

**INSULATED GATE BIPOLAR TRANSISTOR**

# IRG7PH50UPbF

## IRG7PH50U-EP

### Features

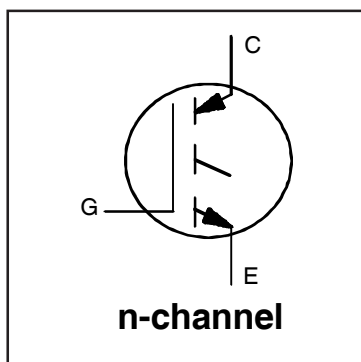
- Low  $V_{CE(ON)}$  trench IGBT technology
- Low switching losses
- Maximum junction temperature 175 °C
- Square RBSOA
- 100% of the parts tested for  $I_{LM}$
- Positive  $V_{CE(ON)}$  temperature co-efficient
- Tight parameter distribution
- Lead-Free

### Benefits

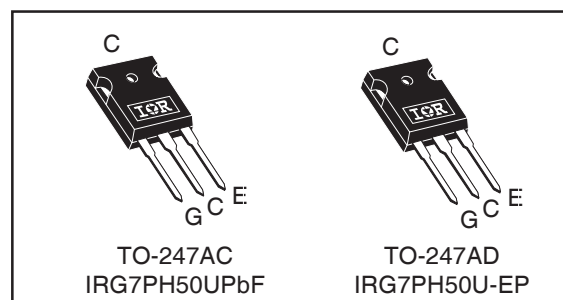
- High efficiency in a wide range of applications
- Suitable for a wide range of switching frequencies due to low  $V_{CE(ON)}$  and low switching losses
- Rugged transient performance for increased reliability
- Excellent current sharing in parallel operation

### Applications

- U.P.S
- Welding
- Solar inverter
- Induction heating



|                                  |
|----------------------------------|
| $V_{CES} = 1200V$                |
| $I_C = 90A, T_C = 100^\circ C$   |
| $T_{J(max)} = 175^\circ C$       |
| $V_{CE(on)} \text{ typ.} = 1.7V$ |



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

### Absolute Maximum Ratings

|                           | Parameter                                        | Max.                                                     | Units |
|---------------------------|--------------------------------------------------|----------------------------------------------------------|-------|
| $V_{CES}$                 | Collector-to-Emitter Voltage                     | 1200                                                     | V     |
| $I_C @ T_C = 25^\circ C$  | Continuous Collector Current (Silicon Limited)   | 140                                                      | A     |
| $I_C @ T_C = 100^\circ C$ | Continuous Collector Current (Silicon Limited)   | 90                                                       |       |
| $I_{NOMINAL}$             | Nominal Current                                  | 50                                                       |       |
| $I_{CM}$                  | Pulse Collector Current, $V_{GE} = 15V$          | 150                                                      |       |
| $I_{LM}$                  | Clamped Inductive Load Current, $V_{GE} = 20V$ ① | 200                                                      |       |
| $V_{GE}$                  | Continuous Gate-to-Emitter Voltage               | $\pm 30$                                                 | V     |
| $P_D @ T_C = 25^\circ C$  | Maximum Power Dissipation                        | 556                                                      | W     |
| $P_D @ T_C = 100^\circ C$ | Maximum Power Dissipation                        | 278                                                      |       |
| $T_J$                     | Operating Junction and                           | -55 to +175                                              | °C    |
| $T_{STG}$                 | Storage Temperature Range                        |                                                          |       |
|                           | Soldering Temperature, for 10 sec.               |                                                          |       |
|                           | Mounting Torque, 6-32 or M3 Screw                | 300 (0.063 in. (1.6mm) from case)<br>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) TO-247AC ④     | —    | —    | 0.27 | °C/W  |
| $R_{\theta CS}$        | Thermal Resistance, Case-to-Sink (flat, greased surface) ④     | —    | 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)

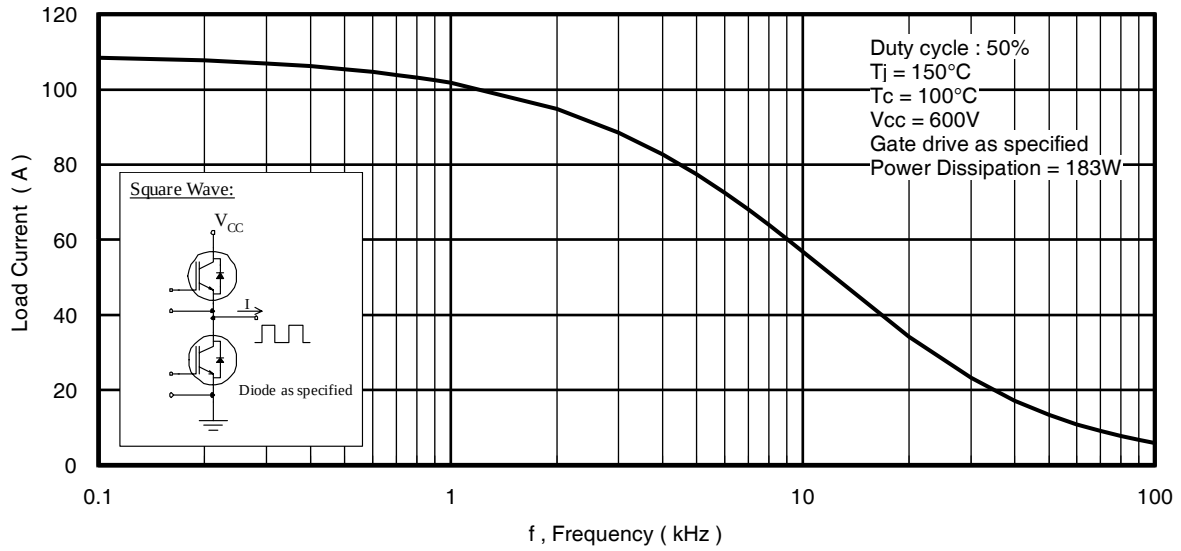
|                                 | Parameter                               | Min. | Typ. | Max.      | Units   | Conditions                                             |
|---------------------------------|-----------------------------------------|------|------|-----------|---------|--------------------------------------------------------|
| $V_{(BR)CES}$                   | Collector-to-Emitter Breakdown Voltage  | 1200 | —    | —         | V       | $V_{GE} = 0V, I_C = 100\mu A$ ③                        |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage | —    | 1.0  | —         | V/°C    | $V_{GE} = 0V, I_C = 1mA$ (25°C-150°C) ③                |
| $V_{CE(on)}$                    | Collector-to-Emitter Saturation Voltage | —    | 1.7  | 2.0       | V       | $I_C = 50A, V_{GE} = 15V, T_J = 25^\circ\text{C}$ ②    |
|                                 |                                         | —    | 2.0  | —         |         | $I_C = 50A, V_{GE} = 15V, T_J = 150^\circ\text{C}$ ②   |
|                                 |                                         | —    | 2.1  | —         |         | $I_C = 50A, V_{GE} = 15V, T_J = 175^\circ\text{C}$ ②   |
| $V_{GE(th)}$                    | Gate Threshold Voltage                  | 3.0  | —    | 6.0       | V       | $V_{CE} = V_{GE}, I_C = 2.0mA$                         |
| $\Delta V_{GE(th)}/\Delta T_J$  | Threshold Voltage temp. coefficient     | —    | -17  | —         | mV/°C   | $V_{CE} = V_{GE}, I_C = 1mA$ (25°C - 175°C)            |
| $g_{fe}$                        | Forward Transconductance                | —    | 55   | —         | S       | $V_{CE} = 50V, I_C = 50A, PW = 80\mu s$                |
| $I_{CES}$                       | Collector-to-Emitter Leakage Current    | —    | 2.0  | 100       | $\mu A$ | $V_{GE} = 0V, V_{CE} = 1200V$                          |
|                                 |                                         | —    | 1700 | —         |         | $V_{GE} = 0V, V_{CE} = 1200V, T_J = 175^\circ\text{C}$ |
| $I_{GES}$                       | Gate-to-Emitter Leakage Current         | —    | —    | $\pm 200$ | nA      | $V_{GE} = \pm 30V$                                     |

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

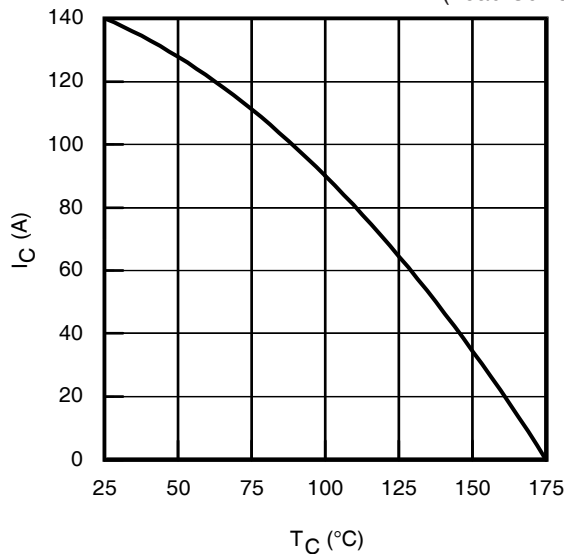
|              | Parameter                          | Min.        | Typ. | Max. | Units   | Conditions                                                                                                               |
|--------------|------------------------------------|-------------|------|------|---------|--------------------------------------------------------------------------------------------------------------------------|
| $Q_g$        | Total Gate Charge (turn-on)        | —           | 290  | 440  | nC      | $I_C = 50A$ ②                                                                                                            |
| $Q_{ge}$     | Gate-to-Emitter Charge (turn-on)   | —           | 40   | 60   |         | $V_{GE} = 15V$                                                                                                           |
| $Q_{gc}$     | Gate-to-Collector Charge (turn-on) | —           | 110  | 170  |         | $V_{CC} = 600V$                                                                                                          |
| $E_{on}$     | Turn-On Switching Loss             | —           | 3600 | 4600 | $\mu J$ | $I_C = 50A, V_{CC} = 600V, V_{GE} = 15V$ ②                                                                               |
| $E_{off}$    | Turn-Off Switching Loss            | —           | 2200 | 3200 |         | $R_G = 5.0\Omega, L = 200\mu H, T_J = 25^\circ\text{C}$                                                                  |
| $E_{total}$  | Total Switching Loss               | —           | 5800 | 7800 |         | Energy losses include tail & diode reverse recovery<br>Diode clamp the same as IRG7PH50UDPbF                             |
| $t_{d(on)}$  | Turn-On delay time                 | —           | 35   | 55   | ns      | Diode clamp the same as IRG7PH50UDPbF                                                                                    |
| $t_r$        | Rise time                          | —           | 40   | 60   |         |                                                                                                                          |
| $t_{d(off)}$ | Turn-Off delay time                | —           | 430  | 500  |         |                                                                                                                          |
| $t_f$        | Fall time                          | —           | 45   | 65   |         |                                                                                                                          |
| $E_{on}$     | Turn-On Switching Loss             | —           | 5600 | —    | $\mu J$ | $I_C = 50A, V_{CC} = 600V, V_{GE} = 15V$ ②                                                                               |
| $E_{off}$    | Turn-Off Switching Loss            | —           | 3900 | —    |         | $R_G = 5.0\Omega, L = 200\mu H, T_J = 175^\circ\text{C}$                                                                 |
| $E_{total}$  | Total Switching Loss               | —           | 9500 | —    |         | Energy losses include tail & diode reverse recovery<br>Diode clamp the same as IRG7PH50UDPbF                             |
| $t_{d(on)}$  | Turn-On delay time                 | —           | 30   | —    | ns      | Diode clamp the same as IRG7PH50UDPbF                                                                                    |
| $t_r$        | Rise time                          | —           | 45   | —    |         |                                                                                                                          |
| $t_{d(off)}$ | Turn-Off delay time                | —           | 500  | —    |         |                                                                                                                          |
| $t_f$        | Fall time                          | —           | 210  | —    |         |                                                                                                                          |
| $C_{ies}$    | Input Capacitance                  | —           | 6000 | —    | pF      | $V_{GE} = 0V$                                                                                                            |
| $C_{oes}$    | Output Capacitance                 | —           | 190  | —    |         | $V_{CC} = 30V$                                                                                                           |
| $C_{res}$    | Reverse Transfer Capacitance       | —           | 130  | —    |         | $f = 1.0MHz$                                                                                                             |
| RBSOA        | Reverse Bias Safe Operating Area   | FULL SQUARE |      |      |         | $I_C = 200A$<br>$V_{CC} = 960V, V_p = 1200V$<br>$R_g = 5.0\Omega, V_{GE} = +20V \text{ to } 0V, T_J = 175^\circ\text{C}$ |

### Notes:

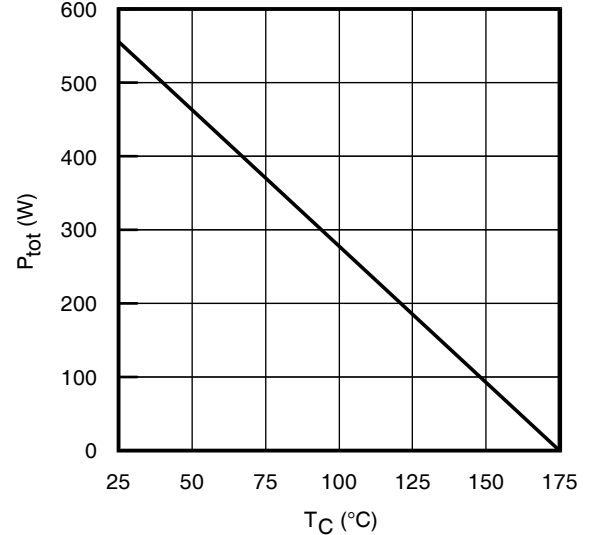
- ①  $V_{CC} = 80\% (V_{CES}), V_{GE} = 20V, L = 200\mu H, R_G = 5.0\Omega$ .
- ② Pulse width  $\leq 400\mu s$ ; duty cycle  $\leq 2\%$ .
- ③ Refer to AN-1086 for guidelines for measuring  $V_{(BR)CES}$  safely.
- ④  $R_g$  is measured at  $T_J$  of approximately  $90^\circ\text{C}$ .



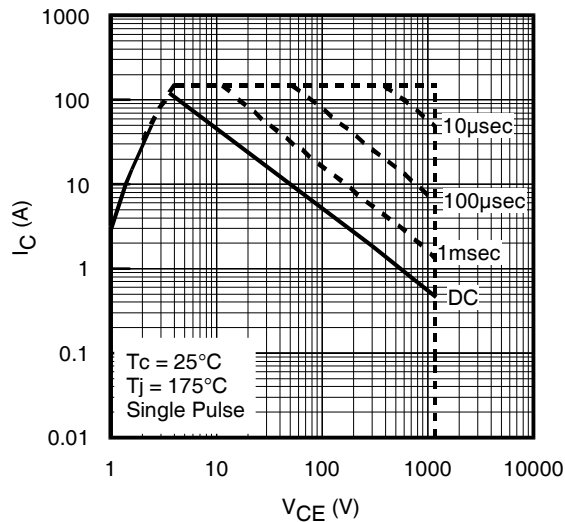
**Fig. 1 - Typical Load Current vs. Frequency**  
 (Load Current =  $I_{RMS}$  of fundamental)



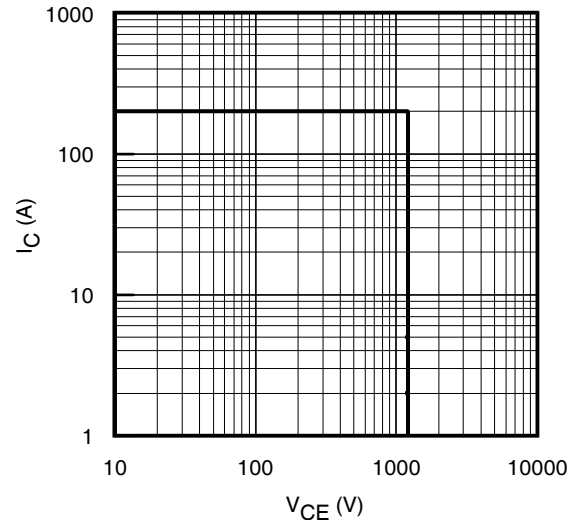
**Fig. 2 - Maximum DC Collector Current vs. Case Temperature**



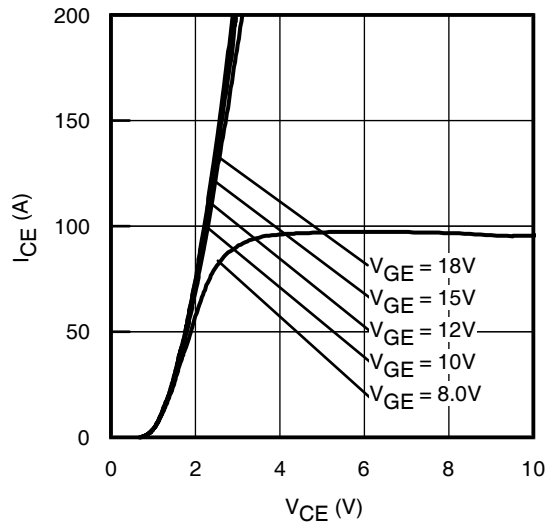
**Fig. 3 - Power Dissipation vs. Case Temperature**



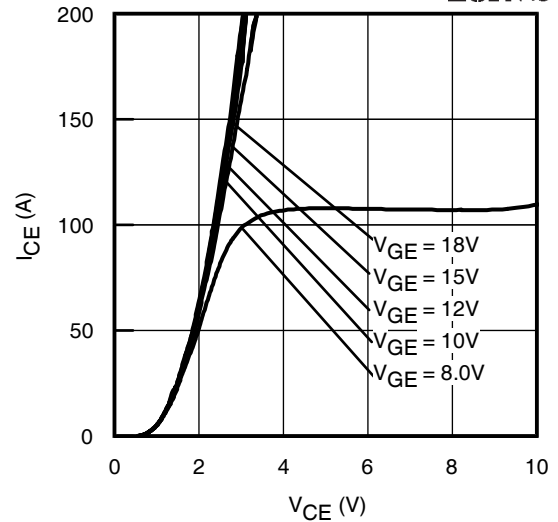
**Fig. 4 - Forward SOA**  
 $T_C = 25^{\circ}\text{C}$ ,  $T_J \leq 175^{\circ}\text{C}$ ;  $V_{GE} = 15\text{V}$



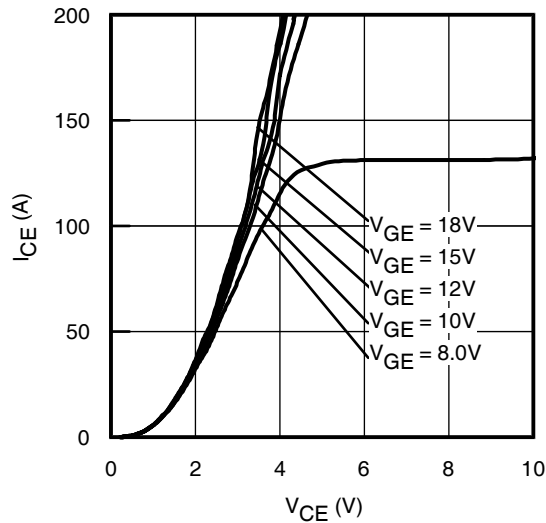
**Fig. 5 - Reverse Bias SOA**  
 $T_J = 175^{\circ}\text{C}$ ;  $V_{GE} = 20\text{V}$



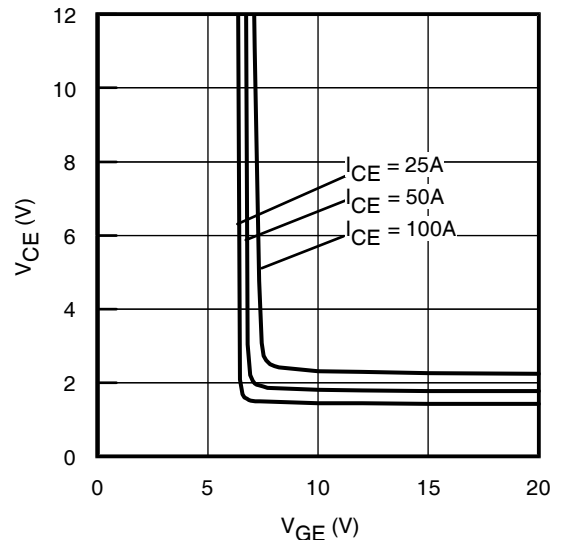
**Fig. 6** - Typ. IGBT Output Characteristics  
 $T_J = -40^{\circ}\text{C}$ ;  $t_p = 30\mu\text{s}$



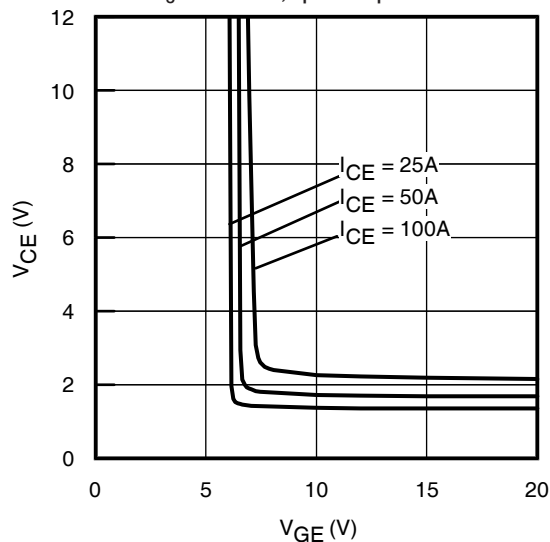
**Fig. 7** - Typ. IGBT Output Characteristics  
 $T_J = 25^{\circ}\text{C}$ ;  $t_p = 30\mu\text{s}$



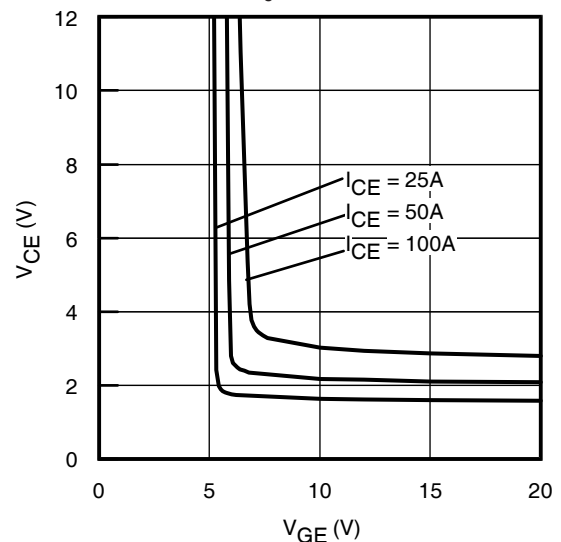
**Fig. 8** - Typ. IGBT Output Characteristics  
 $T_J = 175^{\circ}\text{C}$ ;  $t_p = 30\mu\text{s}$



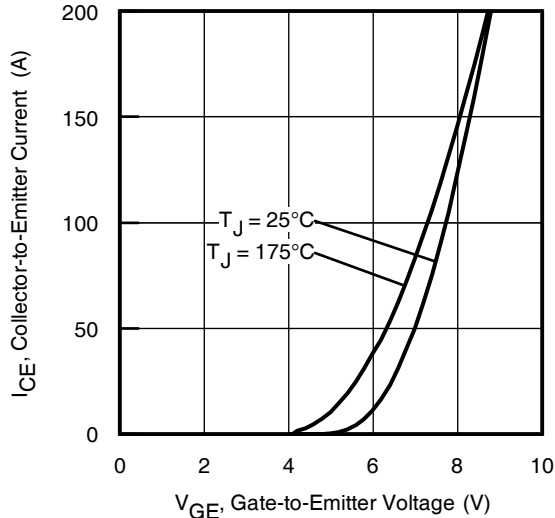
**Fig. 9** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = -40^{\circ}\text{C}$



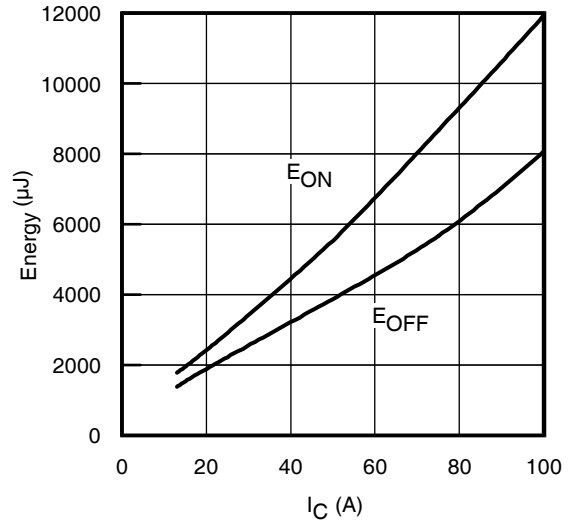
**Fig. 10** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 25^{\circ}\text{C}$



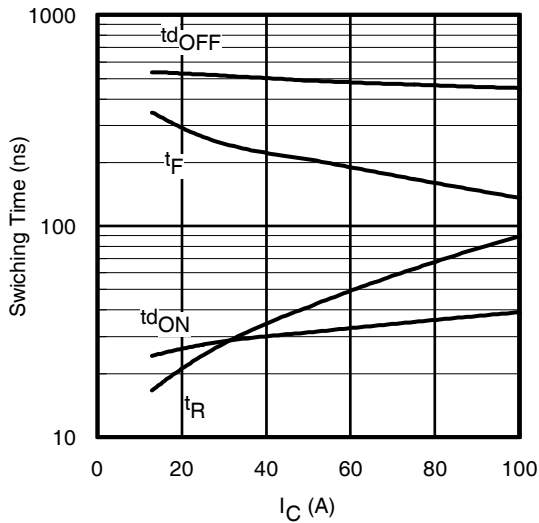
**Fig. 11** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 175^{\circ}\text{C}$



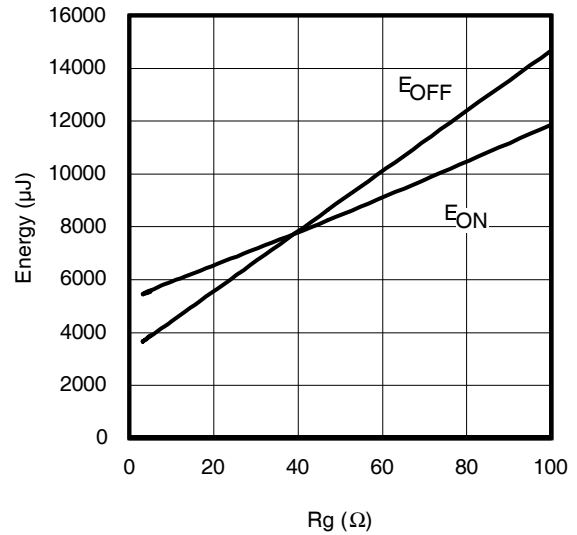
**Fig. 12 - Typ. Transfer Characteristics**  
 $V_{CE} = 50V$ ;  $t_p = 30\mu s$



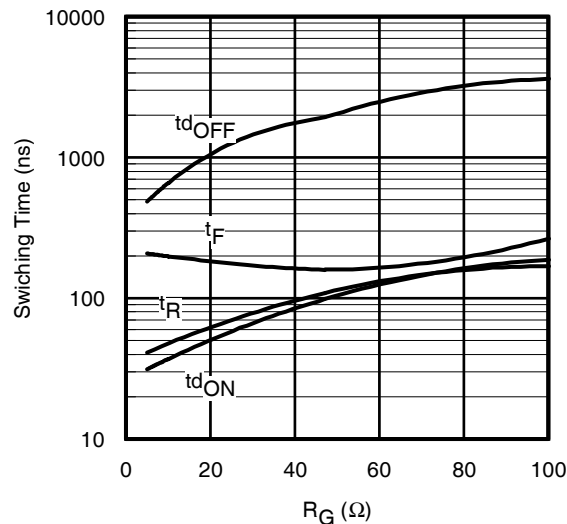
**Fig. 13 - Typ. Energy Loss vs.  $I_C$**   
 $T_J = 175^\circ C$ ;  $L = 200\mu H$ ;  $V_{CE} = 600V$ ;  $R_G = 5.0\Omega$ ;  $V_{GE} = 15V$



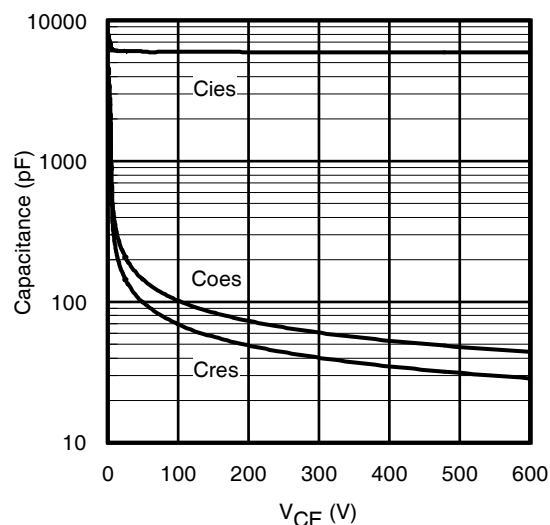
**Fig. 14 - Typ. Switching Time vs.  $I_C$**   
 $T_J = 175^\circ C$ ;  $L = 200\mu H$ ;  $V_{CE} = 600V$ ;  $R_G = 5.0\Omega$ ;  $V_{GE} = 15V$



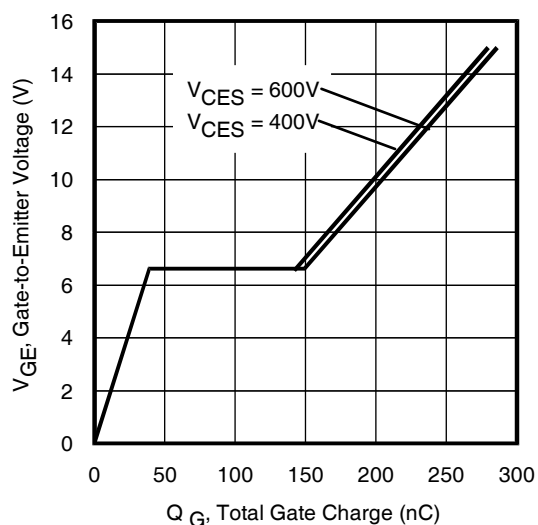
**Fig. 15 - Typ. Energy Loss vs.  $R_G$**   
 $T_J = 175^\circ C$ ;  $L = 200\mu H$ ;  $V_{CE} = 600V$ ;  $I_{CE} = 50A$ ;  $V_{GE} = 15V$



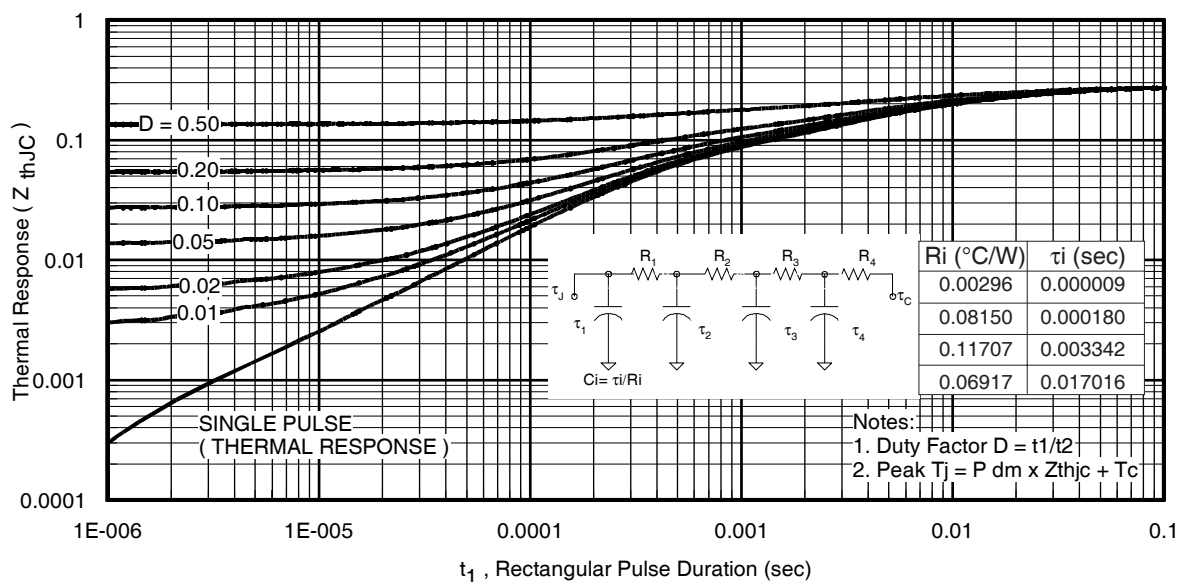
**Fig. 16 - Typ. Switching Time vs.  $R_G$**   
 $T_J = 175^\circ C$ ;  $L = 200\mu H$ ;  $V_{CE} = 600V$ ;  $I_{CE} = 50A$ ;  $V_{GE} = 15V$



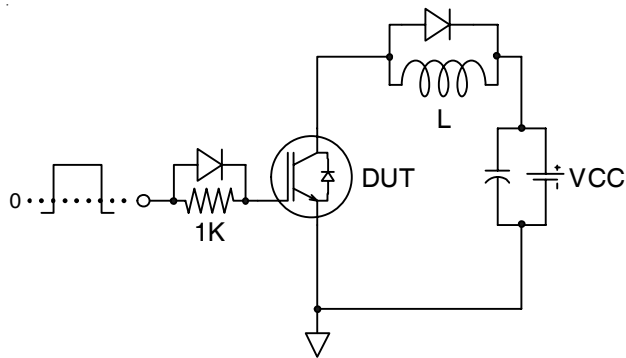
**Fig. 17** - Typ. Capacitance vs.  $V_{CE}$   
 $V_{GE} = 0V$ ;  $f = 1MHz$



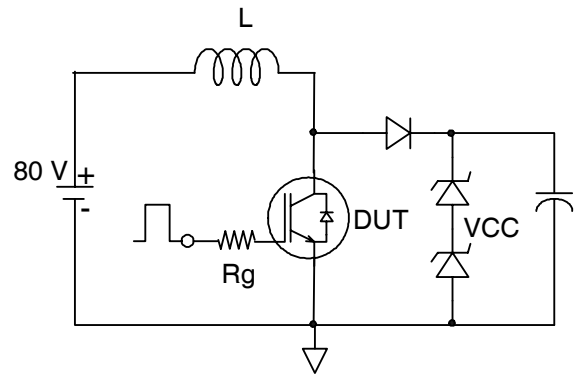
**Fig. 18** - Typical Gate Charge vs.  $V_{GE}$   
 $I_{CE} = 50A$



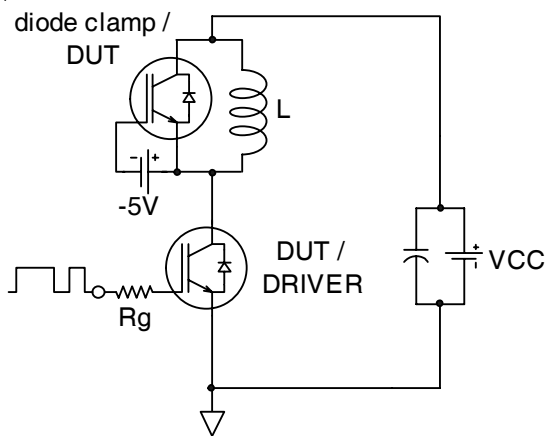
**Fig 19.** Maximum Transient Thermal Impedance, Junction-to-Case (IGBT) TO-247AC



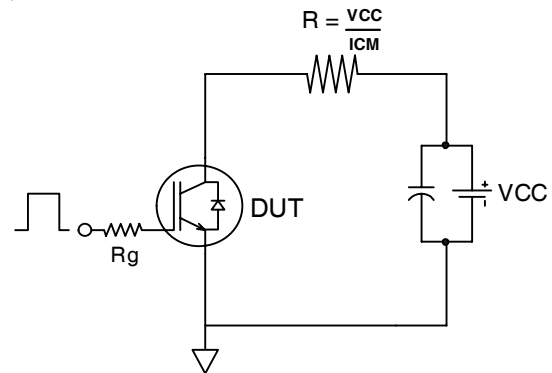
**Fig.C.T.1** - Gate Charge Circuit (turn-off)



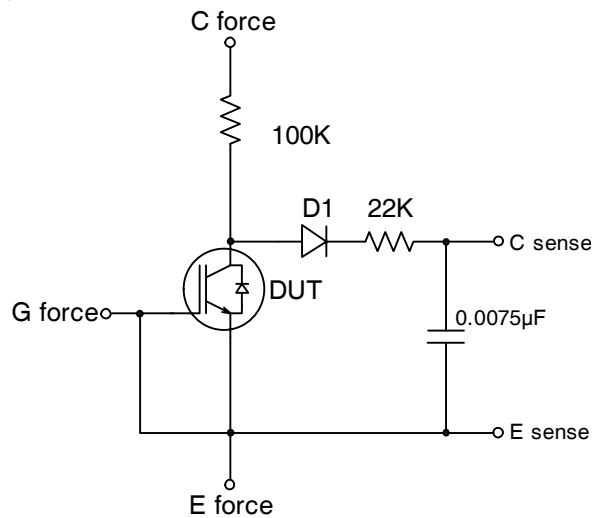
**Fig.C.T.2** - RBSOA Circuit



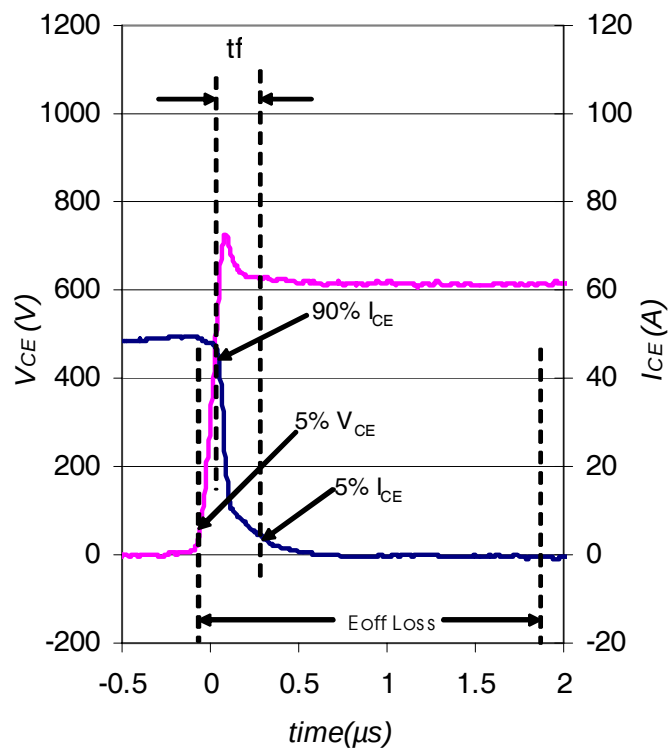
**Fig.C.T.3** - Switching Loss Circuit



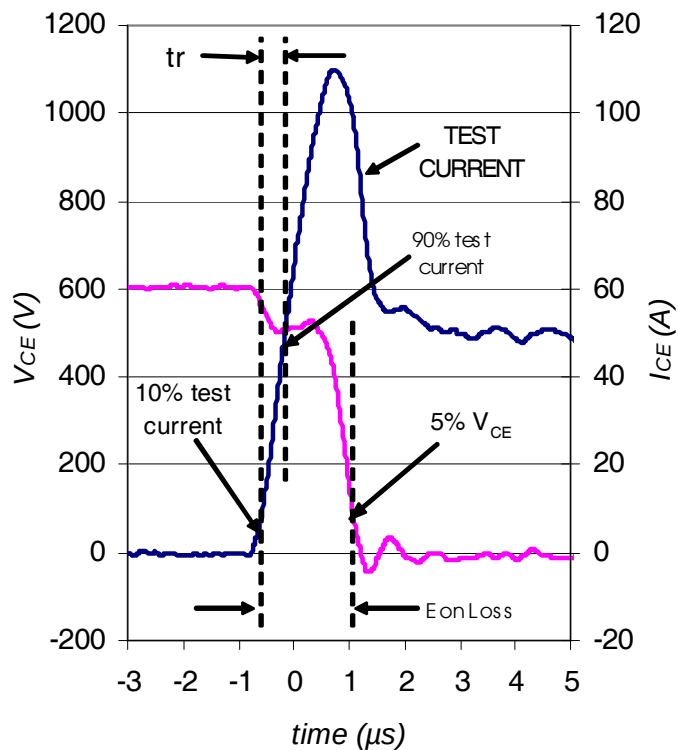
**Fig.C.T.4** - Resistive Load Circuit



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



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

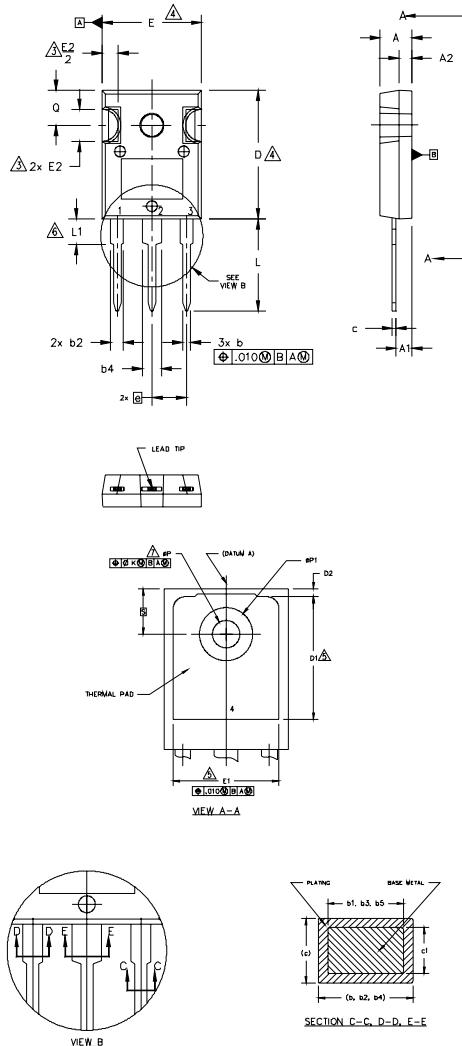


**Fig. WF2** - Typ. Turn-on Loss Waveform  
@  $T_J = 175^\circ\text{C}$  using Fig. CT.4



## 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. ØP TO HAVE A MAXIMUM DRAFT ANGLE OF 1.5 ° TO THE TOP OF THE PART WITH A MAXIMUM HOLE DIAMETER OF .154 INCH.
- B. 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  | 4     |   |
| D      | .776       | .815 | 19.71       | 20.70 |       |   |
| 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

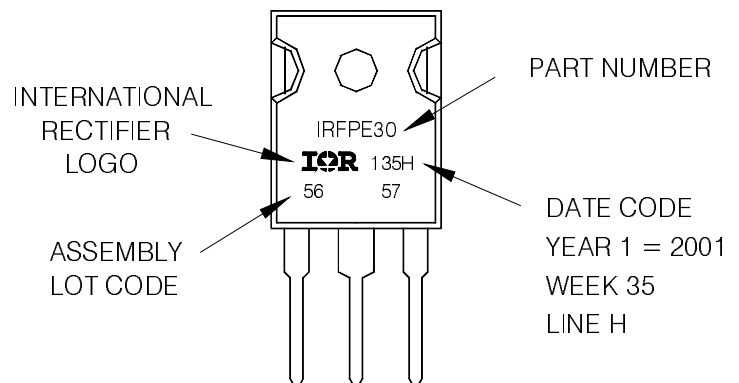
#### DIODES

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

## TO-247AC Part Marking Information

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"

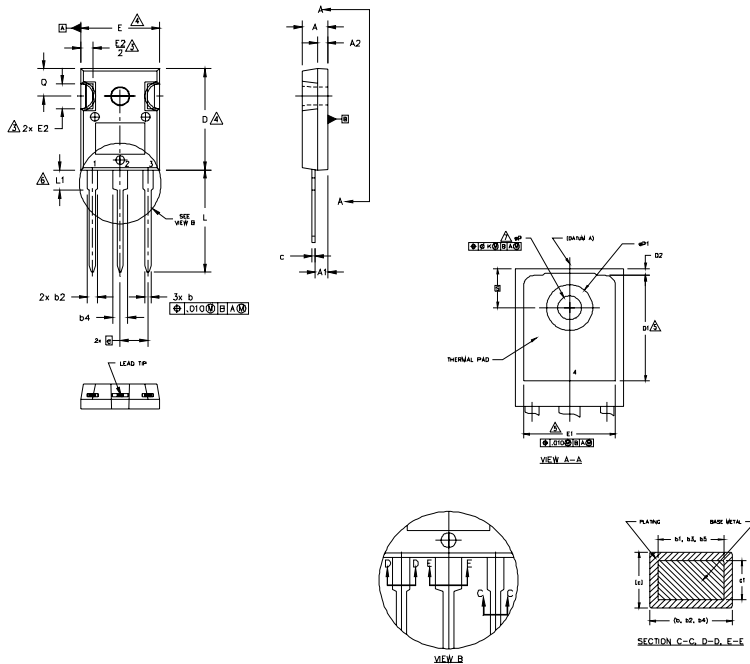


TO-247AC package is not recommended for Surface Mount Application.

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:

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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    |       |      |
| ek        | .010       |      | 0.25        |       |      |
| L         | .780       | .827 | 19.57       | 21.00 |      |
| L1        | .146       | .169 | 3.71        | 4.29  |      |
| $\phi P$  | .140       | .144 | 3.56        | 3.66  |      |
| $\phi P1$ | -          | .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

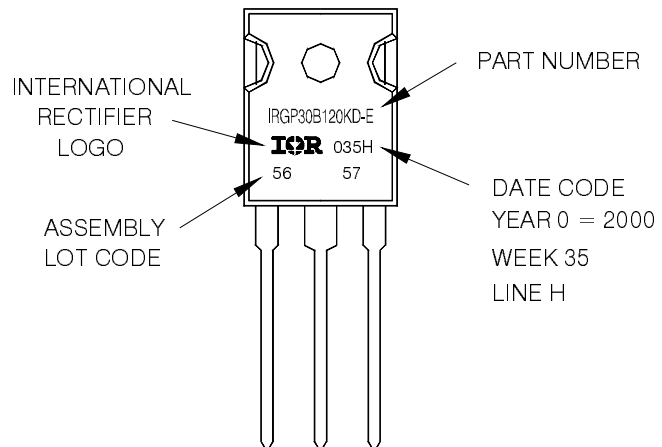
#### DIODES

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/>

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.