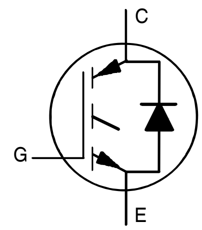
PD- 93818A

International
IOR Rectifier

# IRGP30B120KD-E

**INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE**

**Motor Control Co-Pack IGBT**




**N-channel**

$V_{CES}$ = 1200V

$V_{CE(on)\ typ.}$ = 2.28V

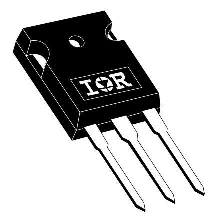
$V_{GE}$ = 15V, $I_C$ = 25A, 25°C

## Features

- Low $V_{CE}$(on) Non Punch Through (NPT) Technology
- Low Diode $V_F$ (1.76V Typical @ 25A & 25°C)
- 10 µs Short Circuit Capability
- Square RBSOA
- Ultrasoft Diode Recovery Characteristics
- Positive $V_{CE}$(on) Temperature Coefficient
- Extended Lead TO-247AD Package

## Benefits

- Benchmark Efficiency for Motor Control Applications
- Rugged Transient Performance
- Low EMI
- Significantly Less Snubber Required
- Excellent Current Sharing in Parallel Operation
- Longer leads for Easier Mounting




**TO-247AD**

## Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $V_{CES}$ | Collector-to-Emitter Breakdown Voltage | 1200 | V |
| $I_C$ @ $T_C$ = 25°C | Continuous Collector Current (Fig.1) | 60 | A |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current (Fig.1) | 30 | |
| $I_{CM}$ | Pulsed Collector Current (Fig.3, Fig. CT.5) | 120 | |
| $I_{LM}$ | Clamped Inductive Load Current(Fig.4, Fig. CT.2) | 120 | |
| $I_F$ @ $T_C$ = 100°C | Diode Continuous Forward Current | 30 | |
| $I_{FM}$ | Diode Maximum Forward Current | 120 | |
| $V_{GE}$ | Gate-to-Emitter Voltage | ± 20 | V |
| $P_D$ @ $T_C$ = 25°C | Maximum Power Dissipation (Fig.2) | 300 | W |
| $P_D$ @ $T_C$ = 100°C | Maximum Power Dissipation (Fig.2) | 120 | |
| $T_J$<br>$T_{STG}$ | Operating Junction and<br>Storage Temperature Range | -55 to + 150 | °C |
| | Soldering Temperature, for 10 seconds | 300, (0.063 in. (1.6mm) from case) | |
| | Mounting Torque, 6-32 or M3 screw. | 10 lbf•in (1.1N•m) | |

## Thermal Resistance

| | Parameter | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $R_{\theta JC}$ | Junction-to-Case - IGBT | ––– | ––– | 0.42 | °C/W |
| $R_{\theta JC}$ | Junction-to-Case - Diode | ––– | ––– | 0.83 | |
| $R_{\theta CS}$ | Case-to-Sink, flat, greased surface | ––– | 0.24 | ––– | |
| $R_{\theta JA}$ | Junction-to-Ambient, typical socket mount | ––– | ––– | 40 | |
| $W_t$ | Weight | ––– | 6 (0.21) | ––– | g (oz) |
| $Z_{\theta JC}$ | Transient Thermal Impedance Junction-to-Case (Fig.24) | | | | |

## Electrical Characteristics @ TJ = 25°C (unless otherwise specified)

| | Parameter | Min. | Typ. | Max. | Units | Conditions | Fig. |
|---|---|---|---|---|---|---|---|
| $V_{(BR)CES}$ | Collector-to-Emitter Breakdown Voltage | 1200 | | | V | $V_{GE}$ = 0V, $I_c$ = 250 μA | |
| $\Delta V_{(BR)CES}/\Delta Tj$ | Temperature Coeff. of Breakdown Voltage | | +1.2 | | V/°C | $V_{GE}$ = 0V, $I_c$ = 1 mA ( 25 -125 °C ) | |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | | 2.28 | 2.48 | V | $I_C$ = 25A, $V_{GE}$ = 15V | 5, 6 |
| | | | 2.46 | 2.66 | | $I_C$ = 30A, $V_{GE}$ = 15V | 7, 9 |
| | | | 3.43 | 4.00 | | $I_C$ = 60A, $V_{GE}$ = 15V | 10 |
| | | | 2.74 | 3.10 | | $I_C$ = 25A, $V_{GE}$ = 15V, $T_J$ = 125°C | 11 |
| | | | 2.98 | 3.35 | | $I_C$ = 30A, $V_{GE}$ = 15V, $T_J$ = 125°C | |
| $V_{GE(th)}$ | Gate Threshold Voltage | 4.0 | 5.0 | 6.0 | V | $V_{CE}$ = $V_{GE}$, $I_C$ = 250 μA | 9,10,11,12 |
| $\Delta V_{GE(th)}/\Delta Tj$ | Temperature Coeff. of Threshold Voltage | | - 1.2 | | mV/°C | $V_{CE}$ = $V_{GE}$, $I_C$ = 1 mA ( 25 -125 °C ) | |
| $g_{fe}$ | Forward Transconductance | 14.8 | 16.9 | 19.0 | S | $V_{CE}$ = 50V, $I_C$ = 25A, PW=80μs | |
| $I_{CES}$ | Zero Gate Voltage Collector Current | | | 250 | μA | $V_{GE}$ = 0V, $V_{CE}$ = 1200V | |
| | | | 325 | 675 | | $V_{GE}$ = 0v, $V_{CE}$ = 1200V, $T_J$ = 125°C | |
| | | | | 2000 | | $V_{GE}$ = 0v, $V_{CE}$ = 1200V, $T_J$ = 150°C | |
| $V_{FM}$ | Diode Forward Voltage Drop | | 1.76 | 2.06 | V | $I_C$ = 25A | 8 |
| | | | 1.86 | 2.17 | | $I_C$ = 30A | |
| | | | 1.87 | 2.18 | | $I_C$ = 25A, $T_J$ = 125°C | |
| | | | 2.01 | 2.40 | | $I_C$ = 30A, $T_J$ = 125°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 | Fig. |
|---|---|---|---|---|---|---|---|
| $Q_g$ | Total Gate charge (turn-on) | | 169 | 254 | nC | $I_C$ = 25A | 23 |
| $Q_{ge}$ | Gate - Emitter Charge (turn-on) | | 19 | 29 | | $V_{CC}$ = 600V | CT1 |
| $Q_{gc}$ | Gate - Collector Charge (turn-on) | | 82 | 123 | | $V_{GE}$ = 15V | |
| $E_{on}$ | Turn-On Switching Loss | | 1066 | 1250 | μJ | $I_C$ = 25A, $V_{CC}$ = 600V | CT4 |
| $E_{off}$ | Turn-Off Switching Loss | | 1493 | 1800 | | $V_{GE}$ = 15V, Rg = 5Ω, L=200μH | WF1 |
| $E_{tot}$ | Total Switching Loss | | 2559 | 3050 | | $T_J$ = 25°C, Energy losses include tail and diode reverse recovery | WF2 |
| $E_{on}$ | Turn-on Switching Loss | | 1660 | 1856 | μJ | Ic = 25A, $V_{CC}$ = 600V | 13, 15 |
| $E_{off}$ | Turn-off Switching Loss | | 2118 | 2580 | | $V_{GE}$ = 15V, Rg = 5Ω, L=200μH | CT4 |
| $E_{tot}$ | Total Switching Loss | | 3778 | 4436 | | $T_J$ = 125°C, Energy losses include tail and diode reverse recovery | WF1 & 2 |
| td(on) | Turn - on delay time | | 50 | 65 | ns | Ic = 25A, $V_{CC}$ = 600V | 14, 16 |
| tr | Rise time | | 25 | 35 | | $V_{GE}$ = 15V, Rg = 5Ω, L=200μH | CT4 |
| td(off) | Turn - off delay time | | 210 | 230 | | $T_J$ = 125°C, | WF1 |
| tf | Fall time | | 60 | 75 | | | WF2 |
| $C_{ies}$ | Input Capacitance | | 2200 | | pF | $V_{GE}$ = 0V | |
| $C_{oes}$ | Output Capacitance | | 210 | | | $V_{CC}$ = 30V | 22 |
| $C_{res}$ | Reverse Transfer Capacitance | | 85 | | | f = 1.0 MHz | |
| RBSOA | Reverse bias safe operating area | FULL SQUARE | | | | $T_J$ = 150°C, Ic = 120A<br>$V_{CC}$ = 1000V, $V_P$ = 1200V<br>Rg = 5Ω, $V_{GE}$ = +15V to 0 V | 4<br>CT2 |
| SCSOA | Short Circuit Safe Operating Area | 10 | ---- | ---- | μs | $T_J$ = 150°C<br>$V_{CC}$ = 900V, $V_P$ = 1200V<br>Rg = 5Ω, $V_{GE}$ = +15V to 0 V | CT3<br>WF4 |
| $E_{rec}$ | Reverse recovery energy of the diode | | 1820 | 2400 | μJ | $T_J$ = 125°C | 17,18,19 |
| trr | Diode Reverse recovery time | | 300 | | ns | $V_{CC}$ = 600V, Ic = 25A | 20, 21 |
| Irr | Peak Reverse Recovery Current | | 34 | 38 | A | $V_{GE}$ = 15V, Rg = 5Ω, L=200μH | CT4, WF3 |
| Le | Internal Emitter Inductance | | 13 | | nH | Measured 5 mm from the package. | |

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

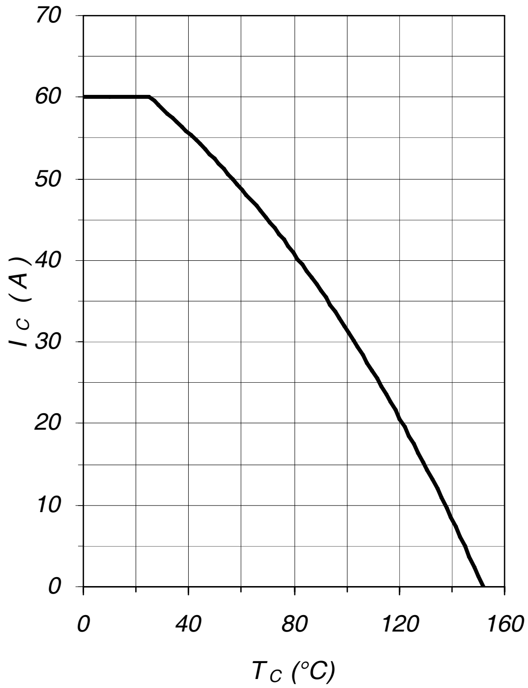



*Fig.2 - Power Dissipation vs. Case Temperature*

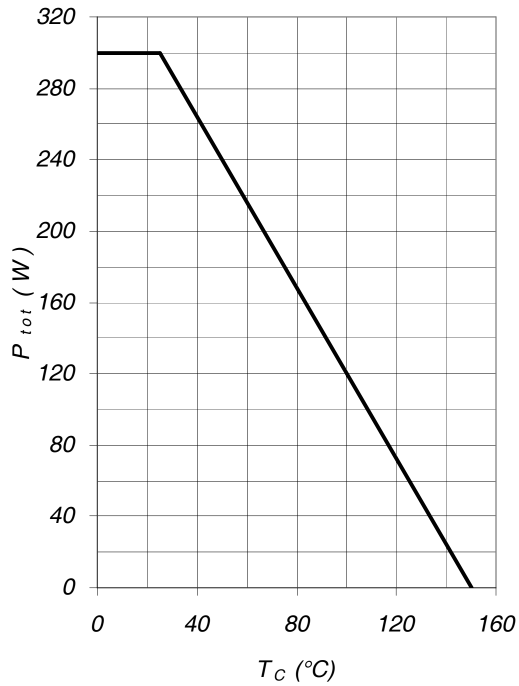



*Fig.3 - Forward SOA*
*$T_C$=25°C; Tj≤150°C*

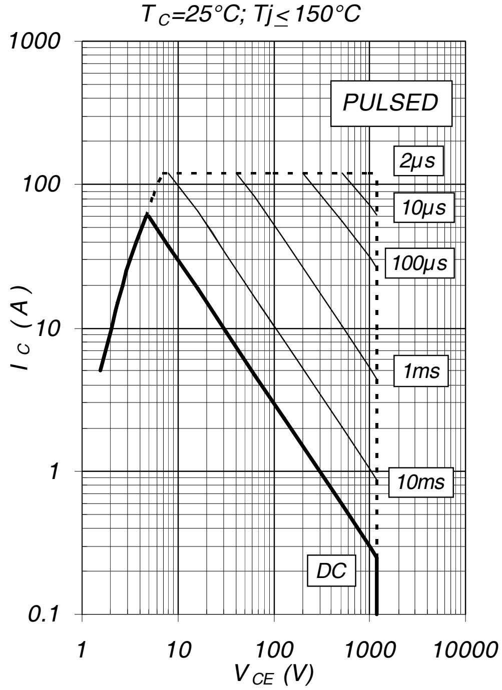



*Fig.4 - Reverse Bias SOA*
*Tj = 150°C, $V_{GE}$ = 15V*

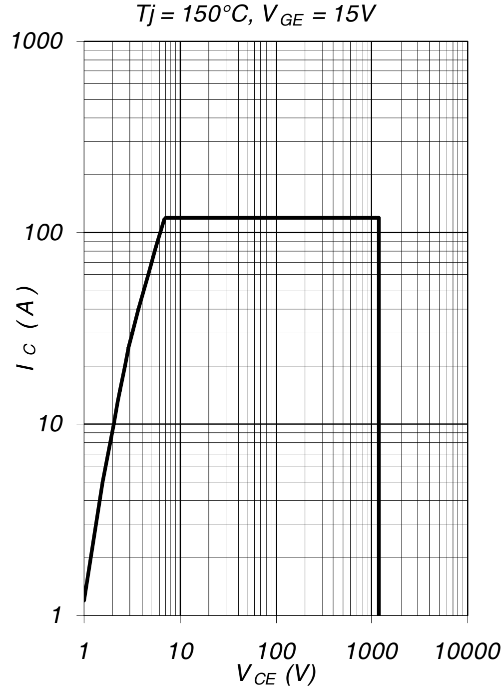


Fig.5 - Typical IGBT Output Characteristics Tj= -40°C; tp=300µs

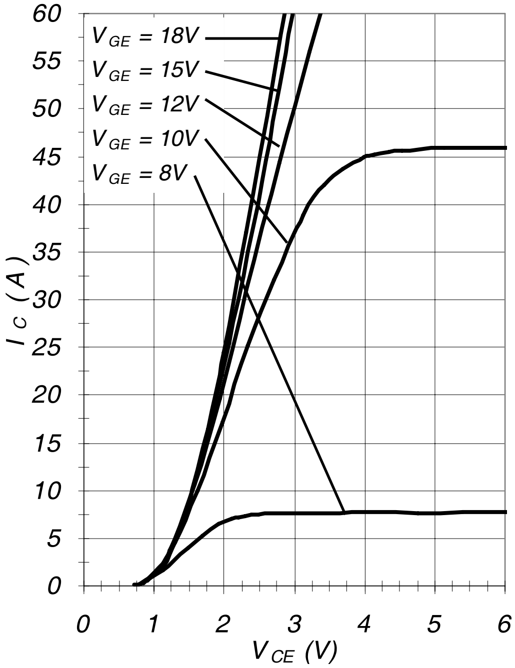



Fig.6 - Typical IGBT Output Characteristics Tj=25°C; tp=300µs

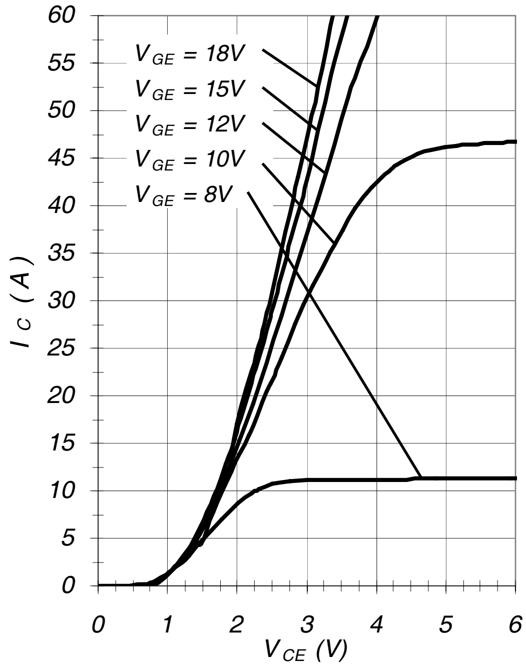



Fig.7 - Typical IGBT Output Characteristics Tj=125°C; tp=300µs

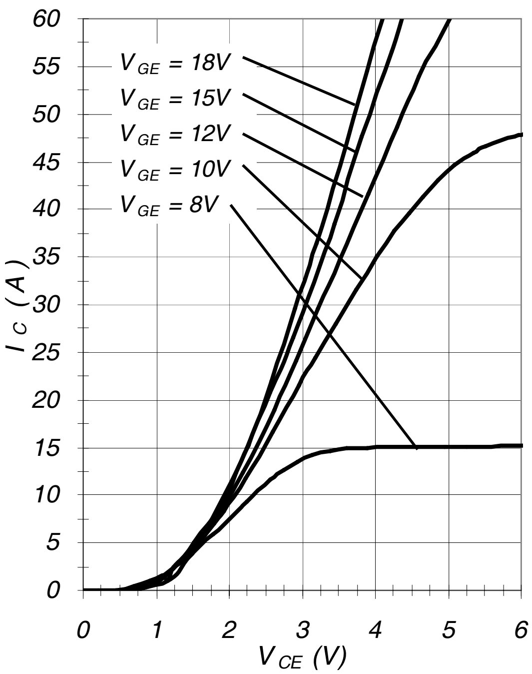



Fig.8 - Typical Diode Forward Characteristic tp=300µs

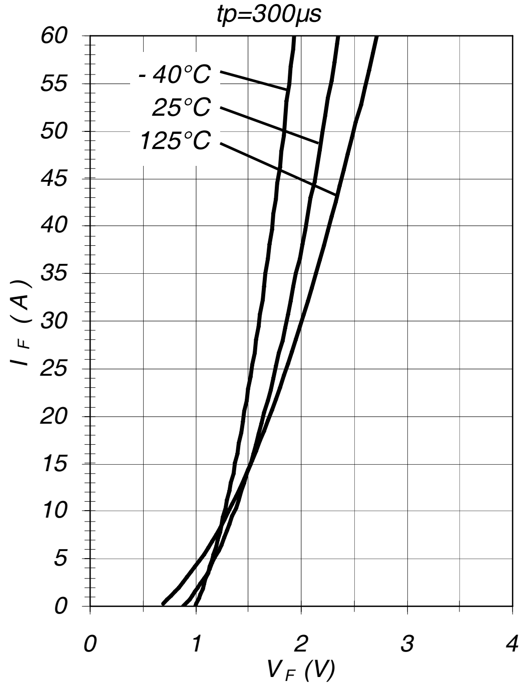


*Fig.9 - Typical $V_{CE}$ vs $V_{GE}$*
*Tj= -40°C*

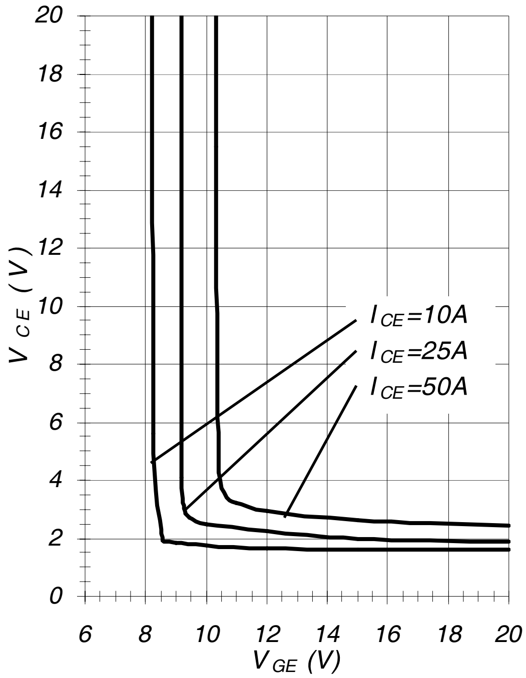



*Fig.10 - Typical $V_{CE}$ vs $V_{GE}$*
*Tj= 25°C*

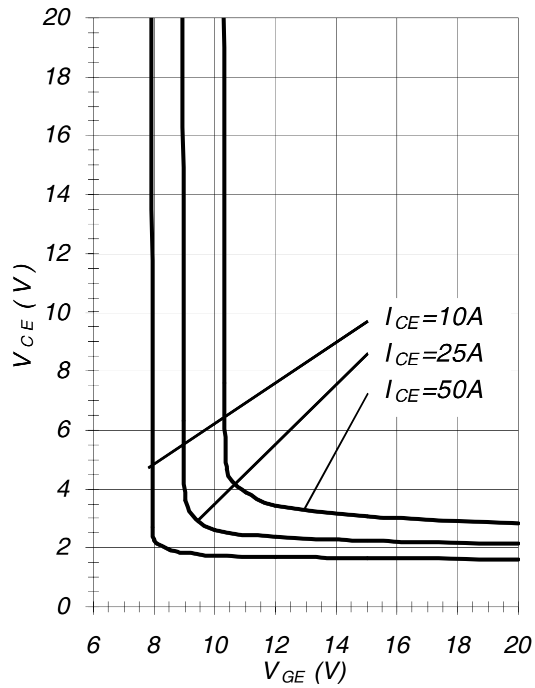



*Fig.11 - Typical $V_{CE}$ vs $V_{GE}$*
*Tj= 125°C*

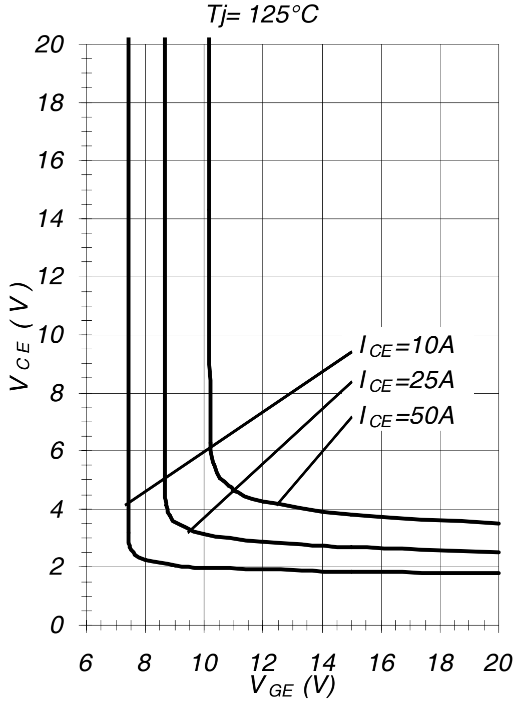



*Fig.12 - Typ. Transfer Characteristics*
*$V_{CE}$=20V; tp=20µs*

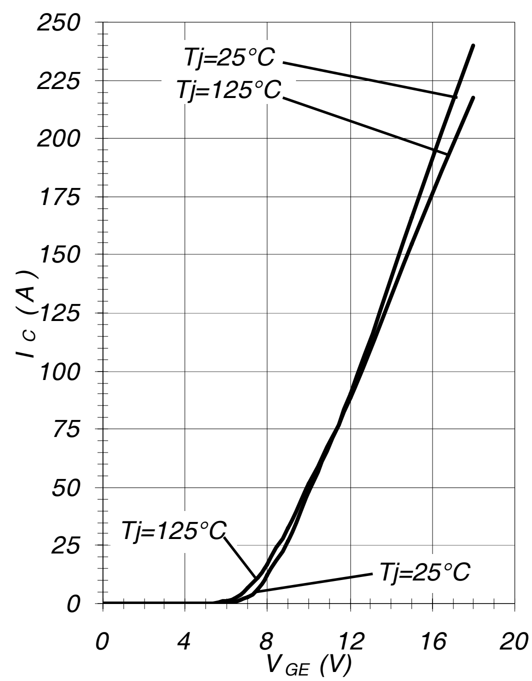


*Fig.13 - Typical Energy Loss vs Ic*
*Tj=125°C; L=200µH; $V_{CE}$=600V;*
*Rg=22 Ω; $V_{GE}$=15V*

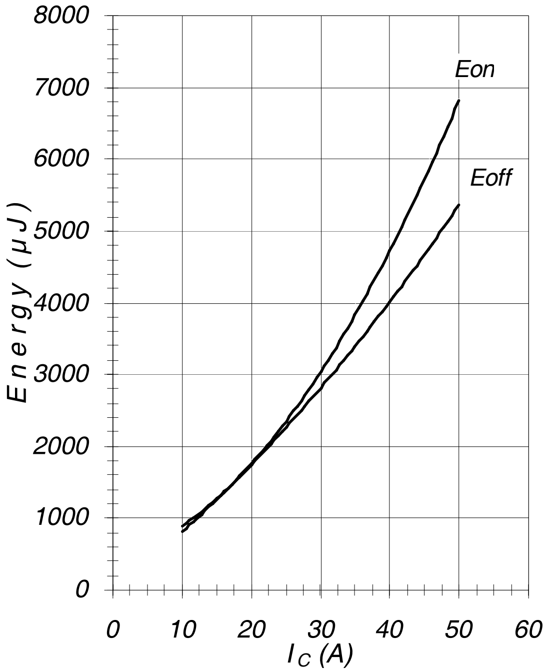



*Fig.14 - Typical Switching Time vs Ic*
*Tj=125°C; L=200µH; $V_{CE}$=600V;*
*Rg=22 Ω;$V_{GE}$=15V*

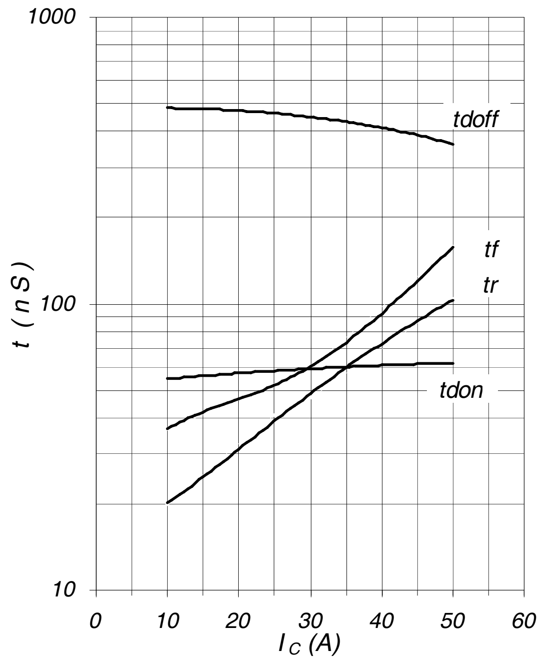



*Fig.15 - Typical Energy Loss vs Rg*
*Tj=125°C; L=200µH; $V_{CE}$=600V;*
*$I_{CE}$=25A; $V_{GE}$=15V*

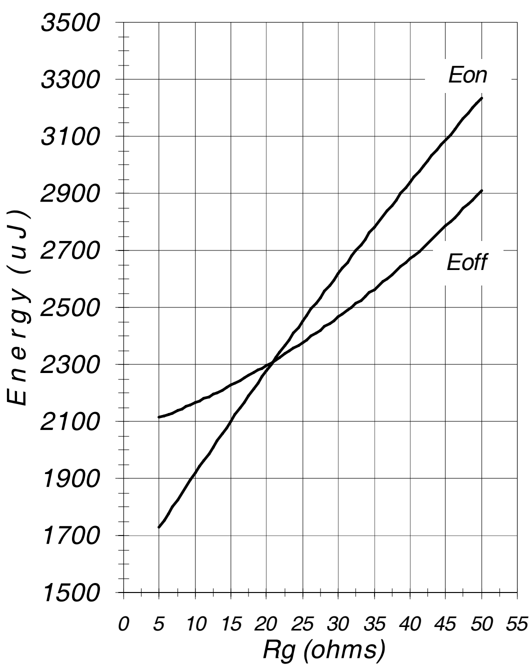
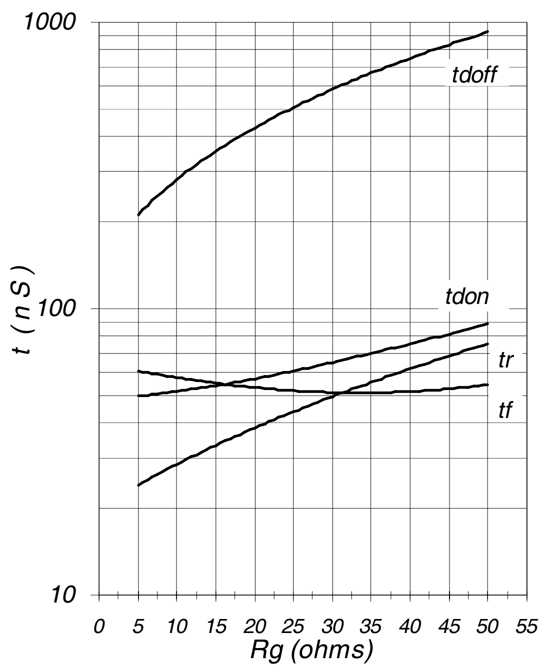



*Fig.16 - Typical Switching Time vs Rg*
*Tj=125°C; L=200µH; $V_{CE}$=600V;*
*$I_{CE}$=25A; $V_{GE}$=15V*



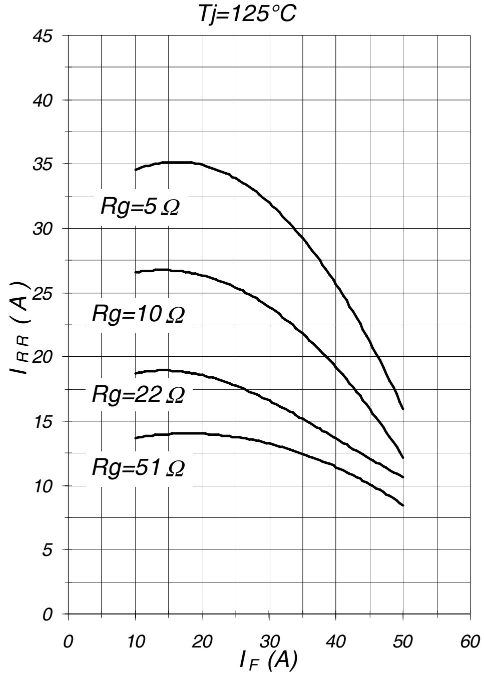



Fig.17 - Typical Diode $I_{RR}$ vs $I_F$
Tj=125°C

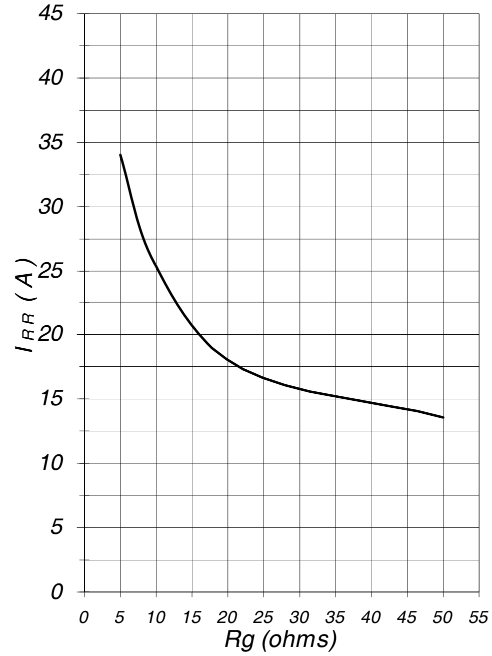



Fig.18 - Typical Diode $I_{RR}$ vs Rg
Tj=125°C; $I_F$=25A

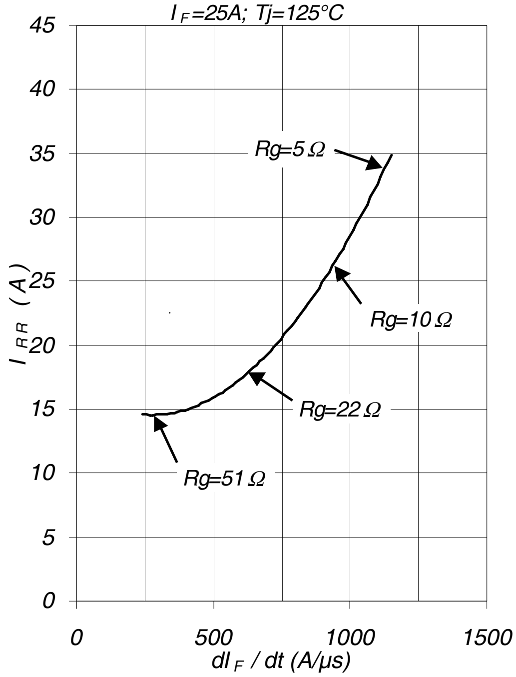



Fig.19 - Typical Diode $I_{RR}$ vs $dI_F/dt$
$V_{CC}$=600V; $V_{GE}$=15V
$I_F$=25A; Tj=125°C

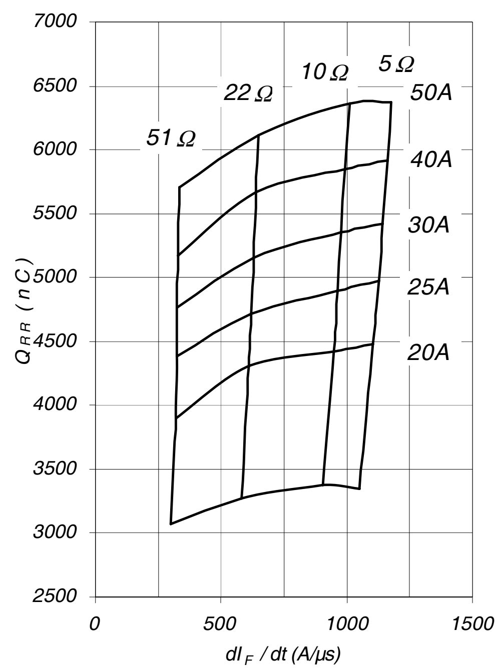



Fig.20 - Typical Diode $Q_{RR}$
$V_{CC}$=600V; $V_{GE}$=15V; Tj=125°C

Fig.21 - Typ. Diode $E_{rec}$ vs. $I_F$
Tj=125°C

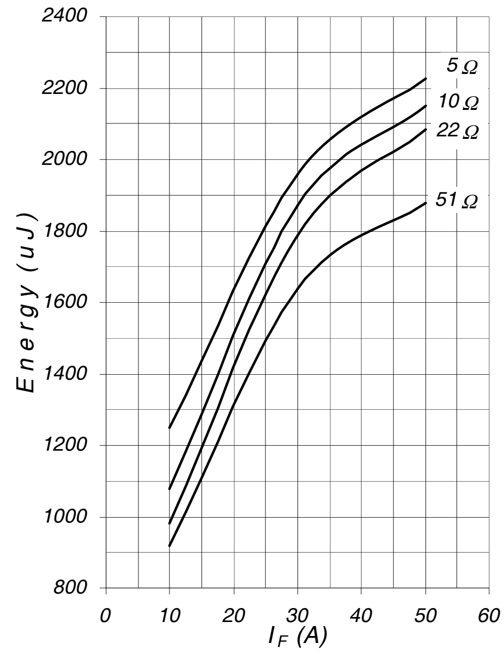



Fig.22 - Typical Capacitance vs $V_{CE}$
$V_{GE}$=0V; f=1MHz

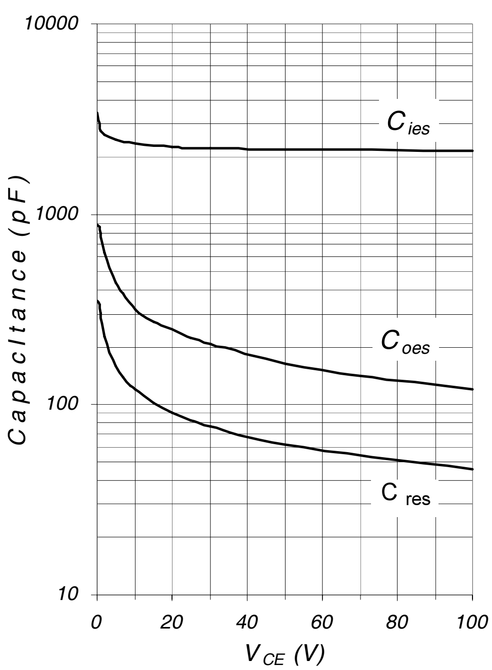



Fig.23 - Typ. Gate Charge vs. $V_{GE}$
$I_C$=25A; L=600μH

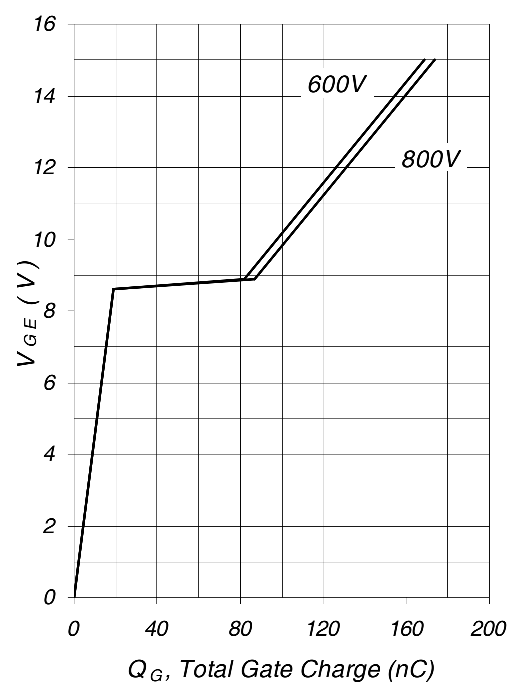


*Fig.24 - Normalized Transient Thermal Impedance, Junction-to-Case*

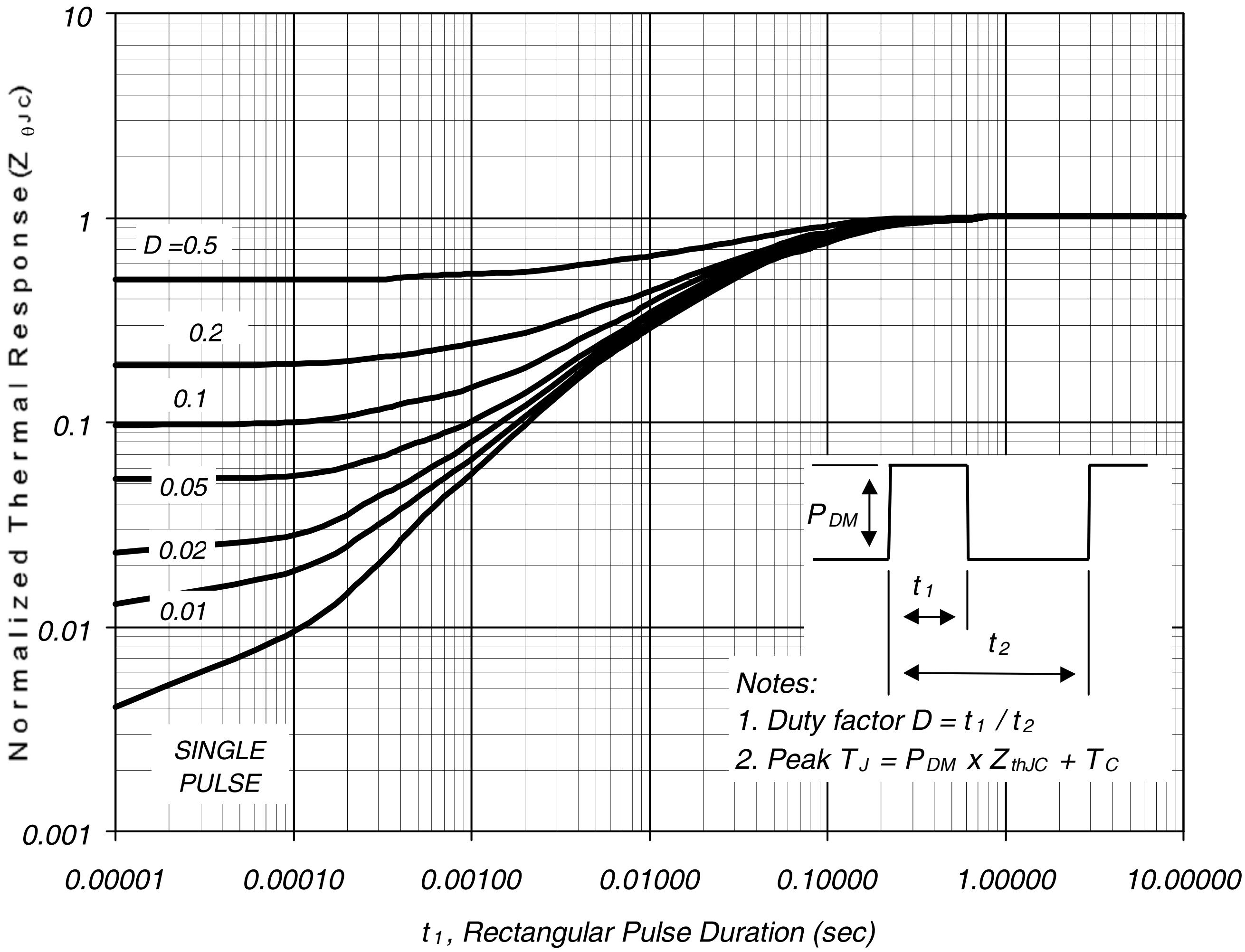


**Fig. CT.1 - Gate Charge Circuit (turn-off)**

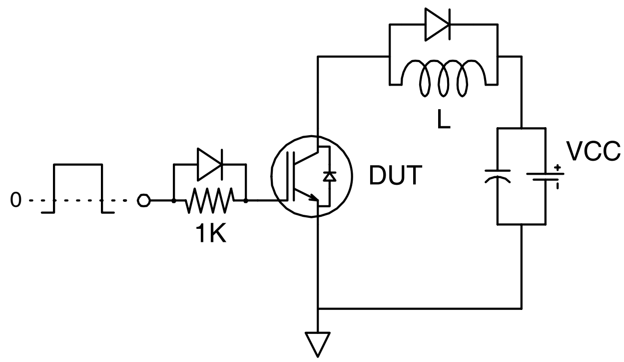



**Fig. CT.2 - RBSOA Circuit**

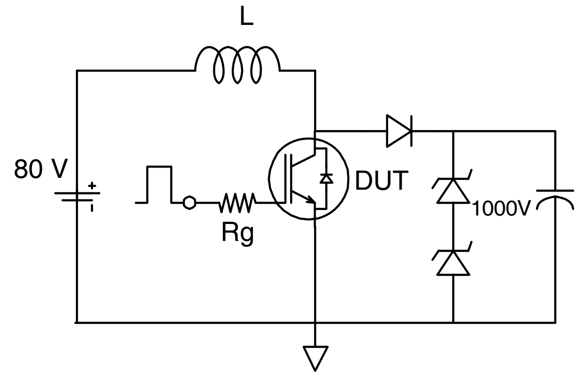



**Fig. CT.3 - S.C. SOA Circuit**

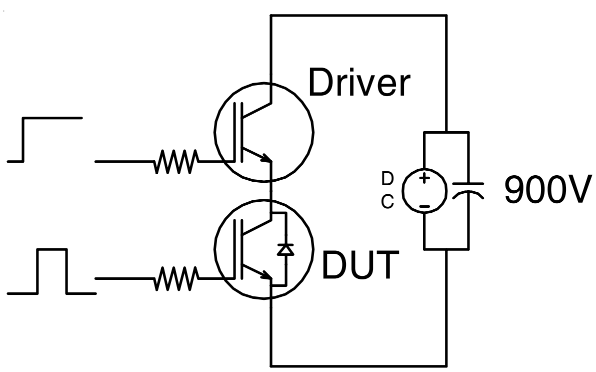



**Fig. CT.4 - Switching Loss Circuit**

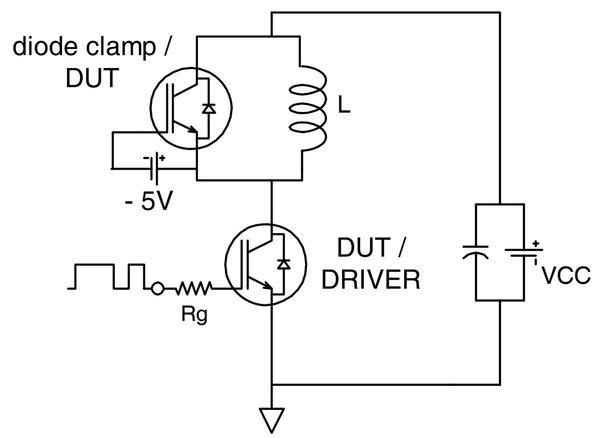



**Fig. CT.5 - Resistive Load Circuit**

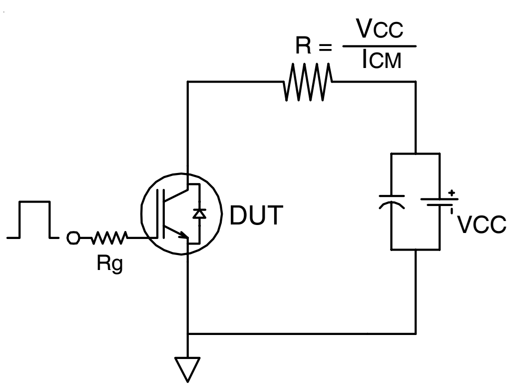


Fig. WF.1 - Typ. Turn-off Loss Waveform
@ Tj=125°C using Fig. CT.4

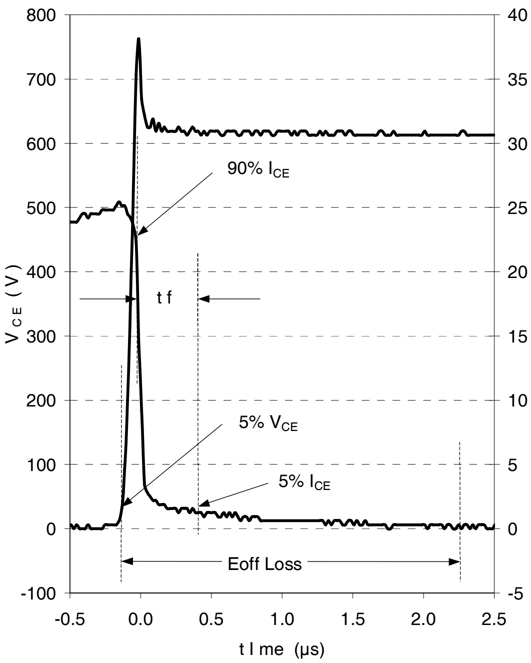



Fig. WF.2 - Typ. Turn-on Loss Waveform
@ Tj=125°C using Fig. CT.4

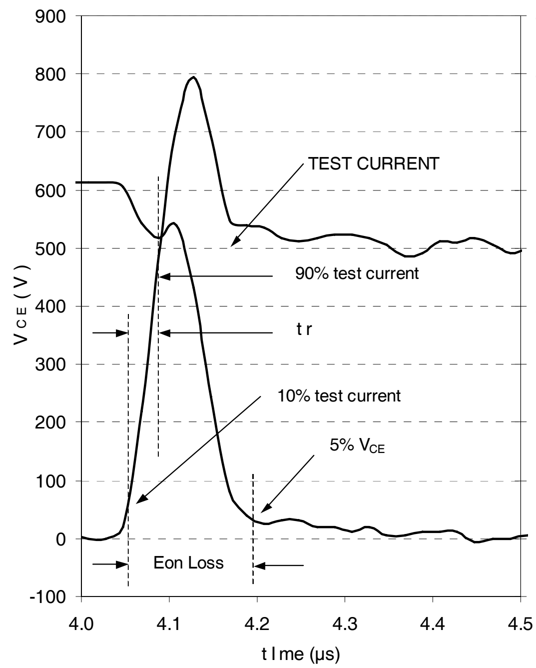



Fig. WF.3 - Typ. Diode Recovery Waveform
@ Tj=125°C using Fig. CT.4

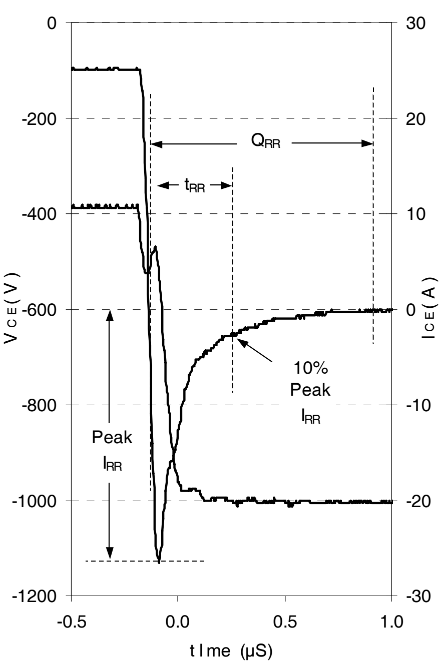
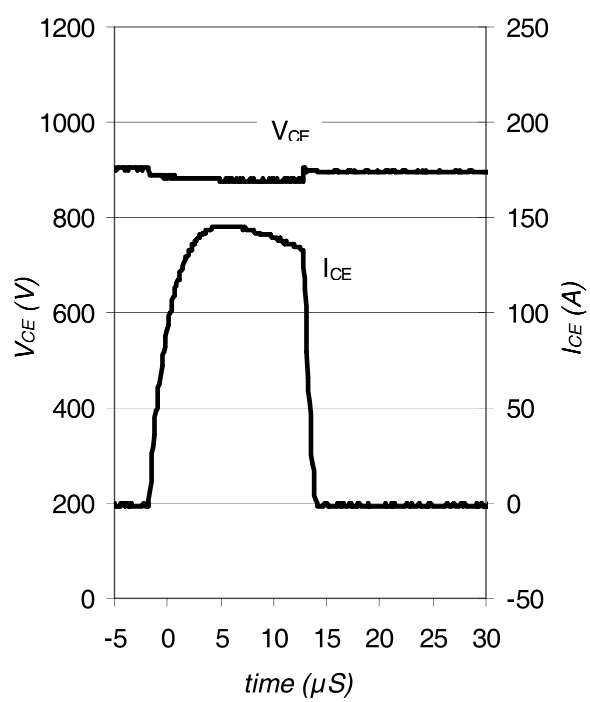
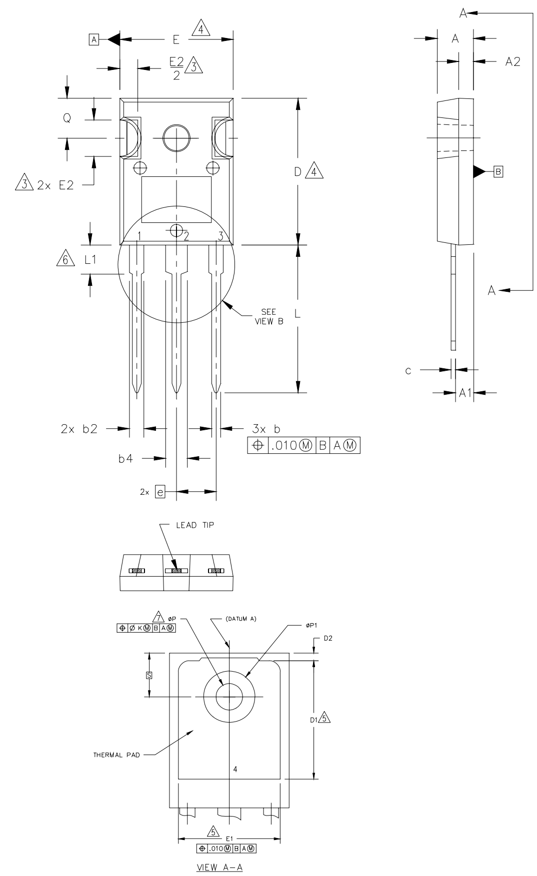



Fig. WF.4 - Typ. S.C. Waveform
@ $T_C$=150°C using Fig. CT.3



## 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

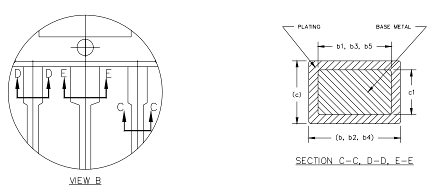
IGBTs, CoPACK

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

DIODES

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

9. For the most current drawing please refer to IR website at http://www.irf.com/package/pkigbt.html

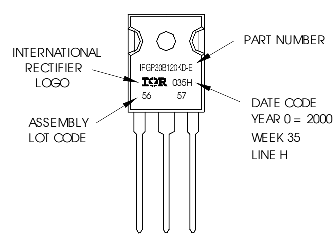



**TO-247AC package is not recommended for Surface Mount Application.**

## 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"

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*Data and specifications subject to change without notice.* *9/07*