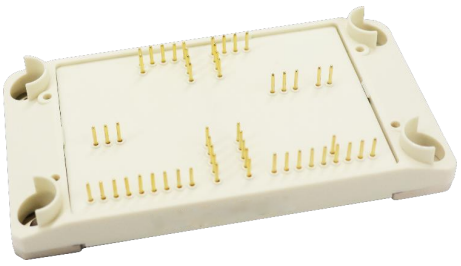
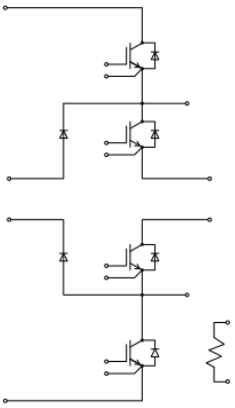
3-Level NPC1 Inverter Module

V_{CES} =1200V， $I_{C\ nom}$ =225A / I_{CRM} =450A



K3



Electrical characteristics：

- 1200V Trench / Field Stop Technology
- Low switching losses
- Vcesat has a positive temperature coefficient

Applications:

- Energy Storage System
- Solar Inverters
- Uninterruptable Power Supplies Systems

IGBT, T1/T4

Maximum Ratings

Parameter	Conditions	Symbol	Value	Unit
Collector-Emitter voltage	T_{vj}=25°C	V_{CES}	1200	V
Continuous DC collector current		$I_{C\ nom}$	225	A
Repetitive peak collector current		I_{CRM}	450	A
Gate emitter voltage		V_{GE}	±20	V

Characteristic Values

Parameter	Conditions		Symbol	Value			Unit
				Min.	Typ.	Max.	
Collector-Emitter saturation voltage	V_{GE}=15V, I_C=225A V_{GE}=15V, I_C=225A V_{GE}=15V, I_C=225A	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	V_{CEsat}		1.75 2.14 2.22	2.25	V

Gate-Emitter threshold voltage	I_C=7.8mA, V_{GE}= V_{CE}	T_{vj}=25°C	$V_{GE(th)}$	5.50	6.10	6.70	
Gate charge	V_{GE}=-15V…+15V		Q_G		2.10		µC
Internal gate resistor			R_{Gint}		--		Ω
Input capacitance	f=1MHz, V_{CE}=25 V, V_{GE}=0 V	T_{vj}=25°C	C_{ies}		34.5		nF
Reverse transfer capacitance			C_{res}		0.23		nF
Collector-emitter cut-off current	V_{CE}=1200V , V_{GE}= 0 V	T_{vj}=25°C	I_{CES}			1	mA
Gate-emitter leakage current	V_{CE}=0 V, V_{GE}= 20 V	T_{vj}=25°C	I_{GES}			100	nA
Turn-on delay time	I_C=225A, V_{CE}=600 V V_{GE}=±15 V, R_G=5Ω ((inductive load)	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	$t_{d\ on}$		108 98 95		ns
Rise time	I_C=225A, V_{CE}=600 V V_{GE}=±15 V, R_G=5Ω (inductive load)	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	t_r		54 57 57		
Turn-off delay time	I_C=225A, V_{CE}=600 V V_{GE}=±15 V, R_G=5Ω (inductive load)	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	$t_{d\ off}$		270 300 302		
Fall time	I_C=225A, V_{CE}=600 V V_{GE}=±15 V, R_G=5Ω (inductive load)	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	t_f		83 125 135		
Turn-on energy loss per pulse	I_C =225A, V_{CE}=600 V V_{GE}=±15 V, R_G =5Ω di/dt = 3100 A/µs (Tvj = 150 °C)	Tvj=25°C Tvj=125°C Tvj=150°C	E_{on}		17.7 22.8 23.9		mJ
Turn-off energy loss per pulse	I_C =225A, V_{CE}=600 V V_{GE}=±15 V, R_G =5Ω dv/dt = 8400 V/µs (Tvj = 150 °C)	Tvj=25°C Tvj=125°C Tvj=150°C	E_{off}		7.54 10.6 11.0		
Thermal resistance, junction to case	per IGBT		R_{thJC}		0.183		K/W
Temperature under switching conditions			$T_{vj\ op}$	-40		175	°C

IGBT, T2/T3

Maximum Ratings

Parameter	Conditions	Symbol	Value	Unit
Collector-Emitter voltage	T_{vj}=25°C	V_{CES}	1200	V
Continuous DC collector current		$I_{C\ nom}$	225	A
Repetitive peak collector current		I_{CRM}	450	A

Gate emitter voltage		V_{GE}	±20	V

Characteristic Values

Parameter	Conditions		Symbol	Value			Unit
				Min.	Typ.	Max.	
Collector-Emitter saturation voltage	V_{GE}=15V, I_C=225A V_{GE}=15V, I_C=225A V_{GE}=15V, I_C=225A	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	V_{CEsat}		1.75 2.14 2.22	2.25	V
Gate-Emitter threshold voltage	I_C=7.8mA, V_{GE}= V_{CE}	T_{vj}=25°C	$V_{GE(th)}$	5.50	6.10	6.70	
Gate charge	V_{GE}=-15V…+15V		Q_G		2.10		µC
Internal gate resistor			R_{Gint}		--		Ω
Input capacitance	f=1MHz, V_{CE}=25 V, V_{GE}=0 V	T_{vj}=25°C	C_{ies}		34.5		nF
Reverse transfer capacitance			C_{res}		0.23		nF
Collector-emitter cut-off current	V_{CE}=1200V , V_{GE}= 0 V	T_{vj}=25°C	I_{CES}			1	mA
Gate-emitter leakage current	V_{CE}=0 V, V_{GE}= 20 V	T_{vj}=25°C	I_{GES}			100	nA
Turn-on delay time	I_C=225A, V_{CE}=600 V V_{GE}=±15 V, R_G=5Ω (inductive load)	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	$t_{d\ on}$		108 92 97		ns
Rise time	I_C=225A, V_{CE}=600 V V_{GE}=±15 V, R_G=5Ω (inductive load)	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	t_r		62 63 66		
Turn-off delay time	I_C=225A, V_{CE}=600 V V_{GE}=±15 V, R_G=5Ω (inductive load)	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	$t_{d\ off}$		266 293 303		
Fall time	I_C=225A, V_{CE}=600 V V_{GE}=±15 V, R_G=5Ω (inductive load)	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	t_f		68 108 120		
Turn-on energy loss per pulse	I_C =225A, V_{CE}=600 V V_{GE}=±15 V, R_G =5Ω di/dt = 2700 A/µs (Tvj = 150 °C)	Tvj=25°C Tvj=125°C Tvj=150°C	E_{on}		18.0 21.2 22.5		mJ
Turn-off energy loss per pulse	I_C =225A, V_{CE}=600 V V_{GE}=±15 V, R_G =5Ω dv/dt = 8300 V/µs (Tvj = 150 °C)	Tvj=25°C Tvj=125°C Tvj=150°C	E_{off}		7.70 10.9 11.7		
Thermal resistance, junction to case	per IGBT		R_{thJC}		0.183		K/W
Temperature under switching conditions			$T_{vj\ op}$	-40		175	°C

Diode,D1/D4

Maximum Ratings

Parameter	Conditions	Symbol	Value	Unit
Repetitive peak reverse voltage	T_{vj}=25ºC	V_{RRM}	1200	V
Continuous DC forward current		I_F	300	A
Repetitive peak forward current		I_{FRM}	600	A
I^2t-value	t_p=10ms，sin180°，T_j=125ºC	I^2t	20000	A^2S

Characteristic Values

Parameter	Conditions		Symbol	Value			Unit
				Min.	Typ.	Max.	
Forward voltage	I_F=300A, V_{GE}=0V I_F=300A, V_{GE}=0V I_F=300A, V_{GE}=0V	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	V_F		1.55 1.68 1.66		V
Peak reverse recovery current	I_F=300A, -di$_F$/dt=3000A/µs(T_{vj}=150°C) V_R=600V, V_{GE}=-15V	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	I_{RM}		140 179 218		A
Recovered charge	I_F=300A, -di$_F$/dt=3000A/µs(T_{vj}=150°C) V_R=600V, V_{GE}=-15V	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	Q_r		25.3 44.1 61.5		µC
Reverse recovered energy	I_F=300A, -di$_F$/dt=3000A/µs(T_{vj}=150°C) V_R=600V, V_{GE}=-15V	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	E_{rec}		9.30 17.6 20.5		mJ
Thermal resistance, junction to case	per diode		R_{thJC}		0.323		K/W
Temperature under switching conditions			$T_{vj\ op}$	-40		175	°C

Diode,D2/D3

Maximum Ratings

Parameter	Conditions	Symbol	Value	Unit
Repetitive peak reverse voltage	T_{vj}=25ºC	V_{RRM}	1200	V
Continuous DC forward current		I_F	200	A
Repetitive peak forward current		I_{FRM}	400	A
I^2t-value	t_p=10ms，sin180°，T_j=125ºC	I^2t	10000	A^2S

Characteristic Values

Parameter	Conditions	Symbol	Value			Unit
			Min.	Typ.	Max.	
Forward voltage	I_F=200A, V_{GE}=0V T_{vj}=25°C I_F=200A, V_{GE}=0V T_{vj}=125°C I_F=200A, V_{GE}=0V T_{vj}=150°C	V_F		1.58 1.70 1.66		V
Peak reverse recovery current	I_F=200A, T_{vj}=25°C -di$_F$/dt=2800A/µs(T_{vj}=150°C) T_{vj}=125°C V_R=600V, V_{GE}=-15V T_{vj}=150°C	I_{RM}		122 141 147		A
Recovered charge	I_F=200A, T_{vj}=25°C -di$_F$/dt=2800A/µs(T_{vj}=150°C) T_{vj}=125°C V_R=600V, V_{GE}=-15V T_{vj}=150°C	Q_r		18.3 29.8 34.2		µC
Reverse recovered energy	I_F=200A, T_{vj}=25°C -di$_F$/dt=2800A/µs(T_{vj}=150°C) T_{vj}=125°C V_R=600V, V_{GE}=-15V T_{vj}=150°C	E_{rec}		6.90 11.9 13.7		mJ
Thermal resistance, junction to case	per diode	R_{thJC}		0.39		K/W
Temperature under switching conditions		$T_{vj\ op}$	-40		175	°C

Diode,D5/D6

Maximum Ratings

Parameter	Conditions	Symbol	Value	Unit
Repetitive peak reverse voltage	T_{vj}=25°C	V_{RRM}	1200	V
Continuous DC forward current		I_F	300	A
Repetitive peak forward current		I_{FRM}	600	A
I^2t-value	t_p=10ms，sin180°，T_j=125°C	I^2t	14000	A^2S

Characteristic Values

Parameter	Conditions	Symbol	Value			Unit
			Min.	Typ.	Max.	
Forward voltage	I_F=300A, V_{GE}=0V T_{vj}=25°C I_F=300A, V_{GE}=0V T_{vj}=125°C I_F=300A, V_{GE}=0V T_{vj}=150°C	V_F		1.64 1.79 1.75		V
Peak reverse recovery current	I_F=300A, T_{vj}=25°C -di$_F$/dt=3400A/µs(T_{vj}=150°C) T_{vj}=125°C V_R=600V, V_{GE}=-15V T_{vj}=150°C	I_{RM}		154 192 221		A
Recovered charge	I_F=300A, T_{vj}=25°C -di$_F$/dt=3400A/µs(T_{vj}=150°C) T_{vj}=125°C V_R=600V, V_{GE}=-15V T_{vj}=150°C	Q_r		9.62 44.1 49.6		µC

Reverse recovered energy	I_F=300A, -di$_F$/dt=3400A/μs(T_{vj}=150°C) V_R=600V, V_{GE}=-15V	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	E_{rec}		6.90 18.1 19.7		mJ
Thermal resistance, junction to case	per diode		R_{thJC}		0.37		K/W
Temperature under switching conditions			$T_{vj\ op}$	-40		175	°C

NTC-Thermistor

Characteristic Values

Parameter	Conditions	Value			Unit
R25	T=25℃		5		KΩ
△R/R		−5		5	%
B−value	B (25/50), tolerance ±3%		3375		K
B−value	B (25/100), tolerance ±3%		3433		K

Module

Parameter	Conditions	Symbol	Value			Unit
Isolation test voltage	RMS, f=50Hz, t=1min	V_{ISOL}	3200			V
Internal isolation			Al2O3			
Creepage distance	terminal to heatsink terminal to terminal		11.5 6.8			mm
Clearance			9.4 5.5			mm
Comperative tracking index		CTI	> 400			
RTI Elec.	housing	RTI	140			
Storage temperature		T_{stg}	-40		125	°C
Mounting torque for modul mounting		M	2.0		5.0	Nm
Weight		W		268		g

IGBT T1/T4

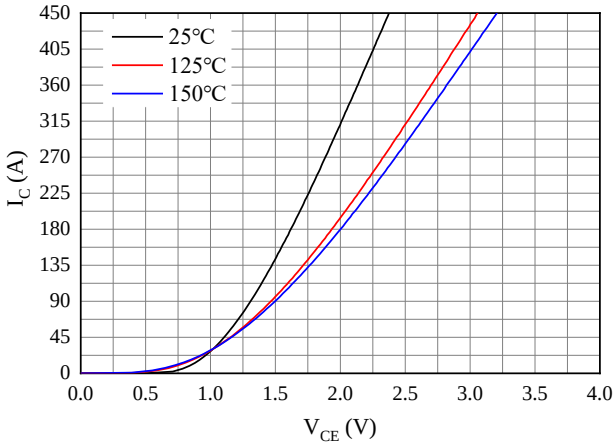


Fig 1. Typical output characteristics (VGE=15V)

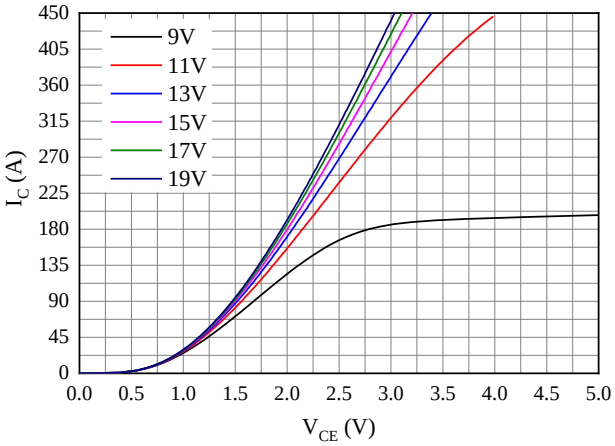


Fig 2. Typical output characteristics (Tvj=150℃)

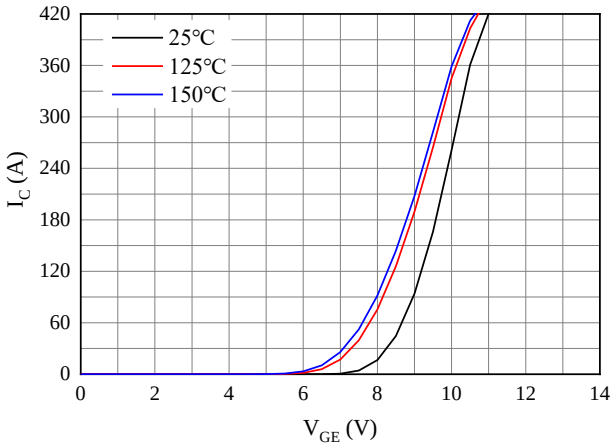


Fig 3. Typical transfer characteristic(V_{CE}=20V)

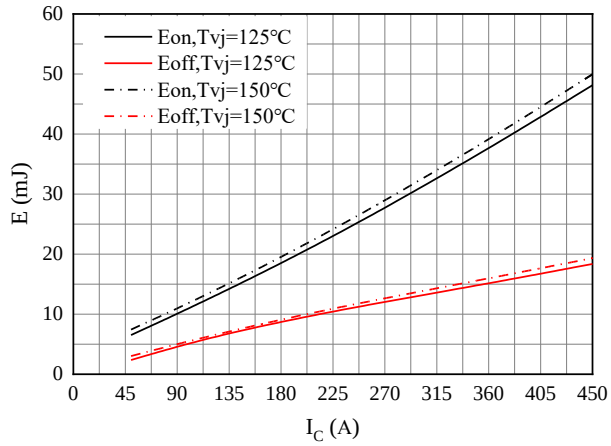


Fig 4. Switching losses of IGBT,
V_{GE}=±15V, Rg=5Ω, V_{CE}=600V

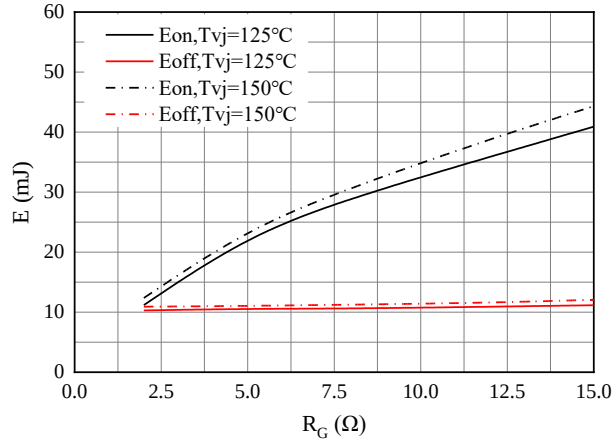


Fig 5. Switching losses of IGBT,
V_{GE}=±15V,Ic=225A, V_{CE}=600V

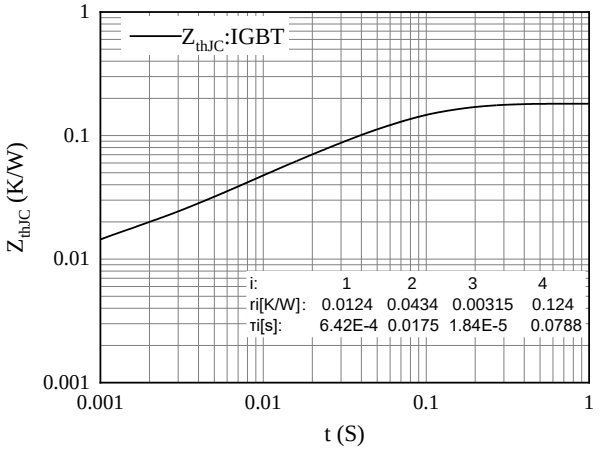


Fig 6. Transient thermal impedance IGBT,
ZthJC=f(t)

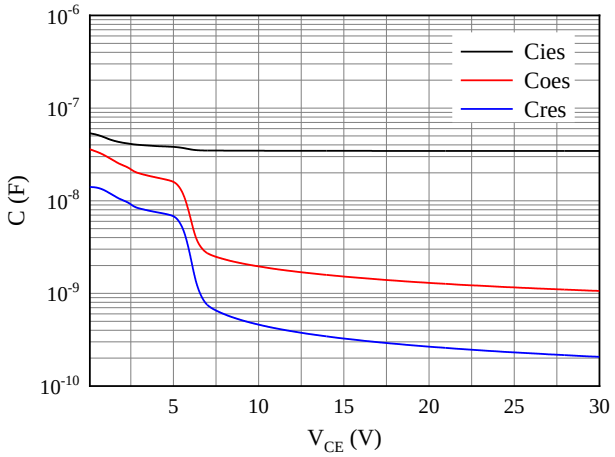


Fig 7. Capacitance characteristic

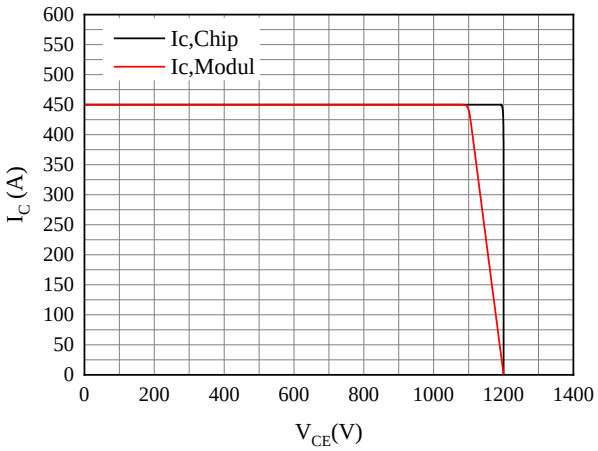


Fig 8. RBSOA

V_{GE}=±15V, Rgoff=5Ω，Tvj=150℃

IGBT T2/T3

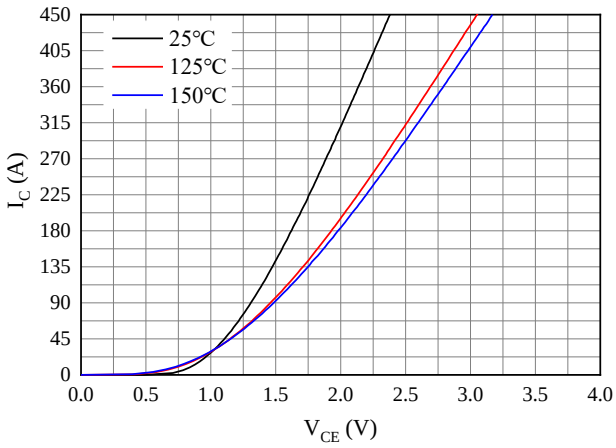


Fig 9. Typical output characteristics (VGE=15V)

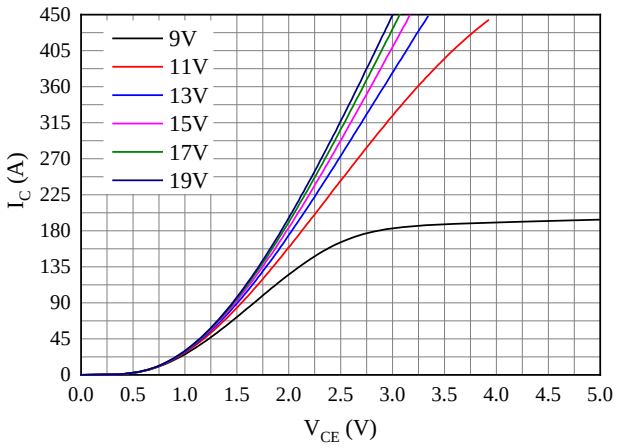


Fig 10. Typical output characteristics (Tvj=150℃)

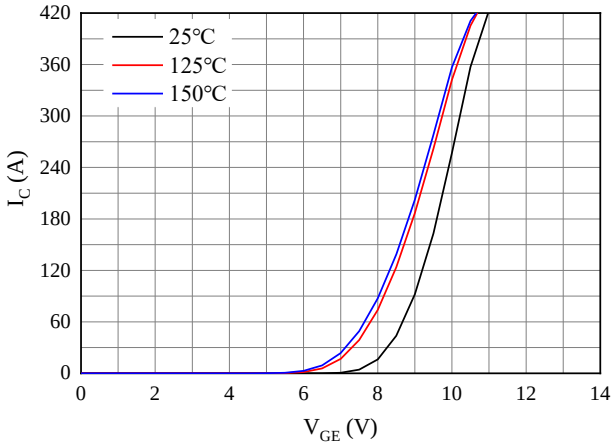


Fig 11. Typical transfer characteristic(VCE=20V)

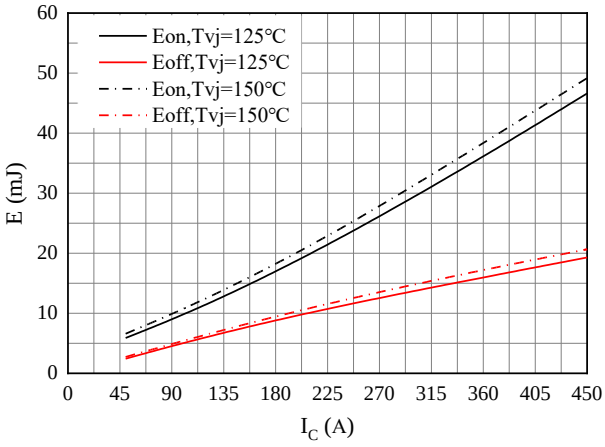


Fig 12. Switching losses of IGBT，

V_{GE}=±15V, Rg=5Ω, V_{CE}=600V

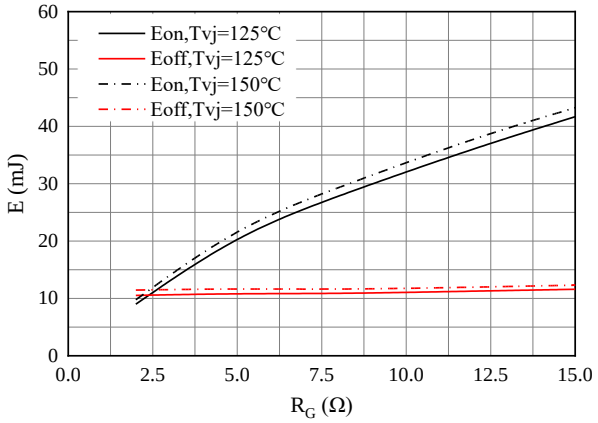


Fig 13. Switching losses of IGBT,
V_{GE}=±15V,Ic=225A, V_{CE}=600V

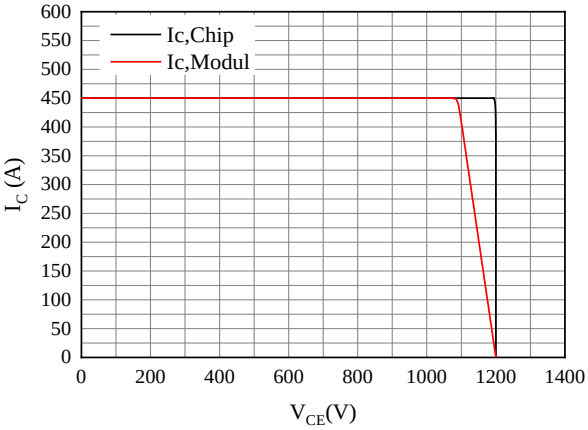


Fig 14. Transient thermal impedance IGBT,
ZthJC=f(t)

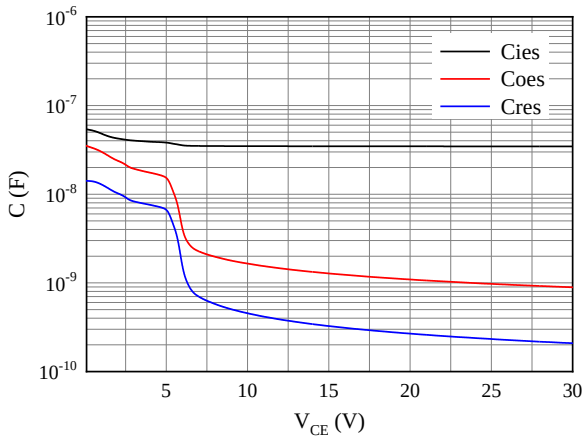


Fig 15. Capacitance characteristic

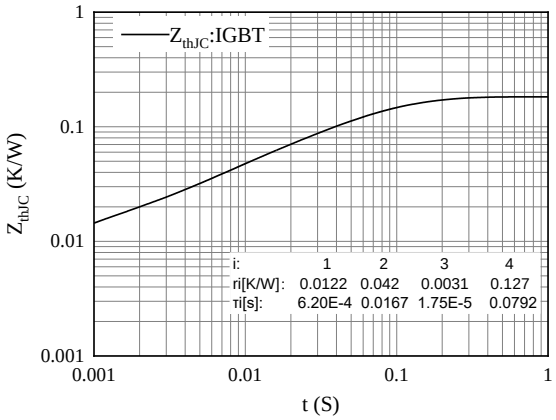


Fig 16. RBSOA
V_{GE}=±15V, Rgoff=5Ω，Tvj=150℃

Diode D1/D4

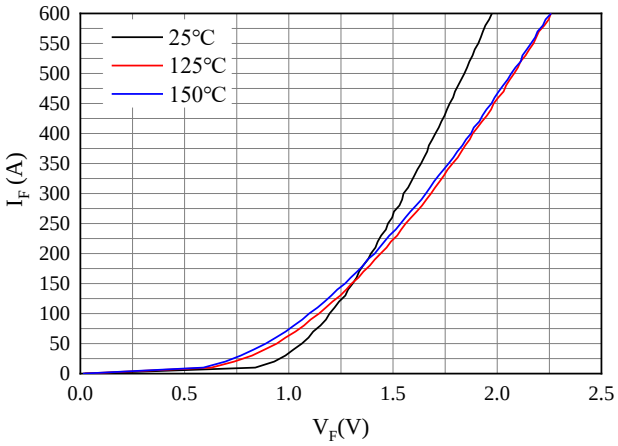


Fig 17. Forward characteristic of Diode

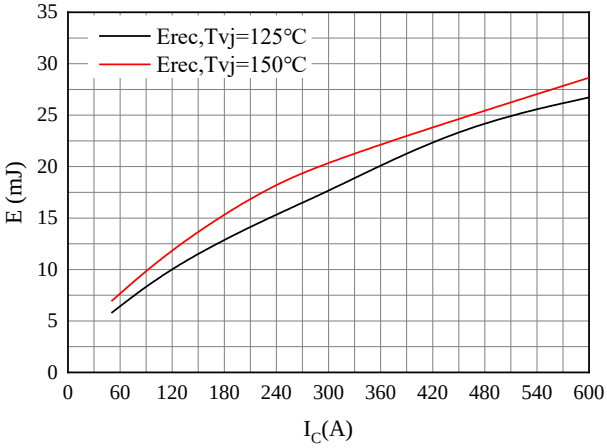


Fig18. Switching losses of Diode
Rg =5Ω, V_{CE}=600V

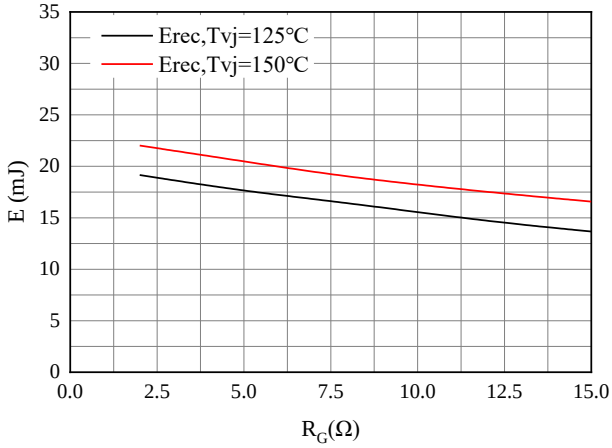


Fig 19. Switching losses of Diode

I_F =300A, V_{CE}=600V

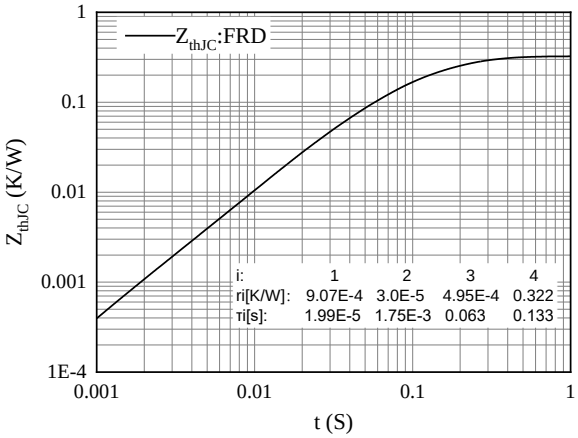


Fig 20. Transient thermal impedance FRD ,

ZthJC=f(t)

Diode D2/D3

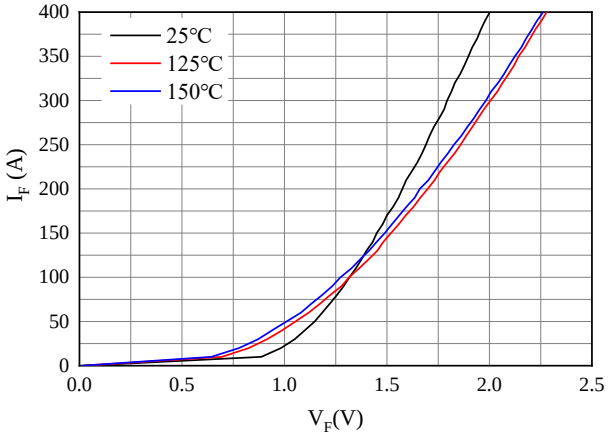


Fig 21. Forward characteristic of Diode

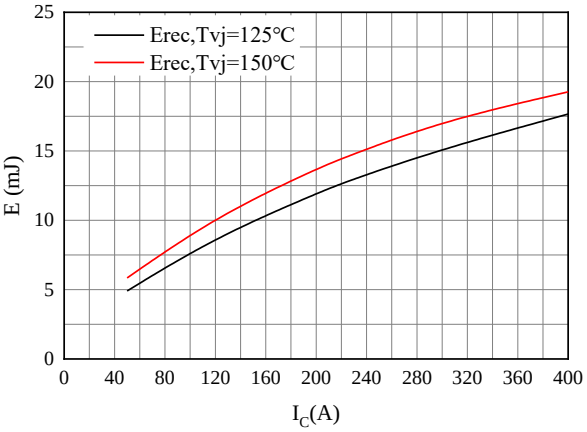


Fig22. Switching losses of Diode

Rg =5Ω, V_{CE}=600V

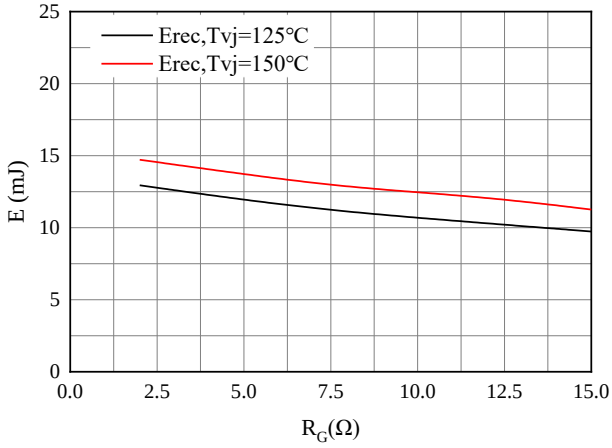


Fig 23. Switching losses of Diode

I_F =200A, V_{CE}=600V

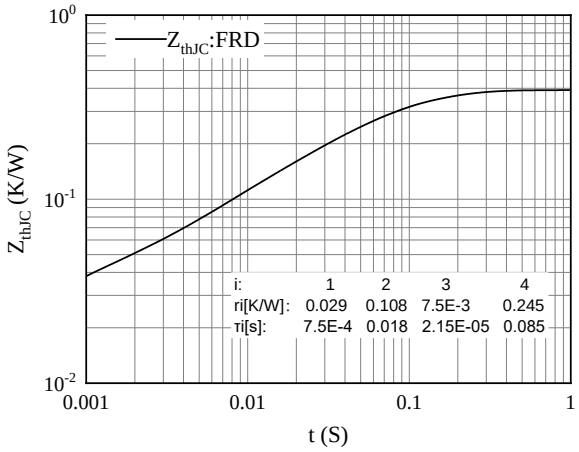


Fig 24. Transient thermal impedance FRD ,

ZthJC=f(t)

Diode D5/D6

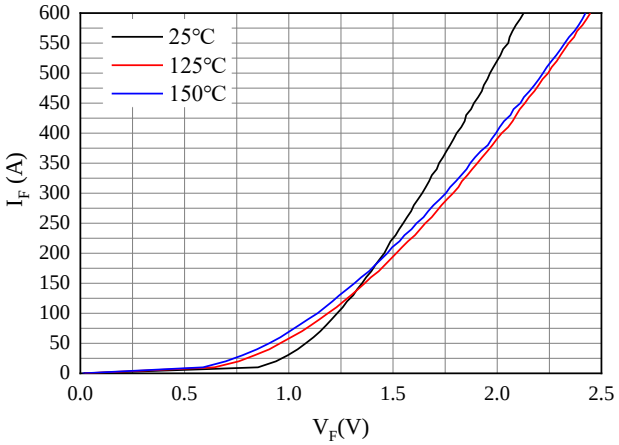


Fig 25. Forward characteristic of Diode

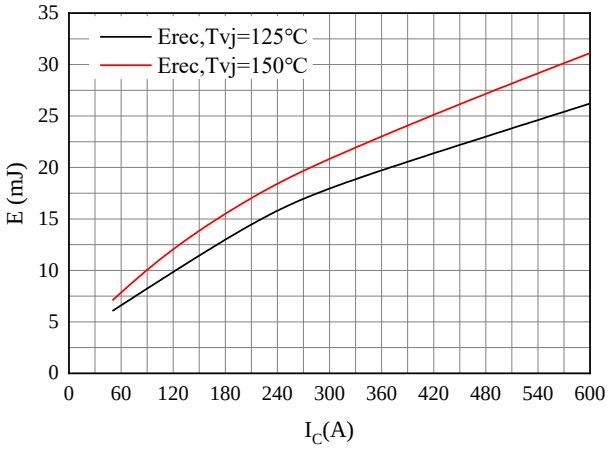


Fig 26. Switching losses of Diode
Rg =5Ω, V_{CE}=600V

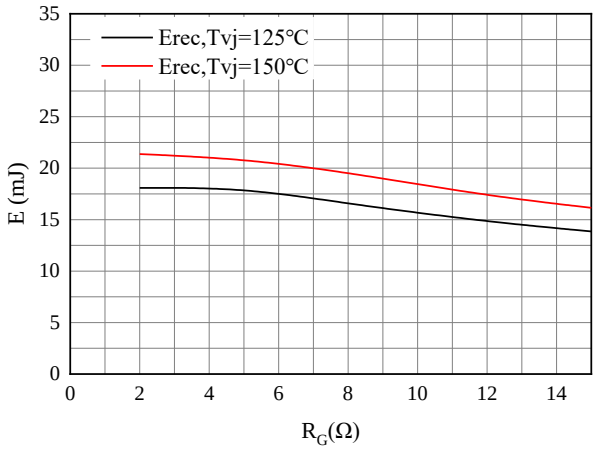


Fig 27. Switching losses of Diode
If=300A, V_{CE}=600V

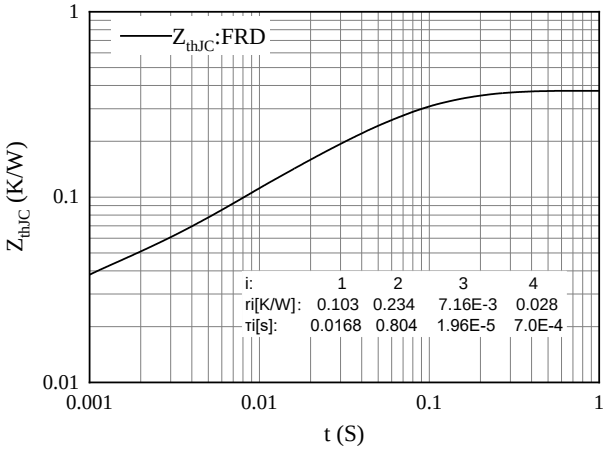


Fig 28. Transient thermal impedance FRD ,
ZthJC=f(t)

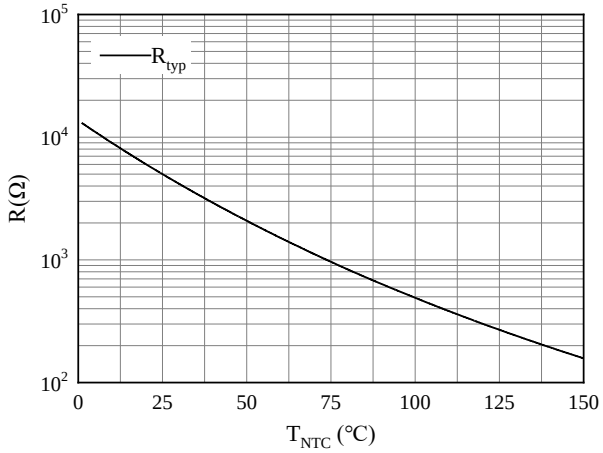
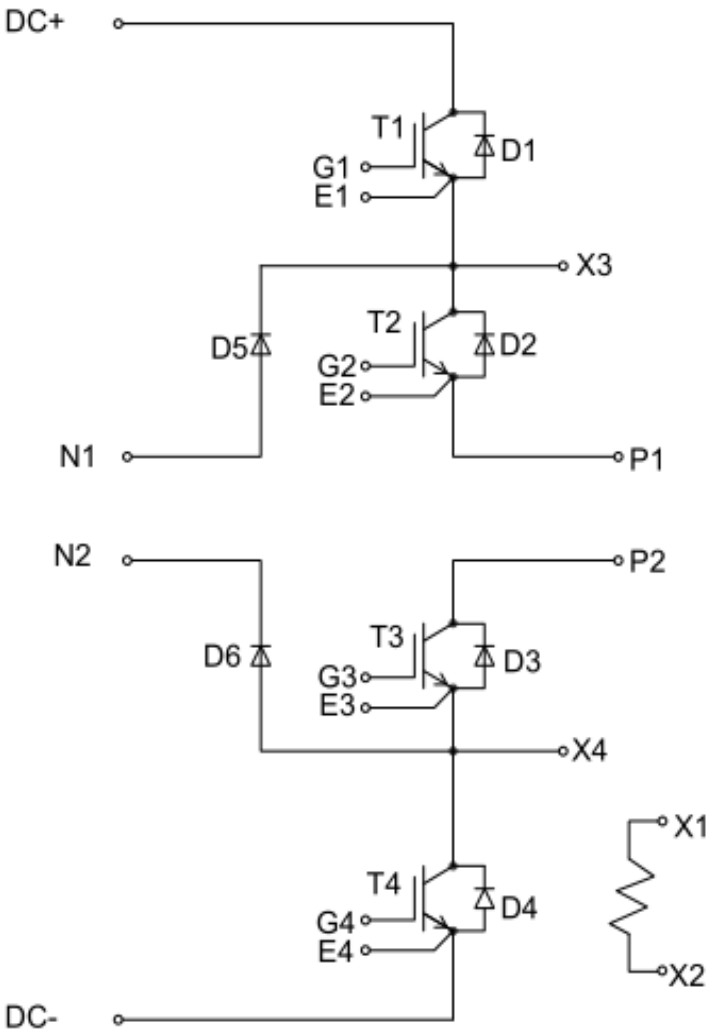


Fig 29. NTC-Thermistor-temperature characteristic

Circuit Diagram



Package outlines