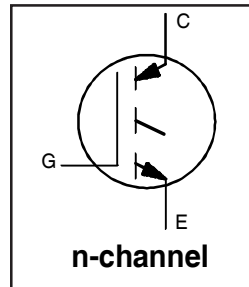


## IRG4BC40WSPbF IRG4BC40WLPbF

### INSULATED GATE BIPOLAR TRANSISTOR

#### Features

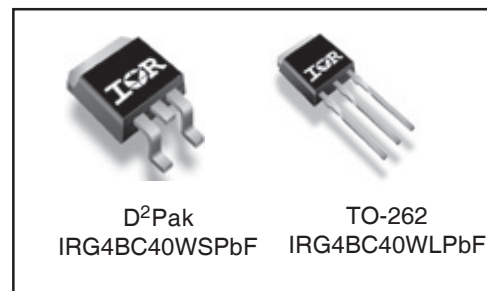
- Designed expressly for Switch-Mode Power Supply and PFC (power factor correction) applications
- Industry-benchmark switching losses improve efficiency of all power supply topologies
- 50% reduction of Eoff parameter
- Low IGBT conduction losses
- Latest-generation IGBT design and construction offers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

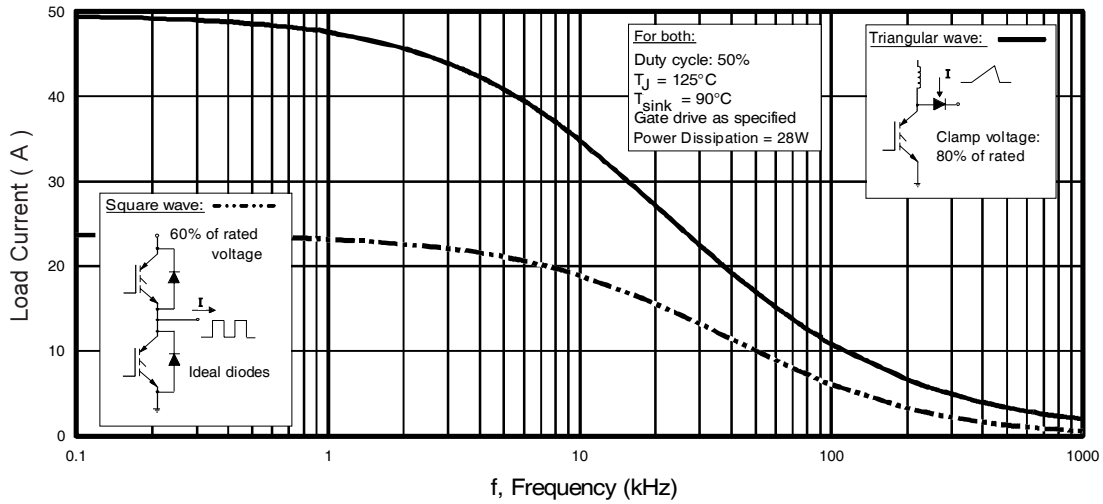
	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	$V_{GE} = 0V, I_C = 250\mu A$
$V_{(BR)ECS}$	Emitter-to-Collector Breakdown Voltage ④	18	—	—	V	$V_{GE} = 0V, I_C = 1.0A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.44	—	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)

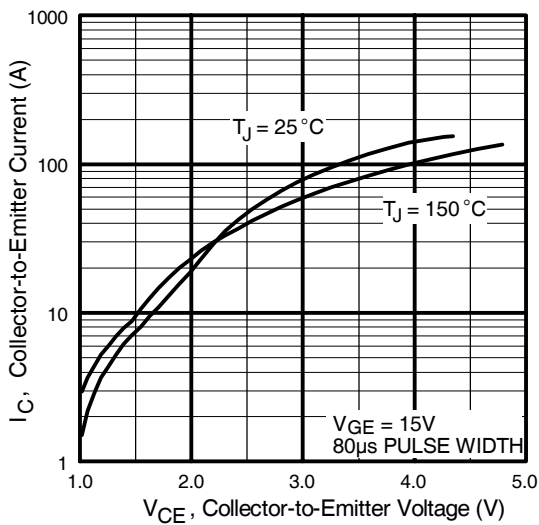
	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge (turn-on)	—	98	147	nC	$I_C = 20A$
$Q_{ge}$	Gate - Emitter Charge (turn-on)	—	12	18		$V_{CC} = 400V$ See Fig.8
$Q_{gc}$	Gate - Collector Charge (turn-on)	—	36	54		$V_{GE} = 15V$
$t_{d(on)}$	Turn-On Delay Time	—	27	—	ns	$T_J = 25^\circ\text{C}$ $I_C = 20A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 10\Omega$ Energy losses include "tail" 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	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	$T_J = 150^\circ\text{C},$ $I_C = 20A, V_{CC} = 480V$ $V_{GE} = 15V, R_G = 10\Omega$ Energy losses include "tail" 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	$V_{GE} = 0V$ $V_{CC} = 30V$ See Fig. 7 $f = 1.0MHz$
$C_{oes}$	Output Capacitance	—	140	—		
$C_{res}$	Reverse Transfer Capacitance	—	35	—		

### Notes:

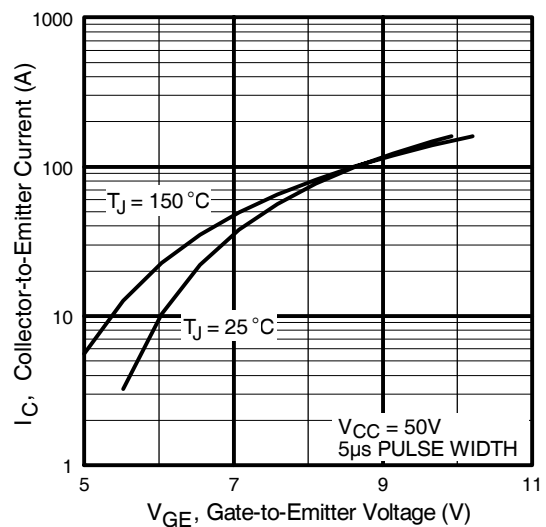
- ① Repetitive rating;  $V_{GE} = 20V$ , pulse width limited by max. junction temperature. ( See fig. 13b )
- ②  $V_{CC} = 80\%(V_{CES}), V_{GE} = 20V, L = 10\mu H, R_G = 10\Omega,$  (See fig. 13a)
- ③ Repetitive rating; pulse width limited by maximum junction temperature.
- ④ Pulse width  $\leq 80\mu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

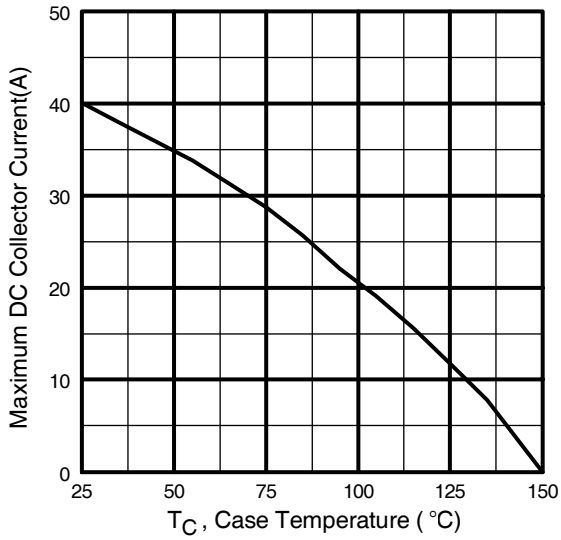


**Fig. 2 - Typical Output Characteristics**

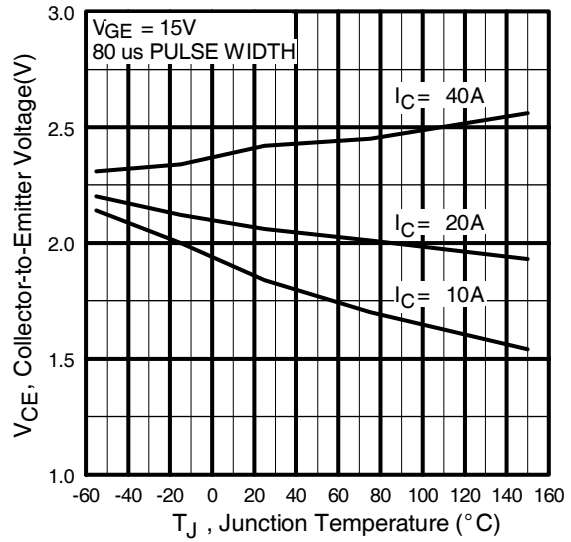


**Fig. 3 - Typical Transfer Characteristics**

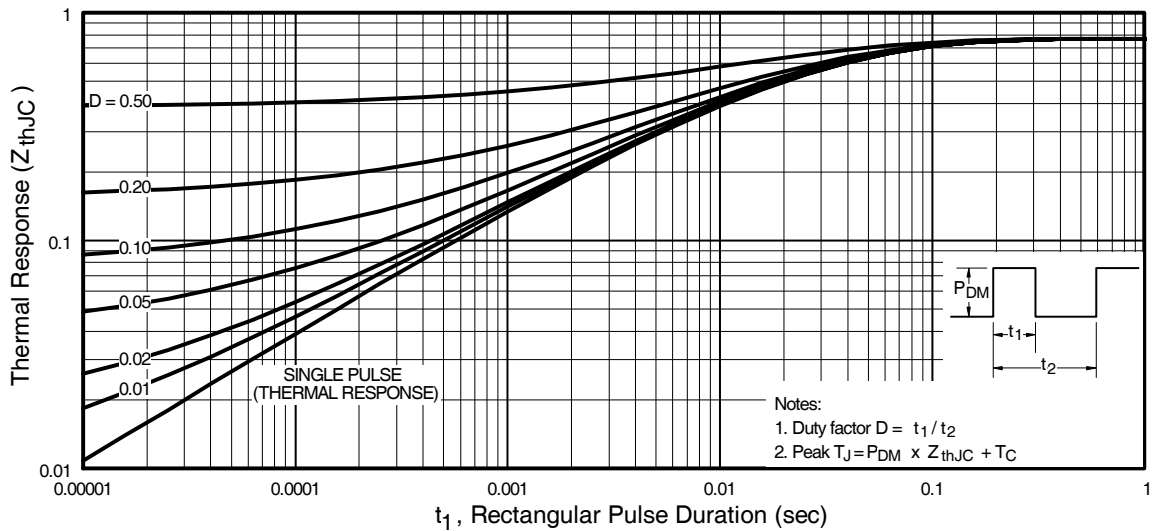
# IRG4BC40WS/LPbF



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

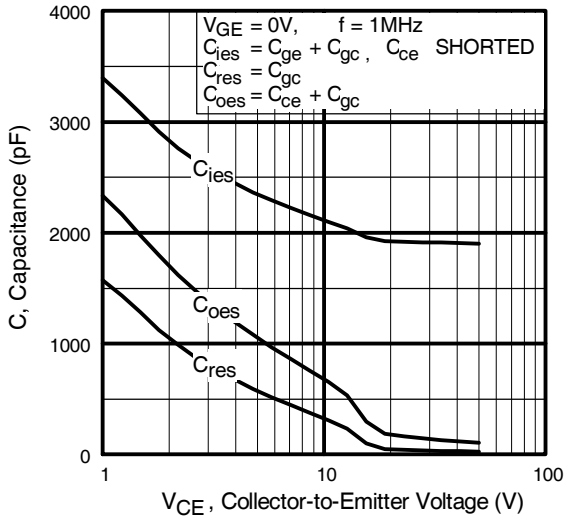


**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature

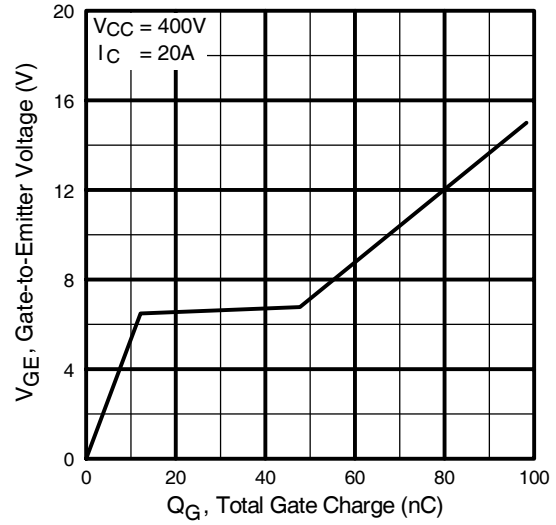


**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case

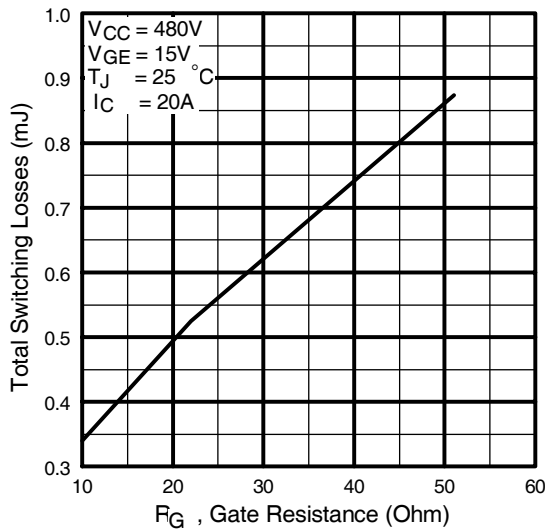
# IRG4BC40WS/LPbF



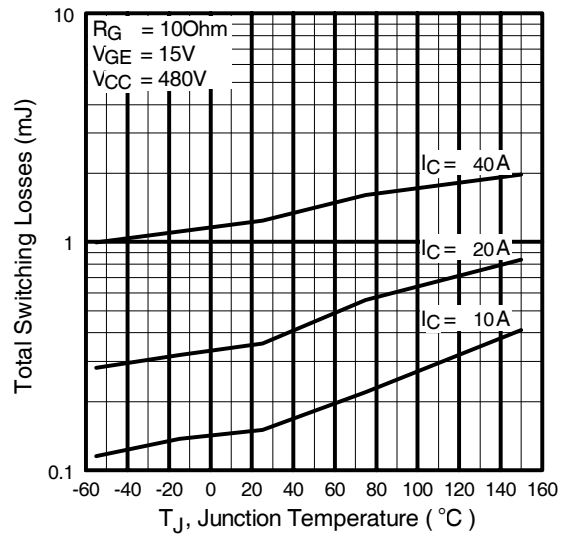
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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

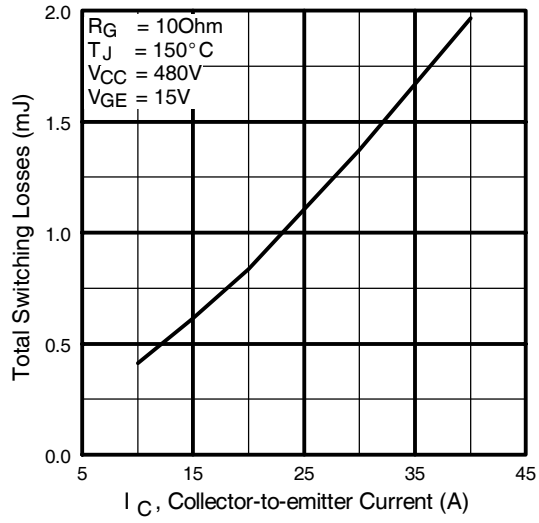


**Fig. 9** - Typical Switching Losses vs. Gate Resistance

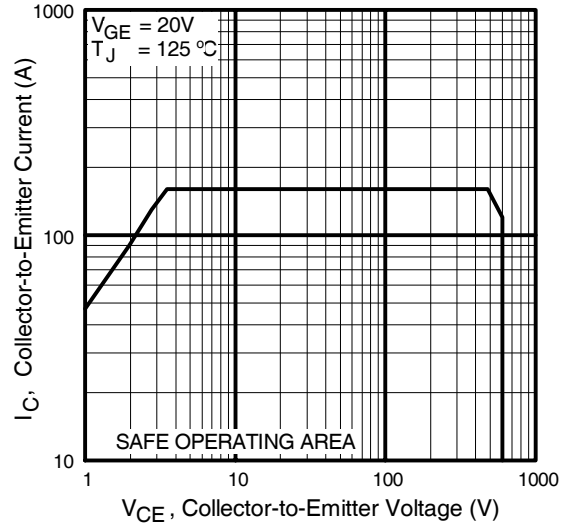


**Fig. 10** - Typical Switching Losses vs. Junction Temperature

# IRG4BC40WS/LPbF

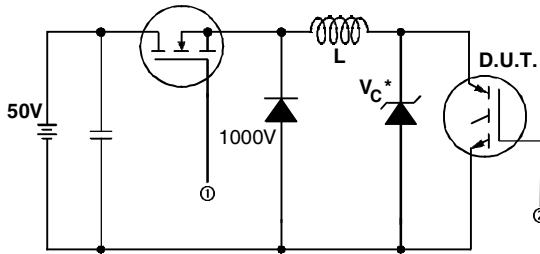


**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current



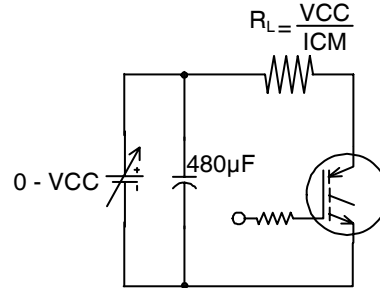
**Fig. 12** - Turn-Off SOA

# IRG4BC40WS/LPbF



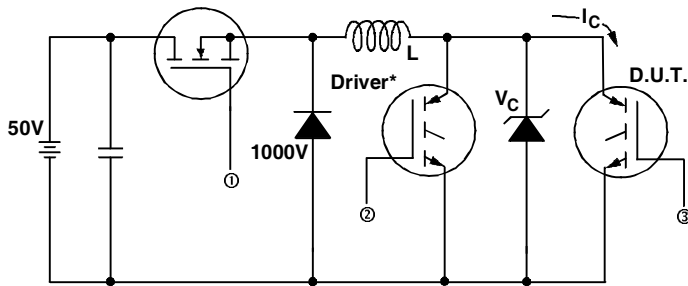
\* Driver same type as D.U.T.;  $V_c = 80\%$  of  $V_{ce(max)}$   
 \* Note: Due to the 50V power supply, pulse width and inductor will increase to obtain rated  $I_d$ .

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



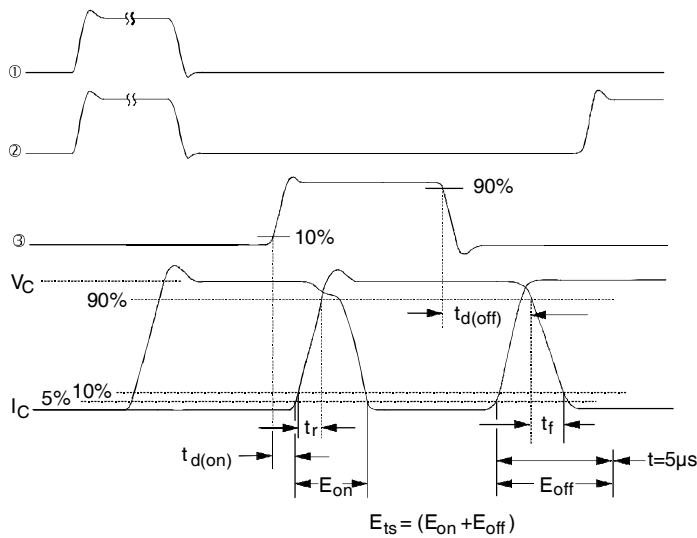
**Pulsed Collector Current Test Circuit**

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



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

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



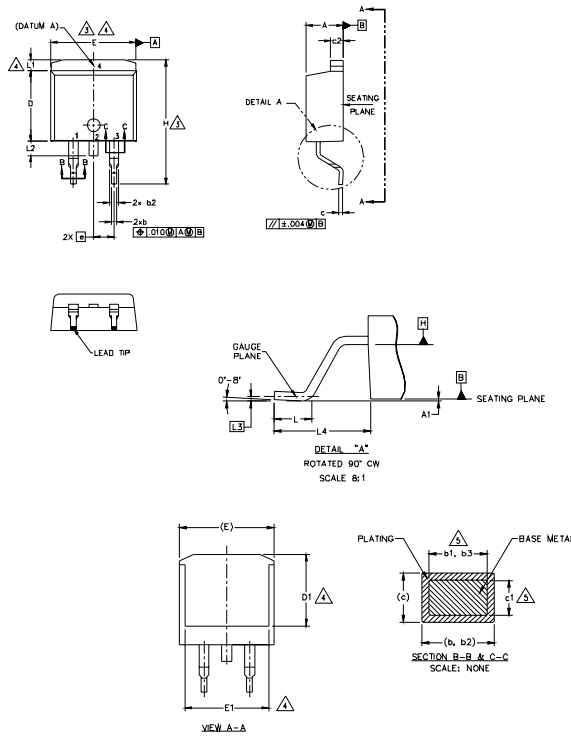
**Fig. 14b** - Switching Loss Waveforms

# 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

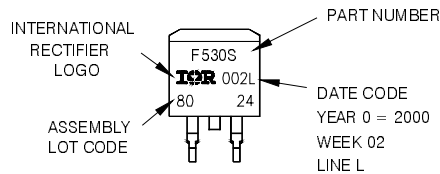
#### IGBTs, CoPACK

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

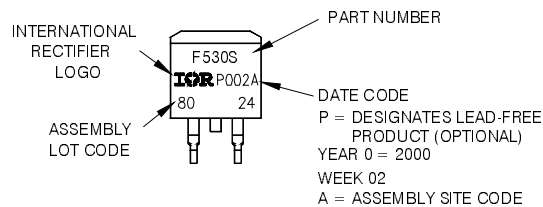
## D<sup>2</sup>Pak Part Marking Information

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

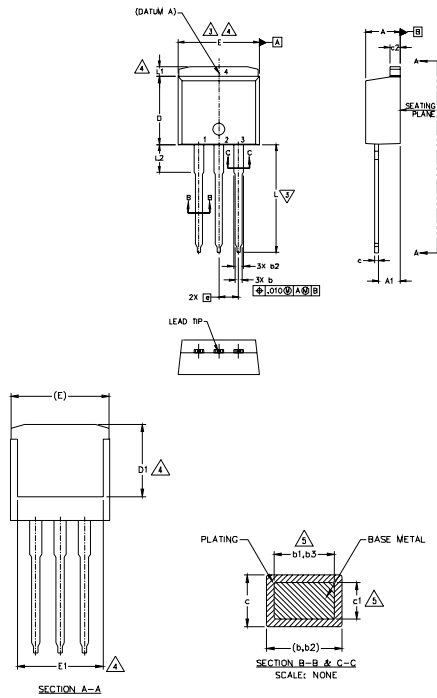


Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/pkigt.html>



## 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 - CoPACK

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

HEXFET

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

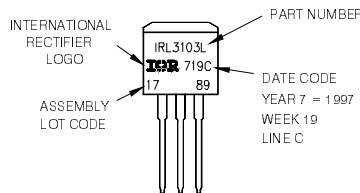
DIODES

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

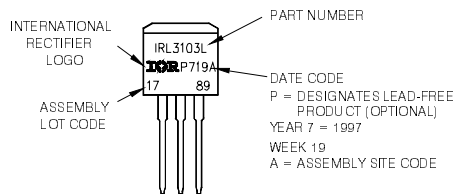
## TO-262 Part Marking Information

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



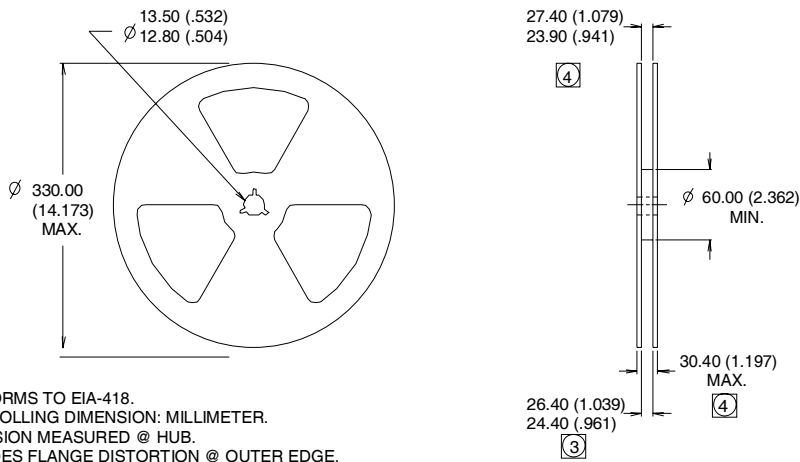
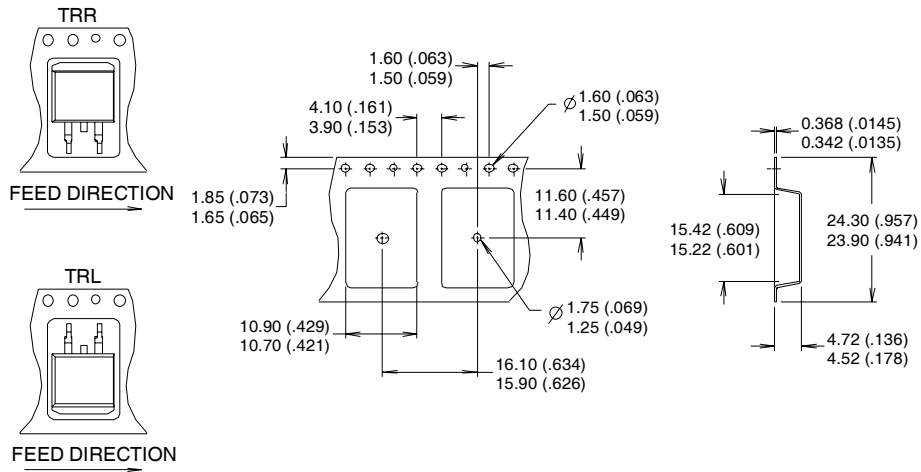
Note: For the most current drawing please refer to IR website at <http://www.irf.com/package/pkigt.html>

# 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

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