

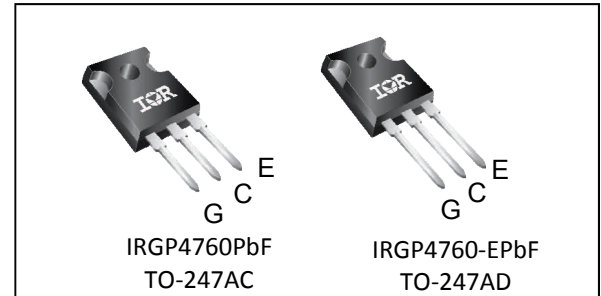
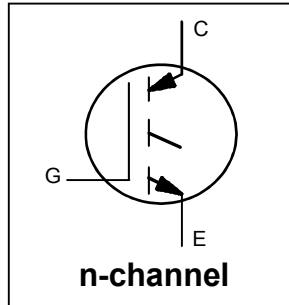
**Insulated Gate Bipolar Transistor**

$$V_{CES} = 650V$$

$$I_C = 60A, T_C = 100^\circ C$$

$$t_{SC} \geq 5.5\mu s, T_{J(max)} = 175^\circ C$$

$$V_{CE(ON)} \text{ typ.} = 1.7V @ I_C = 48A$$



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

**Applications**

- Industrial Motor Drive
- UPS
- Solar Inverters
- Welding

| Features                                      | Benefits                                        |
|-----------------------------------------------|-------------------------------------------------|
| Low $V_{CE(ON)}$ and Switching Losses         | High Efficiency in a Wide Range of Applications |
| 5.5μs Short Circuit SOA                       | Rugged Transient Performance                    |
| Square RBSOA                                  | Increased Reliability                           |
| Maximum Junction Temperature 175°C            | Excellent Current Sharing in Parallel Operation |
| Positive $V_{CE(ON)}$ Temperature Coefficient | Environmentally friendly                        |
| Lead-Free, RoHs compliant                     |                                                 |

| Base part number | Package Type | Standard Pack |          | Orderable Part Number |
|------------------|--------------|---------------|----------|-----------------------|
|                  |              | Form          | Quantity |                       |
| IRGP4760PbF      | TO-247AC     | Tube          | 25       | IRGP4760PbF           |
| IRGP4760-EPbF    | TO-247AD     | Tube          | 25       | IRGP4760-EPbF         |

**Absolute Maximum Ratings**

|                           | Parameter                                      | Max.                              | Units |
|---------------------------|------------------------------------------------|-----------------------------------|-------|
| $V_{CES}$                 | Collector-to-Emitter Voltage                   | 650                               | V     |
| $I_C @ T_C = 25^\circ C$  | Continuous Collector Current                   | 90                                | A     |
| $I_C @ T_C = 100^\circ C$ | Continuous Collector Current                   | 60                                |       |
| $I_{CM}$                  | Pulse Collector Current, $V_{GE}=15V$          | 144                               |       |
| $I_{LM}$                  | Clamped Inductive Load Current, $V_{GE}=20V$ ① | 192                               |       |
| $V_{GE}$                  | Continuous Gate-to-Emitter Voltage             | ±20                               | V     |
| $P_D @ T_C = 25^\circ C$  | Maximum Power Dissipation                      | 325                               | W     |
| $P_D @ T_C = 100^\circ C$ | Maximum Power Dissipation                      | 160                               |       |
| $T_J$                     | Operating Junction and                         | -40 to +175                       | 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 |
|-----------------|----------------------------------------------------------------|------|------|------|-------|
| $R_{\theta JC}$ | Thermal Resistance Junction-to-Case ②                          | —    | —    | 0.46 | °C/W  |
| $R_{\theta CS}$ | 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<sub>J</sub> = 25°C (unless otherwise specified)**

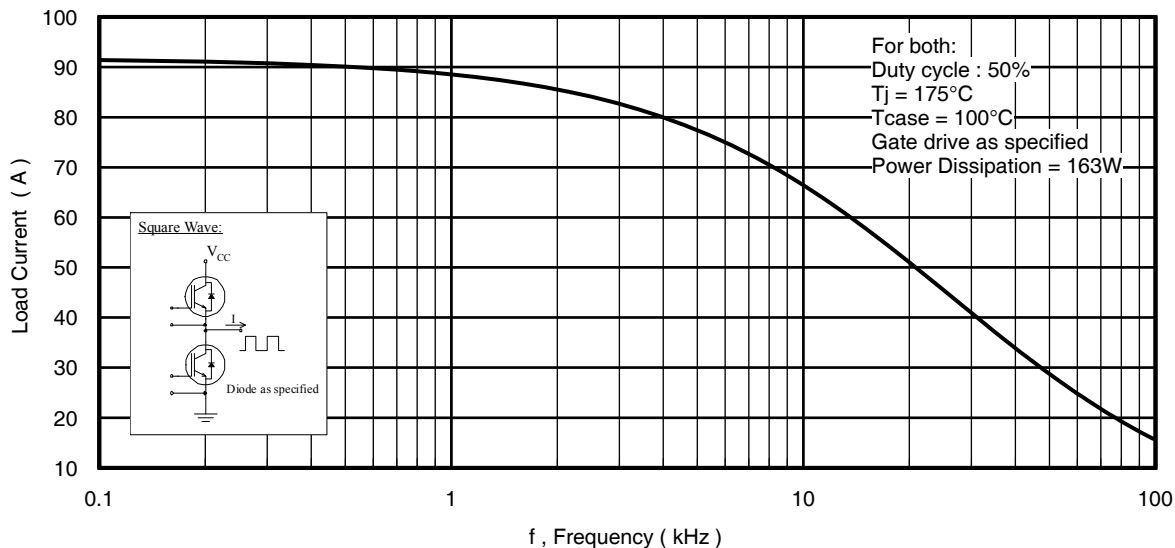
|                                        | Parameter                               | Min. | Typ. | Max. | Units | Conditions                                                              |
|----------------------------------------|-----------------------------------------|------|------|------|-------|-------------------------------------------------------------------------|
| V <sub>(BR)CES</sub>                   | Collector-to-Emitter Breakdown Voltage  | 650  | —    | —    | V     | V <sub>GE</sub> = 0V, I <sub>C</sub> = 100μA ③                          |
| ΔV <sub>(BR)CES</sub> /ΔT <sub>J</sub> | Temperature Coeff. of Breakdown Voltage | —    | 0.69 | —    | V/°C  | V <sub>GE</sub> = 0V, I <sub>C</sub> = 3mA (25°C-175°C)                 |
| V <sub>CE(on)</sub>                    | Collector-to-Emitter Saturation Voltage | —    | 1.7  | 2.0  | V     | I <sub>C</sub> = 48A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 25°C      |
|                                        |                                         | —    | 2.1  | —    |       | I <sub>C</sub> = 48A, V <sub>GE</sub> = 15V, T <sub>J</sub> = 175°C     |
| V <sub>GE(th)</sub>                    | Gate Threshold Voltage                  | 5.5  | —    | 7.4  | V     | V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 1.4mA              |
| ΔV <sub>GE(th)</sub> /ΔT <sub>J</sub>  | Threshold Voltage Temperature Coeff.    | —    | -23  | —    | mV/°C | V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 1.4mA (25°C-150°C) |
| g <sub>fe</sub>                        | Forward Transconductance                | —    | 31   | —    | S     | V <sub>CE</sub> = 50V, I <sub>C</sub> = 48A, PW = 20μs                  |
| I <sub>CES</sub>                       | Collector-to-Emitter Leakage Current    | —    | 1.0  | 25   | μA    | V <sub>GE</sub> = 0V, V <sub>CE</sub> = 650V                            |
|                                        |                                         | —    | 700  | —    |       | V <sub>GE</sub> = 0V, V <sub>CE</sub> = 650V, T <sub>J</sub> = 175°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)**

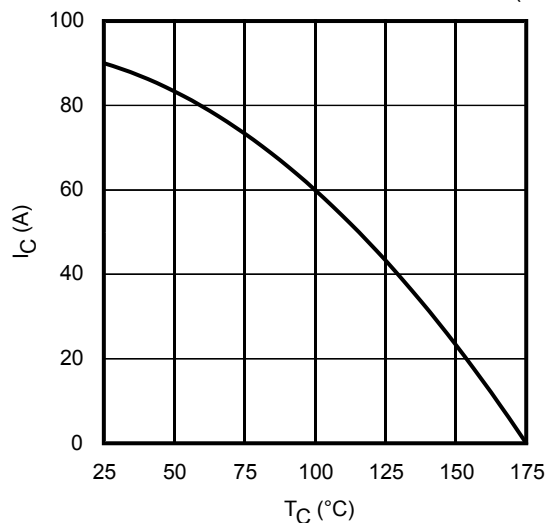
|                     | Parameter                          | Min.        | Typ. | Max④ | Units | Conditions                                                                                                                     |
|---------------------|------------------------------------|-------------|------|------|-------|--------------------------------------------------------------------------------------------------------------------------------|
| Q <sub>g</sub>      | Total Gate Charge (turn-on)        | —           | 96   | 145  | nC    | I <sub>C</sub> = 48A<br>V <sub>GE</sub> = 15V<br>V <sub>CC</sub> = 400V                                                        |
| Q <sub>ge</sub>     | Gate-to-Emitter Charge (turn-on)   | —           | 30   | 45   |       |                                                                                                                                |
| Q <sub>gc</sub>     | Gate-to-Collector Charge (turn-on) | —           | 40   | 60   |       |                                                                                                                                |
| E <sub>on</sub>     | Turn-On Switching Loss             | —           | 1.7  | 2.6  | mJ    | I <sub>C</sub> = 48A, V <sub>CC</sub> = 400V, V <sub>GE</sub> = 15V<br>R <sub>G</sub> = 10Ω, L = 210μH, T <sub>J</sub> = 25°C  |
| E <sub>off</sub>    | Turn-Off Switching Loss            | —           | 1.0  | 1.9  |       |                                                                                                                                |
| E <sub>total</sub>  | Total Switching Loss               | —           | 2.7  | 4.5  |       |                                                                                                                                |
| t <sub>d(on)</sub>  | Turn-On delay time                 | —           | 70   | 90   | ns    | Energy losses include tail & diode reverse recovery ⑤⑥                                                                         |
| t <sub>r</sub>      | Rise time                          | —           | 60   | 80   |       |                                                                                                                                |
| t <sub>d(off)</sub> | Turn-Off delay time                | —           | 140  | 160  |       |                                                                                                                                |
| t <sub>f</sub>      | Fall time                          | —           | 30   | 50   |       |                                                                                                                                |
| E <sub>on</sub>     | Turn-On Switching Loss             | —           | 2.9  | —    | mJ    | I <sub>C</sub> = 48A, V <sub>CC</sub> = 400V, V <sub>GE</sub> = 15V<br>R <sub>G</sub> = 10Ω, L = 210μH, T <sub>J</sub> = 175°C |
| E <sub>off</sub>    | Turn-Off Switching Loss            | —           | 1.4  | —    |       |                                                                                                                                |
| E <sub>total</sub>  | Total Switching Loss               | —           | 4.3  | —    |       |                                                                                                                                |
| t <sub>d(on)</sub>  | Turn-On delay time                 | —           | 55   | —    | ns    | Energy losses include tail & diode reverse recovery ⑤⑥                                                                         |
| t <sub>r</sub>      | Rise time                          | —           | 60   | —    |       |                                                                                                                                |
| t <sub>d(off)</sub> | Turn-Off delay time                | —           | 145  | —    |       |                                                                                                                                |
| t <sub>f</sub>      | Fall time                          | —           | 65   | —    |       |                                                                                                                                |
| C <sub>ies</sub>    | Input Capacitance                  | —           | 3000 | —    | pF    | V <sub>GE</sub> = 0V<br>V <sub>CC</sub> = 30V<br>f = 1.0MHz                                                                    |
| C <sub>oes</sub>    | Output Capacitance                 | —           | 150  | —    |       |                                                                                                                                |
| C <sub>res</sub>    | Reverse Transfer Capacitance       | —           | 80   | —    |       |                                                                                                                                |
| RBSOA               | Reverse Bias Safe Operating Area   | FULL SQUARE |      |      |       | T <sub>J</sub> = 175°C, I <sub>C</sub> = 192A<br>V <sub>CC</sub> = 520V, V <sub>p</sub> ≤ 650V<br>V <sub>GE</sub> = +20V to 0V |
| SCSOA               | Short Circuit Safe Operating Area  | 5.5         | —    | —    | μs    | T <sub>J</sub> = 150°C, V <sub>CC</sub> = 400V, V <sub>p</sub> ≤ 650V<br>V <sub>GE</sub> = +15V to 0V                          |

**Notes:**

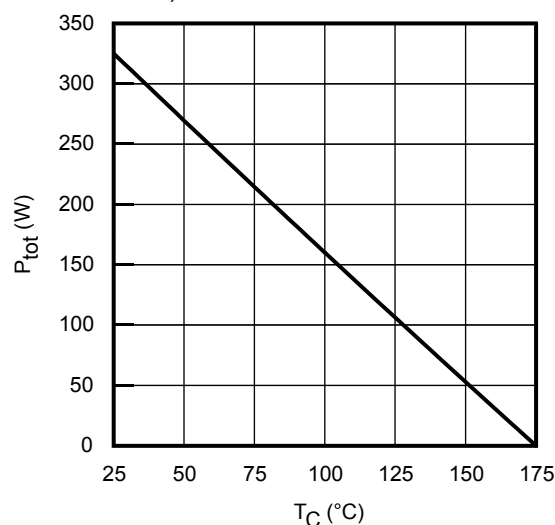
- ① V<sub>CC</sub> = 80% (V<sub>CES</sub>), V<sub>GE</sub> = 20V.
- ② R<sub>θ</sub> is measured at T<sub>J</sub> of approximately 90°C.
- ③ Refer to AN-1086 for guidelines for measuring V<sub>(BR)CES</sub> safely.
- ④ Maximum limits are based on statistical sample size characterization.
- ⑤ Pulse width limited by max. junction temperature.
- ⑥ Values influenced by parasitic L and C in measurement.



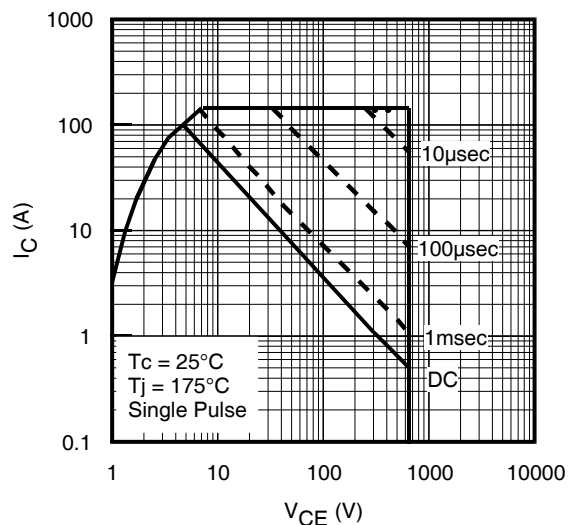
**Fig. 1 - Typical Load Current vs. Frequency**  
 (Load Current =  $I_{\text{RMS}}$  of fundamental)



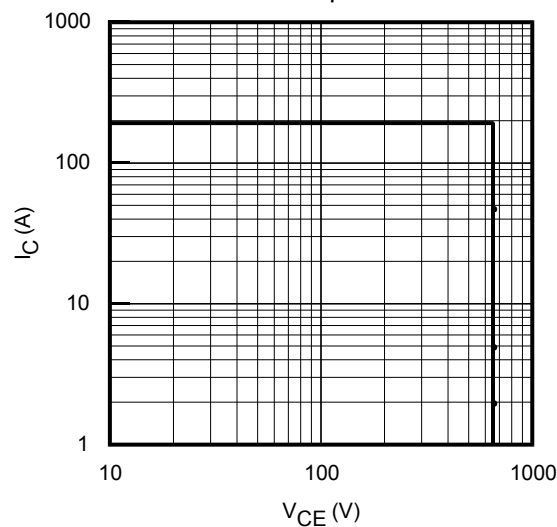
**Fig. 2 - Maximum DC Collector Current vs. Case Temperature**



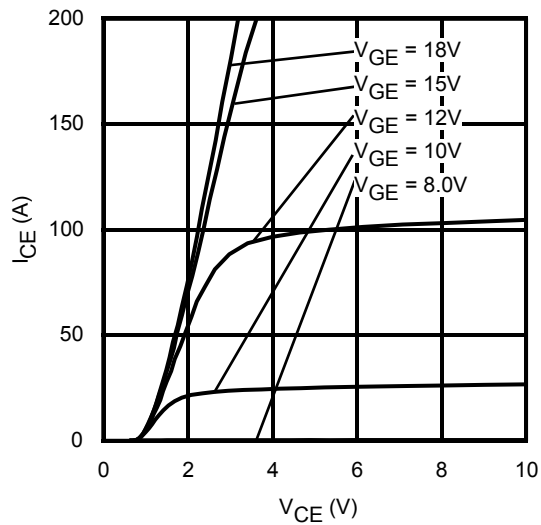
**Fig. 3 - Power Dissipation vs. Case Temperature**



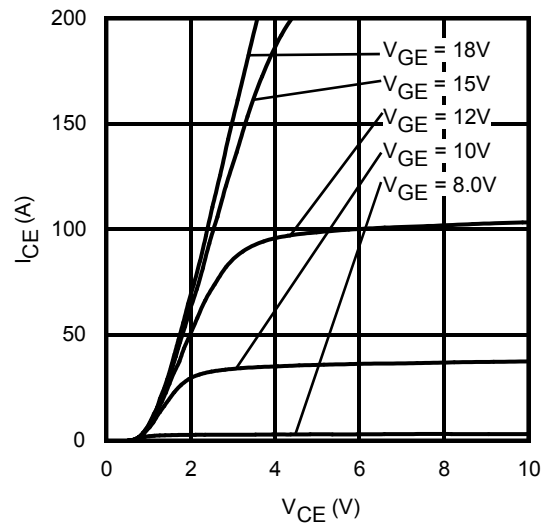
**Fig. 4 - Forward SOA**  
 $T_C = 25^{\circ}\text{C}$ ;  $T_j \leq 175^{\circ}\text{C}$ ;  $V_{\text{GE}} = 15\text{V}$



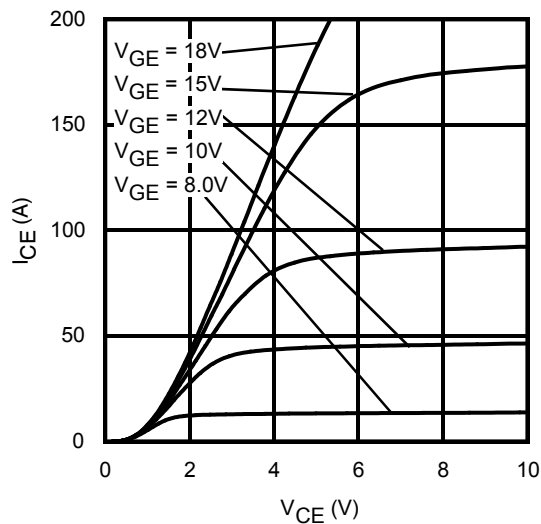
**Fig. 5 - Reverse Bias SOA**  
 $T_j = 175^{\circ}\text{C}$ ;  $V_{\text{GE}} = 20\text{V}$



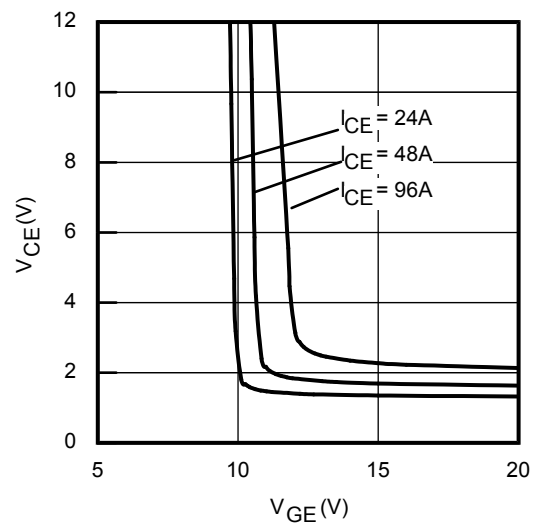
**Fig. 6** - Typ. IGBT Output Characteristics  
 $T_J = -40^{\circ}\text{C}$ ;  $t_p = 20\mu\text{s}$



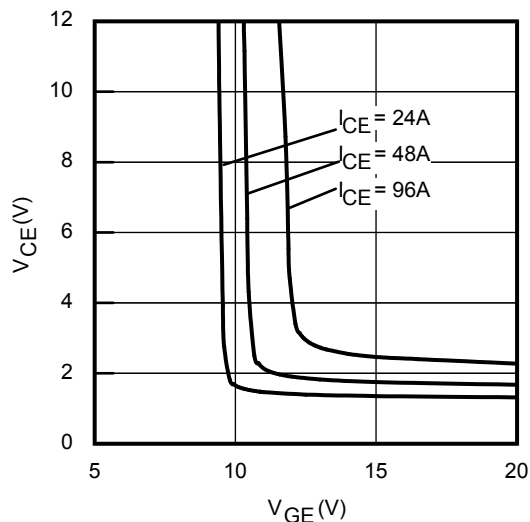
**Fig. 7** - Typ. IGBT Output Characteristics  
 $T_J = 25^{\circ}\text{C}$ ;  $t_p = 20\mu\text{s}$



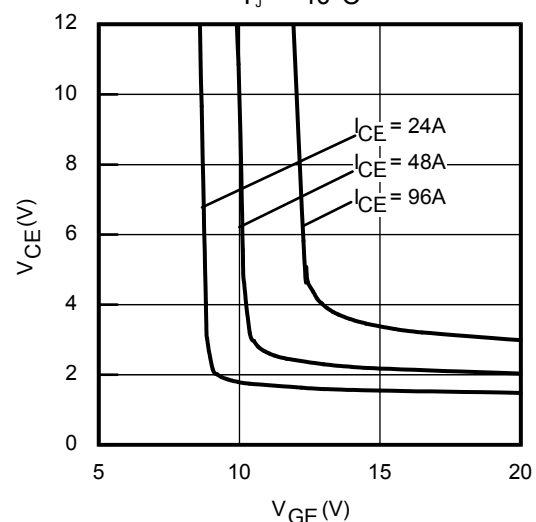
**Fig. 8** - Typ. IGBT Output Characteristics  
 $T_J = 175^{\circ}\text{C}$ ;  $t_p = 20\mu\text{s}$



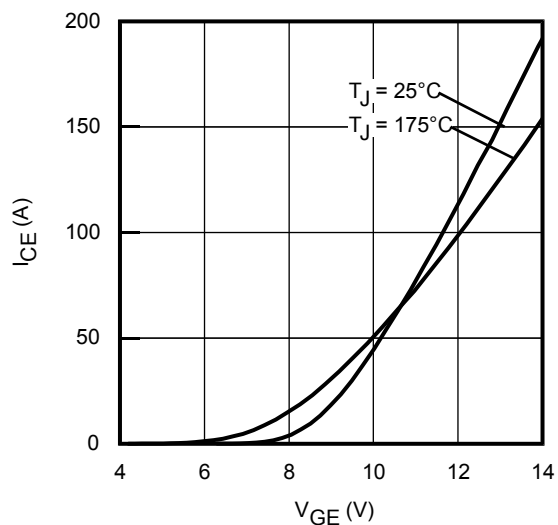
**Fig. 9** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = -40^{\circ}\text{C}$



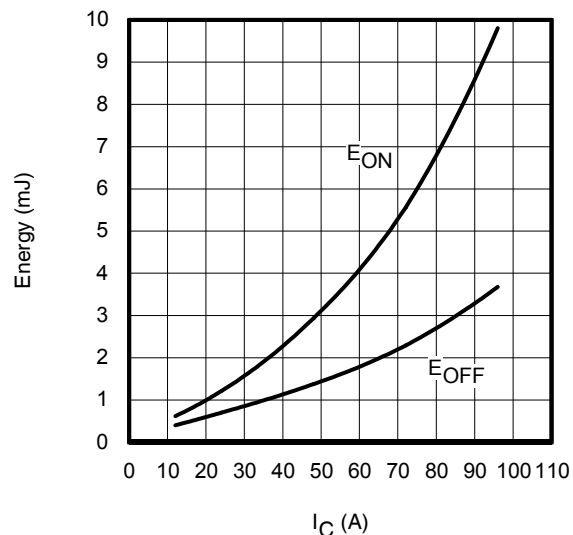
**Fig. 10** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 25^{\circ}\text{C}$



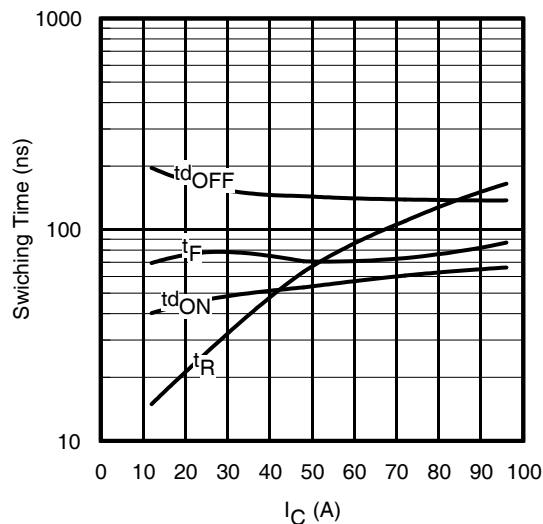
**Fig. 11** - Typical  $V_{CE}$  vs.  $V_{GE}$   
 $T_J = 175^{\circ}\text{C}$



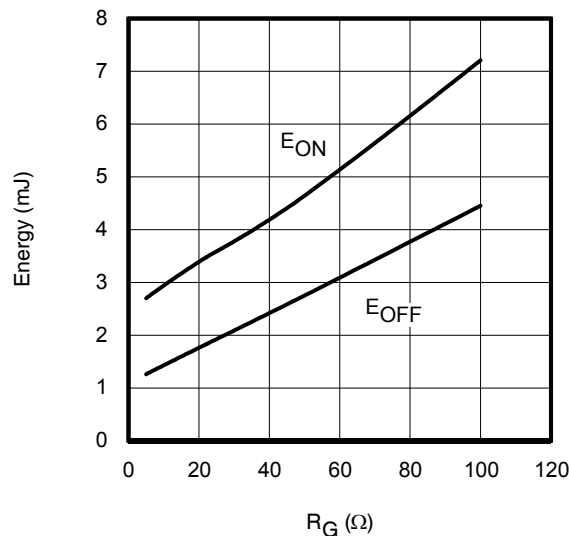
**Fig. 12 - Typ. Transfer Characteristics**  
 $V_{CE} = 50V$ ;  $t_p = 20\mu s$



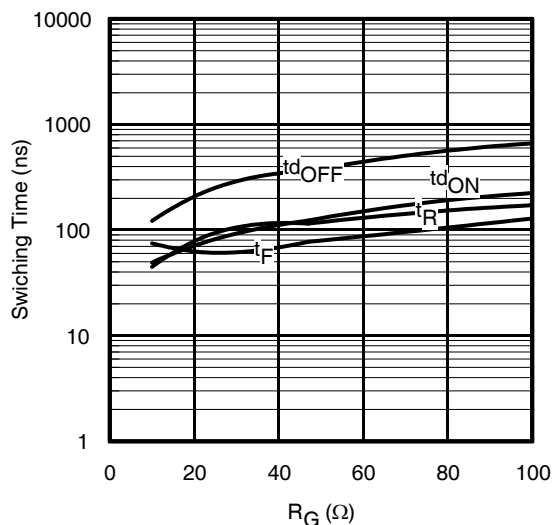
**Fig. 13 - Typ. Energy Loss vs.  $I_C$**   
 $T_J = 175^\circ C$ ;  $L = 210\mu H$ ;  $V_{CE} = 400V$ ;  $R_G = 10\Omega$ ;  $V_{GE} = 15V$



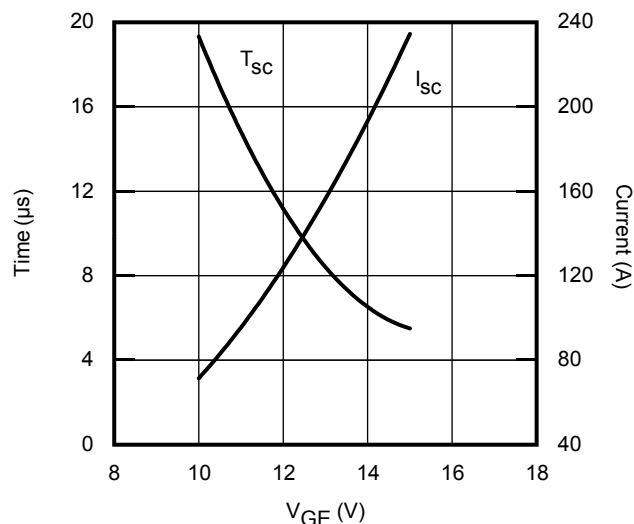
**Fig. 14 - Typ. Switching Time vs.  $I_C$**   
 $T_J = 175^\circ C$ ;  $L = 210\mu H$ ;  $V_{CE} = 400V$ ;  $R_G = 10\Omega$ ;  $V_{GE} = 15V$



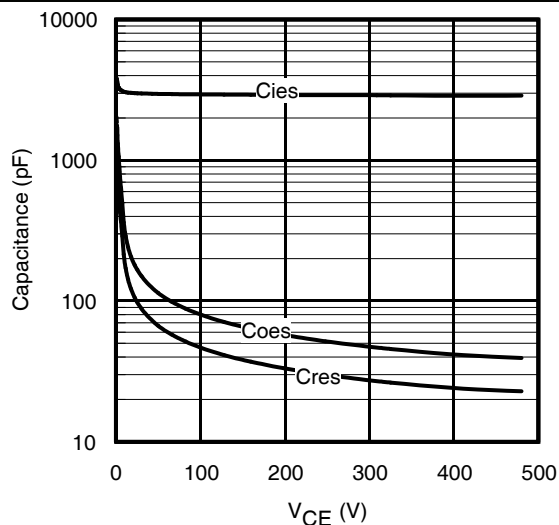
**Fig. 15 - Typ. Energy Loss vs.  $R_G$**   
 $T_J = 175^\circ C$ ;  $L = 210\mu H$ ;  $V_{CE} = 400V$ ;  $I_{CE} = 48A$ ;  $V_{GE} = 15V$



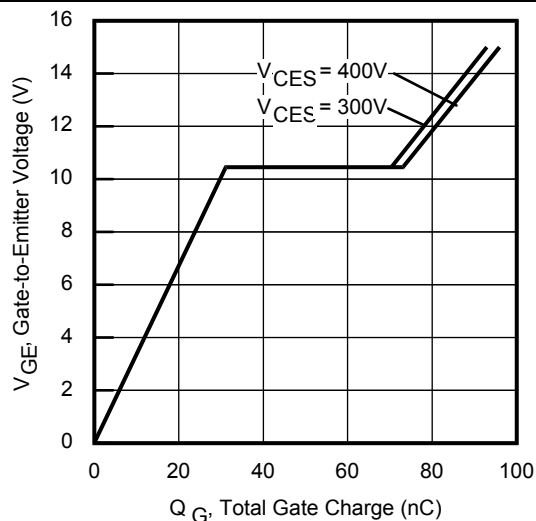
**Fig. 16 - Typ. Switching Time vs.  $R_G$**   
 $T_J = 175^\circ C$ ;  $L = 210\mu H$ ;  $V_{CE} = 400V$ ;  $I_{CE} = 48A$ ;  $V_{GE} = 15V$



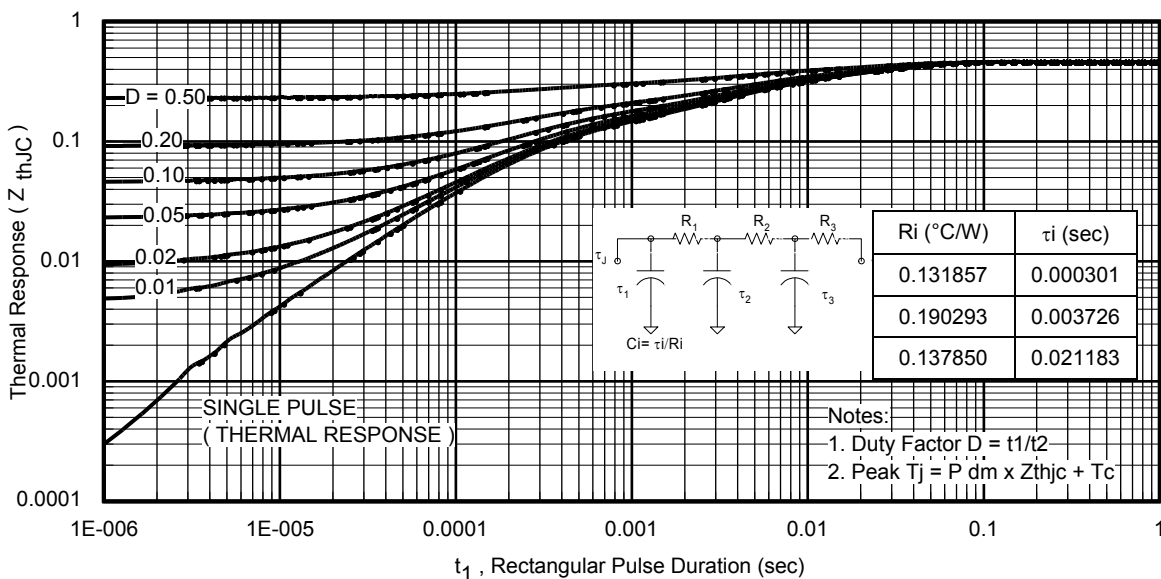
**Fig. 17 -  $V_{GE}$  vs. Short Circuit Time**  
 $V_{CC} = 400V$ ;  $T_C = 150^\circ C$



**Fig. 18** - Typ. Capacitance vs.  $V_{CE}$   
 $V_{GE} = 0V$ ;  $f = 1MHz$



**Fig. 19** - Typical Gate Charge vs.  $V_{GE}$   
 $I_{CE} = 48A$



**Fig. 20** - Maximum Transient Thermal Impedance, Junction-to-Case

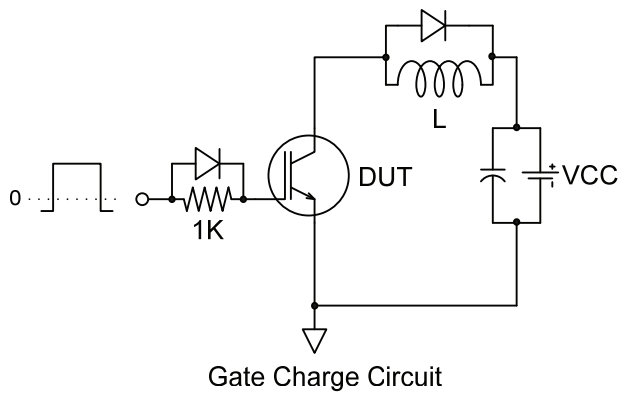


Fig.C.T.1 - Gate Charge Circuit (turn-off)

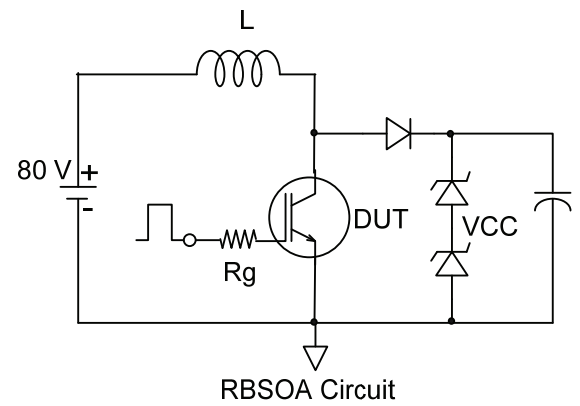


Fig.C.T.2 - RBSOA Circuit

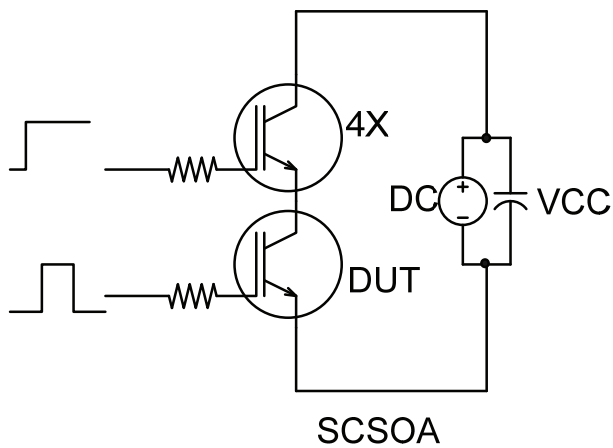


Fig.C.T.3 - S.C. SOA Circuit

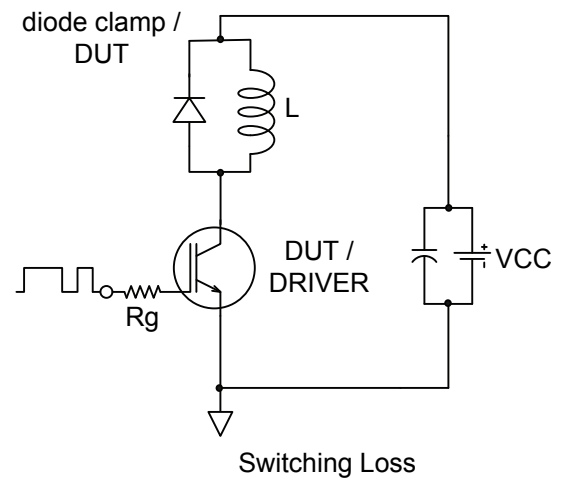


Fig.C.T.4 - Switching Loss Circuit

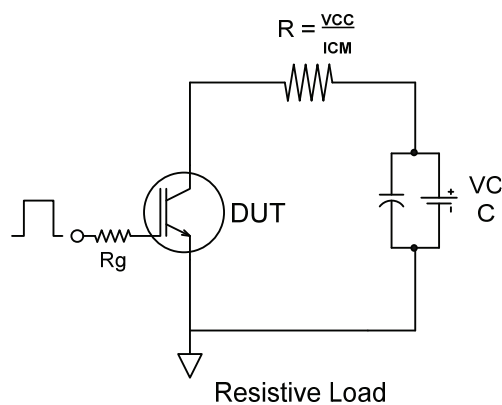


Fig.C.T.5 - Resistive Load Circuit

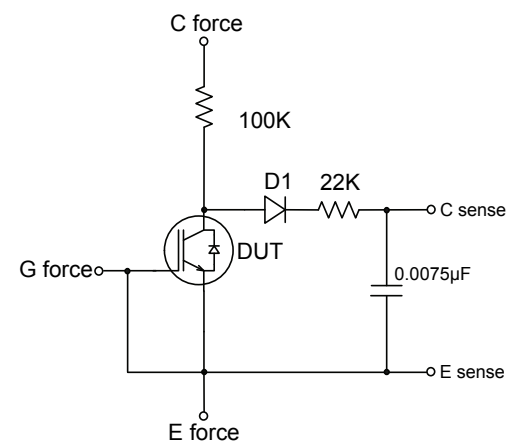
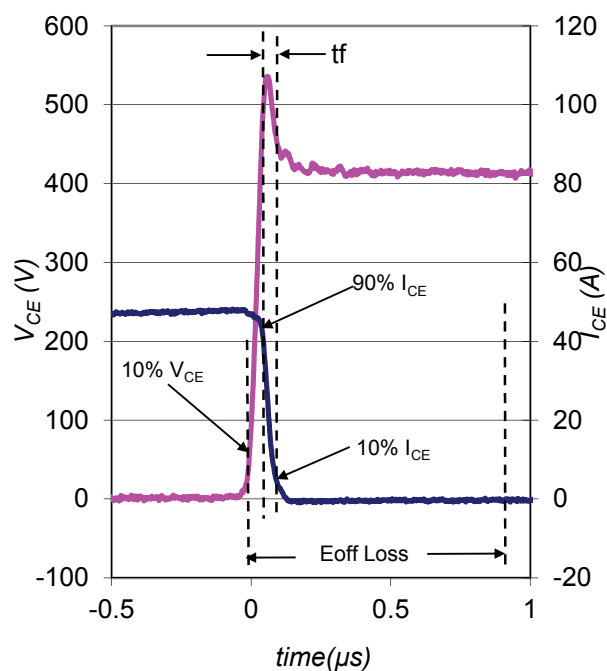
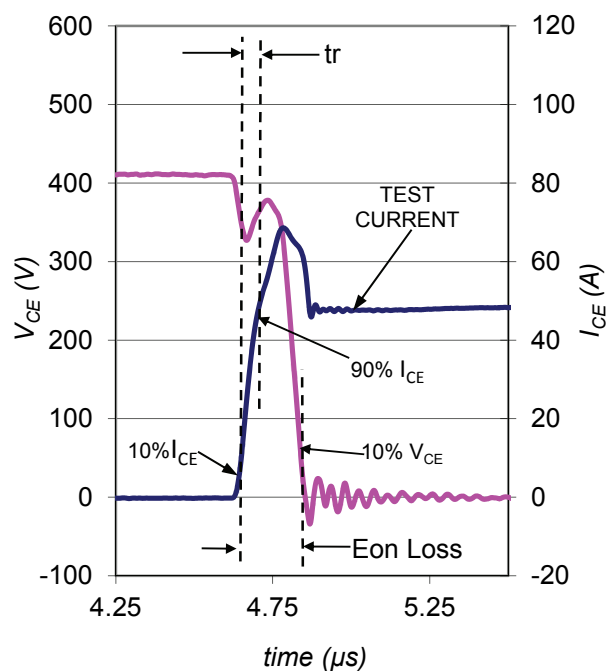


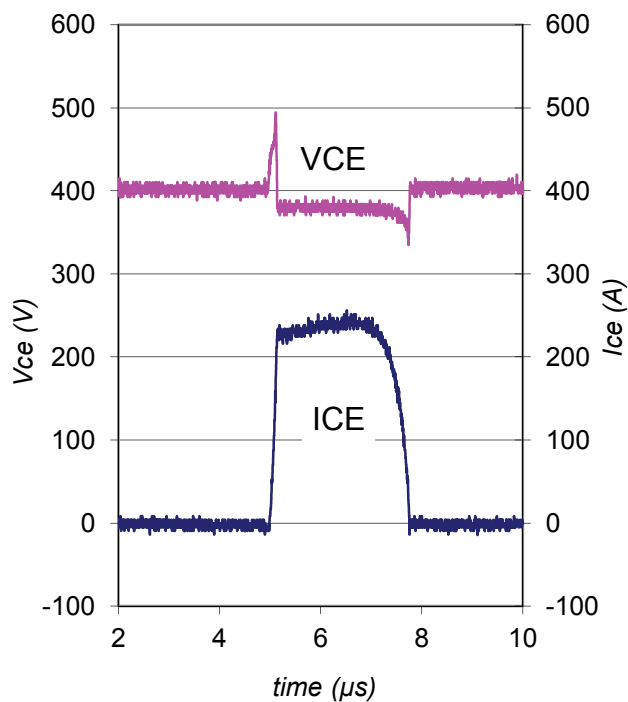
Fig.C.T.6 - BVCES Filter Circuit



**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

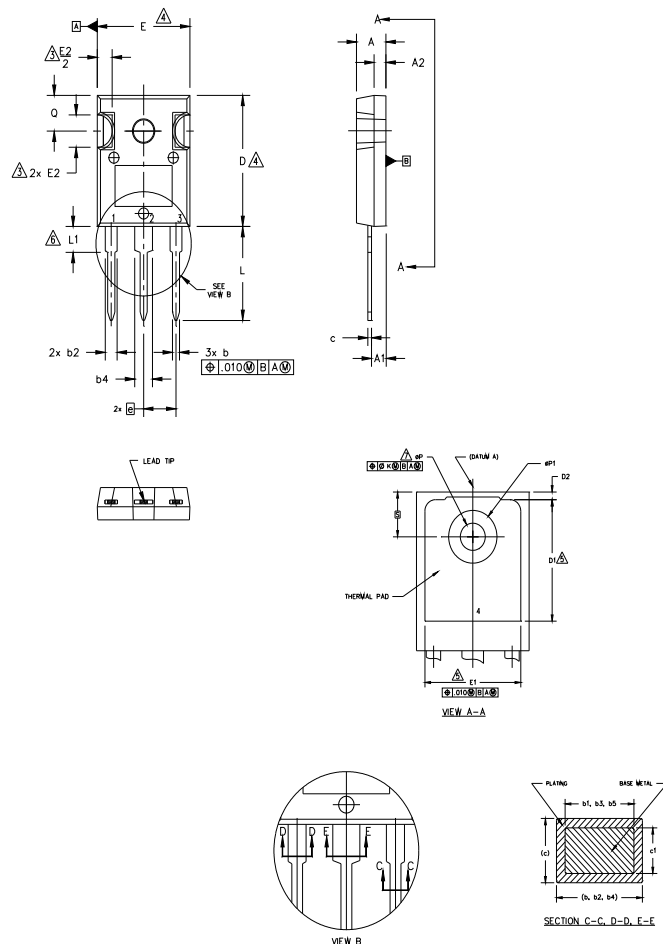


**Fig. WF3** - Typ. S.C. Waveform  
@  $T_J = 150^{\circ}\text{C}$  using Fig. CT.3



# 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. 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-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

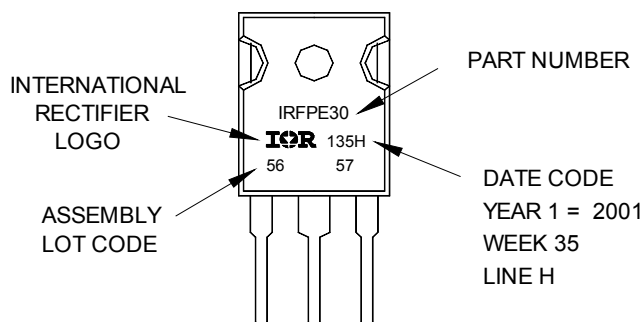
- 1.- ANODE/OPEN
- 2.- CATHODE
- 3.- ANODE

## 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"

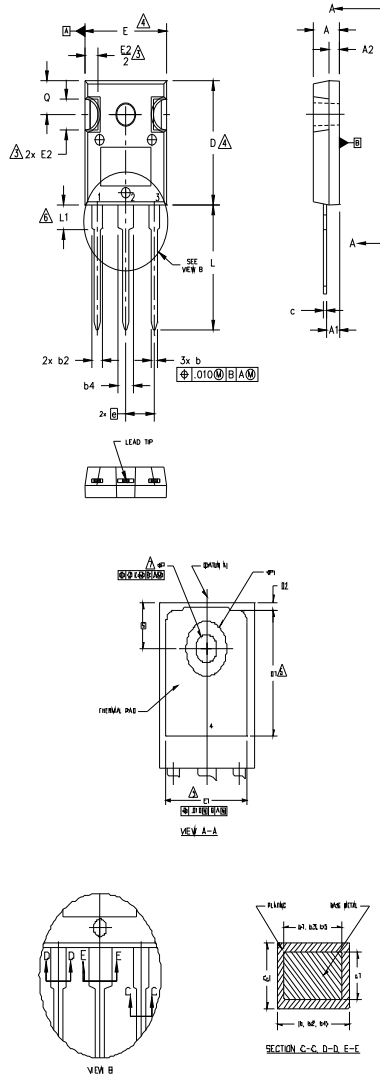


TO-247AC package is not recommended for Surface Mount Application.

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 |      |             |       | 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 |       |
| D1     | .515       | —    | 13.08       | —     | 4     |
| D2     | .020       | .053 | 0.51        | 1.35  | 5     |
| E      | .602       | .625 | 15.29       | 15.87 |       |
| E1     | .530       | —    | 13.46       | —     | 4     |
| E2     | .178       | .216 | 4.52        | 5.49  |       |
| B      | .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

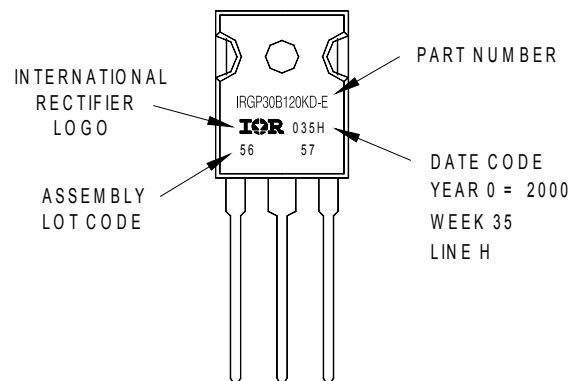
#### DIODES

- 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<br>(per JEDEC JESD47F) <sup>††</sup> |     |
| Moisture Sensitivity Level | TO-247AC                                        | N/A |
|                            | 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.

### Revision History

| Date      | Comments                                                                  |
|-----------|---------------------------------------------------------------------------|
| 8/22/2014 | • Updated $I_C$ vs. $T_C$ graph Fig.2 to match page1 spec data on page 3. |

International  
 Rectifier

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To contact International Rectifier, please visit <http://www.irf.com/whoto-call/>