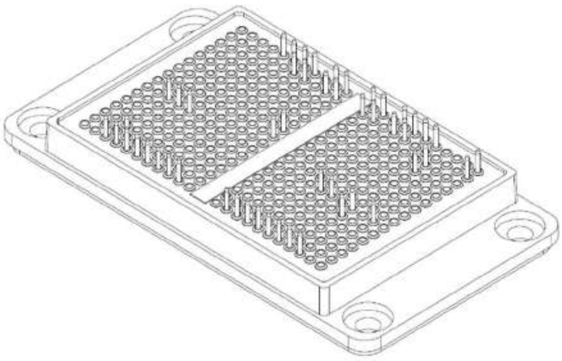
HCG450FL100E3T1

1000V / 450A E3 (size similar to Easy 3 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

HCG450FL100E3T1
1000V / 450A E3 (size similar to Easy 3 with Cu Baseplate)

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

Parameter	Symbol	Value	Unit
IGBT (Q1, Q4)			
Collector−Emitter Voltage	V_{CES}	1000	V
Gate−Emitter Voltage	V_{GE}	±23	V
Continuous Collector Current @ Tc = 65°C, T_j = 175°C	I_C	310	A
Pulsed Collector Current @ T_j = 175°C	I_{CP}	620	A
Junction Temperature	T_j	-40 to +175	°C
IGBT (Q2, Q3)			
Collector−Emitter Voltage	V_{CES}	1000	V
Gate−Emitter Voltage	V_{GE}	±23	V
Continuous Collector Current @ Tc = 65°C, T_j = 175°C	I_C	300	A
Pulsed Collector Current @ T_j = 175°C	I_{CP}	600	A
Junction Temperature	T_j	-40 to +175	°C
IGBT (Q5, Q6)			
Collector−Emitter Voltage	V_{CES}	1000	V
Gate−Emitter Voltage	V_{GE}	±23	V
Continuous Collector Current @ Tc = 65°C, T_j = 175°C	I_C	120	A
Pulsed Collector Current @ T_j = 175°C	I_{CP}	240	A
Junction Temperature	T_j	-40 to +175	°C
DIODE (D1,D2,D3,D4)			
Peak Repetitive Reverse Voltage	V_{RRM}	1000	V
Continuous Forward Current @ Tc = 65°C， T_j = 175°C	I_F	150	A
Repetitive Peak Forward Current @ T_j = 175°C	I_{FRM}	300	A
I^2t-value@VR = 0 V, tP = 10 ms, T_{vj} = 150°C	I^2t	3200	A^2s
Junction Temperature	T_j	-40 to +175	°C
DIODE (D5,D6)			
Peak Repetitive Reverse Voltage	V_{RRM}	1000	V
Continuous Forward Current @ Tc = 65°C， T_j = 175°C	I_F	132	A
Repetitive Peak Forward Current @ T_j = 175°C	I_{FRM}	264	A

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Parameter	Symbol	Value	Unit
I^2t-value@VR = 0 V, tP = 10 ms, T_{vj} = 150°C	I^2t	1500	A^2s
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_{op}	-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 = 400 A	T_j = 25°C	-	1.86	-	V
		V_{GE} = 15 V, I_C = 400 A	T_j = 150°C	-	2.36	-	
Gate−Emitter Threshold Voltage	$V_{GE(TH)}$	V_{GE} = V_{CE}, I_C = 6.5 mA	T_j = 25°C	-	5.05	-	V
Total Gate Charge	Q_g	V_{GE} = ±15 V, V_{CE} = 600 V	T_j = 25°C	-	2.07	-	μC
Gate-Source Leakage Current	I_{GES}	V_{GE} = 20 V, V_{CE} = 0 V	T_j = 25°C	-	-	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_{iss}	V_{GE} = 0 V, V_{CE} = 20 V, f = 100 KHz	T_j = 25°C	-	24.4	-	nF
Output Capacitance	C_{oss}		T_j = 25°C	-	0.88	-	
Reverse Transfer Capacitance	C_{rss}		T_j = 25°C	-	0.11	-	
Turn-on Delay Time(inductive load)	$t_{d\ on}$	V_{GE} = -7 V / +15 V, V_{CE} = 650 V, I_C = 350 A, R_{Gon} = 2.7 Ω, R_{Goff} = 20 Ω	T_j = 25°C	-	91	-	ns
			T_j = 150°C	-	82	-	
Rise Time (inductive load)	t_r		T_j = 25°C	-	59	-	
			T_j = 150°C	-	49	-	
Turn-off Delay Time(inductive load)	$t_{d\ off}$		T_j = 25°C	-	1264	-	
			T_j = 150°C	-	1333	-	

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1000V / 450A E3 (size similar to Easy 3 with Cu Baseplate)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Fall Time (inductive load)	t_f	V_{GE} = -7 V / +15 V V_{CE} = 650 V I_C = 350 A R_{Gon} = 2.7 Ω R_{Goff} = 20 Ω	T_j = 25°C	-	112	-	ns
			T_j = 150°C	-	78	-	
Turn-on Switching Loss	E_{on}		T_j = 25°C	-	27	-	mJ
			T_j = 150°C	-	19	-	
Turn-off Switching Loss	E_{off}		T_j = 25°C	-	22	-	
			T_j = 150°C	-	20	-	
Thermal Resistance – Chip–to–Case	R_{thJC}	Thermal grease，λ = 2.8 W/mK		-	0.13	-	°C /W
Thermal Resistance – Chip–to–Heatsink	R_{thJH}	Thermal grease，λ = 2.8 W/mK		-	0.24	-	°C /W

DIODE (D5,D6)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Diode Forward Voltage	V_F	I_F = 225 A	T_j = 25°C	-	1.92	-	V
		I_F = 225 A	T_j = 150°C	-	2.75	-	
Reverse Recovery Time	T_{RR}	V_{GE} = -7 V / +15 V V_{CE} = 650 V I_C = 350 A R_{Gon} = 2.7 Ω R_{Goff} = 20 Ω	T_j = 25°C	-	27	-	ns
			T_j = 150°C	-	28	-	
Reverse Recovery Charge	Q_{RR}		T_j = 25°C	-	0.54	-	μC
			T_j = 150°C	-	0.83	-	
Peak Reverse Recovery Current	I_{RRM}		T_j = 25°C	-	36.2	-	A
			T_j = 150°C	-	50.3	-	
Reverse Recovery Energy	E_{RR}		T_j = 25°C	-	0.05	-	uJ
			T_j = 150°C	-	0.13	-	
Thermal Resistance – Chip–to–Case	R_{thJC}	Thermal grease，λ = 2.8 W/mK		-	0.26	-	°C /W
Thermal Resistance – Chip–to–Heatsink	R_{thJH}	Thermal grease，λ = 2.8 W/mK		-	0.35	-	°C /W

IGBT (Q2, Q3)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Collector–Emitter Saturation Voltage	$V_{CE(sat)}$	V_{GE} = 15 V, I_C = 400 A	T_j = 25°C	-	1.30	-	V
		V_{GE} = 15 V, I_C = 400 A	T_j = 150°C	-	1.41	-	
Gate–Emitter Threshold Voltage	$V_{GE(TH)}$	V_{GE} = V_{CE}, I_C = 6.5 mA	T_j = 25°C	-	5.01	-	V
Total Gate Charge	Q_g	V_{GE} = ±15 V, V_{CE} = 600 V	T_j = 25°C	-	3.68	-	μC
Gate-Source Leakage Current	I_{GES}	V_{GE} = 20 V, V_{CE} = 0 V	T_j = 25°C	-	-	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

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1000V / 450A E3 (size similar to Easy 3 with Cu Baseplate)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Input Capacitance	C_{iss}	V_{GE} = 0 V, V_{CE} = 20 V, f = 100 KHz	T_j = 25°C	-	57	-	nF
Output Capacitance	C_{oss}		T_j = 25°C	-	0.88	-	
Reverse Transfer Capacitance	C_{rss}		T_j = 25°C	-	0.27	-	
Turn-on Delay Time(inductive load)	$t_{d\ on}$	V_{GE} = -7 V / +15 V, V_{CE} = 650 V, I_C = 350 A, R_{Gon} = 2.7 Ω, R_{Goff} = 40 Ω	T_j = 25°C	-	172	-	ns
			T_j = 150°C	-	153	-	
Rise Time(inductive load)	t_r		T_j = 25°C	-	56.6	-	
			T_j = 150°C	-	57.1	-	
Turn-off Delay Time(inductive load)	$t_{d\ off}$		T_j = 25°C	-	3909	-	
			T_j = 150°C	-	4301	-	
Fall Time(inductive load)	t_f		T_j = 25°C	-	175	-	
			T_j = 150°C	-	139	-	
Turn-on Switching Loss	E_{on}		T_j = 25°C	-	10.4	-	mJ
			T_j = 150°C	-	13.3	-	
Turn-off Switching Loss	E_{off}		T_j = 25°C	-	64.5	-	
			T_j = 150°C	-	68.3	-	
Thermal Resistance – Chip–to–Case	R_{thJC}	Thermal grease，λ = 2.8 W/mK		-	0.14	-	°C /W
Thermal Resistance – Chip–to–Heatsink	R_{thJH}	Thermal grease，λ = 2.8 W/mK		-	0.24	-	°C /W

IGBT (Q5, Q6)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Collector–Emitter Saturation Voltage	$V_{CE(sat)}$	V_{GE} = 15 V, I_C = 400 A	T_j = 25°C	-	2.63	-	V
		V_{GE} = 15 V, I_C = 400 A	T_j = 150°C	-	3.42	-	
Gate–Emitter Threshold Voltage	$V_{GE(TH)}$	V_{GE} = V_{CE}, I_C = 3.25 mA	T_j = 25°C	-	5.1	-	V
Total Gate Charge	Q_g	V_{GE} = ±15 V, V_{CE} = 600 V	T_j = 25°C	-	1.03	-	μC
Gate-Source Leakage Current	I_{GES}	V_{GE} = 20 V, V_{CE} = 0 V	T_j = 25°C	-	-	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_{iss}	V_{GE} = 0 V, V_{CE} = 20 V, f = 100 KHz	T_j = 25°C	-	12.2	-	nF
Output Capacitance	C_{oss}		T_j = 25°C	-	0.44	-	
Reverse Transfer Capacitance	C_{rss}		T_j = 25°C	-	0.06	-	

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1000V / 450A E3 (size similar to Easy 3 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} = 650 V, I_C = 350 A, R_{Gon} = 2.7 Ω, R_{Goff} = 40 Ω	T_j = 25°C	-	83	-	ns
			T_j = 150°C	-	87	-	
Rise Time(inductive load)	t_r		T_j = 25°C	-	169	-	
			T_j = 150°C	-	130	-	
Turn-off Delay Time(inductive load)	$t_{d\ off}$		T_j = 25°C	-	983	-	
			T_j = 150°C	-	1140	-	
Fall Time(inductive load)	t_f		T_j = 25°C	-	178	-	
			T_j = 150°C	-	98	-	
Turn-on Switching Loss	E_{on}		T_j = 25°C	-	39.5	-	mJ
			T_j = 150°C	-	43.9	-	
Turn-off Switching Loss	E_{off}		T_j = 25°C	-	28.6	-	
			T_j = 150°C	-	27.7	-	
Thermal Resistance – Chip–to–Case	R_{thJC}	Thermal grease，λ = 2.8 W/mK		-	0.28	-	°C /W
Thermal Resistance – Chip–to–Heatsink	R_{thJH}	Thermal grease，λ = 2.8 W/mK		-	0.41	-	°C /W

INVERSE DIODE (D1, D2, D3, D4)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
Diode Forward Voltage	V_F	I_F = 225 A	T_j = 25°C	-	2.43	-	V
		I_F = 225 A	T_j = 150°C	-	2.51	-	
Reverse Recovery Time	T_{RR}	V_{GE} = -7 V / +15 V V_{CE} = 650 V I_C = 350 A R_{Gon} = 2.7 Ω R_{Goff} = 40 Ω	T_j = 25°C	-	293	-	ns
			T_j = 150°C	-	335	-	
Reverse Recovery Charge	Q_{RR}		T_j = 25°C	-	8.5	-	μC
			T_j = 150°C	-	17.3	-	
Peak Reverse Recovery Current	I_{RRM}		T_j = 25°C	-	50	-	A
			T_j = 150°C	-	88	-	
Reverse Recovery Energy	E_{RR}		T_j = 25°C	-	2.9	-	mJ
			T_j = 150°C	-	6.3	-	
Thermal Resistance – Chip–to–Case	R_{thJC}	Thermal grease，λ = 2.8 W/mK		-	0.26	-	°C /W
Thermal Resistance – Chip–to–Heatsink	R_{thJH}	Thermal grease，λ = 2.8 W/mK		-	0.37	-	°C /W

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1000V / 450A E3 (size similar to Easy 3 with Cu Baseplate)

Table 3 NTC-Thermistor

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Rated Resistance	R_{25}	T_C = 25°C	-	5	-	kΩ
Deviation of R100	△R/R	T_C = 100°C, R_{100} = 493 Ω	-5	-	5	%
Power Dissipation	P25	TNTC = 25°C	-	-	60	mW
B-value	$B_{25/50}$	B (25/50), tolerance ±3%	-	3375	-	K
B-value	$B_{25/100}$	B (25/100), tolerance ±3%	-	3433	-	K

Table 4 Module Characteristics

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Stray Inductance	L_{CE}		-	15	-	nH
Mounting Torque Screw:M5	M		3.0	-	5.0	N.m
Creepage distance	terminal to heatsink			11.5		
Clearance	terminal to heatsink			9.4		
CTI				≥600		
Flatness of base plate					0.3	mm
Weight				250		g

HCG450FL100E3T1

1000V / 450A E3 (size similar to Easy 3 with Cu Baseplate)

Typical Characteristics

Fig.1 Output characteristic IGBT, Q1 / Q4 (typical)
$I_C = f(V_{CE})$
V_{GE} = 15 V

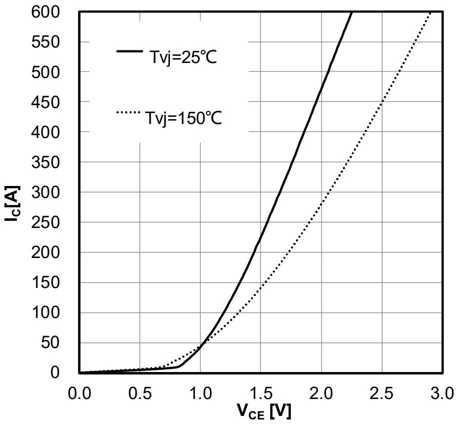


Fig.2 Output characteristic IGBT, Q1 / Q4 (typical)
$I_C = f(V_{CE})$
Tvj = 150°C

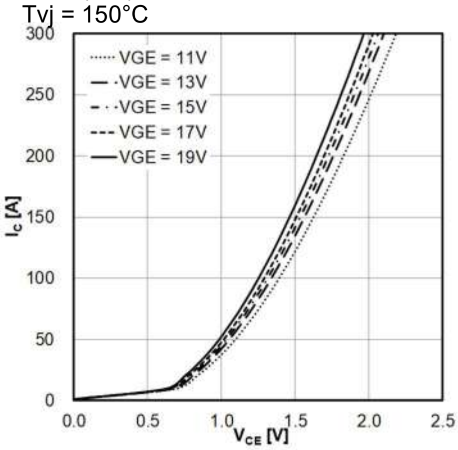


Fig.3 Transfer characteristic IGBT, Q1 / Q4 (typical)
$I_C = f(V_{GE})$
V_{CE} = 20 V

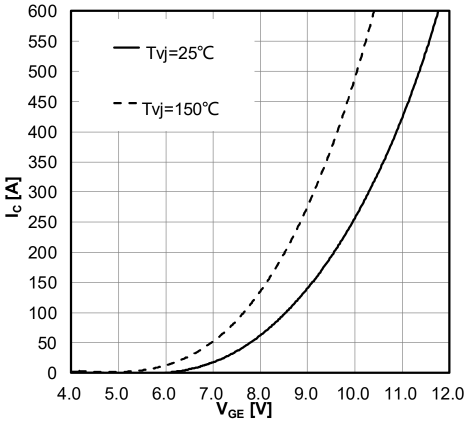


Fig.4 Transient thermal impedance IGBT (Q1, Q4)
$Z_{thJH} = f(t)$

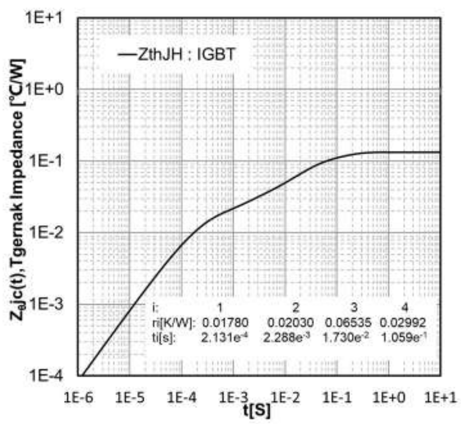


Fig.5 Output characteristic IGBT, Q2 / Q3 (typical)
$I_C = f(V_{CE})$
V_{GE} = 15 V

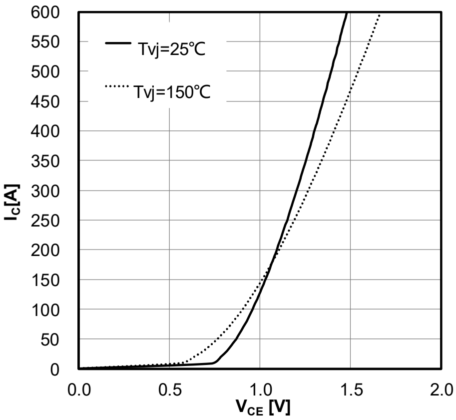
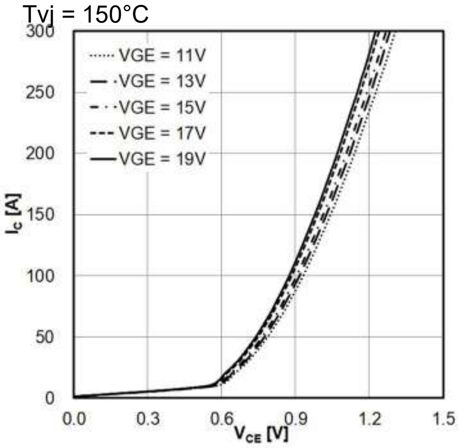


Fig.6 Output characteristic IGBT, Q2 / Q3 (typical)
$I_C = f(V_{CE})$
Tvj = 150°C



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1000V / 450A E3 (size similar to Easy 3 with Cu Baseplate)

Typical Characteristics

Fig.7 Transfer characteristic IGBT, Q2 / Q3 (typical)
$I_C = f(V_{GE})$
$V_{CE} = 20$ V

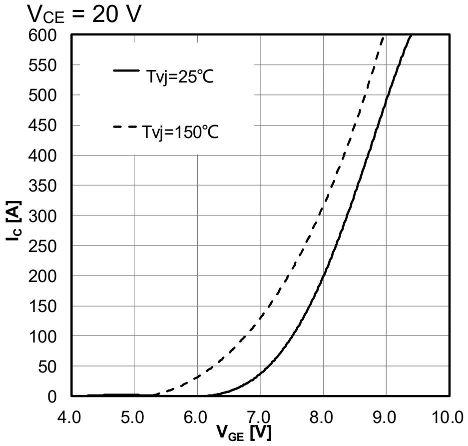


Fig.8 Transient thermal impedance IGBT (Q2, Q3)
$Z_{thJH} = f(t)$

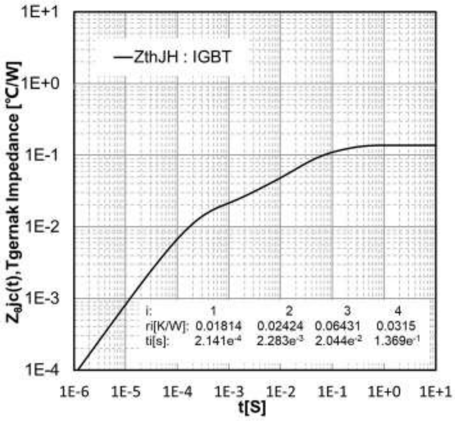


Fig.9 Output characteristic IGBT, Q5 / Q6 (typical)
$I_C = f(V_{CE})$
$V_{GE} = 15$ V

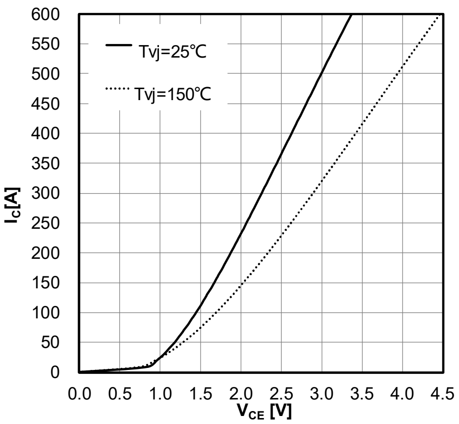


Fig.10 Output characteristic IGBT, Q5 / Q6 (typical)
$I_C = f(V_{CE})$
Tvj = 150°C

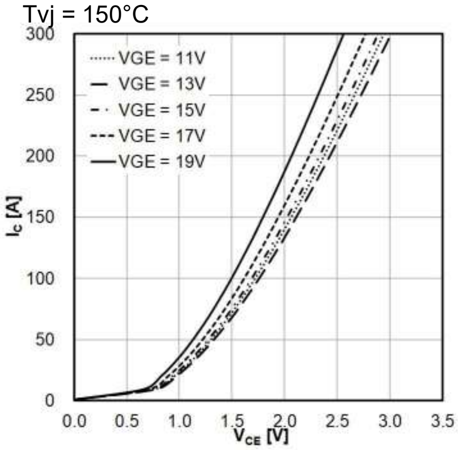


Fig.11 Transfer characteristic IGBT, Q5 / Q6 (typical)
$I_C = f(V_{GE})$
$V_{CE} = 20$ V

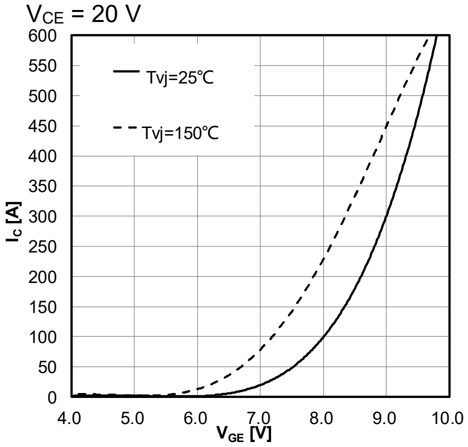
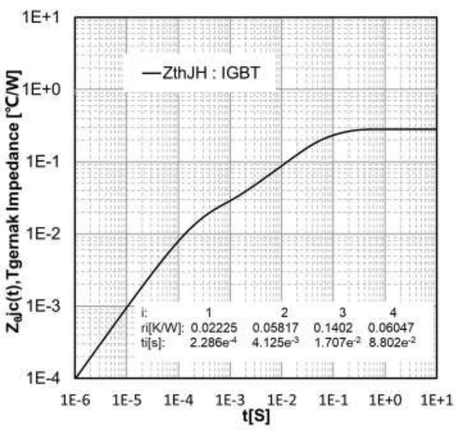


Fig.12 Transient thermal impedance IGBT (Q5, Q6)
$Z_{thJH} = f(t)$



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1000V / 450A E3 (size similar to Easy 3 with Cu Baseplate)

Typical Characteristics

Fig.13 Forward characteristic of Diode, D1 / D2 / D3 / D4 (typical)
$I_F = f\ (V_F)$

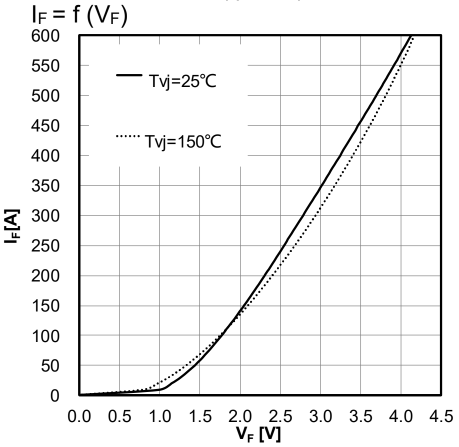


Fig.14 Forward characteristic of Diode, D5 / D6 (typical)
$I_F = f\ (V_F)$

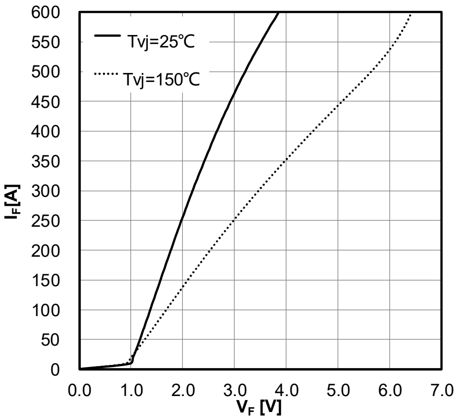


Fig.15 Transient thermal impedance Diode (D1, D2, D3, D4)
$Z_{thJH} = f\ (t)$

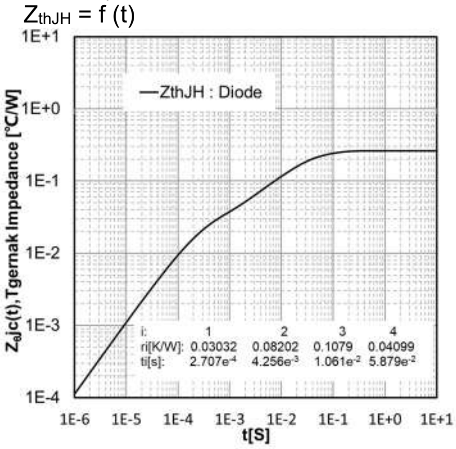
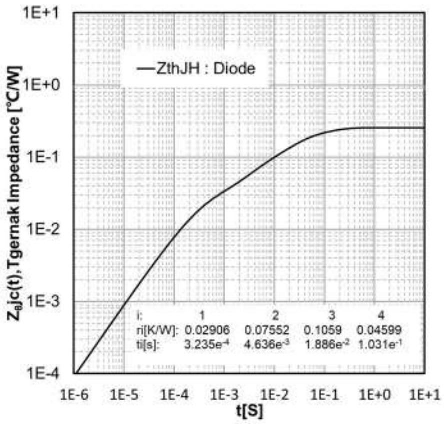


Fig.16 Transient thermal impedance Diode (D5, D6)
$Z_{thJH} = f\ (t)$



Q1 || D5 or Q4 || D6

Fig.17 Switching losses IGBT, Inverter (typical)
$E_{on} = f\ (I_C)$, $E_{off} = f\ (I_C)$,
$V_{GE} = +15\ V\ /\ -7\ V$, $R_{Gon} = 2.7\ \Omega$, $R_{Goff} = 20\ \Omega$,
$V_{CE} = 650\ V$

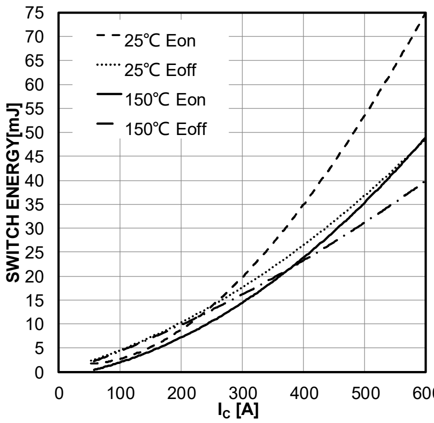
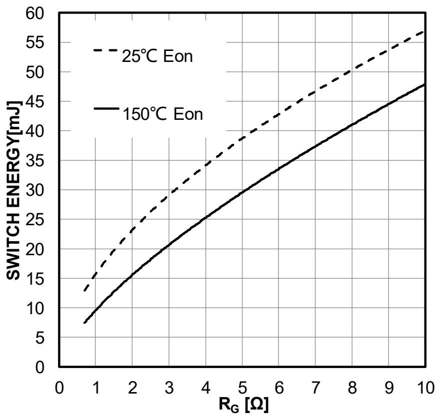


Fig.18 Switching losses IGBT, Inverter (typical)
$E_{on} = f\ (R_G)$,
$V_{GE} = +15\ V\ /\ -7\ V$, $I_C = 350\ A$, $V_{CE} = 650\ V$



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1000V / 450A E3 (size similar to Easy 3 with Cu Baseplate)

Typical Characteristics

Fig.19 Switching losses IGBT, Inverter (typical)
E_{off} = f (R_G),
V_{GE} = +15 V / -7 V, I_C = 350 A, V_{CE} = 650 V

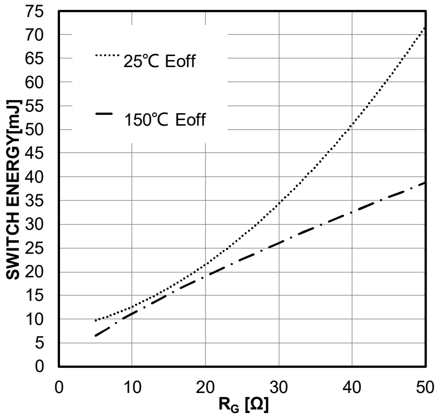


Fig.20 Switching losses IGBT, Inverter (typical)
E_{REC} = f (R_G),
V_{GE} = +15 V / -7 V, I_C = 350 A, V_{CE} = 650 V

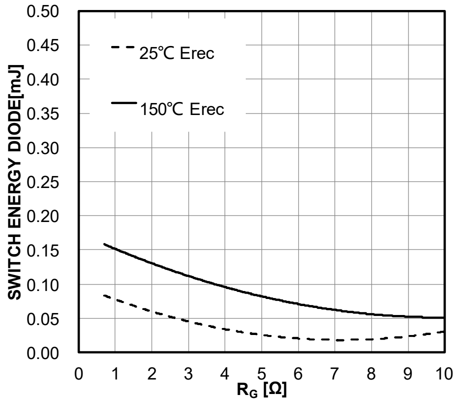


Fig.21 switching losses Diode (typical)
E_{rec} = f (I_F)
R_{Gon} = 2.7 Ω, V_{CE} = 650 V

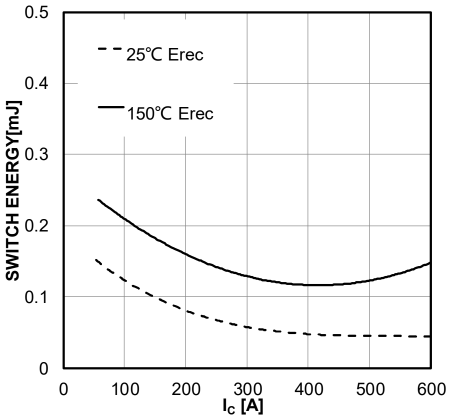
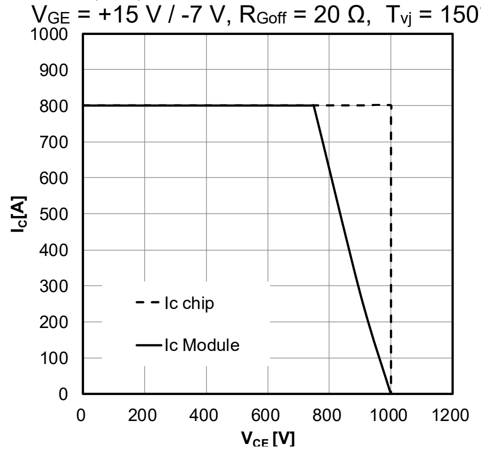


Fig.22 Reverse bias safe operating area IGBT, Q1 / Q4 (RBSOA)
I_C = f (V_{CE})
V_{GE} = +15 V / -7 V, R_{Goff} = 20 Ω, T_{vj} = 150°C



Q2||D5 or Q3||D6

Fig.23 Switching losses IGBT, Inverter (typical)
E_{on} = f (I_C), E_{off} = f (I_C),
V_{GE} = +15 V / -7 V, R_{Gon} = 2.7 Ω, R_{Goff} = 40 Ω,
V_{CE} = 650 V

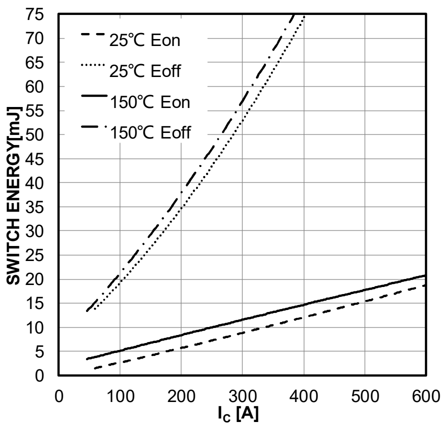
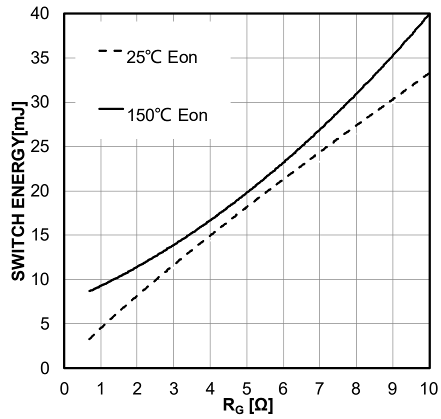


Fig.24 Switching losses IGBT, Inverter (typical)
E_{on} = f (R_G),
V_{GE} = +15 V / -7 V, I_C = 350 A, V_{CE} = 650 V



HCG450FL100E3T1

1000V / 450A E3 (size similar to Easy 3 with Cu Baseplate)

Typical Characteristics

Fig.25 Switching losses IGBT, Inverter (typical)
E_{off} = f (R_G),
V_{GE} = +15 V / -7 V, I_C = 350 A, V_{CE} = 650 V

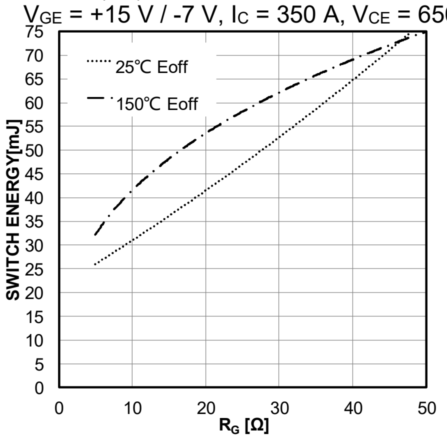


Fig.26 Switching losses IGBT, Inverter (typical)
E_{REC} = f (R_G),
V_{GE} = +15 V / -7 V, I_F = 350 A, V_R = 650 V

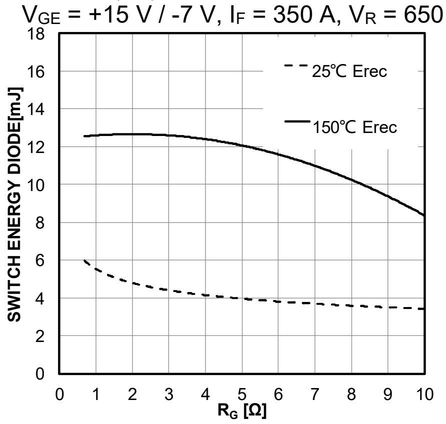


Fig.27 Switching losses Diode (typical)
E_{rec} = f (I_F)
R_{Gon} = 2.7 Ω, V_{CE} = 650 V

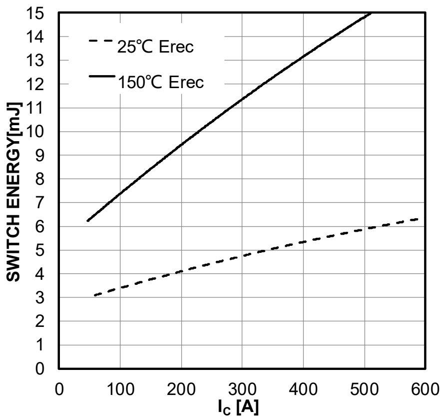
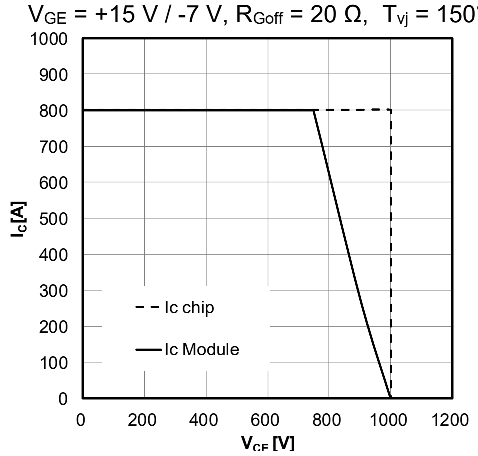


Fig.28 Reverse bias safe operating area IGBT, Q1 / Q4 (RBSOA)
I_C = f (V_{CE})
V_{GE} = +15 V / -7 V, R_{Goff} = 20 Ω, T_{vj} = 150°C



Q5||D1 or Q6||D4

Fig.29 Switching losses IGBT, Inverter (typical)
E_{on} = f (I_C), E_{off} = f (I_C),
V_{GE} = +15 V / -7 V, R_{Gon} = 2.7 Ω, R_{Goff} = 40 Ω,
V_{CE} = 650 V

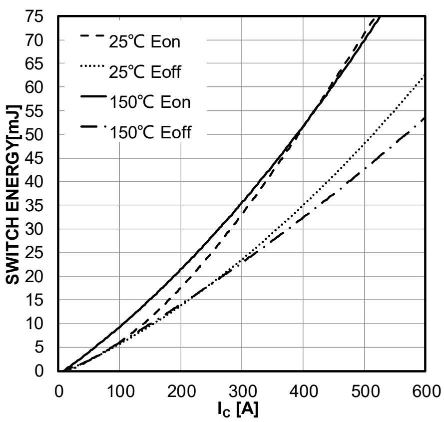
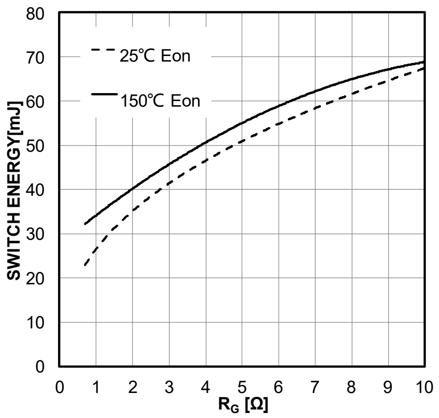


Fig.30 Switching losses IGBT, Inverter (typical)
E_{on} = f (R_G),
V_{GE} = +15 V / -7 V, I_C = 350 A, V_{CE} = 650 V



HCG450FL100E3T1

1000V / 450A E3 (size similar to Easy 3 with Cu Baseplate)

Typical Characteristics

Fig.31 Switching losses IGBT, Inverter (typical)
$E_{off} = f\ (R_G)$,
V_{GE} = +15 V / -7 V, I_C = 350 A, V_{CE} = 650 V

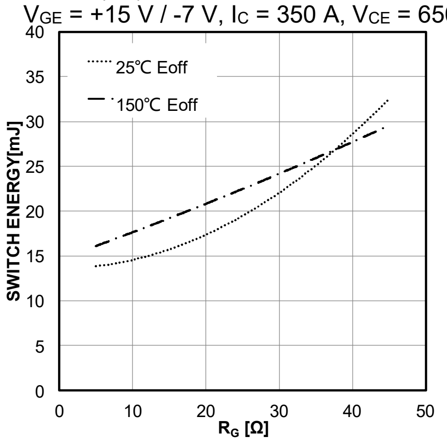


Fig.32 Switching losses IGBT, Inverter (typical)
$E_{REC} = f\ (R_G)$,
V_{GE} = +15 V / -7 V, I_F = 350 A, V_R = 650 V

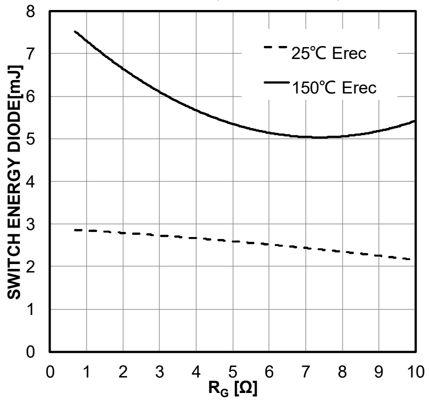


Fig.33 Switching losses IGBT, Inverter (typical)
$E_{off} = f\ (R_G)$,
V_{GE} = +15 V / -7 V, I_C = 350 A, V_{CE} = 650 V

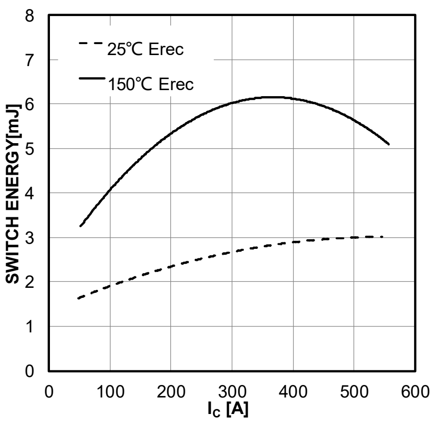


Fig.34 Reverse bias safe operating area IGBT, Q5 / Q6 (RBSOA)
$I_C = f\ (V_{CE})$
V_{GE} = +15 V / -7 V, R_{Goff} = 20 Ω, T_{vj} = 150°C

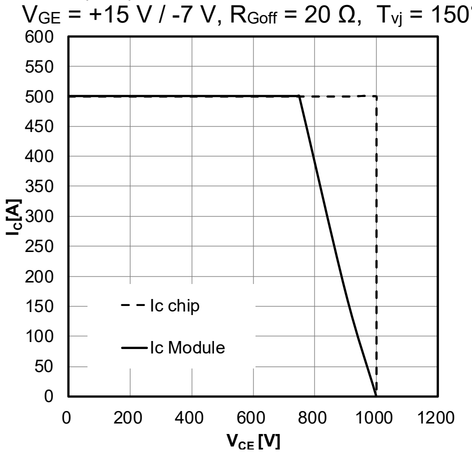
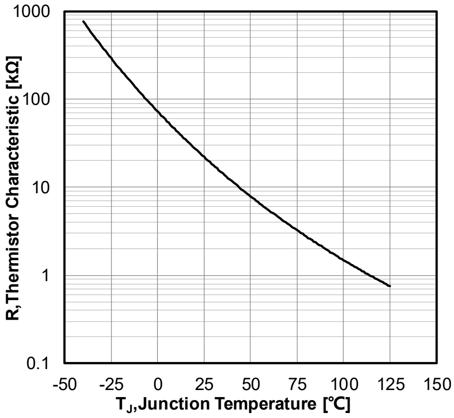
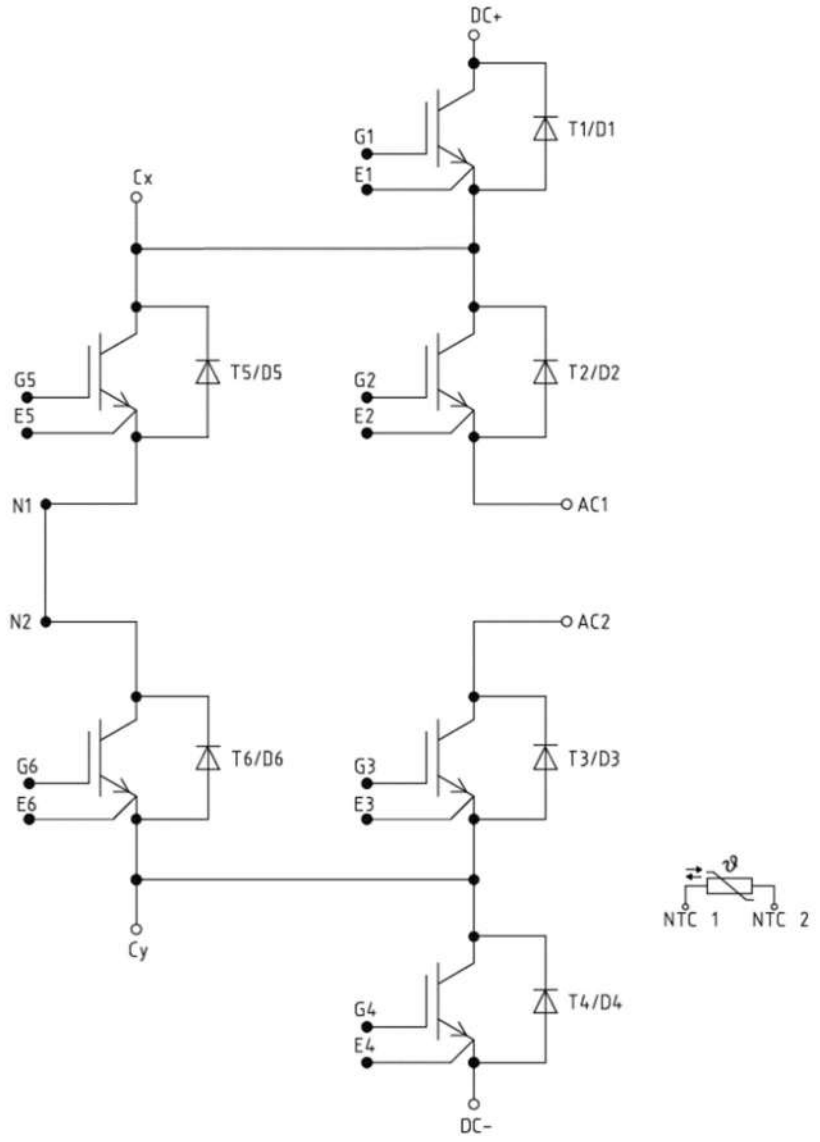


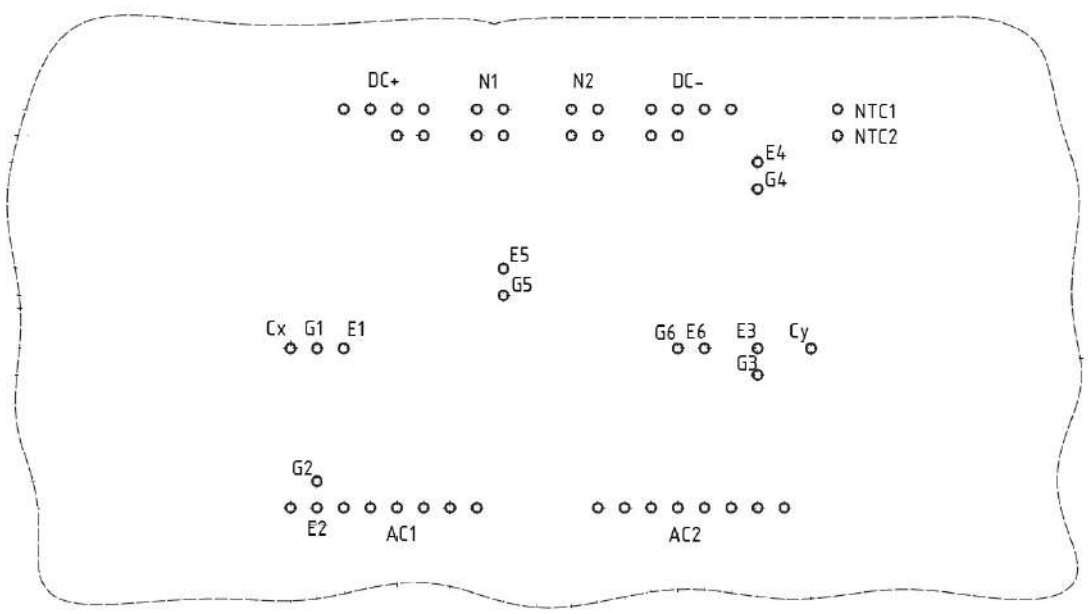
Fig.35 NTC-Thermistor-temperature characteristic (typical)



HCG450FL100E3T1
1000V / 450A E3 (size similar to Easy 3 with Cu Baseplate)

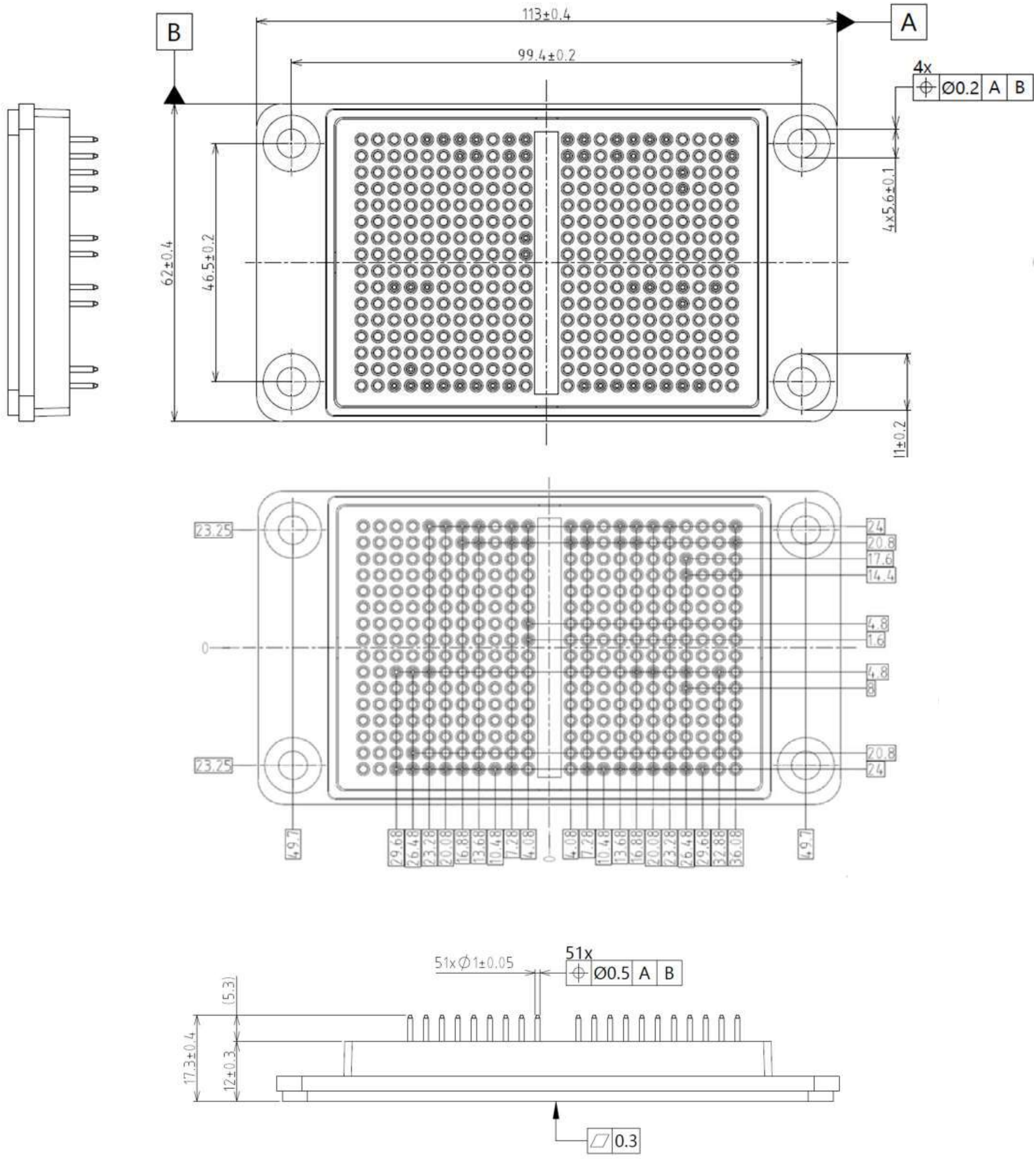
Circuit Diagram





HCG450FL100E3T1
1000V / 450A E3 (size similar to Easy 3 with Cu Baseplate)

Package Outlines



Revision History

Document Version	Description of Changes
RevX.0.1	Released

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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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