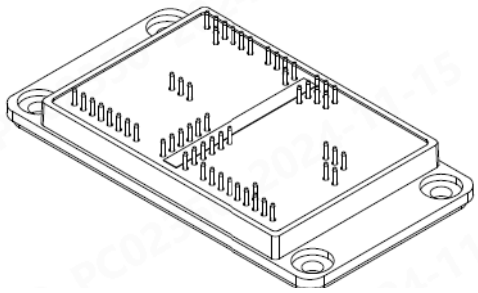
HCG600FL110E3T1

1100V / 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

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

HCG600FL110E3T1

1100V / 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}	1100	V
Gate−Emitter Voltage Positive Transient Gate−emitter Voltage (Tpulse = 5 s, D < 0.10)	V_{GE}	±25 30	V
Continuous Collector Current	I_C	600	A
Pulsed Collector Current (t_p=1ms)	I_{CM}	1200	A
Junction Temperature	T_j	-40 to +175	°C
IGBT (Q2, Q3)			
Collector−Emitter Voltage	V_{CES}	1100	V
Gate−Emitter Voltage Positive Transient Gate−emitter Voltage (Tpulse = 5 s, D < 0.10)	V_{GE}	±25 30	V
Continuous Collector Current	I_C	600	A
Pulsed Collector Current(t_p=1ms)	I_{CM}	1200	A
Junction Temperature	T_j	-40 to +175	°C
SiC DIODE (D1, D4)			
Peak Repetitive Reverse Voltage	V_{RRM}	1200	V
Continuous Forward Current	I_F	300	A
Diode Maximum Forward Current(t_p=1ms)	I_{FM}	600	A
I^2t(V_R = 0 V, tP = 10 ms, Tvj = 25° C)	I^2t	1400	A^2S
Junction Temperature	T_j	-40 to +175	°C
DIODE (D2,D3)			
Peak Repetitive Reverse Voltage	V_{RRM}	1100	V
Continuous Forward Current	I_F	300	A
Diode Maximum Forward Current(t_p=1ms)	I_{FM}	600	A
I^2t(V_R = 0 V, tP = 10 ms, Tvj = 25° C)	I^2t	1000	A^2S
Junction Temperature	T_j	-40 to +175	°C
SiC DIODE (D5,D6)			
Peak Repetitive Reverse Voltage	V_{RRM}	1200	V
Continuous Forward Current	I_F	240	A
Diode Maximum Forward Current(t_p=1ms)	I_{FM}	480	A
I^2t(V_R = 0 V, tP = 10 ms, Tvj = 25° C)	I^2t	1100	A^2S
Junction Temperature	T_j	-40 to +175	°C
INSULATION PROPERTIES			
Isolation Test Voltage, t = 1min, 50 Hz	Viso	4000	V_{RMS}

HCG600FL110E3T1

1100V / 600A E3 (size similar to Easy 3b with Cu Baseplate)

RECOMMENDED TEMPERATURE			
Storage Temperature	T_{stg}	-40 to +125	°C
Operating Temperature	T_{vjop}	-40 to +150	°C

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 = -40°C	-	1.48	-	V
			T_j = 25°C	-	1.63	2.4	
			T_j= 150°C	-	2.20	-	
Gate−Emitter Threshold Voltage	$V_{GE(TH)}$	V_{GE} = V_{CE}, I_C = 9 mA	T_j = -40°C	-	4.44	-	V
			T_j = 25°C	3.5	4.00	4.5	
Total Gate Charge	Q_g	V_{GE} = -7/+15 V, V_{CE} = 600 V	T_j = 25°C	-	1.95	-	μC
Gate input resistance	R_G	f = 1 MHz	T_{vj} = 25°C	-	0.60	-	Ω
Gate-Source Leakage Current	I_{GES}	V_{GE} = ±25 V, V_{CE} = 0 V	T_j = 25°C	-100	-	100	nA
Collector−Emitter Voltage	$V_{(BR)CES}$	V_{GE} = 0 V I_C = 0.2 mA	T_j = -40°C	-	1150	-	V
			T_j = 25°C	1100	-	-	
			T_j = 150°C		1400		
Collector−Emitter Cutoff Current	I_{CES}	V_{CE} = 1100 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	-	nF
Output Capacitance	C_{oes}		T_j = 25°C	-	1.47	-	
Reverse Transfer Capacitance	C_{res}		T_j = 25°C	-	0.06	-	
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} = 18 Ω	T_j = 25°C	-	88	-	ns
			T_j = 150°C	-	88	-	
Rise Time (inductive load)	t_r		T_j = 25°C	-	29	-	
			T_j = 150°C	-	28	-	
Turn-off Delay Time(inductive load)	$t_{d\ off}$		T_j = 25°C	-	1390	-	
			T_j = 150°C	-	1540	-	
Fall Time (inductive load)	t_f		T_j = 25°C	-	46	-	
			T_j = 150°C	-	34	-	
Turn-on Switching Loss	E_{on}		T_j = 25°C	-	5.89	-	mJ
			T_j = 150°C	-	11.28	-	
Turn-off Switching Loss	E_{off}		T_j = 25°C	-	13.37	-	
			T_j = 150°C	-	17.63	-	

HCG600FL110E3T1

1100V / 600A E3 (size similar to Easy 3b with Cu Baseplate)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Thermal Resistance − Chip−to−Case	R_{thJC}	Per IGBT		-	0.092	-	°C/W
SiC DIODE (D5,D6)							
Diode Forward Voltage	V_F	I_F = 300 A	Tj = -40°C	-	1.60	-	V
			T_j = 25°C	-	1.68	2.38	
			T_j = 150°C	-	2.30	-	
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	-	25	-	ns
			T_j = 150°C	-	54	-	
Reverse Recovery Charge	Q_{RR}		T_j = 25°C	-	1.70	-	µC
			T_j = 150°C	-	4.48	-	
Peak Reverse Recovery Current	I_{RRM}		T_j = 25°C	-	109	-	A
			T_j = 150°C	-	145	-	
Reverse Recovery Energy	E_{REC}		T_j = 25°C	-	0.66	-	mJ
			T_j = 150°C	-	1.69	-	
Thermal Resistance Chip to Case	R_{thJC}	Per diode		-	0.189	-	°C/W
IGBT (Q2, Q3)							
Collector−Emitter Saturation Voltage	$V_{CE(sat)}$	V_{GE} = 15 V, I_C = 600 A	T_j = -40°C	-	1.48	-	V
			T_j = 25°C	-	1.63	2.4	
			T_j = 150°C	-	2.20	-	
Gate−Emitter Threshold Voltage	$V_{GE(TH)}$	V_{GE} = V_{CE}, I_C = 9 mA	T_j = -40°C	-	4.44	-	V
			T_j = 25°C	3.5	4.00	4.5	
Total Gate Charge	Q_g	V_{GE} = -7/+15 V, V_{CE} = 600 V	T_j = 25°C	-	1.95	-	µC
Gate input resistance	R_G	f = 1 MHz	T_{vj} = 25°C	-	0.60	-	Ω
Gate-Source Leakage Current	I_{GES}	V_{GE} = ±25 V, V_{CE} = 0 V	T_j = 25°C	-100	-	100	nA
Collector−Emitter Voltage	$V_{(BR)CES}$	V_{GE} = 0 V I_C = 0.2 mA	T_j = -40°C	-	1150	-	V
			T_j = 25°C	1100	-	-	
			T_j = 150°C		1400		
Collector−Emitter Cutoff Current	I_{CES}	V_{CE} = 1100 V, V_{GE} = 0 V	T_j = 25°C	-	-	100	µA
Input Capacitance	C_{ies}	V_{GE} = 0 V, V_{CE} = 675 V, f = 100KHz	T_j = 25°C	-	28	-	nF
Output Capacitance	C_{oes}		T_j = 25°C	-	1.47	-	
Reverse Transfer Capacitance	C_{res}		T_j = 25°C	-	0.06	-	

HCG600FL110E3T1

1100V / 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_{CE} = 675 V, I_C = 330 A, R_{Gon} = 2.0 Ω, R_{Goff} = 18 Ω	T_j = 25°C	-	88	-	ns
			T_j = 150°C	-	88	-	
Rise Time (inductive load)	t_r		T_j = 25°C	-	29	-	
			T_j = 150°C	-	31	-	
Turn-off Delay Time(inductive load)	$t_{d\ off}$		T_j = 25°C	-	1390	-	
			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} = 18 Ω	T_j = 25°C	-	46	-	ns
			T_j = 150°C	-	36	-	
Turn-on Switching Loss	E_{on}		T_j = 25°C	-	5.8	-	mJ
			T_j = 150°C	-	9.4	-	
Turn-off Switching Loss	E_{off}		T_j = 25°C	-	13.0	-	
			T_j = 150°C	-	18.8	-	
Thermal Resistance Chip to Case	R_{thJC}	Per IGBT		-	0.092	-	°C/W

SiC DIODE (D1, D4)

Parameter	Symbol	Conditions		Min.	Typ.	Max	Unit
Diode Forward Voltage	V_F	I_F = 300 A	T_j = -40°C	-	1.41	-	
			T_j = 25°C	-	1.50	2.2	V
			T_j = 150°C	-	2.05	-	
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	-	24	-	ns
			T_j = 150°C	-	26	-	
Reverse Recovery Charge	Q_{RR}		T_j = 25°C	-	1.69	-	µC
			T_j = 150°C	-	1.70	-	
Peak Reverse Recovery Current	I_{RRM}		T_j = 25°C	-	109	-	A
			T_j = 150°C	-	104	-	
Reverse Recovery Energy	E_{REC}		T_j = 25°C	-	0.65	-	mJ
			T_j = 150°C	-	0.59	-	
Thermal Resistance Chip to Case	R_{thJC}	Per diode		-	0.125	-	°C/W

DIODE (D2,D3)

Parameter	Symbol	Conditions		Min.	Typ.	Max	Unit
Diode Forward Voltage	V_F	I_F = 300 A	T_j = -40°C	-	1.80	-	V
			T_j = 25°C	-	1.97	2.7	
			T_j = 150°C	-	2.15	-	
Thermal Resistance Chip to Case	R_{thJC}	Per diode		-	0.197	-	°C/W

HCG600FL110E3T1

1100V / 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	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		

HCG600FL110E3T1

1100V / 600A E3 (size similar to Easy 3b with Cu Baseplate)

Typical Characteristics

Fig.1 Typical output characteristics IGBT
$I_C = f(V_{CE})$
V_{GE} = 15V (Q1, Q2, Q3, Q4)

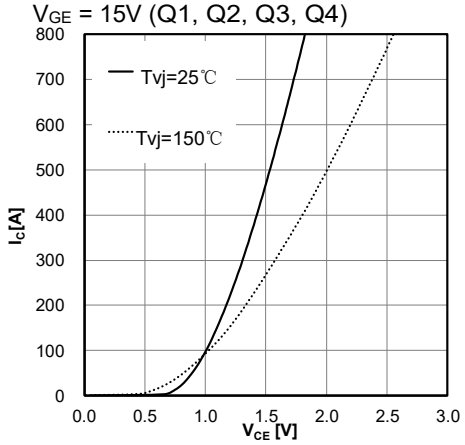


Fig.2 Typical output characteristics IGBT
Tvj = 150°C (Q1, Q2, Q3, Q4)

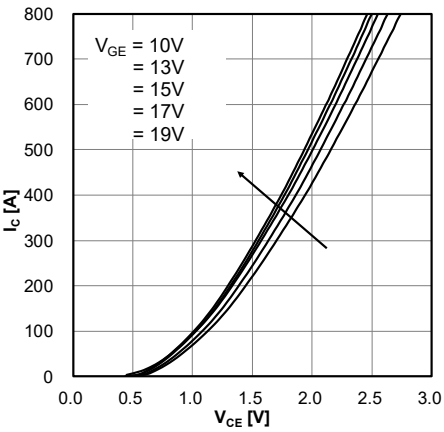


Fig.3 Typical Output Characteristic, IGBT, Inverter
$I_C = f(V_{GE})$ (Q1, Q2, Q3, Q4)
V_{CE} = 20V

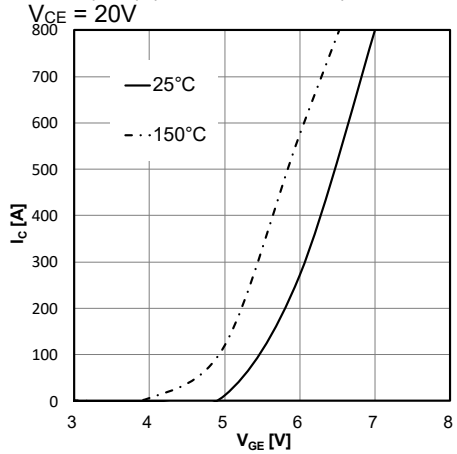


Fig.4 Diode forward characteristics (D1, D4)

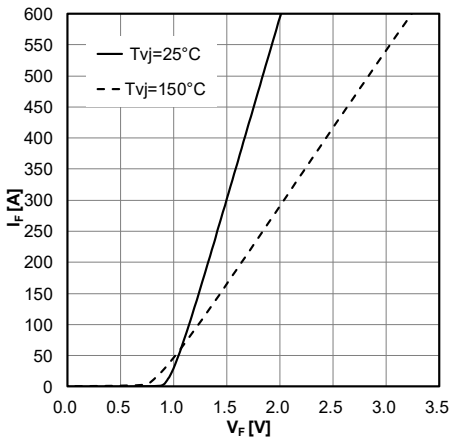


Fig.5 Diode forward characteristics (D5, D6)

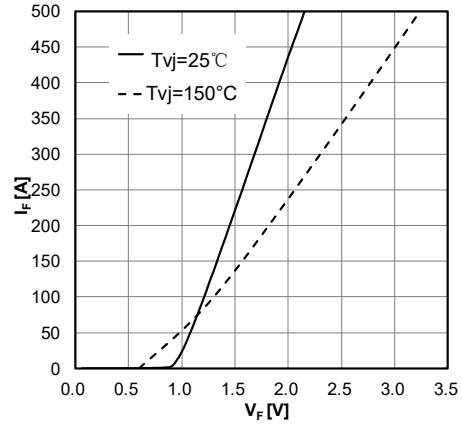
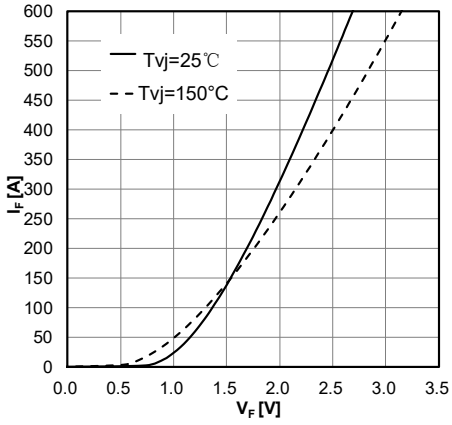


Fig.6 Diode forward characteristics (D2, D3)



HCG600FL110E3T1

1100V / 600A E3 (size similar to Easy 3b with Cu Baseplate)

Typical Characteristics

Q1 || D5 or Q4 || D6

Fig.7 Switching losses IGBT, Inverter (typical)
$E_{on} = f(I_C)$, $E_{off} = f(I_C)$,
V_{GE} = +15 V / -7 V, R_{Gon} = 2 Ω, R_{Goff} = 18Ω,
V_{CE} = 675 V

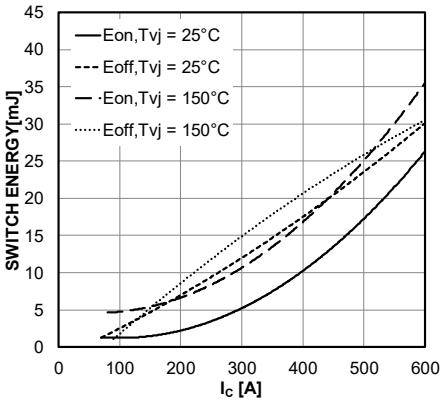


Fig.8 Switching losses IGBT, Inverter (typical)
$E_{on} = f(R_G)$,
V_{GE} = +15 V / -7 V, I_C = 330 A, V_{CE} = 675 V

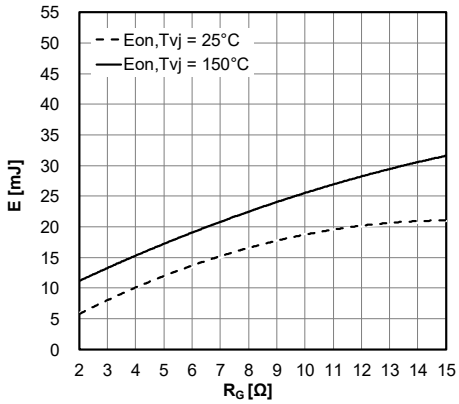


Fig.9 Switching losses IGBT, Inverter (typical)
$E_{off} = f(R_G)$,
V_{GE} = +15 V / -7 V, I_C = 330 A, V_{CE} = 675 V

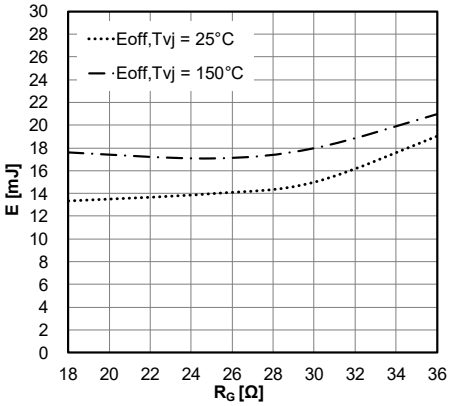


Fig.10 Switching losses IGBT, Inverter (typical)
$E_{REC} = f(R_G)$,
V_{GE} = +15 V / -7 V, I_C = 330 A, V_{CE} = 675 V

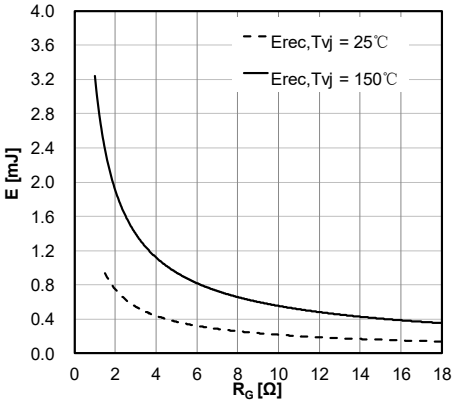
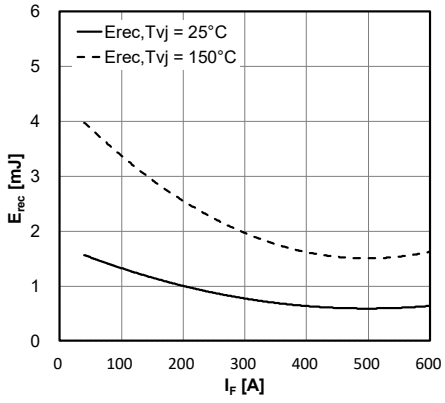


Fig.11 Switching losses IGBT, (typical)
$E_{REC} = f(I_F)$,
V_{GE} = +15 V / -7 V, R_{Gon} = 2.0 Ω, V_{CE} = 675 V



HCG600FL110E3T1

1100V / 600A E3 (size similar to Easy 3b with Cu Baseplate)

Typical Characteristics

Q2||D3+D4 or Q3||D1+D2

Fig.12 Switching losses IGBT, Inverter (typical)
E_{on} = f (I_C), E_{off} = f (I_C),
V_{GE} = +15 V / -7 V, R_{Gon} = 2 Ω, R_{Goff} = 18 Ω,
V_{CE} = 675 V

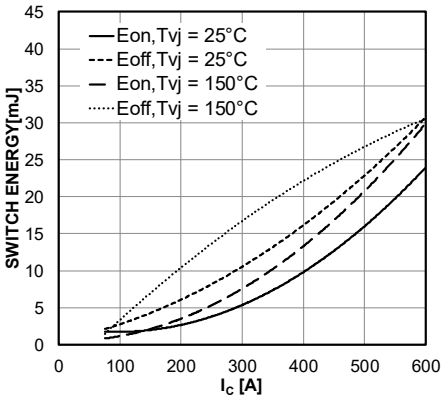


Fig.13 Switching losses IGBT, Inverter (typical)
E_{on} = f (R_G),
V_{GE} = +15 V / -7 V, I_C = 330 A, V_{CE} = 675 V

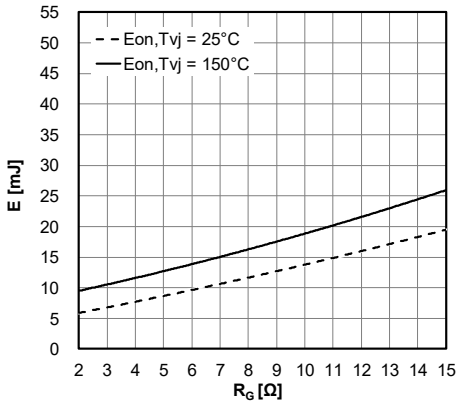


Fig.14 Switching losses IGBT,Inverter (typical)
E_{off} = f (R_G),
V_{GE} = +15 V / -7 V, I_C = 330 A, V_{CE} = 675 V

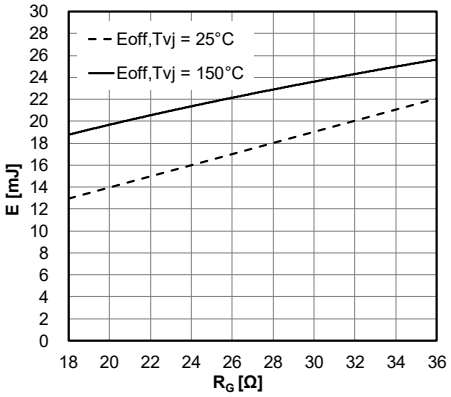


Fig.15 Switching losses IGBT, Inverter (typical)
E_{REC} = f (R_G),
V_{GE} = +15 V / -7 V, I_C = 330 A, V_{CE} = 675 V

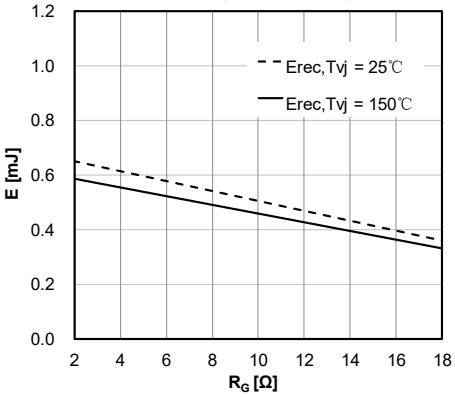


Fig.16 Switching losses IGBT, (typical)
E_{REC} = f (I_F),
V_{GE} = +15 V / -7 V, R_{Gon} = 2 Ω, V_{CE} = 675 V

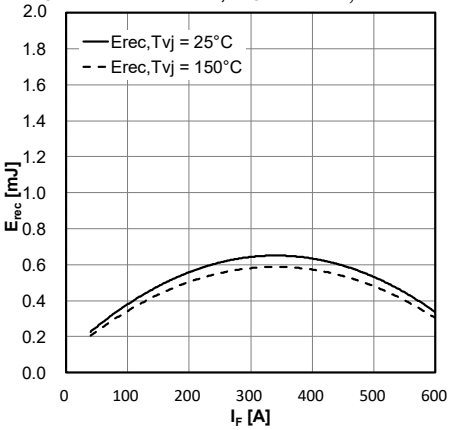
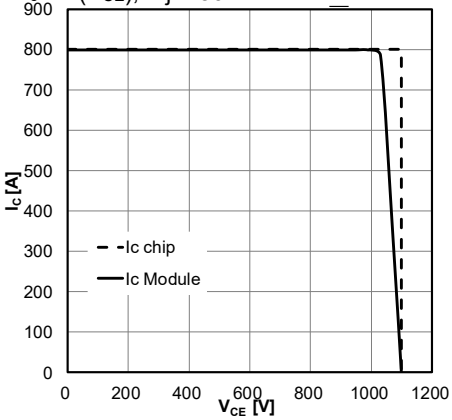


Fig.17 Reverse bias safe operating area IGBT, Inverter (RBSOA)
I_C = f (V_{CE}),Tvj=150℃



HCG600FL110E3T1

1100V / 600A E3 (size similar to Easy 3b with Cu Baseplate)

Typical Characteristics

Fig.18 Reverse bias safe operating area IGBT, Inverter (RBSOA)
$I_c = f(V_{CE})$,Tvj=25℃

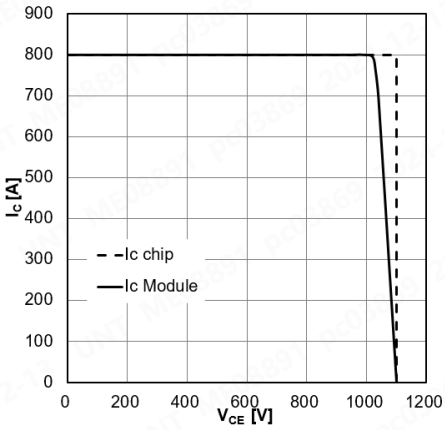


Fig.19 Reverse bias safe operating area IGBT, Inverter (RBSOA)
$I_c = f(V_{CE})$,Tvj=-40℃

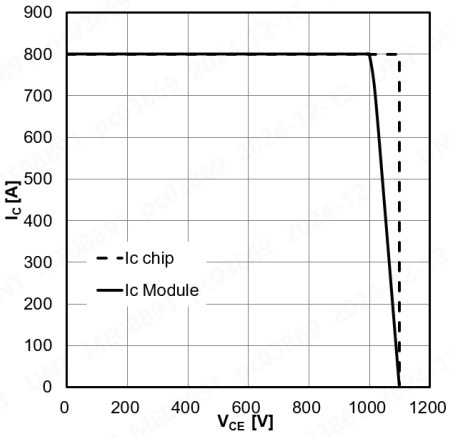


Fig.20 NTC-Thermistor-temperature characteristic (typical)

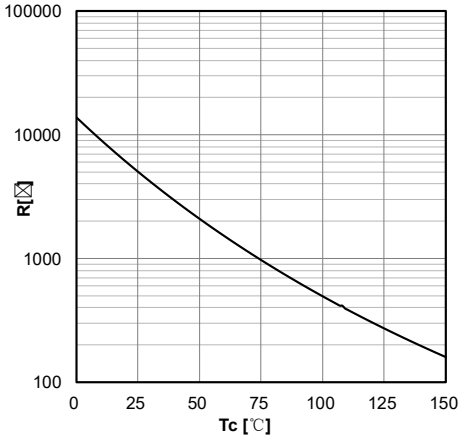


Fig.21 Capacity characteristic
$C = f(V_{CE})$, V_{GE} = 0 V, Tvj = 25°C, f = 100 KHz
(Q1, Q2, Q3, Q4)

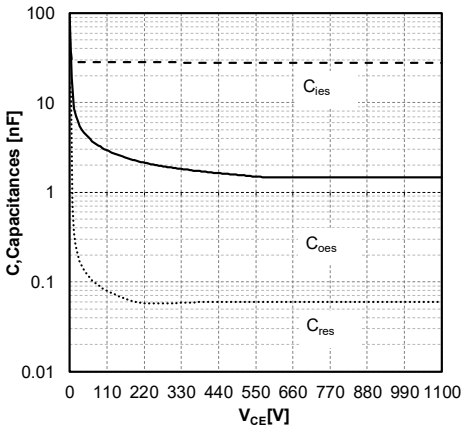


Fig.22 Transient thermal impedance IGBT,
$Z_{thJC} = f(t)$ (Q1, Q2, Q3, Q4)

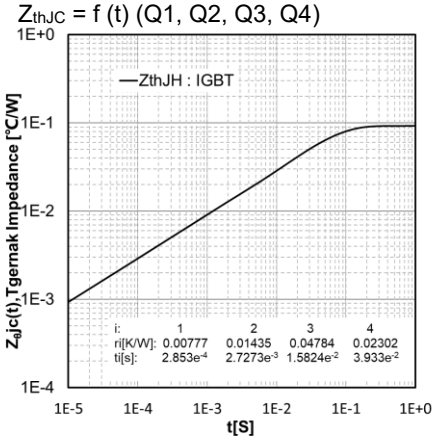
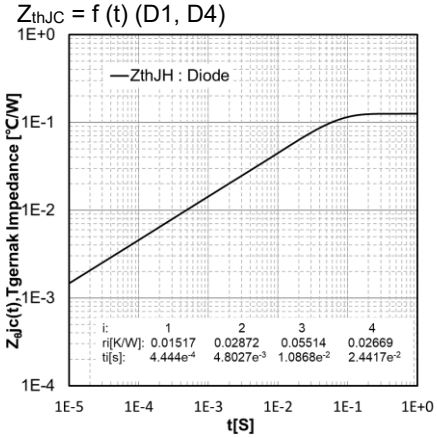


Fig.23 Transient thermal impedance Diode,
$Z_{thJC} = f(t)$ (D1, D4)



HCG600FL110E3T1

1100V / 600A E3 (size similar to Easy 3b with Cu Baseplate)

Typical Characteristics

Fig.24 Transient thermal impedance Diode, Z_{thJC} = f (t) (D2, D3)

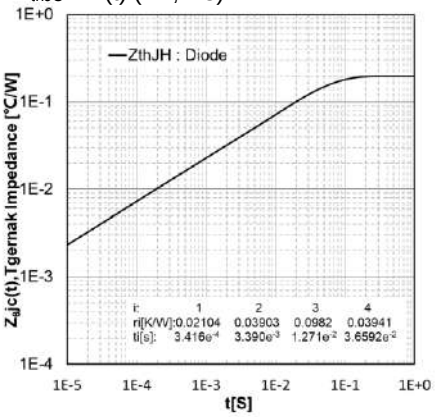
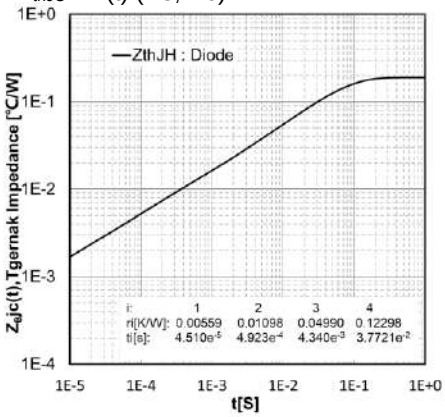


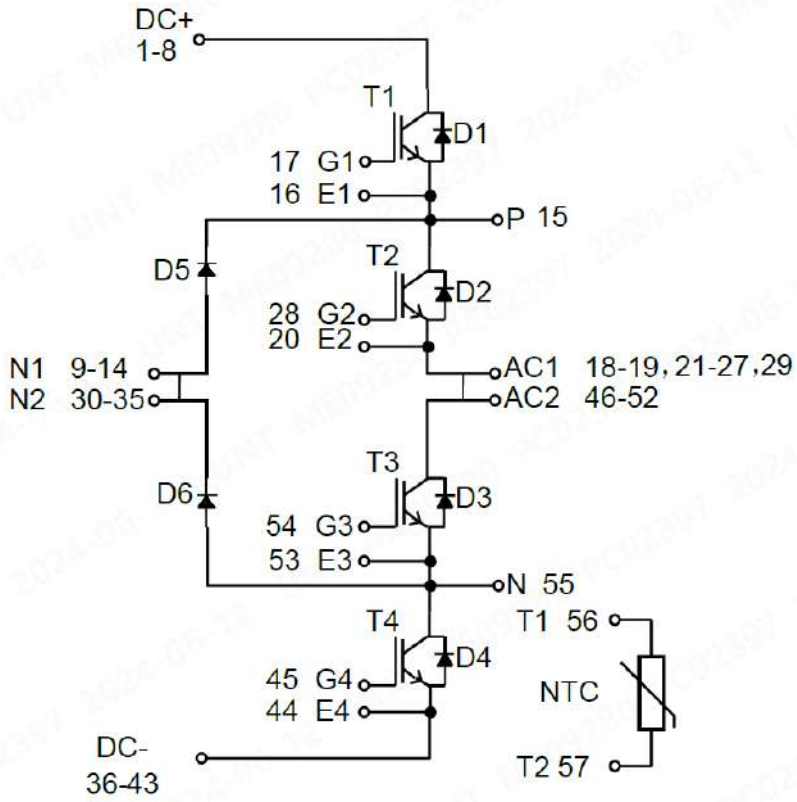
Fig.25 Transient thermal impedance Diode, Z_{thJC} = f (t) (D5, D6)



HCG600FL110E3T1

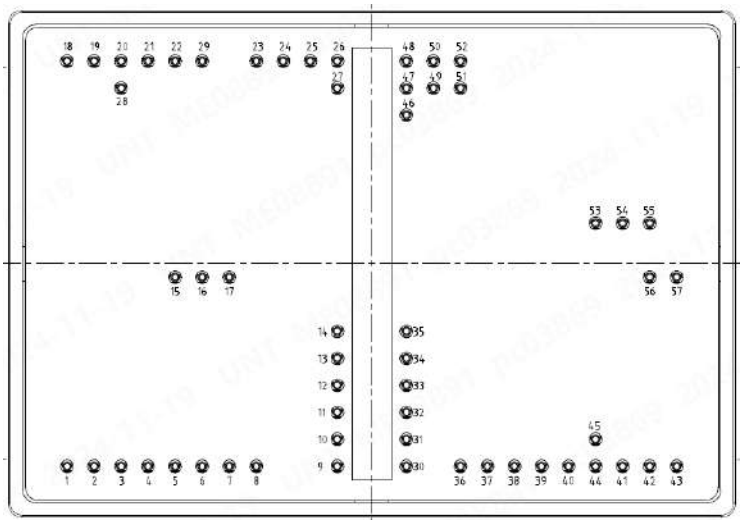
1100V / 600A E3 (size similar to Easy 3b with Cu Baseplate)

Circuit Diagram



1. Suggest that AC1 and AC2, N1 and N2 be electrically connected on the PCB.

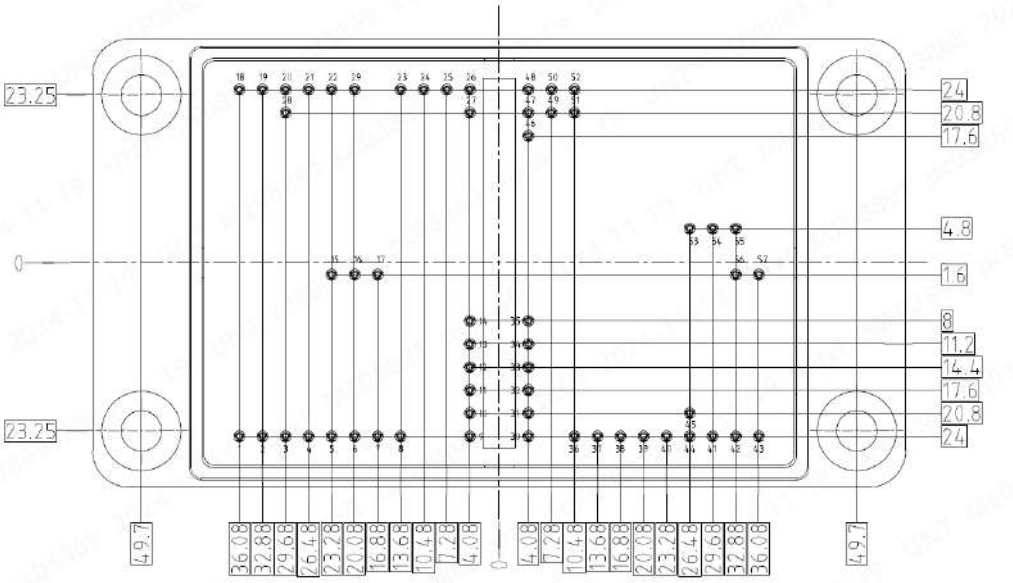
Pin Connections

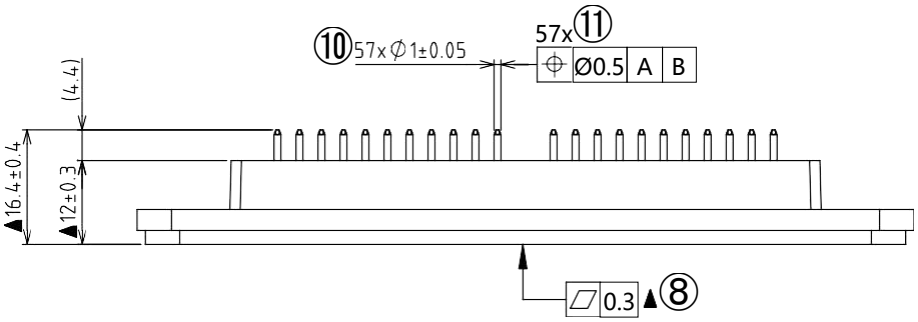


HCG600FL110E3T1

1100V / 600A E3 (size similar to Easy 3b with Cu Baseplate)

Package Outlines

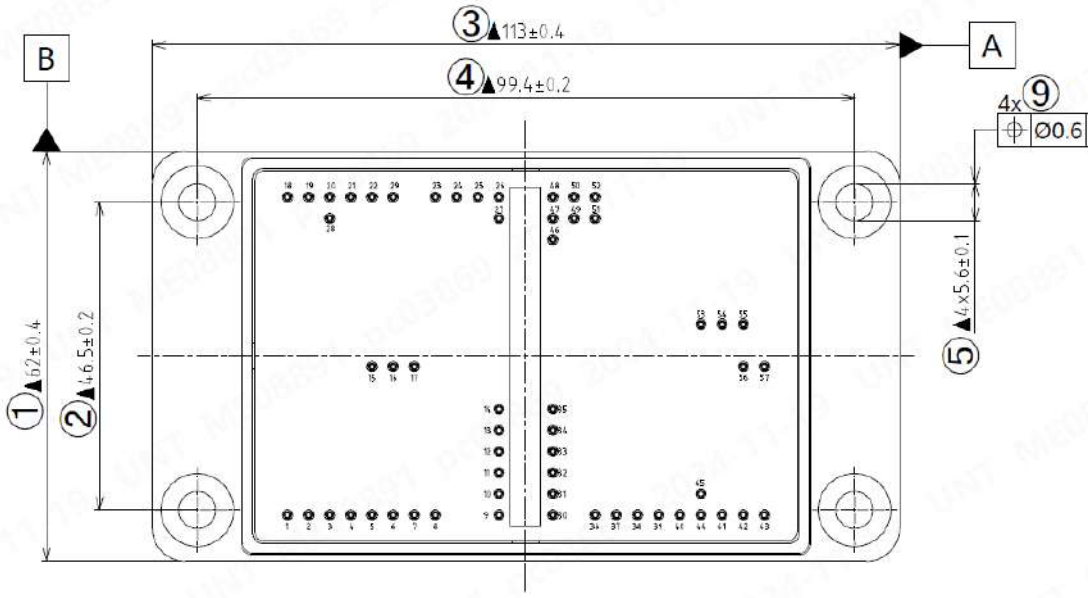


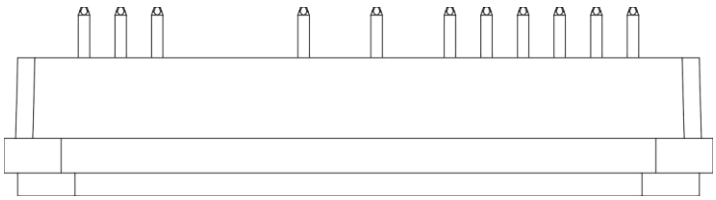


HCG600FL110E3T1

1100V / 600A E3 (size similar to Easy 3b with Cu Baseplate)

Package Outlines





Revision History

Document Version	Description of Changes
RevX.0.1	Released

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