

**INSULATED GATE BIPOLAR TRANSISTOR WITH  
 ULTRAFAST SOFT RECOVERY DIODE**

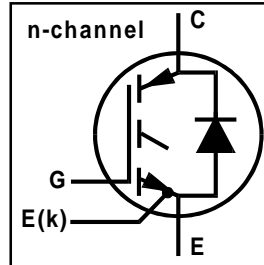
Surface Mountable  
 Short Circuit Rated  
 UltraFast IGBT

**Features**

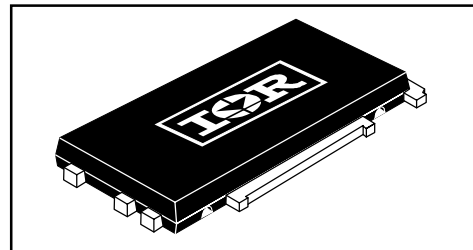
- High short circuit rating optimized for motor control,  $t_{sc} = 10\mu s$ ,  $V_{CC} = 720V$ ,  $T_J = 125^\circ C$ ,  $V_{GE} = 15V$
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft-recovery antiparallel diodes for use in bridge configurations
- Combines low conduction losses with high switching speed
- Low profile low inductance SMD-10 Package
- Separated control & Power-connections for easy paralleling
- Inherently Good coplanarity
- Easy solder inspection and cleaning

**Benefits**

- Highest power density and efficiency available
- HEXFRED Diodes optimized for performance with IGBTs. Minimized recovery characteristics
- IGBTs optimized for specific application conditions



$V_{CES} = 1200V$
$V_{CE(ON)typ} = 2.89V$
@ $V_{GE} = 15V, I_C = 42A$



**Absolute Maximum Ratings**

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	1200	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	78	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	42	
$I_{CM}$	Pulsed Collector Current ①	156	
$I_{LM}$	Clamped Inductive Load Current ②	156	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	42	
$I_{FM}$	Diode Maximum Forward Current	156	
$t_{sc}$	Short Circuit Withstand Time	10	$\mu s$
$V_{GE}$	Gate-to-Emitter Voltage	$\pm 20$	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	350	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	140	
$T_J$ $T_{STG}$	Operating Junction and Storage Temperature Range	-55 to +150	$^\circ C$

**Thermal Resistance**

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT	—	—	0.36	$^\circ C/W$
$R_{\theta JC}$	Junction-to-Case - Diode	—	—	0.69	
$R_{\theta CS}$	SMD-10 Case-to-Heatsink (typical), *	—	0.44	—	
	Weight	—	6.0(0.21)	—	g (oz)

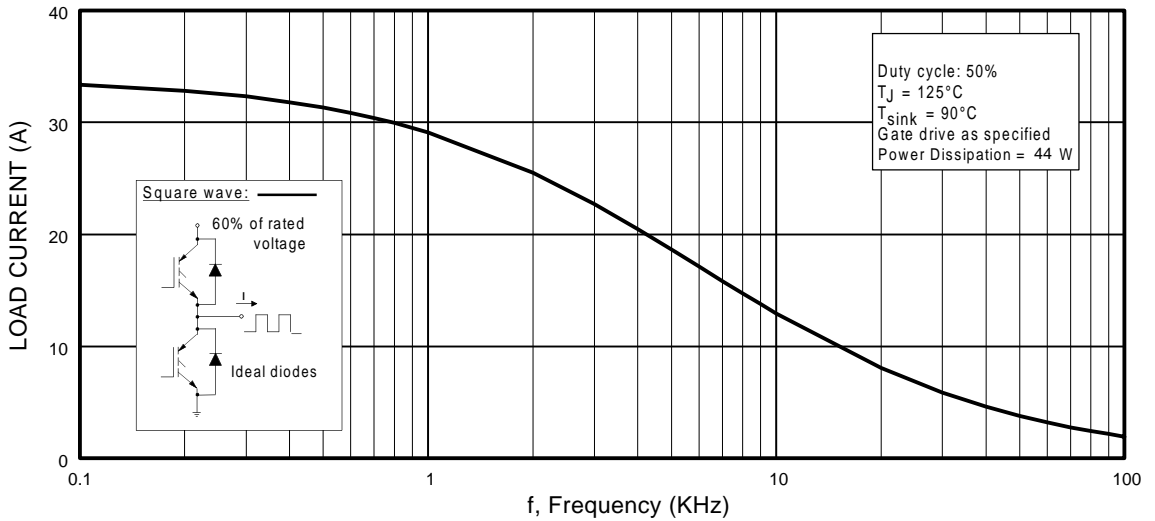
\* Assumes device soldered to 3.0 oz. Cu on 3.0mm IMS/Aluminum board, mounted to flat, greased heatsink.

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

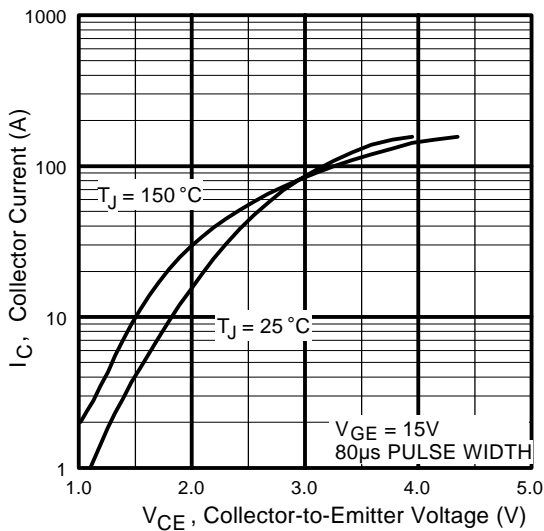
	Parameter	Min.	Typ.	Max.	Units	Conditions
V <sub>(BR)CES</sub>	Collector-to-Emitter Breakdown Voltage <sup>③</sup>	1200	—	—	V	V <sub>GE</sub> = 0V, I <sub>C</sub> = 250μA
ΔV <sub>(BR)CES/ΔT<sub>J</sub></sub>	Temperature Coeff. of Breakdown Voltage	—	0.26	—	V/°C	V <sub>GE</sub> = 0V, I <sub>C</sub> = 4.0mA
V <sub>CE(on)</sub>	Collector-to-Emitter Saturation Voltage	—	2.89	3.9	V	I <sub>C</sub> = 42A I <sub>C</sub> = 78A I <sub>C</sub> = 42A, T <sub>J</sub> = 150°C
		—	3.73	—		
		—	2.55	—		
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
ΔV <sub>GE(th)/ΔT<sub>J</sub></sub>	Temperature Coeff. of Threshold Voltage	—	-11	—	mV/°C	V <sub>CE</sub> = V <sub>GE</sub> , I <sub>C</sub> = 1.5mA
g <sub>fe</sub>	Forward Transconductance <sup>④</sup>	23	34	—	S	V <sub>CE</sub> = 50V, I <sub>C</sub> = 42A
I <sub>CES</sub>	Zero Gate Voltage Collector Current	—	—	500	μA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 1200V
		—	—	10	mA	V <sub>GE</sub> = 0V, V <sub>CE</sub> = 1200V, T <sub>J</sub> = 150°C
V <sub>FM</sub>	Diode Forward Voltage Drop	—	2.45	3.7	V	I <sub>C</sub> = 42A I <sub>C</sub> = 42A, T <sub>J</sub> = 150°C
		—	2.40	—		
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)**

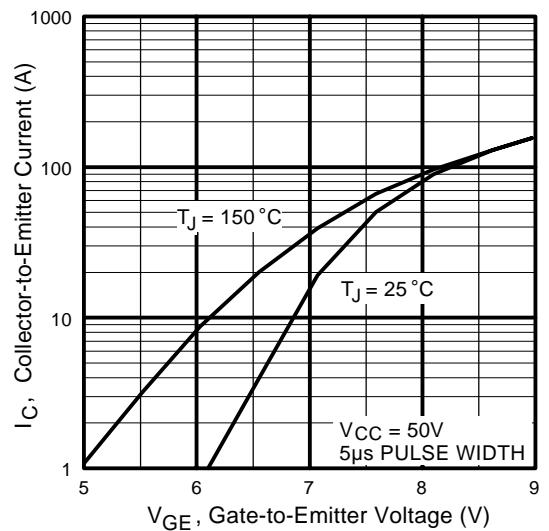
	Parameter	Min.	Typ.	Max.	Units	Conditions
Q <sub>g</sub>	Total Gate Charge (turn-on)	—	380	570	nC	I <sub>C</sub> = 42A V <sub>CC</sub> = 400V V <sub>GE</sub> = 15V
Q <sub>ge</sub>	Gate - Emitter Charge (turn-on)	—	48	72		
Q <sub>gc</sub>	Gate - Collector Charge (turn-on)	—	120	180		
t <sub>d(on)</sub>	Turn-On Delay Time	—	80	—	ns	T <sub>J</sub> = 25°C I <sub>C</sub> = 42A, V <sub>CC</sub> = 800V V <sub>GE</sub> = 15V, R <sub>G</sub> = 5.0Ω
t <sub>r</sub>	Rise Time	—	45	—		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	215	320		
t <sub>f</sub>	Fall Time	—	220	330	mJ	Energy losses include "tail" and diode reverse recovery See Fig. 9,10,18
E <sub>on</sub>	Turn-On Switching Loss	—	3.64	—		
E <sub>off</sub>	Turn-Off Switching Loss	—	3.17	—		
E <sub>ts</sub>	Total Switching Loss	—	6.81	9.8	μs	V <sub>CC</sub> = 720V, T <sub>J</sub> = 125°C V <sub>GE</sub> = 15V, R <sub>G</sub> = 5.0Ω
t <sub>sc</sub>	Short Circuit Withstand Time	10	—	—		
t <sub>d(on)</sub>	Turn-On Delay Time	—	91	—	ns	T <sub>J</sub> = 150°C, See Fig. 10,11,18 I <sub>C</sub> = 42A, V <sub>CC</sub> = 800V V <sub>GE</sub> = 15V, R <sub>G</sub> = 5.0Ω, Energy losses include "tail" and diode reverse recovery
t <sub>r</sub>	Rise Time	—	48	—		
t <sub>d(off)</sub>	Turn-Off Delay Time	—	430	—		
t <sub>f</sub>	Fall Time	—	400	—	mJ	Measured 5mm from package
E <sub>ts</sub>	Total Switching Loss	—	14.6	—		
L <sub>E</sub>	Internal Emitter Inductance	—	2.0	—	pF	V <sub>GE</sub> = 0V V <sub>CC</sub> = 30V f = 1.0MHz
C <sub>ies</sub>	Input Capacitance	—	5620	—		
C <sub>oes</sub>	Output Capacitance	—	400	—		
C <sub>res</sub>	Reverse Transfer Capacitance	—	94	—	ns	T <sub>J</sub> = 25°C See Fig. 14 T <sub>J</sub> = 125°C
t <sub>rr</sub>	Diode Reverse Recovery Time	—	107	160		
I <sub>rr</sub>	Diode Peak Reverse Recovery Current	—	10	15	A	T <sub>J</sub> = 25°C See Fig. 15 T <sub>J</sub> = 125°C
		—	16	24		
Q <sub>rr</sub>	Diode Reverse Recovery Charge	—	680	1020	nC	T <sub>J</sub> = 25°C See Fig. 16 T <sub>J</sub> = 125°C
		—	1400	2100		
di <sub>(rec)M</sub> /dt	Diode Peak Rate of Fall of Recovery During t <sub>b</sub>	—	250	—	A/μs	T <sub>J</sub> = 25°C See Fig. 17 T <sub>J</sub> = 125°C
		—	320	—		



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



**Fig. 2 - Typical Output Characteristics**



**Fig. 3 - Typical Transfer Characteristics**

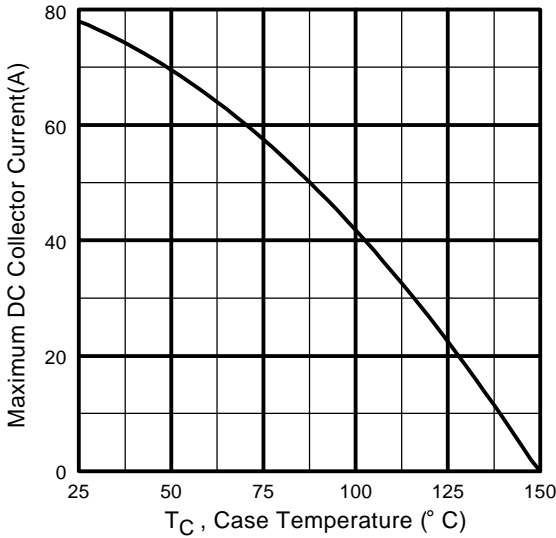


Fig. 4 - Maximum Collector Current vs. Case Temperature

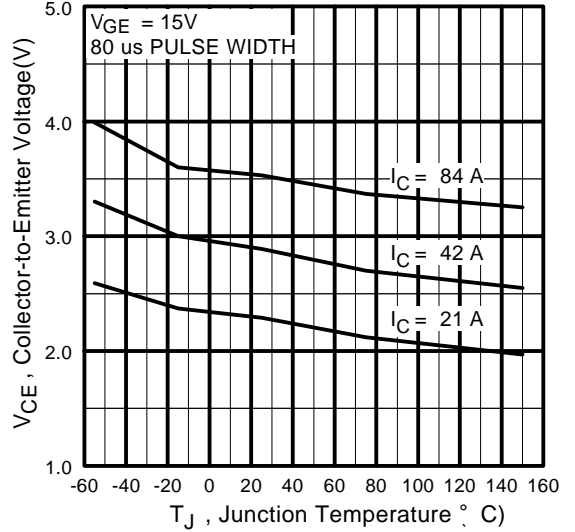


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

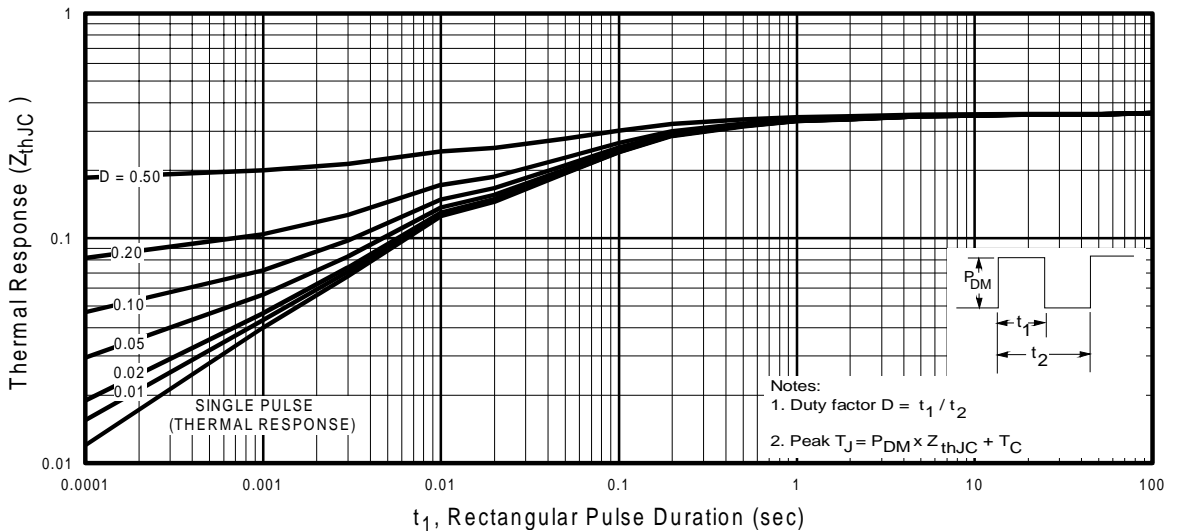


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

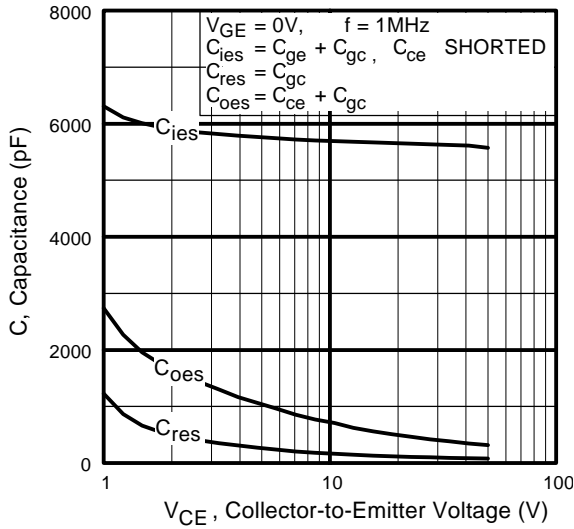


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

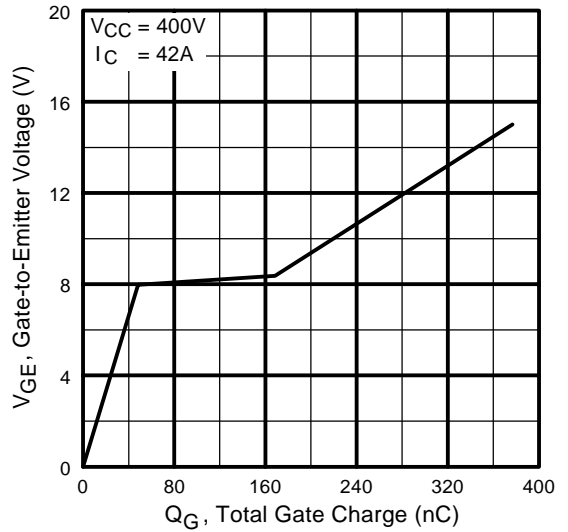


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

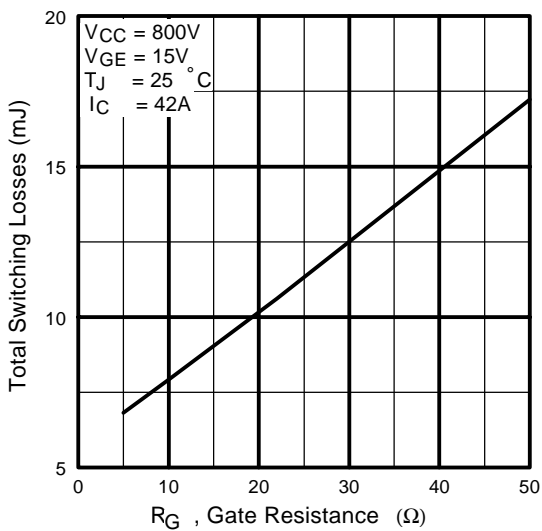


Fig. 9 - Typical Switching Losses vs. Gate Resistance

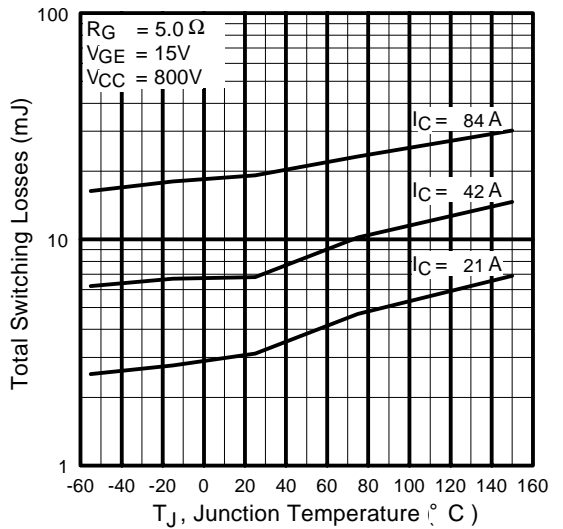


Fig. 10 - Typical Switching Losses vs. Junction Temperature

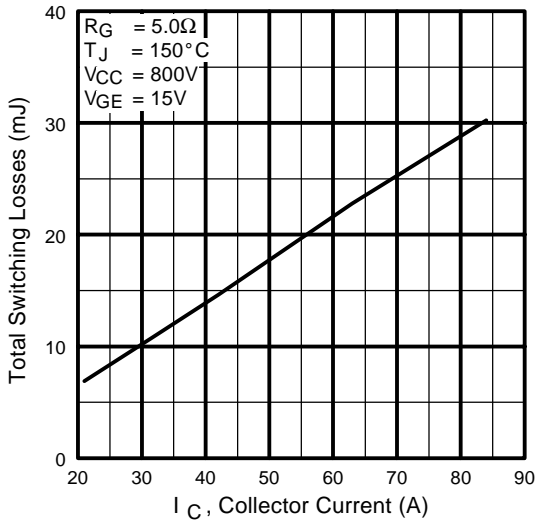


Fig. 11 - Typical Switching Losses vs. Collector Current

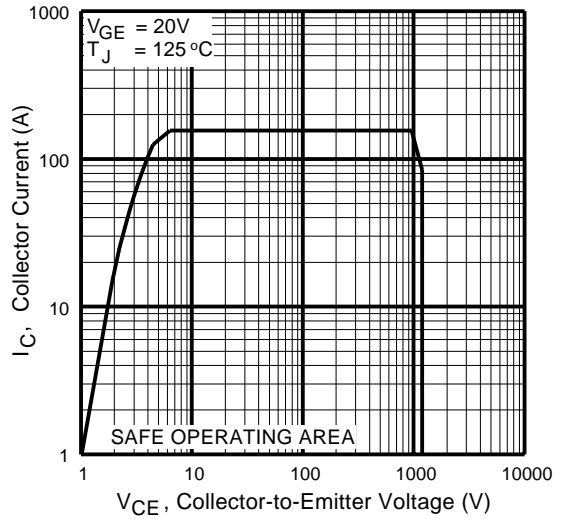


Fig. 12 - Turn-Off SOA

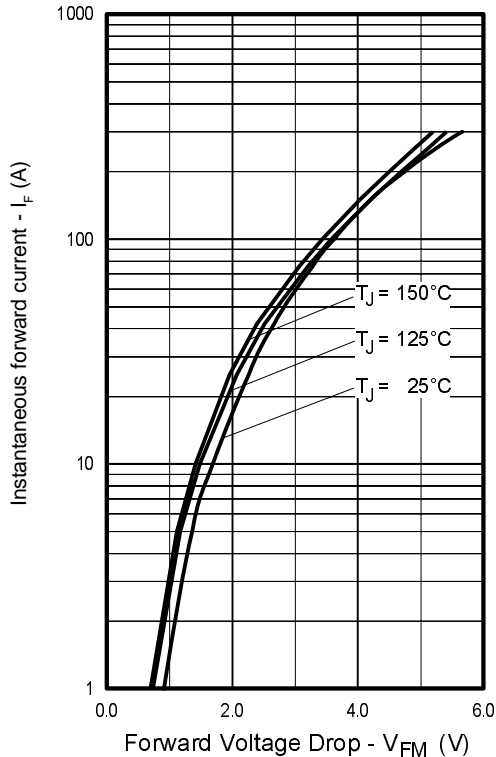


Fig. 13 - Typical Forward Voltage Drop vs. Instantaneous Forward Current

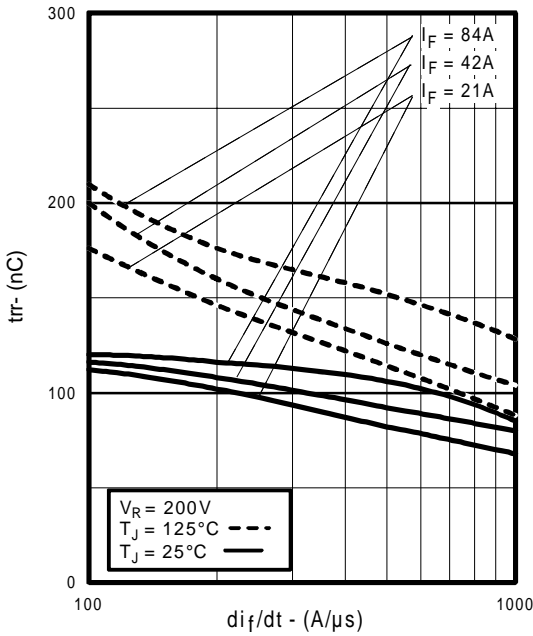


Fig. 14 - Typical Reverse Recovery vs.  $di_f/dt$

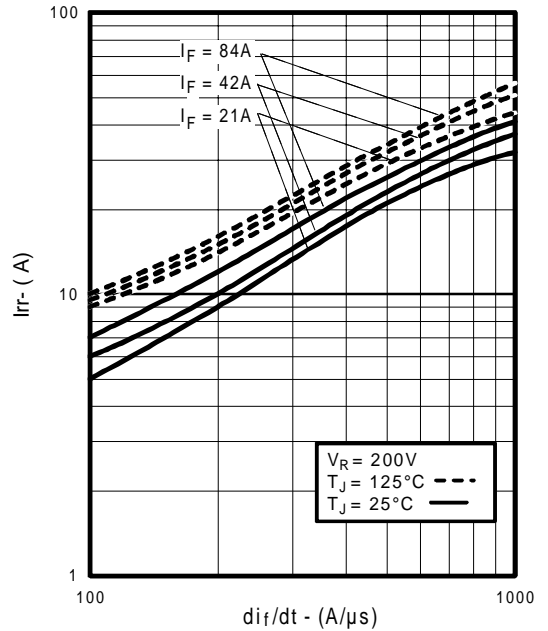


Fig. 15 - Typical Recovery Current vs.  $di_f/dt$

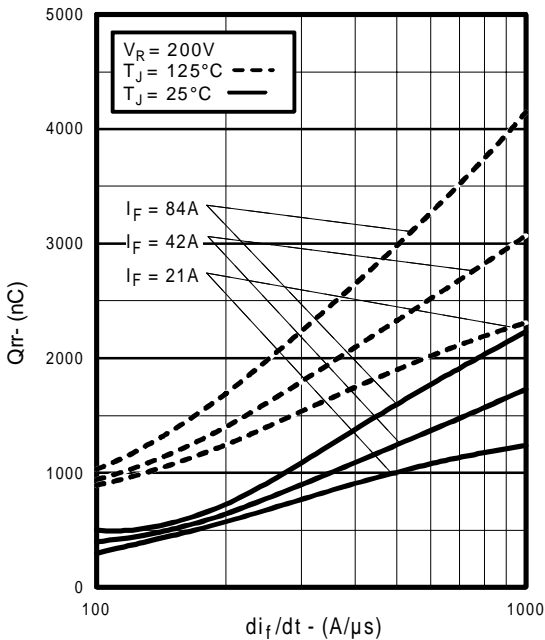


Fig. 16 - Typical Stored Charge vs.  $di_f/dt$

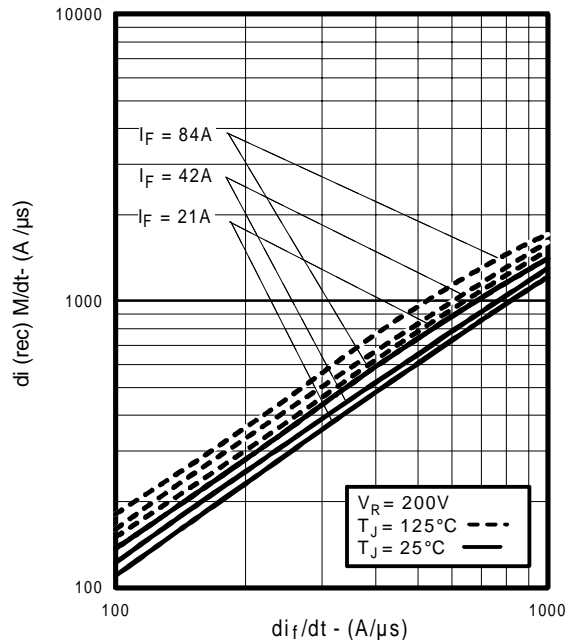
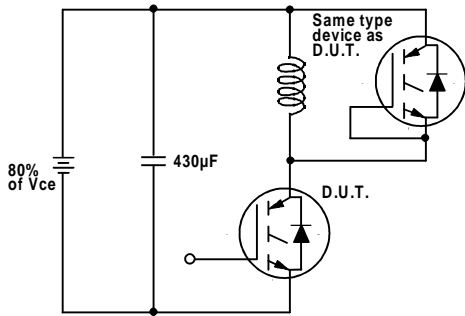
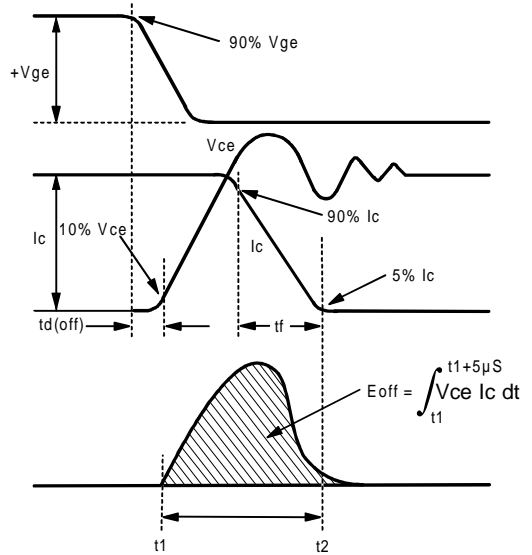


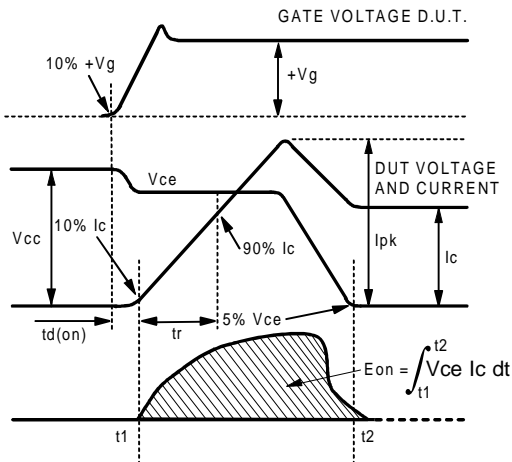
Fig. 17 - Typical  $di_{(rec)}M/dt$  vs.  $di_f/dt$



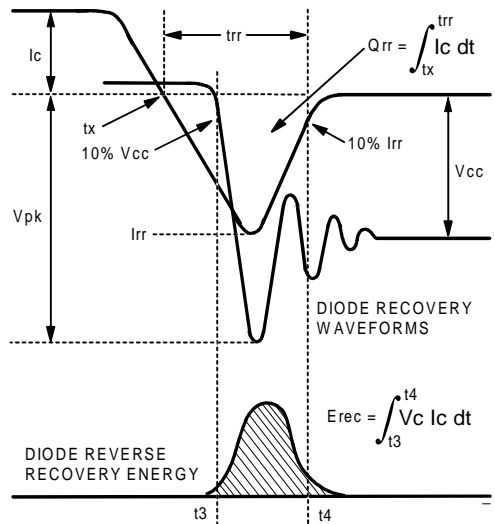
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



**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  $E_{rec}$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$



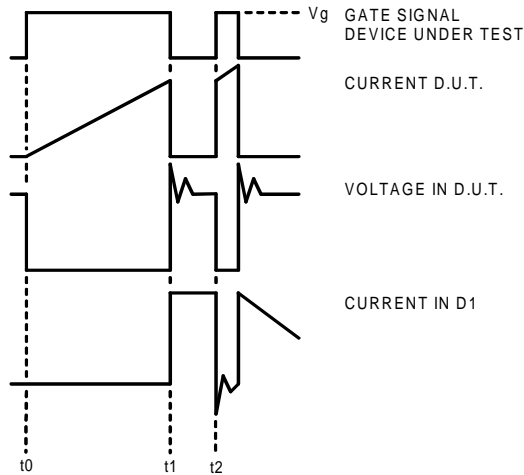


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

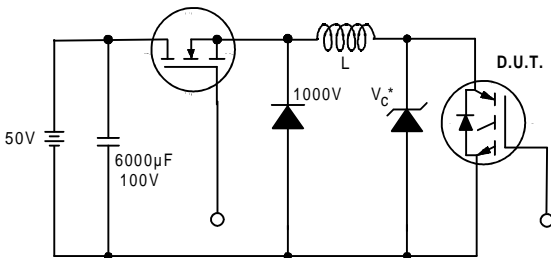


Figure 19. Clamped Inductive Load Test Circuit

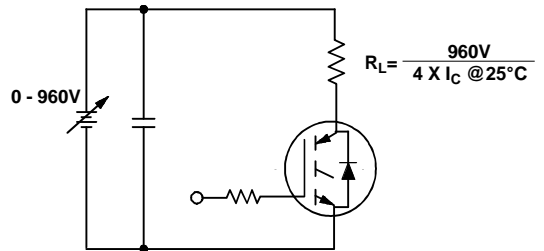


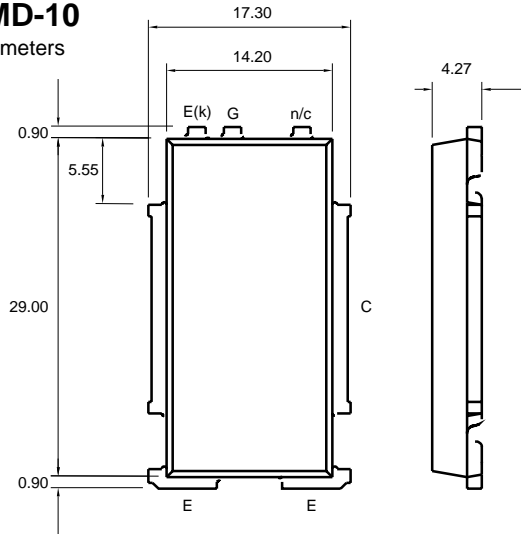
Figure 20. Pulsed Collector Current Test Circuit

**Notes:**

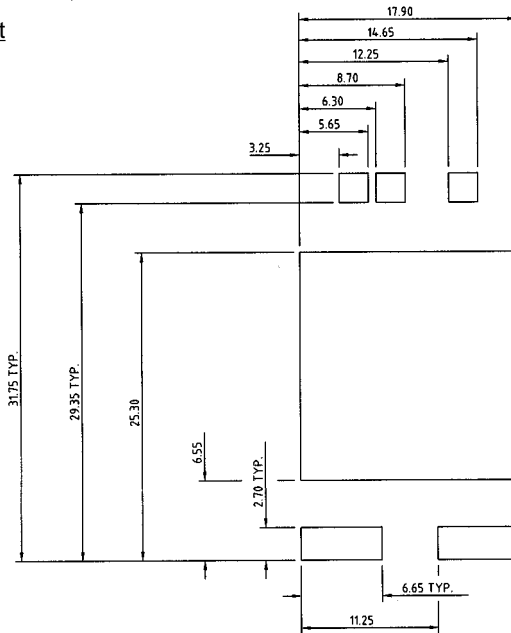
- ① Repetitive rating:  $V_{GE}=20V$ ; pulse width limited by maximum junction temperature (figure 20)
- ②  $V_{CC}=80\%(V_{CES})$ ,  $V_{GE}=20V$ ,  $L=10\mu H$ ,  $R_G=5.0\Omega$  (figure 19)
- ③ Pulse width  $\leq 80\mu s$ ; duty factor  $\leq 0.1\%$
- ④ Pulse width  $5.0\mu s$ , single shot

**Case Outline — SMD-10**

Dimensions are shown in millimeters



Recommended footprint



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**EUROPEAN HEADQUARTERS:** Hurst Green, Oxted, Surrey RH8 9BB, UK Tel: ++ 44 1883 732020

**IR CANADA:** 7321 Victoria Park Ave., Suite 201, Markham, Ontario L3R 2Z8, Tel: (905) 475 1897

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

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