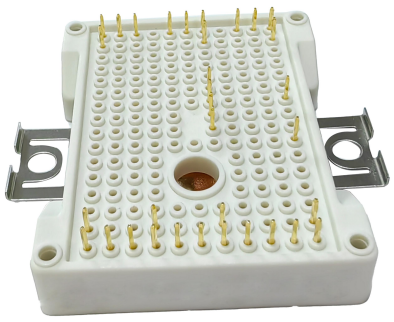
3-Level NPC Inverter Module with 650V Trench Stop IGBTs

Features

- Electrical features
  - 650V Trench Stop IGBTs
  - Low Inductive Layout
  - Low Switching Losses
  - Thermistor

- Mechanical features
  - Compact Design
  - Solderable Pins
  - Al_2O_3 Substrate with Low Thermal Resistance
  - Rugged mounting due to integrated mounting clamps

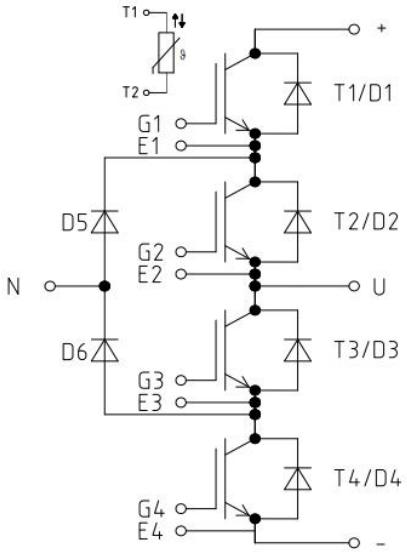


H6

Typical Applications

- 3-Level-Applications
- Solar Applications
- UPS Systems

Description



Package Insulation coordination

Parameter	Symbol	Note or test condition	Values	Unit
Isolation test voltage	V_{ISOL}	RMS,f=50Hz,t=60s	2.5	kV
Internal isolation		basic insulation(class 1,IEC 61140)	Al_2O_3	
Creepage distance	d_{creep}	terminal to heatsink	11.5	mm
Clearance	d_{clear}	terminal to heatsink	10	mm
Comparative tracking index (electrical)	CTI		>200	
RTI Elec.	RTI	housing	140	℃

Package Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Stray Inductance	L_{CE}		--	15	--	nH
Module Lead Resistance, Terminal to Chip	$R_{CC'+EE'}$		--	2.00	--	mΩ
Storage Temperature Range	T_{STG}		-40		125	℃
Mounting torque for module mounting	M	-Mounting according to valid application note	40	--	80	N
Weight	G		--	39	--	g

IGBT （T1、T2、T3、T4）

Absolute Maximum Ratings (Tc = 25°C unless otherwise noted)

Symbol	Description	Value	Unit
V_{CES}	Collector-Emitter Voltage	650	V
V_{GES}	Gate-Emitter Voltage	±30	V
I_{CDC}	Continuous Collector Current @ T_C = 80°C (T_{JMAX} = 175°C)	100	A
I_{CM}	Pulsed Collector Current，t_p limited by $T_{vj\,max}$	200	A
Tjmax	Maximum Junction Temperature	175	℃
P_D	Power Dissipation @ T_C = 25°C	430	W
	Power Dissipation @T_C = 100 °C	215	W

Characteristics （Tc=25℃ unless otherwise noted）

Symbol	Parameter	Test Condition		Min	Typ	Max	Unit
$V_{CE(sat)}$	Collector−Emitter Saturation Voltage	I_C =100A,V_{GE} = 15V	T_{vj} = 25 °C	--	1.25	1.70	V
			T_{vj} = 150 °C	--	1.45	--	
$V_{GE(TH)}$	Gate−Emitter Threshold Voltage	I_C=1mA,V_{CE}=V_{GE}		4.0	5.0	6.0	V
I_{CES}	Collector−Emitter Cutoff Current	V_{GE} = 0 V, V_{CE} = 650 V		--	--	200	μA
I_{GES}	Gate-Emitter Leakage Current	V_{GE} = ±30 V, V_{CE} = 0 V, T_{vj} = 25°C		--	--	±100	nA
RGint	Internal Gate Resistance	T_{vj} = 25°C		--	1.51	--	Ω
Cies	Input Capacitance	V_{CE}=25V,V_{GE}=0V, f=1MHz		--	6390	--	pF
Coes	Output capacitance			--	401	--	pF
Cres	Reverse Transfer			--	60.3	--	pF
Q_G	Gate Charge	V_{CE} = 480 V, I_C = 100 A V_{GE} = −5 V to +15 V		--	0.242	--	μC
td(on)	Turn−On Delay Time	V_{CE}=400V,I_C=100A, V_{GE}= −5 V to +15 V, Rgon=25Ω,Rgoff=50Ω, Inductive Load, Tvj=25°C		--	0.15	--	μs
tr	Rise Time			--	0.03	--	
td(off)	Turn−off Delay Time			--	0.86	--	
tf	Fall Time			--	0.11	--	
Eon	Turn−On Switching Loss per Pulse			--	1.9	--	mJ
Eoff	Turn Off Switching Loss per Pulse			--	6.8	--	
td(on)	Turn−On Delay Time	V_{CE}=400V,I_C=100A, V_{GE}= −5 V to +15 V, Rgon=25Ω,Rgoff=50Ω, Inductive Load, T_j=150°C		--	0.14	--	μs
tr	Rise Time			--	0.03	--	
td(off)	Turn−off Delay Time			--	0.91	--	
tf	Fall Time			--	0.08	--	
Eon	Turn−on Switching Loss per Pulse			--	5.7	--	mJ
Eoff	Turn Off Switching Loss per Pulse			--	6.9	--	
RthJC	Thermal resistance	Junction-to-Case (per IGBT)		--	0.35	--	K/W
$T_{vj\,op}$		Temperature under switching conditions		-40		175[1)]	℃

[1)] $T_{vj\,op}$ > 150℃ is only allowed for operation at overload conditions.

Diode（D1、D2、D3、D4）

Absolute Maximum Ratings (Tc = 25°C unless otherwise noted)

Symbol	Description	Value	Unit
V_{RRM}	Repetitive Peak Reverse Voltage	650	V
I_F	Diode Continuous Forward Current	100	A
I_{FM}	Diode Maximum Forward Current t_p=1ms	200	A

Characteristics （Tc=25℃ unless otherwise noted）

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
VF	Diode Forward Voltage	I_F = 100 A, T_J = 25°C	--	1.40	1.95	V
		I_F = 100 A, T_J = 150°C	--	1.20	--	
T_{rr}	Reverse Recovery Time	V_{CE}=400V,I_F=100A, V_{GE}= −5 V to +15 V, Rgon=25Ω,Rgoff=50Ω, Inductive Load, T_j=25°C	--	0.64	--	μs
IRRM	Peak Reverse Recovery Current		--	100	--	A
Qrr	Recovered Charge		--	3.6	--	μC
Erec	Reverse Recovery Energy		--	1.4	--	mJ
T_{rr}	Reverse Recovery Time	V_{CE}=400V,I_F=100A, V_{GE}= −5 V to +15 V, Rgon=25Ω,Rgoff=50Ω, Inductive Load, T_j=150°C	--	0.164	--	μs
IRRM	Peak Reverse Recovery Current		--	104.1	--	A
Qrr	Recovered Charge		--	9.0	--	μC
Erec	Reverse Recovery Energy		--	2.14	--	mJ
RthJC	Thermal resistance	Junction-to-Case (per diode)	--	0.40	--	K/W
$T_{vj\ op}$		Temperature under switching conditions	-40		175[2)]	℃

[2)] $T_{vj\ op}$ > 150℃ is only allowed for operation at overload conditions.

Diode（D5、D6）

Absolute Maximum Ratings (Tc = 25°C unless otherwise noted)

Symbol	Description	Value	Unit
V_{RRM}	Repetitive Peak Reverse Voltage	650	V
I_F	Diode Continuous Forward Current	100	A
I_{FM}	Diode Maximum Forward Current t_p=1ms	200	A

Characteristics （Tc=25℃ unless otherwise noted）

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
VF	Diode Forward Voltage	I_F = 100 A, T_J = 25°C	--	1.30	1.85	V
		I_F = 100 A, T_J = 150°C	--	1.35	--	
T_{rr}	Reverse Recovery Time	V_{CE}=400V V_{GE}= −5 V to +15 V I_F=100A,R_g=5Ω T_{vj}=25°C	--	0.13	--	μs
IRRM	Peak Reverse Recovery Current		--	93.5	--	A
Qrr	Recovered Charge		--	4.9	--	μC
Erec	Reverse Recovery Energy		--	1.45	--	mJ
T_{rr}	Reverse Recovery Time	V_{CE}=400V V_{GE}= −5 V to +15 V I_F=100A, R_g=5Ω, T_{vj}=150°C	--	0.3	--	μs
IRRM	Peak Reverse Recovery Current		--	89.9	--	A
Qrr	Recovered Charge		--	10.3	--	μC
Erec	Reverse Recovery Energy		--	2.64	--	mJ
RthJC	Thermal resistance	Junction-to-Case (per diode)	--	0.30	--	K/W
$T_{vj\ op}$		Temperature under switching conditions	-40		175[3)]	℃

[3)] $T_{vj\ op}$ > 150℃ is only allowed for operation at overload conditions.

NTC Characteristics (Tc = 25°C unless otherwise noted)

Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
R_{25}	Rated Resistance		--	5.0	--	kΩ
ΔR/R	Deviation of R100	Tc=100 ℃,R_{100}=493.3Ω	-5	--	5	%
P_{25}	Power Dissipation		--	--	20.0	mW
$B_{25/50}$	B-value	$R_2=R_{25}\exp[B_{25/50}(1/T_2- 1/(298.15K))]$	--	3375	--	K
$B_{25/80}$	B-value	$R_2=R_{25}\exp[B_{25/80}(1/T_2- 1/(298.15K))]$	--	3411	--	K
$B_{25/100}$	B-value	$R_2=R_{25}\exp[B_{25/100}(1/T_2- 1/(298.15K))]$	--	3433	--	K

Figure1.output characteristic IGBT(typical)
T_{vj}=25°C

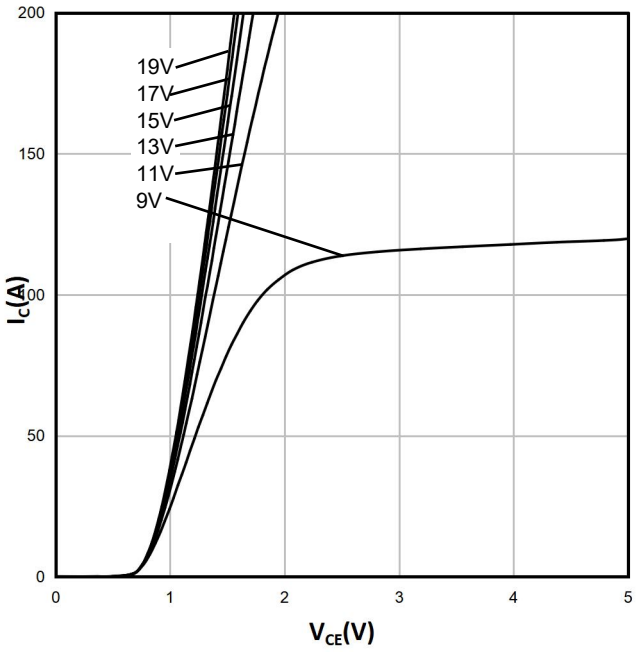


Figure2.output characteristic IGBT(typical)
T_{vj}=150°C

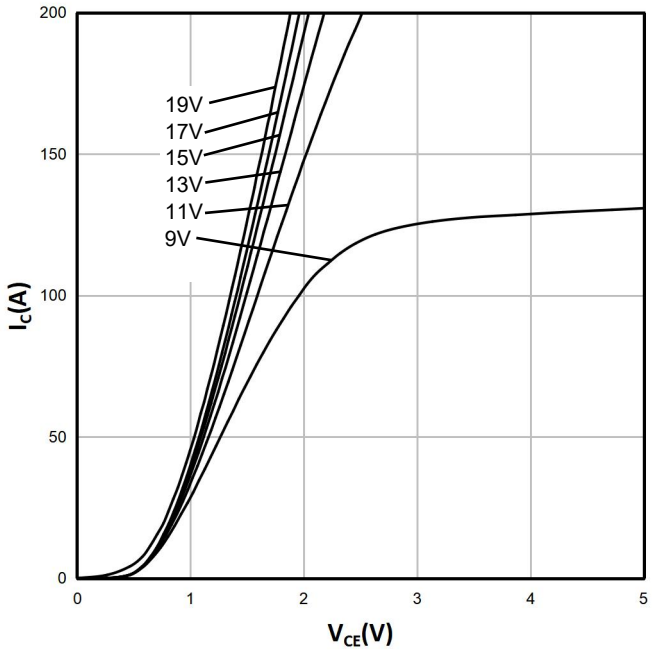


Figure3. $V_{CE(sat)}$ vs. Temperature

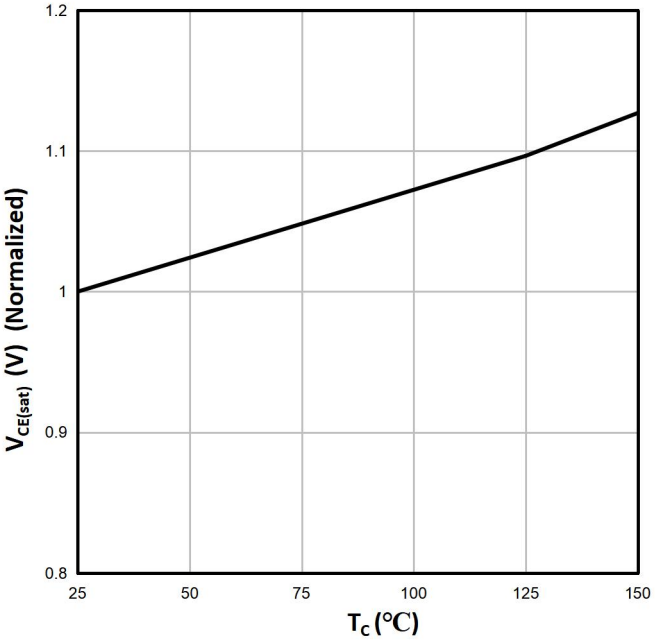


Figure4.transfer characteristic IGBT(typical)
V_{CE}=20V

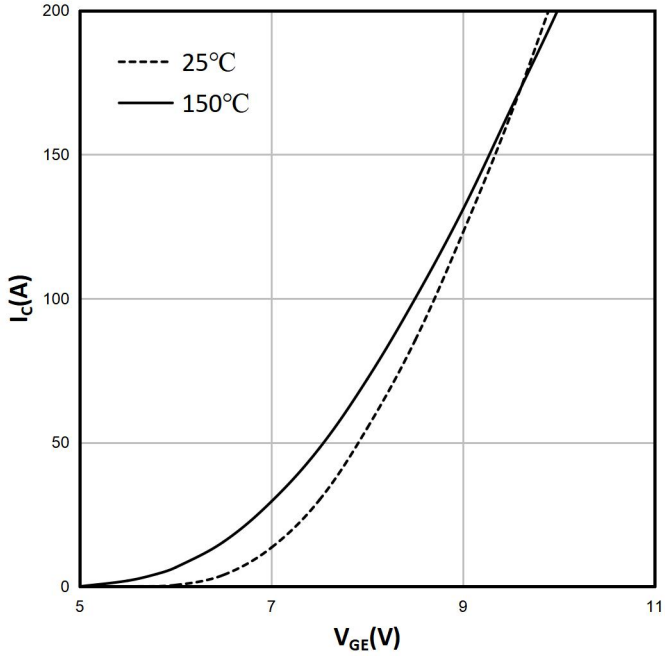


Figure5. V_{TH} vs. Temperature

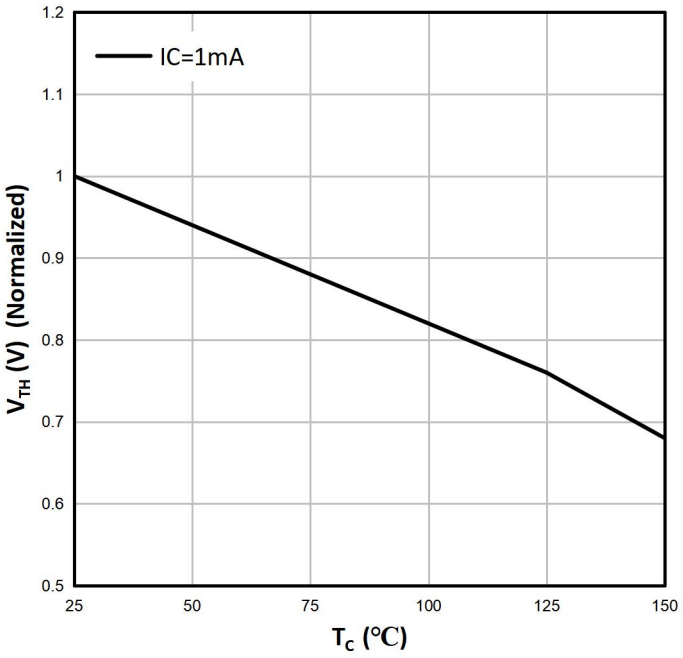


Figure6. Gate Charge Waveform

VCC=400V,IC=100A,VGE=15V

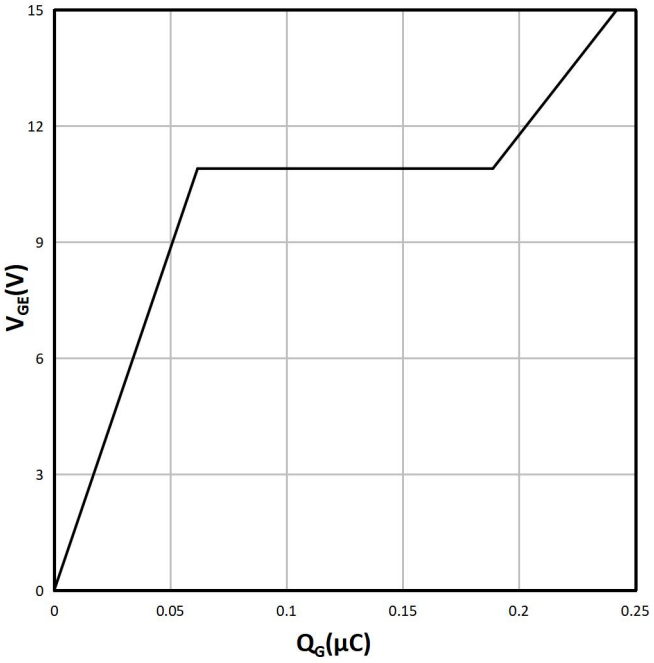


Figure7.switching losses IGBT(typical)（T1，T4）

Vcc=400V,Rgon=25Ω,Rgoff=50Ω,Vge=15V/-5V

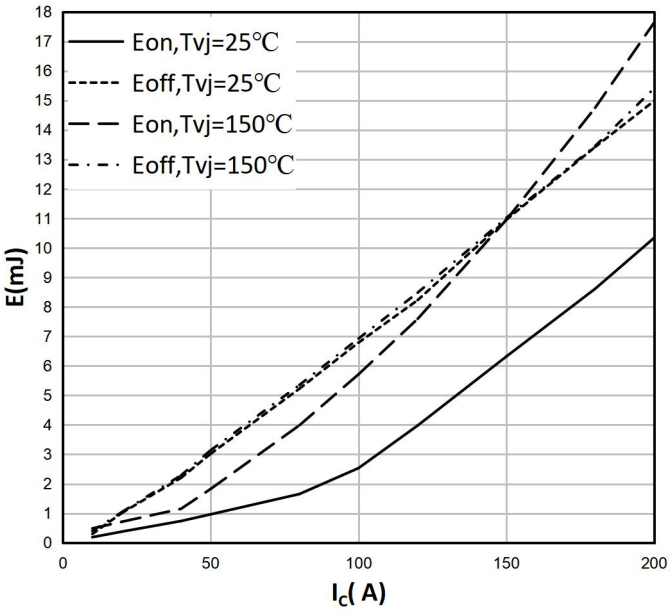


Figure8.switching losses IGBT(typical)（T1，T4）

Vcc=400V,IC=100A,Vge=15V/-5V

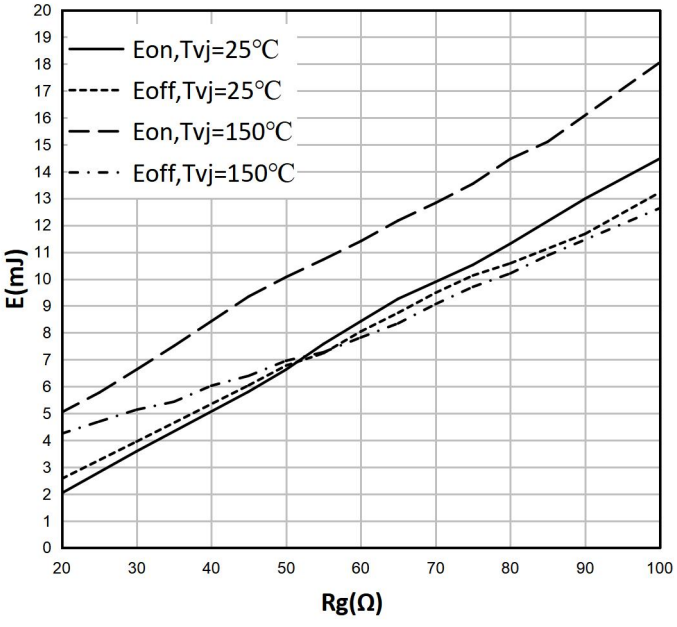


Figure9.switching losses IGBT(typical)（T2，T3）

Vcc=400V,Rgon=25Ω,Rgoff=50Ω,Vge=15V/-5V

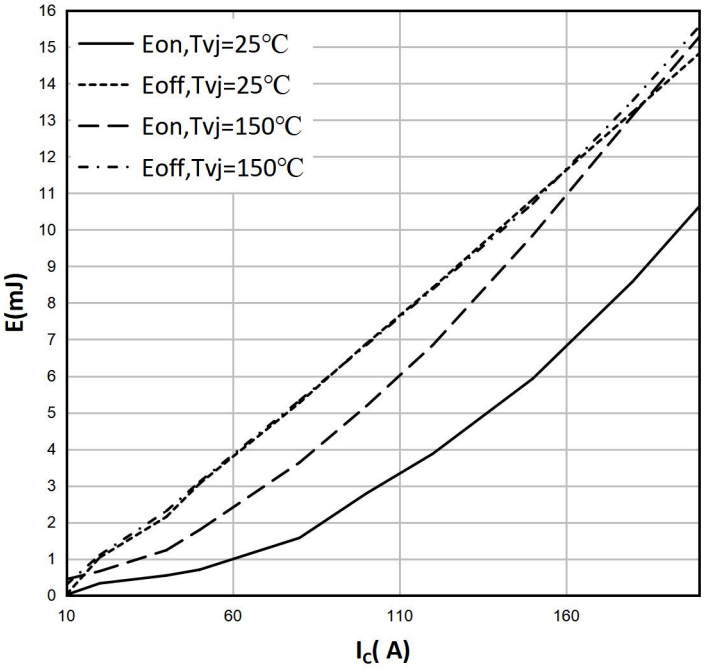


Figure10.switching losses IGBT(typical)（T2，T3）

Vcc=400V,IC=100A,Vge=15V/-5V

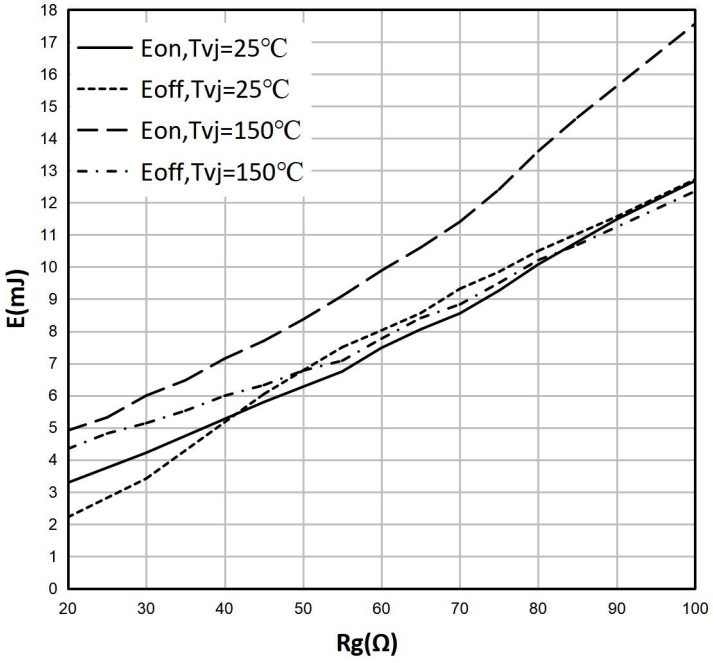


Figure11. FBSOA IGBT(typical)（T1，T2，T3，T4）

D=0, Tc=25℃,Tj<=175℃,Vge=15V

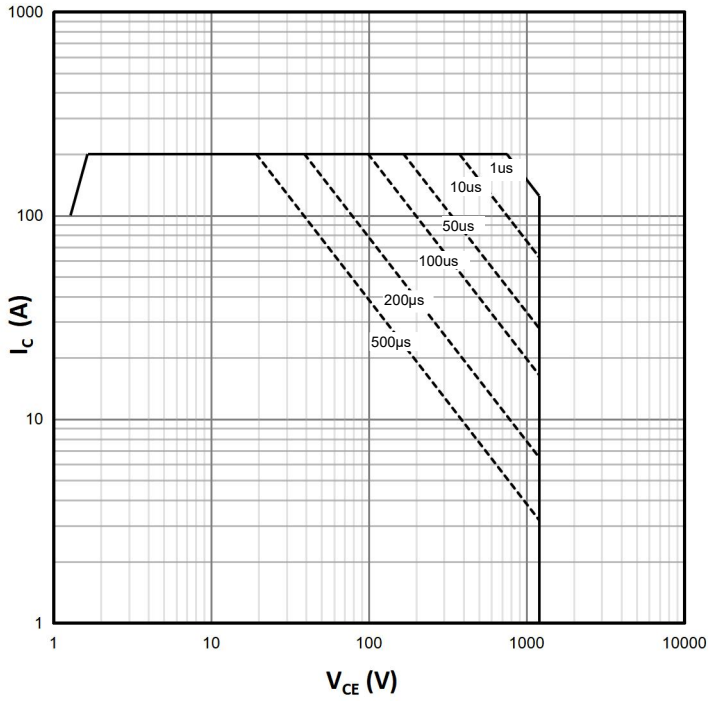


Figure12. transient thermal impedance IGBT(typical)（T1，T2，T3，T4）

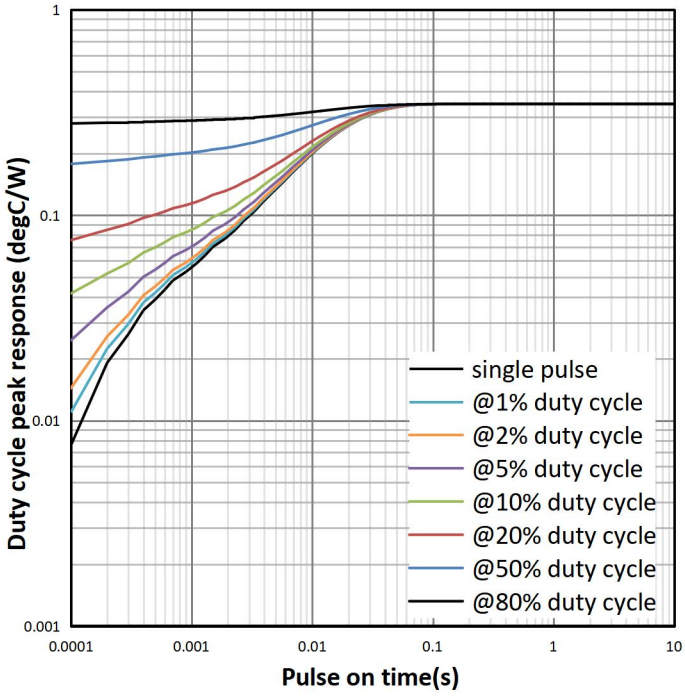


Figure13. forward characteristic of Diode (typical)
（D1，D2，D3，D4）

V_{GE}=0V

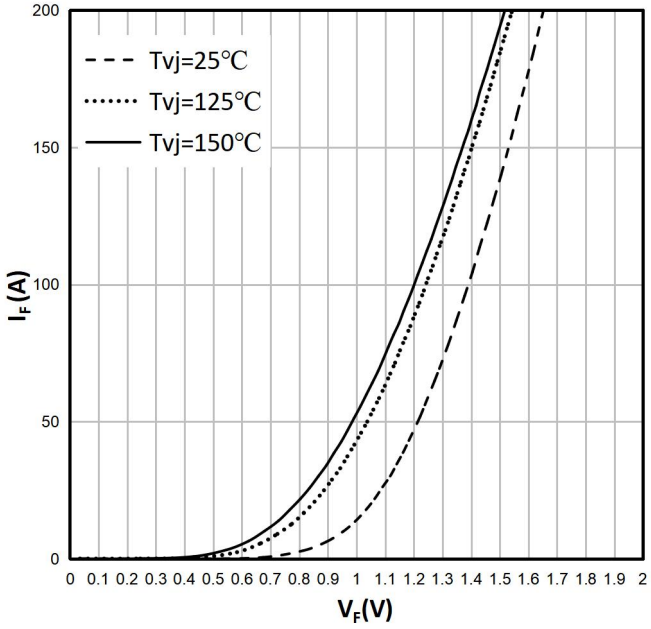


Figure14. forward characteristic of Diode (typical)
（D5，D6）

V_{GE}=0V

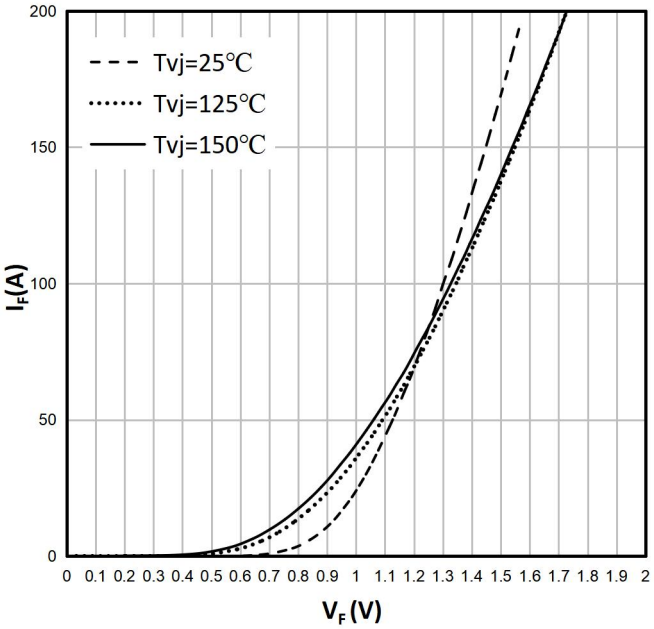


Figure15.Reverse Recovery Energy Loss vs.vs. RG
（D1，D4）

Vcc=400V,IC=100A,Vge=15V/-5V

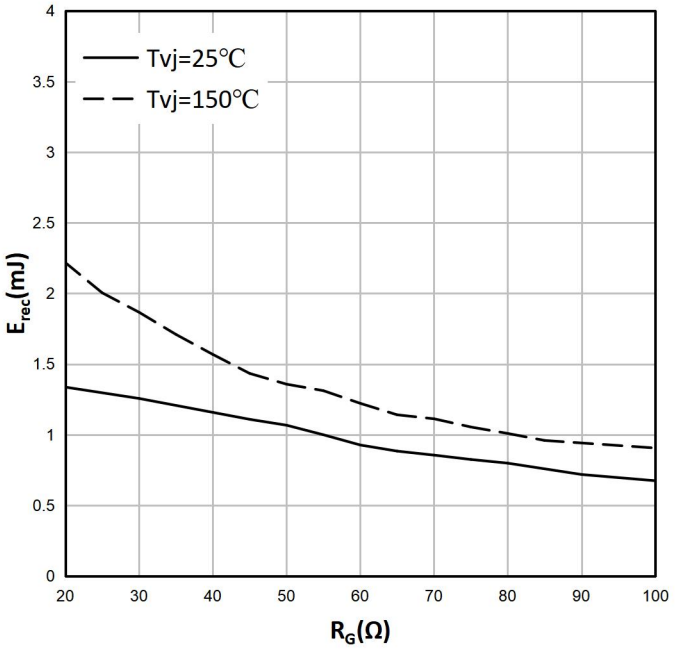


Figure16.Reverse Recovery Energy Loss vs. IC
（D1，D4）

Vcc=400V,Rg=25Ω,Vge=15V/-5V

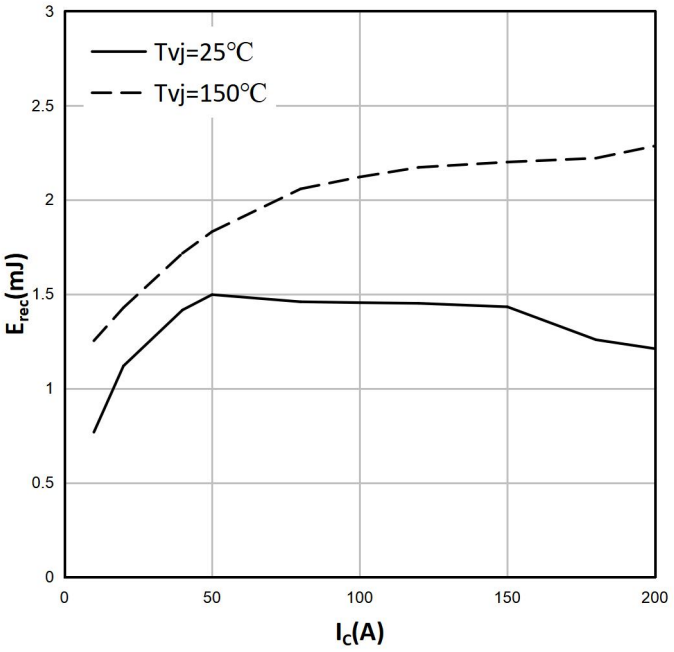


Figure17.Reverse Recovery Energy Loss vs.vs. RG（D2，D3）

Vcc=400V,IC=100A,Vge=15V/-5V

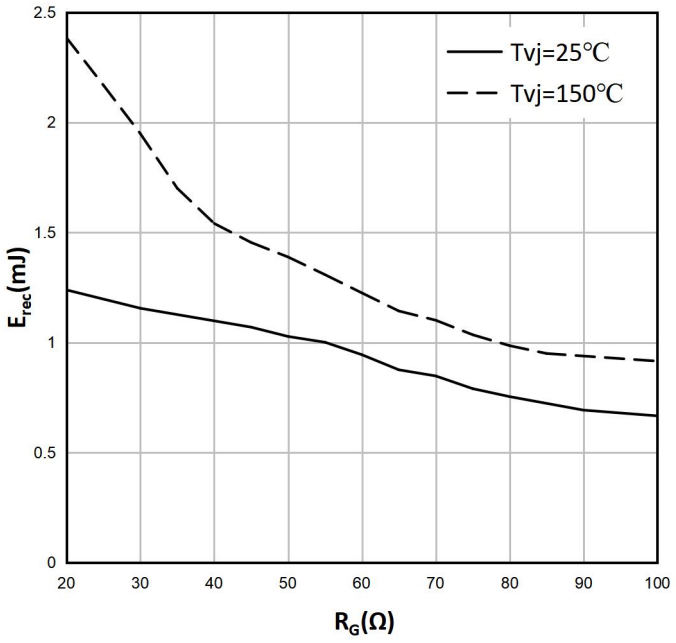


Figure18.Reverse Recovery Energy Loss vs. IC（D2，D3）

Vcc=400V,Rg=25Ω,Vge=15V/-5V

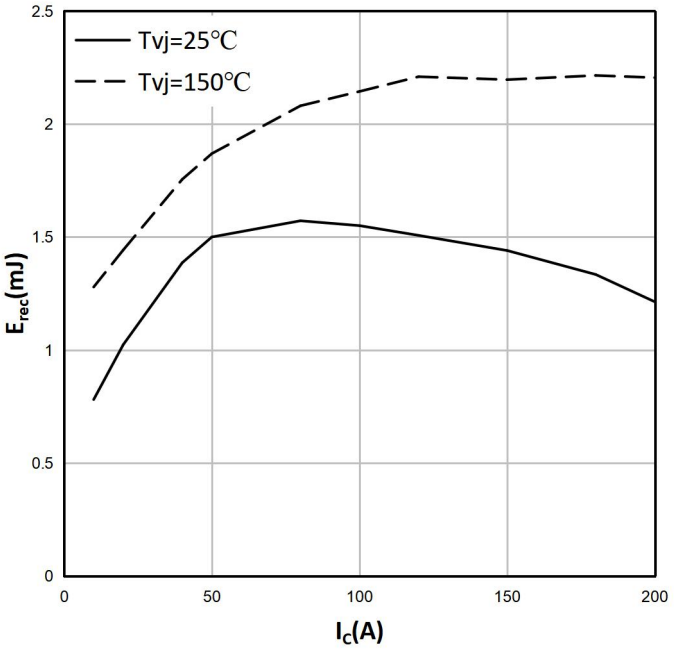


Figure19.Reverse Recovery Energy Loss vs.vs. RG（D5，D6）

Vcc=400V,IC=100A,Vge=15V/-5V

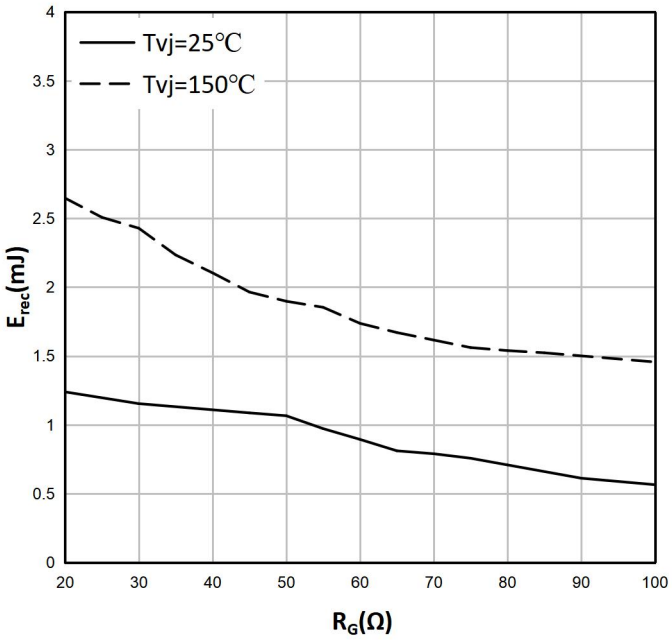


Figure20.Reverse Recovery Energy Loss vs.vs. RG（D5，D6）

Vcc=400V,IC=100A,Vge=15V/-5V

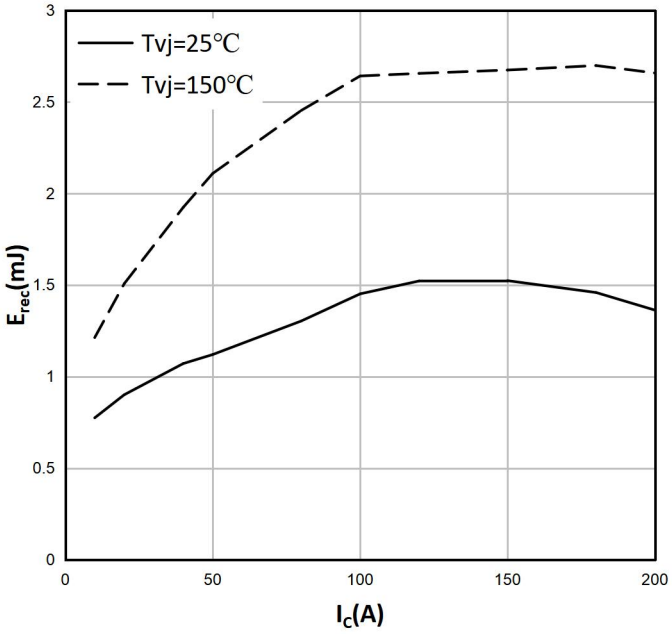


Figure21. transient thermal impedance FRD, (typical)（D1，D2，D3，D4）

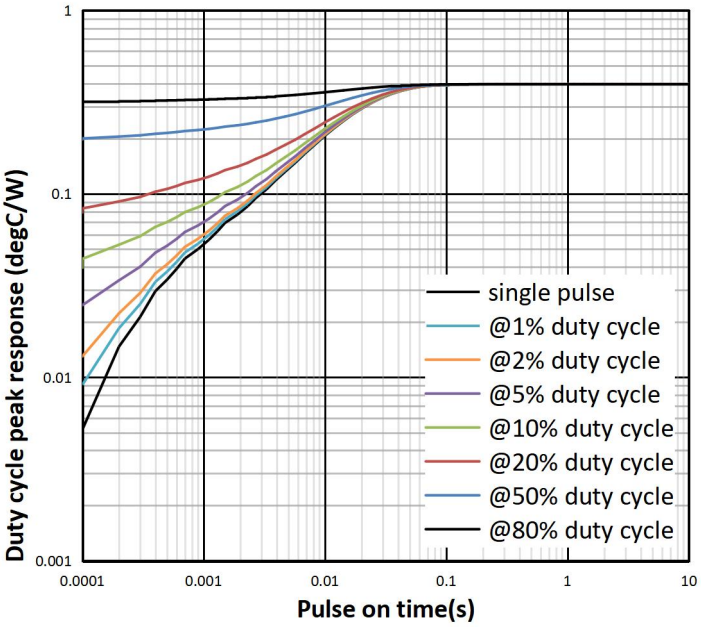
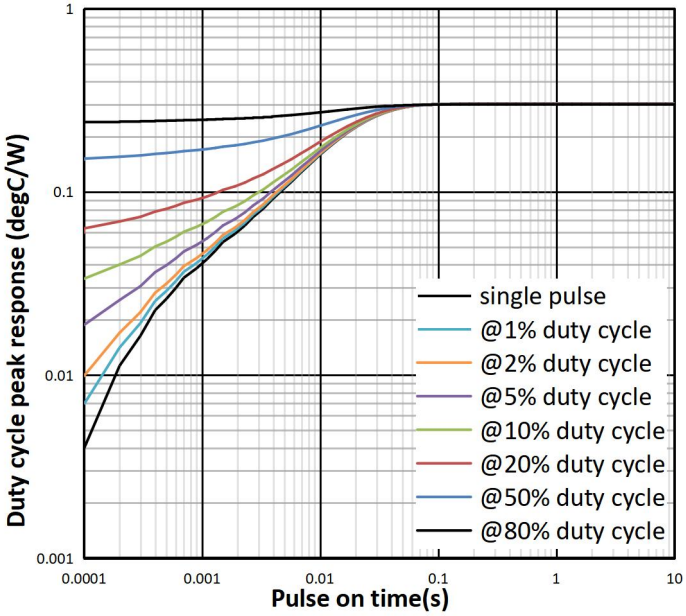
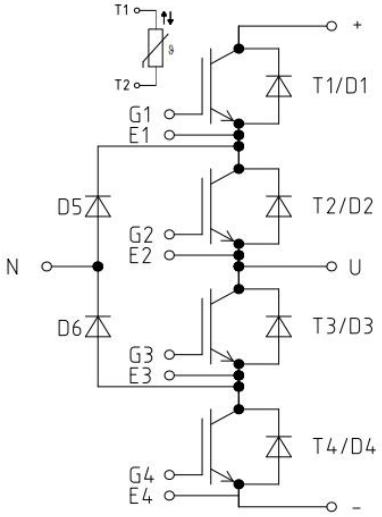


Figure22. transient thermal impedance FRD, (typical)（D5，D6）

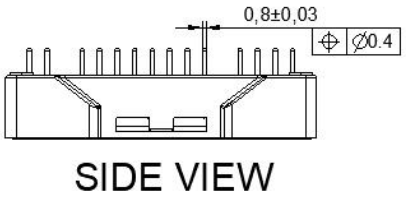


CIRCUIT DIAGRAM

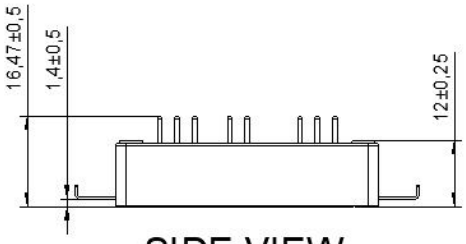


PACKAGE DIMENSION

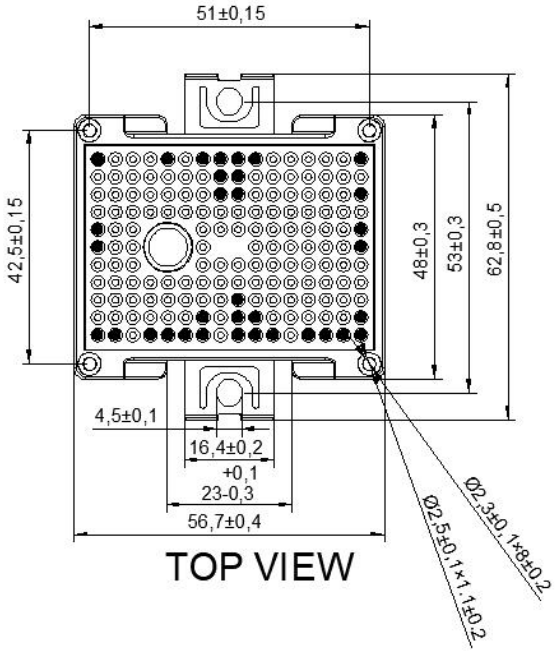
Dimensions in Millimeters



SIDE VIEW



SIDE VIEW



TOP VIEW