PD - 9.1296

International
IOR Rectifier

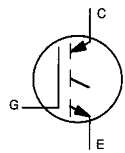
# IRGPC60K

INSULATED GATE BIPOLAR TRANSISTOR

Short Circuit Rated
UltraFast IGBT

## Features

- Short circuit rated - 10µs @ 125°C, $V_{GE}$ = 15V
- Switching-loss rating includes all "tail" losses
- Optimized for high operating frequency (over 5kHz)
  See Figure 1 for Current vs. Frequency curve




n-channel

$V_{CES}$ = 600V

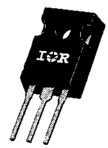
$V_{CE(sat)} \leq 3.1V$

@$V_{GE}$ = 15V, $I_C$ = 41A

## Description

Insulated Gate Bipolar Transistors (IGBTs) from International Rectifier have higher usable current densities than comparable bipolar transistors, while at the same time having simpler gate-drive requirements of the familiar power MOSFET. They provide substantial benefits to a host of high-voltage, high-current applications.

These new short circuit rated devices are especially suited for motor control and other applications requiring short circuit withstand capability.




TO-247AC

## Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $V_{CES}$ | Collector-to-Emitter Voltage | 600 | V |
| $I_C$ @ $T_C$ = 25°C | Continuous Collector Current | 70 * | A |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 41 | |
| $I_{CM}$ | Pulsed Collector Current ① | 140 | |
| $I_{LM}$ | Clamped Inductive Load Current ② | 140 | |
| $t_{sc}$ | Short Circuit Withstand Time | 10 | µs |
| $V_{GE}$ | Gate-to-Emitter Voltage | ±20 | V |
| $E_{ARV}$ | Reverse Voltage Avalanche Energy ③ | 25 | mJ |
| $P_D$ @ $T_C$ = 25°C | Maximum Power Dissipation | 280 | W |
| $P_D$ @ $T_C$ = 100°C | Maximum Power Dissipation | 110 | |
| $T_J$<br>$T_{STG}$ | Operating Junction and<br>Storage Temperature Range | -55 to +150 | °C |
| | Soldering Temperature, for 10 sec. | 300 (0.063 in. (1.6mm) from case) | |
| | Mounting torque, 6-32 or M3 screw. | 10 lbf•in (1.1N•m) | |

## Thermal Resistance

| | Parameter | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $R_{\theta JC}$ | Junction-to-Case | ---- | ---- | 0.45 | °C/W |
| $R_{\theta CS}$ | Case-to-Sink, flat, greased surface | ---- | 0.24 | ---- | |
| $R_{\theta JA}$ | Junction-to-Ambient, typical socket mount | ---- | ---- | 40 | |
| Wt | Weight | ---- | 6 (0.21) | ---- | g (oz) |

## 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, $I_C$ = 250μA |
| $V_{(BR)ECS}$ | Emitter-to-Collector Breakdown Voltage ④ | 20 | — | — | V | $V_{GE}$ = 0V, $I_C$ = 1.0A |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage | — | 0.36 | — | V/°C | $V_{GE}$ = 0V, $I_C$ = 2.0mA |
| $V_{CE(ON)}$ | Collector-to-Emitter Saturation Voltage | — | 2.1 | 3.1 | | $I_C$ = 41A; $V_{GE}$ = 15V, See Fig. 2, 5 |
| | | — | 2.6 | — | V | $I_C$ = 72A |
| | | — | 2.3 | — | | $I_C$ = 41A, $T_J$ = 150°C |
| $V_{GE(th)}$ | Gate Threshold Voltage | 3.0 | — | 5.5 | | $V_{CE}$ = $V_{GE}$, $I_C$ = 250μA |
| $\Delta V_{GE(th)}/\Delta T_J$ | Temperature Coeff. of Threshold Voltage | — | -18 | — | mV/°C | $V_{CE}$ = $V_{GE}$, $I_C$ = 250μA |
| $g_{fe}$ | Forward Transconductance ⑤ | 20 | 30 | — | S | $V_{CE}$ = 100V, $I_C$ = 41A |
| $I_{CES}$ | Zero Gate Voltage Collector Current | — | — | 250 | μA | $V_{GE}$ = 0V, $V_{CE}$ = 600V |
| | | — | — | 5000 | | $V_{GE}$ = 0V, $V_{CE}$ = 600V, $T_J$ = 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 |
|---|---|---|---|---|---|---|
| $Q_g$ | Total Gate Charge (turn-on) | --- | 140 | 220 | | $I_C$ = 41A |
| $Q_{ge}$ | Gate - Emitter Charge (turn-on) | --- | 29 | 44 | nC | $V_{CC}$ = 400V See Fig. 8 |
| $Q_{gc}$ | Gate - Collector Charge (turn-on) | --- | 43 | 65 | | $V_{GE}$ = 15V |
| $t_{d(on)}$ | Turn-On Delay Time | --- | 38 | --- | | |
| $t_r$ | Rise Time | --- | 28 | --- | ns | |
| $t_{d(off)}$ | Turn-Off Delay Time | --- | 130 | 290 | | $I_C$ = 41A, $V_{CC}$ = 480V |
| $t_f$ | Fall Time | --- | 110 | 220 | | $V_{GE}$ = 15V, $R_G$ = 3.3Ω |
| $E_{on}$ | Turn-On Switching Loss | --- | 1.0 | --- | | Energy losses include "tail" |
| $E_{off}$ | Turn-Off Switching Loss | --- | 0.9 | --- | mJ | See Fig. 9, 10, 11, 14 |
| $E_{ts}$ | Total Switching Loss | --- | 1.9 | 2.9 | | |
| $t_{sc}$ | Short Circuit Withstand Time | 10 | --- | --- | μs | $V_{CC}$ = 360V, $T_J$ = 125°C<br>$V_{GE}$ = 15V, $R_G$ = 3.3Ω, $V_{CPK}$ < 500V |
| $t_{d(on)}$ | Turn-On Delay Time | --- | 38 | --- | | $T_J$ = 150°C, |
| $t_r$ | Rise Time | --- | 31 | --- | ns | $I_C$ = 41A, $V_{CC}$ = 480V |
| $t_{d(off)}$ | Turn-Off Delay Time | --- | 290 | --- | | $V_{GE}$ = 15V, $R_G$ = 3.3Ω |
| $t_f$ | Fall Time | --- | 150 | --- | | Energy losses include "tail" |
| $E_{ts}$ | Total Switching Loss | --- | 3.6 | --- | mJ | See Fig. 10, 14 |
| $L_E$ | Internal Emitter Inductance | --- | 13 | --- | nH | Measured 5mm from package |
| $C_{ies}$ | Input Capacitance | --- | 4200 | --- | | $V_{GE}$ = 0V |
| $C_{oes}$ | Output Capacitance | --- | 340 | --- | pF | $V_{CC}$ = 30V See Fig. 7 |
| $C_{res}$ | Reverse Transfer Capacitance | --- | 32 | --- | | $f$ = 1.0MHz |

**Notes:**

① Repetitive rating; $V_{GE}$ = 20V, pulse width limited by max. junction temperature. ( See fig. 13b )

② $V_{CC}$ = 80%($V_{CES}$), $V_{GE}$ = 20V, L = 10μH, $R_G$ = 3.3Ω, ( See fig. 13a )

* Current limited by package, (Die Current = 72A )

③ Repetitive rating; pulse width limited by maximum junction temperature.

④ Pulse width ≤ 80μs; duty factor ≤ 0.1%.

⑤ Pulse width 5.0μs, single shot.

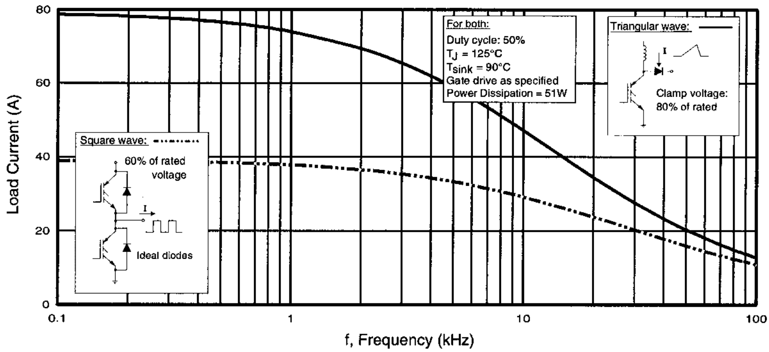



**Fig. 1** - Typical Load Current vs. Frequency
(For square wave, $I=I_{RMS}$ of fundamental; for triangular wave, $I=I_{PK}$)

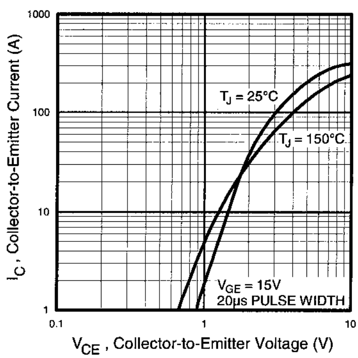



**Fig. 2** - Typical Output Characteristics

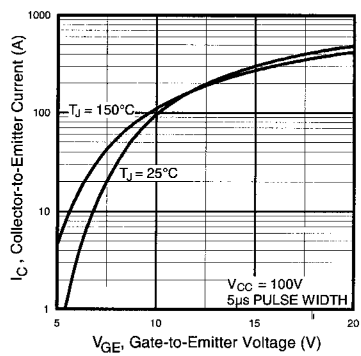



**Fig. 3** - Typical Transfer Characteristics

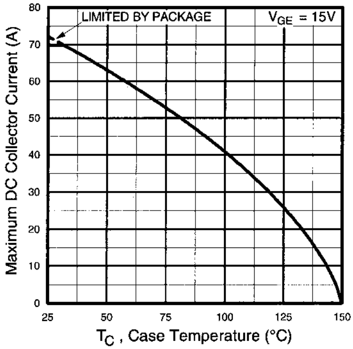



**Fig. 4** - Maximum Collector Current vs. Case Temperature

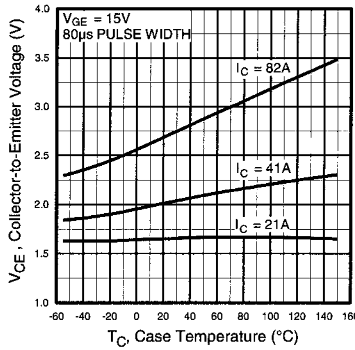



**Fig. 5** - Collector-to-Emitter Voltage vs. Case Temperature

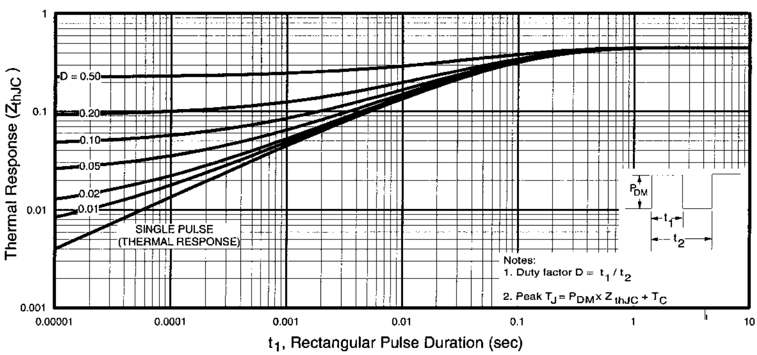



**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case

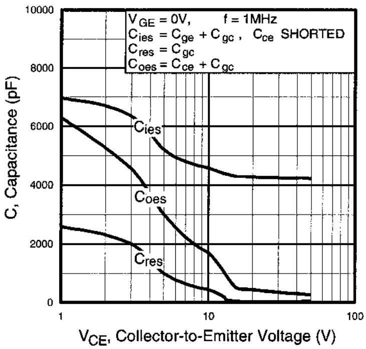



**Fig. 7 -** Typical Capacitance vs. Collector-to-Emitter Voltage

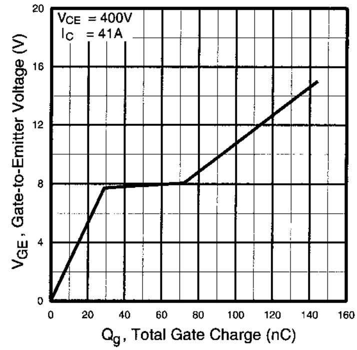



**Fig. 8** - Typical Gate Charge vs. Gate-to-Emitter Voltage

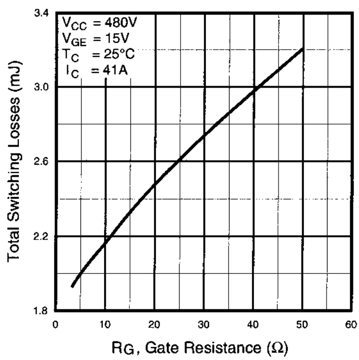



**Fig. 9** - Typical Switching Losses vs. Gate Resistance

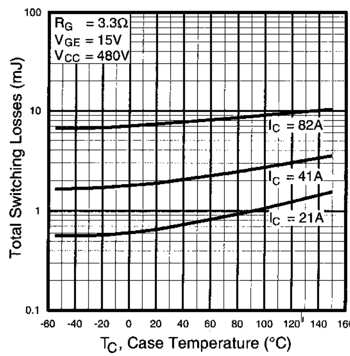



**Fig. 10 -** Typical Switching Losses vs. Case Temperature

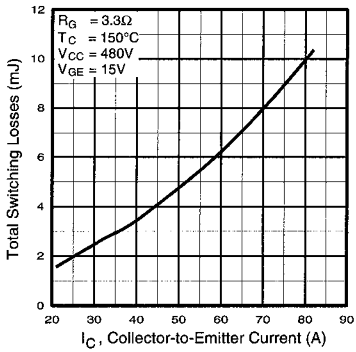



**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current

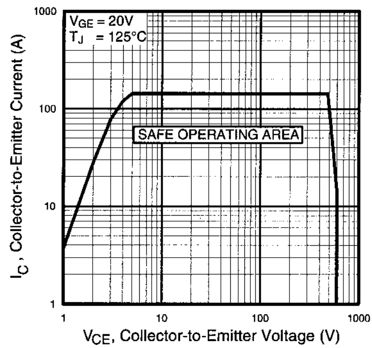
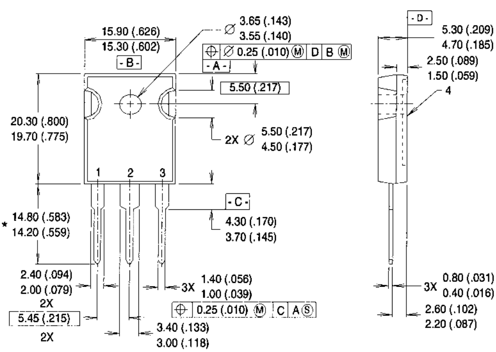



**Fig. 12** - Turn-Off SOA



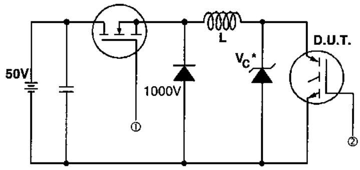

NOTES:
1 DIMENSIONS & TOLERANCING PER ANSI Y14.5M, 1982.
2 CONTROLLING DIMENSION : INCH.
3 DIMENSIONS ARE SHOWN MILLIMETERS (INCHES).
4 CONFORMS TO JEDEC OUTLINE TO-247AC.

LEAD ASSIGNMENTS
1 - GATE
2 - COLLECTOR
3 - EMITTER
4 - COLLECTOR

* LONGER LEADED (20mm) VERSION AVAILABLE (TO-247AD) TO ORDER ADD "-E" SUFFIX TO PART NUMBER

**CONFORMS TO JEDEC OUTLINE TO-247AC (TO-3P)**

Dimensions in Millimeters and (Inches)




* Driver same type as D.U.T.; Vc = 80% of Vce(max)
* Note: Due to the 50V power supply, pulse width and inductor will increase to obtain rated Id.

**Fig. 13a** - Clamped Inductive Load Test Circuit

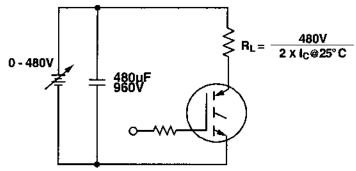



**Fig. 13b** - Pulsed Collector Current Test Circuit

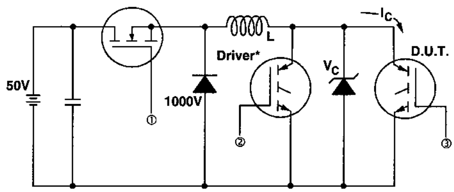
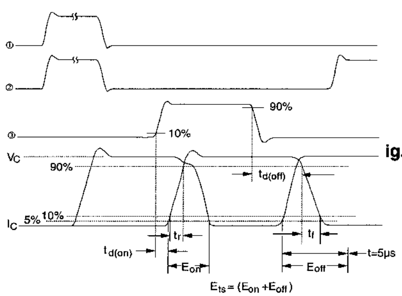



**Fig. 14a** - Switching Loss Test Circuit

* Driver same type as D.U.T., VC = 480V




**ig. 14b** - Switching Loss Waveforms

**International**
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