英飞凌 HybridPACK™ Drive 模块

FS380R12A6T4LB

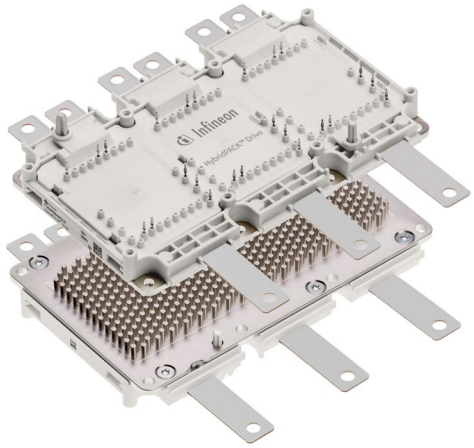
最终数据手册

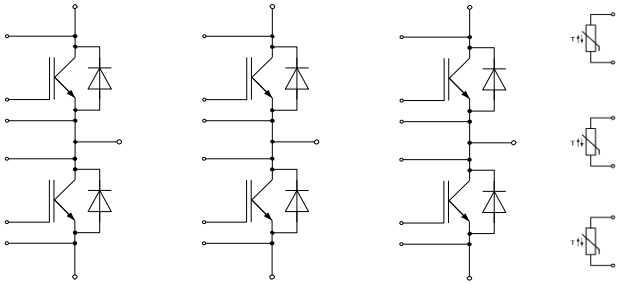
V3.0, 2020-03-23

汽车高功率

1 特点/描述

英飞凌 HybridPACK™ Drive 模块，带Trench/Fieldstop IGBT4 和发射极控制第4代二极管





V_{CES} = 1200 V
I_C = 380 A

典型应用

- 汽车应用
- 混合动力汽车
- 电机驱动
- 商业性农用车辆

电气特性

- 阻断电压 1200V
- 低 V_{CEsat}
- 低开关损耗
- 低 Qg 和 Crss
- 低电感设计
- $T_{vj\,op}$ = 150°C

机械特性

- 4.2kV 直流电压 1 秒绝缘
- 高爬电距离和电气间隙
- 高功率密度
- 高性能氮化硅陶瓷
- 直冷式 PinFin底板
- PCB和冷却器组装的安装指导
- 集成NTC温度传感器
- PressFit 技术
- 符合 RoHS 标准
- UL 94 V0 模块框架

描述

HybridPACK™ Drive 是一款非常紧凑的三相全桥模块（1200V/380A）针对混合动力和电动汽车进行了优化。功率模块采用4代IGBT。该芯片组具有很高的短路耐受力，并配有匹配的高效软开关 Emcon4 二极管。

全新 HybridPACK™Drive 功率模块系列配备机械安装指导，方便客户轻松组装。此外，信号端子采用压接引脚，避免了额外耗时的选择性焊接工艺，从而节省了系统成本并提高了系统可靠性。
FS380R12A6T4LB 产品采用带PinFin 结构的直冷底板和优化陶瓷材料，最大程度地利用了所采用的芯片组并展现出卓越的散热性能。由于电气间隙和爬电距离较大，该模块非常适合更高的系统工作电压，并支持模块化逆变器方案。

Product Name	Ordering Code
FS380R12A6T4LB	SP002516834

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）。

2 IGBT、逆变器

2.1 最大额定值

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 特征值

				最小值	典型值	最大值	
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} ≤ 15 V, V_{CC} = 800 V V_{CEmax} = V_{CES} -L_{sCE} ·di/dt	t_P ≤ 8 µs, T_{vj} = 25°C t_P ≤ 6 µs, T_{vj} = 150°C	I_{SC}		1500 1200		A
Thermal resistance, junction to cooling fluid	per IGBT; ΔV/Δt = 10 dm^3/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] 对于施加的阻断电压> 指定最大集电极－发射极电压的60%的应用，我们建议在早期设计阶段评估宇宙辐射效应的影响。如需评估，请联系当地英飞凌销售办事处。
[2] 通过特性/设计进行验证，而不是通过测试。
[3] 冷却器设计和流动方向参考应用手册 AN-HPDPERF-ASSEMBLY 。冷却液 50% 水/50% 乙二醇.

3 二极管、逆变器

3.1 最大额定值

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 特征值

				最小值	典型值	最大值	
Forward voltage	I_F = 250 A, V_{GE} = 0 V	T_{vj} = 25°C	V_F		1.60	2.00	V
	I_F = 250 A, V_{GE} = 0 V	T_{vj} = 125°C			1.55		
	I_F = 250 A, V_{GE} = 0 V	T_{vj} = 150°C			1.55		
	I_F = 380 A, V_{GE} = 0 V	T_{vj} = 25°C			1,85		
	I_F = 380 A, V_{GE} = 0 V	T_{vj} = 150°C			1,80		
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	I_{RM}		245		A
		T_{vj} = 125°C			300		
		T_{vj} = 150°C			315		
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	Q_r		24.0		µC
		T_{vj} = 125°C			42.5		
		T_{vj} = 150°C			48.0		
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	E_{rec}		10.0		mJ
		T_{vj} = 125°C			17.5		
		T_{vj} = 150°C			19.5		
Thermal resistance, junction to cooling fluid	per diode; $\Delta V/\Delta t$ = 10 dm^3/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 热敏电阻

Parameter	Conditions	Symbol	最小值	典型值	最大值	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

根据应用手册标定

[1]对于施加的阻断电压> 指定最大集电极－发射极电压的60%的应用，我们建议在早期设计阶段评估宇宙辐射效应的影响。如需评估，请联系当地英飞凌销售办事处。
[2]通过特性/设计进行验证，而不是通过测试。
[3]冷却器设计和流动方向参考应用手册 AN-HPDPERF-ASSEMBLY 。冷却液 50% 水/50% 乙二醇.

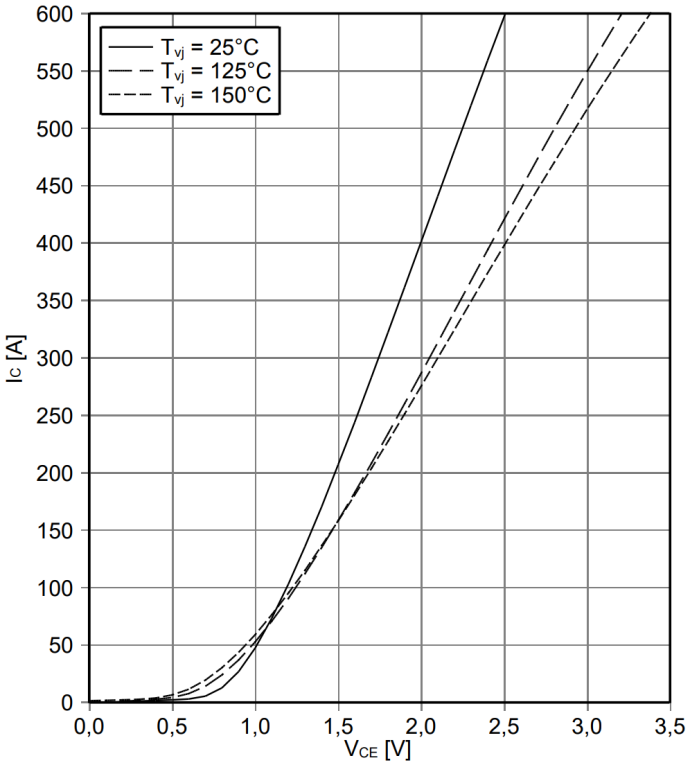
5 模块

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}		500		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		
			最小值	典型值	最大值	
Pressure drop in cooling circuit	$\Delta V/\Delta t$ = 10.0 dm^3/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

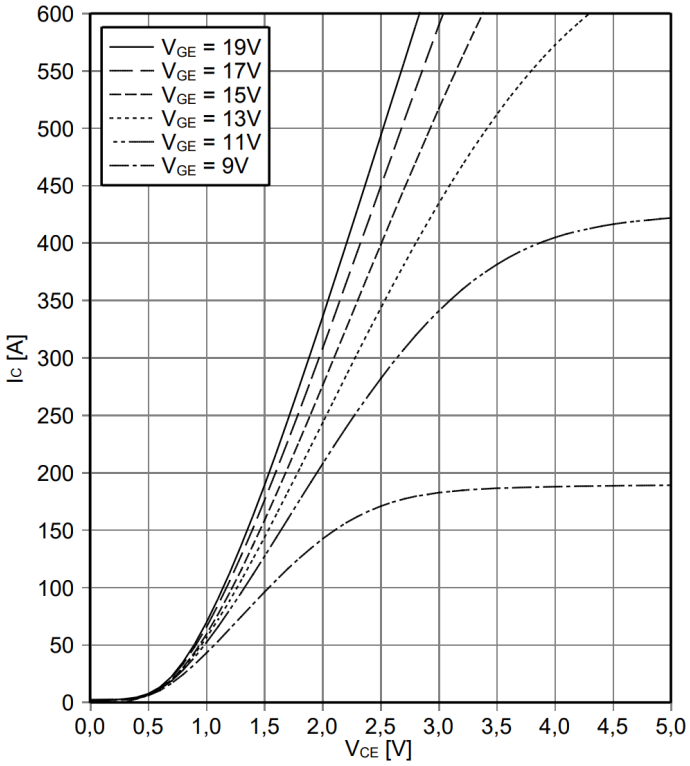
[1] 镀镍铜底板。
[2] 冷却器设计和流动方向参考应用手册 AN-HPDPERF-ASSEMBLY。冷却液 50% 水/50% 乙二醇.
[3]参考应用手册 AN-HPDPERF-ASSEMBLY。

6 特性图

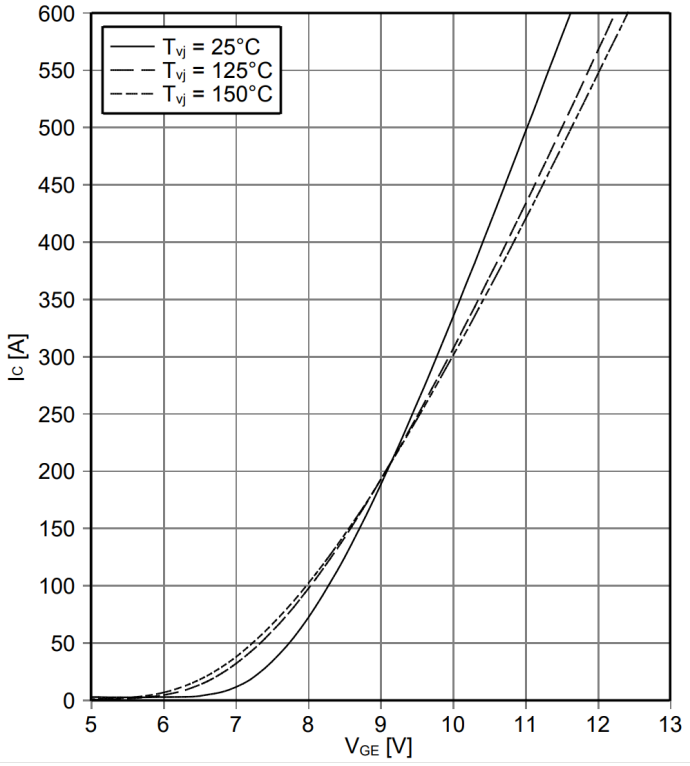
output characteristic IGBT,Inverter (typical)
$I_C = f(V_{CE})$
V_{GE} = 15 V



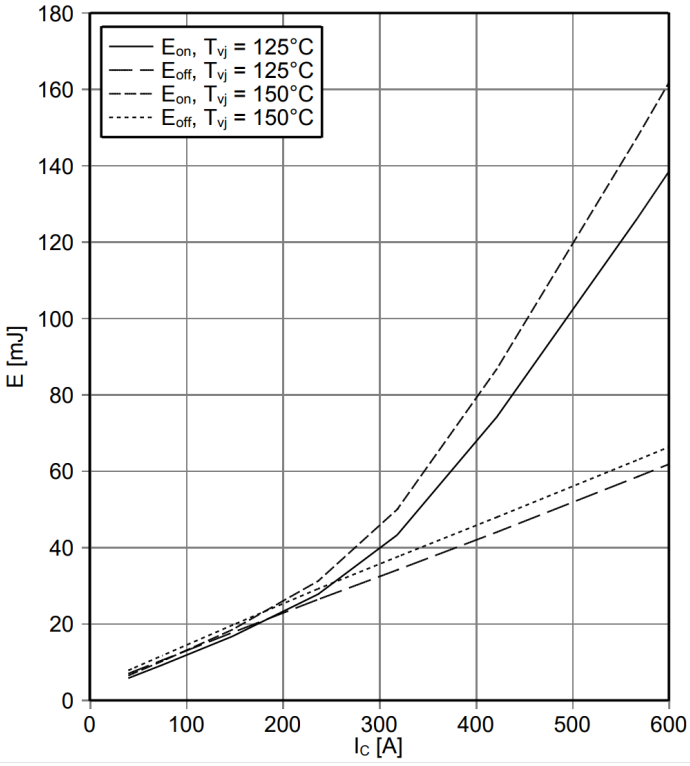
output characteristic IGBT,Inverter (typical)
$I_C = f(V_{CE})$
T_{vj} = 150°C



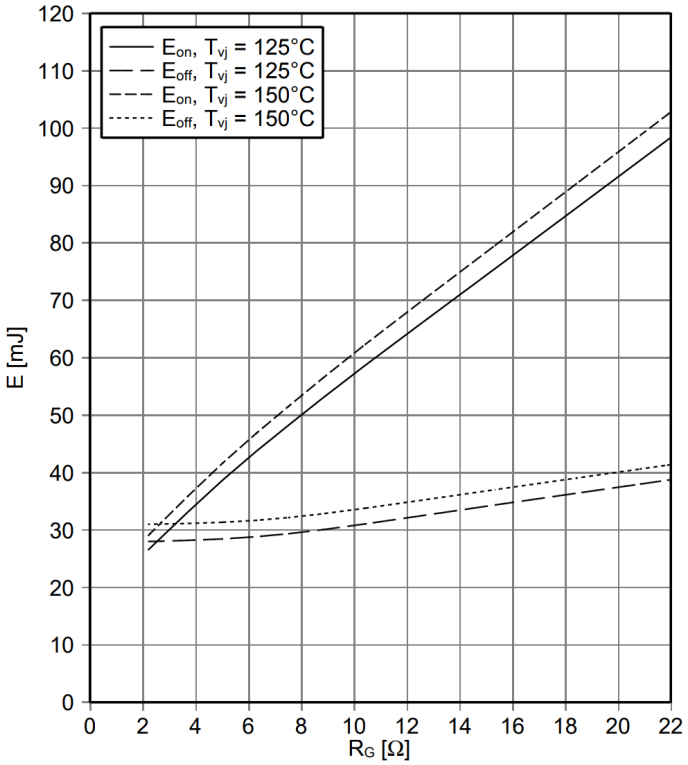
transfer characteristic IGBT,Inverter (typical)
$I_C = f(V_{GE})$
V_{CE} = 20 V



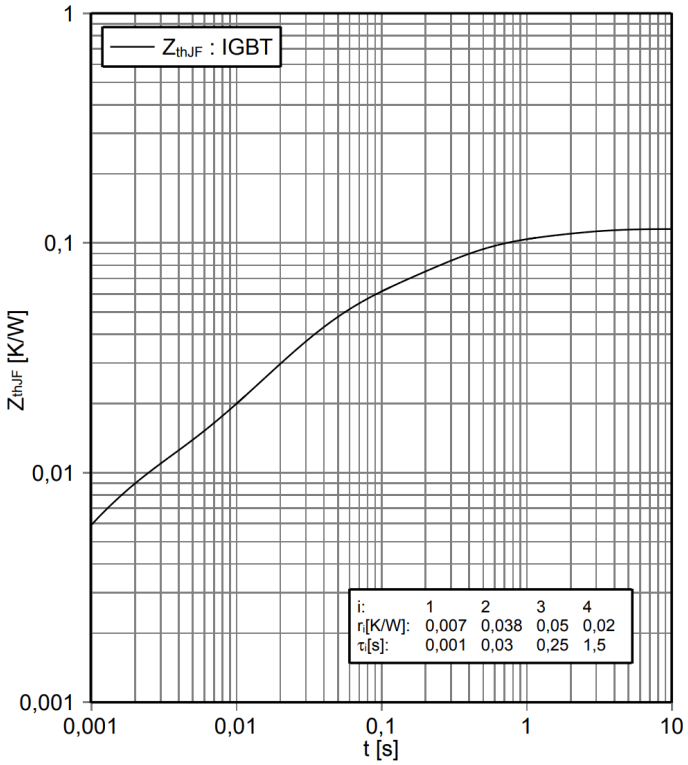
switching losses IGBT,Inverter (typical)
$E_{on} = f(I_C)$, $E_{off} = f(I_C)$,
V_{GE} = +15 V / -8 V, R_{Gon} = 2.2 Ω, R_{Goff} = 2.2 Ω, V_{CE} = 600 V



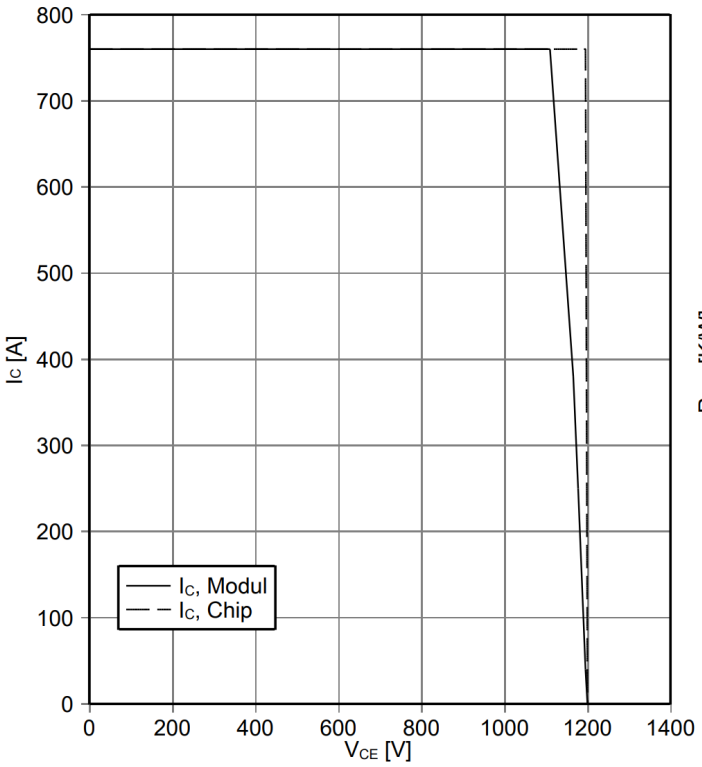
switching losses IGBT,Inverter (typical)
$E_{on} = f(R_G)$, $E_{off} = f(R_G)$,
V_{GE} = +15V / -8V, I_C = 250 A, V_{CE} = 600V



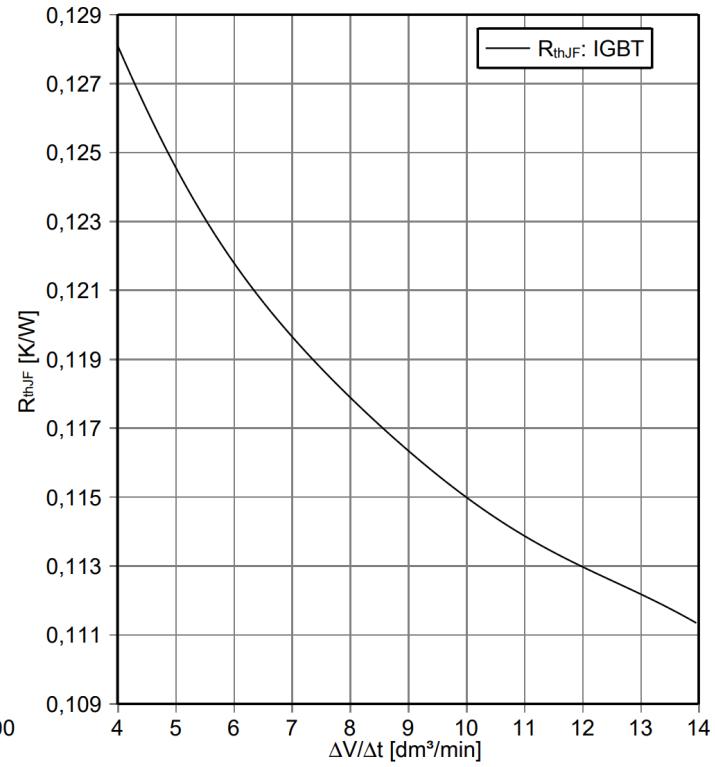
transient thermal impedance IGBT,Inverter
$Z_{thJF} = f(t)$, $\Delta V/\Delta t$ = 10 dm³/min; 50% water / 50% ethylenglycol
Tf = 75°C; cooler design according to AN-HPDPERF-ASSEMBLY



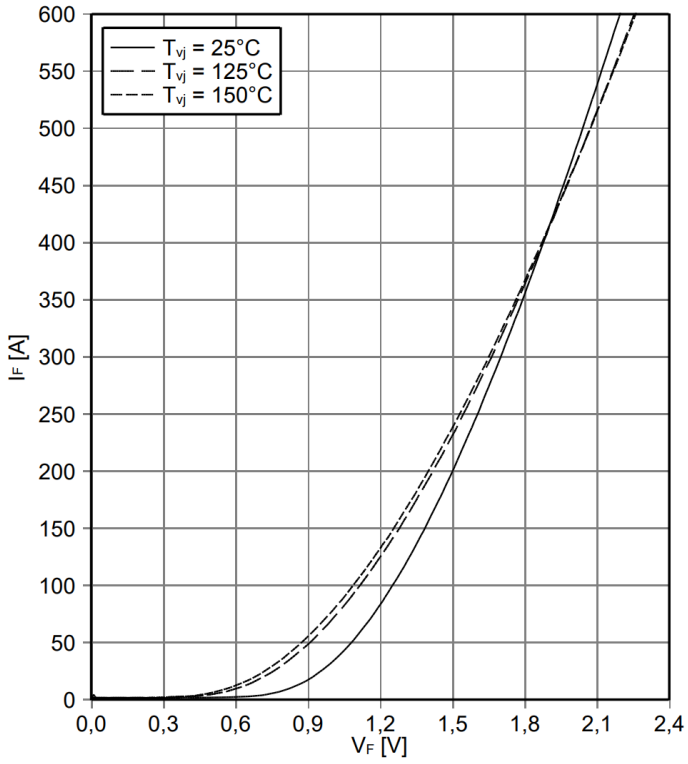
reverse bias safe operating area IGBT,Inverter (RBSOA)
$I_C = f(V_{CE})$;
V_{GE} = +15V / -8V, R_{Goff} = 2.2 Ω, T_{vj} = 150°C



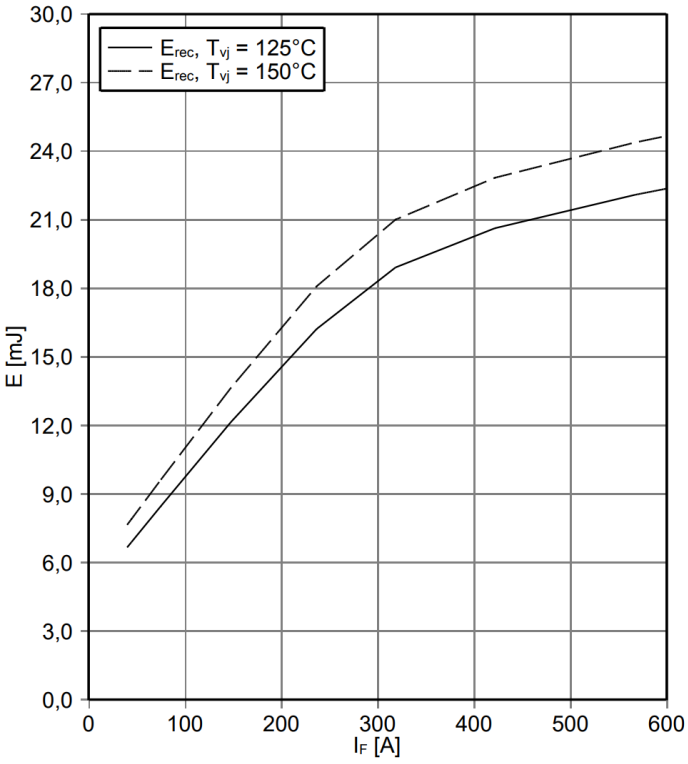
thermal impedance IGBT,Inverter
$R_{thJF} = f(\Delta V/\Delta t)$, Tf = 75°C; 50% water / 50% ethylenglycol
cooler design according to AN-HPDPERF-ASSEMBLY



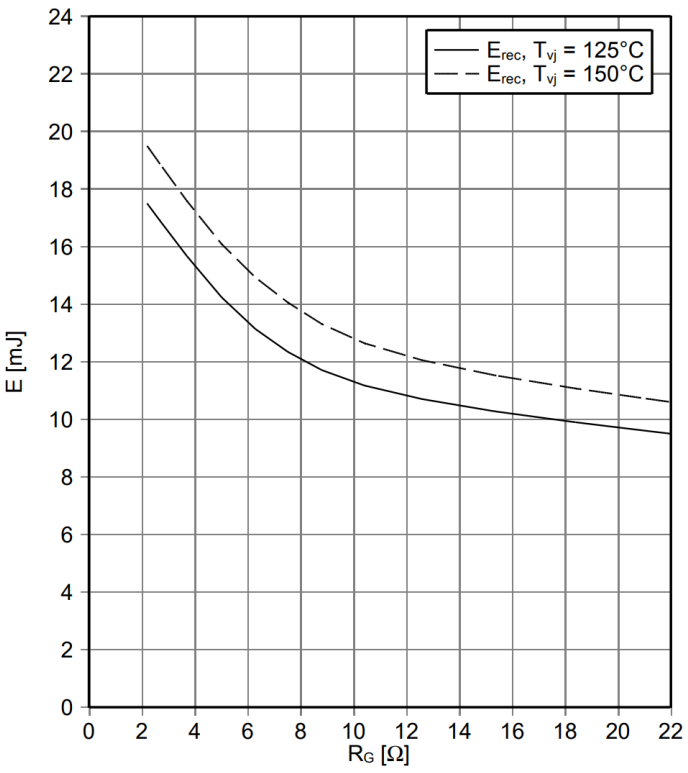
forward characteristic of Diode, Inverter (typical)
$I_F = f(V_F)$



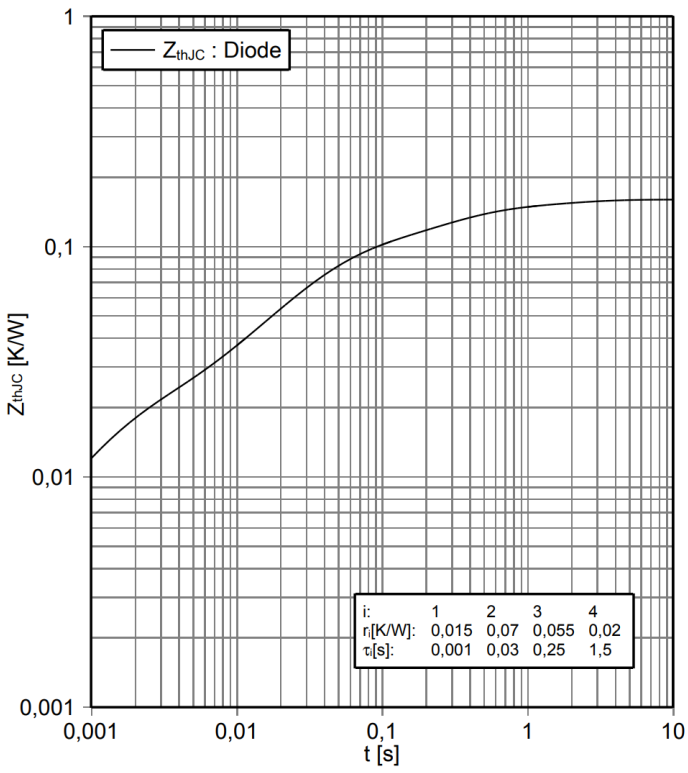
switching losses Diode, Inverter (typical)
$E_{rec} = f(I_F)$,
R_{Gon} = 2.2 Ω, V_{CE} = 600 V



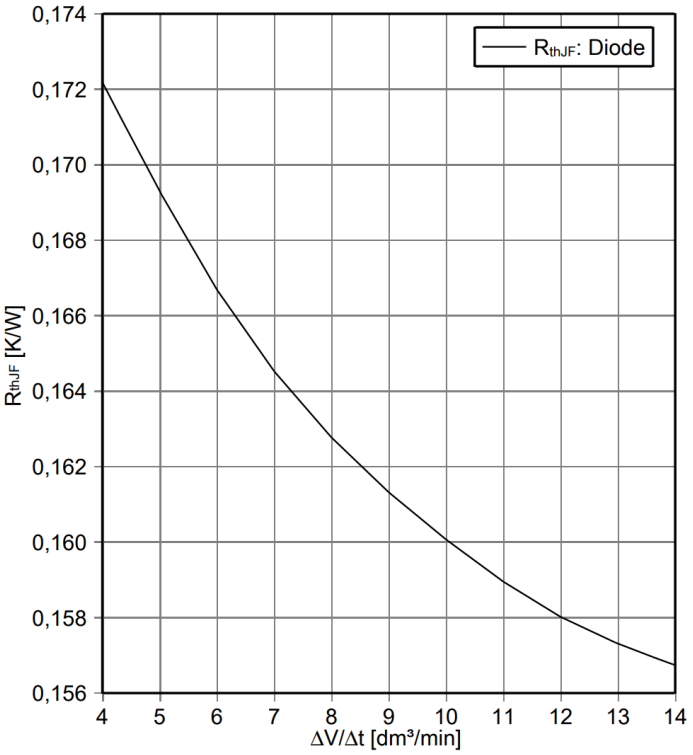
switching losses Diode, Inverter (typical)
$E_{rec} = f(R_G)$,
I_F = 250 A, V_{CE} = 600 V



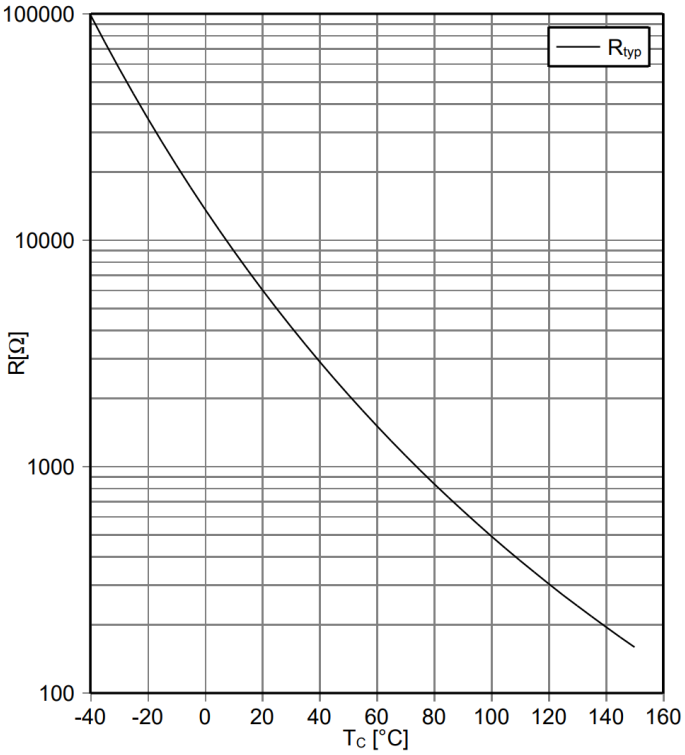
transient thermal impedance Diode, Inverter
$Z_{thJF} = f(t)$, $\Delta V/\Delta t$ = 10 dm³/min; 50% water / 50% ethylenglycol
Tf = 75°C; cooler design according to AN-HPDPERF-ASSEMBLY



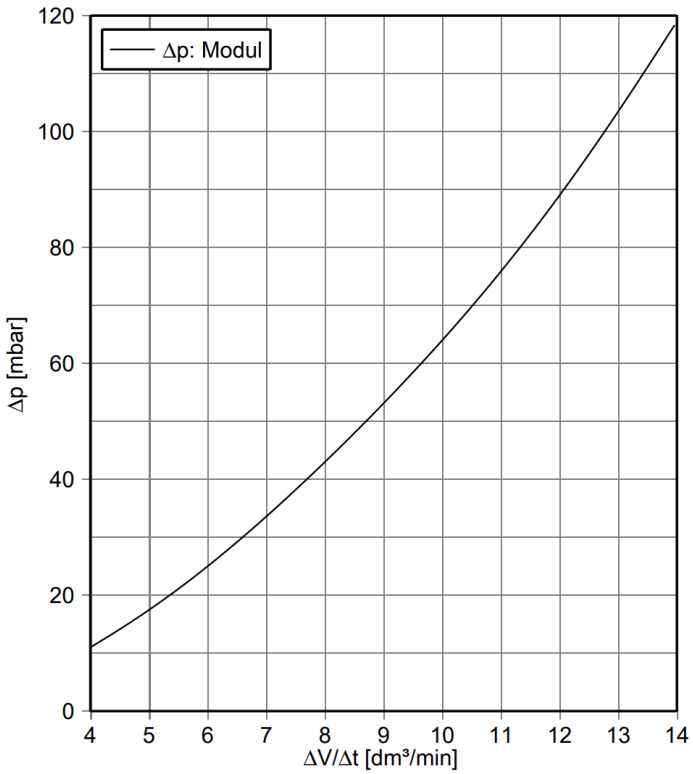
thermal impedance Diode, Inverter
R_{thJF} = f (ΔV/Δt), Tf = 75°C; 50% water / 50% ethylenglycol
cooler design according to AN-HPDPERF-ASSEMBLY



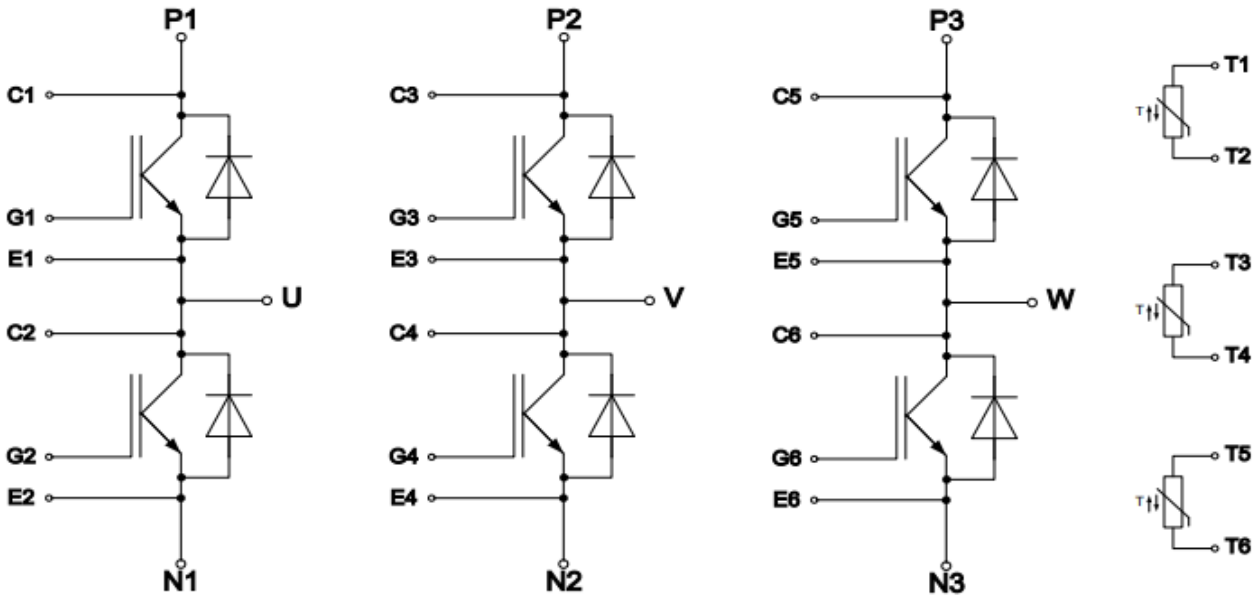
NTC-Thermistor-temperature characteristic (typical)
R = f (T)



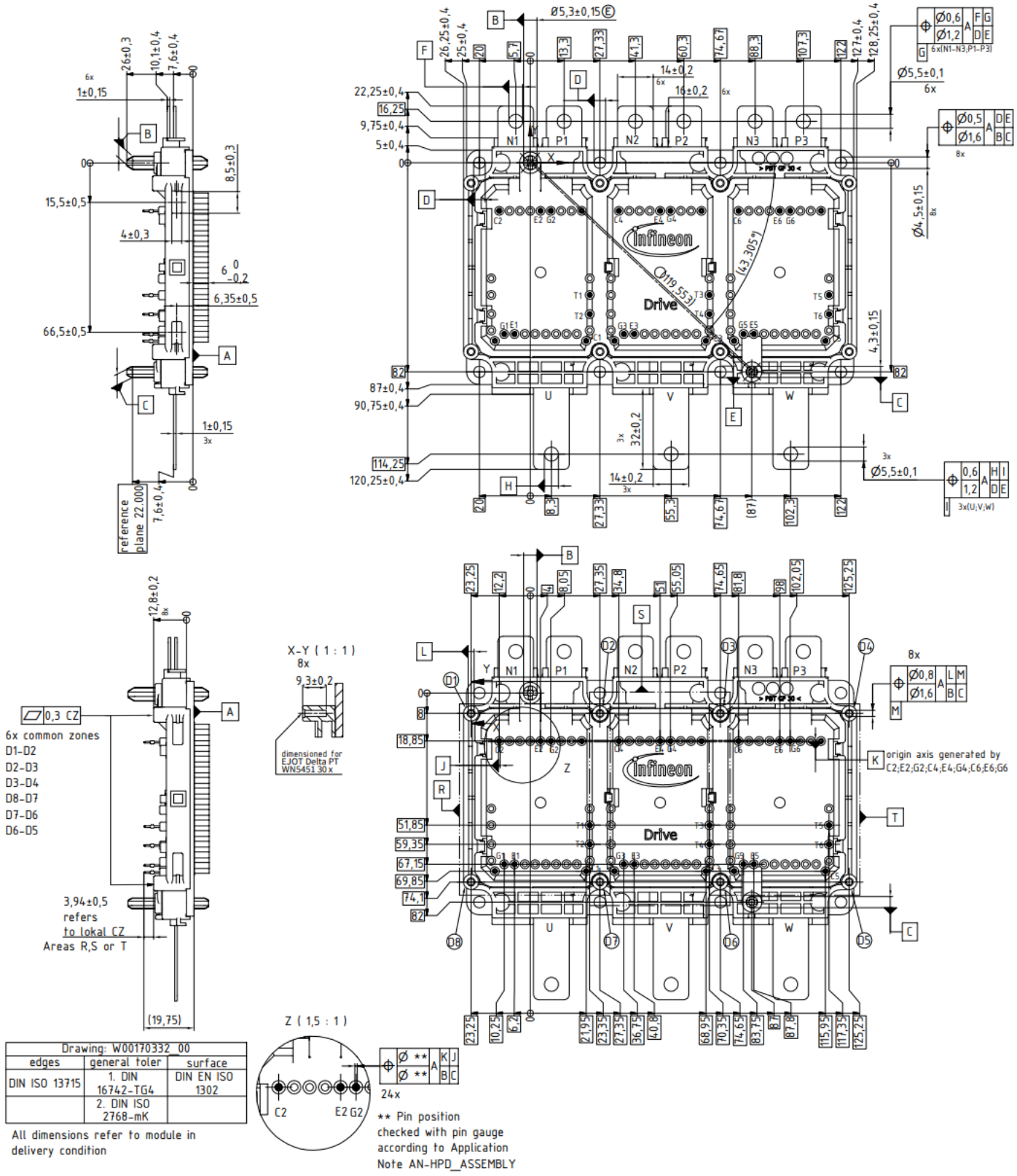
pressure drop in cooling circuit
Δp = f (ΔV/Δt), Tf = 75°C; 50% water / 50% ethylenglycol
cooler design according to AN-HPDPERF-ASSEMBLY



7 电路图


P1
C1
G1
E1
U
C2
G2
E2
N1
P2
C3
G3
E3
V
C4
G4
E4
N2
P3
C5
G5
E5
W
C6
G6
E6
N3
T1
T2
T3
T4
T5
T6

8 封装外形



Drawing: W00170332_00		
edges	general toler	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 标签代码

9.1 模块代码

Code Format	Data Matrix		
Encoding	ASCII Text		
Symbol Size	16x16		
Standard	IEC24720 and IEC16022		
Code Content	Content Module Serial Number Module Material Number Production Order Number Datecode (Production Year) Datecode (Production Week)	Digit 1 - 5 6 - 11 12 - 19 20 - 21 22 - 23	Example (below) 71549 142846 55054991 15 30
Example	7154914284655054991530		

9.2 包装代码

Code Format	Code128			
Encoding	Code Set A			
Symbol Size	34 digits			
Standard	IEC8859-1			
Code Content	Content Backend Construction Number Production Lot Number Serial Number Date Code Box Quantity	Identifier X 1T S 9D Q	Digit 2 - 9 12 - 19 21 - 25 28 - 31 33 - 34	Example (below) 95056609 2X0003E0 754389 1139 15
Example	X950566091T2X0003E0S754389D1139Q15			

修订记录

自上次修订以来的主要变化

修订记录

Reference	Date	Description
V3.0	2020-03-23	Final datasheet

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Last update	2011-11-11

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