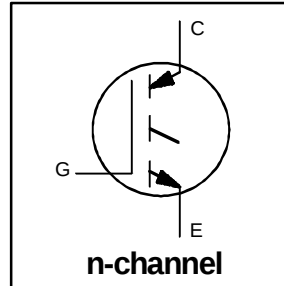

IGBT Designer's Manual

Data Sheets

The IGBT devices listed in this Designer's Manual represent International Rectifier's IGBT line as of August, 1994. The data presented in this manual supersedes all previous specifications.

Features

- Switching-loss rating includes all "tail" losses
- Optimized for line frequency operation (to 400 Hz)
See Fig. 1 for Current vs. Frequency curve



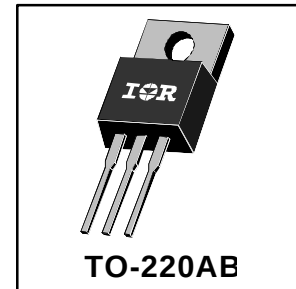
$$V_{CES} = 600V$$

$$V_{CE(sat)} \leq 2.4V$$

$$@V_{GE} = 15V, I_C = 10A$$

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	19	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	10	
I_{CM}	Pulsed Collector Current ①	76	
I_{LM}	Clamped Inductive Load Current ②	38	
V_{GE}	Gate-to-Emitter Voltage	± 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	$V_{GE} = 0V, I_C = 1.0A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.75	—	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 1.0mA$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	1.8	2.4	V	$I_C = 10A$ $V_{GE} = 15V$
		—	2.4	—		$I_C = 19A$ See Fig. 2, 5
		—	1.9	—		$I_C = 10A, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	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	2.0	5.8	—	S	$V_{CE} = 100V, I_C = 10A$
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	μA	$V_{GE} = 0V, V_{CE} = 600V$
		—	—	1000		$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$
I_{GES}	Gate-to-Emitter Leakage Current	—	—	± 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	26	nC	$I_C = 10A$
Q_{ge}	Gate - Emitter Charge (turn-on)	—	2.3	4.0		$V_{CC} = 400V$ See Fig. 8
Q_{gc}	Gate - Collector Charge (turn-on)	—	7.0	12		$V_{GE} = 15V$
$t_{d(on)}$	Turn-On Delay Time	—	24	—	ns	$T_J = 25^\circ\text{C}$
t_r	Rise Time	—	23	—		$I_C = 10A, V_{CC} = 480V$
$t_{d(off)}$	Turn-Off Delay Time	—	820	1200		$V_{GE} = 15V, R_G = 50\Omega$
t_f	Fall Time	—	910	1600		Energy losses include "tail"
E_{on}	Turn-On Switching Loss	—	0.24	—	mJ	See Fig. 9, 10, 11, 14
E_{off}	Turn-Off Switching Loss	—	3.9	—		
E_{ts}	Total Switching Loss	—	4.1	6.0		
$t_{d(on)}$	Turn-On Delay Time	—	26	—	ns	$T_J = 150^\circ\text{C},$
t_r	Rise Time	—	30	—		$I_C = 10A, V_{CC} = 480V$
$t_{d(off)}$	Turn-Off Delay Time	—	1100	—		$V_{GE} = 15V, R_G = 50\Omega$
t_f	Fall Time	—	1800	—		Energy losses include "tail"
E_{ts}	Total Switching Loss	—	7.0	—	mJ	See Fig. 10, 14
L_E	Internal Emitter Inductance	—	7.5	—	nH	Measured 5mm from package
C_{ies}	Input Capacitance	—	360	—	pF	$V_{GE} = 0V$
C_{oes}	Output Capacitance	—	36	—		$V_{CC} = 30V$ See Fig. 7
C_{res}	Reverse Transfer Capacitance	—	5.2	—		$f = 1.0MHz$

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.

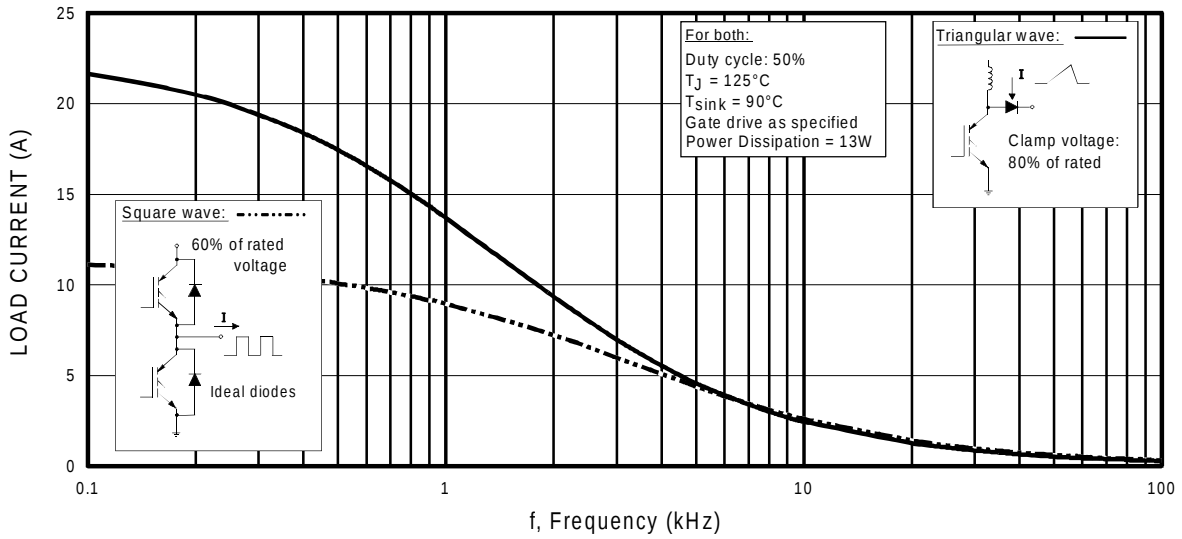


Fig. 1 - Typical Load Current vs. Frequency
(For square wave, $I = I_{\text{RMS}}$ of fundamental; for triangular wave, $I = I_{\text{PK}}$)

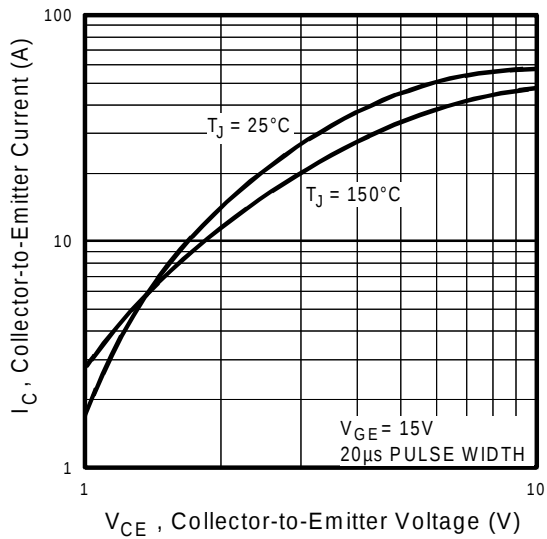


Fig. 2 - Typical Output Characteristics

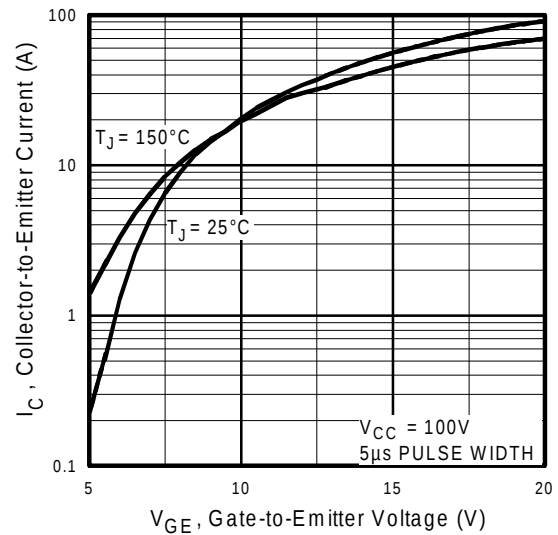


Fig. 3 - Typical Transfer Characteristics

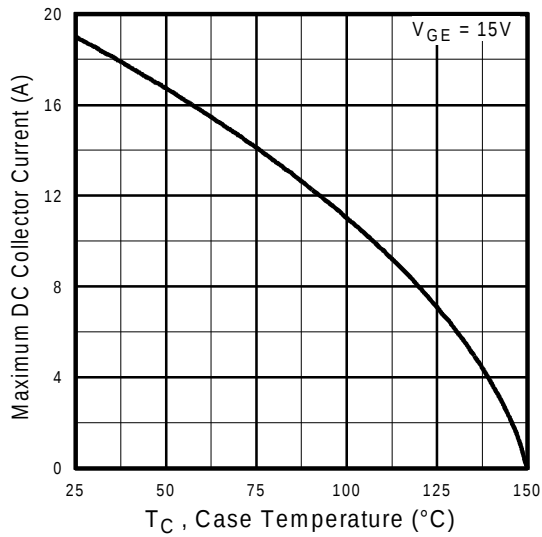


Fig. 4 - Maximum Collector Current vs. Case Temperature

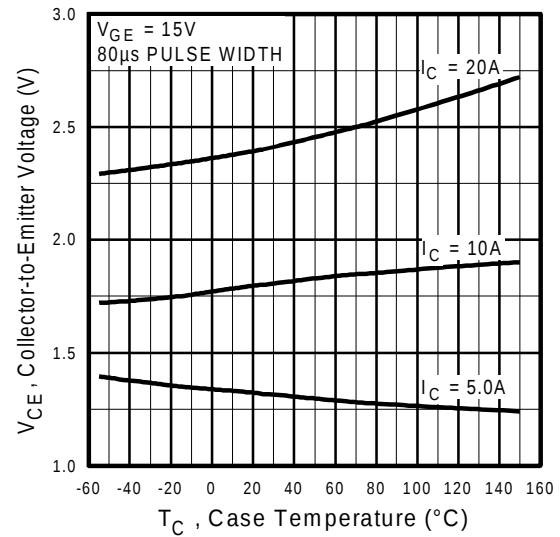


Fig. 5 - Collector-to-Emitter Voltage vs. Case Temperature

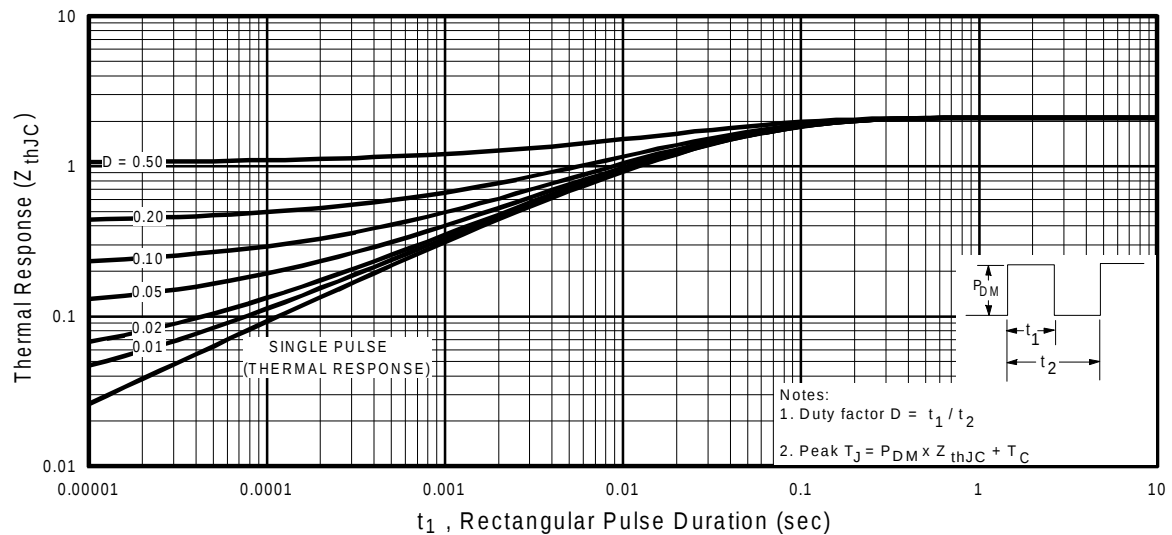


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

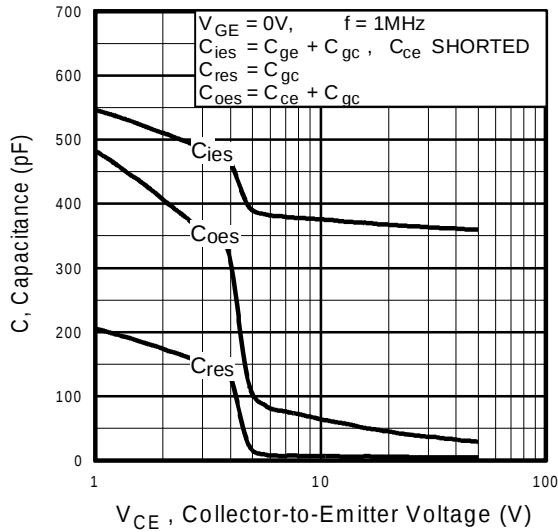


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

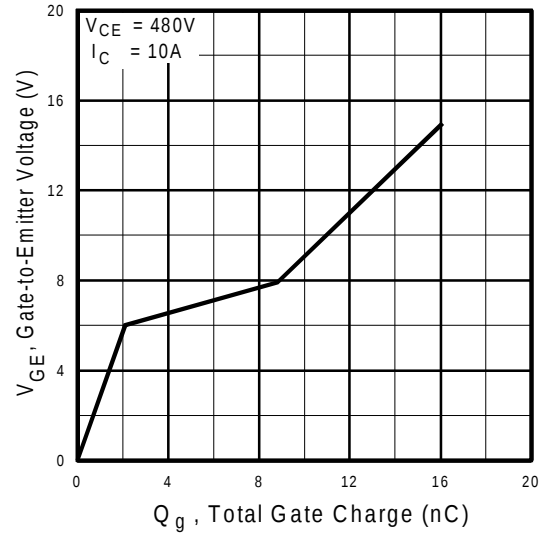


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

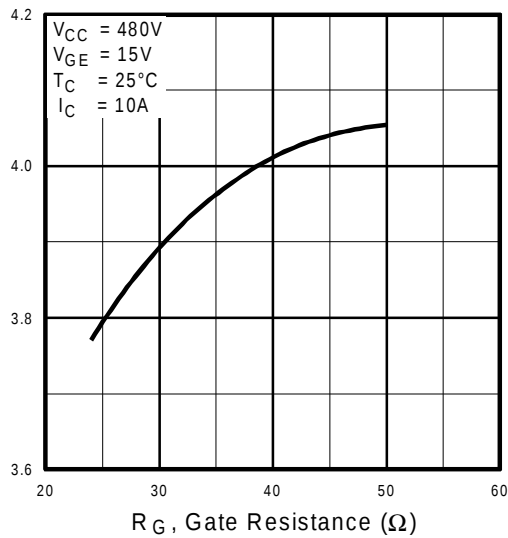


Fig. 9 - Typical Switching Losses vs. Gate Resistance

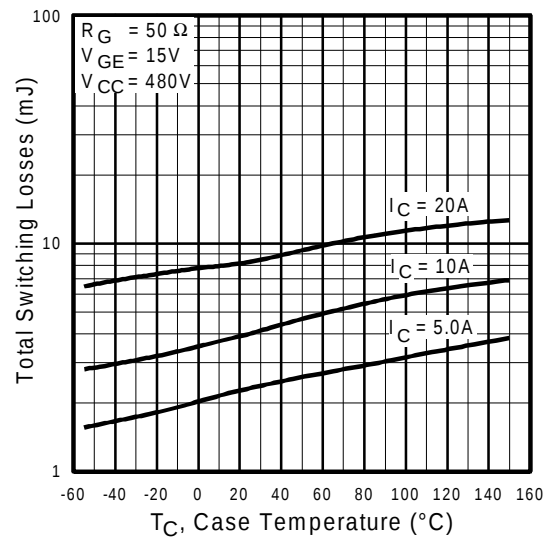


Fig. 10 - Typical Switching Losses vs. Case Temperature

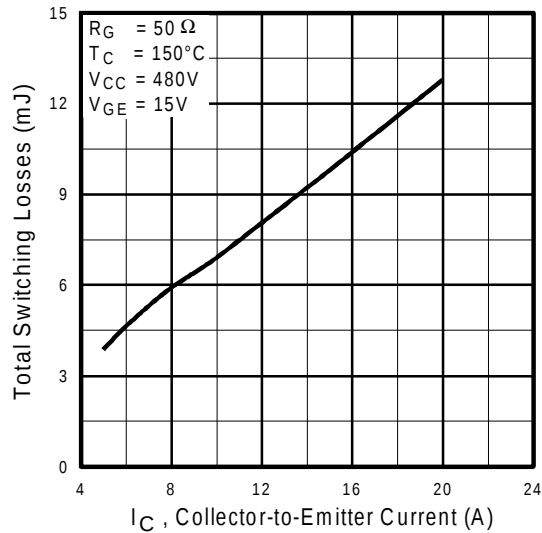


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

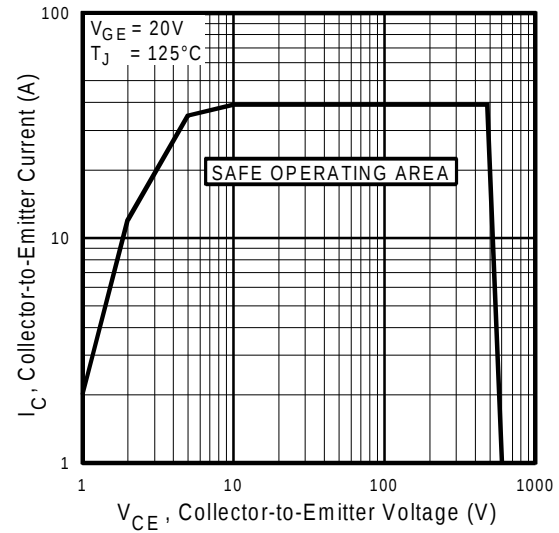


Fig. 12 - Turn-Off SOA

Refer to Section D for the following:

Appendix 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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