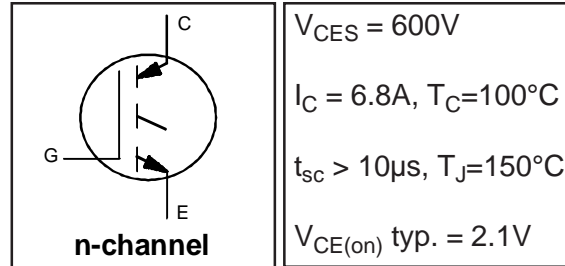


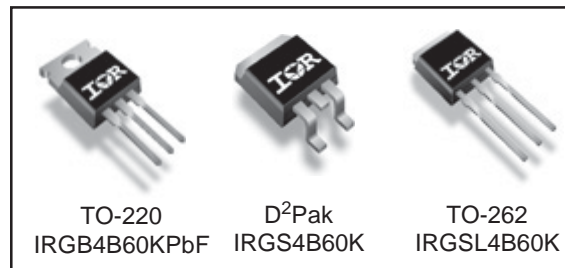
Features

- 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.
- TO-220 is available in PbF as a Lead-Free.



Benefits

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



Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	12	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	6.8	
I_{CM}	Pulse Collector Current (Ref.Fig.C.T.5)	24	
I_{LM}	Clamped Inductive Load current ①	24	
V_{GE}	Gate-to-Emitter Voltage	±20	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	63	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	31	
T_J	Operating Junction and	-55 to +175	°C
T_{STG}	Storage Temperature Range		
	Soldering Temperature, 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
$R_{\theta CS}$	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

IRGB4B60KPbF

IRGS/SL4B60K

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	
ΔV _{(BR)CES} /ΔT _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	2.8		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
ΔV _{GE(th)} /ΔT _J	Threshold Voltage temp. coefficient	—	-8.1	—	mV/°C	V _{CE} = V _{GE} , I _C = 1mA (25°C-150°C)	12
g _{fe}	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	
		—	54	300		V _{GE} = 0V, V _{CE} = 600V, T _J = 150°C	
		—	300	800		V _{GE} = 0V, V _{CE} = 600V, 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	CT4
t _r	Rise time	—	18	23		V _{GE} = 15V, R _G = 100Ω, L = 2.5mH	
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	22
C _{oes}	Output Capacitance	—	25	—		V _{CC} = 30V	
C _{res}	Reverse Transfer Capacitance	—	6.2	—		f = 1.0MHz	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T _J = 150°C, I _C = 24A, V _p = 600V V _{CC} =500V, V _{GE} = +15V to 0V, R _G = 100Ω	4 CT2
SCSOA	Short Circuit Safe Operating Area	10	—	—	μs	T _J = 150°C, V _p = 600V, R _G = 100Ω V _{CC} =360V, V _{GE} = +15V to 0V	CT3 WF3

Note ① to ③ are on page 16

IRGB4B60KPbF IRGS/SL4B60K

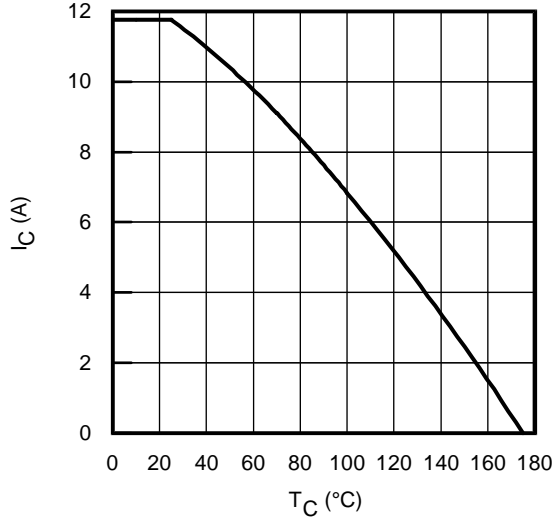


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

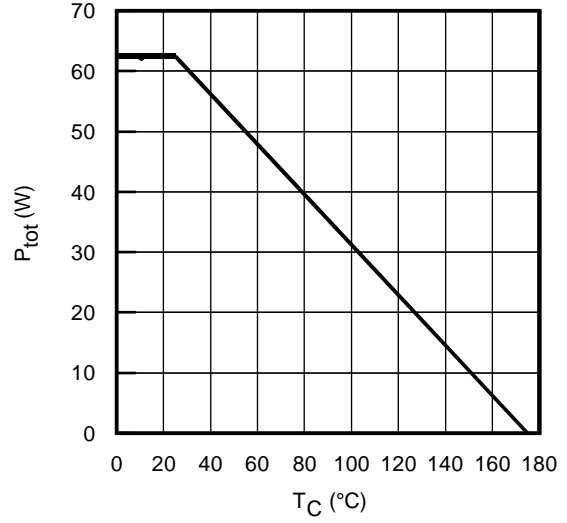


Fig. 2 - Power Dissipation vs. Case Temperature

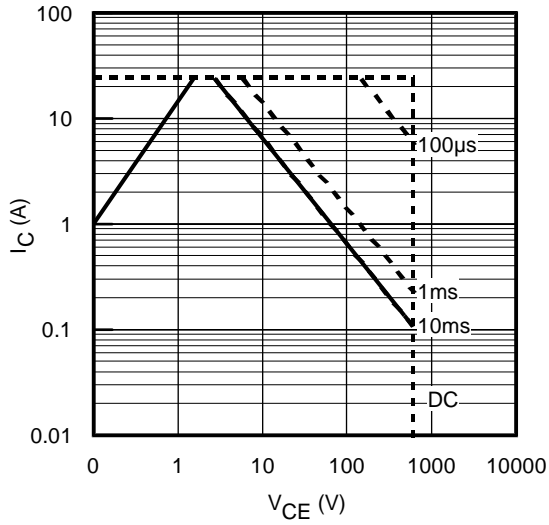


Fig. 3 - Forward SOA
 $T_C = 25^{\circ}C$; $T_J \leq 150^{\circ}C$

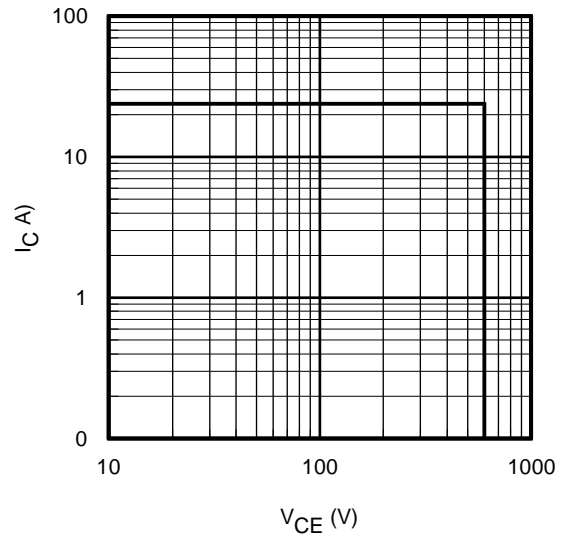


Fig. 4 - Reverse Bias SOA
 $T_J = 150^{\circ}C$; $V_{GE} = 15V$

IRGB4B60KPbF

IRGS/SL4B60K

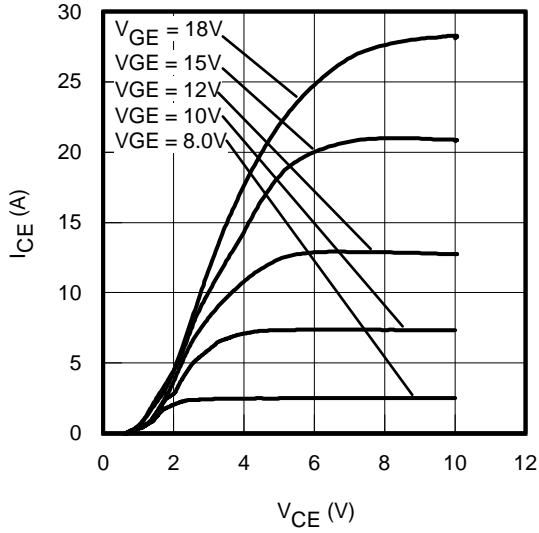


Fig. 5 - Typ. IGBT Output Characteristics
 $T_J = -40^\circ\text{C}$; $t_p = 80\mu\text{s}$

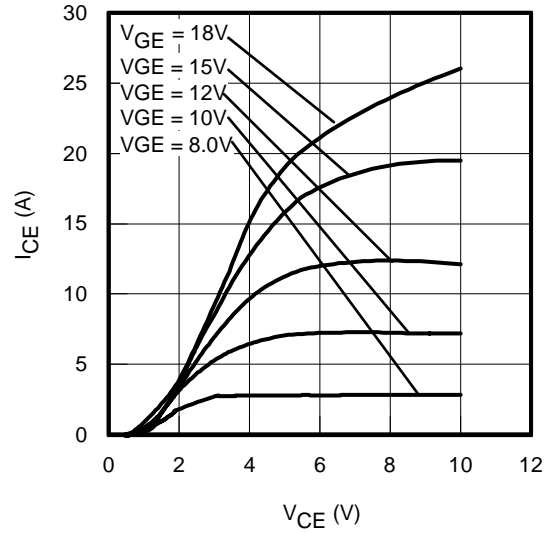


Fig. 6 - Typ. IGBT Output Characteristics
 $T_J = 25^\circ\text{C}$; $t_p = 80\mu\text{s}$

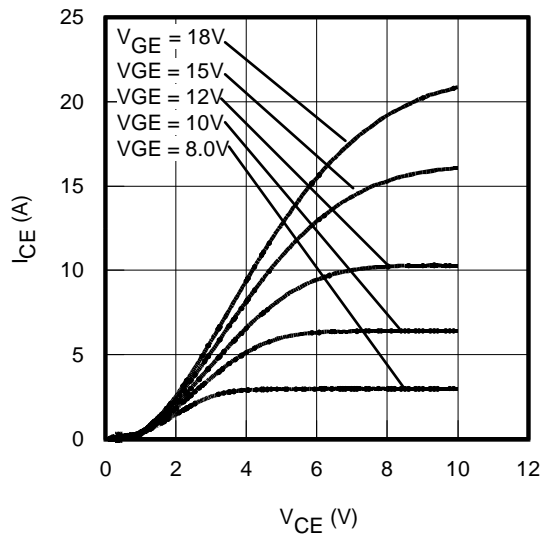


Fig. 7 - Typ. IGBT Output Characteristics
 $T_J = 150^\circ\text{C}$; $t_p = 80\mu\text{s}$

IRGB4B60KPbF IRGS/SL4B60K

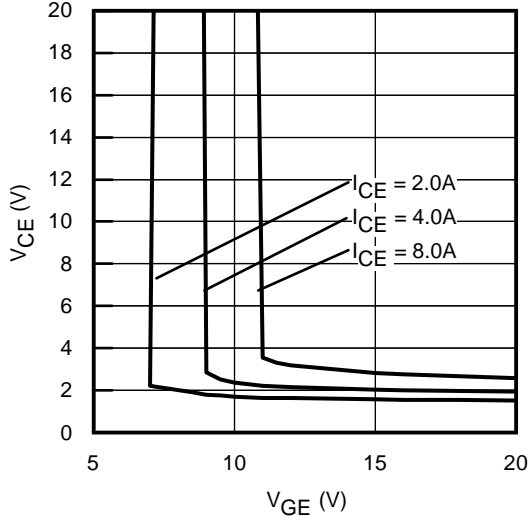


Fig. 8 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^\circ\text{C}$

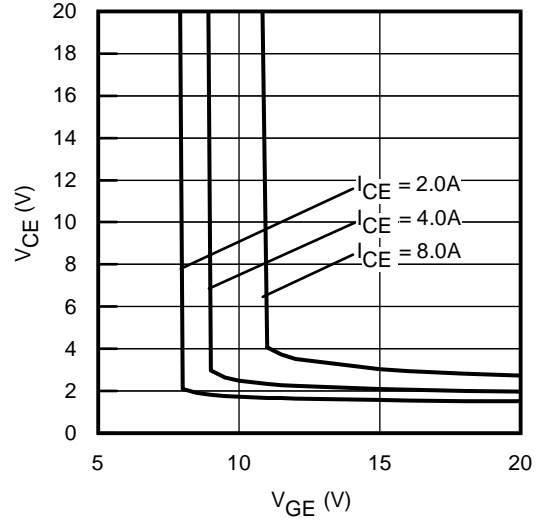


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

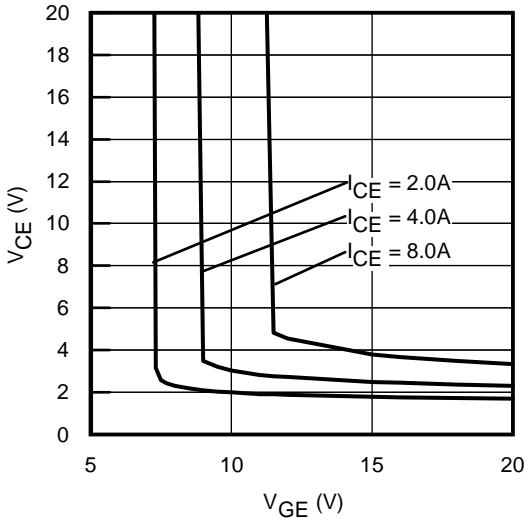


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 150^\circ\text{C}$

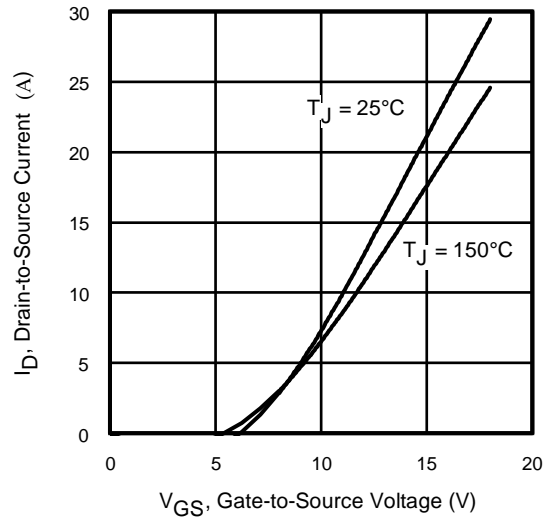


Fig. 11 - Typ. Transfer Characteristics
 $V_{CE} = 360\text{V}$; $t_p = 10\mu\text{s}$

IRGB4B60KPbF

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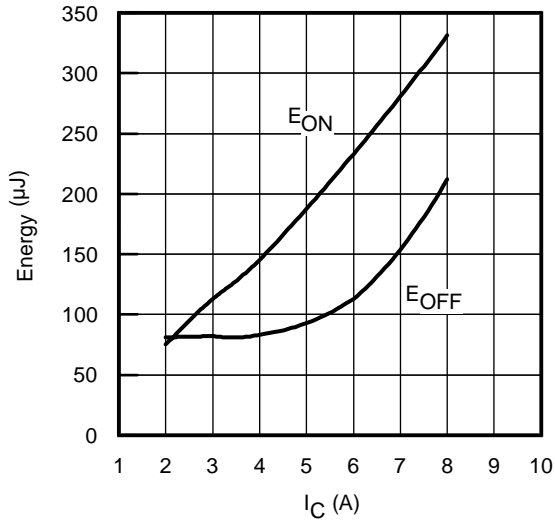


Fig. 12 - Typ. Energy Loss vs. I_C
 $T_J = 150^\circ\text{C}$; $L=2.5\text{mH}$; $V_{CE}=400\text{V}$,
 $R_G=100\Omega$; $V_{GE}=15\text{V}$

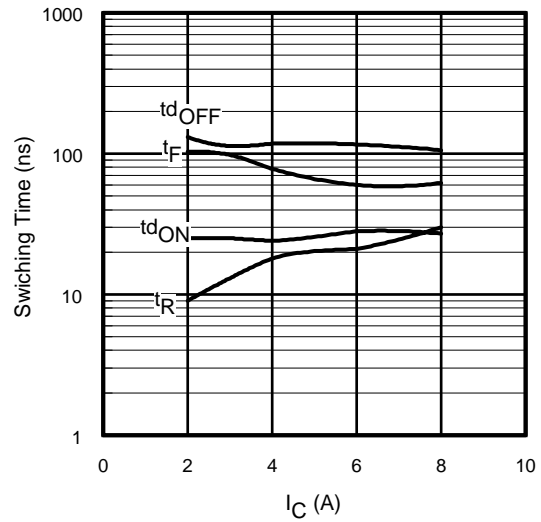


Fig. 13 - Typ. Switching Time vs. I_C
 $T_J = 150^\circ\text{C}$; $L=2.5\text{mH}$; $V_{CE}=400\text{V}$
 $R_G=100\Omega$; $V_{GE}=15\text{V}$

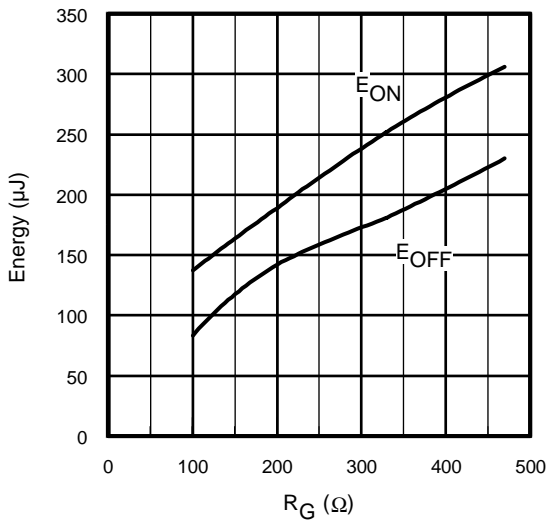


Fig. 14 - Typ. Energy Loss vs. R_G
 $T_J = 150^\circ\text{C}$; $L=2.5\text{mH}$; $V_{CE}=400\text{V}$
 $I_{CE}=4.0\text{A}$; $V_{GE}=15\text{V}$

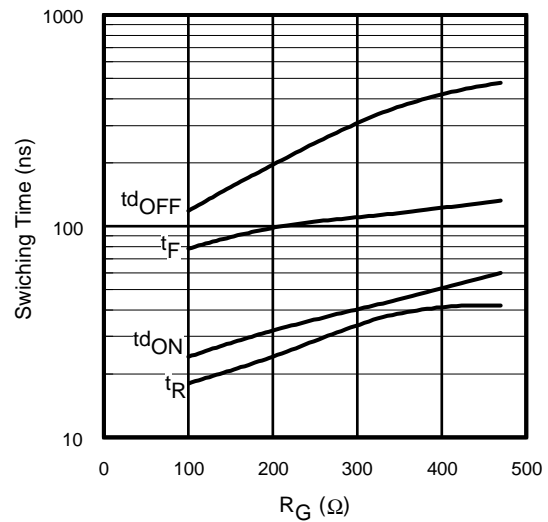


Fig. 15 - Typ. Switching Time vs. R_G
 $T_J = 150^\circ\text{C}$; $L=2.5\text{mH}$; $V_{CE}=400\text{V}$
 $I_{CE}=4.0\text{A}$; $V_{GE}=15\text{V}$

IRGB4B60KPbF IRGS/SL4B60K

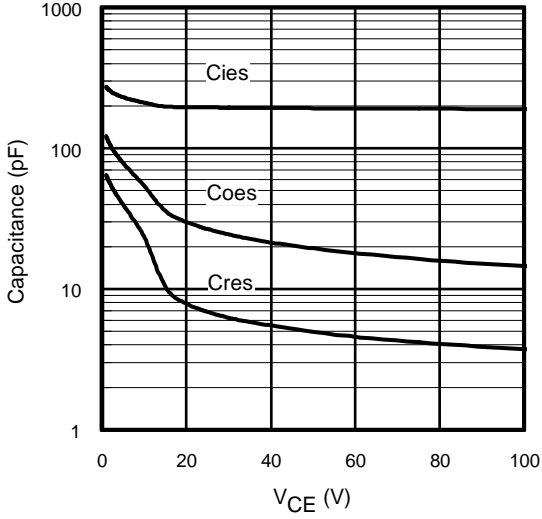


Fig. 16- Typ. Capacitance vs. V_{CE}
V_{GE}= 0V; f = 1MHz

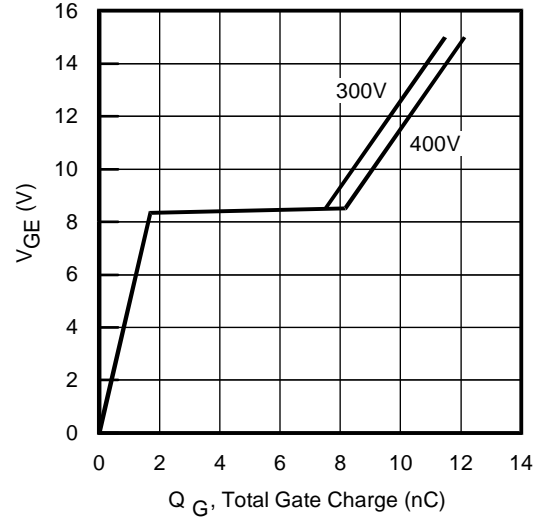


Fig. 17 - Typical Gate Charge vs. V_{GE}
I_{CE} = 4.0A; L = 3150μH

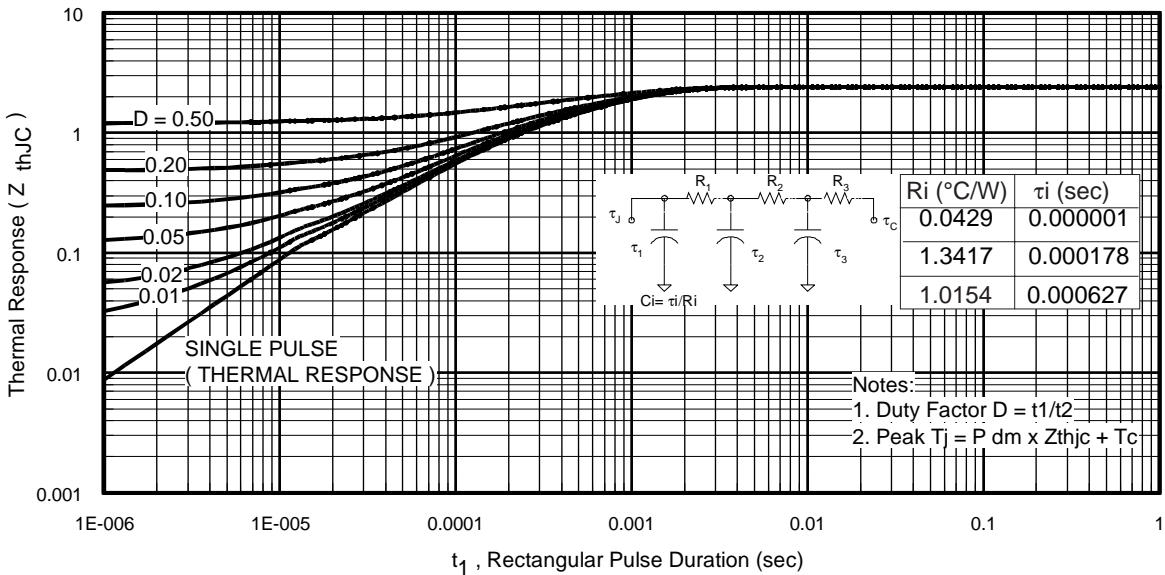


Fig 18. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

IRGB4B60KPbF IRGS/SL4B60K

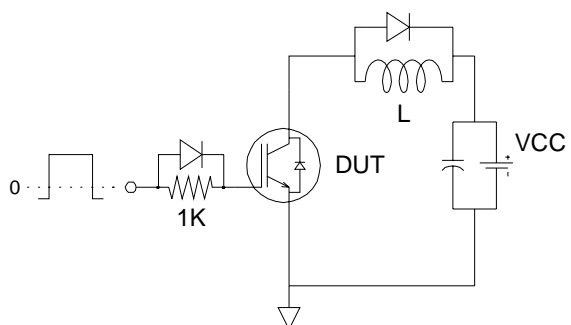


Fig.C.T.1 - Gate Charge Circuit (turn-off)

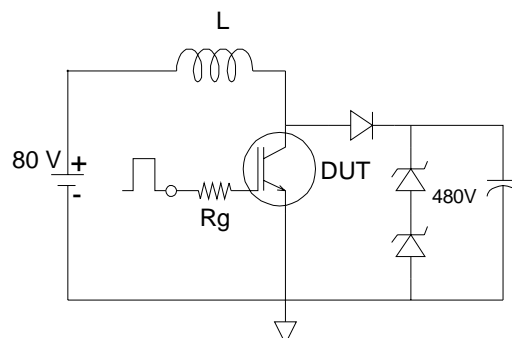


Fig.C.T.2 - RBSOA Circuit

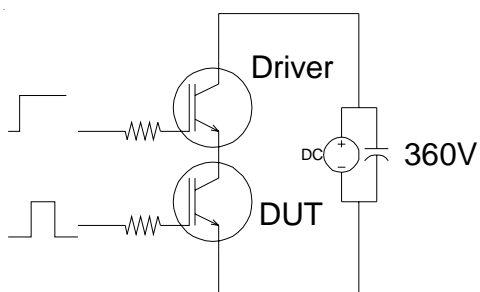


Fig.C.T.3 - S.C.SOA Circuit

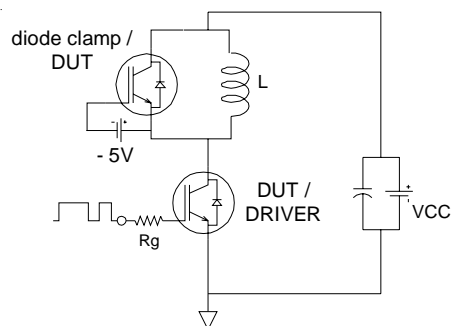


Fig.C.T.4 - Switching Loss Circuit

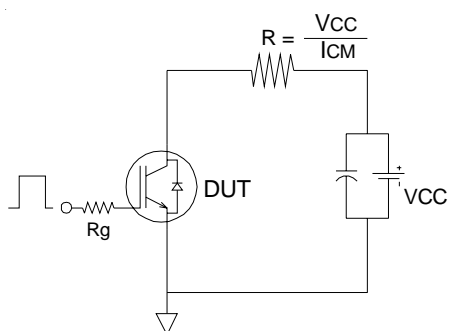


Fig.C.T.5 - Resistive Load Circuit

IRGB4B60KPbF IRGS/SL4B60K

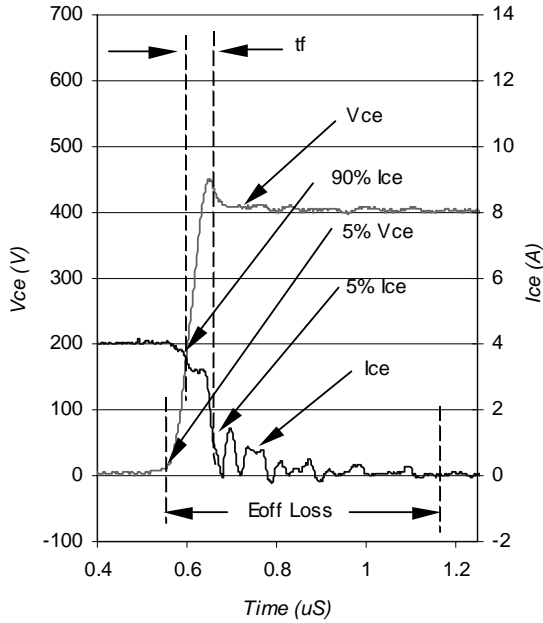


Fig. WF1- Typ. Turn-off Loss Waveform
@ $T_J = 150^\circ\text{C}$ using Fig. CT.4

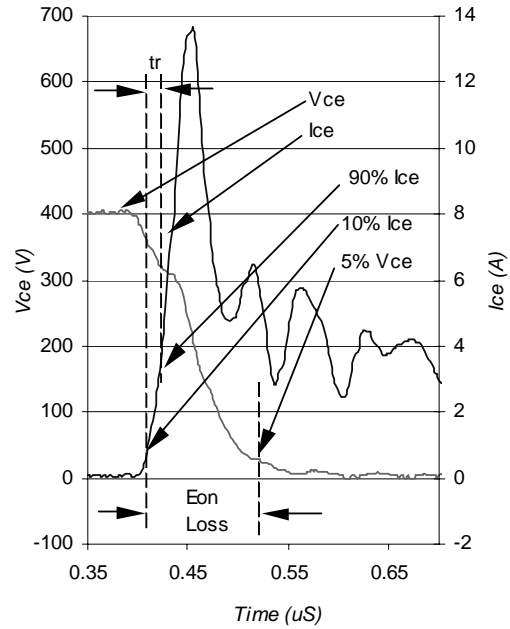


Fig. WF2- Typ. Turn-on Loss Waveform
@ $T_J = 150^\circ\text{C}$ using Fig. CT.4

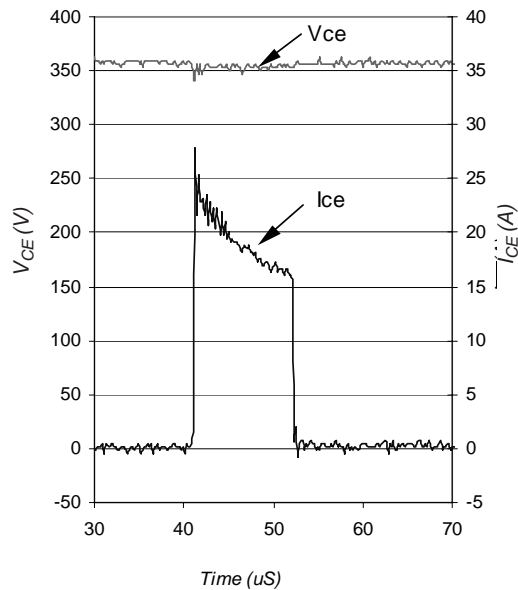
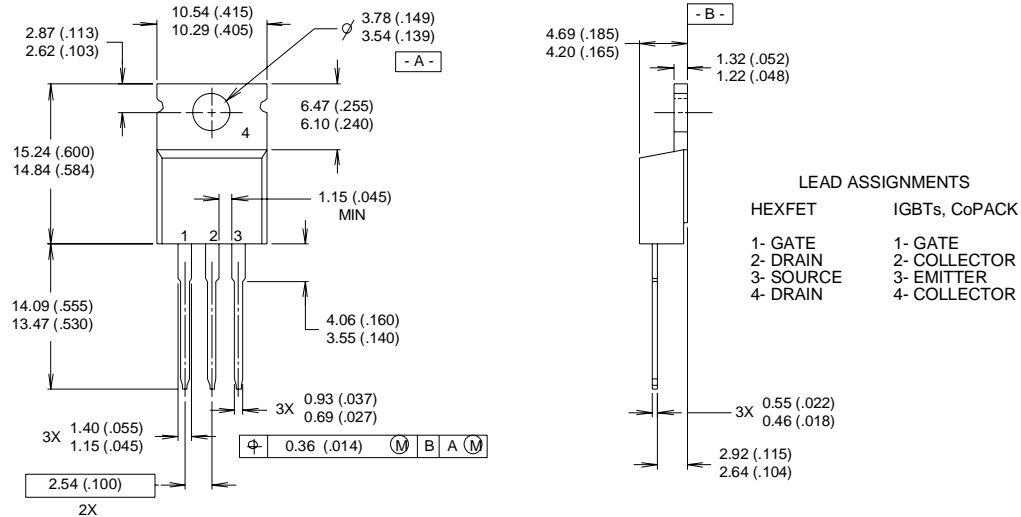


Fig. WF3- Typ. S.C Waveform
@ $T_C = 150^\circ\text{C}$ using Fig. CT.3

IRGB4B60KPbF IRGS/SL4B60K

TO-220AB Package Outline

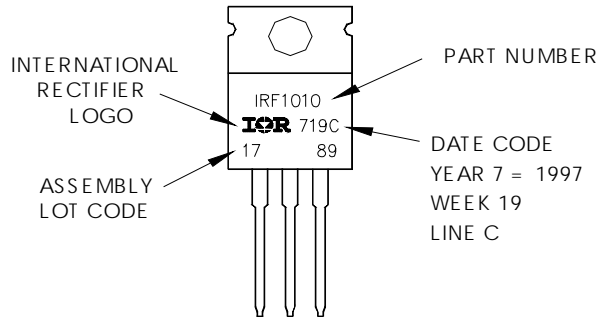
Dimensions are shown in millimeters (inches)



- 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

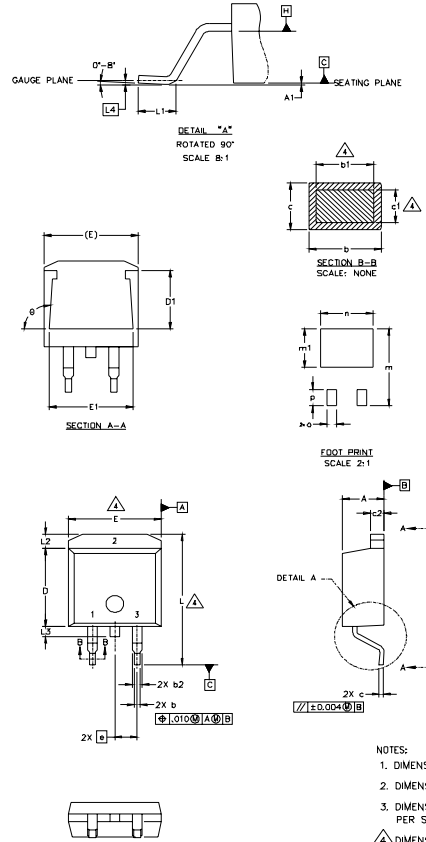
EXAMPLE: THIS IS AN IRF1010
 LOT CODE 1789
 ASSEMBLED ON WW 19, 1997
 IN THE ASSEMBLY LINE "C"
Note: "P" in assembly line position indicates "Lead-Free"



IRGB4B60KPbF IRGS/SL4B60K

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	4
A1		0.127		.005	
b	0.51	0.99	.020	.039	
b1	0.51	0.89	.020	.035	
b2	1.14	1.40	.045	.055	4
c	0.43	0.63	.017	.025	
c1	0.38	0.74	.015	.029	
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		
theta	90°	93°	90°	93°	

LEAD ASSIGNMENTS

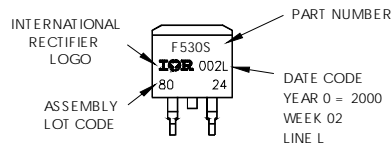
HEXFET	IGBTs, CoPACK	DIODES
1.- GATE	1.- GATE	1.- ANODE *
2.- DRAIN	2.- COLLECTOR	2.- CATHODE
3.- SOURCE	3.- EMITTER	3.- ANODE

* PART DEPENDENT.

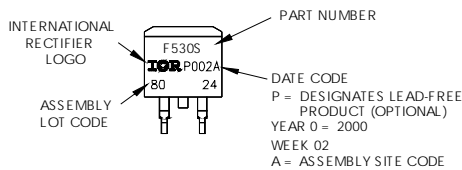
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
 2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
 3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
 4. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
 5. CONTROLLING DIMENSION: INCH.

D²Pak Part Marking Information

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"



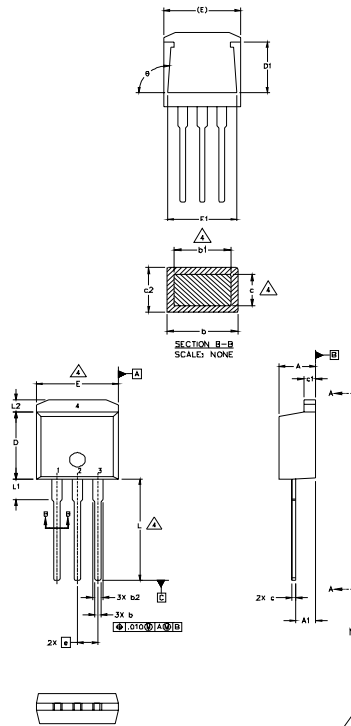
OR



IRGB4B60KPbF IRGS/SL4B60K

TO-262 Package Outline

Dimensions are shown in millimeters (inches)



SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	4.06	4.83	.160	.190	4
A1	2.03	2.92	.080	.115	
b	0.51	0.99	.020	.039	
b1	0.51	0.89	.020	.035	
b2	1.14	1.40	.045	.055	4
c	0.38	0.63	.015	.025	
c1	1.14	1.40	.045	.055	3
c2	0.43	.063	.017	.029	
D	8.51	9.65	.335	.380	
D1	5.33		.210		3
E	9.65	10.67	.380	.420	
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

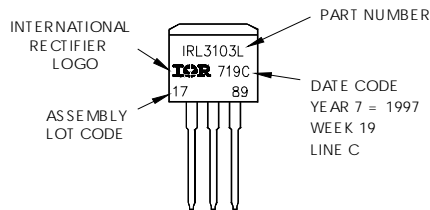
HEXFET	IGBT
1.- GATE	1 - GATE
2.- DRAIN	2 - COLLECTOR
3.- SOURCE	3 - EMITTER
4.- DRAIN	

- 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.
 4. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
 5. CONTROLLING DIMENSION: INCH.

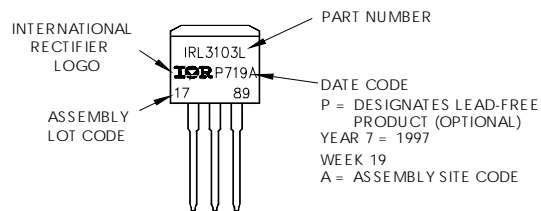
TO-262 Part Marking Information

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"

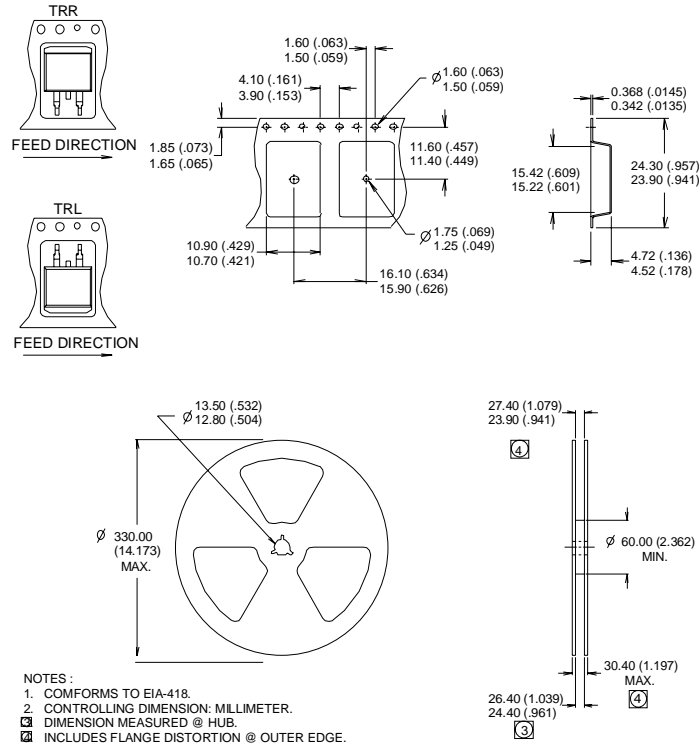


OR



D²Pak Tape & Reel Information

Dimensions are shown in millimeters (inches)



Notes:

- ① $V_{CC} = 80\% (V_{CES})$, $V_{GE} = 20V$, $L = 100\mu H$, $R_G = 50\Omega$.
- 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.

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

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