

International  
**IR** Rectifier  
 INSULATED GATE BIPOLAR TRANSISTOR

PD - 95645B

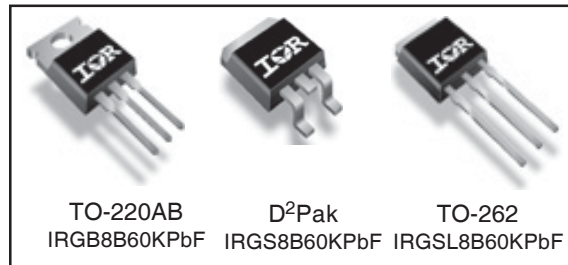
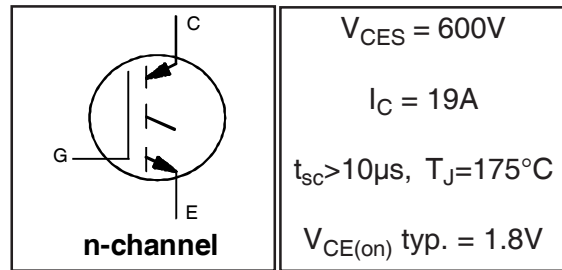
**IRGB8B60KPbF**  
**IRGS8B60KPbF**  
**IRGSL8B60KPbF**

**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
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	28	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	19	
$I_{NOMINAL}$	Nominal Current	8.0	
$I_{CM}$	Pulse Collector Current (Ref.Fig.C.T.5)	34	
$I_{LM}$	Clamped Inductive Load current ①	34	
$V_{GE}$	Gate-to-Emitter Voltage	±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	°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 ⑤	—	—	0.90	°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

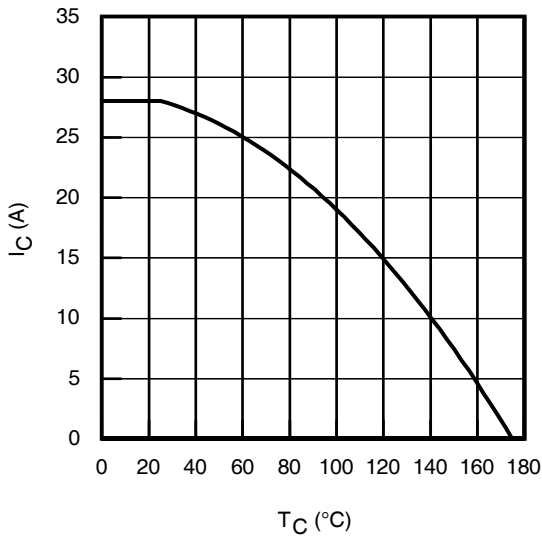
### Electrical Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig.
V <sub>(BR)CES</sub>	Collector-to-Emitter Breakdown Voltage	600	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 500μA	
ΔV <sub>(BR)CES</sub> /ΔT <sub>J</sub>	Temperature Coeff. of Breakdown Voltage	—	0.57	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1mA (25°C-150°C)	
V <sub>CE(on)</sub>	Collector-to-Emitter Voltage	—	1.8	2.2	V	I <sub>C</sub> = 8.0A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 25°C	5,6,7
		—	2.2	2.5		I <sub>C</sub> = 8.0A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 150°C	8,9,10
		—	2.3	2.6		I <sub>C</sub> = 8.0A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 175°C	
V <sub>GE(th)</sub>	Gate Threshold Voltage	3.5	4.5	5.5		V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA	8,9,10,
ΔV <sub>GE(th)</sub> /ΔT <sub>J</sub>	Threshold Voltage temp. coefficient	—	-9.5	—	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 1mA (25°C-125°C)	11
g <sub>fe</sub>	Forward Transconductance	—	3.7	—	S	V <sub>CE</sub> = 50V, I <sub>C</sub> = 8.0A, PW = 80μs	
I <sub>CES</sub>	Zero Gate Voltage Collector Current	—	1.0	150	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V	
		—	200	500		V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V, T <sub>J</sub> = 150°C	
		—	800	1320		V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V, T <sub>J</sub> = 175°C	
I <sub>GES</sub>	Gate-to-Emitter Leakage Current	—	—	±100	nA	V <sub>GE</sub> = ±20V	

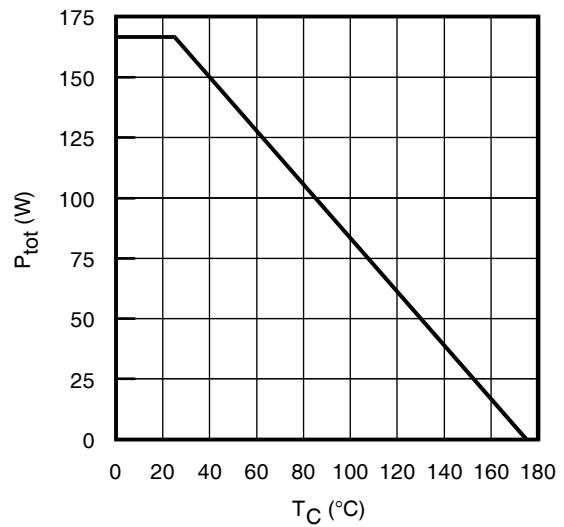
### Switching Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions	Ref.Fig.
Q <sub>g</sub>	Total Gate Charge (turn-on)	—	29	—	nC	I <sub>C</sub> = 8.0A	17
Q <sub>ge</sub>	Gate-to-Emitter Charge (turn-on)	—	3.7	—		V <sub>CC</sub> = 480V	CT1
Q <sub>gc</sub>	Gate-to-Collector Charge (turn-on)	—	14	—		V <sub>GE</sub> = 15V	
E <sub>on</sub>	Turn-On Switching Loss	—	160	268	μJ	I <sub>C</sub> = 8.0A, V <sub>CC</sub> = 400V	CT4
E <sub>off</sub>	Turn-Off Switching Loss	—	160	268		V <sub>GE</sub> = 15V, R <sub>G</sub> = 50Ω, L = 1.1mH	
E <sub>tot</sub>	Total Switching Loss	—	320	433		T <sub>J</sub> = 25°C ④	
t <sub>d(on)</sub>	Turn-On delay time	—	23	27	ns	I <sub>C</sub> = 8.0A, V <sub>CC</sub> = 400V	CT4
t <sub>r</sub>	Rise time	—	22	26		V <sub>GE</sub> = 15V, R <sub>G</sub> = 50Ω, L = 1.1mH	
t <sub>d(off)</sub>	Turn-Off delay time	—	140	150		T <sub>J</sub> = 25°C	
t <sub>f</sub>	Fall time	—	32	42			
E <sub>on</sub>	Turn-On Switching Loss	—	220	330		I <sub>C</sub> = 8.0A, V <sub>CC</sub> = 400V	
E <sub>off</sub>	Turn-Off Switching Loss	—	270	381	μJ	V <sub>GE</sub> = 15V, R <sub>G</sub> = 50Ω, L = 1.1mH	12,14
E <sub>tot</sub>	Total Switching Loss	—	490	608		T <sub>J</sub> = 150°C ④	WF1,WF2
t <sub>d(on)</sub>	Turn-On delay time	—	22	27		I <sub>C</sub> = 8.0A, V <sub>CC</sub> = 400V	13,15
t <sub>r</sub>	Rise time	—	21	25	ns	V <sub>GE</sub> = 15V, R <sub>G</sub> = 50Ω, L = 1.1mH	CT4
t <sub>d(off)</sub>	Turn-Off delay time	—	180	198		T <sub>J</sub> = 150°C	WF1
t <sub>f</sub>	Fall time	—	40	56			WF2
C <sub>ies</sub>	Input Capacitance	—	440	—	pF	V <sub>GE</sub> = 0V	16
C <sub>oes</sub>	Output Capacitance	—	38	—		V <sub>CC</sub> = 30V	
C <sub>res</sub>	Reverse Transfer Capacitance	—	16	—		f = 1.0MHz	
RBSOA	Reverse Bias Safe Operating Area	FULL SQUARE				T <sub>J</sub> = 150°C, I <sub>C</sub> = 34A, V <sub>p</sub> = 600V V <sub>CC</sub> =500V, V <sub>GE</sub> = +15V to 0V, R <sub>G</sub> = 50Ω	4 CT2
SCSOA	Short Circuit Safe Operating Area	10	—	—	μs	T <sub>J</sub> = 150°C, V <sub>p</sub> = 600V, R <sub>G</sub> = 100Ω V <sub>CC</sub> =360V, V <sub>GE</sub> = +15V to 0V	CT3 WF3

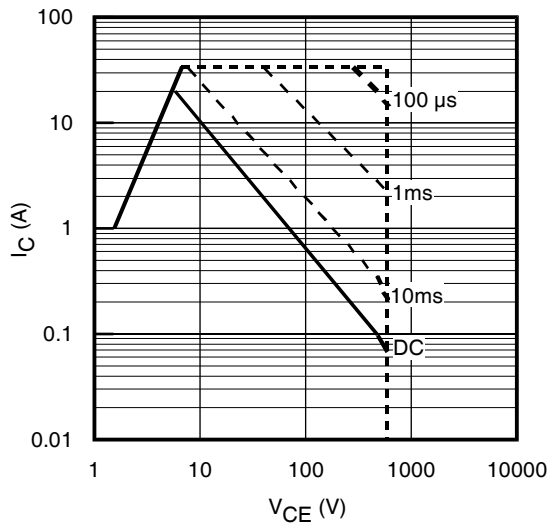
Notes ① to ⑤ are on page 13.



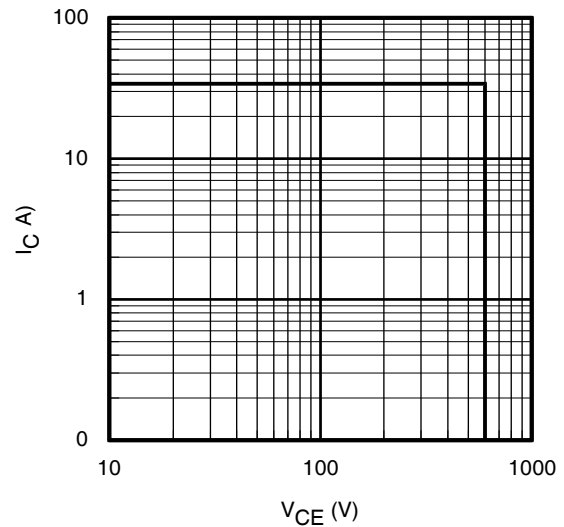
**Fig. 1** - Maximum DC Collector Current vs. Case Temperature



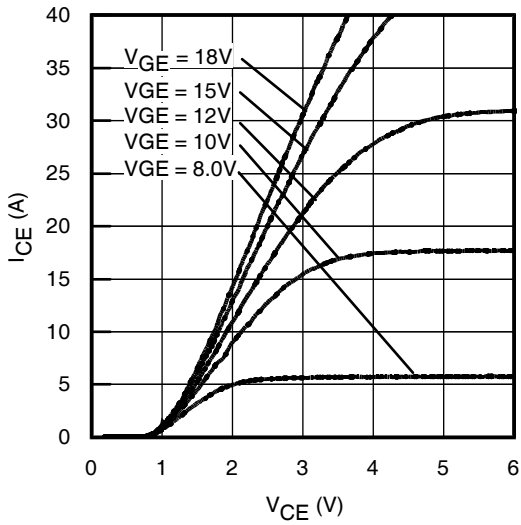
**Fig. 2** - Power Dissipation vs. Case Temperature



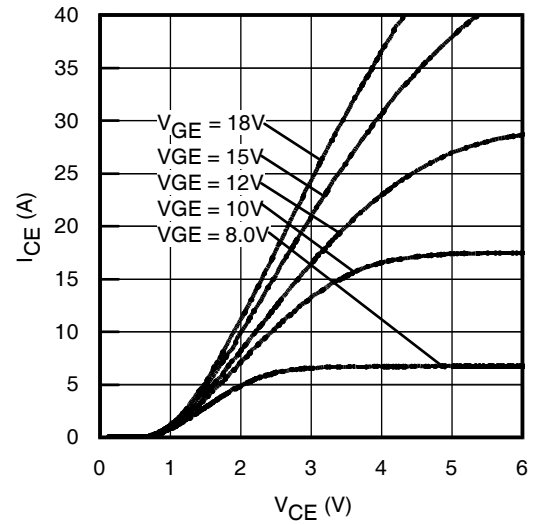
**Fig. 3** - Forward SOA  
 $T_C = 25^\circ\text{C}$ ;  $T_J \leq 150^\circ\text{C}$



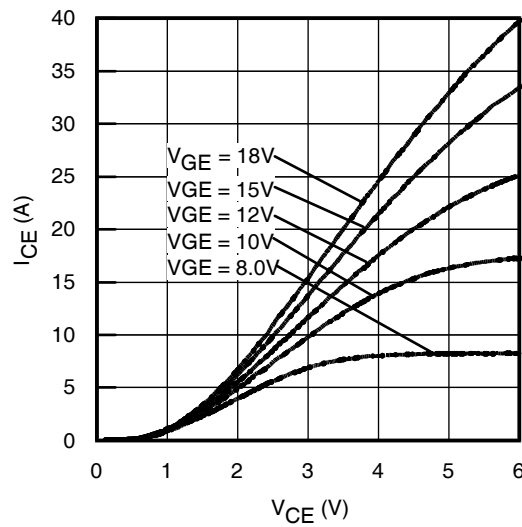
**Fig. 4** - Reverse Bias SOA  
 $T_J = 150^\circ\text{C}$ ;  $V_{GE} = 15\text{V}$



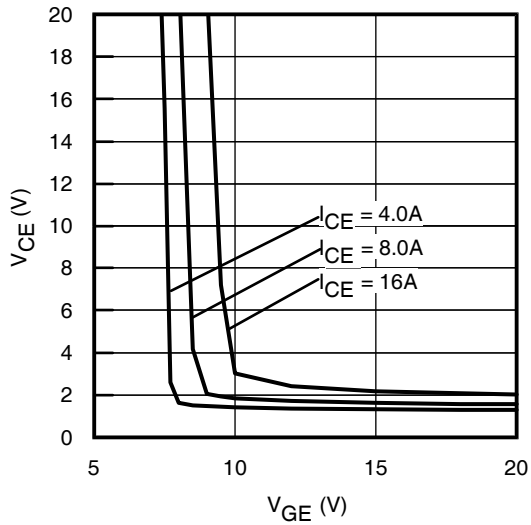
**Fig. 5** - Typ. IGBT Output Characteristics  
 $T_J = -40^{\circ}\text{C}$ ;  $t_p = 80\mu\text{s}$



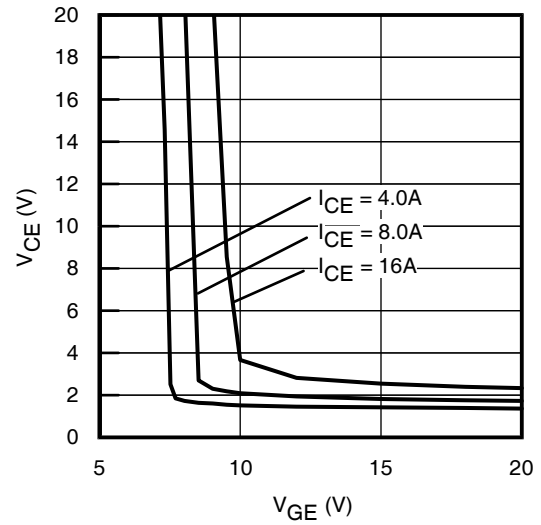
**Fig. 6** - Typ. IGBT Output Characteristics  
 $T_J = 25^{\circ}\text{C}$ ;  $t_p = 80\mu\text{s}$



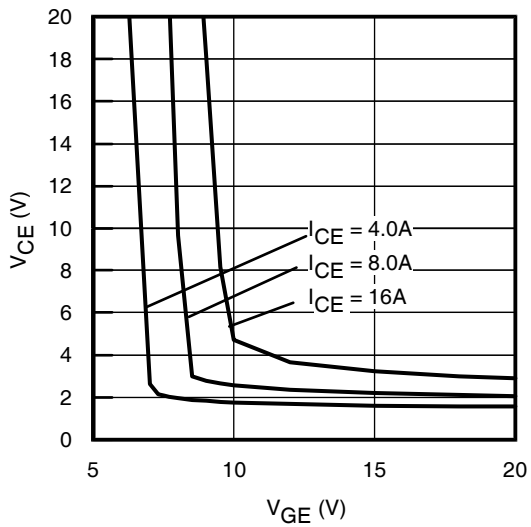
**Fig. 7** - Typ. IGBT Output Characteristics  
 $T_J = 150^{\circ}\text{C}$ ;  $t_p = 80\mu\text{s}$



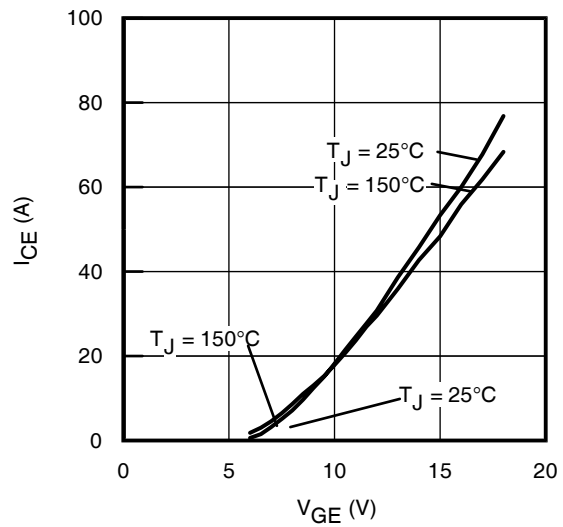
**Fig. 8** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = -40^\circ\text{C}$



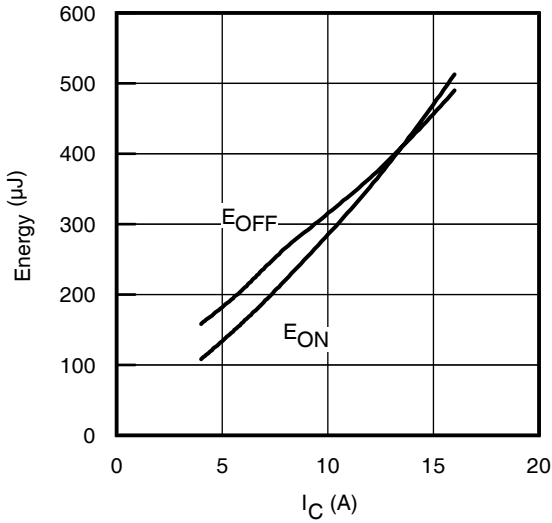
**Fig. 9** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 25^\circ\text{C}$



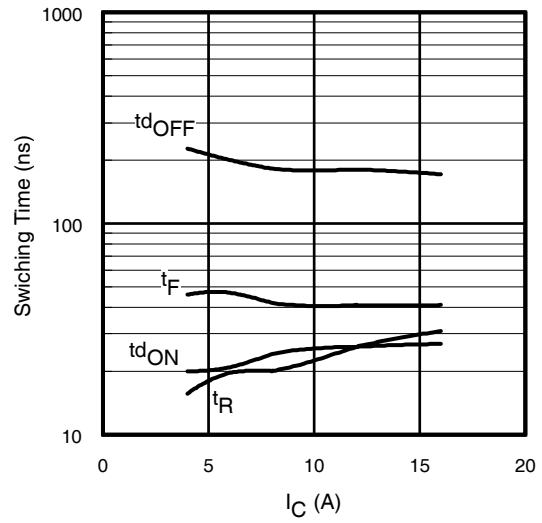
**Fig. 10** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 150^\circ\text{C}$



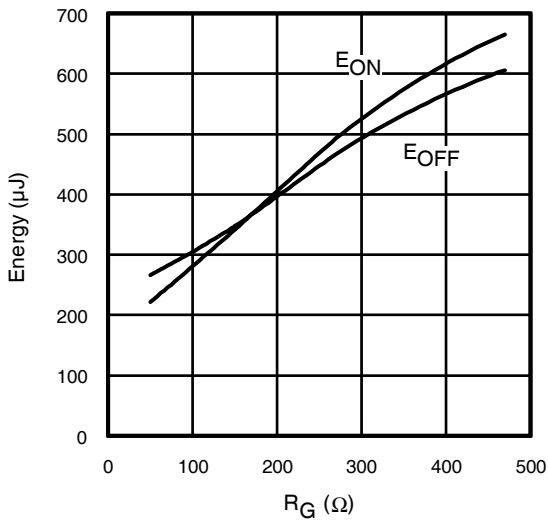
**Fig. 11** - Typ. Transfer Characteristics  
 $V_{CE} = 360\text{V}$ ;  $t_p = 10\mu\text{s}$



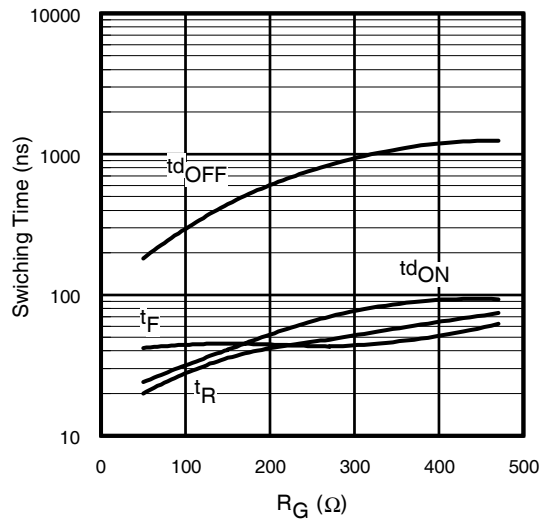
**Fig. 12** - Typ. Energy Loss vs.  $I_C$   
 $T_J = 150^\circ\text{C}$ ;  $L=1.1\text{mH}$ ;  $V_{CE}= 400\text{V}$ ,  
 $R_G= 50\Omega$ ;  $V_{GE}= 15\text{V}$



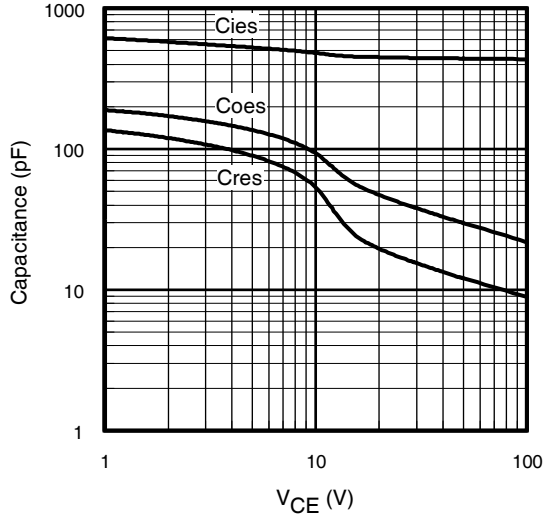
**Fig. 13** - Typ. Switching Time vs.  $I_C$   
 $T_J = 150^\circ\text{C}$ ;  $L=1.1\text{mH}$ ;  $V_{CE}= 400\text{V}$   
 $R_G= 50\Omega$ ;  $V_{GE}= 15\text{V}$



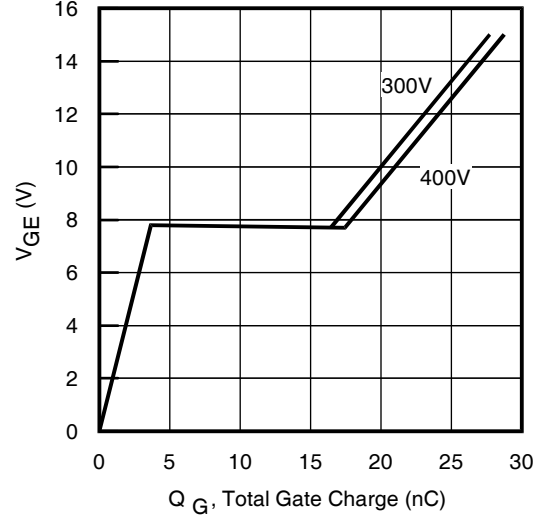
**Fig. 14** - Typ. Energy Loss vs.  $R_G$   
 $T_J = 150^\circ\text{C}$ ;  $L=1.1\text{mH}$ ;  $V_{CE}= 400\text{V}$   
 $I_{CE}= 8.0\text{A}$ ;  $V_{GE}= 15\text{V}$



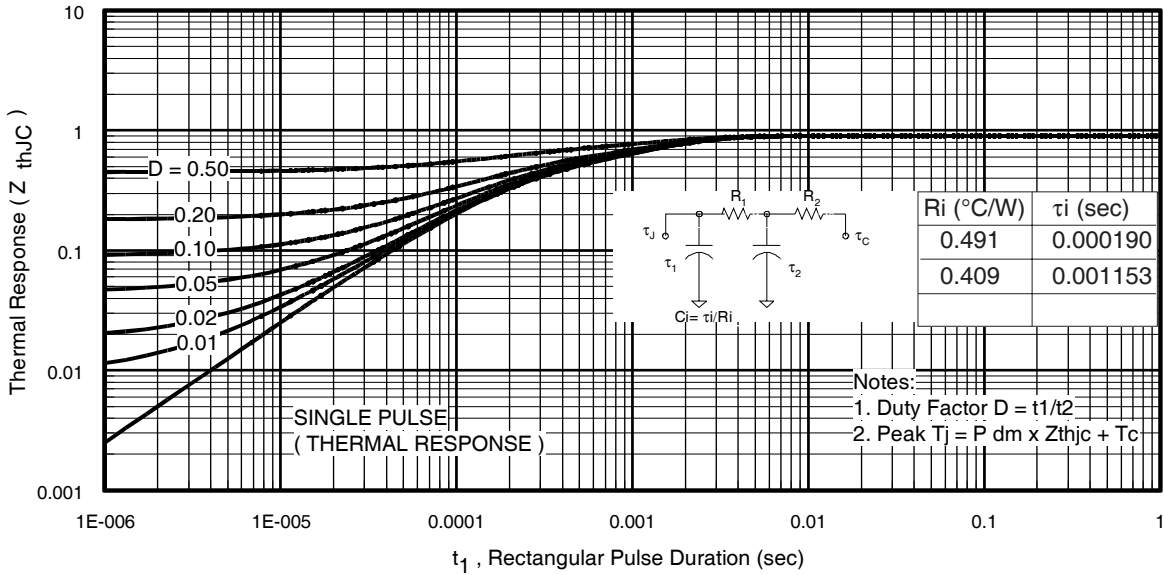
**Fig. 15** - Typ. Switching Time vs.  $R_G$   
 $T_J = 150^\circ\text{C}$ ;  $L=1.1\text{mH}$ ;  $V_{CE}= 400\text{V}$   
 $I_{CE}= 8.0\text{A}$ ;  $V_{GE}= 15\text{V}$



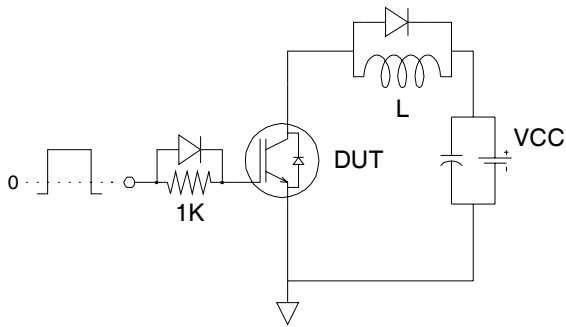
**Fig. 16-** Typ. Capacitance vs. V<sub>CE</sub>  
V<sub>GE</sub> = 0V; f = 1MHz



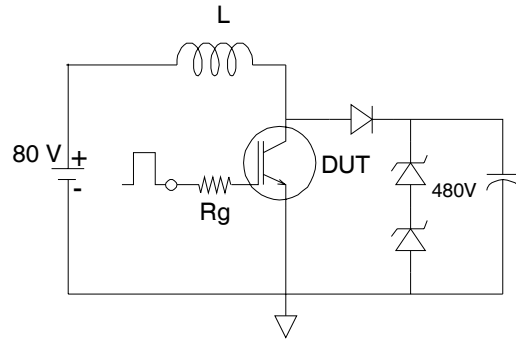
**Fig. 17 -** Typical Gate Charge vs. V<sub>GE</sub>  
I<sub>CE</sub> = 8.0A; L = 600μH



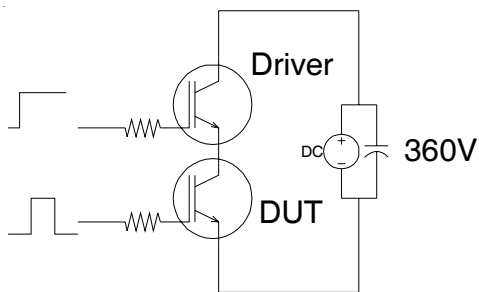
**Fig 18.** Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)



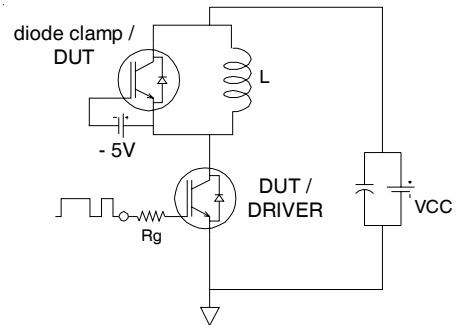
**Fig.C.T.1** - Gate Charge Circuit (turn-off)



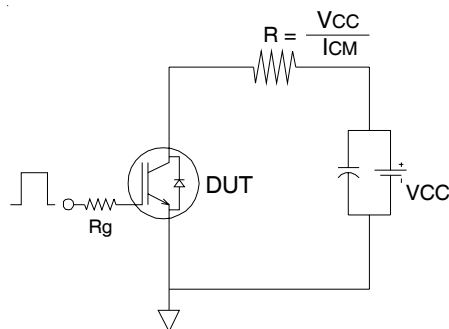
**Fig.C.T.2** - RBSOA Circuit



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



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



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



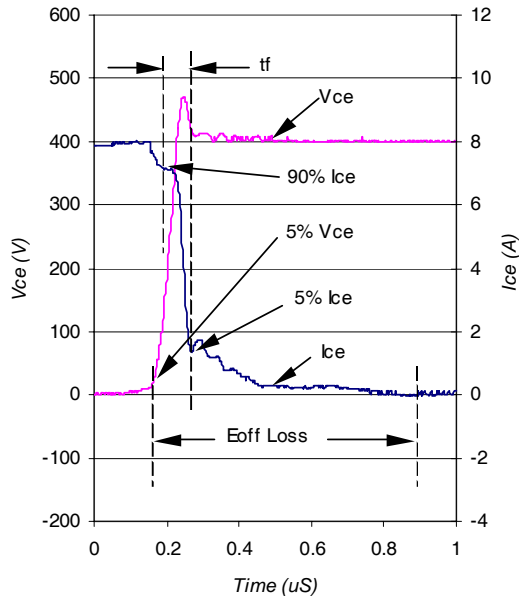


Fig. WF1- Typ. Turn-off Loss Waveform  
@  $T_J = 150^\circ\text{C}$  using Fig. CT.4

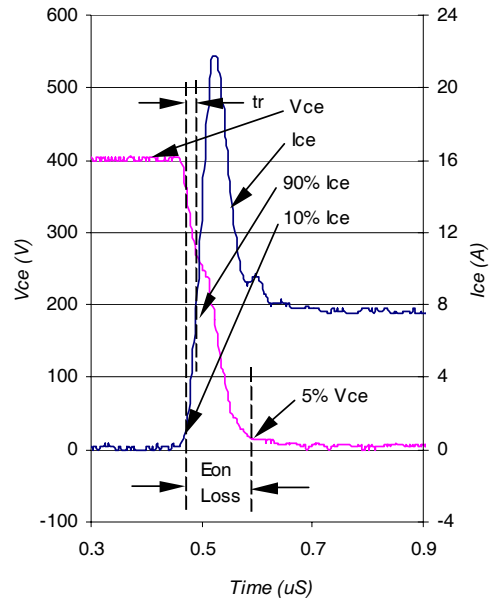


Fig. WF2- Typ. Turn-on Loss Waveform  
@  $T_J = 150^\circ\text{C}$  using Fig. CT.4

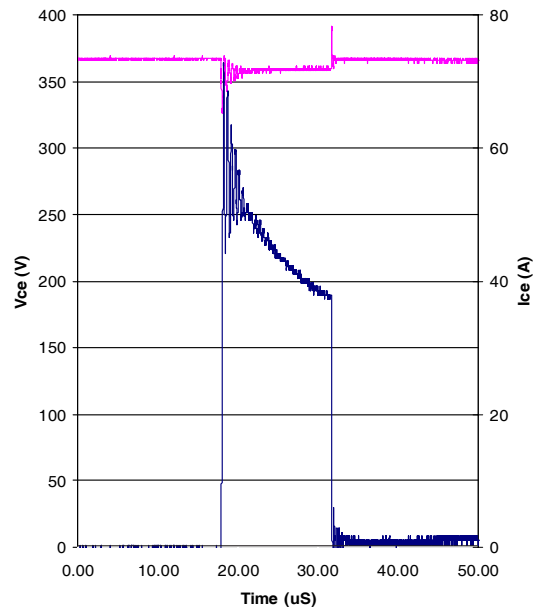


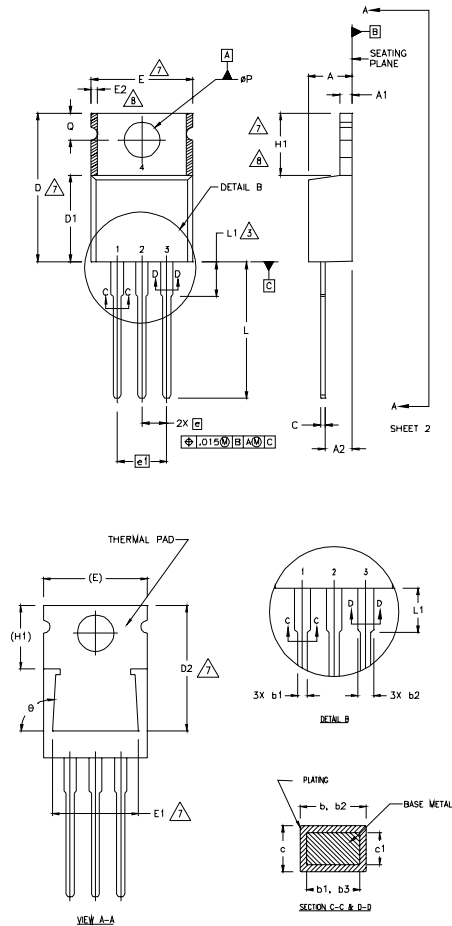
Fig. WF3- Typ. S.C Waveform  
@  $T_C = 150^\circ\text{C}$  using Fig. CT.3

# IRGB/S/SL8B60KPbF

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**

**HEXFET**

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

**IGBTs Co-PAK**

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

**DIODES**

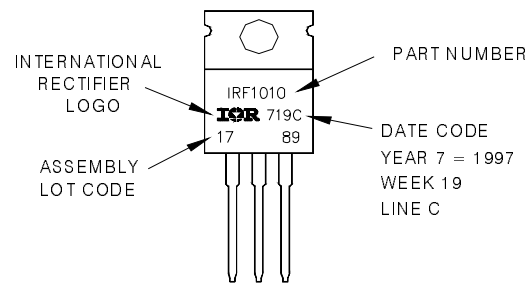
- 1.- ANODE/OPEN
- 2.- CATHODE
- 3.- ANODE

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'

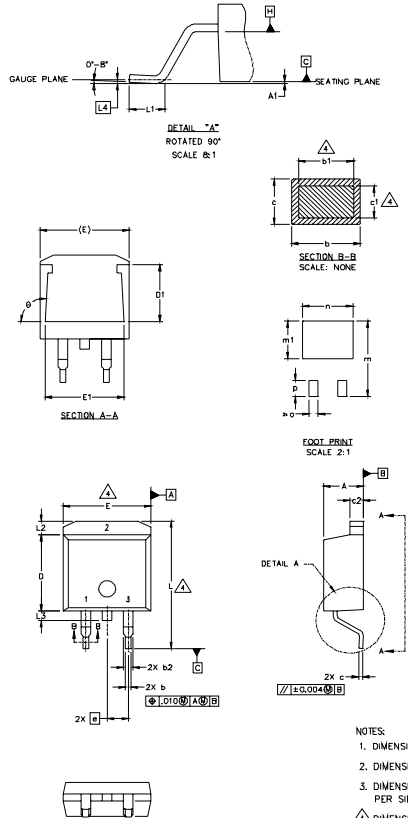
**Note:** "P" in assembly line position indicates "Lead-Free"



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

## 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	4
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	3
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.

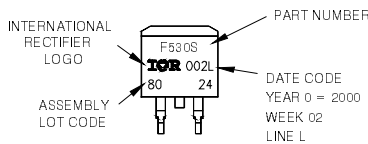
**NOTES:**

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 [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.

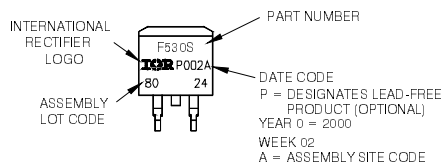
## D<sup>2</sup>Pak Part Marking Information

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

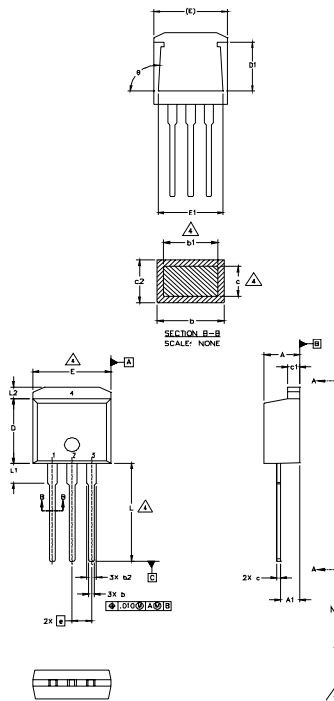


# IRGB/S/SL8B60KpF

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

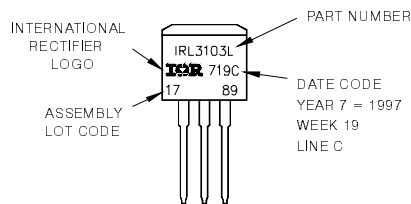
#### NOTES:

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.

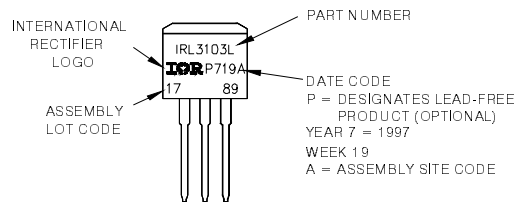
## TO-262 Part Marking Information

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'

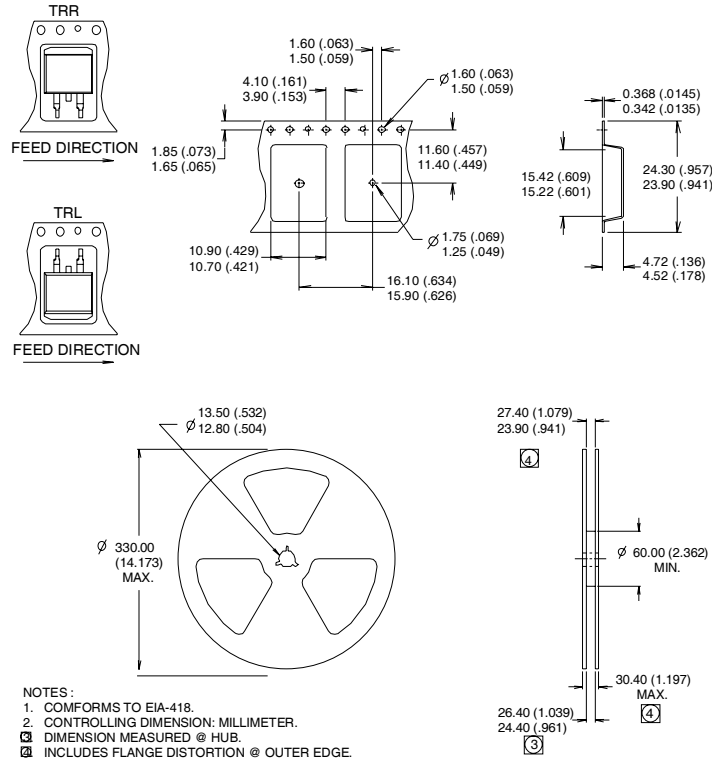


**OR**



## 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.