

3-Level NPC Inverter Module

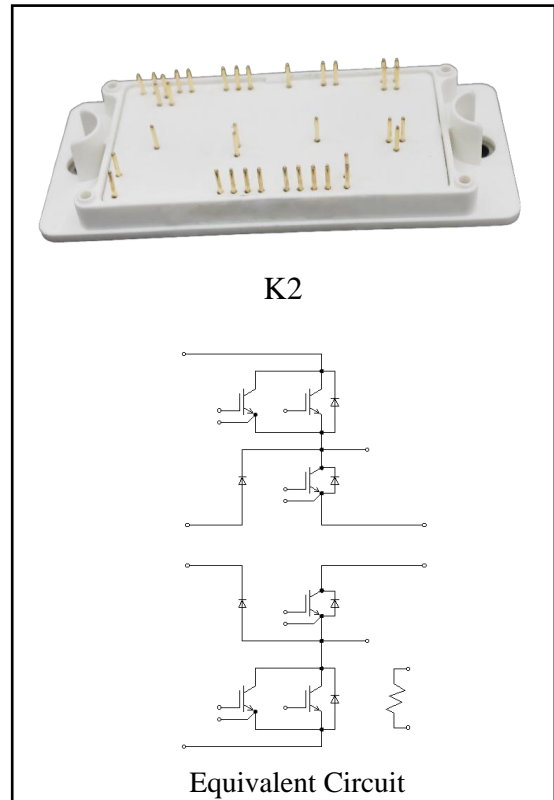
$V_{CES} = 650V, I_{Cnom} = 450A$

Features :

- 650V Trench /Field Stop process
- Low switching losses
- V_{cesat} 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	$T_{vj} = 25^{\circ}C$	V_{CES}	650	V
Continuous DC collector current	$T_c = 80^{\circ}C, T_{vj\ max} = 175^{\circ}C$	I_{cnom}	167	A
Pulsed Collector Current	$T_c = 175^{\circ}C$	I_{cpulse}	500	A
Gate emitter voltage	$T_{vj} = 25^{\circ}C$	V_{GE}	± 20	V

Characteristic Values

Parameter	Conditions	Symbol	Value			Unit
			Min.	Typ.	Max.	
Collector-Emitter saturation voltage	$V_{GE}=15V, I_C=225A$ $T_{vj}=25^{\circ}C$ $V_{GE}=15V, I_C=225A$ $T_{vj}=125^{\circ}C$ $V_{GE}=15V, I_C=225A$ $T_{vj}=150^{\circ}C$	V_{CEsat}		1.65 1.90 2.12	2.20	V
Gate-Emitter Threshold Voltage	$I_C=2.75mA, V_{GE}=V_{CE}$ $T_{vj}=25^{\circ}C$	$V_{GE(th)}$	3.70	4.30	4.90	
Total Gate charge	$V_{CE} = 400 V, I_C = 225 A, V_{GE} = \pm 15 V$	Q_G		750		nC
Input capacitance	$f=100KHz, V_{CE}=25 V, V_{GE}=0 V$ $T_{vj}=25^{\circ}C$	C_{ies}		12.80		nF
Reverse transfer capacitance		C_{res}		0.06		
Collector-emitter cut-off current	$V_{CE}=650V, V_{GE}= 0 V$ $T_{vj}=25^{\circ}C$	I_{CES}			1	mA
Gate-emitter leakage current	$V_{CE}=0 V, V_{GE}= 20 V$ $T_{vj}=25^{\circ}C$	I_{GES}			200	nA
Turn-on delay time	$I_C=200A, V_{CE}=400 V$ $T_{vj}=25^{\circ}C$ $V_{GE}=\pm 15 V, R_G=10\Omega$ $T_{vj}=125^{\circ}C$ (inductive load) $T_{vj}=150^{\circ}C$	$t_{d on}$		60 52 54		ns
Rise time	$I_C=200A, V_{CE}=400 V$ $T_{vj}=25^{\circ}C$ $V_{GE}=\pm 15 V, R_G=10\Omega$ $T_{vj}=125^{\circ}C$ (inductive load) $T_{vj}=150^{\circ}C$	t_r		78 80 76		
Turn-off delay time	$I_C=200A, V_{CE}=400 V$ $T_{vj}=25^{\circ}C$ $V_{GE}=\pm 15 V, R_G=10\Omega$ $T_{vj}=125^{\circ}C$ (inductive load) $T_{vj}=150^{\circ}C$	$t_{d off}$		186 203 210		
Fall time	$I_C=200A, V_{CE}=400 V$ $T_{vj}=25^{\circ}C$ $V_{GE}=\pm 15 V, R_G=10\Omega$ $T_{vj}=125^{\circ}C$ (inductive load) $T_{vj}=150^{\circ}C$	t_f		43 58 64		
Turn-on energy loss per pulse	$I_C=200A, V_{CE}=400 V$ $T_{vj}=25^{\circ}C$ $V_{GE}=\pm 15 V, R_G=10\Omega$ $T_{vj}=125^{\circ}C$ $di/dt=2000A/us(T_{vj}=150^{\circ}C)$ $T_{vj}=150^{\circ}C$ (inductive load)	E_{on}		9.82 11.60 12.43		
Turn-off energy loss per pulse	$I_C=200A, V_{CE}=400 V$ $T_{vj}=25^{\circ}C$ $V_{GE}=\pm 15 V, R_G=10\Omega$ $T_{vj}=125^{\circ}C$ $dv/dt=8500V/us(T_{vj}=150^{\circ}C)$ $T_{vj}=150^{\circ}C$ (inductive load)	E_{off}		2.70 3.73 4.07		mJ
Thermal resistance, junction to case	per IGBT	R_{thJC}		0.25		K/W
Temperature under switching conditions		$T_{vj op}$	-40		150	$^{\circ}C$

IGBT, Q2/Q3

Maximum Ratings

Parameter	Conditions	Symbol	Value	Unit
Collector-Emitter voltage	$T_{vj}=25^{\circ}\text{C}$	V_{CES}	650	V
Continuous DC collector current	$T_c=80^{\circ}\text{C}$, $T_{vj\text{ max}}=175^{\circ}\text{C}$	I_{cnom}	280	A
Pulsed Collector Current	$T_c=175^{\circ}\text{C}$	I_{cpulse}	840	A
Gate emitter voltage	$T_{vj}=25^{\circ}\text{C}$	V_{GE}	± 20	V

Characteristic Values

Parameter	Conditions	Symbol	Value			Unit
			Min.	Typ.	Max.	
Collector-Emitter saturation voltage	$V_{GE}=15\text{V}$, $I_C=375\text{A}$ $T_{vj}=25^{\circ}\text{C}$ $V_{GE}=15\text{V}$, $I_C=375\text{A}$ $T_{vj}=125^{\circ}\text{C}$ $V_{GE}=15\text{V}$, $I_C=375\text{A}$ $T_{vj}=150^{\circ}\text{C}$	V_{CESat}		1.62 1.90 1.97	2.20	V
Gate-Emitter threshold voltage	$I_C=3.75\text{mA}$, $V_{GE}=V_{CE}$ $T_{vj}=25^{\circ}\text{C}$	$V_{GE(th)}$	3.70	4.30	4.90	
Gate charge	$V_{CE}=400\text{V}$, $I_C=375\text{A}$, $V_{GE}=\pm 15\text{V}$	Q_G		1230		nC
Input capacitance	$f=100\text{KHz}$, $V_{CE}=25\text{V}$, $V_{GE}=0\text{V}$ $T_{vj}=25^{\circ}\text{C}$	C_{ies}		21.2		nF
Reverse transfer capacitance		C_{res}		0.10		
Collector-emitter cut-off current	$V_{CE}=650\text{V}$, $V_{GE}=0\text{V}$ $T_{vj}=25^{\circ}\text{C}$	I_{CES}			1	mA
Gate-emitter leakage current	$V_{CE}=0\text{V}$, $V_{GE}=20\text{V}$ $T_{vj}=25^{\circ}\text{C}$	I_{GES}			200	nA
Turn-on delay time	$I_C=200\text{A}$, $V_{CE}=400\text{V}$ $T_{vj}=25^{\circ}\text{C}$ $V_{GE}=\pm 15\text{V}$, $R_G=30\Omega$ $T_{vj}=125^{\circ}\text{C}$ (inductive load) $T_{vj}=150^{\circ}\text{C}$	$t_{d\ on}$		278 236 215		ns
Rise time	$I_C=200\text{A}$, $V_{CE}=400\text{V}$ $T_{vj}=25^{\circ}\text{C}$ $V_{GE}=\pm 15\text{V}$, $R_G=30\Omega$ $T_{vj}=125^{\circ}\text{C}$ (inductive load) $T_{vj}=150^{\circ}\text{C}$	t_r		150 154 157		

Turn-off delay time	$I_C=200A, V_{CE}=400V$ $V_{GE}=\pm 15V, R_G=30\Omega$ (inductive load)	$T_{vj}=25^\circ C$ $T_{vj}=125^\circ C$ $T_{vj}=150^\circ C$	$t_{d\ off}$		726 774 788		
Fall time	$I_C=200A, V_{CE}=400V$ $V_{GE}=\pm 15V, R_G=30\Omega$ (inductive load)	$T_{vj}=25^\circ C$ $T_{vj}=125^\circ C$ $T_{vj}=150^\circ C$	t_f		70 73 75		
Turn-on energy loss per pulse	$I_C=200A, V_{CE}=400V$ $V_{GE}=\pm 15V, R_G=30\Omega$ $di/dt=1000A/\mu s(T_{vj}=150^\circ C)$ (inductive load)	$T_{vj}=25^\circ C$ $T_{vj}=125^\circ C$ $T_{vj}=150^\circ C$	E_{on}		14.10 15.00 15.30		mJ
Turn-off energy loss per pulse	$I_C=200A, V_{CE}=400V$ $V_{GE}=\pm 15V, R_G=30\Omega$ $dv/dt=3800V/\mu s(T_{vj}=150^\circ C)$ (inductive load)	$T_{vj}=25^\circ C$ $T_{vj}=125^\circ C$ $T_{vj}=150^\circ C$	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	$^\circ C$

Diode, D1/D2/D3/D4

Maximum Ratings

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

Characteristic Values

Parameter	Conditions	Symbol	Value			Unit
			Min.	Typ.	Max.	
Forward voltage	$I_F=120A, V_{GE}=0V$ $I_F=120A, V_{GE}=0V$ $I_F=120A, V_{GE}=0V$	$T_{vj}=25^\circ C$ $T_{vj}=125^\circ C$ $T_{vj}=150^\circ C$	V_F		1.60 1.70 1.75	2.00 V
Peak reverse recovery current	$I_F=200A,$ $-di_F/dt=1000A/\mu s$ $V_R=400V, V_{GE}=-15V$	$T_{vj}=25^\circ C$ $T_{vj}=125^\circ C$ $T_{vj}=150^\circ C$	I_{RM}		45 51 58	A

Reverse Recovery Time	IF=200A, -diF/dt=1000A/μs(Tvj=150°C) VR=400V, VGE=-15 V	Tvj=125°C Tvj=150°C	Trr		148 210 223		ns
Recovered charge	IF=200A, -diF/dt=1000A/μs(Tvj=150°C) VR=400V, VGE=-15 V	Tvj=125°C Tvj=150°C	Qrr		3.30 5.78 6.90		μC
Reverse recovered energy	IF=200A, -diF/dt=1000A/μs(Tvj=150°C) VR=400V, VGE=-15 V	Tvj=125°C Tvj=150°C	Erec		0.46 0.94 1.16		mJ
Thermal resistance, junction to case	per diode		RthJC		0.39		K/W
Temperature under switching conditions			Tvj op	-40		150	°C

Diode, D5/D6

Maximum Ratings

Parameter	Conditions	Symbol	Value	Unit
Repetitive peak reverse voltage	Tvj=25°C	VRRM	650	V
Continuous DC forward current	Tc=80°C, Tvj max=175°C	IF	220	A
Repetitive peak forward current	tp=1ms	IFRM	630	A
I ² t-value	VR = 0 V, tp = 10 ms, Tvj = 125°C	I ² t	7000	A ² S

Characteristic Values

Parameter	Conditions	Symbol	Value			Unit
			Min.	Typ.	Max.	
Forward voltage	IF=375A, VGE=0V IF=375A VGE=0V IF=375A, VGE=0V	Tvj=25°C Tvj=125°C Tvj=150°C	VF	1.60 1.70 1.75	2.00	V
Peak reverse recovery current	IF=200A, -diF/dt=2000A/μs(Tvj=150°C) VR=400V, VGE=-15V	Tvj=25°C Tvj=125°C Tvj=150°C	IRM	58 77 90		A
Reverse Recovery Time	IF=200A, -diF/dt=2000A/μs(Tvj=150°C) VR=400V, VGE=-15V	Tvj=25°C Tvj=125°C Tvj=150°C	Trr	142 174 180		ns

Recovered charge	$I_F=200A$, $-di_F/dt=2000A/\mu s(T_{vj}=150^\circ C)$ $V_R=400V, V_{GE}=-15V$	$T_{vj}=25^\circ C$ $T_{vj}=125^\circ C$ $T_{vj}=150^\circ C$	Q_{rr}		4.08 8.12 9.90		μC
Reverse recovered energy	$I_F=200A$, $-di_F/dt=2000A/\mu s(T_{vj}=150^\circ C)$ $V_R=400V, V_{GE}=-15V$	$T_{vj}=25^\circ C$ $T_{vj}=125^\circ C$ $T_{vj}=150^\circ C$	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	$^\circ C$

NTC-Thermistor

Characteristic Values

Parameter	Conditions	Value			Unit
R25	T=25 $^\circ C$		22		K Ω
$\Delta R/R$		-5		5	%
B-value	B (25/50), tolerance $\pm 3\%$		3950		K
B-value	B (25/100), tolerance $\pm 3\%$		3998		K

Module

Parameter	Conditions	Symbol	Value			Unit
Isolation test voltage	RMS, f=50Hz, t=1min	V_{ISOL}	3200			V
Internal isolation			Al ₂ O ₃			
Storage temperature		T_{stg}	-40		125	$^\circ C$
Mounting torque for modul mounting		M	2.0		5.0	Nm
Weight		W		177		g

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

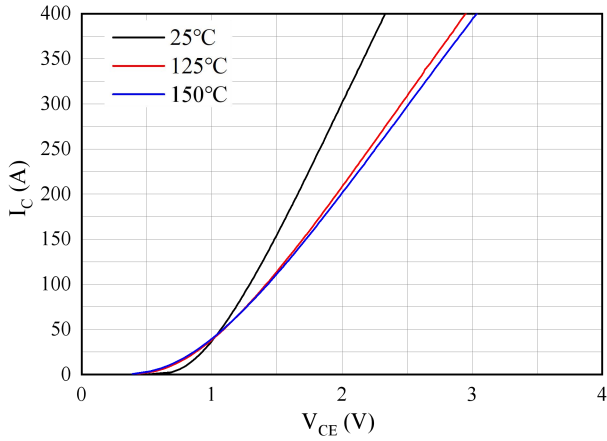


Fig1. Typical output characteristics ($V_{GE}=15V$)

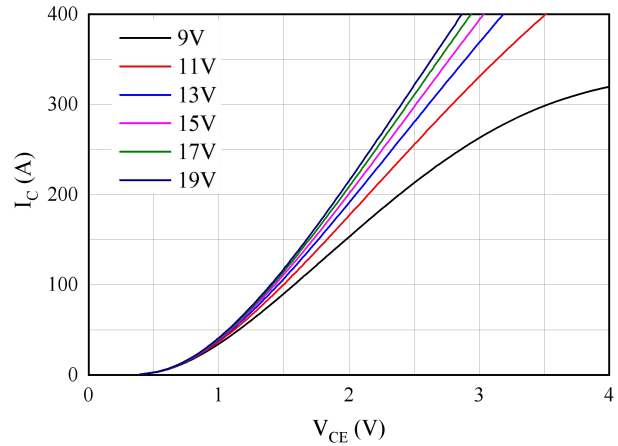


Fig2. Typical output characteristics ($T_{vj}=150^{\circ}C$)

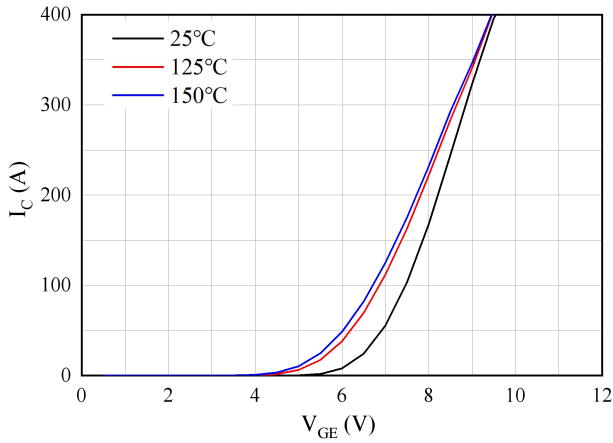


Fig3. Typical transfer characteristic ($V_{CE}=20V$)

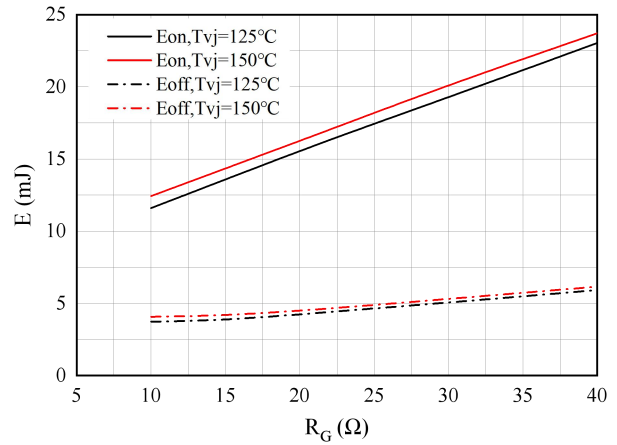


Fig4. Switching losses of IGBT

$V_{GE} = \pm 15V, I_C = 200A, V_{CE} = 400V$

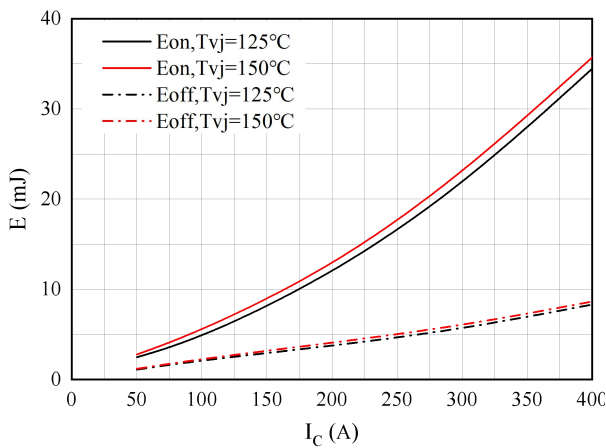


Fig5. Switching losses of IGBT s

$V_{GE} = \pm 15V, R_g = 10\Omega, V_{CE} = 400 V$

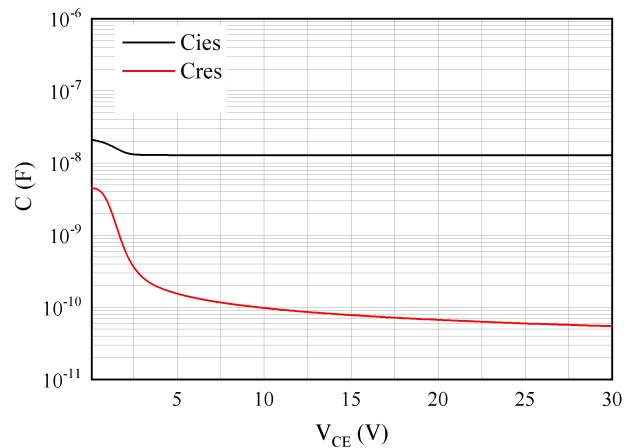


Fig6. Capacitance characteristic

$f = 100 \text{ kHz}, V_{GE} = 0 V, T_{vj} = 25^{\circ}C$

IGBT, Q2/Q3

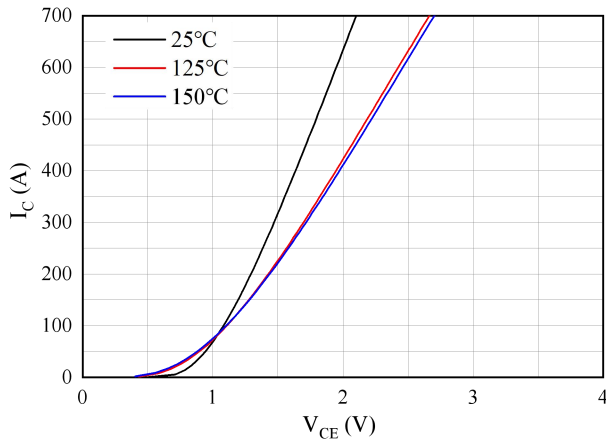


Fig 7. Typical output characteristics ($V_{GE}=15V$)

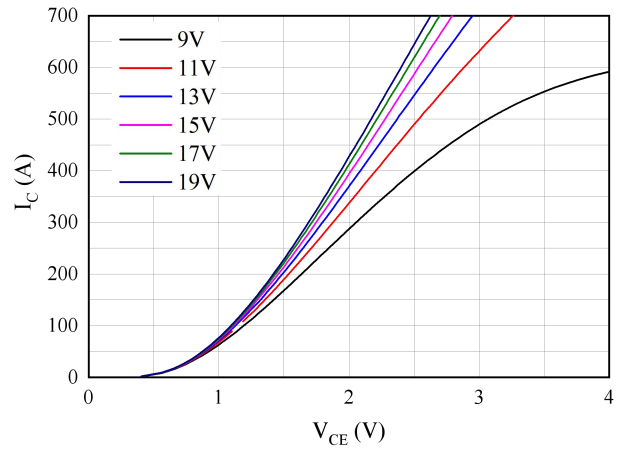


Fig 8. Typical output characteristics ($T_{vj}=150^{\circ}C$)

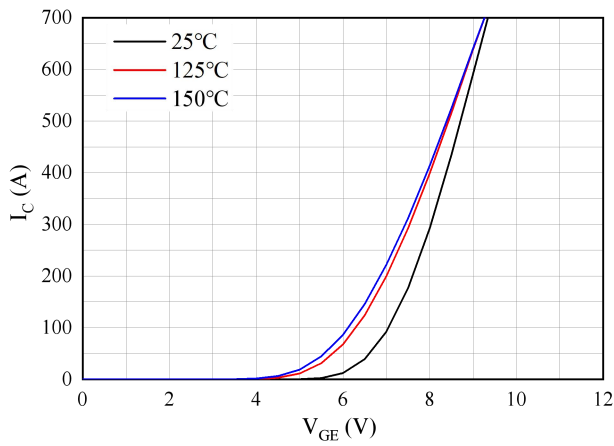


Fig 9. Typical transfer characteristic ($V_{CE}=20V$)

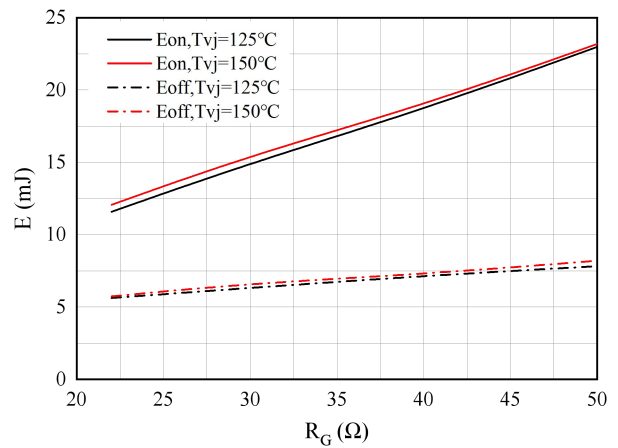


Fig 10. Switching losses of IGBT

$V_{GE} = \pm 15V, I_C = 200A, V_{CE} = 400V$

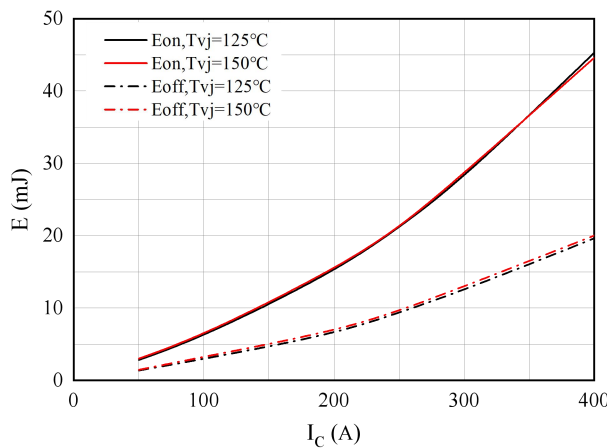


Fig 11. Switching losses of IGBT

$V_{GE} = \pm 15V, R_g = 30\Omega, V_{CE} = 400V$

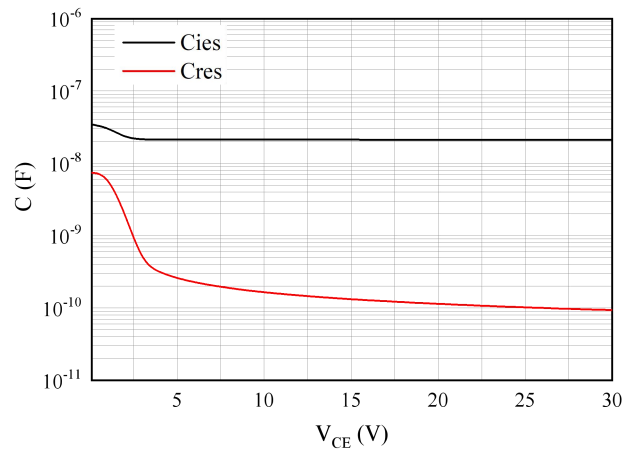


Fig 12. Capacitance characteristic

$f = 100\text{ kHz}, V_{GE} = 0V, T_{vj} = 25^{\circ}C$

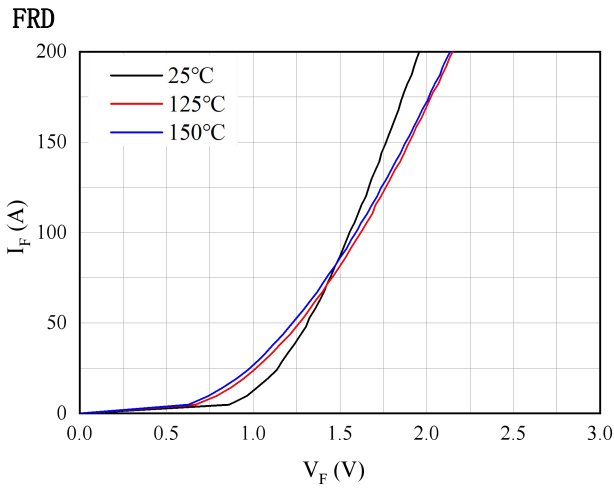


Fig 13 Forward characteristic of Diode (D1/D2/D3/D4)

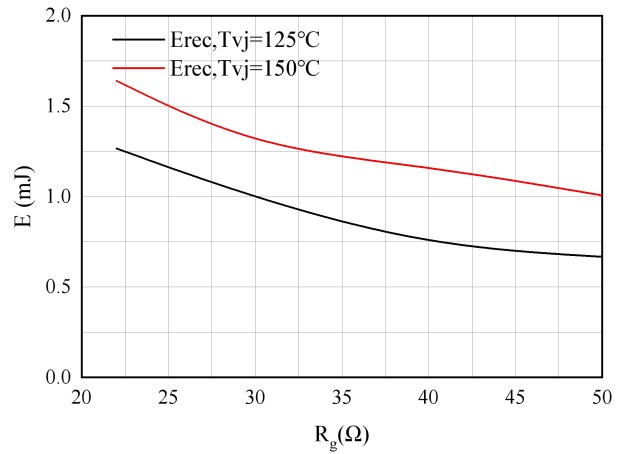


Fig 14. Reverse Recovery Energy (D1/D2/D3/D4)
 $I_F = 200A, V_{CE} = 400V$

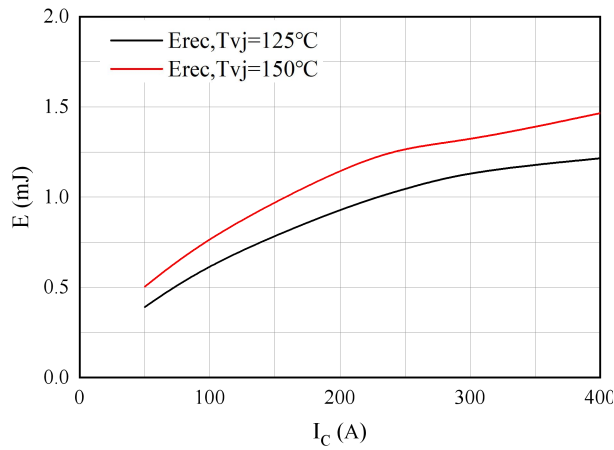


Fig 15. Reverse Recovery Energy (D1/D2/D3/D4)
 $R_g = 30 \mu s, V_{CE} = 400V$

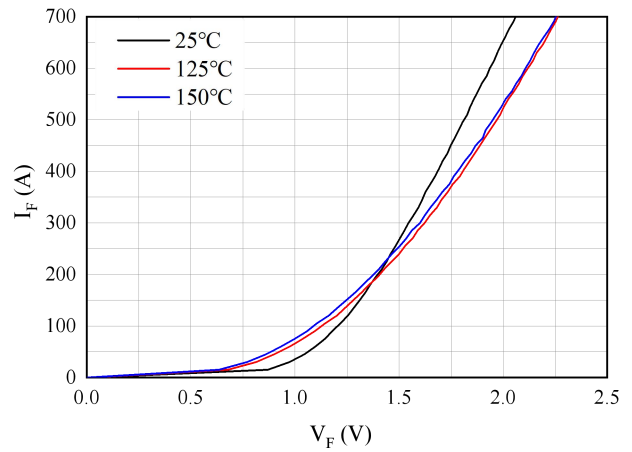


Fig 16 Forward characteristic of Diode (D5/D6)

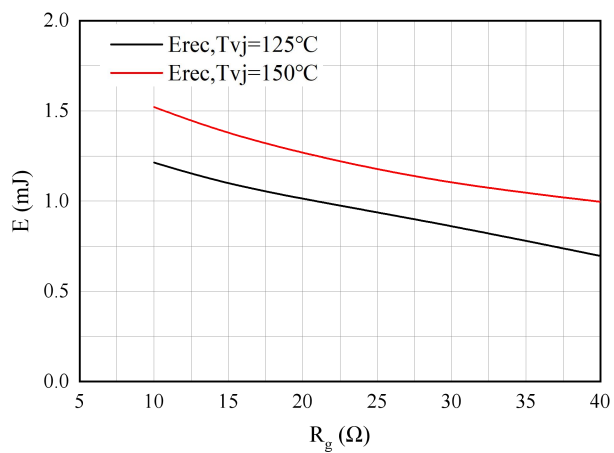


Fig 16. Reverse Recovery Energy
 $I_F = 200A, V_{CE} = 400V$

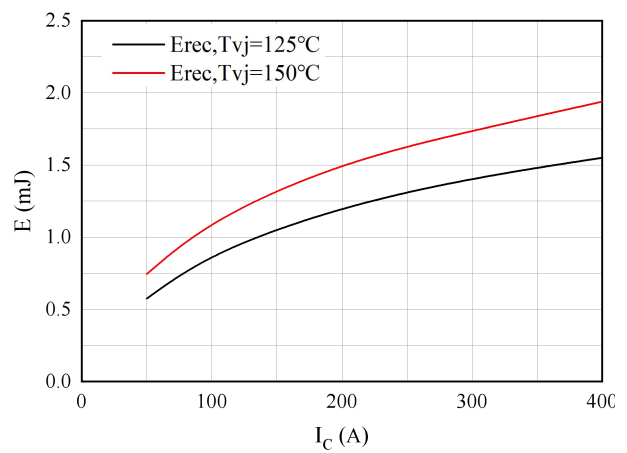


Fig 17. Reverse Recovery Energy
 $R_g = 10 \mu s, V_{CE} = 400V$

NTC

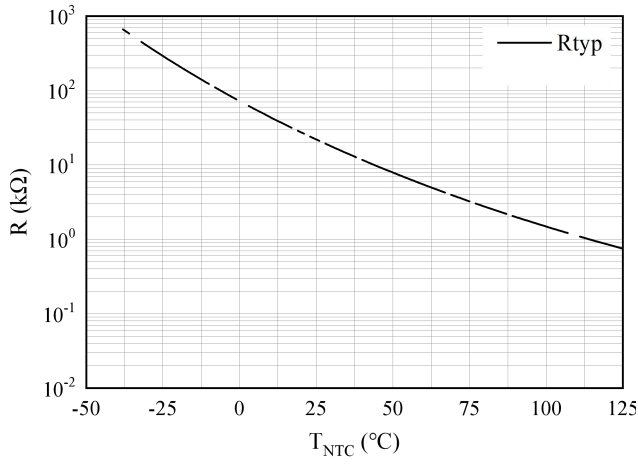
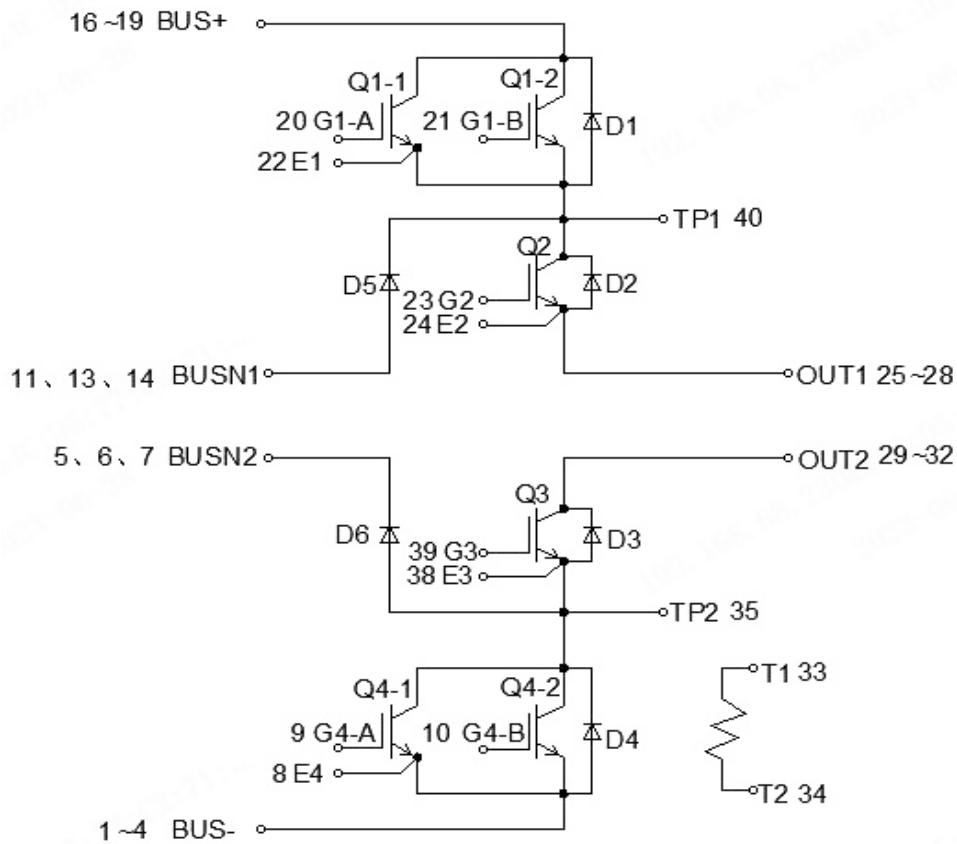
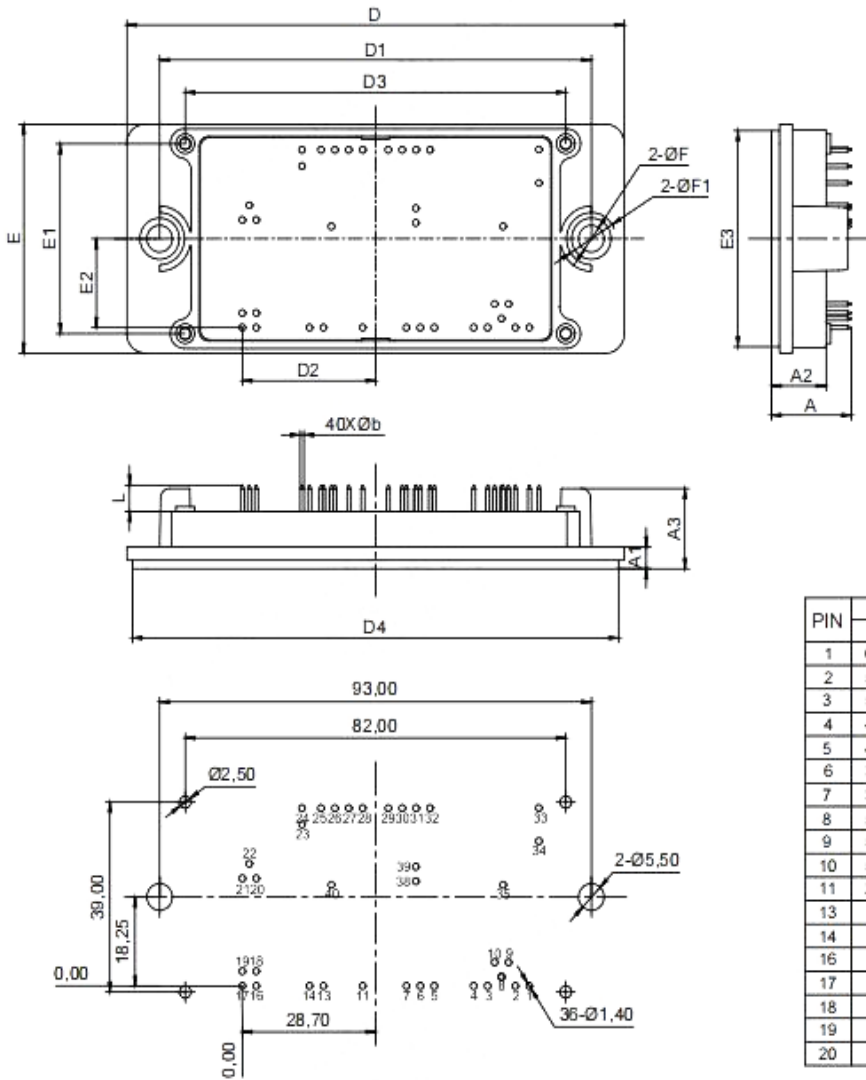


Figure 18. NTC-Themistor-temperature characteristic

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