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[International Rectifier \(Infineon Technologies Americas Corp.\)](#)  
[IRG4BC40W](#)

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# International IR Rectifier

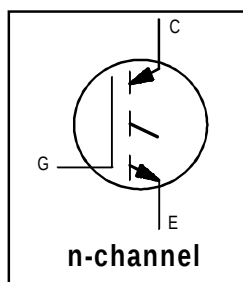
PD - 91654A

## IRG4BC40W

### INSULATED GATE BIPOLAR TRANSISTOR

#### Features

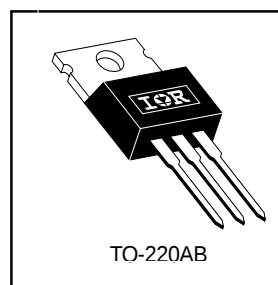
- Designed expressly for Switch-Mode Power Supply and PFC (power factor correction) applications
- Industry-benchmark switching losses improve efficiency of all power supply topologies
- 50% reduction of Eoff parameter
- Low IGBT conduction losses
- Latest-generation IGBT design and construction offers tighter parameters distribution, exceptional reliability



|                                   |
|-----------------------------------|
| $V_{CES} = 600V$                  |
| $V_{CE(on)} \text{ typ.} = 2.05V$ |
| @ $V_{GE} = 15V, I_C = 20A$       |

#### Benefits

- Lower switching losses allow more cost-effective operation than power MOSFETs up to 150 kHz ("hard switched" mode)
- Of particular benefit to single-ended converters and boost PFC topologies 150W and higher
- Low conduction losses and minimal minority-carrier recombination make these an excellent option for resonant mode switching as well (up to >>300 kHz)



#### 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           | 40                                 | A          |
| $I_C @ T_C = 100^\circ C$ | Continuous Collector Current           | 20                                 |            |
| $I_{CM}$                  | Pulsed Collector Current ①             | 160                                |            |
| $I_{LM}$                  | Clamped Inductive Load Current ②       | 160                                |            |
| $V_{GE}$                  | Gate-to-Emitter Voltage                | $\pm 20$                           | V          |
| $E_{ARV}$                 | Reverse Voltage Avalanche Energy ③     | 160                                | mJ         |
| $P_D @ T_C = 25^\circ C$  | Maximum Power Dissipation              | 160                                | W          |
| $P_D @ T_C = 100^\circ C$ | Maximum Power Dissipation              | 65                                 |            |
| $T_J$                     | Operating Junction and                 | -55 to + 150                       | $^\circ C$ |
| $T_{STG}$                 | Storage Temperature Range              |                                    |            |
|                           | Soldering Temperature, for 10 seconds  | 300 (0.063 in. (1.6mm) from case ) |            |
|                           | Mounting torque, 6-32 or M3 screw.     | 10 lbf•in (1.1N•m)                 |            |

#### Thermal Resistance

|                 | Parameter                                 | Typ.       | Max. | Units        |
|-----------------|-------------------------------------------|------------|------|--------------|
| $R_{\theta JC}$ | Junction-to-Case                          | —          | 0.77 | $^\circ C/W$ |
| $R_{\theta CS}$ | Case-to-Sink, Flat, Greased Surface       | 0.5        | —    |              |
| $R_{\theta JA}$ | Junction-to-Ambient, typical socket mount | —          | 80   |              |
| Wt              | Weight                                    | 2.0 (0.07) | —    | g (oz)       |

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## 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       | $V_{GE} = 0V, I_C = 250\mu A$                         |
| $V_{(BR)ECS}$                   | Emitter-to-Collector Breakdown Voltage ④ | 18   | —    | —         | V       | $V_{GE} = 0V, I_C = 1.0A$                             |
| $\Delta V_{(BR)CES}/\Delta T_J$ | Temperature Coeff. of Breakdown Voltage  | —    | 0.44 | —         | V/°C    | $V_{GE} = 0V, I_C = 1.0mA$                            |
| $V_{CE(ON)}$                    | Collector-to-Emitter Saturation Voltage  | —    | 2.05 | 2.5       | V       | $I_C = 20A, V_{GE} = 15V$                             |
|                                 |                                          | —    | 2.36 | —         |         | $I_C = 40A, V_{GE} = 15V$                             |
|                                 |                                          | —    | 1.90 | —         |         | $I_C = 20A, T_J = 150^\circ\text{C}$                  |
| $V_{GE(th)}$                    | Gate Threshold Voltage                   | 3.0  | —    | 6.0       |         | $V_{CE} = V_{GE}, I_C = 250\mu A$                     |
| $\Delta V_{GE(th)}/\Delta T_J$  | Temperature Coeff. of Threshold Voltage  | —    | 13   | —         | mV/°C   | $V_{CE} = V_{GE}, I_C = 250\mu A$                     |
| $g_{fe}$                        | Forward Transconductance ⑤               | 18   | 28   | —         | S       | $V_{CE} = 100V, I_C = 20A$                            |
| $I_{CES}$                       | Zero Gate Voltage Collector Current      | —    | —    | 250       | $\mu A$ | $V_{GE} = 0V, V_{CE} = 600V$                          |
|                                 |                                          | —    | —    | 2.0       |         | $V_{GE} = 0V, V_{CE} = 10V, T_J = 25^\circ\text{C}$   |
|                                 |                                          | —    | —    | 2500      |         | $V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$ |
| $I_{GES}$                       | 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)       | —    | 98   | 147  | nC    | $I_C = 20A$                                                                                                                                 |
| $Q_{ge}$     | Gate - Emitter Charge (turn-on)   | —    | 12   | 18   |       | $V_{CC} = 400V$                                                                                                                             |
| $Q_{gc}$     | Gate - Collector Charge (turn-on) | —    | 36   | 54   |       | $V_{GE} = 15V$                                                                                                                              |
| $t_{d(on)}$  | Turn-On Delay Time                | —    | 27   | —    | ns    | $T_J = 25^{\circ}C$<br>$I_C = 20A, V_{CC} = 480V$<br>$V_{GE} = 15V, R_G = 10\Omega$<br>Energy losses include "tail"<br>See Fig. 9,10, 14    |
| $t_r$        | Rise Time                         | —    | 22   | —    |       |                                                                                                                                             |
| $t_{d(off)}$ | Turn-Off Delay Time               | —    | 100  | 150  |       |                                                                                                                                             |
| $t_f$        | Fall Time                         | —    | 74   | 110  |       |                                                                                                                                             |
| $E_{on}$     | Turn-On Switching Loss            | —    | 0.11 | —    | mJ    |                                                                                                                                             |
| $E_{off}$    | Turn-Off Switching Loss           | —    | 0.23 | —    |       |                                                                                                                                             |
| $E_{ts}$     | Total Switching Loss              | —    | 0.34 | 0.45 |       |                                                                                                                                             |
| $t_{d(on)}$  | Turn-On Delay Time                | —    | 25   | —    | ns    | $T_J = 150^{\circ}C,$<br>$I_C = 20A, V_{CC} = 480V$<br>$V_{GE} = 15V, R_G = 10\Omega$<br>Energy losses include "tail"<br>See Fig. 10,11, 14 |
| $t_r$        | Rise Time                         | —    | 23   | —    |       |                                                                                                                                             |
| $t_{d(off)}$ | Turn-Off Delay Time               | —    | 170  | —    |       |                                                                                                                                             |
| $t_f$        | Fall Time                         | —    | 124  | —    |       |                                                                                                                                             |
| $E_{ts}$     | Total Switching Loss              | —    | 0.85 | —    | mJ    |                                                                                                                                             |
| $L_E$        | Internal Emitter Inductance       | —    | 7.5  | —    | nH    | Measured 5mm from package                                                                                                                   |
| $C_{ies}$    | Input Capacitance                 | —    | 1900 | —    | pF    | $V_{GE} = 0V$                                                                                                                               |
| $C_{oes}$    | Output Capacitance                | —    | 140  | —    |       | $V_{CC} = 30V$                                                                                                                              |
| $C_{res}$    | Reverse Transfer Capacitance      | —    | 35   | —    |       | $f = 1.0MHz$                                                                                                                                |

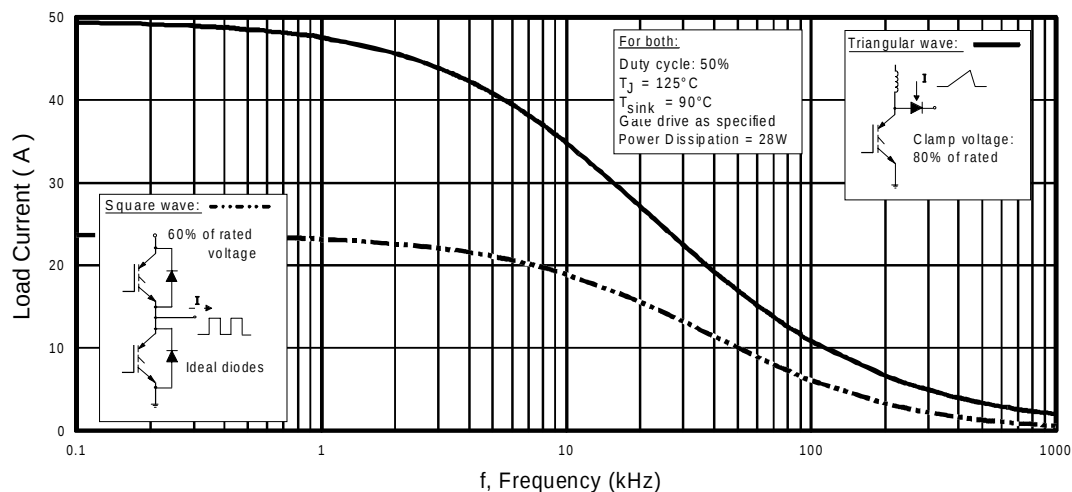
### Notes:

- ① Repetitive rating;  $V_{GE} = 20V$ , pulse width limited by max. junction temperature. ( See fig. 13b )
- ②  $V_{CC} = 80\%(V_{CES})$ ,  $V_{GE} = 20V$ ,  $L = 10\mu H$ ,  $R_G = 10\Omega$ , (See fig. 13a)
- ③ Repetitive rating; pulse width limited by maximum junction temperature.

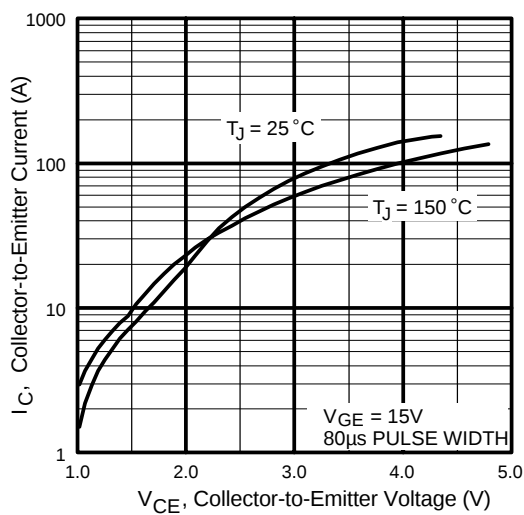
- ④ Pulse width  $\leq 80\mu s$ ; duty factor  $\leq 0.1\%$ .
- ⑤ Pulse width  $5.0\mu s$ , single shot.

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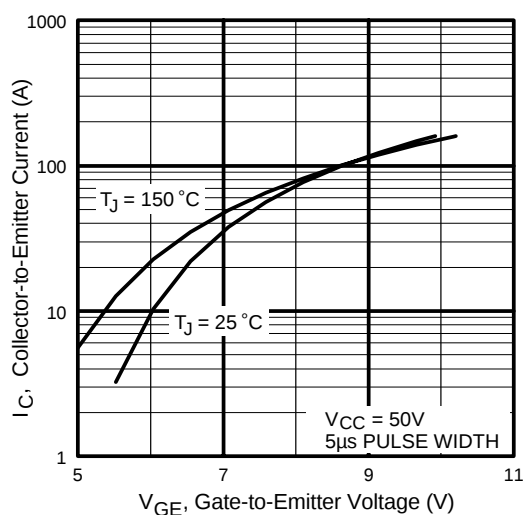
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**Fig. 1** - Typical Load Current vs. Frequency  
(Load Current =  $I_{RMS}$  of fundamental)



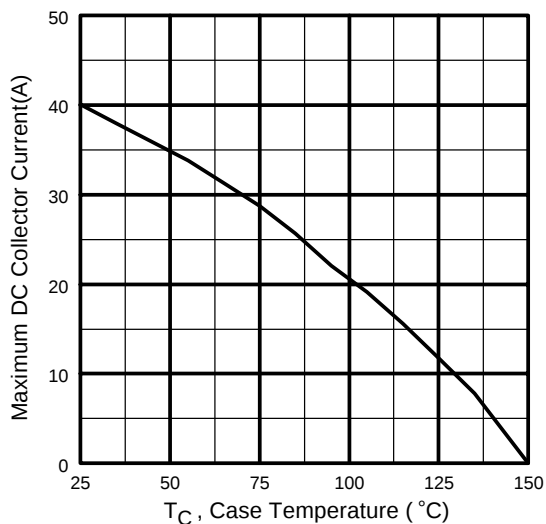
**Fig. 2** - Typical Output Characteristics



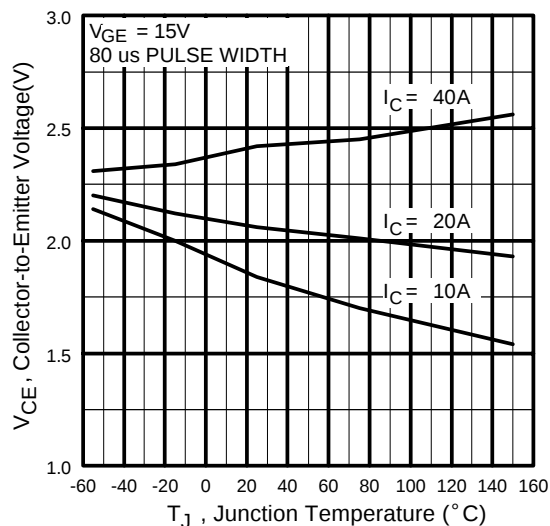
**Fig. 3** - Typical Transfer Characteristics

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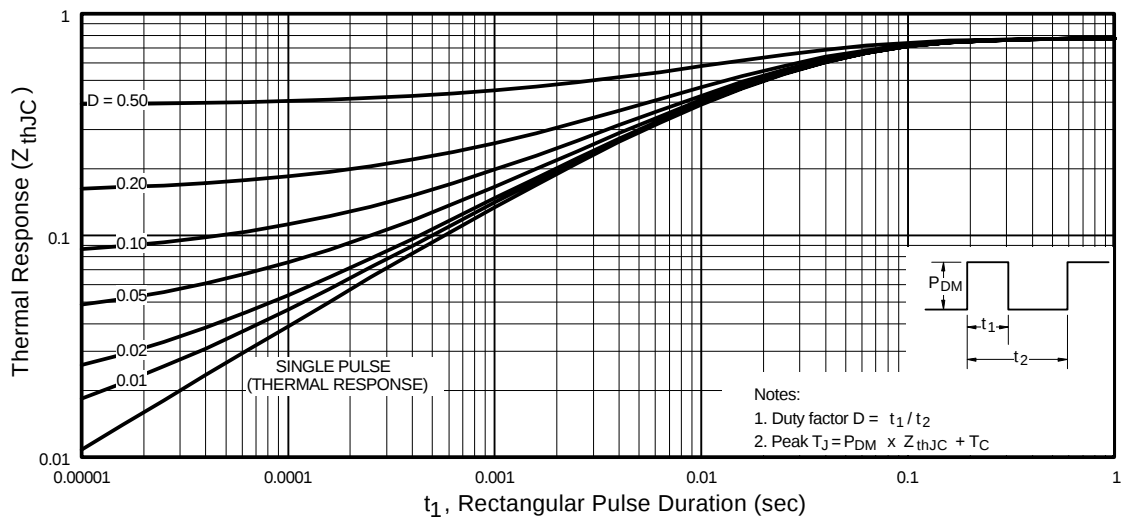
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**Fig. 4** - Maximum Collector Current vs. Case Temperature



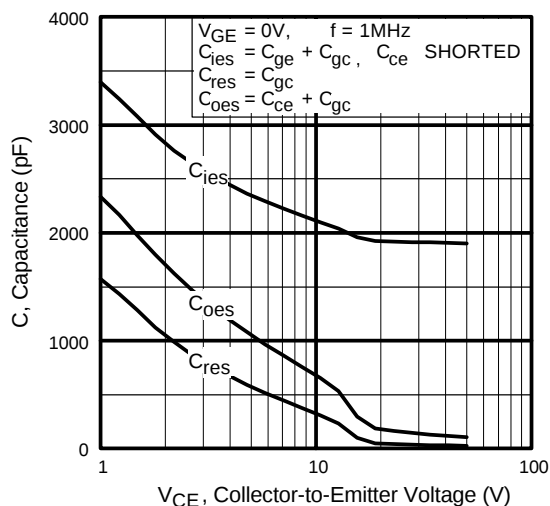
**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature



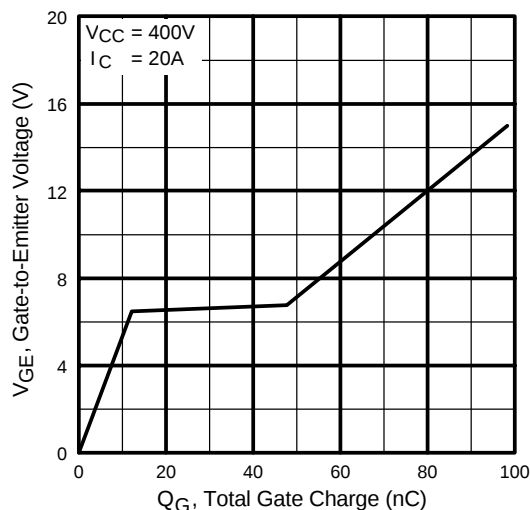
**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case

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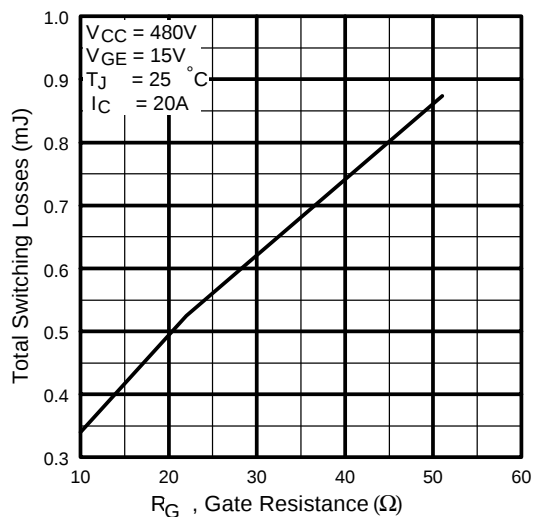
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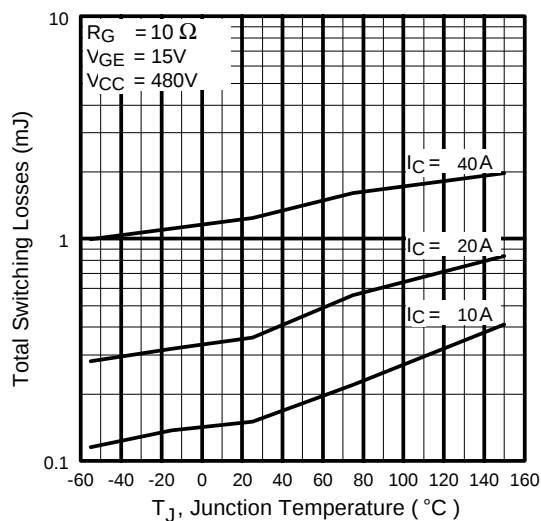
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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



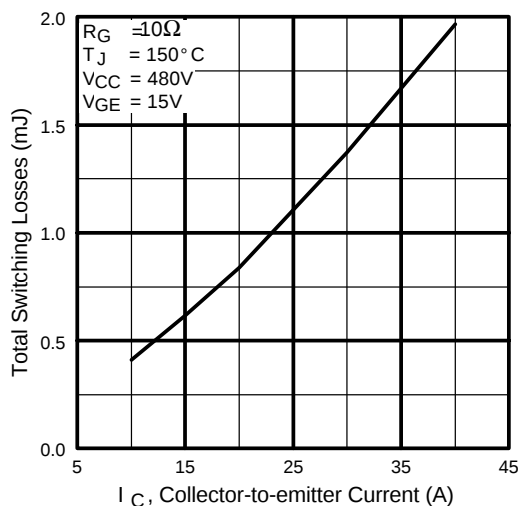
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



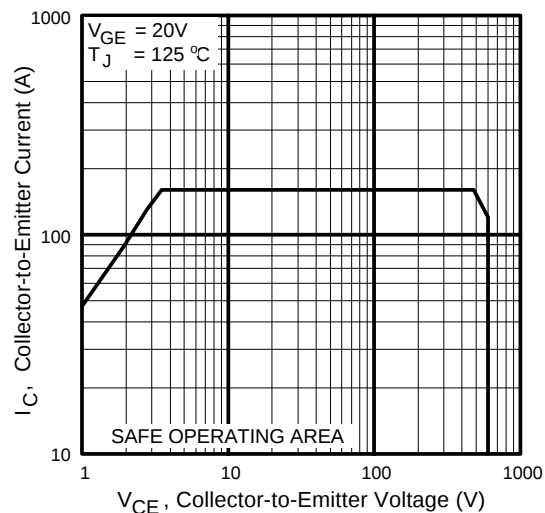
**Fig. 10** - Typical Switching Losses vs. Junction Temperature

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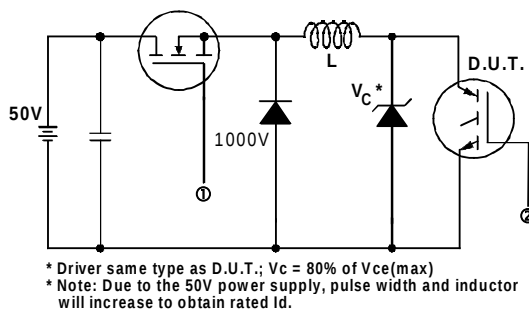
**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current



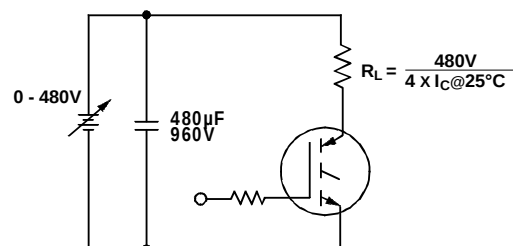
**Fig. 12** - Turn-Off SOA

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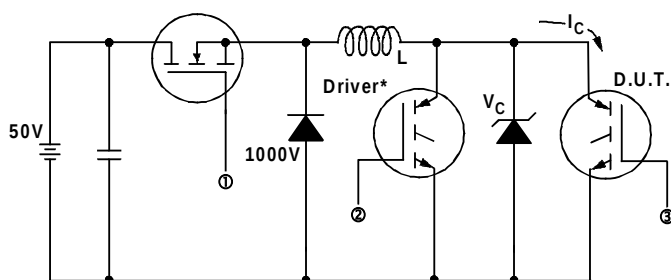
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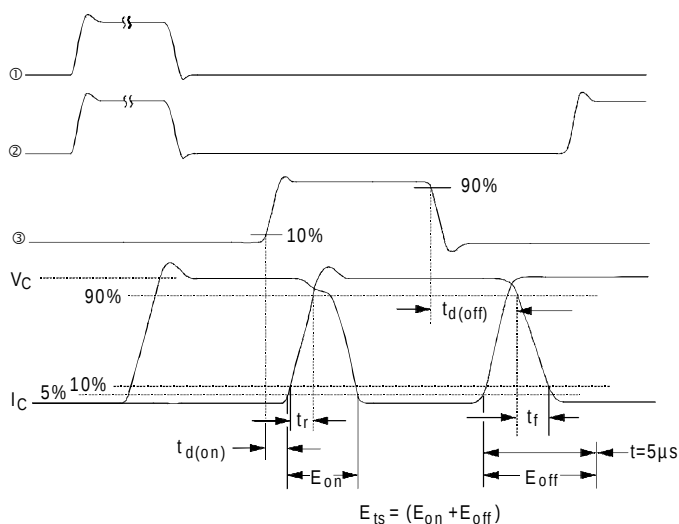
**Fig. 13a** - Clamped Inductive Load Test Circuit



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



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

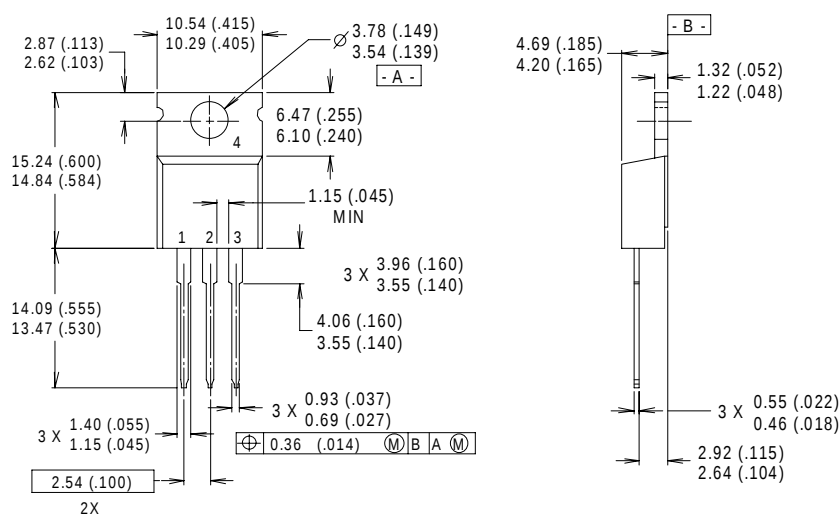


**Fig. 14b** - Switching Loss Waveforms

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### Case Outline and Dimensions — TO-220AB



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*Data and specifications subject to change without notice. 10/00*

Note: For the most current drawings please refer to the IR website at:

<http://www.irf.com/package/>