

IRG4PC40KD

INSULATED GATE BIPOLAR TRANSISTOR WITH
ULTRAFAST SOFT RECOVERY DIODE

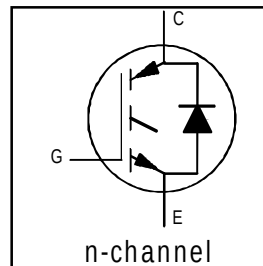
Short Circuit Rated
UltraFast IGBT

Features

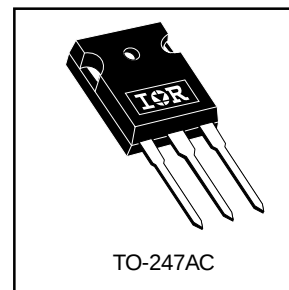
- Short Circuit Rated UltraFast: Optimized for high operating frequencies >5.0 kHz , and Short Circuit Rated to 10μs @ 125°C, $V_{GE} = 15V$
- Generation 4 IGBT design provides tighter parameter distribution and higher efficiency than Generation 3
- IGBT co-packaged with HEXFRED™ ultrafast, ultra-soft-recovery anti-parallel diodes for use in bridge configurations
- Industry standard TO-247AC package

Benefits

- Generation 4 IGBTs offer highest efficiencies available
- HEXFRED diodes optimized for performance with IGBTs. Minimized recovery characteristics require less/no snubbing
- Designed to be a "drop-in" replacement for equivalent industry-standard Generation 3 IR IGBTs



$V_{CES} = 600V$
$V_{CE(on)} \text{ typ.} = 2.1V$
@ $V_{GE} = 15V, I_C = 25A$



Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Voltage	600	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	42	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	25	
I_{CM}	Pulsed Collector Current ①	84	
I_{LM}	Clamped Inductive Load Current ②	84	
$I_F @ T_C = 100^\circ C$	Diode Continuous Forward Current	15	
I_{FM}	Diode Maximum Forward Current	84	
t_{SC}	Short Circuit Withstand Time	10	μs
V_{GE}	Gate-to-Emitter Voltage	± 20	V
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	160	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	65	
T_J	Operating Junction and	-55 to +150	°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	—	—	0.77	°C/W
$R_{\theta JC}$	Junction-to-Case - Diode	—	—	1.7	
$R_{\theta CS}$	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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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 ^③	600	—	—	V	$V_{GE} = 0V, I_C = 250\mu A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	0.46	—	V/ $^\circ\text{C}$	$V_{GE} = 0V, I_C = 1.0mA$
$V_{CE(on)}$	Collector-to-Emitter Saturation Voltage	—	2.10	2.6	V	$I_C = 25A, V_{GE} = 15V$
		—	2.70	—		$I_C = 42A$
		—	2.14	—		$I_C = 25A, T_J = 150^\circ\text{C}$
$V_{GE(th)}$	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	—	-13	—	mV/ $^\circ\text{C}$	$V_{CE} = V_{GE}, I_C = 250\mu A$
g_{fe}	Forward Transconductance ^④	7.0	14	—	S	$V_{CE} = 100V, I_C = 25A$
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	μA	$V_{GE} = 0V, V_{CE} = 600V$
		—	—	3500		$V_{GE} = 0V, V_{CE} = 600V, T_J = 150^\circ\text{C}$
V_{FM}	Diode Forward Voltage Drop	—	1.3	1.7	V	$I_C = 15A$
		—	1.2	1.6		$I_C = 15A, T_J = 150^\circ\text{C}$
I_{GES}	Gate-to-Emitter Leakage Current	—	—	± 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)	—	120	180	nC	$I_C = 25A$
Q_{ge}	Gate - Emitter Charge (turn-on)	—	16	24		$V_{CC} = 400V$
Q_{gc}	Gate - Collector Charge (turn-on)	—	51	77		$V_{GE} = 15V$
$t_{d(on)}$	Turn-On Delay Time	—	53	—	ns	$T_J = 25^\circ\text{C}$
t_r	Rise Time	—	33	—		$I_C = 25A, V_{CC} = 480V$
$t_{d(off)}$	Turn-Off Delay Time	—	110	160		$V_{GE} = 15V, R_G = 10\Omega$
t_f	Fall Time	—	100	150		Energy losses include "tail"
E_{on}	Turn-On Switching Loss	—	0.95	—	mJ	See Fig. 9,10,14
E_{off}	Turn-Off Switching Loss	—	0.76	—		
E_{ts}	Total Switching Loss	—	1.71	2.3		
t_{sc}	Short Circuit Withstand Time	10	—	—	μs	$V_{CC} = 360V, T_J = 125^\circ\text{C}$ $V_{GE} = 15V, R_G = 10\Omega, V_{CPK} < 500V$
$t_{d(on)}$	Turn-On Delay Time	—	52	—	ns	$T_J = 150^\circ\text{C},$
t_r	Rise Time	—	37	—		$I_C = 25A, V_{CC} = 480V$
$t_{d(off)}$	Turn-Off Delay Time	—	220	—		$V_{GE} = 15V, R_G = 10\Omega$
t_f	Fall Time	—	140	—		Energy losses include "tail"
E_{ts}	Total Switching Loss	—	2.67	—	mJ	See Fig. 11,14
L_E	Internal Emitter Inductance	—	13	—	nH	Measured 5mm from package
C_{ies}	Input Capacitance	—	1600	—	pF	$V_{GE} = 0V$
C_{oes}	Output Capacitance	—	130	—		$V_{CC} = 30V$
C_{res}	Reverse Transfer Capacitance	—	55	—		$f = 1.0MHz$
t_{rr}	Diode Reverse Recovery Time	—	42	60	ns	$T_J = 25^\circ\text{C}$ See Fig. 14
		—	74	120		$T_J = 125^\circ\text{C}$
I_{rr}	Diode Peak Reverse Recovery Current	—	4.0	6.0	A	$T_J = 25^\circ\text{C}$ See Fig. 15
		—	6.5	10		$T_J = 125^\circ\text{C}$
Q_{rr}	Diode Reverse Recovery Charge	—	80	180	nC	$T_J = 25^\circ\text{C}$ See Fig. 16
		—	220	600		$T_J = 125^\circ\text{C}$
$di_{(rec)M}/dt$	Diode Peak Rate of Fall of Recovery During t_b	—	188	—	A/ μs	$T_J = 25^\circ\text{C}$ See Fig. 17
		—	160	—		$T_J = 125^\circ\text{C}$

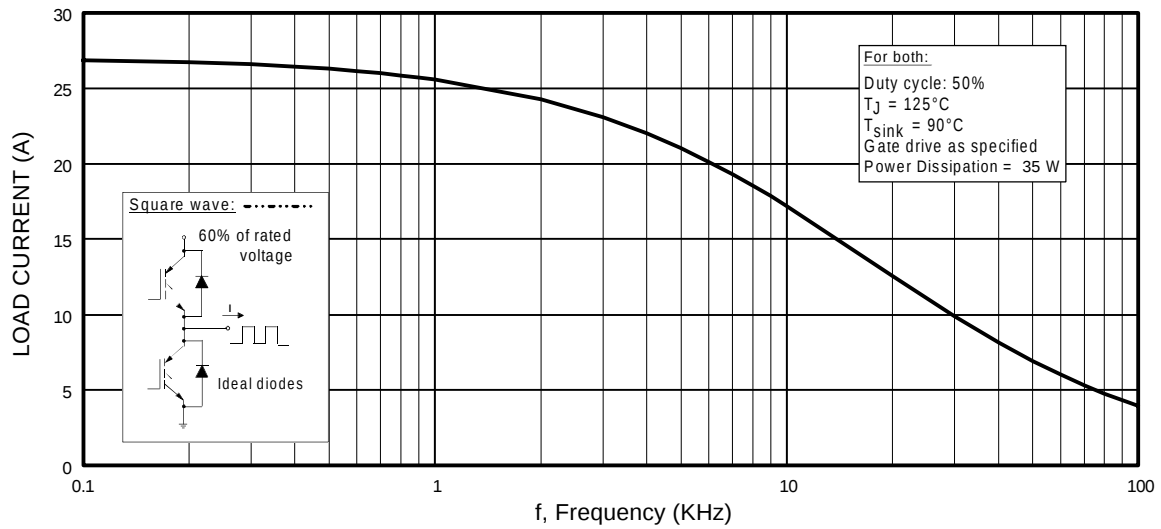


Fig. 1 - Typical Load Current vs. Frequency
(Load Current = I_{RMS} of fundamental)

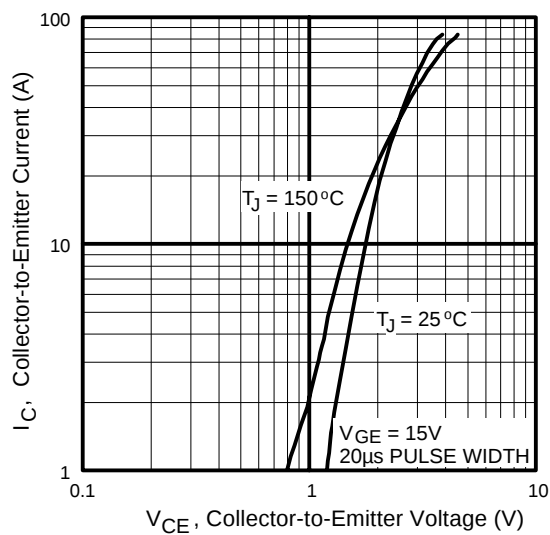


Fig. 2 - Typical Output Characteristics

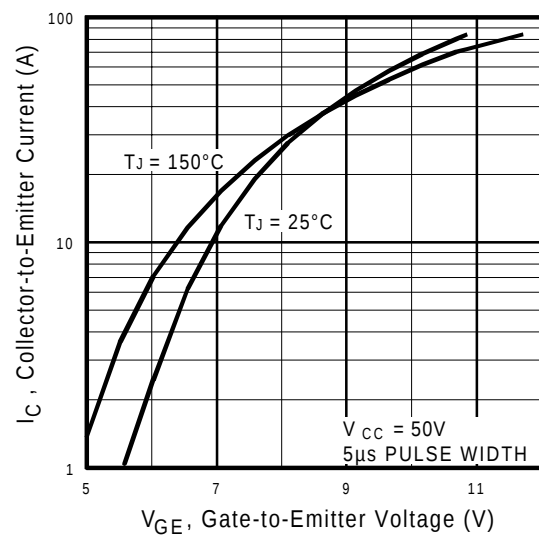


Fig. 3 - Typical Transfer Characteristics

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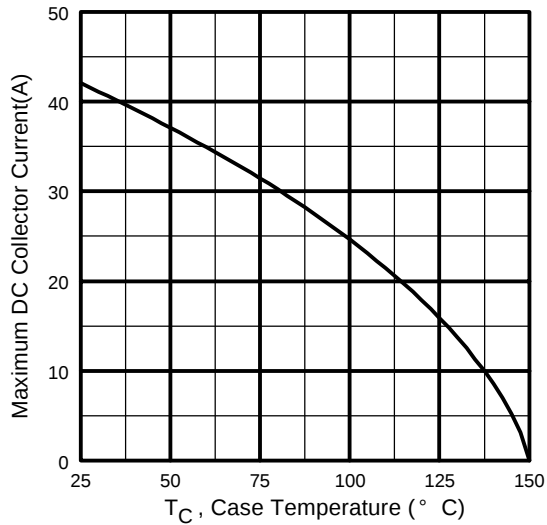


Fig. 4 - Maximum Collector Current vs. Case Temperature

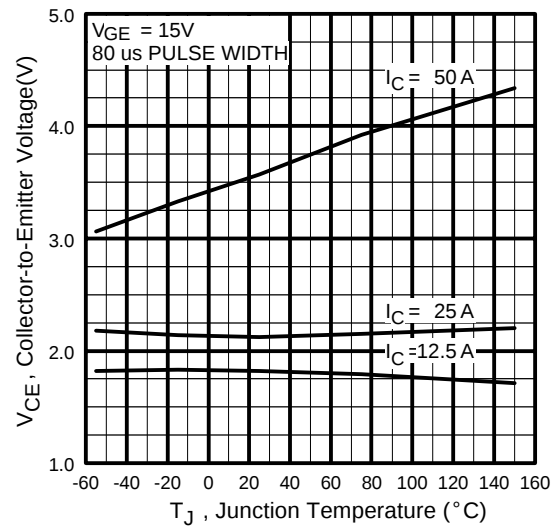


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

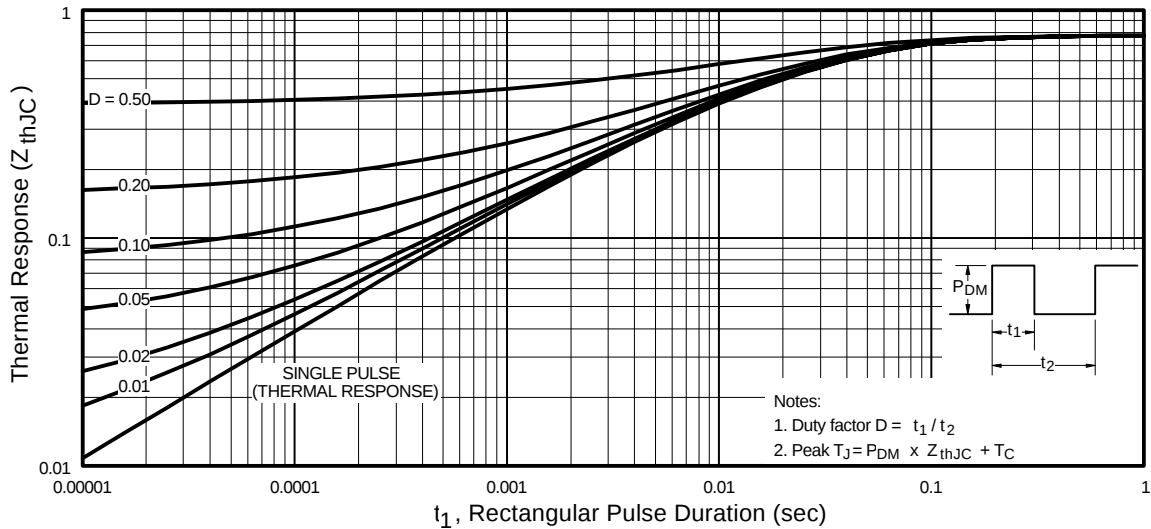


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

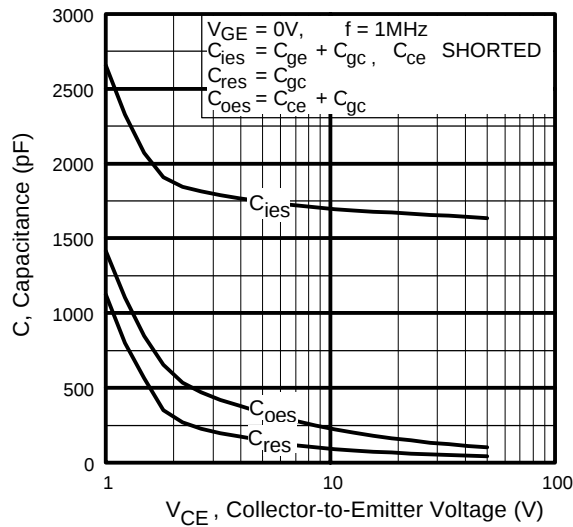


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

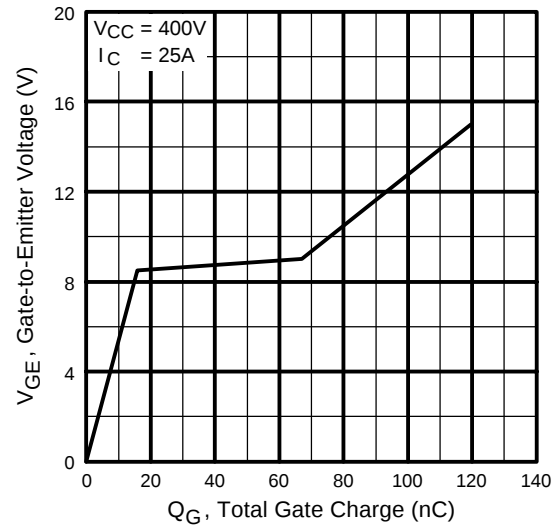


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

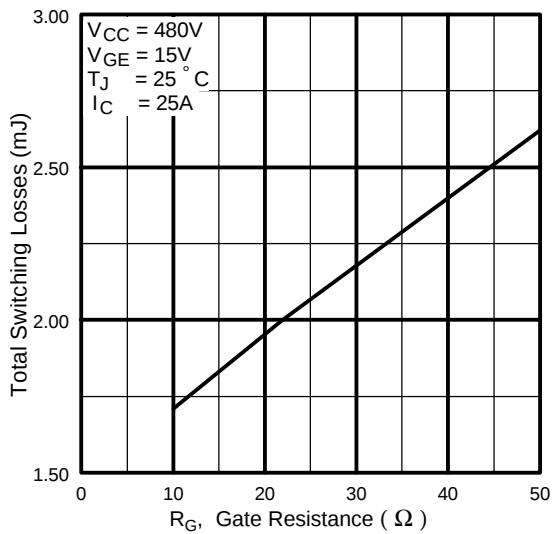


Fig. 9 - Typical Switching Losses vs. Gate Resistance

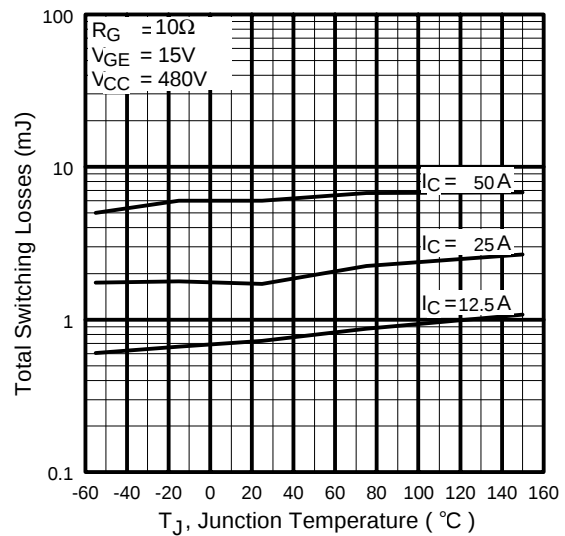
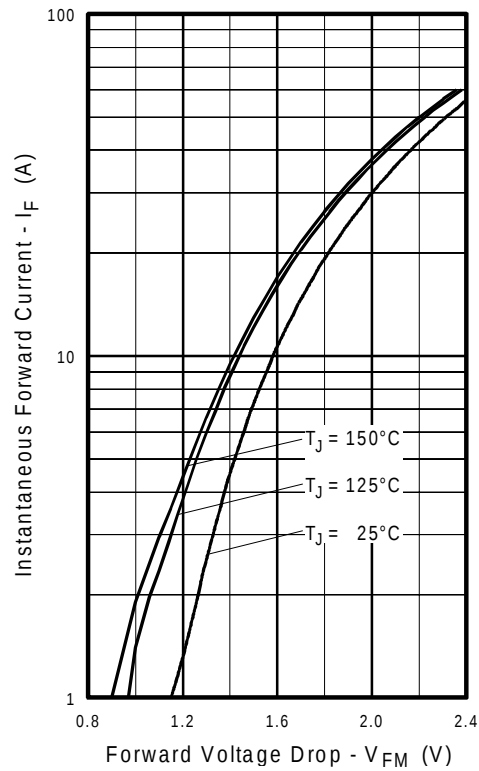
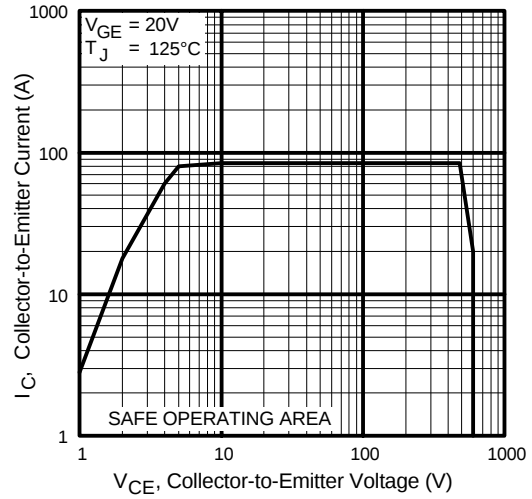
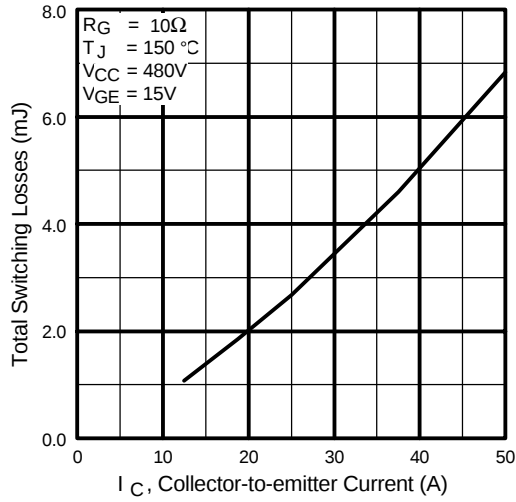


Fig. 10 - Typical Switching Losses vs. Junction Temperature

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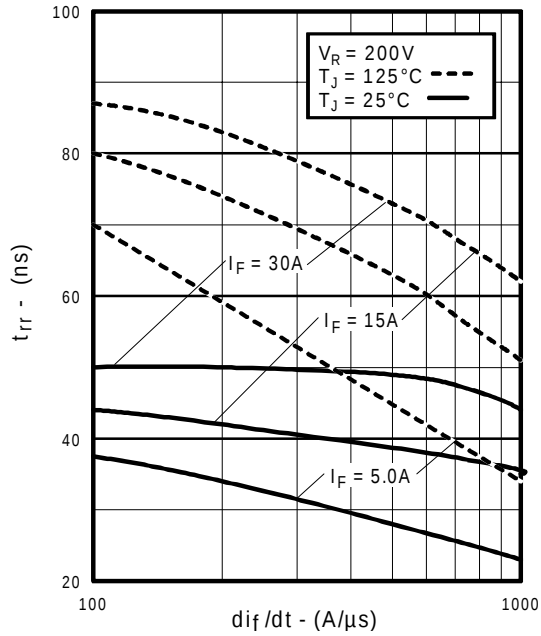


Fig. 14 - Typical Reverse Recovery vs. di_f/dt

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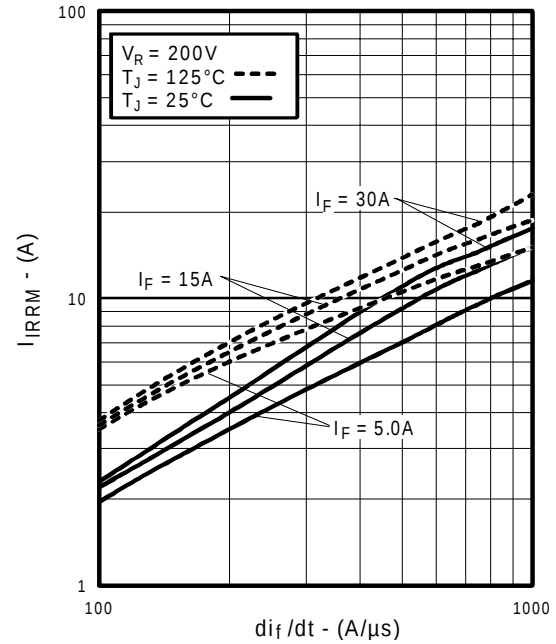


Fig. 15 - Typical Recovery Current vs. di_f/dt

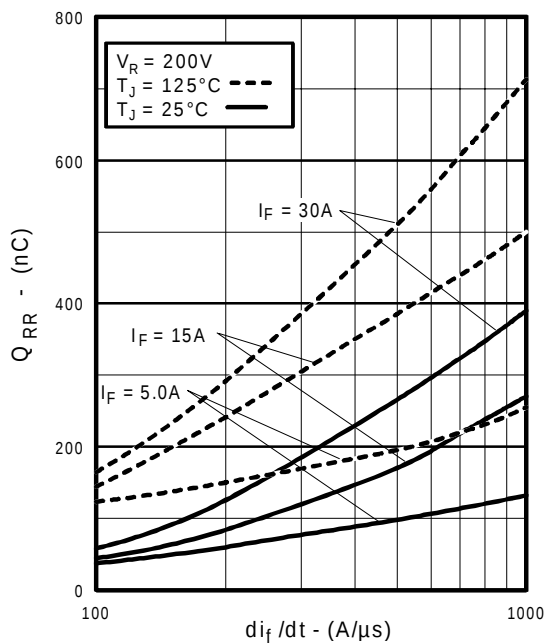


Fig. 16 - Typical Stored Charge vs. di_f/dt

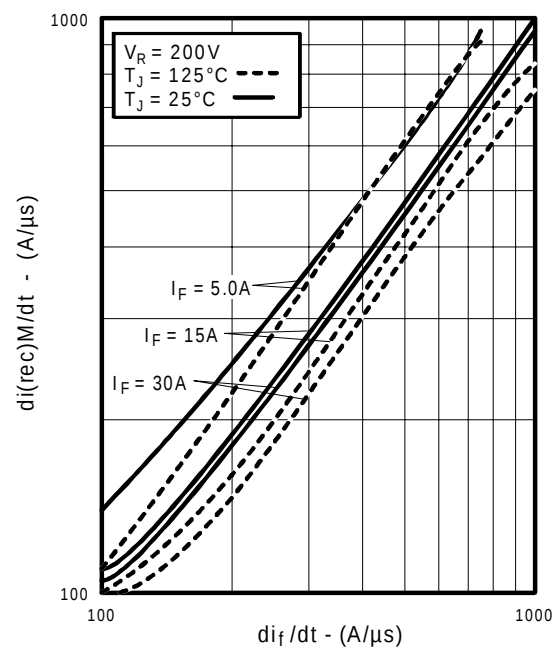


Fig. 17 - Typical $di_{(rec)M}/dt$ vs. di_f/dt

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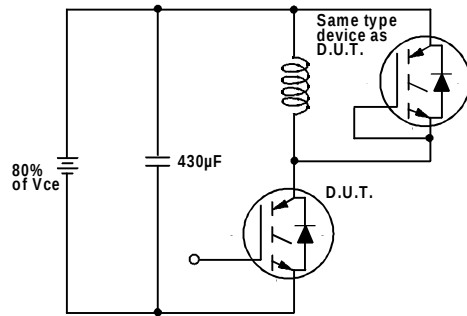


Fig. 18a - Test Circuit for Measurement of I_{LM} , E_{on} , $E_{off}(\text{diode})$, t_{rr} , Q_{rr} , I_{rr} , $t_{d(on)}$, t_r , $t_{d(off)}$, t_f

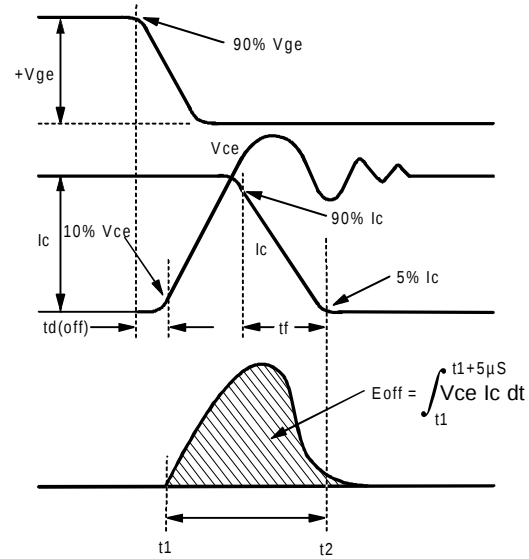


Fig. 18b - Test Waveforms for Circuit of Fig. 18a, Defining E_{off} , $t_{d(off)}$, t_f

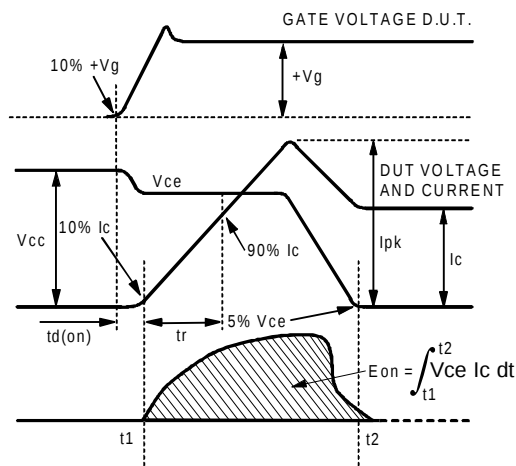


Fig. 18c - Test Waveforms for Circuit of Fig. 18a, Defining E_{on} , $t_{d(on)}$, t_r

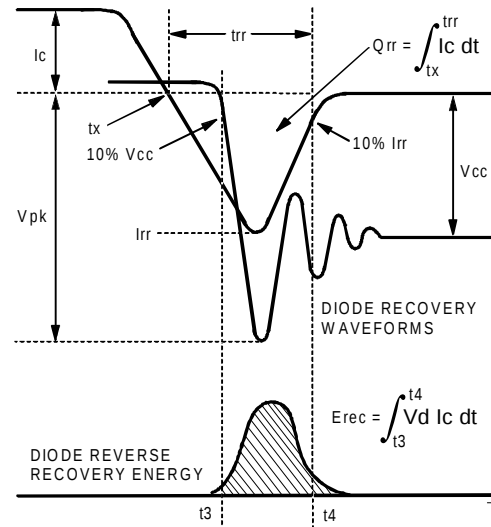


Fig. 18d - Test Waveforms for Circuit of Fig. 18a, Defining E_{rec} , t_{rr} , Q_{rr} , I_{rr}

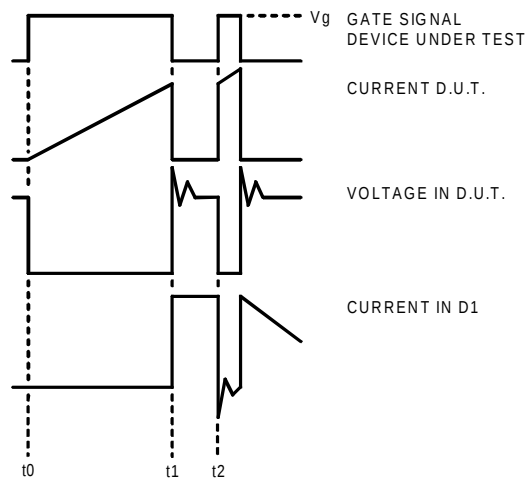


Figure 18e. Macro Waveforms for Figure 18a's Test Circuit

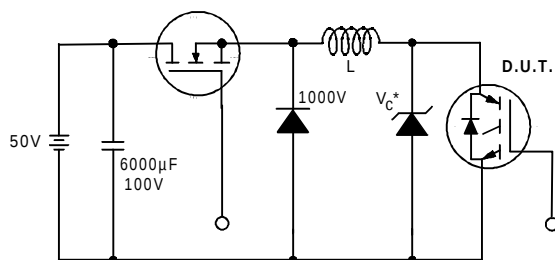


Figure 19. Clamped Inductive Load Test Circuit

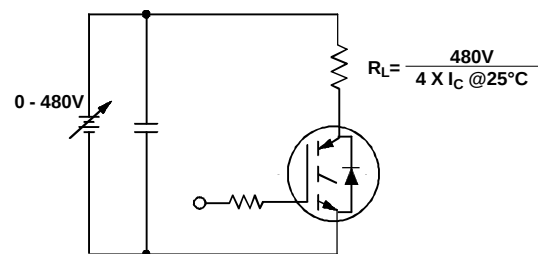


Figure 20. Pulsed Collector Current Test Circuit

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④ Pulse width 5.0μs, single shot.

Technical drawing of a mechanical part showing three views: front, top, and side. Dimensions are given in millimeters (mm) and inches (in).

Front View Dimensions:

- Overall width: 15.90 (.626)
- Inner width: 15.30 (.602)
- Top hole diameter: $\varnothing 3.65$ (.143)
- Top hole position: 3.55 (.140)
- Top hole tolerance: $\varnothing 0.25$ (.010) (M) D B M
- Top hole depth: 5.50 (.217)
- Top hole position: 2X $\varnothing 5.50$ (.217)
- Top hole position: 4.50 (.177)
- Top hole position: 4.30 (.170)
- Top hole position: 3.70 (.145)
- Top hole position: 1.40 (.056)
- Top hole position: 1.00 (.039)
- Top hole position: 3.40 (.133)
- Top hole position: 3.00 (.118)
- Top hole position: 2.40 (.094)
- Top hole position: 2.00 (.079)
- Top hole position: 2X 5.45 (.215)
- Top hole position: 2X
- Top hole position: 14.80 (.583)
- Top hole position: 14.20 (.559)
- Top hole position: 20.30 (.800)
- Top hole position: 19.70 (.775)

Top View Dimensions:

- Overall width: 15.90 (.626)
- Inner width: 15.30 (.602)
- Top hole diameter: $\varnothing 3.65$ (.143)
- Top hole position: 3.55 (.140)
- Top hole tolerance: $\varnothing 0.25$ (.010) (M) D B M
- Top hole depth: 5.50 (.217)
- Top hole position: 2X $\varnothing 5.50$ (.217)
- Top hole position: 4.50 (.177)
- Top hole position: 4.30 (.170)
- Top hole position: 3.70 (.145)
- Top hole position: 1.40 (.056)
- Top hole position: 1.00 (.039)
- Top hole position: 3.40 (.133)
- Top hole position: 3.00 (.118)
- Top hole position: 2.40 (.094)
- Top hole position: 2.00 (.079)
- Top hole position: 2X 5.45 (.215)
- Top hole position: 2X
- Top hole position: 14.80 (.583)
- Top hole position: 14.20 (.559)
- Top hole position: 20.30 (.800)
- Top hole position: 19.70 (.775)

Side View Dimensions:

- Overall height: 5.30 (.209)
- Inner height: 4.70 (.185)
- Top hole diameter: $\varnothing 3.65$ (.143)
- Top hole position: 3.55 (.140)
- Top hole tolerance: $\varnothing 0.25$ (.010) (M) D B M
- Top hole depth: 5.50 (.217)
- Top hole position: 2X $\varnothing 5.50$ (.217)
- Top hole position: 4.50 (.177)
- Top hole position: 4.30 (.170)
- Top hole position: 3.70 (.145)
- Top hole position: 1.40 (.056)
- Top hole position: 1.00 (.039)
- Top hole position: 3.40 (.133)
- Top hole position: 3.00 (.118)
- Top hole position: 2.40 (.094)
- Top hole position: 2.00 (.079)
- Top hole position: 2X 5.45 (.215)
- Top hole position: 2X
- Top hole position: 14.80 (.583)
- Top hole position: 14.20 (.559)
- Top hole position: 20.30 (.800)
- Top hole position: 19.70 (.775)

* LONGER LEADED (20mm)
VERSION AVAILABLE (TO-247AD)
TO ORDER ADD "-E" SUFFIX
TO PART NUMBER

Dimensions in Millimeters and (Inches)

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Data and specifications subject to change without notice. 4/00