英飞凌 HybridPACK™ Drive 模块

FS770R08A6P2B

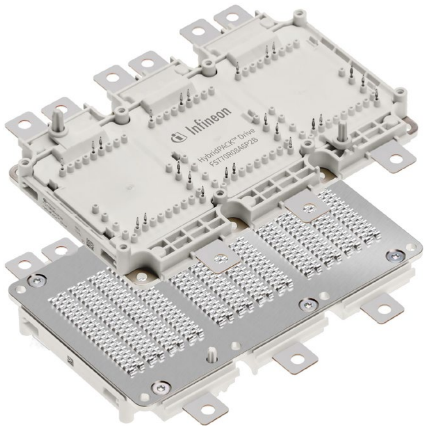
最终数据手册

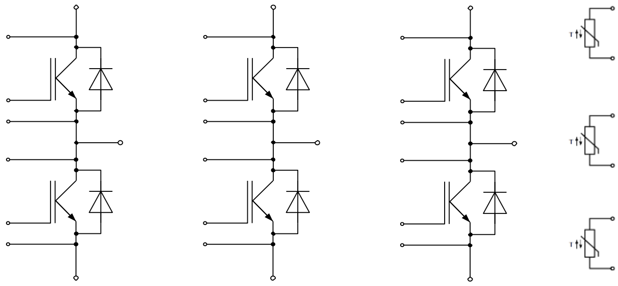
V3.0, 2019-05-28

汽车高功率

1 特点/描述

英飞凌 HybridPACK™ Drive 带 EDT2 IGBT 和二极管模块





V_{CES} = 750 V
I_C = 770 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 750V
- 低 V_{CEsat}
- 低开关损耗
- 低Qg和Crss
- 低杂散电感设计
- $T_{vj\,op}$ = 150°C
- 短时延长工作温度
  $T_{vj\,op}$ = 175°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
- 紧凑型设计
- 高功率密度
- 带状直接冷却底板
- 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 是一款非常紧凑的针对混合动力和电动汽车优化的三相全桥模块。

FS770R08A6P2FB 产品配有扁平底板和带状冷却结构，是 HybridPACK Drive 系列中的 750V/770A 模块衍生产品。该电源模块采用了新一代 EDT2 IGBT，这是一种针对电力传动系统应用而优化的汽车级微模式沟槽场截止单元设计。该芯片组具有基准电流密度、短路耐久性和更高的阻断电压，可在恶劣的环境条件下实现可靠的逆变器运行。

EDT2 IGBT 还表现出了出色的轻载功率损耗，这有助于提高实际驾驶周期内的系统效率。EDT2 IGBT 针对开关频率在 10 kHz 范围内的应用进行了优化。

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。HybridPACK Drive 系列产品中FS660R08A6P2FB采用扁平底板、PinFin 底板有FS820R08A6P2B以及FS770R08A6P2B该技术能够以极低的成本实现不同逆变器功率水平的灵活扩展，且在逆变器的设计工作量方面要求极低。

Product Name	Ordering Code
FS770R08A6P2B	SP001706976

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}	750	V
Implemented collector current		I_{CN}	770	A
Continuous DC collector current	$T_F = 75°C$, $T_{vj\,max} = 175°C$	$I_{C\,nom}$	450[1]	A
Repetitive peak collector current	$t_P = 1$ ms	I_{CRM}	1540	A
Total power dissipation	$T_F = 75°C$, $T_{vj\,max} = 175°C$	P_{tot}	654[1]	W
Gate-emitter peak voltage		V_{GES}	+/-20	V

2.2 特征值

Parameter	Conditions		Symbol	最小值	典型值	最大值	Unit
Collector-emitter saturation voltage	$I_C = 450$ A, $V_{GE} = 15$ V $I_C = 450$ A, $V_{GE} = 15$ V $I_C = 450$ A, $V_{GE} = 15$ V $I_C = 770$ A, $V_{GE} = 15$ V $I_C = 770$ A, $V_{GE} = 15$ V	$T_{vj} = 25°C$ $T_{vj} = 150°C$ $T_{vj} = 175°C$ $T_{vj} = 25°C$ $T_{vj} = 175°C$	$V_{CE\,sat}$		1.10 1.15 1.15 1.28 1.44	1.35	V
Gate threshold voltage	$I_C = 9.60$ mA, $V_{CE} = V_{GE}$	$T_{vj} = 25°C$ $T_{vj} = 175°C$	V_{GEth}	4.90	5.80 4,10	6.50	V
Gate charge	$V_{GE} = -8$ V ... 15 V, $V_{CE} = 400V$		Q_G		4.40		µC
Internal gate resistor		$T_{vj} = 25°C$	R_{Gint}		0.7		Ω
Input capacitance	f = 1 MHz, $V_{CE} = 50$ V, $V_{GE} = 0$ V	$T_{vj} = 25°C$	C_{ies}		80.0		nF
Output capacitance	f = 1 MHz, $V_{CE} = 50$ V, $V_{GE} = 0$ V	$T_{vj} = 25°C$	C_{oes}		1.00		nF
Reverse transfer capacitance	f = 1 MHz, $V_{CE} = 50$ V, $V_{GE} = 0$ V	$T_{vj} = 25°C$	C_{res}		0.30		nF
Collector-emitter cut-off current	$V_{CE} = 750$ V, $V_{GE} = 0$ V $V_{CE} = 750$ V, $V_{GE} = 0$ V	$T_{vj} = 25°C$ $T_{vj} = 175°C$	I_{CES}		 5	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	$I_C = 450$ A, $V_{CE} = 400$ V $V_{GE} = -8$ V / +15 V $R_{Gon} = 2.4$ Ω	$T_{vj} = 25°C$ $T_{vj} = 150°C$ $T_{vj} = 175°C$	$t_{d\,on}$		0.28 0.29 0.30		µs
Rise time, inductive load	$I_C = 450$ A, $V_{CE} = 400$ V $V_{GE} = -8$ V / +15 V $R_{Gon} = 2.4$ Ω	$T_{vj} = 25°C$ $T_{vj} = 150°C$ $T_{vj} = 175°C$	t_r		0.07 0.08 0.08		µs
Turn-off delay time, inductive load	$I_C = 450$ A, $V_{CE} = 400$ V $V_{GE} = -8$ V / +15 V $R_{Goff} = 5.1$ Ω	$T_{vj} = 25°C$ $T_{vj} = 150°C$ $T_{vj} = 175°C$	$t_{d\,off}$		0.94 1.05 1.05		µs
Fall time, inductive load	$I_C = 450$ A, $V_{CE} = 400$ V $V_{GE} = -8$ V / +15 V $R_{Goff} = 5.1$ Ω	$T_{vj} = 25°C$ $T_{vj} = 150°C$ $T_{vj} = 175°C$	t_f		0.04 0.05 0.06		µs
Turn-on energy loss per pulse	$I_C = 450$ A, $V_{CE} = 400$ V, $L_S = 20$ nH $V_{GE} = -8$ V / +15 V $R_{Gon} = 2.4$ Ω di/dt (T_{vj} 25°C) = 5500 A/µs di/dt (T_{vj} 150°C) = 5000 A/µs	$T_{vj} = 25°C$ $T_{vj} = 150°C$ $T_{vj} = 175°C$	E_{on}		13.5 17.5 18.0		mJ
Turn-off energy loss per pulse	$I_C = 450$ A, $V_{CE} = 400$ V, $L_S = 20$ nH $V_{GE} = -8$ V / +15 V $R_{Goff} = 5.1$ Ω dv/dt (T_{vj} 25°C) = 3100 V/µs dv/dt (T_{vj} 150°C) = 2500 V/µs	$T_{vj} = 25°C$ $T_{vj} = 150°C$ $T_{vj} = 175°C$	E_{off}		23.5 29.0 30.0		mJ
SC data	$V_{GE} \leq 15$ V, $V_{CC} = 400$ V $V_{CEmax} = V_{CES} - L_{sCE} \cdot di/dt$	$t_P \leq 6$ µs, $T_{vj} = 25°C$ $t_P \leq 3$ µs, $T_{vj} = 175°C$	I_{SC}		4800 3900		A
Thermal resistance, junction to cooling fluid	per IGBT; $\Delta V/\Delta t = 10$ dm^3/min, $T_F = 75°C$		R_{thJF}		0.130[2]	0.153[2]	K/W
Temperature under switching conditions	t_{op} continuous for 10s within a period of 30s, occurence maximum 3000 times over lifetime		$T_{vj\,op}$	-40 150		150[3] 175	°C

[1]通过特性/设计验证，而不是通过测试。
[2]对于水冷设计请参考 AN-HPD-ASSEMBLY。冷却液 50% 水/50% 乙二醇。
[3]当 Tvjop > 150°C 时：底板温度必须限制在 125°C。

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}	750	V
Implemented forward current		I_{FN}	770	A
Continuous DC forward current		I_F	450[1]	A
Repetitive peak forward current	$t_P = 1$ ms	I_{FRM}	1540	A
I^2t - value	$V_R = 0$ V, $t_P = 10$ ms, $T_{vj} = 150°C$ $V_R = 0$ V, $t_P = 10$ ms, $T_{vj} = 175°C$	I^2t	19000 16000	A^2s A^2s

3.2 特征值

Parameter	Conditions		Symbol	最小值	典型值	最大值	Unit
Forward voltage	$I_F = 450$ A, $V_{GE} = 0$ V $I_F = 450$ A, $V_{GE} = 0$ V $I_F = 450$ A, $V_{GE} = 0$ V $I_F = 770$ A, $V_{GE} = 0$ V $I_F = 770$ A, $V_{GE} = 0$ V	$T_{vj} = 25°C$ $T_{vj} = 150°C$ $T_{vj} = 175°C$ $T_{vj} = 25°C$ $T_{vj} = 175°C$	V_F		1.45 1.30 1.25 1.65 1.55	1.65	V
Peak reverse recovery current	$I_F = 450$ A, - $di_F/dt = 5000$ A/µs ($T_{vj} = 150°C$) $V_R = 400$ V $V_{GE} = -8$ V	$T_{vj} = 25°C$ $T_{vj} = 150°C$ $T_{vj} = 175°C$	I_{RM}		250 350 370		A
Recovered charge	$I_F = 450$ A, - $di_F/dt = 5000$ A/µs ($T_{vj} = 150°C$) $V_R = 400$ V $V_{GE} = -8$ V	$T_{vj} = 25°C$ $T_{vj} = 150°C$ $T_{vj} = 175°C$	Q_r		20.0 40.0 45.0		µC
Reverse recovery energy	$I_F = 450$ A, - $di_F/dt = 5000$ A/µs ($T_{vj} = 150°C$) $V_R = 400$ V $V_{GE} = -8$ V	$T_{vj} = 25°C$ $T_{vj} = 150°C$ $T_{vj} = 175°C$	E_{rec}		7.00 13.0 15.0		mJ
Thermal resistance, junction to cooling fluid	per diode; $\Delta V/\Delta t = 10$ dm^3/min, $T_F = 75°C$		R_{thJF}		0.185[2]	0.217[2]	K/W
Temperature under switching conditions	t_{op} continuous for 10s within a period of 30s, occurence maximum 3000 times over lifetime		$T_{vj\,op}$	-40 150		150[3] 175	°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]通过特性/设计验证，而不是通过测试。
[2]对于水冷设计请参考 AN-HPD-ASSEMBLY。冷却液 50% 水/50% 乙二醇。
[3]当 Tvjop > 150°C 时：底板温度必须限制在 125°C。

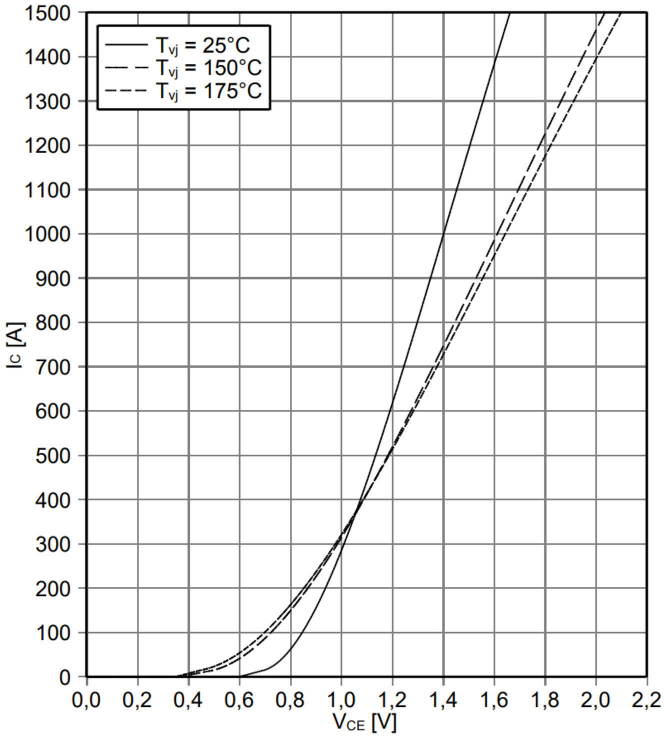
5 模块

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[1]			A
Material of module baseplate			Cu+Ni[2]			
Internal isolation	basic insulation (class 1, IEC 61140)		Al_2O_3[3]			
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		87[4]		mbar
Maximum pressure in cooling circuit	$T_{baseplate}$ < 40°C $T_{baseplate}$ > 40°C (relative pressure)	p			3.0[5] 2.5	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 Screw EJOT Delta PCB to frame	M	1.80 0.45	2.00 0.50	2.20 0.55[6]	Nm
Weight		G		605		g

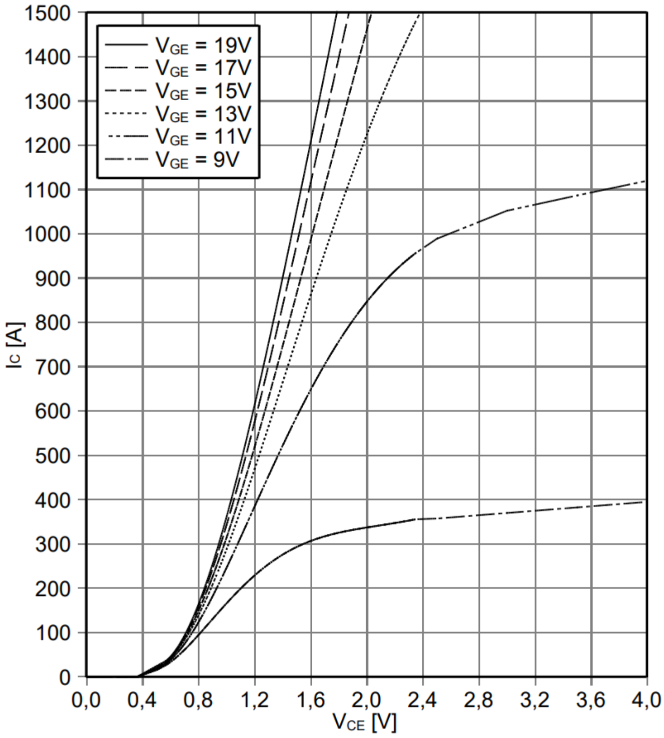
[1]连续、稳定状态。通过特性/设计验证，而非测试。
[2]镀镍铜底板。
[3] 改进的Al_2O_3陶瓷。
[4]对于水冷设计请参考 AN-HPD-ASSEMBLY。冷却液 50% 水/50% 乙二醇。
[5]参考应用手册AN-HPD-ASSEMBLY。
[6] EJOT Delta PT WN 5451 30x10。有效安装扭矩请参考应用手册 AN-HPD-ASSEMBLY

6 特性图

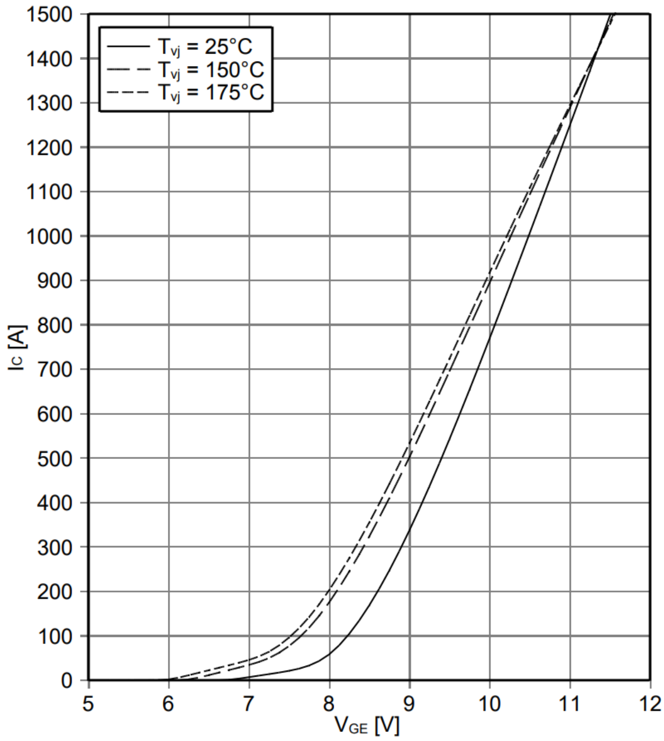
output characteristic IGBT,Inverter (typical)
$I_C = f(V_{CE})$
$V_{GE} = 15\ V$



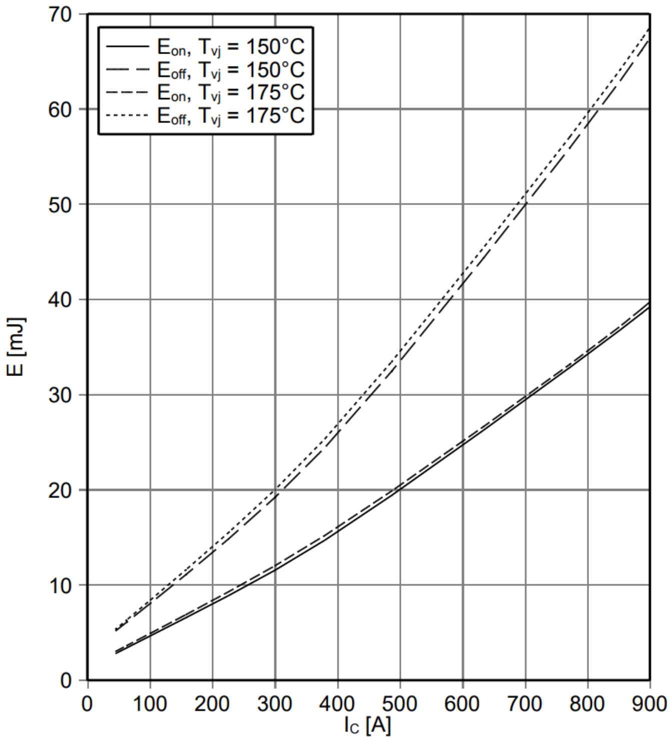
output characteristic IGBT,Inverter (typical)
$I_C = f(V_{CE})$
$T_{vj} = 150°C$



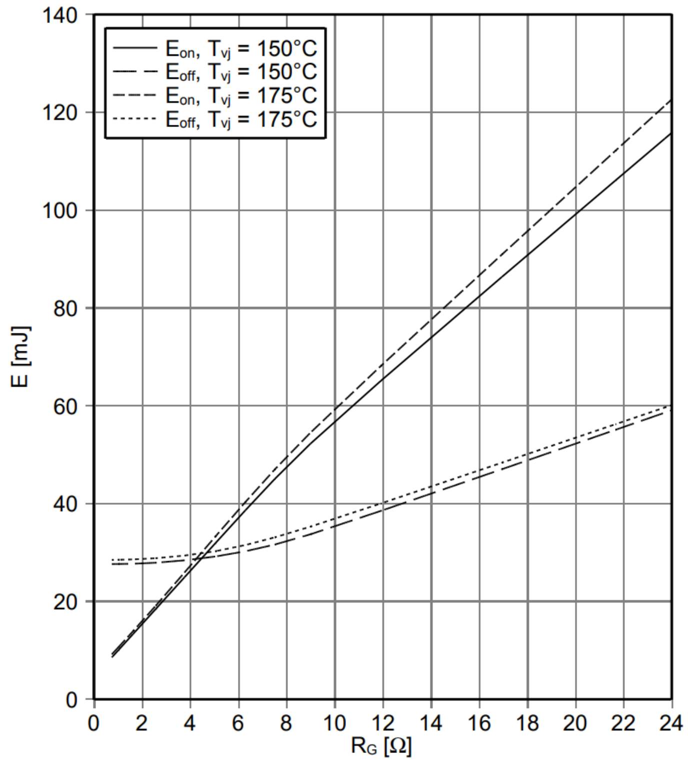
transfer characteristic IGBT,Inverter (typical)
$I_C = f(V_{GE})$
$V_{CE} = 20\ V$



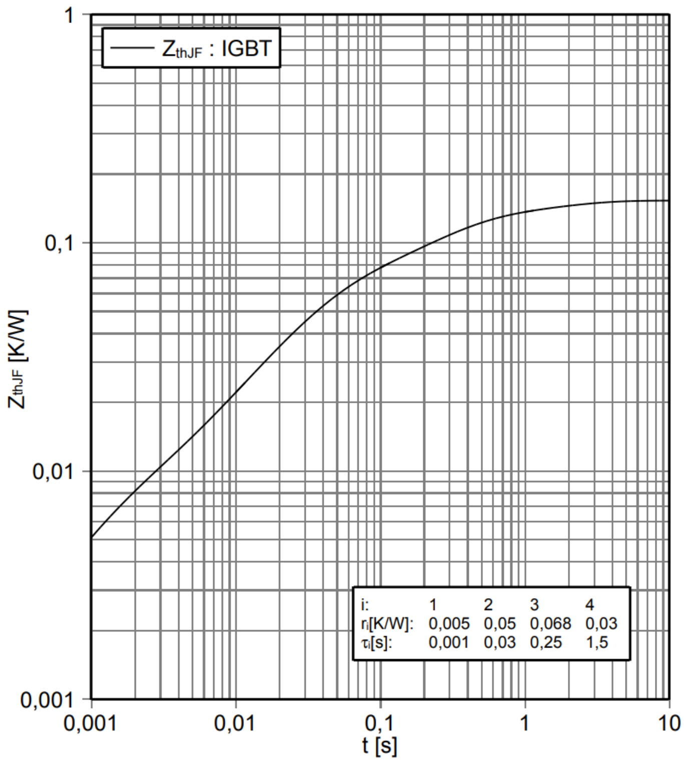
switching losses IGBT,Inverter (typical)
$E_{on} = f(I_C)$, $E_{off} = f(I_C)$,
$V_{GE} = +15\ V\ /\ -8\ V$, $R_{Gon} = 2.4\ \Omega$, $R_{Goff} = 5.1\ \Omega$, $V_{CE} = 400\ V$



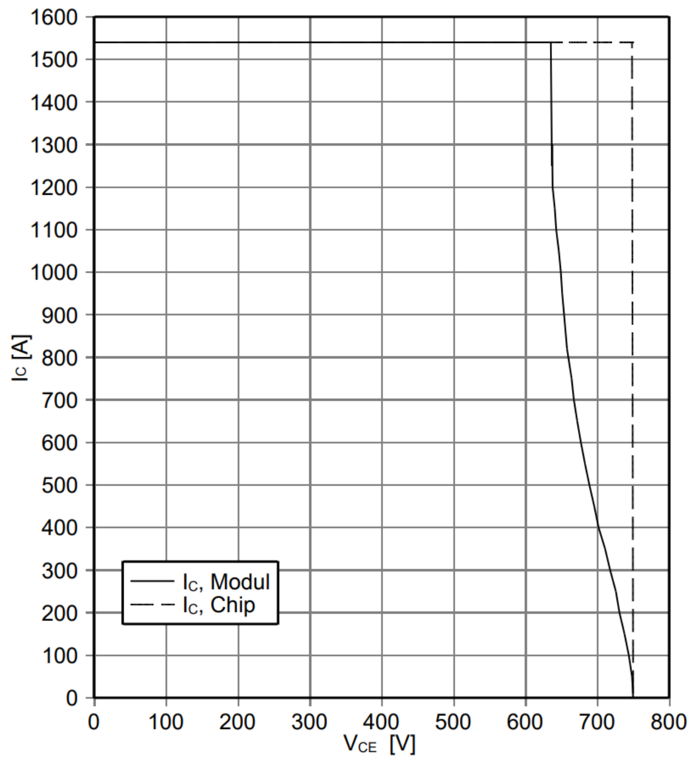
switching losses IGBT,Inverter (typical)
$E_{on} = f(R_G)$, $E_{off} = f(R_G)$,
V_{GE} = +15V / -8V, I_C = 450 A, V_{CE} = 400 V



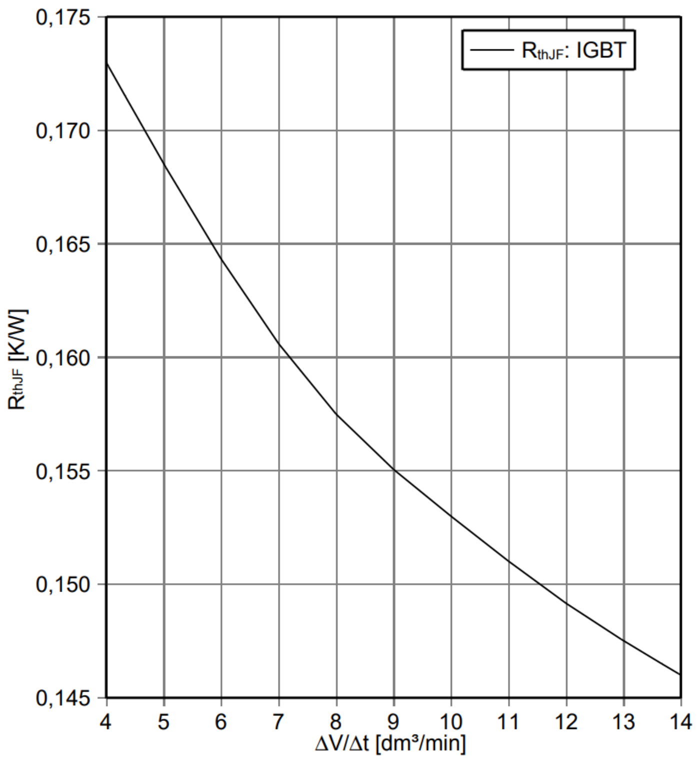
transient thermal impedance IGBT,Inverter
$Z_{thJF} = f(t)$, cooler design according to AN-HPD-ASSEMBLY
ΔV/Δt = 10 dm³/min; Tf = 75°C; 50% water / 50% ethylenglycol



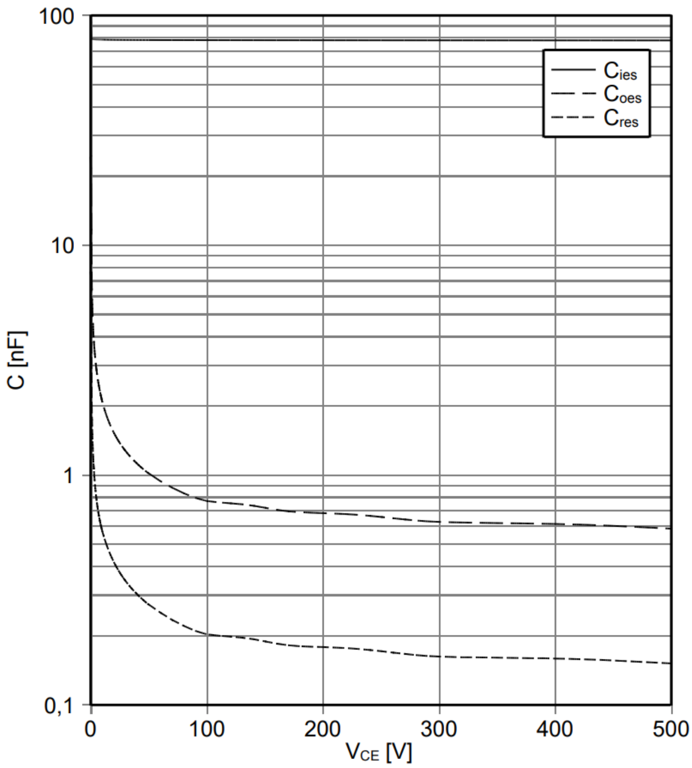
reverse bias safe operating area IGBT,Inverter (RBSOA)
$I_C = f(V_{CE})$
V_{GE} = +15V / -8V, R_{Goff} = 5,1 Ω, T_{vj} = 175°C



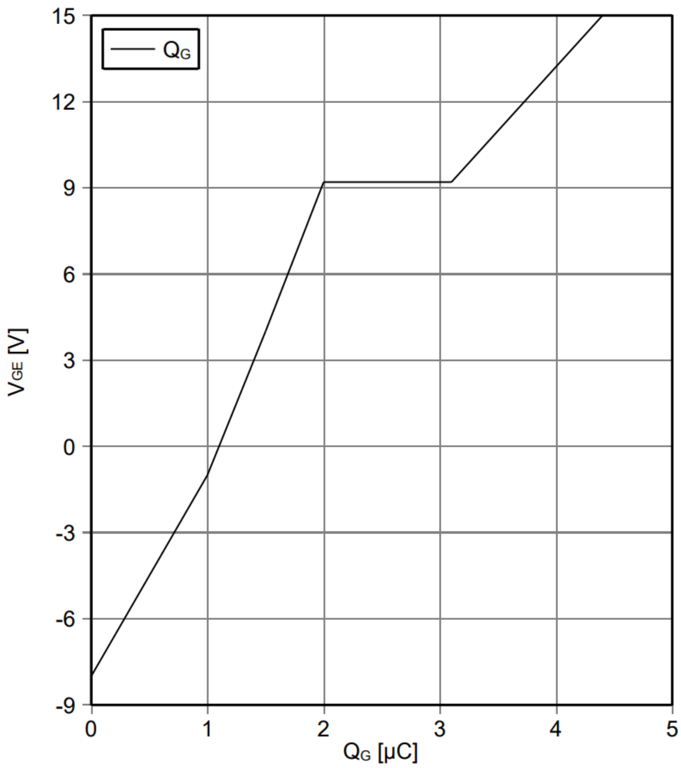
thermal impedance IGBT,Inverter
$R_{thJF} = f(\Delta V/\Delta t)$, cooler design according to AN-HPD-Assembly
Tf = 75°C; 50% water / 50% ethylenglycol



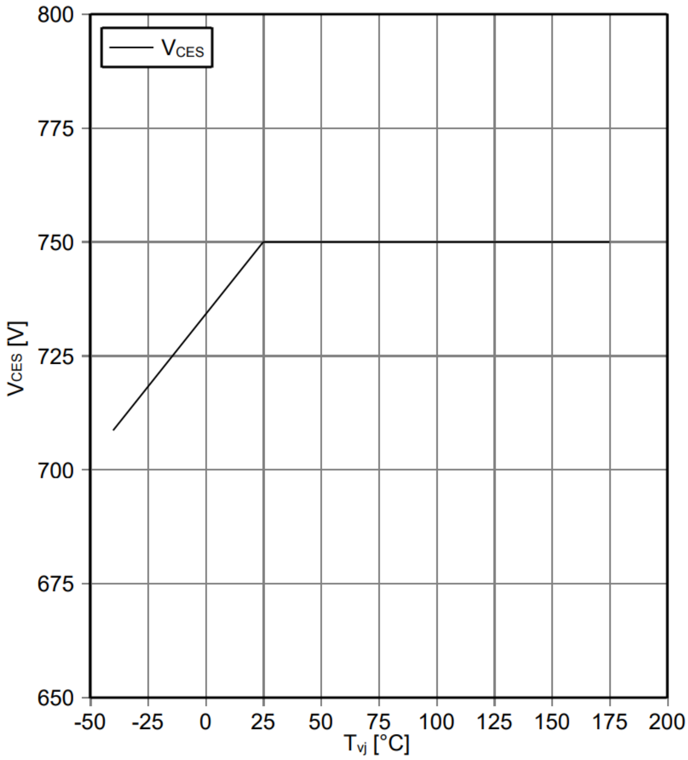
capacity characteristic IGBT,Inverter (typical)
$C = f(V_{CE})$
$V_{GE} = 0$ V, $T_{vj} = 25°C$, f = 1MHz



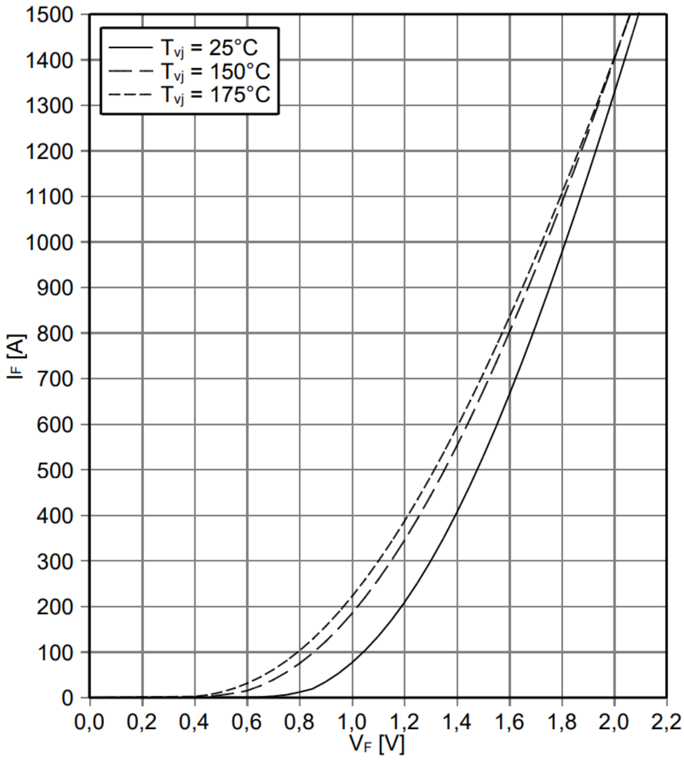
gate charge characteristic IGBT,Inverter (typical)
$V_{GE} = f(Q_G)$
$V_{CE} = 400$ V, $I_C = 450$ A, $T_{vj} = 25°C$



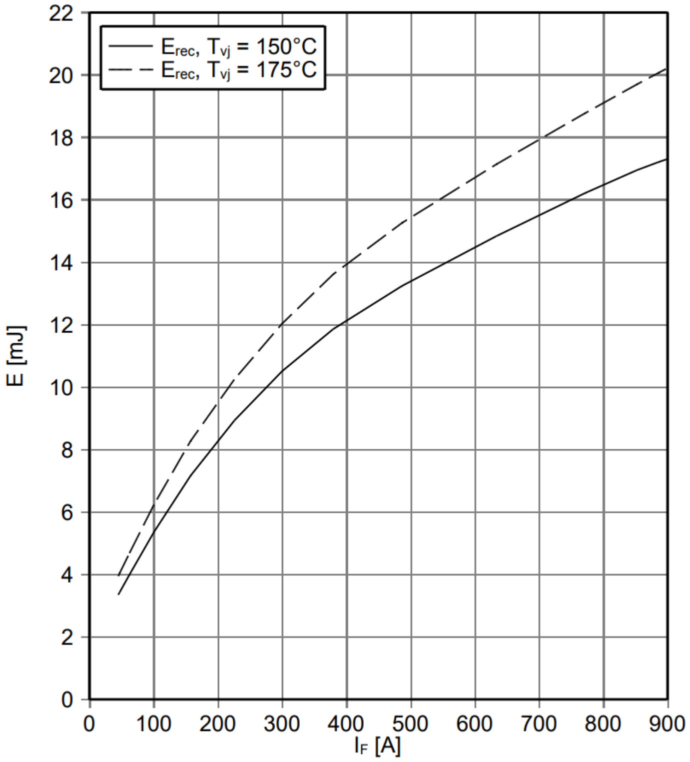
maximum allowed collector-emitter voltage
$V_{CES} = f(T_{vj})$, verified by characterization / design not by test
$I_{CES} = 1$ mA for $T_{vj} \leq 25°C$; $I_{CES} = 30$ mA for $T_{vj} > 25°C$



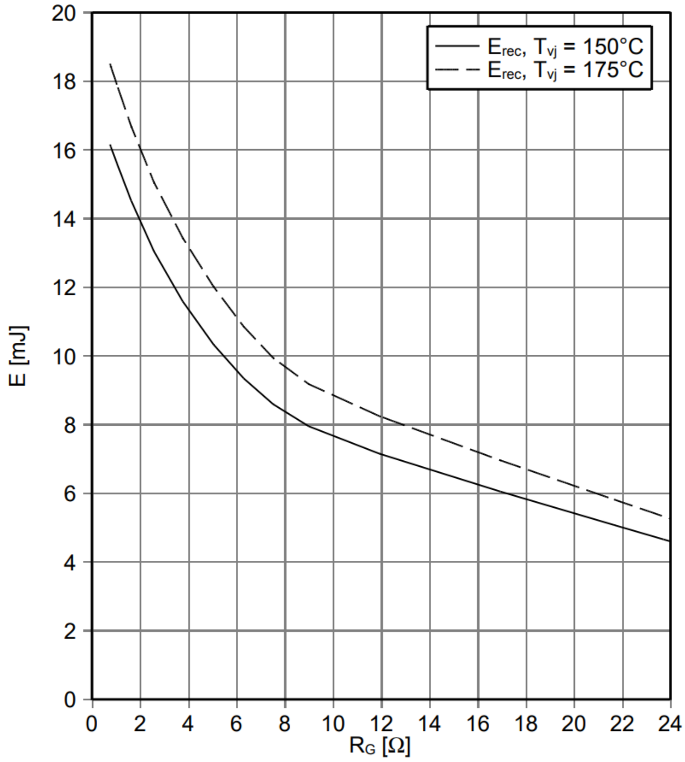
forward characteristic of Diode, Inverter (typical)
$I_F = f(V_F)$



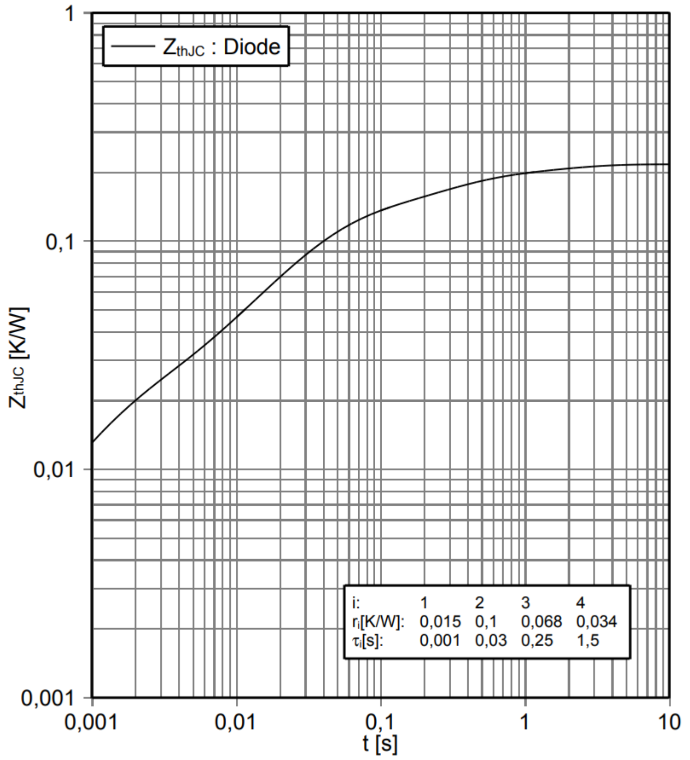
switching losses Diode, Inverter (typical)
$E_{rec} = f\,(I_F)$,
$R_{Gon} = 2.4\ \Omega$, $V_{CE} = 400$ V



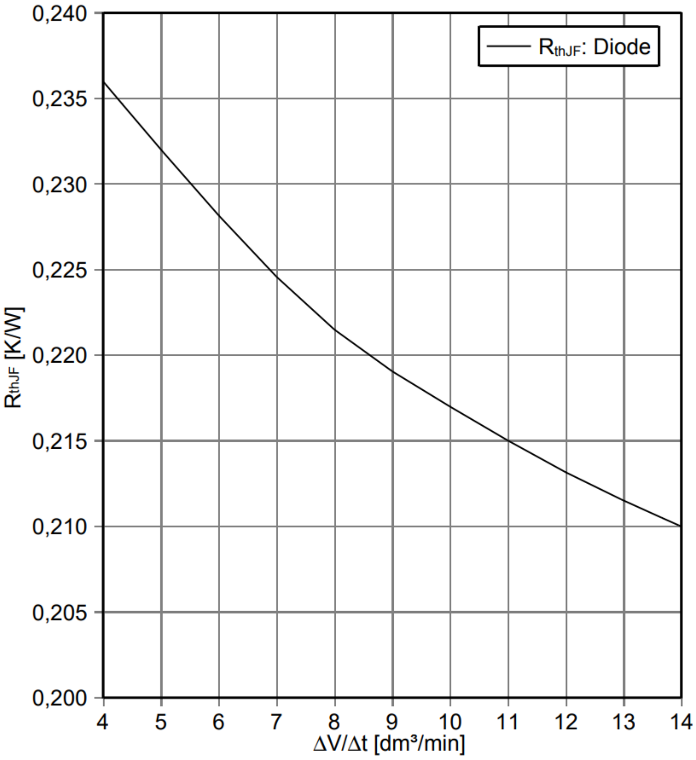
switching losses Diode, Inverter (typical)
$E_{rec} = f\,(R_G)$,
$I_F = 450$ A, $V_{CE} = 400$ V



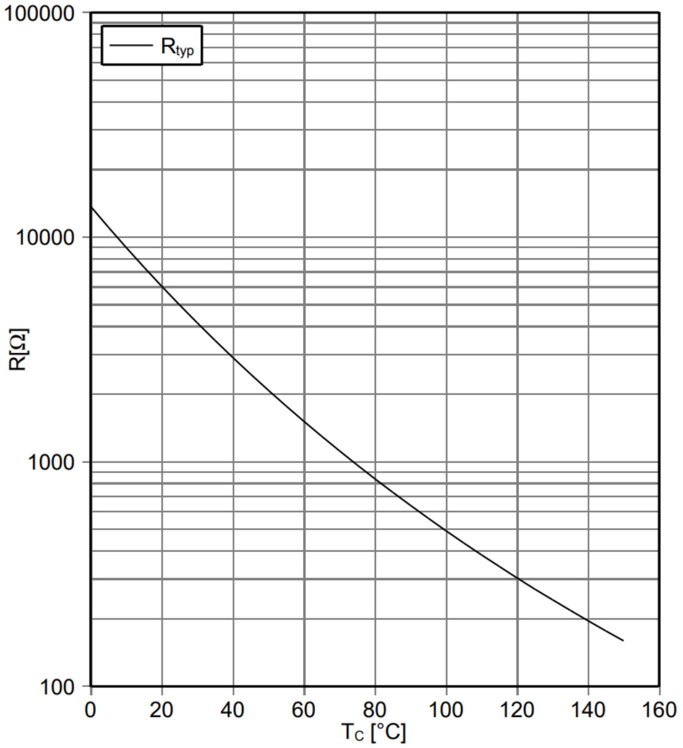
transient thermal impedance Diode, Inverter
$Z_{thJF} = f\,(t)$, cooler design according to AN-HPD-ASSEMBLY
$\Delta V/\Delta t = 10$ dm³/min; Tf = 75°C; 50% water / 50% ethylenglycol



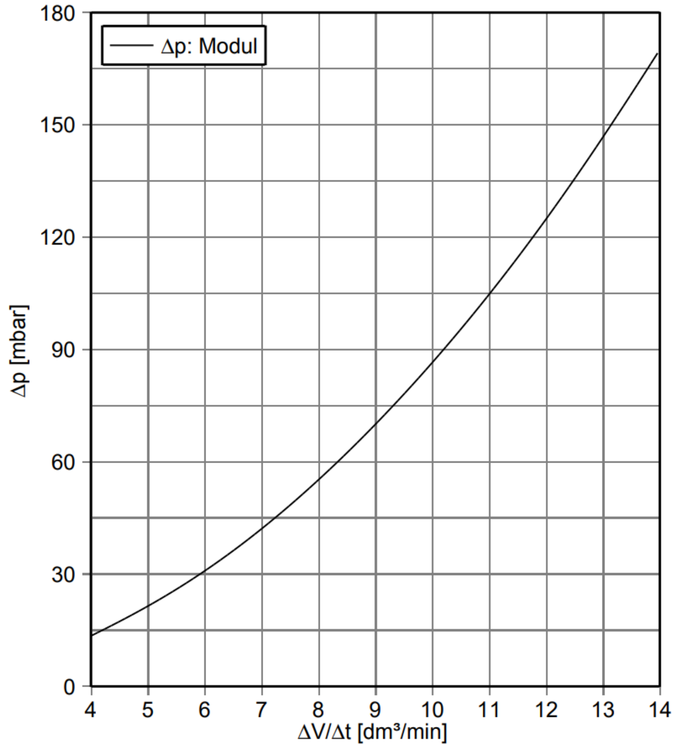
thermal impedance Diode, Inverter
$R_{thJF} = f\,(\Delta V/\Delta t)$, cooler design according to AN-HPD-ASSEMBLY
Tf = 75°C; 50% water / 50% ethylenglycol



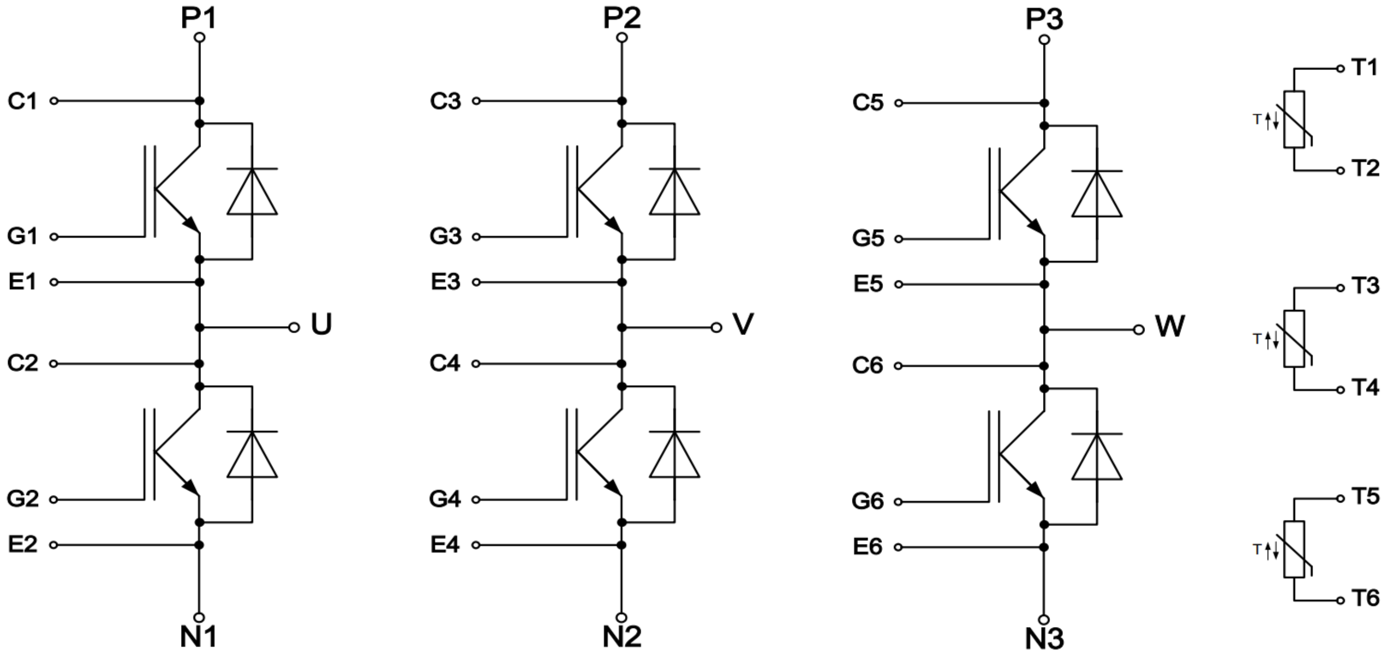
NTC-Thermistor-temperature characteristic (typical)
R = f (T)



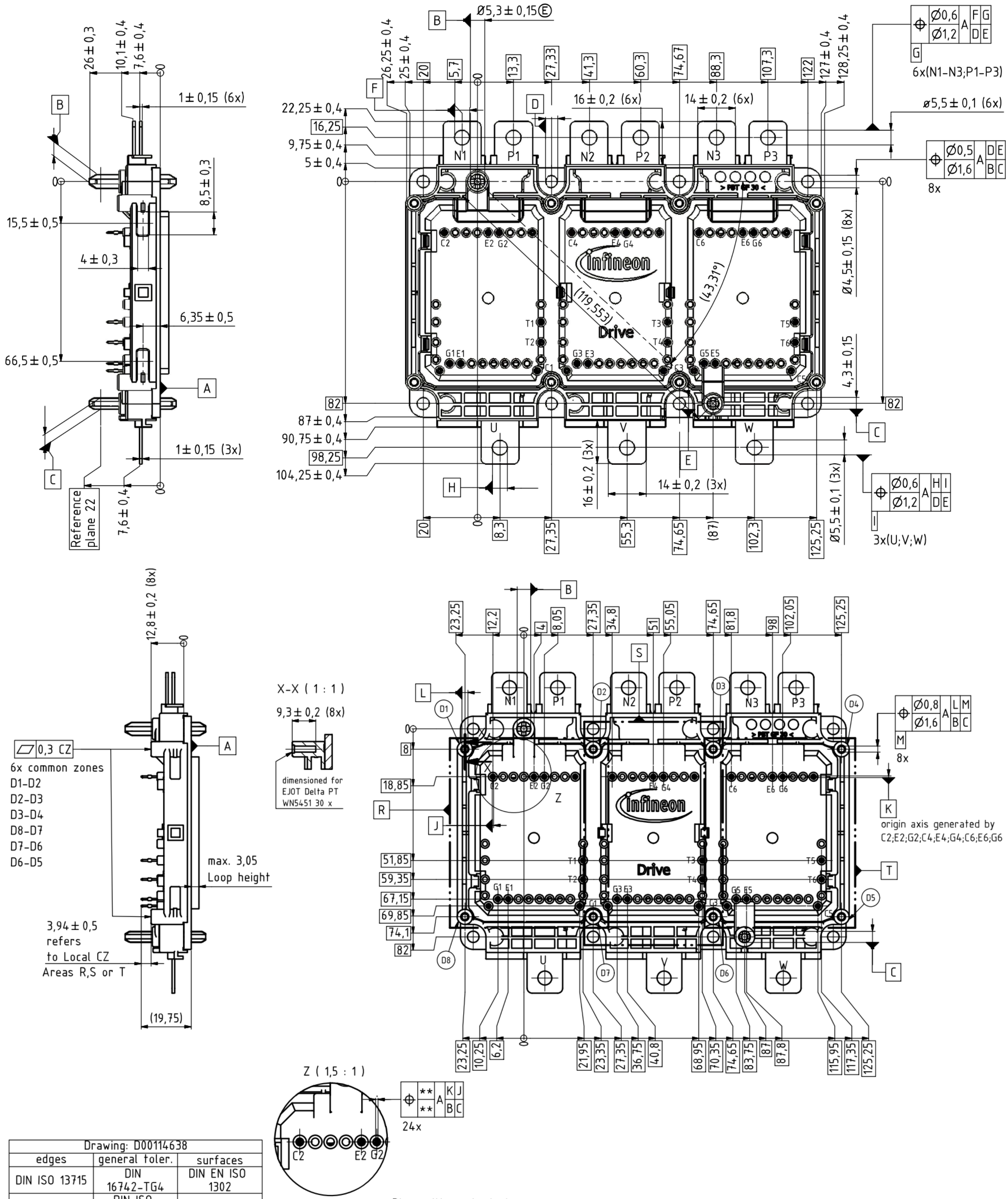
pressure drop in cooling circuit
Δp = f (ΔV/Δt), cooler design according to AN-HPD-ASSEMBLY
Tf = 75°C; 50% water / 50% ethylenglycol



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: D00114638		
edges	general toler.	surfaces
DIN ISO 13715	DIN 16742-TG4	DIN EN ISO 1302
	DIN ISO 2768-mK	

All dimensions refer to module in delivery condition.

** Pin positions checked with pin gauge according to Application Note AB-HPD-ASSEMBLY

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	71549142846550549911530		

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
V1.0	2017-06-06	Target datasheet
V2.0	2018-07-10	-
V3.0	2019-05-28	-

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