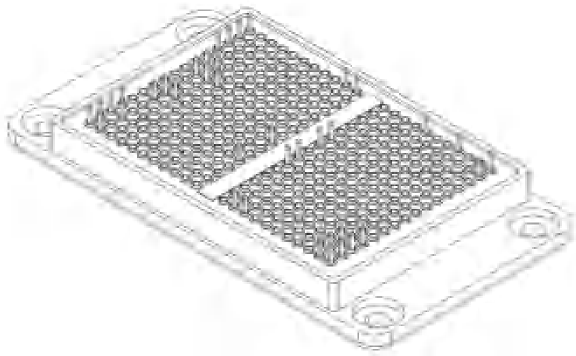
Features

- Neutral Point Clamped Three−Level Inverter Module
- Low Inductive Layout
- Solderable Pins



Benefits

- Higher System Efficiency
- Reduced Cooling Requirements
- Low Conduction Losses Over Temperature

Applications

- Three-level applications
- High-frequency switching application
- Solar applications

Table 1 Absolute Maximum Ratings (Ta = 25 °C)

Parameter	Symbol	Value	Unit
IGBT (T1, T4, T5, T6)			
Collector−Emitter Voltage	V_{CES}	1000	V
Gate−Emitter Voltage	V_{GE}	±20	V
Continuous Collector Current	I_C	200	A
Pulsed Collector Current (t_p=1ms)	I_{CM}	400	A
Junction Temperature	T_j	-40 to +175	°C
MOSFET (M2, M3)			
Drain−Source Voltage	V_{DSS}	1200	V
Gate−Source Voltage	V_{GS}	-10/22	V
Continuous Drain Current	I_D	600	A
Repetitive Peak Drain Current (tp limited by T_{vjmax})	I_{DRM}	1200	A
Junction Temperature	T_j	-40 to +175	°C
DIODE (D1, D4)			
Peak Repetitive Reverse Voltage	V_{RRM}	1000	V
Continuous Forward Current	I_F	400	A
Diode Maximum Forward Current(t_p=1ms)	I_{FM}	800	A
Junction Temperature	T_j	-40 to +175	°C
DIODE (D5,D6)			
Peak Repetitive Reverse Voltage	V_{RRM}	1000	V
Continuous Forward Current	I_F	200	A
Diode Maximum Forward Current(t_p=1ms)	I_{FM}	400	A
Junction Temperature	T_j	-40 to +175	°C
INSULATION PROPERTIES			
Isolation Test Voltage, t = 1 s, 50 Hz	Viso	4000	V_{RMS}
RECOMMENDED TEMPERATURE			
Storage Temperature	T_{stg}	-40 to +125	°C
Operating Temperature	T_{vjop}	-40 to +150	°C

Table 2 Characteristics Values

IGBT (T1, T4)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Collector−Emitter Saturation Voltage	$V_{CE(sat)}$	V_{GE} = 15 V, I_C = 200 A	T_j = 25°C	-	1.29	-	V
		V_{GE} = 15 V, I_C = 200 A	T_j= 150°C	-	1.41	-	
Gate−Emitter Threshold Voltage	$V_{GE(TH)}$	V_{GE} = V_{CE}, I_C = 9 mA	T_j = 25°C	-	5.18	-	V
Total Gate Charge	Q_g	V_{GE} = -7/+15 V, V_{CE} = 600 V	T_j = 25°C	-	2.1	-	μC
Gate- Emitter Leakage Current	I_{GES}	V_{GE} = ±20 V, V_{CE} = 0 V	T_j = 25°C	-100	-	100	nA
Collector−Emitter Voltage	$V_{(BR)CES}$	V_{GE} = 0 V	T_j = 25°C	1000	-	-	V
Collector−Emitter Cutoff Current	I_{CES}	V_{CE} = 1000 V, V_{GE} = 0 V	T_j = 25°C	-	-	100	μA
Input Capacitance	C_{ies}	V_{GE} = 0 V, V_{CE} = 675 V, f = 100 KHz	T_j = 25°C	-	27.8	-	nF
Output Capacitance	C_{oes}		T_j = 25°C	-	0.37	-	
Reverse Transfer Capacitance	C_{res}		T_j = 25°C	-	0.04	-	
Turn-on Delay Time(inductive load)	$t_{d\ on}$	V_{GE} = -7 V / +15 V, V_{CE} = 675 V, I_C = 200 A, R_{Gon} = 10 Ω, R_{Goff} = 20 Ω	T_j = 25°C	-	230	-	ns
			T_j = 150°C	-	235.2	-	
Rise Time (inductive load)	t_r		T_j = 25°C	-	46.89	-	
			T_j = 150°C	-	48.5	-	
Turn-off Delay Time(inductive load)	$t_{d\ off}$		T_j = 25°C	-	1417	-	
			T_j = 150°C	-	1617	-	
Fall Time (inductive load)	t_f		T_j = 25°C	-	98.64	-	
			T_j = 150°C	-	154.4	-	
Turn-on Switching Loss	E_{on}		T_j = 25°C	-	26.37	-	mJ
			T_j = 150°C	-	29.5	-	
Turn-off Switching Loss	E_{off}		T_j = 25°C	-	10	-	
			T_j = 150°C	-	17.2	-	
Thermal Resistance − Chip−to−Case	R_{thJC}	Per IGBT		-	0.241	-	°C/W

IGBT (T5, T6)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Collector−Emitter Saturation Voltage	$V_{CE(sat)}$	V_{GE} = 15 V, I_C = 200 A	T_j = 25°C	-	1.30	-	V
		V_{GE} = 15 V, I_C = 200 A	T_j= 150°C	-	1.42	-	
Gate−Emitter Threshold Voltage	$V_{GE(TH)}$	V_{GE} = V_{CE}, I_C = 9 mA	T_j = 25°C	-	5.2	-	V
Total Gate Charge	Q_g	V_{GE} = -7/+15 V, V_{CE} = 600 V	T_j = 25°C	-	2.13	-	μC
Gate- Emitter Leakage Current	I_{GES}	V_{GE} = ±20 V, V_{CE} = 0 V	T_j = 25°C	-100	-	100	nA
Collector−Emitter Voltage	$V_{(BR)CES}$	V_{GE} = 0 V	T_j = 25°C	1000	-	-	V
Collector−Emitter Cutoff Current	I_{CES}	V_{CE} = 1000 V, V_{GE} = 0 V	T_j = 25°C	-	-	100	μA
Input Capacitance	C_{ies}	V_{GE} = 0 V, V_{CE} = 675 V, f = 100 KHz	T_j = 25°C	-	28.34	-	nF
Output Capacitance	C_{oes}		T_j = 25°C	-	1.25	-	
Reverse Transfer Capacitance	C_{res}		T_j = 25°C	-	0.047	-	
Turn-on Delay Time(inductive load)	$t_{d\ on}$	V_{GE} = -7 V / +15 V, V_{CE} = 675 V, I_C = 200 A, R_{Gon} = 10 Ω, R_{Goff} = 20 Ω	T_j = 25°C	-	242	-	ns
			T_j = 150°C	-	237.4	-	
Rise Time (inductive load)	t_r		T_j = 25°C	-	44	-	
			T_j = 150°C	-	51.94	-	
Turn-off Delay Time(inductive load)	$t_{d\ off}$		T_j = 25°C	-	1665	-	
			T_j = 150°C	-	1633	-	
Fall Time (inductive load)	t_f		T_j = 25°C	-	74.8	-	
			T_j = 150°C	-	145	-	
Turn-on Switching Loss	E_{on}		T_j = 25°C	-	32.86	-	mJ
			T_j = 150°C	-	39.85	-	
Turn-off Switching Loss	E_{off}		T_j = 25°C	-	11.55	-	
			T_j = 150°C	-	19.2	-	
Thermal Resistance − Chip−to−Case	R_{thJC}	Per IGBT		-	0.241	-	°C/W

MOSFET M2 / M3

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Drain-source on-state resistance	$R_{DS(on)}$	I_D = 330 A	V_{GS} =18V T_j = 25°C	-	2.6	-	mΩ
			V_{GS} =18V T_j = 150°C		4.2		
Gate Threshold Voltage	$V_{GS(TH)}$	V_{GE} = V_{CE}, I_C = 9 mA	T_j = 25°C	-	3.6	-	V
Total Gate Charge	Q_g	V_{GE} = -5/+18 V, V_{CE} = 600 V	T_j = 25°C	-	1.09	-	μC
Gate-Source Leakage Current	I_{GES}	V_{GE} = ±20 V, V_{CE} = 0 V	T_j = 25°C	-100	-	100	nA
Drain−Source Voltage	$V_{(BR)CES}$	V_{GE} = 0 V	T_j = 25°C	1200	-	-	V
Drain−Source Cutoff Current	I_{CES}	V_{CE} = 1200 V, V_{GE} = 0 V	T_j = 25°C	-	-	100	μA
Input Capacitance	C_{iss}	V_{GE} = 0 V, V_{CE} = 675 V, f = 100KHz	T_j = 25°C	-	32.8	-	nF
Output Capacitance	C_{oss}		T_j = 25°C	-	1.36	-	
Reverse Transfer Capacitance	C_{rss}		T_j = 25°C	-	0.03	-	
Turn-on Delay Time(inductive load)	$t_{d\ on}$	V_{GE} = -7 V / +15 V, V_{CE} = 675 V, I_C = 330 A, R_{Gon} = 2.0 Ω, R_{Goff} = 16 Ω	T_j = 25°C	-	88	-	ns
			T_j = 150°C	-	69	-	
Rise Time (inductive load)	t_r		T_j = 25°C	-	42.9	-	
			T_j = 150°C	-	35.17	-	
Turn-off Delay Time(inductive load)	$t_{d\ off}$		T_j = 25°C	-	530	-	
			T_j = 150°C	-	1530	-	
Fall Time (inductive load)	t_f	V_{GE} = -7 V / +15 V, V_{CE} = 675 V, I_C = 330 A, R_{Gon} = 2.0 Ω, R_{Goff} = 16Ω	T_j = 25°C	-	78.2	-	ns
			T_j = 150°C	-	69	-	
Turn-on Switching Loss	E_{on}		T_j = 25°C	-	7.6	-	mJ
			T_j = 150°C	-	6.0	-	
Turn-off Switching Loss	E_{off}		T_j = 25°C	-	17.15	-	
			T_j = 150°C	-	20.58	-	
Thermal Resistance − Chip−to−Case	R_{thJC}	Per MOS		-	0.118	-	°C/W

DIODE (D1, D4)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Diode Forward Voltage	V_F	I_F = 200 A	T_j = 25°C	-	1.25	-	V
		I_F = 200 A	T_j = 150°C	-	1.26	-	
Reverse Recovery Time	t_{RR}	V_{GE} = -5 V / +18 V, V_{CE} = 675 V, I_C = 330 A, R_{Gon} = 2.0 Ω, R_{Goff} = 16 Ω	T_j = 25°C	-	263	-	ns
			T_j = 150°C	-	340	-	
Reverse Recovery Charge	Q_{RR}		T_j = 25°C	-	40	-	µC
			T_j = 150°C	-	67.25	-	
Peak Reverse Recovery Current	I_{RRM}		T_j = 25°C	-	288	-	A
			T_j = 150°C	-	336	-	
Reverse Recovery Energy	E_{REC}		T_j = 25°C	-	15.66	-	mJ
			T_j = 150°C	-	29.68	-	
Thermal Resistance – Chip–to–Case	R_{thJC}	Per diode		-	0.276	-	°C/W

DIODE (D2,D3)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Diode Forward Voltage	V_{SD}	I_F = 300 A, V_{GE} = -5 V	T_j = 25°C	-	4.7	-	V
			T_j = 150°C	-	4.27	-	
Reverse Recovery Time	t_{RR}	V_{GE} = -5 V / +18 V, V_{CE} = 675 V, I_C = 330 A, R_{Gon} = 2.0 Ω, R_{Goff} = 16 Ω	T_j = 25°C	-	25.78	-	ns
			T_j = 150°C	-	30.89	-	
Reverse Recovery Charge	Q_{RR}		T_j = 25°C	-	1.76	-	µC
			T_j = 150°C	-	2.46	-	
Peak Reverse Recovery Current	I_{RRM}		T_j = 25°C	-	122	-	A
			T_j = 150°C	-	141	-	
Reverse Recovery Energy	E_{REC}		T_j = 25°C	-	1.24	-	mJ
			T_j = 150°C	-	1.92	-	

DIODE (D5,D6)

Diode Forward Voltage	V_F	I_F = 200 A	T_j = 25°C	-	1.39	-	V
		I_F = 200 A	T_j = 150°C	-	1.45	-	
Reverse Recovery Time	t_{RR}	V_{GE} = -7 V / +15 V, V_{CE} = 675 V, I_C = 330 A, R_{Gon} = 2.0 Ω, R_{Goff} = 18 Ω	T_j = 25°C	-	297	-	ns
			T_j = 150°C	-	406	-	
Reverse Recovery Charge	Q_{RR}		T_j = 25°C	-	31.6	-	μC
			T_j = 150°C	-	50.99	-	
Peak Reverse Recovery Current	I_{RRM}		T_j = 25°C	-	250	-	A
			T_j = 150°C	-	280	-	
Reverse Recovery Energy	E_{REC}		T_j = 25°C	-	13.5	-	mJ
			T_j = 150°C	-	24.37	-	
Thermal Resistance − Chip−to−Case	R_{thJC}	Per diode		-	0.276	-	°C/W

Table 3 NTC-Thermistor

Parameter	Symbol	Min	Typ.	Max	Unit	Conditions
Rated resistance	R_{25}	-	5	-	kΩ	T_C = 25°C
Deviation of R100	ΔR/R	-5	-	5	%	T_C = 100°C, R_{100} = 493 Ω
B-value	$B_{25/50}$	-	3375	-	K	$R_2 = R_{25}$ exp [$B_{25/50}$(1/T_2-1/(298,15K))]

Table 4 Module Characteristics

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Mounting Torque Screw:M5	M		3.0	-	5.0	N.m
Creepage Distance		terminal to heatsink		16.2		
Clearance		terminal to heatsink		15.2		
CTI				≥600		

Typical Characteristics

Fig.1 Typical output characteristics IGBT
V_{GE} = 15 V (T1, T4)

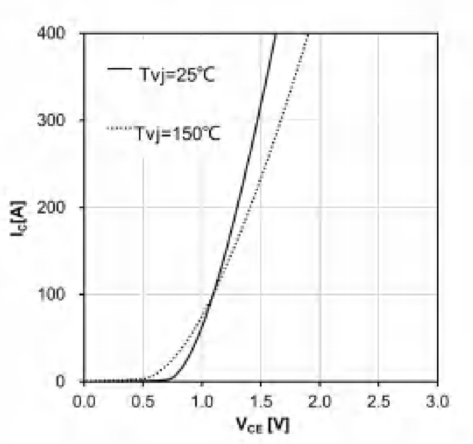


Fig.2 Typical output characteristics IGBT
Tvj = 150°C (T1, T4)

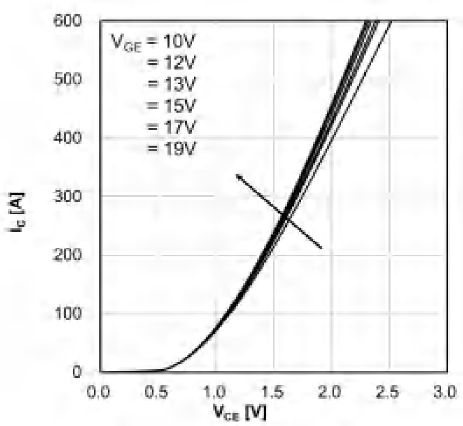


Fig.3 Typical output characteristics MOSFET
V_{GE} = 18 V (M2, M3)

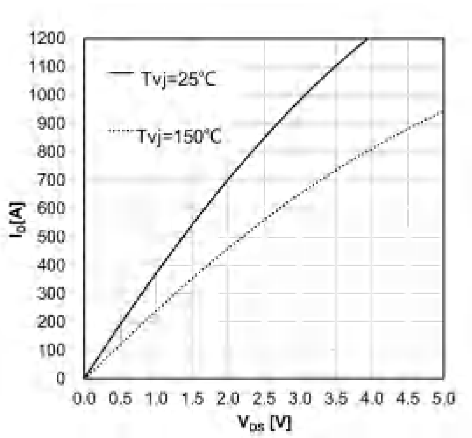


Fig.4 Typical output characteristics MOSFET
Tvj = 150°C (M2, M3)

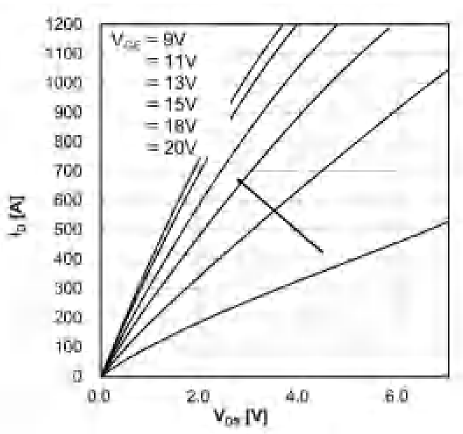


Fig.5 Typical output characteristics IGBT
V_{GE} = 15 V (T5, T6)

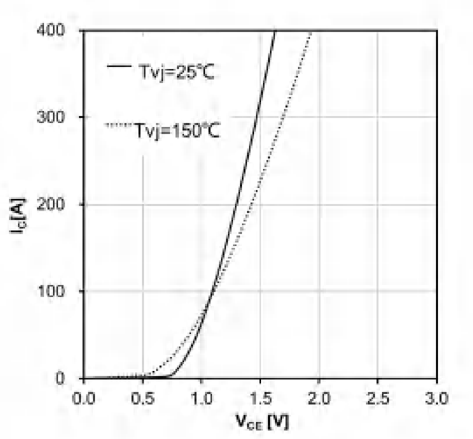


Fig.6 Typical output characteristics IGBT
Tvj = 150°C (T5, T6)

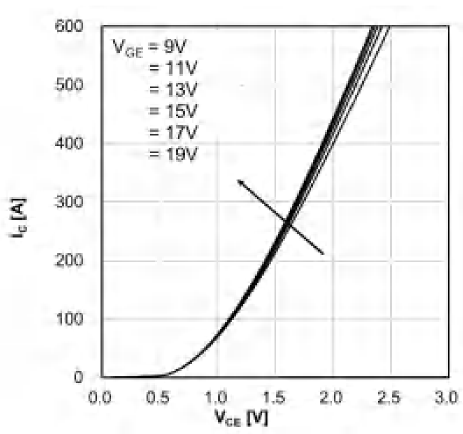


Fig.7 Diode forward characteristics (D1/D4)

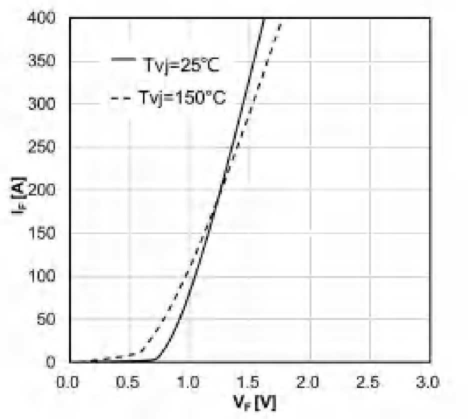


Fig.8 Diode forward characteristics (D5/D6)

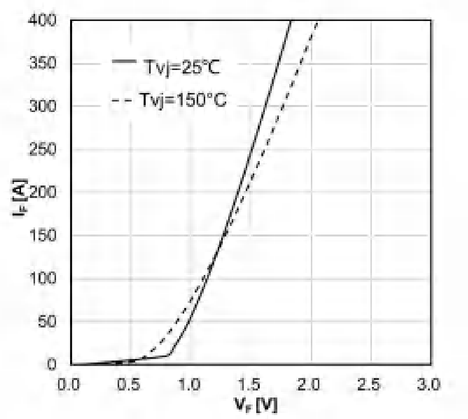


Fig.9 Reverse voltage of MOSFET (M2 / M3)

$I_D = f(V_{DS})$, V_{GS} = 18V

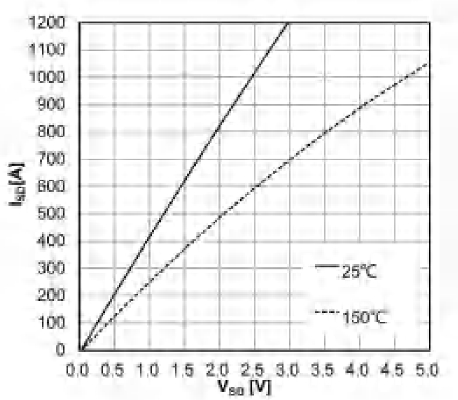


Fig.10 Reverse voltage of MOSFET（M2 / M3）

$I_D = f(V_{DS})$, V_{GS} = 0V

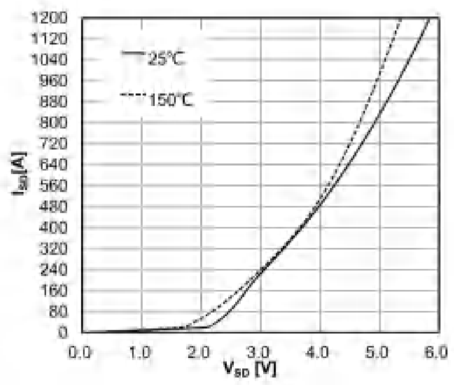


Fig.11 Reverse voltage of MOSFET (M2 / M3)

$I_D = f(V_{DS})$, V_{GS} = -5V

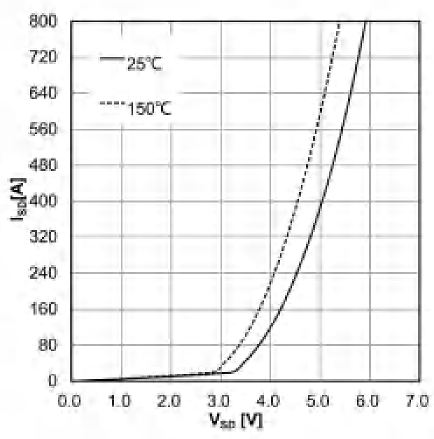


Fig.12 Capacity characteristic

C = f (V_{CE}), V_{GE} = 0 V, Tvj = 25°C, f = 100 KHz

(T1, T4)

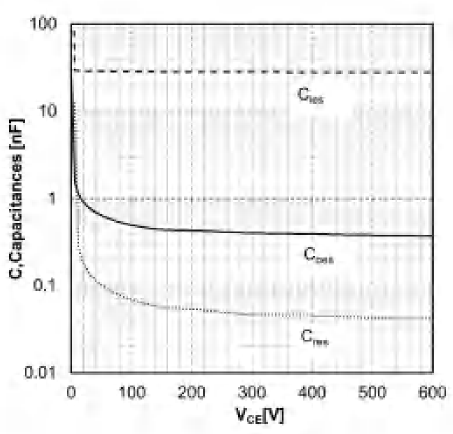


Fig.13 Capacity characteristic
C = f (V_{CE}), V_{GE} = 0 V, Tvj = 25°C, f = 100 KHz
(T5, T6)

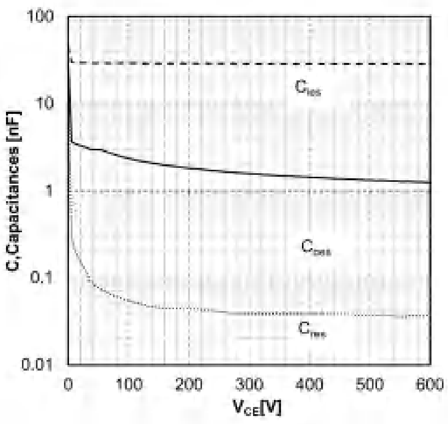
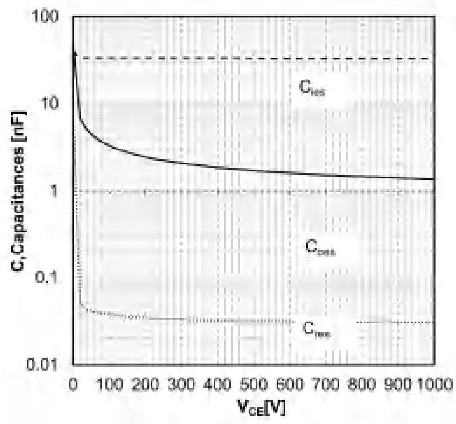


Fig.14 Capacity characteristic
C = f (Vds), V_{GS} = 0 V, Tvj = 25°C, f = 100 KHz
(M2, M3)



Typical Output Characteristic, IGBT, Inverter

Fig.15 Typical output characteristics IGBT
IC = f (VGE) (T1, T4)
VCE = 20V

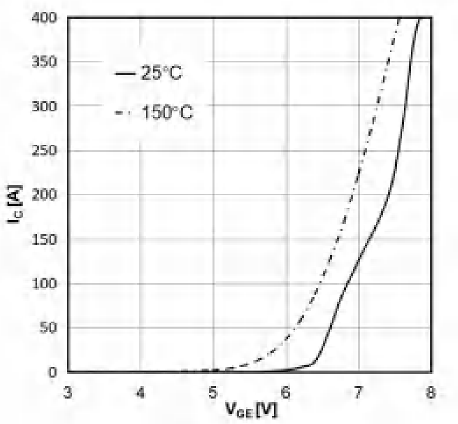


Fig.16 Typical output characteristicsSIC MOSFET
IC = f (VGE) (M2, M3)
VCE = 20V

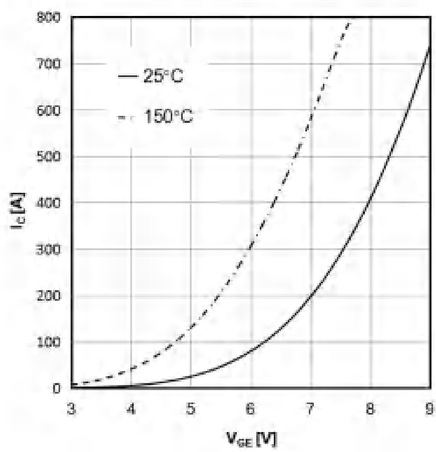
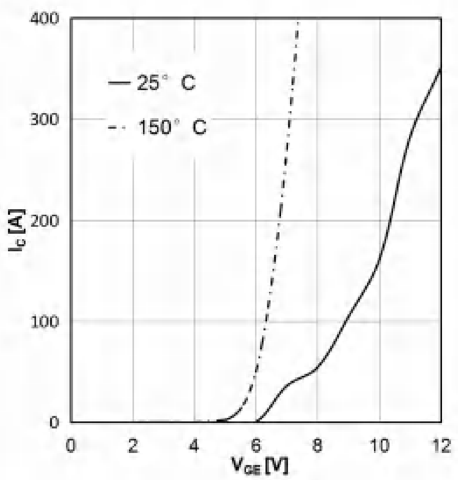


Fig.17 Typical output characteristics IGBT
IC = f (VGE) (T5, T6)
VCE = 20V



T1 || D5 or T4 || D6

Fig.18 Switching losses IGBT, (typical)
E_{on} = f (I_C), E_{off} = f (I_C),
V_{GE} = +15 V / -7 V, R_{Gon} = 10 Ω, R_{Goff} = 20Ω,
V_{DC}= 675 V

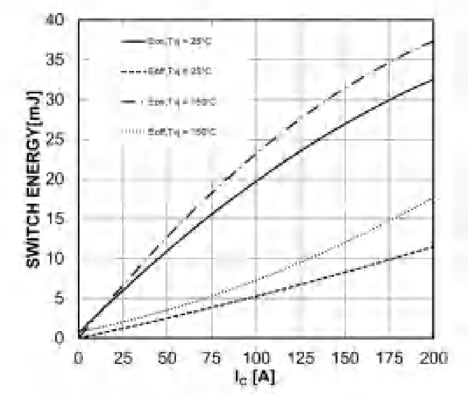


Fig.19 Switching losses Diode, (typical)
E_{REC} = f (I_F),
V_{GE} = +15 V / -7 V, R_{Gon} = 10 Ω, R_{Goff} = 20 Ω,
V_{DC} =675 V

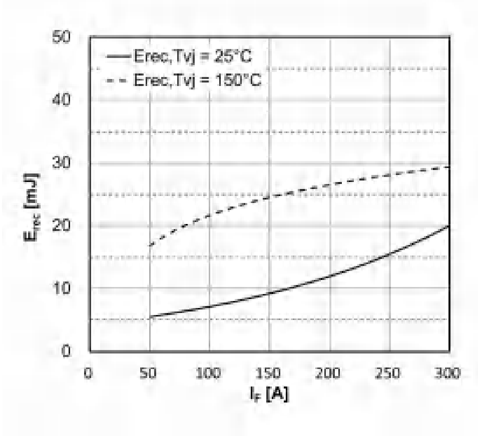


Fig.20 Switching losses IGBT, (typical)
E_{on} = f (R_G), E_{off} = f (R_G),
V_{GE} = +15 V / -7 V, I_C = 200 A,
V_{DC} = 675 V

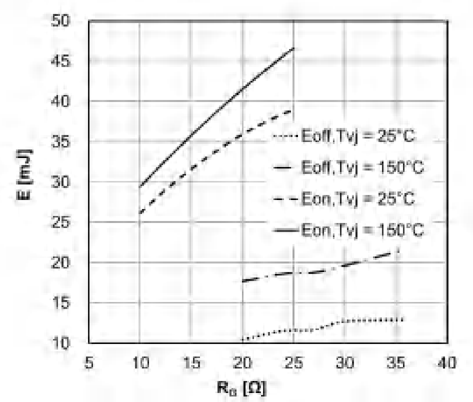
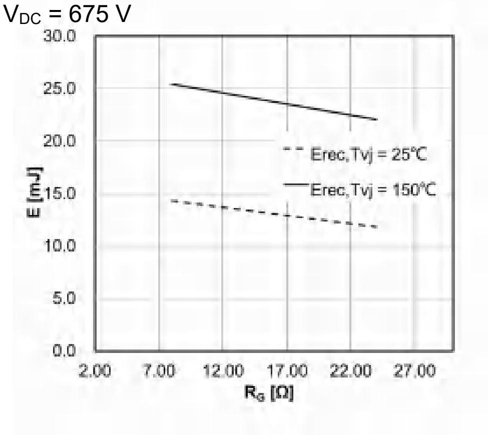


Fig.21 Switching losses Diode, (typical)
E_{REC} = f (R_G),
V_{GE} = +15 V / -7 V, I_F = 200 A,
V_{DC} = 675 V



T5 || D1 or T6 || D4

Fig.22 Switching losses IGBT, (typical)
E_{on} = f (I_C), E_{off} = f (I_C),
V_{GE} = +15 V / -7 V, R_{Gon} = 10 Ω, R_{Goff} = 20Ω,
V_{DC}= 675 V

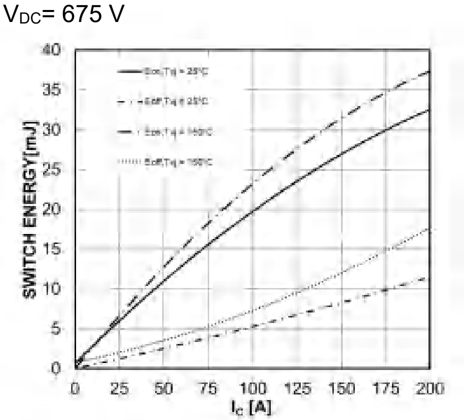


Fig.23 Switching losses Diode, (typical)
E_{REC} = f (R_G),
V_{GE} = +15 V / -7 V, I_F = 200 A,
V_{DC} = 675 V

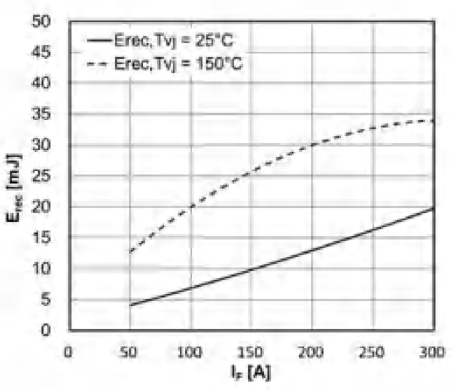


Fig.24 Switching losses IGBT, (typical)
E_{on} = f (R_G), E_{off} = f (R_G),
V_{GE} = +15 V / -7 V, I_C = 200 A,
V_{DC} = 675 V

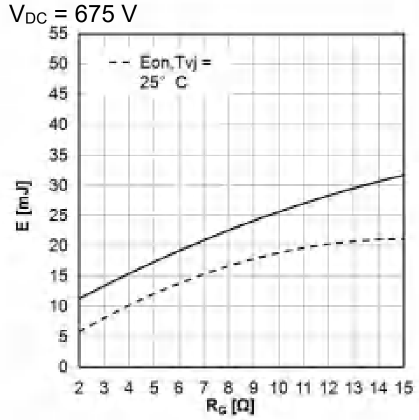


Fig.25 Switching losses IGBT, (typical)
E_{on} = f (R_G), E_{off} = f (R_G),
V_{GE} = +15 V / -7 V, I_C = 200 A,
V_{DC} = 675 V

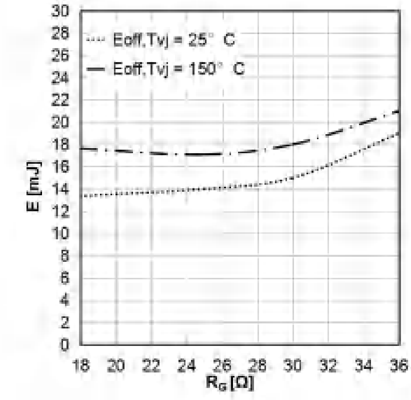
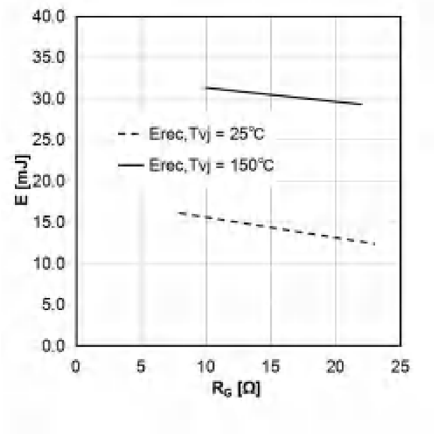


Fig.26 Switching losses IGBT, (typical)
E_{on} = f (I_C), E_{off} = f (I_C),
V_{GE} = +15 V / -7 V, R_{Gon} = 10 Ω, R_{Goff} = 20Ω,
V_{DC}= 675 V



M2 || D3 or M3 || D2

Fig.27 Switching losses MOSFET, (typical)
E_{on} = f (I_{ds}), E_{off} = f (I_{ds}),
V_{GS} = +18 V / -5 V, R_{Gon} = 2 Ω, R_{Goff} = 16Ω,
V_{DC}= 675 V

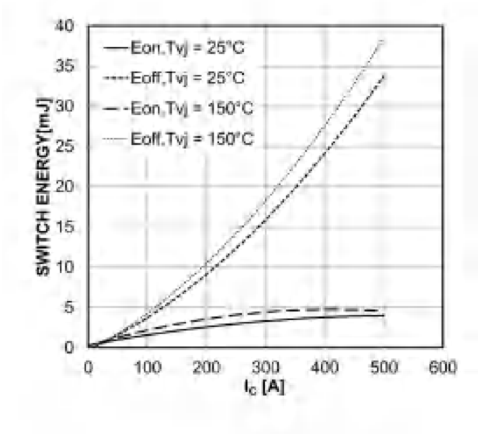


Fig.28 Switching losses Diode, (typical)
E_{on} = f (I_{ds}), E_{off} = f (I_{ds}),
V_{GS} = +18 V / -5 V, R_{Gon} = 2 Ω, R_{Goff} = 16Ω,
V_{DC}= 675 V

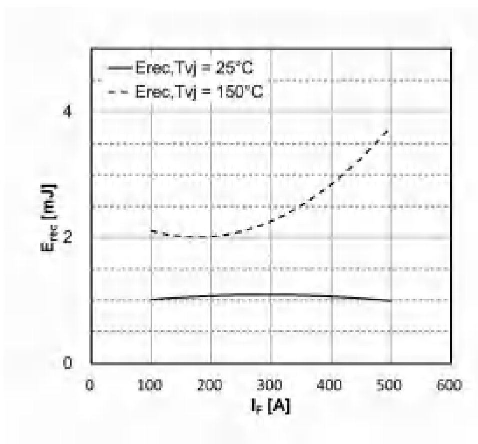


Fig.29 Switching losses MOSFET, (typical)
E_{on} = f (R_G), E_{off} = f (R_G),
V_{GS} = +18V / -5 V, I_{ds} = 330 A,
V_{DC} = 675V

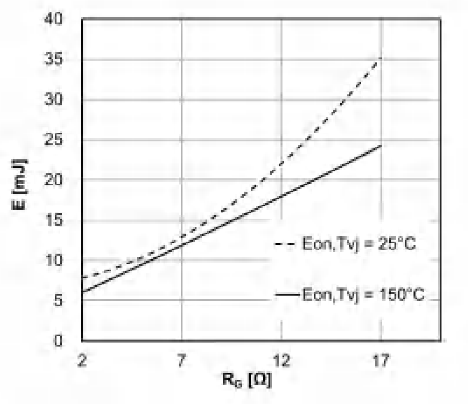


Fig.30 Switching losses MOSFET, (typical)
E_{on} = f (R_G), E_{off} = f (R_G),
V_{GS} = +18V / -5V, I_{ds} = 330 A,
V_{DC} = 675V

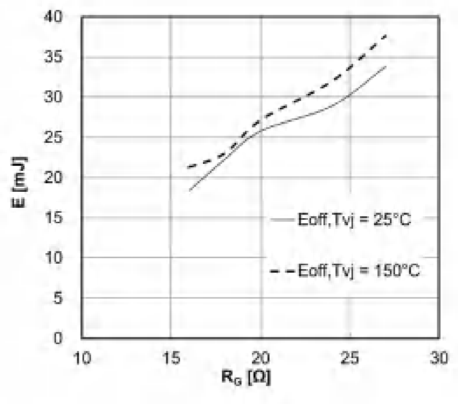


Fig.31 Switching losses of Diode, (typical)
E_{on} = f (R_G), E_{off} = f (R_G),
V_{GS} = +18V / -5 V, I_{ds} = 330 A,
V_{DC} = 675V

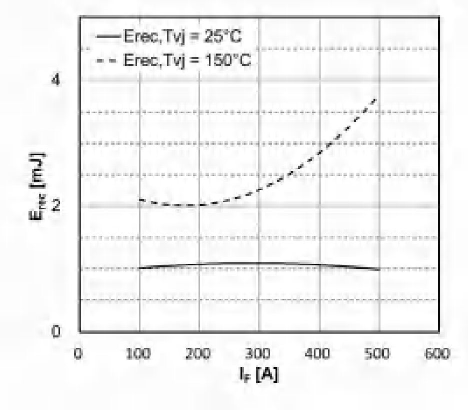


Fig.32 Transient thermal impedance IGBT,
Z_{thJC} = f (t) (T1,T4,T5,T6)

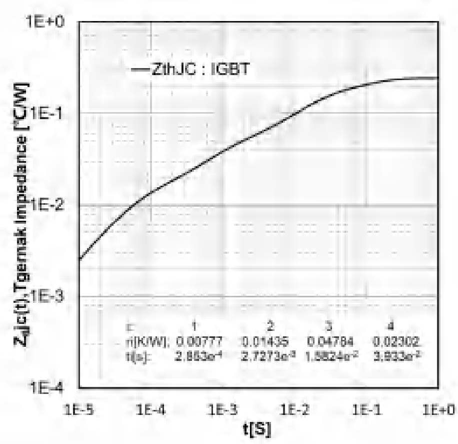


Fig.33 Transient thermal impedance MOSFET
Z_{thJC} = f (t) (M2, M3)

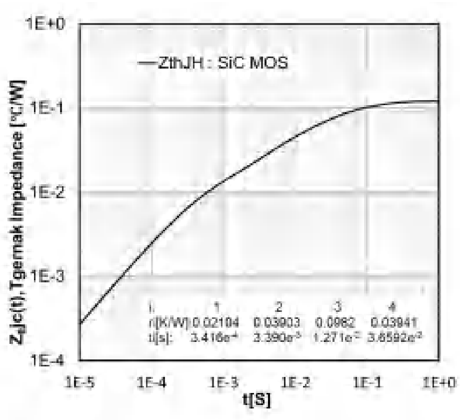


Fig.34 Transient thermal impedance Diode
Z_{thJC} = f (t) (D1,D4)

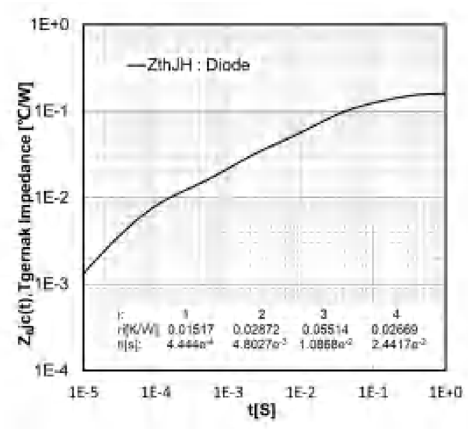


Fig.35 Transient thermal impedance Diode
Z_{thJC} = f (t) (D5,D6)

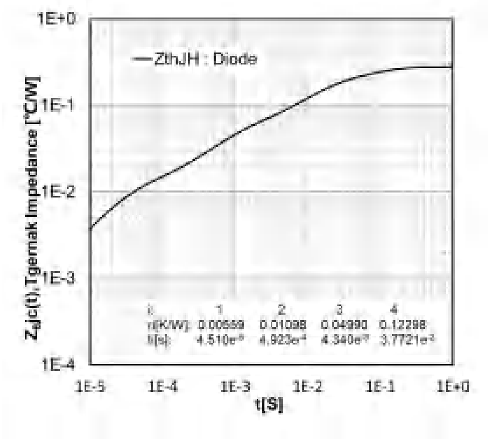


Fig.36 NTC-Thermistor-temperature characteristic (typical)

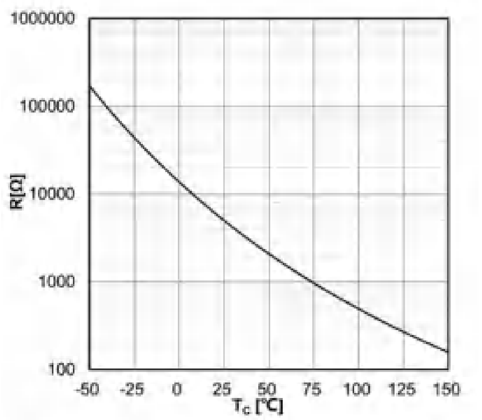


Fig.37 Reverse bias safe operating area IGBT, Inverter (RBSOA)
I_c = f (V_{CE}), (T1, T4, T5, T6)
V_{GE} = +15 V / -7 V, R_{Goff} = 0.5 Ω, Tvj = 25°C

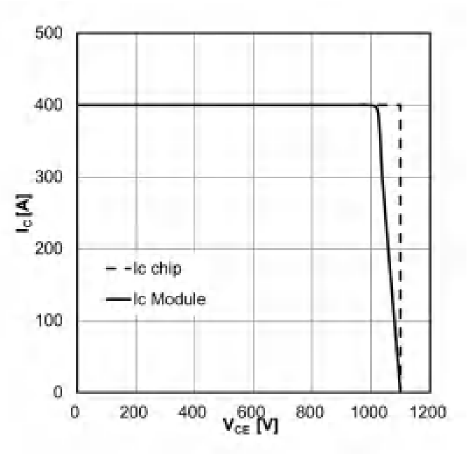
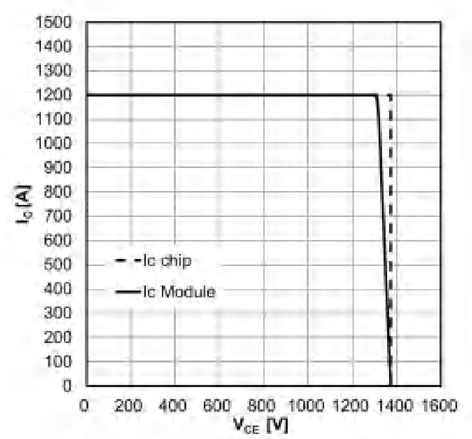
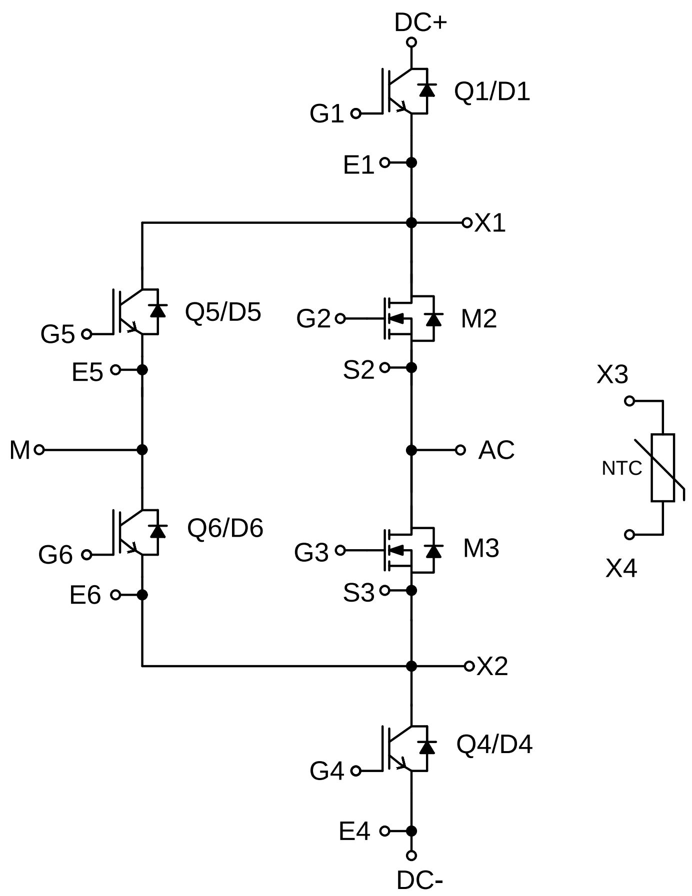


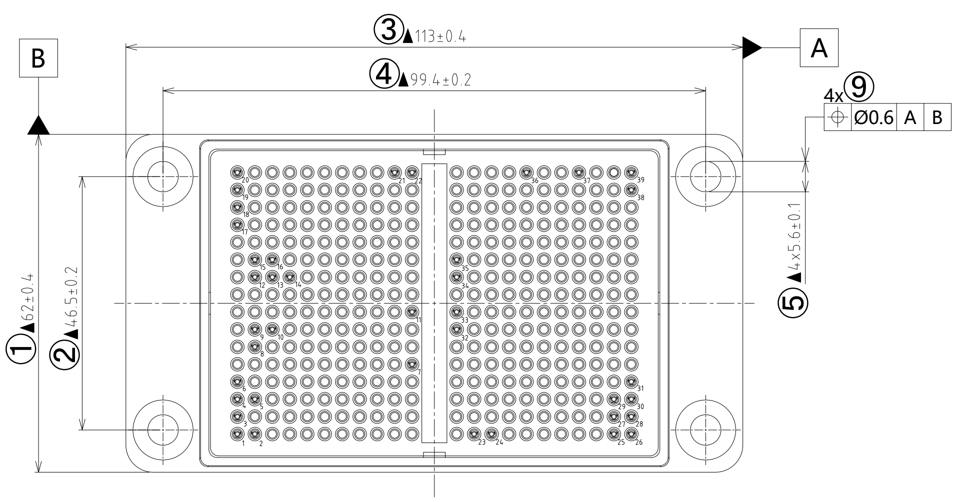
Fig.38 Reverse bias safe operating area IGBT, Inverter (RBSOA)
I_c = f (V_{CE}), (M2, M3)
V_{GE} = +18 V / -5 V, R_{Goff} = 0.5 Ω, Tvj = 25°C



Circuit Diagram



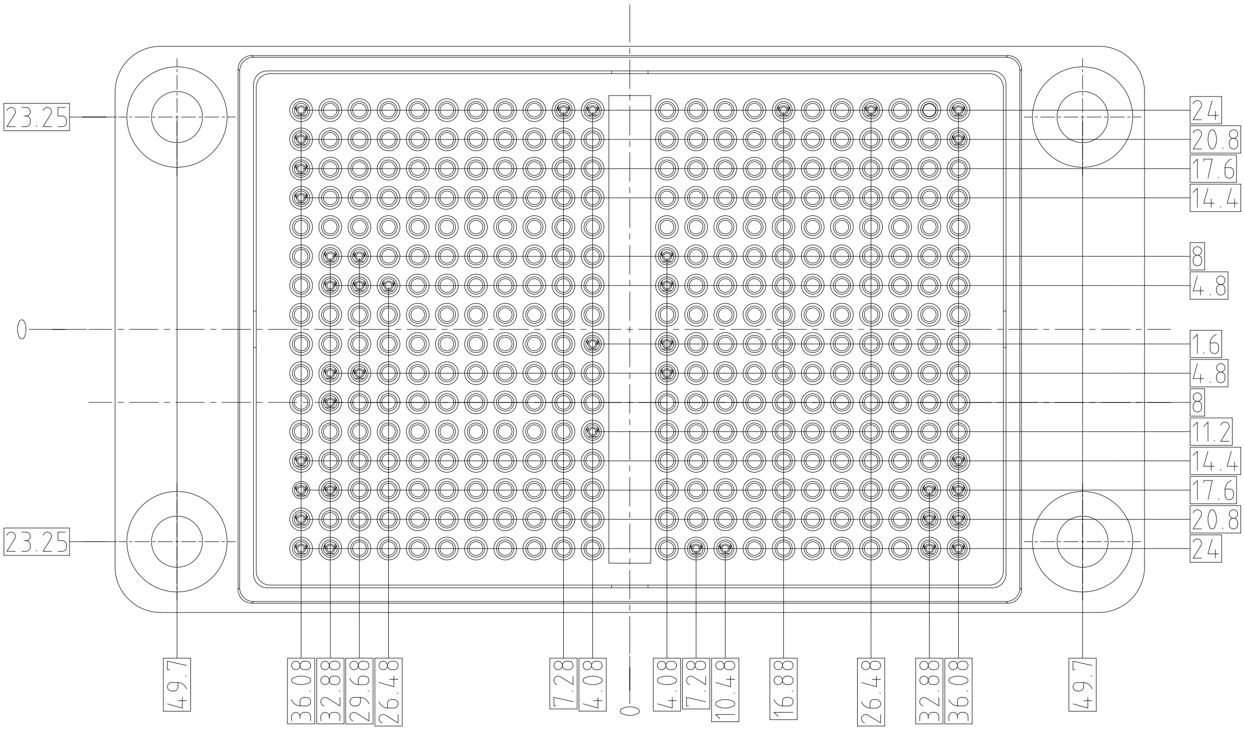
Pin Connections

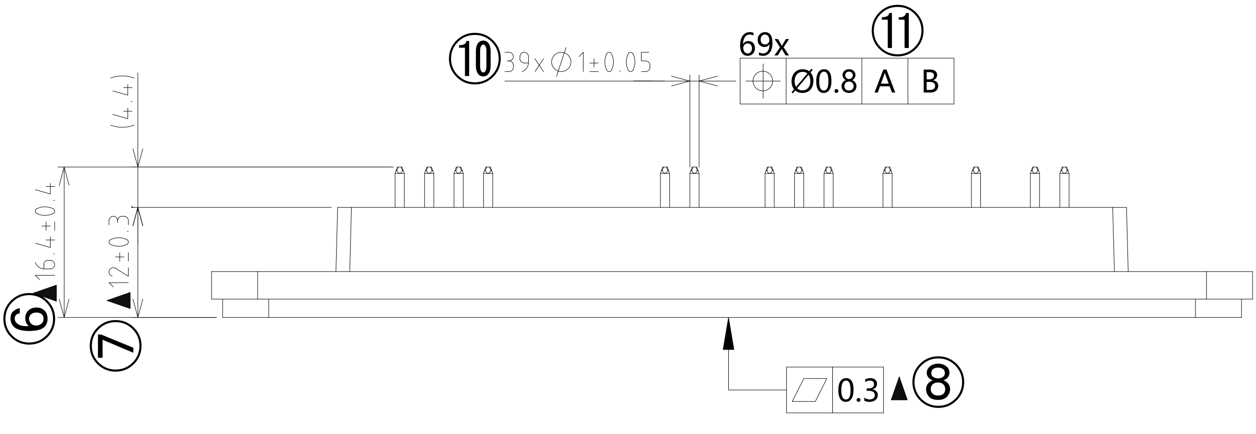


PIN 脚定义:

1/3/4/6	DC-
2	E4
5	G4
7	E6
8~10	M
11	G6
12\15\16	M
13	E5
14	G5
17~20	DC+
21	G1
22	E1
23	S3
24	G3
25~31	AC
32\33	X2
34\35	X1
36	X3
37	X4
38	G2
39	S2

Package Outlines





Package Outlines