

# IRGB4062DPbF IRGP4062DPbF

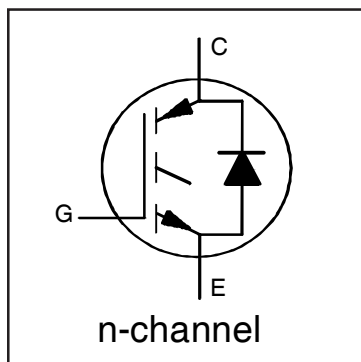
## INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

### Features

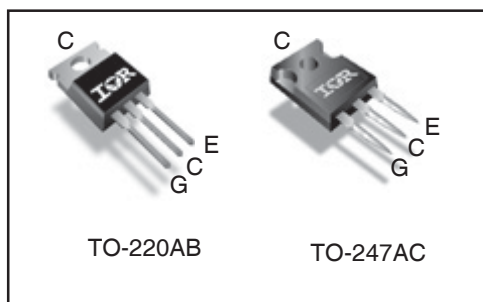
- Low  $V_{CE(ON)}$  Trench IGBT Technology
- Low switching losses
- Maximum Junction temperature 175 °C
- 5  $\mu$ S short circuit SOA
- Square RBSOA
- 100% of the parts tested for 4X rated current ( $I_{LM}$ )
- Positive  $V_{CE(ON)}$  Temperature co-efficient
- Ultra fast soft Recovery Co-Pak Diode
- Tight parameter distribution
- Lead Free Package

### 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
- Low EMI



$V_{CES} = 600V$
$I_C = 24A, T_C = 100^\circ C$
$t_{SC} \geq 5\mu s, T_{J(max)} = 175^\circ C$
$V_{CE(on)} \text{ typ.} = 1.65V$



<b>G</b>	<b>C</b>	<b>E</b>
Gate	Collector	Emitter

### Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	48	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	24	
$I_{CM}$	Pulse Collector Current	96	
$I_{LM}$	Clamped Inductive Load Current ①	96	
$I_F @ T_C = 25^\circ C$	Diode Continuous Forward Current	48	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	24	
$I_{FM}$	Diode Maximum Forward Current ③	96	
$V_{GE}$	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	250	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	125	
$T_J$ $T_{STG}$	Operating Junction and Storage Temperature Range	-55 to +175	°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) TO-220AB	—	—	0.60	°C/W
$R_{\theta JC}$ (Diode)	Thermal Resistance Junction-to-Case-(each Diode) TO-220AB	—	—	1.53	
$R_{\theta JC}$ (IGBT)	Thermal Resistance Junction-to-Case-(each IGBT) TO-247AC	—	—	0.65	
$R_{\theta JC}$ (Diode)	Thermal Resistance Junction-to-Case-(each Diode) TO-247AC	—	—	1.62	
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink (flat, greased surface)	—	0.50	—	
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (typical socket mount)	—	80	—	

**Electrical Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)**

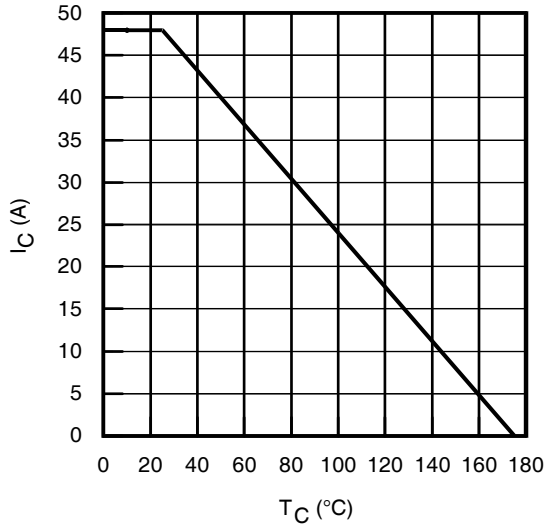
	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig
V <sub>(BR)CES</sub>	Collector-to-Emitter Breakdown Voltage	600	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 100μA ④	CT6
ΔV <sub>(BR)CES</sub> /ΔT <sub>J</sub>	Temperature Coeff. of Breakdown Voltage	—	0.30	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1mA (25°C-175°C)	CT6
V <sub>CE(on)</sub>	Collector-to-Emitter Saturation Voltage	—	1.60	1.95	V	I <sub>C</sub> = 24A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 25°C	5,6,7
		—	2.03	—		I <sub>C</sub> = 24A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 150°C	9,10,11
		—	2.04	—		I <sub>C</sub> = 24A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 175°C	
V <sub>GE(th)</sub>	Gate Threshold Voltage	4.0	—	6.5	V	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 700μA	9, 10,
ΔV <sub>GE(th)</sub> /ΔT <sub>J</sub>	Threshold Voltage temp. coefficient	—	-18	—	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 1.0mA (25°C - 175°C)	11, 12
g <sub>fe</sub>	Forward Transconductance	—	17	—	S	V <sub>CE</sub> = 50V, I <sub>C</sub> = 24A, PW = 80μs	
I <sub>CES</sub>	Collector-to-Emitter Leakage Current	—	2.0	25	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V	
		—	775	—		V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V, T <sub>J</sub> = 175°C	
V <sub>FM</sub>	Diode Forward Voltage Drop	—	1.80	2.6	V	I <sub>F</sub> = 24A	8
		—	1.28	—		I <sub>F</sub> = 24A, T <sub>J</sub> = 175°C	
I <sub>GES</sub>	Gate-to-Emitter Leakage Current	—	—	±100	nA	V <sub>GE</sub> = ±20V	

**Switching Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)**

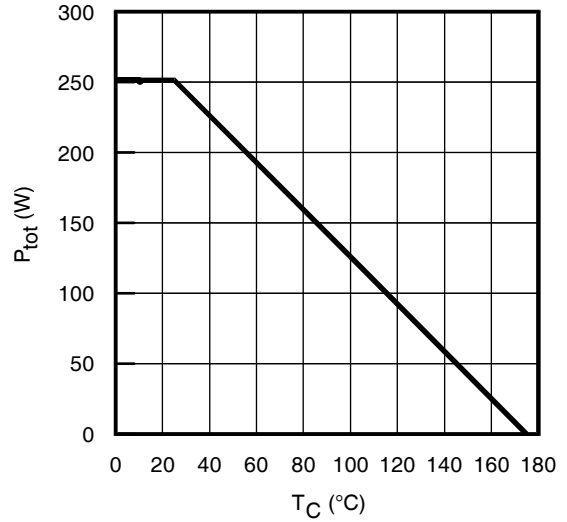
	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig
Q <sub>g</sub>	Total Gate Charge (turn-on)	—	50	75	nC	I <sub>C</sub> = 24A	24
Q <sub>ge</sub>	Gate-to-Emitter Charge (turn-on)	—	13	20		V <sub>GE</sub> = 15V	CT1
Q <sub>gc</sub>	Gate-to-Collector Charge (turn-on)	—	21	31		V <sub>CC</sub> = 400V	
E <sub>on</sub>	Turn-On Switching Loss	—	115	201	μJ	I <sub>C</sub> = 24A, V <sub>CC</sub> = 400V, V <sub>GE</sub> = 15V	CT4
E <sub>off</sub>	Turn-Off Switching Loss	—	600	700		R <sub>G</sub> = 10Ω, L = 200μH, L <sub>S</sub> = 150nH, T <sub>J</sub> = 25°C	
E <sub>total</sub>	Total Switching Loss	—	715	901		Energy losses include tail & diode reverse recovery	
t <sub>d(on)</sub>	Turn-On delay time	—	41	53	ns	I <sub>C</sub> = 24A, V <sub>CC</sub> = 400V, V <sub>GE</sub> = 15V	CT4
t <sub>r</sub>	Rise time	—	22	31		R <sub>G</sub> = 10Ω, L = 200μH, L <sub>S</sub> = 150nH, T <sub>J</sub> = 25°C	
t <sub>d(off)</sub>	Turn-Off delay time	—	104	115			
t <sub>f</sub>	Fall time	—	29	41			
E <sub>on</sub>	Turn-On Switching Loss	—	420	—	μJ	I <sub>C</sub> = 24A, V <sub>CC</sub> = 400V, V <sub>GE</sub> = 15V	13, 15
E <sub>off</sub>	Turn-Off Switching Loss	—	840	—		R <sub>G</sub> = 10Ω, L = 100μH, L <sub>S</sub> = 150nH, T <sub>J</sub> = 175°C ④	CT4
E <sub>total</sub>	Total Switching Loss	—	1260	—		Energy losses include tail & diode reverse recovery	WF1, WF2
t <sub>d(on)</sub>	Turn-On delay time	—	40	—	ns	I <sub>C</sub> = 24A, V <sub>CC</sub> = 400V, V <sub>GE</sub> = 15V	14, 16
t <sub>r</sub>	Rise time	—	24	—		R <sub>G</sub> = 10Ω, L = 200μH, L <sub>S</sub> = 150nH	CT4
t <sub>d(off)</sub>	Turn-Off delay time	—	125	—		T <sub>J</sub> = 175°C	WF1
t <sub>f</sub>	Fall time	—	39	—			WF2
C <sub>ies</sub>	Input Capacitance	—	1490	—	pF	V <sub>GE</sub> = 0V	23
C <sub>oes</sub>	Output Capacitance	—	129	—		V <sub>CC</sub> = 30V	
C <sub>res</sub>	Reverse Transfer Capacitance	—	45	—		f = 1.0Mhz	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T <sub>J</sub> = 175°C, I <sub>C</sub> = 96A V <sub>CC</sub> = 480V, V <sub>p</sub> = 600V R <sub>G</sub> = 10Ω, V <sub>GE</sub> = +15V to 0V	4 CT2
SCSOA	Short Circuit Safe Operating Area	5	—	—	μs	V <sub>CC</sub> = 400V, V <sub>p</sub> = 600V R <sub>G</sub> = 10Ω, V <sub>GE</sub> = +15V to 0V	22, CT3 WF4
E <sub>rec</sub>	Reverse Recovery Energy of the Diode	—	621	—	μJ	T <sub>J</sub> = 175°C	17, 18, 19
t <sub>rr</sub>	Diode Reverse Recovery Time	—	89	—	ns	V <sub>CC</sub> = 400V, I <sub>F</sub> = 24A	20, 21
I <sub>rr</sub>	Peak Reverse Recovery Current	—	37	—	A	V <sub>GE</sub> = 15V, R <sub>G</sub> = 10Ω, L = 200μH, L <sub>S</sub> = 150nH	WF3

**Notes:**

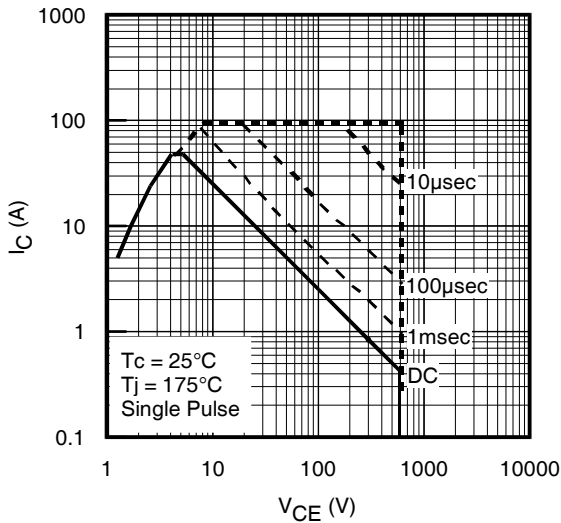
- ① V<sub>CC</sub> = 80% (V<sub>CES</sub>), V<sub>GE</sub> = 20V, L = 100μH, R<sub>G</sub> = 10Ω.
- ② This is only applied to TO-220AB package.
- ③ Pulse width limited by max. junction temperature.
- ④ Refer to AN-1086 for guidelines for measuring V<sub>(BR)CES</sub> safely.



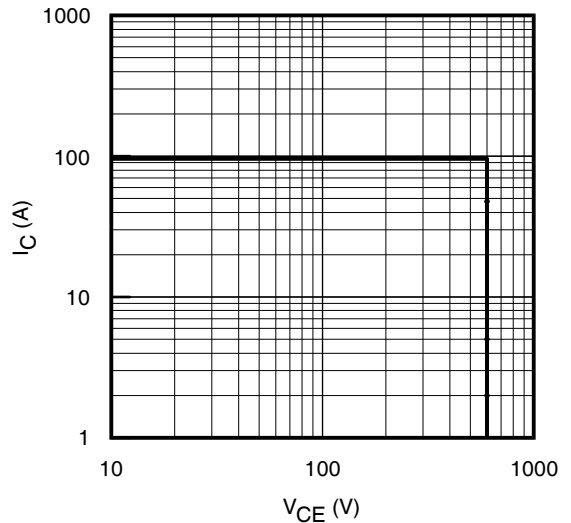
**Fig. 1** - Maximum DC Collector Current vs. Case Temperature



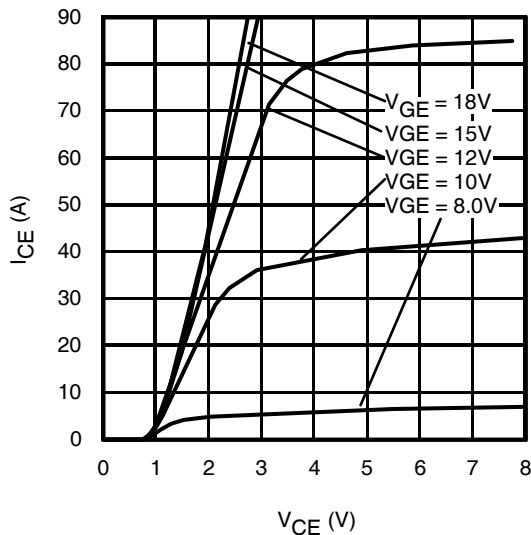
**Fig. 2** - Power Dissipation vs. Case Temperature



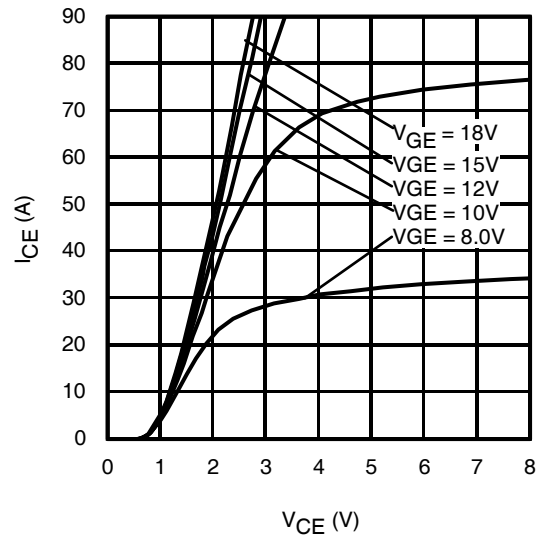
**Fig. 3** - Forward SOA  
 $T_C = 25^{\circ}C$ ,  $T_J \leq 175^{\circ}C$ ;  $V_{GE} = 15V$



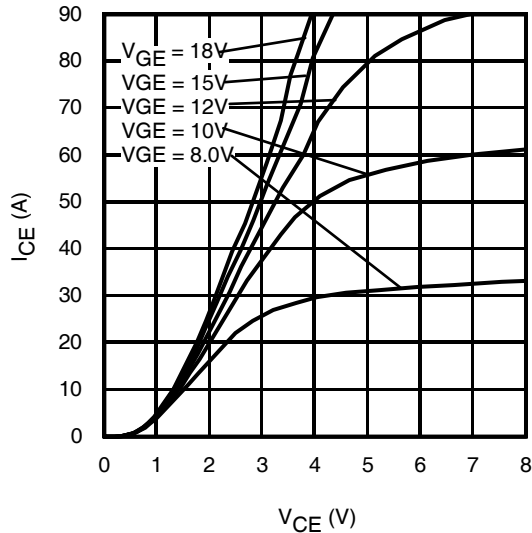
**Fig. 4** - Reverse Bias SOA  
 $T_J = 175^{\circ}C$ ;  $V_{GE} = 15V$



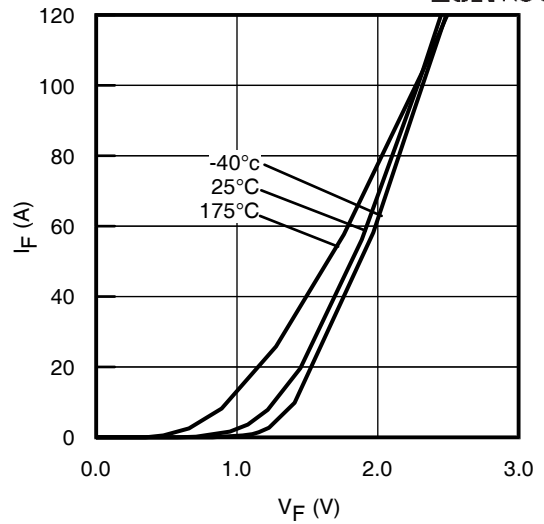
**Fig. 5** - Typ. IGBT Output Characteristics  
 $T_J = -40^{\circ}C$ ;  $t_p = 80\mu s$



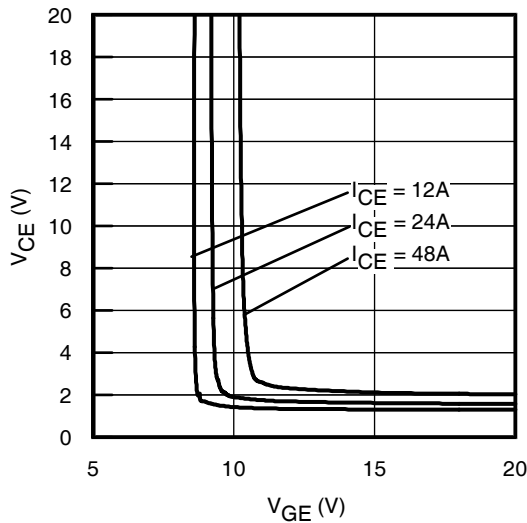
**Fig. 6** - Typ. IGBT Output Characteristics  
 $T_J = 25^{\circ}C$ ;  $t_p = 80\mu s$



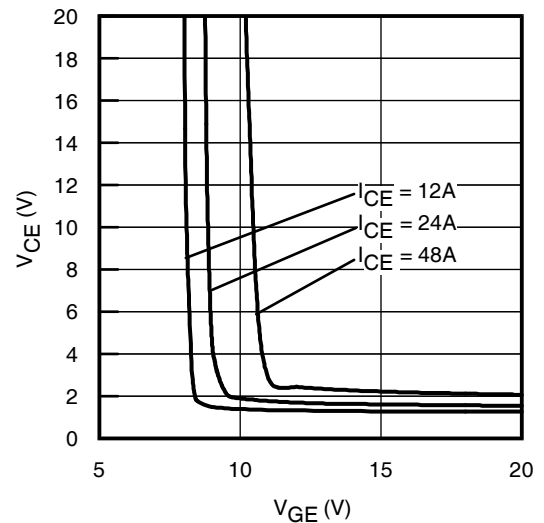
**Fig. 7** - Typ. IGBT Output Characteristics  
 $T_J = 175^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$



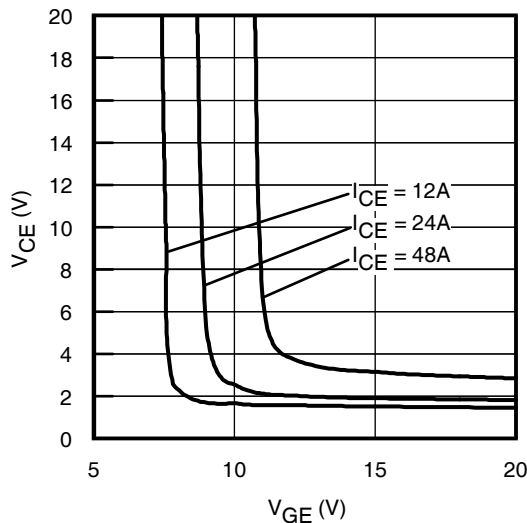
**Fig. 8** - Typ. Diode Forward Characteristics  
 $t_p = 80\mu\text{s}$



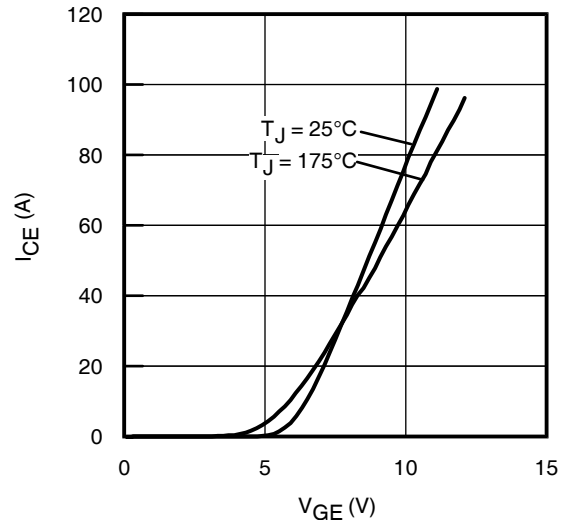
**Fig. 9** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = -40^\circ\text{C}$



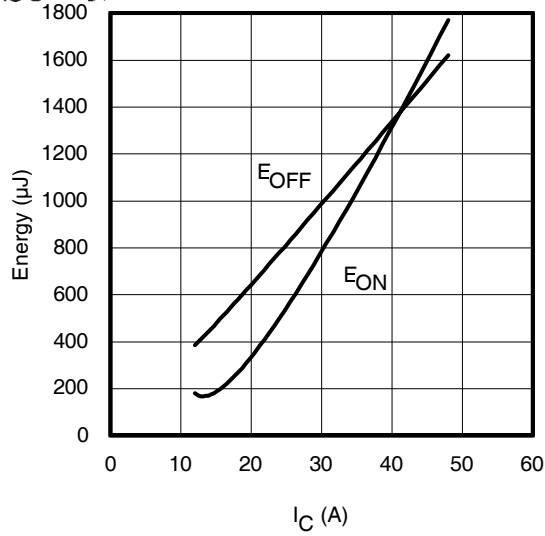
**Fig. 10** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 25^\circ\text{C}$



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

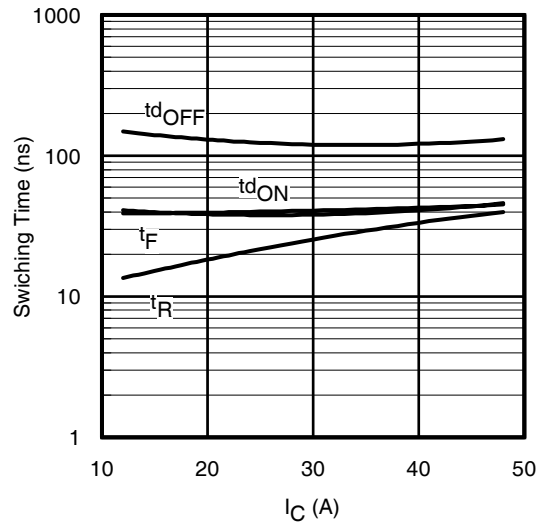


**Fig. 12** - Typ. Transfer Characteristics  
 $V_{CE} = 50\text{V}$ ;  $t_p = 10\mu\text{s}$



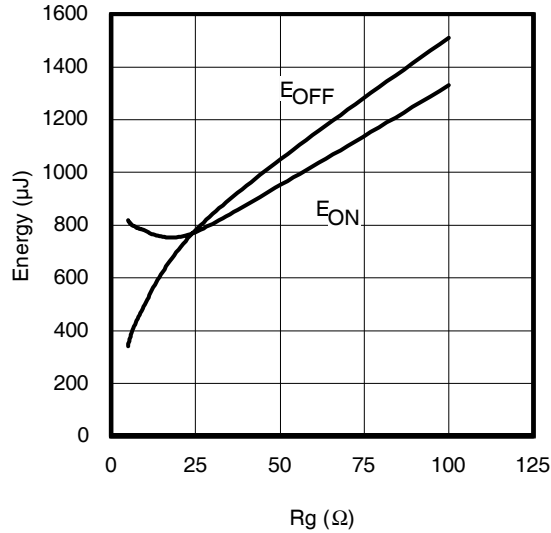
**Fig. 13** - Typ. Energy Loss vs.  $I_C$

$T_J = 175^\circ\text{C}$ ;  $L = 200\mu\text{H}$ ;  $V_{CE} = 400\text{V}$ ,  $R_G = 10\Omega$ ;  $V_{GE} = 15\text{V}$



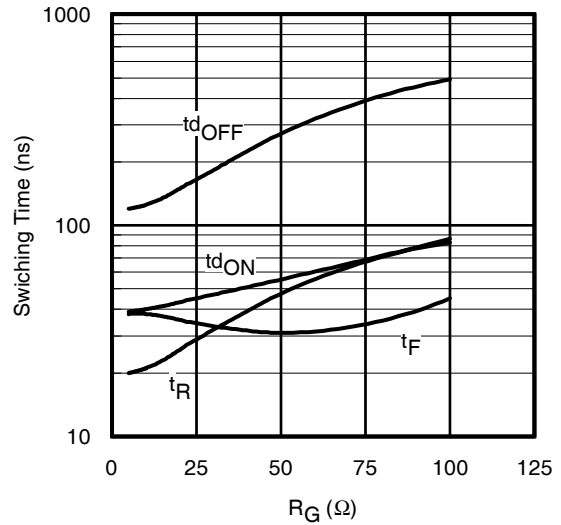
**Fig. 14** - Typ. Switching Time vs.  $I_C$

$T_J = 175^\circ\text{C}$ ;  $L = 200\mu\text{H}$ ;  $V_{CE} = 400\text{V}$ ,  $R_G = 10\Omega$ ;  $V_{GE} = 15\text{V}$



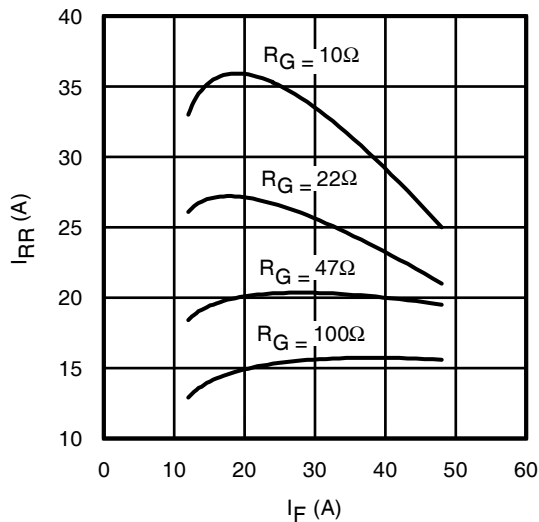
**Fig. 15** - Typ. Energy Loss vs.  $R_G$

$T_J = 175^\circ\text{C}$ ;  $L = 200\mu\text{H}$ ;  $V_{CE} = 400\text{V}$ ,  $I_{CE} = 24\text{A}$ ;  $V_{GE} = 15\text{V}$



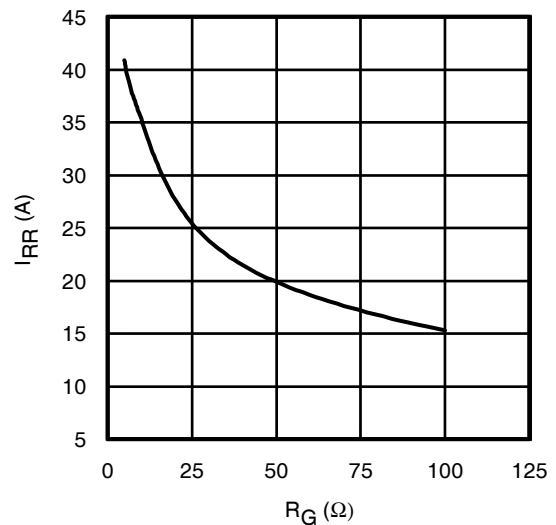
**Fig. 16** - Typ. Switching Time vs.  $R_G$

$T_J = 175^\circ\text{C}$ ;  $L = 200\mu\text{H}$ ;  $V_{CE} = 400\text{V}$ ,  $I_{CE} = 24\text{A}$ ;  $V_{GE} = 15\text{V}$



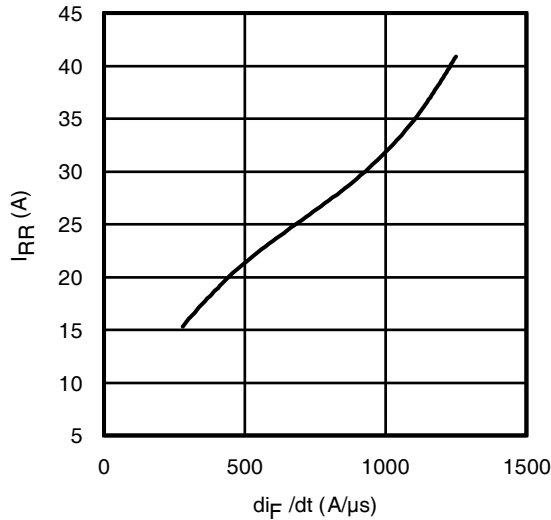
**Fig. 17** - Typ. Diode  $I_{RR}$  vs.  $I_F$

$T_J = 175^\circ\text{C}$

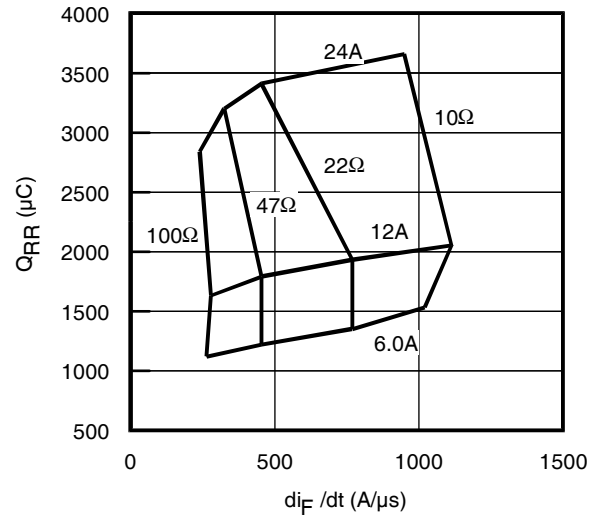


**Fig. 18** - Typ. Diode  $I_{RR}$  vs.  $R_G$

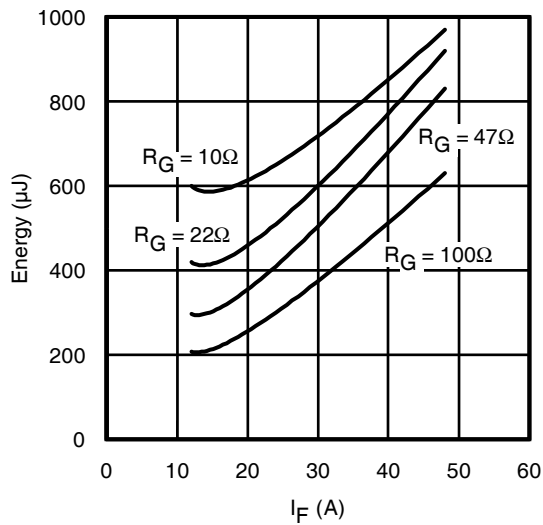
$T_J = 175^\circ\text{C}$



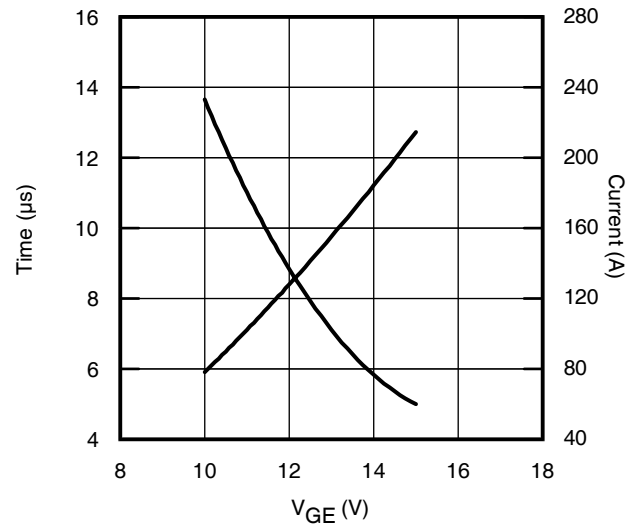
**Fig. 19** - Typ. Diode  $I_{RR}$  vs.  $di_F/dt$   
 $V_{CC} = 400V$ ;  $V_{GE} = 15V$ ;  $I_F = 24A$ ;  $T_J = 175^\circ C$



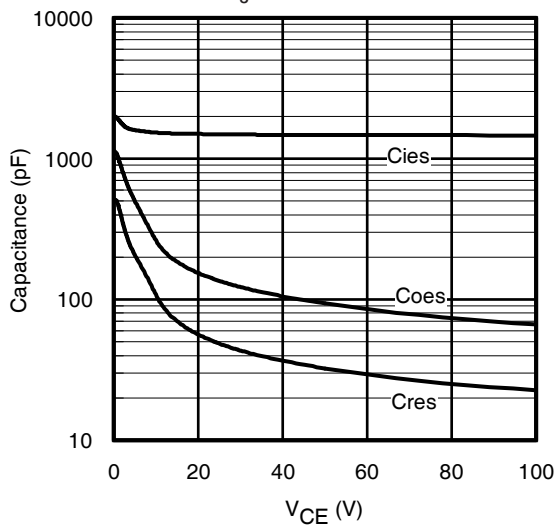
**Fig. 20** - Typ. Diode  $Q_{RR}$  vs.  $di_F/dt$   
 $V_{CC} = 400V$ ;  $V_{GE} = 15V$ ;  $T_J = 175^\circ C$



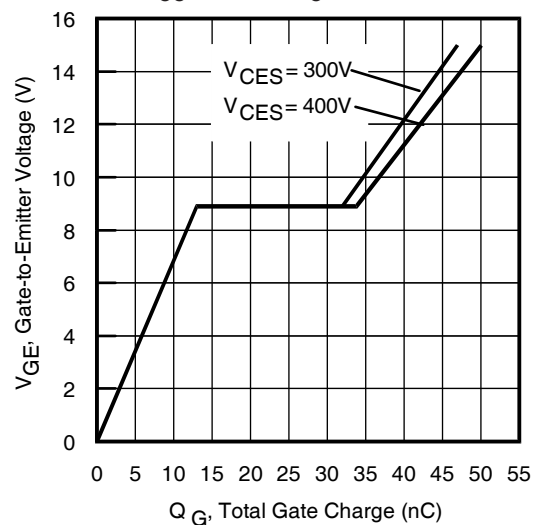
**Fig. 21** - Typ. Diode  $E_{RR}$  vs.  $I_F$   
 $T_J = 175^\circ C$



**Fig. 22** -  $V_{GE}$  vs. Short Circuit Time  
 $V_{CC} = 400V$ ;  $T_C = 25^\circ C$



**Fig. 23** - Typ. Capacitance vs.  $V_{CE}$   
 $V_{GE} = 0V$ ;  $f = 1MHz$



**Fig. 24** - Typical Gate Charge vs.  $V_{GE}$   
 $I_{CE} = 24A$ ;  $L = 600\mu H$

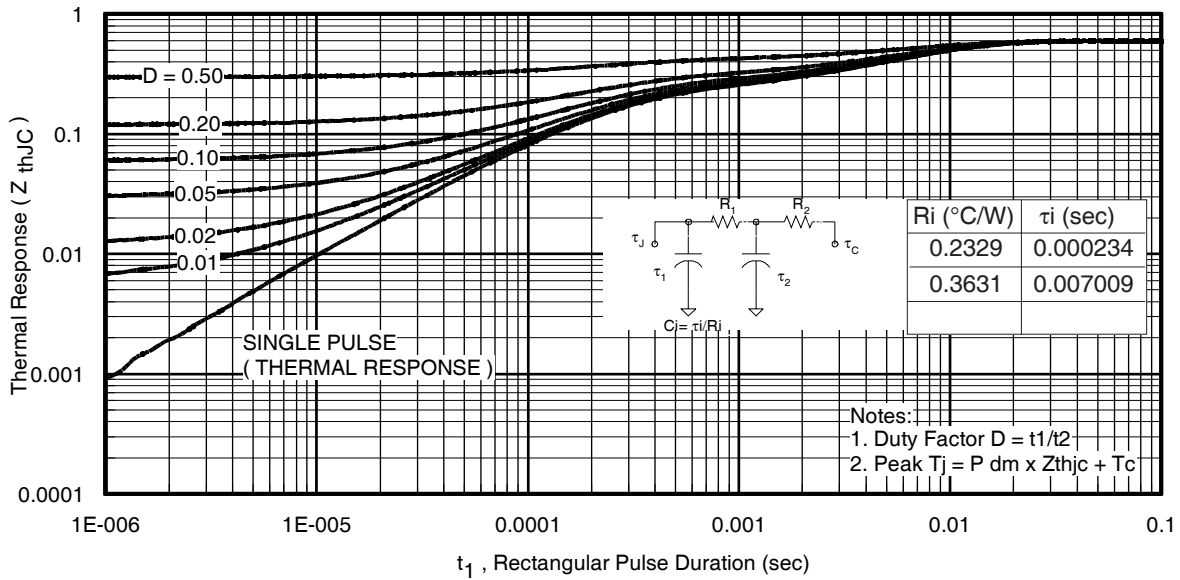


Fig 23. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT) TO-220AB

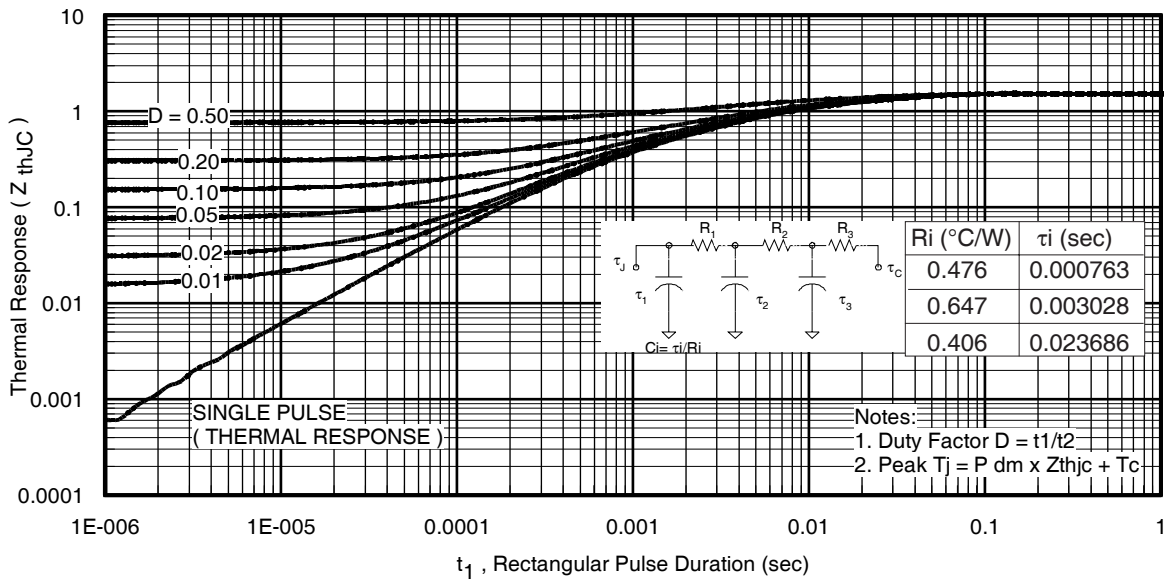


Fig. 24. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE) TO-220AB

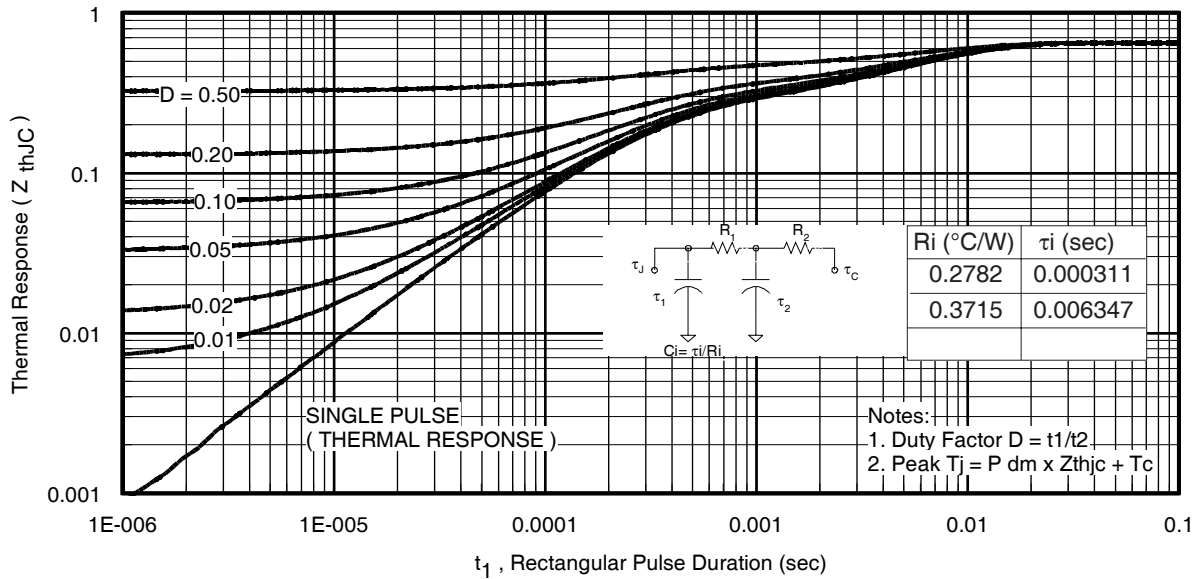


Fig 23. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT) TO-247AC

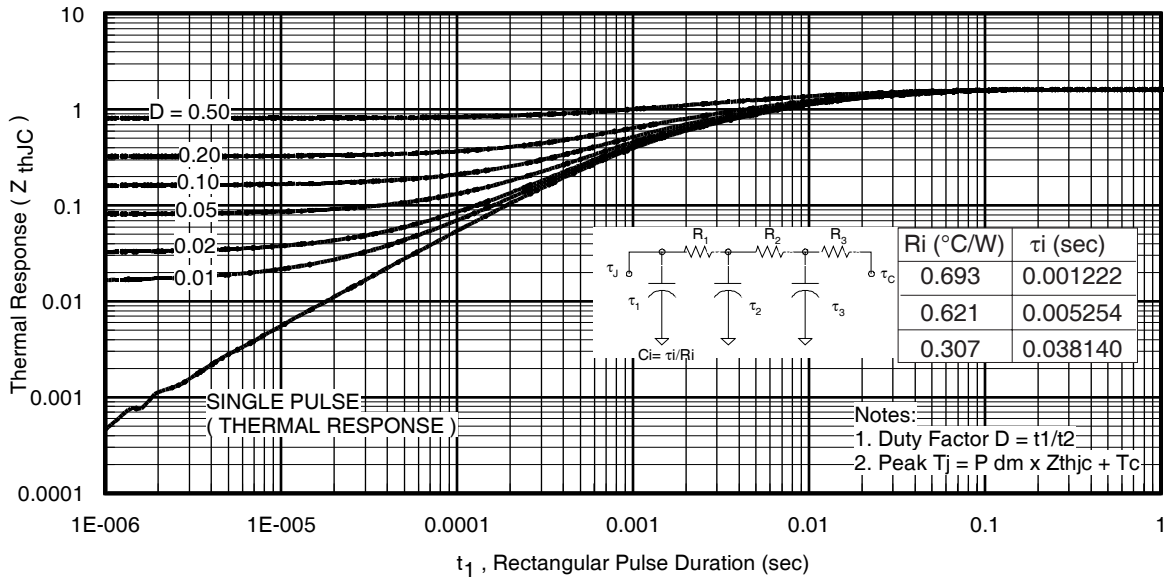


Fig. 24. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE) TO-247AC



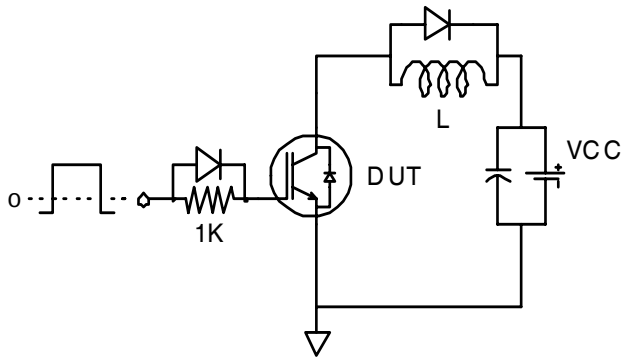


Fig.C.T.1 - Gate Charge Circuit (turn-off)

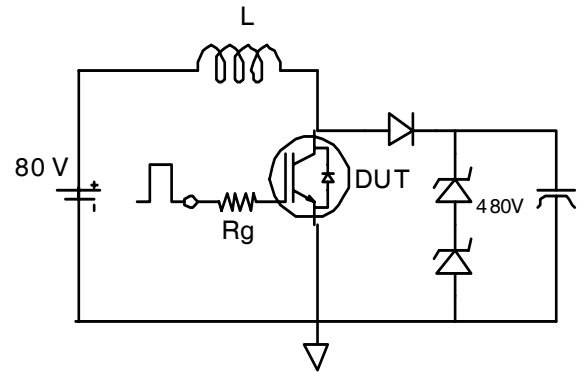


Fig.C.T.2 - RBSOA Circuit

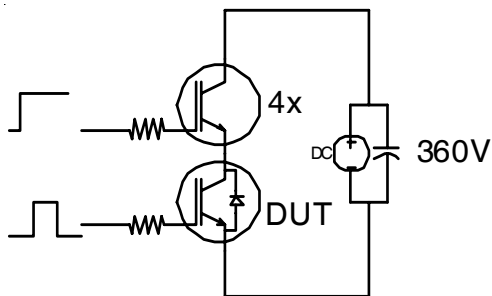


Fig.C.T.3 - S.C. SOA Circuit

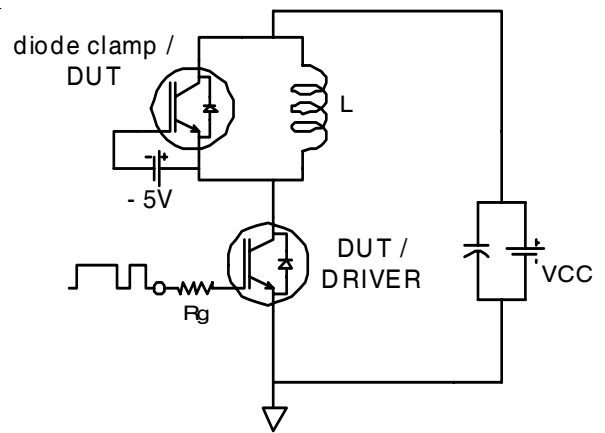


Fig.C.T.4 - Switching Loss Circuit

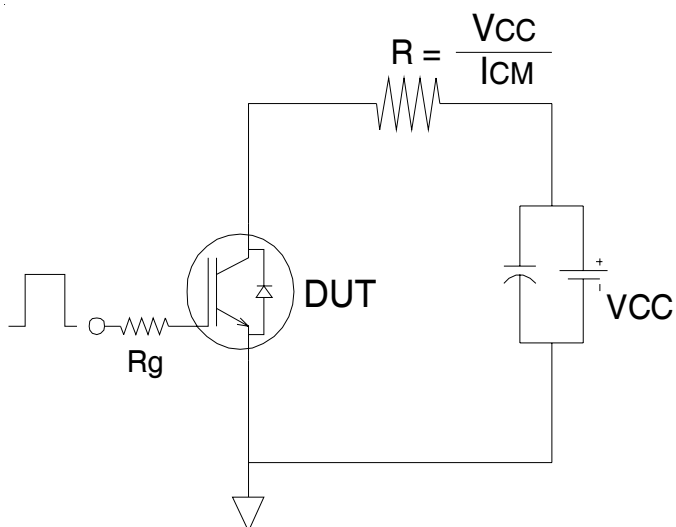


Fig.C.T.5 - Resistive Load Circuit

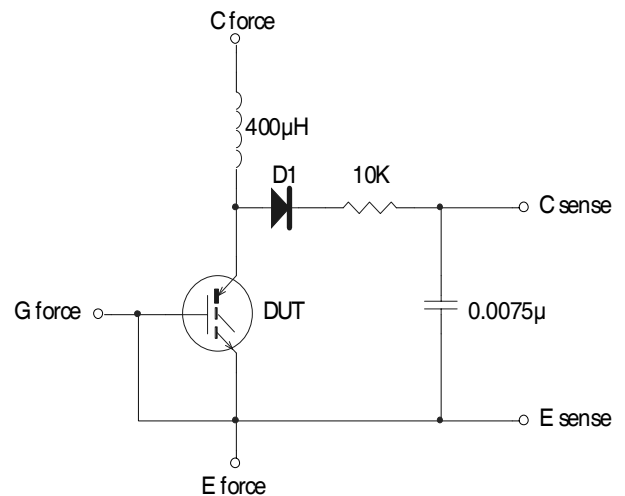
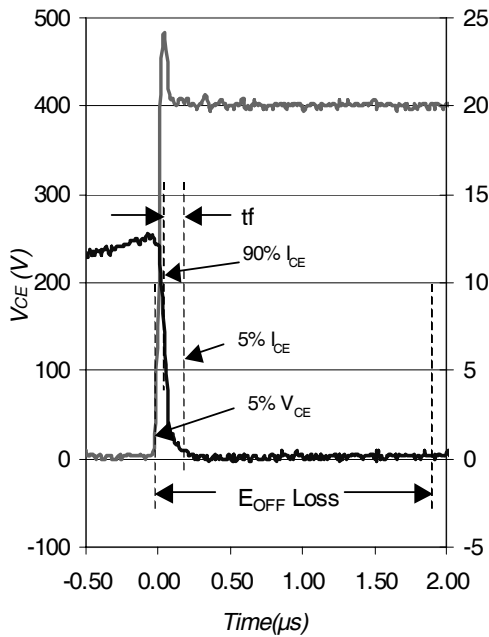
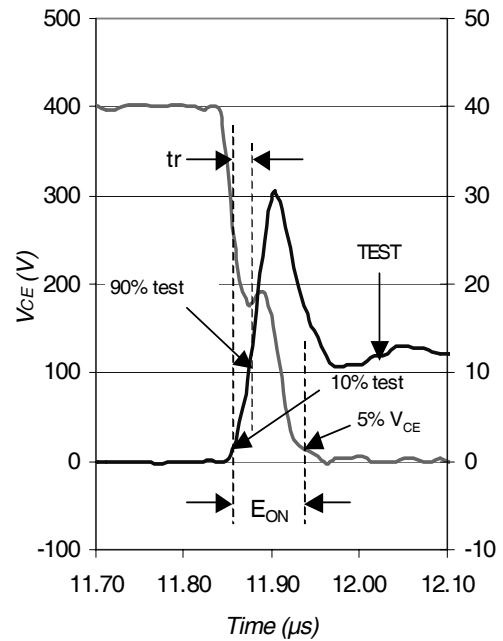


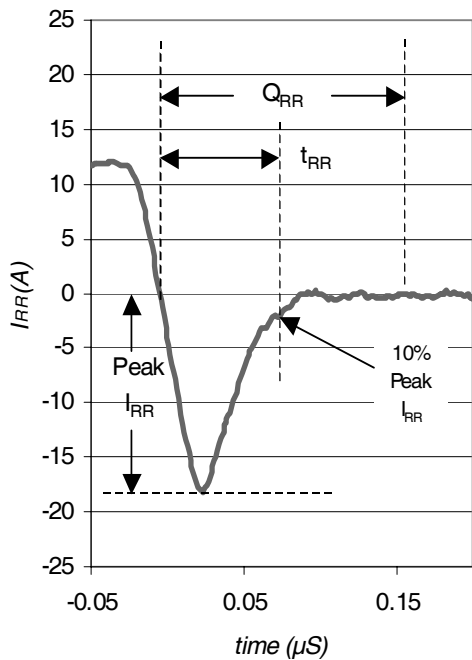
Fig.C.T.6 - BVCES Filter Circuit



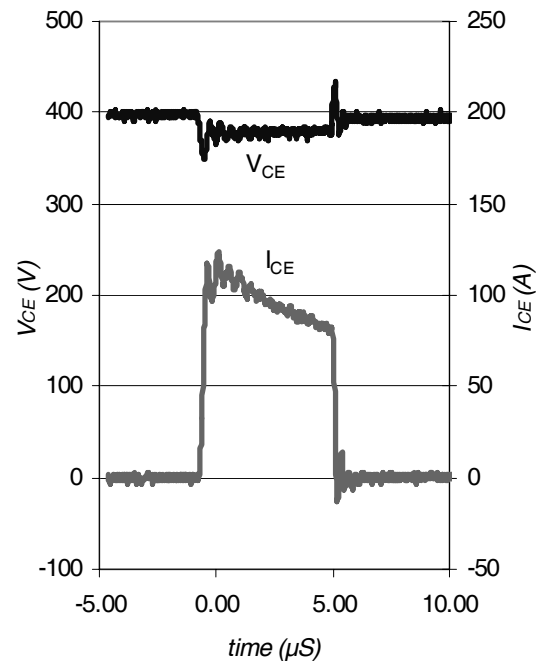
**Fig. WF1** - Typ. Turn-off Loss Waveform  
@  $T_J = 175^\circ\text{C}$  using Fig. CT.4



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



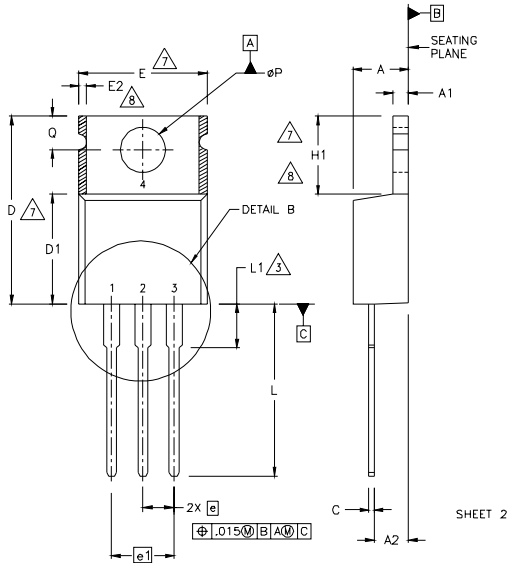
**Fig. WF3** - Typ. Diode Recovery Waveform  
@  $T_J = 175^\circ\text{C}$  using Fig. CT.4



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

**TO-220AB Package Outline**

Dimensions are shown in millimeters (inches)



- NOTES:
- 1 DIMENSIONING AND TOLERANCING PER ASME Y14.5 M- 1994.
  - 2 DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
  - 3 LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
  - 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 DIMENSION b1 & c1 APPLY TO BASE METAL ONLY.
  - 6 CONTROLLING DIMENSION : INCHES.
  - 7 THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E,H1,D2 & E1
  - 8 DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED.

**LEAD ASSIGNMENTS**

**HEXFET**

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

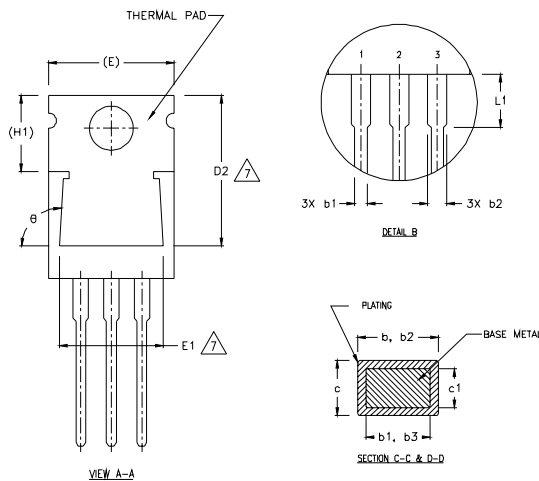
**IGBTs, CoPACK**

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

**DIODES**

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

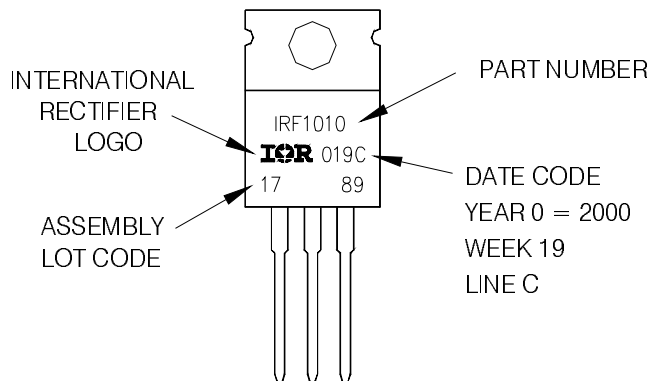
SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	3.56	4.82	.140	.190	
A1	0.51	1.40	.020	.055	
A2	2.04	2.92	.080	.115	
b	0.38	1.01	.015	.040	
b1	0.38	0.96	.015	.038	5
b2	1.15	1.77	.045	.070	
b3	1.15	1.73	.045	.068	
c	0.36	0.61	.014	.024	
c1	0.36	0.56	.014	.022	5
D	14.22	16.51	.560	.650	4
D1	8.38	9.02	.330	.355	
D2	12.19	12.88	.480	.507	7
E	9.66	10.66	.380	.420	4,7
E1	8.38	8.89	.330	.350	7
e	2.54 BSC		.100 BSC		
e1	5.08		.200 BSC		
H1	5.85	6.55	.230	.270	7,8
L	12.70	14.73	.500	.580	
L1	-	6.35	-	.250	3
øP	3.54	4.08	.139	.161	
Q	2.54	3.42	.100	.135	
ø	90°-93°		90°-93°		



**TO-220AB Part Marking Information**

EXAMPLE: THIS IS AN IRF1010  
LOT CODE 1789  
ASSEMBLED ON WW 19, 2000  
IN THE ASSEMBLY LINE "C"

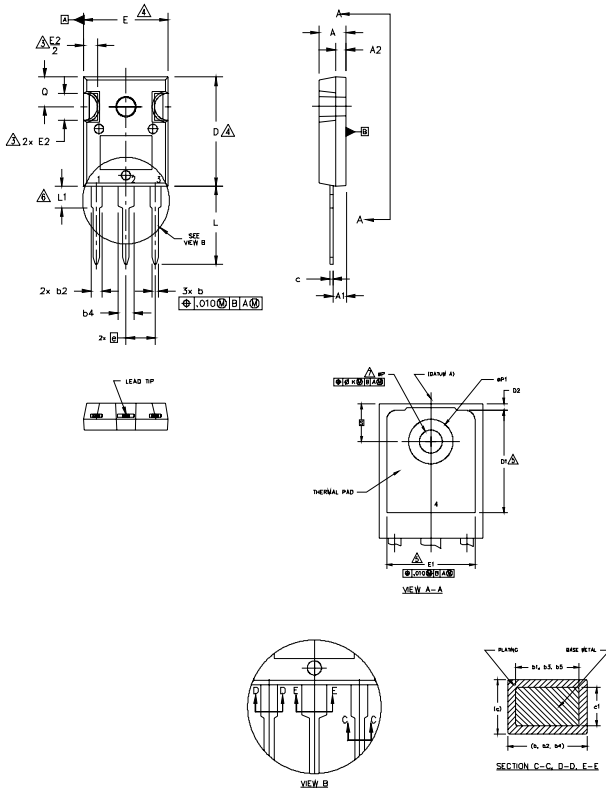
Note: "P" in assembly line position indicates "Lead - Free"



**TO-220AB package is not recommended for Surface Mount Application.**

## 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

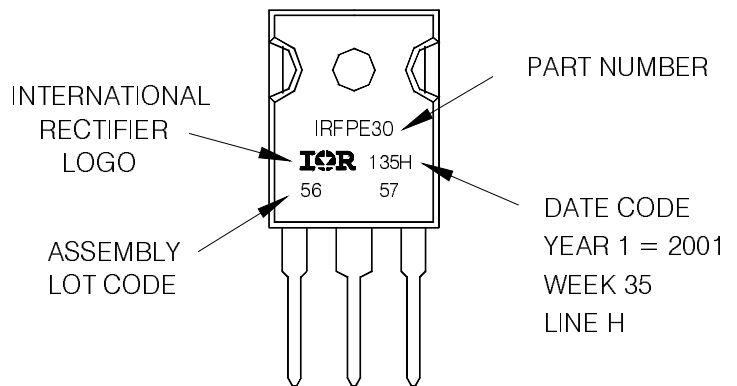
**DIODES**

- 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.**

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.