

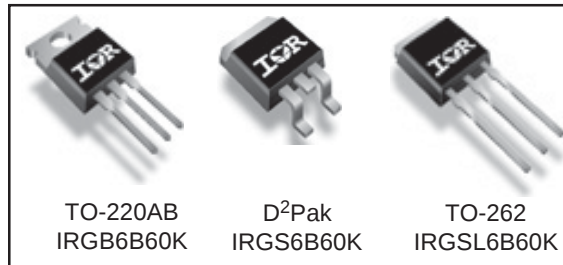
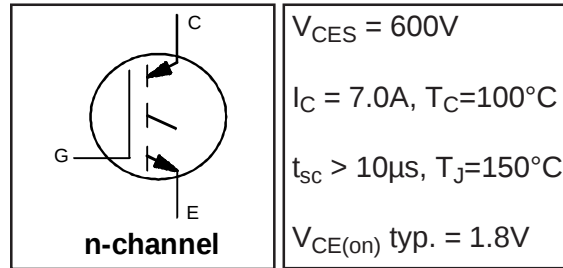
IRGB6B60KPbF
IRGS6B60KPbF
IRGSL6B60KPbF

Features

- Low VCE (on) Non Punch Through IGBT Technology.
- 10μs Short Circuit Capability.
- Square RBSOA.
- Positive VCE (on) Temperature Coefficient.
- 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°C	Continuous Collector Current	13	A
I _C @ T _C = 100°C	Continuous Collector Current	7.0	
I _{CM}	Pulsed Collector Current	26	
I _{LM}	Clamped Inductive Load Current ①	26	
V _{GE}	Gate-to-Emitter Voltage	± 20	V
P _D @ T _C = 25°C	Maximum Power Dissipation	90	W
P _D @ T _C = 100°C	Maximum Power Dissipation	36	
T _J	Operating Junction and	-55 to +150	°C
T _{STG}	Storage Temperature Range		
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
R _{θJC}	Junction-to-Case - IGBT	—	—	1.4	°C/W
R _{θCS}	Case-to-Sink, flat, greased surface	—	0.50	—	
R _{θJA}	Junction-to-Ambient, typical socket mount②	—	—	62	
R _{θJA}	Junction-to-Ambient (PCB Mount, steady state)③	—	—	40	
Wt	Weight	—	1.44	—	g

IRGB/S/SL6B60KPbF

International
IR Rectifier

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	$V_{GE} = 0V, I_C = 500\mu A$	
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.3	—	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 1.0mA, (25^\circ\text{C}-150^\circ\text{C})$	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	1.5	1.80	2.20	V	$I_C = 5.0A, V_{GE} = 15V$	5, 6, 7
		—	2.20	2.50		$I_C = 5.0A, V_{GE} = 15V, T_J = 150^\circ\text{C}$	8, 9, 10
$V_{GE(th)}$	Gate Threshold Voltage	3.5	4.5	5.5	V	$V_{CE} = V_{GE}, I_C = 250\mu A$	8, 9, 10
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	—	-10	—	mV/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 1.0mA, (25^\circ\text{C}-150^\circ\text{C})$	11
g_{fe}	Forward Transconductance	—	3.0	—	S	$V_{CE} = 50V, I_C = 5.0A, PW=80\mu s$	
I_{CES}	Zero Gate Voltage Collector Current	—	1.0	150	μA	$V_{GE} = 0V, V_{CE} = 600V$	
		—	200	500		$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$	
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.	Units	Conditions	Ref.Fig.
Q_g	Total Gate Charge (turn-on)	—	18.2	—	nC	$I_C = 5.0A$	17
Q_{ge}	Gate - Emitter Charge (turn-on)	—	1.9	—		$V_{CC} = 400V$	CT1
Q_{gc}	Gate - Collector Charge (turn-on)	—	9.2	—		$V_{GE} = 15V$	
E_{on}	Turn-On Switching Loss	—	110	210	μJ	$I_C = 5.0A, V_{CC} = 400V$	CT4
E_{off}	Turn-Off Switching Loss	—	135	245		$V_{GE} = 15V, R_G = 100\Omega, L = 1.4mH$	
E_{tot}	Total Switching Loss	—	245	455		$L_s = 150nH, T_J = 25^\circ\text{C} \text{ ④}$	
$t_{d(on)}$	Turn-On Delay Time	—	25	34	ns	$I_C = 5.0A, V_{CC} = 400V$	CT4
t_r	Rise Time	—	17	26		$V_{GE} = 15V, R_G = 100\Omega, L = 1.4mH$	
$t_{d(off)}$	Turn-Off Delay Time	—	215	230		$L_s = 150nH, T_J = 25^\circ\text{C}$	
t_f	Fall Time	—	13.2	22			
E_{on}	Turn-On Switching Loss	—	150	260	μJ	$I_C = 5.0A, V_{CC} = 400V$	CT4
E_{off}	Turn-Off Switching Loss	—	190	300		$V_{GE} = 15V, R_G = 100\Omega, L = 1.4mH$	12, 14
E_{tot}	Total Switching Loss	—	340	560		$L_s = 150nH, T_J = 150^\circ\text{C} \text{ ④}$	WF1, WF2
$t_{d(on)}$	Turn-On Delay Time	—	28	37	ns	$I_C = 5.0A, V_{CC} = 400V$	13, 15
t_r	Rise Time	—	17	26		$V_{GE} = 15V, R_G = 100\Omega, L = 1.4mH$	CT4
$t_{d(off)}$	Turn-Off Delay Time	—	240	255		$L_s = 150nH, T_J = 150^\circ\text{C}$	WF1
t_f	Fall Time	—	18	27			WF2
C_{ies}	Input Capacitance	—	290	—	pF	$V_{GE} = 0V$	16
C_{oes}	Output Capacitance	—	34	—		$V_{CC} = 30V$	
C_{res}	Reverse Transfer Capacitance	—	10	—		$f = 1.0MHz$	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 150^\circ\text{C}, I_C = 26A, V_p = 600V$ $V_{CC} = 500V, V_{GE} = +15V \text{ to } 0V, R_G = 100\Omega$	4 CT2
SCSOA	Short Circuit Safe Operating Area	10	—	—	μs	$T_J = 150^\circ\text{C}, V_p = 600V, R_G = 100\Omega$ $V_{CC} = 360V, V_{GE} = +15V \text{ to } 0V$	CT3 WF3

Note ① to ④ are on page 13

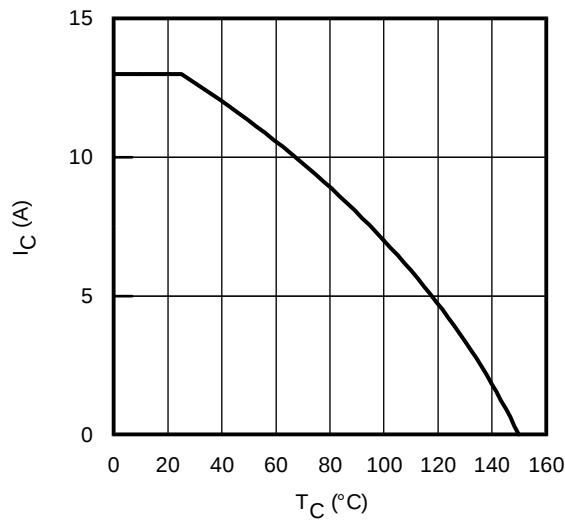


Fig. 1 - Maximum DC Collector Current vs. Case Temperature

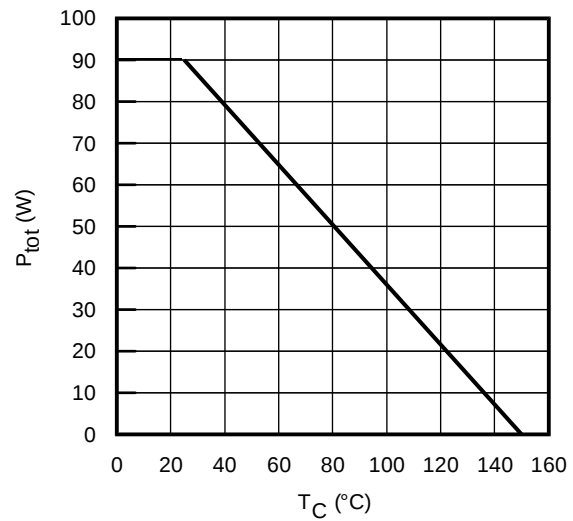


Fig. 2 - Power Dissipation vs. Case Temperature

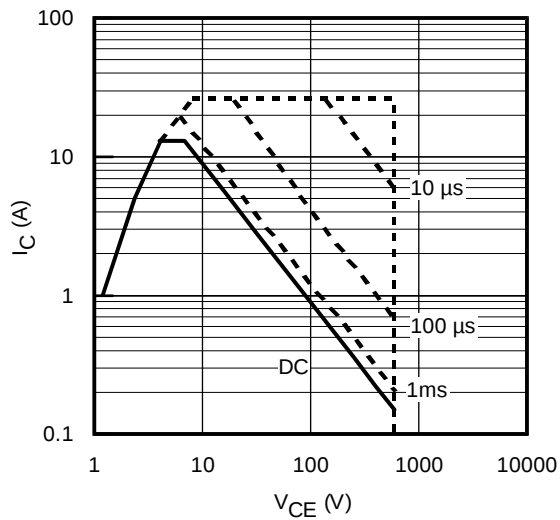


Fig. 3 - Forward SOA
 $T_C = 25^\circ\text{C}$; $T_J \leq 150^\circ\text{C}$

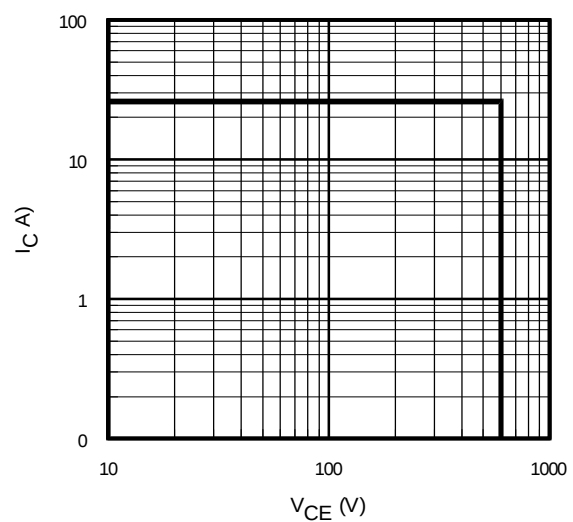


Fig. 4 - Reverse Bias SOA
 $T_J = 150^\circ\text{C}$; $V_{GE} = 15\text{V}$

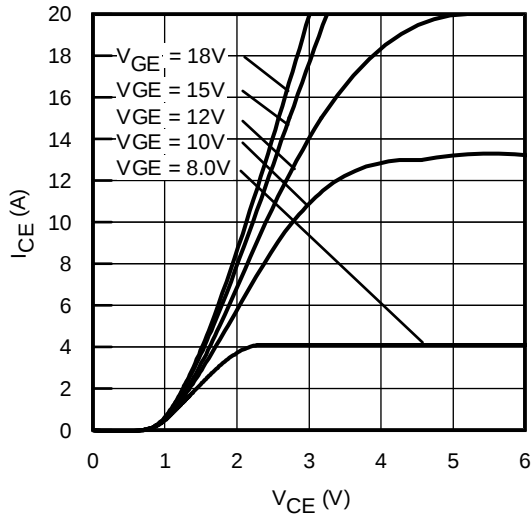


Fig. 5 - Typ. IGBT Output Characteristics
 $T_j = -40^\circ\text{C}$; $t_p = 80\mu\text{s}$

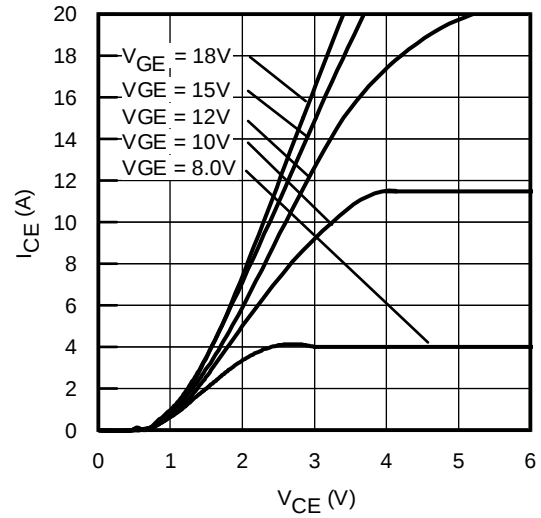


Fig. 6 - Typ. IGBT Output Characteristics
 $T_j = 25^\circ\text{C}$; $t_p = 80\mu\text{s}$

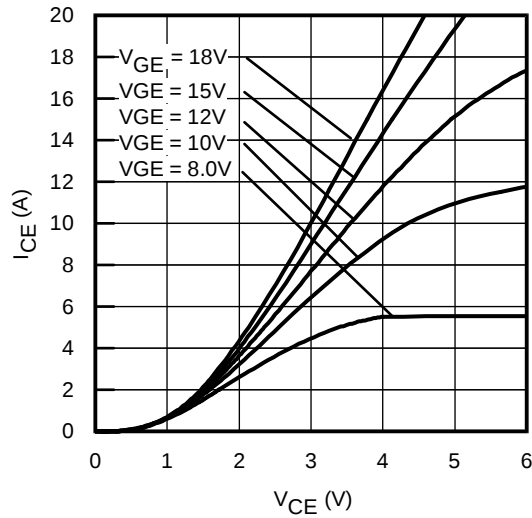


Fig. 7 - Typ. IGBT Output Characteristics
 $T_j = 150^\circ\text{C}$; $t_p = 80\mu\text{s}$

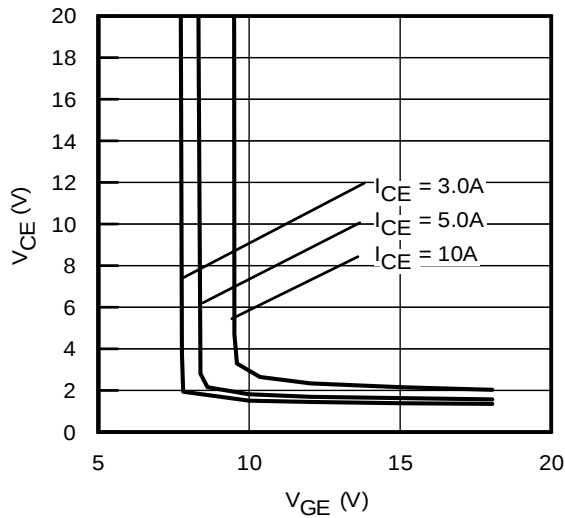


Fig. 8 - Typical V_{CE} vs. V_{GE}
 $T_J = -40^\circ\text{C}$

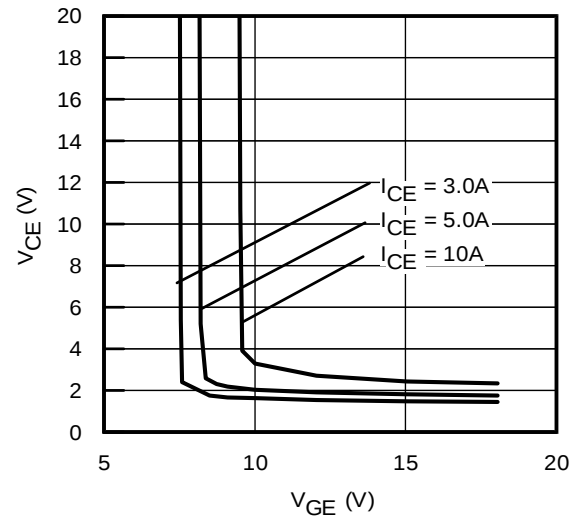


Fig. 9 - Typical V_{CE} vs. V_{GE}
 $T_J = 25^\circ\text{C}$

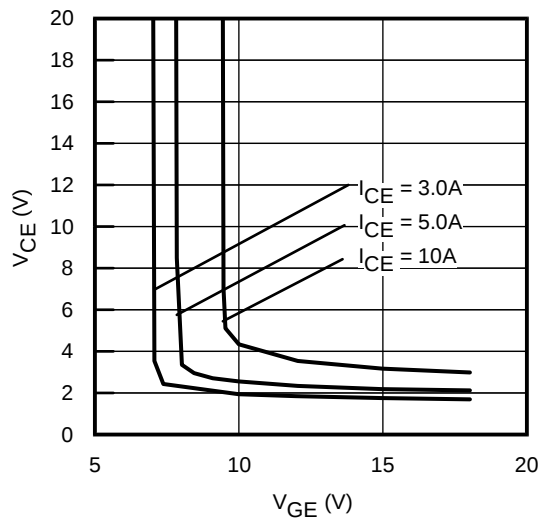


Fig. 10 - Typical V_{CE} vs. V_{GE}
 $T_J = 150^\circ\text{C}$

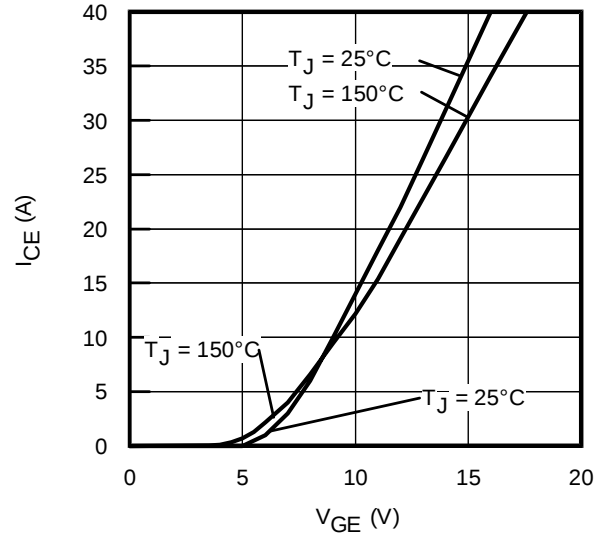


Fig. 11 - Typ. Transfer Characteristics
 $V_{CE} = 50\text{V}$; $t_p = 10\mu\text{s}$

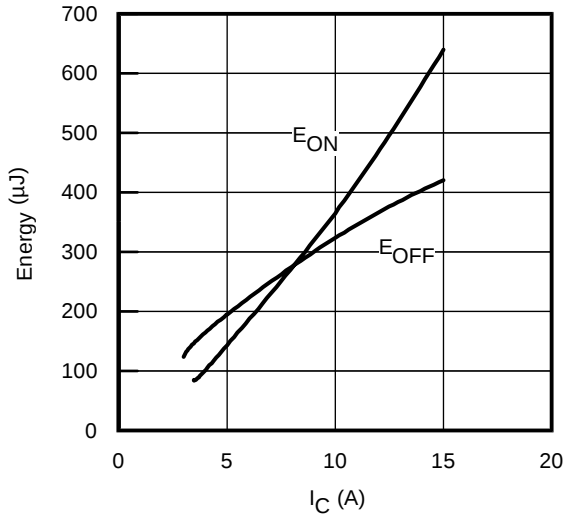


Fig. 12 - Typ. Energy Loss vs. I_C
 $T_J = 150^\circ\text{C}$; $L=1.4\text{mH}$; $V_{CE}= 400\text{V}$
 $R_G= 100\Omega$; $V_{GE}= 15\text{V}$

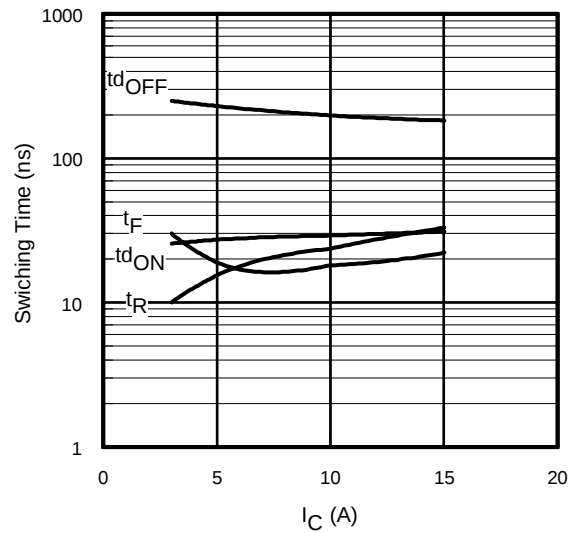


Fig. 13 - Typ. Switching Time vs. I_C
 $T_J = 150^\circ\text{C}$; $L=1.4\text{mH}$; $V_{CE}= 400\text{V}$
 $R_G= 100\Omega$; $V_{GE}= 15\text{V}$

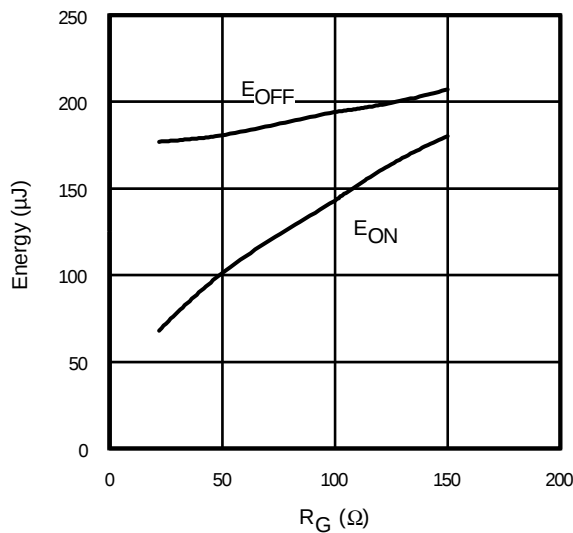


Fig. 14 - Typ. Energy Loss vs. R_G
 $T_J = 150^\circ\text{C}$; $L=1.4\text{mH}$; $V_{CE}= 400\text{V}$
 $I_{CE}= 5.0\text{A}$; $V_{GE}= 15\text{V}$

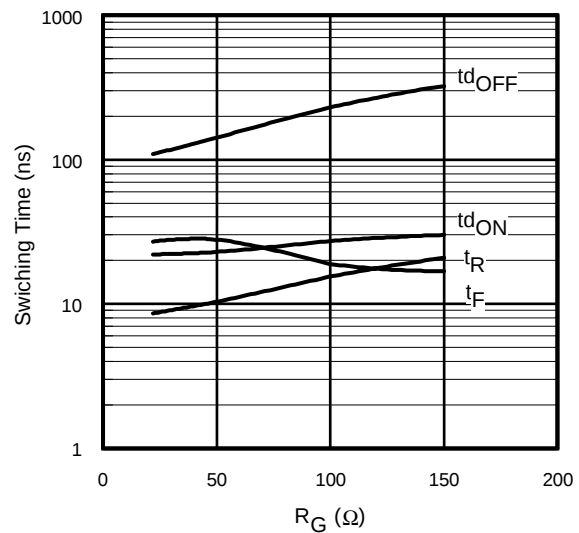


Fig. 15 - Typ. Switching Time vs. R_G
 $T_J = 150^\circ\text{C}$; $L=1.4\text{mH}$; $V_{CE}= 400\text{V}$
 $I_{CE}= 5.0\text{A}$; $V_{GE}= 15\text{V}$

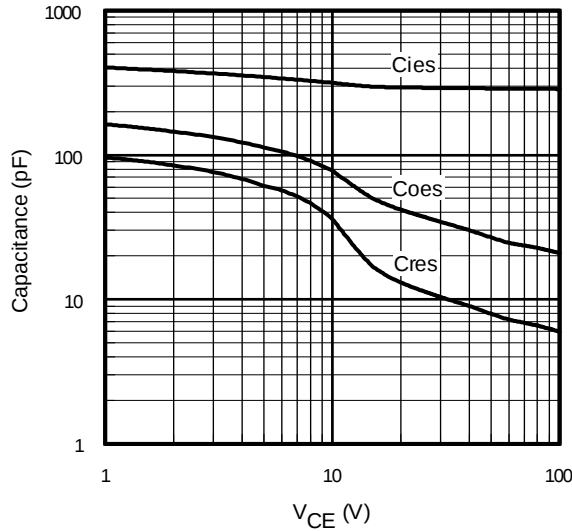


Fig. 16- Typ. Capacitance vs. V_{CE}
 $V_{GE} = 0V$; $f = 1MHz$

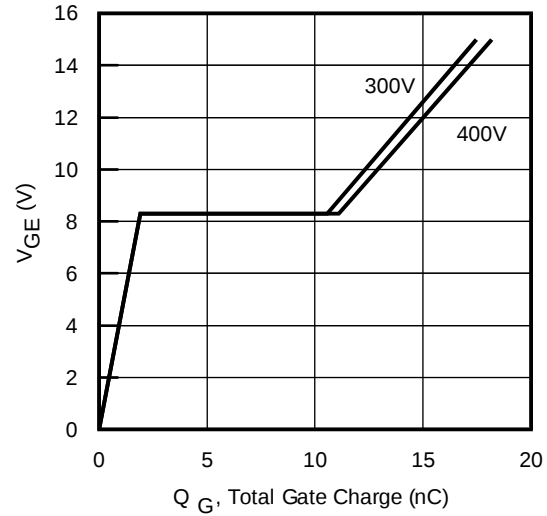


Fig. 17 - Typical Gate Charge vs. V_{GE}
 $I_{CE} = 5.0A$; $L = 600\mu H$

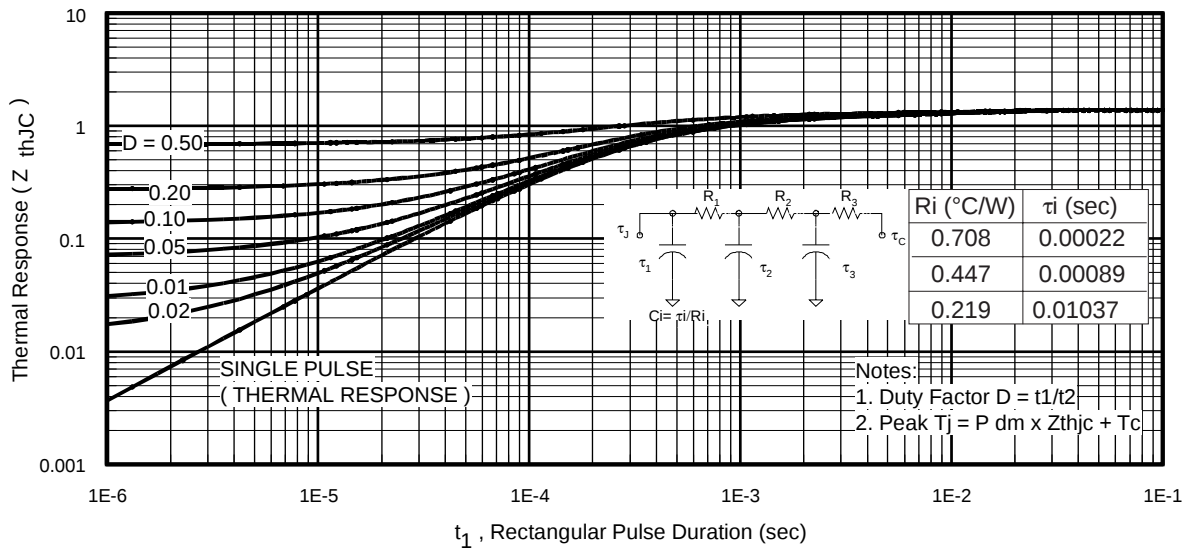


Fig 18. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

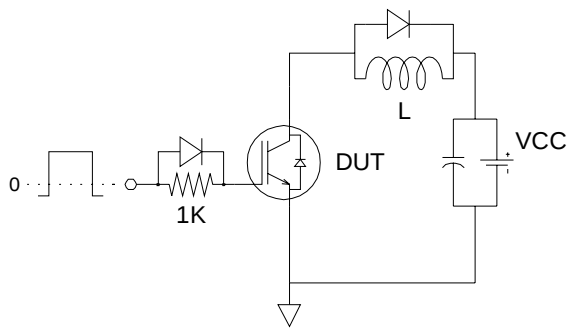


Fig.C.T.1 - Gate Charge Circuit (turn-off)

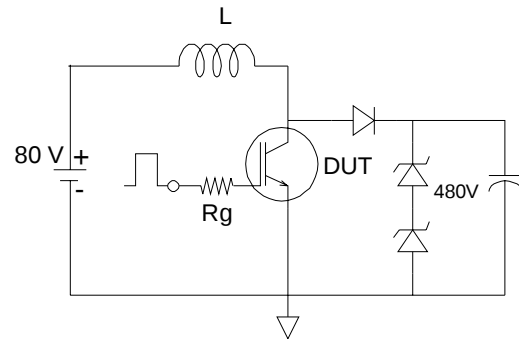


Fig.C.T.2 - RBSOA Circuit

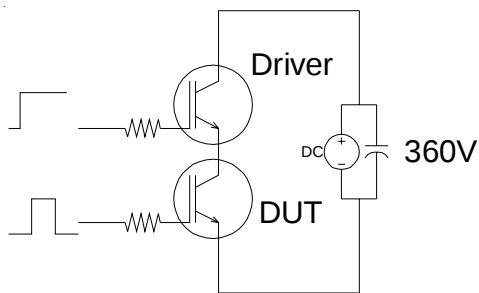


Fig.C.T.3 - S.C.SOA Circuit

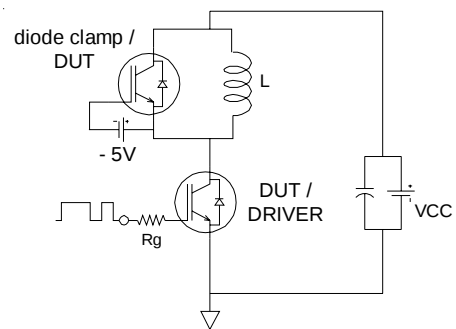


Fig.C.T.4 - Switching Loss Circuit

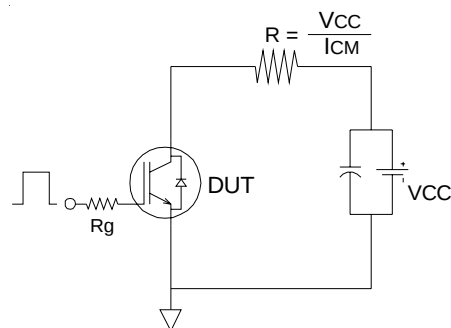


Fig.C.T.5 - Resistive Load Circuit

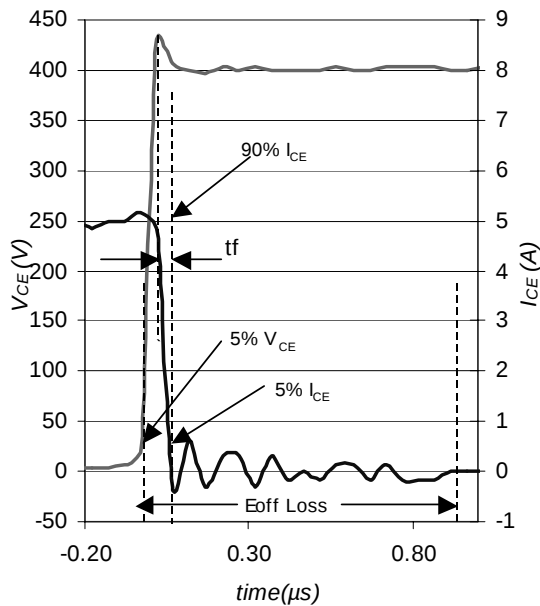


Fig. WF1- Typ. Turn-off Loss Waveform
@ $T_J = 150^\circ\text{C}$ using Fig. CT.4

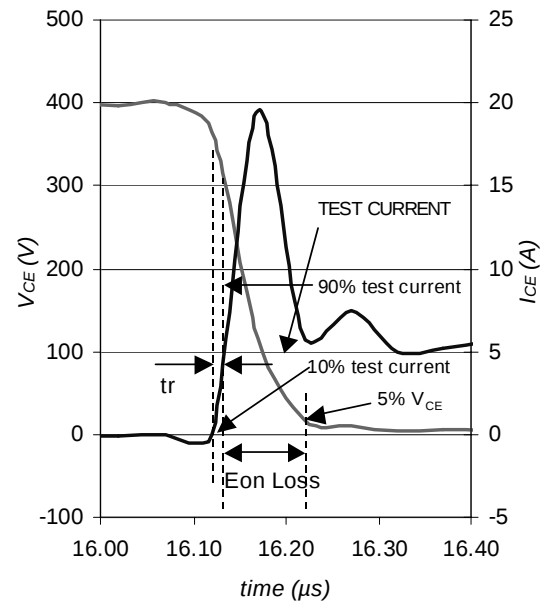


Fig. WF2- Typ. Turn-on Loss Waveform
@ $T_J = 150^\circ\text{C}$ using Fig. CT.4

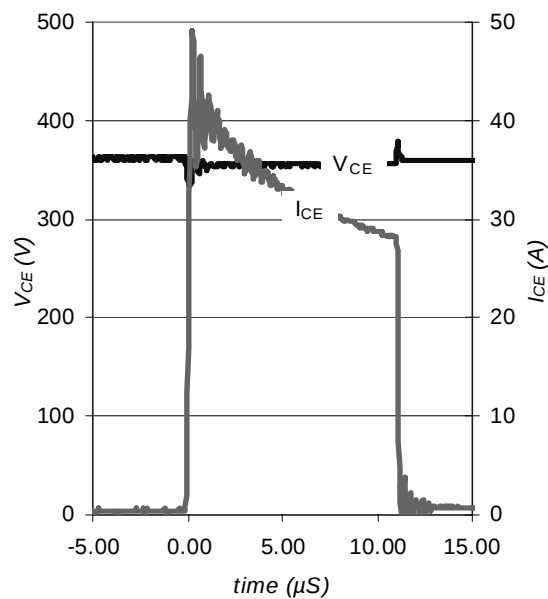


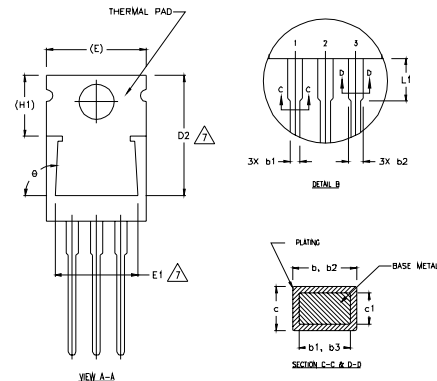
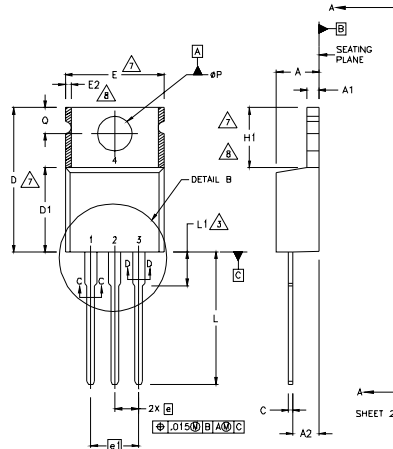
Fig. WF3- Typ. S.C Waveform
@ $T_C = 150^\circ\text{C}$ using Fig. CT.3

IRGB/S/SL6B60KPbF

International
IR Rectifier

TO-220AB Package Outline

Dimensions are shown in millimeters (inches)



NOTES:

- 1 DIMENSIONING AND TOLERANCING PER ASME Y14.5 M- 1994.
- 2 DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
- 3 LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
- 4 DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED .005" (0.127) PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
- 5 DIMENSION b1 & c1 APPLY TO BASE METAL ONLY.
- 6 CONTROLLING DIMENSION : INCHES.
- 7 THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E,H1,D2 & E1
- 8 DIMENSION E2 X H1 DEFINE A ZONE WHERE STAMPING AND SINGULATION IRREGULARITIES ARE ALLOWED.

LEAD ASSIGNMENTS

DIODET

- 1 - GATE
- 2 - DRAIN
- 3 - SOURCE

IGBTs, COPACK

- 1 - GATE
- 2 - COLLECTOR
- 3 - EMITTER

DIODES

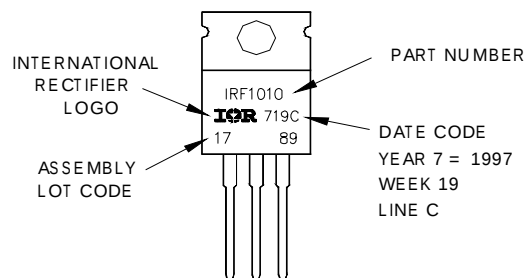
- 1 - ANODE/OPEN
- 2 - CATHODE
- 3 - ANODE

SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	3.56	4.82	.140	.190	5
A1	0.51	1.40	.020	.055	
A2	2.04	2.92	.080	.115	
b	0.38	1.01	.015	.040	
b1	0.38	0.96	.015	.038	
b2	1.15	1.77	.045	.070	
b3	1.15	1.73	.045	.068	
c	0.36	0.61	.014	.024	
c1	0.36	0.56	.014	.022	5
D	14.22	16.51	.560	.650	4
D1	8.38	9.02	.330	.355	
D2	12.19	12.88	.480	.507	7
E	9.66	10.66	.380	.420	4,7
E1	8.38	8.89	.330	.350	7
e	2.54 BSC		.100 BSC		
e1	5.08		.200 BSC		
H1	5.85	6.55	.230	.270	7,8
L	12.70	14.73	.500	.580	
L1	—	6.35	—	.250	3
øP	3.54	4.08	.139	.161	
Q	2.54	3.42	.100	.135	
ø	90°-93°		90°-93°		

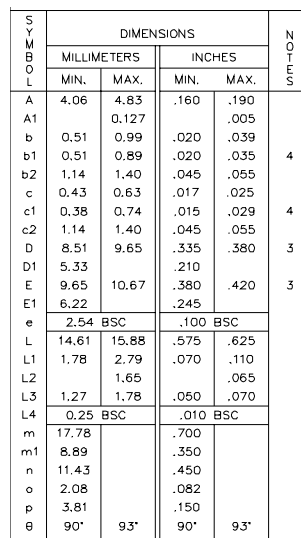
TO-220AB Part Marking Information

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"



Dimensions are shown in millimeters (inches)



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

* PART DEPENDENT.

D²Pak Part Marking Information

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

INTERNATIONAL RECTIFIER LOGO

ASSEMBLY LOT CODE

F530S

002L

80 24

PART NUMBER

DATE CODE

YEAR 0 = 2000

WEEK 02

LINE L

OR

Diagram illustrating the marking on a 530S diode:

- INTERNATIONAL RECTIFIER LOGO**: Points to the IR logo on the diode marking.
- PART NUMBER**: Points to the F530S marking.
- DATE CODE**: Points to the 199 P002A marking.
- ASSEMBLY LOT CODE**: Points to the 80 24 marking.
- WEEK 02**: Points to the 02 marking.
- A = ASSEMBLY SITE CODE**: Points to the A marking.

Legend:

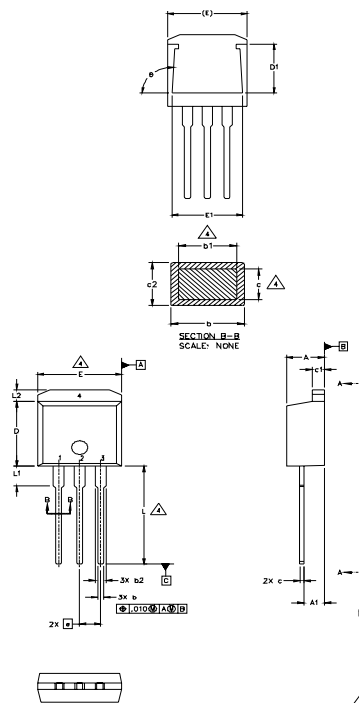
- P = DESIGNATES LEAD-FREE PRODUCT (OPTIONAL)
- YEAR 0 = 2000

IRGB/S/SL6B60KPbF

International
IR Rectifier

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	
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

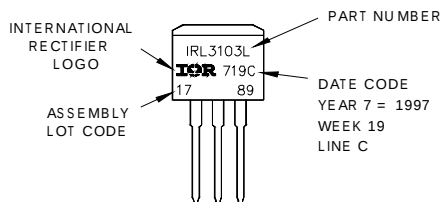
- 1 - GATE
- 2 - COLLECTOR
- 3 - EMITTER

- 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 [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.

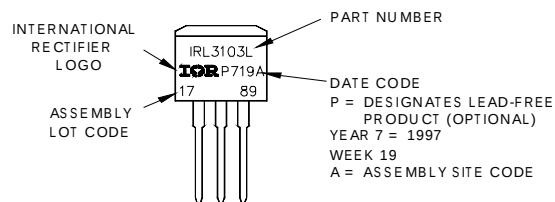
TO-262 Part Marking Information

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"

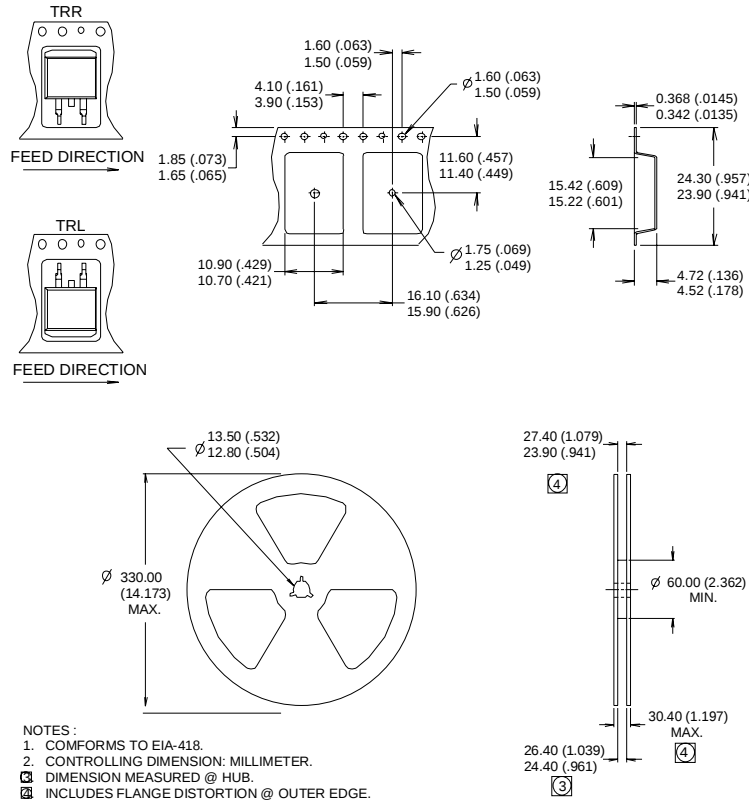


OR



D²Pak Tape & Reel Information

Dimensions are shown in millimeters (inches)



Notes:

- ① $V_{CC} = 80\%$ (V_{CES}), $V_{GE} = 15V$, $L = 28\mu H$, $R_G = 22\Omega$
- ② This is only applied to TO-220AB package
- ③ This is applied to D²Pak, when mounted on 1" square PCB (FR-4 or G-10 Material).
For recommended footprint and soldering techniques refer to application note #AN-994.
- ④ Energy losses include "tail" and diode reverse recovery, using Diode HF03D060ACE.

TO-220 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
IR Rectifier

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

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