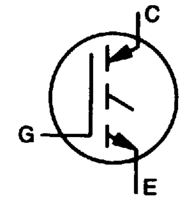
International
IOR Rectifier

PD-9.724A

IRGAC40U

INSULATED GATE BIPOLAR TRANSISTOR

UltraFast™ IGBT



n-channel

Description

Insulated Gate Bipolar Transistors (IGBTs) from International Rectifier have higher 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 higher-voltage, higher-current applications.

The performance of various IGBTs varies greatly with frequency. Note that IR now provides the designer with a speed benchmark ($f_{Ic/2}$, or the "half-current frequency"), as well as an indication of the current handling capability of the device. Refer to Figure 14.

Product Summary

Part Number	$V_{(BR)CES}$	$V_{CE(on)}$	I_C	E_{ts}
IRGAC40U	600V	3.0V	31A	2.0 mJ

Features:

- Hermetically Sealed
- Simple Drive Requirements
- Latch-Proof
- Ultra-fast operation > 10 kHz
- Switching-loss rating includes all "tail" losses

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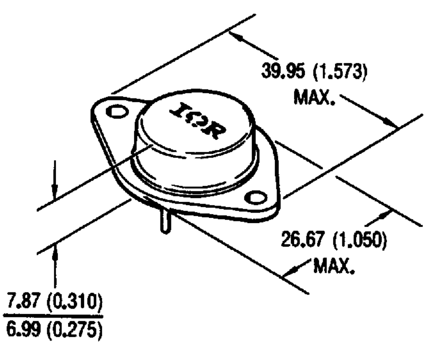
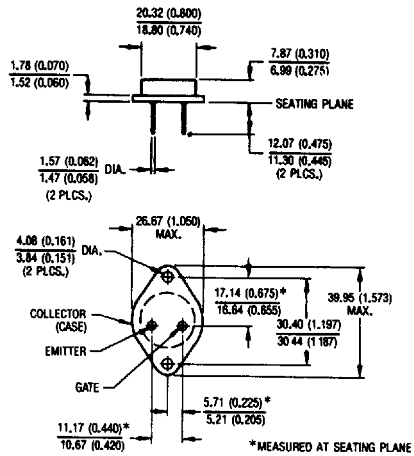
CASE STYLE AND DIMENSIONS





Conforms to JEDEC Outline TO-204AE (Modified TO-3)
Dimensions in Millimeters and (Inches)

Absolute Maximum Ratings

	Parameter	Max.	Units
I_C @ T_C = 25°C	Continuous Collector Current	31	A
I_C @ T_C = 100°C	Continuous Collector Current	15	A
I_{CM}	Pulsed Collector Current ①	124	A
V_{CE}	Collector-to-Emitter Breakdown Voltage	600	V
V_{GE}	Gate-to-Emitter Voltage	±20	V
I_{LM}	Clamped Inductive Load Current ②	124	A
P_D @ T_C = 25°C	Maximum Power Dissipation	125	W
P_D @ T_C = 100°C	Maximum Power Dissipation	50	W
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to +150	°C
	Lead Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	°C
	Weight	11.5 (typical)	g

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	—	—	1.0	K/W ⑤
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	—	0.21	—	K/W ⑤
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	—	—	30	K/W ⑤

Electrical Characteristic @ T_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	—	—	V	V_{GE} = 0V, I_C = 1.0 mA
$V_{(BR)ECS}$	Emitter-to-Collector Breakdown Volt. ③	15	—	—	V	V_{GE} = 0V, I_C = 1.0A
$\Delta V_{(BR)CES}/\Delta T_J$	Temp. Coeff. of Breakdown Voltage	—	0.63	—	V/°C	V_{GE} = 0V, I_C = 1.0 mA
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	—	3.0	V	V_{GE} = 15V, I_C = 15A See Fig. 4
		—	2.7	—	V	V_{GE} = 15V, I_C = 31A
		—	2.3	—	V	V_{CE} = 15V, I_C = 15A, T_J = 125°C
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	5.5	V	V_{CE} = V_{GE}, I_C = 250 μA
$\Delta V_{GE(th)}/\Delta T_J$	Temp. Coeff. of Threshold Voltage	—	-13	—	mV/°C	V_{CE} = V_{GE}, I_C = 250 μA
g_{fe}	Forward Transconductance ④	11	—	—	S	V_{CE} ≥ 15V, I_C = 15A
I_{CES}	Zero Gate Voltage Collector Current	—	—	50	μA	V_{GE} = 0V, V_{CE} = 480V, T_J = 25°C
		—	—	2500	μA	V_{GE} = 0V, V_{CE} = 480V, T_J = 125°C
I_{GES}	Gate-to-Emitter Leakage Current	—	—	±500	nA	V_{GE} = ±20V

Notes:

① Repetitive rating; V_{GE} = 20V, pulse width limited by max. junction temperature (See figure 12b).

② V_{CC} = 80% (BV_{CES}), V_{GE} = 20V, L ≥ 10 μH, R_G = 10Ω, (See figure 12a)

③ Pulse width ≤ 80 μs; duty factor ≤ 0.1%.

④ Pulse width ≤ 5 μs, single shot

⑤ K/W equivalent to °C/W

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

	Parameter	Min.	Typ.	Max.	Units	Test Conditions
Q_G	Total Gate Charge (turn-on)	—	50	100	nC	I_C = 15A, V_{CC} = 300V
Q_{GE}	Gate - Emitter Charge (turn-on)	—	9	18		See Figure 6.
Q_{GC}	Gate - Collector Charge (turn-on)	—	20	40		V_{GE} = 15V
$t_{d(on)}$	Turn-On Delay Time	—	—	50	ns	See test circuit, figure 13.
t_r	Rise Time	—	—	42		I_C = 15A, V_{CC} = 480V
$t_{d(off)}$	Turn-Off Delay Time	—	—	190		T_J = 25°C
t_f	Fall Time	—	—	120		V_{GE} = 15V, R_G = 9.1Ω
E_{on}	Turn-On Switching Loss	—	0.18	—	mJ	Energy losses include "tail".
E_{off}	Turn-Off Switching Loss	—	1.3	—		Also see figures 9, 10, & 11.
E_{ts}	Total Switching Loss	—	1.5	2.0		
$t_{d(on)}$	Turn-On Delay Time	—	25	—	ns	I_C = 15A, V_{CC} = 480V
t_r	Rise Time	—	23	—		T_J = 125°C
$t_{d(off)}$	Turn-Off Delay Time	—	174	—		V_{GE} = 15V
t_f	Fall Time	—	140	—		R_G = 9.1Ω
E_{ts}	Total Switching Loss	—	2.4	—	mJ	
L_E	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package.
C_{ies}	Input Capacitance	—	1500	—	pF	V_{GE} = 0V
C_{oes}	Output Capacitance	—	190	—		V_{CC} = 30V See fig 5.
C_{res}	Reverse Transfer Capacitance	—	17	—		f = 1.0 MHz
C_{CC}	Collector-to-Case Capacitance	—	12	—		

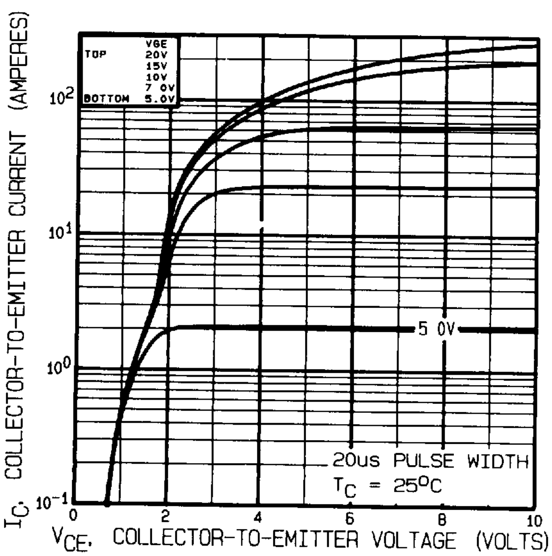


Fig. 1 — Typical Output Characteristics, T_C = 25°C

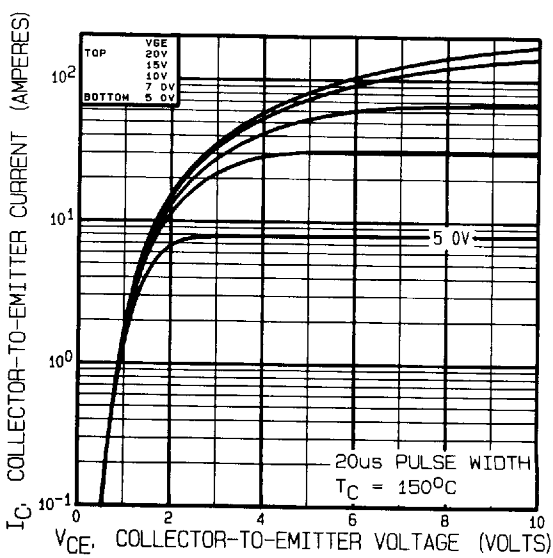


Fig. 2 — Typical Output Characteristics, T_C = 150°C

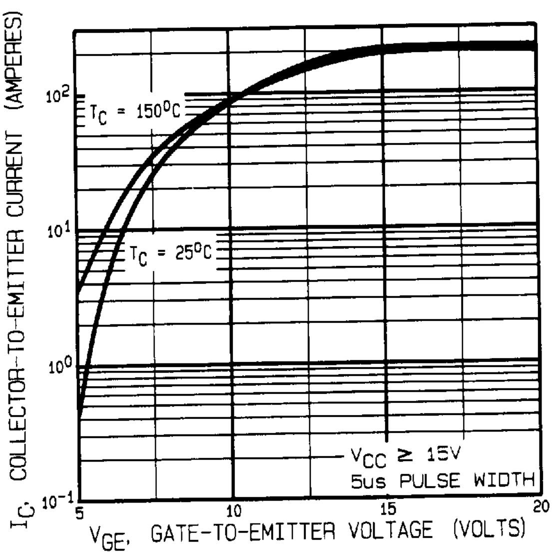


Fig. 3 — Typical Transfer Characteristics

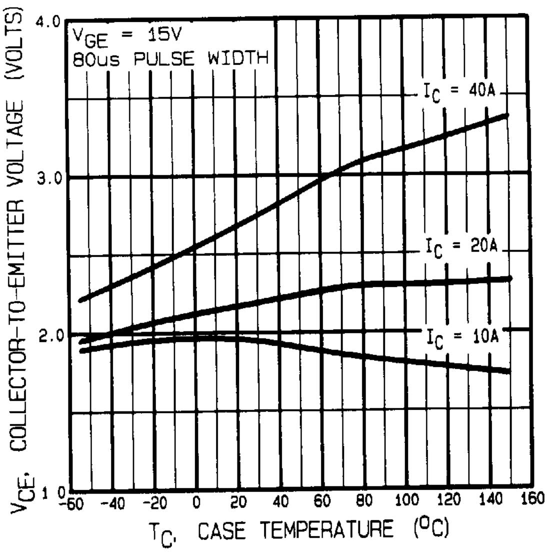


Fig. 4 — Collector-to-Emitter Saturation Voltage vs. Case Temperature

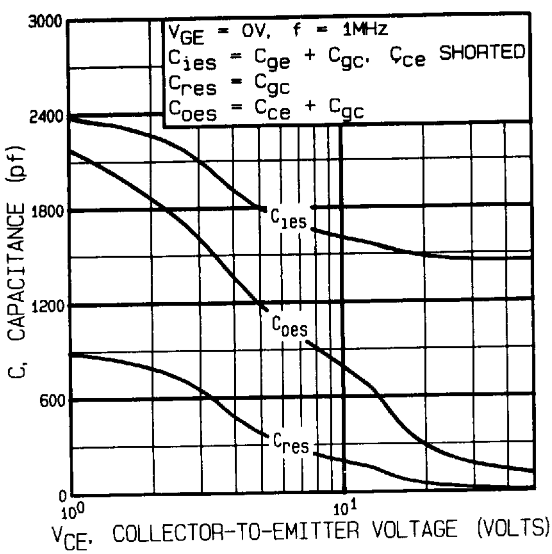


Fig. 5 — Typical Capacitance vs. Collector-to-Emitter Voltage

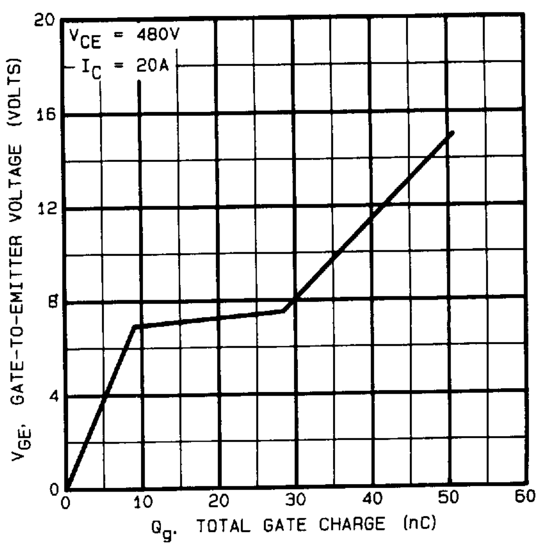


Fig. 6 — Typical Gate Charge vs. Gate-to-Emitter Voltage

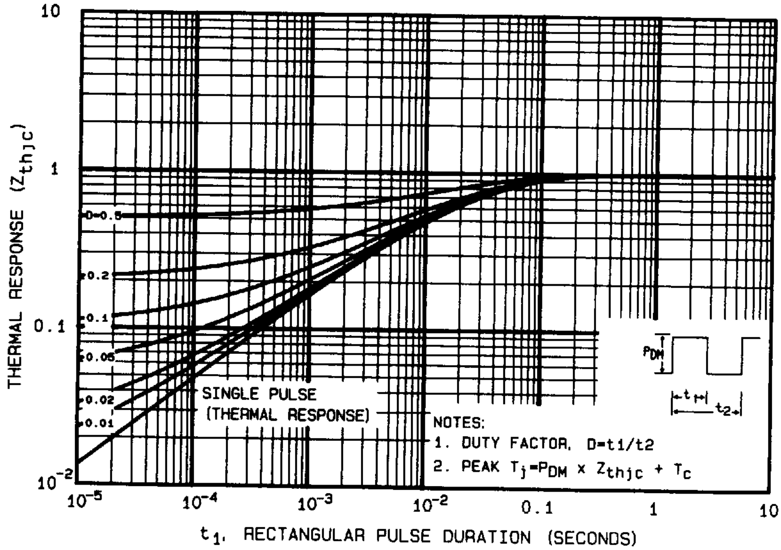


Fig. 7 — Maximum Effective Transient Thermal Impedance, Junction-to-Case

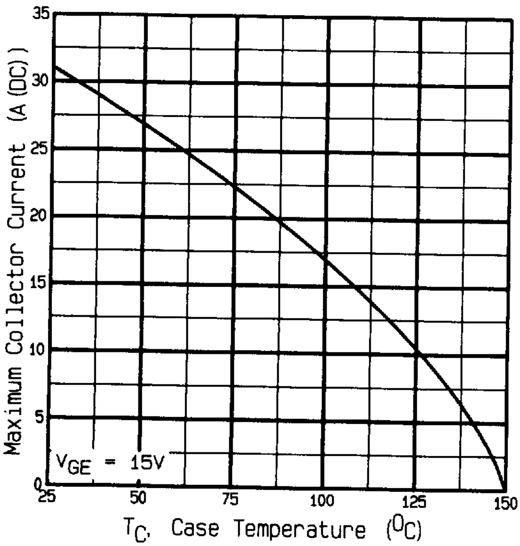


Fig. 8 — Maximum Collector Current vs. Case Temperature

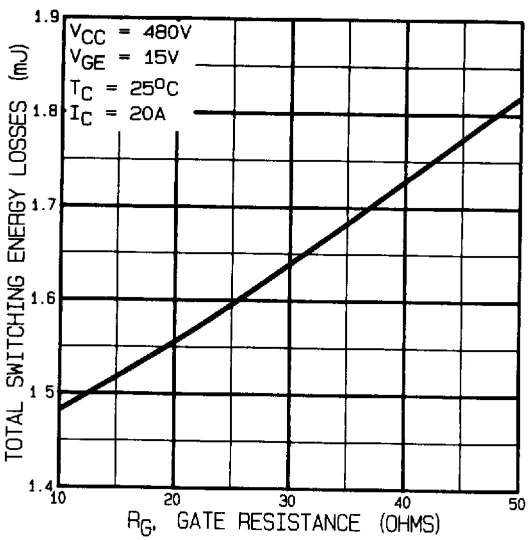


Fig. 9 — Typical Switching Losses vs. Gate Resistance

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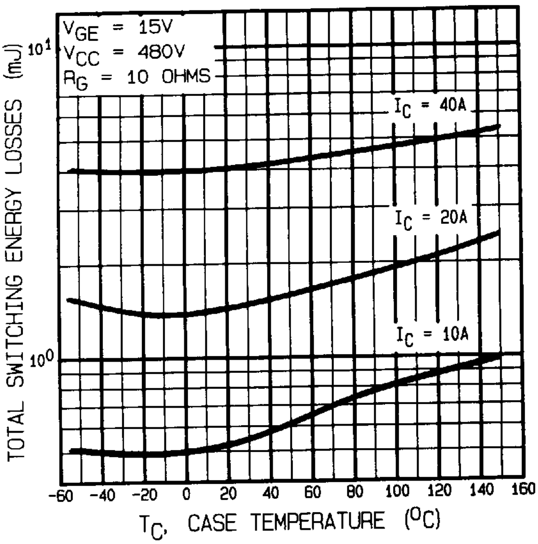

Fig. 10 — Typical Switching Losses vs. Case Temperature

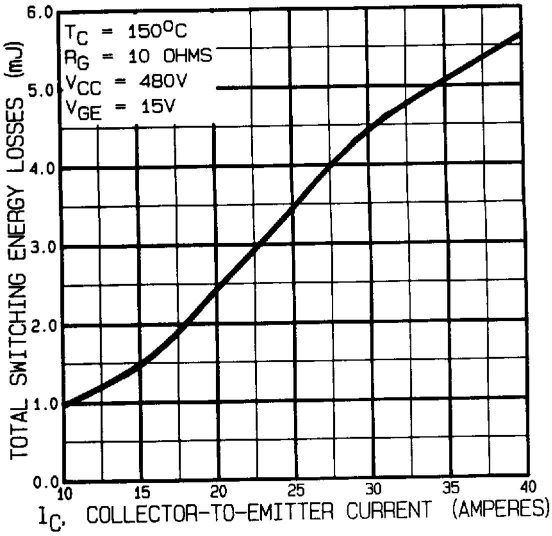

Fig. 11 — Typical Switching Losses vs. Collector-to-Emitter Current

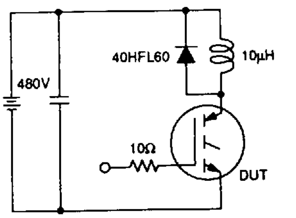

Fig 12a. Clamped Inductive Load Test Circuit

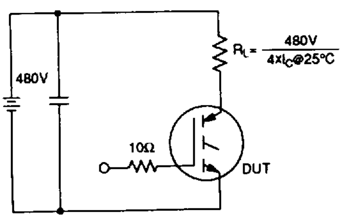

Fig 12b. Pulsed Collector Current Test Circuit

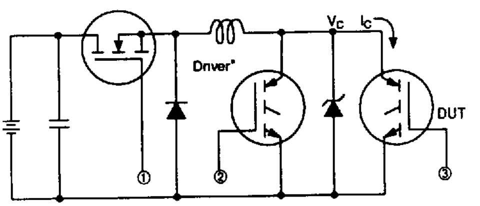

Fig 13a. Switching Loss Test Circuit

* Driver same type as DUT, V_C = 480V

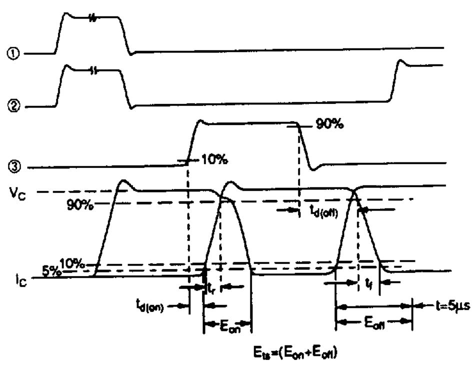

Fig 13b. Switching Loss Waveforms

For both, power dissipation = 29W

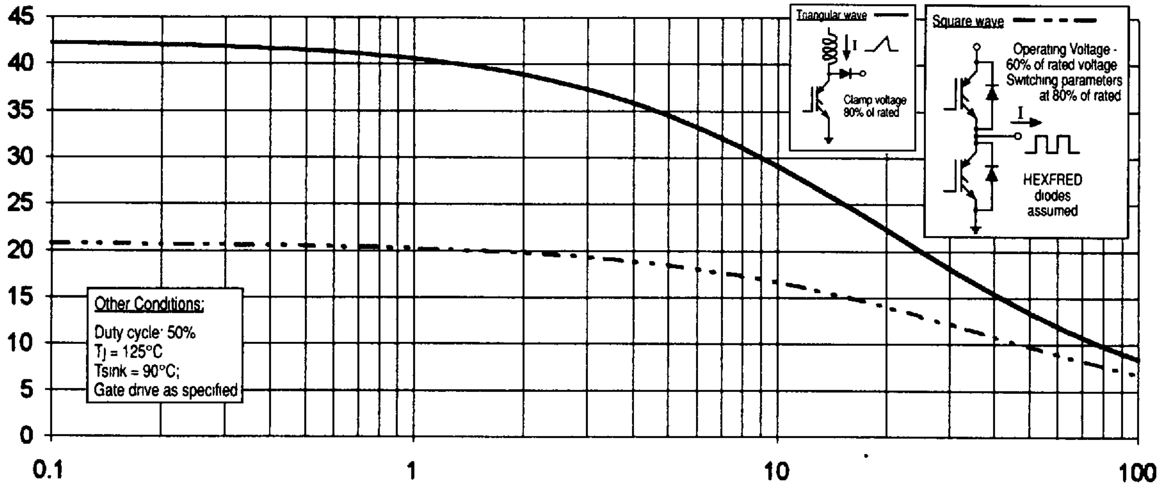

Fig. 14 — Typical Load Current vs. Frequency
(For square wave, I = I_{RMS} of fundamental; for triangular wave, I = I_{PK})