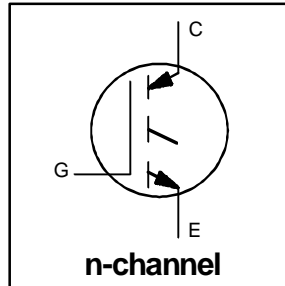


### Features

- Switching-loss rating includes all "tail" losses
- Optimized for medium operating frequency ( 1 to 10kHz) See Fig. 1 for Current vs. Frequency curve



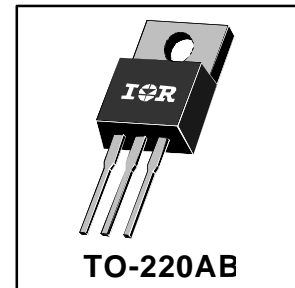
$$V_{CES} = 600V$$

$$V_{CE(sat)} \leq 2.8V$$

$$@V_{GE} = 15V, I_C = 9.0A$$

### 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	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	16	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	9.0	
$I_{CM}$	Pulsed Collector Current ①	64	
$I_{LM}$	Clamped Inductive Load Current ②	64	
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	V
$E_{ARV}$	Reverse Voltage Avalanche Energy ③	5.0	mJ
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	60	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	24	
$T_J$	Operating Junction and	-55 to +150	$^\circ C$
$T_{STG}$	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	—	—	2.1	$^\circ C/W$
$R_{\theta CS}$	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	600	—	—	V	$V_{GE} = 0V, I_C = 250\mu A$
$V_{(BR)ECS}$	Emitter-to-Collector Breakdown Voltage ④	20	—	—	V	$V_{GE} = 0V, I_C = 1.0A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temp. Coeff. of Breakdown Voltage	—	0.72	—	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 1.0mA$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	2.0	2.8	V	$I_C = 9.0A, V_{GE} = 15V$
		—	2.6	—		$I_C = 16A$
		—	2.3	—		$I_C = 9.0A, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	5.5		$V_{CE} = V_{GE}, I_C = 250\mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Temp. Coeff. of Threshold Voltage	—	-11	—	mV/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 250\mu A$
$g_{fe}$	Forward Transconductance ⑤	2.9	5.1	—	S	$V_{CE} = 100V, I_C = 9.0A$
$I_{CES}$	Zero Gate Voltage Collector Current	—	—	250	$\mu A$	$V_{GE} = 0V, V_{CE} = 600V$
		—	—	1000		$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{GE} = \pm 20V$

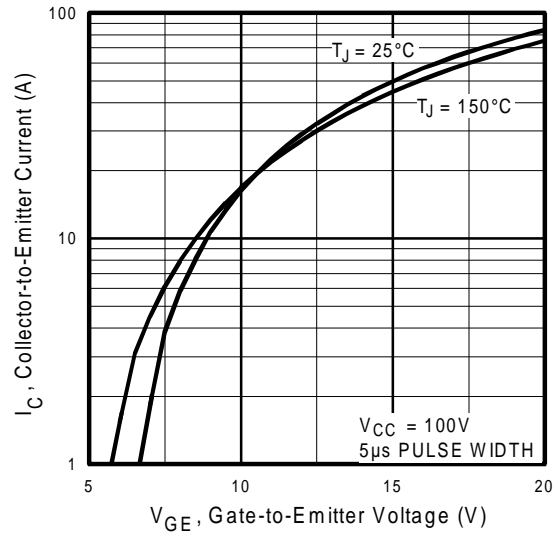
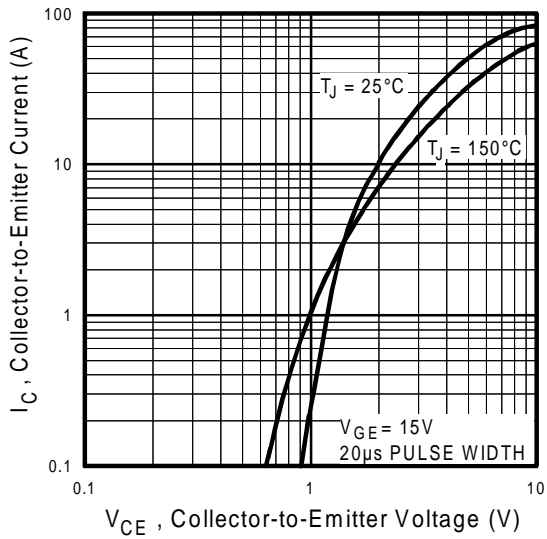
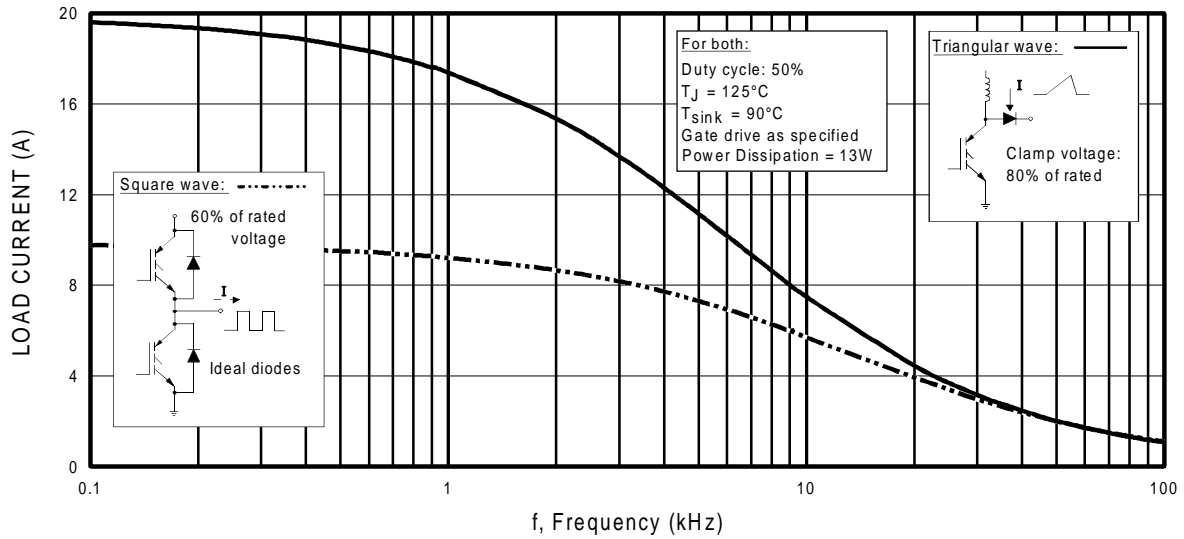
**Switching Characteristics @  $T_J = 25^\circ\text{C}$  (unless otherwise specified)**

	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge (turn-on)	—	16	21	nC	$I_C = 9.0A$
$Q_{ge}$	Gate - Emitter Charge (turn-on)	—	2.4	3.4		$V_{CC} = 400V$
$Q_{gc}$	Gate - Collector Charge (turn-on)	—	7.8	10		$V_{GE} = 15V$
$t_{d(on)}$	Turn-On Delay Time	—	24	—	ns	$T_J = 25^\circ\text{C}$
$t_r$	Rise Time	—	13	—		$I_C = 9.0A, V_{CC} = 480V$
$t_{d(off)}$	Turn-Off Delay Time	—	160	270		$V_{GE} = 15V, R_G = 50\Omega$
$t_f$	Fall Time	—	310	600		Energy losses include "tail"
$E_{on}$	Turn-On Switching Loss	—	0.18	—	mJ	See Fig. 9, 10, 11, 14
$E_{off}$	Turn-Off Switching Loss	—	0.90	—		
$E_{ts}$	Total Switching Loss	—	1.08	2.0		
$t_{d(on)}$	Turn-On Delay Time	—	25	—	ns	$T_J = 150^\circ\text{C},$
$t_r$	Rise Time	—	18	—		$I_C = 9.0A, V_{CC} = 480V$
$t_{d(off)}$	Turn-Off Delay Time	—	210	—		$V_{GE} = 15V, R_G = 50\Omega$
$t_f$	Fall Time	—	600	—		Energy losses include "tail"
$E_{ts}$	Total Switching Loss	—	1.65	—	mJ	See Fig. 10, 14
$L_E$	Internal Emitter Inductance	—	7.5	—	nH	Measured 5mm from package
$C_{ies}$	Input Capacitance	—	340	—	pF	$V_{GE} = 0V$
$C_{oes}$	Output Capacitance	—	63	—		$V_{CC} = 30V$
$C_{res}$	Reverse Transfer Capacitance	—	5.9	—		$f = 1.0MHz$

**Notes:**

- ① Repetitive rating;  $V_{GE}=20V$ , pulse width limited by max. junction temperature.  
( See fig. 13b )
- ②  $V_{CC}=80\%(V_{CES})$ ,  $V_{GE}=20V$ ,  $L=10\mu H$ ,  $R_G=50\Omega$ , ( 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.







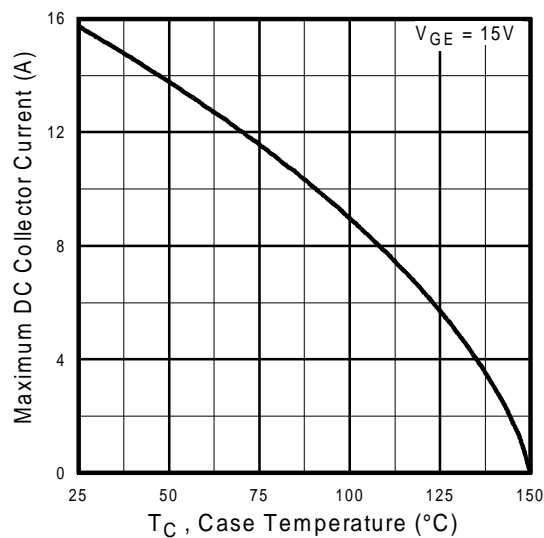


Fig. 4 - Maximum Collector Current vs. Case Temperature

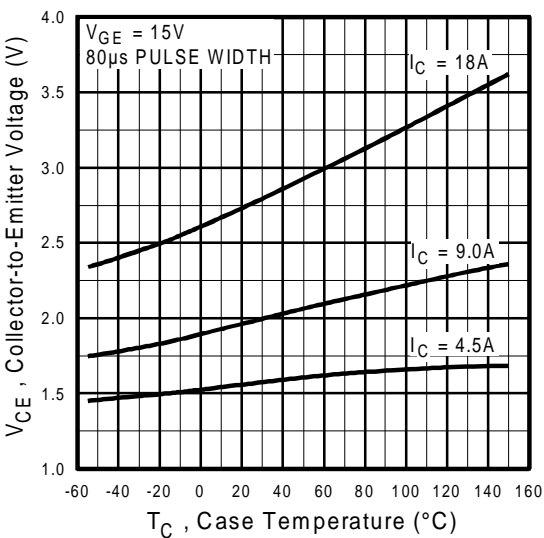


Fig. 5 - Collector-to-Emitter Voltage vs. Case Temperature

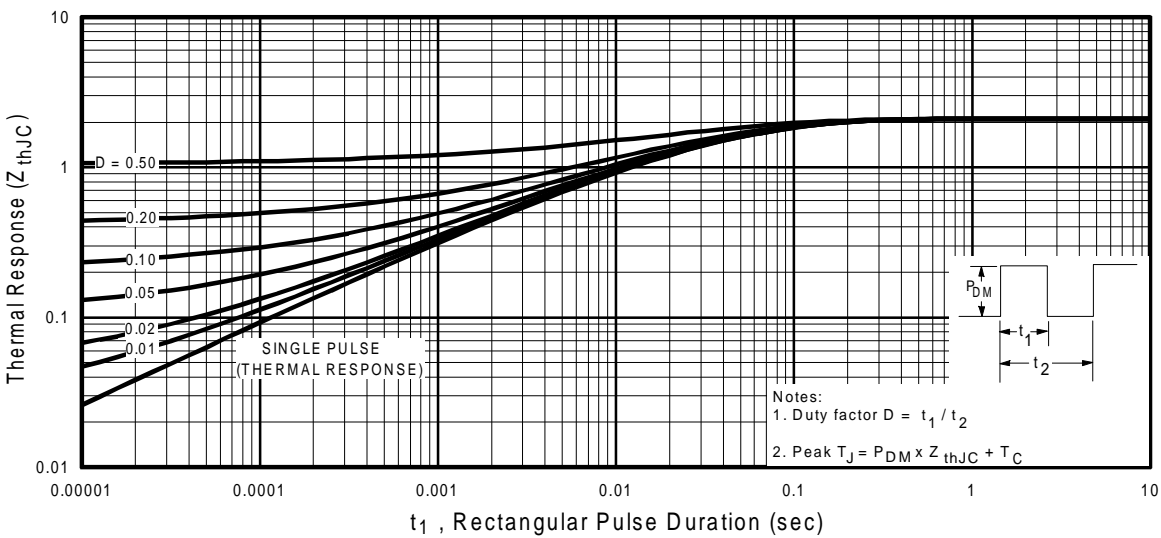
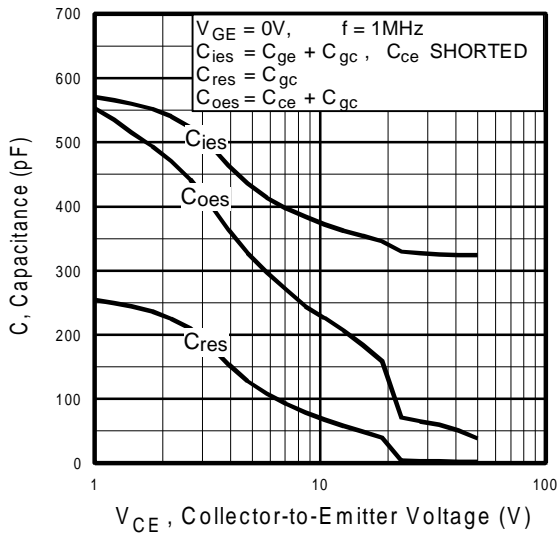
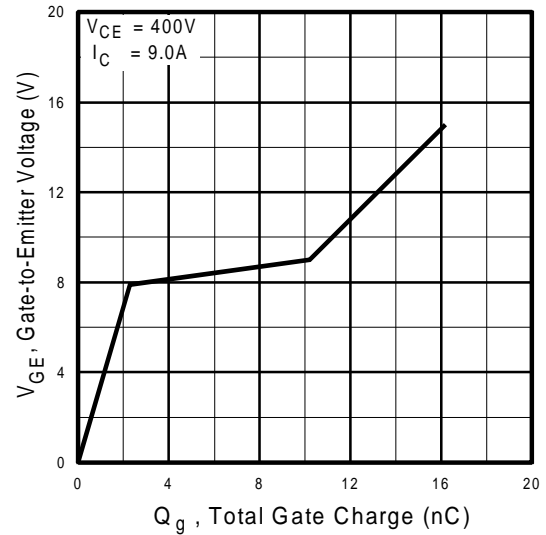


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

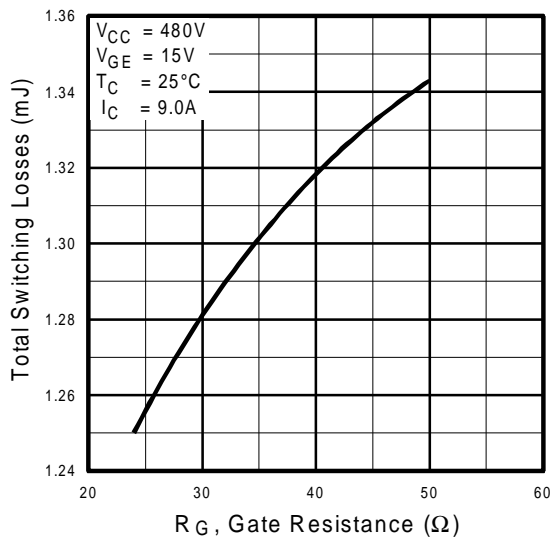




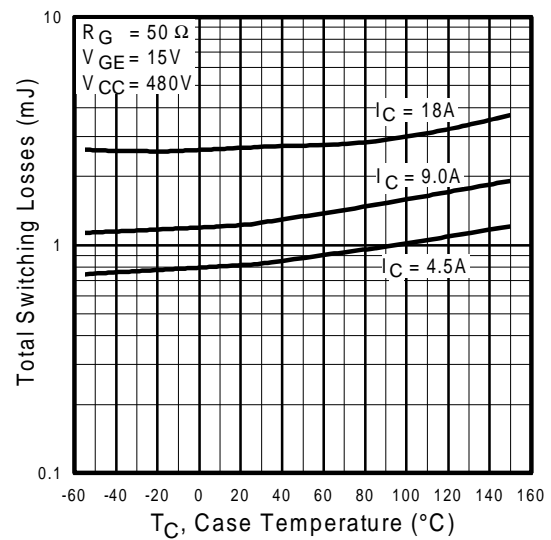
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



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

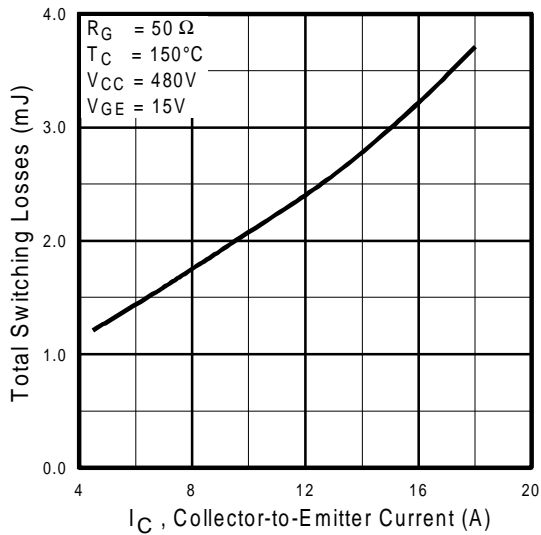


**Fig. 9** - Typical Switching Losses vs. Gate Resistance

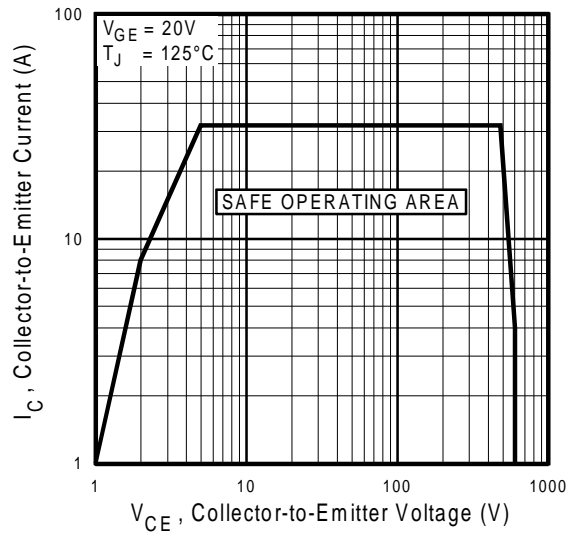


**Fig. 10** - Typical Switching Losses vs. Case Temperature





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



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

Refer to Section D for the following:

## Appendix C: Section D - page D-5

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

Package Outline 1 - JEDEC Outline TO-220AB

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