

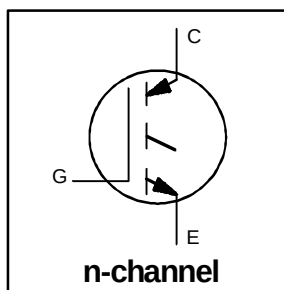
# IRGPH20M

INSULATED GATE BIPOLAR TRANSISTOR

Short Circuit Rated  
Fast IGBT

## Features

- Short circuit rated - 10 $\mu$ s @ 125°C,  $V_{GE} = 15V$
- Switching-loss rating includes all "tail" losses
- Optimized for medium operating frequency (1 to 10kHz) See Fig. 1 for Current vs. Frequency curve



$$V_{CES} = 1200V$$

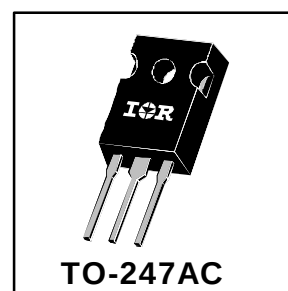
$$V_{CE(sat)} \leq 4.6V$$

$$@V_{GE} = 15V, I_C = 4.5A$$

## 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.



## Absolute Maximum Ratings

|                           | Parameter                          | Max.                              | Units      |
|---------------------------|------------------------------------|-----------------------------------|------------|
| $V_{CES}$                 | Collector-to-Emitter Voltage       | 1200                              | V          |
| $I_C @ T_C = 25^\circ C$  | Continuous Collector Current       | 6.9                               | A          |
| $I_C @ T_C = 100^\circ C$ | Continuous Collector Current       | 4.5                               |            |
| $I_{CM}$                  | Pulsed Collector Current ①         | 14                                |            |
| $I_{LM}$                  | Clamped Inductive Load Current ②   | 14                                |            |
| $t_{sc}$                  | Short Circuit Withstand Time       | 10                                | $\mu$ s    |
| $V_{GE}$                  | Gate-to-Emitter Voltage            | $\pm 20$                          | V          |
| $E_{ARV}$                 | Reverse Voltage Avalanche Energy ③ | 5.0                               | mJ         |
| $P_D @ T_C = 25^\circ C$  | Maximum Power Dissipation          | 60                                | W          |
| $P_D @ T_C = 100^\circ C$ | Maximum Power Dissipation          | 24                                |            |
| $T_J$                     | Operating Junction and             | -55 to +150                       | $^\circ C$ |
| $T_{STG}$                 | Storage Temperature Range          |                                   |            |
|                           | 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                          | —    | —        | 2.1  | $^\circ C/W$ |
| $R_{\theta CS}$ | 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 @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)**

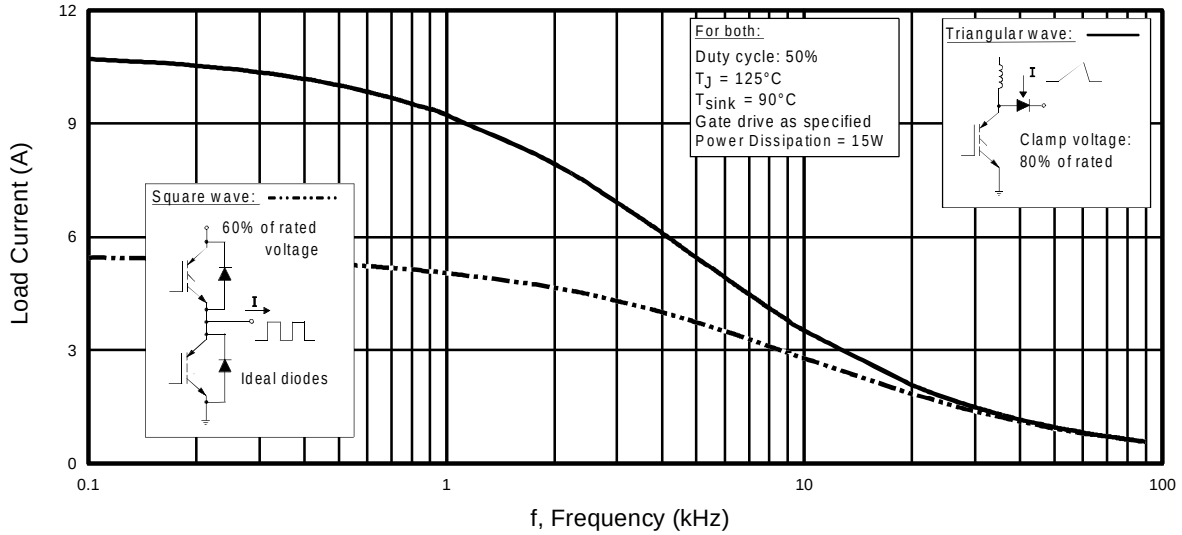
|                                 | Parameter                                | Min. | Typ. | Max.      | Units                | Conditions                                             |
|---------------------------------|------------------------------------------|------|------|-----------|----------------------|--------------------------------------------------------|
| $V_{(BR)CES}$                   | Collector-to-Emitter Breakdown Voltage   | 1200 | —    | —         | V                    | $V_{GE} = 0V, I_C = 250\mu A$                          |
| $V_{(BR)ECS}$                   | 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  | —    | 1.3  | —         | V/ $^\circ\text{C}$  | $V_{GE} = 0V, I_C = 1.0mA$                             |
| $V_{CE(on)}$                    | Collector-to-Emitter Saturation Voltage  | —    | 3.1  | 4.6       | V                    | $I_C = 4.5A, V_{GE} = 15V$                             |
|                                 |                                          | —    | 3.9  | —         |                      | $I_C = 6.9A$ See Fig. 2, 5                             |
|                                 |                                          | —    | 4.0  | —         |                      | $I_C = 4.5A, T_J = 150^\circ\text{C}$                  |
| $V_{GE(th)}$                    | Gate Threshold Voltage                   | 3.0  | —    | 5.5       |                      | $V_{CE} = V_{GE}, I_C = 250\mu A$                      |
| $\Delta V_{GE(th)}/\Delta T_J$  | Temperature Coeff. of Threshold Voltage  | —    | -11  | —         | mV/ $^\circ\text{C}$ | $V_{CE} = V_{GE}, I_C = 250\mu A$                      |
| $g_{fe}$                        | Forward Transconductance ⑤               | 1.3  | 2.6  | —         | S                    | $V_{CE} = 100V, I_C = 4.5A$                            |
| $I_{CES}$                       | Zero Gate Voltage Collector Current      | —    | —    | 250       | $\mu A$              | $V_{GE} = 0V, V_{CE} = 1200V$                          |
|                                 |                                          | —    | —    | 1000      |                      | $V_{GE} = 0V, V_{CE} = 1200V, T_J = 150^\circ\text{C}$ |
| $I_{GES}$                       | Gate-to-Emitter Leakage Current          | —    | —    | $\pm 100$ | nA                   | $V_{GE} = \pm 20V$                                     |

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

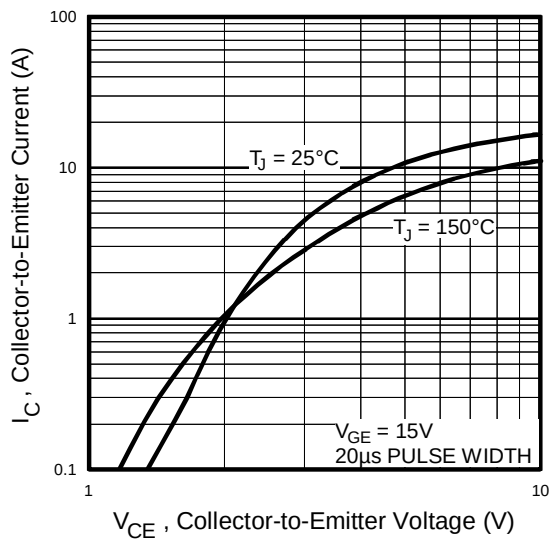
|              | Parameter                         | Min. | Typ. | Max. | Units   | Conditions                                                                                                                   |
|--------------|-----------------------------------|------|------|------|---------|------------------------------------------------------------------------------------------------------------------------------|
| $Q_g$        | Total Gate Charge (turn-on)       | —    | 16   | 24   | nC      | $I_C = 4.5A$<br>$V_{CC} = 400V$ See Fig. 8<br>$V_{GE} = 15V$                                                                 |
| $Q_{ge}$     | Gate - Emitter Charge (turn-on)   | —    | 4.4  | 7.0  |         |                                                                                                                              |
| $Q_{gc}$     | Gate - Collector Charge (turn-on) | —    | 5.5  | 8.3  |         |                                                                                                                              |
| $t_{d(on)}$  | Turn-On Delay Time                | —    | 26   | —    | ns      | $T_J = 25^\circ\text{C}$<br>$I_C = 4.5A, V_{CC} = 960V$<br>$V_{GE} = 15V, R_G = 50\Omega$<br>Energy losses include "tail"    |
| $t_r$        | Rise Time                         | —    | 13   | —    |         |                                                                                                                              |
| $t_{d(off)}$ | Turn-Off Delay Time               | —    | 43   | 65   |         |                                                                                                                              |
| $t_f$        | Fall Time                         | —    | 430  | 640  |         |                                                                                                                              |
| $E_{on}$     | Turn-On Switching Loss            | —    | 0.33 | —    | mJ      | See Fig. 9, 10, 11, 14                                                                                                       |
| $E_{off}$    | Turn-Off Switching Loss           | —    | 0.78 | —    |         |                                                                                                                              |
| $E_{ts}$     | Total Switching Loss              | —    | 1.1  | 1.7  |         |                                                                                                                              |
| $t_{sc}$     | Short Circuit Withstand Time      | 10   | —    | —    | $\mu s$ | $V_{CC} = 720V, T_J = 125^\circ\text{C}$<br>$V_{GE} = 15V, R_G = 50\Omega, V_{CPK} < 1000V$                                  |
| $t_{d(on)}$  | Turn-On Delay Time                | —    | 32   | —    | ns      | $T_J = 150^\circ\text{C}$ ,<br>$I_C = 4.5A, V_{CC} = 960V$<br>$V_{GE} = 15V, R_G = 50\Omega$<br>Energy losses include "tail" |
| $t_r$        | Rise Time                         | —    | 20   | —    |         |                                                                                                                              |
| $t_{d(off)}$ | Turn-Off Delay Time               | —    | 480  | —    |         |                                                                                                                              |
| $t_f$        | Fall Time                         | —    | 450  | —    |         |                                                                                                                              |
| $E_{ts}$     | Total Switching Loss              | —    | 2.4  | —    | mJ      | See Fig. 10, 14                                                                                                              |
| $L_E$        | Internal Emitter Inductance       | —    | 13   | —    | nH      | Measured 5mm from package                                                                                                    |
| $C_{ies}$    | Input Capacitance                 | —    | 340  | —    | pF      | $V_{GE} = 0V$<br>$V_{CC} = 30V$ See Fig. 7<br>$f = 1.0MHz$                                                                   |
| $C_{oes}$    | Output Capacitance                | —    | 25   | —    |         |                                                                                                                              |
| $C_{res}$    | Reverse Transfer Capacitance      | —    | 4.7  | —    |         |                                                                                                                              |

**Notes:**

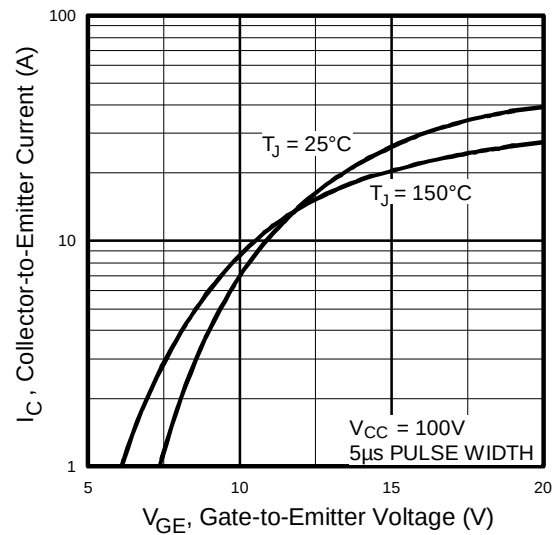
- ① Repetitive rating;  $V_{GE}=20V$ , pulse width limited by max. junction temperature. ( See fig. 13b )
- ②  $V_{CC}=80\%(V_{CES})$ ,  $V_{GE}=20V$ ,  $L=10\mu H$ ,  $R_G=50\Omega$ , ( See fig. 13a )
- ③ Repetitive rating; pulse width limited by maximum junction temperature.
- ④ Pulse width  $\leq 80\mu s$ ; duty factor  $\leq 0.1\%$ .
- ⑤ Pulse width  $5.0\mu s$ , single shot.



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



**Fig. 2 - Typical Output Characteristics**



**Fig. 3 - Typical Transfer Characteristics**

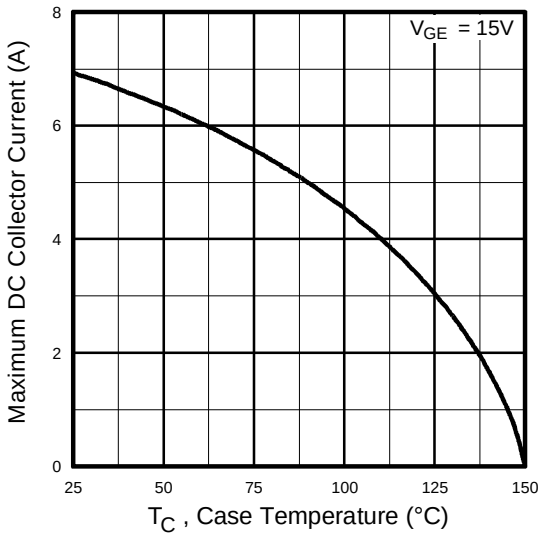


Fig. 4 - Maximum Collector Current vs. Case Temperature

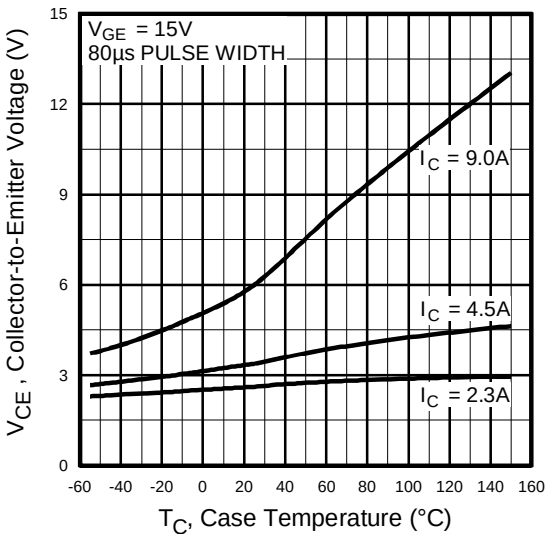


Fig. 5 - Collector-to-Emitter Voltage vs. Case Temperature

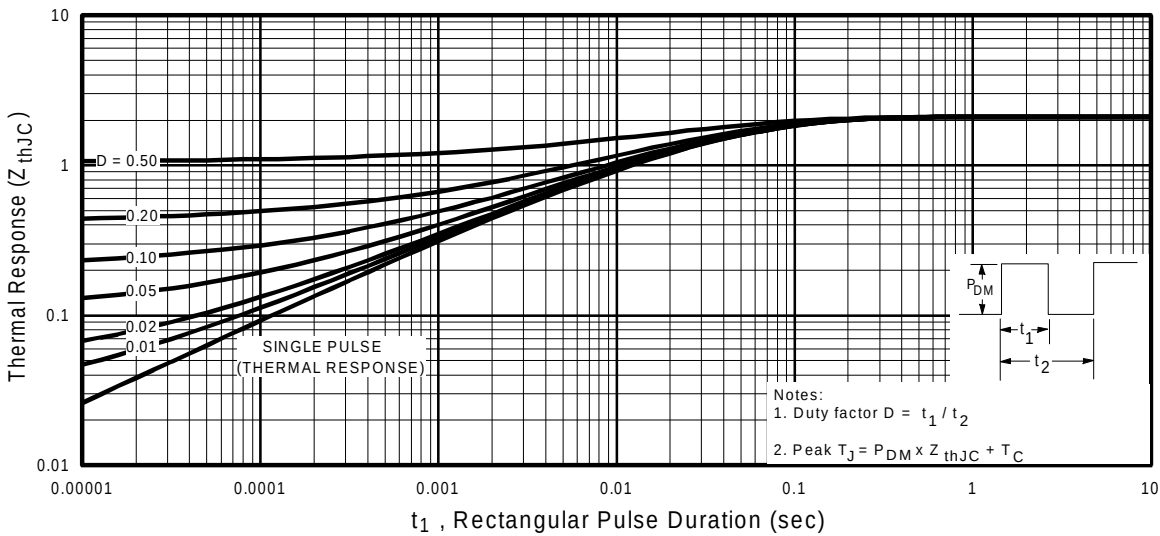
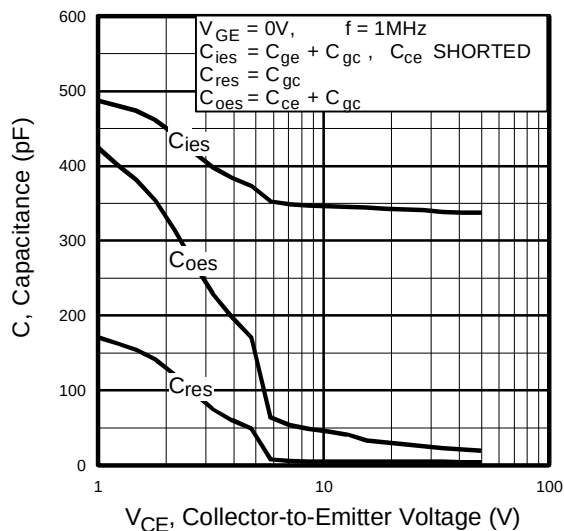
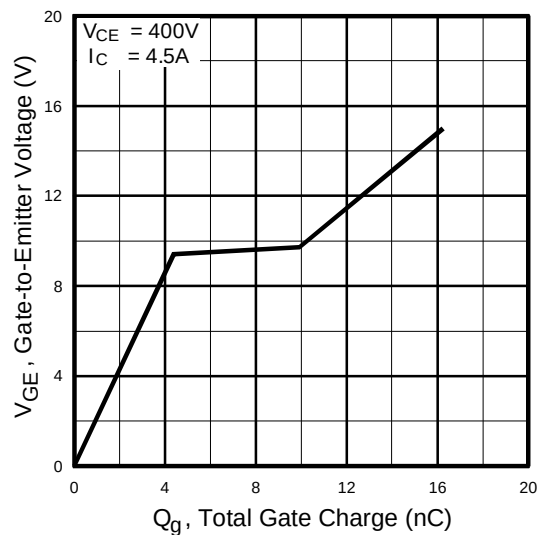


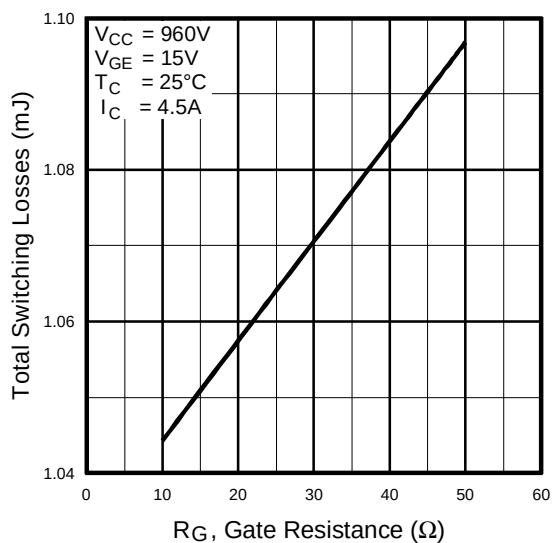
Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case



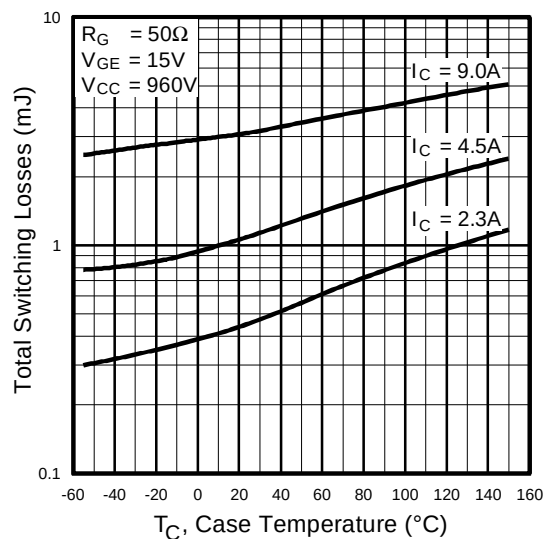
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



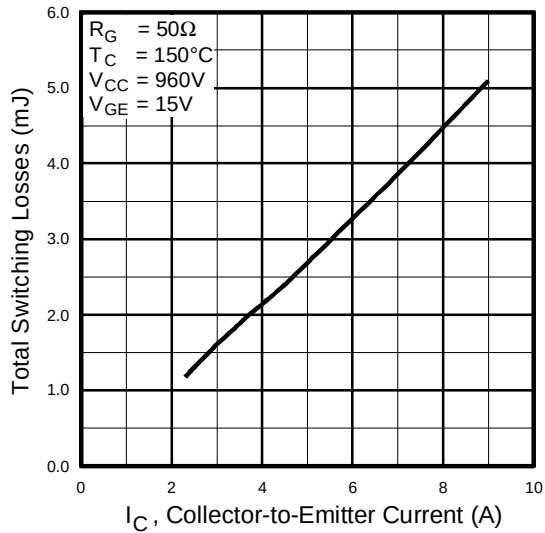
**Fig. 8** - Typical Gate Charge vs. Gate-to-Emitter Voltage



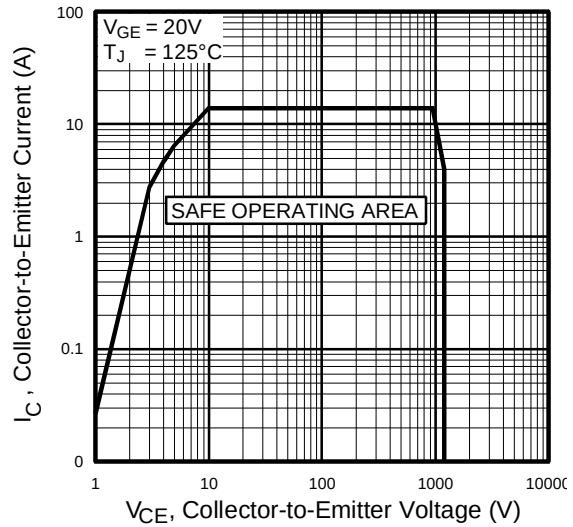
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



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



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



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

Refer to Section D for the following:

**Appendix G: Section D - page D-9**

- Fig. 13a - Clamped Inductive Load Test Circuit
- Fig. 13b - Pulsed Collector Current Test Circuit
- Fig. 14a - Switching Loss Test Circuit
- Fig. 14b - Switching Loss Waveform

Package Outline 3 - JEDEC Outline TO-247AC

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