

## 62 mm C-Series module with CoolSiC™ Trench MOSFET

### Features

- Electrical features
  - $V_{DSS} = 2000\text{ V}$
  - $I_{DN} = 200\text{ A} / I_{DRM} = 400\text{ A}$
  - High current density
  - Low switching losses
- Mechanical features
  - 4 kV AC 1 min insulation

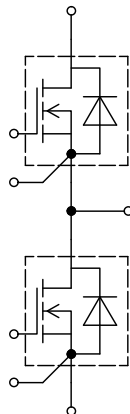
### Potential applications

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

### 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, $f = 50 \text{ Hz}$ , $t = 1 \text{ min}$	4.0	kV
Material of module baseplate			Cu	
Internal isolation		basic insulation (class 1, IEC 61140)	$Al_2O_3$	
Creepage distance	$d_{Creep}$	terminal to heatsink	29.0	mm
Creepage distance	$d_{Creep}$	terminal to terminal	23.0	mm
Clearance	$d_{Clear}$	terminal to heatsink	23.0	mm
Clearance	$d_{Clear}$	terminal to terminal	11.0	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	$L_{sCE}$			20		nH
Module lead resistance, terminals - chip	$R_{CC'+EE'}$	$T_C = 25 \text{ °C}$ , per switch		0.535		mΩ
Storage temperature	$T_{stg}$		-40		125	°C
Mounting torque for module mounting	$M$	- Mounting according to valid application note	M6, Screw	3	6	Nm
Terminal connection torque	$M$	- Mounting according to valid application note	M6, Screw	2.5	5	Nm
Weight	$G$			340		g

## 2 MOSFET, T1 / T2

**Table 3** Maximum rated values

Parameter	Symbol	Note or test condition	Values	Unit
Drain-source voltage	$V_{DSS}$	$T_{vj} = 25 \text{ °C}$	2000	V
Implemented drain current	$I_{DN}$		200	A
Continuous DC drain current	$I_{DDC}$	$T_{vj} = 175 \text{ °C}$ , $V_{GS} = 18 \text{ V}$ $T_C = 25 \text{ °C}$	195	A
Repetitive peak drain current	$I_{DRM}$	verified by design, $t_p$ limited by $T_{vjmax}$	400	A

(table continues...)

**Table 3 (continued) Maximum rated values**

Parameter	Symbol	Note or test condition	Values	Unit
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	$V_{GS(on)}$		18	V
Off-state gate voltage	$V_{GS(off)}$		-3	V

**Table 5 Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit		
			Min.	Typ.	Max.			
Drain-source on-resistance	$R_{DS(on)}$	$I_D = 200\text{ A}$		$V_{GS} = 18\text{ V}$ , $T_{vj} = 25\text{ °C}$	5.2	8	mΩ	
				$V_{GS} = 18\text{ V}$ , $T_{vj} = 125\text{ °C}$		11		
				$V_{GS} = 18\text{ V}$ , $T_{vj} = 175\text{ °C}$		15.5		
Gate threshold voltage	$V_{GS(th)}$	$I_D = 112\text{ mA}$ , $V_{DS} = V_{GS}$ , $T_{vj} = 25\text{ °C}$ , (tested after 1ms pulse at $V_{GS} = +20\text{ V}$ )	3.45	4.3	5.15	V		
Total gate charge	$Q_G$	$V_{DD} = 1200\text{ V}$ , $V_{GS} = -3/18\text{ V}$		0.78		μC		
Internal gate resistor	$R_{Gint}$	$T_{vj} = 25\text{ °C}$		1.8		Ω		
Input capacitance	$C_{ISS}$	$f = 100\text{ kHz}$ , $V_{DS} = 1200\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_{vj} = 25\text{ °C}$		24.1		nF		
Output capacitance	$C_{OSS}$	$f = 100\text{ kHz}$ , $V_{DS} = 1200\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_{vj} = 25\text{ °C}$		0.563		nF		
Reverse transfer capacitance	$C_{rSS}$	$f = 100\text{ kHz}$ , $V_{DS} = 1200\text{ V}$ , $V_{GS} = 0\text{ V}$ , $T_{vj} = 25\text{ °C}$		0.041		nF		
$C_{OSS}$ stored energy	$E_{OSS}$	$V_{DS} = 1200\text{ V}$ , $V_{GS} = -3/18\text{ V}$ , $T_{vj} = 25\text{ °C}$		1020		μJ		
Drain-source leakage current	$I_{DSS}$	$V_{DS} = 2000\text{ V}$ , $V_{GS} = -3\text{ V}$ , $T_{vj} = 25\text{ °C}$		0.04	378	μA		
Gate-source leakage current	$I_{GSS}$	$V_{DS} = 0\text{ V}$ , $T_{vj} = 25\text{ °C}$			400	nA		
Turn-on delay time (inductive load)	$t_{d\ on}$	$I_D = 200\text{ A}$ , $R_{Gon} = 7.5\text{ Ω}$ , $V_{DD} = 1200\text{ V}$ , $V_{GS} = -3/18\text{ V}$	$T_{vj} = 25\text{ °C}$		152	ns		
			$T_{vj} = 125\text{ °C}$		140			
			$T_{vj} = 175\text{ °C}$		137			

**(table continues...)**

**Table 5 (continued) Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rise time (inductive load)	$t_r$	$I_D = 200 \text{ A}$ , $R_{Gon} = 7.5 \text{ } \Omega$ , $V_{DD} = 1200 \text{ V}$ , $V_{GS} = -3/18 \text{ V}$	$T_{vj} = 25 \text{ } ^\circ\text{C}$	173		ns
			$T_{vj} = 125 \text{ } ^\circ\text{C}$	153		
			$T_{vj} = 175 \text{ } ^\circ\text{C}$	150		
Turn-off delay time (inductive load)	$t_{d\ off}$	$I_D = 200 \text{ A}$ , $R_{Goff} = 4.7 \text{ } \Omega$ , $V_{DD} = 1200 \text{ V}$ , $V_{GS} = -3/18 \text{ V}$	$T_{vj} = 25 \text{ } ^\circ\text{C}$	213		ns
			$T_{vj} = 125 \text{ } ^\circ\text{C}$	233		
			$T_{vj} = 175 \text{ } ^\circ\text{C}$	244		
Fall time (inductive load)	$t_f$	$I_D = 200 \text{ A}$ , $R_{Goff} = 4.7 \text{ } \Omega$ , $V_{DD} = 1200 \text{ V}$ , $V_{GS} = -3/18 \text{ V}$	$T_{vj} = 25 \text{ } ^\circ\text{C}$	73.5		ns
			$T_{vj} = 125 \text{ } ^\circ\text{C}$	75.6		
			$T_{vj} = 175 \text{ } ^\circ\text{C}$	77.3		
Turn-on energy loss per pulse	$E_{on}$	$I_D = 200 \text{ A}$ , $V_{DD} = 1200 \text{ V}$ , $L_\sigma = 25 \text{ nH}$ , $V_{GS} = -3/18 \text{ V}$ , $R_{Gon} = 7.5 \text{ } \Omega$ , $di/dt = 3.1 \text{ kA}/\mu\text{s}$ ( $T_{vj} = 175 \text{ } ^\circ\text{C}$ )	$T_{vj} = 25 \text{ } ^\circ\text{C}$	24.5		mJ
			$T_{vj} = 125 \text{ } ^\circ\text{C}$	26.6		
			$T_{vj} = 175 \text{ } ^\circ\text{C}$	29.2		
Turn-off energy loss per pulse	$E_{off}$	$I_D = 200 \text{ A}$ , $V_{DD} = 1200 \text{ V}$ , $L_\sigma = 25 \text{ nH}$ , $V_{GS} = -3/18 \text{ V}$ , $R_{Goff} = 4.7 \text{ } \Omega$ , $dv/dt = 12.4 \text{ kV}/\mu\text{s}$ ( $T_{vj} = 175 \text{ } ^\circ\text{C}$ )	$T_{vj} = 25 \text{ } ^\circ\text{C}$	13.1		mJ
			$T_{vj} = 125 \text{ } ^\circ\text{C}$	13.4		
			$T_{vj} = 175 \text{ } ^\circ\text{C}$	13.7		
Thermal resistance, junction to case	$R_{thJC}$	per MOSFET			0.181	K/W
Thermal resistance, case to heat sink	$R_{thCH}$	per MOSFET, $\lambda_{grease} = 1 \text{ W}/(\text{m}^*\text{K})$		0.0500		K/W
Temperature under switching conditions	$T_{vj\ op}$		-40		175	$^\circ\text{C}$

*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 Notes AN 2018-09 and AN 2021-13 must be considered to ensure sound operation of the device over the planned lifetime.*

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

### 3 Body diode (MOSFET, T1 / T2)

**Table 6 Maximum rated values**

Parameter	Symbol	Note or test condition	Values	Unit
DC body diode forward current	$I_{SD}$	$T_{vj} = 175 \text{ } ^\circ\text{C}$ , $V_{GS} = -3 \text{ V}$ $T_C = 25 \text{ } ^\circ\text{C}$	165	A

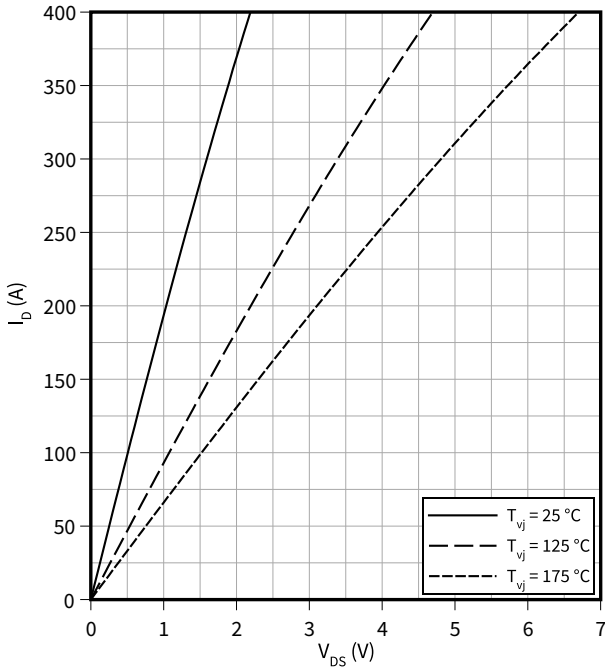
**Table 7**                    **Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit	
			Min.	Typ.	Max.		
Forward voltage	$V_{SD}$	$I_{SD} = 200 \text{ A}, V_{GS} = -3 \text{ V}$	$T_{vj} = 25 \text{ }^\circ\text{C}$		4.6	6.15	V
			$T_{vj} = 125 \text{ }^\circ\text{C}$		4.15		
			$T_{vj} = 175 \text{ }^\circ\text{C}$		4		

## 4 Characteristics diagrams

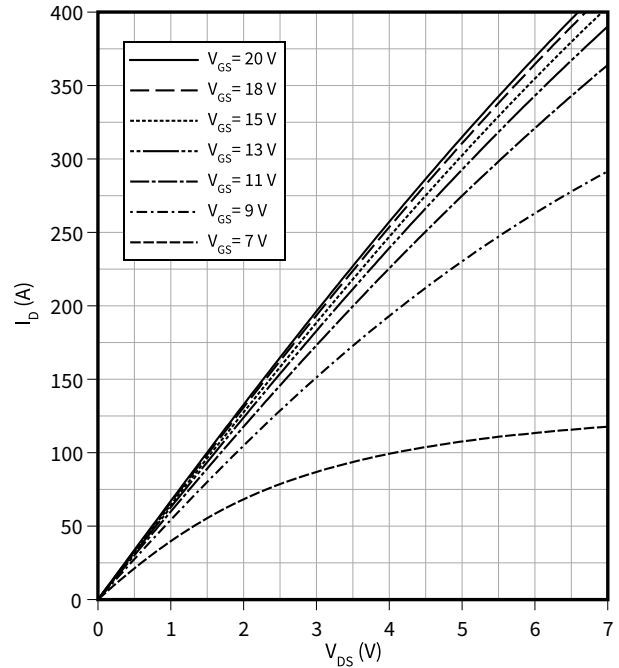
**Output characteristic (typical), MOSFET, T1 / T2**

$I_D = f(V_{DS})$   
 $V_{GS} = 18\text{ V}$



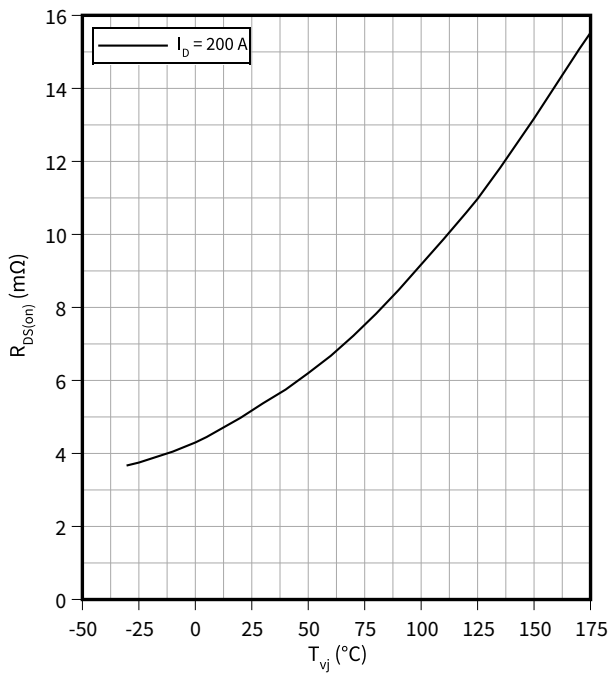
**Output characteristic field (typical), MOSFET, T1 / T2**

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



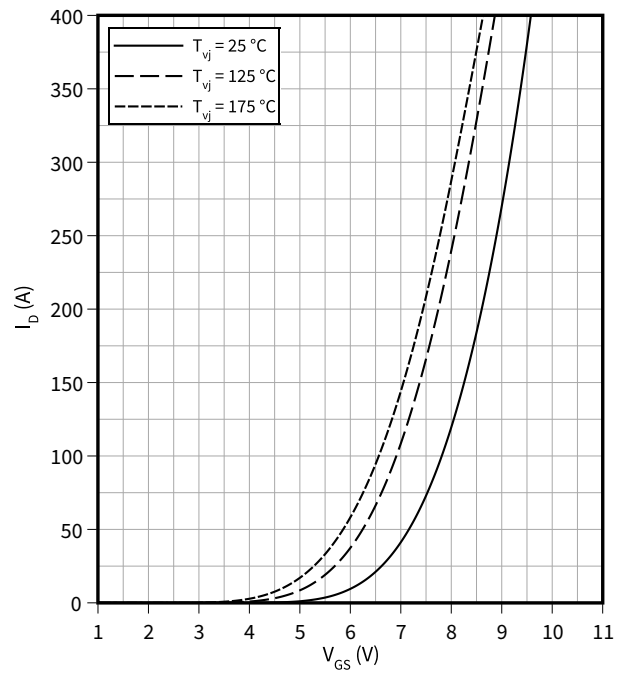
**Drain source on-resistance (typical), MOSFET, T1 / T2**

$R_{DS(on)} = f(T_{vj})$   
 $V_{GS} = 18\text{ V}$



**Transfer characteristic (typical), MOSFET, T1 / T2**

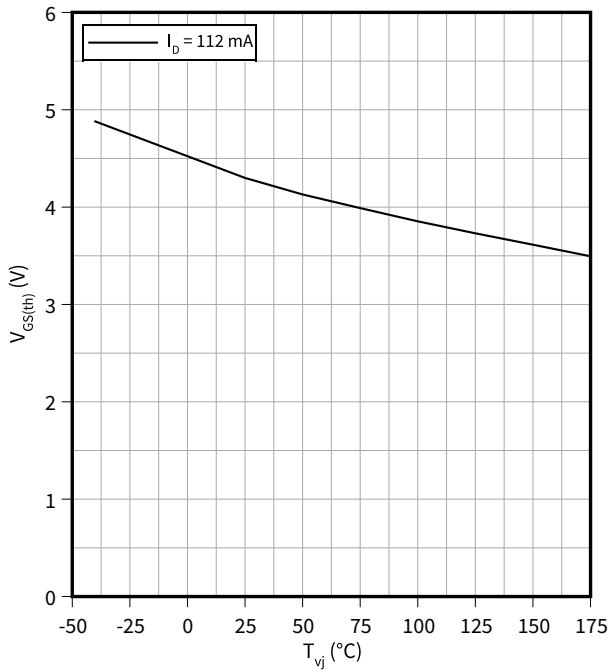
$I_D = f(V_{GS})$   
 $V_{DS} = 20\text{ V}$



4 Characteristics diagrams

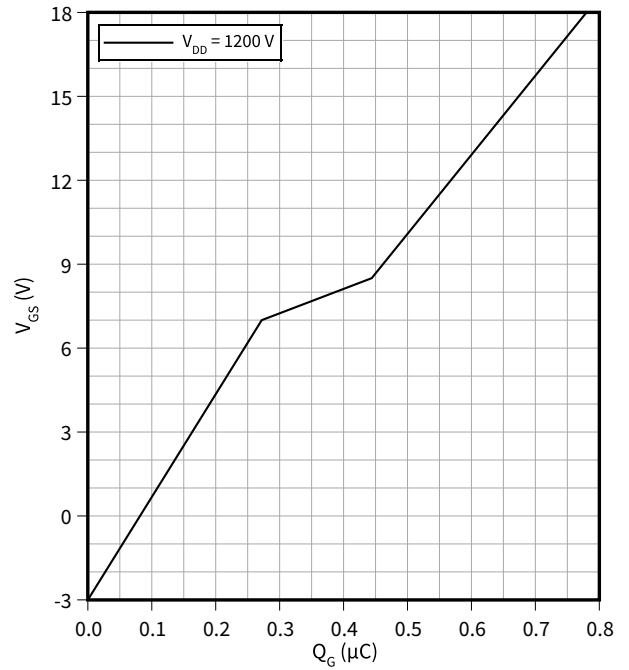
**Gate-source threshold voltage (typical), MOSFET, T1 / T2**

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



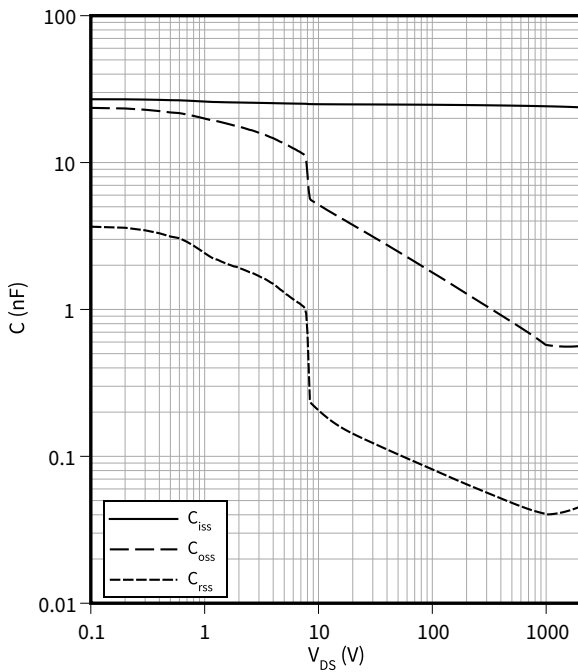
**Gate charge characteristic (typical), MOSFET, T1 / T2**

$V_{GS} = f(Q_G)$   
 $I_D = 200 \text{ A}, T_{vj} = 25 \text{ °C}$



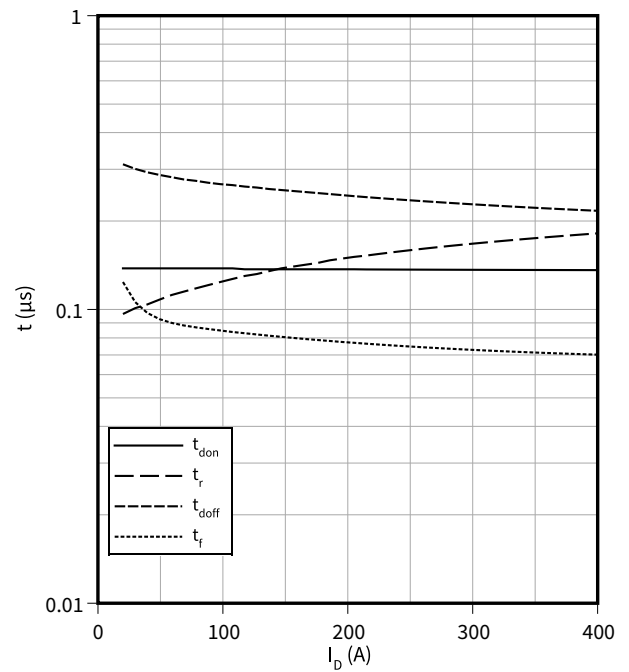
**Capacity characteristic (typical), MOSFET, T1 / T2**

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



**Switching times (typical), MOSFET, T1 / T2**

$t = f(I_D)$   
 $R_{Goff} = 4.7 \text{ } \Omega, R_{Gon} = 7.5 \text{ } \Omega, V_{DD} = 1200 \text{ V}, T_{vj} = 175 \text{ °C}, V_{GS} = -3/18 \text{ V}$



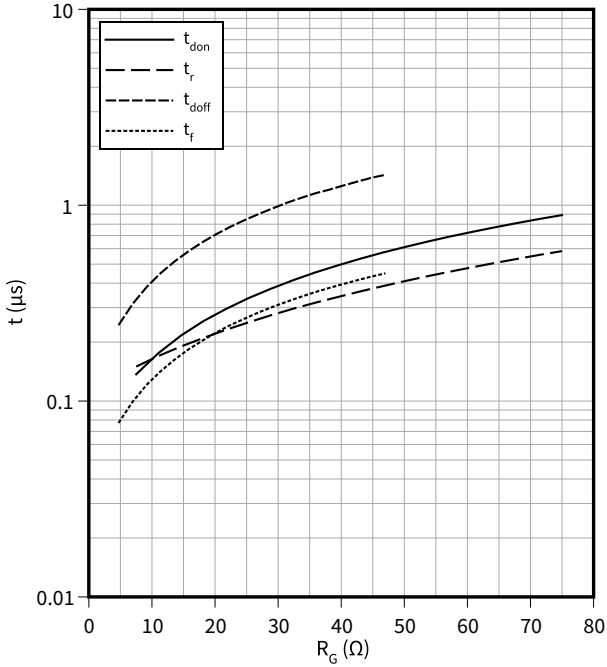


4 Characteristics diagrams

**Switching times (typical), MOSFET, T1 / T2**

$t = f(R_G)$

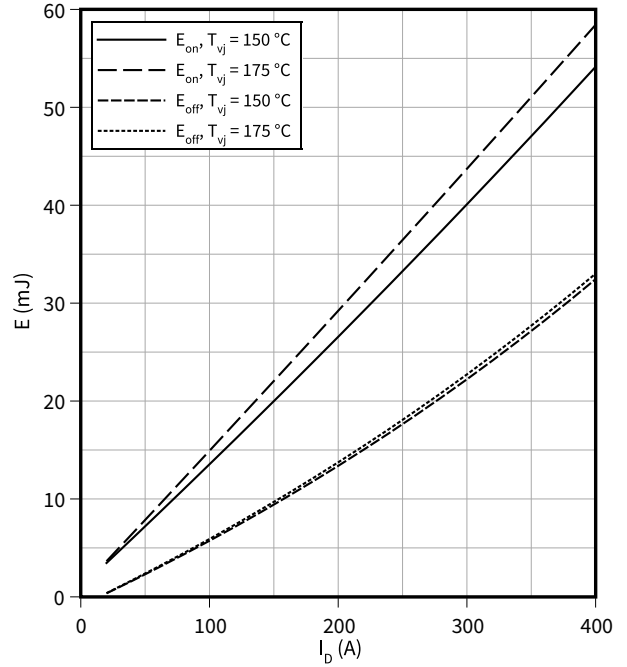
$V_{DD} = 1200\text{ V}$ ,  $I_D = 200\text{ A}$ ,  $T_{vj} = 175\text{ }^\circ\text{C}$ ,  $V_{GS} = -3/18\text{ V}$



**Switching losses (typical), MOSFET, T1 / T2**

$E = f(I_D)$

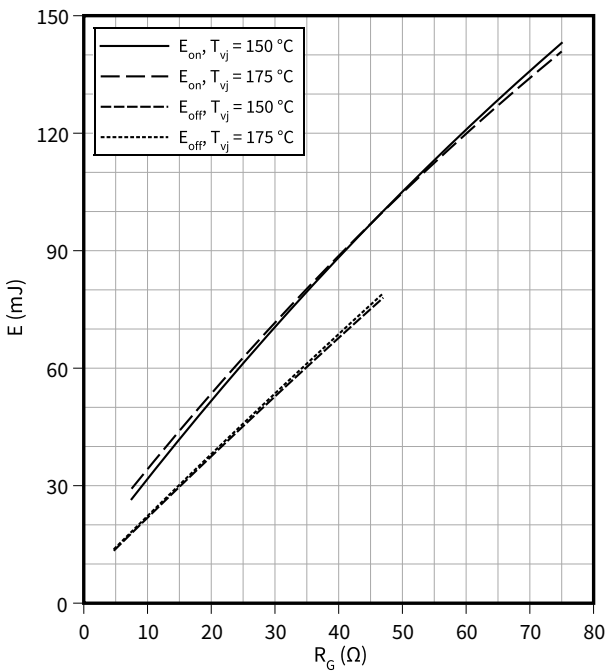
$R_{Goff} = 4.7\ \Omega$ ,  $R_{Gon} = 7.5\ \Omega$ ,  $V_{DD} = 1200\text{ V}$ ,  $V_{GS} = -3/18\text{ V}$



**Switching losses (typical), MOSFET, T1 / T2**

$E = f(R_G)$

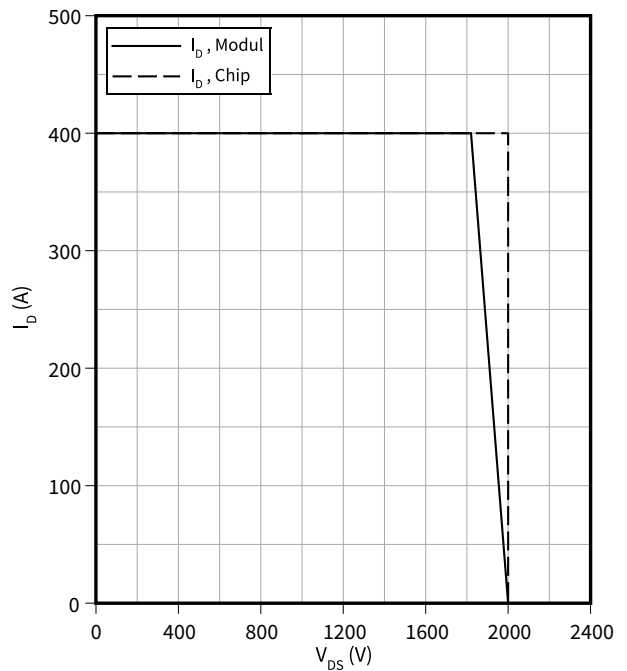
$V_{DD} = 1200\text{ V}$ ,  $I_D = 200\text{ A}$ ,  $V_{GS} = -3/18\text{ V}$



**Reverse bias safe operating area (RBSOA), MOSFET, T1 / T2**

$I_D = f(V_{DS})$

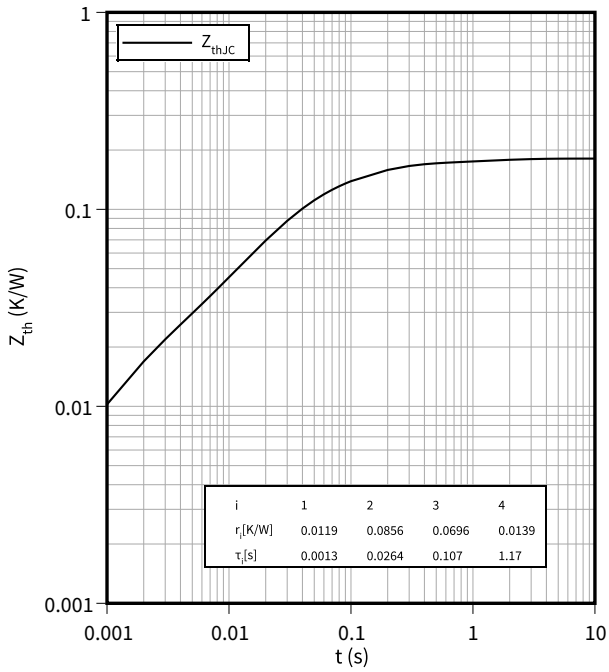
$R_{Goff} = 4.7\ \Omega$ ,  $T_{vj} = 175\text{ }^\circ\text{C}$ ,  $V_{GS} = -3/18\text{ V}$



4 Characteristics diagrams

**Transient thermal impedance, MOSFET, T1 / T2**

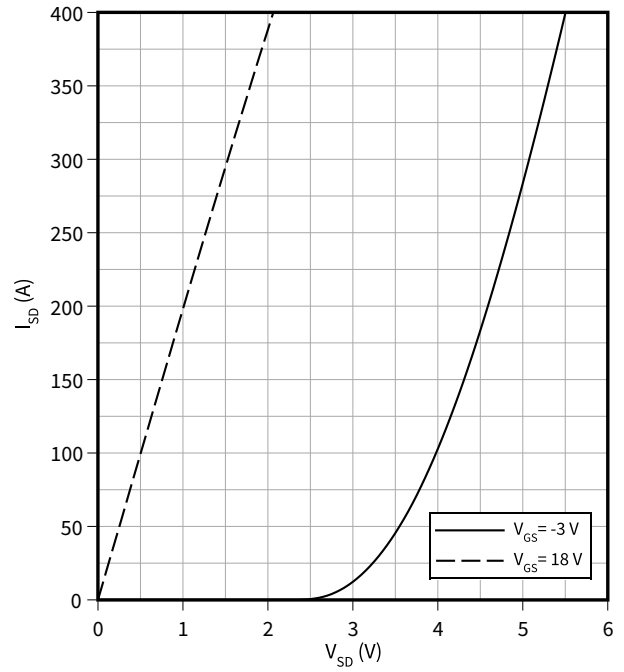
$Z_{th} = f(t)$



**Forward characteristic body diode (typical), MOSFET, T1 / T2**

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

$T_{vj} = 25\text{ °C}$



## 5 Circuit diagram

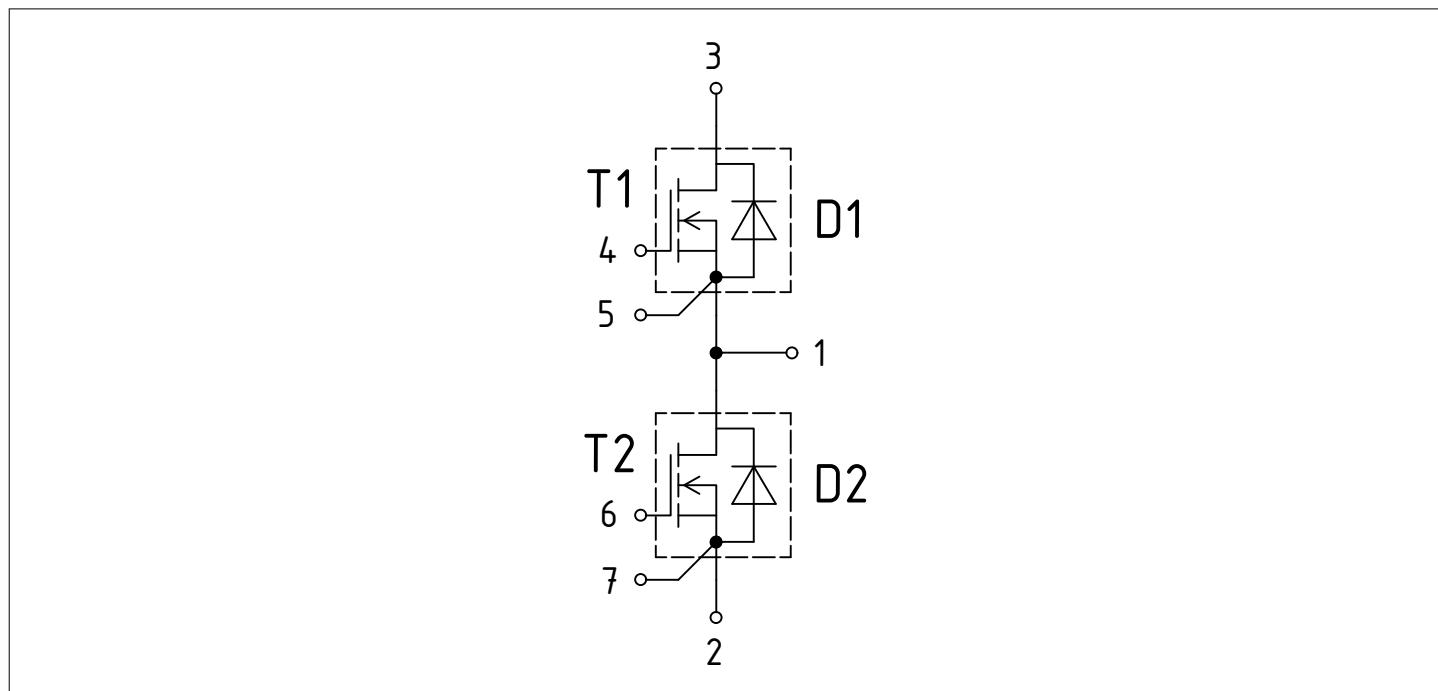
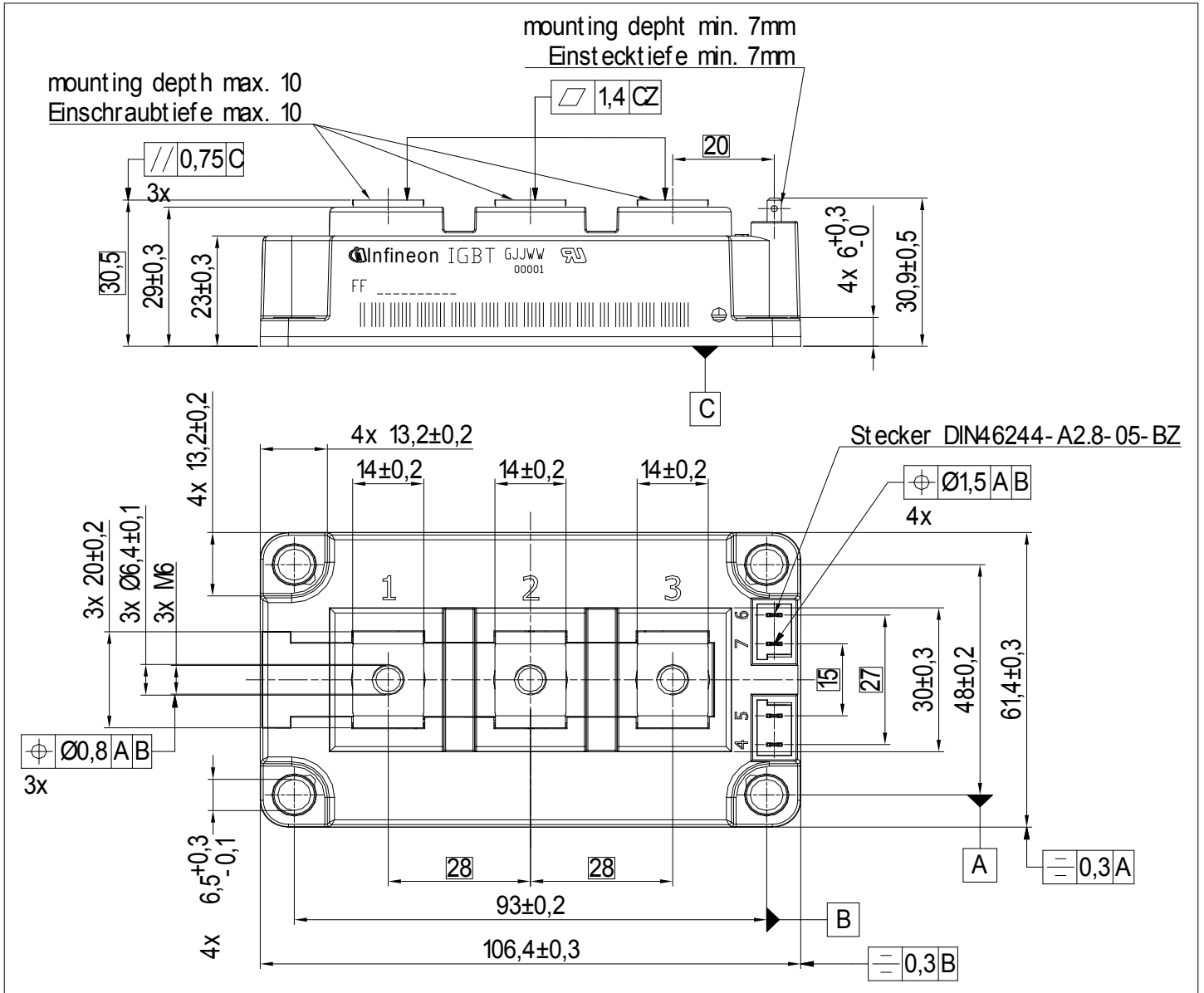


Figure 1

**6 Package outlines**



**Figure 2**

## 7 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
1.00	2023-06-21	Initial version

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**Document reference**

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