International **IƎR** Rectifier

IRGPC40U

## 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

n-channel
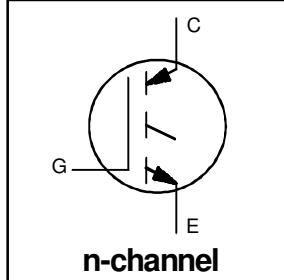
$V_{CES} = 600V$

$V_{CE(sat)} \leq 3.0V$

@$V_{GE} = 15V$, $I_C = 20A$

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.

TO-247AC
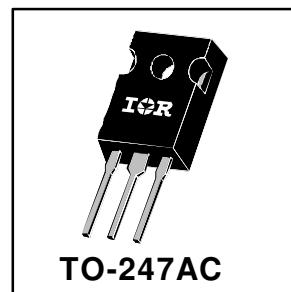
Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
I_C @ $T_C = 25°C$	Continuous Collector Current	40	
I_C @ $T_C = 100°C$	Continuous Collector Current	20	A
I_{CM}	Pulsed Collector Current ①	160	
I_{LM}	Clamped Inductive Load Current ②	160	
V_{GE}	Gate-to-Emitter Voltage	±20	V
E_{ARV}	Reverse Voltage Avalanche Energy ③	15	mJ
P_D @ $T_C = 25°C$	Maximum Power Dissipation	160	W
P_D @ $T_C = 100°C$	Maximum Power Dissipation	65	
T_J	Operating Junction and	-55 to +150	
T_{STG}	Storage Temperature Range		°C
	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	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	—	0.24	—	°C/W
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	—	—	40	
Wt	Weight	—	6 (0.21)	—	g (oz)

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Electrical Characteristics @ T_J = 25°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	—	0.63	—	V/°C	$V_{GE} = 0V$, $I_C = 1.0mA$	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	2.2	3.0		$I_C = 20A$	$V_{GE} = 15V$
		—	2.7	—	V	$I_C = 40A$	See Fig. 2, 5
		—	2.3	—		$I_C = 20A$, $T_J = 150°C$	
$V_{GE(th)}$	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	—	-13	—	mV/°C	$V_{CE} = V_{GE}$, $I_C = 250\mu A$	
g_{fe}	Forward Transconductance ⑤	11	18	—	S	$V_{CE} = 100V$, $I_C = 20A$	
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	µA	$V_{GE} = 0V$, $V_{CE} = 600V$	
		—	—	2500		$V_{GE} = 0V$, $V_{CE} = 600V$, $T_J = 150°C$	
I_{GES}	Gate-to-Emitter Leakage Current	—	—	±100	nA	$V_{GE} = \pm20V$	

Switching Characteristics @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions	
Q_g	Total Gate Charge (turn-on)	—	51	67		$I_C = 20A$	
Q_{ge}	Gate - Emitter Charge (turn-on)	—	8.9	11	nC	$V_{CC} = 400V$	See Fig. 8
Q_{gc}	Gate - Collector Charge (turn-on)	—	20	33		$V_{GE} = 15V$	
$t_{d(on)}$	Turn-On Delay Time	—	25	—		$T_J = 25°C$	
t_r	Rise Time	—	21	—	ns	$I_C = 20A$, $V_{CC} = 480V$	
$t_{d(off)}$	Turn-Off Delay Time	—	96	190		$V_{GE} = 15V$, $R_G = 10\Omega$	
t_f	Fall Time	—	43	120		Energy losses include "tail"	
E_{on}	Turn-On Switching Loss	—	0.34	—			
E_{off}	Turn-Off Switching Loss	—	0.41	—	mJ	See Fig. 9, 10, 11, 14	
E_{ts}	Total Switching Loss	—	0.75	1.6			
$t_{d(on)}$	Turn-On Delay Time	—	25	—		$T_J = 150°C$,	
t_r	Rise Time	—	23	—	ns	$I_C = 20A$, $V_{CC} = 480V$	
$t_{d(off)}$	Turn-Off Delay Time	—	174	—		$V_{GE} = 15V$, $R_G = 10\Omega$	
t_f	Fall Time	—	140	—		Energy losses include "tail"	
E_{ts}	Total Switching Loss	—	1.4	—	mJ	See Fig. 10, 14	
L_E	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package	
C_{ies}	Input Capacitance	—	1500	—		$V_{GE} = 0V$	
C_{oes}	Output Capacitance	—	190	—	pF	$V_{CC} = 30V$	See Fig. 7
C_{res}	Reverse Transfer Capacitance	—	17	—		$f = 1.0MHz$	

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=10µH, R_G= 10Ω, (See fig. 13a)

③ Repetitive rating; pulse width limited by maximum junction temperature.

④ Pulse width ≤ 80µs; duty factor ≤ 0.1%.

⑤ Pulse width 5.0µs, single shot.
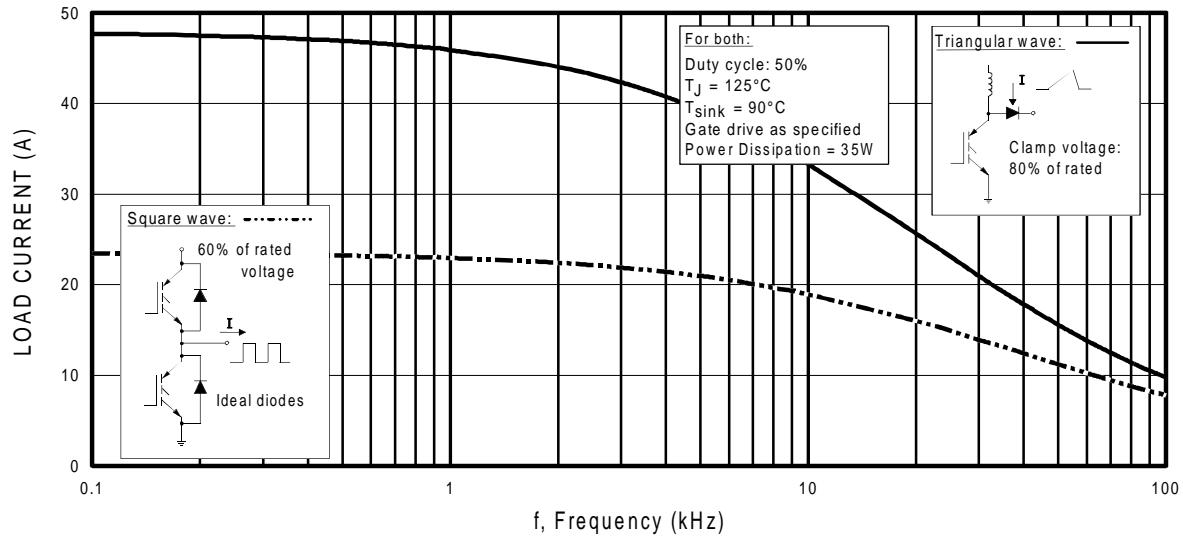
Fig. 1 - Typical Load Current vs. Frequency
(For square wave, I=I$_{RMS}$ of fundamental; for triangular wave, I=I$_{PK}$)
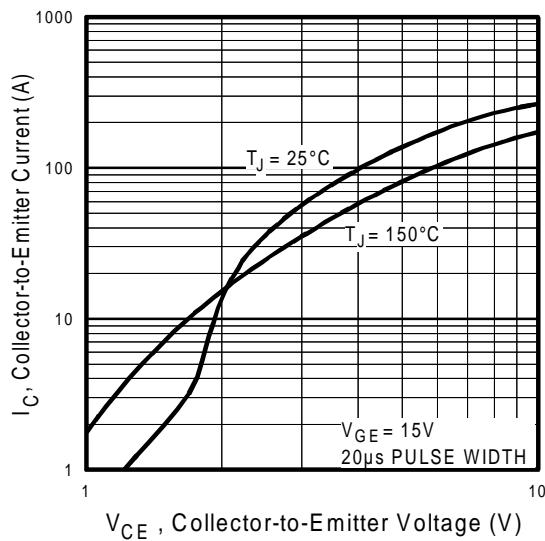
**Fig. 2** - Typical Output Characteristics   **Fig. 3** - Typical Transfer Characteristics
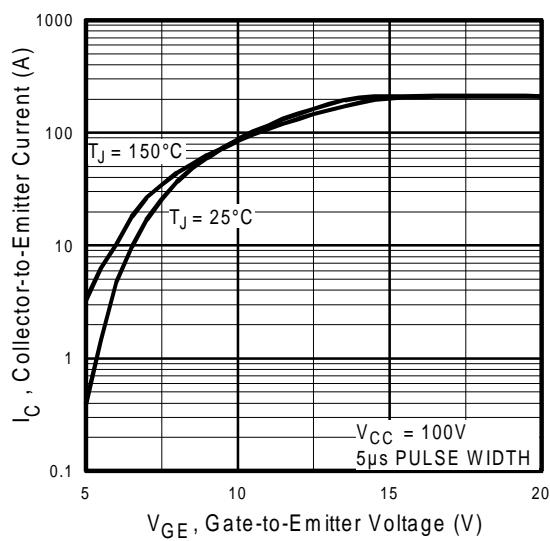
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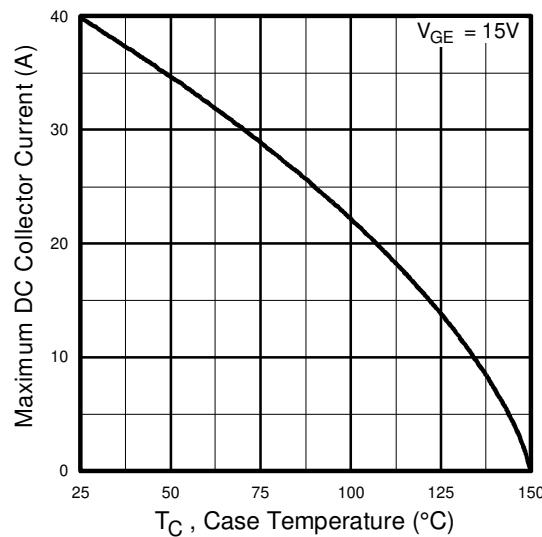
Fig. 4 - Maximum Collector Current vs.
Case Temperature
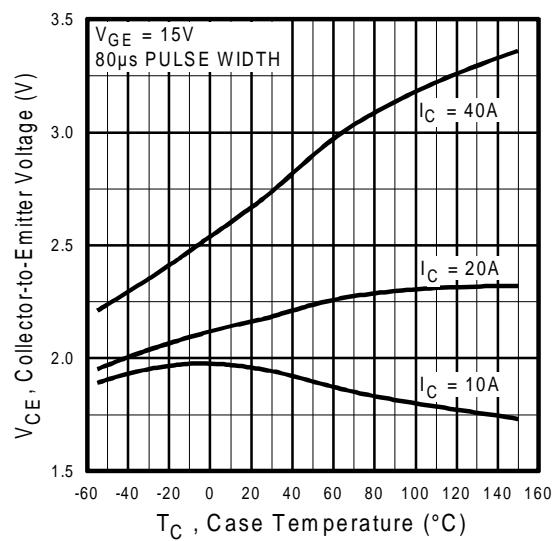
Fig. 5 - Collector-to-Emitter Voltage vs.
Case Temperature

Notes:
1. Duty factor D = t_1 / t_2

2. Peak $T_J = P_{DM}$ x $Z_{thJC} + T_C$
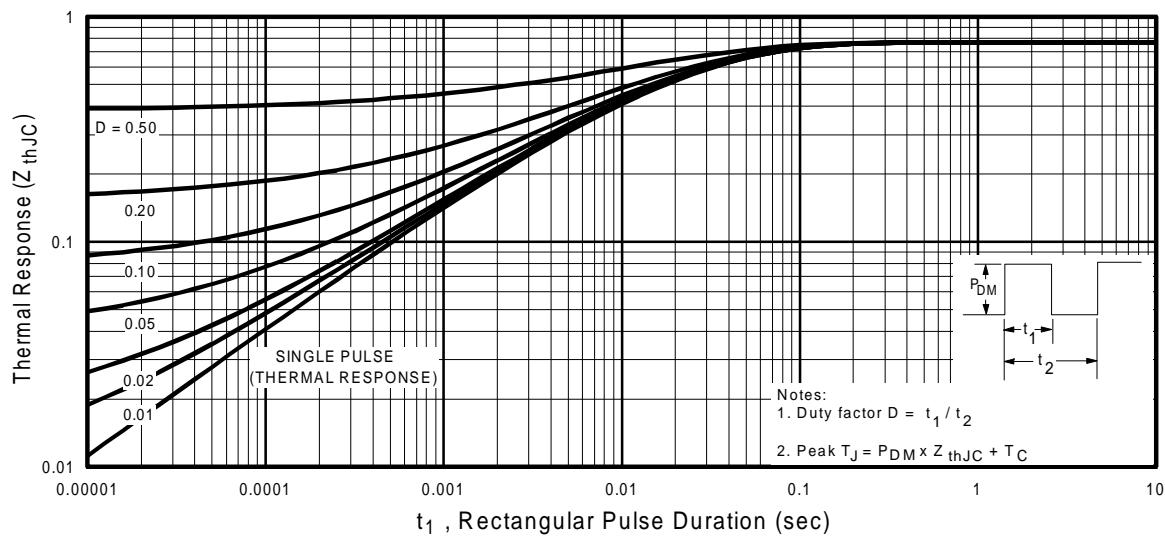
Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case
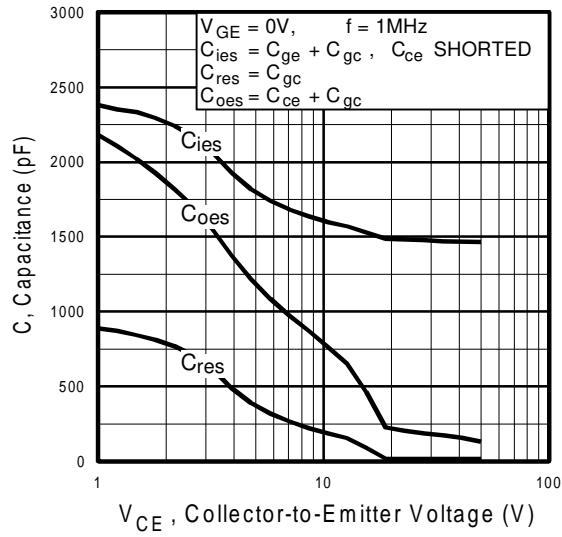
**Fig. 7 -** Typical Capacitance vs.
Collector-to-Emitter Voltage
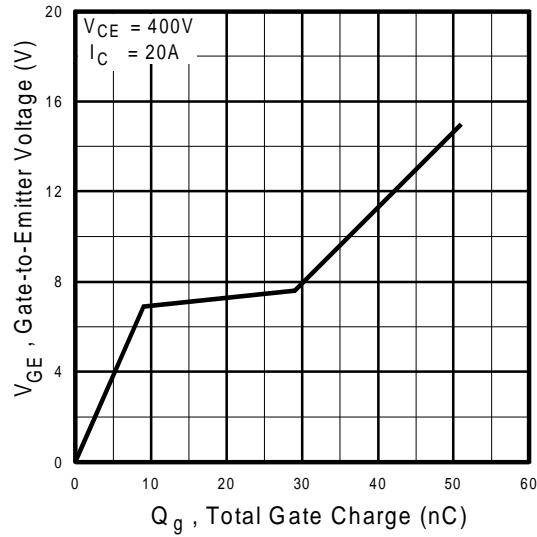
**Fig. 8** - Typical Gate Charge vs.
Gate-to-Emitter Voltage
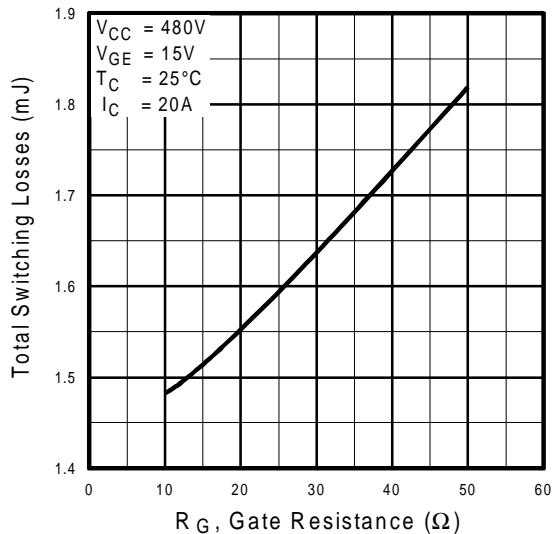

Fig. 9 - Typical Switching Losses vs. Gate
Resistance
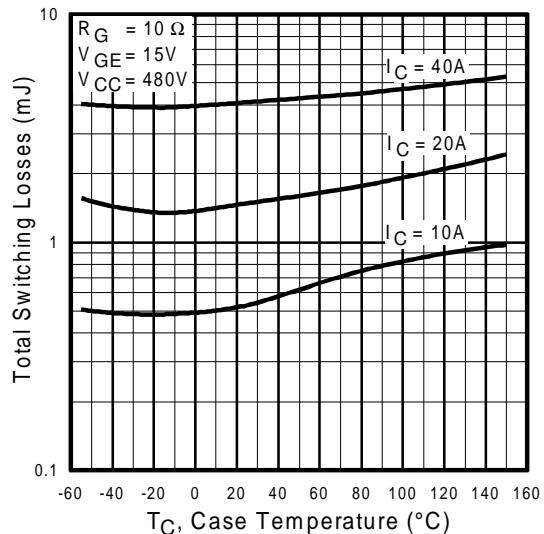
**Fig. 10** - Typical Switching Losses vs.
Case Temperature
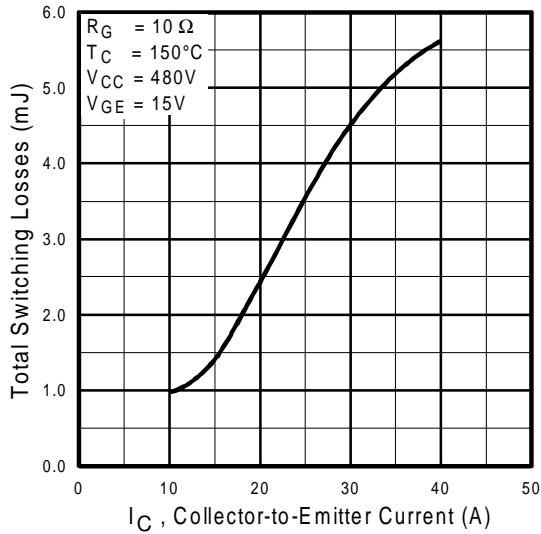
**Fig. 11 -** Typical Switching Losses vs. Collector-to-Emitter Current
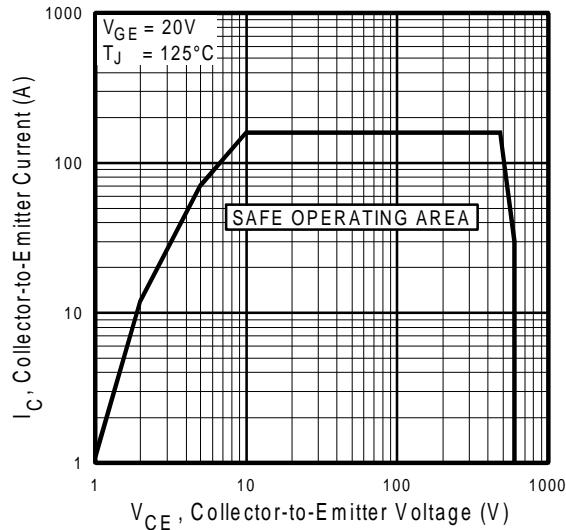
Fig. 12 - Turn-Off SOA

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 3 - JEDEC Outline TO-247AC   **Section D - page D-13**

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