

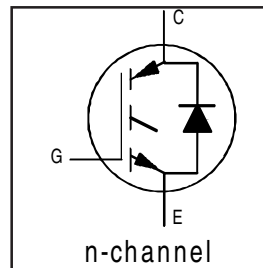
# IRG4PH30KD

INSULATED GATE BIPOLAR TRANSISTOR WITH  
 ULTRAFAST SOFT RECOVERY DIODE

Short Circuit Rated  
 UltraFast IGBT

## Features

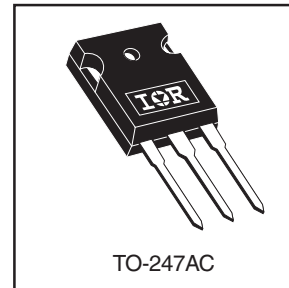
- High short circuit rating optimized for motor control,  $t_{sc} = 10\mu s$ ,  $V_{CC} = 720V$ ,  $T_J = 125^\circ C$ ,  $V_{GE} = 15V$
- Combines low conduction losses with high switching speed
- Tighter parameter distribution and higher efficiency than previous generations
- IGBT co-packaged with HEXFRED™ ultrafast, ultrasoft recovery antiparallel diodes



$V_{CES} = 1200V$   
 $V_{CE(on)} \text{ typ.} = 3.10V$   
 @  $V_{GE} = 15V, I_C = 10A$

## Benefits

- Latest generation 4 IGBT's offer highest power density motor controls possible
- HEXFRED™ diodes optimized for performance with IGBTs. Minimized recovery characteristics reduce noise, EMI and switching losses
- This part replaces IRGPH30MD2 products
- For hints see design tip 97003



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## Absolute Maximum Ratings

	Parameter	Max.	Units
$V_{CES}$	Collector-to-Emitter Voltage	1200	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	20	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	10	
$I_{CM}$	Pulsed Collector Current ①	40	
$I_{LM}$	Clamped Inductive Load Current ②	40	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	10	
$I_{FM}$	Diode Maximum Forward Current	40	
$t_{sc}$	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	100	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	42	
$T_J$	Operating Junction and	-55 to +150	$^\circ C$
$T_{STG}$	Storage Temperature Range		
	Soldering Temperature, for 10 sec.	300 (0.063 in. (1.6mm) from case)	
	Mounting Torque, 6-32 or M3 Screw.	10 lbf•in (1.1 N•m)	

## Thermal Resistance

	Parameter	Min.	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case - IGBT	—	—	1.2	$^\circ C/W$
$R_{\theta JC}$	Junction-to-Case - Diode	—	—	2.5	
$R_{\theta CS}$	Case-to-Sink, flat, greased surface	—	0.24	—	
$R_{\theta JA}$	Junction-to-Ambient, typical socket mount	—	—	40	
Wt	Weight	—	6 (0.21)	—	g (oz)

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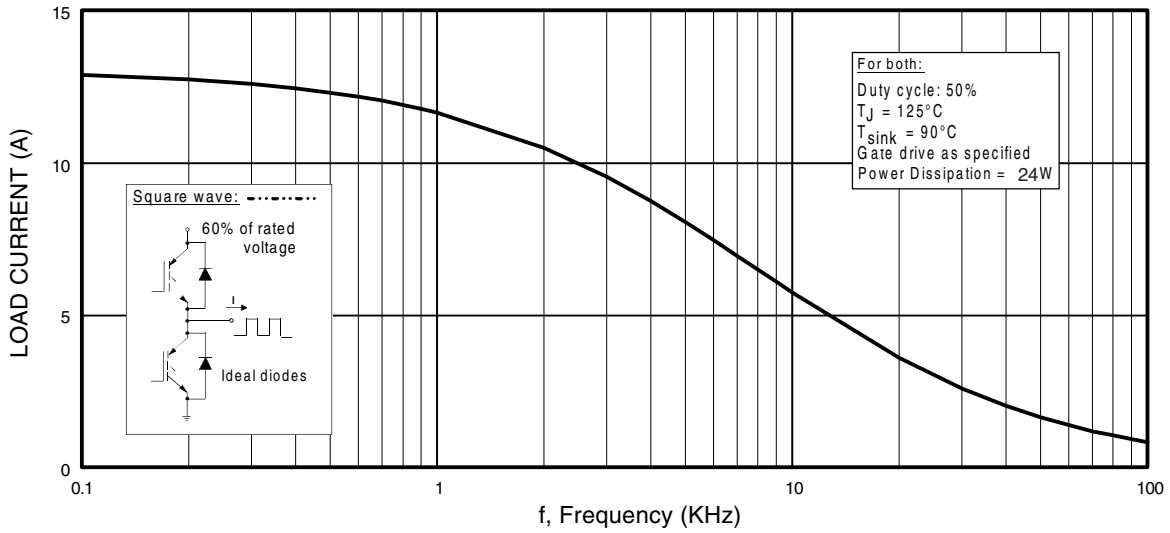
International  
**IRF** Rectifier

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

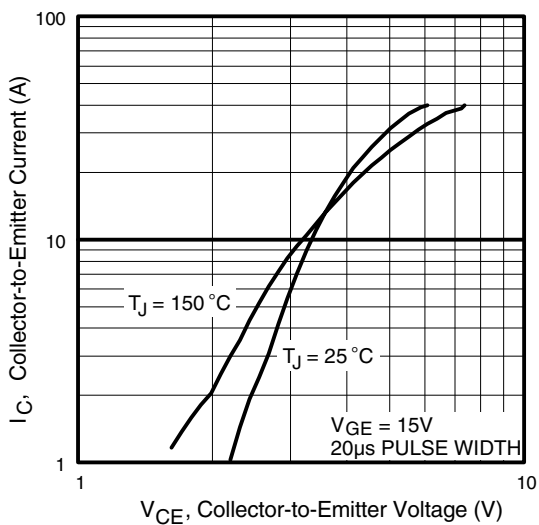
	Parameter	Min.	Typ.	Max.	Units	Conditions
$V_{(BR)CES}$	Collector-to-Emitter Breakdown Voltage <sup>③</sup>	1200	—	—	V	$V_{GE} = 0V, I_C = 250\mu A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.19	—	V/°C	$V_{GE} = 0V, I_C = 1.0mA$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	3.10	4.2	V	$I_C = 10A$ $I_C = 20A$ $I_C = 10A, T_J = 150^\circ\text{C}$ $V_{GE} = 15V$ See Fig. 2, 5
		—	3.90	—		
		—	3.01	—		
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	6.0		$V_{CE} = V_{GE}, I_C = 250\mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	—	-12	—	mV/°C	$V_{CE} = V_{GE}, I_C = 250\mu A$
$g_{fe}$	Forward Transconductance <sup>④</sup>	4.3	6.5	—	S	$V_{CE} = 100V, I_C = 10A$
$I_{CES}$	Zero Gate Voltage Collector Current	—	—	250	$\mu A$	$V_{GE} = 0V, V_{CE} = 1200V$
		—	—	3500		$V_{GE} = 0V, V_{CE} = 1200V, T_J = 150^\circ\text{C}$
$V_{FM}$	Diode Forward Voltage Drop	—	3.4	3.8	V	$I_C = 10A$ $I_C = 10A, T_J = 150^\circ\text{C}$ See Fig. 13
		—	3.3	3.7		
$I_{GES}$	Gate-to-Emitter Leakage Current	—	—	$\pm 100$	nA	$V_{GE} = \pm 20V$

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

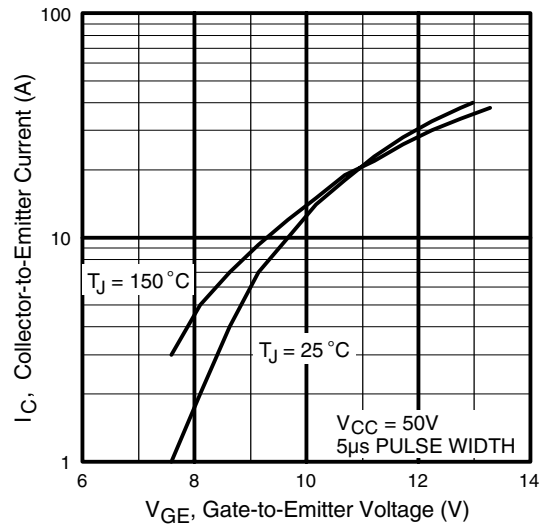
	Parameter	Min.	Typ.	Max.	Units	Conditions
$Q_g$	Total Gate Charge (turn-on)	—	53	80	nC	$I_C = 10A$ $V_{CC} = 400V$ $V_{GE} = 15V$ See Fig.8
$Q_{ge}$	Gate - Emitter Charge (turn-on)	—	9.0	14		
$Q_{gc}$	Gate - Collector Charge (turn-on)	—	21	32		
$t_{d(on)}$	Turn-On Delay Time	—	39	—	ns	$T_J = 25^\circ\text{C}$ $I_C = 10A, V_{CC} = 800V$ $V_{GE} = 15V, R_G = 23\Omega$
$t_r$	Rise Time	—	84	—		
$t_{d(off)}$	Turn-Off Delay Time	—	220	340		
$t_f$	Fall Time	—	90	140		
$E_{on}$	Turn-On Switching Loss	—	0.95	—	mJ	Energy losses include "tail" and diode reverse recovery See Fig. 9,10,18
$E_{off}$	Turn-Off Switching Loss	—	1.15	—		
$E_{ts}$	Total Switching Loss	—	2.10	2.6		
$t_{sc}$	Short Circuit Withstand Time	10	—	—	$\mu s$	$V_{CC} = 720V, T_J = 125^\circ\text{C}$ $V_{GE} = 15V, R_G = 5.0\Omega$
$t_{d(on)}$	Turn-On Delay Time	—	42	—	ns	$T_J = 150^\circ\text{C}$ , $I_C = 10A, V_{CC} = 800V$ $V_{GE} = 15V, R_G = 23\Omega$ , Energy losses include "tail" and diode reverse recovery See Fig. 10,11,18
$t_r$	Rise Time	—	79	—		
$t_{d(off)}$	Turn-Off Delay Time	—	540	—		
$t_f$	Fall Time	—	97	—		
$E_{ts}$	Total Switching Loss	—	3.5	—	mJ	
$L_E$	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package
$C_{ies}$	Input Capacitance	—	800	—	pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0MHz$ See Fig. 7
$C_{oes}$	Output Capacitance	—	60	—		
$C_{res}$	Reverse Transfer Capacitance	—	14	—		
$t_{rr}$	Diode Reverse Recovery Time	—	50	76	ns	$T_J = 25^\circ\text{C}$ See Fig. 14 $T_J = 125^\circ\text{C}$ 14
		—	72	110		
$I_{rr}$	Diode Peak Reverse Recovery Current	—	4.4	7.0	A	$T_J = 25^\circ\text{C}$ See Fig. 15 $T_J = 125^\circ\text{C}$ 15
		—	5.9	8.8		
$Q_{rr}$	Diode Reverse Recovery Charge	—	130	200	nC	$T_J = 25^\circ\text{C}$ See Fig. 16 $T_J = 125^\circ\text{C}$ 16
		—	250	380		
$di_{(rec)}/dt$	Diode Peak Rate of Fall of Recovery During $t_b$	—	210	—	A/ $\mu s$	$T_J = 25^\circ\text{C}$ See Fig. 17 $T_J = 125^\circ\text{C}$ 17



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



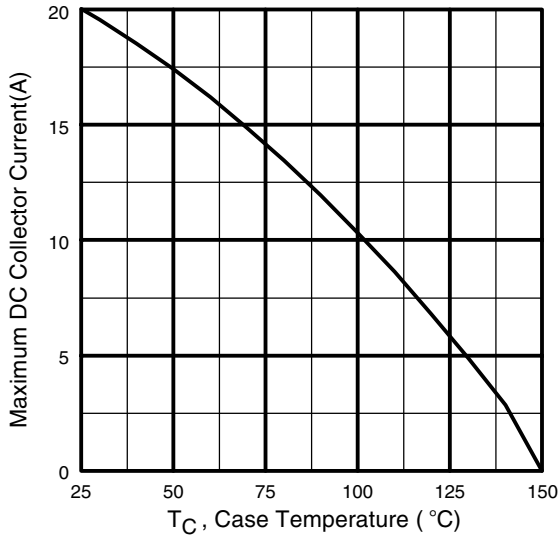
**Fig. 2 - Typical Output Characteristics**



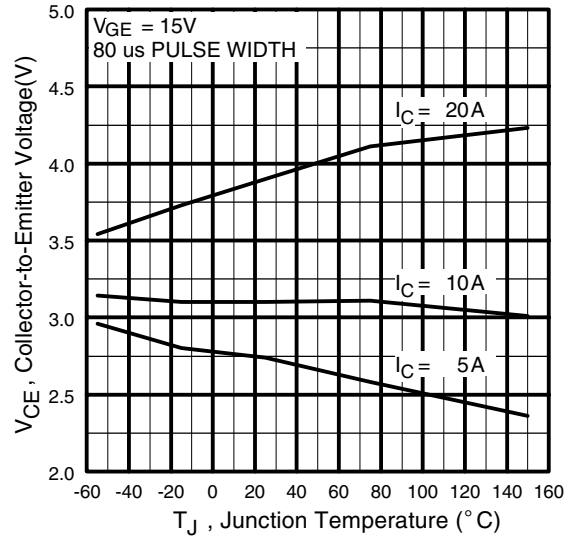
**Fig. 3 - Typical Transfer Characteristics**

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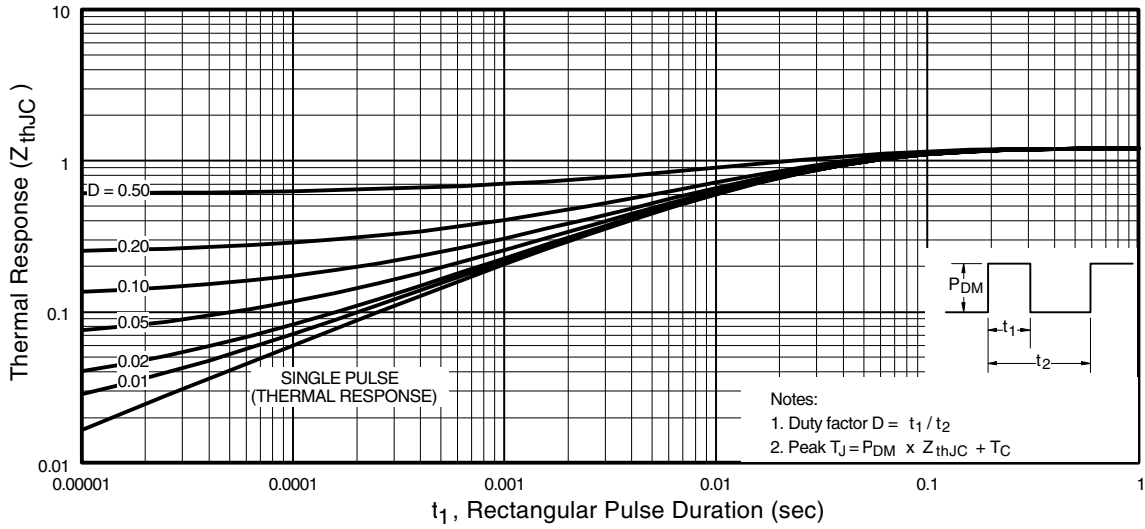
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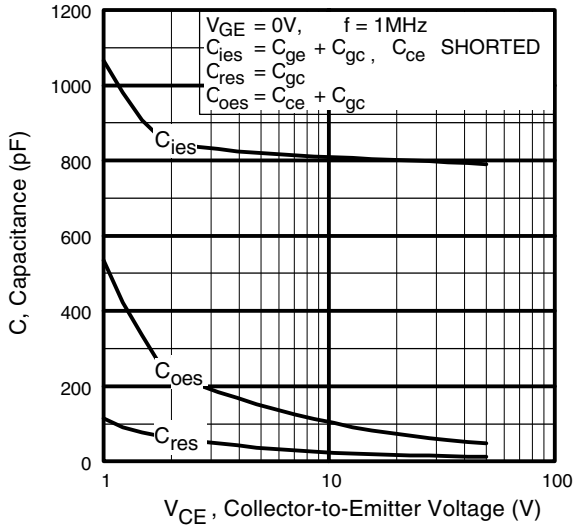
**Fig. 4** - Maximum Collector Current vs. Case Temperature



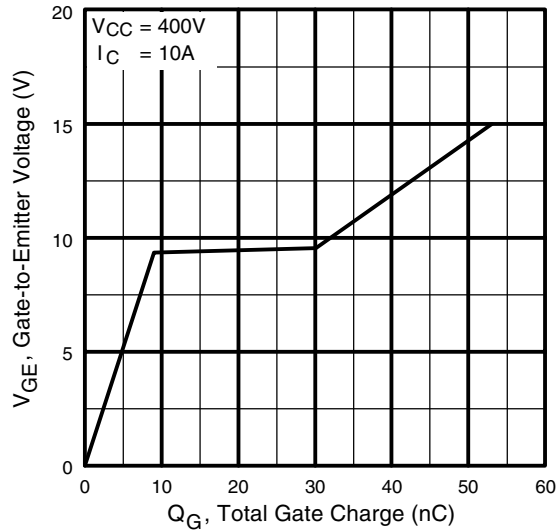
**Fig. 5** - Typical Collector-to-Emitter Voltage vs. Junction Temperature



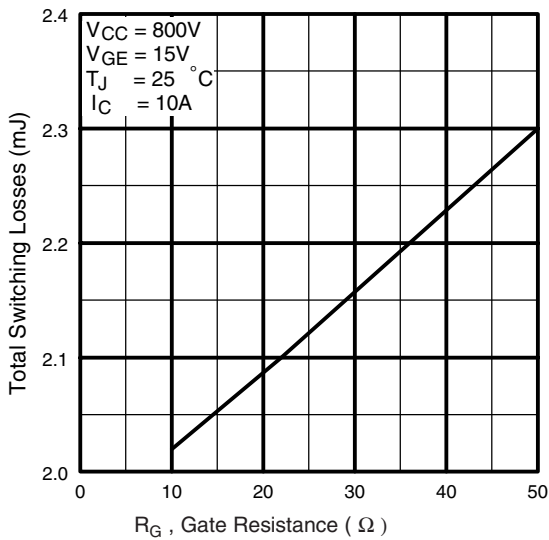
**Fig. 6** - Maximum Effective Transient Thermal Impedance, Junction-to-Case



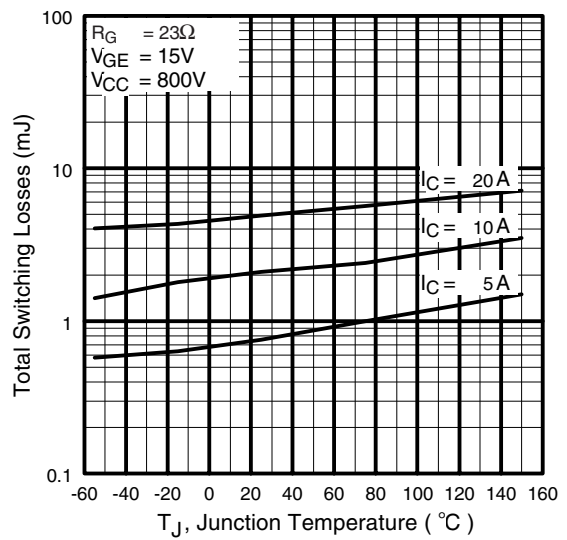
**Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage**



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



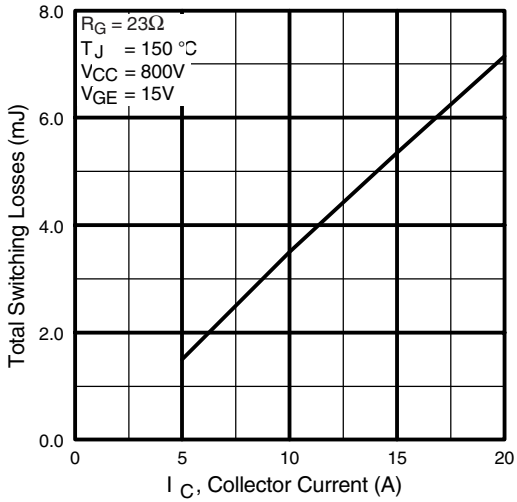
**Fig. 9 - Typical Switching Losses vs. Gate Resistance**



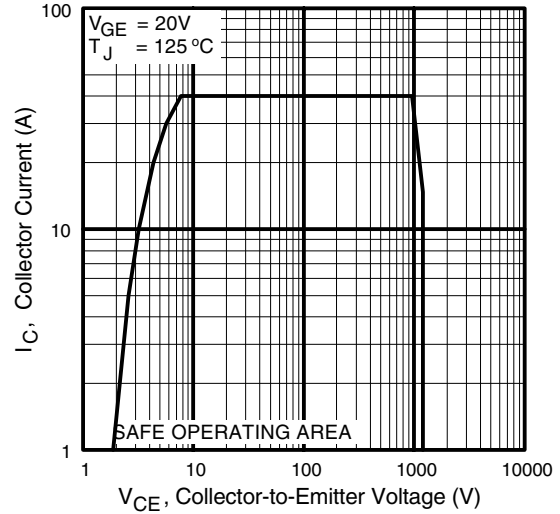
**Fig. 10 - Typical Switching Losses vs. Junction Temperature**

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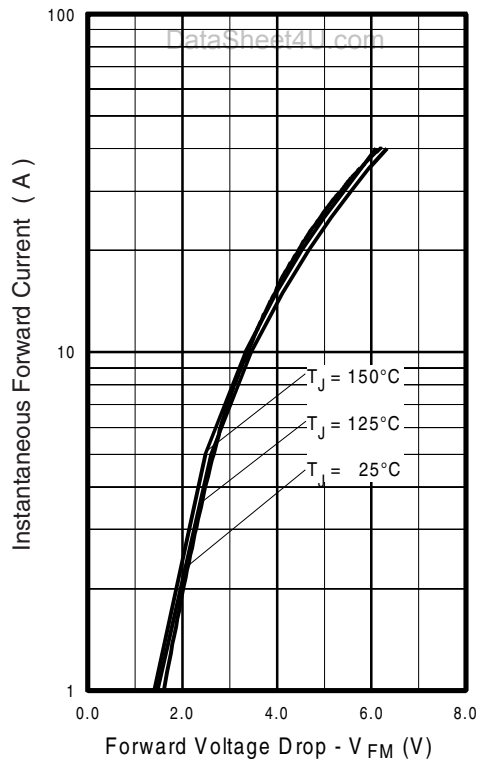
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**Fig. 11** - Typical Switching Losses vs. Collector Current



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



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

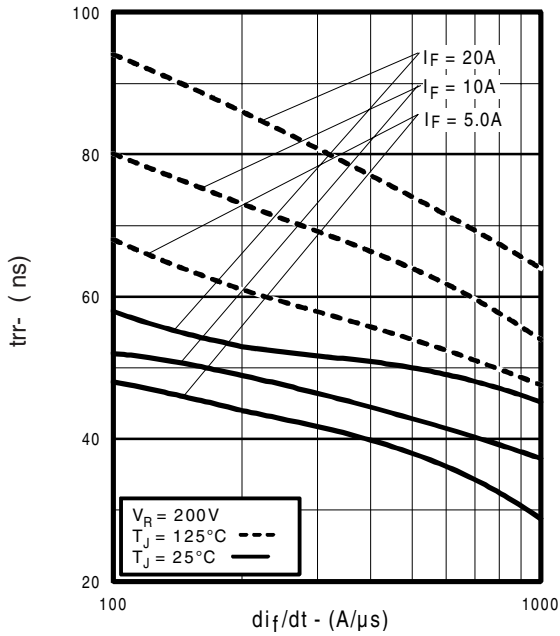


Fig. 14 - Typical Reverse Recovery vs.  $di/dt$

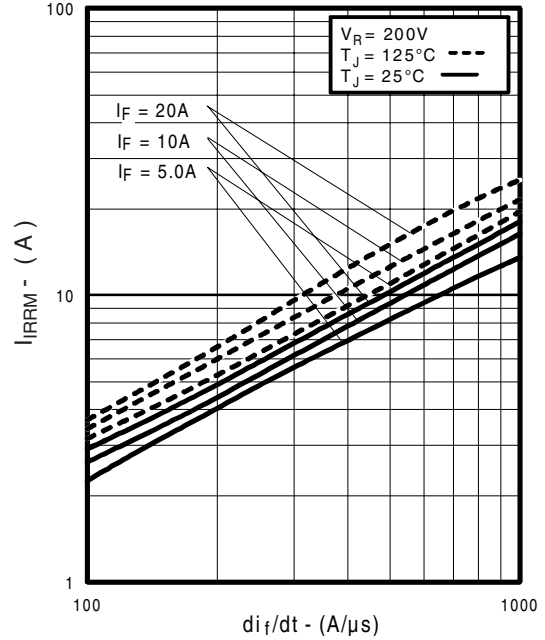


Fig. 15 - Typical Recovery Current vs.  $di/dt$

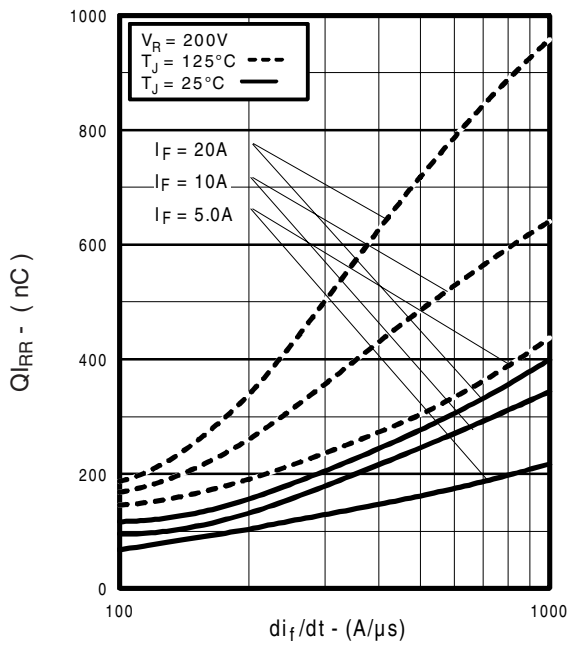


Fig. 16 - Typical Stored Charge vs.  $di/dt$

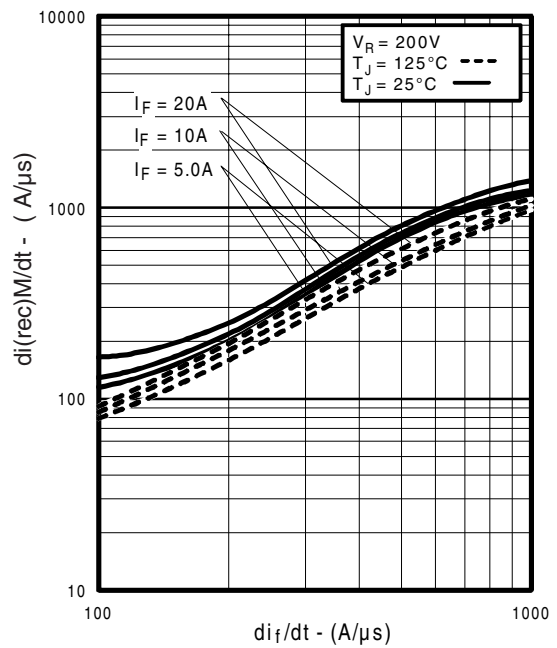
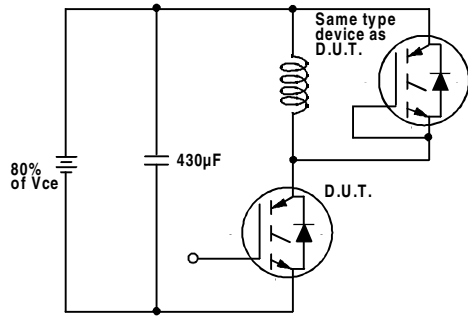


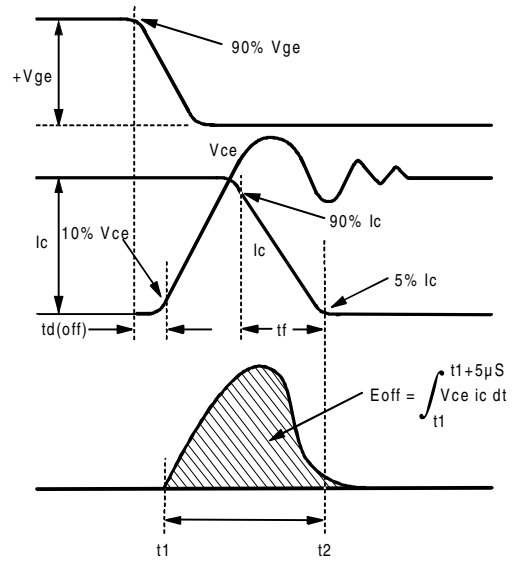
Fig. 17 - Typical  $di_{(rec)M}/dt$  vs.  $di/dt$

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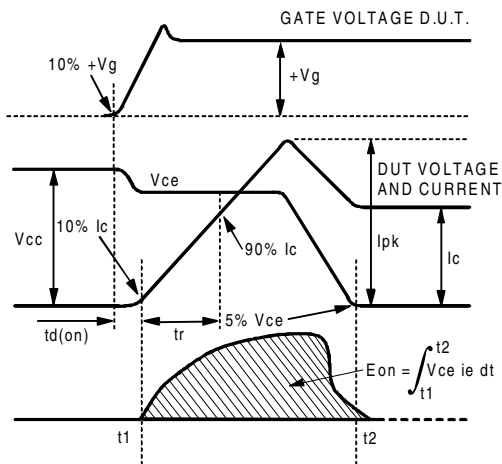
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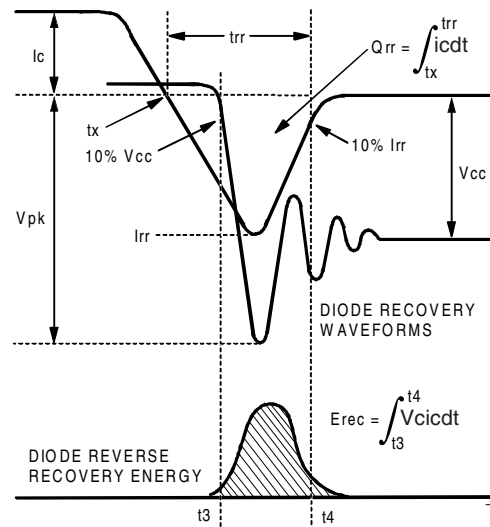
**Fig. 18a** - Test Circuit for Measurement of  $I_{LM}$ ,  $E_{on}$ ,  $E_{off}(\text{diode})$ ,  $t_{rr}$ ,  $Q_{rr}$ ,  $I_{rr}$ ,  $t_{d(on)}$ ,  $t_r$ ,  $t_{d(off)}$ ,  $t_f$



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



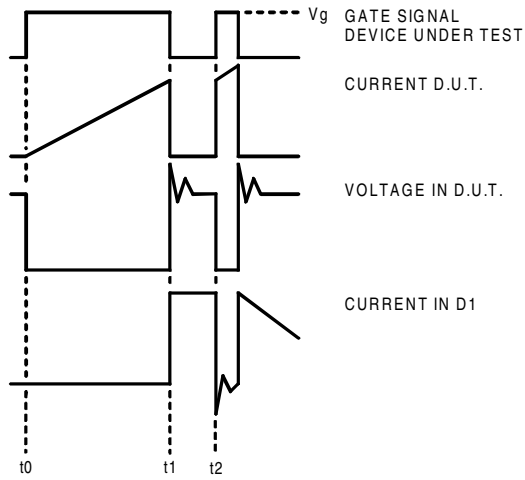


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

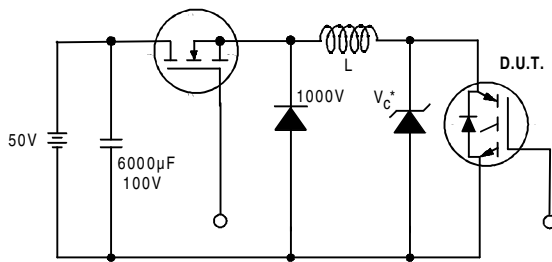


Figure 19. Clamped Inductive Load Test Circuit

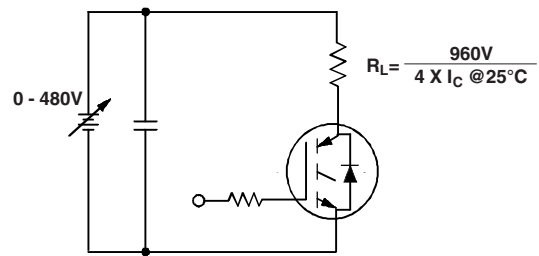


Figure 20. Pulsed Collector Current Test Circuit

