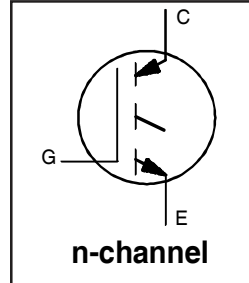


## IRG4BC40WSPbF IRG4BC40WLPbF

### INSULATED GATE BIPOLAR TRANSISTOR

#### Features

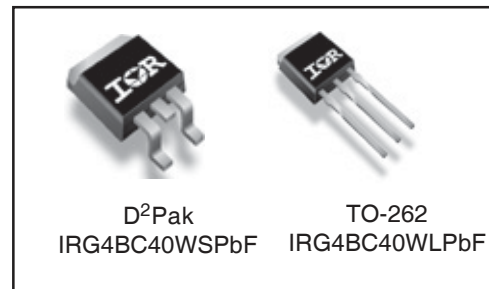
- Designed expressly for Switch-Mode Power Supply and PFC (power factor correction) applications
- Industry-benchmark switching losses improve efficiency of all power supply topologies
- 50% reduction of Eoff parameter
- Low IGBT conduction losses
- Latest-generation IGBT design and construction offers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



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

#### 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                       | °C    |
| $T_{STG}$                 | Storage Temperature Range              |                                    |       |
|                           | Soldering Temperature, for 10 seconds  | 300 (0.063 in. (1.6mm) from case ) |       |

#### Thermal Resistance

|                 | Parameter                                      | Typ.       | Max. | Units  |
|-----------------|------------------------------------------------|------------|------|--------|
| $R_{\theta JC}$ | Junction-to-Case                               | ---        | 0.77 | °C/W   |
| $R_{\theta CS}$ | Case-to-Sink, Flat, Greased Surface            | 0.5        | ---  |        |
| $R_{\theta JA}$ | Junction-to-Ambient (PCB Mounted steady-state) | ---        | 40   |        |
| Wt              | Weight                                         | 2.0 (0.07) | ---  | g (oz) |

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

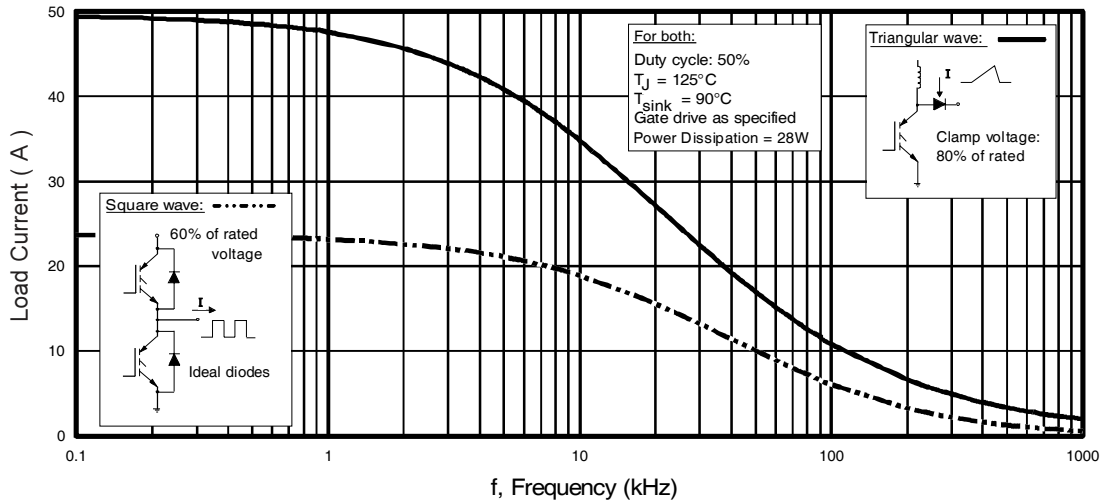
|                                 | Parameter                                | Min. | Typ. | Max.      | Units   | Conditions                                            |
|---------------------------------|------------------------------------------|------|------|-----------|---------|-------------------------------------------------------|
| $V_{(BR)CES}$                   | Collector-to-Emitter Breakdown Voltage   | 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 | —         |         | $I_C = 40A$ See Fig.2, 5                              |
|                                 |                                          | —    | 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)

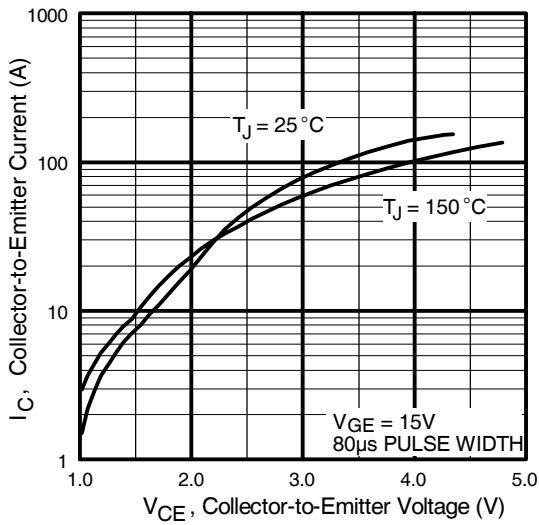
|              | Parameter                         | Min. | Typ. | Max. | Units | Conditions                                                                                                                 |
|--------------|-----------------------------------|------|------|------|-------|----------------------------------------------------------------------------------------------------------------------------|
| $Q_g$        | Total Gate Charge (turn-on)       | —    | 98   | 147  | nC    | $I_C = 20A$                                                                                                                |
| $Q_{ge}$     | Gate - Emitter Charge (turn-on)   | —    | 12   | 18   |       | $V_{CC} = 400V$ See Fig.8                                                                                                  |
| $Q_{gc}$     | Gate - Collector Charge (turn-on) | —    | 36   | 54   |       | $V_{GE} = 15V$                                                                                                             |
| $t_{d(on)}$  | Turn-On Delay Time                | —    | 27   | —    | ns    | $T_J = 25^\circ\text{C}$<br>$I_C = 20A, V_{CC} = 480V$<br>$V_{GE} = 15V, R_G = 10\Omega$                                   |
| $t_r$        | 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    | Energy losses include "tail"<br>See Fig. 9,10, 14                                                                          |
| $E_{off}$    | Turn-Off Switching Loss           | —    | 0.23 | —    |       |                                                                                                                            |
| $E_{ts}$     | Total Switching Loss              | —    | 0.34 | 0.45 |       |                                                                                                                            |
| $t_{d(on)}$  | Turn-On Delay Time                | —    | 25   | —    | ns    | $T_J = 150^\circ\text{C},$<br>$I_C = 20A, V_{CC} = 480V$<br>$V_{GE} = 15V, R_G = 10\Omega$<br>Energy losses include "tail" |
| $t_r$        | Rise Time                         | —    | 23   | —    |       |                                                                                                                            |
| $t_{d(off)}$ | Turn-Off Delay Time               | —    | 170  | —    |       |                                                                                                                            |
| $t_f$        | Fall Time                         | —    | 124  | —    |       |                                                                                                                            |
| $E_{ts}$     | Total Switching Loss              | —    | 0.85 | —    | mJ    | See Fig. 10,11, 14                                                                                                         |
| $L_E$        | Internal Emitter Inductance       | —    | 7.5  | —    | nH    | Measured 5mm from package                                                                                                  |
| $C_{ies}$    | Input Capacitance                 | —    | 1900 | —    | pF    | $V_{GE} = 0V$<br>$V_{CC} = 30V$ See Fig. 7<br>$f = 1.0MHz$                                                                 |
| $C_{oes}$    | Output Capacitance                | —    | 140  | —    |       |                                                                                                                            |
| $C_{res}$    | Reverse Transfer Capacitance      | —    | 35   | —    |       |                                                                                                                            |

### Notes:

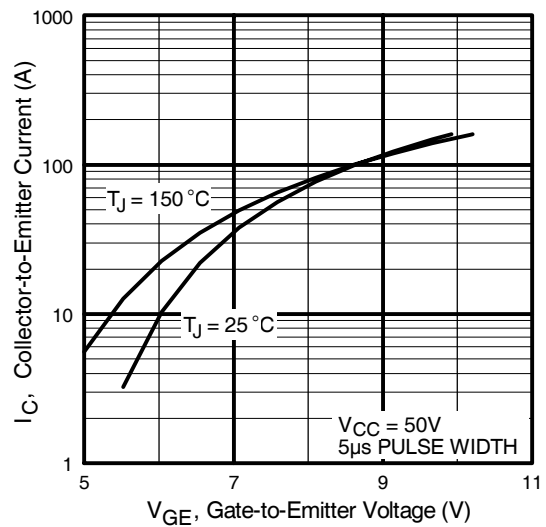
- ① Repetitive rating;  $V_{GE} = 20V$ , pulse width limited by max. junction temperature. ( See fig. 13b )
- ②  $V_{CC} = 80\%(V_{CES}), V_{GE} = 20V, L = 10\mu H, R_G = 10\Omega,$  (See fig. 13a)
- ③ Repetitive rating; pulse width limited by maximum junction temperature.
- ④ Pulse width  $\leq 80\mu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



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



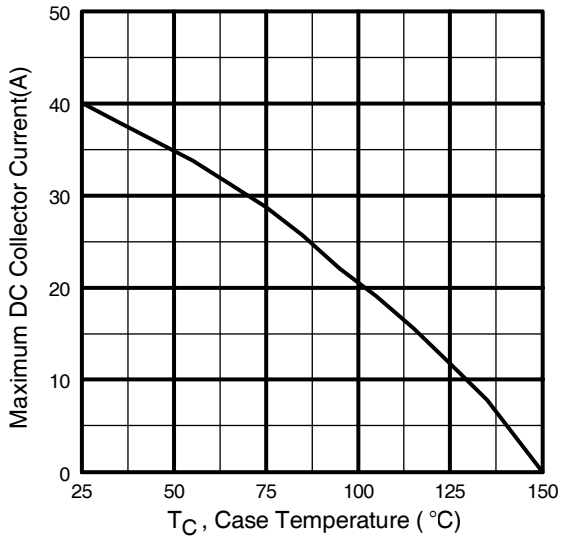
**Fig. 2 - Typical Output Characteristics**



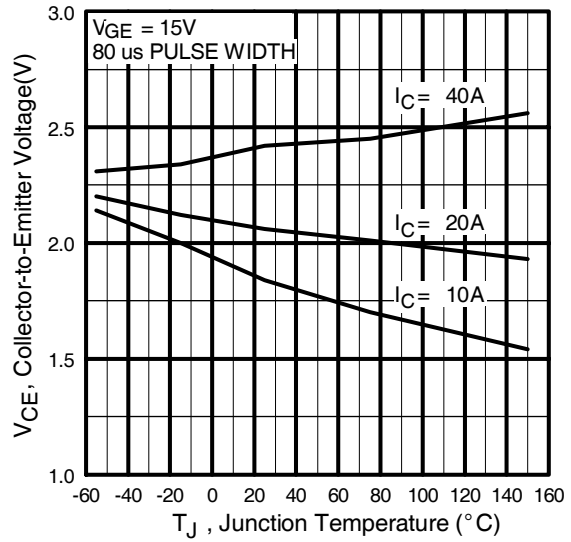
**Fig. 3 - Typical Transfer Characteristics**

# IRG4BC40WS/LPbF

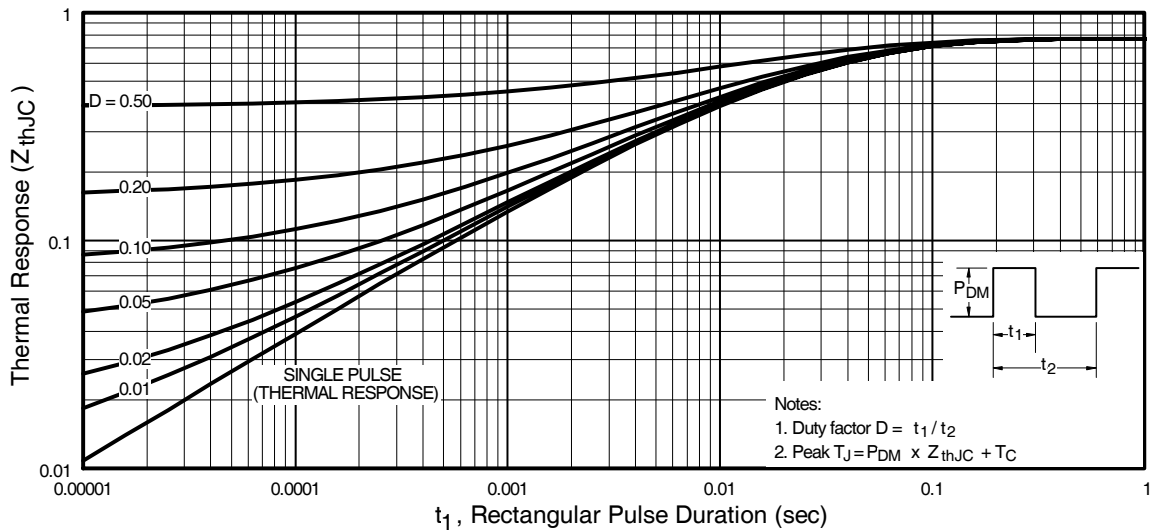
International  
**IRF** Rectifier



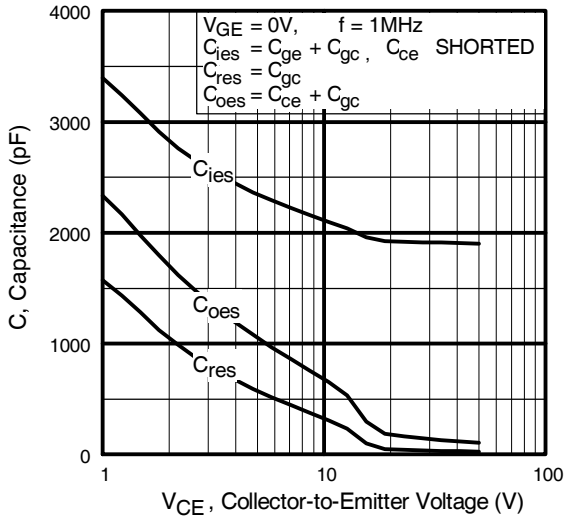
**Fig. 4** - Maximum Collector Current vs. Case Temperature



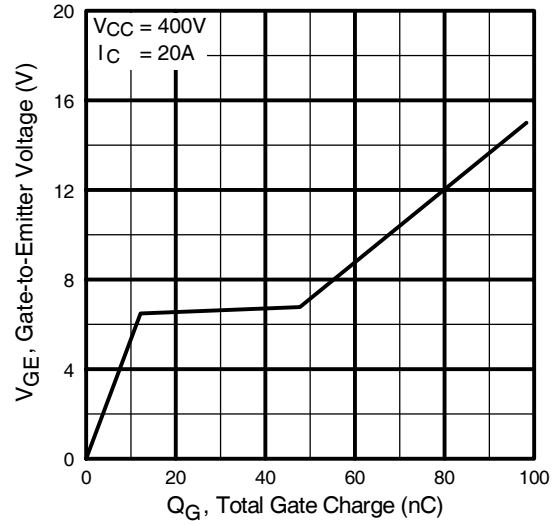
**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature



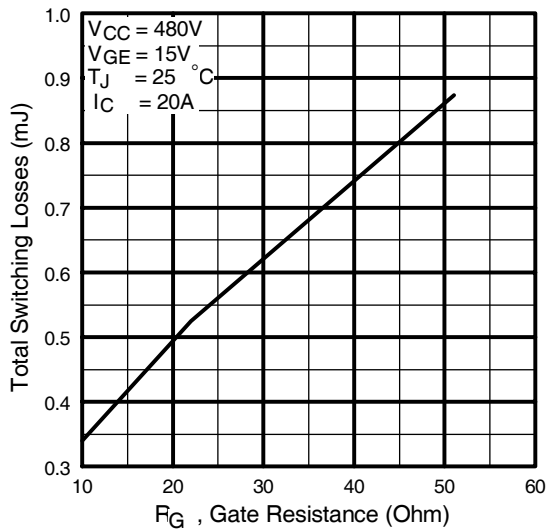
**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case



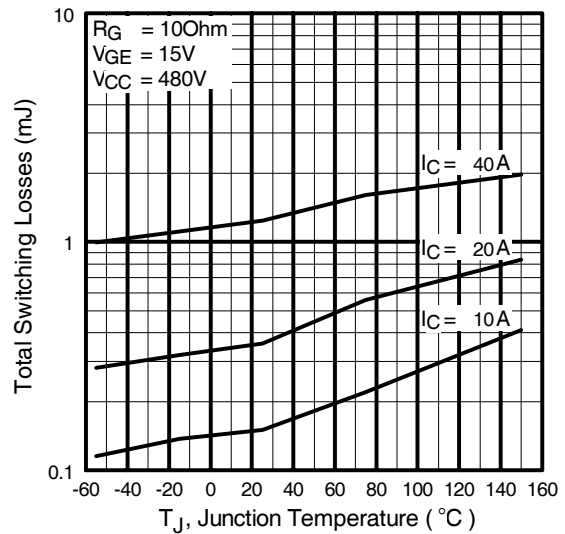
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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

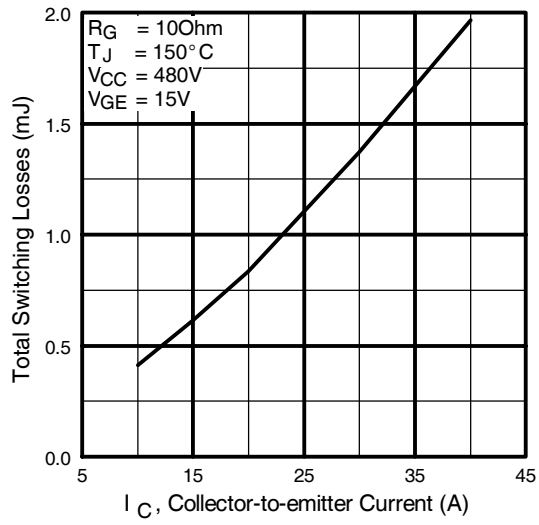


**Fig. 9** - Typical Switching Losses vs. Gate Resistance

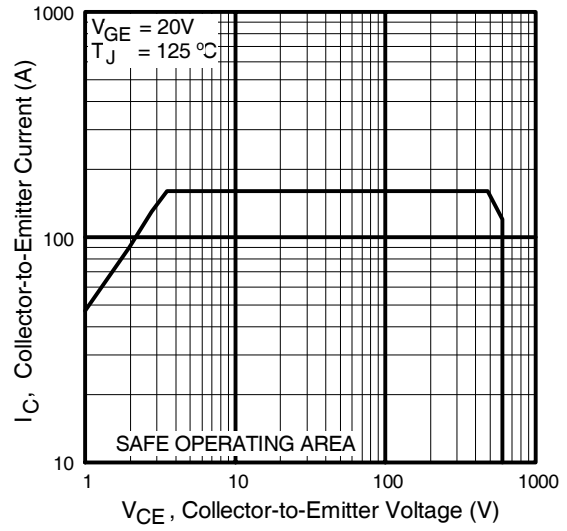


**Fig. 10** - Typical Switching Losses vs. Junction Temperature

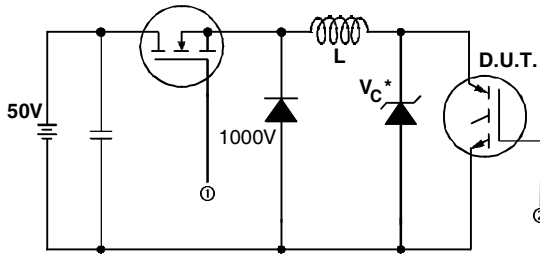
# IRG4BC40WS/LPbF



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

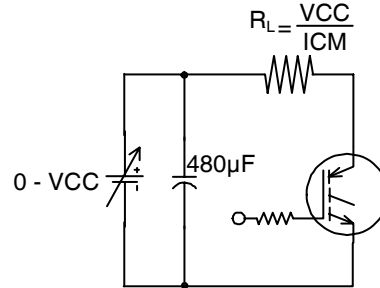


**Fig. 12** - Turn-Off SOA



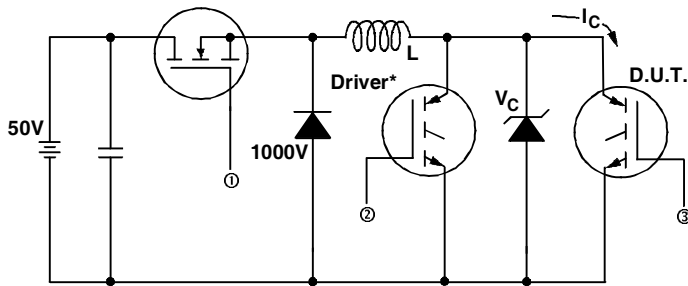
\* Driver same type as D.U.T.;  $V_c = 80\%$  of  $V_{ce(max)}$   
 \* Note: Due to the 50V power supply, pulse width and inductor will increase to obtain rated  $I_d$ .

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



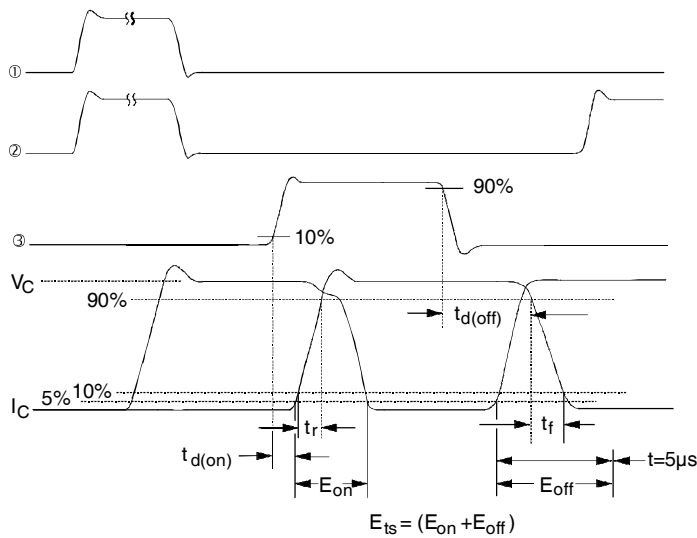
**Pulsed Collector Current Test Circuit**

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



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

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



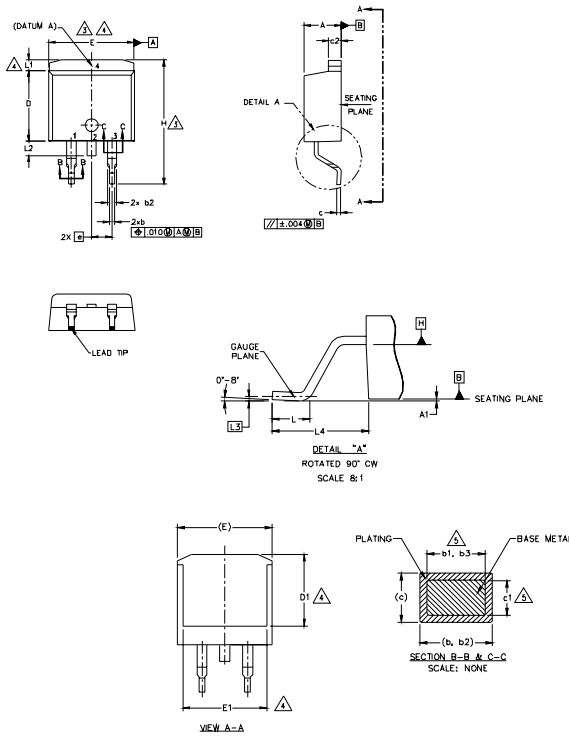
**Fig. 14b** - Switching Loss Waveforms

# IRG4BC40WS/LPbF



## D<sup>2</sup>Pak Package Outline

Dimensions are shown in millimeters (inches)



| SYMBOL | DIMENSIONS  |       |          |      | UNIT |
|--------|-------------|-------|----------|------|------|
|        | MILLIMETERS |       | INCHES   |      |      |
|        | MIN.        | MAX.  | MIN.     | MAX. |      |
| A      | 4.06        | 4.83  | .160     | .190 | 5    |
| A1     | 0.00        | 0.254 | .000     | .010 |      |
| b      | 0.51        | 0.99  | .020     | .039 | 5    |
| b1     | 0.51        | 0.89  | .020     | .035 |      |
| b2     | 1.14        | 1.78  | .045     | .070 | 5    |
| b3     | 1.14        | 1.73  | .045     | .068 |      |
| c      | 0.38        | 0.74  | .015     | .029 | 5    |
| c1     | 0.38        | 0.58  | .015     | .023 |      |
| c2     | 1.14        | 1.65  | .045     | .065 | 3    |
| D      | 8.38        | 9.65  | .330     | .380 |      |
| D1     | 6.86        | —     | .270     | —    | 4    |
| E      | 9.65        | 10.67 | .380     | .420 | 3,4  |
| E1     | 6.22        | —     | .245     | —    | 4    |
| e      | 2.54 BSC    |       | .100 BSC |      | 4    |
| H      | 14.61       | 15.88 | .575     | .625 |      |
| L      | 1.78        | 2.79  | .070     | .110 | 4    |
| L1     | —           | 1.65  | —        | .066 |      |
| L2     | —           | 1.78  | —        | .070 | 4    |
| L3     | 0.25 BSC    |       | .010 BSC |      |      |
| L4     | 4.78        | 5.28  | .188     | .208 |      |

- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
  2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES].
  3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005"] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY AT DATUM H.
  4. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
  5. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
  6. DATUM A & B TO BE DETERMINED AT DATUM PLANE H.
  7. CONTROLLING DIMENSION: INCH.
  8. OUTLINE CONFORMS TO JEDEC OUTLINE TO-263AB.

### LEAD ASSIGNMENTS

#### DIODES

- 1.- ANODE (TWO DIE) / OPEN (ONE DIE)
- 2, 4.- CATHODE
- 3.- ANODE

#### HEXFET

- 1.- GATE
- 2, 4.- DRAIN
- 3.- SOURCE

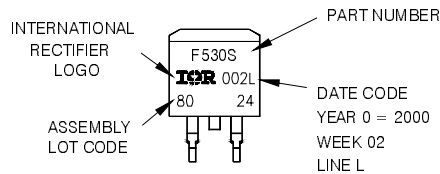
#### IGBTs, CoPACK

- 1.- GATE
- 2, 4.- COLLECTOR
- 3.- EMITTER

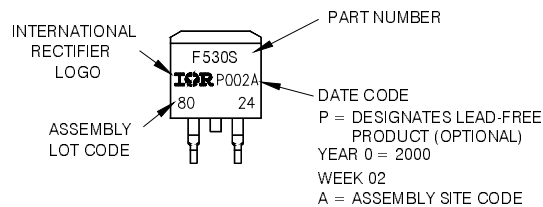
## D<sup>2</sup>Pak Part Marking Information

EXAMPLE: THIS IS AN IRF530S WITH LOT CODE 8024 ASSEMBLED ON WW 02, 2000 IN THE ASSEMBLY LINE 'L'

Note: 'P' in assembly line position indicates 'Lead-Free'



OR

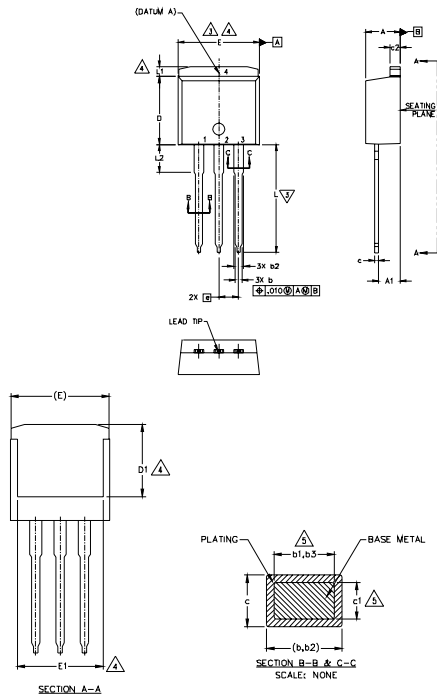


Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/pkigt.html>



## TO-262 Package Outline

Dimensions are shown in millimeters (inches)



| SYMBOL | DIMENSIONS  |       |          |      | NOTES |
|--------|-------------|-------|----------|------|-------|
|        | MILLIMETERS |       | INCHES   |      |       |
|        | MIN.        | MAX.  | MIN.     | MAX. |       |
| A      | 4.06        | 4.83  | .160     | .190 | 5     |
| A1     | 2.03        | 3.02  | .080     | .119 |       |
| b      | 0.51        | 0.99  | .020     | .039 | 5     |
| b1     | 0.51        | 0.89  | .020     | .035 |       |
| b2     | 1.14        | 1.78  | .045     | .070 | 5     |
| b3     | 1.14        | 1.73  | .045     | .068 |       |
| c      | 0.38        | 0.74  | .015     | .029 | 5     |
| c1     | 0.38        | 0.58  | .015     | .023 |       |
| c2     | 1.14        | 1.65  | .045     | .065 | 3     |
| D      | 8.38        | 9.65  | .330     | .380 |       |
| D1     | 6.86        | -     | .270     | -    | 4     |
| E      | 9.65        | 10.67 | .380     | .420 | 3,4   |
| E1     | 6.22        | -     | .245     | -    | 4     |
| e      | 2.54 BSC    |       | .100 BSC |      | 4     |
| L      | 13.46       | 14.10 | .530     | .555 |       |
| L1     | -           | 1.65  | -        | .065 |       |
| L2     | 3.56        | 3.71  | .140     | .146 |       |

- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994
  2. DIMENSIONS ARE SHOWN IN MILLIMETERS [INCHES]
  3. DIMENSION D & E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.127 [0.005] PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTMOST EXTREMES OF THE PLASTIC BODY.
  4. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSION E, L1, D1 & E1.
  5. DIMENSION b1 AND c1 APPLY TO BASE METAL ONLY.
  6. CONTROLLING DIMENSION: INCH
  7. OUTLINE CONFORM TO JEDEC TO-262 EXCEPT A1(max.), b1(min.), AND D1(min.) WHERE DIMENSIONS DERIVED THE ACTUAL PACKAGE OUTLINE.

LEAD ASSIGNMENTS

IGBTs - G3PACK

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

HEXFET

- 1- GATE
- 2- DRAIN
- 3- SOURCE
- 4- DRAIN

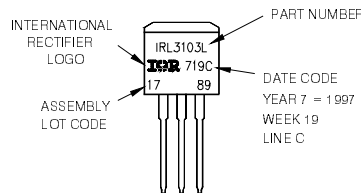
DIODES

- 1- ANODE (NO DI) / OPEN (NO DI)
- 2, 4- CATHODE
- 3- ANODE

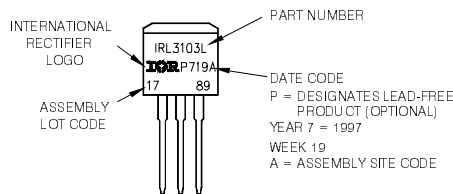
## TO-262 Part Marking Information

EXAMPLE: THIS IS AN IRL3103L  
LOT CODE E 17 89  
ASSEMBLED ON WW 19, 1997  
IN THE ASSEMBLY LINE 'C'

Note: 'P' in assembly line position indicates 'Lead-Free'



OR



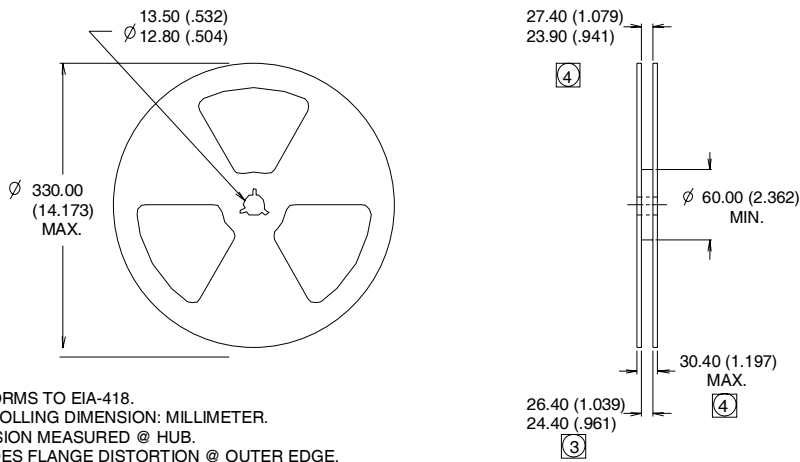
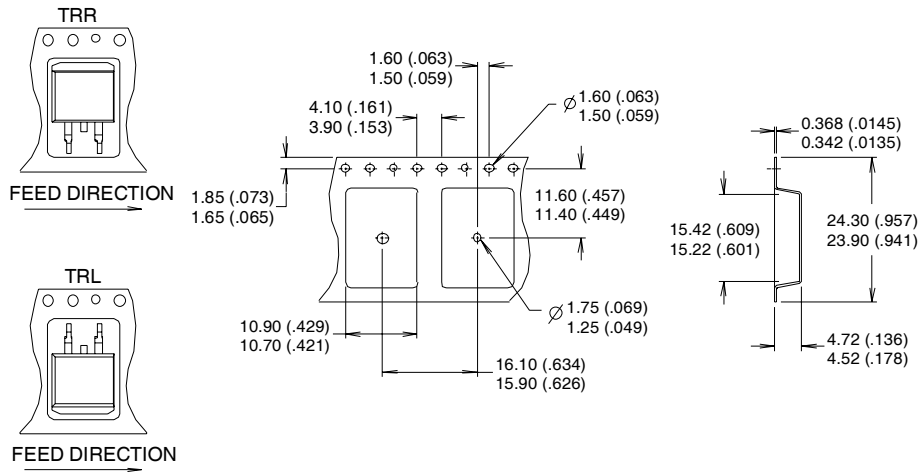
Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/pkigt.html>

# IRG4BC40WS/LPbF

International  
**IR** Rectifier

## D<sup>2</sup>Pak Tape & Reel Information

Dimensions are shown in millimeters (inches)



Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/pkigt.html>

International  
**IR** Rectifier

IR WORLD HEADQUARTERS: 233 Kansas St., El Segundo, California 90245, USA Tel: (310) 252-7105  
TAC Fax: (310) 252-7903

Visit us at [www.irf.com](http://www.irf.com) for sales contact information. 02/2010