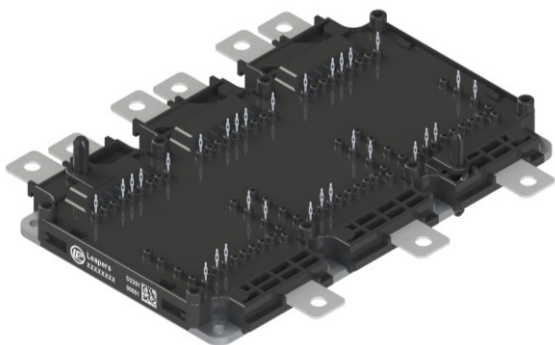


Description

The DFS04FB12HDW1 is a 3 Phase SiC MOSFET Power Module. It integrates high performance SiC MOSFET chips for xEV or motor drives application.



Features

- Blocking voltage 1200V
- $R_{DS(on)} = 4.2m\Omega$ ($T_j = 25^\circ C$)
- $R_{DS(on)} = 6.8m\Omega$ ($T_j = 175^\circ C$)
- Arcbonding™ technology
- 175°C maximum junction temperature
- Si₃N₄ AMB substrate
- Direct Cooled Pin Fin Base Plate
- Thermistor inside
- Press FIT Contact Technology

Applications

- xEV Applications
- Motor Drives

Circuit diagram

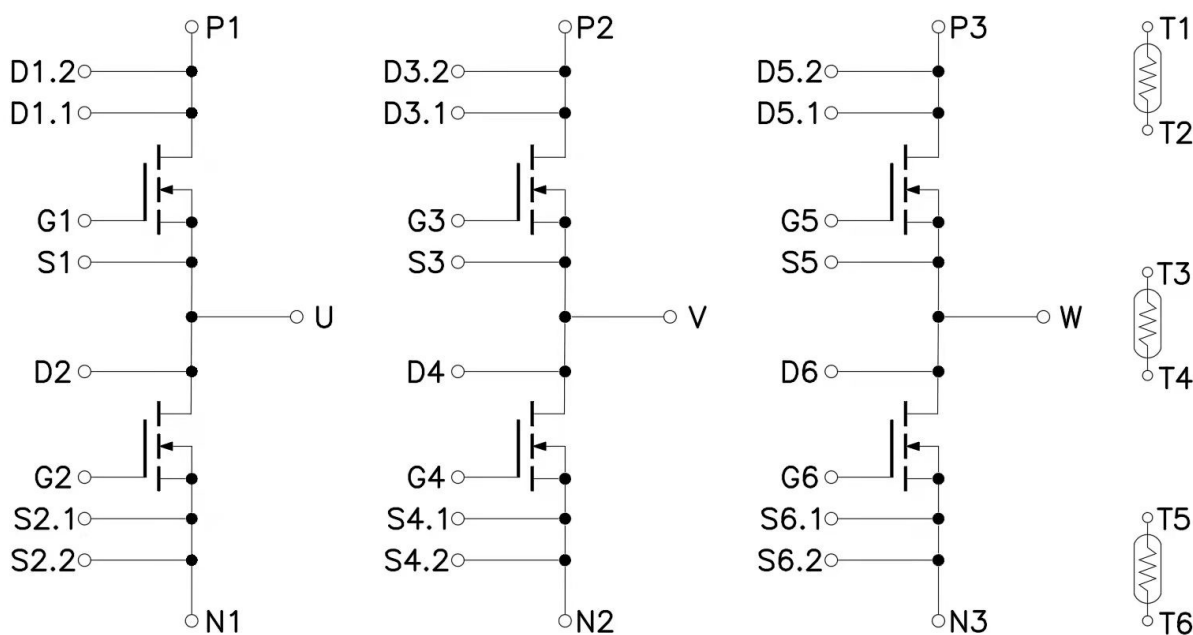


Figure 1. Out drawing & circuit diagram for DFS04FB12HDW1

Physical Dimensions

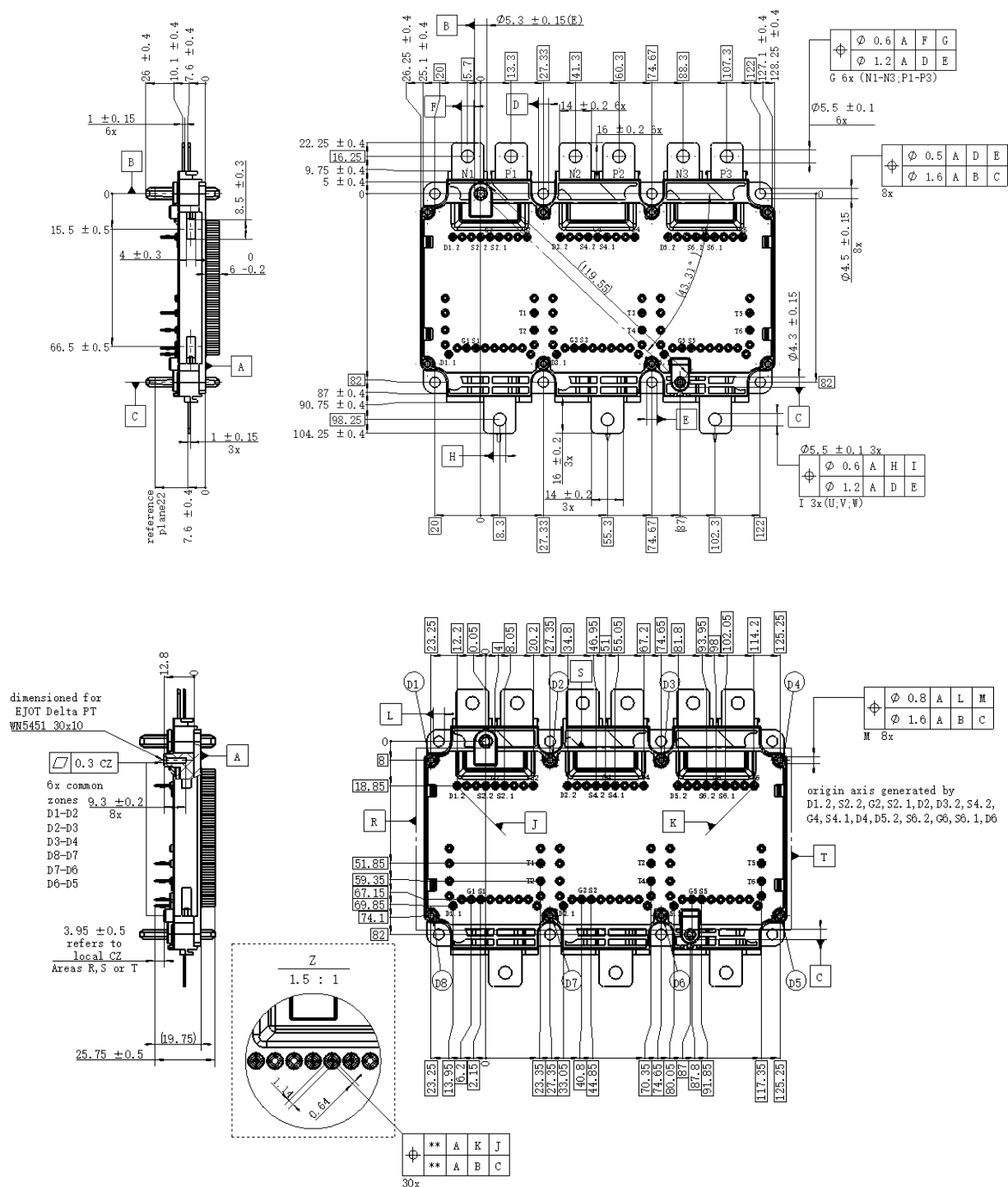


Figure2. Physical Dimensions

Maximum Ratings ($T_j = 25^\circ\text{C}$ unless otherwise specified)

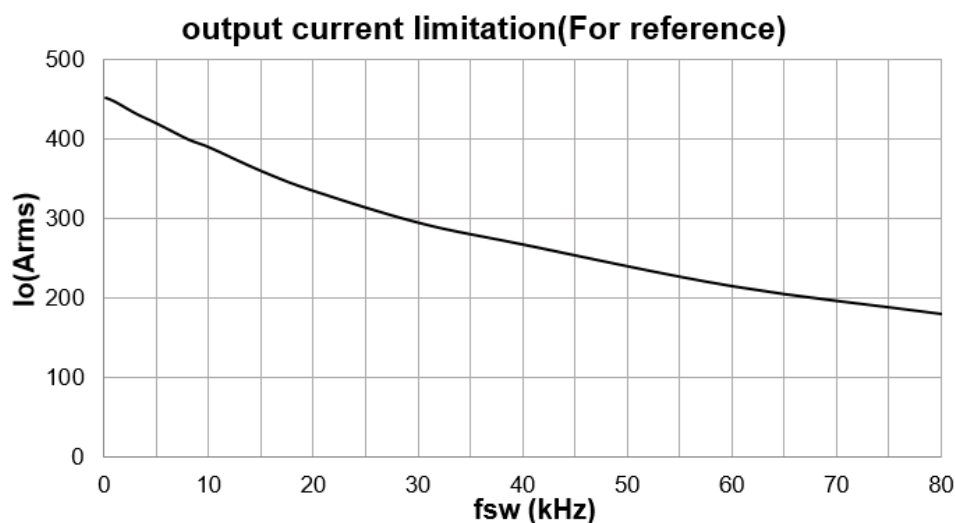
Symbol	Parameter	Conditions	Ratings	Unit
V_{DS}	Drain-Source Voltage	G-S Short	1200	V
V_{GS}	Gate-Source Voltage	D-S Short, AC frequency $\geq 1\text{Hz}$, Note1	-8V/+19V	V
I_{DS}	DC Continuous Drain Current	$T_f = 25^\circ\text{C}$	375	A
I_{DS}	DC Continuous Drain Current	$T_f = 65^\circ\text{C}$	320	A
I_{SD}	Source (Body Diode) Current	$T_f = 25^\circ\text{C}$, with ON signal	375	A
I_{SD}	Source (Body Diode) Current	$T_f = 65^\circ\text{C}$, with ON signal	320	A
I_{DP}	Drain Pulse Current, Peak	Less than 1ms, Note2	800	A
P_D	Maximum Power Dissipation	$T_f = 25^\circ\text{C}$	962	W
T_j	junction temperature	-	-40 to 175	$^\circ\text{C}$
T_{stg}	Storage temperature	-	-40 to 125	$^\circ\text{C}$

Note1: Recommended Operating Value, -4V/+15V

Note2: Pulse width limited by maximum junction temperature

Typical current output ability

Condition: SPWM control, $V_{CC} = 800\text{V}$, $R_g = 4.5\Omega$, $T_f = 65^\circ\text{C}$, $T_{jmax} = 175^\circ\text{C}$, $\text{PF} = 0.8$, Modulation rate = 1



Note3: This graph is calculated value for reference based on the limitation of $T_{jmax} = 175^\circ\text{C}$. The actual current out ability depends on inverter electrical, thermal and mechanic design. Please confirm it in actual application system.

Module

Parameter	Conditions	Value	Unit
Isolation voltage	Main terminal to base plate, f=0Hz, t=1sec	4.2	kV
Material of module baseplate	-	Cu+Ni	-
Creepage distance	terminal to heatsink terminal to terminal	9	mm
Clearance	terminal to heatsink terminal to terminal	4.5	mm
Stray inductance module	$T_f = 65^\circ\text{C}$	8	nH
Module lead resistance, terminals – chip	$T_f = 65^\circ\text{C}$	0.2	mΩ
Mounting torque for module mounting	Screw M4 baseplate to heatsink	1.8 to 2.2	Nm
Weight	-	798	g

NTC characteristics

Symbol	Parameter	Condition	Value			Unit
			Min.	Typ.	Max.	
R ₂₅	Resistance	$T_c = 25^\circ\text{C}$	-	5	-	kΩ
ΔR/R	Deviation of R ₁₀₀	$T_c = 100^\circ\text{C}$, R ₁₀₀ = 493Ω	5	-	5	%
P ₂₅	Power dissipation	$T_c = 25^\circ\text{C}$	-	-	20	mW
B _{25/50}	B-value	$R_2 = R_{25} \exp [B_{25/50}(1/T_2 - 1/(298,15 \text{ K}))]$	-	3375	-	K
B _{25/80}	B-value	$R_2 = R_{25} \exp [B_{25/80}(1/T_2 - 1/(298,15 \text{ K}))]$	-	3411	-	K
B _{25/100}	B-value	$R_2 = R_{25} \exp [B_{25/100}(1/T_2 - 1/(298,15 \text{ K}))]$	-	3433	-	K

MOSFET Electrical characteristics ($T_j = 25^\circ\text{C}$ unless otherwise specified, chip)

Symbol	Item	Condition		Value			Unit
				Min.	Typ.	Max	
V _{(BR)DSS}	Drain-Source Breakdown Voltage	V _{GS} =0V, I _D =1mA		1200	-	-	V
I _{DSS}	Zero gate voltage drain current	V _{DS} =1200V, V _{GS} =0V		-	80	400	μA
V _{GS(th)}	Gate-source threshold voltage	I _D =110mA, V _{DS} =V _{GS}		1.8	2.5	3.6	V
I _{GSS}	Gate-Source Leakage Current	V _{GS} =15V, V _{DS} =0V, T _J =25°C		-	0.04	10	μA
R _{DS(on)} (Chip)	Static drain-source	I _D =400A	T _J =25°C	3	4.2	5.5	mΩ
	On-state resistance	V _{GS} =15V	T _J =175°C	-	6.8	9.5	mΩ
V _{DS(on)} (Chip)	Static drain-source	I _D =400A	T _J =25°C	-	1.68	2.2	V
	On-state voltage	V _{GS} =15V	T _J =175°C	-	-	3.8	V
C _{iss}	Input capacitance	V _{DS} =800V, V _{GS} =0V f =100KHz, V _{ac} =25mV		-	22	-	nF
C _{oss}	Output capacitance			-	0.8	-	nF
C _{rss}	Reverse transfer capacitance			-	0.05	-	nF
Q _G	Total gate charge	V _{DD} =800V, I _D =400A, V _{GS} =-4/+15V		-	760	-	nC
t _{d(on)}	Turn-on delay time	V _{DD} =600V I _D =400A V _{GS} =+15/-4V R _G =4.5Ω Inductive load switching operation	T _J =25°C	-	138	-	ns
			T _J =150°C	-	122	-	
t _r	Rise time		T _J =25°C	-	88	-	ns
			T _J =150°C	-	82	-	
t _{d(off)}	Turn-off delay time		T _J =25°C	-	286	-	ns
			T _J =150°C	-	325	-	
t _f	Fall time		T _J =25°C	-	55	-	ns
			T _J =150°C	-	69	-	
E _{on}	Turn-on power dissipation		T _J =25°C	-	14.5	-	mJ
			T _J =150°C	-	15.6	-	
E _{off}	Turn-off power dissipation		T _J =25°C	-	15.7	-	mJ
			T _J =150°C	-	16.1	-	
R _{th(j-f)}	FET Thermal Resistance	Junction to cooling fluid ΔV/Δt =10dm³/min, T _f =65°C		-	0.156	-	K/W

Body Diode Electrical characteristics ($T_j=25^\circ\text{C}$ unless otherwise specified, chip)

Symbol	Item	Condition		Value			Unit
				Min.	Typ.	Max	
V_{SD}	Body Diode Forward Voltage	$V_{GS} = -4\text{V}$ $I_{SD} = 400\text{A}$	$T_j = 25^\circ\text{C}$	4.6	6.0	-	V
			$T_j = 175^\circ\text{C}$	4.2	5.5	-	
T_{rr}	Reverse recovery time	$V_{DD} = 600\text{V}$ $I_D = 400\text{A}$	$T_j = 25^\circ\text{C}$	-	35	-	ns
			$T_j = 150^\circ\text{C}$	-	60	-	
Q_{rr}	Reverse recovery charge	$V_{GS} = +15/-4\text{V}$ $R_G = 4.5\Omega$	$T_j = 25^\circ\text{C}$	-	1.73	-	uC
			$T_j = 150^\circ\text{C}$	-	5.6	-	
E_{rr}	Diode switching power dissipation	Inductive load switching operation	$T_j = 25^\circ\text{C}$	-	0.40	-	mJ
			$T_j = 150^\circ\text{C}$	-	1.32	-	

Test Conditions

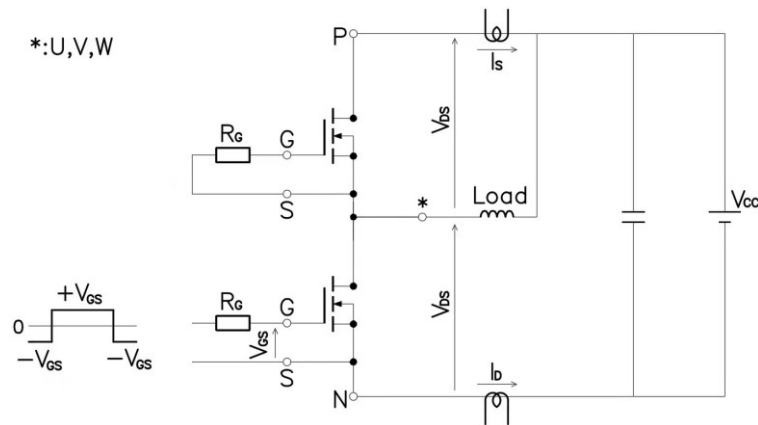


Figure 3. Switching time measure circuit

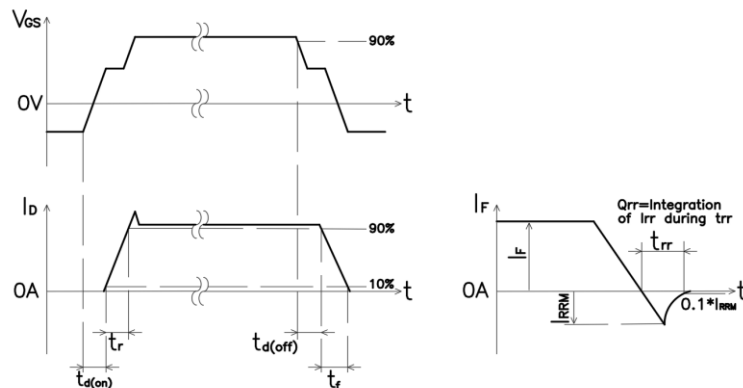


Figure 4. Switching time definition

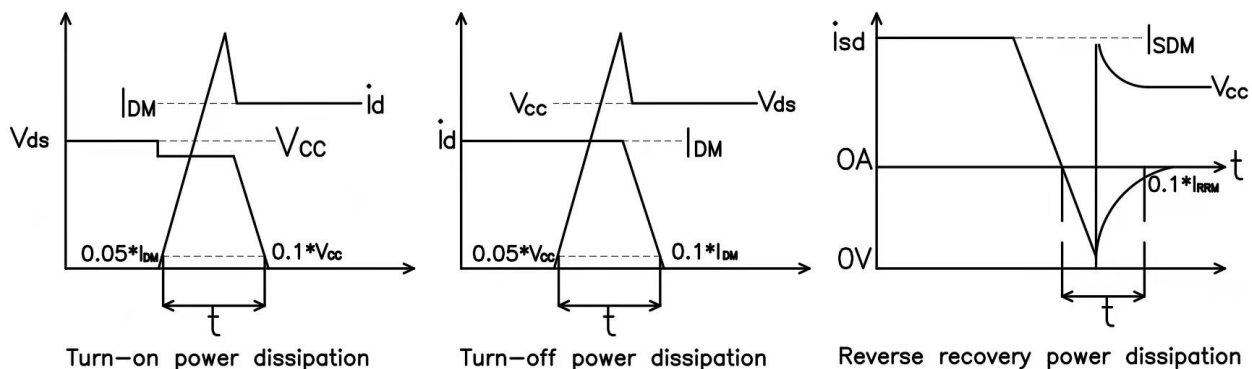


Figure 5. Switching power dissipation definition

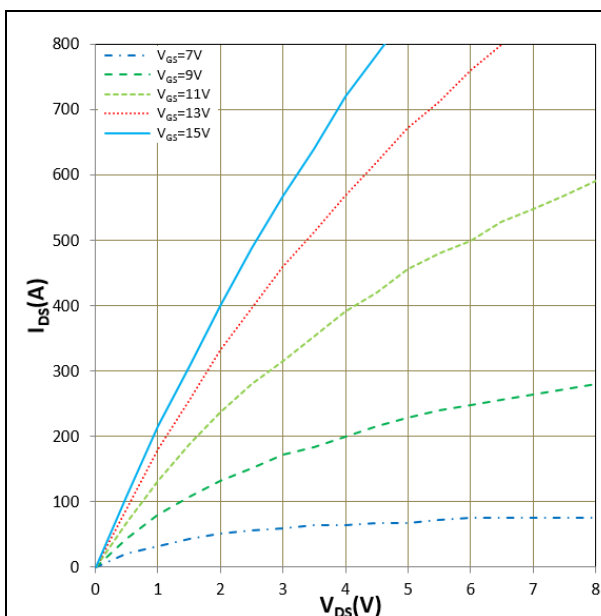


Figure 6. I_{DS} vs V_{DS}
 $T_j = 25^\circ\text{C}$, V_{GS} parameter

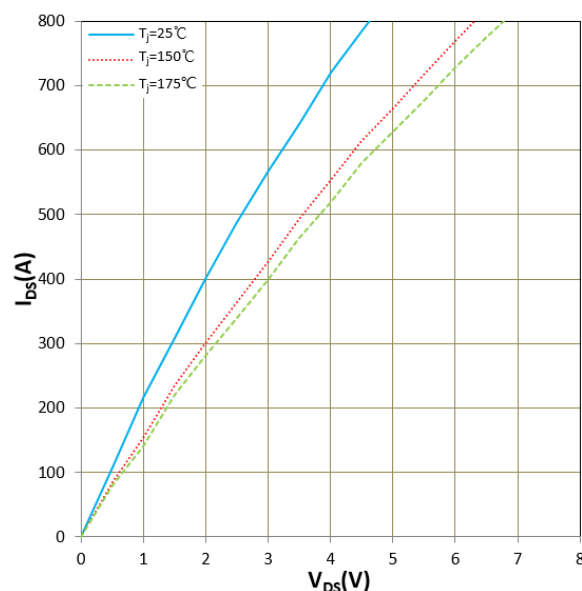


Figure 7. I_{DS} vs V_{DS}
 $V_{GS} = 15\text{V}$, T_j parameter

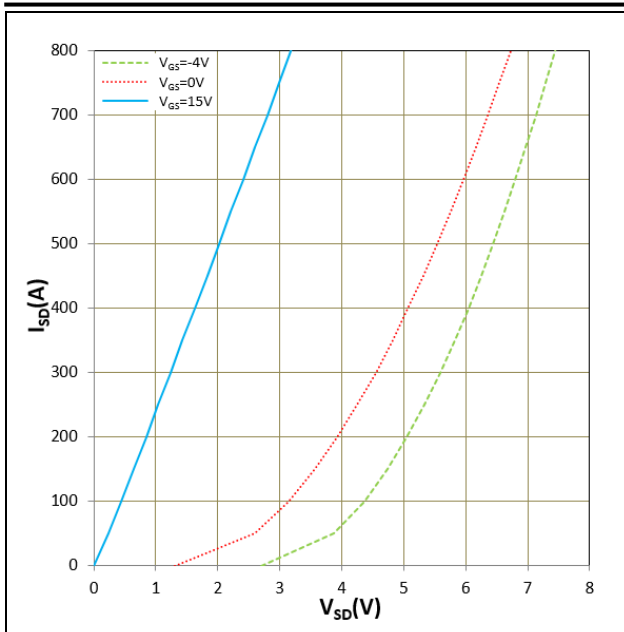


Figure 8. I_{SD} vs V_{SD}
 $T_j = 25^\circ\text{C}$, V_{GS} parameter

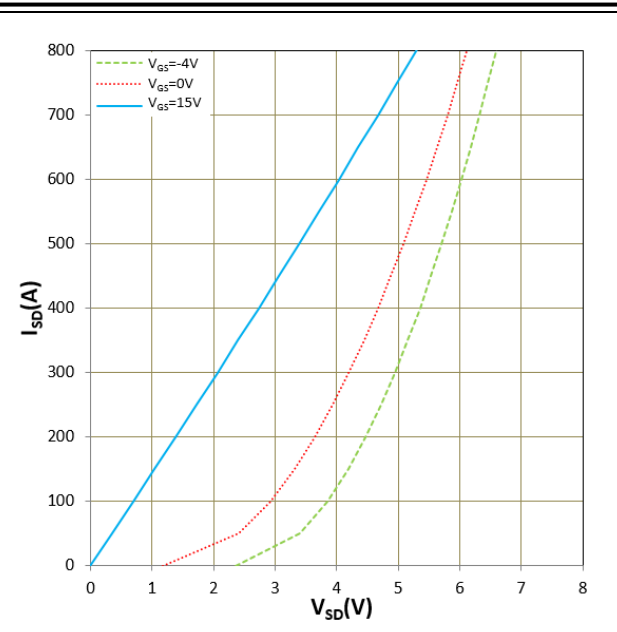


Figure 9. I_{SD} vs V_{SD}
 $T_j = 175^\circ\text{C}$, V_{GS} parameter

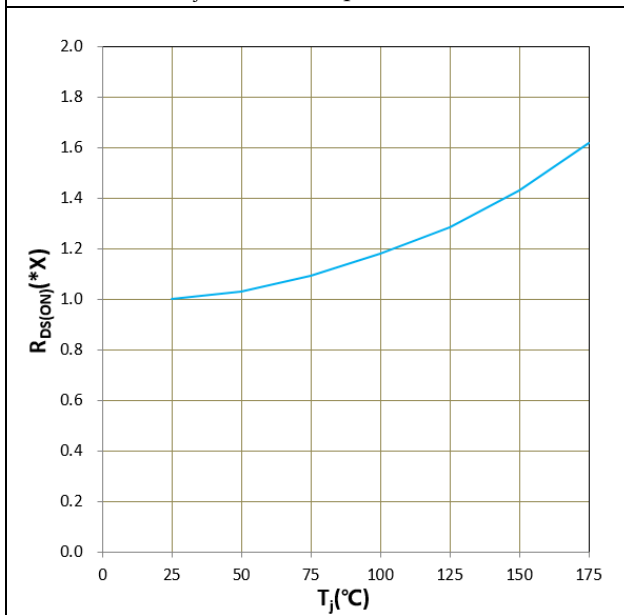


Figure 10. $R_{DS(on)}$ vs T_j
 $1.0x = 4.2\text{m}\Omega$, $I_D = 400\text{A}$

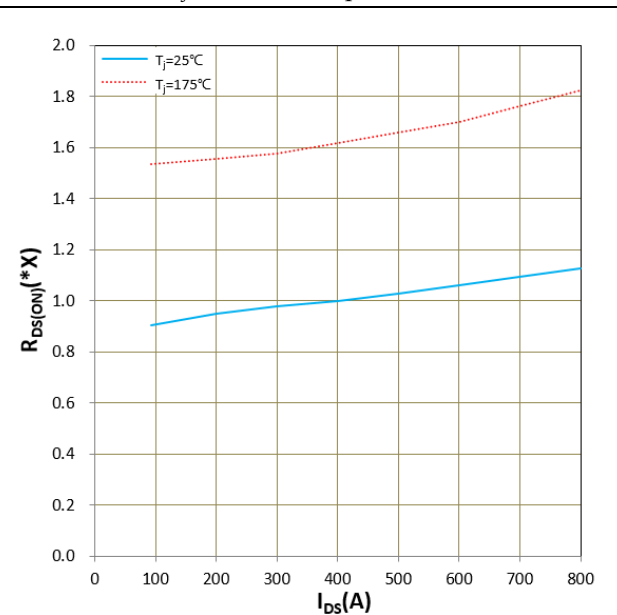


Figure 11. $R_{DS(on)}$ vs I_{DS}
 $1.0x = 4.2\text{m}\Omega$

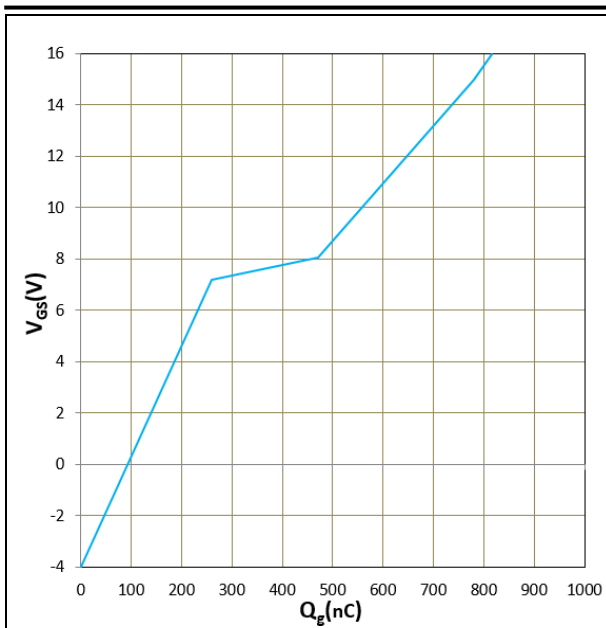


Figure 12. V_{GS} vs Q_g
 $T_j = 25^\circ\text{C}$, $V_{CC} = 800\text{V}$, $I_D = 400\text{A}$

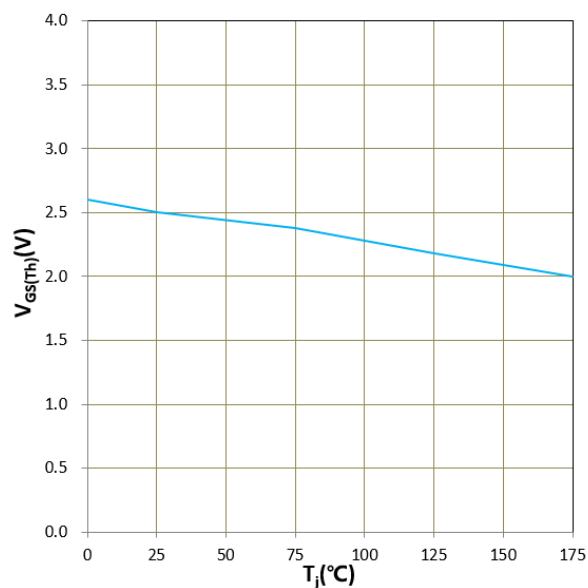


Figure 13. $V_{GS(TH)}$ vs T_j
 $V_{GS} = V_{DS}$, $I_D = 110\text{mA}$

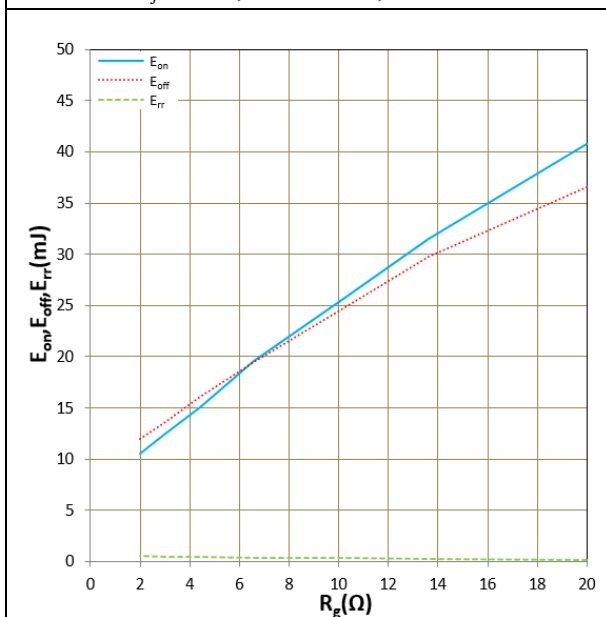


Figure 14. E_{on} , E_{off} , E_{rr} vs R_g
 $T_j = 25^\circ\text{C}$, $V_{CC} = 600\text{V}$, $I_D = 400\text{A}$, $V_{GS} = +15\text{V}/-4\text{V}$
 Inductive Load

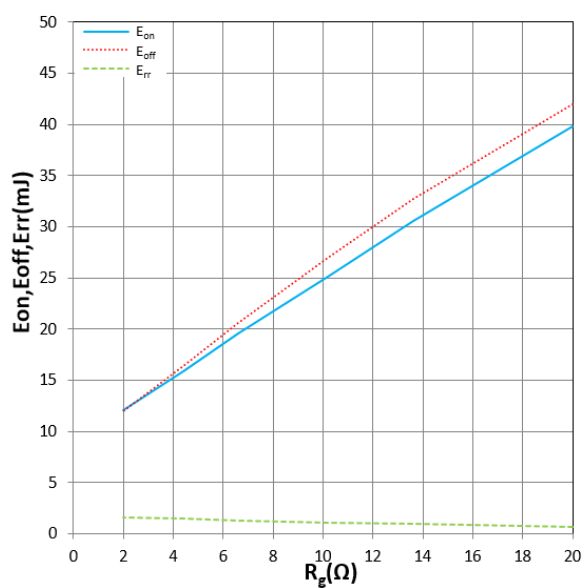


Figure 15. E_{on} , E_{off} , E_{rr} vs R_g
 $T_j = 150^\circ\text{C}$, $V_{CC} = 600\text{V}$, $I_D = 400\text{A}$, $V_{GS} = +15\text{V}/-4\text{V}$
 Inductive Load

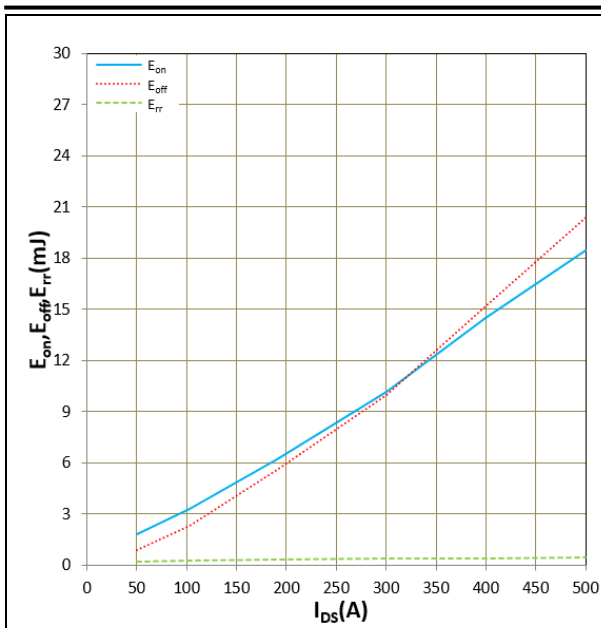


Figure 16. E_{on} , E_{off} , E_{rr} vs I_{DS}
 $T_j = 25^\circ\text{C}$, $V_{CC} = 600\text{V}$, $R_G = 4.5\Omega$, $V_{GS} = +15\text{V}/-4\text{V}$
 Inductive Load

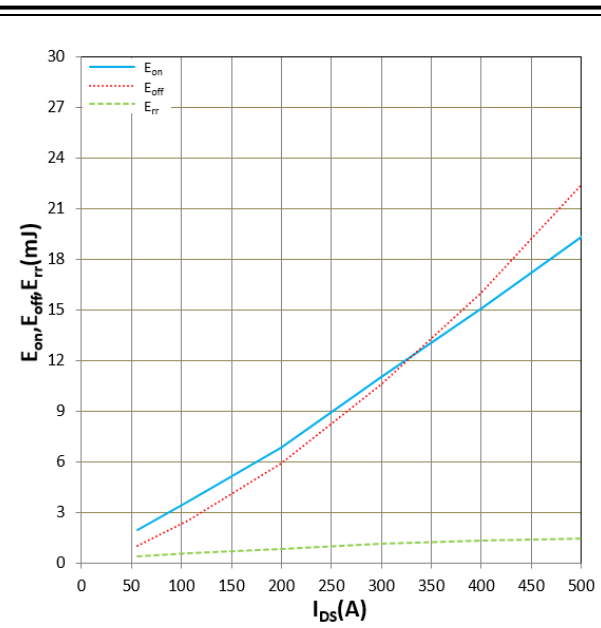


Figure 17. E_{on} , E_{off} , E_{rr} vs I_{DS}
 $T_j = 150^\circ\text{C}$, $V_{CC} = 600\text{V}$, $R_G = 4.5\Omega$, $V_{GS} = +15\text{V}/-4\text{V}$
 Inductive Load

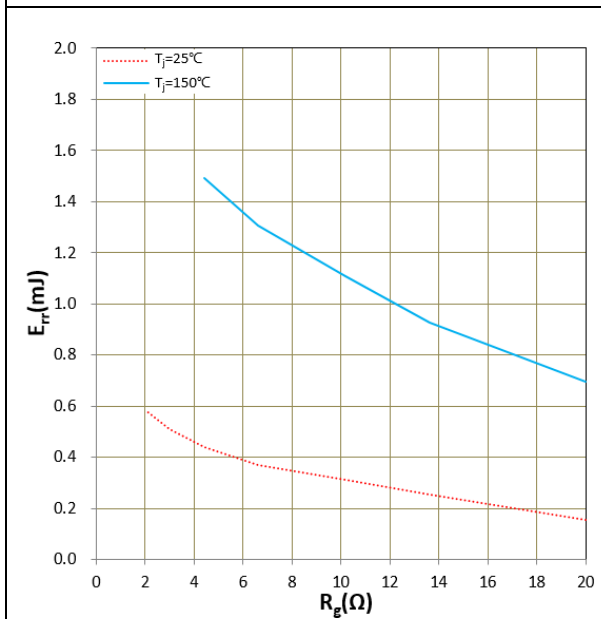


Figure 18. E_{rr} vs R_G
 $V_{DD} = 600\text{V}$, $I_F = 400\text{A}$, $V_{GS} = +15\text{V}/-4\text{V}$
 Inductive Load

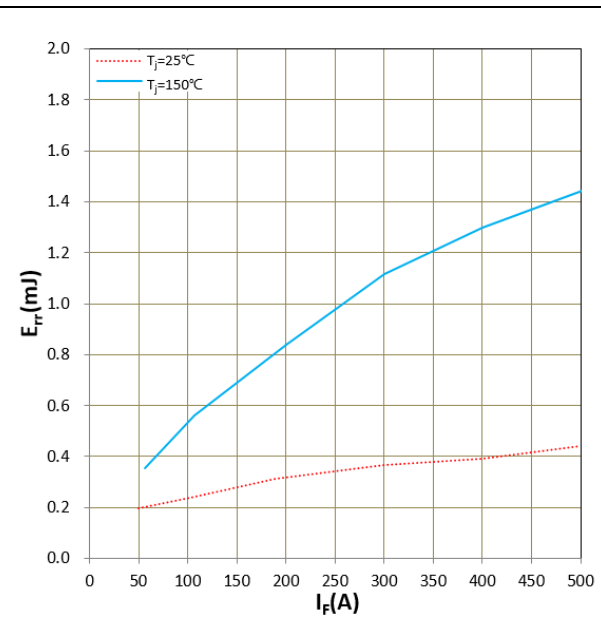


Figure 19. E_{rr} vs I_F
 $V_{DD} = 600\text{V}$, $R_G = 4.5\Omega$, $V_{GS} = +15\text{V}/-4\text{V}$
 Inductive Load

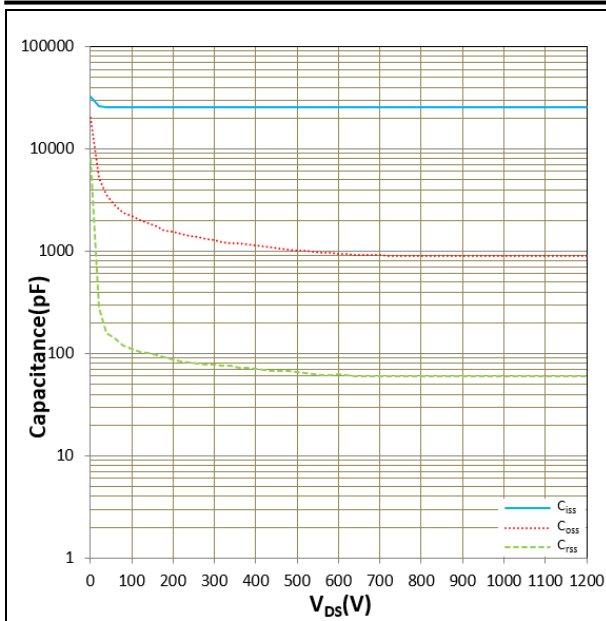


Figure 20. C_{iss} , C_{oss} , C_{rss} vs V_{DS}
 $T_j = 25^\circ\text{C}$

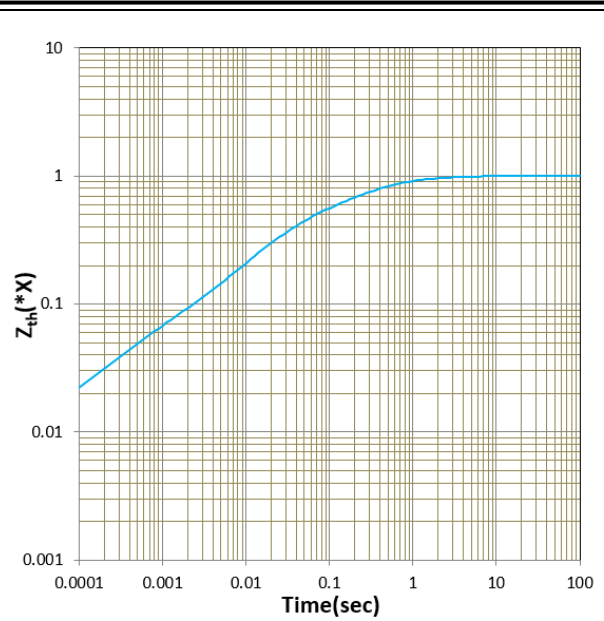


Figure 21. Transient thermal impedance
1.0x = 0.156K/W

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