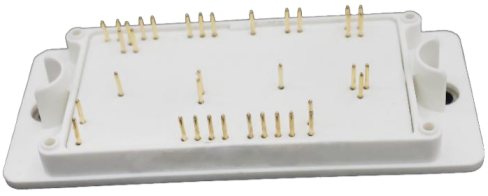
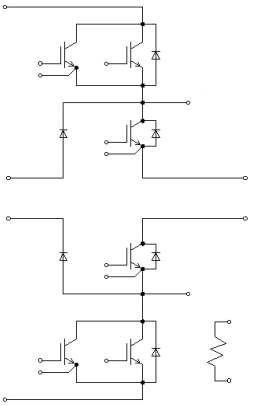
3-Level NPC Inverter Module

V_{CES} =650V， $I_{C\,nom}$ =450A



K2



Electrical characteristics：

- 650V Trench /Field Stop process
- Low switching losses
- Vcesat has a positive temperature coefficient
- Integrated NTC temperature sensor

Applications:

- 3-level-applications
- Solar Inverters
- Uninterruptable Power Supplies Systems

IGBT, Q1.1/Q1.2/Q4.1/Q4.2

Maximum Ratings

Parameter	Conditions	Symbol	Value	Unit
Collector-Emitter voltage	Tvj=25℃	V_{CES}	650	V
Continuous DC collector current	Tc=80℃, Tvj max=175℃	Icnom	167	A
Pulsed Collector Current	Tc=175℃	Icpulse	500	A
Gate emitter voltage	Tvj=25℃	V_{GE}	±20	V

Characteristic Values

Parameter	Conditions	Symbol	Value			Unit
			Min.	Typ.	Max.	
Collector-Emitter saturation voltage	V_{GE}=15V, I_C=225A T_{vj}=25°C V_{GE}=15V, I_C=225A T_{vj}=125°C V_{GE}=15V, I_C=225A T_{vj}=150°C	V_{CEsat}		1.65 1.90 2.12	2.20	V
Gate−Emitter Threshold Voltage	I_C=2.75mA, V_{GE}= V_{CE} T_{vj}=25°C	$V_{GE(th)}$	3.70	4.30	4.90	
Total Gate charge	V_{CE} = 400 V, I_C = 225 A, V_{GE} = ±15 V	Q_G		750		nC
Input capacitance	f=100KHz, V_{CE}=25 V, V_{GE}=0 V T_{vj}=25°C	Cies		12.80		nF
Reverse transfer capacitance		Cres		0.06		
Collector-emitter cut-off current	V_{CE}=650V , 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}			200	nA
Turn-on delay time	I_C=200A, V_{CE}=400 V T_{vj}=25°C V_{GE}=±15 V, R_G=10Ω T_{vj}=125°C (inductive load) T_{vj}=150°C	$t_{d\ on}$		60 52 54		ns
Rise time	I_C=200A, V_{CE}=400 V T_{vj}=25°C V_{GE}=±15 V, R_G=10Ω T_{vj}=125°C (inductive load) T_{vj}=150°C	t_r		78 80 76		
Turn-off delay time	I_C=200A, V_{CE}=400 V T_{vj}=25°C V_{GE}=±15 V, R_G=10Ω T_{vj}=125°C (inductive load) T_{vj}=150°C	$t_{d\ off}$		186 203 210		
Fall time	I_C=200A, V_{CE}=400 V T_{vj}=25°C V_{GE}=±15 V, R_G=10Ω T_{vj}=125°C (inductive load) T_{vj}=150°C	t_f		43 58 64		
Turn-on energy loss per pulse	I_C=200A, V_{CE}=400 V V_{GE}=±15 V, R_G=10Ω T_{vj}=25°C di/dt=2000A/us(T_{vj}=150°C) T_{vj}=125°C (inductive load) T_{vj}=150°C	E_{on}		9.82 11.60 12.43		mJ
Turn-off energy loss per pulse	I_C=200A, V_{CE}=400 V V_{GE}=±15 V, R_G=10Ω T_{vj}=25°C dv/dt=8500V/us(T_{vj}=150°C) T_{vj}=125°C (inductive load) T_{vj}=150°C	E_{off}		2.70 3.73 4.07		
Thermal resistance, junction to case	per IGBT	R_{thJC}		0.25		K/W
Temperature under switching conditions		$T_{vj\ op}$	-40		150	°C

IGBT, Q2/Q3

Maximum Ratings

Parameter	Conditions	Symbol	Value	Unit
Collector-Emitter voltage	Tvj=25℃	V_{CES}	650	V
Continuous DC collector current	T_C=80℃, Tvj max=175℃	Icnom	280	A
Pulsed Collector Current	Tc=175℃	Icpulse	840	A
Gate emitter voltage	Tvj=25℃	V_{GE}	±20	V

Characteristic Values

Parameter	Conditions	Symbol	Value			Unit
			Min.	Typ.	Max.	
Collector-Emitter saturation voltage	V_{GE}=15V, I_C=375A T_{vj}=25°C V_{GE}=15V, I_C=375A T_{vj}=125°C V_{GE}=15V, I_C=375A T_{vj}=150°C	V_{CEsat}		1.62 1.90 1.97	2.20	V
Gate-Emitter threshold voltage	I_C=3.75mA, V_{GE}= V_{CE} T_{vj}=25°C	$V_{GE(th)}$	3.70	4.30	4.90	
Gate charge	V_{CE} = 400 V, I_C = 375 A, V_{GE} = ±15 V	Q_G		1230		nC
Input capacitance	f=100KHz, V_{CE}=25 V, V_{GE}=0 V T_{vj}=25°C	Cies		21.2		nF
Reverse transfer capacitance		Cres		0.10		
Collector-emitter cut-off current	V_{CE}=650V , 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}			200	nA
Turn-on delay time	I_C=200A, V_{CE}=400V T_{vj}=25°C V_{GE}=±15 V, R_G=30Ω T_{vj}=125°C (inductive load) T_{vj}=150°C	$t_{d\ on}$		278 236 215		ns
Rise time	I_C=200A, V_{CE}=400V T_{vj}=25°C V_{GE}=±15 V, R_G=30Ω T_{vj}=125°C (inductive load) T_{vj}=150°C	t_r		150 154 157		

Turn-off delay time	I_C=200A, V_{CE}=400V V_{GE}=±15 V, R_G=30Ω (inductive load)	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	$t_{d\ off}$		726 774 788		
Fall time	I_C=200A, V_{CE}=400V V_{GE}=±15 V, R_G=30Ω (inductive load)	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	t_f		70 73 75		
Turn-on energy loss per pulse	I_C=200A, V_{CE}=400V V_{GE}=±15 V, R_G=30Ω di/dt=1000A/us(T_{vj}=150°C) (inductive load)	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	E_{on}		14.10 15.00 15.30		mJ
Turn-off energy loss per pulse	I_C=200A, V_{CE}=400V V_{GE}=±15 V, R_G=30Ω dv/dt=3800V/us(T_{vj}=150°C) (inductive load)	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	E_{off}		6.00 6.40 6.78		
Thermal resistance, junction to case	per IGBT		R_{thJC}		0.15		K/W
Temperature under switching conditions			$T_{vj\ op}$	-40		150	°C

Diode，D1/D2/D3/D4

Maximum Ratings

Parameter	Conditions	Symbol	Value	Unit
Repetitive peak reverse voltage	T_{vj}=25°C	V_{RRM}	650	V
Continuous DC forward current	TC=80°C, Tvj max=175°C	I_F	93	A
Repetitive peak forward current	t_p=1ms	I_{FRM}	280	A
I^2t-value	V_R = 0 V, t_P = 10 ms, T_{vj} = 125°C	I^2t	1900	A^2S

Characteristic Values

Parameter	Conditions		Symbol	Value			Unit
				Min.	Typ.	Max.	
Forward voltage	I_F=120A, V_{GE}=0V I_F=120A, V_{GE}=0V I_F=120A, V_{GE}=0V	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	V_F		1.60 1.70 1.75	2.00	V
Peak reverse recovery current	IF=200A, -diF/dt=1000A/μs VR=400V, V_{GE}=-15 V	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	I_{RM}		45 51 58		A

Reverse Recovery Time	IF=200A, -diF/dt=1000A/μs(T_{vj}=150°C) VR=400V, V_{GE}=-15 V	Tvj=125°C Tvj=150°C	Trr		148 210 223		ns
Recovered charge	IF=200A, -diF/dt=1000A/μs(T_{vj}=150°C) VR=400V, V_{GE}=-15 V	Tvj=125°C Tvj=150°C	Q_{rr}		3.30 5.78 6.90		μC
Reverse recovered energy	IF=200A, -diF/dt=1000A/μs(T_{vj}=150°C) VR=400V, V_{GE}=-15 V	Tvj=125°C Tvj=150°C	E_{rec}		0.46 0.94 1.16		mJ
Thermal resistance, junction to case	per diode		R_{thJC}		0.39		K/W
Temperature under switching conditions			$T_{vj\ op}$	-40		150	°C

Diode，D5/D6

Maximum Ratings

Parameter	Conditions	Symbol	Value	Unit
Repetitive peak reverse voltage	T_{vj}=25°C	V_{RRM}	650	V
Continuous DC forward current	T_C=80°C, Tvj max=175°C	I_F	220	A
Repetitive peak forward current	t_p=1ms	I_{FRM}	630	A
I^2t-value	V_R = 0 V, t_P = 10 ms, T_{vj} = 125°C	I^2t	7000	A^2S

Characteristic Values

Parameter	Conditions		Symbol	Value			Unit
				Min.	Typ.	Max.	
Forward voltage	I_F=375A, V_{GE}=0V I_F=375A V_{GE}=0V I_F=375A, V_{GE}=0V	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	V_F		1.60 1.70 1.75	2.00	V
Peak reverse recovery current	I_F=200A, -di_F/dt=2000A/μs(T_{vj}=150°C) V_R=400V, V_{GE}=-15V	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	I_{RM}		58 77 90		A
Reverse Recovery Time	I_F=200A, -di_F/dt=2000A/μs(T_{vj}=150°C) V_R=400V, V_{GE}=-15V	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	Trr		142 174 180		ns

Recovered charge	I_F=200A, -di$_F$/dt=2000A/μs(T_{vj}=150°C) V_R=400V, V_{GE}=-15V	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	Q_{rr}		4.08 8.12 9.90		μC
Reverse recovered energy	I_F=200A, -di$_F$/dt=2000A/μs(T_{vj}=150°C) V_R=400V, V_{GE}=-15V	T_{vj}=25°C T_{vj}=125°C T_{vj}=150°C	E_{rec}		0.53 1.21 1.52		mJ
Thermal resistance, junction to case	per diode		R_{thJC}		0.19		K/W
Temperature under switching conditions			$T_{vj\ op}$	-40		150	°C

NTC-Thermistor

Characteristic Values

Parameter	Conditions	Value			Unit
R25	T=25°C		22		KΩ
△R/R		−5		5	%
B−value	B (25/50), tolerance ±3%		3950		K
B−value	B (25/100), tolerance ±3%		3998		K

Module

Parameter	Conditions	Symbol	Value			Unit
Isolation test voltage	RMS, f=50Hz, t=1min	V_{ISOL}	3200			V
Internal isolation			Al_2O_3			
Storage temperature		T_{stg}	-40		125	°C
Mounting torque for modul mounting		M	2.0		5.0	Nm
Weight		W		177		g

IGBT, Q1.1/Q1.2/Q4.1/Q4.2

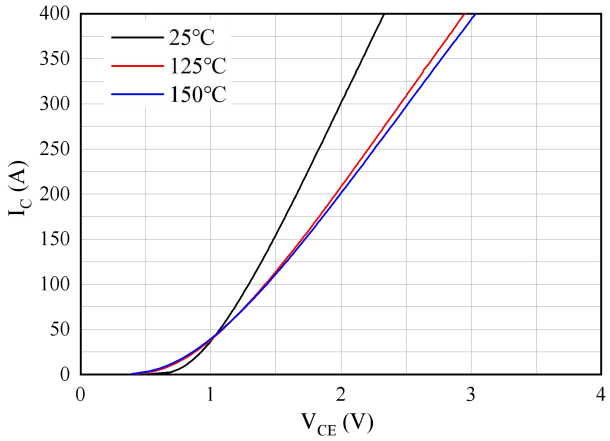


Fig1.Typical output characteristics (V_{GE}=15V)

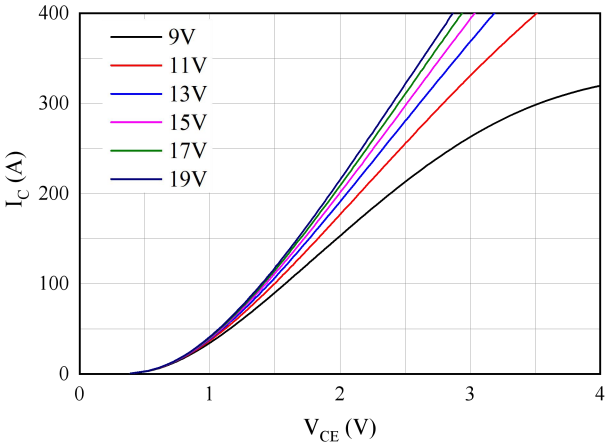


Fig2.Typical output characteristics (T_{vj}=150℃)

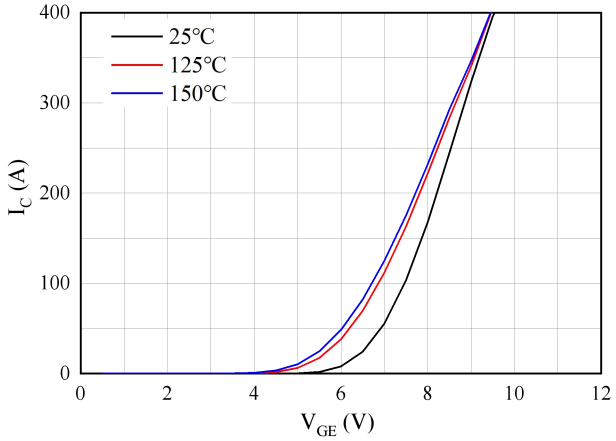


Fig3.Typical transfer characteristic(V_{CE}=20V)

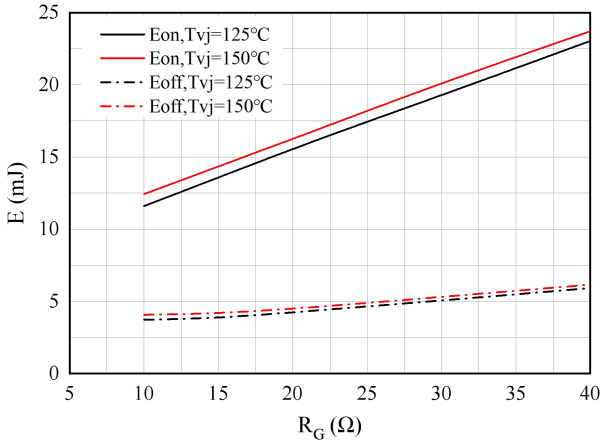


Fig4. Switching losses of IGBT

V_{GE} =±15V, I_C =200A, V_{CE} =400V

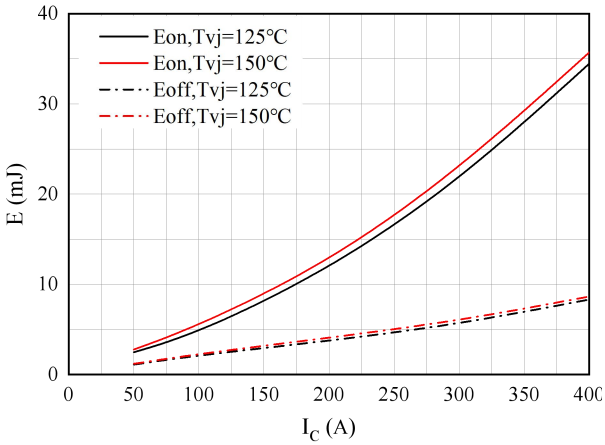


Fig5. Switching losses of IGBT s

V_{GE} =±15V, R_g =10Ω, V_{CE} = 400 V

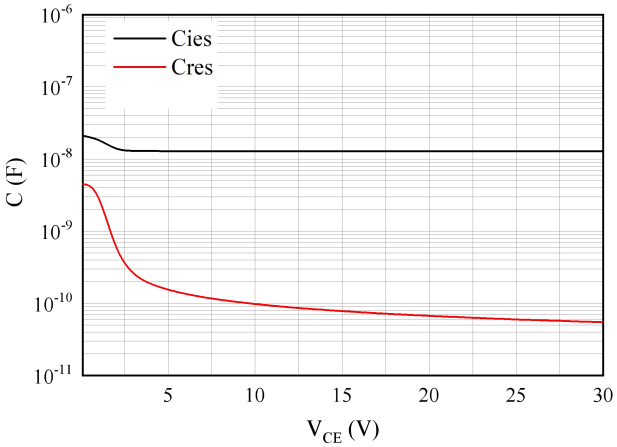


Fig6.Capacitance characteristic

f = 100 kHz, V_{GE} = 0 V, Tvj = 25 °C

IGBT, Q2/Q3

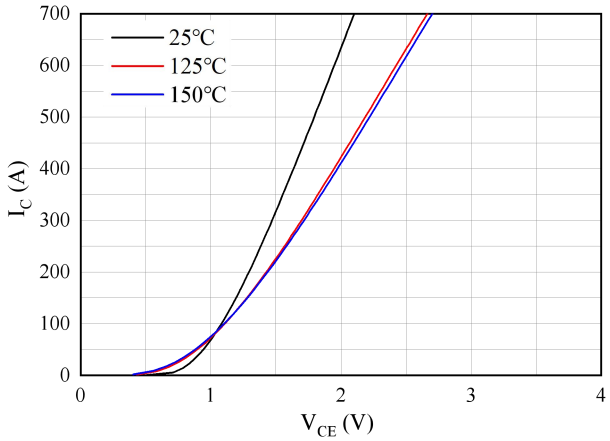


Fig 7.Typical output characteristics (V_{GE}=15V)

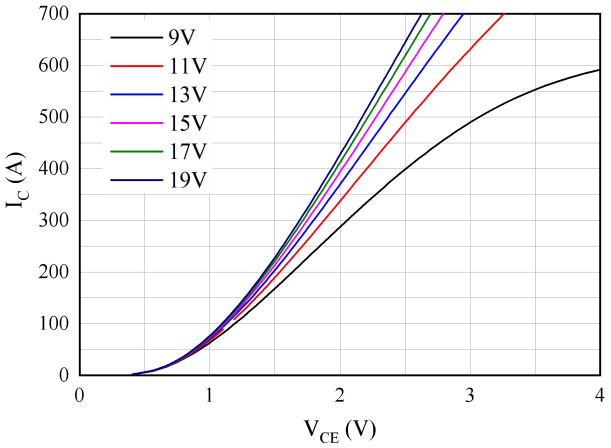


Fig 8.Typical output characteristics (T_{vj}=150℃)

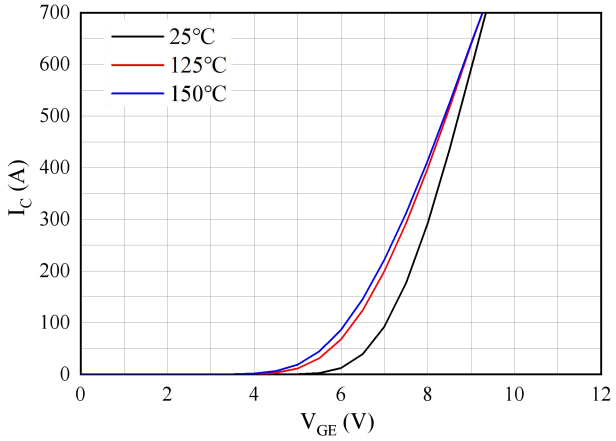


Fig9.Typical transfer characteristic(V_{CE}=20V)

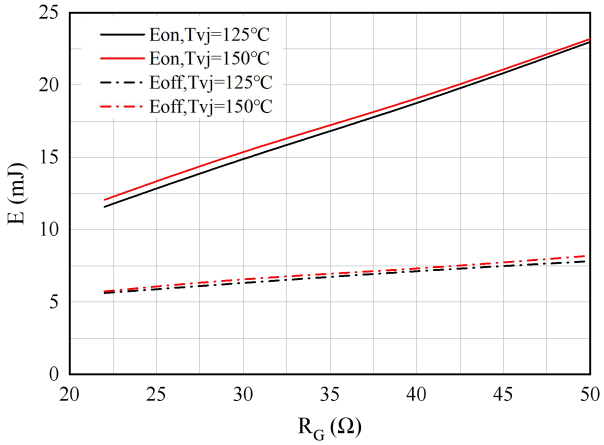


Fig 10. Switching losses of IGBT

V_{GE} =±15V, I_C =200A, V_{CE} =400V

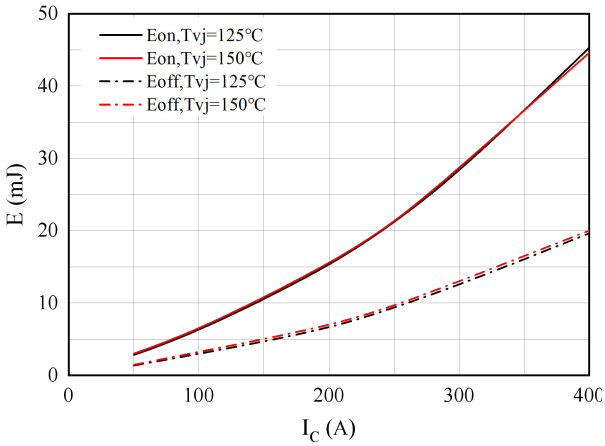


Fig11. Switching losses of IGBT

V_{GE} =±15V, R_g =30Ω, V_{CE} = 400 V

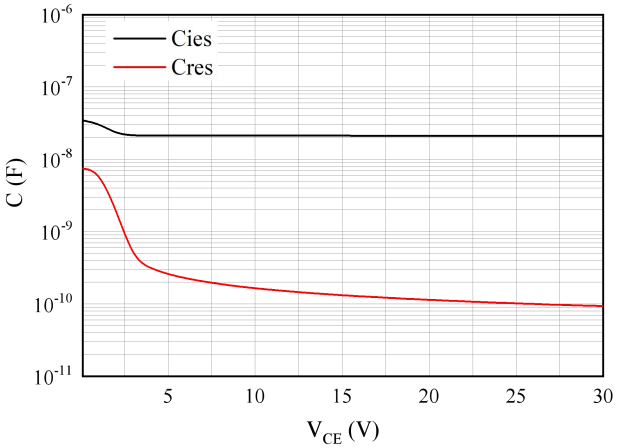


Fig 12.Capacitance characteristic

f = 100 kHz, V_{GE} = 0 V, Tvj = 25 °C

FRD

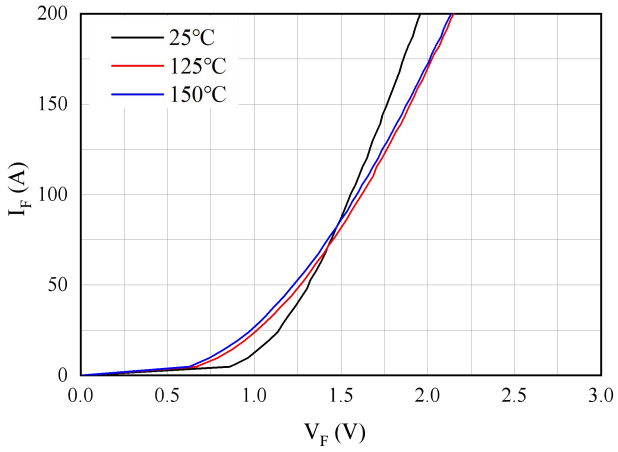


Fig 13 Forward characteristic of Diode
（D1/D2/D3/D4）

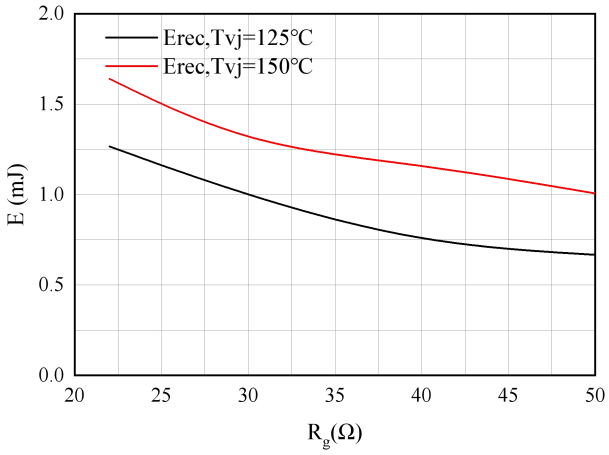


Fig14. Reverse Recovery Energy
（D1/D2/D3/D4）
I_F =200A, V_{CE} =400V

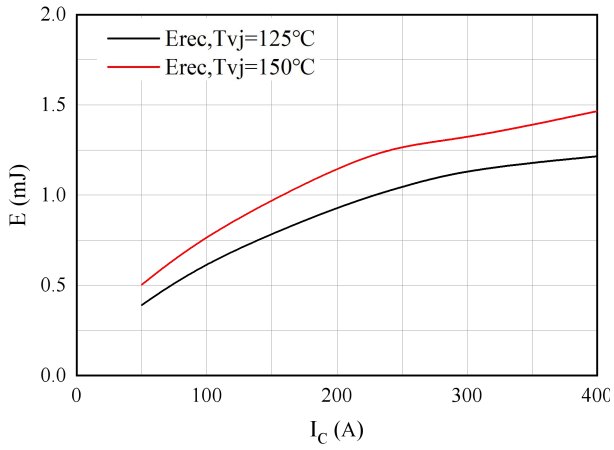


Fig 15. Reverse Recovery Energy（D1/D2/D3/D4）
R_g =30Ω, V_{CE} =400V

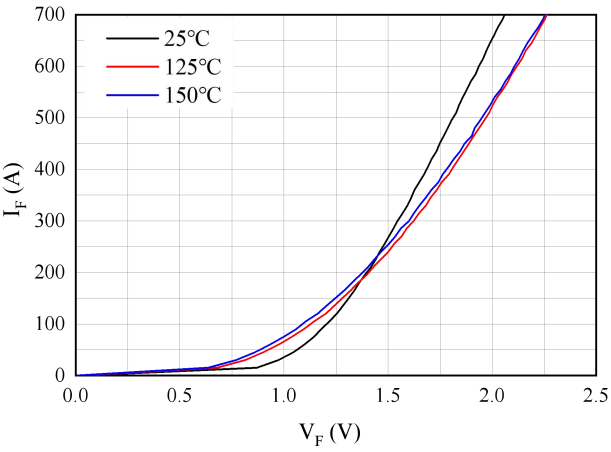


Fig 16 Forward characteristic of Diode（D5/D6）

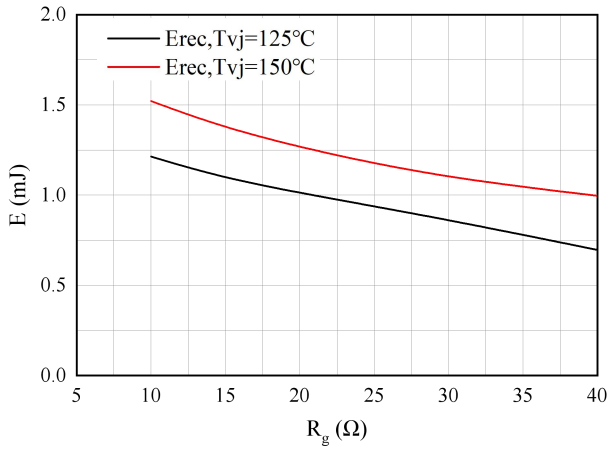


Fig 16. Reverse Recovery Energy
I_F =200A, V_{CE} =400V

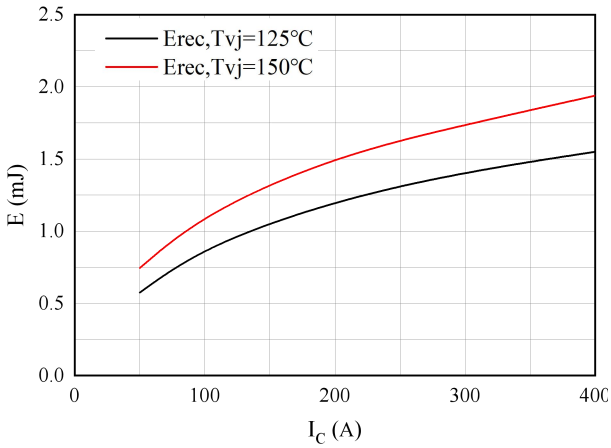


Fig 17. Reverse Recovery Energy
Rg =10Ω, VCE =400V

NTC

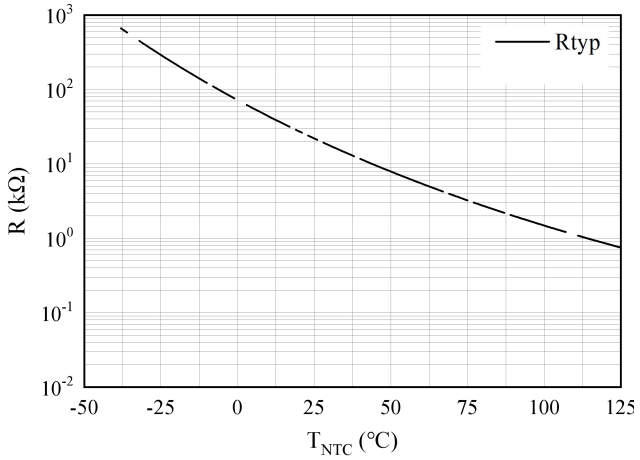
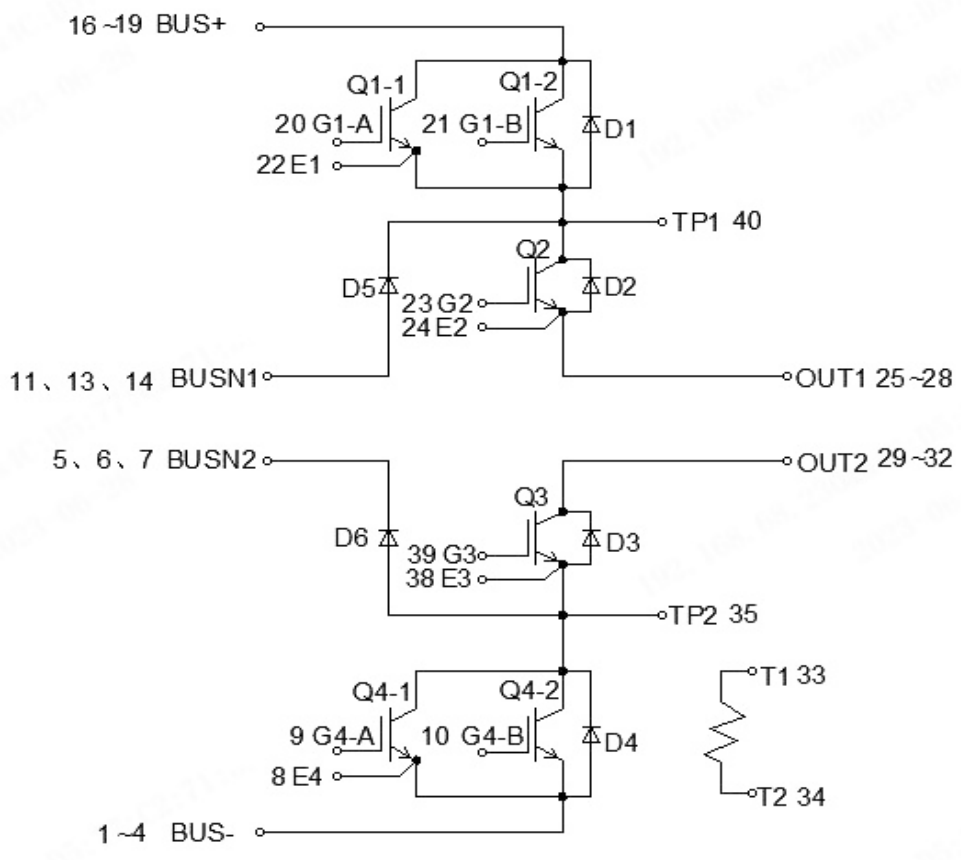
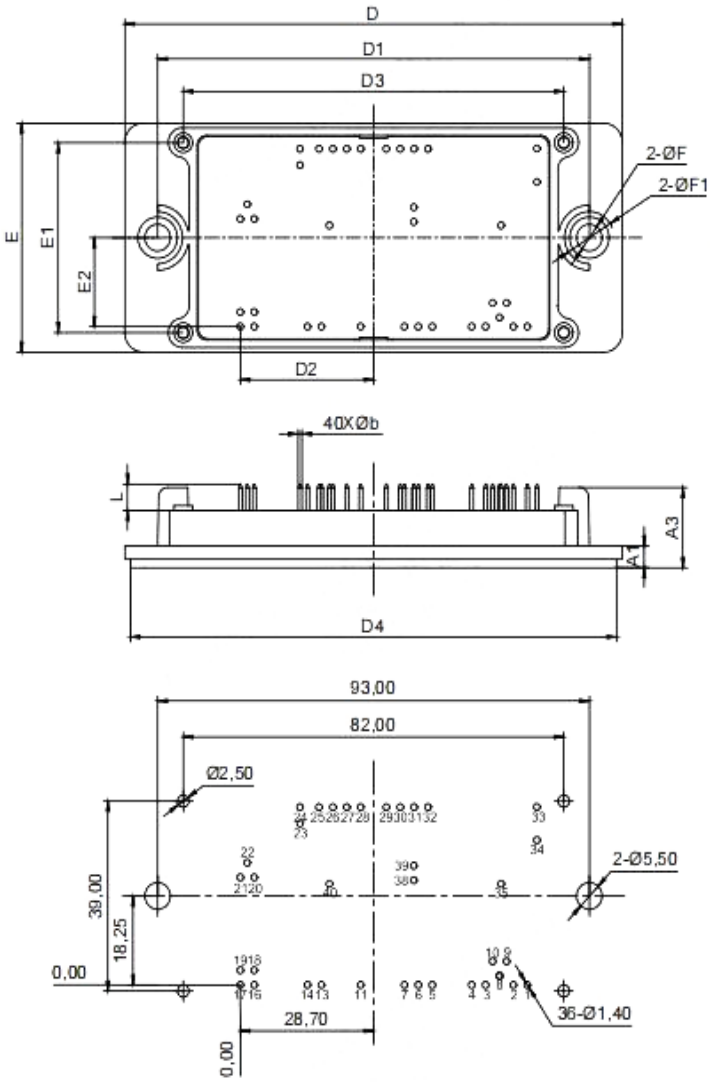


Figure 18. NTC-Themistor-temperature characteristic

Circuit diagram



Package outlines



DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A	16.63	17.23	17.83
A1	4.60	4.70	4.80
A2	11.90	12.00	12.10
A3	16.40	16.70	17.00
b	0.95	1.00	1.05
D	106.80	107.20	107.60
D1	92.90	93.00	93.10
D2	28.40	28.70	29.00
D3	81.80	82.00	82.20
D4	104.35	104.75	105.15
E	46.60	47.00	47.40
E1	38.80	39.00	39.20
E2	17.95	18.25	18.55
E3	44.30	44.40	44.50
F	5.40	5.50	5.60
F1	10.70REF		
L	5.03	5.23	5.43

PIN	PIN POSITION	
	X	Y
1	61.85	0
2	58.85	0
3	52.85	0
4	49.85	0
5	41.35	0
6	38.35	0
7	35.35	0
8	55.85	1.85
9	57.35	4.85
10	54.35	4.85
11	25.95	0
13	17.50	0
14	14.50	0
16	3.00	0
17	0	0
18	3.00	3.00
19	0	3.00
20	3.00	22.10

PIN	PIN POSITION	
	X	Y
21	0.00	22.10
22	1.50	25.10
23	12.85	33.15
24	12.85	36.50
25	16.95	36.50
26	19.95	36.50
27	22.95	36.50
28	25.95	36.50
29	31.45	36.50
30	34.45	36.50
31	37.45	36.50
32	40.45	36.50
33	63.90	36.50
34	63.90	29.70
35	56.20	20.75
38	37.40	21.50
39	37.40	24.50
40	19.20	20.75