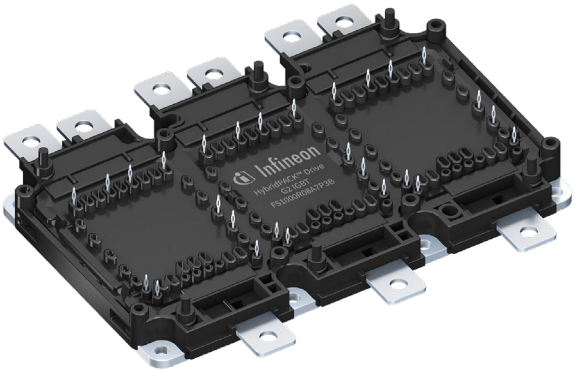
Final datasheet

英飞凌 HybridPACK™ Drive G2 模块

特性



- 电气特性
  - V_{CES} = 750 V
  - I_{CN} = 1000 A / I_{CRM} = 2000 A
  - 低 $V_{CE,sat}$
  - 低开关损耗
  - 低 Q_g和 C_{rss}
  - 低杂散电感设计
  - $T_{vj,op}$ = 175°C
  - 集成片上温度传感器
  - 短时延长工作温度 $T_{vj,op}$ = 185 °C
- 机械特性
  - 4.25 kV 直流电压 1 秒绝缘
  - 高爬电距离和电气间隙
  - 直冷式 PinFin 底板
  - PCB和冷却器组装的安装指导
  - PressFIT 压接技术
  - 符合 RoHS 标准，无铅
  - UL 94 V0 模块框架
  - 低热阻 Al_2O_3 基板

Lead-free

RoHS

Green

潜在应用

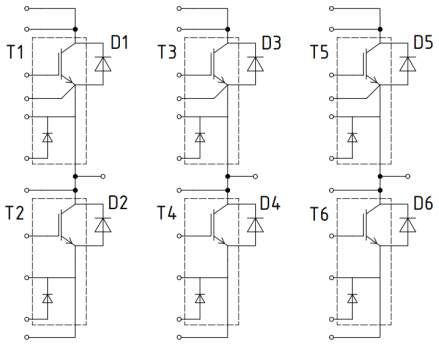
- 汽车应用
- （混合动力）电动汽车 (H)EV

产品验证

- 符合 AQG 324 标准，发布号：03.1/2021

描述

英飞凌HybridPACK™ Drive 是一款非常紧凑的B6桥式模块 (750V/1000A)，专为混合动力和电动汽车优化。



本数据手册的原文使用英文撰写。为方便起见，英飞凌提供了译文；由于翻译过程中可能使用了自动化工具，英飞凌不保证译文的准确性。为确认准确性，请务必访问 infineon.com 参考最新的英文版本（控制文档）。

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1 封装

表1 绝缘配合

Parameter	Symbol	Note or test condition	Values	Unit
Isolation test voltage	V_{ISOL}	RMS, f = 0 Hz, t = 1 sec	4.25	kV
Material of module baseplate			Cu+Ni[1)]	
Internal isolation		basic insulation (class 1, IEC 61140)	Al_2O_3	
Creepage distance	d_{creep}	terminal to heatsink	10.6	mm
Creepage distance	d_{creep}	terminal to terminal	10.6	mm
Clearance	d_{clear}	terminal to heatsink	4.5	mm
Clearance	d_{clear}	terminal to terminal	4.5	mm
Comparative tracking index	*CTI*		> 175	

1) 镀镍铜底板

表 2 最大额定值

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Maximum RMS module terminal current	$I_{t,rms}$	T_{Ct} = 125 °C		800		A
Heat-staking dome temperature[1)]	T_{HS}	$t_{staking}$ < 10s			280	°C

1) 热熔组装参考应用笔记 AN-G2-ASSEMBLY 。

表3 特征值

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Pressure drop in cooling circuit	Δp	50% water / 50% ethylene glycol, $\Delta V/\Delta t$ = 10 dm^3/min, T_f = 65 °C		76[1)]		mbar
Maximum pressure in cooling circuit	p	$T_{baseplate}$ < 40 °C (relative pressure)			3.0	bar
		$T_{baseplate}$ ≥ 40 °C (relative pressure)			2.5	
Stray inductance module	$L_{s,CE}$			8.0		nH
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	T_f = 25 °C, per switch		0.73		mΩ
Storage temperature	T_{stg}		-40		125	°C
Mounting torque for module mounting[2)]	M	Screw M4 baseplate to heatsink	1.8	2.0	2.2	Nm
		Screw EJOT Delta PCB to frame	0.45	0.5	0.55	
Weight	G			760		g

1) 冷却器设计和流动方向参考应用笔记 AN-G2-ASSEMBLY 。

2) 螺钉类型和扭矩参考应用笔记 AN-G2-ASSEMBLY。

2 IGBT、逆变器

表4 最大额定值

Parameter	Symbol	Note or test condition		Values	Unit
Collector-emitter voltage	V_{CES}		T_{vj} = 25 °C	750	V
Implemented collector current	I_{CN}			1000	A
Continuous DC collector current	$I_{C,nom}$	T_f = 65 °C, $T_{vj,max}$ = 175 °C		600*1)*	A
Repetitive peak collector current	I_{CRM}	verified by design, t_p limited by $T_{vj,max}$		2000	A
Total power dissipation	P_{tot}	T_f = 65 °C, $T_{vj,max}$ = 175 °C		750	W
Gate-emitter peak voltage	V_{GES}			±20	V

1) 通过特性/设计验证，而不是通过测试

表5 特征值

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Collector-emitter saturation voltage	$V_{CE,sat}$	I_C = 600 A, V_{GE} = 15 V	T_{vj} = 25 °C		1.08	1.21	V
			T_{vj} = 175 °C		1.09		
Collector-emitter saturation voltage	$V_{CE,sat}$	I_C = 1000 A, V_{GE} = 15 V	T_{vj} = 25 °C		1.22		V
			T_{vj} = 175 °C		1.32		
Gate threshold voltage	$V_{GE,th}$	I_C = 10.32 mA, V_{CE} = V_{GE}	T_{vj} = 25 °C	4.9	5.8	6.65	V
			T_{vj} = 175 °C		4		
Gate charge	Q_G	V_{CE} = 400 V, V_{GE} = -8...15 V			2.65		µC
Internal gate resistor	$R_{G,int}$		T_{vj} = 25 °C		1.0		Ω
Input capacitance	C_{ies}	f = 0.1 MHz, V_{CE} = 50 V, V_{GE} = 0 V	T_{vj} = 25 °C		60.8		nF
Output capacitance	C_{oes}	f = 0.1 MHz, V_{CE} = 50 V, V_{GE} = 0 V	T_{vj} = 25 °C		2.1		nF
Reverse transfer capacitance	C_{res}	f = 0.1 MHz, V_{CE} = 50 V, V_{GE} = 0 V	T_{vj} = 25 °C		0.27		nF
Collector-emitter cut-off current	I_{CES}	V_{CE} = 750 V, V_{GE} = 0 V	T_{vj} = 25 °C			1.0	mA
			T_{vj} = 175 °C		15.0		
			T_{vj} = 185 °C		28.0		
Gate-emitter leakage current	I_{GES}	V_{CE} = 0 V, V_{GE} = 20 V	T_{vj} = 25 °C			400	nA

（表格续下页……）

表 5　　（续） 特征值

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Turn-on delay time, inductive load	$t_{d,on}$	I_C = 600 A, V_{CE} = 400 V, V_{GE} = -8/15 V, $R_{G,on}$ = 2.4 Ω	T_{vj} = 25 °C		222		ns
			T_{vj} = 175 °C		255		
Rise time, inductive load	t_r	I_C = 600 A, V_{CE} = 400 V, V_{GE} = -8/15 V, $R_{G,on}$ = 2.4 Ω	T_{vj} = 25 °C		50.0		ns
			T_{vj} = 175 °C		55.0		
Turn-off delay time, inductive load	$t_{d,off}$	I_C = 600 A, V_{CE} = 400 V, V_{GE} = -8/15 V, $R_{G,off}$ = 7.5 Ω	T_{vj} = 25 °C		929		ns
			T_{vj} = 175 °C		1060		
Fall time, inductive load	t_f	I_C = 600 A, V_{CE} = 400 V, V_{GE} = -8/15 V, $R_{G,off}$ = 7.5 Ω	T_{vj} = 25 °C		91.0		ns
			T_{vj} = 175 °C		199		
Turn-on energy loss per pulse	E_{on}	I_C = 600 A, V_{CE} = 400 V, L_σ = 7 nH, V_{GE} = -8/15 V, $R_{G,on}$ = 2.4 Ω	T_{vj} = 25 °C, di/dt = 9600 A/µs		4.5		mJ
			T_{vj} = 175 °C, di/dt = 8700 A/µs		10.7		
Turn-off energy loss per pulse	E_{off}	I_C = 600 A, V_{CE} = 400 V, L_σ = 7 nH, V_{GE} = -8/15 V, $R_{G,off}$ = 7.5 Ω	T_{vj} = 25 °C, dv/dt = 4000 V/µs		31.1		mJ
			T_{vj} = 175 °C, dv/dt = 2700 V/µs		43.0		
SC data	I_{SC}	V_{CC} = 400 V, V_{GE} = 15 V, $V_{CEmax} = V_{CES} - L_{s,CE} \cdot di/dt$	T_{vj} = 25 °C, t_P = 3.0 µs		8500		A
			T_{vj} = 175 °C, t_P = 3.0 µs		6700		
			T_{vj} = 185 °C, t_P = 2.5 µs		6600		
Thermal resistance, junction to cooling fluid[1)]	$R_{th,j-f}$	50% water / 50% ethylene glycol, $\Delta V/\Delta t$ = 10 dm³/min, T_f = 65 °C			0.134		K/W
Variance of thermal resistance, junction to cooling fluid[1)]	$\sigma_{Rth,j-f}$	50% water / 50% ethylene glycol, $\Delta V/\Delta t$ = 10 dm³/min, T_f = 65 °C			0.002		K/W
Temperature under switching conditions	$T_{vj,op}$		continuous operation	-40		175	°C
			extended operation			185[2)]	

1)　冷却器设计和流动方向参考应用笔记 AN-G2-ASSEMBLY 。EoL 标准见 AQG324，通过特性验证。
2)　有关限制，请参见 QPAC 文档。

3 二极管、逆变器

表 6 最大额定值

Parameter	Symbol	Note or test condition		Values	Unit
Repetitive peak reverse voltage	V_{RRM}	T_{vj} = 25 °C		750	V
Implemented forward current	I_{FN}			1000	A
Continuous DC forward current	$I_{F,nom}$			600	A
Repetitive peak forward current	I_{FRM}	verified by design, t_p limited by $T_{vj,max}$		2000	A
I2t - value	I^2t	V_R = 0 V, t_P = 10 ms	T_{vj} = 175 °C	24500	A^2s

表 7 特征值

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_F	I_F = 600 A	T_{vj} = 25 °C		1.76	2.08	V
			T_{vj} = 175 °C		1.57		
Forward voltage	V_F	I_F = 1000 A	T_{vj} = 25 °C		2.09		V
			T_{vj} = 175 °C		1.95		
Peak reverse recovery current	I_{rm}	I_F = 600 A, V_{GE} = -8 V, V_R = 400 V	T_{vj} = 25 °C		351		A
			T_{vj} = 175 °C		526		
Recovered charge	Q_r	I_F = 600 A, V_R = 400 V, V_{GE} = -8 V	T_{vj} = 25 °C		14.4		µC
			T_{vj} = 175 °C		43.1		
Reverse recovery energy	E_{rec}	I_F = 600 A, V_{GE} = -8 V, V_R = 400 V	T_{vj} = 25 °C, $-di_F/dt$ = 16.2 A/ns		4.90		mJ
			T_{vj} = 175 °C, $-di_F/dt$ = 13.4 A/ns		13.40		
Thermal resistance, junction to cooling fluid[1]	$R_{th,j-f}$	50% water / 50% ethylene glycol, $\Delta V/\Delta t$ = 10 dm^3/min, T_f = 65 °C			0.173		K/W
Variance of thermal resistance, junction to cooling fluid[1]	$\sigma_{Rth,j-f}$	50% water / 50% ethylene glycol, $\Delta V/\Delta t$ = 10 dm^3/min, T_f = 65 °C			0.0027		K/W
Temperature under switching conditions	$T_{vj,op}$		continuous operation	-40		175	°C
			extended operation			185[2]	

1) 冷却器设计和流动方向参考应用笔记 AN-G2-ASSEMBLY。EoL 标准见 AQG324，通过特性验证。
2) 有关限制，请参见 QPAC 文档。

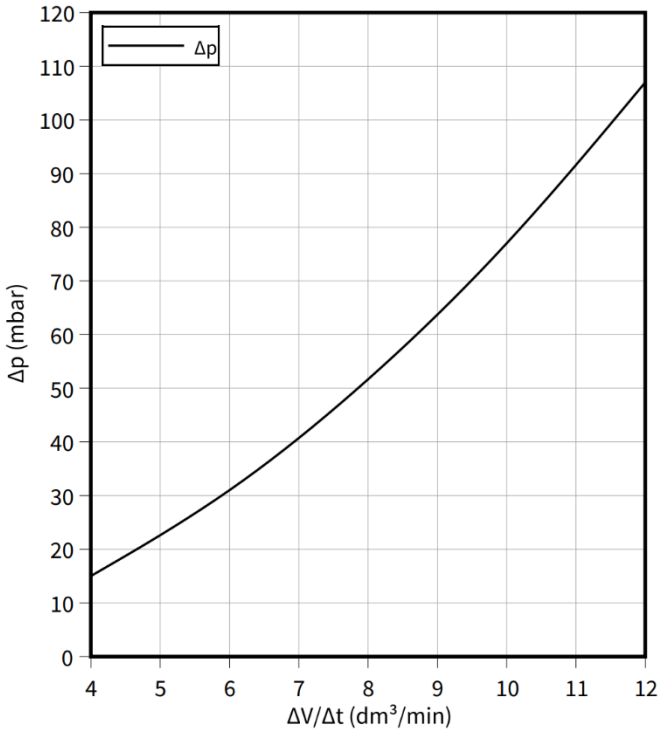
4 温度传感器

表 8 特征值

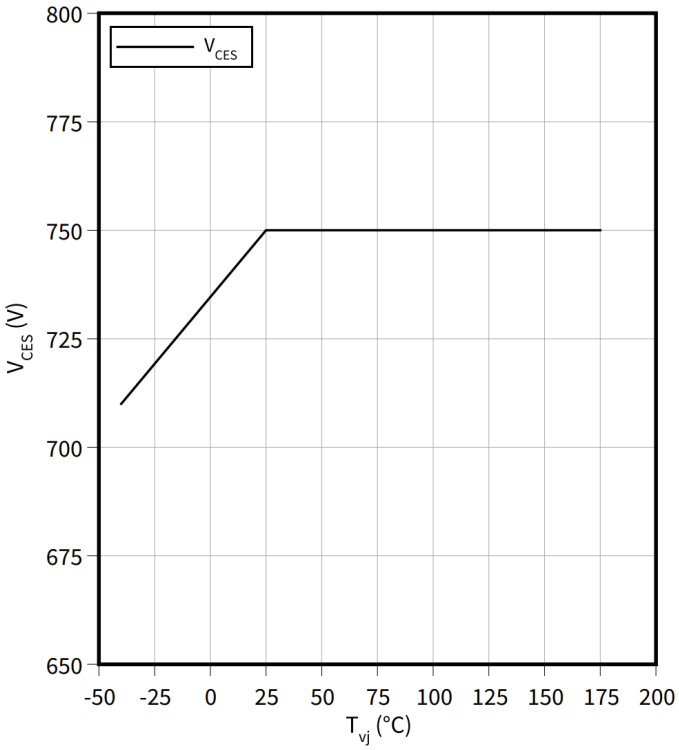
Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Transient sense current	I_{TS}					10	mA
Continuous sense current	I_{TS}					1	mA
Forward voltage	V_{TS}		I_{TS} = 0.2 mA, T_{vj} = 25 °C		2.280		V
Temperature coefficient (TCR)	TC_{TS}	I_{TS} = 0.2 mA			-5.50		mV/K

5 特性图

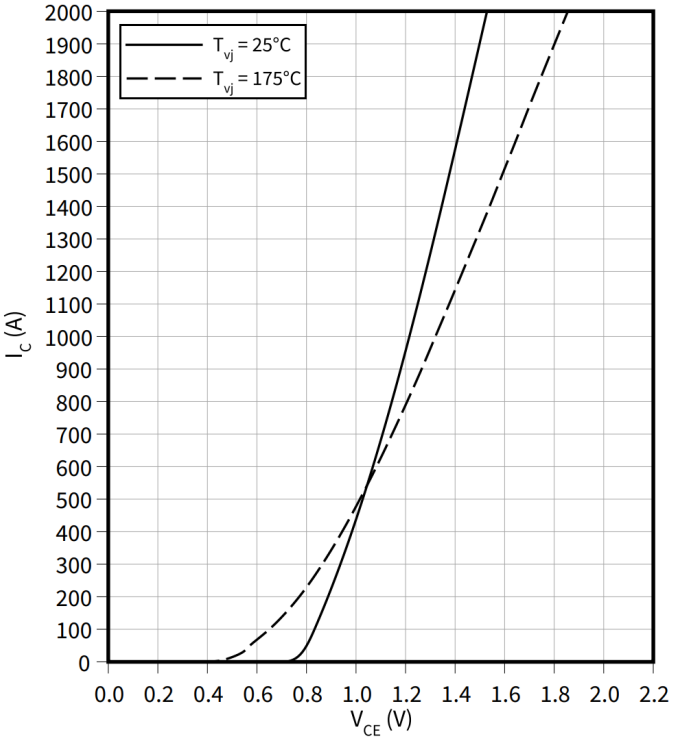
Pressure drop in cooling circuit (typical), Package
$\Delta p = f(\Delta V/\Delta t)$
T_f = 65 °C, 50% water / 50% ethylene glycol



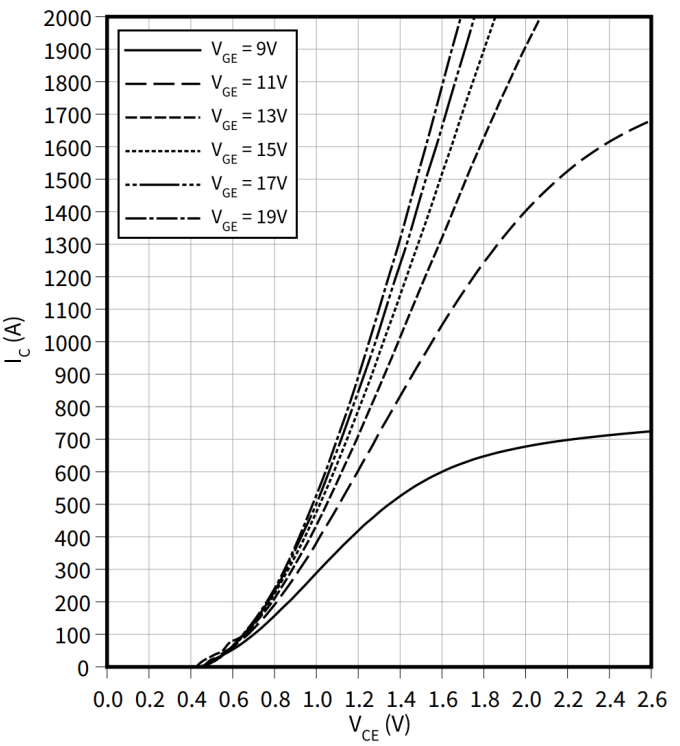
Maximum collector-emitter voltage, IGBT, Inverter
$V_{CES} = f(T_{vj})$
Verified by characterization / design, not by test



Output characteristic (typical), IGBT, Inverter
$I_C = f(V_{CE})$
V_{GE} = 15 V



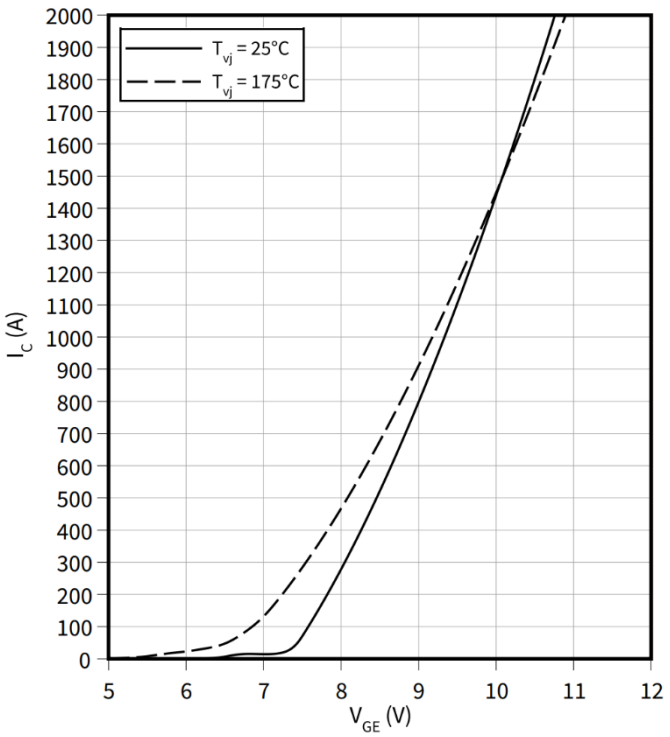
Output characteristic (typical), IGBT, Inverter
$I_C = f(V_{CE})$ T_{vj}
= 175 °C



Transfer characteristic (typical), IGBT, Inverter

$I_C = f(V_{GE})$

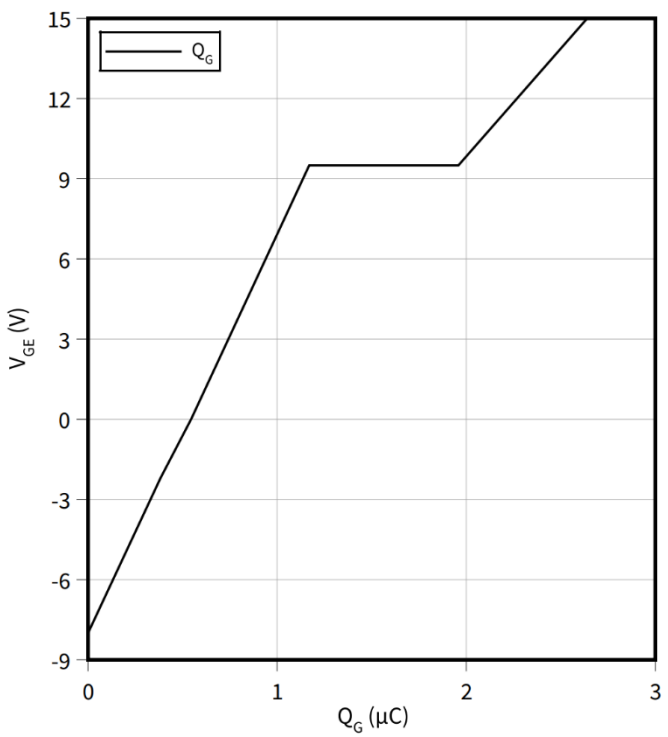
$V_{CE} = 20$ V



Gate charge characteristic (typical), IGBT, Inverter

$V_{GE} = f(Q_G)$

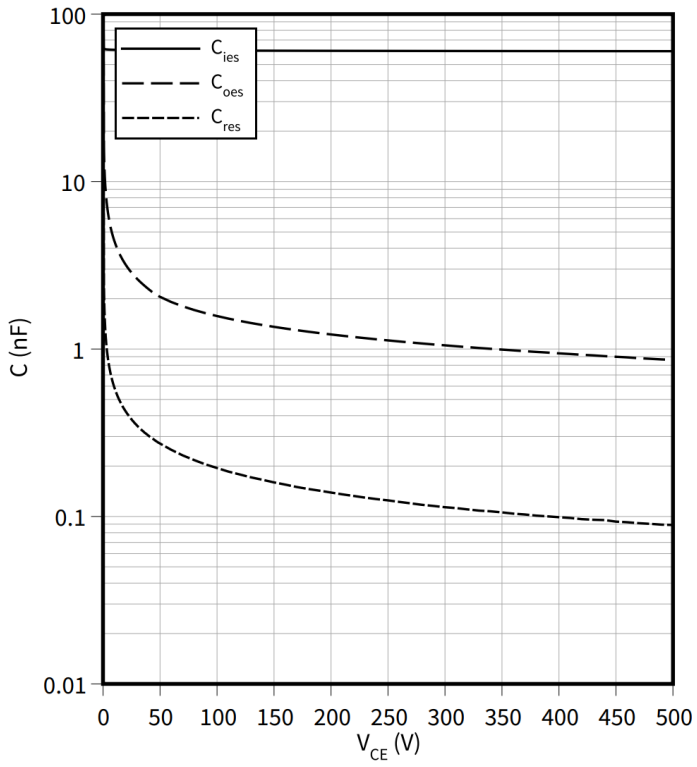
$T_{vj} = 25$ °C, $V_{CE} = 400$ V, $I_C = 600$ A



Capacity characteristic (typical), IGBT, Inverter

$C = f(V_{CE})$

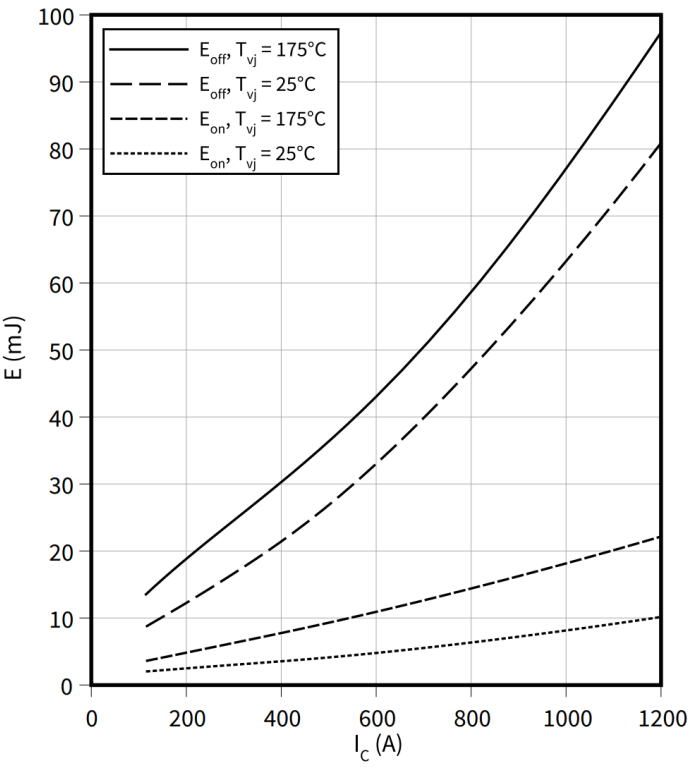
$V_{GE} = 0$ V, $T_{vj} = 25$ °C, $f = 0.1$ MHz



Switching losses (typical), IGBT, Inverter

$E = f(I_C)$

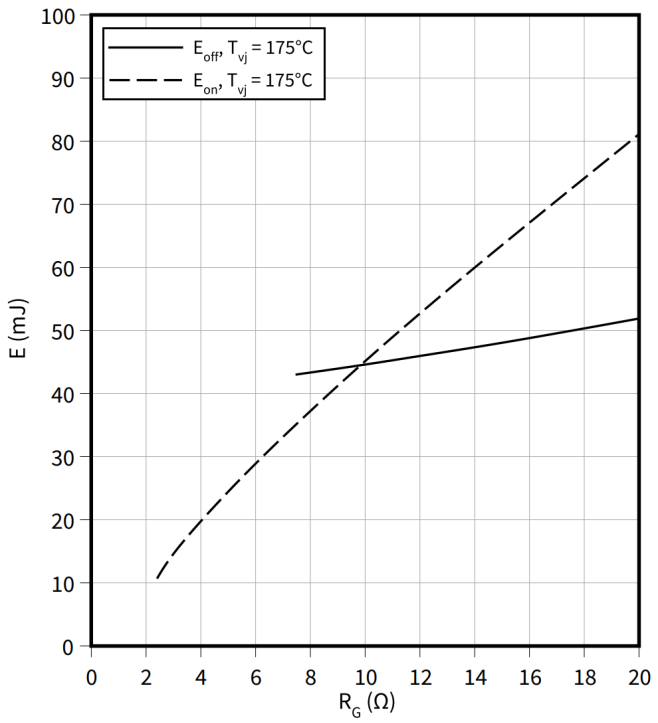
$V_{GE} = -8/15$ V, $R_{G,off} = 7.5\ \Omega$, $R_{G,on} = 2.4\ \Omega$, $V_{CE} = 400$ V



Switching losses (typical), IGBT, Inverter

$E = f(R_G)$

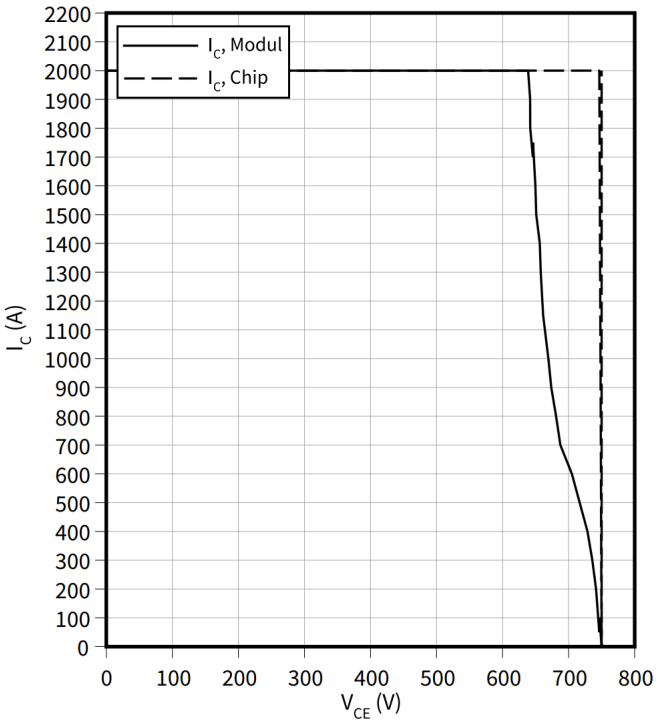
V_{GE} = -8/15 V, V_{CE} = 400 V, I_C = 600 A



Reverse bias safe operating area (RBSOA), IGBT, Inverter

$I_C = f(V_{CE})$

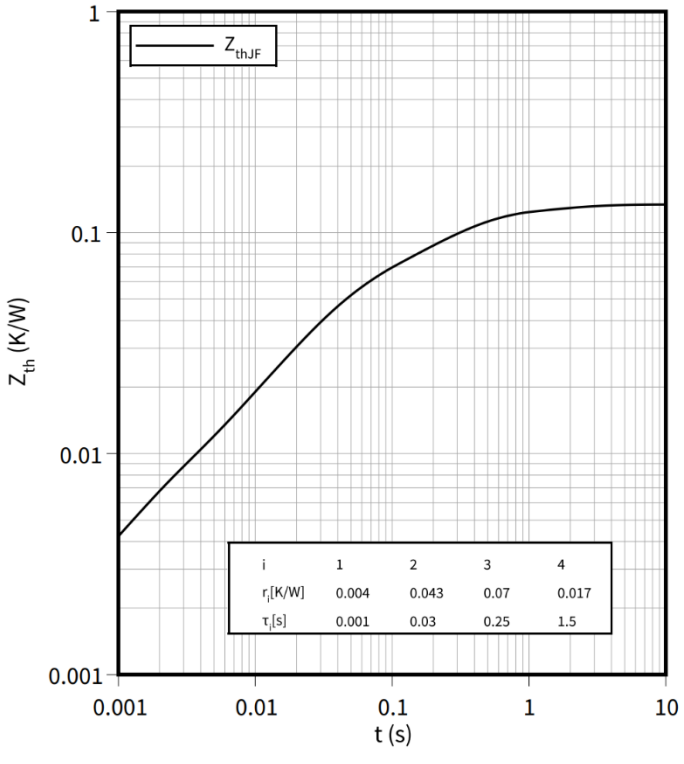
T_{vj} = 175 °C, V_{GE} = -8/15 V, $R_{G,off}$ = 7.5 Ω



Transient thermal impedance (typical), IGBT, Inverter

$Z_{th} = f(t)$

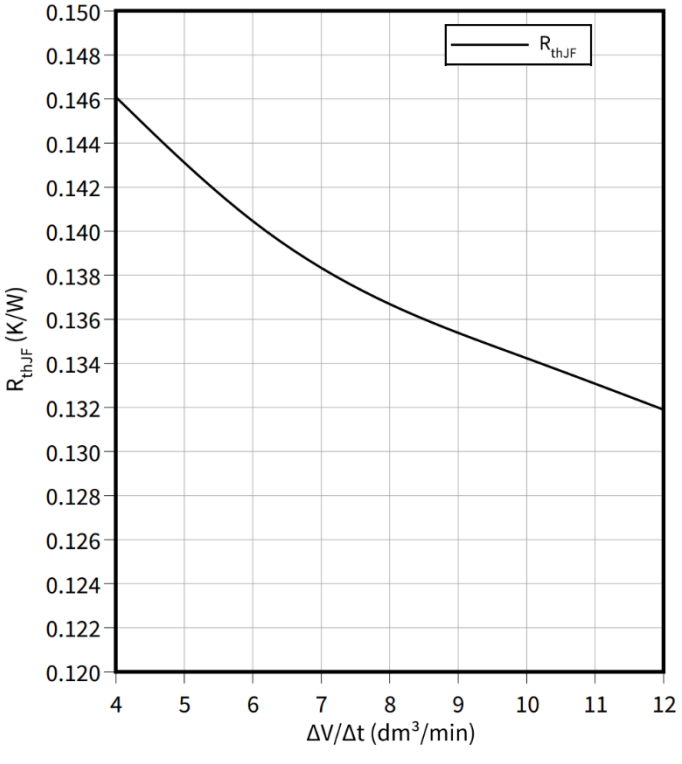
$\Delta V/\Delta t$ = 10 dm³/min, 50% water / 50% ethylene glycol , T_f = 65 °C



Thermal impedance (typical), IGBT, Inverter

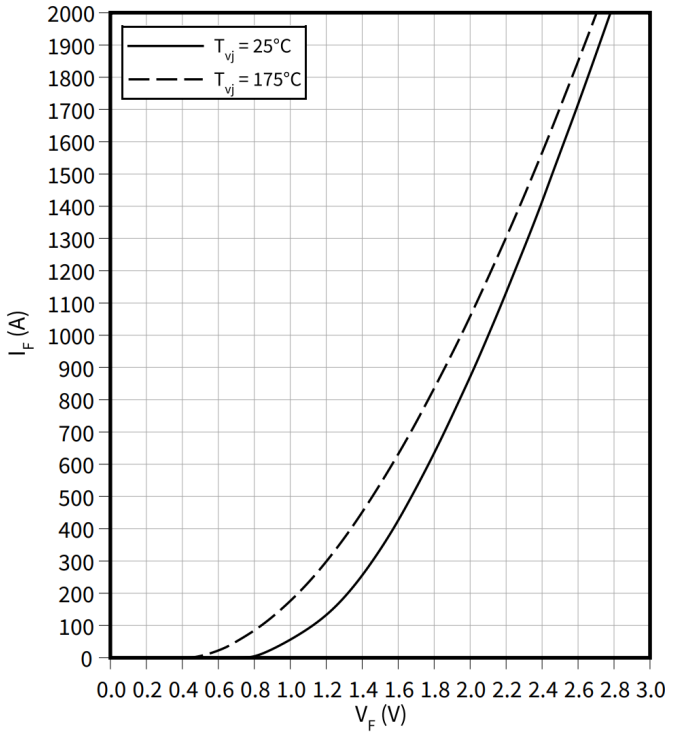
$R_{thJF} = f(\Delta V/\Delta t)$

T_f = 65 °C, 50% water / 50% ethylene glycol



Forward characteristic (typical), Diode, Inverter

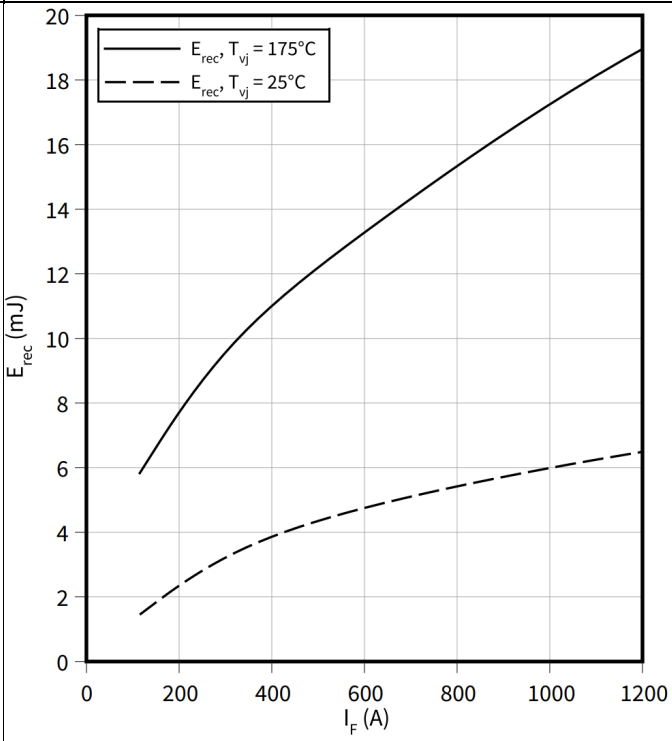
$I_F = f(V_F)$



Switching losses (typical), Diode, Inverter

$E_{rec} = f(I_F)$

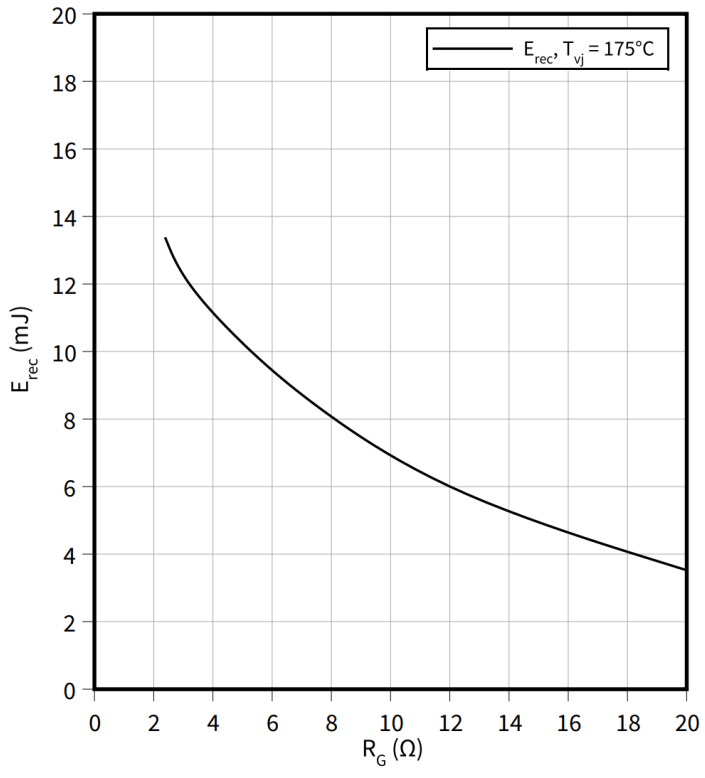
$V_{CE} = 400$ V, $V_{GE} = -8$ V, $R_G = 2.4\ \Omega$



Switching losses (typical), Diode, Inverter

$E_{rec} = f(R_G)$

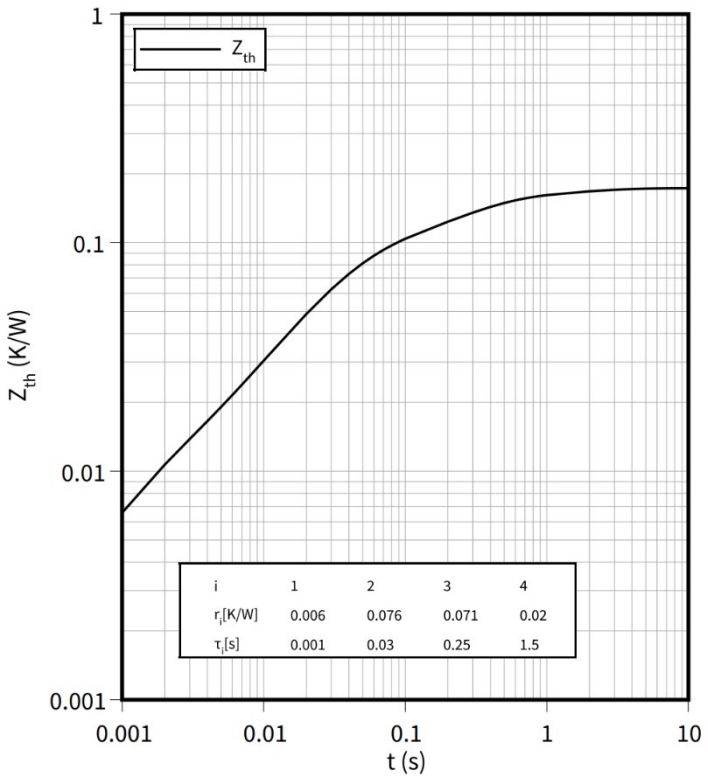
$V_{CE} = 400$ V, $I_F = 600$ A



Transient thermal impedance (typical), Diode, Inverter

$Z_{th} = f(t)$

$\Delta V/\Delta t = 10\ dm^3/min$, 50% water / 50% ethylene glycol , $T_f = 65$ °C

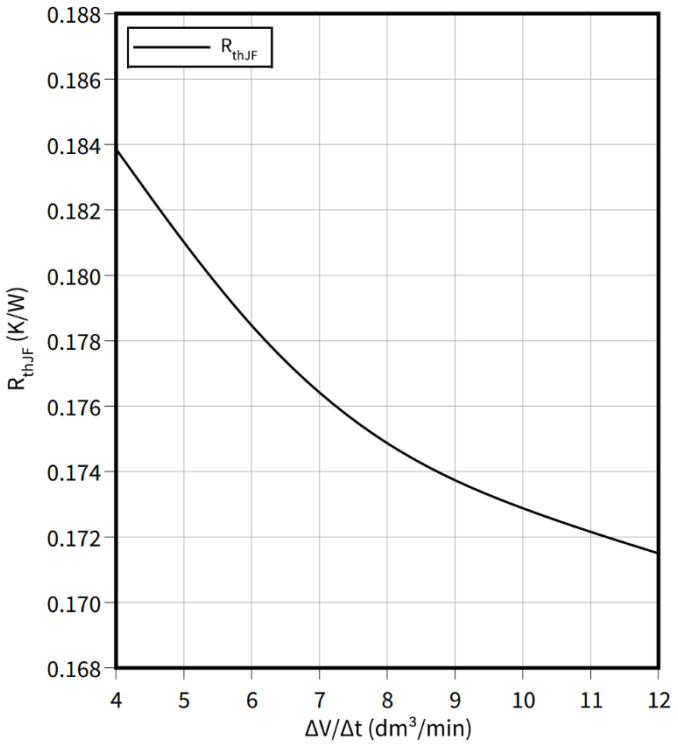


S

Thermal impedance (typical), Diode, Inverter

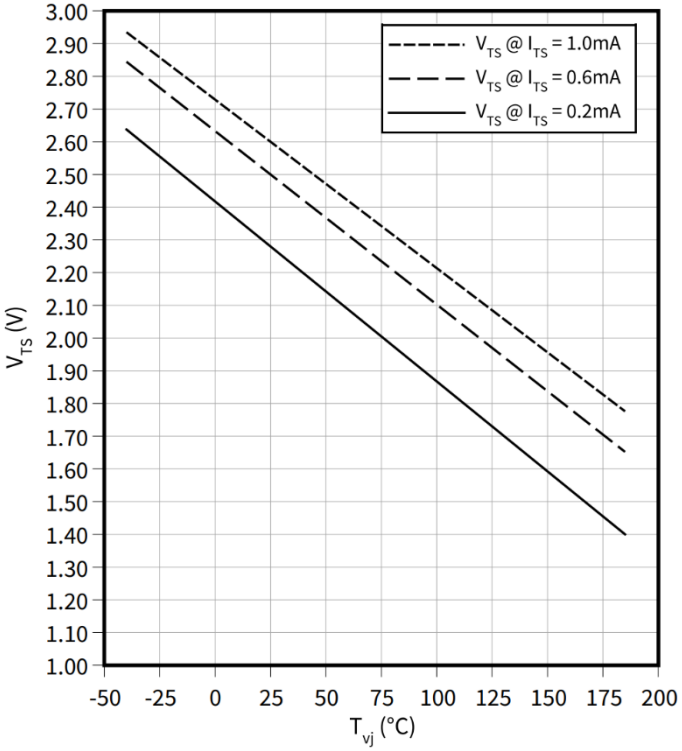
$R_{thJF} = f(\Delta V/\Delta t)$

T_f = 65 °C, 50% water / 50% ethylene glycol



Temperature characteristic (typical), Temperature sensor

$V_{TS} = f(T_{vj})$



6 电路图

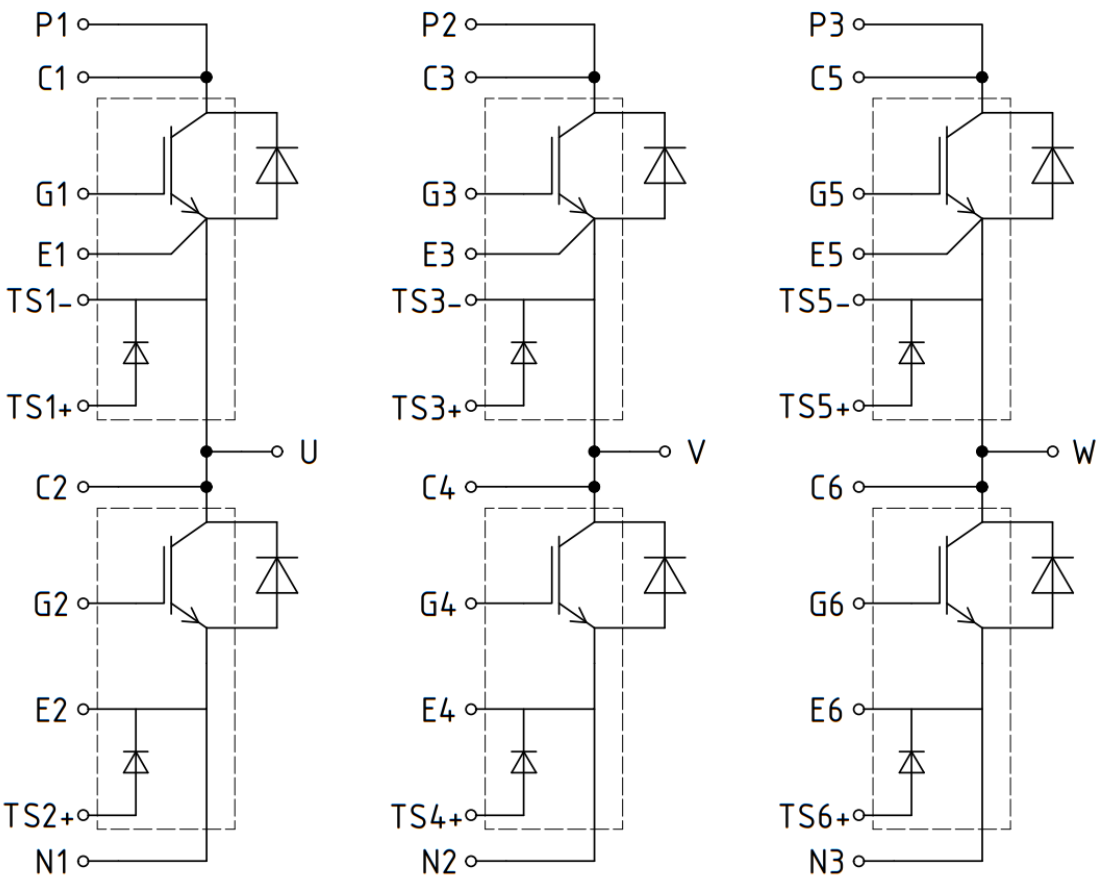

P1
C1
G1
E1
TS1-
TS1+
U
C2
G2
E2
TS2+
N1
P2
C3
G3
E3
TS3-
TS3+
V
C4
G4
E4
TS4+
N2
P3
C5
G5
E5
TS5-
TS5+
W
C6
G6
E6
TS6+
N3

图 1

7 封装外形

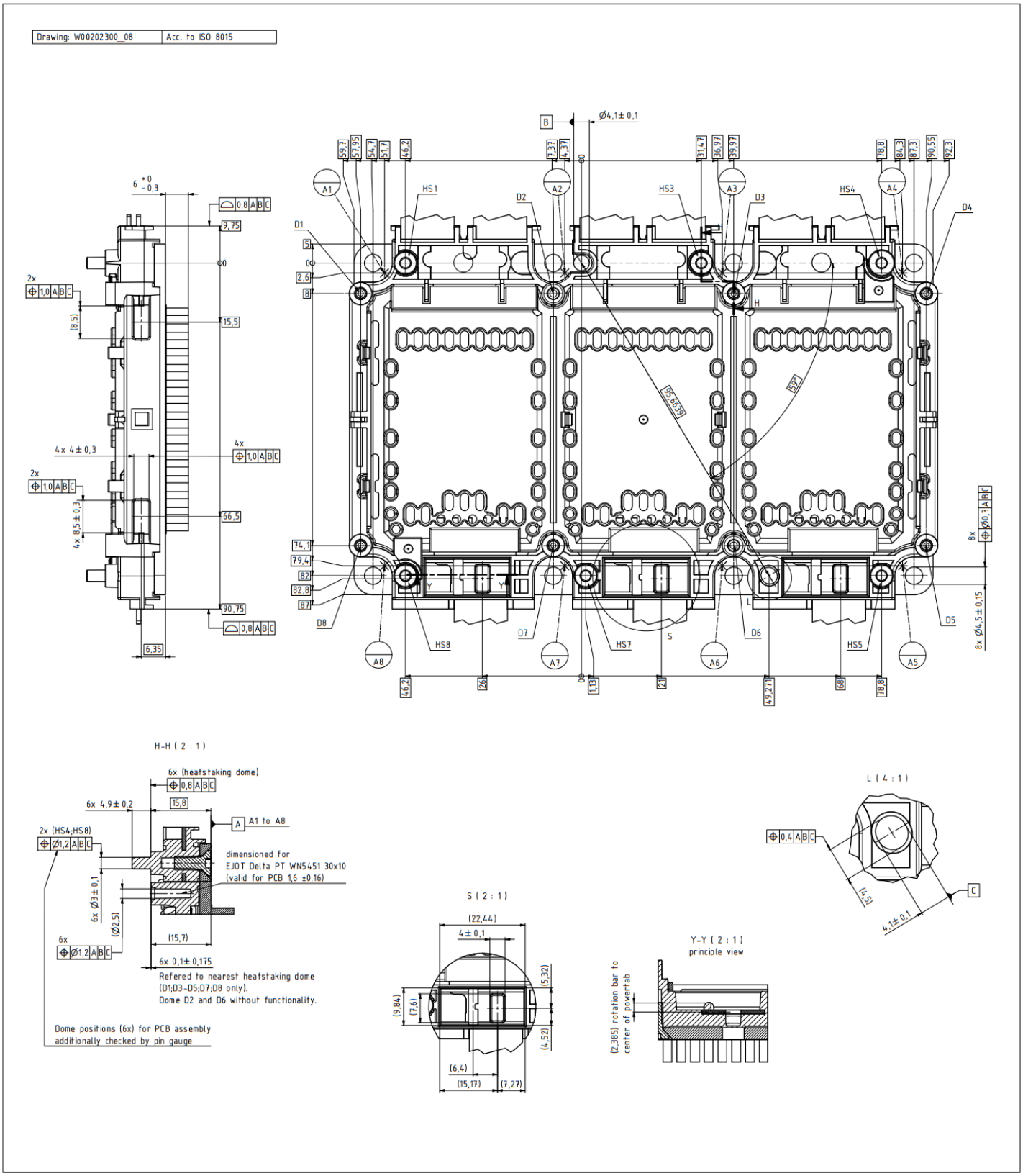

Drawing: W00202300_08
Acc. to ISO 8015
H-H (2 : 1)
S (2 : 1)
L (4 : 1)
Y-Y (2 : 1)
principle view
6x (heatstaking dome)
6x 4,9± 0,2
2x (HS4;HS8)
dimensioned for
EJOT Delta PT WN5451 30x10
(valid for PCB 1,6 ±0,16)
A1 to A8
6x 0,1± 0,175
Refered to nearest heatstaking dome
(D1;D3-D5;D7;D8 only).
Dome D2 and D6 without functionality.
Dome positions (6x) for PCB assembly
additionally checked by pin gauge
(2,385) rotation bar to
center of powertab

图 2

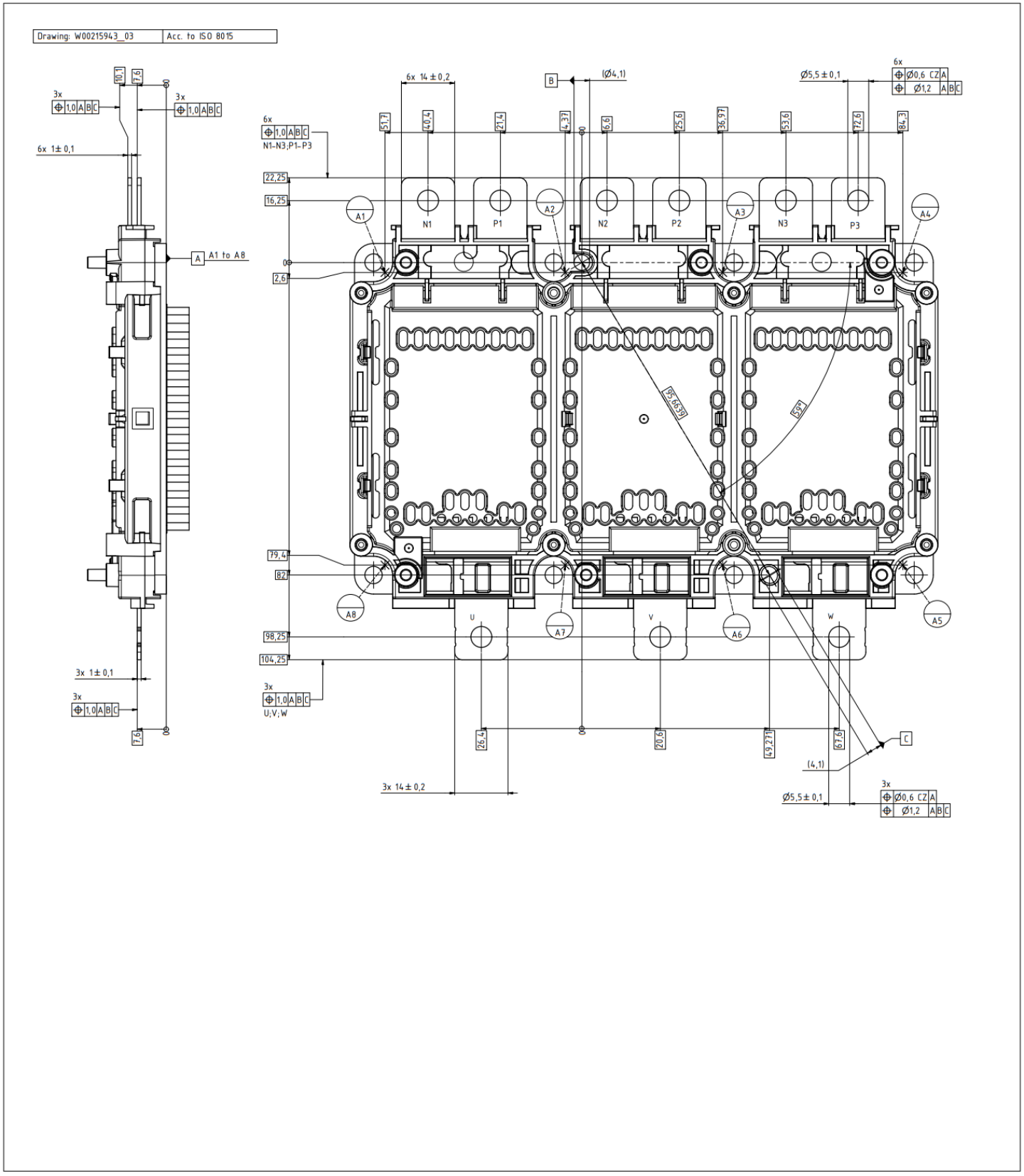

Drawing: W00215943_03
Acc. to ISO 8015
6x 14 ± 0,2
(Ø4,1)
Ø5,5 ± 0,1
6x
Ø0,6 CZ A
Ø1,2 A B C
3x
1,0 A B C
6x 1± 0,1
A A1 to A8
6x
1,0 A B C
N1-N3;P1-P3
22,25
16,25
2,6
79,4
82
98,25
104,25
3x
1,0 A B C
U;V;W
51,7
40,4
21,4
4,33
6,6
25,6
36,97
53,6
72,6
84,3
A1
A2
A3
A4
A5
A6
A7
A8
N1
P1
N2
P2
N3
P3
U
V
W
55,65°
59°
26,4
20,6
49,27
67,6
C
3x 1± 0,1
3x 14 ± 0,2
7,5
10,1
7,6

图 3

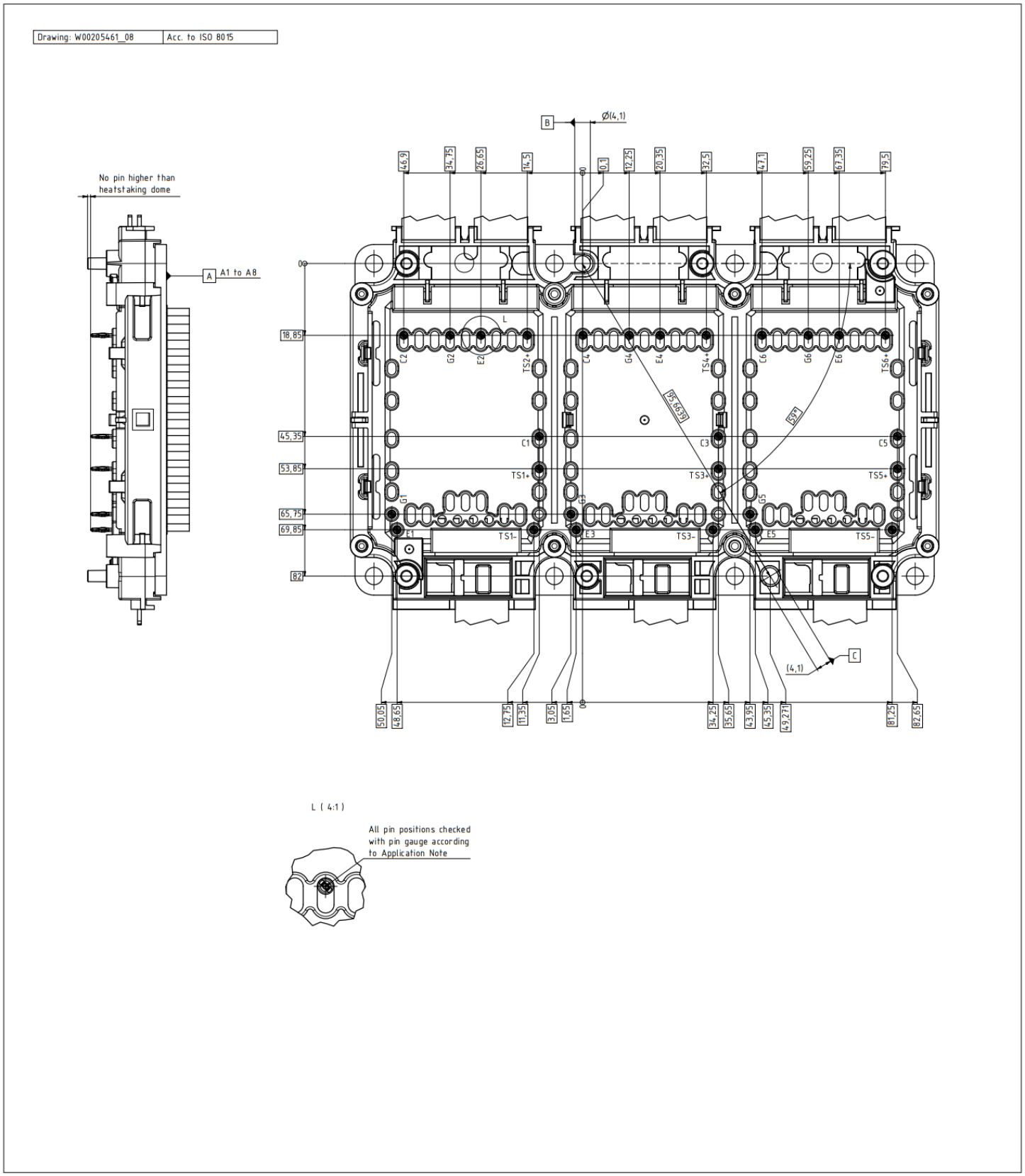

Drawing: W00205461_08
Acc. to ISO 8015
No pin higher than heatstaking dome
A
A1 to A8
B
Ø(4,1)
46,9
34,75
26,65
16,5
0
0,1
12,25
20,35
32,5
47,1
59,25
67,35
79,5
18,85
45,35
53,85
65,75
69,85
82
L
C2
G2
E2
TS2+
C4
G4
E4
TS4+
C6
G6
E6
TS6+
C1
C3
C5
TS1+
TS3+
TS5+
G1
G3
G5
E1
E3
E5
TS1-
TS3-
TS5-
C
(4,1)
50,05
48,65
12,75
11,35
3,05
1,65
0
34,25
35,65
43,95
45,35
49,271
81,25
82,65
L (4:1)
All pin positions checked with pin gauge according to Application Note

图 4

8 模块标签代码

模块标签代码

Code format	Data Matrix	Barcode Code128
Encoding	ASCII text	Code Set A
Symbol size	16x16	23 digits
Standard	IEC24720 and IEC16022	IEC8859-1

Code content	*Content*	*Digit*	*Example*
	Module serial number	1 – 5	71549
	Module material number	6 - 11	142846
	Production order number	12 - 19	55054991
	Date code (production year)	20 – 21	15
	Date code (production week)	22 – 23	30

Example



71549142846550549911530



71549142846550549911530

包装标签代码

Code format	Barcode Code128
Encoding	Code Set A
Symbol size	34 digits
Standard	IEC8859-1

Code content	*Content*	*Identifier*	*Digit*	*Example*
	Backend Construction Number	X	2 – 9	95056609
	Production Lot Number	1T	12 – 19	2X0003E0
	Serial Number	S	21 – 25	754389
	Date code	9D	28 – 31	1139
	Box Quantity	Q	33 – 34	15

Example



X950566091T2X0003E0S754389D1139Q15

图 5

修订记录

Document revision	Date of release	Description of changes
0.10	2023-05-04	Initial version
0.20	2025-02-26	Preliminary datasheet
1.00	2025-07-01	Final datasheet

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Edition 2025-07-01

Published by

Infineon Technologies AG

81726 Munich, Germany

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Document reference
IFX-ABG372-003

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版本 **2026-09-21**

Infineon Technologies AG 出版，
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