HybridPACK™ Drive Module

FS380R12A6T4B

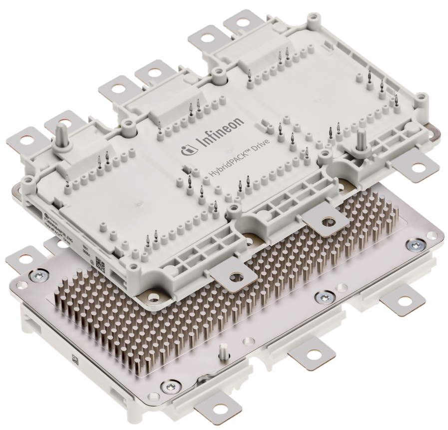
Preliminary Data Sheet

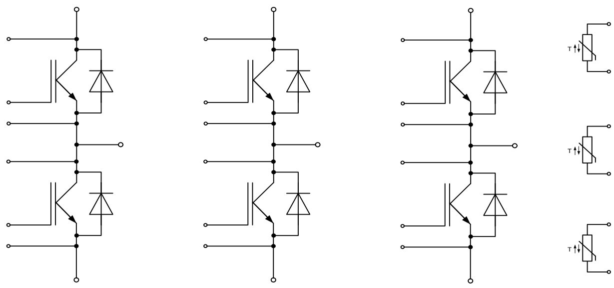
V2.0, 2018-08-27

Automotive High Power

1 Features / Description

HybridPACK™ Drive module with EDT2 IGBT and Diode





V_{CES} = 1200V
$I_{C\ nom}$ = 380A

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 Cres
- Low Inductive Design
- $T_{vj\ op}$ = 150°C

Mechanical Features
- 4.2kV DC 1sec Insulation
- High Creepage and Clearance Distances
- Compact design
- High Power Density
- 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, which is an automotive Micro-Pattern Trench-Field-Stop cell design optimized for electric drive train applications. The chipset has benchmark current density combined with short circuit ruggedness and increased blocking voltage for reliable inverter operation under harsh environmental conditions.

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 family is also 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	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[1]	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[1]	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	2.00	V
Gate threshold voltage	I_C = 9.60 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 dm³/min, T_F = 75°C		R_{thJF}		0.100[2]	0.115[2]	K/W
Temperature under switching conditions	t_{op} continuous		$T_{vj\,op}$	-40		150[3]	°C

[1] Verified by characterization / design not by test.
[2] Cooler design and flow direction according to application note AN-HPD-ASSEMBLY. Cooling fluid 50% water / 50% ethylenglycol.
[3] For Tvjop > 150°C: Baseplate temperature has to be limited to 125°C.

3 Diode, Inverter

3.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
Repetitive peak reverse voltage	T_{vj} = 25°C	V_{RRM}	1200	V
Implemented forward current		I_{FN}	380	A
Continuous DC forward current		I_F	250[1]	A
Repetitive peak forward current	t_P = 1 ms	I_{FRM}	760	A
I²t - value	V_R = 0 V, t_P = 10 ms, T_{vj} = 150°C	I²t	t.b.d.	A²s

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[2]	0.160[2]	K/W
Temperature under switching conditions	t_{op} continuous		$T_{vj\ op}$	-40		150[3]	°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] Verified by characterization / design not by test.
[2] Cooler design and flow direction according to application note AN-HPD-ASSEMBLY. Cooling fluid 50% water / 50% ethylenglycol.
[3] For Tvjop > 150°C: Baseplate temperature has to be limited to 125°C.

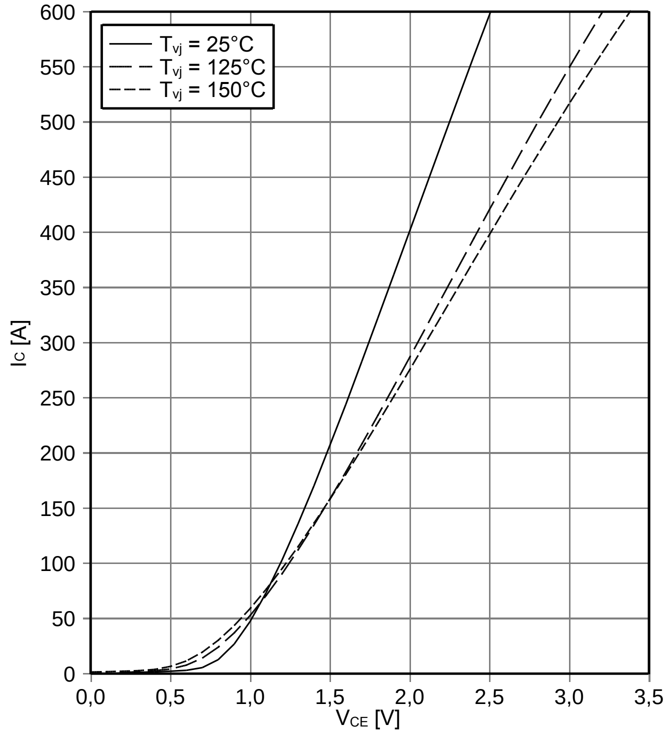
5 Module

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}		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		
			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 Screw EJOT Delta PCB to frame	M	1.80 0.45	2.00 0.50	2.20 0.55[3]	Nm
Weight		G		800		g

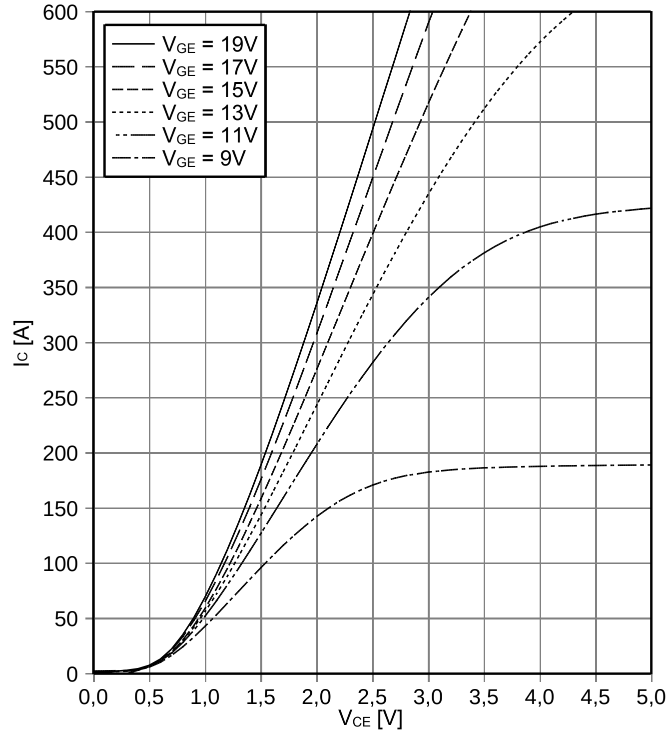
[1] Ni plated Cu baseplate.
[2] Cooler design and flow direction according to application note AN-HPD-ASSEMBLY. Cooling fluid 50% water / 50% ethylenglycol.
[3] EJOT Delta PT WN 5451 30x10. Effective mounting torque according to application note AN-HPD-ASSEMBLY

6 Characteristics Diagrams

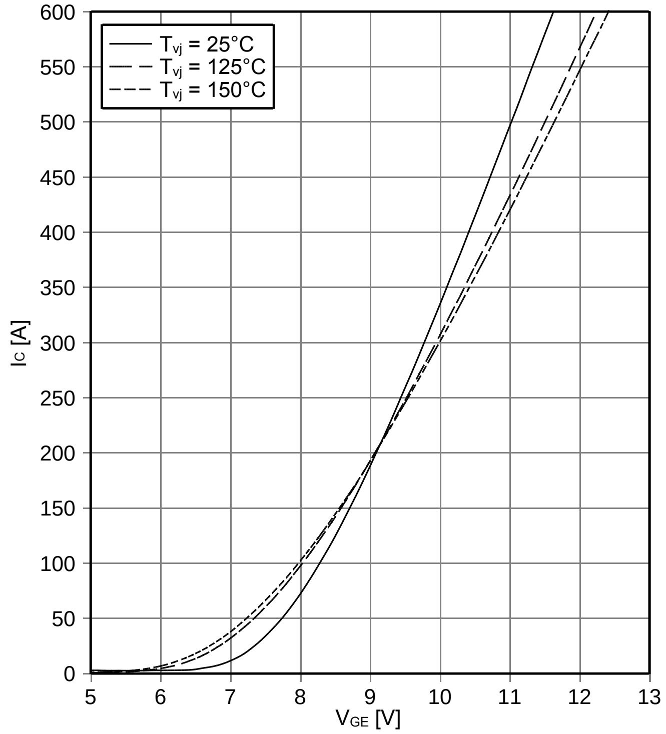
output characteristic IGBT,Inverter (typical)
$I_C = f(V_{CE})$
$V_{GE} = 15$ V



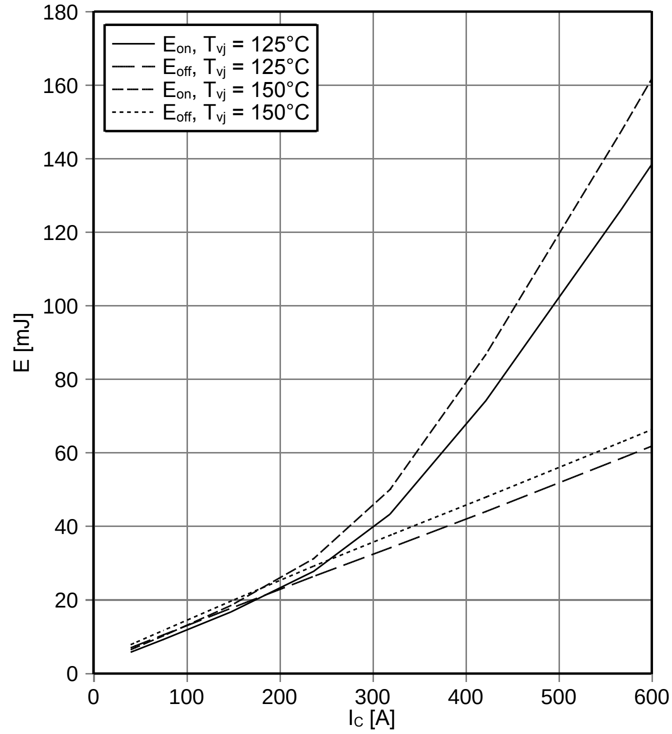
output characteristic IGBT,Inverter (typical)
$I_C = f(V_{CE})$
$T_{vj} = 150°C$



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

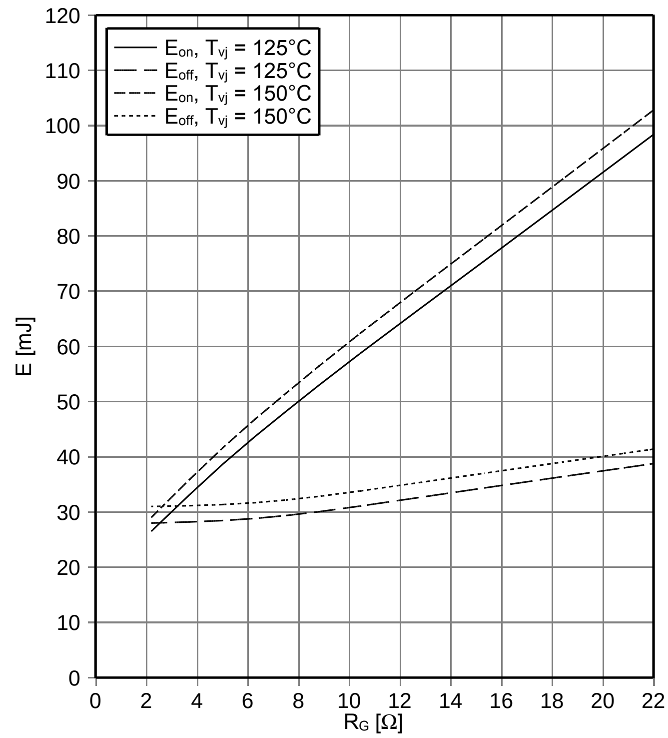


switching losses IGBT,Inverter (typical)
$E_{on} = f(I_C)$, $E_{off} = f(I_C)$,
$V_{GE} = +15$ V / -8 V, $R_{Gon} = 2.2\ \Omega$, $R_{Goff} = 2.2\ \Omega$, $V_{CE} = 600$ V

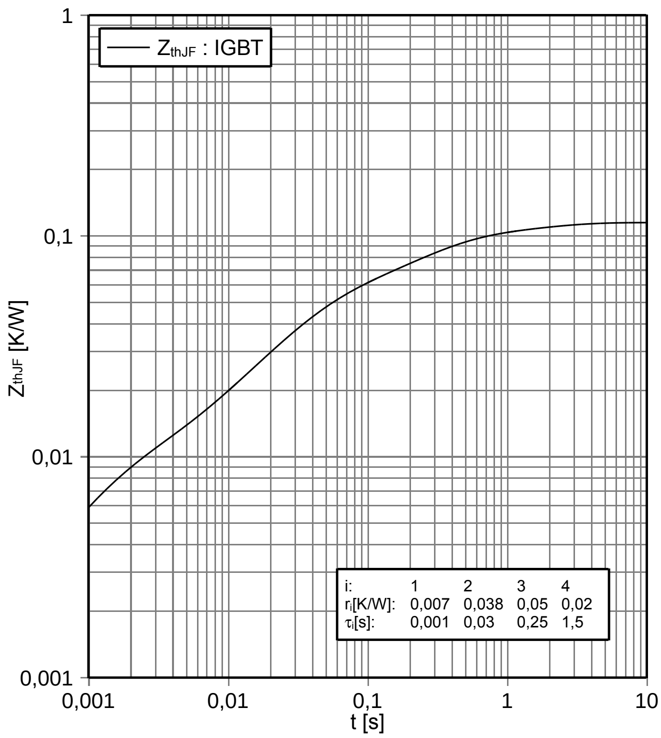


Preliminary Data

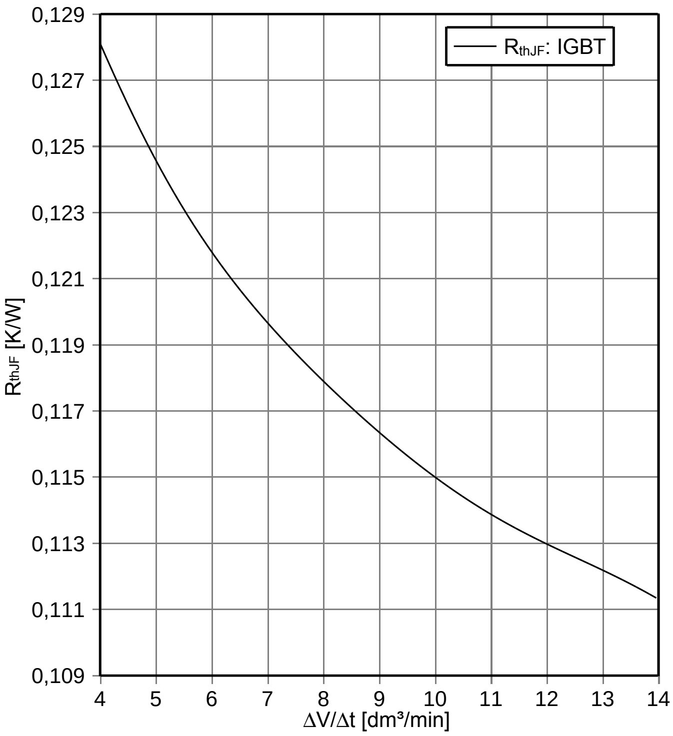
switching losses IGBT,Inverter (typical)
E_{on} = f (R_G), E_{off} = f (R_G),
V_{GE} = +15V / -8V, I_C = 250 A, V_{CE} = 600V



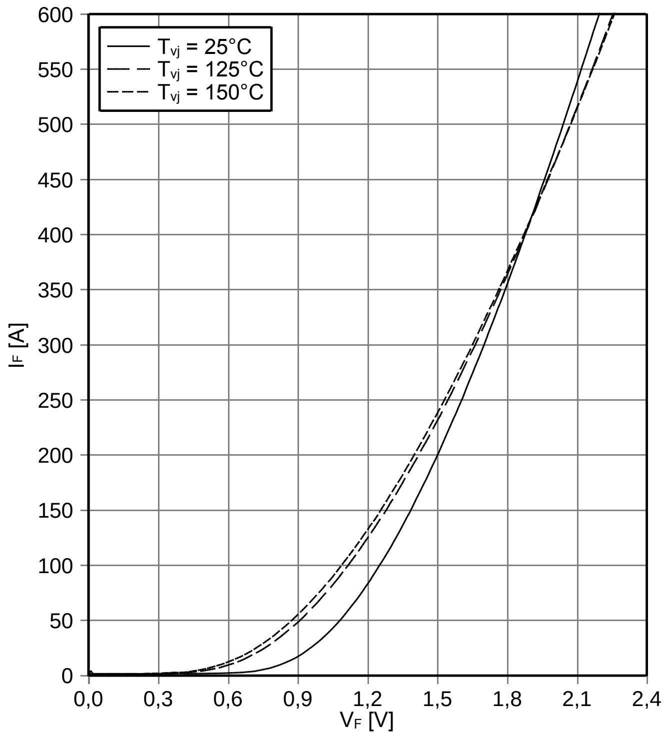
transient thermal impedance IGBT,Inverter
Z_{thJF} = f (t), cooler design according to AN-HPD-ASSEMBLY
ΔV/Δt = 10 dm³/min; Tf = 75°C; 50% water / 50% ethylenglycol



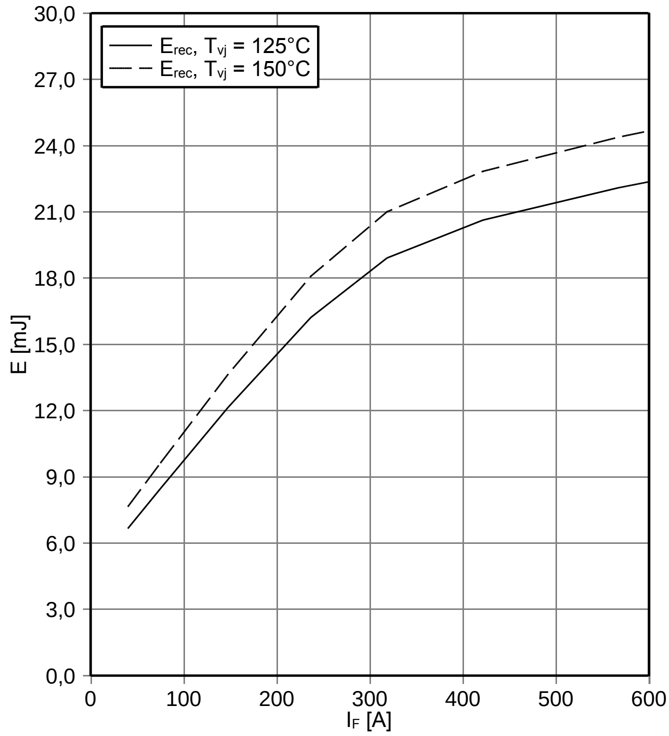
thermal impedance IGBT,Inverter
R_{thJF} = f (ΔV/Δt), cooler design according to AN-HPD-Assembly
Tf = 75°C; 50% water / 50% ethylenglycol



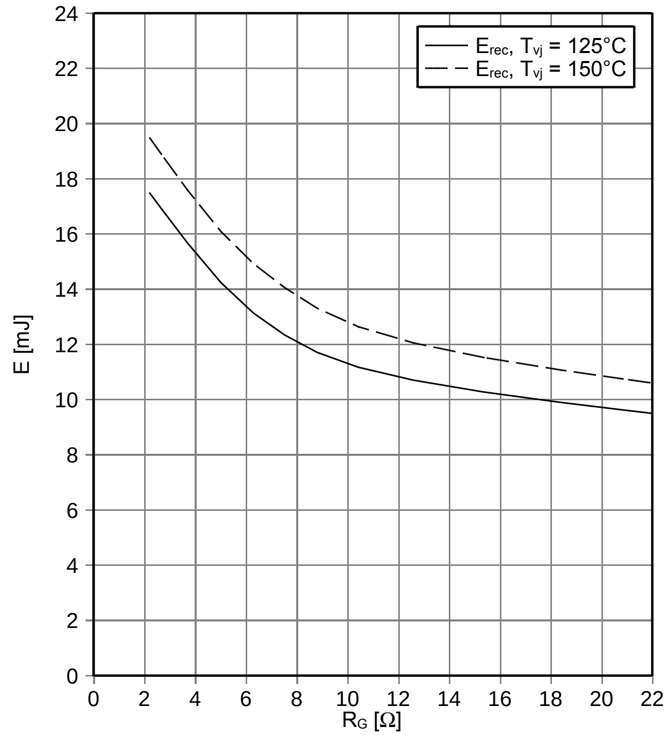
forward characteristic of Diode, Inverter (typical)
I_F = f (V_F)



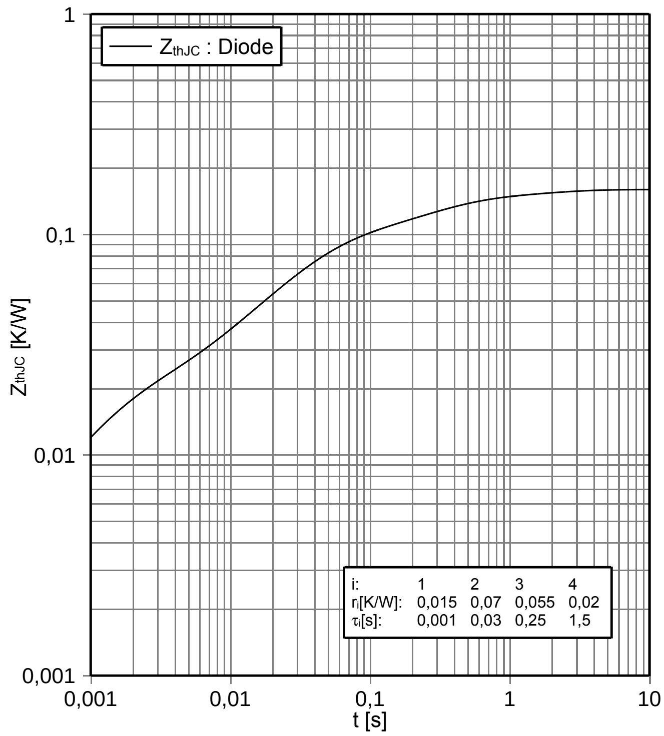
switching losses Diode, Inverter (typical)
$E_{rec} = f(I_F)$,
$R_{Gon} = 2{,}2\ \Omega$, $V_{CE} = 400$ V



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

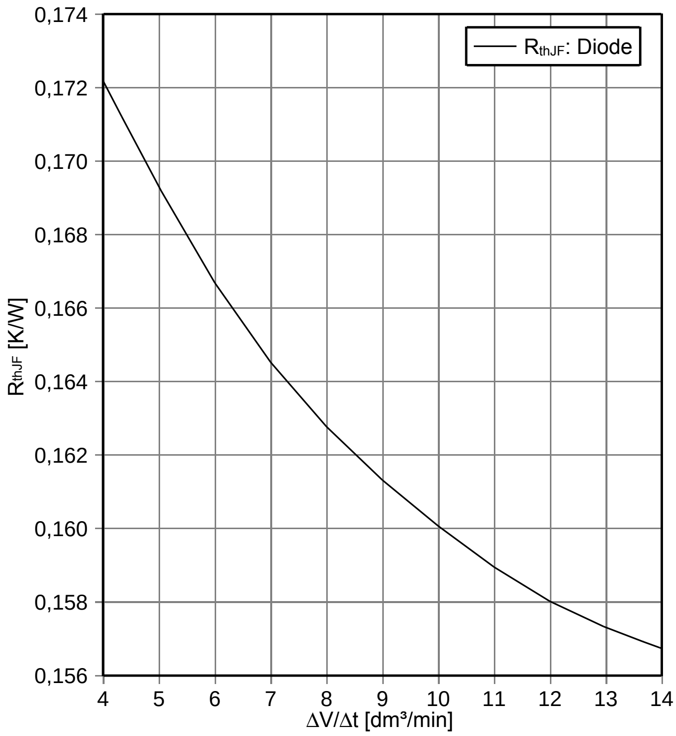


transient thermal impedance Diode, Inverter
$Z_{thJF} = f(t)$, cooler design according to AN-HPD-ASSEMBLY
$\Delta V/\Delta t = 10$ dm³/min; Tf = 75°C; 50% water / 50% ethylenglycol

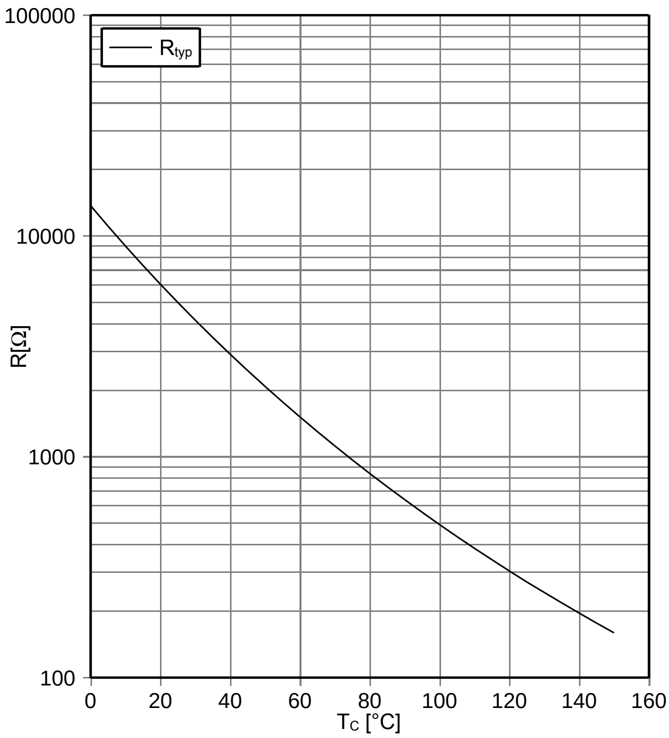


i:	1	2	3	4
r_i[K/W]:	0,015	0,07	0,055	0,02
τ_i[s]:	0,001	0,03	0,25	1,5

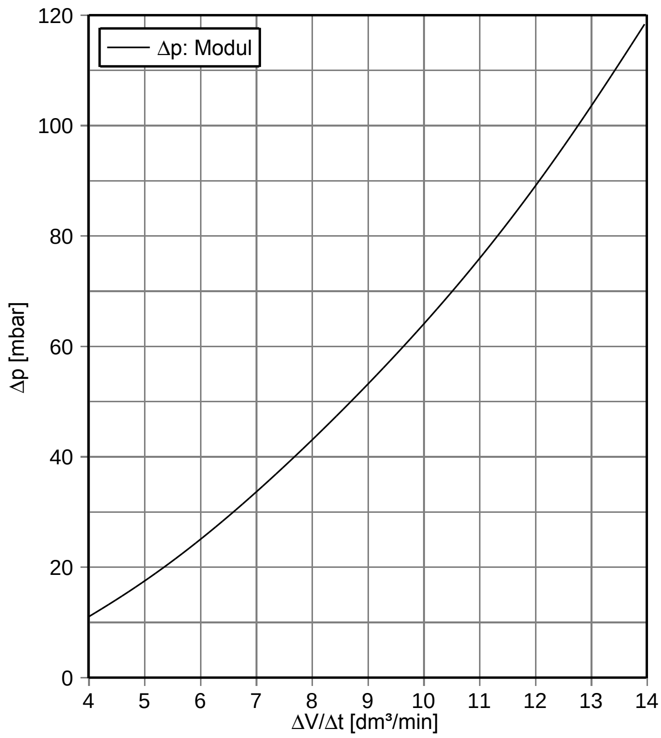
thermal impedance Diode, Inverter
$R_{thJF} = f(\Delta V/\Delta t)$, cooler design according to AN-HPD-ASSEMBLY
Tf = 75°C; 50% water / 50% ethylenglycol



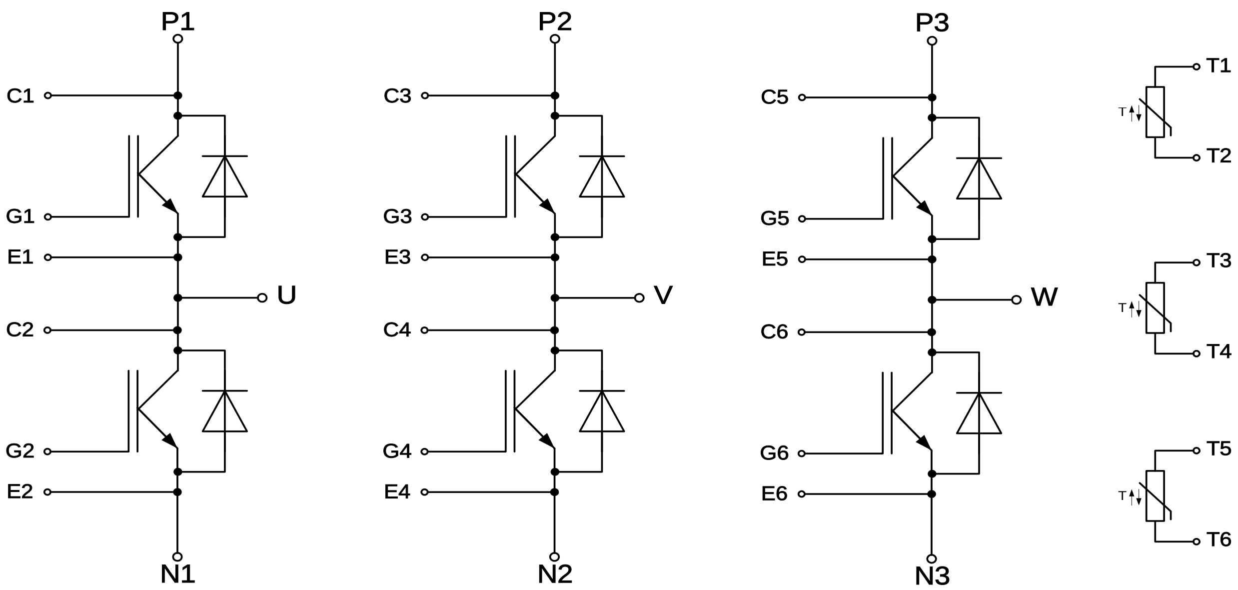
NTC-Thermistor-temperature characteristic (typical)
R = f (T)



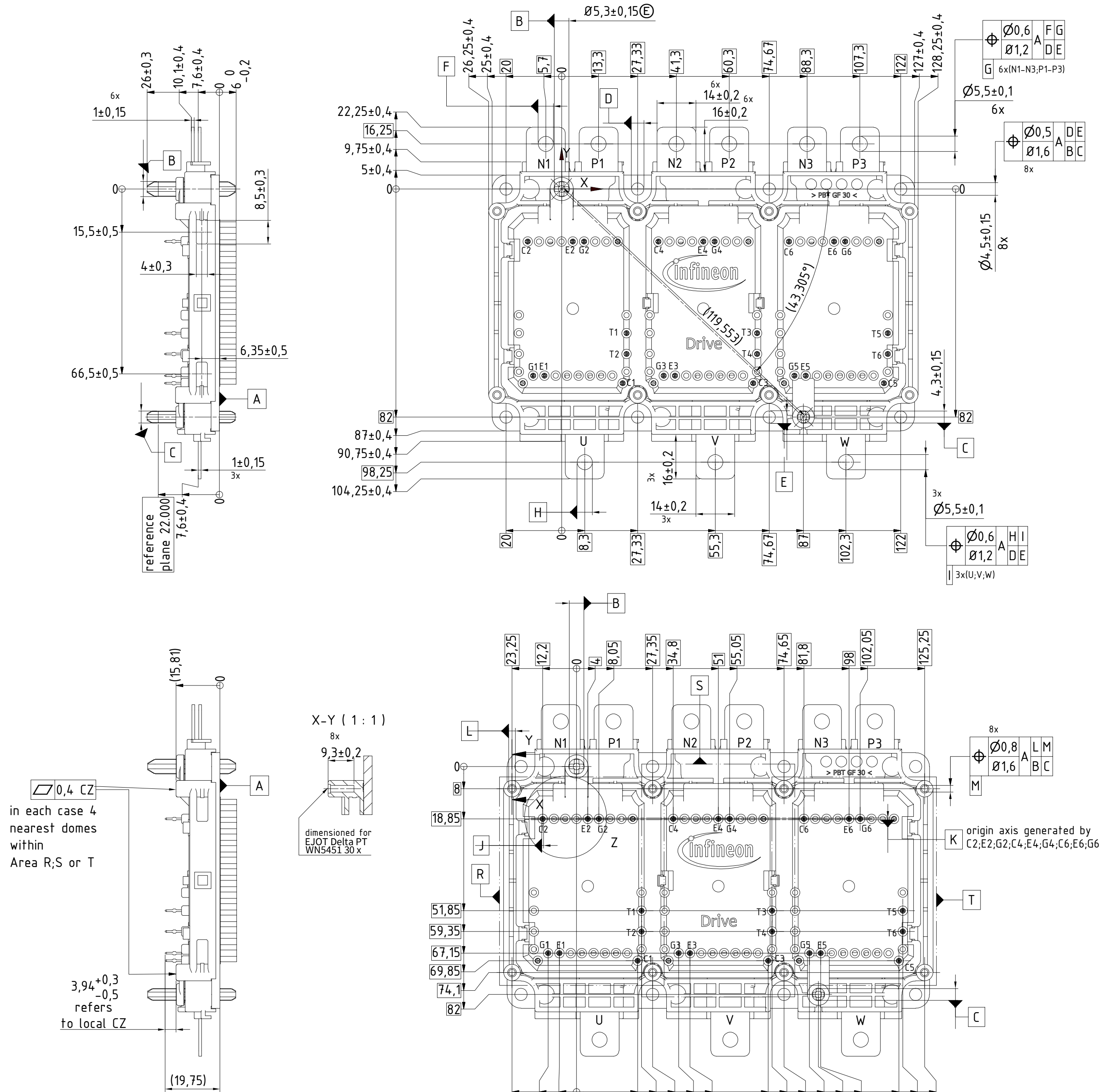
pressure drop in cooling circuit
Δp = f (ΔV/Δt), cooler design according to AN-HPD-ASSEMBLY
Tf = 75°C; 50% water / 50% ethylenglycol



7 Circuit diagram



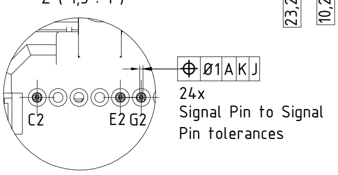
8 Package outlines



Drawing: D00138581_02		
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

Z (1,5 : 1)



24x
Signal Pin to Signal
Pin tolerances

9 Label Codes

9.1 Module Code

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 Packing Code

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			

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

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