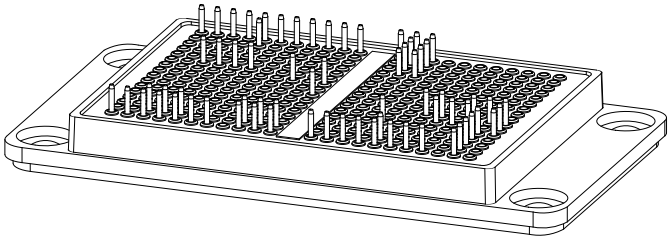
HCG600FL120E3S1

1200V / 600A E3 (size similar to Easy 3b with Cu Baseplate)

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

- Solar Inverters
- Uninterruptable Power Supplies Systems

HCG600FL120E3S1

1200V / 600A E3 (size similar to Easy 3b with Cu Baseplate)

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

Parameter	Symbol	Value	Unit
IGBT (Q1, Q4)			
Collector−Emitter Voltage	V_{CES}	1200	V
Gate−Emitter Voltage Positive Transient Gate−emitter Voltage (Tpulse = 5 s, D < 0.10)	V_{GE}	±2 5 30	V
Continuous Collector Current	I_C	600	A
Pulsed Collector Current	I_{CP}	1200	A
IGBT (Q2, Q3)			
Collector−Emitter Voltage	V_{CES}	700	V
Gate−Emitter Voltage Positive Transient Gate−emitter Voltage (Tpulse = 5 s, D < 0.10)	V_{GE}	±2 5 30	V
Continuous Collector Current	I_C	400	A
Pulsed Collector Current	I_{CP}	800	A
DIODE (D1)			
Peak Repetitive Reverse Voltage	V_{RRM}	1200	V
Continuous Forward Current	I_F	300	A
Repetitive Peak Forward Current	I_{FRM}	600	A
DIODE (D4)			
Peak Repetitive Reverse Voltage	V_{RRM}	1200	V
Continuous Forward Current	I_F	400	A
Repetitive Peak Forward Current	I_{FRM}	800	A
DIODE (D2,D3)			
Peak Repetitive Reverse Voltage	V_{RRM}	700	V
Continuous Forward Current	I_F	100	A
Repetitive Peak Forward Current	I_{FRM}	200	A
DIODE (D5,D6)			
Peak Repetitive Reverse Voltage	V_{RRM}	700	V
Continuous Forward Current	I_F	500	A
Repetitive Peak Forward Current	I_{FRM}	1000	A
INSULATION PROPERTIES			
Isolation Test Voltage, t = 1 s, 50 Hz	Viso	4000	V_{RMS}
RECOMMENDED TEMPERATURE			
Storage Temperature	T_{stg}	-40 to +125	℃
Operating Temperature	T_{vjop}	-40 to +150	℃
Junction Temperature	T_j	-40 to +175	℃

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1200V / 600A E3 (size similar to Easy 3b with Cu Baseplate)

Table 2 Characteristics Values

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
IGBT (Q1, Q4)							
Collector−Emitter Saturation Voltage	$V_{CE(sat)}$	V_{GE} = 15 V, I_C = 600 A	T_j = 25℃	-	1.82	-	V
		V_{GE} = 15 V, I_C = 600 A	T_j= 150℃	-	2.29	-	
Gate−Emitter Threshold Voltage	$V_{GE(TH)}$	V_{GE} = V_{CE}, I_C = 9 mA	T_j = 25℃	-	5.50	-	V
Total Gate Charge	Q_g	V_{GE} = -7/+15 V, V_{CE} = 600 V	T_j = 25℃	-	3.17	-	μC
Gate-Source Leakage Current	I_{GES}	V_{GE} = ±25 V, V_{CE} = 0 V	T_j = 25℃	-100	-	100	nA
Collector−Emitter Voltage	$V_{(BR)CES}$	V_{GE} = 0 V	T_j = 25℃	1200	-	-	V
Collector−Emitter Cutoff Current	I_{CES}	V_{CE} = 1200 V, V_{GE} = 0 V	T_j = 25℃	-	-	100	μA
Input Capacitance	C_{iss}	V_{GE} = 0 V, V_{CE} = 30 V, f = 100 KHz	T_j = 25℃	-	63.5	-	nF
Output Capacitance	C_{oss}		T_j = 25℃	-	1.83	-	
Reverse Transfer Capacitance	C_{rss}		T_j = 25℃	-	0.20	-	
Turn-on Delay Time(inductive load)	$t_{d\ on}$	V_{GE} = -7 V / +15 V, V_{DC+} =400 V, V_{DC-} =400 V, I_C = 330 A, R_{Gon} = 0.5 Ω, R_{Goff} = 0.5 Ω	T_j = 25℃	-	53	-	ns
			T_j = 150℃	-	110	-	
Rise Time (inductive load)	t_r		T_j = 25℃	-	27	-	
			T_j = 150℃	-	35	-	
Turn-off Delay Time(inductive load)	$t_{d\ off}$		T_j = 25℃	-	194	-	
			T_j = 150℃	-	205	-	
Fall Time (inductive load)	t_f		T_j = 25℃	-	155	-	
			T_j = 150℃	-	268	-	
Turn-on Switching Loss	E_{on}		T_j = 25℃	-	2.97	-	mJ
			T_j = 150℃	-	6.17	-	
Turn-off Switching Loss	E_{off}		T_j = 25℃	-	12.9	-	
			T_j = 150℃	-	17.7	-	
Thermal Resistance − Chip−to−Case	R_{thJC}	Per IGBT		-	0.063	-	℃ /W

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1200V / 600A E3 (size similar to Easy 3b with Cu Baseplate)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
DIODE (D5,D6)							
Diode Forward Voltage	V_F	I_F = 500 A	T_j = 25℃	-	1.92	-	V
		I_F = 500 A	T_j = 150℃	-	2.09	-	
Reverse Recovery Time	T_{RR}	V_{GE} = -7 V / +15 V, V_{DC+} =400 V, V_{DC-} =400 V, I_C = 330 A, R_{Gon} = 0.5 Ω, R_{Goff} = 0.5 Ω	T_j = 25℃	-	151	-	ns
			T_j = 150℃	-	210	-	
Reverse Recovery Charge	Q_{RR}		T_j = 25℃	-	15.3	-	μC
			T_j = 150℃	-	29.8	-	
Peak Reverse Recovery Current	I_{RRM}		T_j = 25℃	-	229	-	A
			T_j = 150℃	-	293	-	
Reverse Recovery Energy	E_{REC}		T_j = 25℃	-	5.0	-	mJ
			T_j = 150℃	-	9.9	-	
Thermal Resistance − Chip−to−Case	R_{thJC}	Per diode		-	0.135	-	°C/W
IGBT (Q3)							
Collector−Emitter Saturation Voltage	$V_{CE(sat)}$	V_{GE} = 15 V, I_C = 400 A	T_j = 25℃	-	1.53	-	V
		V_{GE} = 15 V, I_C = 400 A	T_j = 150℃	-	1.73	-	
Gate−Emitter Threshold Voltage	$V_{GE(TH)}$	V_{GE} = V_{CE}, I_C = 9 mA	T_j = 25℃	-	5.10	-	V
Total Gate Charge	Q_g	V_{GE} = -7/+15 V, V_{CE} = 600 V	T_j = 25℃	-	3.14	-	μC
Gate-Source Leakage Current	I_{GES}	V_{GE} = ±25 V, V_{CE} = 0 V	T_j = 25℃	-100	-	100	nA
Collector−Emitter Voltage	$V_{(BR)CES}$	V_{GE} = 0 V	T_j = 25℃	700	-	-	V
Collector−Emitter Cutoff Current	I_{CES}	V_{CE} = 700 V, V_{GE} = 0 V	T_j = 25℃	-	-	100	μA
Input Capacitance	C_{iss}	V_{GE} = 0 V, V_{CE} = 30 V, f = 100KHz	T_j = 25℃	-	48.3	-	nF
Output Capacitance	C_{oss}		T_j = 25℃	-	0.75	-	
Reverse Transfer Capacitance	C_{rss}		T_j = 25℃	-	0.23	-	
Turn-on Delay Time(inductive load)	$t_{d\ on}$	V_{GE} = -7 V / +15 V, V_{DC+} =400 V, V_{DC-} =400 V, I_C = 330 A, R_{Gon} = 0.5 Ω, R_{Goff} = 9.1 Ω	T_j = 25℃	-	42	-	ns
			T_j = 150℃	-	95	-	
Rise Time (inductive load)	t_r		T_j = 25℃	-	27	-	
			T_j = 150℃	-	31	-	
Turn-off Delay Time(inductive load)	$t_{d\ off}$		T_j = 25℃	-	886	-	
			T_j = 150℃	-	960	-	

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1200V / 600A E3 (size similar to Easy 3b with Cu Baseplate)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Fall Time (inductive load)	t_f	V_{GE} = -7 V / +15 V, V_{DC+} =400 V, V_{DC-} =400 V, I_C = 330 A, R_{Gon} = 0.5 Ω, R_{Goff} = 9.1 Ω	T_j = 25℃	-	50	-	ns
			T_j = 150℃	-	60	-	
Turn-on Switching Loss	E_{on}		T_j = 25℃	-	1.04	-	mJ
			T_j = 150℃	-	1.96	-	
Turn-off Switching Loss	E_{off}		T_j = 25℃	-	10.2	-	
			T_j = 150℃	-	12.6	-	
Thermal Resistance − Chip−to−Case	R_{thJC}	Per IGBT		-	0.140	-	°C/W
INVERSE DIODE (D1)							
Diode Forward Voltage	V_F	I_F = 300 A	T_j = 25℃	-	1.84	-	V
		I_F = 300 A	T_j = 150℃	-	1.90	-	
Reverse Recovery Time	T_{RR}	V_{GE} = -7 V / +15 V, V_{DC+} =400 V, V_{DC-} =400 V, I_C = 330 A, R_{Gon} = 0.5 Ω, R_{Goff} = 9.1 Ω	T_j = 25℃	-	74	-	ns
			T_j = 150℃	-	306	-	
Reverse Recovery Charge	Q_{RR}		T_j = 25℃	-	13.2	-	μC
			T_j = 150℃	-	38.3	-	
Peak Reverse Recovery Current	I_{RRM}		T_j = 25℃	-	328	-	A
			T_j = 150℃	-	418	-	
Reverse Recovery Energy	E_{REC}		T_j = 25℃	-	6.28	-	mJ
			T_j = 150℃	-	15.5	-	
Thermal Resistance − Chip−to−Case	R_{thJC}	Per diode		-	0.119	-	°C/W
IGBT (Q2)							
Collector−Emitter Saturation Voltage	$V_{CE(sat)}$	V_{GE} = 15 V, I_C = 400 A	T_j = 25℃	-	1.53	-	V
		V_{GE} = 15 V, I_C = 400 A	T_j = 150℃	-	1.73	-	
Gate−Emitter Threshold Voltage	$V_{GE(TH)}$	V_{GE} = V_{CE}, I_C = 9 mA	T_j = 25℃	-	5.10	-	V
Total Gate Charge	Q_g	V_{GE} = -7/+15 V, V_{CE} = 600 V	T_j = 25℃	-	3.14	-	μC
Gate-Source Leakage Current	I_{GES}	V_{GE} = ±25 V, V_{CE} = 0 V	T_j = 25℃	-100	-	100	nA
Collector−Emitter Voltage	$V_{(BR)CES}$	V_{GE} = 0 V	T_j = 25℃	700	-	-	V
Collector−Emitter Cutoff Current	I_{CES}	V_{CE} = 700 V, V_{GE} = 0 V	T_j = 25℃	-	-	100	μA
Input Capacitance	C_{iss}	V_{GE} = 0 V, V_{CE} = 30 V, f = 100KHz	T_j = 25℃	-	48.3	-	nF
Output Capacitance	C_{oss}		T_j = 25℃	-	0.75	-	
Reverse Transfer Capacitance	C_{rss}		T_j = 25℃	-	0.23	-	

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1200V / 600A E3 (size similar to Easy 3b with Cu Baseplate)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Turn-on Delay Time(inductive load)	$t_{d\ on}$	V_{GE} = -7 V / +15 V, V_{DC+} =400 V, V_{DC-} =400 V, I_C = 330 A, R_{Gon} = 0.5 Ω, R_{Goff} = 9.1 Ω	T_j = 25℃	-	93	-	ns
			T_j = 150℃	-	93	-	
Rise Time (inductive load)	t_r		T_j = 25℃	-	29	-	
			T_j = 150℃	-	32	-	
Turn-off Delay Time(inductive load)	$t_{d\ off}$		T_j = 25℃	-	880	-	
			T_j = 150℃	-	950	-	
Fall Time (inductive load)	t_f		T_j = 25℃	-	56	-	ns
			T_j = 150℃	-	61	-	
Turn-on Switching Loss	E_{on}		T_j = 25℃	-	0.68	-	mJ
			T_j = 150℃	-	1.70	-	
Turn-off Switching Loss	E_{off}		T_j = 25℃	-	10.7	-	
			T_j = 150℃	-	13.5	-	
Thermal Resistance − Chip−to−Case	R_{thJC}	Per IGBT		-	0.140	-	°C/W
INVERSE DIODE (D4)							
Diode Forward Voltage	V_F	I_F = 400 A	T_j = 25℃	-	1.97	-	V
		I_F = 400 A	T_j = 150℃	-	2.08	-	
Reverse Recovery Time	T_{RR}	V_{GE} = -7 V / +15 V, V_{DC+} =400 V, V_{DC-} =400 V, I_C = 330 A, R_{Gon} = 0.5 Ω, R_{Goff} = 9.1 Ω	T_j = 25℃	-	85	-	ns
			T_j = 150℃	-	315	-	
Reverse Recovery Charge	Q_{RR}		T_j = 25℃	-	15.7	-	μC
			T_j = 150℃	-	45.5	-	
Peak Reverse Recovery Current	I_{RRM}		T_j = 25℃	-	328	-	A
			T_j = 150℃	-	450	-	
Reverse Recovery Energy	E_{REC}		T_j = 25℃	-	7.51	-	mJ
			T_j = 150℃	-	19.0	-	
Thermal Resistance − Chip−to−Case	R_{thJC}	Per diode		-	0.102	-	°C/W
INVERSE DIODE (D2,D3)							
Diode Forward Voltage	V_F	I_F = 200 A	T_j = 25℃	-	2.10	-	V
		I_F = 200 A	T_j = 150℃	-	2.30	-	

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1200V / 600A E3 (size similar to Easy 3b with Cu Baseplate)

Table 3 NTC-Thermistor

Parameter	Symbol	Min	Typ.	Max	Unit	Conditions
Rated resistance	R_{25}	-	5	-	kΩ	T_C = 25°C
Deviation of R100	$\Delta R/R$	-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		
Flatness of base plate					0.3	mm

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Typical Characteristics

Fig.1 Typical output characteristics IGBT
V_{GE} = 15 V (Q1, Q4)

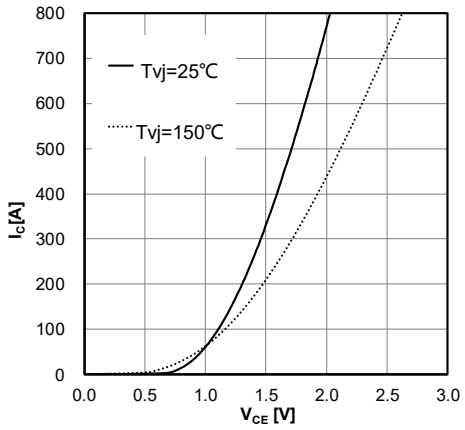


Fig.2 Typical output characteristics IGBT
Tvj = 150°C (Q1, Q4)

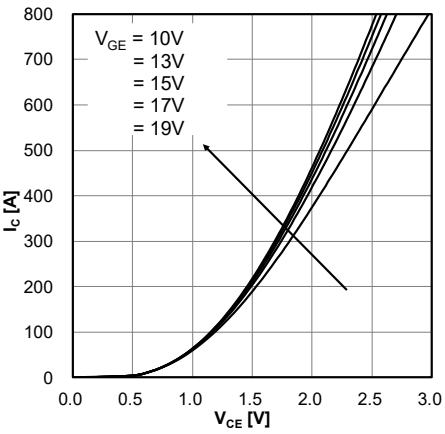


Fig.3 Typical output characteristics IGBT
V_{GE} = 15 V (Q2, Q3)

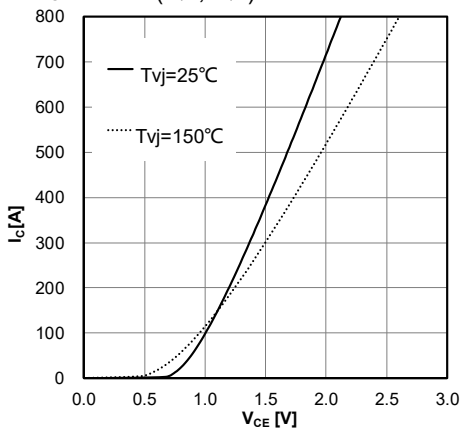


Fig.4 Typical output characteristics IGBT
Tvj = 150°C (Q2, Q3)

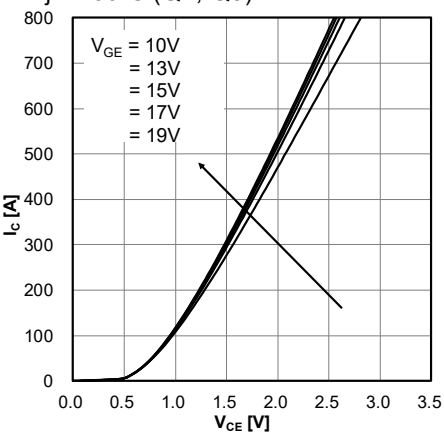


Fig.5 Typical Output Characteristic, IGBT
$I_C = f(V_{GE})$
V_{CE} = 20V (Q1, Q4)

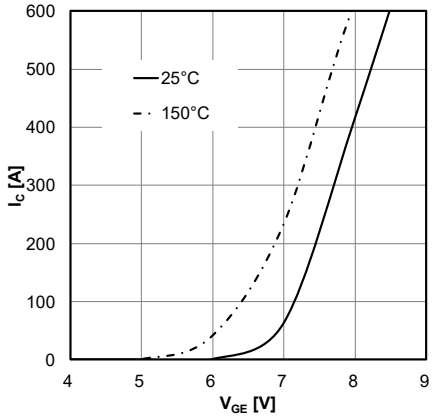
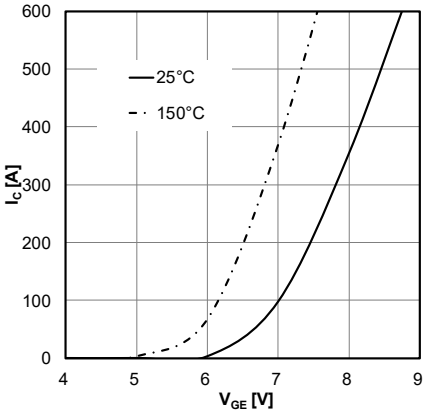


Fig.6 Typical Output Characteristic, IGBT
$I_C = f(V_{GE})$
V_{CE} = 20V (Q2, Q3)



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1200V / 600A E3 (size similar to Easy 3b with Cu Baseplate)

Typical Characteristics

Fig.7 Diode forward characteristics (D1)

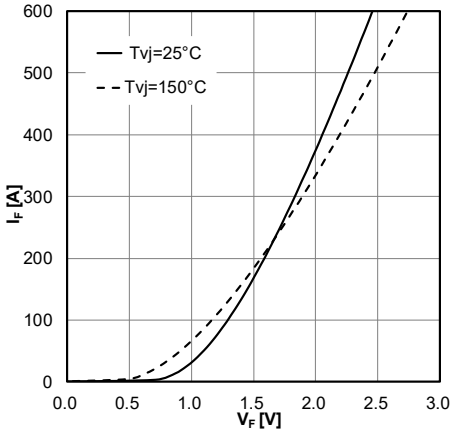


Fig.8 Diode forward characteristics (D2, D3)

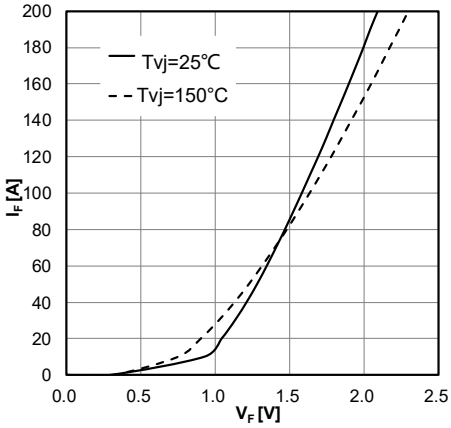


Fig.9 Diode forward characteristics (D4)

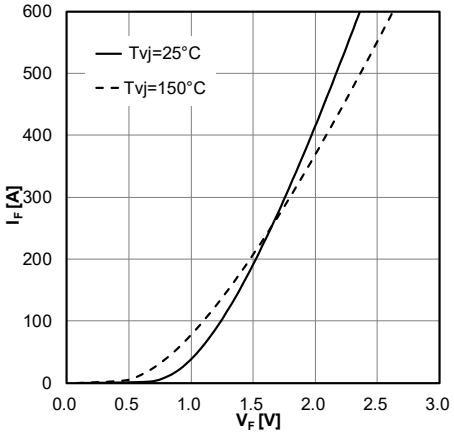


Fig.10 Diode forward characteristics (D5, D6)

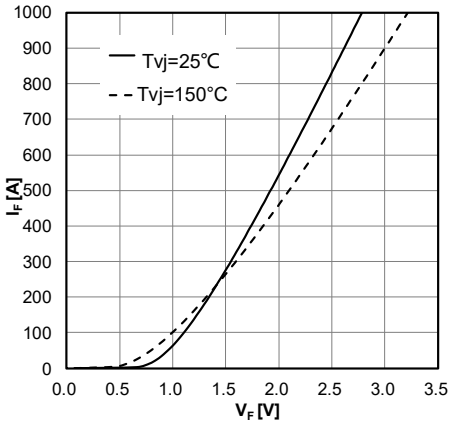


Fig.11 Capacity characteristic
$C = f(V_{CE})$, V_{GE} = 0 V, Tvj = 25°C, f = 100KHz
(Q1, Q4)

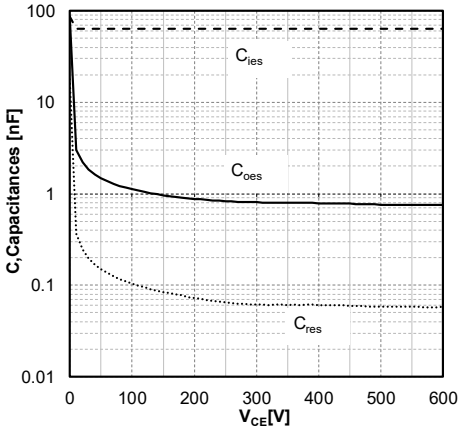
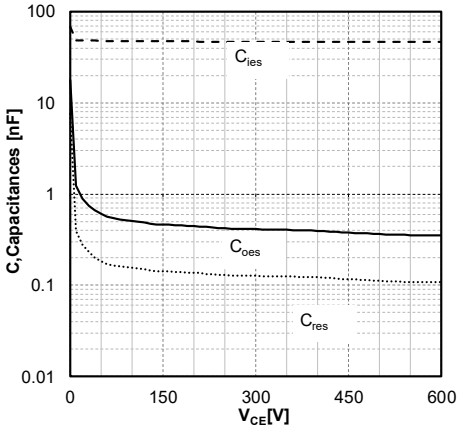


Fig.12 Capacity characteristic
$C = f(V_{CE})$, V_{GE} = 0 V, Tvj = 25°C, f = 100KHz
(Q2, Q3)



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1200V / 600A E3 (size similar to Easy 3b with Cu Baseplate)

Typical Characteristics

Q1 || D5 or Q4 || D6

Fig.13 Switching losses IGBT, (typical)
$E_{on} = f(I_C)$, $E_{off} = f(I_C)$,
V_{GE} = +15 V / -7 V, R_{Gon} = 0.5 Ω, R_{Goff} = 0.5 Ω,
V_{DC+} = 400 V, V_{DC-}= 400 V

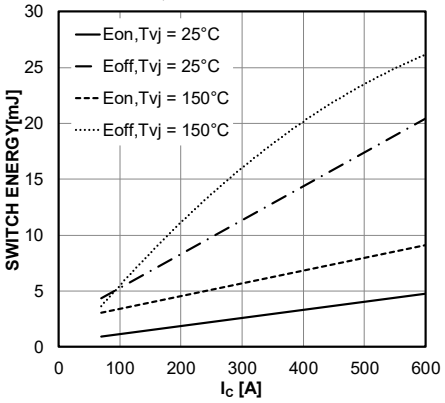


Fig.14 Switching losses Diode, (typical)
$E_{REC} = f(I_F)$,
V_{GE} = +15 V / -7 V, R_{Gon} = 0.5 Ω, R_{Goff} = 0.5 Ω,
V_{DC+} = 400 V, V_{DC-}= 400 V

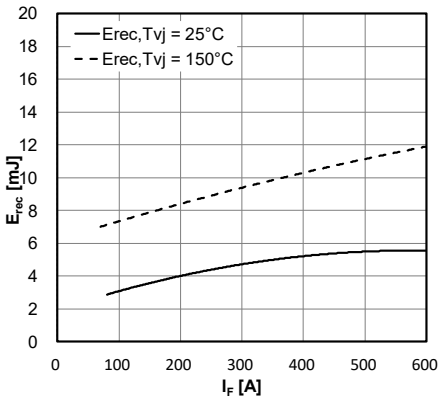


Fig.15 Switching losses IGBT, (typical)
$E_{on} = f(R_G)$, $E_{off} = f(R_G)$,
V_{GE} = +15 V / -7 V, I_C = 330 A,
V_{DC+} = 400 V, V_{DC-}= 400 V

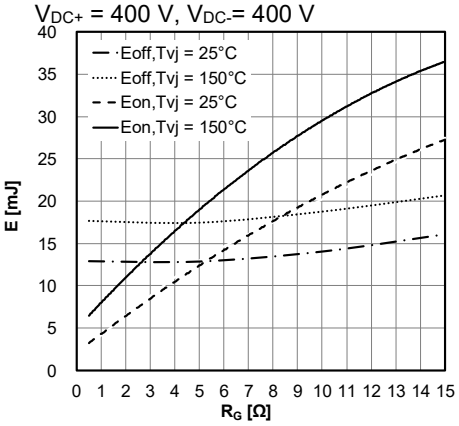
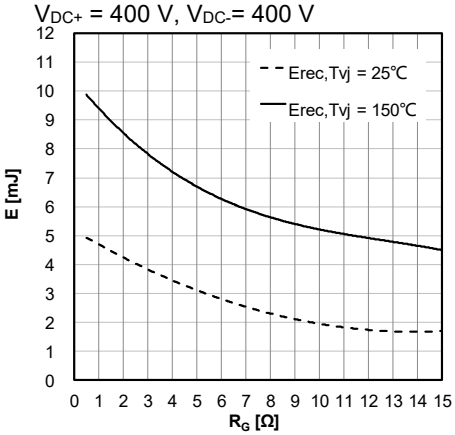


Fig.16 Switching losses Diode, (typical)
$E_{REC} = f(R_G)$,
V_{GE} = +15 V / -7 V, I_F = 330 A,
V_{DC+} = 400 V, V_{DC-}= 400 V



Q3 || D1

Fig.17 Switching losses IGBT, (typical)
$E_{on} = f(I_C)$,
V_{GE} = +15 V / -7 V, R_{Gon} = 0.5 Ω, R_{Goff} = 9.1 Ω,
V_{DC+} = 400 V, V_{DC-}= 400 V

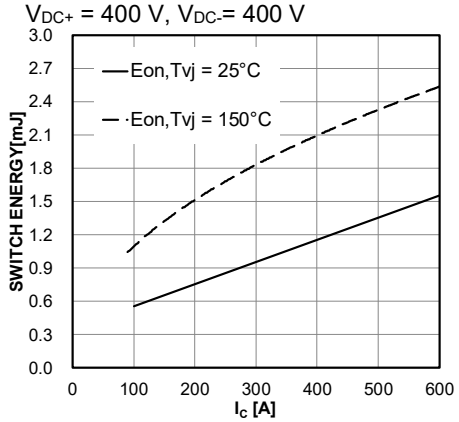
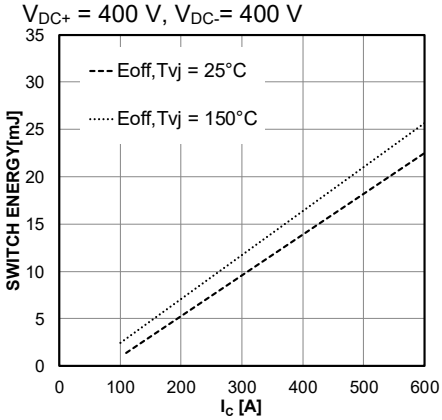


Fig.18 Switching losses IGBT, (typical)
$E_{off} = f(I_C)$,
V_{GE} = +15 V / -7 V, R_{Gon} = 0.5 Ω, R_{Goff} = 9.1 Ω,
V_{DC+} = 400 V, V_{DC-}= 400 V



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1200V / 600A E3 (size similar to Easy 3b with Cu Baseplate)

Typical Characteristics

Fig.19 Switching losses Diode, (typical)
$E_{REC} = f(I_C)$,
V_{GE} = +15 V / -7 V, R_{Gon} = 0.5 Ω, R_{Goff} = 9.1 Ω,
V_{DC+} = 400 V, V_{DC-}= 400 V

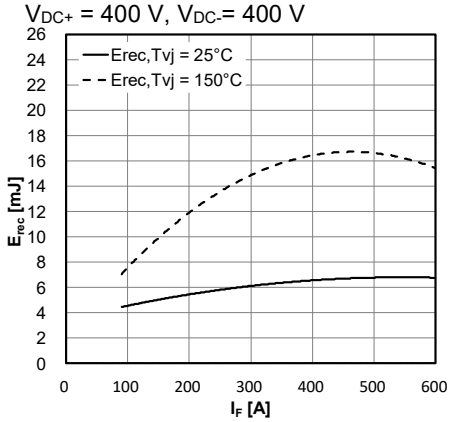


Fig.20 Switching losses IGBT, (typical)
$E_{on} = f(R_G)$,
V_{GE} = +15 V / -7 V, I_C = 330 A,
V_{DC+} = 400 V, V_{DC-}= 400 V

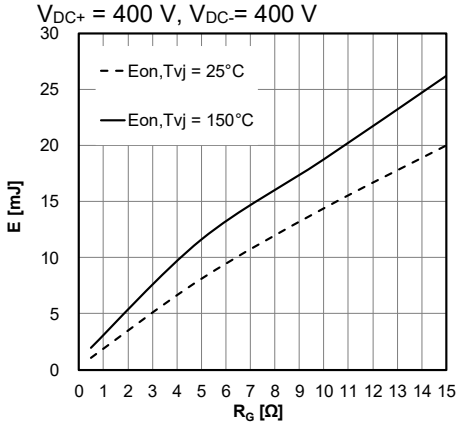


Fig.21 Switching losses IGBT, (typical)
$E_{off} = f(R_G)$,
V_{GE} = +15 V / -7 V, I_C = 330 A,
V_{DC+} = 400 V, V_{DC-}= 400 V

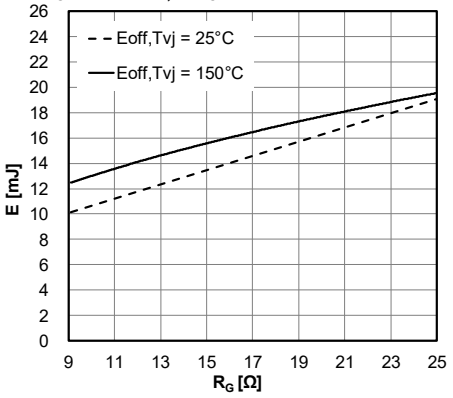
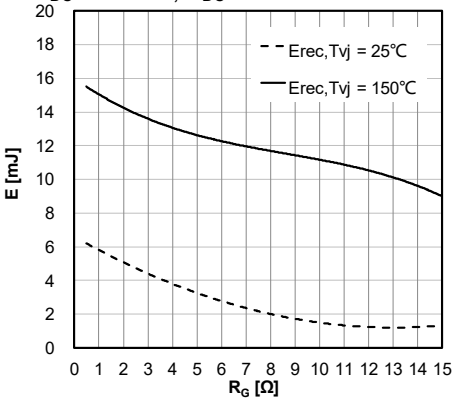


Fig.22 Switching losses Diode, (typical)
$E_{REC} = f(R_G)$,
V_{GE} = +15 V / -7 V, I_F = 330 A,
V_{DC+} = 400 V, V_{DC-}= 400 V



Q2 || D4

Fig.23 Switching losses IGBT, (typical)
$E_{on} = f(I_C)$,
V_{GE} = +15 V / -7 V, R_{Gon} = 0.5 Ω, R_{Goff} = 9.1 Ω,
V_{DC+} = 400 V, V_{DC-}= 400 V

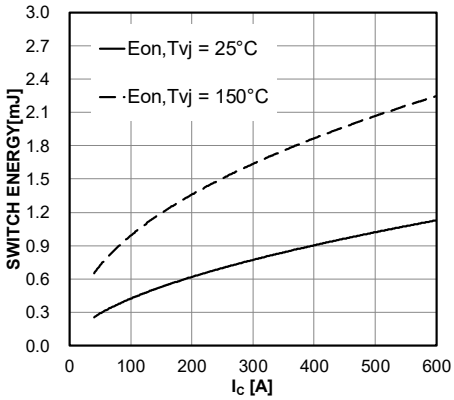
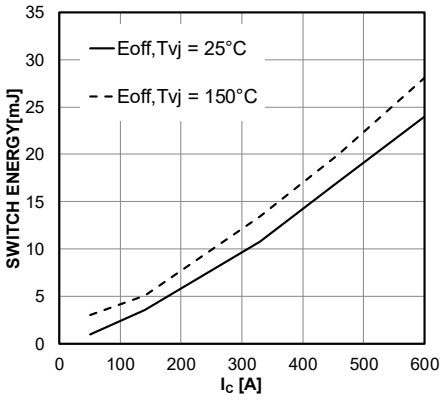


Fig.24 Switching losses IGBT, (typical)
$E_{off} = f(I_C)$,
V_{GE} = +15 V / -7 V, R_{Gon} = 0.5 Ω, R_{Goff} = 9.1 Ω,
V_{DC+} = 400 V, V_{DC-}= 400 V



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Typical Characteristics

Fig.25 Switching losses Diode, (typical)
$E_{REC} = f(I_F)$,
V_{GE} = +15 V / -7 V, R_{Gon} = 0.5 Ω, R_{Goff} = 9.1 Ω,
V_{DC+} = 400 V, V_{DC-}= 400 V

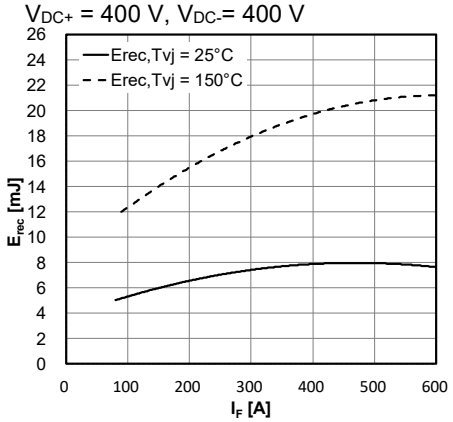


Fig.26 Switching losses IGBT, (typical)
$E_{off} = f(R_G)$,
V_{GE} = +15 V / -7 V, I_C = 330 A,
V_{DC+} = 400 V, V_{DC-}= 400 V

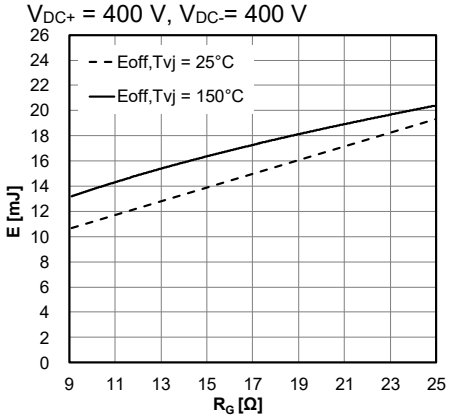


Fig.27 Switching losses IGBT, (typical)
$E_{on} = f(R_G)$,
V_{GE} = +15 V / -7 V, I_C = 330 A,
V_{DC+} = 400 V, V_{DC-}= 400 V

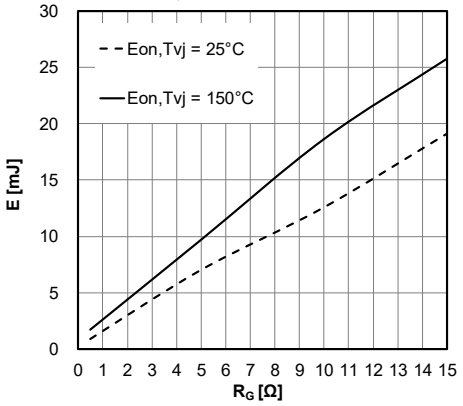


Fig.28 Switching losses Diode, (typical)
$E_{REC} = f(R_G)$,
V_{GE} = +15 V / -7 V, I_F = 330 A,
V_{DC+} = 400 V, V_{DC-}= 400 V

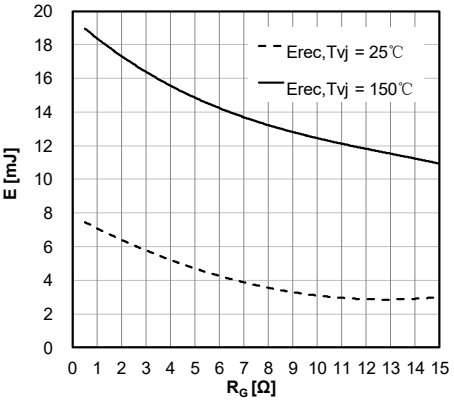


Fig.29 Transient thermal impedance IGBT,
$Z_{thJC} = f(t)$ (Q1, Q4)

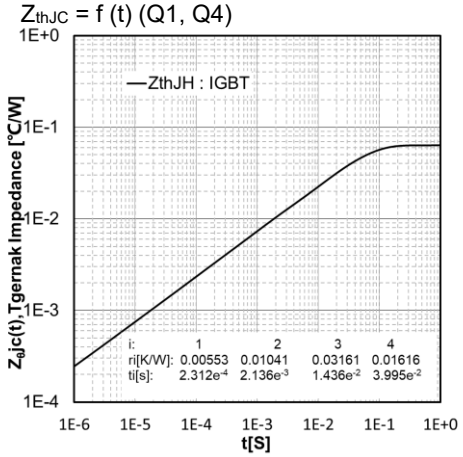
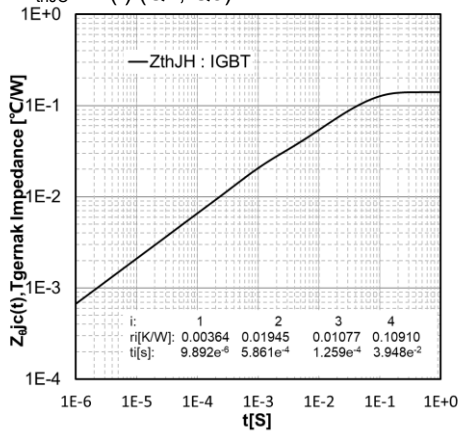


Fig.30 Transient thermal impedance IGBT,
$Z_{thJC} = f(t)$ (Q2, Q3)



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Typical Characteristics

Fig.31 Transient thermal impedance Diode, Z_{thJC} = f (t) (D1)

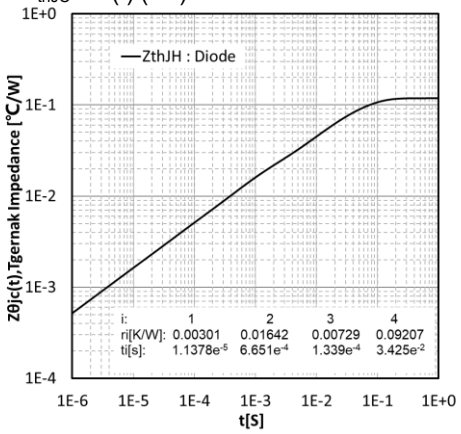


Fig.32 Transient thermal impedance Diode, Z_{thJC} = f (t) (D4)

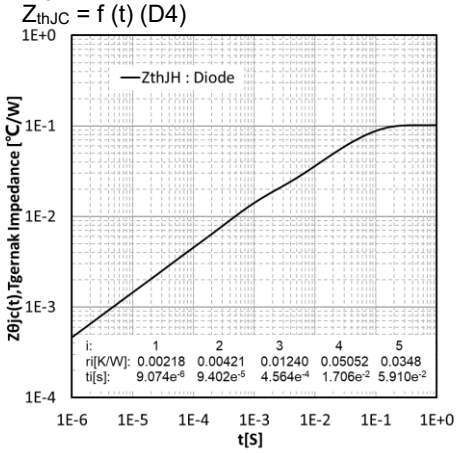


Fig.33 Transient thermal impedance Diode, Z_{thJC} = f (t) (D5, D6)

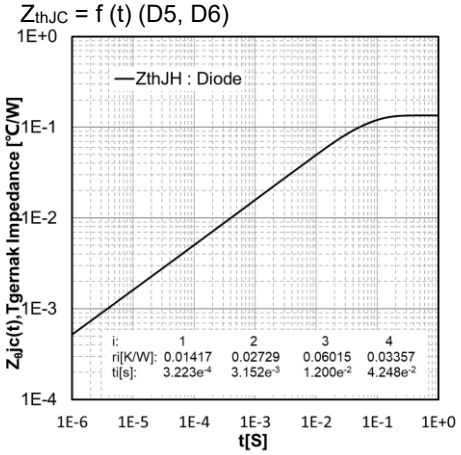
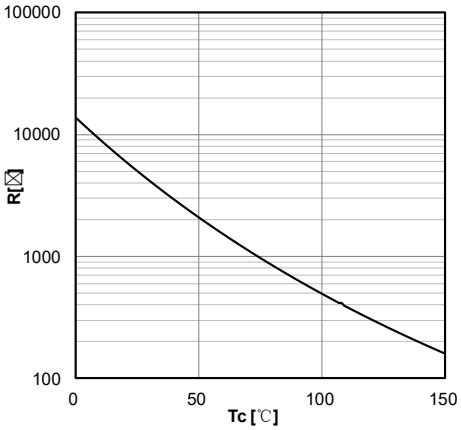


Fig.34 NTC-Thermistor-temperature characteristic (typical)



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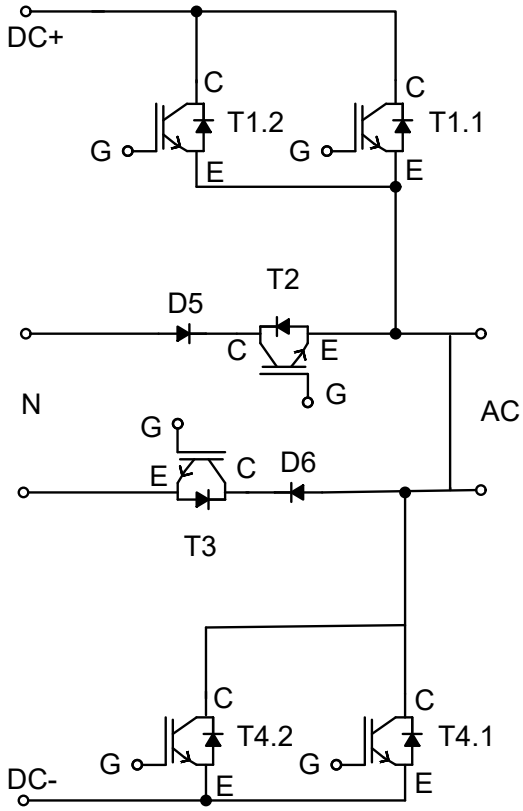
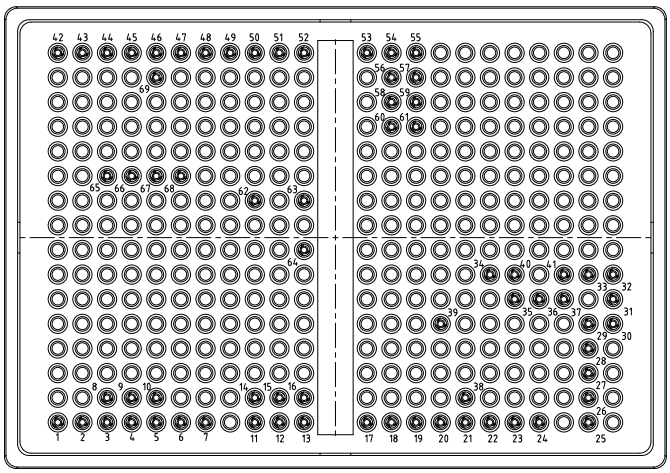
Circuit Diagram



Pin Connections



PIN 脚定义：

1~10	DC+
11~24	N
25~37	DC-
38	G3
39	C3
40	G4.2
41	G4.1
42~61	AC
62	C2
63	T1
64	T2
65	E1.2
66	G1.2
67	G1.1
68	E1.1
69	G2

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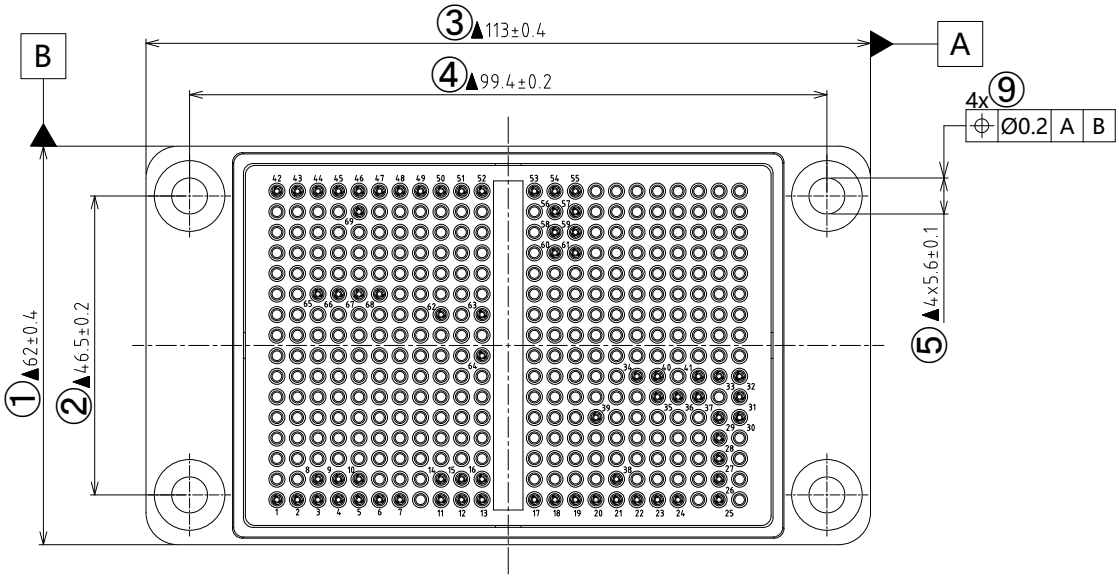
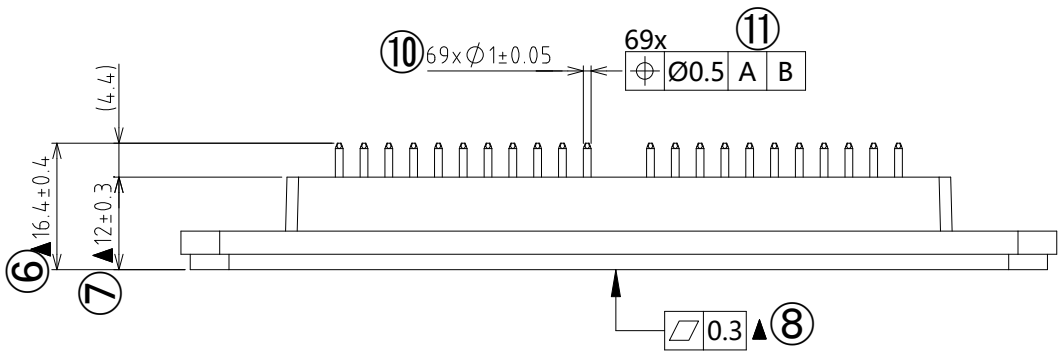
Package Outlines





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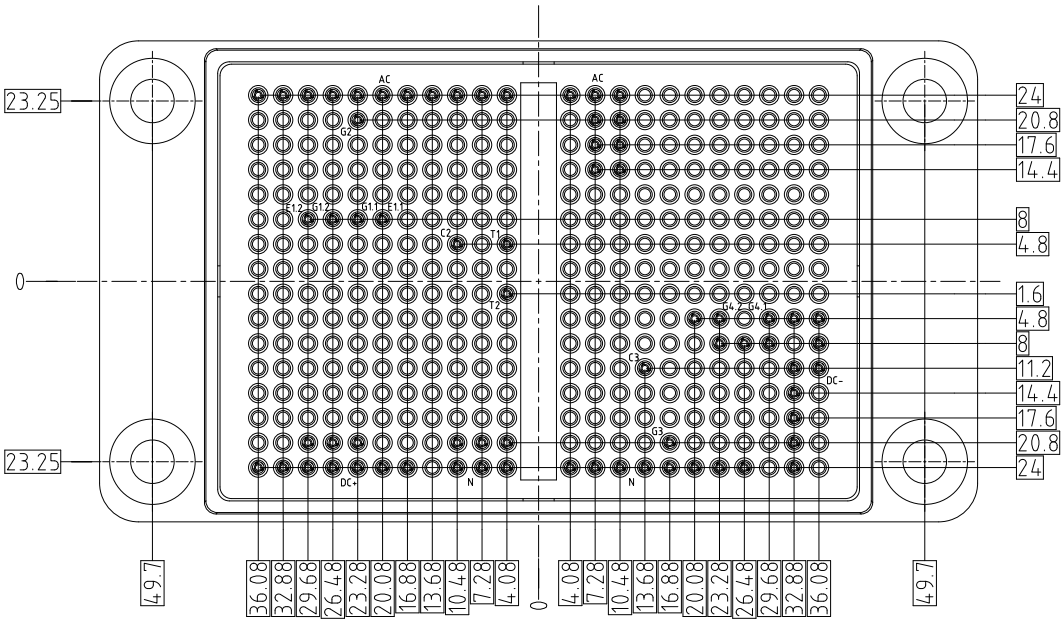
Package Outlines



Revision History

Document Version	Description of Changes
RevX.0.1	Released

Zhejiang HIITIO New Energy Co., Ltd

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The data contained in this document is exclusively intended for technically trained staff. You and your technical departments will have to evaluate the product's suitability for the intended application and the completeness of the product data concerning such application.

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