Final datasheet
XHP™2 module with CoolSiC™ Trench MOSFET

Features

- Electrical features
  - V_{DSS} = 3300 V
  - I_{DN} = 1000 A / I_{DRM} = 2000 A
  - $T_{vj,op}$ = 175°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

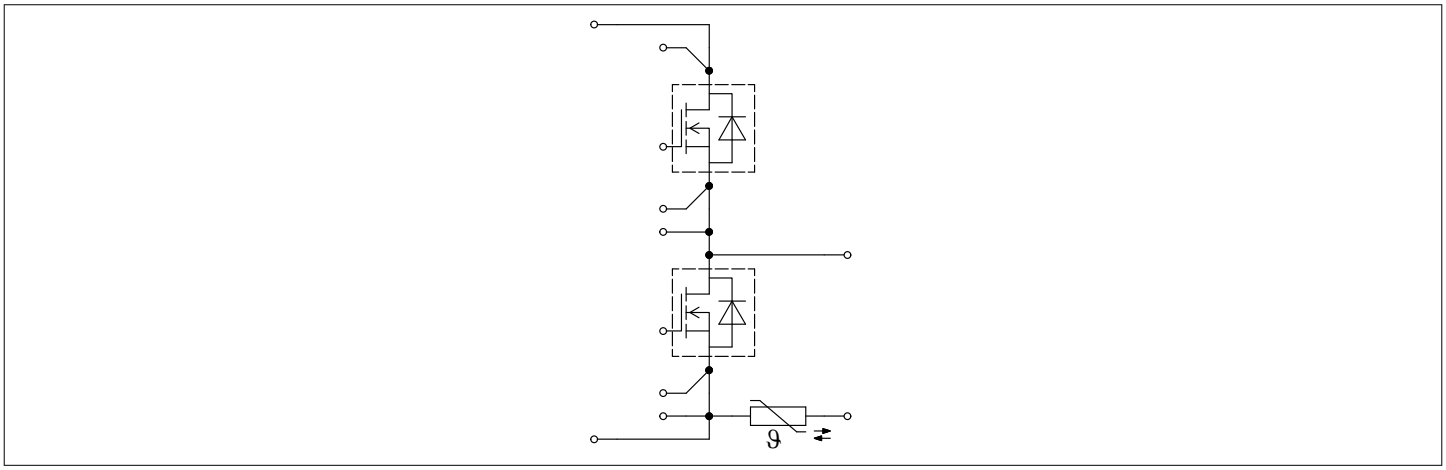
Potential applications

- 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 Hz, t = 1 min	6.0	kV
Partial discharge extinction voltage	V_{isol}	RMS, f = 50 Hz, Q_{PD} ≤ 10 pC	2.6	kV
DC stability	$V_{CE(D)}$	T_{vj} = 25 °C, 100 Fit	2100	V
Material of module baseplate			AlSiC	
Creepage distance	$d_{Creep\ nom}$	terminal to baseplate, nom.	40.0	mm
Creepage distance	$d_{Creep\ nom}$	terminal to terminal, nom.	34.0	mm
Clearance	$d_{Clear\ nom}$	terminal to baseplate, nom.	31.0	mm
Clearance	$d_{Clear\ nom}$	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 °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

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Table 3 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Drain-source voltage	V_{DSS}		T_{vj} = 25 °C	3300	V
Implemented drain current	I_{DN}			1000	A
Continuous DC drain current	I_{DDC}	T_{vj} = 175 °C, V_{GS} = 15 V	T_C = 25 °C	925	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}	2000	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 = 1000 A	V_{GS} = 15 V, T_{vj} = 25 °C		1.9	2.4	mΩ
			V_{GS} = 15 V, T_{vj} = 125 °C		3.7	4.6	
			V_{GS} = 15 V, T_{vj} = 175 °C		5.3	6.6	
Gate threshold voltage	$V_{GS(th)}$	I_D = 900 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			5		µC
Internal gate resistor	R_{Gint}	T_{vj} = 25 °C			0.75		Ω
Input capacitance	C_{ISS}	f = 100 kHz, V_{DS} = 1800 V, V_{GS} = 0 V	T_{vj} = 25 °C		203		nF
Output capacitance	C_{OSS}	f = 100 kHz, V_{DS} = 1800 V, V_{GS} = 0 V	T_{vj} = 25 °C		2.8		nF
Reverse transfer capacitance	C_{rss}	f = 100 kHz, V_{DS} = 1800 V, V_{GS} = 0 V	T_{vj} = 25 °C		0.115		nF
C_{OSS} stored energy	E_{OSS}	V_{DS} = 1800 V, V_{GS} = -5/15 V, T_{vj} = 25 °C			5.8		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 = 1000 A, R_{Gon} = 0.75 Ω, V_{DD} = 1800 V, V_{GS} = -5/15 V	T_{vj} = 25 °C		480		ns
			T_{vj} = 125 °C		420		
			T_{vj} = 175 °C		420		
Rise time (inductive load)	t_r	I_D = 1000 A, R_{Gon} = 0.75 Ω, V_{DD} = 1800 V, V_{GS} = -5/15 V	T_{vj} = 25 °C		170		ns
			T_{vj} = 125 °C		210		
			T_{vj} = 175 °C		210		
Turn-off delay time (inductive load)	$t_{d\,off}$	I_D = 1000 A, R_{Goff} = 1.2 Ω, V_{DD} = 1800 V, V_{GS} = -5/15 V	T_{vj} = 25 °C		330		ns
			T_{vj} = 125 °C		370		
			T_{vj} = 175 °C		380		
Fall time (inductive load)	t_f	I_D = 1000 A, R_{Goff} = 1.2 Ω, V_{DD} = 1800 V, V_{GS} = -5/15 V	T_{vj} = 25 °C		82		ns
			T_{vj} = 125 °C		82		
			T_{vj} = 175 °C		82		
Turn-on time (resistive load)	t_{on_R}	I_D = 500 A, V_{DD} = 2000 V, V_{GS} = -5/15 V, R_{Gon} = 0.75 Ω	T_{vj} = 25 °C	0.50			µs
Turn-on energy loss per pulse	E_{on}	I_D = 1000 A, V_{DD} = 1800 V, L_σ = 30 nH, V_{GS} = -5/15 V, R_{Gon} = 0.75 Ω, di/dt = 7.8 kA/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		280		mJ
			T_{vj} = 125 °C		350		
			T_{vj} = 175 °C		420		
Turn-off energy loss per pulse	E_{off}	I_D = 1000 A, V_{DD} = 1800 V, L_σ = 30 nH, V_{GS} = -5/15 V, R_{Goff} = 1.2 Ω, dv/dt = 18.2 kV/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		160		mJ
			T_{vj} = 125 °C		160		
			T_{vj} = 175 °C		160		
SC data	I_{SC}	V_{GS} = -5/15 V, V_{DD} = 2400 V, $V_{DSmax} = V_{DSS}-L_{sDS}*di/dt$, R_G = 0.75 Ω	t_P = 3 µs, T_{vj} = 175 °C		9100		A
Thermal resistance, junction to case	R_{thJC}	per MOSFET				26.3	K/kW
Thermal resistance, case to heat sink	R_{thCH}	per MOSFET, λ_{grease}= 1 W /(m*K)			21.5		K/kW
Temperature under switching conditions	$T_{vj\,op}$			-40		175	°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 °C, V_{GS} = -5 V	T_C = 55 °C	1000	A
I^2t - value	I^2t	V_{DS} = 0 V, V_{GS} = -5 V, t_P = 10 ms	T_{vj} = 175 °C	500	kA^2s

Table 7 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_{SD}	I_{SD} = 1000 A, V_{GS} = -5 V	T_{vj} = 25 °C		4.6	5.8	V
			T_{vj} = 125 °C		3.9	4.9	
			T_{vj} = 175 °C		3.6	4.5	
Reverse recovery energy	E_{rec}	I_{SD} = 1000 A, di_s/dt = 7.8 kA/µs (T_{vj} = 175 °C), V_{DD} = 1800 V, V_{GS}=-5 V	T_{vj} = 25 °C		40		mJ
			T_{vj} = 125 °C		62		
			T_{vj} = 175 °C		105		

4 NTC-Thermistor

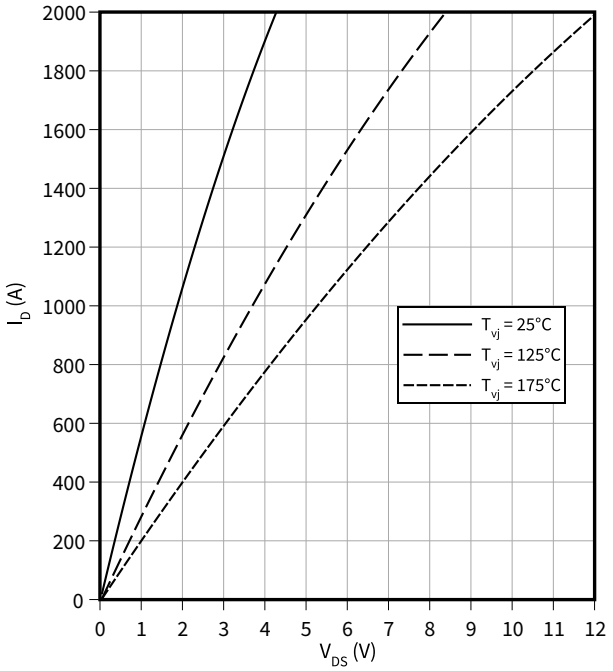
Table 8 Characteristic values

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

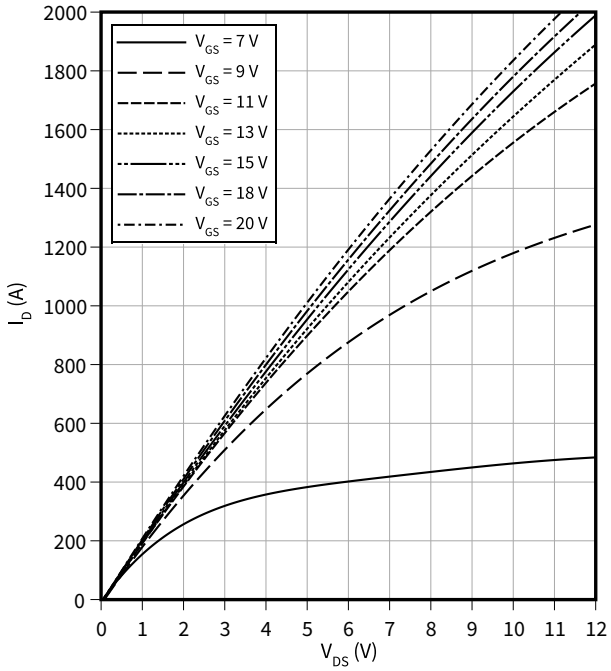
***Note**: Specification according to the valid application note.*

5 Characteristics diagrams

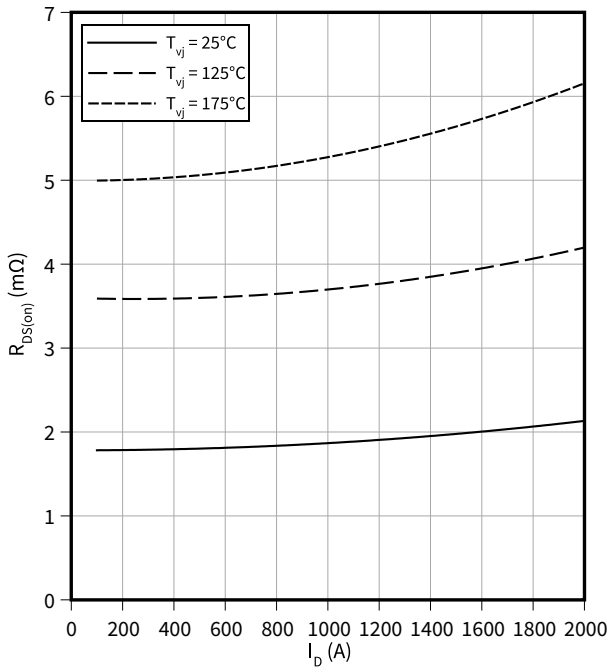
Output characteristic (typical), MOSFET
$I_D = f(V_{DS})$
V_{GS} = 15 V



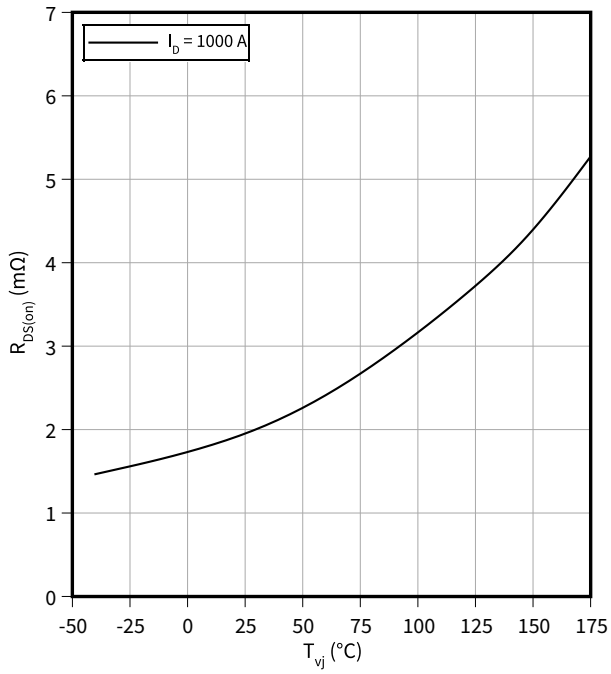
Output characteristic field (typical), MOSFET
$I_D = f(V_{DS})$
T_{vj} = 175 °C



Drain source on-resistance (typical), MOSFET
$R_{DS(on)} = f(I_D)$
V_{GS} = 15 V

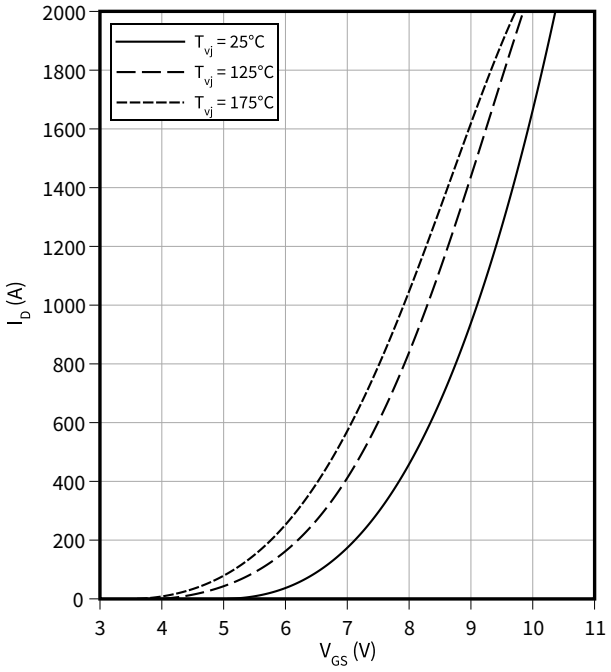


Drain source on-resistance (typical), MOSFET
$R_{DS(on)} = f(T_{vj})$
V_{GS} = 15 V



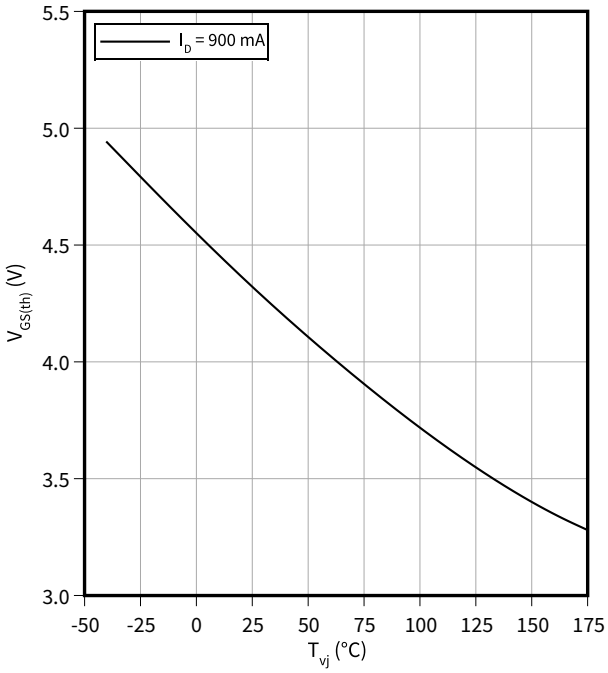
Transfer characteristic (typical), MOSFET

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



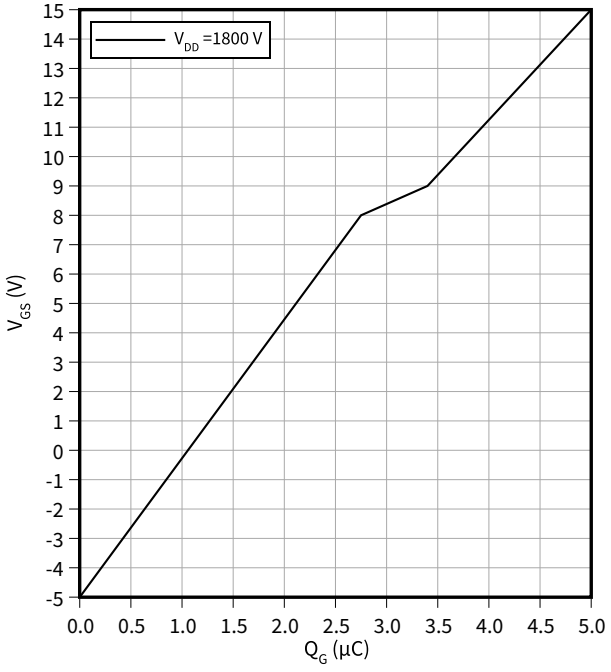
Gate-source threshold voltage (typical), MOSFET

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



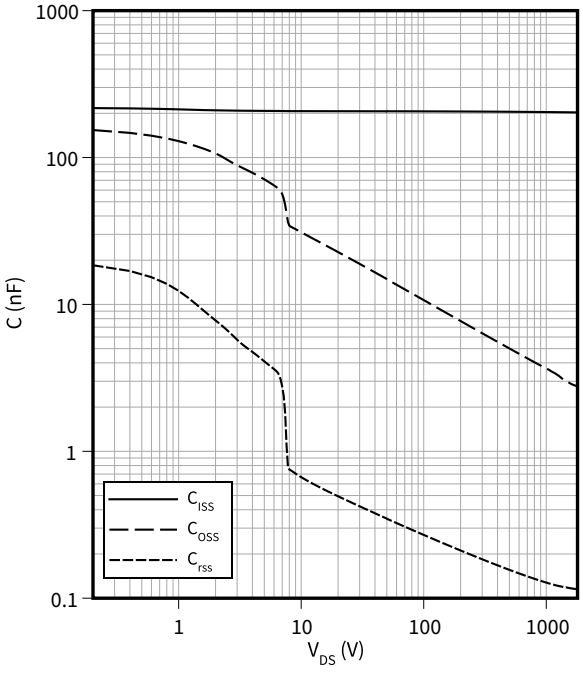
Gate charge characteristic (typical), MOSFET

$V_{GS} = f(Q_G)$
$I_D = 1000$ A, $T_{vj} = 25$ °C



Capacity characteristic (typical), MOSFET

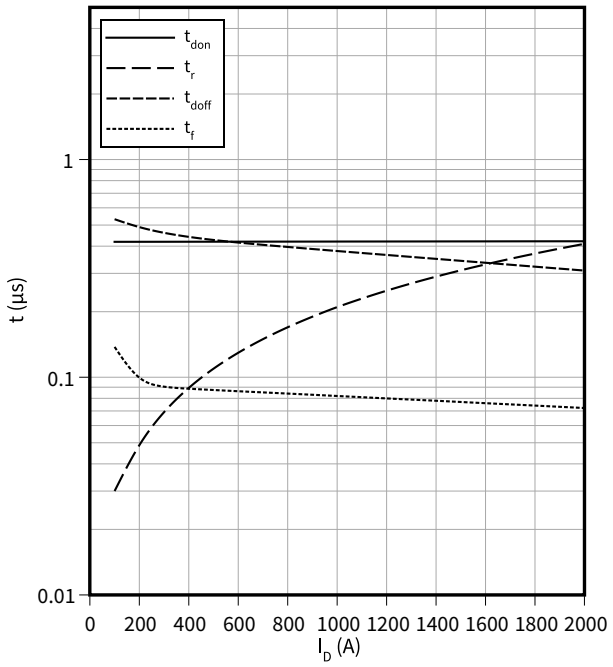
$C = f(V_{DS})$
$f = 100$ kHz, $T_{vj} = 25$ °C, $V_{GS} = 0$ V



Switching times (typical), MOSFET

$t = f(I_D)$

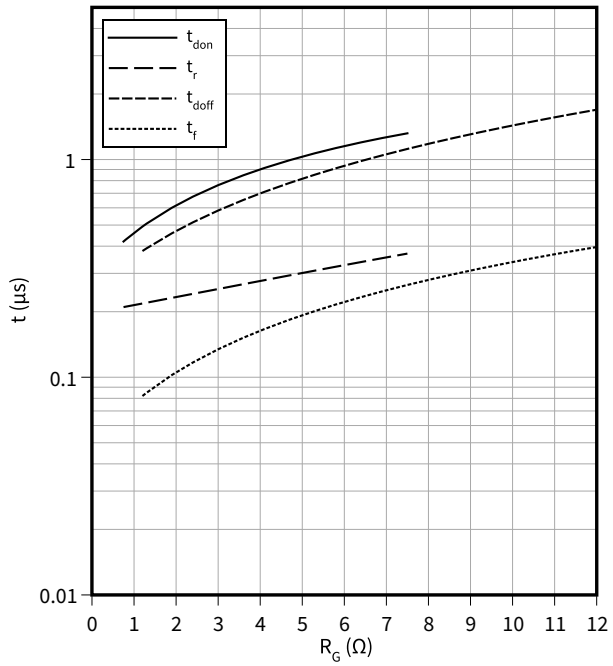
R_{Goff} = 1.2 Ω, R_{Gon} = 0.75 Ω, V_{DD} = 1800 V, T_{vj} = 175 °C, V_{GS} = -5/15 V



Switching times (typical), MOSFET

$t = f(R_G)$

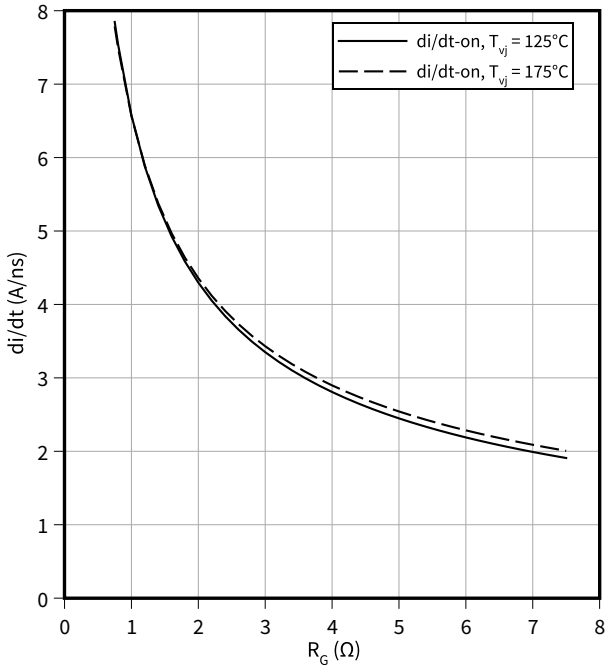
V_{DD} = 1800 V, I_D = 1000 A, T_{vj} = 175 °C, V_{GS} = -5/15 V



Current slope (typical), MOSFET

$di/dt = f(R_G)$

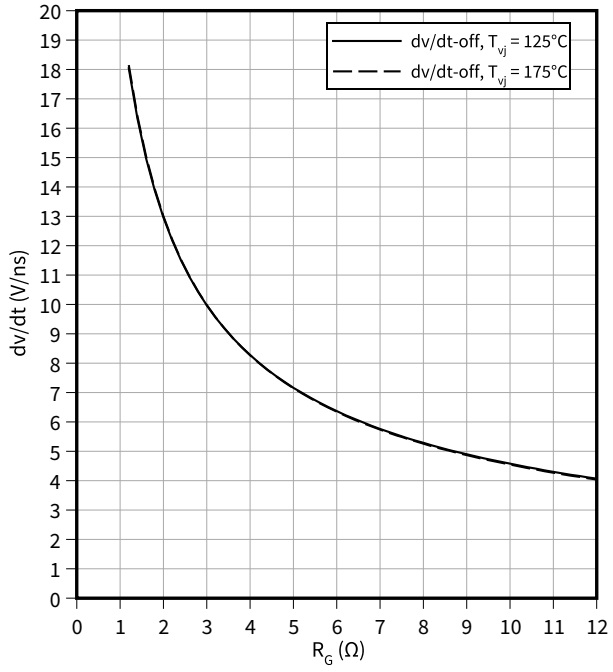
V_{DD} = 1800 V, I_D = 1000 A, V_{GS} = -5/15 V



Voltage slope (typical), MOSFET

$dv/dt = f(R_G)$

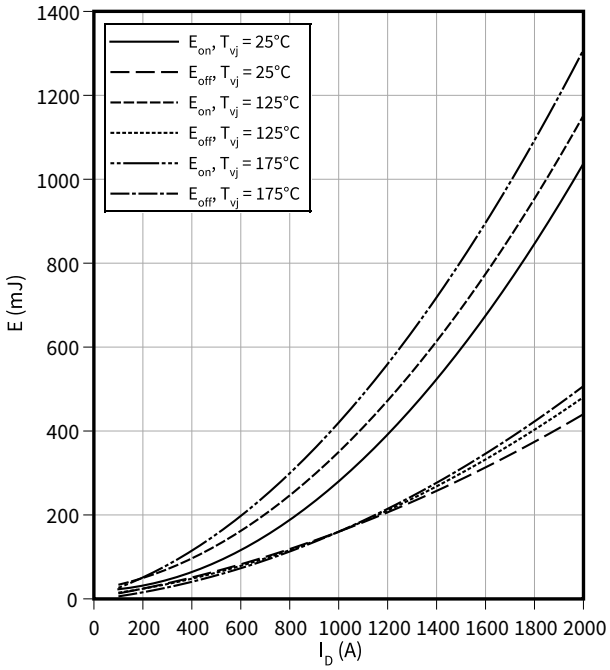
V_{DD} = 1800 V, I_D = 1000 A, V_{GS} = -5/15 V



Switching losses (typical), MOSFET

$E = f(I_D)$

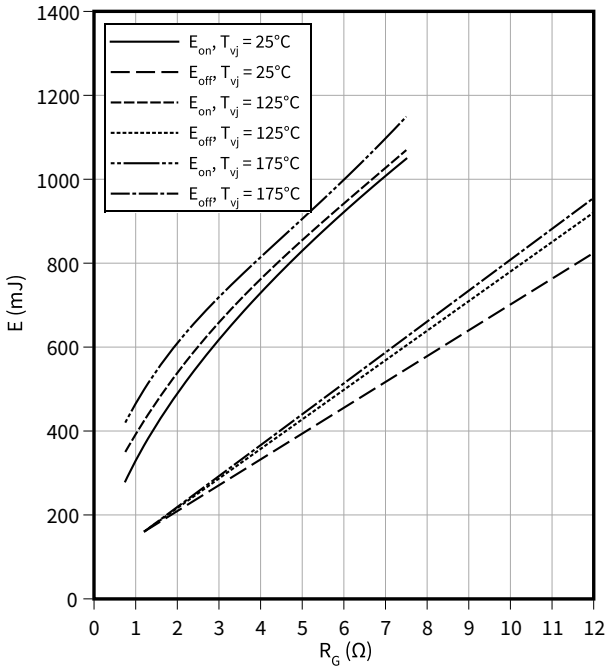
R_{Goff} = 1.2 Ω, R_{Gon} = 0.75 Ω, V_{DD} = 1800 V, V_{GS} = -5/15 V



Switching losses (typical), MOSFET

$E = f(R_G)$

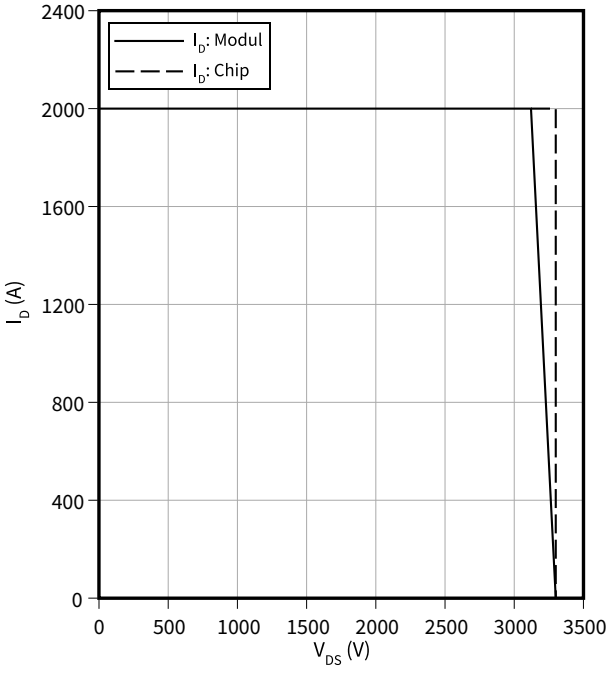
V_{DD} = 1800 V, I_D = 1000 A, V_{GS} = -5/15 V



Reverse bias safe operating area (RBSOA), MOSFET

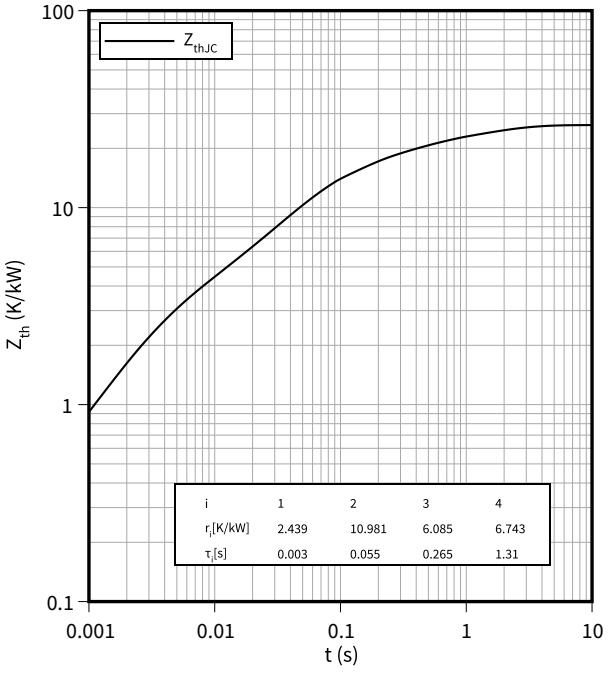
$I_D = f(V_{DS})$

R_{Goff} = 1.2 Ω, T_{vj} = 175 °C, V_{GS} = -5/15 V



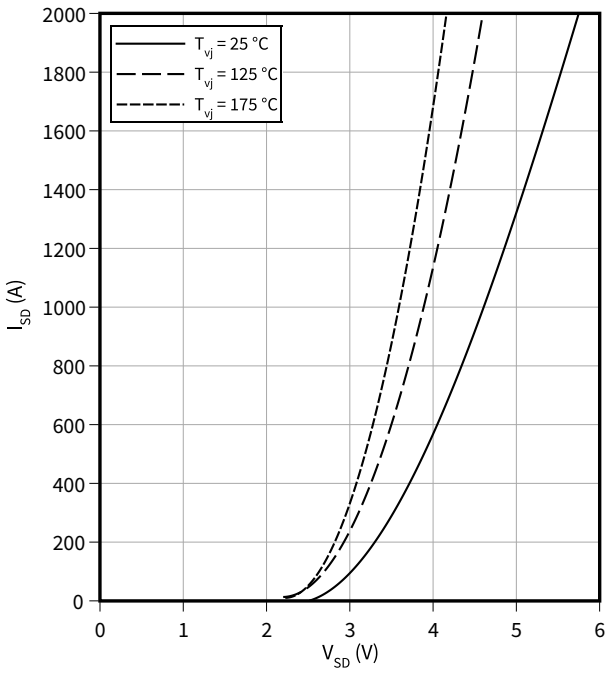
Transient thermal impedance, MOSFET

$Z_{th} = f(t)$



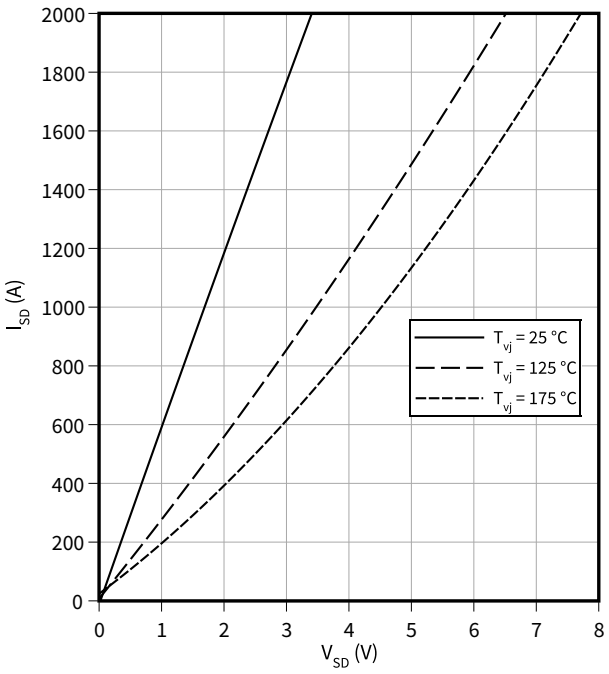
Forward characteristic body diode (typical), MOSFET

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



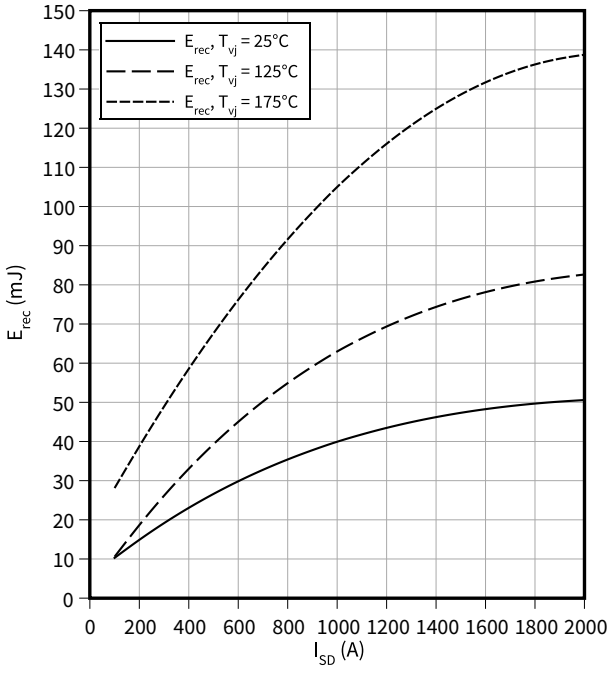
Forward characteristic body diode (typical), MOSFET

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



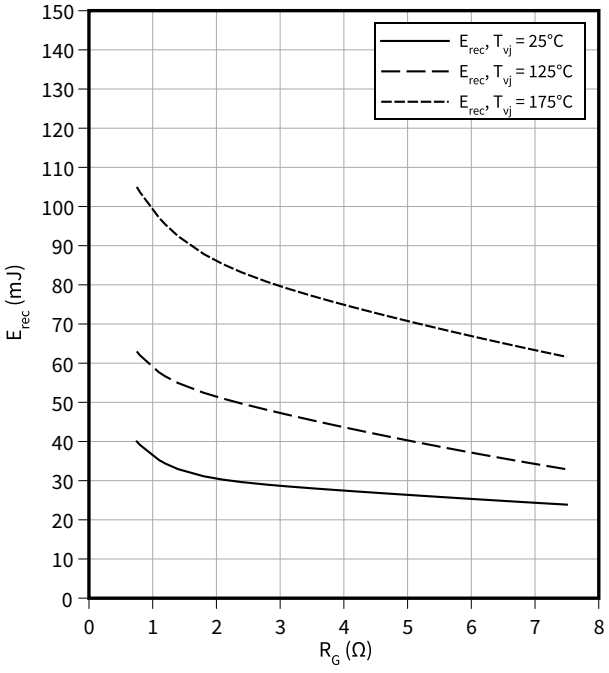
Switching losses body diode (typical), MOSFET

$E_{rec} = f(I_{SD})$
$R_{Gon} = 0.75\ \Omega$, $V_{DD} = 1800$ V



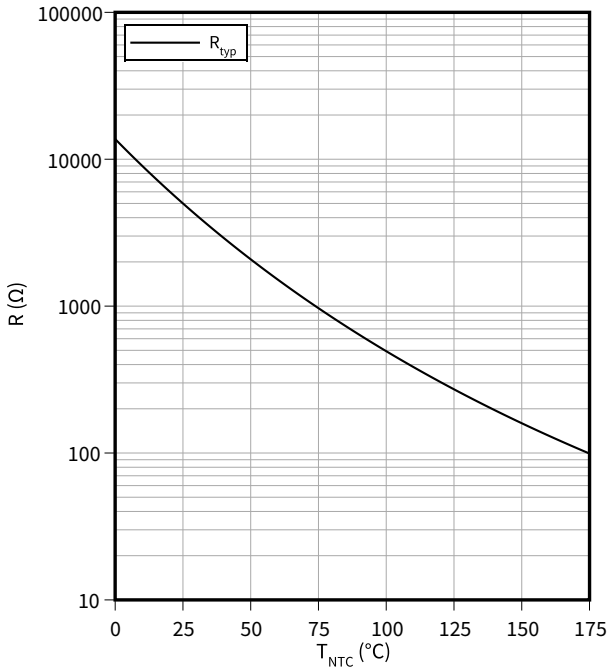
Switching losses body diode (typical), MOSFET

$E_{rec} = f(R_G)$
$V_{DD} = 1800$ V, $I_{SD} = 1000$ A



Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



6 Circuit diagram

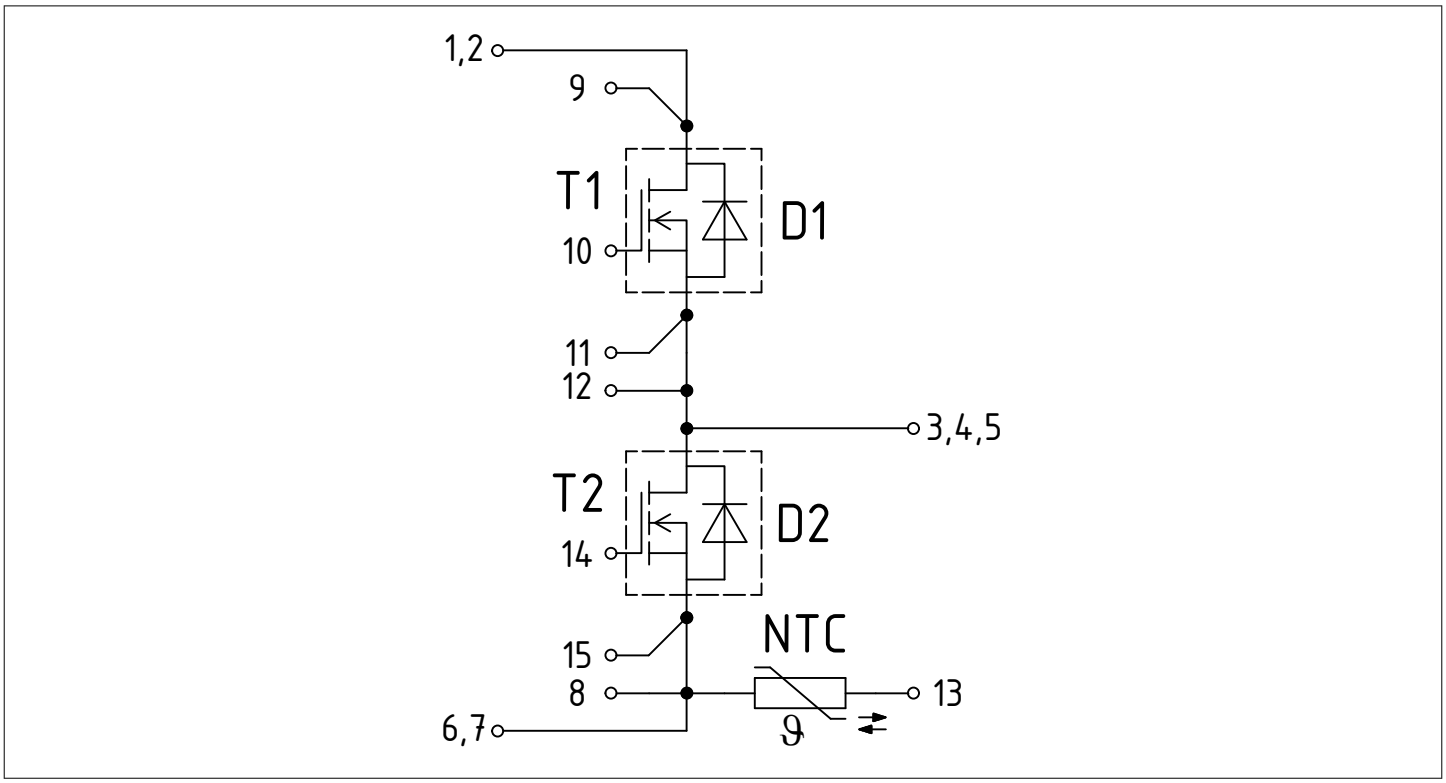


Figure 1

7 Package outlines

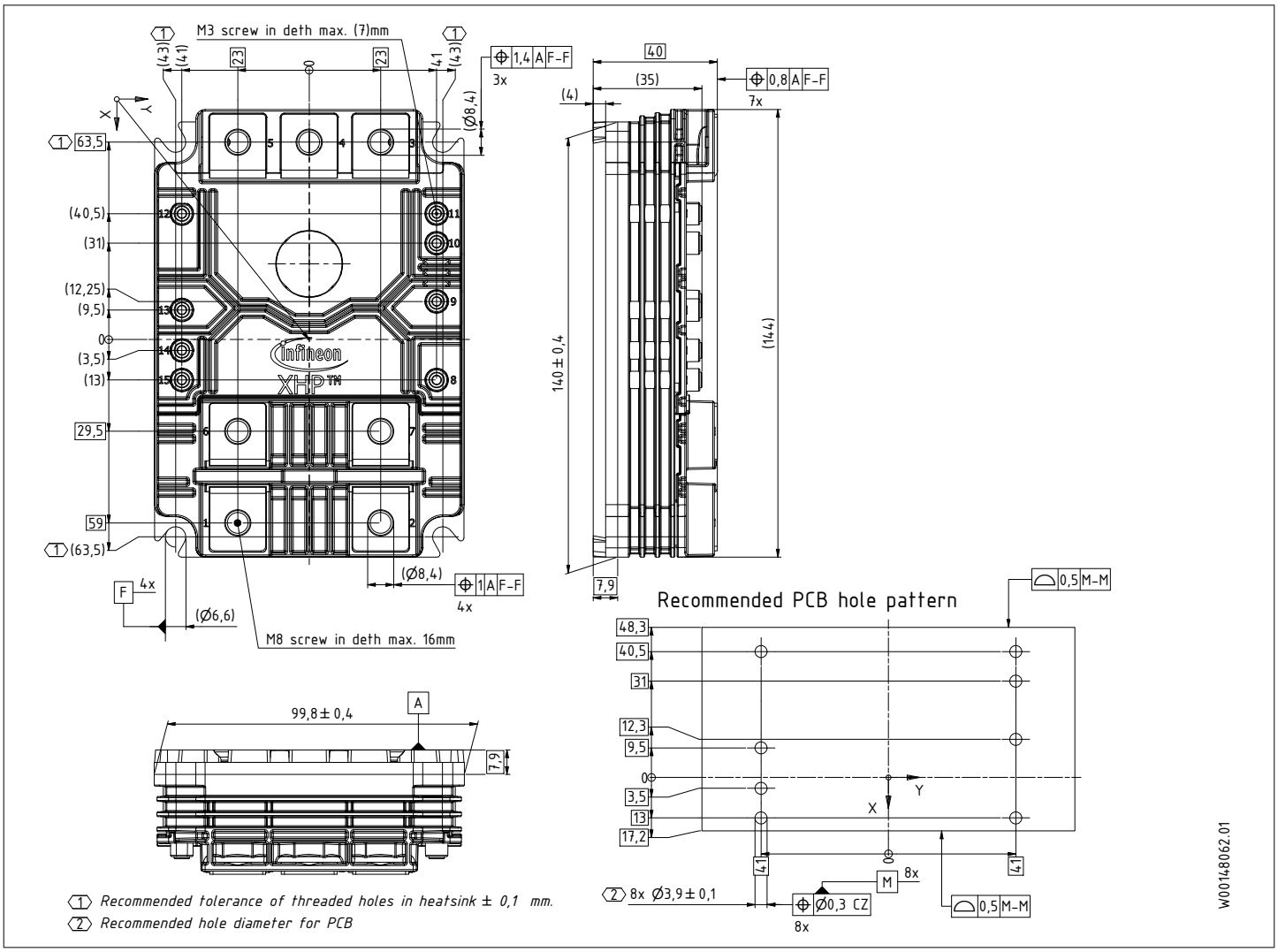


Figure 2

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	*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	71549142846550549911530		71549142846550549911530

Figure 3

Revision history

Document revision	Date of release	Description of changes
V1.0	2019-12-17	Target datasheet
n/a	2020-09-01	Datasheet migrated to a new system with a new layout and new revision number schema: target or preliminary datasheet = 0.xy; final datasheet = 1.xy
0.20	2023-11-21	Preliminary datasheet
1.00	2024-04-16	Final datasheet

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