

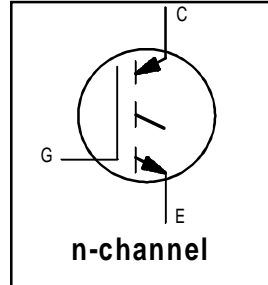
IRG4PH50U

INSULATED GATE BIPOLAR TRANSISTOR

Ultra Fast Speed IGBT

Features

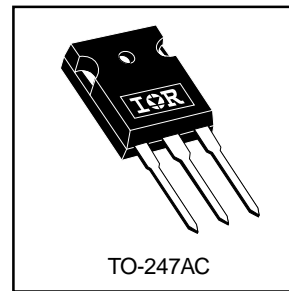
- UltraFast: Optimized for high operating frequencies up to 40 kHz in hard switching, >200 kHz in resonant mode
- New IGBT design provides tighter parameter distribution and higher efficiency than previous generations
- Optimized for power conversion; SMPS, UPS and welding
- Industry standard TO-247AC package



$V_{CES} = 1200V$
$V_{CE(on)} \text{ typ.} = 2.78V$
@ $V_{GE} = 15V, I_C = 24A$

Benefits

- Higher switching frequency capability than competitive IGBTs
- Highest efficiency available
- Much lower conduction losses than MOSFETs
- More efficient than short circuit rated IGBTs



Absolute Maximum Ratings

	Parameter	Max.	Units
V_{CES}	Collector-to-Emitter Breakdown Voltage	1200	V
$I_C @ T_C = 25^\circ C$	Continuous Collector Current	45	A
$I_C @ T_C = 100^\circ C$	Continuous Collector Current	24	
I_{CM}	Pulsed Collector Current ①	180	
I_{LM}	Clamped Inductive Load Current ②	180	
V_{GE}	Gate-to-Emitter Voltage	± 20	V
E_{ARV}	Reverse Voltage Avalanche Energy ③	170	mJ
$P_D @ T_C = 25^\circ C$	Maximum Power Dissipation	200	W
$P_D @ T_C = 100^\circ C$	Maximum Power Dissipation	78	
T_J	Operating Junction and	-55 to + 150	°C
T_{STG}	Storage Temperature Range		
	Soldering Temperature, for 10 seconds	300 (0.063 in. (1.6mm) from case)	
	Mounting torque, 6-32 or M3 screw.	10 lbf•in (1.1N•m)	

Thermal Resistance

	Parameter	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	—	0.64	°C/W
$R_{\theta CS}$	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	1200	—	—	V	$V_{GE} = 0V, I_C = 250\mu A$
$V_{(BR)ECS}$	Emitter-to-Collector Breakdown Voltage ④	18	—	—	V	$V_{GE} = 0V, I_C = 1.0A$
$\Delta V_{(BR)CES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	—	1.20	—	V/°C	$V_{GE} = 0V, I_C = 1.0mA$
$V_{CE(ON)}$	Collector-to-Emitter Saturation Voltage	—	2.56	3.5	V	$V_{GE} = 15V$ See Fig.2, 5
		—	2.78	3.7		
		—	3.20	—		
		—	2.54	—		
$V_{GE(th)}$	Gate Threshold Voltage	3.0	—	6.0		$I_C = 20A$ $I_C = 24A$ $I_C = 45A$ $I_C = 24A, T_J = 150^\circ\text{C}$ $V_{CE} = V_{GE}, I_C = 250\mu A$
$\Delta V_{GE(th)}/\Delta T_J$	Temperature Coeff. of Threshold Voltage	—	-13	—	mV/°C	$V_{CE} = V_{GE}, I_C = 250\mu A$
g_{fe}	Forward Transconductance ⑤	23	35	—	S	$V_{CE} = 100V, I_C = 24A$
I_{CES}	Zero Gate Voltage Collector Current	—	—	250	μA	$V_{GE} = 0V, V_{CE} = 1200V$
		—	—	2.0		$V_{GE} = 0V, V_{CE} = 24V, T_J = 25^\circ\text{C}$
		—	—	5000		$V_{GE} = 0V, V_{CE} = 1200V, T_J = 150^\circ\text{C}$
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)	—	160	250	nC	$I_C = 24A$ $V_{CC} = 400V$ $V_{GE} = 15V$ See Fig. 8		
Q_{ge}	Gate - Emitter Charge (turn-on)	—	27	40				
Q_{gc}	Gate - Collector Charge (turn-on)	—	53	83				
$t_{d(on)}$	Turn-On Delay Time	—	35	—	ns	$T_J = 25^\circ\text{C}$ $I_C = 24A, V_{CC} = 960V$ $V_{GE} = 15V, R_G = 5.0\Omega$ Energy losses include "tail"		
t_r	Rise Time	—	15	—				
$t_{d(off)}$	Turn-Off Delay Time	—	200	350				
t_f	Fall Time	—	290	500	mJ	See Fig. 9, 10, 14		
E_{on}	Turn-On Switching Loss	—	0.53	—				
E_{off}	Turn-Off Switching Loss	—	1.41	—				
E_{ts}	Total Switching Loss	—	1.94	2.6	mJ	See Fig. 11, 14		
$t_{d(on)}$	Turn-On Delay Time	—	31	—				
t_r	Rise Time	—	18	—				
$t_{d(off)}$	Turn-Off Delay Time	—	320	—	ns	$T_J = 150^\circ\text{C}$ $I_C = 24A, V_{CC} = 960V$ $V_{GE} = 15V, R_G = 5.0\Omega$ Energy losses include "tail"		
t_f	Fall Time	—	280	—				
E_{ts}	Total Switching Loss	—	5.40	—				
E_{on}	Turn-On Switching Loss	—	0.35	—	mJ	$T_J = 25^\circ\text{C}, V_{GE} = 15V, R_G = 5.0\Omega$ $I_C = 20A, V_{CC} = 960V$ Energy losses include "tail"		
E_{off}	Turn-Off Switching Loss	—	1.43	—				
E_{ts}	Total Switching Loss	—	1.78	2.9				
		—	4.56	—	mJ	See Fig. 9, 10, 11, 14, $T_J = 150^\circ\text{C}$		
L_E	Internal Emitter Inductance	—	13	—			nH	Measured 5mm from package
C_{ies}	Input Capacitance	—	3600	—			pF	$V_{GE} = 0V$ $V_{CC} = 30V$ $f = 1.0MHz$ See Fig. 7
C_{oes}	Output Capacitance	—	160	—				
C_{res}	Reverse Transfer Capacitance	—	31	—				

Notes:

- ① Repetitive rating; $V_{GE} = 20V$, pulse width limited by max. junction temperature. (See fig. 13b)
- ② $V_{CC} = 80\%(V_{CES}), V_{GE} = 20V, L = 10\mu H, R_G = 5.0\Omega$, (See fig. 13a)
- ③ Repetitive rating; pulse width limited by maximum junction temperature.
- ④ Pulse width $\leq 80\mu s$; duty factor $\leq 0.1\%$.
- ⑤ Pulse width $5.0\mu s$, single shot.

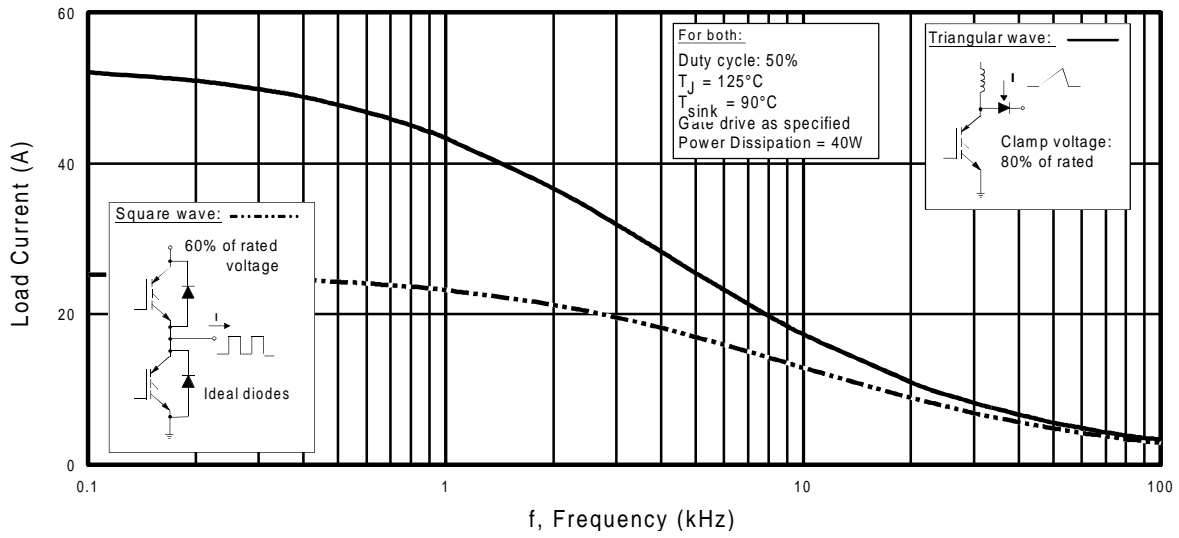


Fig. 1 - Typical Load Current vs. Frequency
 (Load Current = I_{RMS} of fundamental)

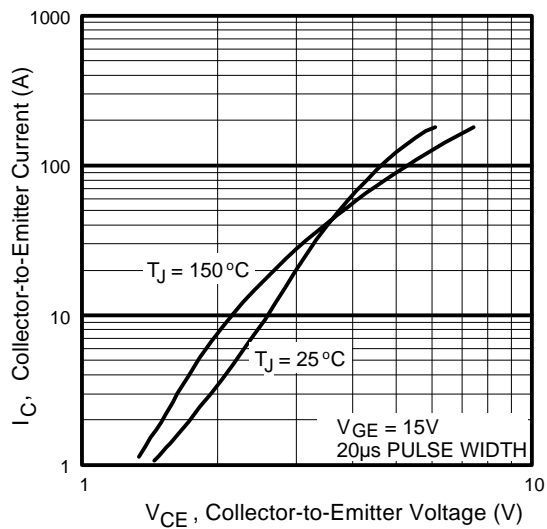


Fig. 2 - Typical Output Characteristics

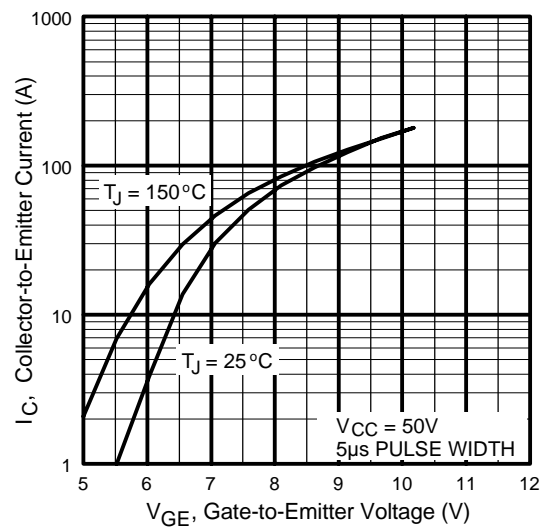


Fig. 3 - Typical Transfer Characteristics

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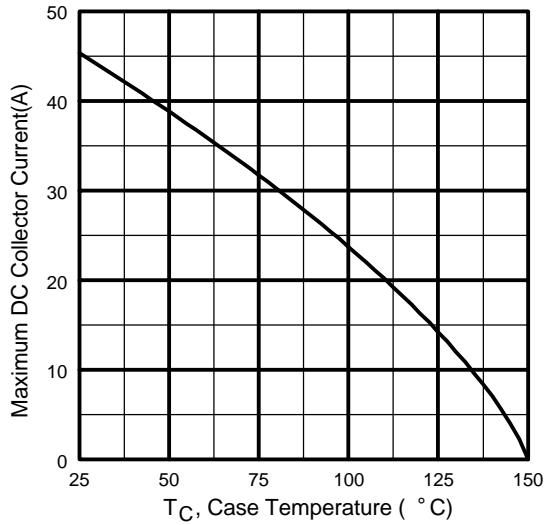


Fig. 4 - Maximum Collector Current vs. Case Temperature

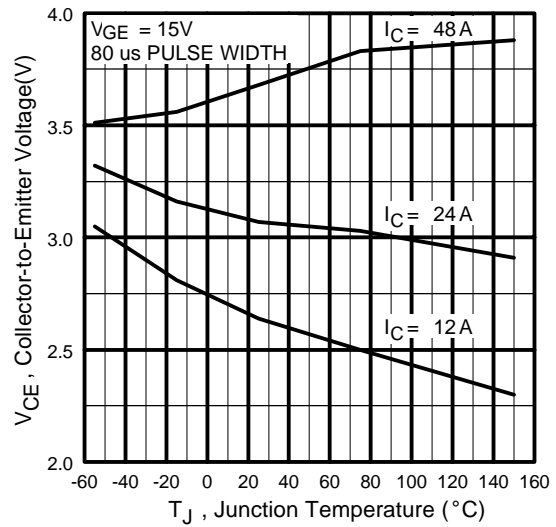


Fig. 5 - Typical Collector-to-Emitter Voltage vs. Junction Temperature

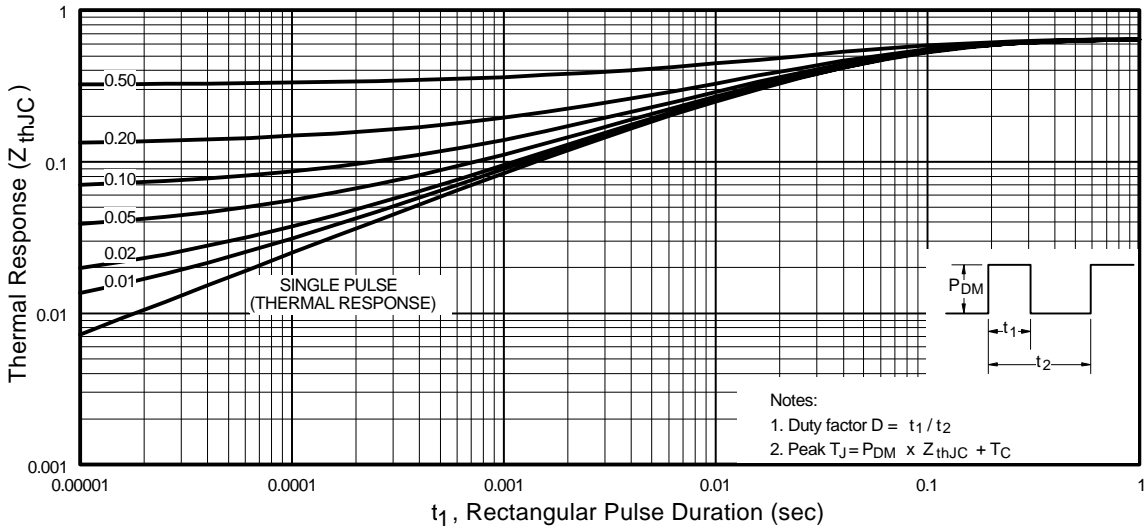


Fig. 6 - Maximum Effective Transient Thermal Impedance, Junction-to-Case

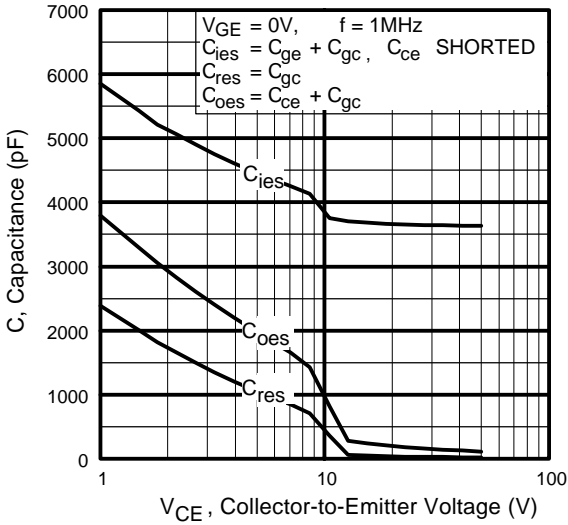


Fig. 7 - Typical Capacitance vs. Collector-to-Emitter Voltage

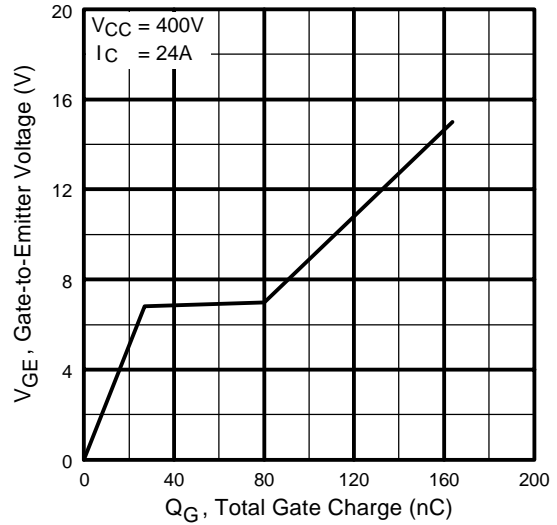


Fig. 8 - Typical Gate Charge vs. Gate-to-Emitter Voltage

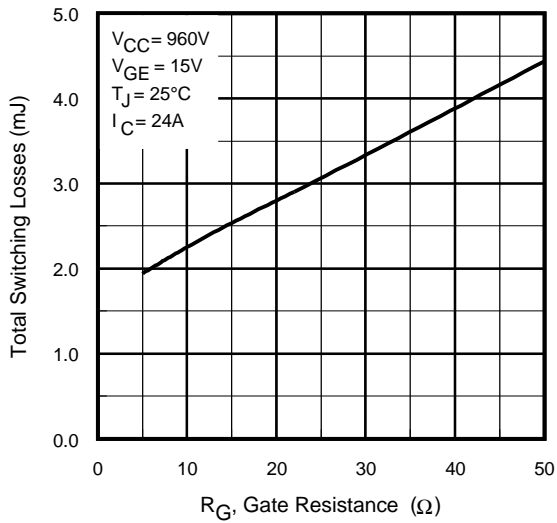


Fig. 9 - Typical Switching Losses vs. Gate Resistance

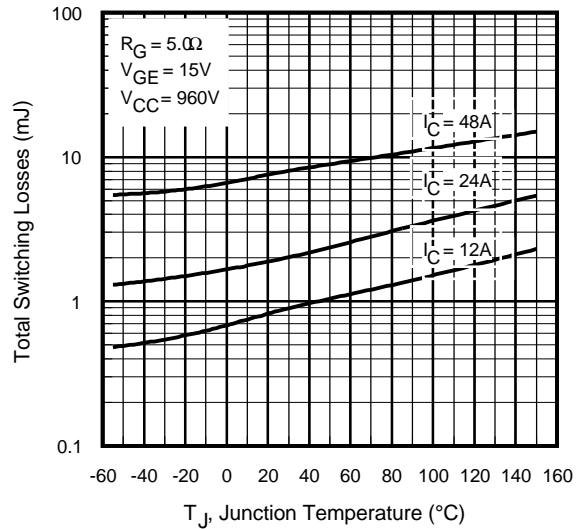


Fig. 10 - Typical Switching Losses vs. Junction Temperature

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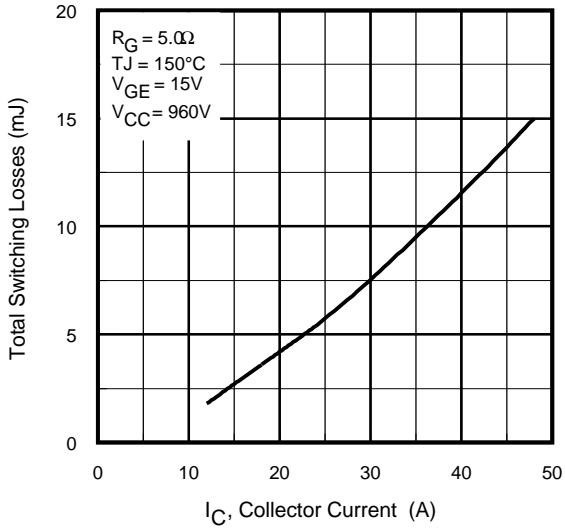


Fig. 11 - Typical Switching Losses vs. Collector-to-Emitter Current

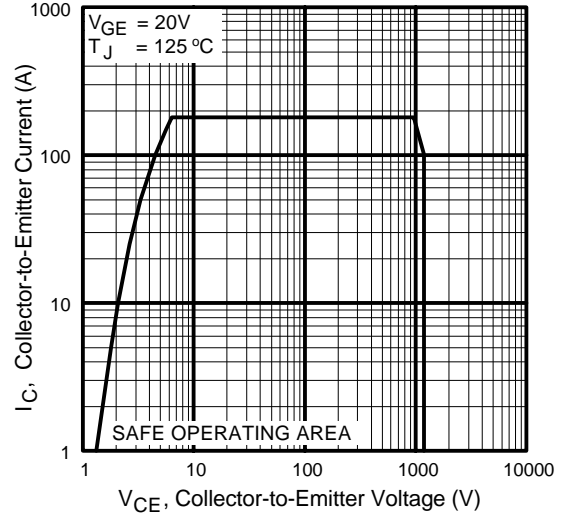
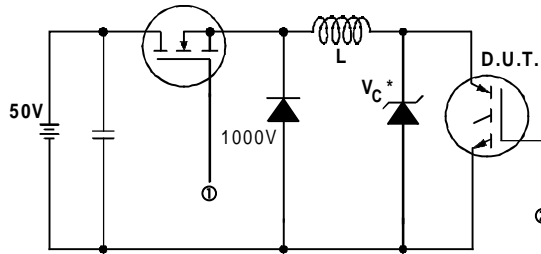


Fig. 12 - Turn-Off SOA



* Driver same type as D.U.T.; $V_c = 80\%$ of $V_{ce(max)}$
* Note: Due to the 50V power supply, pulse width and inductor will increase to obtain rated I_d .

Fig. 13a - Clamped Inductive Load Test Circuit

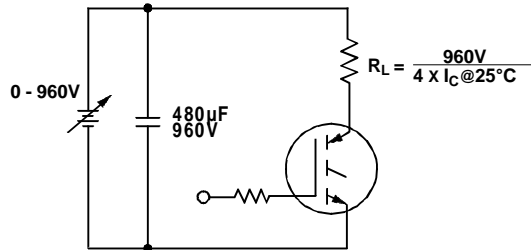


Fig. 13b - Pulsed Collector Current Test Circuit

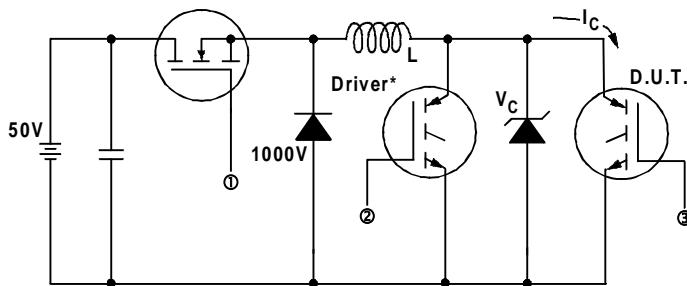


Fig. 14a - Switching Loss Test Circuit

* Driver same type as D.U.T., $V_C = 960V$

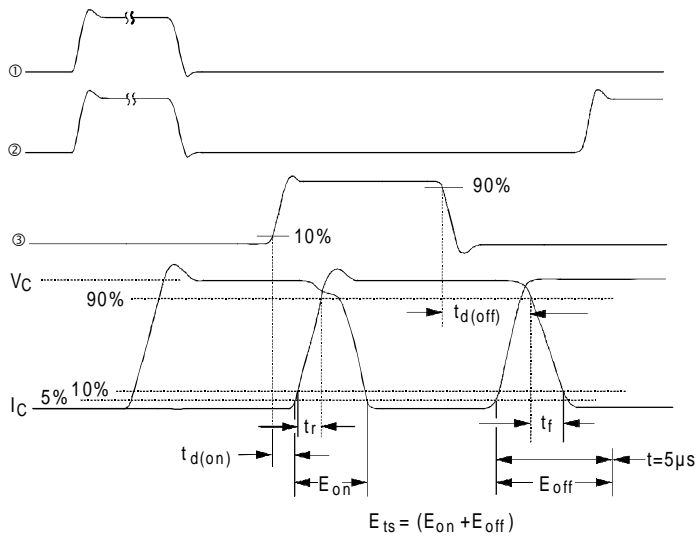


Fig. 14b - Switching Loss Waveforms

