

IRGS4064DPbF

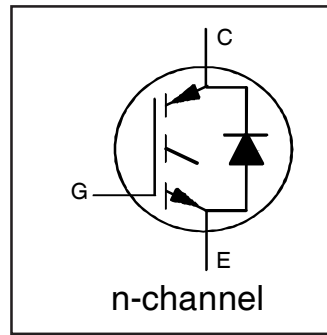
INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Features

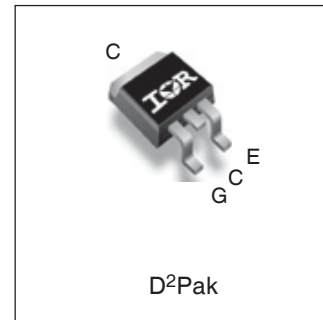
- Low $V_{CE(on)}$ Trench IGBT Technology
- Low Switching Losses
- Maximum Junction temperature 175 °C
- 5 μ s SCSOA
- Square RBSOA
- 100% of The Parts Tested for (I_{LM})
- Positive $V_{CE(on)}$ Temperature Coefficient.
- Ultra Fast Soft Recovery Co-pak Diode
- Tighter Distribution of Parameters
- Lead-Free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



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



G	C	E
Gate	Collector	Emitter

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Breakdown Voltage	600	V
$I_C @ T_C = 25^\circ C$	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	± 20	V
	Transient Gate-to-Emitter Voltage	± 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	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

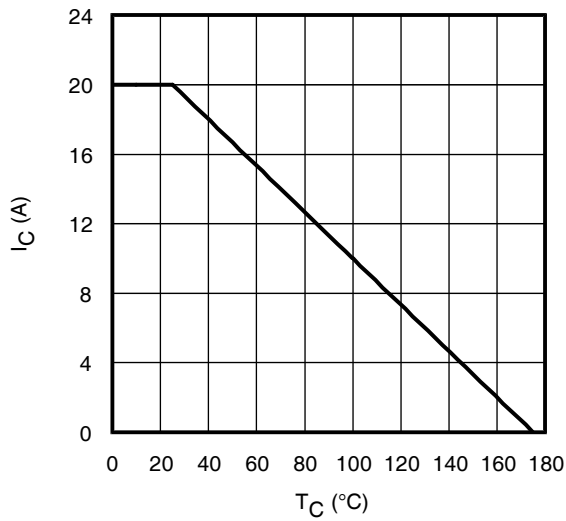


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

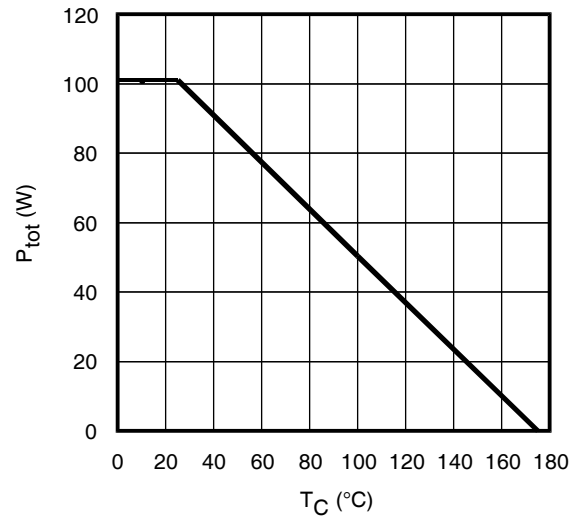


Fig. 2 - Power Dissipation vs. Case Temperature

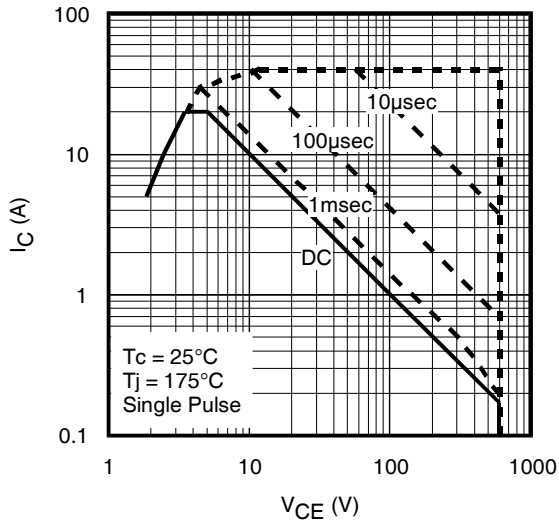


Fig. 3 - Forward SOA,
 $T_C = 25^\circ\text{C}$; $T_J \leq 175^\circ\text{C}$

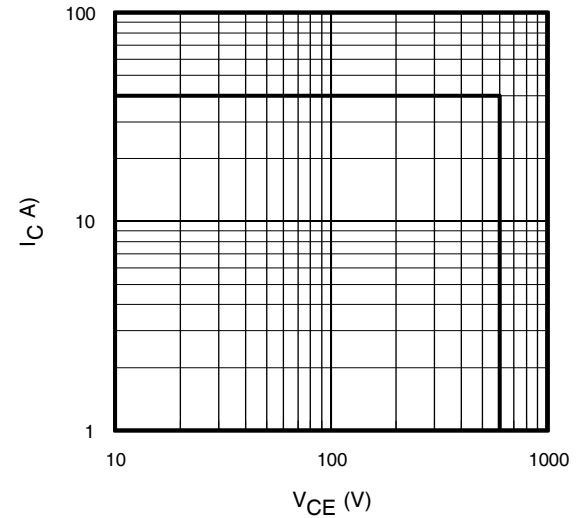


Fig. 4 - Reverse Bias SOA
 $T_J = 175^\circ\text{C}$; $V_{CE} = 15\text{V}$

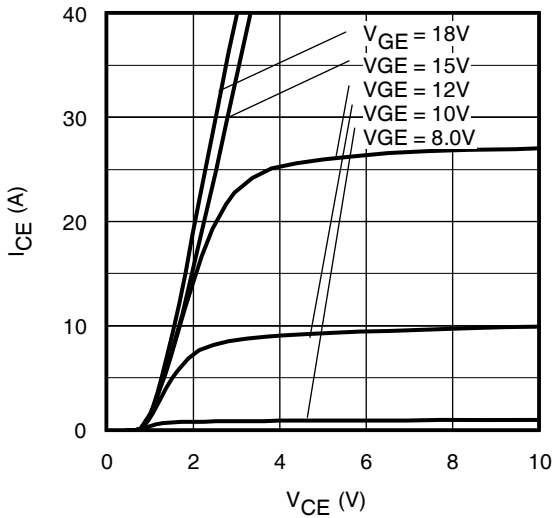


Fig. 5 - Typ. IGBT Output Characteristics
 $T_J = -40^\circ\text{C}$; $t_p = 80\mu\text{s}$

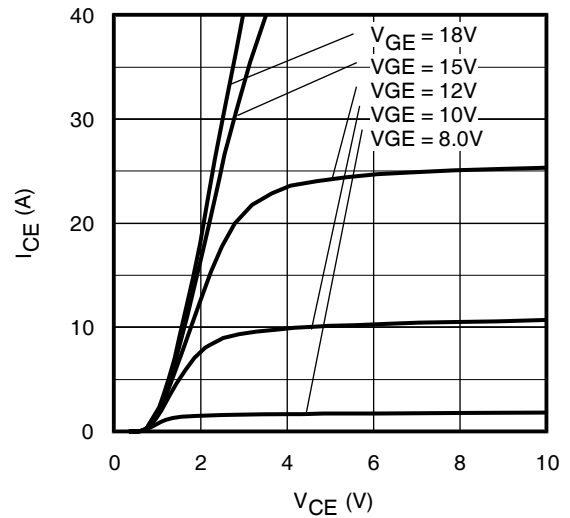


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = 25^\circ\text{C}$; $t_p = 80\mu\text{s}$

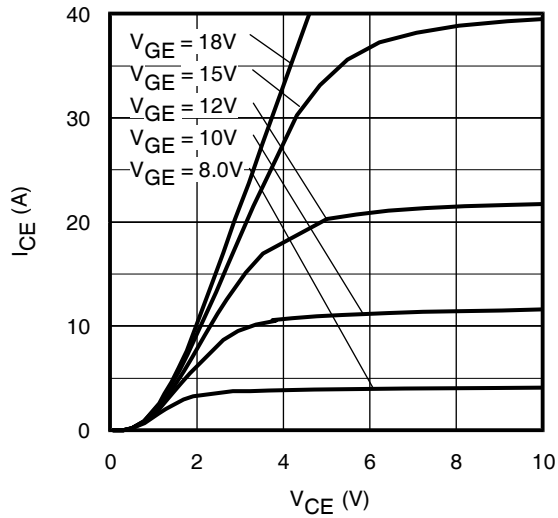


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 175^\circ\text{C}$; $t_p = 80\mu\text{s}$

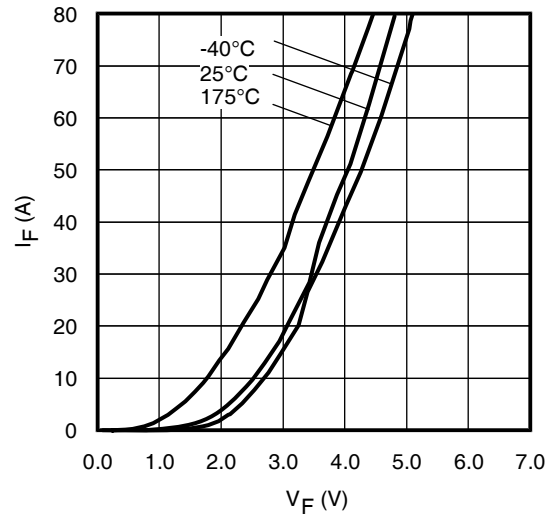


Fig. 8 - Typ. Diode Forward Characteristics
 $t_p = 80\mu\text{s}$

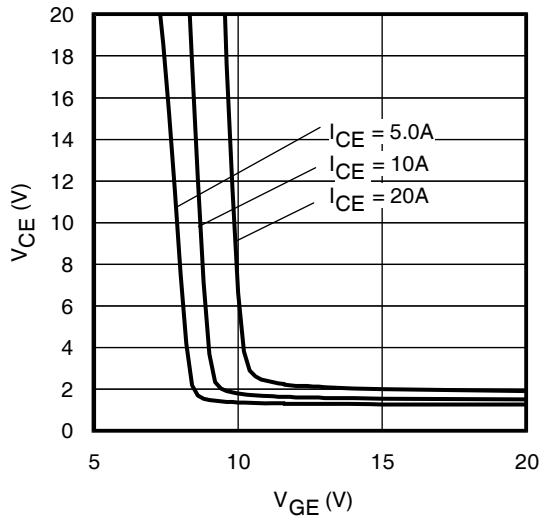


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^\circ\text{C}$

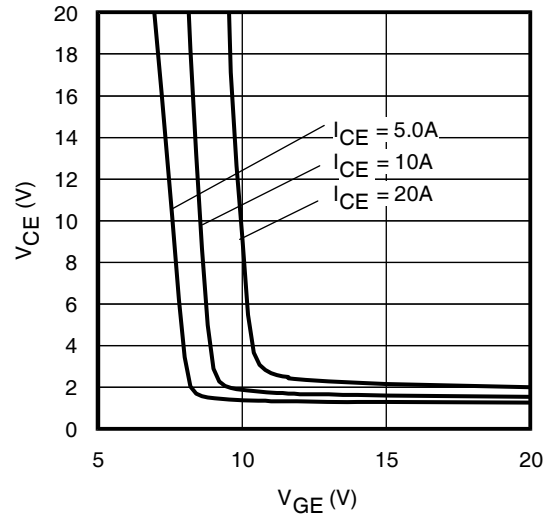


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

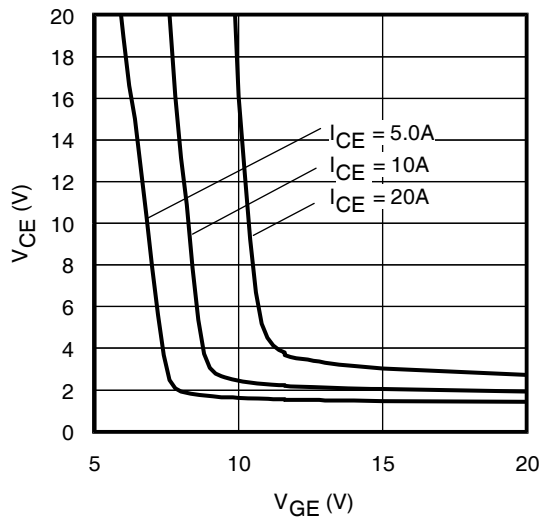


Fig. 11 - Typical V_{CE} vs. V_{GE}
 $T_J = 175^\circ\text{C}$

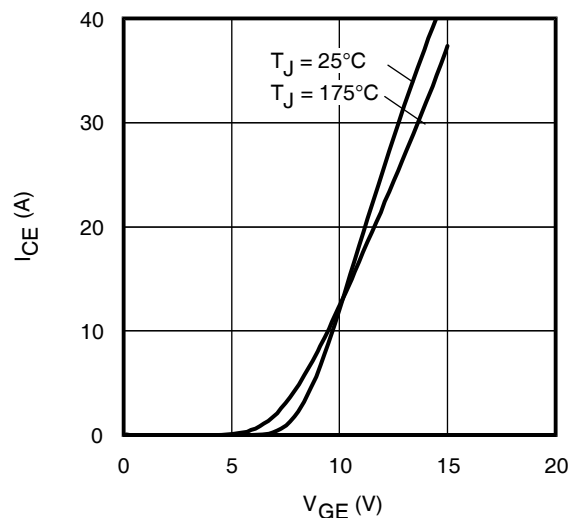


Fig. 12 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 10\mu\text{s}$

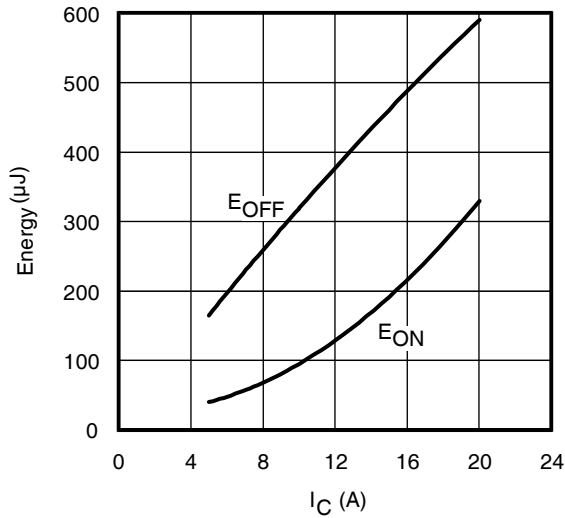


Fig. 13 - Typ. Energy Loss vs. I_C
 $T_J = 175^\circ\text{C}$; $L = 1\text{mH}$; $V_{CE} = 400\text{V}$, $R_G = 22\Omega$; $V_{GE} = 15\text{V}$.

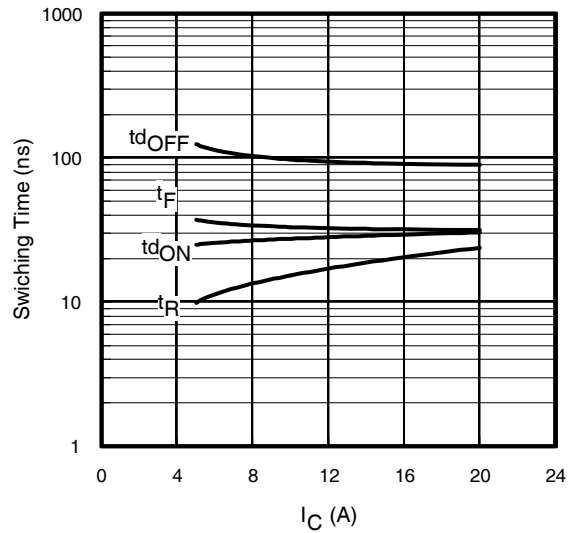


Fig. 14 - Typ. Switching Time vs. I_C
 $T_J = 175^\circ\text{C}$; $L = 1\text{mH}$; $V_{CE} = 400\text{V}$
 $R_G = 22\Omega$; $V_{GE} = 15\text{V}$

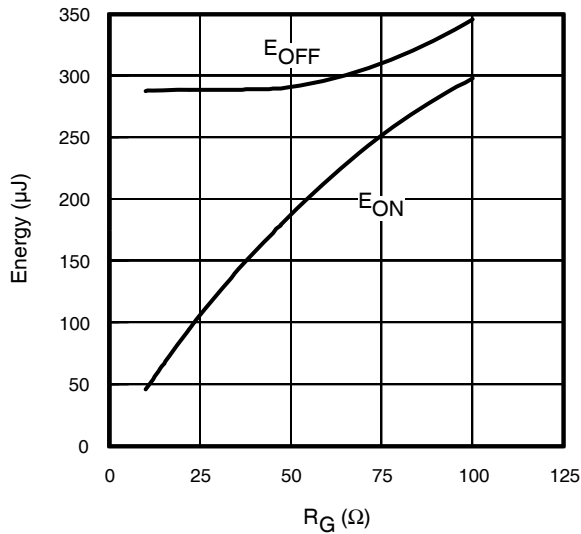


Fig. 15 - Typ. Energy Loss vs. R_G
 $T_J = 175^\circ\text{C}$; $L = 1\text{mH}$; $V_{CE} = 400\text{V}$, $I_{CE} = 10\text{A}$; $V_{GE} = 15\text{V}$

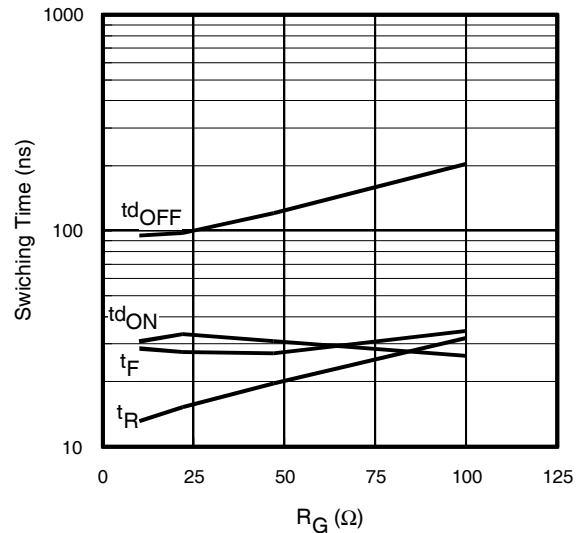


Fig. 16 - Typ. Switching Time vs. R_G
 $T_J = 175^\circ\text{C}$; $L = 1\text{mH}$; $V_{CE} = 400\text{V}$
 $I_{CE} = 10\text{A}$; $V_{GE} = 15\text{V}$

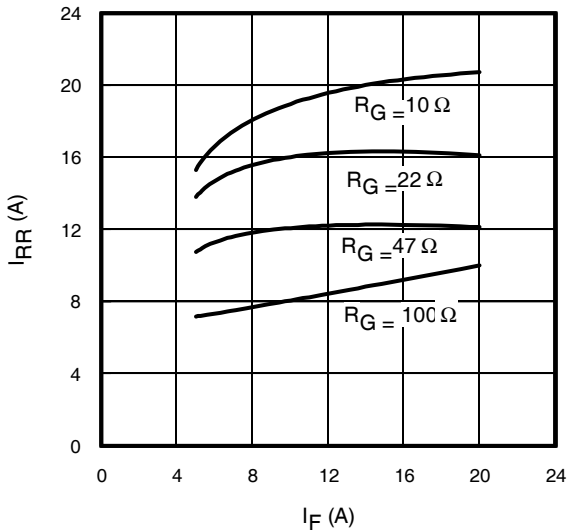


Fig. 17 - Typical Diode I_{RR} vs. I_F
 $T_J = 175^\circ\text{C}$

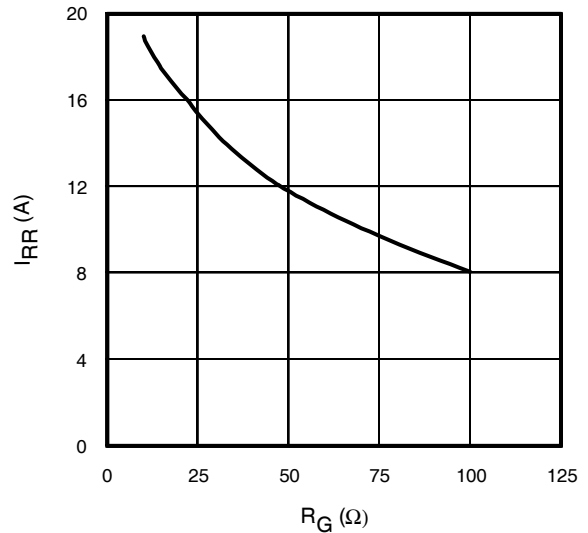


Fig. 18 - Typical Diode I_{RR} vs. R_G
 $T_J = 175^\circ\text{C}$; $I_F = 10\text{A}$

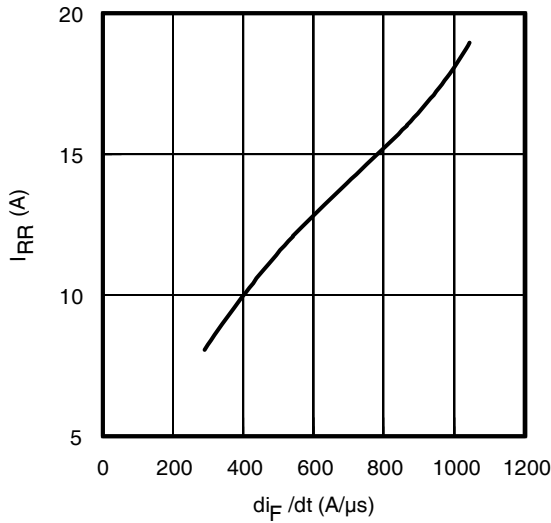


Fig. 19- Typical Diode I_{RR} vs. di_F/dt
 $V_{CC}=400V$; $V_{GE}=15V$;
 $I_{CE}=10A$; $T_J=175^\circ C$

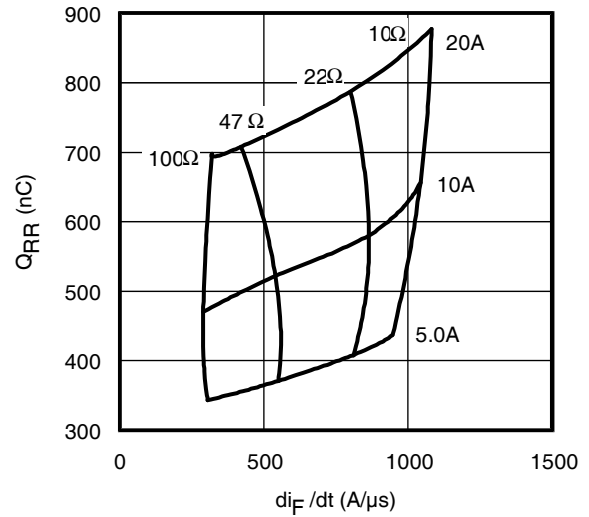


Fig. 20 - Typical Diode Q_{RR}
 $V_{CC}=400V$; $V_{GE}=15V$; $T_J=175^\circ C$

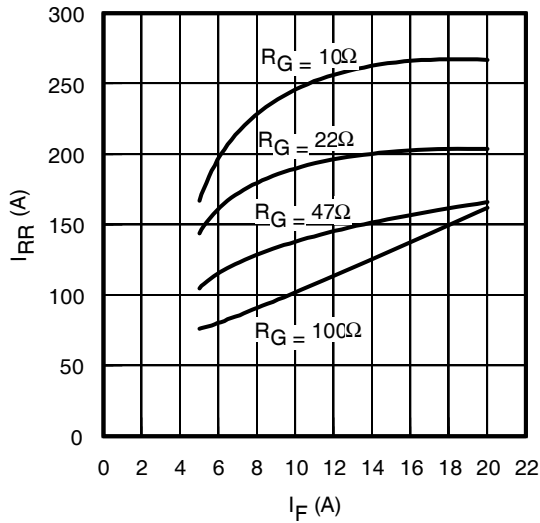


Fig. 21 - Typical Diode E_{RR} vs. I_F
 $T_J=175^\circ C$

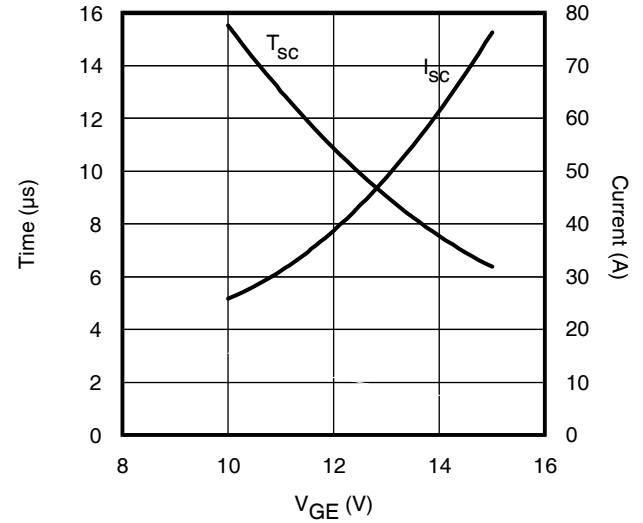


Fig. 22- Typ. V_{GE} vs Short Circuit Time
 $V_{CC}=400V$, $T_C=25^\circ C$

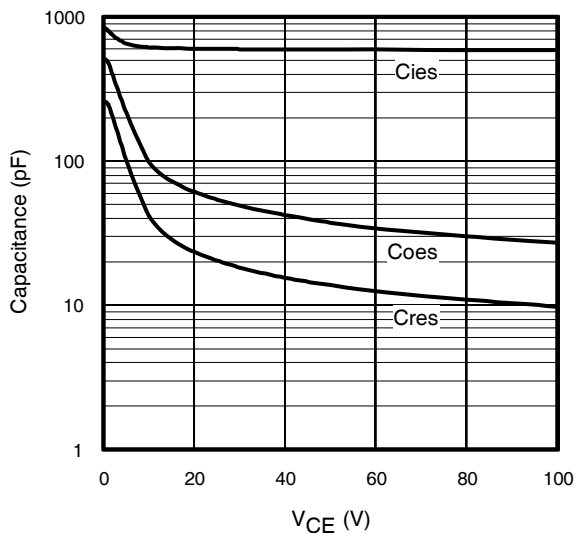


Fig. 23- Typ. Capacitance vs. V_{CE}
 $V_{GE}=0V$; $f=1MHz$

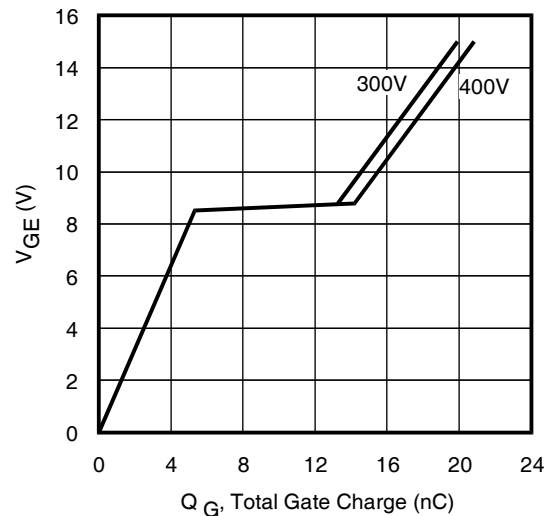


Fig. 24 - Typical Gate Charge vs. V_{GE}
 $I_{CE}=10A$, $L=600\mu H$

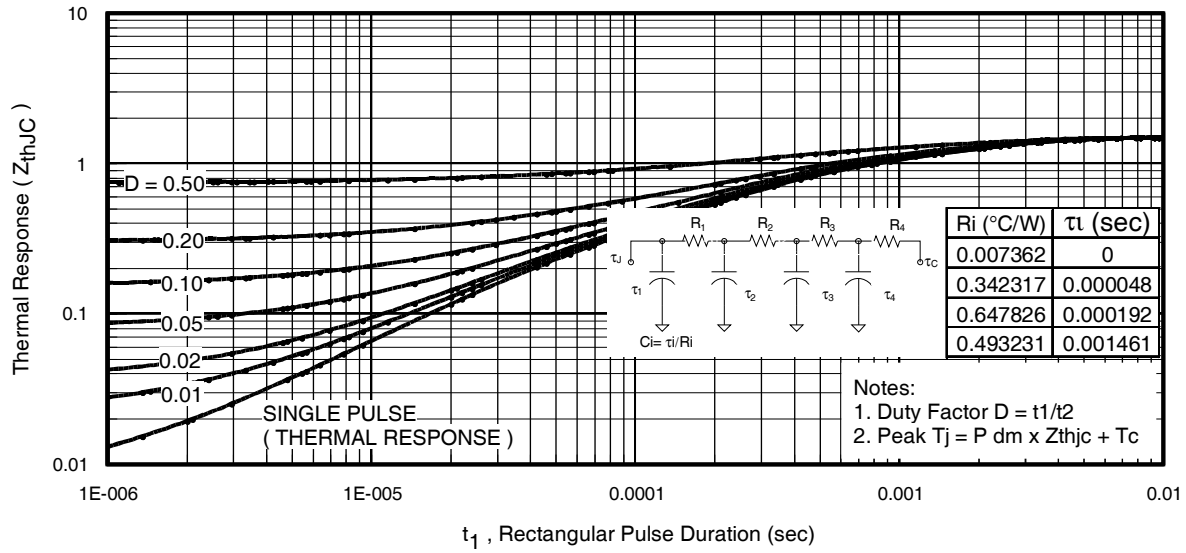


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

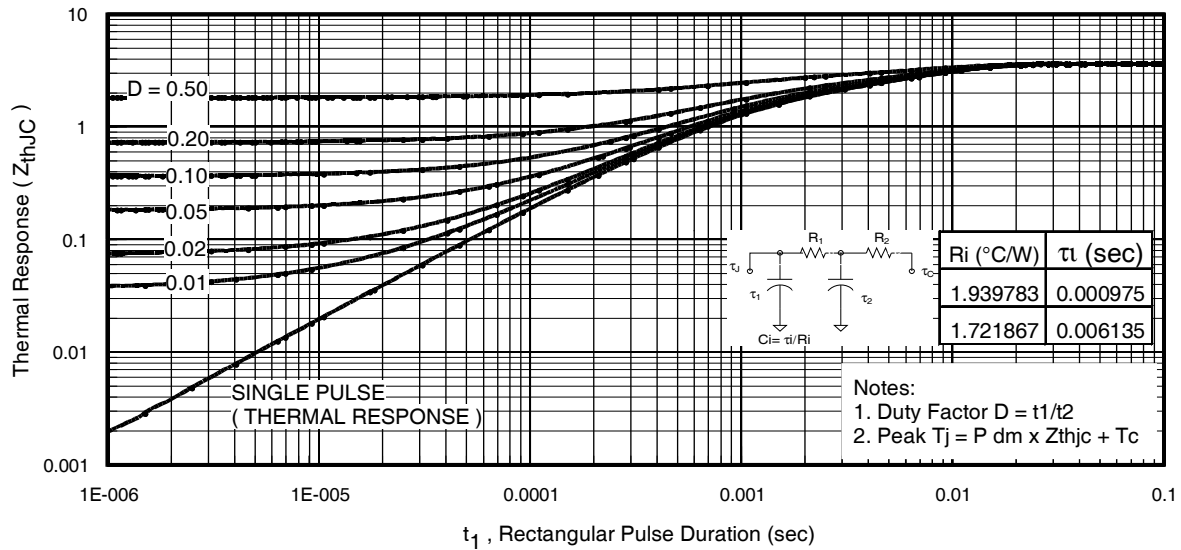


Fig. 26. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

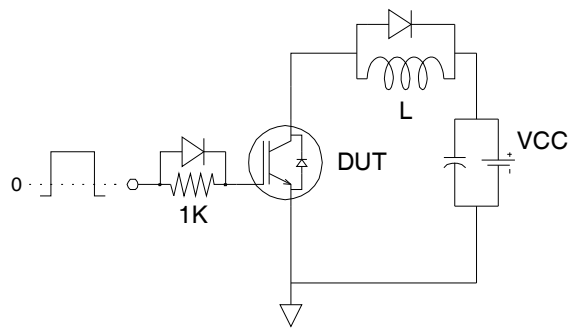


Fig.C.T.1 - Gate Charge Circuit (turn-off)

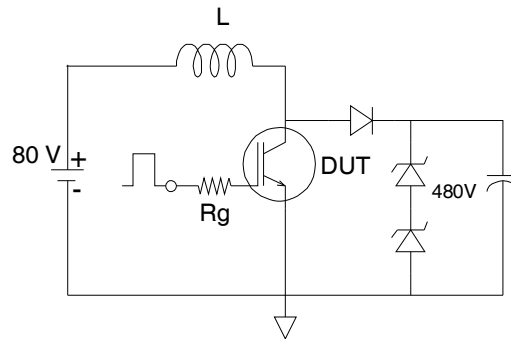


Fig.C.T.2 - RBSOA Circuit

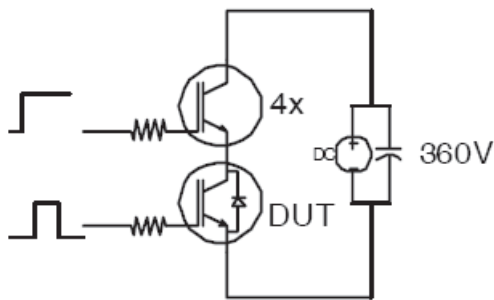


Fig.C.T.3 - S.C.SOA Circuit

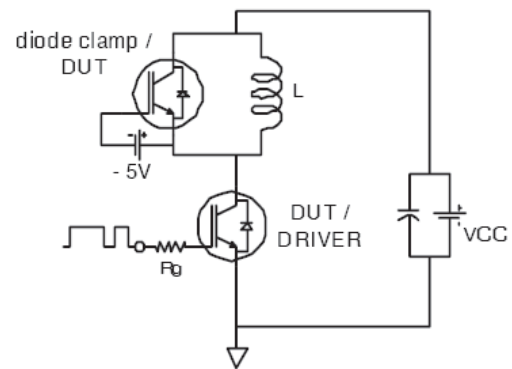


Fig.C.T.4 - Switching Loss Circuit

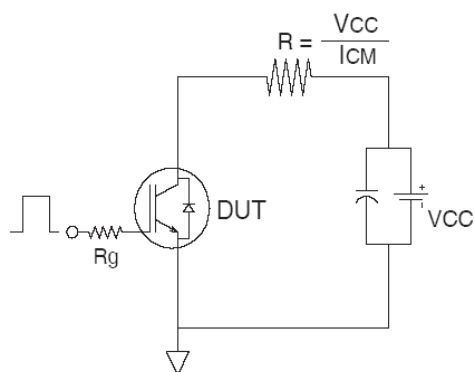


Fig.C.T.5 - Resistive Load Circuit

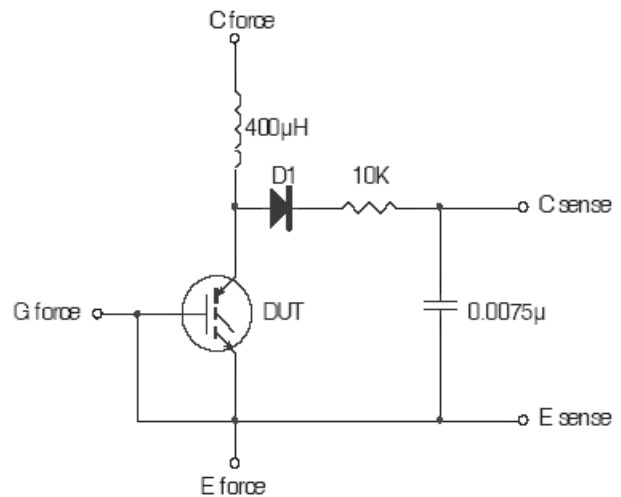


Fig.C.T.6 - Typical Filter Circuit for $V_{(BR)CES}$ Measurement

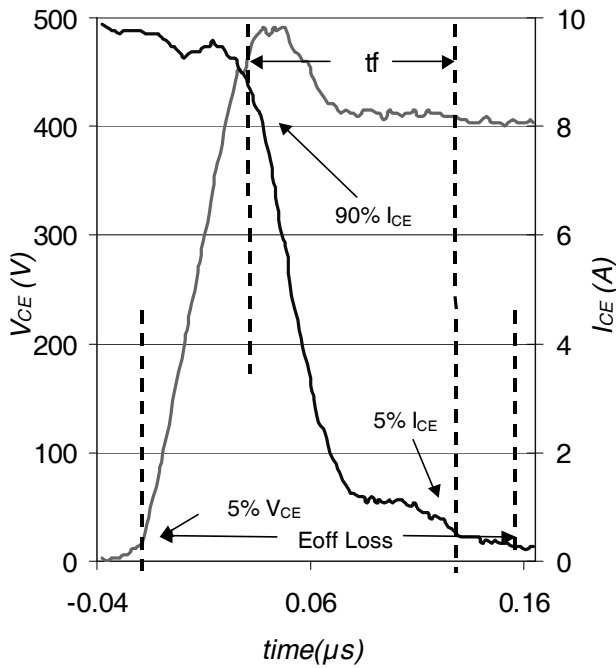


Fig. WF1 - Typ. Turn-off Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

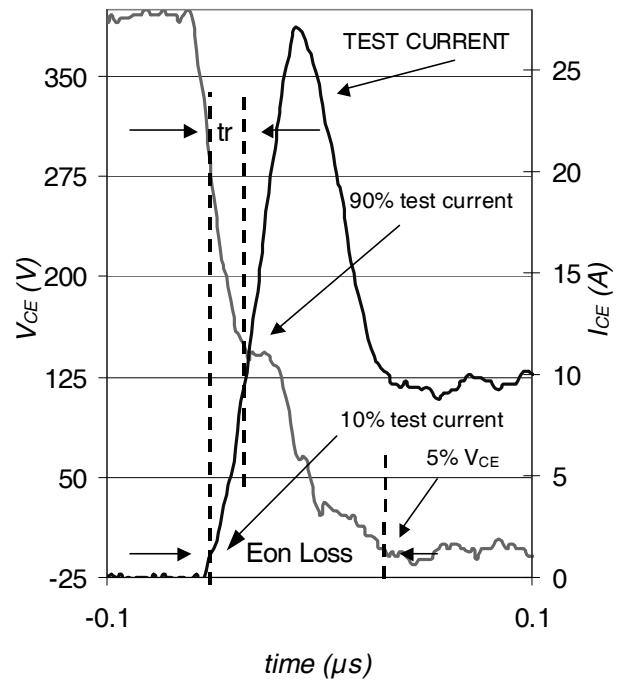
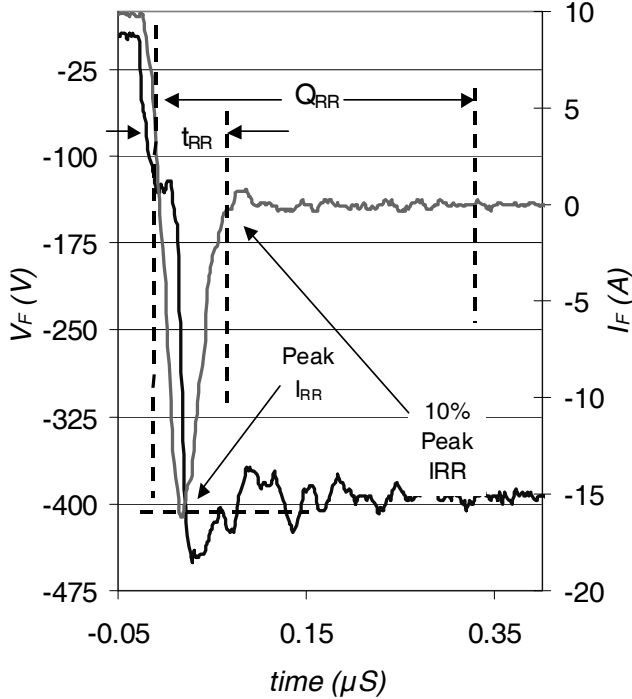
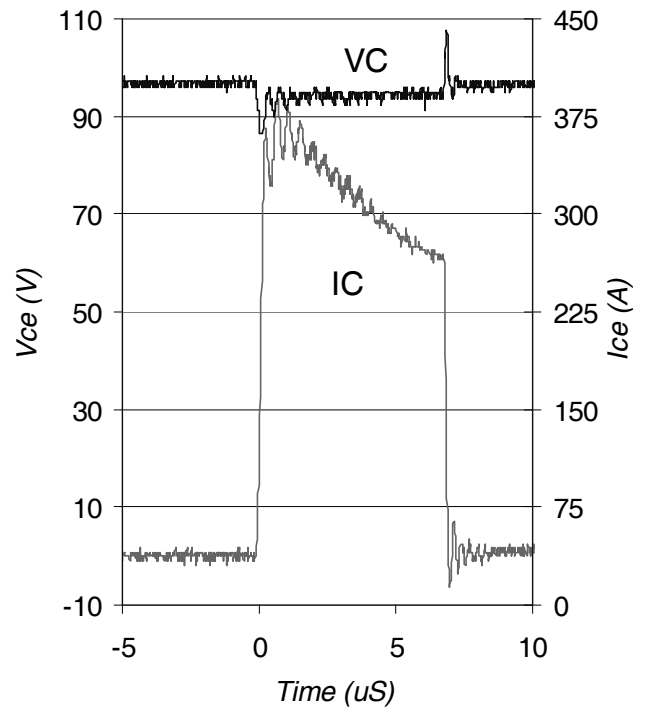


Fig. WF2 - Typ. Turn-on Loss Waveform
@ $T_J = 175^\circ\text{C}$ using Fig. CT.4

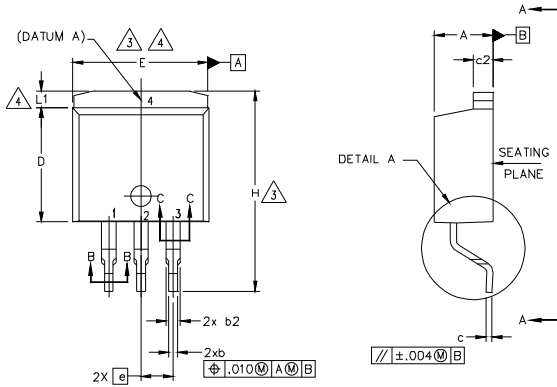


WF.3- Typ. Reverse Recovery Waveform
@ $T_J = 175^\circ\text{C}$ using CT.4



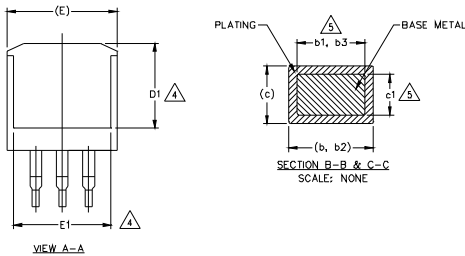
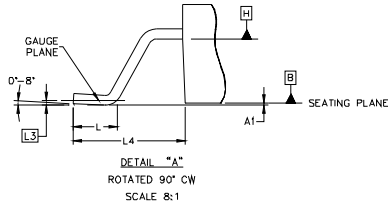
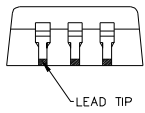
WF.4- Typ. Short Circuit Waveform
@ $T_J = 25^\circ\text{C}$ using CT.3

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.



SYMBOLOL	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		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		4
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

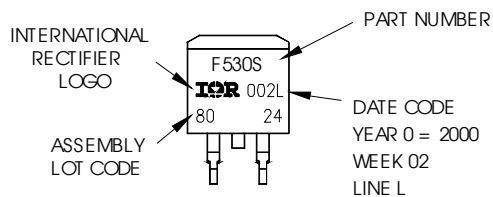
- 1.- ANODE *
- 2, 4.- CATHODE
- 3.- ANODE

* PART DEPENDENT.

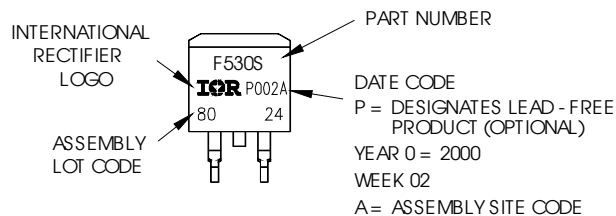
D²Pak Part Marking Information

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

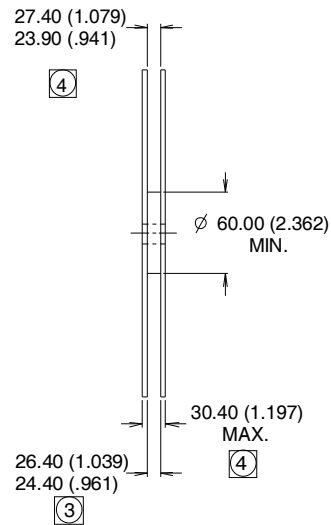
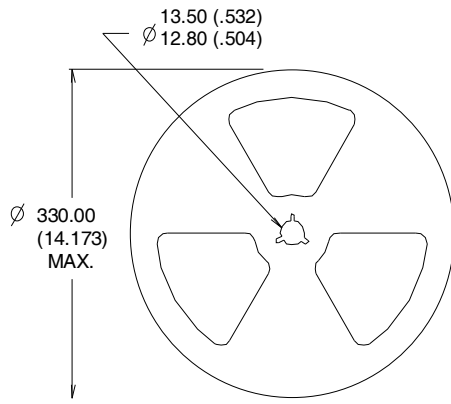
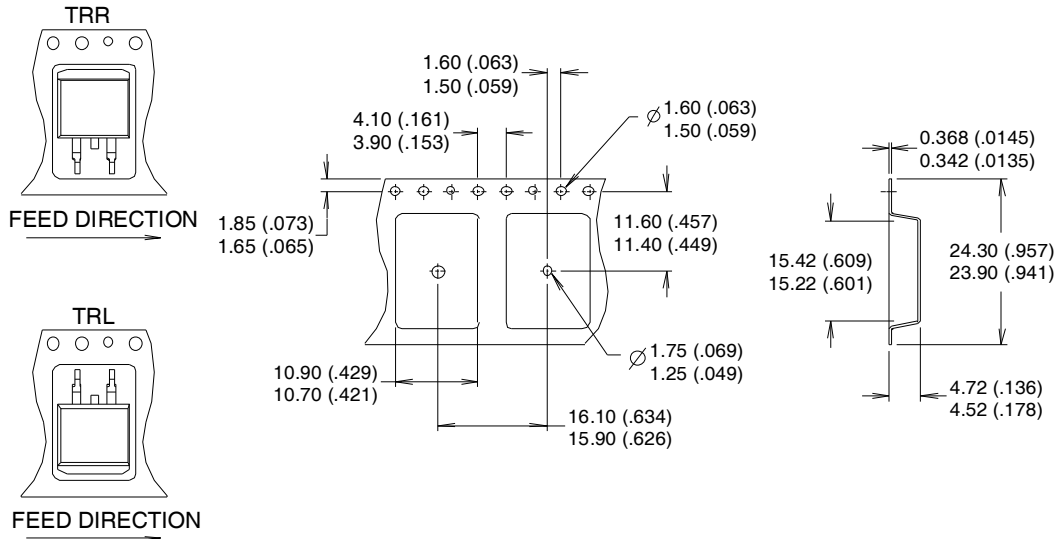
Note: "P" in assembly line position
indicates "Lead - Free"



OR



D²Pak Tape & Reel Information



- 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.