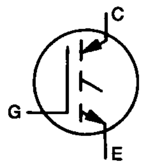
# International IOR Rectifier

PD-9.717A

# IRGMC40U

**INSULATED GATE BIPOLAR TRANSISTOR** — UltraFast™ IGBT




n-channel

## Description

Insulated Gate Bipolar Transistors (IGBTs) from International Rectifier have higher 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 higher-voltage, higher-current applications.

The performance of various IGBTs varies greatly with frequency. Note that IR now provides the designer with a speed benchmark ($f_{Ic/2}$, or the "half-current frequency"), as well as an indication of the current handling capability of the device. Refer to Figure 14.

## Product Summary

| Part Number | $V_{(BR)CES}$ | $V_{CE(on)}$ | $I_C$ | $E_{ts}$ |
|---|---|---|---|---|
| IRGMC40U | 600V | 3.0V | 31A | 2.0 mJ |

## Features:

- Electronically Isolated and Hermetically Sealed
- Simple Drive Requirements
- Latch-proof
- Ultra-fast operation > 10 kHz
- Switching-Loss Rating includes all "tail" losses
- Ceramic Eyelets

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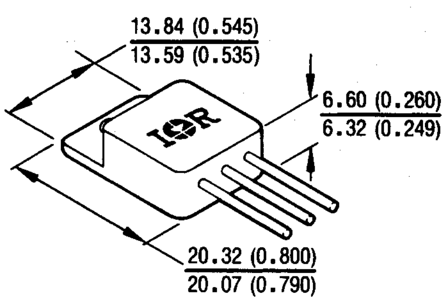
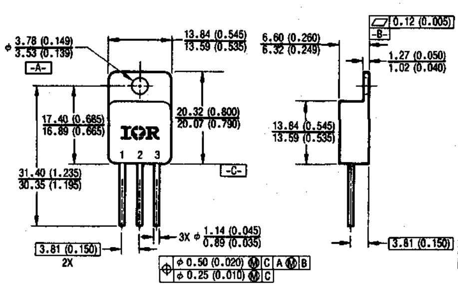
### CASE STYLE AND DIMENSIONS




CAUTION

BERYLLIA WARNING PER MIL-S-19500
SEE PAGE G-89




NOTES:
1 DIMENSIONING & TOLERANCING PER ANSI Y14.5M - 1982.
2 ALL DIMENSIONS ARE SHOWN IN MILLIMETERS (INCHES).

LEGEND
1 COLLECTOR
2 EMITTER
3 GATE

*For leadform configuration see page G-89, fig. 15

**Conforms to JEDEC Outline TO-254AA***
Dimensions in Millimeters and (Inches)

## Absolute Maximum Ratings

| | Parameter | Max. | Units |
|---|---|---|---|
| $I_C$ @ $T_C$ = 25°C | Continuous Collector Current | 31 | A |
| $I_C$ @ $T_C$ = 100°C | Continuous Collector Current | 15 | |
| $I_{CM}$ | Pulsed Collector Current ① | 124 | |
| $V_{CE}$ | Collector-to-Emitter Breakdown Voltage | 600 | V |
| $V_{GE}$ | Gate-to-Emitter Voltage | ±20 | |
| $I_{LM}$ | Clamped Inductive Load Current ② | 124 | A |
| $P_D$ @ $T_C$ = 25°C | Maximum Power Dissipation | 125 | W |
| $P_D$ @ $T_C$ = 100°C | Maximum Power Dissipation | 50 | |
| $T_J$<br>$T_{STG}$ | Operating Junction and<br>Storage Temperature Range | -55 to +150 | °C |
| | Lead Temperature, for 10 sec. | 300 (0.063 in. (1.6mm) from case) | |
| | Weight | 9.3 (typical) | g |

## Thermal Resistance

| | Parameter | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|
| $R_{\theta JC}$ | Junction-to-Case | — | — | 1.0 | K/W ⑤ |
| $R_{\theta CS}$ | Case-to-Sink, flat, greased surface | — | 0.21 | — | |
| $R_{\theta JA}$ | Junction-to-Ambient, typical socket mount | — | — | 48 | |

## Electrical Characteristic @ $T_J$ = 25°C (unless otherwise specified)

| | Parameter | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|
| $V_{(BR)CES}$ | Collector-to-Emitter Breakdown Voltage | 600 | — | — | V | $V_{GE}$ = 0V, $I_C$ = 1.0 mA |
| $V_{(BR)ECS}$ | Emitter-to-Collector Breakdown Volt. ③ | 15 | — | — | | $V_{GE}$ = 0V, $I_C$ = 1.0A |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temp. Coeff. of Breakdown Voltage | — | 0.63 | — | V/°C | $V_{GE}$ = 0V, $I_C$ = 1.0 mA |
| $V_{CE(on)}$ | Collector-to-Emitter Saturation Voltage | — | — | 3.0 | V | $V_{GE}$ = 15V, $I_C$ = 15A See Fig. 4 |
| | | — | 2.7 | — | | $V_{GE}$ = 15V, $I_C$ = 31A |
| | | — | 2.3 | — | | $V_{CE}$ = 15V, $I_C$ = 15A, $T_J$ = 125°C |
| $V_{GE(th)}$ | Gate Threshold Voltage | 3.0 | — | 5.5 | | $V_{CE}$ = $V_{GE}$, $I_C$ = 250 μA |
| $\Delta V_{GE(th)}/\Delta T_J$ | Temp. Coeff. of Threshold Voltage | — | -13 | — | mV/°C | $V_{CE}$ = $V_{GE}$, $I_C$ = 250 μA |
| $g_{fe}$ | Forward Transconductance ④ | 11 | — | — | S | $V_{CE}$ ≥ 15V, $I_C$ = 15A |
| $I_{CES}$ | Zero Gate Voltage Collector Current | — | — | 50 | μA | $V_{GE}$ = 0V, $V_{CE}$ = 480V, $T_J$ = 25°C |
| | | — | — | 2500 | | $V_{GE}$ = 0V, $V_{CE}$ = 480V, $T_J$ = 125°C |
| $I_{GES}$ | Gate-to-Emitter Leakage Current | — | — | ±500 | nA | $V_{GE}$ = ±20V |

**Notes:**

① Repetitive rating; $V_{GE}$ = 20V, pulse width limited by max. junction temperature (See figure 12b).

② $V_{CC}$ = 80% ($BV_{CES}$), $V_{GE}$ = 20V, L ≥ 10 μH, $R_G$ = 10Ω, (See figure 12a)

③ Pulse width ≤ 80 μs; duty factor ≤ 0.1%.

④ Pulse width ≤ 5 μs, single shot

⑤ K/W equivalent to °C/W

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

| | Parameter | Min. | Typ. | Max. | Units | Test Conditions |
|---|---|---|---|---|---|---|
| $Q_G$ | Total Gate Charge (turn-on) | — | 50 | 100 | nC | $I_C$ = 15A, $V_{CC}$ = 300V |
| $Q_{GE}$ | Gate - Emitter Charge (turn-on) | — | 9 | 18 | | See Figure 6. |
| $Q_{GC}$ | Gate - Collector Charge (turn-on) | — | 20 | 40 | | $V_{GE}$ = 15V |
| $t_{d(on)}$ | Turn-On Delay Time | — | — | 50 | ns | See test circuit, figure 13. |
| $t_r$ | Rise Time | — | — | 42 | | $I_C$ = 15A, $V_{CC}$ = 480V |
| $t_{d(off)}$ | Turn-Off Delay Time | — | — | 190 | | $T_J$ = 25°C |
| $t_f$ | Fall Time | — | — | 120 | | $V_{GE}$ = 15V, $R_G$ = 9.1Ω |
| $E_{on}$ | Turn-On Switching Loss | — | 0.18 | — | mJ | Energy losses include "tail". |
| $E_{off}$ | Turn-Off Switching Loss | — | 1.3 | — | | Also see figures 9, 10, & 11. |
| $E_{ts}$ | Total Switching Loss | — | 1.5 | 2.0 | | |
| $t_{d(on)}$ | Turn-On Delay Time | — | 25 | — | ns | $I_C$ = 15A, $V_{CC}$ = 480V |
| $t_r$ | Rise Time | — | 23 | — | | $T_J$ = 125°C |
| $t_{d(off)}$ | Turn-Off Delay Time | — | 174 | — | | $V_{GE}$ = 15V |
| $t_f$ | Fall Time | — | 140 | — | | $R_G$ = 9.1Ω |
| $E_{ts}$ | Total Switching Loss | — | 2.4 | — | mJ | |
| $L_E$ | Internal Emitter Inductance | — | 8.7 | — | nH | Measured 5mm from package. |
| $C_{ies}$ | Input Capacitance | — | 1500 | — | pF | $V_{GE}$ = 0V |
| $C_{oes}$ | Output Capacitance | — | 190 | — | | $V_{CC}$ = 30V See fig 5. |
| $C_{res}$ | Reverse Transfer Capacitance | — | 17 | — | | f = 1.0 MHz |
| $C_{CC}$ | Collector-to-Case Capacitance | — | 12 | — | | |

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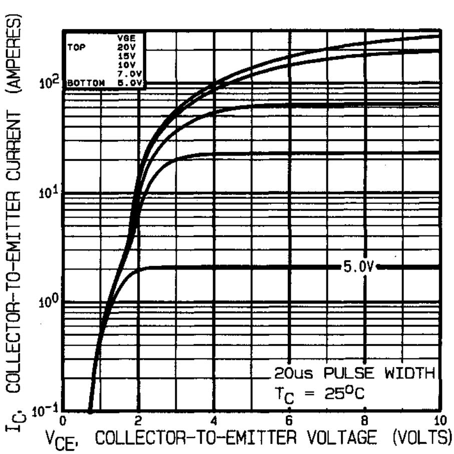


**Fig. 1 — Typical Output Characteristics, $T_C$ = 25°C**

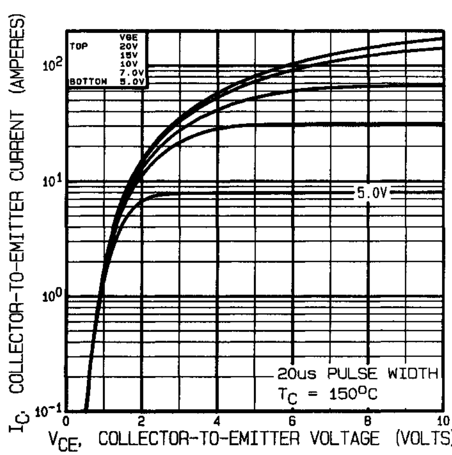


**Fig. 2 — Typical Output Characteristics, $T_C$ = 150°C**

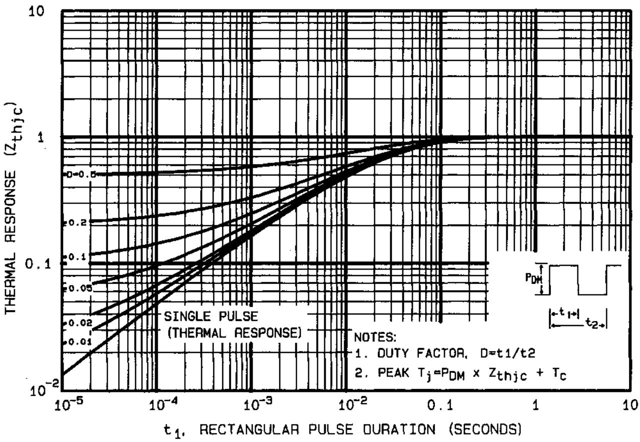


**Fig. 7 — Maximum Effective Transient Thermal Impedance, Junction-to-Case**

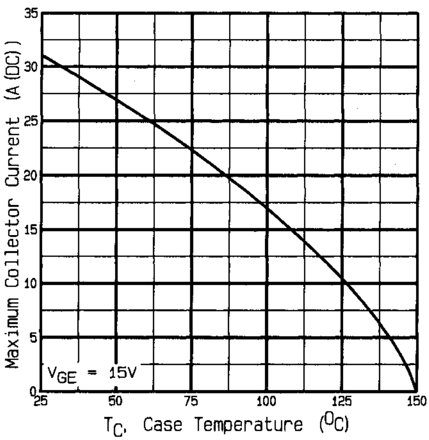


**Fig. 8 — Maximum Collector Current vs. Case Temperature**

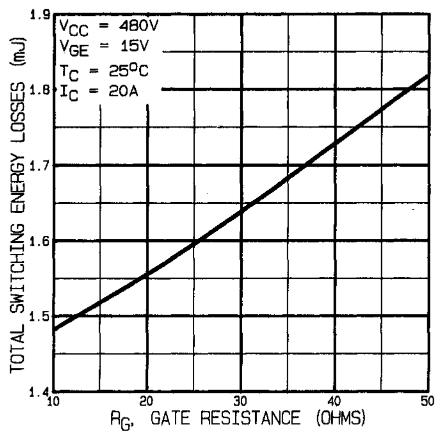


**Fig. 9 — Typical Switching Losses vs. Gate Resistance**

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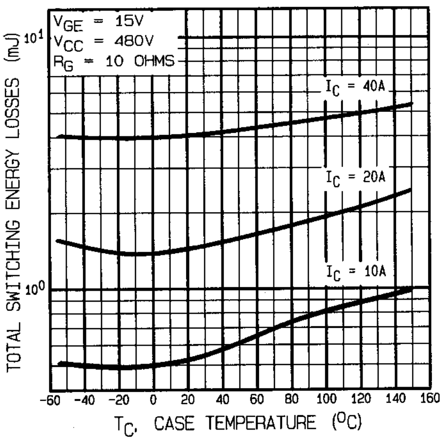



**Fig. 10 — Typical Switching Losses vs. Case Temperature**

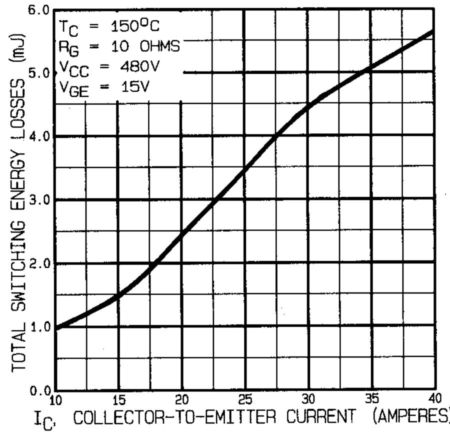



**Fig. 11 — Typical Switching Losses vs. Collector-to-Emitter Current**

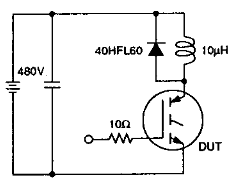



**Fig 12a.** Clamped Inductive Load Test Circuit

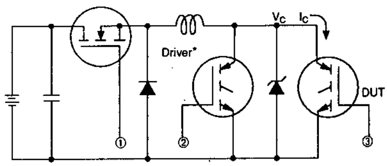



**Fig 13a.** Switching Loss Test Circuit

* Driver same type as DUT, $V_C$ = 480V

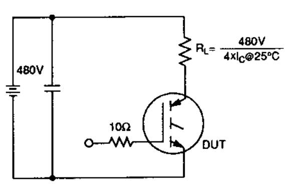



**Fig 12b.** Pulsed Collector Current Test Circuit

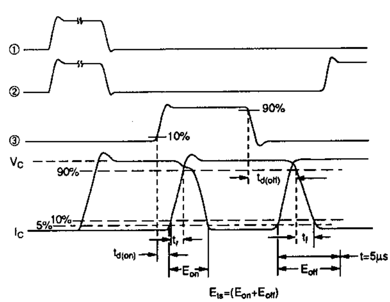



**Fig 13b.** Switching Loss Waveforms

For both, power dissipation = 29W

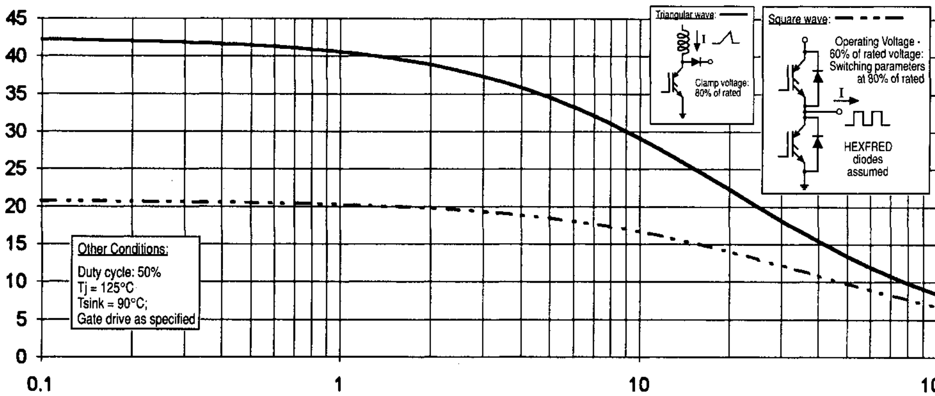
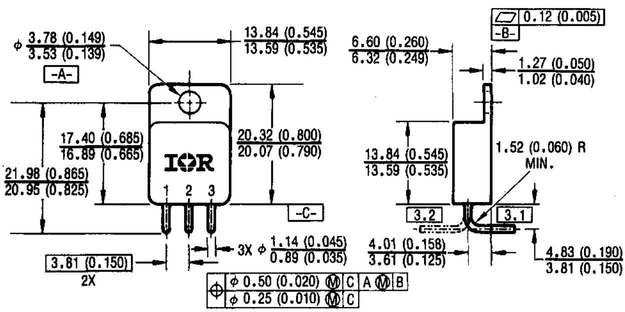



**Fig. 14 — Typical Load Current vs. Frequency**
**(For square wave, I = $I_{RMS}$ of fundamental; for triangular wave, I = $I_{PK}$)**




NOTES:
1 DIMENSIONING & TOLERANCING PER ANSI Y14.5M - 1982.
2 ALL DIMENSIONS ARE SHOWN IN MILLIMETERS (INCHES).
3 LEADFORM IS AVAILABLE IN EITHER ORIENTATION:
3.1 EXAMPLE: IRGMC40UD
3.2 EXAMPLE: IRGMC40UU

LEGEND
1 COLLECTOR
2 EMITTER
3 GATE

**BERYLLIA WARNING PER MIL-S-19500**
**Packages containing beryllia shall not be ground, sandblasted, machined, or have other operations performed on them which will produce beryllia or beryllium dust. Furthermore, beryllium oxide packages shall not be placed in acids that will produce fumes containing beryllium.**

**Fig. 15 – Optional Leadforms for Outline TO-254**