

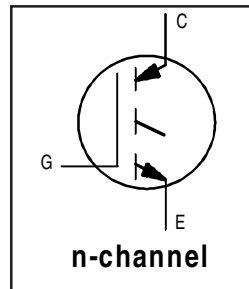
## INSULATED GATE BIPOLAR TRANSISTOR

# IRGMC40U

## Ultra Fast Speed IGBT

### Features

- Electrically Isolated and Hermetically Sealed
- Simple Drive Requirements
- Latch-proof
- Fast Speed operation > 10 kHz
- Switching-loss rating includes all "tail" losses



$$V_{CES} = 600V$$

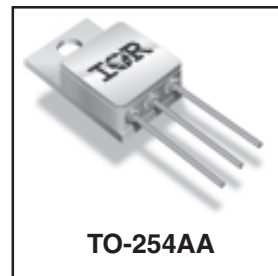
$$V_{CE(on) \max} = 2.0V$$

$$@ V_{GE} = 15V, I_C = 20A$$

### 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.

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.



### Absolute Maximum Ratings

|                           | Parameter                              | Max.                                   | Units      |
|---------------------------|----------------------------------------|----------------------------------------|------------|
| $V_{CES}$                 | Collector-to-Emitter Breakdown Voltage | 600                                    | V          |
| $I_C @ T_C = 25^\circ C$  | Continuous Collector Current           | 35*                                    | A          |
| $I_C @ T_C = 100^\circ C$ | Continuous Collector Current           | 20                                     |            |
| $I_{CM}$                  | Pulsed Collector Current ①             | 152                                    |            |
| $I_{LM}$                  | Clamped Inductive Load Current ②       | 152                                    |            |
| $V_{GE}$                  | Gate-to-Emitter Voltage                | $\pm 20$                               | V          |
| $P_D @ T_C = 25^\circ C$  | Maximum Power Dissipation              | 125                                    | W          |
| $P_D @ T_C = 100^\circ C$ | Maximum Power Dissipation              | 50                                     |            |
| $T_J$                     | Operating Junction and                 | -55 to + 150                           | $^\circ C$ |
| $T_{STG}$                 | Storage Temperature Range              |                                        |            |
|                           | Lead Temperature                       | 300 (0.063in./1.6mm from case for 10s) |            |
|                           | Weight                                 | 9.3 (typical)                          | g          |

\*Current is limited by pin diameter

### Thermal Resistance

|            | Parameter           | Min | Typ  | Max | Units        | Test Conditions |
|------------|---------------------|-----|------|-----|--------------|-----------------|
| $R_{thJC}$ | Junction-to-Case    | —   | —    | 1.0 | $^\circ C/W$ |                 |
| $R_{thCS}$ | Case-to-Sink        | —   | 0.21 | —   |              |                 |
| $R_{thJA}$ | Junction-to-Ambient | —   | —    | 48  |              |                 |

For footnotes refer to the last page

[www.irf.com](http://www.irf.com)

**Electrical Characteristics @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)**

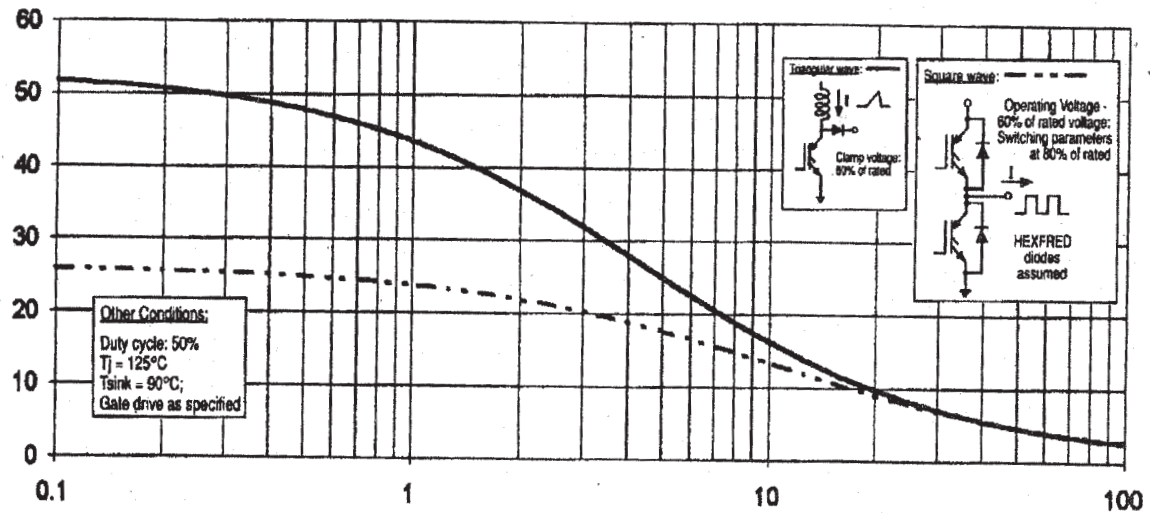
|                                 | Parameter                                | Min. | Typ. | Max.      | Units         | Conditions                                            |
|---------------------------------|------------------------------------------|------|------|-----------|---------------|-------------------------------------------------------|
| $V_{(BR)CES}$                   | Collector-to-Emitter Breakdown Voltage   | 600  | —    | —         | V             | $V_{GE} = 0V, I_C = 1.0\text{ mA}$                    |
| $V_{(BR)ECS}$                   | Emitter-to-Collector Breakdown Voltage ③ | 24   | —    | —         | V             | $V_{GE} = 0V, I_C = 1.0\text{ A}$                     |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage  | —    | 0.70 | —         | V/°C          | $V_{GE} = 0V, I_C = 1.0\text{ mA}$                    |
| $V_{CE(ON)}$                    | Collector-to-Emitter Saturation Voltage  | —    | —    | 2.0       | V             | $I_C = 20A$ $V_{GE} = 15V$                            |
|                                 |                                          | —    | 2.2  | —         |               | $I_C = 35A$ See Fig.5                                 |
|                                 |                                          | —    | 1.9  | —         |               | $I_C = 20A, T_J = 125^\circ\text{C}$                  |
| $V_{GE(th)}$                    | Gate Threshold Voltage                   | 3.0  | —    | 5.5       |               | $V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}$       |
| $\Delta V_{GE(th)}/\Delta T_J$  | Temperature Coeff. of Threshold Voltage  | —    | -12  | —         | mV/°C         | $V_{CE} = V_{GE}, I_C = 250\text{ }\mu\text{A}$       |
| $g_{fe}$                        | Forward Transconductance ④               | 9.2  | —    | —         | S             | $V_{CE} \geq 15V, I_C = 20A$                          |
| $I_{CES}$                       | Zero Gate Voltage Collector Current      | —    | —    | 50        | $\mu\text{A}$ | $V_{GE} = 0V, V_{CE} = 480V$                          |
|                                 |                                          | —    | —    | 1000      |               | $V_{GE} = 0V, V_{CE} = 480V, T_J = 125^\circ\text{C}$ |
| $I_{GES}$                       | Gate-to-Emitter Leakage Current          | —    | —    | $\pm 100$ | nA            | $V_{GE} = \pm 20V$                                    |

**Switching Characteristics @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)**

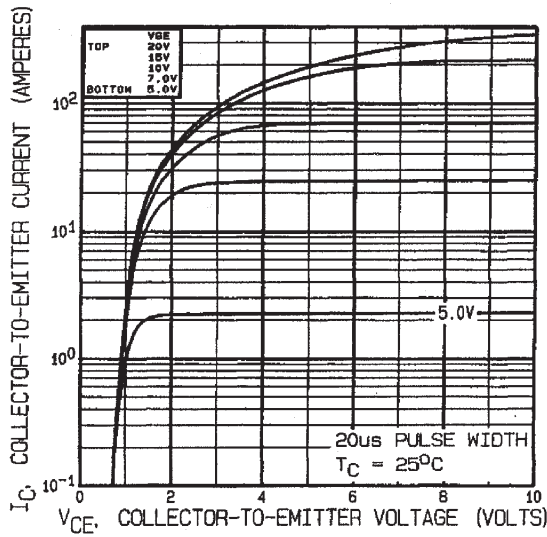
|              | Parameter                         | Min. | Typ. | Max. | Units | Conditions                                                                                             |
|--------------|-----------------------------------|------|------|------|-------|--------------------------------------------------------------------------------------------------------|
| $Q_g$        | Total Gate Charge (turn-on)       | —    | 58   | 116  | nC    | $I_C = 20A$                                                                                            |
| $Q_{ge}$     | Gate - Emitter Charge (turn-on)   | —    | 8.0  | 16   |       | $V_{CC} = 300V$ See Fig. 8                                                                             |
| $Q_{gc}$     | Gate - Collector Charge (turn-on) | —    | 30   | 60   |       | $V_{GE} = 15V$                                                                                         |
| $t_{d(on)}$  | Turn-On Delay Time                | —    | —    | 52   | ns    | $I_C = 20A, V_{CC} = 480V$                                                                             |
| $t_r$        | Rise Time                         | —    | —    | 74   |       | $V_{GE} = 15V, R_G = 9.1\Omega$                                                                        |
| $t_{d(off)}$ | Turn-Off Delay Time               | —    | —    | 410  |       | Energy losses include "tail"                                                                           |
| $t_f$        | Fall Time                         | —    | —    | 420  |       | See Fig. 9, 10 & 13                                                                                    |
| $E_{on}$     | Turn-On Switching Loss            | —    | 0.6  | —    | mJ    |                                                                                                        |
| $E_{off}$    | Turn-off Switching Loss           | —    | 3.8  | —    |       |                                                                                                        |
| $E_{ts}$     | Total Switching Loss              | —    | 4.4  | 9.0  |       |                                                                                                        |
| $t_{d(on)}$  | Turn-On Delay Time                | —    | 28   | —    | ns    | $T_J = 125^\circ\text{C}$                                                                              |
| $t_r$        | Rise Time                         | —    | 37   | —    |       | $I_C = 20A, V_{CC} = 480V$                                                                             |
| $t_{d(off)}$ | Turn-Off Delay Time               | —    | 380  | —    |       | $V_{GE} = 15V, R_G = 9.1\Omega$                                                                        |
| $t_f$        | Fall Time                         | —    | 460  | —    |       | Energy losses include "tail"                                                                           |
| $E_{ts}$     | Total Switching Loss              | —    | 7.0  | —    | mJ    | See Fig. 11, 13                                                                                        |
| $L_C + L_E$  | Total Inductance                  | —    | 6.8  | —    | nH    | Measured from Collector lead (6mm / 0.25in. from package) to Emitter lead (6mm / 0.25in. from package) |
| $C_{ies}$    | Input Capacitance                 | —    | 1500 | —    | pF    | $V_{GE} = 0V$                                                                                          |
| $C_{oes}$    | Output Capacitance                | —    | 190  | —    |       | $V_{CC} = 30V$ See Fig. 7                                                                              |
| $C_{res}$    | Reverse Transfer Capacitance      | —    | 20   | —    |       | $f = 1.0\text{MHz}$                                                                                    |

**Note:** Corresponding Spice and Saber models are available on the Website.

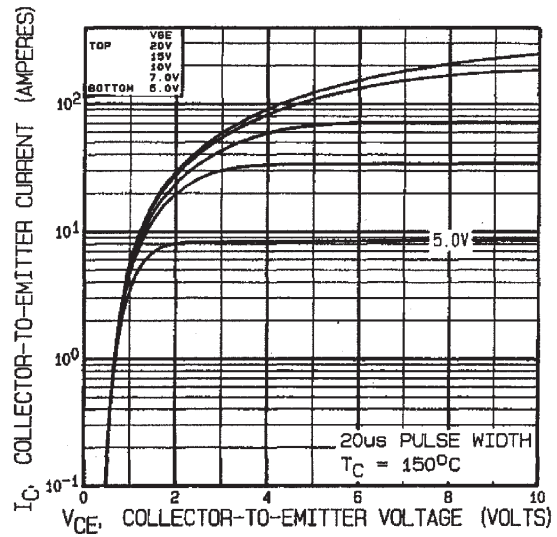
For footnotes refer to the last page



**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**

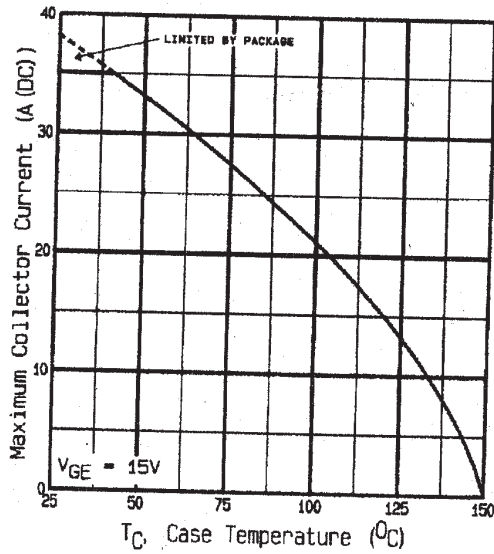


Fig. 4 - Maximum Collector Current vs. Case Temperature

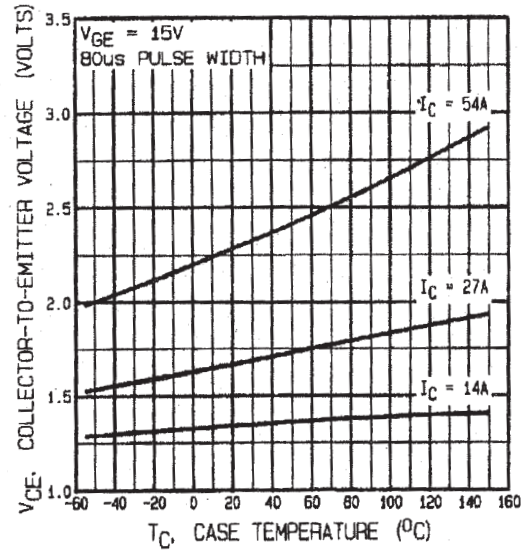


Fig. 5 - Collector-to-Emitter Voltage vs. Junction Temperature

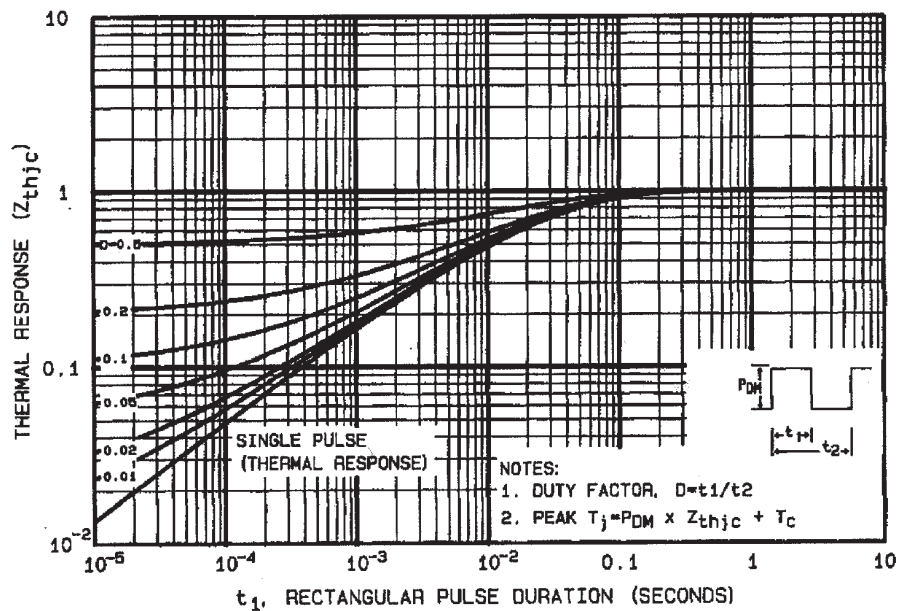
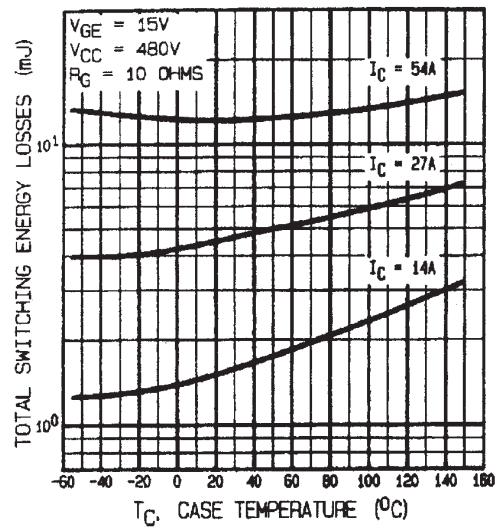
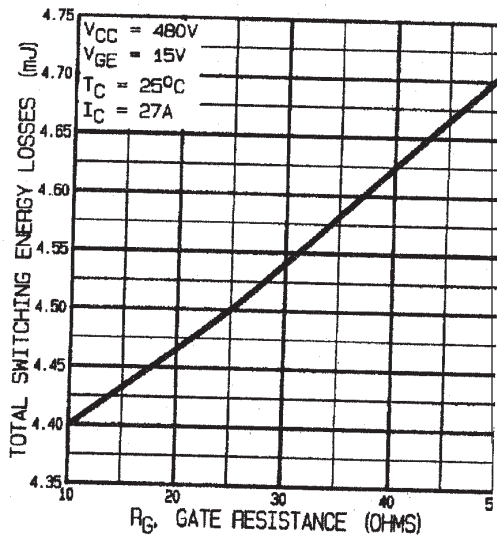
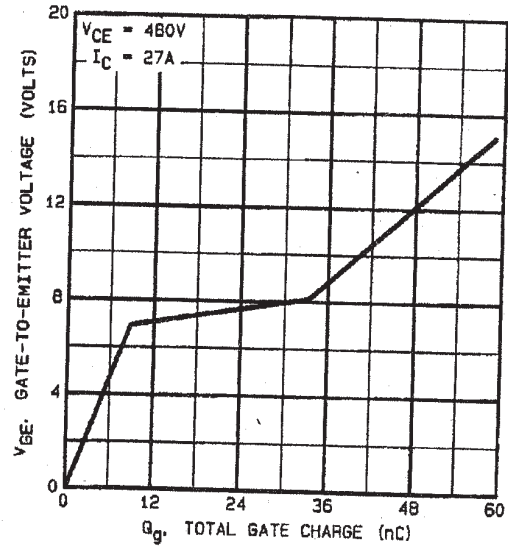
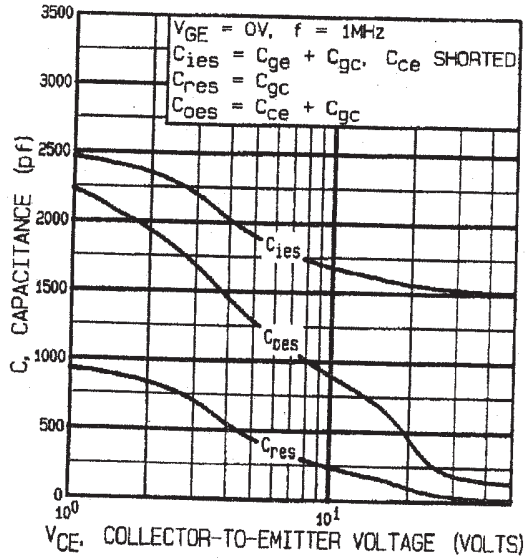
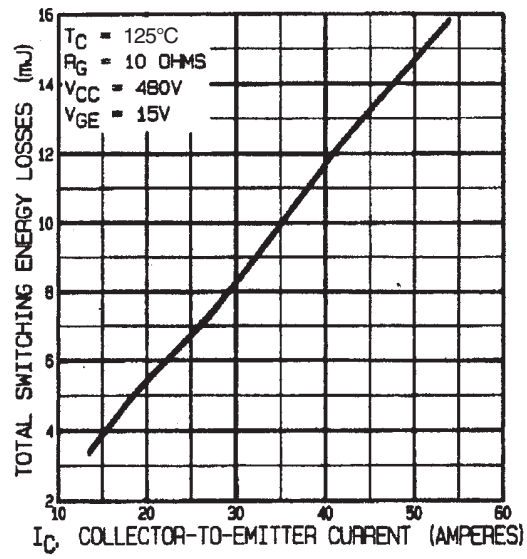
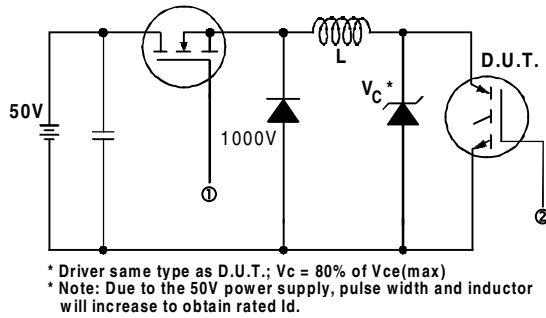


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

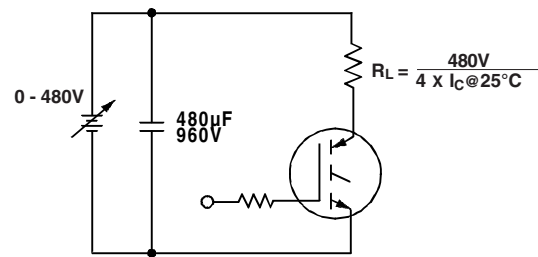




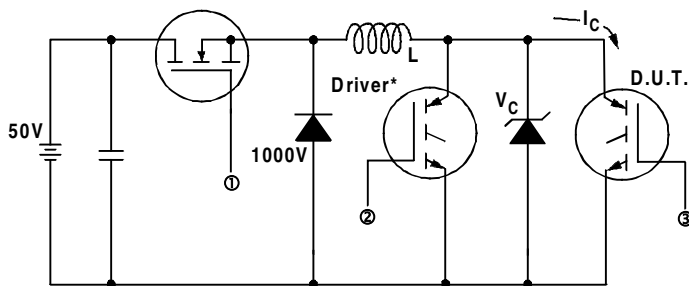
**Fig. 11** - Typical Switching Losses vs.  
Collector-to-Emitter Current



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

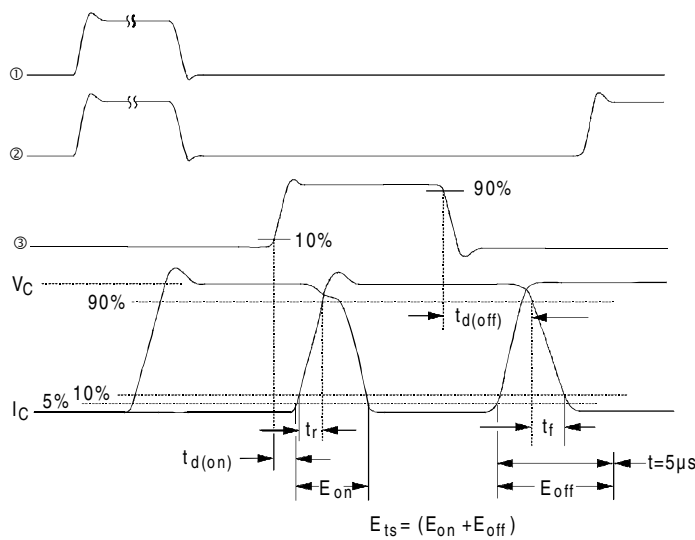


**Fig. 12b** - Pulsed Collector Current Test Circuit



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

\* Driver same type as D.U.T.,  $V_C = 480V$



**Fig. 13b** - Switching Loss Waveforms

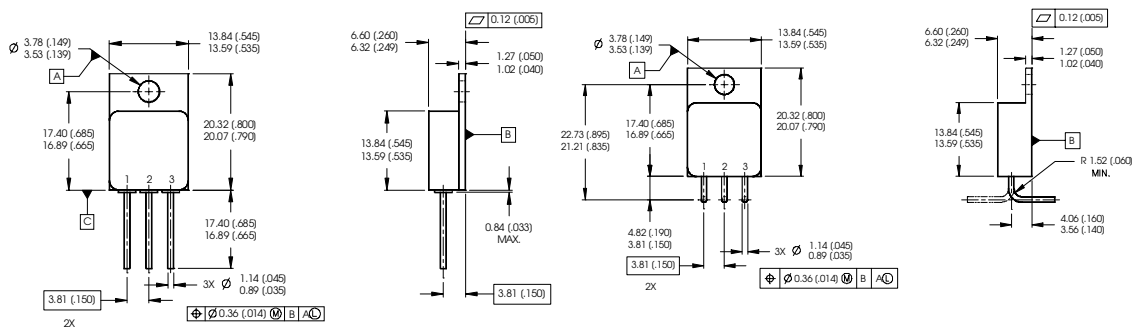
# IRGMC40U

International  
**IOR** Rectifier

## Notes:

- ① Repetitive rating;  $V_{GE} = 20V$ , pulse width limited by max. junction temperature.
- ②  $V_{CC} = 80\%(V_{CES})$ ,  $V_{GE} = 20V$ ,  $L = 10\mu H$ ,  $R_G = 10\Omega$
- ③ Pulse width  $\leq 80\mu s$ ; duty factor  $\leq 0.1\%$ .
- ④ Pulse width  $5.0\mu s$ , single shot.

## Case Outline and Dimensions — TO-254AA



## NOTES:

1. DIMENSIONING & TOLERANCING PER ASME Y14.5M-1994.
2. ALL DIMENSIONS ARE SHOWN IN MILLIMETERS (INCHES).
3. CONTROLLING DIMENSION: INCH.
4. CONFORMS TO JEDEC OUTLINE TO-254AA

## LEGEND

- 1 = COLLECTOR
- 2 = EMITTER
- 3 = GATE

## CAUTION

### BERYLLIA WARNING PER MIL-PRF-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.

International  
**IOR** Rectifier

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