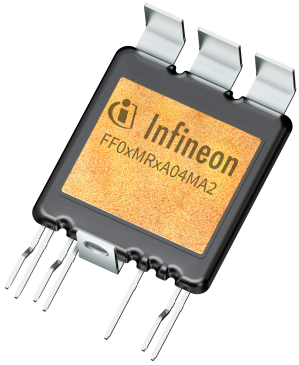
Final datasheet
HybridPACK™ DSC S module with SiC MOSFET and NTC

Features

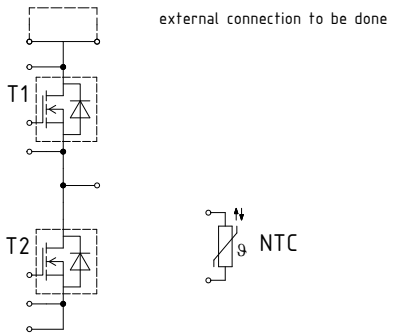


- Electrical features
  - V_{DSS} = 1200 V
  - I_{DN} = 190 A / I_{DRM} = 380 A
  - Low inductive design ≤ 8 nH
  - Low $R_{DS,on}$
  - Low switching losses
  - Low Q_g and C_{rss}
  - New semiconductor material - silicon carbide
  - $T_{vj,op}$ = 175°C
- Mechanical features
  - 4.25 kV DC 1 second insulation
  - 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

Table of contents

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)	AlN	
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 A, V_{GS} = 18 V	T_{vj} = 25 °C		5.56		mΩ
			T_{vj} = 125 °C		8.78		
			T_{vj} = 175 °C		11.61	14.50	
Gate threshold voltage[1)]	$V_{GS,th}$	I_D = 60 mA, V_{GS} = V_{DS}, (tested after 1ms pulse at V_{GS} = +20 V)	T_{vj} = 25 °C	3.25	3.90	4.55	V
Total gate charge	Q_G	V_{DS} = 850 V, V_{GS} = -5/18 V			0.42		µC
Internal gate resistor	$R_{G,int}$		T_{vj} = 25 °C		0.9		Ω
Input capacitance	C_{iss}	f = 100 kHz, V_{DS} = 850 V	T_{vj} = 25 °C		10.1		nF
Output capacitance	C_{oss}	f = 100 kHz, V_{DS} = 850 V	T_{vj} = 25 °C		0.43		nF
Reverse transfer capacitance	C_{rss}	f = 100 kHz, V_{DS} = 850 V	T_{vj} = 25 °C		0.04		nF
C_{OSS} stored energy	E_{oss}	V_{DS} = 850 V, V_{GS} = -5/18 V	T_{vj} = 25 °C		196		µJ
Drain-source leakage current	I_{DSX}	V_{GS} = -5 V, V_{DSS} = 1200 V	T_{vj} = 25 °C			100	µA
Gate-source leakage current	I_{GSS}	V_{GS} = 20 V, V_{DS} = 0 V	T_{vj} = 25 °C			100	nA
Turn-on delay time, inductive load	$t_{d,on}$	I_D = 190 A, $R_{G,on}$ = 5.1 Ω, V_{GS} = -5/18 V, V_{DS} = 850 V	T_{vj} = 25 °C		32		ns
			T_{vj} = 125 °C		30		
			T_{vj} = 175 °C		29		
Rise time (inductive load)	t_r	I_D = 190 A, $R_{G,on}$ = 5.1 Ω, V_{GS} = -5/18 V, V_{DS} = 850 V	T_{vj} = 25 °C		25		ns
			T_{vj} = 125 °C		24		
			T_{vj} = 175 °C		23		
Turn-off delay time, inductive load	$t_{d,off}$	I_D = 190 A, $R_{G,off}$ = 12 Ω, V_{GS} = -5/18 V, V_{DS} = 850 V	T_{vj} = 25 °C		228		ns
			T_{vj} = 125 °C		243		
			T_{vj} = 175 °C		251		
Fall time (inductive load)	t_f	I_D = 190 A, $R_{G,off}$ = 12 Ω, V_{GS} = -5/18 V, V_{DS} = 850 V	T_{vj} = 25 °C		53		ns
			T_{vj} = 125 °C		58		
			T_{vj} = 175 °C		62		
Turn-on energy loss per pulse	E_{on}	I_D = 190 A, $R_{G,on}$ = 5.1 Ω, V_{GS} = -5/18 V, V_{DS} = 850 V, L_σ = 10 nH	T_{vj} = 25 °C, di/dt = 6.3 kA/µs		7.10		mJ
			T_{vj} = 125 °C, di/dt = 6.7 kA/µs		8.80		
			T_{vj} = 175 °C, di/dt = 6.8 kA/µs		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 A, $R_{G,off}$ = 12 Ω, V_{GS} = -5/18 V, V_{DS} = 850 V, L_σ = 10 nH	T_{vj} = 25 °C, dv/dt = 11.5 kV/µs		8.30		mJ
			T_{vj} = 125 °C, dv/dt = 11.3 kV/µs		8.80		
			T_{vj} = 175 °C, dv/dt = 11.1 kV/µs		9.10		
Thermal resistance, junction to cooling fluid	$R_{th,j-f}$	50% water / 50% ethylenglycol, clamping force F=800 N, $\Delta V/\Delta t$ = 10 dm³/min, T_f = 60 °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 °C	1200	V
DC body diode forward current	$I_{F,S}$	$T_{vj,max}$ = 175 °C, V_{GS} = -5 V	T_f = 45 °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 A, V_{GS} = -5 V	T_{vj} = 25 °C		5.15	6.88	V
			T_{vj} = 125 °C		4.75		
			T_{vj} = 175 °C		4.60		
Peak reverse recovery current	I_{rrm}	$I_{F,S}$ = 190 A, V_{GS} = -5 V, $V_{R,DS}$ = 850 V	T_{vj} = 25 °C		43		A
			T_{vj} = 125 °C		73		
			T_{vj} = 175 °C		98		
Recovered charge	Q_{rr}	$I_{F,S}$ = 190 A, V_{GS} = -5 V, $V_{R,DS}$ = 850 V	T_{vj} = 25 °C		0.50		µC
			T_{vj} = 125 °C		2.40		
			T_{vj} = 175 °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 A, V_{GS} = -5 V, $V_{R,DS}$ = 850 V	T_{vj} = 25 °C, -di/dt = 7.8 kA/µs		0.1		mJ
			T_{vj} = 125 °C, -di/dt = 6.5 kA/µs		0.6		
			T_{vj} = 175 °C, -di/dt = 6.2 kA/µs		0.8		

4 NTC-Thermistor

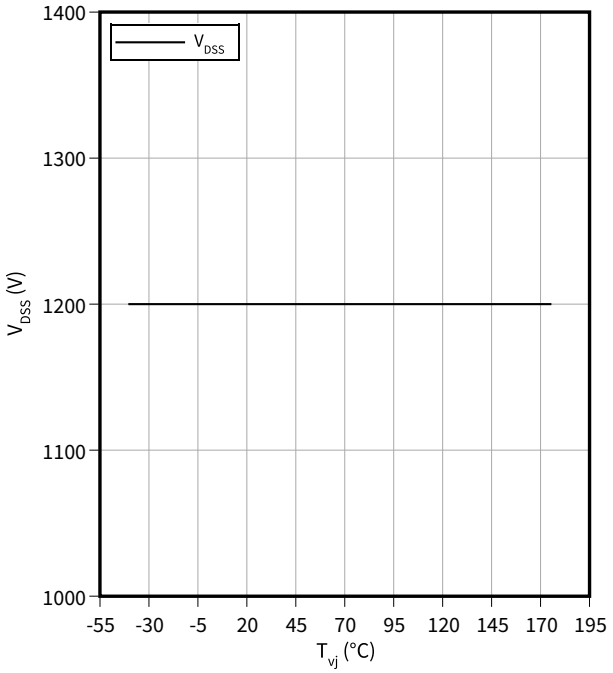
Table 8 Characteristic values

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

5 Characteristics diagrams

Maximum allowed drain-source voltage, MOSFET

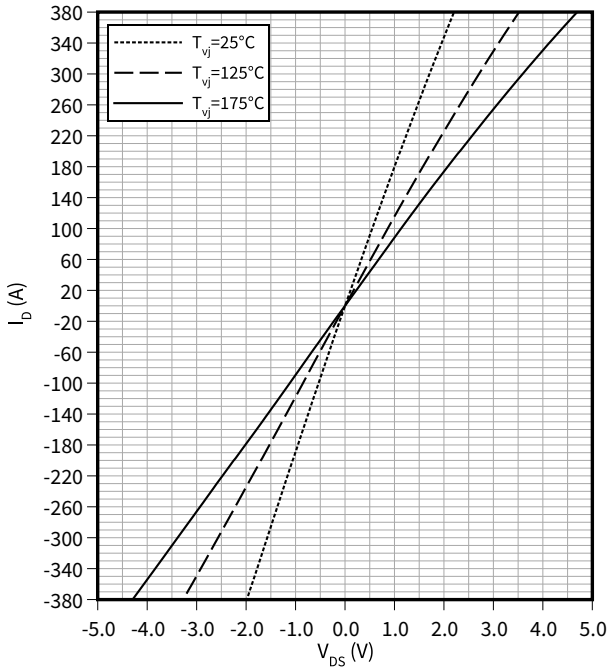
$V_{DSS} = f(T_{vj})$



Output characteristic (typical), MOSFET

$I_D = f(V_{DS})$

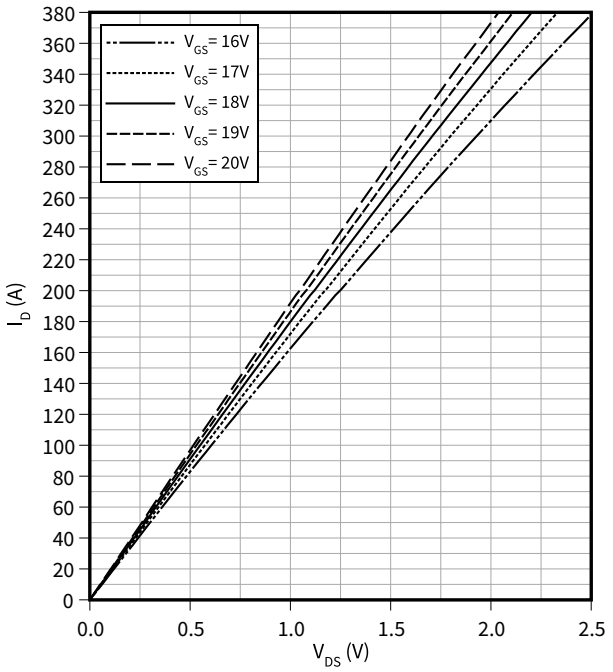
$V_{GS} = 18$ V



Output characteristic (typical), MOSFET

$I_D = f(V_{DS})$

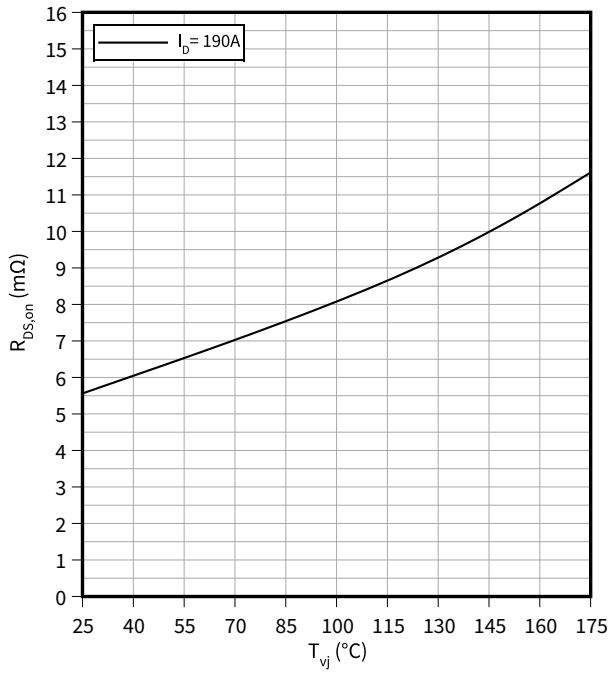
$T_{vj} = 25$ °C



Drain-source on-resistance (typical), MOSFET

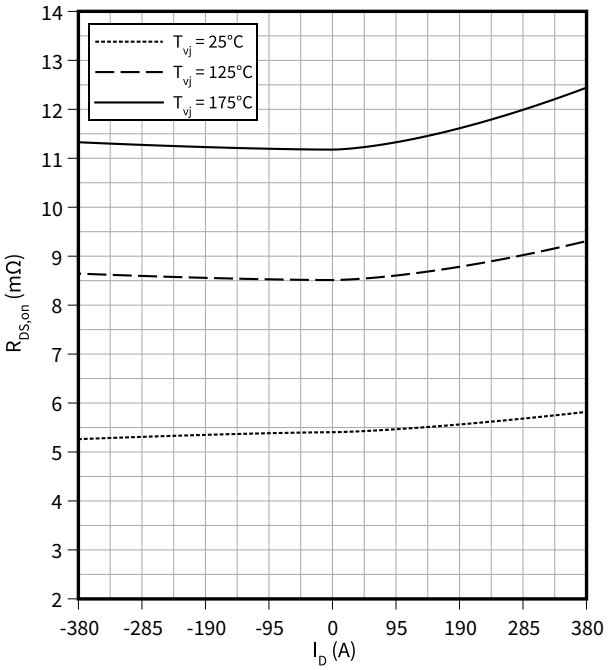
$R_{DS,on} = f(T_{vj})$

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



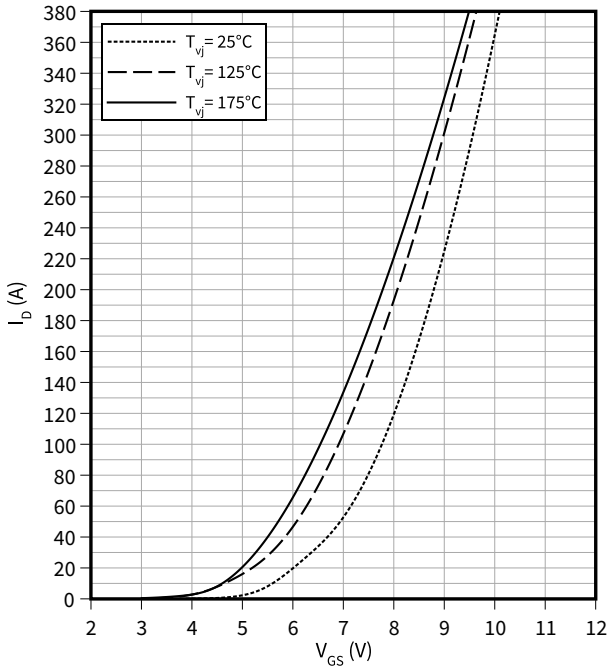
Drain-source on-resistance (typical), MOSFET

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



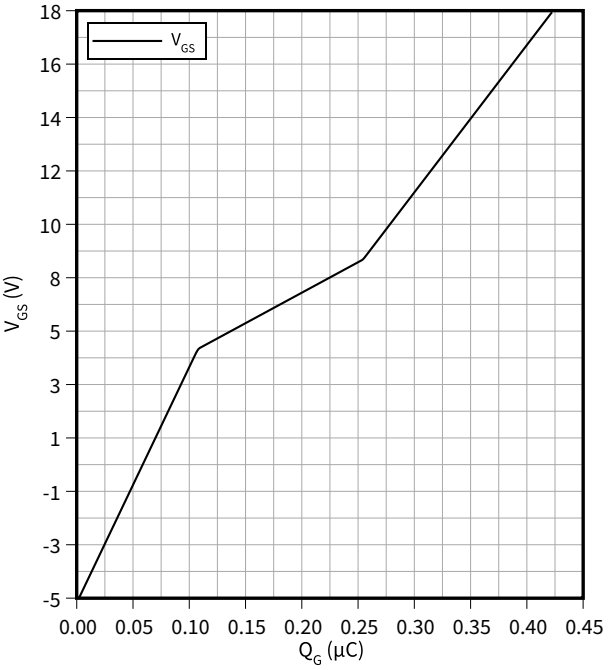
Transfer characteristic (typical), MOSFET

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



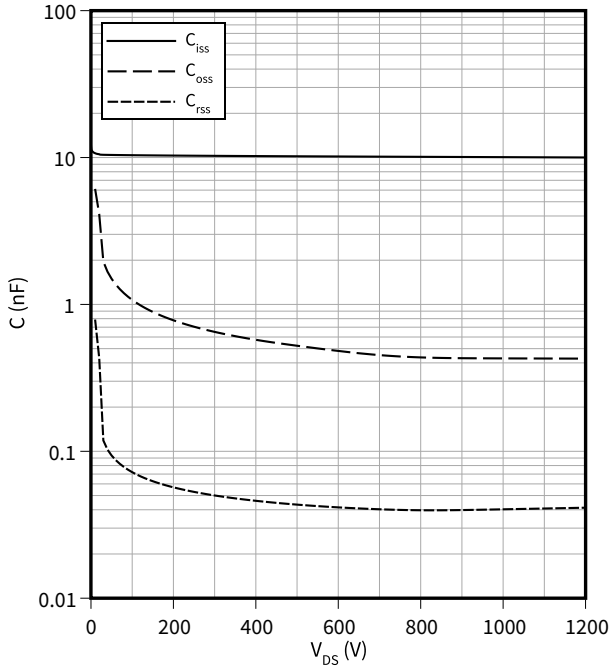
Gate charge characteristic (typical), MOSFET

$V_{GS} = f(Q_G)$
$V_{DD} = 850$ V, $T_{vj} = 25$ °C



Capacity characteristic (typical), MOSFET

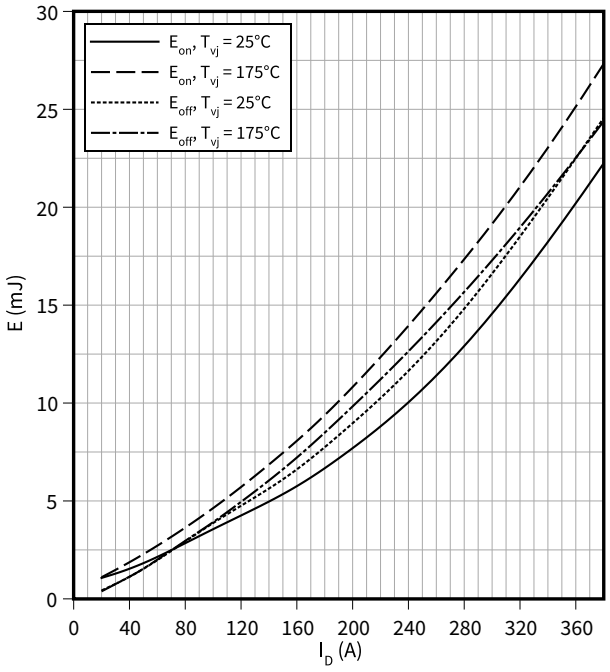
$C = f(V_{DS})$
$f = 100$ kHz, $V_{GS} = -5/18$ V, $T_{vj} = 25$ °C



Switching losses (typical), MOSFET

$E = f(I_D)$

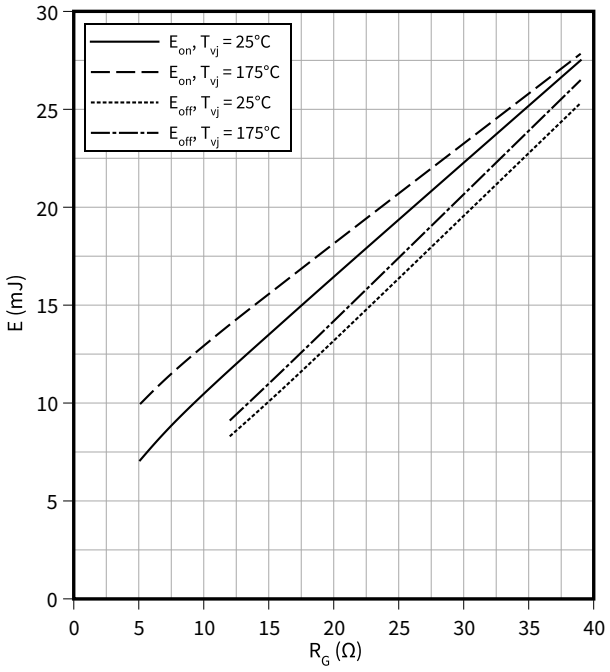
V_{DS} = 850 V, $R_{G,off}$ = 12 Ω, $R_{G,on}$ = 5.1 Ω, V_{GS} = -5/18 V



Switching losses (typical), MOSFET

$E = f(R_G)$

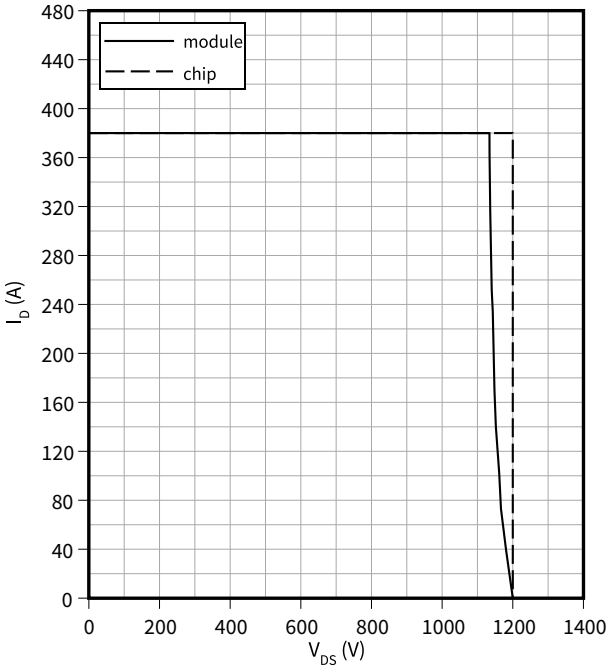
I_D = 190 A, V_{DS} = 850 V, V_{GS} = -5/18 V



Reverse bias safe operating area (RBSOA), MOSFET

$I_D = f(V_{DS})$

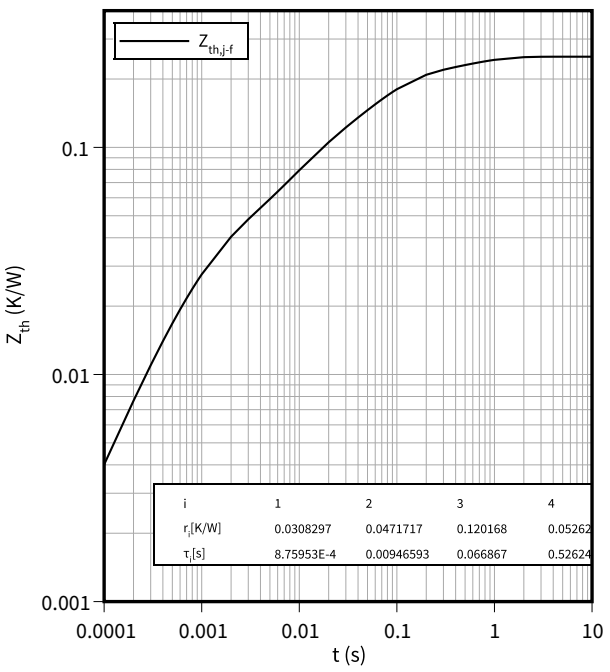
$R_{G,off}$ = 12 Ω, V_{GS} = 18/-5 V, T_{vj} = 175 °C



Transient thermal impedance (typical), MOSFET

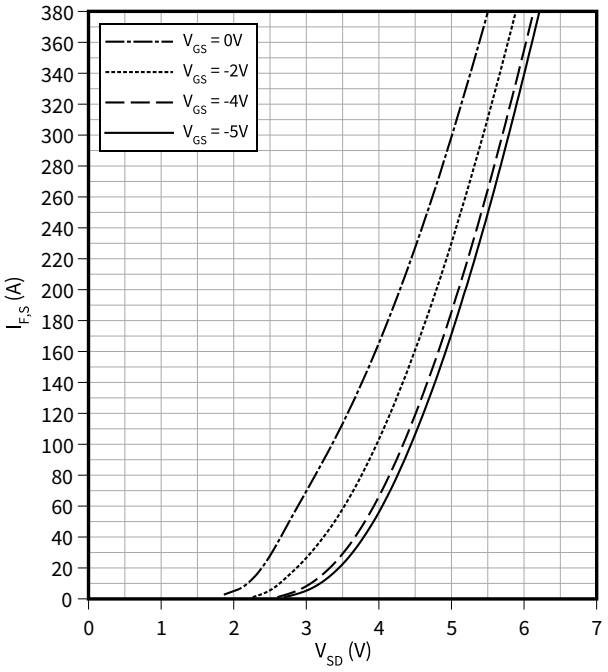
$Z_{th} = f(t)$

$\Delta V/\Delta t$ = 10 dm^3/min, T_f = 60 °C, fluid = 50% water / 50% ethylenglycol, clamping force F=800 N



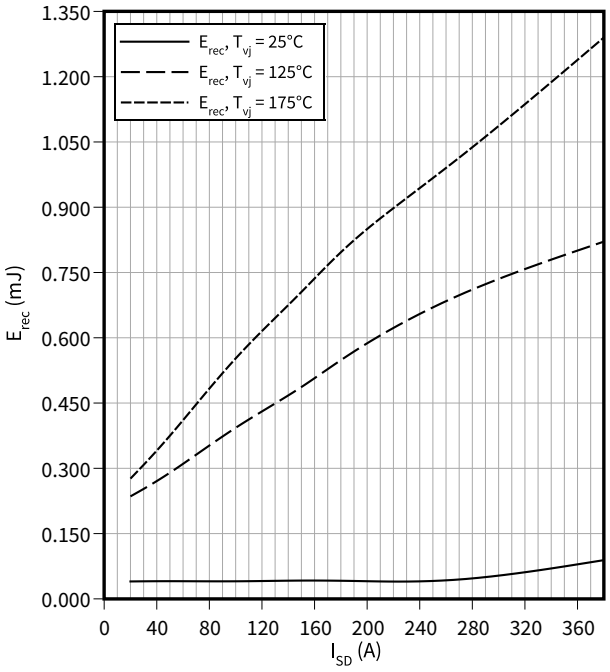
Forward characteristic body diode (typical), MOSFET

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



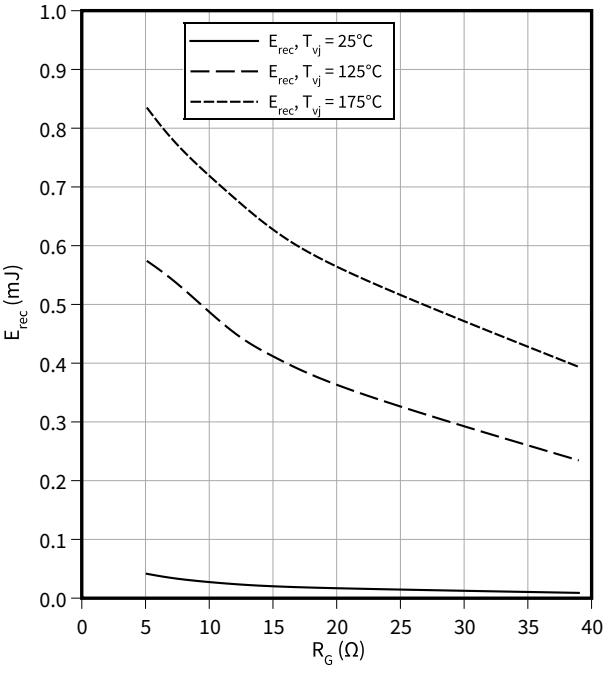
Switching losses body diode (typical), MOSFET

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



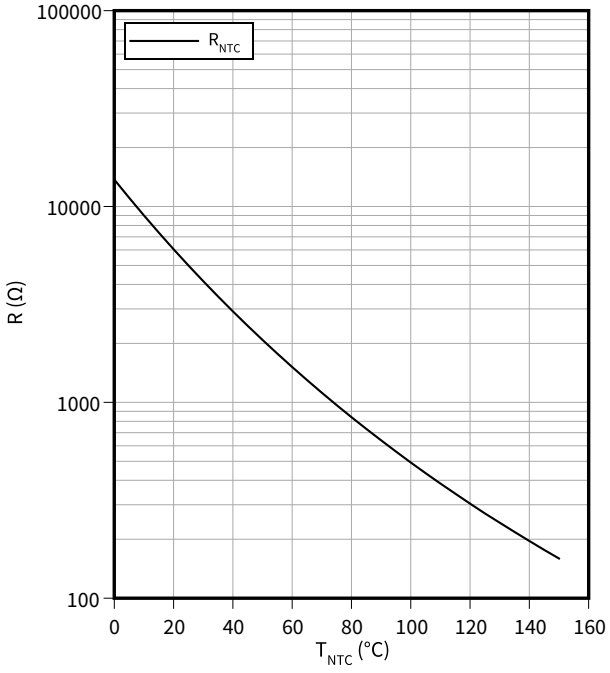
Switching losses body diode (typical), MOSFET

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



Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



6 Circuit diagram

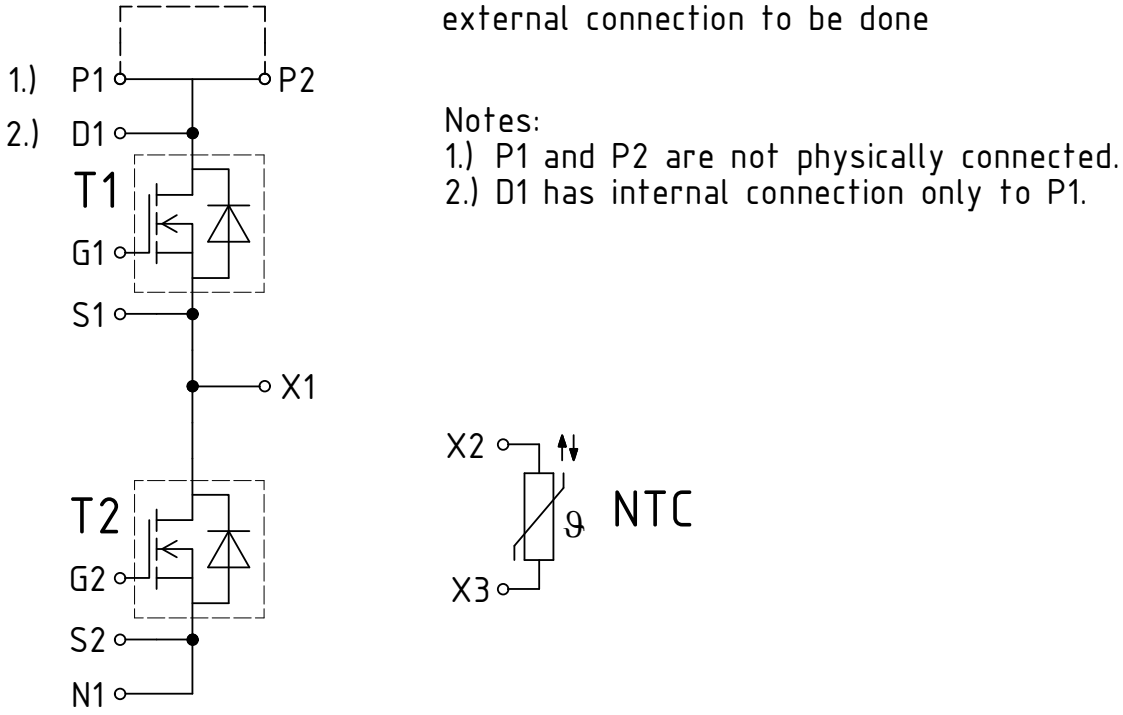


Figure 1

7 Package outlines

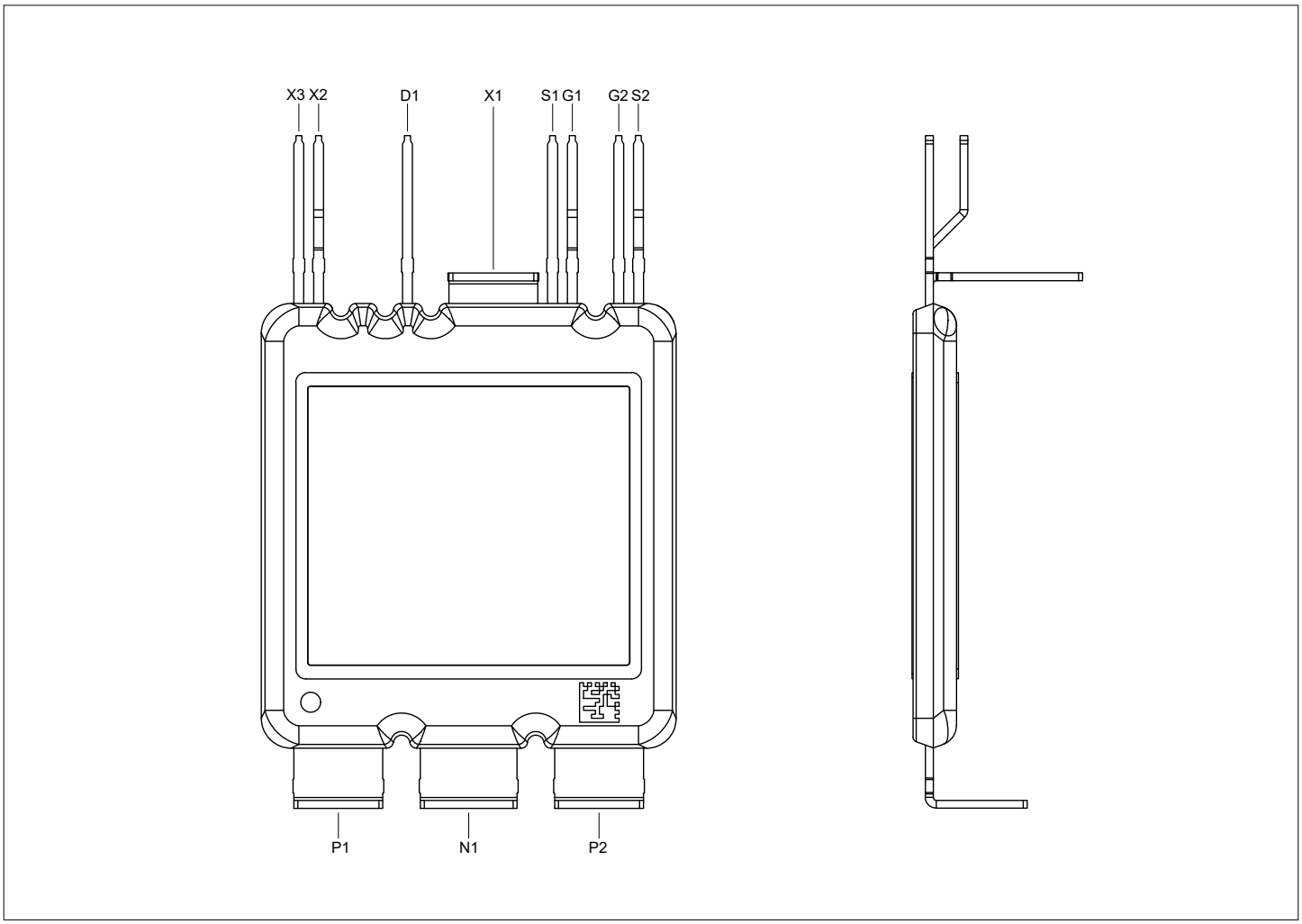
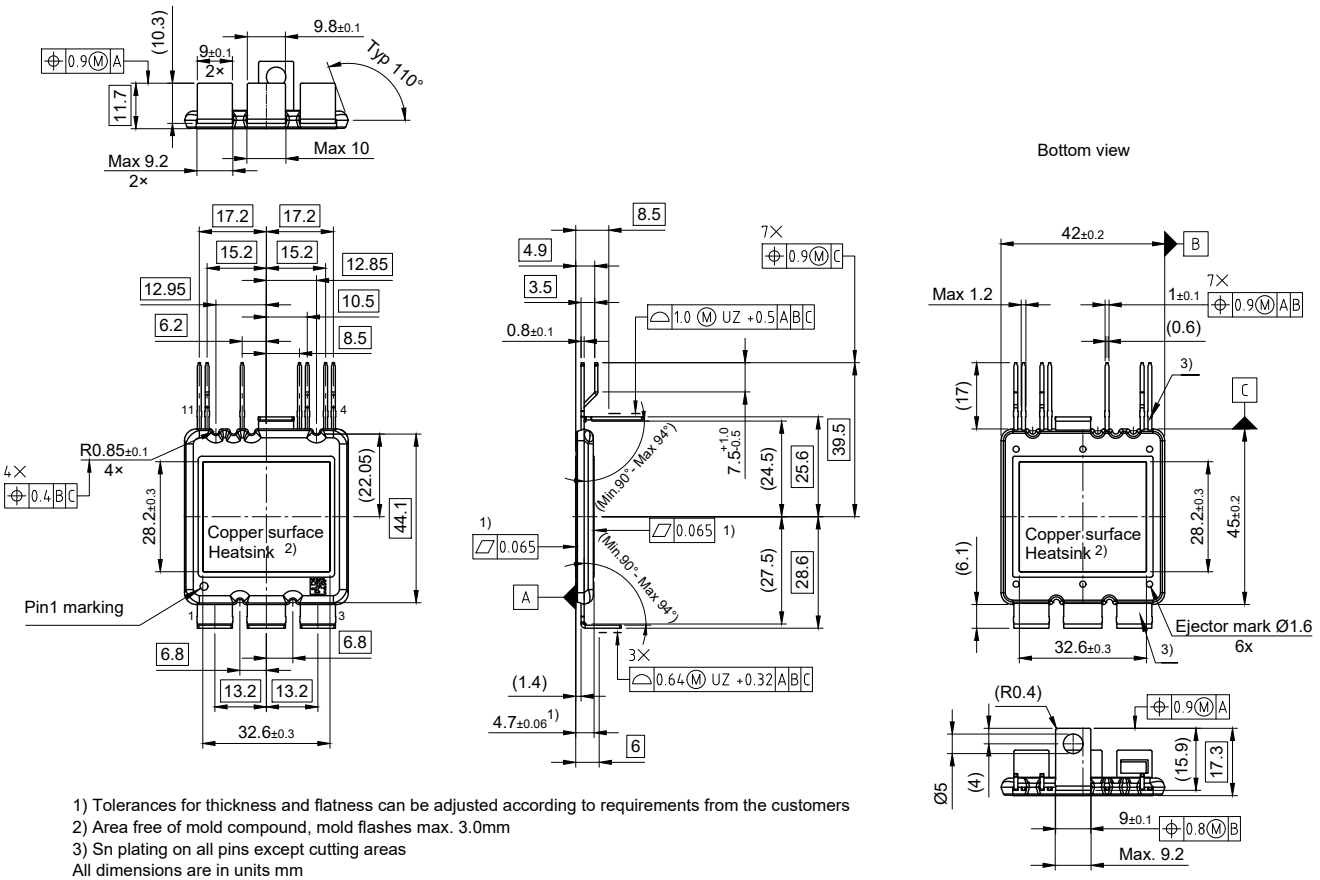


Figure 2

7 Package outlines



1) Tolerances for thickness and flatness can be adjusted according to requirements from the customers
2) Area free of mold compound, mold flashes max. 3.0mm
3) Sn plating on all pins except cutting areas
All dimensions are in units mm
The drawing is in compliance with ISO 128-30, Projection Method 1 [ ]
Drawing according to ISO 8015, general tolerances ISO 2768-mK

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	*Content* Module serial number Module material number Production order number Date code (production year) Date code (production week)	*Digit* 1 – 5 6 - 11 12 - 19 20 – 21 22 – 23	*Example* 71549 142846 55054991 15 30
Example	 715491428465505499115 30	 715491428465505499115 30	

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

Figure 4

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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