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[International Rectifier \(Infineon Technologies Americas Corp.\)  
IRGI4061DPBF](#)

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# International IOR Rectifier

## IRGI4061DPbF

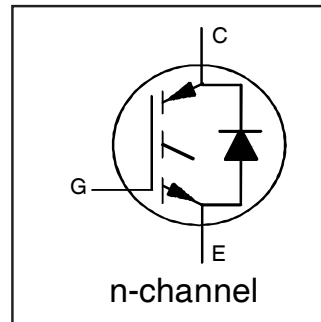
INSULATED GATE BIPOLAR TRANSISTOR WITH  
 ULTRAFAST SOFT RECOVERY DIODE

### Features

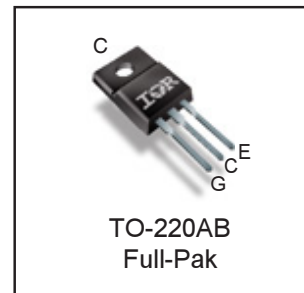
- Low  $V_{CE(on)}$  Trench IGBT Technology
- Low Switching Losses
- 5 $\mu$ s SCSOA
- Square RBSOA
- 100% of The Parts Tested for  $I_{LM}$
- Positive  $V_{CE(on)}$  Temperature Coefficient.
- Ultra Fast Soft Recovery Co-pak Diode
- Tighter Distribution of Parameters
- Lead-Free Package

### 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



$V_{CES} = 600V$
$I_C = 11A, T_C = 100^\circ C$
$t_{sc} > 5\mu s, T_{jmax} = 150^\circ C$
$V_{CE(on) typ.} = 1.35V$



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

### Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Breakdown Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	20	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	11	
$I_{CM}$	Pulsed Collector Current	40	
$I_{LM}$	Clamped Inductive Load Current ①	40	
$I_F @ T_C = 25^\circ C$	Diode Continuous Forward Current	20	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	11	
$I_{FM}$	Diode Maximum Forward Current ②	40	
$V_{GE}$	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	43	W
		$P_D @ T_C = 100^\circ C$	
$T_J$ $T_{STG}$	Operating Junction and Storage Temperature Range	-55 to + 150	$^\circ C$
	Soldering Temperature, for 10 seconds	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
$R_{\theta JC}$	Junction-to-Case - IGBT ③	—	—	2.90	$^\circ C/W$
$R_{\theta JC}$	Junction-to-Case - Diode ③	—	—	4.60	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	—	0.5	—	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount ③	—	—	65	
Wt	Weight	—	2.0	—	g

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

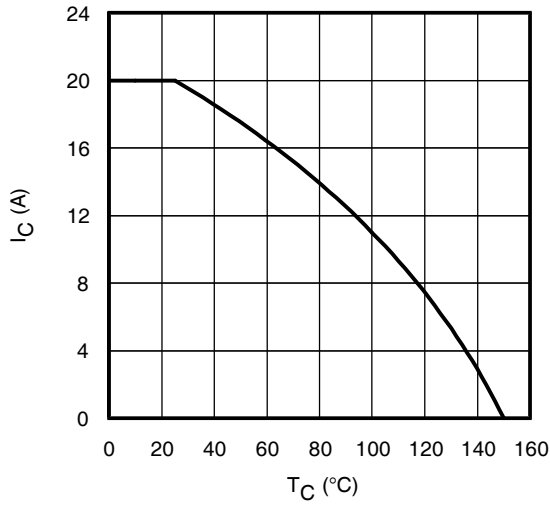
	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	$V_{GE} = 0V, I_C = 100 \mu A$ ④
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.75	—	V/°C	$V_{GE} = 0V, I_C = 250 \mu A$ (-55 -150 °C) ④
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.35	1.59	V	$I_C = 11A, V_{GE} = 15V, T_J = 25^\circ\text{C}$
		—	1.53	—		$I_C = 11A, V_{GE} = 15V, T_J = 125^\circ\text{C}$
		—	1.58	—		$I_C = 11A, V_{GE} = 15V, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	$V_{CE} = V_{GE}, I_C = 500 \mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-15	—	mV/°C	$V_{CE} = V_{GE}, I_C = 1.0mA$ (25 -150 °C)
$g_{fe}$	Forward Transconductance	—	11	—	S	$V_{CE} = 50V, I_C = 11A, PW = 80\mu s$
$I_{CES}$	Collector-to-Emitter Leakage Current	—	2.0	25	$\mu A$	$V_{GE} = 0V, V_{CE} = 600V$
		—	550	—	$\mu A$	$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$
$V_{FM}$	Diode Forward Voltage Drop	—	2.20	2.6	V	$I_F = 11A$
		—	1.33	—		$I_F = 11A, T_J = 150^\circ\text{C}$
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{GE} = \pm 20 V$

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

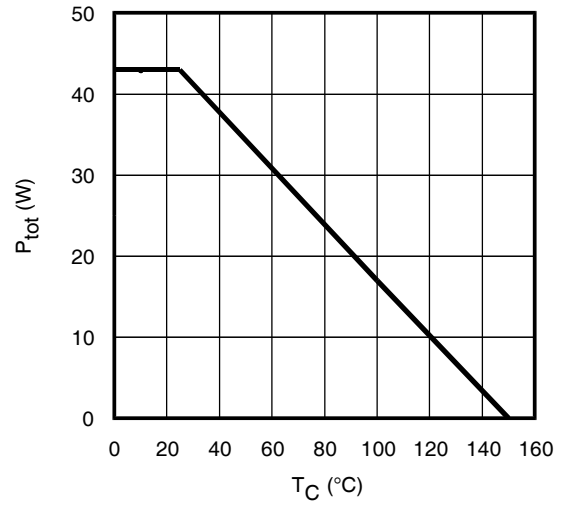
	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge (turn-on)	—	35	53	nC	$I_C = 11A$
$Q_{ge}$	Gate-to-Emitter Charge (turn-on)	—	8.0	12		$V_{CC} = 400V$
$Q_{gc}$	Gate-to-Collector Charge (turn-on)	—	13	23		$V_{GE} = 15V$
$E_{on}$	Turn-On Switching Loss	—	52	95	$\mu J$	$I_C = 11A, V_{CC} = 400V, V_{GE} = 15V$
$E_{off}$	Turn-Off Switching Loss	—	231	340		$R_G = 22\Omega, L = 1mH, L_S = 150nH, T_J = 25^\circ\text{C}$
$E_{total}$	Total Switching Loss	—	283	435		Energy losses include tail and diode reverse recovery
$t_{d(on)}$	Turn-On delay time	—	37	46	ns	$I_C = 11A, V_{CC} = 400V$
$t_r$	Rise time	—	18	26		$R_G = 22\Omega, L = 1mH, L_S = 150nH$
$t_{d(off)}$	Turn-Off delay time	—	111	129		$T_J = 25^\circ\text{C}$
$t_f$	Fall time	—	30	41		
$E_{on}$	Turn-On Switching Loss	—	143	—	$\mu J$	$I_C = 11A, V_{CC} = 400V, V_{GE} = 15V$
$E_{off}$	Turn-Off Switching Loss	—	316	—		$R_G = 22\Omega, L = 1mH, L_S = 150nH, T_J = 150^\circ\text{C}$
$E_{total}$	Total Switching Loss	—	459	—		Energy losses include tail and diode reverse recovery
$t_{d(on)}$	Turn-On delay time	—	35	—	ns	$I_C = 11A, V_{CC} = 400V$
$t_r$	Rise time	—	19	—		$R_G = 22\Omega, L = 1mH, L_S = 150nH$
$t_{d(off)}$	Turn-Off delay time	—	134	—		$T_J = 150^\circ\text{C}$
$t_f$	Fall time	—	45	—		
$C_{ies}$	Input Capacitance	—	1050	—	pF	$V_{GE} = 0V$
$C_{oes}$	Output Capacitance	—	89	—		$V_{CC} = 30V$
$C_{res}$	Reverse Transfer Capacitance	—	30	—		$f = 1Mhz$
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 150^\circ\text{C}, I_C = 40A$ $V_{CC} = 480V, V_p = 600V$ $R_g = 22\Omega, V_{GE} = +15V$ to 0V
SCSOA	Short Circuit Safe Operating Area	5	—	—	$\mu s$	$V_{CC} = 400V, V_p = 600V$ $R_G = 22\Omega, V_{GE} = +15V$ to 0V
$E_{rec}$	Reverse recovery energy of the diode	—	211	—	$\mu J$	$T_J = 150^\circ\text{C}$
$t_{rr}$	Diode Reverse recovery time	—	60	—	ns	$V_{CC} = 400V, I_F = 11A$
$I_{rr}$	Peak Reverse Recovery Current	—	18	—	A	$V_{GE} = 15V, R_g = 22\Omega, L = 1mH, L_S = 150nH$

## Notes:

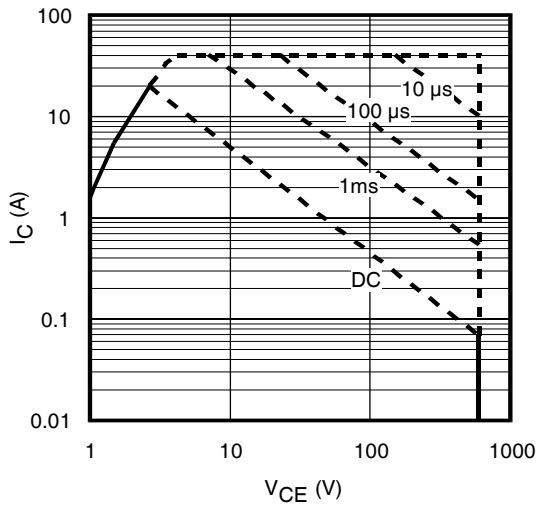
- ①  $V_{CC} = 80\% (V_{CES}), V_{GE} = 15V, L = 28 \mu H, R_G = 22 \Omega$ .
- ② Pulse width limited by max. junction temperature.
- ③  $R_\theta$  is measured at  $T_J$  approximately  $90^\circ\text{C}$
- ④ Refer to AN-1086 for guidelines for measuring  $V_{(BR)CES}$  safely



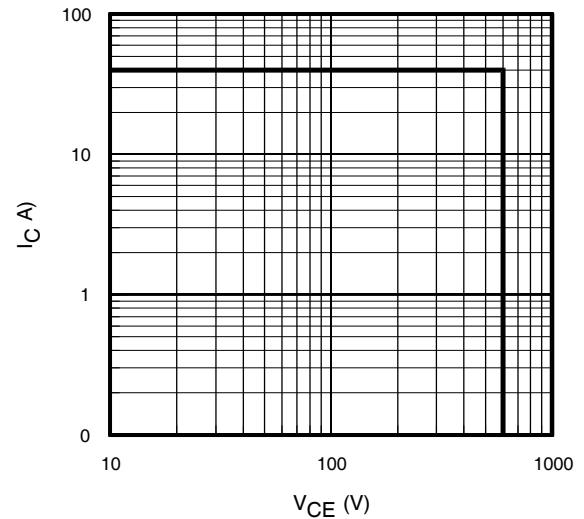
**Fig. 1** - Maximum DC Collector Current vs. Case Temperature



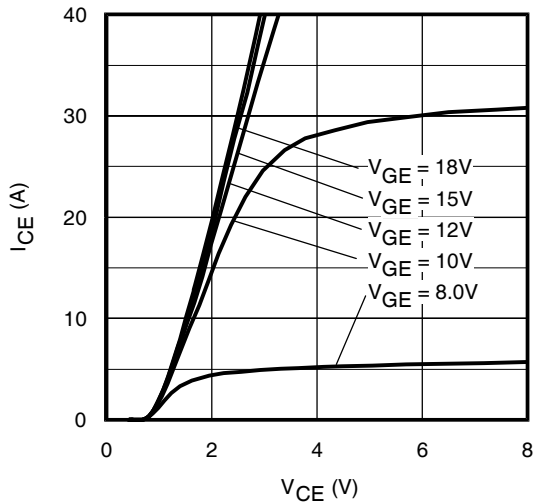
**Fig. 2** - Power Dissipation vs. Case Temperature



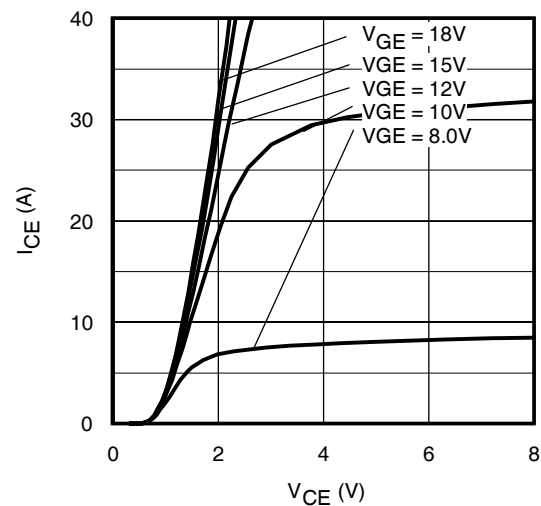
**Fig. 3** - Forward SOA,  
 $T_C = 25^\circ\text{C}; T_J \leq 150^\circ\text{C}$



**Fig. 4** - Reverse Bias SOA  
 $T_J = 150^\circ\text{C}; V_{CE} = 15\text{V}$

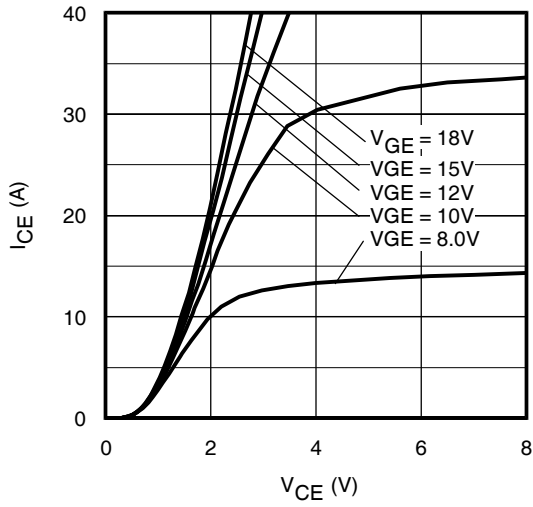


**Fig. 5** - Typ. IGBT Output Characteristics  
 $T_J = -40^\circ\text{C}; t_p < 60\mu\text{s}$

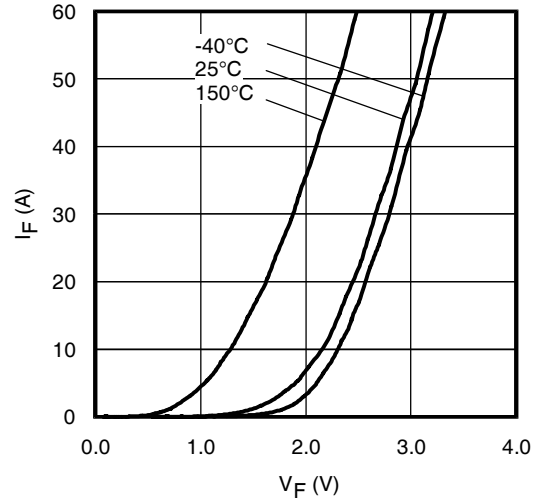


**Fig. 6** - Typ. IGBT Output Characteristics  
 $T_J = 25^\circ\text{C}; t_p < 60\mu\text{s}$

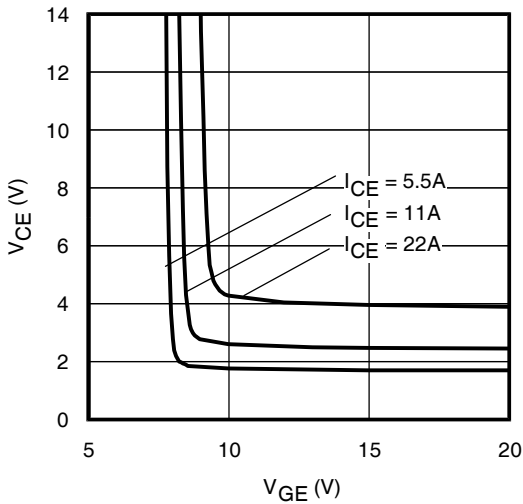
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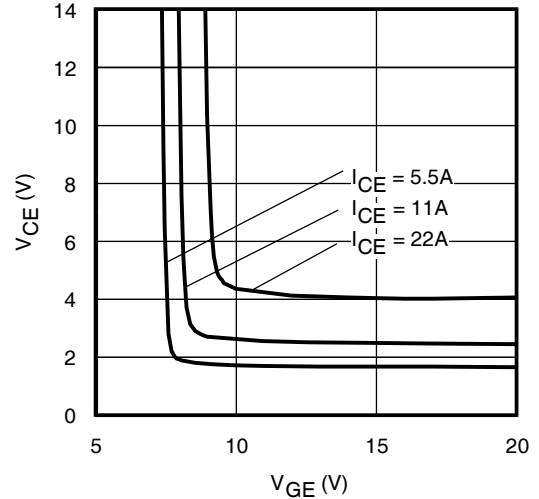
**Fig. 7 - Typ. IGBT Output Characteristics**  
 $T_J = 150^\circ\text{C}$ ;  $t_p < 60\mu\text{s}$



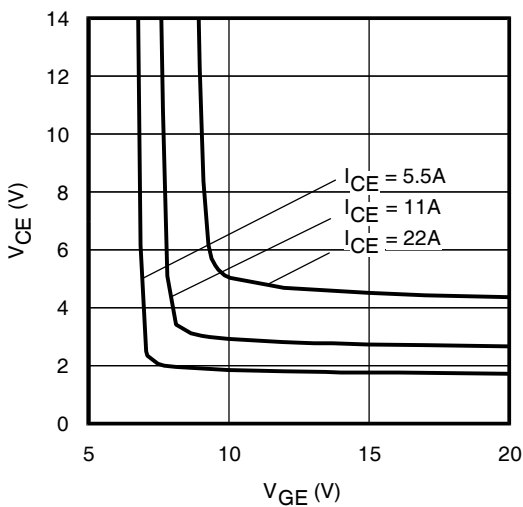
**Fig. 8 - Typ. Diode Forward Characteristics**  
 $t_p < 60\mu\text{s}$



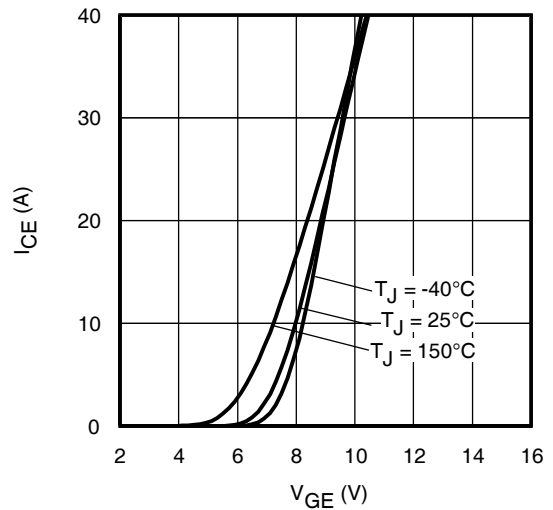
**Fig. 9 - Typical  $V_{CE}$  vs.  $V_{GE}$**   
 $T_J = -40^\circ\text{C}$



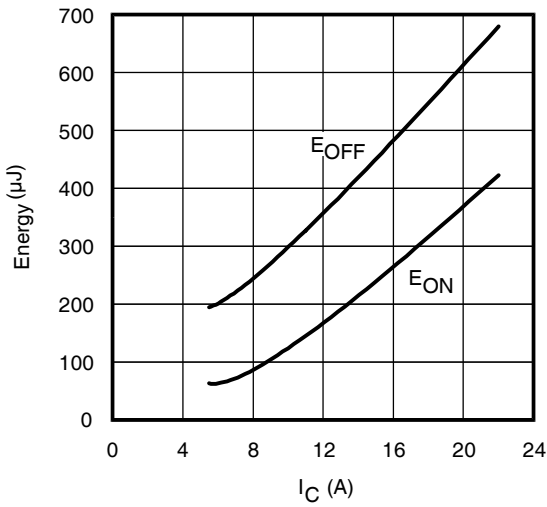
**Fig. 10 - Typical  $V_{CE}$  vs.  $V_{GE}$**   
 $T_J = 25^\circ\text{C}$



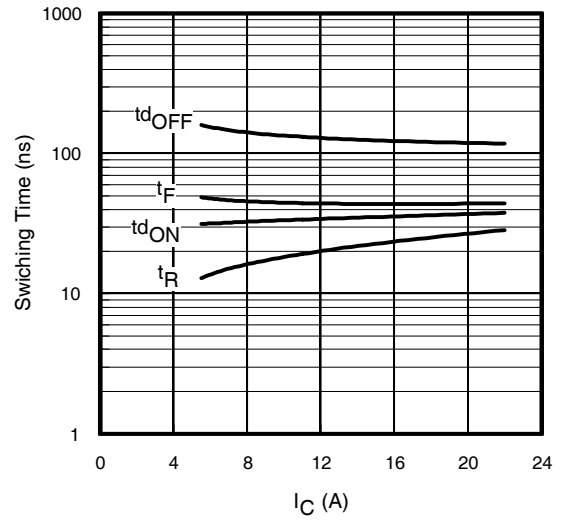
**Fig. 11 - Typical  $V_{CE}$  vs.  $V_{GE}$**   
 $T_J = 150^\circ\text{C}$



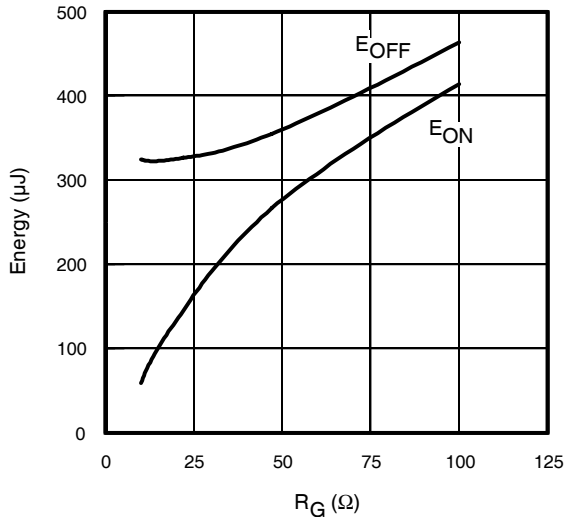
**Fig. 12 - Typ. Transfer Characteristics**  
 $V_{CE} = 50\text{V}$ ;  $t_p < 60\mu\text{s}$



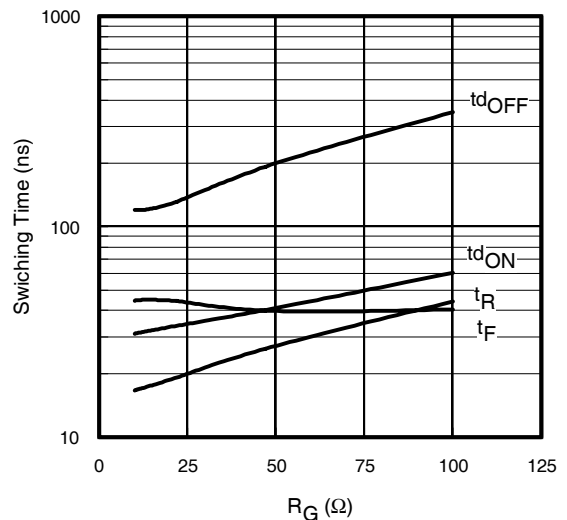
**Fig. 13 - Typ. Energy Loss vs.  $I_C$**   
 $T_J = 150^\circ\text{C}$ ;  $L = 1\text{mH}$ ;  $V_{CE} = 400\text{V}$ ;  $R_G = 22\Omega$ ;  $V_{GE} = 15\text{V}$ .



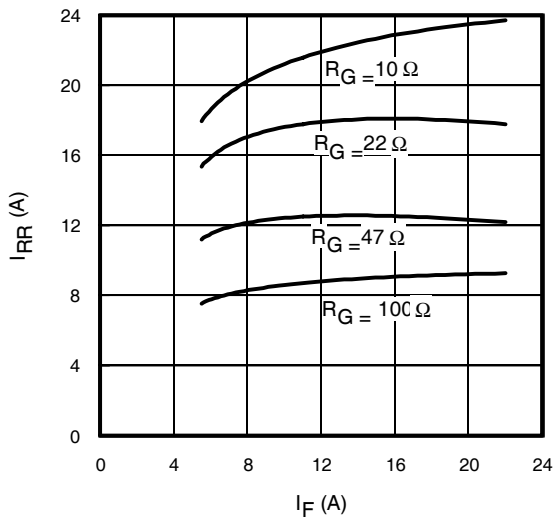
**Fig. 14 - Typ. Switching Time vs.  $I_C$**   
 $T_J = 150^\circ\text{C}$ ;  $L = 1\text{mH}$ ;  $V_{CE} = 400\text{V}$   
 $R_G = 22\Omega$ ;  $V_{GE} = 15\text{V}$



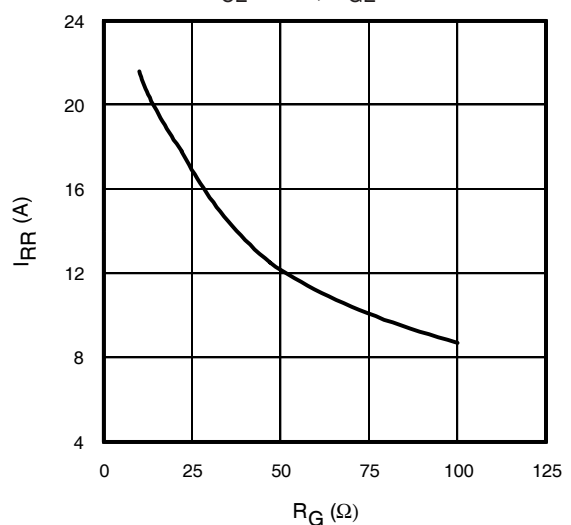
**Fig. 15 - Typ. Energy Loss vs.  $R_G$**   
 $T_J = 150^\circ\text{C}$ ;  $L = 1\text{mH}$ ;  $V_{CE} = 400\text{V}$ ;  $I_{CE} = 11\text{A}$ ;  $V_{GE} = 15\text{V}$



**Fig. 16 - Typ. Switching Time vs.  $R_G$**   
 $T_J = 150^\circ\text{C}$ ;  $L = 1\text{mH}$ ;  $V_{CE} = 400\text{V}$   
 $I_{CE} = 11\text{A}$ ;  $V_{GE} = 15\text{V}$

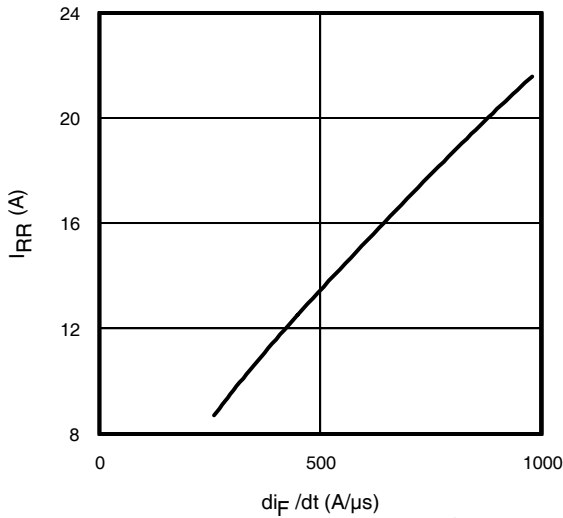


**Fig. 17 - Typical Diode  $I_{RR}$  vs.  $I_F$**   
 $T_J = 150^\circ\text{C}$

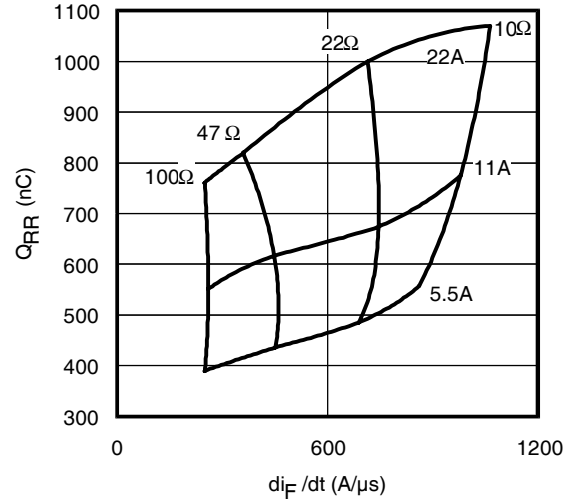


**Fig. 18 - Typical Diode  $I_{RR}$  vs.  $R_G$**   
 $T_J = 150^\circ\text{C}$ ;  $I_F = 11\text{A}$

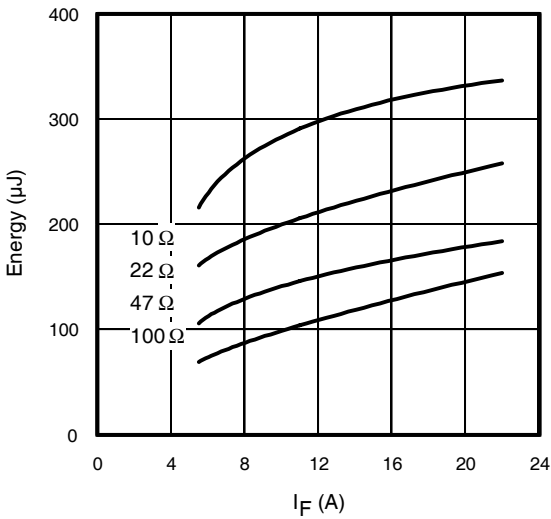
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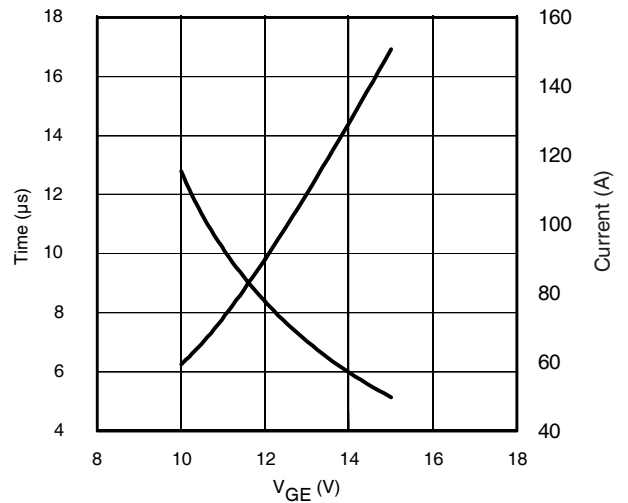
**Fig. 19** - Typical Diode  $I_{RR}$  vs.  $di_F/dt$   
 $V_{CC}=400V$ ;  $V_{GE}=15V$ ;  
 $I_{CE}=11A$ ;  $T_J=150^\circ C$



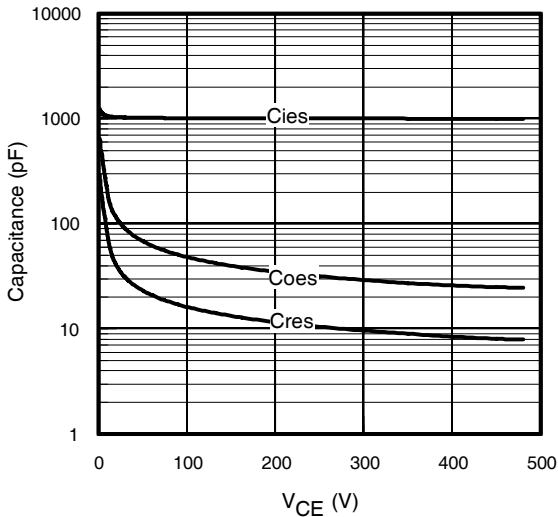
**Fig. 20** - Typical Diode  $Q_{RR}$   
 $V_{CC}=400V$ ;  $V_{GE}=15V$ ;  $T_J=150^\circ C$



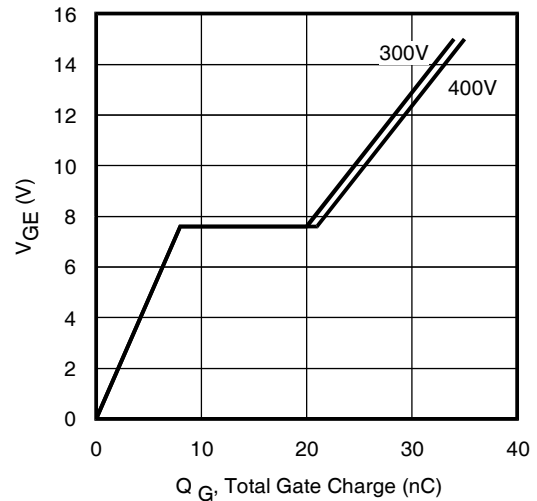
**Fig. 21** - Typical Diode  $E_{RR}$  vs.  $I_F$   
 $T_J=150^\circ C$



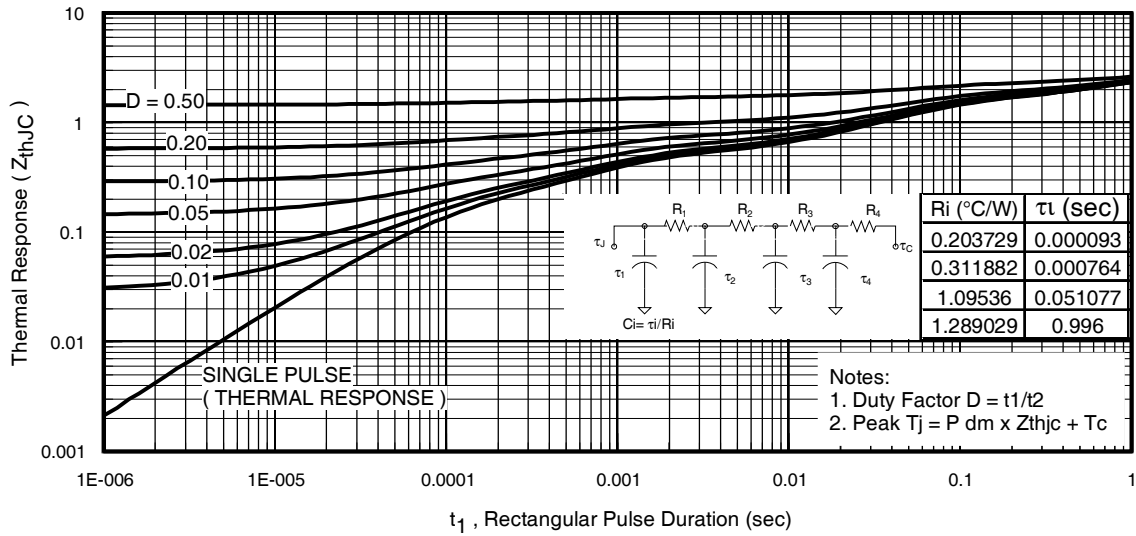
**Fig. 22** - Typ.  $V_{GE}$  vs Short Circuit Time  
 $V_{CC}=400V$ ,  $T_C=25^\circ C$



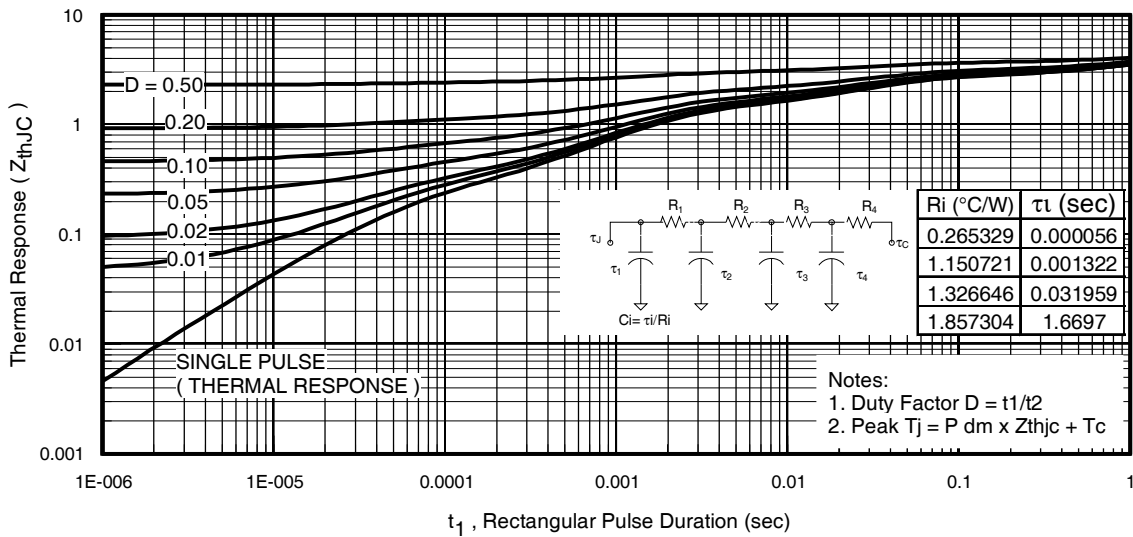
**Fig. 23** - Typ. Capacitance vs.  $V_{CE}$   
 $V_{GE}=0V$ ;  $f=1MHz$



**Fig. 24** - Typical Gate Charge vs.  $V_{GE}$   
 $I_{CE}=11A$ ,  $L=600\mu H$



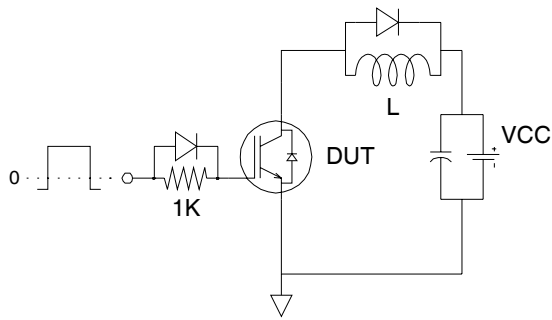
**Fig 25.** Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)



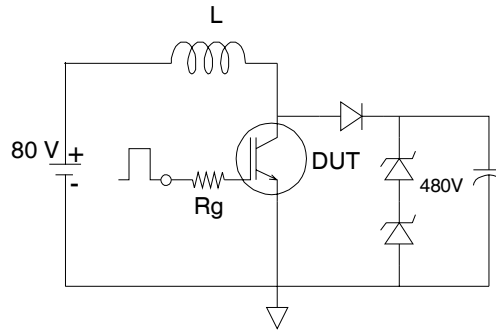
**Fig. 26.** Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)



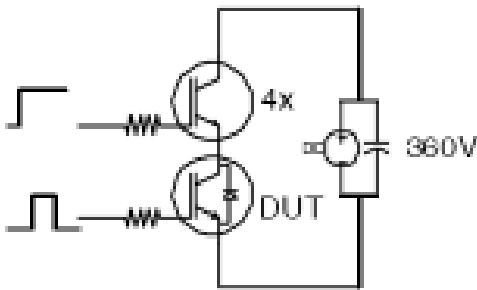
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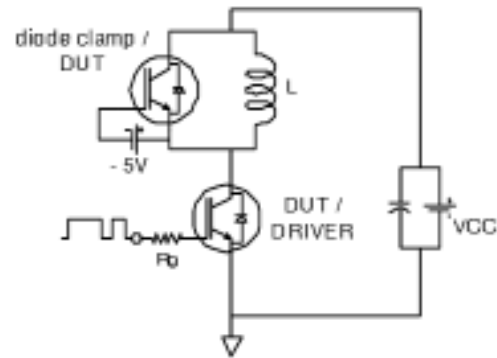
**Fig.C.T.1 - Gate Charge Circuit (turn-off)**



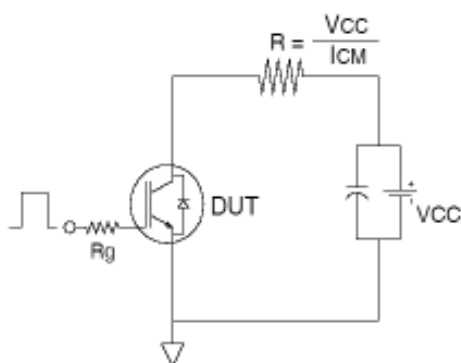
**Fig.C.T.2 - RBSOA Circuit**



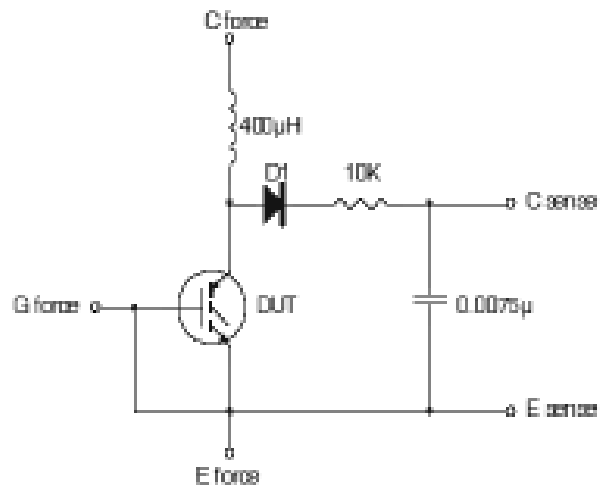
**Fig.C.T.3 - S.C.SOA Circuit**



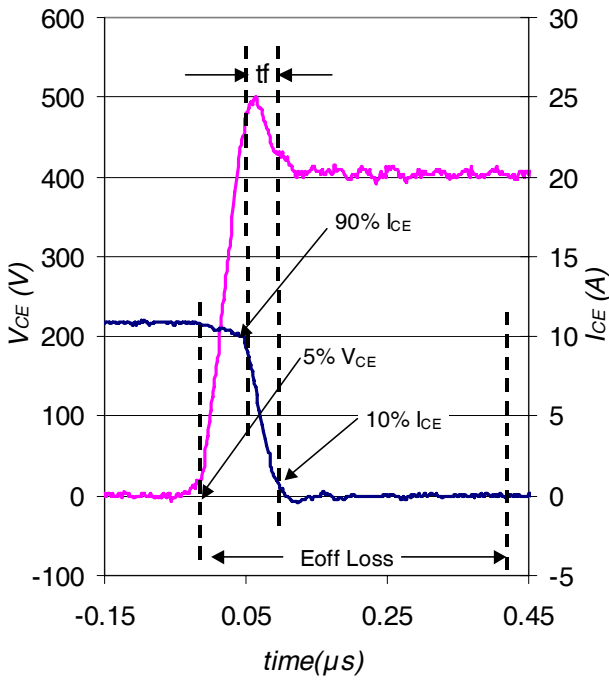
**Fig.C.T.4 - Switching Loss Circuit**



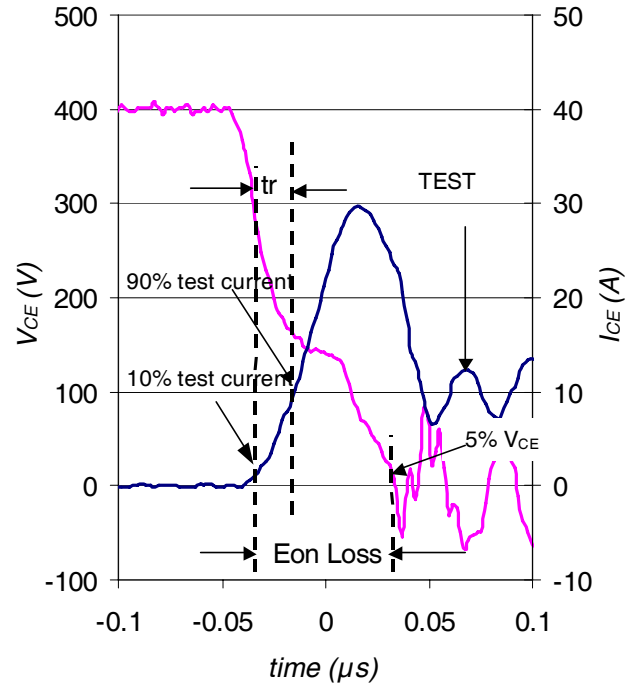
**Fig.C.T.5 - Resistive Load Circuit**



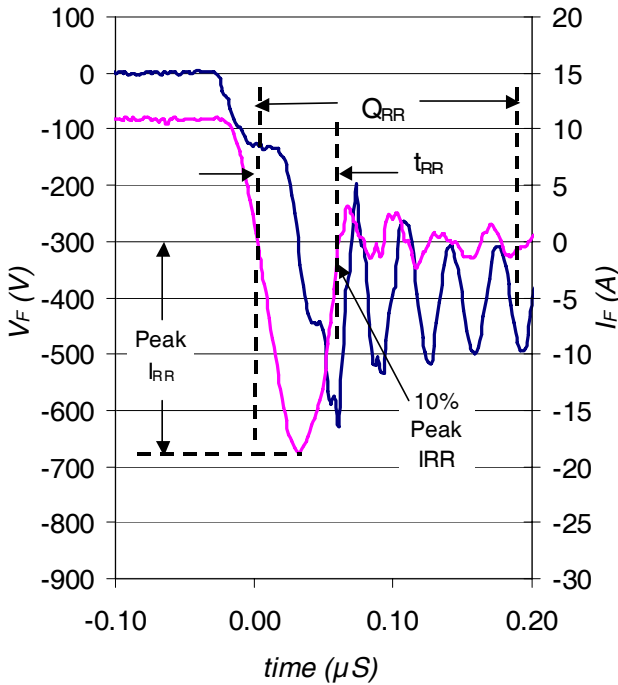
**Fig.C.T.6 - Typical Filter Circuit for  $V_{(BR)CES}$  Measurement**



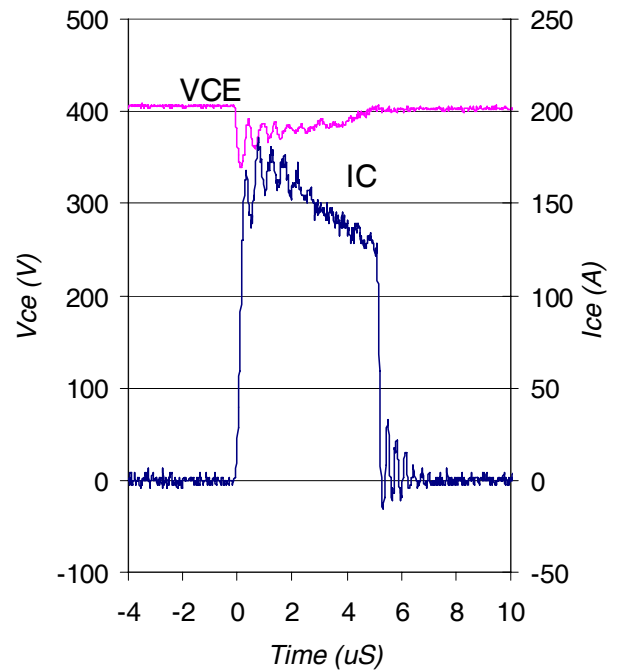
**Fig. WF1** - Typ. Turn-off Loss Waveform  
@  $T_J = 150^\circ\text{C}$  using Fig. CT.4



**Fig. WF2** - Typ. Turn-on Loss Waveform  
@  $T_J = 150^\circ\text{C}$  using Fig. CT.4



**WF.3**- Typ. Reverse Recovery Waveform  
@  $T_J = 150^\circ\text{C}$  using CT.4

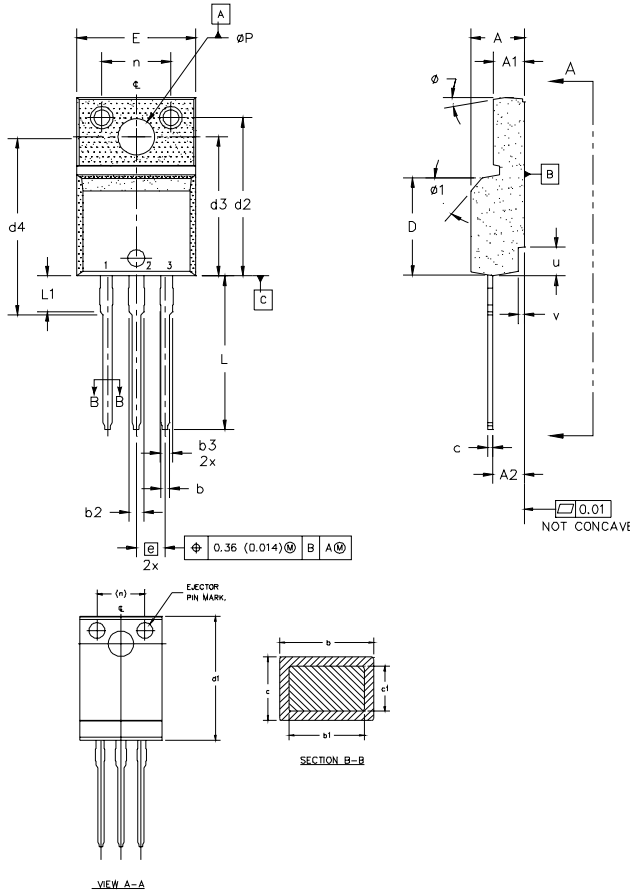


**WF.4**- Typ. Short Circuit Waveform  
@  $T_J = 25^\circ\text{C}$  using CT.3

# IRGI4061DPbF

## TO-220 Full-Pak Package Outline

Dimensions are shown in millimeters (inches)



**NOTES:**

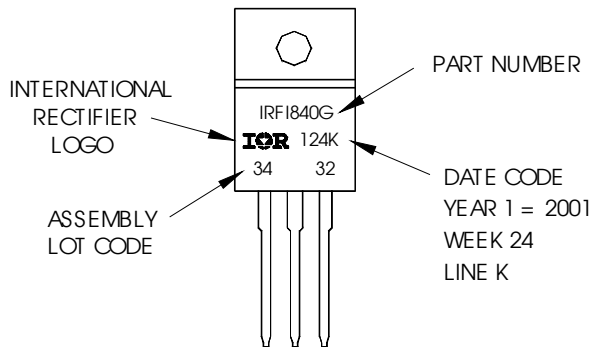
- 1.0 DIMENSIONING AND TOLERANCING PER ASME Y14.5 M- 1994.
- 2.0 DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
- 3.0 LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
- 4.0 DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
- 5.0 DIMENSION b1 APPLY TO BASE METAL ONLY.
- 6.0 STEP OPTIONAL ON PLASTIC BODY DEFINED BY DIMENSIONS u & v.
- 7.0 CONTROLLING DIMENSION : INCHES.

SYMBOL	DIMENSIONS				NOTES	LEAD ASSIGNMENTS	
	MILLIMETERS		INCHES				
	MIN.	MAX.	MIN.	MAX.			
A	4.57	4.83	0.180	0.190	5	HEXFET 1- GATE 2- DRAIN 3- SOURCE	
A1	2.57	2.83	0.101	0.114			
A2	2.51	2.85	0.099	0.112			
b	0.622	0.89	0.024	0.035		4	IGBTs, CoPACK 1- GATE 2- COLLECTOR 3- EMITTER
b1	0.622	0.838	0.024	0.033			
b2	1.229	1.400	0.048	0.055			
b3	1.229	1.400	0.048	0.055		4	
c	0.440	0.629	0.017	0.025			
c1	0.440	0.584	0.017	0.023			
D	8.65	9.80	0.341	0.386			
D1	15.80	16.12	0.622	0.635			
d2	13.97	14.22	0.550	0.560	4		
d3	12.30	12.92	0.484	0.509			
d4	8.64	9.91	0.340	0.390			
E	10.36	10.63	0.408	0.419	4		
e	2.54 BSC		0.100 BSC				
L	13.20	13.73	0.520	0.541	3		
L1	3.10	3.50	0.122	0.138			
n	6.05	6.15	0.238	0.242			
φP	3.05	3.45	0.120	0.136	6		
u	2.40	2.50	0.094	0.098			
v	0.40	0.50	0.016	0.020			
φ	3"	7"	3"	7"			
φ1		45°		45°			

## TO-220 Full-Pak Part Marking Information

EXAMPLE: THIS IS AN IRF1840G  
 WITH ASSEMBLY  
 LOT CODE 3432  
 ASSEMBLED ON WW 24, 2001  
 IN THE ASSEMBLY LINE "K"

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



TO-220 Full-Pak 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.