

# HCS02FS140HDA1S

## 1400V/800A 3 Phase SiC MOSFET Module

### Description

The HCS02FS140HDA1S is a 3 Phase SiC MOSFET Power Module. It integrates high performance SiC MOSFET chips for xEV or motor drives application.



### Features

- Blocking Voltage 1400V
- $R_{DS(on)}=2.5m\Omega$  ( $V_{GS}=20V, T_j=25^\circ C$ )
- 175°C Maximum Junction Temperature
- Si<sub>3</sub>N<sub>4</sub> AMB Substrate
- Direct Cooled Pin Fin Base Plate
- Thermistor Inside
- Press FIT Contact Technology

### Application

- xEV Applications
- Motor Drives

### Circuit Diagram

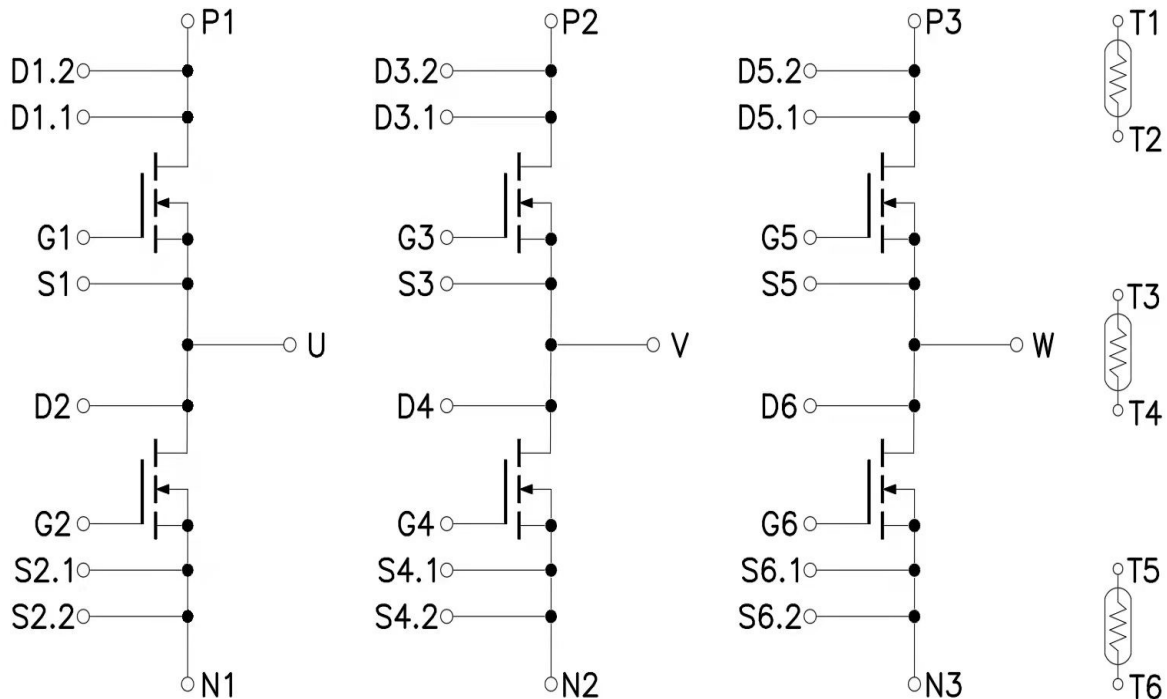
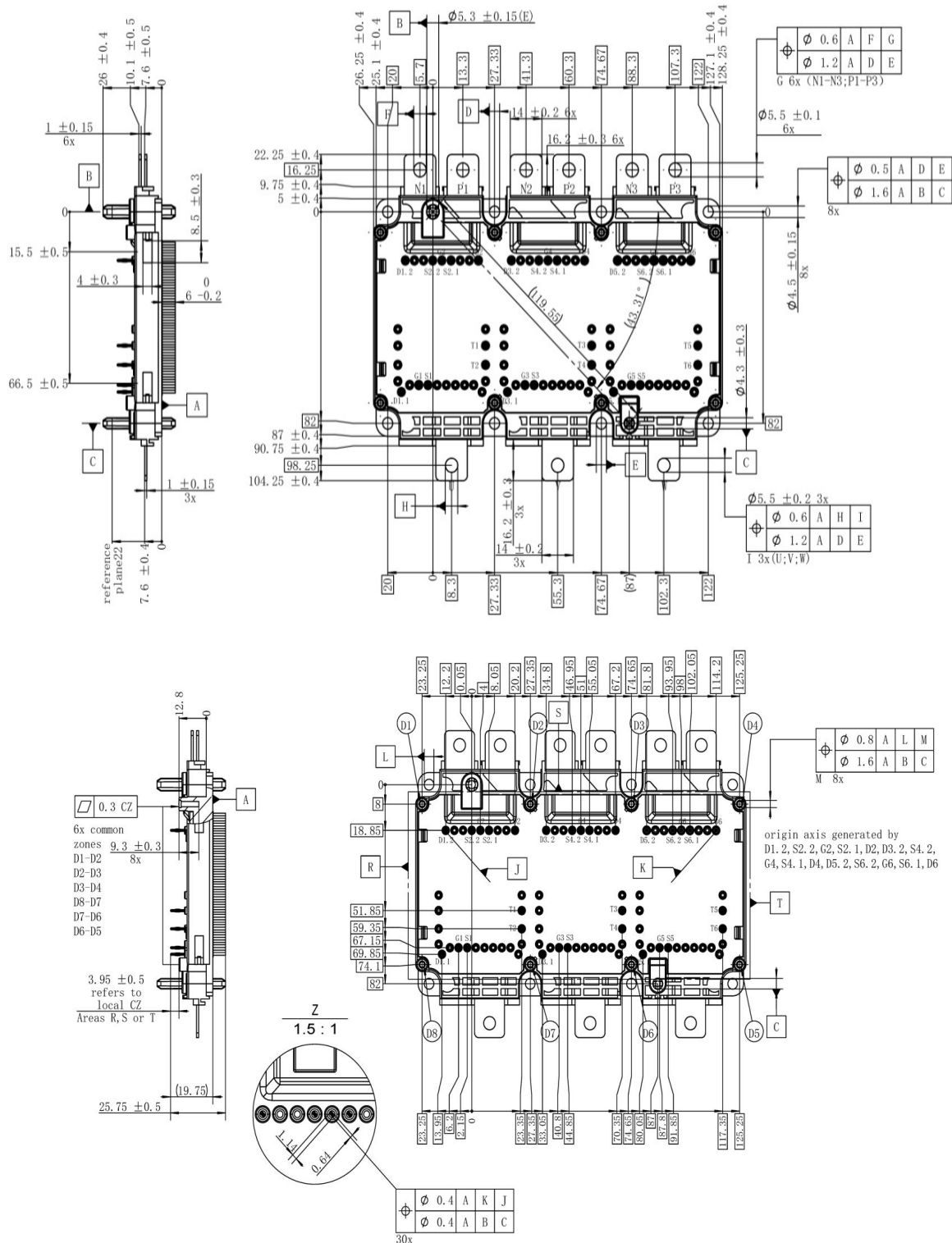


Figure 1. Out Drawing & Circuit Diagram HCS02FS140HDA1S

# HCS02FS140HDA1S

## 1400V/800A 3 Phase SiC MOSFET Module

### Physical Dimensions



# HCS02FS140HDA1S

## 1400V/800A 3 Phase SiC MOSFET Module

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

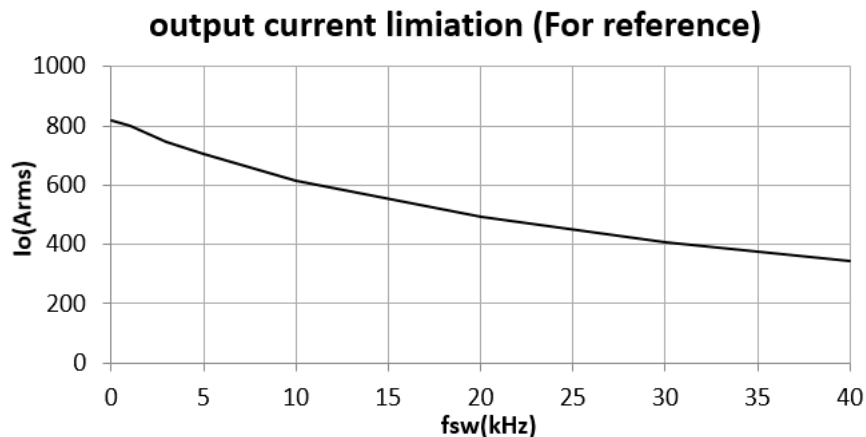
Symbol	Parameter	Conditions	Value	Unit
$V_{\text{DSS}}$	Drain-Source Voltage	G-S Short	1400	V
$V_{\text{DS nom}}$	Continuous Operating DC Voltage	Not include surge voltage	1200	V
$V_{\text{GSS}}$	Gate-Source Voltage	D-S Short, AC frequency • 4Hz, Note1	-10V/+25V	V
$I_{\text{DS}}$	DC Continuous Drain Current	$T_f=25^{\circ}\text{C}$ , $V_{\text{GS}}=20\text{V}$	700	A
		$T_f=25^{\circ}\text{C}$ , $V_{\text{GS}}=20\text{V}$	600	A
$I_{\text{DS}}$	DC Continuous Drain Current	$T_f=65^{\circ}\text{C}$ , $V_{\text{GS}}=18\text{V}$	690	A
		$T_f=25^{\circ}\text{C}$ , $V_{\text{GS}}=18\text{V}$	590	A
$I_{\text{SD}}$	Source (Body Diode) Current	$T_f=25^{\circ}\text{C}$ , with ON signal	700	A
$I_{\text{SD}}$	Source (Body Diode) Current	$T_f=65^{\circ}\text{C}$ , with ON signal	600	A
$I_{\text{DP}}$	Drain Pulse Current, Peak	Less than 1ms, Note2	1600	A
$P_{\text{D}}$	Maximum Power Dissipation	$T_f=25^{\circ}\text{C}$	2308	W
$T_j$	Junction temperature	-	-40 to 175	$^{\circ}\text{C}$
$T_{\text{stg}}$	Storage temperature	-	-40 to 125	$^{\circ}\text{C}$

Note1: Recommended Operating Value: +20V/-5V, +20V/-4V, +18V/-5V, +18V/-4V

Note2: Pulse width limited by maximum junction temperature

### Typical Current Output Ability

Condition: SPWM control,  $V_{\text{CC}}=900\text{V}$ ,  $V_{\text{GS}}=+18\text{V}/-5\text{V}$ ,  $R_{\text{g(ON)}}=R_{\text{g(OFF)}}=5.6\Omega$ ,  $T_f=65^{\circ}\text{C}$ ,  $T_{\text{jmax}}=175^{\circ}\text{C}$ , PF=0.8, Modulation rate=1



Note1: This graph is calculated value for reference based on the limitation of  $T_{\text{jmax}}=175^{\circ}\text{C}$ . The actual current out ability depends on inverter electrical, thermal and mechanic design. Please confirm it in actual application system.

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### 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	$T_f = 65^\circ\text{C}$	0.5	m $\Omega$
Mounting torque for module mounting	Screw M4 baseplate to heatsink	1.8 to 2.2	Nm
Weight	-	780	g

### NTC Characteristics

Symbol	Parameter	Conditions	Value			Unit
			Min.	Typ.	Max.	
R25	Resistance	$T_c = 25^\circ\text{C}$	-	5	-	k $\Omega$
$\Delta R/R$	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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## 1400V/800A 3 Phase SiC MOSFET Module

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

Symbol	Parameter	Conditions	Value			Unit	
			Min.	Typ.	Max.		
$V_{(BR)DSS}$	Drain-Source Breakdown Voltage	$V_{GS}=0V, I_D=800\mu A$	1400	-	-	V	
$I_{DSS}$	Zero gate voltage drain current	$V_{DS}=1200V, V_{GS}=0V$	-	8	400	$\mu A$	
$V_{GS(Th)}$	Gate-source threshold voltage	$I_D=160mA$ $V_{DS}=V_{GS}$	$T_j=25^\circ\text{C}$	1.9	2.45	3.8	V
			$T_j=150^\circ\text{C}$	-	1.70	-	V
			$T_j=175^\circ\text{C}$	-	1.60	-	V
$I_{GSS}$	Gate-Source Leakage Current	$V_{GS}=20V, V_{DS}=0V$	-	8	1600	nA	
		$V_{GS}=-5V, V_{DS}=0V$	-1600	-8	0	nA	
$R_{DS(on)}$ (Chip)	Static drain-source On-state resistance	$I_D=800A$ $V_{GS}=20V$	$T_j=25^\circ\text{C}$	-	2.5	-	m $\Omega$
			$T_j=175^\circ\text{C}$	-	4.7	-	m $\Omega$
	Static drain-source On-state resistance	$I_D=800A$ $V_{GS}=18V$	$T_j=25^\circ\text{C}$	-	2.7	-	m $\Omega$
			$T_j=175^\circ\text{C}$	-	4.80	-	m $\Omega$
$V_{DS(on)}$ (Chip)	Static drain-source On-state resistance	$I_D=800A$ $V_{GS}=20V$	$T_j=25^\circ\text{C}$	-	2.00	-	V
			$T_j=175^\circ\text{C}$	-	3.76	-	V
		$I_D=800A$ $V_{GS}=18V$	$T_j=25^\circ\text{C}$	-	2.16	-	V
			$T_j=175^\circ\text{C}$	-	3.84	-	V
$C_{iss}$	Input capacitance	$V_{DS}=1000V$ $V_{GS}=0V$ $f=100kHz$	-	38.2	-	nF	
$C_{oss}$	Output capacitance		-	1.73	-	nF	
$C_{rss}$	Reverse transfer capacitance		-	0.13	-	nF	
$Q_g$	Total gate charge	$V_{DS}=800V$ $I_D=400A$ $V_{GS}=+20/-5V$	-	1912	-	nC	
$Q_{gs}$	Gate to source charge		-	496	-	nC	
$Q_{gd}$	Gate to drain charge		-	624	-	nC	
$R_{gint}$	Internal gate resistance	$f=1MHz$	-	1.1	-	$\Omega$	
$t_{d(on)}$	Turn-on delay tim	$V_{DD}=900V$ $I_D=800A$ $V_{GS}=+18/-5V$ $R_{G(ON)}=5.6\Omega$ $R_{G(OFF)}=5.6\Omega$ Inductive load Switching operation	$T_j=25^\circ\text{C}$	-	162	-	ns
			$T_j=150^\circ\text{C}$	-	144	-	
$t_r$	Rise time		$T_j=25^\circ\text{C}$	-	113	-	ns
			$T_j=150^\circ\text{C}$	-	105	-	
$t_{d(off)}$	Turn-off delay time		$T_j=25^\circ\text{C}$	-	392	-	ns
			$T_j=150^\circ\text{C}$	-	470	-	
$t_f$	Fall time		$T_j=25^\circ\text{C}$	-	69	-	ns
			$T_j=150^\circ\text{C}$	-	79	-	
$E_{on}$	Turn-on power dissipation		$T_j=25^\circ\text{C}$	-	87.9	-	mJ
			$T_j=150^\circ\text{C}$	-	87.5	-	
$E_{off}$	Turn-off power dissipation	$T_j=25^\circ\text{C}$	-	82.1	-	mJ	
		$T_j=150^\circ\text{C}$	-	89.8	-		
$R_{th(j-f)}$	FET Thermal Resistance	Junction to cooling fluid $\Delta V/\Delta t=10dm^3/min, T_f=65^\circ\text{C}$	-	0.065	-	K/W	

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

Symbol	Parameter	Conditions	Value			Unit	
			Min.	Typ.	Max.		
$V_{SD}$	Body Diode Forward Voltage	$V_{GS}=-5\text{V}$ $I_{SD}=800\text{A}$	$T_j=25^\circ\text{C}$	-	5.8	-	V
			$T_j=175^\circ\text{C}$	-	5.2	-	
$T_{rr}$	Reverse Recovery Time	$V_{DD}=900\text{V}$ $I_D=800\text{A}$ $V_{GS}=+18/-5\text{V}$ $R_{G(ON)}=R_{G(OFF)}=5.6\Omega$ Inductive loads Switching operation	$T_j=25^\circ\text{C}$	-	41	-	ns
			$T_j=150^\circ\text{C}$	-	76	-	
$Q_{rr}$	Reverse Recovery Charge	$V_{DD}=900\text{V}$ $I_D=800\text{A}$ $V_{GS}=+18/-5\text{V}$ $R_{G(ON)}=R_{G(OFF)}=5.6\Omega$ Inductive loads Switching operation	$T_j=25^\circ\text{C}$	-	3.42	-	$\mu\text{C}$
			$T_j=150^\circ\text{C}$	-	13.2	-	
$E_{rr}$	Diode Switching Power Dissipation	$V_{DD}=900\text{V}$ $I_D=800\text{A}$ $V_{GS}=+18/-5\text{V}$ $R_{G(ON)}=R_{G(OFF)}=5.6\Omega$ Inductive loads Switching operation	$T_j=25^\circ\text{C}$	-	0.69	-	mJ
			$T_j=150^\circ\text{C}$	-	3.52	-	

### Test Conditions

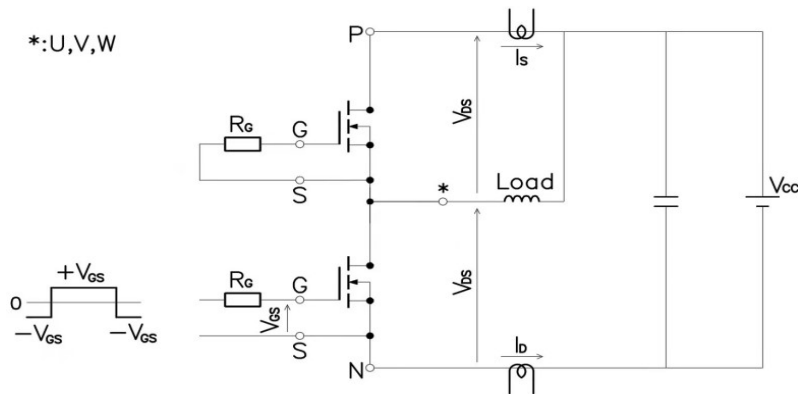


Figure 3. Switching Time Measure Circuit

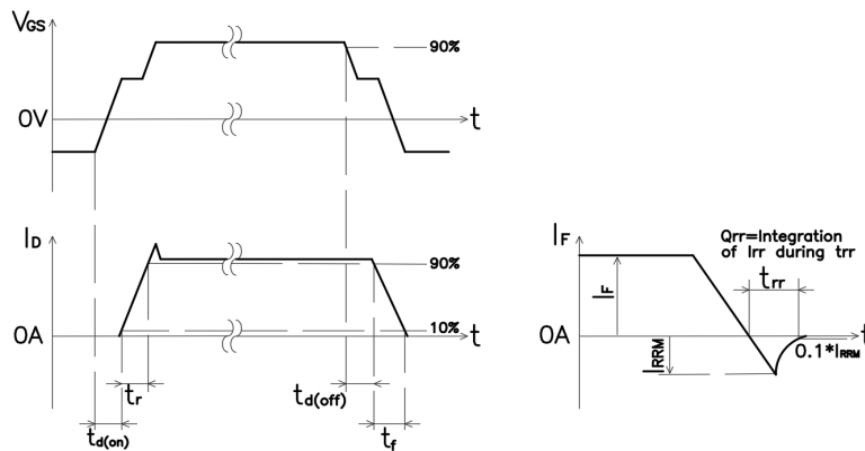


Figure 4. Switching Time Definition

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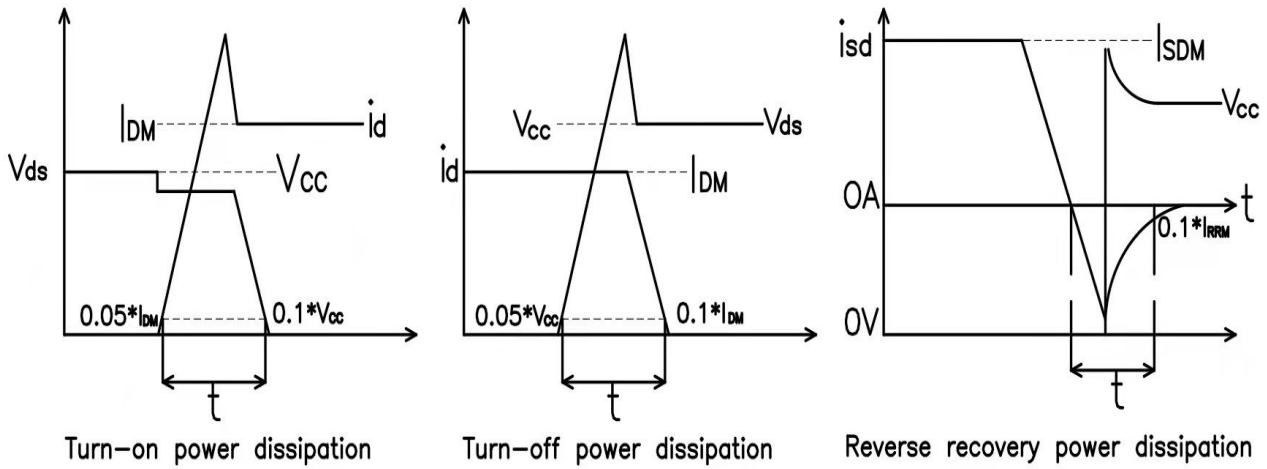


Figure 4. Switching Power Dissipation Definition

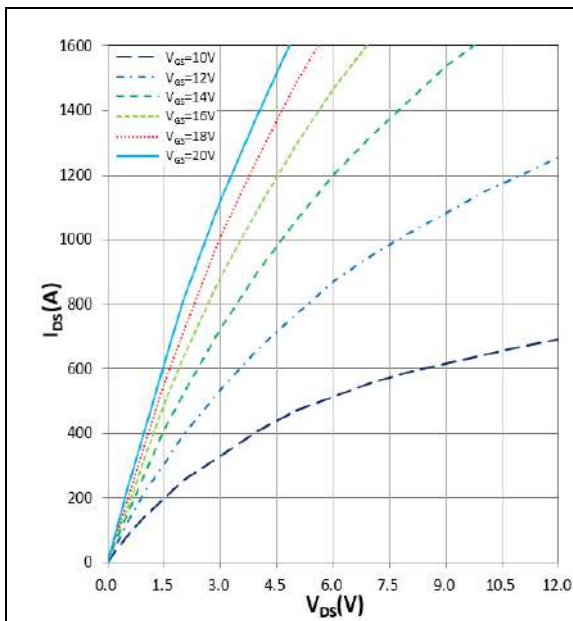


Figure 6.  $I_{DS}$  VS  $V_{DS}$   
 $T_j = 25^\circ\text{C}$ ,  $V_{GS}$  Parameter

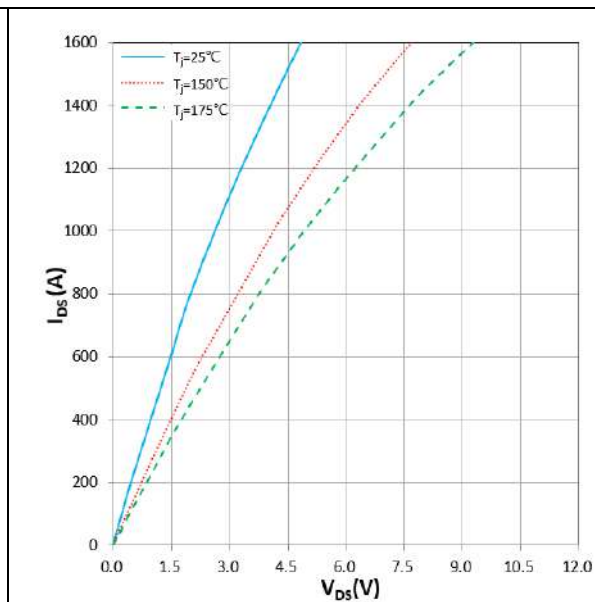


Figure 7.  $I_{DS}$  VS  $V_{DS}$   
 $V_{GS} = 20\text{V}$ ,  $T_j$  Parameter

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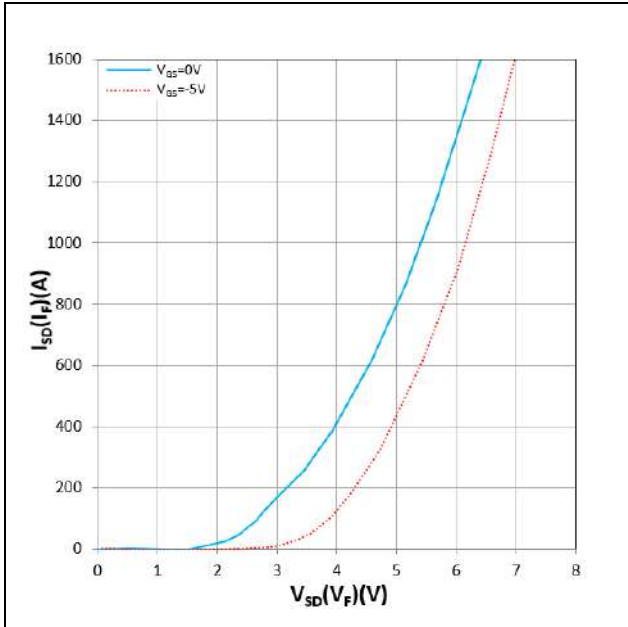


Figure 8.  $I_{SD}$  VS  $V_{SD}$   
 $T_j=25^{\circ}\text{C}$ ,  $V_{GS}$  Parameter

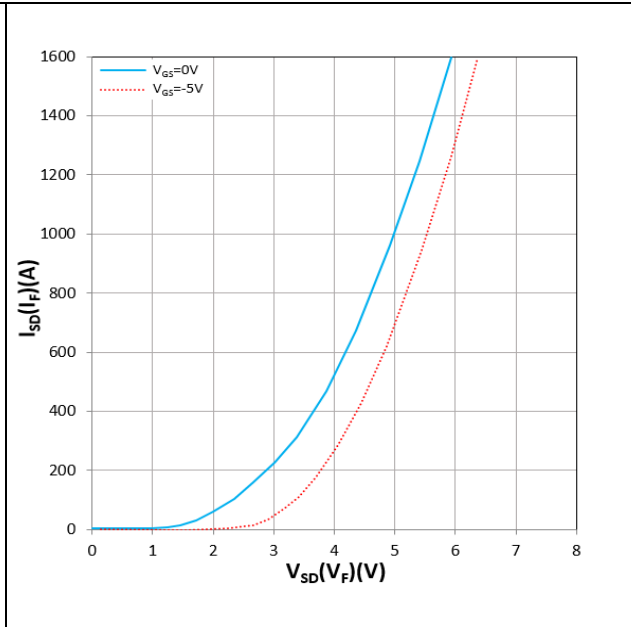


Figure 9.  $I_{SD}$  VS  $V_{SD}$   
 $T_j=175^{\circ}\text{C}$ ,  $V_{GS}$  Parameter

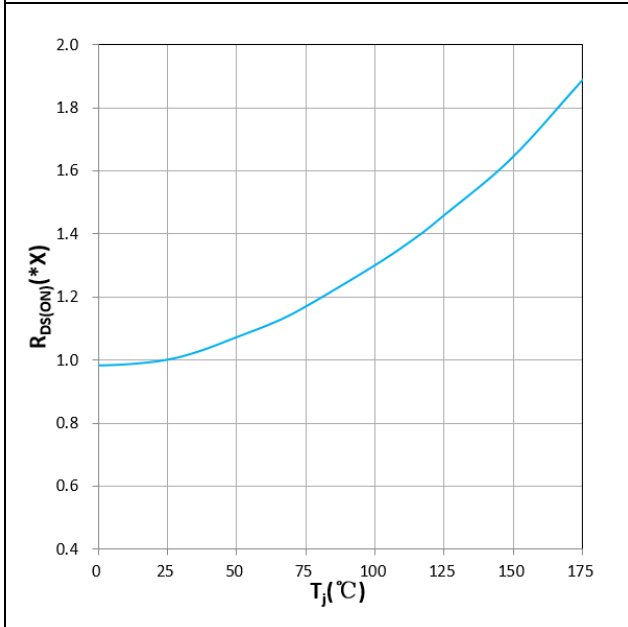


Figure 10.  $R_{DS(ON)}$  VS  $T_j$   
 $V_{GS}=+20\text{V}$ ,  $I_b=800\text{A}$ ,  $1.0X=2.5\text{m}\Omega$

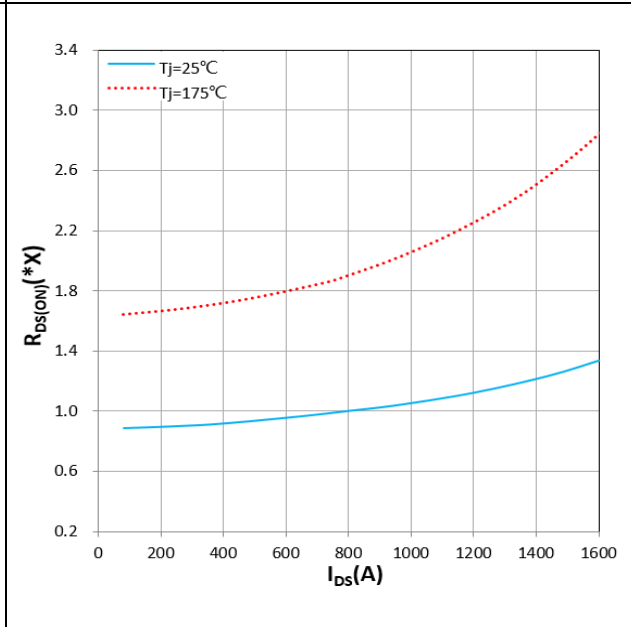


Figure 11.  $R_{DS(ON)}$  VS  $I_{DS}$   
 $V_{GS}=+20\text{V}$ ,  $1.0X=2.5\text{m}\Omega$



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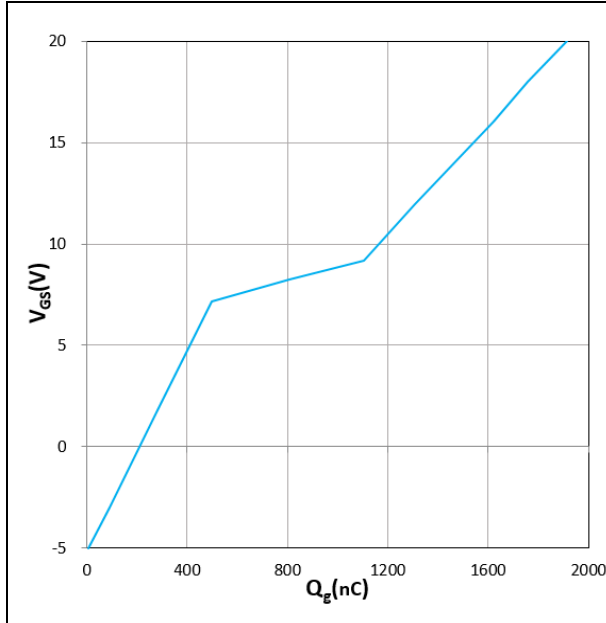


Figure 12.  $V_{GS}$  VS  $Q_g$   
 $T_j=25^\circ\text{C}$ ,  $I_D=400\text{A}$ ,  $V_{DS}=800\text{V}$

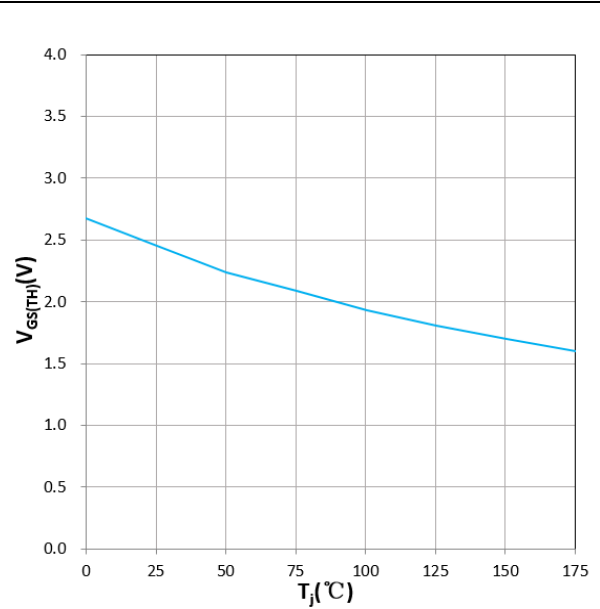


Figure 13.  $V_{GS(Th)}$  VS  $T_j$   
 $V_{GS}=V_{DS}$ ,  $I_D=160\text{mA}$

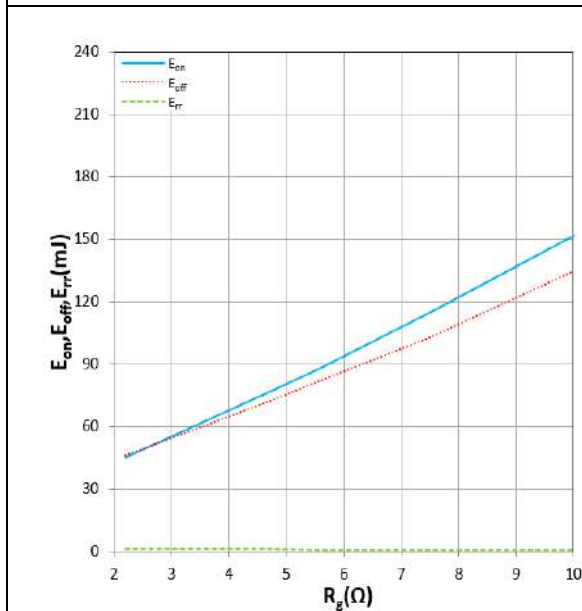


Figure 14.  $E_{on}$ ,  $E_{off}$ ,  $E_{rr}$  VS  $R_g$   
 $T_j=25^\circ\text{C}$ ,  $V_{DD}=900\text{V}$ ,  $I_D=800\text{A}$ ,  $V_{GS}=+18/-5\text{V}$   
 Inductive Load

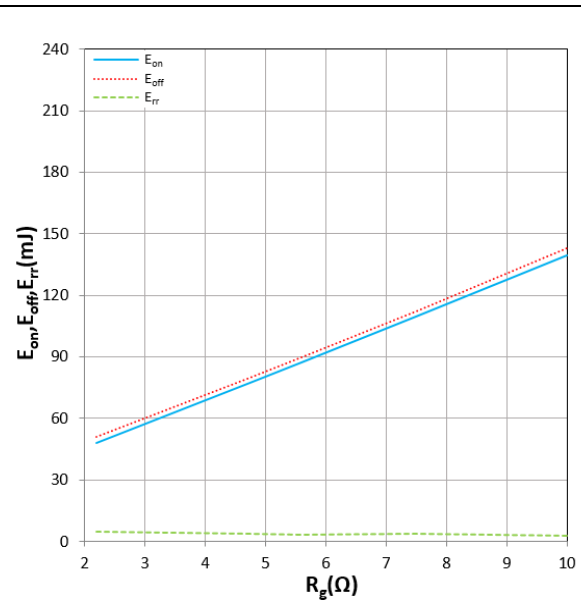


Figure 15.  $E_{on}$ ,  $E_{off}$ ,  $E_{rr}$  VS  $R_g$   
 $T_j=150^\circ\text{C}$ ,  $V_{DD}=900\text{V}$ ,  $I_D=800\text{A}$ ,  $V_{GS}=+18\text{V}/-5\text{V}$   
 Inductive Load

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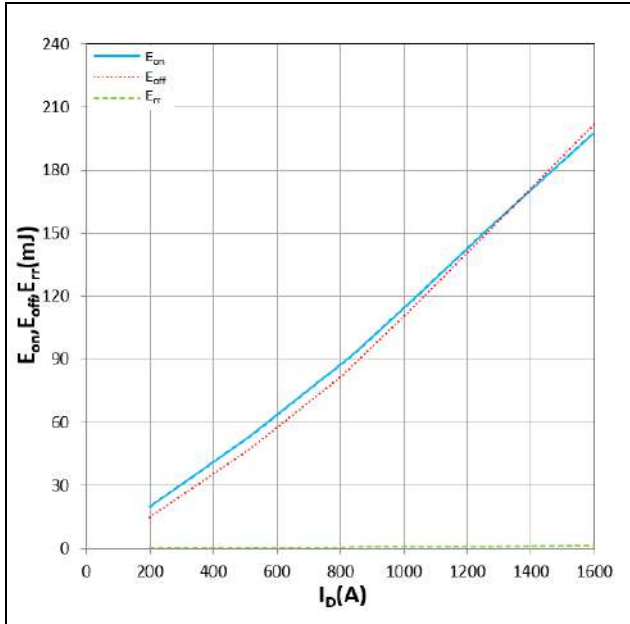


Figure 16.  $E_{on}$ ,  $E_{off}$ ,  $E_{rr}$  VS  $I_{DS}$   
 $T_j=25^{\circ}\text{C}$ ,  $V_{DD}=900\text{V}$ ,  $R_G=5.6\Omega$ ,  $V_{GS}=+18\text{V}/-5\text{V}$   
 Inductive Load

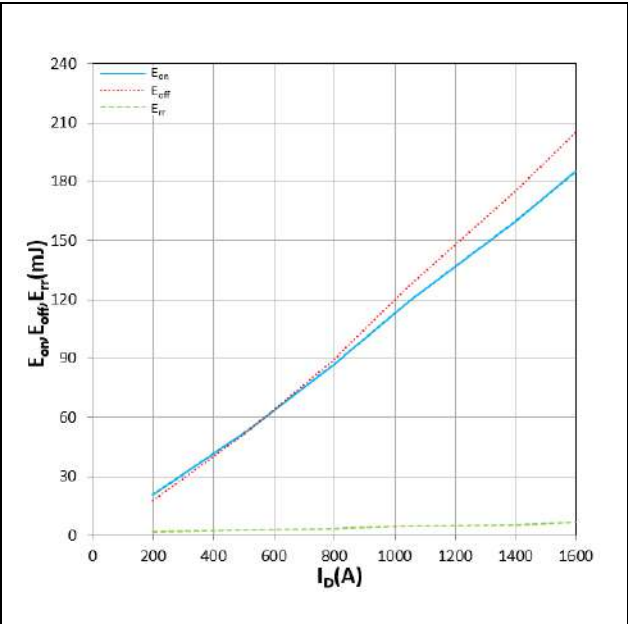


Figure 17.  $E_{on}$ ,  $E_{off}$ ,  $E_{rr}$  VS  $I_{DS}$   
 $T_j=150^{\circ}\text{C}$ ,  $V_{DD}=900\text{V}$ ,  $R_G=5.6\Omega$ ,  $V_{GS}=+18\text{V}/-5\text{V}$   
 Inductive Load

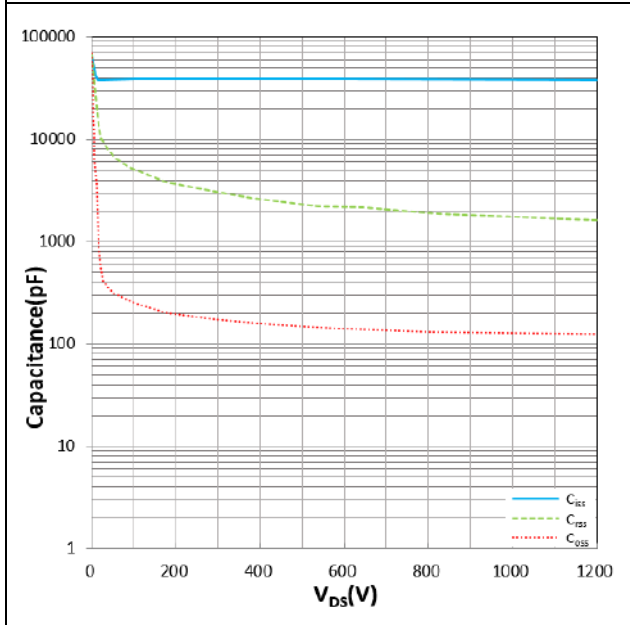


Figure 18.  $C_{iss}$ ,  $C_{oss}$ ,  $C_{rss}$  VS  $V_{DS}$   
 $V_{GS}=0\text{V}$ ,  $f=100\text{kHz}$

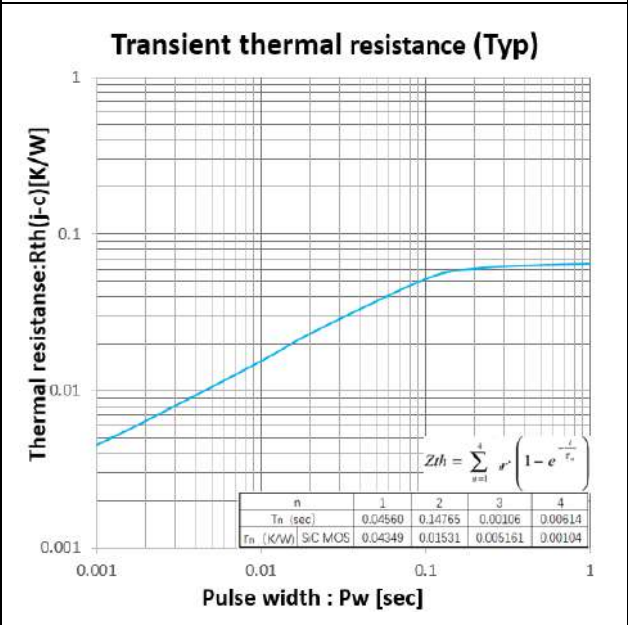


Figure 19. Transient Thermal Impedance

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### IMPORTANT NOTICE

This product data sheet describes the characteristics of this product for which a warranty is granted. Any such warranty is granted exclusively under the terms and conditions of the supply agreement. There will be no guarantee or of any kind for the product and its characteristics.

The data contained in this document is exclusively intended for technically trained staff. You and your technical departments will have to evaluate the product's suitability for the intended application and the completeness of the product data concerning such application.

Due to technical requirements, our product may contain dangerous substances. For information on the types in question, please contact the sales staff responsible for you.

Changes to this product data sheet are reserved.

Please contact the sales staff ([sales@hiitio.com](mailto:sales@hiitio.com)) for further information on the product, technology, delivery terms, conditions and prices.

## Instruction note

Naming rules for power module product models (Industrial module)

Product Model			
<b>HC</b>	<b>G</b>	<b>02</b>	<b>FF 120 E3 A</b>
Hecheng Code			
Module type G : IGBT module D : FRD module S : SiC module H : Si/SiC hybrid			
On-state resistance (mΩ) 01~80			
Topology structure FZ : A switch unit    FF : Half bridge FS : Three phase                      F4 : H Bridge F3L : Three level                      DF : Boost Circuit FD : Braking Circuit FP : Rectification+Inverter+Control move AL : ANPC                              CL : Chopper			
Voltage level (x10) (V) 650~2200			
Packaging form+features (A...Z)	A1: 34 mm B1: Easy 1B B2: Easy 2B... D1: Flow0 E0 : E0 E3: ED3 E6 : EPM2 E9 : ED3H	A2: 62 mm B1A B3: Easy 3B... D2: Flow1 E1: Econo 2... E4 : E4 E7 : EPM3 F0 : F0	B1B... D3: Flow2 E2: E2 E5 : ED3S E8 : EconoPIM3 P2 : EPM2
Feature :A: Special Code    Nil: Standard			

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