

# HybridPACK™ 2 Module

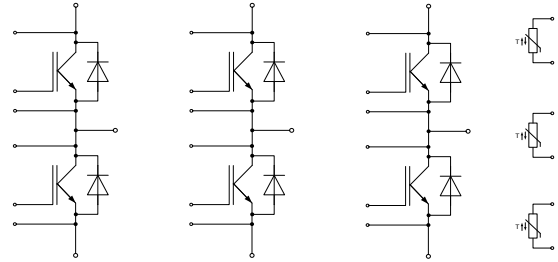
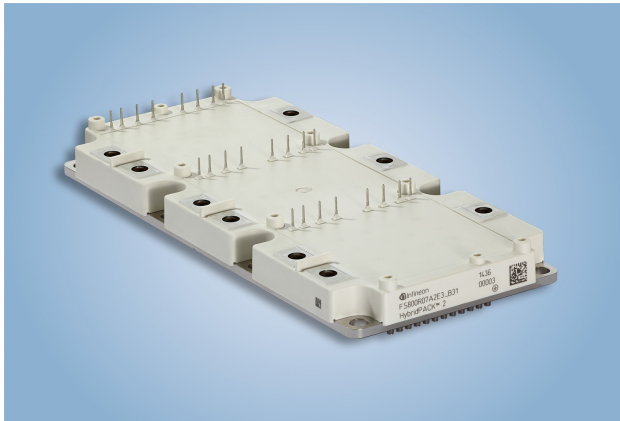
FS900R08A2P2\_B31

## Final Data Sheet

V3.2, 2017-08-30

Automotive High Power

## 1 Features / Description



$V_{CES} = 750V$   
 $I_{C\ nom} = 900A$

### Typical Applications

- Automotive Applications
- Hybrid Electrical Vehicles (H)EV
- Commercial Agriculture Vehicles
- Motor Drives
- Optimized for automotive applications with DC link voltages up to 450 V

### Electrical Features

- $V_{CESat}$  with positive Temperature Coefficient
- Low  $V_{CESat}$
- Low Switching Losses
- Low  $Q_g$  and  $C_{res}$
- Low Inductive Design
- $T_{vj\ op} = 150^\circ C$
- Short-time extended Operation Temperature  
 $T_{vj\ op} = 175^\circ C$

### Mechanical Features

- 2.5kV AC 1min Insulation
- Direct Cooled PinFin Base Plate
- High Power Density
- Integrated NTC temperature sensor
- Copper Base Plate
- Isolated Base Plate
- RoHS compliant

Product Name	Ordering Code
FS900R08A2P2_B31	-

## 2 IGBT, Inverter

### 2.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
Collector-emitter voltage	$T_{vj} = 25^{\circ}\text{C}$	$V_{CES}$	750	V
Implemented collector current		$I_{CN}$	900	A
Continuous DC collector current	$T_F = 105^{\circ}\text{C}$ , $T_{vj\max} = 175^{\circ}\text{C}$	$I_{C\text{nom}}$	550	A
Repetitive peak collector current	$t_p = 1\text{ ms}$	$I_{CRM}$	1800	A
Total power dissipation	$T_F = 25^{\circ}\text{C}$ , $T_{vj\max} = 175^{\circ}\text{C}$	$P_{\text{tot}}$	1546	W
Gate-emitter peak voltage		$V_{GES}$	+/-20	V

### 2.2 Characteristic Values

Parameter	Conditions	Symbol	min. typ. max.			Unit	
Collector-emitter saturation voltage	$I_C = 550\text{ A}$ , $V_{GE} = 15\text{ V}$ $I_C = 550\text{ A}$ , $V_{GE} = 15\text{ V}$ $I_C = 550\text{ A}$ , $V_{GE} = 15\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$V_{CE\text{sat}}$	1.10 1.10 1.10	1.25	V	
Gate threshold voltage	$I_C = 13.0\text{ mA}$ , $V_{CE} = V_{GE}$	$T_{vj} = 25^{\circ}\text{C}$	$V_{GE\text{th}}$	4.90	5.80	6.50	V
Gate charge	$V_{GE} = -8\text{ V} \dots 15\text{ V}$ , $V_{CE} = 400\text{ V}$		$Q_G$	5.80		$\mu\text{C}$	
Internal gate resistor		$T_{vj} = 25^{\circ}\text{C}$	$R_{G\text{int}}$	0.5		$\Omega$	
Input capacitance	$f = 1\text{ MHz}$ , $V_{CE} = 25\text{ V}$ , $V_{GE} = 0\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$	$C_{\text{ies}}$	105		nF	
Reverse transfer capacitance	$f = 1\text{ MHz}$ , $V_{CE} = 25\text{ V}$ , $V_{GE} = 0\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$	$C_{\text{res}}$	0.50		nF	
Collector-emitter cut-off current	$V_{CE} = 450\text{ V}$ , $V_{GE} = 0\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$	$I_{CES}$		0.5	mA	
Gate-emitter leakage current	$V_{CE} = 0\text{ V}$ , $V_{GE} = 20\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$	$I_{GES}$		400	nA	
Turn-on delay time, inductive load	$I_C = 550\text{ A}$ , $V_{CE} = 400\text{ V}$ $V_{GE} = -8\text{ V} / +15\text{ V}$ $R_{G\text{on}} = 3.3\ \Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$t_{d\text{on}}$	0.39 0.39 0.39		$\mu\text{s}$	
Rise time, inductive load	$I_C = 550\text{ A}$ , $V_{CE} = 400\text{ V}$ $V_{GE} = -8\text{ V} / +15\text{ V}$ $R_{G\text{on}} = 3.3\ \Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$t_r$	0.09 0.11 0.11		$\mu\text{s}$	
Turn-off delay time, inductive load	$I_C = 550\text{ A}$ , $V_{CE} = 400\text{ V}$ $V_{GE} = -8\text{ V} / +15\text{ V}$ $R_{G\text{off}} = 2.0\ \Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$t_{d\text{off}}$	0.63 0.71 0.74		$\mu\text{s}$	
Fall time, inductive load	$I_C = 550\text{ A}$ , $V_{CE} = 400\text{ V}$ $V_{GE} = -8\text{ V} / +15\text{ V}$ $R_{G\text{off}} = 2.0\ \Omega$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$t_f$	0.06 0.08 0.08		$\mu\text{s}$	
Turn-on energy loss per pulse	$I_C = 550\text{ A}$ , $V_{CE} = 400\text{ V}$ , $L_S = 20\text{ nH}$ $V_{GE} = -8\text{ V} / +15\text{ V}$ $R_{G\text{on}} = 3.3\ \Omega$ $di/dt (T_{vj} = 150^{\circ}\text{C}) = 4100\text{ A}/\mu\text{s}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$E_{\text{on}}$	21.0 29.0 30.5		mJ	
Turn-off energy loss per pulse	$I_C = 550\text{ A}$ , $V_{CE} = 400\text{ V}$ , $L_S = 20\text{ nH}$ $V_{GE} = -8\text{ V} / +15\text{ V}$ $R_{G\text{off}} = 2.0\ \Omega$ $dv/dt (T_{vj} = 150^{\circ}\text{C}) = 2600\text{ V}/\mu\text{s}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$E_{\text{off}}$	27.5 36.0 38.5		mJ	
SC data	$V_{GE} \leq 15\text{ V}$ , $V_{CC} = 400\text{ V}$ $V_{CE\text{max}} = V_{CES} - L_{S\text{CE}} \cdot di/dt$ $t_p \leq 4\ \mu\text{s}$ , $T_{vj} = 150^{\circ}\text{C}$		$I_{SC}$	4500		A	
Thermal resistance, junction to cooling fluid	per IGBT; $\Delta V/\Delta t = 10\text{ dm}^3/\text{min}$		$R_{\text{thJF}}$		0.097	K/W	
Temperature under switching conditions	$t_{op}$ continuous $t_{op\max}$ 30h over life time, for 10s within period of 10min		$T_{vj\text{op}}$	-40 150	150 175	$^{\circ}\text{C}$	

### 3 Diode, Inverter

#### 3.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
Repetitive peak reverse voltage	$T_{vj} = 25^{\circ}\text{C}$	$V_{RRM}$	750	V
Implemented forward current		$I_{FN}$	860	A
Continuous DC forward current		$I_F$	550	A
Repetitive peak forward current	$t_p = 1 \text{ ms}$	$I_{FRM}$	1720	A
$I^2t$ - value	$V_R = 0 \text{ V}, t_p = 10 \text{ ms}, T_{vj} = 125^{\circ}\text{C}$ $V_R = 0 \text{ V}, t_p = 10 \text{ ms}, T_{vj} = 150^{\circ}\text{C}$	$I^2t$	19500 19000	$\text{A}^2\text{s}$ $\text{A}^2\text{s}$

#### 3.2 Characteristic Values

Parameter	Conditions	Symbol	min. typ. max.			Unit	
Forward voltage	$I_F = 550 \text{ A}, V_{GE} = 0 \text{ V}$ $I_F = 550 \text{ A}, V_{GE} = 0 \text{ V}$ $I_F = 550 \text{ A}, V_{GE} = 0 \text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$V_F$		1.40 1.30 1.25	1.65	V
Peak reverse recovery current	$I_F = 550 \text{ A}, -di_F/dt = 4100 \text{ A}/\mu\text{s} (T_{vj} = 150^{\circ}\text{C})$ $V_R = 400 \text{ V}$ $V_{GE} = -8 \text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$I_{RM}$		265 385 420		A
Recovered charge	$I_F = 550 \text{ A}, -di_F/dt = 4100 \text{ A}/\mu\text{s} (T_{vj} = 150^{\circ}\text{C})$ $V_R = 400 \text{ V}$ $V_{GE} = -8 \text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$Q_r$		23.0 49.5 58.5		$\mu\text{C}$
Reverse recovery energy	$I_F = 550 \text{ A}, -di_F/dt = 4100 \text{ A}/\mu\text{s} (T_{vj} = 150^{\circ}\text{C})$ $V_R = 400 \text{ V}$ $V_{GE} = -8 \text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$E_{rec}$		7.20 15.0 17.5		mJ
Thermal resistance, junction to cooling fluid	per diode; $\Delta V/\Delta t = 10 \text{ dm}^3/\text{min}$		$R_{thJF}$			0.125	K/W
Temperature under switching conditions	$t_{op}$ continuous $t_{op \text{ max}}$ 30h over life time, for 10s within period of 10min		$T_{vj \text{ op}}$	-40 150		150 175	$^{\circ}\text{C}$

### 4 NTC-Thermistor

Parameter	Conditions	Symbol	min. typ. max.			Unit
Rated resistance	$T_C = 25^{\circ}\text{C}$	$R_{25}$		5.00		$\text{k}\Omega$
Deviation of $R_{100}$	$T_C = 100^{\circ}\text{C}, R_{100} = 493 \Omega$	$\Delta R/R$	5		5	%
Power dissipation	$T_C = 25^{\circ}\text{C}$	$P_{25}$			20.0	mW
B-value	$R_2 = R_{25} \exp [B_{25/50}(1/T_2 - 1/(298,15 \text{ K}))]$	$B_{25/50}$		3375		K
B-value	$R_2 = R_{25} \exp [B_{25/80}(1/T_2 - 1/(298,15 \text{ K}))]$	$B_{25/80}$		3411		K
B-value	$R_2 = R_{25} \exp [B_{25/100}(1/T_2 - 1/(298,15 \text{ K}))]$	$B_{25/100}$		3433		K

Specification according to the valid application note.

## 5 Module

Parameter	Conditions	Symbol	Value			Unit
			min.	typ.	max.	
Isolation test voltage	RMS, f = 50 Hz, t = 1 min.	V <sub>ISOL</sub>	2.5			kV
Material of module baseplate			Cu			
Internal isolation	basic insulation (class 1, IEC 61140)		Al <sub>2</sub> O <sub>3</sub>			
Creepage distance	terminal to heatsink	d <sub>Creep</sub>	7.0			mm
	terminal to terminal		5.5			
Clearance	terminal to heatsink	d <sub>Clear</sub>	7.0			mm
	terminal to terminal		5.0			
Comperative tracking index		CTI	> 200			
Pressure drop in cooling circuit	$\Delta V/\Delta t = 10.0 \text{ dm}^3/\text{min}; T_F = 25^\circ\text{C}$	$\Delta p$		119		mbar
Maximum pressure in cooling circuit		p			2.5	bar
Stray inductance module		L <sub>sCE</sub>		14		nH
Module lead resistance, terminals - chip	T <sub>F</sub> = 25 °C, per switch	R <sub>CC'+EE'</sub>		0.80		mΩ
Storage temperature		T <sub>stg</sub>	-40		125	°C
Mounting torque for modul mounting	Screw M6 baseplate to heatsink	M	3.00		6.00	Nm
Terminal connection torque	Screw M6	M	2.5	-	5.0	Nm
Weight		G		1340		g

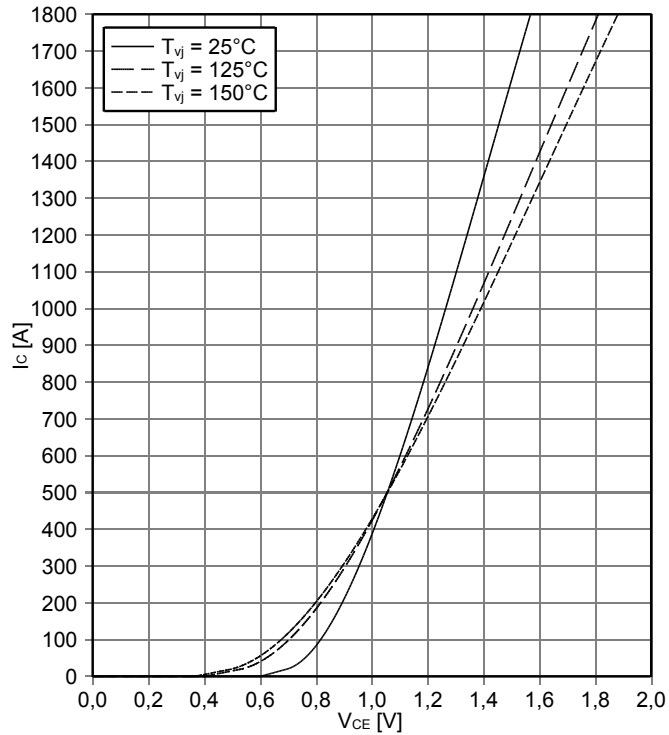
\* Kühleraufbau gemäß gültiger Application Note.

\* Cooler setup according to the valid application note.

## 6 Characteristics Diagrams

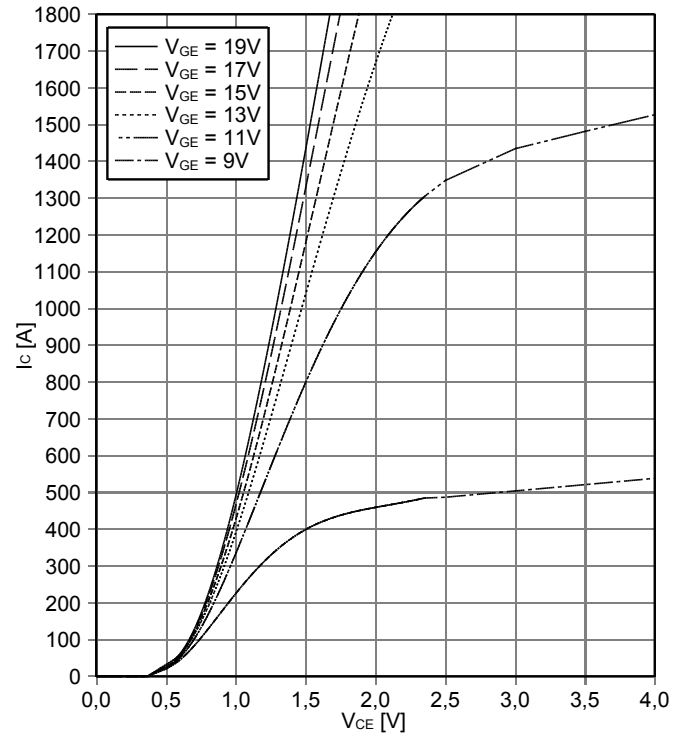
output characteristic IGBT, Inverter (typical)

$I_C = f(V_{CE})$   
 $V_{GE} = 15\text{ V}$



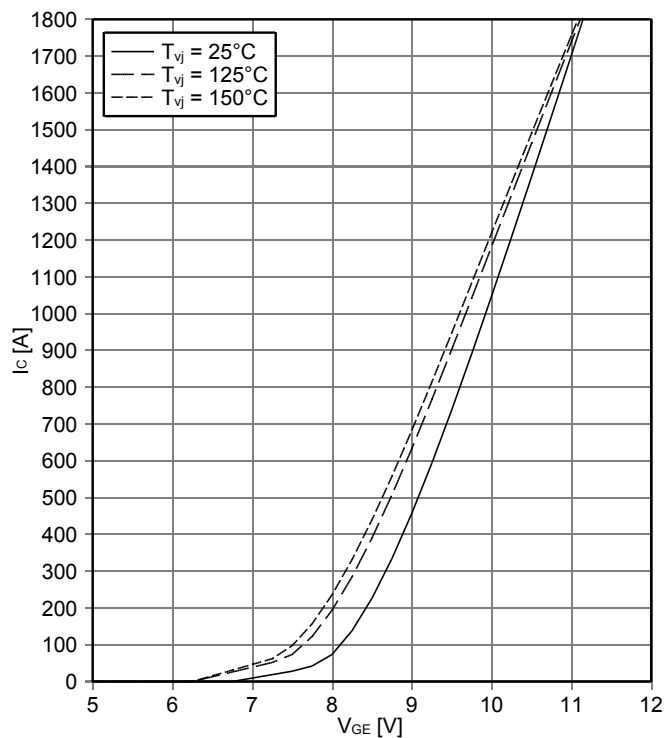
output characteristic IGBT, Inverter (typical)

$I_C = f(V_{CE})$   
 $T_{vj} = 150^\circ\text{C}$



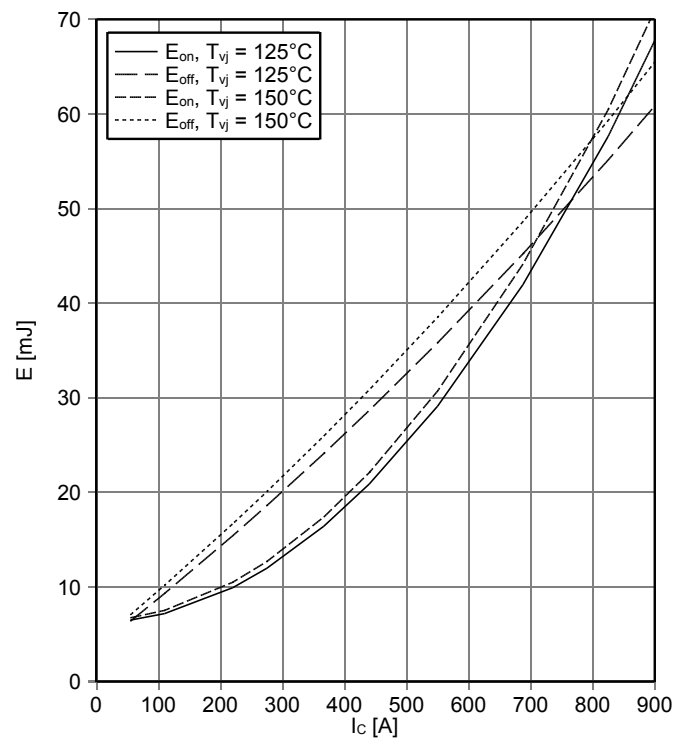
transfer characteristic IGBT, Inverter (typical)

$I_C = f(V_{GE})$   
 $V_{CE} = 20\text{ V}$



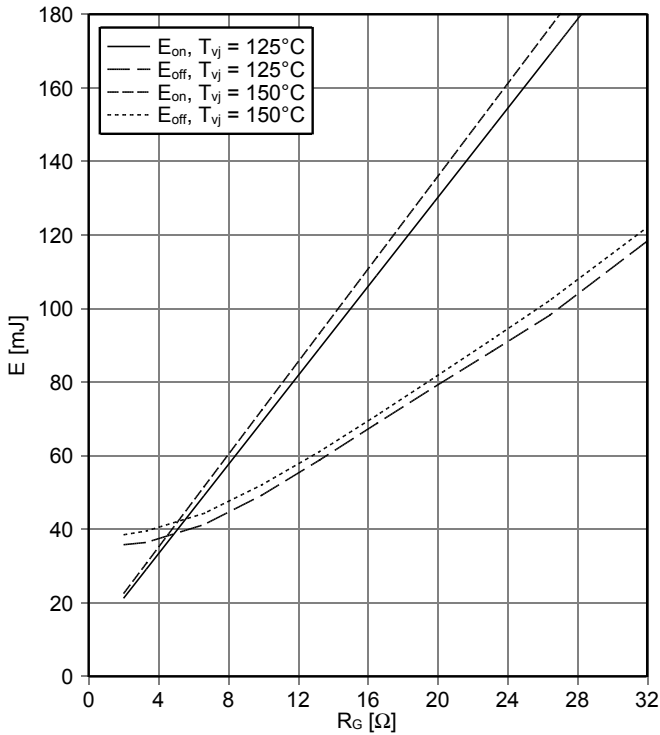
switching losses IGBT, Inverter (typical)

$E_{on} = f(I_C)$ ,  $E_{off} = f(I_C)$   
 $V_{GE} = \pm 15\text{ V}$ ,  $R_{Gon} = 3.3\ \Omega$ ,  $R_{Goff} = 2\ \Omega$ ,  $V_{CE} = 400\text{ V}$



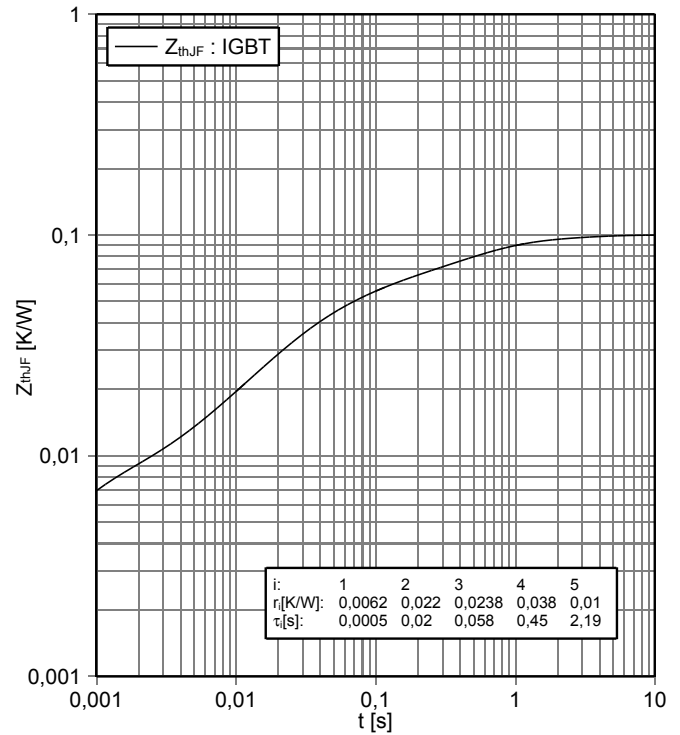
**switching losses IGBT, Inverter (typical)**

$E_{on} = f(R_G)$ ,  $E_{off} = f(R_G)$   
 $V_{GE} = \pm 15\text{ V}$ ,  $I_C = 550\text{ A}$ ,  $V_{CE} = 400\text{ V}$



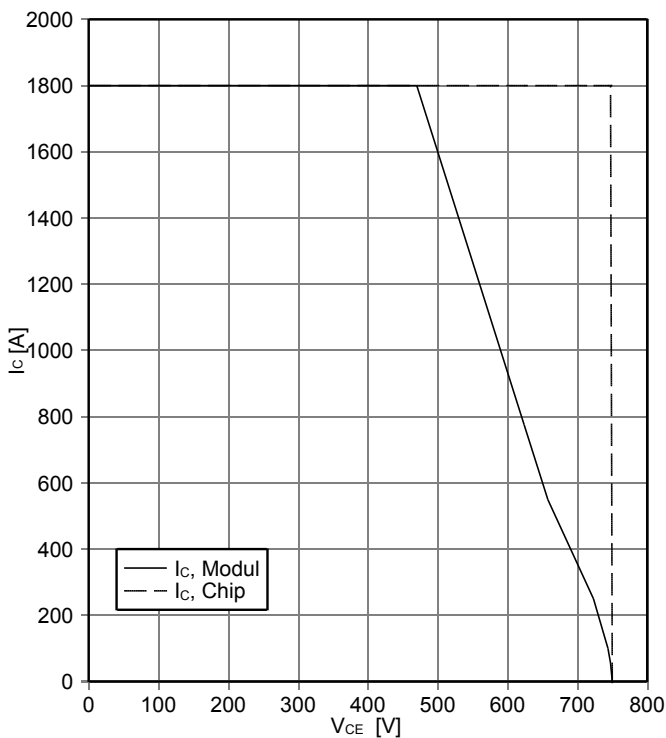
**transient thermal impedance IGBT, Inverter**

$Z_{thJF} = f(t)$  ( $\Delta V/\Delta t = 10\text{ dm}^3/\text{min}$ )



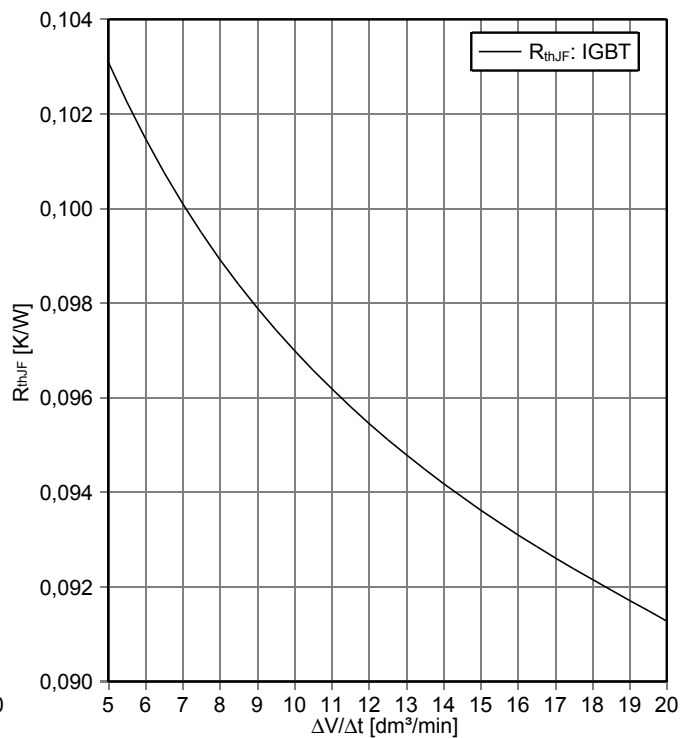
**reverse bias safe operating area IGBT, Inverter (RBSOA)**

$I_C = f(V_{CE})$   
 $V_{GE} = \pm 15\text{ V}$ ,  $R_{Goff} = 2\ \Omega$ ,  $T_{vj} = 150^\circ\text{C}$



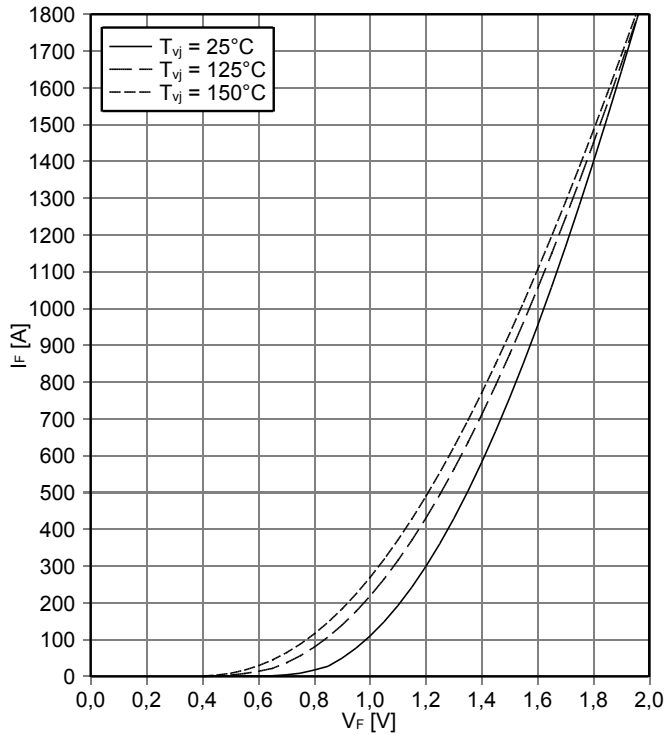
**thermal impedance IGBT, Inverter**

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



**forward characteristic of Diode, Inverter (typical)**

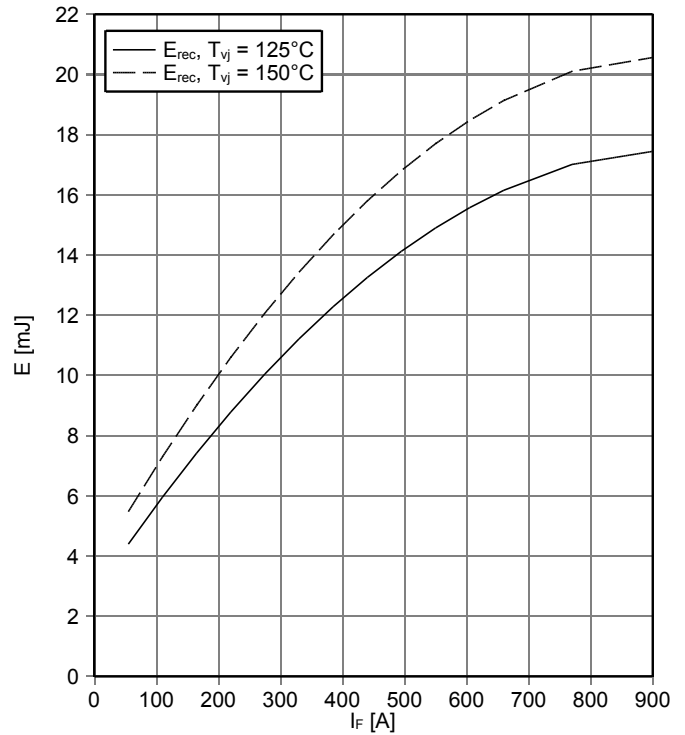
$I_F = f(V_F)$



**switching losses Diode, Inverter (typical)**

$E_{rec} = f(I_F)$

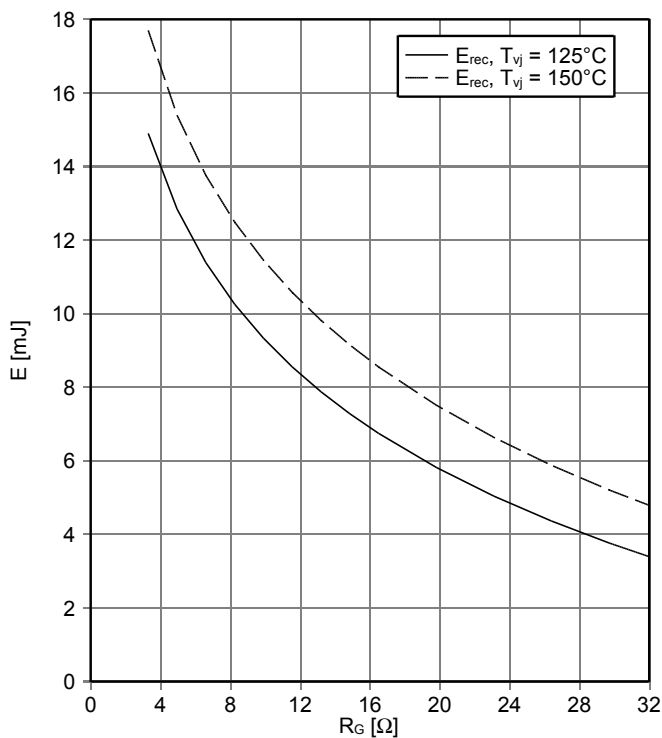
$R_{Gon} = 3.3 \Omega$ ,  $V_{CE} = 400 \text{ V}$



**switching losses Diode, Inverter (typical)**

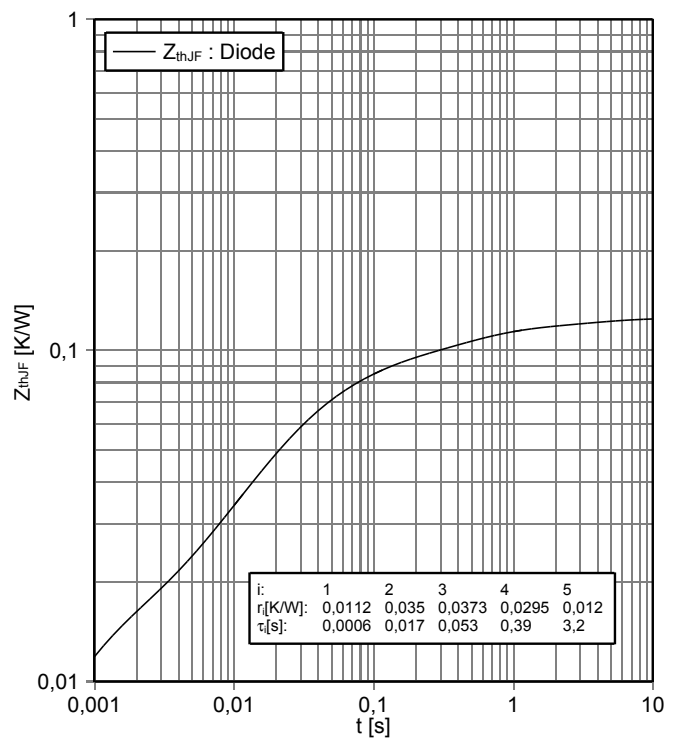
$E_{rec} = f(R_G)$

$I_F = 550 \text{ A}$ ,  $V_{CE} = 400 \text{ V}$



**transient thermal impedance Diode, Inverter**

$Z_{thJF} = f(t)$  ( $\Delta V/\Delta t = 10 \text{ dm}^3/\text{min}$ )

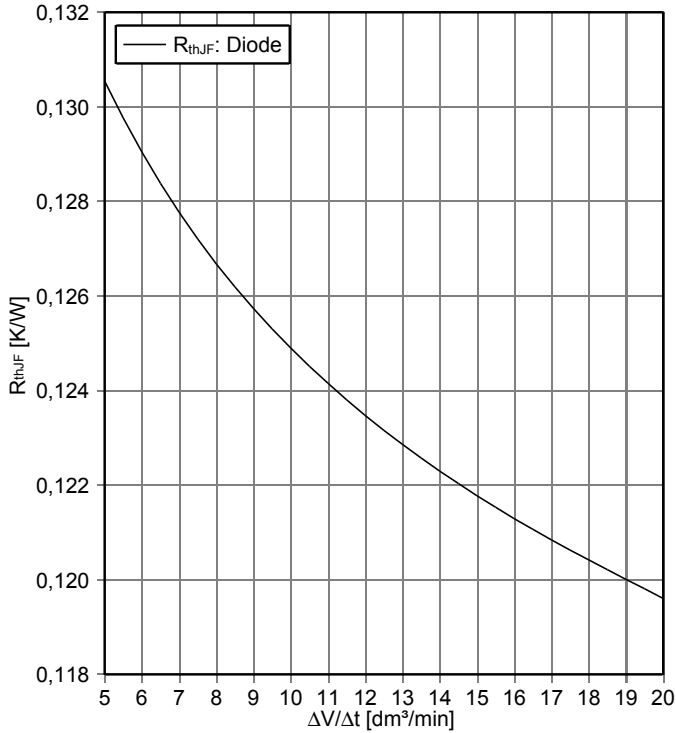




**thermal impedance Diode, Inverter**

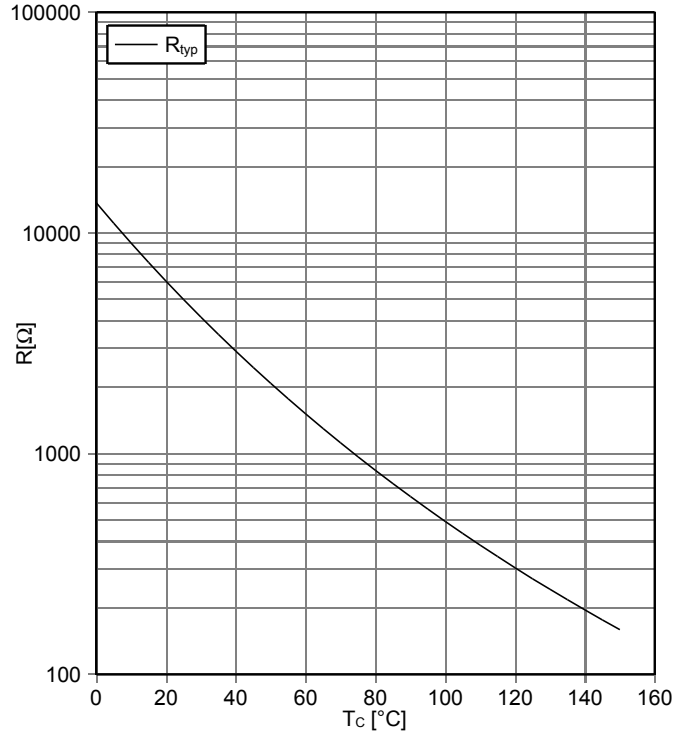
$R_{thJF} = f(\Delta V/\Delta t)$

cooling fluid = 50% water/50% ethylenglycol



**NTC-Thermistor-temperature characteristic (typical)**

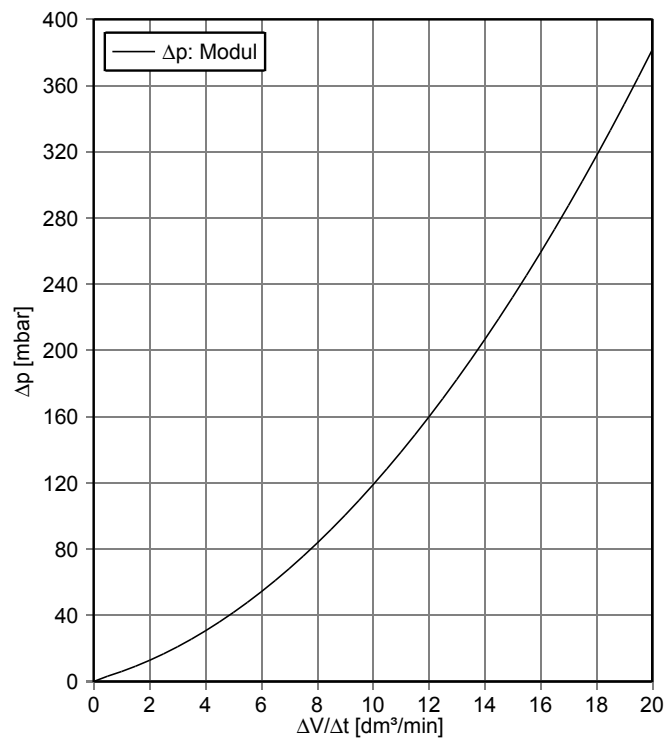
$R = f(T)$



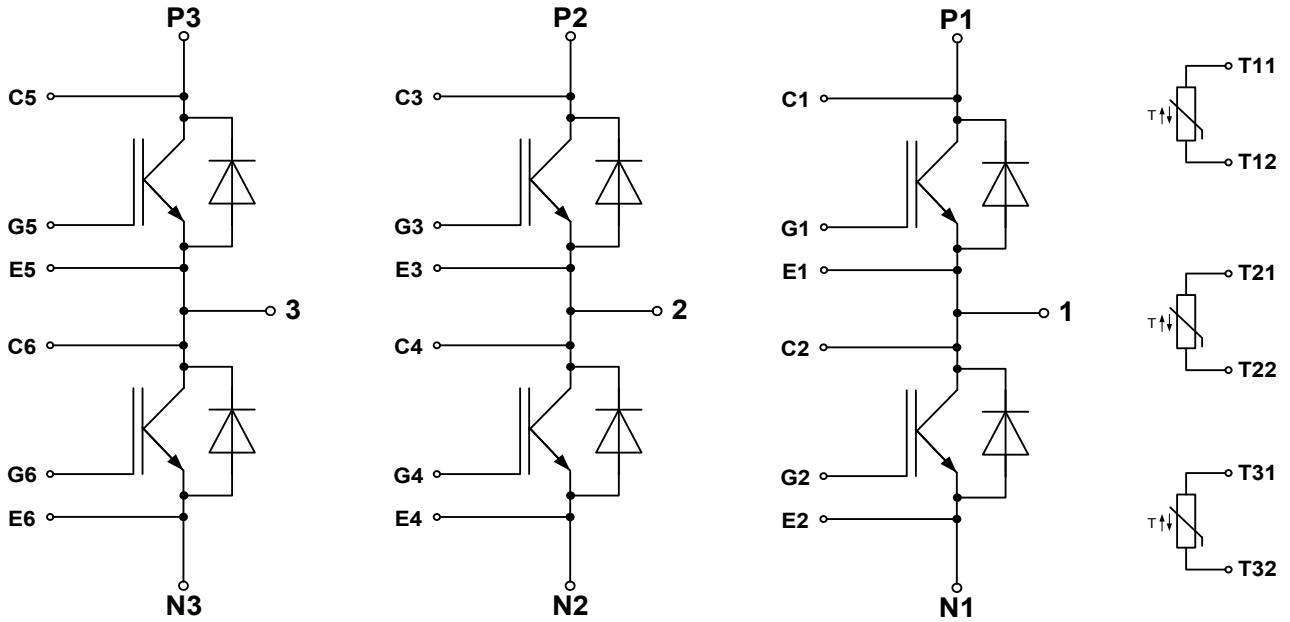
**pressure drop in cooling circuit**

$\Delta p = f(\Delta V/\Delta t)$

cooling fluid = 50% water/50% ethylenglycol, T<sub>F</sub> = 25°C



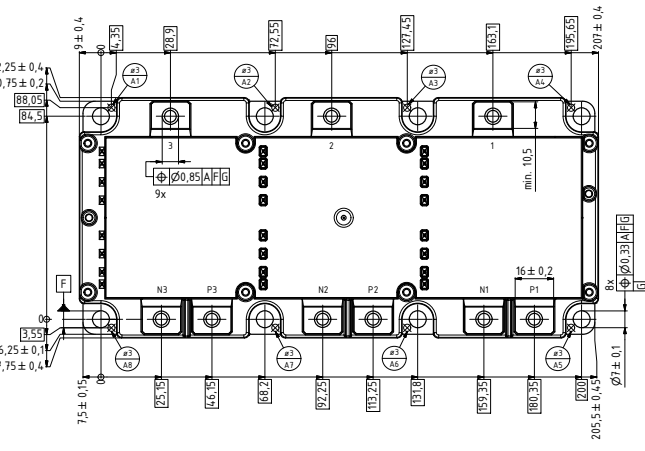
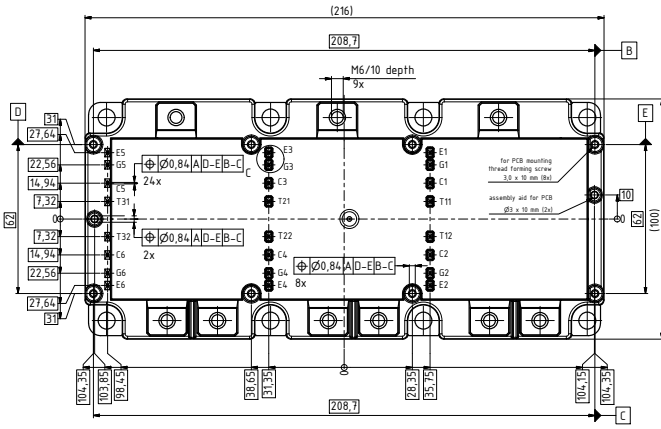
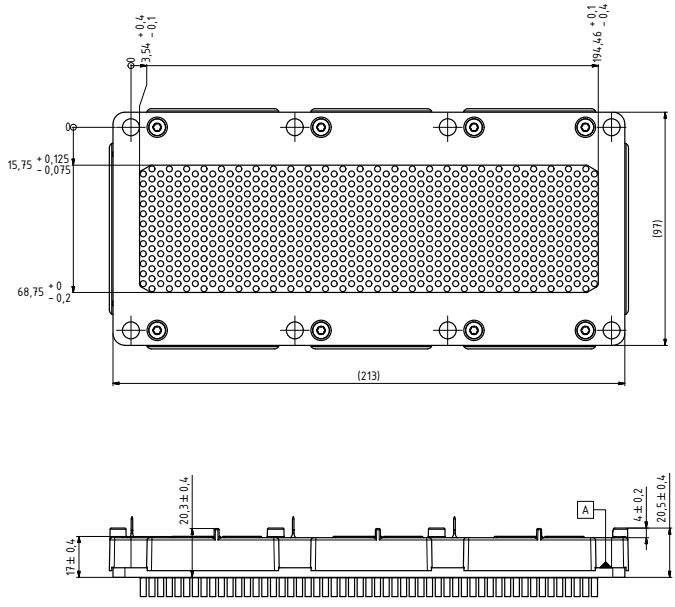
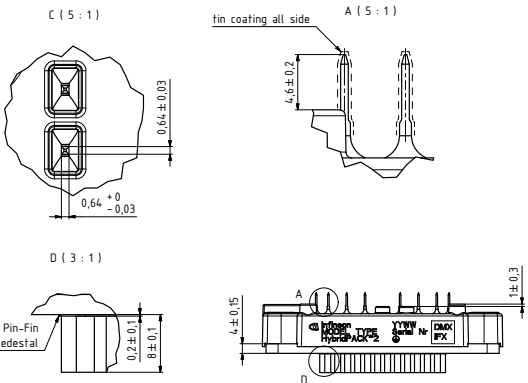
7 Circuit diagram



### 8 Package outlines


ISO 8015 principle of independency dimensions ISO 14405 (G) target geometry according CAD file with general tolerances (M) method of least-squares	Drawing: D00018099.00.G
	edges general tolerances surface
	DIN ISO 13715
	1. DIN 16742-TG6 2. DIN ISO 2768-mk DIN EN ISO 1302

All dimensions refer to module in delivery condition




## 9 Label Codes

### 9.1 Module Code

<b>Code Format</b>	Data Matrix		
<b>Encoding</b>	ASCII Text		
<b>Symbol Size</b>	16x16		
<b>Standard</b>	IEC24720 and IEC16022		
<b>Code Content</b>	<b>Content</b> Module Serial Number Module Material Number Production Order Number Datecode (Production Year) Datecode (Production Week)	<b>Digit</b> 1 - 5 6 - 11 12 - 19 20 - 21 22 - 23	<b>Example (below)</b> 71549 142846 55054991 15 30
<b>Example</b>	 71549142846550549911530		

### 9.2 Packing Code

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

## Revision History

Major changes since previous revision

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### Revision History

Reference	Date	Description
V1.0	2014-07-11	Initial Version
V2.0	2016-01-13	preliminary data
V2.1	2016-04-11	-
V3.0	2016-11-07	Final datasheet
V3.1	2016-11-14	-
V3.2	2017-08-30	-

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