

EasyPACK™ module with CoolSiC™ Trench MOSFET

Features

- Electrical features
 - $V_{DS} = 1200\text{ V}$
 - $I_{DN} = 400\text{ A}$ / $I_{DRM} = 800\text{ A}$
 - 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

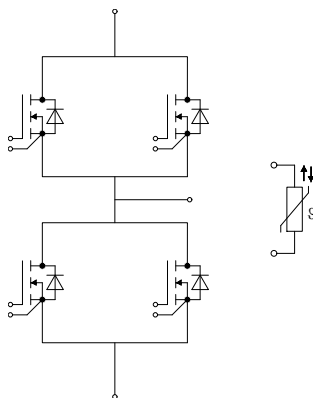


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1 Package

Table 1 Insulation coordination

Parameter	Symbol	Note or test condition	Values	Unit
Isolation test voltage	V_{ISOL}	RMS, $f = 50 \text{ Hz}$, $t = 1 \text{ min}$	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	$R_{CC'+EE'}$	$T_H = 25^\circ\text{C}$, 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}	$T_{vj} = 25^\circ\text{C}$	1200	V
Implemented drain current	I_{DN}		400	A
Continuous DC drain current	I_{DDC}	$T_{vj} = 175^\circ\text{C}$, $V_{GS} = 18 \text{ V}$ $T_H = 75^\circ\text{C}$	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	$R_{DS(on)}$	$I_D = 400\text{ A}$	$V_{GS} = 18\text{ V}, T_{vj} = 25\text{ }^{\circ}\text{C}$		1.44	2.27	mΩ
			$V_{GS} = 18\text{ V}, T_{vj} = 125\text{ }^{\circ}\text{C}$		2.33		
			$V_{GS} = 18\text{ V}, T_{vj} = 175\text{ }^{\circ}\text{C}$		3.09		
			$V_{GS} = 15\text{ V}, T_{vj} = 25\text{ }^{\circ}\text{C}$		1.71		
Gate threshold voltage	$V_{GS(th)}$	$I_D = 224\text{ mA}, V_{DS} = V_{GS}, T_{vj} = 25\text{ }^{\circ}\text{C}$, (tested after 1ms pulse at $V_{GS} = +20\text{ V}$)		3.45	4.3	5.15	V
Total gate charge	Q_G	$V_{DS} = 800\text{ V}, V_{GS} = -3/18\text{ V}$			1.6		μC
Internal gate resistor	R_{Gint}	$T_{vj} = 25\text{ }^{\circ}\text{C}$			0.9		Ω
Input capacitance	C_{ISS}	$f = 100\text{ kHz}, V_{DS} = 800\text{ V}, V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$		48.4		nF
Output capacitance	C_{OSS}	$f = 100\text{ kHz}, V_{DS} = 800\text{ V}, V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$		2.4		nF
Reverse transfer capacitance	C_{rss}	$f = 100\text{ kHz}, V_{DS} = 800\text{ V}, V_{GS} = 0\text{ V}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$		0.158		nF
C_{OSS} stored energy	E_{OSS}	$V_{DS} = 800\text{ V}, V_{GS} = -3/18\text{ V}, T_{vj} = 25\text{ }^{\circ}\text{C}$			945		μJ
Drain-source leakage current	I_{DSS}	$V_{DS} = 1200\text{ V}, V_{GS} = -3\text{ V}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$		0.32	660	μA
Gate-source leakage current	I_{GSS}	$V_{DS} = 0\text{ V}, T_{vj} = 25\text{ }^{\circ}\text{C}$	$V_{GS} = 20\text{ V}$			400	nA
Turn-on delay time (inductive load)	$t_{d\text{ on}}$	$I_D = 400\text{ A}, R_{Gon} = 3.6\text{ }\Omega, V_{DS} = 600\text{ V}, V_{GS} = -3/18\text{ V}$	$T_{vj} = 25\text{ }^{\circ}\text{C}$		108		ns
			$T_{vj} = 125\text{ }^{\circ}\text{C}$		101		
			$T_{vj} = 175\text{ }^{\circ}\text{C}$		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	$I_D = 400\text{ A}$, $R_{Gon} = 3.6\ \Omega$, $V_{DS} = 600\text{ V}$, $V_{GS} = -3/18\text{ V}$	$T_{vj} = 25\text{ °C}$	137		ns
			$T_{vj} = 125\text{ °C}$	124		
			$T_{vj} = 175\text{ °C}$	124		
Turn-off delay time (inductive load)	$t_{d\ off}$	$I_D = 400\text{ A}$, $R_{Goff} = 1\ \Omega$, $V_{DS} = 600\text{ V}$, $V_{GS} = -3/18\text{ V}$	$T_{vj} = 25\text{ °C}$	136		ns
			$T_{vj} = 125\text{ °C}$	150		
			$T_{vj} = 175\text{ °C}$	156		
Fall time (inductive load)	t_f	$I_D = 400\text{ A}$, $R_{Goff} = 1\ \Omega$, $V_{DS} = 600\text{ V}$, $V_{GS} = -3/18\text{ V}$	$T_{vj} = 25\text{ °C}$	32.2		ns
			$T_{vj} = 125\text{ °C}$	33.7		
			$T_{vj} = 175\text{ °C}$	34.3		
Turn-on energy loss per pulse	E_{on}	$I_D = 400\text{ A}$, $V_{DS} = 600\text{ V}$, $L_\sigma = 18\text{ nH}$, $V_{GS} = -3/18\text{ V}$, $R_{Gon} = 3.6\ \Omega$, $di/dt = 8.7\text{ kA}/\mu\text{s}$ ($T_{vj} = 175\text{ °C}$)	$T_{vj} = 25\text{ °C}$	17.7		mJ
			$T_{vj} = 125\text{ °C}$	17.9		
			$T_{vj} = 175\text{ °C}$	18.7		
Turn-off energy loss per pulse	E_{off}	$I_D = 400\text{ A}$, $V_{DS} = 600\text{ V}$, $L_\sigma = 18\text{ nH}$, $V_{GS} = -3/18\text{ V}$, $R_{Goff} = 1\ \Omega$, $dv/dt = 14\text{ kV}/\mu\text{s}$ ($T_{vj} = 175\text{ °C}$)	$T_{vj} = 25\text{ °C}$	2.83		mJ
			$T_{vj} = 125\text{ °C}$	3.28		
			$T_{vj} = 175\text{ °C}$	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.

$T_{vj,op} > 150\text{ °C}$ 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}	$T_{vj} = 175\text{ °C}$, $V_{GS} = -3\text{ V}$	$T_H = 75\text{ °C}$	160	A

Table 7 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Forward voltage	V_{SD}	$I_{SD} = 400 \text{ A}$, $V_{GS} = -3 \text{ V}$		3.98	5.05	V
				3.75		
				3.65		

4 NTC-Thermistor

Table 8 Characteristic values

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rated resistance	R_{25}	$T_{NTC} = 25 \text{ °C}$		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

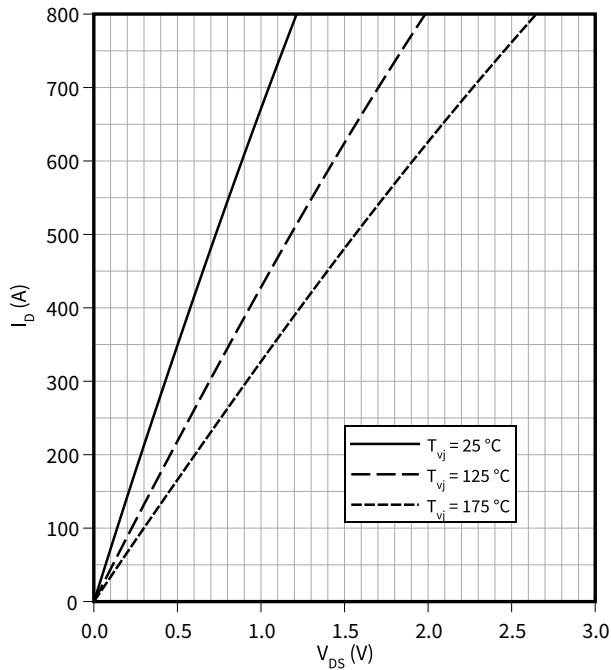
Note: Specification according to the valid application note.

5 Characteristics diagrams

Output characteristic (typical), MOSFET

$I_D = f(V_{DS})$

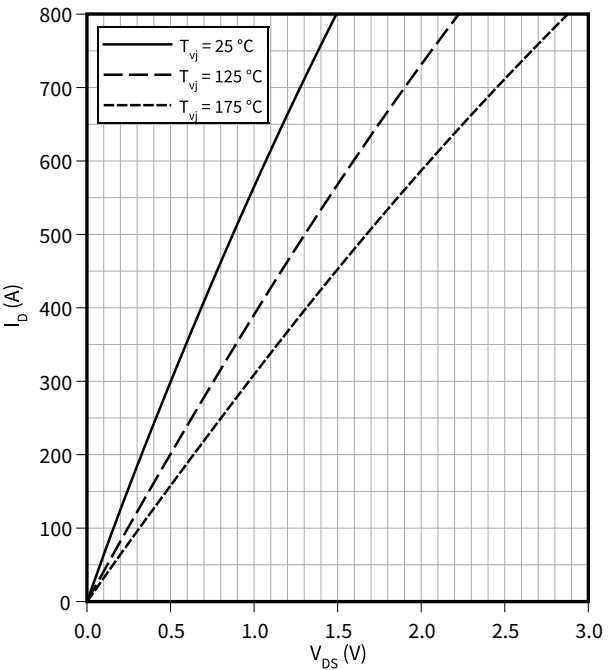
$V_{GS} = 18\text{ V}$



Output characteristic (typical), MOSFET

$I_D = f(V_{DS})$

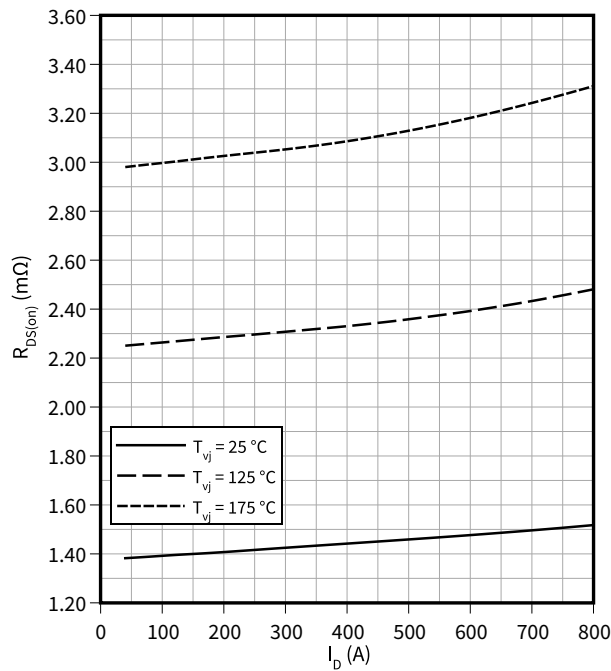
$V_{GS} = 15\text{ V}$



Drain source on-resistance (typical), MOSFET

$R_{DS(on)} = f(I_D)$

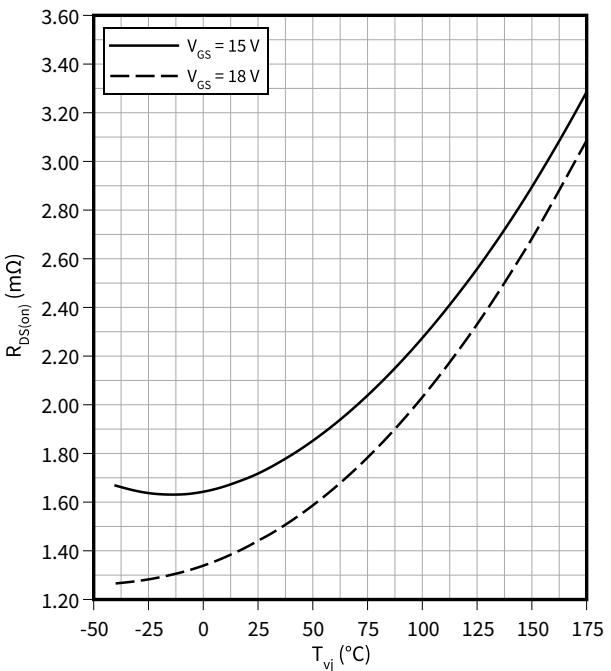
$V_{GS} = 18\text{ V}$



Drain source on-resistance (typical), MOSFET

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

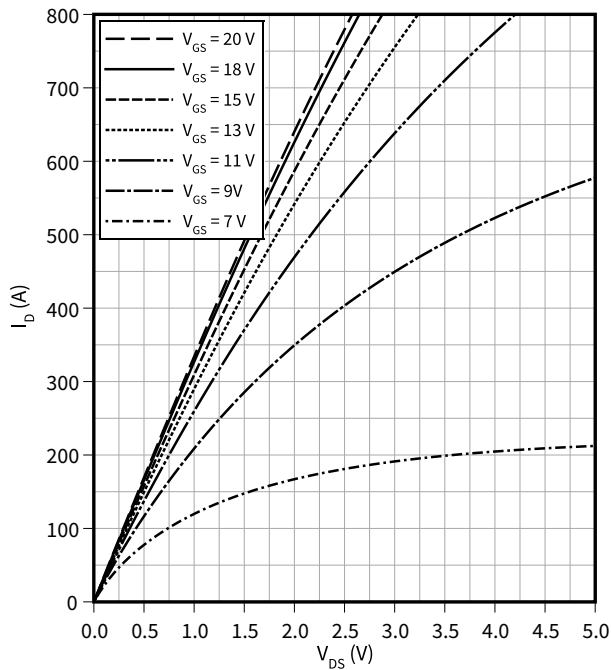
$I_D = 400\text{ A}, V_{GS} = 18\text{ V}$



5 Characteristics diagrams

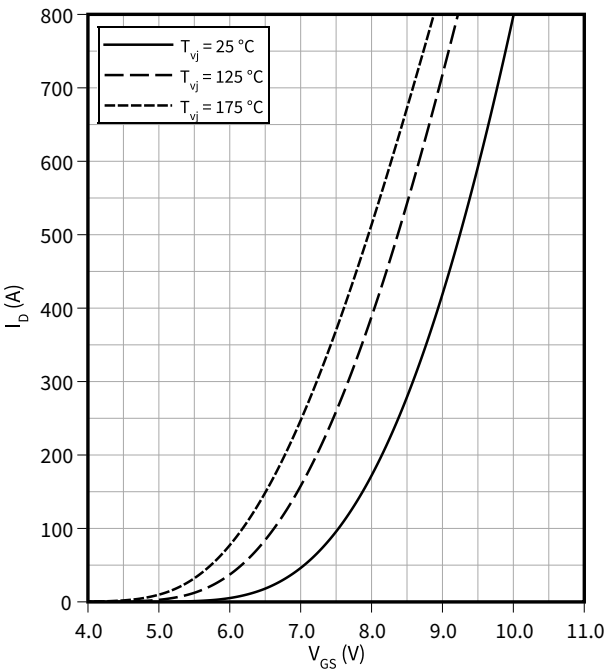
Output characteristic field (typical), MOSFET

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



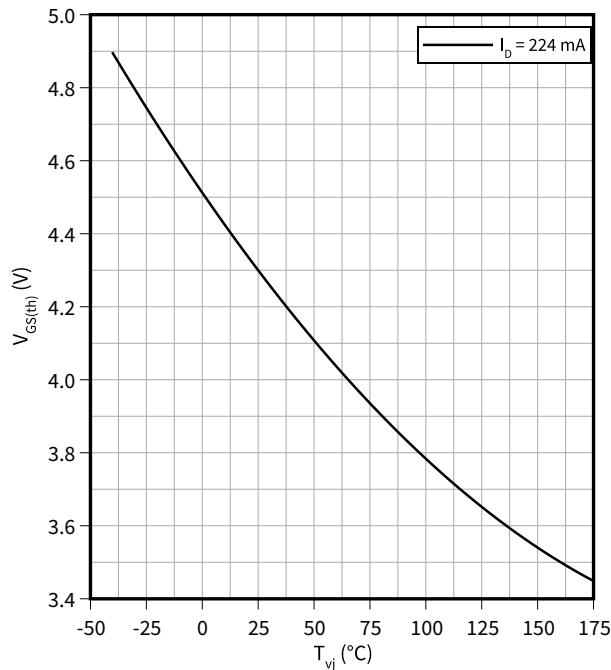
Transfer characteristic (typical), MOSFET

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



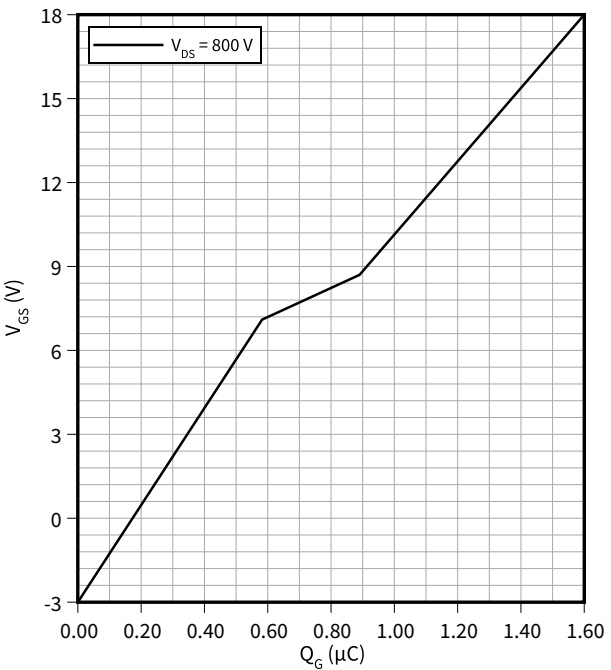
Gate-source threshold voltage (typical), MOSFET

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



Gate charge characteristic (typical), MOSFET

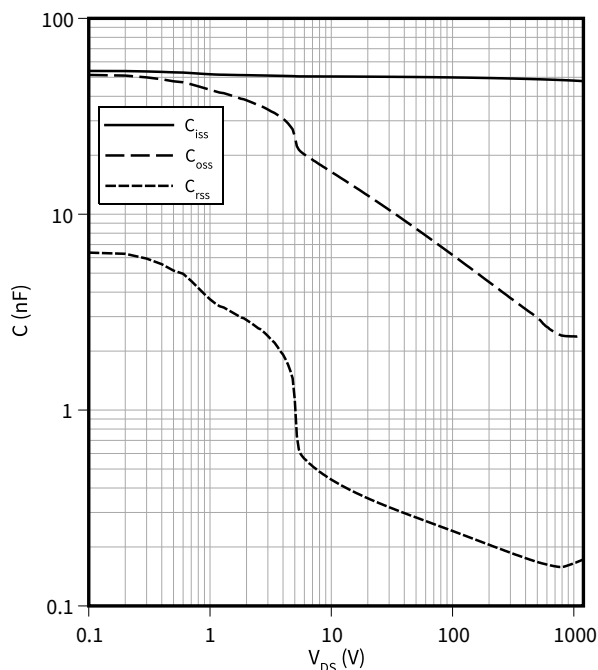
$V_{GS} = f(Q_G)$
 $I_D = 400\text{ A}, T_{vj} = 25\text{ °C}$



Capacity characteristic (typical), MOSFET

$$C = f(V_{DS})$$

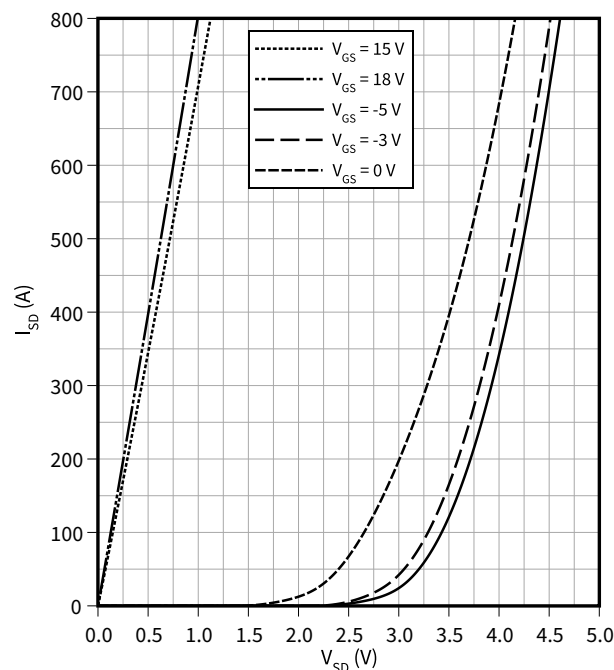
$f = 100 \text{ kHz}$, $T_{vj} = 25 \text{ °C}$, $V_{GS} = -3 \text{ V}$



Forward characteristic body diode (typical), MOSFET

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

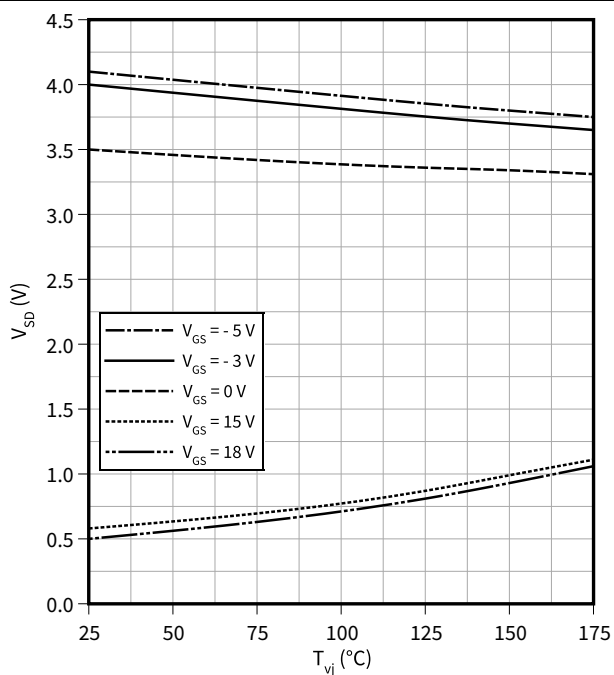
$T_{vj} = 25 \text{ °C}$



Forward voltage of body diode (typical), MOSFET

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

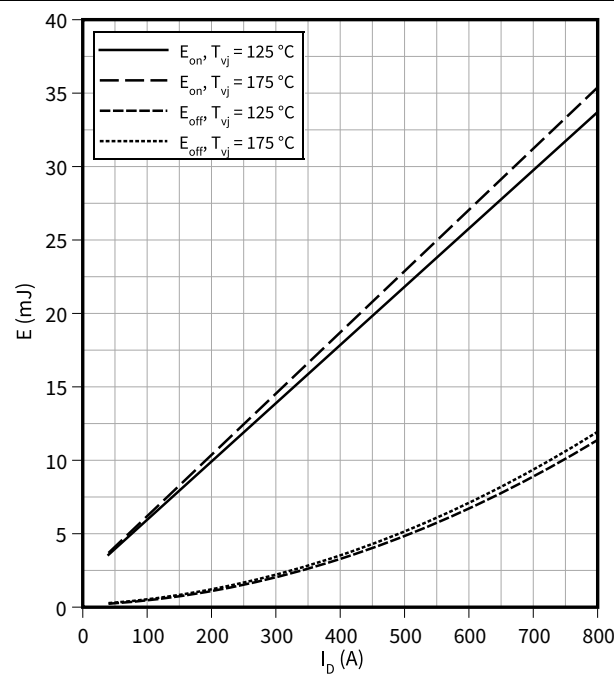
$I_{SD} = 400 \text{ A}$



Switching losses (typical), MOSFET

$$E = f(I_D)$$

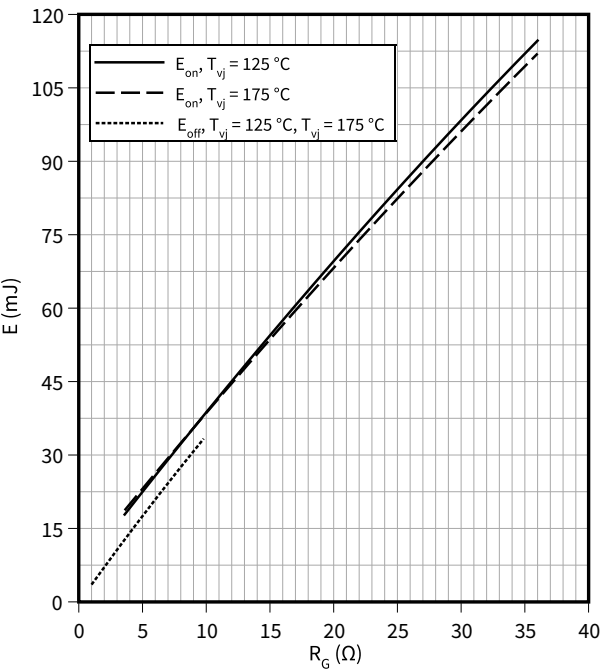
$R_{Goff} = 1 \text{ } \Omega$, $R_{Gon} = 3.6 \text{ } \Omega$, $V_{DS} = 600 \text{ V}$, $V_{GS} = -3/18 \text{ V}$



5 Characteristics diagrams

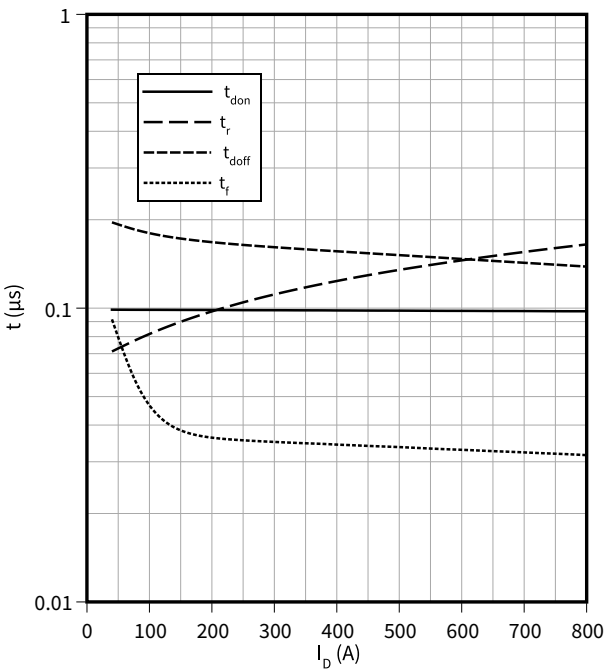
Switching losses (typical), MOSFET

$E = f(R_G)$
 $V_{DS} = 600\text{ V}$, $I_D = 400\text{ A}$, $V_{GS} = -3/18\text{ V}$



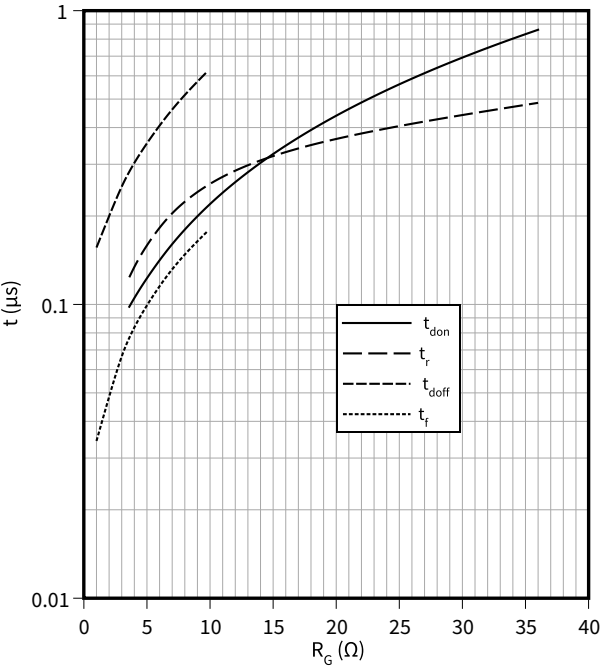
Switching times (typical), MOSFET

$t = f(I_D)$
 $R_{Goff} = 1\text{ }\Omega$, $R_{Gon} = 3.6\text{ }\Omega$, $V_{DS} = 600\text{ V}$, $T_{vj} = 175\text{ }^\circ\text{C}$, $V_{GS} = -3/18\text{ V}$



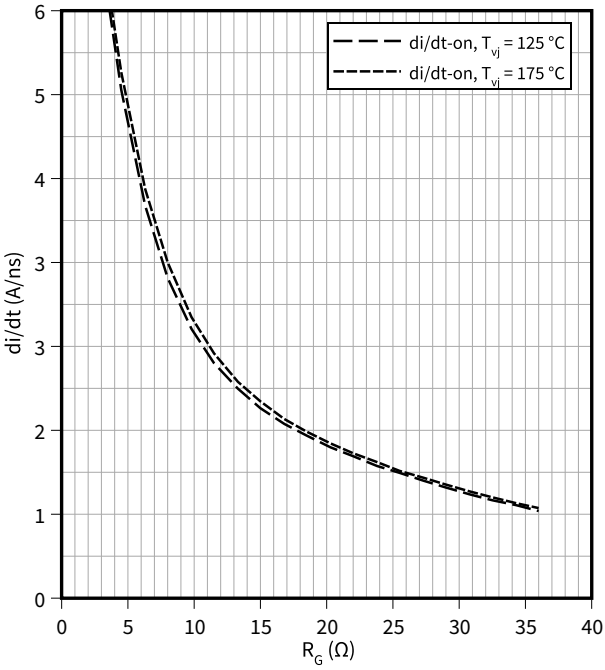
Switching times (typical), MOSFET

$t = f(R_G)$
 $V_{DS} = 600\text{ V}$, $I_D = 400\text{ A}$, $T_{vj} = 175\text{ }^\circ\text{C}$, $V_{GS} = -3/18\text{ V}$



Current slope (typical), MOSFET

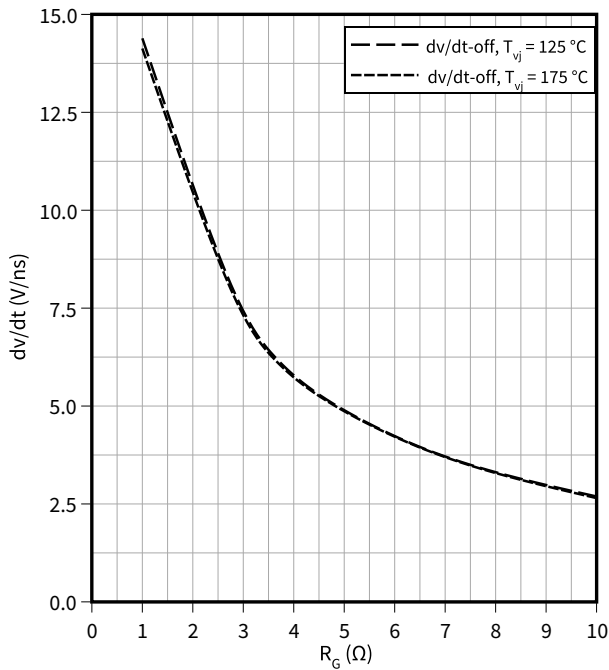
$di/dt = f(R_G)$
 $V_{DS} = 600\text{ V}$, $I_D = 400\text{ A}$, $V_{GS} = -3/18\text{ V}$



5 Characteristics diagrams

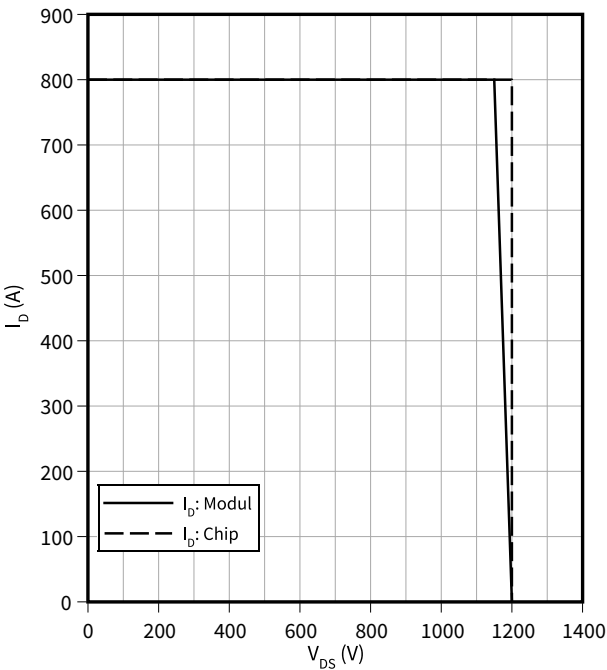
Voltage slope (typical), MOSFET

$dv/dt = f(R_G)$
 $V_{DS} = 600\text{ V}$, $I_D = 400\text{ A}$, $V_{GS} = -3/18\text{ V}$



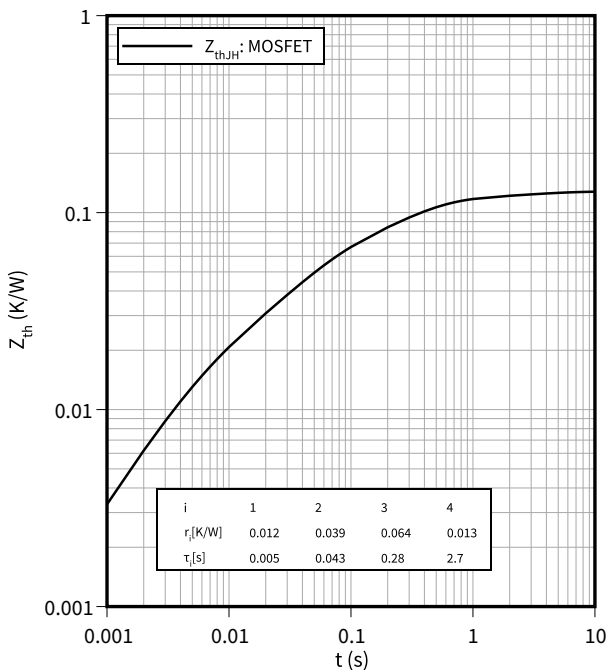
Reverse bias safe operating area (RBSOA), MOSFET

$I_D = f(V_{DS})$
 $R_{Goff} = 1\text{ Ω}$, $T_{vj} = 175\text{ °C}$, $V_{GS} = -3/18\text{ V}$



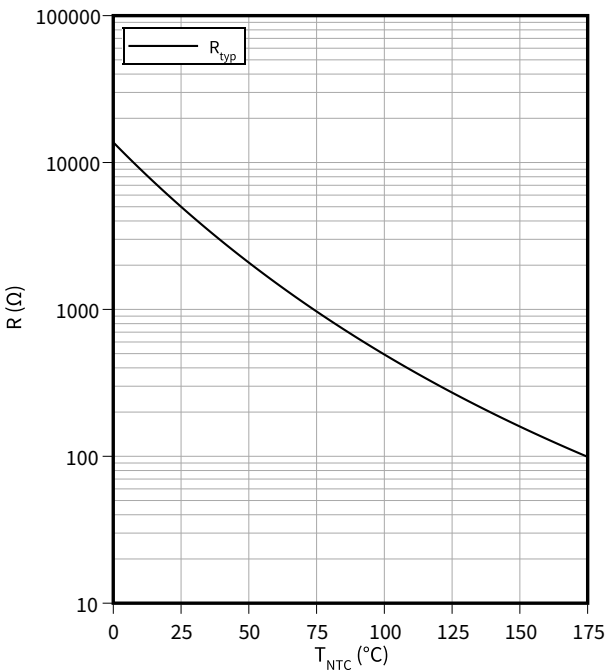
Transient thermal impedance, MOSFET

$Z_{th} = f(t)$



Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



6 **Circuit diagram**

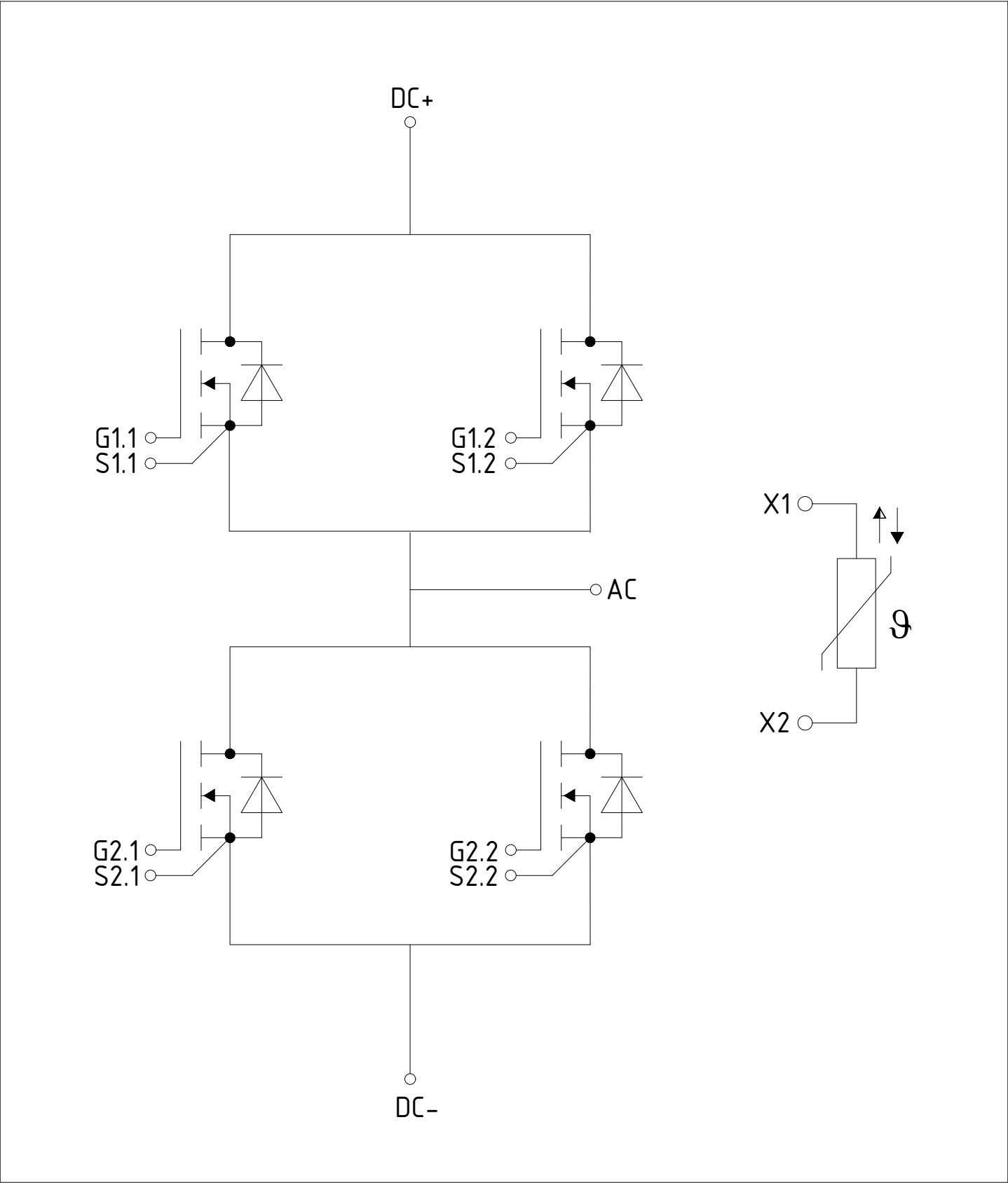


Figure 1

7 Package outlines

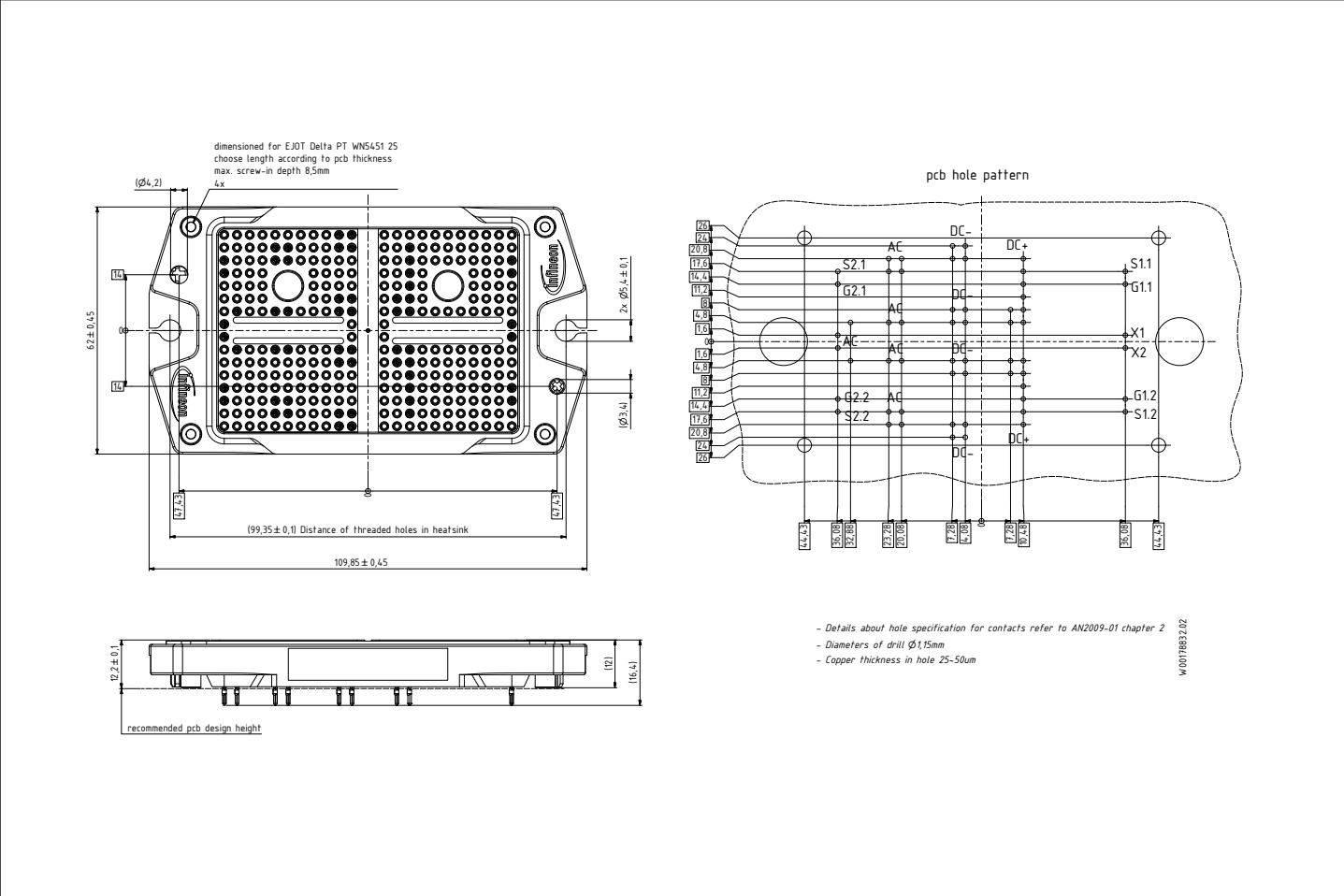


Figure 2

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	<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

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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