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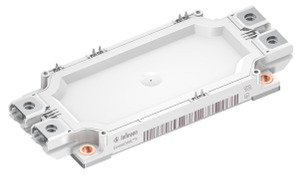
FF1MR12MM1H_B11

EconoDUAL™3 module

Final datasheet

EconoDUAL™3 module with CoolSiC™ Trench MOSFET and PressFIT / NTC

Features



- Electrical features
  - V_{DSS} = 1200 V
  - I_{DN} = 500 A / I_{DRM} = 1000 A
  - Integrated temperature sensor
  - Suitable Infineon gate drivers can be found under https://www.infineon.com/gdfinder
- Mechanical features
  - Standard housing
  - PressFIT contact technology
  - Isolated base plate
  - High power density

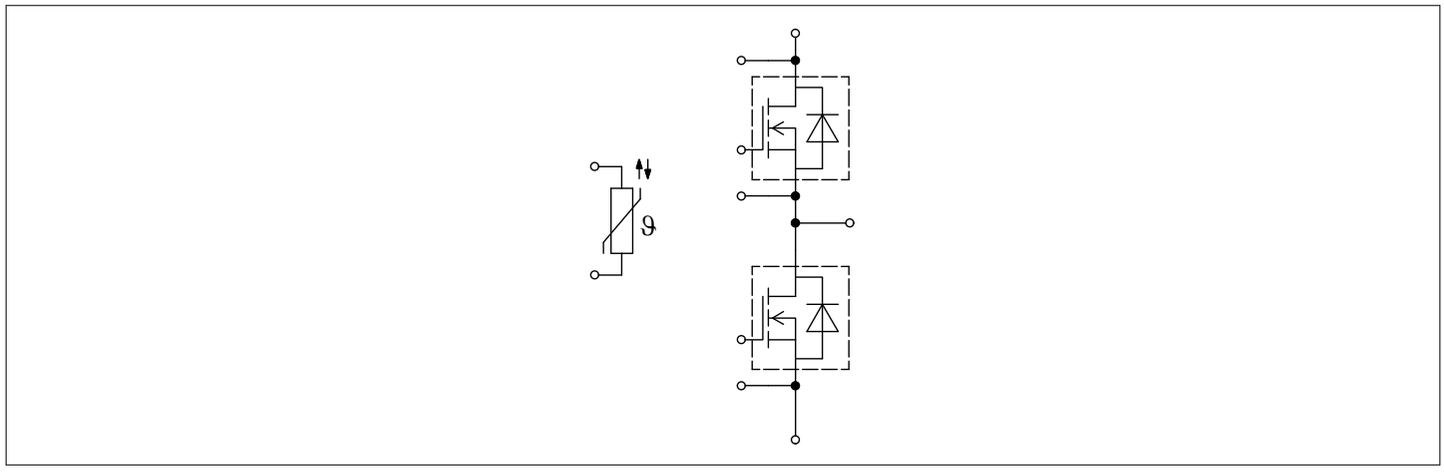
Potential applications

- Construction, commercial, and agriculture vehicles
- Wind turbines
- Motor drives
- UPS systems
- 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 Hz, *t* = 1 min	3.4	kV
Isolation test voltage NTC	$V_{ISOL(NTC)}$	RMS, f = 50 Hz, *t* = 1 min	3.4	kV
Material of module baseplate			Cu	
Internal isolation		basic insulation (class 1, IEC 61140)	Al_2O_3	
Creepage distance	$d_{Creep\ nom}$	terminal to baseplate, nom., (PD2, IEC 60664-1, Ed. 3.0)	> 15	mm
Creepage distance	$d_{Creep\ min}$	terminal to baseplate, min., (PD2, IEC 60664-1, Ed. 3.0)	14.7	mm
Creepage distance	$d_{Creep\ nom}$	terminal to terminal, nom., (PD2, IEC 60664-1, Ed. 3.0)	12.1	mm
Creepage distance	$d_{Creep\ min}$	terminal to terminal, min., (PD2, IEC 60664-1, Ed. 3.0)	11.5	mm
Clearance	$d_{Clear\ nom}$	terminal to baseplate, nom.	> 12.5	mm
Clearance	$d_{Clear\ min}$	terminal to baseplate, min.	12.5	mm
Clearance	$d_{Clear\ nom}$	terminal to terminal, nom.	10.0	mm
Clearance	$d_{Clear\ min}$	terminal to terminal, min.	9.6	mm
Comparative tracking index	*CTI*		> 200	
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 °C, per switch			0.8		mΩ
Storage temperature	T_{stg}			-40		125	°C
Mounting torque for module mounting	*M*	- Mounting according to valid application note	M5, Screw	3		6	Nm
Terminal connection torque	*M*	- Mounting according to valid application note	M6, Screw	3		6	Nm
Weight	*G*				345		g

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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 °C	1200	V
Implemented drain current	I_{DN}			500	A
Continuous DC drain current	I_{DDC}	T_{vj} = 175 °C, V_{GS} = 18 V	T_C = 115 °C	420	A
Repetitive peak drain current	I_{DRM}	verified by design, t_p limited by T_{vjmax}		1000	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	$V_{GS(on)}$		15...18	V
Off-state gate voltage	$V_{GS(off)}$		-5...0	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 = 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		
Gate threshold voltage	$V_{GS(th)}$	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
Total gate charge	Q_G	V_{DD} = 800 V, V_{GS} = -3/18 V, T_{vj} = 25 °C			1.6		µC
Internal gate resistor	R_{Gint}	T_{vj} = 25 °C			0.9		Ω
Input capacitance	C_{ISS}	f = 100 kHz, V_{DS} = 800 V, V_{GS} = 0 V	T_{vj} = 25 °C		48.4		nF
Output capacitance	C_{OSS}	f = 100 kHz, V_{DS} = 800 V, V_{GS} = 0 V	T_{vj} = 25 °C		2.4		nF
Reverse transfer capacitance	C_{rss}	f = 100 kHz, V_{DS} = 800 V, V_{GS} = 0 V	T_{vj} = 25 °C		0.158		nF

(table continues...)

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Table 5 (continued) Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
C_{OSS} stored energy	E_{OSS}	V_{DS} = 800 V, V_{GS} = -3/18 V, T_{vj} = 25 °C			945		µJ
Drain-source leakage current	I_{DSS}	V_{DS} = 1200 V, V_{GS} = -3 V	T_{vj} = 25 °C		0.32	660	µA
Gate-source leakage current	I_{GSS}	V_{DS} = 0 V, T_{vj} = 25 °C	V_{GS} = 20 V			400	nA
Turn-on delay time (inductive load)	$t_{d\,on}$	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		
Rise time (inductive load)	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		
Turn-off delay time (inductive load)	$t_{d\,off}$	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		
Fall time (inductive load)	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		
Turn-on energy loss per pulse	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		
Turn-on energy loss per pulse, optimized	$E_{on,o}$	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		
Turn-off energy loss per pulse	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		
Thermal resistance, junction to case	R_{thJC}	per MOSFET				0.0820	K/W
Thermal resistance, case to heat sink	R_{thCH}	per MOSFET, λ_{grease}= 1 W /(m*K)			0.0300		K/W
Temperature under switching conditions	$T_{vj\,op}$			-40		175	°C

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***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.*

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)

Table 6 Maximum rated values

Parameter	Symbol	Note or test condition		Values	Unit
DC body diode forward current	I_{SD}	T_{vj} = 175 °C, V_{GS} = -3 V	T_C = 115 °C	200	A

Table 7 Characteristic values

Parameter	Symbol	Note or test condition		Values			Unit
				Min.	Typ.	Max.	
Forward voltage	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		
Peak reverse recovery current	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		
Recovered charge	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		
Reverse recovery energy	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		
Reverse recovery energy, optimized	$E_{rec,o}$	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 NTC-Thermistor

Table 8 Characteristic values

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	%

(table continues...)

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Table 8 (continued) Characteristic values

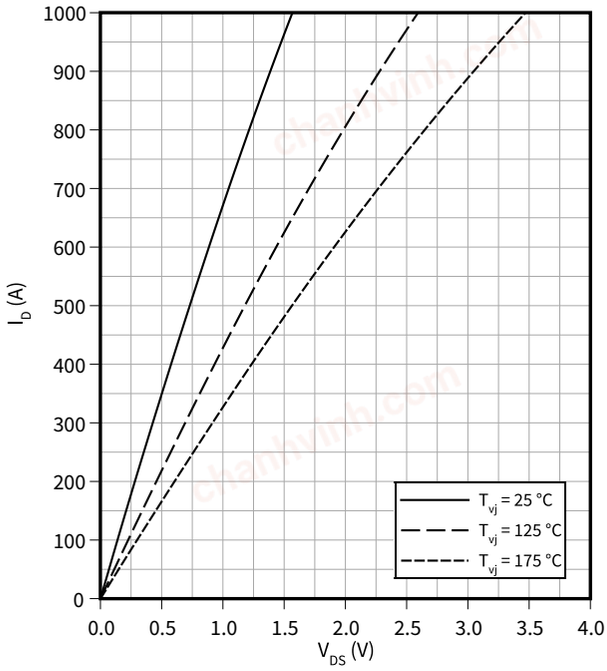
Parameter	Symbol	Note or test condition	Values			Unit
			Min.	Typ.	Max.	
Power dissipation	P_{25}	T_{NTC} = 25 °C			20	mW
B-value	$B_{25/50}$	$R_2 = R_{25} \exp[B_{25/50}(1/T_2-1/(298{,}15\ K))]$		3375		K
B-value	$B_{25/80}$	$R_2 = R_{25} \exp[B_{25/80}(1/T_2-1/(298{,}15\ K))]$		3411		K
B-value	$B_{25/100}$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

***Note**: For an analytical description of the NTC characteristics please refer to AN2009-10, chapter 4.*

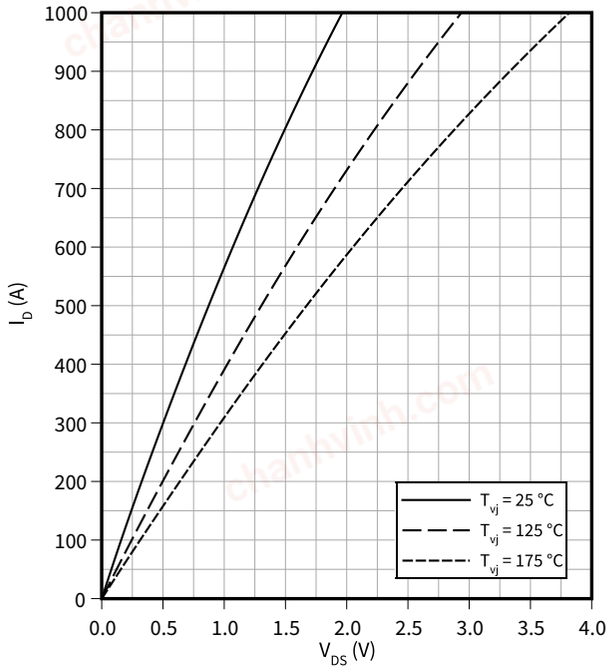
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5 Characteristics diagrams

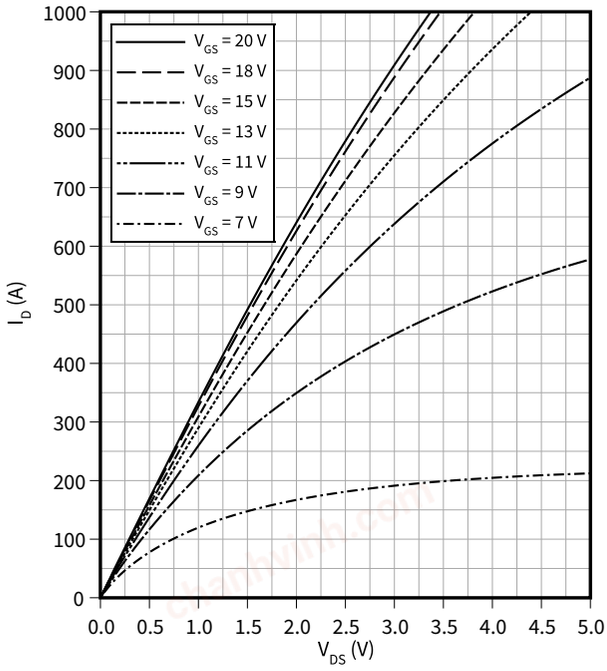
Output characteristic (typical), MOSFET, T1 / T2
$I_D = f(V_{DS})$
V_{GS} = 18 V



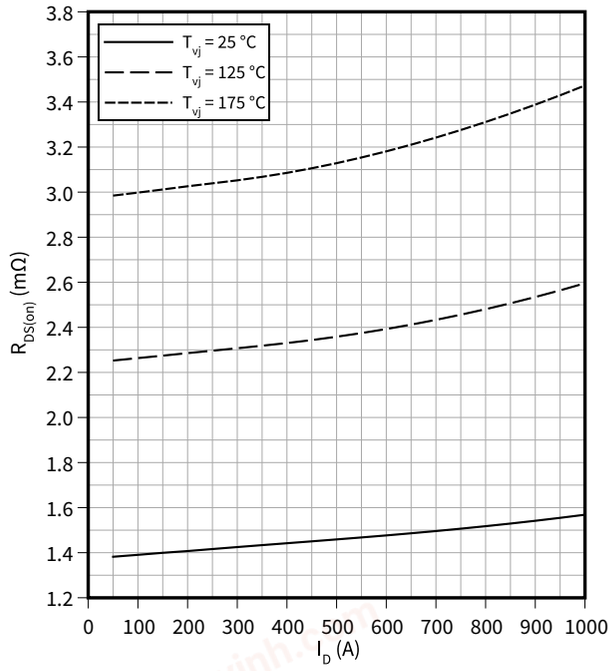
Output characteristic (typical), MOSFET, T1 / T2
$I_D = f(V_{DS})$
V_{GS} = 15 V



Output characteristic field (typical), MOSFET, T1 / T2
$I_D = f(V_{DS})$
T_{vj} = 175 °C



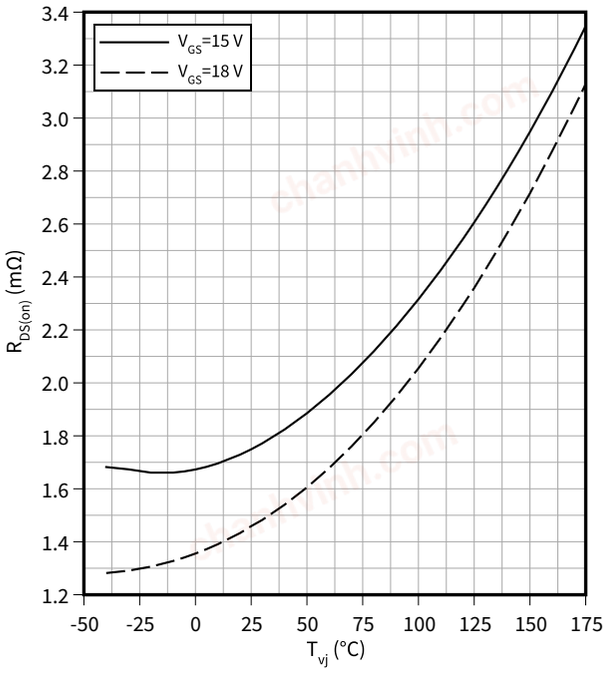
Drain source on-resistance (typical), MOSFET, T1 / T2
$R_{DS(on)} = f(I_D)$
V_{GS} = 18 V



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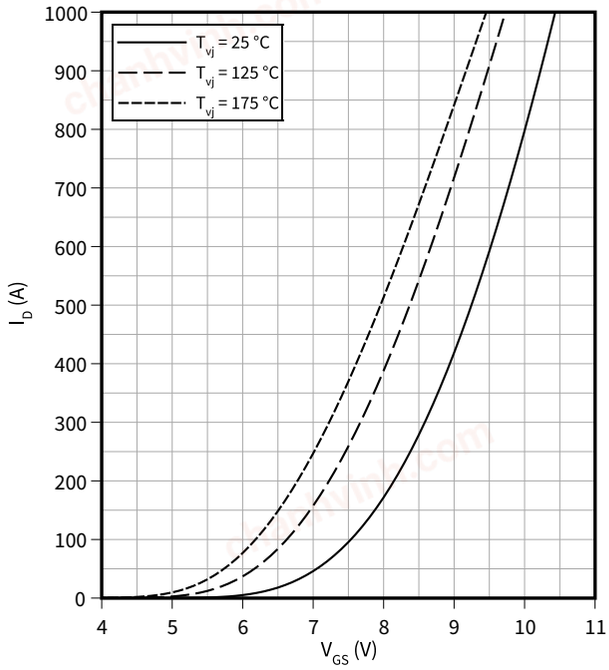
Drain source on-resistance (typical), MOSFET, T1 / T2

$R_{DS(on)} = f(T_{vj})$
$I_D = 500$ A



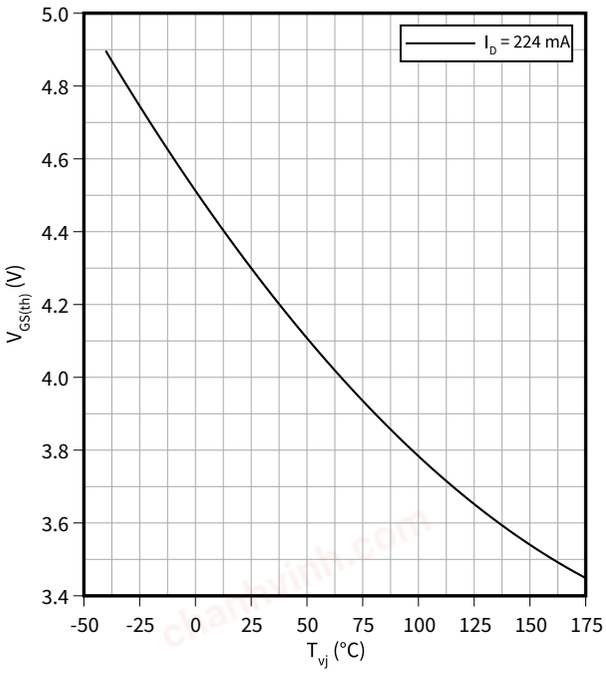
Transfer characteristic (typical), MOSFET, T1 / T2

$I_D = f(V_{GS})$
$V_{DS} = 20$ V



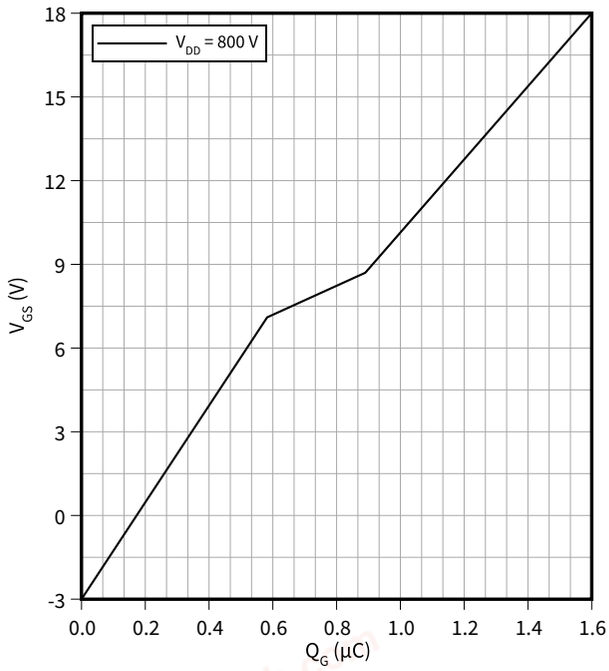
Gate-source threshold voltage (typical), MOSFET, T1 / T2

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



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

$V_{GS} = f(Q_G)$
$I_D = 500$ A, $T_{vj} = 25$ °C



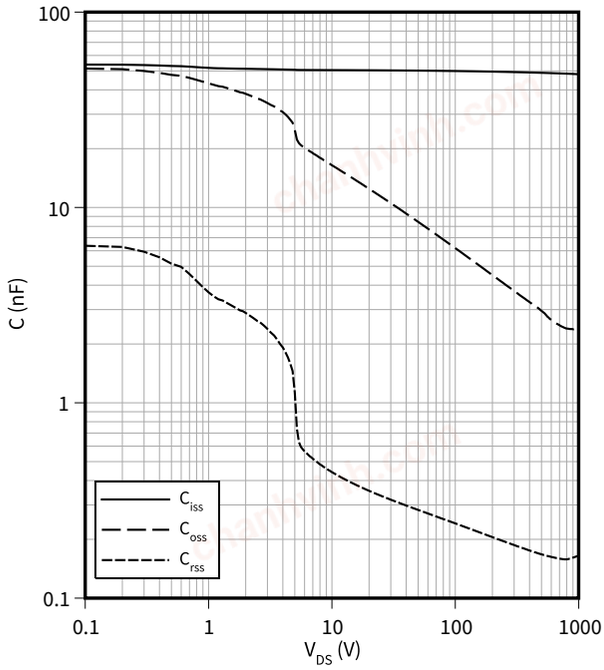
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5 Characteristics diagrams

Capacity characteristic (typical), MOSFET, T1 / T2

$C = f(V_{DS})$

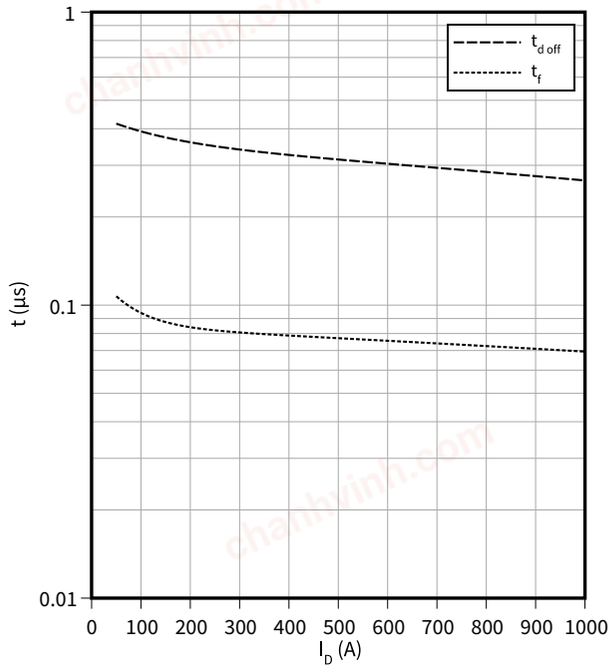
V_{GS} = 0 V, f = 100 kHz, T_{vj} = 25 °C



Switching times (typical), MOSFET, T1 / T2

$t = f(I_D)$

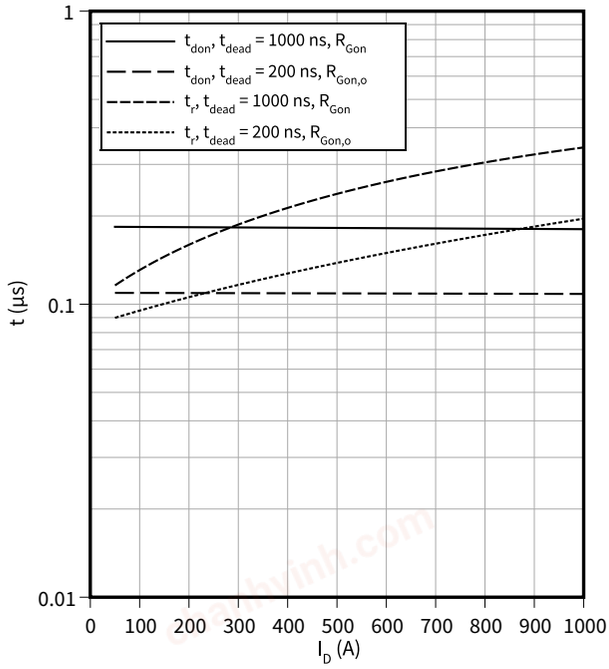
R_{Goff} = 3.9 Ω, V_{DD} = 600 V, T_{vj} = 175 °C, V_{GS} = -3/18 V



Switching times (typical), MOSFET, T1 / T2

$t = f(I_D)$

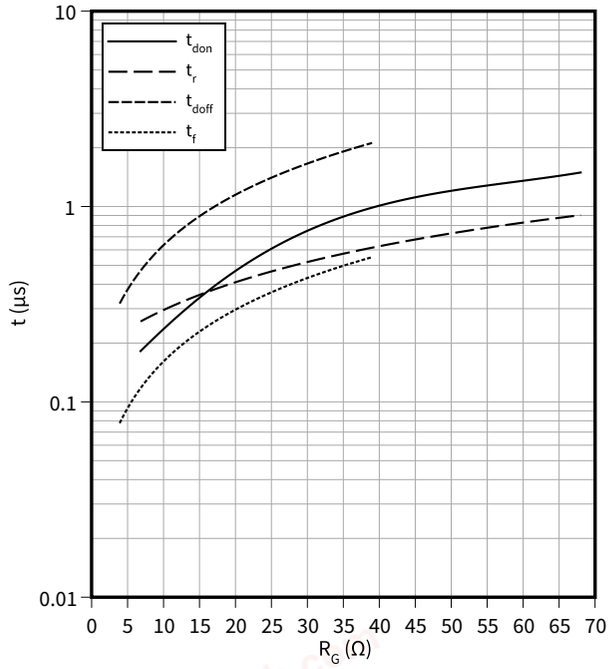
V_{DD} = 600 V, R_{Gon} = 6.8 Ω, $R_{Gon,o}$ = 2.4 Ω, T_{vj} = 175 °C, V_{GS} = -3/18 V



Switching times (typical), 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



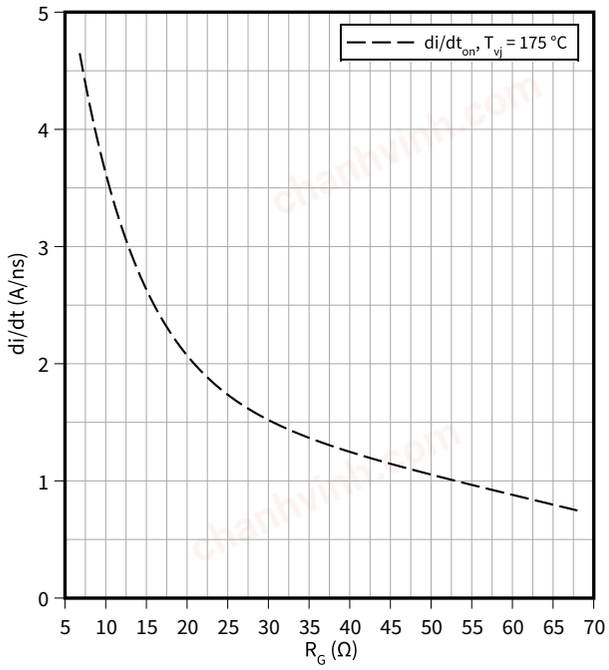
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5 Characteristics diagrams

Current slope (typical), MOSFET, T1 / T2

di/dt = f(R_G)

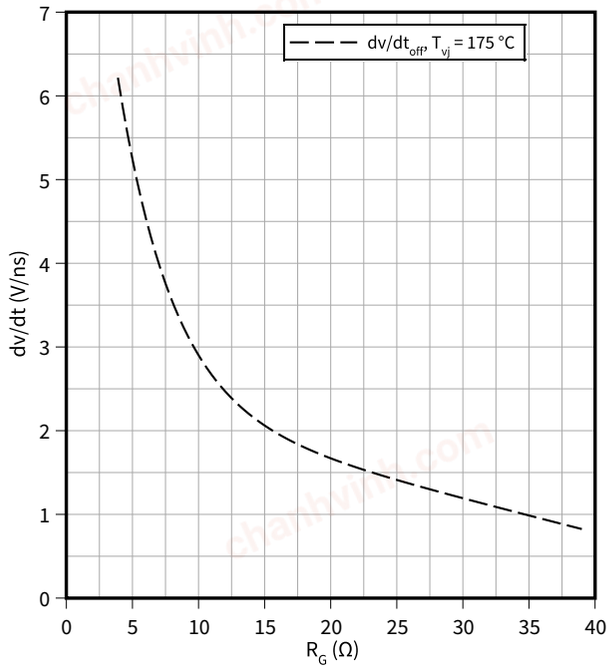
V_{DD} = 600 V, I_D = 500 A, V_{GS} = -3/18 V



Voltage slope (typical), MOSFET, T1 / T2

dv/dt = f(R_G)

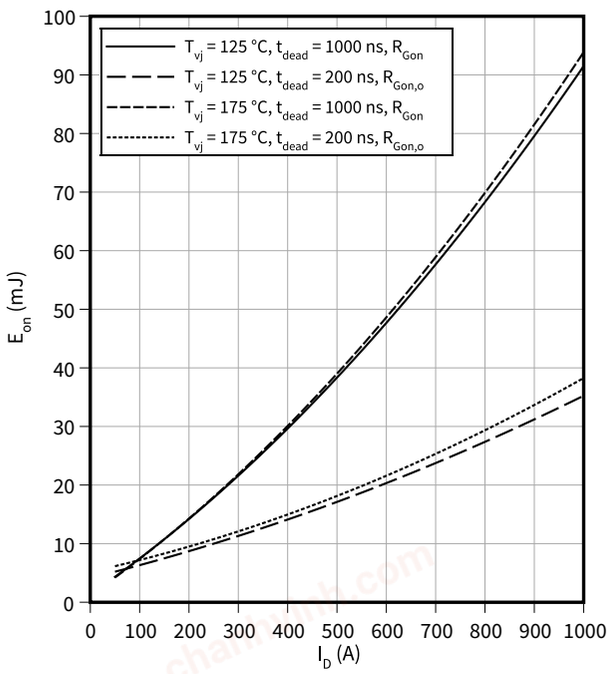
V_{DD} = 600 V, I_D = 500 A, V_{GS} = -3/18 V



Switching losses (typical), MOSFET, T1 / T2

E_{on} = f(I_D)

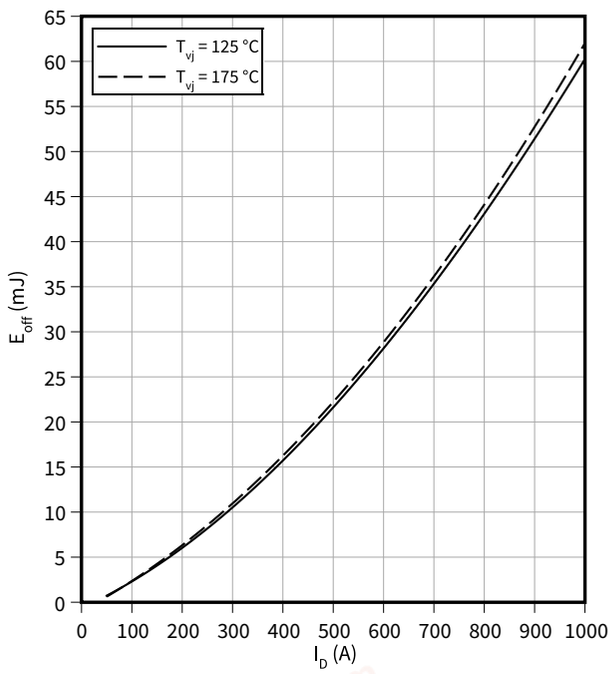
V_{DD} = 600 V, R_{Gon} = 6.8 Ω, $R_{Gon,o}$ = 2.4 Ω, V_{GS} = -3/18 V



Switching losses (typical), MOSFET, T1 / T2

E_{off} = f(I_D)

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

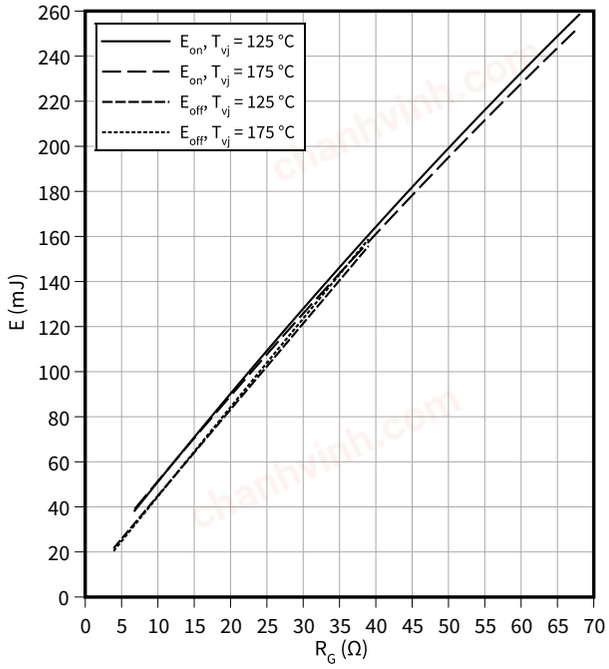


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Switching losses (typical), MOSFET, T1 / T2

$E = f(R_G)$

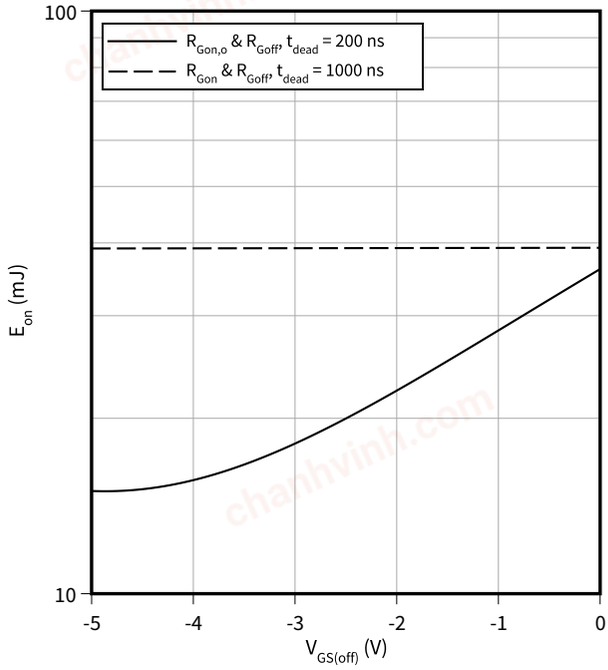
V_{DD} = 600 V, t_{dead} = 1000 ns, I_D = 500 A, V_{GS} = -3/18 V



Switching losses (typical), MOSFET, T1 / T2

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

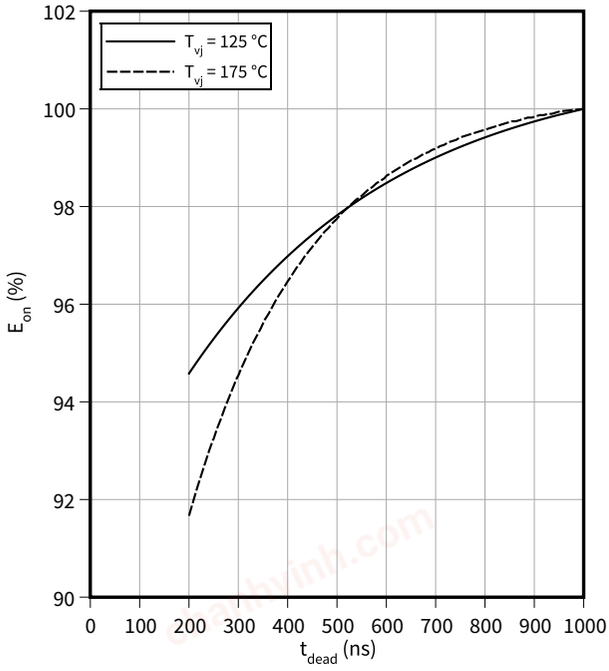
R_{Goff} = 3.9 Ω, V_{DD} = 600 V, R_{Gon} = 6.8 Ω, $V_{GS(on)}$ = 18 V, I_D = 500 A, $R_{Gon,o}$ = 2.4 Ω, T_{vj} = 175 °C



Switching losses (typical), MOSFET, T1 / T2

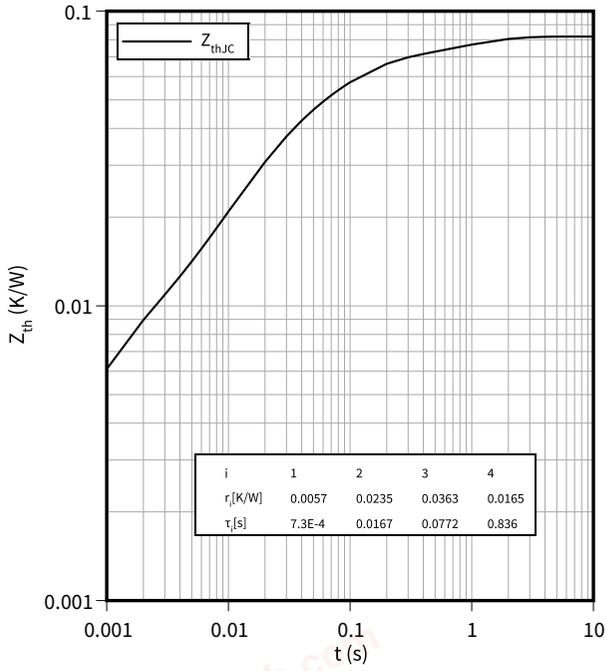
$E_{on} = f(t_{dead})$

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



Transient thermal impedance, MOSFET, T1 / T2

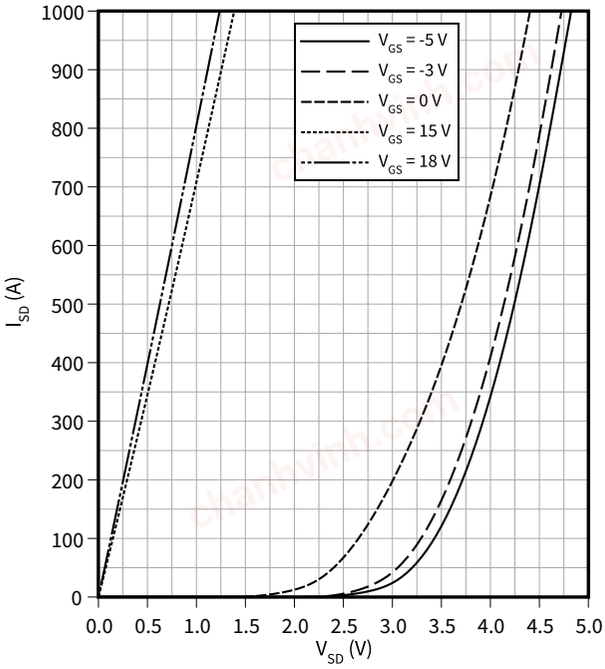
$Z_{th} = f(t)$



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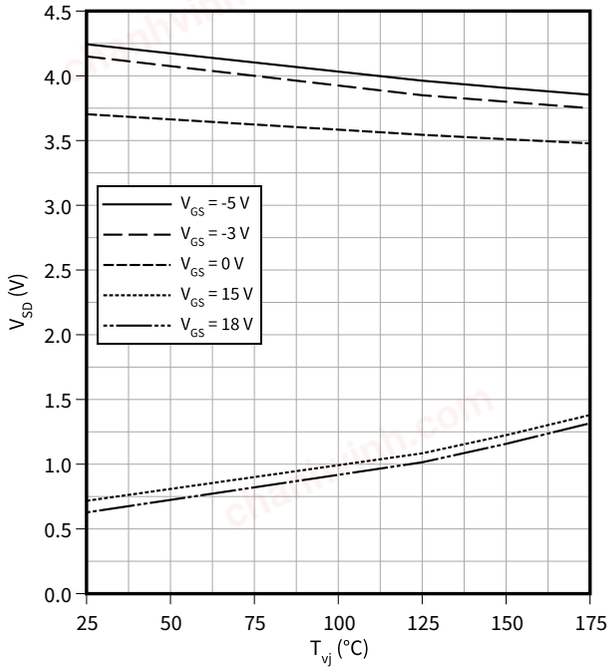
Forward characteristic body diode (typical), MOSFET, T1 / T2

$I_{SD} = f(V_{SD})$
$T_{vj} = 25\ °C$



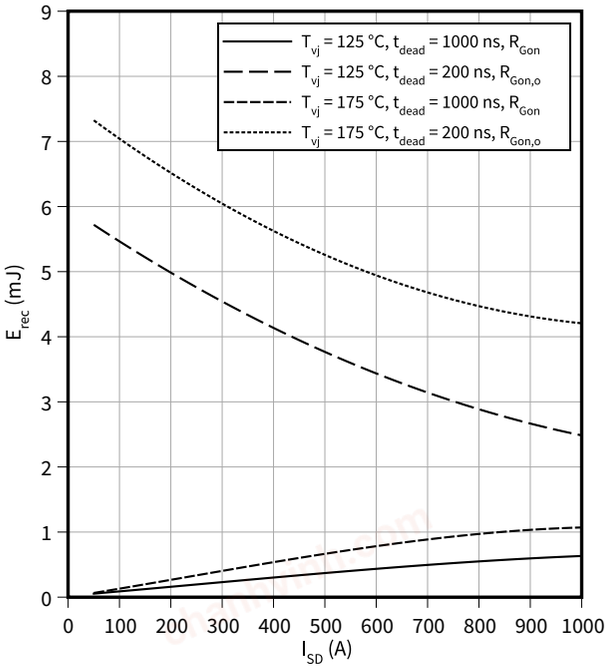
Forward voltage of body diode (typical), MOSFET, T1 / T2

$V_{SD} = f(T_{vj})$
$I_{SD} = 500\ A$



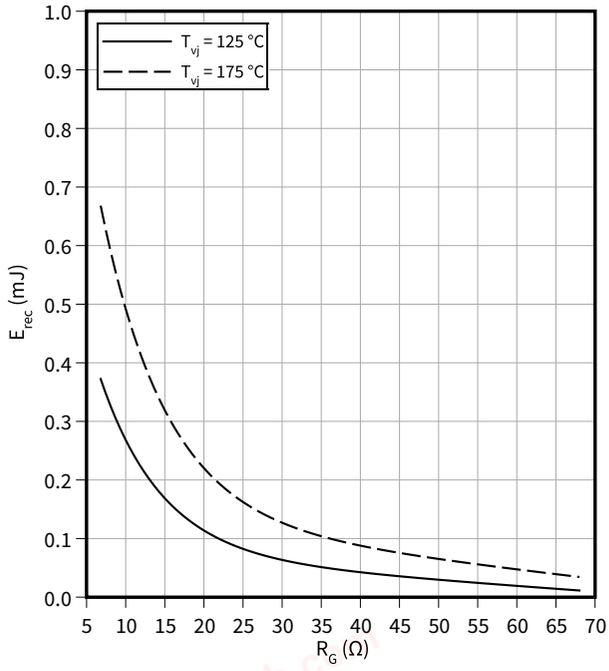
Switching losses body diode (typical), MOSFET, T1 / T2

$E_{rec} = f(I_{SD})$
$R_{Gon} = 6.8\ \Omega$, $R_{Gon,o} = 2.4\ \Omega$, $V_{DD} = 600\ V$



Switching losses body diode (typical), MOSFET, T1 / T2

$E_{rec} = f(R_G)$
$t_{dead} = 1000\ ns$, $I_{SD} = 500\ A$, $V_{DD} = 600\ V$

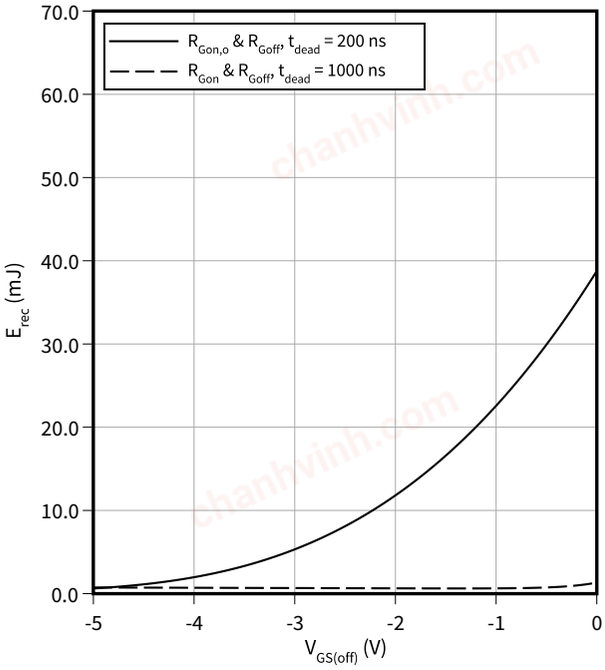


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Switching losses body diode (typical), MOSFET, T1 / T2

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

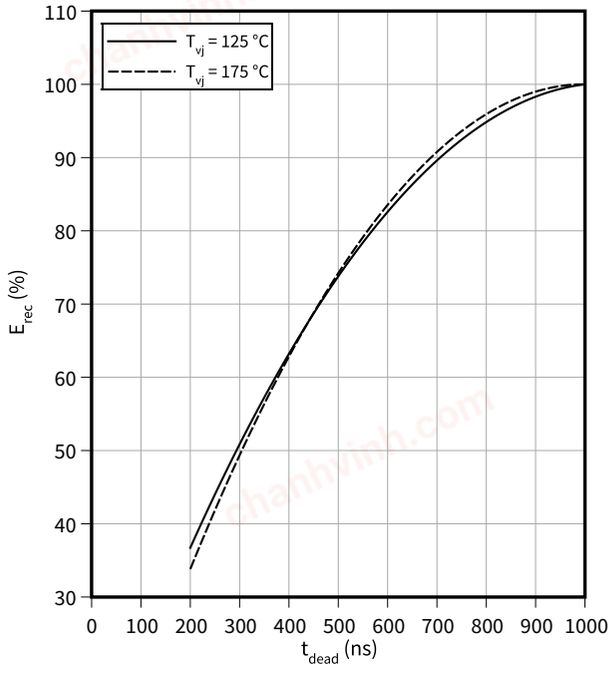
R_{Goff} = 3.9 Ω, R_{Gon} = 6.8 Ω, $V_{GS(on)}$ = 18 V, I_{SD} = 500 A, $R_{Gon,o}$ = 2.4 Ω, V_{DD} = 600 V, T_{vj} = 175 °C



Switching losses body diode (typical), MOSFET, T1 / T2

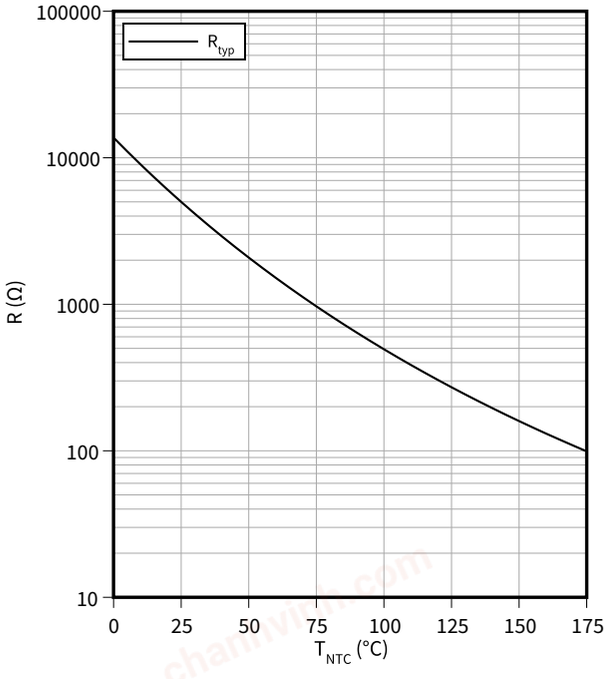
$E_{rec} = f(t_{dead})$

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



Temperature characteristic (typical), NTC-Thermistor

$R = f(T_{NTC})$



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6 Circuit diagram

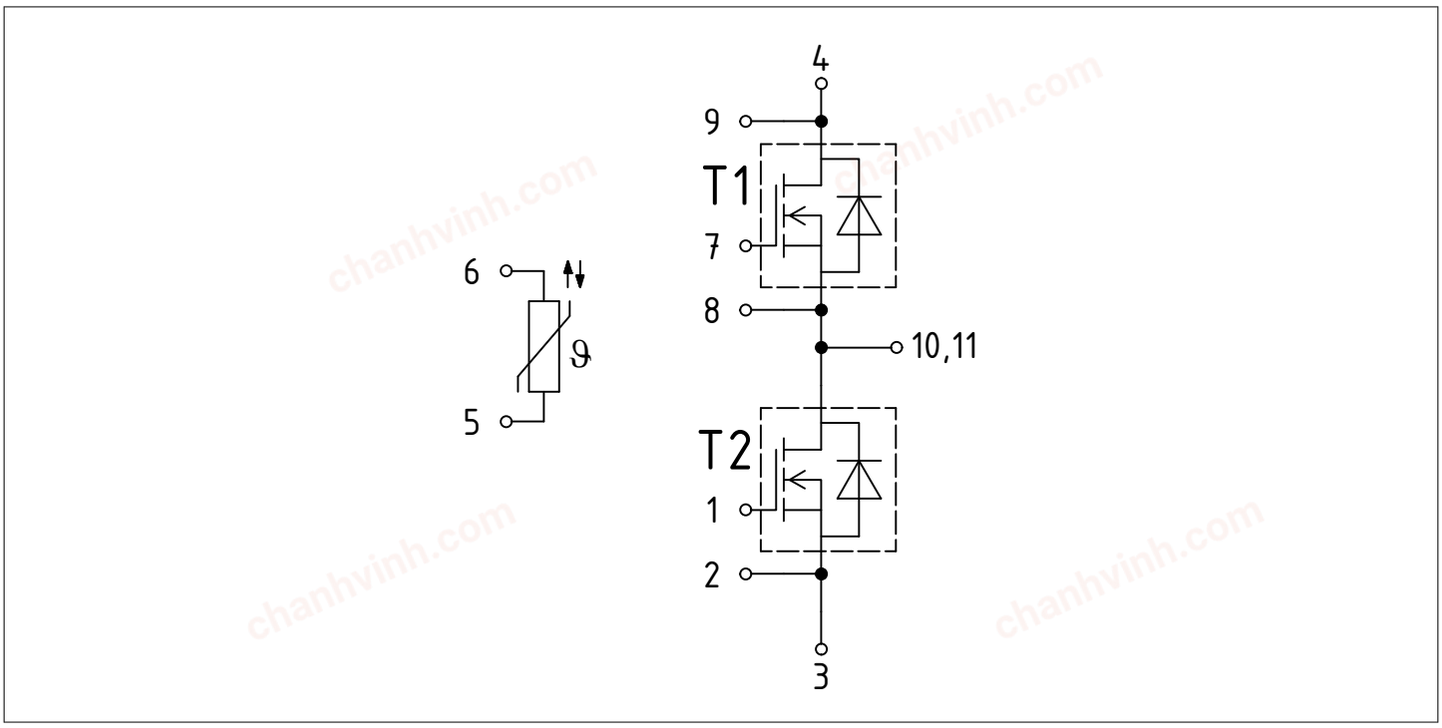


Figure 1

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7 Package outlines

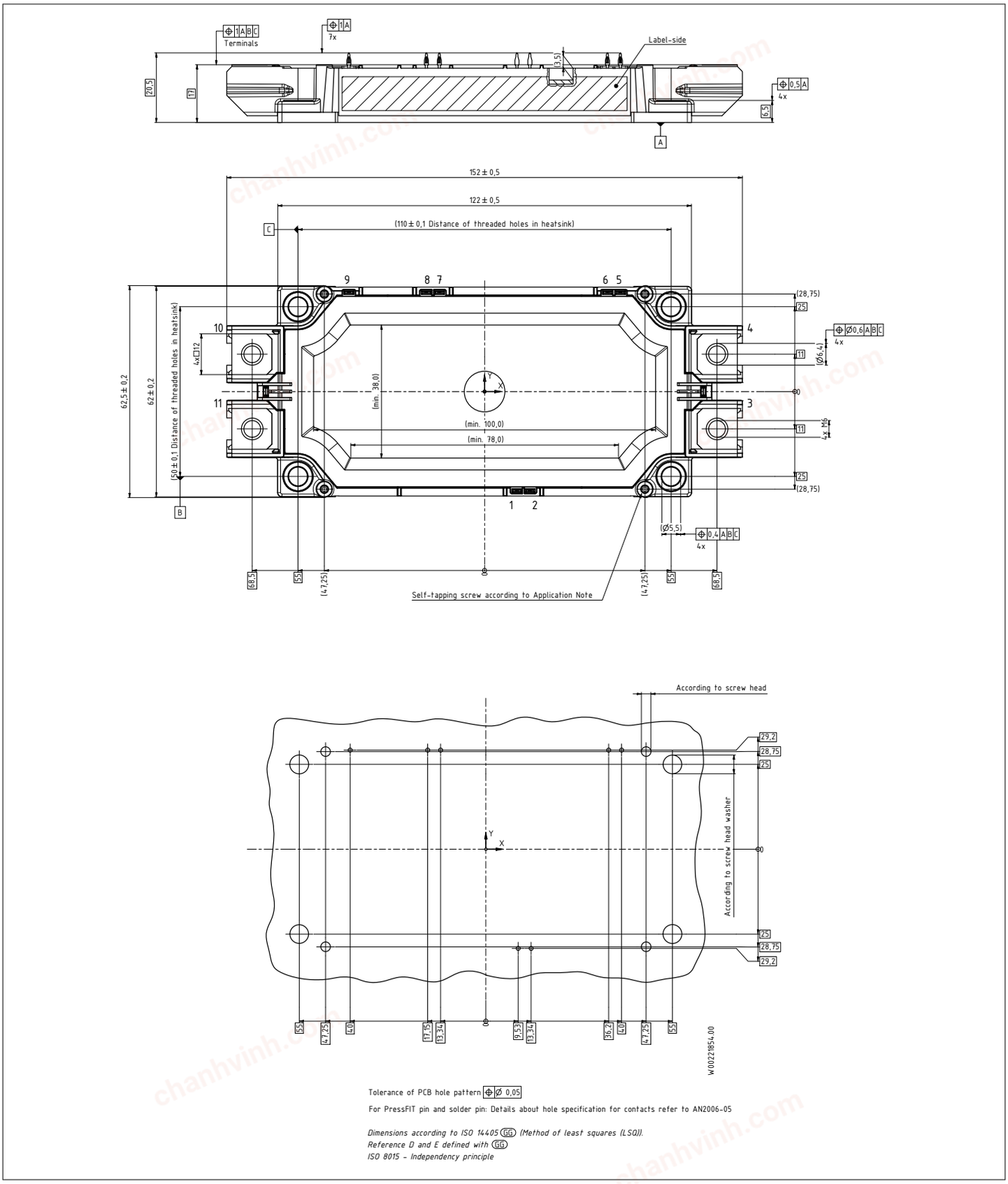


Figure 2

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8 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	*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	7154914284655054991530		7154914284655054991530

Figure 3

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Revision history

Document revision	Date of release	Description of changes
0.10	2024-03-20	Initial version
0.20	2024-08-28	Target datasheet
1.00	2024-11-11	Final datasheet
1.01	2024-12-10	General update

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