HybridPACK™ Drive Module

FS820R08A6P2B

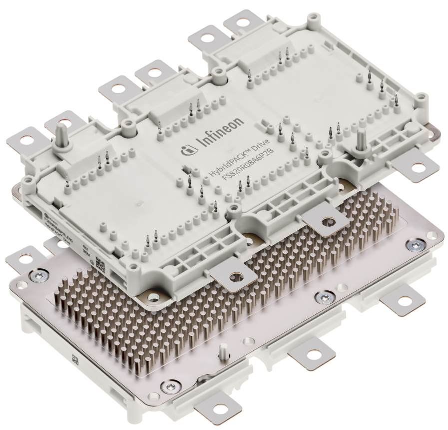
Final Data Sheet

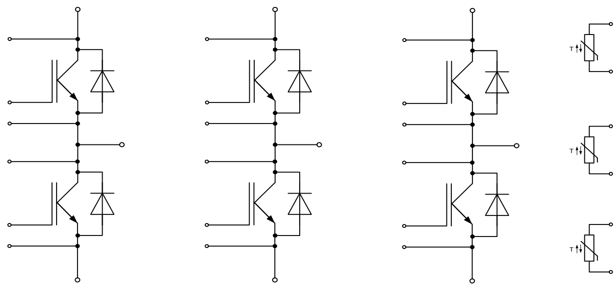
V3.1, 2019-10-10

Automotive High Power

1 Features / Description

HybridPACK™ Drive module with EDT2 IGBT and Diode





V_{CES} = 750 V
I_C = 820 A

Typical Applications

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

Electrical Features

- Blocking voltage 750V
- Low V_{CEsat}
- Low Switching Losses
- Low Qg and Crss
- Low Inductive Design
- $T_{vj\ op}$ = 150°C
- Short-time extended Operation Temperature
  $T_{vj\ op}$ = 175°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 (750V/820A) optimized for hybrid and electric vehicles. The power module implements the new EDT2 IGBT 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 EDT2 IGBTs also show excellent light load power losses, which helps to improve system efficiency over a real driving cycle. The EDT2 IGBT was optimized for applications with switching frequencies in the range of 10 kHz.

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 in the FS820R08A6P2B 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
FS820R08A6P2B	SP001499708

2 IGBT,Inverter

2.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
Collector-emitter voltage	T_{vj} = 25°C	V_{CES}	750	V
Implemented collector current		I_{CN}	820	A
Continuous DC collector current	T_F = 80°C, $T_{vj\,max}$ = 175°C	$I_{C\,nom}$	450[1]	A
Repetitive peak collector current	t_P = 1 ms	I_{CRM}	1640	A
Total power dissipation	T_F = 75°C, $T_{vj\,max}$ = 175°C	P_{tot}	714[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 = 450 A, V_{GE} = 15 V I_C = 450 A, V_{GE} = 15 V I_C = 450 A, V_{GE} = 15 V I_C = 820 A, V_{GE} = 15 V I_C = 820 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 1.30 1.50	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} ·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; ΔV/Δt = 10 dm³/min, T_F = 75°C		R_{thJF}		0.120[2]	0.140[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) 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}	750	V
Implemented forward current		I_{FN}	820	A
Continuous DC forward current		I_F	450[1)]	A
Repetitive peak forward current	t_P = 1 ms	I_{FRM}	1640	A
I²t - 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	I²t	19000 16000	A²s A²s

3.2 Characteristic Values

Parameter	Conditions		Symbol	min.	typ.	max.	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 = 820 A, V_{GE} = 0 V I_F = 820 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 1.70 1.60	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; ΔV/Δt = 10 dm³/min, T_F = 75°C		R_{thJF}		0.175[2)]	0.200[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-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.

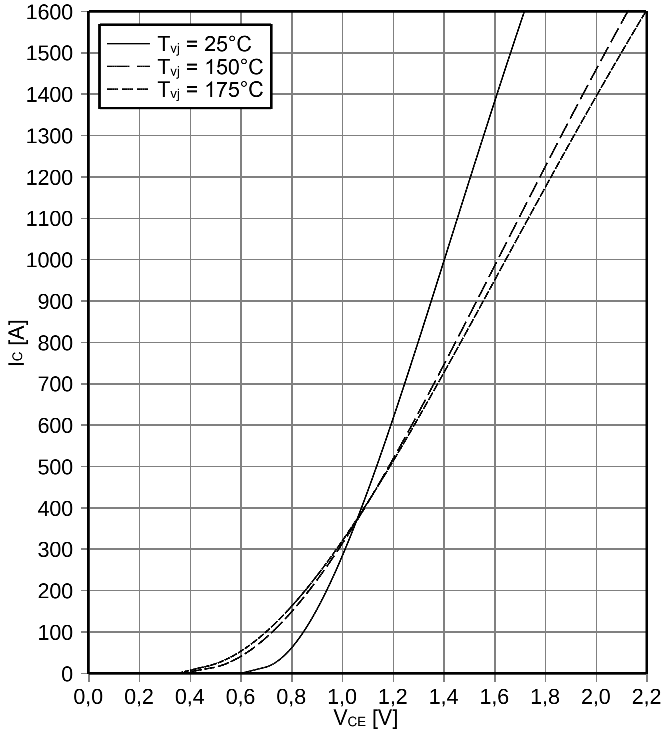
5 Module

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)		Al_2O_3[2]			
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[3]		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[4]	Nm
Weight		G		720		g

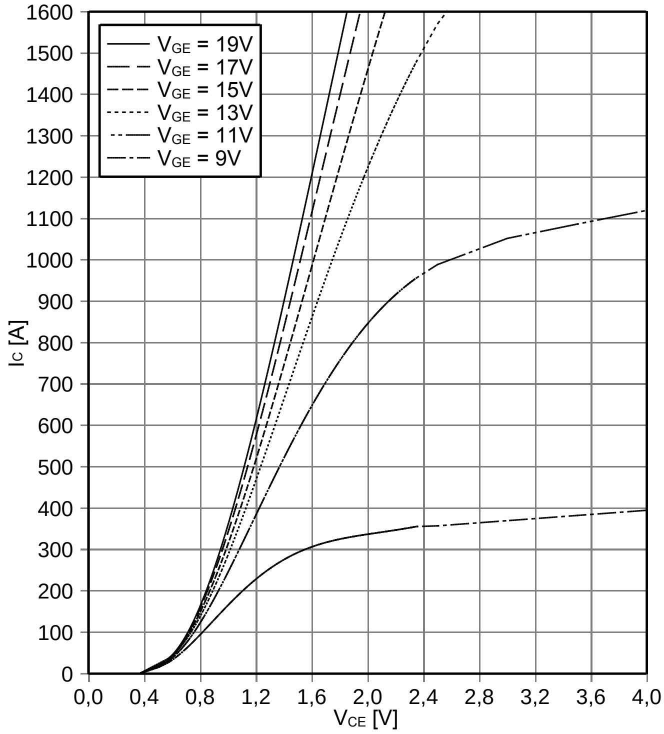
[1] Ni plated Cu baseplate.
[2] Improved Al_2O_3 ceramic.
[3] Cooler design and flow direction according to application note AN-HPD-ASSEMBLY. Cooling fluid 50% water / 50% ethylenglycol.
[4] EJOT Delta PT WN 5451 30x10. Effective mounting torque according to application note AN-HPD-ASSEMBLY

6 Characteristics Diagrams

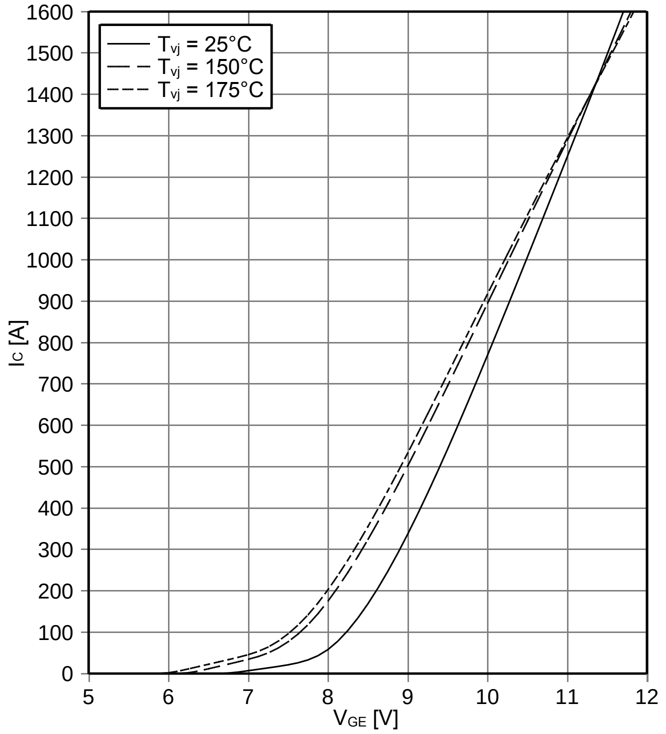
output characteristic IGBT,Inverter (typical)
$I_C = f(V_{CE})$
$V_{GE} = 15$ V



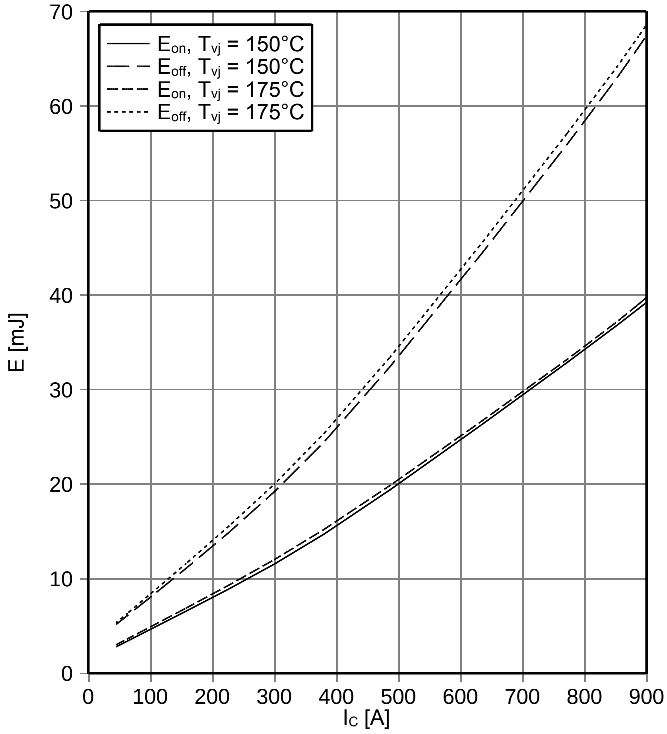
output characteristic IGBT,Inverter (typical)
$I_C = f(V_{CE})$
$T_{vj} = 150°C$



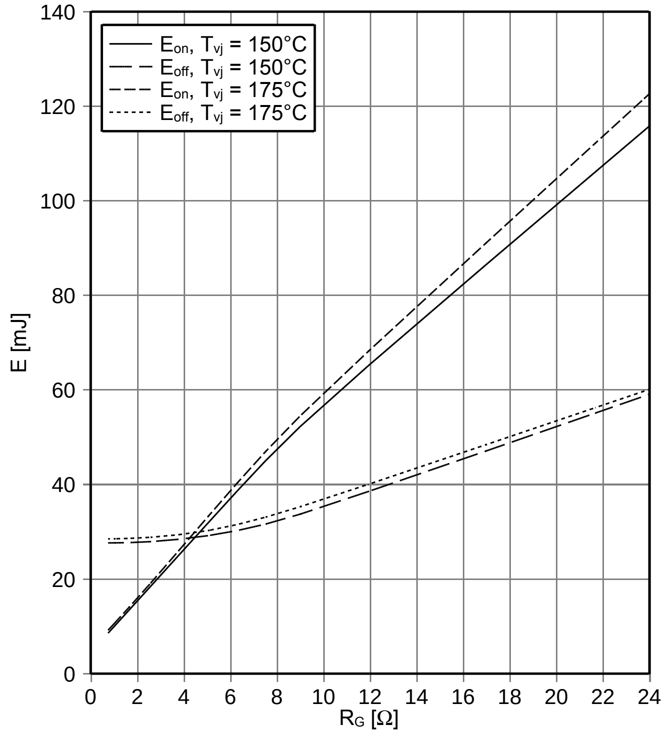
transfer characteristic IGBT,Inverter (typical)
$I_C = f(V_{GE})$
$V_{CE} = 20$ V



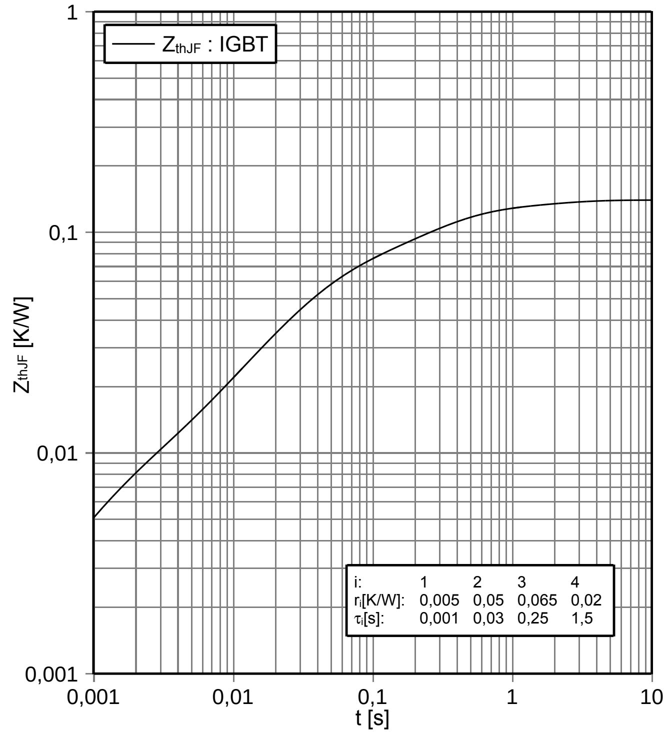
switching losses IGBT,Inverter (typical)
$E_{on} = f(I_C)$, $E_{off} = f(I_C)$,
$V_{GE} = +15$ V / -8 V, $R_{Gon} = 2.4\ \Omega$, $R_{Goff} = 5.1\ \Omega$, $V_{CE} = 400$ V



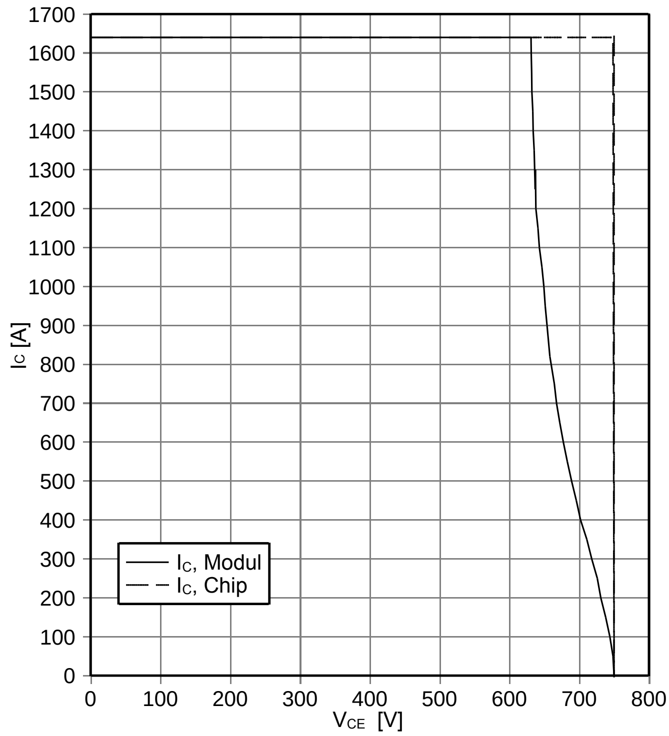
switching losses IGBT,Inverter (typical)
$E_{on} = f(R_G)$, $E_{off} = f(R_G)$,
V_{GE} = +15V / -8V, I_C = 450 A, V_{CE} = 400 V



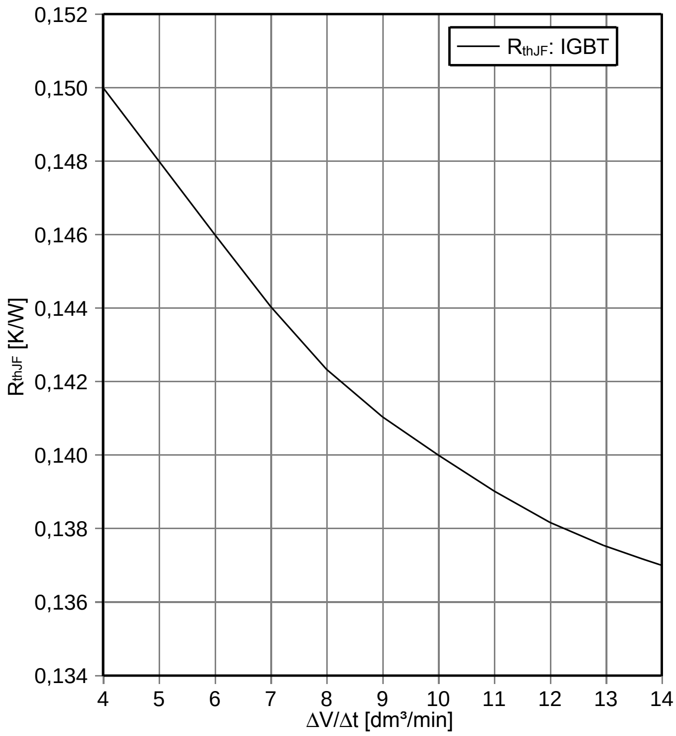
transient thermal impedance IGBT,Inverter
$Z_{thJF} = f(t)$, cooler design according to AN-HPD-ASSEMBLY
ΔV/Δt = 10 dm³/min; Tf = 75°C; 50% water / 50% ethylenglycol



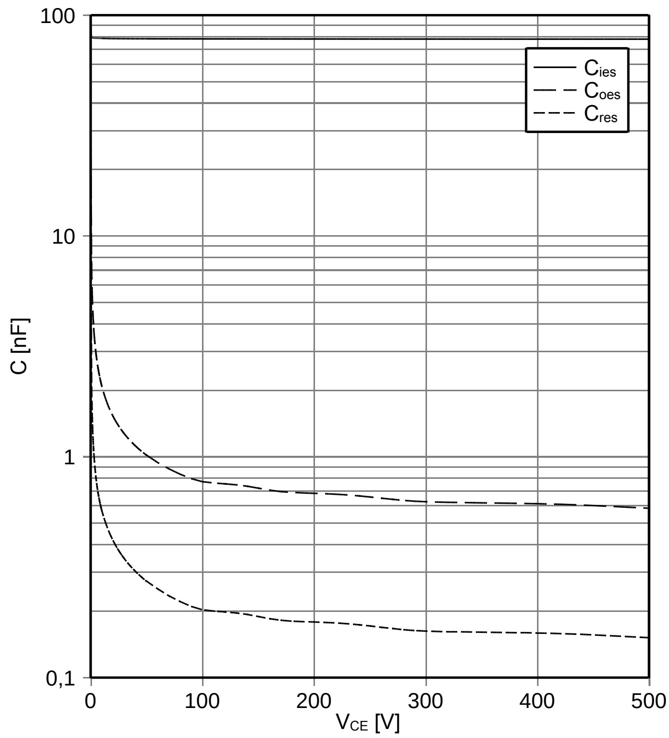
reverse bias safe operating area IGBT,Inverter (RBSOA)
$I_C = f(V_{CE})$
V_{GE} = +15V / -8V, R_{Goff} = 5,1 Ω, T_{vj} = 175°C



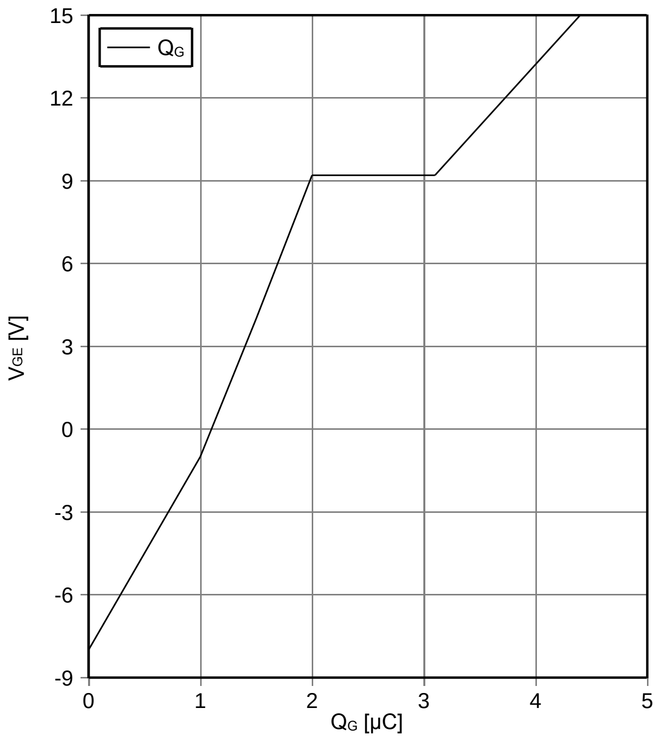
thermal impedance IGBT,Inverter
$R_{thJF} = f(\Delta V/\Delta t)$, cooler design according to AN-HPD-Assembly
Tf = 75°C; 50% water / 50% ethylenglycol



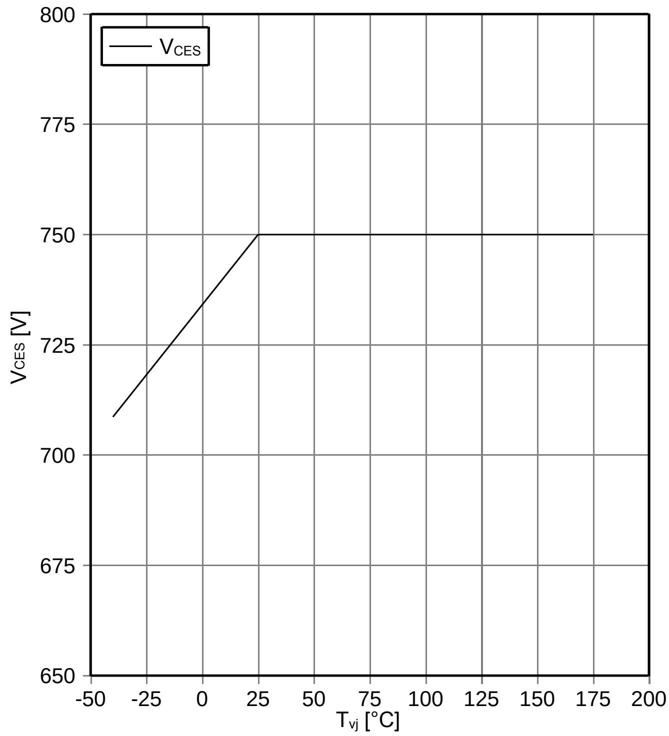
capacity characteristic IGBT,Inverter (typical)
$C = f(V_{CE})$
$V_{GE} = 0$ V, $T_{vj} = 25$°C, f = 1MHz



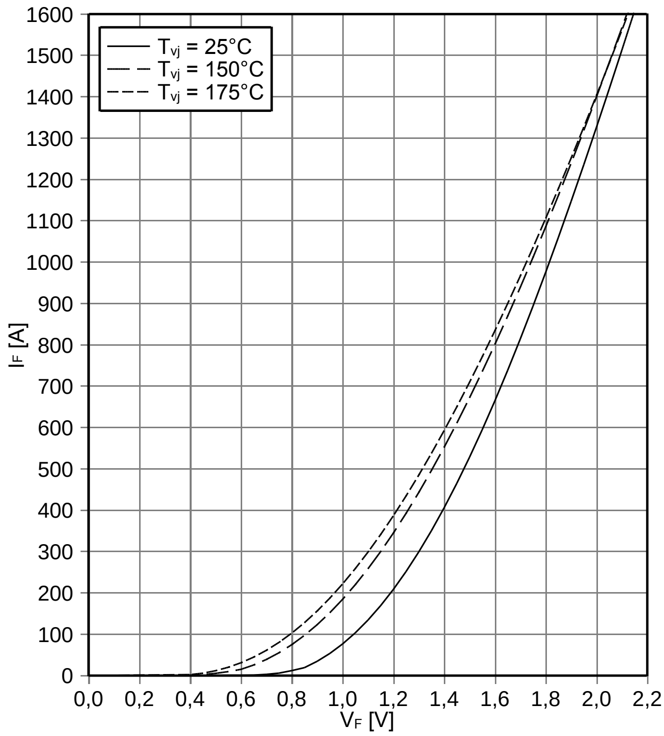
gate charge characteristic IGBT,Inverter (typical)
$V_{GE} = f(Q_G)$
$V_{CE} = 400$ V, $I_C = 450$ A, $T_{vj} = 25$°C



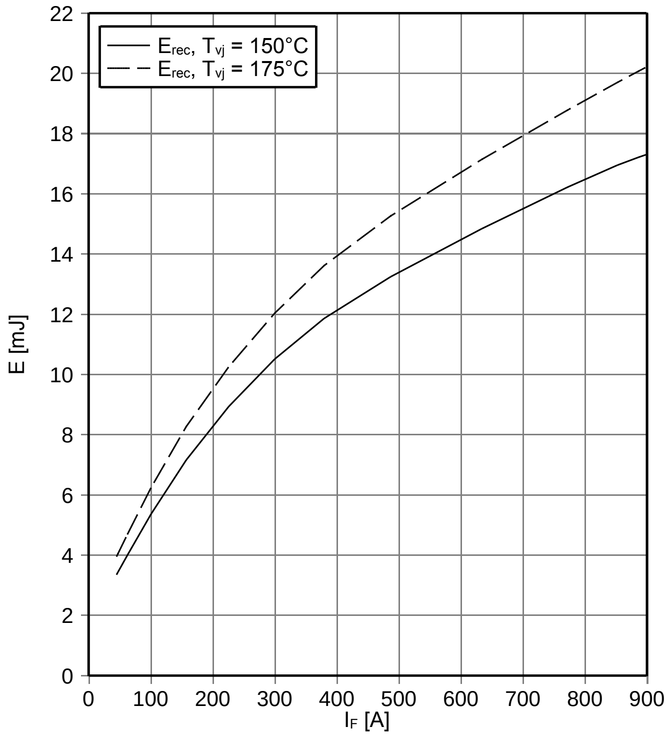
maximum allowed collector-emitter voltage
$V_{CES} = f(T_{vj})$, verified by characterization / design not by test
$I_{CES} = 1$ mA for $T_{vj} \leq 25$°C; $I_{CES} = 30$ mA for $T_{vj} > 25$°C



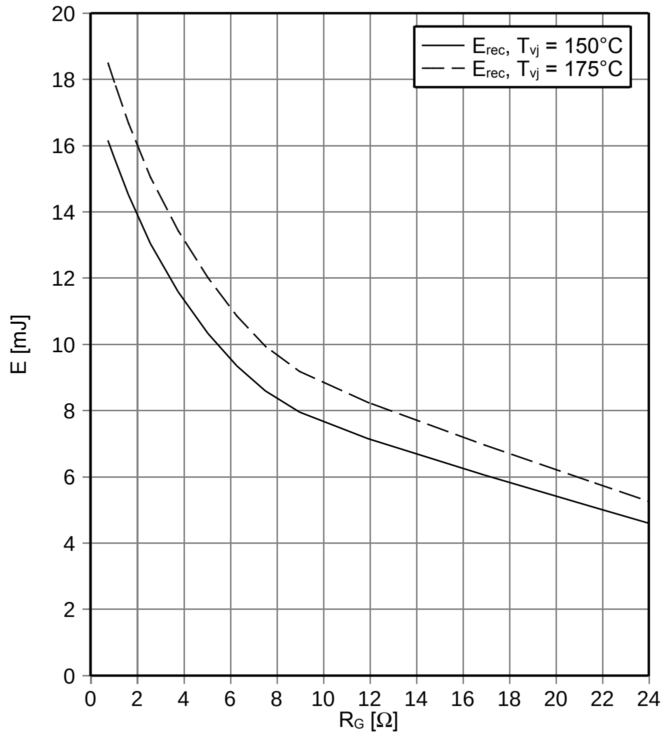
forward characteristic of Diode, Inverter (typical)
$I_F = f(V_F)$



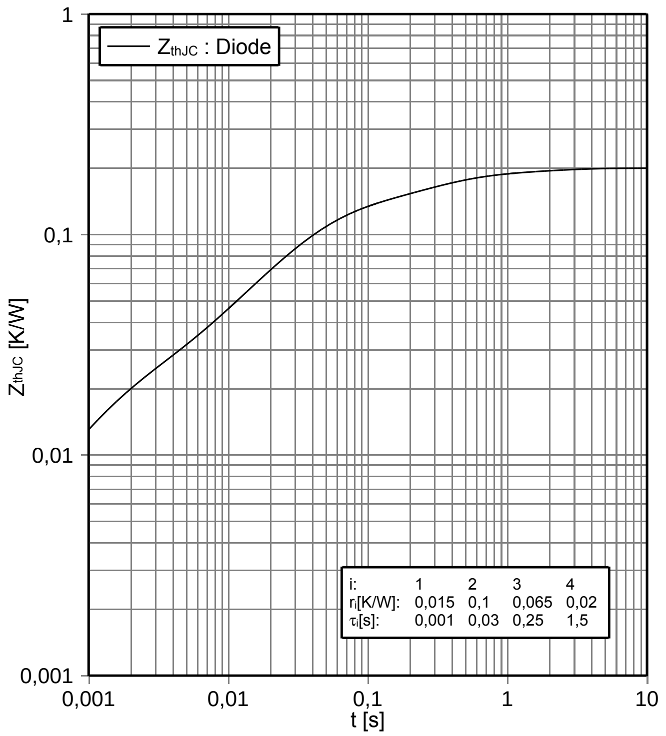
switching losses Diode, Inverter (typical)
$E_{rec} = f(I_F)$,
$R_{Gon} = 2.4\ \Omega$, $V_{CE} = 400$ V



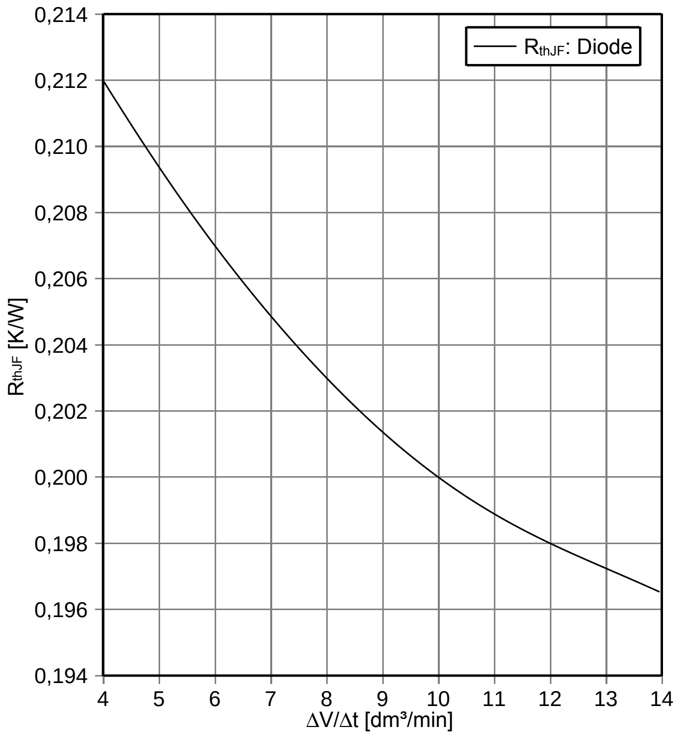
switching losses Diode, Inverter (typical)
$E_{rec} = f(R_G)$,
$I_F = 450$ A, $V_{CE} = 400$ V



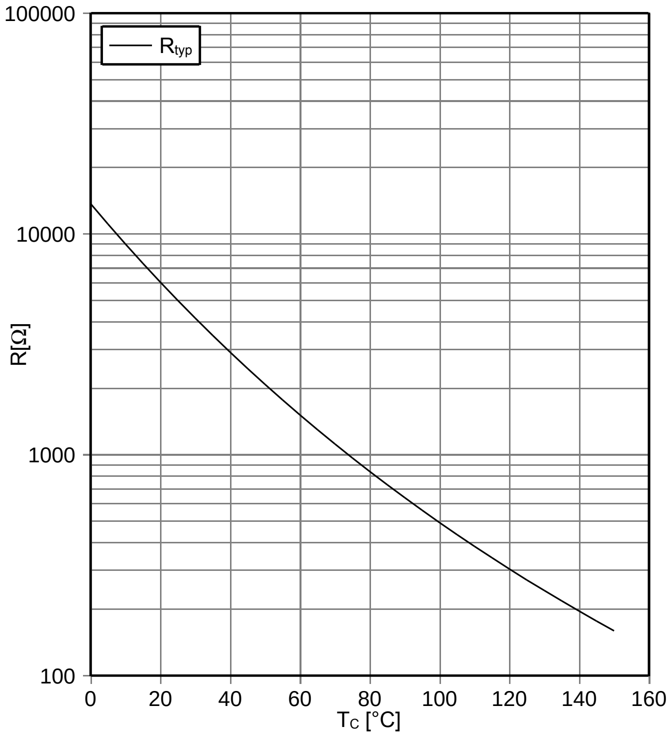
transient thermal impedance Diode, Inverter
$Z_{thJF} = f(t)$, cooler design according to AN-HPD-ASSEMBLY
$\Delta V/\Delta t$ = 10 dm³/min; Tf = 75°C; 50% water / 50% ethylenglycol



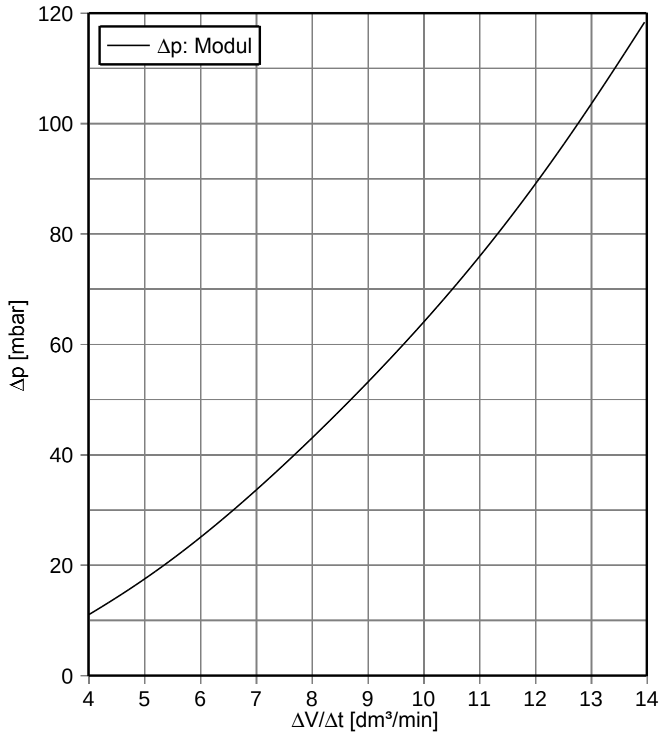
thermal impedance Diode, Inverter
$R_{thJF} = f(\Delta V/\Delta t)$, cooler design according to AN-HPD-ASSEMBLY
Tf = 75°C; 50% water / 50% ethylenglycol



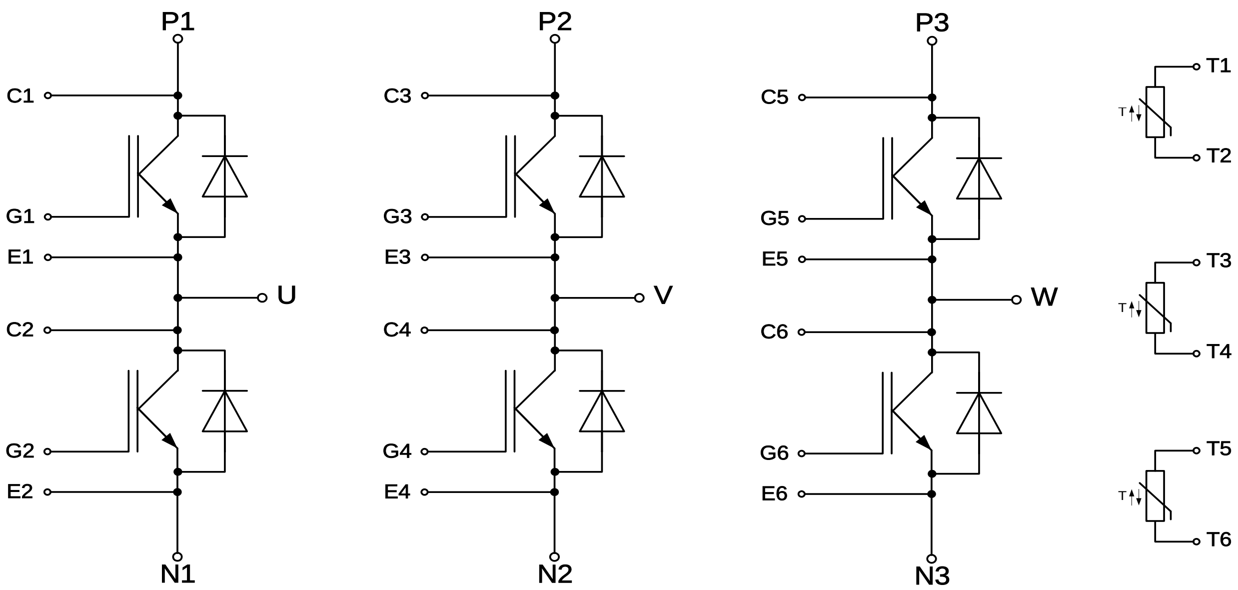
NTC-Thermistor-temperature characteristic (typical)
R = f (T)



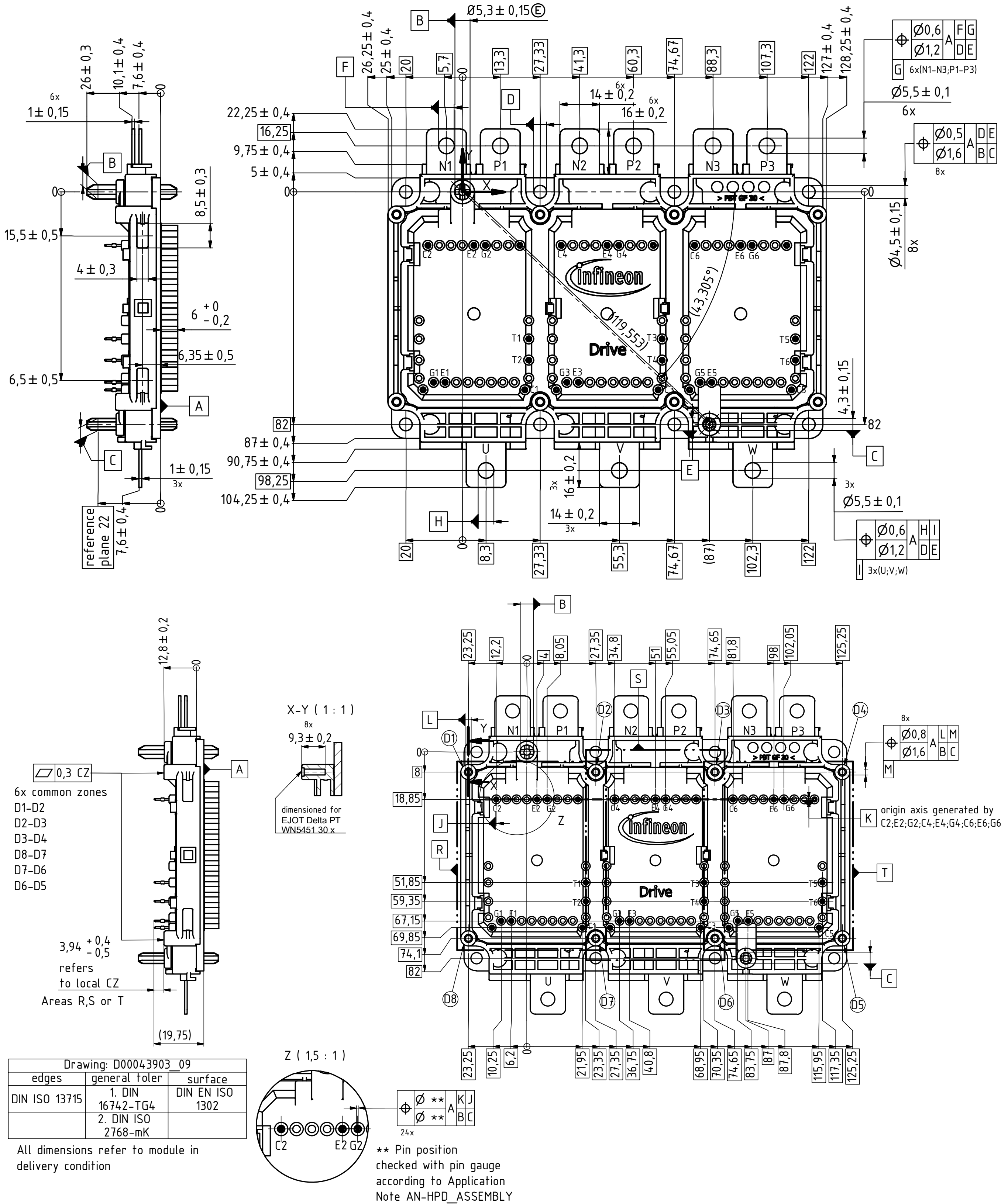
pressure drop in cooling circuit
Δp = f (ΔV/Δt), cooler design according to AN-HPD-ASSEMBLY
Tf = 75°C; 50% water / 50% ethylenglycol



7 Circuit diagram



8 Package outlines



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
V1.2	2016-01-14	Increased ICRM and minor revisions, based on FS660R08A6P2B revision 1.1
V2.0	2016-11-24	Preliminary datasheet 2.0
V3.0	2017-03-09	Final datasheet 3.0
V3.1	2019-10-10	Adjustment of package outlines. Correction of typing errors.

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