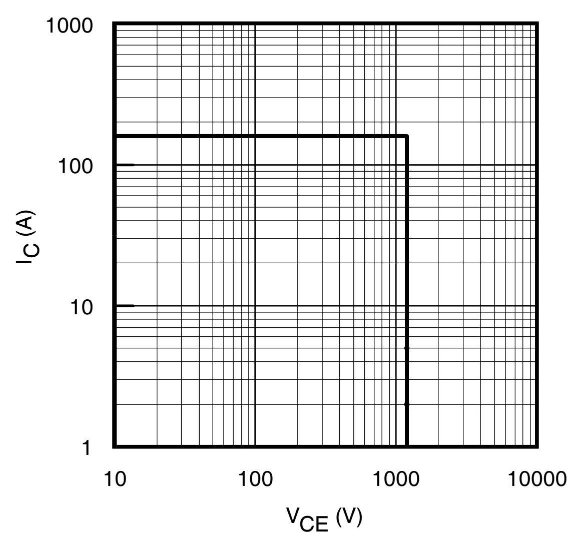


Fig. 4 - Reverse Bias SOA
T_J = 150°C; V_{GE} = 20V

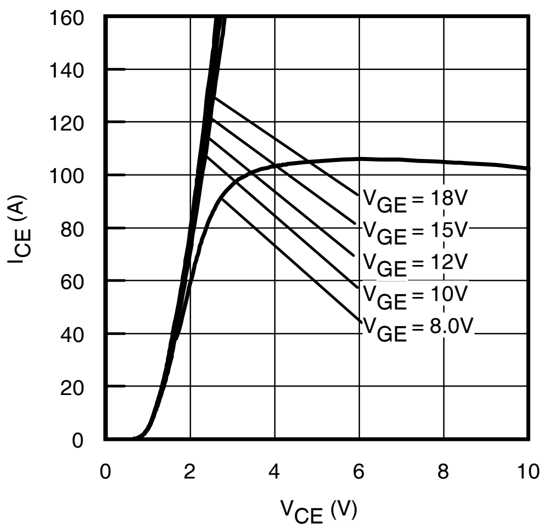


Fig. 5 - Typ. IGBT Output Characteristics
T_J = -40°C; tp = 30µs

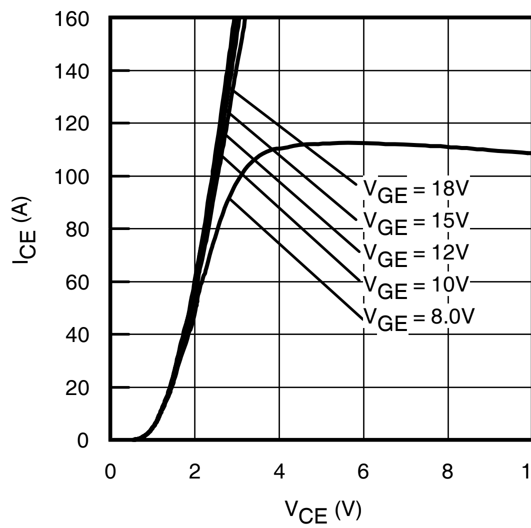


Fig. 6 - Typ. IGBT Output Characteristics
T_J = 25°C; tp = 30µs

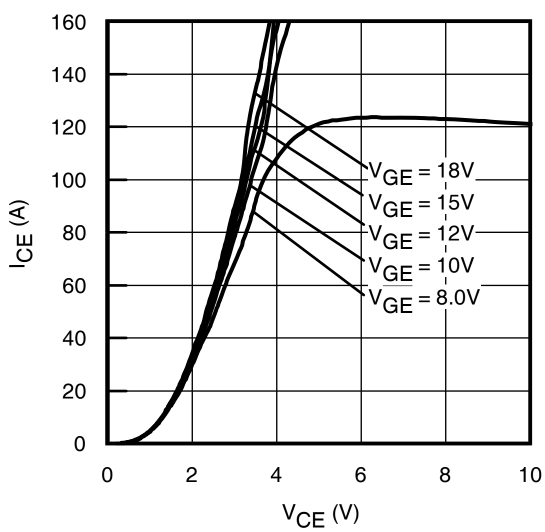


Fig. 7 - Typ. IGBT Output Characteristics
T_J = 150°C; tp = 30µs

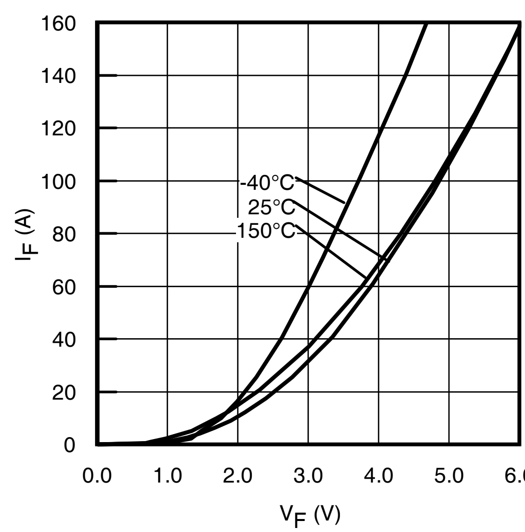


Fig. 8 - Typ. Diode Forward Characteristics
tp = 30µs

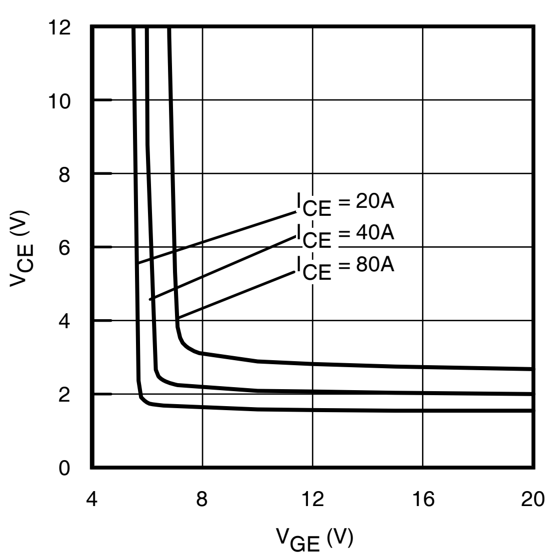


Fig. 9 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

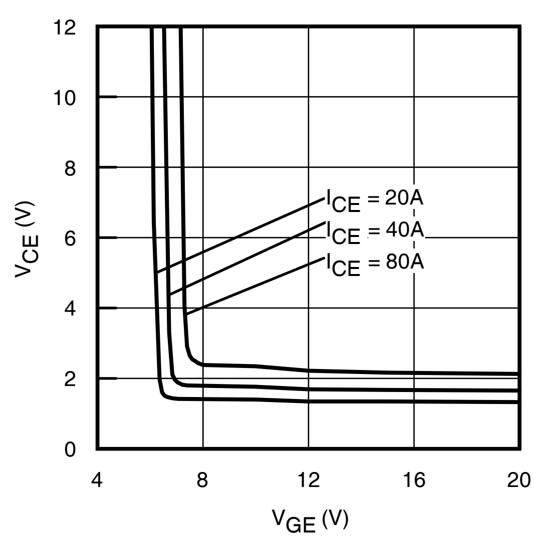


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

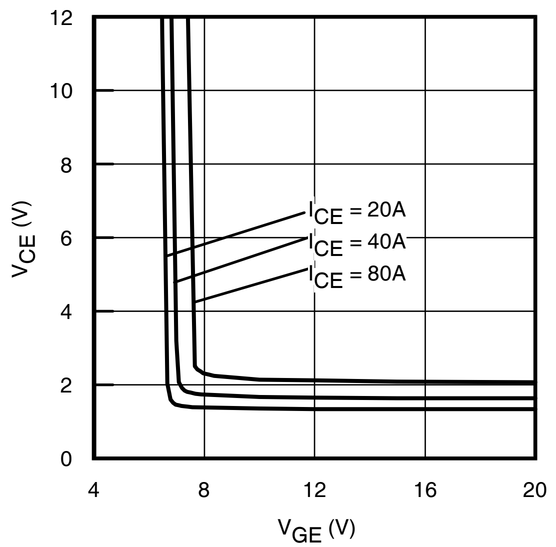


Fig. 11 - Typical V_{CE} vs. V_{GE}
$T_J = 150°C$

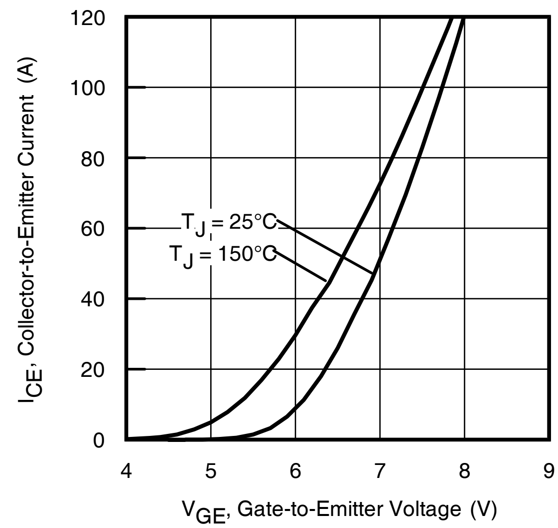


Fig. 12 - Typ. Transfer Characteristics
$V_{CE} = 50V$

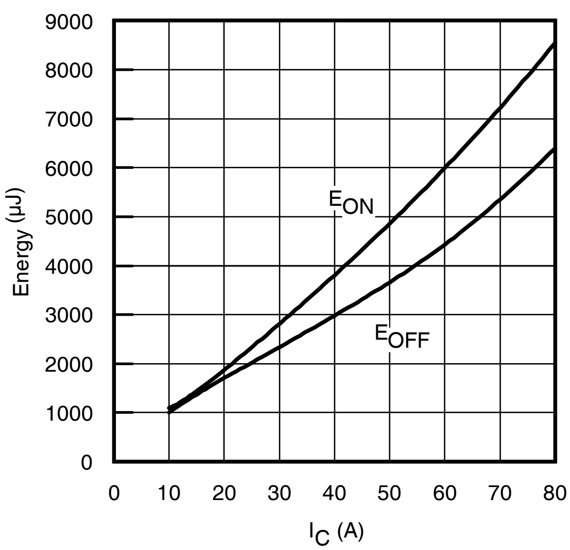


Fig. 13 - Typ. Energy Loss vs. I_C
$T_J = 150°C$; $L = 200μH$; $V_{CE} = 600V$, $R_G = 10Ω$; $V_{GE} = 15V$

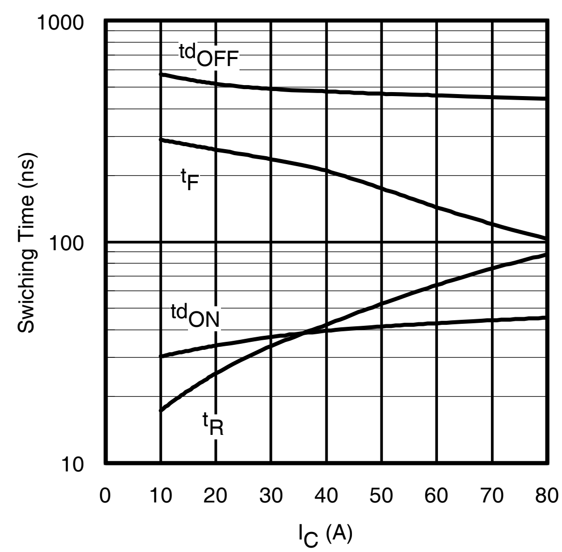


Fig. 14 - Typ. Switching Time vs. I_C
$T_J = 150°C$; $L = 200μH$; $V_{CE} = 600V$, $R_G = 10Ω$; $V_{GE} = 15V$

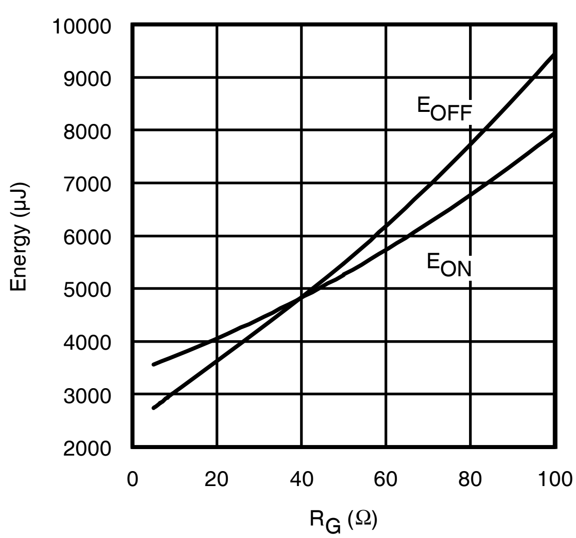


Fig. 15 - Typ. Energy Loss vs. R_G
$T_J = 150°C$; $L = 200μH$; $V_{CE} = 600V$, $I_{CE} = 40A$; $V_{GE} = 15V$

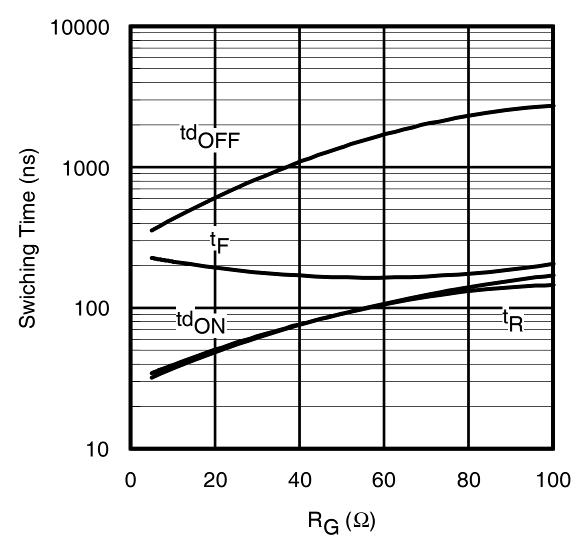


Fig. 16 - Typ. Switching Time vs. R_G
$T_J = 150°C$; $L = 200μH$; $V_{CE} = 600V$, $I_{CE} = 40A$; $V_{GE} = 15V$

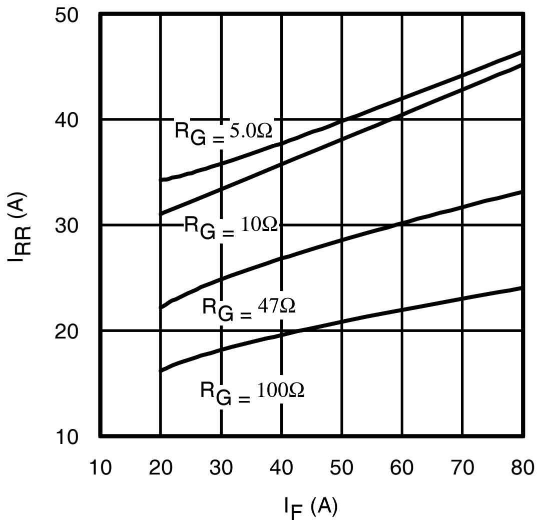


Fig. 17 - Typ. Diode I_{RR} vs. I_F
$T_J = 150°C$

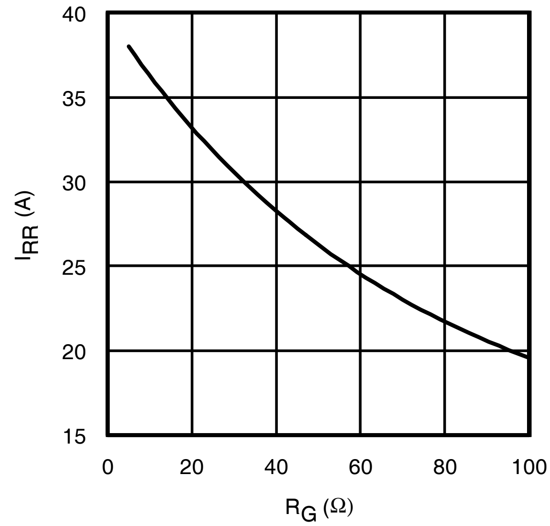


Fig. 18 - Typ. Diode I_{RR} vs. R_G
$T_J = 150°C$

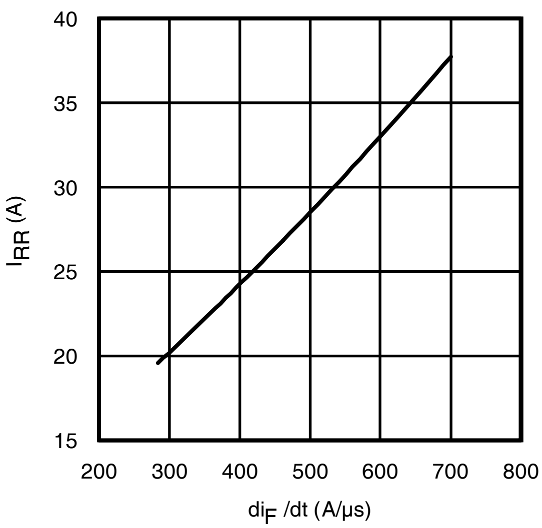


Fig. 19 - Typ. Diode I_{RR} vs. di_F/dt
V_{CC} = 600V; V_{GE} = 15V; I_F = 40A; T_J = 150°C

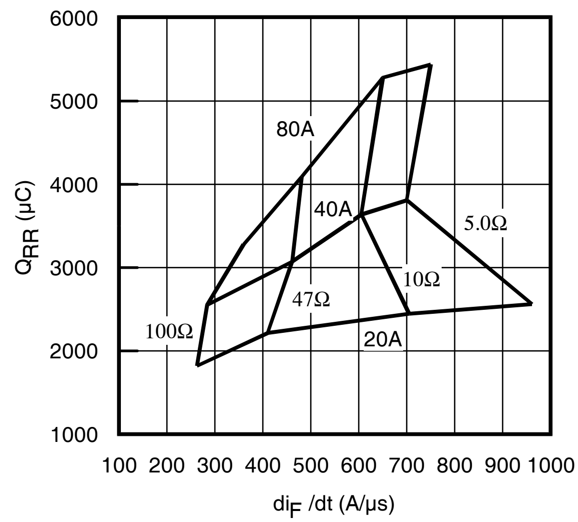


Fig. 20 - Typ. Diode Q_{RR} vs. di_F/dt
V_{CC} = 600V; V_{GE} = 15V; T_J = 150°C

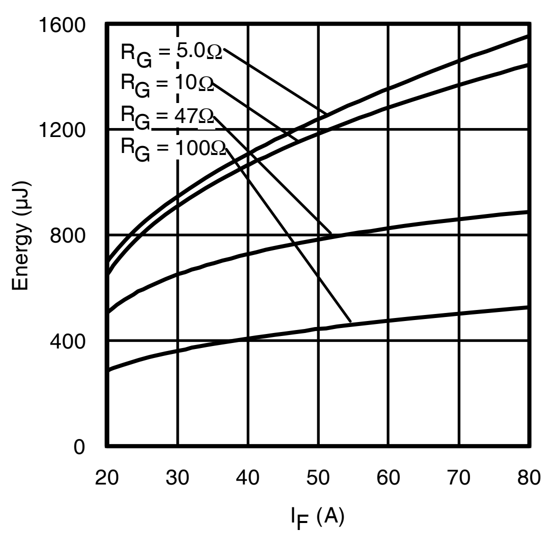


Fig. 21 - Typ. Diode E_{RR} vs. I_F
$T_J = 150°C$

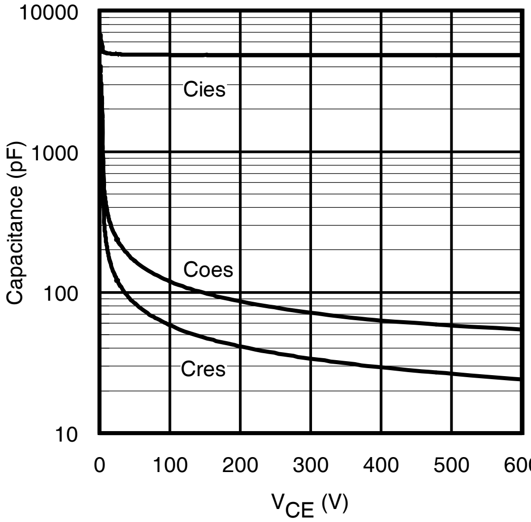


Fig. 22 - Typ. Capacitance vs. V_{CE}
V_{GE}= 0V; f = 1MHz

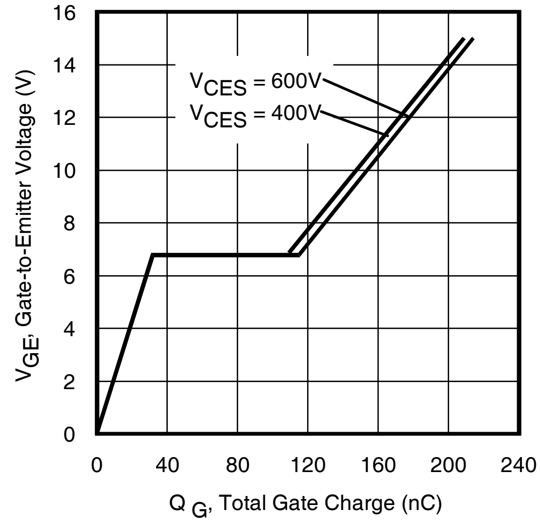
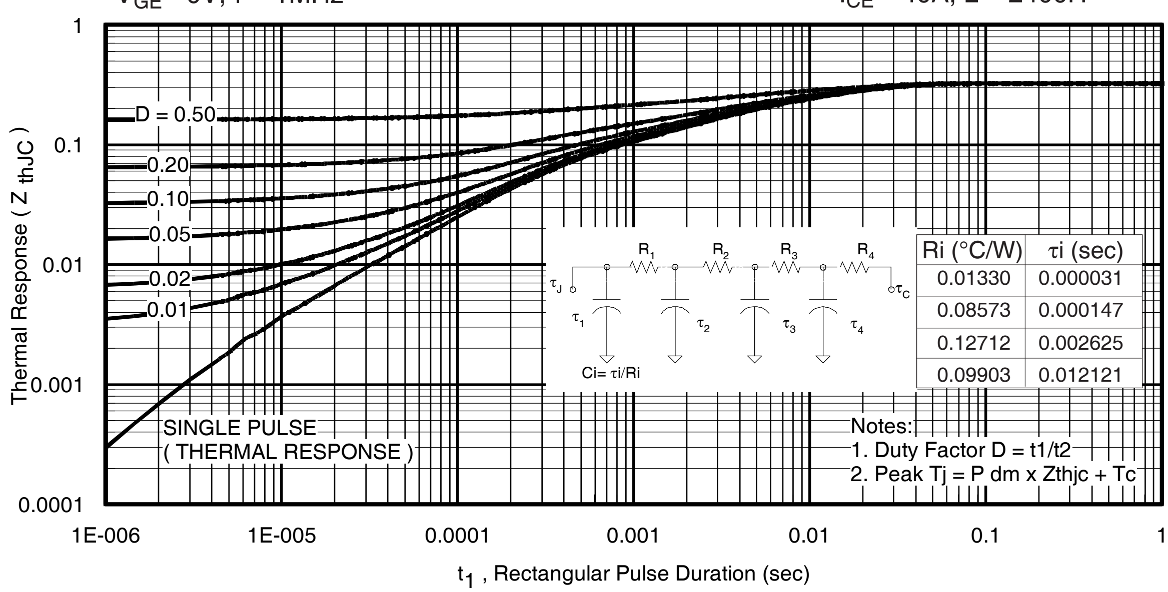
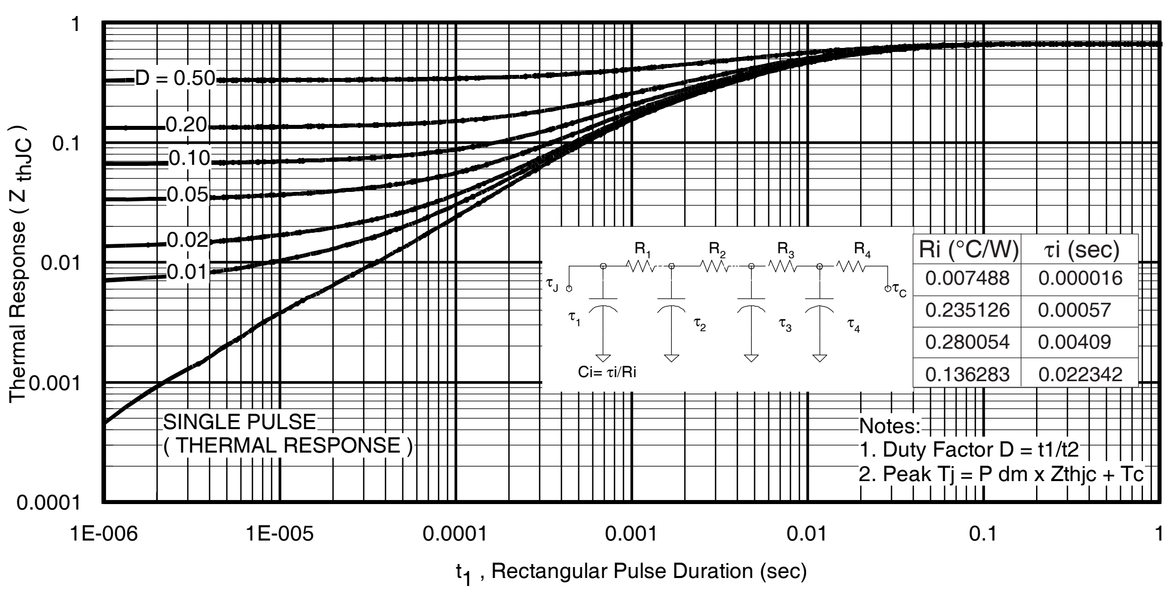


Fig. 23 - Typical Gate Charge vs. V_{GE}
I_{CE} = 40A; L = 2400H



Ri (°C/W)	τi (sec)
0.01330	0.000031
0.08573	0.000147
0.12712	0.002625
0.09903	0.012121

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



Ri (°C/W)	τi (sec)
0.007488	0.000016
0.235126	0.00057
0.280054	0.00409
0.136283	0.022342

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

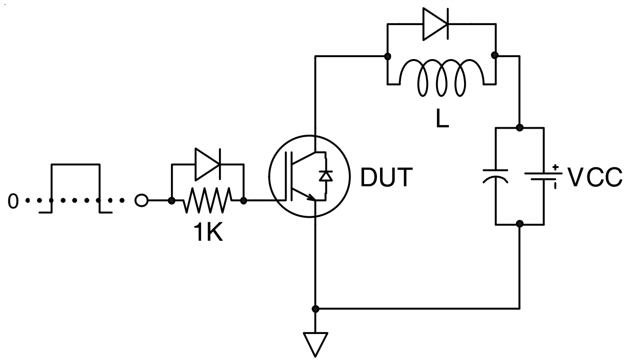


Fig.C.T.1 - Gate Charge Circuit (turn-off)

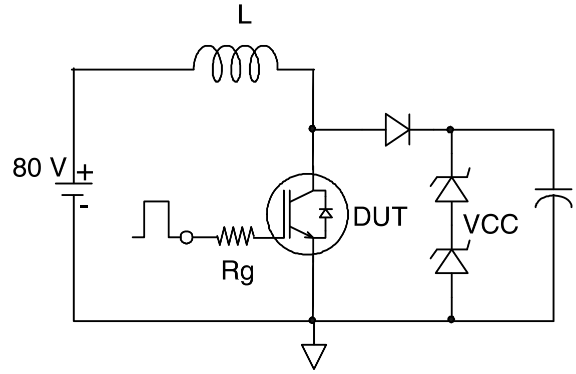


Fig.C.T.2 - RBSOA Circuit

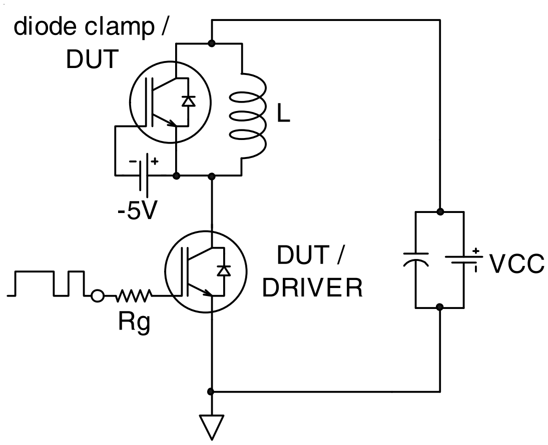


Fig.C.T.3 - Switching Loss Circuit

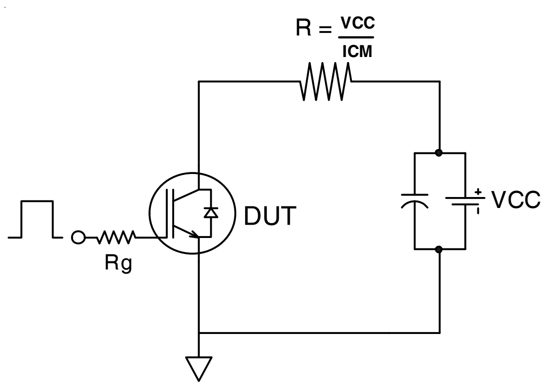


Fig.C.T.4 - Resistive Load Circuit

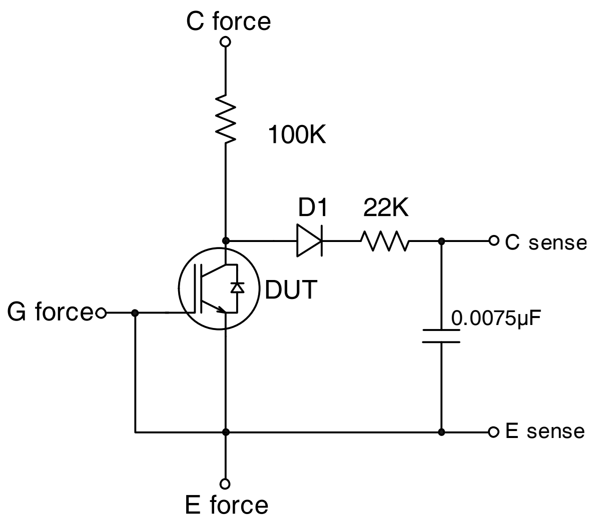


Fig.C.T.5 - BVCES Filter Circuit

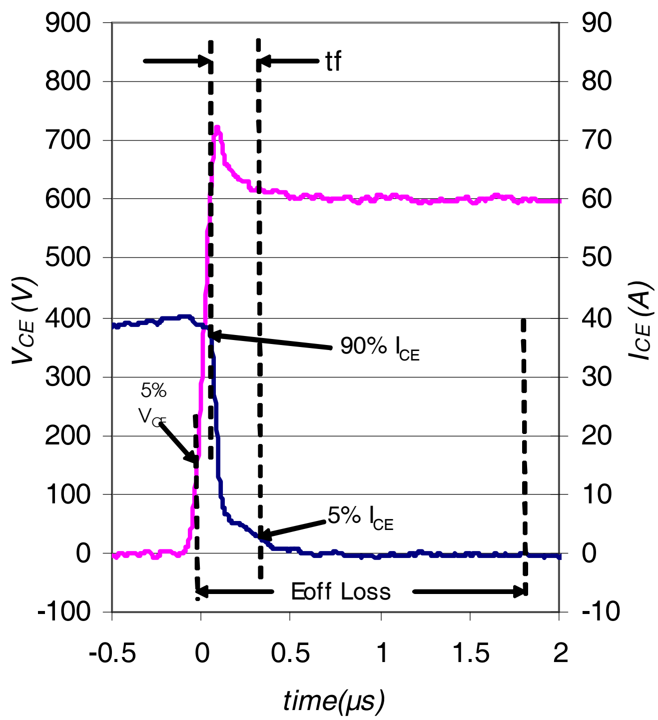


Fig. WF1 - Typ. Turn-off Loss Waveform
@ T_J = 150°C using Fig. CT.4

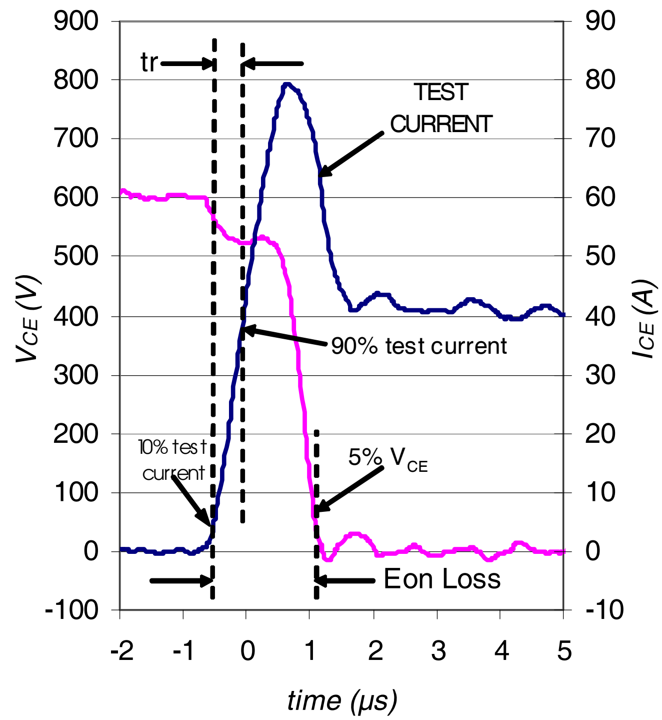


Fig. WF2 - Typ. Turn-on Loss Waveform
@ T_J = 150°C using Fig. CT.4

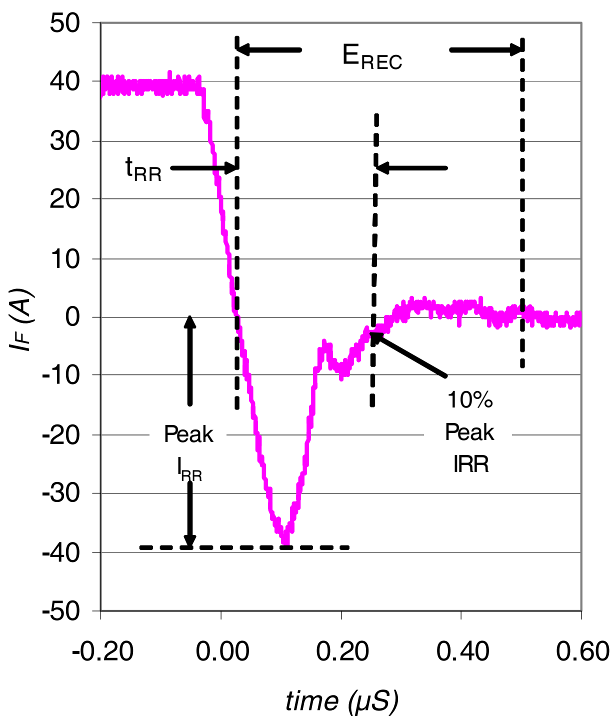
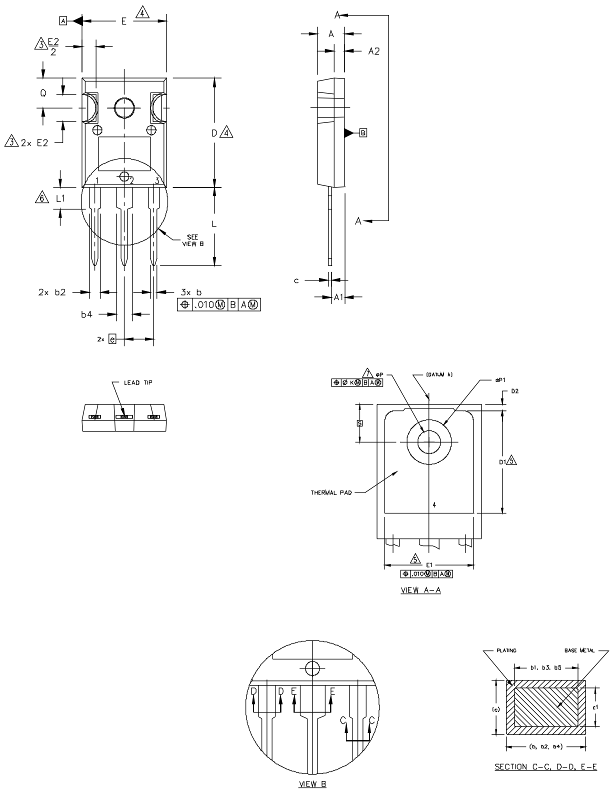


Fig. WF3 - Typ. Diode Recovery Waveform
@ T_J = 150°C using Fig. CT.4

 www.irf.com July 17, 2013

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

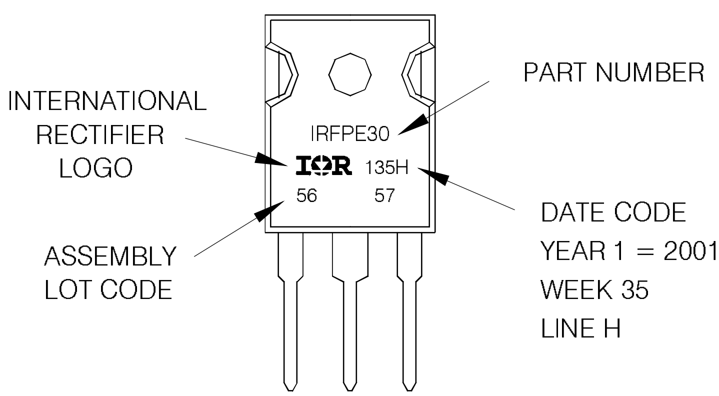
DIODES

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"

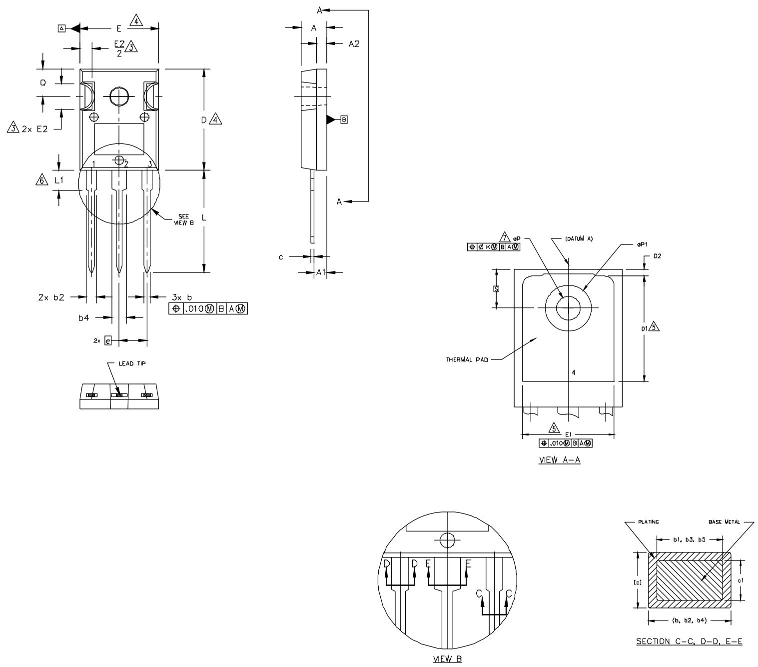


TO-247AC package is not recommended for Surface Mount Application.

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

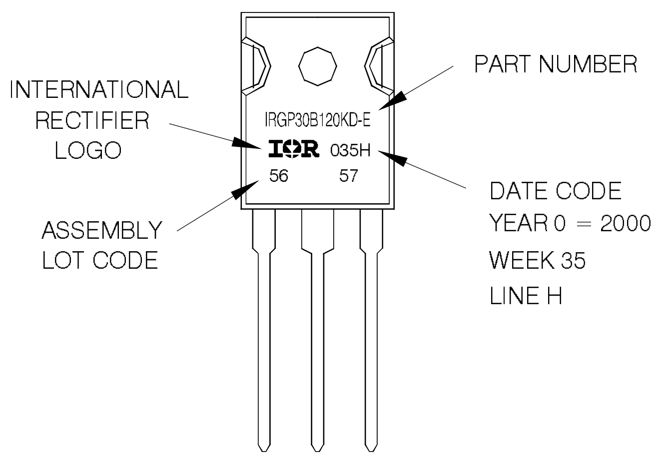
DIODES

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/

International Rectifier

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To contact International Rectifier, please visit http://www.irf.com/whoto-call/

