

# IRGS4064DPbF

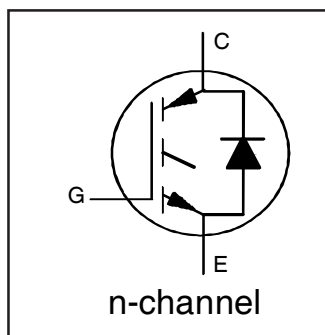
## INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

### Features

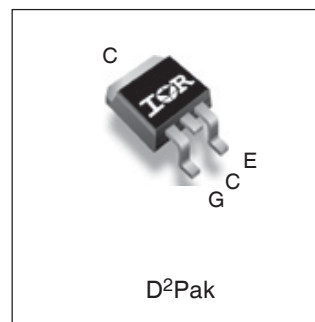
- Low  $V_{CE(on)}$  Trench IGBT Technology
- Low Switching Losses
- Maximum Junction temperature 175 °C
- 5 $\mu$ s SCSOA
- Square RBSOA
- 100% of The Parts Tested for ( $I_{LM}$ )
- Positive  $V_{CE(on)}$  Temperature Coefficient.
- Ultra Fast Soft Recovery Co-pak Diode
- Tighter Distribution of Parameters
- 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



$V_{CES} = 600V$
$I_C = 10A, T_C = 100^\circ C$
$t_{sc} > 5\mu s, T_{jmax} = 175^\circ C$
$V_{CE(on) typ.} = 1.6V$



<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	10	
$I_{CM}$	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	10	
$I_{FM}$	Diode Maximum Forward Current ②	40	
$V_{GE}$	Continuous Gate-to-Emitter Voltage	$\pm 20$	V
	Transient Gate-to-Emitter Voltage	$\pm 30$	
$P_D @ T_C = 25^\circ$	Maximum Power Dissipation	101	W
		$P_D @ T_C = 100^\circ$	
$T_J$	Operating Junction and	-55 to + 175	°C
$T_{STG}$	Storage Temperature Range		
	Soldering Temperature, for 10 seconds	300 (0.063 in. (1.6mm) from case)	

### Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT ③	---	---	1.49	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode ③	---	---	3.66	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	---	0.50	---	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount ③	---	---	40	
Wt	Weight		1.5		g

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

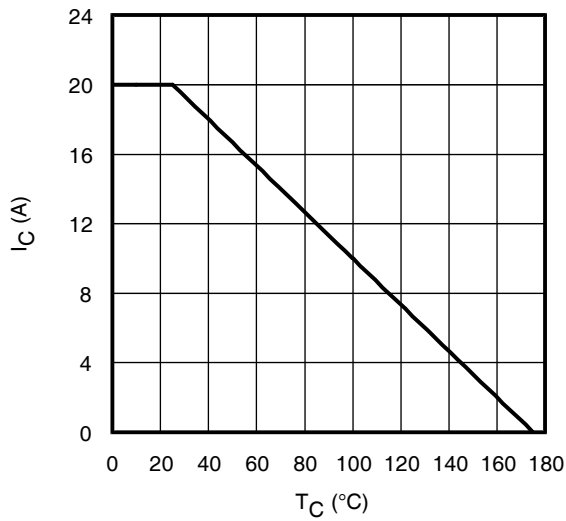
	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	$V_{GE} = 0V, I_C = 100\mu A$ ④	CT 6
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.47	—	V/°C	$V_{GE} = 0V, I_C = 500\mu A$ (25°C-175°C)	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.6	1.91	V	$I_C = 10A, V_{GE} = 15V, T_J = 25^\circ\text{C}$	5,6,7,9, 10,11
		—	1.9	—		$I_C = 10A, V_{GE} = 15V, T_J = 150^\circ\text{C}$	
		—	2.0	—		$I_C = 10A, V_{GE} = 15V, T_J = 175^\circ\text{C}$	
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	$V_{CE} = V_{GE}, I_C = 275\mu A$	9,10,11,12
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-11	—	mV/°C	$V_{CE} = V_{GE}, I_C = 1.0mA$ (25°C - 175°C)	
gfe	Forward Transconductance	—	6.9	—	S	$V_{CE} = 50V, I_C = 10A, PW = 80\mu s$	
$I_{CES}$	Collector-to-Emitter Leakage Current	—	—	25	$\mu A$	$V_{GE} = 0V, V_{CE} = 600V$	8
		—	328	—		$V_{GE} = 0V, V_{CE} = 600V, T_J = 175^\circ\text{C}$	
$V_{FM}$	Diode Forward Voltage Drop	—	2.5	3.1	V	$I_F = 10A$	
		—	1.7	—		$I_F = 10A, T_J = 175^\circ\text{C}$	
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{GE} = \pm 20V$	

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

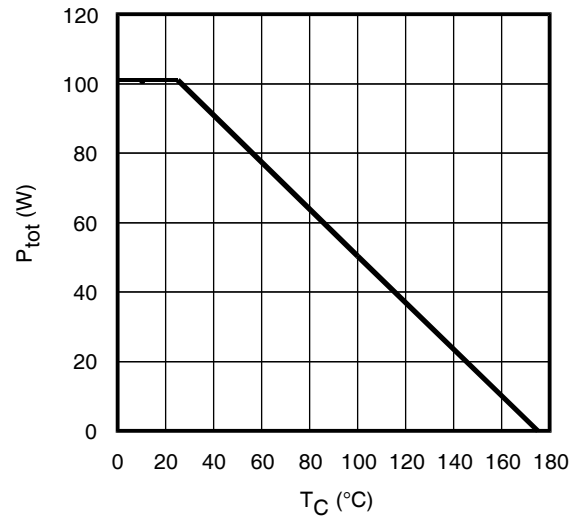
	Parameter	Min.	Typ.	Max. ⑤	Units	Conditions	Ref.Fig
$Q_g$	Total Gate Charge (turn-on)	—	21	32	nC	$I_C = 10A$	24
$Q_{ge}$	Gate-to-Emitter Charge (turn-on)	—	5.3	8.0		$V_{GE} = 15V$	CT 1
$Q_{gc}$	Gate-to-Collector Charge (turn-on)	—	8.9	13		$V_{CC} = 400V$	
$E_{on}$	Turn-On Switching Loss	—	29	40	$\mu J$	$I_C = 10A, V_{CC} = 400V, V_{GE} = 15V$	CT 4
$E_{off}$	Turn-Off Switching Loss	—	200	281		$R_G = 22\Omega, L = 1.0mH, T_J = 25^\circ\text{C}$	
$E_{total}$	Total Switching Loss	—	229	313		Energy losses include tail & diode reverse recovery	
$t_{d(on)}$	Turn-On delay time	—	27	37	ns	$I_C = 10A, V_{CC} = 400V, V_{GE} = 15V$	CT 4
$t_r$	Rise time	—	15	23		$R_G = 22\Omega, L = 1.0mH, T_J = 25^\circ\text{C}$	
$t_{d(off)}$	Turn-Off delay time	—	79	90			
$t_f$	Fall time	—	21	29			
$E_{on}$	Turn-On Switching Loss	—	99	—	$\mu J$	$I_C = 10A, V_{CC} = 400V, V_{GE} = 15V$	13,15
$E_{off}$	Turn-Off Switching Loss	—	316	—		$R_G = 22\Omega, L = 1.0mH, T_J = 175^\circ\text{C}$ ④	CT 4
$E_{total}$	Total Switching Loss	—	415	—		Energy losses include tail & diode reverse recovery	WF 1,WF 2
$t_{d(on)}$	Turn-On delay time	—	27	—	ns	$I_C = 10A, V_{CC} = 400V, V_{GE} = 15V$	14,16
$t_r$	Rise time	—	16	—		$R_G = 22\Omega, L = 1.0mH, T_J = 175^\circ\text{C}$	CT 4
$t_{d(off)}$	Turn-Off delay time	—	98	—			WF 1,WF 2
$t_f$	Fall time	—	33	—			
$C_{ies}$	Input Capacitance	—	594	—	pF	$V_{GE} = 0V$	22
$C_{oes}$	Output Capacitance	—	49	—		$V_{CC} = 30V$	
$C_{res}$	Reverse Transfer Capacitance	—	17	—		$f = 1.0MHz$	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 175^\circ\text{C}, I_C = 40A$ $V_{CC} = 480V, V_p = 600V$ $R_G = 22\Omega, V_{GE} = +15V$ to 0V	4 CT 2
SCSOA	Short Circuit Safe Operating Area	5	—	—	$\mu s$	$V_{CC} = 400V, V_p = 600V$ $R_G = 22\Omega, V_{GE} = +15V$ to 0V	22, CT 3 WF 4
Erec	Reverse Recovery Energy of the Diode	—	191	—	$\mu J$	$T_J = 175^\circ\text{C}$	17,18,19
$t_{rr}$	Diode Reverse Recovery Time	—	62	—	ns	$V_{CC} = 400V, I_F = 10A$	20,21
$I_{rr}$	Peak Reverse Recovery Current	—	16	—	A	$V_{GE} = 15V, R_G = 22\Omega, L = 1.0mH$	WF 3

## Notes:

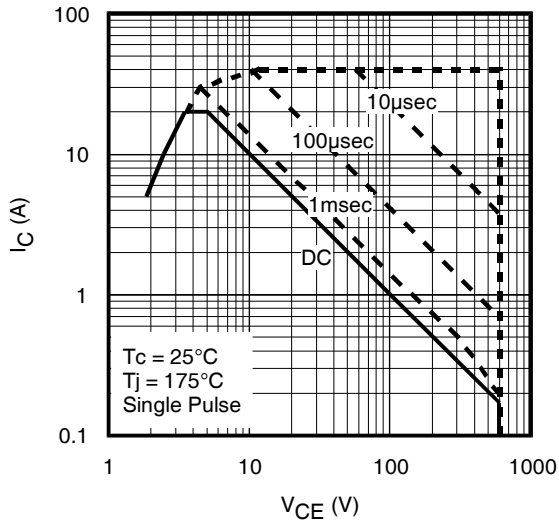
- ①  $V_{CC} = 80\% (V_{CES}), V_{GE} = 15V, L = 28 \mu H, R_G = 22 \Omega$ .
- ② Pulse width limited by max. junction temperature.
- ③  $R_\theta$  is measured at  $T_J$  approximately  $90^\circ\text{C}$
- ④ Refer to AN-1086 for guidelines for measuring  $V_{(BR)CES}$  safely
- ⑤ Maximum limits are based on statistical sample size characterization



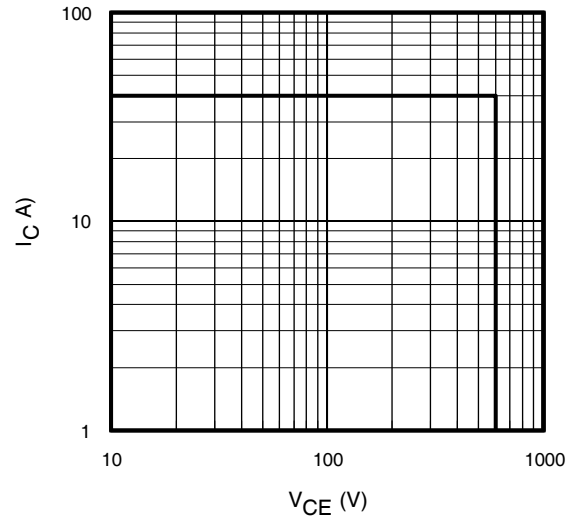
**Fig. 1** - Maximum DC Collector Current vs. Case Temperature



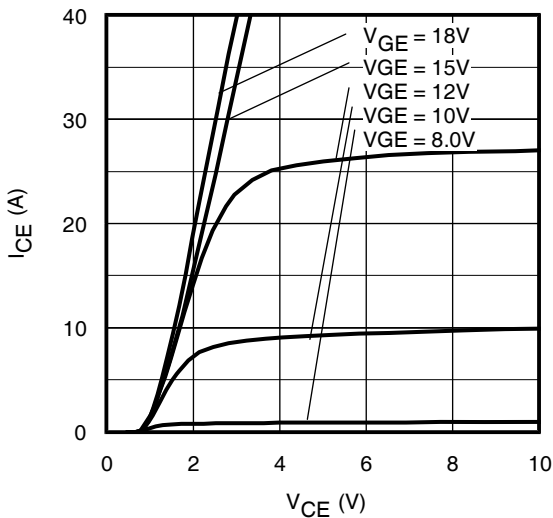
**Fig. 2** - Power Dissipation vs. Case Temperature



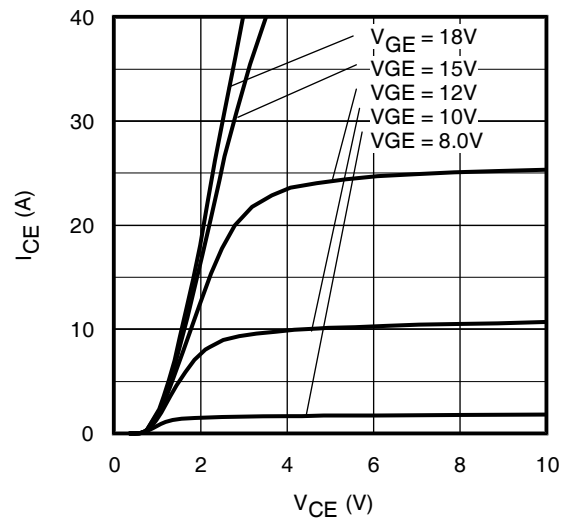
**Fig. 3** - Forward SOA,  
 $T_C = 25^\circ\text{C}$ ;  $T_J \leq 175^\circ\text{C}$



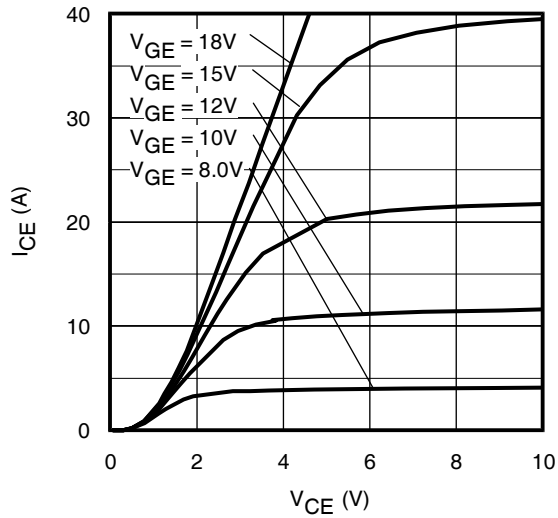
**Fig. 4** - Reverse Bias SOA  
 $T_J = 175^\circ\text{C}$ ;  $V_{CE} = 15\text{V}$



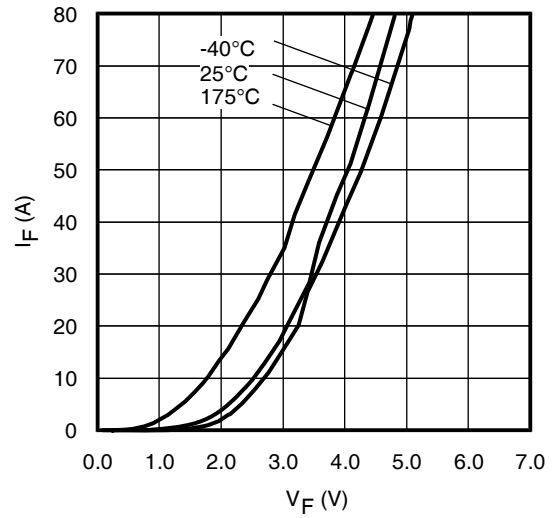
**Fig. 5** - Typ. IGBT Output Characteristics  
 $T_J = -40^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$



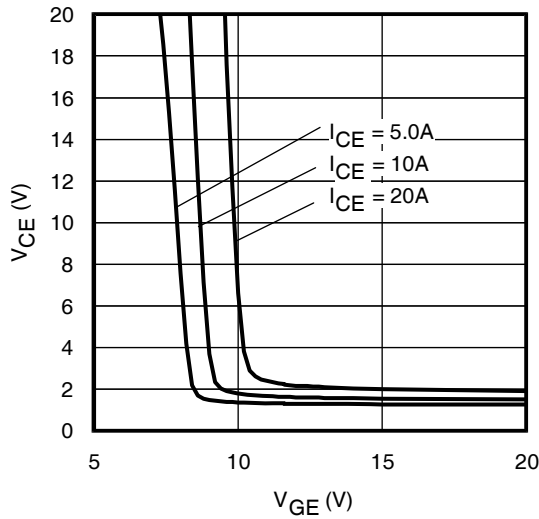
**Fig. 6** - Typ. IGBT Output Characteristics  
 $T_J = 25^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$



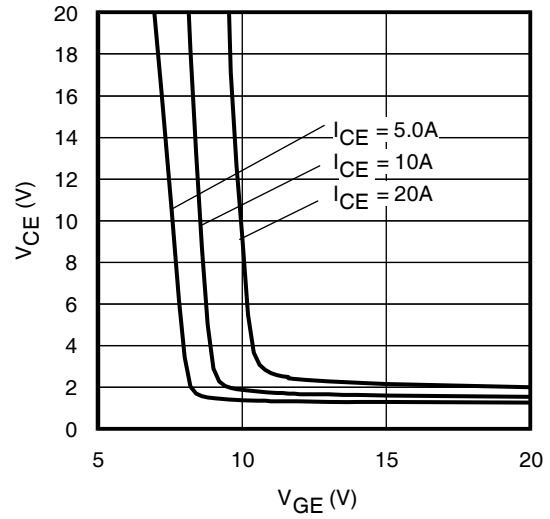
**Fig. 7** - Typ. IGBT Output Characteristics  
 $T_J = 175^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$



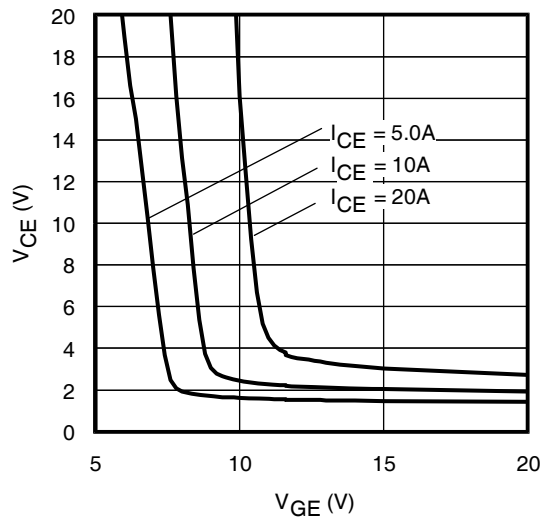
**Fig. 8** - Typ. Diode Forward Characteristics  
 $t_p = 80\mu\text{s}$



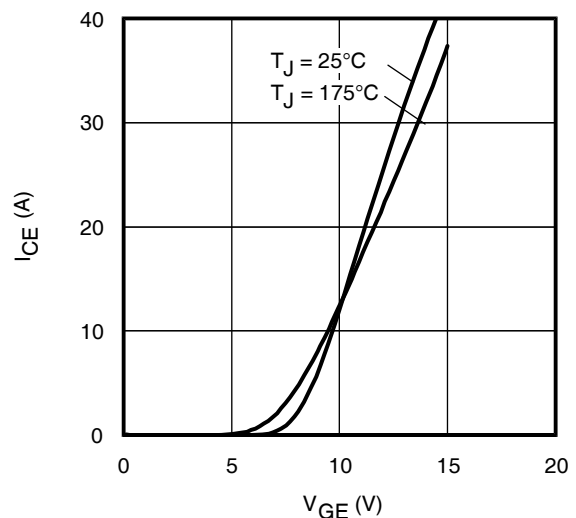
**Fig. 9** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = -40^\circ\text{C}$



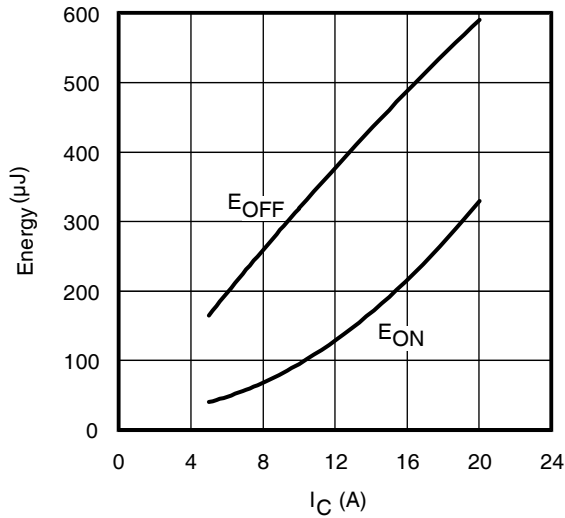
**Fig. 10** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 25^\circ\text{C}$



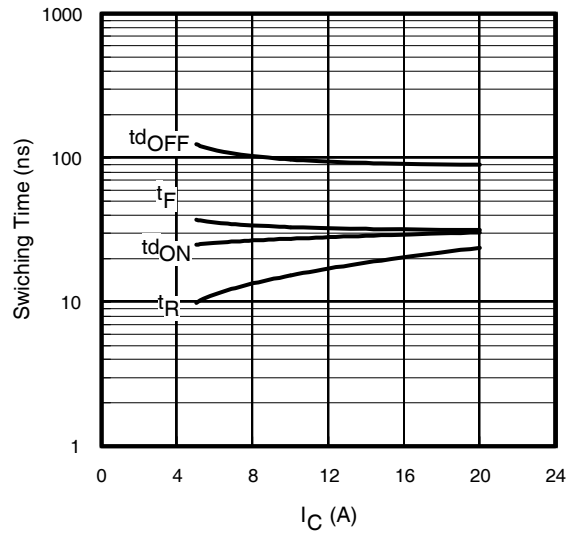
**Fig. 11** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 175^\circ\text{C}$



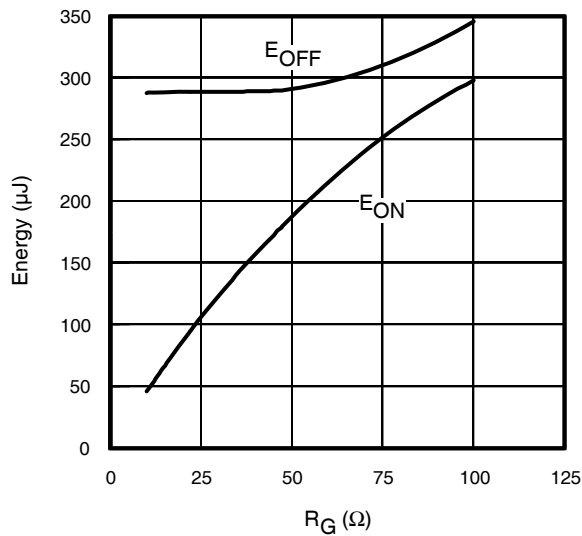
**Fig. 12** - Typ. Transfer Characteristics  
 $V_{CE} = 50\text{V}$ ;  $t_p = 10\mu\text{s}$



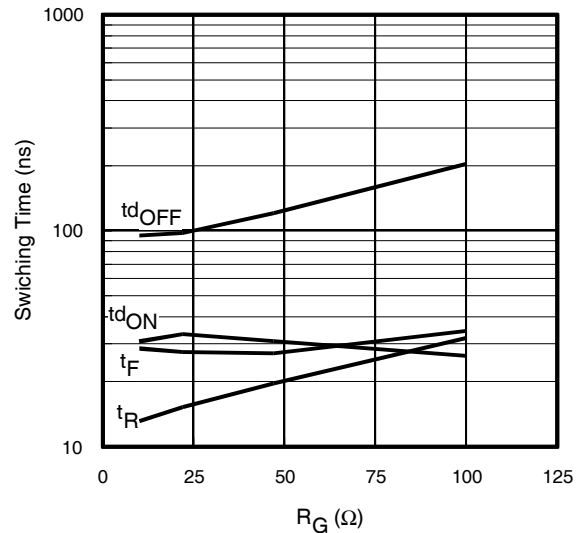
**Fig. 13** - Typ. Energy Loss vs.  $I_C$   
 $T_J = 175^\circ\text{C}$ ;  $L = 1\text{mH}$ ;  $V_{CE} = 400\text{V}$ ,  $R_G = 22\Omega$ ;  $V_{GE} = 15\text{V}$ .



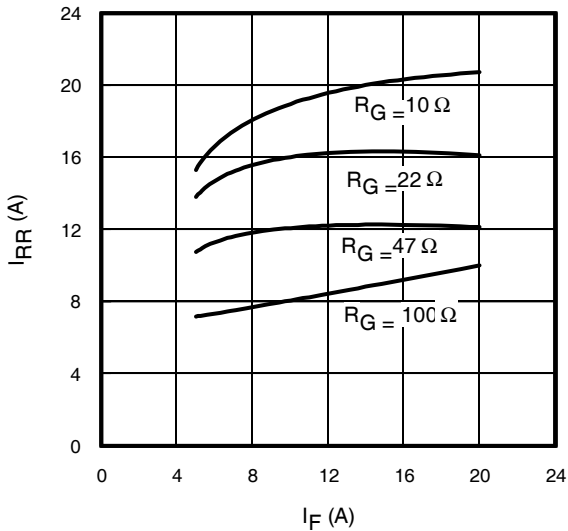
**Fig. 14** - Typ. Switching Time vs.  $I_C$   
 $T_J = 175^\circ\text{C}$ ;  $L = 1\text{mH}$ ;  $V_{CE} = 400\text{V}$   
 $R_G = 22\Omega$ ;  $V_{GE} = 15\text{V}$



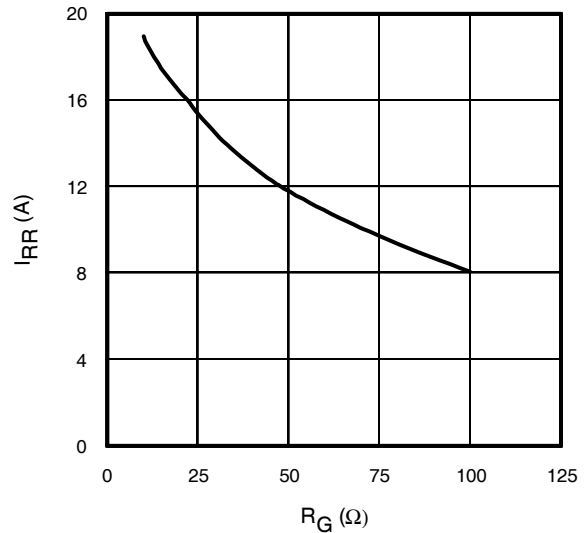
**Fig. 15** - Typ. Energy Loss vs.  $R_G$   
 $T_J = 175^\circ\text{C}$ ;  $L = 1\text{mH}$ ;  $V_{CE} = 400\text{V}$ ,  $I_{CE} = 10\text{A}$ ;  $V_{GE} = 15\text{V}$



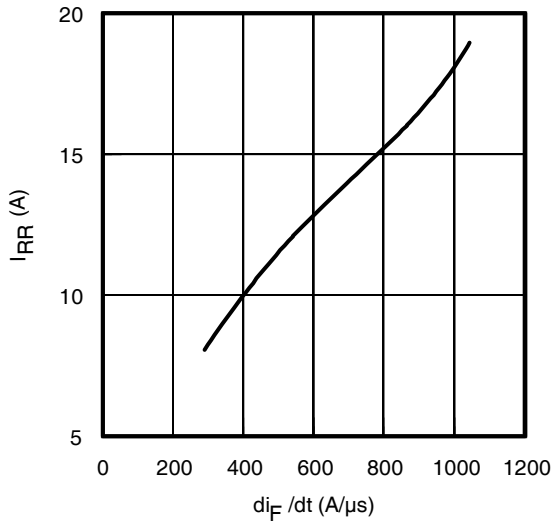
**Fig. 16** - Typ. Switching Time vs.  $R_G$   
 $T_J = 175^\circ\text{C}$ ;  $L = 1\text{mH}$ ;  $V_{CE} = 400\text{V}$   
 $I_{CE} = 10\text{A}$ ;  $V_{GE} = 15\text{V}$



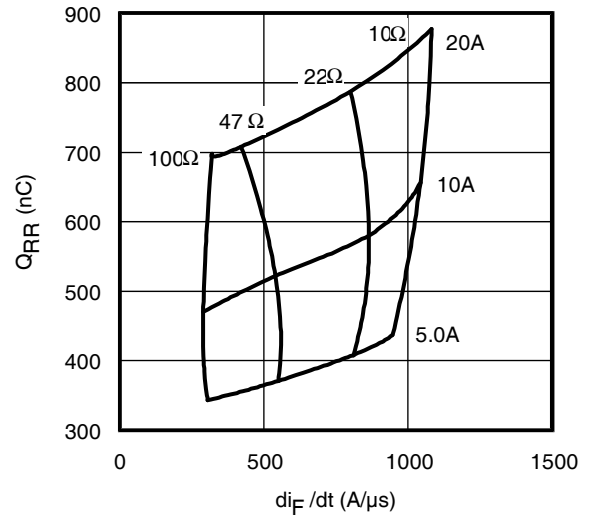
**Fig. 17** - Typical Diode  $I_{RR}$  vs.  $I_F$   
 $T_J = 175^\circ\text{C}$



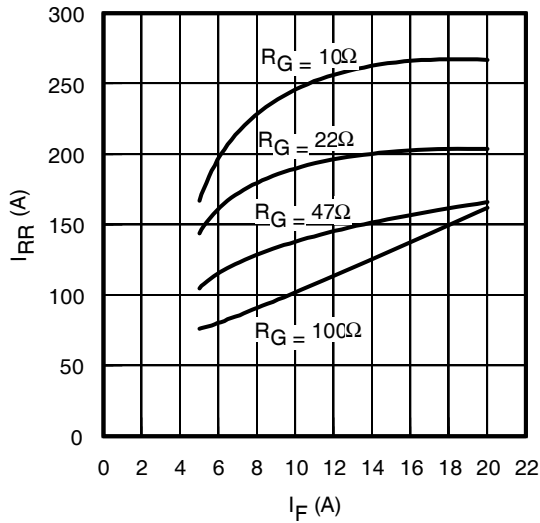
**Fig. 18** - Typical Diode  $I_{RR}$  vs.  $R_G$   
 $T_J = 175^\circ\text{C}$ ;  $I_F = 10\text{A}$



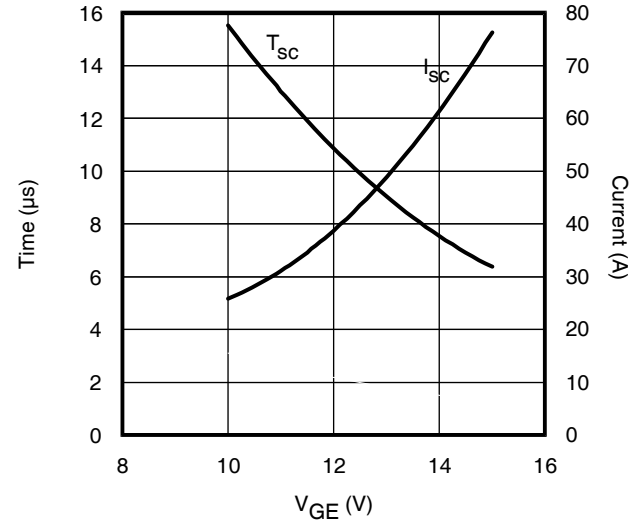
**Fig. 19**- Typical Diode  $I_{RR}$  vs.  $di_F/dt$   
 $V_{CC}=400V$ ;  $V_{GE}=15V$ ;  
 $I_{CE}=10A$ ;  $T_J=175^\circ C$



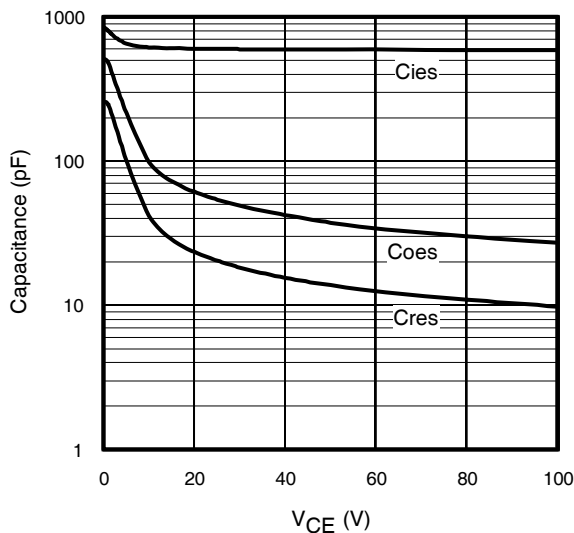
**Fig. 20** - Typical Diode  $Q_{RR}$   
 $V_{CC}=400V$ ;  $V_{GE}=15V$ ;  $T_J=175^\circ C$



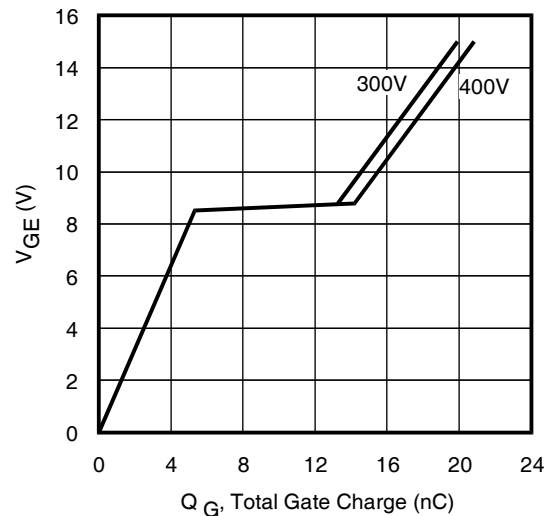
**Fig. 21** - Typical Diode  $E_{RR}$  vs.  $I_F$   
 $T_J=175^\circ C$



**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.  $V_{GE}$   
 $I_{CE}=10A$ ,  $L=600\mu H$

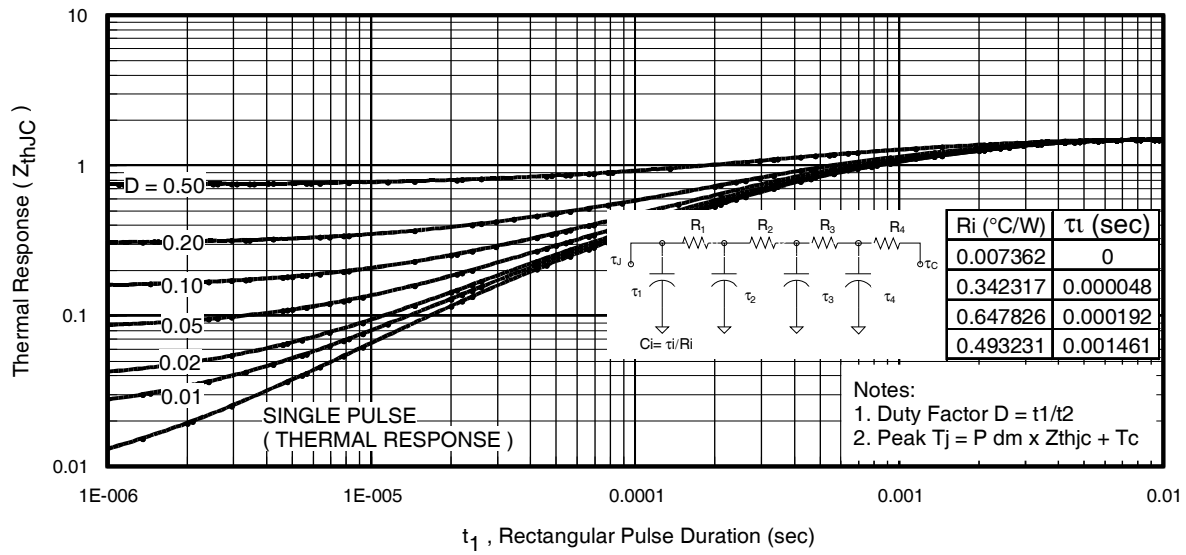


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

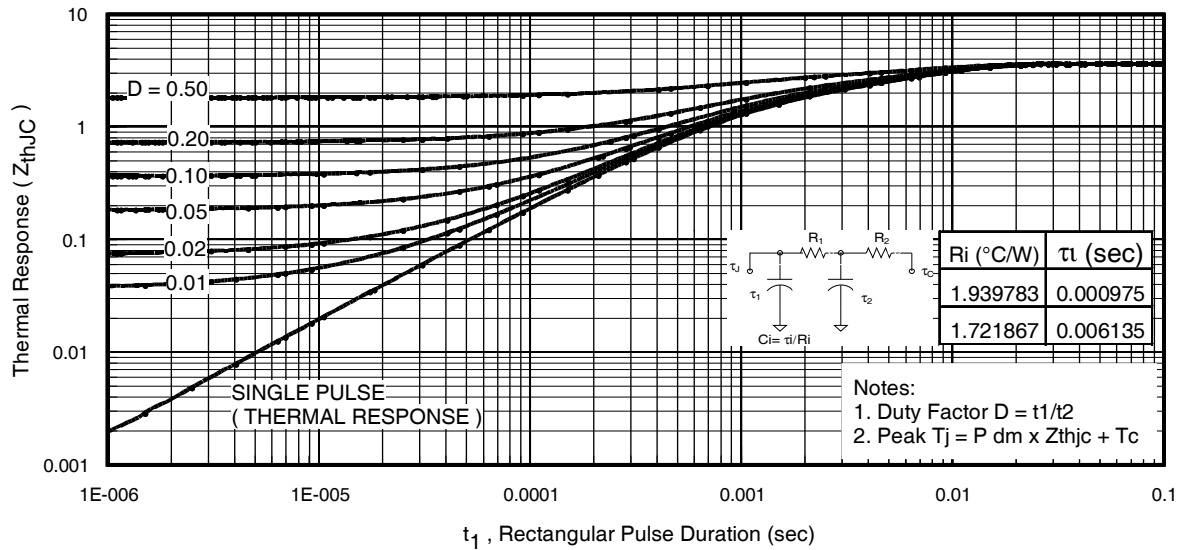
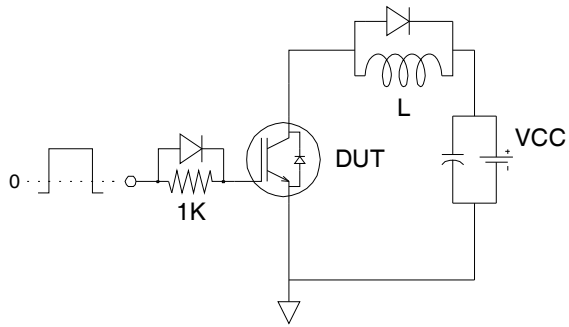
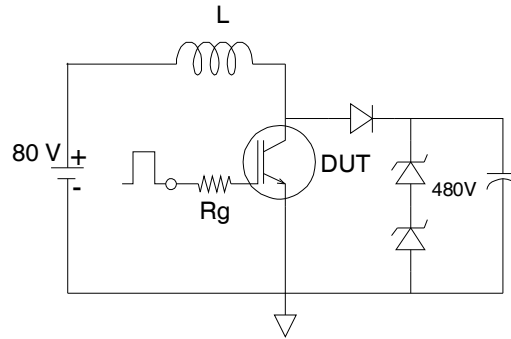


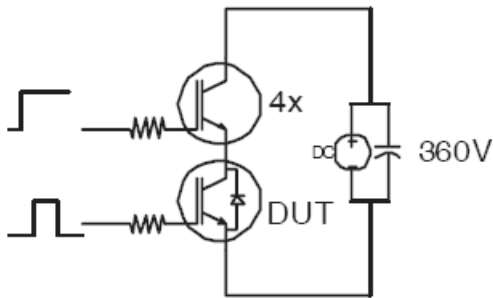
Fig. 26. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)



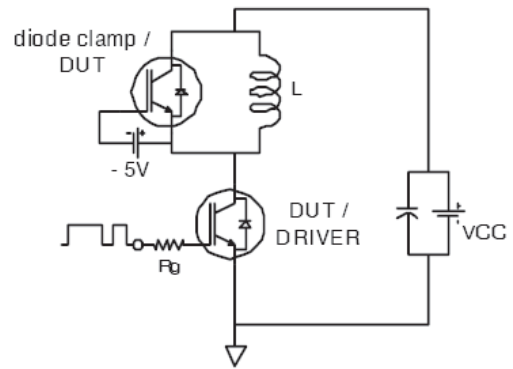
**Fig.C.T.1 - Gate Charge Circuit (turn-off)**



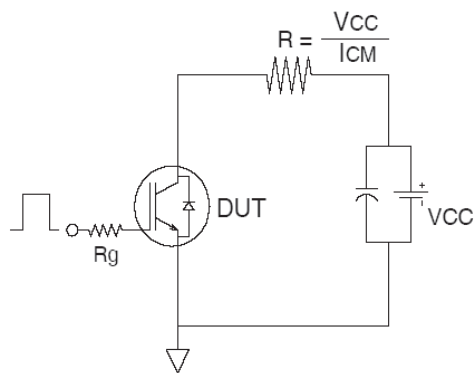
**Fig.C.T.2 - RBSOA Circuit**



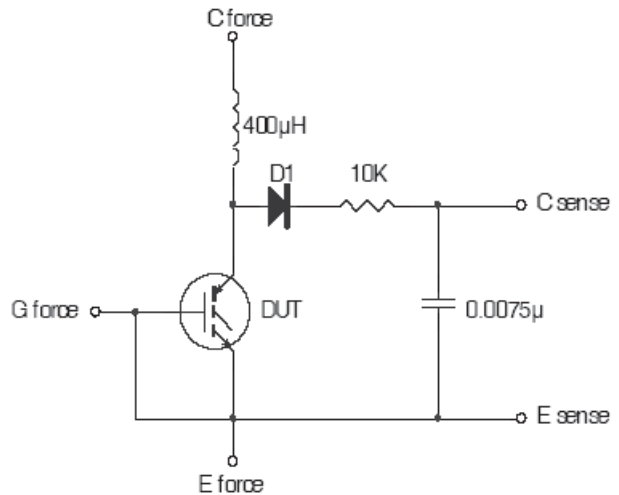
**Fig.C.T.3 - S.C.SOA Circuit**



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

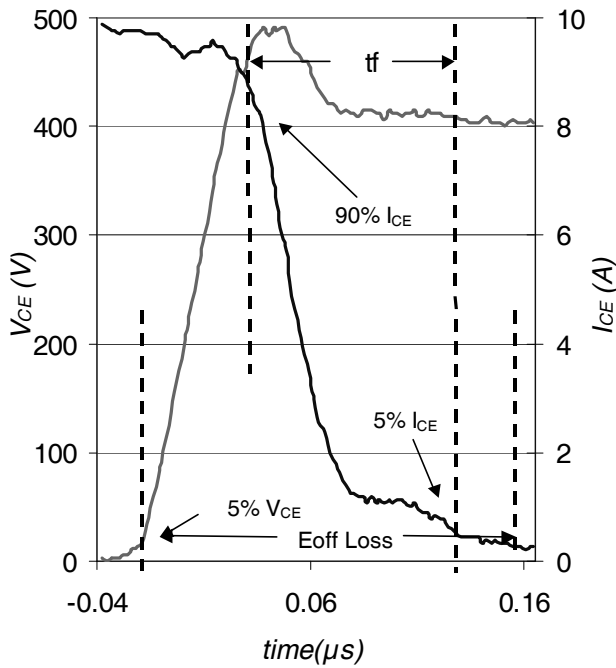


**Fig.C.T.5 - Resistive Load Circuit**

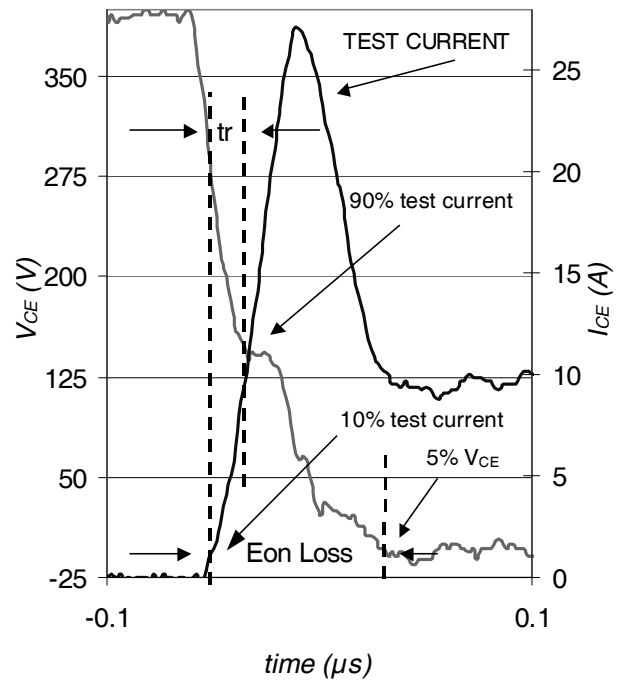


**Fig.C.T.6 - Typical Filter Circuit for  $V_{(BR)CES}$  Measurement**

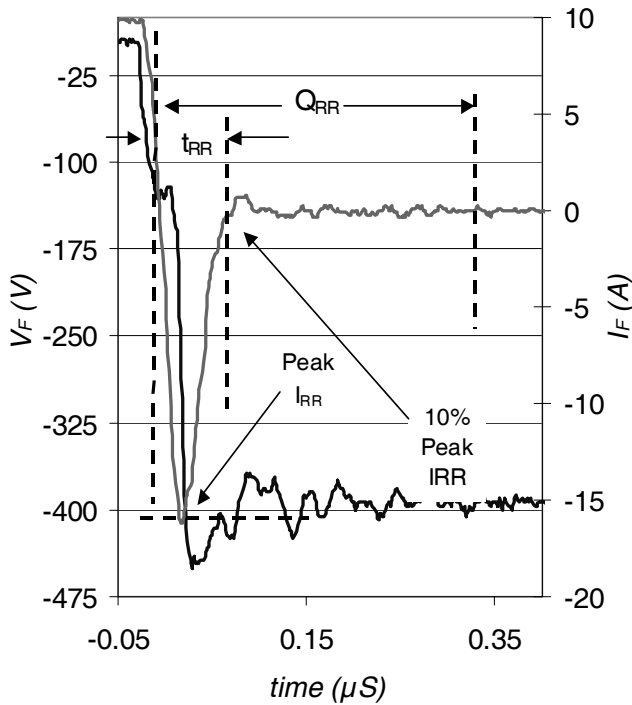




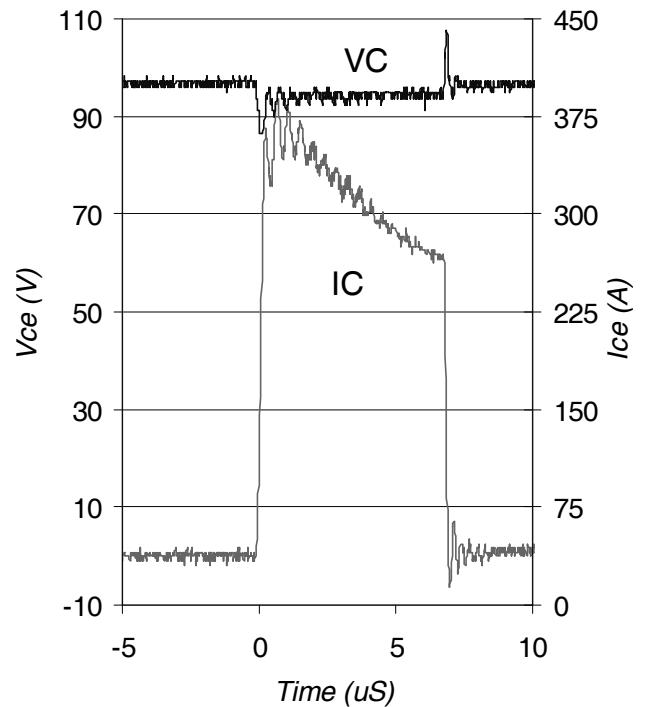
**Fig. WF1** - Typ. Turn-off Loss Waveform  
@  $T_J = 175^\circ\text{C}$  using Fig. CT.4



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

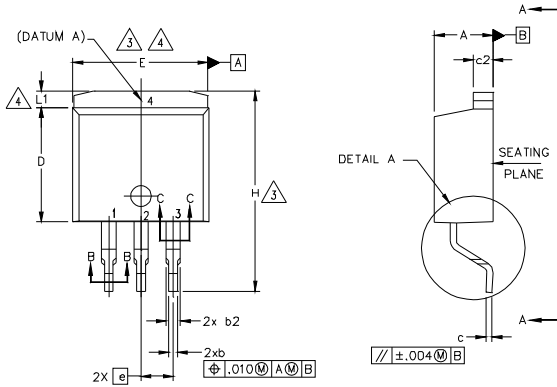


**WF.3**- Typ. Reverse Recovery Waveform  
@  $T_J = 175^\circ\text{C}$  using CT.4



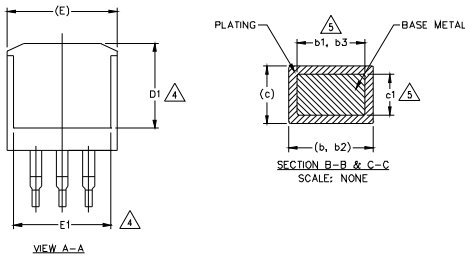
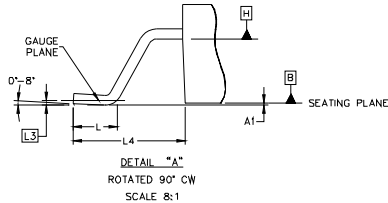
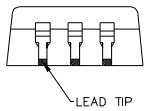
**WF.4**- Typ. Short Circuit Waveform  
@  $T_J = 25^\circ\text{C}$  using CT.3

## D<sup>2</sup>Pak Package Outline (Dimensions are shown in millimeters (inches))



**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY AT DATUM H.
4. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
5. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
6. DATUM A & B TO BE DETERMINED AT DATUM PLANE H.
7. CONTROLLING DIMENSION: INCH.
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-263AB.



SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	5
A1	-	0.254	-	.010	
b	0.51	0.99	.020	.039	
b1	0.51	0.89	.020	.035	
b2	1.14	1.78	.045	.070	
b3	1.14	1.73	.045	.068	
c	0.38	0.74	.015	.029	
c1	0.38	0.58	.015	.023	
c2	1.14	1.65	.045	.065	
D	8.38	9.65	.330	.380	
D1	6.86	-	.270	-	4
E	9.65	10.67	.380	.420	3,4
E1	6.22	-	.245	-	4
e	2.54 BSC		.100 BSC		
H	14.61	15.88	.575	.625	4
L	1.78	2.79	.070	.110	
L1	-	1.65	-	.066	
L3	0.25 BSC		.010 BSC		
L4	4.78	5.28	.188	.208	

**LEAD ASSIGNMENTS**

**HEXFET**

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

**IGBTs, CoPACK**

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

**DIODES**

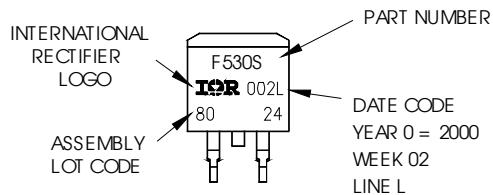
- 1.- ANODE \*
- 2, 4.- CATHODE
- 3.- ANODE

\* PART DEPENDENT.

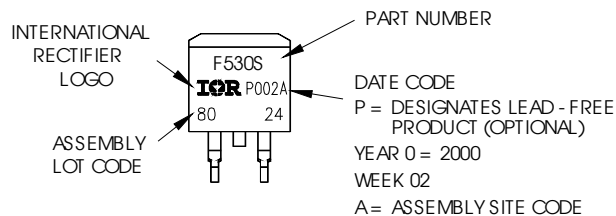
## D<sup>2</sup>Pak Part Marking Information

EXAMPLE: THIS IS AN IRF530S WITH  
LOT CODE 8024  
ASSEMBLED ON WW 02, 2000  
IN THE ASSEMBLY LINE "L"

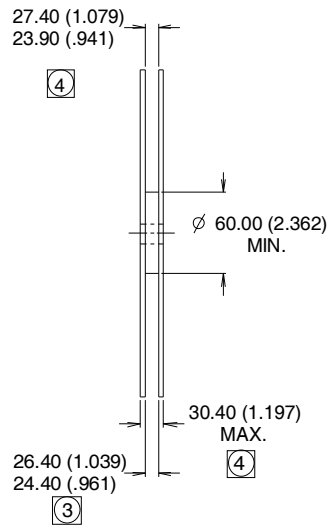
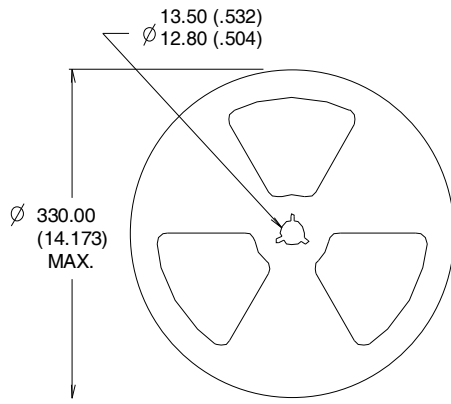
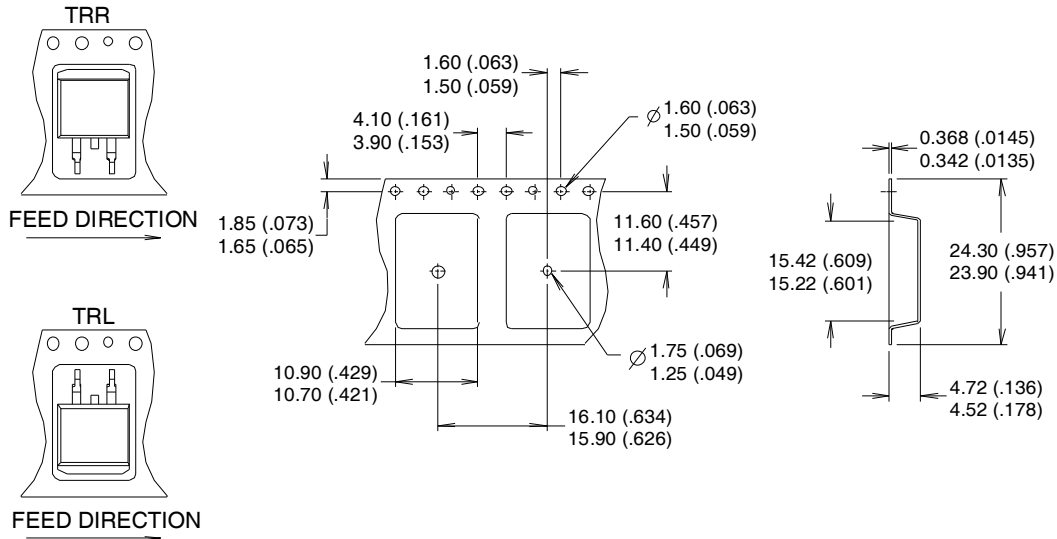
Note: "P" in assembly line position  
indicates "Lead - Free"



OR



D<sup>2</sup>Pak Tape & Reel Information



- NOTES :
1. COMFORMS TO EIA-418.
  2. CONTROLLING DIMENSION: MILLIMETER.
  - ③ DIMENSION MEASURED @ HUB.
  - ④ INCLUDES FLANGE DISTORTION @ OUTER EDGE.

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.