International
IOR Rectifier

PD - 9.1627A

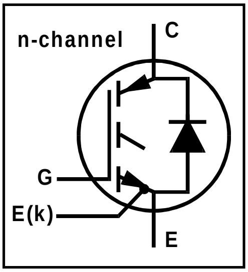
IRG4ZH70UD

INSULATED GATE BIPOLAR TRANSISTOR WITH
ULTRAFAST SOFT RECOVERY DIODE

Surface Mountable
UltraFast CoPack IGBT

Features

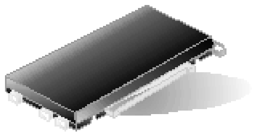
- UltraFast IGBT optimized for high switching frequencies
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft recovery antiparallel diodes for use in bridge configurations
- Low Gate Charge
- Low profile low inductance SMD-10 Package
- Separated control & Power-connections for easy paralleling
- Inherently good coplanarity
- Easy solder inspection and cleaning



V_{CES} = 1200V

$V_{CE(ON)typ}$ = 2.23V

@V_{GE} = 15V, I_C = 42A


SMD-10

Benefits

- Highest power density and efficiency available
- HEXFRED Diodes optimized for performance with IGBTs. Minimized recovery characteristics
- IGBTs optimized for specific application conditions
- High input impedance requires low gate drive power
- Less noise and interference

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Breakdown Voltage	1200	V
I_C @ T_C = 25°C	Continuous Collector Current	78	A
I_C @ T_C = 100°C	Continuous Collector Current	42	
I_{CM}	Pulsed Collector Current ①	312	
I_{LM}	Clamped Inductive Load Current ②	312	
I_F @ T_C = 100°C	Diode Continuous Forward Current	42	
I_{FM}	Diode Maximum Forward Current	312	
V_{GE}	Gate-to-Emitter Voltage	± 20	V
P_D @ T_C = 25°C	Maximum Power Dissipation	350	W
P_D @ T_C = 100°C	Maximum Power Dissipation	140	
T_J T_{STG}	Operating Junction and Storage Temperature Range	-55 to + 150	°C

Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT	—	—	0.36	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode	—	—	0.69	
$R_{\theta CS}$	SMD-10 Case-to-Heatsink (typical), *	—	0.44	—	
Wt	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_J = 25°C (unless otherwise specified)

	Parameter	Min.	Typ.	Max.	Units	Conditions	
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage ③	1200	—	—	V	V_{GE} = 0V, I_C = 250µA	
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	1.20	—	V/°C	V_{GE} = 0V, I_C = 1.0mA	
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	2.23	3.5	V	I_C = 42A	V_{GE} = 15V
		—	2.58	—		I_C = 78A	see figures 2, 5
		—	2.15	—		I_C = 42A, T_J = 150°C	
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	6.0		V_{CE} = V_{GE}, I_C = 250µA	
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	—	-13	—	mV/°C	V_{CE} = V_{GE}, I_C = 250µA	
g_{fe}	Forward Transconductance ④	30	46	—	S	V_{CE} = 100V, I_C = 42A	
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	µA	V_{GE} = 0V, V_{CE} = 1200V	
		—	—	10	mA	V_{GE} = 0V, V_{CE} = 1200V, T_J = 150°C	
V_{FM}	Diode Forward Voltage Drop	—	2.45	3.7	V	I_C = 42A	see figure 13
		—	2.40	—		I_C = 42A, T_J = 150°C	
I_{GES}	Gate-to-Emitter Leakage Current	—	—	±100	nA	V_{GE} = ±20V	

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

	Parameter	Min.	Typ.	Max.	Units	Conditions		
Q_g	Total Gate Charge (turn-on)	—	390	590	nC	I_C = 42A		
Qge	Gate - Emitter Charge (turn-on)	—	47	71		V_{CC} = 400V	see figure 8	
Q_{gc}	Gate - Collector Charge (turn-on)	—	120	180		V_{GE} = 15V		
$t_{d(on)}$	Turn-On Delay Time	—	100	—	ns	T_J = 25°C		
t_r	Rise Time	—	28	—		I_C = 42A, V_{CC} = 800V		
$t_{d(off)}$	Turn-Off Delay Time	—	271	400		V_{GE} = 15V, R_G = 5.0Ω		
t_f	Fall Time	—	189	280		Energy losses include "tail" and		
E_{on}	Turn-On Switching Loss	—	3.0	—	mJ	diode reverse recovery.		
E_{off}	Turn-Off Switching Loss	—	3.67	—		see figures 9, 10, 18		
E_{ts}	Total Switching Loss	—	6.67	9.8				
$t_{d(on)}$	Turn-On Delay Time	—	37	—	ns	T_J = 150°C,	see figures 11, 18	
t_r	Rise Time	—	124	—		I_C = 42A, V_{CC} = 800V		
$t_{d(off)}$	Turn-Off Delay Time	—	200	—		V_{GE} = 15V, R_G = 5.0Ω		
t_f	Fall Time	—	435	—		Energy losses include "tail" and		
E_{ts}	Total Switching Loss	—	12.36	—	mJ	diode reverse recovery.		
L_E	Internal Emitter Inductance	—	2.0	—	nH			
C_{ies}	Input Capacitance	—	7090	—	pF	V_{GE} = 0V		
C_{oes}	Output Capacitance	—	420	—		V_{CC} = 30V	see figure 7	
C_{res}	Reverse Transfer Capacitance	—	56	—		f = 1.0MHz		
t_{rr}	Diode Reverse Recovery Time	—	107	160	ns	T_J = 25°C	see figure	
		—	160	240		T_J = 125°C	14	I_F = 42A
I_{rr}	Diode Peak Reverse Recovery Current	—	10	15	A	T_J = 25°C	see figure	
		—	16	24		T_J = 125°C	15	V_R = 200V
Q_{rr}	Diode Reverse Recovery Charge	—	680	1020	nC	T_J = 25°C	see figure	
		—	1400	2100		T_J = 125°C	16	di/dt = 200Aµs
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery During t_b	—	250	—	A/µs	T_J = 25°C	see figure	
		—	320	—		T_J = 125°C	17	

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 =10µH, R_G = 5.0Ω (figure 19)

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

④ Pulse width 5.0µs, single shot.

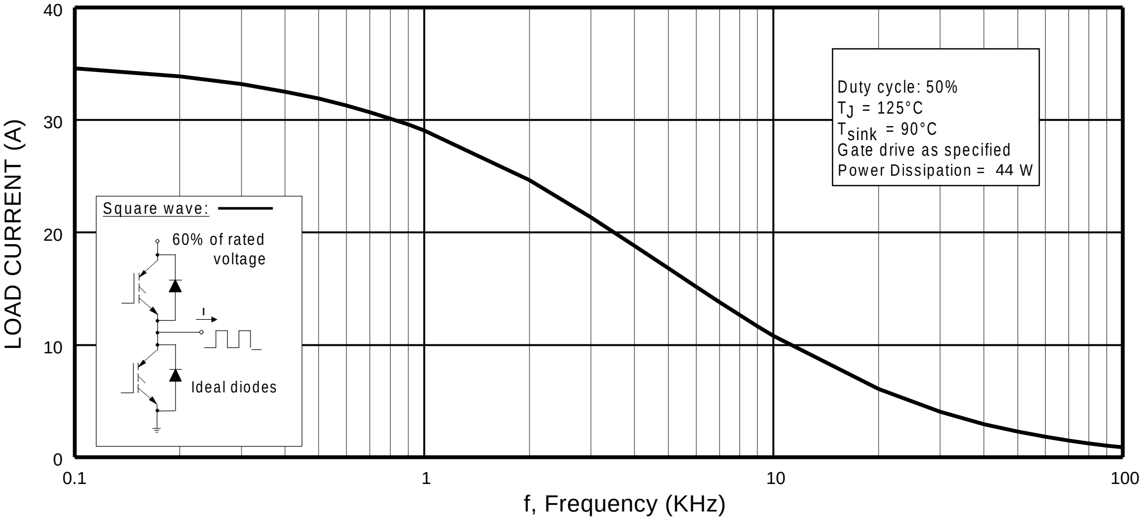
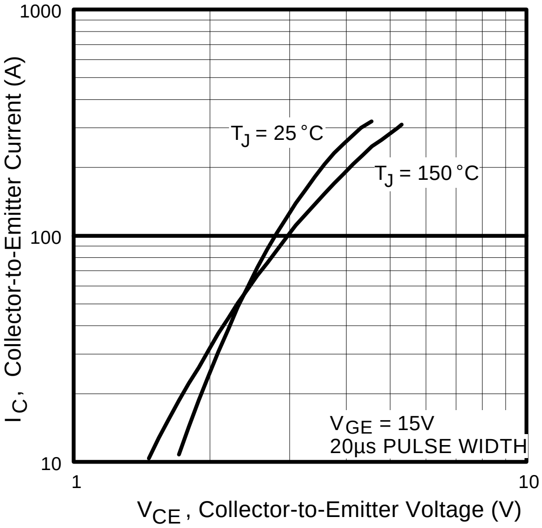


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)



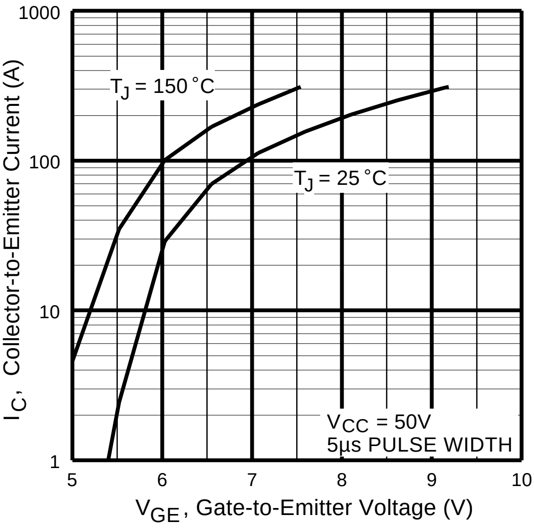


Fig. 2 - Typical Output Characteristics

Fig. 3 - Typical Transfer Characteristics

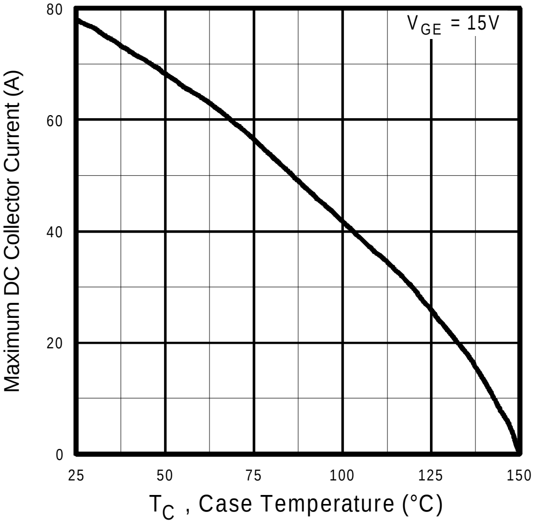


Fig. 4 - Maximum Collector Current vs. Case Temperature

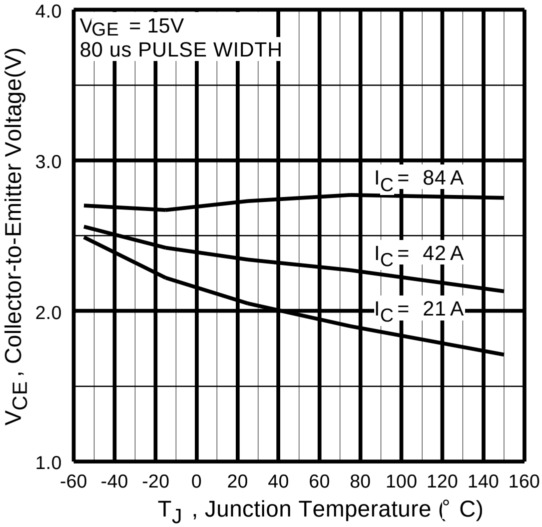


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

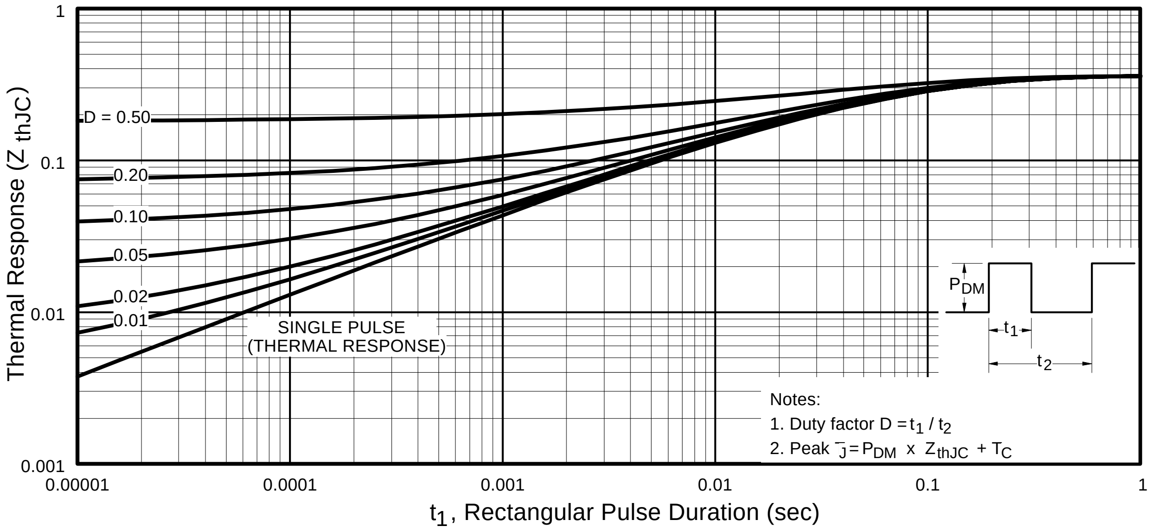


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

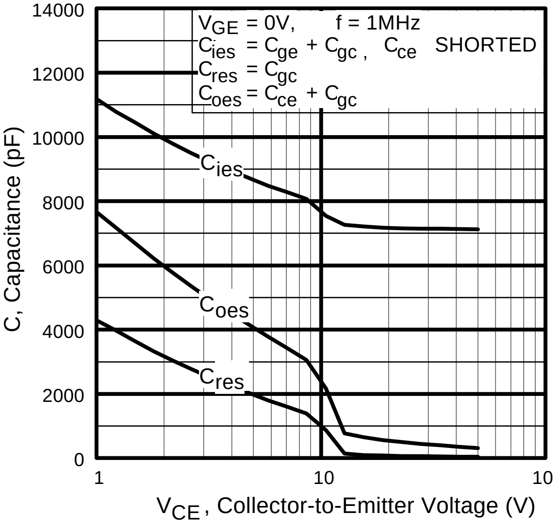


Fig. 7 - Typical Capacitance vs.
Collector-to-Emitter Voltage

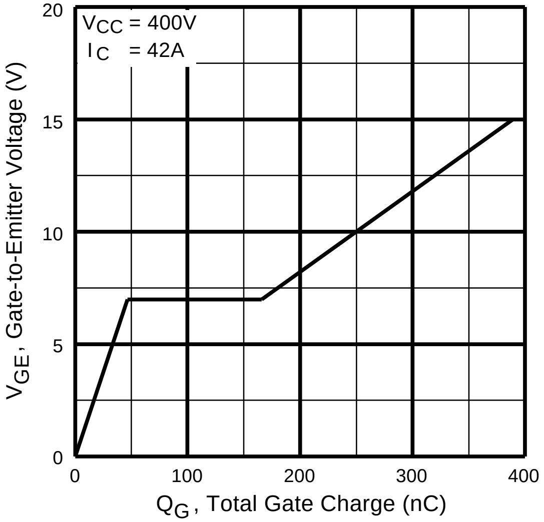


Fig. 8 - Typical Gate Charge vs.
Gate-to-Emitter Voltage

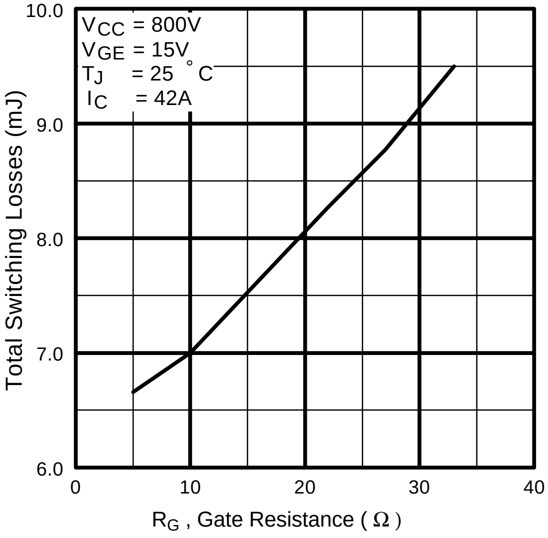


Fig. 9 - Typical Switching Losses vs.
Gate Resistance

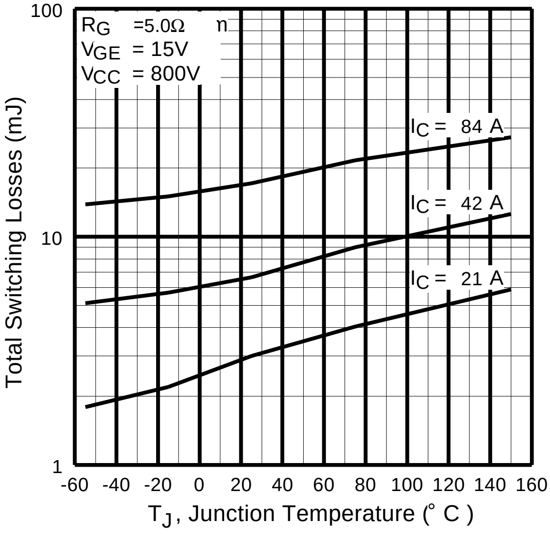


Fig. 10 - Typical Switching Losses vs.
Junction Temperature

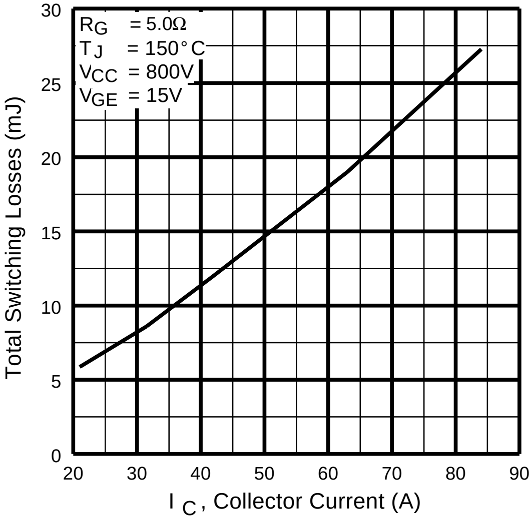


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

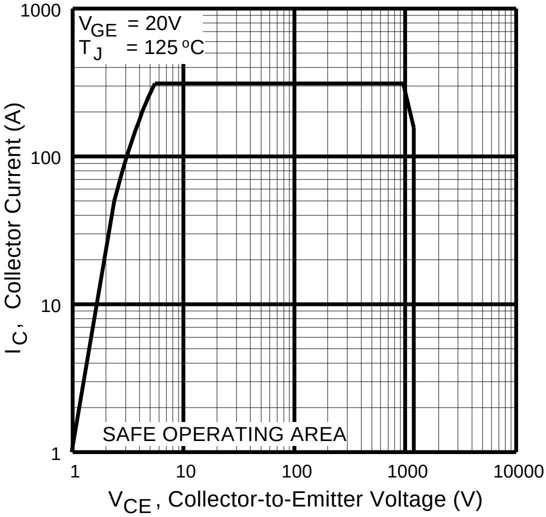


Fig. 12 - Turn-Off SOA

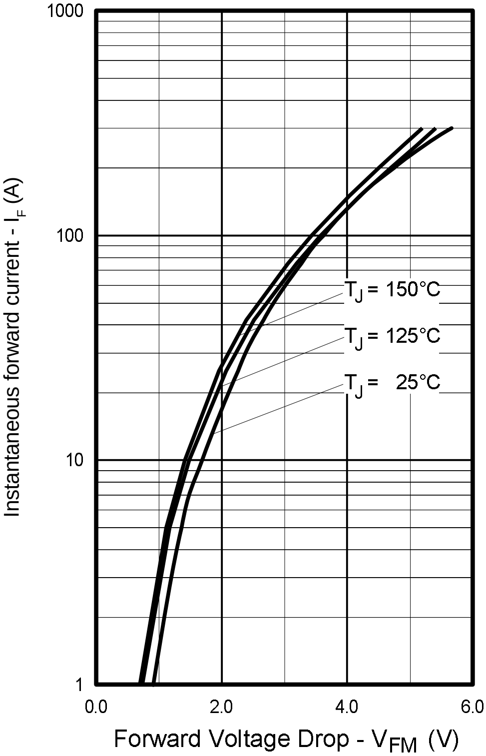


Fig. 13 - Typical Forward Voltage Drop vs. Instantaneous Forward Current

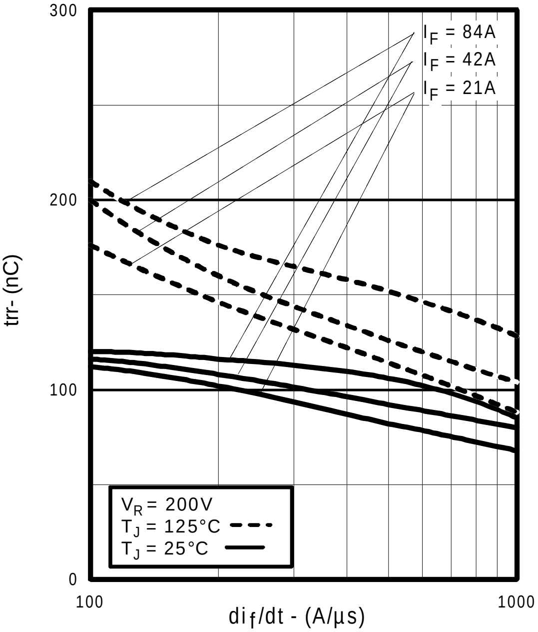


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

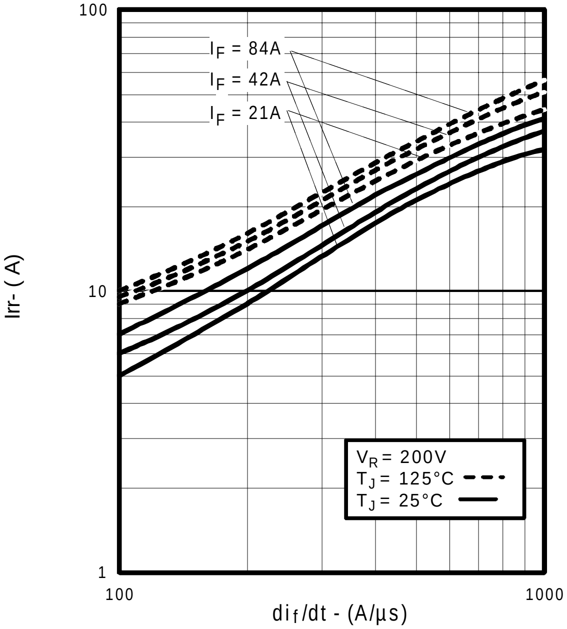


Fig. 15 - Typical Recovery Current vs. di_f/dt

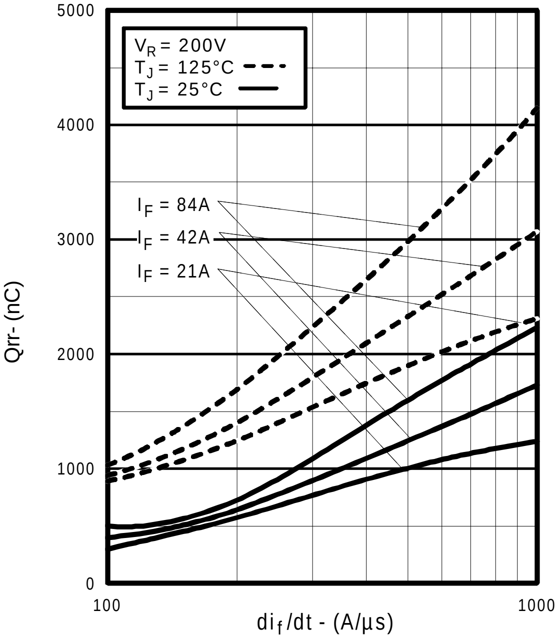


Fig. 16 - Typical Stored Charge vs. di_f/dt

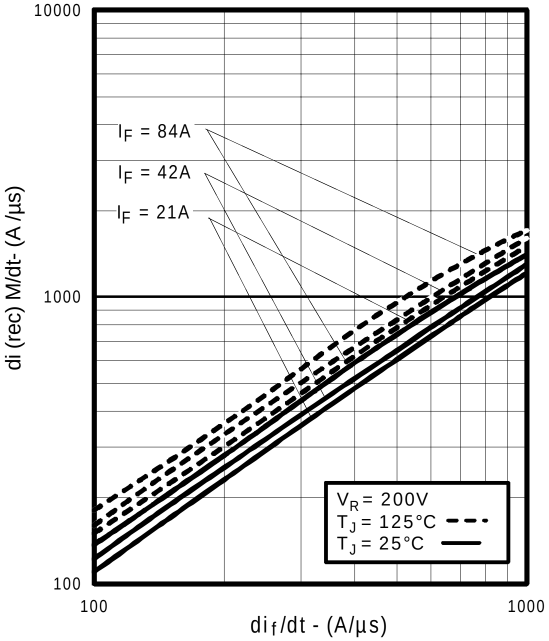


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

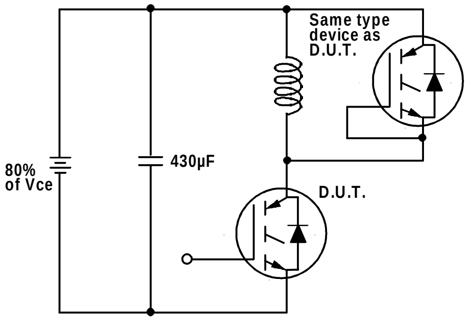


Fig. 18a - Test Circuit for Measurement of I_{LM}, E_{on}, $E_{off(diode)}$, t_{rr}, Q_{rr}, I_{rr}, $t_{d(on)}$, t_r, $t_{d(off)}$, t_f

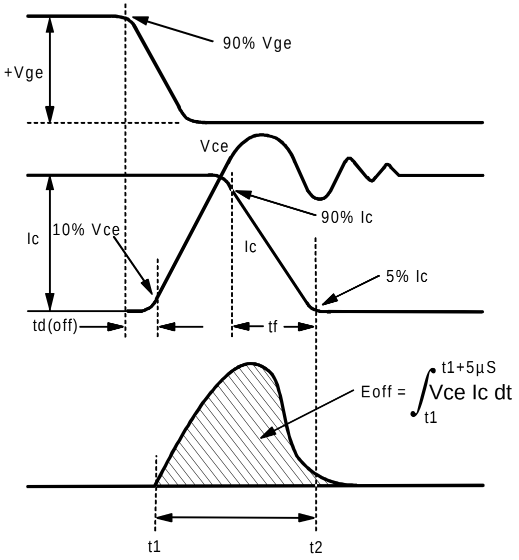


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off}, $t_{d(off)}$, t_f

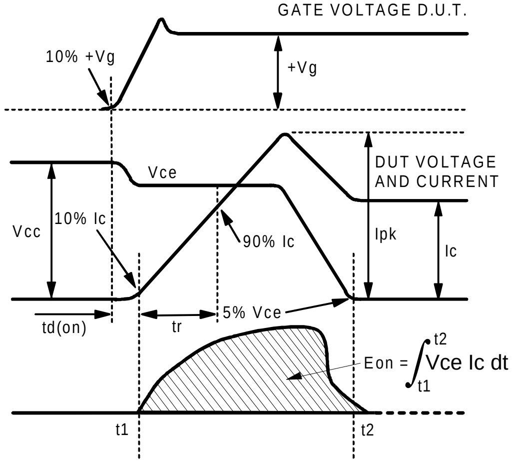


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on}, $t_{d(on)}$, t_r

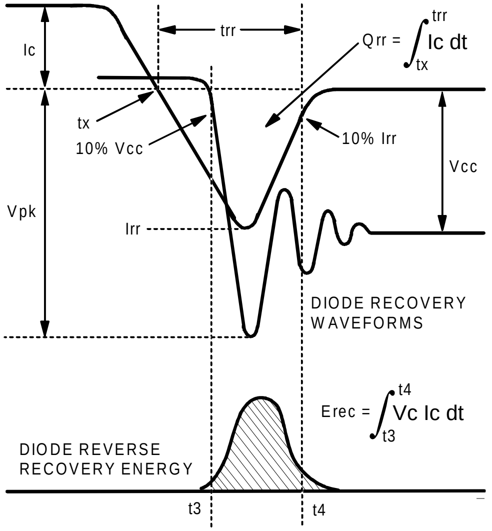


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec}, t_{rr}, Q_{rr}, I_{rr}

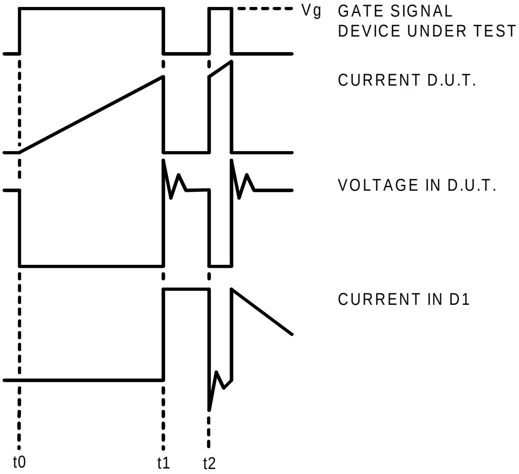


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

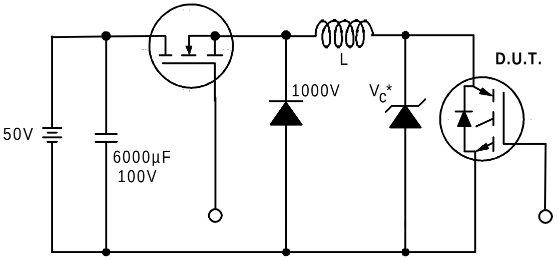


Figure 19. Clamped Inductive Load Test Circuit

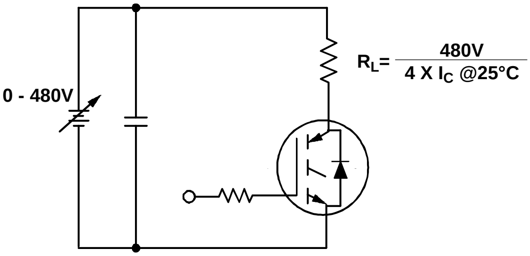
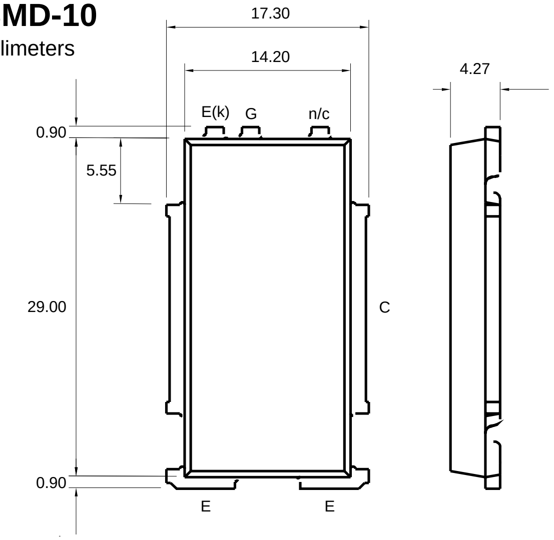


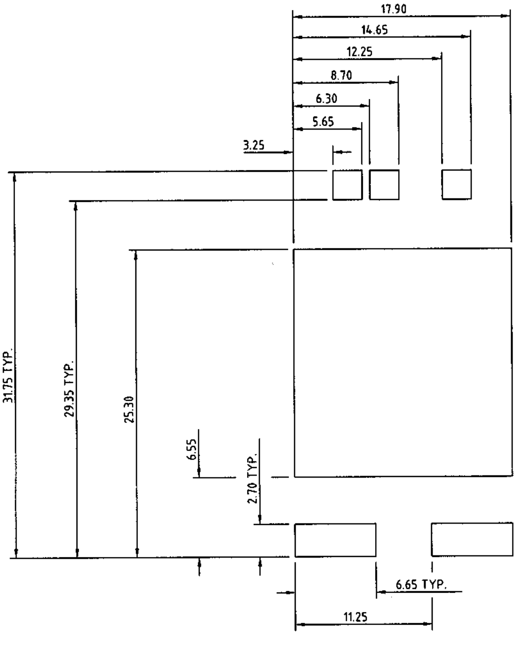
Figure 20. Pulsed Collector Current Test Circuit

Case Outline — SMD-10

Dimensions are shown in milimeters



Recomended footprint



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