International
IOR Rectifier

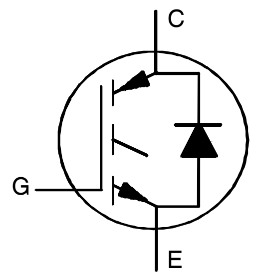
PD - 97250C

# IRGP4068DPbF
# IRGP4068D-EPbF

***INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRA-LOW VF DIODE FOR INDUCTION HEATING AND SOFT SWITCHING APPLICATIONS***

## Features

- Low $V_{CE\,(ON)}$ Trench IGBT Technology
- Low Switching Losses
- Maximum Junction temperature 175 °C
- 5 µS short circuit SOA
- Square RBSOA
- 100% of the parts tested for $I_{LM}$ ①
- Positive $V_{CE\,(ON)}$ Temperature co-efficient
- Ultra-low $V_F$ Hyperfast Diode
- Tight parameter distribution
- Lead Free Package



n-channel

$V_{CES}$ = 600V

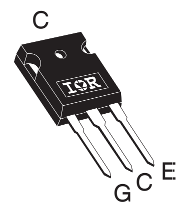
$I_C$ = 48A, $T_C$ = 100°C

$t_{SC} \geq$ 5µs, $T_{J(max)}$ = 175°C

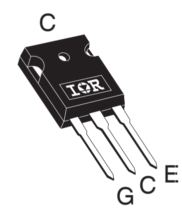
$V_{CE(on)}$ typ. = 1.65V

## Benefits

- Device optimized for induction heating and soft switching applications
- High Efficiency due to Low $V_{CE(on)}$, Low Switching Losses and Ultra-low $V_F$
- Rugged transient Performance for increased reliability
- Excellent Current sharing in parallel operation
- Low EMI



TO-247AC
IRGP4068DPbF



TO-247AD
IRGP4068D-EPbF

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

## Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $V_{CES}$ | Collector-to-Emitter Voltage | 600 | V |
| $I_C$ @ $T_C$ = 25°C | Continuous Collector Current | 96 | A |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 48 | |
| $I_{CM}$ | Pulse Collector Current, $V_{GE}$ = 15V | 144 | |
| $I_{LM}$ | Clamped Inductive Load Current, $V_{GE}$ = 20V ① | 192 | |
| $I_F$ @ $T_C$ = 160°C | Diode Continous Forward Current ⑤ | 8.0 | |
| $I_{FSM}$ | Diode Non Repetitive Peak Surge Current @ $T_J$ = 25°C ②⑤ | 175 | |
| $I_{FRM}$ @Tc = 100°C | Diode Repetitive Peak Forward Current at tp=10µs ②④ | 100 | |
| $V_{GE}$ | Continuous Gate-to-Emitter Voltage | ±20 | V |
| | Transient Gate-to-Emitter Voltage | ±30 | |
| $P_D$ @ $T_C$ = 25°C | Maximum Power Dissipation | 330 | W |
| $P_D$ @ $T_C$ = 100°C | Maximum Power Dissipation | 170 | |
| $T_J$<br>$T_{STG}$ | Operating Junction and<br>Storage Temperature Range | -55 to +175 | °C |
| | Soldering Temperature, for 10 sec. | 300 (0.063 in. (1.6mm) from case) | |
| | Mounting Torque, 6-32 or M3 Screw | 10 lbf·in (1.1 N·m) | |

## Thermal Resistance

| | Parameter | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $R_{\theta JC}$ (IGBT) | Thermal Resistance Junction-to-Case-(each IGBT) | — | — | 0.45 | °C/W |
| $R_{\theta JC}$ (Diode) | Thermal Resistance Junction-to-Case-(each Diode) | — | — | 2.0 | |
| $R_{\theta CS}$ | Thermal Resistance, Case-to-Sink (flat, greased surface) | — | 0.24 | — | |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient (typical socket mount) | — | 80 | — | |

**Electrical Characteristics @ $T_J$ = 25°C (unless otherwise specified)**

| | Parameter | Min. | Typ. | Max. | Units | Conditions | Ref.Fig |
|---|---|---|---|---|---|---|---|
| $V_{(BR)CES}$ | Collector-to-Emitter Breakdown Voltage | 600 | — | — | V | $V_{GE}$ = 0V, $I_C$ = 100µA ③ | CT6 |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage | — | 0.30 | — | V/°C | $V_{GE}$ = 0V, $I_C$ = 1mA (25°C-175°C) | CT6 |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | — | 1.65 | 2.14 | V | $I_C$ = 48A, $V_{GE}$ = 15V, $T_J$ = 25°C | 4,5,6 |
| | | — | 2.0 | — | | $I_C$ = 48A, $V_{GE}$ = 15V, $T_J$ = 150°C | 8,9,10 |
| | | — | 2.05 | — | | $I_C$ = 48A, $V_{GE}$ = 15V, $T_J$ = 175°C | |
| $V_{GE(th)}$ | Gate Threshold Voltage | 4.0 | — | 6.5 | V | $V_{CE}$ = $V_{GE}$, $I_C$ = 1.4mA | 8,9,10,11,20 |
| gfe | Forward Transconductance | — | 32 | — | S | $V_{CE}$ = 50V, $I_C$ = 48A, PW = 80µs | |
| $I_{CES}$ | Collector-to-Emitter Leakage Current | — | 1.0 | 150 | µA | $V_{GE}$ = 0V, $V_{CE}$ = 600V | |
| | | — | 450 | 1000 | | $V_{GE}$ = 0V, $V_{CE}$ = 600V, $T_J$ = 175°C | |
| $V_{FM}$ | Diode Forward Voltage Drop | — | 0.96 | 1.05 | V | $I_F$ = 8.0A | 7 |
| | | — | 0.81 | 0.86 | | $I_F$ = 8.0A, $T_J$ = 150°C | |
| $I_{GES}$ | Gate-to-Emitter Leakage Current | — | — | ±100 | nA | $V_{GE}$ = ±20V | |

**Switching Characteristics @ $T_J$ = 25°C (unless otherwise specified)**

| | Parameter | Min. | Typ. | Max. | Units | Conditions | Ref.Fig |
|---|---|---|---|---|---|---|---|
| $Q_g$ | Total Gate Charge (turn-on) | — | 95 | 140 | nC | $I_C$ = 48A | 18 |
| $Q_{ge}$ | Gate-to-Emitter Charge (turn-on) | — | 28 | 42 | | $V_{GE}$ = 15V | CT1 |
| $Q_{gc}$ | Gate-to-Collector Charge (turn-on) | — | 35 | 53 | | $V_{CC}$ = 400V | |
| $E_{off}$ | Turn-Off Switching Loss | — | 1275 | 1481 | µJ | $I_C$ = 48A, $V_{CC}$ = 400V, $V_{GE}$ = 15V<br>$R_G$ = 10Ω, L = 200µH, $T_J$ = 25°C<br>Energy losses include tail | CT4 |
| $t_{d(off)}$ | Turn-Off delay time | — | 145 | 176 | ns | $I_C$ = 48A, $V_{CC}$ = 400V, $V_{GE}$ = 15V | |
| $t_f$ | Fall time | — | 35 | 46 | | $R_G$ = 10Ω, L = 200µH, $T_J$ = 25°C | |
| $E_{off}$ | Turn-Off Switching Loss | — | 1585 | — | µJ | $I_C$ = 48A, $V_{CC}$ = 400V, $V_{GE}$ = 15V<br>$R_G$ = 10Ω, L = 200µH, $T_J$ = 175°C<br>Energy losses include tail | CT4 |
| $t_{d(off)}$ | Turn-Off delay time | — | 165 | — | ns | $I_C$ = 48A, $V_{CC}$ = 400V, $V_{GE}$ = 15V | WF1 |
| $t_f$ | Fall time | — | 45 | — | | $R_G$=10Ω, L=200µH, $T_J$ = 175°C | |
| $C_{ies}$ | Input Capacitance | — | 3025 | — | pF | $V_{GE}$ = 0V | 17 |
| $C_{oes}$ | Output Capacitance | — | 245 | — | | $V_{CC}$ = 30V | |
| $C_{res}$ | Reverse Transfer Capacitance | — | 90 | — | | f = 1.0Mhz | |
| RBSOA | Reverse Bias Safe Operating Area | FULL SQUARE | | | | $T_J$ = 175°C, $I_C$ = 192A<br>$V_{CC}$ = 480V, Vp =600V<br>Rg = 10Ω, $V_{GE}$ = +20V to 0V | 3<br>CT2 |
| SCSOA | Short Circuit Safe Operating Area | 5 | — | — | µs | $V_{CC}$ = 400V, Vp =600V<br>Rg = 10Ω, $V_{GE}$ = +15V to 0V | 16, CT3<br>WF2 |

**Notes:**

① $V_{CC}$ = 80% ($V_{CES}$), $V_{GE}$ = 20V, L = 200µH, $R_G$ = 10Ω.
② Pulse width limited by max. junction temperature.
③ Refer to AN-1086 for guidelines for measuring $V_{(BR)CES}$ safely.
④ fsw = 20KHz, refer to figure 19.
⑤ Sinusoidal half wave, t=10ms.

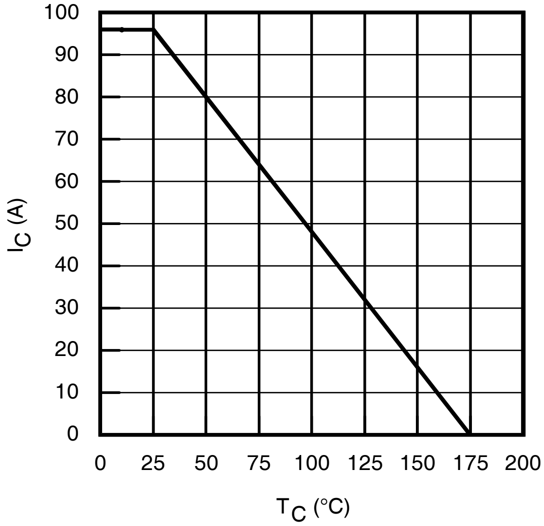



**Fig. 1** - Maximum DC Collector Current vs. Case Temperature

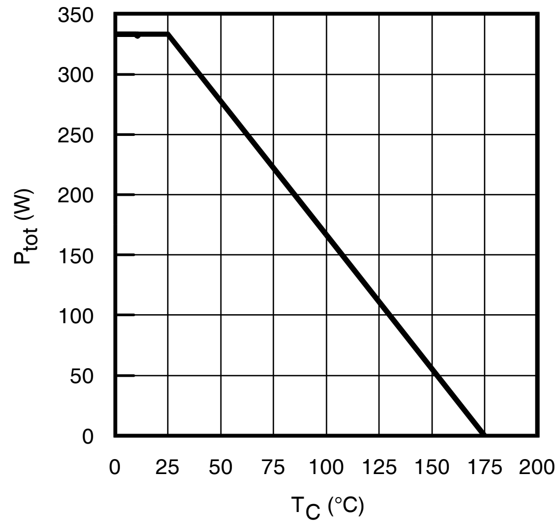



**Fig. 2** - Power Dissipation vs. Case Temperature

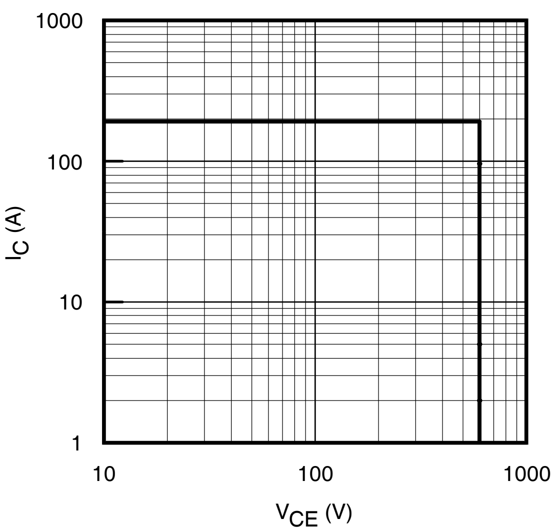



**Fig. 3** - Reverse Bias SOA
$T_J$ = 175°C; $V_{GE}$ = 20V

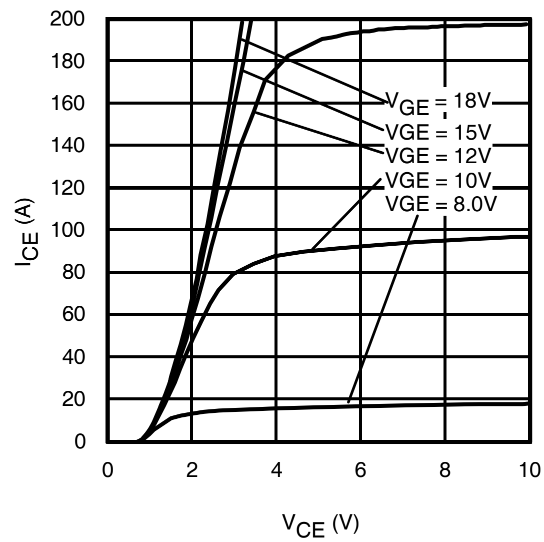



**Fig. 4** - Typ. IGBT Output Characteristics
$T_J$ = -40°C; tp = 80µs

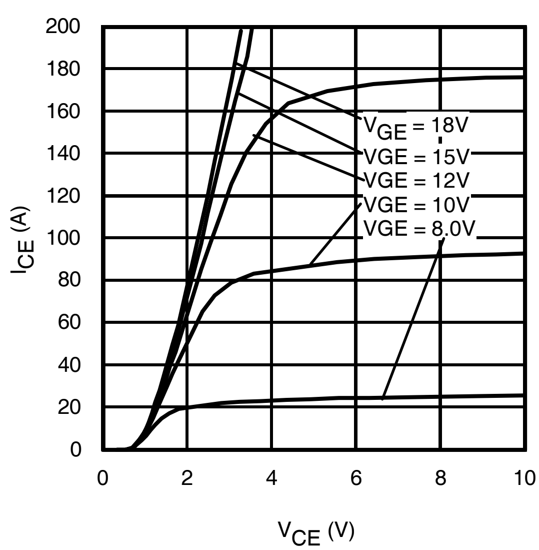



**Fig. 5** - Typ. IGBT Output Characteristics
$T_J$ = 25°C; tp = 80µs

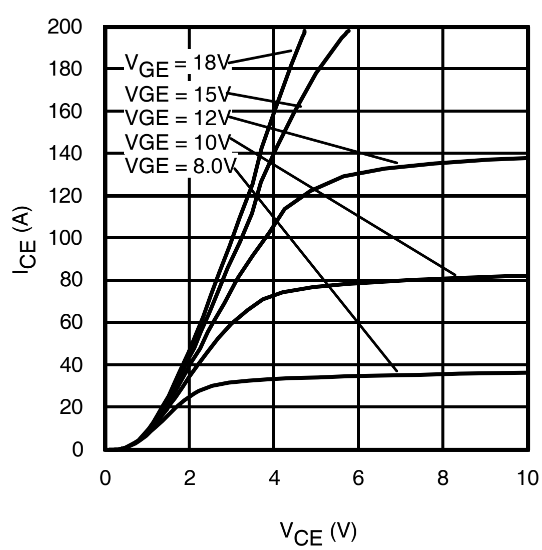



**Fig. 6** - Typ. IGBT Output Characteristics
$T_J$ = 175°C; tp = 80µs

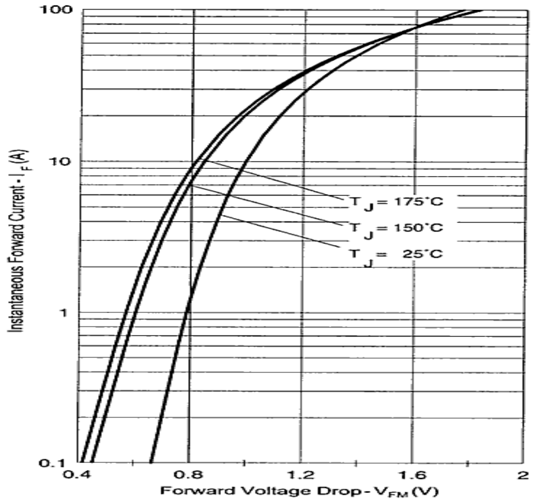



**Fig. 7** - Typ. Diode Forward Voltage Drop Characteristics

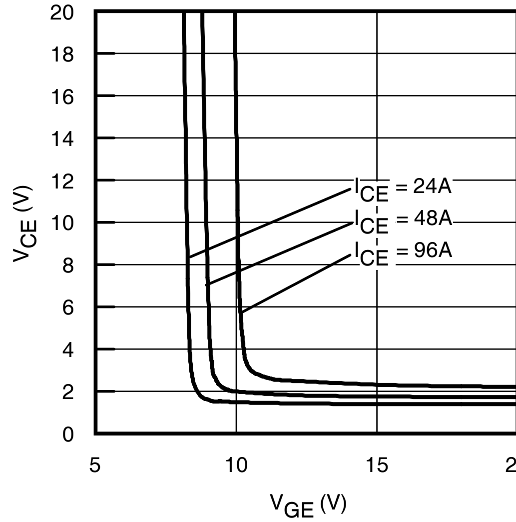



**Fig. 8** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J = -40°C$

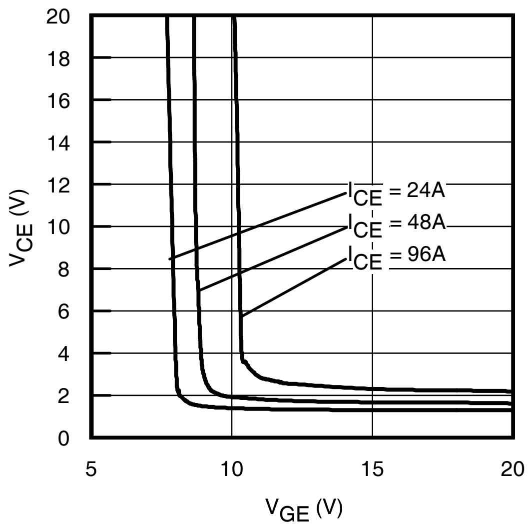



**Fig. 9** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J = 25°C$

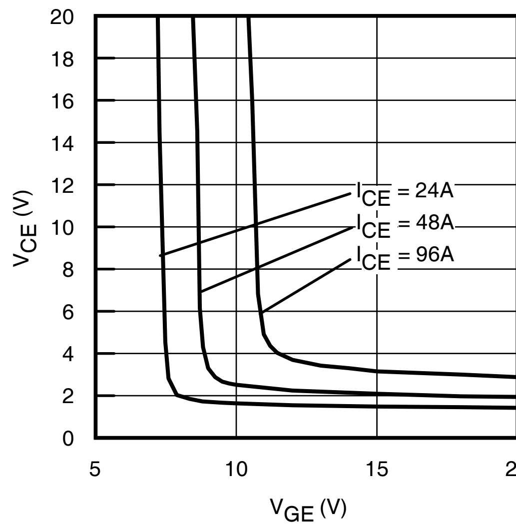



**Fig. 10** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J = 175°C$

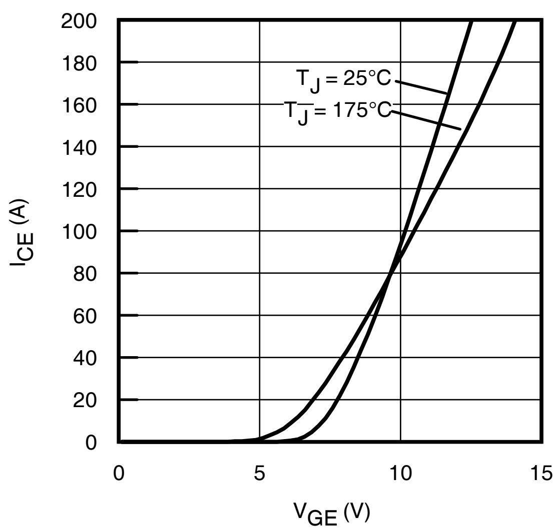



**Fig. 11** - Typ. Transfer Characteristics
$V_{CE} = 50V$; tp = 10µs

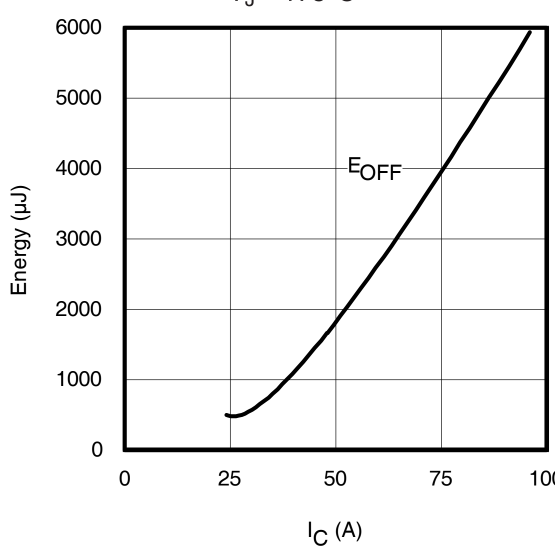



**Fig. 12** - Typ. Energy Loss vs. $I_C$
$T_J = 175°C$; L = 200µH; $V_{CE} = 400V$, $R_G = 10\Omega$; $V_{GE} = 15V$

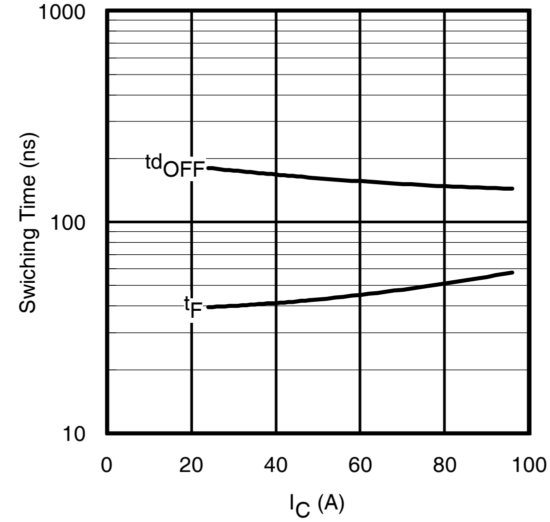



**Fig. 13** - Typ. Switching Time vs. $I_C$
$T_J = 175°C$; $L = 200µH$; $V_{CE} = 400V$, $R_G = 10\Omega$; $V_{GE} = 15V$

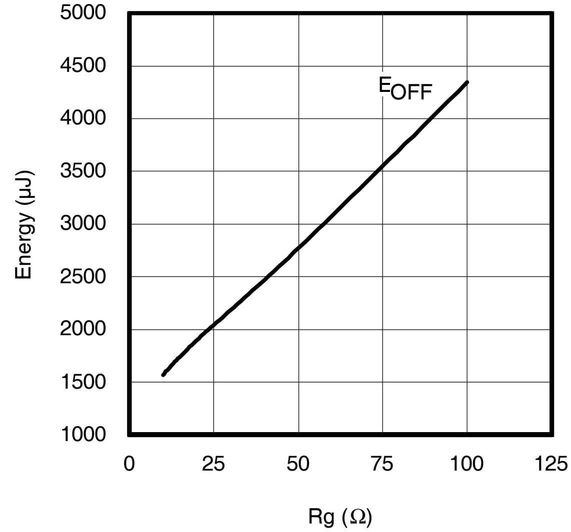



**Fig. 14** - Typ. Energy Loss vs. $R_G$
$T_J = 175°C$; $L = 200µH$; $V_{CE} = 400V$, $I_{CE} = 48A$; $V_{GE} = 15V$

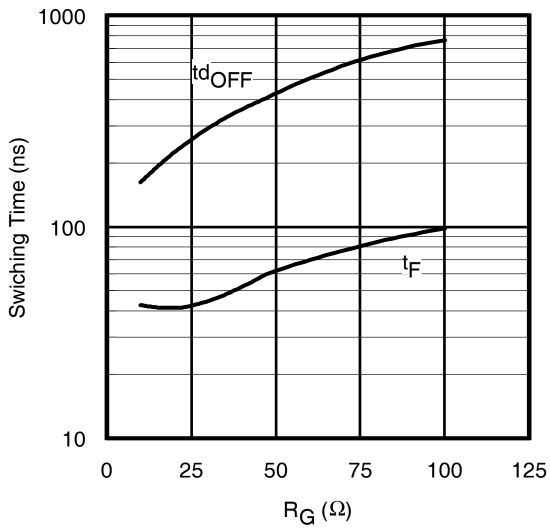



**Fig. 15** - Typ. Switching Time vs. $R_G$
$T_J = 175°C$; $L = 200µH$; $V_{CE} = 400V$, $I_{CE} = 48A$; $V_{GE} = 15V$

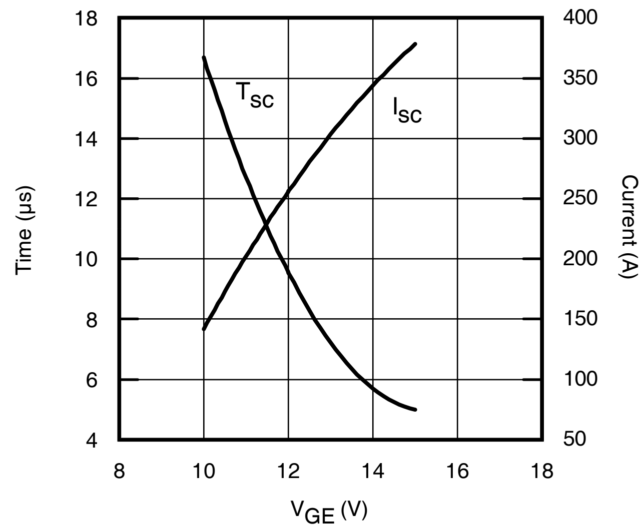



**Fig. 16** - $V_{GE}$ vs. Short Circuit
$V_{CC} = 400V$; $T_C = 25°C$

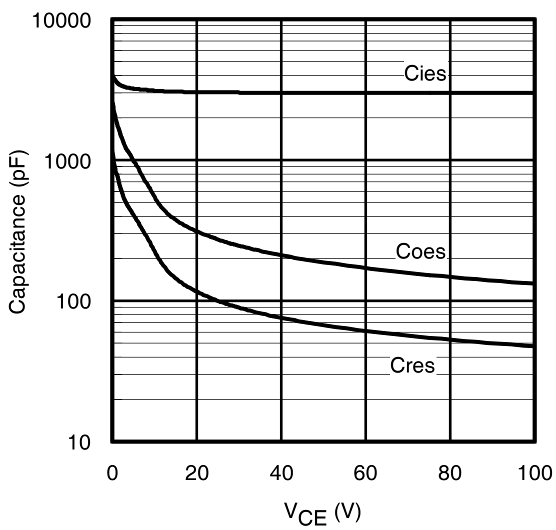



**Fig. 17** - Typ. Capacitance vs. $V_{CE}$
$V_{GE}$= 0V; f = 1MHz

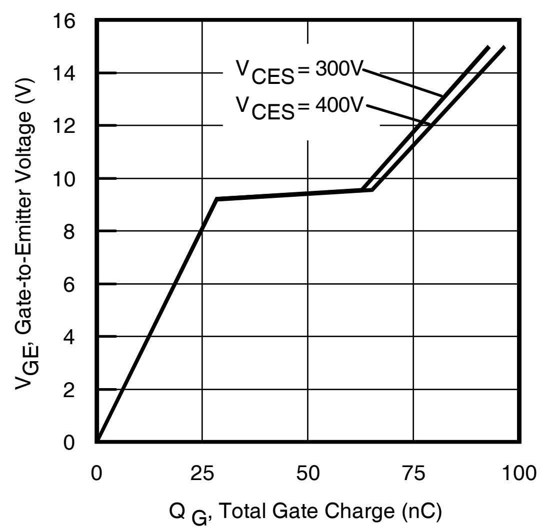



**Fig. 18** - Typical Gate Charge vs. $V_{GE}$
$I_{CE} = 48A$; $L = 600µH$

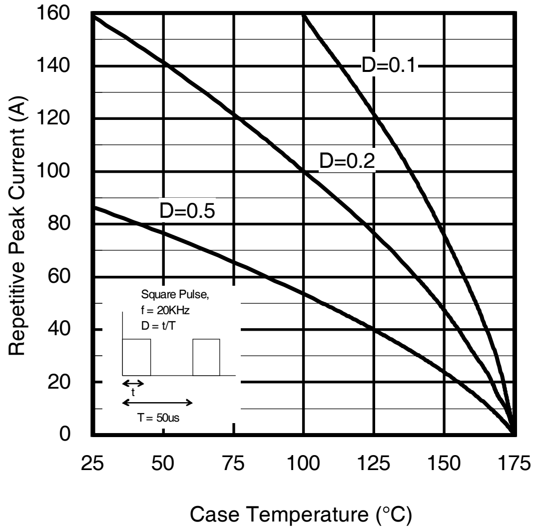



**Fig 19.** Maximum Diode Repetitive Forward Peak Current vs. Case Temperature

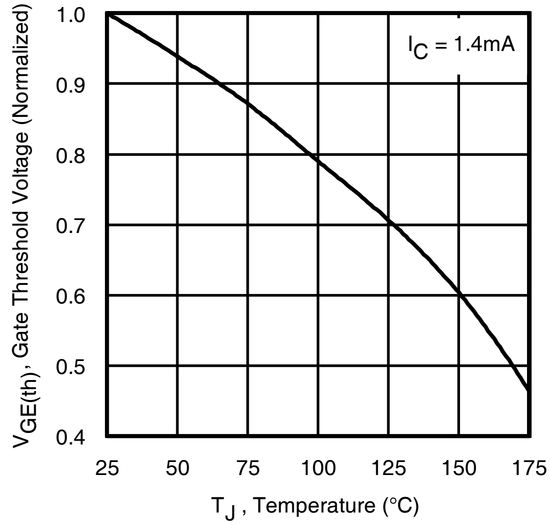



**Fig 20.** Typical Gate Threshold Voltage (Normalized) vs. Junction Temperature

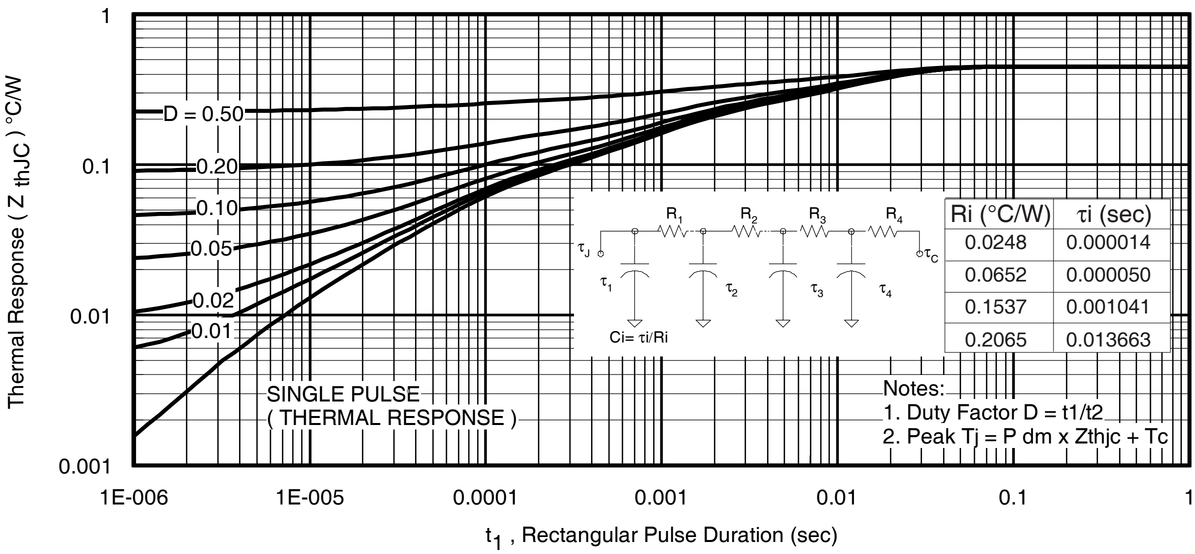



**Fig 21.** Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

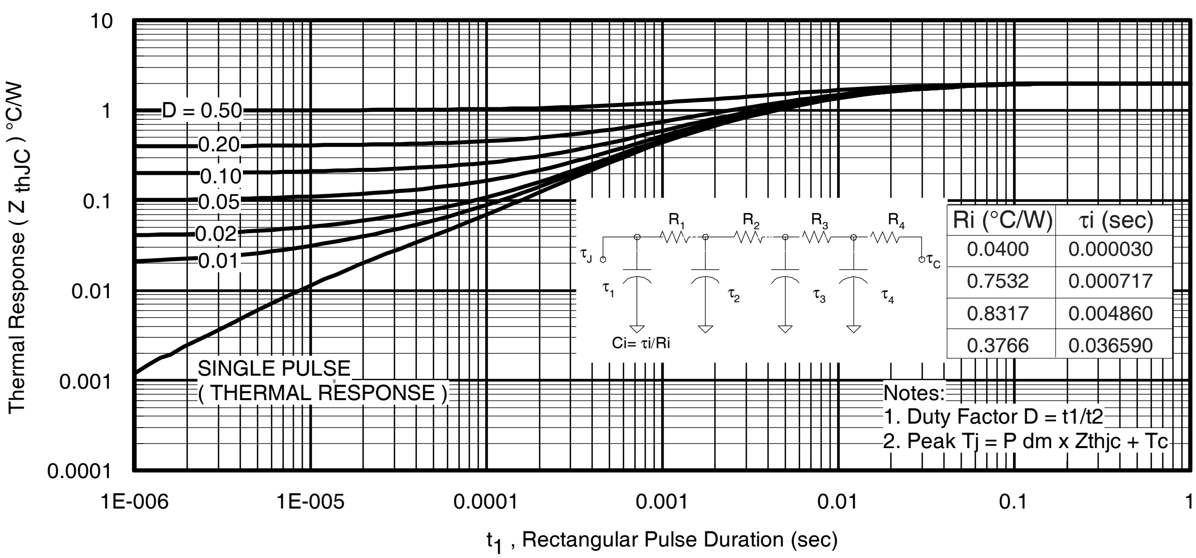



**Fig. 22.** Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

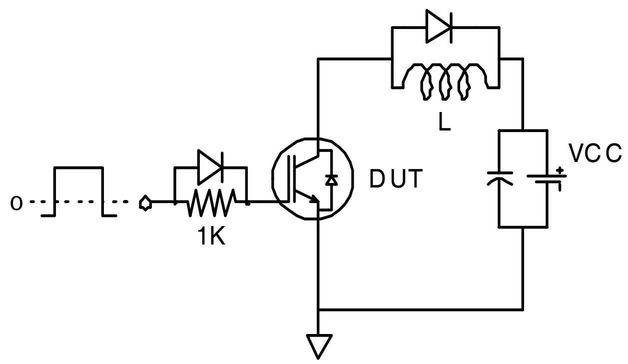



**Fig.C.T.1** - Gate Charge Circuit (turn-off)

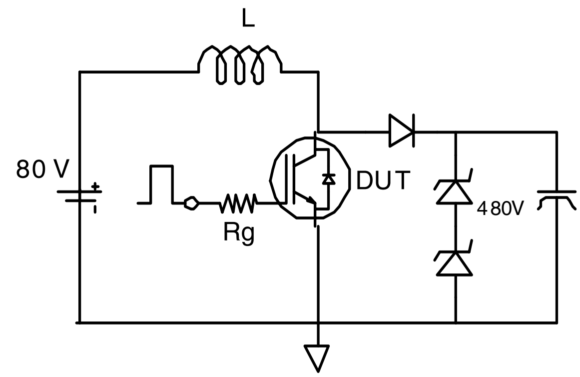



**Fig.C.T.2** - RBSOA Circuit

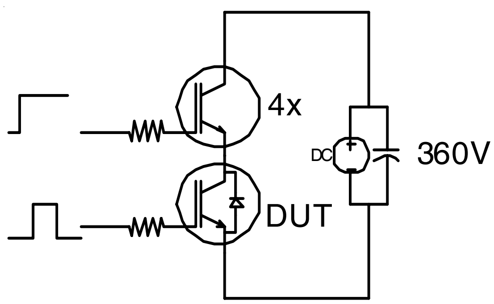



**Fig.C.T.3** - S.C. SOA Circuit

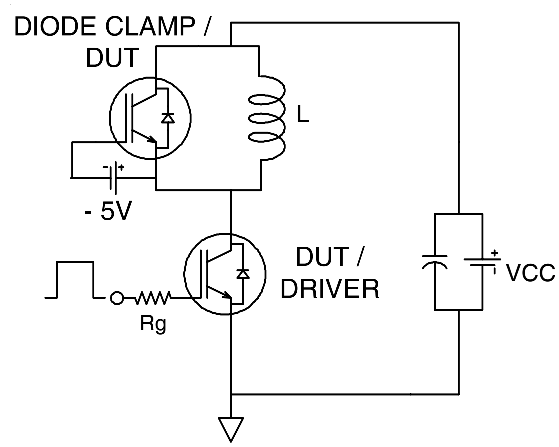



**Fig.C.T.4** - Switching Loss Circuit

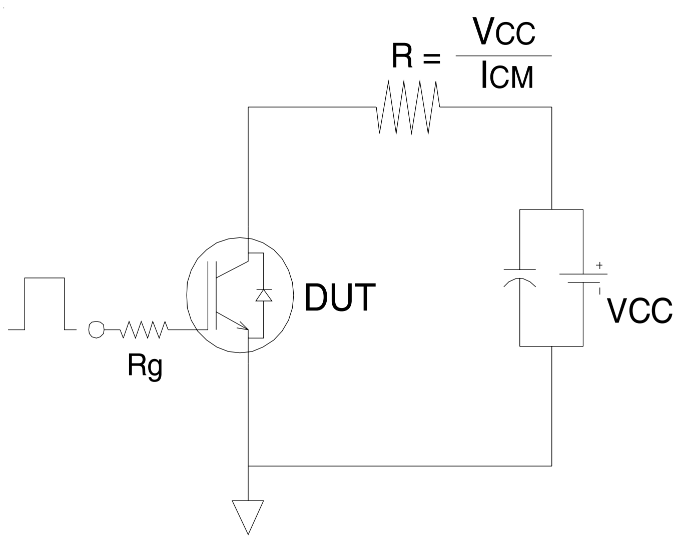



**Fig.C.T.5** - Resistive Load Circuit

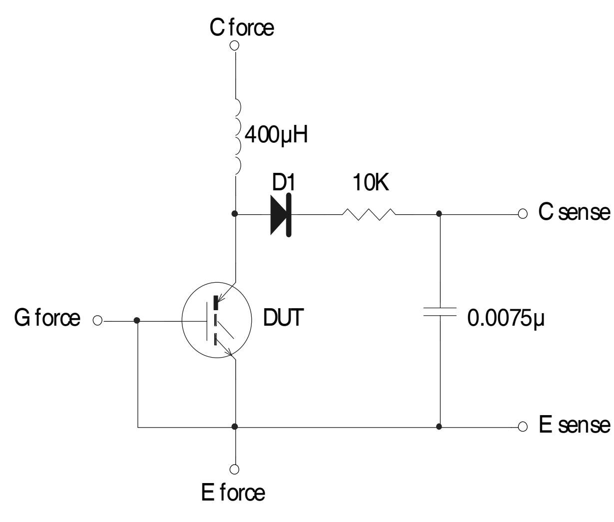



**Fig.C.T.6** - BVCES Filter Circuit

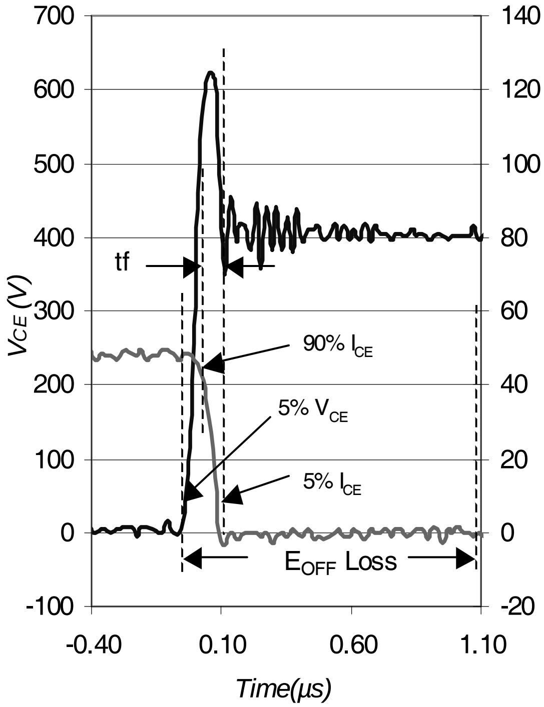



**Fig. WF1** - Typ. Turn-off Loss Waveform
@ $T_J$ = 175°C using Fig. CT.4

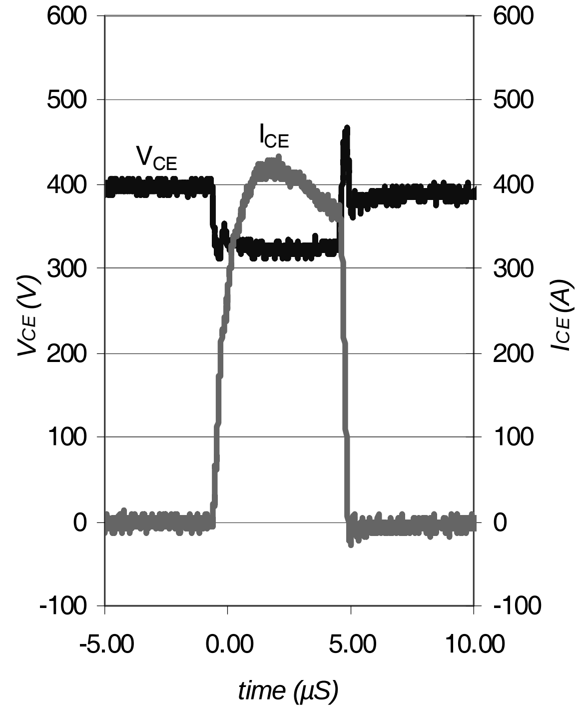
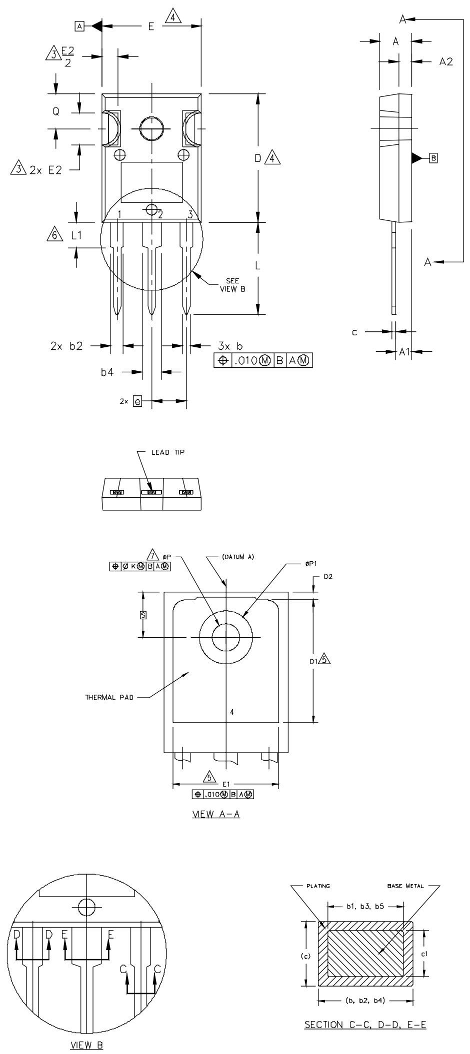



**Fig. WF2** - Typ. S.C. Waveform
@ $T_J$ = 25°C using Fig. CT.3

## 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

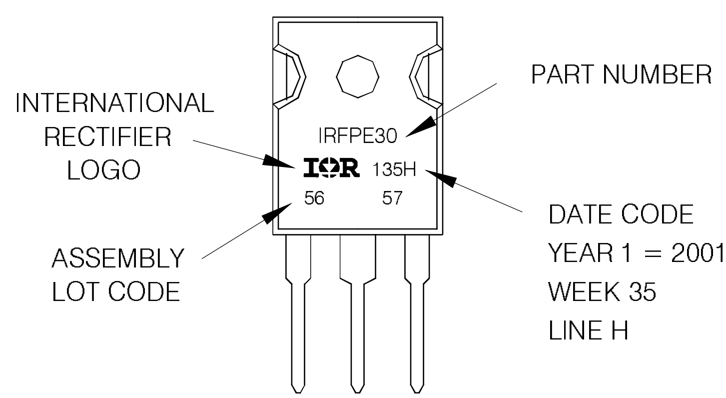
DIODES

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

## TO-247AC Part Marking Information

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"

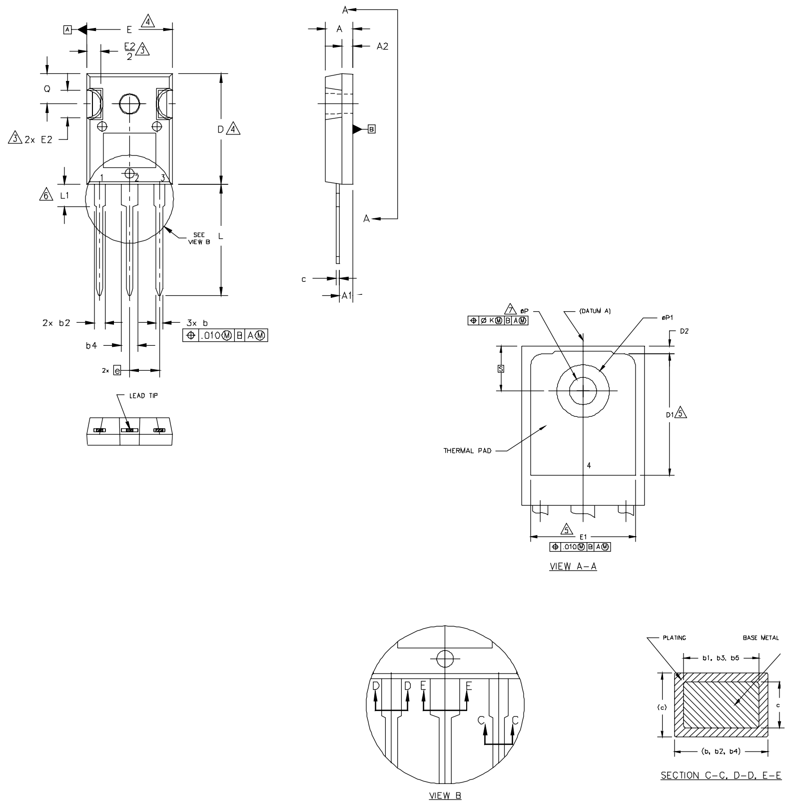



TO-247AC package is not recommended for Surface Mount Application.

**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 | 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

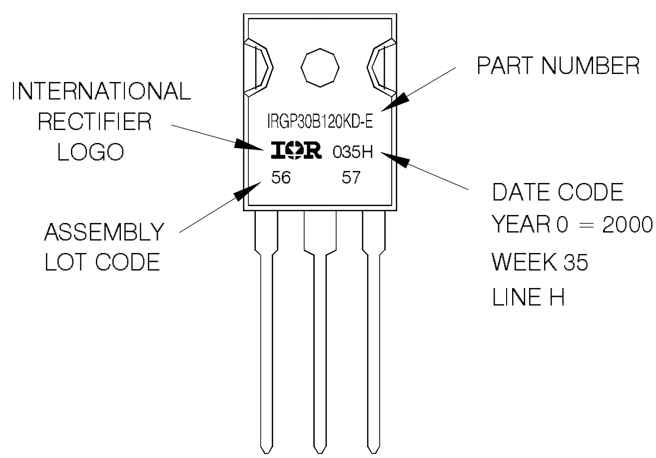
DIODES

1.– ANODE/OPEN
2.– CATHODE
3.– ANODE

## TO-247AD Part Marking Information

EXAMPLE: THIS IS AN 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.

International
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