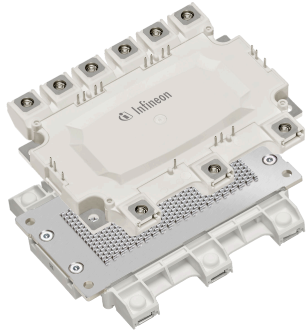
HybridPACK™ DC6 module with Trench/Fieldstop IGBT3 and emitter controlled 3 diode and NTC



Features

- Electrical features
  - V_{CES} = 700 V
  - $I_{C,nom}$ = 400 A
  - Low switching losses
  - Low $V_{CE,sat}$
  - $T_{vj,op}$ = 150°C
  - $V_{CE,sat}$ with positive temperature coefficient
  - Increased blocking voltage capability to 705 V
  - Low inductive design
- Mechanical features
  - 2.5 kV AC 1 minute insulation
  - Al_2O_3 substrate with low thermal resistance
  - Direct-cooled base plate with ribbon bonds
  - High mechanical robustness
  - Integrated NTC temperature sensor
  - RoHS compliant

Potential applications

- (Hybrid) electrical vehicles (H)EV
- Motor drives
- Optimized for automotive applications with DC link voltages up to 450 V

Description

Infineon's HybridPACK™ DC6 with ribbon bonded cooling structures is a variant of the HybridPACK™ 1 power module family with increased continuous current capability and a reduced stray inductance.

Like all HybridPACK™ 1 products the HybridPACK™ DC6 with ribbon bonds is an automotive qualified power module designed for electric vehicle applications. Designed for a 150°C junction operation temperature, the module accommodates a 3-phase Six-Pack configuration of Trench-Field-Stop IGBT3 and matching emitter controlled diodes. The HybridPACK™ DC6 power module family is built on Infineon's long time experience in the development of IGBT power modules, intense research efforts of new material combinations and assembly technologies. HybridPACK™ DC6 with ribbon bonds is suitable for direct liquid cooling. The copper base plate combined with high-performance ceramic substrate and Infineon's enhanced wire-bonding process provides unparalleled thermal and power cycling capabilityand highest reliability for inverter or generator applications. For a compact design the driver stage PCB can easily be soldered on top of the module. All power connections are realized with screw terminals.

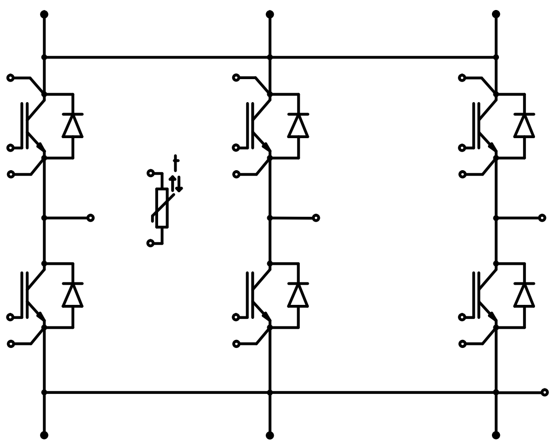


Table of contents

1 Package

Table 1 Insulation coordination

Parameter	Symbol	Note or test condition	Values	Unit
Isolation test voltage	V_{ISOL}	RMS, f = 50 Hz, t = 1 min	2.5	kV
Material of module baseplate			Cu	
Internal isolation		basic insulation (class 1, IEC 61140)	Al_2O_3	
Creepage distance	d_{creep}	terminal to heatsink	12.0	mm
Creepage distance	d_{creep}	terminal to terminal	6.1	mm
Clearance	d_{clear}	terminal to heatsink	12.0	mm
Clearance	d_{clear}	terminal to terminal	6.1	mm
Comparative tracking index	*CTI*		>200	

Table 2 Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Maximum RMS module terminal current	$I_{t,rms}$	T_f = 25, $T_{terminal}$ = 150 °C	320[1)]	A

1) DC-collector current limited by internal busbar.

Table 3 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Pressure drop in cooling circuit	Δp	$\Delta V/\Delta t$ = 10 dm^3/min, T_f = 25 °C		100		mbar
Maximum pressure in cooling circuit	p				2.0	bar
Stray inductance module	$L_{s,CE}$			16.0		nH
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	T = 25°C, per switch		1.00		mΩ
Storage temperature	T_{stg}		-40		125	°C
Mounting torque for module mounting	M	Screw M5 baseplate to heatsink	3.0		6.0	Nm
Terminal connection torque	M	Screw M6	3.0		6.0	Nm
Weight	G			515		g

2 IGBT, Inverter

Table 4 Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Collector-emitter voltage	V_{CES}	T_{vj} = 25 °C	705	V
Continuous DC collector current	$I_{C,nom}$	T_f = 75 °C, $T_{vj,max}$ = 175 °C	400	A
Continuous DC collector current	I_C	T_f = 25 °C, $T_{vj,max}$ = 175 °C	500	A
Repetitive peak collector current	I_{CRM}	t_P = 1 ms	800	A
Total power dissipation	P_{tot}	T_f = 25 °C, $T_{vj,max}$ = 175 °C	811	W
Gate-emitter peak voltage	V_{GES}		±20	V

Table 5 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Collector-emitter saturation voltage	$V_{CE,sat}$	I_C = 400 A, V_{GE} = 15 V	T_{vj} = 25 °C		1.45	1.70	V
			T_{vj} = 125 °C		1.60		
			T_{vj} = 150 °C		1.70		
Gate threshold voltage	$V_{GE,th}$	I_C = 6.4 mA, V_{CE} = V_{GE}	T_{vj} = 25 °C	4.9	5.8	6.5	V
Gate charge	Q_G	V_{GE} = ±15 V			4.3		µC
Internal gate resistor	$R_{G,int}$		T_{vj} = 25 °C		1.0		Ω
Input capacitance	C_{ies}	f = 1 MHz, V_{CE} = 25 V, V_{GE} = 0 V	T_{vj} = 25 °C		26.0		nF
Reverse transfer capacitance	C_{res}	f = 1 MHz, V_{CE} = 25 V, V_{GE} = 0 V	T_{vj} = 25 °C		0.76		nF
Collector-emitter cut-off current	I_{CES}	V_{CE} = 705 V, V_{GE} = 0 V	T_{vj} = 25 °C			0.1	mA
Gate-emitter leakage current	I_{GES}	V_{CE} = 0 V, V_{GE} = 20 V	T_{vj} = 25 °C			400	nA
Turn-on delay time, inductive load	$t_{d,on}$	I_C = 400 A, V_{CE} = 300 V, V_{GE} = ±15 V, $R_{G,on}$ = 1.8 Ω	T_{vj} = 25 °C		0.12		µs
			T_{vj} = 125 °C		0.12		
			T_{vj} = 150 °C		0.12		
Rise time, inductive load	t_r	I_C = 400 A, V_{CE} = 300 V, V_{GE} = ±15 V, $R_{G,on}$ = 1.8 Ω	T_{vj} = 25 °C		0.08		µs
			T_{vj} = 125 °C		0.08		
			T_{vj} = 150 °C		0.08		
Turn-off delay time, inductive load	$t_{d,off}$	I_C = 400 A, V_{CE} = 300 V, V_{GE} = ±15 V, $R_{G,off}$ = 1.8 Ω	T_{vj} = 25 °C		0.36		µs
			T_{vj} = 125 °C		0.40		
			T_{vj} = 150 °C		0.40		

(table continues...)

Table 5 **(continued) Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Fall time, inductive load	t_f	I_C = 400 A, V_{CE} = 300 V, V_{GE} = ±15 V, $R_{G,off}$ = 1.8 Ω	T_{vj} = 25 °C		0.02		µs
			T_{vj} = 125 °C		0.03		
			T_{vj} = 150 °C		0.03		
Turn-on energy loss per pulse	E_{on}	I_C = 400 A, V_{CE} = 300 V, L_σ = 16 nH, V_{GE} = ±15 V, $R_{G,on}$ = 1.8 Ω	T_{vj} = 25 °C		5.1		mJ
			T_{vj} = 125 °C		6.8		
			T_{vj} = 150 °C, di/dt = 4500 A/µs		7.3		
Turn-off energy loss per pulse	E_{off}	I_C = 400 A, V_{CE} = 300 V, L_σ = 16 nH, V_{GE} = ±15 V, $R_{G,off}$ = 1.8 Ω	T_{vj} = 25 °C		9.1		mJ
			T_{vj} = 125 °C		12.0		
			T_{vj} = 150 °C, du/dt = 3400 V/µs		12.5		
SC data	I_{SC}	V_{CC} = 360 V, V_{GE} ≤ 15 V, $V_{CEmax} = V_{CES} - L_{sCE}$ di/dt	t_P ≤ 8 µs, T_{vj} = 25 °C		2800		A
			t_P ≤ 6 µs, T_{vj} = 150 °C		2000		
Thermal resistance, junction to cooling fluid	$R_{th,j-f}$	per IGBT, ΔV/Δt = 10.0 dm^3/min			0.170	0.185	K/W
Temperature under switching conditions	$T_{vj,op}$	t_{op} continuous		-40		150	°C

Note: *DC-collector current limited by power terminals.*

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 °C		705	V
Continuous DC forward current	$I_{F,nom}$			400	A
Repetitive peak forward current	I_{FRM}	t_P = 1 ms		800	A
I^2t - value	I^2t	V_R = 0 V, t_P = 10 ms	T_{vj} = 125 °C	8800	A^2s
			T_{vj} = 150 °C	8500	

Table 7 **Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_F	I_F = 400 A, V_{GE} = 0 V	T_{vj} = 25 °C		1.55	1.95	V
			T_{vj} = 125 °C		1.50		
			T_{vj} = 150 °C		1.45		
Peak reverse recovery current	I_{rm}	I_F = 400 A, V_{GE} = -15 V, V_R = 300	T_{vj} = 25 °C		205		A
			T_{vj} = 125 °C		295		
			T_{vj} = 150 °C, $-di_F/dt$ = 4500 A/µs		305		
Recovered charge	Q_r	I_F = 400 A, V_{GE} = -15 V, V_R = 300	T_{vj} = 25 °C		15.0		µC
			T_{vj} = 125 °C		32.0		
			T_{vj} = 150 °C, $-di_F/dt$ = 4500 A/µs		34.0		
Reverse recovery energy	E_{rec}	I_F = 400 A, V_{GE} = -15 V, V_R = 300	T_{vj} = 25 °C		3.35		mJ
			T_{vj} = 125 °C		6.90		
			T_{vj} = 150 °C, $-di_F/dt$ = 4500 A/µs		8.10		
Thermal resistance, junction to cooling fluid	$R_{th,j\text{-}f}$	per diode, ΔV/Δt = 10.0 dm^3/min			0.270	0.300	K/W
Temperature under switching conditions	$T_{vj,op}$	t_{op} continuous		-40		150	°C

Note: *DC-collector current limited by power terminals*

4 NTC-Thermistor

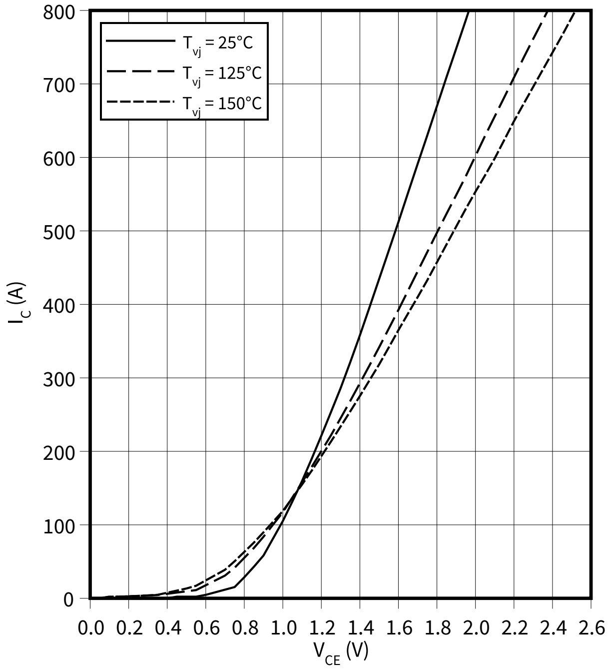
Table 8 **Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rated resistance	R_{25}	T_{NTC} = 25 °C		5		kΩ
Deviation of R_{100}	$\Delta R/R$	T_{NTC} = 25 °C, R_{100} = 493 Ω	-5		5	%
Power dissipation	P_{25}	T_{NTC} = 25 °C			20	mW
B-value	$B_{25/50}$	$R_2 = R_{25} \exp[B_{25/50}(1/T_2 - 1/(298,15\ K))]$		3375		K
B-value	$B_{25/80}$	$R_2 = R_{25} \exp[B_{25/80}(1/T_2 - 1/(298,15\ K))]$		3411		K
B-value	$B_{25/100}$	$R_2 = R_{25} \exp[B_{25/100}(1/T_2 - 1/(298,15\ K))]$		3433		K

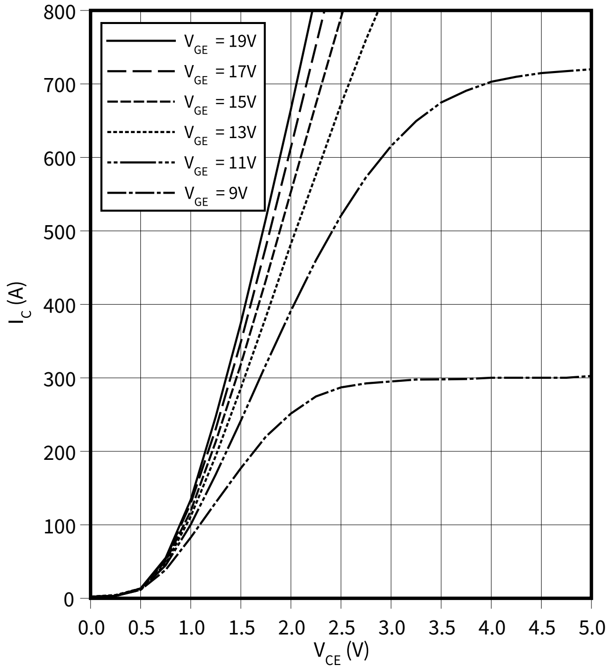
Note: *Specification according to the valid application note.*

5 Characteristics diagrams

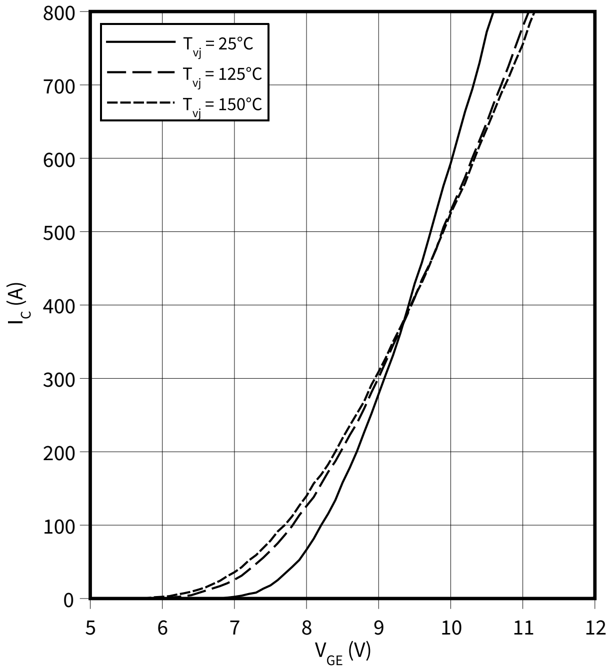
Output characteristic (typical), IGBT, Inverter
$I_C = f(V_{CE})$
$V_{GE} = 15$ V



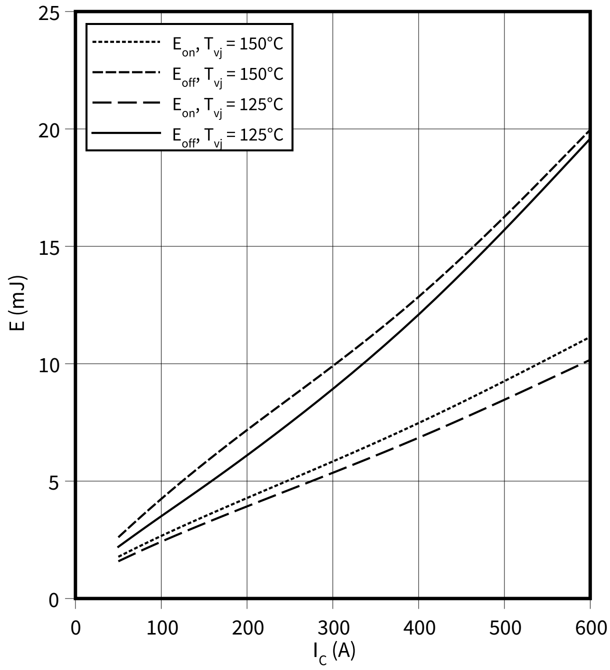
Output characteristic (typical), IGBT, Inverter
$I_C = f(V_{CE})$
$T_{vj} = 150$ °C



Transfer characteristic (typical), IGBT, Inverter
$I_C = f(V_{GE})$
$V_{CE} = 20$ V



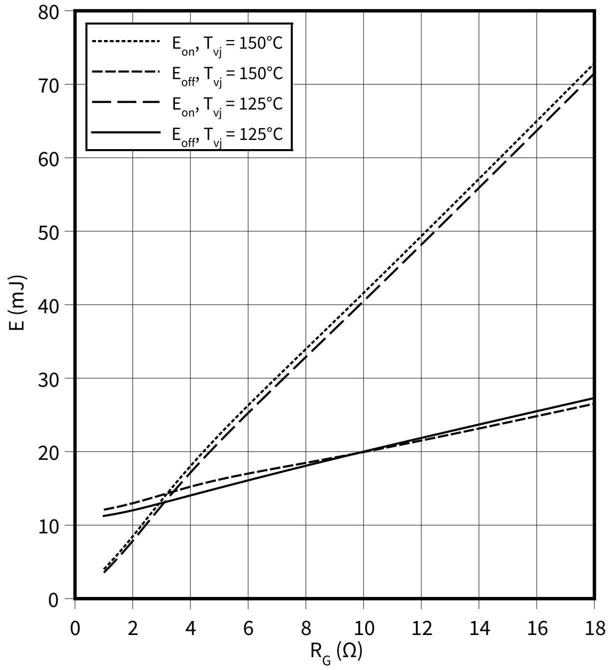
Switching losses (typical), IGBT, Inverter
$E = f(I_C)$
$R_{G,off} = 1.8\ \Omega$, $R_{G,on} = 1.8\ \Omega$, $V_{CE} = 300$ V, $V_{GE} = \pm 15$ V



Switching losses (typical), IGBT, Inverter

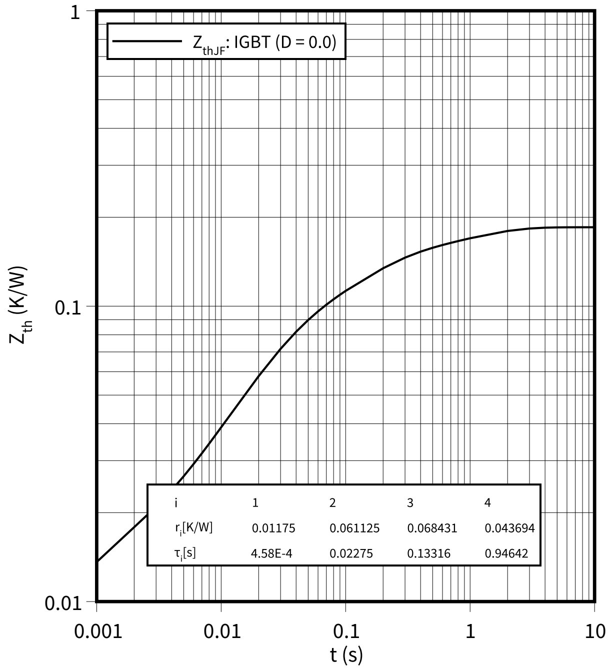
$E = f(R_G)$

$V_{CE} = 300$ V, $V_{GE} = \pm15$ V, $I_C = 400$ A



Transient thermal impedance , IGBT, Inverter

$Z_{th} = f(t)$

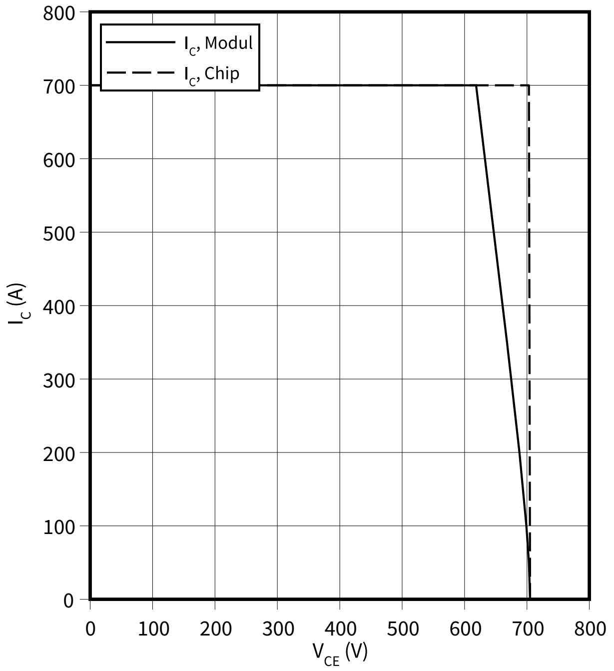


i	1	2	3	4
r_i[K/W]	0.01175	0.061125	0.068431	0.043694
τ_i[s]	4.58E-4	0.02275	0.13316	0.94642

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

$I_C = f(V_{CE})$

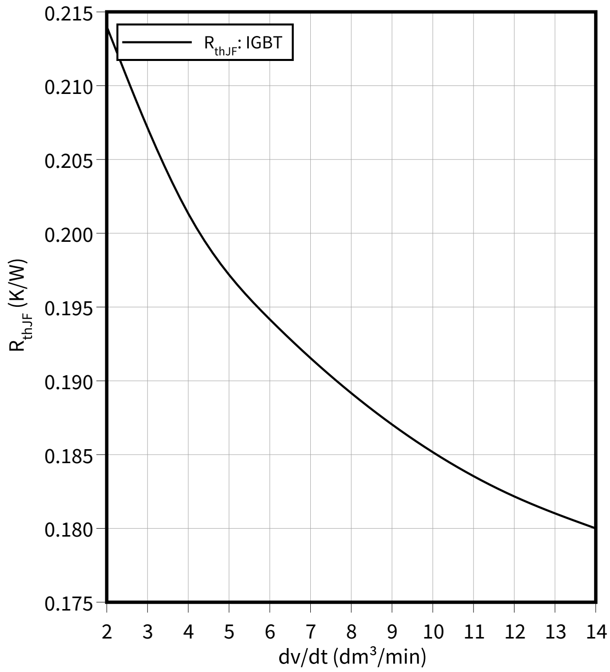
$T_{vj} = 150$ °C, $R_{G,off} = 1.8$ Ω, $V_{GE} = \pm15$ V



Thermal impedance , IGBT, Inverter

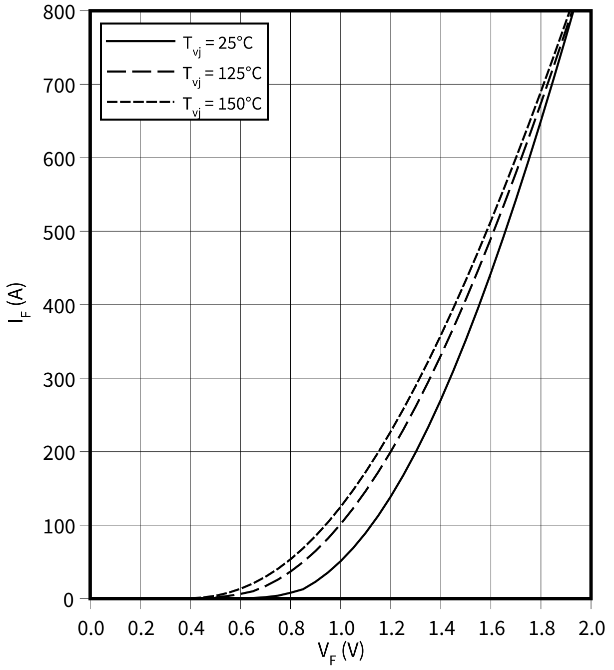
$R_{thJF} = f(dv/dt)$

$T_f = 25$ °C, fluid = 50% water/50% ethylenglycol



Forward characteristic (typical), Diode, Inverter

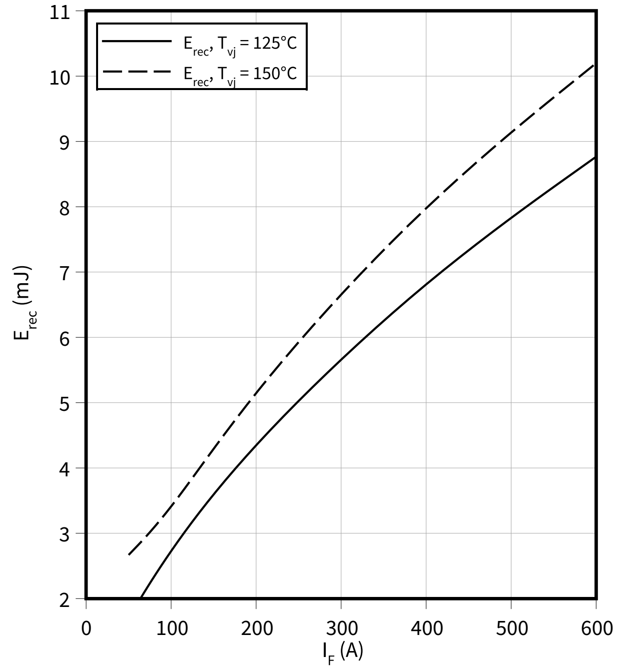
$I_F = f(V_F)$



Switching losses (typical), Diode, Inverter

$E_{rec} = f(I_F)$

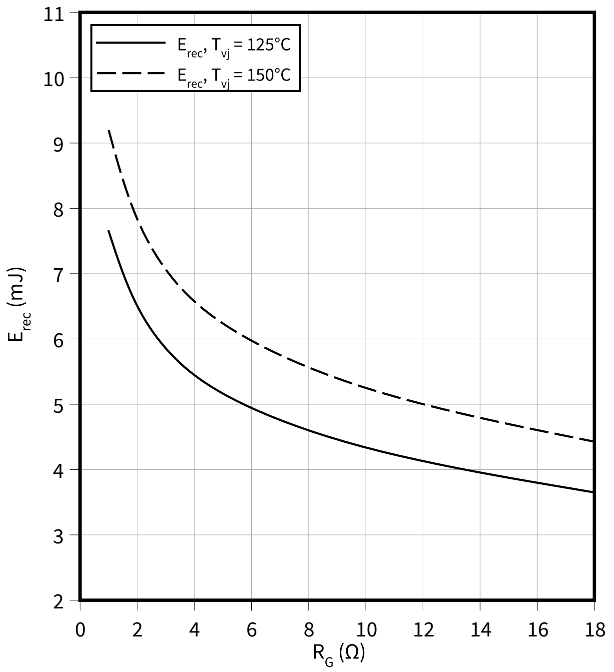
$R_{Gon} = 1.8\ \Omega$, $V_{CE} = 300$ V



Switching losses (typical), Diode, Inverter

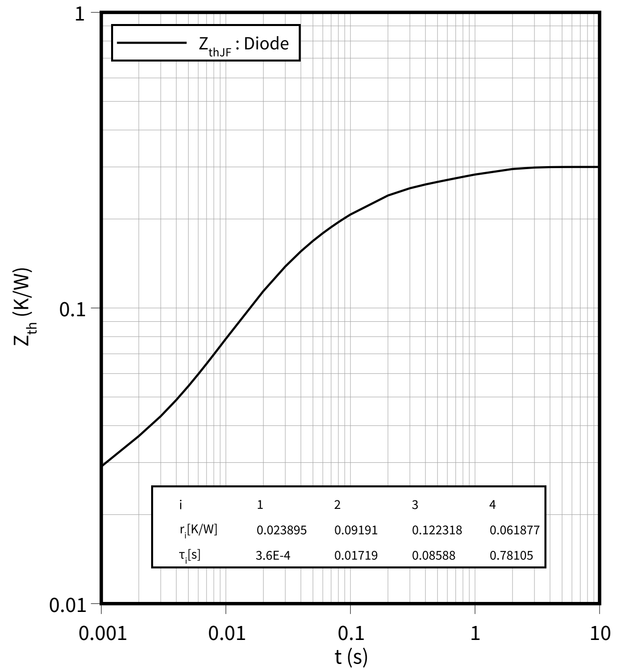
$E_{rec} = f(R_G)$

$V_{CE} = 300$ V, $I_F = 400$ A



Transient thermal impedance , Diode, Inverter

$Z_{th} = f(t)$

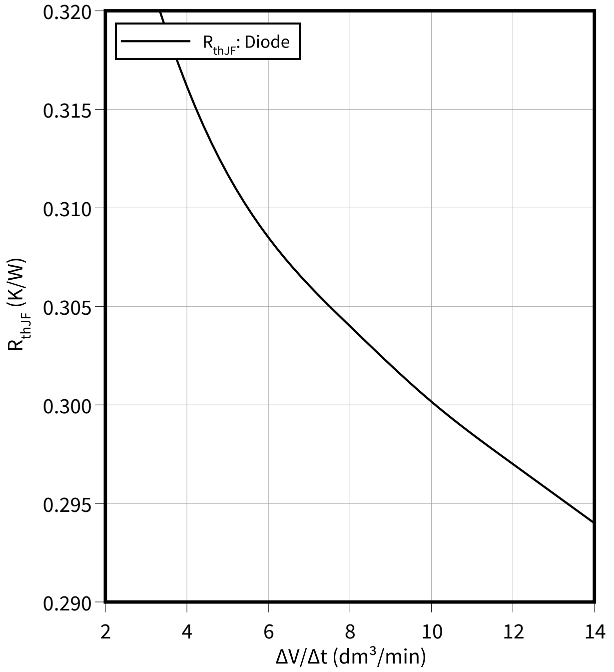


i	1	2	3	4
r_i[K/W]	0.023895	0.09191	0.122318	0.061877
τ_i[s]	3.6E-4	0.01719	0.08588	0.78105

Thermal impedance , Diode, Inverter

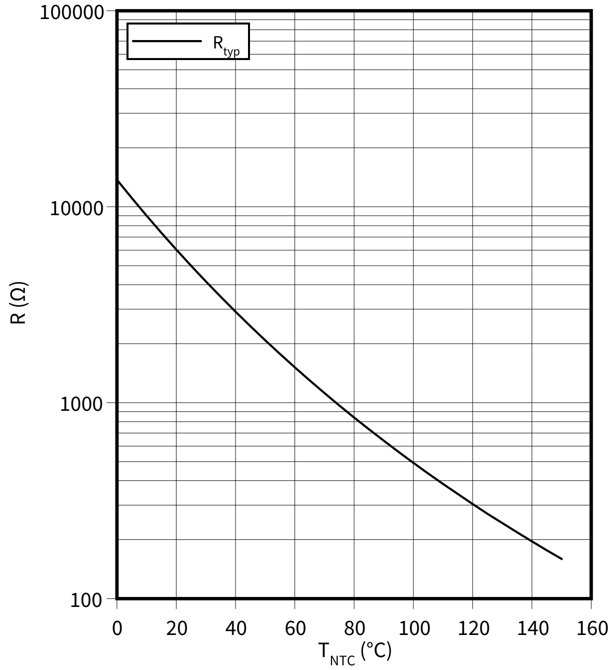
$R_{thJF} = f(\Delta V/\Delta t)$

$T_f = 25\ °C$, fluid = 50% water/50% ethylenglycol



Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



6 Circuit diagram

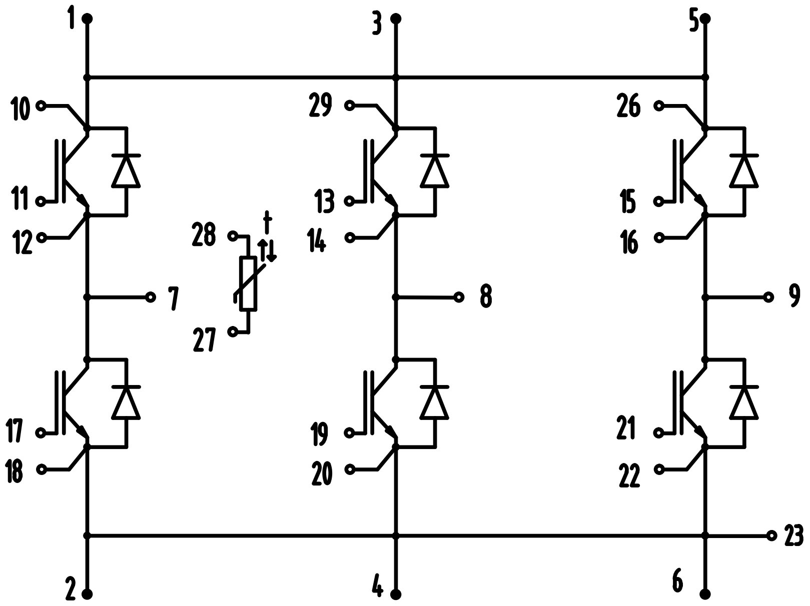


Figure 1

7 Package outlines

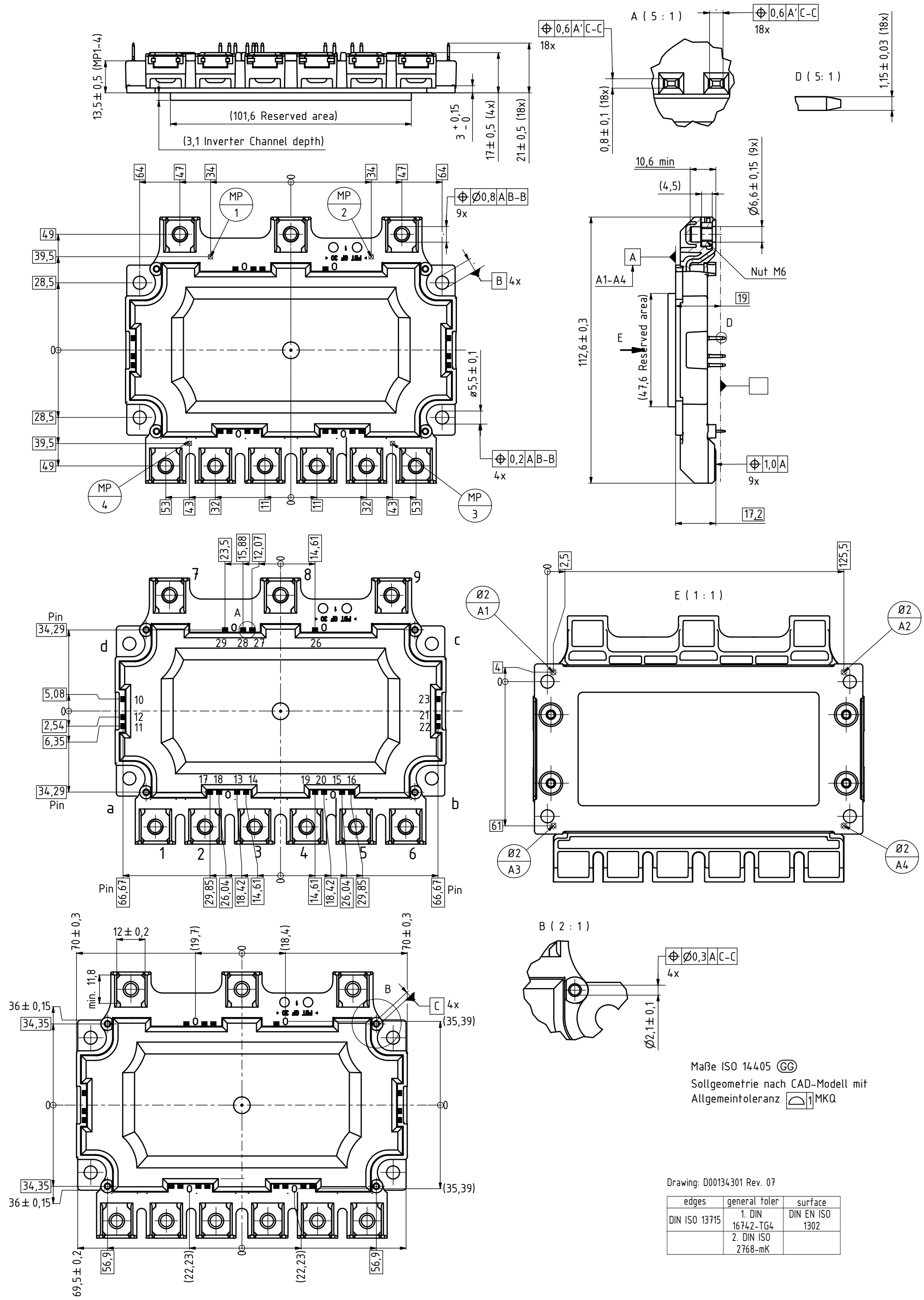


Figure 2

8 Module label code

Module label code

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

Packing label code

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

Code content	*Content*	*Identifier*	*Digit*	*Example*
	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 3

Revision history

Document revision	Date of release	Description of changes
V1.0	2017-04-06	
V2.0	2018-01-15	
V3.0	2018-03-26	Final datasheet
V3.1	2019-12-19	Correction of mechanical feature
n/a	2020-10-05	Datasheet migrated to a new system with a new layout and new revision number schema: target or preliminary datasheet = 0.xy; final datasheet = 1.xy
1.10	2021-03-05	Adaption of electrical features
1.20	2021-12-21	Adjustment of package outline

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