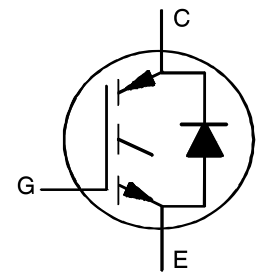
PD - 97736

International Rectifier

# IRGPS4067DPbF

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




n-channel

$V_{CES}$ = 600V

$I_{C(Nominal)}$ = 120A

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

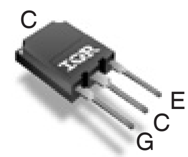
$V_{CE(on)}$ typ. = 1.70V

## Features

- Low $V_{CE\ (on)}$ Trench IGBT Technology
- Low Switching Losses
- 5µs SCSOA
- Square RBSOA
- 100% of The Parts Tested for $I_{LM}$ ①
- Positive $V_{CE\ (on)}$ Temperature Coefficient.
- Ultra Fast Soft Recovery Co-pak Diode
- Tighter Distribution of Parameters
- Lead-Free, RoHS Compliant

## 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
- Low EMI




Super-247

| 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 | 240⑤ | A |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 160⑤ | |
| $I_{NOMINAL}$ | Nominal Current | 120 | |
| $I_{CM}$ | Pulse Collector Current, $V_{GE}$ = 15V | 360 | |
| $I_{LM}$ | Clamped Inductive Load Current, $V_{GE}$ = 20V ① | 480 | |
| $I_F$ @ $T_C$ = 25°C | Diode Continous Forward Current | 240 | |
| $I_F$ @ $T_C$ = 100°C | Diode Continous Forward Current | 160 | |
| $I_{FM}$ | Diode Maximum Forward Current ② | 480 | |
| $V_{GE}$ | Continuous Gate-to-Emitter Voltage | ±20 | V |
| | Transient Gate-to-Emitter Voltage | ±30 | |
| $P_D$ @ $T_C$ = 25°C | Maximum Power Dissipation | 750 | W |
| $P_D$ @ $T_C$ = 100°C | Maximum Power Dissipation | 375 | |
| $T_J$<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) | |

## Thermal Resistance

| | Parameter | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $R_{\theta JC}$ (IGBT) | Thermal Resistance Junction-to-Case-(each IGBT) ④ | —— | —— | 0.20 | °C/W |
| $R_{\theta JC}$ (Diode) | Thermal Resistance Junction-to-Case-(each Diode) ④ | —— | —— | 0.63 | |
| $R_{\theta CS}$ | 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°C (unless otherwise specified)**

| | Parameter | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| $V_{(BR)CES}$ | Collector-to-Emitter Breakdown Voltage | 600 | — | — | V | $V_{GE}$ = 0V, $I_C$ = 100µA ③ |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage | — | 0.27 | — | V/°C | $V_{GE}$ = 0V, $I_C$ = 4.0mA (25°C-175°C) |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | — | 1.70 | 2.05 | V | $I_C$ = 120A, $V_{GE}$ = 15V, $T_J$ = 25°C |
| | | — | 2.15 | — | | $I_C$ = 120A, $V_{GE}$ = 15V, $T_J$ = 150°C |
| | | — | 2.20 | — | | $I_C$ = 120A, $V_{GE}$ = 15V, $T_J$ = 175°C |
| $V_{GE(th)}$ | Gate Threshold Voltage | 4.0 | — | 6.5 | V | $V_{CE}$ = $V_{GE}$, $I_C$ = 5.6mA |
| $\Delta V_{GE(th)}/\Delta T_J$ | Threshold Voltage temp. coefficient | — | -17 | — | mV/°C | $V_{CE}$ = $V_{GE}$, $I_C$ = 5.6mA (25°C - 175°C) |
| gfe | Forward Transconductance | — | 77 | — | S | $V_{CE}$ = 50V, $I_C$ = 120A |
| $I_{CES}$ | Collector-to-Emitter Leakage Current | — | 1.0 | 150 | µA | $V_{GE}$ = 0V, $V_{CE}$ = 600V |
| | | — | 2.3 | — | mA | $V_{GE}$ = 0V, $V_{CE}$ = 600V, $T_J$ = 175°C |
| $V_{FM}$ | Diode Forward Voltage Drop | — | 2.4 | 3.0 | V | $I_F$ = 120A |
| | | — | 1.9 | — | | $I_F$ = 120A, $T_J$ = 175°C |
| $I_{GES}$ | Gate-to-Emitter Leakage Current | — | — | ±400 | nA | $V_{GE}$ = ±20V |

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

| | Parameter | Min. | Typ. | Max.⑥ | Units | Conditions |
|---|---|---|---|---|---|---|
| $Q_g$ | Total Gate Charge (turn-on) | — | 240 | 360 | nC | $I_C$ = 120A |
| $Q_{ge}$ | Gate-to-Emitter Charge (turn-on) | — | 70 | 105 | | $V_{GE}$ = 15V |
| $Q_{gc}$ | Gate-to-Collector Charge (turn-on) | — | 90 | 135 | | $V_{CC}$ = 400V |
| $E_{on}$ | Turn-On Switching Loss | — | 5750 | 7990 | µJ | $I_C$ = 120A, $V_{CC}$ = 400V, $V_{GE}$ = 15V |
| $E_{off}$ | Turn-Off Switching Loss | — | 3430 | 4360 | | $R_G$ = 4.7Ω, L = 66µH, $T_J$ = 25°C |
| $E_{total}$ | Total Switching Loss | — | 9180 | 12350 | | Energy losses include tail & diode reverse recovery |
| $t_{d(on)}$ | Turn-On delay time | — | 80 | 100 | ns | $I_C$ = 120A, $V_{CC}$ = 400V, $V_{GE}$ = 15V |
| $t_r$ | Rise time | — | 70 | 125 | | $R_G$ = 4.7Ω, L = 66µH, TJ = 25°C |
| $t_{d(off)}$ | Turn-Off delay time | — | 190 | 220 | | |
| $t_f$ | Fall time | — | 40 | 60 | | |
| $E_{on}$ | Turn-On Switching Loss | — | 7740 | — | µJ | $I_C$ = 120A, $V_{CC}$ = 400V, $V_{GE}$=15V |
| $E_{off}$ | Turn-Off Switching Loss | — | 4390 | — | | $R_G$=4.7Ω, L=66µH, $T_J$ = 175°C |
| $E_{total}$ | Total Switching Loss | — | 12130 | — | | Energy losses include tail & diode reverse recovery |
| $t_{d(on)}$ | Turn-On delay time | — | 80 | — | ns | $I_C$ = 120A, $V_{CC}$ = 400V, $V_{GE}$ = 15V |
| $t_r$ | Rise time | — | 75 | — | | $R_G$ = 4.7Ω, L = 66µH |
| $t_{d(off)}$ | Turn-Off delay time | — | 230 | — | | $T_J$ = 175°C |
| $t_f$ | Fall time | — | 55 | — | | |
| $C_{ies}$ | Input Capacitance | — | 7750 | — | pF | $V_{GE}$ = 0V |
| $C_{oes}$ | Output Capacitance | — | 550 | — | | $V_{CC}$ = 30V |
| $C_{res}$ | Reverse Transfer Capacitance | — | 225 | — | | f = 1.0Mhz |
| RBSOA | Reverse Bias Safe Operating Area | FULL SQUARE | | | | $T_J$ = 175°C, $I_C$ = 480A<br>$V_{CC}$ = 480V, Vp =600V<br>Rg = 4.7Ω, $V_{GE}$ = +20V to 0V |
| SCSOA | Short Circuit Safe Operating Area | 5 | — | — | µs | $V_{CC}$ = 400V, Vp =600V<br>Rg = 4.7Ω, $V_{GE}$ = +15V to 0V |
| Erec | Reverse Recovery Energy of the Diode | — | 500 | — | µJ | $T_J$ = 175°C |
| $t_{rr}$ | Diode Reverse Recovery Time | — | 130 | — | ns | $V_{CC}$ = 400V, $I_F$ = 120A |
| $I_{rr}$ | Peak Reverse Recovery Current | — | 36 | — | A | $V_{GE}$ = 15V, Rg = 4.7Ω, L =100µH |

**Notes:**

① $V_{CC}$ = 80% ($V_{CES}$), $V_{GE}$ = 20V, L = 66µH, $R_G$ = 4.7Ω, tested in production $I_{LM} \leq$ 400A.
② Pulse width limited by max. junction temperature.
③ Refer to AN-1086 for guidelines for measuring $V_{(BR)CES}$ safely.
④ $R_\theta$ is measured at $T_J$ of approximately 90°C.
⑤ Calculated continuous current based on maximum allowable junction temperature. Package IGBT current limit is 195A. Package diode current limit is 120A. Note that current limitations arising from heating of the device leads may occur.
⑥ Maximum limits are based on statistical sample size characterization.

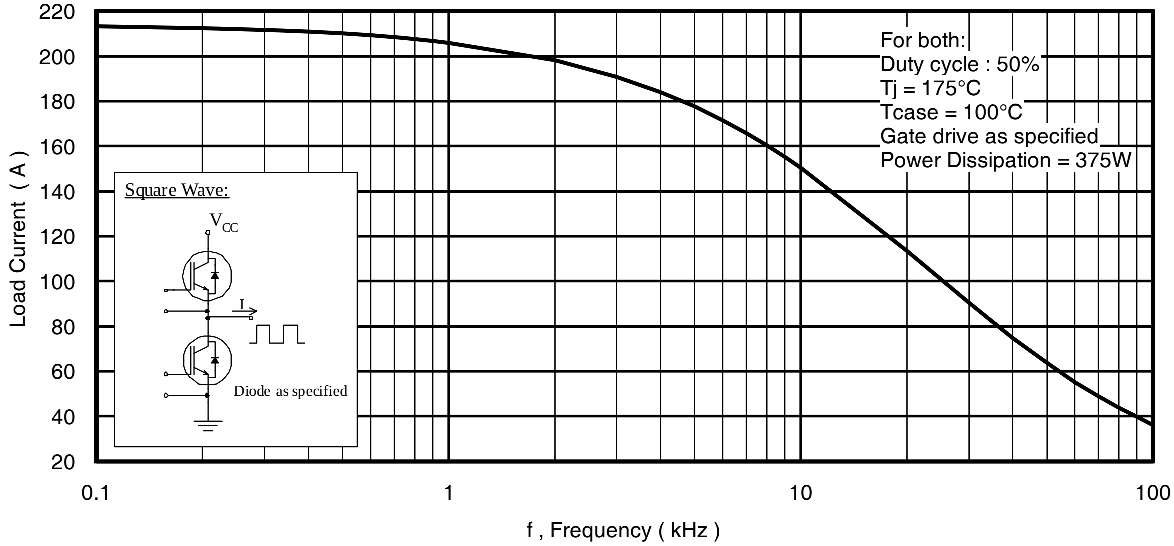



**Fig. 1** - Typical Load Current vs. Frequency
(Load Current = $I_{RMS}$ of fundamental)

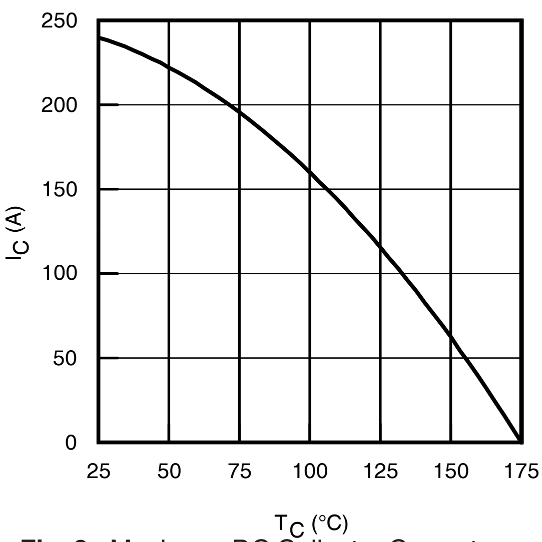



**Fig. 2** - Maximum DC Collector Current vs. Case Temperature

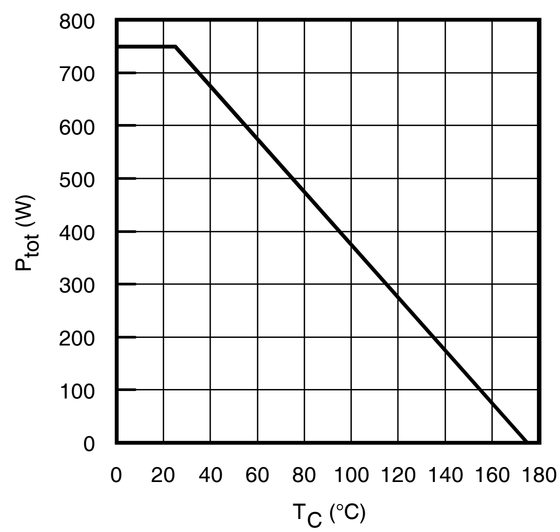



**Fig. 3** - Power Dissipation vs. Case Temperature

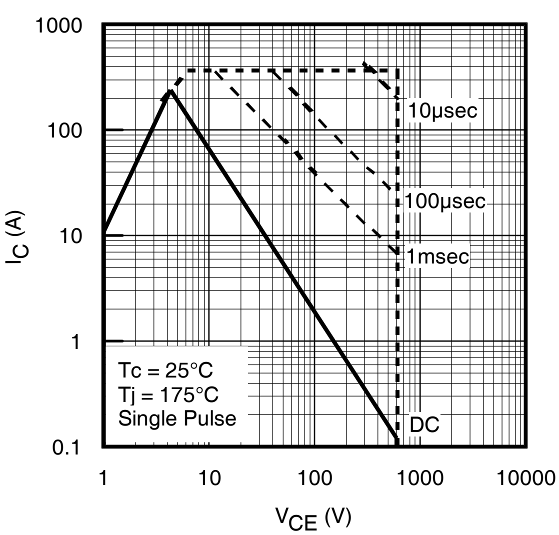



**Fig. 4** - Forward SOA
$T_C$ = 25°C, $T_J \leq$ 175°C; $V_{GE}$ =15V

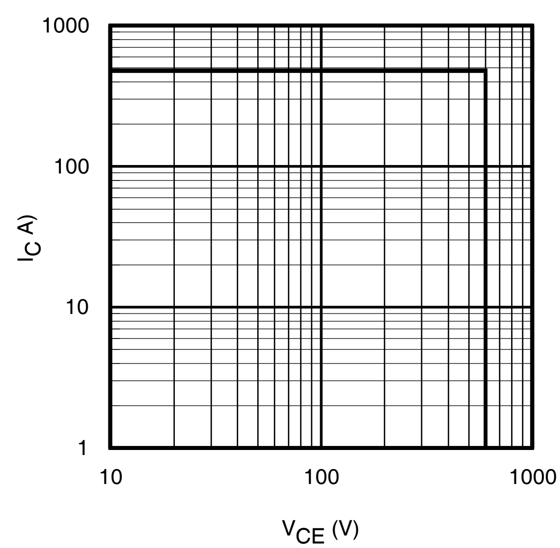



**Fig. 5** - Reverse Bias SOA
$T_J$ = 175°C; $V_{GE}$ =20V

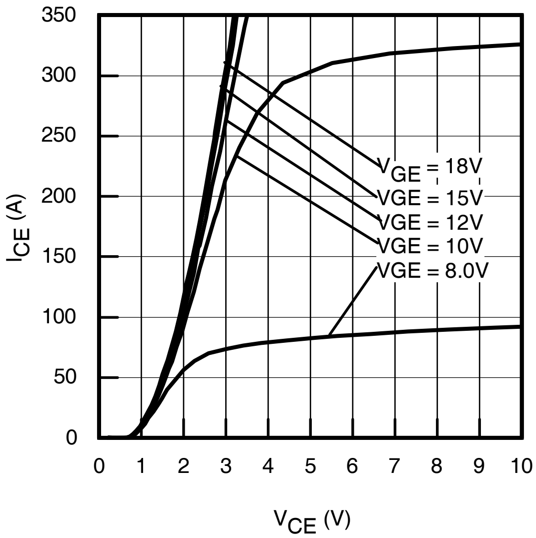



**Fig. 6** - Typ. IGBT Output Characteristics
$T_J$ = -40°C; tp = 80µs

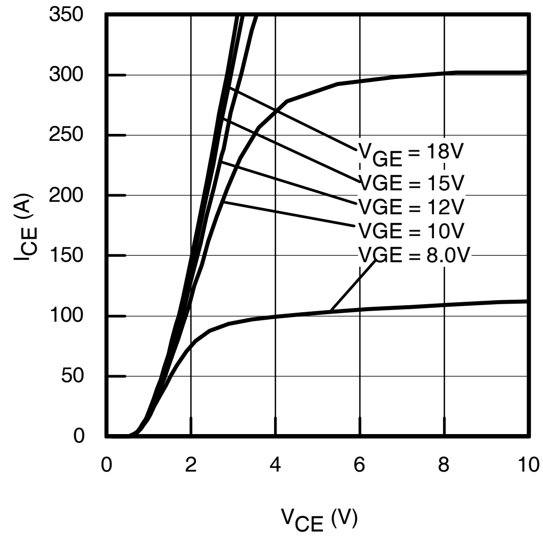



**Fig. 7** - Typ. IGBT Output Characteristics
$T_J$ = 25°C; tp = 80µs

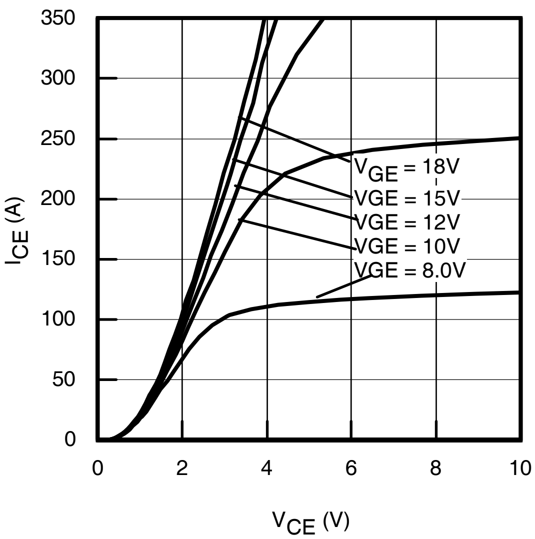



**Fig. 8** - Typ. IGBT Output Characteristics
$T_J$ = 175°C; tp = 80µs

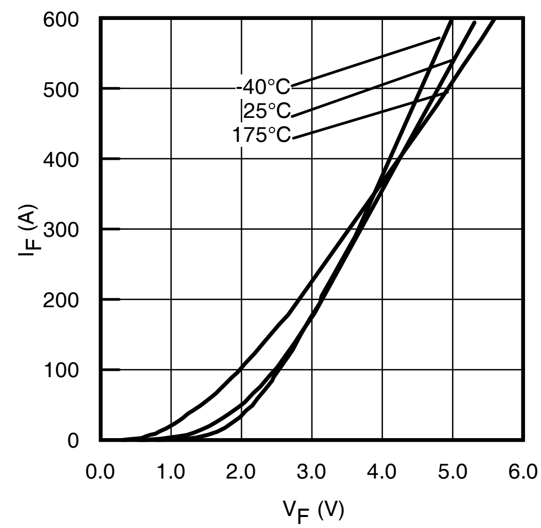



**Fig. 9** - Typ. Diode Forward Characteristics
tp = 80µs

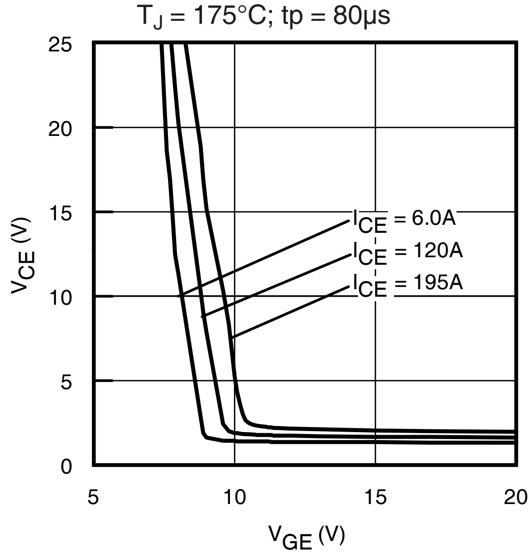



**Fig. 10** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J$ = -40°C

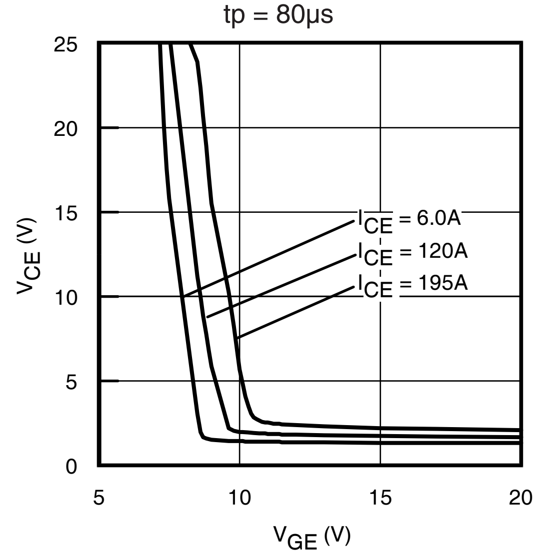



**Fig. 11** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J$ = 25°C

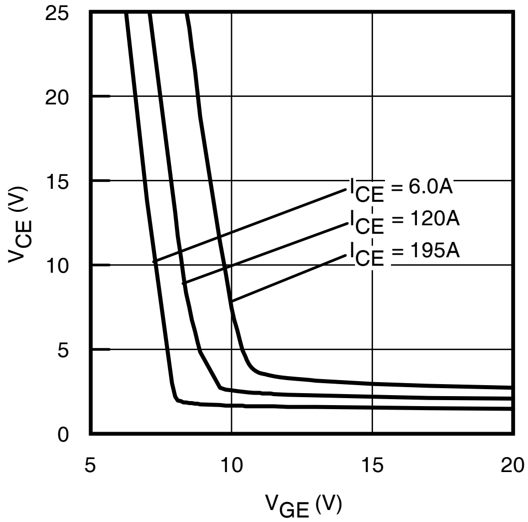



**Fig. 12** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J = 175°C$

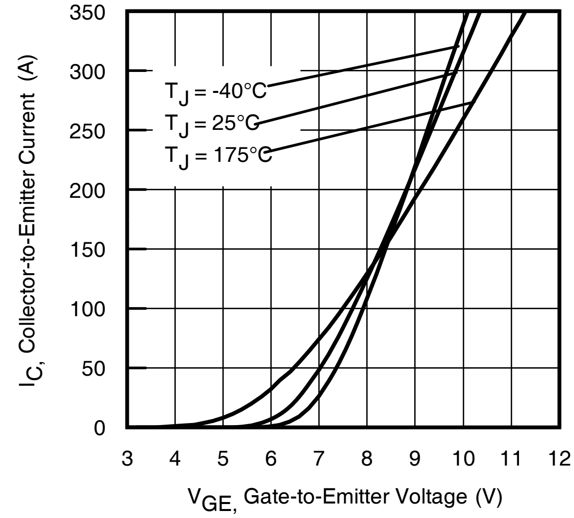



**Fig. 13** - Typ. Transfer Characteristics
$V_{CE} = 50V$; tp = 10µs

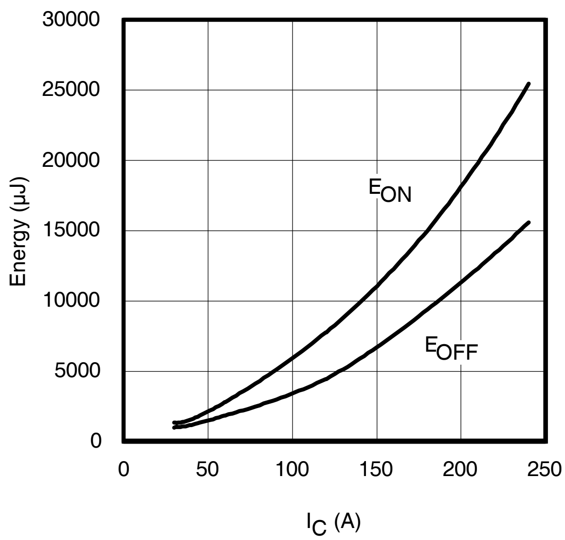



**Fig. 14** - Typ. Energy Loss vs. $I_C$
$T_J = 175°C$; L = 66µH; $V_{CE} = 400V$, $R_G = 4.7\Omega$; $V_{GE} = 15V$

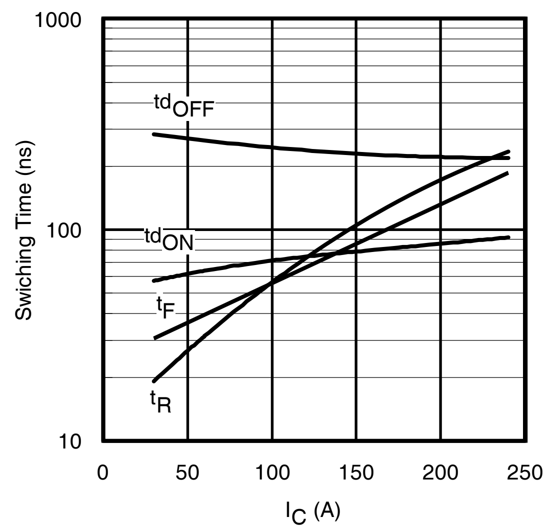



**Fig. 15** - Typ. Switching Time vs. $I_C$
$T_J = 175°C$; L = 66µH; $V_{CE} = 400V$, $R_G = 4.7\Omega$; $V_{GE} = 15V$

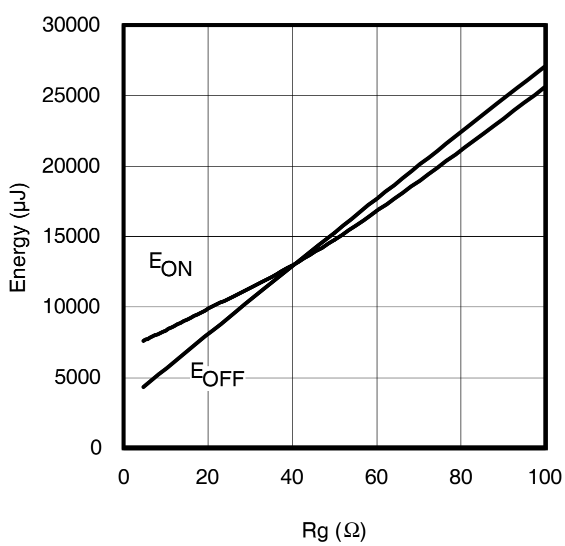



**Fig. 16** - Typ. Energy Loss vs. $R_G$
$T_J = 175°C$; L = 66µH; $V_{CE} = 400V$, $I_{CE} = 120A$; $V_{GE} = 15V$

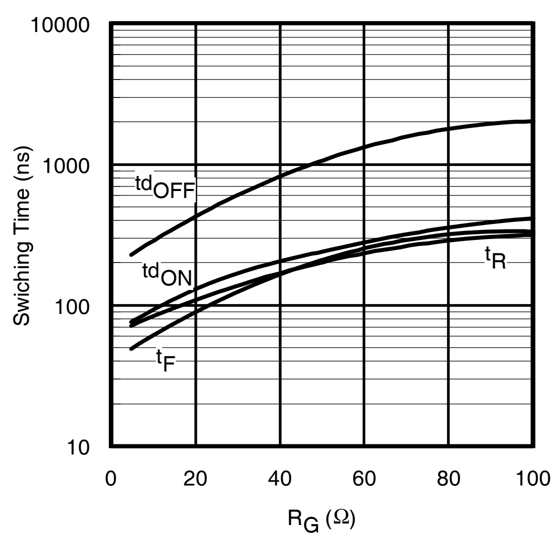



**Fig. 17** - Typ. Switching Time vs. $R_G$
$T_J = 175°C$; L = 66µH; $V_{CE} = 400V$, $I_{CE} = 120A$; $V_{GE} = 15V$

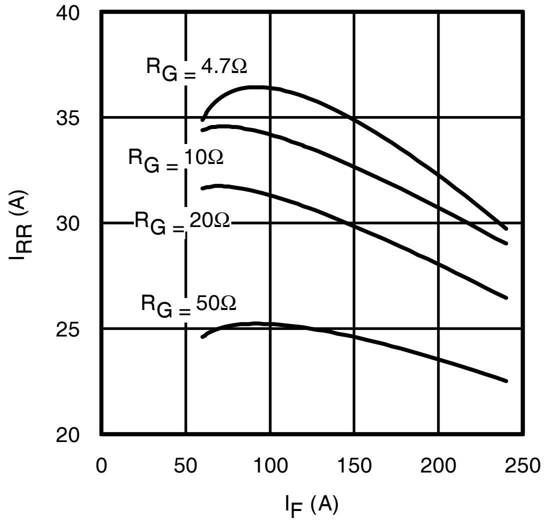



**Fig. 18** - Typ. Diode $I_{RR}$ vs. $I_F$
$T_J$ = 175°C

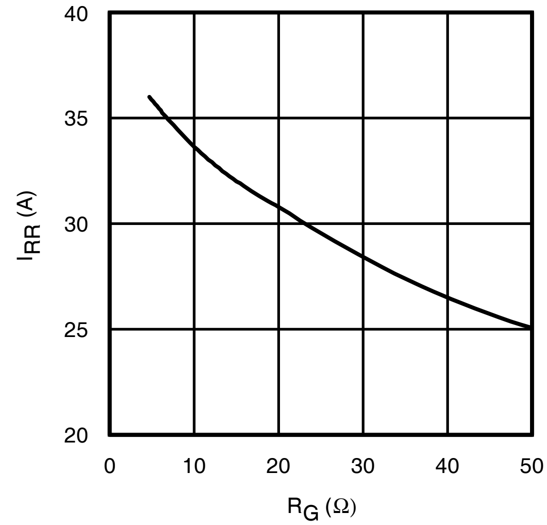



**Fig. 19** - Typ. Diode $I_{RR}$ vs. $R_G$
$T_J$ = 175°C

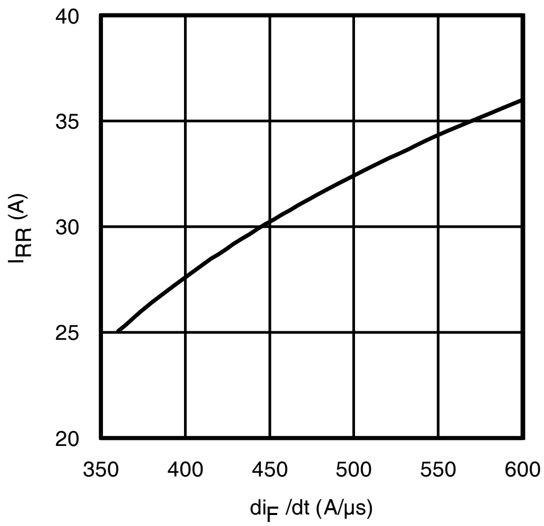



**Fig. 20** - Typ. Diode $I_{RR}$ vs. $di_F$/dt
$V_{CC}$ = 400V; $V_{GE}$ = 15V; $I_F$ = 120A; $T_J$ = 175°C

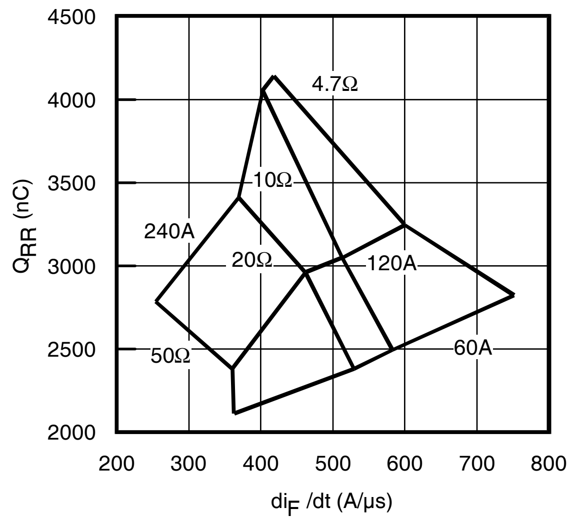



**Fig. 21** - Typ. Diode $Q_{RR}$ vs. $di_F$/dt
$V_{CC}$ = 400V; $V_{GE}$ = 15V; $T_J$ = 175°C

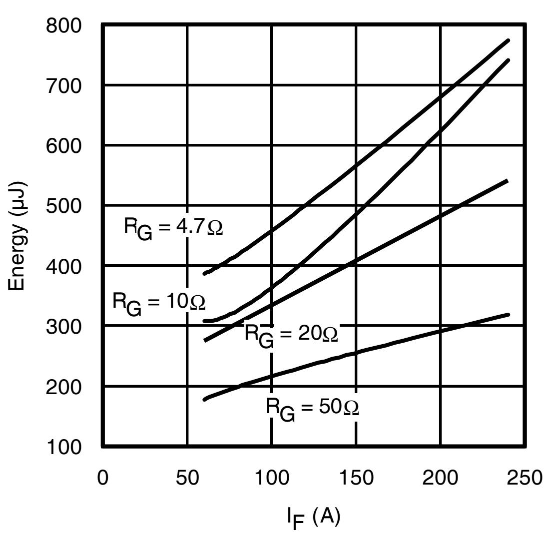



**Fig. 22** - Typ. Diode $E_{RR}$ vs. $I_F$
$T_J$ = 175°C

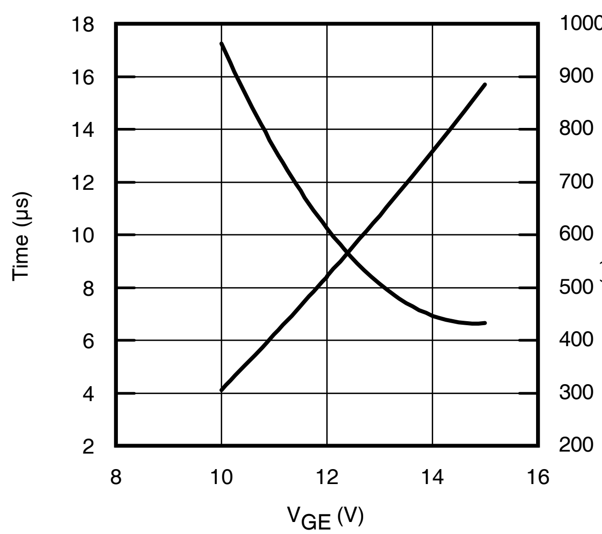



**Fig. 23** - $V_{GE}$ vs. Short Circuit Time
$V_{CC}$ = 400V; $T_C$ = 25°C

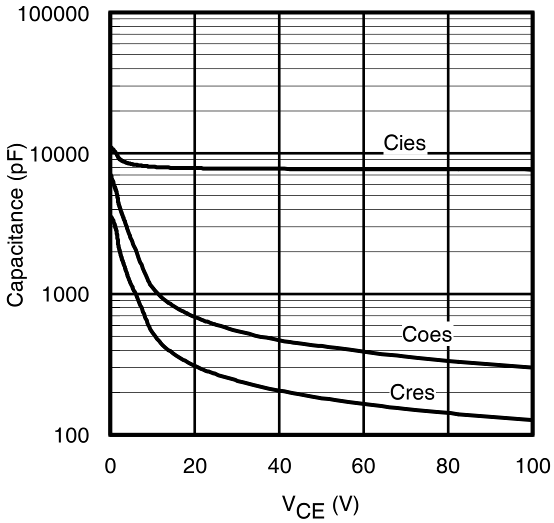



**Fig. 24** - Typ. Capacitance vs. $V_{CE}$
$V_{GE}$= 0V; f = 1MHz

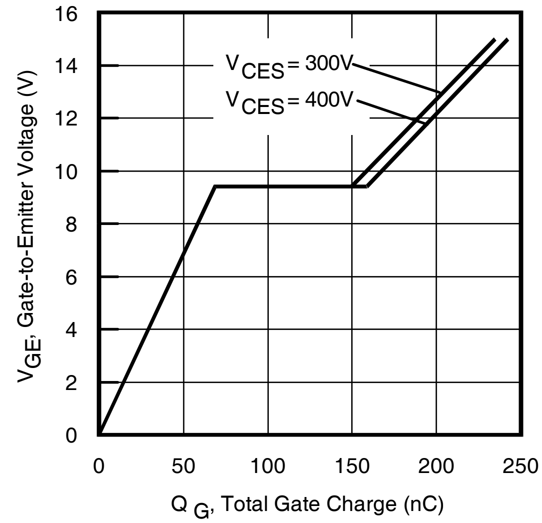



**Fig. 25** - Typical Gate Charge vs. $V_{GE}$
$I_{CE}$ = 120A; L = 100µH

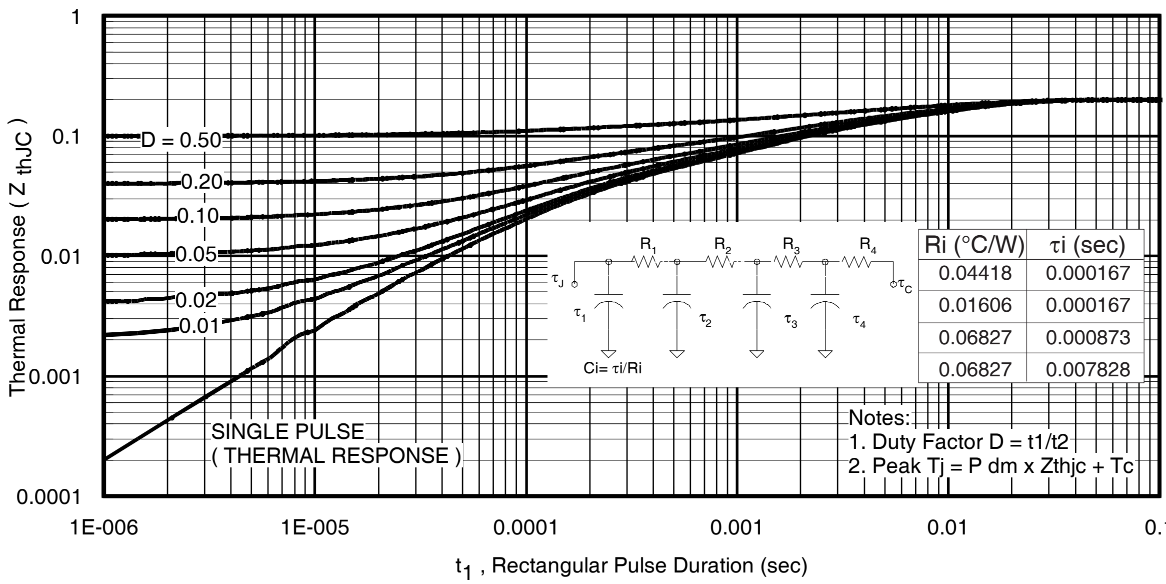



**Fig 26.** Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

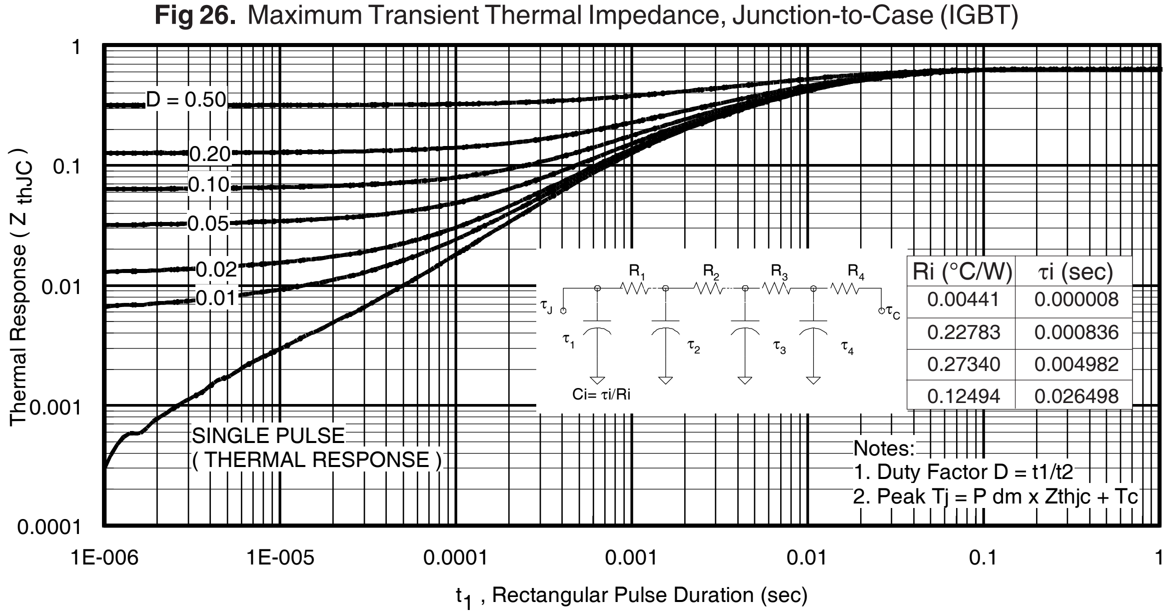



**Fig. 27.** Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

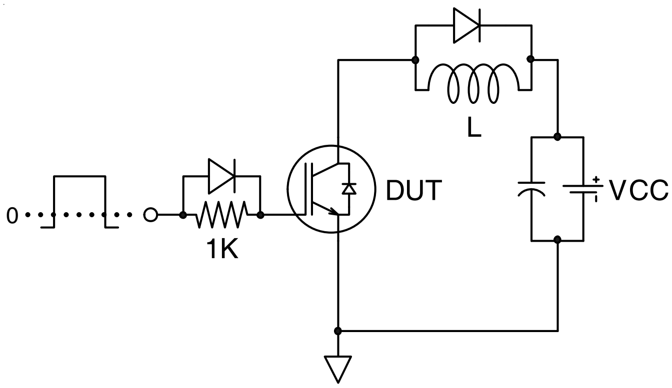



**Fig.C.T.1** - Gate Charge Circuit (turn-off)

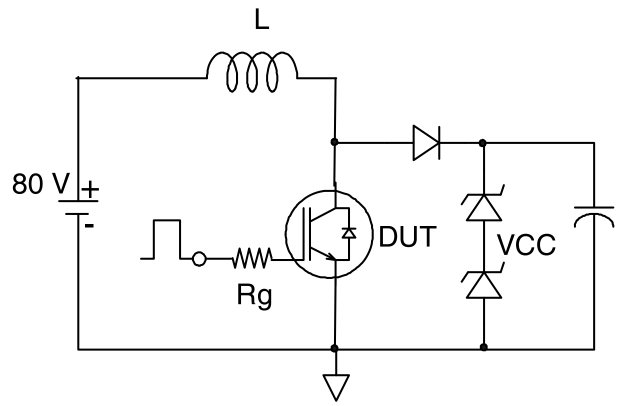
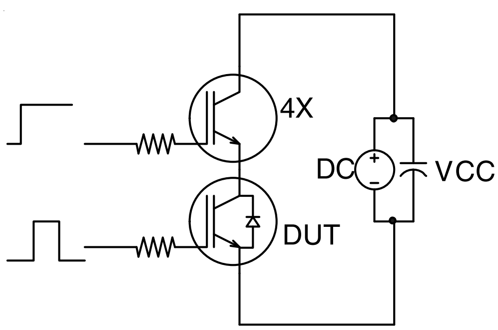



**Fig.C.T.2** - RBSOA Circuit




SCSOA

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

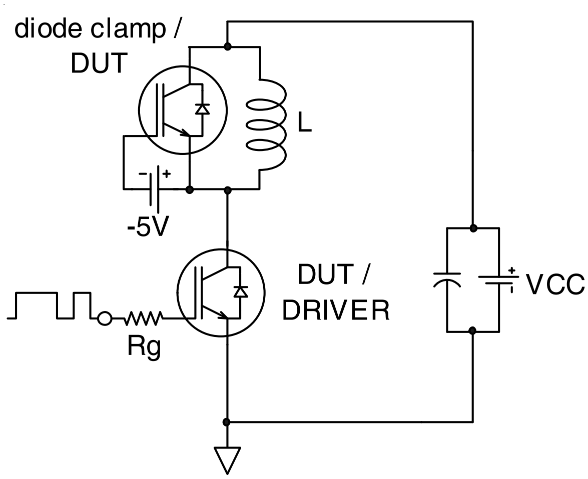



**Fig.C.T.4** - Switching Loss Circuit

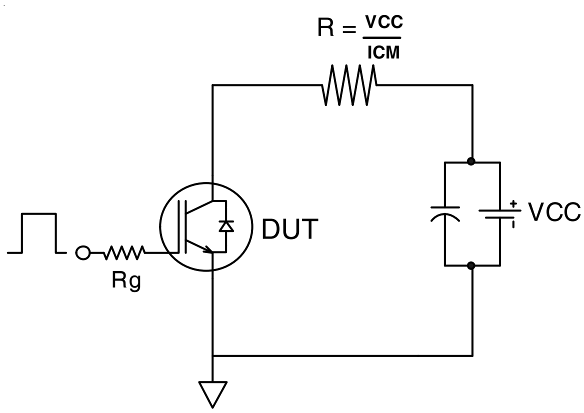



**Fig.C.T.5** - Resistive Load Circuit

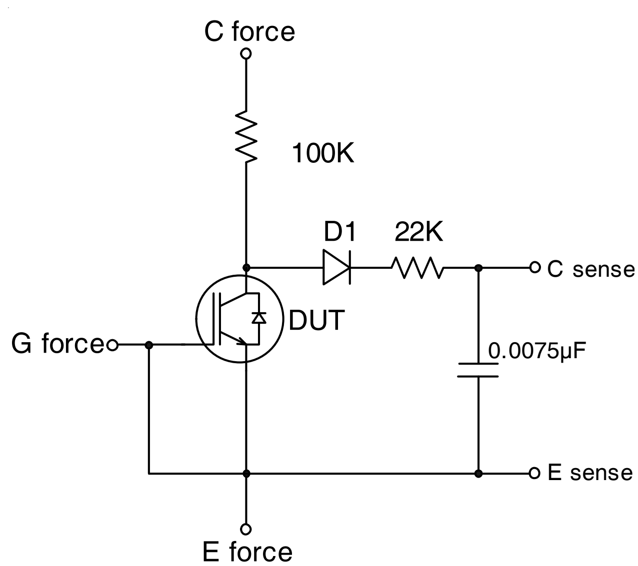



**Fig.C.T.6** - BVCES Filter Circuit

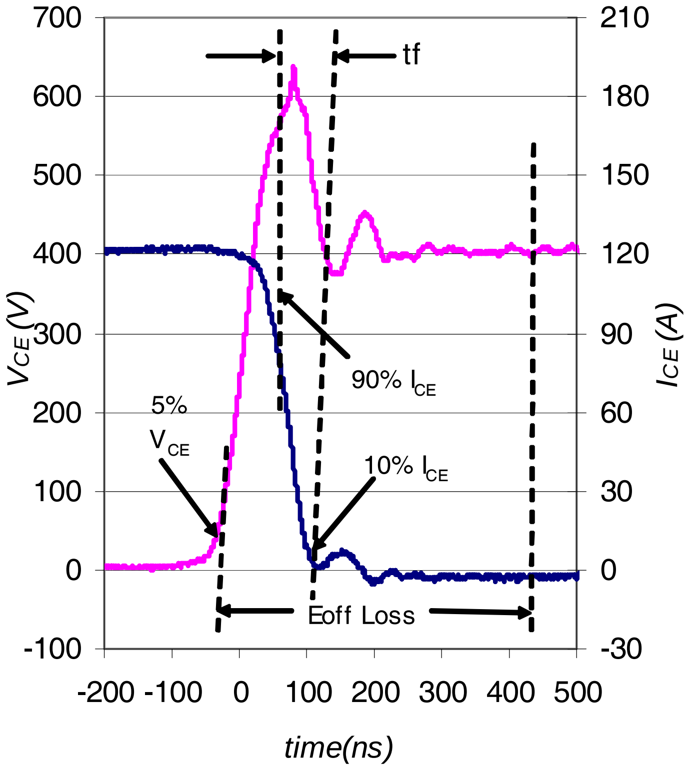



**Fig. WF1** - Typ. Turn-off Loss Waveform
@ $T_J$ = 175°C using Fig. CT.4

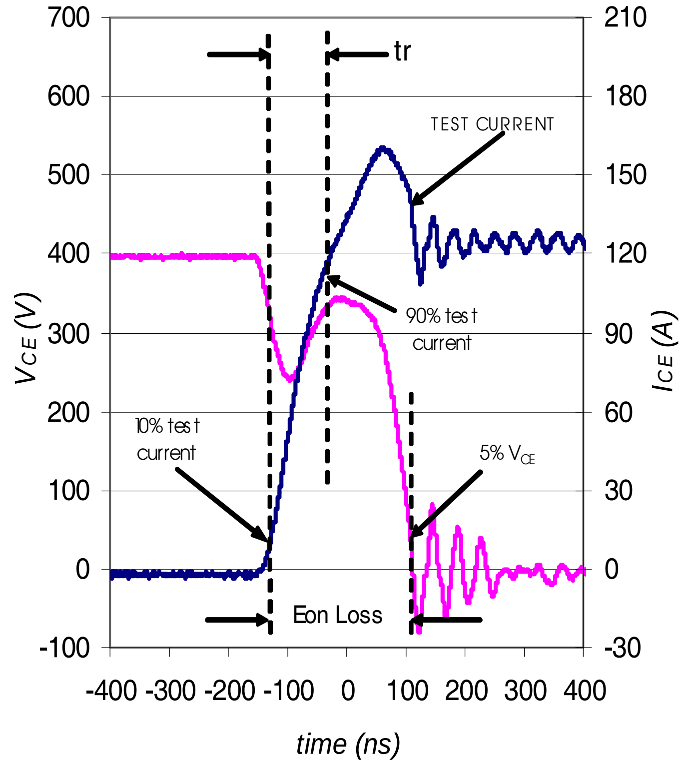



**Fig. WF2** - Typ. Turn-on Loss Waveform
@ $T_J$ = 175°C using Fig. CT.4

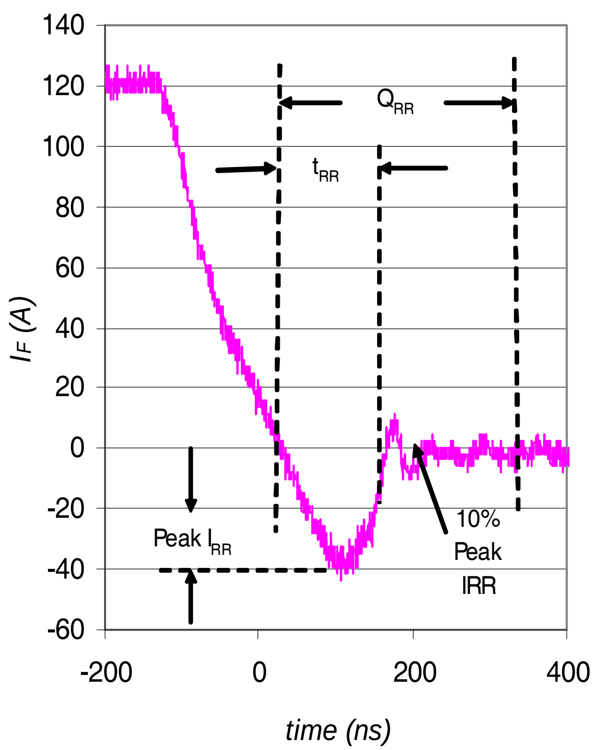



**Fig. WF3** - Typ. Diode Recovery Waveform
@ $T_J$ = 175°C using Fig. CT.4

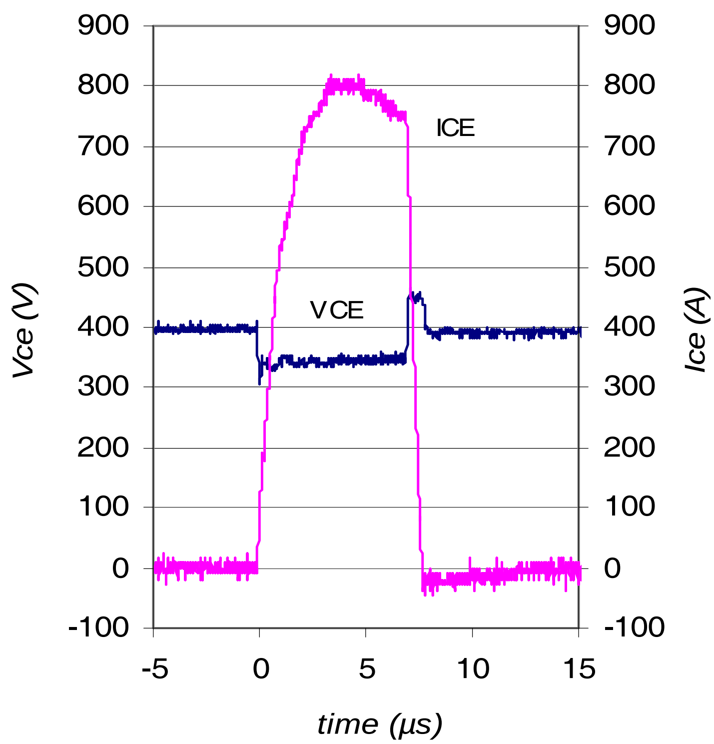
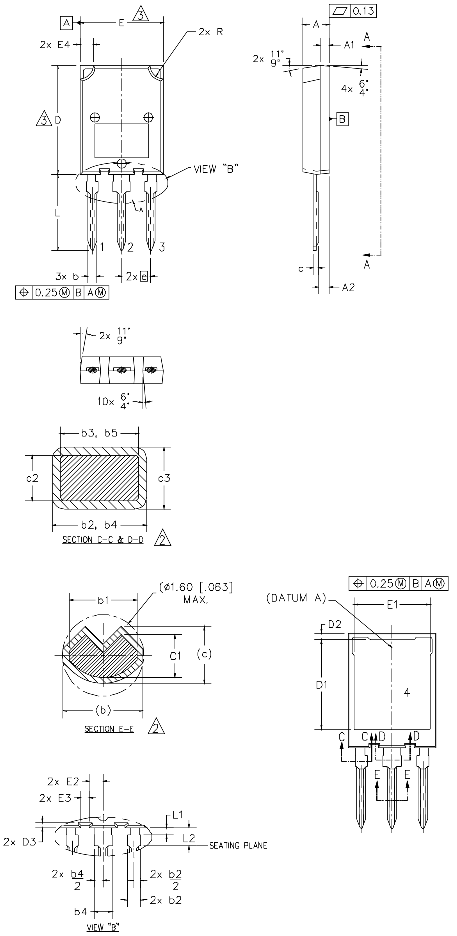



**Fig. WF4** - Typ. S.C. Waveform
@ $T_J$ = 25°C using Fig. CT.3

## Case Outline and Dimensions — Super-247



NOTES:
1. DIMENSIONING AND TOLERANCING AS PER ASME Y14.5M-1994
2. DIMENSIONS b1, b3, b5, c1 & c3 APPLY TO BASE METAL ONLY.
3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTER EXTREMES OF THE PLASTIC BODY.
4.- ALL DIMENSIONS SHOWN IN MILLIMETERS.
5.- CONTROLLING DIMENSION: MILLIMETER.
6.- OUTLINE CONFORMS TO JEDEC OUTLINE TO-274AA

| SYMBOL | DIMENSIONS | | | | NOTES |
|---|---|---|---|---|---|
| | MILLIMETERS | | INCHES | | |
| | MIN. | MAX. | MIN. | MAX. | |
| A | 4.50 | 5.50 | .177 | .217 | |
| A1 | 1.45 | 2.15 | .057 | .085 | |
| A2 | 1.65 | 2.35 | .065 | .093 | |
| b | 1.45 | 1.60 | .054 | .063 | |
| b1 | 1.40 | 1.50 | .055 | .059 | 2 |
| b2 | 2.00 | 2.40 | .079 | .094 | |
| b3 | 1.95 | 2.35 | .077 | .093 | 2 |
| b4 | 3.00 | 3.15 | .118 | .124 | |
| b5 | 2.95 | 3.35 | .116 | .132 | 2 |
| c | 1.10 | 1.30 | .043 | .051 | |
| c1 | 0.90 | 1.10 | .035 | .043 | 2 |
| c2 | 0.65 | 0.85 | .026 | .033 | |
| c3 | 0.50 | 0.70 | .020 | .028 | 2 |
| D | 19.80 | 20.80 | .780 | .819 | 3 |
| D1 | 15.50 | 16.10 | .610 | .634 | |
| D2 | 0.70 | 1.30 | .028 | .051 | |
| D3 | 0.75 | 1.25 | .030 | .049 | |
| E | 15.10 | 16.10 | .594 | .634 | 3 |
| E1 | 13.30 | 13.90 | .524 | .547 | |
| E2 | 2.25 | 2.70 | .089 | .109 | |
| E3 | 1.20 | 1.70 | .047 | .067 | |
| E4 | 2.00 | 3.00 | .079 | .118 | |
| e | 5.45 BSC | | .215 BSC | | |
| L | 13.80 | 14.80 | .535 | .583 | |
| L1 | 1.00 | 1.60 | .039 | .063 | |
| L2 | 3.85 | 4.25 | .152 | .167 | |
| R | 2.00 | 3.00 | .079 | .118 | |

LEAD ASSIGNMENTS

MOSFET

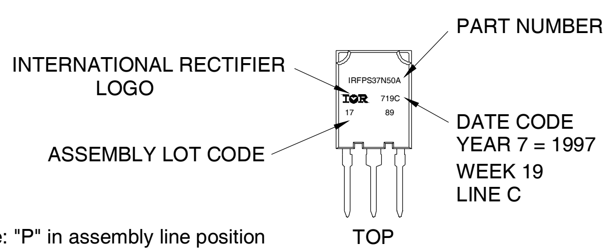
1.- GATE
2.- DRAIN
3.- SOURCE
4.- DRAIN

IGBT

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

## Super-247 (TO-274AA) Part Marking Information

EXAMPLE: THIS IS AN IRFPS37N50A WITH
ASSEMBLY LOT CODE 1789
ASSEMBLED ON WW 19, 1997
IN THE ASSEMBLY LINE "C"




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

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
IOR Rectifier
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