

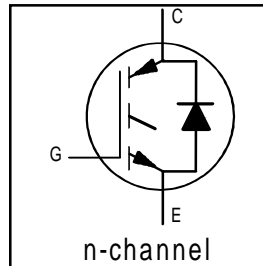
# IRG4BC20SD-S

INSULATED GATE BIPOLAR TRANSISTOR WITH  
 ULTRAFAST SOFT RECOVERY DIODE

Standard Speed IGBT

### Features

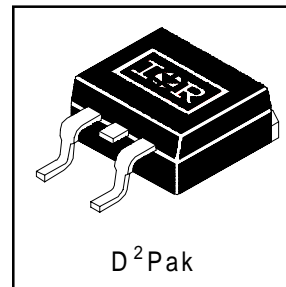
- Extremely low voltage drop 1.4Vtyp. @ 10A
- S-Series: Minimizes power dissipation at up to 3 KHz PWM frequency in inverter drives, up to 4 KHz in brushless DC drives.
- Very Tight Vce(on) distribution
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft-recovery anti-parallel diodes for use in bridge configurations
- Industry standard D<sup>2</sup>Pak package



$V_{CES} = 600V$
$V_{CE(on)} \text{ typ.} = 1.4V$
@ $V_{GE} = 15V, I_C = 10A$

### Benefits

- Generation 4 IGBT's offer highest efficiencies available
- IGBT's optimized for specific application conditions
- HEXFRED diodes optimized for performance with IGBT's . Minimized recovery characteristics require less/no snubbing
- Lower losses than MOSFET's conduction and Diode losses



### 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	38	
$I_{LM}$	Clamped Inductive Load Current ②	38	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	7.0	
$I_{FM}$	Diode Maximum Forward Current	38	V
$V_{GE}$	Gate-to-Emitter Voltage	± 20	
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	60	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	24	
$T_J$	Operating Junction and	-55 to +150	°C
$T_{STG}$	Storage Temperature Range		

### Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT	—	2.1	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode	—	3.5	
$R_{\theta JA}$	Junction-to-Ambient ( PCB Mounted,steady-state)*	—	80	
Wt	Weight	1.44	—	g (oz)

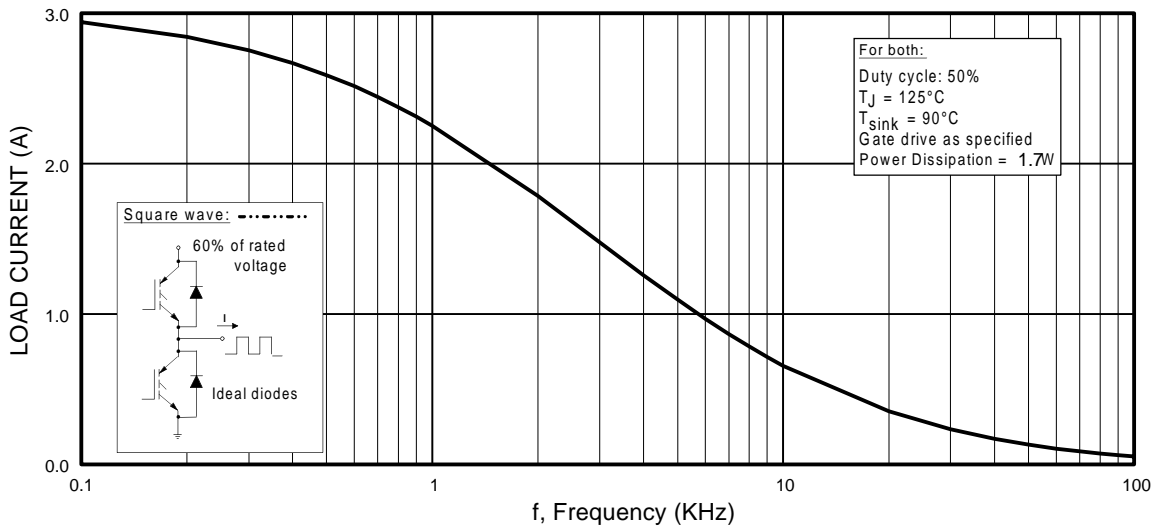
\* When mounted on 1" square PCB (FR-4 or G-10 Material ). For recommended footprint and soldering techniques refer to application note #AN-994.

**Electrical Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)**

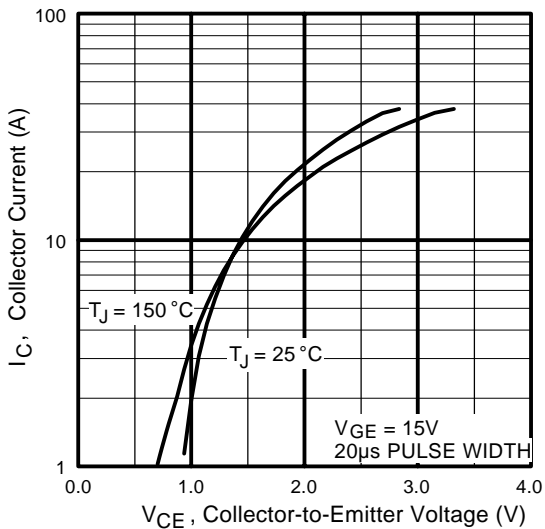
	Parameter	Min.	Typ.	Max.	Units	Conditions
V <sub>(BR)CES</sub>	Collector-to-Emitter Breakdown Voltage <sub>f</sub>	600	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 250μA
dV <sub>(BR)CES</sub> /dT <sub>J</sub>	Temperature Coeff. of Breakdown Voltage	—	0.75	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 1.0mA
V <sub>CE(on)</sub>	Collector-to-Emitter Saturation Voltage	—	1.40	1.6	V	I <sub>C</sub> = 10A
		—	1.85	—		I <sub>C</sub> = 19A
		—	1.44	—		I <sub>C</sub> = 10A, T <sub>J</sub> = 150°C
V <sub>GE(th)</sub>	Gate Threshold Voltage	3.0	—	6.0		V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA
dV <sub>GE(th)</sub> /dT <sub>J</sub>	Temperature Coeff. of Threshold Voltage	—	-11	—	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 250μA
g <sub>fe</sub>	Forward Transconductance ④	2.0	5.8	—	S	V <sub>CE</sub> = 100V, I <sub>C</sub> = 10A
I <sub>CEs</sub>	Zero Gate Voltage Collector Current	—	—	250	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V
		—	—	1700		V <sub>GE</sub> = 0V, V <sub>CE</sub> = 600V, T <sub>J</sub> = 150°C
V <sub>FM</sub>	Diode Forward Voltage Drop	—	1.4	1.7	V	I <sub>C</sub> = 8.0A
		—	1.3	1.6		I <sub>C</sub> = 8.0A, T <sub>J</sub> = 150°C
I <sub>GES</sub>	Gate-to-Emitter Leakage Current	—	—	±100	nA	V <sub>GE</sub> = ±20V

**Switching Characteristics @ T<sub>J</sub> = 25°C (unless otherwise specified)**

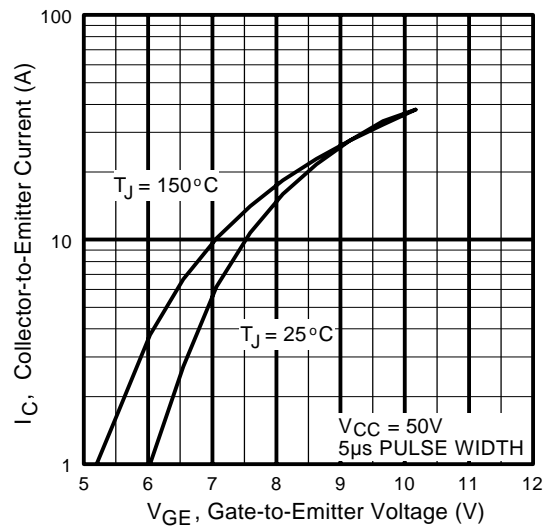
	Parameter	Min.	Typ.	Max.	Units	Conditions
Q <sub>g</sub>	Total Gate Charge (turn-on)	—	27	40	nC	I <sub>C</sub> = 10A V <sub>CC</sub> = 400V V <sub>GE</sub> = 15V See Fig. 8
Q <sub>ge</sub>	Gate - Emitter Charge (turn-on)	—	4.3	6.5		
Q <sub>gc</sub>	Gate - Collector Charge (turn-on)	—	10	15		
t <sub>d(on)</sub>	Turn-On Delay Time	—	62	—	ns	T <sub>J</sub> = 25°C I <sub>C</sub> = 10A, V <sub>CC</sub> = 480V V <sub>GE</sub> = 15V, R <sub>G</sub> = 50Ω Energy losses include "tail" and diode reverse recovery. See Fig. 9, 10, 11, 18
t <sub>r</sub>	Rise Time	—	32	—		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	690	1040		
t <sub>f</sub>	Fall Time	—	480	730		
E <sub>on</sub>	Turn-On Switching Loss	—	0.32	—	mJ	T <sub>J</sub> = 150°C, See Fig. 10, 11, 18 I <sub>C</sub> = 10A, V <sub>CC</sub> = 480V V <sub>GE</sub> = 15V, R <sub>G</sub> = 50Ω Energy losses include "tail" and diode reverse recovery.
E <sub>off</sub>	Turn-Off Switching Loss	—	2.58	—		
E <sub>ts</sub>	Total Switching Loss	—	2.90	4.5		
t <sub>d(on)</sub>	Turn-On Delay Time	—	64	—	ns	Measured 5mm from package
t <sub>r</sub>	Rise Time	—	35	—		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	980	—		
t <sub>f</sub>	Fall Time	—	800	—		
E <sub>ts</sub>	Total Switching Loss	—	4.33	—	mJ	
L <sub>E</sub>	Internal Emitter Inductance	—	7.5	—	nH	Measured 5mm from package
C <sub>ies</sub>	Input Capacitance	—	550	—	pF	V <sub>GE</sub> = 0V V <sub>CC</sub> = 30V f = 1.0MHz See Fig. 7
C <sub>oes</sub>	Output Capacitance	—	39	—		
C <sub>res</sub>	Reverse Transfer Capacitance	—	7.1	—		
t <sub>rr</sub>	Diode Reverse Recovery Time	—	37	55	ns	T <sub>J</sub> = 25°C See Fig. 14
		—	55	90		T <sub>J</sub> = 125°C
I <sub>rr</sub>	Diode Peak Reverse Recovery Current	—	3.5	5.0	A	T <sub>J</sub> = 25°C See Fig. 15
		—	4.5	8.0		T <sub>J</sub> = 125°C
Q <sub>rr</sub>	Diode Reverse Recovery Charge	—	65	138	nC	T <sub>J</sub> = 25°C See Fig. 16
		—	124	360		T <sub>J</sub> = 125°C
di <sub>(rec)</sub> M/dt	Diode Peak Rate of Fall of Recovery During t <sub>b</sub>	—	240	—	A/μs	T <sub>J</sub> = 25°C See Fig. 17
		—	210	—		T <sub>J</sub> = 125°C



**Fig. 1 - Typical Load Current vs. Frequency**  
 (Load Current =  $I_{\text{RMS}}$  of fundamental)



**Fig. 2 - Typical Output Characteristics**



**Fig. 3 - Typical Transfer Characteristics**

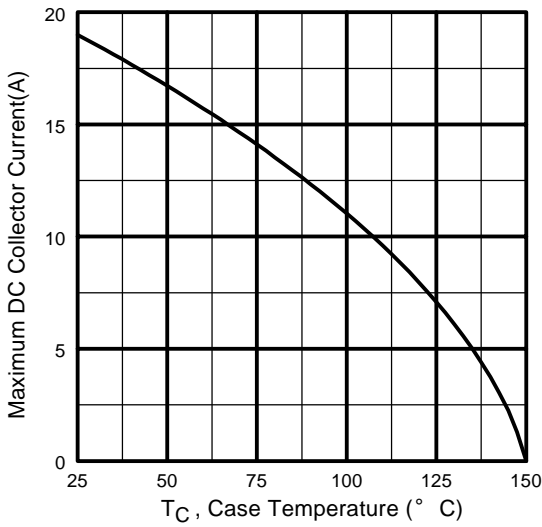


Fig. 4 - Maximum Collector Current vs. Case Temperature

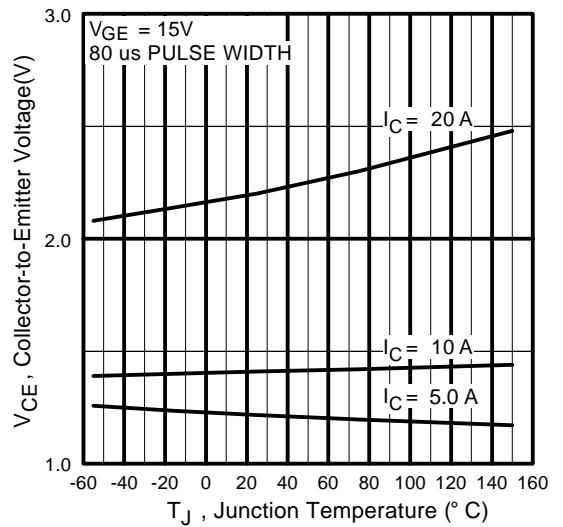


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

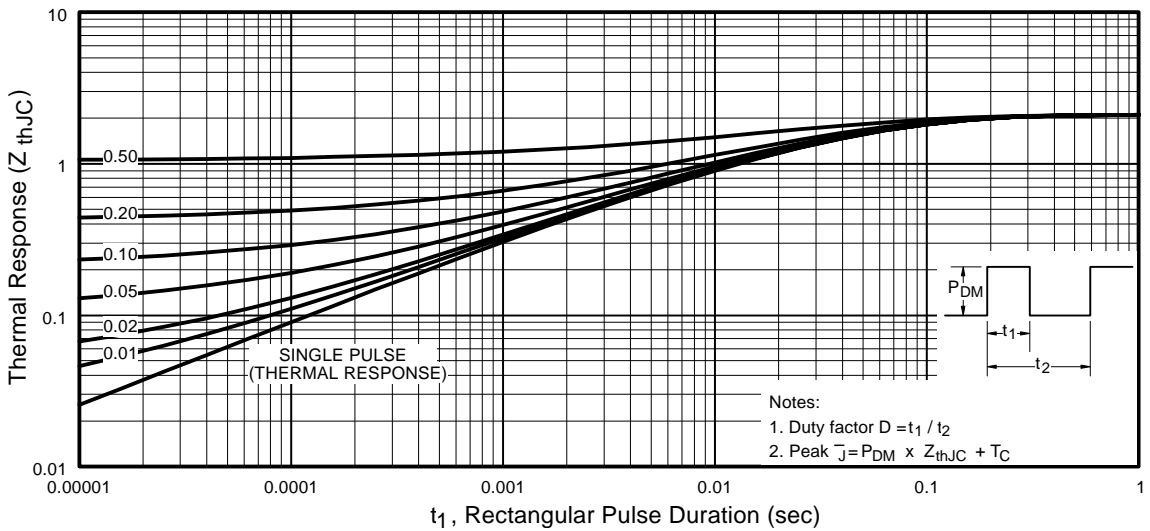
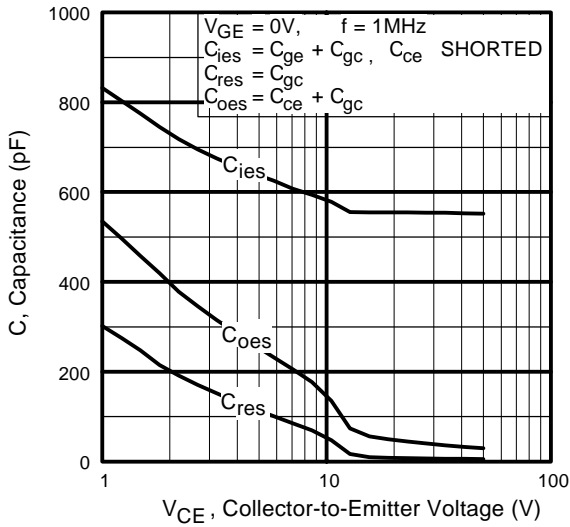
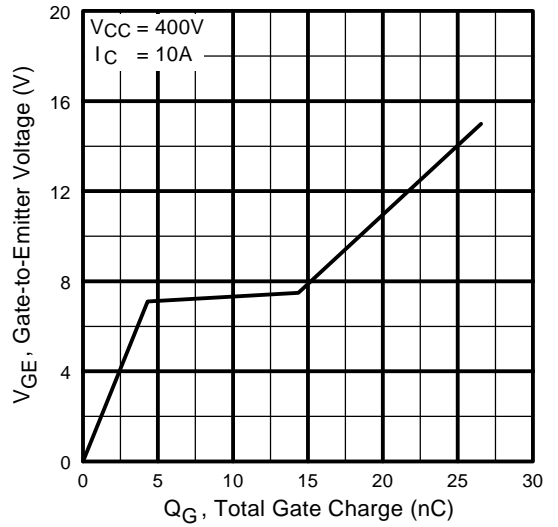


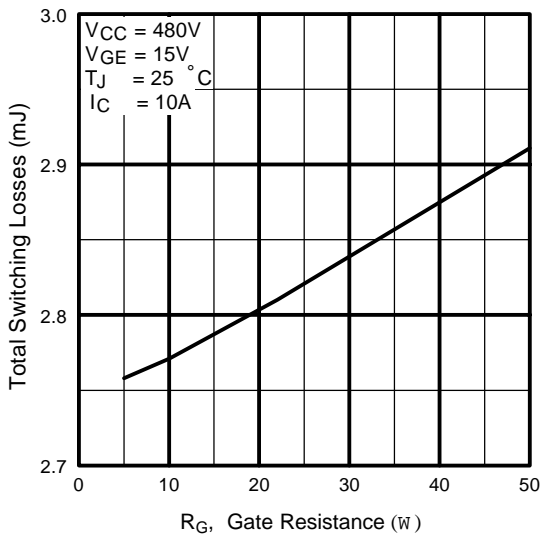
Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case



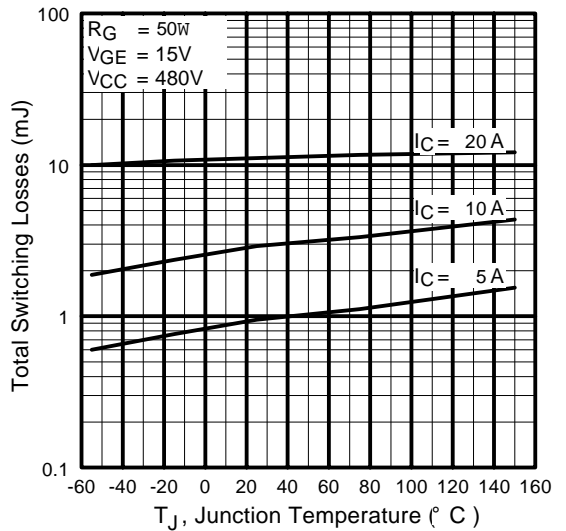
**Fig. 7** - Typical Capacitance vs. Collector-to-Emitter Voltage



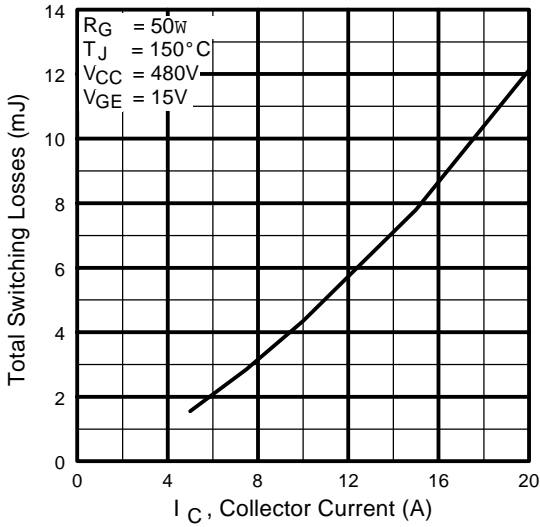
**Fig. 8** - Typical Gate Charge vs. Gate-to-Emitter Voltage



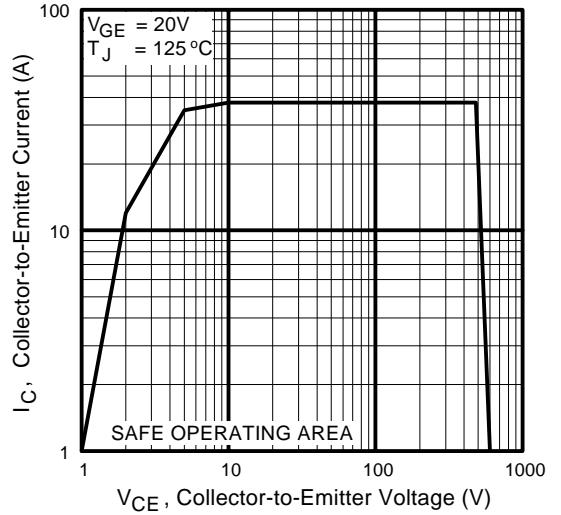
**Fig. 9** - Typical Switching Losses vs. Gate Resistance



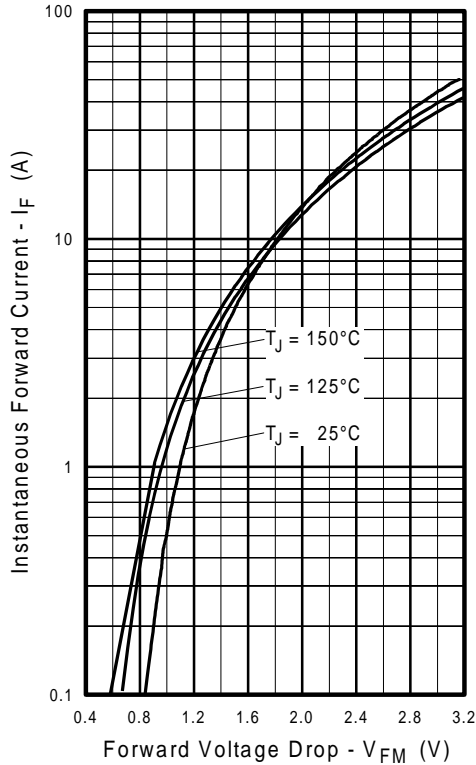
**Fig. 10** - Typical Switching Losses vs. Junction Temperature



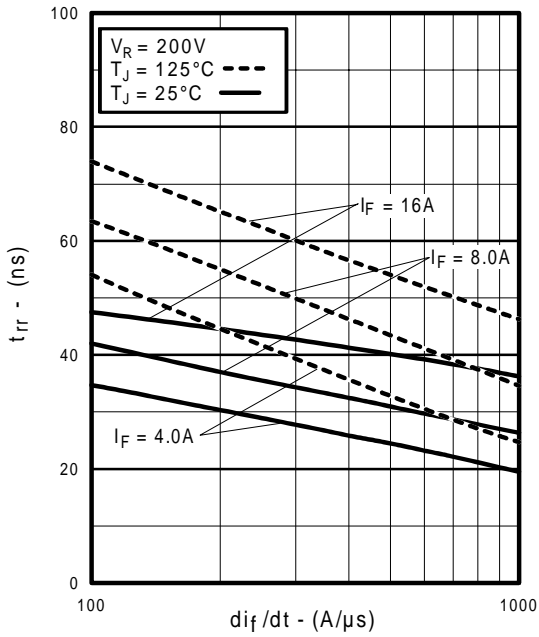
**Fig. 11** - Typical Switching Losses vs. Collector-to-Emitter Current



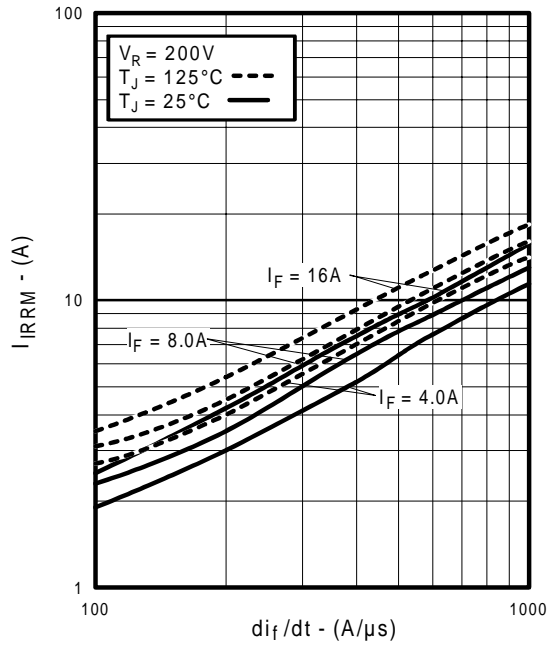
**Fig. 12** - Turn-Off SOA



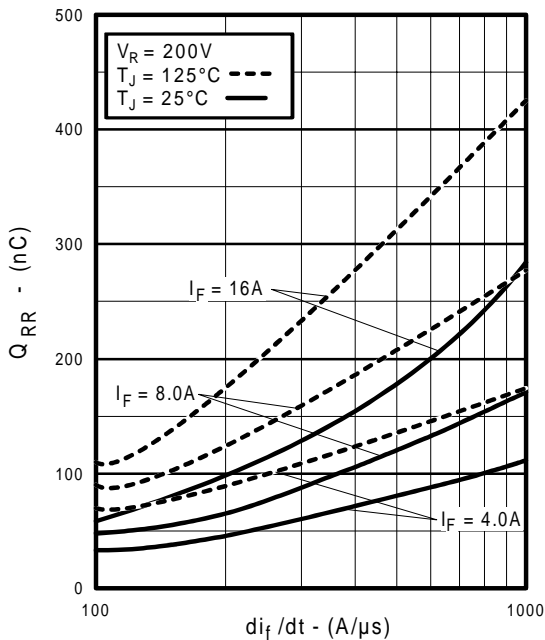
**Fig. 13** - Maximum Forward Voltage Drop vs. Instantaneous Forward Current



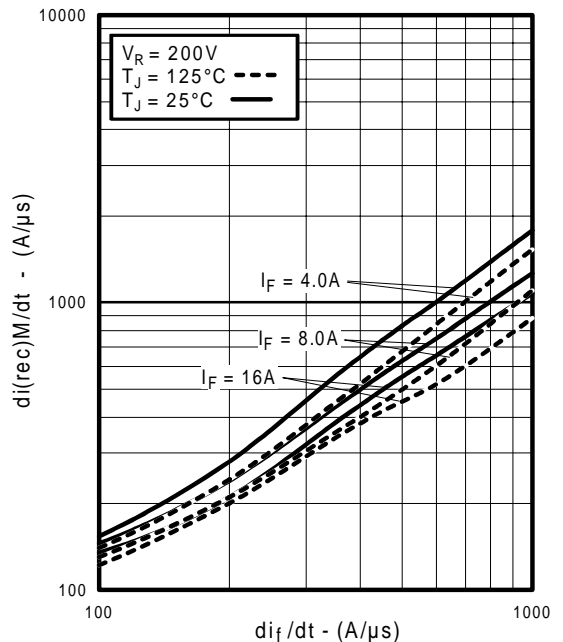
**Fig. 14** - Typical Reverse Recovery vs.  $di_f/dt$



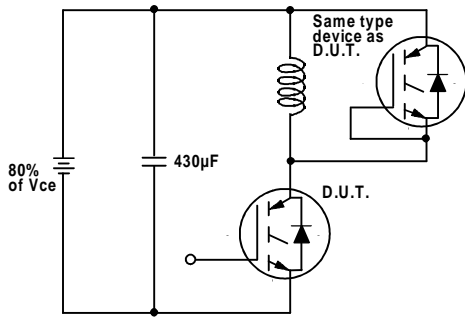
**Fig. 15** - Typical Recovery Current vs.  $di_f/dt$



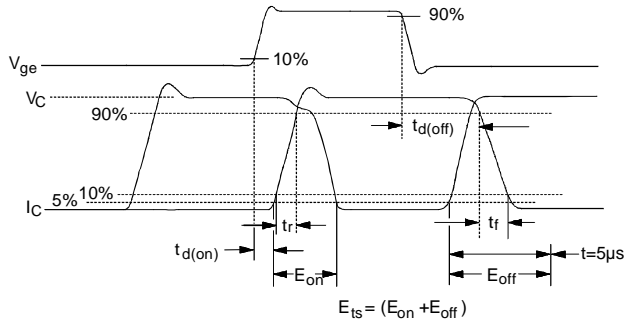
**Fig. 16** - Typical Stored Charge vs.  $di_f/dt$   
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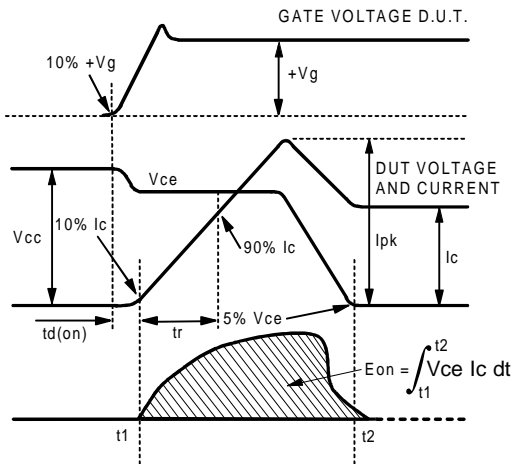
**Fig. 17** - Typical  $di(rec)M/dt$  vs.  $di_f/dt$



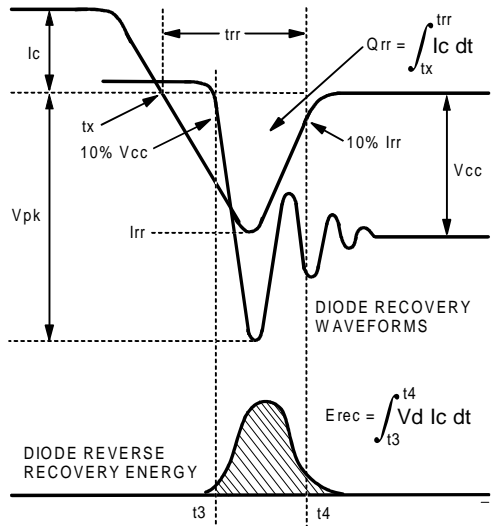
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



**Fig. 18b** - Test Waveforms for Circuit of Fig. 18a, Defining  $E_{off}$ ,  $t_{d(off)}$ ,  $t_f$



**Fig. 18c** - Test Waveforms for Circuit of Fig. 18a, Defining  $E_{on}$ ,  $t_{d(on)}$ ,  $t_r$



**Fig. 18d** - Test Waveforms for Circuit of Fig. 18a, Defining  $E_{rec}$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$



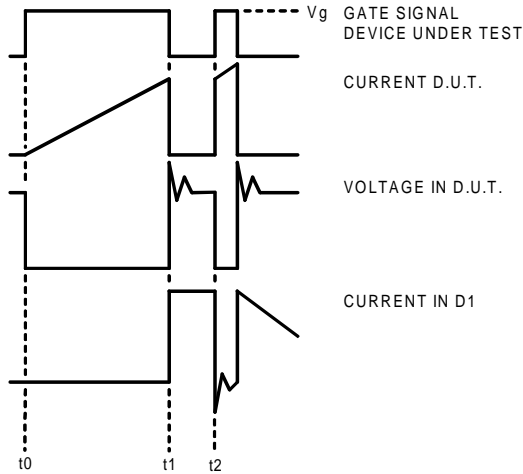


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

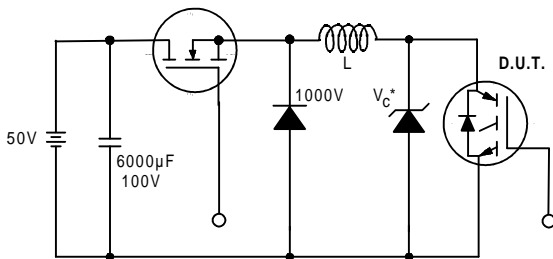


Figure 19. Clamped Inductive Load Test Circuit

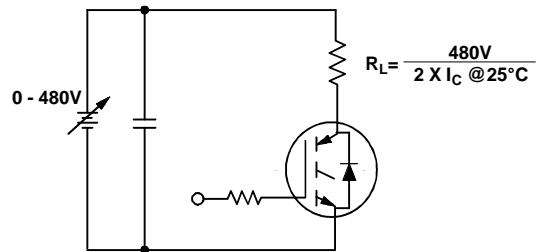
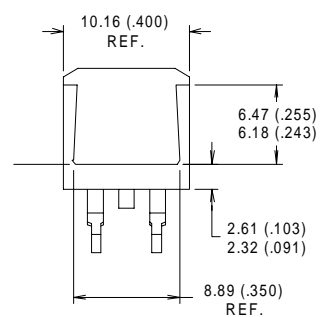
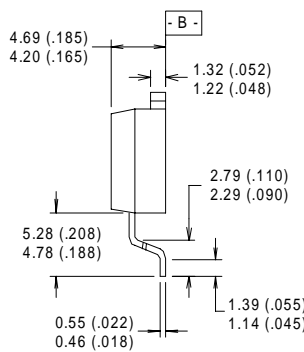
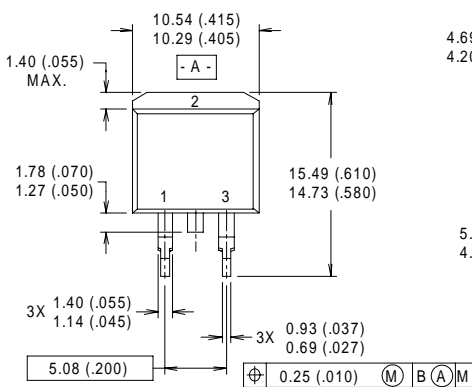


Figure 20. Pulsed Collector Current Test Circuit

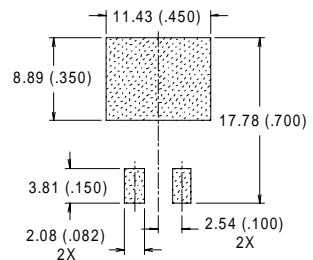
**Notes:**

- ① Repetitive rating:  $V_{GE}=20V$ ; pulse width limited by maximum junction temperature (figure 20)
- ②  $V_{CC}=80\% (V_{CES})$ ,  $V_{GE}=20V$ ,  $L=10\mu H$ ,  $R_G = 50\omega$  (figure 19)
- ③ Pulse width  $\leq 80\mu s$ ; duty factor  $\leq 0.1\%$ .
- ④ Pulse width  $5.0\mu s$ , single shot.

**D<sup>2</sup>Pak Package Outline**



MINIMUM RECOMMENDED FOOTPRINT



**NOTES:**

- 1 DIMENSIONS AFTER SOLDER DIP.
- 2 DIMENSIONING & TOLERANCING PER ANSI Y14.5M, 1982.
- 3 CONTROLLING DIMENSION : INCH.
- 4 HEATSINK & LEAD DIMENSIONS DO NOT INCLUDE BURRS.

**LEAD ASSIGNMENTS**

- 1 - GATE
- 2 - DRAIN
- 3 - SOURCE

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**IR GREAT BRITAIN:** Hurst Green, Oxted, Surrey RH8 9BB, UK Tel: ++ 44 1883 732020

**IR CANADA:** 15 Lincoln Court, Brampton, Ontario L6T3Z2, Tel: (905) 453 2200

**IR GERMANY:** Saalburgstrasse 157, 61350 Bad Homburg Tel: ++ 49 6172 96590

**IR ITALY:** Via Liguria 49, 10071 Borgaro, Torino Tel: ++ 39 11 451 0111

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**IR SOUTHEAST ASIA:** 1 Kim Seng Promenade, Great World City West Tower, 13-11, Singapore 237994 Tel: ++ 65 838 4630

**IR TAIWAN:** 16 Fl. Suite D. 207, Sec. 2, Tun Haw South Road, Taipei, 10673, Taiwan Tel: 886-2-2377-9936

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