

62 mm C-Series module with CoolSiC™ Trench MOSFET**Features**

- Electrical features
 - $V_{DS} = 2000\text{ V}$
 - $I_{DN} = 400\text{ A} / I_{DRM} = 800\text{ A}$
 - Low switching losses
 - High current density
- 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

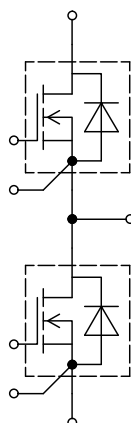
Description

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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		0.465		mΩ
Storage temperature	T_{stg}		-40		125	°C
Mounting torque for module mounting	M	- Mounting according to valid application note	3		6	Nm
Terminal connection torque	M	- Mounting according to valid application note	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}		400	A
Continuous DC drain current	I_{DDC}	$T_{vj} = 175 \text{ °C}$, $V_{GS} = 18 \text{ V}$ $T_C = 25 \text{ °C}$	375	A
Repetitive peak drain current	I_{DRM}	verified by design, t_p limited by T_{vjmax}	800	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	$R_{DS(on)}$	$I_D = 400\text{ A}$		2.6	4	mΩ
Gate threshold voltage	$V_{GS(th)}$	$I_D = 224\text{ mA}$, $V_{DS} = V_{GS}$, $T_{vj} = 25\text{ °C}$, (tested after 1ms pulse at $V_{GS} = +20\text{ V}$)	3.45	4.3	5.15	V
Total gate charge	Q_G	$V_{DD} = 1200\text{ V}$, $V_{GS} = -3/18\text{ V}$		1.56		μC
Internal gate resistor	R_{Gint}	$T_{vj} = 25\text{ °C}$		0.9		Ω
Input capacitance	C_{ISS}	$f = 100\text{ kHz}$, $V_{DS} = 1200\text{ V}$, $V_{GS} = 0\text{ V}$, $T_{vj} = 25\text{ °C}$		48.2		nF
Output capacitance	C_{OSS}	$f = 100\text{ kHz}$, $V_{DS} = 1200\text{ V}$, $V_{GS} = 0\text{ V}$, $T_{vj} = 25\text{ °C}$		1.13		nF
Reverse transfer capacitance	C_{rss}	$f = 100\text{ kHz}$, $V_{DS} = 1200\text{ V}$, $V_{GS} = 0\text{ V}$, $T_{vj} = 25\text{ °C}$		0.08		nF
C_{OSS} stored energy	E_{OSS}	$V_{DS} = 1200\text{ V}$, $V_{GS} = -3/18\text{ V}$, $T_{vj} = 25\text{ °C}$		2030		μJ
Drain-source leakage current	I_{DSS}	$V_{DS} = 2000\text{ V}$, $V_{GS} = -3\text{ V}$, $T_{vj} = 25\text{ °C}$		0.08	660	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_{don}	$I_D = 400\text{ A}$, $R_{Gon} = 8.2\text{ Ω}$, $V_{DD} = 1200\text{ V}$, $V_{GS} = -3/18\text{ V}$		286		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	$I_D = 400\text{ A}$, $R_{Gon} = 8.2\ \Omega$, $V_{DD} = 1200\text{ V}$, $V_{GS} = -3/18\text{ V}$	$T_{vj} = 25\text{ °C}$	266		ns
			$T_{vj} = 125\text{ °C}$	252		
			$T_{vj} = 175\text{ °C}$	239		
Turn-off delay time (inductive load)	$t_{d\ off}$	$I_D = 400\text{ A}$, $R_{Goff} = 2.2\ \Omega$, $V_{DD} = 1200\text{ V}$, $V_{GS} = -3/18\text{ V}$	$T_{vj} = 25\text{ °C}$	226		ns
			$T_{vj} = 150\text{ °C}$	244		
			$T_{vj} = 175\text{ °C}$	255		
Fall time (inductive load)	t_f	$I_D = 400\text{ A}$, $R_{Goff} = 2.2\ \Omega$, $V_{DD} = 1200\text{ V}$, $V_{GS} = -3/18\text{ V}$	$T_{vj} = 25\text{ °C}$	57.5		ns
			$T_{vj} = 150\text{ °C}$	57.7		
			$T_{vj} = 175\text{ °C}$	60.5		
Turn-on energy loss per pulse	E_{on}	$I_D = 400\text{ A}$, $V_{DD} = 1200\text{ V}$, $L_\sigma = 25\text{ nH}$, $V_{GS} = -3/18\text{ V}$, $R_{Gon} = 8.2\ \Omega$, $di/dt = 3.2\text{ kA}/\mu\text{s}$ ($T_{vj} = 175\text{ °C}$)	$T_{vj} = 25\text{ °C}$	75.3		mJ
			$T_{vj} = 125\text{ °C}$	75.8		
			$T_{vj} = 175\text{ °C}$	79.8		
Turn-off energy loss per pulse	E_{off}	$I_D = 400\text{ A}$, $V_{DD} = 1200\text{ V}$, $L_\sigma = 25\text{ nH}$, $V_{GS} = -3/18\text{ V}$, $R_{Goff} = 2.2\ \Omega$, $dv/dt = 15.9\text{ kV}/\mu\text{s}$ ($T_{vj} = 175\text{ °C}$)	$T_{vj} = 25\text{ °C}$	24.3		mJ
			$T_{vj} = 125\text{ °C}$	25.5		
			$T_{vj} = 175\text{ °C}$	26.7		
Thermal resistance, junction to case	R_{thJC}	per MOSFET			0.0880	K/W
Thermal resistance, case to heat sink	R_{thCH}	per MOSFET, $\lambda_{grease} = 1\text{ W}/(\text{m}^2\text{K})$, $\lambda_{grease} = 1\text{ W}/(\text{m}^2\text{K})$		0.0330		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 Notes AN 2018-09 and AN 2021-13 must be considered to ensure sound operation of the device over the planned lifetime.

$T_{vj,op} > 150\text{ °C}$ 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}	$T_{vj} = 175\text{ °C}$, $V_{GS} = -3\text{ V}$ $T_C = 25\text{ °C}$	315	A

Table 7 **Characteristic values**

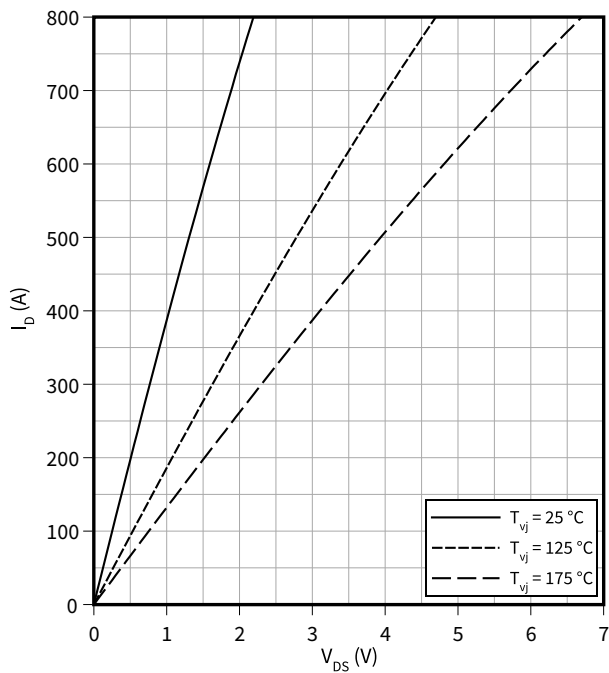
Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_{SD}	$I_{SD} = 400 \text{ A}$, $V_{GS} = -3 \text{ V}$	$T_{vj} = 25 \text{ °C}$		4.6	6.15	V
			$T_{vj} = 125 \text{ °C}$		4.15		
			$T_{vj} = 175 \text{ °C}$		4		

4 Characteristics diagrams

Output characteristic (typical), MOSFET, T1 / T2

$I_D = f(V_{DS})$

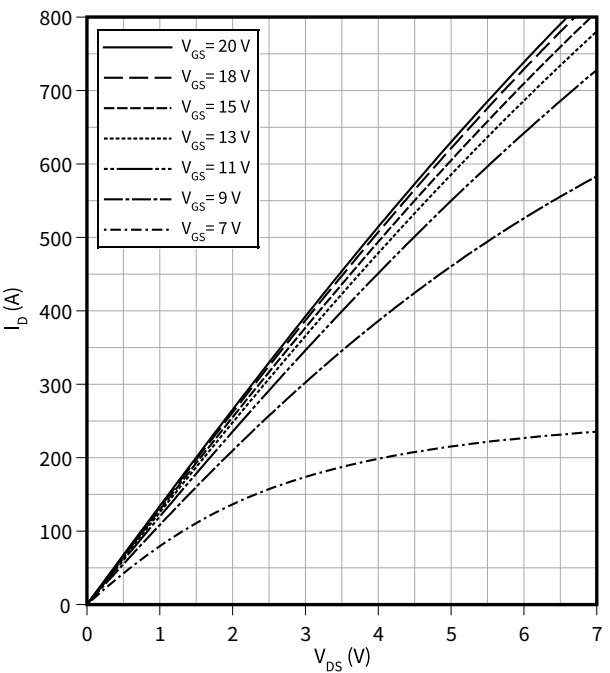
$V_{GS} = 18\text{ V}$



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

$I_D = f(V_{DS})$

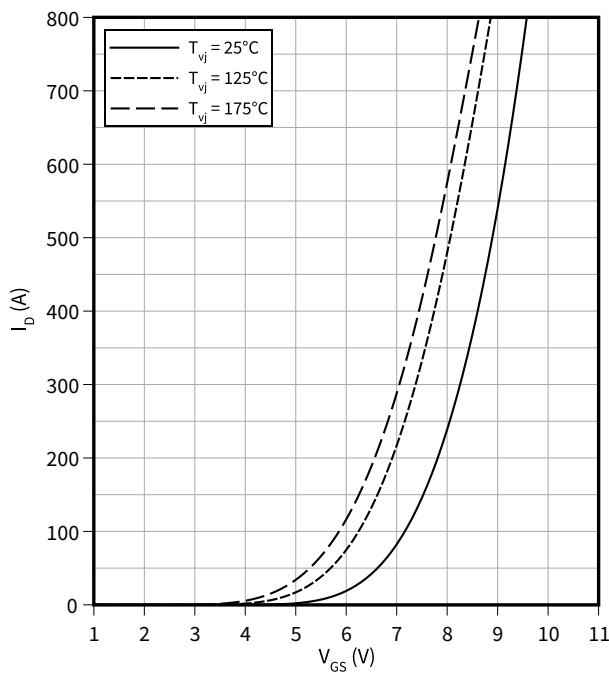
$T_{vj} = 175\text{ °C}$



Transfer characteristic (typical), MOSFET, T1 / T2

$I_D = f(V_{GS})$

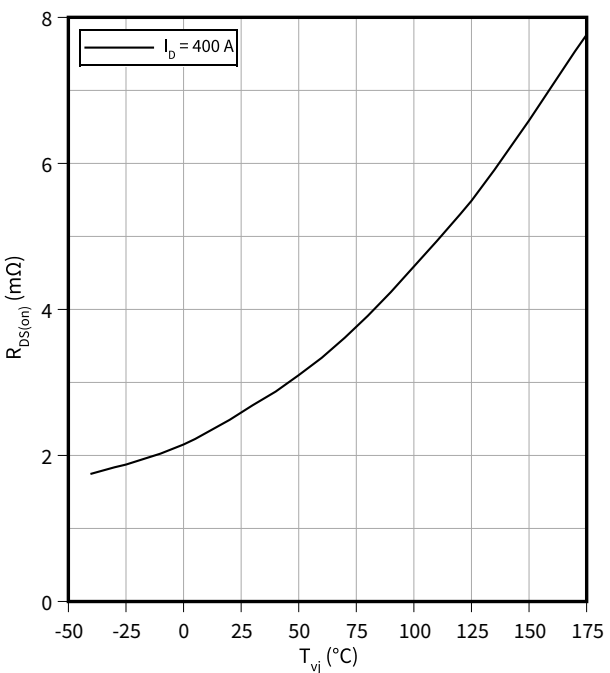
$V_{DS} = 20\text{ V}$



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

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

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

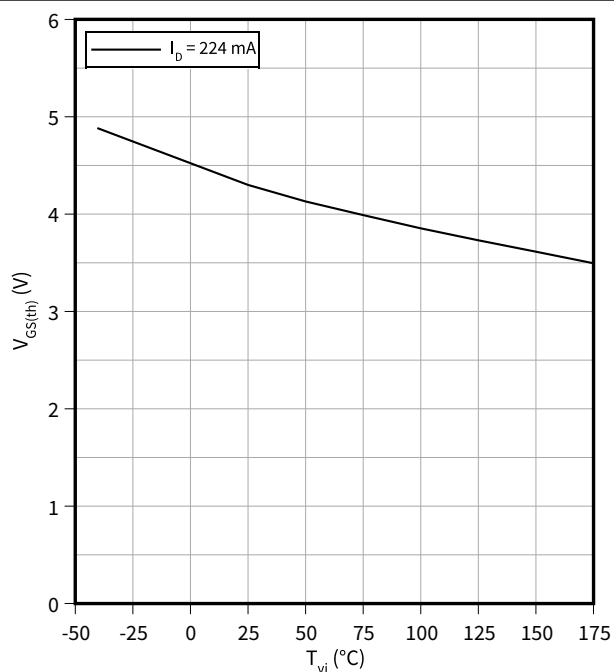


4 Characteristics diagrams

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

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

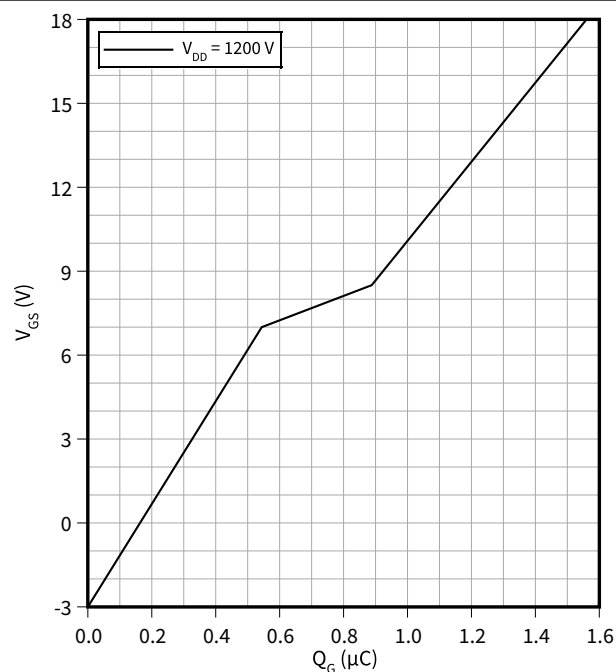
$$V_{GS} = V_{DS}$$



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

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

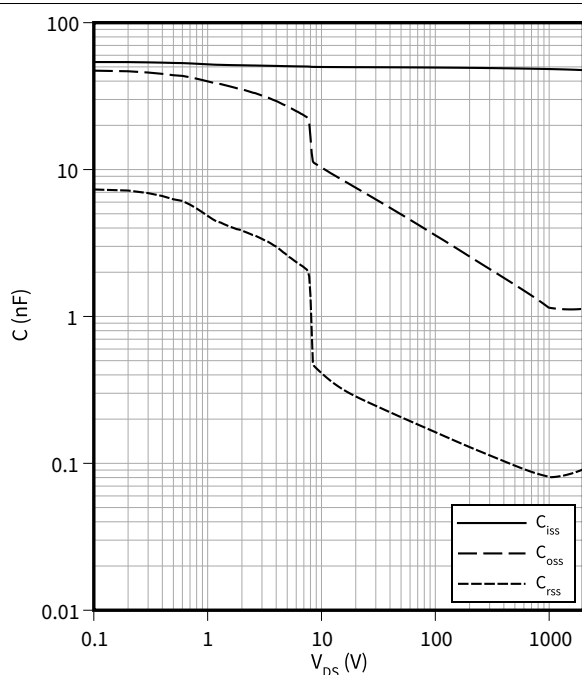
$$I_D = 400$$
 A, $T_{vj} = 25$ °C



Capacity characteristic (typical), MOSFET, T1 / T2

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

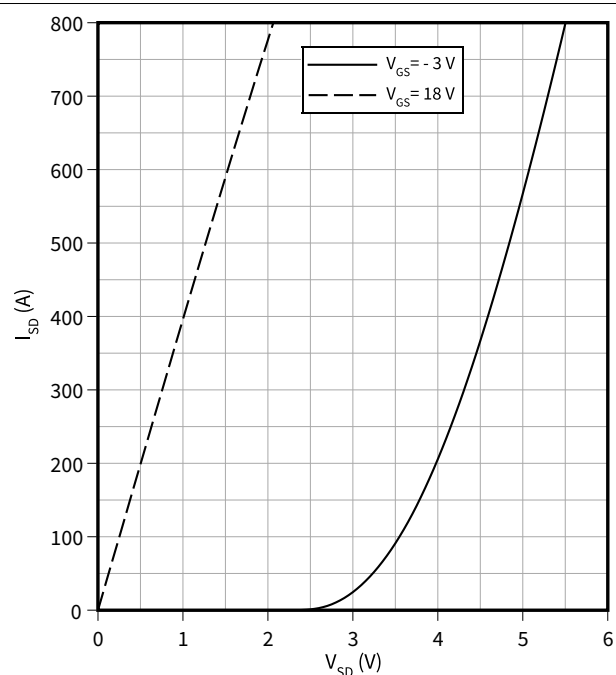
$$f = 100$$
 kHz, $T_{vj} = 125$ °C, $V_{GS} = -3$ V



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

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

$$T_{vj} = 25$$
 °C

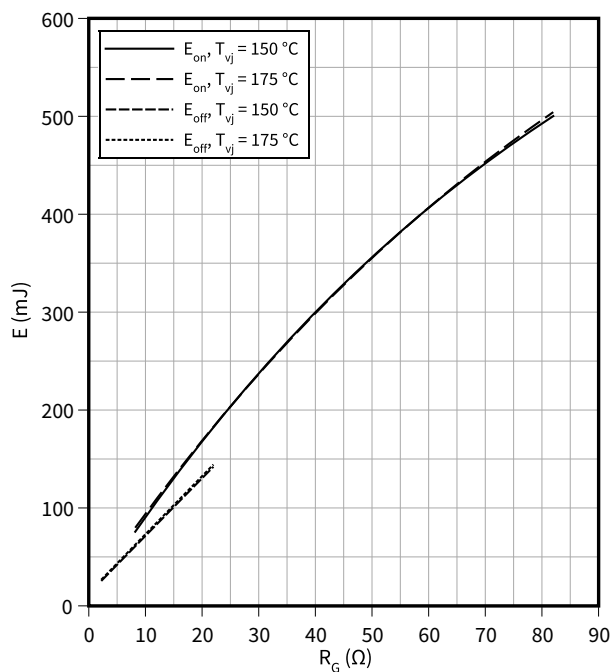


4 Characteristics diagrams

Switching losses (typical), MOSFET, T1 / T2

$$E = f(R_G)$$

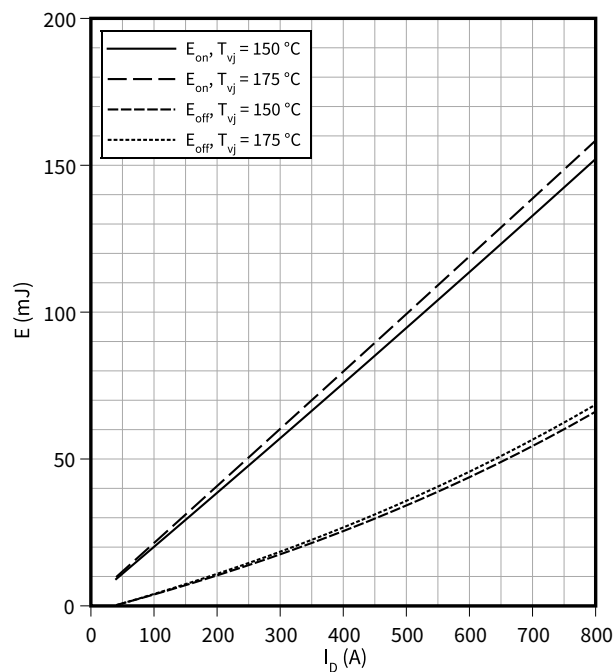
$V_{DD} = 1200 \text{ V}$, $I_D = 400 \text{ A}$, $V_{GS} = -3/18 \text{ V}$



Switching losses (typical), MOSFET, T1 / T2

$$E = f(I_D)$$

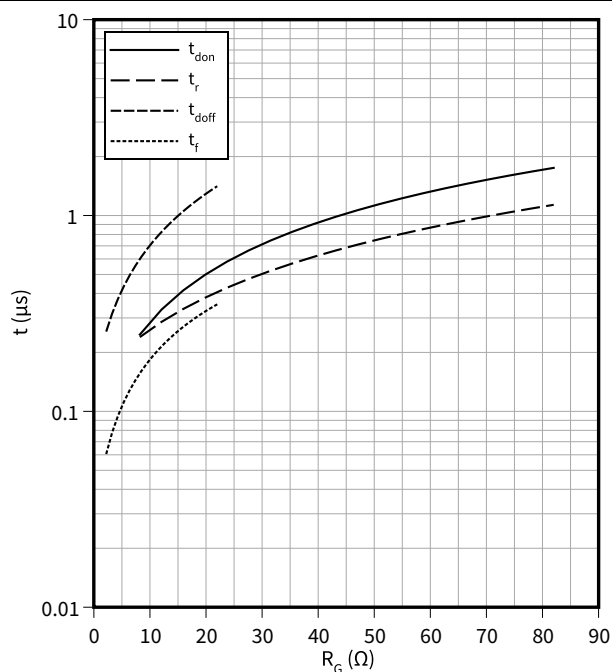
$R_{Goff} = 2.2 \text{ } \Omega$, $R_{Gon} = 8.2 \text{ } \Omega$, $V_{DD} = 1200 \text{ V}$, $V_{GS} = -3/18 \text{ V}$



Switching times (typical), MOSFET, T1 / T2

$$t = f(R_G)$$

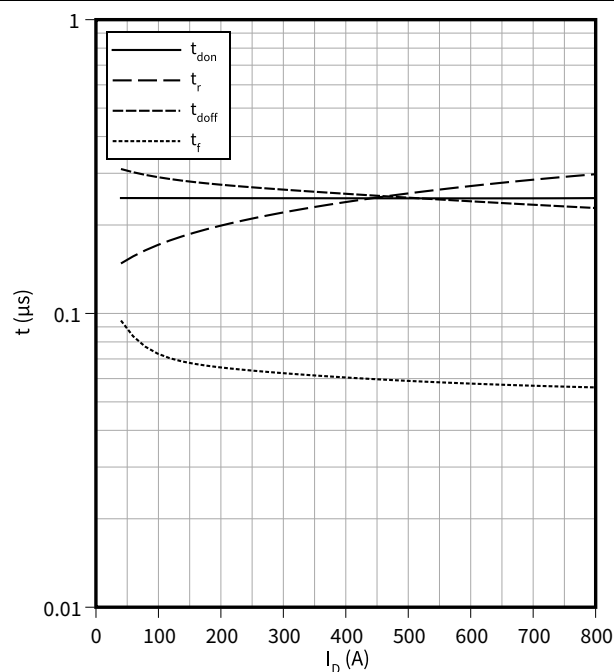
$V_{DD} = 1200 \text{ V}$, $I_D = 400 \text{ A}$, $T_{vj} = 175 \text{ } ^\circ\text{C}$, $V_{GS} = -3/18 \text{ V}$



Switching times (typical), MOSFET, T1 / T2

$$t = f(I_D)$$

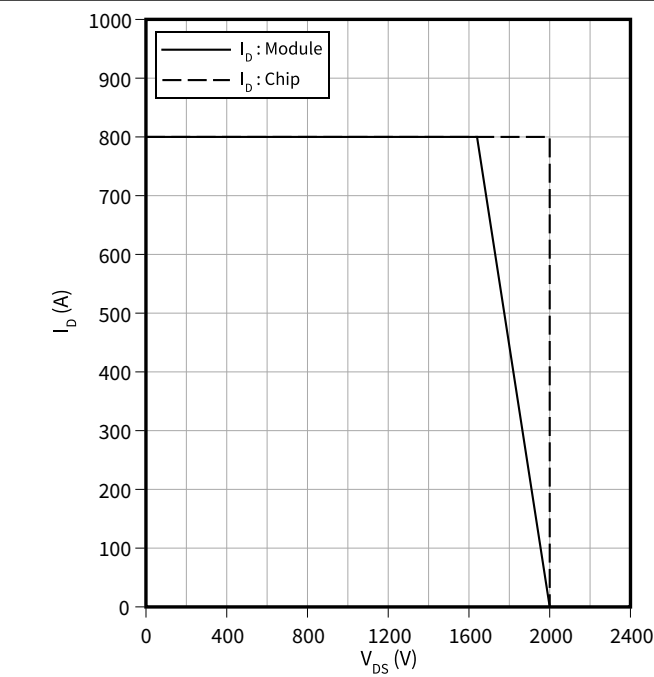
$R_{Goff} = 2.2 \text{ } \Omega$, $R_{Gon} = 8.2 \text{ } \Omega$, $V_{DD} = 1200 \text{ V}$, $T_{vj} = 175 \text{ } ^\circ\text{C}$, $V_{GS} = -3/18 \text{ V}$



4 Characteristics diagrams

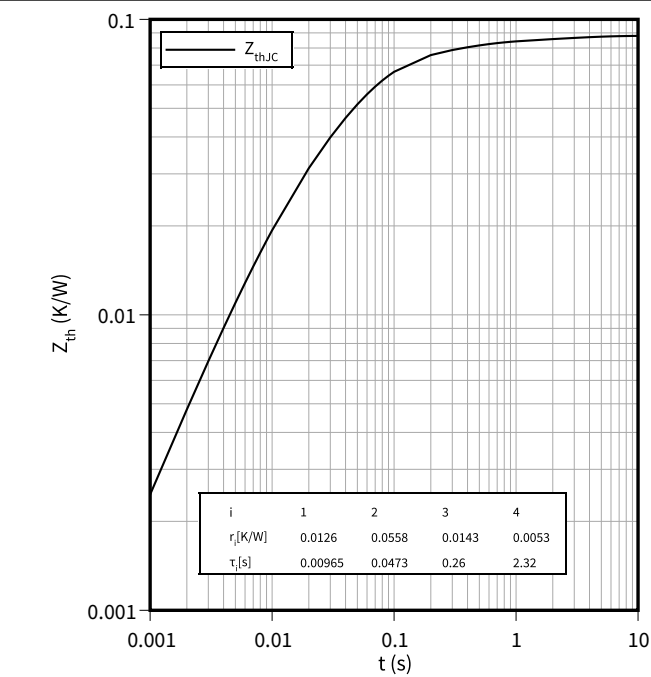
Reverse bias safe operating area (RBSOA), MOSFET, T1 / T2

$I_D = f(V_{DS})$
 $R_{Goff} = 2.2 \Omega$, $T_{vj} = 175 \text{ }^\circ\text{C}$, $V_{GS} = -3/18 \text{ V}$



Transient thermal impedance , MOSFET, T1 / T2

$Z_{th} = f(t)$



5 Circuit diagram

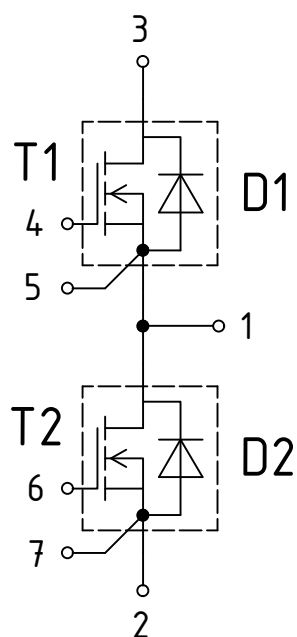


Figure 1

6 Package outlines

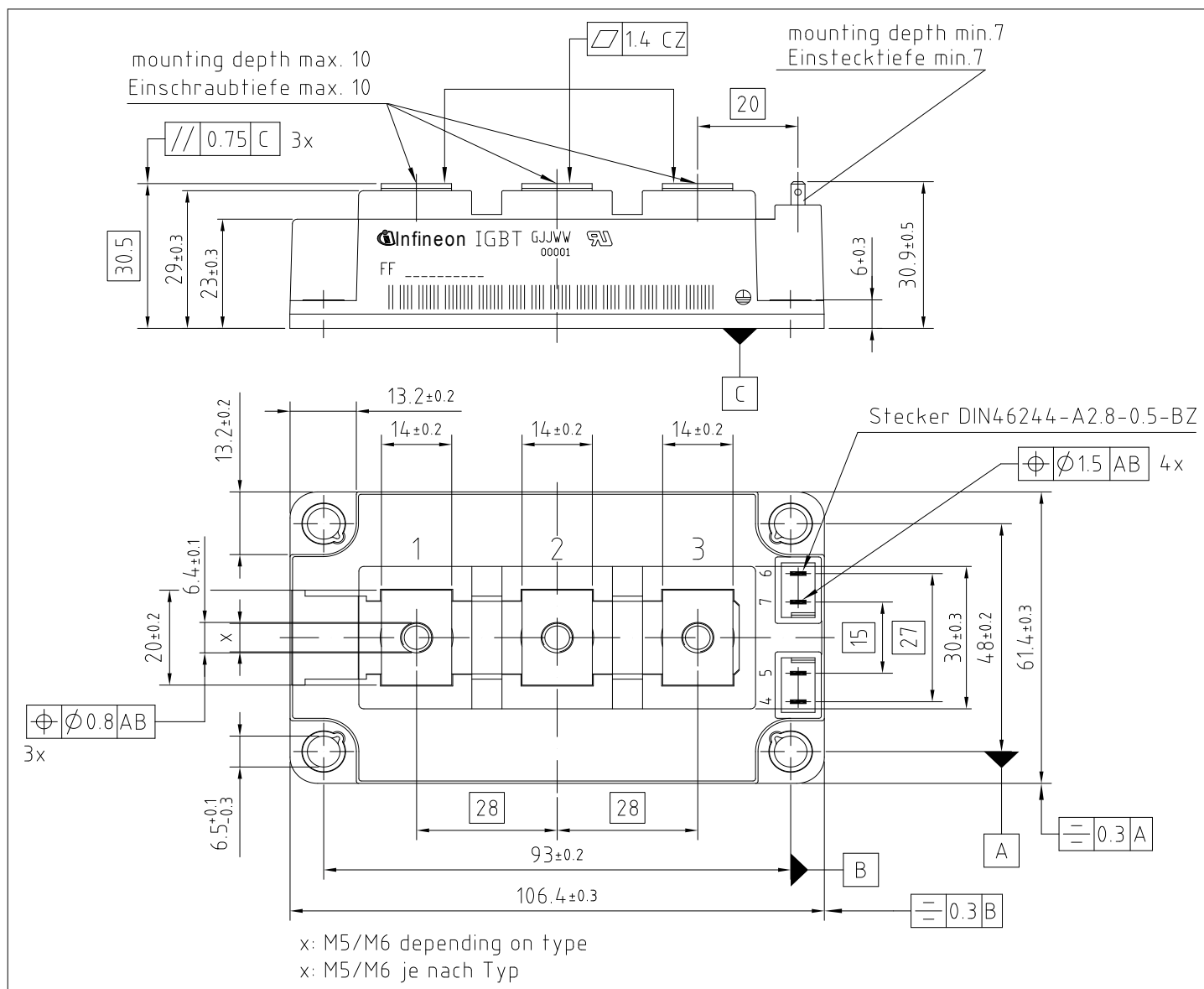


Figure 2

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
V1.0	2017-12-21	Target datasheet
V1.1	2018-01-19	Target datasheet
V1.2	2018-10-17	Target datasheet
n/a	2020-09-01	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
0.10	2021-06-28	Target datasheet
0.20	2022-08-09	Target datasheet
0.30	2022-09-27	Target datasheet
1.00	2022-12-22	Final datasheet

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