

STARPOWER

SEMICONDUCTOR

MOSFET

MD400CLR120C2S

1200V/400A chopper in one-package

General Description

STARPOWER MOSFET Power Module provides very low $R_{DS(on)}$ as well as optimized intrinsic diode. It's designed for the applications such SMPS and DC drives.

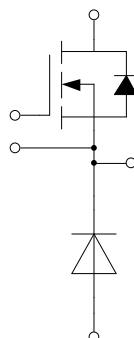
Features

- SiC power MOSFET
- Low $R_{DS(on)}$
- Optimized intrinsic reverse diode
- Chip sintering technology
- Low inductance case avoid oscillations
- Isolated copper baseplate using AlN DBC technology

Typical Applications

- Main and auxiliary AC drives of electric vehicles
- DC servo and robot drives
- Battery vehicles
- UPS equipment
- Plasma cutting

Equivalent Circuit Schematic



Absolute Maximum Ratings $T_c=25^{\circ}\text{C}$ unless otherwise noted**MOSFET**

Symbol	Description	Value	Unit
V_{DSS}	Drain-Source Voltage	1200	V
V_{GSS}	Gate-Source Voltage	-4/+22	V
I_D	Drain Current @ $T_c=25^{\circ}\text{C}$	542	A
	@ $T_c=90^{\circ}\text{C}$	400	A
I_{DM}	Pulsed Drain Current	1644	A

Inverse Diode

Symbol	Description	Value	Unit
I_S	Source Current	400	A
I_{SM}	Pulsed Source Current	1644	A

Series Diode

Symbol	Description	Values	Unit
V_{RRM}	Repetitive Peak Reverse Voltage	1200	V
I_F	Diode Continuous Forward Current	400	A
I_{FM}	Diode Maximum Forward Current $t_p=1\text{ms}$	800	A

Module

Symbol	Description	Value	Unit
T_{jmax}	Maximum Junction Temperature	175	$^{\circ}\text{C}$
T_{jop}	Operating Junction Temperature	-40 to +150	$^{\circ}\text{C}$
T_{STG}	Storage Temperature Range	-40 to +125	$^{\circ}\text{C}$
V_{ISO}	Isolation Voltage RMS, $f=50\text{Hz}$, $t=1\text{min}$	2500	V

MOSFET Characteristics $T_C=25^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit	
$R_{DS(on)}$	Static Drain-Source On-Resistance	$I_D=240\text{A}, V_{GS}=18\text{V}, T_j=25^\circ\text{C}$		3.3	4.4	$\text{m}\Omega$	
		$I_D=240\text{A}, V_{GS}=18\text{V}, T_j=125^\circ\text{C}$		5.0			
$V_{GS(th)}$	Gate-Source Threshold Voltage	$I_D=120\text{mA}, V_{DS}=V_{GS}, T_j=25^\circ\text{C}$	2.7		5.6	V	
g_{fs}	Forward Transconductance	$V_{DS}=10\text{V}, I_D=240\text{A}$		99.6		S	
I_{DSS}	Drain-Source Leakage Current	$V_{DS}=V_{DSS}, V_{GS}=0\text{V}, T_j=25^\circ\text{C}$			120	μA	
I_{GSS}	Gate-Source Leakage Current	$V_{GS}=V_{GSS}, V_{DS}=0\text{V}, T_j=25^\circ\text{C}$			1.2	μA	
R_{Gint}	Internal Gate Resistance			0.75		Ω	
C_{iss}	Input Capacitance	$V_{GS}=0\text{V}, V_{DS}=800\text{V}, f=1\text{MHz}$		16.0		nF	
C_{oss}	Output Capacitance			0.90		nF	
C_{rss}	Reverse Transfer Capacitance			0.33		nF	
Q_g	Total Gate Charge	$I_D=240\text{A}, V_{DS}=600\text{V}, V_{GS}=18\text{V}$		1284		nC	
Q_{gs}	Gate-Source Charge			264		nC	
Q_{gd}	Gate-Drain ("Miller") Charge			492		nC	
$t_{d(on)}$	Turn-On Delay Time	$V_{DS}=900\text{V}, I_D=400\text{A}, R_G=1.6\Omega, V_{GS}=0/+18\text{V}, T_j=25^\circ\text{C}$		93		ns	
t_r	Rise Time			93		ns	
$t_{d(off)}$	Turn-Off Delay Time			296		ns	
t_f	Fall Time			78		ns	
E_{on}	Turn-On Switching Loss				8.47		mJ
E_{off}	Turn-Off Switching Loss				31.5		mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{DS}=900\text{V}, I_D=400\text{A}, R_G=1.6\Omega, V_{GS}=0/+18\text{V}, T_j=125^\circ\text{C}$		95		ns	
t_r	Rise Time			95		ns	
$t_{d(off)}$	Turn-Off Delay Time			336		ns	
t_f	Fall Time			78		ns	
E_{on}	Turn-On Switching Loss				8.60		mJ
E_{off}	Turn-Off Switching Loss				33.1		mJ
$t_{d(on)}$	Turn-On Delay Time	$V_{DS}=900\text{V}, I_D=400\text{A}, R_G=1.6\Omega, V_{GS}=0/+18\text{V}, T_j=150^\circ\text{C}$		100		ns	
t_r	Rise Time			95		ns	
$t_{d(off)}$	Turn-Off Delay Time			343		ns	
t_f	Fall Time			82		ns	
E_{on}	Turn-On Switching Loss				8.65		mJ
E_{off}	Turn-Off Switching Loss				33.3		mJ

Inverse Diode Characteristics $T_C=25^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{SD}	Diode Forward Voltage	$I_S=240\text{A}, V_{GS}=0\text{V}, T_j=25^\circ\text{C}$		3.20		V
t_{rr}	Diode Reverse Recovery Time	$V_R=600\text{V}, I_S=240\text{A},$ $-di/dt=13200\text{A}/\mu\text{s},$ $T_j=25^\circ\text{C}$		25		ns
Q_r	Diode Reverse Recovery Charge			1.32		μC
I_{RM}	Peak Reverse Recovery Current			108		A

Series Diode Characteristics $T_C=25^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_F	Diode Forward Voltage	$I_F=400\text{A}, V_{GE}=0\text{V}, T_j=25^\circ\text{C}$		1.40	1.85	V
		$I_F=400\text{A}, V_{GE}=0\text{V}, T_j=125^\circ\text{C}$		1.80		
		$I_F=400\text{A}, V_{GE}=0\text{V}, T_j=150^\circ\text{C}$		1.90		
t_{rr}	Diode Reverse Recovery Time	$V_R=900\text{V}, I_S=400\text{A},$ $-di/dt=4550\text{A}/\mu\text{s},$ $V_{GS}=0\text{V},$ $T_j=25^\circ\text{C}$		34.8		ns
Q_r	Diode Reverse Recovery Charge			2.75		μC
I_{rrm}	Peak Reverse Recovery Current			79		A
E_{rec}	Reverse Recovery Energy			0.23		mJ
t_{rr}	Diode Reverse Recovery Time	$V_R=900\text{V}, I_S=400\text{A},$ $-di/dt=4600\text{A}/\mu\text{s},$ $V_{GS}=0\text{V},$ $T_j=125^\circ\text{C}$		37.2		ns
Q_r	Diode Reverse Recovery Charge			3.05		μC
I_{rrm}	Peak Reverse Recovery Current			82		A
E_{rec}	Reverse Recovery Energy			0.51		mJ
t_{rr}	Diode Reverse Recovery Time	$V_R=900\text{V}, I_S=400\text{A},$ $-di/dt=4650\text{A}/\mu\text{s},$ $V_{GS}=0\text{V},$ $T_j=150^\circ\text{C}$		38.4		ns
Q_r	Diode Reverse Recovery Charge			3.19		μC
I_{rrm}	Peak Reverse Recovery Current			83		A
E_{rec}	Reverse Recovery Energy			0.53		mJ

Module Characteristics $T_c=25^\circ\text{C}$ unless otherwise noted

Symbol	Parameter	Min.	Typ.	Max.	Unit
R_{thJC}	Junction-to-Case(Mosfet)			0.074	K/W
	Junction-to-Case(Diode)			0.061	
R_{thCH}	Case-to-Heatsink (Mosfet)		0.022		K/W
	Case-to-Heatsink (Diode)		0.018		
	Case-to-Heatsink (per Module)		0.010		
M	Terminal Connection Torque, Screw M6	2.5		5.0	N.m
	Mounting Torque, Screw M6	3.0		5.0	
G	Weight of Module		300		g

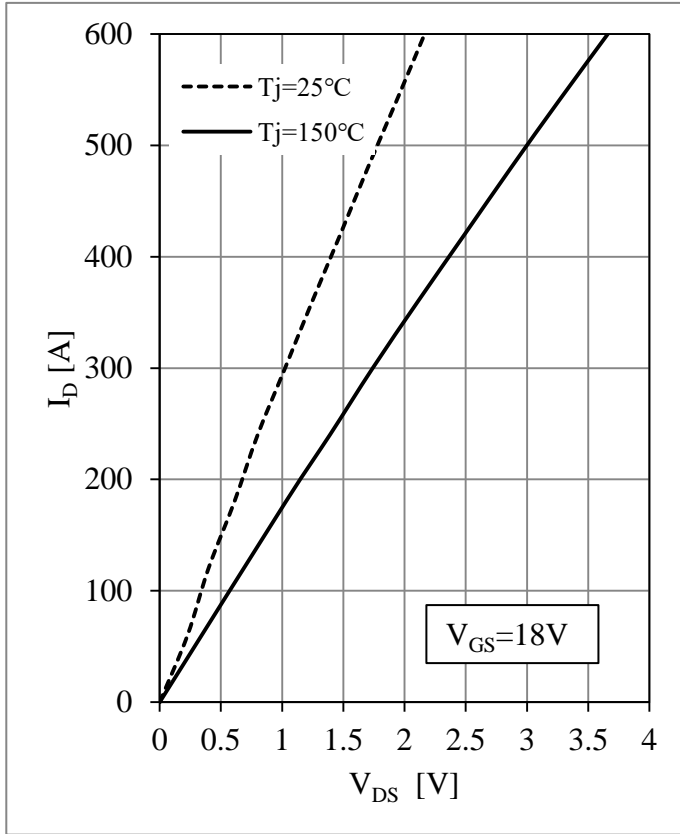


Fig 1. MOSFET Output Characteristics

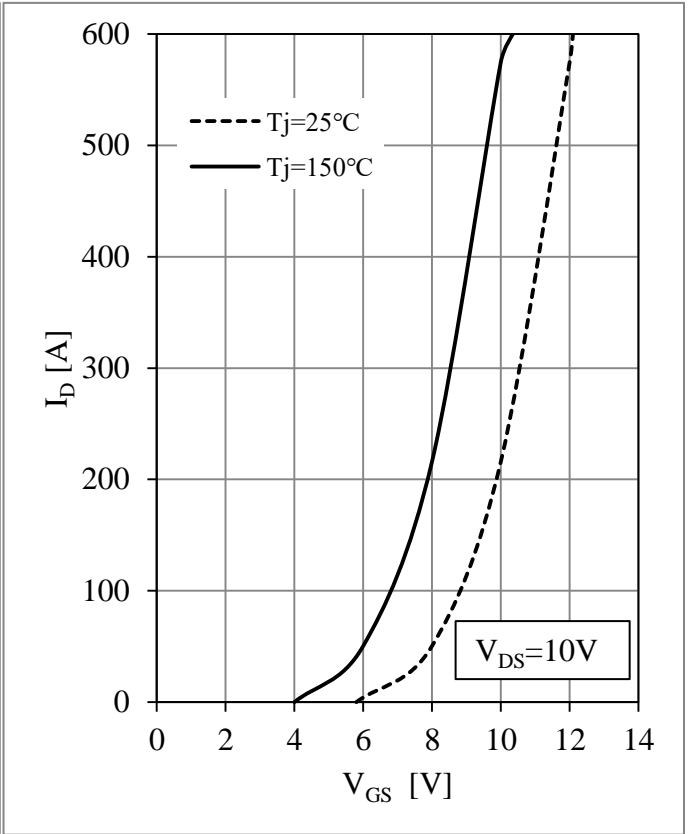


Fig 2. MOSFET Transfer Characteristics

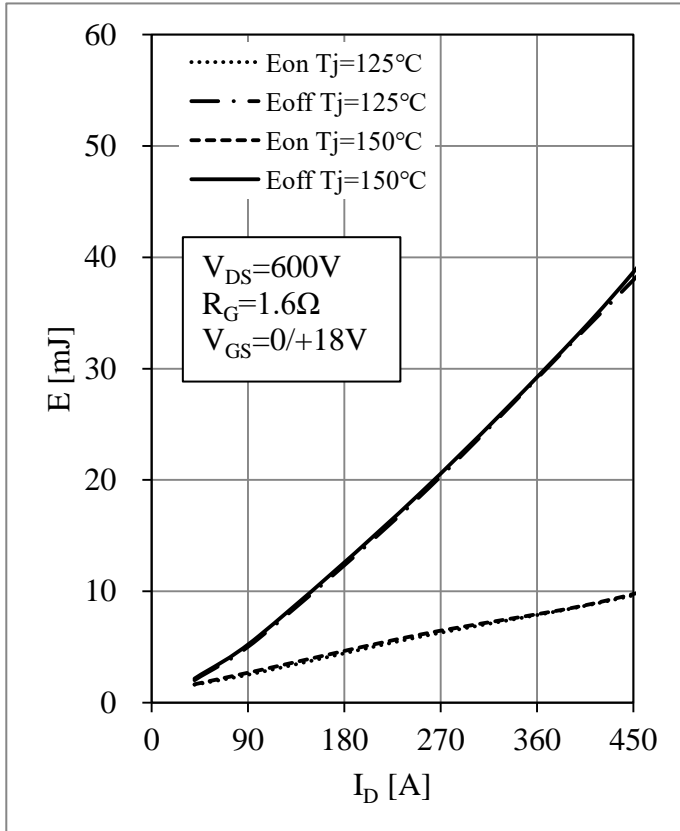


Fig 3. MOSFET Switching Loss vs. I_D

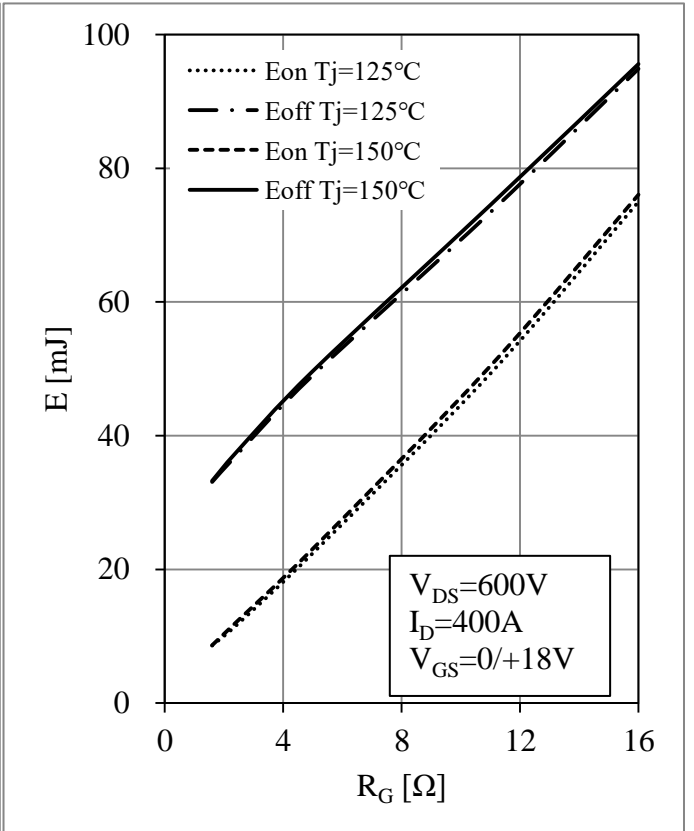


Fig 4. MOSFET Switching Loss vs. R_G

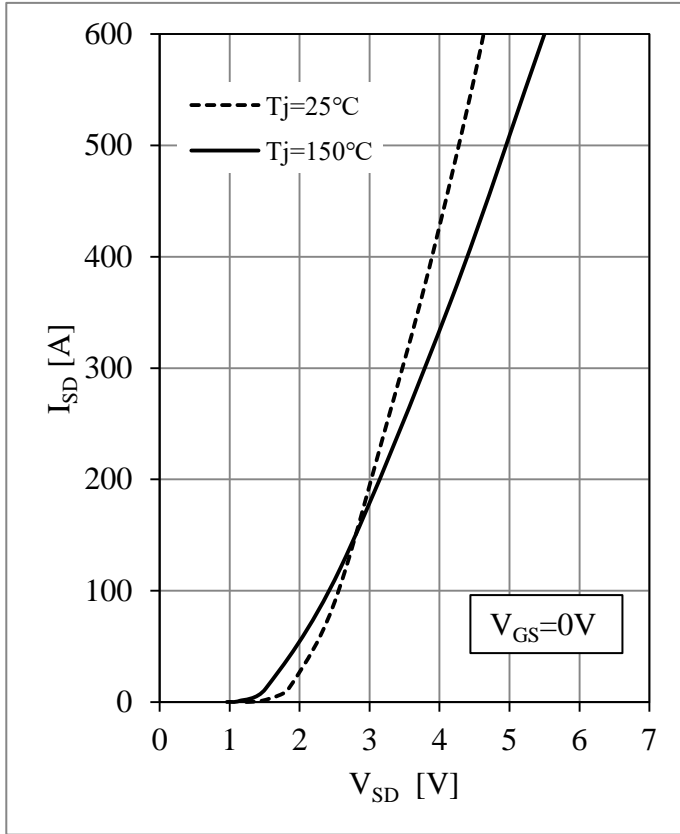


Fig 5. Body Diode Output Characteristics

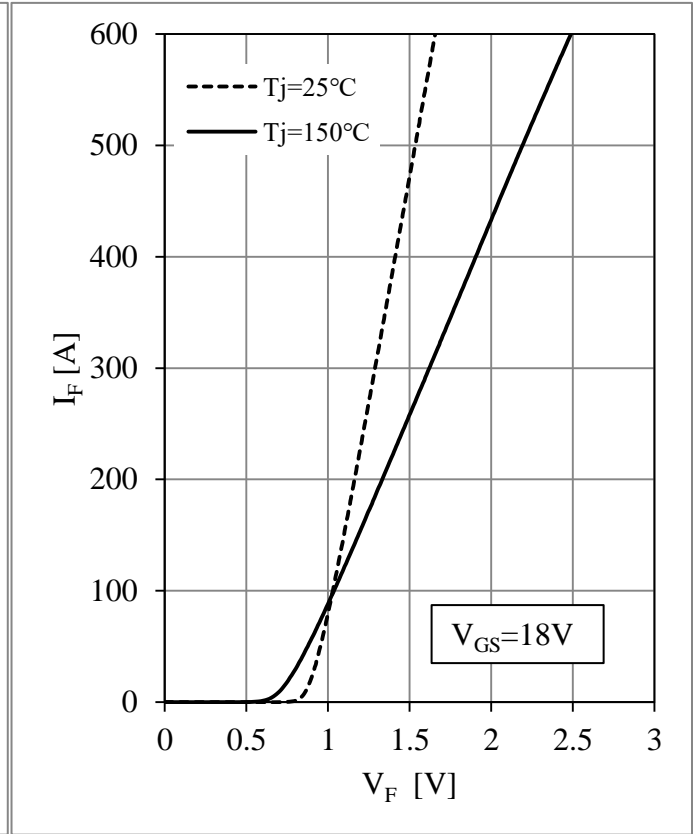


Fig 6. Diode Output Characteristics

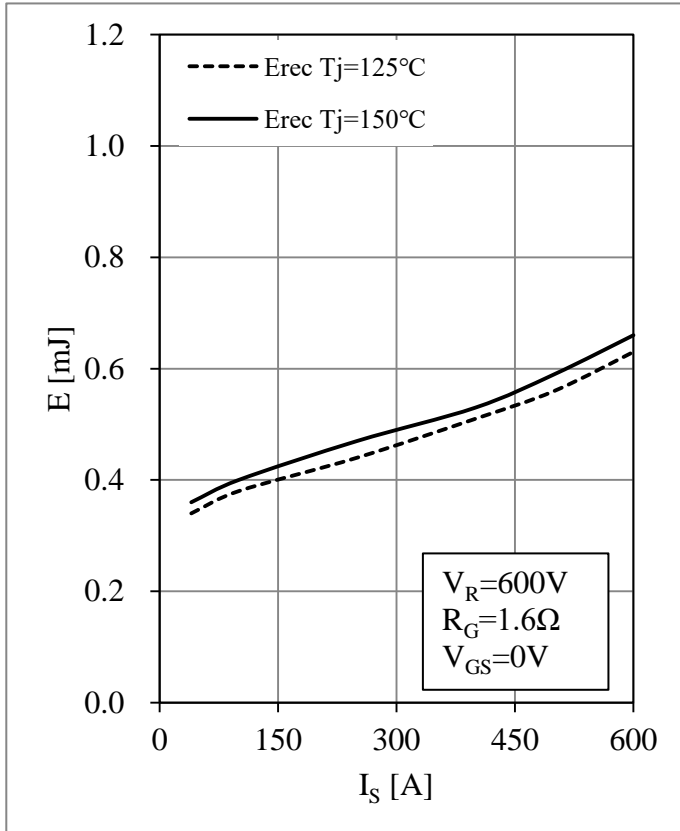


Fig 7. Diode Switching Loss vs. I_S

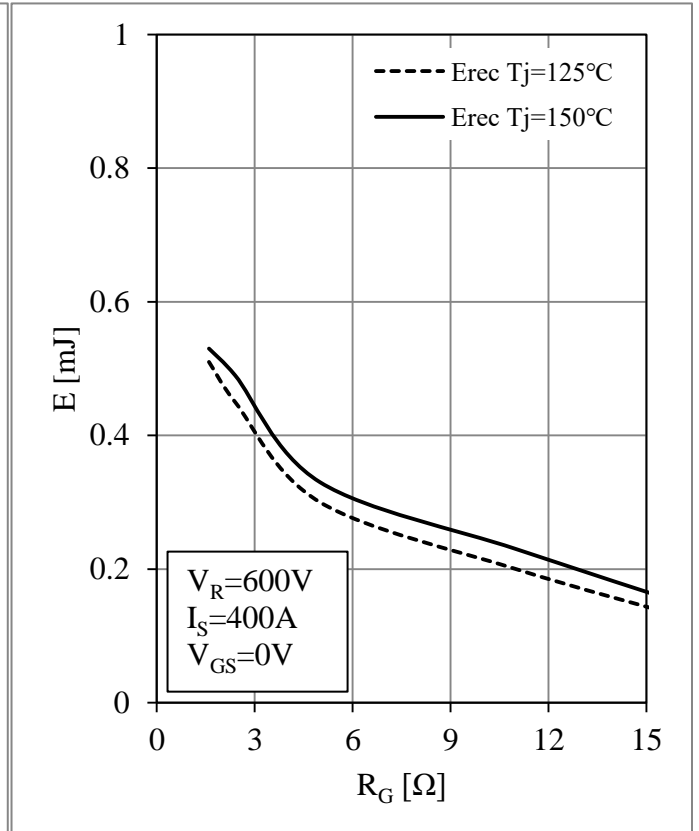


Fig 8. Diode Switching Loss vs. R_G

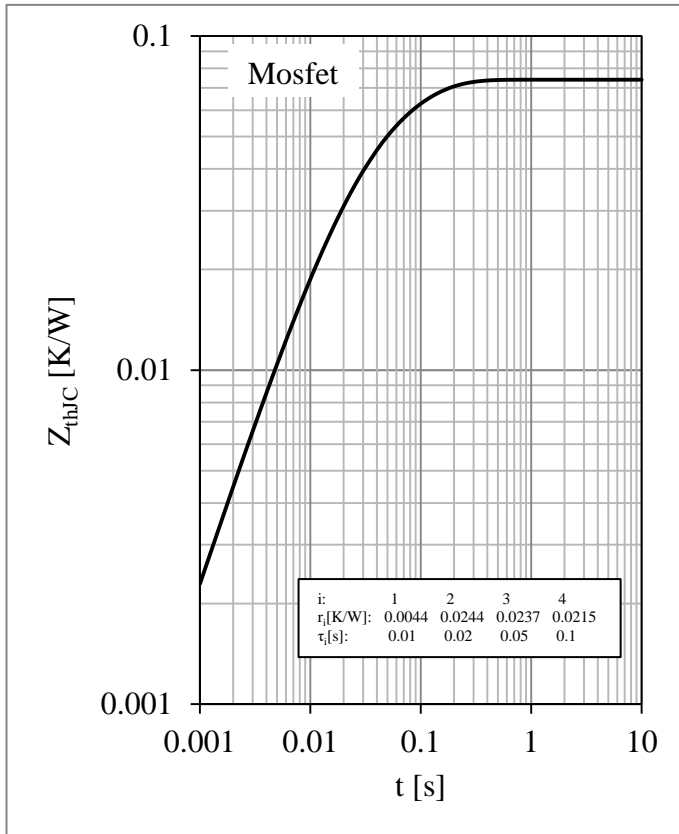


Fig 9. MOSFET Transient Thermal Impedance

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