

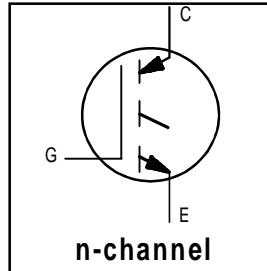
# IRG4PH50K

## INSULATED GATE BIPOLAR TRANSISTOR

Short Circuit Rated  
UltraFast IGBT

### Features

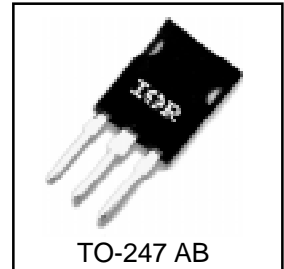
- High short circuit rating optimized for motor control,  $t_{sc} = 10\mu s$ ,  $V_{CC} = 720V$ ,  $T_J = 125^\circ C$ ,  $V_{GE} = 15V$
- Combines low conduction losses with high switching speed
- Latest generation design provides tighter parameter distribution and higher efficiency than previous generations



$V_{CES} = 1200V$
$V_{CE(on) typ.} = 2.77V$
@ $V_{GE} = 15V$ , $I_C = 24A$

### Benefits

- As a Freewheeling Diode we recommend our HEXFRED™ ultrafast, ultrasoft recovery diodes for minimum EMI/Noise and switching losses in the Diode and IGBT
- Latest generation 4 IGBTs offer highest power density motor controls possible
- This part replaces the IRGPH50K and IRGPH50M devices



TO-247 AB

### Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	1200	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	45	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	24	
$I_{CM}$	Pulsed Collector Current ①	90	
$I_{LM}$	Clamped Inductive Load Current ②	90	
$t_{sc}$	Short Circuit Withstand Time	10	$\mu s$
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	V
$E_{ARV}$	Reverse Voltage Avalanche Energy ③	190	mJ
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	200	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	78	
$T_J$	Operating Junction and Storage Temperature Range	-55 to +150	$^\circ C$
$T_{STG}$			
	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	—	0.64	$^\circ C/W$
$R_{\theta CS}$	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)

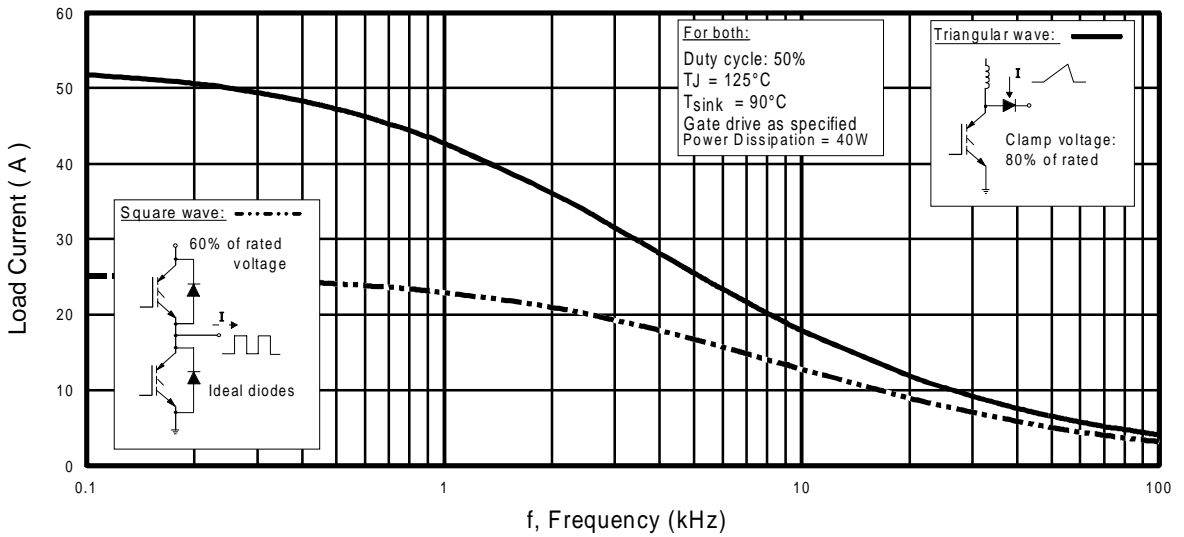
	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	1200	—	—	V	$V_{GE} = 0V, I_C = 250\mu A$
$V_{(BR)ECS}$	Emitter-to-Collector Breakdown Voltage	18	—	—	V	$V_{GE} = 0V, I_C = 1.0A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.91	—	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 2.0mA$
$V_{CE(ON)}$	Collector-to-Emitter Saturation Voltage	—	2.77	3.5	V	$I_C = 24A, V_{GE} = 15V$
		—	3.28	—		$I_C = 45A$ see figures 2, 5
		—	2.54	—		$I_C = 24A, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	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	—	-10	—	mV/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 2.0mA$
$g_{fe}$	Forward Transconductance	13	19	—	S	$V_{CE} = 100V, I_C = 24A$
$I_{CES}$	Zero Gate Voltage Collector Current	—	—	250	$\mu A$	$V_{GE} = 0V, V_{CE} = 1200V$
		—	—	2.0		$V_{GE} = 0V, V_{CE} = 10V, T_J = 25^\circ\text{C}$
		—	—	5000		$V_{GE} = 0V, V_{CE} = 1200V, T_J = 150^\circ\text{C}$
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{GE} = \pm 20V$

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

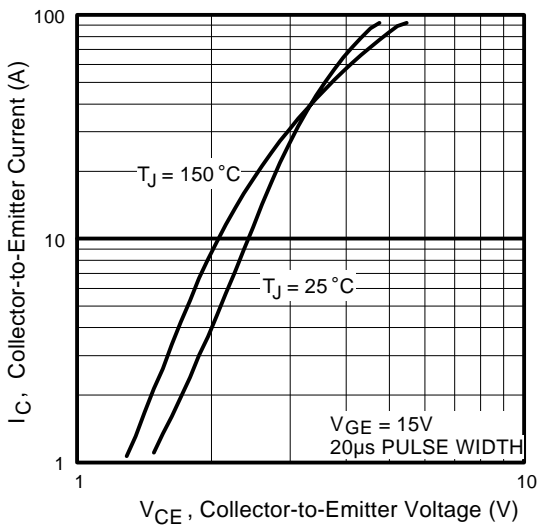
	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge (turn-on)	—	180	270	nC	$I_C = 24A$
$Q_{ge}$	Gate - Emitter Charge (turn-on)	—	25	38		$V_{CC} = 400V$ see figure 8
$Q_{gc}$	Gate - Collector Charge (turn-on)	—	70	110		$V_{GE} = 15V$
$t_{d(on)}$	Turn-On Delay Time	—	36	—	ns	$T_J = 25^\circ\text{C}$ $I_C = 24A, V_{CC} = 960V$ $V_{GE} = 15V, R_G = 5.0\Omega$
$t_r$	Rise Time	—	27	—		
$t_{d(off)}$	Turn-Off Delay Time	—	200	300		
$t_f$	Fall Time	—	130	190		
$E_{on}$	Turn-On Switching Loss	—	1.21	—	mJ	Energy losses include "tail" see figures 9,10,14
$E_{off}$	Turn-Off Switching Loss	—	2.25	—		
$E_{ts}$	Total Switching Loss	—	3.46	4.1		
$t_{sc}$	Short Circuit Withstand Time	10	—	—	$\mu s$	$V_{CC} = 720V, T_J = 125^\circ\text{C}$ $V_{GE} = 15V, R_G = 5.0\Omega$
$t_{d(on)}$	Turn-On Delay Time	—	35	—	ns	$T_J = 150^\circ\text{C}$ , $I_C = 24A, V_{CC} = 960V$ $V_{GE} = 15V, R_G = 5.0\Omega$ Energy losses include "tail" see figures 10,11,14
$t_r$	Rise Time	—	29	—		
$t_{d(off)}$	Turn-Off Delay Time	—	380	—		
$t_f$	Fall Time	—	280	—		
$E_{ts}$	Total Switching Loss	—	7.80	—	mJ	
$L_E$	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package
$C_{ies}$	Input Capacitance	—	2800	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ see figure 7 $f = 1.0MHz$
$C_{oes}$	Output Capacitance	—	140	—		
$C_{res}$	Reverse Transfer Capacitance	—	53	—		

### Notes:

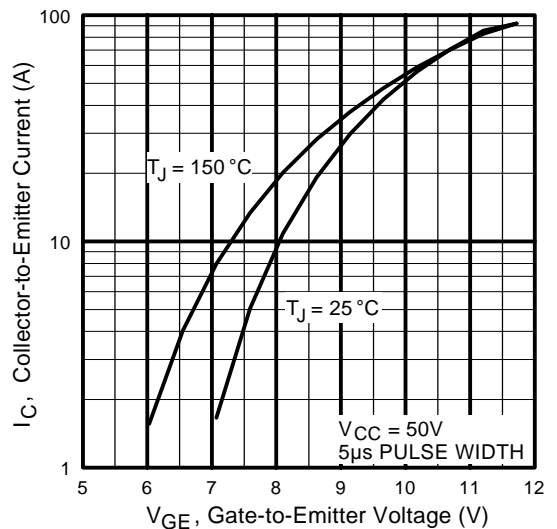
- ① Repetitive rating;  $V_{GE} = 20V$ , pulse width limited by max. junction temperature. (see figure 13b)
- ②  $V_{CC} = 80\% (V_{CES})$ ,  $V_{GE} = 20V$ ,  $L = 10\mu H$ ,  $R_G = 5.0\Omega$ , (see figure 13a)
- ③ Repetitive rating; pulse width limited by maximum junction temperature.
- ④ Pulse width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

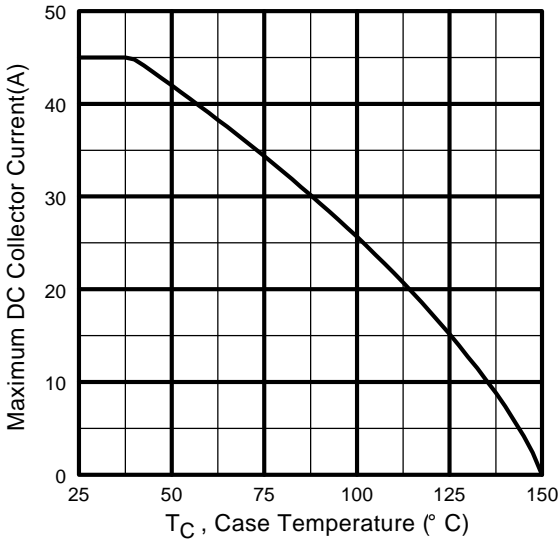


Fig. 4 - Maximum Collector Current vs. Case Temperature

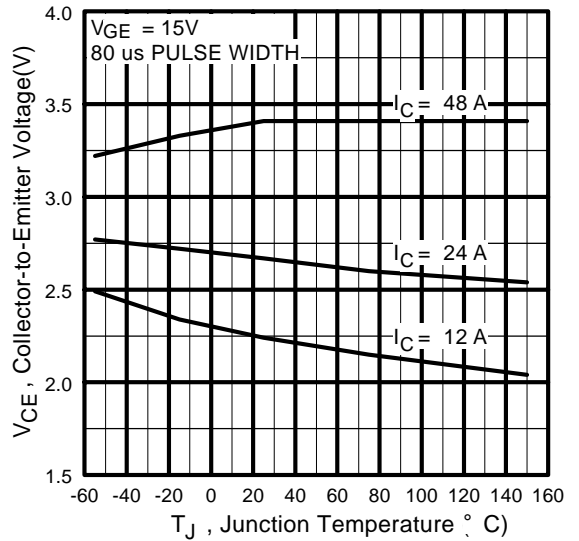


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

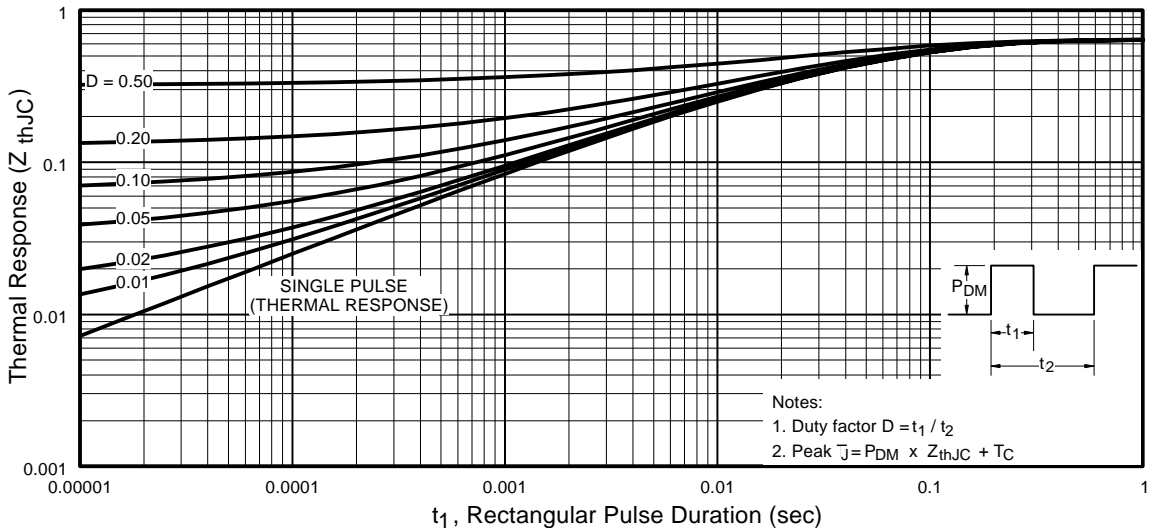
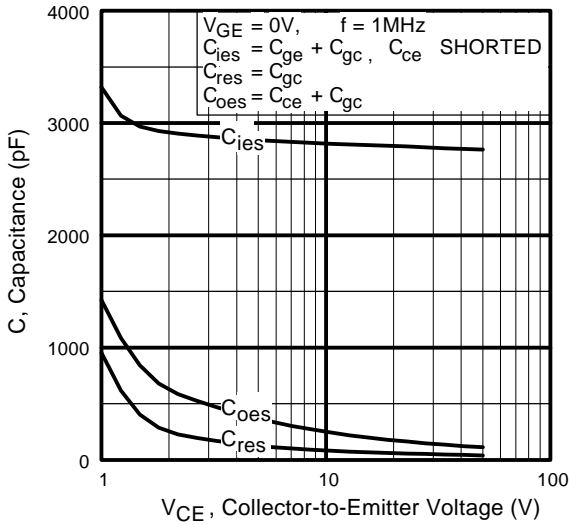
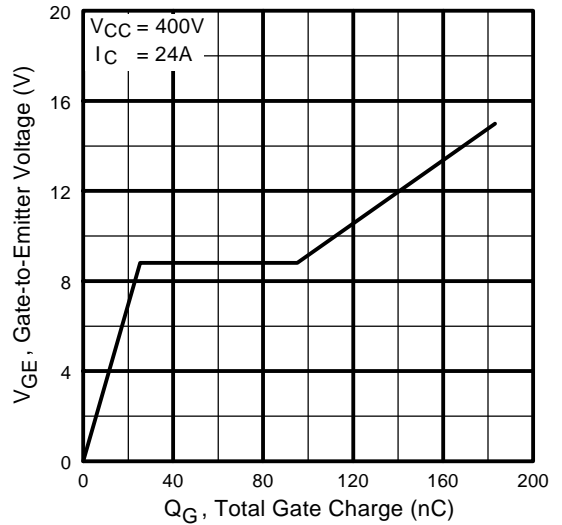


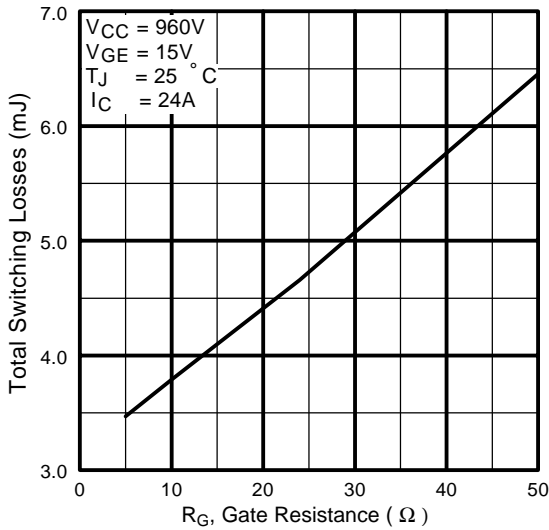
Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case



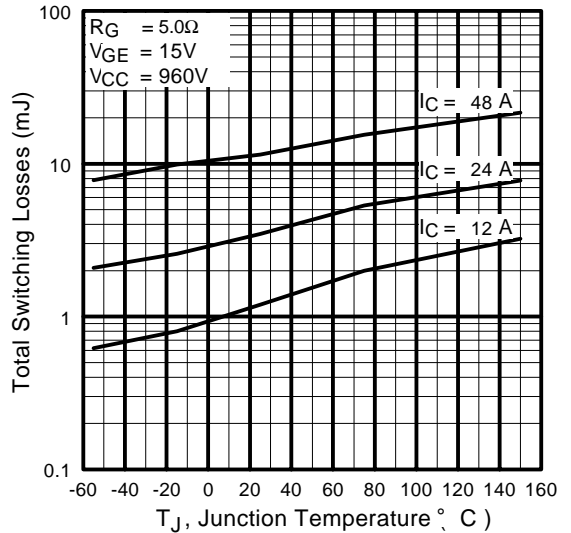
**Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage**



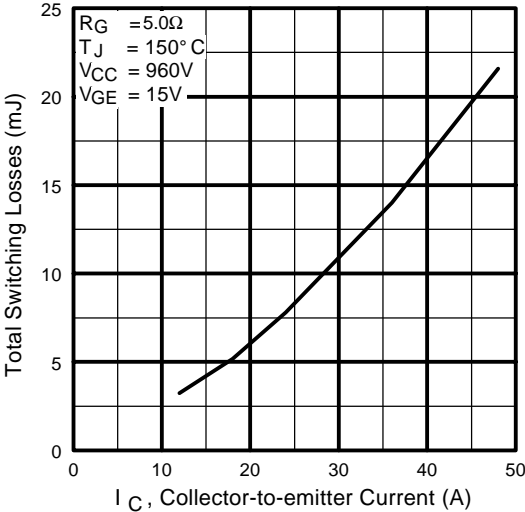
**Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage**



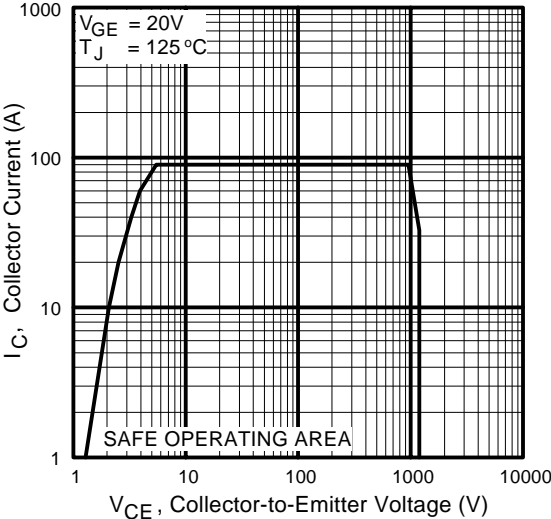
**Fig. 9 - Typical Switching Losses vs. Gate Resistance**



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



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



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