International
IOR Rectifier

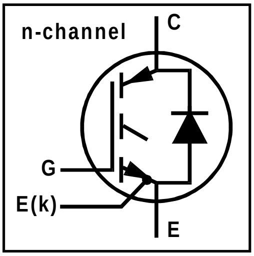
IRG4ZH50KD

INSULATED GATE BIPOLAR TRANSISTOR WITH ULTRAFAST SOFT RECOVERY DIODE

Surface Mountable Short Circuit Rated UltraFast IGBT

Features

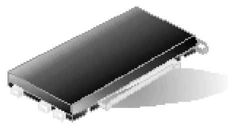
- High short circuit rating optimized for motor control, t_{sc} = 10µs, V_{CC} = 720V, T_J = 125°C, V_{GE} = 15V
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft recovery antiparallel diodes for use in bridge configurations
- Combines low conduction losses with high switching speed
- Low profile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



V_{CES} = 1200V

$V_{CE(ON)typ}$ = 2.79V

@V_{GE} = 15V, I_C = 29A



SMD-10

Benefits

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

Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	1200	V
I_C @ T_C = 25°C	Continuous Collector Current	54	A
I_C @ T_C = 100°C	Continuous Collector Current	29	
I_{CM}	Pulsed Collector Current ①	108	
I_{LM}	Clamped Inductive Load Current ②	108	
I_F @ T_C = 100°C	Diode Continuous Forward Current	16	
I_{FM}	Diode Maximum Forward Current	108	
t_{sc}	Short Circuit Withstand Time	10	µs
V_{GE}	Gate-to-Emitter Voltage	± 20	V
P_D @ T_C = 25°C	Maximum Power Dissipation	210	W
P_D @ T_C = 100°C	Maximum Power Dissipation	83	
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	—	—	0.60	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode	—	—	1.20	
$R_{\theta CS}$	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.

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.

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
$DV_{(BR)CES}/DT_J$	Temperature Coeff. of Breakdown Voltage	—	0.91	—	V/°C	V_{GE} = 0V, I_C = 1.0mA
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	2.79	3.5	V	I_C = 29A; V_{GE} = 15V
		—	3.32	—		I_C = 54A; see figures 2, 5
		—	2.66	—		I_C = 29A, T_J = 150°C
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	6.0		V_{CE} = V_{GE}, I_C = 250µA
$DV_{GE(th)}/DT_J$	Temperature Coeff. of Threshold Voltage	—	-10	—	mV/°C	V_{CE} = V_{GE}, I_C = 250µA
g_{fe}	Forward Transconductance ④	14	21	—	S	V_{CE} = 100V, I_C = 29A
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	µA	V_{GE} = 0V, V_{CE} = 1200V
		—	—	6500		V_{GE} = 0V, V_{CE} = 1200V, T_J = 150°C
V_{FM}	Diode Forward Voltage Drop	—	2.5	3.5	V	I_C = 16A; see figure 13
		—	2.1	—		I_C = 16A, 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)	—	190	280	nC	I_C = 29A
Q_{ge}	Gate - Emitter Charge (turn-on)	—	25	38		V_{CC} = 400V; see figure 8
Q_{gc}	Gate - Collector Charge (turn-on)	—	70	110		V_{GE} = 15V
$t_{d(on)}$	Turn-On Delay Time	—	110	—	ns	
t_r	Rise Time	—	43	—		T_J = 25°C
$t_{d(off)}$	Turn-Off Delay Time	—	150	230		I_C = 29A, V_{CC} = 800V
t_f	Fall Time	—	200	290		V_{GE} = 15V, R_G = 5.0Ω
E_{on}	Turn-On Switching Loss	—	3.20	—	mJ	Energy losses include "tail"
E_{off}	Turn-Off Switching Loss	—	2.28	—		and diode reverse recovery
E_{ts}	Total Switching Loss	—	5.48	6.5		see figures 9,10,18
t_{sc}	Short Circuit Withstand Time	10	—	—	µs	V_{CC} = 720V, T_J = 125°C; V_{GE} = 15V, R_G = 5.0Ω
$t_{d(on)}$	Turn-On Delay Time	—	73	—	ns	T_J = 150°C, see figures 10,11,18
t_r	Rise Time	—	72	—		I_C = 29A, V_{CC} = 800V
$t_{d(off)}$	Turn-Off Delay Time	—	290	—		V_{GE} = 15V, R_G = 5.0Ω,
t_f	Fall Time	—	390	—		Energy losses include "tail"
E_{ts}	Total Switching Loss	—	10.12	—	mJ	and diode reverse recovery
L_E	Internal Emitter Inductance	—	2.0	—	nH	Measured 5mm from package
C_{ies}	Input Capacitance	—	2800	—	pF	V_{GE} = 0V
C_{oes}	Output Capacitance	—	140	—		V_{CC} = 30V; see figure 7
C_{res}	Reverse Transfer Capacitance	—	53	—		f = 1.0MHz
t_{rr}	Diode Reverse Recovery Time	—	90	135	ns	T_J = 25°C; see figure 14
		—	164	245		T_J = 125°C; I_F = 16A
I_{rr}	Diode Peak Reverse Recovery Current	—	5.8	10	A	T_J = 25°C; see figure 15
		—	8.3	15		T_J = 125°C; V_R = 200V
Q_{rr}	Diode Reverse Recovery Charge	—	260	675	nC	T_J = 25°C; see figure 16
		—	680	1838		T_J = 125°C; di/dt = 200A/µs
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery During t_b	—	120	—	A/µs	T_J = 25°C; see figure 17
		—	76	—		T_J = 125°C

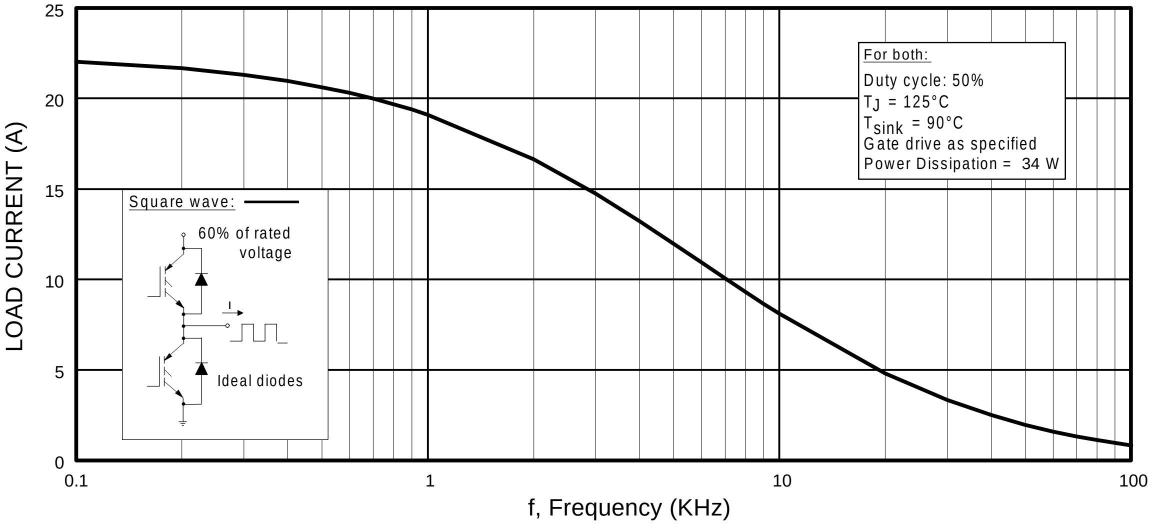


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

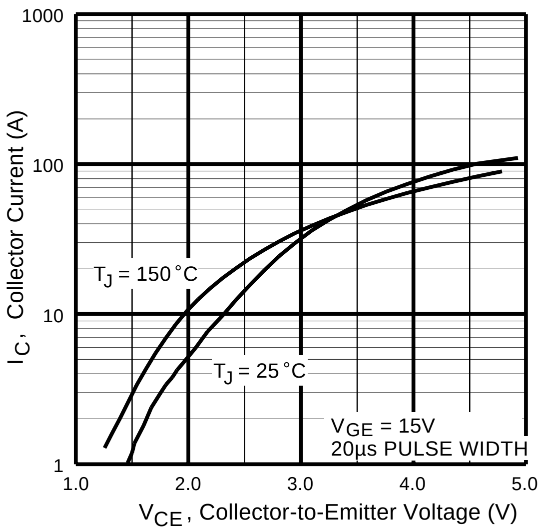


Fig. 2 - Typical Output Characteristics

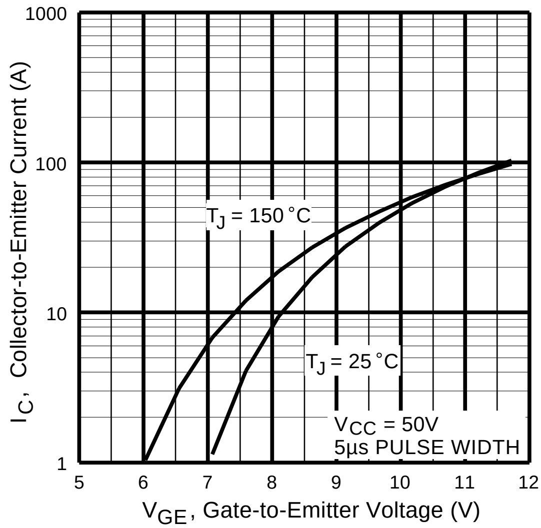


Fig. 3 - Typical Transfer Characteristics

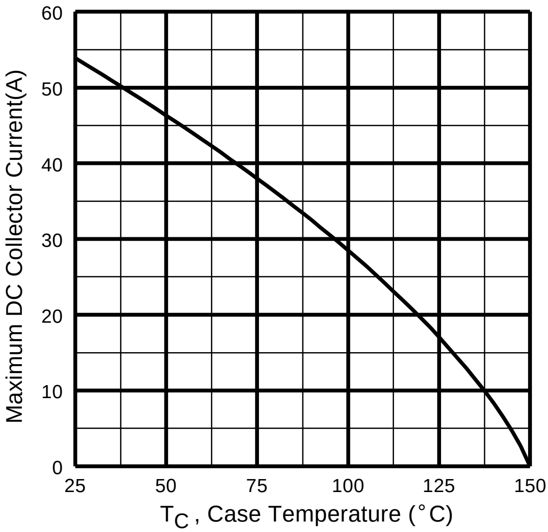


Fig. 4 - Maximum Collector Current vs. Case Temperature

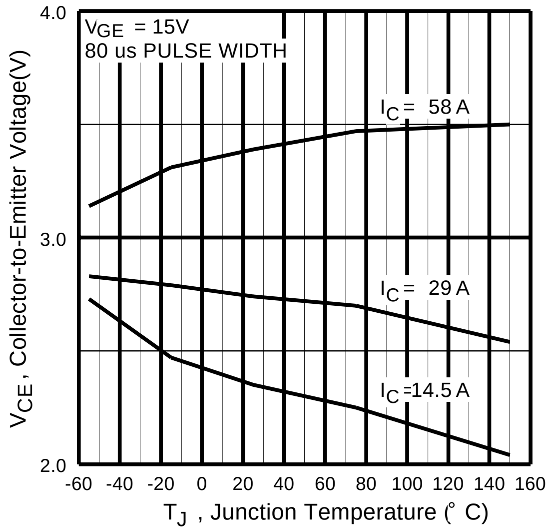


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

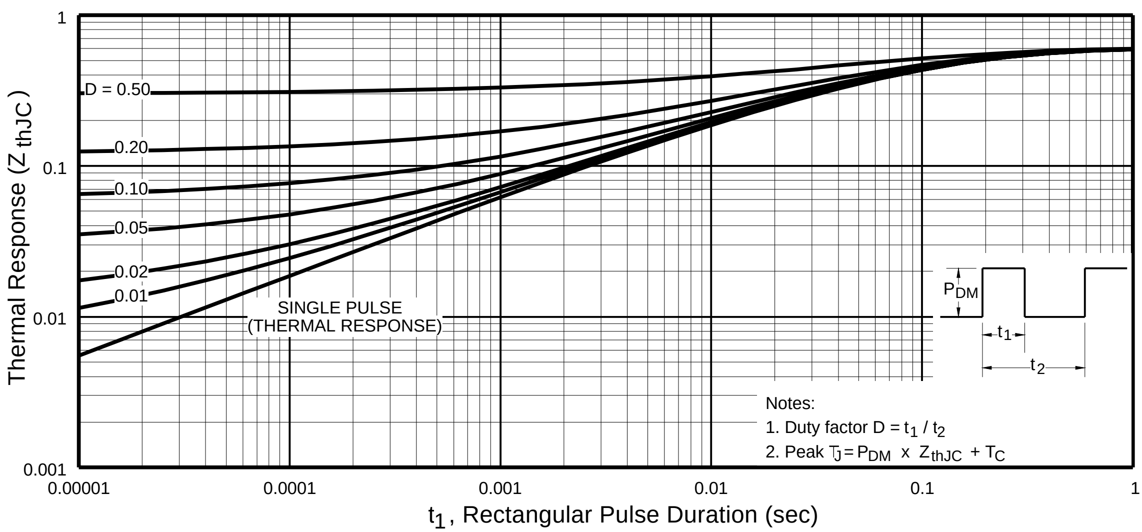


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

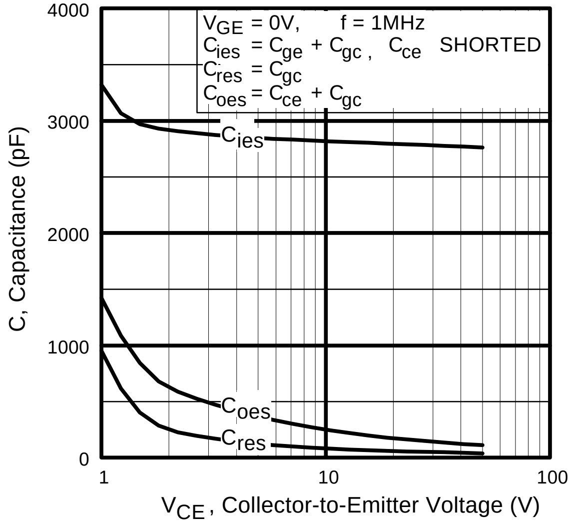


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

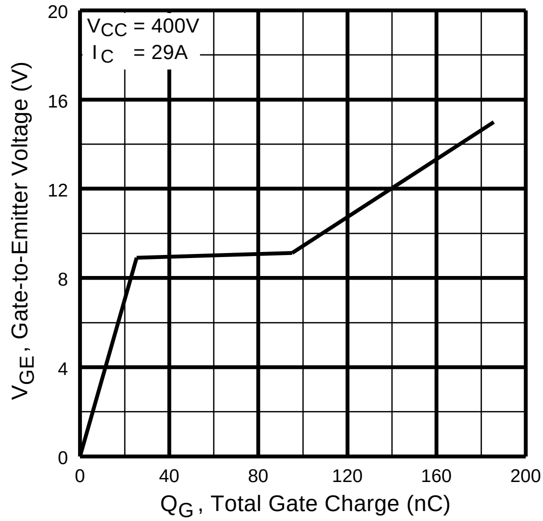


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

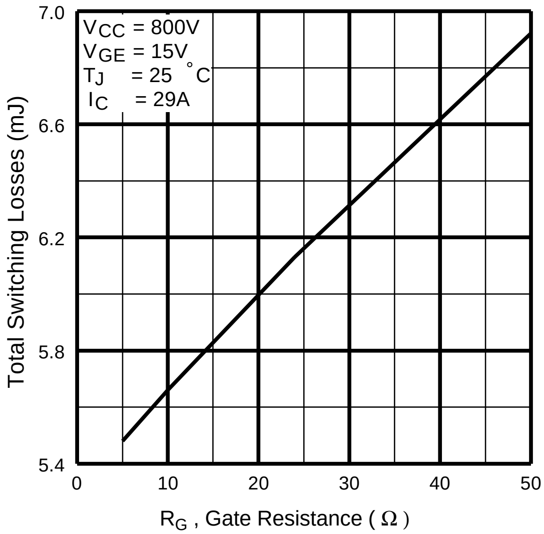


Fig. 9 - Typical Switching Losses vs. Gate Resistance

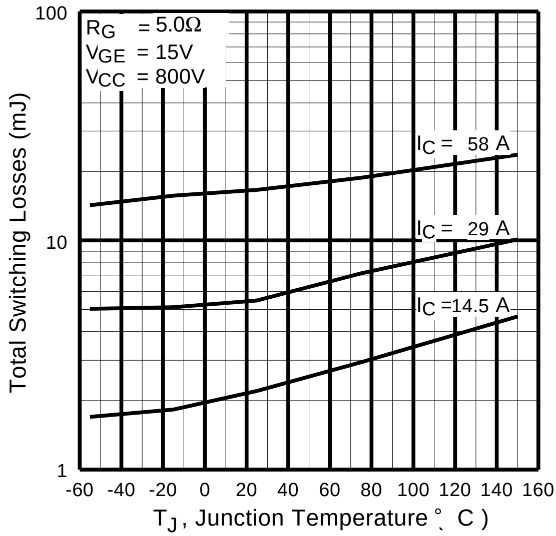


Fig. 10 - Typical Switching Losses vs. Junction Temperature

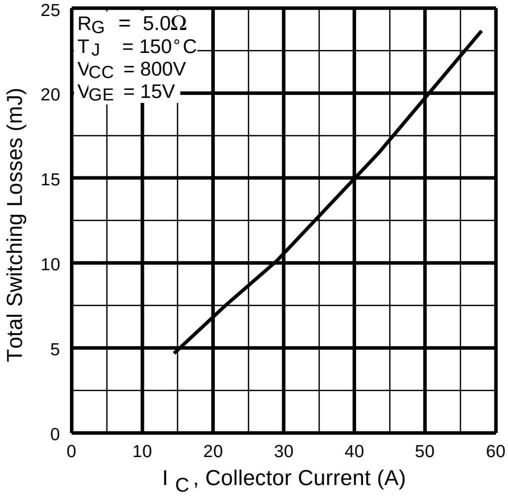


Fig. 11 - Typical Switching Losses vs. Collector Current

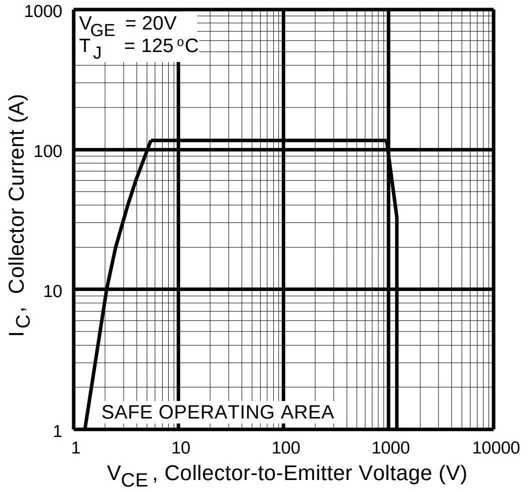


Fig. 12 - Turn-Off SOA

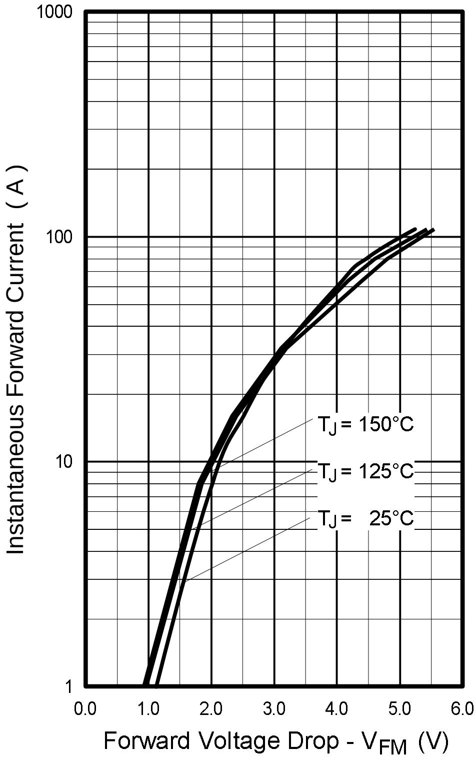


Fig. 13 - Typical Forward Voltage Drop vs. Instantaneous Forward Current

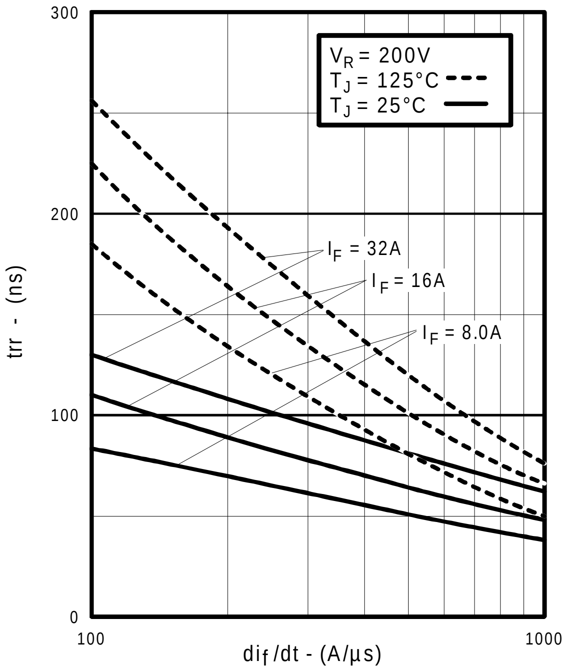


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

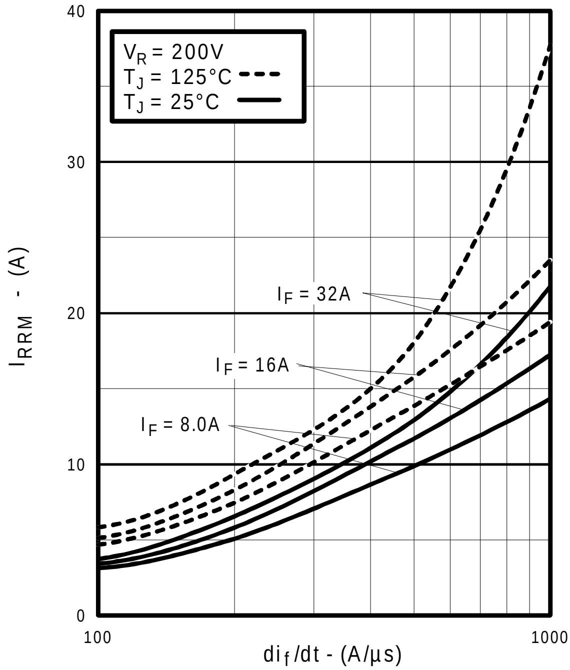


Fig. 15 - Typical Recovery Current vs. di_f/dt

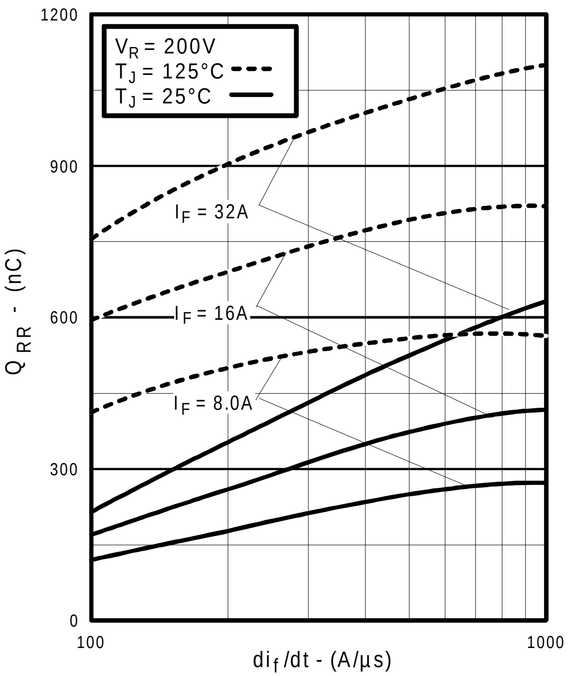


Fig. 16 - Typical Stored Charge vs. di_f/dt

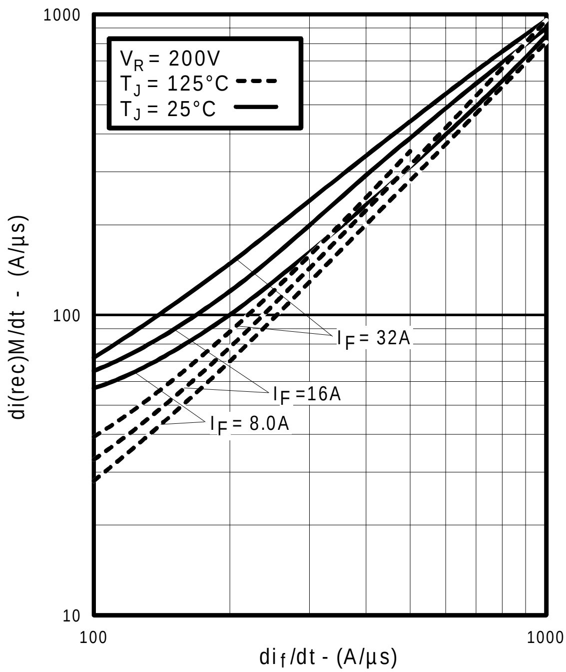


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

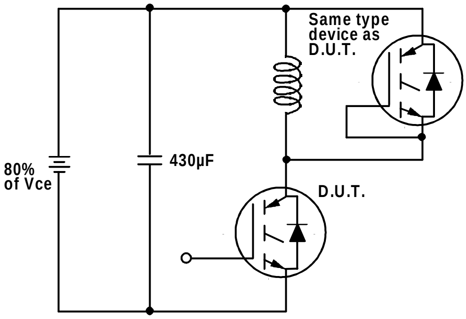


Fig. 18a - Test Circuit for Measurement of I_{LM}, E_{on}, $E_{off(diode)}$, t_{rr}, Q_{rr}, I_{rr}, $t_{d(on)}$, t_r, $t_{d(off)}$, t_f

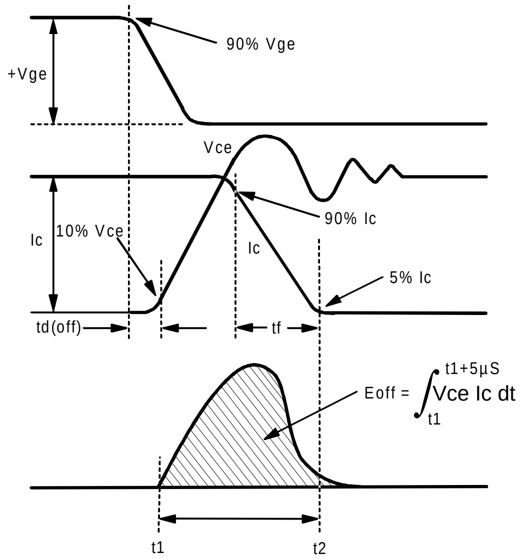


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off}, $t_{d(off)}$, t_f

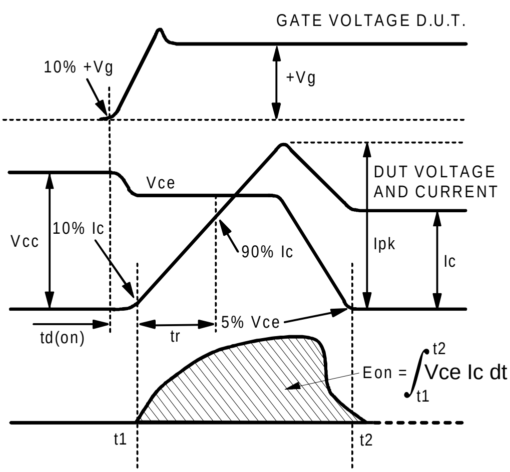


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on}, $t_{d(on)}$, t_r

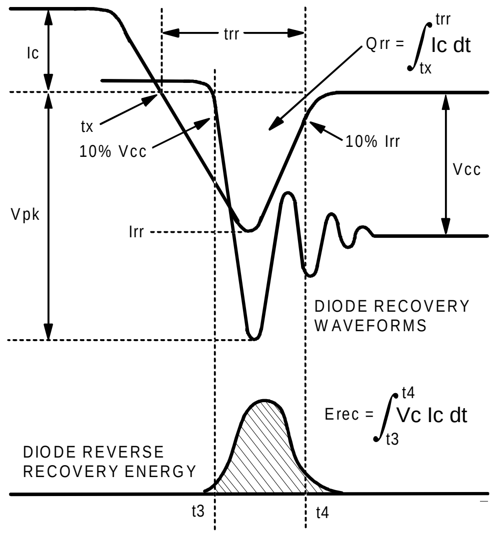


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec}, t_{rr}, Q_{rr}, I_{rr}

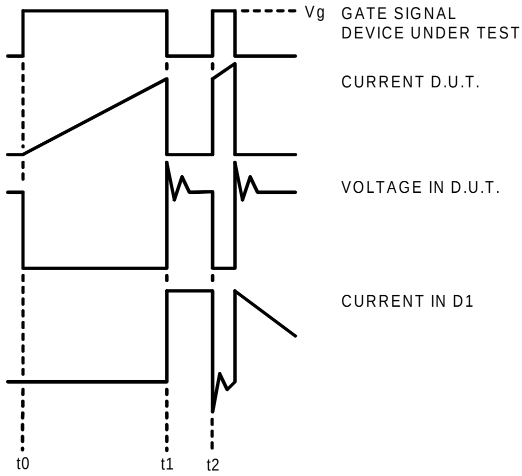


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

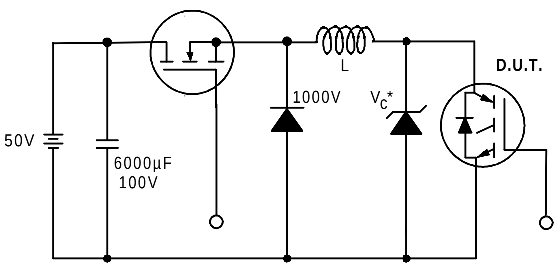


Figure 19. Clamped Inductive Load Test Circuit

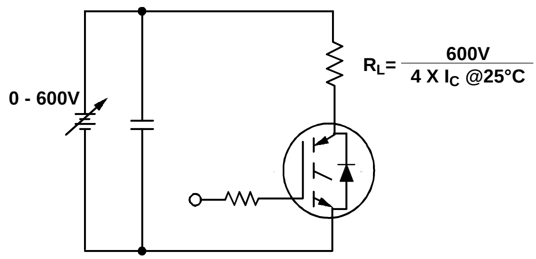
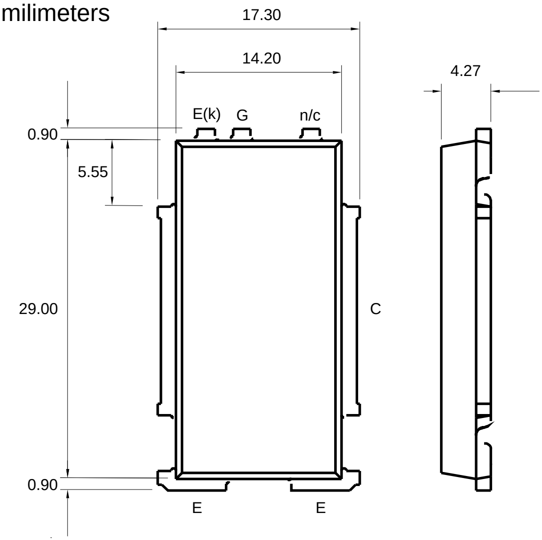


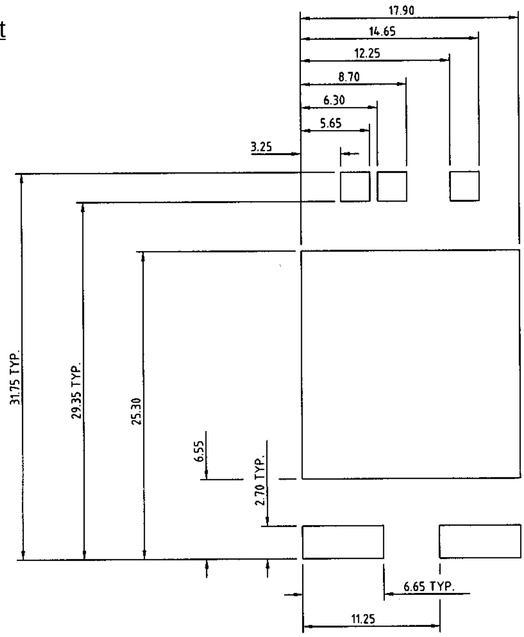
Figure 20. Pulsed Collector Current Test Circuit

Case Outline — SMD-10

Dimensions are shown in milimeters



Recommended footprint



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