EasyPACK™ module with CoolSiC™ Trench MOSFET

Features

- Electrical features
  - V_{DSS} = 1200 V
  - I_{DN} = 400 A / I_{DRM} = 800 A
  - Low switching losses
  - High current density
  - Low inductive design
- Mechanical features
  - PressFIT contact technology
  - Integrated NTC temperature sensor
  - Rugged mounting due to integrated mounting clamps

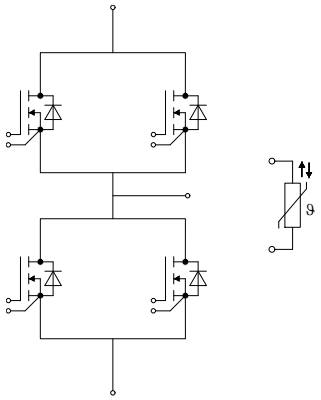
Potential applications

- High-frequency switching application
- Solar applications
- UPS systems
- DC/DC converter
- Servo drives

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	3.0	kV
Internal isolation		basic insulation (class 1, IEC 61140)	Al_2O_3	
Creepage distance	d_{Creep}	terminal to heatsink	9.6	mm
Creepage distance	d_{Creep}	terminal to terminal	11.3	mm
Clearance	d_{Clear}	terminal to heatsink	9.2	mm
Clearance	d_{Clear}	terminal to terminal	10.0	mm
Comparative tracking index	*CTI*		> 400	
Relative thermal index (electrical)	*RTI*	housing	140	°C

Table 2 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Stray inductance module	L_{sCE}				5		nH
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	T_H=25°C, per switch			0.235		mΩ
Storage temperature	T_{stg}			-40		125	°C
Mounting torque for module mounting	*M*	- Mounting according to valid application note	M5, Screw	1.3		1.5	Nm
Weight	*G*				78		g

Note: The current under continuous operation is limited to 25 A rms per connector pin.

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
Implemented drain current	I_{DN}			400	A
Continuous DC drain current	I_{DDC}	T_{vj} = 175 °C, V_{GS} = 18 V	T_H = 75 °C	400	A
Repetitive peak drain current	I_{DRM}	verified by design, t_p limited by T_{vjmax}		800	A
Gate-source voltage, max. transient voltage	V_{GS}	*D* = 0.01		-10/23	V

(table continues...)

Table 3 (continued) Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
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...0	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 = 400 A	V_{GS} = 18 V, T_{vj} = 25 °C		1.44	2.27	mΩ
			V_{GS} = 18 V, T_{vj} = 125 °C		2.33		
			V_{GS} = 18 V, T_{vj} = 175 °C		3.09		
			V_{GS} = 15 V, T_{vj} = 25 °C		1.71		
Gate threshold voltage	$V_{GS(th)}$	I_D = 224 mA, V_{DS} = V_{GS}, T_{vj} = 25 °C, (tested after 1ms pulse at V_{GS} = +20 V)		3.45	4.3	5.15	V
Total gate charge	Q_G	V_{DS} = 800 V, V_{GS} = -3/18 V			1.6		µC
Internal gate resistor	R_{Gint}	T_{vj} = 25 °C			0.9		Ω
Input capacitance	C_{ISS}	f = 100 kHz, V_{DS} = 800 V, V_{GS} = 0 V	T_{vj} = 25 °C		48.4		nF
Output capacitance	C_{OSS}	f = 100 kHz, V_{DS} = 800 V, V_{GS} = 0 V	T_{vj} = 25 °C		2.4		nF
Reverse transfer capacitance	C_{rss}	f = 100 kHz, V_{DS} = 800 V, V_{GS} = 0 V	T_{vj} = 25 °C		0.158		nF
C_{OSS} stored energy	E_{OSS}	V_{DS} = 800 V, V_{GS} = -3/18 V, T_{vj} = 25 °C			945		µJ
Drain-source leakage current	I_{DSS}	V_{DS} = 1200 V, V_{GS} = -3 V	T_{vj} = 25 °C		0.32	660	µA
Gate-source leakage current	I_{GSS}	V_{DS} = 0 V, T_{vj} = 25 °C	V_{GS} = 20 V			400	nA
Turn-on delay time (inductive load)	$t_{d\,on}$	I_D = 400 A, R_{Gon} = 3.6 Ω, V_{DS} = 600 V, V_{GS} = -3/18 V	T_{vj} = 25 °C		108		ns
			T_{vj} = 125 °C		101		
			T_{vj} = 175 °C		98.2		

(table continues...)

Table 5 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Rise time (inductive load)	t_r	I_D = 400 A, R_{Gon} = 3.6 Ω, V_{DS} = 600 V, V_{GS} = -3/18 V	T_{vj} = 25 °C		137		ns
			T_{vj} = 125 °C		124		
			T_{vj} = 175 °C		124		
Turn-off delay time (inductive load)	$t_{d\,off}$	I_D = 400 A, R_{Goff} = 1 Ω, V_{DS} = 600 V, V_{GS} = -3/18 V	T_{vj} = 25 °C		136		ns
			T_{vj} = 125 °C		150		
			T_{vj} = 175 °C		156		
Fall time (inductive load)	t_f	I_D = 400 A, R_{Goff} = 1 Ω, V_{DS} = 600 V, V_{GS} = -3/18 V	T_{vj} = 25 °C		32.2		ns
			T_{vj} = 125 °C		33.7		
			T_{vj} = 175 °C		34.3		
Turn-on energy loss per pulse	E_{on}	I_D = 400 A, V_{DS} = 600 V, L_σ = 18 nH, V_{GS} = -3/18 V, R_{Gon} = 3.6 Ω, di/dt = 8.7 kA/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		17.7		mJ
			T_{vj} = 125 °C		17.9		
			T_{vj} = 175 °C		18.7		
Turn-off energy loss per pulse	E_{off}	I_D = 400 A, V_{DS} = 600 V, L_σ = 18 nH, V_{GS} = -3/18 V, R_{Goff} = 1 Ω, dv/dt = 14 kV/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		2.83		mJ
			T_{vj} = 125 °C		3.28		
			T_{vj} = 175 °C		3.52		
Thermal resistance, junction to heat sink	R_{thJH}	per MOSFET			0.128		K/W
Temperature under switching conditions	$T_{vj\,op}$			-40		175	°C

Note: The selection of positive and negative gate-source voltages impacts losses and the long-term behavior of the MOSFET and body diode. The design guidelines described in Application Note AN 2018-09 and AN 2021-13 must be considered to ensure sound operation of the device over the planned lifetime.

$T_{vj,op}$ > 150°C is allowed for operation at overload conditions for MOSFET and body diode. For detailed specifications, please refer to AN 2021-13.

3 Body diode

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} = -3 V	T_H = 75 °C	160	A

Table 7 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_{SD}	I_{SD} = 400 A, V_{GS} = -3 V	T_{vj} = 25 °C		3.98	5.05	V
			T_{vj} = 125 °C		3.75		
			T_{vj} = 175 °C		3.65		

4 NTC-Thermistor

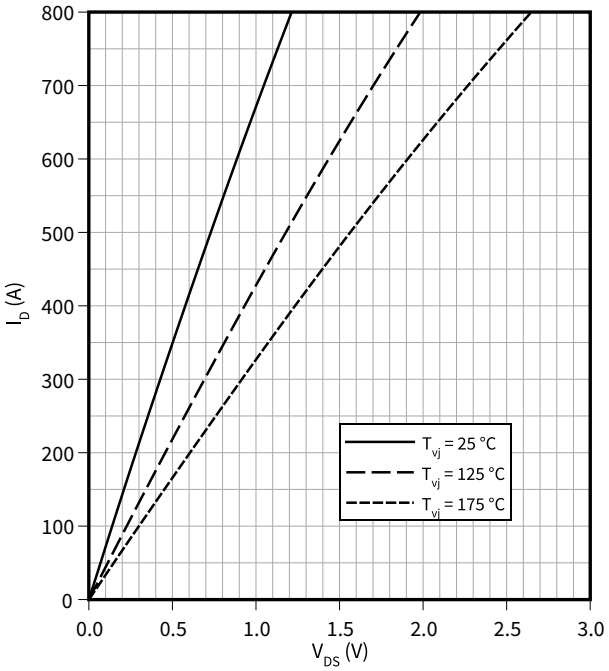
Table 8 Characteristic values

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	$B_{25/50}$	$R_2 = R_{25} \exp[B_{25/50}(1/T_2\text{-}1/(298{,}15\ K))]$		3375		K
B-value	$B_{25/80}$	$R_2 = R_{25} \exp[B_{25/80}(1/T_2\text{-}1/(298{,}15\ K))]$		3411		K
B-value	$B_{25/100}$	$R_2 = R_{25} \exp[B_{25/100}(1/T_2\text{-}1/(298{,}15\ K))]$		3433		K

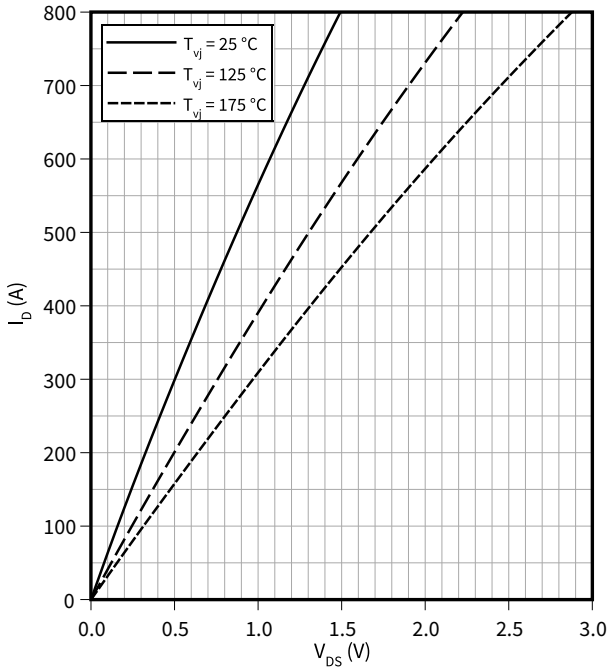
Note: Specification according to the valid application note.

5 Characteristics diagrams

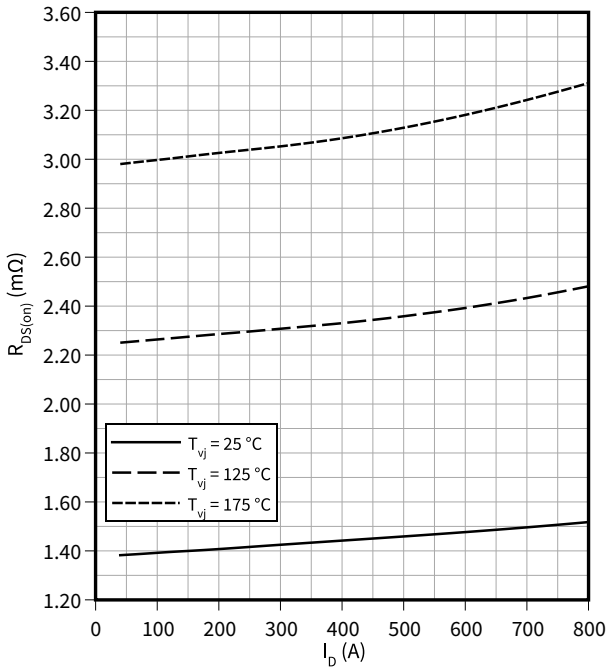
Output characteristic (typical), MOSFET
$I_D = f(V_{DS})$
V_{GS} = 18 V



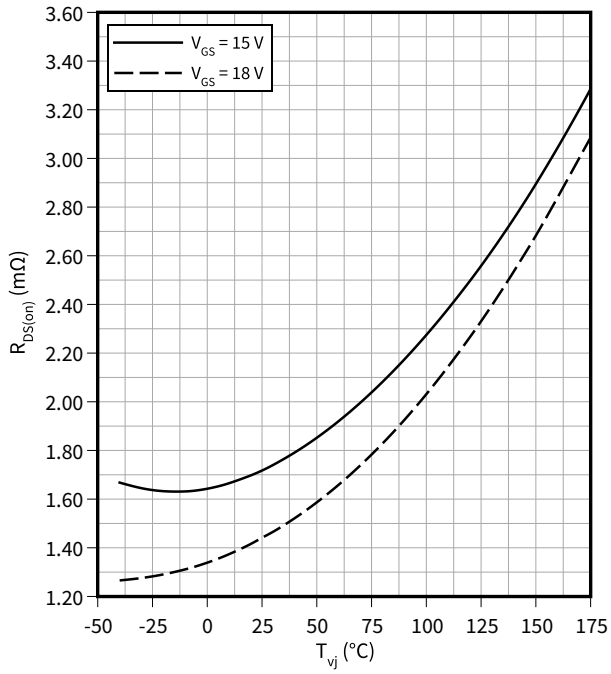
Output characteristic (typical), MOSFET
$I_D = f(V_{DS})$
V_{GS} = 15 V



Drain source on-resistance (typical), MOSFET
$R_{DS(on)} = f(I_D)$
V_{GS} = 18 V

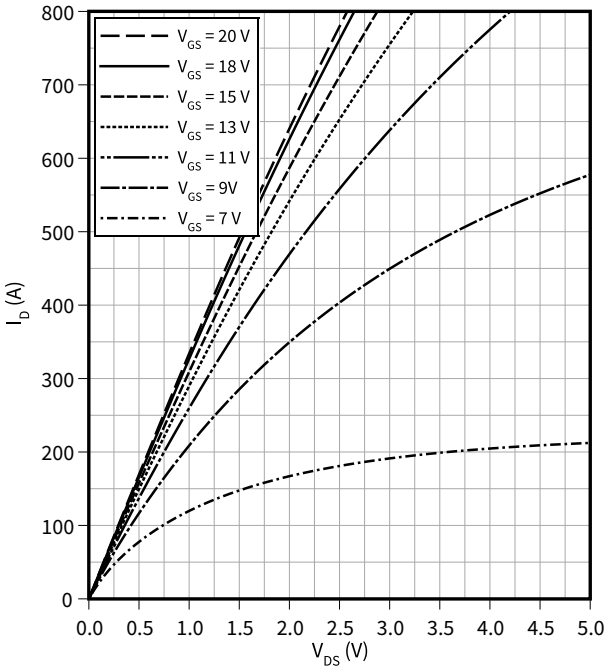


Drain source on-resistance (typical), MOSFET
$R_{DS(on)} = f(T_{vj})$
I_D = 400 A, V_{GS} = 18 V



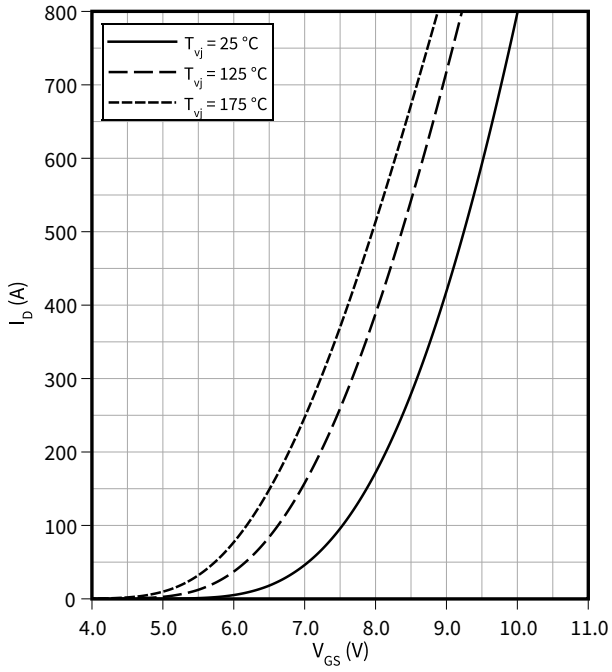
Output characteristic field (typical), MOSFET

$I_D = f(V_{DS})$
$T_{vj} = 175\ °C$



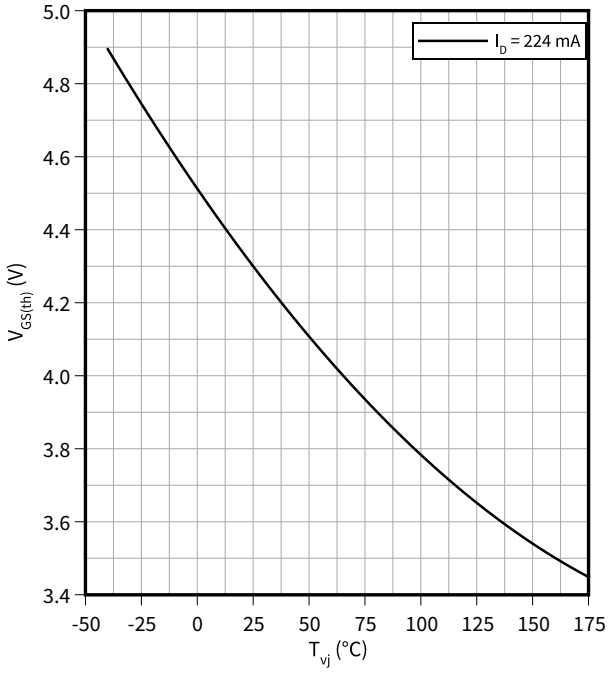
Transfer characteristic (typical), MOSFET

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



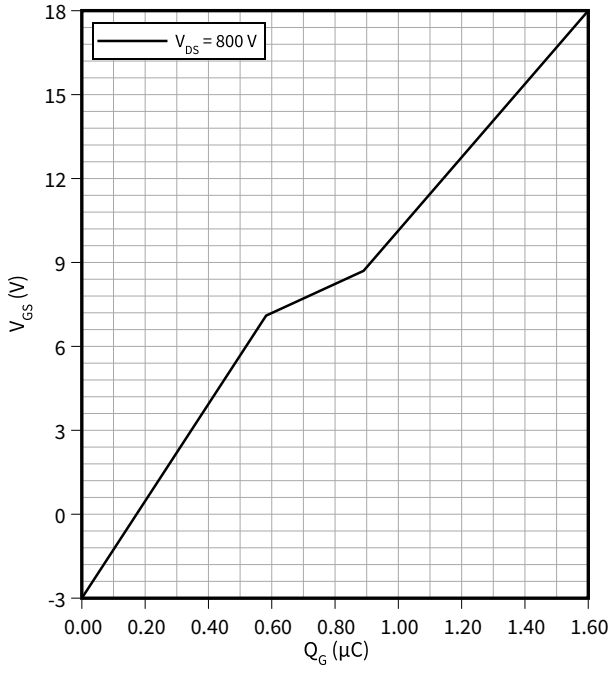
Gate-source threshold voltage (typical), MOSFET

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



Gate charge characteristic (typical), MOSFET

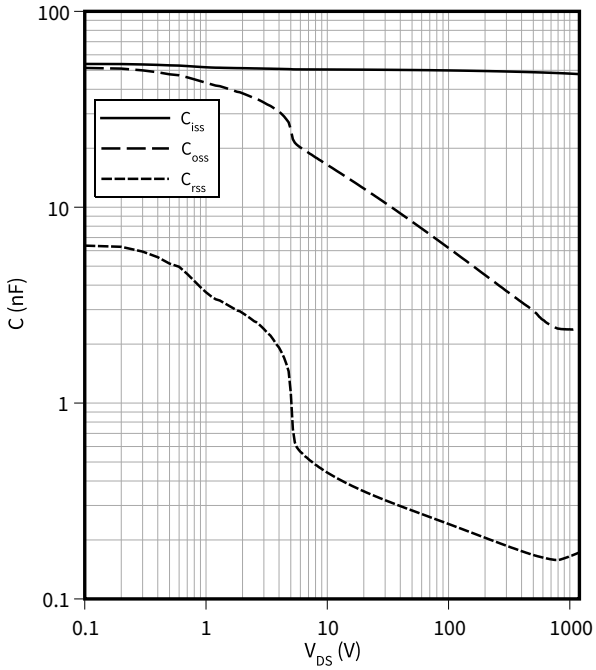
$V_{GS} = f(Q_G)$
$I_D = 400\ A$, $T_{vj} = 25\ °C$



Capacity characteristic (typical), MOSFET

$C = f(V_{DS})$

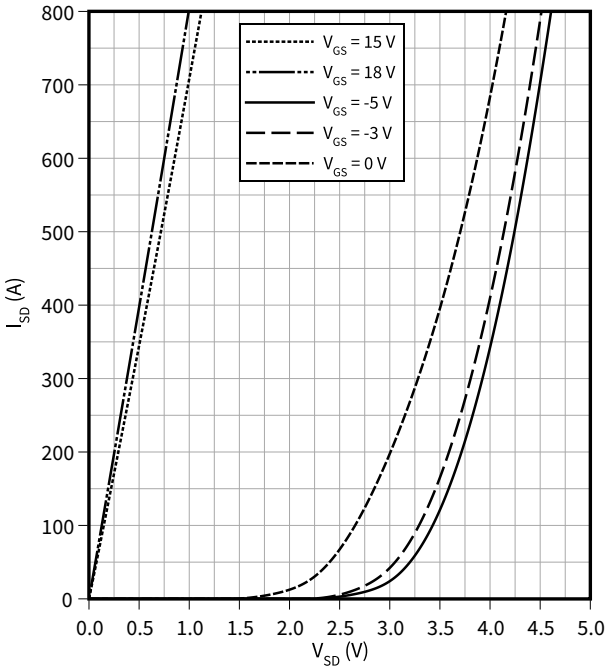
$f = 100\ kHz$, $T_{vj} = 25\ °C$, $V_{GS} = -3\ V$



Forward characteristic body diode (typical), MOSFET

$I_{SD} = f(V_{SD})$

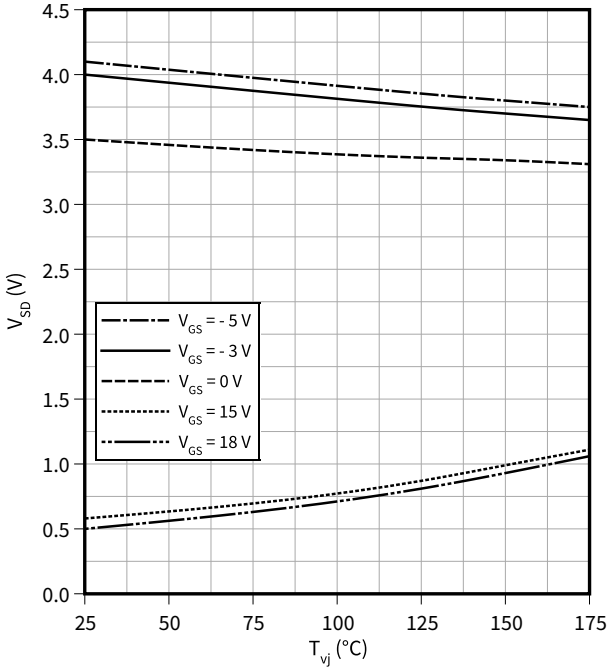
$T_{vj} = 25\ °C$



Forward voltage of body diode (typical), MOSFET

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

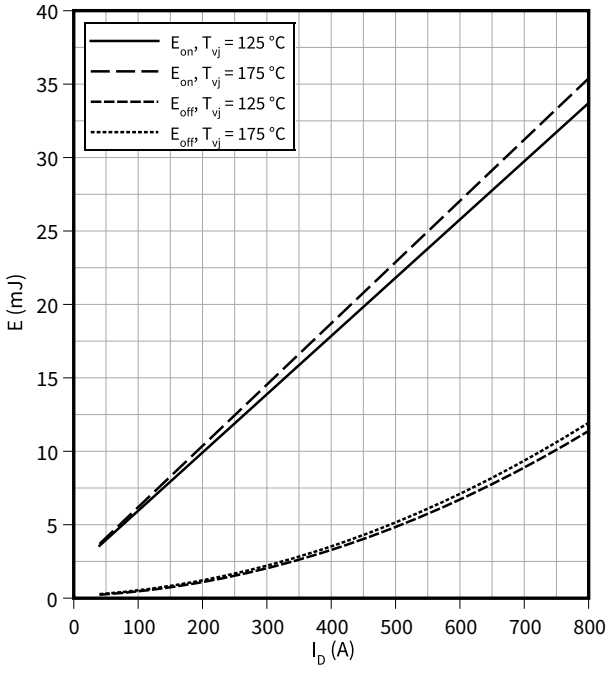
$I_{SD} = 400\ A$



Switching losses (typical), MOSFET

$E = f(I_D)$

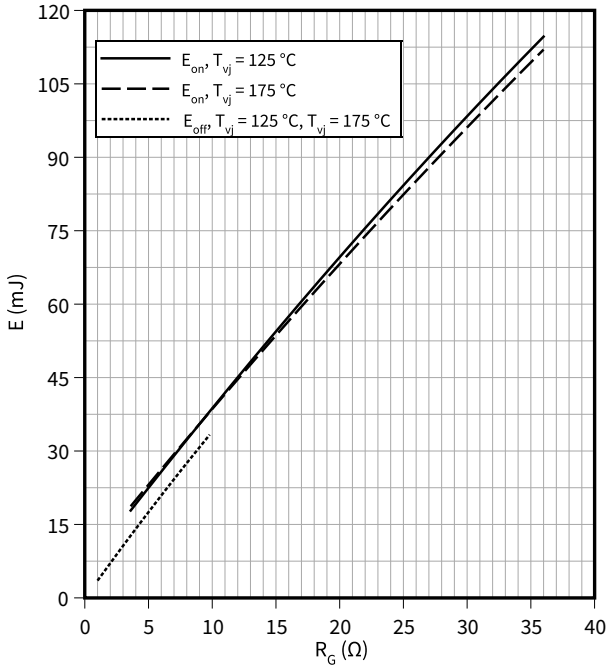
$R_{Goff} = 1\ \Omega$, $R_{Gon} = 3.6\ \Omega$, $V_{DS} = 600\ V$, $V_{GS} = -3/18\ V$



Switching losses (typical), MOSFET

$E = f(R_G)$

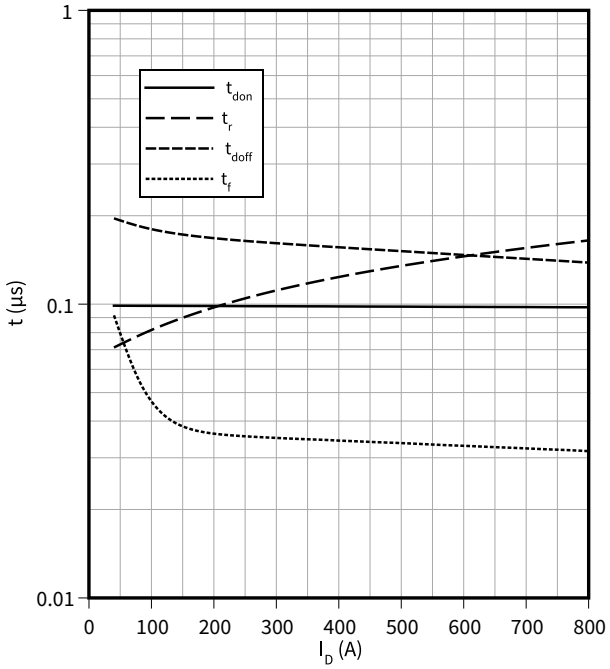
V_{DS} = 600 V, I_D = 400 A, V_{GS} = -3/18 V



Switching times (typical), MOSFET

$t = f(I_D)$

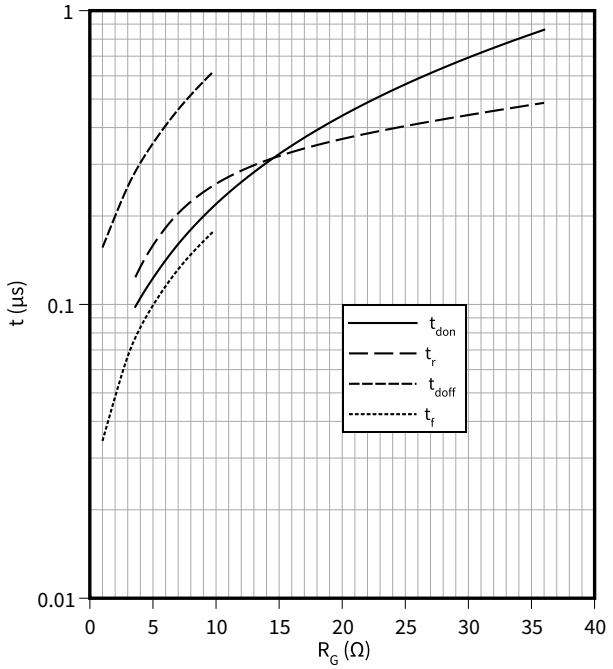
R_{Goff} = 1 Ω, R_{Gon} = 3.6 Ω, V_{DS} = 600 V, T_{vj} = 175 °C, V_{GS} = -3/18 V



Switching times (typical), MOSFET

$t = f(R_G)$

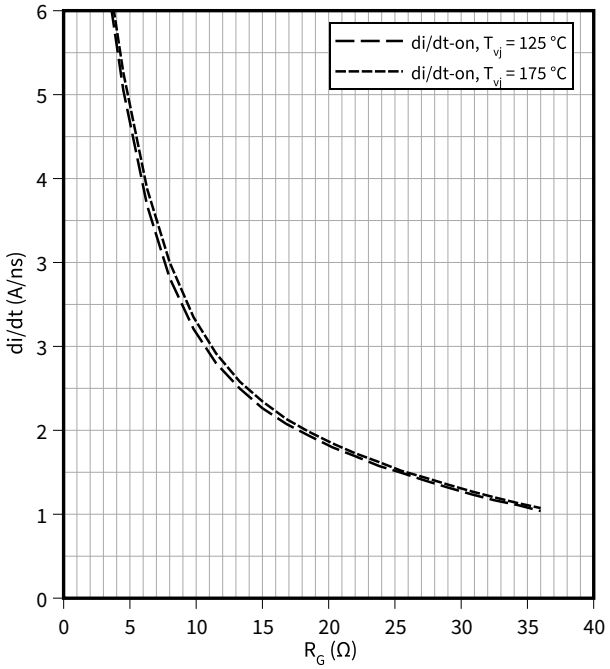
V_{DS} = 600 V, I_D = 400 A, T_{vj} = 175 °C, V_{GS} = -3/18 V



Current slope (typical), MOSFET

$di/dt = f(R_G)$

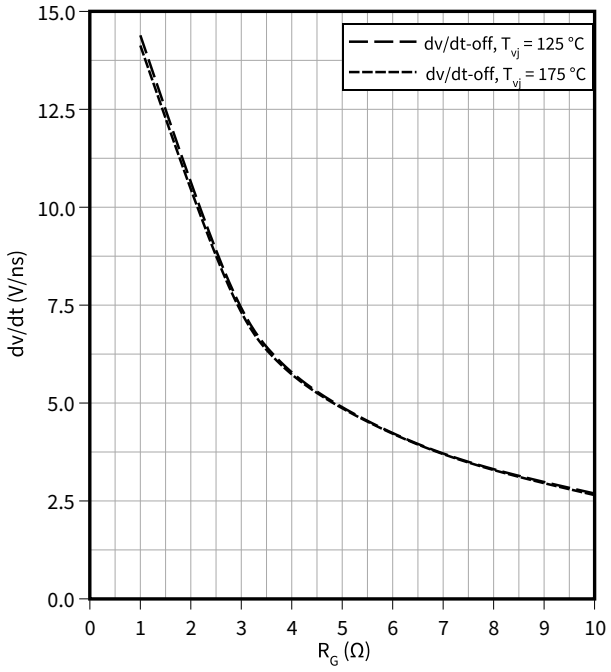
V_{DS} = 600 V, I_D = 400 A, V_{GS} = -3/18 V



Voltage slope (typical), MOSFET

$dv/dt = f(R_G)$

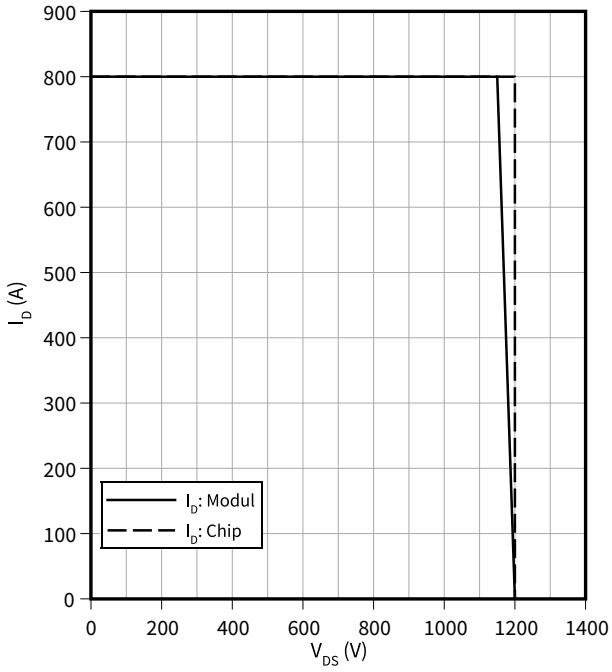
V_{DS} = 600 V, I_D = 400 A, V_{GS} = -3/18 V



Reverse bias safe operating area (RBSOA), MOSFET

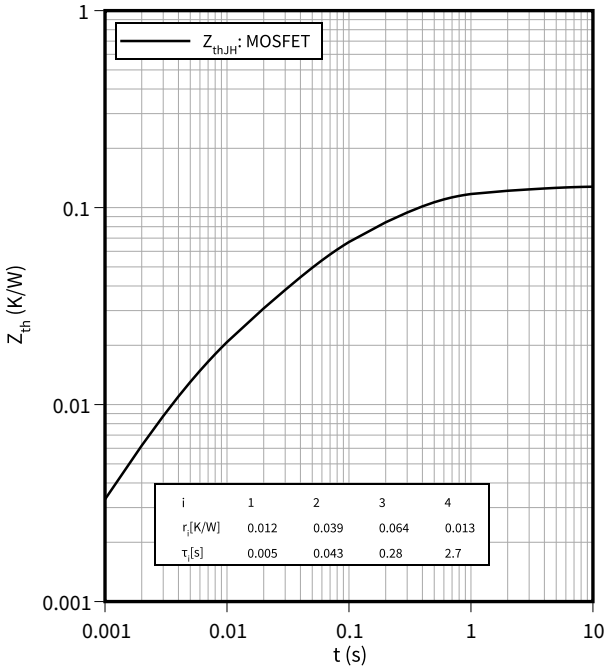
$I_D = f(V_{DS})$

R_{Goff} = 1 Ω, T_{vj} = 175 °C, V_{GS} = -3/18 V



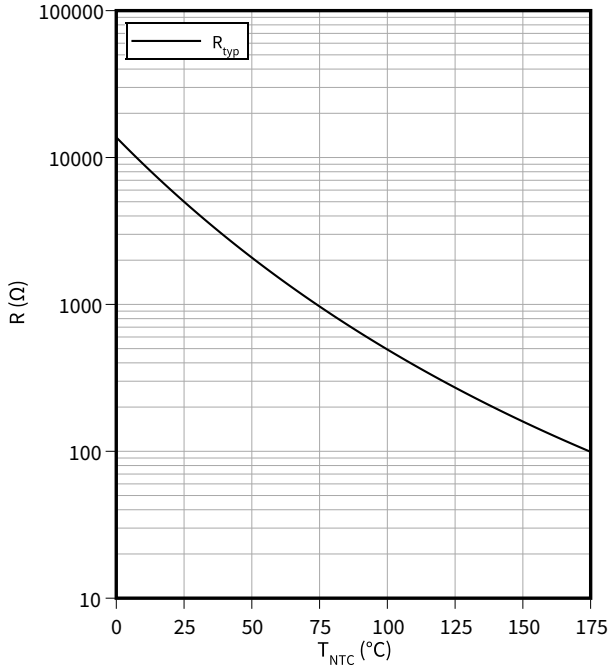
Transient thermal impedance , MOSFET

$Z_{th} = f(t)$



Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



6 Circuit diagram

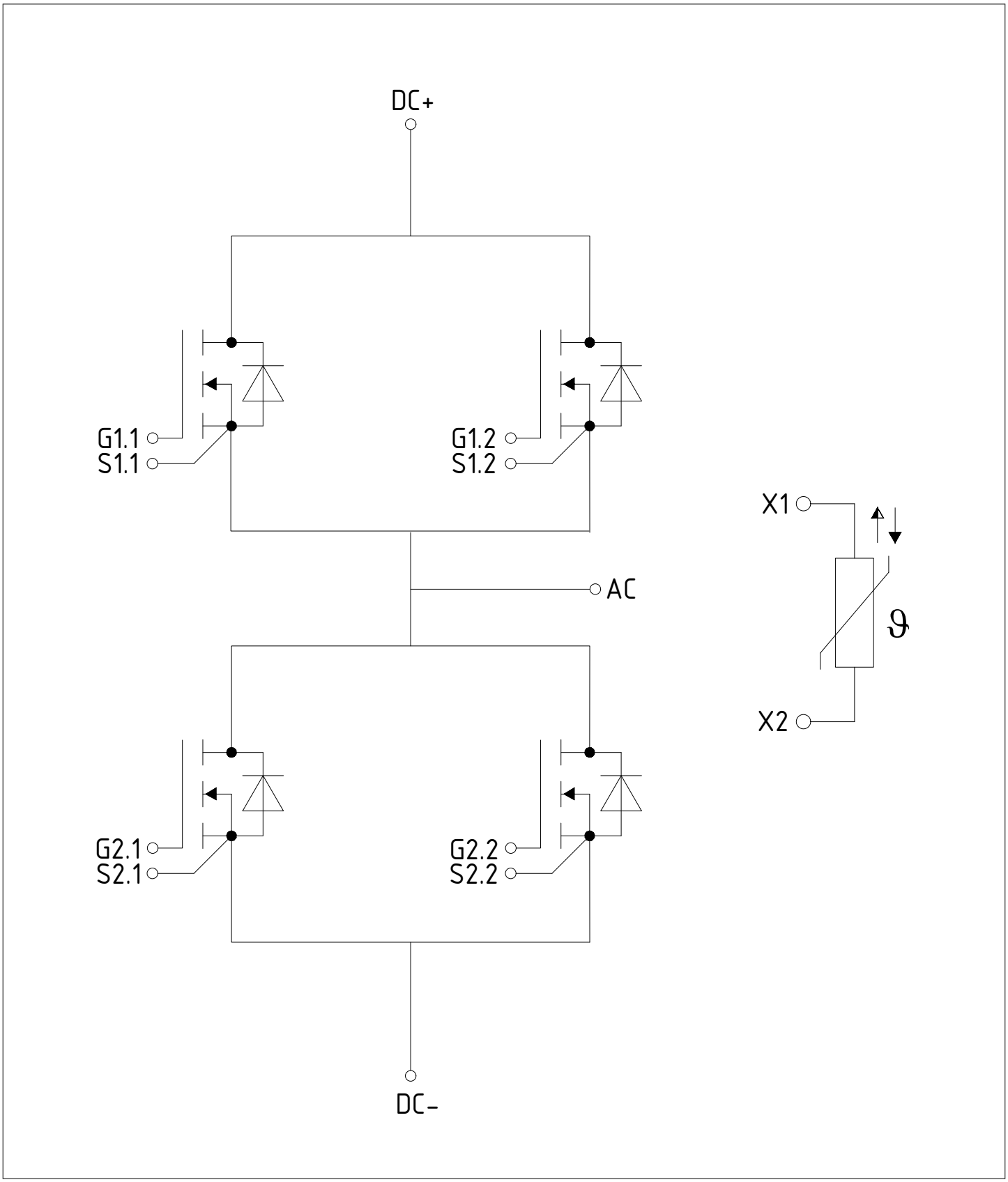


Figure 1

7 Package outlines

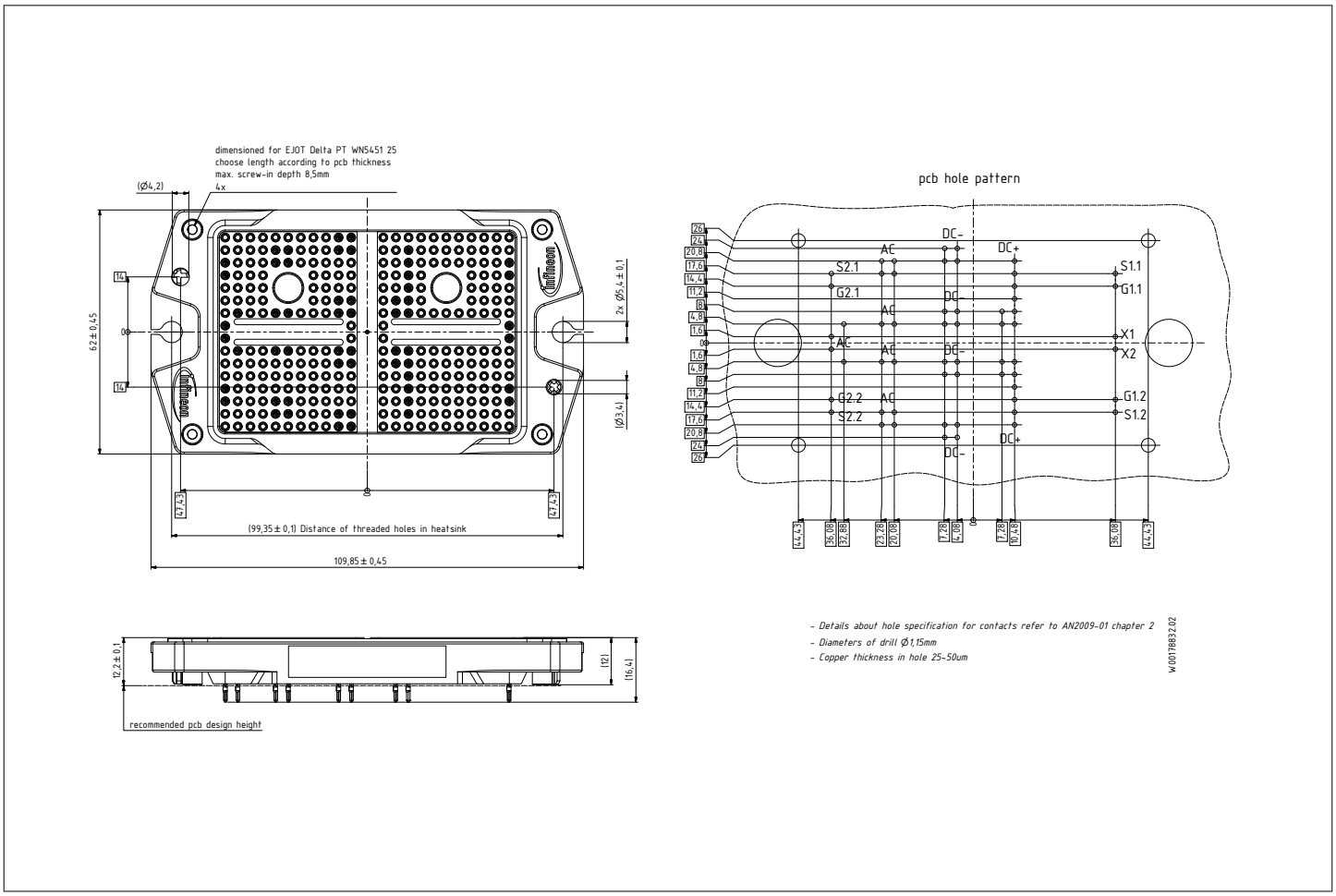


Figure 2

8 Module label code

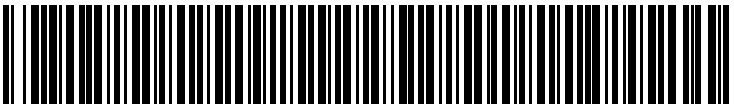
Module label code			
Code format	Data Matrix		Barcode Code128
Encoding	ASCII text		Code Set A
Symbol size	16x16		23 digits
Standard	IEC24720 and IEC16022		IEC8859-1
Code content	*Content* Module serial number Module material number Production order number Date code (production year) Date code (production week)	*Digit* 1 – 5 6 - 11 12 - 19 20 – 21 22 – 23	*Example* 71549 142846 55054991 15 30
Example	 7154914284655054991530		 7154914284655054991530

Figure 3

Revision history

Document revision	Date of release	Description of changes
0.10	2021-04-27	Target datasheet
1.00	2022-03-08	Final datasheet
1.10	2022-04-13	- Correction of switching times dimension. - Add of missing dv/dt and di/dt in table for dynamic parameters

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