International
IOR Rectifier

# IRGPS66160DPbF

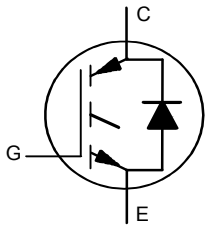
***Insulated Gate Bipolar Transistor with Ultrafast Soft Recovery Diode***

$V_{CES}$ = 600V

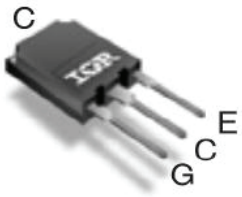
$I_C$ = 160A, $T_C$ =100°C

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

$V_{CE(ON)}$ typ. = 1.65V @ $I_C$ = 120A




n-channel




IRGPS66160DPbF
Super 247

**Applications**

- Welding
- H Bridge Converters

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

| Features | → | Benefits |
|---|---|---|
| Low $V_{CE(ON)}$ and Switching Losses | | High Efficiency in a Wide Range of Applications |
| Optimized Diode for Full Bridge Hard Switch Converters | | Optimized for Welding and H Bridge Converters |
| Square RBSOA and Maximum Temperature of 175°C | | Improved Reliability due to Rugged Hard Switching Performance and High Power Capability |
| 5µs Short Circuit | | Enables Short Circuit Protection Operation |
| Positive $V_{CE\ (ON)}$ Temperature Co-efficient | | Excellent Current Sharing in Parallel Operation |
| Lead-free, RoHS compliant | | Environmentally friendly |

| Base part number | Package Type | Standard Pack | | Orderable Part Number |
|---|---|---|---|---|
| | | Form | Quantity | |
| IRGPS66160DPbF | Super 247 | Tube | 25 | IRGPS66160DPbF |

**Absolute Maximum Ratings**

| | Parameter | Max. | Units |
|---|---|---|---|
| $V_{CES}$ | Collector-to-Emitter Voltage | 600 | V |
| $I_C$ @ $T_C$ = 25°C | Continuous Collector Current | 240 | A |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 160 | |
| $I_{CM}$ | Pulse Collector Current, $V_{GE}$ = 15V | 360 | |
| $I_{LM}$ | Clamped Inductive Load Current, $V_{GE}$ = 20V ① | 480 | |
| $I_{FRM}$ @ $T_C$ = 100°C | Diode Repetitive Peak Forward Current④⑥ | 80 | |
| $I_{FM}$ | Diode Maximum Forward Current ④ | 480 | |
| $V_{GE}$ | Continuous Gate-to-Emitter Voltage | ±20 | V |
| $P_D$ @ $T_C$ = 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 | -40 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) ② | — | — | 0.20 | °C/W |
| $R_{\theta JC}$ (Diode) | Thermal Resistance Junction-to-Case-(each Diode) ② | — | — | 1.37 | |
| $R_{\theta CS}$ | 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 | — | 0.54 | — | V/°C | $V_{GE}$ = 0V, $I_C$ = 4.0mA (25°C-175°C) |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | — | 1.65 | 1.95 | V | $I_C$ = 120A, $V_{GE}$ = 15V, $T_J$ = 25°C |
| | | — | 1.95 | — | | $I_C$ = 120A, $V_{GE}$ = 15V, $T_J$ = 150°C |
| | | — | 2.0 | — | | $I_C$ = 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 Temperature Coeff. | — | -16 | — | mV/°C | $V_{CE}$ = $V_{GE}$, $I_C$ = 5.6mA (25°C-175°C) |
| gfe | Forward Transconductance | — | 86 | — | S | $V_{CE}$ = 50V, $I_C$ = 120A, PW = 20µs |
| $I_{CES}$ | Collector-to-Emitter Leakage Current | — | 1.0 | 150 | µA | $V_{GE}$ = 0V, $V_{CE}$ = 600V |
| | | — | 2000 | — | | $V_{GE}$ = 0V, $V_{CE}$ = 600V, $T_J$ = 175°C |
| $I_{GES}$ | Gate-to-Emitter Leakage Current | — | — | ±400 | nA | $V_{GE}$ = ±20V |
| $V_F$ | Diode Forward Voltage Drop | — | 1.80 | 2.60 | V | $I_F$ = 24A |
| | | — | 1.30 | — | | $I_F$ = 24A, $T_J$ = 175°C |

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

| | Parameter | Min. | Typ. | Max | Units | Conditions |
|---|---|---|---|---|---|---|
| $Q_g$ | Total Gate Charge (turn-on) | — | 220 | — | nC | $I_C$ = 120A |
| $Q_{ge}$ | Gate-to-Emitter Charge (turn-on) | — | 60 | — | | $V_{GE}$ = 15V |
| $Q_{gc}$ | Gate-to-Collector Charge (turn-on) | — | 90 | — | | $V_{CC}$ = 400V |
| $E_{on}$ | Turn-On Switching Loss | — | 4470 | — | µJ | $I_C$ = 120A, $V_{CC}$ = 400V, $V_{GE}$=15V<br>$R_G$ = 4.7Ω, L= 66µH, $T_J$ = 25°C<br>Energy losses include tail & diode reverse recovery ⑤ |
| $E_{off}$ | Turn-Off Switching Loss | — | 3430 | — | | |
| $E_{total}$ | Total Switching Loss | — | 7900 | — | | |
| $t_{d(on)}$ | Turn-On delay time | — | 80 | — | ns | |
| $t_r$ | Rise time | — | 75 | — | | |
| $t_{d(off)}$ | Turn-Off delay time | — | 190 | — | | |
| $t_f$ | Fall time | — | 40 | — | | |
| $E_{on}$ | Turn-On Switching Loss | — | 5360 | — | µJ | $I_C$ = 120A, $V_{CC}$ = 400V, $V_{GE}$=15V<br>$R_G$ = 4.7Ω, L= 66µH, $T_J$ = 175°C<br>Energy losses include tail & diode reverse recovery ⑤ |
| $E_{off}$ | Turn-Off Switching Loss | — | 4390 | — | | |
| $E_{total}$ | Total Switching Loss | — | 9750 | — | | |
| $t_{d(on)}$ | Turn-On delay time | — | 80 | — | ns | |
| $t_r$ | Rise time | — | 130 | — | | |
| $t_{d(off)}$ | Turn-Off delay time | — | 260 | — | | |
| $t_f$ | Fall time | — | 90 | — | | |
| $C_{ies}$ | Input Capacitance | — | 7660 | — | pF | $V_{GE}$ = 0V |
| $C_{oes}$ | Output Capacitance | — | 470 | — | | $V_{CC}$ = 30V |
| $C_{res}$ | Reverse Transfer Capacitance | — | 250 | — | | 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>$V_{GE}$ = +20V to 0V |
| SCSOA | Short Circuit Safe Operating Area | 5 | — | — | µs | $T_J$ = 150°C,$V_{CC}$ = 400V, Vp ≤ 600V<br>$V_{GE}$ = +15V to 0V |
| Erec | Reverse Recovery Energy of the Diode | — | 420 | — | µJ | $T_J$ = 175°C |
| $t_{rr}$ | Diode Reverse Recovery Time | — | 95 | — | ns | $V_{CC}$ = 400V, $I_F$ = 24A, $V_{GE}$ = 15V |
| $I_{rr}$ | Peak Reverse Recovery Current | — | 34 | — | A | Rg = 4.7Ω, L=200µH, Ls=150nH |

**Notes:**

① $V_{CC}$ = 80% ($V_{CES}$), $V_{GE}$ = 20V, Rg = 4.7Ω, L=66µH.

② $R_\theta$ is measured at $T_J$ of approximately 90°C.

③ Refer to AN-1086 for guidelines for measuring $V_{(BR)CES}$ safely.

④ Pulse width limited by max. junction temperature.

⑤ Values influenced by parasitic L and C in measurement.

⑥ fsw =40KHz, refer to figure 26.

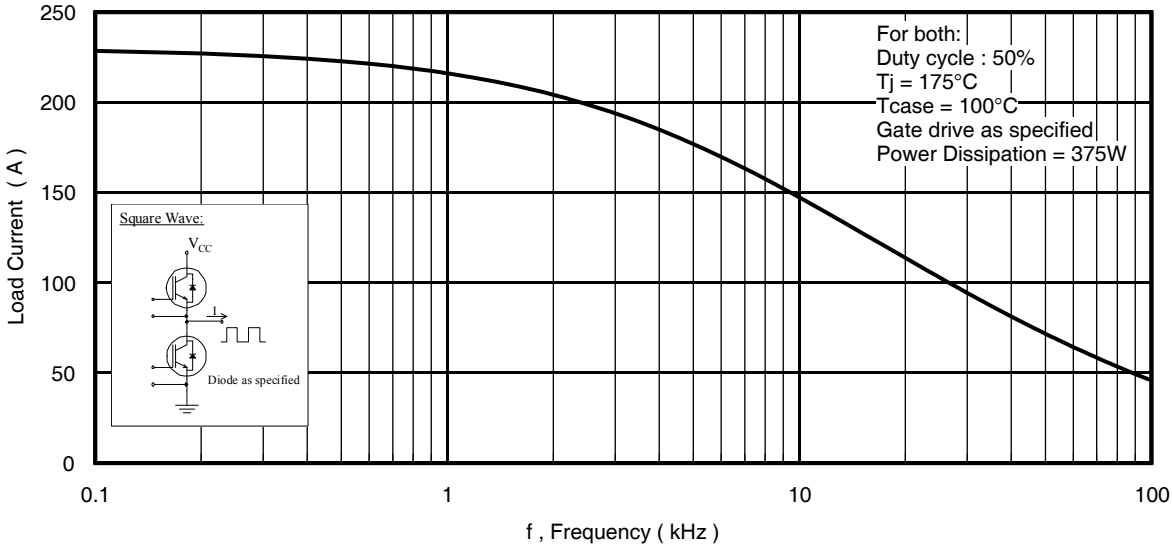



**Fig. 1** - Typical Load Current vs. Frequency
(Load Current = IRMS of fundamental)

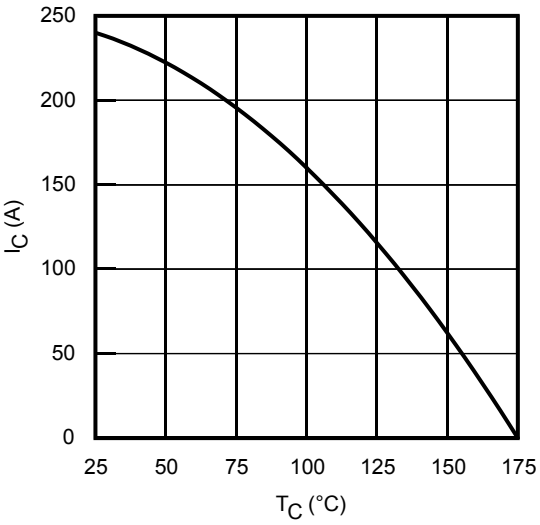



**Fig. 2** - Maximum DC Collector Current vs. Case Temperature

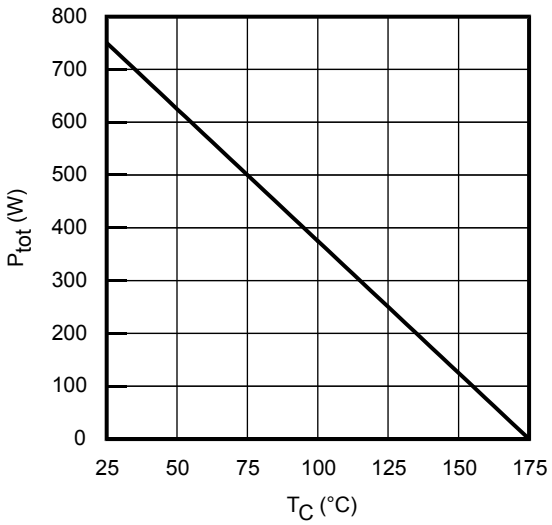



**Fig. 3** - Power Dissipation vs. Case Temperature

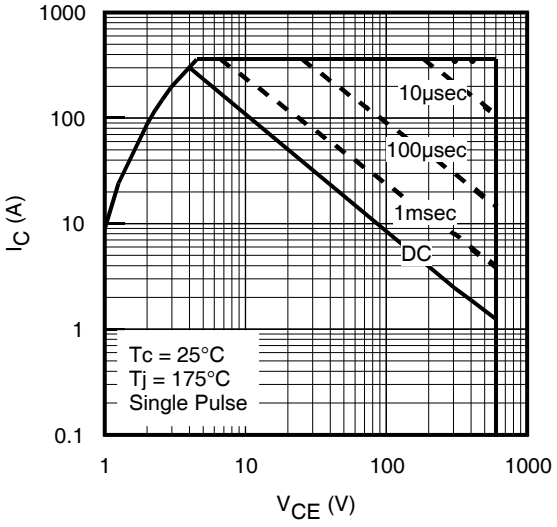



**Fig. 4** - Forward SOA
$T_C$ = 25°C; $T_J$ ≤ 175°C; $V_{GE}$ = 15V

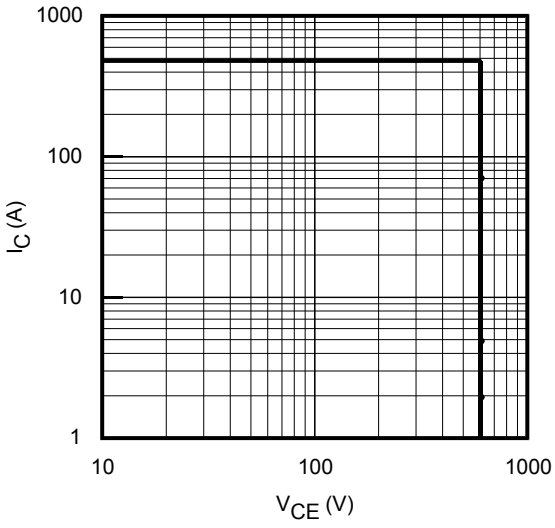



**Fig. 5** - Reverse Bias SOA
$T_J$ = 175°C; $V_{GE}$ = 20V

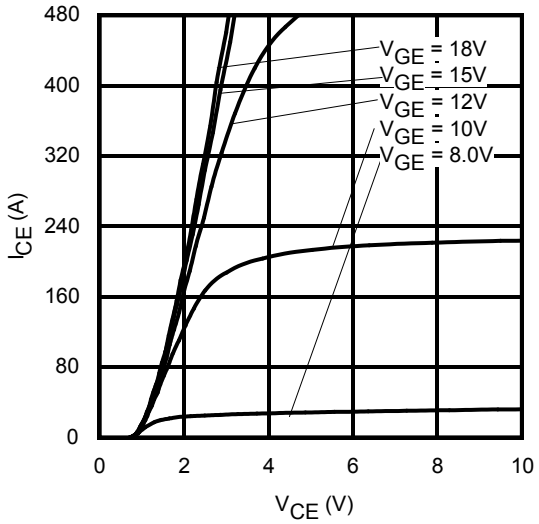



**Fig. 6** - Typ. IGBT Output Characteristics
$T_J$ = -40°C; tp = 20µs

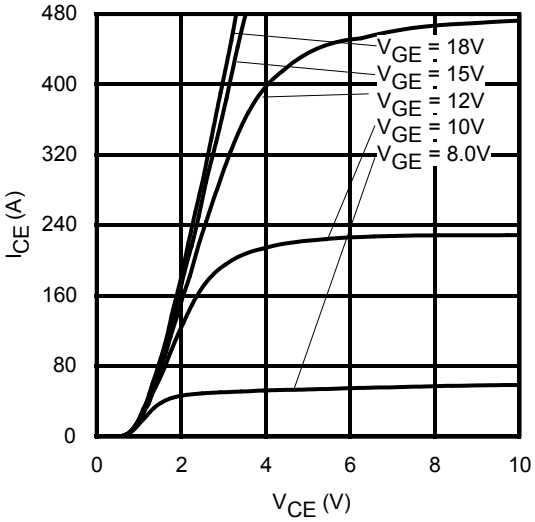



**Fig. 7** - Typ. IGBT Output Characteristics
$T_J$ = 25°C; tp = 20µs

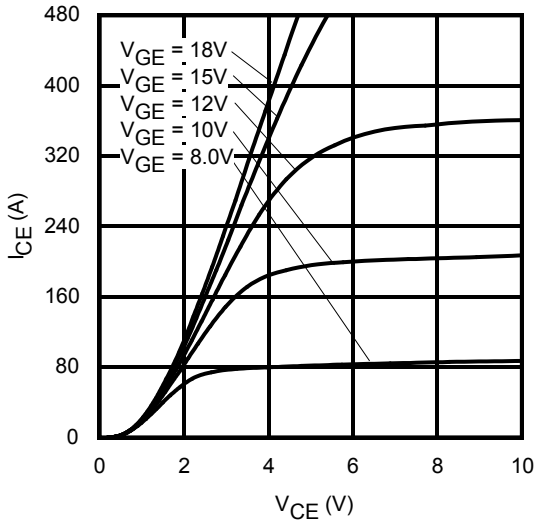



**Fig. 8** - Typ. IGBT Output Characteristics
$T_J$ = 175°C; tp = 20µs

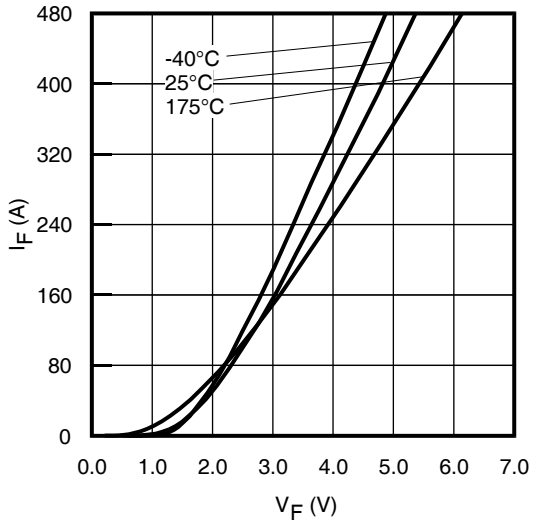



**Fig. 9** - Typ. Diode Forward Voltage Drop Characteristics

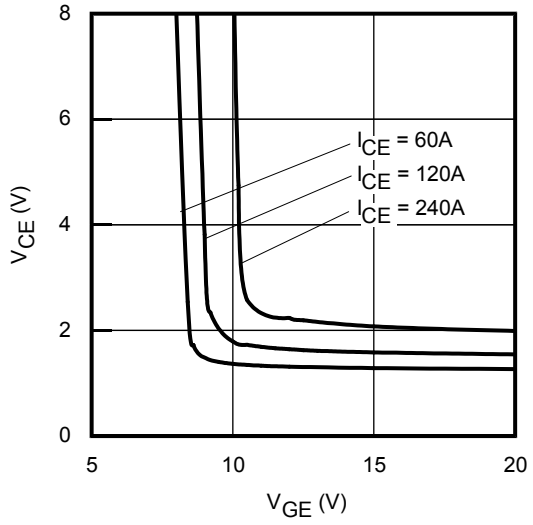



**Fig. 10** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J$ = -40°C

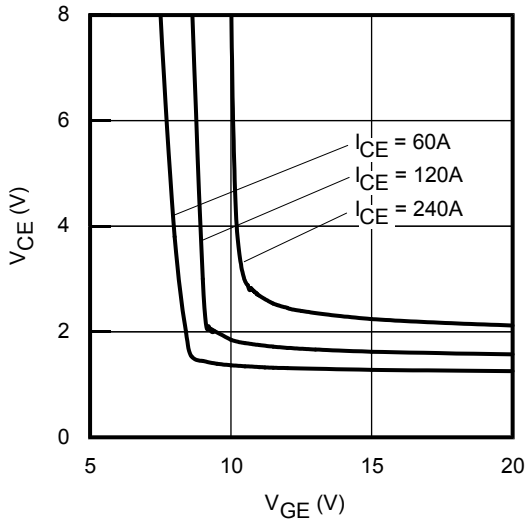



**Fig. 11** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J$ = 25°C

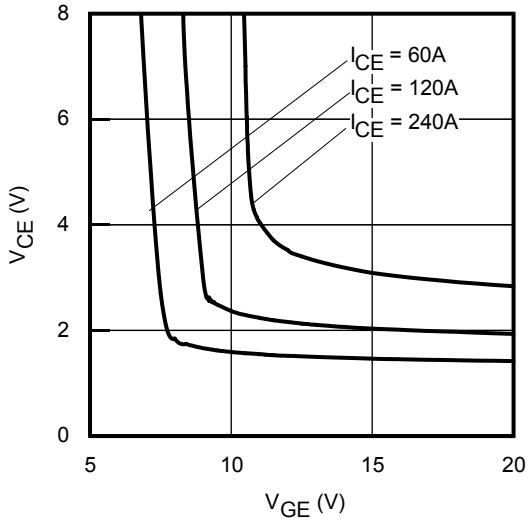



**Fig. 12** - Typical $V_{CE}$ vs. $V_{GE}$
$T_J$ = 175°C

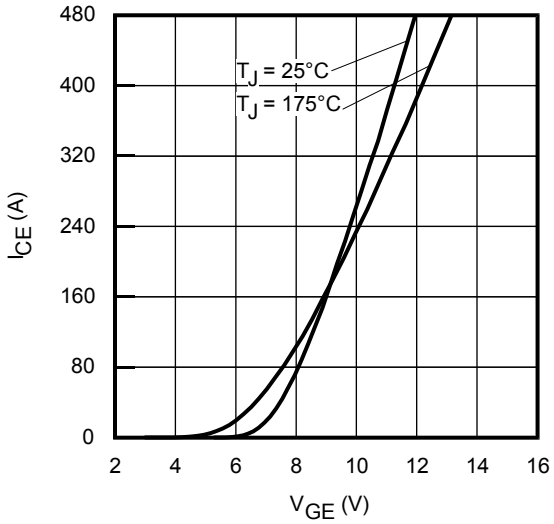



**Fig. 13** - Typ. Transfer Characteristics
$V_{CE}$ = 50V; tp = 20µs

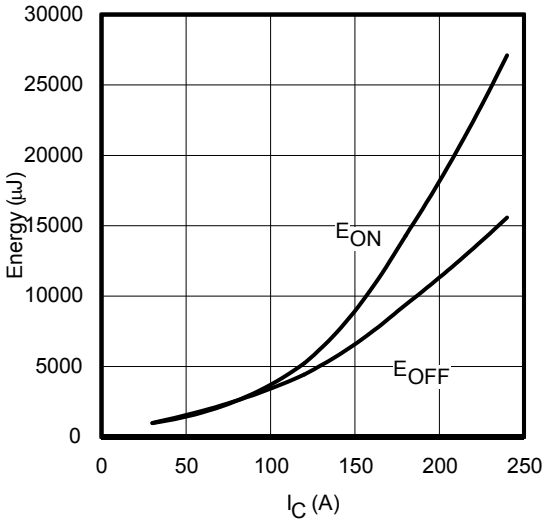



**Fig. 14** - Typ. Energy Loss vs. $I_C$
$T_J$ = 175°C; ; $V_{CE}$ = 400V, $R_G$ = 4.7 Ω; $V_{GE}$ = 15V

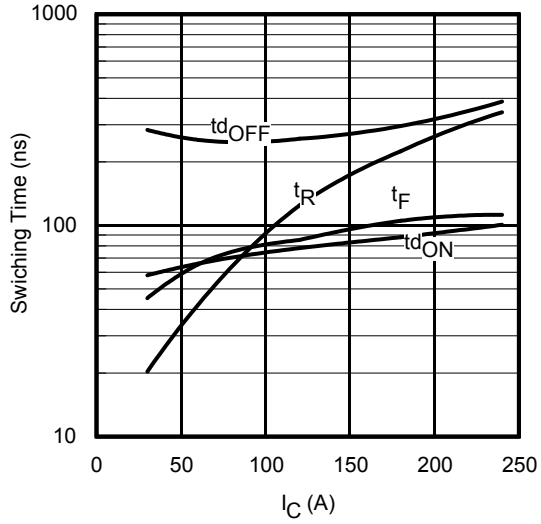



**Fig. 15** - Typ. Switching Time vs. $I_C$
$T_J$ = 175°C; $V_{CE}$ = 400V, $R_G$ = 4.7Ω; $V_{GE}$ = 15V

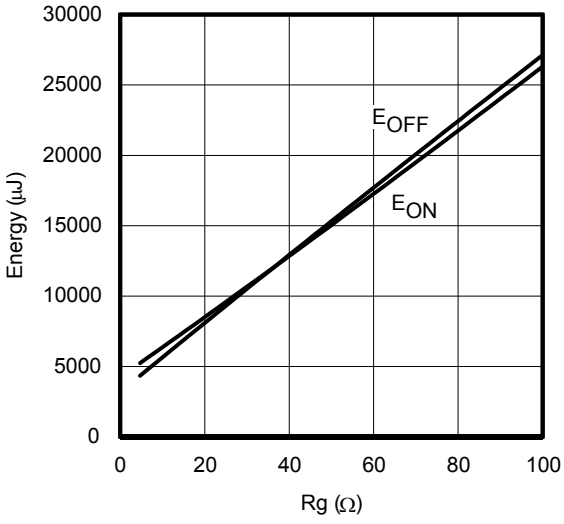



**Fig. 16** - Typ. Energy Loss vs. $R_G$
$T_J$ = 175°C; $V_{CE}$ = 400V, $I_{CE}$ = 120A; $V_{GE}$ = 15V

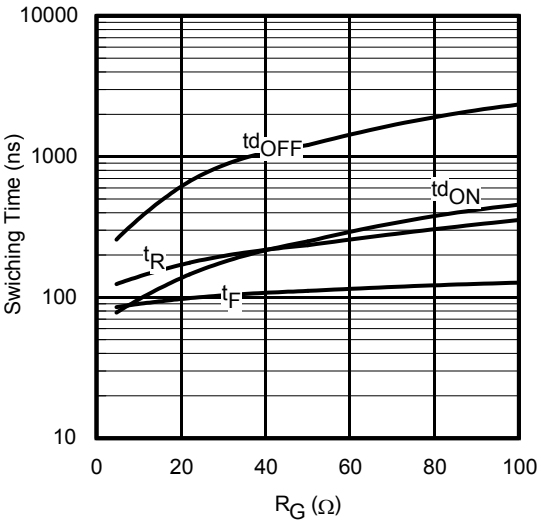



**Fig. 17** - Typ. Switching Time vs. $R_G$
$T_J$ = 175°C; $V_{CE}$ = 400V, $I_{CE}$ = 120A; $V_{GE}$ = 15V

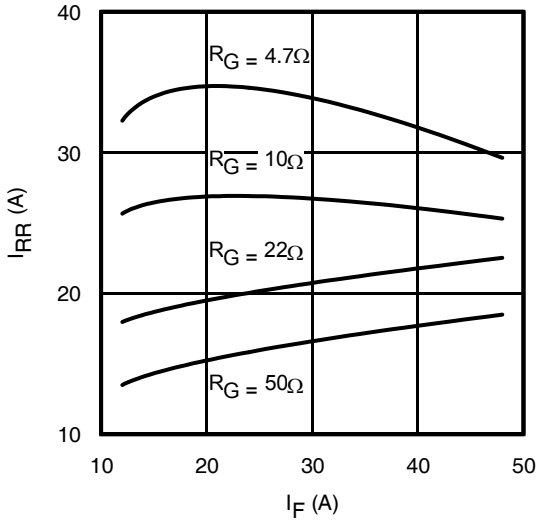



**Fig. 18** - Typ. Diode $I_{RR}$ vs. $I_F$
$T_J$ = 175°C

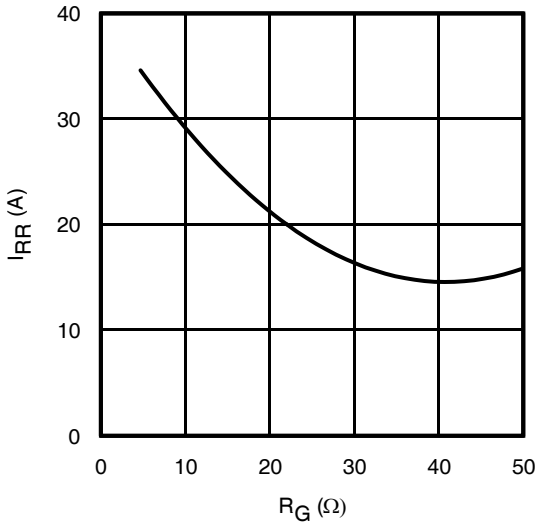



**Fig. 19** - Typ. Diode $I_{RR}$ vs. $R_G$
$T_J$ = 175°C

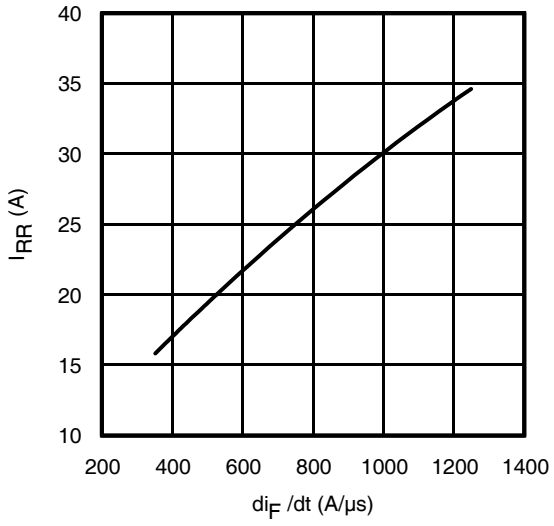



**Fig. 20** - Typ. Diode $I_{RR}$ vs. $di_F/dt$
$V_{CC}$ = 400V; $V_{GE}$ = 15V; $I_F$ = 24A; $T_J$ = 175°C

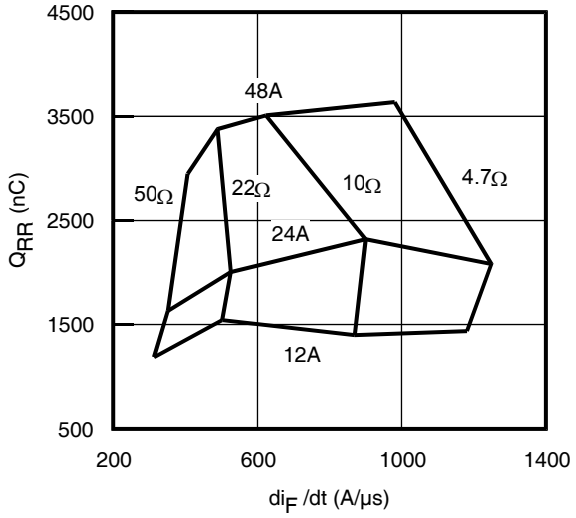



**Fig. 21** - Typ. Diode $Q_{RR}$ vs. $di_F/dt$
$V_{CC}$ = 400V; $V_{GE}$ = 15V; $T_J$ = 175°C

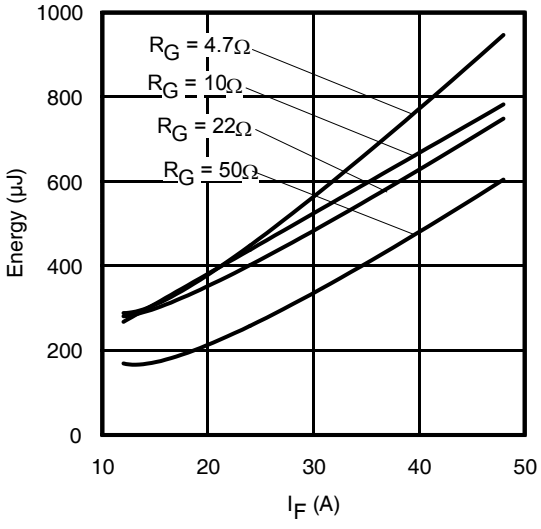



**Fig. 22** - Typ. Diode $E_{RR}$ vs. $I_F$
$T_J$ = 175°C

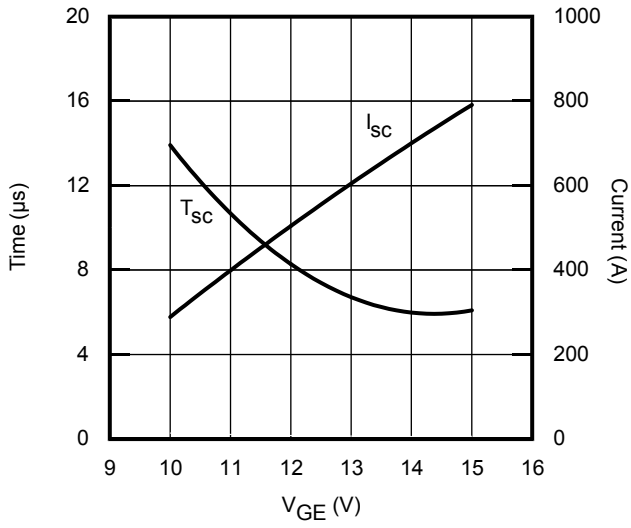



**Fig. 23** - $V_{GE}$ vs. Short Circuit Time
$V_{CC}$ = 400V; $T_C$ = 150°C

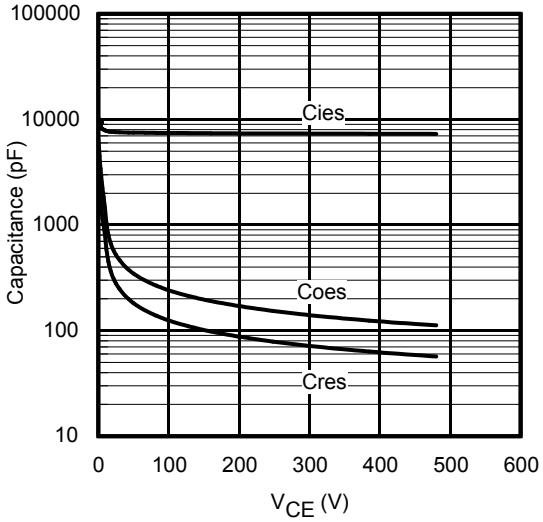



**Fig. 24** - Typ. Capacitance vs. $V_{CE}$
$V_{GE}$= 0V; f = 1MHz

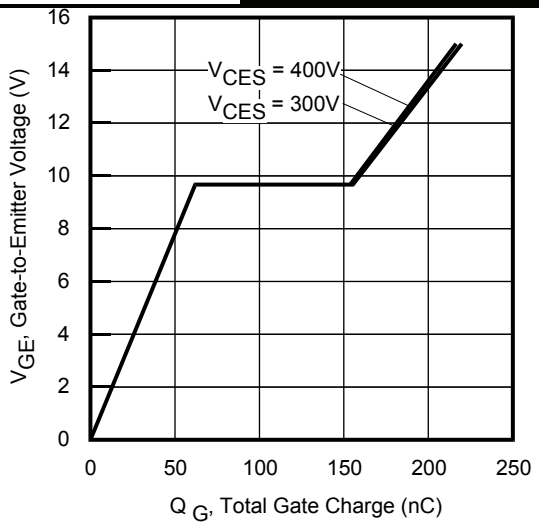



**Fig. 25** - Typical Gate Charge vs. $V_{GE}$
$I_{CE}$ = 120A

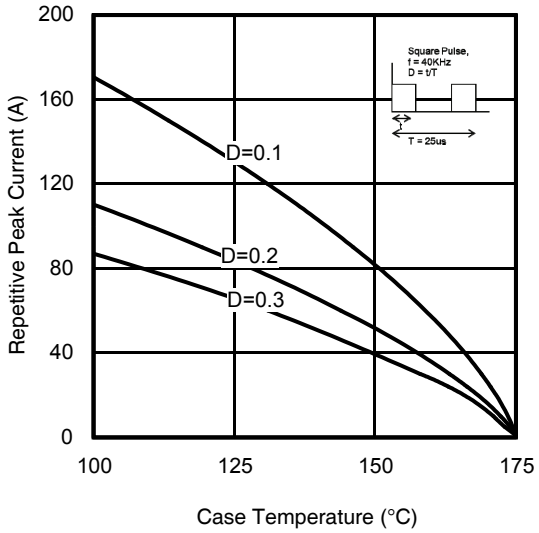



**Fig 26.** Maximum Diode Repetitive Forward Peak Current vs. Case Temperature

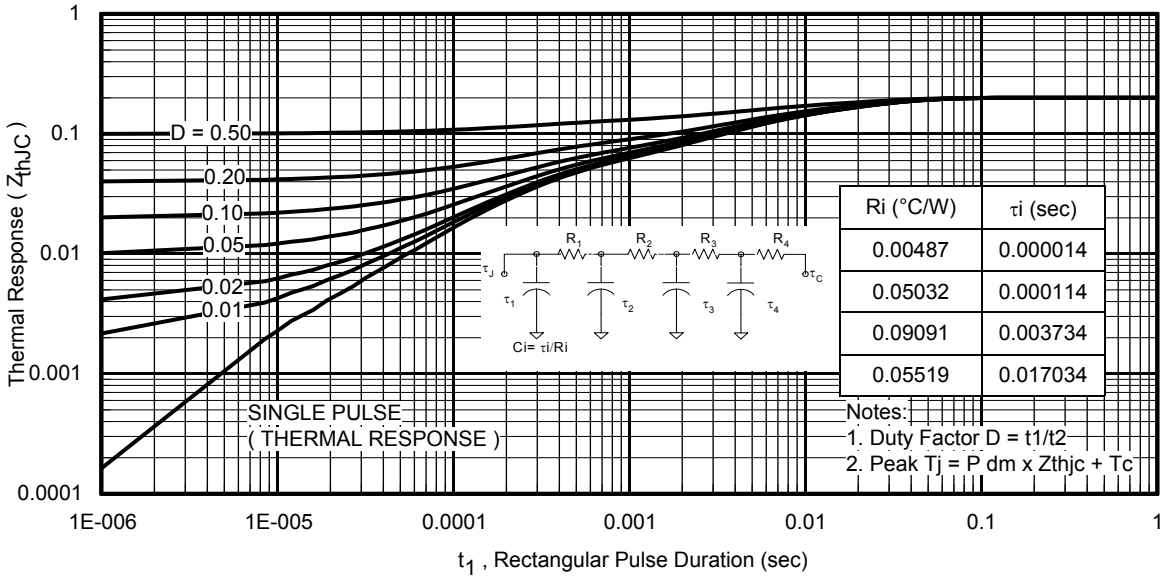



**Fig. 27 -** Maximum Transient Thermal Impedance, Junction-to-Case (IGBT)

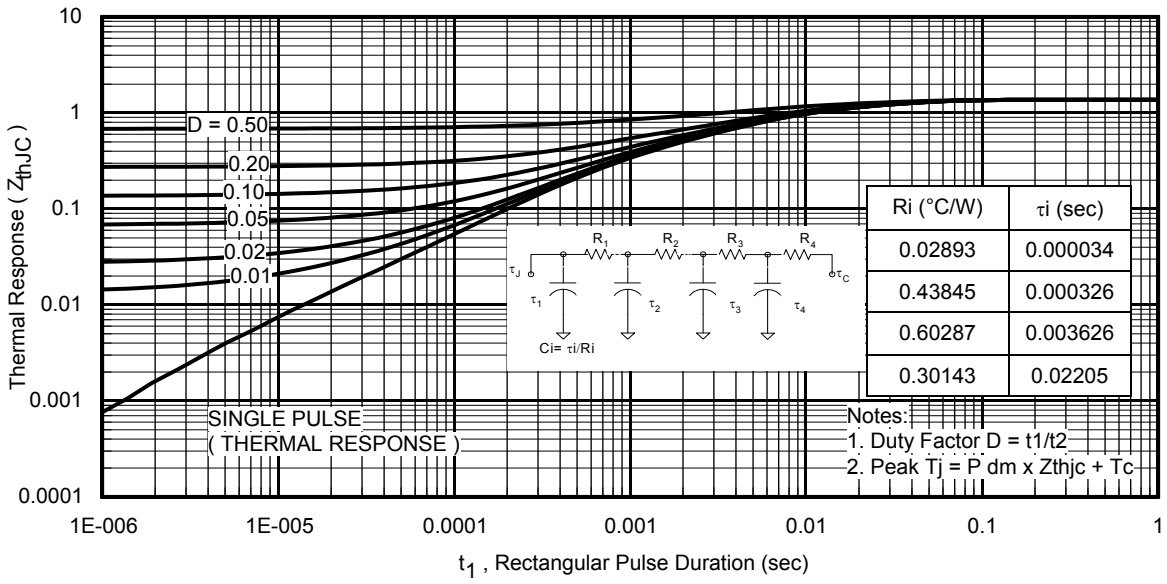



**Fig. 28 -** Maximum Transient Thermal Impedance, Junction-to-Case (DIODE)

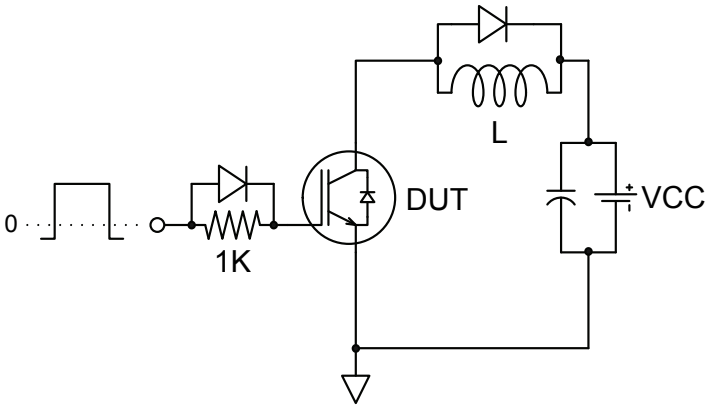



**Fig.C.T.1** - Gate Charge Circuit (turn-off)

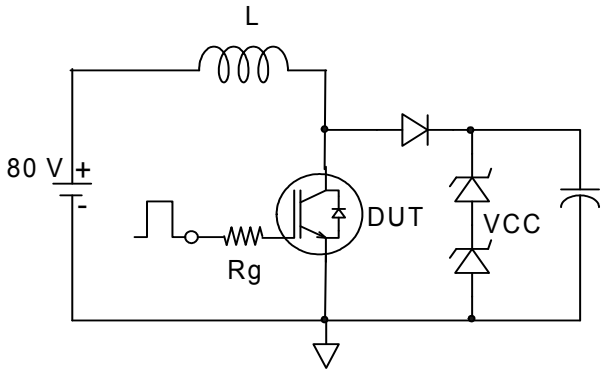



**Fig.C.T.2** - RBSOA Circuit

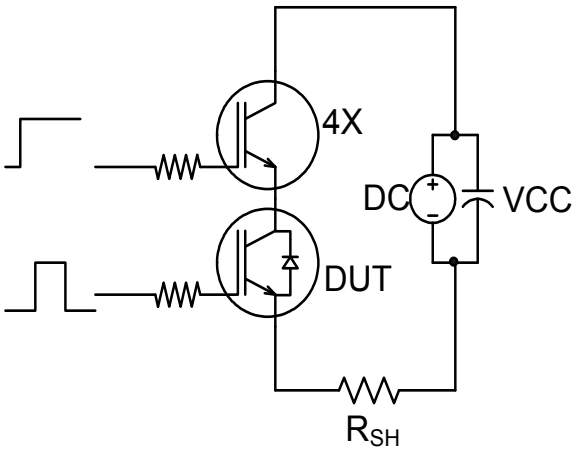



**Fig.C.T.3** - S.C. SOA Circuit

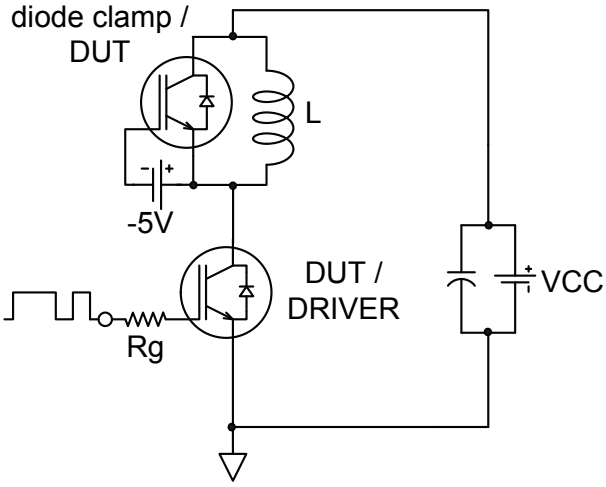



**Fig.C.T.4** - Switching Loss Circuit

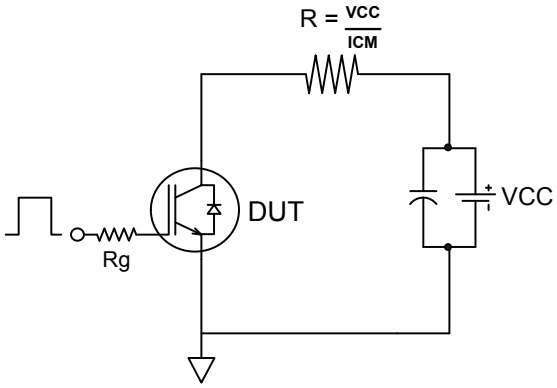



**Fig.C.T.5** - Resistive Load Circuit

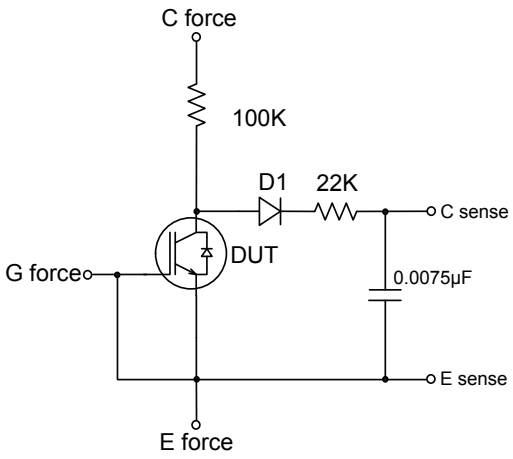



**Fig.C.T.6** - BVCES Filter Circuit

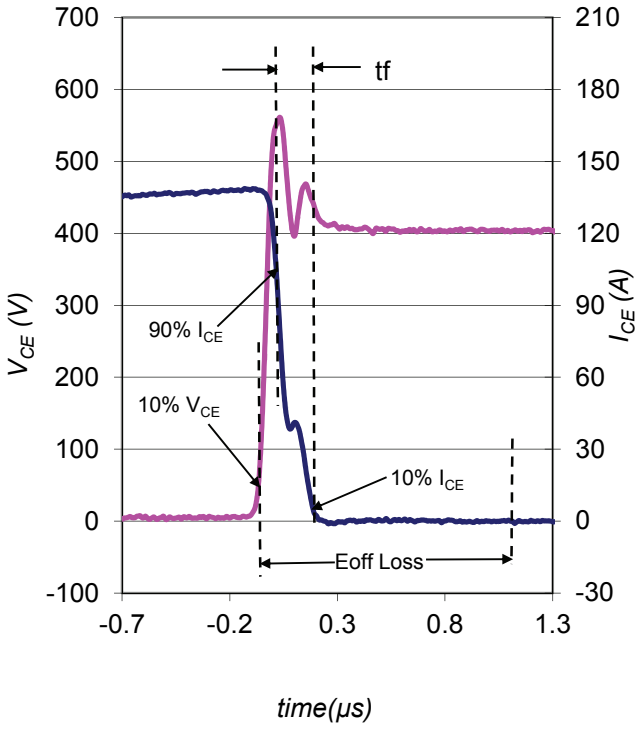



**Fig. WF1** - Typ. Turn-off Loss Waveform
@ $T_J$ = 175°C using Fig. CT.4

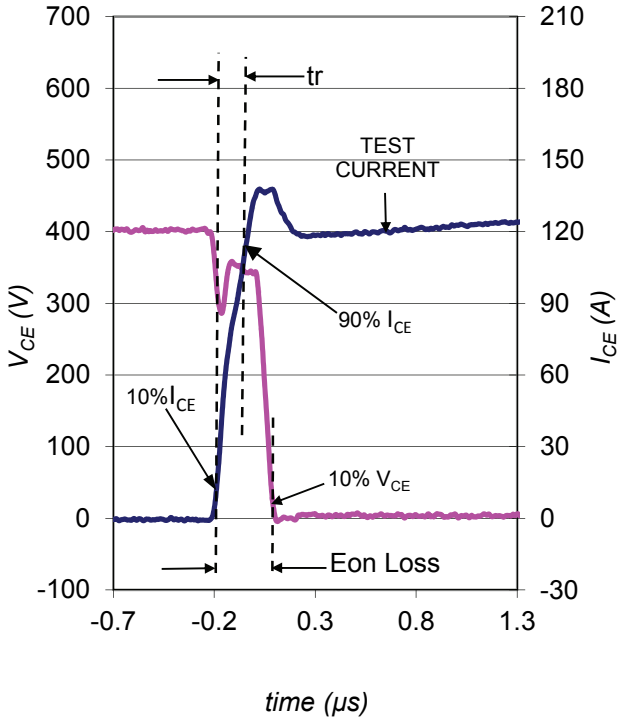



**Fig. WF2** - Typ. Turn-on Loss Waveform
@ $T_J$ = 175°C using Fig. CT.4

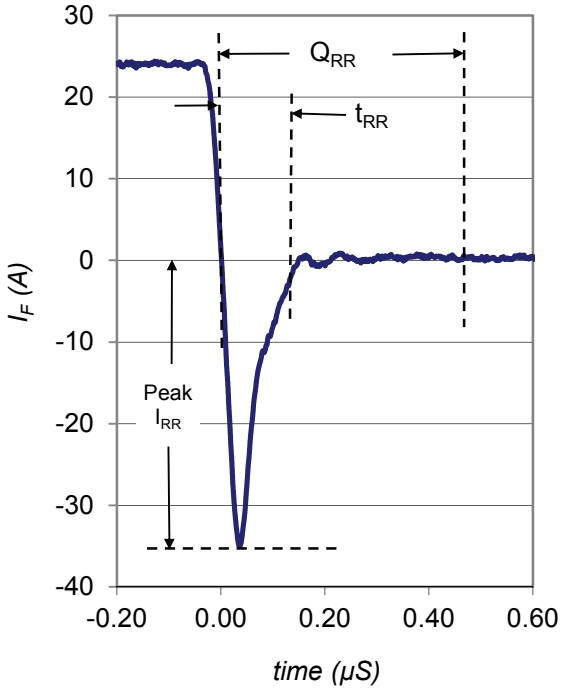



**Fig. WF3** - Typ. Diode Recovery Waveform
@ $T_J$ = 175°C using Fig. CT.4

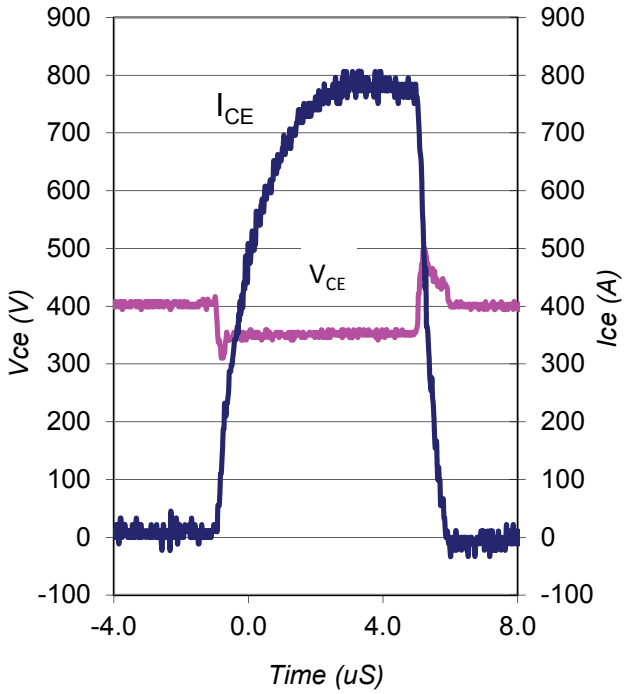
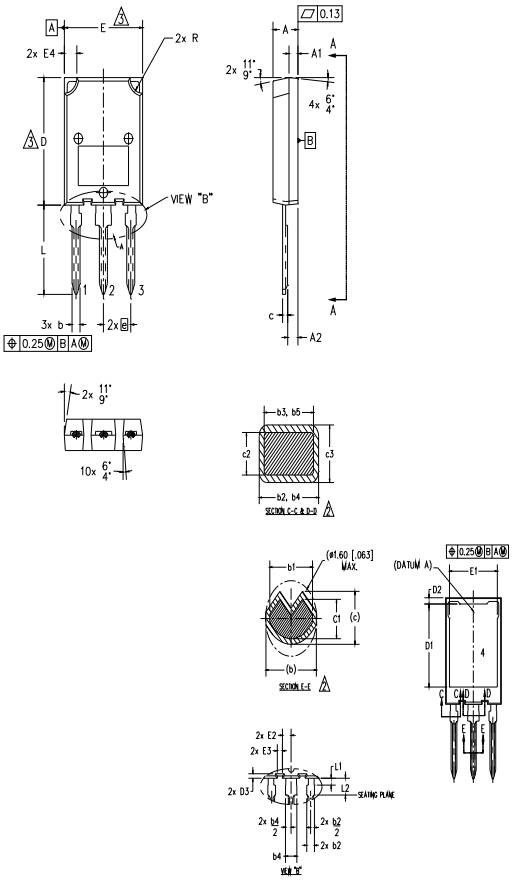



**Fig. WF4** - Typ. S.C. Waveform
@ $T_J$ = 150°C using Fig. CT.3

# Super 247 Package Outline

Dimensions are shown in millimeters (inches)




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

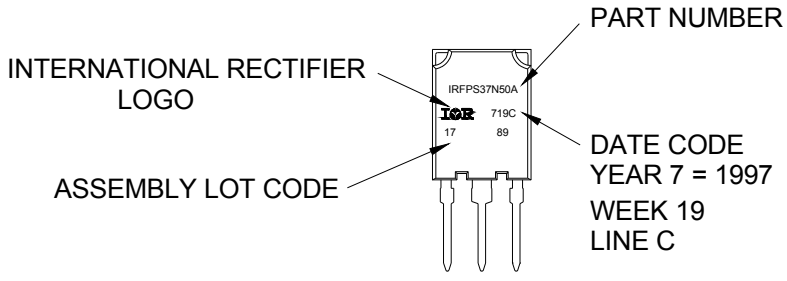
1.– GATE
2.– DRAIN
3.– SOURCE
4.– DRAIN

IGBT

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

# Super 247 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"

Super 247 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**†

| | | |
|---|---|---|
| **Qualification Level** | Industrial | |
| **Moisture Sensitivity Level** | Super 247 | N/A |
| **RoHS Compliant** | Yes | |

† Qualification standards can be found at International Rectifier's web site: http://www.irf.com/product-info/reliability/

†† Applicable version of JEDEC standard at the time of product release.

**Revision History**

| Date | Comments |
|---|---|
| 11/13/2014 | • Added $I_{FM}$ Diode Maximum Forward Current = 480A with the note ④ on page 1.<br>• Removed note ④ from switching losses test condition on page 2. |

International
IOR Rectifier
**IR WORLD HEADQUARTERS:** 101 N. Sepulveda Blvd., El Segundo, California 90245, USA
To contact International Rectifier, please visit http://www.irf.com/whoto-call/