

Final datasheet

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
 - Suitable Infineon gate drivers can be found under <https://www.infineon.com/gdfinder>
- 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

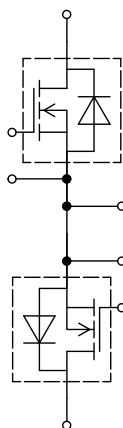




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1 Package

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	$d_{Creep \text{ nom}}$	terminal to baseplate, nom.	29.0	mm
Creepage distance	$d_{Creep \text{ nom}}$	terminal to terminal, nom.	23.0	mm
Clearance	$d_{Clear \text{ nom}}$	terminal to baseplate, nom.	23.0	mm
Clearance	$d_{Clear \text{ nom}}$	terminal to terminal, nom.	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		0.385		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

Note: The electrical characterization was performed in NPC2 topology, which combines the modules FF3MR20KM1H and FF3MR20KM1H_S.
It has to be considered, that the commutation in this configuration takes place between both modules.

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

(table continues...)

Table 3 (continued) Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
Continuous DC drain current	I_{DDC}	$T_{\text{vj}} = 175\text{ °C}$, $V_{\text{GS}} = 18\text{ V}$	$T_{\text{C}} = 25\text{ °C}$	375	A
Repetitive peak drain current	I_{DRM}	verified by design, t_{p} limited by T_{vjmax}		800	A
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	$V_{\text{GS(on)}}$		18	V
Off-state gate voltage	$V_{\text{GS(off)}}$		-3	V

Table 5 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Drain-source on-resistance	$R_{\text{DS(on)}}$	$I_{\text{D}} = 400\text{ A}$	$V_{\text{GS}} = 18\text{ V}$, $T_{\text{vj}} = 25\text{ °C}$		2.6	4	mΩ
			$V_{\text{GS}} = 18\text{ V}$, $T_{\text{vj}} = 125\text{ °C}$		5.5		
			$V_{\text{GS}} = 18\text{ V}$, $T_{\text{vj}} = 175\text{ °C}$		7.8		
Gate threshold voltage	$V_{\text{GS(th)}}$	$I_{\text{D}} = 224\text{ mA}$, $V_{\text{DS}} = V_{\text{GS}}$, $T_{\text{vj}} = 25\text{ °C}$, (tested after 1ms pulse at $V_{\text{GS}} = +20\text{ V}$)		3.45	4.3	5.15	V
Total gate charge	Q_{G}	$V_{\text{DD}} = 1200\text{ V}$, $V_{\text{GS}} = -3/18\text{ V}$, $T_{\text{vj}} = 25\text{ °C}$			1.56		μC
Internal gate resistor	R_{Gint}	$T_{\text{vj}} = 25\text{ °C}$			0.9		Ω
Input capacitance	C_{ISS}	$f = 100\text{ kHz}$, $V_{\text{DS}} = 1200\text{ V}$, $V_{\text{GS}} = 0\text{ V}$	$T_{\text{vj}} = 25\text{ °C}$		48.2		nF
Output capacitance	C_{OSS}	$f = 100\text{ kHz}$, $V_{\text{DS}} = 1200\text{ V}$, $V_{\text{GS}} = 0\text{ V}$	$T_{\text{vj}} = 25\text{ °C}$		1.13		nF
Reverse transfer capacitance	C_{rSS}	$f = 100\text{ kHz}$, $V_{\text{DS}} = 1200\text{ V}$, $V_{\text{GS}} = 0\text{ V}$	$T_{\text{vj}} = 25\text{ °C}$		0.08		nF
C_{OSS} stored energy	E_{OSS}	$V_{\text{DS}} = 1200\text{ V}$, $V_{\text{GS}} = -3/18\text{ V}$, $T_{\text{vj}} = 25\text{ °C}$			2030		μJ
Drain-source leakage current	I_{DSS}	$V_{\text{DS}} = 2000\text{ V}$, $V_{\text{GS}} = -3\text{ V}$	$T_{\text{vj}} = 25\text{ °C}$		0.08	660	μA
Gate-source leakage current	I_{GSS}	$V_{\text{DS}} = 0\text{ V}$, $T_{\text{vj}} = 25\text{ °C}$	$V_{\text{GS}} = 20\text{ V}$			400	nA

(table continues...)

Table 5 (continued) **Characteristic values**

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Turn-on delay time (inductive load)	$t_{d\ on}$	$I_D = 400\ A, R_{Gon} = 9.1\ \Omega,$ $V_{DD} = 1200\ V,$ $V_{GS} = -3/18\ V$	$T_{vj} = 25\ ^\circ C$	341		ns
			$T_{vj} = 125\ ^\circ C$	304		
			$T_{vj} = 175\ ^\circ C$	285		
Rise time (inductive load)	t_r	$I_D = 400\ A, R_{Gon} = 9.1\ \Omega,$ $V_{DD} = 1200\ V,$ $V_{GS} = -3/18\ V$	$T_{vj} = 25\ ^\circ C$	246		ns
			$T_{vj} = 125\ ^\circ C$	244		
			$T_{vj} = 175\ ^\circ C$	244		
Turn-off delay time (inductive load)	$t_{d\ off}$	$I_D = 400\ A, R_{Goff} = 2.7\ \Omega,$ $V_{DD} = 1200\ V,$ $V_{GS} = -3/18\ V$	$T_{vj} = 25\ ^\circ C$	235		ns
			$T_{vj} = 125\ ^\circ C$	256		
			$T_{vj} = 175\ ^\circ C$	267		
Fall time (inductive load)	t_f	$I_D = 400\ A, R_{Goff} = 2.7\ \Omega,$ $V_{DD} = 1200\ V,$ $V_{GS} = -3/18\ V$	$T_{vj} = 25\ ^\circ C$	63.4		ns
			$T_{vj} = 125\ ^\circ C$	66.1		
			$T_{vj} = 175\ ^\circ C$	66.2		
Turn-on energy loss per pulse	E_{on}	$I_D = 400\ A, V_{DD} = 1200\ V,$ $L_\sigma = 40\ nH, V_{GS} = -3/18\ V,$ $R_{Gon} = 9.1\ \Omega, di/dt = 2.86$ $kA/\mu s (T_{vj} = 175\ ^\circ C)$	$T_{vj} = 25\ ^\circ C$	77.7		mJ
			$T_{vj} = 125\ ^\circ C$	79.1		
			$T_{vj} = 175\ ^\circ C$	84		
Turn-off energy loss per pulse	E_{off}	$I_D = 400\ A, V_{DD} = 1200\ V,$ $L_\sigma = 40\ nH, V_{GS} = -3/18\ V,$ $R_{Goff} = 2.7\ \Omega, dv/dt = 14.5$ $kV/\mu s (T_{vj} = 175\ ^\circ C)$	$T_{vj} = 25\ ^\circ C$	26.2		mJ
			$T_{vj} = 125\ ^\circ C$	27.3		
			$T_{vj} = 175\ ^\circ C$	27.9		
Thermal resistance, junction to case	R_{thJC}	per MOSFET			0.0880	K/W
Thermal resistance, case to heat sink	R_{thCH}	per MOSFET, $\lambda_{grease} = 1\ W/(m^*K)$		0.0330		K/W
Temperature under switching conditions	$T_{vj\ op}$		-40		175	$^\circ C$

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.

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

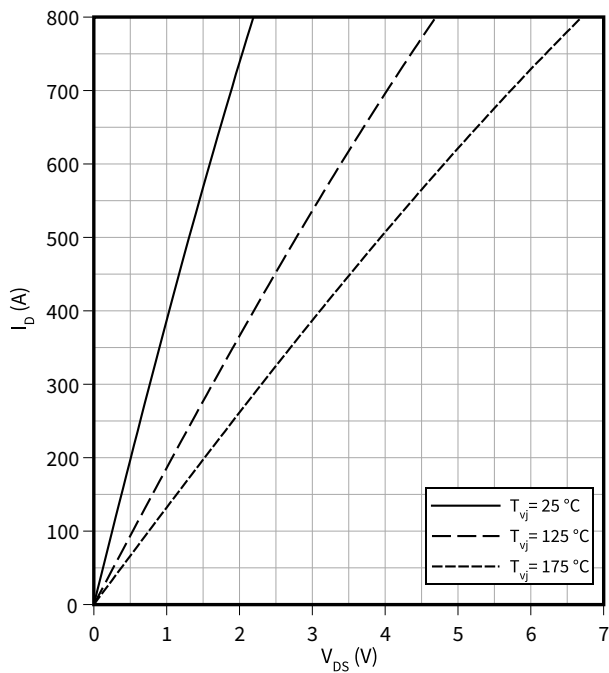
Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	V_{SD}	$I_{SD} = 400\text{ A}$, $V_{GS} = -3\text{ V}$	$T_{vj} = 25\text{ °C}$		4.6	6.15	V
			$T_{vj} = 125\text{ °C}$		4.15		
			$T_{vj} = 175\text{ °C}$		4		

4 Characteristics diagrams

Output characteristic (typical), MOSFET, T1 / T2

$I_D = f(V_{DS})$

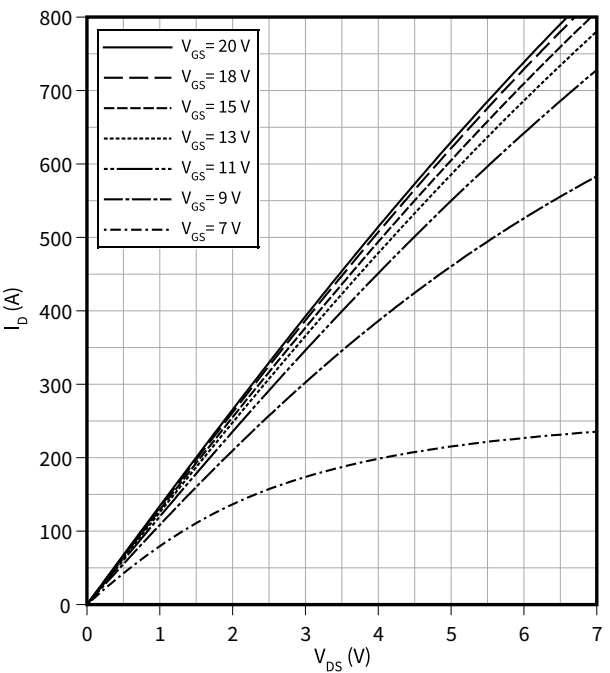
$V_{GS} = 18\text{ V}$



Output characteristic (typical), MOSFET, T1 / T2

$I_D = f(V_{DS})$

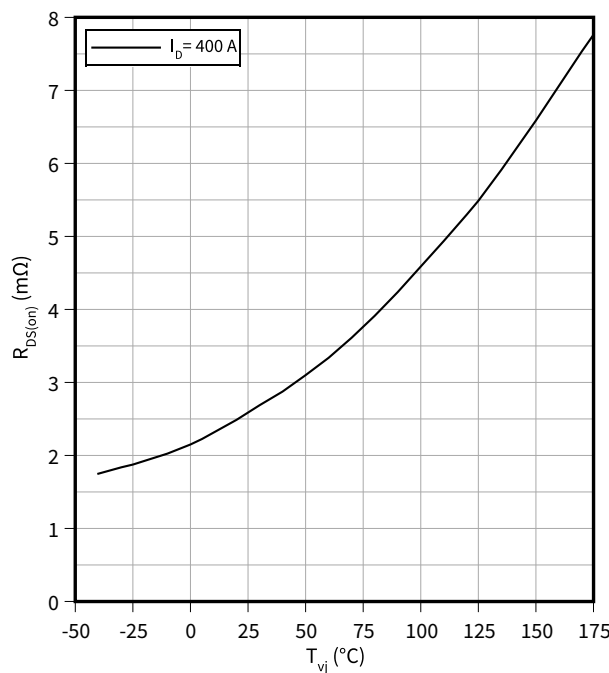
$T_{vj} = 175\text{ °C}$



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

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

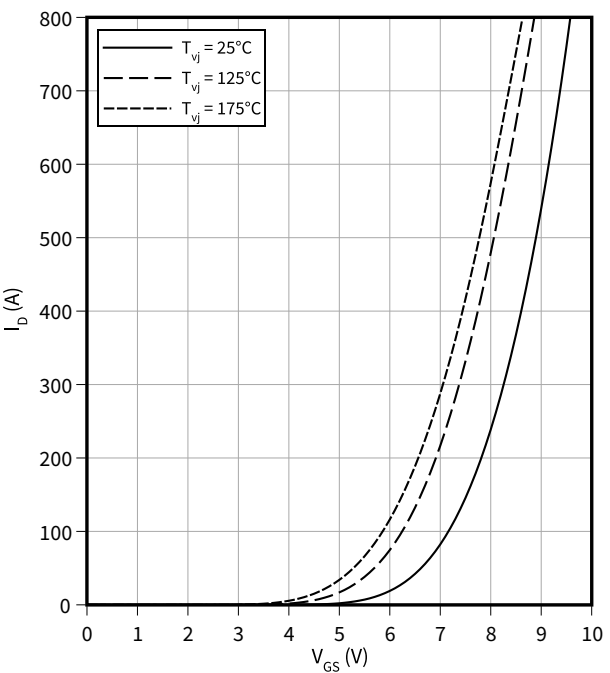
$V_{GS} = 18\text{ V}$



Transfer characteristic (typical), MOSFET, T1 / T2

$I_D = f(V_{GS})$

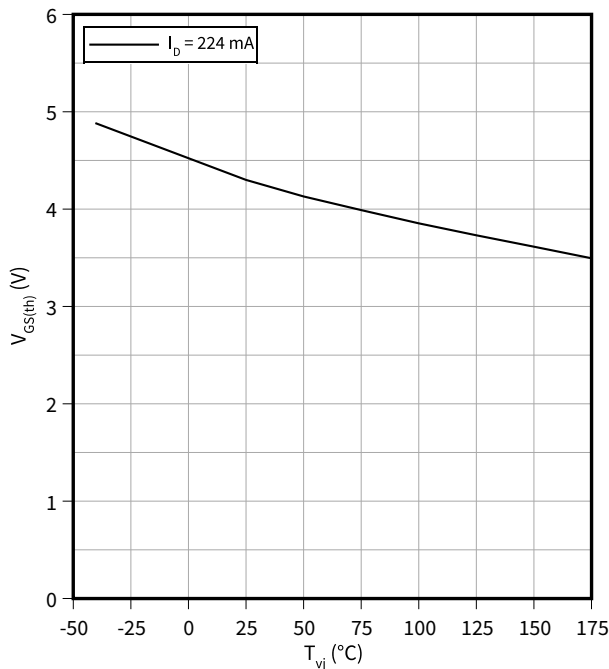
$V_{DS} = 20\text{ V}$



4 Characteristics diagrams

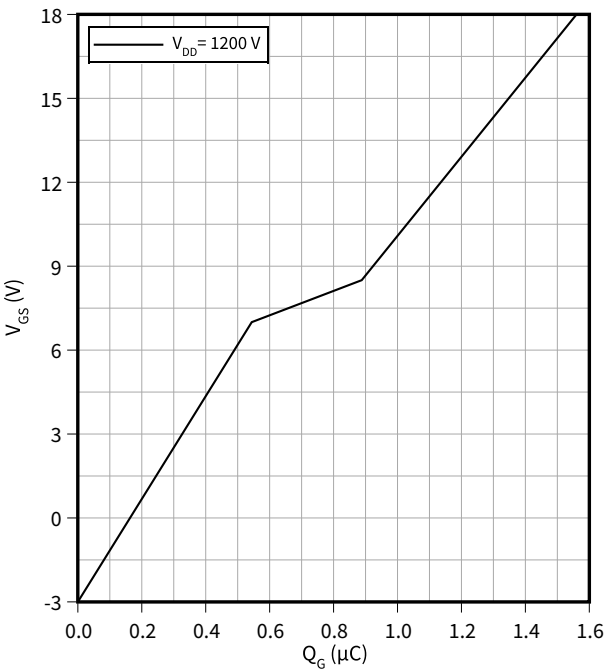
Gate-source threshold voltage (typical), MOSFET, T1 / T2

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



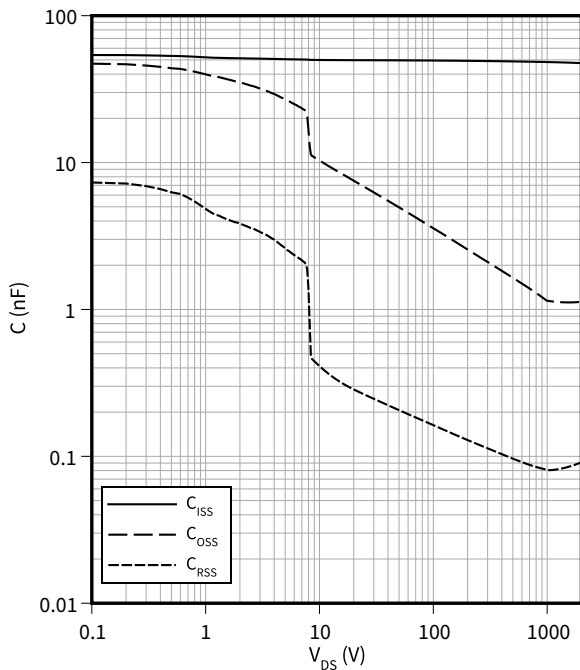
Gate charge characteristic (typical), MOSFET, T1 / T2

$V_{GS} = f(Q_G)$
 $I_D = 400\text{ A}, T_{vj} = 25\text{ °C}$



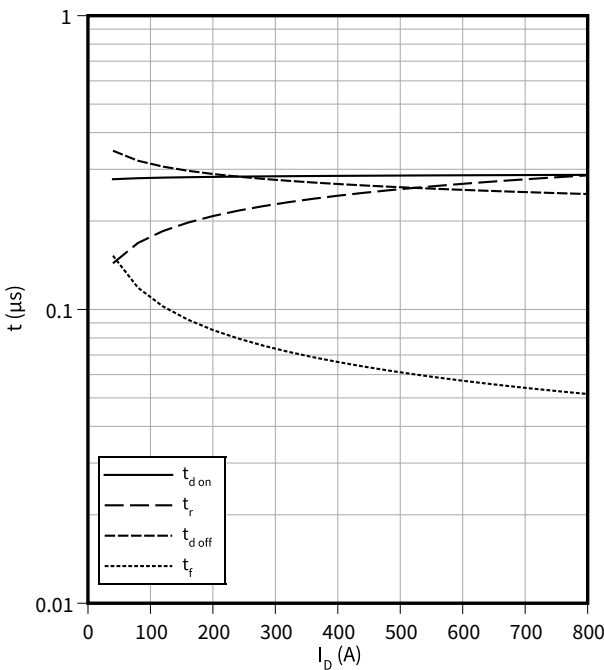
Capacity characteristic (typical), MOSFET, T1 / T2

$C = f(V_{DS})$
 $f = 100\text{ kHz}, T_{vj} = 25\text{ °C}, V_{GS} = -3\text{ V}$



Switching times (typical), MOSFET, T1 / T2

$t = f(I_D)$
 $R_{Goff} = 2.7\text{ }\Omega, R_{Gon} = 9.1\text{ }\Omega, V_{DD} = 1200\text{ V}, T_{vj} = 175\text{ °C}, V_{GS} = -3/18\text{ V}$

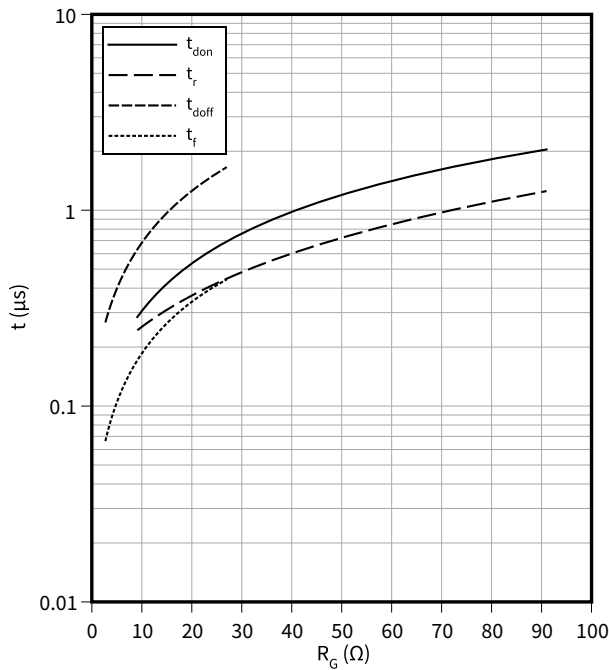


4 Characteristics diagrams

Switching times (typical), MOSFET, T1 / T2

$t = f(R_G)$

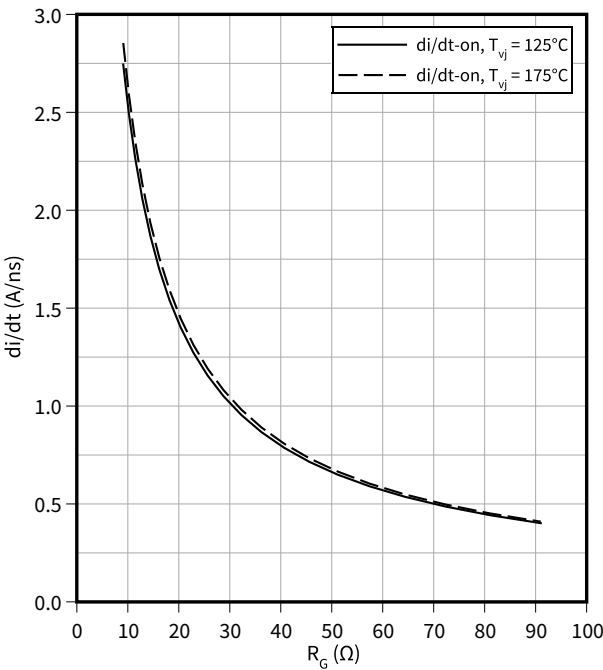
$V_{DD} = 1200\text{ V}$, $I_D = 400\text{ A}$, $T_{vj} = 175\text{ }^\circ\text{C}$, $V_{GS} = -3/18\text{ V}$



Current slope (typical), MOSFET, T1 / T2

$di/dt = f(R_G)$

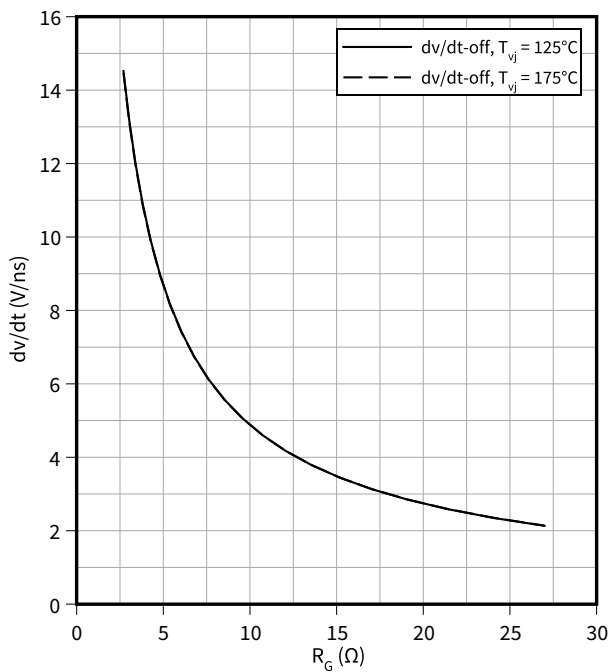
$V_{DD} = 1200\text{ V}$, $I_D = 400\text{ A}$, $V_{GS} = -3/18\text{ V}$



Voltage slope (typical), MOSFET, T1 / T2

$dv/dt = f(R_G)$

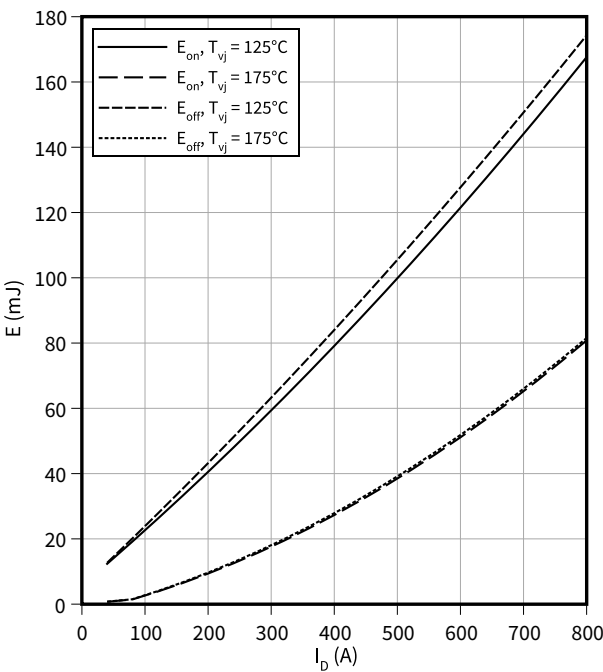
$V_{DD} = 1200\text{ V}$, $I_D = 400\text{ A}$, $V_{GS} = -3/18\text{ V}$



Switching losses (typical), MOSFET, T1 / T2

$E = f(I_D)$

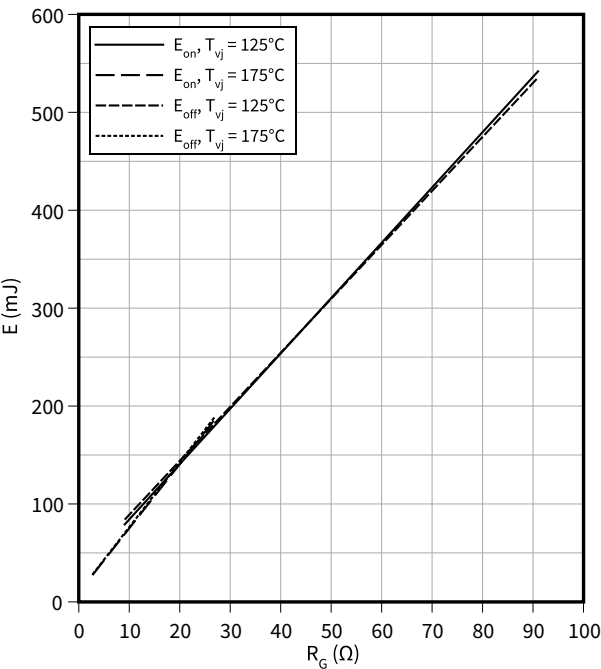
$R_{Goff} = 2.7\text{ }\Omega$, $R_{Gon} = 9.1\text{ }\Omega$, $V_{DD} = 1200\text{ V}$, $V_{GS} = -3/18\text{ V}$



4 Characteristics diagrams

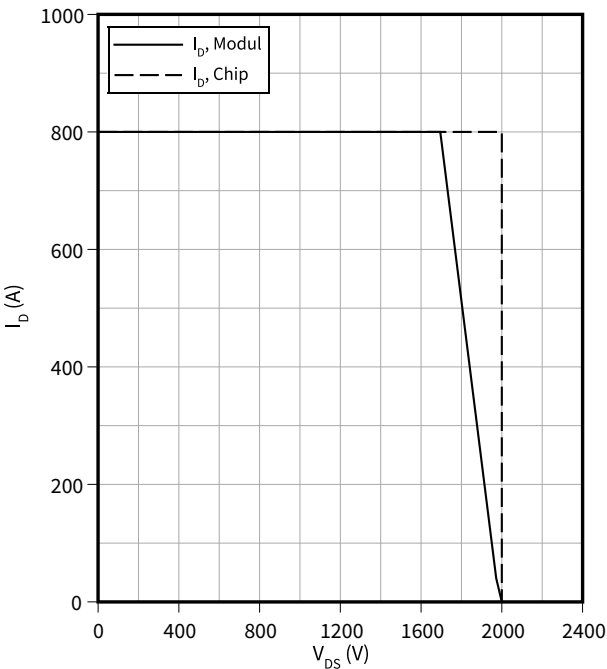
Switching losses (typical), MOSFET, T1 / T2

$E = f(R_G)$
 $V_{DD} = 1200\text{ V}$, $I_D = 400\text{ A}$, $V_{GS} = -3/18\text{ V}$



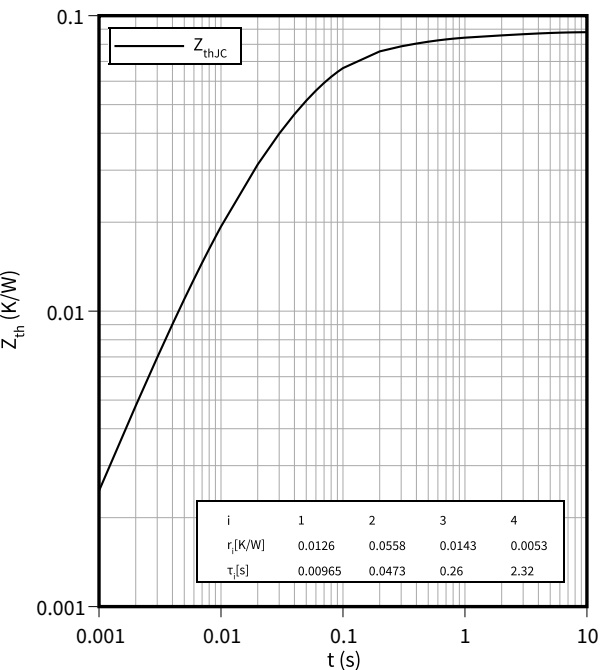
Reverse bias safe operating area (RBSOA), MOSFET, T1 / T2

$I_D = f(V_{DS})$
 $R_{Goff} = 2.7\text{ }\Omega$, $T_{vj} = 175\text{ }^\circ\text{C}$, $V_{GS} = -3/18\text{ V}$



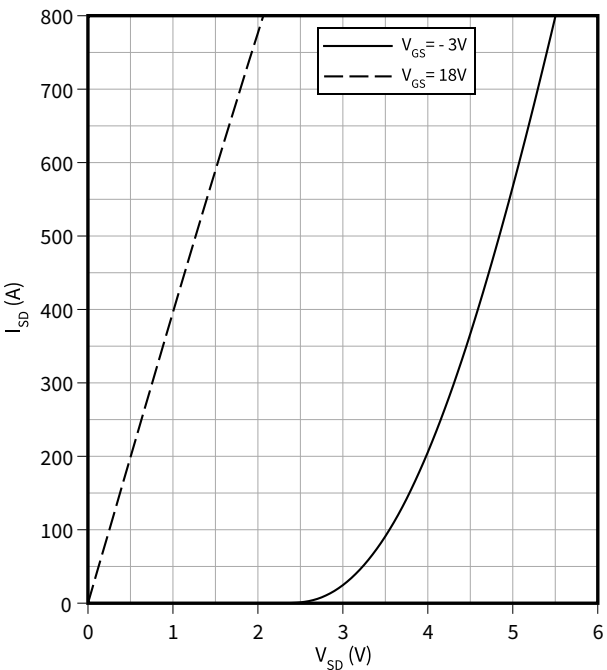
Transient thermal impedance, MOSFET, T1 / T2

$Z_{th} = f(t)$



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

$I_{SD} = f(V_{SD})$
 $T_{vj} = 25\text{ }^\circ\text{C}$



5 **Circuit diagram**

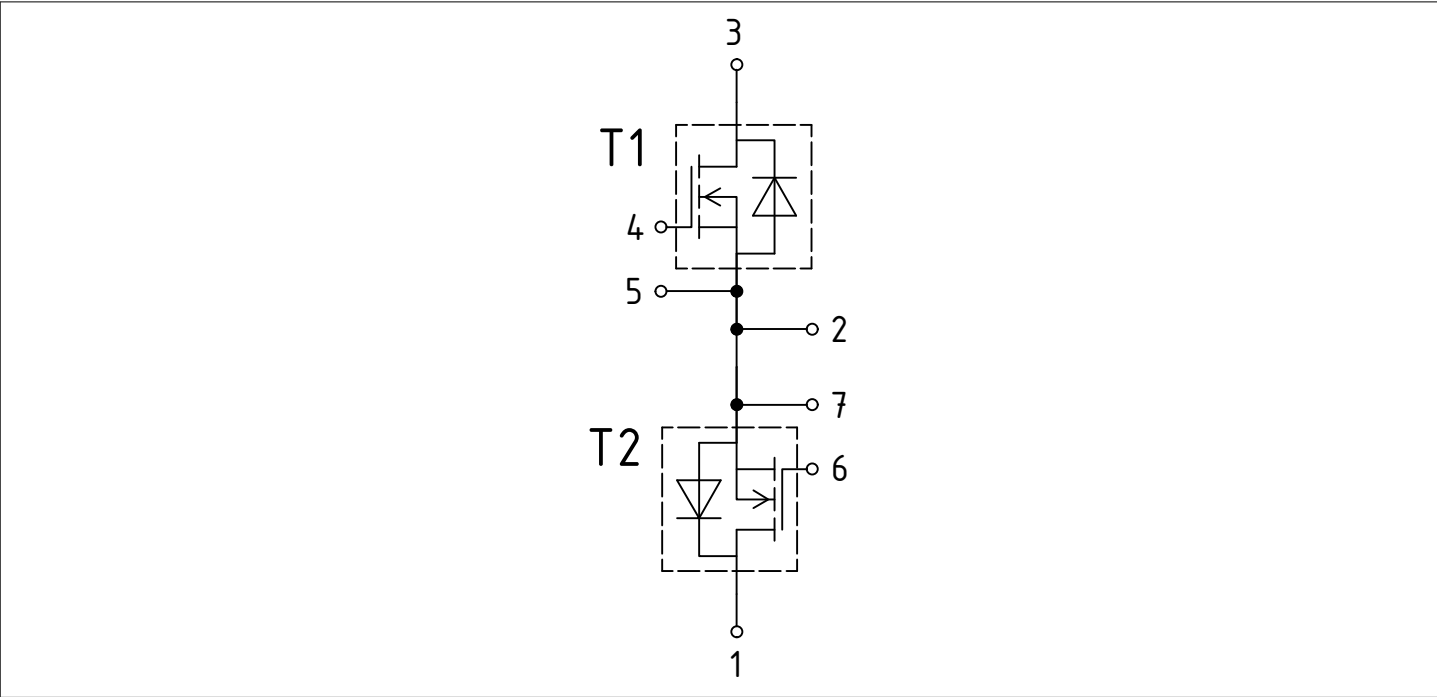


Figure 1

6 Package outlines

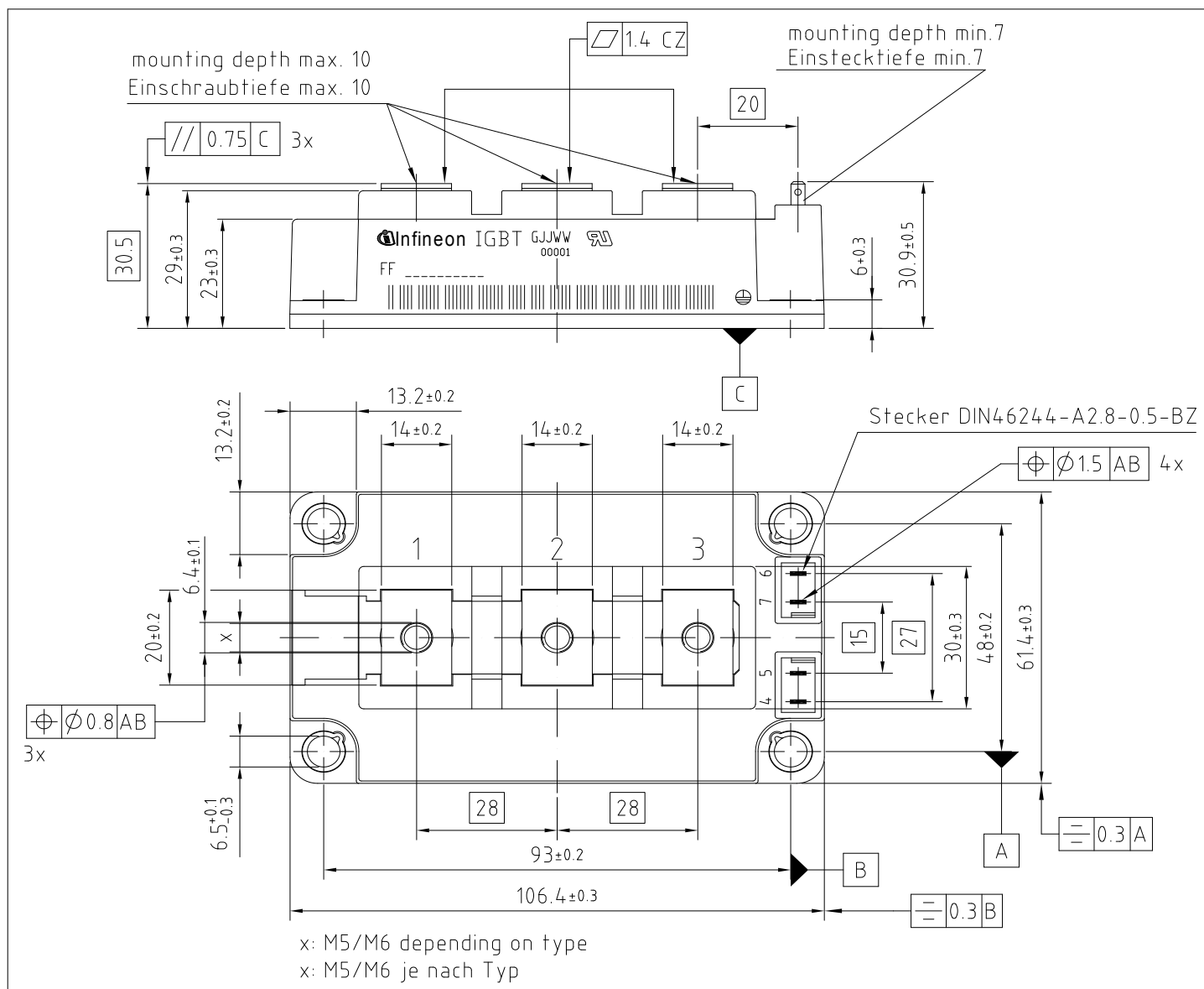


Figure 2

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

Revision history

Document revision	Date of release	Description of changes
0.10	2023-02-02	Initial version
1.00	2024-09-05	Final datasheet

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