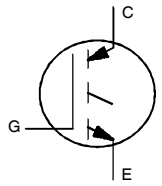
# IRGS15B60KPbF

INSULATED GATE BIPOLAR TRANSISTOR

## Features

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




**n-channel**

$V_{CES}$ = 600V

$I_C$ = 15A, $T_C$=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.

$D^2$Pak
IRGS15B60KPbF

## Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $V_{CES}$ | Collector-to-Emitter Voltage | 600 | V |
| $I_C$ @ $T_C$ = 25°C | Continuous Collector Current | 31 | A |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 15 | |
| $I_{CM}$ | Pulse Collector Current Vge = 15V | 62 | |
| $I_{LM}$ | Clamped Inductive Load Current Vge = 20V ④ | 62 | |
| $V_{GE}$ | Continuous Gate-to-Emitter Voltage | ±20 | V |
| $P_D$ @ $T_C$ = 25°C | Maximum Power Dissipation | 208 | W |
| $P_D$ @ $T_C$ = 100°C | Maximum Power Dissipation | 83 | |
| $T_J$ | 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 |
|---|---|---|---|---|---|
| $R_{\theta JC}$ (IGBT) | Junction-to-Case-IGBT | — | — | 0.6 | °C/W |
| $R_{\theta CS}$ | Case-to-Sink (flat, greased surface) | — | 0.5 | — | |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB Mount steady state)① | — | — | 40 | |
| | Weight | — | 1.44 | — | g (oz) |

**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 | — | 0.3 | — | V/°C | $V_{GE}$ = 0V, $I_C$ = 1.0mA (25°C-150°C) | |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | 1.5 | 1.8 | 2.2 | V | $I_C$ = 15A, $V_{GE}$ = 15V, $T_J$ = 25°C | 5,6,7 |
| | | — | 2.05 | 2.5 | | $I_C$ = 15A, $V_{GE}$ = 15V, $T_J$ = 125°C | 8,9,10 |
| | | — | 2.1 | 2.6 | | $I_C$ = 15A, $V_{GE}$ = 15V, $T_J$ = 150°C | |
| $V_{GE(th)}$ | Gate Threshold Voltage | 3.5 | 4.5 | 5.5 | V | $V_{CE}$ = $V_{GE}$, $I_C$ = 250µA | 8,9 |
| $\Delta V_{GE(th)}/\Delta TJ$ | Threshold Voltage temp. coefficient | — | -10 | — | mV/°C | $V_{CE}$ = $V_{GE}$, $I_C$ =1.0mA (25°C - 150°C) | 10,11 |
| gfe | Forward Transconductance | — | 10.6 | — | S | $V_{CE}$ = 50V, $I_C$ = 20A, PW = 80µs | |
| $I_{CES}$ | Collector-to-Emitter Leakage Current | — | 5.0 | 150 | µA | $V_{GE}$ = 0V, $V_{CE}$ = 600V, $T_J$ = 25°C | |
| | | — | 500 | 1000 | | $V_{GE}$ = 0V, $V_{CE}$ = 600V, $T_J$ = 150°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) | — | 56 | 84 | nC | $I_C$ = 15A | |
| $Q_{ge}$ | Gate-to-Emitter Charge (turn-on) | — | 7.0 | 10 | | $V_{GE}$ = 15V | CT1 |
| $Q_{gc}$ | Gate-to-Collector Charge (turn-on) | — | 26 | 39 | | $V_{CC}$ = 400V | |
| $E_{on}$ | Turn-On Switching Loss | — | 220 | 330 | µJ | $I_C$ = 15A, $V_{CC}$ = 400V, $V_{GE}$ = 15V | CT4 |
| $E_{off}$ | Turn-Off Switching Loss | — | 340 | 455 | | $R_G$ = 22Ω, L = 200µH | |
| $E_{total}$ | Total Switching Loss | — | 560 | 785 | | $L_S$ = 150nH $T_J$ = 25°C ② | |
| $t_{d(on)}$ | Turn-On delay time | — | 34 | 44 | ns | $I_C$ = 15A, $V_{CC}$ = 400V, $V_{GE}$ = 15V | CT4 |
| $t_r$ | Rise time | — | 16 | 22 | | $R_G$ = 22Ω, L = 200µH | |
| $t_{d(off)}$ | Turn-Off delay time | — | 184 | 200 | | $L_S$ = 150nH $T_J$ = 25°C | |
| $t_f$ | Fall time | — | 20 | 26 | | | |
| $E_{on}$ | Turn-On Switching Loss | — | 355 | 470 | µJ | $I_C$ = 15A, $V_{CC}$ = 400V, $V_{GE}$ = 15V | CT4 |
| $E_{off}$ | Turn-Off Switching Loss | — | 490 | 600 | | $R_G$ = 22Ω, L = 200µH | 12,14 |
| $E_{total}$ | Total Switching Loss | — | 835 | 1070 | | $L_S$ = 150nH $T_J$ = 150°C ② | WF1, WF2 |
| $t_{d(on)}$ | Turn-On delay time | — | 34 | 44 | ns | $I_C$ = 15A, $V_{CC}$ = 400V, $V_{GE}$ = 15V | 13, 15 |
| $t_r$ | Rise time | — | 18 | 25 | | $R_G$ = 22Ω, L = 200µH | CT4 |
| $t_{d(off)}$ | Turn-Off delay time | — | 203 | 226 | | $L_S$ = 150nH $T_J$ = 150°C | WF1 |
| $t_f$ | Fall time | — | 28 | 36 | | | WF2 |
| $C_{ies}$ | Input Capacitance | — | 850 | — | pF | $V_{GE}$ = 0V | |
| $C_{oes}$ | Output Capacitance | — | 75 | — | | $V_{CC}$ = 30V | |
| $C_{res}$ | Reverse Transfer Capacitance | — | 35 | — | | f = 1.0Mhz | |
| RBSOA | Reverse Bias Safe Operating Area | FULL SQUARE | | | | $I_C$ = 62A<br>$V_{CC}$ = 500V, Vp =600V<br>Rg = 22Ω, $V_{GE}$ = +20V to 0V, $T_J$ =150°C | 4<br>CT2 |
| SCSOA | Short Circuit Safe Operating Area | 10 | — | — | µs | $V_{CC}$ = 360V, Vp =600V ,$T_J$ = 150°C<br>Rg = 22Ω, $V_{GE}$ = +15V to 0V | CT3<br>WF3 |

Note ① to ③ are on page 11

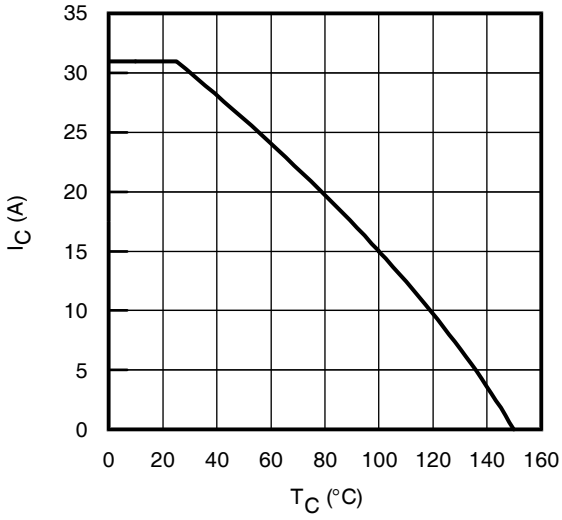



**Fig. 1** - Maximum DC Collector Current vs. Case Temperature

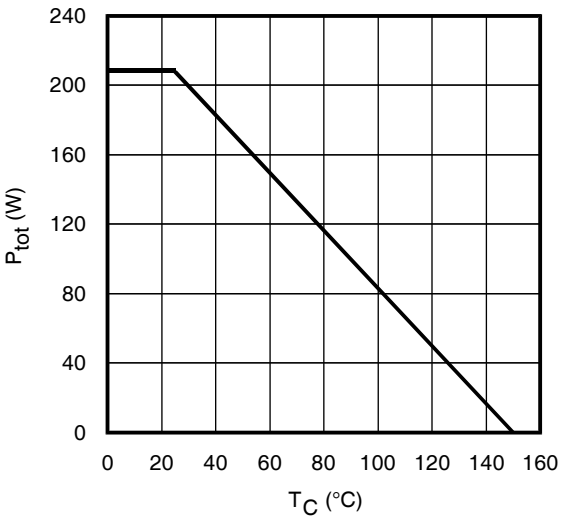



**Fig. 2** - Power Dissipation vs. Case Temperature

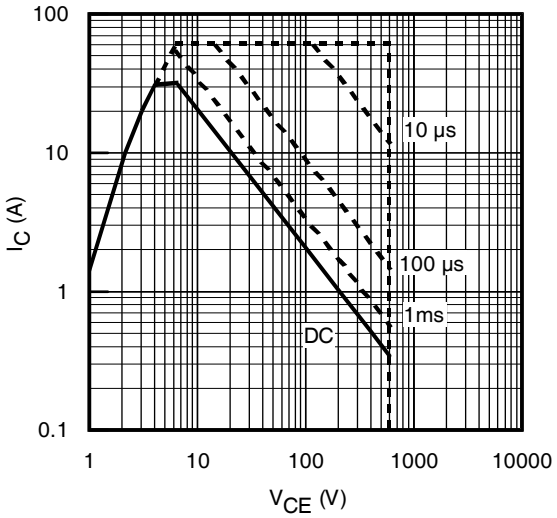



**Fig. 3** - Forward SOA
$T_C$ = 25°C; $T_J \leq$ 150°C

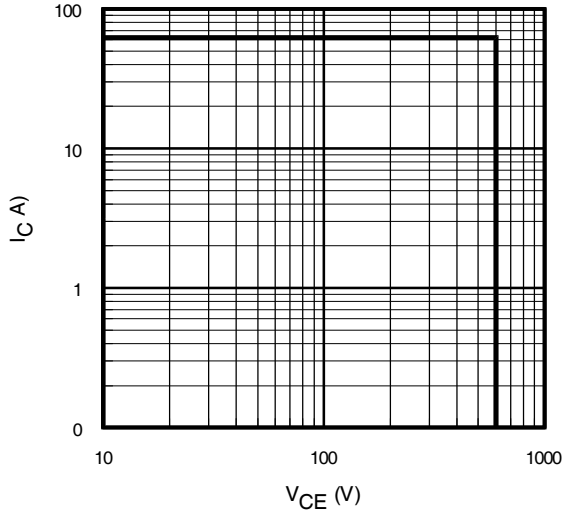



**Fig. 4** - Reverse Bias SOA
$T_J$ = 150°C; $V_{GE}$ =15V

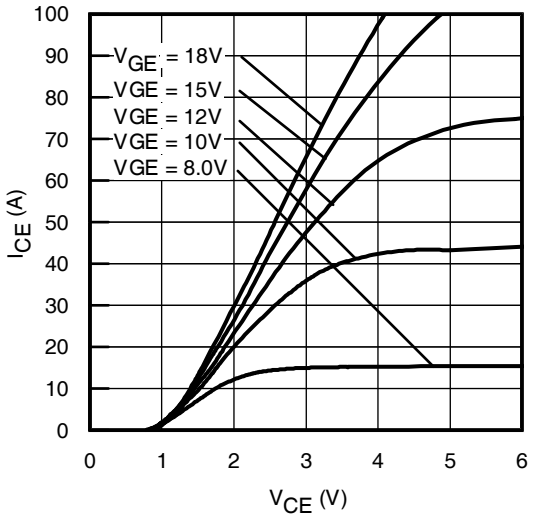



**Fig. 5** - Typ. IGBT Output Characteristics
$T_J$ = -40°C; tp = 300µs

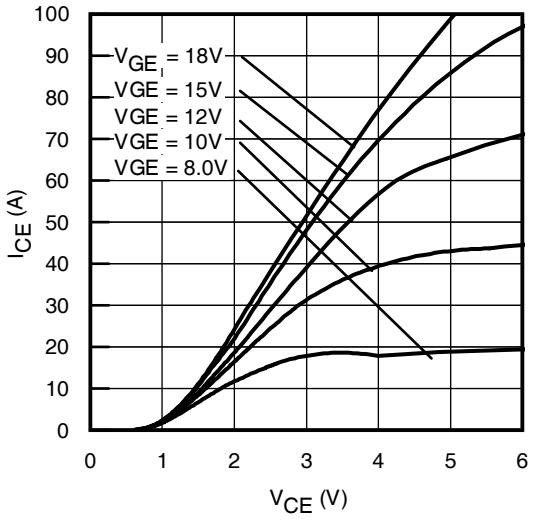



**Fig. 6** - Typ. IGBT Output Characteristics
$T_J$ = 25°C; tp = 300µs

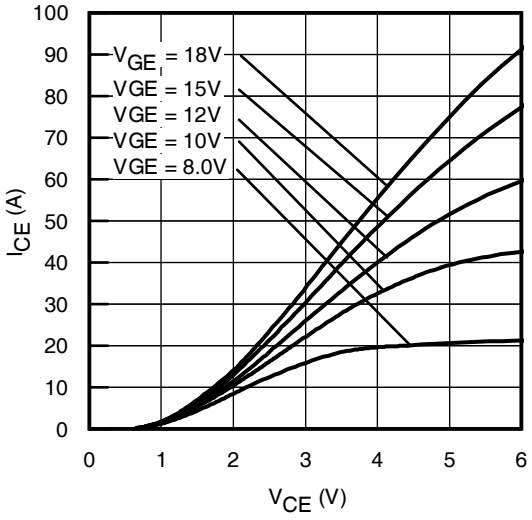



**Fig. 7** - Typ. IGBT Output Characteristics
$T_J$ = 150°C; tp = 300µs

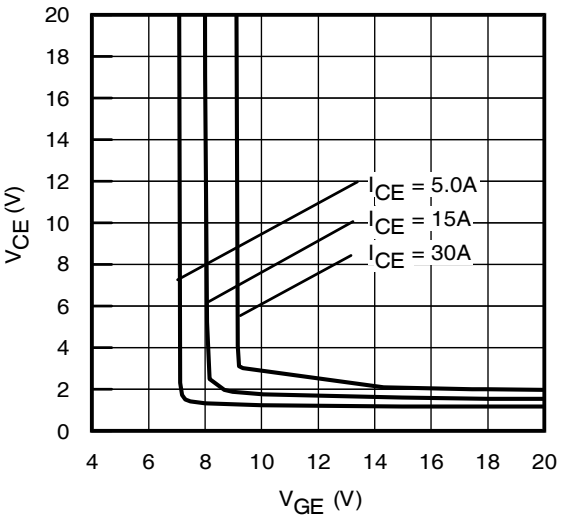



**Fig. 8** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J$ = -40°C

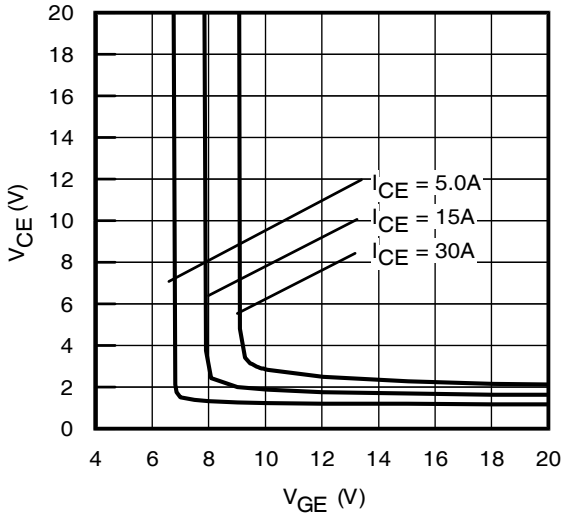



**Fig. 9** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J = 25°C$

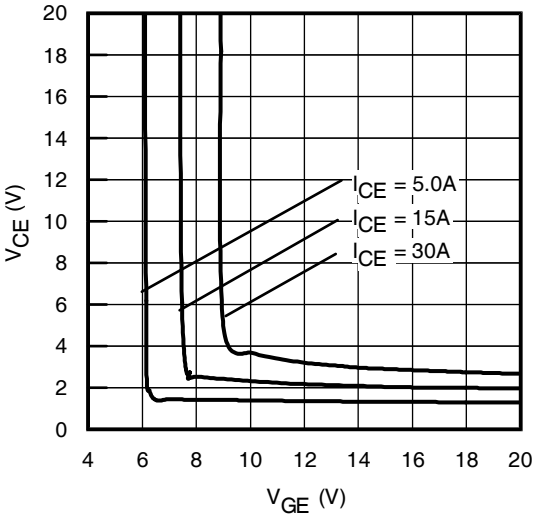



**Fig. 10** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J = 150°C$

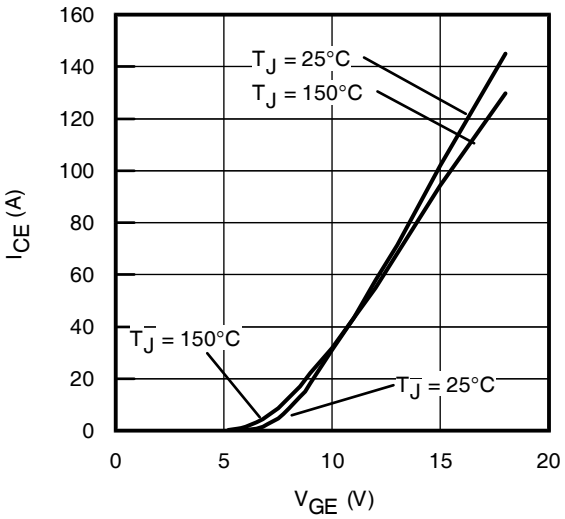



**Fig. 11** - Typ. Transfer Characteristics
$V_{CE} = 50V$; tp = 10µs

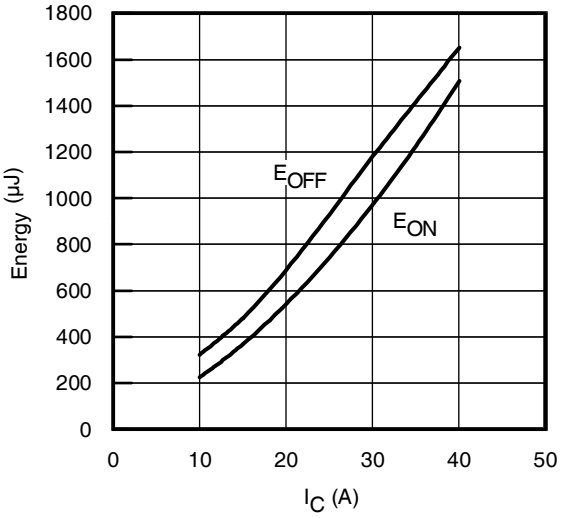



**Fig. 12** - Typ. Energy Loss vs. $I_C$
$T_J$ = 150°C; L=200µH; $V_{CE}$= 400V
$R_G$= 22Ω; $V_{GE}$= 15V

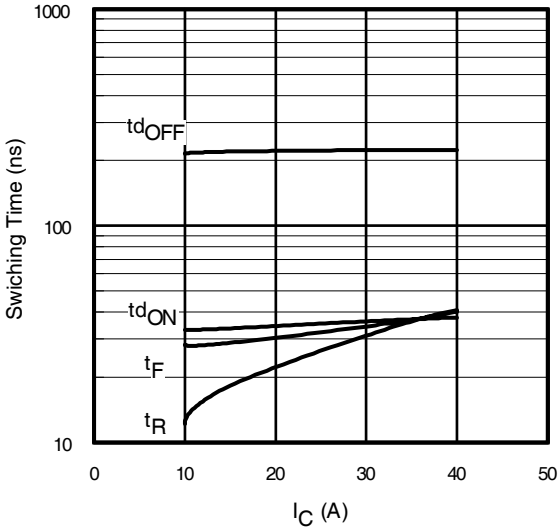



**Fig. 13** - Typ. Switching Time vs. $I_C$
$T_J$ = 150°C; L=200µH; $V_{CE}$= 400V
$R_G$= 22Ω; $V_{GE}$= 15V

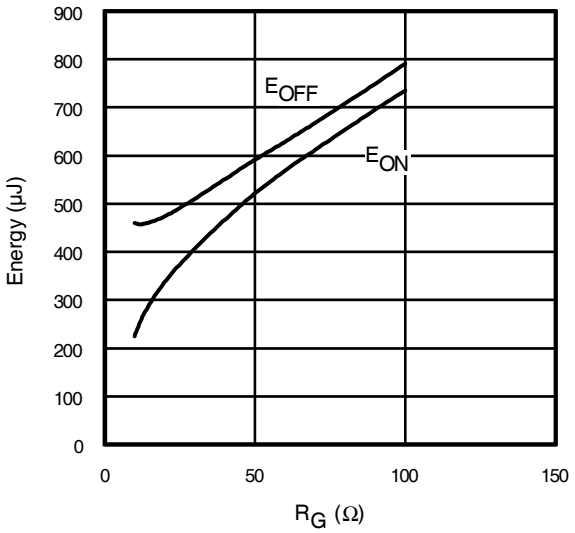



**Fig. 14** - Typ. Energy Loss vs. $R_G$
$T_J$ = 150°C; L=200µH; $V_{CE}$= 400V
$I_{CE}$= 15A; $V_{GE}$= 15V

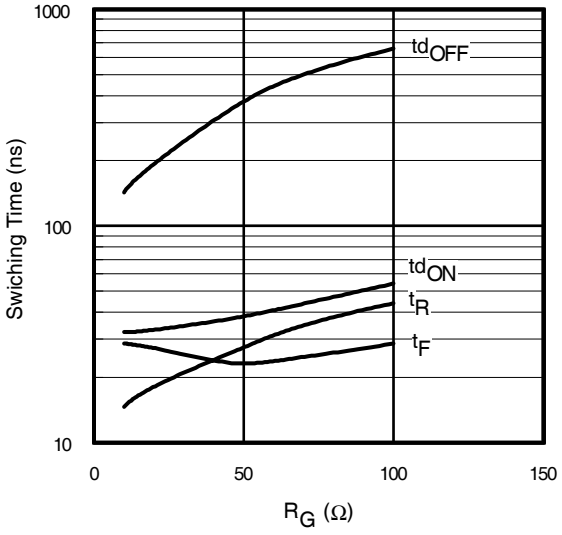



**Fig. 15**- Typ. Switching Time vs. $R_G$
$T_J$ = 150°C; L=200µH; $V_{CE}$= 600V
$I_{CE}$= 15A; $V_{GE}$= 15V

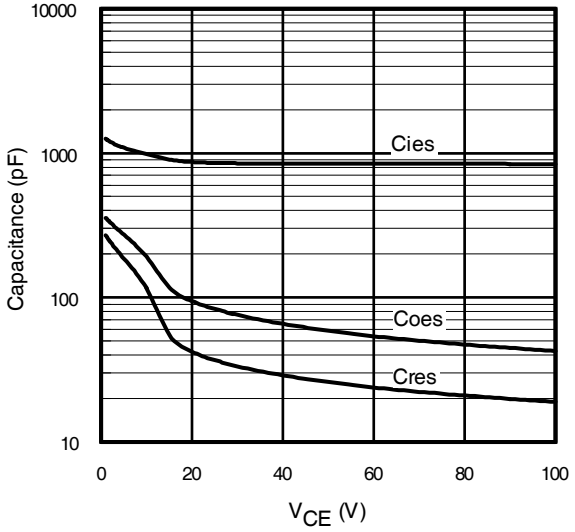



**Fig. 16**- Typ. Capacitance vs. $V_{CE}$
$V_{GE}$= 0V; f = 1MHz

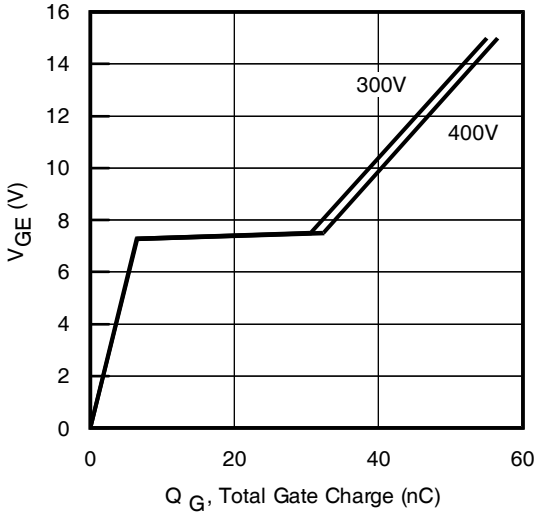



**Fig. 17** - Typical Gate Charge vs. $V_{GE}$
$I_{CE}$ = 15A; L = 600µH

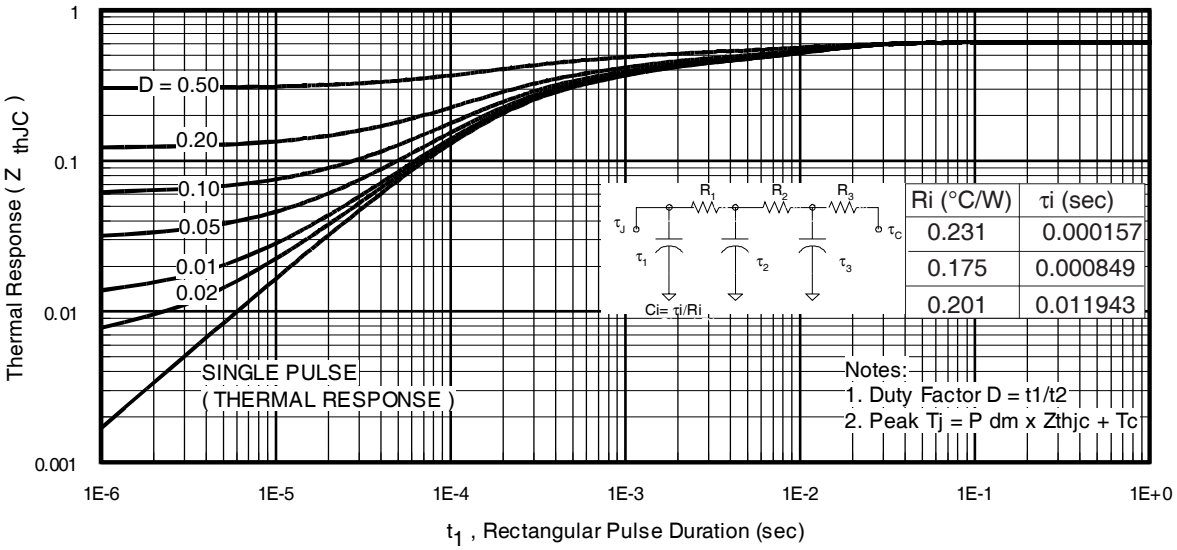



**Fig 18.** Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

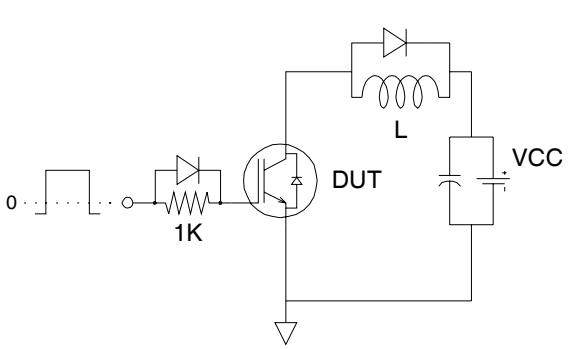



**Fig.C.T.1** - Gate Charge Circuit (turn-off)

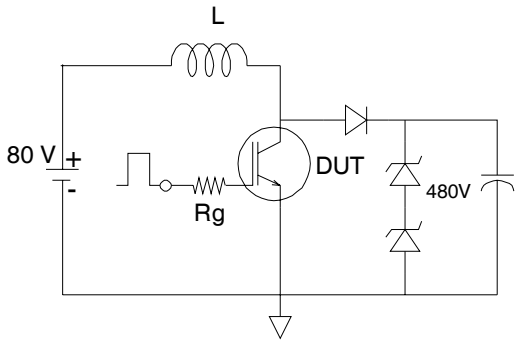



**Fig.C.T.2** - RBSOA Circuit

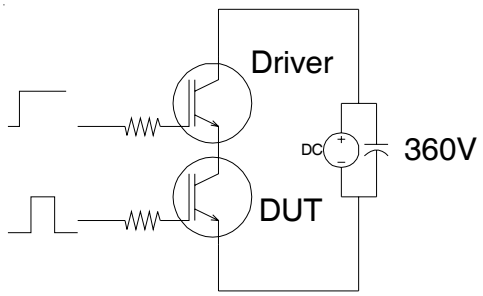



**Fig.C.T.3** - S.C.SOA Circuit

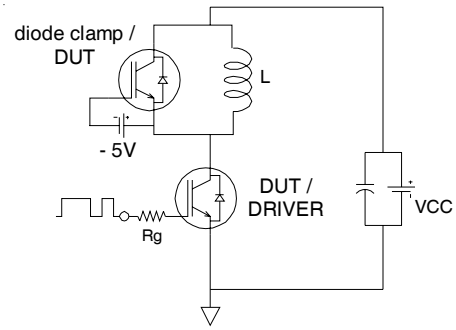



**Fig.C.T.4** - Switching Loss Circuit

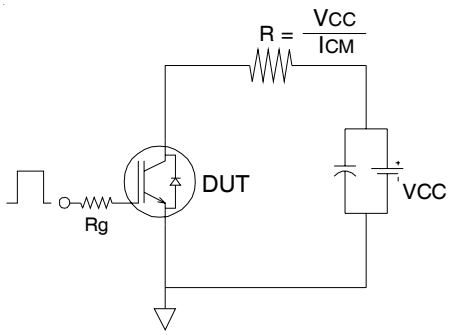
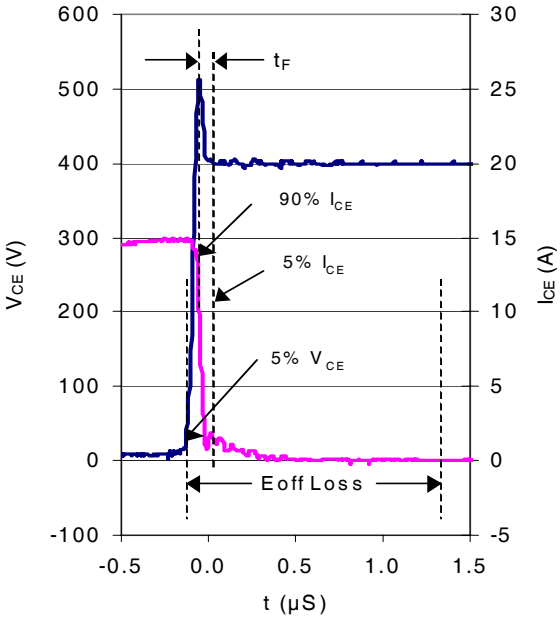
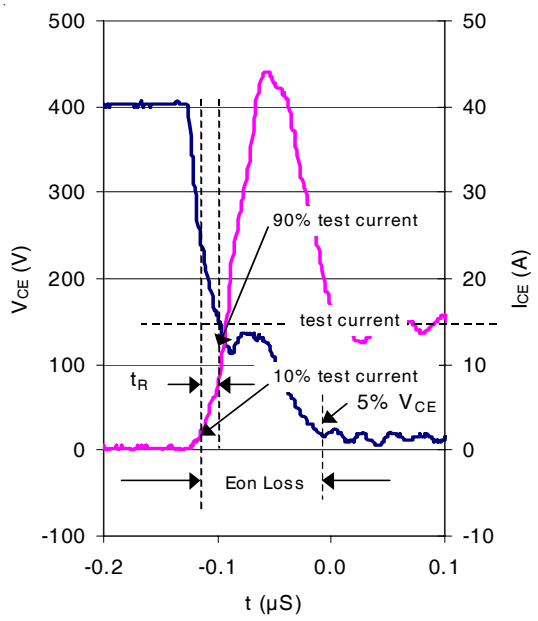


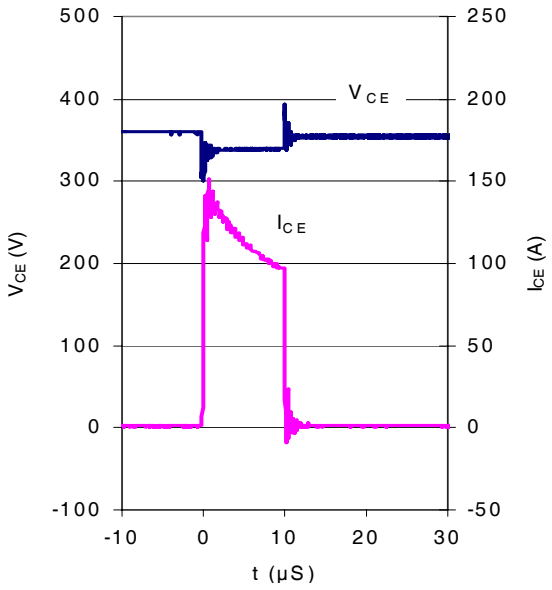

**Fig.C.T.5** - Resistive Load Circuit




WF.1- Typ. Turn-off Loss
@ $T_J$ = 150°C using CT.4




WF.2- Typ. Turn-on Loss
@ $T_J$ = 150°C using Fig. CT.4

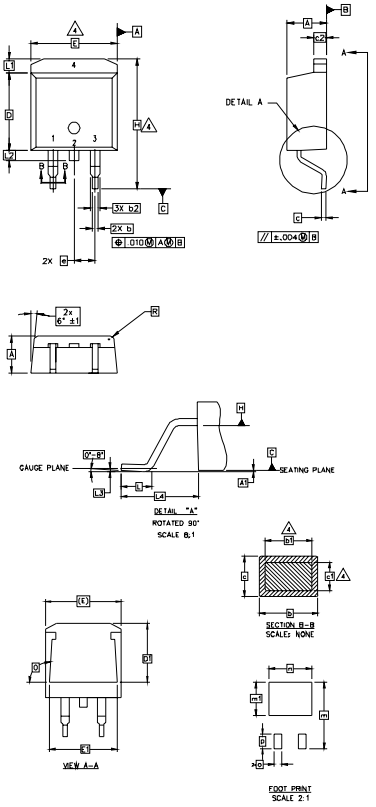



WF.3- Typ. Short Circuit
@ $T_J$ = 150°C using CT.3

# IRGS15B60KPbF

## D²Pak Package Outline

Dimensions are shown in millimeters (inches)




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.

| SYMBOL | DIMENSIONS | | | | NOTES |
|---|---|---|---|---|---|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.06 | 4.83 | .160 | .190 | |
| A1 | 0.00 | 0.254 | .000 | .010 | |
| b | 0.51 | 0.99 | .020 | .039 | |
| b1 | 0.51 | 0.89 | .020 | .035 | 4 |
| b2 | 1.14 | 1.78 | .045 | .070 | |
| c | 0.38 | 0.74 | .015 | .029 | |
| c1 | 0.38 | 0.58 | .015 | .023 | 4 |
| c2 | 1.14 | 1.65 | .045 | .065 | |
| D | 8.51 | 9.65 | .335 | .380 | 3 |
| D1 | 6.86 | | .270 | | |
| E | 9.65 | 10.67 | .380 | .420 | 3 |
| E1 | 6.22 | | .245 | | |
| e | 2.54 BSC | | .100 BSC | | |
| H | 14.61 | 15.88 | .575 | .625 | |
| L | 1.78 | 2.79 | .070 | .110 | |
| L1 | | 1.65 | | .065 | |
| L2 | 1.27 | 1.78 | .050 | .070 | |
| L3 | 0.25 BSC | | .010 BSC | | |
| L4 | 4.78 | 5.28 | .188 | .208 | |
| m | 17.78 | | .700 | | |
| m1 | 8.89 | | .350 | | |
| n | 11.43 | | .450 | | |
| o | 2.08 | | .082 | | |
| p | 3.81 | | .150 | | |
| R | 0.51 | 0.71 | .020 | .028 | |
| θ | 90° | 93° | 90° | 93° | |

LEAD ASSIGNMENTS

HEXFET

1.– GATE
2, 4.– DRAIN
3.– SOURCE

IGBTs, CoPACK

1.– GATE
2, 4.– COLLECTOR
3.– EMITTER

DIODES

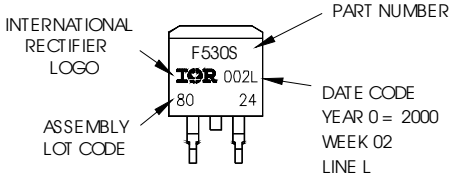
1.– ANODE *
2, 4.– CATHODE
3.– ANODE

* PART DEPENDENT.

## 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"

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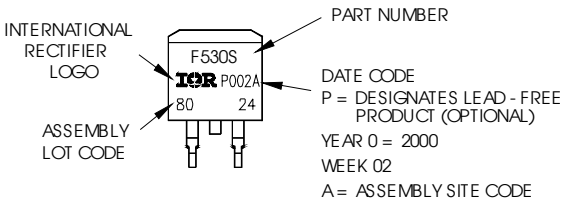
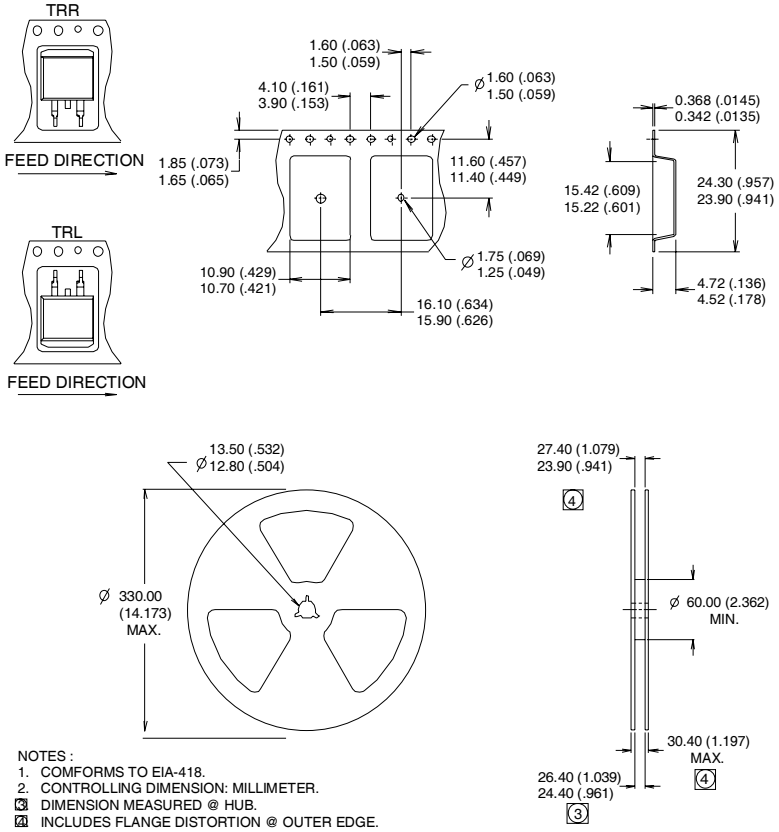


## D²Pak Tape & Reel Information

Dimensions are shown in millimeters (inches)




Notes:

① 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.

② Energy losses include "tail" and diode reverse recovery, using Diode HF15D060ACE.

③ $V_{CC}$ = 80% ($V_{CES}$), $V_{GE}$ = 20V, L = 100µH, $R_G$ = 22Ω.

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.

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