

HCS400FC120D4C2

1200V/400A Chopper SiC MOSFET Module

Description

The HCS400FC120D4C2 is a Chopper SiC MOSFET Power Module. It integrates high performance SiC MOSFET chips designed for the applications such as xEV Application and Renewable energy.



Features

- Blocking Voltage 1700V
- $R_{DS(ON)}=5.2m\Omega@T_J=25^{\circ}C, V_{GS}=15V$
- Low Thermal Resistance with Si_3N_4 AMB
- 175°C Maximum Junction Temperature
- Low Inductive Design
- Thermistor Inside
- Pressfit Terminal
- Copper Base Size: 79mm*62mm

Application

- xEV Applications
- Converter
- Vehicle Fast Chargers
- Renewable Energy

Circuit Diagram

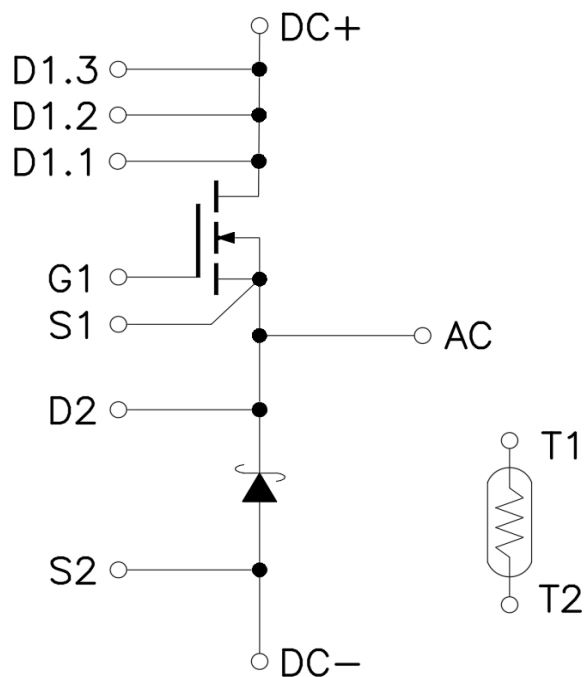


Figure 1. Out Drawing & Circuit Diagram HCS400FC120D4C2

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Physical Dimensions

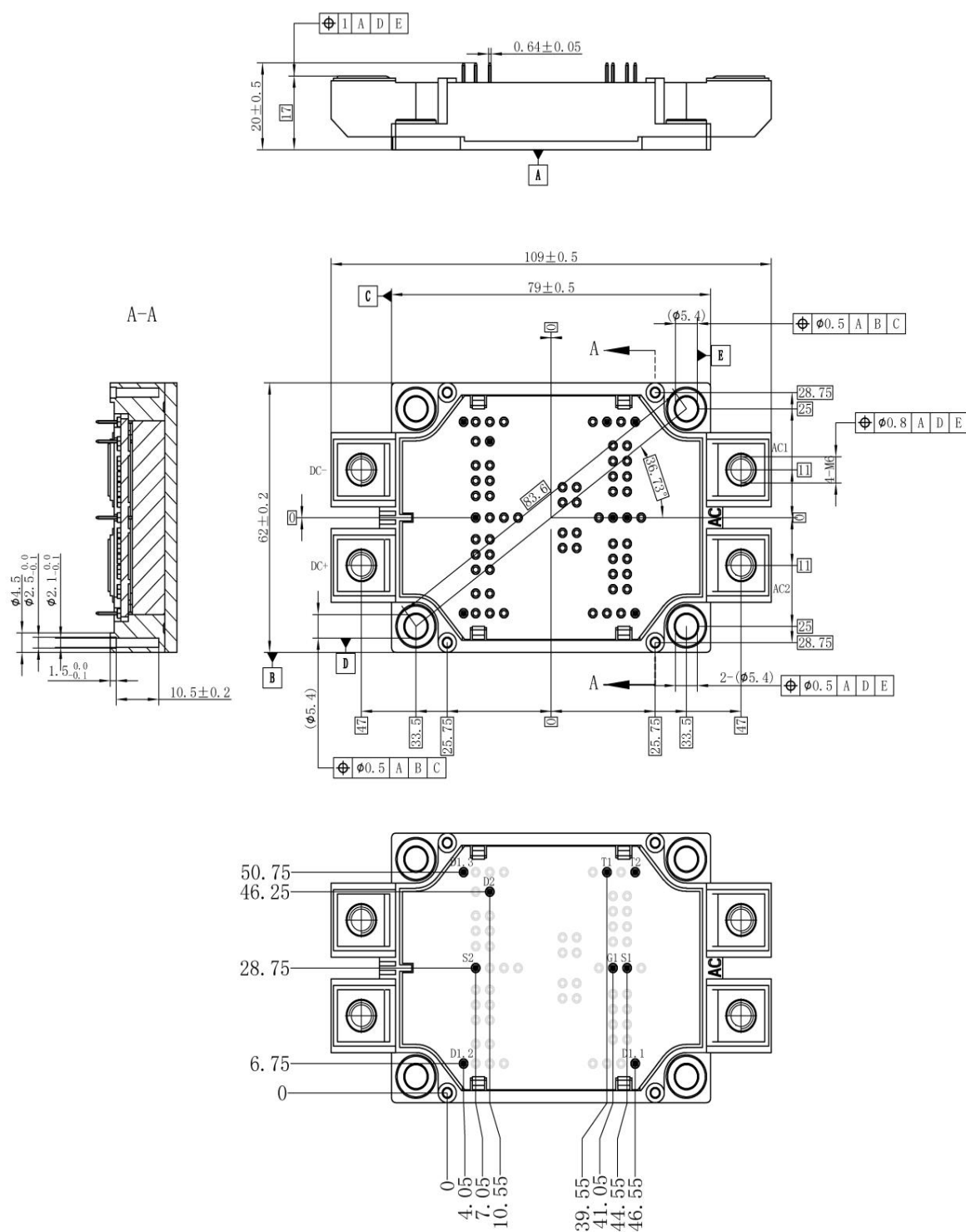


Figure 2. Physical Dimensions

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Pin Configuration

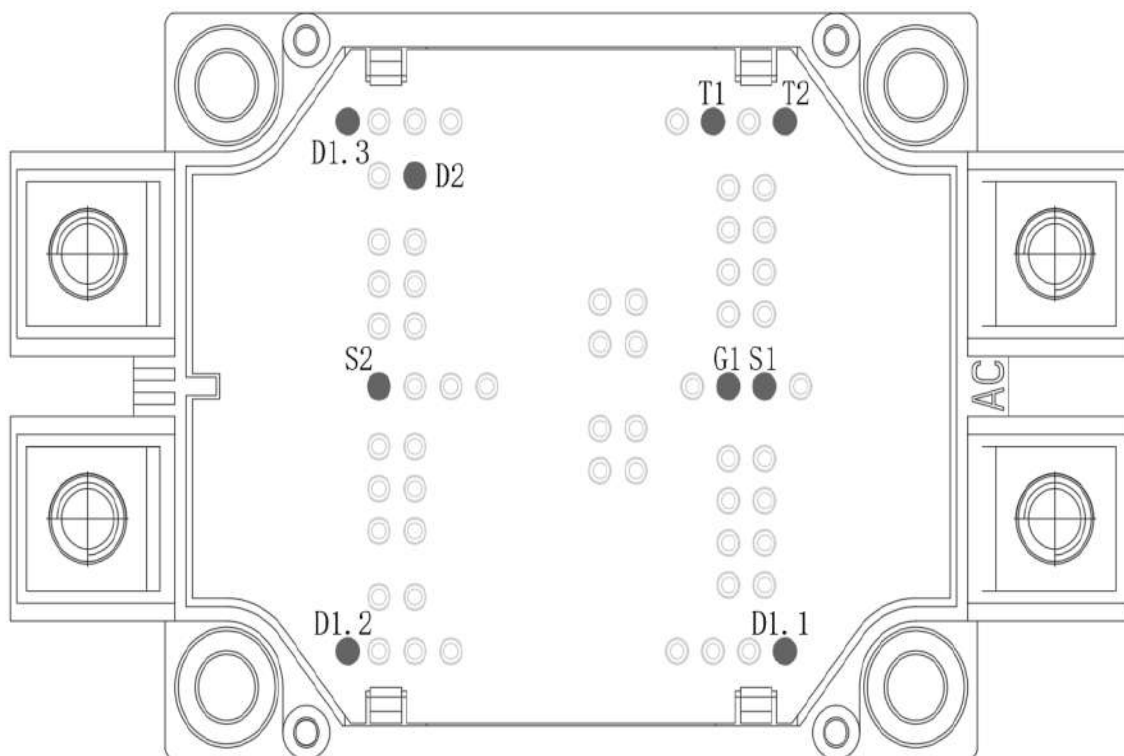


Figure 3. Pin Configuration

Module

Parameter	Conditions	Value	Unit
Isolation voltage	RMS, f =50Hz, t =1min	3.4	kV
Material of module baseplate	-	Cu	-
Creepage distance	terminal to heatsink terminal to terminal	14.5 10	mm
Clearance	terminal to heatsink terminal to terminal	12.5 10	mm
CTI	-	>400	-
Module lead resistance, terminals – chip	Tc=25°C	0.3	mΩ
Mounting torque for module mounting	M5, M6	3 to 6	Nm
Weight	-	250	g

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Maximum Ratings ($T_j=25^{\circ}\text{C}$ Unless Otherwise Specified)

Symbol	Parameter	Conditions	Value	Unit
V_{DS}	Drain-Source Voltage	G-S Short	1200	V
V_{GS}	Gate-Source Voltage	D-S Short, AC frequency • 4Hz, Note 1	-10 to 20	V
I_{DS}	DC Continuous Drain Current	$T_f=25^{\circ}\text{C}$, $V_{\text{GS}}=+15\text{V}$	370	A
I_{DS}	DC Continuous Drain Current	$T_f=65^{\circ}\text{C}$, $V_{\text{GS}}=+18\text{V}$	410	A
I_{DSM}	Pulse Forward Current	$T_c=65^{\circ}\text{C}$, Pulse width =1ms, $V_{\text{GS}}=15\text{V}$, Note2	800	A
I_{F}	Forward Current (Diode)	$T_f=65^{\circ}\text{C}$	450	A
I_{FRM}	Pulse Forward Current (Diode)	Less than 1ms, Note2	800	A
P_{tot}	Total Power Dissipation	$T_c=25^{\circ}\text{C}$	1720	W
T_{jmax}	Max Junction Temperature	-	175	$^{\circ}\text{C}$
T_{stg}	Storage Temperature	-	-40 to 125	$^{\circ}\text{C}$

Note1: Recommended Operating Value: +18V/-4V, +15V/-5V

Note2: Pulse width limited by maximum junction temperature

NTC Characteristics

Symbol	Parameter	Conditions	Value			Unit
			Min.	Typ.	Max.	
R25	Resistance	$T_c=25^{\circ}\text{C}$	-	5	-	k Ω
$\Delta R/R$	Deviation of R_{100}	$T_c=100^{\circ}\text{C}$, $R_{100}=493\Omega$	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

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MOSFET Electrical Characteristics (T_j=25°C Unless Otherwise Specified, Chip)

Symbol	Parameter	Conditions		Value			Unit
				Min.	Typ.	Max.	
V _{(BR)DSS}	Drain-Source Breakdown Voltage	V _{GS} =0V, I _D =400μA		1200	-	-	V
I _{DSS}	Zero gate voltage drain current	V _{DS} =1200V, V _{GS} =0V		-	4	-	μA
V _{GS(Th)}	Gate-source threshold voltage	I _D =140mA, V _{DS} =V _{GS}	T _J =25°C	1.8	2.7	-	V
I _{GSS}	Gate-Source Leakage Current	V _{GS} =20V, V _{DS} =0V	T _J =25°C	-	-	400	nA
R _{DS(on)} (Chip)	Static drain-source On-state resistance	I _D =400A, V _{GS} =+15V	T _J =25°C	-	5.4	10.3	mΩ
			T _J =175°C	-	7.7	-	mΩ
		I _D =400A, V _{GS} =+18V	T _J =25°C	-	4.50	10.3	mΩ
			T _J =175°C	-	6.40	10.3	mΩ
V _{DS(on)} (Chip)	Static drain-source On-state resistance	I _D =400A, V _{GS} =+15V	T _J =25°C	-	2.16	3.09	V
			T _J =175°C	-	3.08	-	V
		I _D =400A, V _{GS} =+18V	T _J =25°C	-	1.80	-	V
			T _J =175°C	-	2.56	-	V
V _{SD}	Body Diode Forward Voltage	V _{GS} =0V, I _{SD} =400A	T _J =25°C	-	5.2	-	V
			T _J =175°C	-	4.3	-	V
C _{iss}	Input capacitance	V _{DS} =800V, V _{GS} =0V, f=100KHz		-	23.3	-	nF
C _{oss}	Output capacitance			-	0.70	-	nF
C _{rss}	Reverse transfer capacitance			-	0.057	-	nF
Q _g	Total gate charge	VDD=800V, ID=240A, VGS=-5/+15V		-	720	-	nC
t _{d(on)}	Turn-on delay time	V _{DD} =600V I _D =400A V _{GS} =+15/-4V R _{G(ON)} =5.1Ω R _{G(OFF)} =3.3Ω Inductive load switching operation	T _J =25°C	-	56	-	ns
			T _J =150°C	-	49	-	
t _r	Rise time		T _J =25°C	-	33	-	ns
			T _J =150°C	-	27	-	
t _{d(off)}	Turn-off delay time		T _J =25°C	-	119	-	ns
			T _J =150°C	-	131	-	
t _f	Fall time		T _J =25°C	-	19	-	ns
			T _J =150°C	-	48	-	
E _{on}	Turn-on power dissipation		T _J =25°C	-	13.64	-	mJ
			T _J =150°C	-	13.43	-	
E _{off}	Turn-off power dissipation		T _J =25°C	-	5.64	-	mJ
			T _J =150°C	-	6.11	-	
R _{th(j-c)}	FET Thermal Resistance	Junction to Case		-	0.087	-	K/W
R _{th(c-f)}	Contact thermal Resistance	With thermal conductive grease, Note1		-	0.015	-	K/W

Note1: Assumes Thermal Conductivity of grease is 0.9W/m• K and thickness is 50um.

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SiC SBD Electrical Characteristics ($T_j=25^{\circ}\text{C}$ Unless Otherwise Specified, Chip)

Symbol	Parameter	Conditions		Value			Unit
				Min.	Typ.	Max.	
V_{DC}	DC blocking Voltage	$T_j=25^{\circ}\text{C}$		-	1200	-	V
V_{BR}	Breakdown Voltage	$R=20\text{mA}$, $T_j=25^{\circ}\text{C}$		-	1350	-	V
V_F	Forward Voltage	$I_F=400$	$T_j=25^{\circ}\text{C}$	-	1.75	-	V
			$T_j=175^{\circ}\text{C}$	-	2.83	-	
I_{RRM}	Reverse Current	$V_{RRM}=1200\text{V}$	$T_j=25^{\circ}\text{C}$	-	24	400	μA
			$T_j=175^{\circ}\text{C}$	-	772	3000	
Q_C	Total Capacitive Charge	$V_R=800\text{V}$	$T_j=25^{\circ}\text{C}$	-	1076	-	nc
C	Total Capacitance	$f=1\text{MHz}$	$V_R=1\text{V}$	-	12160	-	pF
			$V_R=400\text{V}$	-	1012	-	
			$V_R=800\text{V}$	-	724	-	
T_{rr}	Reverse Recovery Time	$V_{RR}=600\text{V}$ $I_F=400\text{A}$ $V_{GS}=+15/-4\text{V}$ $R_G=6.8\Omega$ Inductive load	$T_j=25^{\circ}\text{C}$	-	17	-	μC
			$T_j=150^{\circ}\text{C}$	-	14	-	
E_{rr}	Diode Switching Power Dissipation		$T_j=25^{\circ}\text{C}$	-	0.6	-	mJ
			$T_j=150^{\circ}\text{C}$	-	0.87	-	
$R_{th(j-c)}$	SiC SBD Thermal Resistance	Junction to Case		-	0.06	-	K/W
$R_{th(c-f)}$	Contact thermal Resistance	With thermal conductive grease Note1		-	0.015	-	K/W

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Test Conditions

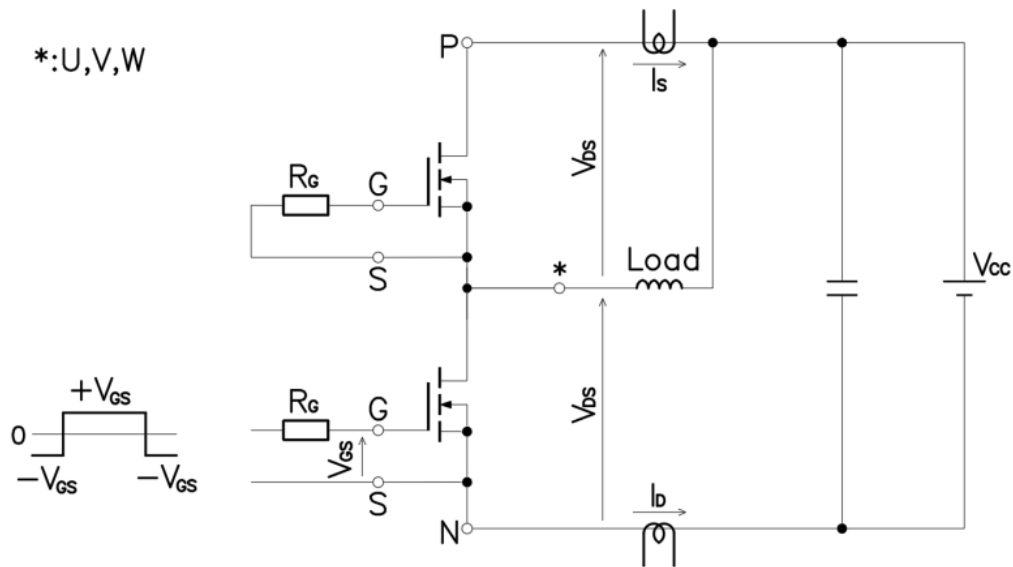


Figure 4. Switching Time Measure Circuit

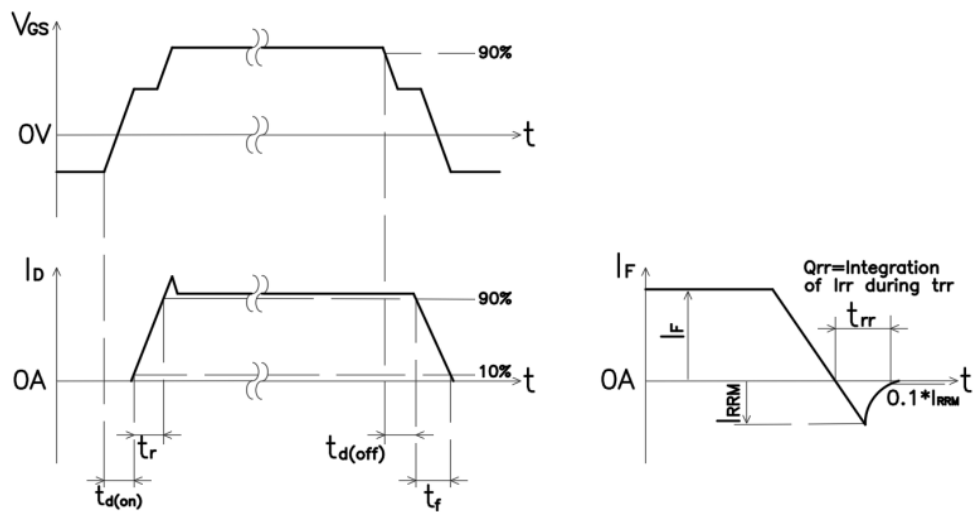


Figure 5. Switching Time Definition

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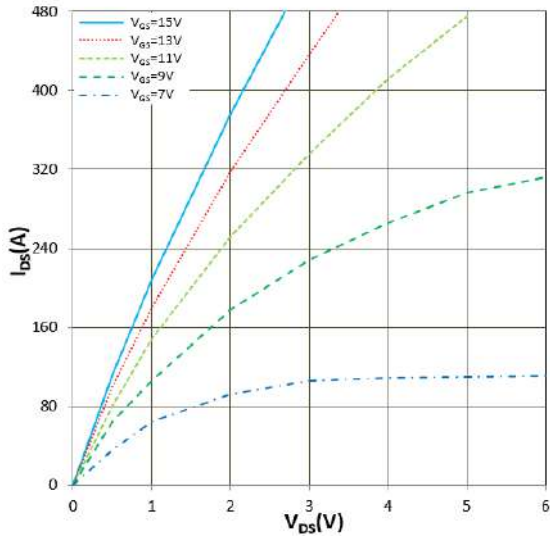


Figure 6. I_{DS} VS V_{DS}
 $T_J = 25^\circ\text{C}$

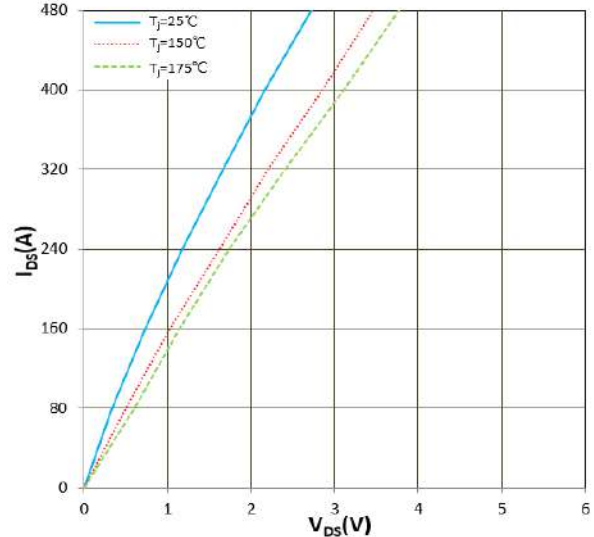


Figure 7. I_{DS} VS V_{DS}
 $V_{GS} = +15\text{V}$

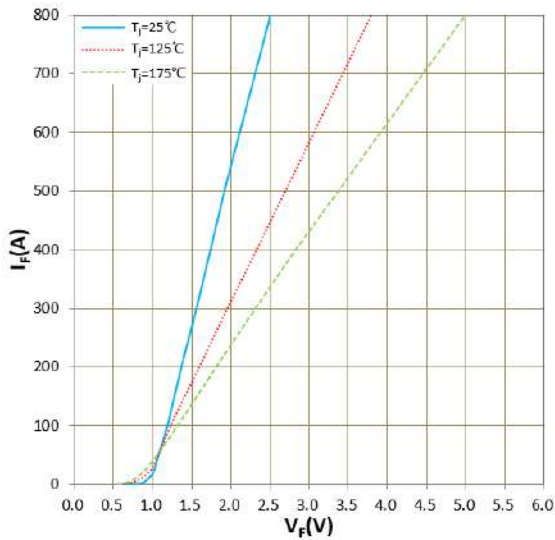


Figure 8. I_{DS} (I_F) VS V_{DS} (V_F)
 T_J Parameter

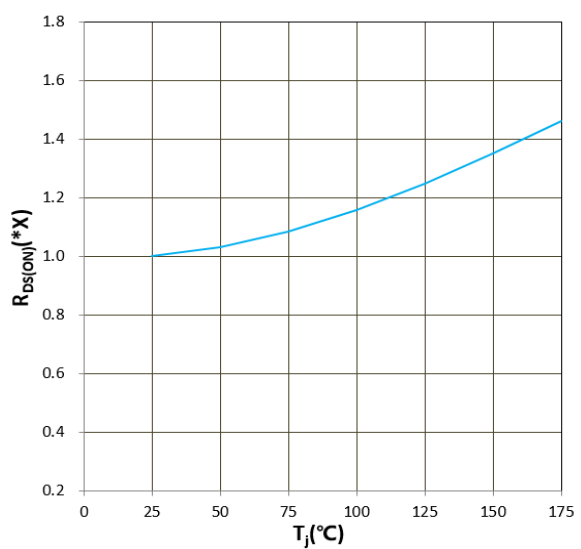
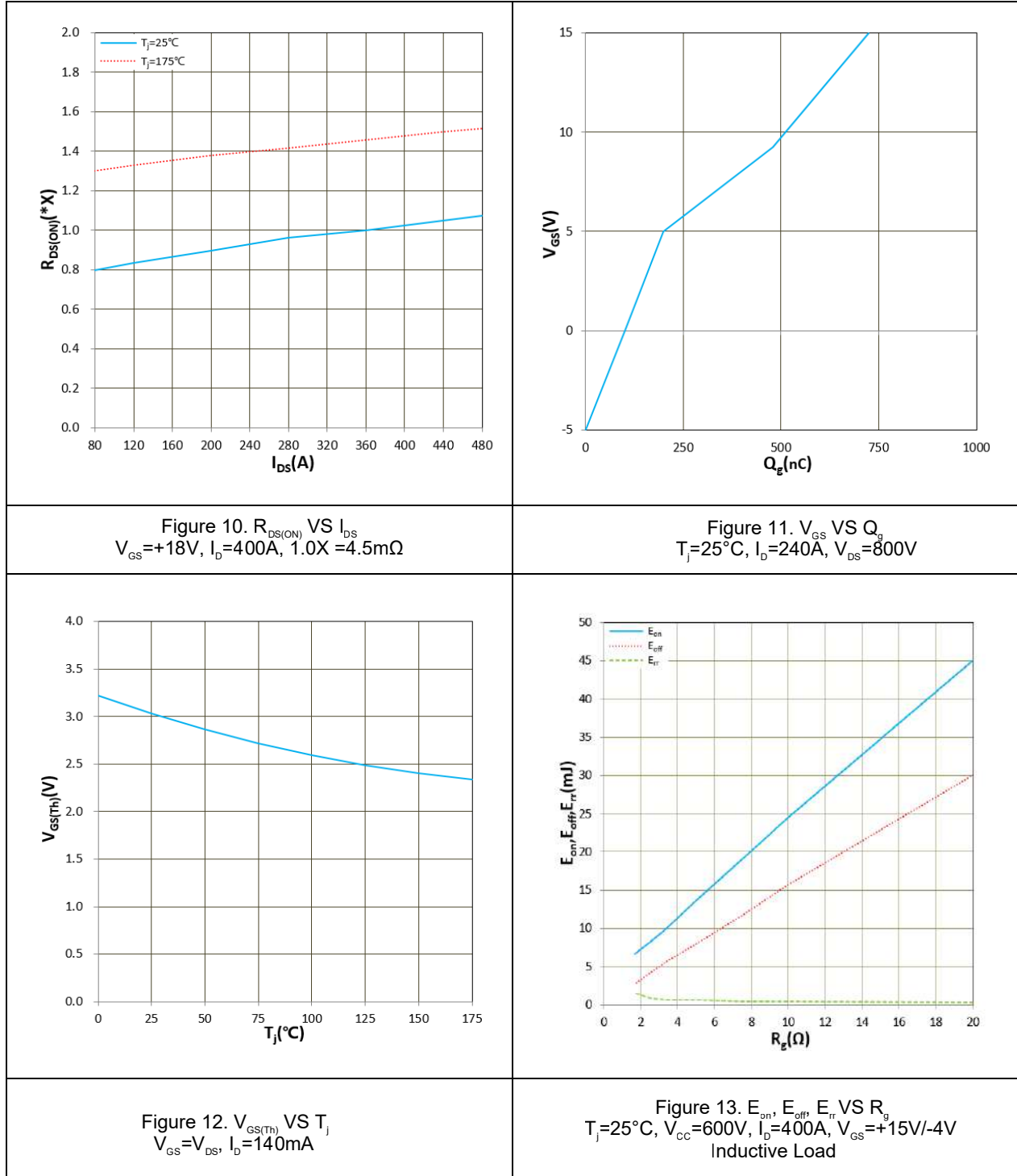


Figure 9. $R_{DS(on)}$ VS T_J
 $V_{GS} = +18\text{V}$, $I_D = 400\text{A}$, $1.0X = 4.5\text{m}\Omega$

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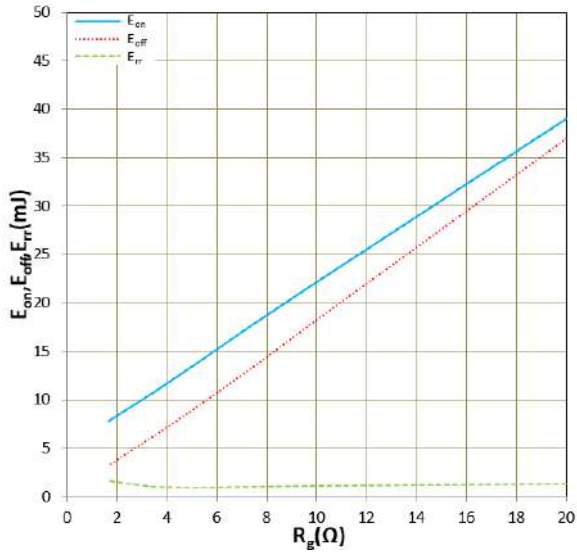


Figure 14. E_{on} , E_{off} , E_{rr} VS R_g
 $T_j=150^{\circ}\text{C}$, $V_{CC}=600\text{V}$, $I_D=400\text{A}$, $V_{GS}=+15\text{V}/-4\text{V}$
 Inductive Load

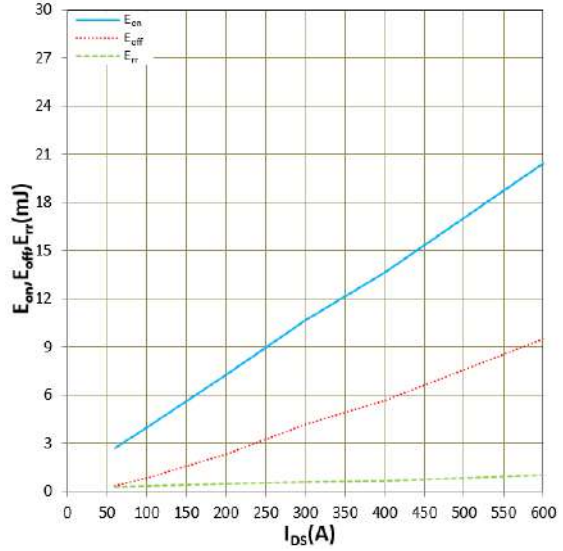


Figure 15. E_{on} , E_{off} , E_{rr} VS I_{DS}
 $T_j=25^{\circ}\text{C}$, $V_{CC}=600\text{V}$, $V_{GS}=+15\text{V}/-4\text{V}$,
 $R_{G(ON)}/R_{G(OFF)}=5.1/3.3\Omega$, Inductive Load

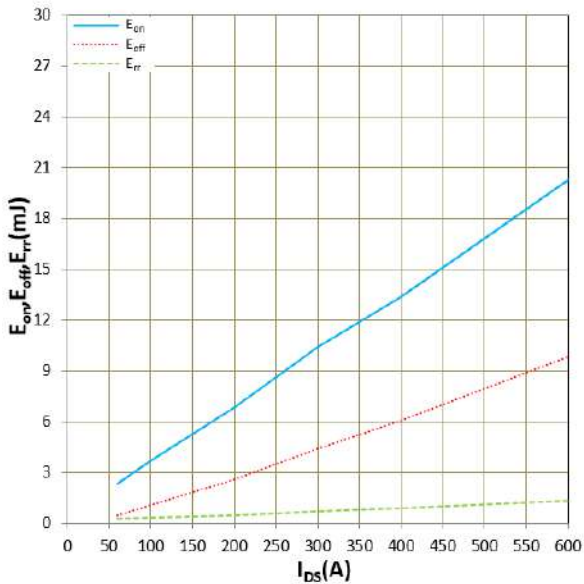


Figure 16. E_{on} , E_{off} , E_{rr} VS I_{DS}
 $T_j=150^{\circ}\text{C}$, $V_{CC}=600\text{V}$, $V_{GS}=+15\text{V}/-4\text{V}$
 $R_{G(ON)}/R_{G(OFF)}=5.1/3.3\Omega$, Inductive Load

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Revision History

Document Version	Description of Changes
RevX.0.1	Released

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