

# International Rectifier

PD - 9.1134

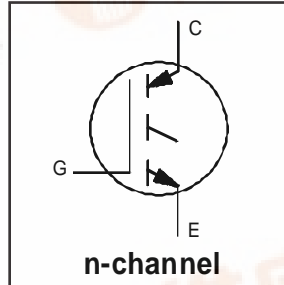
## IRGBC40K-S

INSULATED GATE BIPOLAR TRANSISTOR

Short Circuit Rated  
UltraFast Fast IGBT

### Features

- Short circuit rated - 10 $\mu$ s @ 125°C, V<sub>GE</sub> = 15V
- Switching-loss rating includes all "tail" losses
- Optimized for high operating frequency (over 5kHz) See Fig. 1 for Current vs. Frequency curve

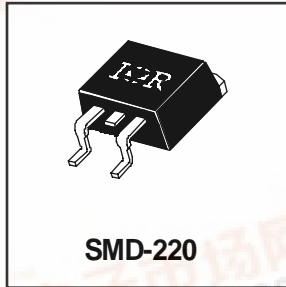


V <sub>CES</sub> = 600V
V <sub>CE(sat)</sub> ≤ 3.2V
@ V <sub>GE</sub> = 15V, I <sub>C</sub> = 25A

### 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.

These new short circuit rated devices are especially suited for motor control and other applications requiring short circuit withstand capability.



### Absolute Maximum Ratings

	Parameter	Max.	Units
V <sub>CES</sub>	Collector-to-Emitter Voltage	600	V
I <sub>C</sub> @ T <sub>C</sub> = 25°C	Continuous Collector Current	42	A
I <sub>C</sub> @ T <sub>C</sub> = 100°C	Continuous Collector Current	25	
I <sub>CM</sub>	Pulsed Collector Current ①	84	
I <sub>LM</sub>	Clamped Inductive Load Current ②	84	
t <sub>sc</sub>	Short Circuit Withstand Time	10	$\mu$ s
V <sub>GE</sub>	Gate-to-Emitter Voltage	±20	V
E <sub>ARV</sub>	Reverse Voltage Avalanche Energy ③	15	mJ
P <sub>D</sub> @ T <sub>C</sub> = 25°C	Maximum Power Dissipation	160	W
P <sub>D</sub> @ T <sub>C</sub> = 100°C	Maximum Power Dissipation	65	
T <sub>J</sub>	Operating Junction and Storage Temperature Range	-55 to +150	°C
T <sub>STG</sub>			
	Mounting torque, 6-32 or M3 screw.	10 lbf•in (1.1N•m)	

### Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
R <sub>θJC</sub>	Junction-to-Case	-----	-----	0.77	°C/W
R <sub>θJA</sub>	Junction-to-Ambient, (PCB mount)**	-----	-----	40	
R <sub>θJA</sub>	Junction-to-Ambient, typical socket mount	-----	-----	80	
Wt	Weight	-----	2 (0.07)	-----	g (oz)

\*\* When mounted on 1" square PCB (FR-4 or G-10 Material)

For recommended footprint and soldering techniques refer to application note #AN-994.



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

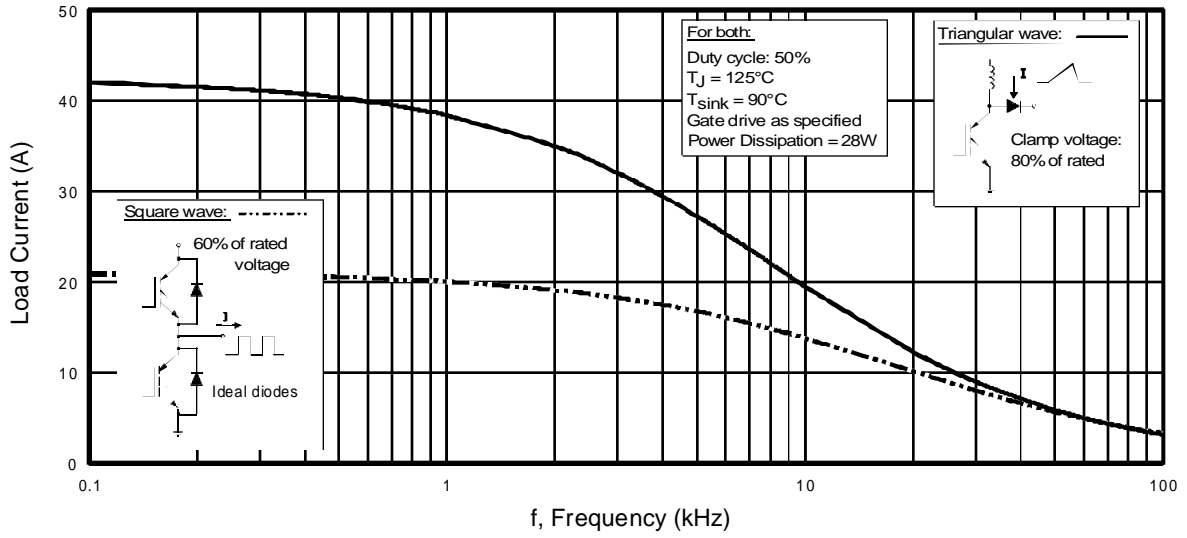
	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage	600	----	----	V	$V_{GE} = 0V, I_C = 250\mu A$
$V_{(BR)ECS}$	Emitter-to-Collector Breakdown Voltage	④ 20	----	----	V	$V_{GE} = 0V, I_C = 1.0A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	----	0.46	----	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 1.0mA$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	----	2.1	3.2	V	$I_C = 25A$ $V_{GE} = 15V$
		----	2.8	----		$I_C = 42A$ See Fig. 2, 5
		----	2.5	----		$I_C = 25A, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	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	----	-13	----	mV/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 250\mu A$
$g_{fe}$	Forward Transconductance ⑤	7.0	14	----	S	$V_{CE} = 100V, I_C = 25A$
$I_{CES}$	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)

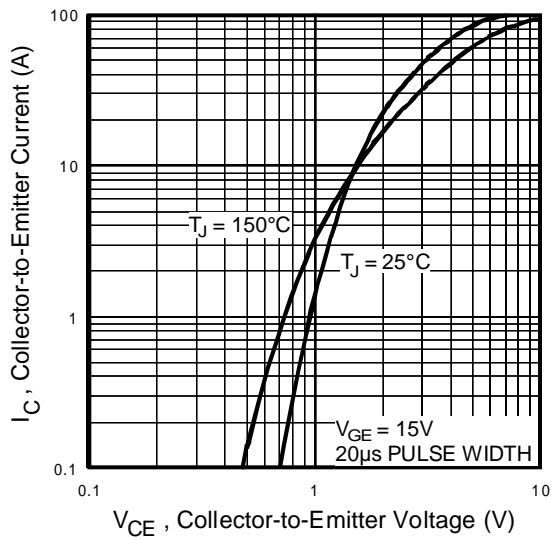
	Parameter	Min.	Typ.	Max.	Units	Conditions	
$Q_g$	Total Gate Charge (turn-on)	----	61	92	nC	$I_C = 25A$	
$Q_{ge}$	Gate - Emitter Charge (turn-on)	----	13	19		$V_{CC} = 400V$ See Fig. 8	
$Q_{gc}$	Gate - Collector Charge (turn-on)	----	22	33		$V_{GE} = 15V$	
$t_{d(on)}$	Turn-On Delay Time	----	35	----	ns	$T_J = 25^\circ\text{C}$	
$t_r$	Rise Time	----	27	----		$I_C = 25A, V_{CC} = 480V$	
$t_{d(off)}$	Turn-Off Delay Time	----	160	240		$V_{GE} = 15V, R_G = 10\Omega$	
$t_f$	Fall Time	----	130	200		Energy losses include "tail"	
$E_{on}$	Turn-On Switching Loss	----	0.52	----		mJ	See Fig. 9, 10, 11, 14
$E_{off}$	Turn-Off Switching Loss	----	1.2	----			
$E_{ts}$	Total Switching Loss	----	1.7	2.6			
$t_{sc}$	Short Circuit Withstand Time	10	----	----	$\mu s$	$V_{CC} = 360V, T_J = 125^\circ\text{C}$ $V_{GE} = 15V, R_G = 10\Omega, V_{CPK} < 500V$	
$t_{d(on)}$	Turn-On Delay Time	----	34	----	ns	$T_J = 150^\circ\text{C},$	
$t_r$	Rise Time	----	28	----		$I_C = 25A, V_{CC} = 480V$	
$t_{d(off)}$	Turn-Off Delay Time	----	300	----		$V_{GE} = 15V, R_G = 10\Omega$	
$t_f$	Fall Time	----	310	----		Energy losses include "tail"	
$E_{ts}$	Total Switching Loss	----	3.6	----	mJ	See Fig. 10, 14	
$L_E$	Internal Emitter Inductance	----	7.5	----	nH	Measured 5mm from package	
$C_{ies}$	Input Capacitance	----	1500	----	pF	$V_{GE} = 0V$	
$C_{oes}$	Output Capacitance	----	190	----		$V_{CC} = 30V$ See Fig. 7	
$C_{res}$	Reverse Transfer Capacitance	----	17	----		$f = 1.0MHz$	

### Notes:

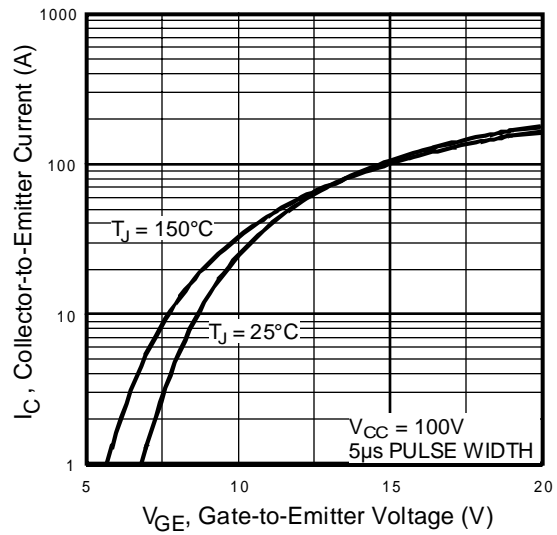
- ① Repetitive rating;  $V_{GE}=20V$ , pulse width limited by max. junction temperature. ( See fig. 13b )
- ②  $V_{CC}=80\%(V_{CES}), V_{GE}=20V, L=10\mu H, R_G=10\Omega,$  ( See fig. 13a )
- ③ Repetitive rating; pulse width limited by maximum junction temperature.
- ④ Pulse width  $\leq 80\mu s$ ; duty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



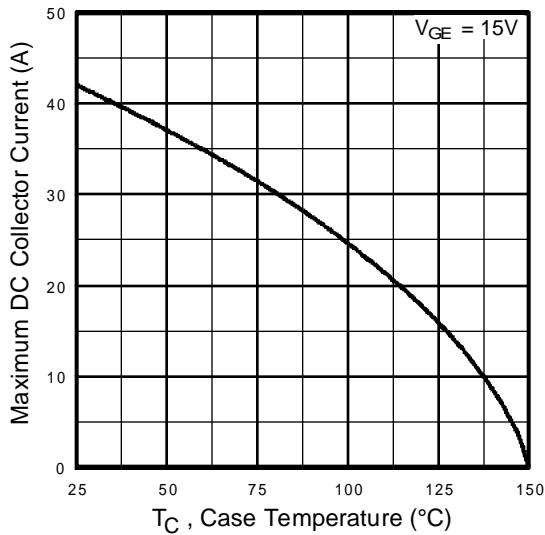
**Fig. 1 - Typical Load Current vs. Frequency**  
 (For square wave,  $I = I_{RMS}$  of fundamental; for triangular wave,  $I = I_{PK}$ )



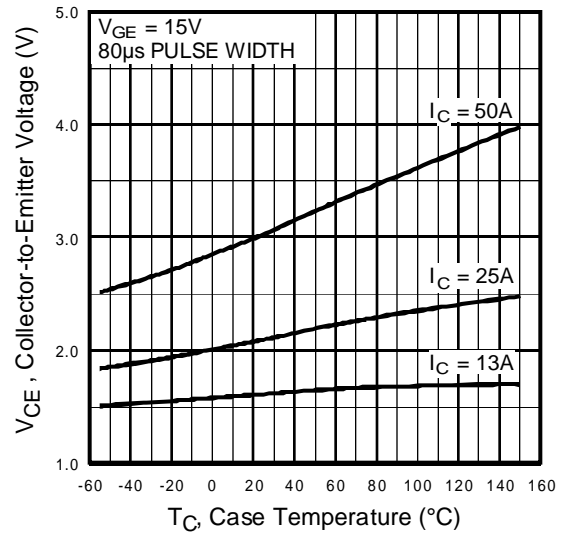
**Fig. 2 - Typical Output Characteristics**



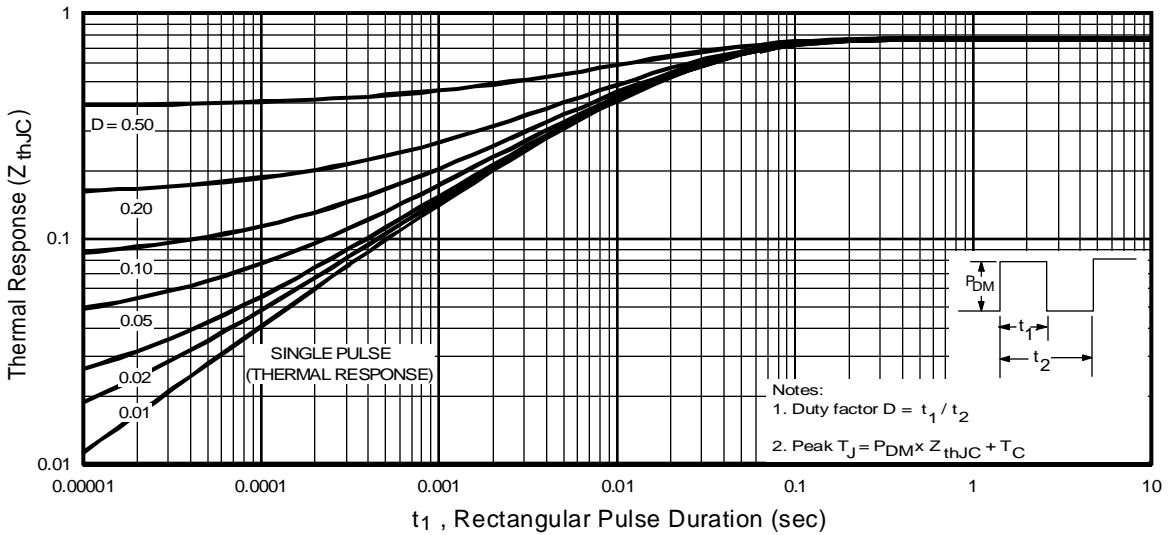
**Fig. 3 - Typical Transfer Characteristics**



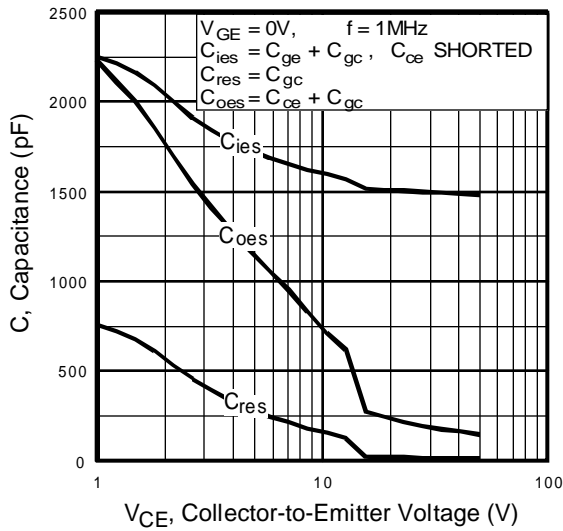
**Fig. 4** - Maximum Collector Current vs. Case Temperature



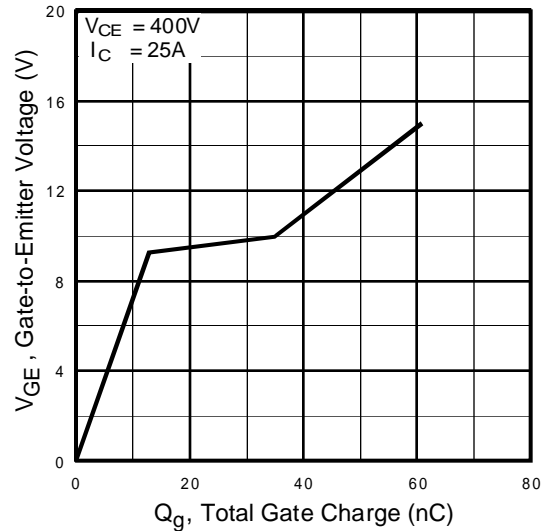
**Fig. 5** - Collector-to-Emitter Voltage vs. Case Temperature



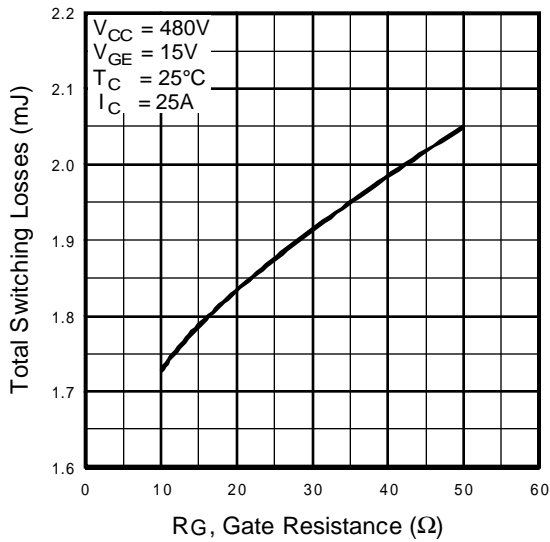
**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case



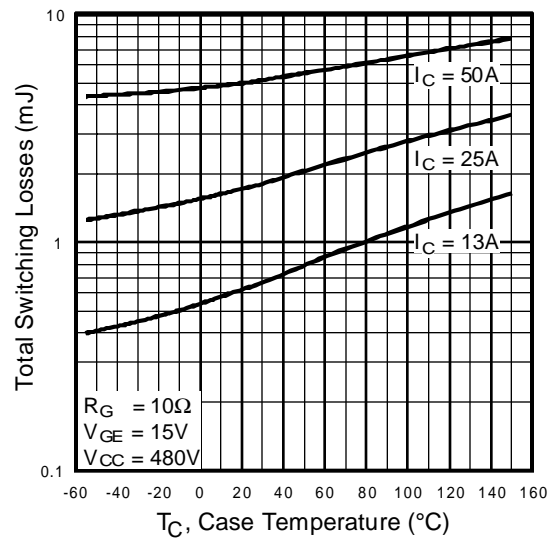
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



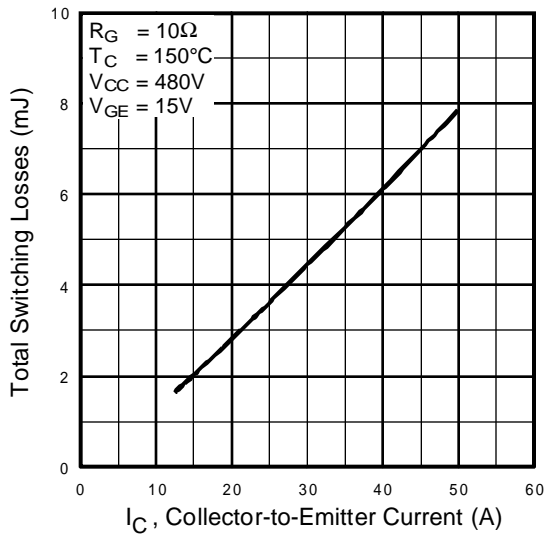
**Fig. 8** - Typical Gate Charge vs. Gate-to-Emitter Voltage



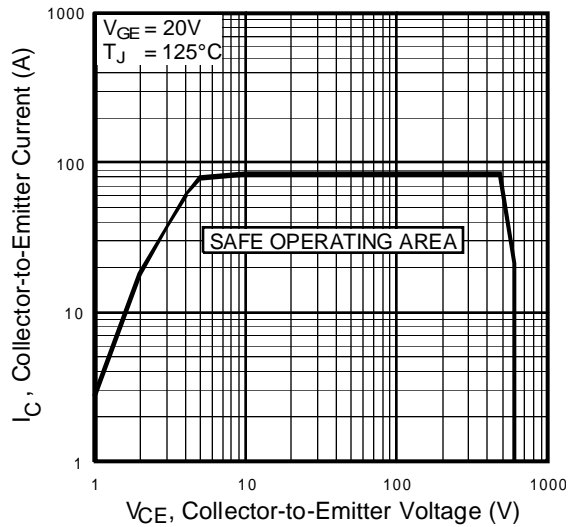
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



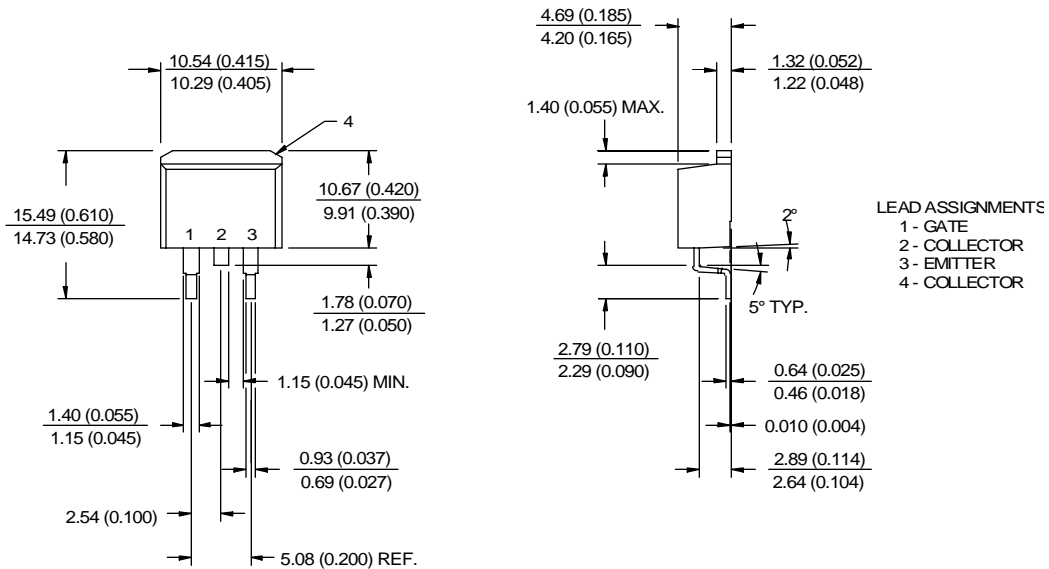
**Fig. 10** - Typical Switching Losses vs. Case Temperature



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

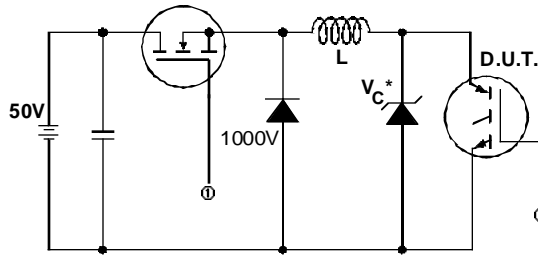


**Fig. 12** - Turn-Off SOA



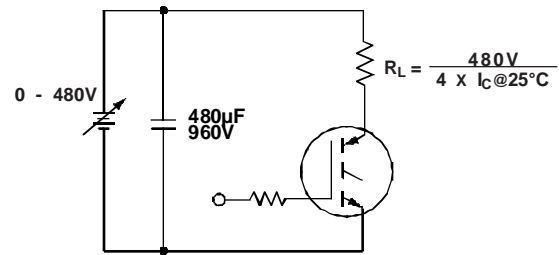
**OUTLINE SMD-220**

Dimensions in Millimeters and (Inches)

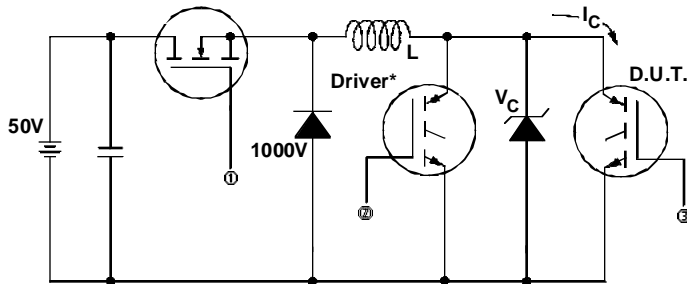


\* Driver same type as D.U.T.;  $V_c = 80\%$  of  $V_{ce(max)}$   
 \* Note: Due to the 50V power supply, pulse width and inductor will increase to obtain rated  $I_d$ .

**Fig. 13a** - Clamped Inductive Load Test Circuit

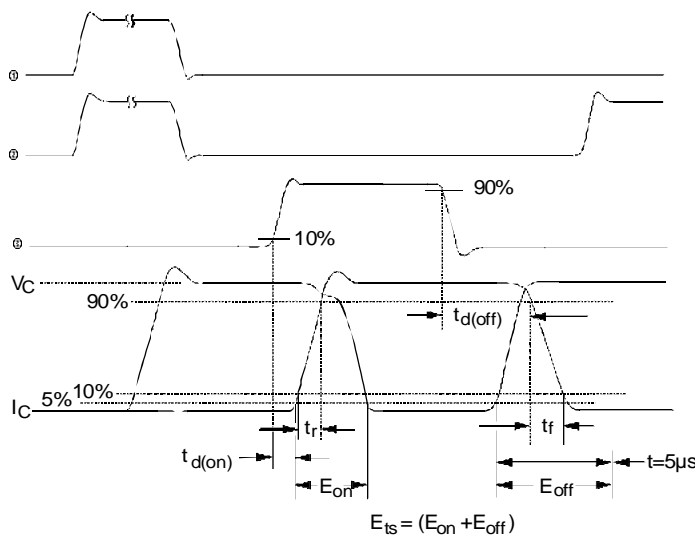


**Fig. 13b** - Pulsed Collector Current Test Circuit



**Fig. 14a** - Switching Loss Test Circuit

\* Driver same type as D.U.T.,  $V_C = 480V$



**Fig. 14b** - Switching Loss Waveforms