# infineon

#### EasyPACK<sup>™</sup> module with CoolSiC<sup>™</sup> Automotive MOSFET and PressFIT / NTC

#### **Features**

- · Electrical features
  - V<sub>DSS</sub> = 1200 V
  - I<sub>DN</sub> = 150 A
  - New semiconductor material silicon carbide
  - Blocking voltage 1200 V
  - Low R<sub>DS on</sub>
  - Low switching losses
  - Low Qg and Crss
  - Low inductive design
  - $T_{vj,op} = 150$ °C
- Mechanical features
  - 5.1 kV DC 1 second Insulation
  - Compact design
  - High power density
  - Integrated NTC temperature sensor
  - PressFIT contact technology
  - RoHS compliant

#### **Potential applications**

- Automotive applications
- · Auxiliary inverters
- DC/DC converter
- (Hybrid) electrical vehicles (H)EV

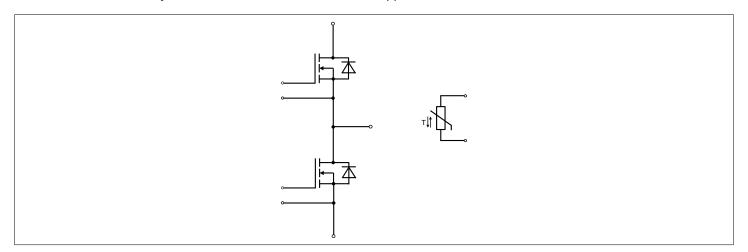
#### **Product validation**

• Qualified according to AQG 324, release no.: 02.1/2019

#### **Description**

The Automotive CoolSiC<sup>TM</sup> EasyPACK<sup>TM</sup>1B is a half bridge module which combines the benefits of Infineon's robust silicon carbide technology with a very compact and flexible package for hybrid and (fuel cell) electric vehicles. The power module implements the new CoolSiC<sup>TM</sup> Automotive MOSFET 1200V Gen1, optimized for high voltage applications like DC/DC converter and Auxiliary inverter. The chipset offers benchmark current density, high block voltage and reduced switching losses, which allows compact designs and helps to improve system efficiency, as well as allows a reliable operation under harsh environmental conditions.

The Automotive CoolSiC<sup>TM</sup> EasyPACK<sup>TM</sup>1B power module family comes with mechanical guiding elements and mounting clamps supporting easy assembly processes for customers. Furthermore, the press-fit pins for the signal terminals avoid additional time consuming selective solder processes, which provides cost savings on system level and increases system reliability. The Automotive CoolSiC<sup>TM</sup> EasyPACK<sup>TM</sup>1B allows a flexible cooler and application construction.





# FF08MR12W1MA1\_B11A EasyPACK<sup>™</sup> module





# **Table of contents**

Description	1
Features	1
Potential applications	1
Product validation	1
Table of contents	2
Package	3
MOSFET	3
Body diode	5
NTC-Thermistor	6
Characteristics diagrams	7
•	
-	
Disclaimer	
	Features  Potential applications  Product validation  Table of contents  Package  MOSFET  Body diode  NTC-Thermistor  Characteristics diagrams  Circuit diagram  Package outlines  Module label code  Revision history

# **EasyPACK**<sup>™</sup> module

1 Package



# 1 Package

#### Table 1 Insulation coordination

Parameter	Symbol	Note or test condition	Values	Unit
Isolation test voltage	V <sub>ISOL</sub>	RMS, f = 0 Hz, t = 1 sec	5.10	kV
Internal isolation		basic insulation (class 1, IEC 61140)	Al <sub>2</sub> O <sub>3</sub>	
Creepage distance	$d_{\rm creep}$	terminal to heatsink	11.5	mm
Creepage distance	$d_{\rm creep}$	terminal to terminal	8.0	mm
Clearance	d <sub>clear</sub>	terminal to heatsink	10.0	mm
Clearance	d <sub>clear</sub>	terminal to terminal	5.5	mm
Comparative tracking index	СТІ		> 200	

#### Table 2 Characteristic values

Parameter	Symbol	Note or test condition		Values		Unit
			Min.	Тур.	Max.	
Stray inductance module	$L_{s,CE}$			5.0		nH
Module lead resistance, terminals - chip	R <sub>AA'+CC'</sub>	$T_{\rm c}$ = 25 °C, per switch		1.00		mΩ
Storage temperature	$T_{\rm stg}$		-40		150	°C
Weight	G			24		g
Mounting force per clamp	F		20		50	N

#### 2 MOSFET

#### Table 3 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Drain-source voltage	$V_{\rm DSS}$		T <sub>vj</sub> = 25 °C	1200	V
DC drain current	I <sub>D,nom</sub>	$V_{\rm GS}$ = 15 V, $T_{\rm h}$ = 65 °C	<i>T</i> <sub>vj,max</sub> = 175 °C	150	Α
Pulsed drain current	I <sub>D,pulse</sub>	verified by design, t <sub>p</sub> limited by T <sub>vimax</sub>		300	Α
Gate-source voltage	$V_{GSS}$			-10/20	V

#### Table 4 Characteristic values

Parameter	Symbol Note or test condition			Values			Unit
				Min.	Тур.	Max.	
Drain-source on-resistance	R <sub>DS,on</sub>	$I_{\rm D}$ = 150 A, $V_{\rm GS}$ = 15 V	T <sub>vj</sub> = 25 °C		7.33	9.80	mΩ
			T <sub>vj</sub> = 125 °C		10.60		
			T <sub>vj</sub> = 150 °C		12.10		

### (table continues...)

# **EasyPACK**<sup>™</sup> module

2 MOSFET



(continued) Characteristic values Table 4

Parameter	Symbol	Note or test condition			Values		Unit
				Min.	Тур.	Max.	
Gate threshold voltage	V <sub>GS,th</sub>	$I_D$ = 90 mA, $V_{GS}$ = $V_{DS}$ , (tested after 1ms pulse at $V_{GS}$ = +20 V)	T <sub>vj</sub> = 25 °C	3.25	4.40	5.55	V
Total gate charge	Q <sub>G</sub>	$V_{\rm DS}$ = 600 V, $V_{\rm GS}$ = -5/15 V			0.49		μC
Internal gate resistor	$R_{G,int}$		T <sub>vj</sub> = 25 °C		0.6		Ω
Input capacitance	C <sub>iss</sub>	$f = 1 \text{ MHz}, V_{DS} = 600 \text{ V},$ $V_{GS} = 0 \text{ V}$	T <sub>vj</sub> = 25 °C		16		nF
Output capacitance	C <sub>oss</sub>	$f = 1 \text{ MHz}, V_{DS} = 600 \text{ V},$ $V_{GS} = 0 \text{ V}$	T <sub>vj</sub> = 25 °C		0.70		nF
Reverse transfer capacitance	C <sub>rss</sub>	$f = 1 \text{ MHz}, V_{DS} = 600 \text{ V},$ $V_{GS} = 0 \text{ V}$	T <sub>vj</sub> = 25 °C		0.06		nF
C <sub>OSS</sub> stored energy	E <sub>oss</sub>	$V_{\rm DS}$ = 600 V, $V_{\rm GS}$ = -5/15 V	T <sub>vj</sub> = 25 °C		164		μJ
Drain-source leakage current	I <sub>DSX</sub>	$V_{GS} = -5 \text{ V}, V_{DSS} = 1200 \text{ V}$	T <sub>vj</sub> = 25 °C			100	μA
Gate-source leakage current	I <sub>GSS</sub>	$V_{\rm GS} = 20 \text{ V}, V_{\rm DS} = 0 \text{ V}$	T <sub>vj</sub> = 25 °C			400	nA
Turn-on delay time, inductive load	t <sub>d,on</sub>		T <sub>vj</sub> = 25 °C		53		ns
		$V_{\rm GS} = -5/15  \text{V}, V_{\rm DS} = 600  \text{V}$	T <sub>vj</sub> = 125 °C		48		_
			T <sub>vj</sub> = 150 °C		46		
Rise time (inductive load)	t <sub>r</sub>	$I_{\rm D} = 150  \text{A}, R_{\rm G,on} = 5.1  \Omega,$	T <sub>vj</sub> = 25 °C		35		ns
		$V_{\rm GS} = -5/15  \rm V$	T <sub>vj</sub> = 125 °C		34		
			T <sub>vj</sub> = 150 °C		33		
Turn-off delay time,	$t_{\sf d,off}$	$I_{\rm D} = 150  \text{A}, R_{\rm G,off} = 5.1  \Omega,$	T <sub>vj</sub> = 25 °C		146		ns
inductive load		$V_{\rm GS} = -5/15  \text{V}, V_{\rm DS} = 600  \text{V}$	T <sub>vj</sub> = 125 °C		148		
			T <sub>vj</sub> = 150 °C		149		
Fall time (inductive load)	t <sub>f</sub>	$I_{\rm D} = 150  \text{A}, R_{\rm G,off} = 5.1  \Omega,$	T <sub>vj</sub> = 25 °C		38		ns
		$V_{\rm GS} = -5/15 \text{ V}, V_{\rm DS} = 600 \text{ V}$	T <sub>vj</sub> = 125 °C		38		
			T <sub>vj</sub> = 150 °C		39		
Turn-on energy loss per	E <sub>on</sub>	$I_{\rm D} = 150  \text{A}, R_{\rm G,on} = 5.1  \Omega,$	T <sub>vj</sub> = 25 °C		4.26		mJ
pulse		$V_{GS} = -5/15 \text{ V}, V_{DS} = 600 \text{ V},$ $L_{\sigma} = 20 \text{ nH}$	T <sub>vj</sub> = 125 °C		5.01		
		25 25 1111	$T_{vj}$ = 150 °C, di/dt = 4.9 kA/µs		5.29		
Turn-off energy loss per	E <sub>off</sub>	$I_{\rm D} = 150 \text{ A}, R_{\rm G,off} = 5.1 \Omega,$	T <sub>vj</sub> = 25 °C		2.67		mJ
pulse		$V_{\text{GS}} = -5/15 \text{ V}, V_{\text{DS}} = 600 \text{ V},$ $L_{\sigma} = 20 \text{ nH}$	T <sub>vj</sub> = 125 °C		2.73		
		-σ 20 1111	$T_{\rm vj}$ = 150 °C, du/dt = 15.5 kV/µs		2.76		

# **EasyPACK**<sup>™</sup> module

3 Body diode



# Table 4 (continued) Characteristic values

Parameter	Symbol	Note or test condition			Values		
				Min.	Тур.	Max.	
Short circuit data	I <sub>SC</sub>	$V_{\rm DD}$ = 800 V, $V_{\rm GS}$ = -5/15 V, $R_{\rm G}$ = 5.1 $\Omega$ , $V_{\rm DSmax}$ = $V_{\rm DSS}$ -	$t_{SC} \le 3 \mu s$ , $T_{vj} = 150 ^{\circ}C$		2000		А
		L <sub>sDS</sub> ·di/dt	$t_{SC} \le 3 \mu s$ , $T_{vj} = 25 ^{\circ}C$		2200		
Thermal resistance, junction to heat sink	R <sub>th,j-h</sub>	per MOSFET			0.46	0.55	K/W
Temperature under switching conditions	$T_{\rm vj,op}$			-40		150	°C

# 3 Body diode

#### Table 5 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
DC body diode forward current	I <sub>F,S</sub>	$V_{\rm GS}$ = -5 V	T <sub>h</sub> = 65 °C	60	A
Pulsed body diode current	I <sub>F,S,pulse</sub>	verified by design, t <sub>p</sub> limi	ted by T <sub>vjmax</sub>	300	Α

### Table 6 Characteristic values

Parameter	Symbol	Note or test condition			Values		Unit
				Min.	Тур.	Max.	
Forward voltage	$V_{F,SD}$	I <sub>F,S</sub> = 150 A, V <sub>GS</sub> = -5 V	T <sub>vj</sub> = 25 °C		4.40	5.95	V
			T <sub>vj</sub> = 125 °C		4.18		
			T <sub>vj</sub> = 150 °C		4.12		
Peak reverse recovery	I <sub>rrm</sub>	$I_{F,S} = 150 \text{ A}, V_{GS} = -5 \text{ V},$	T <sub>vj</sub> = 25 °C		75		Α
current		$V_{R,DS} = 600 \text{ V}$	T <sub>vj</sub> = 125 °C		135		
			$-di/dt = 6.1 \text{ kA/}\mu\text{s},$ $T_{\text{vj}} = 150 ^{\circ}\text{C}$		158		
Recovered charge	Q <sub>rr</sub>	$I_{F,S} = 150 \text{ A}, V_{GS} = -5 \text{ V},$	T <sub>vj</sub> = 25 °C		2.58		μC
		1/ - 600 \/	T <sub>vj</sub> = 125 °C		4.10		
			$-di/dt = 6.1 \text{ kA/}\mu\text{s},$ $T_{\text{vj}} = 150 ^{\circ}\text{C}$		5.13		
Reverse recovery energy	E <sub>rec</sub>	$I_{F,S} = 150 \text{ A}, V_{GS} = -5 \text{ V},$ $V_{R,DS} = 600 \text{ V}$	T <sub>vj</sub> = 25 °C		0.5		mJ
		$V_{R,DS} = 600 \text{ V}$	T <sub>vj</sub> = 125 °C		0.9		
			$T_{vj} = 150 ^{\circ}\text{C},$ -di/dt = 6.1 kA/µs		1.4		

# **EasyPACK<sup>™</sup> module**

4 NTC-Thermistor



# 4 NTC-Thermistor

#### Table 7 Characteristic values

Parameter	Symbol	Note or test condition		Values			
			Min.	Тур.	Мах.		
Rated resistance	R <sub>25</sub>	T <sub>NTC</sub> = 25 °C		5		kΩ	
Deviation of R <sub>100</sub>	∆R/R	$T_{\rm NTC}$ = 100 °C, $R_{100}$ = 493 $\Omega$	-5		5	%	
Power dissipation	P <sub>25</sub>	T <sub>NTC</sub> = 25 °C			20	mW	
B-value	B <sub>25/50</sub>	$R_2 = R_{25} \exp[B_{25/50}(1/T_2-1/(298,15 \text{ K}))]$		3375		K	
B-value	B <sub>25/80</sub>	$R_2 = R_{25} \exp[B_{25/80}(1/T_2-1/(298,15 \text{ K}))]$		3411		K	
B-value	B <sub>25/100</sub>	$R_2 = R_{25} \exp[B_{25/100}(1/T_2-1/(298,15 \text{ K}))]$		3433		K	

# **EasyPACK**<sup>™</sup> module

5 Characteristics diagrams

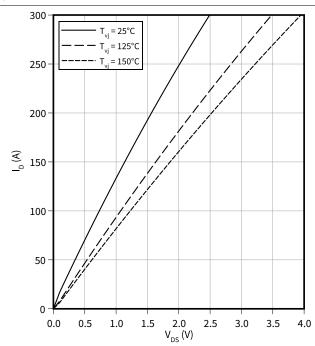


# **5** Characteristics diagrams

#### Output characteristic (typical), MOSFET

 $I_D = f(V_{DS})$ 

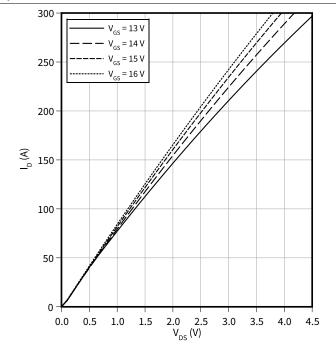
 $V_{GS} = 15 \text{ V}$ 



#### Output characteristic (typical), MOSFET

 $I_D = f(V_{DS})$ 

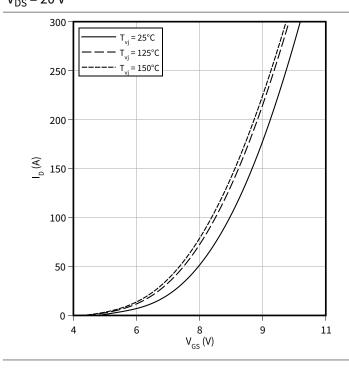
T<sub>vj</sub> = 150 °C



#### Transfer characteristic (typical), MOSFET

 $I_D = f(V_{GS})$ 

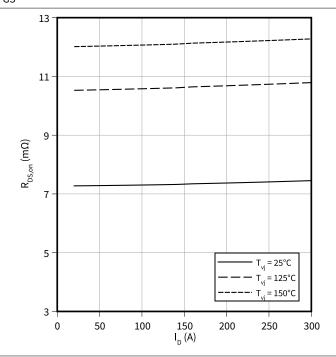
 $V_{DS} = 20 \text{ V}$ 



# Drain-source on-resistance (typical), MOSFET

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

 $V_{GS} = 15 V$ 



# **EasyPACK**<sup>™</sup> module

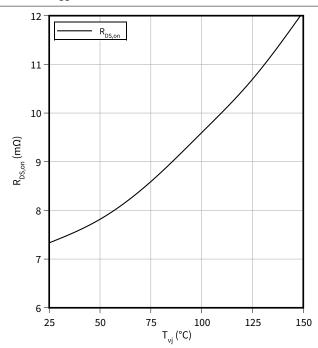
5 Characteristics diagrams



#### Drain-source on-resistance (typical), MOSFET

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

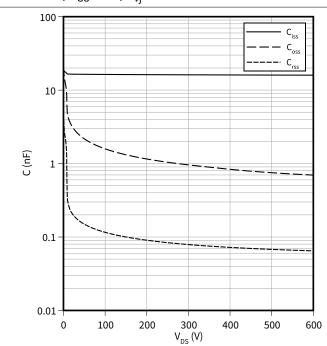
$$I_D = 150 A, V_{GS} = 15 V$$



#### Capacity characteristic (typical), MOSFET

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

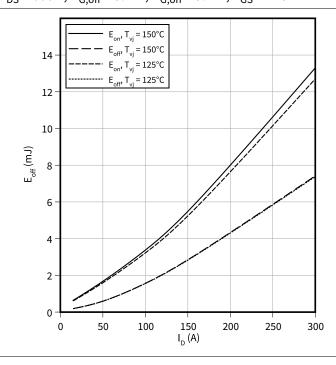
$$f = 100 \text{ kHz}$$
,  $V_{GS} = 0 \text{ V}$ ,  $T_{vi} = 25 \,^{\circ}\text{C}$ 



#### Switching losses (typical), MOSFET

$$E_{off} = f(I_D), E_{on} = f(I_D)$$

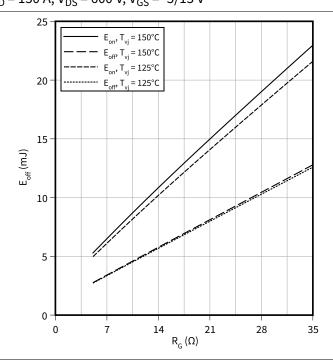
$$V_{DS} = 600 \text{ V}, R_{G,off} = 5.1 \Omega, R_{G,on} = 5.1 \Omega, V_{GS} = \pm 15 \text{ V}$$



#### Switching losses (typical), MOSFET

$$E_{off} = f(R_G), E_{on} = f(R_G)$$

$$I_D = 150 \text{ A}, V_{DS} = 600 \text{ V}, V_{GS} = -5/15 \text{ V}$$



# **EasyPACK**<sup>™</sup> module

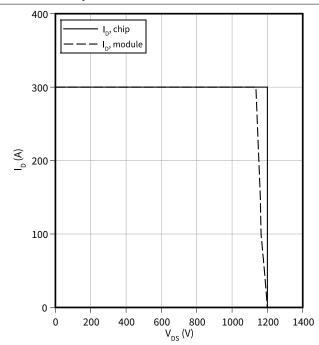
5 Characteristics diagrams



# Reverse bias safe operating area (RBSOA), MOSFET

 $I_D = f(V_{DS})$ 

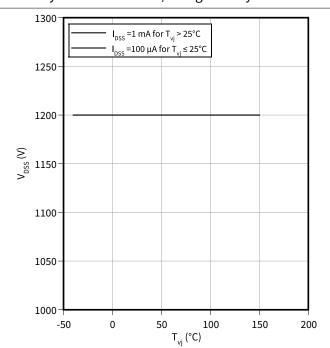
$$V_{GS}$$
 = -5/15 V,  $T_{vj}$  = 150 °C



# Maximum allowed drain-source voltage, MOSFET

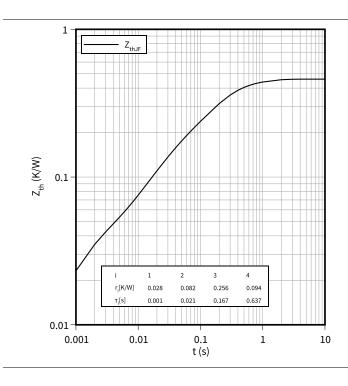
 $V_{DSS} = f(T_{vi})$ 

verified by characterization / design not by test



# ${\bf Transient\ thermal\ impedance\ ,\ MOSFET}$

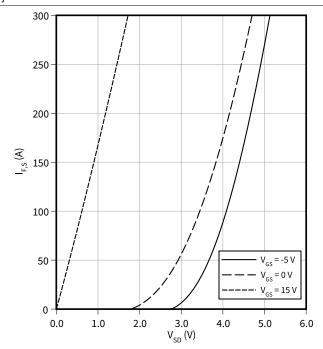
 $Z_{th} = f(t)$ 



#### Forward characteristic body diode (typical), MOSFET

 $I_{F,S} = f(V_{SD})$ 

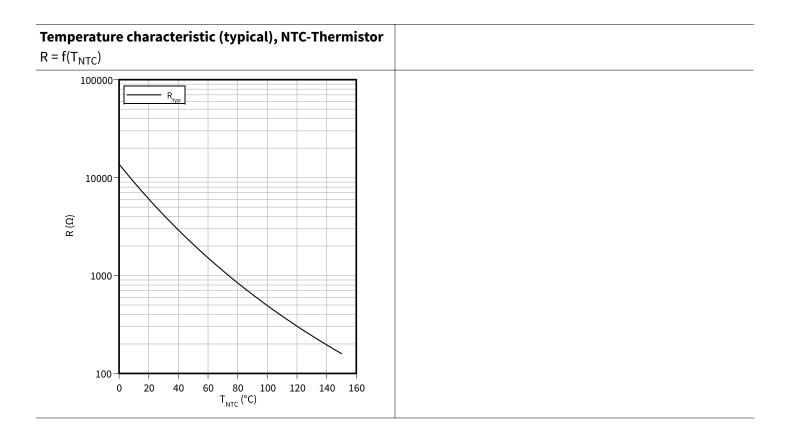
$$T_{vj} = 25 \,^{\circ}\text{C}$$



# **EasyPACK**<sup>™</sup> module



5 Characteristics diagrams



10

6 Circuit diagram



# 6 Circuit diagram

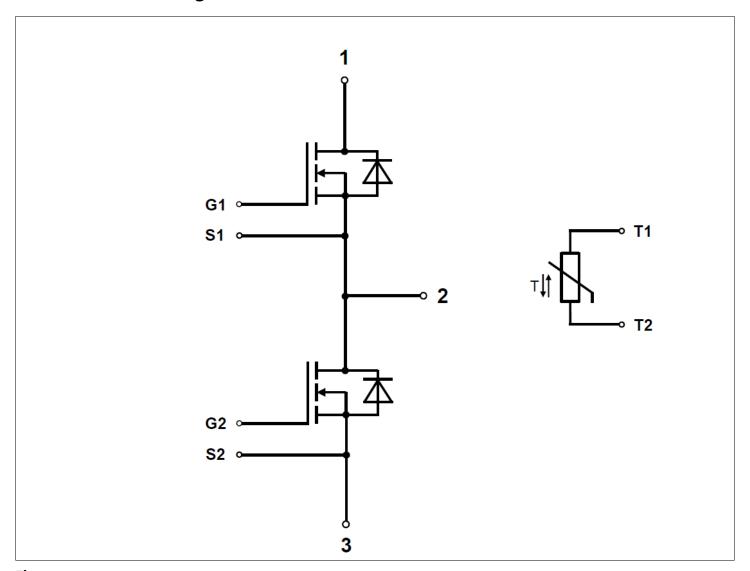


Figure 1

7 Package outlines



# 7 Package outlines

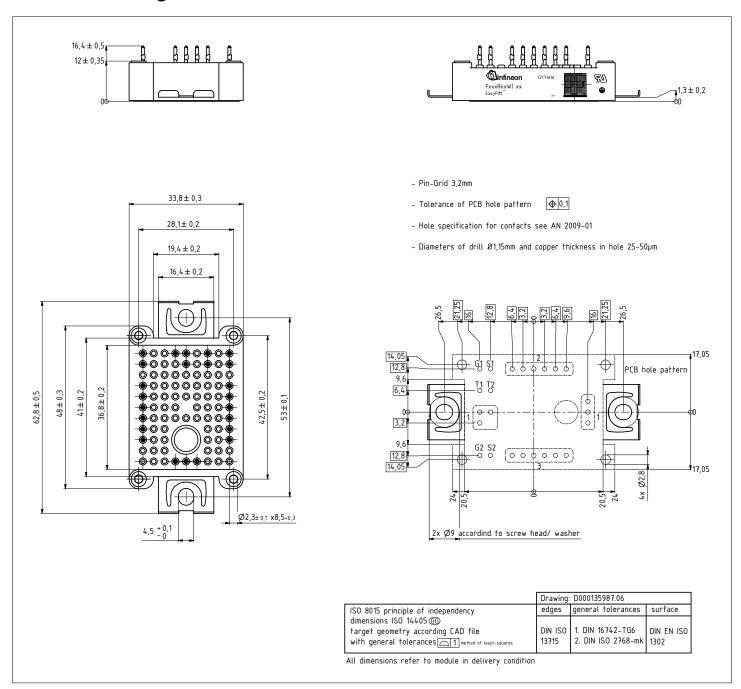


Figure 2

8 Module label code



#### Module label code 8

Code format	Data Matrix	Data Matrix Barcode Code128					
	ASCII text		Code Set A	.120			
Encoding							
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	71 14	ample 549 2846 054991			
Example	71549142846550549911530		71549142846550	549911530			
	1						
Code format	Barcode Code128						
Code format Encoding	Barcode Code128  Code Set A						
Code format Encoding	Barcode Code128						
Packing label co Code format Encoding Symbol size Standard	Barcode Code128  Code Set A						
Code format Encoding Symbol size	Barcode Code128  Code Set A  34 digits	Identifier X 1T S 9D Q	Digit 2 - 9 12 - 19 21 - 25 28 - 31 33 - 34	Example 95056609 2X0003E0 754389 1139 15			

Figure 3

# **EasyPACK<sup>™</sup> module**

Revision history



# **Revision history**

Document revision	Date of release	Description of changes		
V1.0	2018-11-21	Target datasheet		
V1.1	2018-11-27 Correction of pin designation in circuit diagram			
V2.0	2019-08-13	Target datasheet 1.1, New data for preliminary datasheet		
V3.0	2020-03-25	Final datasheet		
V3.1	2020-09-15	Correction of Erec energy and du/dt value		
n/a	2020-10-05	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		
1.11	2022-09-16	Fixed various typos		

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 ${\bf Email: erratum@infineon.com}$ 

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