

International  
**IR** Rectifier  
 INSULATED GATE BIPOLAR TRANSISTOR

PD - 95645B

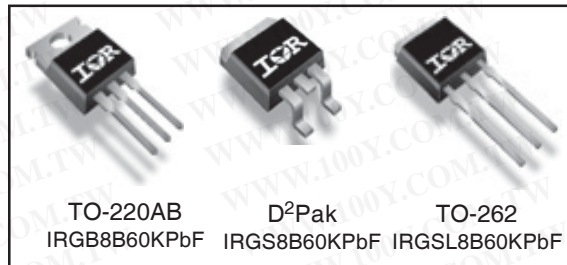
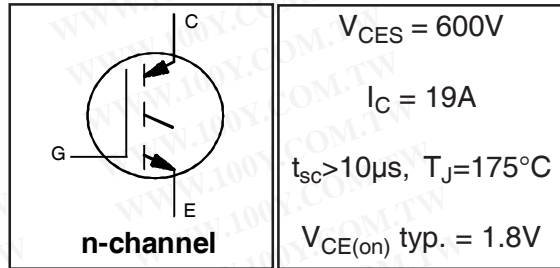
**IRGB8B60KPbF**  
**IRGS8B60KPbF**  
**IRGSL8B60KPbF**

**Features**

- Low VCE (on) Non Punch Through IGBT Technology.
- 10 $\mu$ s 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
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	28	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	19	
$I_{NOMINAL}$	Nominal Current	8.0	W
$I_{CM}$	Pulse Collector Current (Ref.Fig.C.T.5)	34	
$I_{LM}$	Clamped Inductive Load current ①	34	
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	167	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	83	
$T_J$	Operating Junction and	-55 to +175	$^\circ C$
$T_{STG}$	Storage Temperature Range		
	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 ③	—	—	0.90	$^\circ C/W$
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	—	0.50	—	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount ②	—	—	62	
$R_{\theta JA}$	Junction-to-Ambient (PCB Mount, Steady State) ③	—	—	40	
	Weight	—	1.44	—	g

# IRGB/S/SL8B60KPbF

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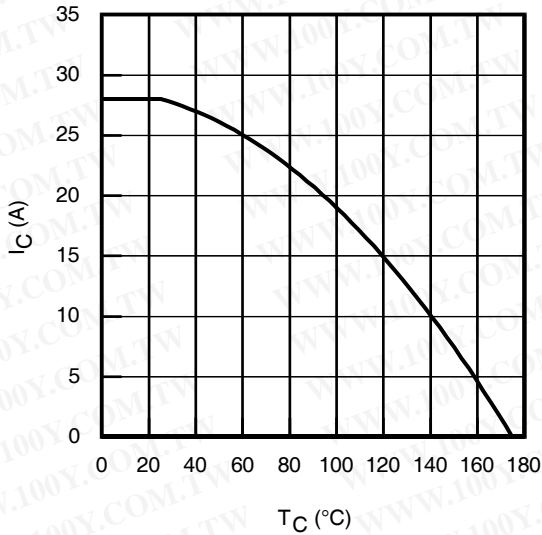
## Electrical Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	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	—	0.57	—	$V/^\circ\text{C}$	$V_{GE} = 0V, I_C = 1mA (25^\circ\text{C}-150^\circ\text{C})$	
$V_{CE(on)}$	Collector-to-Emitter Voltage	—	1.8	2.2	V	$I_C = 8.0A, V_{GE} = 15V, T_J = 25^\circ\text{C}$	5,6,7
		—	2.2	2.5		$I_C = 8.0A, V_{GE} = 15V, T_J = 150^\circ\text{C}$	8,9,10
		—	2.3	2.6		$I_C = 8.0A, V_{GE} = 15V, T_J = 175^\circ\text{C}$	
$V_{GE(th)}$	Gate Threshold Voltage	3.5	4.5	5.5		$V_{CE} = V_{GE}, I_C = 250\mu A$	8,9,10,
$\Delta V_{GE(th)}/\Delta T_J$	Threshold Voltage temp. coefficient	—	-9.5	—	$mV/^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 1mA (25^\circ\text{C}-125^\circ\text{C})$	11
gfe	Forward Transconductance	—	3.7	—	S	$V_{CE} = 50V, I_C = 8.0A, PW = 80\mu s$	
$I_{CES}$	Zero Gate Voltage Collector Current	—	1.0	150	$\mu A$	$V_{GE} = 0V, V_{CE} = 600V$	
		—	200	500		$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$	
		—	800	1320		$V_{GE} = 0V, V_{CE} = 600V, T_J = 175^\circ\text{C}$	
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{GE} = \pm 20V$	

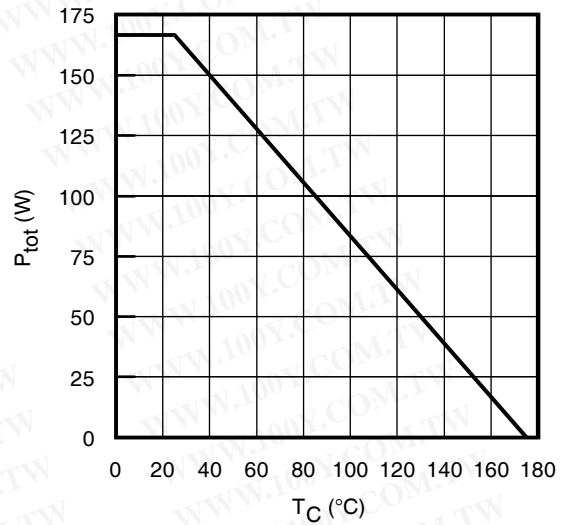
## Switching Characteristics @ $T_J = 25^\circ\text{C}$ (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig.
$Q_g$	Total Gate Charge (turn-on)	—	29	—	nC	$I_C = 8.0A$	17
$Q_{ge}$	Gate-to-Emitter Charge (turn-on)	—	3.7	—		$V_{CC} = 480V$	CT1
$Q_{gc}$	Gate-to-Collector Charge (turn-on)	—	14	—		$V_{GE} = 15V$	
$E_{on}$	Turn-On Switching Loss	—	160	268	$\mu J$	$I_C = 8.0A, V_{CC} = 400V$	CT4
$E_{off}$	Turn-Off Switching Loss	—	160	268		$V_{GE} = 15V, R_G = 50\Omega, L = 1.1mH$	
$E_{tot}$	Total Switching Loss	—	320	433		$T_J = 25^\circ\text{C} \text{ ④}$	
$t_{d(on)}$	Turn-On delay time	—	23	27	ns	$I_C = 8.0A, V_{CC} = 400V$	CT4
$t_r$	Rise time	—	22	26		$V_{GE} = 15V, R_G = 50\Omega, L = 1.1mH$	
$t_{d(off)}$	Turn-Off delay time	—	140	150		$T_J = 25^\circ\text{C}$	
$t_f$	Fall time	—	32	42			
$E_{on}$	Turn-On Switching Loss	—	220	330		$I_C = 8.0A, V_{CC} = 400V$	
$E_{off}$	Turn-Off Switching Loss	—	270	381	$\mu J$	$V_{GE} = 15V, R_G = 50\Omega, L = 1.1mH$	12,14
$E_{tot}$	Total Switching Loss	—	490	608		$T_J = 150^\circ\text{C} \text{ ④}$	WF1,WF2
$t_{d(on)}$	Turn-On delay time	—	22	27		$I_C = 8.0A, V_{CC} = 400V$	13,15
$t_r$	Rise time	—	21	25	ns	$V_{GE} = 15V, R_G = 50\Omega, L = 1.1mH$	CT4
$t_{d(off)}$	Turn-Off delay time	—	180	198		$T_J = 150^\circ\text{C}$	WF1
$t_f$	Fall time	—	40	56			WF2
$C_{ies}$	Input Capacitance	—	440	—	pF	$V_{GE} = 0V$	16
$C_{oes}$	Output Capacitance	—	38	—		$V_{CC} = 30V$	
$C_{res}$	Reverse Transfer Capacitance	—	16	—		$f = 1.0MHz$	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				$T_J = 150^\circ\text{C}, I_C = 34A, V_p = 600V$ $V_{CC}=500V, V_{GE} = +15V \text{ to } 0V, R_G = 50\Omega$	4 CT2
SCSOA	Short Circuit Safe Operating Area	10	—	—	$\mu s$	$T_J = 150^\circ\text{C}, V_p = 600V, R_G = 100\Omega$ $V_{CC}=360V, V_{GE} = +15V \text{ to } 0V$	CT3 WF3

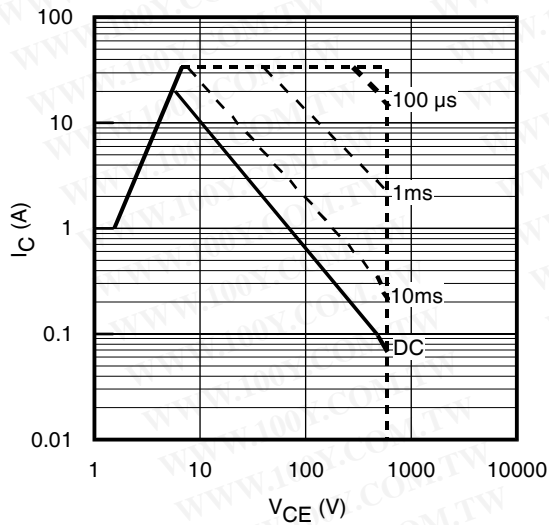
Notes ① to ⑤ are on page 13.



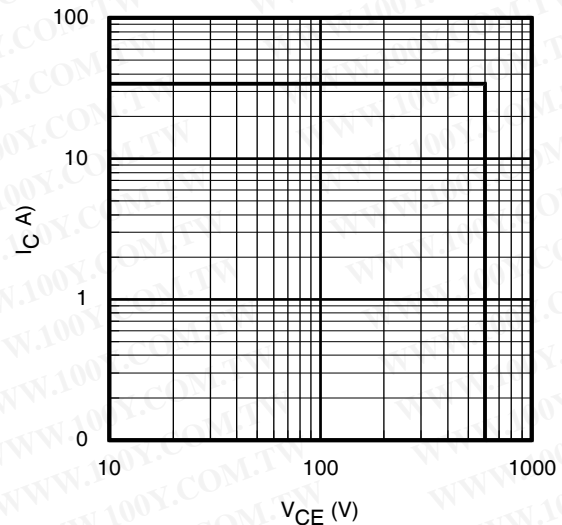
**Fig. 1** - Maximum DC Collector Current vs. Case Temperature



**Fig. 2** - Power Dissipation vs. Case Temperature



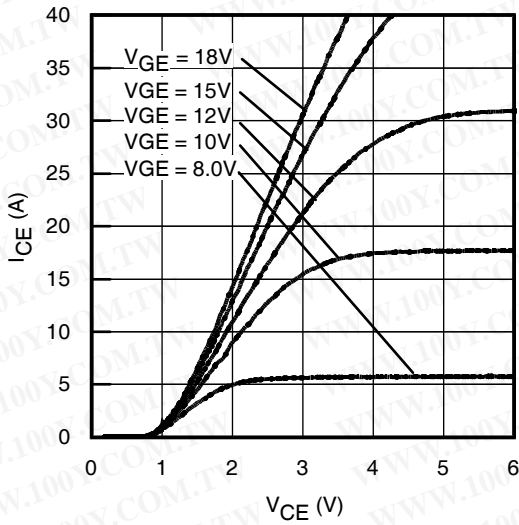
**Fig. 3** - Forward SOA  
 $T_C = 25^{\circ}C$ ;  $T_J \leq 150^{\circ}C$



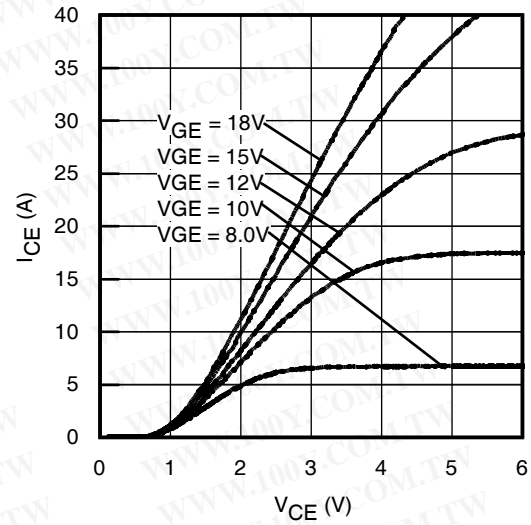
**Fig. 4** - Reverse Bias SOA  
 $T_J = 150^{\circ}C$ ;  $V_{GE} = 15V$

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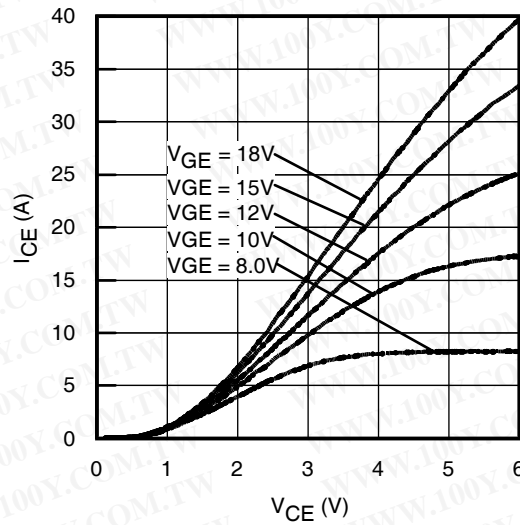
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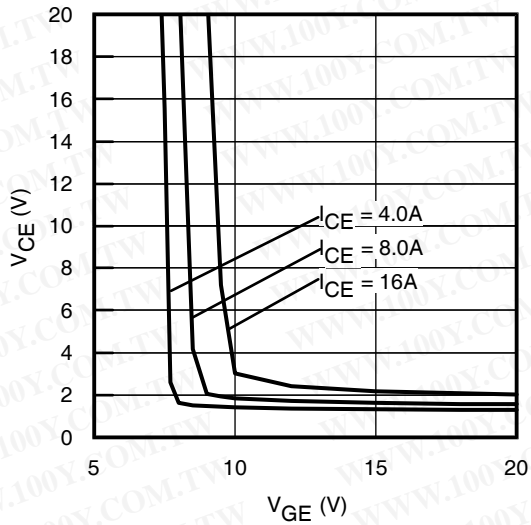
**Fig. 5** - Typ. IGBT Output Characteristics  
 $T_J = -40^{\circ}\text{C}$ ;  $t_p = 80\mu\text{s}$



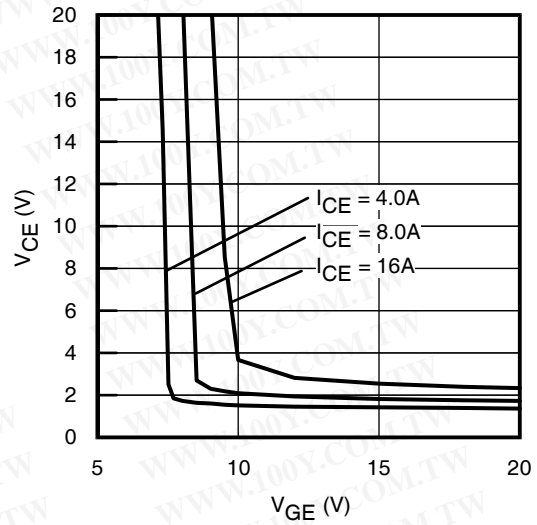
**Fig. 6** - Typ. IGBT Output Characteristics  
 $T_J = 25^{\circ}\text{C}$ ;  $t_p = 80\mu\text{s}$



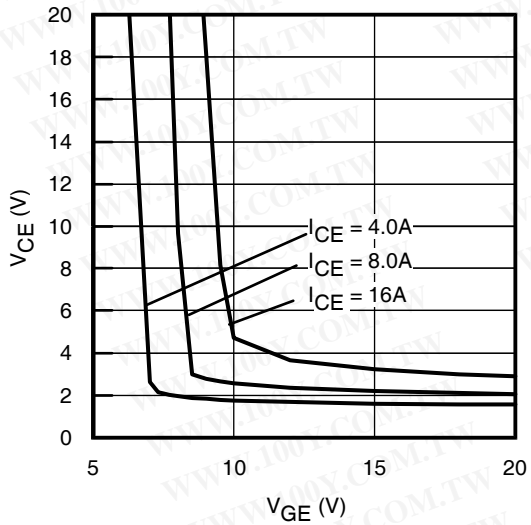
**Fig. 7** - Typ. IGBT Output Characteristics  
 $T_J = 150^{\circ}\text{C}$ ;  $t_p = 80\mu\text{s}$



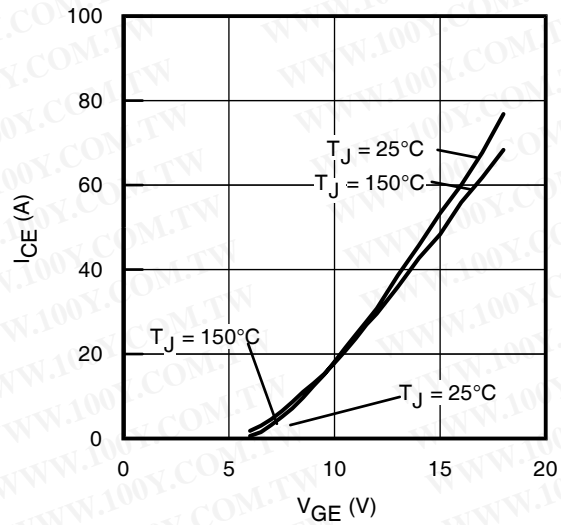
**Fig. 8** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = -40^\circ\text{C}$



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



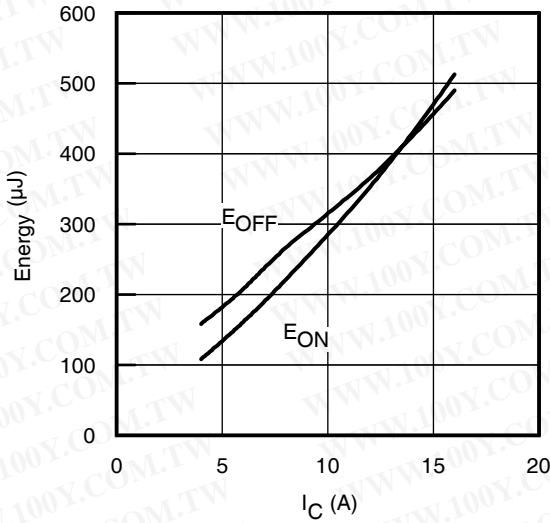
**Fig. 10** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 150^\circ\text{C}$



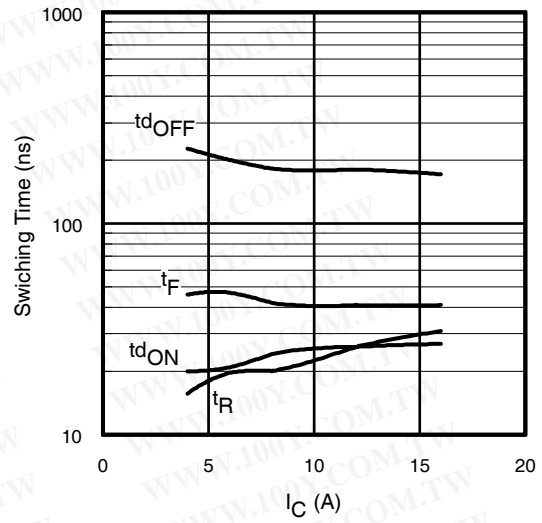
**Fig. 11** - Typ. Transfer Characteristics  
 $V_{CE} = 360\text{V}$ ;  $t_p = 10\mu\text{s}$

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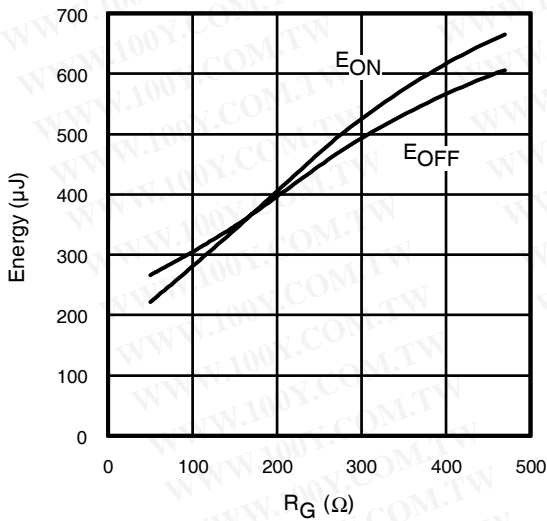
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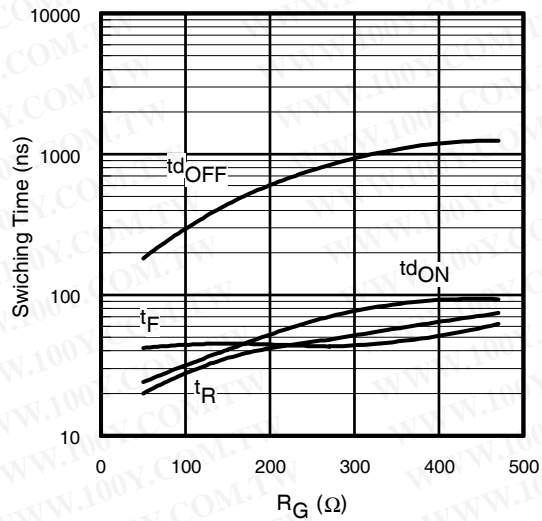
**Fig. 12** - Typ. Energy Loss vs.  $I_C$   
 $T_J = 150^\circ\text{C}$ ;  $L = 1.1\text{mH}$ ;  $V_{CE} = 400\text{V}$ ,  
 $R_G = 50\Omega$ ;  $V_{GE} = 15\text{V}$



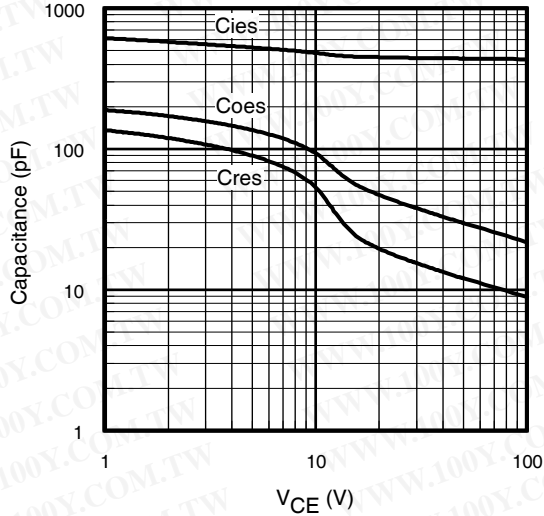
**Fig. 13** - Typ. Switching Time vs.  $I_C$   
 $T_J = 150^\circ\text{C}$ ;  $L = 1.1\text{mH}$ ;  $V_{CE} = 400\text{V}$   
 $R_G = 50\Omega$ ;  $V_{GE} = 15\text{V}$



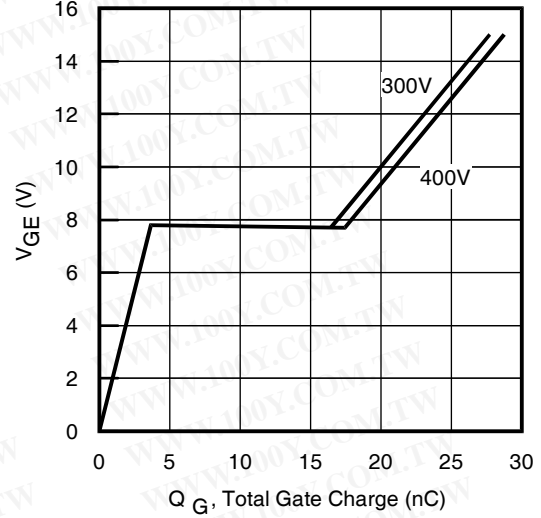
**Fig. 14** - Typ. Energy Loss vs.  $R_G$   
 $T_J = 150^\circ\text{C}$ ;  $L = 1.1\text{mH}$ ;  $V_{CE} = 400\text{V}$   
 $I_{CE} = 8.0\text{A}$ ;  $V_{GE} = 15\text{V}$



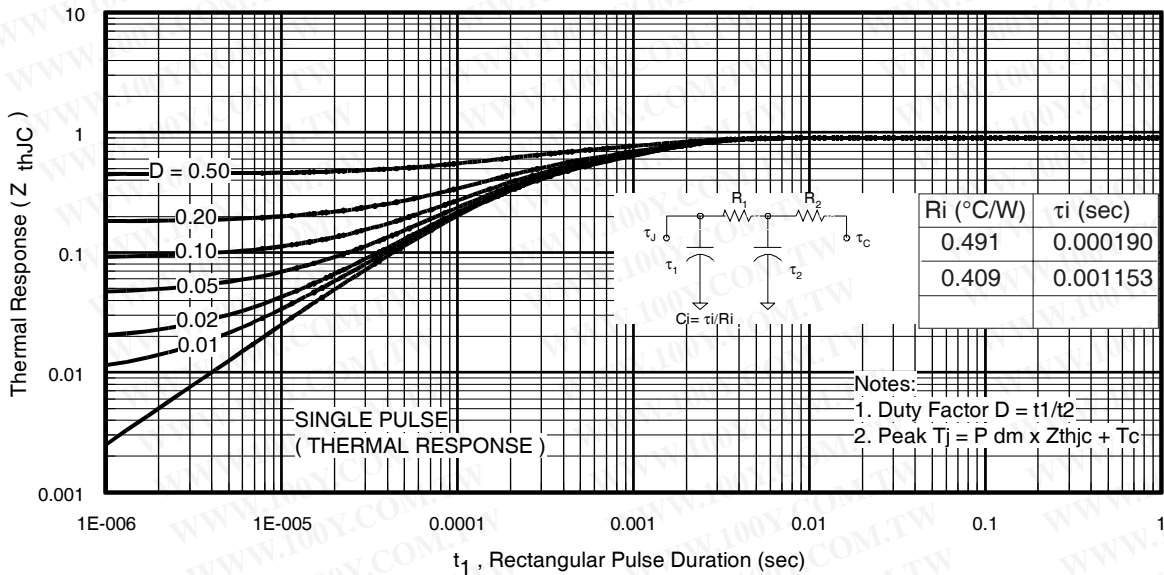
**Fig. 15** - Typ. Switching Time vs.  $R_G$   
 $T_J = 150^\circ\text{C}$ ;  $L = 1.1\text{mH}$ ;  $V_{CE} = 400\text{V}$   
 $I_{CE} = 8.0\text{A}$ ;  $V_{GE} = 15\text{V}$



**Fig. 16-** Typ. Capacitance vs. V<sub>CE</sub>  
V<sub>GE</sub> = 0V; f = 1MHz



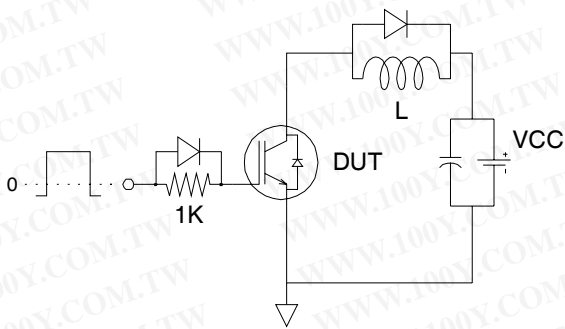
**Fig. 17 -** Typical Gate Charge vs. V<sub>GE</sub>  
I<sub>CE</sub> = 8.0A; L = 600μH



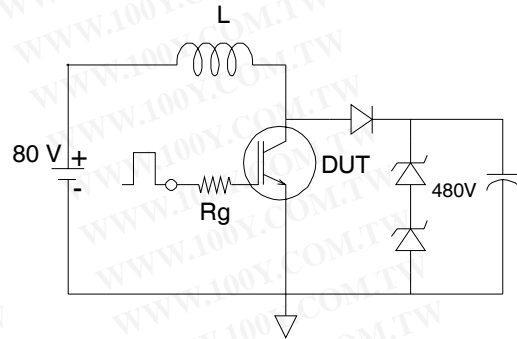
**Fig 18.** Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

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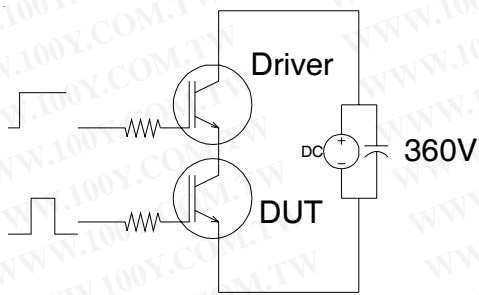
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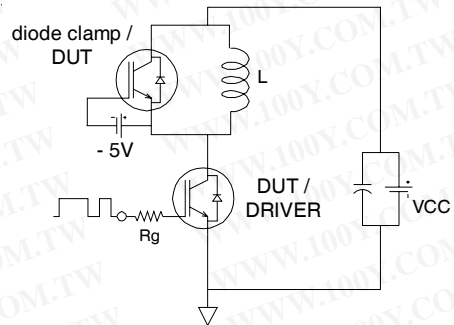
**Fig.C.T.1** - Gate Charge Circuit (turn-off)



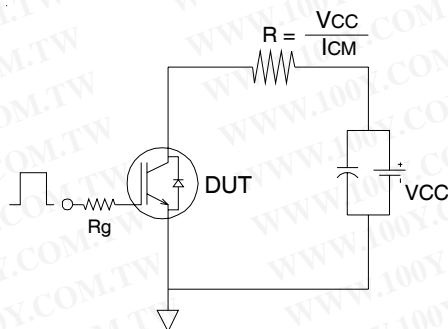
**Fig.C.T.2** - RBSOA Circuit



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



**Fig.C.T.4** - Switching Loss Circuit



**Fig.C.T.5** - Resistive Load Circuit



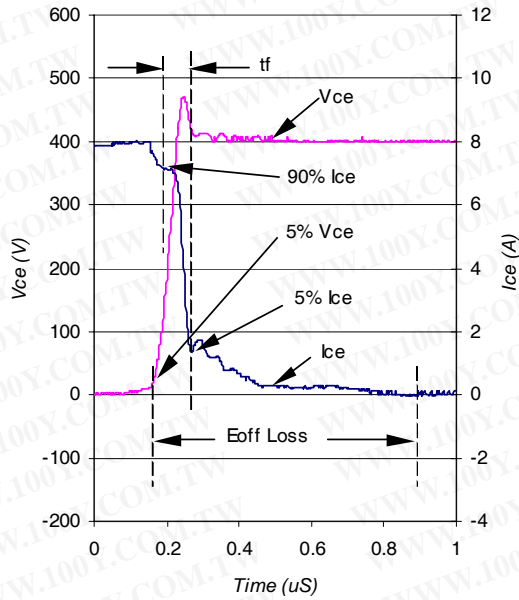


Fig. WF1- Typ. Turn-off Loss Waveform  
@  $T_J = 150^\circ\text{C}$  using Fig. CT.4

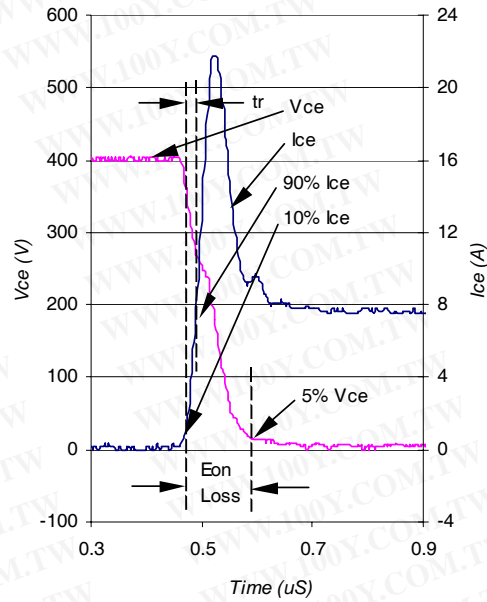


Fig. WF2- Typ. Turn-on Loss Waveform  
@  $T_J = 150^\circ\text{C}$  using Fig. CT.4

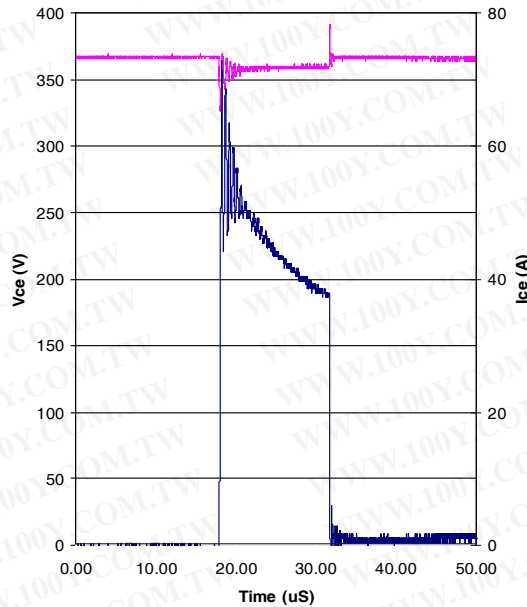


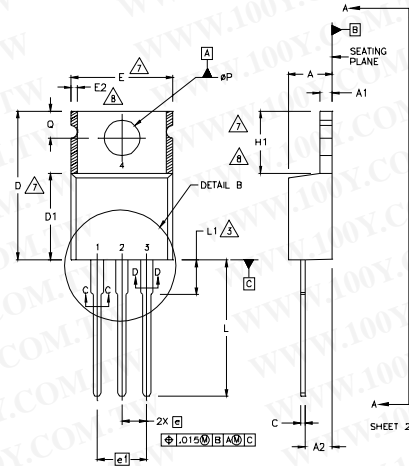
Fig. WF3- Typ. S.C Waveform  
@  $T_C = 150^\circ\text{C}$  using Fig. CT.3

# IRGB/S/SL8B60Kpbf

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## 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**

**HEXFET**

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

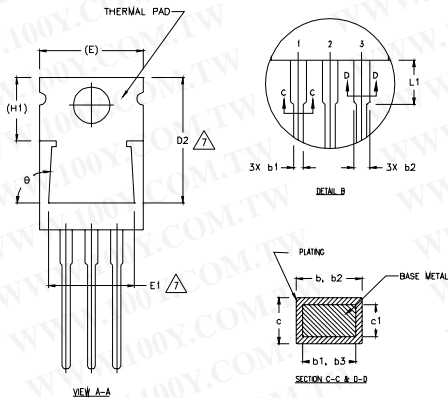
**IGBTs- CoPACK**

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

**DIODES**

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

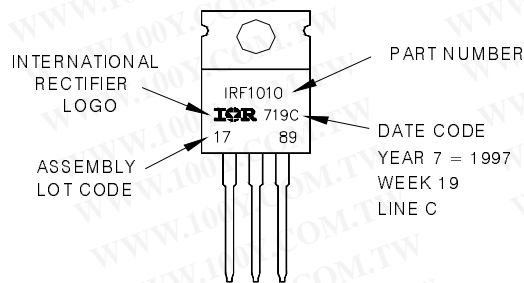
SYMBOL	DIMENSIONS				NOTES
	MILLIMETERS		INCHES		
	MIN.	MAX.	MIN.	MAX.	
A	3.56	4.82	.140	.190	
A1	0.51	1.40	.020	.055	
A2	2.04	2.92	.080	.115	
b	0.38	1.01	.015	.040	
b1	0.38	0.96	.015	.038	5
b2	1.15	1.77	.045	.070	
b3	1.15	1.73	.045	.068	
c	0.36	0.61	.014	.024	
c1	0.56	0.56	.014	.022	5
D	14.22	16.51	.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"



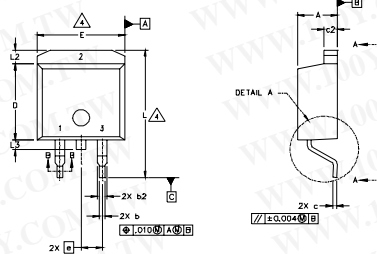
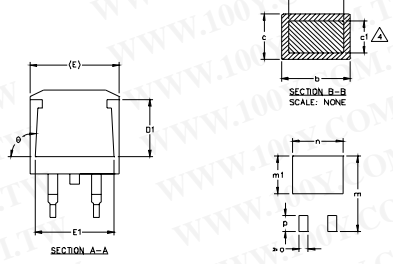
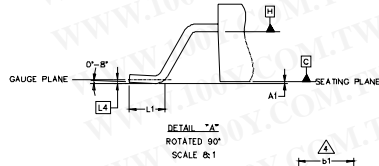
**TO-220AB package is not recommended for Surface Mount Application.**

International  
**IR** Rectifier

# IRGB/S/SL8B60KPbF

## D<sup>2</sup>Pak 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

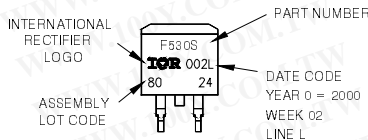
\* PART DEPENDENT.

- 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 [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.

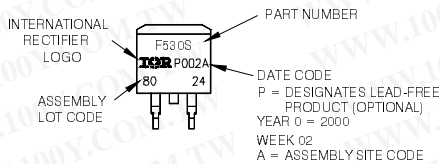
## D<sup>2</sup>Pak Part Marking Information

**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**

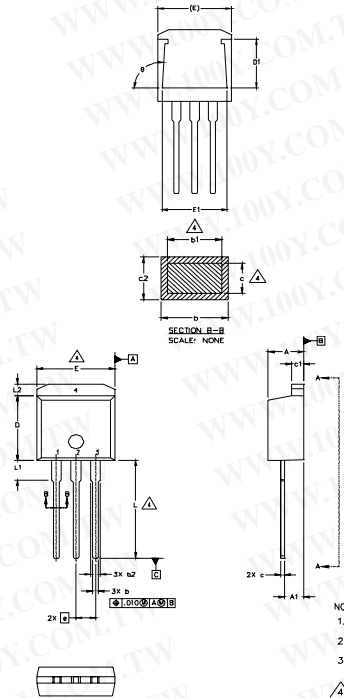


# IRGB/S/SL8B60KPbF

International  
**IRF** 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	
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

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

#### NOTES:

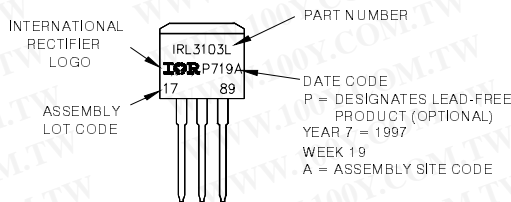
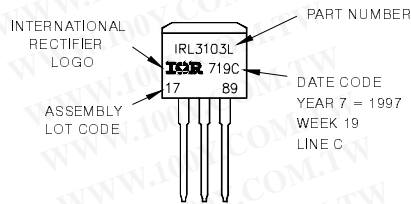
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. DIMENSION b1 AND c1 APPLY 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**

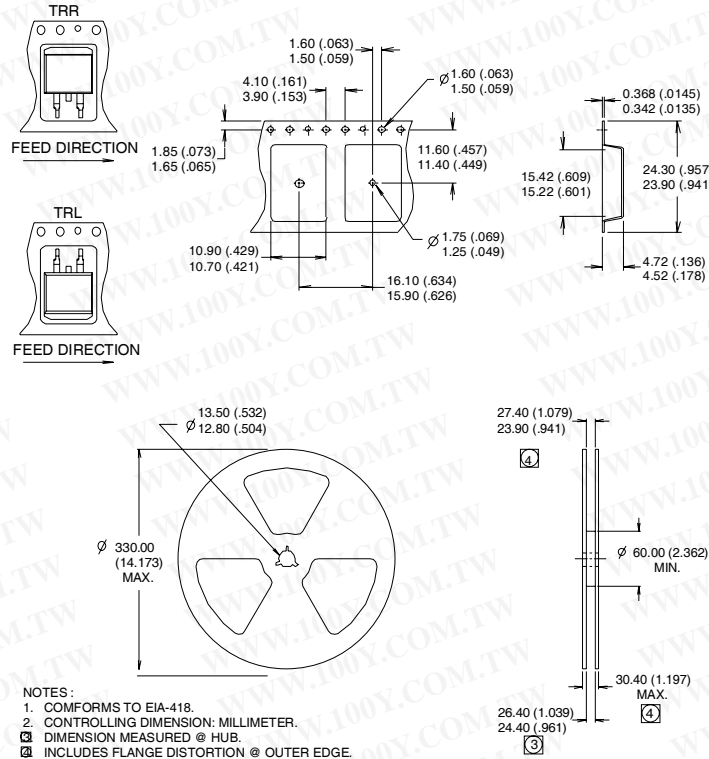


International  
**IR** Rectifier

# IRGB/S/SL8B60KPbF

## D<sup>2</sup>Pak Tape & Reel Information

Dimensions are shown in millimeters (inches)



### Notes:

- ①  $V_{CC} = 80\% (V_{CES})$ ,  $V_{GE} = 15V$ ,  $L = 100\mu H$ ,  $R_G = 50\Omega$ .
- ② This is only applied to TO-220AB package.
- ③ This is applied to D<sup>2</sup>Pak, 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.
- ⑤  $R_{\theta}$  is measured at  $T_J$  of approximately 90°C.

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

Data and specifications subject to change without notice.

This product has been designed and qualified for the Industrial market.

Qualification Standards can be found on IR's Web site.

International  
**IR** Rectifier

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