

IRGS4064DPbF

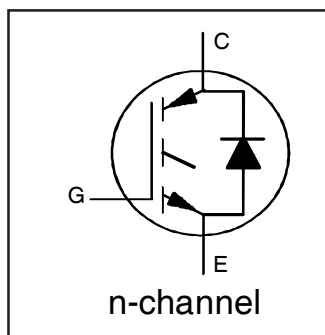
INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Features

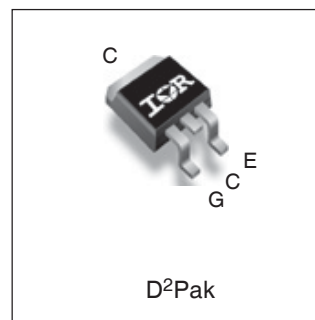
- Low $V_{CE(on)}$ Trench IGBT Technology
- Low Switching Losses
- Maximum Junction temperature 175 °C
- 5μs SCSOA
- Square RBSOA
- 100% of The Parts Tested for (I_{LM})
- Positive $V_{CE(on)}$ Temperature Coefficient.
- Ultra Fast Soft Recovery Co-pak Diode
- Tighter Distribution of Parameters
- Lead-Free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



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



G	C	E
Gate	Collector	Emitter

Absolute Maximum Ratings

	Parameter	Max.	Units
V _{CES}	Collector-to-Emitter Breakdown Voltage	600	V
I _C @ T _C = 25°C	Continuous Collector Current	20	A
I _C @ T _C = 100°C	Continuous Collector Current	10	
I _{CM}	Pulsed Collector Current	40	
I _{LM}	Clamped Inductive Load Current ①	40	
I _F @T _C =25°C	Diode Continuous Forward Current	20	
I _F @T _C =100°C	Diode Continuous Forward Current	10	
I _{FM}	Diode Maximum Forward Current ②	40	
V _{GE}	Continuous Gate-to-Emitter Voltage	±20	V
	Transient Gate-to-Emitter Voltage	±30	
P _D @ T _C =25°	Maximum Power Dissipation	101	W
P _D @ T _C =100°	Maximum Power Dissipation	50	
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	μA	$V_{GE} = 0V, V_{CE} = 600V$	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	—	—	± 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	μJ	$I_C = 10A, V_{CC} = 400V, V_{GE} = 15V$	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	—	μJ	$I_C = 10A, V_{CC} = 400V, V_{GE} = 15V$	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	—	—	μs	$V_{CC} = 400V, V_p = 600V$ $R_G = 22\Omega, V_{GE} = +15V$ to 0V	22, CT 3 WF 4
Erec	Reverse Recovery Energy of the Diode	—	191	—	μJ	$T_J = 175^\circ\text{C}$	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_θ is measured at T_J approximately 90°C
 ④ Refer to AN-1086 for guidelines for measuring $V_{(BR)CES}$ safely
 ⑤ Maximum limits are based on statistical sample size characterization

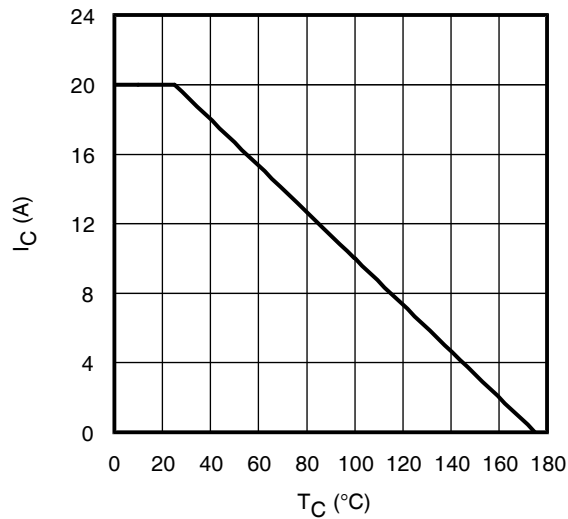


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

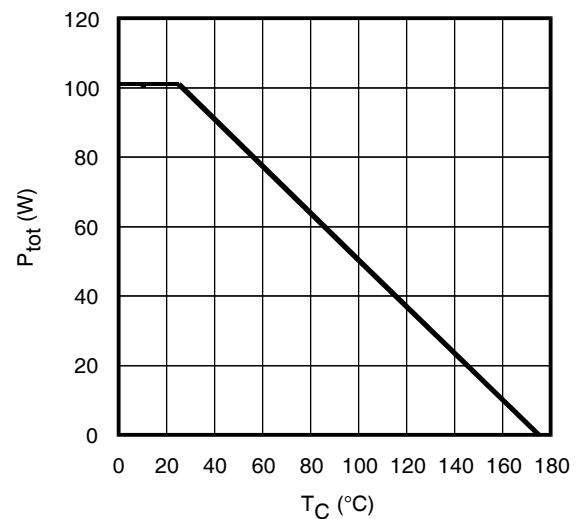


Fig. 2 - Power Dissipation vs. Case Temperature

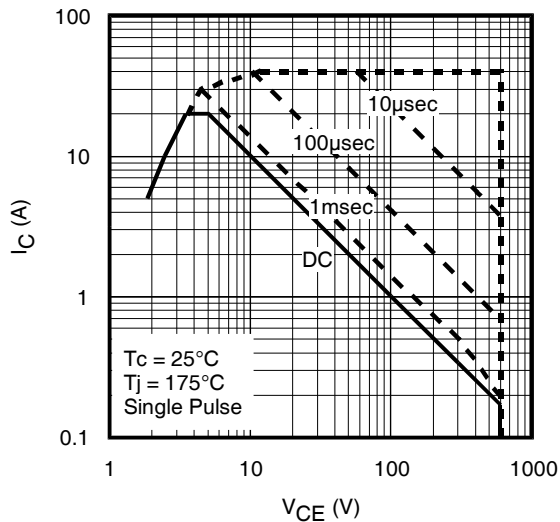


Fig. 3 - Forward SOA,
 $T_C = 25^\circ\text{C}$; $T_J \leq 175^\circ\text{C}$

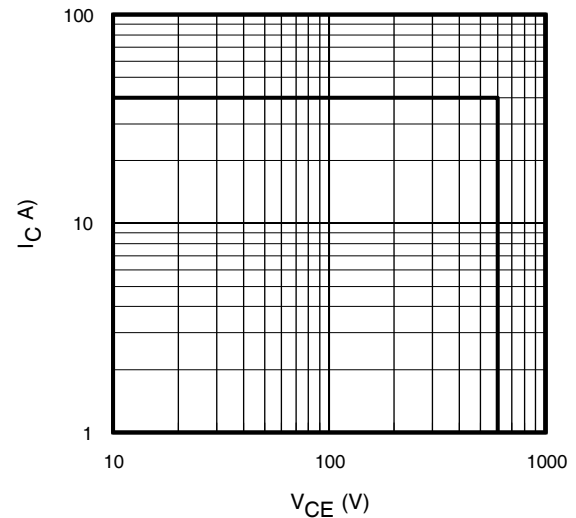


Fig. 4 - Reverse Bias SOA
 $T_J = 175^\circ\text{C}$; $V_{CE} = 15$ V

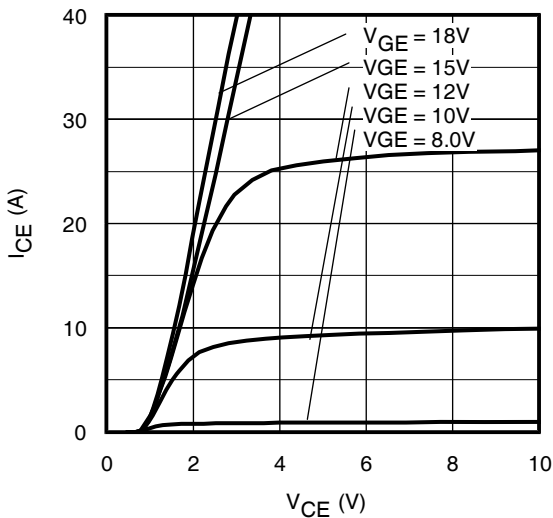


Fig. 5 - Typ. IGBT Output Characteristics
 $T_J = -40^\circ\text{C}$; $t_p = 80 \mu\text{s}$

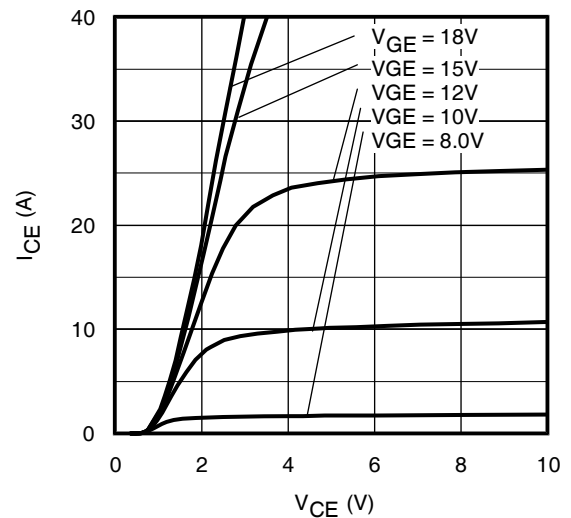


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = 25^\circ\text{C}$; $t_p = 80 \mu\text{s}$

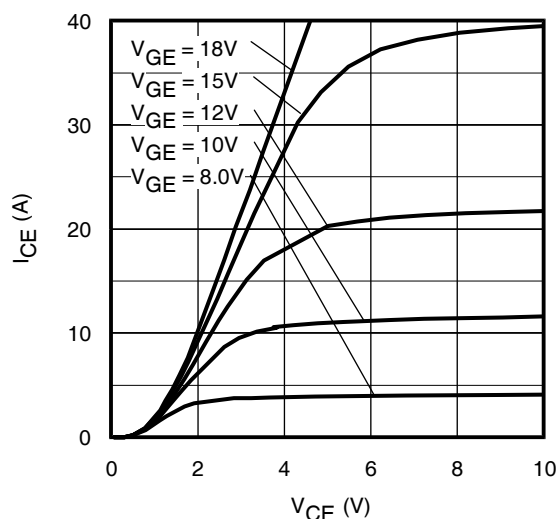


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 175^\circ\text{C}$; $t_p = 80\mu\text{s}$

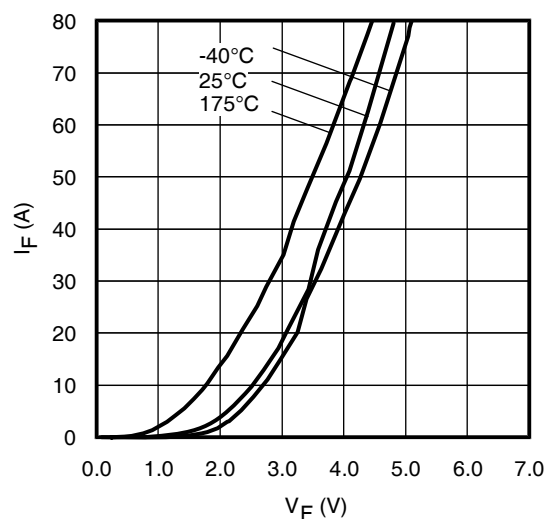


Fig. 8 - Typ. Diode Forward Characteristics
 $t_p = 80\mu\text{s}$

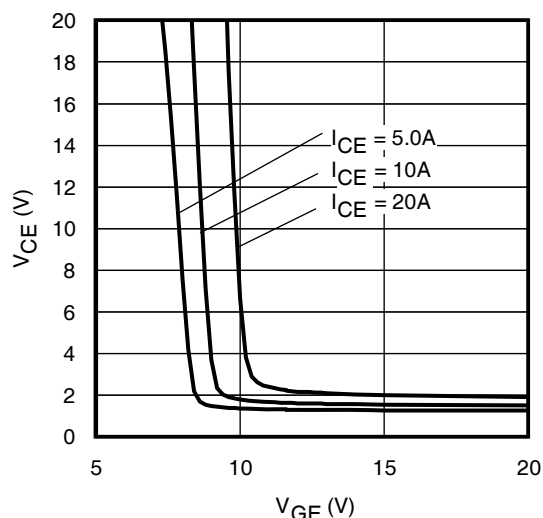


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^\circ\text{C}$

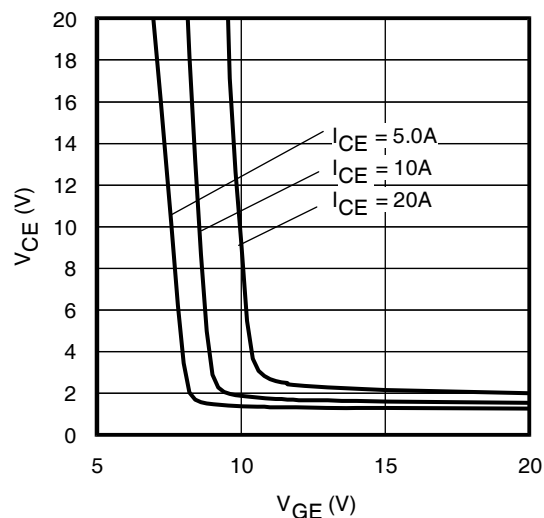


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

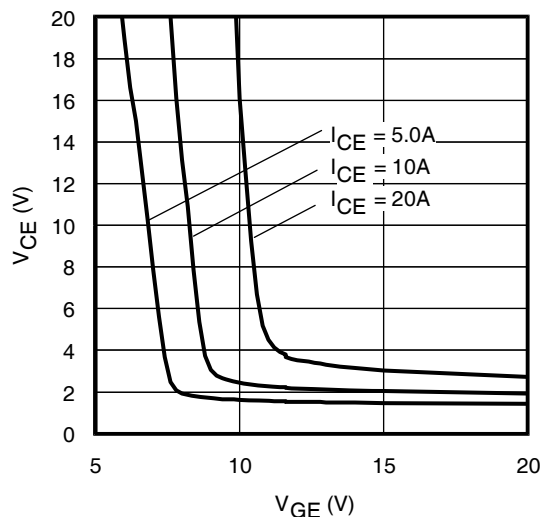


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 175^\circ\text{C}$

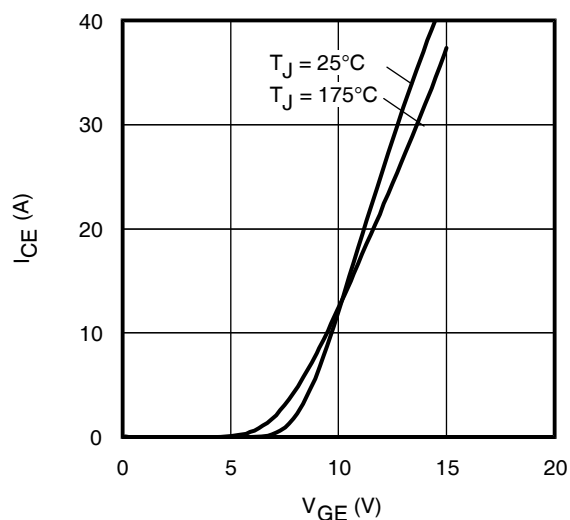


Fig. 12 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 10\mu\text{s}$

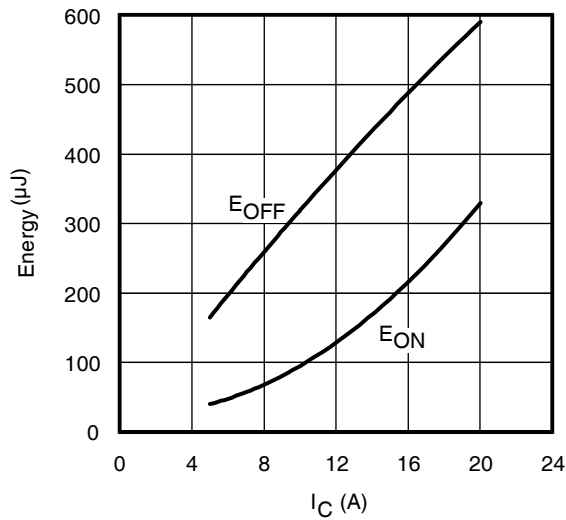


Fig. 13 - Typ. Energy Loss vs. I_C
 $T_J = 175^\circ\text{C}$; $L = 1\text{mH}$; $V_{CE} = 400\text{V}$; $R_G = 22\Omega$; $V_{GE} = 15\text{V}$.

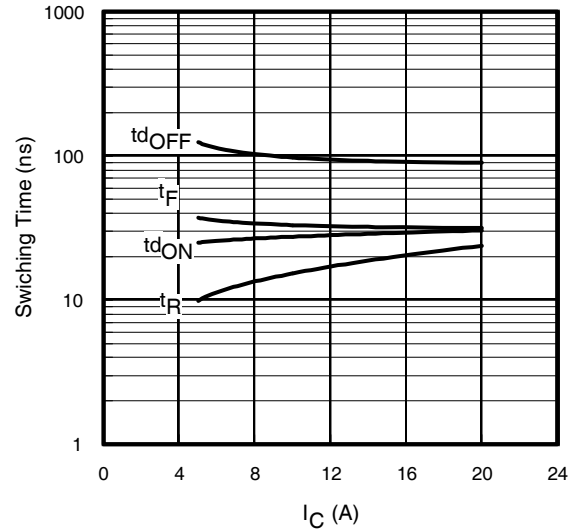


Fig. 14 - Typ. Switching Time vs. I_C
 $T_J = 175^\circ\text{C}$; $L = 1\text{mH}$; $V_{CE} = 400\text{V}$
 $R_G = 22\Omega$; $V_{GE} = 15\text{V}$

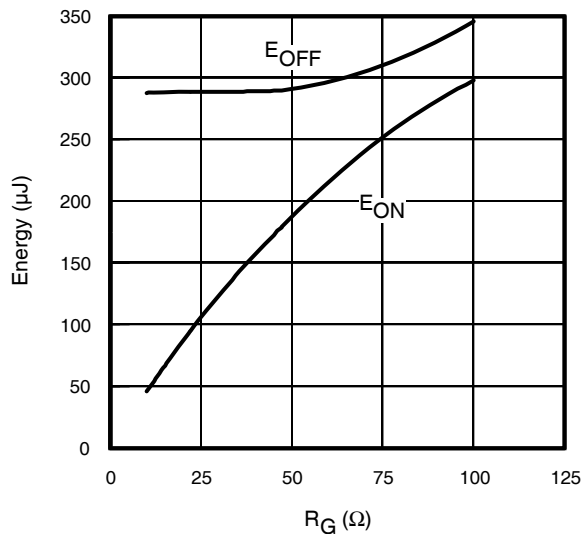


Fig. 15 - Typ. Energy Loss vs. R_G
 $T_J = 175^\circ\text{C}$; $L = 1\text{mH}$; $V_{CE} = 400\text{V}$; $I_{CE} = 10\text{A}$; $V_{GE} = 15\text{V}$

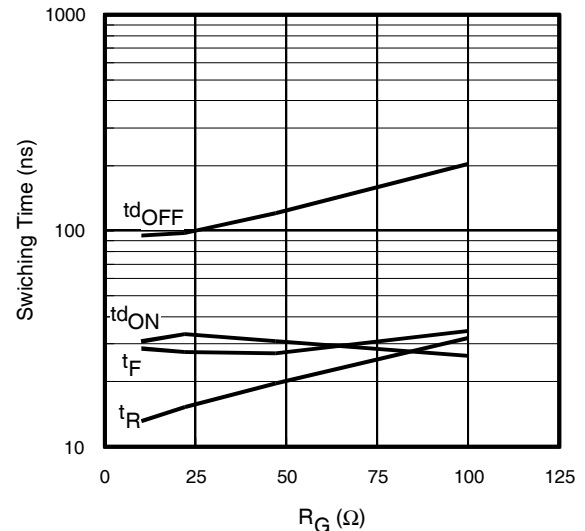


Fig. 16 - Typ. Switching Time vs. R_G
 $T_J = 175^\circ\text{C}$; $L = 1\text{mH}$; $V_{CE} = 400\text{V}$
 $I_{CE} = 10\text{A}$; $V_{GE} = 15\text{V}$

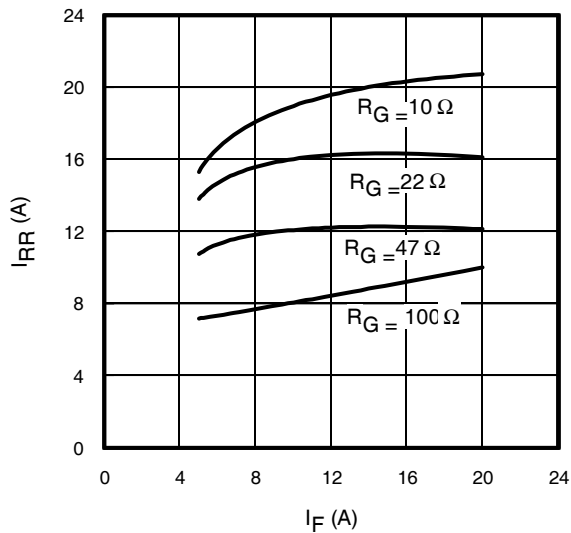


Fig. 17 - Typical Diode I_{RR} vs. I_F
 $T_J = 175^\circ\text{C}$

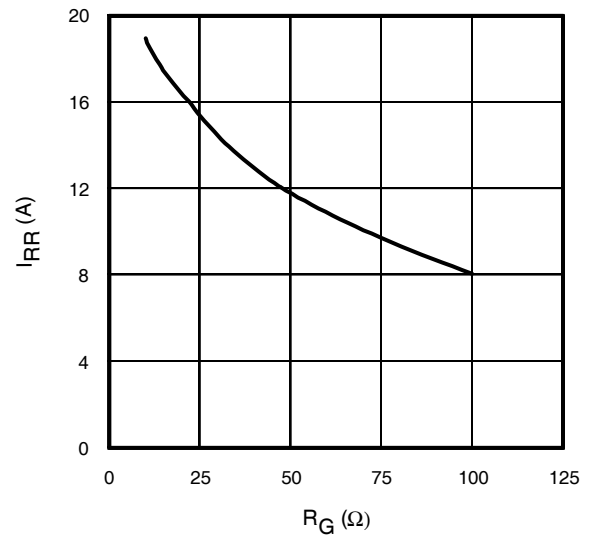


Fig. 18 - Typical Diode I_{RR} vs. R_G
 $T_J = 175^\circ\text{C}$; $I_F = 10\text{A}$

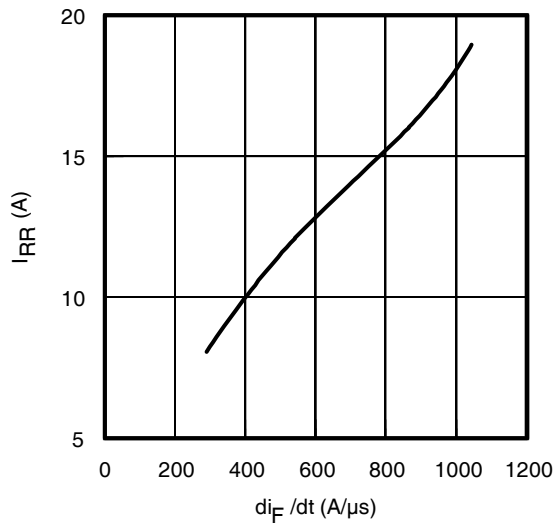


Fig. 19 - Typical Diode I_{RR} vs. di_F/dt
 $V_{CC}=400V$; $V_{GE}=15V$;
 $I_{CE}=10A$; $T_J=175^{\circ}C$

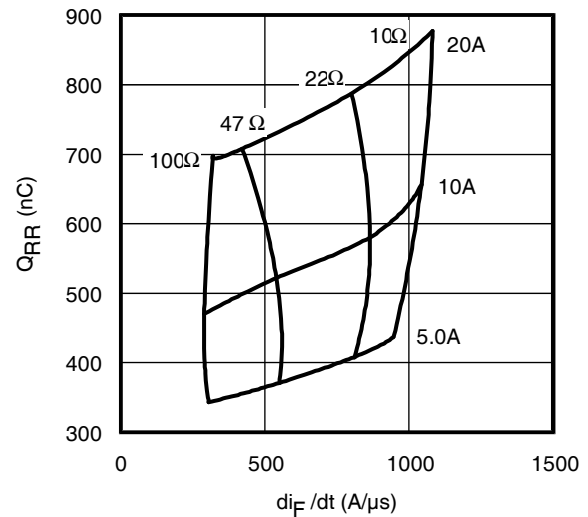


Fig. 20 - Typical Diode Q_{RR}
 $V_{CC}=400V$; $V_{GE}=15V$; $T_J=175^{\circ}C$

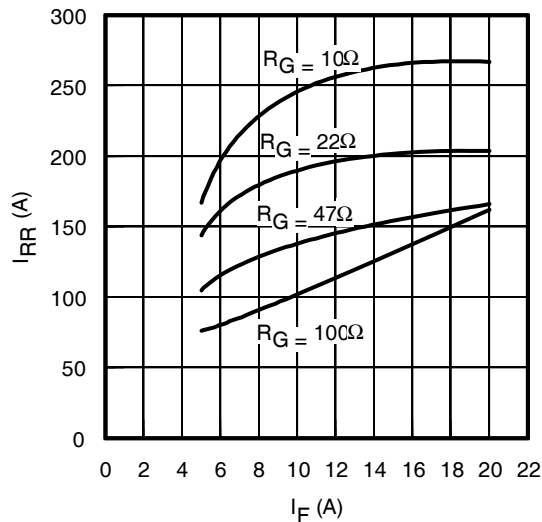


Fig. 21 - Typical Diode E_{RR} vs. I_F
 $T_J=175^{\circ}C$

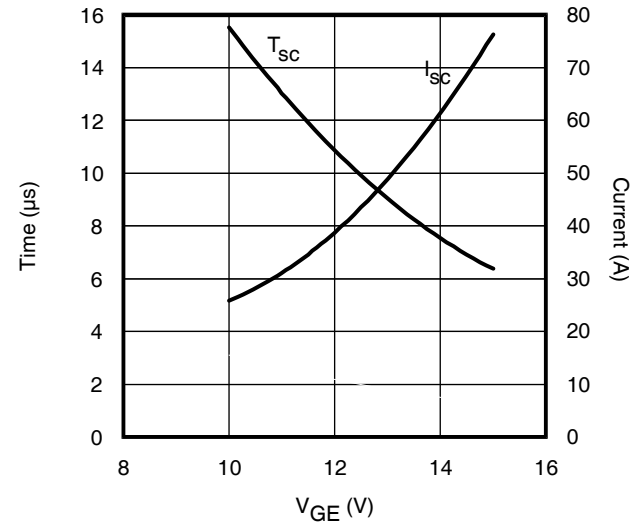


Fig. 22 - Typ. V_{GE} vs Short Circuit Time
 $V_{CC}=400V$, $T_C=25^{\circ}C$

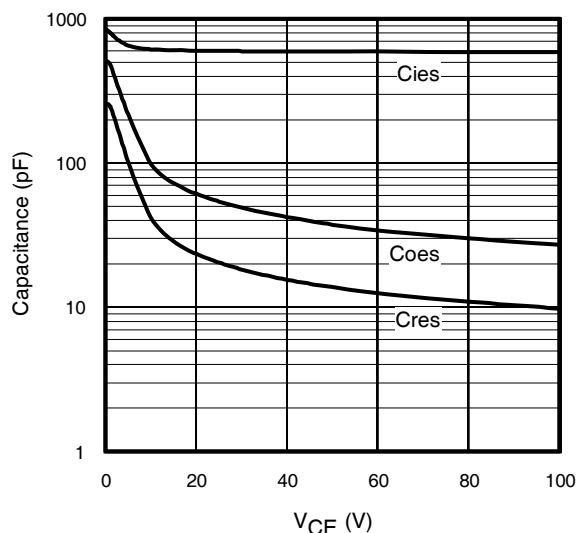


Fig. 23 - Typ. Capacitance vs. V_{CE}
 $V_{GE}=0V$; $f=1MHz$

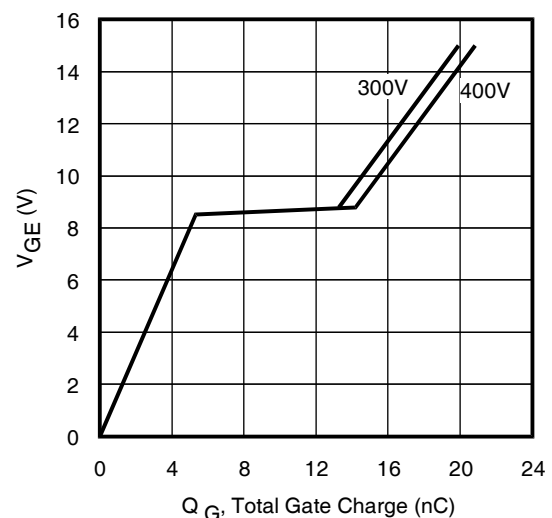


Fig. 24 - Typical Gate Charge vs. V_{GE}
 $I_{CE}=10A$, $L=600\mu H$

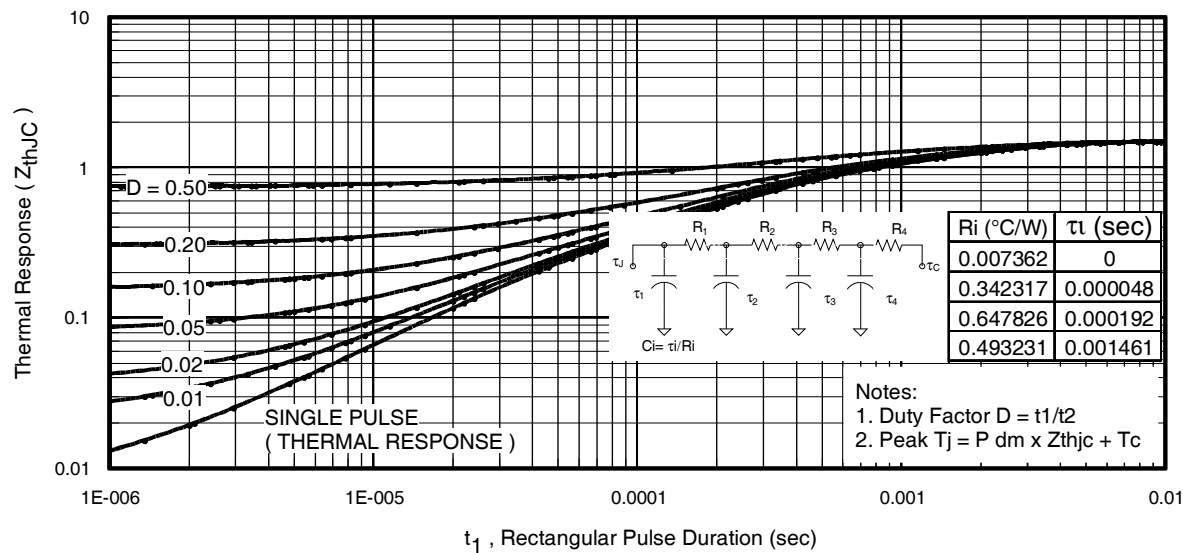


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

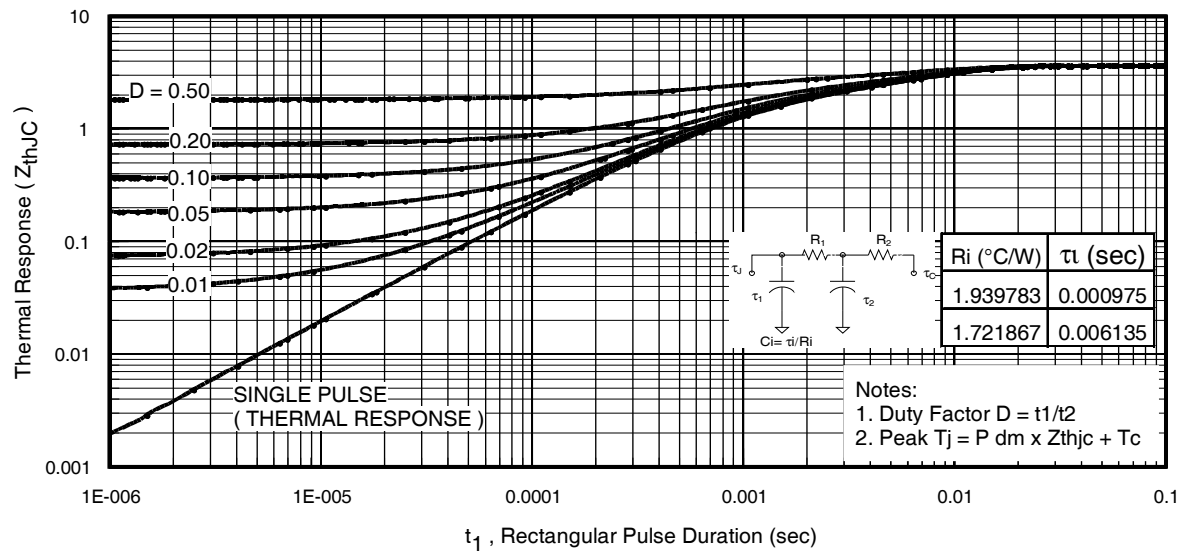


Fig. 26. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

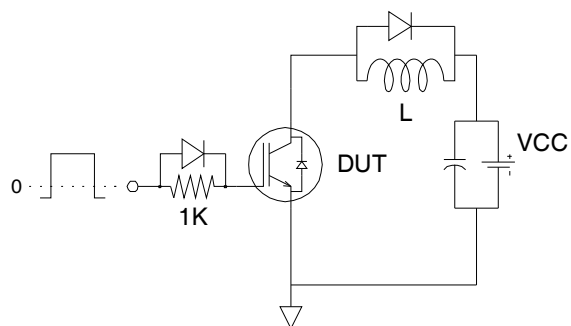


Fig.C.T.1 - Gate Charge Circuit (turn-off)

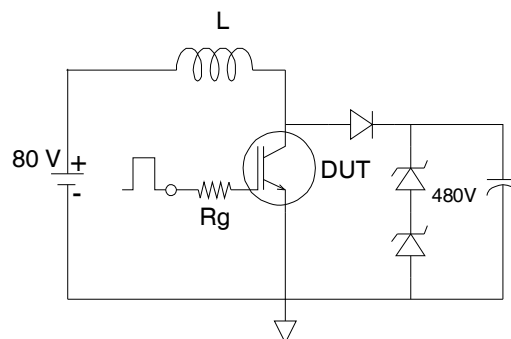


Fig.C.T.2 - RBSOA Circuit

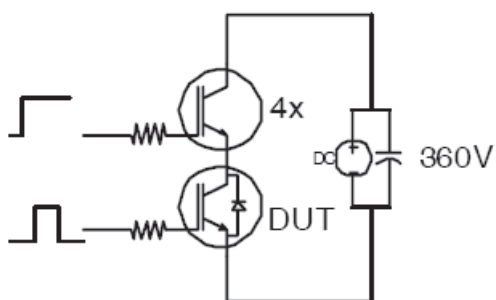


Fig.C.T.3 - S.C.SOA Circuit

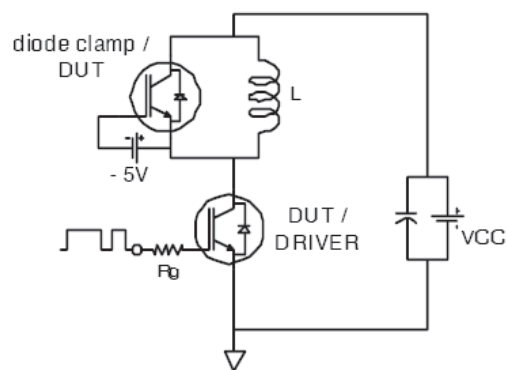


Fig.C.T.4 - Switching Loss Circuit

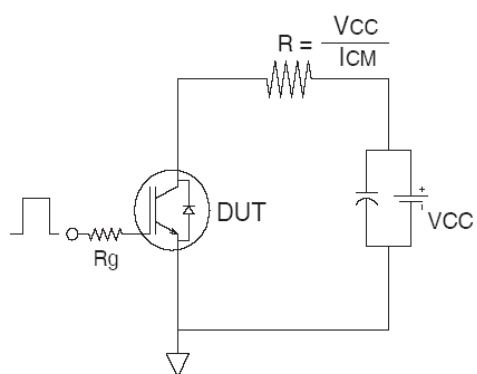


Fig.C.T.5 - Resistive Load Circuit

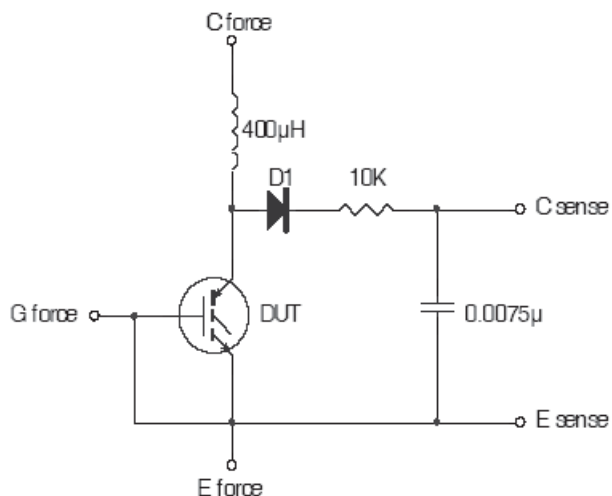


Fig.C.T.6 - Typical Filter Circuit for $V_{(BR)CES}$ Measurement

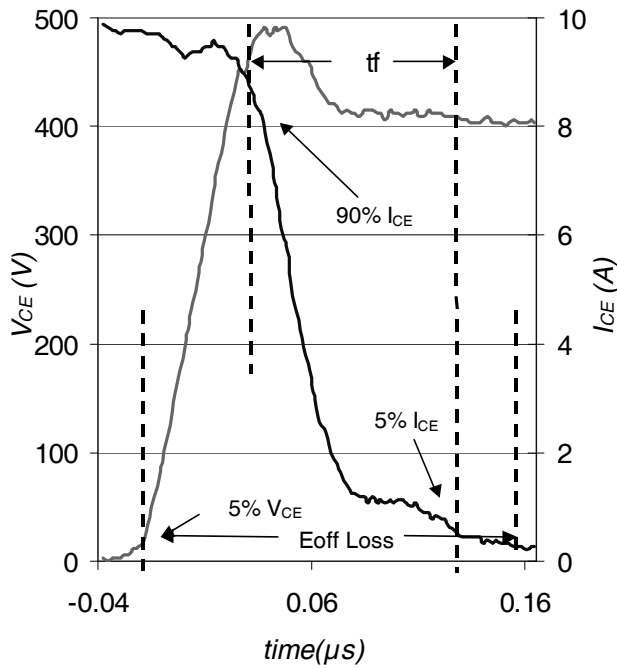


Fig. WF1 - Typ. Turn-off Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

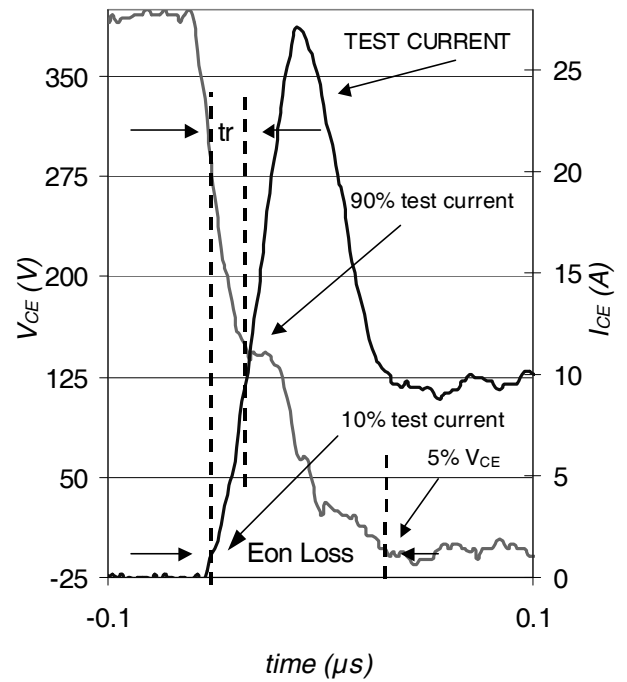
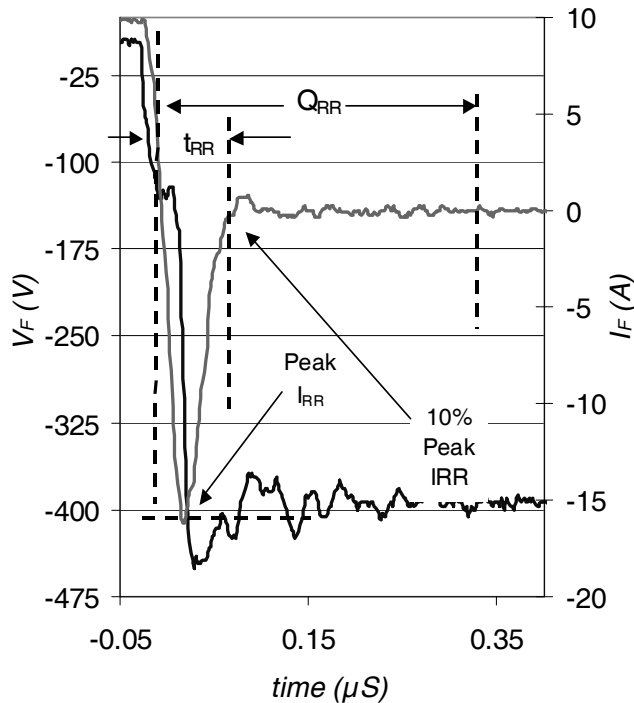
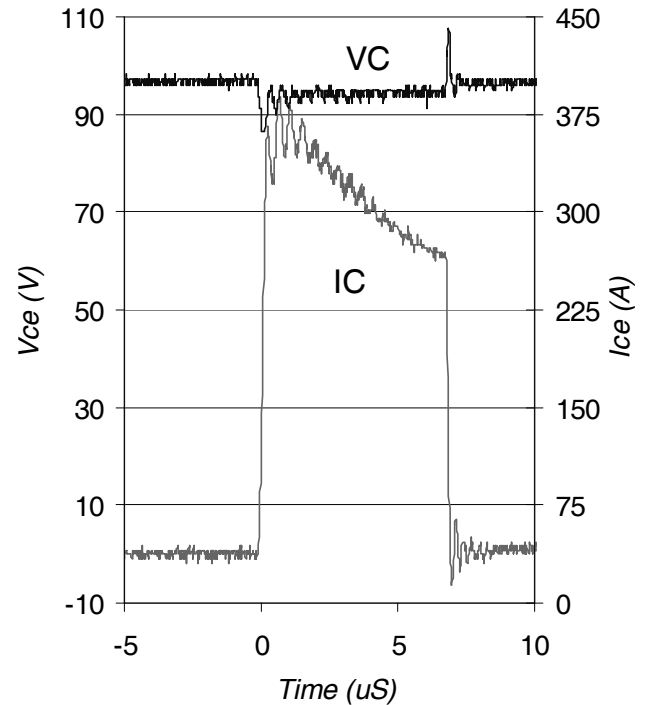


Fig. WF2 - Typ. Turn-on Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

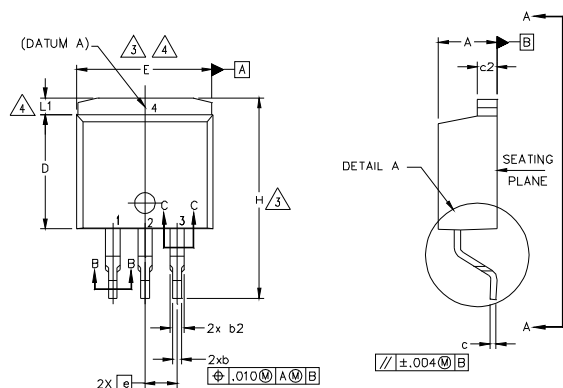


WF.3- Typ. Reverse Recovery Waveform
@ $T_J = 175^\circ\text{C}$ using CT.4



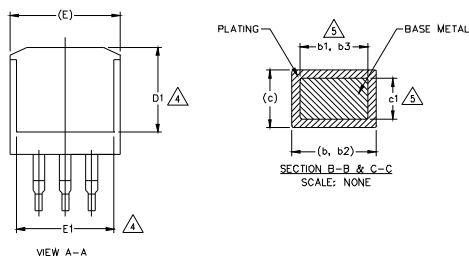
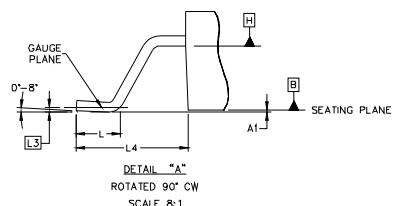
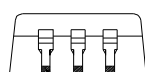
WF.4- Typ. Short Circuit Waveform
@ $T_J = 25^\circ\text{C}$ using CT.3

D²Pak 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	5
c	0.38	0.74	.015	.029	5
c1	0.38	0.58	.015	.023	
c2	1.14	1.65	.045	.065	3
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		4
H	14.61	15.88	.575	.625	
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

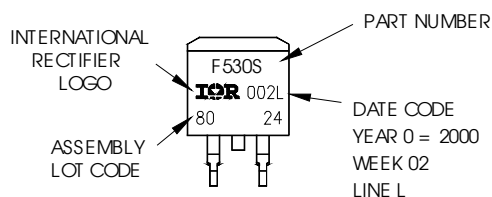
- 1.— ANODE *
- 2, 4.— CATHODE
- 3.— ANODE

* PART DEPENDENT.

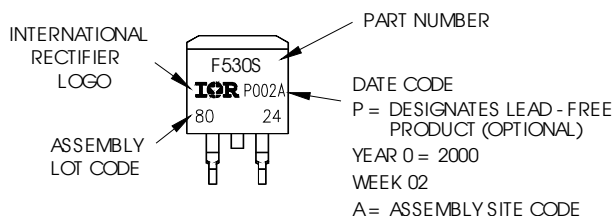
D²Pak Part Marking Information

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

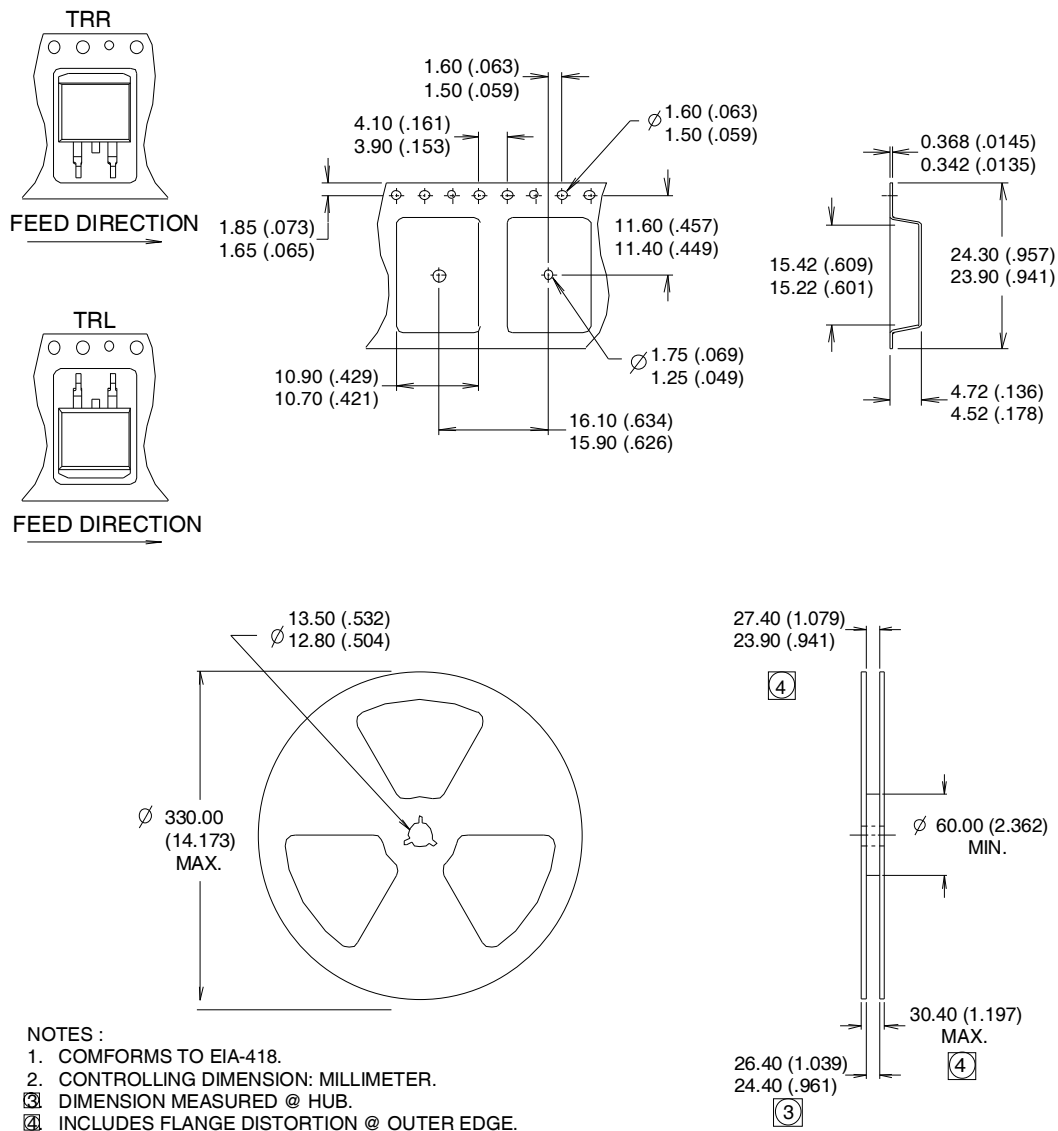
Note: "P" in assembly line position
indicates "Lead - Free"



OR



D²Pak Tape & Reel Information



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.

International
IOR Rectifier

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