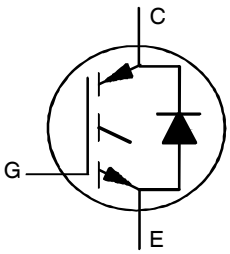
International
IOR Rectifier

# IRGS4064DPbF

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE



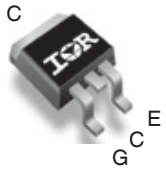

n-channel

$V_{CES}$ = 600V

$I_C$ = 10A, $T_C$ = 100°C

$t_{sc}$ > 5µs, $T_{jmax}$ = 175°C

$V_{CE(on)\ typ.}$ = 1.6V




$D^2Pak$

### Features

- Low $V_{CE\ (on)}$ Trench IGBT Technology
- Low Switching Losses
- Maximum Junction temperature 175 °C
- 5µs SCSOA
- Square RBSOA
- 100% of The Parts Tested for ($I_{LM}$)
- Positive $V_{CE\ (on)}$ Temperature Coefficient.
- Ultra Fast Soft Recovery Co-pak Diode
- Tighter Distribution of Parameters
- Lead-Free Package

### Benefits

- High Efficiency in a Wide Range of Applications
- Suitable for a Wide Range of Switching Frequencies due to Low $V_{CE\ (ON)}$ and Low Switching Losses
- Rugged Transient Performance for Increased Reliability
- Excellent Current Sharing in Parallel Operation
- Low EMI

| G | C | E |
|---|---|---|
| Gate | Collector | Emitter |

### Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $V_{CES}$ | Collector-to-Emitter Breakdown Voltage | 600 | V |
| $I_C$ @ $T_C$ = 25°C | Continuous Collector Current | 20 | A |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 10 | |
| $I_{CM}$ | Pulsed Collector Current | 40 | |
| $I_{LM}$ | Clamped Inductive Load Current ① | 40 | |
| $I_F$ @$T_C$=25°C | Diode Continuous Forward Current | 20 | |
| $I_F$ @$T_C$=100°C | Diode Continuous Forward Current | 10 | |
| $I_{FM}$ | Diode Maximum Forward Current ② | 40 | |
| $V_{GE}$ | Continuous Gate-to-Emitter Voltage | ±20 | V |
| | Transient Gate-to-Emitter Voltage | ±30 | |
| $P_D$ @ $T_C$ =25° | Maximum Power Dissipation | 101 | W |
| $P_D$ @ $T_C$ =100° | Maximum Power Dissipation | 50 | |
| $T_J$<br>$T_{STG}$ | Operating Junction and<br>Storage Temperature Range | -55 to + 175 | °C |
| | Soldering Temperature, for 10 seconds | 300 (0.063 in. (1.6mm) from case) | |

### Thermal Resistance

| | Parameter | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $R_{\theta JC}$ | Junction-to-Case - IGBT ③ | ––– | ––– | 1.49 | °C/W |
| $R_{\theta JC}$ | Junction-to-Case - Diode ③ | ––– | ––– | 3.66 | |
| $R_{\theta CS}$ | Case-to-Sink, flat, greased surface | ––– | 0.50 | ––– | |
| $R_{\theta JA}$ | Junction-to-Ambient, typical socket mount ③ | ––– | ––– | 40 | |
| Wt | Weight | | 1.5 | | g |

**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, $I_C$ = 100µA ④ | CT 6 |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage | — | 0.47 | — | V/°C | $V_{GE}$ = 0V, $I_C$ = 500µA (25°C-175°C) | |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | — | 1.6 | 1.91 | V | $I_C$ = 10A, $V_{GE}$ = 15V, $T_J$ = 25°C | |
| | | — | 1.9 | — | | $I_C$ = 10A, $V_{GE}$ = 15V, $T_J$ = 150°C | 5,6,7,9, |
| | | — | 2.0 | — | | $I_C$ = 10A, $V_{GE}$ = 15V, $T_J$ = 175°C | 10 ,11 |
| $V_{GE(th)}$ | Gate Threshold Voltage | 4.0 | — | 6.5 | V | $V_{CE}$ = $V_{GE}$, $I_C$ = 275µA | 9, 10, 11, 12 |
| $\Delta V_{GE(th)}/\Delta TJ$ | Threshold Voltage temp. coefficient | — | -11 | — | mV/°C | $V_{CE}$ = $V_{GE}$, $I_C$ = 1.0mA (25°C - 175°C) | |
| gfe | Forward Transconductance | — | 6.9 | — | S | $V_{CE}$ = 50V, $I_C$ = 10A, PW = 80µs | |
| $I_{CES}$ | Collector-to-Emitter Leakage Current | — | — | 25 | µA | $V_{GE}$ = 0V, $V_{CE}$ = 600V | |
| | | — | 328 | — | | $V_{GE}$ = 0V, $V_{CE}$ = 600V, $T_J$ = 175°C | 8 |
| $V_{FM}$ | Diode Forward Voltage Drop | — | 2.5 | 3.1 | V | $I_F$ = 10A | |
| | | — | 1.7 | — | | $I_F$ = 10A, $T_J$ = 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.⑤ | Units | Conditions | Ref.Fig |
|---|---|---|---|---|---|---|---|
| $Q_g$ | Total Gate Charge (turn-on) | — | 21 | 32 | | $I_C$ = 10A | 24 |
| $Q_{ge}$ | Gate-to-Emitter Charge (turn-on) | — | 5.3 | 8.0 | nC | $V_{GE}$ = 15V | CT 1 |
| $Q_{gc}$ | Gate-to-Collector Charge (turn-on) | — | 8.9 | 13 | | $V_{CC}$ = 400V | |
| $E_{on}$ | Turn-On Switching Loss | — | 29 | 40 | | $I_C$ = 10A, $V_{CC}$ = 400V, $V_{GE}$ = 15V | |
| $E_{off}$ | Turn-Off Switching Loss | — | 200 | 281 | µJ | $R_G$ = 22Ω, L = 1.0mH, $T_J$ = 25°C | CT 4 |
| $E_{total}$ | Total Switching Loss | — | 229 | 313 | | Energy losses include tail & diode reverse recovery | |
| $t_{d(on)}$ | Turn-On delay time | — | 27 | 37 | | $I_C$ = 10A, $V_{CC}$ = 400V, $V_{GE}$ = 15V | |
| $t_r$ | Rise time | — | 15 | 23 | ns | $R_G$ = 22Ω, L = 1.0mH, $T_J$ = 25°C | CT 4 |
| $t_{d(off)}$ | Turn-Off delay time | — | 79 | 90 | | | |
| $t_f$ | Fall time | — | 21 | 29 | | | |
| $E_{on}$ | Turn-On Switching Loss | — | 99 | — | | $I_C$ = 10A, $V_{CC}$ = 400V, $V_{GE}$ = 15V | 13, 15 |
| $E_{off}$ | Turn-Off Switching Loss | — | 316 | — | µJ | $R_G$=22Ω, L=1.0mH, $T_J$ = 175°C ④ | CT 4 |
| $E_{total}$ | Total Switching Loss | — | 415 | — | | Energy losses include tail & diode reverse recovery | WF 1,WF 2 |
| $t_{d(on)}$ | Turn-On delay time | — | 27 | — | | $I_C$ = 10A, $V_{CC}$ = 400V, $V_{GE}$ = 15V | 14, 16 |
| $t_r$ | Rise time | — | 16 | — | ns | $R_G$ = 22Ω, L = 1.0mH, $T_J$ = 175°C | CT 4 |
| $t_{d(off)}$ | Turn-Off delay time | — | 98 | — | | | WF 1,WF 2 |
| $t_f$ | Fall time | — | 33 | — | | | |
| $C_{ies}$ | Input Capacitance | — | 594 | — | pF | $V_{GE}$ = 0V | 22 |
| $C_{oes}$ | Output Capacitance | — | 49 | — | | $V_{CC}$ = 30V | |
| $C_{res}$ | Reverse Transfer Capacitance | — | 17 | — | | f = 1.0Mhz | |
| RBSOA | Reverse Bias Safe Operating Area | FULL SQUARE | | | | $T_J$ = 175°C, $I_C$ = 40A<br>$V_{CC}$ = 480V, Vp =600V<br>Rg = 22Ω, $V_{GE}$ = +15V to 0V | 4<br>CT 2 |
| SCSOA | Short Circuit Safe Operating Area | 5 | — | — | µs | $V_{CC}$ = 400V, Vp =600V<br>Rg = 22Ω, $V_{GE}$ = +15V to 0V | 22, CT 3<br>WF 4 |
| Erec | Reverse Recovery Energy of the Diode | — | 191 | — | µJ | $T_J$ = 175°C | 17, 18, 19 |
| $t_{rr}$ | Diode Reverse Recovery Time | — | 62 | — | ns | $V_{CC}$ = 400V, $I_F$ = 10A | 20,21 |
| $I_{rr}$ | Peak Reverse Recovery Current | — | 16 | — | A | $V_{GE}$ = 15V, Rg = 22Ω, L=1.0mH | WF 3 |

Notes:

① $V_{CC}$ = 80% ($V_{CES}$), $V_{GE}$ = 15V, L = 28 µH, $R_G$ = 22 Ω.

② Pulse width limited by max. junction temperature.

③ $R_\theta$ is measured at $T_J$ approximately 90°C

④ Refer to AN-1086 for guidelines for measuring $V_{(BR)CES}$ safely

⑤ Maximum limits are based on statistical sample size characterization

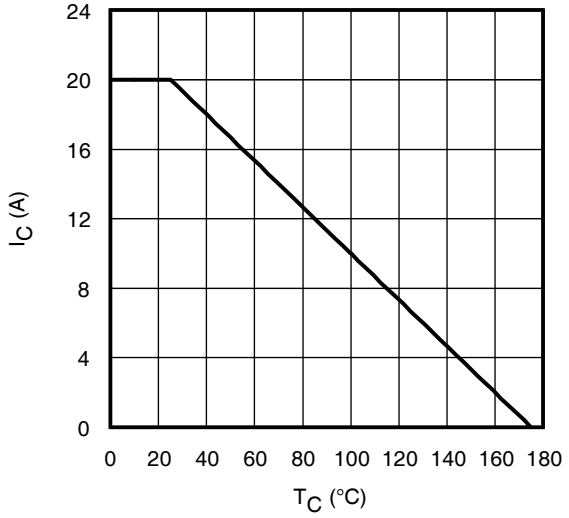



**Fig. 1** - Maximum DC Collector Current vs. Case Temperature

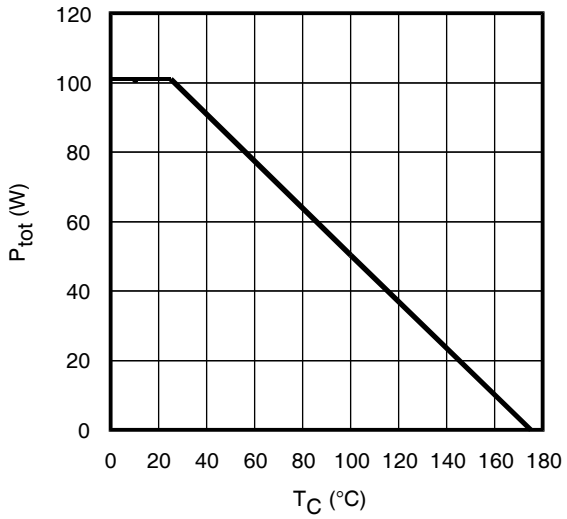



**Fig. 2** - Power Dissipation vs. Case Temperature

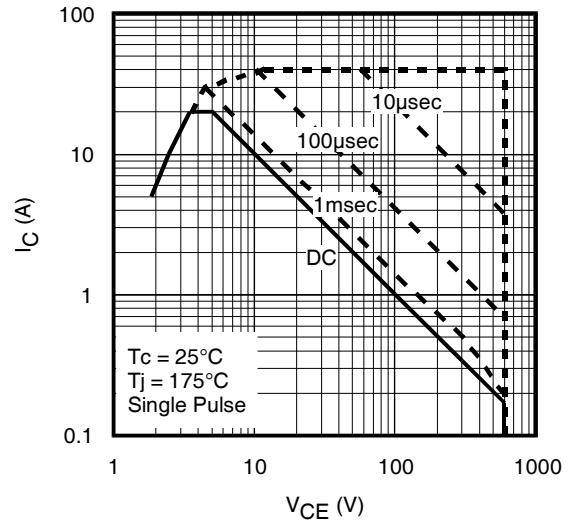



**Fig. 3** - Forward SOA,
$T_C$ = 25°C; $T_J \leq$ 175°C

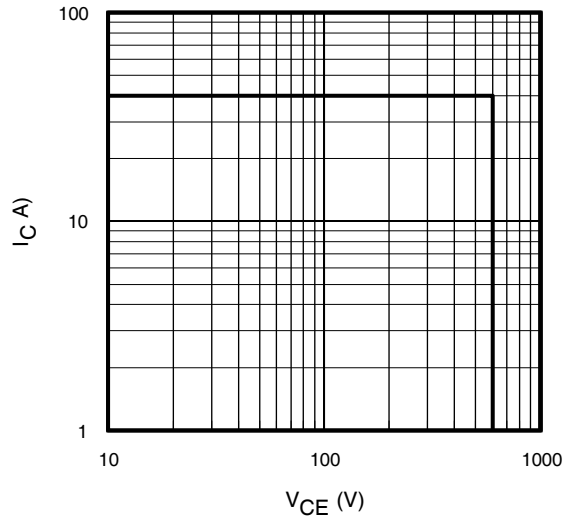



**Fig. 4** - Reverse Bias SOA
$T_J$ = 175°C; $V_{CE}$ = 15V

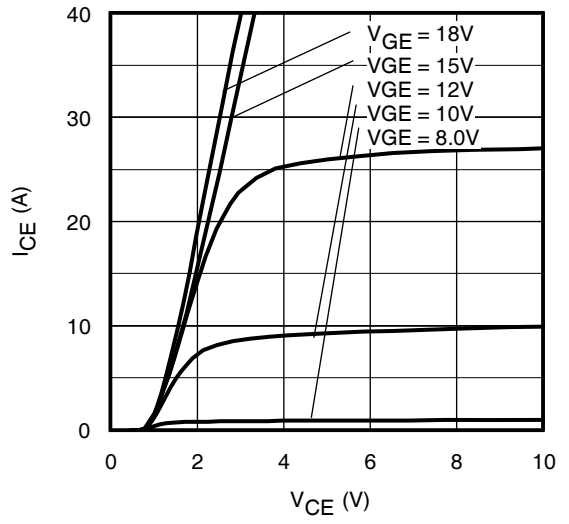



**Fig. 5** - Typ. IGBT Output Characteristics
$T_J$ = -40°C; tp = 80µs

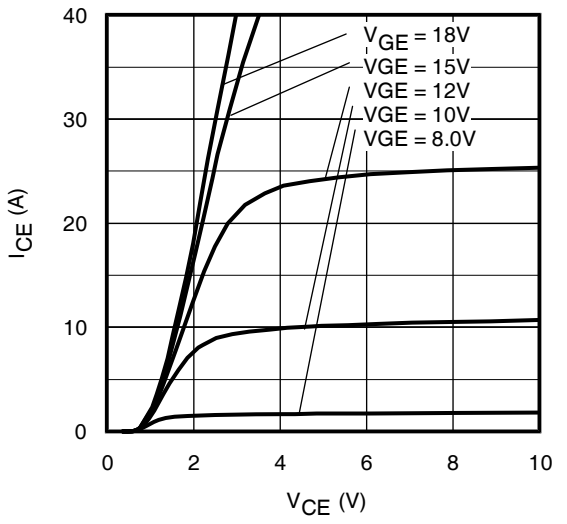



**Fig. 6** - Typ. IGBT Output Characteristics
$T_J$ = 25°C; tp = 80µs

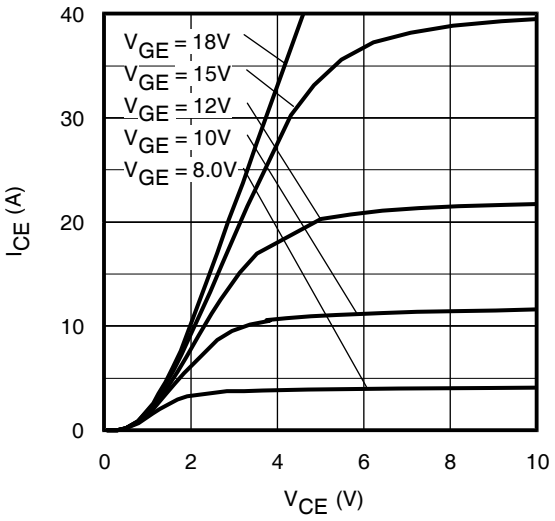



**Fig. 7** - Typ. IGBT Output Characteristics
$T_J$ = 175°C; tp = 80µs

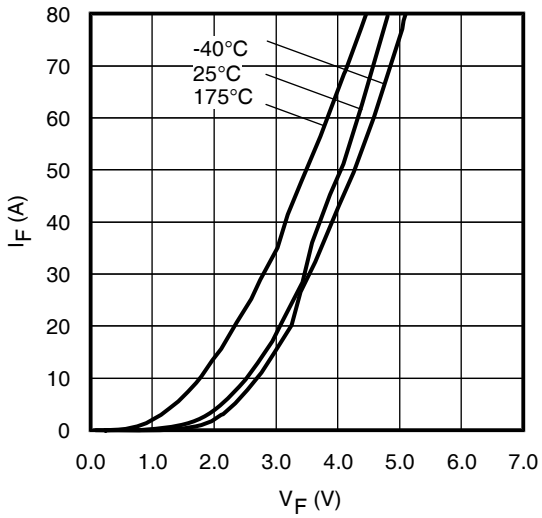



**Fig. 8** - Typ. Diode Forward Characteristics
tp = 80µs

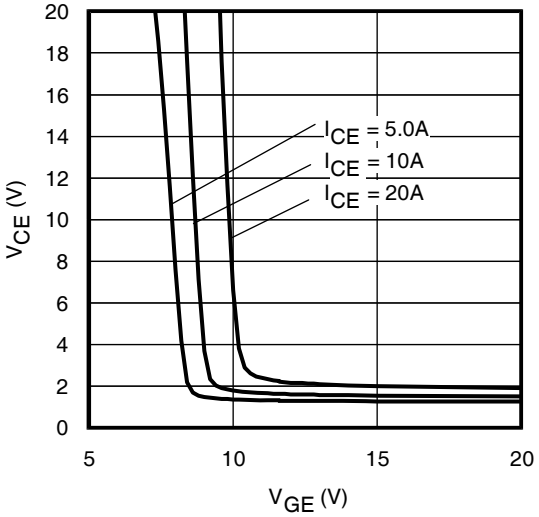



**Fig. 9** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J$ = -40°C

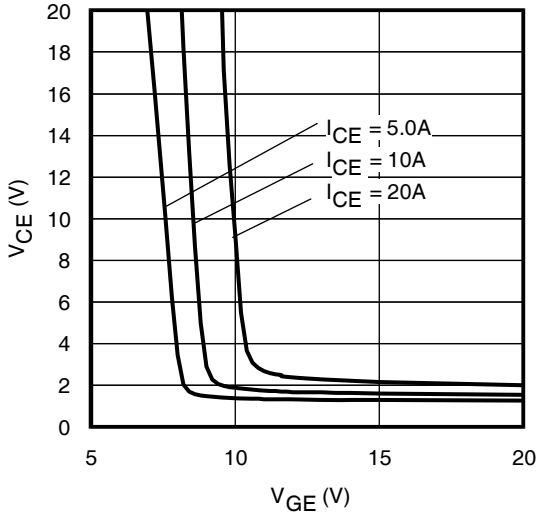



**Fig. 10** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J$ = 25°C

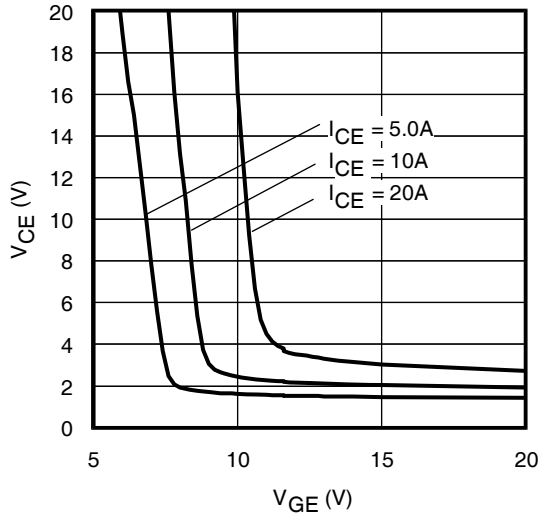



**Fig. 11** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J$ = 175°C

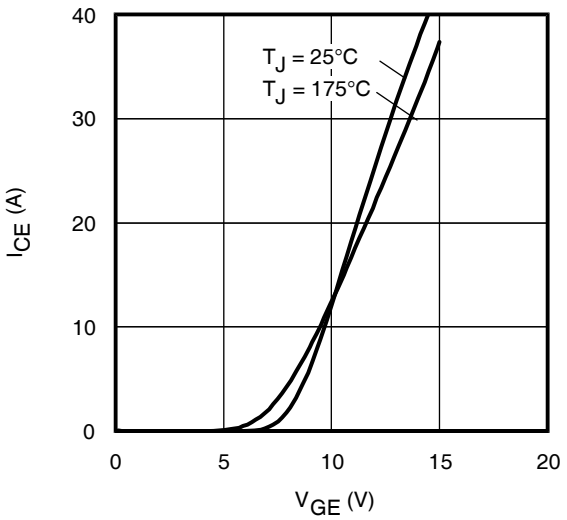



**Fig. 12** - Typ. Transfer Characteristics
$V_{CE}$ = 50V; tp = 10µs

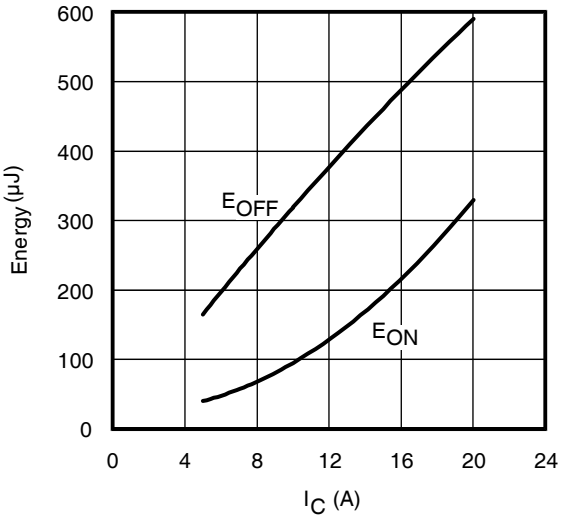



**Fig. 13** - Typ. Energy Loss vs. $I_C$
$T_J$ = 175°C; L = 1mH; $V_{CE}$ = 400V, $R_G$ = 22Ω; $V_{GE}$ = 15V.

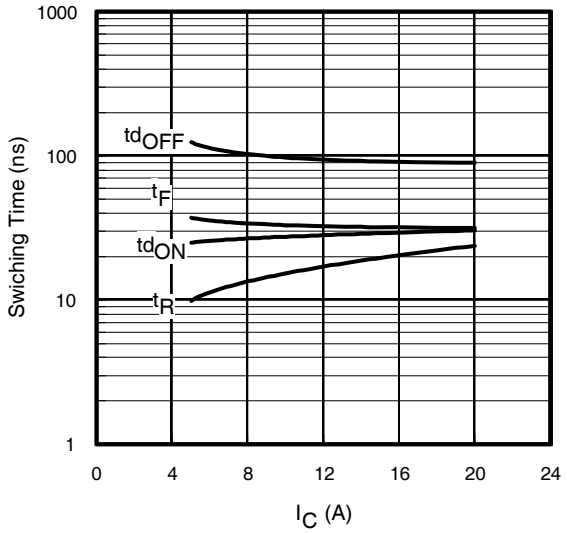



**Fig. 14** - Typ. Switching Time vs. $I_C$
$T_J$ = 175°C; L=1mH; $V_{CE}$= 400V
$R_G$= 22Ω; $V_{GE}$= 15V

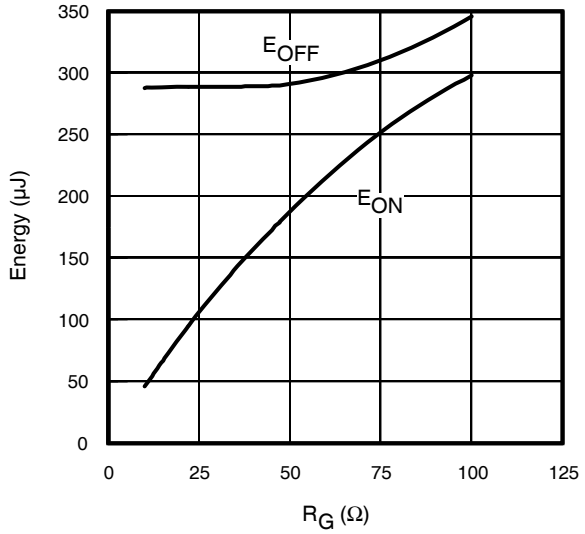



**Fig. 15** - Typ. Energy Loss vs. $R_G$
$T_J$ = 175°C; L = 1mH; $V_{CE}$ = 400V, $I_{CE}$ = 10A; $V_{GE}$ = 15V

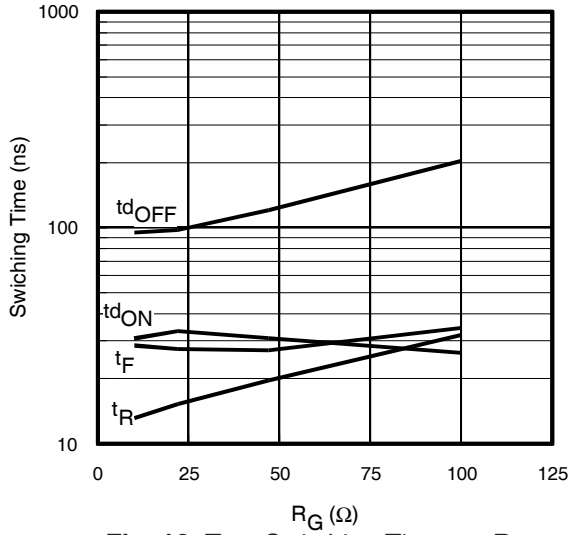



**Fig. 16**- Typ. Switching Time vs. $R_G$
$T_J$ = 175°C; L=1mH; $V_{CE}$= 400V
$I_{CE}$= 10A; $V_{GE}$= 15V

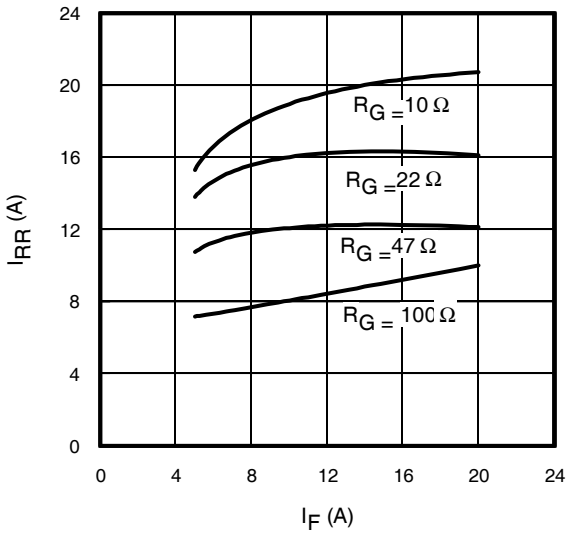



**Fig. 17** - Typical Diode $I_{RR}$ vs. $I_F$
$T_J$ = 175°C

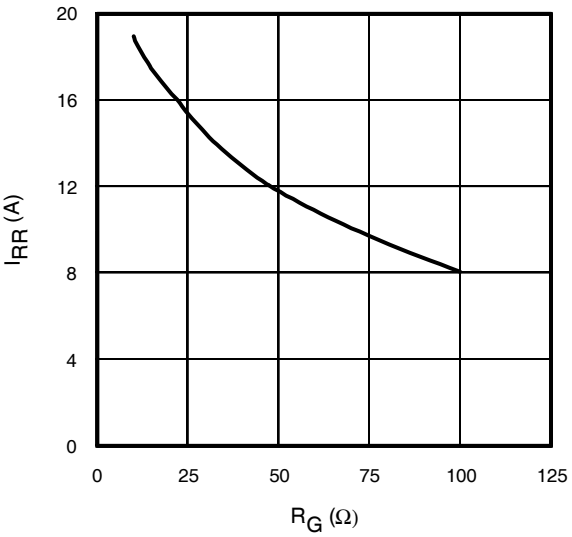



**Fig. 18** - Typical Diode $I_{RR}$ vs. $R_G$
$T_J$ = 175°C; $I_F$ = 10A

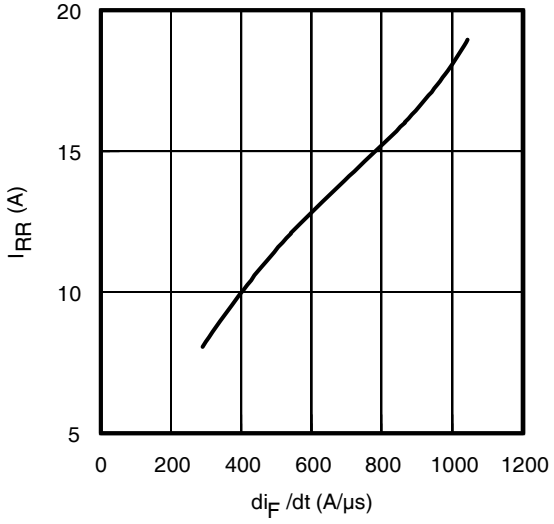



**Fig. 19**- Typical Diode $I_{RR}$ vs. $di_F/dt$
$V_{CC}$= 400V; $V_{GE}$= 15V;
$I_{CE}$= 10A; $T_J$ = 175°C

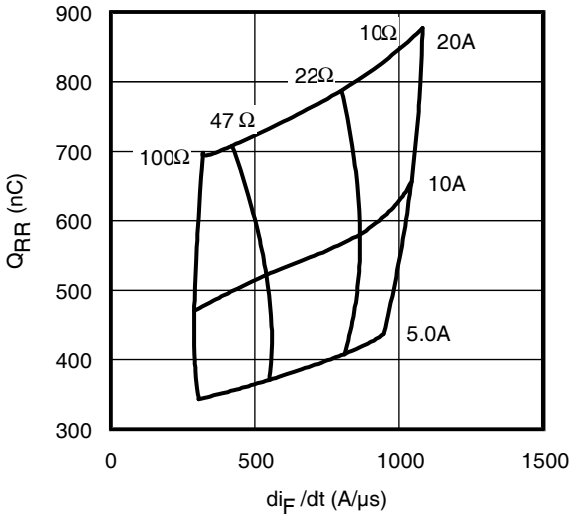



**Fig. 20** - Typical Diode $Q_{RR}$
$V_{CC}$= 400V; $V_{GE}$= 15V; $T_J$ = 175°C

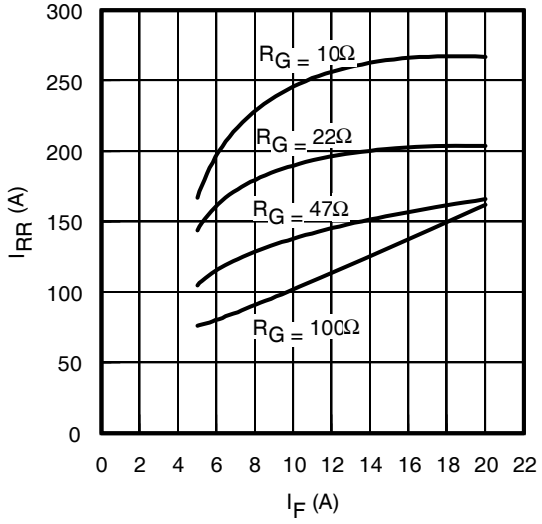



**Fig. 21** - Typical Diode $E_{RR}$ vs. $I_F$
$T_J$ = 175°C

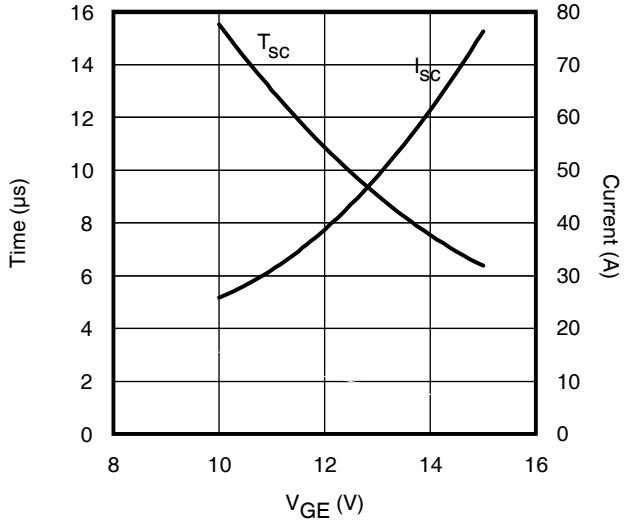



**Fig. 22**- Typ. $V_{GE}$ vs Short Circuit Time
$V_{CC}$=400V, $T_C$ =25°C

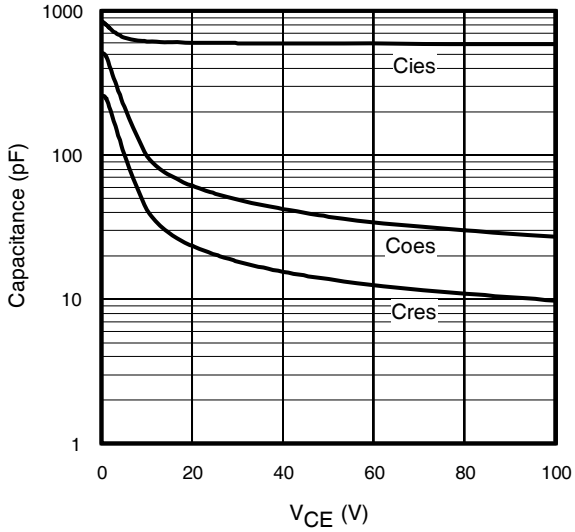



**Fig. 23**- Typ. Capacitance vs. $V_{CE}$
$V_{GE}$= 0V; f = 1MHz

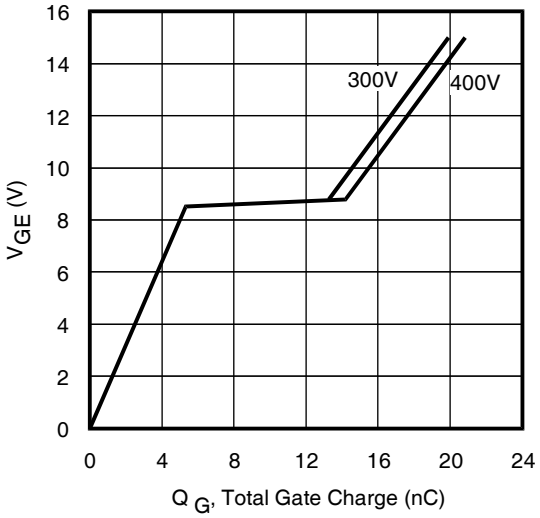



**Fig. 24** - Typical Gate Charge vs. $V_{GE}$
$I_{CE}$ = 10A, L=600µH

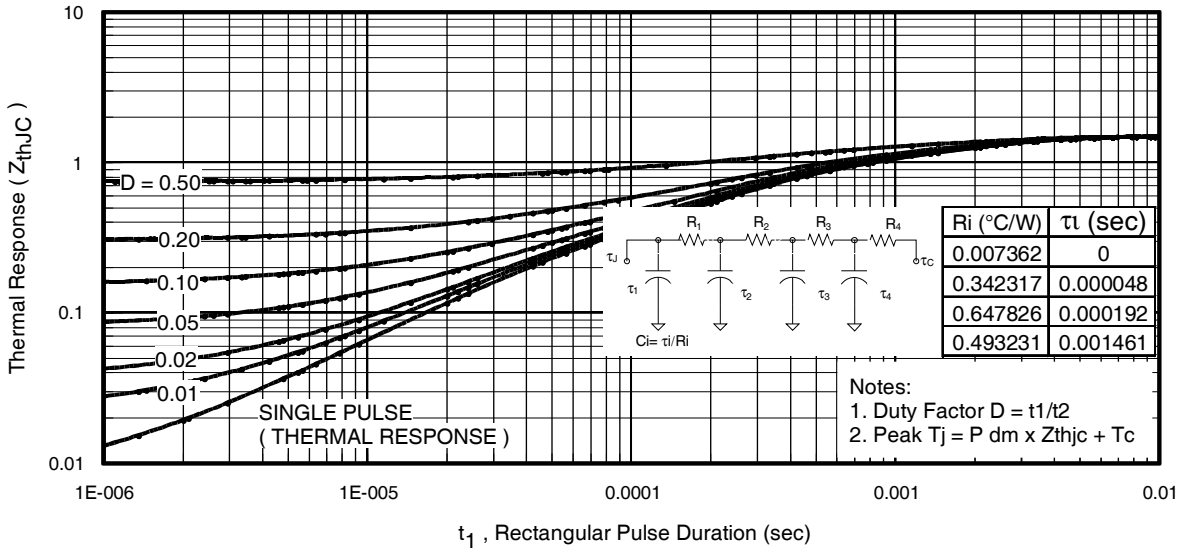



**Fig 25.** Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

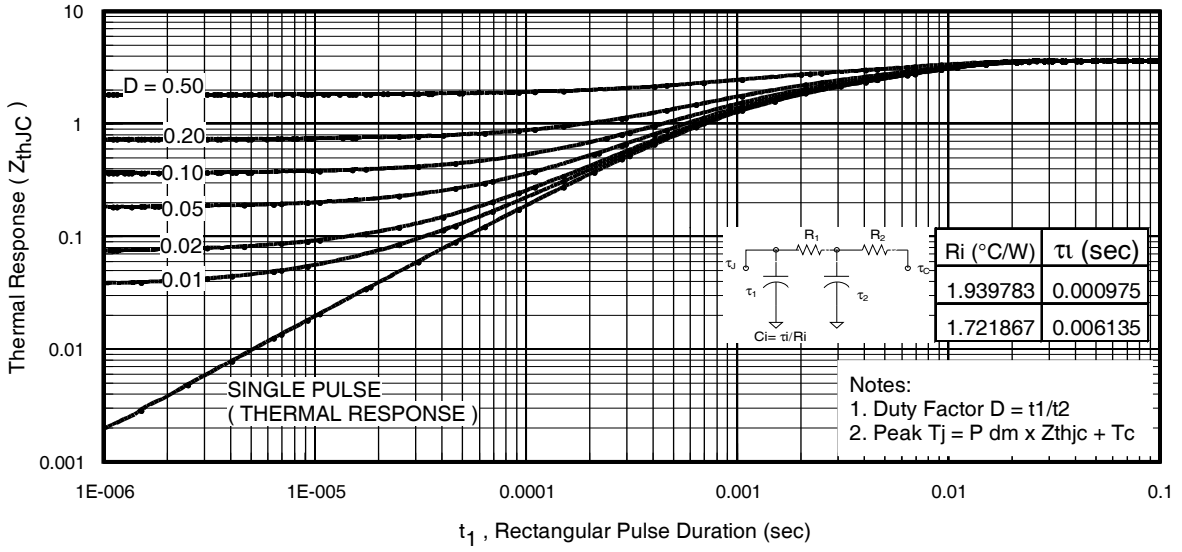



**Fig. 26.** Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

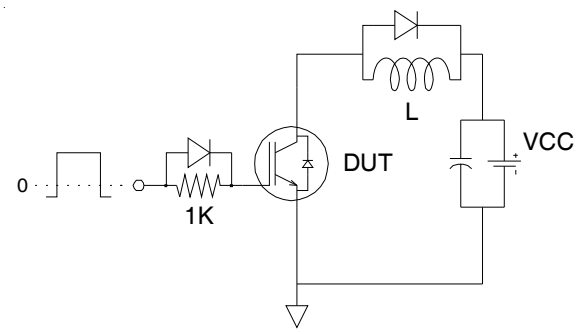



**Fig.C.T.1** - Gate Charge Circuit (turn-off)

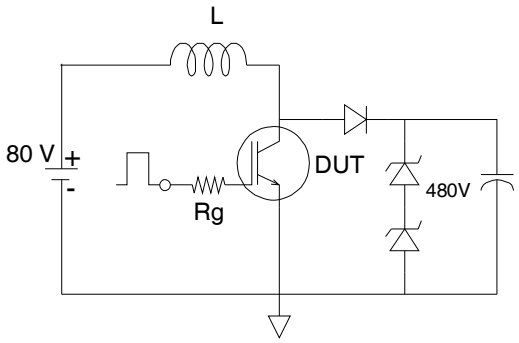



**Fig.C.T.2** - RBSOA Circuit

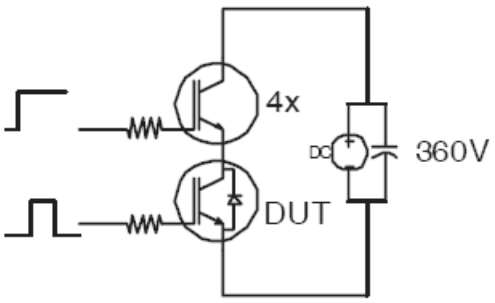



**Fig.C.T.3** - S.C.SOA Circuit

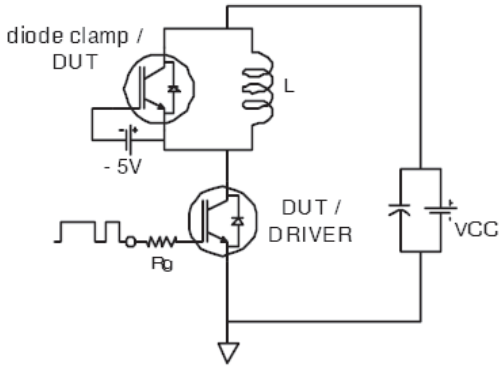



**Fig.C.T.4** - Switching Loss Circuit

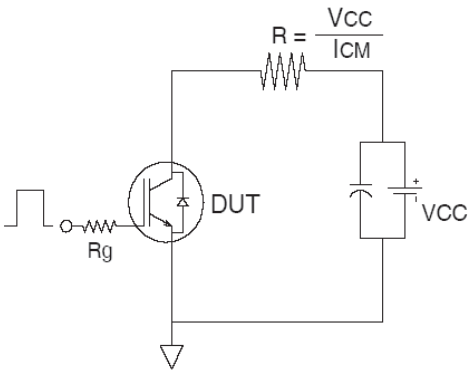



**Fig.C.T.5** - Resistive Load Circuit

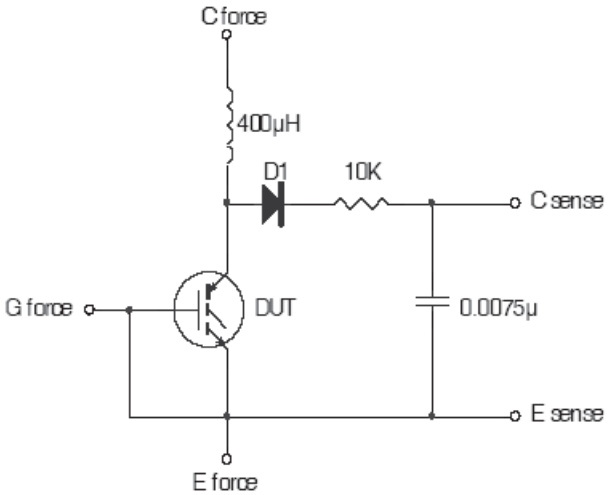



**Fig.C.T.6** - Typical Filter Circuit for $V_{(BR)CES}$ Measurement

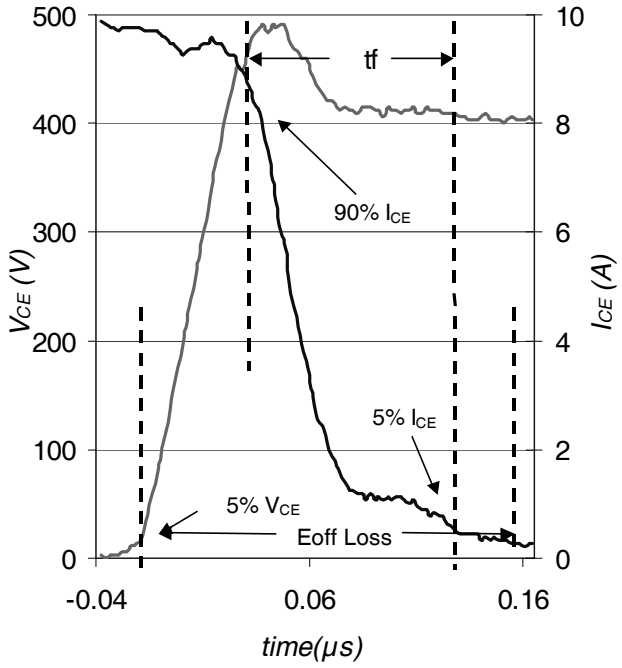



**Fig. WF1** - Typ. Turn-off Loss Waveform
@ $T_J$ = 175°C using Fig. CT.4

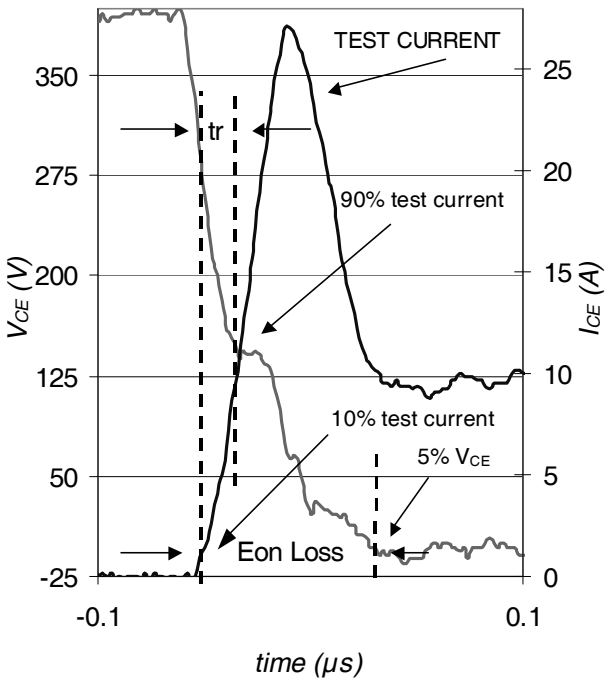
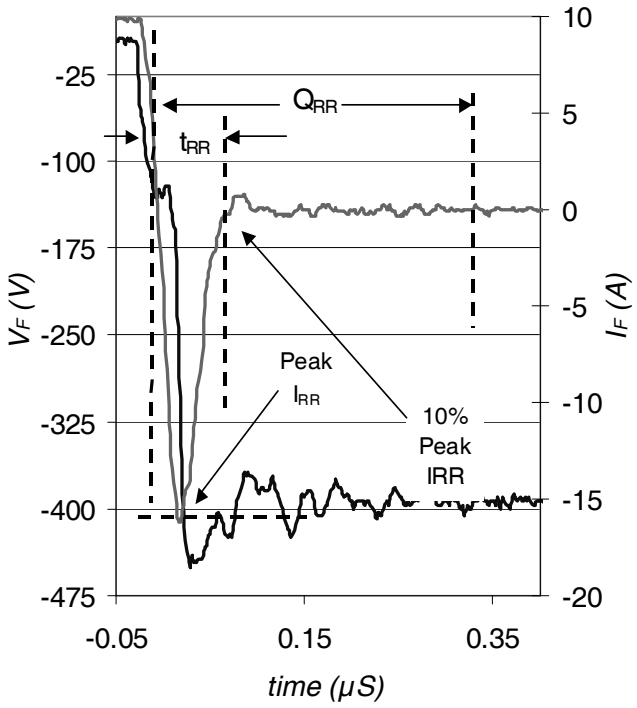
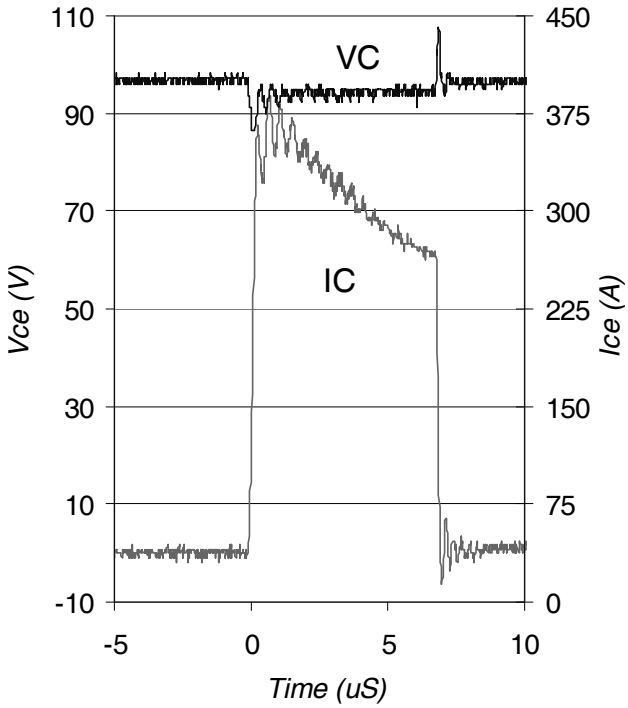



**Fig. WF2** - Typ. Turn-on Loss Waveform
@ $T_J$ = 175°C using Fig. CT.4

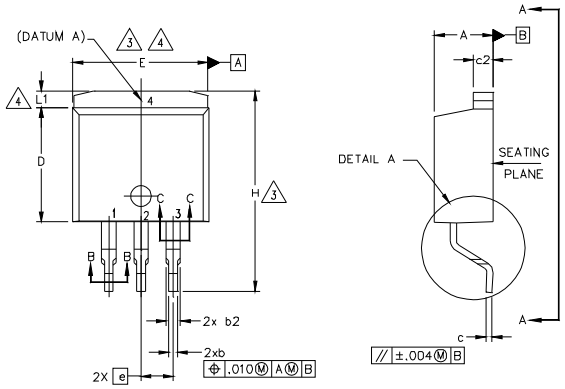


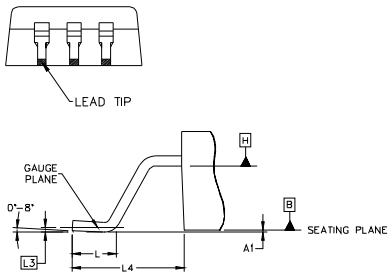

WF.3- Typ. Reverse Recovery Waveform
@ $T_J$ = 175°C using CT.4

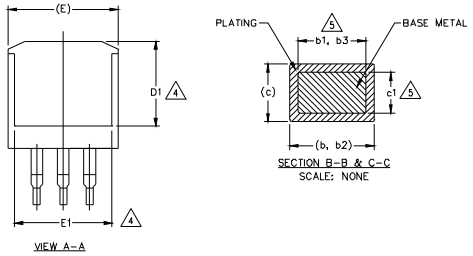



WF.4- Typ. Short Circuit Waveform
@ $T_J$ = 25°C using CT.3

## 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 AT DATUM H.
4. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
5. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
6. DATUM A & B TO BE DETERMINED AT DATUM PLANE H.
7. CONTROLLING DIMENSION: INCH.
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-263AB.

| SYMBOL | DIMENSIONS | | | | NOTES |
|---|---|---|---|---|---|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.06 | 4.83 | .160 | .190 | |
| A1 | – | 0.254 | – | .010 | |
| b | 0.51 | 0.99 | .020 | .039 | |
| b1 | 0.51 | 0.89 | .020 | .035 | 5 |
| b2 | 1.14 | 1.78 | .045 | .070 | |
| b3 | 1.14 | 1.73 | .045 | .068 | 5 |
| c | 0.38 | 0.74 | .015 | .029 | |
| c1 | 0.38 | 0.58 | .015 | .023 | 5 |
| c2 | 1.14 | 1.65 | .045 | .065 | |
| D | 8.38 | 9.65 | .330 | .380 | 3 |
| D1 | 6.86 | – | .270 | | 4 |
| E | 9.65 | 10.67 | .380 | .420 | 3,4 |
| E1 | 6.22 | – | .245 | | 4 |
| e | 2.54 BSC | | .100 BSC | | |
| H | 14.61 | 15.88 | .575 | .625 | |
| L | 1.78 | 2.79 | .070 | .110 | |
| L1 | – | 1.65 | – | .066 | 4 |
| L3 | 0.25 BSC | | .010 BSC | | |
| L4 | 4.78 | 5.28 | .188 | .208 | |

LEAD ASSIGNMENTS

HEXFET

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

IGBTs, CoPACK

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

DIODES

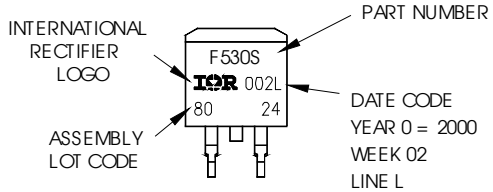
1.- ANODE *
2, 4.- CATHODE
3.- ANODE

* PART DEPENDENT.

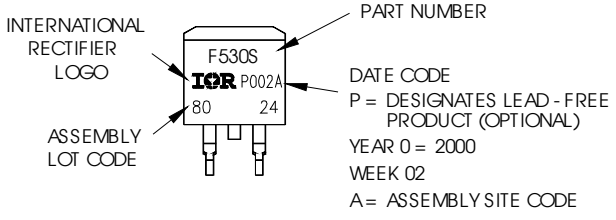
## D²Pak Part Marking Information

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

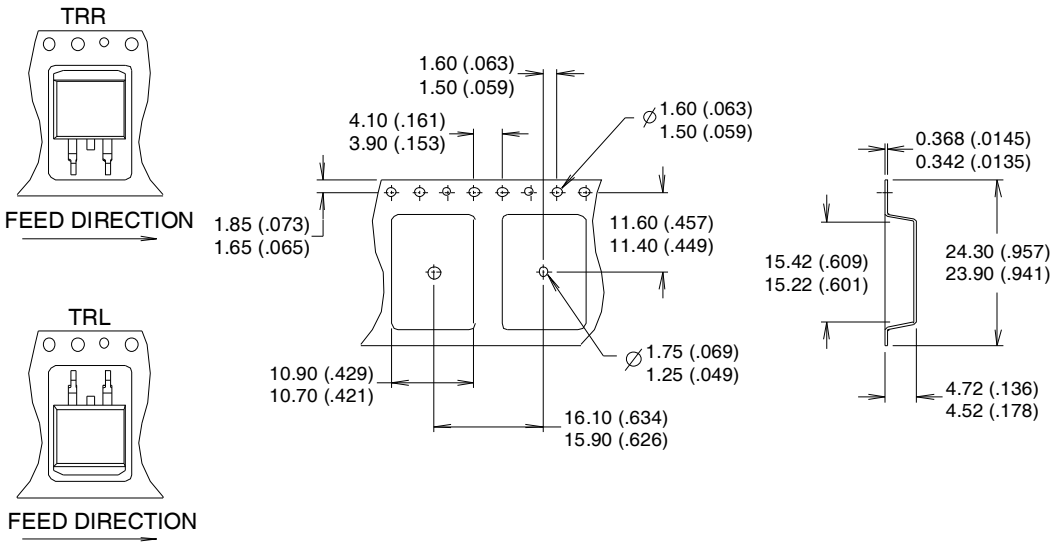
Note: "P" in assembly line position
indicates "Lead – Free"

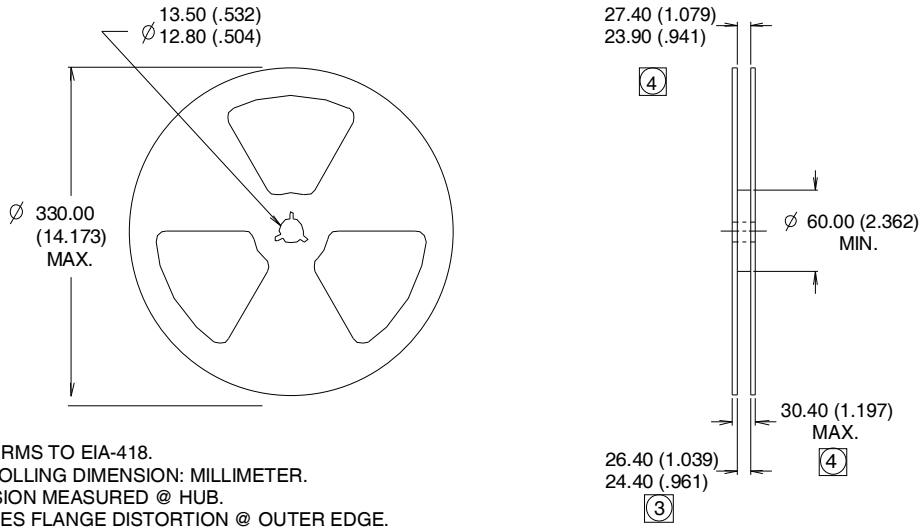



OR



## D$^2$Pak Tape & Reel Information




NOTES :
1. COMFORMS TO EIA-418.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION MEASURED @ HUB.
4. INCLUDES FLANGE DISTORTION @ OUTER EDGE.



International
IOR Rectifier

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