Infineon

HybridPACK™ DC6 Module

FS400R07A3E3_H6

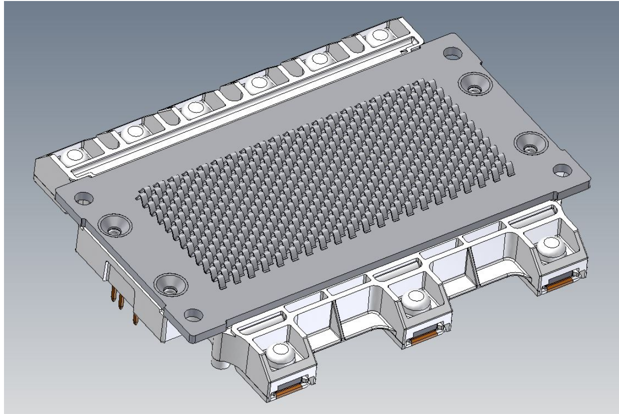
Final Data Sheet

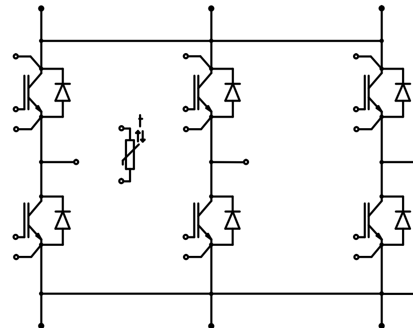
V3.1, 2019-12-19

Automotive High Power

1 Features / Description

HybridPACK™ DC6 module with Trench/Fieldstop IGBT3 and Emitter Controlled 3 diode and NTC





V_{CES} = 700 V
I_C = 400 A

Typical Applications

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

Electrical Features

- Low Switching Losses
- Low V_{CEsat}
- $T_{vj\ op}$ = 150°C
- V_{CEsat} with positive Temperature Coefficient
- Increased blocking voltage capability to 705V

Mechanical Features

- 2.5kV AC 1min Insulation
- Al_2O_3 Substrate with Low Thermal Resistance
- Direct Cooled Base Plate with Ribbon Bonds
- High mechanical robustness
- Integrated NTC temperature sensor
- Copper Base Plate
- RoHS compliant

Description

Infineon's HybridPACK™ DC6 with ribbon bonded cooling structures is a variant of the HybridPACK™ 1 power module family with increased continuous current capability and a reduced stray inductance. Like all HybridPACK™ 1 products the HybridPACK™ DC6 with ribbon bonds is an automotive qualified power module designed for electric vehicle applications. Designed for a 150°C junction operation temperature, with a 30 hour limited 175°C capacity the module accommodates a 3-phase Six-Pack configuration of Trench-Field-Stop IGBT3 and matching emitter controlled diodes. The HybridPACK™ DC6 power module family is built on Infineon's long time experience in the development of IGBT power modules, intense research efforts of new material combinations and assembly technologies. HybridPACK™ DC6 with ribbon bonds is suitable for direct liquid cooling. The copper base plate combined with high-performance ceramic substrate and Infineon's enhanced wire-bonding process provides unparalleled thermal and power cycling capabilityand highest reliability for mild hybrid inverter or generator applications. For a compact design the driver stage PCB can easily be soldered on top of the module. All power connections are realized with screw terminals.

Product Name	Ordering Code
FS400R07A3E3_H6	SP001632430

2 IGBT,Inverter

2.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
Collector-emitter voltage	T_{vj} = 25°C	V_{CES}	705	V
Continuous DC collector current	T_F = 75°C, $T_{vj\,max}$ = 175°C T_F = 25°C, $T_{vj\,max}$ = 175°C	$I_{C\,nom}$ I_C	400[1)] 500[1)]	A A
Repetitive peak collector current	t_P = 1 ms	I_{CRM}	800	A
Total power dissipation	T_F = 25°C, $T_{vj\,max}$ = 175°C	P_{tot}	811	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 = 400 A, V_{GE} = 15 V I_C = 400 A, V_{GE} = 15 V I_C = 400 A, V_{GE} = 15 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	$V_{CE\,sat}$		1.45 1.60 1.70	1.70	V
Gate threshold voltage	I_C = 6.40 mA, V_{CE} = V_{GE}	T_{vj} = 25°C	V_{GEth}	4.90	5.80	6.50	V
Gate charge	V_{GE} = -15 V ... 15 V		Q_G		4.30		µC
Internal gate resistor		T_{vj} = 25°C	R_{Gint}		1.0		Ω
Input capacitance	f = 1 MHz, V_{CE} = 25 V, V_{GE} = 0 V	T_{vj} = 25°C	C_{ies}		26.0		nF
Reverse transfer capacitance	f = 1 MHz, V_{CE} = 25 V, V_{GE} = 0 V	T_{vj} = 25°C	C_{res}		0.76		nF
Collector-emitter cut-off current	V_{CE} = 705 V, V_{GE} = 0 V	T_{vj} = 25°C	I_{CES}			0.1	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 = 400 A, V_{CE} = 300 V V_{GE} = ±15 V R_{Gon} = 1.8 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	$t_{d\,on}$		0.12 0.12 0.12		µs
Rise time, inductive load	I_C = 400 A, V_{CE} = 300 V V_{GE} = ±15 V R_{Gon} = 1.8 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	t_r		0.08 0.08 0.08		µs
Turn-off delay time, inductive load	I_C = 400 A, V_{CE} = 300 V V_{GE} = ±15 V R_{Goff} = 1.8 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	$t_{d\,off}$		0.36 0.40 0.40		µs
Fall time, inductive load	I_C = 400 A, V_{CE} = 300 V V_{GE} = ±15 V R_{Goff} = 1.8 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	t_f		0.02 0.03 0.03		µs
Turn-on energy loss per pulse	I_C = 400 A, V_{CE} = 300 V, L_S = 25 nH V_{GE} = ±15 V, di/dt = 5500 A/µs (T_{vj} = 150°C) R_{Gon} = 1.8 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	E_{on}		5.10 6.80 7.30		mJ
Turn-off energy loss per pulse	I_C = 400 A, V_{CE} = 300 V, L_S = 25 nH V_{GE} = ±15 V, du/dt = 3000 V/µs (T_{vj} = 150°C) R_{Goff} = 1.8 Ω	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	E_{off}		9.10 12.0 12.5		mJ
SC data	$V_{GE} \leq$ 15 V, V_{CC} = 360 V V_{CEmax} = V_{CES} -L_{sCE} ·di/dt	$t_P \leq$ 8 µs, T_{vj} = 25°C $t_P \leq$ 6 µs, T_{vj} = 150°C	I_{SC}		2800 2000		A
Thermal resistance, junction to cooling fluid	per IGBT; ΔV/Δt = 10 dm³/min		R_{thJF}		0.170	0.185	K/W
Temperature under switching conditions	t_{op} continuous		$T_{vj\,op}$	-40		150	°C

[1)] DC-collector current limited by power terminals.

3 Diode, Inverter

3.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
Repetitive peak reverse voltage	T_{vj} = 25°C	V_{RRM}	705	V
Continuous DC forward current		I_F	400[1)]	A
Repetitive peak forward current	t_P = 1 ms	I_{FRM}	800	A
I²t - 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	I²t	8800 8500	A²s A²s

3.2 Characteristic Values

				min.	typ.	max.	
Forward voltage	I_F = 400 A, V_{GE} = 0 V I_F = 400 A, V_{GE} = 0 V I_F = 400 A, V_{GE} = 0 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	V_F		1.55 1.50 1.45	1.95	V
Peak reverse recovery current	I_F = 400 A, - di_F/dt = 5500 A/µs (T_{vj} = 150°C) V_R = 300 V V_{GE} = -15 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	I_{RM}		205 295 305		A
Recovered charge	I_F = 400 A, - di_F/dt = 5500 A/µs (T_{vj} = 150°C) V_R = 300 V V_{GE} = -15 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	Q_r		15.0 32.0 34.0		µC
Reverse recovery energy	I_F = 400 A, - di_F/dt = 5500 A/µs (T_{vj} = 150°C) V_R = 300 V V_{GE} = -15 V	T_{vj} = 25°C T_{vj} = 125°C T_{vj} = 150°C	E_{rec}		3.35 6.90 8.10		mJ
Thermal resistance, junction to cooling fluid	per diode; ΔV/Δt = 10 dm³/min		R_{thJF}		0.270	0.300	K/W
Temperature under switching conditions	t_{op} continuous		$T_{vj\,op}$	-40		150	°C

4 NTC-Thermistor

Parameter	Conditions	Symbol	Value min.	Value typ.	Value 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)] DC-collector current limited by power terminals.

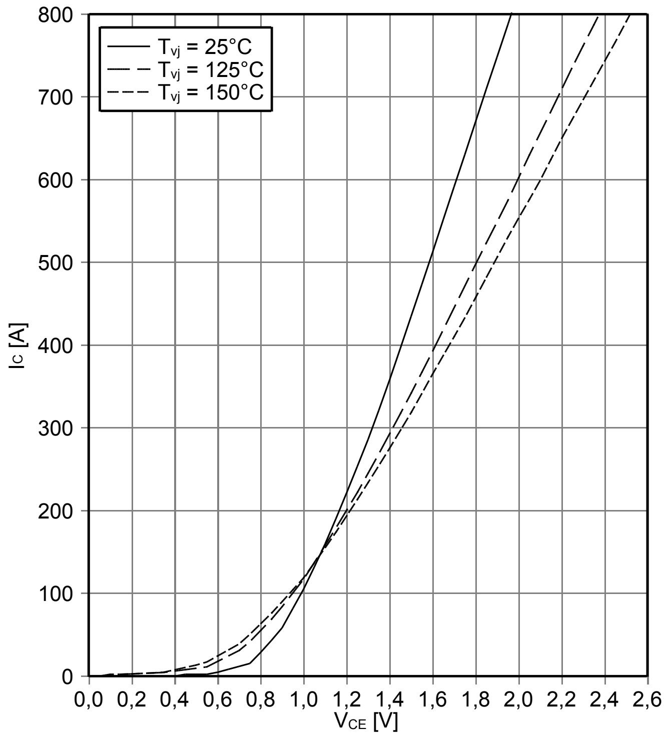
5 Module

Parameter	Conditions	Symbol	Value			Unit
Isolation test voltage	RMS, f = 50 Hz, t = 1 min.	V_{ISOL}	2.5			kV
Maximum RMS module terminal current	T_F = 25°C, T_{Ct} = 150°C	I_{tRMS}	320[1]			A
Material of module baseplate			Cu			
Internal isolation	basic insulation (class 1, IEC 61140)		Al_2O_3			
Creepage distance	terminal to heatsink terminal to terminal	d_{Creep}	12.0 6.1			mm
Clearance	terminal to heatsink terminal to terminal	d_{Clear}	12.0 6.1			mm
Comperative tracking index		CTI	> 200			
			min.	typ.	max.	
Pressure drop in cooling circuit	$\Delta V/\Delta t$ = 10.0 dm³/min; T_F = 25°C	Δp		100		mbar
Maximum pressure in cooling circuit		p			2.0	bar
Stray inductance module		L_{sCE}		15		nH
Module lead resistance, terminals - chip	T_F = 25 °C, per switch	$R_{CC'+EE'}$		1.00		mΩ
Storage temperature		T_{stg}	-40		125	°C
Mounting torque for modul mounting	Screw M5 baseplate to heatsink	M	3.00		6.00	Nm
Terminal connection torque	Screw M6	M	3.0	-	6.0	Nm
Weight		G		515		g

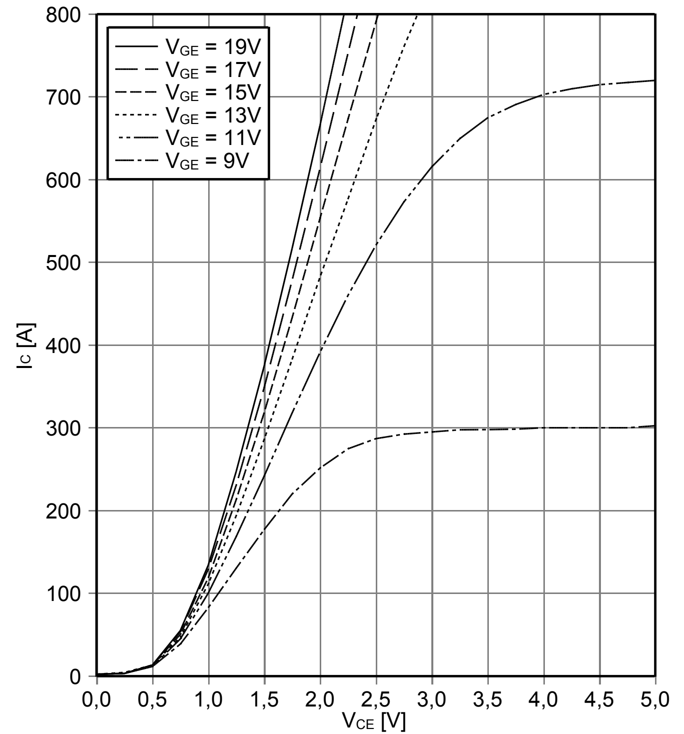
[1] DC-collector current limited by internal busbar

6 Characteristics Diagrams

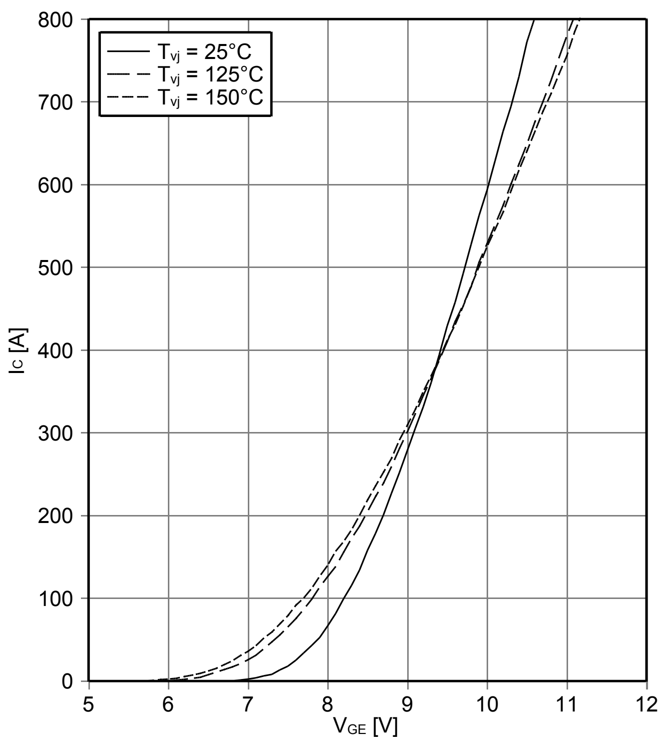
output characteristic IGBT,Inverter (typical)
$I_C = f(V_{CE})$
$V_{GE} = 15$ V



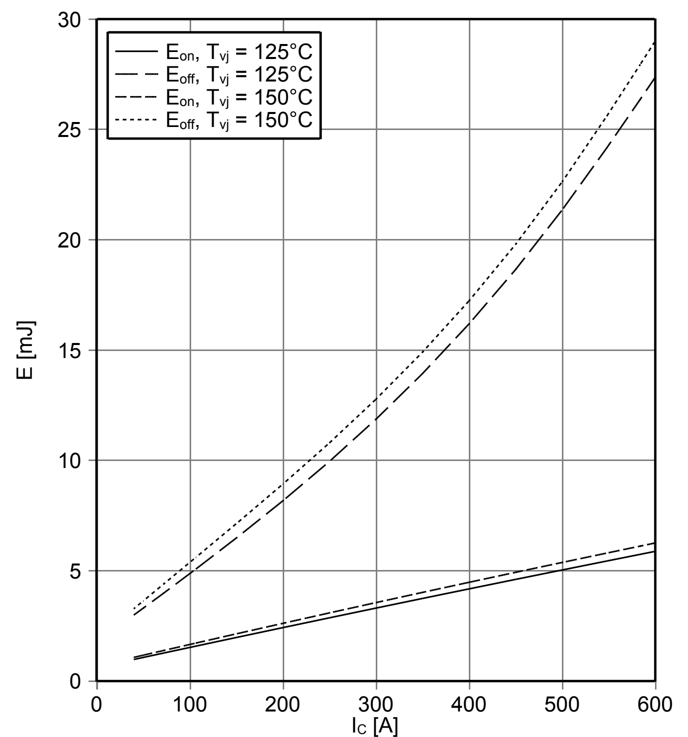
output characteristic IGBT,Inverter (typical)
$I_C = f(V_{CE})$
$T_{vj} = 150°C$



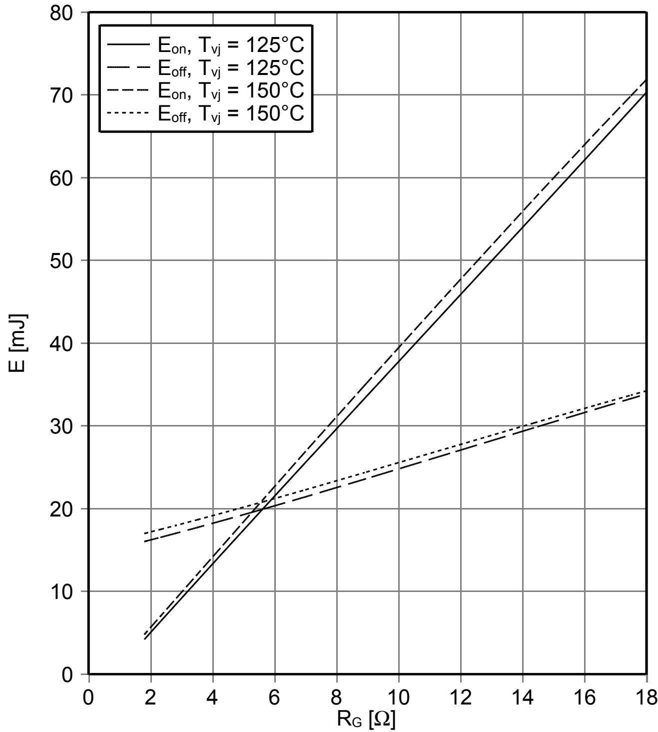
transfer characteristic IGBT,Inverter (typical)
$I_C = f(V_{GE})$
$V_{CE} = 20$ V



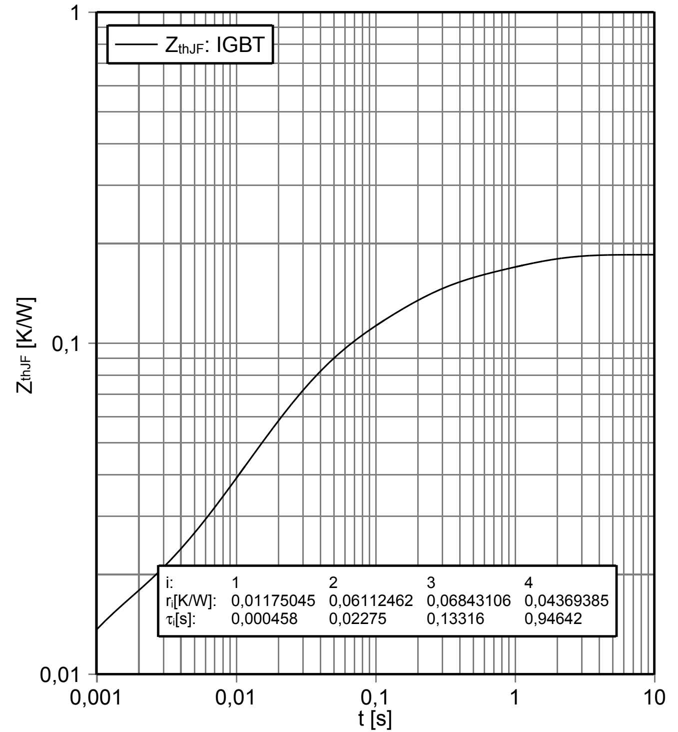
switching losses IGBT,Inverter (typical)
$E_{on} = f(I_C)$, $E_{off} = f(I_C)$
$V_{GE} = \pm 15$ V, $R_{Gon} = 1.8\ \Omega$, $R_{Goff} = 1.8\ \Omega$, $V_{CE} = 300$ V



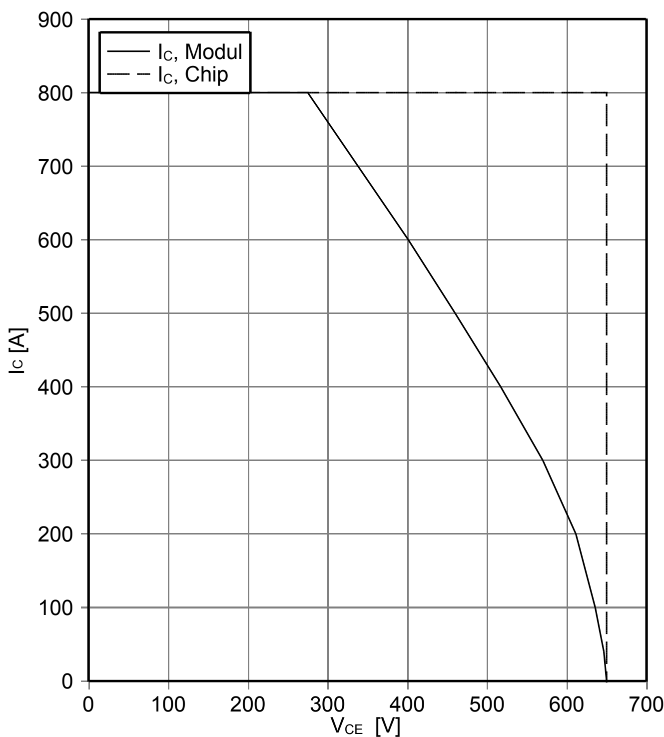
switching losses IGBT,Inverter (typical)
E_{on} = f (R_G), E_{off} = f (R_G)
V_{GE} = ±15 V, I_C = 400 A, V_{CE} = 300 V



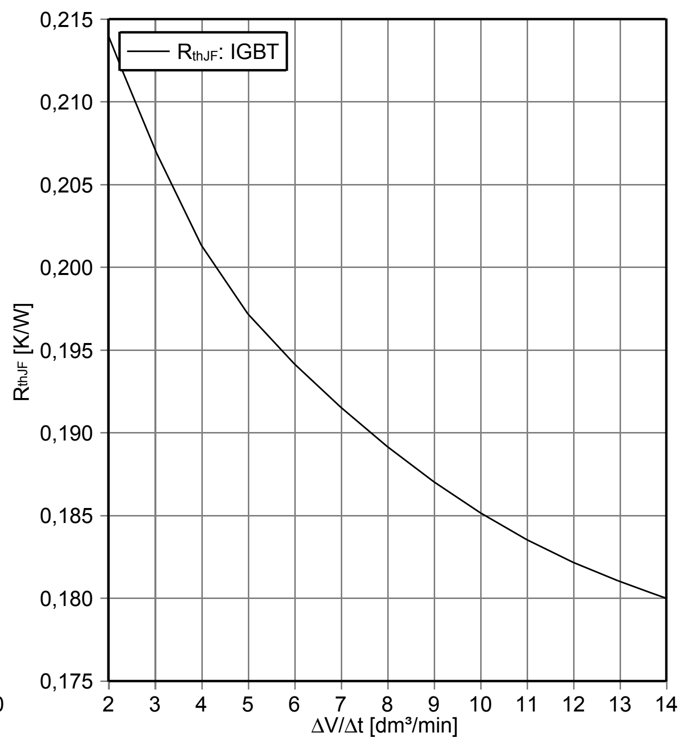
transient thermal impedance IGBT,Inverter
Z_{thJF} = f (t) (ΔV/Δt=10 dm³/min)



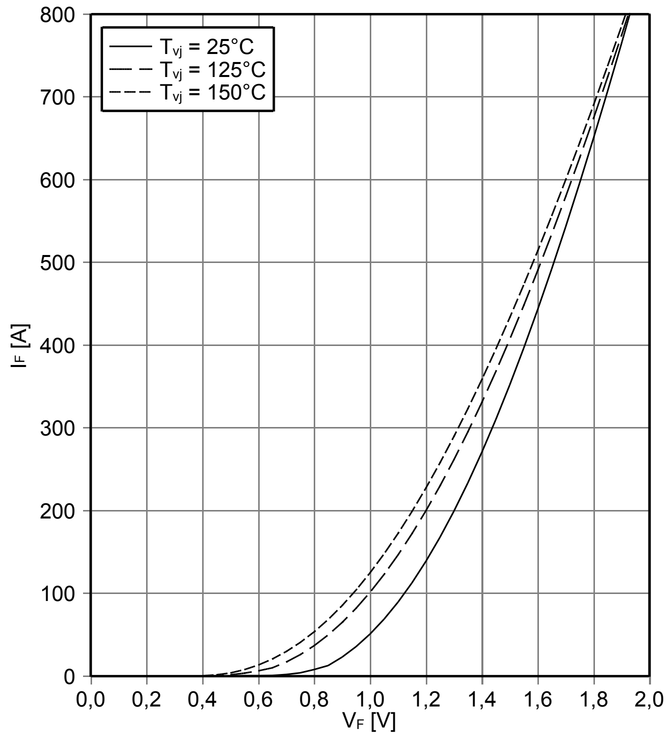
reverse bias safe operating area IGBT,Inverter (RBSOA)
I_C = f (V_{CE})
V_{GE} = ±15 V, R_{Goff} = 1.8 Ω, T_{vj} = 150°C



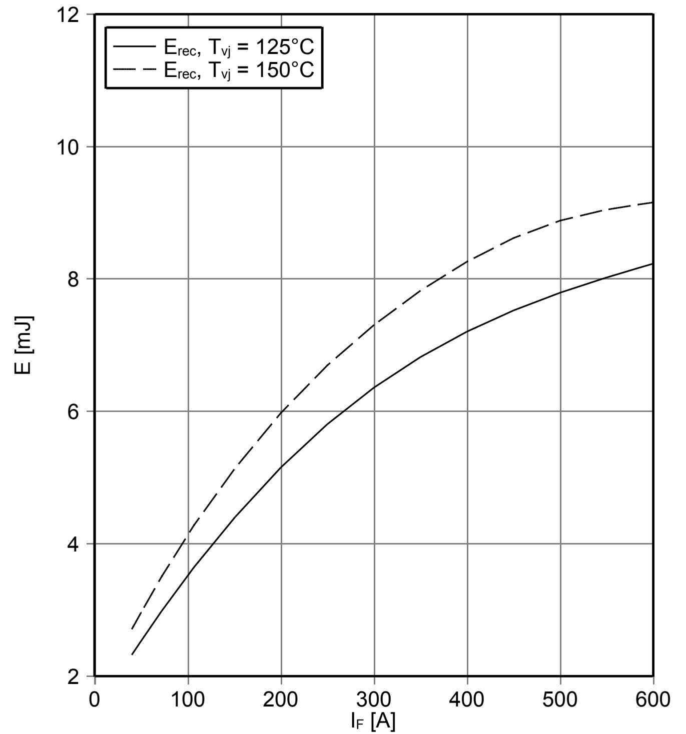
thermal impedance IGBT,Inverter
R_{thJF} = f (ΔV/Δt)
cooling fluid = 50% water/50% ethylenglycol



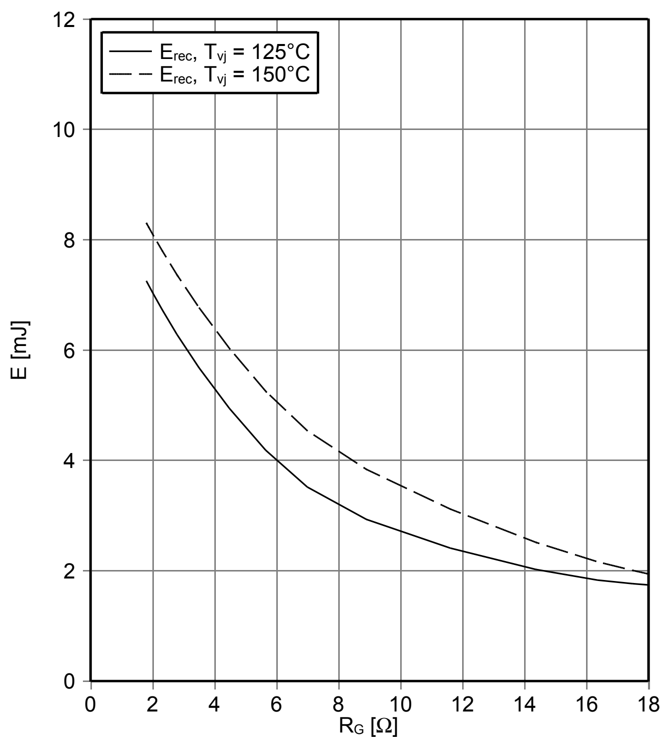
forward characteristic of Diode, Inverter (typical)
$I_F = f(V_F)$



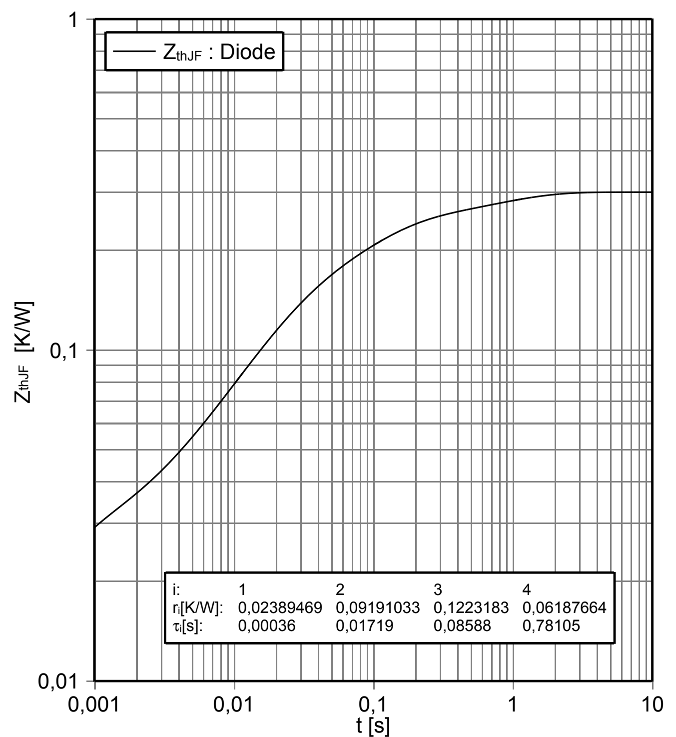
switching losses Diode, Inverter (typical)
$E_{rec} = f(I_F)$
R_{Gon} = 1.8 Ω, V_{CE} = 300 V



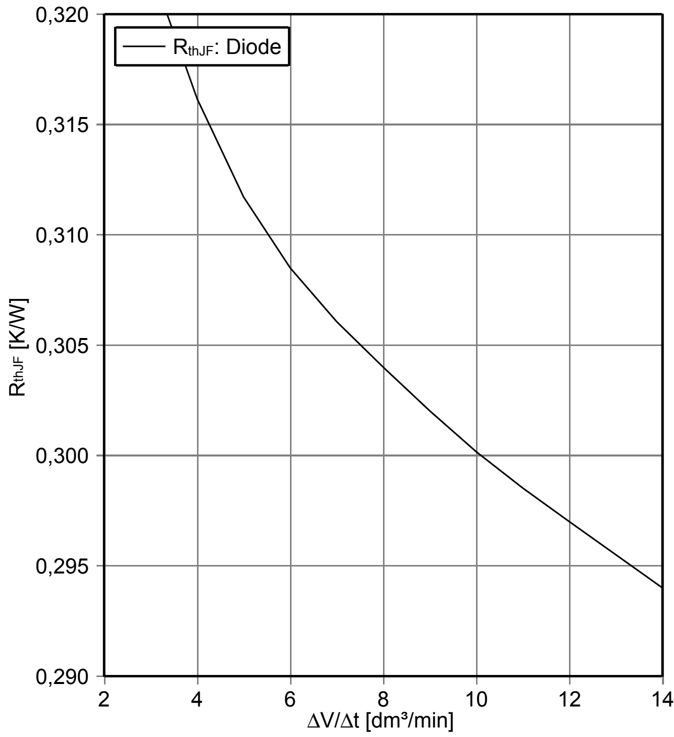
switching losses Diode, Inverter (typical)
$E_{rec} = f(R_G)$
I_F = 400 A, V_{CE} = 300 V



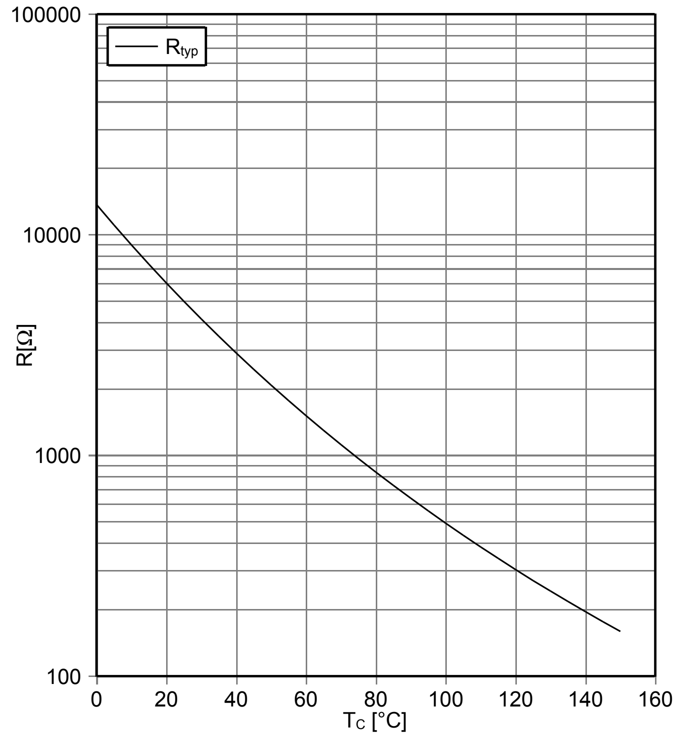
transient thermal impedance Diode, Inverter
$Z_{thJF} = f(t)$ (ΔV/Δt=10 dm³/min)



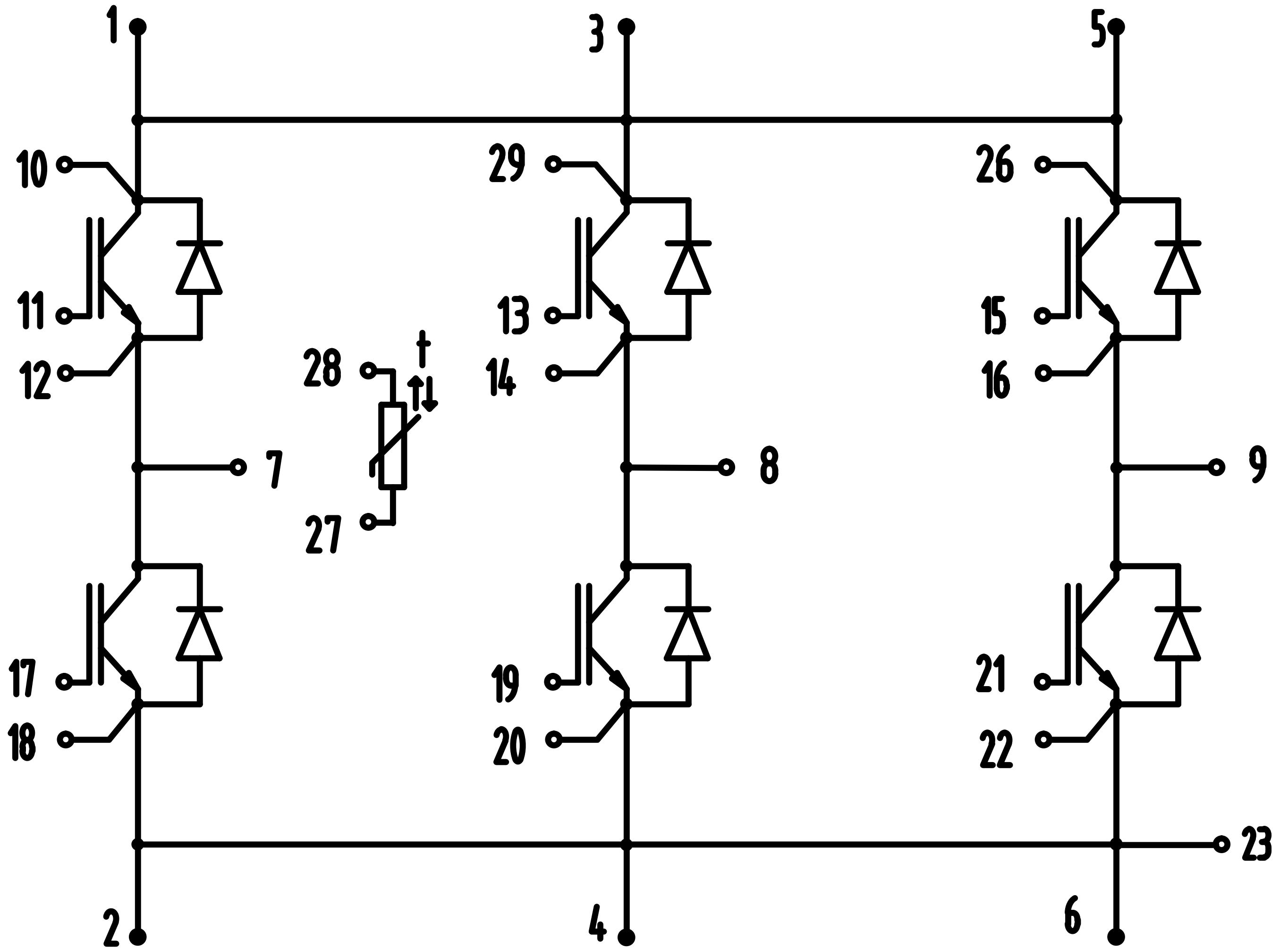
thermal impedance Diode, Inverter
R_{thJF} = f ($\Delta V/\Delta t$)
cooling fluid = 50% water/50% ethylenglycol



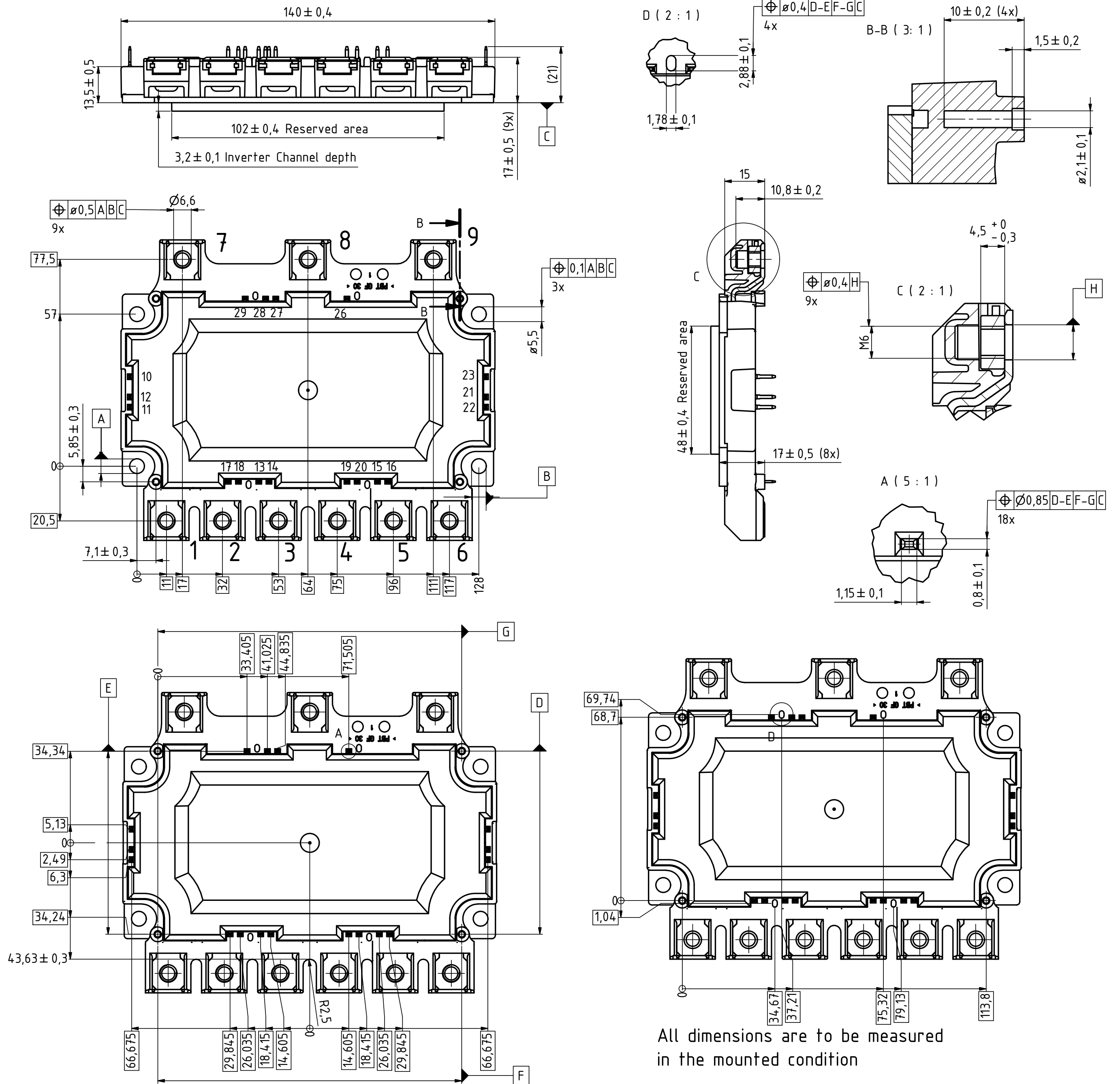
NTC-Thermistor-temperature characteristic (typical)
R = f (T)



7 Circuit diagram

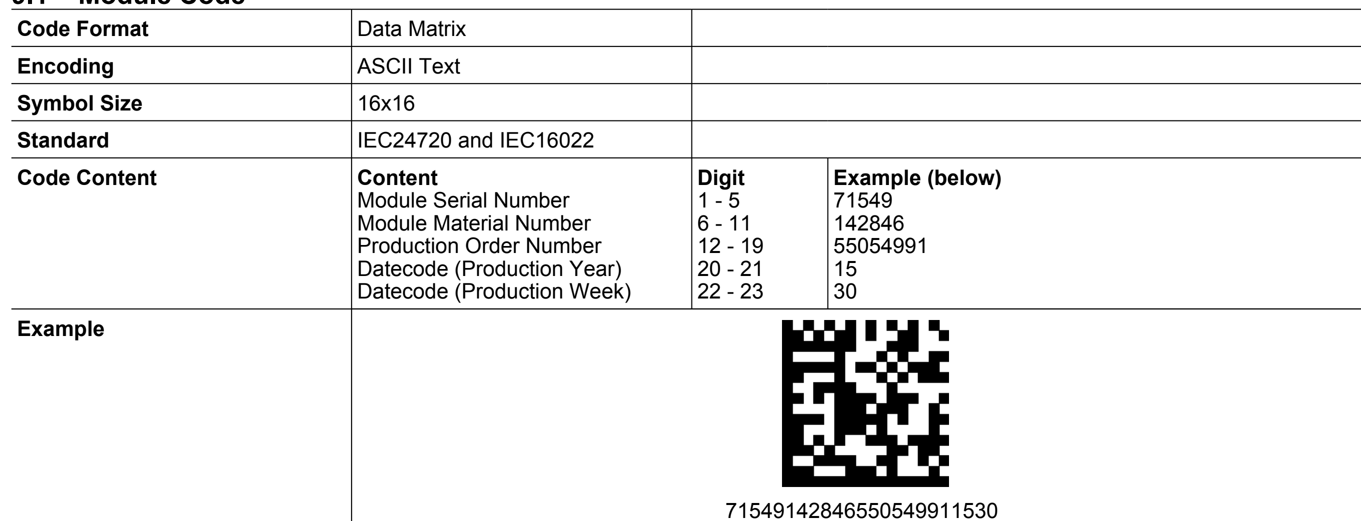


8 Package outlines



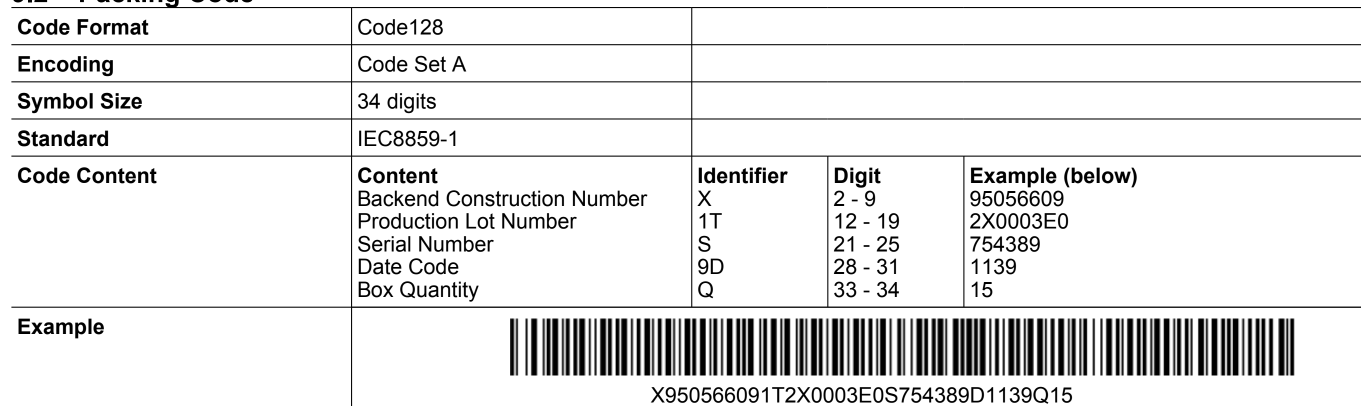
9 Label Codes

9.1 Module Code



Code Format	Data Matrix		
Encoding	ASCII Text		
Symbol Size	16x16		
Standard	IEC24720 and IEC16022		
Code Content	**Content**	**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	2017-04-06	-
V2.0	2018-01-15	-
V3.0	2018-03-26	Final datasheet
V3.1	2019-12-19	Correction of mechanical feature

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