

62 mm C-Series module with CoolSiC™ Trench MOSFET

Features

- Electrical features
 - $V_{DS} = 2000\text{ V}$
 - $I_{DN} = 200\text{ A}$ / $I_{DRM} = 400\text{ A}$
 - 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

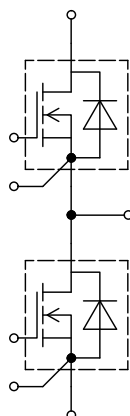


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1 Package

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	$R_{DS(on)}$	$I_D = 200\text{ A}$		5.2	8	mΩ
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)	$t_{d on}$	$I_D = 200\text{ A}$, $R_{Gon} = 7.5\text{ Ω}$, $V_{DD} = 1200\text{ V}$, $V_{GS} = -3/18\text{ V}$		152		ns

(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)	$t_{d\text{ off}}$	$I_D = 200 \text{ A}$, $R_{Goff} = 4.7 \text{ } \Omega$, $V_{DD} = 1200 \text{ V}$, $V_{GS} = -3/18 \text{ V}$	$T_{vj} = 25 \text{ } ^\circ\text{C}$	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, $\lambda_{grease} = 1 \text{ W}/(\text{m}^2\text{K})$		0.0500		K/W
Temperature under switching conditions	$T_{vj\text{ op}}$		-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.

$T_{vj,op} > 150^\circ\text{C}$ 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**

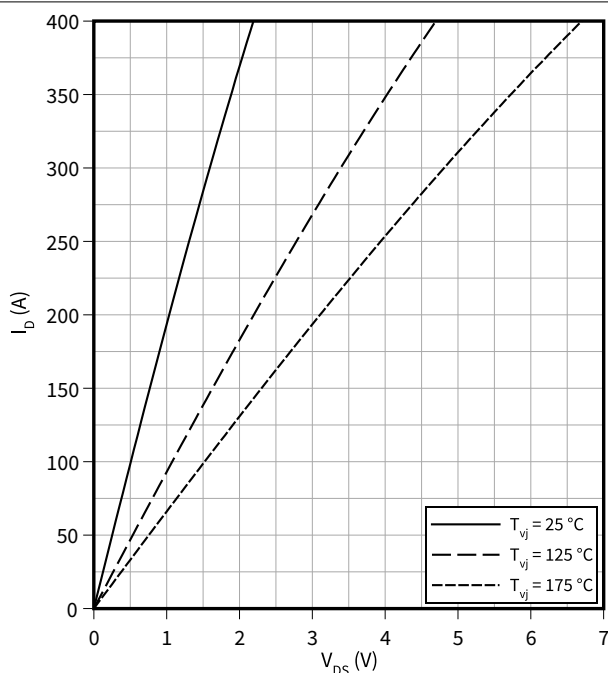
Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_{SD}	$I_{SD} = 200 \text{ A}$, $V_{GS} = -3 \text{ V}$	$T_{vj} = 25 \text{ °C}$		4.6	6.15	V
			$T_{vj} = 125 \text{ °C}$		4.15		
			$T_{vj} = 175 \text{ °C}$		4		

4 Characteristics diagrams

Output characteristic (typical), MOSFET, T1 / T2

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

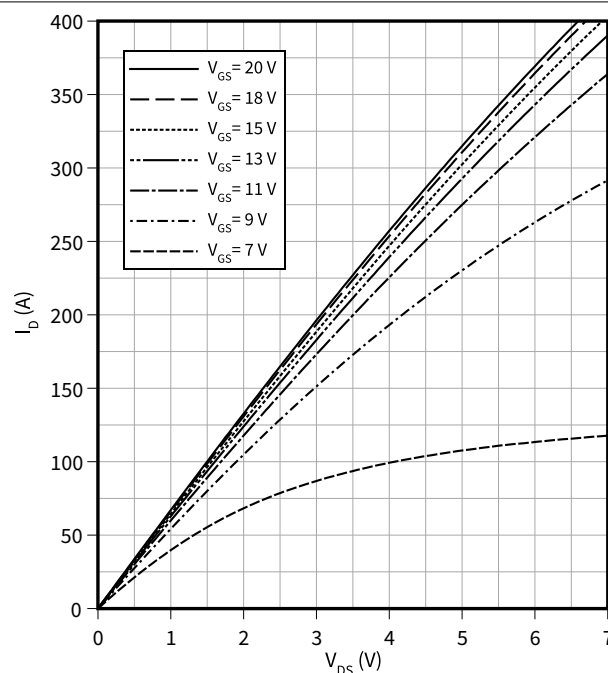
$$V_{GS} = 18 \text{ V}$$



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

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

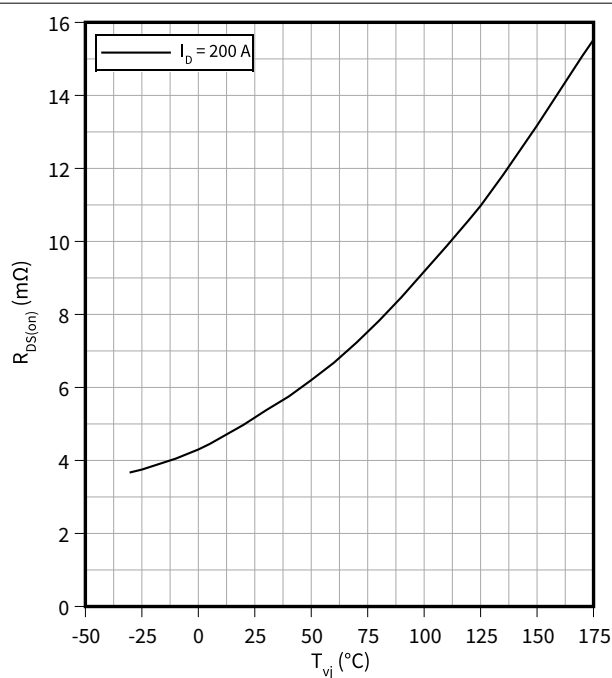
$$T_{vj} = 175^\circ\text{C}$$



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

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

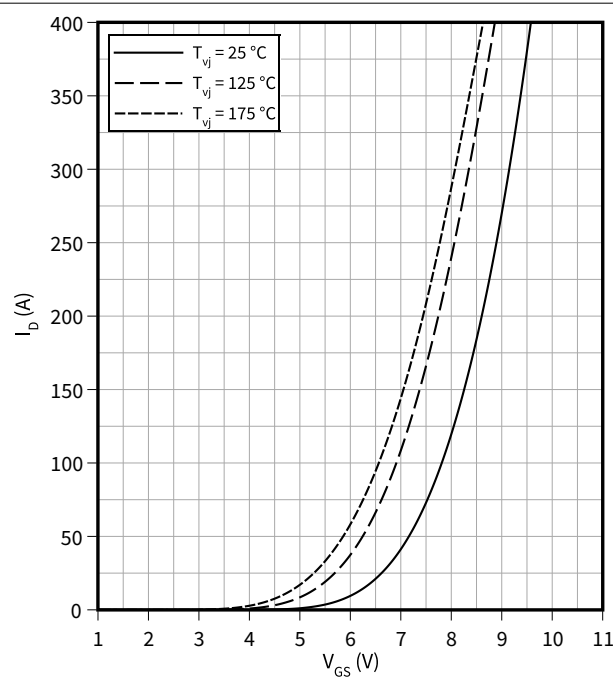
$$V_{GS} = 18 \text{ V}$$



Transfer characteristic (typical), MOSFET, T1 / T2

$$I_D = f(V_{GS})$$

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

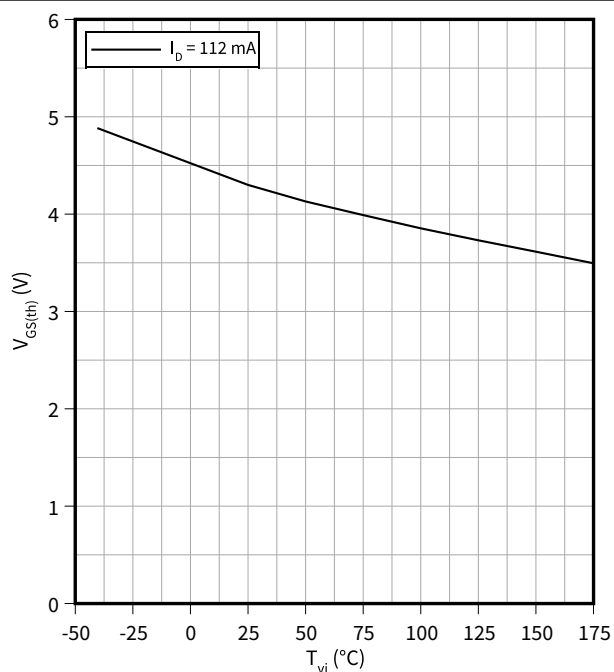


4 Characteristics diagrams

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

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

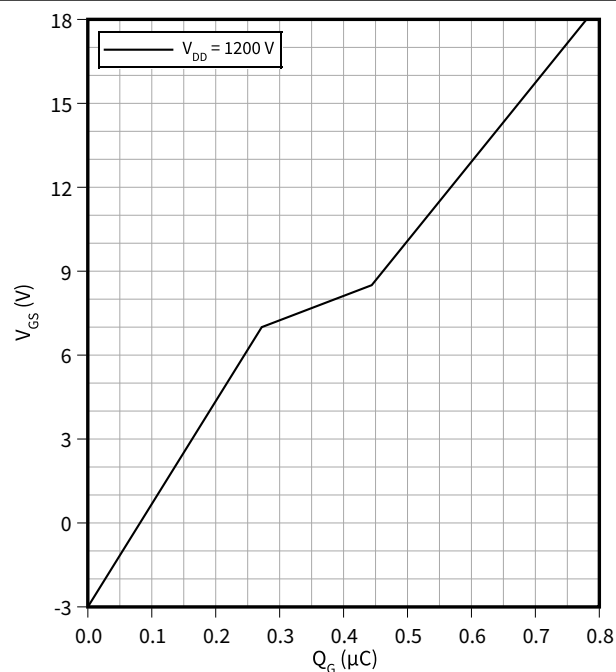
$$V_{GS} = V_{DS}$$



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

$$V_{GS} = f(Q_G)$$

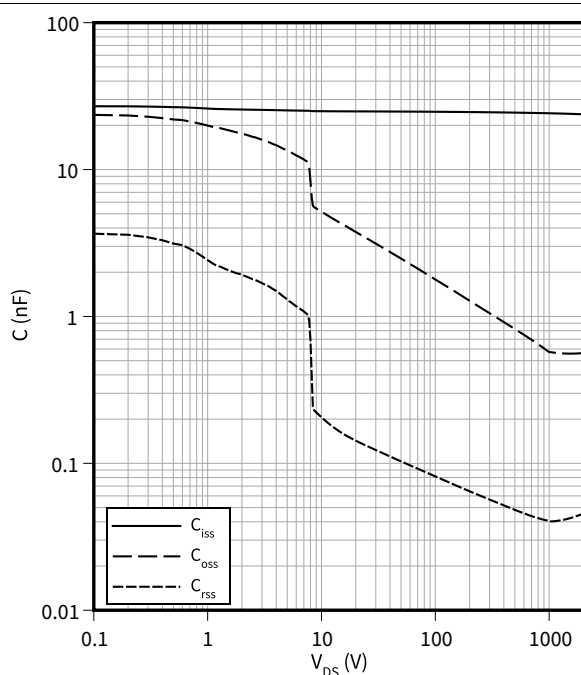
$$I_D = 200$$
 A, $T_{vj} = 25$ °C



Capacity characteristic (typical), MOSFET, T1 / T2

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

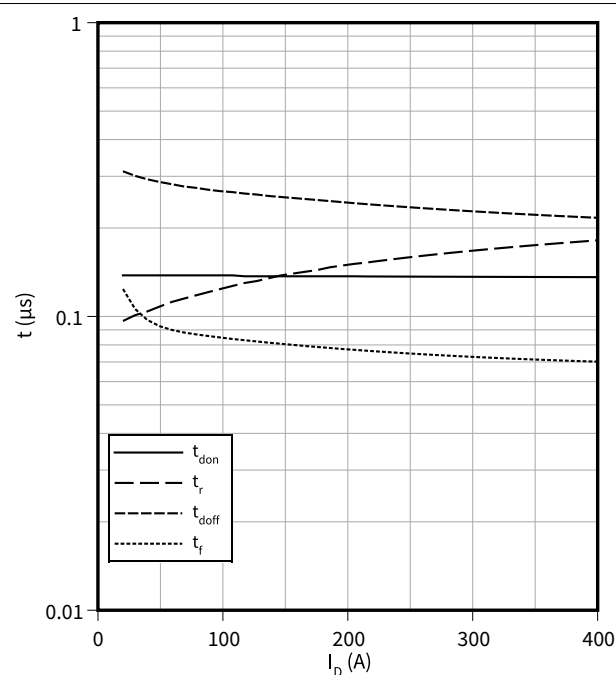
$$f = 100$$
 kHz, $T_{vj} = 25$ °C, $V_{GS} = 0$ V



Switching times (typical), MOSFET, T1 / T2

$$t = f(I_D)$$

$$R_{Goff} = 4.7$$
 Ω, $R_{Gon} = 7.5$ Ω, $V_{DD} = 1200$ V, $T_{vj} = 175$ °C, $V_{GS} = -3/18$ V

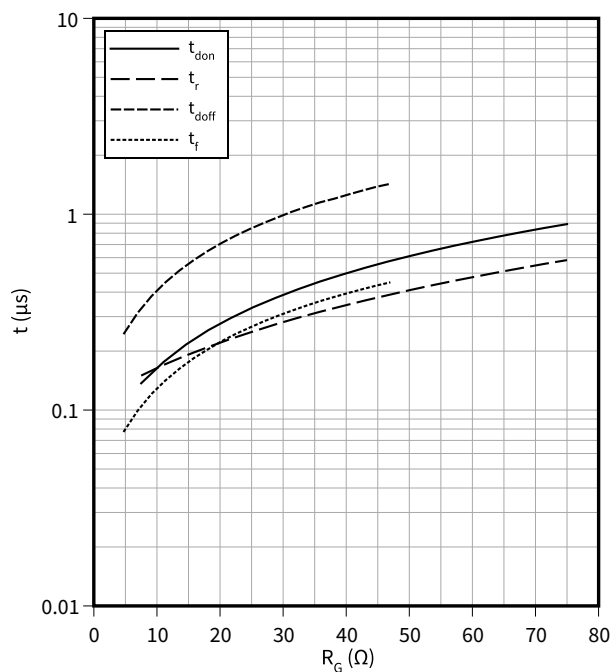


4 Characteristics diagrams

Switching times (typical), MOSFET, T1 / T2

$$t = f(R_G)$$

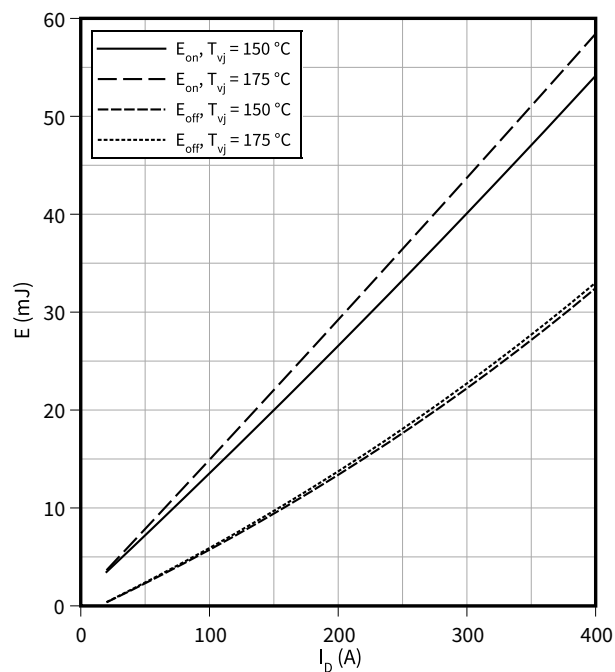
$V_{DD} = 1200 \text{ V}$, $I_D = 200 \text{ A}$, $T_{vj} = 175 \text{ }^\circ\text{C}$, $V_{GS} = -3/18 \text{ V}$



Switching losses (typical), MOSFET, T1 / T2

$$E = f(I_D)$$

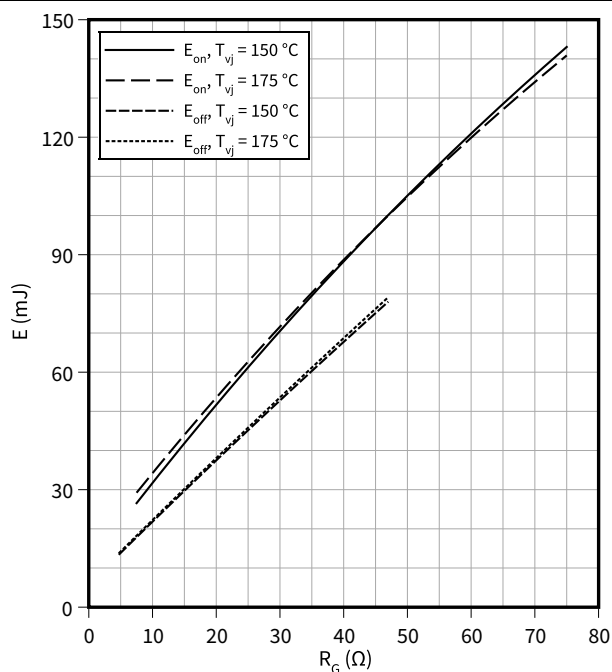
$R_{Goff} = 4.7 \text{ } \Omega$, $R_{Gon} = 7.5 \text{ } \Omega$, $V_{DD} = 1200 \text{ V}$, $V_{GS} = -3/18 \text{ V}$



Switching losses (typical), MOSFET, T1 / T2

$$E = f(R_G)$$

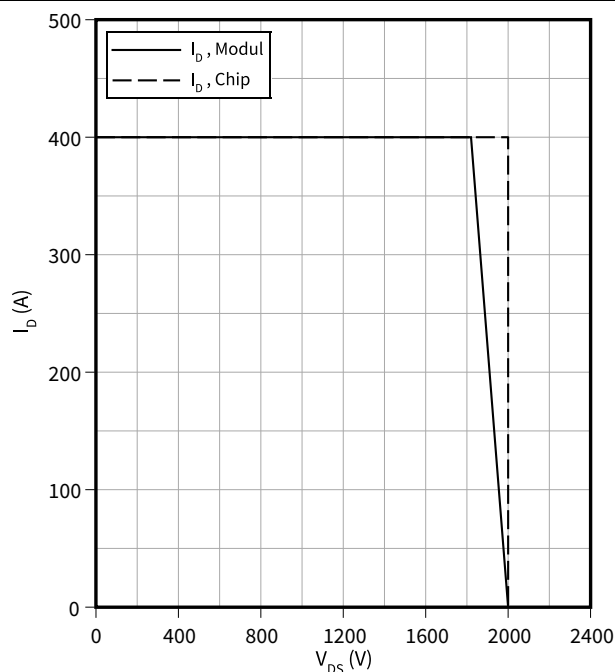
$V_{DD} = 1200 \text{ V}$, $I_D = 200 \text{ A}$, $V_{GS} = -3/18 \text{ V}$



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

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

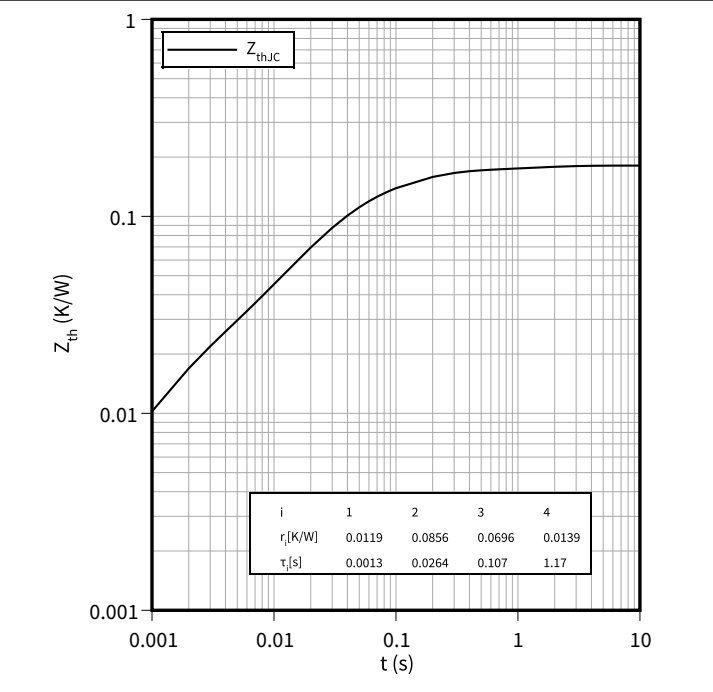
$R_{Goff} = 4.7 \text{ } \Omega$, $T_{vj} = 175 \text{ }^\circ\text{C}$, $V_{GS} = -3/18 \text{ V}$



4 Characteristics diagrams

Transient thermal impedance, MOSFET, T1 / T2

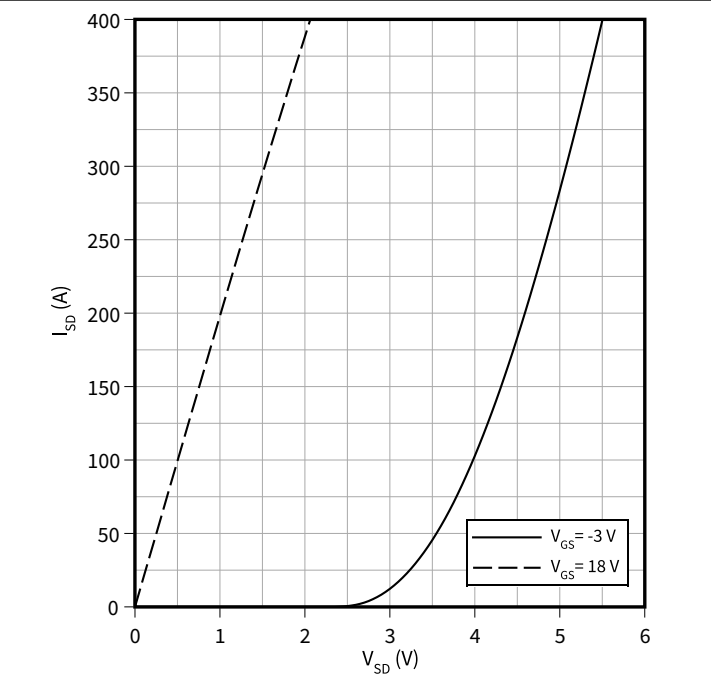
$Z_{th} = f(t)$



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

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

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



5 **Circuit diagram**

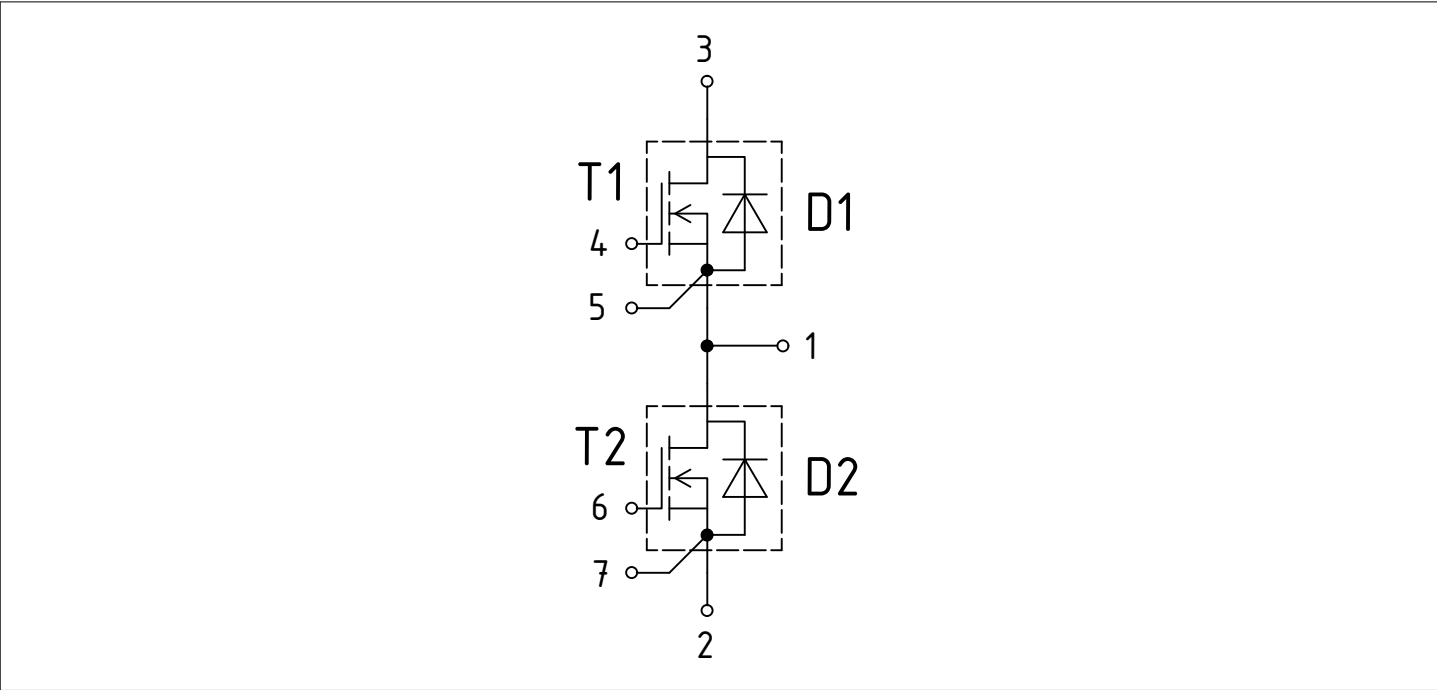


Figure 1

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

Revision history

Document revision	Date of release	Description of changes
1.00	2023-06-21	Initial version

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Email: erratum@infineon.com

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