Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

With the principle of “Quality Parts,Customers Priority,Honest Operation,and Considerate Service”,our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!

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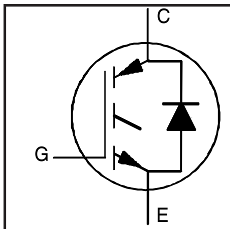
Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
Email & Skype: info@chipsmall.com Web: www.chipsmall.com
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

PD - 95616A

International
IOR Rectifier

IRGB4B60KD1PbF
IRGS4B60KD1PbF
IRGSL4B60KD1PbF

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE



n-channel

V_{CES} = 600V

I_C = 7.6A, T_C=100°C

t_{sc} > 10µs, T_J=150°C

$V_{CE(on)}$ typ. = 2.1V

Features

- Low VCE (on) Non Punch Through IGBT Technology.
- 10µs Short Circuit Capability.
- Square RBSOA.
- Positive VCE (on) Temperature Coefficient.
- Maximum Junction Temperature rated at 175°C.
- Lead-Free

Benefits

- Benchmark Efficiency for Motor Control.
- Rugged Transient Performance.
- Low EMI.
- Excellent Current Sharing in Parallel Operation.

TO-220	D²Pak	TO-262
IRGB4B60KD1	IRGS4B60KD1	IRGSL4B60KD1

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
I_C @ T_C = 25°C	Continuous Collector Current	11	A
I_C @ T_C = 100°C	Continuous Collector Current	7.6	
I_{CM}	Pulse Collector Current (Ref.Fig.C.T.5)	22	
I_{LM}	Clamped Inductive Load current ①	22	
I_F @ T_C = 25°C	Diode Continuous Forward Current	11	
I_F @ T_C = 100°C	Diode Continuous Forward Current	6.7	
I_{FM}	Diode Maximum Forward Current	22	
V_{GE}	Gate-to-Emitter Voltage	±20	V
P_D @ T_C = 25°C	Maximum Power Dissipation	63	W
P_D @ T_C = 100°C	Maximum Power Dissipation	31	
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +175	°C
	Storage Temperature Range, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

Thermal / Mechanical Characteristics

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case- IGBT	–––	–––	2.4	°C/W
$R_{\theta JC}$	Junction-to-Case- Diode	–––	–––	6.1	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	–––	0.50	–––	
$R_{\theta JA}$	Junction-to-Ambient	–––	–––	62	
$R_{\theta JA}$	Junction-to-Ambient (PCB Mount, steady state)②	–––	–––	40	
Wt	Weight	–––	1.44	–––	g

8/30/04

Electrical Characteristics @ T_J = 25°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 = 500μA	
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.28	—	V/°C	V_{GE} = 0V, I_C = 1mA (25°C-150°C)	
$V_{CE(on)}$	Collector-to-Emitter Voltage	—	2.1	2.5	V	I_C = 4.0A, V_{GE} = 15V, T_J = 25°C	5,6,7
		—	2.5	2.8		I_C = 4.0A, V_{GE} = 15V, T_J = 150°C	9,10,11
		—	2.6	2.9		I_C = 4.0A, V_{GE} = 15V, T_J = 175°C	
$V_{GE(th)}$	Gate Threshold Voltage	3.5	4.5	5.5	V	V_{CE} = V_{GE}, I_C = 250μA	9,10,11
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-8.1	—	mV/°C	V_{CE} = V_{GE}, I_C = 1mA (25°C-150°C)	12
gfe	Forward Transconductance	—	1.7	—	S	V_{CE} = 50V, I_C = 4.0A, PW = 80μs	
I_{CES}	Zero Gate Voltage Collector Current	—	1.0	150	μA	V_{GE} = 0V, V_{CE} = 600V	
		—	136	600		V_{GE} = 0V, V_{CE} = 600V, T_J = 150°C	
		—	722	2400		V_{GE} = 0V, V_{CE} = 600V, T_J = 175°C	
V_{FM}	Diode Forward Voltage Drop	—	1.4	2.0	V	I_F = 4.0A	8
		—	1.3	1.8		I_F = 4.0A, T_J = 150°C	
		—	1.2	1.7		I_F = 4.0A, T_J = 175°C	
I_{GES}	Gate-to-Emitter Leakage Current	—	—	±100	nA	V_{GE} = ±20V	

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

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig.
Q_g	Total Gate Charge (turn-on)	—	12	—	nC	I_C = 4.0A	23
Q_{ge}	Gate-to-Emitter Charge (turn-on)	—	1.7	—		V_{CC} = 400V	CT1
Q_{gc}	Gate-to-Collector Charge (turn-on)	—	6.5	—		V_{GE} = 15V	
E_{on}	Turn-On Switching Loss	—	73	80	μJ	I_C = 4.0A, V_{CC} = 400V	CT4
E_{off}	Turn-Off Switching Loss	—	47	53		V_{GE} = 15V, R_G = 100Ω, L = 2.5mH	
E_{tot}	Total Switching Loss	—	120	130		T_J = 25°C ③	
$t_{d(on)}$	Turn-On delay time	—	22	28	ns	I_C = 4.0A, V_{CC} = 400V	
t_r	Rise time	—	18	23		V_{GE} = 15V, R_G = 100Ω, L = 2.5mH	CT4
$t_{d(off)}$	Turn-Off delay time	—	100	110		T_J = 25°C	
t_f	Fall time	—	66	80			
E_{on}	Turn-On Switching Loss	—	130	150	μJ	I_C = 4.0A, V_{CC} = 400V	CT4
E_{off}	Turn-Off Switching Loss	—	83	140		V_{GE} = 15V, R_G = 100Ω, L = 2.5mH	13,15
E_{tot}	Total Switching Loss	—	220	280		T_J = 150°C ③	WF1,WF2
$t_{d(on)}$	Turn-On delay time	—	22	27	ns	I_C = 4.0A, V_{CC} = 400V	14,16
t_r	Rise time	—	18	22		V_{GE} = 15V, R_G = 100Ω, L = 2.5mH	CT4
$t_{d(off)}$	Turn-Off delay time	—	120	130		T_J = 150°C	WF1
t_f	Fall time	—	79	89			WF2
C_{ies}	Input Capacitance	—	190	—	pF	V_{GE} = 0V	
C_{oes}	Output Capacitance	—	25	—		V_{CC} = 30V	22
C_{res}	Reverse Transfer Capacitance	—	6.2	—		f = 1.0MHz	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T_J = 150°C, I_C = 22A, Vp = 600V	4
						V_{CC}=500V,V_{GE} = +15V to 0V,R_G = 100Ω	CT2
SCSOA	Short Circuit Safe Operating Area	10	—	—	μs	T_J = 150°C, Vp = 600V, R_G = 100Ω	CT3
						V_{CC}=360V,V_{GE} = +15V to 0V	WF4
E_{rec}	Reverse Recovery Energy of the Diode	—	81	100	μJ	T_J = 150°C	17,18,19
t_{rr}	Diode Reverse Recovery Time	—	93	—	ns	V_{CC} = 400V, I_F = 4.0A, L = 2.5mH	20,21
I_{rr}	Peak Reverse Recovery Current	—	6.3	7.9	A	V_{GE} = 15V, R_G = 100Ω	CT4,WF3

Note ① to ③ are on page 16

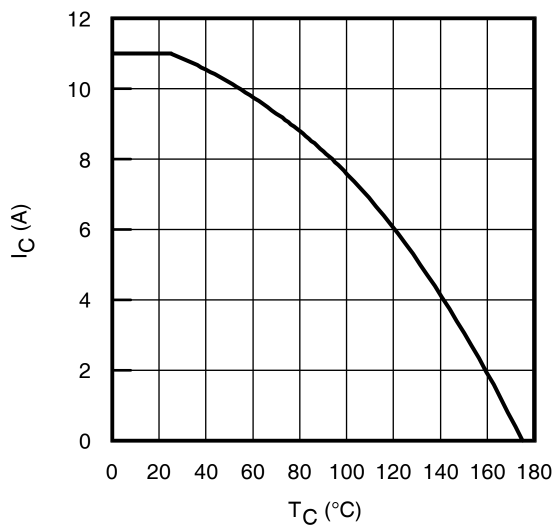


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

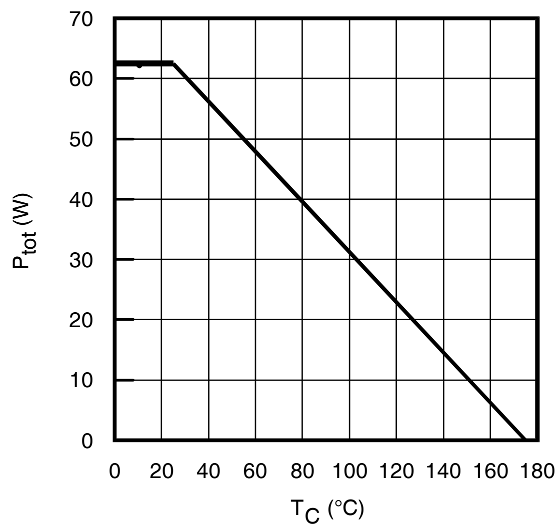


Fig. 2 - Power Dissipation vs. Case Temperature

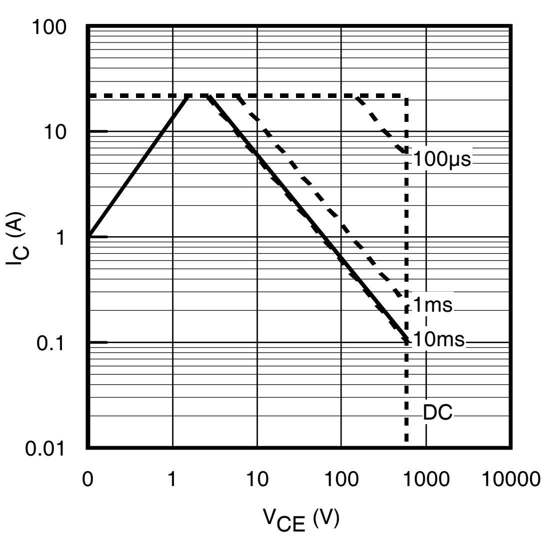


Fig. 3 - Forward SOA
T_C = 25°C; $T_J \le$ 150°C

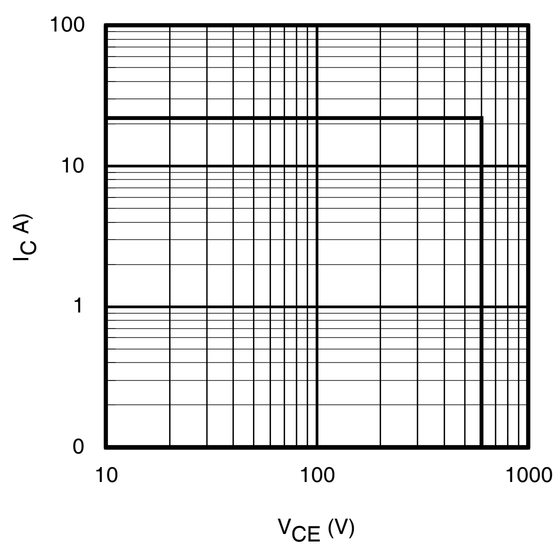


Fig. 4 - Reverse Bias SOA
T_J = 150°C; V_{GE} =15V

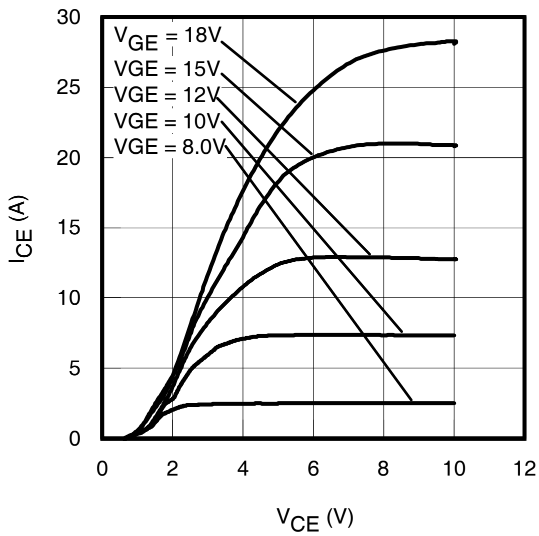


Fig. 5 - Typ. IGBT Output Characteristics
T_J = -40°C; tp = 80µs

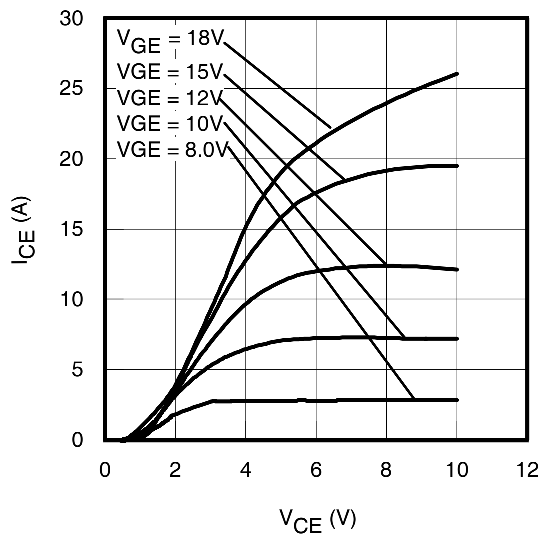


Fig. 6 - Typ. IGBT Output Characteristics
T_J = 25°C; tp = 80µs

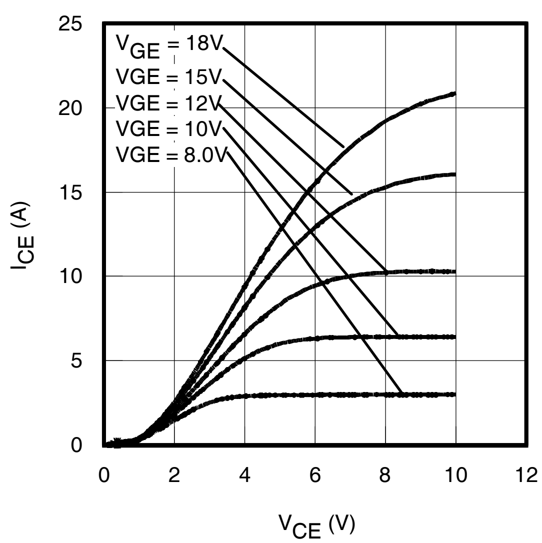


Fig. 7 - Typ. IGBT Output Characteristics
T_J = 150°C; tp = 80µs

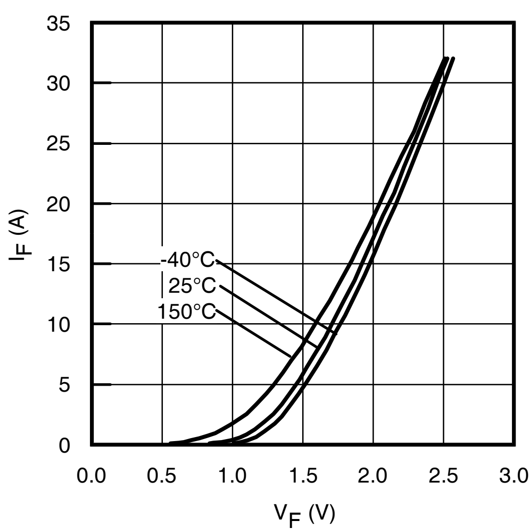


Fig. 8 - Typ. Diode Forward Characteristics
tp = 80µs

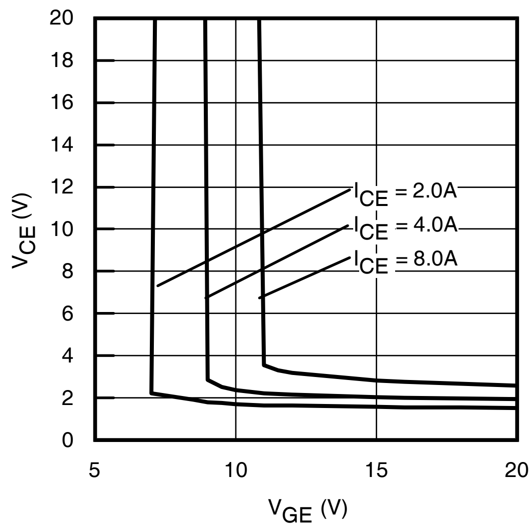


Fig. 9 - Typical V_{CE} vs. V_{GE}
T_J = -40°C

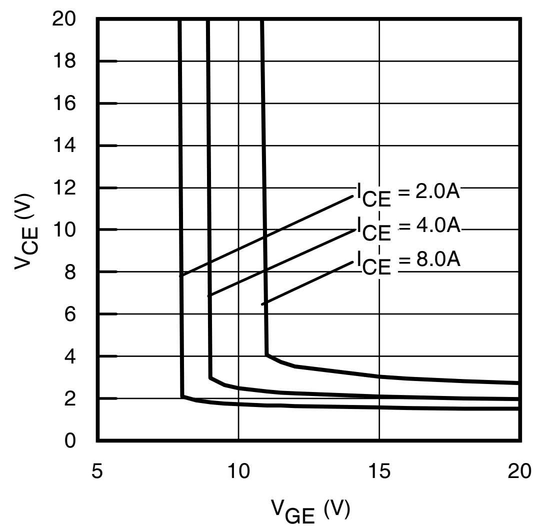


Fig. 10 - Typical V_{CE} vs. V_{GE}
T_J = 25°C

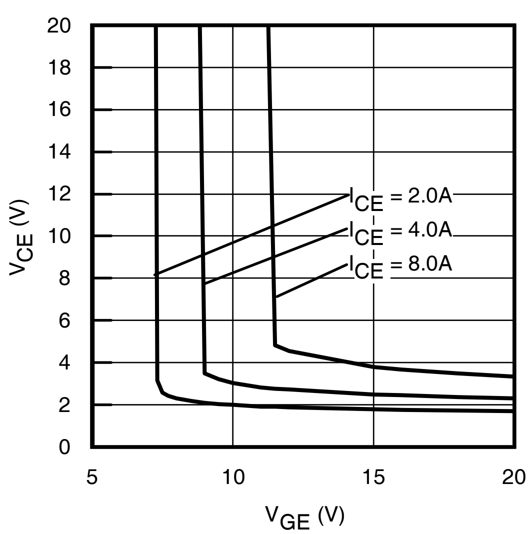


Fig. 11 - Typical V_{CE} vs. V_{GE}
T_J = 150°C

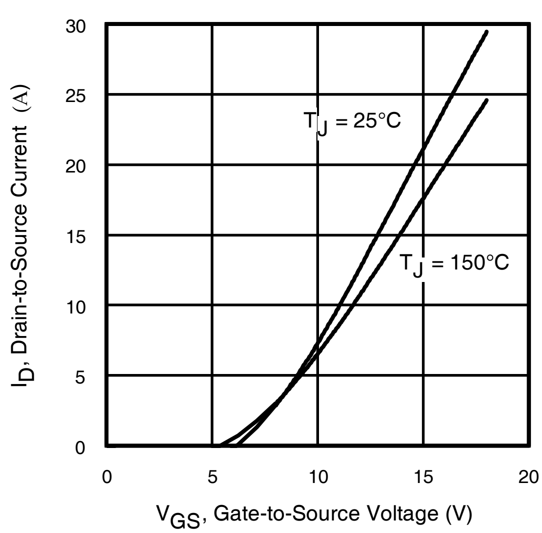


Fig. 12 - Typ. Transfer Characteristics
V_{CE} = 360V; tp = 10µs

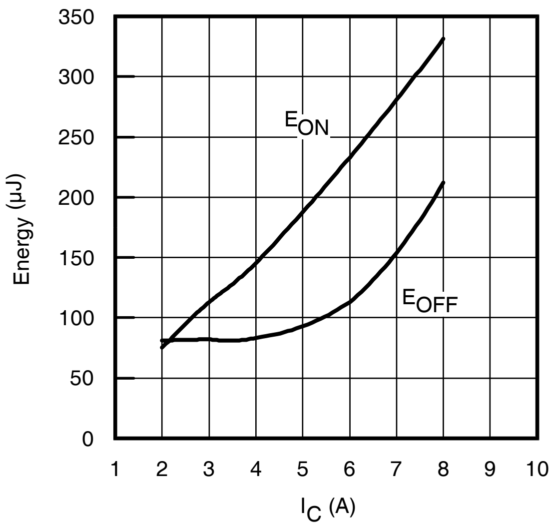


Fig. 13 - Typ. Energy Loss vs. I_C
T_J = 150°C; L=2.5mH; V_{CE}= 400V,
R_G= 100Ω; V_{GE}= 15V

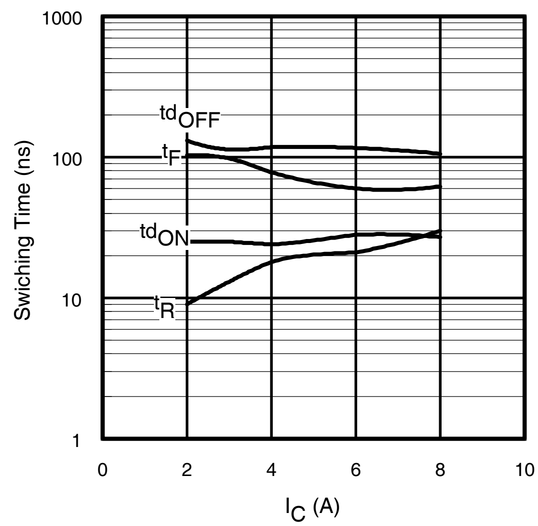


Fig. 14 - Typ. Switching Time vs. I_C
T_J = 150°C; L=2.5mH; V_{CE}= 400V
R_G= 100Ω; V_{GE}= 15V

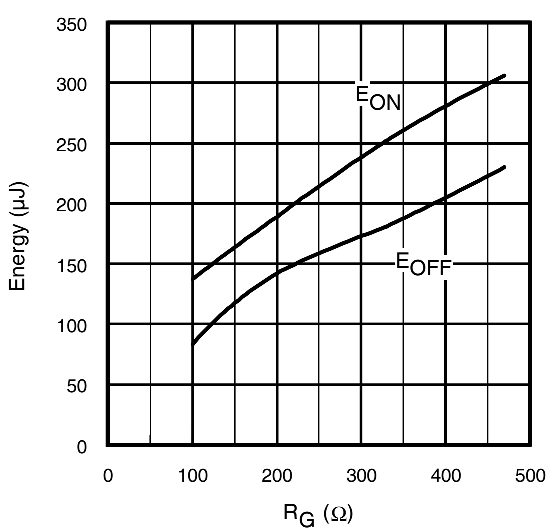


Fig. 15 - Typ. Energy Loss vs. R_G
T_J = 150°C; L=2.5mH; V_{CE}= 400V
I_{CE}= 4.0A; V_{GE}= 15V

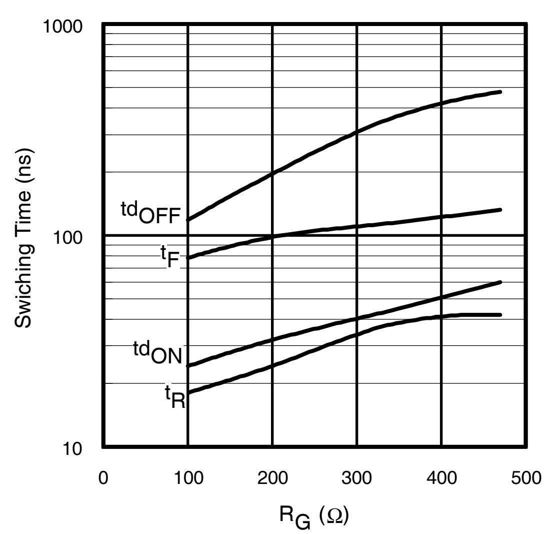


Fig. 16 - Typ. Switching Time vs. R_G
T_J = 150°C; L=2.5mH; V_{CE}= 400V
I_{CE}= 4.0A; V_{GE}= 15V

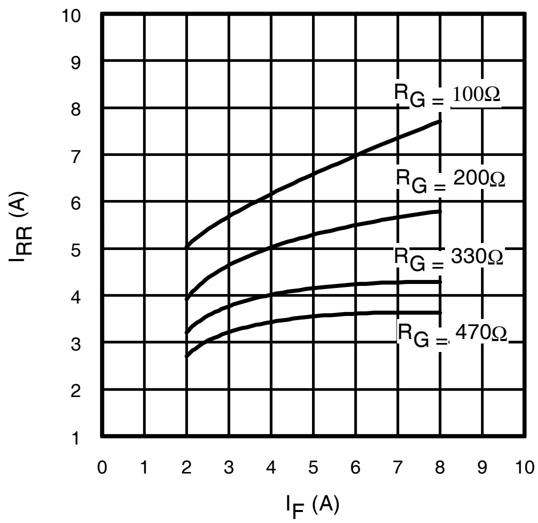


Fig. 17 - Typical Diode I_{RR} vs. I_F
$T_J = 150°C$

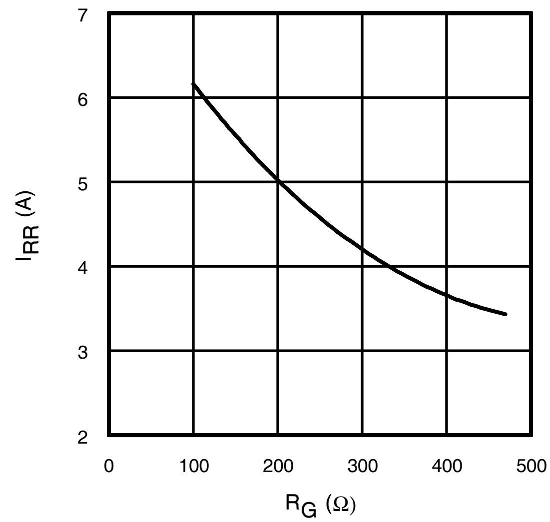


Fig. 18 - Typical Diode I_{RR} vs. R_G
$T_J = 150°C$; $I_F = 4.0A$

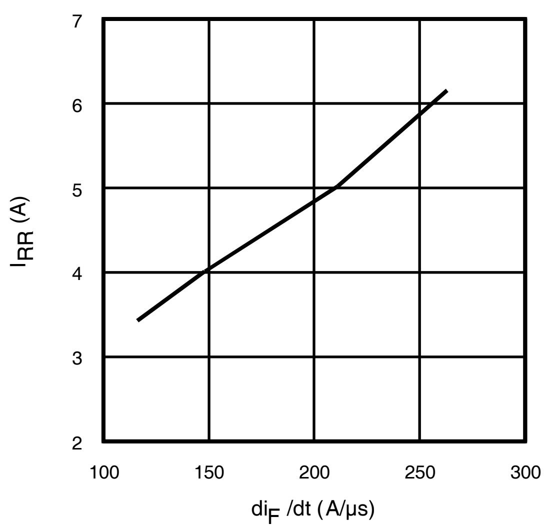


Fig. 19- Typical Diode I_{RR} vs. di_F/dt
V_{CC}= 400V; V_{GE}= 15V;
$I_F = 4.0A$; $T_J = 150°C$

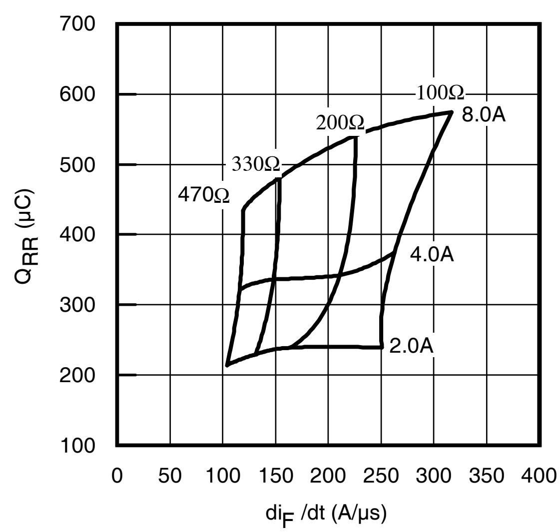


Fig. 20 - Typical Diode Q_{RR}
V_{CC}= 400V; V_{GE}= 15V;$T_J = 150°C$

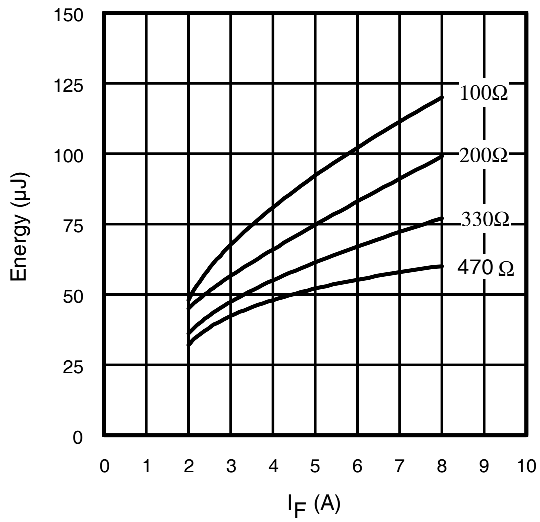


Fig. 21 - Typical Diode E_{RR} vs. I_F
T_J = 150°C

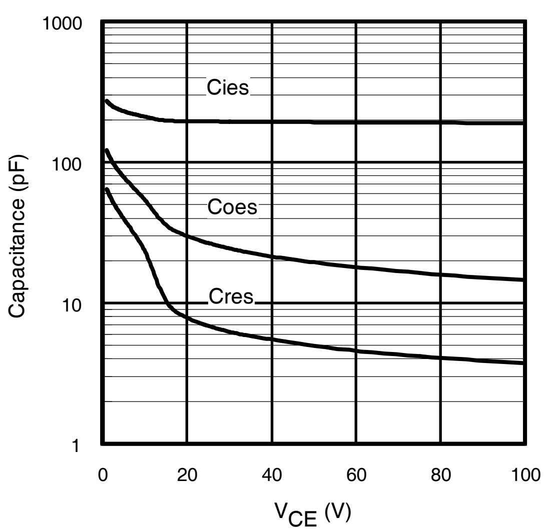


Fig. 22- Typ. Capacitance vs. V_{CE}
V_{GE}= 0V; f = 1MHz

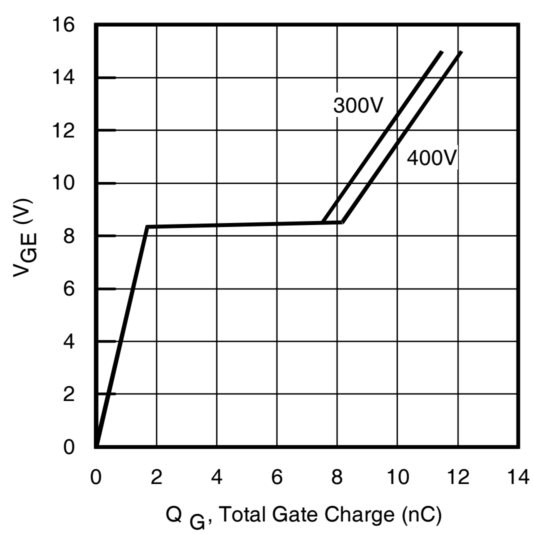


Fig. 23 - Typical Gate Charge vs. V_{GE}
I_{CE} = 4.0A; L = 3150µH

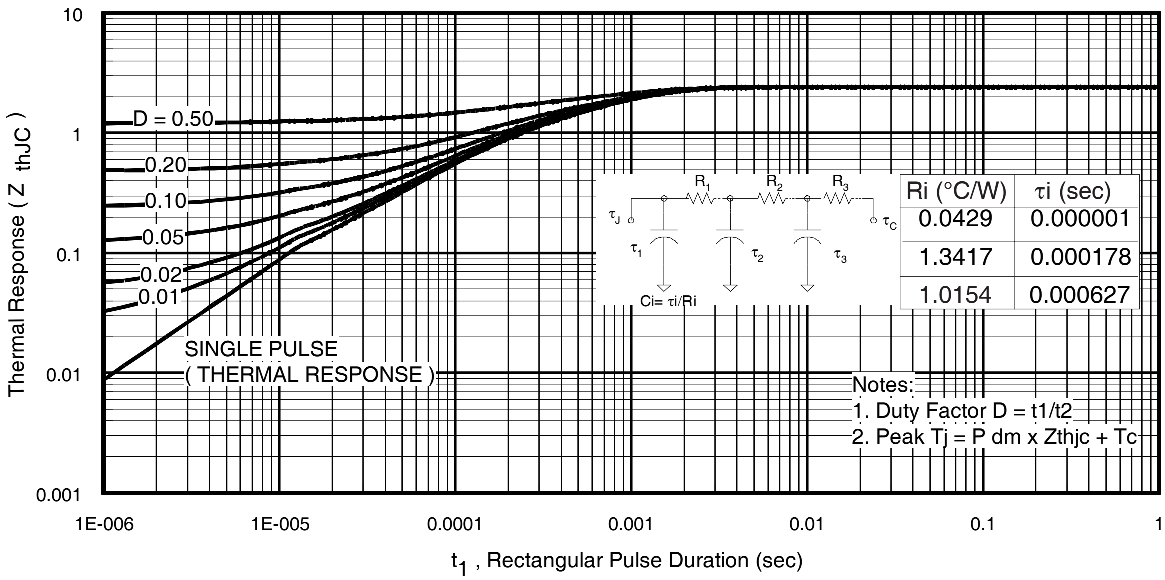


Fig 24. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

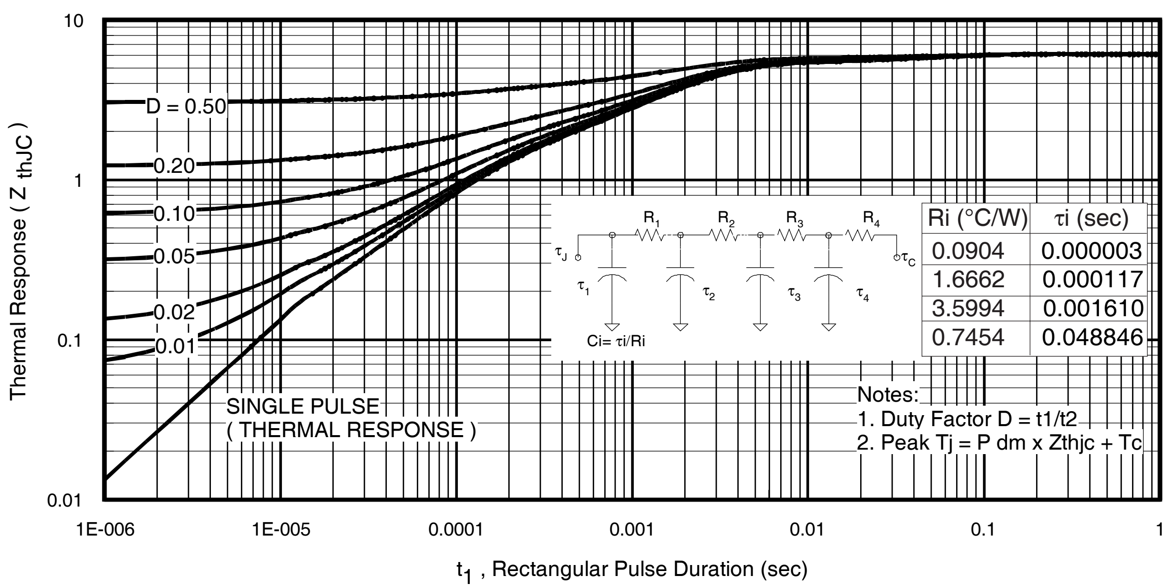


Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

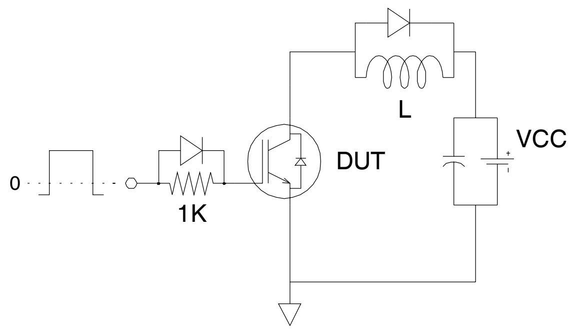


Fig.C.T.1 - Gate Charge Circuit (turn-off)

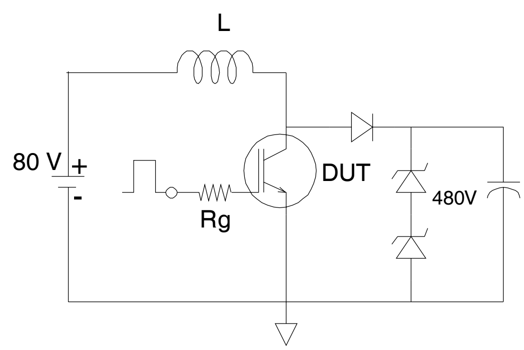


Fig.C.T.2 - RBSOA Circuit

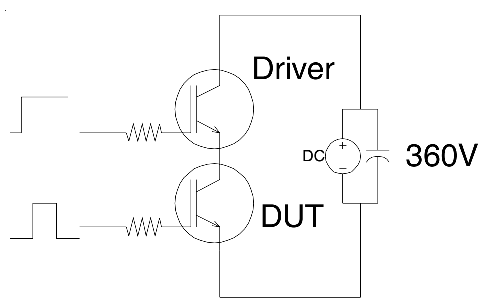


Fig.C.T.3 - S.C.SOA Circuit

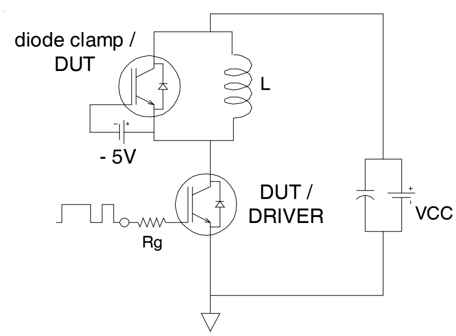


Fig.C.T.4 - Switching Loss Circuit

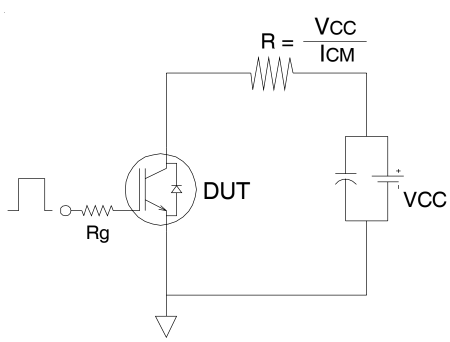


Fig.C.T.5 - Resistive Load Circuit

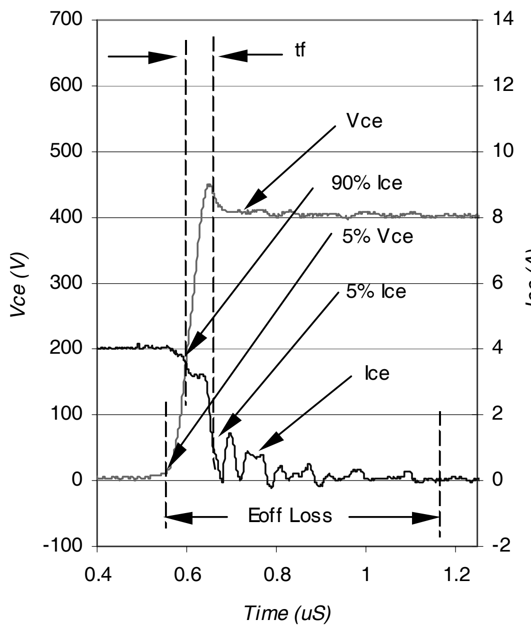


Fig. WF1- Typ. Turn-off Loss Waveform
@ T_J = 150°C using Fig. CT.4

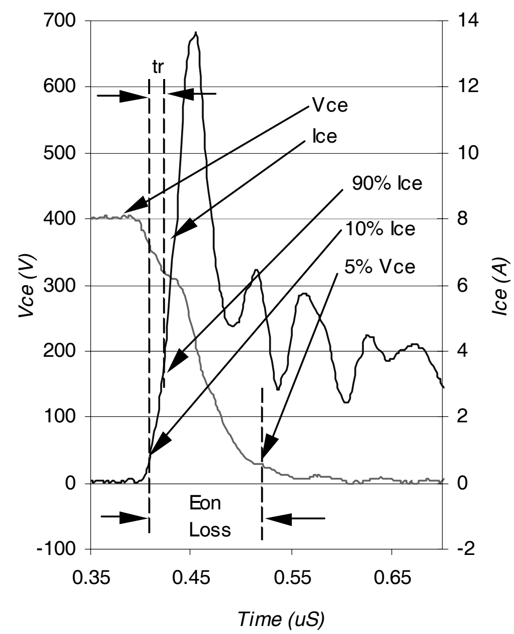


Fig. WF2- Typ. Turn-on Loss Waveform
@ T_J = 150°C using Fig. CT.4

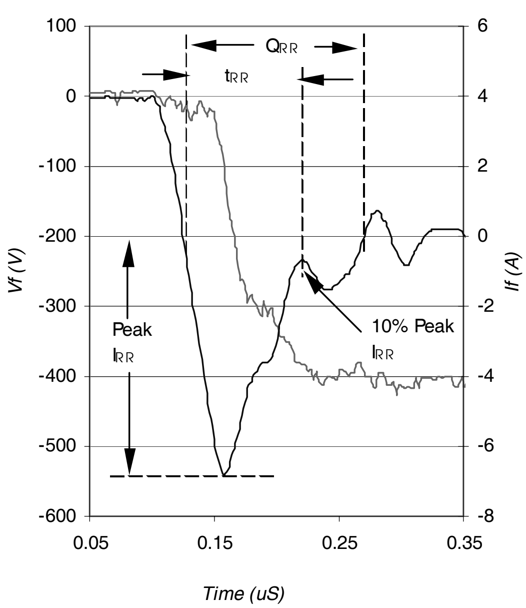


Fig. WF3- Typ. Diode Recovery Waveform
@ T_J = 150°C using Fig. CT.4

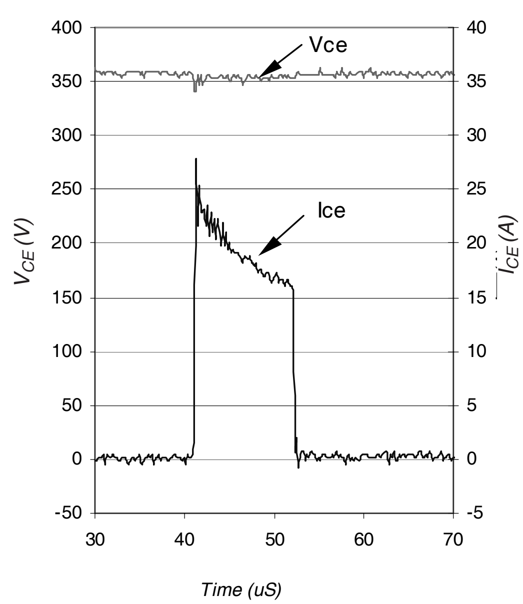
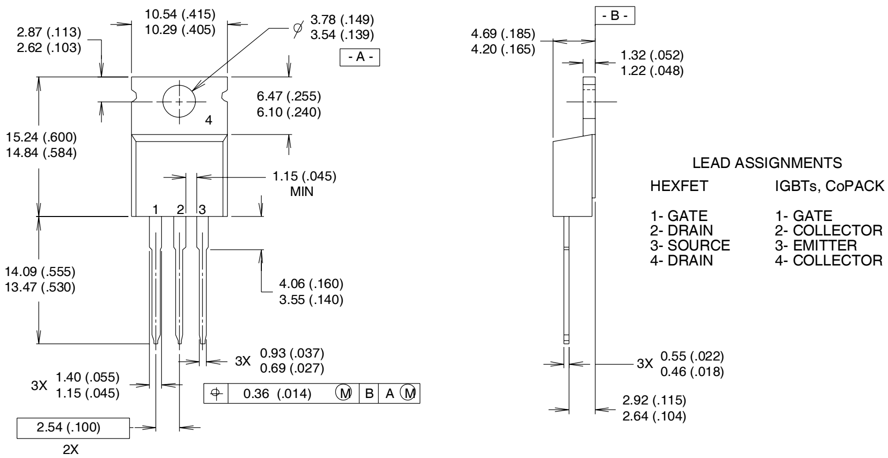


Fig. WF4- Typ. S.C Waveform
@ T_C = 150°C using Fig. CT.3

TO-220AB Package Outline

Dimensions are shown in millimeters (inches)



NOTES:

1 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.

2 CONTROLLING DIMENSION : INCH

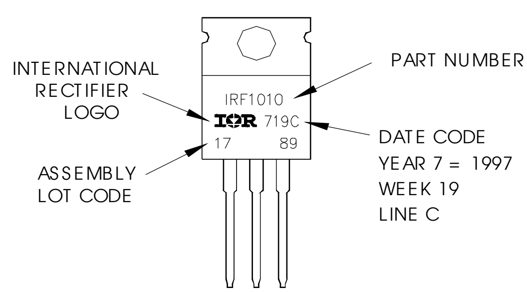
3 OUTLINE CONFORMS TO JEDEC OUTLINE TO-220AB.

4 HEATSINK & LEAD MEASUREMENTS DO NOT INCLUDE BURRS.

TO-220AB Part Marking Information

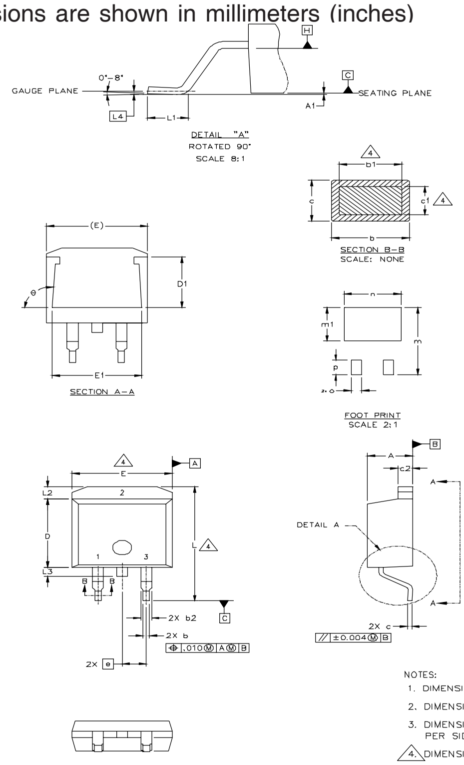
EXAMPLE: THIS IS AN IRF1010
LOT CODE 1789
ASSEMBLED ON WW 19, 1997
IN THE ASSEMBLY LINE "C"

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



D²Pak Package Outline

Dimensions are shown in millimeters (inches)



SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	
A1		0.127		.005	
b	0.51	0.99	.020	.039	
b1	0.51	0.89	.020	.035	4
b2	1.14	1.40	.045	.055	
c	0.43	0.63	.017	.025	
c1	0.38	0.74	.015	.029	4
c2	1.14	1.40	.045	.055	
D	8.51	9.65	.335	.380	3
D1	5.33		.210		
E	9.65	10.67	.380	.420	3
E1	6.22		.245		
e	2.54 BSC		.100 BSC		
L	14.61	15.88	.575	.625	
L1	1.78	2.79	.070	.110	
L2		1.65		.065	
L3	1.27	1.78	.050	.070	
L4	0.25 BSC		.010 BSC		
m	17.78		.700		
m1	8.89		.350		
n	11.43		.450		
o	2.08		.082		
p	3.81		.150		
θ	90°	93°	90°	93°	

LEAD ASSIGNMENTS

HEXFET	IGBTs, CoPACK	DIODES
1.- GATE	1.- GATE	1.- ANODE *
2.- DRAIN	2.- COLLECTOR	2.- CATHODE
3.- SOURCE	3.- EMITTER	3.- ANODE

* PART DEPENDENT.

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.

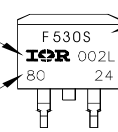
D²Pak Part Marking Information (Lead-Free)

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"

INTERNATIONAL RECTIFIER LOGO

ASSEMBLY LOT CODE



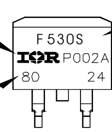
PART NUMBER

DATE CODE
YEAR 0 = 2000
WEEK 02
LINE L

OR

INTERNATIONAL RECTIFIER LOGO

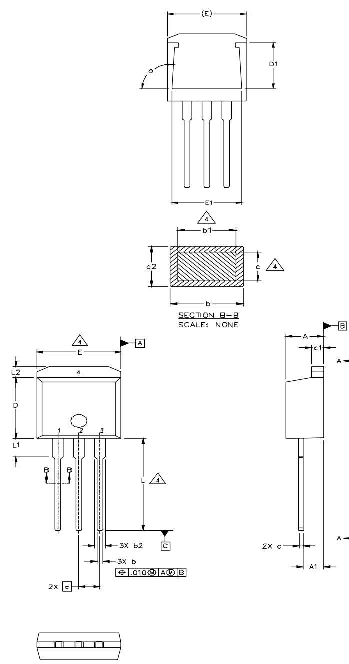
ASSEMBLY LOT CODE



PART NUMBER

DATE CODE
P = DESIGNATES LEAD-FREE PRODUCT (OPTIONAL)
YEAR 0 = 2000
WEEK 02
A = ASSEMBLY SITE CODE

TO-262 Package Outline



SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	
A1	2.03	2.92	.080	.115	
b	0.51	0.99	.020	.039	
b1	0.51	0.89	.020	.035	4
b2	1.14	1.40	.045	.055	
c	0.38	0.63	.015	.025	4
c1	1.14	1.40	.045	.055	
c2	0.43	.063	.017	.029	
D	8.51	9.65	.335	.380	3
D1	5.33		.210		
E	9.65	10.67	.380	.420	3
E1	6.22		.245		
e	2.54 BSC		.100 BSC		
L	13.46	14.09	.530	.555	
L1	3.56	3.71	.140	.146	
L2		1.65		.065	

LEAD ASSIGNMENTS

HEXFET
1.– GATE
2.– DRAIN
3.– SOURCE
4.– DRAIN

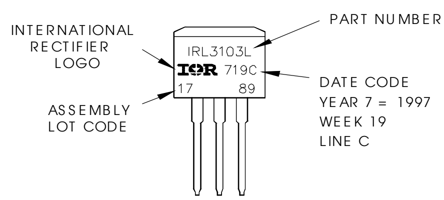
IGBT
1 - GATE
2 - COLLECTOR
3 - EMITTER

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.

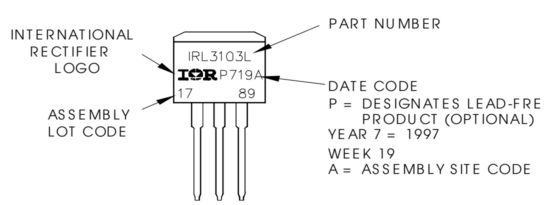
TO-262 Part Marking Information

EXAMPLE: THIS IS AN IRL3103L
LOT CODE 1789
ASSEMBLED ON WW 19, 1997
IN THE ASSEMBLY LINE "C"

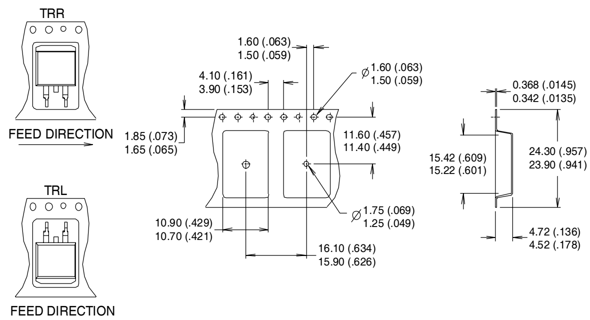
Note: "P" in assembly line position indicates "Lead-Free"

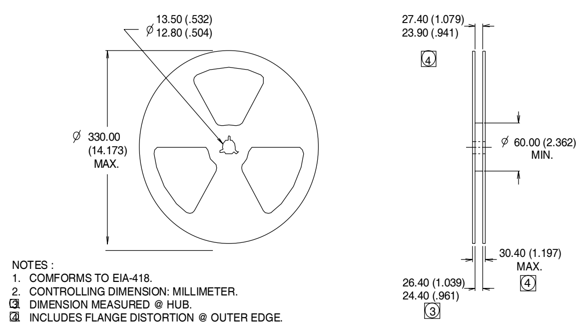


OR



D^2Pak Tape & Reel Infomation





Notes:

① V_{CC} = 80% (V_{CES}), V_{GE} = 15V, L = 100µH, R_G = 100Ω.

② When mounted on 1" square PCB (FR-4 or G-10 Material). For recommended footprint and soldering techniques refer to application note #AN-994.

③ Energy losses include "tail" and diode reverse recovery, using Diode FD059H06A5.

TO-220AB 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.

International
IOR Rectifier

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TAC Fax: (310) 252-7903
Visit us at www.irf.com for sales contact information. 08/04

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