International
IOR Rectifier

IRGS4045DPbF

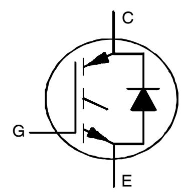
INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

V_{CES} = 600V

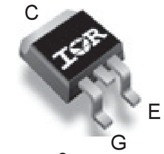
I_C = 6.0A, T_C = 100°C

t_{sc} > 5μs, T_{jmax} = 175°C

$V_{CE(on)\ typ.}$ = 1.7V



n-channel



D^2-Pak
IRGS4045DPbF

G	C	E
Gate	Colletor	Emitter

Applications
- Appliance Motor Drive
- Inverters
- SMPS

Features	→	Benefits
Low $V_{CE(ON)}$ and switching losses		High efficiency in a wide range of applications and switching frequencies
Square RBSOA and maximum junction temperature 175°C		Improved reliability due to rugged hard switching performance and higher power capability
Positive $V_{CE(ON)}$ temperature coefficient and tighter distribution of parameters		Excellent current sharing in parallel operation
5μs short circuit SOA		Enables short circuit protection scheme
Ultra fast soft recovery copak diode		Performance optimized for motor drive operation
Lead-free, RoHS compliant		Environmentally friendly

Base part number	Package Type	Standard Pack		Orderable Part Number
		Form	Quantity	
IRGS4045DPbF	D2Pak	Tube	50	IRGS4045DPbF
		Tape and Reel Left	800	IRGS4045DTRLPbF
		Tape and Reel Right	800	IRGS4045DTRRPbF

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Breakdown Voltage	600	V
I_C@ T_C = 25°C	Continuous Collector Current	12	A
I_C@ T_C = 100°C	Continuous Collector Current	6.0	
I_{CM}	Pulsed Collector Current, V_{GE} = 15V	18	
I_{LM}	Clamped Inductive Load Current, V_{GE} = 20V ①	24	
I_F@T_C=25°C	Diode Continuous Forward Current	8.0	
I_F@T_C=100°C	Diode Continuous Forward Current	4.0	
I_{FM}	Diode Maximum Forward Current ②	24	
V_{GE}	Continuous Gate-to-Emitter Voltage	± 20	V
	Transient Gate-to-Emitter Voltage	± 30	
P_D @ T_C =25°	Maximum Power Dissipation	77	W
P_D @ T_C =100°	Maximum Power Dissipation	39	
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 175	°C
	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	—	—	1.9	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode ③	—	—	6.3	
$R_{\theta CS}$	Case-to-Sink, Flat, Greased Surface	—	0.5	—	
$R_{\theta JA}$	Junction-to-Ambient (PCB Mountet, steady-state) ⑤	—	—	40	

*Qualification standards can be found at http://www.irf.com/

Electrical Characteristics @ T_J = 25°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 μA ④
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.36	—	V/°C	V_{GE} = 0V, I_c = 250μA (25 -175 °C) ④
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.7	2.0	V	I_C = 6.0A, V_{GE} = 15V, T_J = 25°C
		—	2.07	—		I_C = 6.0A, V_{GE} = 15V, T_J = 150°C
		—	2.14	—		I_C = 6.0A, V_{GE} = 15V, T_J = 175°C
$V_{GE(th)}$	Gate Threshold Voltage	4.0	—	6.5	V	V_{CE} = V_{GE}, I_C = 150μA
$\Delta V_{GE(th)}/\Delta TJ$	Threshold Voltage temp. coefficient	—	-13	—	mV/°C	V_{CE} = V_{GE}, I_C = 250μA (25 -175 °C)
gfe	Forward Transconductance	—	5.8	—	S	V_{CE} = 25V, I_C = 6.0A, PW =80μs
I_{CES}	Collector-to-Emitter Leakage Current	—	—	25	μA	V_{GE} = 0V,V_{CE} = 600V
		—	—	250		V_{GE} = 0V, V_{CE} = 600V, T_J =175°C
V_{FM}	Diode Forward Voltage Drop	—	1.60	2.30	V	I_F = 6.0A
		—	1.30	—		I_F = 6.0A, T_J = 175°C
I_{GES}	Gate-to-Emitter Leakage Current	—	—	±100	nA	V_{GE} = ± 20 V

Switching Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.⑥	Units	Conditions
Q_g	Total Gate Charge (turn-on)	—	13	19.5	nC	I_C = 6.0A
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	3.1	4.65		V_{CC} = 400V
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	6.4	9.6		V_{GE} = 15V
E_{on}	Turn-On Switching Loss	—	56	86	μJ	I_C = 6.0A, V_{CC} = 400V, V_{GE} = 15V
E_{off}	Turn-Off Switching Loss	—	122	143		R_G = 47Ω, L=1mH, L_S= 150nH, T_J = 25°C
E_{total}	Total Switching Loss	—	178	229		Energy losses include tail and diode reverse recovery
$t_{d(on)}$	Turn-On delay time	—	27	35	ns	I_C = 6.0A, V_{CC} = 400V
t_r	Rise time	—	11	15		R_G = 47Ω, L=1mH, L_S= 150nH
$t_{d(off)}$	Turn-Off delay time	—	75	93		T_J = 25°C
t_f	Fall time	—	17	22		
E_{on}	Turn-On Switching Loss	—	140	—	μJ	I_C = 6.0A, V_{CC} = 400V, V_{GE} = 15V
E_{off}	Turn-Off Switching Loss	—	189	—		R_G = 47Ω, L=1mH, L_S= 150nH, T_J = 175°C
E_{total}	Total Switching Loss	—	329	—		Energy losses include tail and diode reverse recovery
$t_{d(on)}$	Turn-On delay time	—	26	—	ns	I_C = 6.0A, V_{CC} = 400V
t_r	Rise time	—	12	—		R_G = 47Ω, L=1mH, L_S= 150nH
$t_{d(off)}$	Turn-Off delay time	—	95	—		T_J = 175°C
t_f	Fall time	—	32	—		
C_{ies}	Input Capacitance	—	350	—	pF	V_{GE} = 0V
C_{oes}	Output Capacitance	—	29	—		V_{CC} = 30V
C_{res}	Reverse Transfer Capacitance	—	10	—		f = 1Mhz
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T_J = 175°C, I_C = 24A V_{CC} = 500V, Vp =600V R_G = 100Ω, V_{GE} = +20V to 0V
SCSOA	Short Circuit Safe Operating Area	5	—	—	μs	V_{CC} = 400V, Vp =600V R_G = 100Ω, V_{GE} = +15V to 0V
Erec	Reverse recovery energy of the diode	—	178	—	μJ	T_J = 175°C
trr	Diode Reverse recovery time	—	74	—	ns	V_{CC} = 400V, I_F = 6.0A
Irr	Peak Reverse Recovery Current	—	12	—	A	V_{GE} = 15V, Rg = 47Ω, L=1mH, L_S=150nH

Notes:

① V_{CC} = 80% (V_{CES}), V_{GE} = 15V, L = 1.0mH, R_G = 47Ω.
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 When mounted on 1" square PCB (FR-4 or G-10 Material). For recommended footprint and soldering techniques refer to application note #AN-994.
⑥ Maximum limits are based on statistical sample size characterization.

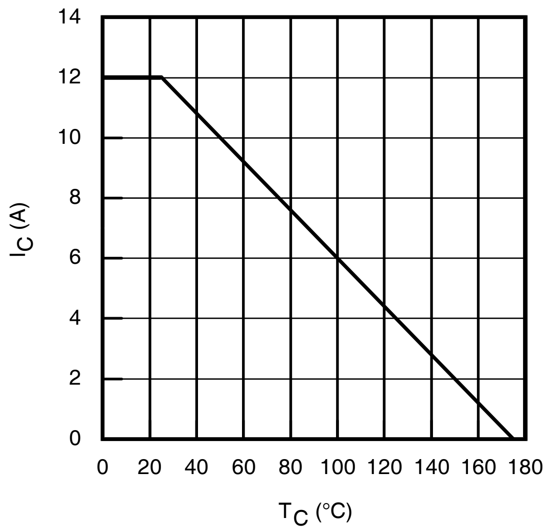


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

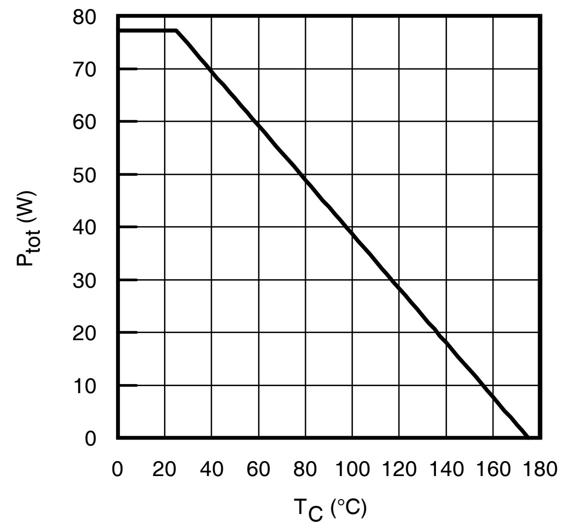


Fig. 2 - Power Dissipation vs. Case Temperature

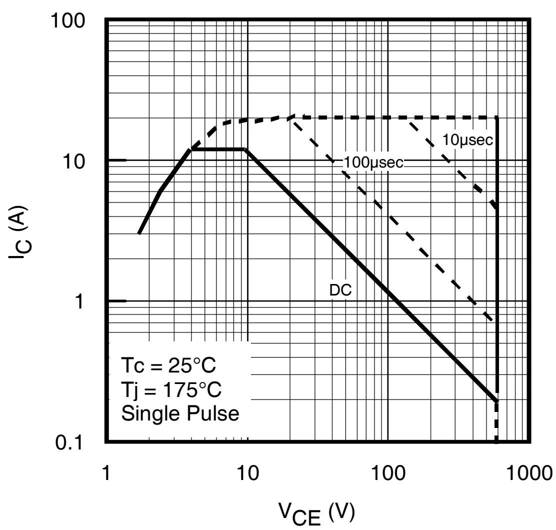


Fig. 3 - Forward SOA, $T_C = 25°C$, $T_J \leq 175°C$, $V_{GE} = 15V$

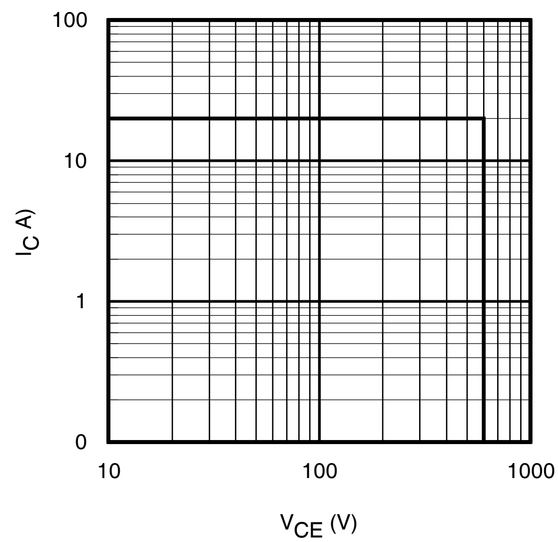


Fig. 4 - Reverse Bias SOA $T_J = 175°C$, $V_{GE} = 20V$

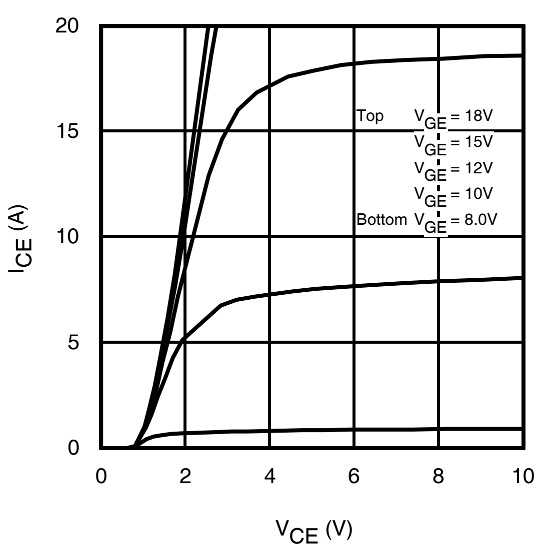


Fig. 5 - Typ. IGBT Output Characteristics $T_J = -40°C$; tp = 80µs

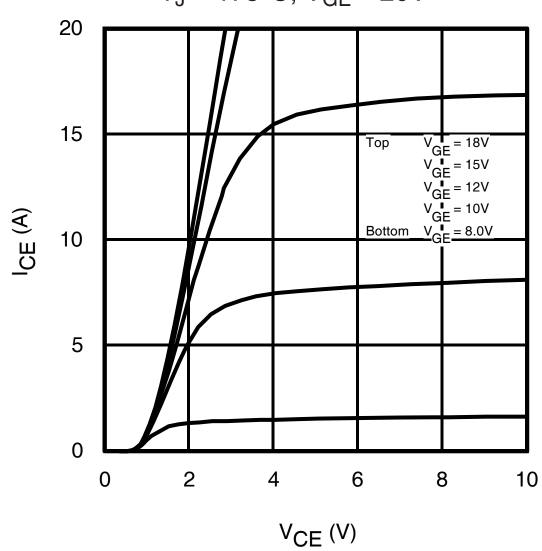


Fig. 6 - Typ. IGBT Output Characteristics $T_J = 25°C$; tp = 80µs

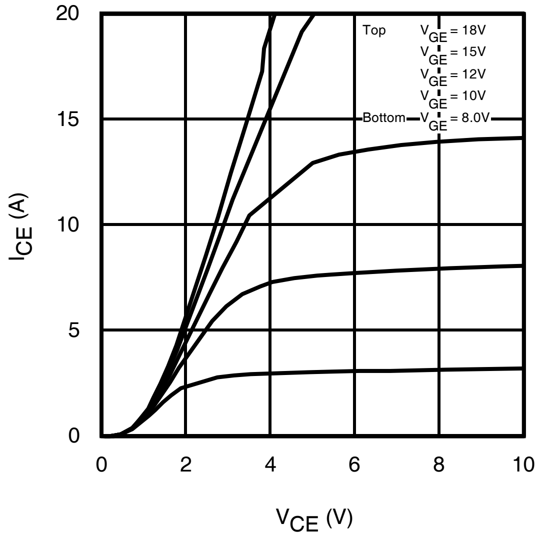


Fig. 7 - Typ. IGBT Output Characteristics
T_J = 175°C; tp = 80µs

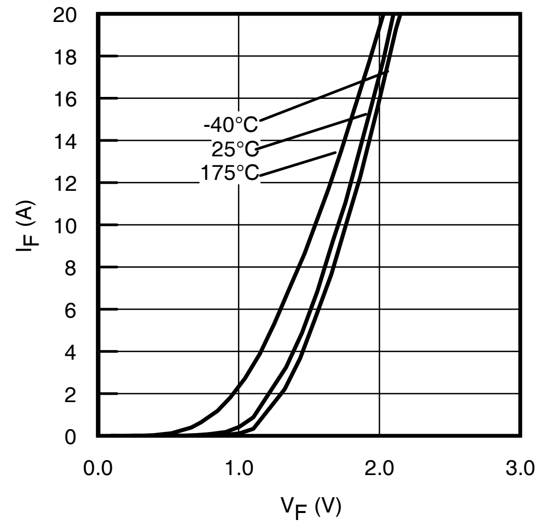


Fig. 8 - Typ. Diode Forward Characteristics
tp = 80µs

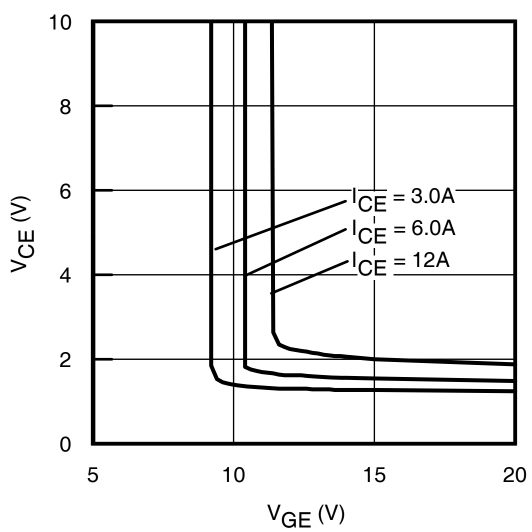


Fig. 9 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

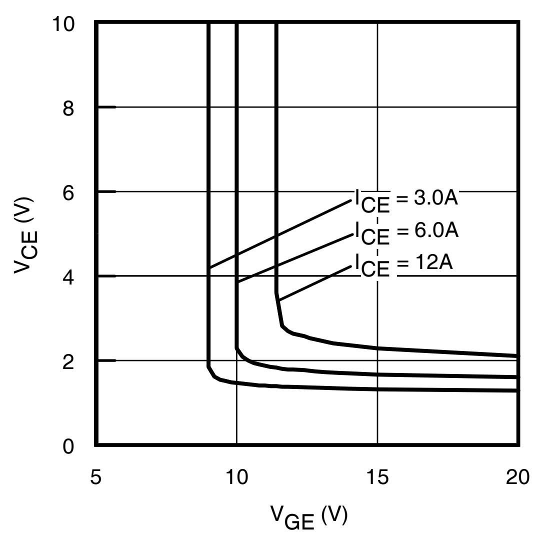


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

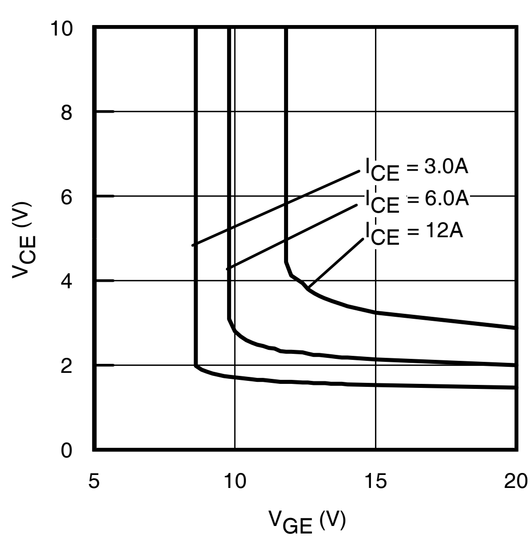


Fig. 11 - Typical V_{CE} vs. V_{GE}
T_J = 175°C

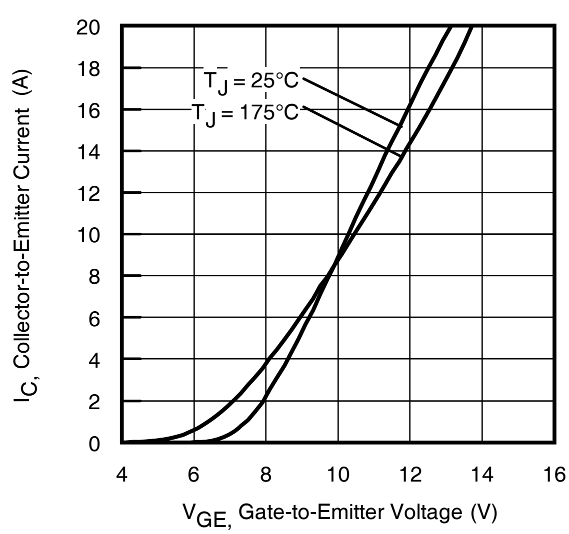


Fig. 12 - Typ. Transfer Characteristics
V_{CE} = 50V; tp = 10µs

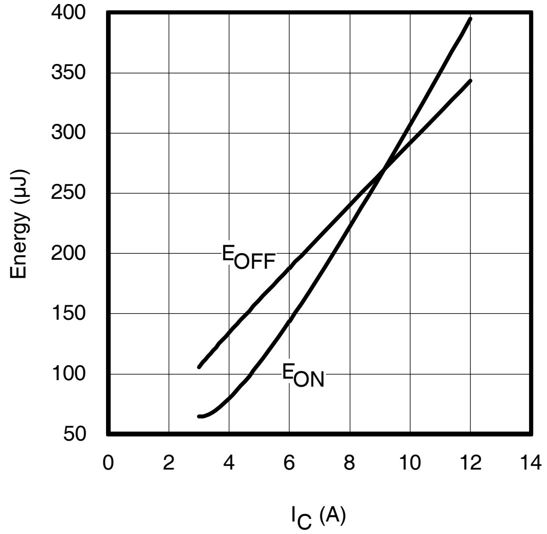


Fig. 13 - Typ. Energy Loss vs. I_C
T_J = 175°C; L = 1mH; V_{CE} = 400V, R_G = 47Ω; V_{GE} = 15V.

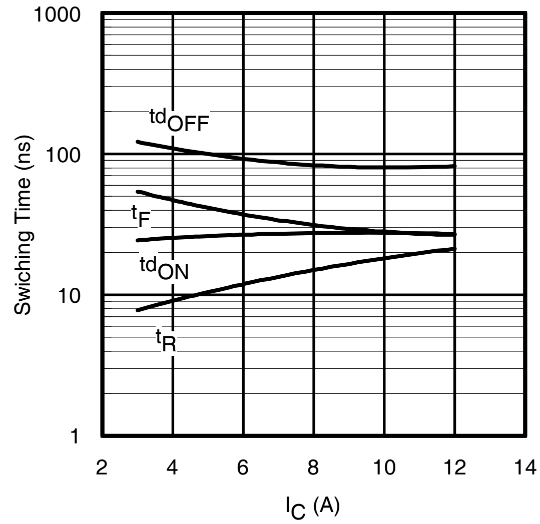


Fig. 14 - Typ. Switching Time vs. I_C
T_J = 175°C; L=1mH; V_{CE}= 400V
R_G= 47Ω; V_{GE}= 15V

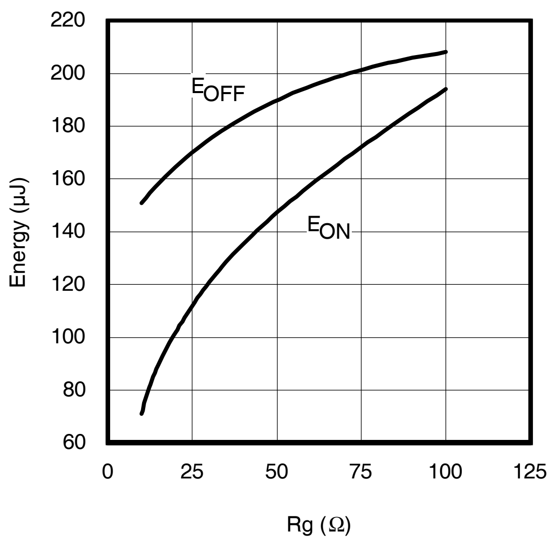


Fig. 15 - Typ. Energy Loss vs. R_G
T_J = 175°C; L = 1mH; V_{CE} = 400V, I_{CE} = 6.0A; V_{GE} = 15V

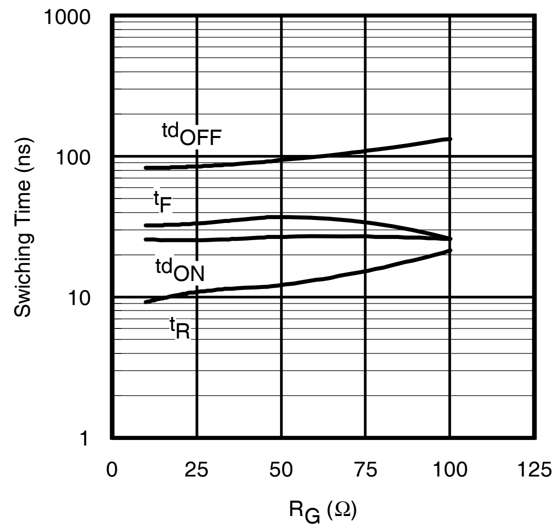


Fig. 16- Typ. Switching Time vs. R_G
T_J = 175°C; L=1mH; V_{CE}= 400V
I_{CE}= 6.0A; V_{GE}= 15V

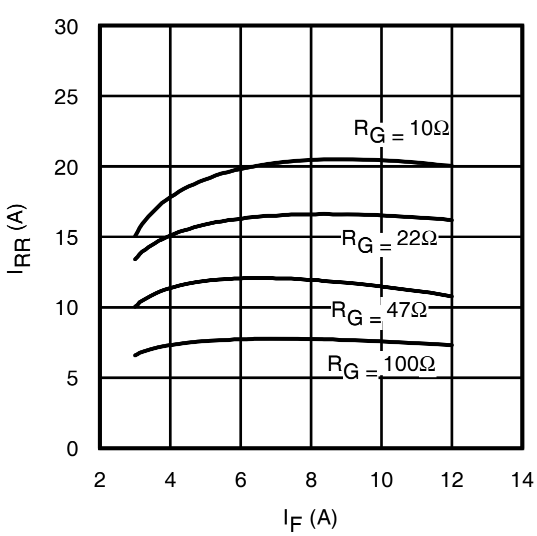


Fig. 17 - Typical Diode I_{RR} vs. I_F
T_J = 175°C

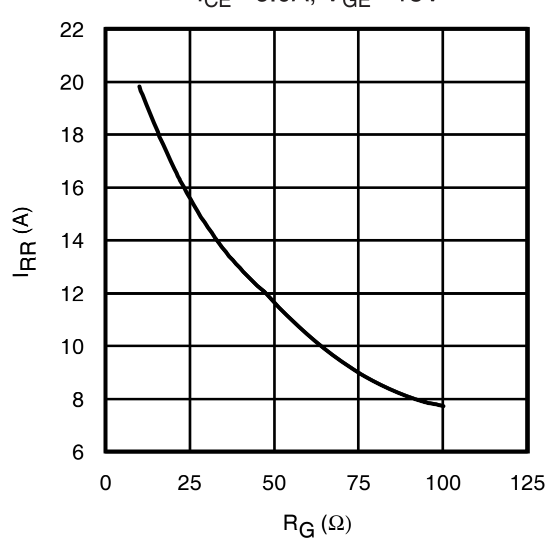


Fig. 18 - Typical Diode I_{RR} vs. R_G
T_J = 175°C; I_F = 6.0A

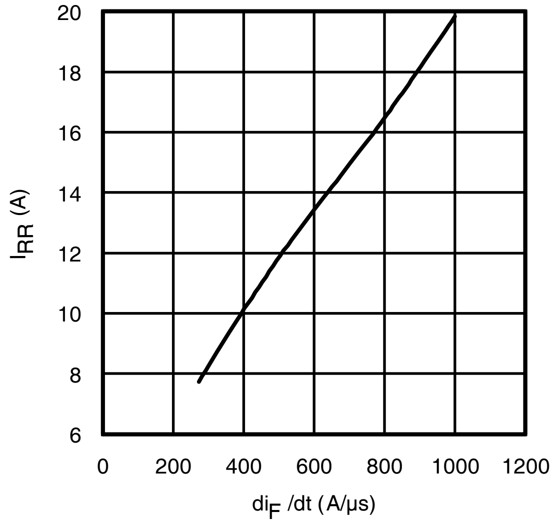


Fig. 19- Typical Diode I_{RR} vs. di_F/dt
V_{CC}= 400V; V_{GE}= 15V;
I_{CE}= 6.0A; T_J = 175°C

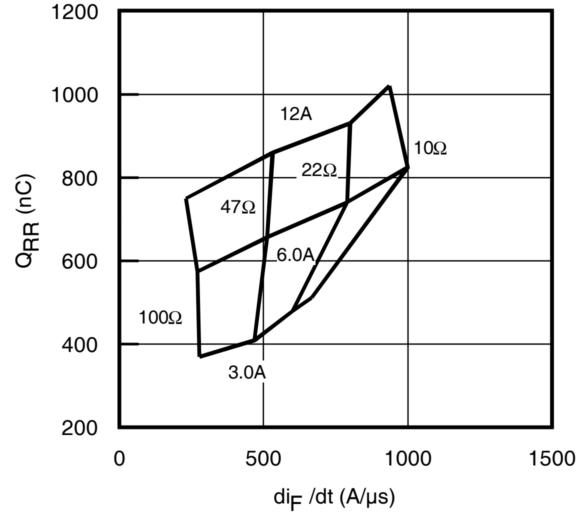


Fig. 20 - Typical Diode Q_{RR}
V_{CC}= 400V; V_{GE}= 15V; T_J = 175°C

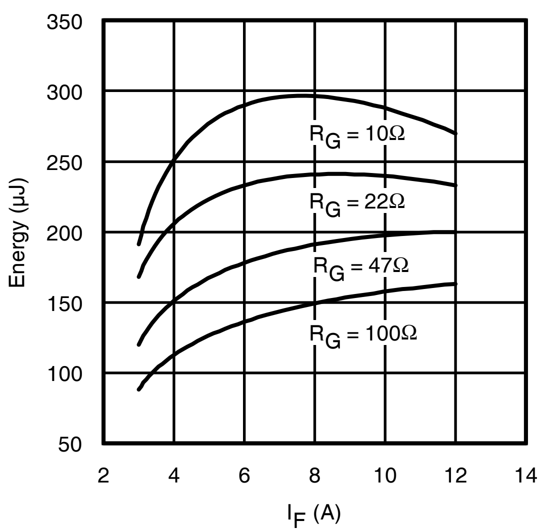


Fig. 21 - Typical Diode E_{RR} vs. I_F
T_J = 175°C

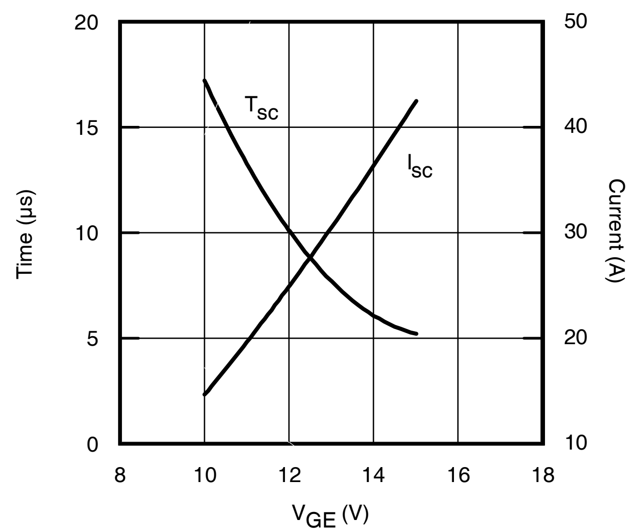


Fig. 22- Typ. V_{GE} vs. Short Circuit Time
V_{CC}=400V, T_C =25°C

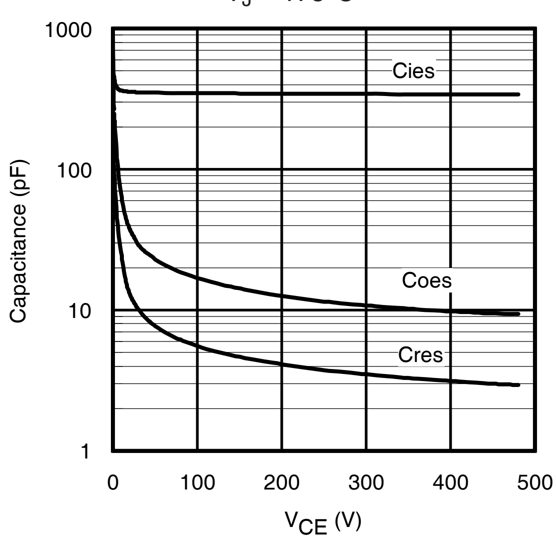


Fig. 23- Typ. Capacitance vs. V_{CE}
V_{GE}= 0V; f = 1MHz

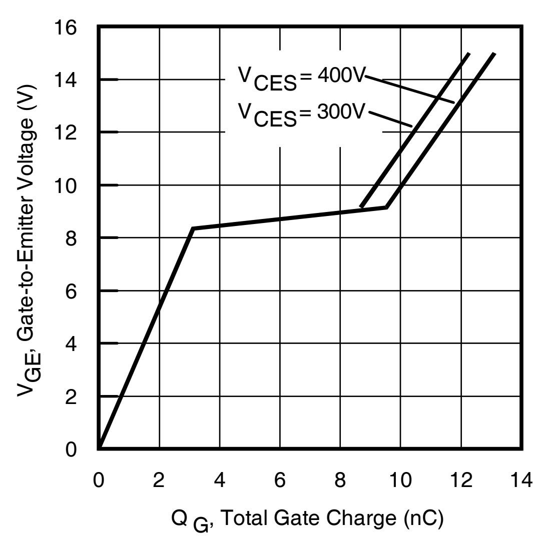


Fig. 24 - Typical Gate Charge vs. V_{GE}
I_{CE} = 6.0A, L=600µH

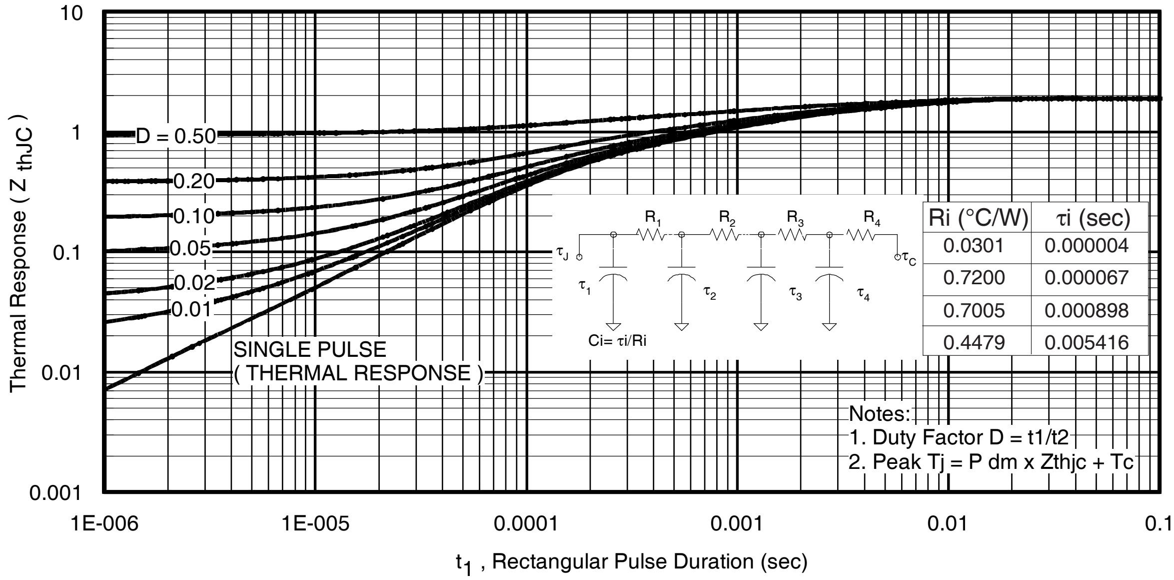


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

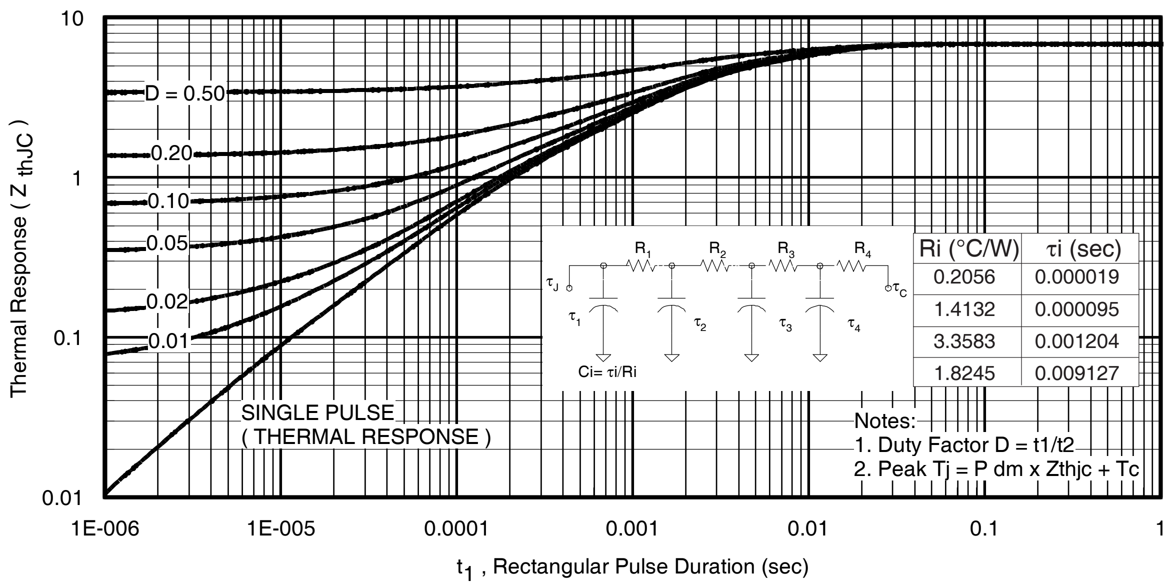


Fig. 26. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

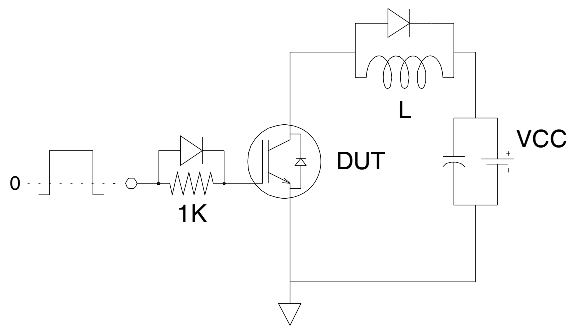


Fig.C.T.1 - Gate Charge Circuit (turn-off)

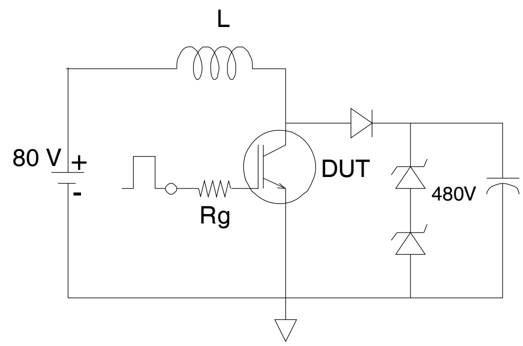


Fig.C.T.2 - RBSOA Circuit

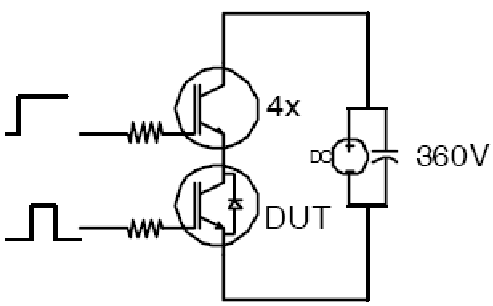


Fig.C.T.3 - S.C.SOA Circuit

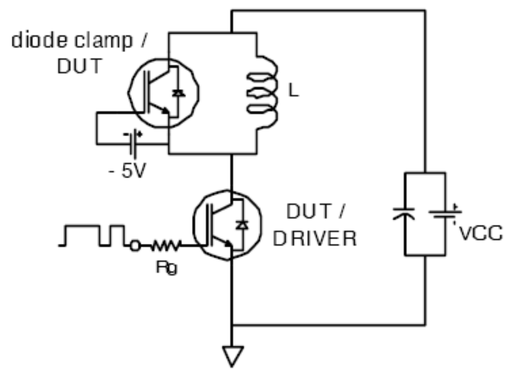


Fig.C.T.4 - Switching Loss Circuit

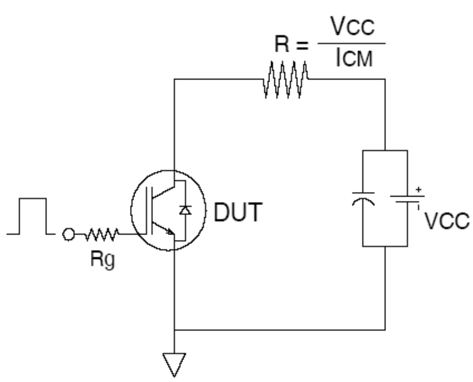


Fig.C.T.5 - Resistive Load Circuit

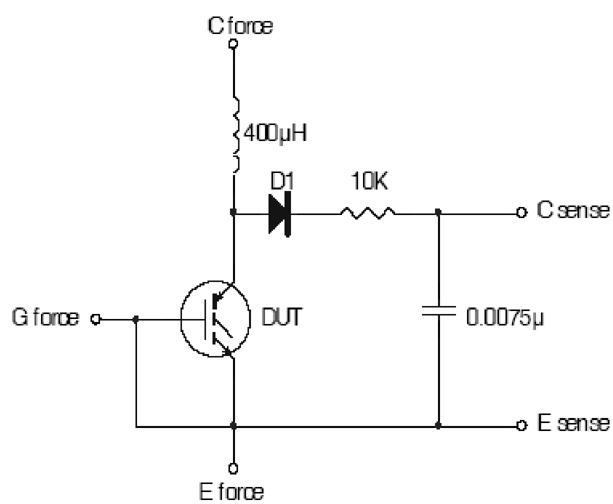


Fig.C.T.6 - Typical Filter Circuit for $V_{(BR)CES}$ Measurement

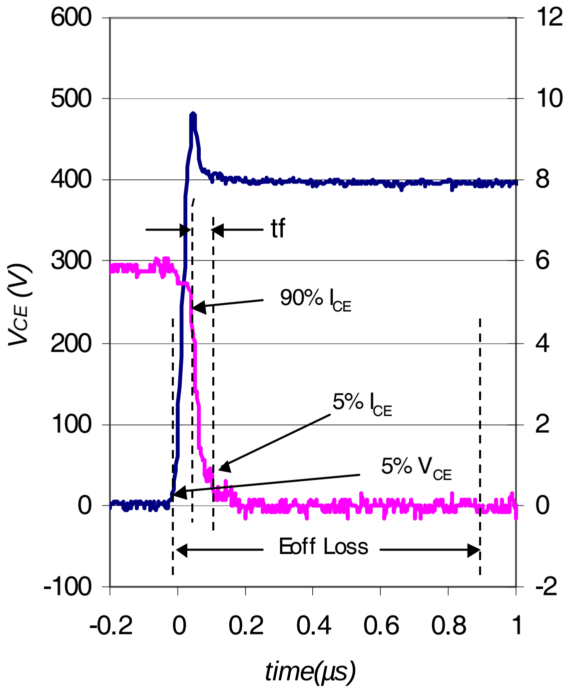


Fig. WF1 - Typ. Turn-off Loss Waveform
@ T_J = 175°C using Fig. CT.4

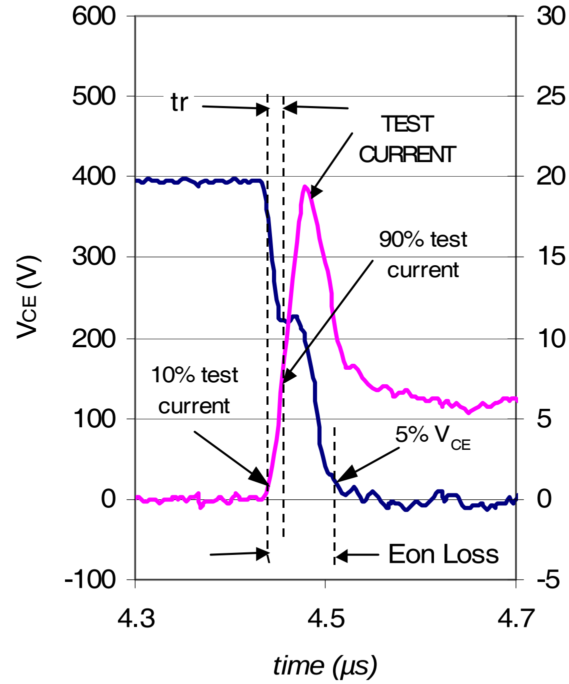
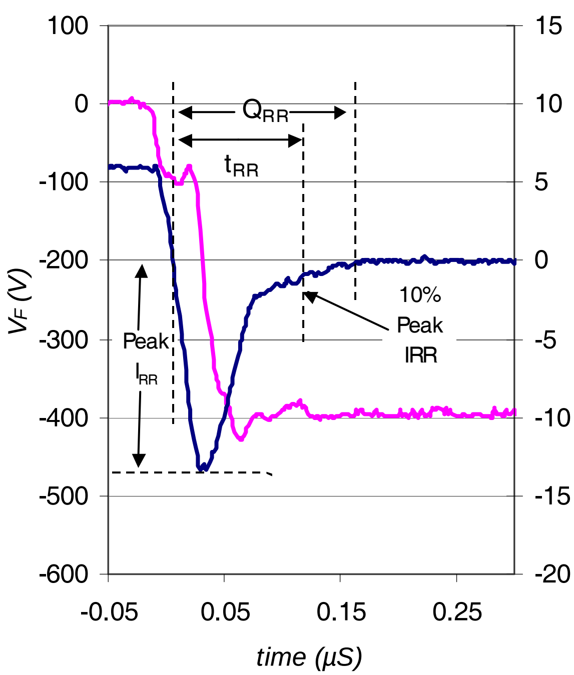
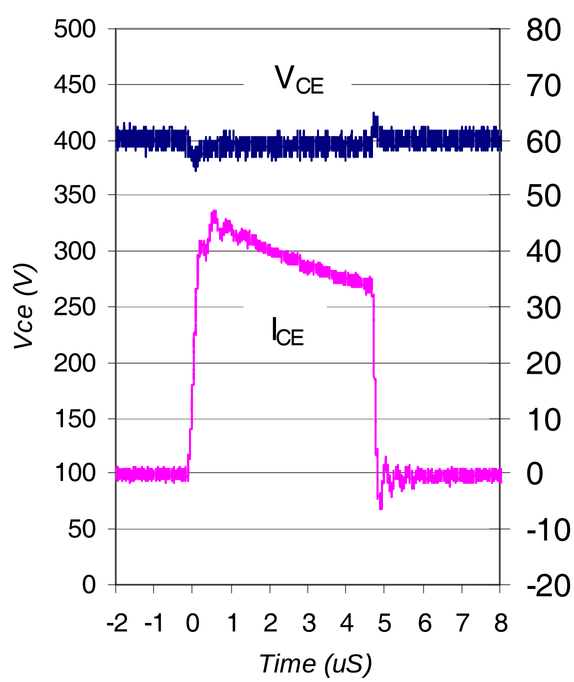


Fig. WF2 - Typ. Turn-on Loss Waveform
@ T_J = 175°C using Fig. CT.4



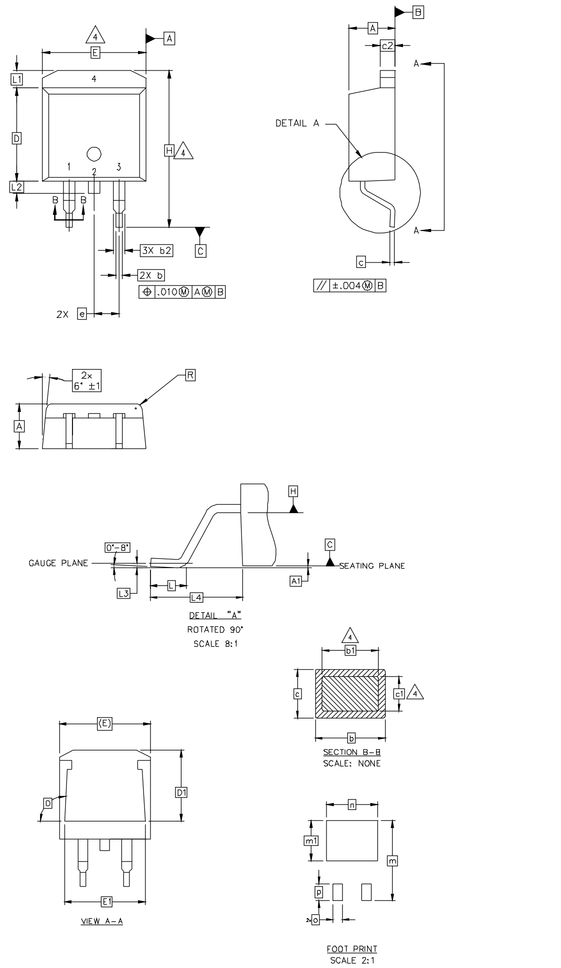
WF.3- Typ. Diode Recovery Waveform
@ T_J = 175°C using CT.4



WF.4- Typ. Short Circuit Waveform
@ T_J = 25°C using CT.3

D^{2}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 [.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
5. CONTROLLING DIMENSION: INCH.

SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	
A1	0.00	0.254	.000	.010	
b	0.51	0.99	.020	.039	
b1	0.51	0.89	.020	.035	4
b2	1.14	1.78	.045	.070	
c	0.38	0.74	.015	.029	
c1	0.38	0.58	.015	.023	4
c2	1.14	1.65	.045	.065	
D	8.51	9.65	.335	.380	3
D1	6.86		.270		
E	9.65	10.67	.380	.420	3
E1	6.22		.245		
e	2.54 BSC		.100 BSC		
H	14.61	15.88	.575	.625	
L	1.78	2.79	.070	.110	
L1		1.65		.065	
L2	1.27	1.78	.050	.070	
L3	0.25 BSC		.010 BSC		
L4	4.78	5.28	.188	.208	
m	17.78		.700		
m1	8.89		.350		
n	11.43		.450		
o	2.08		.082		
p	3.81		.150		
R	0.51	0.71	.020	.028	
θ	90°	93°	90°	93°	

LEAD ASSIGNMENTS

HEXFET

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

IGBTs, CoPACK

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

DIODES

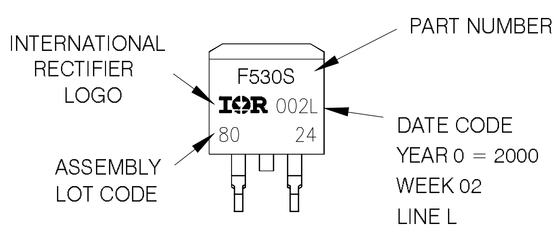
1.- ANODE *
2, 4.- CATHODE
3.- ANODE

* PART DEPENDENT.

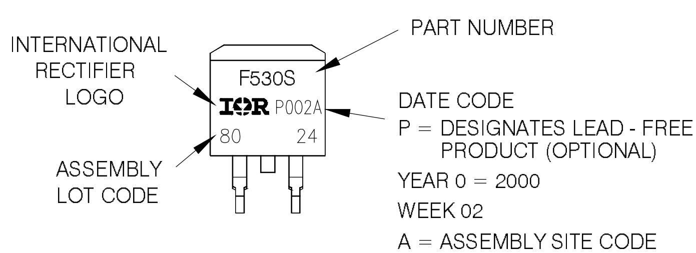
D^{2}Pak Part Marking Information

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"



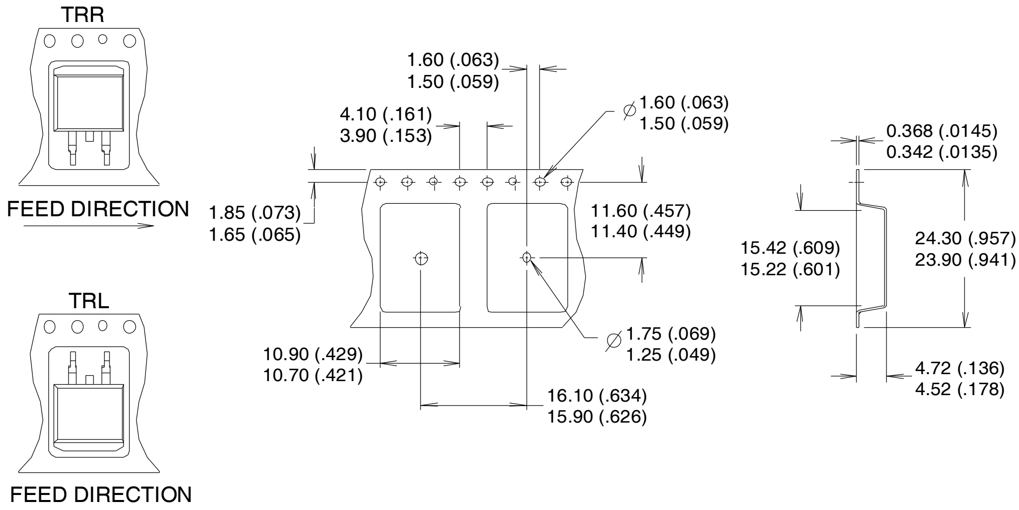
OR

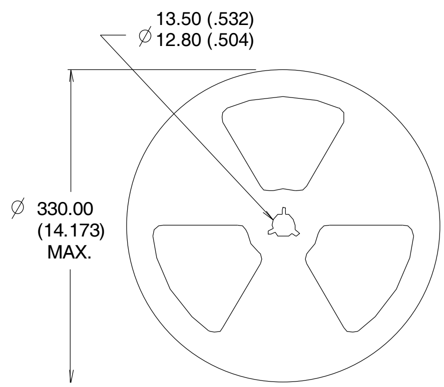


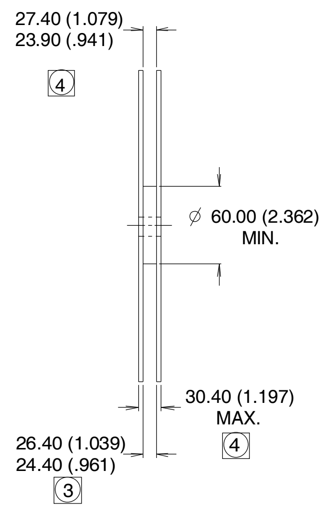
Note: For the most current drawing please refer to IR website at http://www.irf.com/package/

D^2Pak Tape & Reel Information

Dimensions are shown in millimeters (inches)







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

Qualification Information†

Qualification Level		Industrial†† (per JEDEC JESD47F) †††	
Moisture Sensitivity Level		D2Pak	MSL1 (per JEDEC J-STD-020D)†††
ESD	Machine Model	Class M2 (+/- 200V)††† AEC-Q101-002	
	Human Body Model	Class H1A (+/- 500V)††† AEC-Q101-001	
	Charged Device Model	Class C5 (+/- 1000V)††† AEC-Q101-005	
RoHS Compliant		Yes	

† Qualification standards can be found at International Rectifier's web site: http://www.irf.com/product-info/reliability/

†† Higher qualification ratings may be available should the user have such requirements. Please contact your International Rectifier sales representative for further information: http:www.irf.com/whoto-call/salesrep/

††† Applicable version of JEDEC standard at the time of product release.

Data and specifications subject to change without notice.

International Rectifier

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