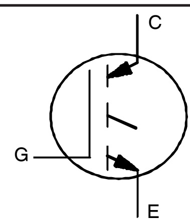
PD - 94545C

International
IOR Rectifier

INSULATED GATE BIPOLAR TRANSISTOR

# IRGB8B60K
# IRGS8B60K
# IRGSL8B60K

## Features
- Low VCE (on) Non Punch Through IGBT Technology.
- 10µs Short Circuit Capability.
- Square RBSOA.
- Positive VCE (on) Temperature Coefficient.



**n-channel**

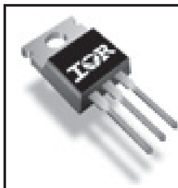
$V_{CES}$ = 600V

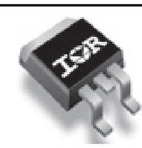
$I_C$ = 20A, $T_C$=100°C

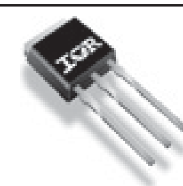
$t_{sc}$>10µs, $T_J$=150°C

$V_{CE(on)}$ typ. = 1.8V

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


TO-220AB
IRGB8B60K


$D^2$Pak
IRGS8B60K


TO-262
IRGSL8B60K

## Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $V_{CES}$ | Collector-to-Emitter Voltage | 600 | V |
| $I_C$ @ $T_C$ = 25°C | Continuous Collector Current | 28 | A |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 19 | |
| $I_{CM}$ | Pulse Collector Current (Ref.Fig.C.T.5) | 56 | |
| $I_{LM}$ | Clamped Inductive Load current ① | 56 | |
| $V_{GE}$ | Gate-to-Emitter Voltage | ±20 | V |
| $P_D$ @ $T_C$ = 25°C | Maximum Power Dissipation | 167 | W |
| $P_D$ @ $T_C$ = 100°C | Maximum Power Dissipation | 83 | |
| $T_J$<br>$T_{STG}$ | Operating Junction and<br>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 | — | — | 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 |



10/16/03

## 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 | — | 0.57 | — | V/°C | $V_{GE}$ = 0V, $I_C$ = 1mA (25°C-150°C) | |
| $V_{CE(on)}$ | Collector-to-Emitter Voltage | — | 1.8 | 2.2 | V | $I_C$ = 8.0A, $V_{GE}$ = 15V, $T_J$ = 25°C | 5,6,7 |
| | | — | 2.2 | 2.5 | | $I_C$ = 8.0A, $V_{GE}$ = 15V, $T_J$ = 150°C | 8,9,10 |
| | | — | 2.3 | 2.6 | | $I_C$ = 8.0A, $V_{GE}$ = 15V, $T_J$ = 175°C | |
| $V_{GE(th)}$ | Gate Threshold Voltage | 3.5 | 4.5 | 5.5 | | $V_{CE}$ = $V_{GE}$, $I_C$ = 250µA | 8,9,10, |
| $\Delta V_{GE(th)}/\Delta T_J$ | Threshold Voltage temp. coefficient | — | -9.5 | — | mV/°C | $V_{CE}$ = $V_{GE}$, $I_C$ = 1mA (25°C-125°C) | 11 |
| gfe | Forward Transconductance | — | 3.7 | — | S | $V_{CE}$ = 50V, $I_C$ = 8.0A, PW = 80µs | |
| $I_{CES}$ | 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°C | |
| | | — | 800 | 1320 | | $V_{GE}$ = 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) | — | 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 | µJ | $I_C$ = 8.0A, $V_{CC}$ = 400V | CT4 |
| $E_{off}$ | Turn-Off Switching Loss | — | 160 | 268 | | $V_{GE}$ = 15V, $R_G$ = 50Ω, L = 1.1mH | |
| $E_{tot}$ | Total Switching Loss | — | 320 | 433 | | $T_J$ = 25°C ④ | |
| $t_{d(on)}$ | Turn-On delay time | — | 23 | 27 | ns | $I_C$ = 8.0A, $V_{CC}$ = 400V | |
| $t_r$ | Rise time | — | 22 | 26 | | $V_{GE}$ = 15V, $R_G$ = 50Ω, L = 1.1mH | CT4 |
| $t_{d(off)}$ | Turn-Off delay time | — | 140 | 150 | | $T_J$ = 25°C | |
| $t_f$ | Fall time | — | 32 | 42 | | | |
| $E_{on}$ | Turn-On Switching Loss | — | 220 | 330 | µJ | $I_C$ = 8.0A, $V_{CC}$ = 400V | CT4 |
| $E_{off}$ | Turn-Off Switching Loss | — | 270 | 381 | | $V_{GE}$ = 15V, $R_G$ = 50Ω, L = 1.1mH | 12,14 |
| $E_{tot}$ | Total Switching Loss | — | 490 | 608 | | $T_J$ = 150°C ④ | WF1,WF2 |
| $t_{d(on)}$ | Turn-On delay time | — | 22 | 27 | ns | $I_C$ = 8.0A, $V_{CC}$ = 400V | 13,15 |
| $t_r$ | Rise time | — | 21 | 25 | | $V_{GE}$ = 15V, $R_G$ = 50Ω, L = 1.1mH | CT4 |
| $t_{d(off)}$ | Turn-Off delay time | — | 180 | 198 | | $T_J$ = 150°C | WF1 |
| $t_f$ | Fall time | — | 40 | 56 | | | WF2 |
| $C_{ies}$ | Input Capacitance | — | 440 | — | pF | $V_{GE}$ = 0V | |
| $C_{oes}$ | Output Capacitance | — | 38 | — | | $V_{CC}$ = 30V | 16 |
| $C_{res}$ | Reverse Transfer Capacitance | — | 16 | — | | f = 1.0MHz | |
| RBSOA | Reverse Bias Safe Operating Area | | FULL SQUARE | | | $T_J$ = 150°C, $I_C$ = 34A, Vp = 600V<br>$V_{CC}$=500V,$V_{GE}$ = +15V to 0V,$R_G$ = 50Ω | 4<br>CT2 |
| SCSOA | Short Circuit Safe Operating Area | 10 | — | — | µs | $T_J$ = 150°C, Vp = 600V, $R_G$ = 100Ω<br>$V_{CC}$=360V,$V_{GE}$ = +15V to 0V | CT3<br>WF3 |

Notes ① to ④ are on page 13.

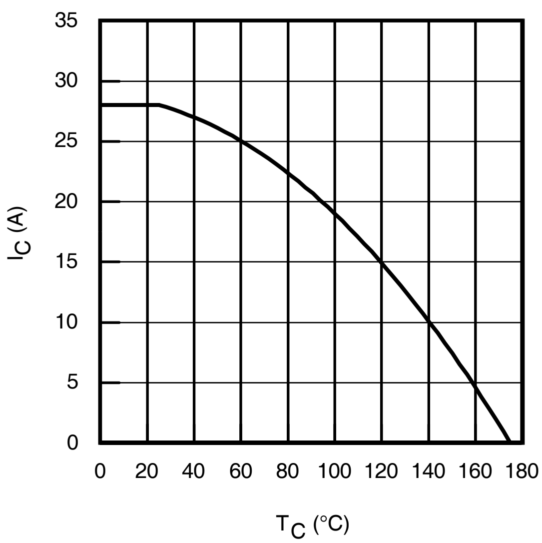



**Fig. 1** - Maximum DC Collector Current vs. Case Temperature

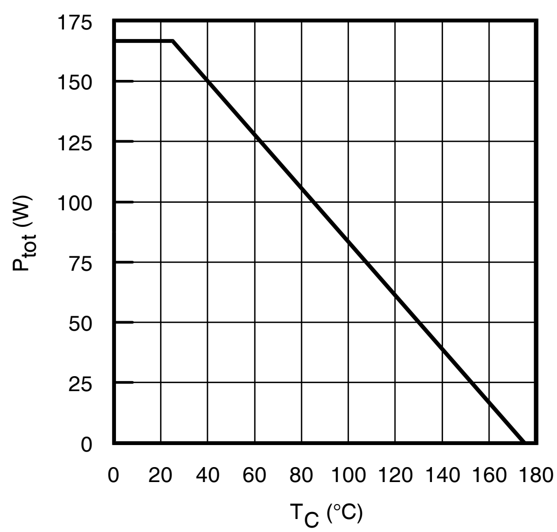



**Fig. 2** - Power Dissipation vs. Case Temperature

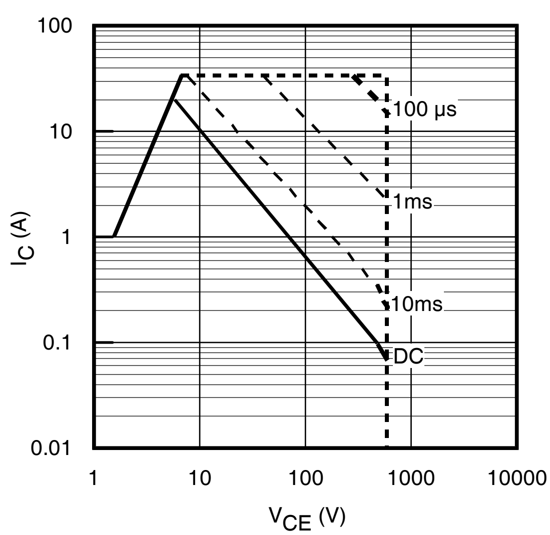



**Fig. 3** - Forward SOA
$T_C$ = 25°C; $T_J \leq$ 150°C

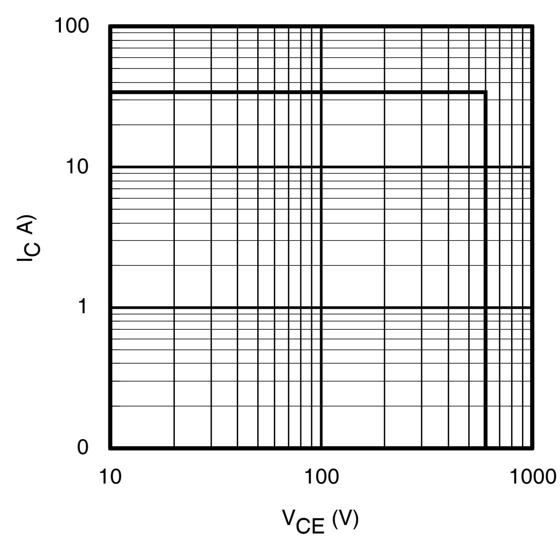



**Fig. 4** - Reverse Bias SOA
$T_J$ = 150°C; $V_{GE}$ =15V

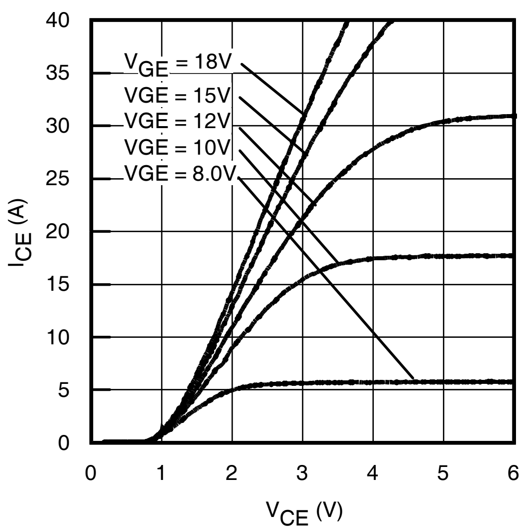



**Fig. 5** - Typ. IGBT Output Characteristics
$T_J$ = -40°C; tp = 80μs

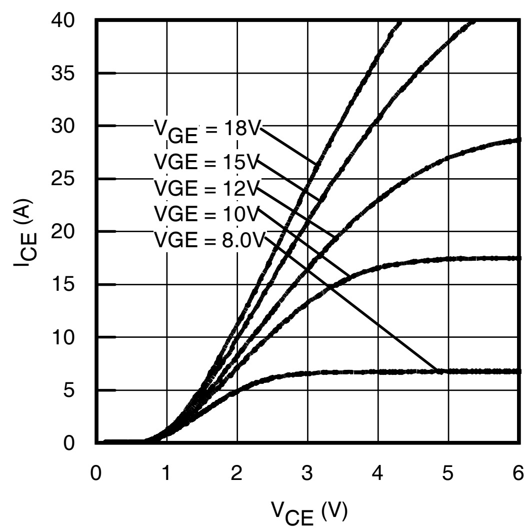



**Fig. 6** - Typ. IGBT Output Characteristics
$T_J$ = 25°C; tp = 80μs

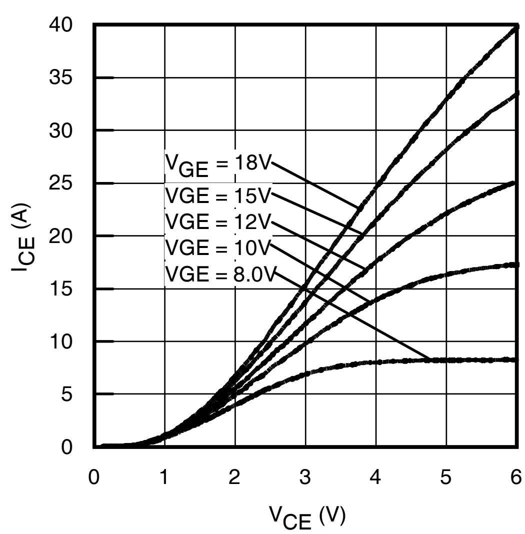



**Fig. 7** - Typ. IGBT Output Characteristics
$T_J$ = 150°C; tp = 80μs

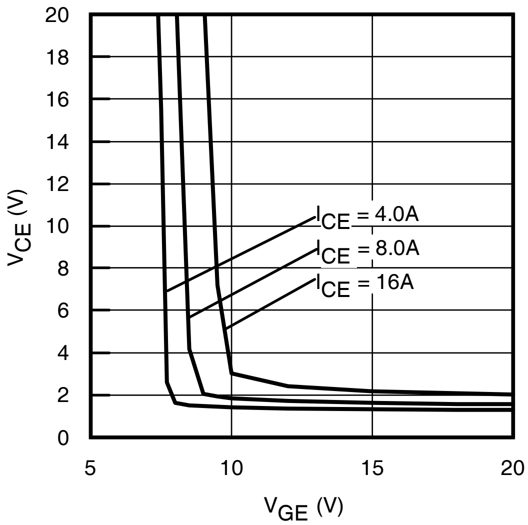



**Fig. 8** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J$ = -40°C

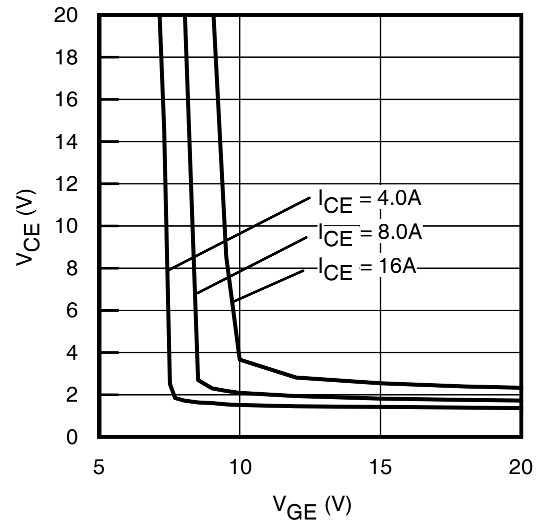



**Fig. 9** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J$ = 25°C

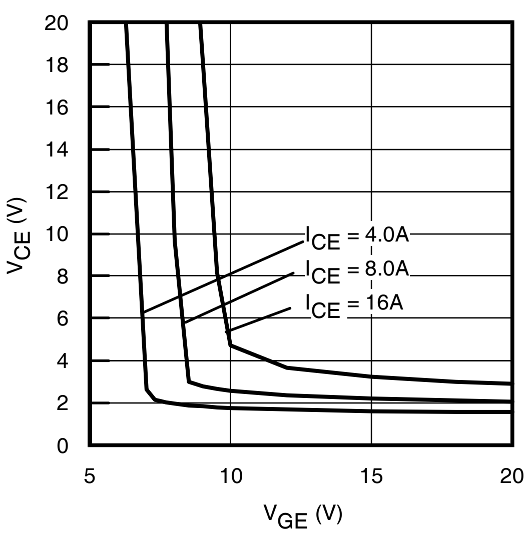



**Fig. 10** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J$ = 150°C

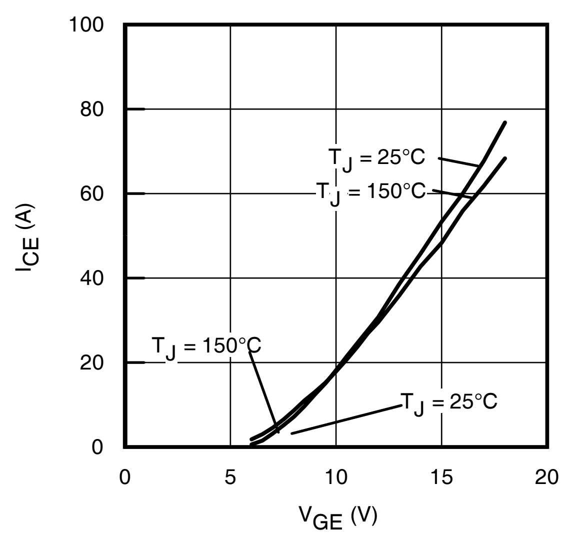



**Fig. 11** - Typ. Transfer Characteristics
$V_{CE}$ = 360V; tp = 10µs

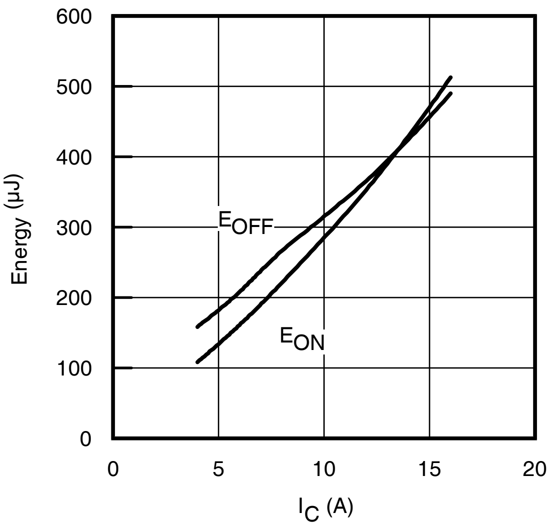



**Fig. 12** - Typ. Energy Loss vs. $I_C$
$T_J$ = 150°C; L=1.1mH; $V_{CE}$= 400V,
$R_G$= 50Ω; $V_{GE}$= 15V

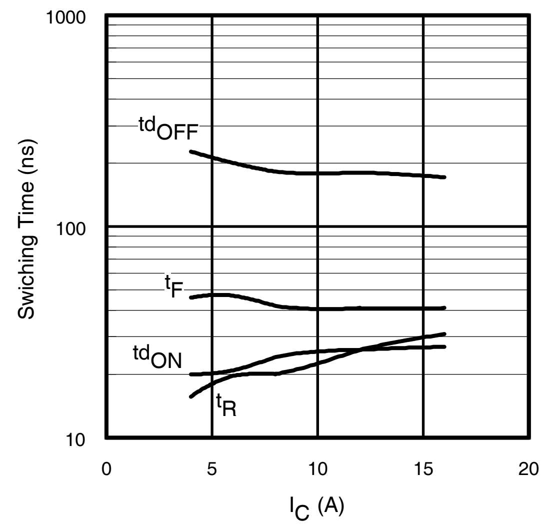



**Fig. 13** - Typ. Switching Time vs. $I_C$
$T_J$ = 150°C; L=1.1mH; $V_{CE}$= 400V
$R_G$= 50Ω; $V_{GE}$= 15V

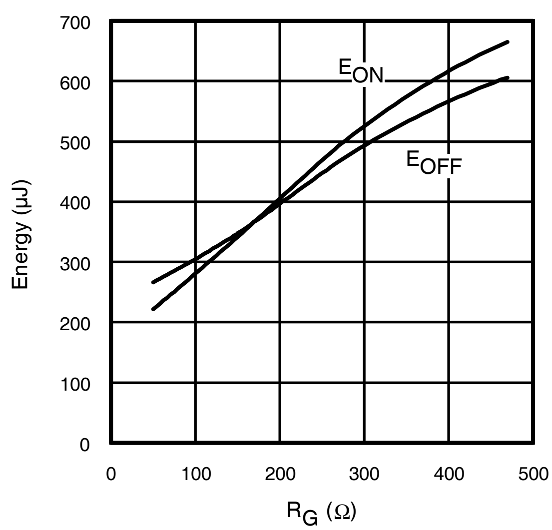



**Fig. 14** - Typ. Energy Loss vs. $R_G$
$T_J$ = 150°C; L=1.1mH; $V_{CE}$= 400V
$I_{CE}$= 8.0A; $V_{GE}$= 15V

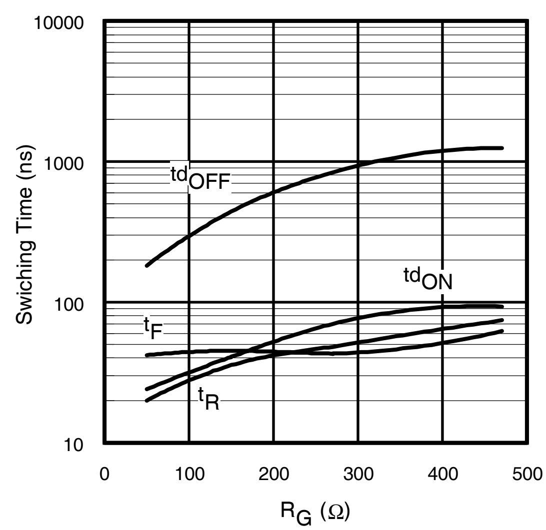



**Fig. 15** - Typ. Switching Time vs. $R_G$
$T_J$ = 150°C; L=1.1mH; $V_{CE}$= 400V
$I_{CE}$= 8.0A; $V_{GE}$= 15V

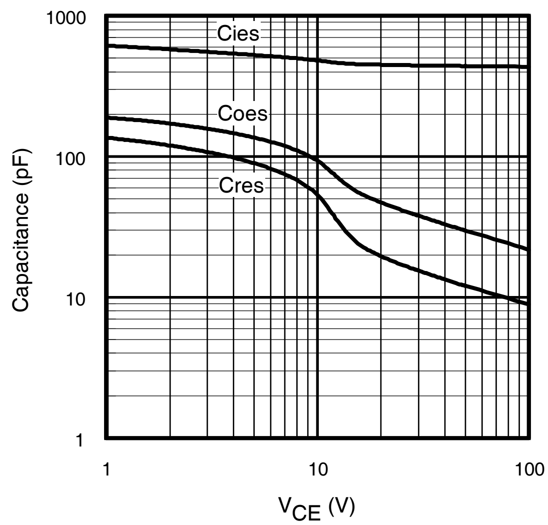



**Fig. 16**- Typ. Capacitance vs. $V_{CE}$
$V_{GE}$= 0V; f = 1MHz

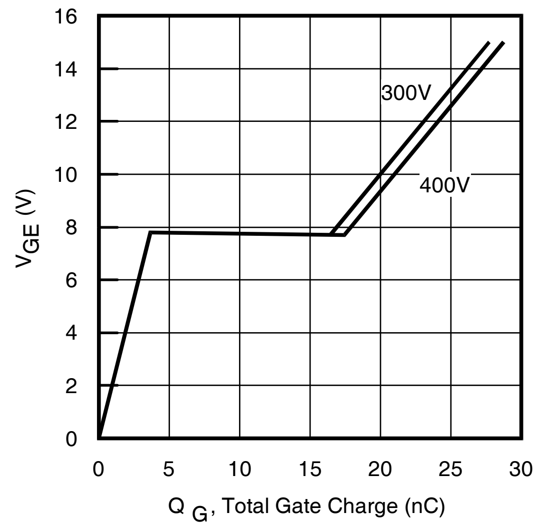



**Fig. 17** - Typical Gate Charge vs. $V_{GE}$
$I_{CE}$ = 8.0A; L = 600µH

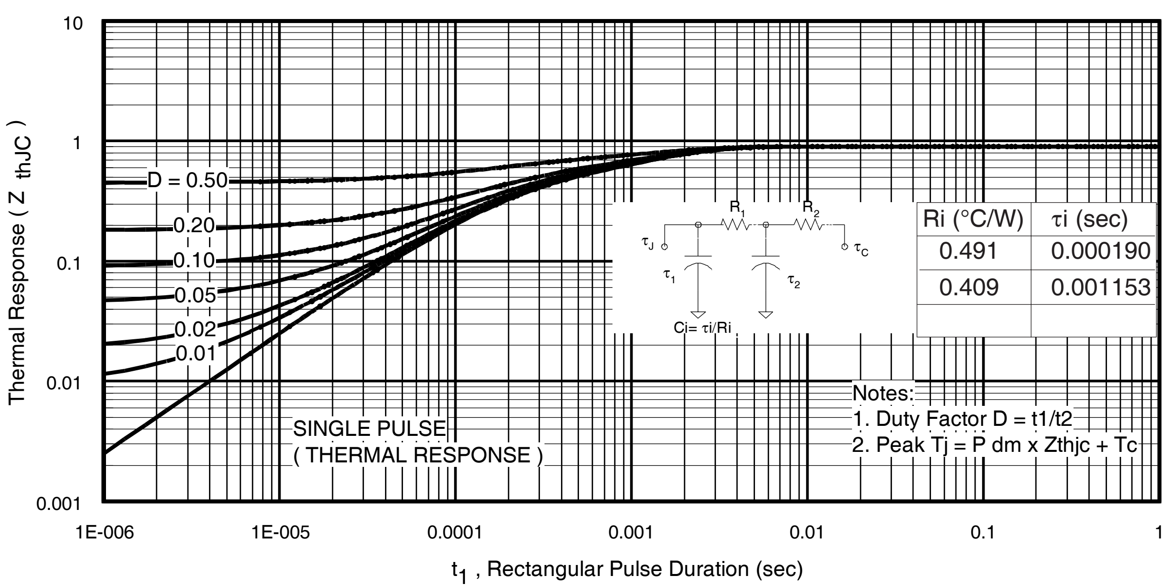



**Fig 18.** Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

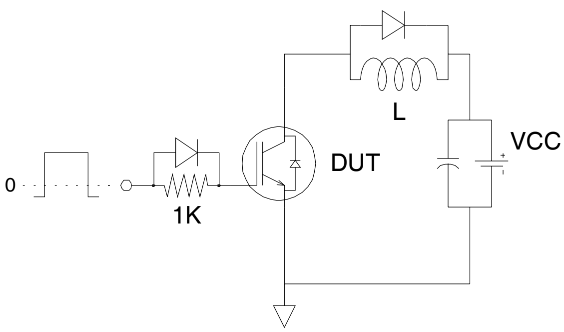



Fig.C.T.1 - Gate Charge Circuit (turn-off)

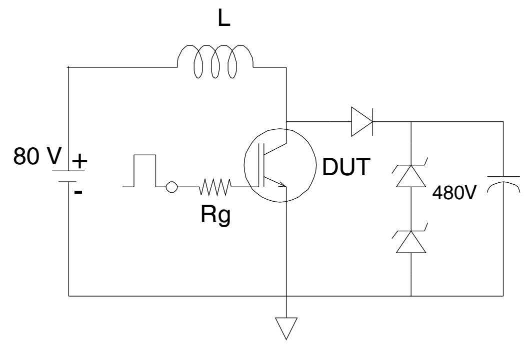



Fig.C.T.2 - RBSOA Circuit

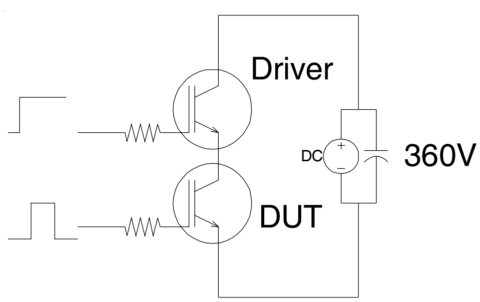



Fig.C.T.3 - S.C.SOA Circuit

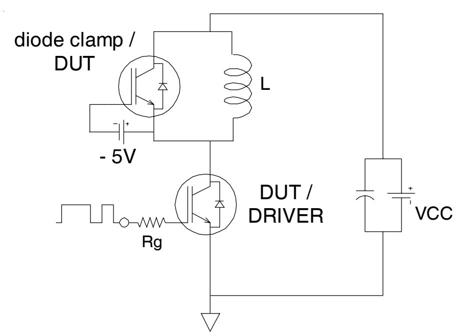



Fig.C.T.4 - Switching Loss Circuit

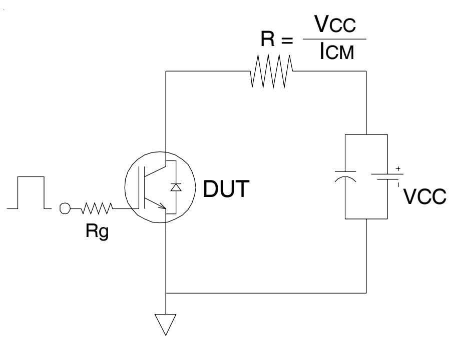



Fig.C.T.5 - Resistive Load Circuit

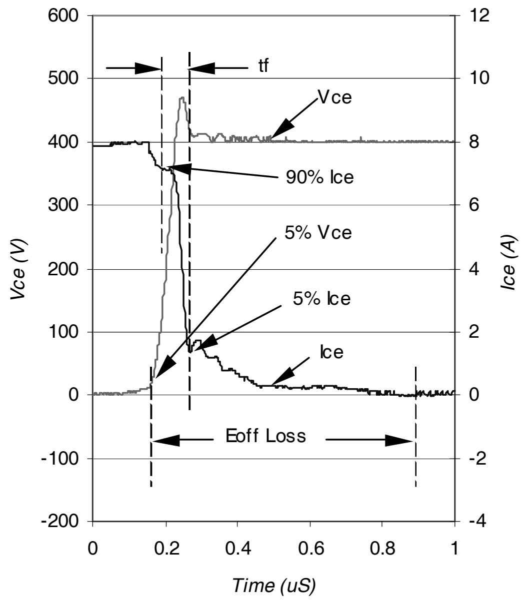



Fig. WF1- Typ. Turn-off Loss Waveform
@ $T_J$ = 150°C using Fig. CT.4

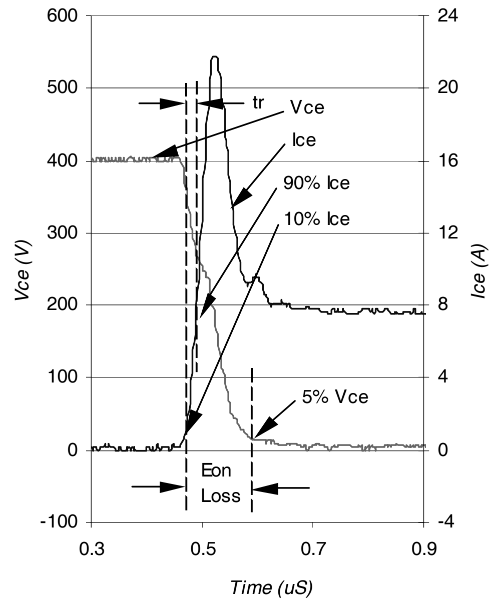



Fig. WF2- Typ. Turn-on Loss Waveform
@ $T_J$ = 150°C using Fig. CT.4

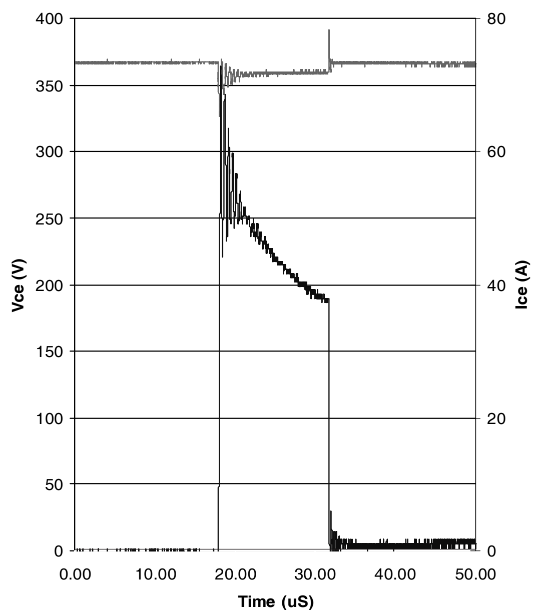
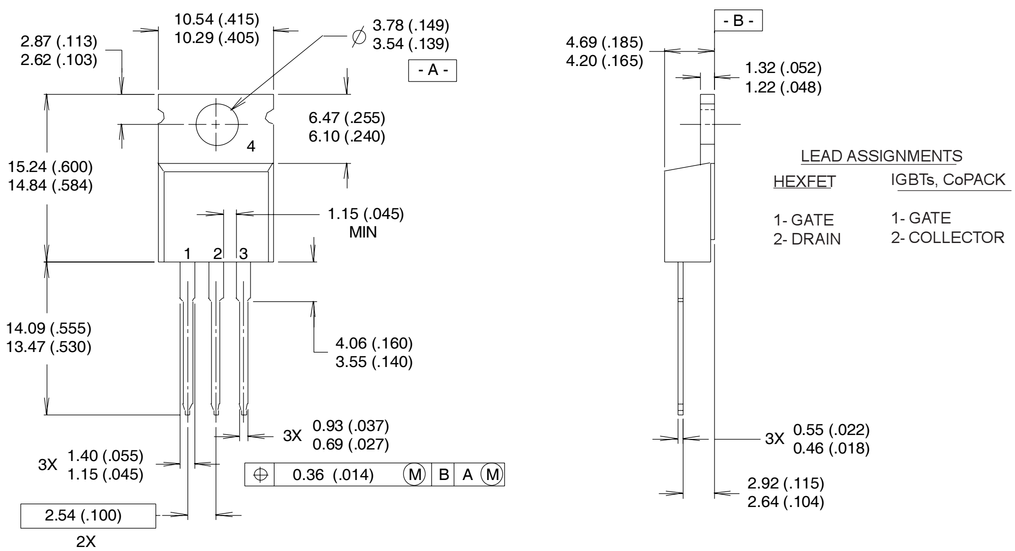



Fig. WF3- Typ. S.C Waveform
@ $T_C$ = 150°C using Fig. CT.3

## TO-220AB Package Outline

Dimensions are shown in millimeters (inches)




NOTES:

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

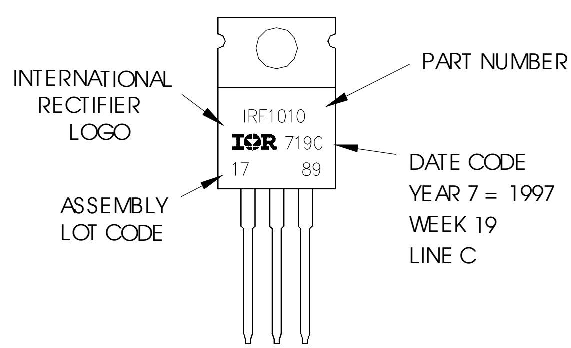
2 CONTROLLING DIMENSION : INCH

3 OUTLINE CONFORMS TO JEDEC OUTLINE TO-220AB.

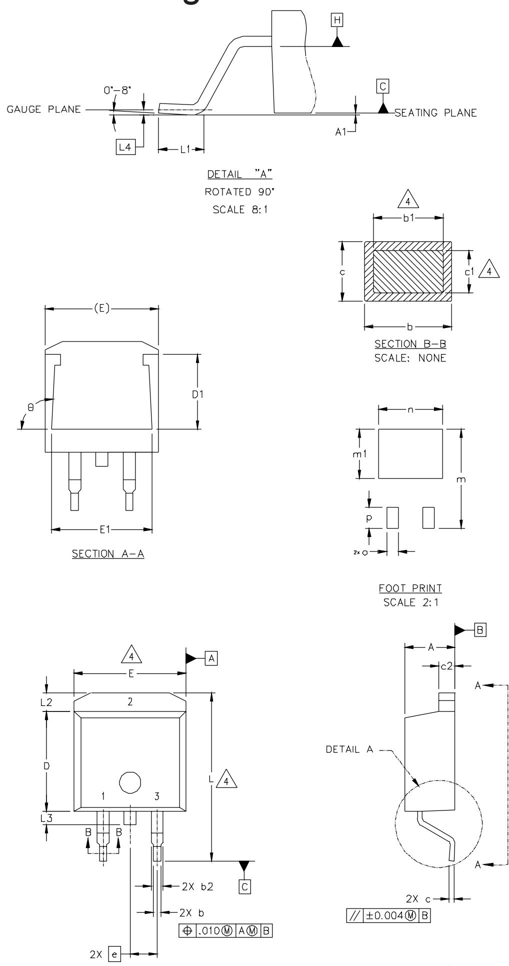
4 HEATSINK & LEAD MEASUREMENTS DO NOT INCLUDE BURRS.

## TO-220AB Part Marking Information

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



## D²Pak Package Outline

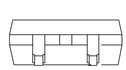



| SYMBOL | DIMENSIONS | | | | NOTES |
|---|---|---|---|---|---|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.06 | 4.83 | .160 | .190 | |
| A1 | | 0.127 | | .005 | |
| b | 0.51 | 0.99 | .020 | .039 | |
| b1 | 0.51 | 0.89 | .020 | .035 | 4 |
| b2 | 1.14 | 1.40 | .045 | .055 | |
| 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.

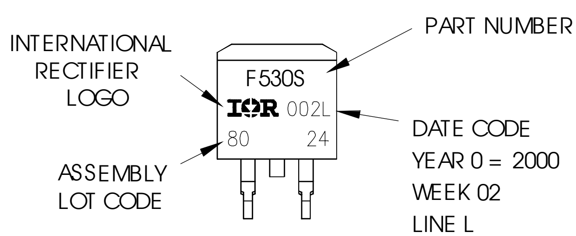


NOTES:

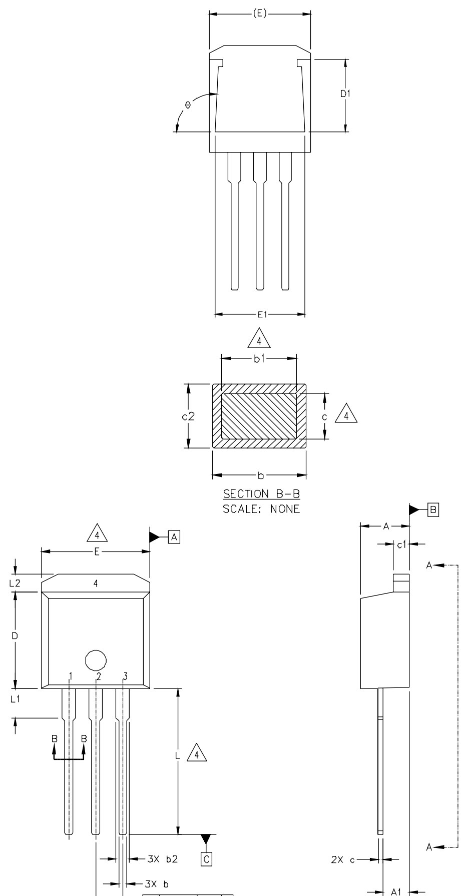
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. DIMENSION b1 AND c1 APPLY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

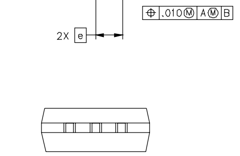
## D²Pak Part Marking Information

EXAMPLE: THIS IS AN IRF530S WITH LOT CODE 8024
ASSEMBLED ON WW 02, 2000
IN THE ASSEMBLY LINE "L"



## 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**

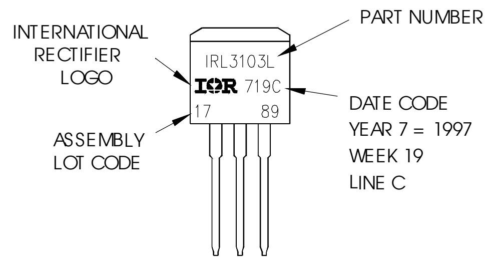
1- GATE
2- COLLECTOR
3- EMITTER

NOTES:

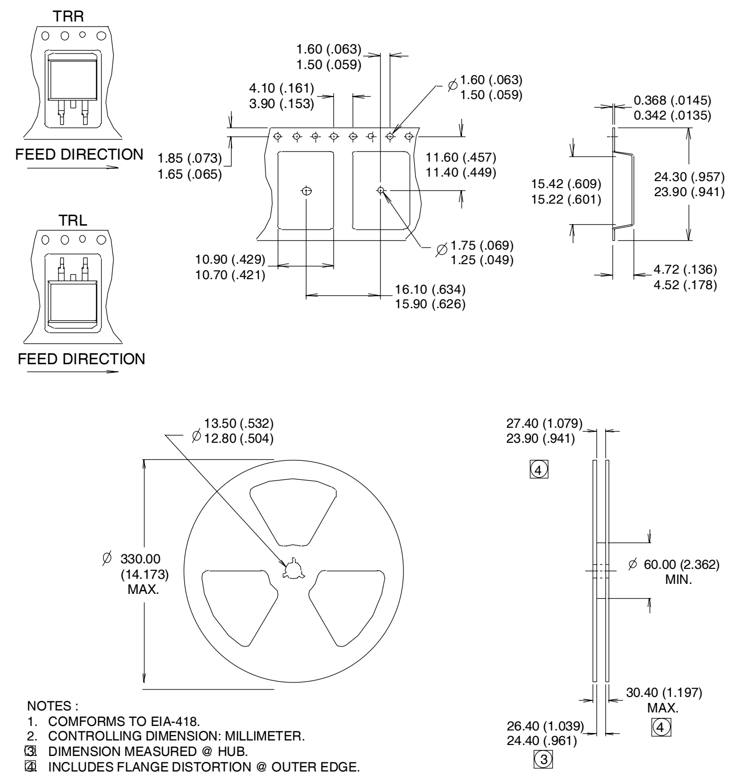
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994
2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
4. DIMENSION b1 AND c1 APPLY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



# $D^2$Pak Tape & Reel Information




Notes:

① $V_{CC}$ = 80% ($V_{CES}$), $V_{GE}$ = 15V, L = 100µH, $R_G$ = 50Ω.
② This is only applied to TO-220AB package.
③ This is applied to $D^2$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.

**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 the Industrial market.
Qualification Standards can be found on IR's Web site.

International
IOR Rectifier

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Visit us at www.irf.com for sales contact information. 10/03

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