

# International Rectifier

PD - 9.782A

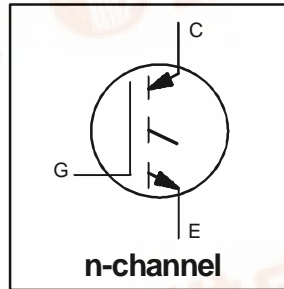
## IRGB440U

INSULATED GATE BIPOLAR TRANSISTOR

UltraFast IGBT

### Features

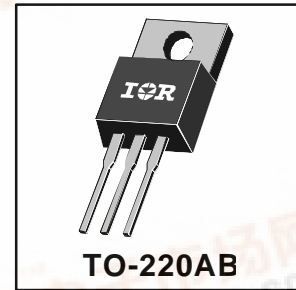
- Switching-loss rating includes all "tail" losses
- Optimized for high operating frequency (over 5kHz)  
See Fig. 1 for Current vs. Frequency curve



$V_{CES} = 500V$
$V_{CE(sat)} \leq 3.0V$
@ $V_{GE} = 15V, I_C = 22A$

### 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.



### Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	500	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	40	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	22	
$I_{CM}$	Pulsed Collector Current ①	80	
$I_{LM}$	Clamped Inductive Load Current ②	80	
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	V
$E_{ARV}$	Reverse Voltage Avalanche Energy ③	15	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 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	—	—	0.77	°C/W
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	—	0.50	—	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	—	—	80	
Wt	Weight	—	2.0 (0.07)	—	g (oz)



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

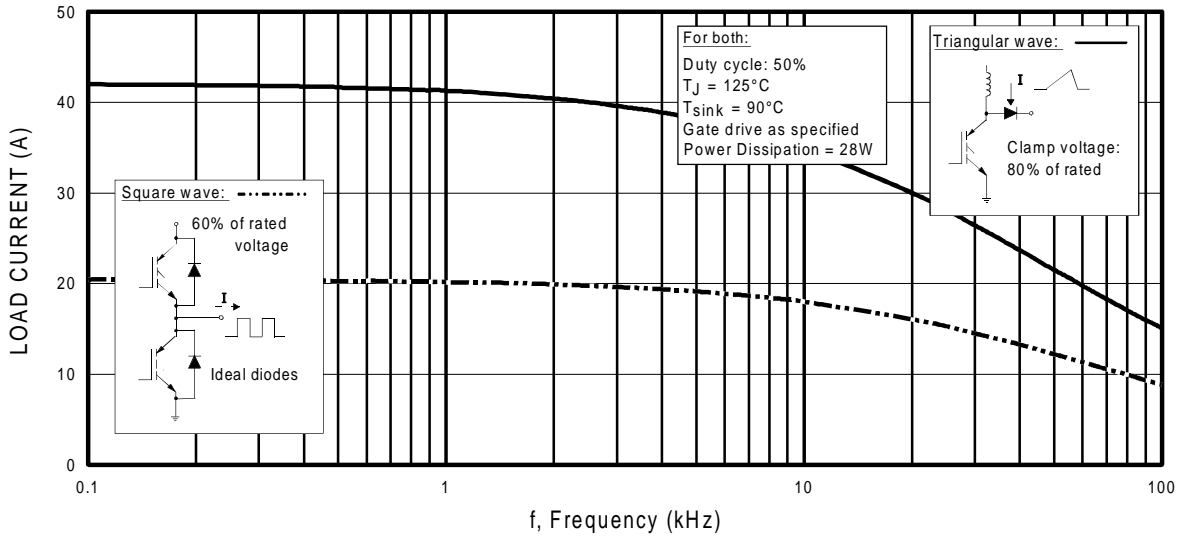
	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	500	—	—	V	$V_{GE} = 0V, I_C = 250\mu A$
$V_{(BR)ECS}$	Emitter-to-Collector Breakdown Voltage ④	20	—	—	V	$V_{GE} = 0V, I_C = 1.0A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.35	—	$V/^\circ\text{C}$	$V_{GE} = 0V, I_C = 1.0mA$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	2.4	3.0	V	$I_C = 22A$
		—	2.8	—		$I_C = 40A$
		—	2.4	—		$I_C = 22A, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	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	6.6	13	—	S	$V_{CE} = 100V, I_C = 22A$
$I_{CES}$	Zero Gate Voltage Collector Current	—	—	250	$\mu A$	$V_{GE} = 0V, V_{CE} = 220V$
		—	—	1000		$V_{GE} = 0V, V_{CE} = 500V, T_J = 150^\circ\text{C}$
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{GE} = \pm 20V$

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

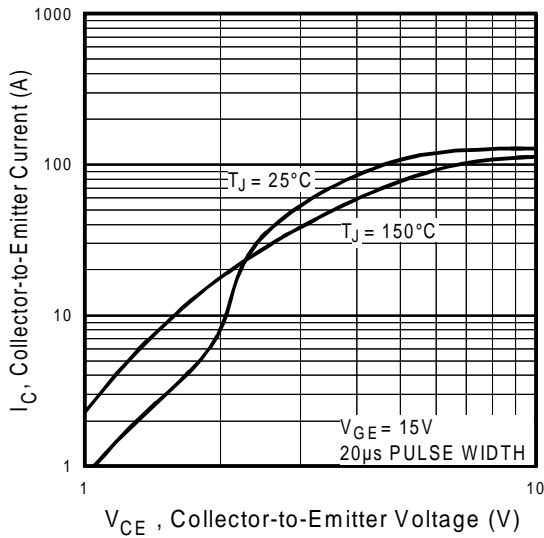
	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge (turn-on)	—	55	83	nC	$I_C = 22A$
$Q_{ge}$	Gate - Emitter Charge (turn-on)	—	11	17		$V_{CC} = 400V$
$Q_{gc}$	Gate - Collector Charge (turn-on)	—	19	29		$V_{GE} = 15V$
$t_{d(on)}$	Turn-On Delay Time	—	27	—	ns	$T_J = 25^\circ\text{C}$
$t_r$	Rise Time	—	13	—		$I_C = 22A, V_{CC} = 400V$
$t_{d(off)}$	Turn-Off Delay Time	—	100	150		$V_{GE} = 15V, R_G = 10\Omega$
$t_f$	Fall Time	—	56	100		Energy losses include "tail"
$E_{on}$	Turn-On Switching Loss	—	0.37	—	mJ	See Fig. 9, 10, 11, 14
$E_{off}$	Turn-Off Switching Loss	—	0.18	—		
$E_{ts}$	Total Switching Loss	—	0.55	0.70		
$t_{d(on)}$	Turn-On Delay Time	—	27	—	ns	$T_J = 150^\circ\text{C}$ ,
$t_r$	Rise Time	—	15	—		$I_C = 22A, V_{CC} = 400V$
$t_{d(off)}$	Turn-Off Delay Time	—	137	—		$V_{GE} = 15V, R_G = 10\Omega$
$t_f$	Fall Time	—	100	—		Energy losses include "tail"
$E_{ts}$	Total Switching Loss	—	0.96	—	mJ	See Fig. 10, 14
$L_E$	Internal Emitter Inductance	—	7.5	—	nH	Measured 5mm from package
$C_{ies}$	Input Capacitance	—	1400	—	pF	$V_{GE} = 0V$
$C_{oes}$	Output Capacitance	—	250	—		$V_{CC} = 30V$
$C_{res}$	Reverse Transfer Capacitance	—	42	—		$f = 1.0MHz$

**Notes:**

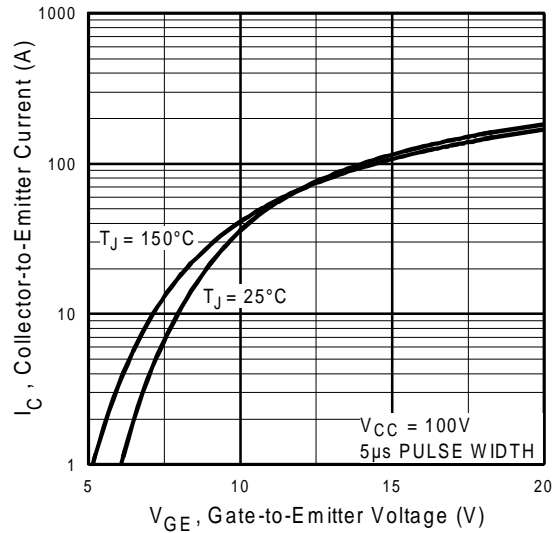
- ① Repetitive rating;  $V_{GE}=20V$ , pulse width limited by max. junction temperature. ( See fig. 13b )
- ②  $V_{CC}=80\%(V_{CES}), V_{GE}=20V, L=10\mu H, R_G=10\Omega$ , ( See fig. 13a )
- ③ Repetitive rating; pulse width limited by maximum junction temperature.
- ④ Pulse width  $\leq 80\mu s$ ; duty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



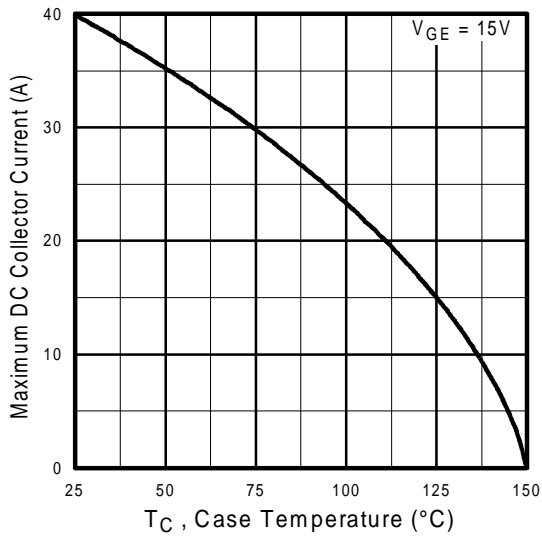
**Fig. 1 - Typical Load Current vs. Frequency**  
 (For square wave,  $I = I_{RMS}$  of fundamental; for triangular wave,  $I = I_{PK}$ )



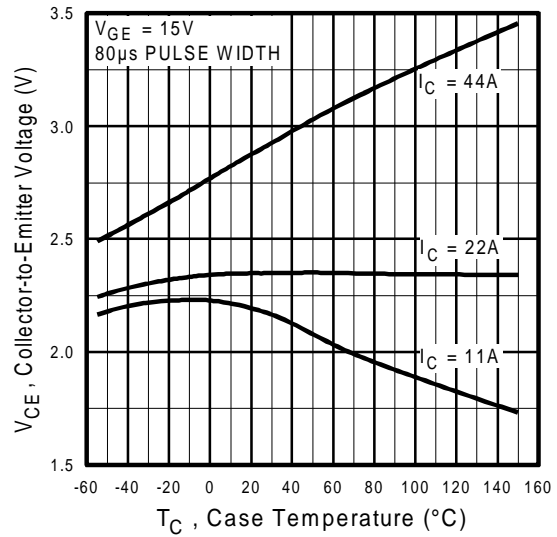
**Fig. 2 - Typical Output Characteristics**



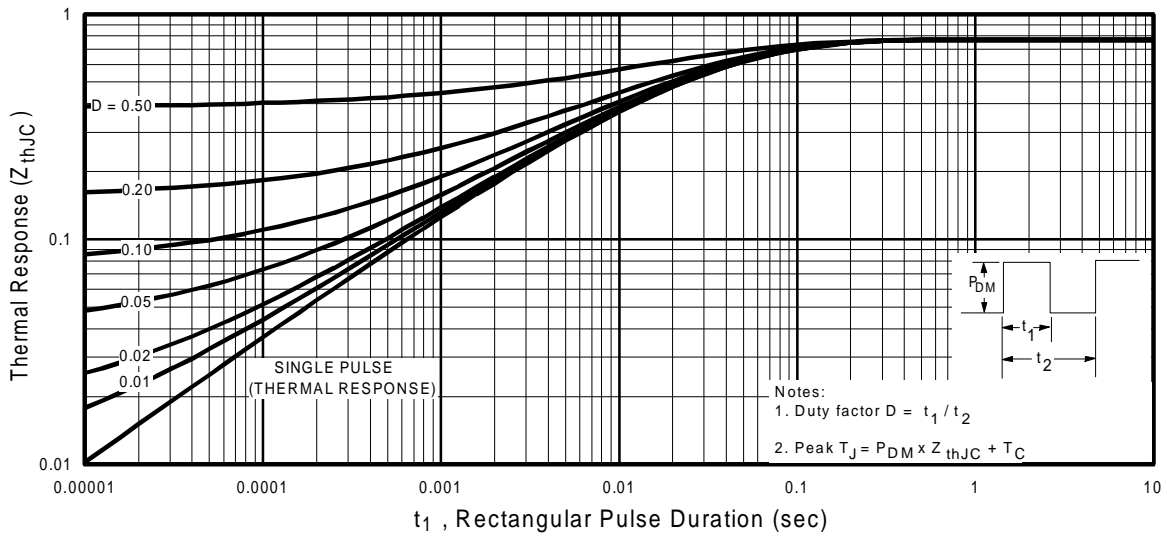
**Fig. 3 - Typical Transfer Characteristics**



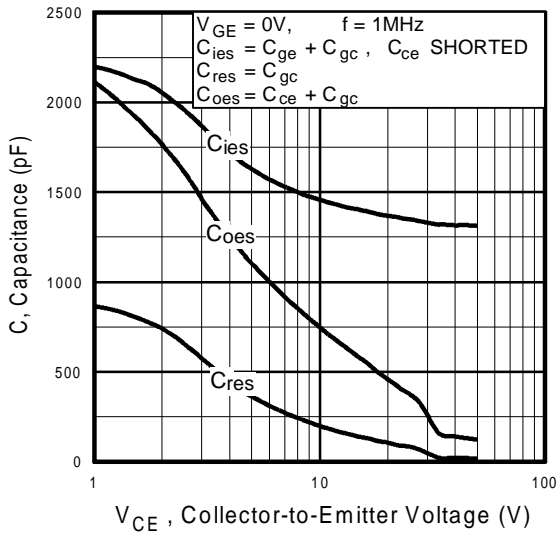
**Fig. 4 - Maximum Collector Current vs. Case Temperature**



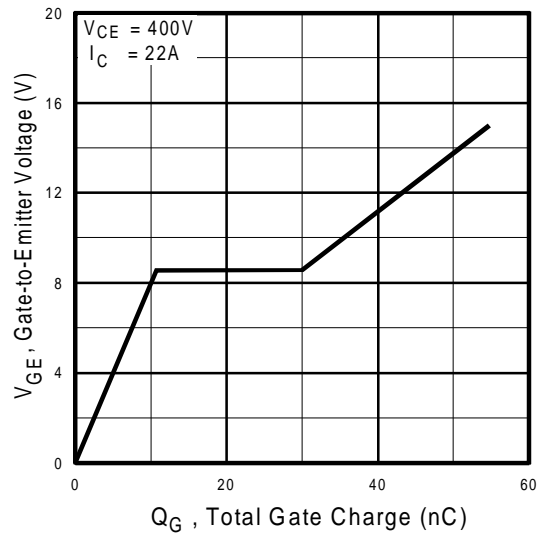
**Fig. 5 - Collector-to-Emitter Voltage vs. Case Temperature**



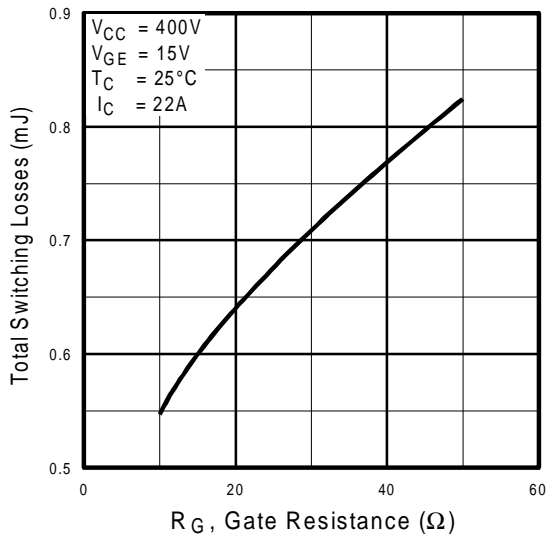
**Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case**



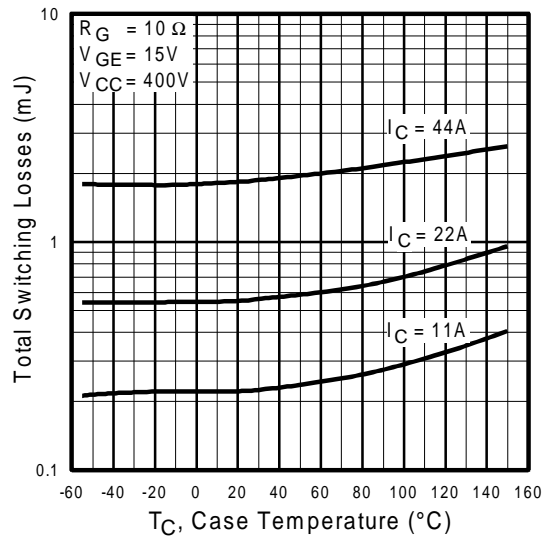
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



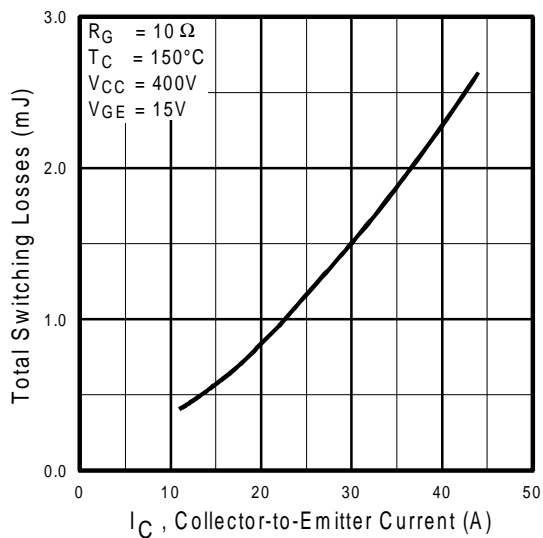
**Fig. 8** - Typical Gate Charge vs. Gate-to-Emitter Voltage



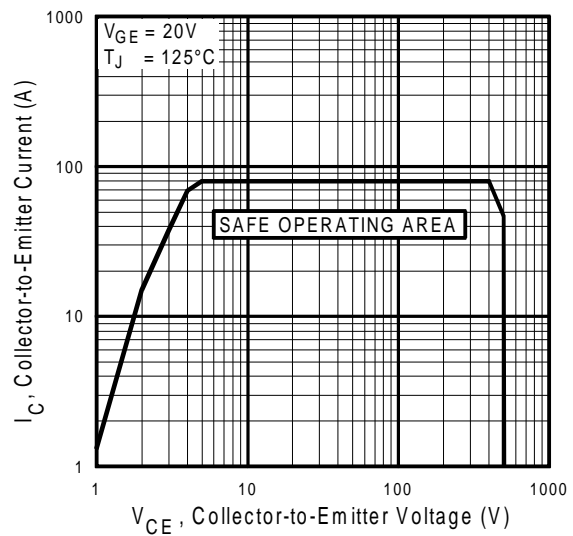
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



**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 A: Section D - page D-3**

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