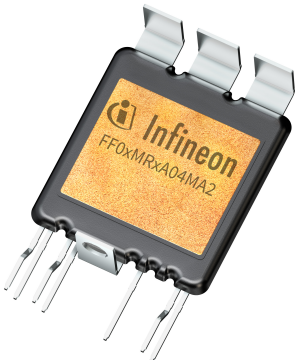


Final datasheet
HybridPACK™ DSC S module with SiC MOSFET and NTC

Features

- Electrical features
 - $V_{DS} = 1200\text{ V}$
 - $I_{DN} = 190\text{ A}$ / $I_{DRM} = 380\text{ A}$
 - Low inductive design $\leq 8\text{ nH}$
 - Low $R_{DS,on}$
 - Low switching losses
 - Low Q_g and C_{rss}
 - New semiconductor material - silicon carbide
 - $T_{vj,op} = 175^{\circ}\text{C}$
- Mechanical features
 - 4.25 kV DC 1 second insulation
 - Compact design
 - High power density
 - AlN Substrate with low thermal resistance
 - Integrated NTC temperature sensor
 - RoHS compliant
 - UL 94 V0 module frame



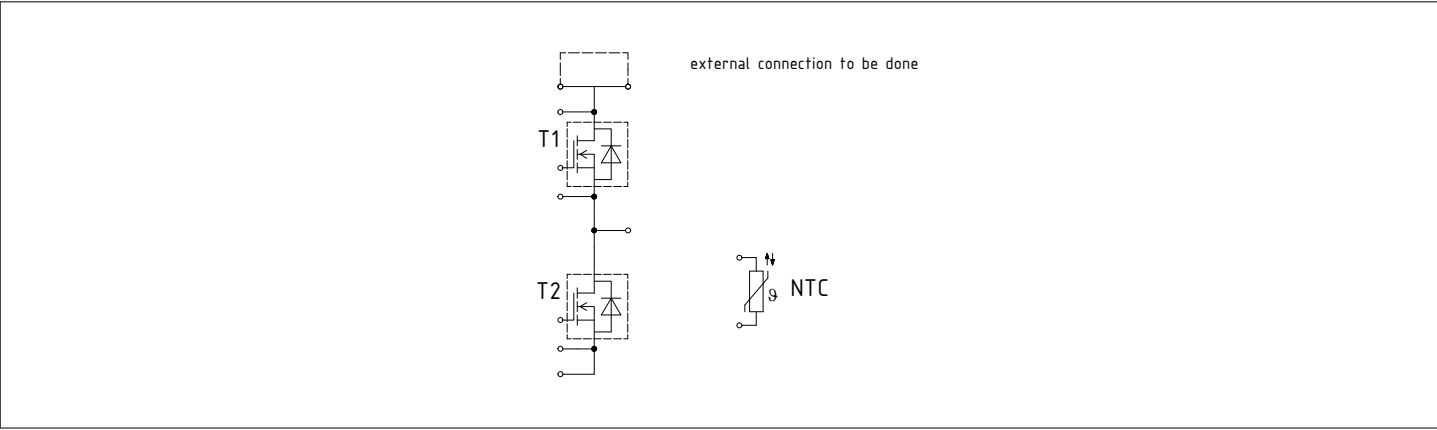
Potential applications

- Automotive applications
- (Hybrid) electrical vehicles (H)EV
- Motor drives

Product validation

- Qualified according to IFX automotive standard

Description



Type	Package	Marking
FF06MR12A04MA2	HybridPACK™ DSC S Module	SP005558866

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1 Package

Table 1 Insulation coordination

Parameter	Symbol	Note or test condition	Values	Unit
Isolation test voltage	V_{ISOL}	RMS, $f = 0$ Hz, $t = 1$ sec	4.25	kV
Internal isolation		basic insulation (class 1, IEC 61140)	AIN	
Creepage distance	d_{creep}	terminal to heatsink	8.5	mm
Creepage distance	d_{creep}	terminal to terminal	4.3	mm
Clearance	d_{clear}	terminal to heatsink	8.5	mm
Clearance	d_{clear}	terminal to terminal	3.4	mm
Comparative tracking index	CTI		> 600	

Table 2 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Stray inductance module	$L_{s,DS}$			7.5		nH
Module lead resistance, terminals - chip	$R_{DD'+SS'}$	$T_h = 25$ °C, per switch		0.45		mΩ
Storage temperature	T_{stg}		-40		125	°C
Weight	G			30.9		g

2 MOSFET

Table 3 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Drain-source voltage	V_{DSS}		$T_{vj} = 25$ °C	1200	V
DC drain current	$I_{D,nom}$	$V_{GS} = 18$ V, $T_f = 43$ °C	$T_{vj,max} = 175$ °C	190	A
Pulsed drain current	$I_{D,pulse}$	verified by design, t_p limited by $T_{vj,max}$		380	A
Gate-source voltage, max. static voltage	V_{GS}			-5/20	V
Gate-source voltage, max. transient voltage	V_{GS}			-10/23	V

Table 4 Recommended values

Parameter	Symbol	Note or test condition	Values	Unit
On-state gate voltage	$V_{GS(on)}$		18	V
Off-state gate voltage	$V_{GS(off)}$		-5	V

Table 5 **Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Drain-source on-resistance	$R_{DS,on}$	$I_D = 190\text{ A}$, $V_{GS} = 18\text{ V}$	$T_{vj} = 25\text{ °C}$		5.56		mΩ
			$T_{vj} = 125\text{ °C}$		8.78		
			$T_{vj} = 175\text{ °C}$		11.61	14.50	
Gate threshold voltage ¹⁾	$V_{GS,th}$	$I_D = 60\text{ mA}$, $V_{GS} = V_{DS}$, (tested after 1ms pulse at $V_{GS} = +20\text{ V}$)	$T_{vj} = 25\text{ °C}$	3.25	3.90	4.55	V
Total gate charge	Q_G	$V_{DS} = 850\text{ V}$, $V_{GS} = -5/18\text{ V}$			0.42		μC
Internal gate resistor	$R_{G,int}$		$T_{vj} = 25\text{ °C}$		0.9		Ω
Input capacitance	C_{iss}	$f = 100\text{ kHz}$, $V_{DS} = 850\text{ V}$	$T_{vj} = 25\text{ °C}$		10.1		nF
Output capacitance	C_{oss}	$f = 100\text{ kHz}$, $V_{DS} = 850\text{ V}$	$T_{vj} = 25\text{ °C}$		0.43		nF
Reverse transfer capacitance	C_{rss}	$f = 100\text{ kHz}$, $V_{DS} = 850\text{ V}$	$T_{vj} = 25\text{ °C}$		0.04		nF
C_{oss} stored energy	E_{oss}	$V_{DS} = 850\text{ V}$, $V_{GS} = -5/18\text{ V}$	$T_{vj} = 25\text{ °C}$		196		μJ
Drain-source leakage current	I_{DSX}	$V_{GS} = -5\text{ V}$, $V_{DSS} = 1200\text{ V}$	$T_{vj} = 25\text{ °C}$			100	μA
Gate-source leakage current	I_{GSS}	$V_{GS} = 20\text{ V}$, $V_{DS} = 0\text{ V}$	$T_{vj} = 25\text{ °C}$			100	nA
Turn-on delay time, inductive load	$t_{d,on}$	$I_D = 190\text{ A}$, $R_{G,on} = 5.1\text{ Ω}$, $V_{GS} = -5/18\text{ V}$, $V_{DS} = 850\text{ V}$	$T_{vj} = 25\text{ °C}$		32		ns
			$T_{vj} = 125\text{ °C}$		30		
			$T_{vj} = 175\text{ °C}$		29		
Rise time (inductive load)	t_r	$I_D = 190\text{ A}$, $R_{G,on} = 5.1\text{ Ω}$, $V_{GS} = -5/18\text{ V}$, $V_{DS} = 850\text{ V}$	$T_{vj} = 25\text{ °C}$		25		ns
			$T_{vj} = 125\text{ °C}$		24		
			$T_{vj} = 175\text{ °C}$		23		
Turn-off delay time, inductive load	$t_{d,off}$	$I_D = 190\text{ A}$, $R_{G,off} = 12\text{ Ω}$, $V_{GS} = -5/18\text{ V}$, $V_{DS} = 850\text{ V}$	$T_{vj} = 25\text{ °C}$		228		ns
			$T_{vj} = 125\text{ °C}$		243		
			$T_{vj} = 175\text{ °C}$		251		
Fall time (inductive load)	t_f	$I_D = 190\text{ A}$, $R_{G,off} = 12\text{ Ω}$, $V_{GS} = -5/18\text{ V}$, $V_{DS} = 850\text{ V}$	$T_{vj} = 25\text{ °C}$		53		ns
			$T_{vj} = 125\text{ °C}$		58		
			$T_{vj} = 175\text{ °C}$		62		
Turn-on energy loss per pulse	E_{on}	$I_D = 190\text{ A}$, $R_{G,on} = 5.1\text{ Ω}$, $V_{GS} = -5/18\text{ V}$, $V_{DS} = 850\text{ V}$, $L_\sigma = 10\text{ nH}$	$T_{vj} = 25\text{ °C}$, $di/dt = 6.3\text{ kA/}\mu\text{s}$		7.10		mJ
			$T_{vj} = 125\text{ °C}$, $di/dt = 6.7\text{ kA/}\mu\text{s}$		8.80		
			$T_{vj} = 175\text{ °C}$, $di/dt = 6.8\text{ kA/}\mu\text{s}$		9.90		

(table continues...)

Table 5 (continued) **Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Turn-off energy loss per pulse	E_{off}	$I_D = 190\text{ A}$, $R_{G,off} = 12\ \Omega$, $V_{GS} = -5/18\text{ V}$, $V_{DS} = 850\text{ V}$, $L_\sigma = 10\text{ nH}$	$T_{vj} = 25\text{ °C}$, $dv/dt = 11.5\text{ kV}/\mu\text{s}$		8.30		mJ
			$T_{vj} = 125\text{ °C}$, $dv/dt = 11.3\text{ kV}/\mu\text{s}$		8.80		
			$T_{vj} = 175\text{ °C}$, $dv/dt = 11.1\text{ kV}/\mu\text{s}$		9.10		
Thermal resistance, junction to cooling fluid	$R_{th,j-f}$	50% water / 50% ethylenglycol, clamping force $F=800\text{ N}$, $\Delta V/\Delta t = 10\text{ dm}^3/\text{min}$, $T_f = 60\text{ °C}$			0.251 ²⁾		K/W
Temperature under switching conditions	$T_{vj,op}$			-40		175	°C

- 1) At 0h operating time. During inverter operation the value can be lower depending on T_{vj} , $V_{GS(off)}$, (switching frequency) f_{sw} over lifetime. For a final assessment of $V_{GS,th}$ Min. value depending on customer application please contact the Infineon sales office for the necessary technical support by Infineon.
- 2) Cooler design and characterization according to application notes AN-HPDSCSIC and AN-HPDSCRTH

3 Body diode (MOSFET)

Table 6 **Maximum rated values**

Parameter	Symbol	Note or test condition		Values	Unit
Drain-source voltage	V_{DSS}		$T_{vj} = 25\text{ °C}$	1200	V
DC body diode forward current	$I_{F,S}$	$T_{vj,max} = 175\text{ °C}$, $V_{GS} = -5\text{ V}$	$T_f = 45\text{ °C}$	75	A
Pulsed body diode current	$I_{F,S,pulse}$	verified by design, t_p limited by $T_{vj,max}$		380	A

Table 7 **Characteristic values**

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	$V_{F,SD}$	$I_{F,S} = 190\text{ A}$, $V_{GS} = -5\text{ V}$	$T_{vj} = 25\text{ °C}$		5.15	6.88	V
			$T_{vj} = 125\text{ °C}$		4.75		
			$T_{vj} = 175\text{ °C}$		4.60		
Peak reverse recovery current	I_{rrm}	$I_{F,S} = 190\text{ A}$, $V_{GS} = -5\text{ V}$, $V_{R,DS} = 850\text{ V}$	$T_{vj} = 25\text{ °C}$		43		A
			$T_{vj} = 125\text{ °C}$		73		
			$T_{vj} = 175\text{ °C}$		98		
Recovered charge	Q_{rr}	$I_{F,S} = 190\text{ A}$, $V_{GS} = -5\text{ V}$, $V_{R,DS} = 850\text{ V}$	$T_{vj} = 25\text{ °C}$		0.50		μC
			$T_{vj} = 125\text{ °C}$		2.40		
			$T_{vj} = 175\text{ °C}$		3.40		

(table continues...)

Table 7 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Reverse recovery energy	E_{rec}	$I_{F,S} = 190 \text{ A}$, $V_{GS} = -5 \text{ V}$, $V_{R,DS} = 850 \text{ V}$		0.1		mJ
				0.6		
				0.8		

4 NTC-Thermistor

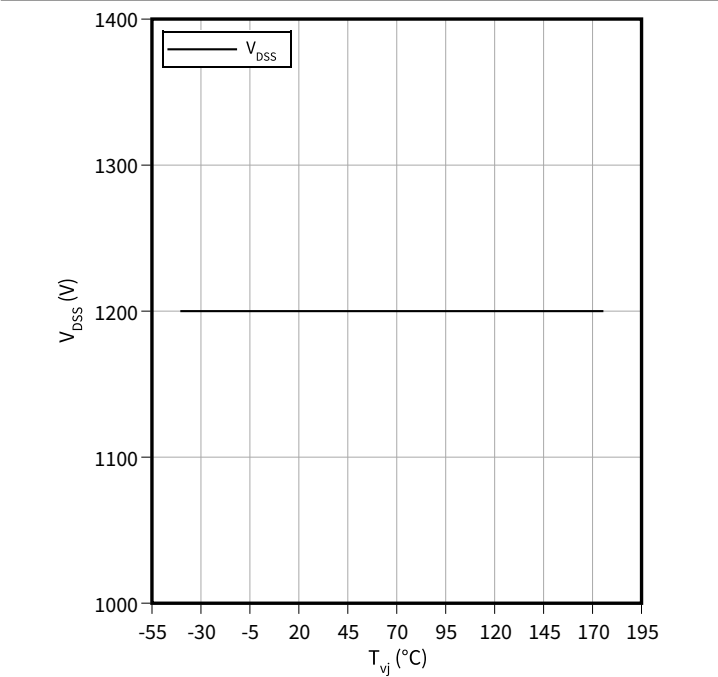
Table 8 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rated resistance	R_{25}	$T_{NTC} = 25 \text{ °C}$		5		kΩ
Deviation of R_{100}	$\Delta R/R$	$T_{NTC} = 100 \text{ °C}$, $R_{100} = 493 \text{ Ω}$	-5		5	%
Power dissipation	P_{25}	$T_{NTC} = 25 \text{ °C}$			20	mW
B-value	$B_{25/50}$	$R_2 = R_{25} \exp[B_{25/50}(1/T_2 - 1/(298.15 \text{ K}))]$		3375		K
B-value	$B_{25/80}$	$R_2 = R_{25} \exp[B_{25/80}(1/T_2 - 1/(298.15 \text{ K}))]$		3411		K
B-value	$B_{25/100}$	$R_2 = R_{25} \exp[B_{25/100}(1/T_2 - 1/(298.15 \text{ K}))]$		3433		K

5 Characteristics diagrams

Maximum allowed drain-source voltage, MOSFET

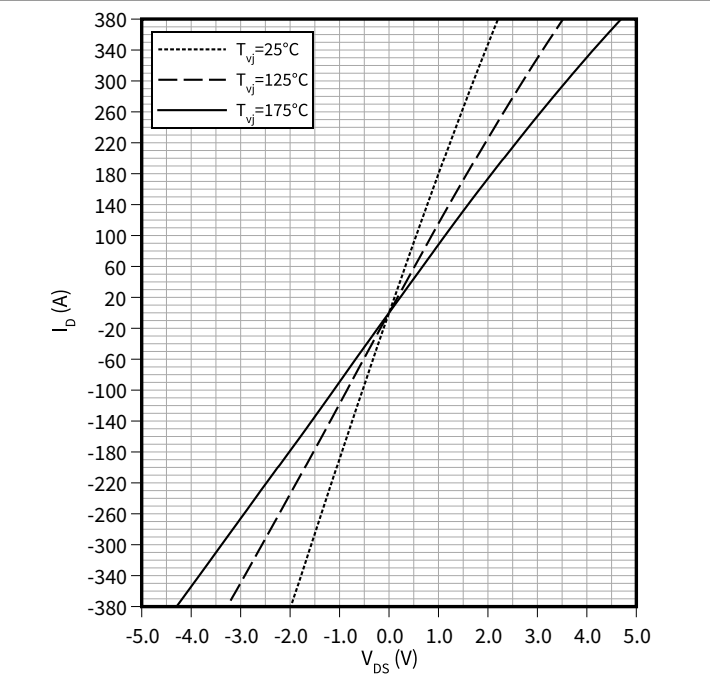
$V_{DSS} = f(T_{vj})$



Output characteristic (typical), MOSFET

$I_D = f(V_{DS})$

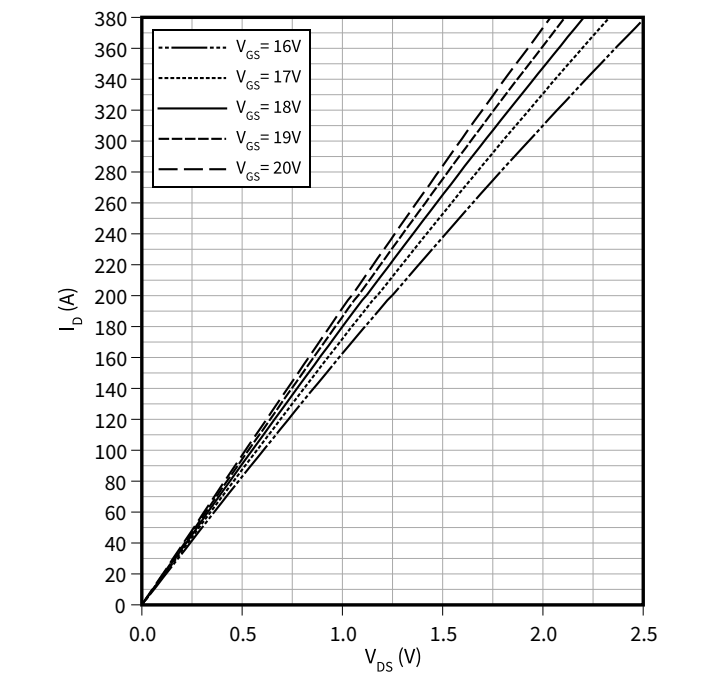
$V_{GS} = 18$ V



Output characteristic (typical), MOSFET

$I_D = f(V_{DS})$

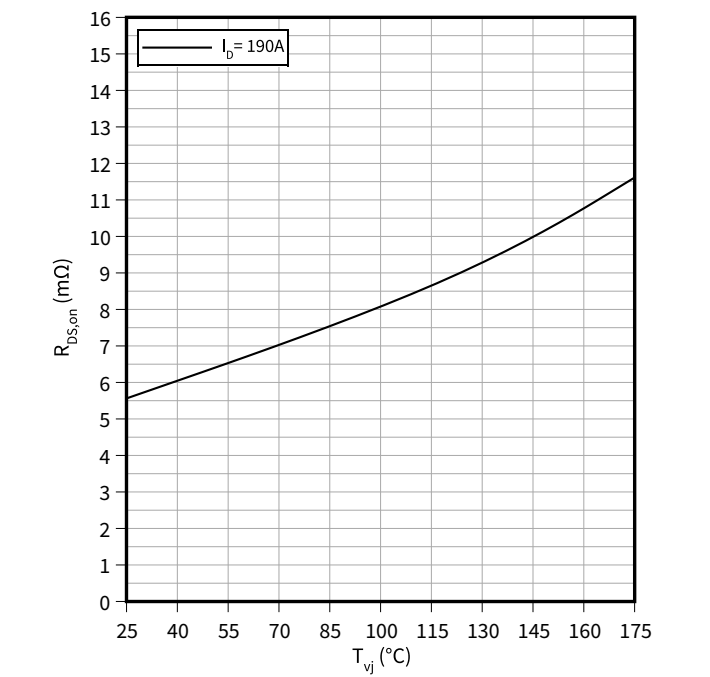
$T_{vj} = 25$ °C



Drain-source on-resistance (typical), MOSFET

$R_{DS,on} = f(T_{vj})$

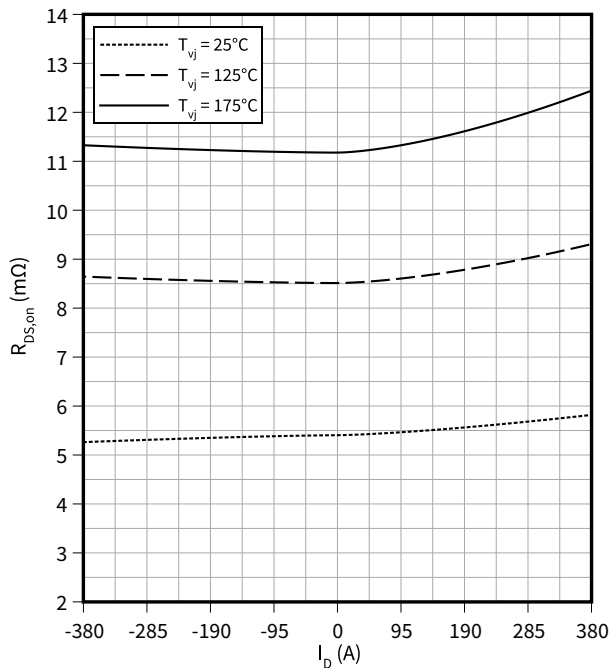
$I_D = 190$ A, $V_{GS} = 18$ V



5 Characteristics diagrams

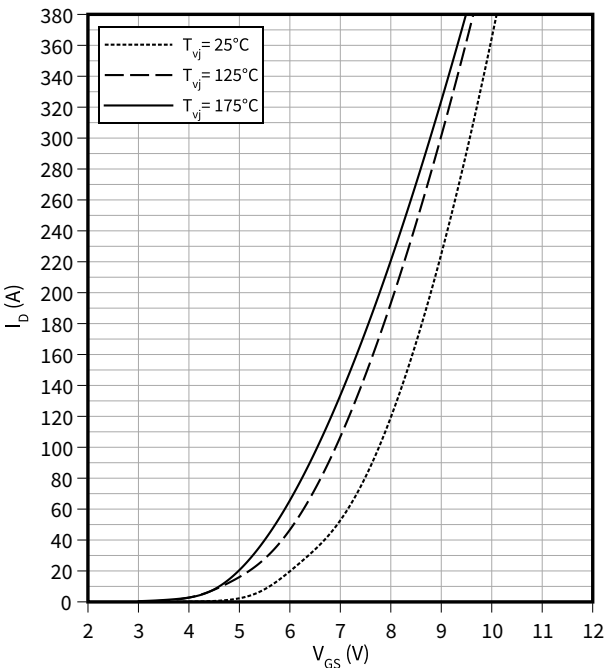
Drain-source on-resistance (typical), MOSFET

$R_{DS,on} = f(I_D)$
 $V_{GS} = 18\text{ V}$



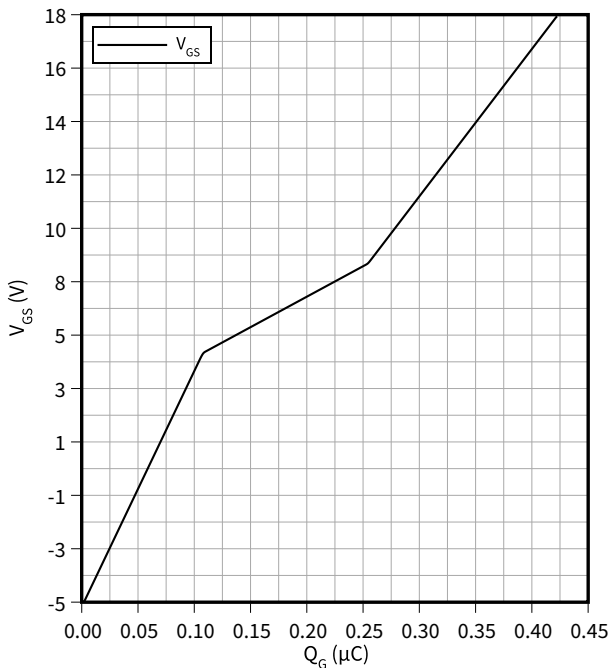
Transfer characteristic (typical), MOSFET

$I_D = f(V_{GS})$
 $V_{DS} = 20\text{ V}$



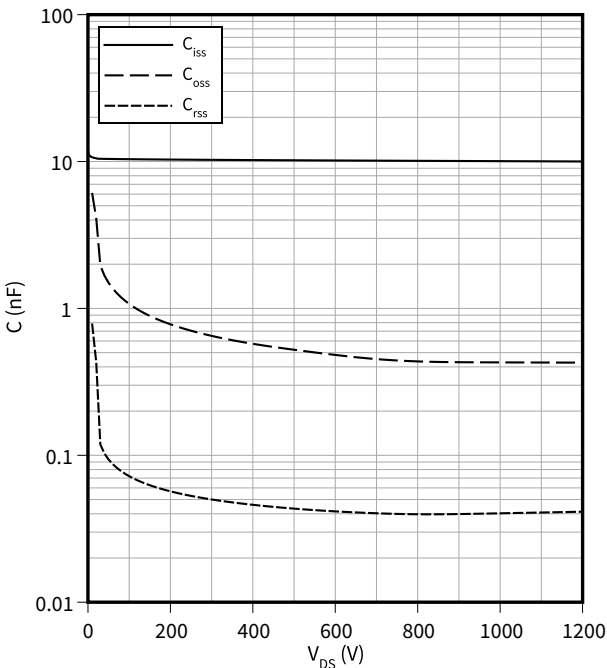
Gate charge characteristic (typical), MOSFET

$V_{GS} = f(Q_G)$
 $V_{DD} = 850\text{ V}, T_{vj} = 25^\circ\text{C}$



Capacity characteristic (typical), MOSFET

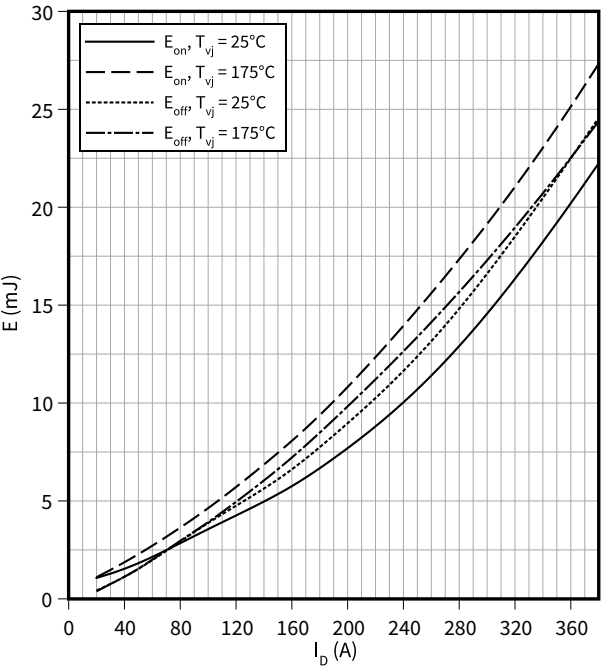
$C = f(V_{DS})$
 $f = 100\text{ kHz}, V_{GS} = -5/18\text{ V}, T_{vj} = 25^\circ\text{C}$



5 Characteristics diagrams

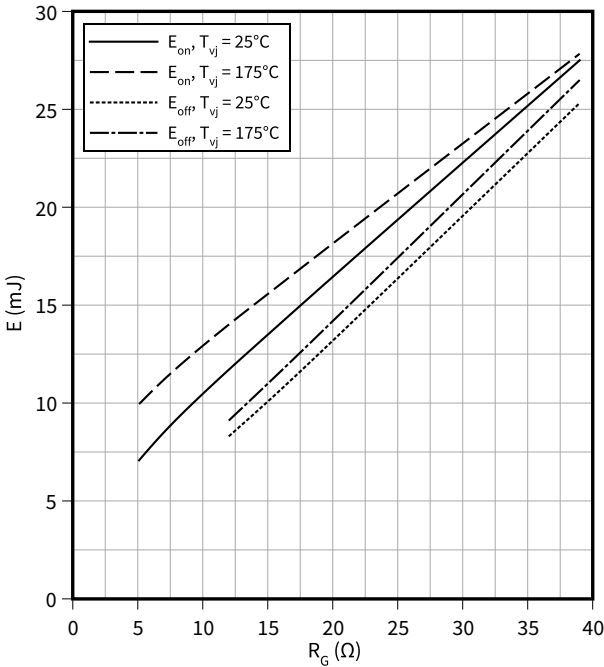
Switching losses (typical), MOSFET

$E = f(I_D)$
 $V_{DS} = 850\text{ V}$, $R_{G,off} = 12\text{ }\Omega$, $R_{G,on} = 5.1\text{ }\Omega$, $V_{GS} = -5/18\text{ V}$



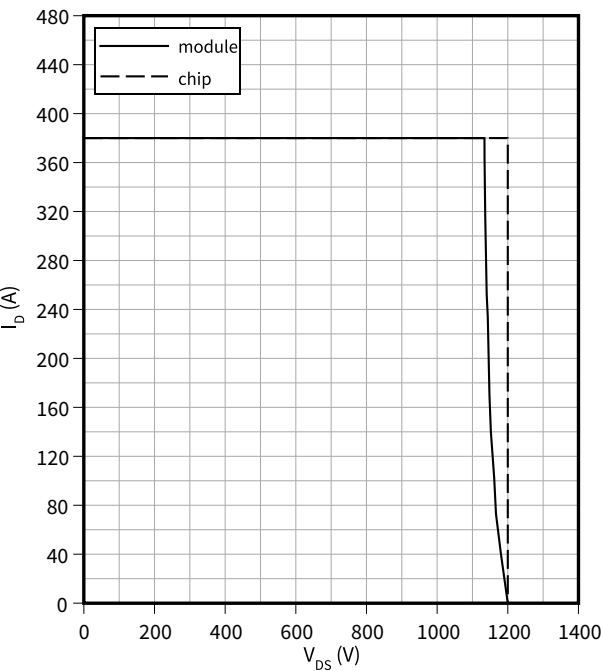
Switching losses (typical), MOSFET

$E = f(R_G)$
 $I_D = 190\text{ A}$, $V_{DS} = 850\text{ V}$, $V_{GS} = -5/18\text{ V}$



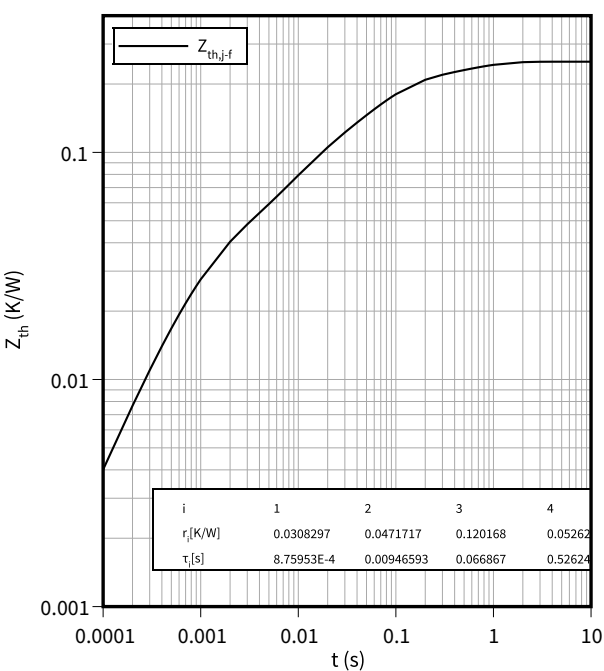
Reverse bias safe operating area (RBSOA), MOSFET

$I_D = f(V_{DS})$
 $R_{G,off} = 12\text{ }\Omega$, $V_{GS} = 18/-5\text{ V}$, $T_{vj} = 175\text{ }^\circ\text{C}$



Transient thermal impedance (typical), MOSFET

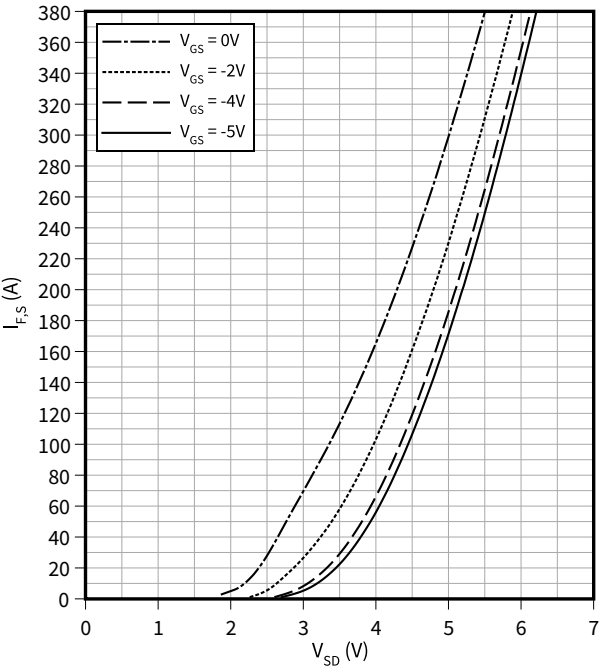
$Z_{th} = f(t)$
 $\Delta V/\Delta t = 10\text{ dm}^3/\text{min}$, $T_f = 60\text{ }^\circ\text{C}$, fluid = 50% water / 50% ethylenglycol, clamping force $F=800\text{ N}$



5 Characteristics diagrams

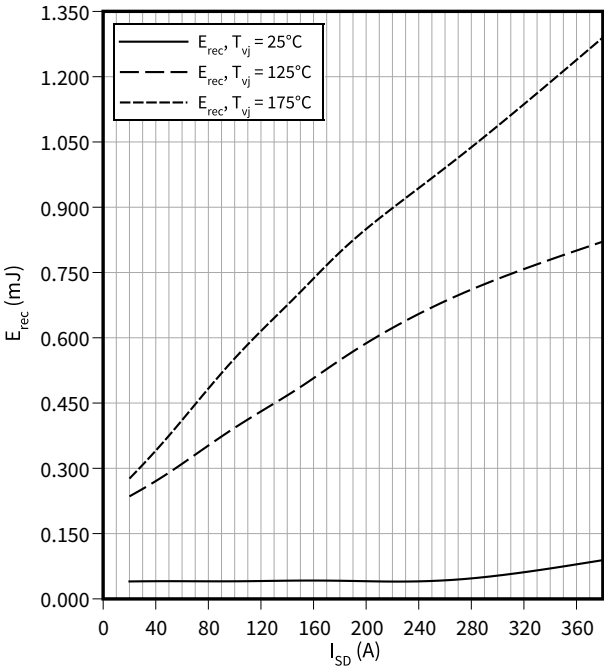
Forward characteristic body diode (typical), MOSFET

$I_{F,S} = f(V_{SD})$
 $T_{vj} = 25\text{ °C}$



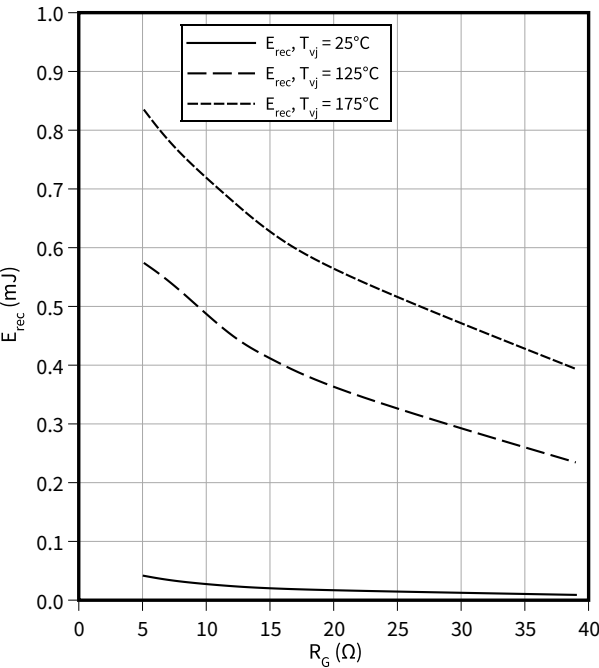
Switching losses body diode (typical), MOSFET

$E_{rec} = f(I_{SD})$
 $V_r = 850\text{ V}, R_{G,on} = 5.1\text{ }\Omega$



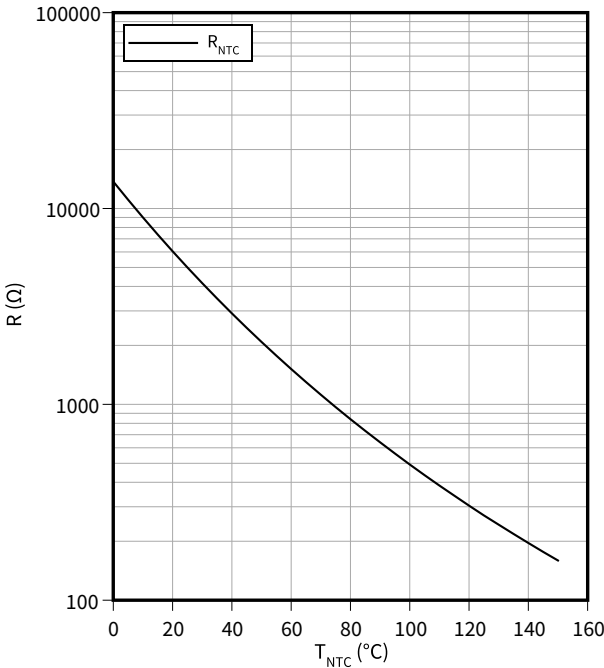
Switching losses body diode (typical), MOSFET

$E_{rec} = f(R_G)$
 $V_r = 850\text{ V}, I_{F,S} = 190\text{ A}$



Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



6 Circuit diagram

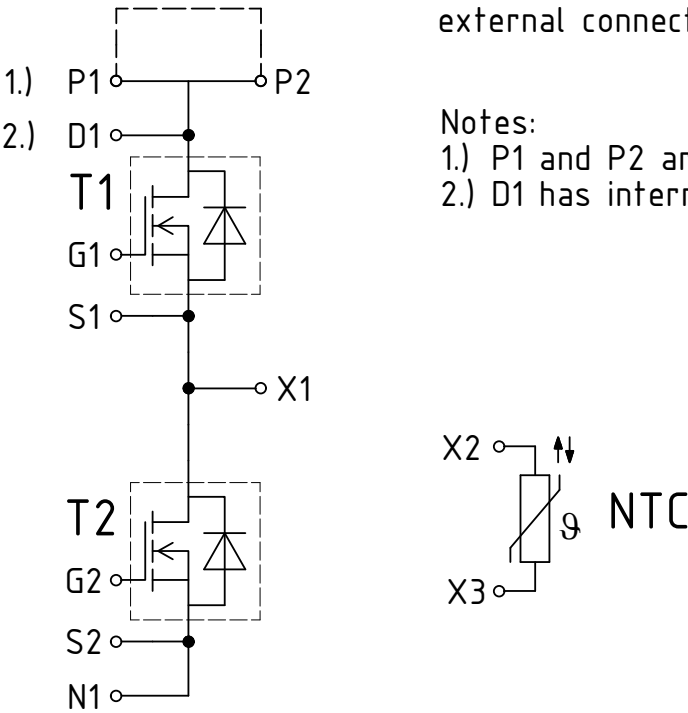


Figure 1

7 Package outlines

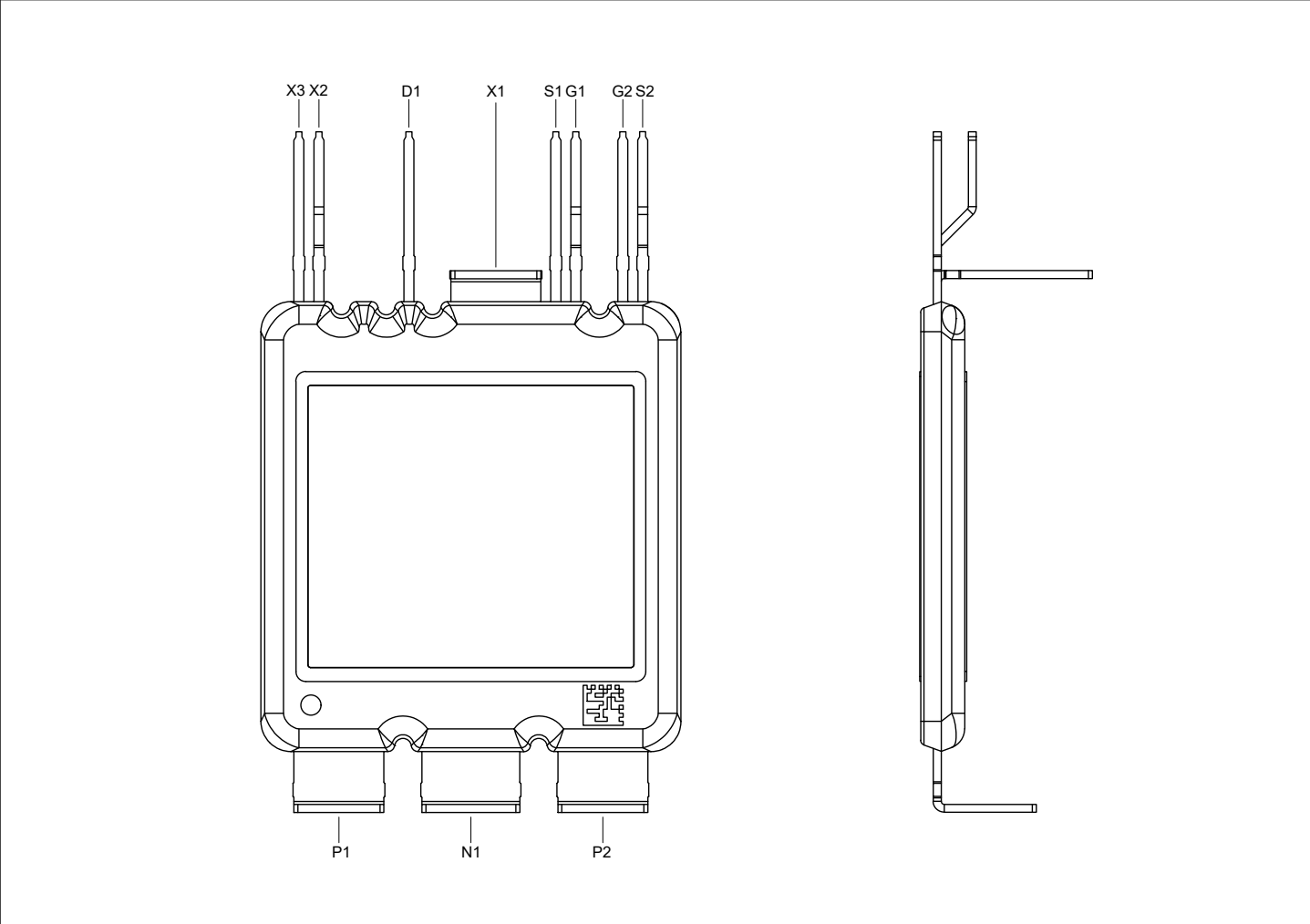


Figure 2

7 Package outlines

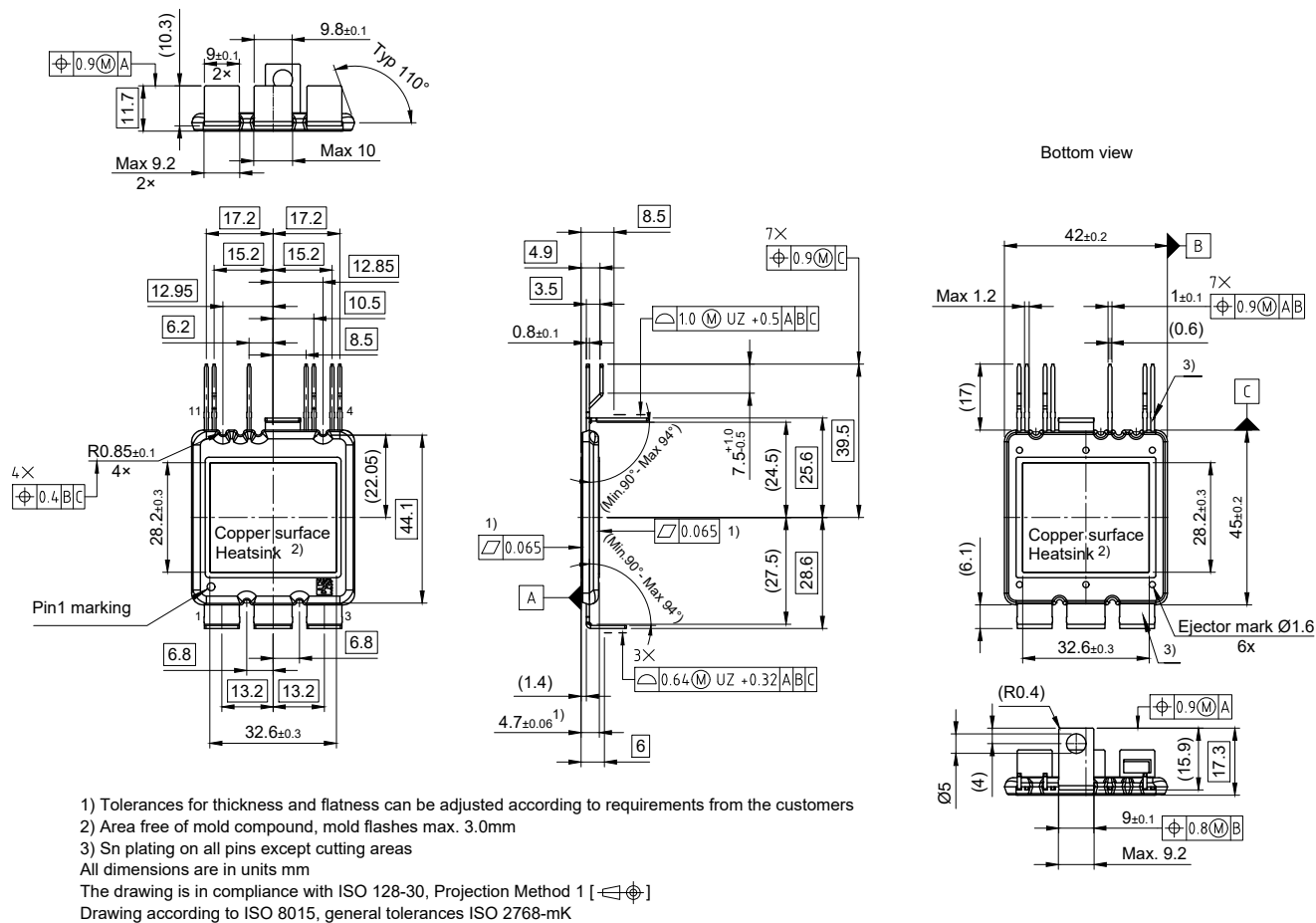


Figure 3

8 Module label code

Module label code			
Code format	Data Matrix		Barcode Code128
Encoding	ASCII text		Code Set A
Symbol size	16x16		23 digits
Standard	IEC24720 and IEC16022		IEC8859-1
Code content	<i>Content</i> Module serial number Module material number Production order number Date code (production year) Date code (production week)	<i>Digit</i> 1 – 5 6 - 11 12 - 19 20 – 21 22 – 23	<i>Example</i> 71549 142846 55054991 15 30
Example	 71549142846550549911530  71549142846550549911530		

Packing label code				
Code format	Barcode Code128			
Encoding	Code Set A			
Symbol size	34 digits			
Standard	IEC8859-1			
Code content	<i>Content</i> Module serial number Module material number Production order number Date code (production year) Date code (production week)	<i>Identifier</i> X 1T S 9D Q	<i>Digit</i> 2 – 9 12 – 19 21 – 25 28 – 31 33 – 34	<i>Example</i> 95056609 2X0003E0 754389 1139 15
Example	 X950566091T2X0003E0S754389D1139Q15			

Figure 4



Revision history

Revision history

Document revision	Date of release	Description of changes
0.10	2021-11-29	Initial version
0.20	2023-05-04	Preliminary datasheet
1.00	2024-08-05	Final datasheet

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