

$$V_{CES} = 1200V$$

$$I_C = 50A, T_C = 100^\circ C$$

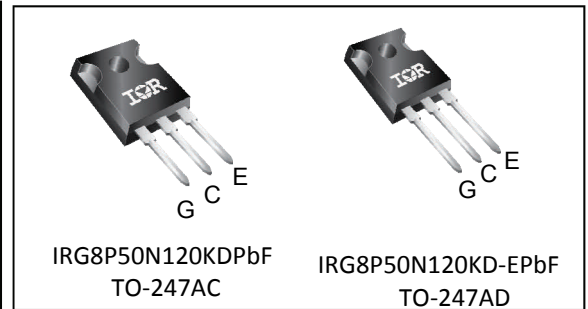
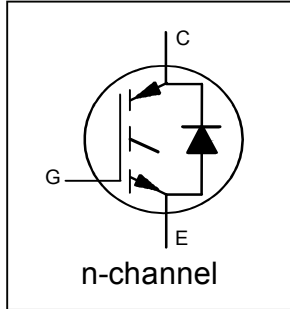
$$t_{SC} \geq 10\mu s, T_{J(max)} = 150^\circ C$$

$$V_{CE(ON)} \text{ typ.} = 1.7V @ I_C = 35A$$

### Applications

- Industrial Motor Drive
- UPS
- Solar Inverters
- Welding

### Insulated Gate Bipolar Transistor with Ultrafast Soft Recovery Diode



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

| Features                                      | Benefits                                             |
|-----------------------------------------------|------------------------------------------------------|
| Benchmark Low $V_{CE(ON)}$                    | High Efficiency in a Motor Drive Applications        |
| 10 $\mu s$ Short Circuit SOA                  | Increases margin for short circuit protection scheme |
| Positive $V_{CE(ON)}$ Temperature Coefficient | Excellent Current Sharing in Parallel Operation      |
| Square RBSOA and high $I_{LM}$ rating         | Rugged Transient Performance                         |
| Lead-Free, RoHS compliant                     | Environmentally friendly                             |

| Base part number   | Package Type | Standard Pack |          | Orderable Part Number |
|--------------------|--------------|---------------|----------|-----------------------|
|                    |              | Form          | Quantity |                       |
| IRG8P50N120KDPbF   | TO-247AC     | Tube          | 25       | IRG8P50N120KDPbF      |
| IRG8P50N120KD-EPbF | TO-247AD     | Tube          | 25       | IRG8P50N120KD-EPbF    |

### Absolute Maximum Ratings

|                           | Parameter                                    | Max.                              | Units |
|---------------------------|----------------------------------------------|-----------------------------------|-------|
| $V_{CES}$                 | Collector-to-Emitter Voltage                 | 1200                              | V     |
| $I_C @ T_C = 25^\circ C$  | Continuous Collector Current                 | 80                                | A     |
| $I_C @ T_C = 100^\circ C$ | Continuous Collector Current                 | 50                                |       |
| $I_{CM}$                  | Pulse Collector Current (see fig. 2)         | 105                               |       |
| $I_{LM}$                  | Clamped Inductive Load Current (see fig. 3)① | 140                               |       |
| $I_F @ T_C = 25^\circ C$  | Diode Continuous Forward Current             | 45                                |       |
| $I_F @ T_C = 100^\circ C$ | Diode Continuous Forward Current             | 25                                |       |
| $I_{FM}$                  | Diode Maximum Forward Current ⑤              | 140                               | V     |
| $V_{GE}$                  | Continuous Gate-to-Emitter Voltage           | $\pm 30$                          |       |
| $P_D @ T_C = 25^\circ C$  | Maximum Power Dissipation                    | 350                               | W     |
| $P_D @ T_C = 100^\circ C$ | Maximum Power Dissipation                    | 140                               |       |
| $T_J$                     | Operating Junction and                       | -40 to +150                       | 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 (1.1 N·m)               |       |

### Thermal Resistance

|                         | Parameter                                                      | Min. | Typ. | Max. | Units        |
|-------------------------|----------------------------------------------------------------|------|------|------|--------------|
| $R_{\theta JC}$ (IGBT)  | Thermal Resistance Junction-to-Case-(each IGBT) ②              | —    | —    | 0.36 | $^\circ C/W$ |
| $R_{\theta JC}$ (Diode) | Thermal Resistance Junction-to-Case-(each Diode) ②             | —    | —    | 0.83 |              |
| $R_{\theta CS}$         | Thermal Resistance, Case-to-Sink (flat, greased surface)       | —    | 0.24 | —    |              |
| $R_{\theta JA}$         | Thermal Resistance, Junction-to-Ambient (typical socket mount) | —    | 40   | —    |              |

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

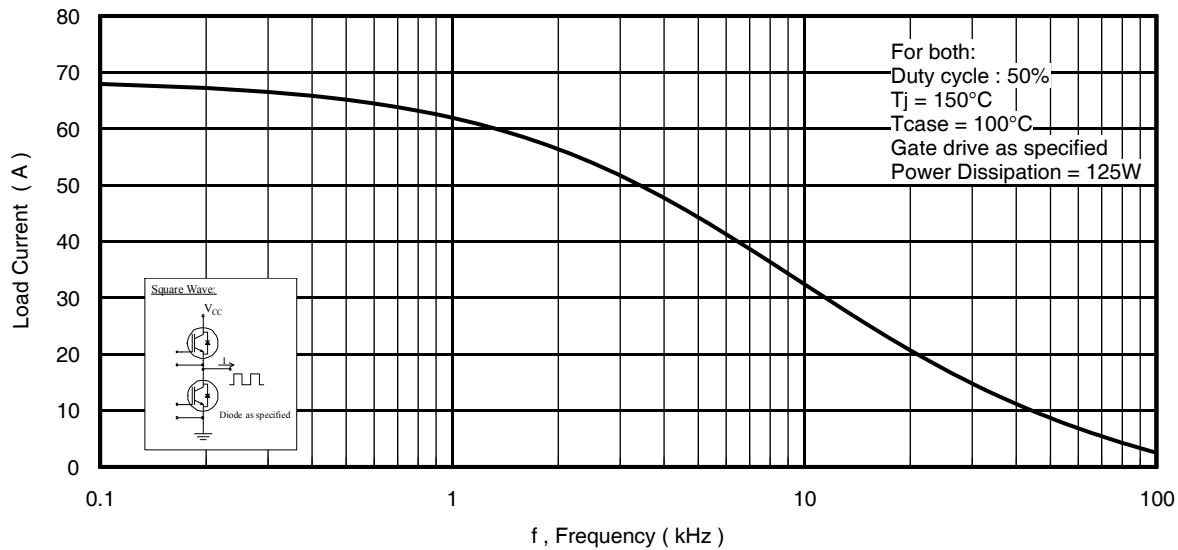
|                                 | Parameter                               | Min. | Typ. | Max.      | Units                | Conditions                                                                  |
|---------------------------------|-----------------------------------------|------|------|-----------|----------------------|-----------------------------------------------------------------------------|
| $V_{(BR)CES}$                   | Collector-to-Emitter Breakdown Voltage  | 1200 | —    | —         | V                    | $V_{GE} = 0V, I_C = 250\mu A$ ③                                             |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage | —    | 0.93 | —         | V/ $^\circ\text{C}$  | $V_{GE} = 0V, I_C = 2mA$ (25 $^\circ\text{C}$ -150 $^\circ\text{C}$ )       |
| $V_{CE(on)}$                    | Collector-to-Emitter Saturation Voltage | —    | 1.7  | 2.0       | V                    | $I_C = 35A, V_{GE} = 15V, T_J = 25^\circ\text{C}$                           |
|                                 |                                         | —    | 2.0  | —         |                      | $I_C = 35A, V_{GE} = 15V, T_J = 150^\circ\text{C}$                          |
| $V_{GE(th)}$                    | Gate Threshold Voltage                  | 5.0  | —    | 6.5       | V                    | $V_{CE} = V_{GE}, I_C = 1.4mA$                                              |
| $\Delta V_{GE(th)}/\Delta T_J$  | Threshold Voltage Temperature Coeff.    | —    | -16  | —         | mV/ $^\circ\text{C}$ | $V_{CE} = V_{GE}, I_C = 1.4mA$ (25 $^\circ\text{C}$ -150 $^\circ\text{C}$ ) |
| $g_{fe}$                        | Forward Transconductance                | —    | 20   | —         | S                    | $V_{CE} = 50V, I_C = 35A, PW = 20\mu s$                                     |
| $I_{CES}$                       | Collector-to-Emitter Leakage Current    | —    | 1    | 35        | $\mu A$              | $V_{GE} = 0V, V_{CE} = 1200V$                                               |
|                                 |                                         | —    | 1.2  | —         | mA                   | $V_{GE} = 0V, V_{CE} = 1200V, T_J = 150^\circ\text{C}$                      |
| $I_{GES}$                       | Gate-to-Emitter Leakage Current         | —    | —    | $\pm 300$ | nA                   | $V_{GE} = \pm 30V$                                                          |
| $V_F$                           | Diode Forward Voltage Drop              | —    | 2.1  | 2.7       | V                    | $I_F = 35A$                                                                 |
|                                 |                                         | —    | 2.4  | —         |                      | $I_F = 35A, T_J = 150^\circ\text{C}$                                        |

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

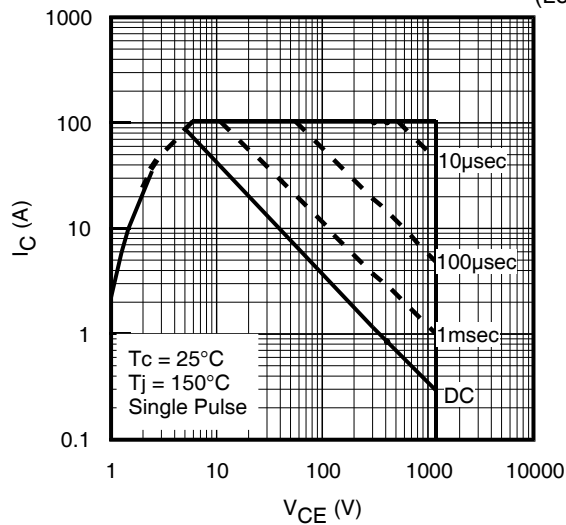
|              | Parameter                            | Min.        | Typ. | Max④ | Units   | Conditions                                                                                        |
|--------------|--------------------------------------|-------------|------|------|---------|---------------------------------------------------------------------------------------------------|
| $Q_g$        | Total Gate Charge (turn-on)          | —           | 210  | 315  | nC      | $I_C = 35A$<br>$V_{GE} = 15V$<br>$V_{CC} = 600V$                                                  |
| $Q_{ge}$     | Gate-to-Emitter Charge (turn-on)     | —           | 10   | 15   |         |                                                                                                   |
| $Q_{gc}$     | Gate-to-Collector Charge (turn-on)   | —           | 135  | 205  |         |                                                                                                   |
| $E_{on}$     | Turn-On Switching Loss               | —           | 2.3  | —    | mJ      | $I_C = 35A, V_{CC} = 600V, V_{GE} = 15V$<br>$R_G = 5\Omega, T_J = 25^\circ\text{C}$               |
| $E_{off}$    | Turn-Off Switching Loss              | —           | 1.9  | —    |         |                                                                                                   |
| $E_{total}$  | Total Switching Loss                 | —           | 4.2  | —    |         |                                                                                                   |
| $t_{d(on)}$  | Turn-On delay time                   | —           | 35   | —    | ns      | Energy losses include tail & diode reverse recovery ⑥                                             |
| $t_r$        | Rise time                            | —           | 25   | —    |         |                                                                                                   |
| $t_{d(off)}$ | Turn-Off delay time                  | —           | 190  | —    |         |                                                                                                   |
| $t_f$        | Fall time                            | —           | 105  | —    |         |                                                                                                   |
| $E_{on}$     | Turn-On Switching Loss               | —           | 3.8  | —    | mJ      | $I_C = 35A, V_{CC} = 600V, V_{GE} = 15V$<br>$R_G = 5\Omega, T_J = 150^\circ\text{C}$              |
| $E_{off}$    | Turn-Off Switching Loss              | —           | 3.9  | —    |         |                                                                                                   |
| $E_{total}$  | Total Switching Loss                 | —           | 7.7  | —    |         |                                                                                                   |
| $t_{d(on)}$  | Turn-On delay time                   | —           | 30   | —    | ns      | Energy losses include tail & diode reverse recovery ⑥                                             |
| $t_r$        | Rise time                            | —           | 25   | —    |         |                                                                                                   |
| $t_{d(off)}$ | Turn-Off delay time                  | —           | 270  | —    |         |                                                                                                   |
| $t_f$        | Fall time                            | —           | 140  | —    |         |                                                                                                   |
| $C_{ies}$    | Input Capacitance                    | —           | 3300 | —    | pF      | $V_{GE} = 0V$<br>$V_{CC} = 30V$<br>$f = 1.0MHz$                                                   |
| $C_{oes}$    | Output Capacitance                   | —           | 200  | —    |         |                                                                                                   |
| $C_{res}$    | Reverse Transfer Capacitance         | —           | 105  | —    |         |                                                                                                   |
| RBSOA        | Reverse Bias Safe Operating Area     | FULL SQUARE |      |      |         | $T_J = 150^\circ\text{C}, I_C = 140A$<br>$V_{CC} = 960V, V_p \leq 1200V$<br>$V_{GE} = +20V$ to 0V |
| SCSOA        | Short Circuit Safe Operating Area    | 10          | —    | —    | $\mu s$ | $T_J = 150^\circ\text{C}, V_{CC} = 600V, V_p \leq 1200V$<br>$V_{GE} = +15V$ to 0V                 |
| $E_{rec}$    | Reverse Recovery Energy of the Diode | —           | 0.52 | —    | mJ      | $T_J = 150^\circ\text{C}$                                                                         |
| $t_{rr}$     | Diode Reverse Recovery Time          | —           | 170  | —    | ns      | $V_{CC} = 600V, I_F = 35A$                                                                        |
| $I_{rr}$     | Peak Reverse Recovery Current        | —           | 22   | —    | A       | $V_{GE} = 15V, R_G = 5\Omega$                                                                     |

**Notes:**

- ①  $V_{CC} = 80\% (V_{CES}), V_{GE} = 20V$ .
- ②  $R_\theta$  is measured at  $T_J$  of approximately 90 $^\circ\text{C}$ .
- ③ Refer to AN-1086 for guidelines for measuring  $V_{(BR)CES}$  safely.
- ④ Maximum limits are based on statistical sample size characterization.
- ⑤ Pulse width limited by max. junction temperature.
- ⑥ Values influenced by parasitic L and C in measurement.

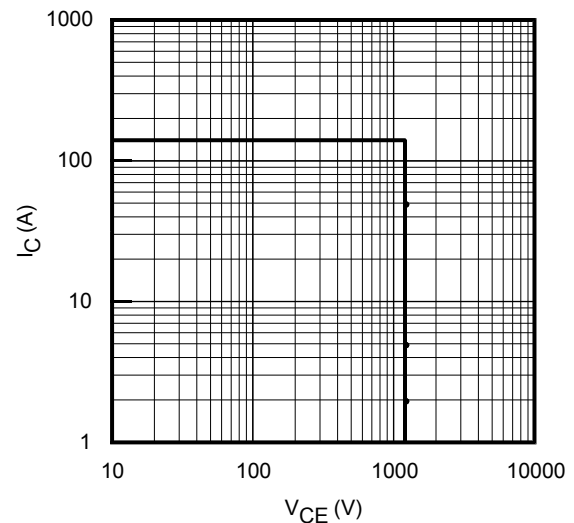


**Fig. 1 - Typical Load Current vs. Frequency**  
(Load Current =  $I_{\text{RMS}}$  of fundamental)



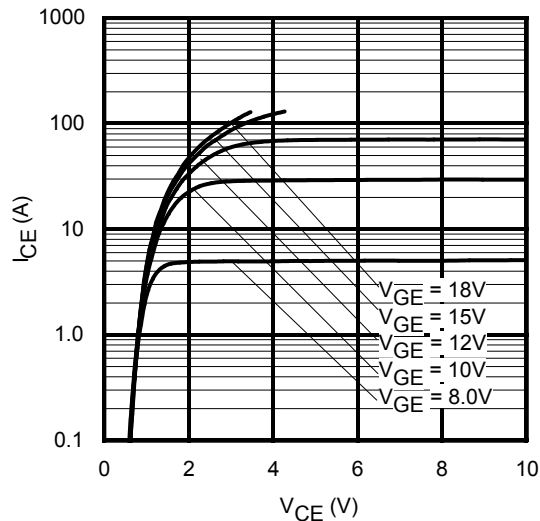
**Fig. 2 - Forward SOA**

$T_c = 25^{\circ}\text{C}$ ;  $T_j \leq 150^{\circ}\text{C}$ ;  $V_{\text{GE}} = 15\text{V}$

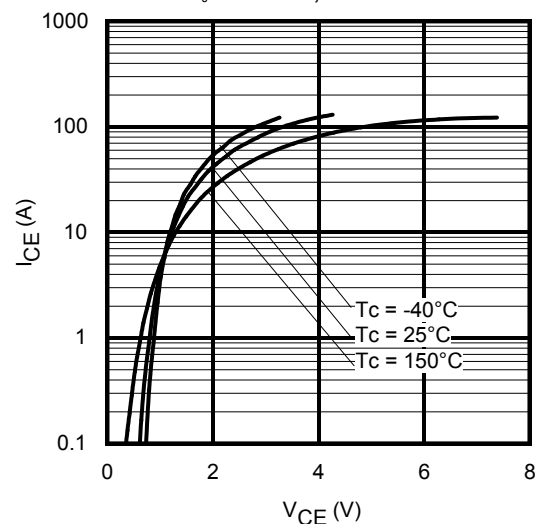


**Fig. 3 - Reverse Bias SOA**

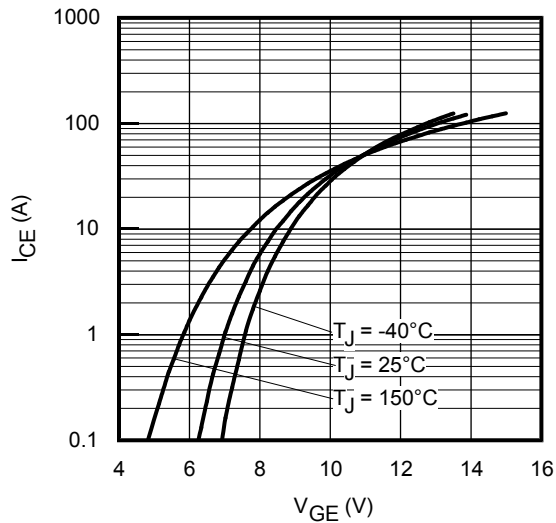
$T_j = 150^{\circ}\text{C}$ ;  $V_{\text{GE}} = 20\text{V}$



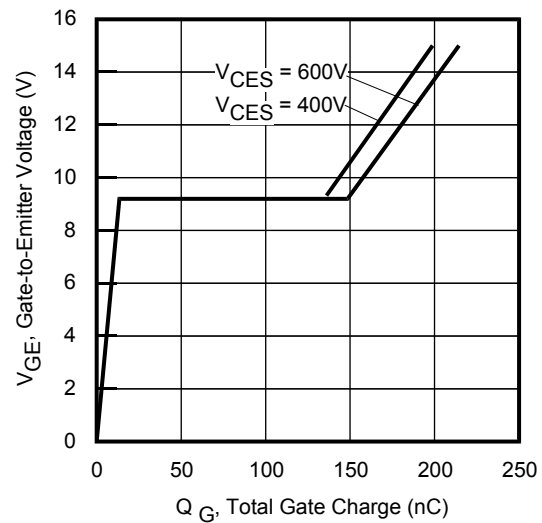
**Fig. 4 -Typ. IGBT Output Characteristics**  
 $T_j = 25^{\circ}\text{C}$ ;  $t_p = 20\mu\text{s}$



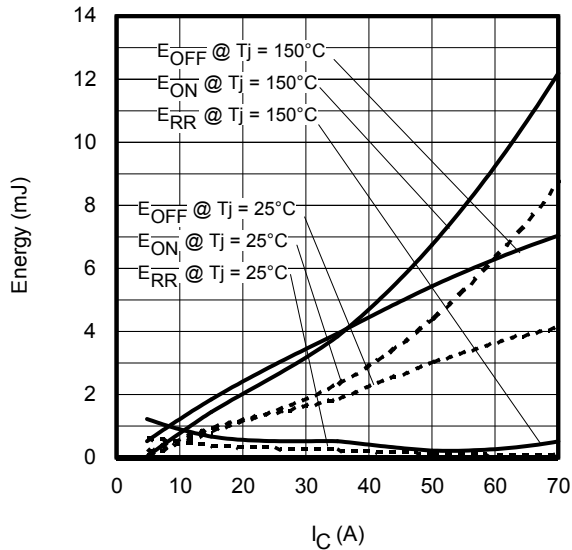
**Fig. 5 - Typ. IGBT Saturation Voltage**  
 $V_{\text{GE}} = 15\text{V}$ ;  $t_p = 20\mu\text{s}$



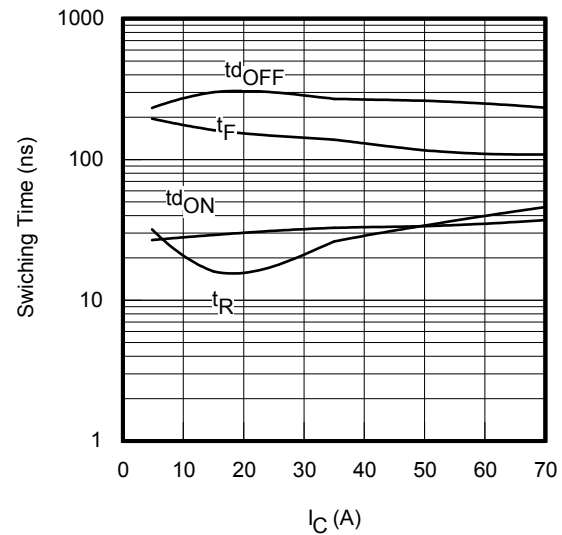
**Fig. 6 - Typ. Transfer Characteristics**  
 $V_{CE} = 50V$ ;  $t_p = 20\mu s$



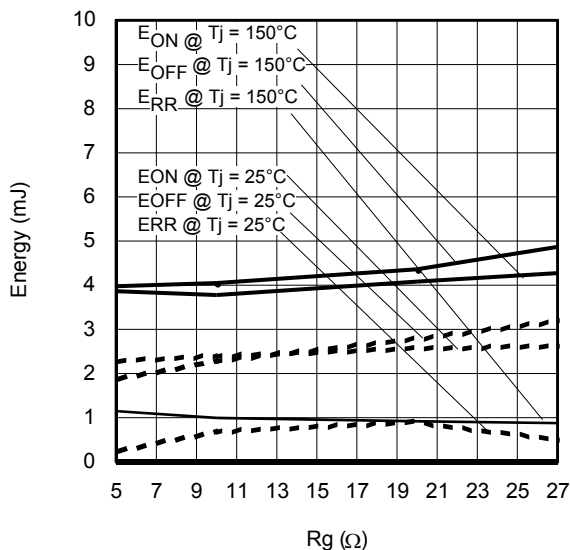
**Fig. 7 - Typical Gate Charge vs.  $V_{GE}$**   
 $I_{CE} = 35A$



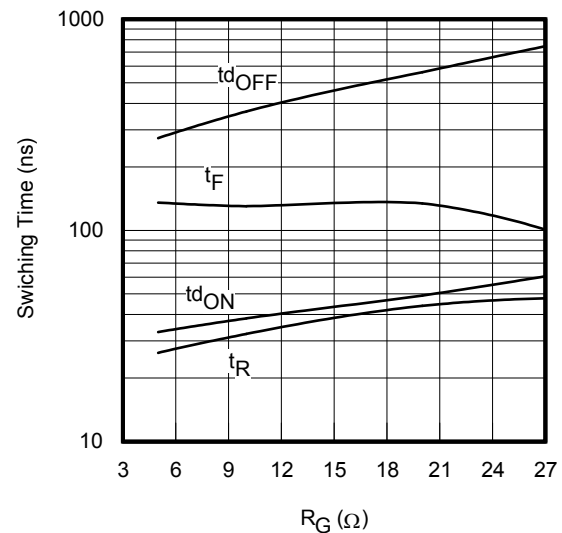
**Fig. 8 - Typ. Energy Loss vs.  $I_C$**   
 $V_{CE} = 600V$ ,  $R_G = 5.0\Omega$ ;  $V_{GE} = 15V$



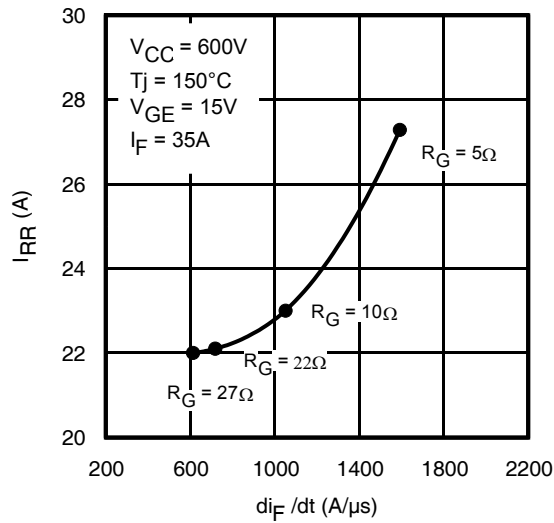
**Fig. 9 - Typ. Switching Time vs.  $I_C$**   
 $T_J = 150^\circ C$ ;  $V_{CE} = 600V$ ,  $R_G = 5.0\Omega$ ;  $V_{GE} = 15V$



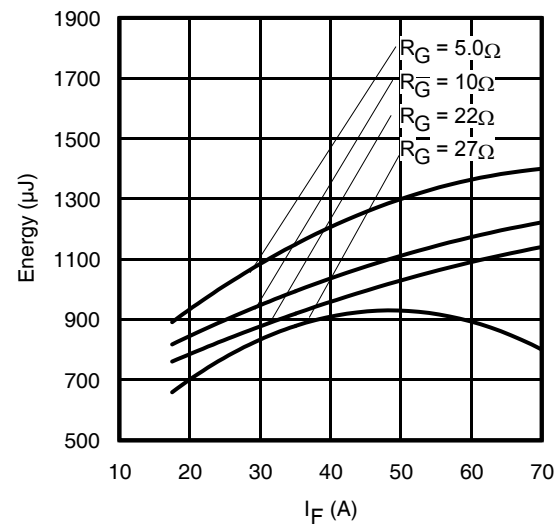
**Fig. 10 - Typ. Energy Loss vs.  $R_G$**   
 $V_{CE} = 600V$ ,  $I_{CE} = 35A$ ;  $V_{GE} = 15V$



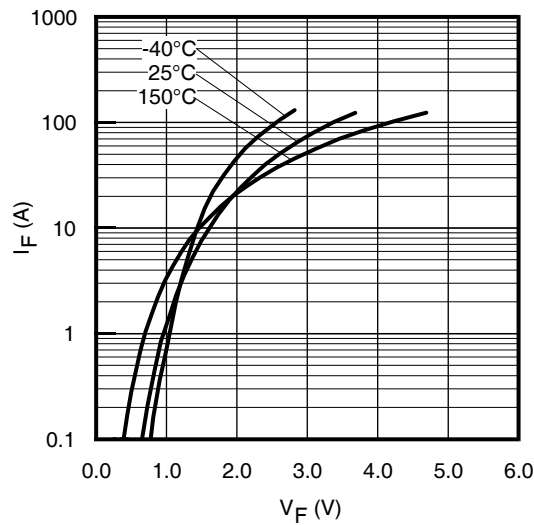
**Fig. 11 - Typ. Switching Time vs.  $R_G$**   
 $T_J = 150^\circ C$ ;  $V_{CE} = 600V$ ,  $I_{CE} = 35A$ ;  $V_{GE} = 15V$



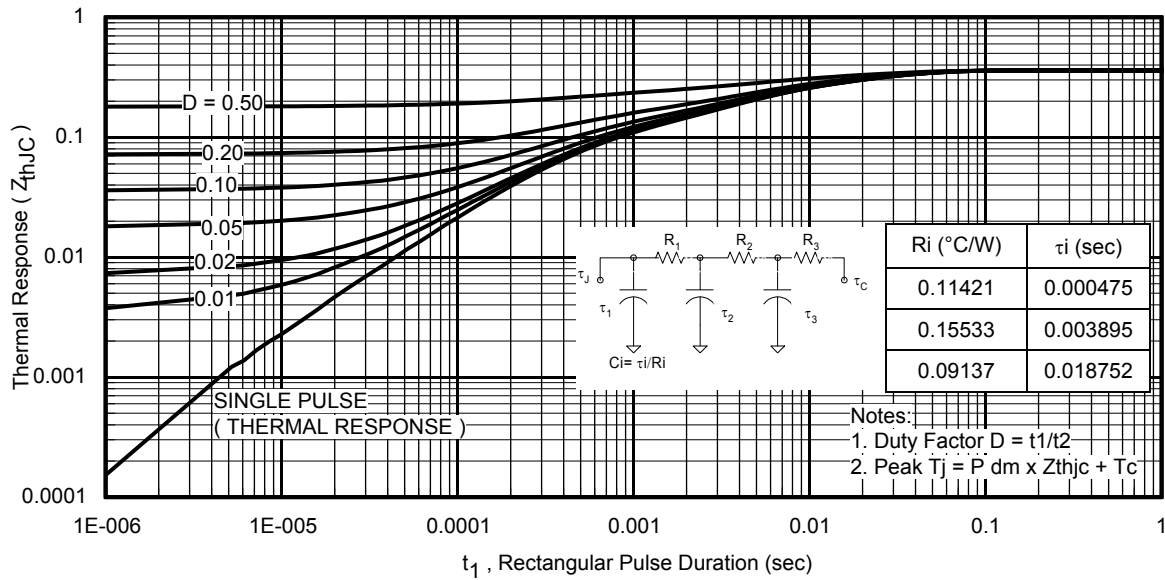
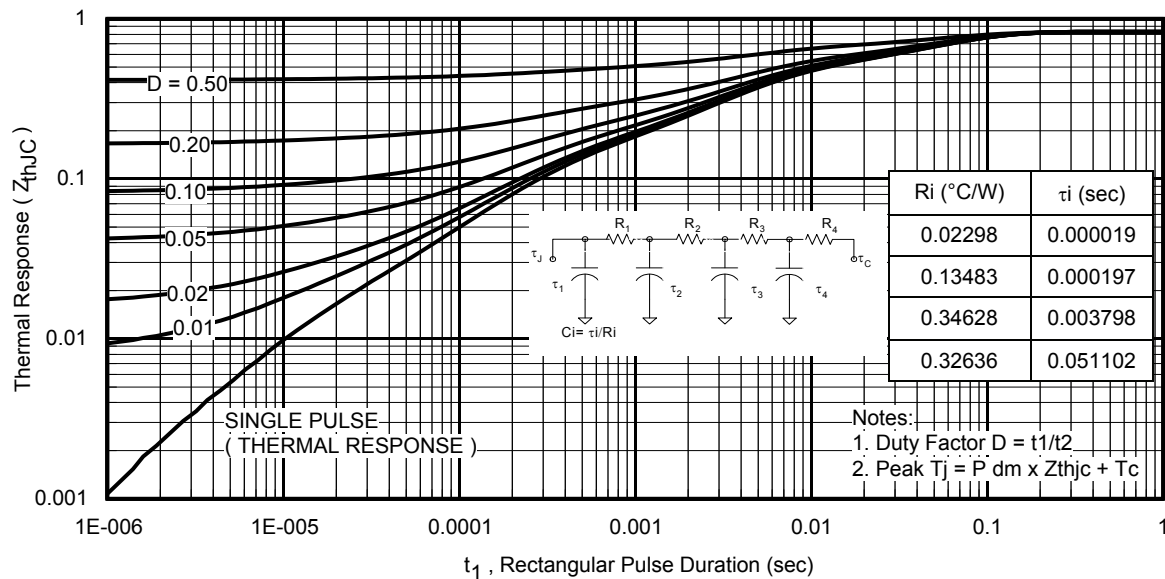
**Fig. 12** - Typ.  $I_{RR}$  vs.  $di/dt$

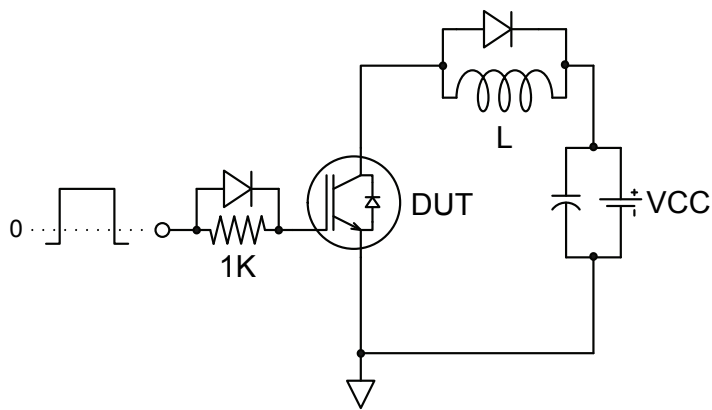
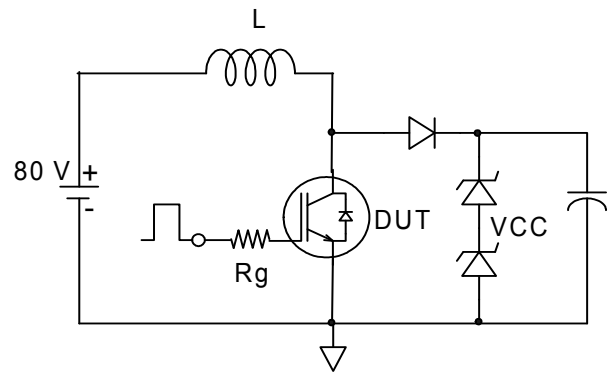
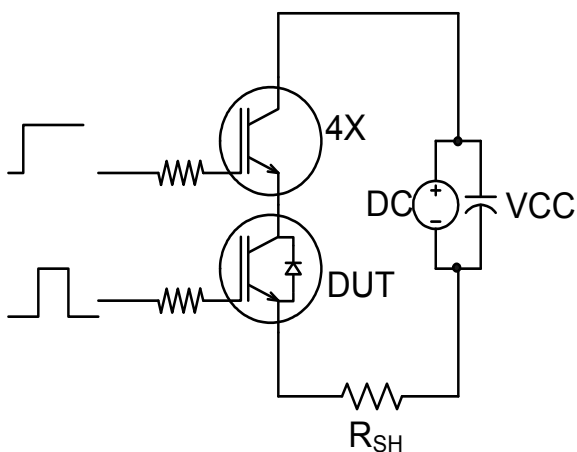
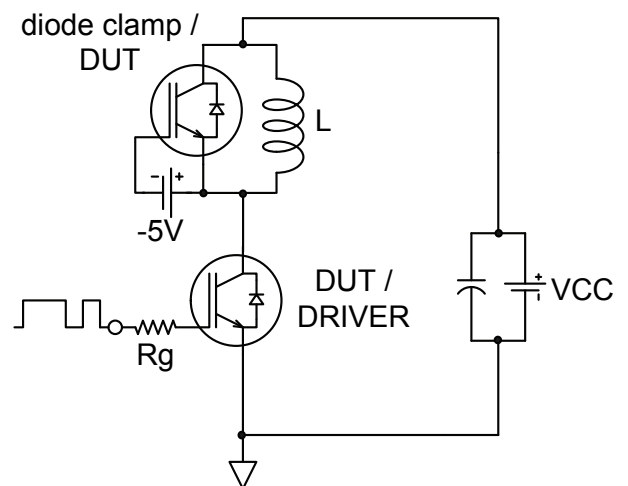
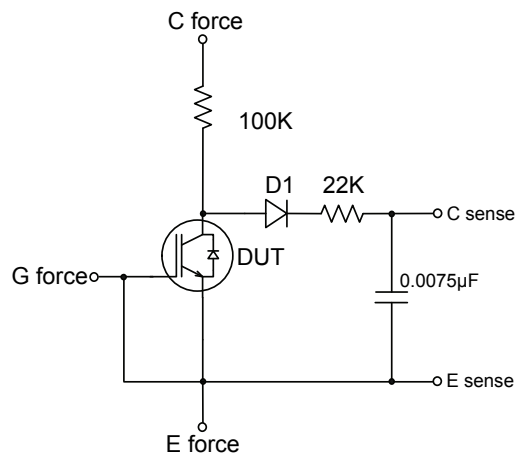


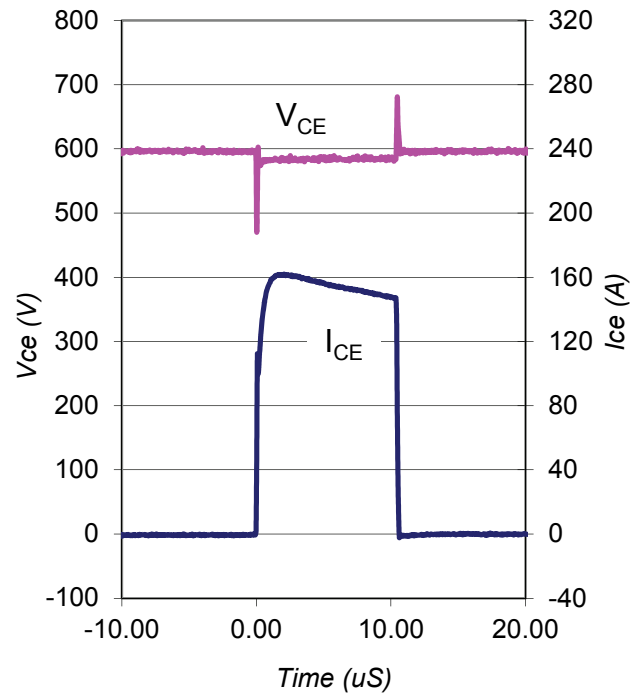
**Fig. 13** - Typ. Diode  $E_{RR}$  vs.  $I_F$   
 $T_J = 150^\circ C$



**Fig. 14** - Typ. Diode Forward Voltage Drop Characteristics


**Fig. 15 - Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)**

**Fig. 16 - Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)**

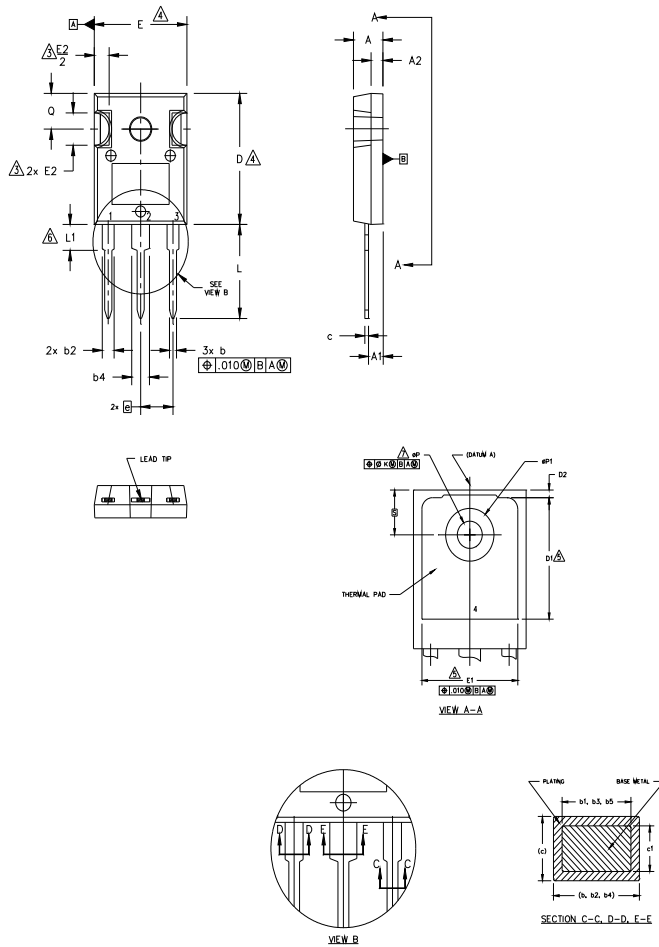

**Fig.C.T.1 - Gate Charge Circuit (turn-off)**

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

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

**Fig.C.T.4 - Switching Loss Circuit  
(Board Stray Inductance 180nH)**

**Fig.C.T.5 - BVCES Filter Circuit**



**Fig. WF1** - Typ. S.C. Waveform  
@  $T_J = 150^\circ\text{C}$  using Fig. CT.3

## TO-247AC 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.  $\phi P$  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-247AC.

| SYMBOL | DIMENSIONS |      |             |       | NOTES |
|--------|------------|------|-------------|-------|-------|
|        | 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      | .559       | .634 | 14.20       | 16.10 |       |
| 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

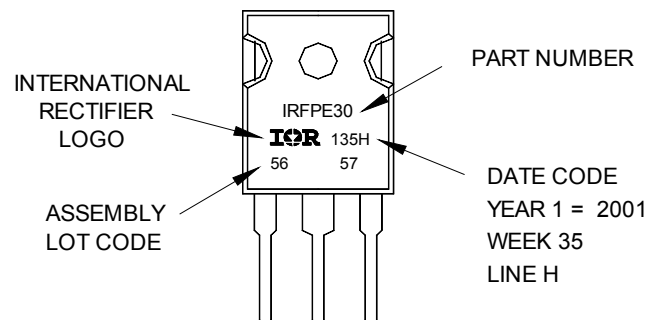
- 1.- ANODE/OPEN
- 2.- CATHODE
- 3.- ANODE

## TO-247AC Part Marking Information

Notes: This part marking information applies to devices produced after 02/26/2001

EXAMPLE: THIS IS AN IRFPE30  
WITH ASSEMBLY  
LOT CODE 5657  
ASSEMBLED ON WW 35, 2001  
IN THE ASSEMBLY LINE "H"

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

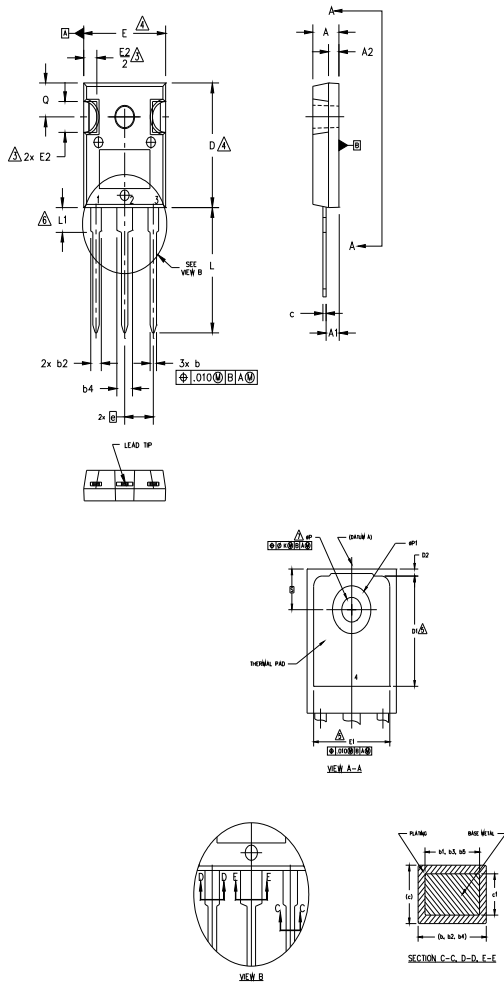


TO-247AC package is not recommended for Surface Mount Application.

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

## 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 |      |
| D1     | .515       | —    | 13.08       | —     | 4    |
| D2     | .020       | .053 | 0.51        | 1.35  | 5    |
| E      | .602       | .625 | 15.29       | 15.87 |      |
| 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

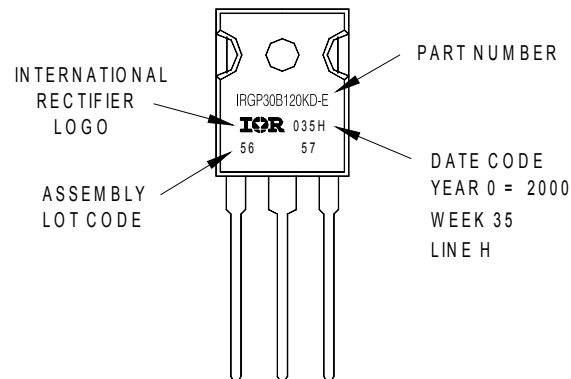
### DIODES

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

## TO-247AD Part Marking Information

EXAMPLE: THIS IS AN IRGP30B120KD-E  
WITH ASSEMBLY  
LOT CODE 5657  
ASSEMBLED ON WW 35, 2000  
IN THE ASSEMBLY LINE "H"

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



TO-247AD package is not recommended for Surface Mount Application.

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

**Qualification Information<sup>†</sup>**

| Qualification Level        | Industrial <sup>†</sup><br>(per JEDEC JESD47F) <sup>††</sup> |     |
|----------------------------|--------------------------------------------------------------|-----|
|                            | TO-247AC                                                     | N/A |
| Moisture Sensitivity Level | TO-247AD                                                     | N/A |
| RoHS Compliant             | Yes                                                          |     |

<sup>†</sup> Qualification standards can be found at International Rectifier's web site: <http://www.irf.com/product-info/reliability/>

<sup>††</sup> Applicable version of JEDEC standard at the time of product release.