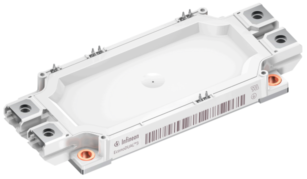
Final datasheet

EconoDUAL™3 模块 采用 CoolSiC™ Trench MOSFET 带有 PressFIT 压接管脚和温度检测 NTC



特性

- 电气特性
  - V_{DSS} = 1200 V
  - I_{DN} = 500 A / I_{DRM} = 1000 A
  - 集成温度传感器
  - 可以从下面链接寻找适合的英飞凌驱动 IC https://www.infineon.com/gdfinder
- 机械特性
  - 标准封装
  - PressFIT 压接技术
  - 绝缘的基板
  - 高功率密度
  - 直接冷却型基板

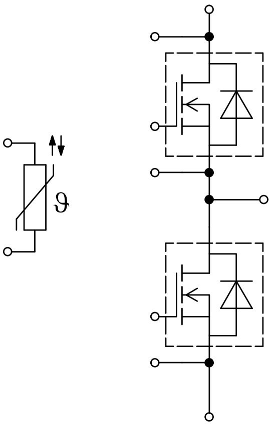
可选应用

- 建设用，商用及农用载具
- 风力发电机
- 电机传动
- UPS 系统
- 太阳能应用

产品认证

- 根据 IEC 60747、60749 和 60068 标准的相关测试，符合工业应用的要求。

描述



内容

1 封装

表 1 绝缘参数

特征参数	代号	标注或测试条件	数值	单位
绝缘测试电压	V_{ISOL}	RMS, f = 50 Hz, t = 1 min	3.4	kV
NTC 绝缘测试电压	$V_{ISOL(NTC)}$	RMS, f = 50 Hz, t = 1 min	3.4	kV
模块基板材料			Cu	
内部绝缘		基本绝缘 (class 1, IEC 61140)	Al_2O_3	
爬电距离	$d_{Creep\ nom}$	端子到基板, nom.	> 15	mm
爬电距离	$d_{Creep\ min}$	端子到基板, min.	14.7	mm
爬电距离	$d_{Creep\ nom}$	端子至端子, nom.	> 19.3	mm
爬电距离	$d_{Creep\ min}$	端子至端子, min.	19.3	mm
电气间隙	$d_{Clear\ nom}$	端子到基板, nom.	> 12.5	mm
电气间隙	$d_{Clear\ min}$	端子到基板, min.	12.5	mm
电气间隙	$d_{Clear\ nom}$	端子至端子, nom.	> 10	mm
电气间隙	$d_{Clear\ min}$	端子至端子, min.	9.6	mm
相对电痕指数	CTI		> 200	
相对温度指数 (电)	RTI	封装	140	°C

表 2 特征值

特征参数	代号	标注或测试条件		数值			单位
				最小值	典型值	最大值	
冷却回路的压降	Δp	$\Delta V/\Delta t$ = 10.0 dm^3/min, 50% water / 50% ethylenglycol, T_F = 60 °C			65		mbar
冷却回路的最大压力	p					3	bar
杂散电感,模块	L_{sCE}				20		nH
模块引线电阻,端子-芯片	$R_{CC'+EE'}$	T_F = 25 °C, 每个开关			0.8		mΩ
储存温度	T_{stg}			-40		125	°C
模块安装的安装扭距	M	根据相应的应用手册进行安装	M5, 螺丝	3		6	Nm
端子安装扭矩	M	根据相应的应用手册进行安装	M6, 螺丝	3		6	Nm
重量	G				345		g

2 MOSFET, T1 / T2

表 3 最大标定值

特征参数	代号	标注或测试条件		数值	单位
漏源极电压	V_{DSS}		$T_{vj} = 25$ °C	1200	V
连续漏极直流电流	I_{DDC}	$T_{vj} = 175$ °C, $V_{GS} = 18$ V	$T_F = 50$ °C	500	A
漏极重复峰值电流	I_{DRM}	verified by design, t_p limited by T_{vjmax}		1000	A
栅-源瞬态最大电压	V_{GS}	$D < 0.01$		-10/23	V
栅-源稳态最大电压	V_{GS}			-7/20	V

表 4 推荐值

特征参数	代号	标注或测试条件	**[ZH]Values**	单位
通态栅极电压	$V_{GS(on)}$		15...18	V
断态栅极电压	$V_{GS(off)}$		-5...0	V

表 5 特征值

特征参数	代号	标注或测试条件		数值			单位
				最小值	典型值	最大值	
漏源通态电阻	$R_{DS(on)}$	$I_D = 500$ A	$V_{GS} = 15$ V, $T_{vj} = 25$ °C		1.75		mΩ
			$V_{GS} = 18$ V, $T_{vj} = 25$ °C		1.46	1.91	
			$V_{GS} = 18$ V, $T_{vj} = 125$ °C		2.36		
			$V_{GS} = 18$ V, $T_{vj} = 175$ °C		3.13		
栅极阈值电压	$V_{GS(th)}$	$I_D = 224$ mA, $V_{DS} = V_{GS}$, $T_{vj} = 25$ °C, (tested after 1ms pulse at $V_{GS} = +20$ V)		3.45	4.3	5.15	V
栅极电荷	Q_G	$V_{DD} = 800$ V, $V_{GS} = -3/18$ V, $T_{vj} = 25$ °C			1.6		µC
内部栅极电阻	R_{Gint}	$T_{vj} = 25$ °C			0.9		Ω
输入电容	C_{ISS}	$f = 100$ kHz, $V_{DS} = 800$ V, $V_{GS} = 0$ V	$T_{vj} = 25$ °C		48.4		nF
输出电容	C_{OSS}	$f = 100$ kHz, $V_{DS} = 800$ V, $V_{GS} = 0$ V	$T_{vj} = 25$ °C		2.4		nF
反向传输电容	C_{rss}	$f = 100$ kHz, $V_{DS} = 800$ V, $V_{GS} = 0$ V	$T_{vj} = 25$ °C		0.158		nF
C_{OSS} 存储能量	E_{OSS}	$V_{DS} = 800$ V, $V_{GS} = -3/18$ V, $T_{vj} = 25$ °C			945		µJ
漏源泄漏电流	I_{DSS}	$V_{DS} = 1200$ V, $V_{GS} = -3$ V	$T_{vj} = 25$ °C		0.32	660	µA

(待续)

表 5 **(续) 特征值**

特征参数	代号	标注或测试条件		数值			单位
				最小值	典型值	最大值	
栅极漏电流	I_{GSS}	V_{DS} = 0 V, T_{vj} = 25 °C	V_{GS} = 20 V			400	nA
开通延迟时间(感性负载)	$t_{d\,on}$	I_D = 500 A, R_{Gon} = 6.8 Ω, V_{DD} = 600 V, V_{GS} = -3/18 V, t_{dead} = 1000 ns	T_{vj} = 25 °C		156		ns
			T_{vj} = 125 °C		172		
			T_{vj} = 175 °C		182		
上升时间(感性负载)	t_r	I_D = 500 A, R_{Gon} = 6.8 Ω, V_{DD} = 600 V, V_{GS} = -3/18 V, t_{dead} = 1000 ns	T_{vj} = 25 °C		261		ns
			T_{vj} = 125 °C		243		
			T_{vj} = 175 °C		238		
关断延迟时间(感性负载)	$t_{d\,off}$	I_D = 500 A, R_{Goff} = 3.9 Ω, V_{DD} = 600 V, V_{GS} = -3/18 V	T_{vj} = 25 °C		276		ns
			T_{vj} = 125 °C		305		
			T_{vj} = 175 °C		319		
下降时间(感性负载)	t_f	I_D = 500 A, R_{Goff} = 3.9 Ω, V_{DD} = 600 V, V_{GS} = -3/18 V	T_{vj} = 25 °C		74		ns
			T_{vj} = 125 °C		76		
			T_{vj} = 175 °C		77		
开通损耗能量 (每脉冲)	E_{on}	I_D = 500 A, V_{DD} = 600 V, $L_σ$ = 8 nH, V_{GS} = -3/18 V, R_{Gon} = 6.8 Ω, di/dt = 4.7 kA/µs (T_{vj} = 175 °C), t_{dead} = 1000 ns	T_{vj} = 25 °C		40.2		mJ
			T_{vj} = 125 °C		38.3		
			T_{vj} = 175 °C		39		
开通损耗能量 (每脉冲), 优化条件下	$E_{on,o}$	I_D = 500 A, V_{DD} = 600 V, $L_σ$ = 8 nH, V_{GS} = -3/18 V, $R_{Gon,o}$ = 2.4 Ω, di/dt = 9.3 kA/µs (T_{vj} = 175 °C), t_{dead} = 200 ns	T_{vj} = 25 °C		16.8		mJ
			T_{vj} = 125 °C		17.1		
			T_{vj} = 175 °C		18.1		
关断损耗能量 (每脉冲）	E_{off}	I_D = 500 A, V_{DD} = 600 V, $L_σ$ = 8 nH, V_{GS} = -3/18 V, R_{Goff} = 3.9 Ω, dv/dt = 6.2 kV/µs (T_{vj} = 175 °C)	T_{vj} = 25 °C		20.4		mJ
			T_{vj} = 125 °C		21.6		
			T_{vj} = 175 °C		22.2		
结一冷媒热阻 1)	R_{thJF}	每个 MOSFET, ΔV/Δt = 10.0 dm^3/min, 冷却剂 = 50% water / 50% ethylenglycol, T_F = 60 °C			0.12		K/W
允许开关的温度范围	$T_{vj\,op}$			-40		175	°C

1) Typical R_{thJF} value using the heat sink described in AN-2022-05

注: *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.*

Tvj op > 150°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)

表 6 最大标定值

特征参数	代号	标注或测试条件		数值	单位
体二极管正向直流电流	I_{SD}	T_{vj} = 175 °C, V_{GS} = -3 V	T_F = 25 °C	295	A

表 7 特征值

特征参数	代号	标注或测试条件		数值			单位
				最小值	典型值	最大值	
正向电压	V_{SD}	I_{SD} = 500 A, V_{GS} = -3 V	T_{vj} = 25 °C		4.14	5.2	V
			T_{vj} = 125 °C		3.88		
			T_{vj} = 175 °C		3.78		
反向恢复峰值电流	I_{rrm}	I_{SD} = 500 A, di_S/dt = 4.7 kA/µs, V_{DD} = 600 V, V_{GS}=-3 V, t_{dead} = 1000 ns	T_{vj} = 25 °C		76		A
			T_{vj} = 125 °C		114		
			T_{vj} = 175 °C		148		
恢复电荷	Q_{rr}	I_{SD} = 500 A, di_S/dt = 4.7 kA/µs, V_{DD} = 600 V, V_{GS}=-3 V, t_{dead} = 1000 ns	T_{vj} = 25 °C		3.7		µC
			T_{vj} = 125 °C		4.9		
			T_{vj} = 175 °C		7		
反向恢复损耗（每脉冲）	E_{rec}	I_{SD} = 500 A, di_S/dt = 4.7 kA/µs (T_{vj} = 175 °C), V_{DD} = 600 V, V_{GS}=-3 V, t_{dead} = 1000 ns	T_{vj} = 25 °C		0.12		mJ
			T_{vj} = 125 °C		0.37		
			T_{vj} = 175 °C		0.67		
反向恢复损耗（每脉冲），优化条件下	$E_{rec,o}$	I_{SD} = 500 A, di_S/dt = 9.3 kA/µs (T_{vj} = 175 °C), V_{DD} = 600 V, V_{GS} = -3 V, t_{dead} = 200 ns	T_{vj} = 25 °C		1.3		mJ
			T_{vj} = 125 °C		3.8		
			T_{vj} = 175 °C		5.3		

4 负温度系数热敏电阻

表 8 特征值

特征参数	代号	标注或测试条件	数值			单位
			最小值	典型值	最大值	
额定电阻值	R_{25}	T_{NTC} = 25 °C		5		kΩ

(待续)

表 8 (续) 特征值

特征参数	代号	标注或测试条件	数值			单位
			最小值	典型值	最大值	
R_{100} 偏差	$\Delta R/R$	T_{NTC} = 100 °C, R_{100} = 493 Ω	-5		5	%
耗散功率	P_{25}	T_{NTC} = 25 °C			20	mW
B-值	$B_{25/50}$	$R_2 = R_{25}\ \exp[B_{25/50}(1/T_2-1/(298{,}15\ K))]$		3375		K
B-值	$B_{25/80}$	$R_2 = R_{25}\ \exp[B_{25/80}(1/T_2-1/(298{,}15\ K))]$		3411		K
B-值	$B_{25/100}$	$R_2 = R_{25}\ \exp[B_{25/100}(1/T_2-1/(298{,}15\ K))]$		3433		K

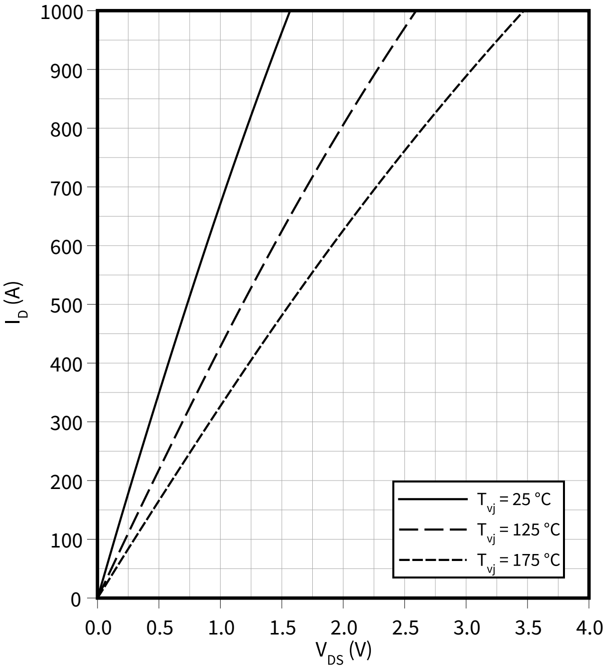
注: NTC 的具体参数分析请见 AN2009-10, 第 4 章

5 特征参数图表

输出特性 （典型), MOSFET, T1 / T2

$I_D = f(V_{DS})$

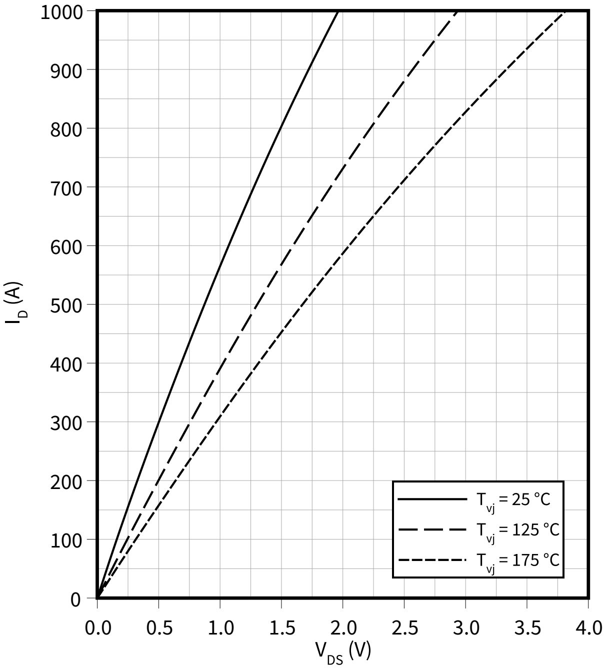
$V_{GS} = 18$ V



输出特性 （典型), MOSFET, T1 / T2

$I_D = f(V_{DS})$

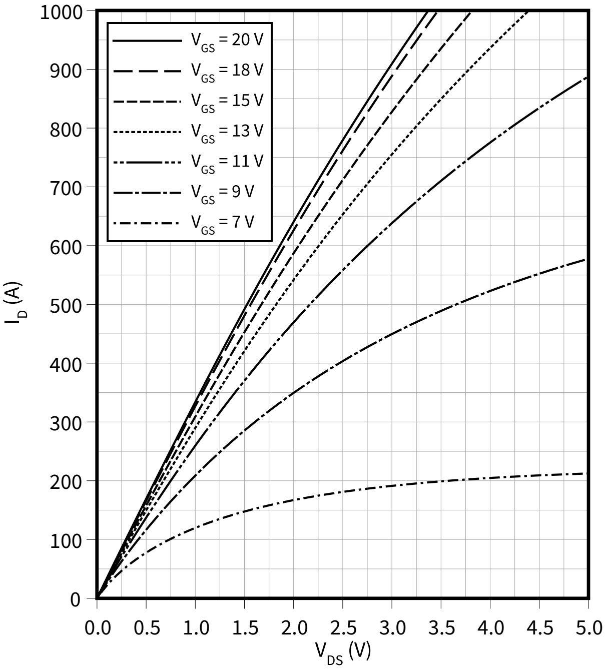
$V_{GS} = 15$ V



输出特性 （典型), MOSFET, T1 / T2

$I_D = f(V_{DS})$

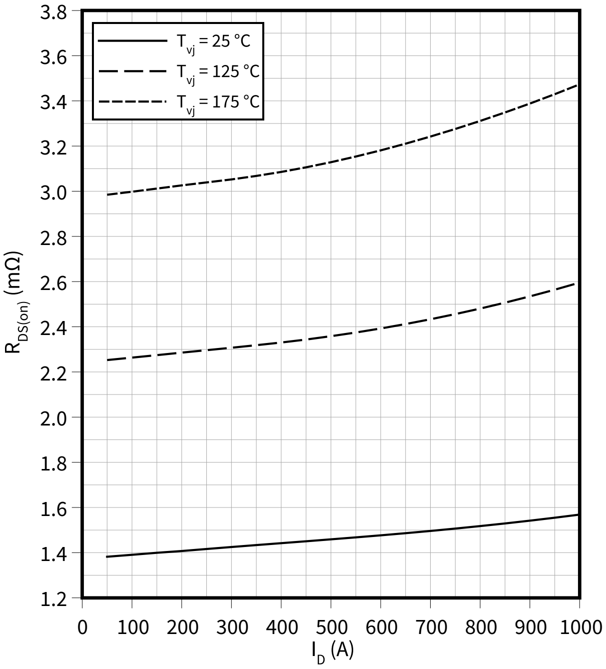
$T_{vj} = 175$ °C



漏源通态电阻 （典型), MOSFET, T1 / T2

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

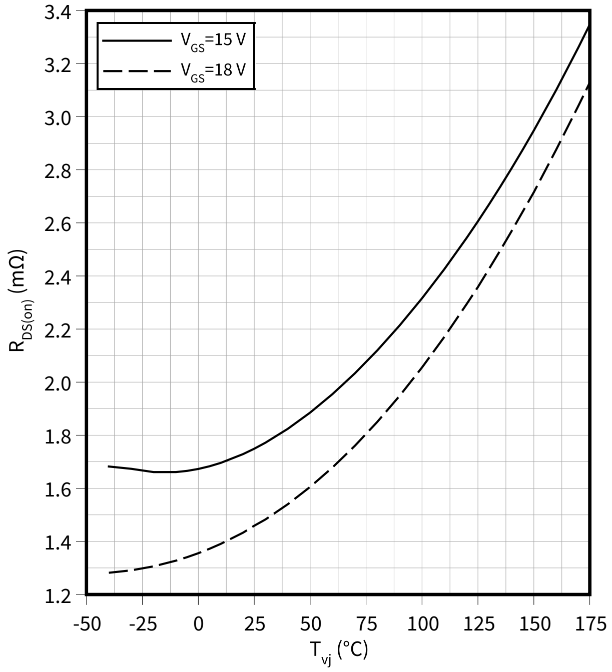
$V_{GS} = 18$ V



漏源通态电阻 （典型), MOSFET, T1 / T2

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

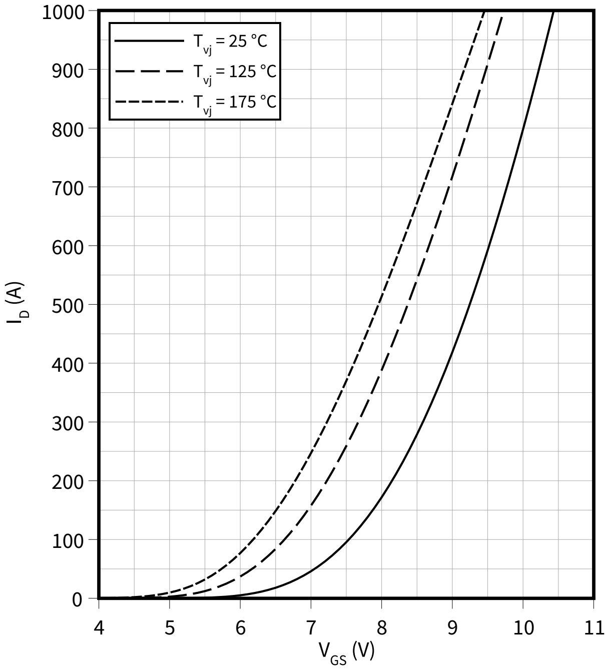
$I_D = 500$ A



传输特性 （典型), MOSFET, T1 / T2

$I_D = f(V_{GS})$

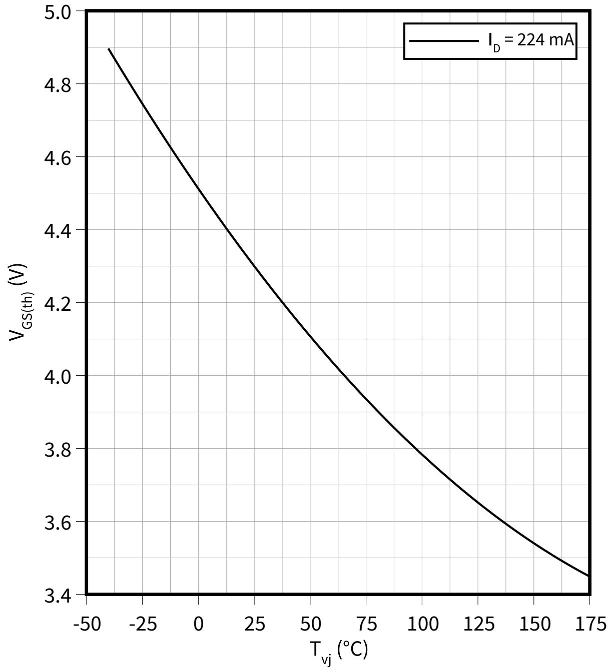
$V_{DS} = 20$ V



栅-源阀值电压（典型）, MOSFET, T1 / T2

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

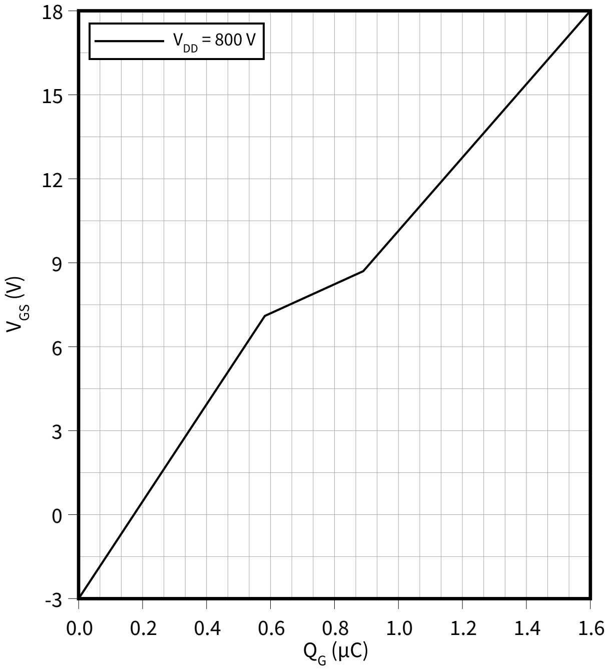
$V_{GS} = V_{DS}$



栅极电荷特性 （典型), MOSFET, T1 / T2

$V_{GS} = f(Q_G)$

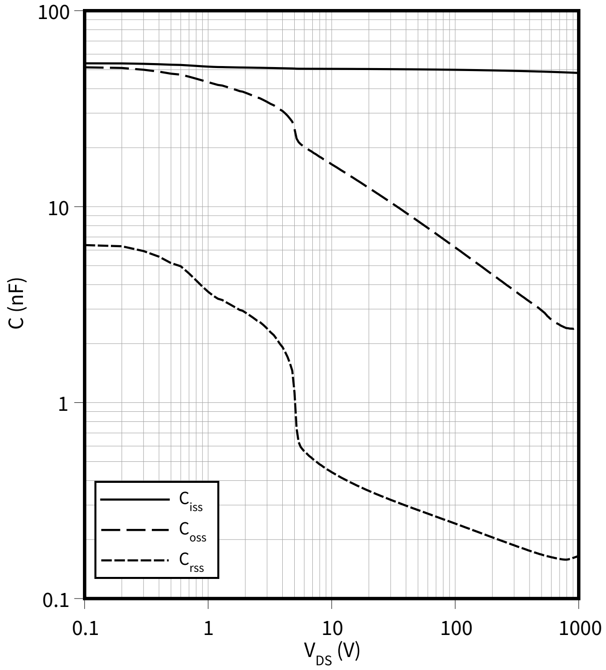
$I_D = 500$ A, $T_{vj} = 25$ °C



电容特性 （典型), **MOSFET, T1 / T2**

$C = f(V_{DS})$

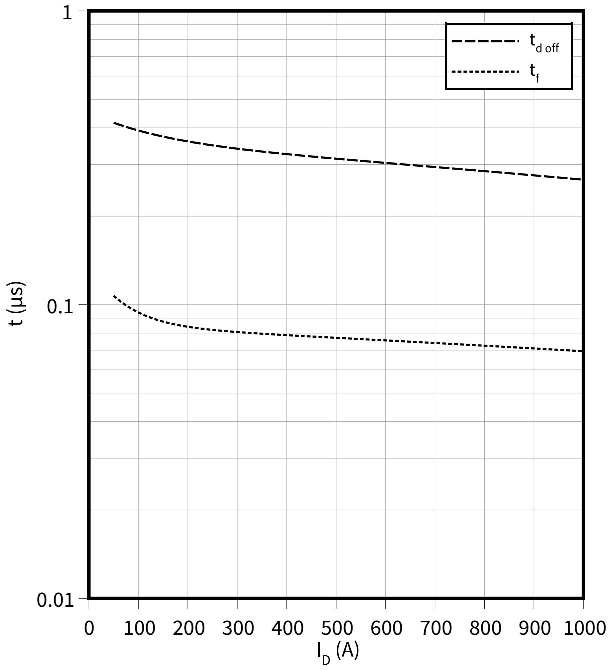
$T_{vj} = 25$ °C, $V_{GS} = 0$ V, f = 100 kHz



开关时间 （典型), **MOSFET, T1 / T2**

$t = f(I_D)$

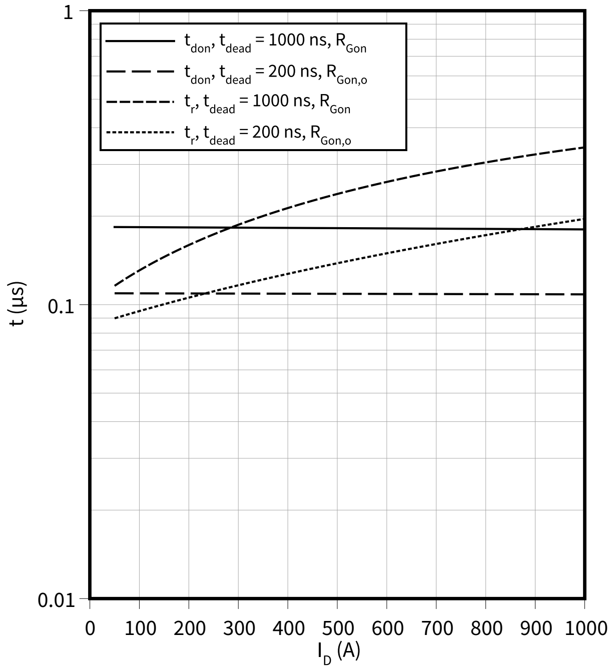
$R_{Goff} = 3.9\ \Omega$, $V_{DD} = 600$ V, $T_{vj} = 175$ °C, $V_{GS} = -3/18$ V



开关时间 （典型), **MOSFET, T1 / T2**

$t = f(I_D)$

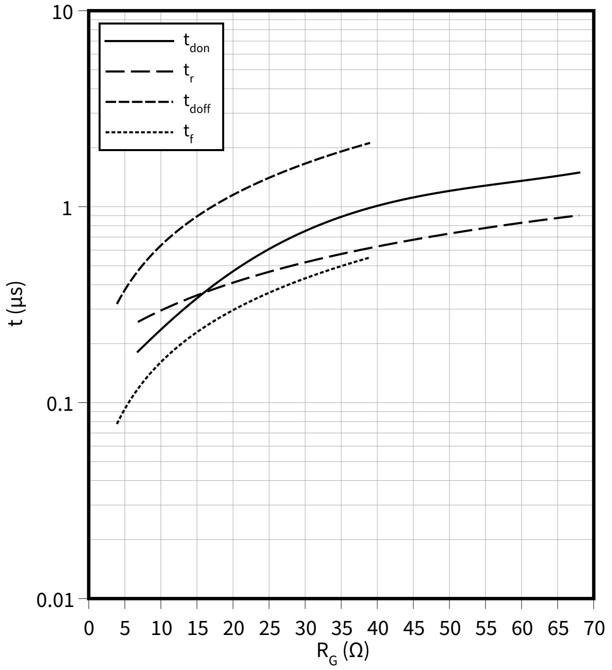
$V_{DD} = 600$ V, $R_{Gon} = 6.8\ \Omega$, $R_{Gon,o} = 2.4\ \Omega$, $T_{vj} = 175$ °C, $V_{GS} = -3/18$ V



开关时间 （典型), **MOSFET, T1 / T2**

$t = f(R_G)$

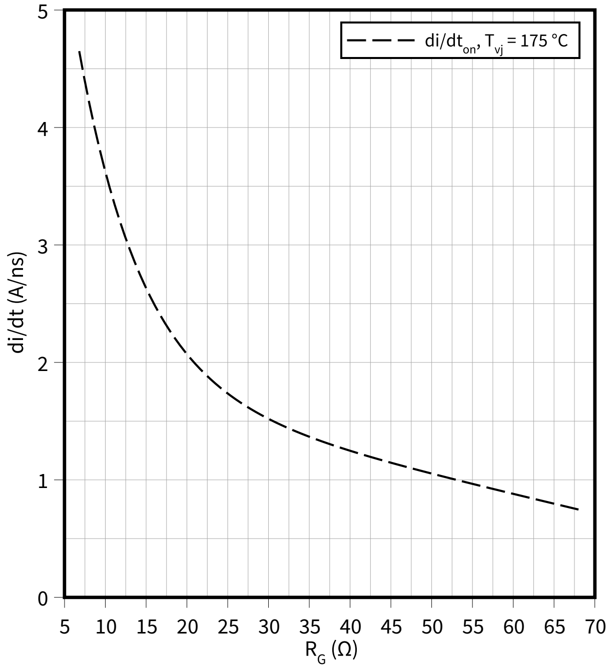
$V_{DD} = 600$ V, $t_{dead} = 1000$ ns, $I_D = 500$ A, $T_{vj} = 175$ °C, $V_{GS} = -3/18$ V



电流变化斜率 （典型), **MOSFET, T1 / T2**

di/dt = f(R_G)

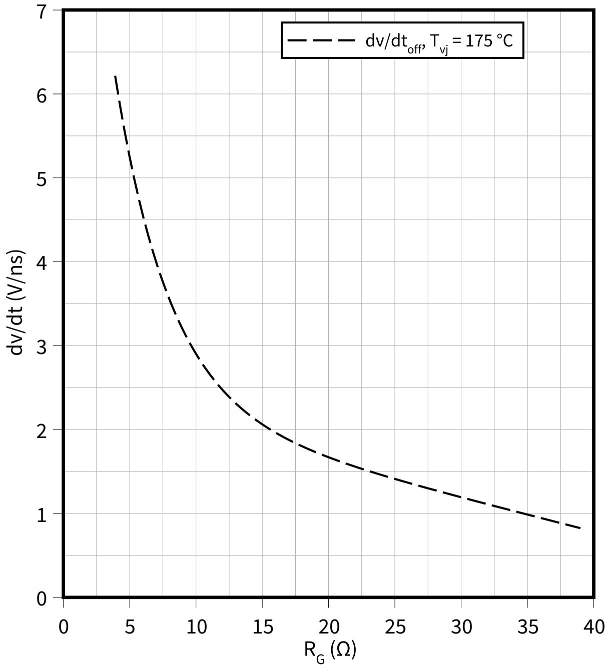
V_{DD} = 600 V, I_D = 500 A, V_{GS} = -3/18 V



电压变化斜率 （典型), **MOSFET, T1 / T2**

dv/dt = f(R_G)

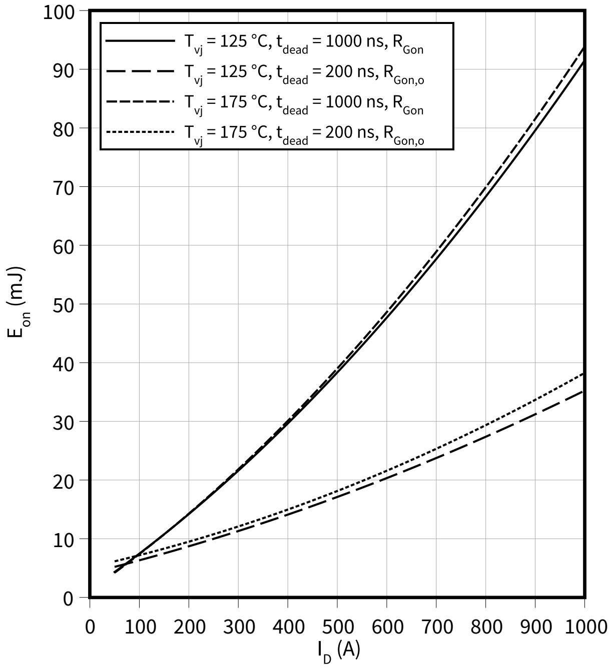
V_{DD} = 600 V, I_D = 500 A, V_{GS} = -3/18 V



开关损耗 （典型), **MOSFET, T1 / T2**

E_{on} = f(I_D)

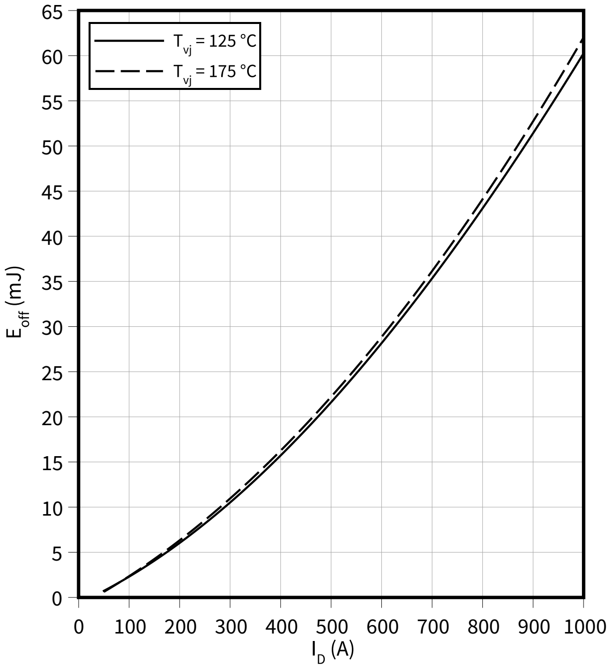
V_{DD} = 600 V, R_{Gon} = 6.8 Ω, $R_{Gon,o}$ = 2.4 Ω, V_{GS} = -3/18 V



开关损耗 （典型), **MOSFET, T1 / T2**

E_{off} = f(I_D)

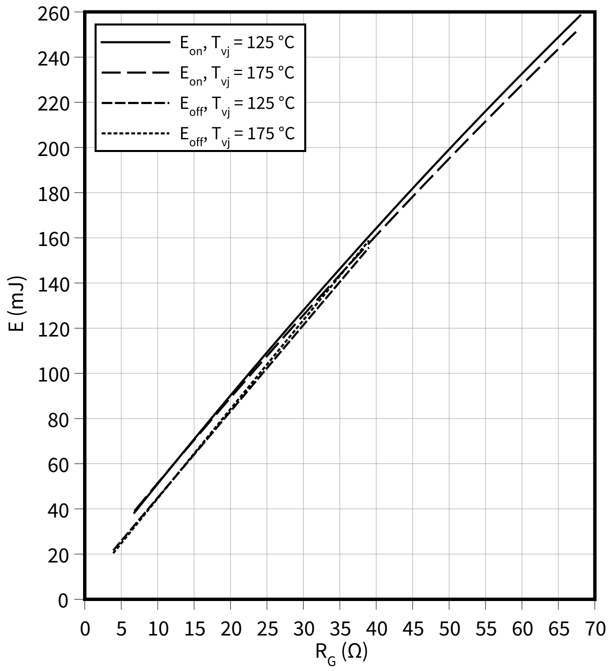
R_{Goff} = 3.9 Ω, V_{DD} = 600 V, V_{GS} = -3/18 V



开关损耗 （典型), **MOSFET, T1 / T2**

$E = f(R_G)$

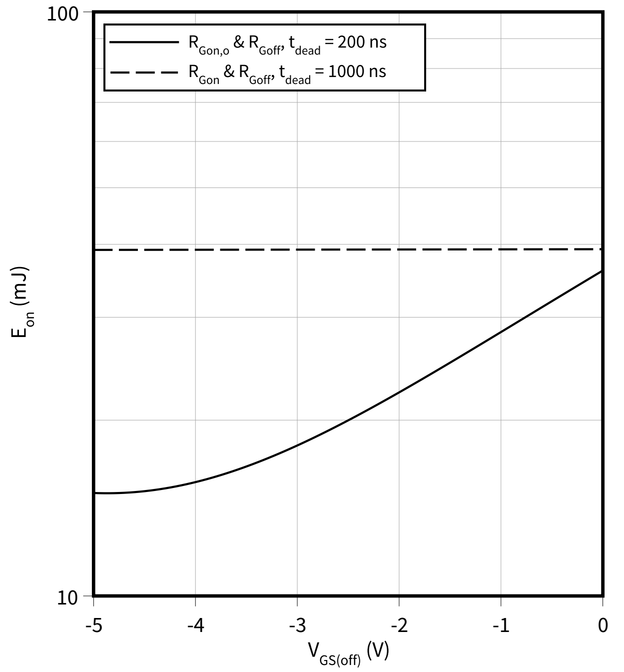
$V_{DD} = 600$ V, $t_{dead} = 1000$ ns, $I_D = 500$ A, $V_{GS} = -3/18$ V



开关损耗 （典型), **MOSFET, T1 / T2**

$E_{on} = f(V_{GS(off)})$

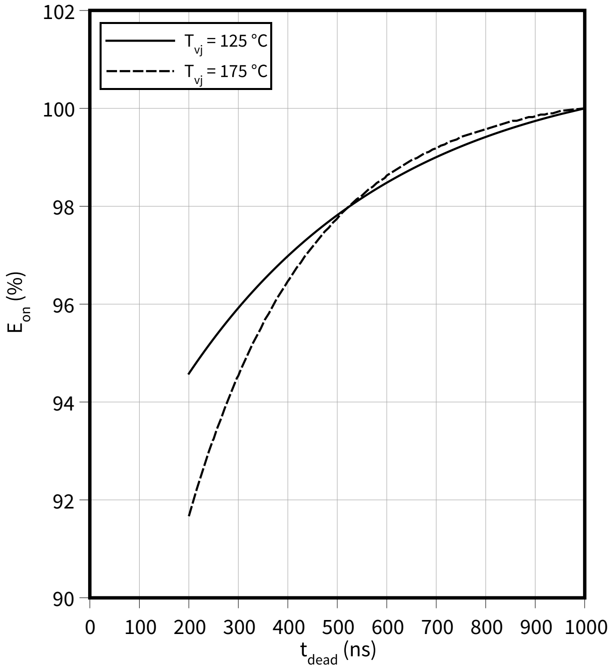
$R_{Goff} = 3.9$ Ω, $V_{DD} = 600$ V, $R_{Gon} = 6.8$ Ω, $V_{GS(on)} = 18$ V, $I_D = 500$ A, $R_{Gon,o} = 2.4$ Ω, $T_{vj} = 175$ °C



开关损耗 （典型), **MOSFET, T1 / T2**

$E_{on} = f(t_{dead})$

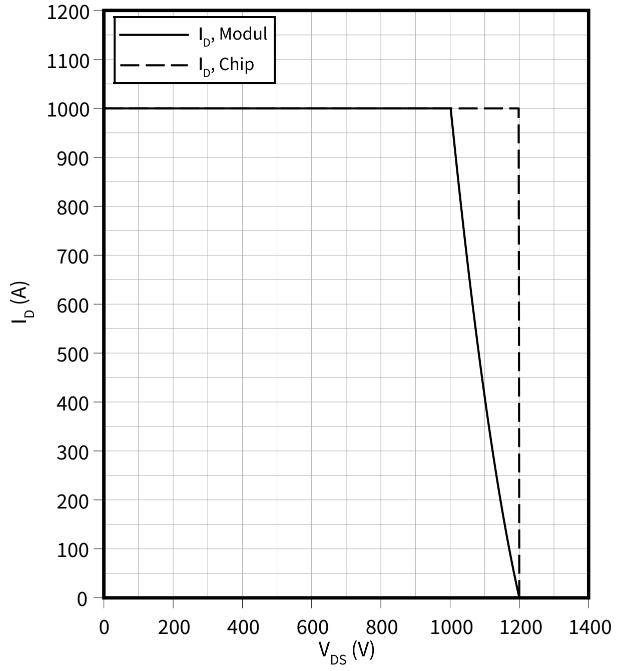
$R_{Gon} = 6.8$ Ω, $I_D = 500$ A, $V_{DD} = 600$ V, $V_{GS} = -3/18$ V



反偏安全工作区 （**RBSOA**）, **MOSFET, T1 / T2**

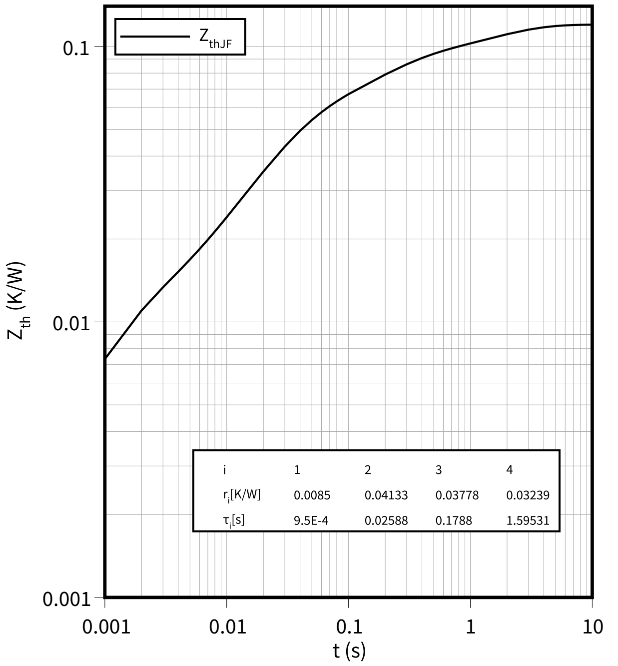
$I_D = f(V_{DS})$

$R_{Goff} = 3.9$ Ω, $T_{vj} = 175$ °C, $V_{GS} = -3/18$ V



瞬态热阻抗, MOSFET, T1 / T2

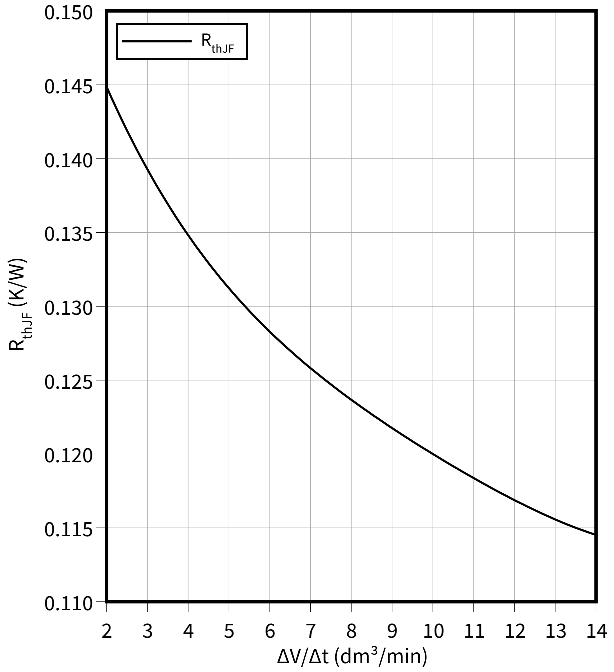
$Z_{th} = f(t)$



i	1	2	3	4
r_i[K/W]	0.0085	0.04133	0.03778	0.03239
τ_i[s]	9.5E-4	0.02588	0.1788	1.59531

热阻抗, MOSFET, T1 / T2

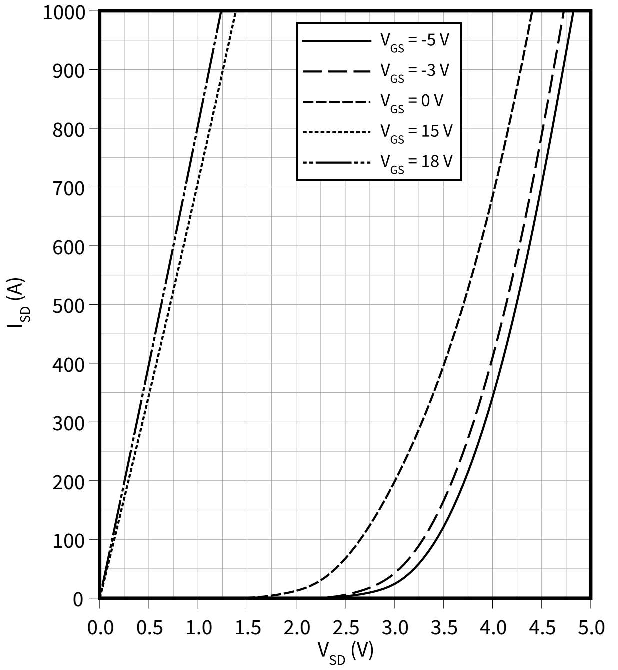
$R_{thJF} = f(\Delta V/\Delta t)$



正向特性 体二极管（典型), MOSFET, T1 / T2

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

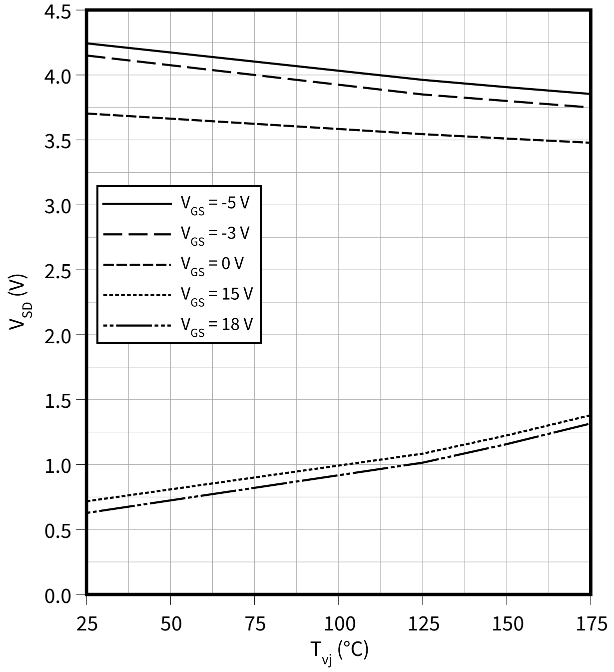
$T_{vj} = 25$ °C



体二极管正向压降（典型), MOSFET, T1 / T2

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

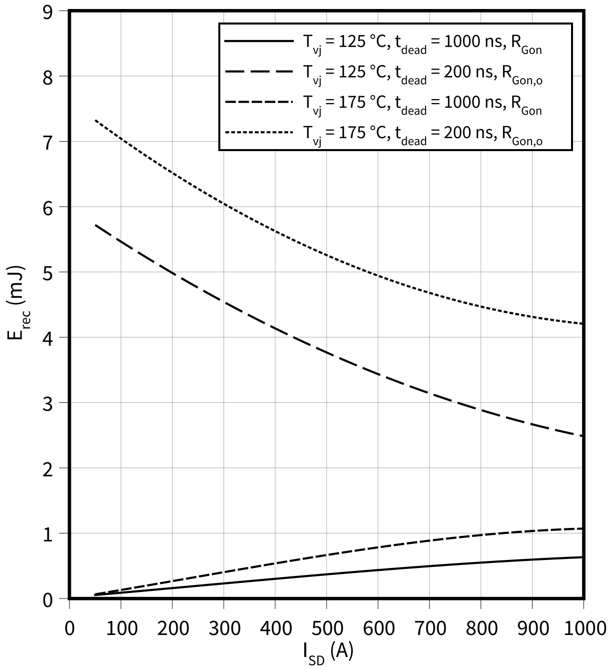
$I_{SD} = 500$ A



开关损耗 体二极管（典型), **MOSFET, T1 / T2**

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

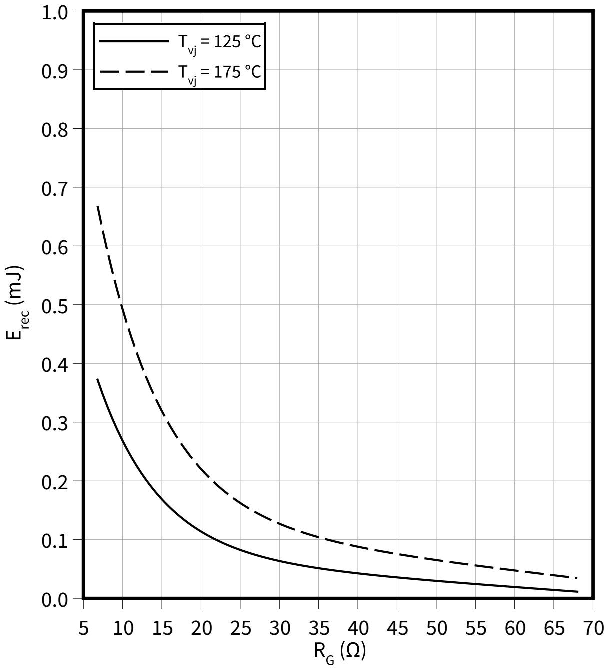
$R_{Gon} = 6.8\ \Omega$, $R_{Gon,o} = 2.4\ \Omega$, $V_{DD} = 600\ V$



开关损耗 体二极管（典型), **MOSFET, T1 / T2**

$E_{rec} = f(R_G)$

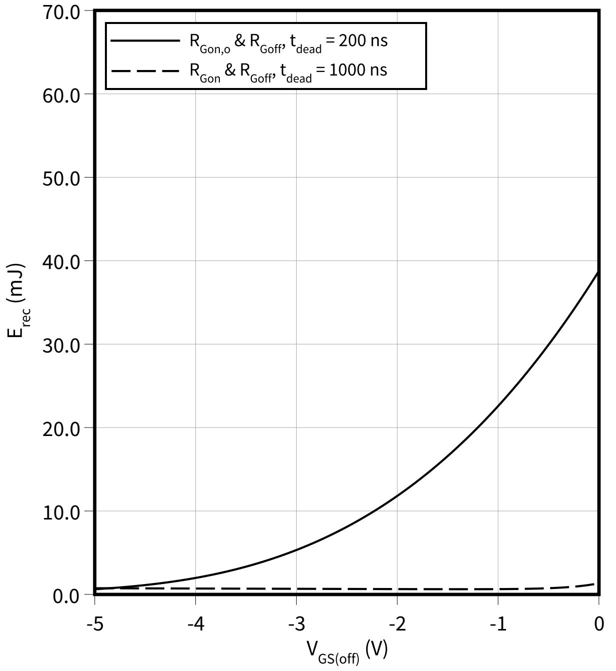
$t_{dead} = 1000\ ns$, $I_{SD} = 500\ A$, $V_{DD} = 600\ V$



开关损耗 体二极管（典型), **MOSFET, T1 / T2**

$E_{rec} = f(V_{GS(off)})$

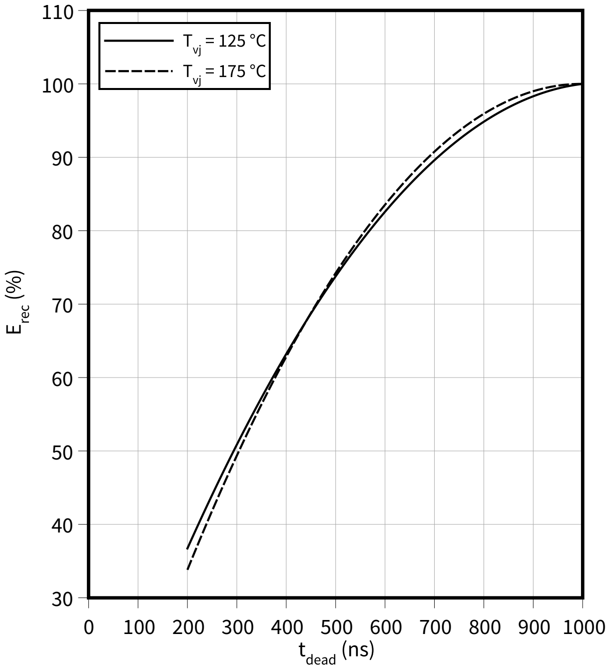
$R_{Goff} = 3.9\ \Omega$, $R_{Gon} = 6.8\ \Omega$, $V_{GS(on)} = 18\ V$, $I_{SD} = 500\ A$, $R_{Gon,o} = 2.4\ \Omega$, $V_{DD} = 600\ V$, $T_{vj} = 175\ °C$



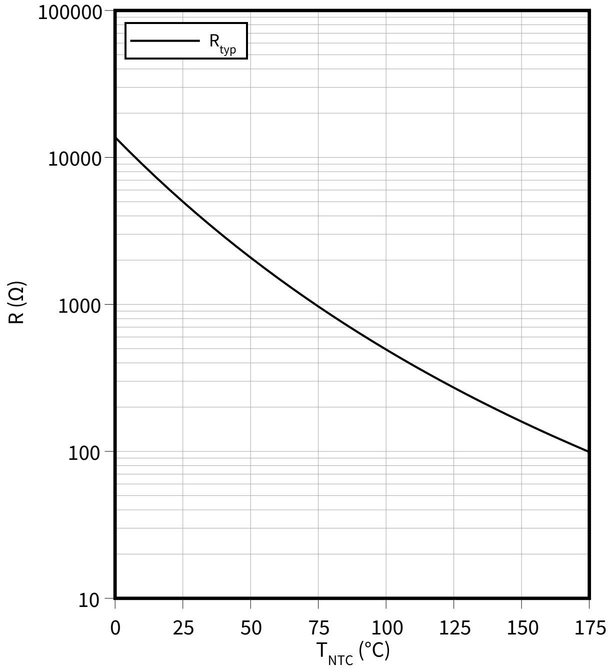
开关损耗 体二极管（典型), **MOSFET, T1 / T2**

$E_{rec} = f(t_{dead})$

$R_{Gon} = 6.8\ \Omega$, $I_D = 500\ A$, $V_{DD} = 600\ V$, $V_{GS} = -3/18\ V$



温度特性, 负温度系数热敏电阻
R = f(T_{NTC})



6 电路拓扑图

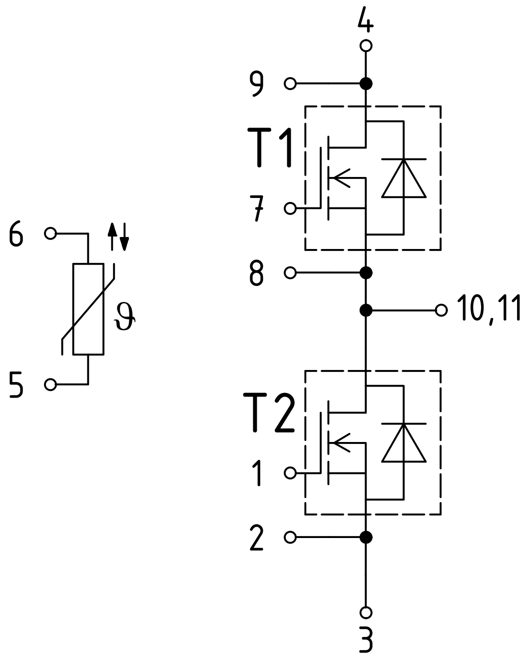
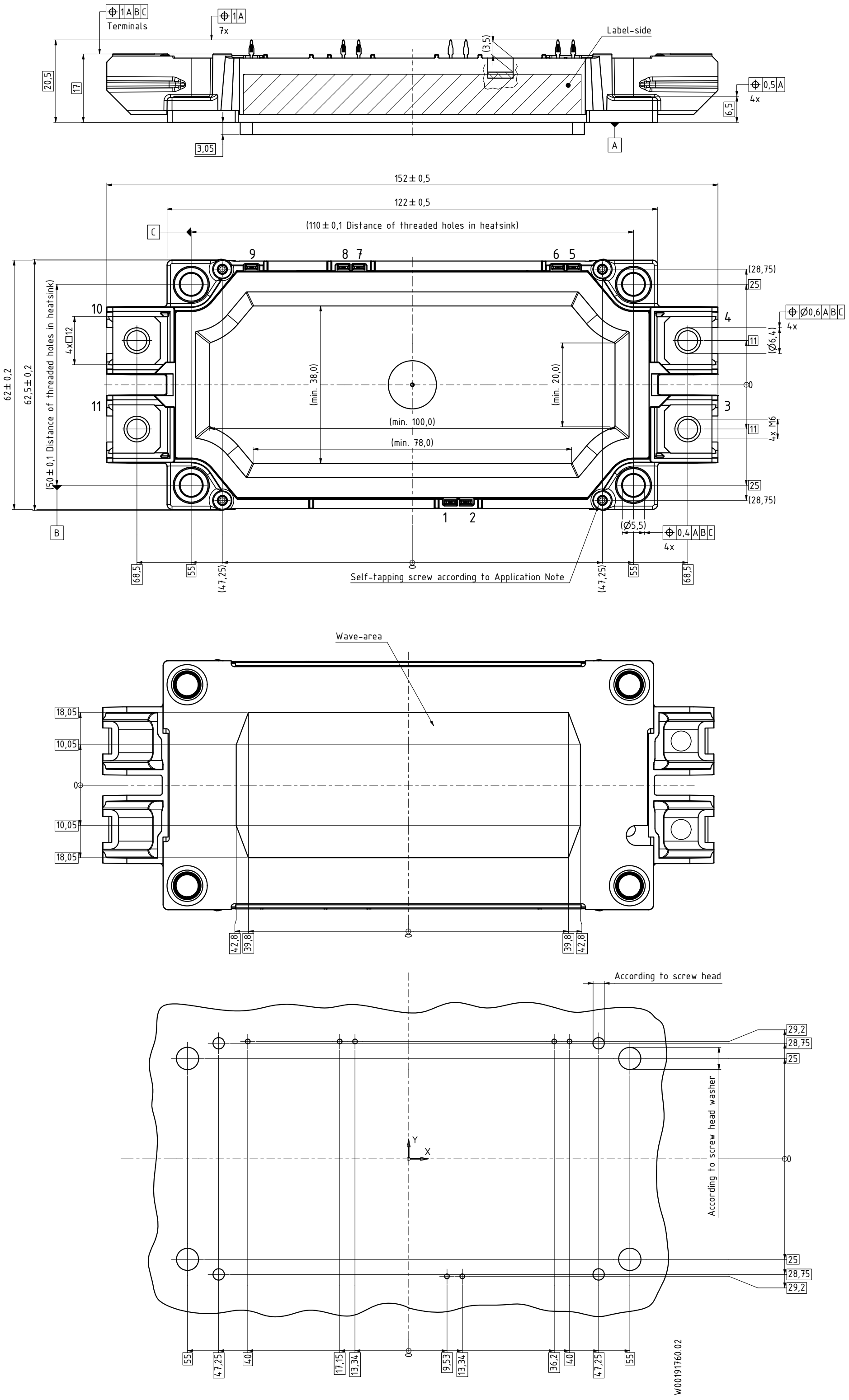


图 1

7 封装尺寸



Tolerance of PCB hole pattern ⌖ Ø 0,05

For PressFIT pin and solder pin: Details about hole specification for contacts refer to AN2006-05

Dimensions according to ISO 14405 (GG) (Method of least squares (LSQ)).
ISO 8015 - Independency principle

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*	*Digit*	*Example*
	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	

图 3

修订历史

修订版本	发布日期	变更说明
0.10	2024-12-02	Preliminary datasheet
1.00	2025-03-06	Final datasheet
1.10	2025-07-25	Final datasheet

Trademarks

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