Nov 2023

SemiHow
Know-How for Semiconductor

HID10N65T-SA

650V N-Channel Trench Field Stop IGBT

Features

- Very Low $V_{CE(sat)}$
- Extremely low switching loss
- Excellent stability and uniformity
- Soft Fast Reverse Recovery Diode
- Short Circuit Withstand Time 5.0μs
- Maximum Junction temperature, $T_{J(max)}$=175℃

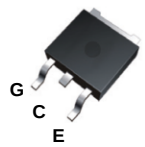
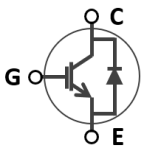
Application

- Uninterruptible Power Supplies (UPS)
- Solar / Welding converters
- Motor drivers
- High frequency Converters

Key Parameters

Parameter	Value	Unit
V_{CES}	650	V
I_C	10	A
$V_{CE(sat)}$	1.38	V
E_{tot}	0.204	mJ

Package & Internal Circuit

D-PAK	SYMBOL
	

Absolute Maximum Ratings

T_C=25℃ unless otherwise specified

Symbol	Parameter		Value	Unit
V_{CES}	Collector-Emitter Voltage		650	V
V_{GE}	Gate-Emitter Voltage		±20	V
I_C	Collector Current	(@ T_C = 25 ℃)	20	A
		(@ T_C = 100 ℃)	10	A
I_{CM}	Pulsed Collector Current (Note. 1)		40	A
I_F	Diode Continuous Forward Current (@ T_C = 100 ℃)		10	A
I_{FM}	Diode Maximum Forward Current		40	A
P_D	Power Dissipation	(@ T_C = 25 ℃)	81	W
		(@ T_C = 100 ℃)	40	W
T_J	Maximum Operating Junction Temperature		175	℃
T_{STG}	Storage Temperature Range		-55 to +175	℃

Thermal Resistance Characteristics

Symbol	Parameter	Value	Unit
$R_{\theta JC}$	IGBT Thermal Resistance, Junction-to-Case, Max.	1.84	℃/W
$R_{\theta JC}$	Diode Thermal Resistance, Junction-to-Case, Max.	2.4	℃/W
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient , Max.	40	℃/W

Notes : 1. Repetitive Rating, Pulse width limited by maximum junction temperature

Electrical Characteristics T_J=25°C unless otherwise specified

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Static Characteristics						
BV_{CES}	Collector-Emitter Breakdown Voltage	V_{GE} = 0 V, I_C = 250 μA	650	-	-	V
I_{CES}	Zero Gate Voltage Collector Current	V_{CE} = 650 V, V_{GE} = 0 T_j=25 ℃ T_j=150 ℃	- -	- 300	30 -	μA
I_{GES}	Gate Leakage Current	V_{GE} = ±20 V, V_{CE} = 0 V	-	-	±100	nA
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	V_{CE} = V_{GE} , I_C = 250 μA	4.2	5.0	5.8	V
$V_{CE(SAT)}$	Collector-Emitter Saturation Voltage	V_{GE} = 15 V, I_C = 5 A, T_j=25 ℃ T_j=175 ℃	- -	1.11 1.12	- -	V
		V_{GE} = 15 V, I_C = 10 A, T_j=25 ℃ T_j=150 ℃ T_j=175 ℃	- -	1.37 1.52 1.55	1.80 - -	
V_{FEC}	Diode Forward Voltage	V_{GE} = 0 V, I_F = 5 A, T_j=25 ℃ T_j=175 ℃	- -	1.35 1.33	- -	V
		V_{GE} = 0 V, I_F = 10 A, T_j=25 ℃ T_j=175 ℃	- -	1.70 1.80	2.20 -	
g_{fs}	Transconductance	V_{CE} = 10 V, I_C = 10 A	-	4.9	-	S
Dynamic Characteristics						
C_{ies}	Input Capacitance	V_{CE} = 25 V, V_{GE} = 0 V, f = 1.0 MHz	-	745	-	pF
C_{oes}	Output Capacitance		-	31	-	pF
C_{res}	Reverse Transfer Capacitance		-	7.7	-	pF
Q_g	Total Gate Charge	V_{CE} = 520 V, I_C = 10 A, V_{GE} = 15 V	-	25	-	nC
t_{SC}	Short Circuit Withstand Time	V_{CE} = 400 V, V_{GE} = 15 V T_J = 100℃	5.0	-	-	μs

Electrical Characteristics T_J=25°C unless otherwise specified

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Switching Characteristics						
$t_{d(on)}$	Turn-On Time	V_{CE} = 400 V, I_C = 10 A, R_G = 10 Ω, V_{GE} = 0 / 15 V (Note. 2)	-	59	-	ns
t_r	Turn-On Rise Time		-	10.5	-	ns
$t_{d(off)}$	Turn-Off Delay Time		-	100	-	ns
t_f	Turn-Off Fall Time		-	41	-	ns
E_{on}	Turn-On Energy Loss		-	0.018	-	mJ
E_{off}	Turn-Off Energy Loss		-	0.186	-	mJ
E_{tot}	Total Energy Loss		-	0.204	-	mJ
$t_{d(on)}$	Turn-On Time	V_{CE} = 400 V, I_C = 10 A, R_G = 10 Ω, V_{GE} = 0 / 15 V T_J = 150 ℃ (Note. 2)	-	58	-	ns
t_r	Turn-On Rise Time		-	11	-	ns
$t_{d(off)}$	Turn-Off Delay Time		-	125	-	ns
t_f	Turn-Off Fall Time		-	62	-	ns
E_{on}	Turn-On Energy Loss		-	0.026	-	mJ
E_{off}	Turn-Off Energy Loss		-	0.262	-	mJ
E_{tot}	Total Energy Loss		-	0.288	-	mJ
$t_{d(on)}$	Turn-On Time	V_{CE} = 400 V, I_C = 15 A, R_G = 10 Ω, V_{GE} = 0 / 15 V (Note. 2)	-	60	-	ns
t_r	Turn-On Rise Time		-	11.9	-	ns
$t_{d(off)}$	Turn-Off Delay Time		-	90	-	ns
t_f	Turn-Off Fall Time		-	41	-	ns
E_{on}	Turn-On Energy Loss		-	0.025	-	mJ
E_{off}	Turn-Off Energy Loss		-	0.275	-	mJ
E_{tot}	Total Energy Loss		-	0.300	-	mJ

Notes : 2. Include tail current and diode reverse recovery.

Electrical Characteristics T_J=25°C unless otherwise specified

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Switching Characteristics						
$t_{d(on)}$	Turn-On Time	V_{CE} = 400 V, I_C = 15 A, R_G = 10 Ω, V_{GE} = 0 / 15 V T_J = 150 ℃ (Note. 2)	-	61	-	ns
t_r	Turn-On Rise Time		-	12.5	-	ns
$t_{d(off)}$	Turn-Off Delay Time		-	108	-	ns
t_f	Turn-Off Fall Time		-	55	-	ns
E_{on}	Turn-On Energy Loss		-	0.033	-	mJ
E_{off}	Turn-Off Energy Loss		-	0.380	-	mJ
E_{tot}	Total Energy Loss		-	0.413	-	mJ
Diode Reverse Recovery Characteristics						
t_{rr}	Diode Reverse Recovery Time	V_R = 400 V, I_F = 10 A, di/dt = 1,000 A/μs	-	58.5	-	ns
I_{rr}	Diode Reverse Recovery Current		-	9.7	-	A
Q_{rr}	Diode Reverse Recovery Charge		-	0.289	-	μC
t_{rr}	Diode Reverse Recovery Time	V_R = 400 V, I_F = 10 A, T_J = 150 ℃ di/dt = 1,000 A/μs	-	70	-	ns
I_{rr}	Diode Reverse Recovery Current		-	12.4	-	A
Q_{rr}	Diode Reverse Recovery Charge		-	0.492	-	μC

Notes : 2. Include tail current and diode reverse recovery.

IGBT Static Characteristics Figure.

Figure.1 Saturation Voltage characteristics ,Junction Temperature(T_J) 25℃

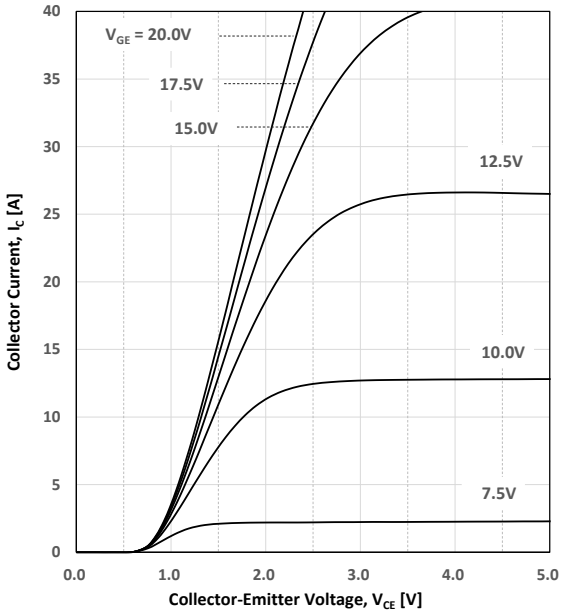


Figure.2 Saturation Voltage characteristics ,Junction Temperature(T_J) 150℃

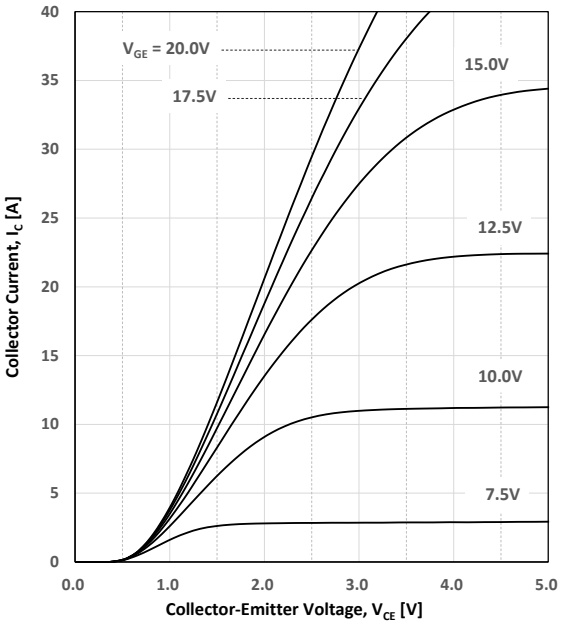


Figure.3 Saturation Voltage characteristics as Junction Temperature, V_{GE}=15V

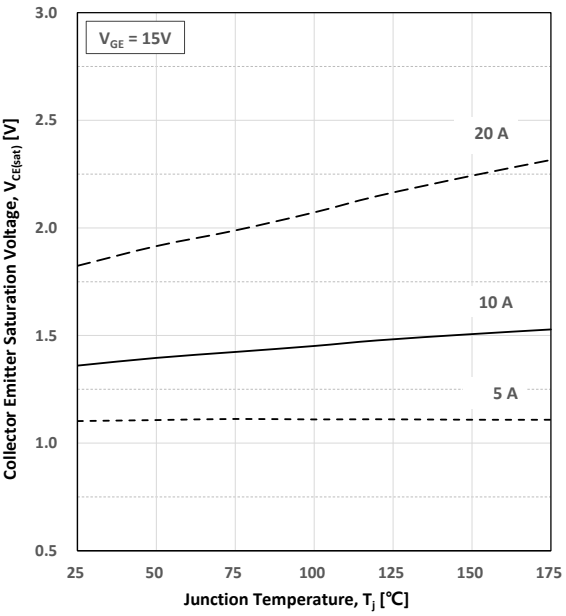


Figure.4 Transconductance characteristics as Junction Temperature, V_{CE}=10V

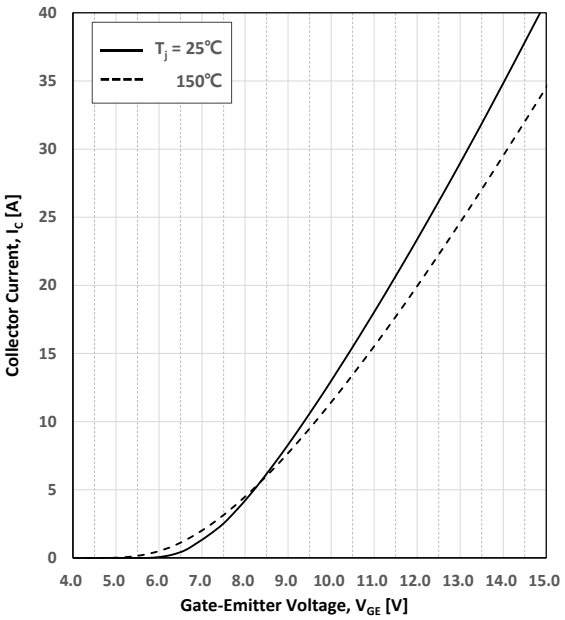


Figure.5 Threshold Voltage characteristics as Junction Temperature

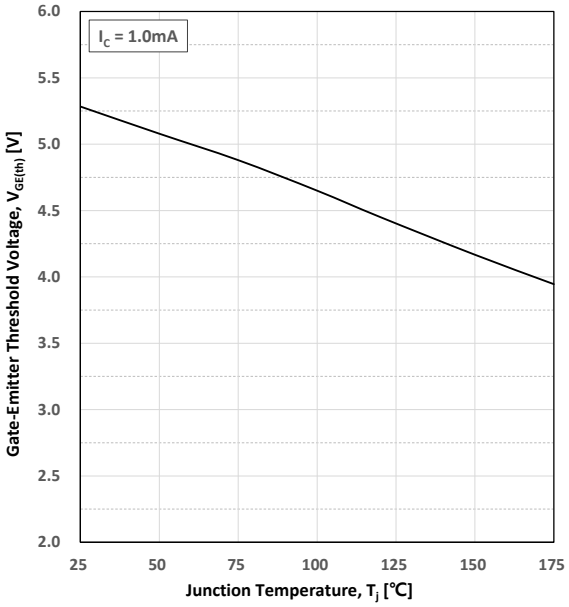
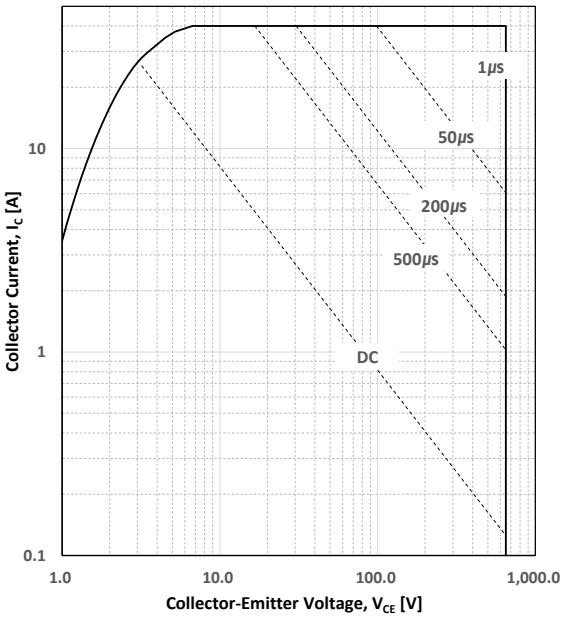


Figure.6 Forward Bias Safe Operating Area (T_C=25℃, T_J≤175℃, V_{GE}≥15V, t_p=1μs, D=0)



IGBT Dynamic Characteristics Figure.

Figure.7 Capacitance characteristics (f=1MHz)

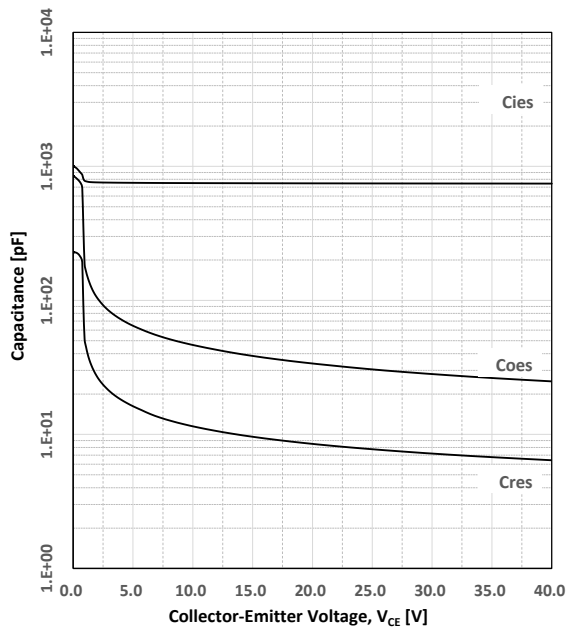
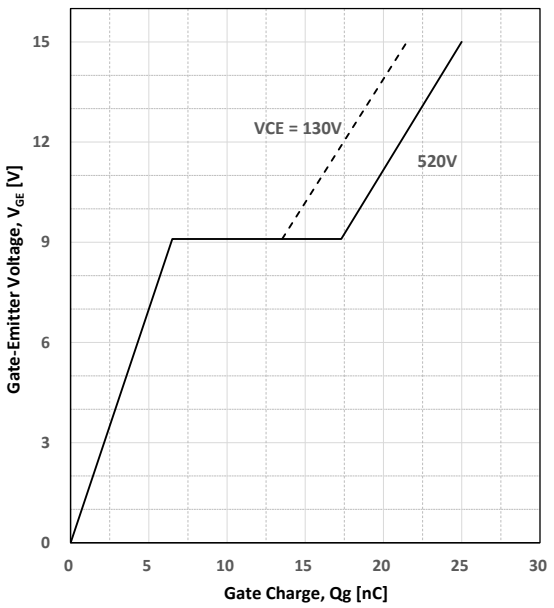


Figure.8 Gate Charge characteristics (I_C=10A)



IGBT Switching Characteristics Figure.

Figure.9 Switching Times as Gate Resistance
(V_{CE}=400V, I_C=10A, V_{GE}=15V, T_J=25℃)

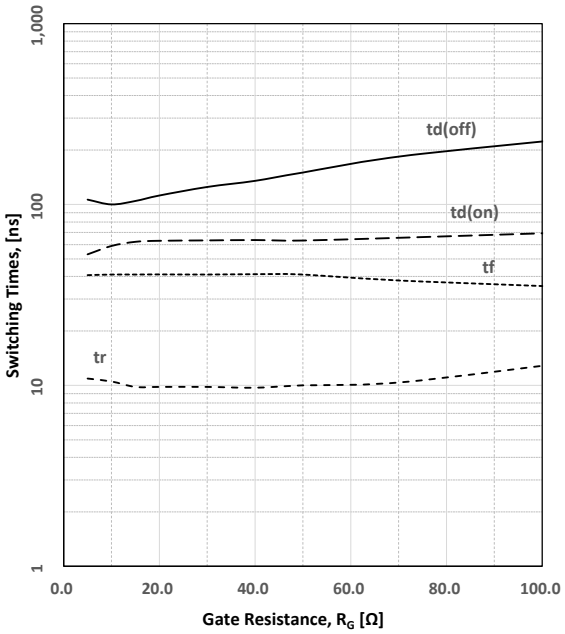


Figure.10 Switching Loss as Gate Resistance
(V_{CE}=400V, I_C=10A, V_{GE}=15V, T_J=25℃)

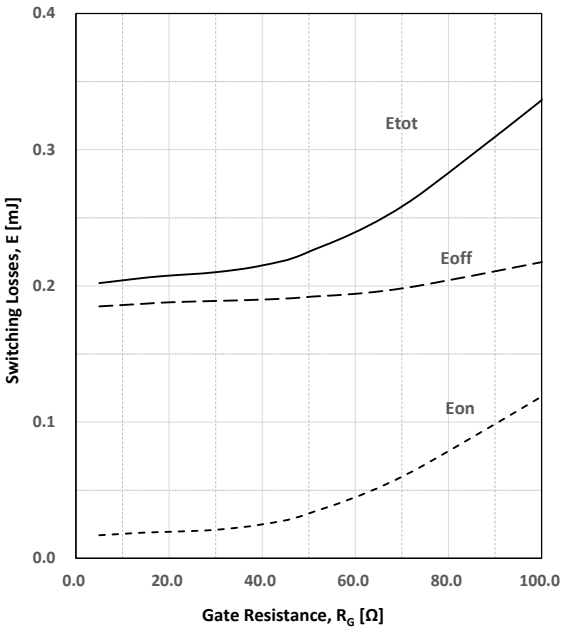


Figure.11 Switching Times as Collector Current
(V_{CE}=400V, V_{GE}=15V, Rg=10Ω, T_J=25℃)

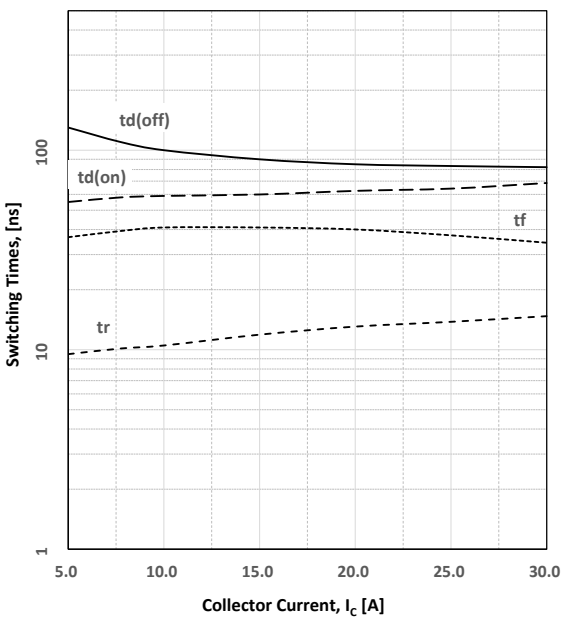


Figure.12 Switching Loss as Collector Current
(V_{CE}=400V, V_{GE}=15V, Rg=10Ω, T_J=25℃)

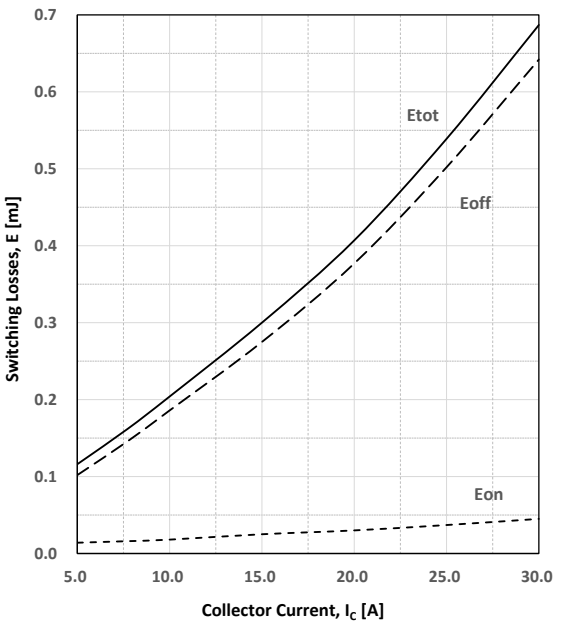


Figure.13 Switching Times as Collector Voltage
(I_C=10A, V_{GE}=15V, Rg=10Ω, T_J=25℃)

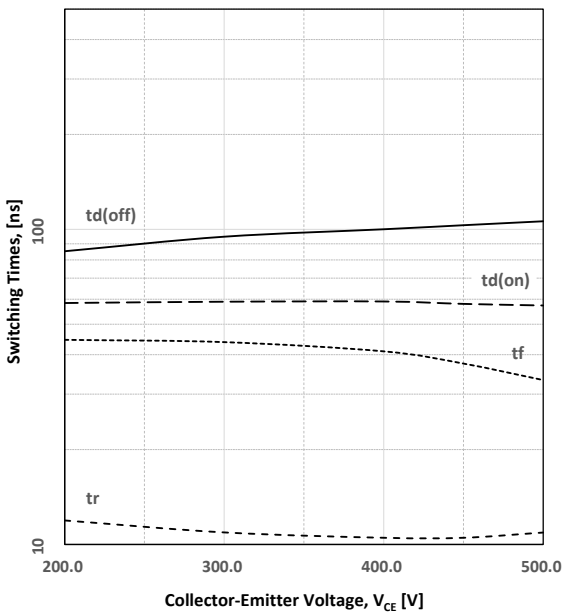


Figure.14 Switching Loss as Collector Voltage
(I_C=10A, V_{GE}=15V, Rg=10Ω, T_J=25℃)

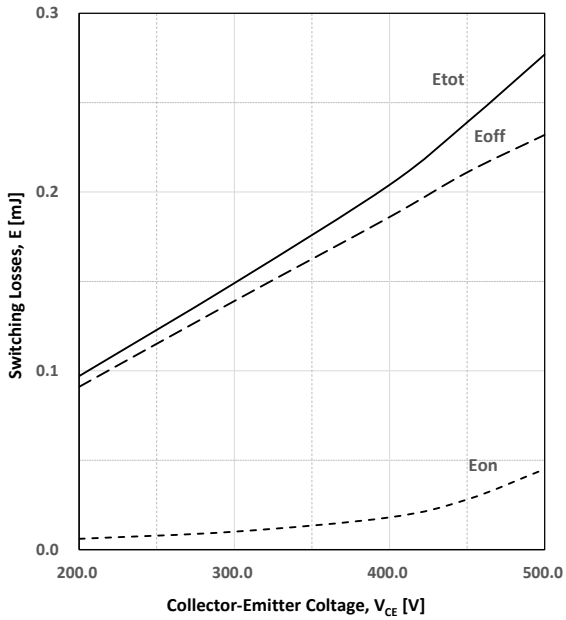


Figure.15 Switching Times as Gate Resistance
(V_{CE}=400V, I_C=10A, V_{GE}=15V, T_J=150℃)

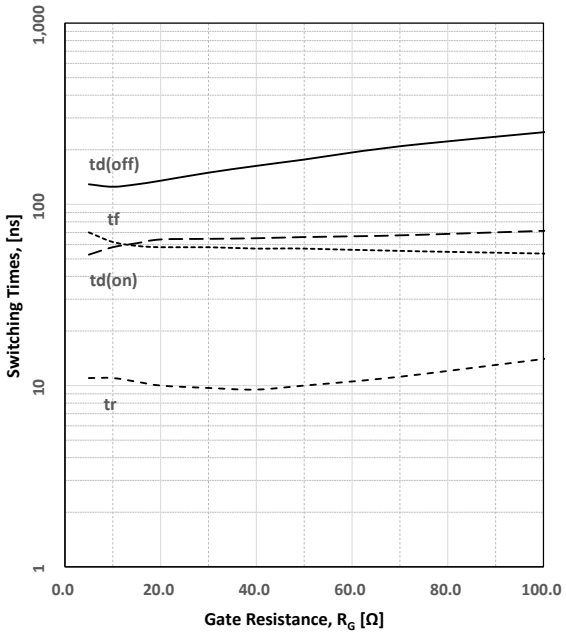


Figure.16 Switching Loss as Gate Resistance
(V_{CE}=400V, I_C=10A, V_{GE}=15V, T_J=150℃)

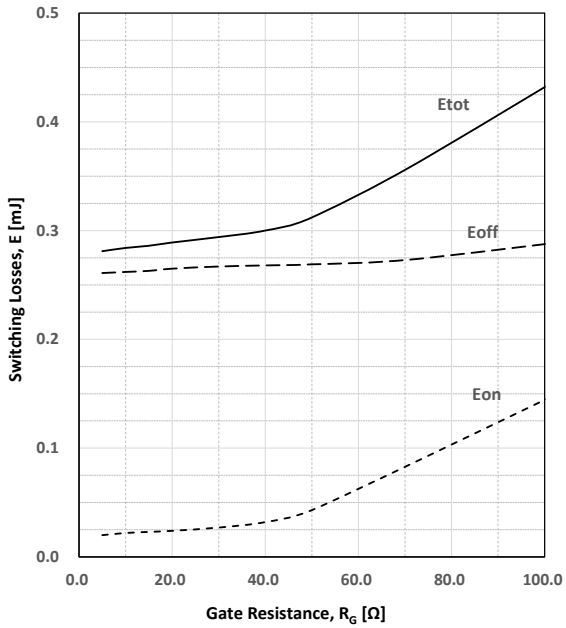


Figure.17 Switching Times as Collector Current
(V_{CE}=400V, V_{GE}=15V, Rg=10Ω, T_J=150℃)

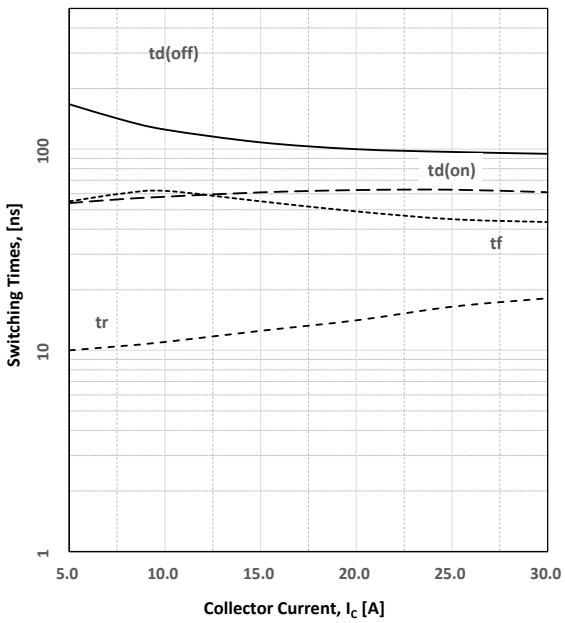


Figure.18 Switching Loss as Collector Current
(V_{CE}=400V, V_{GE}=15V, Rg=10Ω, T_J=150℃)

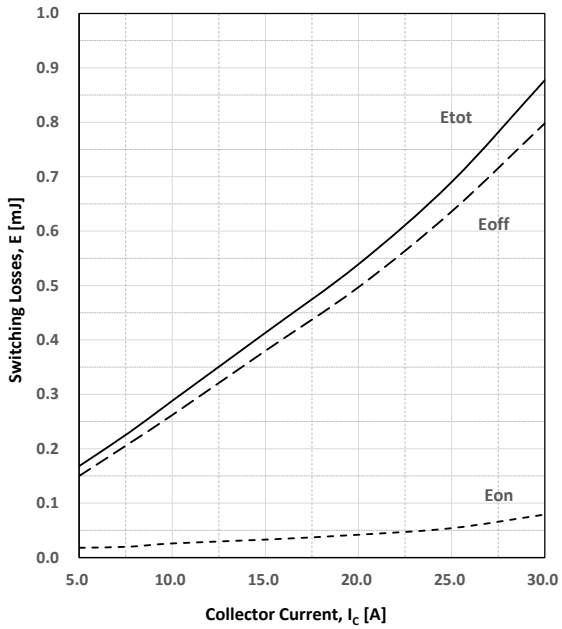


Figure.19 Switching Times as Collector Voltage
(I_C=10A, V_{GE}=15V, Rg=10Ω, T_J=150℃)

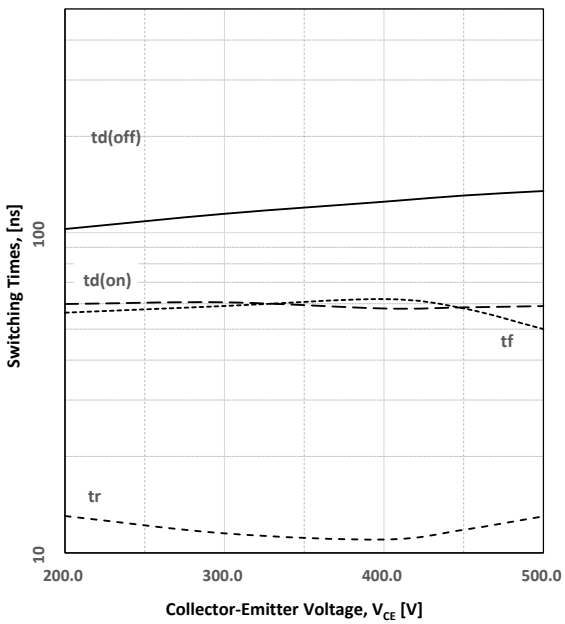


Figure.20 Switching Loss as Collector Voltage
(I_C=10A, V_{GE}=15V, Rg=10Ω, T_J=150℃)

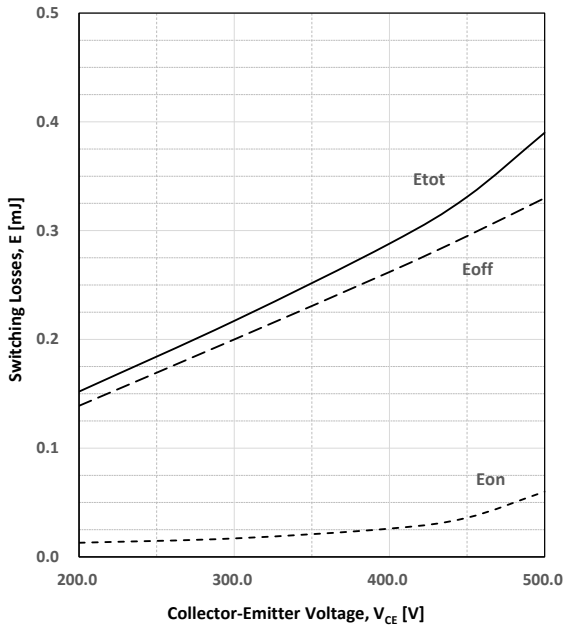


Figure.21 Switching Times as Junction Temp.
(V_{CE}=400V, I_C=10A, V_{GE}=15V, Rg=10Ω)

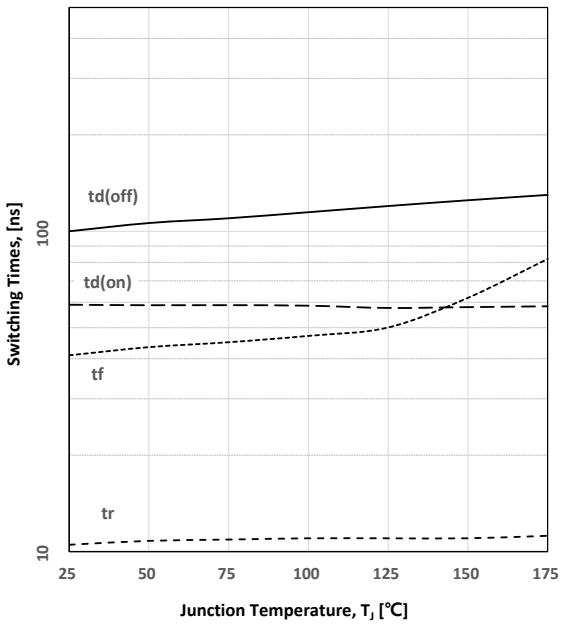
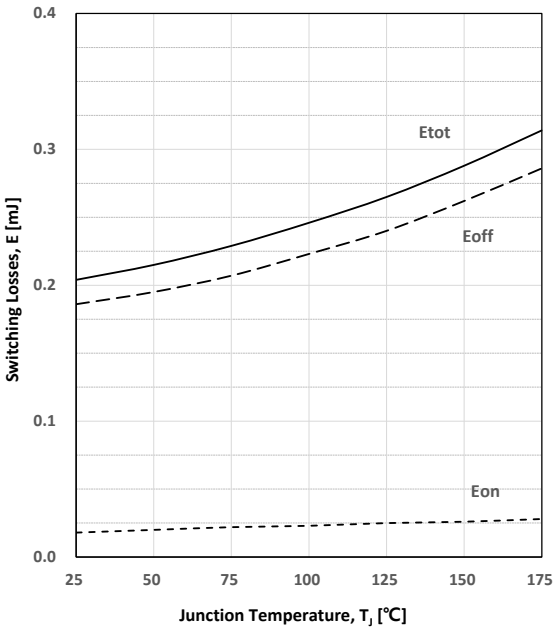
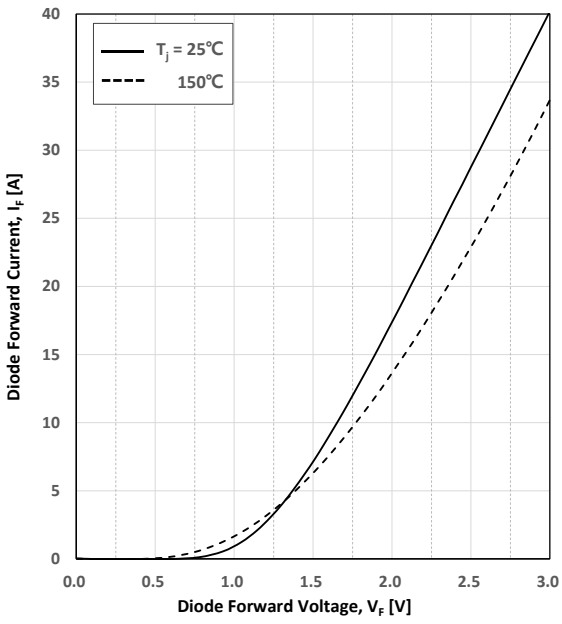


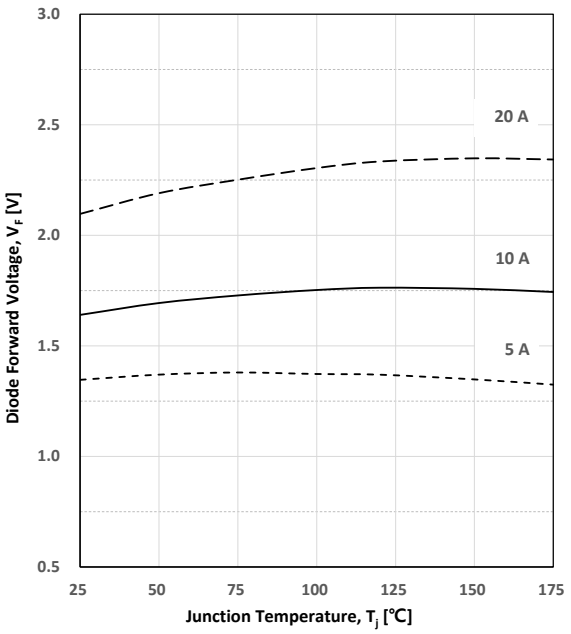
Figure.22 Switching Loss as Junction Temp.
(V_{CE}=400V, I_C=10A, V_{GE}=15V, Rg=10Ω)



Diode Static Characteristics Figure.

Figure.23 Diode Forward current characteristics as Junction Temperature and Forward current





Diode Reverse Recovery Characteristics Figure.

Figure.24 Reverse Recovery Current as di/dt (V_R=400V, I_F=10A)

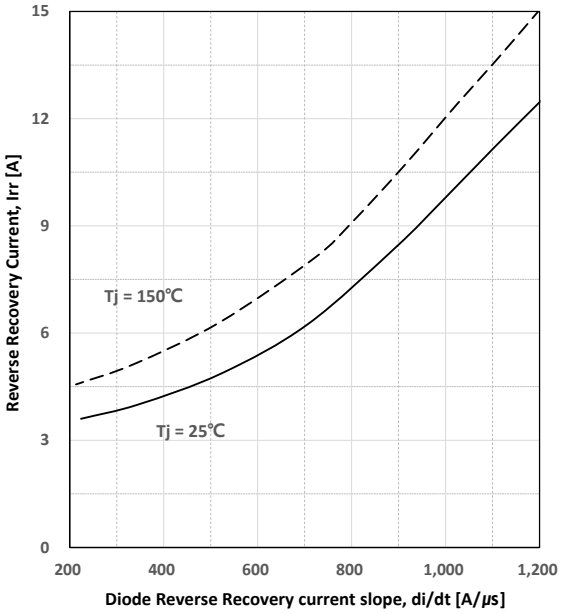


Figure.25 Reverse Recovery Time as di/dt (V_R=400V, I_F=10A)

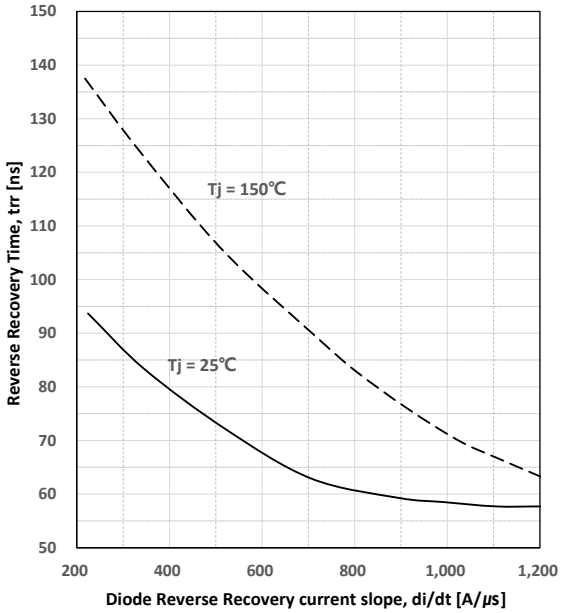
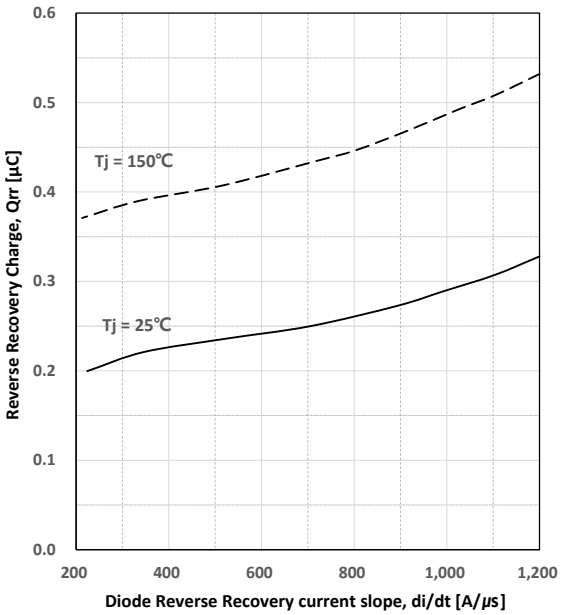
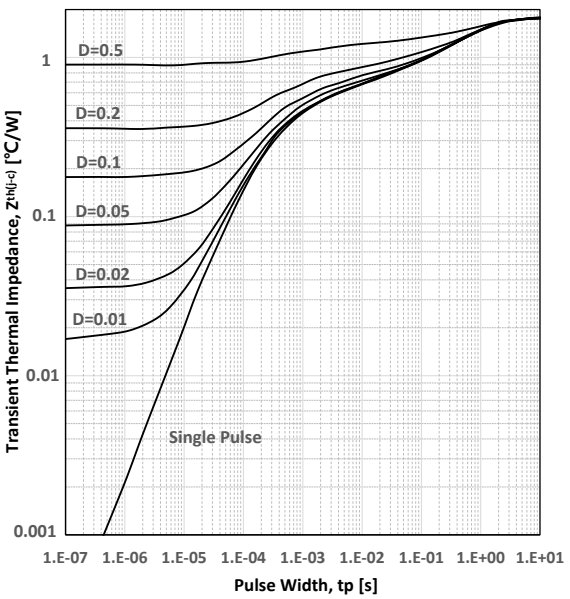


Figure.26 Reverse Recovery Charge as di/dt (V_R=400V, I_F=10A)

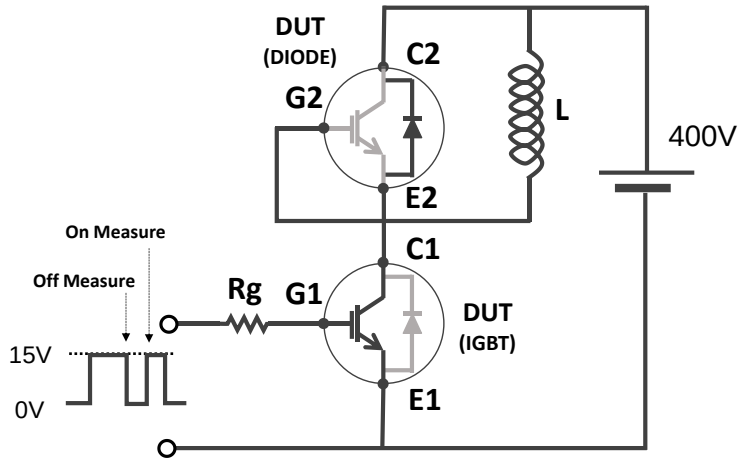


Transient Thermal Impedance Figure.

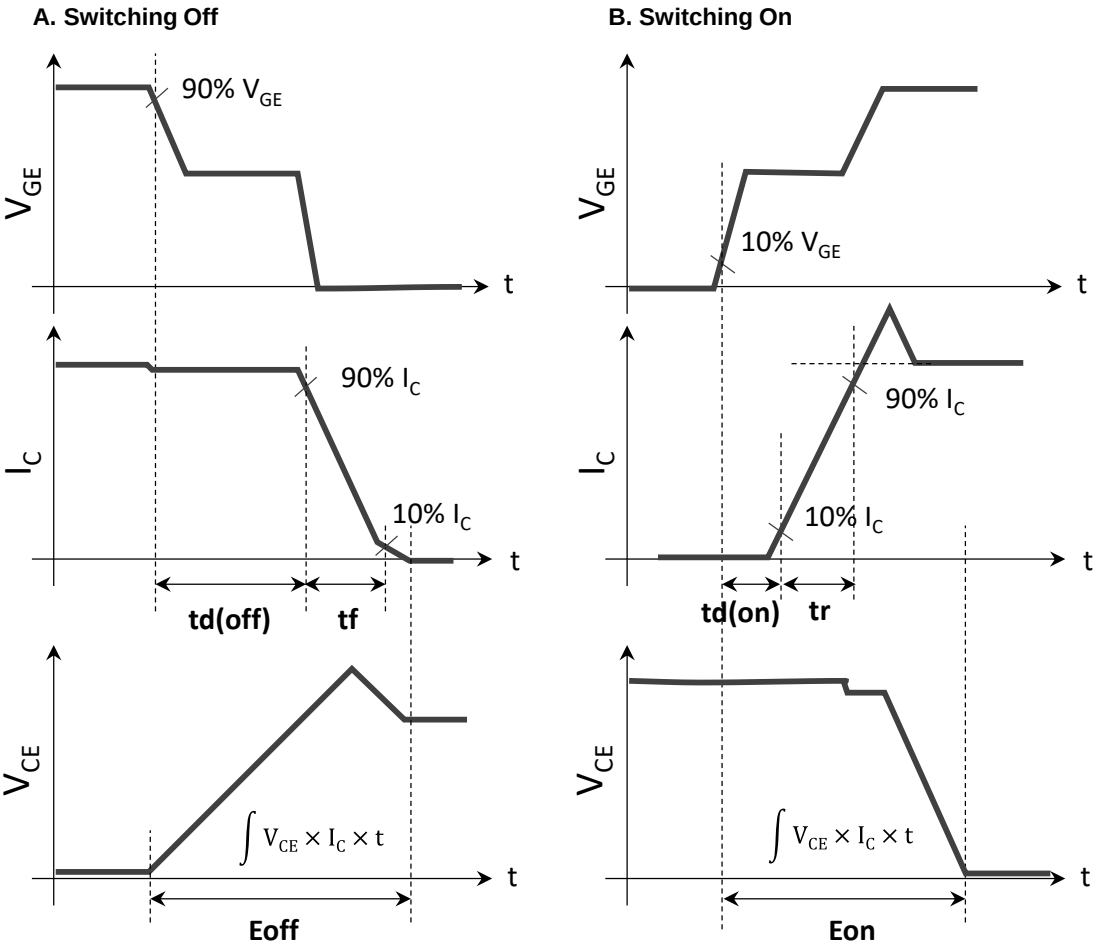
Figure.27 IGBT Transient Thermal Impedance



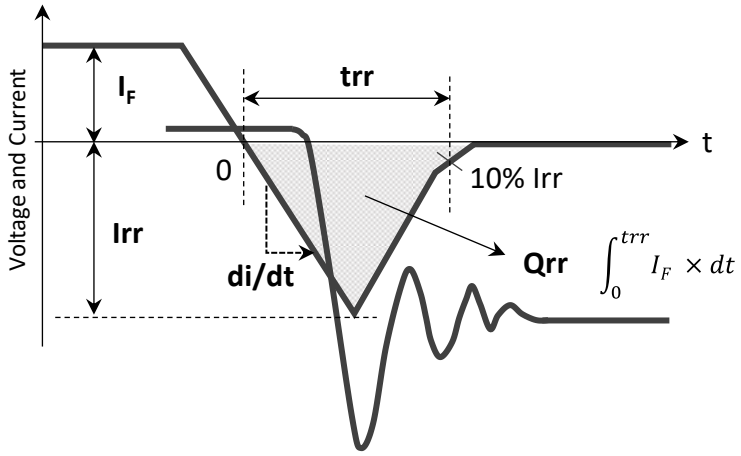
Ref. 1) Switching Test Circuit



Ref. 2) Definition of switching time and loss



Ref. 3) Definition of Diode switching time



Package Dimension : D-PAK (TO-252(A))

Unit : mm