

## Easy 1B Module

CoolSiC™ Automotive MOSFET

# FF08MR12W1MA1\_B11A

Qualified for Automotive Applications. Product Validation according to AQC 324

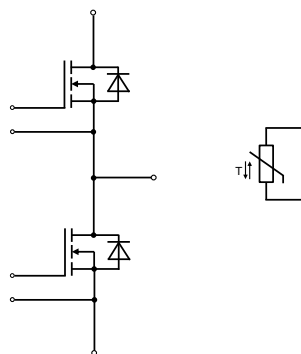
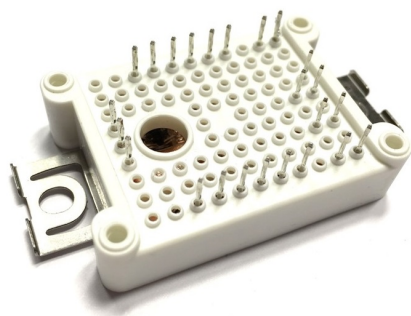
## Final Data Sheet

V3.1, 2020-09-15

## Automotive High Power

### 1 Features / Description

EasyDUAL module with CoolSiC™ Automotive MOSFET and PressFIT / NTC



$V_{DSS} = 1200\text{ V}$   
 $I_D = 150\text{ A}$

#### Typical Applications

- Automotive Applications
- Auxiliary Inverters
- DC/DC converter
- Hybrid Electrical Vehicles (H)EV

#### Electrical Features

- New semiconductor material - Silicon Carbide
- Blocking voltage 1200V
- Low  $R_{DSon}$
- Low Switching Losses
- Low  $Q_g$  and  $Cr_{ss}$
- Low Inductive Design
- $T_{vj\ op} = 150^\circ\text{C}$

#### Mechanical Features

- 5.1kV DC 1sec Insulation
- Compact design
- High Power Density
- Integrated NTC temperature sensor
- PressFIT Contact Technology
- RoHS compliant

#### Description

The Automotive CoolSiC™ EasyPACK™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™ 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.

It is qualified for Automotive Applications and validated according to AQC 324.

The Automotive CoolSiC™ EasyPACK™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™ EasyPACK™1B allows a flexible cooler and application construction. Due to the high clearance & creepage distances, the module family is also well suited for increased system working voltages and supports modular approaches.

Product Name	Ordering Code
FF08MR12W1MA1_B11A	SP002314006

## 2 MOSFET

### 2.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
Drain-source voltage	$T_{vj} = 25^{\circ}\text{C}$	$V_{DSS}$	1200	V
DC drain current	$T_{vj} = 175^{\circ}\text{C}, V_{GS} = 15\text{ V}$ $T_H = 65^{\circ}\text{C}$	$I_{D\text{ nom}}$	150	A
Pulsed drain current	verified by design, $t_p$ limited by $T_{vj\text{ max}}$	$I_{D\text{ pulse}}$	300	A
Gate-source voltage		$V_{GSS}$	-10/20	V

### 2.2 Characteristic Values

Parameter	Conditions	Symbol	min. typ. max.			Unit	
Drain-source on resistance	$I_{D\text{ nom}} = 150\text{ A}$ $V_{GS} = 15\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$R_{D\text{S on}}$	7.33 10.6 12.1	9.80	m $\Omega$	
Gate threshold voltage	$I_D = 90.0\text{ mA}, V_{DS} = V_{GS}$ (tested after 1ms pulse at $V_{GS} = +20\text{ V}$ )	$T_{vj} = 25^{\circ}\text{C}$	$V_{GS(th)}$	3.25	4.40	5.55	V
Total gate charge	$V_{GS} = -5/15\text{ V}, V_{DS} = 600\text{ V}$		$Q_G$	0.495		$\mu\text{C}$	
Internal gate resistor		$T_{vj} = 25^{\circ}\text{C}$	$R_{Gint}$	0.6		$\Omega$	
Input capacitance	$f = 1\text{ MHz}, V_{GS} = 0\text{ V}$ $V_{DS} = 600\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$	$C_{iss}$	16.0		nF	
Output capacitance	$f = 1\text{ MHz}, V_{GS} = 0\text{ V}$ $V_{DS} = 600\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$	$C_{oss}$	0.70		nF	
Reverse transfer capacitance	$f = 1\text{ MHz}, V_{GS} = 0\text{ V}$ $V_{DS} = 600\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$	$C_{rss}$	0.06		nF	
$C_{oss}$ stored energy	$V_{DS} = 600\text{ V}, V_{GS} = -5/15\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$	$E_{OSS}$	164		$\mu\text{J}$	
Drain-source leakage current	$V_{DSS} = 1200\text{ V}, V_{GS} = -5\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$	$I_{DSX}$		100	$\mu\text{A}$	
Gate-source leakage current	$V_{DS} = 0\text{ V}, T_{vj} = 25^{\circ}\text{C}$	$V_{GS} = 20\text{ V}$	$I_{GSS}$		400	nA	
Turn on delay time, inductive load	$I_{D\text{ nom}} = 150\text{ A}, R_{Gon} = 5.10\ \Omega$ $V_{DS} = 600\text{ V}$ $V_{GS} = -5/15\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$t_{d\text{ on}}$	53.0 48.0 46.0		ns	
Rise time, inductive load	$I_{D\text{ nom}} = 150\text{ A}, R_{Gon} = 5.10\ \Omega$ $V_{DS} = 600\text{ V}$ $V_{GS} = -5/15\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$t_r$	35.0 34.0 33.0		ns	
Turn off delay time, inductive load	$I_{D\text{ nom}} = 150\text{ A}, R_{Goff} = 5.10\ \Omega$ $V_{DS} = 600\text{ V}$ $V_{GS} = -5/15\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$t_{d\text{ off}}$	146 148 149		ns	
Fall time, inductive load	$I_{D\text{ nom}} = 150\text{ A}, R_{Goff} = 5.10\ \Omega$ $V_{DS} = 600\text{ V}$ $V_{GS} = -5/15\text{ V}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$t_f$	38.0 38.0 39.0		ns	
Turn-on energy loss per pulse	$I_{D\text{ nom}} = 150\text{ A}, V_{GS} = -5/15\text{ V}$ $V_{DS} = 600\text{ V}, R_{Gon} = 5.10\ \Omega$ $L_S = 20\text{ nH}$ $di/dt = 4.92\text{ kA}/\mu\text{s}$ ( $T_{vj\text{ op}} = 150^{\circ}\text{C}$ )	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$E_{on}$	4.26 5.01 5.29		mJ	
Turn-off energy loss per pulse	$I_{D\text{ nom}} = 150\text{ A}, V_{GS} = -5/15\text{ V}$ $V_{DS} = 600\text{ V}, R_{Goff} = 5.10\ \Omega$ $L_S = 20\text{ nH}$ $du/dt = 15.5\text{ kV}/\mu\text{s}$ ( $T_{vj\text{ op}} = 150^{\circ}\text{C}$ )	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	$E_{off}$	2.67 2.73 2.76		mJ	
SC data	$V_{GS} = -5/15\text{ V}, R_G = 5.10\ \Omega$ $V_{DD} = 800\text{ V}$ $V_{DS\text{ max}} = V_{DSS} - L_{SDS} \cdot di/dt$	$t_p \leq 3\ \mu\text{s}, T_{vj} = 150^{\circ}\text{C}$ $t_p \leq 3\ \mu\text{s}, T_{vj} = 25^{\circ}\text{C}$	$I_{SC}$	2000 2200		A	
Thermal resistance, junction to heatsink	per MOSFET		$R_{thJH}$	0.460	0.550	K/W	
Temperature under switching conditions			$T_{vj\text{ op}}$	-40	150	$^{\circ}\text{C}$	

### 3 Body diode

#### 3.1 Maximum Rated Values

Parameter	Conditions	Symbol	Value	Unit
DC body diode forward current	$T_{vj} = 175^{\circ}\text{C}$ , $V_{GS} = -5\text{ V}$ <span style="float: right;"><math>T_H = 65^{\circ}\text{C}</math></span>	$I_{SD}$	60	A
Pulsed body diode current	verified by design, $t_p$ limited by $T_{vjmax}$	$I_{SD\ pulse}$	300	A

#### 3.2 Characteristic Values

Parameter	Conditions	Symbol	Value			Unit
			min.	typ.	max.	
Forward voltage	$I_{SD} = 150\text{ A}$ , $V_{GS} = -5\text{ V}$	$V_{DSR}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	4.40 4.18 4.12	5.95	V
Peak reverse recovery current	$I_{SD} = 150\text{ A}$ , $V_{GS} = -5\text{ V}$ $-di_S/dt = 6.10\text{ kA}/\mu\text{s}$ $V_R = 600\text{ V}$	$I_{rrm}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	75.0 135 158		A
Recovered charge	$I_{SD} = 150\text{ A}$ , $V_{GS} = -5\text{ V}$ $-di_S/dt = 6.10\text{ kA}/\mu\text{s}$ $V_R = 600\text{ V}$	$Q_{rr}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	2.58 4.10 5.13		$\mu\text{C}$
Reverse recovery energy	$I_{SD} = 150\text{ A}$ , $V_{GS} = -5\text{ V}$ $-di_S/dt = 6.10\text{ kA}/\mu\text{s}$ $V_R = 600\text{ V}$	$E_{rec}$	$T_{vj} = 25^{\circ}\text{C}$ $T_{vj} = 125^{\circ}\text{C}$ $T_{vj} = 150^{\circ}\text{C}$	0.48 0.95 1.35		mJ

### 4 NTC-Thermistor

Parameter	Conditions	Symbol	Value			Unit
			min.	typ.	max.	
Rated resistance	$T_C = 25^{\circ}\text{C}$	$R_{25}$		5.00		$\text{k}\Omega$
Deviation of R100	$T_C = 100^{\circ}\text{C}$ , $R_{100} = 493\ \Omega$	$\Delta R/R$	-5		5	%
Power dissipation	$T_C = 25^{\circ}\text{C}$	$P_{25}$			20.0	mW
B-value	$R_2 = R_{25} \exp [B_{25/50}(1/T_2 - 1/(298,15\text{ K}))]$	$B_{25/50}$		3375		K
B-value	$R_2 = R_{25} \exp [B_{25/80}(1/T_2 - 1/(298,15\text{ K}))]$	$B_{25/80}$		3411		K
B-value	$R_2 = R_{25} \exp [B_{25/100}(1/T_2 - 1/(298,15\text{ K}))]$	$B_{25/100}$		3433		K

Specification according to the valid application note.

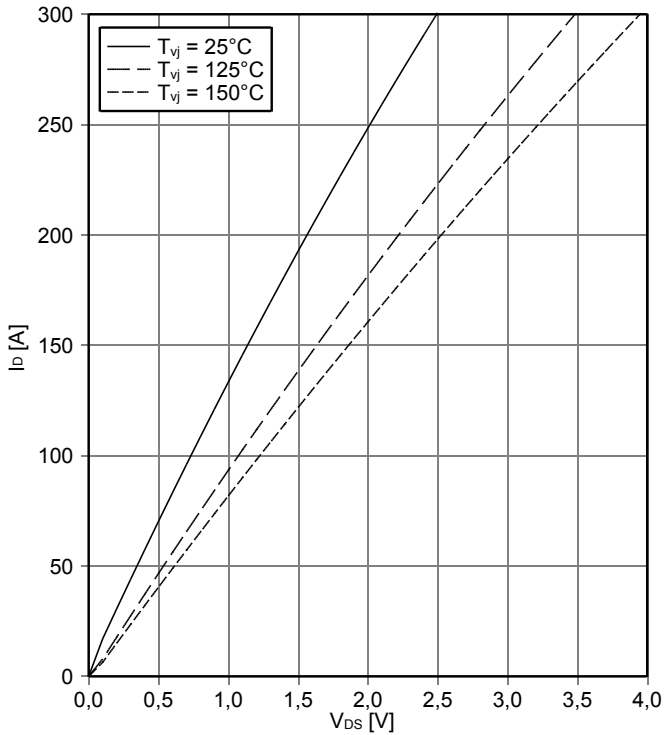
### 5 Module

Parameter	Conditions	Symbol	Value			Unit
			min.	typ.	max.	
Isolation test voltage	RMS, $f = 0\text{ Hz}$ , $t = 1\text{ sec}$	$V_{ISOL}$		5.1		kV
Internal isolation	basic insulation (class 1, IEC 61140)			$\text{Al}_2\text{O}_3$		
Creepage distance	terminal to heatsink terminal to terminal	$d_{Creep}$		11.5 8.0		mm
Clearance	terminal to heatsink terminal to terminal	$d_{Clear}$		10.0 5.5		mm
Comperative tracking index		CTI		> 200		
Stray inductance module		$L_{sCE}$		5.0		nH
Module lead resistance, terminals - chip	$T_C = 25^{\circ}\text{C}$ , per switch	$R_{AA'+CC'}$		1.00		m $\Omega$
Storage temperature		$T_{stg}$	-40		150	$^{\circ}\text{C}$
Mounting force per clamp		F	20	-	50	N
Weight		G		24		g

## 6 Characteristics Diagrams

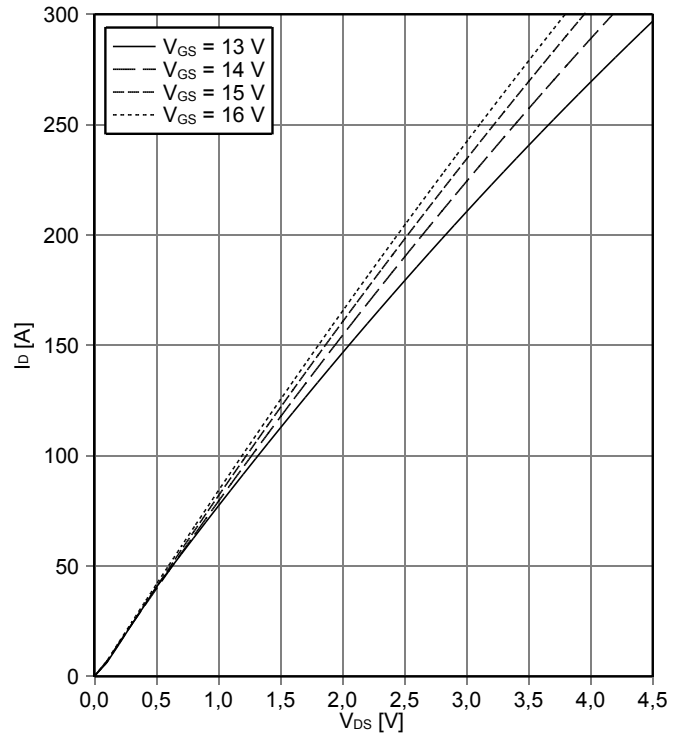
output characteristic MOSFET (typical)

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



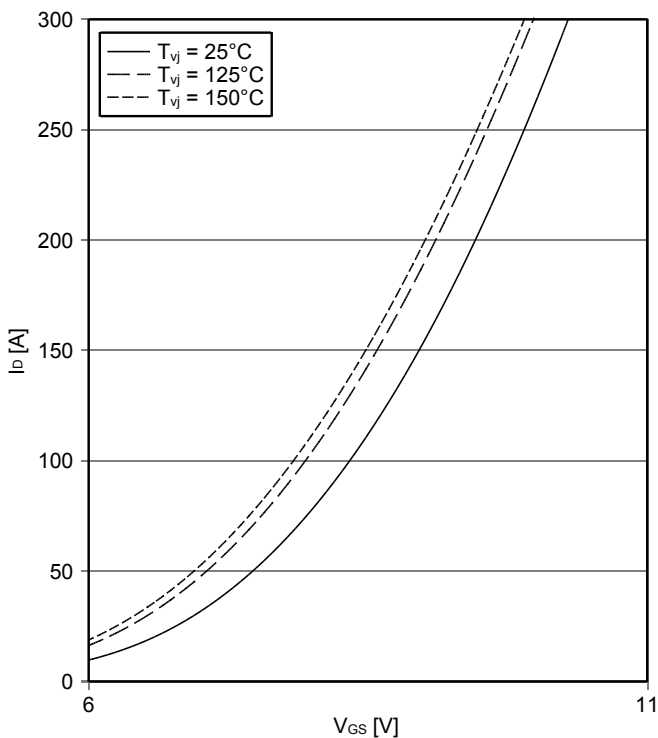
output characteristic MOSFET (typical)

$I_D = f(V_{DS})$   
 $T_{vj} = 150^\circ\text{C}$



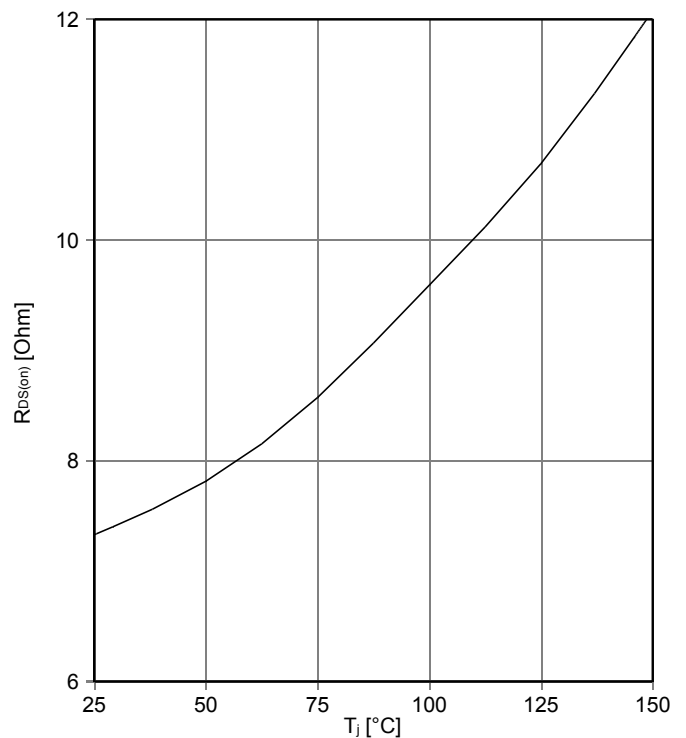
transfer characteristic MOSFET (typical)

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



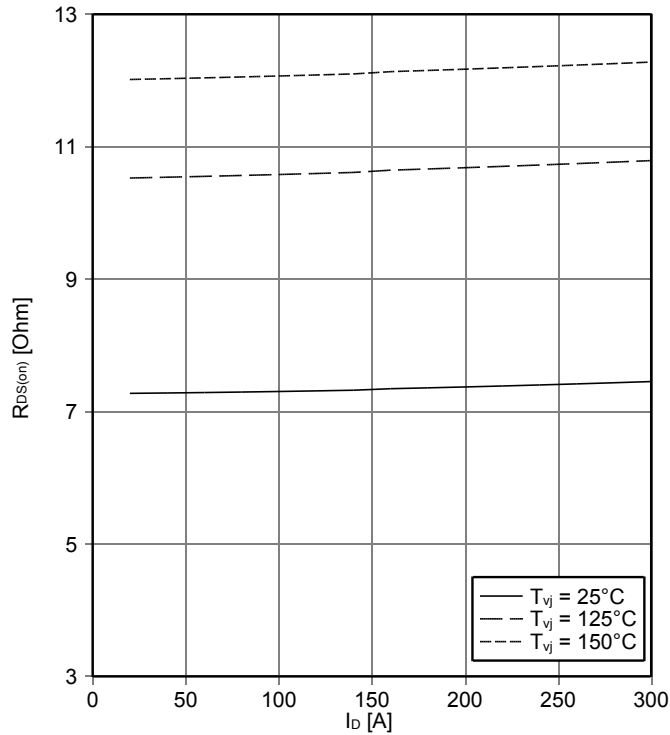
drain source on-resistance MOSFET (typical)

$R_{DS(on)} = f(T_j)$   
 $V_{GS} = 15\text{ V}; I_D = 150\text{ A}$



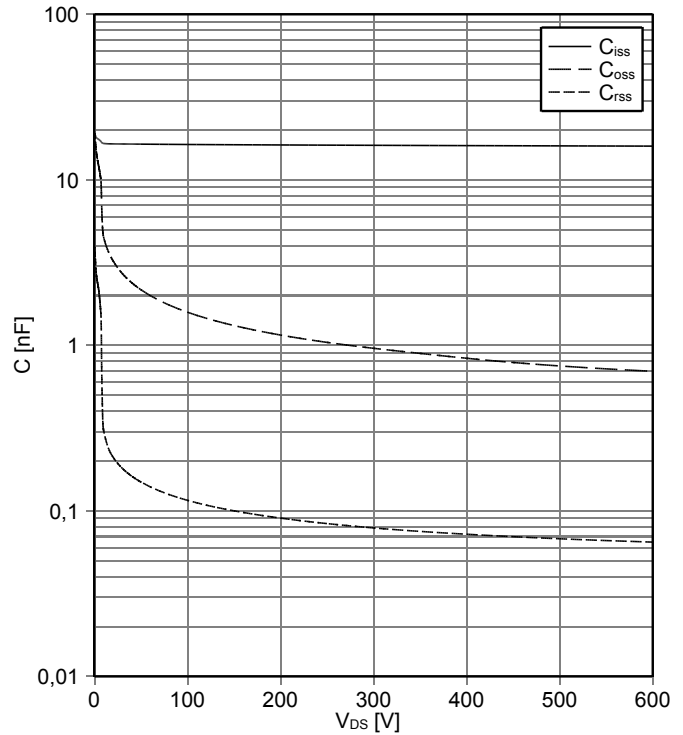
**drain source on-resistance MOSFET (typical)**

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



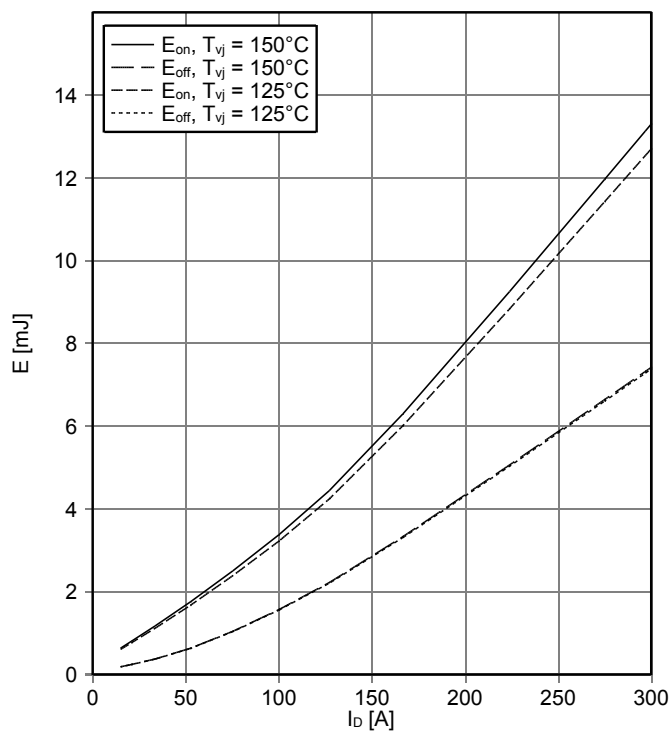
**capacity characteristic MOSFET (typical)**

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



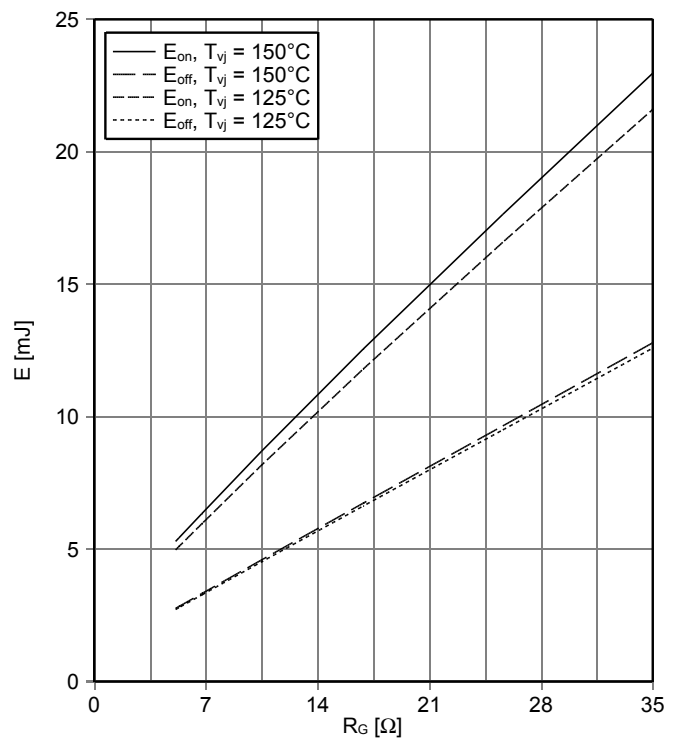
**switching losses MOSFET (typical)**

$E_{on} = f(I_D), E_{off} = f(I_D)$   
 $V_{GS} = -5\text{ V} / +15\text{ V}, R_{Gon} = R_{Goff} = 5.1\ \Omega, V_{DS} = 600\text{ V}$



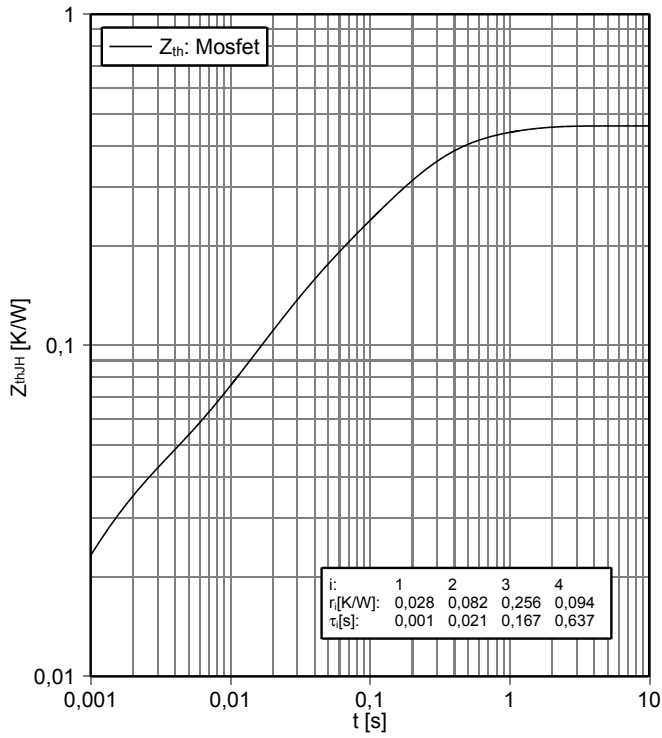
**switching losses MOSFET (typical)**

$E_{on} = f(R_G), E_{off} = f(R_G)$   
 $V_{GS} = -5\text{ V} / +15\text{ V}, I_D = 150\text{ A}, V_{DS} = 600\text{ V}$



**transient thermal impedance MOSFET**

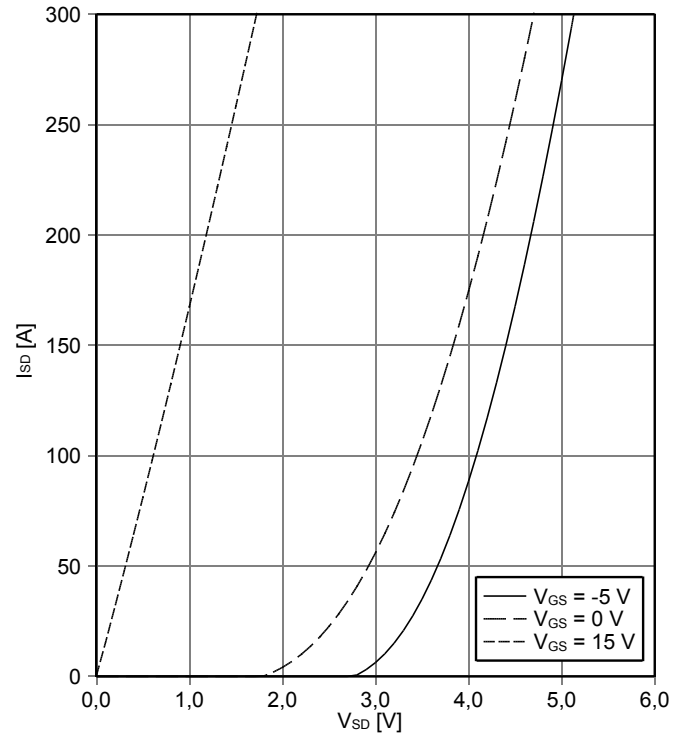
$Z_{thJH} = f(t)$  (typical)



**forward characteristic MOSFET body diode (typical)**

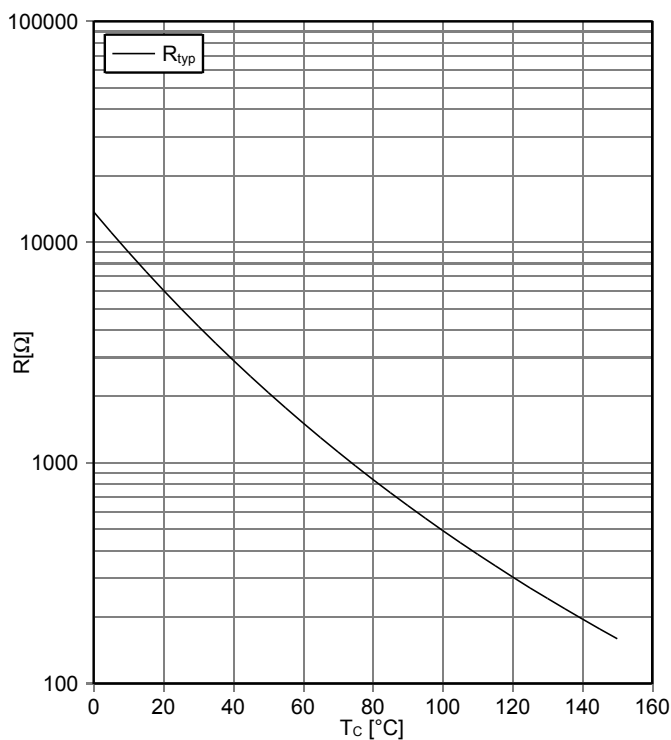
$I_{SD} = f(V_{SD})$

$T_j = 25^\circ\text{C}$

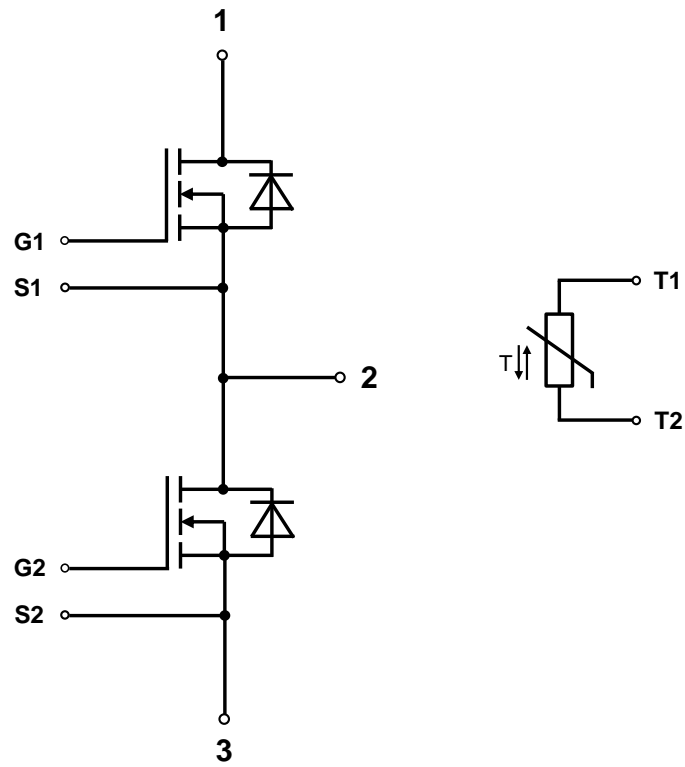


**NTC-Thermistor-temperature characteristic (typical)**

$R = f(T)$

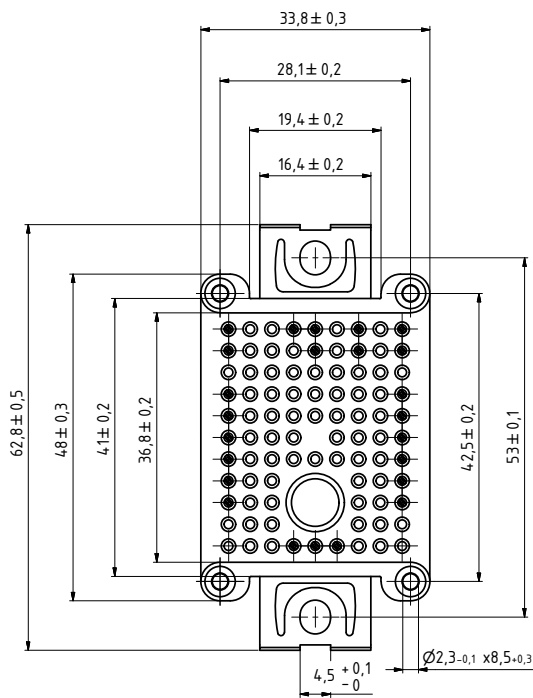
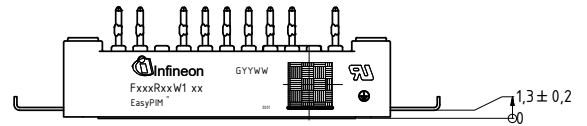
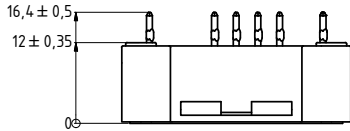


7 Circuit diagram

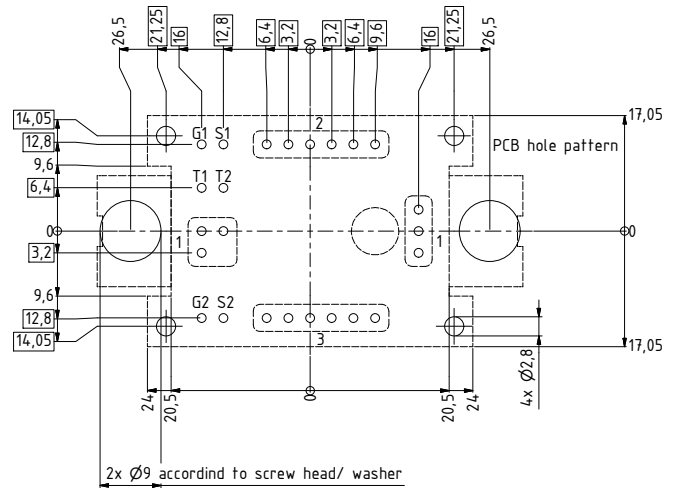




### 8 Package outlines



- Pin-Grid 3,2mm
- Tolerance of PCB hole pattern  $\oplus 0,1$
- Hole specification for contacts see AN 2009-01
- Diameters of drill  $\varnothing 1,15$ mm and copper thickness in hole 25-50 $\mu$ m




Drawing: D000135987.02			
ISO 8015 principle of independency	edges	general tolerances	surface
dimensions ISO 14405 $\oplus$			
target geometry according CAD file	DIN ISO 13715	1. DIN 16742-TG6 2. DIN ISO 2768-mk	DIN EN ISO 1302
with general tolerances $\oplus 1$ method of least-squares			


All dimensions refer to module in delivery condition

## 9 Label Codes

### 9.1 Module Code

Code Format	Data Matrix		
Encoding	ASCII Text		
Symbol Size	16x16		
Standard	IEC24720 and IEC16022		
Code Content	Content Module Serial Number Module Material Number Production Order Number Datecode (Production Year) Datecode (Production Week)	Digit 1 - 5 6 - 11 12 - 19 20 - 21 22 - 23	Example (below) 71549 142846 55054991 15 30
Example	 71549142846550549911530		

### 9.2 Packing Code

Code Format	Code128			
Encoding	Code Set A			
Symbol Size	34 digits			
Standard	IEC8859-1			
Code Content	Content Backend Construction Number Production Lot Number Serial Number Date Code Box Quantity	Identifier X 1T S 9D Q	Digit 2 - 9 12 - 19 21 - 25 28 - 31 33 - 34	Example (below) 95056609 2X0003E0 754389 1139 15
Example	 X950566091T2X0003E0S754389D1139Q15			

## Revision History

Major changes since previous revision

Revision History		
Reference	Date	Description
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

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