HybridPACK™ Drive Module

FS380R12A6T4B

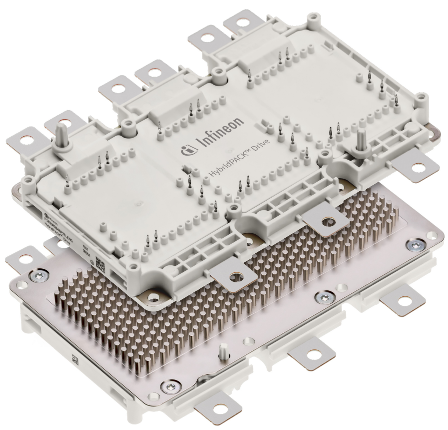
Final Data Sheet

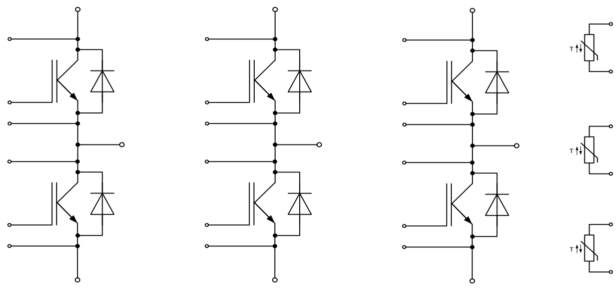
V3.1, 2019-09-10

Automotive High Power

1 Features / Description

HybridPACK™ Drive module with Trench/Fieldstop IGBT4 and Emitter Controlled 4 diode





V_{CES} = 1200 V
I_C = 380 A

Typical Applications
- Automotive Applications
- Hybrid Electrical Vehicles (H)EV
- Motor Drives
- Commercial Agriculture Vehicles

Electrical Features
- Blocking voltage 1200V
- Low V_{CEsat}
- Low Switching Losses
- Low Qg and Crss
- Low Inductive Design
- $T_{vj\ op}$ = 150°C

Mechanical Features
- 4.2kV DC 1sec Insulation
- High Creepage and Clearance Distances
- High Power Density
- High Performance Si3N4 Ceramic
- Direct Cooled PinFin Base Plate
- Guiding elements for PCB and cooler assembly
- Integrated NTC temperature sensor
- PressFIT Contact Technology
- RoHS compliant
- UL 94 V0 module frame

Description

The HybridPACK™ Drive is a very compact six-pack module (1200V/380A) optimized for hybrid and electric vehicles. The power module implements the IGBT4 generation. The chipset has high short circuit ruggedness and come with a matching efficient and soft switching Emcon4 diode.

The new HybridPACK™ Drive power module family comes with mechanical guiding elements supporting easy assembly processes for customers. Furthermore, the press-fit pins for the signal terminals avoid additional time consuming selective solder processes, which provides cost savings on system level and increases system reliability. The direct cooled baseplate with PinFin structure and optimized ceramic material in the FS380R12A6T4B product best utilizes the implemented chipset and shows superior thermal characteristics. Due to the high clearance & creepage distances, the module well suited for increased system working voltages and supports modular inverter approaches.

Product Name	Ordering Code
FS380R12A6T4B	SP001632438

2 IGBT,Inverter

2.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
Collector-emitter voltage	T_{vj} = 25°C	V_{CES}	1200[1]	V
Implemented collector current		I_{CN}	380	A
Continuous DC collector current	T_F = 100°C, $T_{vj\,max}$ = 175°C	$I_{C\,nom}$	250[2]	A
Repetitive peak collector current	t_P = 1 ms	I_{CRM}	760	A
Total power dissipation	T_F = 75°C, $T_{vj\,max}$ = 175°C	P_{tot}	870[2]	W
Gate-emitter peak voltage		V_{GES}	+/-20	V

2.2 Characteristic Values

Parameter	Conditions		Symbol	min.	typ.	max.	Unit
Collector-emitter saturation voltage	I_C = 250 A, V_{GE} = 15 V I_C = 250 A, V_{GE} = 15 V I_C = 250 A, V_{GE} = 15 V I_C = 380 A, V_{GE} = 15 V I_C = 380 A, V_{GE} = 15 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C T_{vj} = 25°C T_{vj} = 150°C	$V_{CE\,sat}$		1.60 1.85 1.90 1,95 2,40	1.95	V
Gate threshold voltage	I_C = 9.75 mA, V_{CE} = V_{GE}	T_{vj} = 25°C	V_{GEth}	5.20	5.80	6.40	V
Gate charge	V_{GE} = -8 V ... 15 V, V_{CE} = 600V		Q_G		1.75		µC
Internal gate resistor		T_{vj} = 25°C	R_{Gint}		2.5		Ω
Input capacitance	f = 1 MHz, V_{CE} = 25 V, V_{GE} = 0 V	T_{vj} = 25°C	C_{ies}		19.0		nF
Reverse transfer capacitance	f = 1 MHz, V_{CE} = 25 V, V_{GE} = 0 V	T_{vj} = 25°C	C_{res}		0.81		nF
Collector-emitter cut-off current	V_{CE} = 1200 V, V_{GE} = 0 V	T_{vj} = 25°C	I_{CES}			1.0	mA
Gate-emitter leakage current	V_{CE} = 0 V, V_{GE} = 20 V	T_{vj} = 25°C	I_{GES}			400	nA
Turn-on delay time, inductive load	I_C = 250 A, V_{CE} = 600 V V_{GE} = -8 / +15 V R_{Gon} = 2.2 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	$t_{d\,on}$		0.13 0.14 0.14		µs
Rise time, inductive load	I_C = 250 A, V_{CE} = 600 V V_{GE} = -8 / +15 V R_{Gon} = 2.2 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	t_r		0.05 0.05 0.05		µs
Turn-off delay time, inductive load	I_C = 250 A, V_{CE} = 600 V V_{GE} = -8 / +15 V R_{Goff} = 2.2 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	$t_{d\,off}$		0.47 0.57 0.60		µs
Fall time, inductive load	I_C = 250 A, V_{CE} = 600 V V_{GE} = -8 / +15 V R_{Goff} = 2.2 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	t_f		0.10 0.20 0.22		µs
Turn-on energy loss per pulse	I_C = 250 A, V_{CE} = 600 V, L_S = 20 nH V_{GE} = -8 / +15 V R_{Gon} = 2.2 Ω di/dt (T_{vj} 25°C) = 4000 A/µs di/dt (T_{vj} 150°C) = 3800 A/µs	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	E_{on}		19.0 26.5 29.0		mJ
Turn-off energy loss per pulse	I_C = 250 A, V_{CE} = 600 V, L_S = 20 nH V_{GE} = -8 / +15 V R_{Goff} = 2.2 Ω dv/dt (T_{vj} 25°C) = 3300 V/µs dv/dt (T_{vj} 150°C) = 3000 V/µs	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	E_{off}		18.5 28.0 31.0		mJ
SC data	$V_{GE} \leq 15$ V, V_{CC} = 800 V $V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$	$t_P \leq 8$ µs, T_{vj} = 25°C $t_P \leq 6$ µs, T_{vj} = 150°C	I_{SC}		1500 1200		A
Thermal resistance, junction to cooling fluid	per IGBT; ΔV/Δt = 10 dm³/min, T_F = 75°C		R_{thJF}		0.100[3]	0.115[3]	K/W
Temperature under switching conditions	t_{op} continuous		$T_{vj\,op}$	-40		150	°C

[1] For applications with applied blocking voltage > 60% of the specified maximum collector-emitter voltage, we recommend to evaluate the impact of the cosmic radiation effect in early design phase. For assessment please contact local Infineon sales office.
[2] Verified by characterization / design not by test.
[3] Cooler design and flow direction according to application note AN-HPDPERF-ASSEMBLY. Cooling fluid 50% water / 50% ethylenglycol.

3 Diode, Inverter

3.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
Repetitive peak reverse voltage	T_{vj} = 25°C	V_{RRM}	1200[1]	V
Implemented forward current		I_{FN}	380	A
Continuous DC forward current		I_F	250[2]	A
Repetitive peak forward current	t_P = 1 ms	I_{FRM}	760	A
I^2t - value	V_R = 0 V, t_P = 10 ms, T_{vj} = 125°C V_R = 0 V, t_P = 10 ms, T_{vj} = 150°C	I^2t	10000 8800	A^2s A^2s

3.2 Characteristic Values

Parameter	Conditions		Symbol	min.	typ.	max.	Unit
Forward voltage	I_F = 250 A, V_{GE} = 0 V I_F = 250 A, V_{GE} = 0 V I_F = 250 A, V_{GE} = 0 V I_F = 380 A, V_{GE} = 0 V I_F = 380 A, V_{GE} = 0 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C T_{vj} = 25°C T_{vj} = 150°C	V_F		1.60 1.55 1.55 1,85 1,80	2.00	V
Peak reverse recovery current	I_F = 250 A, - di_F/dt = 3800 A/µs (T_{vj} = 150°C) V_R = 600 V V_{GE} = -8 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	I_{RM}		245 300 315		A
Recovered charge	I_F = 250 A, - di_F/dt = 3800 A/µs (T_{vj} = 150°C) V_R = 600 V V_{GE} = -8 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	Q_r		24.0 42.5 48.0		µC
Reverse recovery energy	I_F = 250 A, - di_F/dt = 3800 A/µs (T_{vj} = 150°C) V_R = 600 V V_{GE} = -8 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	E_{rec}		10.0 17.5 19.5		mJ
Thermal resistance, junction to cooling fluid	per diode; ΔV/Δt = 10 dm³/min, T_F = 75°C		R_{thJF}		0.140[3]	0.160[3]	K/W
Temperature under switching conditions	t_{op} continuous		$T_{vj\,op}$	-40		150	°C

4 NTC-Thermistor

Parameter	Conditions	Symbol	min.	typ.	max.	Unit
Rated resistance	T_C = 25°C	R_{25}		5.00		kΩ
Deviation of R100	T_C = 100°C, R_{100} = 493 Ω	ΔR/R	5		5	%
Power dissipation	T_C = 25°C	P_{25}			20.0	mW
B-value	$R_2 = R_{25}$ exp [$B_{25/50}$(1/T_2 - 1/(298,15 K))]	$B_{25/50}$		3375		K
B-value	$R_2 = R_{25}$ exp [$B_{25/80}$(1/T_2 - 1/(298,15 K))]	$B_{25/80}$		3411		K
B-value	$R_2 = R_{25}$ exp [$B_{25/100}$(1/T_2 - 1/(298,15 K))]	$B_{25/100}$		3433		K

Specification according to the valid application note.

[1] For applications with applied blocking voltage > 60% of the specified maximum collector-emitter voltage, we recommend to evaluate the impact of the cosmic radiation effect in early design phase. For assessment please contact local Infineon sales office.
[2] Verified by characterization / design not by test.
[3] Cooler design and flow direction according to application note AN-HPDPERF-ASSEMBLY. Cooling fluid 50% water / 50% ethylenglycol.

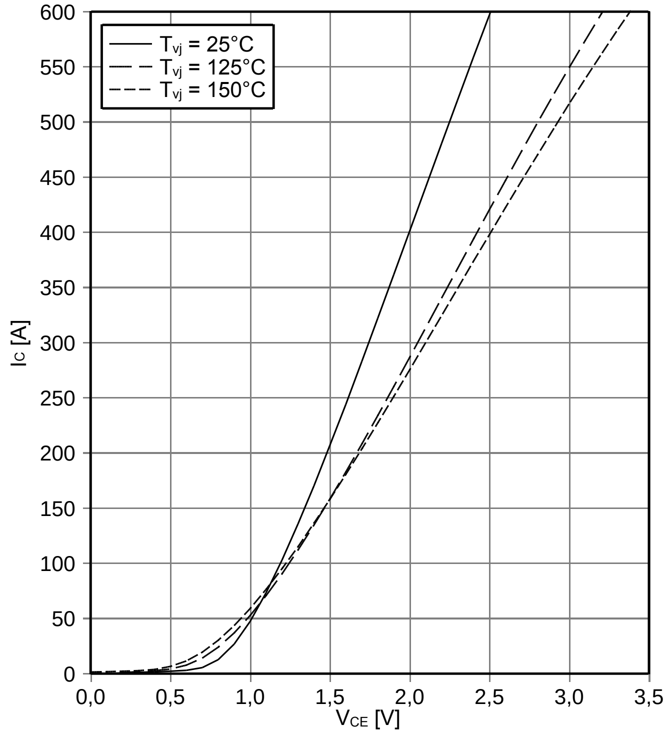
5 Module

Parameter	Conditions	Symbol	Value			Unit
Isolation test voltage	RMS, f = 0 Hz, t = 1 sec	V_{ISOL}		4.2		kV
Maximum RMS module terminal current	T_F = 75°C, T_{Ct} = 105°C	I_{tRMS}		550		A
Material of module baseplate				Cu+Ni[1]		
Internal isolation	basic insulation (class 1, IEC 61140)			Si_3N_4		
Creepage distance	terminal to heatsink terminal to terminal	d_{Creep}		9.0 9.0		mm
Clearance	terminal to heatsink terminal to terminal	d_{Clear}		4.5 4.5		mm
Comperative tracking index		CTI		> 200		
			min.	typ.	max.	
Pressure drop in cooling circuit	$\Delta V/\Delta t$ = 10.0 dm³/min; T_F = 75°C	Δp		64[2]		mbar
Maximum pressure in cooling circuit	$T_{baseplate}$ < 40°C $T_{baseplate}$ > 40°C (relative pressure)	p			2.5 2.0	bar
Stray inductance module		L_{sCE}		8.0		nH
Module lead resistance, terminals - chip	T_F = 25 °C, per switch	$R_{CC'+EE'}$		0.75		mΩ
Storage temperature		T_{stg}	-40		125	°C
Mounting torque for modul mounting	Screw M4 baseplate to heatsink	M	1.80	2.00	2.20[3]	Nm
Weight		G		720		g

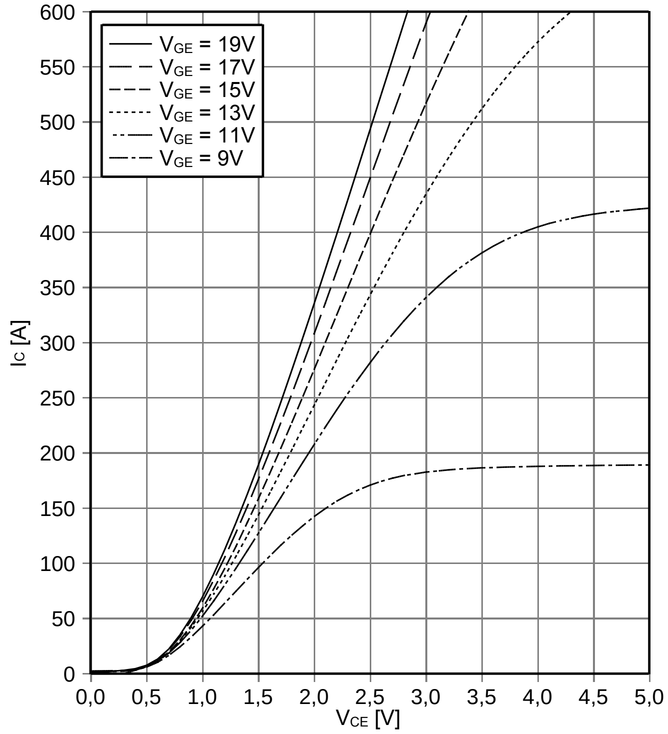
[1] Ni plated Cu baseplate.
[2] Cooler design and flow direction according to application note AN-HPDPERF-ASSEMBLY. Cooling fluid 50% water / 50% ethylenglycol.
[3] According to application note AN-HPDPERF-ASSEMBLY.

6 Characteristics Diagrams

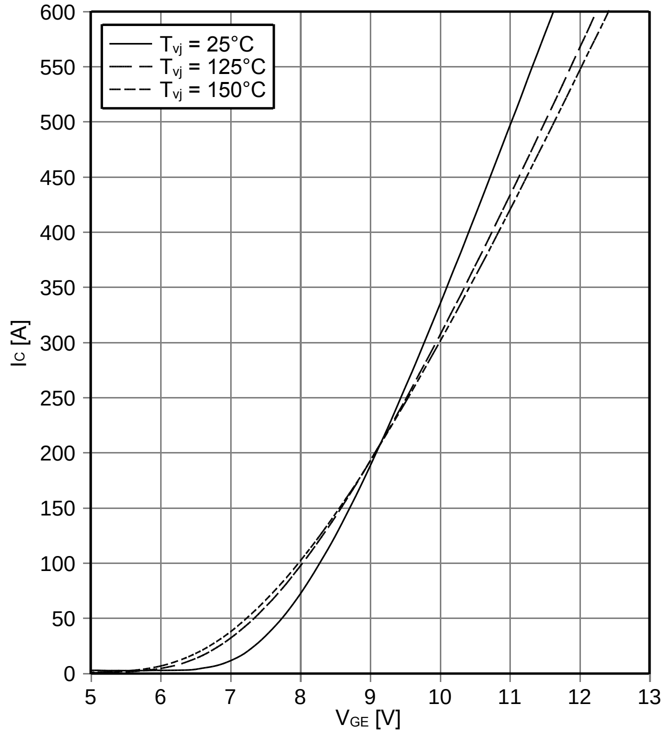
output characteristic IGBT,Inverter (typical)
$I_C = f(V_{CE})$
$V_{GE} = 15$ V



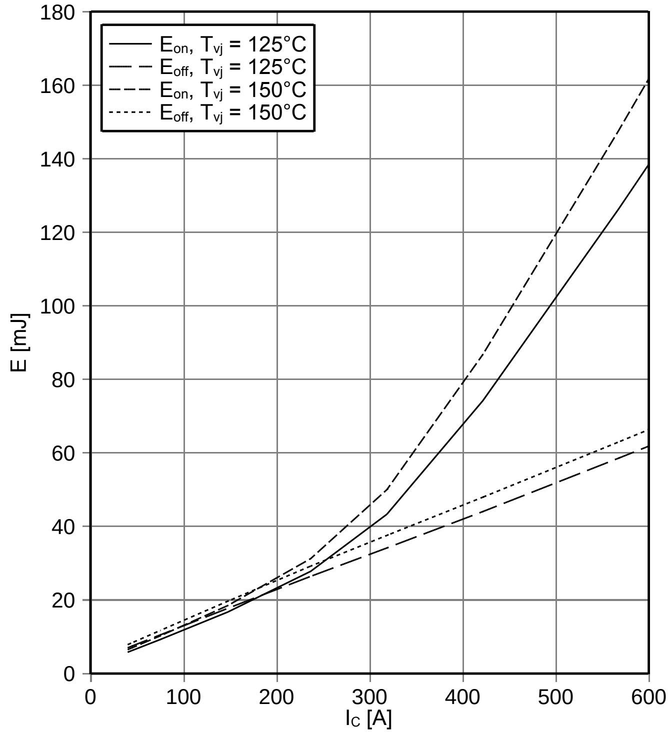
output characteristic IGBT,Inverter (typical)
$I_C = f(V_{CE})$
$T_{vj} = 150°C$



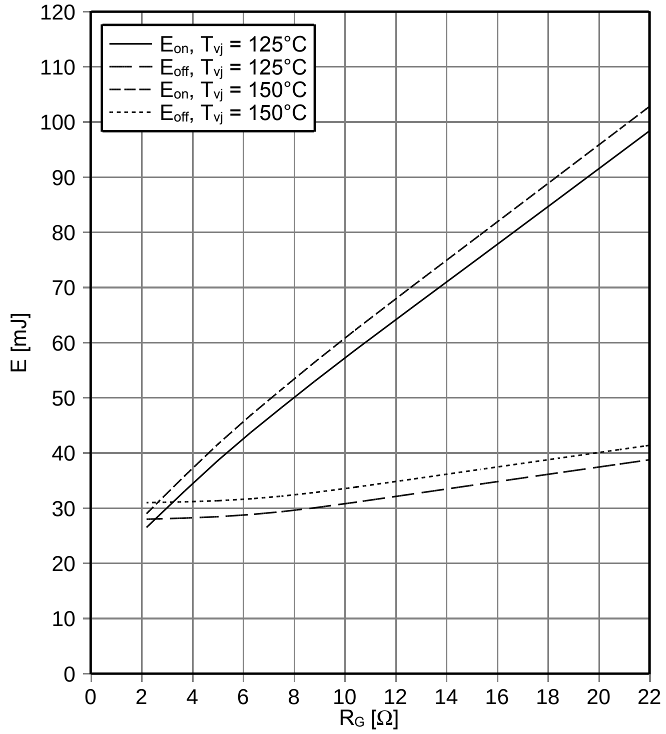
transfer characteristic IGBT,Inverter (typical)
$I_C = f(V_{GE})$
$V_{CE} = 20$ V



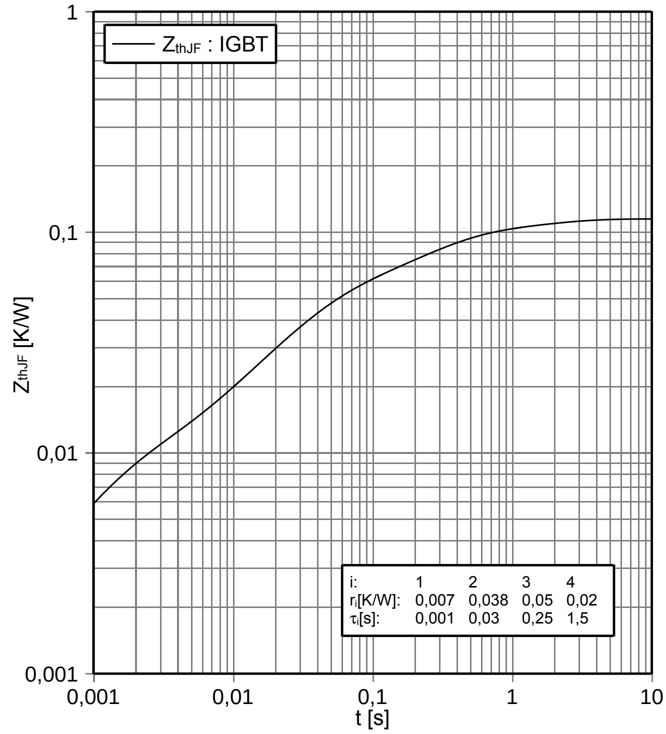
switching losses IGBT,Inverter (typical)
$E_{on} = f(I_C)$, $E_{off} = f(I_C)$,
$V_{GE} = +15$ V / -8 V, $R_{Gon} = 2.2\ \Omega$, $R_{Goff} = 2.2\ \Omega$, $V_{CE} = 600$ V



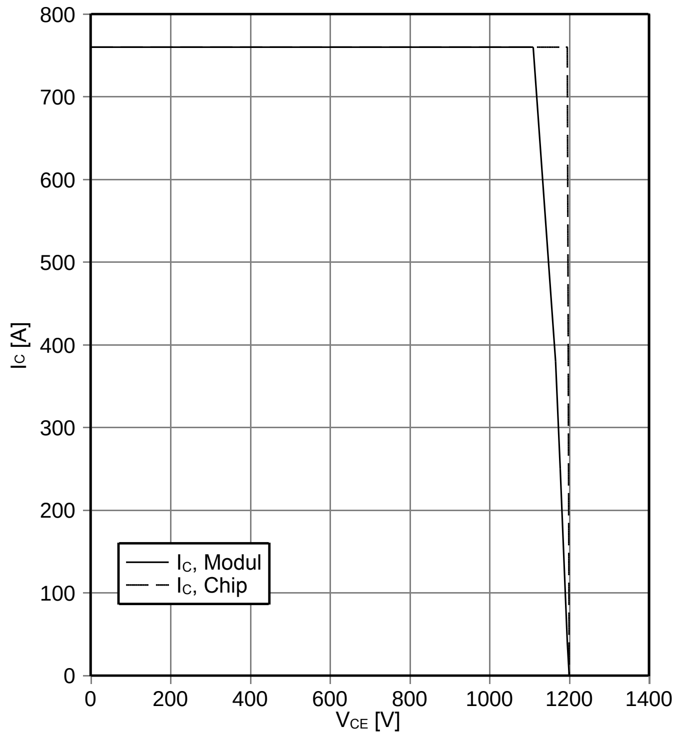
switching losses IGBT,Inverter (typical)
$E_{on} = f(R_G)$, $E_{off} = f(R_G)$,
V_{GE} = +15V / -8V, I_C = 250 A, V_{CE} = 600V



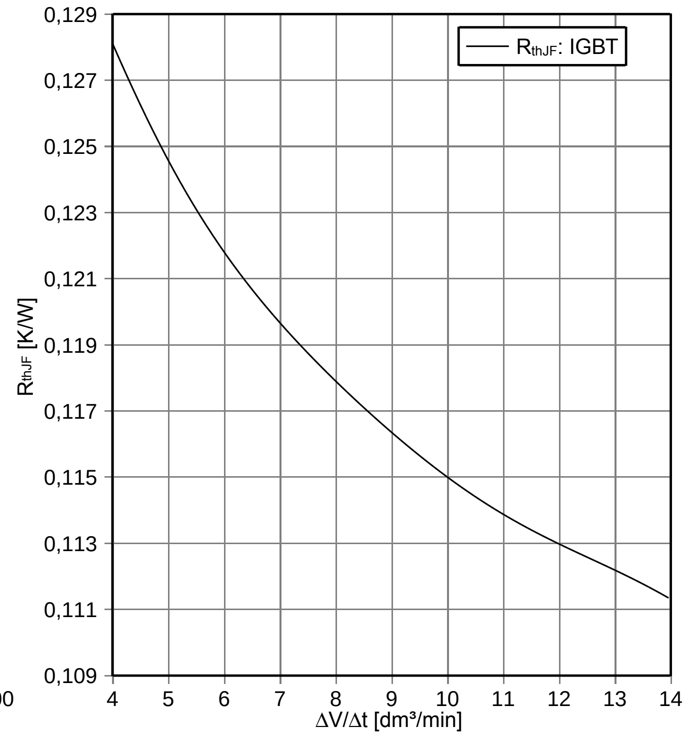
transient thermal impedance IGBT,Inverter
$Z_{thJF} = f(t)$, ΔV/Δt = 10 dm³/min; 50% water / 50% ethylenglycol
Tf = 75°C; cooler design according to AN-HPDPERF-ASSEMBLY



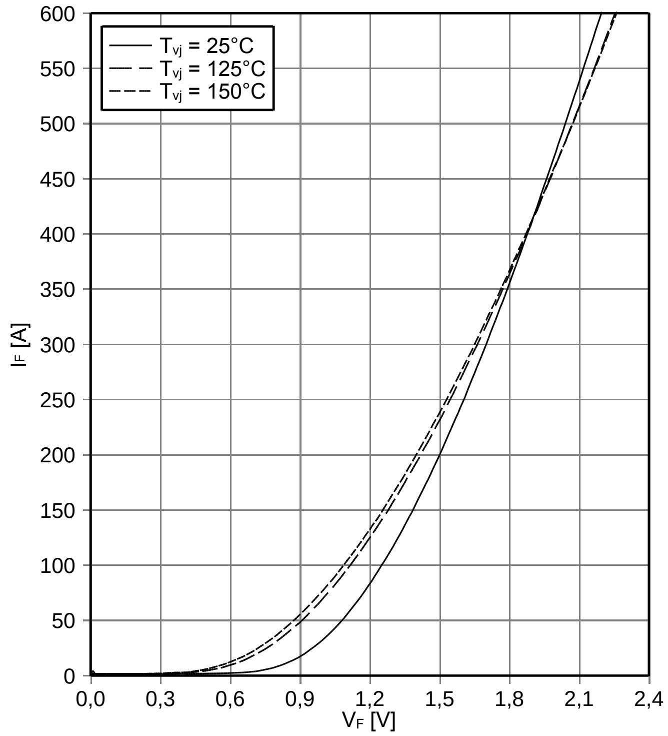
reverse bias safe operating area IGBT,Inverter (RBSOA)
$I_C = f(V_{CE})$;
V_{GE} = +15V / -8V, R_{Goff} = 2.2 Ω, T_{vj} = 150°C



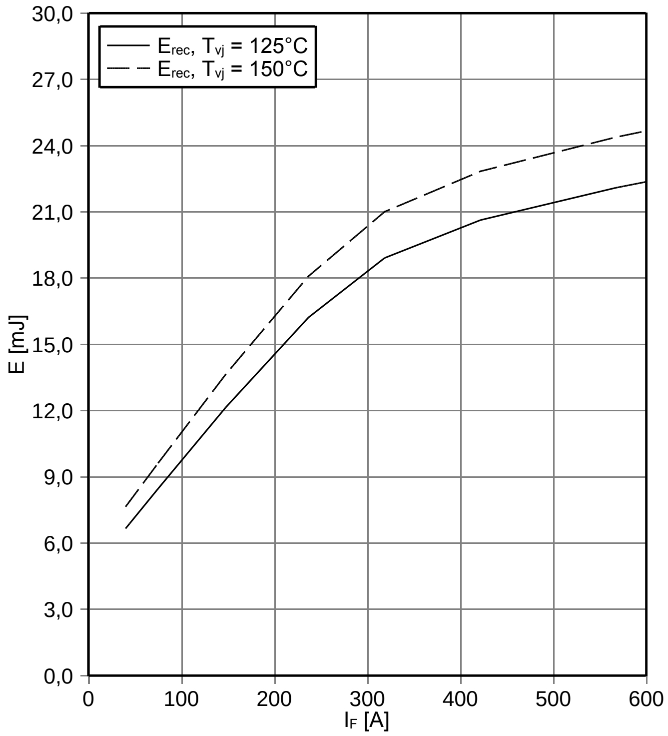
thermal impedance IGBT,Inverter
$R_{thJF} = f(\Delta V/\Delta t)$, Tf = 75°C; 50% water / 50% ethylenglycol
cooler design according to AN-HPDPERF-ASSEMBLY



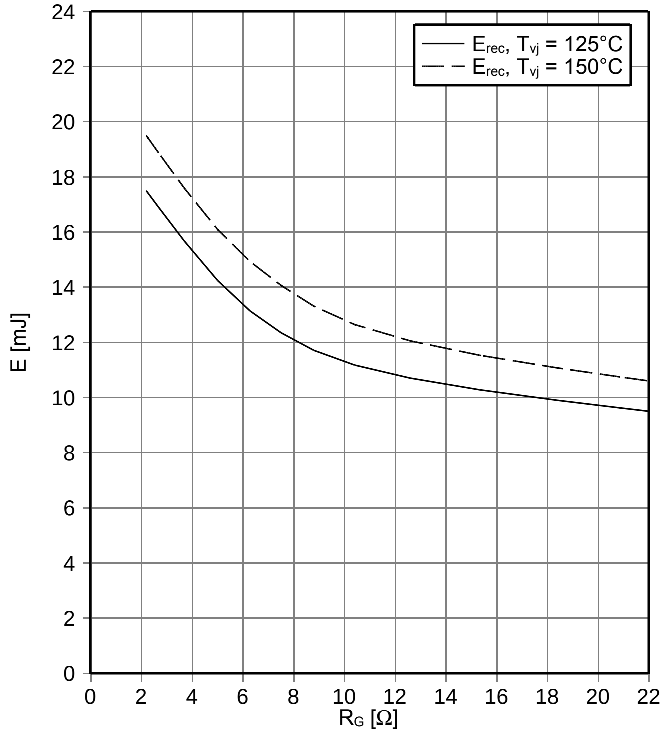
forward characteristic of Diode, Inverter (typical)
$I_F = f(V_F)$



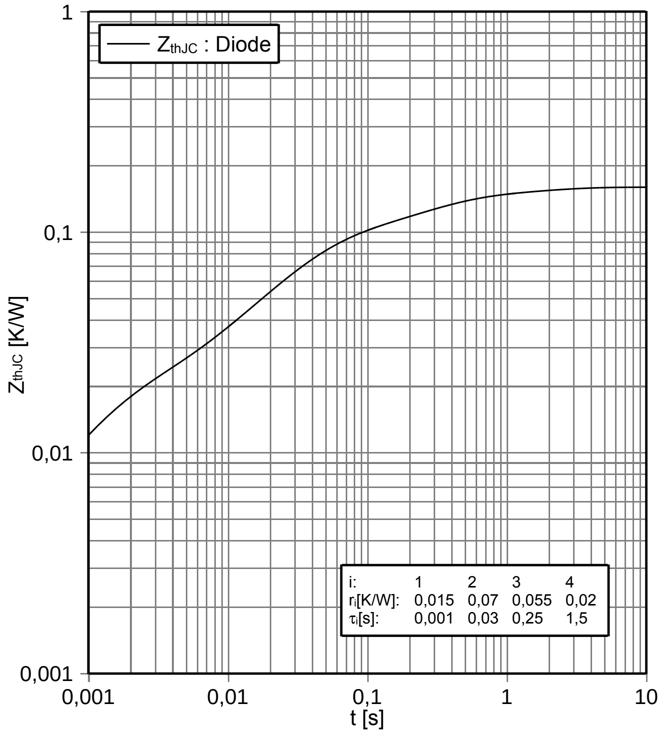
switching losses Diode, Inverter (typical)
$E_{rec} = f(I_F)$,
$R_{Gon} = 2.2\ \Omega$, $V_{CE} = 600$ V



switching losses Diode, Inverter (typical)
$E_{rec} = f(R_G)$,
$I_F = 250$ A, $V_{CE} = 600$ V

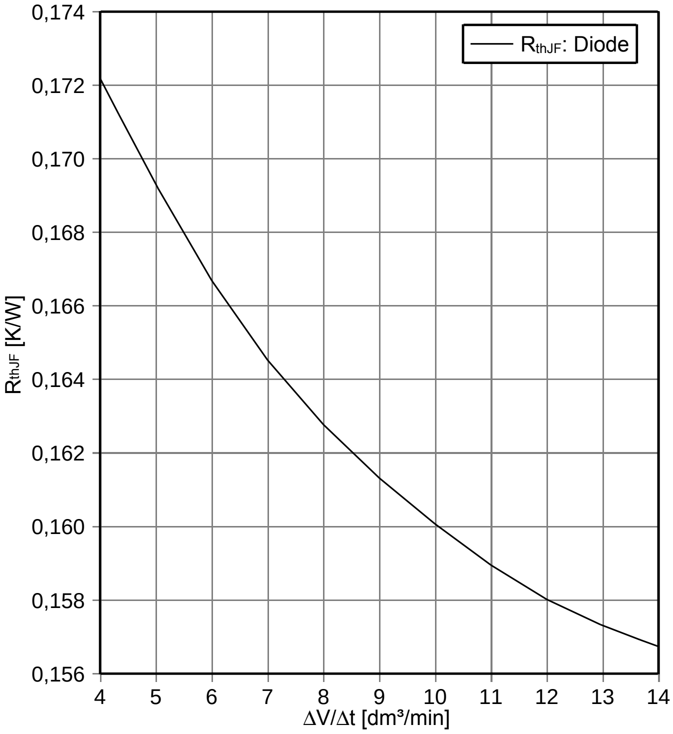


transient thermal impedance Diode, Inverter
$Z_{thJF} = f(t)$, $\Delta V/\Delta t = 10$ dm³/min; 50% water / 50% ethylenglycol
Tf = 75°C; cooler design according to AN-HPDPERF-ASSEMBLY

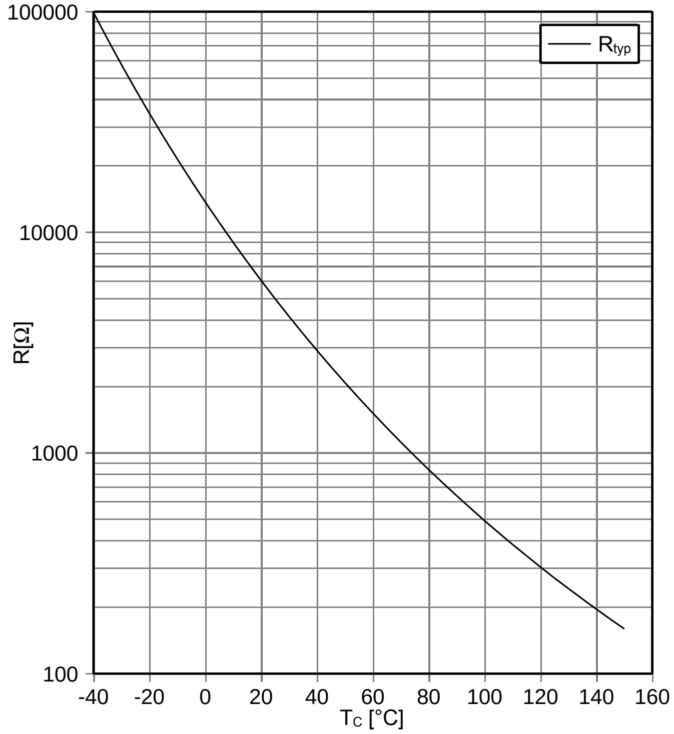


i:	1	2	3	4
r_i[K/W]:	0,015	0,07	0,055	0,02
τ_i[s]:	0,001	0,03	0,25	1,5

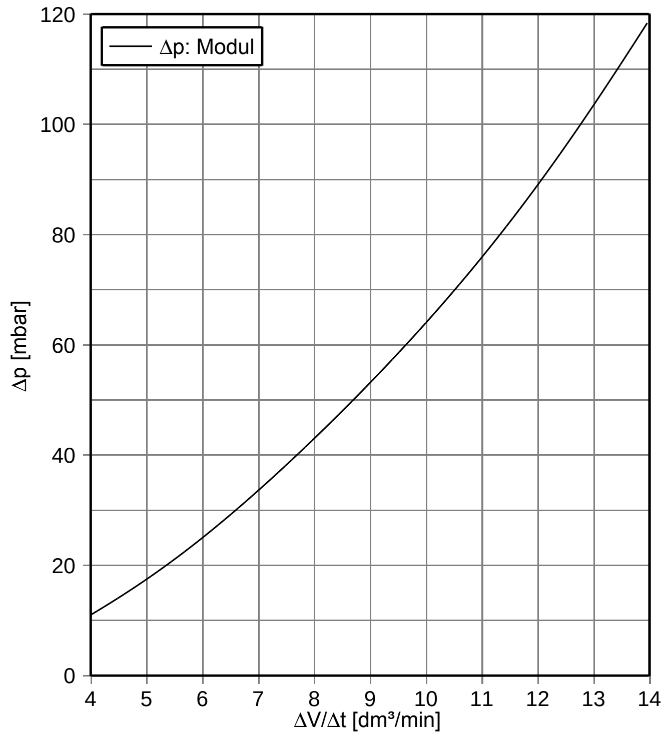
thermal impedance Diode, Inverter
$R_{thJF} = f(\Delta V/\Delta t)$, Tf = 75°C; 50% water / 50% ethylenglycol
cooler design according to AN-HPDPERF-ASSEMBLY



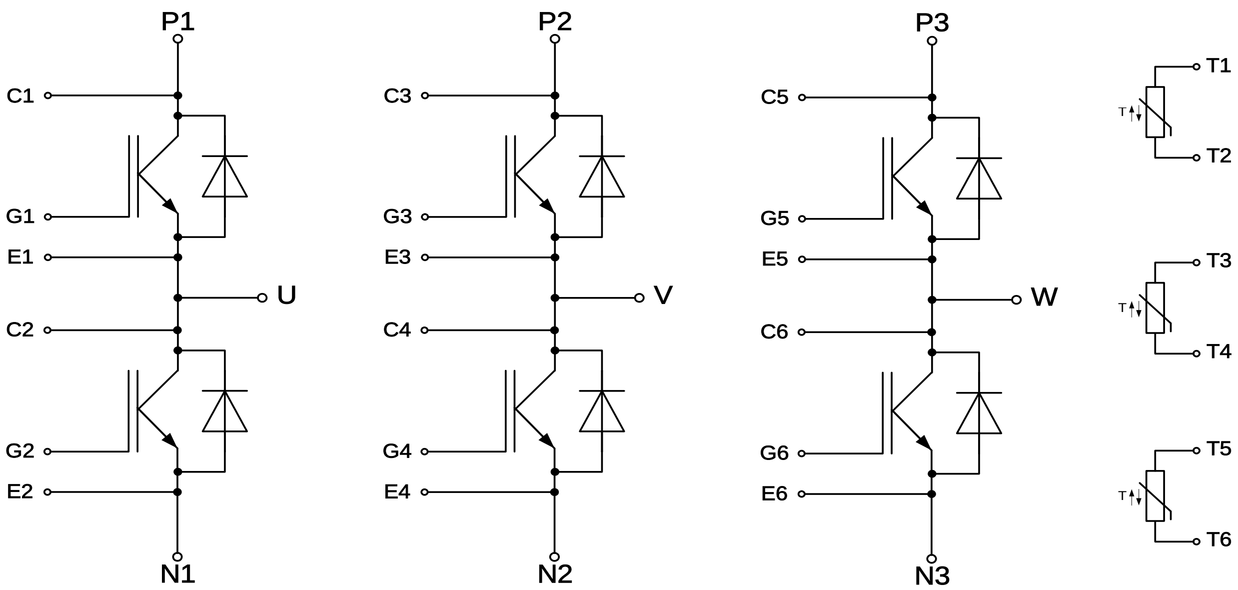
NTC-Thermistor-temperature characteristic (typical)
R = f (T)



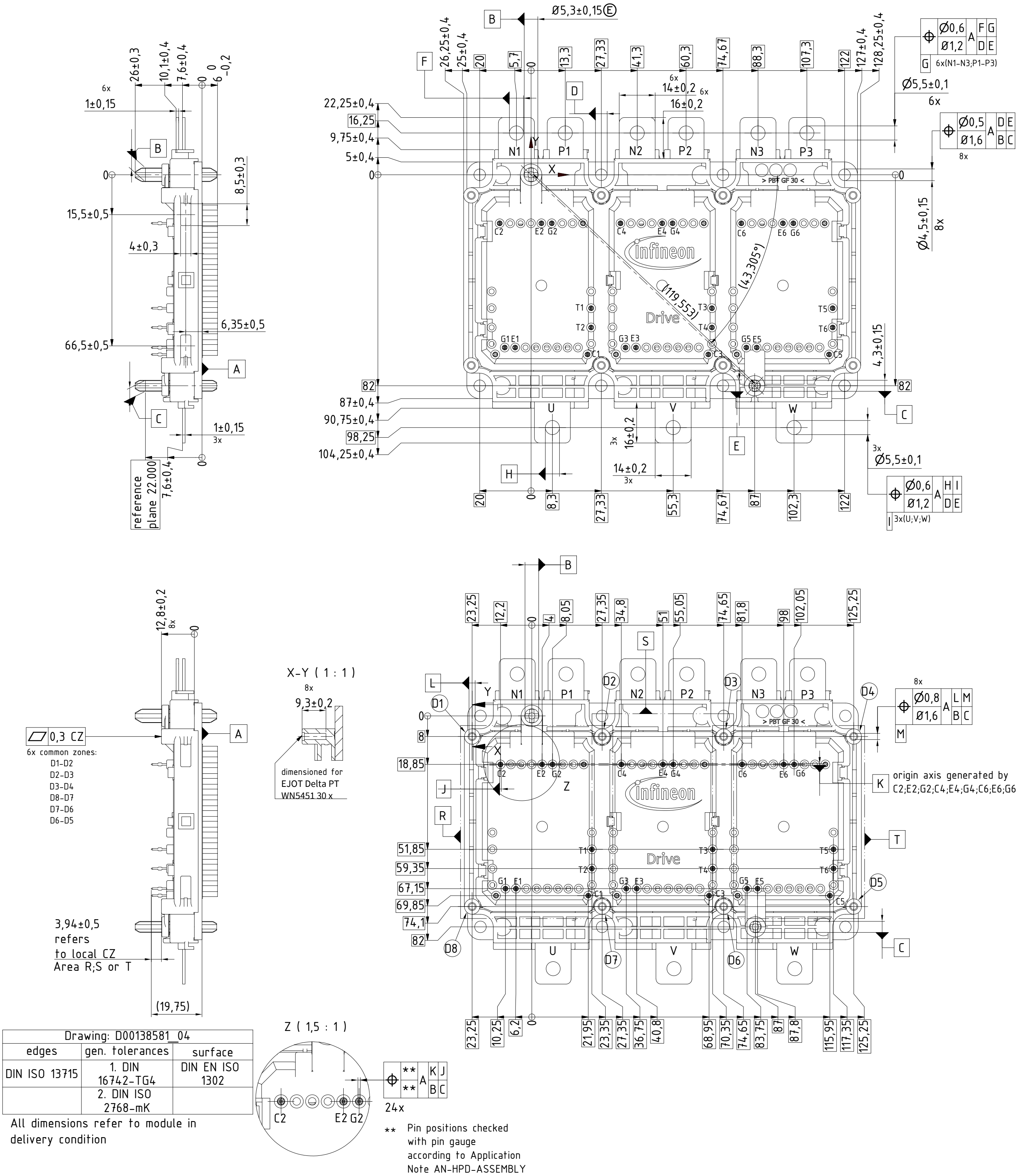
pressure drop in cooling circuit
$\Delta p = f(\Delta V/\Delta t)$, Tf = 75°C; 50% water / 50% ethylenglycol
cooler design according to AN-HPDPERF-ASSEMBLY



7 Circuit diagram



8 Package outlines



Drawing: D00138581_04		
edges	gen. tolerances	surface
DIN ISO 13715	1. DIN 16742-TG4	DIN EN ISO 1302
	2. DIN ISO 2768-mK	

All dimensions refer to module in delivery condition

9 Label Codes

9.1 Module Code

Code Format	Data Matrix		
Encoding	ASCII Text		
Symbol Size	16x16		
Standard	IEC24720 and IEC16022		
Code Content	Content	Digit	Example (below)
	Module Serial Number	1 - 5	71549
	Module Material Number	6 - 11	142846
	Production Order Number	12 - 19	55054991
	Datecode (Production Year)	20 - 21	15
	Datecode (Production Week)	22 - 23	30
Example	71549142846550549911530		

9.2 Packing Code

Code Format	Code128			
Encoding	Code Set A			
Symbol Size	34 digits			
Standard	IEC8859-1			
Code Content	Content	Identifier	Digit	Example (below)
	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			

Revision History

Major changes since previous revision

Revision History		
Reference	Date	Description
V1.0	2017-05-11	Target datasheet
V2.0	2018-08-27	Preliminary datasheet
V3.0	2019-05-09	Final datasheet
V3.1	2019-09-10	Correction of product weight and document cross references

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