

**Final datasheet**  
**HybridPACK™ Drive G2 module**

**Features**

- Electrical features
  - $V_{CES} = 750\text{ V}$
  - $I_{CN} = 1150\text{ A} / I_{CRM} = 2300\text{ A}$
  - Blocking voltage 750 V
  - Low  $V_{CE,sat}$
  - Low switching losses
  - Low  $Q_g$  and  $C_{rSS}$
  - Low inductive design
  - $T_{vj,op} = 175^\circ\text{C}$
  - Integrated on-chip temperature sensor
  - Short-time extended operation temperature  $T_{vj,op} = 185^\circ\text{C}$
- Mechanical features
  - 4.2 kV DC 1 second insulation
  - High creepage and clearance distances
  - Direct-cooled PinFin base plate
  - Guiding elements for PCB and cooler assembly
  - PressFIT contact technology
  - RoHS compliant, lead-free
  - UL 94 V0 module frame
  - High-performance  $\text{Si}_3\text{N}_4$  ceramic
  - High power and thermal cycling capability

- Lead-free
- RoHS
- Green

**Potential applications**

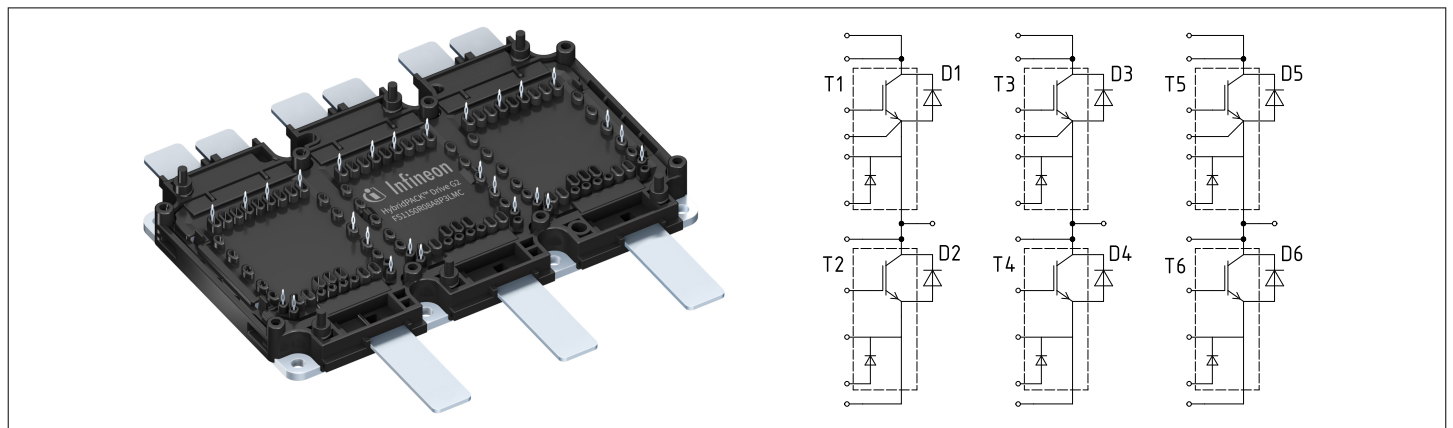
- Automotive applications
- (Hybrid) electrical vehicles (H)EV

**Product validation**

- Qualified according to AQC 324, release no.: 03.1/2021

**Description**

The HybridPACK™ Drive is a very compact six-pack module (750V/1150A) optimized for hybrid and electric vehicles.



## Table of contents

	<b>Description</b> .....	1
	<b>Features</b> .....	1
	<b>Potential applications</b> .....	1
	<b>Product validation</b> .....	1
	<b>Table of contents</b> .....	2
<b>1</b>	<b>Package</b> .....	3
<b>2</b>	<b>IGBT, Inverter</b> .....	4
<b>3</b>	<b>Diode, Inverter</b> .....	6
<b>4</b>	<b>Temperature sensor</b> .....	7
<b>5</b>	<b>Characteristics diagrams</b> .....	8
<b>6</b>	<b>Circuit diagram</b> .....	13
<b>7</b>	<b>Package outlines</b> .....	14
<b>8</b>	<b>Module label code</b> .....	17
	<b>Revision history</b> .....	18
	<b>Disclaimer</b> .....	19

## 1 Package

**Table 1** Insulation coordination

Parameter	Symbol	Note or test condition	Values	Unit
Isolation test voltage	$V_{ISOL}$	RMS, $f = 0$ Hz, $t = 1$ sec	4.20	kV
Material of module baseplate			Cu+Ni <sup>1)</sup>	
Internal isolation		basic insulation (class 1, IEC 61140)	Si <sub>3</sub> N <sub>4</sub>	
Creepage distance	$d_{creep}$	terminal to heatsink	9.5	mm
Creepage distance	$d_{creep}$	terminal to terminal	9.5	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) Ni plated Cu baseplate.

**Table 2** Maximum rated values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Maximum RMS module terminal current	$I_{t,rms}$		900			A
Heat-staking dome temperature <sup>1)</sup>	$T_{HS}$	$t_{staking} < 10s$			280	°C

1) Heat-staking according to application note AN-G2-ASSEMBLY.

**Table 3** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Pressure drop in cooling circuit	$\Delta p$	50% water / 50% ethylenglycol, $\Delta V/\Delta t = 10$ dm <sup>3</sup> /min, $T_f = 65$ °C		76 <sup>1)</sup>		mbar
Maximum pressure in cooling circuit	$p$	$T_{baseplate} < 40$ °C			3.0	bar
		$T_{baseplate} \geq 40$ °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 <sup>2)</sup>	$M$	Screw M4 baseplate to heatsink	1.8	2.0	2.2	Nm
		Screw EJOT Delta PCB to frame	0.45	0.50	0.55	
Weight	$G$			760		g

1) Cooler design and flow direction according to application note AN-G2-ASSEMBLY.

2) Screw types and torque according to application note AN-G2-ASSEMBLY.

## 2 IGBT, Inverter

**Table 4** Maximum rated values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Collector-emitter voltage	$V_{CES}$	$T_{vj} = 25\text{ °C}$		750		V
Implemented collector current	$I_{CN}$			1150		A
Continuous DC collector current	$I_{C,nom}$	$T_f = 65\text{ °C}, T_{vj,max} = 175\text{ °C}$		600 <sup>1)</sup>		A
Repetitive peak collector current	$I_{CRM}$	verified by design, $t_p$ limited by $T_{vj,max}$		2300		A
Total power dissipation	$P_{tot}$	$T_f = 65\text{ °C}, T_{vj,max} = 175\text{ °C}$		1000 <sup>1)</sup>		W
Gate-emitter peak voltage	$V_{GES}$			±20		V

1) Verified by characterization / design not by test.

**Table 5** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Collector-emitter saturation voltage	$V_{CE,sat}$	$I_C = 600\text{ A}, V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$		1.08	1.21	V
			$T_{vj} = 175\text{ °C}$		1.09		
Collector-emitter saturation voltage	$V_{CE,sat}$	$I_C = 1000\text{ A}, V_{GE} = 15\text{ V}$	$T_{vj} = 25\text{ °C}$		1.22		V
			$T_{vj} = 175\text{ °C}$		1.32		
Gate threshold voltage	$V_{GE,th}$	$I_C = 10.3\text{ mA}, V_{CE} = V_{GE}$	$T_{vj} = 25\text{ °C}$	4.9	5.8	6.65	V
			$T_{vj} = 175\text{ °C}$		4		
Gate charge	$Q_G$	$V_{CE} = 400\text{ V}, V_{GE} = -8...15\text{ V}$		2.6		μC	
Internal gate resistor	$R_{G,int}$		$T_{vj} = 25\text{ °C}$	1.0		Ω	
Input capacitance	$C_{ies}$	$f = 0.1\text{ MHz}, V_{CE} = 50\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$	60.8		nF	
Output capacitance	$C_{oes}$	$f = 0.1\text{ MHz}, V_{CE} = 50\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$	2.0		nF	
Reverse transfer capacitance	$C_{res}$	$f = 0.1\text{ MHz}, V_{CE} = 50\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$	0.27		nF	
Collector-emitter cut-off current	$I_{CES}$	$V_{CE} = 750\text{ V}, V_{GE} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$			1.0	mA
			$T_{vj} = 175\text{ °C}$			15.0	
			$T_{vj} = 185\text{ °C}$			28.0	
Gate-emitter leakage current	$I_{GES}$		$T_{vj} = 25\text{ °C}$			400	nA

**(table continues...)**

**Table 5 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-on delay time, inductive load	$t_{d,on}$	$I_C = 600\text{ A}, V_{CE} = 400\text{ V}, V_{GE} = -8/15\text{ V}, R_{G,on} = 2.4\ \Omega$	$T_{vj} = 25\text{ °C}$	222		ns
			$T_{vj} = 175\text{ °C}$	255		
Rise time, inductive load	$t_r$	$I_C = 600\text{ A}, V_{CE} = 400\text{ V}, V_{GE} = -8/15\text{ V}, R_{G,on} = 2.4\ \Omega$	$T_{vj} = 25\text{ °C}$	50.0		ns
			$T_{vj} = 175\text{ °C}$	55.0		
Turn-off delay time, inductive load	$t_{d,off}$	$I_C = 600\text{ A}, V_{CE} = 400\text{ V}, V_{GE} = -8/15\text{ V}, R_{G,off} = 7.5\ \Omega$	$T_{vj} = 25\text{ °C}$	929		ns
			$T_{vj} = 175\text{ °C}$	1060		
Fall time, inductive load	$t_f$	$I_C = 600\text{ A}, V_{CE} = 400\text{ V}, V_{GE} = -8/15\text{ V}, R_{G,off} = 7.5\ \Omega$	$T_{vj} = 25\text{ °C}$	91.0		ns
			$T_{vj} = 175\text{ °C}$	199		
Turn-on energy loss per pulse	$E_{on}$	$I_C = 600\text{ A}, V_{CE} = 400\text{ V}, L_\sigma = 7\text{ nH}, V_{GE} = -8/15\text{ V}, R_{G,on} = 2.4\ \Omega$	$T_{vj} = 25\text{ °C}, di/dt = 9600\text{ A}/\mu\text{s}$	4.5		mJ
			$T_{vj} = 175\text{ °C}, di/dt = 8700\text{ A}/\mu\text{s}$	10.7		
Turn-off energy loss per pulse	$E_{off}$	$I_C = 600\text{ A}, V_{CE} = 400\text{ V}, L_\sigma = 7\text{ nH}, V_{GE} = -8/15\text{ V}, R_{G,off} = 7.5\ \Omega$	$T_{vj} = 25\text{ °C}, dv/dt = 4000\text{ V}/\mu\text{s}$	31.1		mJ
			$T_{vj} = 175\text{ °C}, dv/dt = 2700\text{ V}/\mu\text{s}$	43.0		
SC data	$I_{SC}$	$V_{CC} = 400\text{ V}, V_{GE} = 15\text{ V}, V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$	$T_{vj} = 25\text{ °C}, t_p = 3.0\ \mu\text{s}$	8500		A
			$T_{vj} = 175\text{ °C}, t_p = 3.0\ \mu\text{s}$	6700		
			$T_{vj} = 185\text{ °C}, t_p = 2.5\ \mu\text{s}$	6600		
Thermal resistance, junction to cooling fluid <sup>1)</sup>	$R_{th,j-f}$	50% water / 50% ethylenglycol, $\Delta V/\Delta t = 10\text{ dm}^3/\text{min}, T_f = 65\text{ °C}$		0.100	0.110 <sup>2)</sup>	K/W
Temperature under switching conditions <sup>3)</sup>	$T_{vj,op}$	continuous operation	-40		175	°C
		extended operation			185	

1) Cooler design and flow direction according to application note AN-G2-ASSEMBLY.

2) EoL criteria see AQG324, verified by characterization with 4.5 sigma.

3)  $T_{vj} > 175\text{ °C}$  only blocking and short circuit capability specified

### 3 Diode, Inverter

**Table 6** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Repetitive peak reverse voltage	$V_{RRM}$	$T_{vj} = 25\text{ °C}$	750	V
Implemented forward current	$I_{FN}$		1150	A
Continuous DC forward current	$I_{F,nom}$		600	A
Repetitive peak forward current	$I_{FRM}$	verified by design, $t_p$ limited by $T_{vj,max}$	2300	A
$I^2t$ - value	$I^2t$	$V_R = 0\text{ V}$ , $t_p = 10\text{ ms}$ $T_{vj} = 175\text{ °C}$	31250	A <sup>2</sup> s

**Table 7** Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Forward voltage	$V_F$	$I_F = 600\text{ A}$	$T_{vj} = 25\text{ °C}$	1.76	2.08	V
			$T_{vj} = 175\text{ °C}$	1.57		
Forward voltage	$V_F$	$I_F = 1000\text{ A}$	$T_{vj} = 25\text{ °C}$	2.09		V
			$T_{vj} = 175\text{ °C}$	1.95		
Peak reverse recovery current	$I_{rm}$	$I_F = 600\text{ A}$ , $V_{GE} = -8\text{ V}$ , $V_R = 400\text{ V}$	$T_{vj} = 25\text{ °C}$	351		A
			$T_{vj} = 175\text{ °C}$	526		
Recovered charge	$Q_r$	$I_F = 600\text{ A}$ , $V_R = 400\text{ V}$ , $V_{GE} = -8\text{ V}$	$T_{vj} = 25\text{ °C}$	14.4		μC
			$T_{vj} = 175\text{ °C}$	43.1		
Reverse recovery energy	$E_{rec}$	$I_F = 600\text{ A}$ , $V_{GE} = -8\text{ V}$ , $V_R = 400\text{ V}$	$T_{vj} = 25\text{ °C}$ , $-di_F/dt = 16200\text{ A}/\mu\text{s}$	4.90		mJ
			$T_{vj} = 175\text{ °C}$ , $-di_F/dt = 13400\text{ A}/\mu\text{s}$	13.40		
Thermal resistance, junction to cooling fluid <sup>1)</sup>	$R_{th,j-f}$	50% water / 50% ethylenglycol, $\Delta V/\Delta t = 10\text{ dm}^3/\text{min}$ , $T_f = 65\text{ °C}$		0.129	0.142 <sup>2)</sup>	K/W
Temperature under switching conditions <sup>3)</sup>	$T_{vj,op}$	continuous operation		-40	175	°C
		extended operation			185	

1) Cooler design and flow direction according to application note AN-G2-ASSEMBLY.

2) EoL criteria see AQG324, verified by characterization with 4.5 sigma.

3)  $T_{vj}>175\text{ °C}$  only blocking specified

## 4 Temperature sensor

**Table 8** Characteristic values

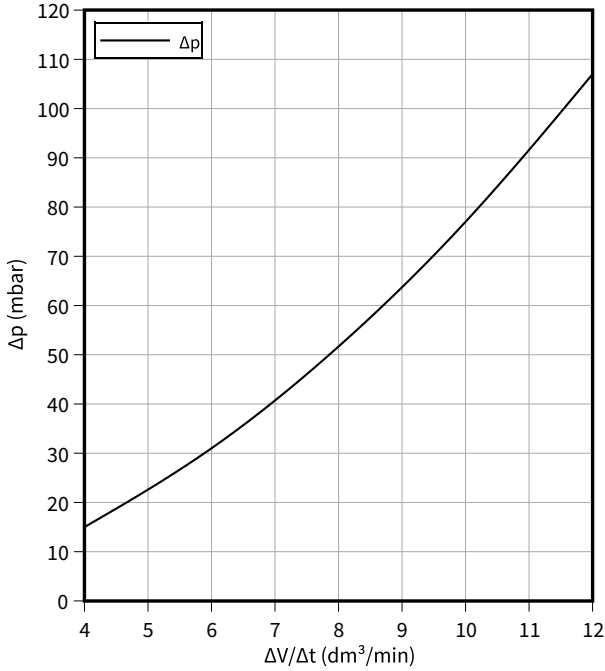
Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Transient sense current	$I_{TS}$				10	mA
Forward voltage	$V_{TS}$	$I_{TS} = 0.2 \text{ mA}$ , $T_{vj} = 25 \text{ °C}$		2.280		V
Temperature coefficient (TCR)	$TC_{TS}$	$I_{TS} = 0.2 \text{ mA}$		-5.50		mV/K

## 5 Characteristics diagrams

### Pressure drop in cooling circuit (typical), Package

$$\Delta p = f(\Delta V/\Delta t)$$

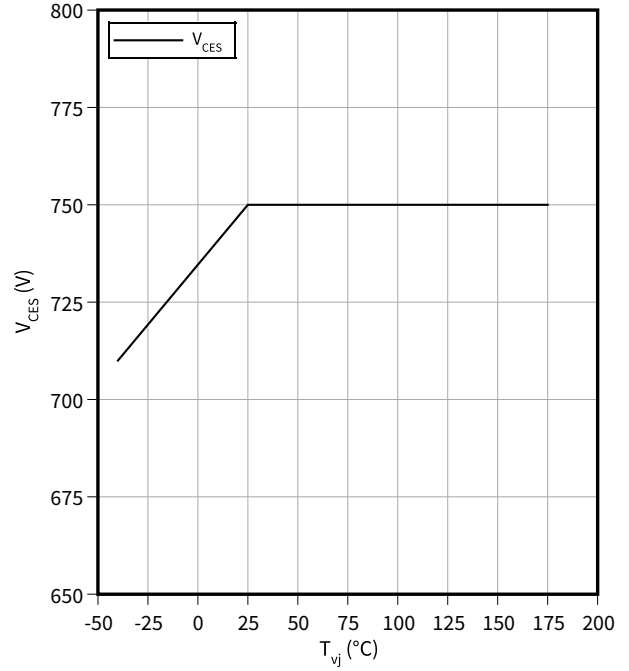
fluid = 50% water / 50% ethylenglycol ,  $T_f = 65\text{ °C}$



### Maximum collector-emitter voltage, IGBT, Inverter

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

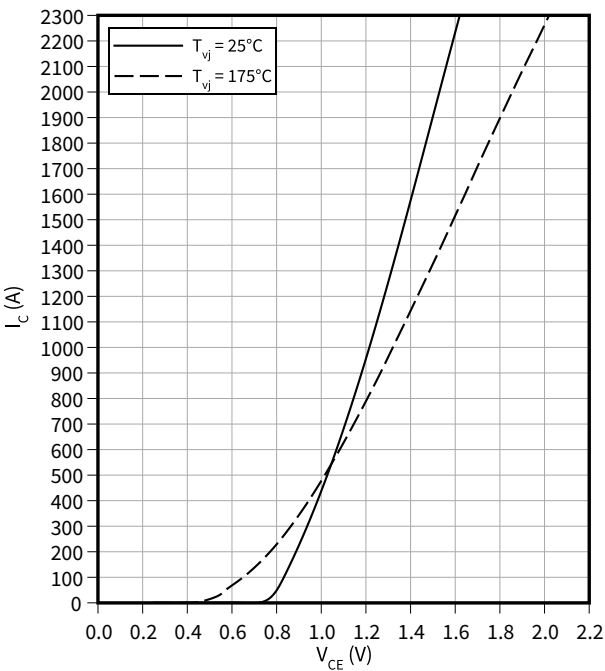
Note = verified by characterization / design, not by test



### Output characteristic (typical), IGBT, Inverter

$$I_C = f(V_{CE})$$

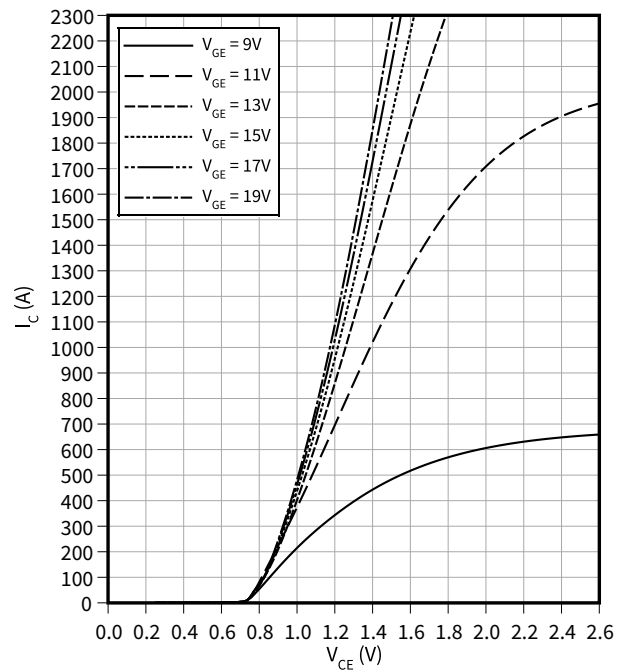
$V_{GE} = 15\text{ V}$



### Output characteristic (typical), IGBT, Inverter

$$I_C = f(V_{CE})$$

$T_{vj} = 25\text{ °C}$

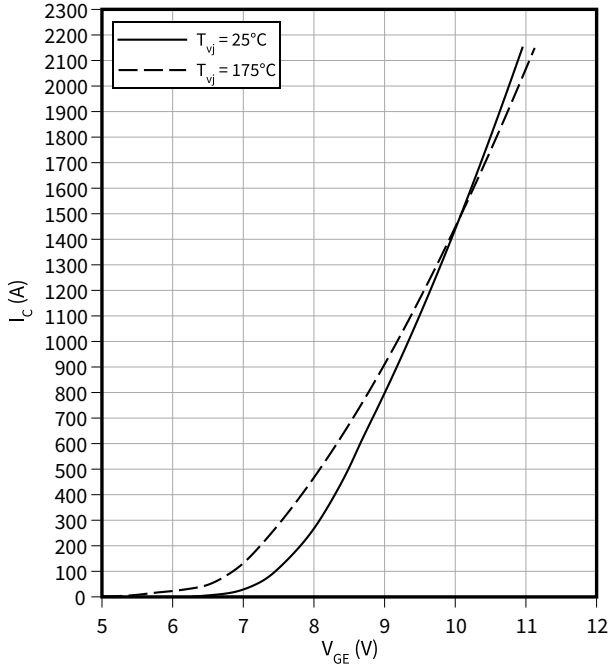




5 Characteristics diagrams

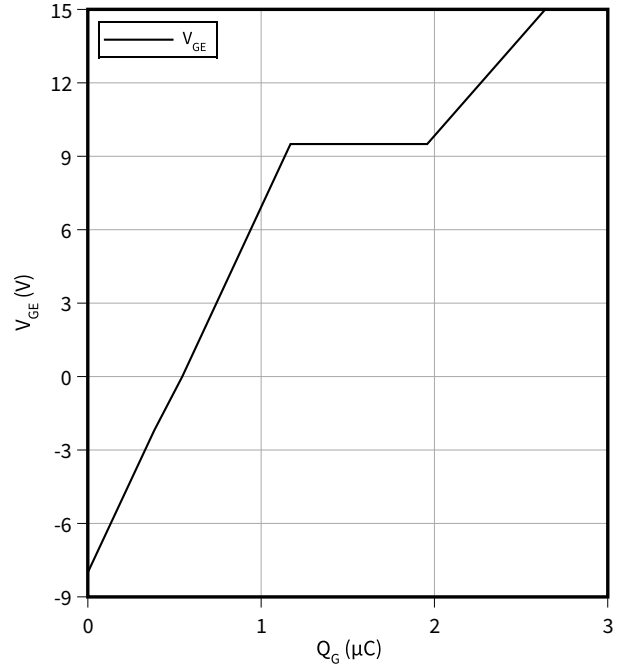
**Transfer characteristic (typical), IGBT, Inverter**

$I_C = f(V_{GE})$   
 $V_{CE} = 20\text{ V}$



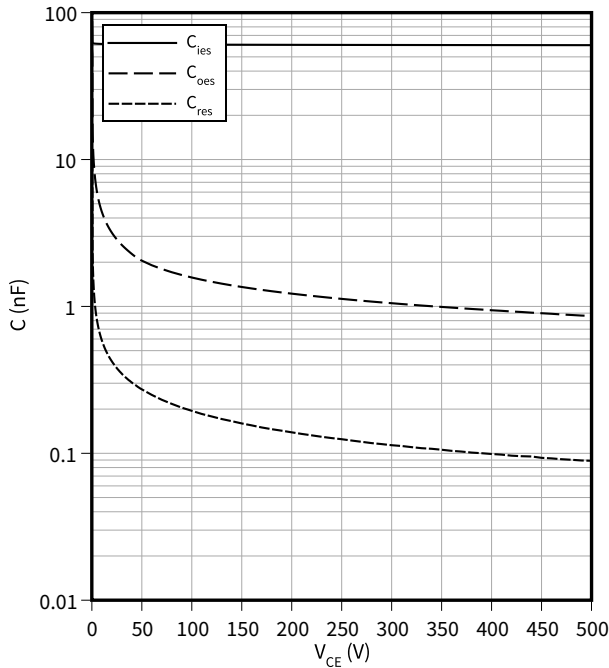
**Gate charge characteristic (typical), IGBT, Inverter**

$V_{GE} = f(Q_G)$   
 $T_{vj} = 25^\circ\text{C}, V_{CE} = 400\text{ V}, I_C = 600\text{ A}$



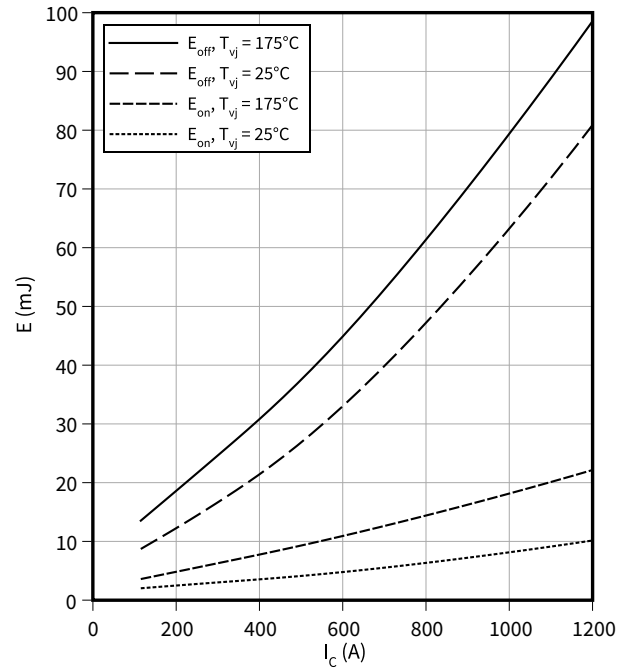
**Capacity characteristic (typical), IGBT, Inverter**

$C = f(V_{CE})$   
 $T_{vj} = 25^\circ\text{C}, f = 0.1\text{ MHz}, V_{GE} = 0\text{ V}$



**Switching losses (typical), IGBT, Inverter**

$E = f(I_C)$   
 $R_{G,off} = 7.5\ \Omega, R_{G,on} = 2.4\ \Omega, V_{CE} = 400\text{ V}, V_{GE} = +15/-8\text{ V}$

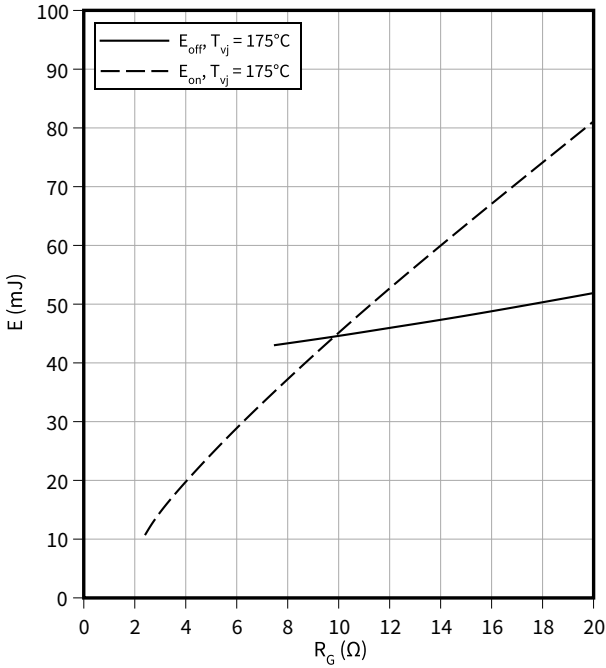


**5 Characteristics diagrams**

**Switching losses (typical), IGBT, Inverter**

$E = f(R_G)$

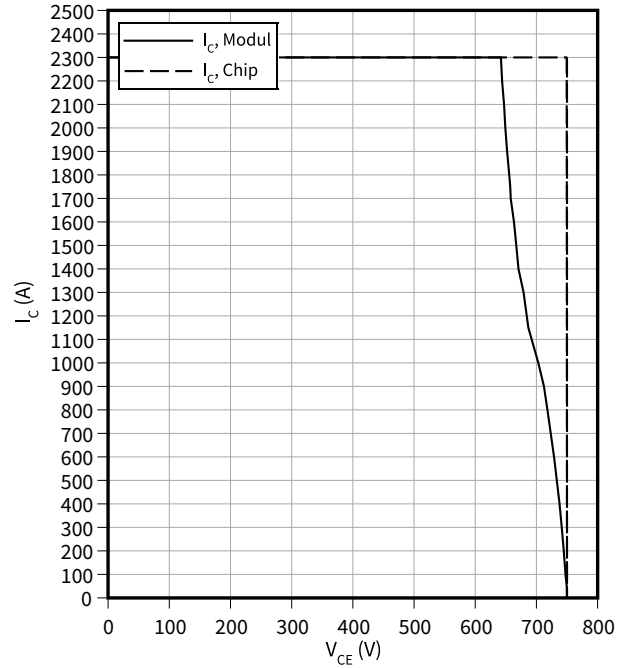
$V_{CE} = 400\text{ V}$ ,  $V_{GE} = +15/-8\text{ V}$ ,  $I_C = 600\text{ A}$



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

$I_C = f(V_{CE})$

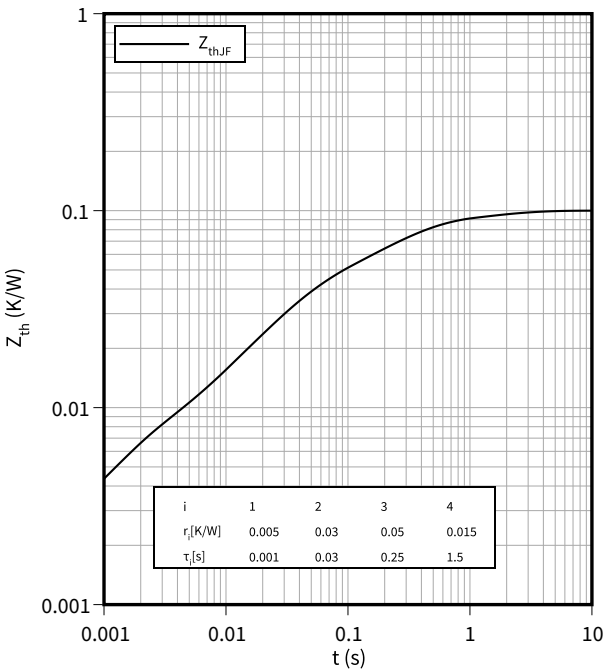
$T_{vj} = 175^\circ\text{C}$ ,  $R_{G,off} = 7.5\ \Omega$ ,  $V_{GE} = +15/-8\text{ V}$



**Transient thermal impedance (typical), IGBT, Inverter**

$Z_{th} = f(t)$

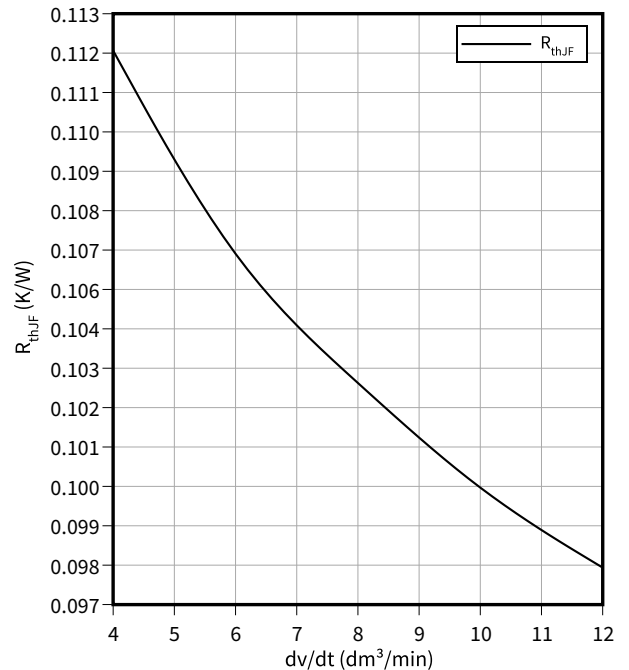
$\Delta V/\Delta t = 10\text{ dm}^3/\text{min}$ , fluid = 50% water / 50% ethylenglycol,  $T_f = 65^\circ\text{C}$



**Thermal impedance (typical), IGBT, Inverter**

$R_{thJF} = f(dv/dt)$

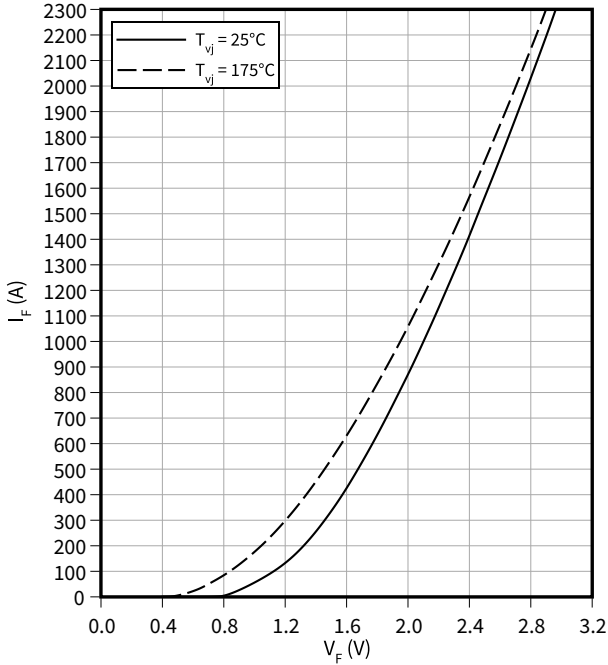
$T_f = 65^\circ\text{C}$ , fluid = 50% water / 50% ethylenglycol



5 Characteristics diagrams

**Forward characteristic (typical), Diode, Inverter**

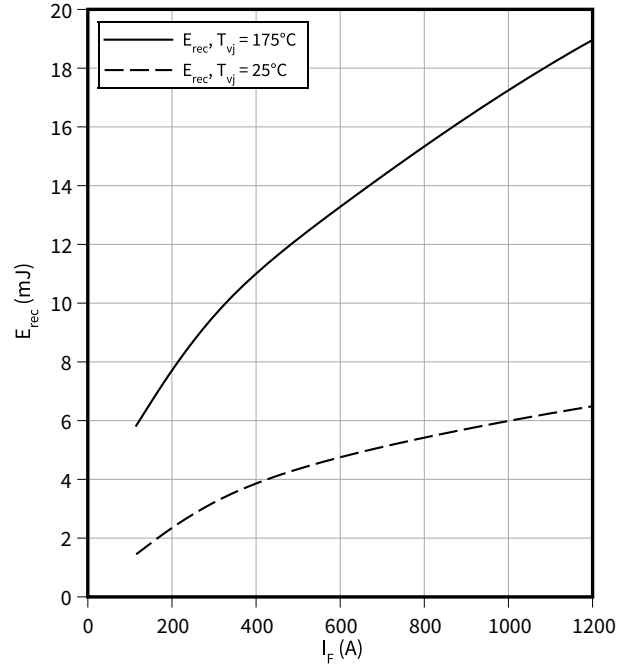
$I_F = f(V_F)$



**Switching losses (typical), Diode, Inverter**

$E_{rec} = f(I_F)$

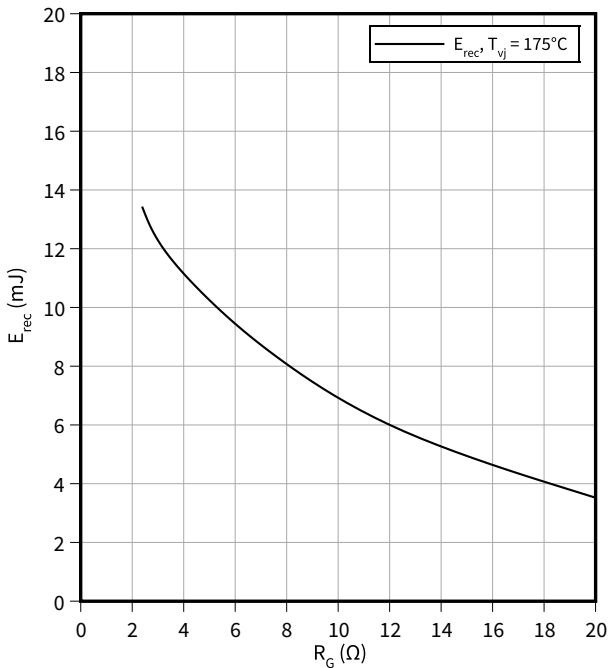
$V_{CE} = 400\text{ V}, V_{GE} = +15/-8\text{ V}, R_G = 2.4\ \Omega$



**Switching losses (typical), Diode, Inverter**

$E_{rec} = f(R_G)$

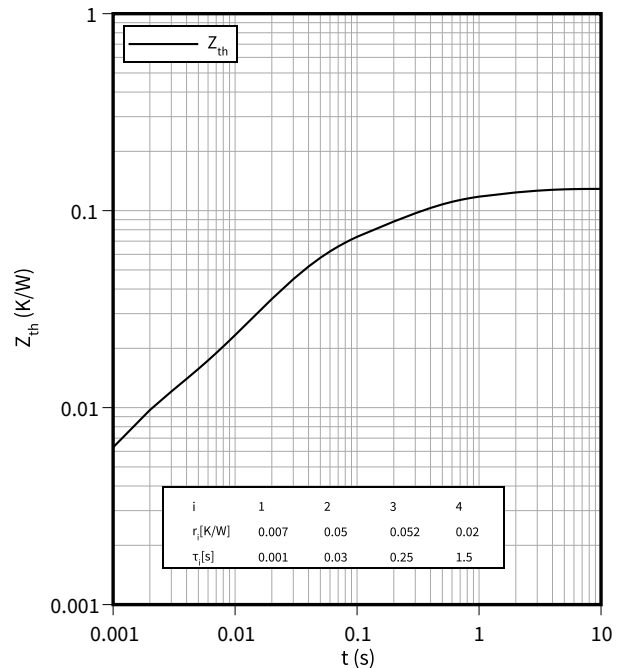
$V_{CE} = 400\text{ V}, I_F = 600\text{ A}$



**Transient thermal impedance (typical), Diode, Inverter**

$Z_{th} = f(t)$

$\Delta V/\Delta t = 10\text{ dm}^3/\text{min}$ , fluid = 50% water / 50% ethylenglycol,  $T_f = 65\text{ °C}$

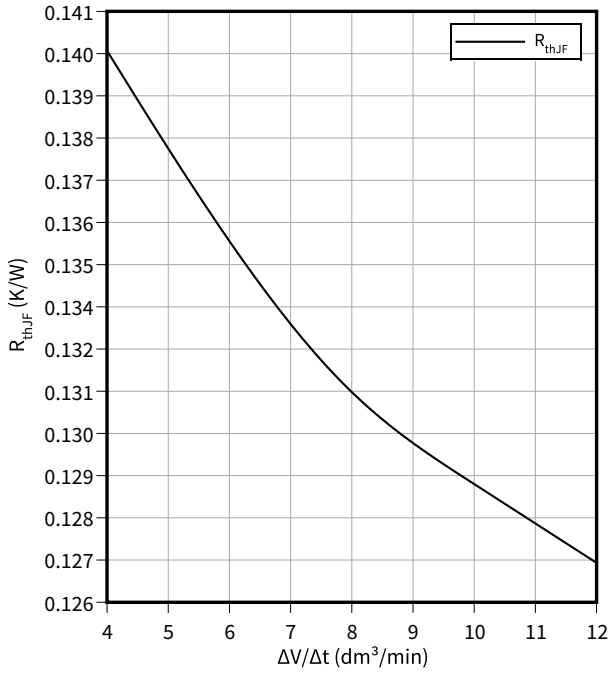


5 Characteristics diagrams

**Thermal impedance (typical), Diode, Inverter**

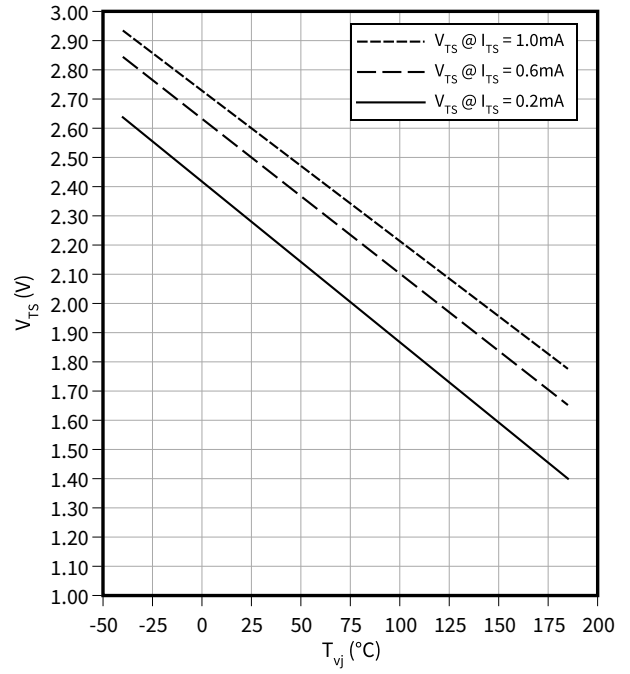
$$R_{thJF} = f(\Delta V/\Delta t)$$

$T_f = 65\text{ °C}$ , fluid = 50% water / 50% ethylenglycol



**Temperature characteristic (typical), Temperature sensor**

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



## 6 Circuit diagram

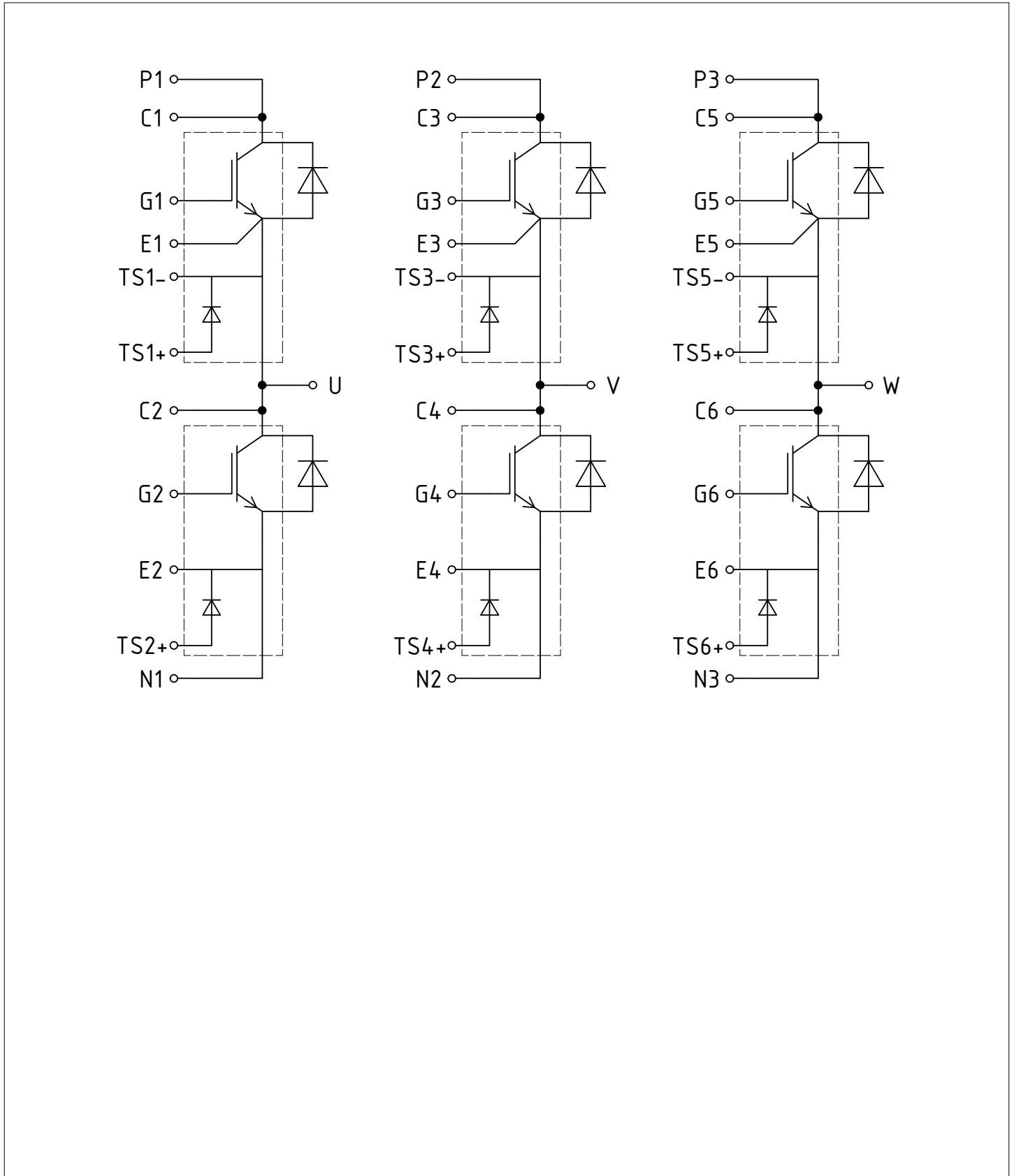
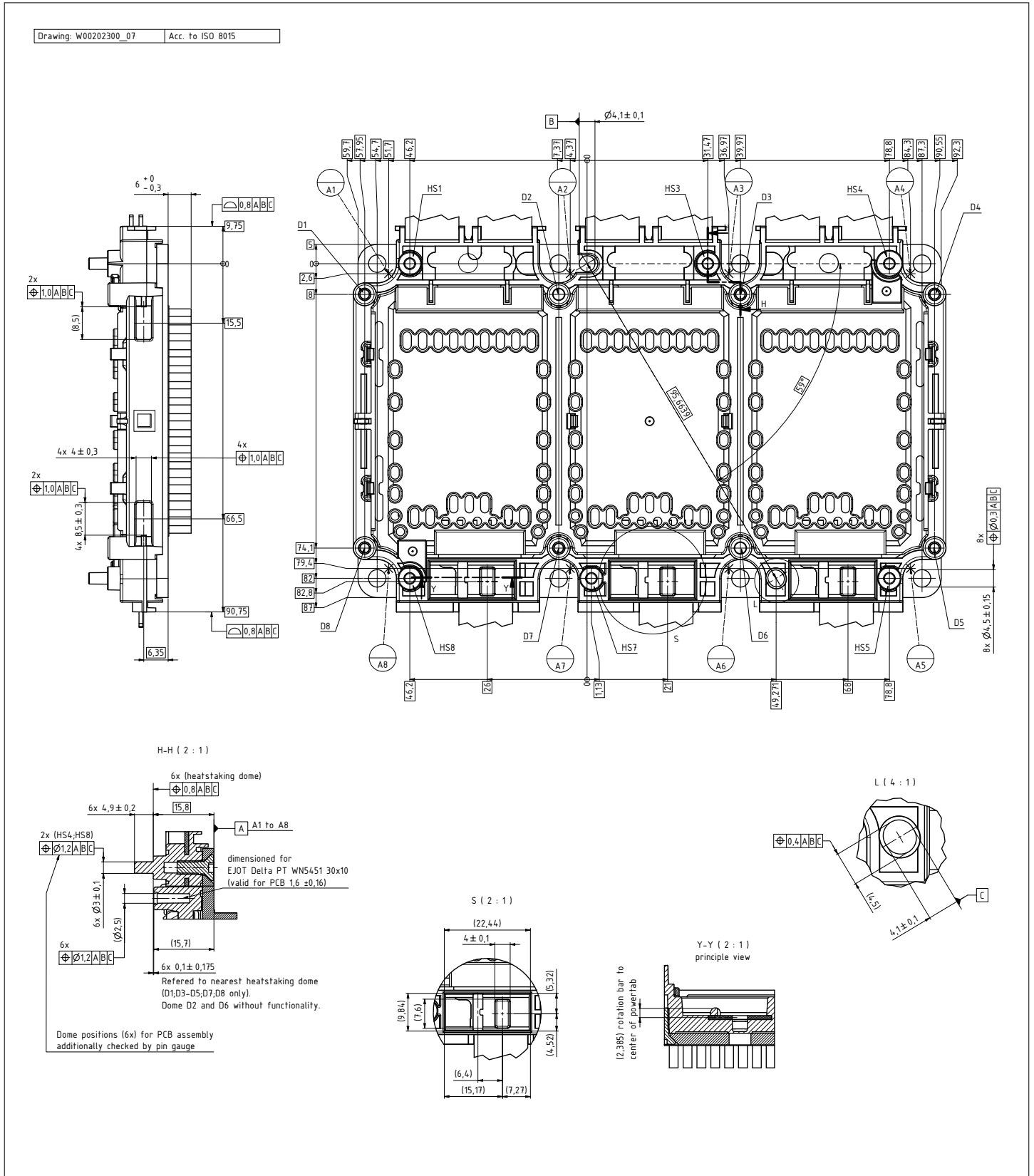


Figure 1

**7 Package outlines**



**Figure 2**

7 Package outlines

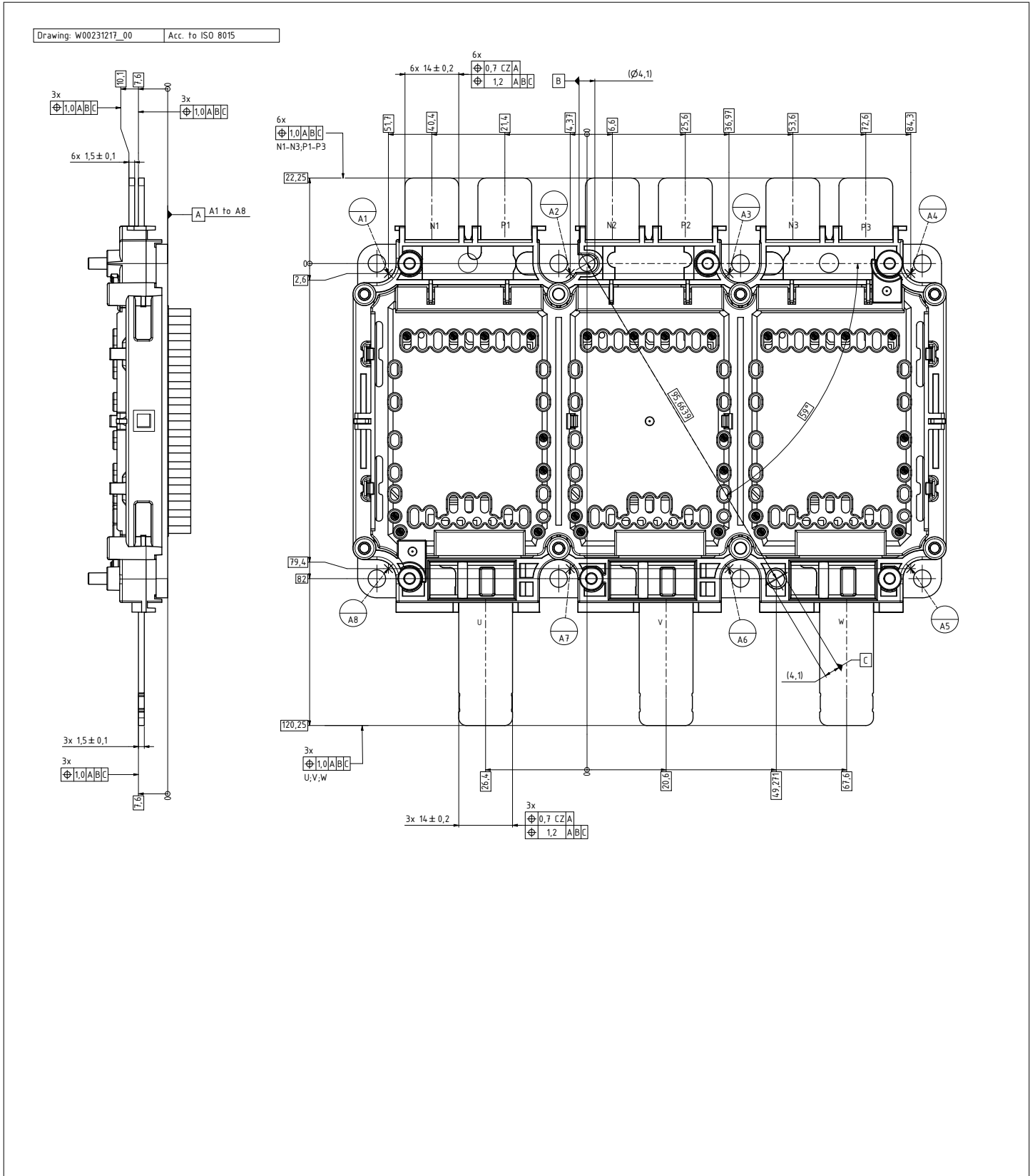
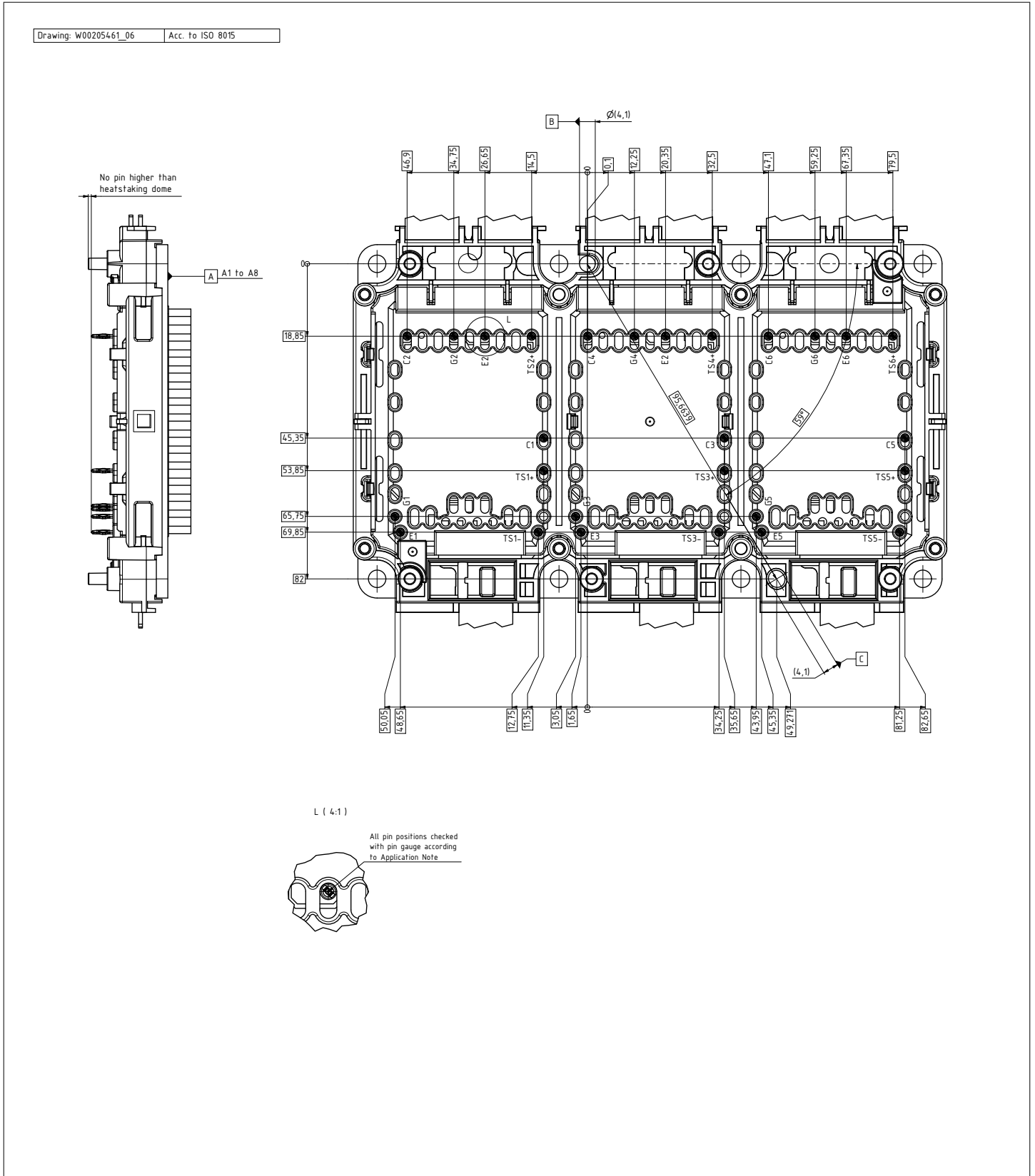


Figure 3




7 Package outlines



**Figure 4**



## 8 Module label code

<b>Module label code</b>				
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	<i>Content</i>	<i>Digit</i>	<i>Example</i>	
	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	
<b>Packing label code</b>				
Code format	Barcode Code128			
Encoding	Code Set A			
Symbol size	34 digits			
Standard	IEC8859-1			
Code content	<i>Content</i>	<i>Identifier</i>	<i>Digit</i>	<i>Example</i>
	Module serial number	X	2 - 9	95056609
	Module material number	1T	12 - 19	2X0003E0
	Production order number	S	21 - 25	754389
	Date code (production year)	9D	28 - 31	1139
	Date code (production week)	Q	33 - 34	15
Example				
	X950566091T2X0003E0S754389D1139Q15			

**Figure 5**

## Revision history

Document revision	Date of release	Description of changes
0.10	2024-04-10	Initial version
1.00	2024-04-19	Final datasheet

## Trademarks

All referenced product or service names and trademarks are the property of their respective owners.

**Edition 2024-04-19**

**Published by**

**Infineon Technologies AG**

**81726 Munich, Germany**

**© 2024 Infineon Technologies AG**

**All Rights Reserved.**

**Do you have a question about any aspect of this document?**

**Email: [erratum@infineon.com](mailto:erratum@infineon.com)**

**Document reference**

**IFX-ABH554-002**

## Important notice

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics ("Beschaffheitsgarantie").

With respect to any examples, hints or any typical values stated herein and/or any information regarding the application of the product, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation warranties of non-infringement of intellectual property rights of any third party.

In addition, any information given in this document is subject to customer's compliance with its obligations stated in this document and any applicable legal requirements, norms and standards concerning customer's products and any use of the product of Infineon Technologies in customer's applications.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of customer's technical departments to evaluate the suitability of the product for the intended application and the completeness of the product information given in this document with respect to such application.

## Warnings

Due to technical requirements products may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies office.

Except as otherwise explicitly approved by Infineon Technologies in a written document signed by authorized representatives of Infineon Technologies, Infineon Technologies' products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.

## X-ON Electronics

Largest Supplier of Electrical and Electronic Components

*Click to view similar products for [Discrete Semiconductor Modules](#) category:*

*Click to view products by [Infineon](#) manufacturer:*

Other Similar products are found below :

[M254045V](#) [M254085](#) [DD380N16A](#) [DDB6U145N16L](#) [DR7306](#) [DZ540N26K](#) [EFG15D](#) [B484-2](#) [B485A-2](#) [B522F-2-YEC](#) [25.320.4853.1](#)  
[25.320.5253.1](#) [25.334.3253.1](#) [25.334.3353.1](#) [25.350.2053.0](#) [25.352.4753.1](#) [25.522.3253.0](#) [T2180N18TOF](#) [VT](#) [T484C](#) [T485F](#) [T485H](#) [T514F](#)  
[T554](#) [T582](#) [25.332.4353.1](#) [25.350.1653.0](#) [25.352.1453.0](#) [25.352.1653.0](#) [25.352.2453.0](#) [25.352.5453.1](#) [25.522.3353.0](#) [25.640.5053.0](#)  
[M252532V](#) [M252555](#) [M2550TB400](#) [M471B5673EH1-CH900](#) [M505012F-YEC](#) [TD330N16AOF](#) [B512-2T-YDA](#) [TT215N22KOF](#) [V100-](#)  
[35.200N](#) [V50-14.45M](#) [V72-26.150M](#) [DD700N22K](#) [DD89N16K](#) [DD98N22K](#) [MSD30-12](#) [MSKD120-16](#) [TD500N16KOF](#) [TD570N16KOF](#)