

$$V_{CES} = 600V$$

$$I_C = 60A, T_C = 100^{\circ}C$$

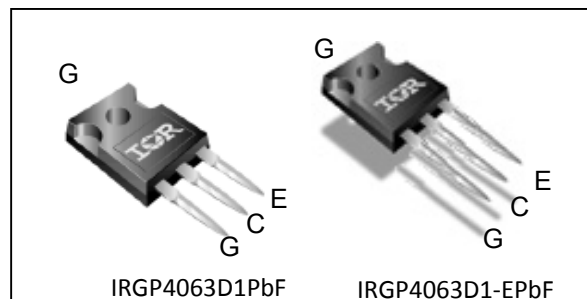
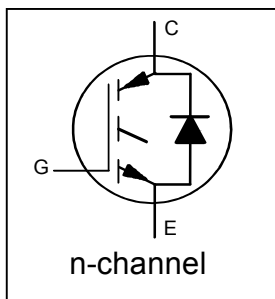
$$t_{SC} \geq 5\mu s, T_{J(max)} = 175^{\circ}C$$

$$V_{CE(ON)} \text{ typ.} = 1.65V @ I_C = 48A$$

Applications

- Industrial Motor Drive
- Inverters
- UPS
- Welding

Insulated Gate Bipolar Transistor with Ultrafast Soft Recovery Diode



G	C	E
Gate	Collector	Emitter

Features	Benefits
Low $V_{CE(ON)}$ and switching losses	High efficiency in a wide range of applications and switching frequencies
Square RBSOA and maximum junction temperature $175^{\circ}C$	Improved reliability due to rugged hard switching performance and higher power capability
Positive $V_{CE(ON)}$ temperature coefficient	Excellent current sharing in parallel operation
$5\mu s$ short circuit SOA	Enables short circuit protection scheme
Lead-free, RoHS compliant	Environmentally friendly

Base part number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
IRGP4063D1PbF	TO-247AC	Tube	25	IRGP4063D1PbF
IRGP4063D1-EPbF	TO-247AD	Tube	25	IRGP4063D1-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	100	A
$I_C @ T_C = 100^{\circ}C$	Continuous Collector Current	60	
I_{CM}	Pulse Collector Current, $V_{GE} = 15V$	200	
I_{LM}	Clamped Inductive Load Current, $V_{GE} = 20V$ ①	192	
$I_F @ T_C = 25^{\circ}C$	Diode Continuous Forward Current	30	
$I_F @ T_C = 100^{\circ}C$	Diode Continuous Forward Current	15	V
I_{FM}	Diode Maximum Forward Current ①	120	
V_{GE}	Continuous Gate-to-Emitter Voltage	± 20	V
	Transient Gate-to-Emitter Voltage	± 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	-40 to +175	$^{\circ}C$
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) ②	—	—	0.45	$^{\circ}C/W$
$R_{\theta JC}$ (Diode)	Thermal Resistance Junction-to-Case-(each Diode) ②	—	—	2.4	
$R_{\theta CS}$	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	—	0.3	—	V/ $^\circ\text{C}$	$V_{GE}=0V, I_C=1mA$ (25 $^\circ\text{C}$ -175 $^\circ\text{C}$)
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.65	2.14	V	$I_C = 48A, V_{GE} = 15V, T_J = 25^\circ\text{C}$
		—	2.05	—		$I_C = 48A, V_{GE} = 15V, T_J = 175^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	$V_{CE} = V_{GE}, I_C = 1.4mA$
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-21	—	mV/ $^\circ\text{C}$	$V_{CE}=V_{GE}, I_C=1.4mA$ (25 $^\circ\text{C}$ -175 $^\circ\text{C}$)
g_{fe}	Forward Transconductance	—	32	—	S	$V_{CE} = 50V, I_C = 48A, PW = 20\mu s$
I_{CES}	Collector-to-Emitter Leakage Current	—	1.0	200	μA	$V_{GE} = 0V, V_{CE} = 600V$
		—	850	—		$V_{GE} = 0V, V_{CE} = 600V, T_J = 175^\circ\text{C}$
V_{FM}	Diode Forward Voltage Drop	—	1.9	2.4	V	$I_F = 8A$
		—	1.2	—		$I_F = 8A, T_J = 175^\circ\text{C}$
I_{GES}	Gate-to-Emitter Leakage Current	—	—	± 100	nA	$V_{GE} = \pm 20V$

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

	Parameter	Min.	Typ.	Max.④	Units	Conditions
Q_g	Total Gate Charge (turn-on)	—	100	150	nC	$I_C = 48A$ $V_{GE} = 15V$ $V_{CC} = 400V$
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	25	40		
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	40	60		
E_{on}	Turn-On Switching Loss	—	1.4	2.3	mJ	$I_C = 48A, V_{CC} = 400V, V_{GE} = 15V$ $R_G = 10\Omega, L = 485\mu H, T_J = 25^\circ\text{C}$ Energy losses include tail & diode reverse recovery ⑤⑥
E_{off}	Turn-Off Switching Loss	—	1.1	2.0		
E_{total}	Total Switching Loss	—	2.5	4.3		
$t_{d(on)}$	Turn-On delay time	—	60	80	ns	$I_C = 48A, V_{CC} = 400V, V_{GE}=15V$ $R_G=10\Omega, L=485\mu H, T_J = 175^\circ\text{C}$ Energy losses include tail & diode reverse recovery ⑤⑥
t_r	Rise time	—	50	70		
$t_{d(off)}$	Turn-Off delay time	—	160	185		
t_f	Fall time	—	30	50	mJ	$I_C = 48A, V_{CC} = 400V, V_{GE}=15V$ $R_G=10\Omega, L=485\mu H, T_J = 175^\circ\text{C}$ Energy losses include tail & diode reverse recovery ⑤⑥
E_{on}	Turn-On Switching Loss	—	2.0	—		
E_{off}	Turn-Off Switching Loss	—	1.5	—		
E_{total}	Total Switching Loss	—	3.5	—	ns	$I_C = 48A, V_{CC} = 400V, V_{GE}=15V$ $R_G=10\Omega, L=485\mu H, T_J = 175^\circ\text{C}$ Energy losses include tail & diode reverse recovery ⑤⑥
$t_{d(on)}$	Turn-On delay time	—	50	—		
t_r	Rise time	—	55	—		
$t_{d(off)}$	Turn-Off delay time	—	165	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0MHz$
t_f	Fall time	—	55	—		
C_{ies}	Input Capacitance	—	2900	—		
C_{oes}	Output Capacitance	—	200	—	pF	$T_J = 175^\circ\text{C}, I_C = 192A$ $V_{CC} = 480V, V_p \leq 600V$ $R_g = 50\Omega, V_{GE} = +20V$ to 0V
C_{res}	Reverse Transfer Capacitance	—	90	—		
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$V_{CC} = 400V, V_p \leq 600V$ $R_g = 50\Omega, V_{GE} = +15V$ to 0V
SCSOA	Short Circuit Safe Operating Area	5	—	—	μs	$T_J = 175^\circ\text{C}$ $V_{CC} = 400V, I_F = 48A$
E_{rec}	Reverse Recovery Energy of the Diode	—	245	—	μJ	$V_{GE} = 15V, R_g = 10\Omega, L = 485\mu H$
t_{rr}	Diode Reverse Recovery Time	—	80	—	ns	
I_{rr}	Peak Reverse Recovery Current	—	20	—	A	

Notes:

- ① $V_{CC} = 80\% (V_{CES}), V_{GE} = 20V, L = 50\mu H, R_G = 50\Omega$.
- ② R_θ is measured at T_J of approximately 90 $^\circ\text{C}$.
- ③ Refer to AN-1086 for guidelines for measuring $V_{(BR)CES}$ safely.
- ④ Maximum limits are based on statistical sample size characterization.
- ⑤ Pulse width limited by max. junction temperature.
- ⑥ Values influenced by parasitic L and C in measurement.

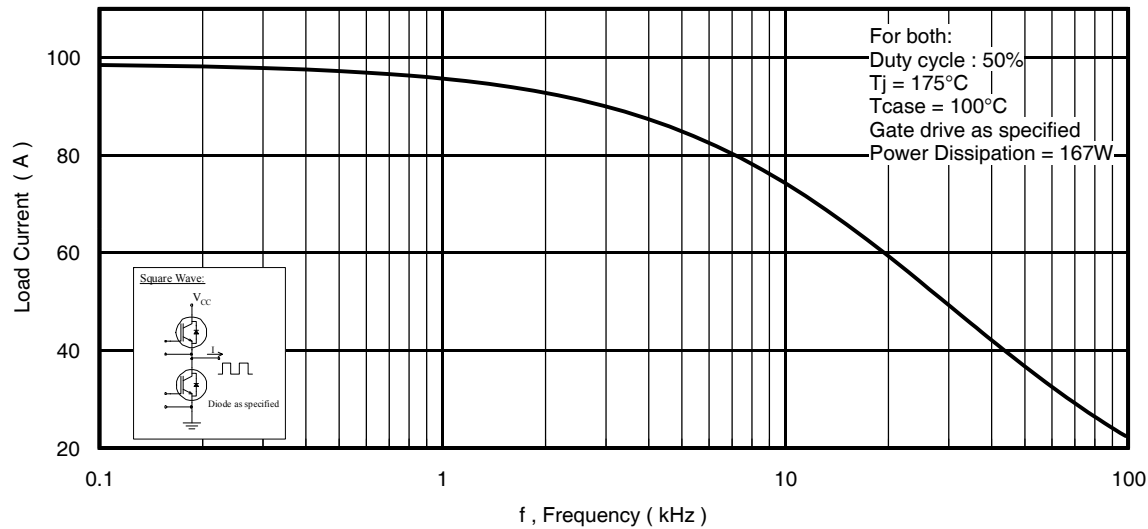


Fig. 1 - Typical Load Current vs. Frequency
 (Load Current = I_{RMS} of fundamental)

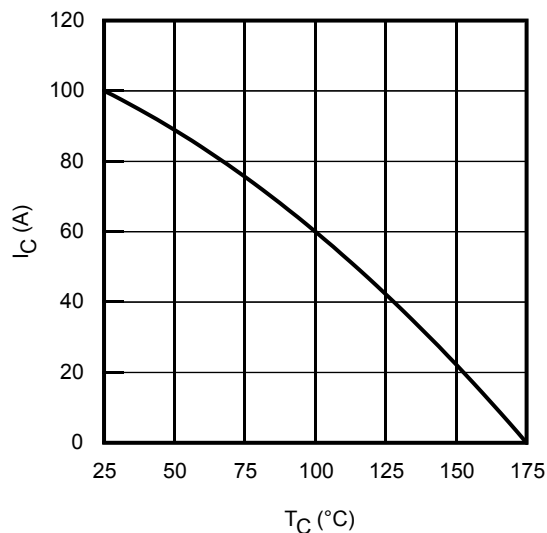


Fig. 2 - Maximum DC Collector Current vs.

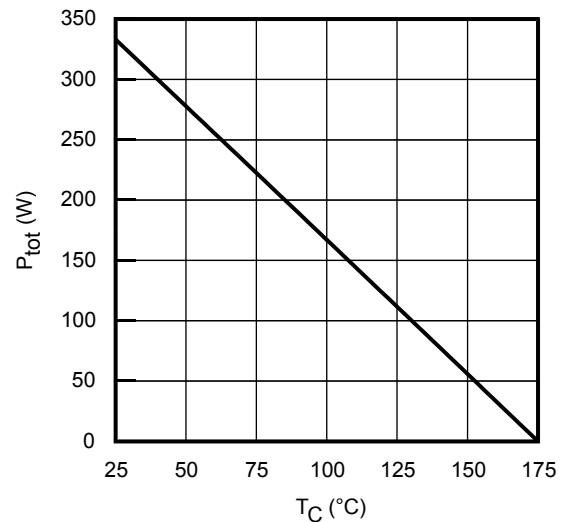


Fig. 3 - Power Dissipation vs.
 Case Temperature

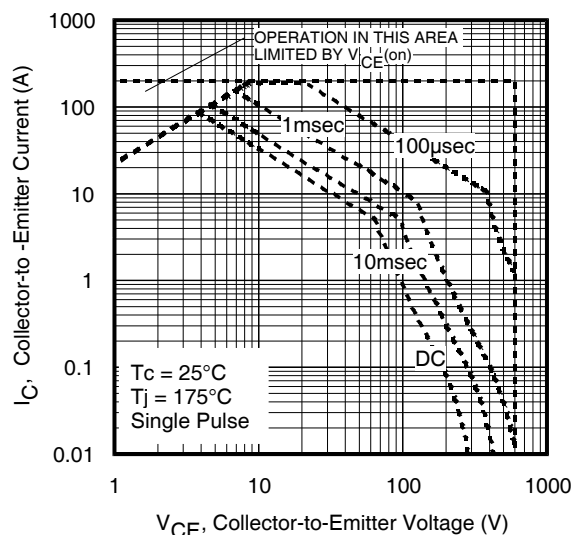


Fig. 4 - Forward SOA
 $T_C = 25^{\circ}\text{C}$, $T_J @ 175^{\circ}\text{C}$; $V_{\text{GE}} = 15\text{V}$

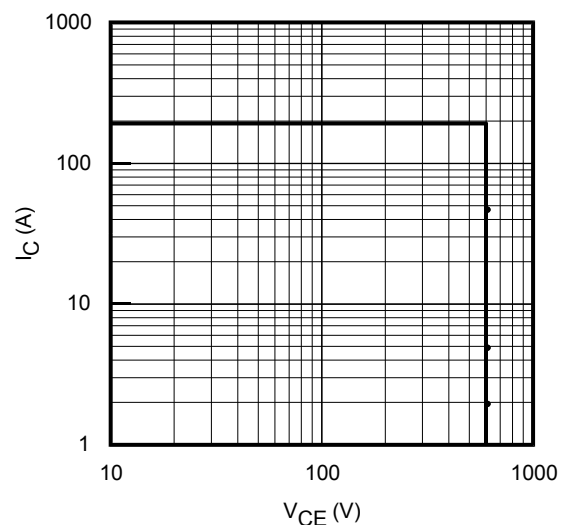


Fig. 5 - Reverse Bias SOA
 $T_J = 175^{\circ}\text{C}$; $V_{\text{GE}} = 20\text{V}$

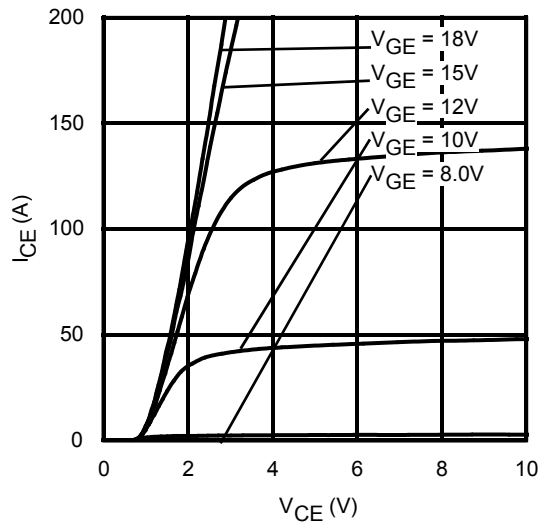


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = -40^\circ\text{C}$; $t_p = 20\mu\text{s}$

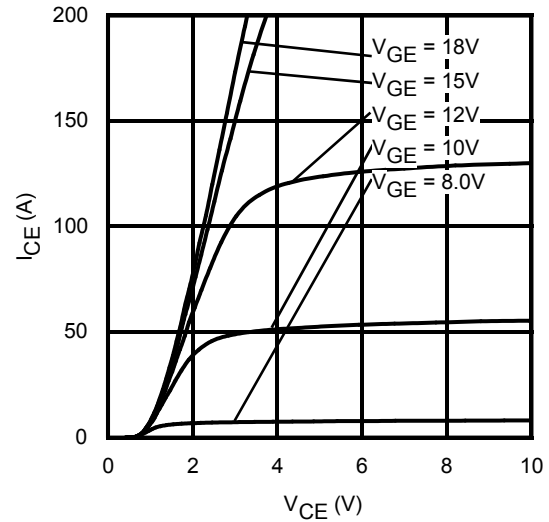


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 25^\circ\text{C}$; $t_p = 20\mu\text{s}$

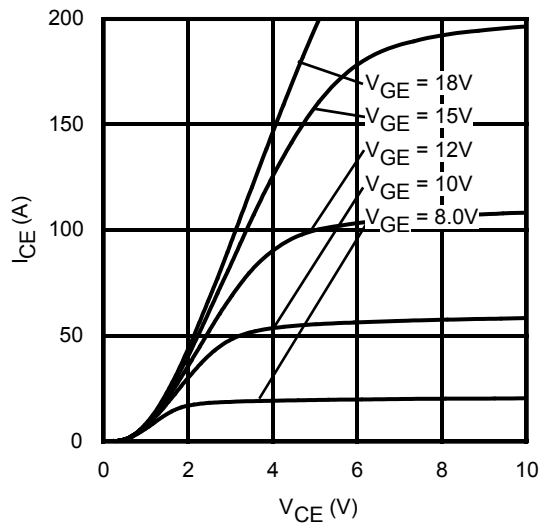


Fig. 8 - Typ. IGBT Output Characteristics
 $T_J = 175^\circ\text{C}$; $t_p = 20\mu\text{s}$

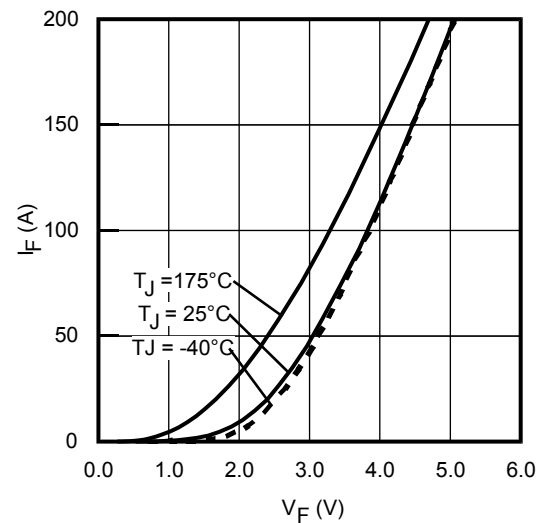


Fig. 9 - Typ. Diode Forward Characteristics
 $t_p = 20\mu\text{s}$

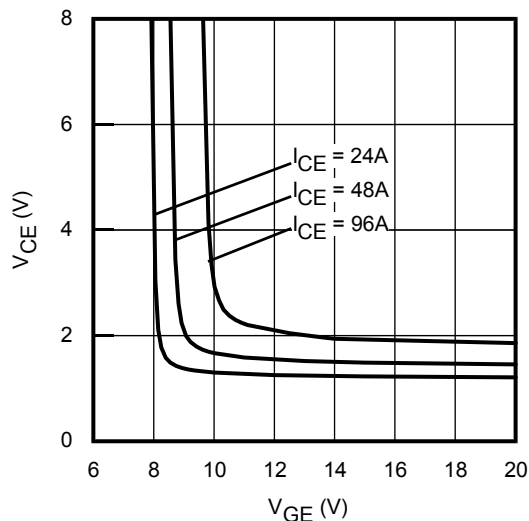


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^\circ\text{C}$

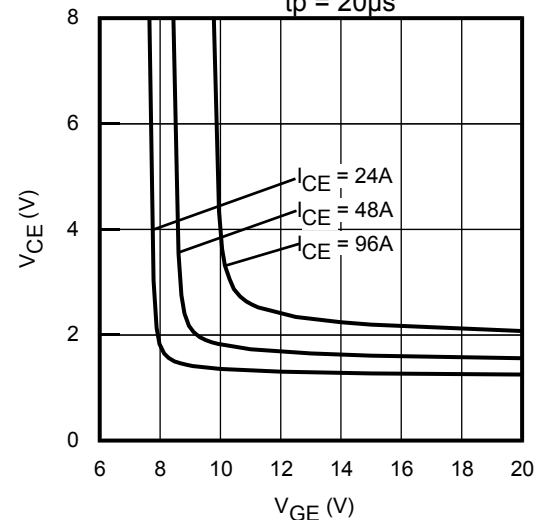


Fig. 111 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

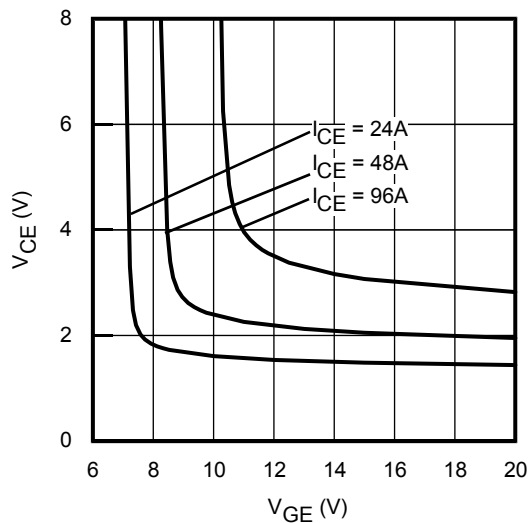


Fig. 12 - Typical V_{CE} vs. V_{GE}
 $T_J = 175^\circ\text{C}$

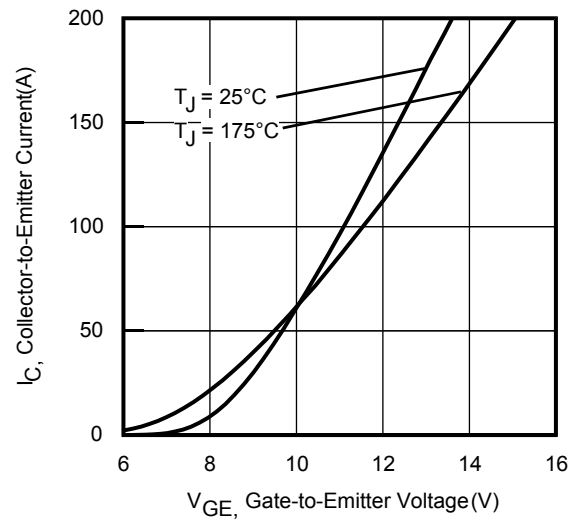


Fig. 13 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 20\mu\text{s}$

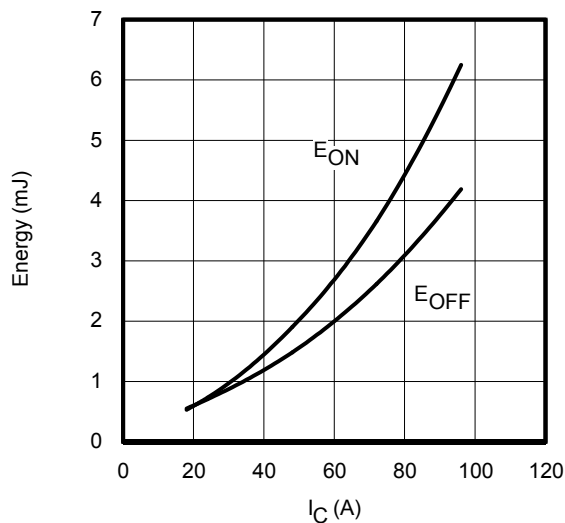


Fig. 14 - Typ. Energy Loss vs. I_C
 $T_J = 175^\circ\text{C}$; $L = 485\mu\text{H}$; $V_{CE} = 400\text{V}$; $R_G = 10\Omega$; $V_{GE} = 15\text{V}$

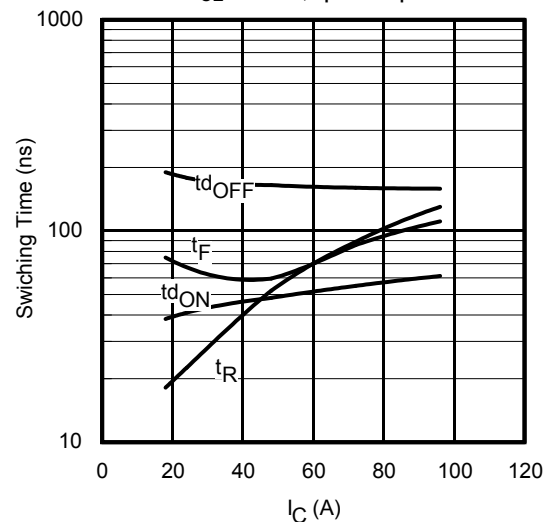


Fig. 15 - Typ. Switching Time vs. I_C
 $T_J = 175^\circ\text{C}$; $L = 485\mu\text{H}$; $V_{CE} = 400\text{V}$; $R_G = 10\Omega$; $V_{GE} = 15\text{V}$

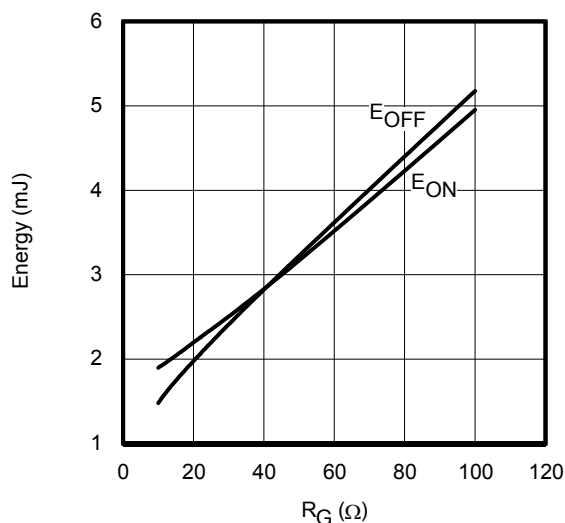


Fig. 16 - Typ. Energy Loss vs. R_G
 $T_J = 175^\circ\text{C}$; $L = 485\mu\text{H}$; $V_{CE} = 400\text{V}$; $I_{CE} = 48\text{A}$; $V_{GE} = 15\text{V}$

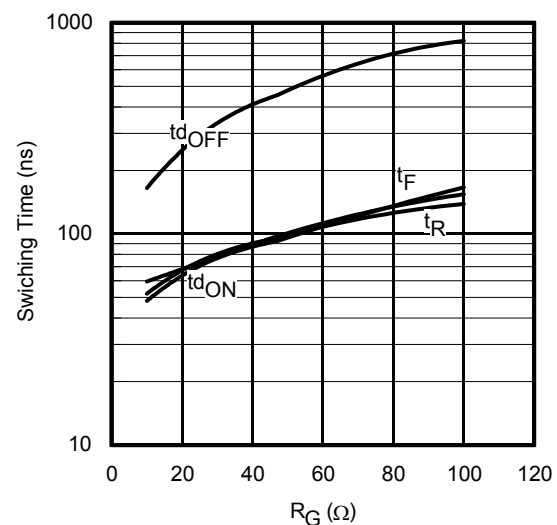


Fig. 17 - Typ. Switching Time vs. R_G
 $T_J = 175^\circ\text{C}$; $L = 485\mu\text{H}$; $V_{CE} = 400\text{V}$; $I_{CE} = 48\text{A}$; $V_{GE} = 15\text{V}$

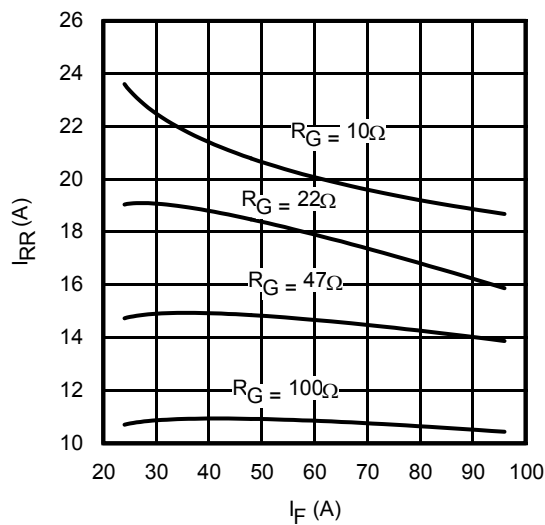


Fig. 18 - Typ. Diode I_{RR} vs. I_F
 $T_J = 175^\circ\text{C}$

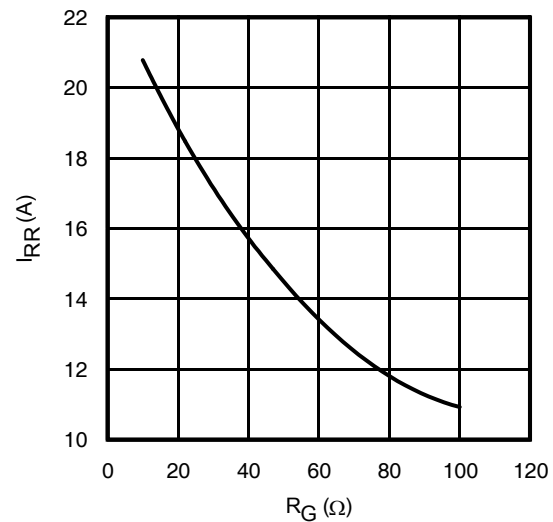


Fig. 19 - Typ. Diode I_{RR} vs. R_G
 $T_J = 175^\circ\text{C}$

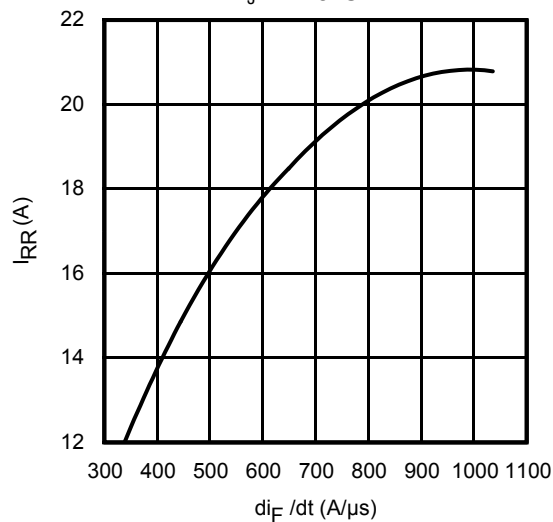


Fig. 20 - Typ. Diode I_{RR} vs. diF/dt
 $V_{CC} = 400\text{V}$; $V_{GE} = 15\text{V}$; $I_F = 48\text{A}$; $T_J = 175^\circ\text{C}$

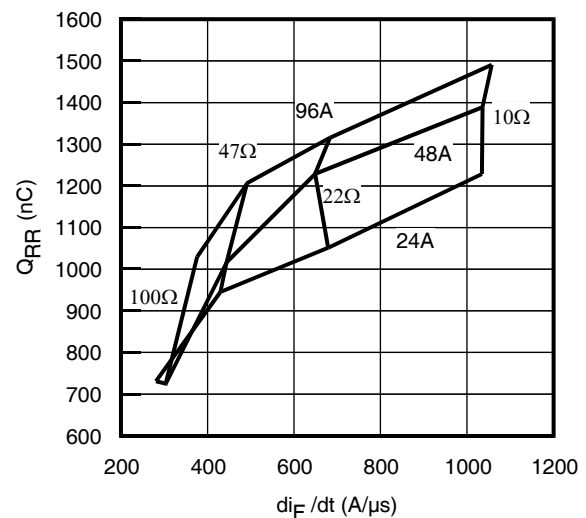


Fig. 21 - Typ. Diode Q_{RR} vs. diF/dt
 $V_{CC} = 400\text{V}$; $V_{GE} = 15\text{V}$; $T_J = 175^\circ\text{C}$

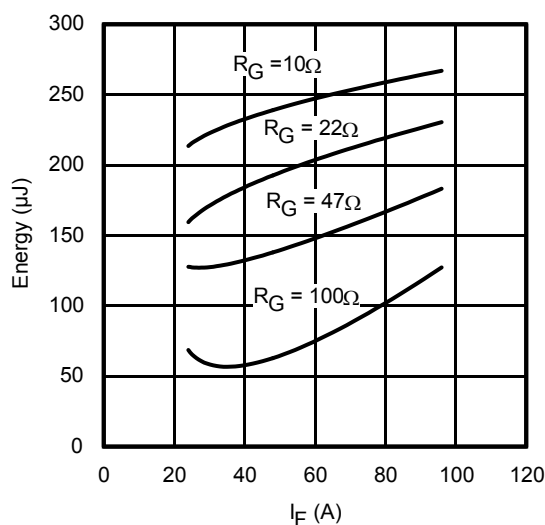


Fig. 22 - Typ. Diode E_{RR} vs. I_F
 $T_J = 175^\circ\text{C}$

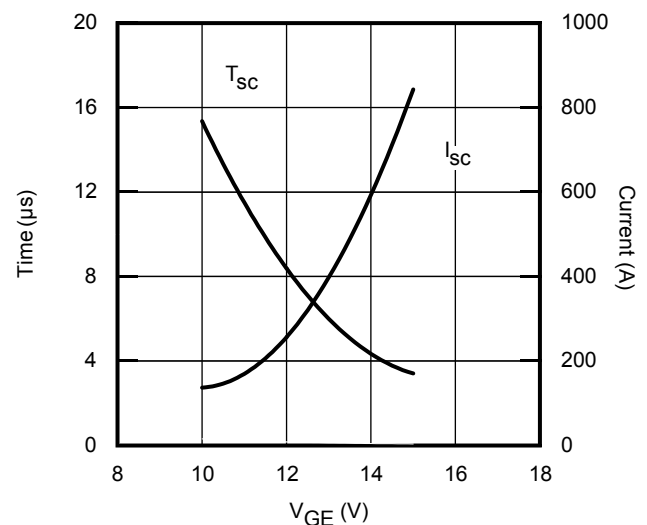


Fig. 23 - V_{GE} vs. Short Circuit Time
 $V_{CC} = 400\text{V}$; $T_C = 25^\circ\text{C}$

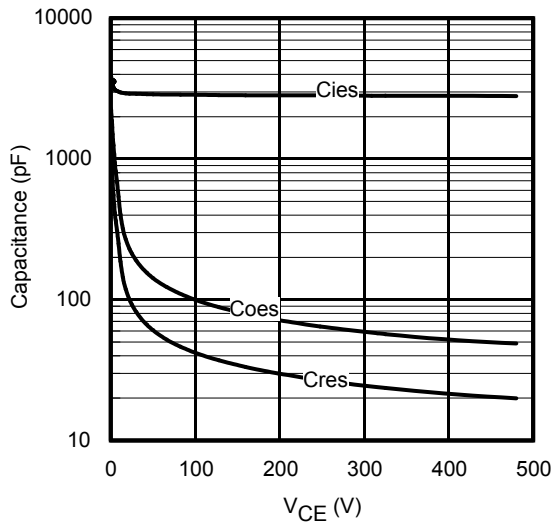


Fig. 24 - Typ. Capacitance vs. V_{CE}
 $V_{GE} = 0V$; $f = 1MHz$

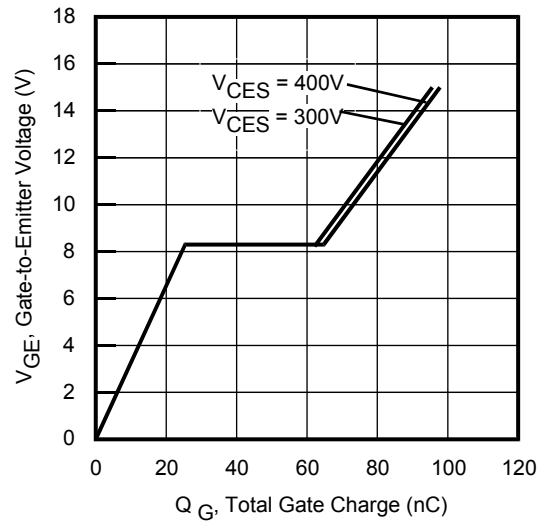


Fig. 25 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 48A$

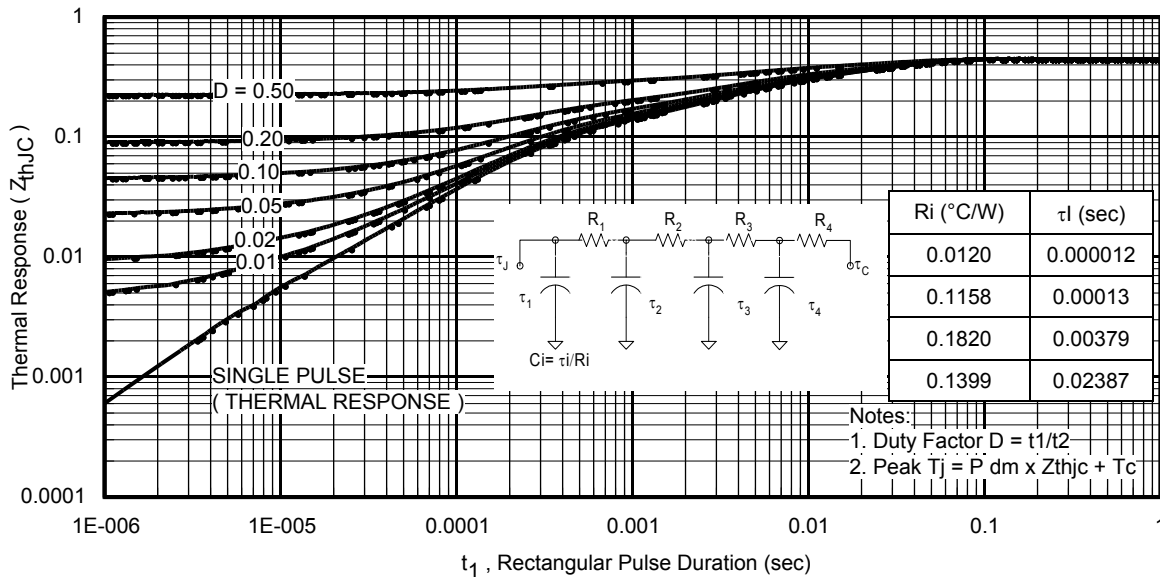


Fig. 27. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

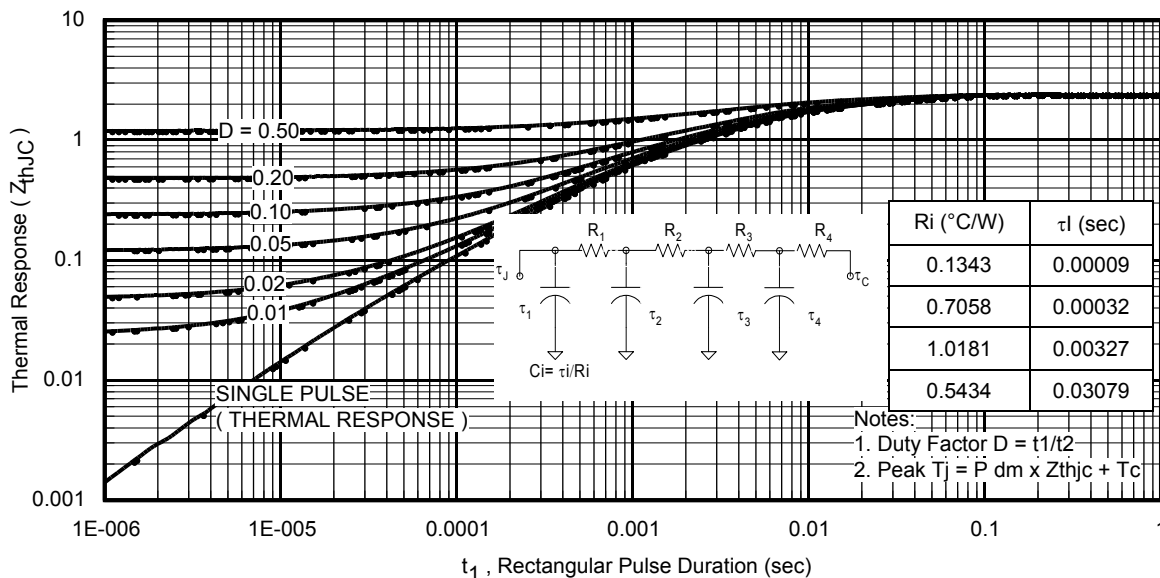


Fig. 28. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

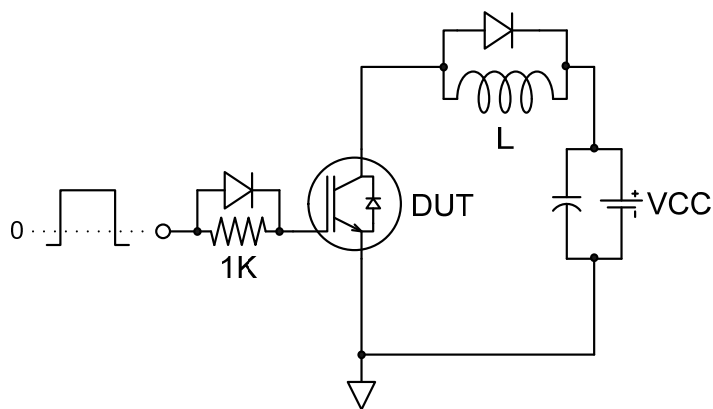


Fig.C.T.1 - Gate Charge Circuit (turn-off)

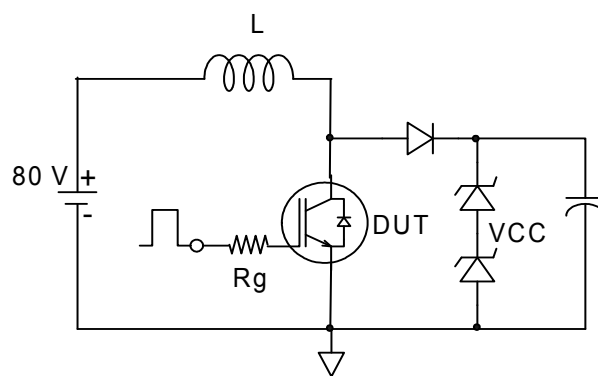


Fig.C.T.2 - RBSOA Circuit

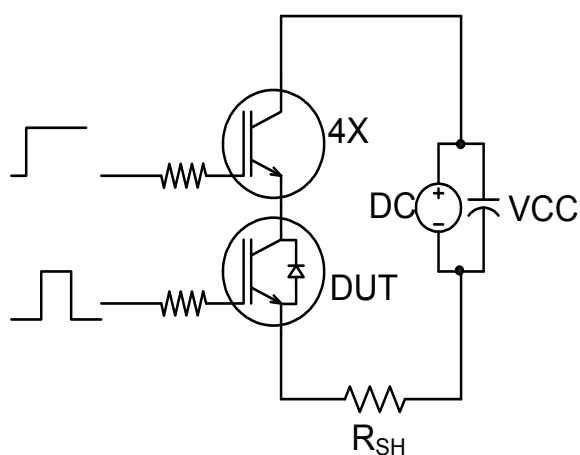


Fig.C.T.3 - S.C. SOA Circuit

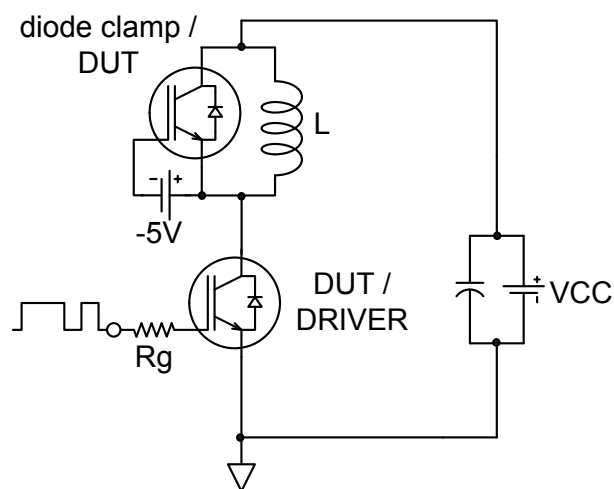


Fig.C.T.4 - Switching Loss Circuit

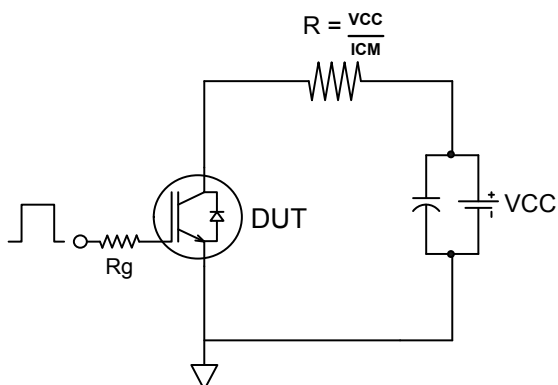


Fig.C.T.5 - Resistive Load Circuit

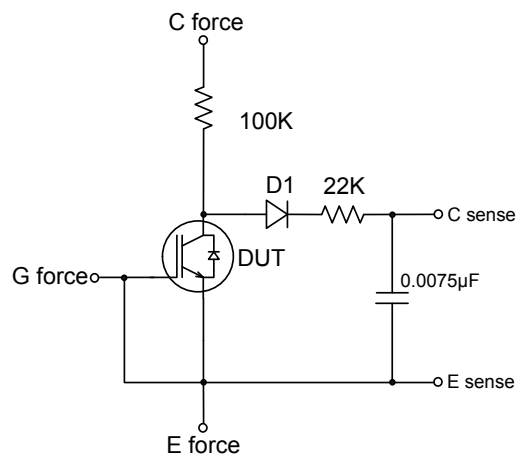


Fig.C.T.6 - BVCES Filter Circuit

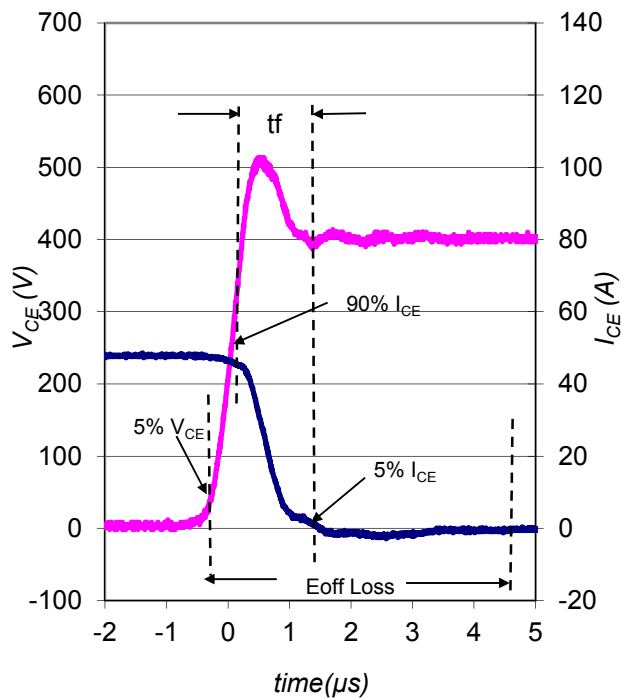


Fig. WF1 - Typ. Turn-off Loss Waveform
@ $T_J = 175^{\circ}\text{C}$ using Fig. CT.4

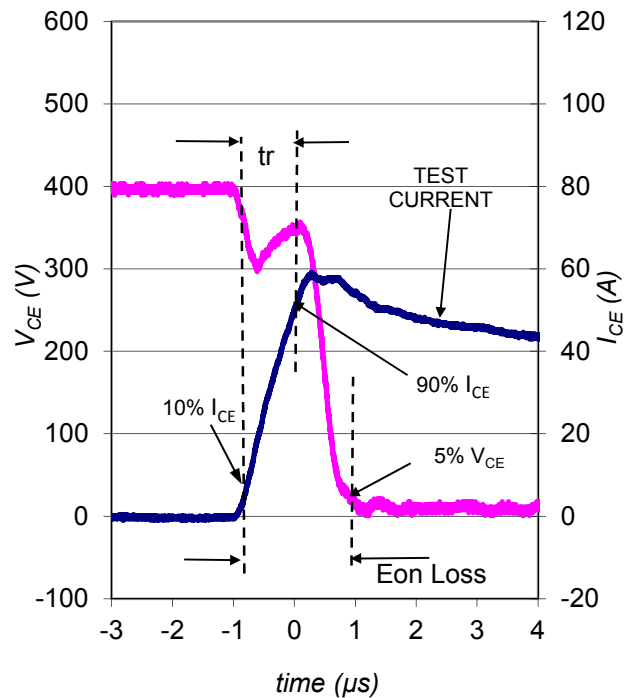


Fig. WF2 - Typ. Turn-on Loss Waveform
@ $T_J = 175^{\circ}\text{C}$ using Fig. CT.4

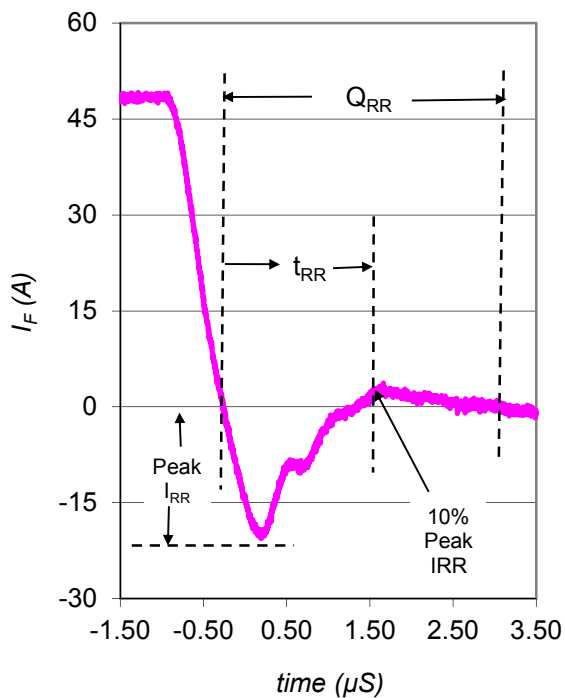


Fig. WF3 - Typ. Diode Recovery Waveform
@ $T_J = 175^{\circ}\text{C}$ using Fig. CT.4

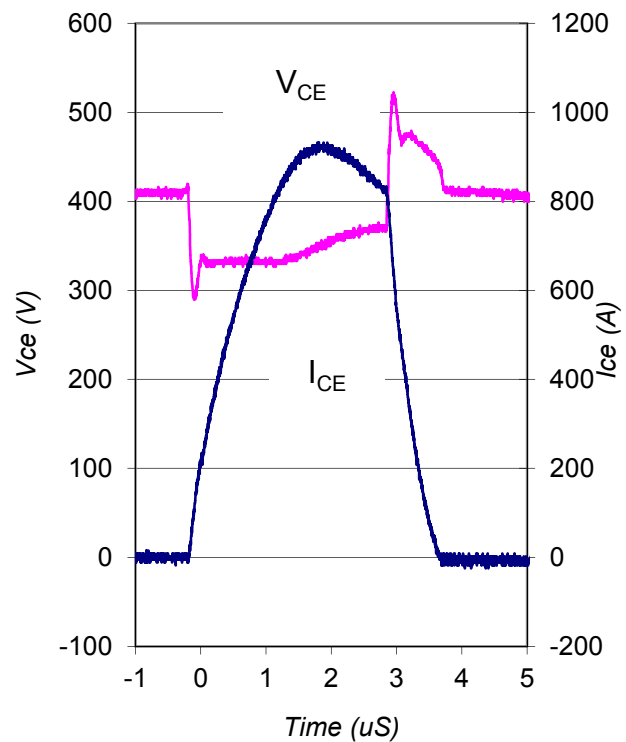
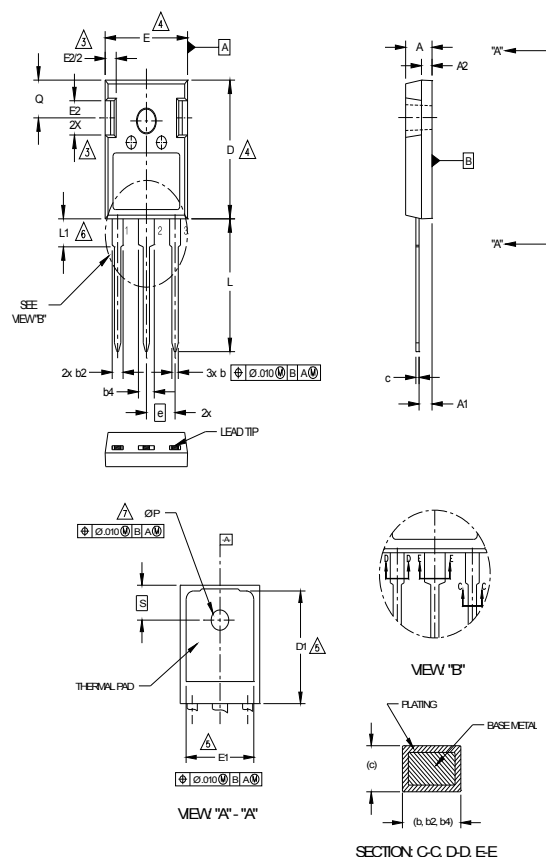


Fig. WF4 - Typ. S.C. Waveform
@ $T_J = 25^{\circ}\text{C}$ using Fig. CT.3

TO-247AC Package Outline

Dimensions are shown in millimeters (inches)



SYMBOL	D I M E N S I O N S				NOTES
	INCHES		MILLIMETERS		
	MIN.	MAX.	MIN.	MAX.	
A	.190	.204	4.83	5.20	4 5 4
A1	.090	.100	2.29	2.54	
A2	.075	.085	1.91	2.16	
b	.042	.052	1.07	1.33	
b2	.075	.094	1.91	2.41	
b4	.113	.133	2.87	3.38	
c	.022	.026	0.55	0.68	
D	.819	.830	20.80	21.10	
D1	.640	.694	16.25	17.65	
E	.620	.635	15.75	16.13	
E1	.512	.570	13.00	14.50	
E2	.145	.196	3.68	5.00	
e	.215 Typical		5.45 Typical		
L	.780	.800	19.80	20.32	
L1	.161	.173	4.10	4.40	
ø P	.138	.143	3.51	3.65	
Q	.216	.236	5.49	6.00	
S	.238	.248	6.04	6.30	

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

NOTES:

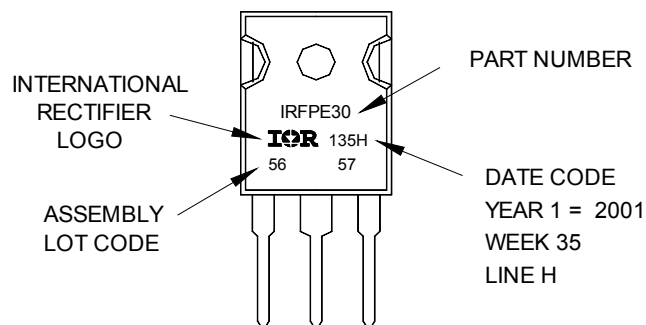
- 1 DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M 1994.
- 2 DIMENSIONS ARE SHOWN IN INCHES AND MILLIMETERS.
- 3 CONTOUR OF SLOT OPTIONAL.
- 4 DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
- 5 THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS D1 & E1.
- 6 LEAD FINISH UNCONTROLLED IN L1.
- 7 ø P TO HAVE A MAXIMUM DRAFT ANGLE OF 1.5 ° TO THE TOP OF THE PART WITH A MAXIMUM HOLE DIAMETER OF .154 INCH.

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"

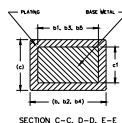
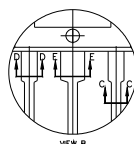
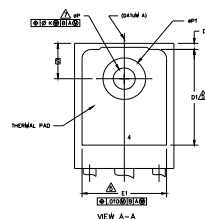
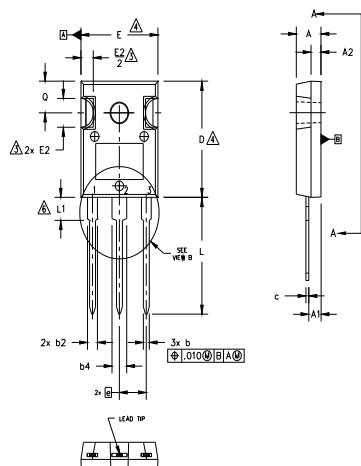


TO-247AC package is not recommended for Surface Mount Application.

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				NOTE
	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

HEM-FET

- 1.- GATE
- 2.- DRAIN
- 3.- SOURCE
- 4.- DRAIN

IGBTs, CoPACK

- 1.- GATE
- 2.- COLLECTOR
- 3.- EMITTER
- 4.- COLLECTOR

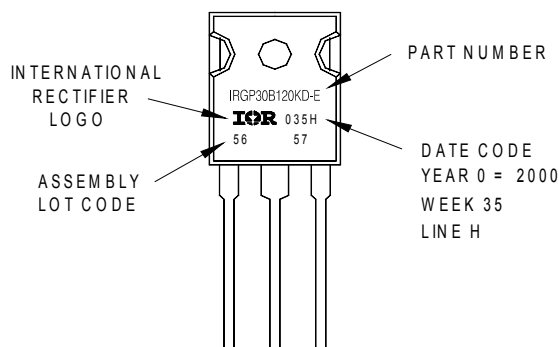
DIODES

- 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[†]

Qualification Information		
Qualification Level	Industrial (per JEDEC JESD47F) ^{††}	
Moisture Sensitivity Level	TO-247AC	N/A
	TO-247AD	
RoHS Compliant	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.

Data and specifications subject to change without notice.

International
 Rectifier

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TAC Fax: (310) 252-7903

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