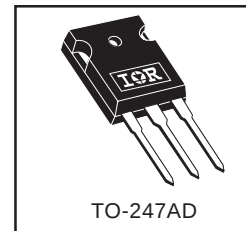
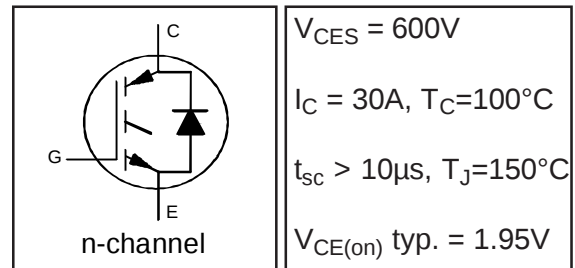


# IRGP30B60KD-EP

## INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

### Features

- Low  $V_{CE(on)}$  Non Punch Through IGBT Technology.
- Low Diode  $V_F$ .
- 10 $\mu$ s Short Circuit Capability.
- Square RBSOA.
- Ultrasoft Diode Reverse Recovery Characteristics.
- Positive  $V_{CE(on)}$  Temperature Coefficient.
- TO-247AD Package
- 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       | 60                                | A          |
| $I_C @ T_C = 100^\circ C$ | Continuous Collector Current       | 30                                |            |
| $I_{CM}$                  | Pulsed Collector Current           | 120                               |            |
| $I_{LM}$                  | Clamped Inductive Load Current ①   | 120                               |            |
| $I_F @ T_C = 25^\circ C$  | Diode Continuous Forward Current   | 60                                |            |
| $I_F @ T_C = 100^\circ C$ | Diode Continuous Forward Current   | 30                                | V          |
| $I_{FM}$                  | Diode Maximum Forward Current      | 120                               |            |
| $V_{GE}$                  | Gate-to-Emitter Voltage            | $\pm 20$                          |            |
| $P_D @ T_C = 25^\circ C$  | Maximum Power Dissipation          | 304                               | W          |
| $P_D @ T_C = 100^\circ C$ | Maximum Power Dissipation          | 122                               |            |
| $T_J$                     | Operating Junction and             | -55 to +150                       | $^\circ C$ |
| $T_{STG}$                 | 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 (1.1N•m)                |            |

### Thermal Resistance

|                 | Parameter                                 | Min. | Typ. | Max. | Units        |
|-----------------|-------------------------------------------|------|------|------|--------------|
| $R_{\theta JC}$ | Junction-to-Case - IGBT                   | —    | —    | 0.41 | $^\circ C/W$ |
| $R_{\theta JC}$ | Junction-to-Case - Diode                  | —    | —    | 1.32 |              |
| $R_{\theta CS}$ | Case-to-Sink, flat, greased surface       | —    | 0.24 | —    |              |
| $R_{\theta JA}$ | Junction-to-Ambient, typical socket mount | —    | —    | 40   |              |
| Wt              | Weight                                    | —    | 6.0  | —    | g            |

# IRGP30B60KD-EP

International  
**IR** Rectifier

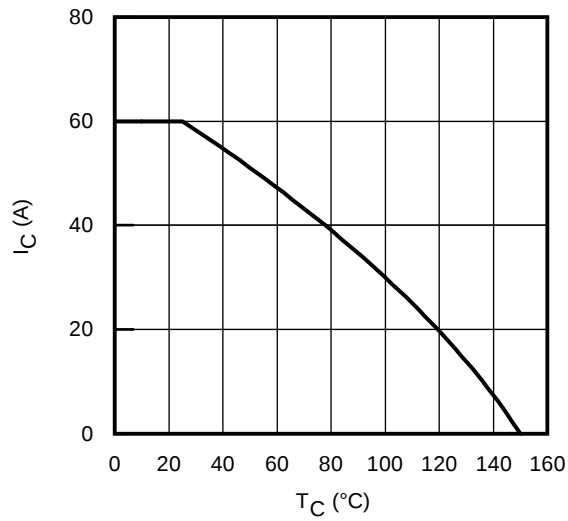
## Electrical Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)

|                                        | 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 | —    | 0.4  | —    | V/°C  | V <sub>GE</sub> = 0V, I <sub>C</sub> = 1.0mA, (25°C-150°C)               |          |
| V <sub>CE(on)</sub>                    | Collector-to-Emitter Saturation Voltage | —    | 1.95 | 2.35 | V     | I <sub>C</sub> = 30A, V <sub>GE</sub> = 15V                              | 5,6,7    |
|                                        |                                         | —    | 2.40 | 2.75 |       | I <sub>C</sub> = 30A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 150°C      | 9,10,11  |
| V <sub>GE(th)</sub>                    | Gate Threshold Voltage                  | 3.5  | 4.5  | 5.5  | V     | V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA               | 9,10,11  |
| ΔV <sub>GE(th)</sub> /ΔT <sub>J</sub>  | Temperature Coeff. of Threshold Voltage | —    | -10  | —    | mV/°C | V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 1.0mA, (25°C-150°C) | 12       |
| g <sub>fe</sub>                        | Forward Transconductance                | —    | 18   | —    | S     | V <sub>CE</sub> = 50V, I <sub>C</sub> = 50A, PW=80μs                     |          |
| I <sub>CES</sub>                       | Zero Gate Voltage Collector Current     | —    | 5.0  | 250  | μA    | V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V                             |          |
|                                        |                                         | —    | 1000 | 2000 |       | V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V, T <sub>J</sub> = 150°C     |          |
| V <sub>FM</sub>                        | Diode Forward Voltage Drop              | —    | 1.30 | 1.55 | V     | I <sub>F</sub> = 30A                                                     | 8        |
|                                        |                                         | —    | 1.25 | 1.50 |       | I <sub>F</sub> = 30A T <sub>J</sub> = 150°C                              |          |
| I <sub>GES</sub>                       | Gate-to-Emitter Leakage Current         | —    | —    | ±100 | nA    | V <sub>GE</sub> = ±20V                                                   |          |

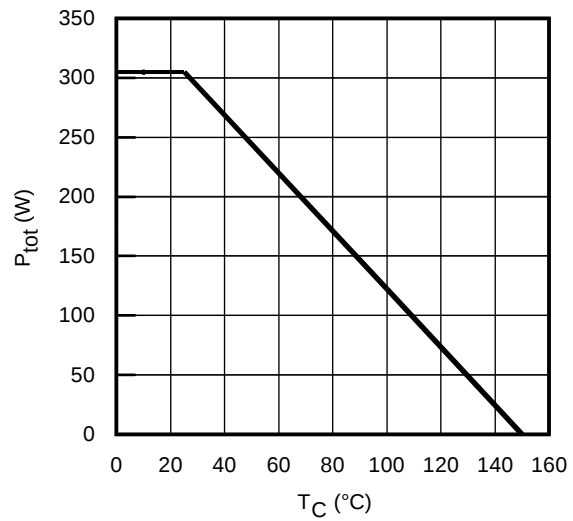
## Switching Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)

|                     | Parameter                            | Min.        | Typ. | Max. | Units | Conditions                                                                                                                                                | Ref.Fig.                 |
|---------------------|--------------------------------------|-------------|------|------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| Q <sub>g</sub>      | Total Gate Charge (turn-on)          | —           | 102  | 153  | nC    | I <sub>C</sub> = 30A<br>V <sub>CC</sub> = 400V                                                                                                            | 23<br>CT.1               |
| Q <sub>ge</sub>     | Gate - Emitter Charge (turn-on)      | —           | 14   | 21   |       | V <sub>GE</sub> = 15V                                                                                                                                     |                          |
| Q <sub>gc</sub>     | Gate - Collector Charge (turn-on)    | —           | 44   | 66   |       |                                                                                                                                                           |                          |
| E <sub>on</sub>     | Turn-On Switching Loss               | —           | 350  | 620  | μJ    | I <sub>C</sub> = 30A, V <sub>CC</sub> = 400V<br>V <sub>GE</sub> = 15V, R <sub>G</sub> = 10Ω, L = 200μH,<br>L <sub>S</sub> = 150nH T <sub>J</sub> = 25°C ② | CT.4                     |
| E <sub>off</sub>    | Turn-Off Switching Loss              | —           | 825  | 955  |       |                                                                                                                                                           |                          |
| E <sub>tot</sub>    | Total Switching Loss                 | —           | 1175 | 1575 |       |                                                                                                                                                           |                          |
| t <sub>d(on)</sub>  | Turn-On Delay Time                   | —           | 46   | 60   | ns    | I <sub>C</sub> = 30A, V <sub>CC</sub> = 400V<br>V <sub>GE</sub> = 15V, R <sub>G</sub> = 10Ω L = 200μH<br>L <sub>S</sub> = 150nH, T <sub>J</sub> = 25°C    | CT.4                     |
| t <sub>r</sub>      | Rise Time                            | —           | 28   | 39   |       |                                                                                                                                                           |                          |
| t <sub>d(off)</sub> | Turn-Off Delay Time                  | —           | 185  | 200  |       |                                                                                                                                                           |                          |
| t <sub>f</sub>      | Fall Time                            | —           | 31   | 40   |       |                                                                                                                                                           |                          |
| E <sub>on</sub>     | Turn-On Switching Loss               | —           | 635  | 1085 | μJ    | I <sub>C</sub> = 30A, V <sub>CC</sub> = 400V<br>V <sub>GE</sub> = 15V, R <sub>G</sub> = 10Ω, L = 200μH<br>L <sub>S</sub> = 150nH T <sub>J</sub> = 150°C ② | CT.4<br>13,15<br>WF1,WF2 |
| E <sub>off</sub>    | Turn-Off Switching Loss              | —           | 1150 | 1350 |       |                                                                                                                                                           |                          |
| E <sub>tot</sub>    | Total Switching Loss                 | —           | 1785 | 2435 |       |                                                                                                                                                           |                          |
| t <sub>d(on)</sub>  | Turn-On Delay Time                   | —           | 46   | 60   | ns    | I <sub>C</sub> = 30A, V <sub>CC</sub> = 400V<br>V <sub>GE</sub> = 15V, R <sub>G</sub> = 10Ω L = 200μH<br>L <sub>S</sub> = 150nH, T <sub>J</sub> = 150°C   | CT.4<br>14,16<br>WF1,WF2 |
| t <sub>r</sub>      | Rise Time                            | —           | 28   | 39   |       |                                                                                                                                                           |                          |
| t <sub>d(off)</sub> | Turn-Off Delay Time                  | —           | 205  | 235  |       |                                                                                                                                                           |                          |
| t <sub>f</sub>      | Fall Time                            | —           | 32   | 42   |       |                                                                                                                                                           |                          |
| C <sub>ies</sub>    | Input Capacitance                    | —           | 1750 | —    | pF    | V <sub>GE</sub> = 0V<br>V <sub>CC</sub> = 30V<br>f = 1.0MHz                                                                                               | 22                       |
| C <sub>oes</sub>    | Output Capacitance                   | —           | 160  | —    |       |                                                                                                                                                           |                          |
| C <sub>res</sub>    | Reverse Transfer Capacitance         | —           | 60   | —    |       |                                                                                                                                                           |                          |
| RBSOA               | Reverse Bias Safe Operating Area     | FULL SQUARE |      |      |       | T <sub>J</sub> = 150°C, I <sub>C</sub> = 120A, V <sub>p</sub> = 600V<br>V <sub>CC</sub> = 500V, V <sub>GE</sub> = +15V to 0V, R <sub>G</sub> = 10Ω        | 4<br>CT.2                |
| SCSOA               | Short Circuit Safe Operating Area    | 10          | —    | —    | μs    | T <sub>J</sub> = 150°C, V <sub>p</sub> = 600V, R <sub>G</sub> = 10Ω<br>V <sub>CC</sub> = 360V, V <sub>GE</sub> = +15V to 0V                               | CT.3<br>WF.4             |
| E <sub>rec</sub>    | Reverse Recovery energy of the diode | —           | 925  | 1165 | μJ    | T <sub>J</sub> = 150°C                                                                                                                                    | 17,18,19                 |
| t <sub>rr</sub>     | Diode Reverse Recovery time          | —           | 125  | —    | ns    | V <sub>CC</sub> = 400V, I <sub>F</sub> = 30A, L = 200μH                                                                                                   | 20,21                    |
| I <sub>rr</sub>     | Diode Peak Reverse Recovery Current  | —           | 43   | 48   | A     | V <sub>GE</sub> = 15V, R <sub>G</sub> = 10Ω, L <sub>S</sub> = 150nH                                                                                       | CT.4,WF.3                |

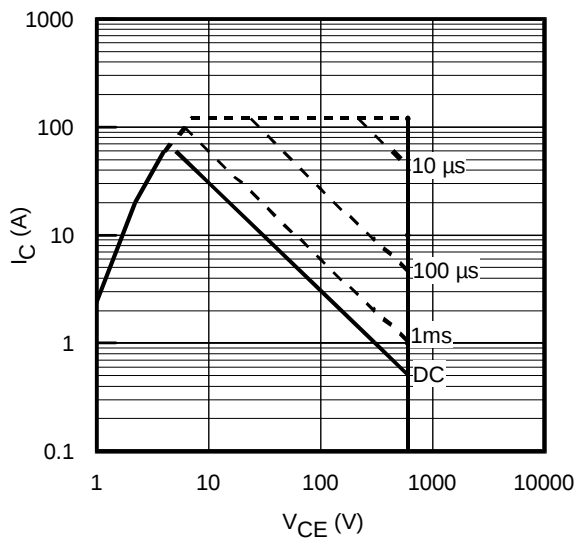
Notes: ① V<sub>CC</sub> = 80% (V<sub>CES</sub>), V<sub>GE</sub> = 15V, L = 28μH, R<sub>G</sub> = 22Ω. ② Energy losses include "tail" and diode reverse recovery.



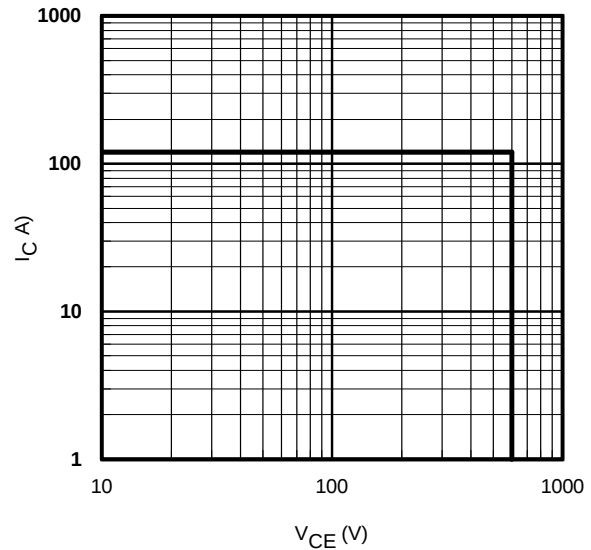
**Fig. 1** - Maximum DC Collector Current vs. Case Temperature



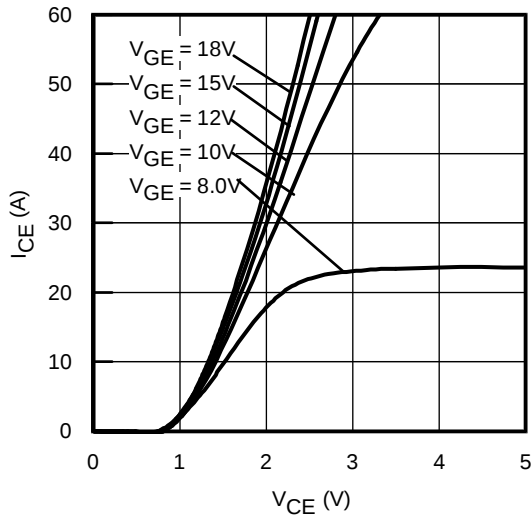
**Fig. 2** - Power Dissipation vs. Case Temperature



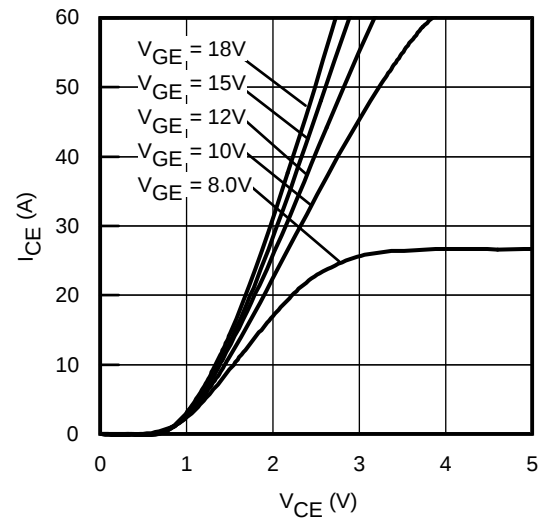
**Fig. 3** - Forward SOA  
 $T_C = 25^\circ\text{C}$ ;  $T_J \leq 150^\circ\text{C}$



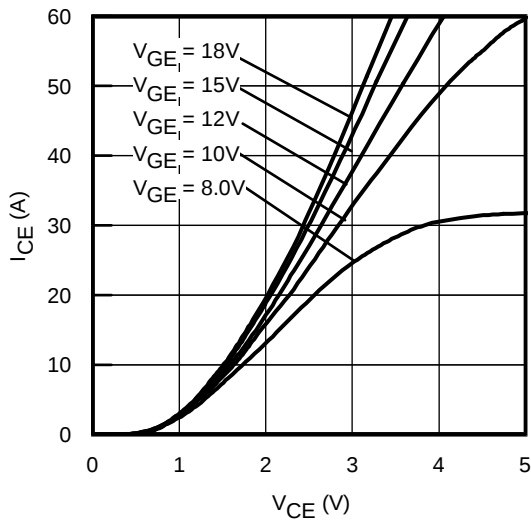
**Fig. 4** - Reverse Bias SOA  
 $T_J = 150^\circ\text{C}$ ;  $V_{GE} = 15\text{V}$



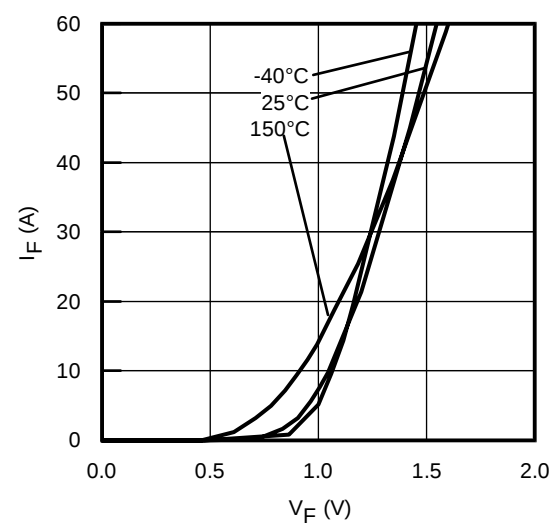
**Fig. 5** - Typ. IGBT Output Characteristics  
T<sub>j</sub> = -40°C; tp = 80μs



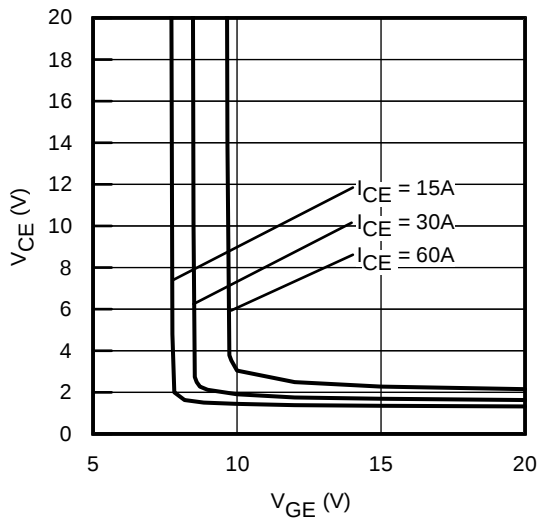
**Fig. 6** - Typ. IGBT Output Characteristics  
T<sub>j</sub> = 25°C; tp = 80μs



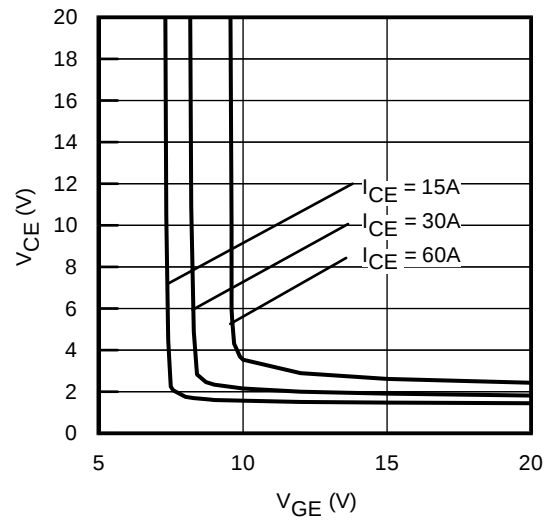
**Fig. 7** - Typ. IGBT Output Characteristics  
T<sub>j</sub> = 150°C; tp = 80μs



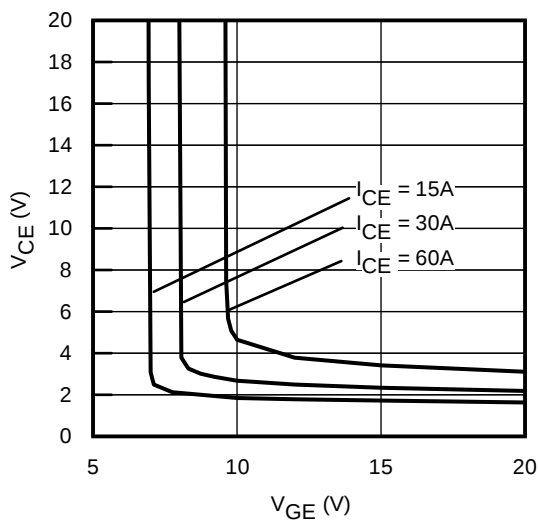
**Fig. 8** - Typ. Diode Forward Characteristics  
tp = 80μs



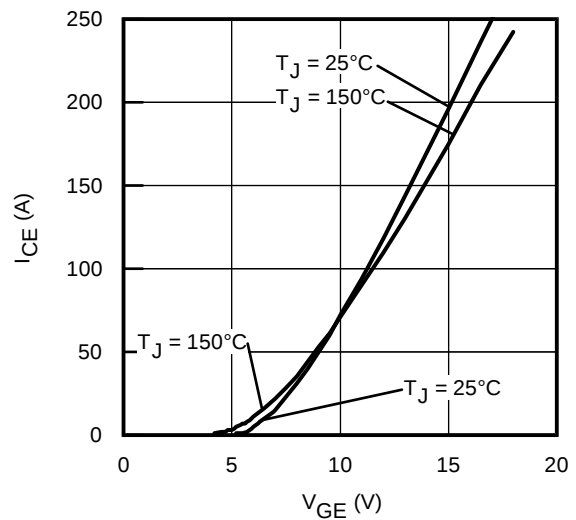
**Fig. 9** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = -40^{\circ}\text{C}$



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



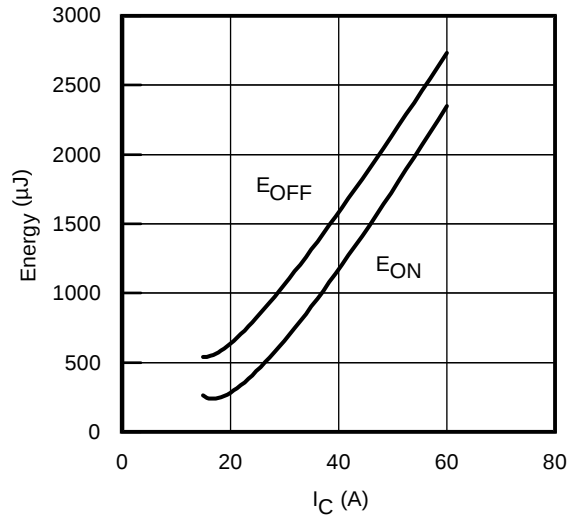
**Fig. 11** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 150^{\circ}\text{C}$



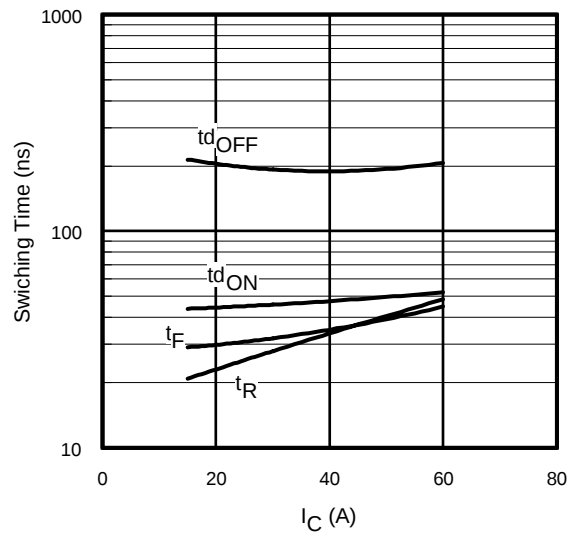
**Fig. 12** - Typ. Transfer Characteristics  
 $V_{CE} = 50\text{V}$ ;  $t_p = 10\mu\text{s}$

# IRGP30B60KD-EP

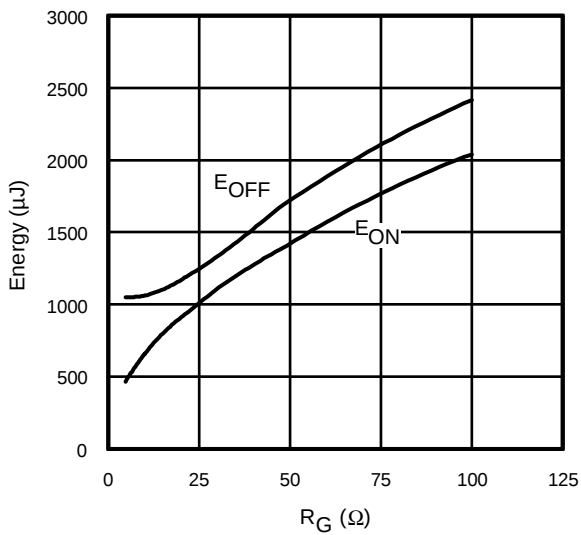
International  
**IR** Rectifier



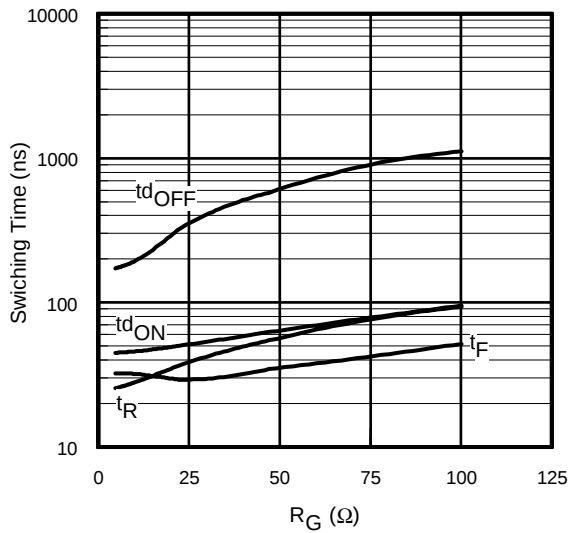
**Fig. 13** - Typ. Energy Loss vs.  $I_C$   
 $T_J = 150^\circ\text{C}$ ;  $L = 200\mu\text{H}$ ;  $V_{CE} = 400\text{V}$   
 $R_G = 10\Omega$ ;  $V_{GE} = 15\text{V}$



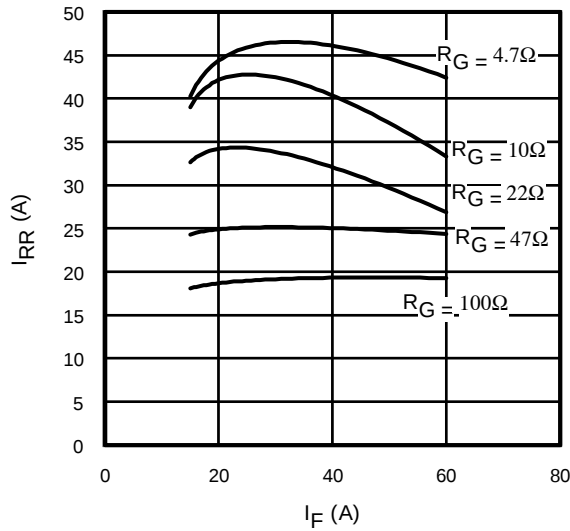
**Fig. 14** - Typ. Switching Time vs.  $I_C$   
 $T_J = 150^\circ\text{C}$ ;  $L = 200\mu\text{H}$ ;  $V_{CE} = 400\text{V}$   
 $R_G = 10\Omega$ ;  $V_{GE} = 15\text{V}$



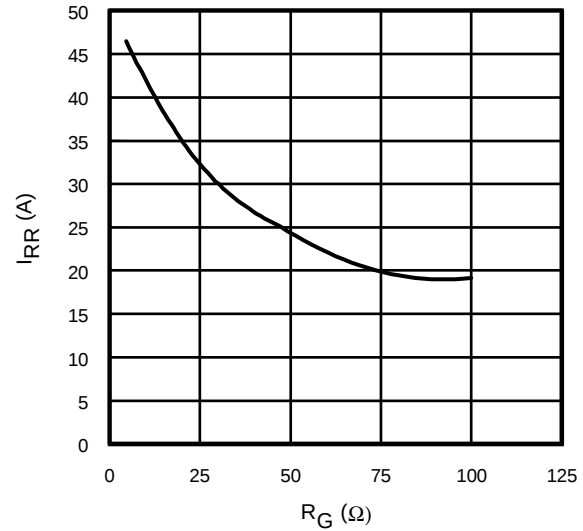
**Fig. 15** - Typ. Energy Loss vs.  $R_G$   
 $T_J = 150^\circ\text{C}$ ;  $L = 200\mu\text{H}$ ;  $V_{CE} = 400\text{V}$   
 $I_{CE} = 30\text{A}$ ;  $V_{GE} = 15\text{V}$



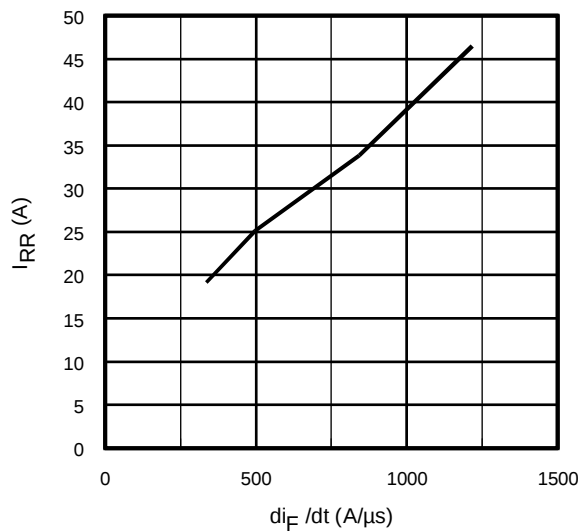
**Fig. 16** - Typ. Switching Time vs.  $R_G$   
 $T_J = 150^\circ\text{C}$ ;  $L = 200\mu\text{H}$ ;  $V_{CE} = 400\text{V}$   
 $I_{CE} = 30\text{A}$ ;  $V_{GE} = 15\text{V}$



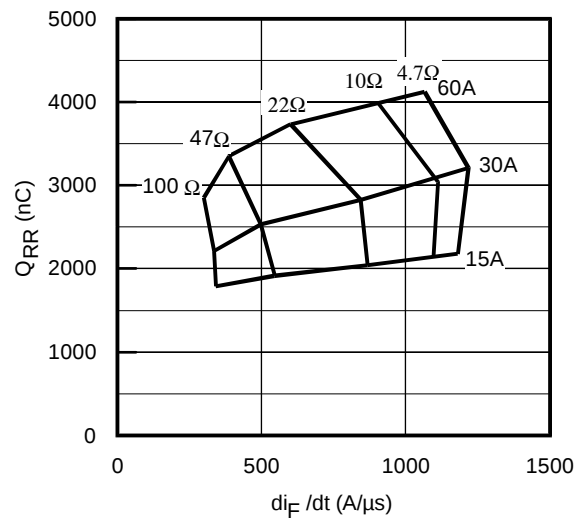
**Fig. 17** - Typical Diode  $I_{RR}$  vs.  $I_F$   
 $T_J = 150^\circ\text{C}$



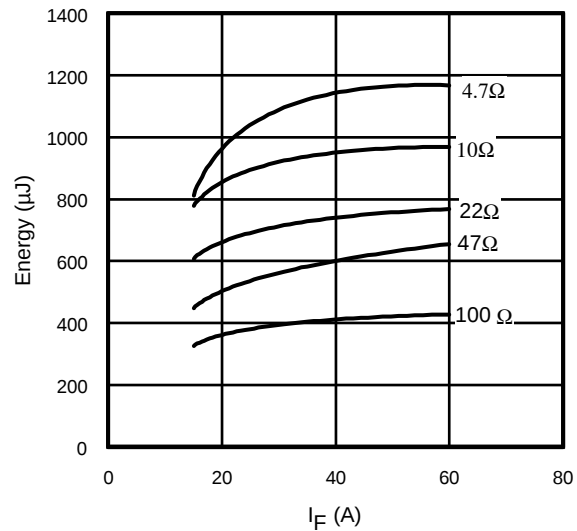
**Fig. 18** - Typical Diode  $I_{RR}$  vs.  $R_G$   
 $T_J = 150^\circ\text{C}$ ;  $I_F = 30\text{A}$



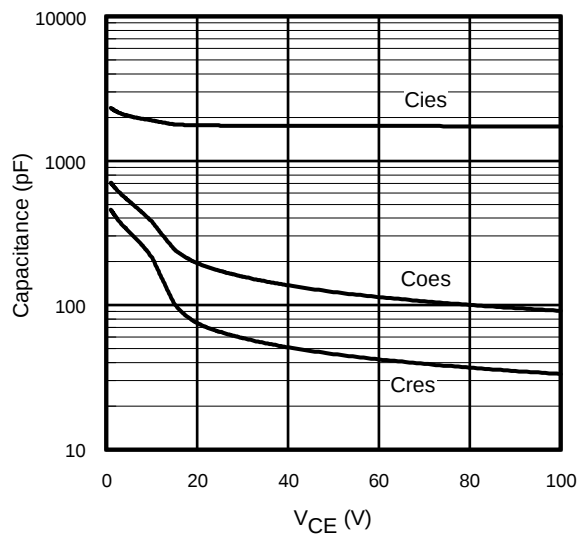
**Fig. 19** - Typical Diode  $I_{RR}$  vs.  $di_F/dt$   
 $V_{CC} = 400\text{V}$ ;  $V_{GE} = 15\text{V}$ ;  
 $I_F = 30\text{A}$ ;  $T_J = 150^\circ\text{C}$



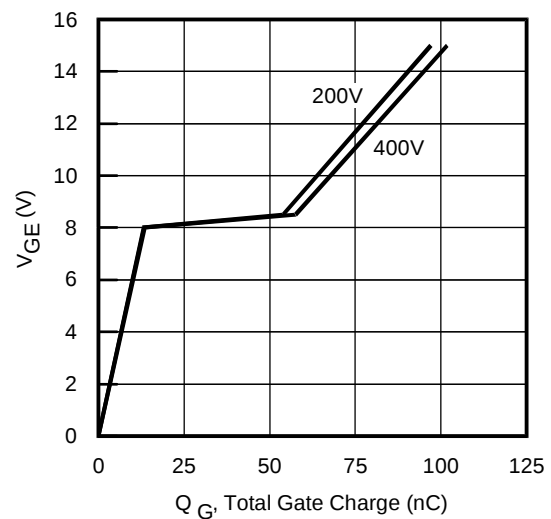
**Fig. 20** - Typical Diode  $Q_{RR}$   
 $V_{CC} = 400\text{V}$ ;  $V_{GE} = 15\text{V}$ ;  $T_J = 150^\circ\text{C}$



**Fig. 21** - Typical Diode  $E_{RR}$  vs.  $I_F$   
 $T_J = 150^\circ C$



**Fig. 22**- Typ. Capacitance vs.  $V_{CE}$   
 $V_{GE} = 0V$ ;  $f = 1MHz$



**Fig. 23** - Typical Gate Charge vs.  $V_{GE}$   
 $I_{CE} = 30A$ ;  $L = 600\mu H$

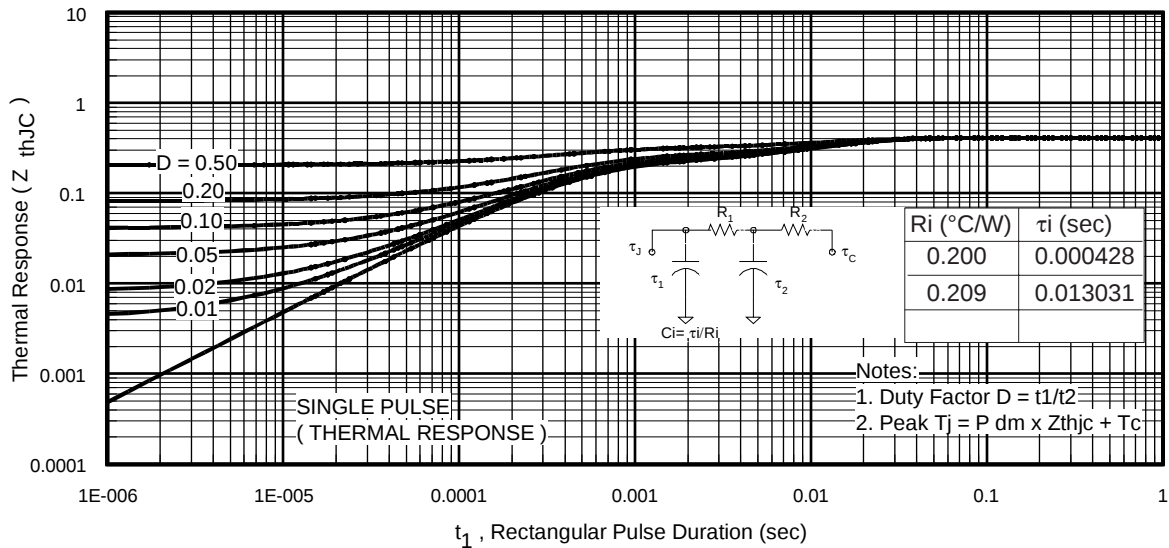


Fig 24. Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

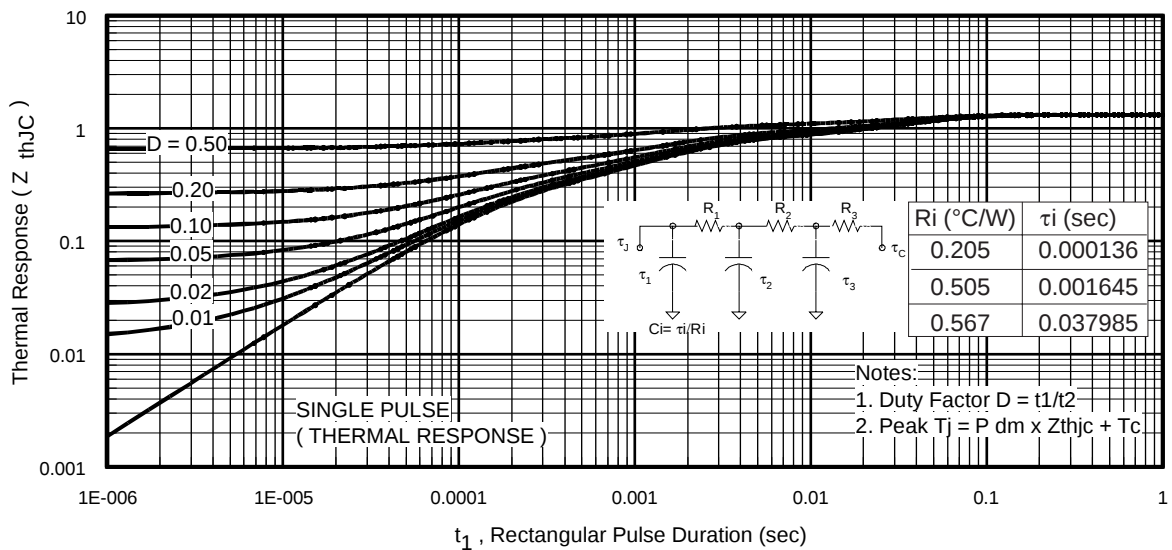
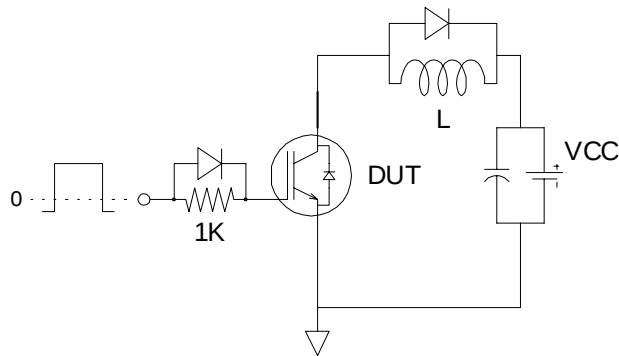


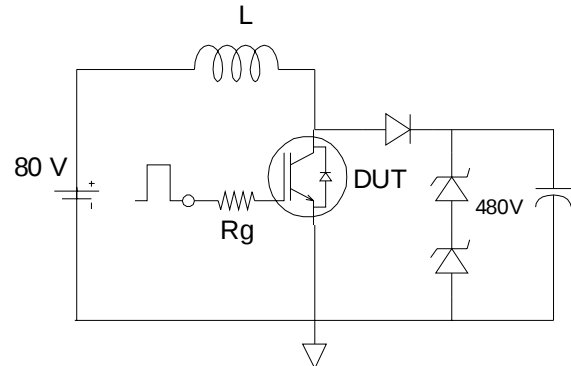
Fig 25. Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

# IRGP30B60KD-EP

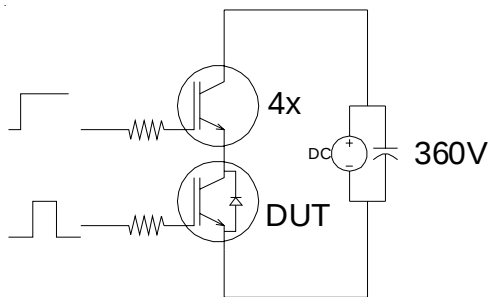
International  
**IR** Rectifier



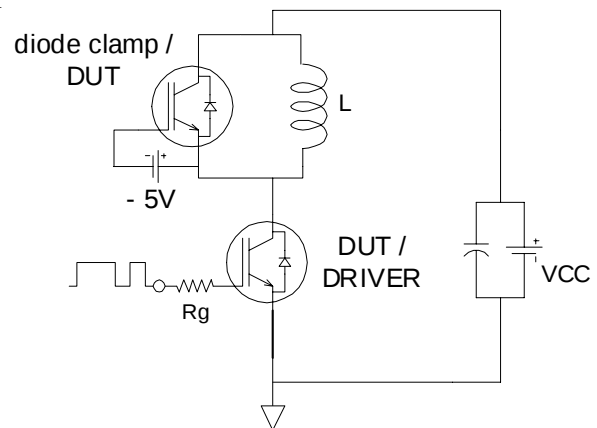
**Fig.C.T.1** - Gate Charge Circuit (turn-off)



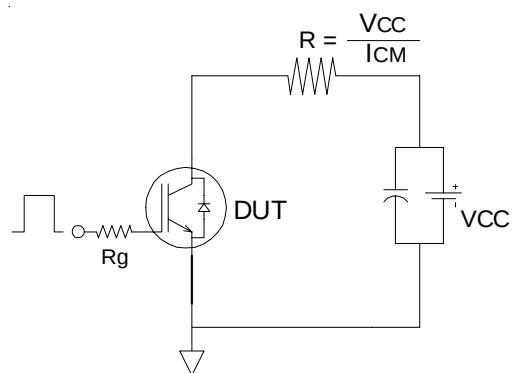
**Fig.C.T.2** - RBSOA Circuit



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



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



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

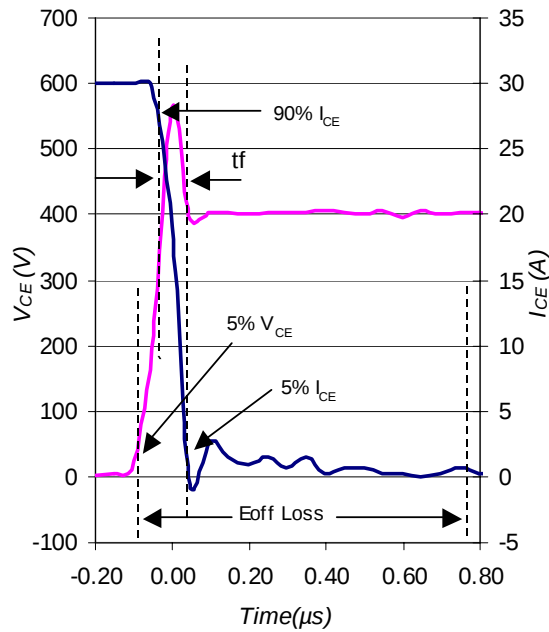


Fig. WF1- Typ. Turn-off Loss Waveform  
@  $T_J = 150^\circ\text{C}$  using Fig. CT.4

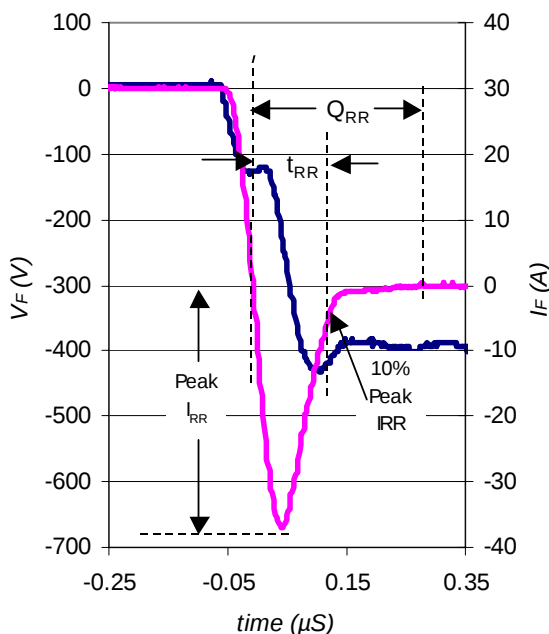


Fig. WF3- Typ. Diode Recovery Waveform  
@  $T_J = 150^\circ\text{C}$  using Fig. CT.4

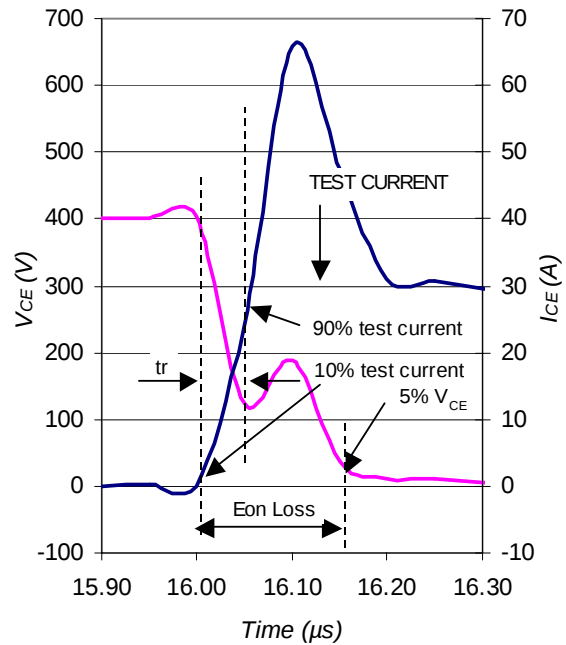


Fig. WF2- Typ. Turn-on Loss Waveform  
@  $T_J = 150^\circ\text{C}$  using Fig. CT.4

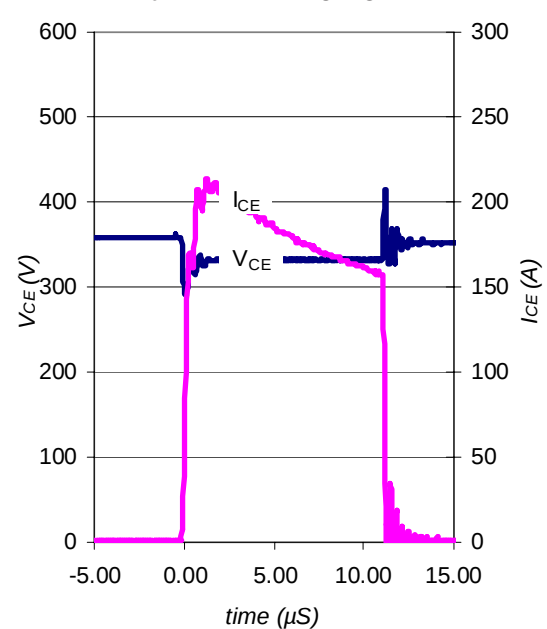


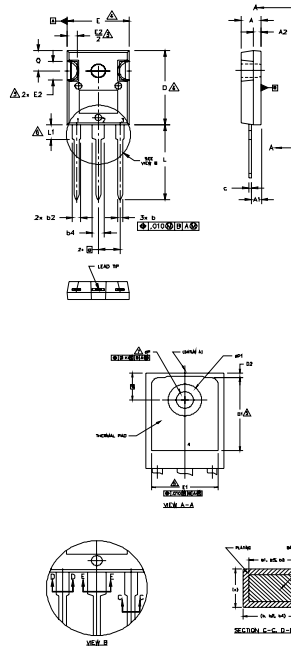
Fig. WF4- Typ. S.C Waveform  
@  $T_C = 150^\circ\text{C}$  using Fig. CT.3

# IRGP30B60KD-EP

International  
**IR** Rectifier

## TO-247AD Package Outline

Dimensions are shown in millimeters (inches)



### NOTES:

1. DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M 1994.
2. DIMENSIONS ARE SHOWN IN INCHES.
3. CONTOUR OF SLOT OPTIONAL.
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. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS D1 & E1.
6. LEAD FINISH UNCONTROLLED IN L1.
7. ØP TO HAVE A MAXIMUM DRAFT ANGLE OF 1.5 ° TO THE TOP OF THE PART WITH A MAXIMUM HOLE DIAMETER OF .154 INCH.
8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-247AD.

| SYMBOL | DIMENSIONS |      |             |       | NOTE |
|--------|------------|------|-------------|-------|------|
|        | INCHES     |      | MILLIMETERS |       |      |
|        | MIN.       | MAX. | MIN.        | MAX.  |      |
| A      | .183       | .209 | 4.65        | 5.31  |      |
| A1     | .087       | .102 | 2.21        | 2.59  |      |
| A2     | .059       | .098 | 1.50        | 2.49  |      |
| b      | .039       | .055 | 0.99        | 1.40  |      |
| b1     | .039       | .053 | 0.99        | 1.35  |      |
| b2     | .065       | .094 | 1.65        | 2.39  |      |
| b3     | .065       | .092 | 1.65        | 2.34  |      |
| b4     | .102       | .135 | 2.59        | 3.43  |      |
| b5     | .102       | .133 | 2.59        | 3.38  |      |
| c      | .015       | .035 | 0.38        | 0.89  |      |
| c1     | .015       | .033 | 0.38        | 0.84  |      |
| D      | .776       | .815 | 19.71       | 20.70 | 4    |
| D1     | .515       | -    | 13.08       | -     | 5    |
| D2     | .020       | .053 | 0.51        | 1.35  |      |
| E      | .602       | .625 | 15.29       | 15.87 | 4    |
| E1     | .530       | -    | 13.46       | -     |      |
| E2     | .178       | .216 | 4.52        | 5.49  |      |
| e      | .215 BSC   |      | 5.46 BSC    |       |      |
| ØK     | .010       |      | 0.25        |       |      |
| L      | .780       | .827 | 19.57       | 21.00 |      |
| L1     | .146       | .169 | 3.71        | 4.29  |      |
| ØP     | .140       | .144 | 3.56        | 3.66  |      |
| ØP1    | -          | .291 | -           | 7.39  |      |
| Q      | .209       | .224 | 5.31        | 5.69  |      |
| S      | .217 BSC   |      | 5.51 BSC    |       |      |

### LEAD ASSIGNMENTS

#### HEXFET

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

#### IGBTs, CoPACK

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

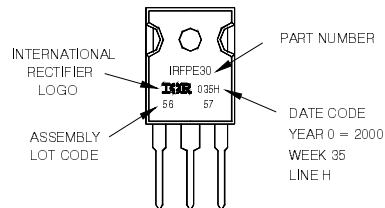
#### DIODES

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

## TO-247AD Part Marking Information

EXAMPLE: THIS IS AN IRFPE30  
WITH ASSEMBLY  
LOT CODE 5657  
ASSEMBLED ON WW 35, 2000  
IN THE ASSEMBLY LINE 'H'

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



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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TAC Fax: (310) 252-7903

Visit us at [www.irf.com](http://www.irf.com) for sales contact information. 02/06

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

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