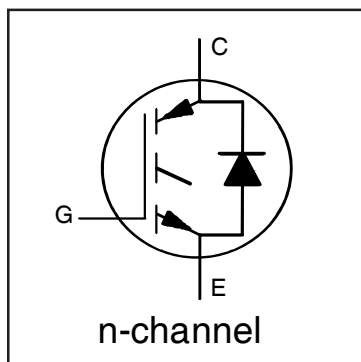


# IRGB4061DPbF

## INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

### Features

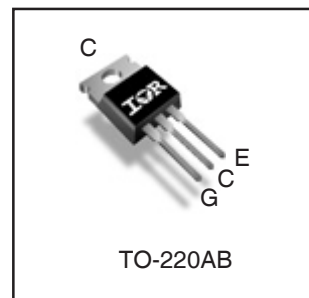
- Low  $V_{CE(ON)}$  Trench IGBT Technology
- Low switching losses
- Maximum Junction temperature 175 °C
- 5  $\mu$ S short circuit SOA
- Square RBSOA
- 100% of the parts tested for 4X rated current ( $I_{LM}$ )
- Positive  $V_{CE(ON)}$  Temperature co-efficient
- Ultra fast soft Recovery Co-Pak Diode
- Tight parameter distribution
- Lead Free Package



|                                                |
|------------------------------------------------|
| $V_{CES} = 600V$                               |
| $I_C = 18A, T_C = 100^\circ C$                 |
| $t_{SC} \geq 5\mu s, T_{J(max)} = 175^\circ C$ |
| $V_{CE(on)} \text{ typ.} = 1.65V$              |

### 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 Voltage       | 600                               | V          |
| $I_C @ T_C = 25^\circ C$  | Continuous Collector Current       | 36                                | A          |
| $I_C @ T_C = 100^\circ C$ | Continuous Collector Current       | 18                                |            |
| $I_{CM}$                  | Pulse Collector Current            | 72                                |            |
| $I_{LM}$                  | Clamped Inductive Load Current ①   | 72                                |            |
| $I_F @ T_C = 25^\circ C$  | Diode Continuous Forward Current   | 36                                |            |
| $I_F @ T_C = 100^\circ C$ | Diode Continuous Forward Current   | 18                                |            |
| $I_{FM}$                  | Diode Maximum Forward Current ③    | 72                                | V          |
| $V_{GE}$                  | Continuous Gate-to-Emitter Voltage | $\pm 20$                          |            |
|                           | Transient Gate-to-Emitter Voltage  | $\pm 30$                          | W          |
| $P_D @ T_C = 25^\circ C$  | Maximum Power Dissipation          | 206                               |            |
| $P_D @ T_C = 100^\circ C$ | Maximum Power Dissipation          | 103                               | $^\circ C$ |
| $T_J$                     | Operating Junction and             | -55 to +175                       |            |
| $T_{STG}$                 | Storage Temperature Range          |                                   |            |
|                           | Soldering Temperature, for 10 sec. | 300 (0.063 in. (1.6mm) from case) |            |
|                           | Mounting Torque, 6-32 or M3 Screw  | 10 lbf-in (1.1 N-m)               |            |

### Thermal Resistance

|                         | Parameter                                                      | Min. | Typ. | Max. | Units        |
|-------------------------|----------------------------------------------------------------|------|------|------|--------------|
| $R_{\theta JC}$ (IGBT)  | Thermal Resistance Junction-to-Case-(each IGBT)                | —    | —    | 0.73 | $^\circ C/W$ |
| $R_{\theta JC}$ (Diode) | Thermal Resistance Junction-to-Case-(each Diode)               | —    | —    | 2.00 |              |
| $R_{\theta CS}$         | Thermal Resistance, Case-to-Sink (flat, greased surface)       | —    | 0.50 | —    |              |
| $R_{\theta JA}$         | Thermal Resistance, Junction-to-Ambient (typical socket mount) | —    | 80   | —    |              |

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

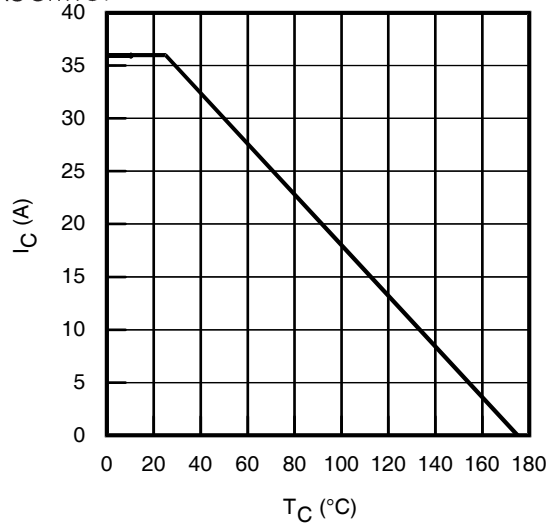
|                                 | Parameter                               | Min. | Typ. | Max.      | Units                | Conditions                                                                   | Ref.Fig |
|---------------------------------|-----------------------------------------|------|------|-----------|----------------------|------------------------------------------------------------------------------|---------|
| $V_{(BR)CES}$                   | Collector-to-Emitter Breakdown Voltage  | 600  | —    | —         | V                    | $V_{GE} = 0V, I_C = 100\mu A$ ④                                              | CT6     |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage | —    | 0.40 | —         | V/ $^\circ\text{C}$  | $V_{GE} = 0V, I_C = 1mA$ (25 $^\circ\text{C}$ -175 $^\circ\text{C}$ )        | CT6     |
| $V_{CE(on)}$                    | Collector-to-Emitter Saturation Voltage | —    | 1.65 | 1.95      | V                    | $I_C = 18A, V_{GE} = 15V, T_J = 25^\circ\text{C}$                            | 5,6,7   |
|                                 |                                         | —    | 2.05 | —         |                      | $I_C = 18A, V_{GE} = 15V, T_J = 150^\circ\text{C}$                           | 9,10,11 |
|                                 |                                         | —    | 2.15 | —         |                      | $I_C = 18A, V_{GE} = 15V, T_J = 175^\circ\text{C}$                           |         |
| $V_{GE(th)}$                    | Gate Threshold Voltage                  | 4.0  | —    | 6.5       | V                    | $V_{CE} = V_{GE}, I_C = 500\mu A$                                            | 9, 10,  |
| $\Delta V_{GE(th)}/\Delta T_J$  | Threshold Voltage temp. coefficient     | —    | -18  | —         | mV/ $^\circ\text{C}$ | $V_{CE} = V_{GE}, I_C = 1.0mA$ (25 $^\circ\text{C}$ - 175 $^\circ\text{C}$ ) | 11, 12  |
| $g_{fe}$                        | Forward Transconductance                | —    | 12   | —         | S                    | $V_{CE} = 50V, I_C = 18A, PW = 80\mu s$                                      |         |
| $I_{CES}$                       | Collector-to-Emitter Leakage Current    | —    | 2.0  | 25        | $\mu A$              | $V_{GE} = 0V, V_{CE} = 600V$                                                 |         |
|                                 |                                         | —    | 550  | —         |                      | $V_{GE} = 0V, V_{CE} = 600V, T_J = 175^\circ\text{C}$                        |         |
| $V_{FM}$                        | Diode Forward Voltage Drop              | —    | 2.30 | 3.30      | V                    | $I_F = 18A$                                                                  | 8       |
|                                 |                                         | —    | 1.6  | —         |                      | $I_F = 18A, T_J = 175^\circ\text{C}$                                         |         |
| $I_{GES}$                       | Gate-to-Emitter Leakage Current         | —    | —    | $\pm 100$ | nA                   | $V_{GE} = \pm 20V$                                                           |         |

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

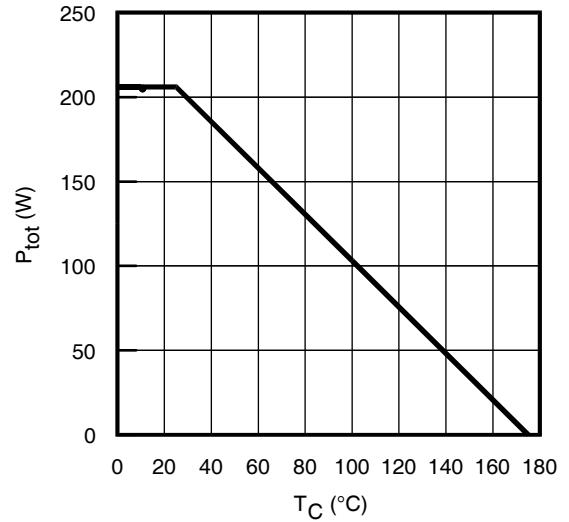
|              | Parameter                            | Min.        | Typ. | Max. | Units   | Conditions                                                                                                   | Ref.Fig        |
|--------------|--------------------------------------|-------------|------|------|---------|--------------------------------------------------------------------------------------------------------------|----------------|
| $Q_g$        | Total Gate Charge (turn-on)          | —           | 35   | 55   | nC      | $I_C = 18A$                                                                                                  | 24             |
| $Q_{ge}$     | Gate-to-Emitter Charge (turn-on)     | —           | 10   | 15   |         | $V_{GE} = 15V$                                                                                               | CT1            |
| $Q_{gc}$     | Gate-to-Collector Charge (turn-on)   | —           | 15   | 25   |         | $V_{CC} = 400V$                                                                                              |                |
| $E_{on}$     | Turn-On Switching Loss               | —           | 95   | 140  | $\mu J$ | $I_C = 18A, V_{CC} = 400V, V_{GE} = 15V$                                                                     | CT4            |
| $E_{off}$    | Turn-Off Switching Loss              | —           | 350  | 405  |         | $R_G = 22\Omega, L = 200\mu H, L_S = 150nH$                                                                  |                |
| $E_{total}$  | Total Switching Loss                 | —           | 445  | 545  |         | Energy losses include tail & diode reverse recovery                                                          |                |
| $t_{d(on)}$  | Turn-On delay time                   | —           | 40   | 55   | ns      | $I_C = 18A, V_{CC} = 400V, V_{GE} = 15V$                                                                     | CT4            |
| $t_r$        | Rise time                            | —           | 25   | 35   |         | $R_G = 22\Omega, L = 200\mu H, L_S = 150nH$                                                                  |                |
| $t_{d(off)}$ | Turn-Off delay time                  | —           | 105  | 120  |         |                                                                                                              |                |
| $t_f$        | Fall time                            | —           | 25   | 35   |         |                                                                                                              |                |
| $E_{on}$     | Turn-On Switching Loss               | —           | 285  | —    | $\mu J$ | $I_C = 18A, V_{CC} = 400V, V_{GE} = 15V$                                                                     | 13, 15         |
| $E_{off}$    | Turn-Off Switching Loss              | —           | 570  | —    |         | $R_G = 22\Omega, L = 200\mu H, L_S = 150nH, T_J = 175^\circ\text{C}$ ④                                       | CT4            |
| $E_{total}$  | Total Switching Loss                 | —           | 855  | —    |         | Energy losses include tail & diode reverse recovery                                                          | WF1, WF2       |
| $t_{d(on)}$  | Turn-On delay time                   | —           | 40   | —    | ns      | $I_C = 18A, V_{CC} = 400V, V_{GE} = 15V$                                                                     | 14, 16         |
| $t_r$        | Rise time                            | —           | 25   | —    |         | $R_G = 22\Omega, L = 200\mu H, L_S = 150nH$                                                                  | CT4            |
| $t_{d(off)}$ | Turn-Off delay time                  | —           | 120  | —    |         | $T_J = 175^\circ\text{C}$                                                                                    | WF1            |
| $t_f$        | Fall time                            | —           | 40   | —    |         |                                                                                                              | WF2            |
| $C_{ies}$    | Input Capacitance                    | —           | 1043 | —    | pF      | $V_{GE} = 0V$                                                                                                | 23             |
| $C_{oes}$    | Output Capacitance                   | —           | 87   | —    |         | $V_{CC} = 30V$                                                                                               |                |
| $C_{res}$    | Reverse Transfer Capacitance         | —           | 32   | —    |         | $f = 1.0MHz$                                                                                                 |                |
| RBSOA        | Reverse Bias Safe Operating Area     | FULL SQUARE |      |      |         | $T_J = 175^\circ\text{C}, I_C = 72A$<br>$V_{CC} = 480V, V_p = 600V$<br>$R_G = 22\Omega, V_{GE} = +15V$ to 0V | 4<br>CT2       |
| SCSOA        | Short Circuit Safe Operating Area    | 5           | —    | —    | $\mu s$ | $V_{CC} = 400V, V_p = 600V$<br>$R_G = 22\Omega, V_{GE} = +15V$ to 0V                                         | 22, CT3<br>WF4 |
| $E_{rec}$    | Reverse Recovery Energy of the Diode | —           | 260  | —    | $\mu J$ | $T_J = 175^\circ\text{C}$                                                                                    | 17, 18, 19     |
| $t_{rr}$     | Diode Reverse Recovery Time          | —           | 100  | —    | ns      | $V_{CC} = 400V, I_F = 18A$                                                                                   | 20, 21         |
| $I_{rr}$     | Peak Reverse Recovery Current        | —           | 23   | —    | A       | $V_{GE} = 15V, R_G = 22\Omega, L = 200\mu H, L_S = 150nH$                                                    | WF3            |

**Notes:**

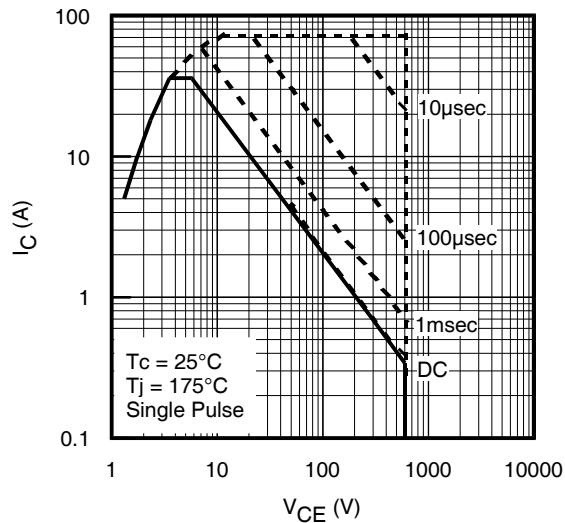
- ①  $V_{CC} = 80\% (V_{CES}), V_{GE} = 20V, L = 100\mu H, R_G = 22\Omega$ .  
 ② This is only applied to TO-220AB package.  
 ③ Pulse width limited by max. junction temperature.  
 ④ Refer to AN-1086 for guidelines for measuring  $V_{(BR)CES}$  safely.



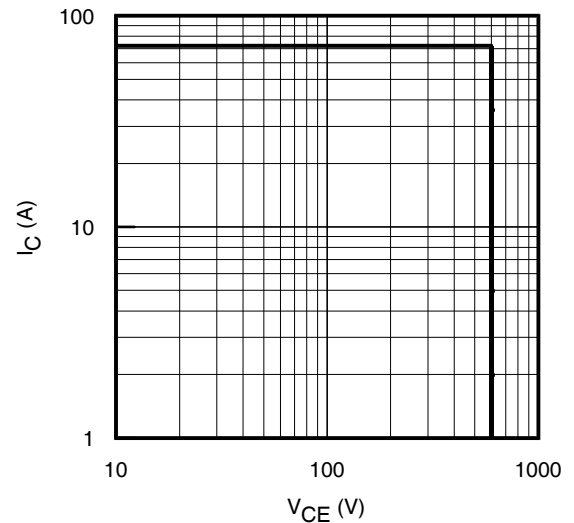
**Fig. 1** - Maximum DC Collector Current vs. Case Temperature



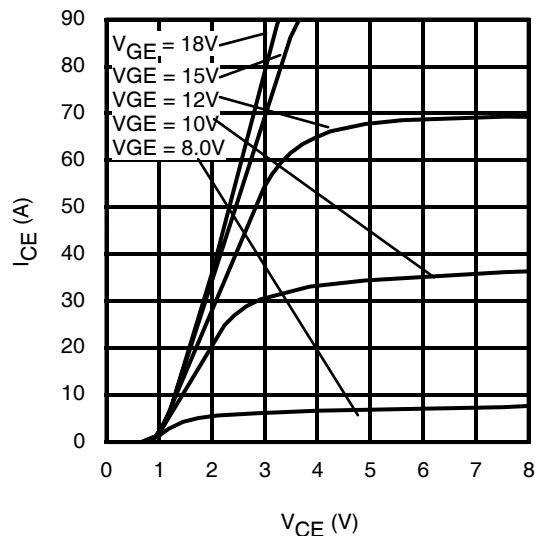
**Fig. 2** - Power Dissipation vs. Case Temperature



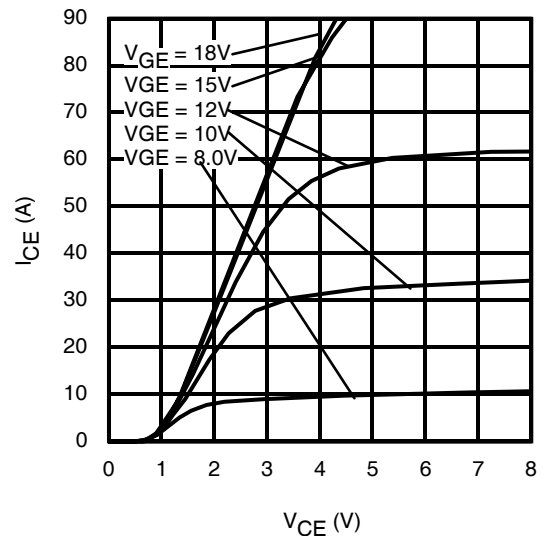
**Fig. 3** - Forward SOA  
 $T_C = 25^\circ\text{C}$ ,  $T_J \leq 175^\circ\text{C}$ ;  $V_{GE} = 15\text{V}$



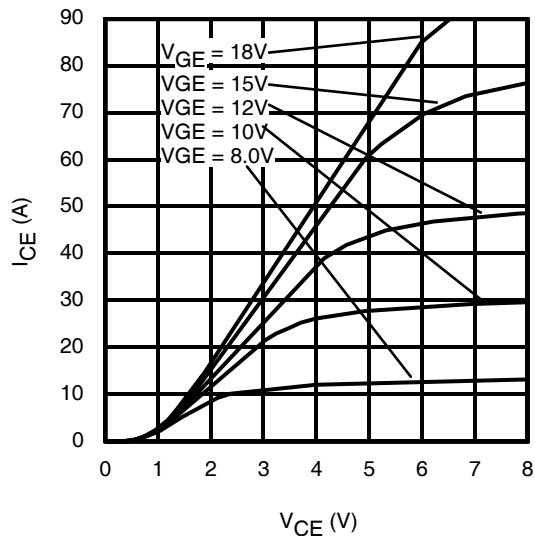
**Fig. 4** - Reverse Bias SOA  
 $T_J = 175^\circ\text{C}$ ;  $V_{GE} = 15\text{V}$



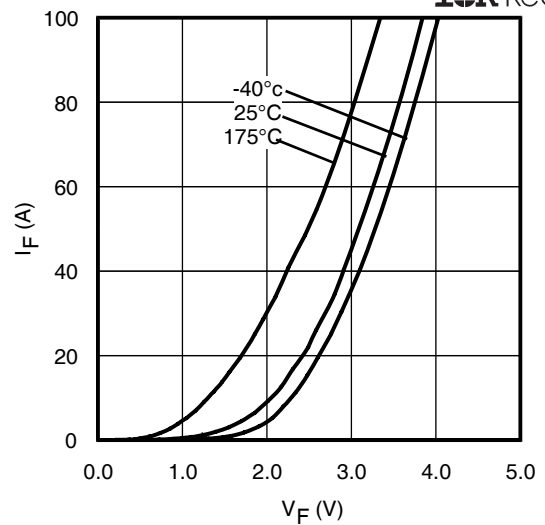
**Fig. 5** - Typ. IGBT Output Characteristics  
 $T_J = -40^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$



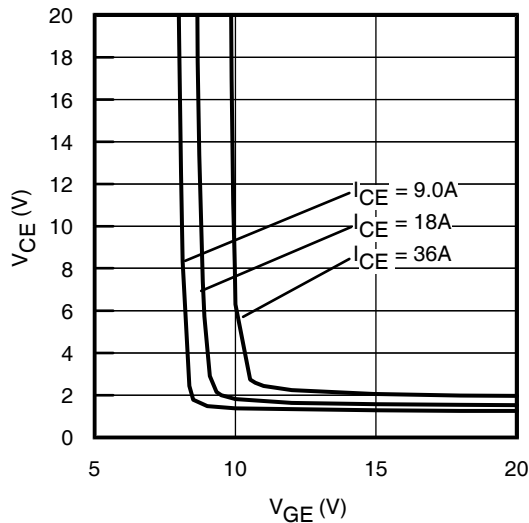
**Fig. 6** - Typ. IGBT Output Characteristics  
 $T_J = 25^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$



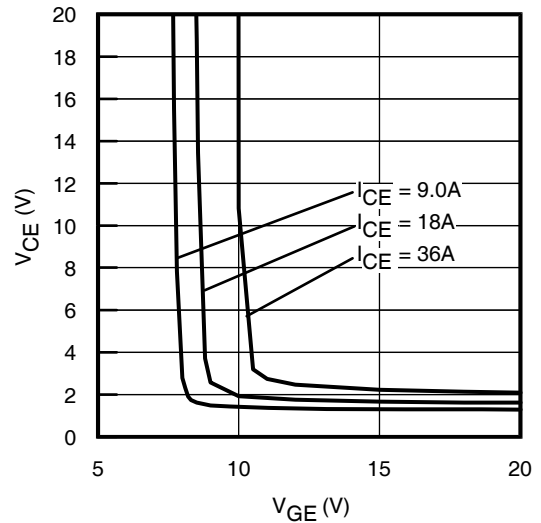
**Fig. 7** - Typ. IGBT Output Characteristics  
 $T_J = 175^\circ\text{C}$ ;  $t_p = 80\mu\text{s}$



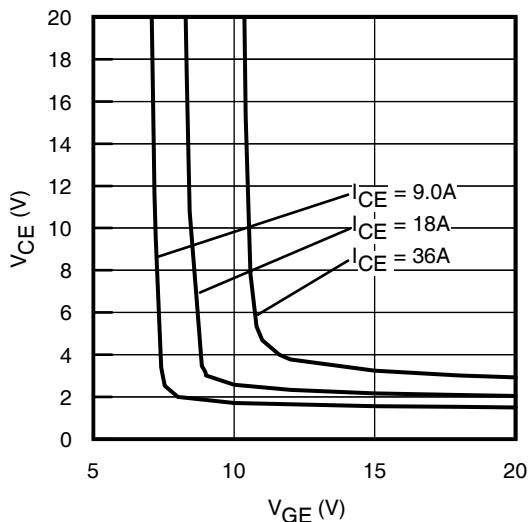
**Fig. 8** - Typ. Diode Forward Characteristics  
 $t_p = 80\mu\text{s}$



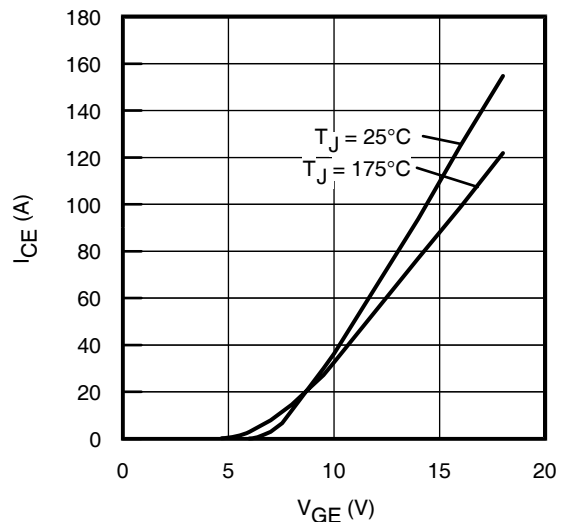
**Fig. 9** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = -40^\circ\text{C}$



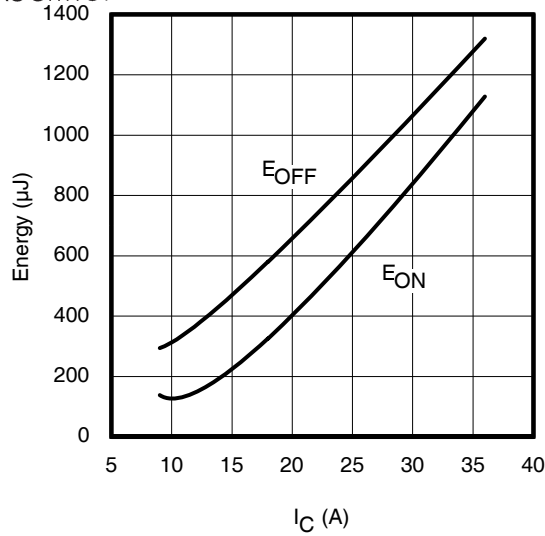
**Fig. 10** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 25^\circ\text{C}$



**Fig. 11** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 175^\circ\text{C}$

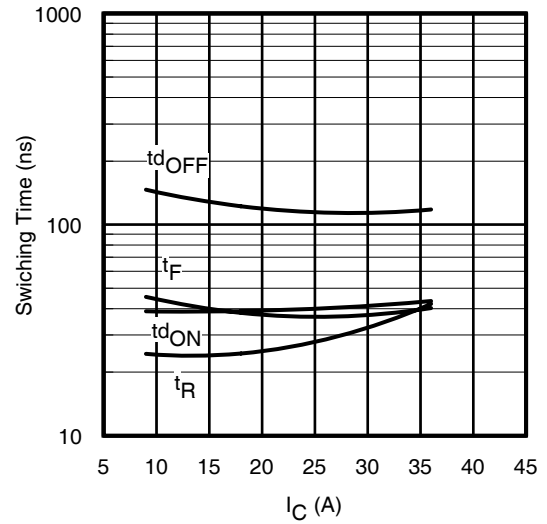


**Fig. 12** - Typ. Transfer Characteristics  
 $V_{CE} = 50\text{V}$ ;  $t_p = 10\mu\text{s}$



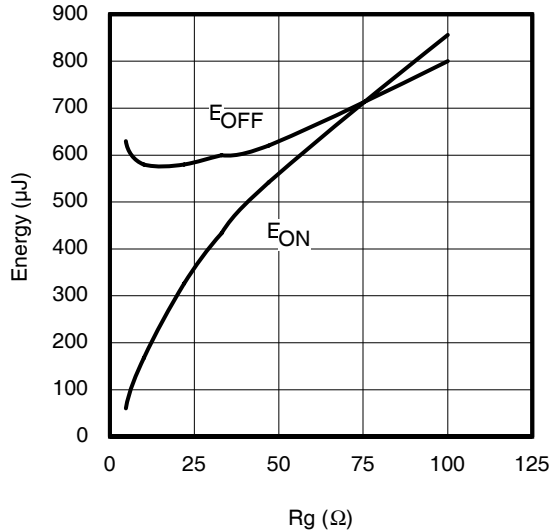
**Fig. 13** - Typ. Energy Loss vs.  $I_C$

$T_J = 175^\circ\text{C}$ ;  $L = 200\mu\text{H}$ ;  $V_{CE} = 400\text{V}$ ;  $R_G = 22\Omega$ ;  $V_{GE} = 15\text{V}$



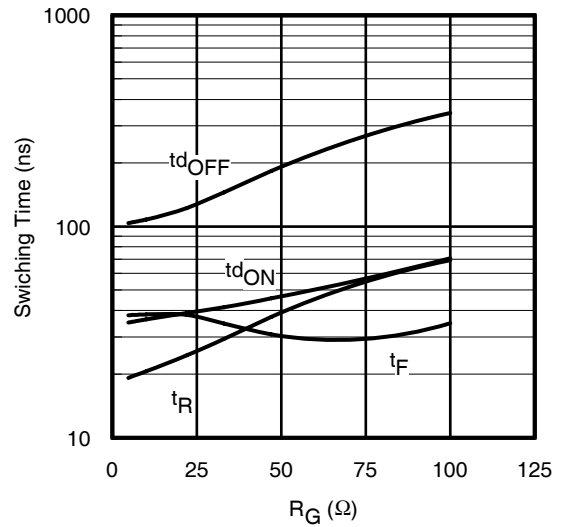
**Fig. 14** - Typ. Switching Time vs.  $I_C$

$T_J = 175^\circ\text{C}$ ;  $L = 200\mu\text{H}$ ;  $V_{CE} = 400\text{V}$ ;  $R_G = 22\Omega$ ;  $V_{GE} = 15\text{V}$



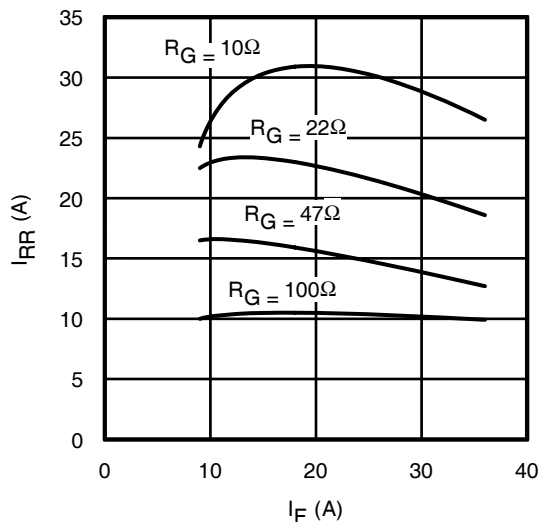
**Fig. 15** - Typ. Energy Loss vs.  $R_G$

$T_J = 175^\circ\text{C}$ ;  $L = 200\mu\text{H}$ ;  $V_{CE} = 400\text{V}$ ;  $I_{CE} = 18\text{A}$ ;  $V_{GE} = 15\text{V}$



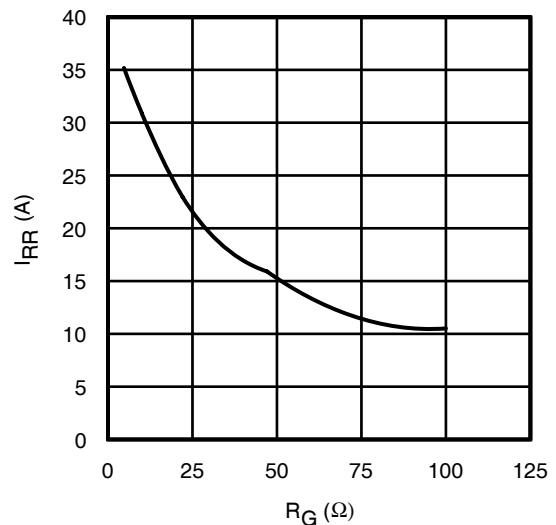
**Fig. 16** - Typ. Switching Time vs.  $R_G$

$T_J = 175^\circ\text{C}$ ;  $L = 200\mu\text{H}$ ;  $V_{CE} = 400\text{V}$ ;  $I_{CE} = 18\text{A}$ ;  $V_{GE} = 15\text{V}$



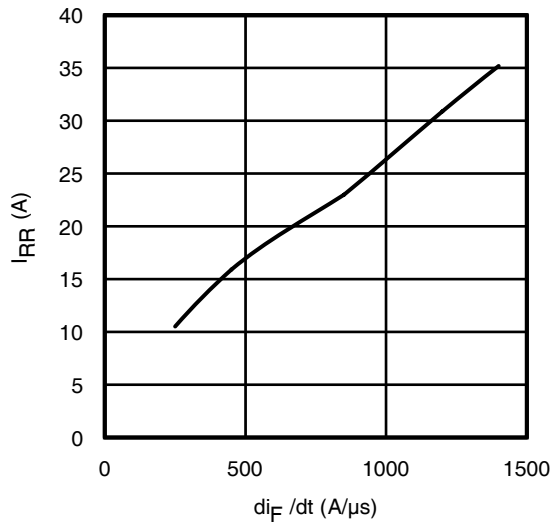
**Fig. 17** - Typ. Diode  $I_{RR}$  vs.  $I_F$

$T_J = 175^\circ\text{C}$

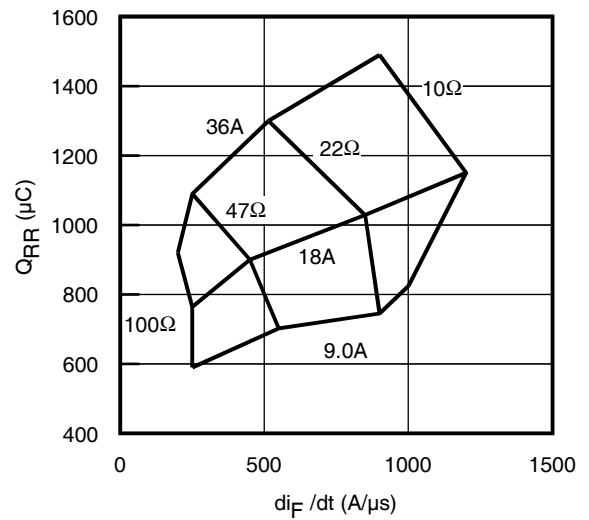


**Fig. 18** - Typ. Diode  $I_{RR}$  vs.  $R_G$

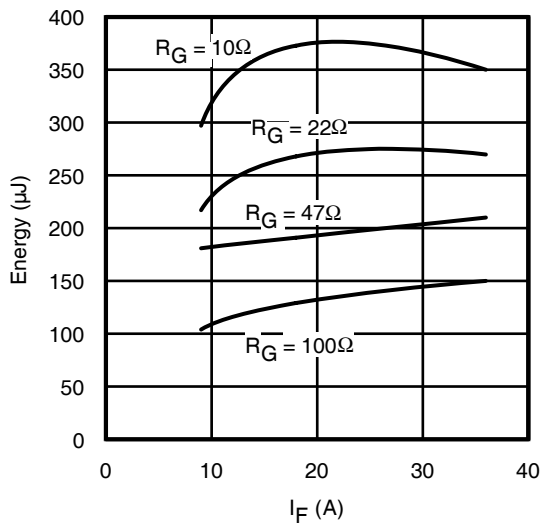
$T_J = 175^\circ\text{C}$



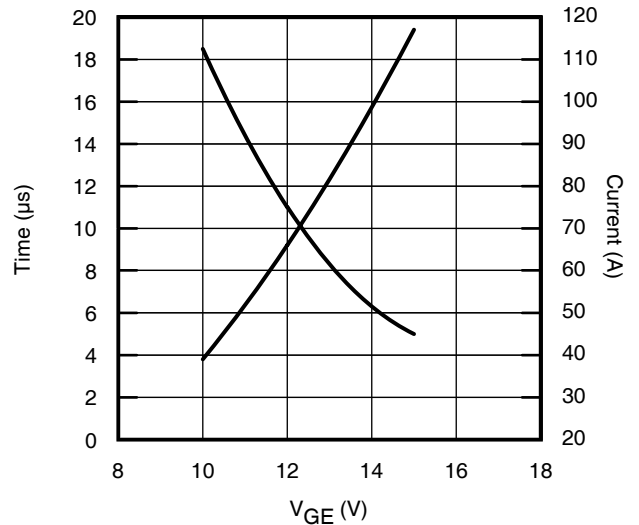
**Fig. 19** - Typ. Diode  $I_{RR}$  vs.  $di_F/dt$   
 $V_{CC} = 400V$ ;  $V_{GE} = 15V$ ;  $I_F = 18A$ ;  $T_J = 175^\circ C$



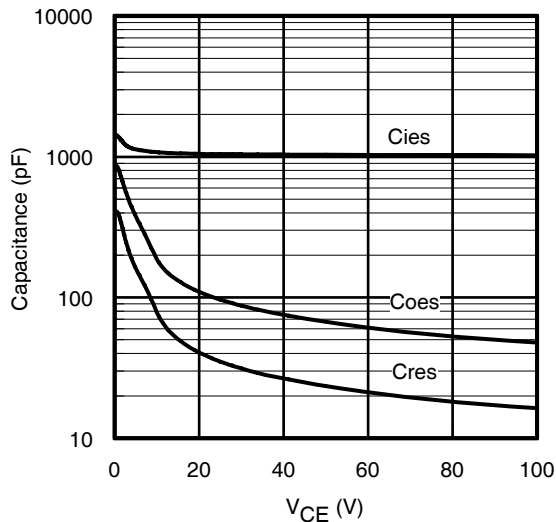
**Fig. 20** - Typ. Diode  $Q_{RR}$  vs.  $di_F/dt$   
 $V_{CC} = 400V$ ;  $V_{GE} = 15V$ ;  $T_J = 175^\circ C$



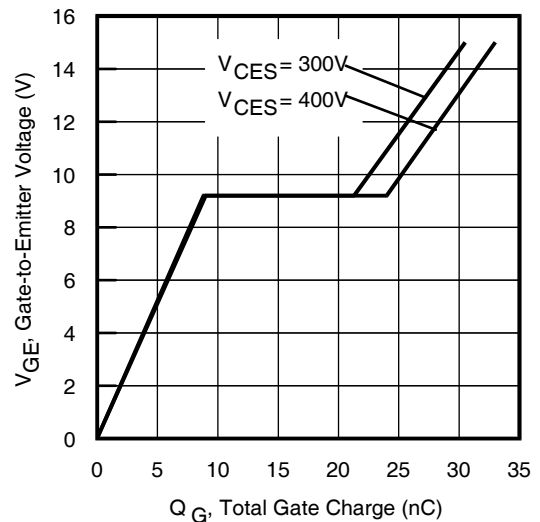
**Fig. 21** - Typ. Diode  $E_{RR}$  vs.  $I_F$   
 $T_J = 175^\circ C$



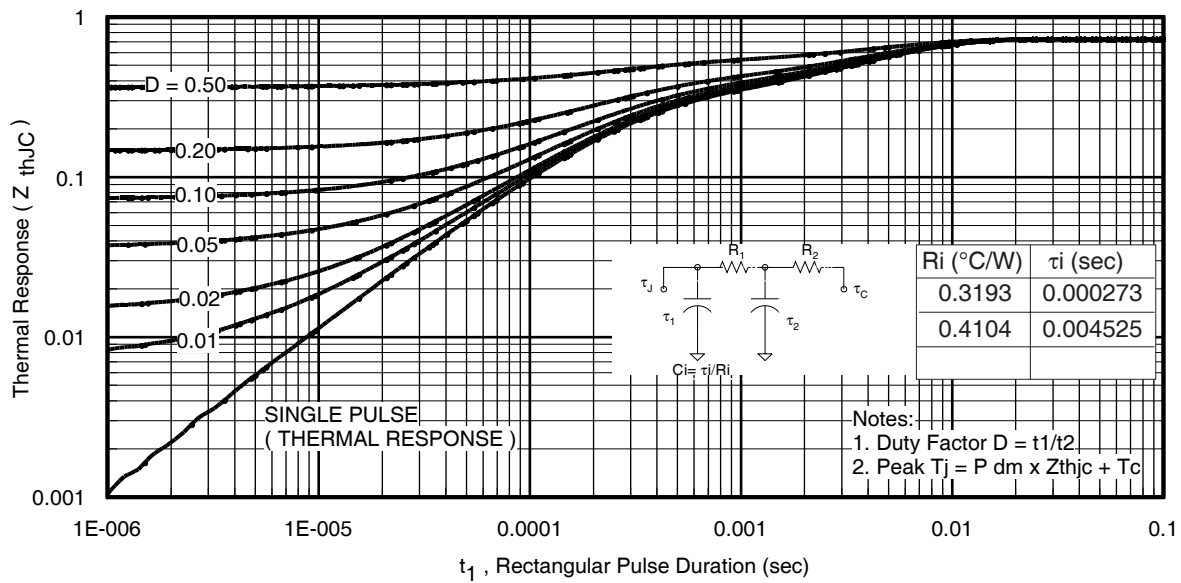
**Fig. 22** -  $V_{GE}$  vs. Short Circuit Time  
 $V_{CC} = 400V$ ;  $T_C = 25^\circ C$



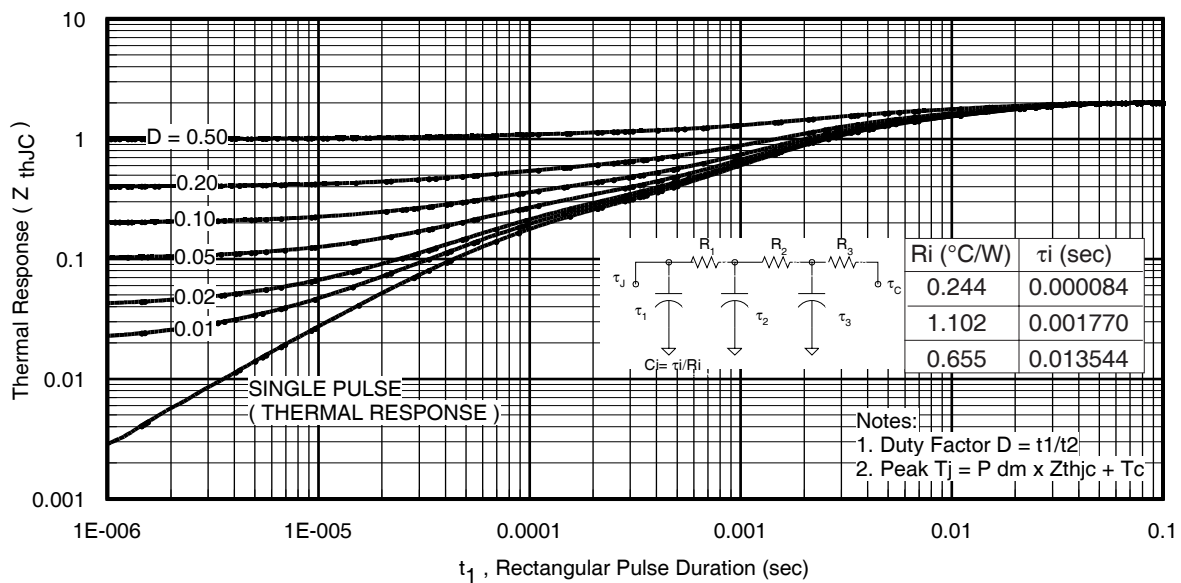
**Fig. 23** - Typ. Capacitance vs.  $V_{CE}$   
 $V_{GE} = 0V$ ;  $f = 1MHz$



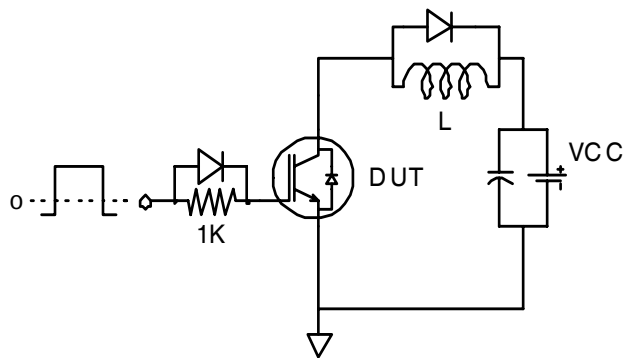
**Fig. 24** - Typical Gate Charge vs.  $V_{GE}$   
 $I_{CE} = 18A$ ;  $L = 600\mu H$



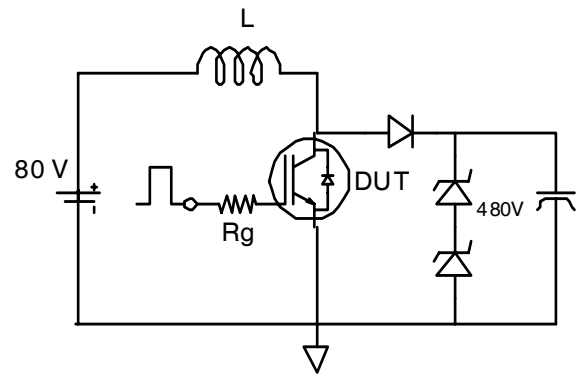
**Fig 25.** Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)



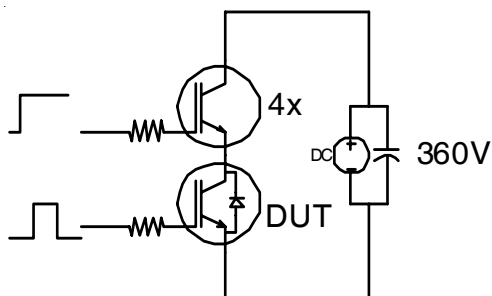
**Fig. 26.** Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)



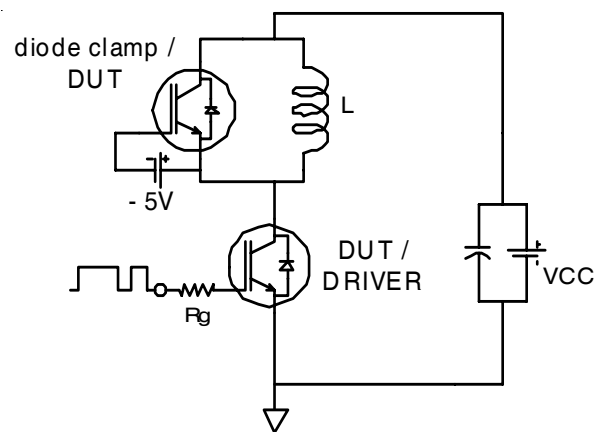
**Fig.C.T.1** - Gate Charge Circuit (turn-off)



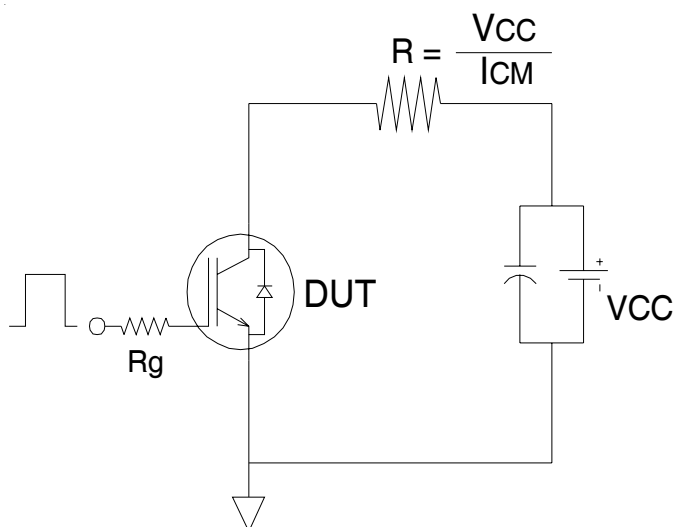
**Fig.C.T.2** - RBSOA Circuit



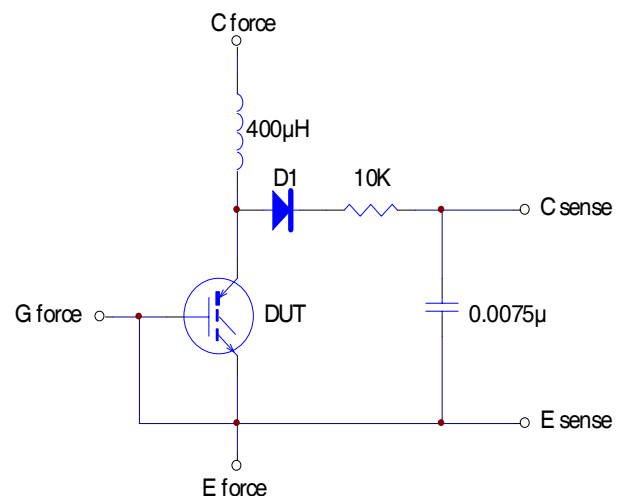
**Fig.C.T.3** - S.C. SOA Circuit



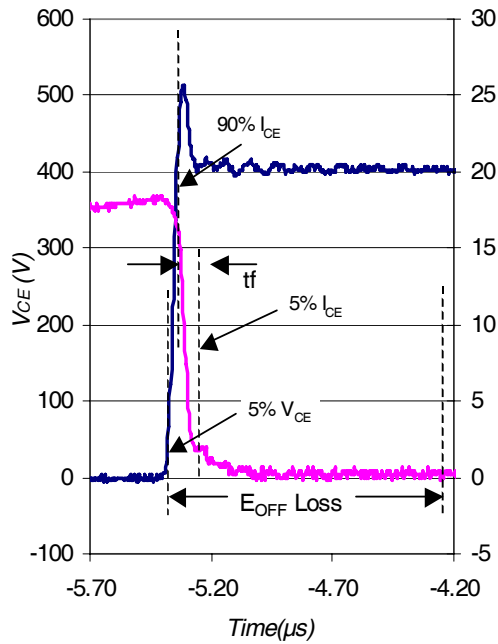
**Fig.C.T.4** - Switching Loss Circuit



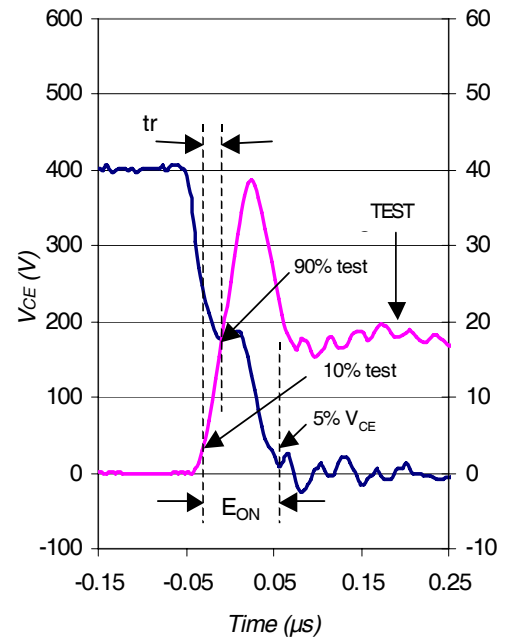
**Fig.C.T.5** - Resistive Load Circuit



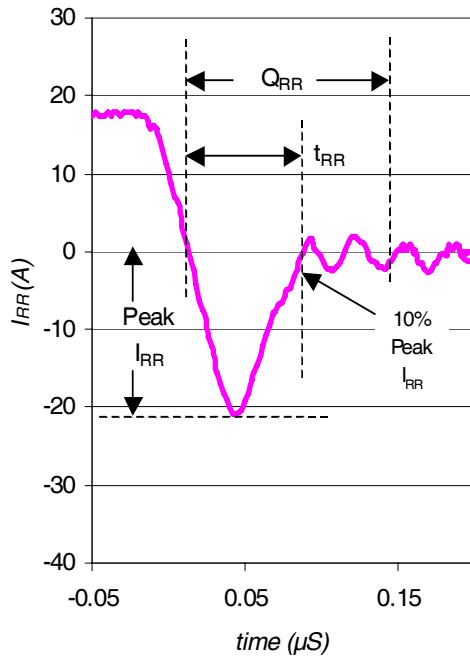
**Fig.C.T.6** - BVCES Filter Circuit



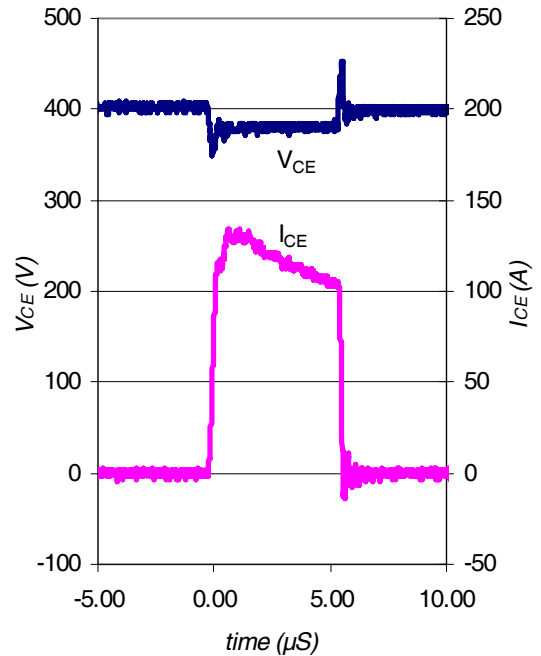
**Fig. WF1** - Typ. Turn-off Loss Waveform  
@  $T_J = 175^\circ\text{C}$  using Fig. CT.4



**Fig. WF2** - Typ. Turn-on Loss Waveform  
@  $T_J = 175^\circ\text{C}$  using Fig. CT.4



**Fig. WF3** - Typ. Diode Recovery Waveform  
@  $T_J = 175^\circ\text{C}$  using Fig. CT.4

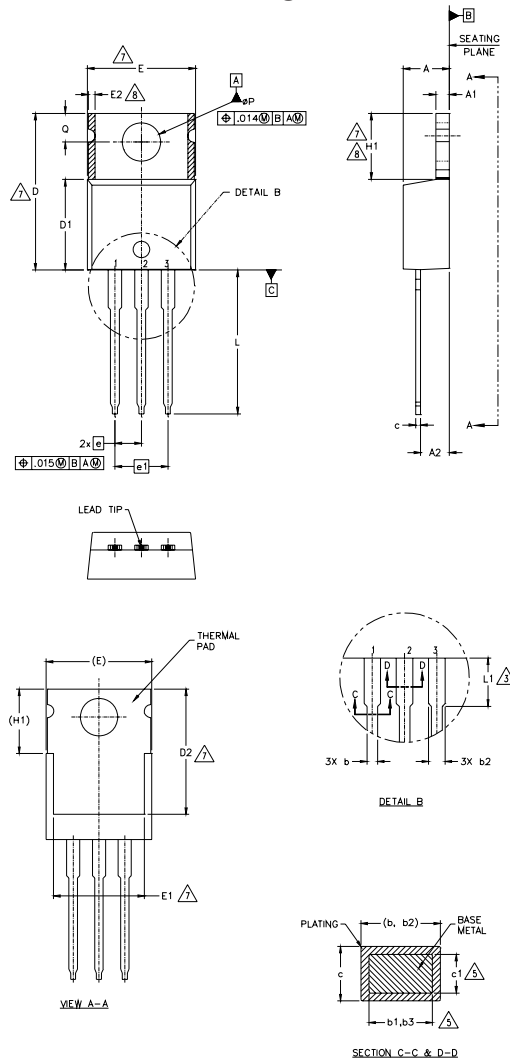


**Fig. WF4** - Typ. S.C. Waveform  
@  $T_J = 25^\circ\text{C}$  using Fig. CT.3

# IRGB4061DPbF

TO-220AB Package Outline (Dimensions are shown in millimeters (inches))

International  
**IR** Rectifier



## NOTES:

- 1.- DIMENSIONING AND TOLERANCING AS PER ASME Y14.5 M- 1994.
- 2.- DIMENSIONS ARE SHOWN IN INCHES [MILLIMETERS].
- 3.- LEAD DIMENSION AND FINISH UNCONTROLLED IN L1.
- 4.- DIMENSION D, D1 & 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, b3 & 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.
- 9.- OUTLINE CONFORMS TO JEDEC TO-220, EXCEPT A2 (max.) AND D2 (min.) WHERE DIMENSIONS ARE DERIVED FROM THE ACTUAL PACKAGE OUTLINE.

| SYMBOL | DIMENSIONS  |       |          |      | NOTES |
|--------|-------------|-------|----------|------|-------|
|        | MILLIMETERS |       | INCHES   |      |       |
|        | MIN.        | MAX.  | MIN.     | MAX. |       |
| A      | 3.56        | 4.83  | .140     | .190 |       |
| A1     | 0.51        | 1.40  | .020     | .055 |       |
| A2     | 2.03        | 2.92  | .080     | .115 |       |
| b      | 0.38        | 1.01  | .015     | .040 |       |
| b1     | 0.38        | 0.97  | .015     | .038 | 5     |
| b2     | 1.14        | 1.78  | .045     | .070 | 5     |
| b3     | 1.14        | 1.73  | .045     | .068 |       |
| c      | 0.36        | 0.61  | .014     | .024 |       |
| c1     | 0.36        | 0.56  | .014     | .022 |       |
| D      | 14.22       | 16.51 | .560     | .650 | 4     |
| D1     | 8.38        | 9.02  | .330     | .355 | 7     |
| D2     | 11.68       | 12.88 | .460     | .507 |       |
| E      | 9.65        | 10.67 | .380     | .420 |       |
| E1     | 6.86        | 8.89  | .270     | .350 |       |
| E2     | —           | 0.76  | —        | .030 | 8     |
| e      | 2.54 BSC    |       | .100 BSC |      |       |
| e1     | 5.08 BSC    |       | .200 BSC |      |       |
| H1     | 5.84        | 6.86  | .230     | .270 | 7,8   |
| L      | 12.70       | 14.73 | .500     | .580 | 3     |
| L1     | —           | 6.35  | —        | .250 |       |
| øP     | 3.54        | 4.08  | .139     | .161 |       |
| Q      | 2.54        | 3.42  | .100     | .135 |       |

## LEAD ASSIGNMENTS

### HEXFET

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

### IGBTs, CoPACK

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

### DIODES

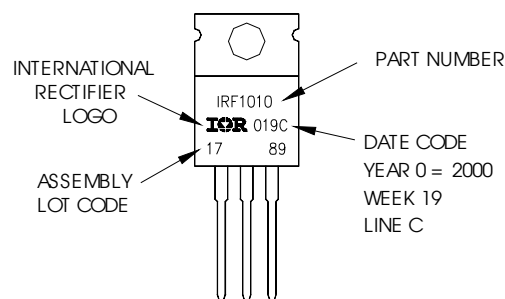
- 1.- ANODE/OPEN
- 2.- CATHODE
- 3.- ANODE

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

## TO-220AB Part Marking Information

EXAMPLE: THIS IS AN IRF1010  
LOT CODE 1789  
ASSEMBLED ON WW 19, 2000  
IN THE ASSEMBLY LINE "C"

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



TO-220AB packages are not recommended for Surface Mount Application.

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.

International  
**IR** Rectifier

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