

Final datasheet

XHP™2 module with CoolSiC™ Trench MOSFET

Features

- Electrical features
 - $V_{DSS} = 3300\text{ V}$
 - $I_{DN} = 500\text{ A} / I_{DRM} = 1000\text{ A}$
 - $T_{vj,op} = 175^{\circ}\text{C}$
 - Low switching losses
 - High current density
 - Low inductive design
- Mechanical features
 - High power density
 - Package with CTI > 600
 - High creepage and clearance distances
 - ALSiC base plate for increased thermal cycling capability
 - AlN substrate with low thermal resistance



Potential applications

- Traction drives
- High-power converters
- High-frequency switching application

Product validation

- Qualified for industrial applications according to the relevant tests of IEC 60747, 60749 and 60068

Description

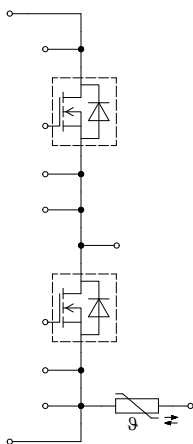


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1 Package

Table 1 Insulation coordination

Parameter	Symbol	Note or test condition	Values	Unit
Isolation test voltage	V_{ISOL}	RMS, $f = 50 \text{ Hz}$, $t = 1 \text{ min}$	6.0	kV
Partial discharge extinction voltage	V_{isol}	RMS, $f = 50 \text{ Hz}$, $Q_{PD} \leq 10 \text{ pC}$	2.6	kV
DC stability	$V_{CE(D)}$	$T_{vj} = 25 \text{ °C}$, 100 Fit	2100	V
Material of module baseplate			AlSiC	
Creepage distance	$d_{Creep \text{ nom}}$	terminal to baseplate, nom.	40.0	mm
Creepage distance	$d_{Creep \text{ nom}}$	terminal to terminal, nom.	34.0	mm
Clearance	$d_{Clear \text{ nom}}$	terminal to baseplate, nom.	31.0	mm
Clearance	$d_{Clear \text{ nom}}$	terminal to terminal, nom.	8.0	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_{SCE}			10		nH	
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	$T_C = 25 \text{ °C}$, per switch		0.43		mΩ	
Storage temperature	T_{stg}		-40		150	°C	
Maximum baseplate operation temperature	T_{BPmax}				150	°C	
Mounting torque for module mounting	M	- Mounting according to valid application note	M6, Screw	4.25		5.75	Nm
Terminal connection torque	M	- Mounting according to valid application note	M3, Screw	0.9		1.1	Nm
			M8, Screw	8		10	
Weight	G			720		g	

2 MOSFET

Table 3 Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Drain-source voltage	V_{DSS}	$T_{vj} = 25 \text{ °C}$	3300	V
Implemented drain current	I_{DN}		500	A
Continuous DC drain current	I_{DDC}	$T_{vj} = 175 \text{ °C}$, $V_{GS} = 15 \text{ V}$ $T_C = 35 \text{ °C}$	500	A

(table continues...)

Table 3 (continued) Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Repetitive peak drain current	I_{DRM}	verified by design, t_p limited by T_{vjmax}	1000	A
Gate-source voltage, max. transient voltage	V_{GS}	$D < 0.01$	-10/23	V
Gate-source voltage, max. static voltage	V_{GS}		-7/20	V

Table 4 Recommended values

Parameter	Symbol	Note or test condition	Values	Unit
On-state gate voltage	$V_{GS(on)}$		15...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	$R_{DS(on)}$	$I_D = 500$ A	$V_{GS} = 15$ V, $T_{vj} = 25$ °C	3.8	4.8	mΩ
			$V_{GS} = 15$ V, $T_{vj} = 125$ °C	7.4	9.3	
			$V_{GS} = 15$ V, $T_{vj} = 175$ °C	10.6	13.3	
Gate threshold voltage	$V_{GS(th)}$	$I_D = 450$ mA, $V_{DS} = V_{GS}$, $T_{vj} = 25$ °C, (tested after 1ms pulse at $V_{GS} = +20$ V)	3.45	4.3	5.55	V
Total gate charge	Q_G	$V_{DD} = 1800$ V, $V_{GS} = -5/15$ V		2.5		μC
Internal gate resistor	R_{Gint}	$T_{vj} = 25$ °C		1.5		Ω
Input capacitance	C_{ISS}	$f = 100$ kHz, $V_{DS} = 1800$ V, $V_{GS} = 0$ V, $T_{vj} = 25$ °C		101		nF
Output capacitance	C_{OSS}	$f = 100$ kHz, $V_{DS} = 1800$ V, $V_{GS} = 0$ V, $T_{vj} = 25$ °C		1.38		nF
Reverse transfer capacitance	C_{rSS}	$f = 100$ kHz, $V_{DS} = 1800$ V, $V_{GS} = 0$ V, $T_{vj} = 25$ °C		0.058		nF
C_{OSS} stored energy	E_{OSS}	$V_{DS} = 1800$ V, $V_{GS} = -5/15$ V, $T_{vj} = 25$ °C		2.9		mJ
Drain-source leakage current	I_{DSS}	$V_{DS} = 3300$ V, $V_{GS} = -5$ V, $T_{vj} = 25$ °C			2000	μA
Gate-source leakage current	I_{GSS}	$V_{DS} = 0$ V, $T_{vj} = 25$ °C, $V_{GS} = 20$ V			10000	nA

(table continues...)

Table 5 (continued) Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-on delay time (inductive load)	$t_{d\ on}$	$I_D = 500\ A, R_{Gon} = 0.42\ \Omega, V_{DD} = 1800\ V, V_{GS} = -5/15\ V$	$T_{vj} = 25\ ^\circ C$	300		ns
			$T_{vj} = 125\ ^\circ C$	270		
			$T_{vj} = 175\ ^\circ C$	250		
Rise time (inductive load)	t_r	$I_D = 500\ A, R_{Gon} = 0.42\ \Omega, V_{DD} = 1800\ V, V_{GS} = -5/15\ V$	$T_{vj} = 25\ ^\circ C$	125		ns
			$T_{vj} = 125\ ^\circ C$	135		
			$T_{vj} = 175\ ^\circ C$	170		
Turn-off delay time (inductive load)	$t_{d\ off}$	$I_D = 500\ A, R_{Goff} = 1.2\ \Omega, V_{DD} = 1800\ V, V_{GS} = -5/15\ V$	$T_{vj} = 25\ ^\circ C$	240		ns
			$T_{vj} = 125\ ^\circ C$	260		
			$T_{vj} = 175\ ^\circ C$	280		
Fall time (inductive load)	t_f	$I_D = 500\ A, R_{Goff} = 1.2\ \Omega, V_{DD} = 1800\ V, V_{GS} = -5/15\ V$	$T_{vj} = 25\ ^\circ C$	60		ns
			$T_{vj} = 125\ ^\circ C$	60		
			$T_{vj} = 175\ ^\circ C$	60		
Turn-on time (resistive load)	t_{on_R}	$I_D = 500\ A, V_{DD} = 2000\ V, V_{GS} = -5/15\ V, R_{Gon} = 0.42\ \Omega$	$T_{vj} = 25\ ^\circ C$	0.26		μs
Turn-on energy loss per pulse	E_{on}	$I_D = 500\ A, V_{DD} = 1800\ V, L_\sigma = 30\ nH, V_{GS} = -5/15\ V, R_{Gon} = 0.42\ \Omega, di/dt = 8.3\ kA/\mu s (T_{vj} = 175\ ^\circ C)$	$T_{vj} = 25\ ^\circ C$	85		mJ
			$T_{vj} = 125\ ^\circ C$	125		
			$T_{vj} = 175\ ^\circ C$	160		
Turn-off energy loss per pulse	E_{off}	$I_D = 500\ A, V_{DD} = 1800\ V, L_\sigma = 30\ nH, V_{GS} = -5/15\ V, R_{Goff} = 1.2\ \Omega, dv/dt = 23\ kV/\mu s (T_{vj} = 175\ ^\circ C)$	$T_{vj} = 25\ ^\circ C$	40		mJ
			$T_{vj} = 125\ ^\circ C$	40		
			$T_{vj} = 175\ ^\circ C$	40		
SC data	I_{SC}	$V_{GS} = -5/15\ V, V_{DD} = 2400\ V, V_{DSmax} = V_{DSS} - L_{sDS} * di/dt, R_G = 0.42\ \Omega$	$t_p = 3\ \mu s, T_{vj} = 175\ ^\circ C$	5400		A
Thermal resistance, junction to case	R_{thJC}	per MOSFET			41.4	K/kW
Thermal resistance, case to heat sink	R_{thCH}	per MOSFET, $\lambda_{grease} = 1\ W/(m^*K)$		24.9		K/kW
Temperature under switching conditions	$T_{vj\ op}$		-40		175	$^\circ C$

3 Body diode (MOSFET)

Table 6 Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
DC body diode forward current	I_{SD}	$T_{vj} = 175\text{ °C}, V_{GS} = -5\text{ V}$ $T_C = 80\text{ °C}$	500	A
I^2t - value	I^2t	$V_{DS} = 0\text{ V}, V_{GS} = -5\text{ V},$ $t_P = 10\text{ ms}$	125	kA^2s

Table 7 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Forward voltage	V_{SD}	$I_{SD} = 500\text{ A}, V_{GS} = -5\text{ V}$	$T_{vj} = 25\text{ °C}$	4.6	5.8	V
			$T_{vj} = 125\text{ °C}$	3.9	4.9	
			$T_{vj} = 175\text{ °C}$	3.6	4.5	
Reverse recovery energy	E_{rec}	$I_{SD} = 500\text{ A}, di_s/dt =$ $8.3\text{ kA}/\mu\text{s} (T_{vj} = 175\text{ °C}),$ $V_{DD} = 1800\text{ V}, V_{GS} = -5\text{ V}$	$T_{vj} = 25\text{ °C}$	13		mJ
			$T_{vj} = 125\text{ °C}$	27		
			$T_{vj} = 175\text{ °C}$	40		

4 NTC-Thermistor

Table 8 Characteristic values

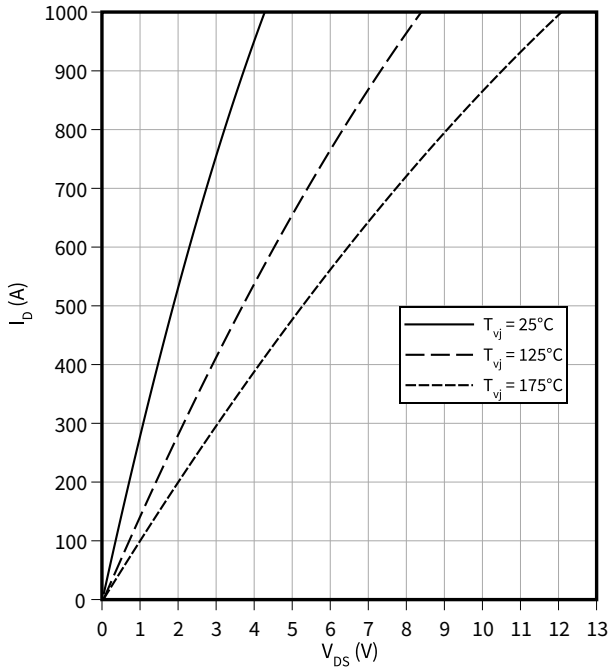
Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rated resistance	R_{25}	$T_{NTC} = 25\text{ °C}$		5		k Ω
Deviation of R_{100}	$\Delta R/R$	$T_{NTC} = 100\text{ °C}, R_{100} = 493\text{ }\Omega$	-5		5	%
Power dissipation	P_{25}	$T_{NTC} = 25\text{ °C}$			20	mW
B-value	$B_{25/50}$	$R_2 = R_{25} \exp[B_{25/50}(1/T_2 - 1/(298,15\text{ K}))]$		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

Note: For an analytical description of the NTC characteristics please refer to AN2009-10, chapter 4.

5 Characteristics diagrams

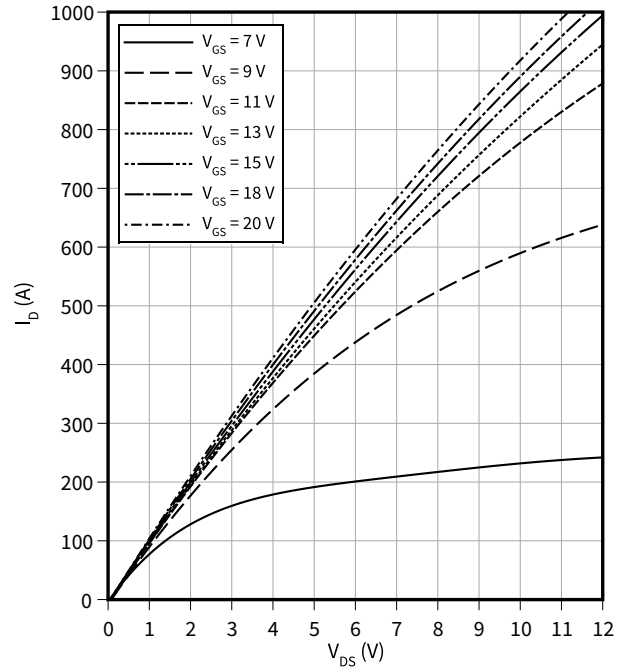
Output characteristic (typical), MOSFET

$I_D = f(V_{DS})$
 $V_{GS} = 15\text{ V}$



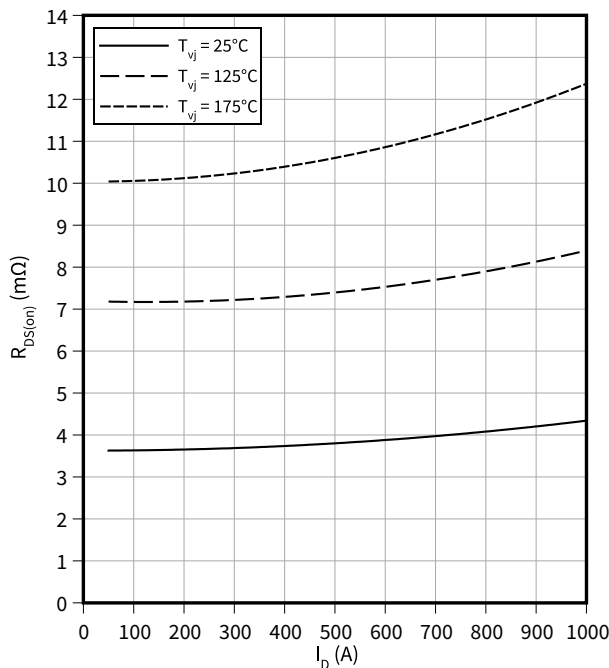
Output characteristic field (typical), MOSFET

$I_D = f(V_{DS})$
 $T_{vj} = 175\text{ °C}$



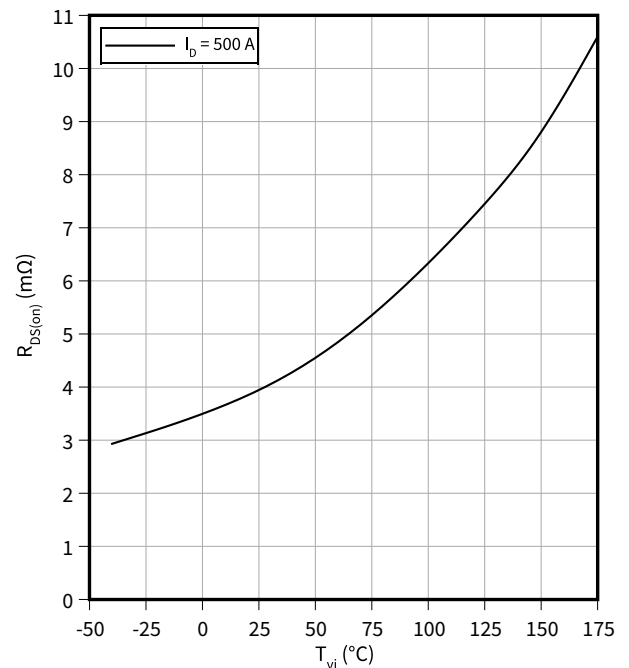
Drain source on-resistance (typical), MOSFET

$R_{DS(on)} = f(I_D)$
 $V_{GS} = 15\text{ V}$



Drain source on-resistance (typical), MOSFET

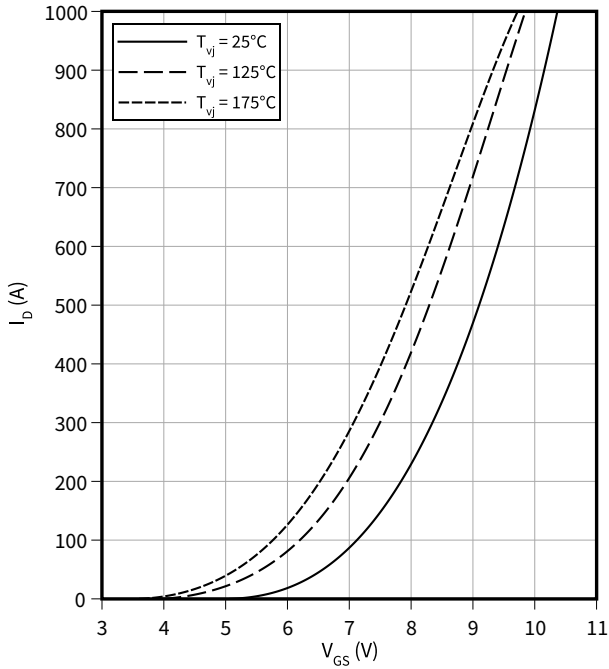
$R_{DS(on)} = f(T_{vj})$
 $V_{GS} = 15\text{ V}$



5 Characteristics diagrams

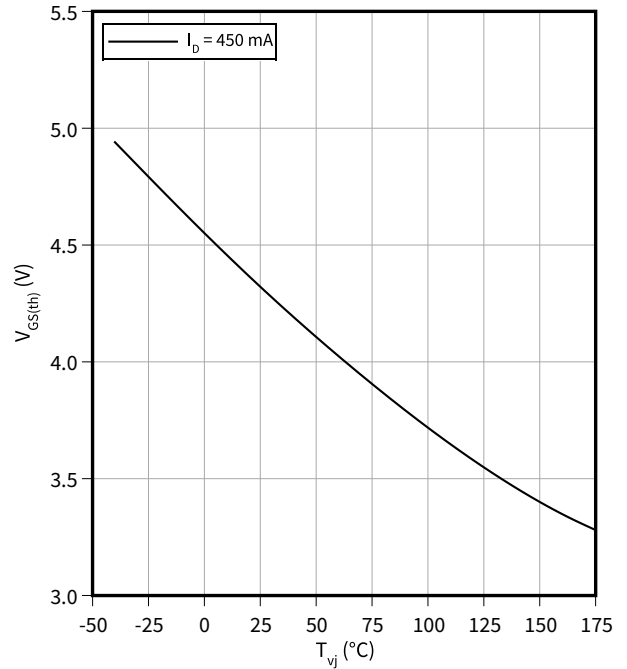
Transfer characteristic (typical), MOSFET

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



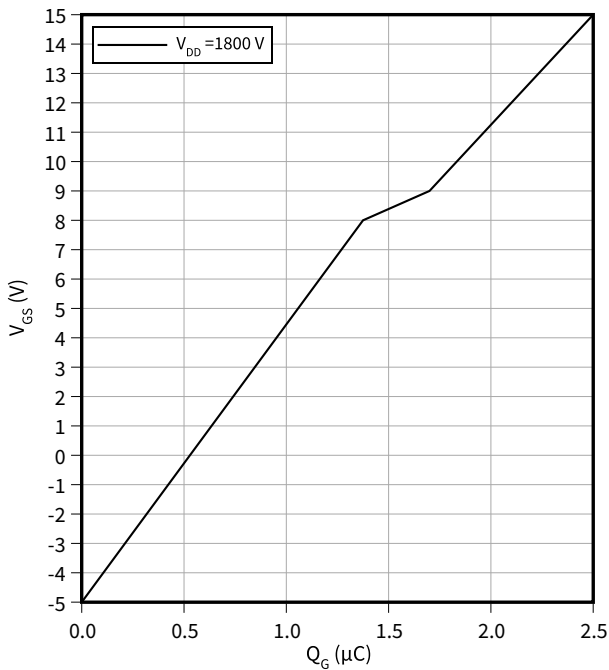
Gate-source threshold voltage (typical), MOSFET

$V_{GS(th)} = f(T_{vj})$
 $V_{GS} = V_{DS}$



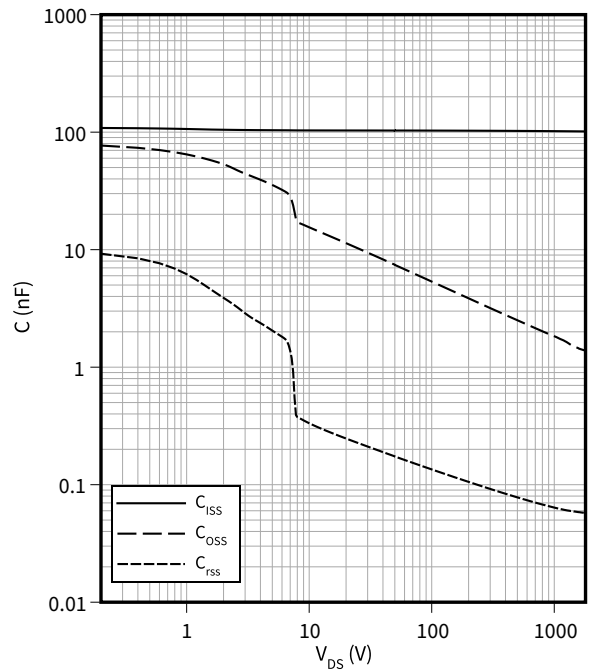
Gate charge characteristic (typical), MOSFET

$V_{GS} = f(Q_G)$
 $I_D = 500\text{ A}, T_{vj} = 25^\circ\text{C}$



Capacity characteristic (typical), MOSFET

$C = f(V_{DS})$
 $f = 100\text{ kHz}, T_{vj} = 25^\circ\text{C}, V_{GS} = 0\text{ V}$

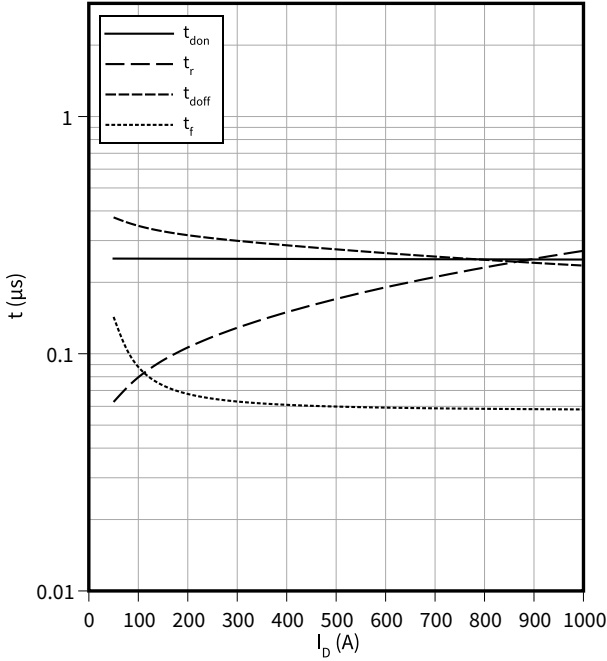


5 Characteristics diagrams

Switching times (typical), MOSFET

$t = f(I_D)$

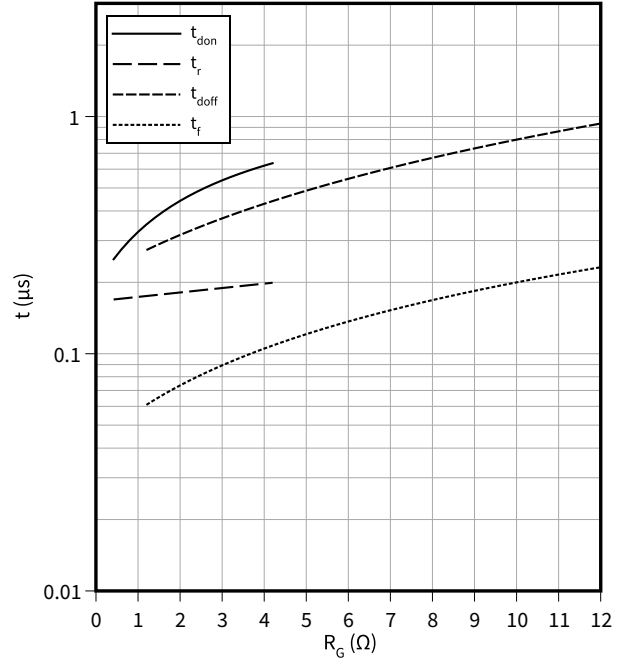
$R_{Goff} = 1.2 \Omega$, $R_{Gon} = 0.42 \Omega$, $V_{DD} = 1800 \text{ V}$, $T_{vj} = 175 \text{ }^\circ\text{C}$, $V_{GS} = -5/15 \text{ V}$



Switching times (typical), MOSFET

$t = f(R_G)$

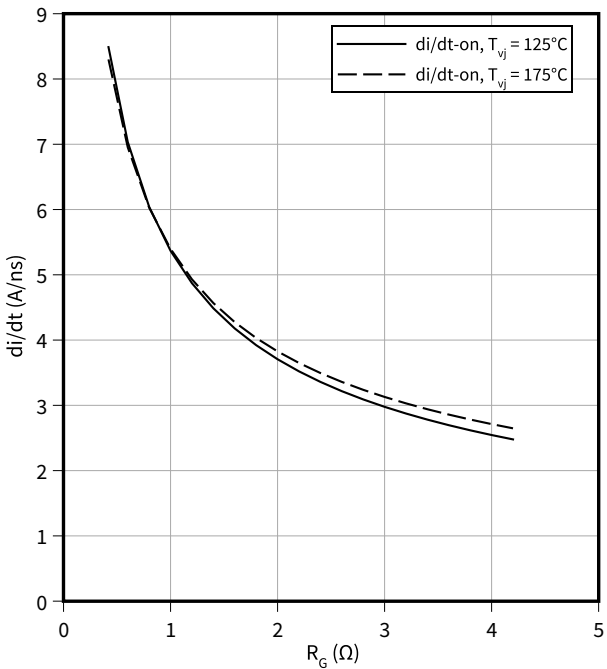
$V_{DD} = 1800 \text{ V}$, $I_D = 500 \text{ A}$, $T_{vj} = 175 \text{ }^\circ\text{C}$, $V_{GS} = -5/15 \text{ V}$



Current slope (typical), MOSFET

$di/dt = f(R_G)$

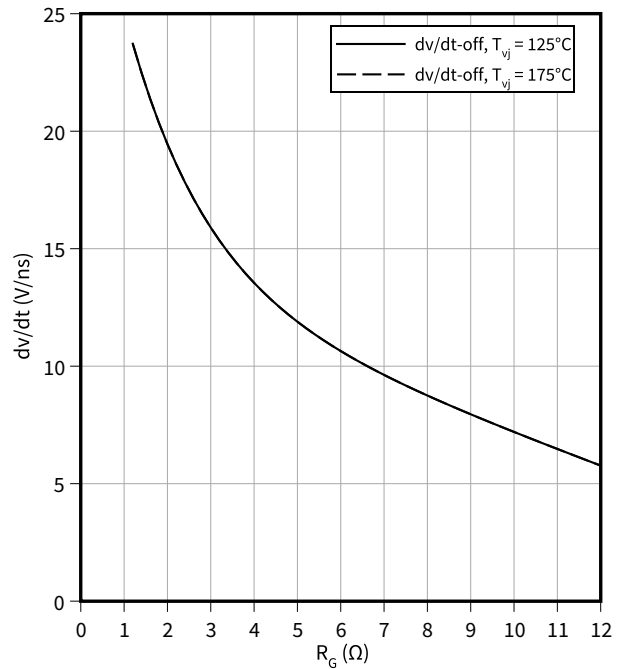
$V_{DD} = 1800 \text{ V}$, $I_D = 500 \text{ A}$, $V_{GS} = -5/15 \text{ V}$



Voltage slope (typical), MOSFET

$dv/dt = f(R_G)$

$V_{DD} = 1800 \text{ V}$, $I_D = 500 \text{ A}$, $V_{GS} = -5/15 \text{ V}$

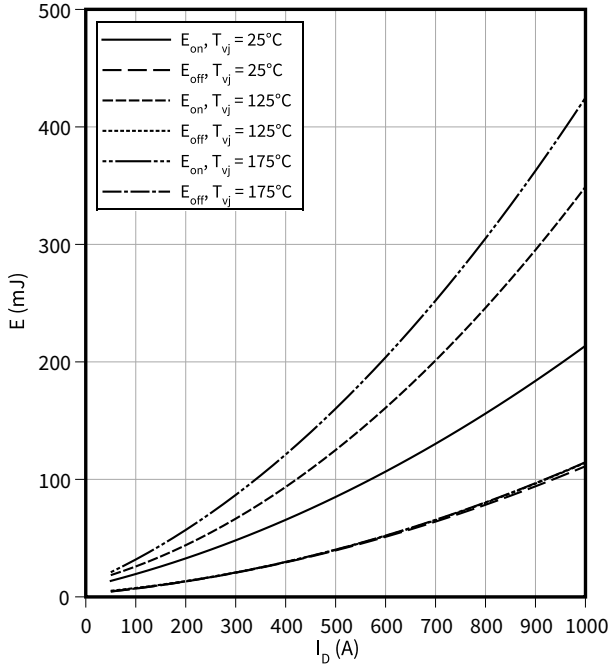


5 Characteristics diagrams

Switching losses (typical), MOSFET

$E = f(I_D)$

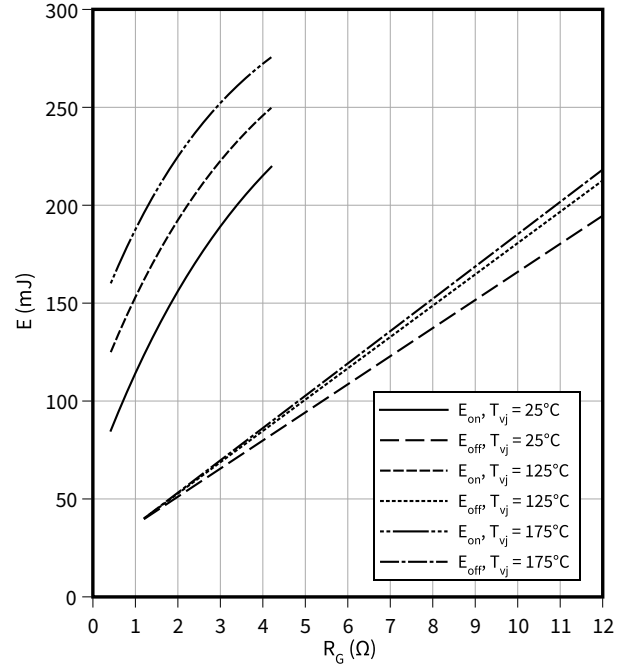
$R_{Goff} = 1.2 \Omega$, $R_{Gon} = 0.42 \Omega$, $V_{DD} = 1800 \text{ V}$, $V_{GS} = -5/15 \text{ V}$



Switching losses (typical), MOSFET

$E = f(R_G)$

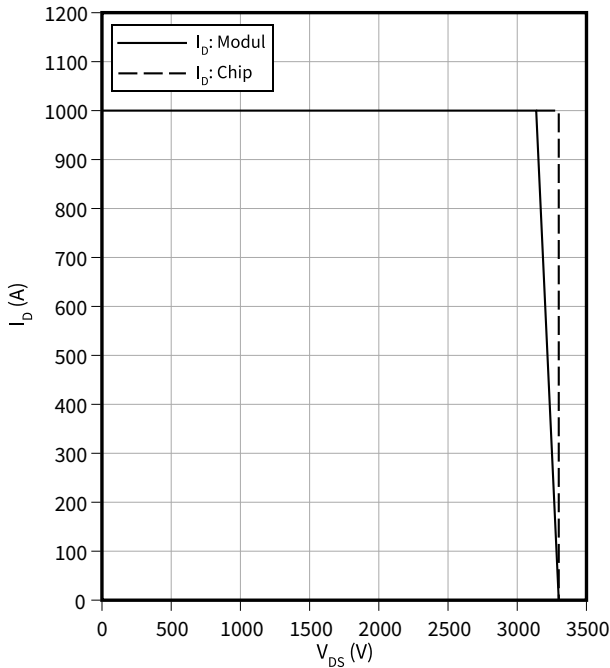
$V_{DD} = 1800 \text{ V}$, $I_D = 500 \text{ A}$, $V_{GS} = -5/15 \text{ V}$



Reverse bias safe operating area (RBSOA), MOSFET

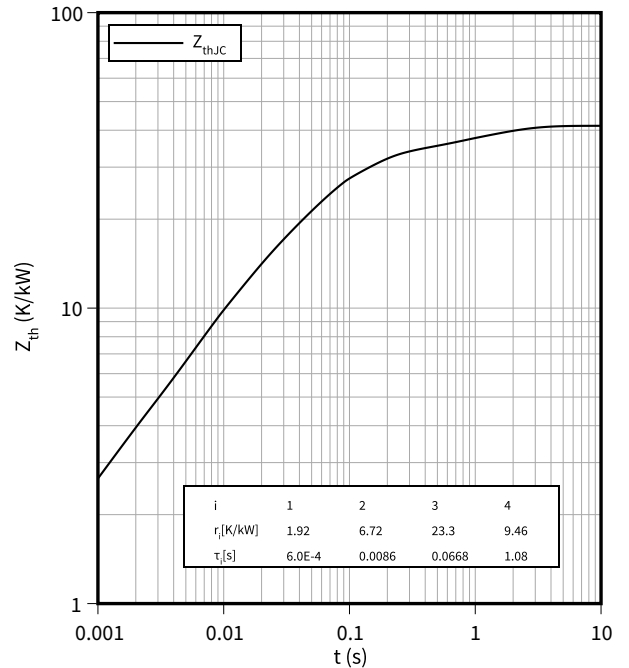
$I_D = f(V_{DS})$

$R_{Goff} = 1.2 \Omega$, $T_{vj} = 175 \text{ °C}$, $V_{GS} = -5/15 \text{ V}$



Transient thermal impedance, MOSFET

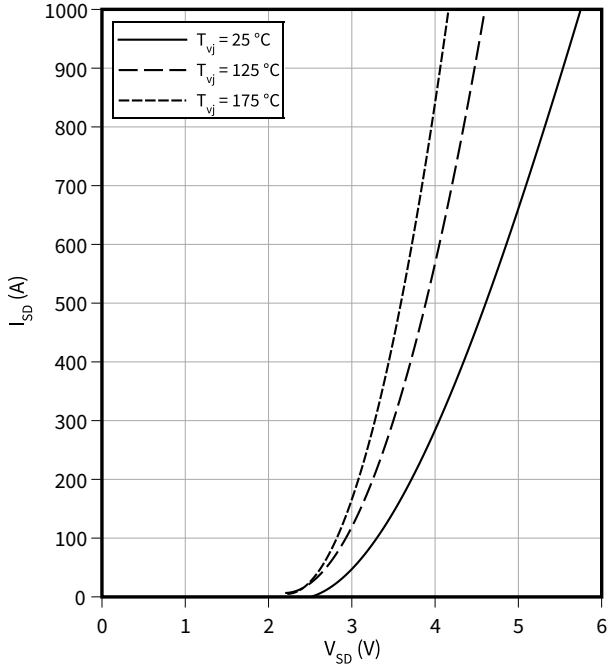
$Z_{th} = f(t)$



5 Characteristics diagrams

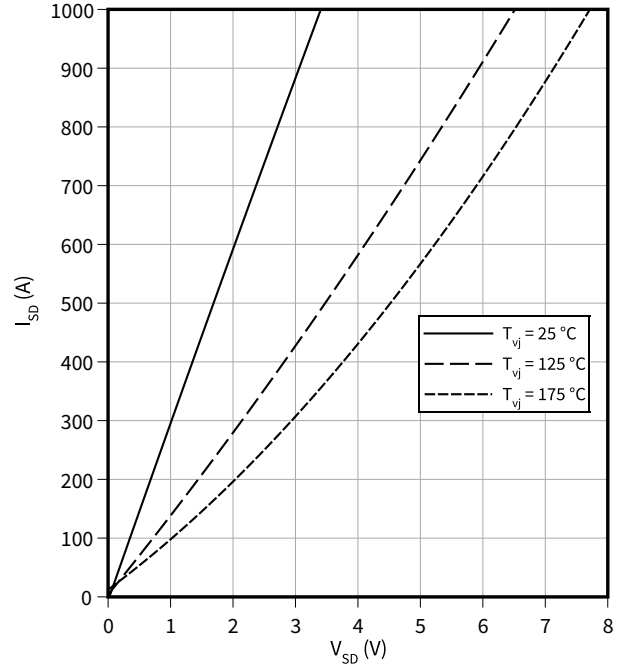
Forward characteristic body diode (typical), MOSFET

$I_{SD} = f(V_{SD})$
 $V_{GS} = -5 \text{ V}$



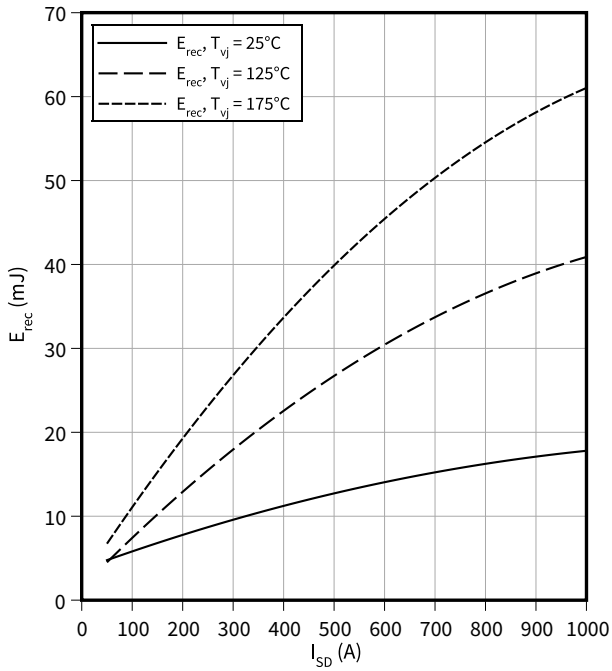
Forward characteristic body diode (typical), MOSFET

$I_{SD} = f(V_{SD})$
 $V_{GS} = 15 \text{ V}$



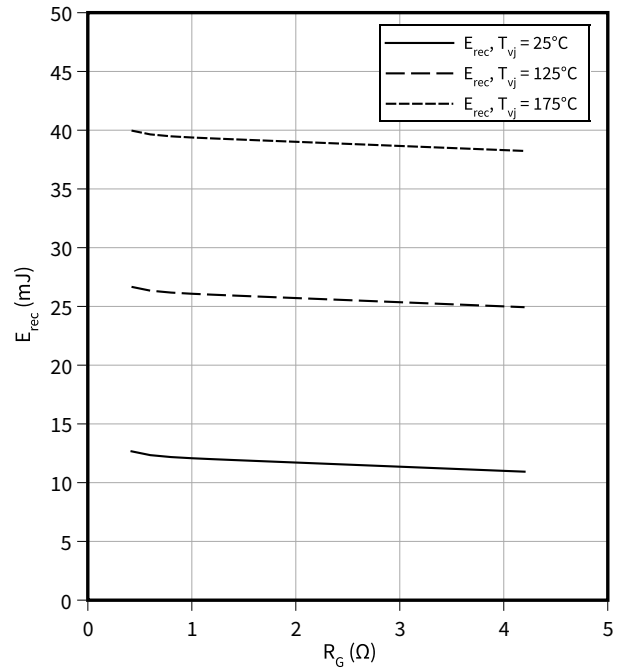
Switching losses body diode (typical), MOSFET

$E_{rec} = f(I_{SD})$
 $R_{Gon} = 0.42 \text{ } \Omega$, $V_{DD} = 1800 \text{ V}$



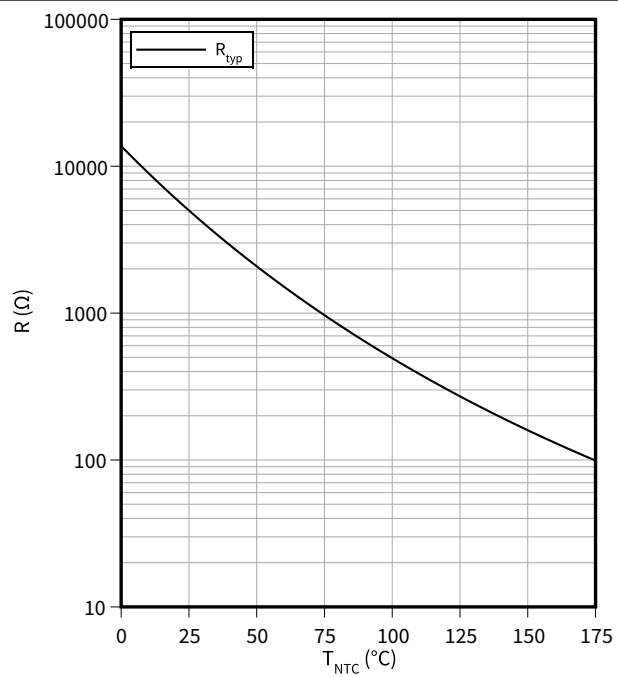
Switching losses body diode (typical), MOSFET

$E_{rec} = f(R_G)$
 $V_{DD} = 1800 \text{ V}$, $I_{SD} = 500 \text{ A}$



Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



6 Circuit diagram

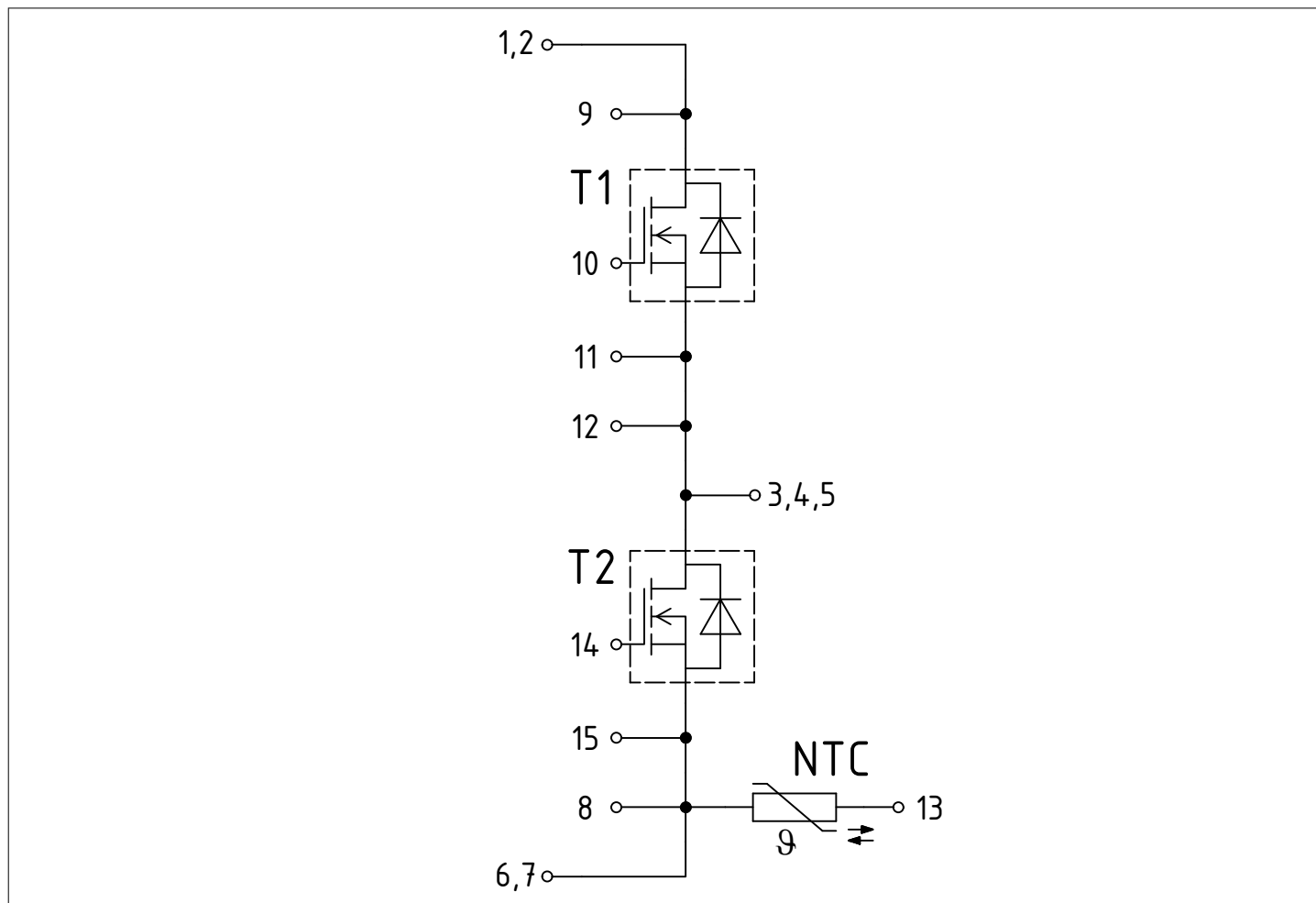


Figure 1

7 Package outlines

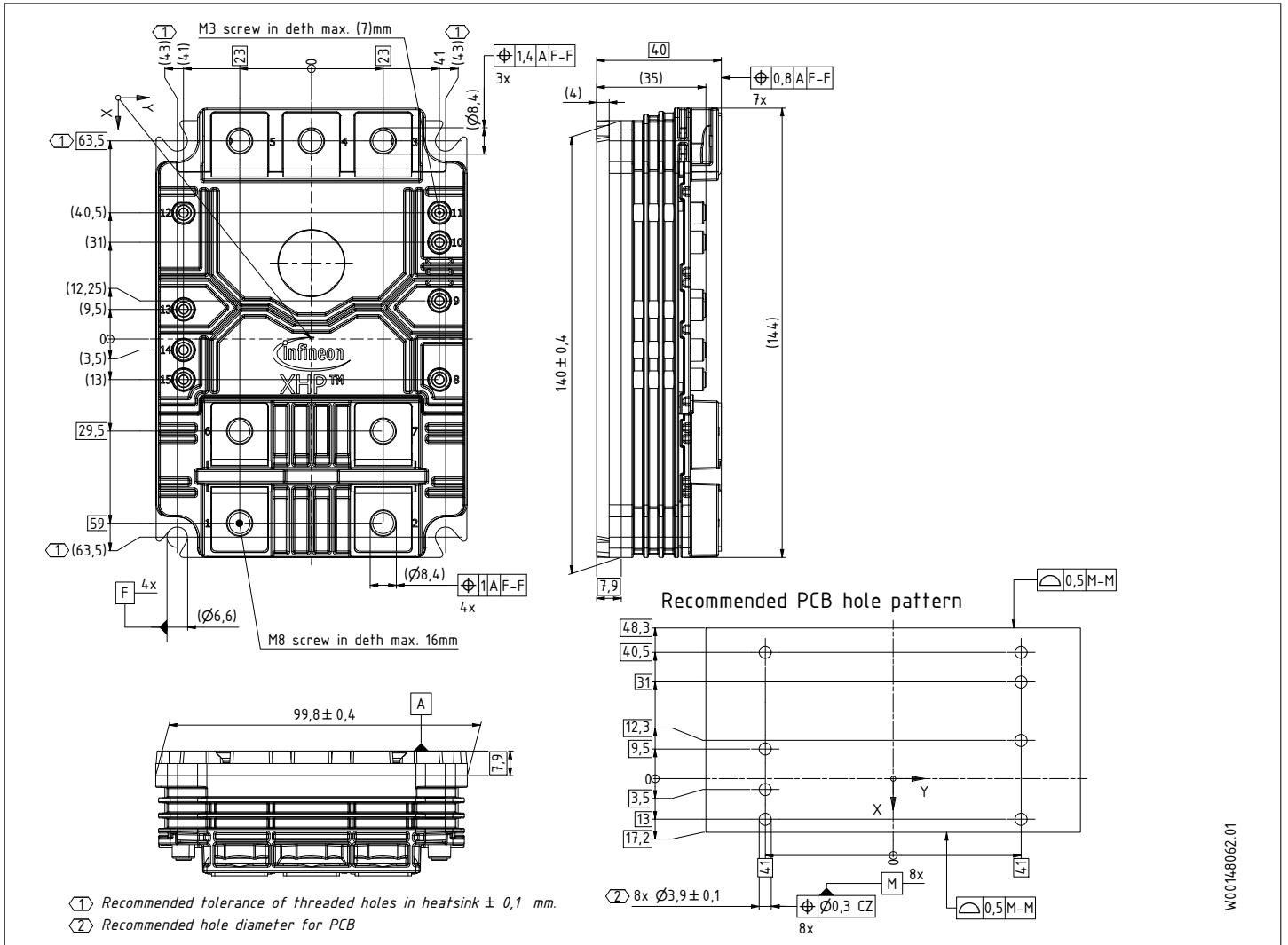


Figure 2

8 Module label code


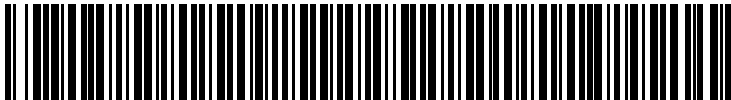
Module label code			
Code format	Data Matrix	Barcode Code128	
Encoding	ASCII text	Code Set A	
Symbol size	16x16	23 digits	
Standard	IEC24720 and IEC16022	IEC8859-1	
Code content	<i>Content</i>	<i>Digit</i>	<i>Example</i>
	Module serial number	1 - 5	71549
	Module material number	6 - 11	142846
	Production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

Figure 3

Revision history

Revision history

Document revision	Date of release	Description of changes
1.00	2024-07-05	Initial version

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