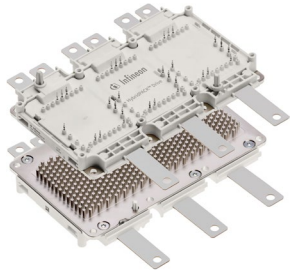
英飞凌采用CoolSiC™汽车级MOSFET的HybridPACK™驱动模块

特性



- 电气特性
  - V_{DSS} = 1200 V
  - $I_{D,nom}$ = 400 A
  - 新型半导体材料—碳化硅
  - 低 $R_{DS,on}$
  - 低开关损耗
  - 低 Q_g和 C_{rss}
  - 低电感设计 <10nH
  - $T_{vj,op}$ = 150°C
- 机械特性
  - 4.2 kV DC 1 s 绝缘
  - 高爬电距离和电气间隙
  - 紧凑型设计
  - 高功率密度
  - 直冷式 PinFin底板
  - 高性能 Si3N4 陶瓷
  - 用于 PCB 和冷却器装配的导向元件
  - 集成NTC温度传感器
  - PressFIT 压接技术
  - 符合 RoHS 标准
  - UL 94 V0 模块框架

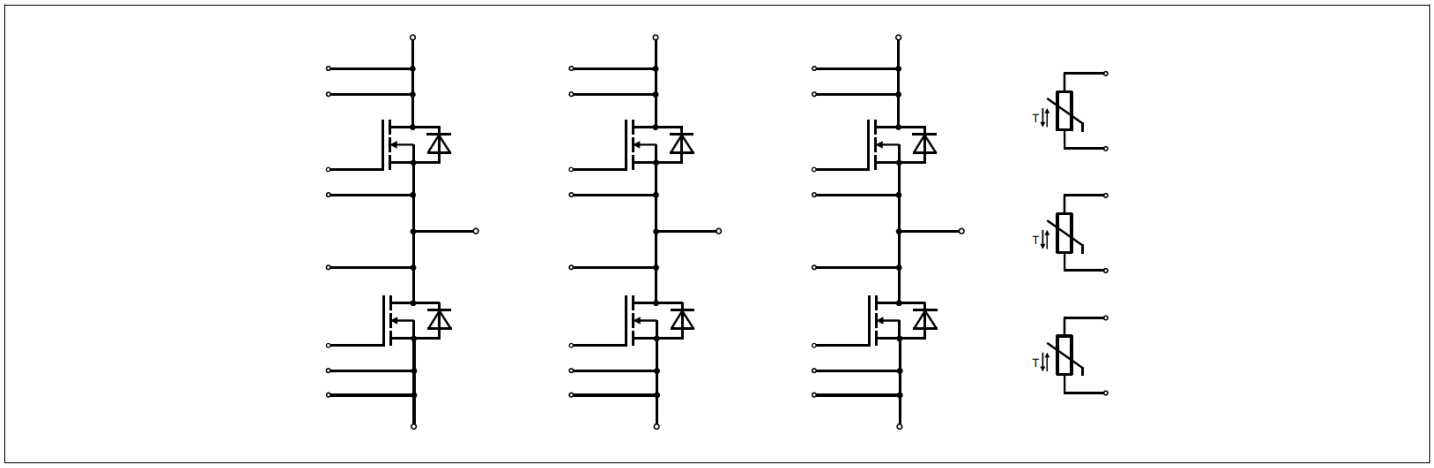
潜在应用

- 汽车应用
- （混合）电动汽车 (H)EV
- 电机驱动
- 商业性农用车辆

产品验证

- 符合 AQG 324 标准，发布号：03.1/2021

描述



本数据手册的原文使用英文撰写。为方便起见，英飞凌提供了译文；由于翻译过程中可能使用了自动化工具，英飞凌不保证译文的准确性。 为确认准确性，请务必访问 infineon.com 参考最新的英文版本（控制文档）。

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1 封装

表1 绝缘配合

Parameter	Symbol	Note or test condition	Values	Unit
Isolation test voltage	V_{ISOL}	RMS, f = 0 Hz, t = 1 sec	4.20	kV
Material of module baseplate			Ni+Cu[1)]	
Internal isolation		basic insulation (class 1, IEC 61140)	Si3N4	
Creepage distance	d_{creep}	terminal to heatsink	9.0	mm
Creepage distance	d_{creep}	terminal to terminal	9.0	mm
Clearance	d_{clear}	terminal to heatsink	4.5	mm
Clearance	d_{clear}	terminal to terminal	4.5	mm
Comparative tracking index	*CTI*		> 200	

1) 镀镍铜底板

表 2 最大额定值

Parameter	Symbol	Note or test condition	Values	Unit
Maximum RMS module terminal current	$I_{t,rms}$	$T_{terminal}$ = 105 °C, T_f = 75 °C	500	A

表3 特征值

Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Pressure drop in cooling circuit	Δp	$\Delta V/\Delta t$ = 10 dm³/min, 50% water / 50% ethylenglycol, T_f = 60 °C		64[1)]		mbar
Maximum pressure in cooling circuit	p	$T_{baseplate}$ < 40°C (relative pressure)			2.5	bar
		$T_{baseplate}$ ≥ 40°C (relative pressure)			2.0	
Stray inductance module	$L_{s,DS}$			8.5		nH
Module lead resistance, terminals - chip	$R_{DD'+SS'}$	T_f = 25 °C, per switch		0.75		mΩ
Storage temperature	T_{stg}		-40		125	°C
Mounting torque for module mounting	M	Screw M4 baseplate to heatsink	1.8	2.0	2.2	Nm
Weight	G			729		g

1) 冷却器设计和流动方向参考应用笔记 AN-HPDPERF-ASSEMBLY

2 MOSFET

表4 最大额定值

Parameter	Symbol	Note or test condition		Values	Unit
Drain-source voltage	V_{DSS}		T_{vj} = 25 °C	1200	V
DC drain current	$I_{D,nom}$	V_{GS} = 15 V, T_f = 60 °C	$T_{vj,max}$ = 175 °C	400	A
Pulsed drain current	$I_{D,pulse}$	verified by design, t_p limited by T_{vjmax}		800	A
Gate-source voltage	V_{GSS}			-10/20	V

表5 特征值

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Drain-source on-resistance	$R_{DS,on}$	I_D = 400 A, V_{GS} = 15 V	T_{vj} = 25 °C		2.75	3.70	mΩ
			T_{vj} = 125 °C		4.00		
			T_{vj} = 150 °C		4.55		
Gate threshold voltage	$V_{GS,th}$	I_D = 240 mA, V_{GS} = V_{DS}, (tested after 1ms pulse at V_{GS} = +20 V)	T_{vj} = 25 °C	3.25	4.40	5.55	V
Total gate charge	Q_G	V_{DS} = 600 V, V_{GS} = -5/15 V			1.32		µC
Internal gate resistor	$R_{G,int}$		T_{vj} = 25 °C		0.23		Ω
Input capacitance	C_{iss}	f = 1 MHz, V_{DS} = 600 V, V_{GS} = 0 V	T_{vj} = 25 °C		42.6		nF
Output capacitance	C_{oss}	f = 1 MHz, V_{DS} = 600 V, V_{GS} = 0 V	T_{vj} = 25 °C		1.86		nF
Reverse transfer capacitance	C_{rss}	f = 1 MHz, V_{DS} = 600 V, V_{GS} = 0 V	T_{vj} = 25 °C		0.17		nF
C_{oss} stored energy	E_{oss}	V_{DS} = 600 V, V_{GS} = -5/15 V	T_{vj} = 25 °C		438		µJ
Drain-source leakage current	I_{DSX}	V_{GS} = -5 V, V_{DSS} = 1200 V	T_{vj} = 25 °C			100	µA
Gate-source leakage current	I_{GSS}	V_{GS} = 20 V, V_{DS} = 0 V	T_{vj} = 25 °C			400	nA
Turn-on delay time, inductive load	$t_{d,on}$	I_D = 400 A, $R_{G,on}$ = 5.1 Ω, V_{GS} = -5/15 V, V_{DS} = 600 V	T_{vj} = 25 °C		77		ns
			T_{vj} = 125 °C		62		
			T_{vj} = 150 °C		59		
Rise time (inductive load)	t_r	I_D = 400 A, $R_{G,on}$ = 5.1 Ω, V_{GS} = -5/15 V, V_{DS} = 600 V	T_{vj} = 25 °C		79		ns
			T_{vj} = 125 °C		70		
			T_{vj} = 150 °C		69		

（表格续下页……）

表 5 （续） 特征值

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Turn-off delay time, inductive load	$t_{d,off}$	I_D = 400 A, $R_{G,off}$ = 5.1 Ω, V_{GS} = -5/15 V, V_{DS} = 600 V	T_{vj} = 25 °C		263		ns
			T_{vj} = 125 °C		287		
			T_{vj} = 150 °C		294		
Fall time (inductive load)	t_f	I_D = 400 A, $R_{G,off}$ = 5.1 Ω, V_{GS} = -5/15 V, V_{DS} = 600 V	T_{vj} = 25 °C		64		ns
			T_{vj} = 125 °C		64		
			T_{vj} = 150 °C		65		
Turn-on energy loss per pulse	E_{on}	I_D = 400 A, $R_{G,on}$ = 5.1 Ω, V_{GS} = -5/15 V, V_{DS} = 600 V, L_σ = 20 nH	T_{vj} = 25 °C, di/dt = 4 kA/µs		19.48		mJ
			T_{vj} = 125 °C, di/dt = 4.6 kA/µs		19.85		
			T_{vj} = 150 °C, di/dt = 4.6 kA/µs		20.16		
Turn-off energy loss per pulse	E_{off}	I_D = 400 A, $R_{G,off}$ = 5.1 Ω, V_{GS} = -5/15 V, V_{DS} = 600 V, L_σ = 20 nH	T_{vj} = 25 °C, du/dt = 7.3 kV/µs		17.61		mJ
			T_{vj} = 125 °C, du/dt = 7.2 kV/µs		17.95		
			T_{vj} = 150 °C, du/dt = 7.1 kV/µs		18.21		
Short circuit data	I_{SC}	V_{DD} = 800 V, V_{GS} = -5/15 V, $R_{G,on}$ = 5.1 Ω, $R_{G,off}$ = 5.1 Ω, V_{DSmax} = V_{DSS}-L_{sDS}·di/dt	t_{SC} = 3 µs, T_{vj} = 25 °C		5300		A
			t_{SC} = 3 µs, T_{vj} = 150 °C		4800		
Thermal resistance, junction to cooling fluid	$R_{th,j-f}$	per MOSFET, T_f = 60 °C, $\Delta V/\Delta t$ = 10 dm³/min, 50% water / 50% ethylenglycol			0.1	0.108[1)]	K/W
Temperature under switching conditions	$T_{vj,op}$			-40		150	°C

1) EoL标准参见AQG324，通过4.5sigma特性验证。冷却器设计和流动方向应参考应用笔记AN-HPDPERF-ASSEMBLY。

3 体二极管

表 6 最大额定值

Parameter	Symbol	Note or test condition		Values	Unit
DC body diode forward current	$I_{F,S}$	$T_{vj,max}$ = 175 °C, V_{GS} = -5 V	T_f = 60 °C	210	A
Pulsed body diode current	$I_{F,S,pulse}$	verified by design, t_p limited by T_{vjmax}		800	A

表 7　　特征值

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	$V_{F,SD}$	$I_{F,S}$ = 400 A, V_{GS} = -5 V	T_{vj} = 25 °C		4.42	6.15	V
			T_{vj} = 125 °C		4.22		
			T_{vj} = 150 °C		4.16		
Peak reverse recovery current	I_{rrm}	$I_{F,S}$ = 400 A, V_{GS} = -5 V, $V_{R,DS}$ = 600 V	T_{vj} = 25 °C		165		A
			T_{vj} = 125 °C		287		
			T_{vj} = 150 °C		309		
Recovered charge	Q_{rr}	$I_{F,S}$ = 400 A, V_{GS} = -5 V, $V_{R,DS}$ = 600 V	T_{vj} = 25 °C		11.20		µC
			T_{vj} = 125 °C		18.10		
			T_{vj} = 150 °C		19.30		
Reverse recovery energy	E_{rec}	$I_{F,S}$ = 400 A, V_{GS} = -5 V, $V_{R,DS}$ = 600 V	T_{vj} = 25 °C, $-di/dt$ = 5.9 kA/µs		1.4		mJ
			T_{vj} = 125 °C, $-di/dt$ = 6.9 kA/µs		4.0		
			T_{vj} = 150 °C, $-di/dt$ = 6.9 kA/µs		4.7		

4　　NTC-热敏电阻

表 8　　特征值

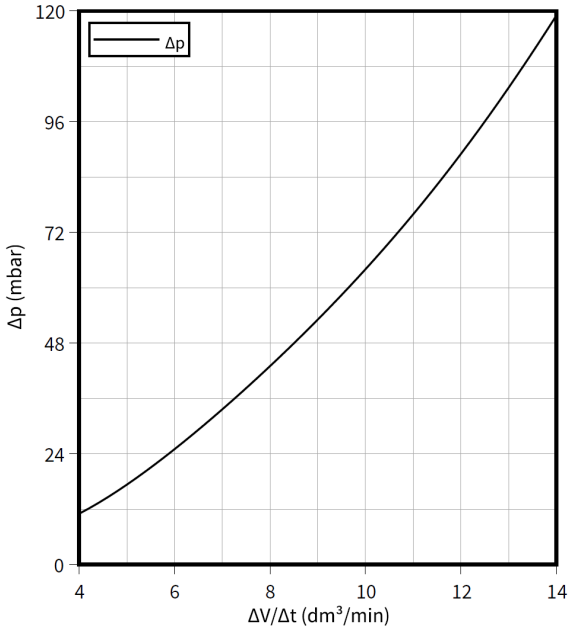
Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Rated resistance	R_{25}	T_{NTC} = 25 °C		5		kΩ
Deviation of R_{100}	$\Delta R/R$	T_{NTC} = 100 °C, R_{100} = 493 Ω	-5		5	%
Power dissipation	P_{25}	T_{NTC} = 25 °C			20	mW
B-value	$B_{25/50}$	$R_2 = R_{25} \exp[B_{25/50}(1/T_2-1/(298{,}15\ K))]$		3375		K
B-value	$B_{25/80}$	$R_2 = R_{25} \exp[B_{25/80}(1/T_2-1/(298{,}15\ K))]$		3411		K
B-value	$B_{25/100}$	$R_2 = R_{25} \exp[B_{25/100}(1/T_2-1/(298{,}15\ K))]$		3433		K

5 特性图

Pressure drop in cooling circuit, Package

$\Delta p = f(\Delta V/\Delta t)$

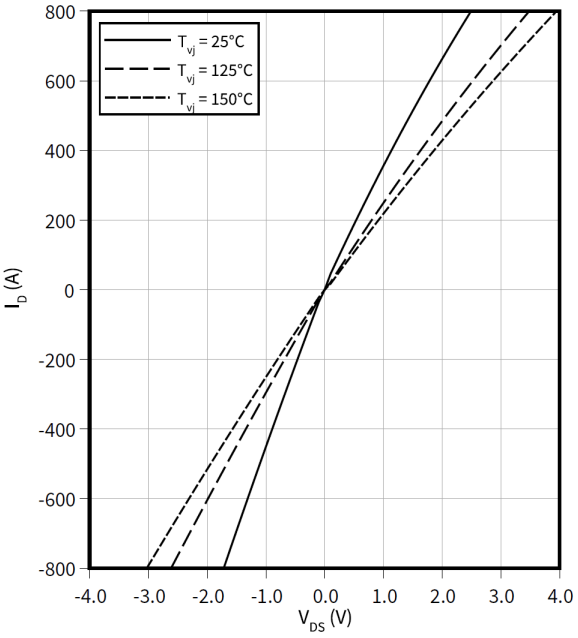
$T_f = 60\ °C$, fluid = 50% water/50% ethylenglycol



Output characteristic (typical), MOSFET

$I_D = f(V_{DS})$

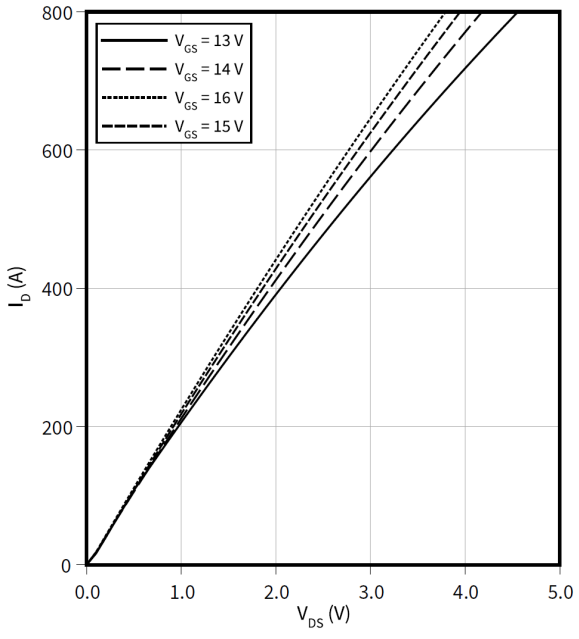
$V_{GS} = 15\ V$



Output characteristic (typical), MOSFET

$I_D = f(V_{DS})$

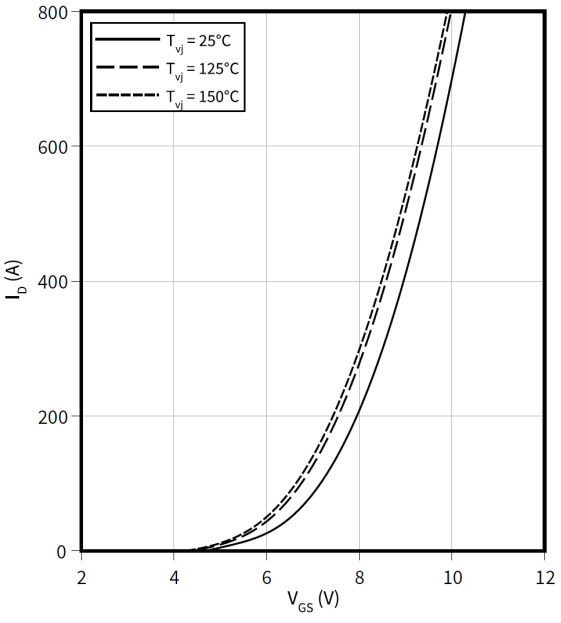
$T_{vj} = 125\ °C$



Transfer characteristic (typical), MOSFET

$I_D = f(V_{GS})$

$V_{DS} = 20\ V$

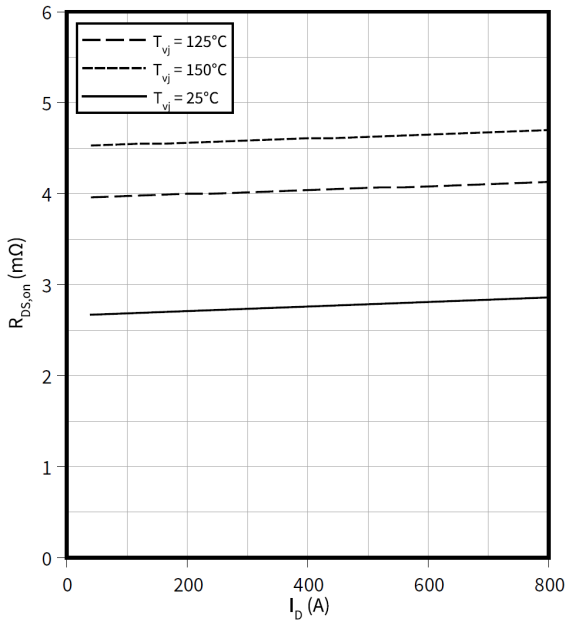


5 特性图

Drain-source on-resistance (typical), MOSFET

$R_{DS,on} = f(I_D)$

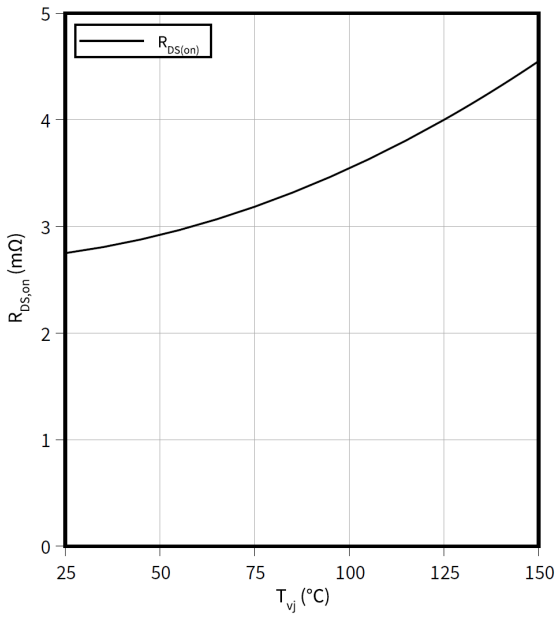
$V_{GS} = 15$ V



Drain-source on-resistance (typical), MOSFET

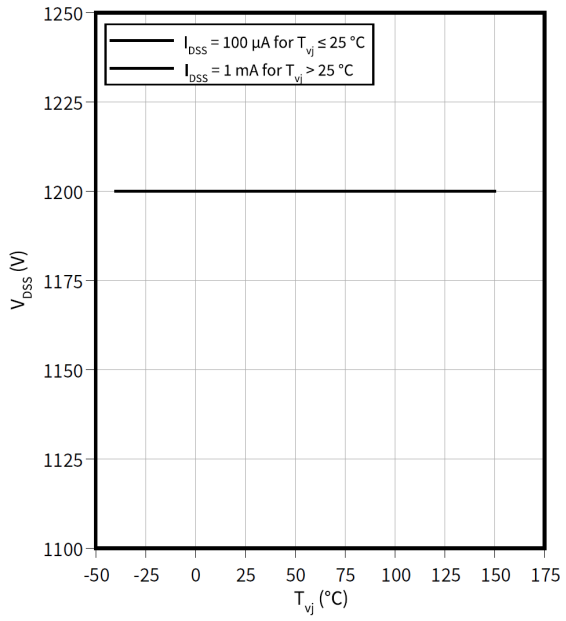
$R_{DS,on} = f(T_{vj})$

$I_D = 400$ A, $V_{GS} = 15$ V



Maximum allowed drain-source voltage, MOSFET

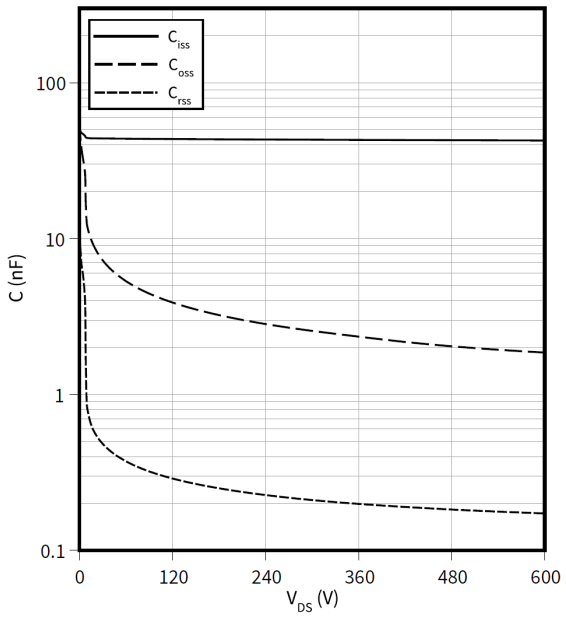
$V_{DSS} = f(T_{vj})$



Capacity characteristic (typical), MOSFET

$C = f(V_{DS})$

$T_{vj} = 25$ °C, $f = 1$ MHz, $V_{GS} = 0$ V

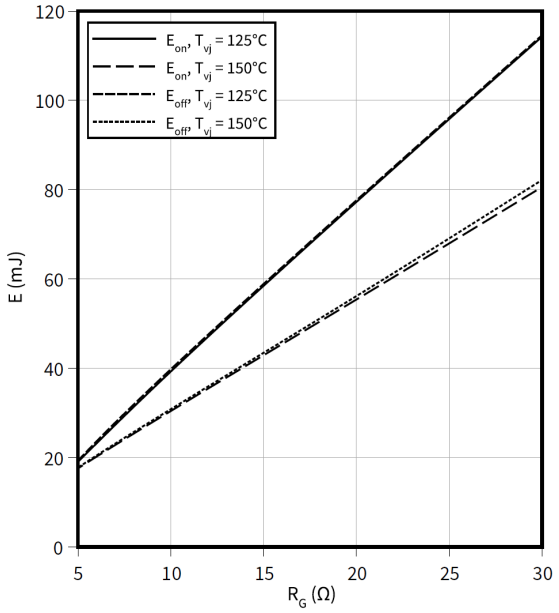


5 特性图

Switching losses (typical), MOSFET

E = f(R_G)

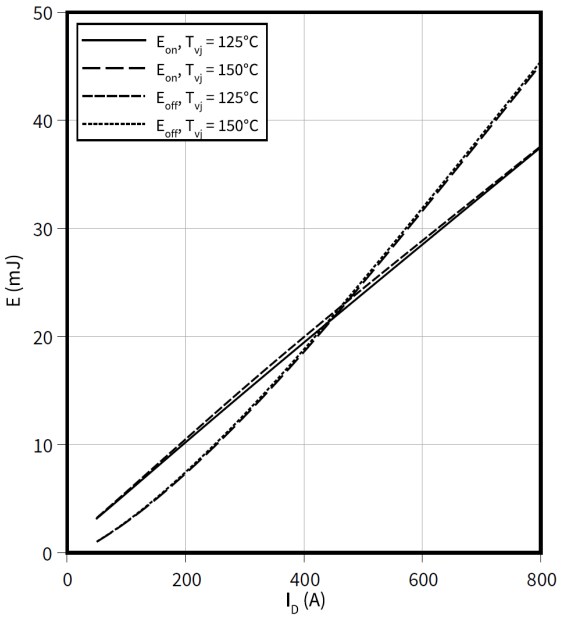
I_D = 400 A, V_{DS} = 600 V, V_{GS} = -5/15 V



Switching losses (typical), MOSFET

E = f(I_D)

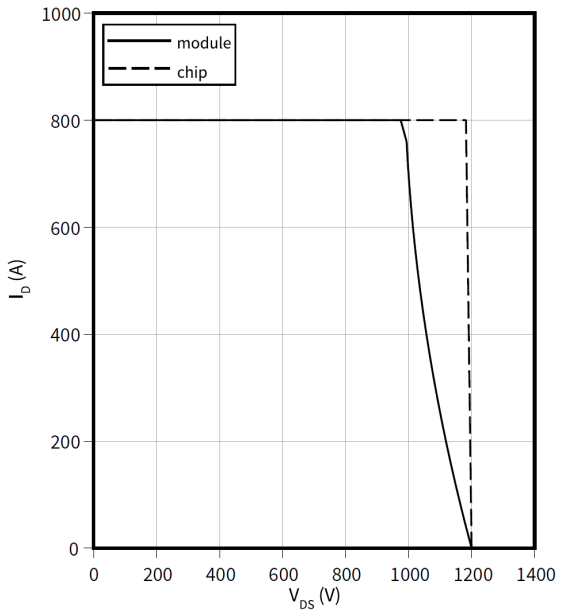
V_{DS} = 600 V, $R_{G,off}$ = 5.1 Ω, $R_{G,on}$ = 5.1 Ω, V_{GS} = -5/15 V



Reverse bias safe operating area (RBSOA), MOSFET

I_D = f(V_{DS})

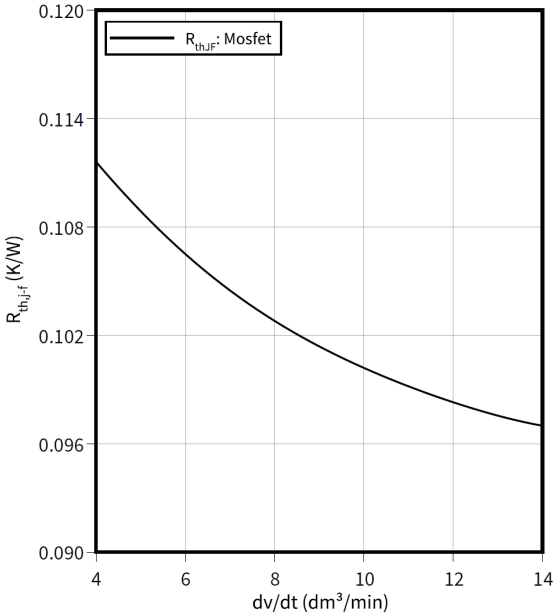
$R_{G,off}$ = 5.1 Ω, V_{GS} = +15/-5 V, T_{vj} = 150 °C



Thermal impedance , MOSFET

$R_{th,j-f}$ = f(dv/dt)

fluid = 50% water/50% ethylenglycol , T_f = 60 °C

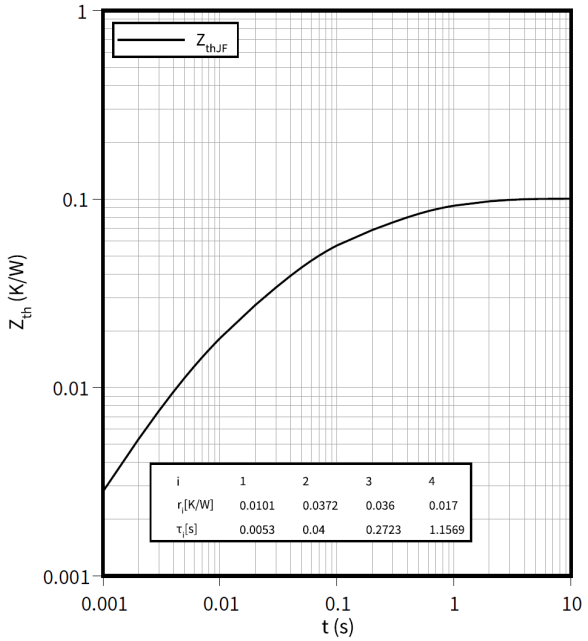


5 特性图

Transient thermal impedance , MOSFET

$Z_{th} = f(t)$

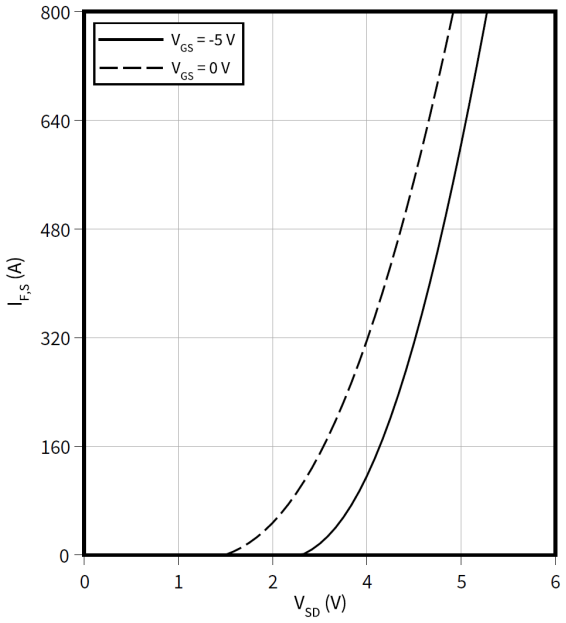
$\Delta V/\Delta t = 10\ dm^3/min$, fluid = 50% water/50% ethylenglycol , $T_f = 60\ °C$



Forward characteristic body diode (typical), MOSFET

$I_{F,S} = f(V_{SD})$

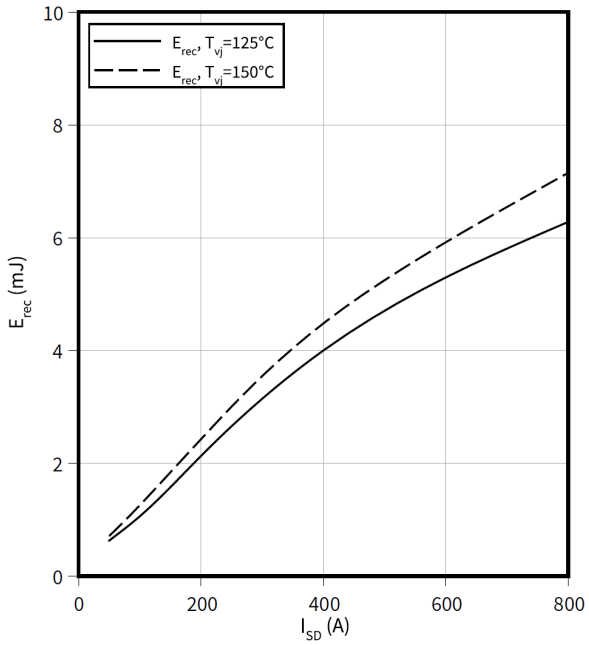
$T_{vj} = 25\ °C$



Switching losses body diode (typical), MOSFET

$E_{rec} = f(I_{SD})$

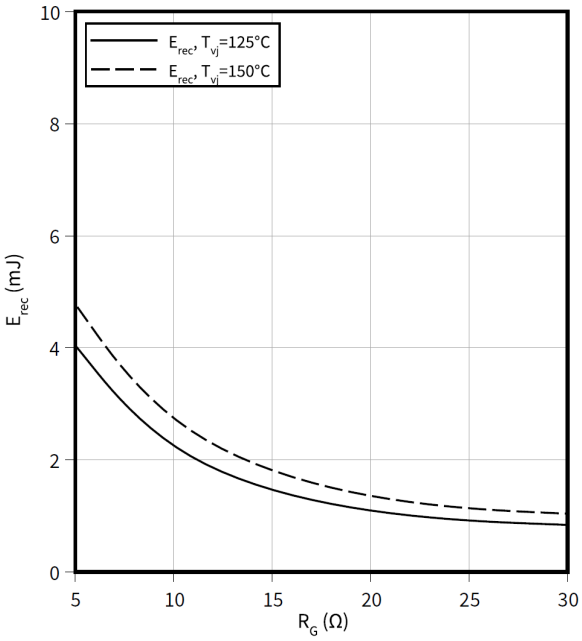
$V_r = 600\ V$, $R_{G,on} = 5.1\ \Omega$, $V_{GS} = -5/15\ V$



Switching losses body diode (typical), MOSFET

$E_{rec} = f(R_G)$

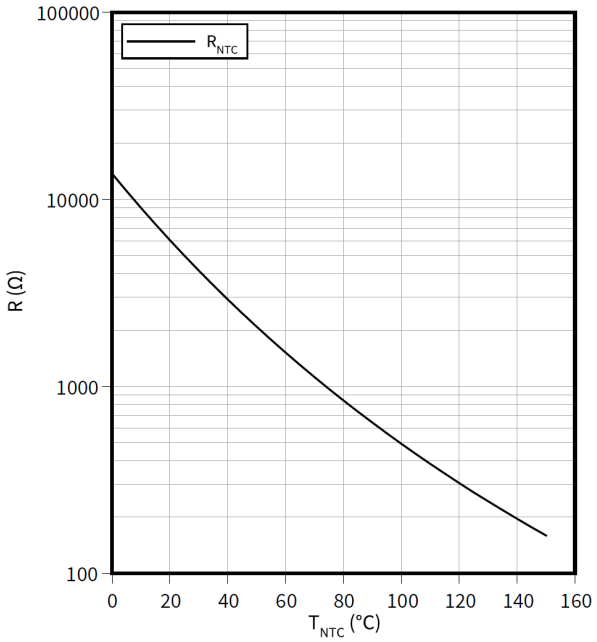
$V_r = 600\ V$, $I_{F,S} = 400\ A$, $V_{GS} = -5/15\ V$



5 特性图

Temperature characteristic (typical), NTC-Thermistor

R = f(TNTC)



6 电路图

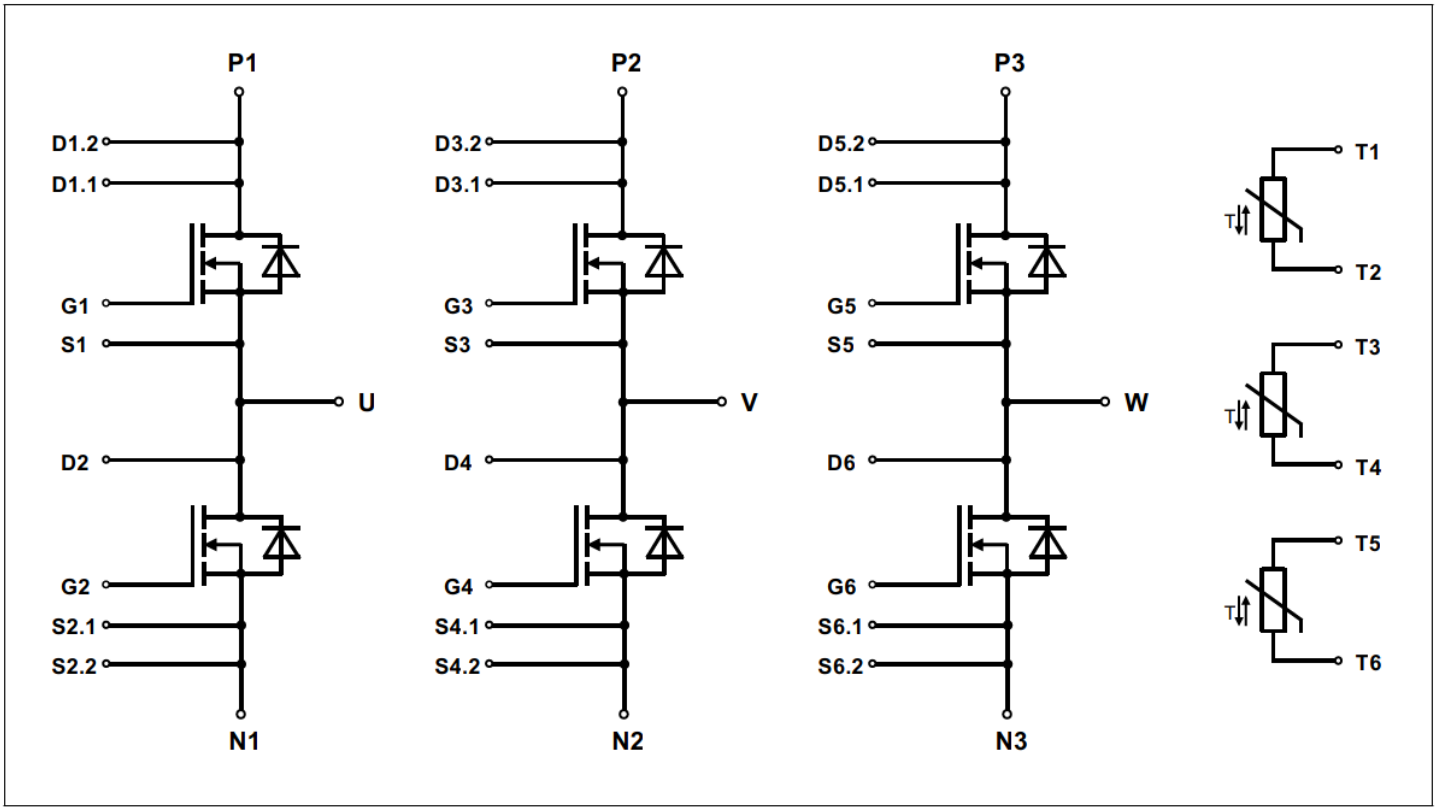

P1
D1.2
D1.1
G1
S1
U
D2
G2
S2.1
S2.2
N1
P2
D3.2
D3.1
G3
S3
V
D4
G4
S4.1
S4.2
N2
P3
D5.2
D5.1
G5
S5
W
D6
G6
S6.1
S6.2
N3
T1
T2
T3
T4
T5
T6

图1

7 封装外形

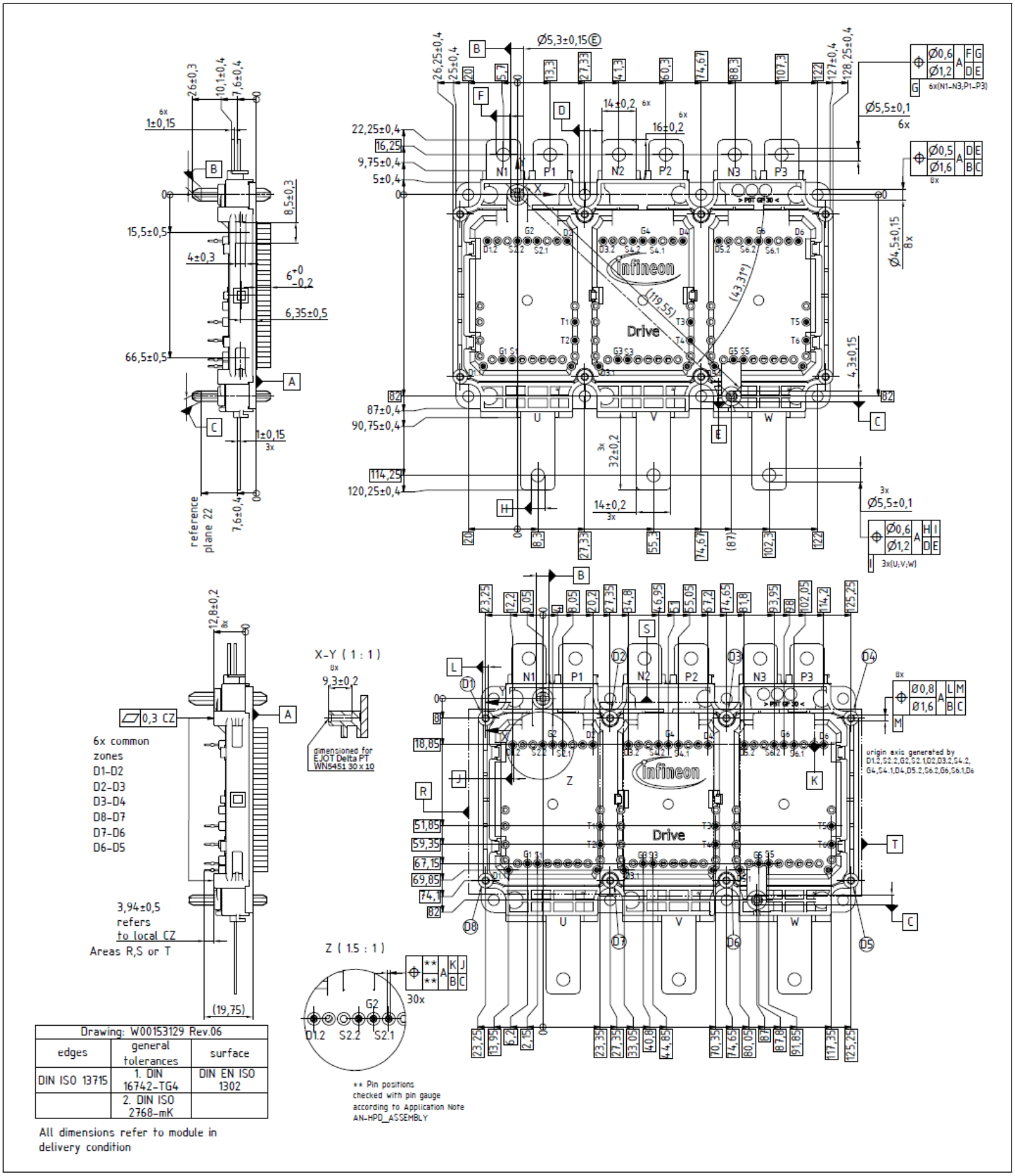
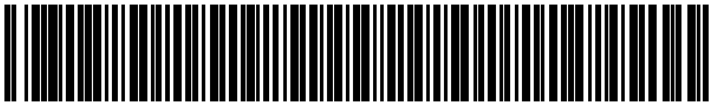

Drawing: W00153129 Rev.06
edges
general tolerances
surface
DIN ISO 13715
1. DIN 16742-TG4
DIN EN ISO 1302
2. DIN ISO 2768-mK
All dimensions refer to module in delivery condition
6x common zones
D1-D2
D2-D3
D3-D4
D8-D7
D7-D6
D6-D5
3,94±0,5 refers to local CZ Areas R,S or T
X-Y (1 : 1)
dimensioned for EJOT Delta PT WN5451 30 x 10
Z (1.5 : 1)
** Pin positions checked with pin gauge according to Application Note AN-HPD_ASSEMBLY
origin axis generated by D1.2,S2.2,G2,S2.1,D2,D3.2,G4.2,G4,S4.1,D4,D5.2,S6.2,G6,S6.1,D6
reference plane 22
Drive
Infineon

图2

8 模块标签代码

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	*Content* Module serial number Module material number Production order number Date code (production year) Date code (production week)	*Digit* 1 – 5 6 - 11 12 - 19 20 – 21 22 – 23	*Example* 71549 142846 55054991 15 30
Example	 71549142846550549911530	 71549142846550549911530	

Packing label code				
Code format	Barcode Code128			
Encoding	Code Set A			
Symbol size	34 digits			
Standard	IEC8859-1			
Code content	*Content* Module serial number Module material number Production order number Date code (production year) Date code (production week)	*Identifier* X 1T S 9D Q	*Digit* 2 – 9 12 – 19 21 – 25 28 – 31 33 – 34	*Example* 95056609 2X0003E0 754389 1139 15
Example	 X950566091T2X0003E0S754389D1139Q15			

图3

修订记录

Document revision	Date of release	Description of changes
V1.0	2019-09-03	Target datasheet
V2.0	2021-01-26	Preliminary datasheet
n/a	2020-10-05	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
1.00	2021-03-23	Final datasheet
1.10	2022-07-19	Adaption of product identification Adding electrical feature diagram Correction of typos

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