

# HCS02FT140H5A1S

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

### Description

The HCS02FT140H5A1S 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
- $Si_3N_4$  AMB Substrate
- Direct Cooled Pin Fin Base Plate
- Thermistor Inside
- Press FIT Contact Technology

### Application

- xEV Applications
- Motor Drives

### Circuit Diagram

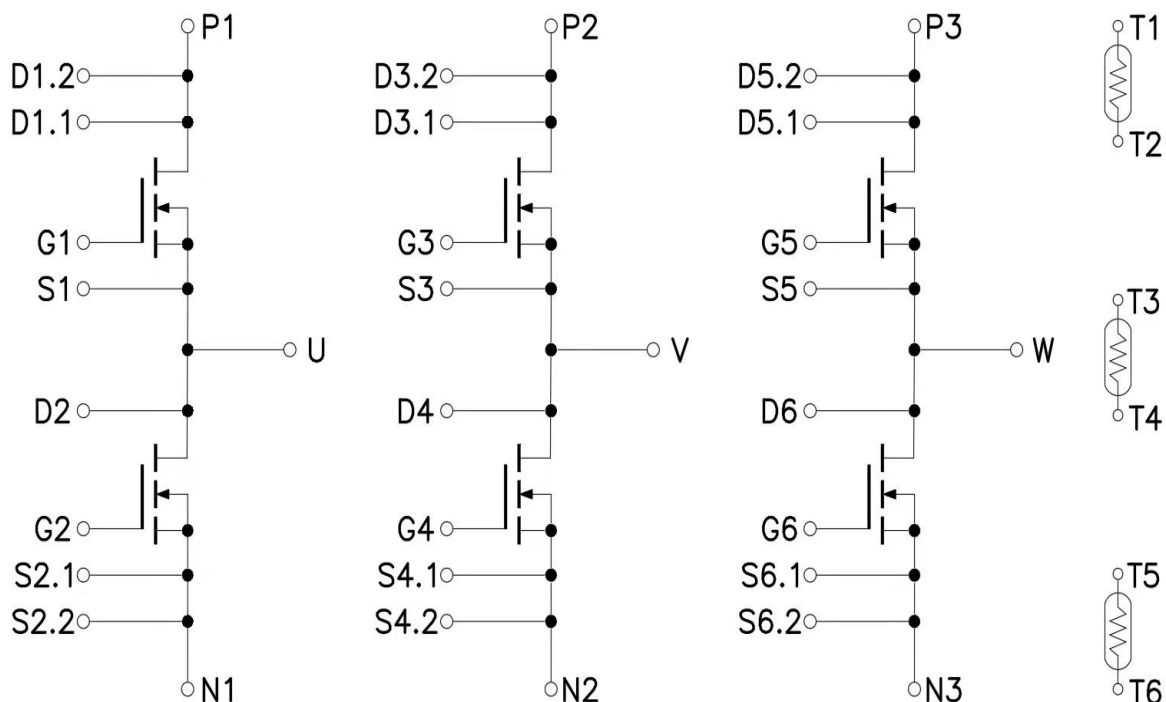
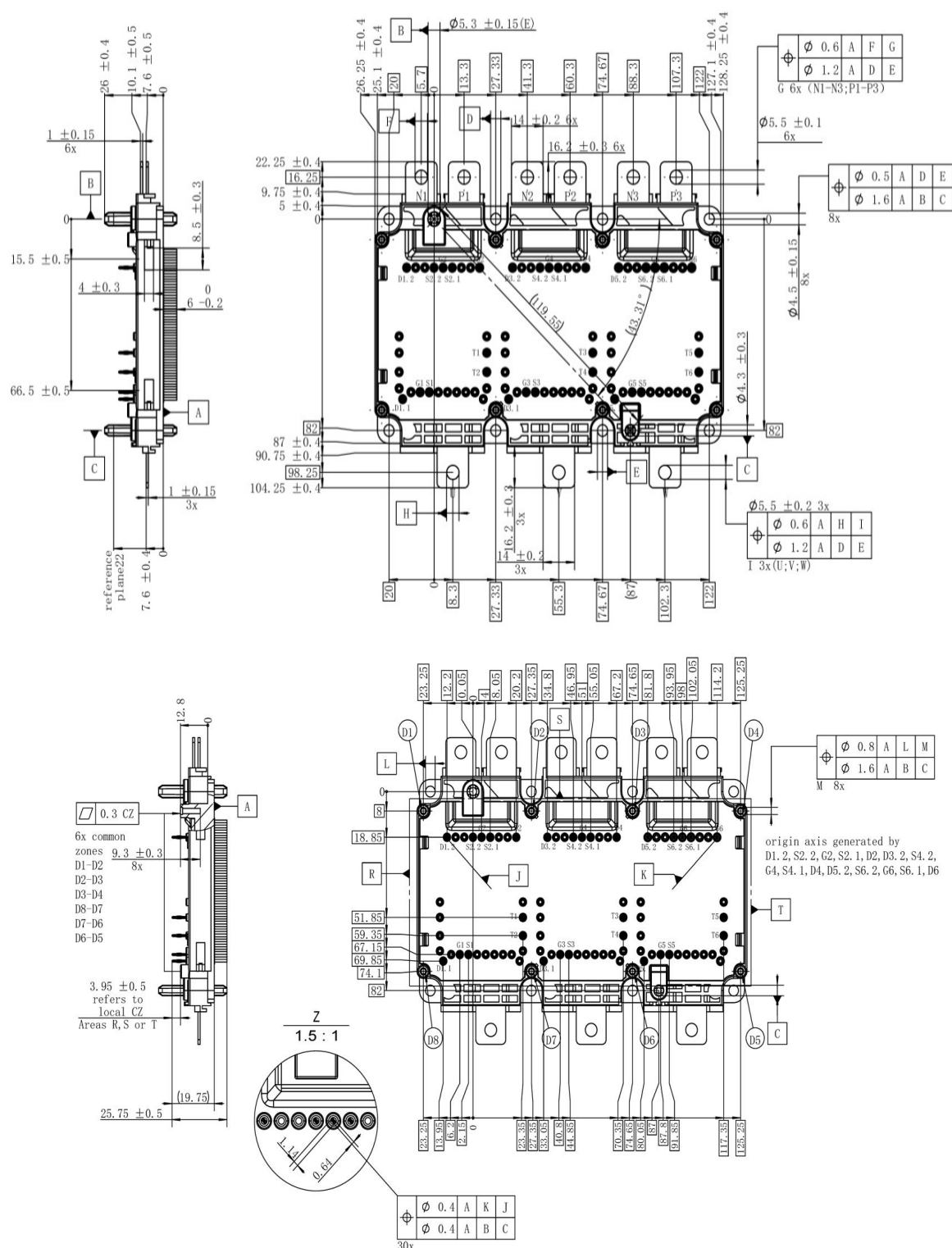


Figure 1. Out Drawing & Circuit Diagram HCS02FT140H5A1S

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## Physical Dimensions



### Figure 2. Physical Dimensions

# HCS02FT140H5A1S

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

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

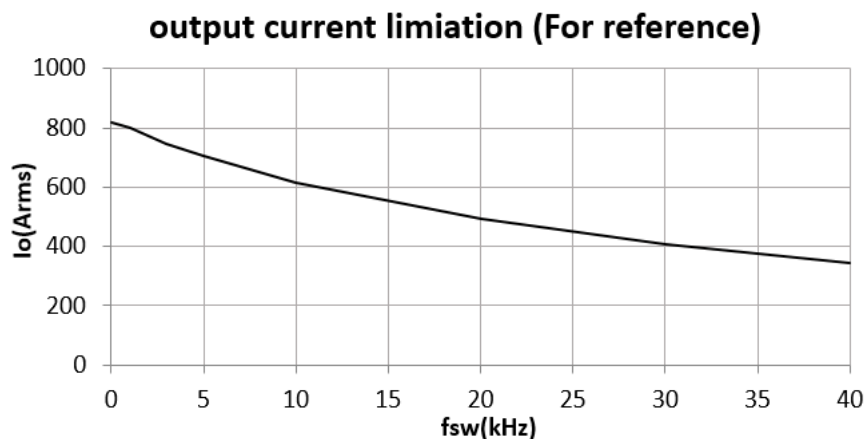
| Symbol              | Parameter                       | Conditions                                            | Value      | Unit               |
|---------------------|---------------------------------|-------------------------------------------------------|------------|--------------------|
| $V_{\text{DSS}}$    | 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 | $^{\circ}\text{C}$ |
| $T_{\text{slg}}$    | 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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## 1400V/800A 3 Phase SiC MOSFET Module

### 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<br>terminal to terminal | 9          | mm         |
| Clearance                                | terminal to heatsink<br>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. |            |
| R <sub>25</sub>     | Resistance                    | T <sub>c</sub> =25°C                                            | -     | 5    | -    | k $\Omega$ |
| $\Delta R/R$        | Deviation of R <sub>100</sub> | T <sub>c</sub> =100°C, R <sub>100</sub> =493 $\Omega$           | -5    | -    | 5    | %          |
| P <sub>25</sub>     | Power dissipation             | T <sub>c</sub> =25°C                                            | -     | -    | 20   | mW         |
| B <sub>25/50</sub>  | B-value                       | $R_2 = R_{25} \exp [B_{25/50} (1/T_2 - 1/(298,15 \text{ K}))]$  | -     | 3375 | -    | K          |
| B <sub>25/80</sub>  | B-value                       | $R_2 = R_{25} \exp [B_{25/80} (1/T_2 - 1/(298,15 \text{ K}))]$  | -     | 3411 | -    | K          |
| B <sub>25/100</sub> | B-value                       | $R_2 = R_{25} \exp [B_{25/100} (1/T_2 - 1/(298,15 \text{ K}))]$ | -     | 3433 | -    | K          |

# HCS02FT140H5A1S

## 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 <sub>(BR)DSS</sub>          | Drain-Source Breakdown Voltage          | V <sub>GS</sub> =0V, I <sub>D</sub> =800μA                                                                                                                                  |                       | 1400  | -     | -    | V    |
| I <sub>DSS</sub>              | Zero gate voltage drain current         | V <sub>DS</sub> =1200V, V <sub>GS</sub> =0V                                                                                                                                 |                       | -     | 8     | 400  | μA   |
| V <sub>GS(Th)</sub>           | Gate-source threshold voltage           | I <sub>D</sub> =160mA<br>V <sub>DS</sub> =V <sub>GS</sub>                                                                                                                   | T <sub>J</sub> =25°C  | 1.9   | 2.45  | 3.8  | V    |
|                               |                                         |                                                                                                                                                                             | T <sub>J</sub> =150°C | -     | 1.70  | -    | V    |
|                               |                                         |                                                                                                                                                                             | T <sub>J</sub> =175°C | -     | 1.60  | -    | V    |
| I <sub>GSS</sub>              | Gate-Source Leakage Current             | V <sub>GS</sub> =20V, V <sub>DS</sub> =0V                                                                                                                                   |                       | -     | 8     | 1600 | nA   |
|                               |                                         | V <sub>GS</sub> =-5V, V <sub>DS</sub> =0V                                                                                                                                   |                       | -1600 | -8    | 0    | nA   |
| R <sub>DS(on)</sub><br>(Chip) | Static drain-source On-state resistance | I <sub>D</sub> =800A<br>V <sub>GS</sub> =20V                                                                                                                                | T <sub>J</sub> =25°C  | -     | 2.5   | -    | mΩ   |
|                               |                                         |                                                                                                                                                                             | T <sub>J</sub> =175°C | -     | 4.7   | -    | mΩ   |
|                               | Static drain-source On-state resistance | I <sub>D</sub> =800A<br>V <sub>GS</sub> =18V                                                                                                                                | T <sub>J</sub> =25°C  | -     | 2.7   | -    | mΩ   |
|                               |                                         |                                                                                                                                                                             | T <sub>J</sub> =175°C | -     | 4.80  | -    | mΩ   |
| V <sub>DS(on)</sub><br>(Chip) | Static drain-source On-state resistance | I <sub>D</sub> =800A<br>V <sub>GS</sub> =20V                                                                                                                                | T <sub>J</sub> =25°C  | -     | 2.00  | -    | V    |
|                               |                                         |                                                                                                                                                                             | T <sub>J</sub> =175°C | -     | 3.76  | -    | V    |
|                               |                                         | I <sub>D</sub> =800A<br>V <sub>GS</sub> =18V                                                                                                                                | T <sub>J</sub> =25°C  | -     | 2.16  | -    | V    |
|                               |                                         |                                                                                                                                                                             | T <sub>J</sub> =175°C | -     | 3.84  | -    | V    |
| C <sub>iss</sub>              | Input capacitance                       | V <sub>DS</sub> =1000V<br>V <sub>GS</sub> =0V<br>f=100kHz                                                                                                                   |                       | -     | 38.2  | -    | nF   |
| C <sub>oss</sub>              | Output capacitance                      |                                                                                                                                                                             |                       | -     | 1.73  | -    | nF   |
| C <sub>rss</sub>              | Reverse transfer capacitance            |                                                                                                                                                                             |                       | -     | 0.13  | -    | nF   |
| Q <sub>g</sub>                | Total gate charge                       | V <sub>DS</sub> =800V<br>I <sub>D</sub> =400A<br>V <sub>GS</sub> =+20/-5V                                                                                                   |                       | -     | 1912  | -    | nC   |
| Q <sub>gs</sub>               | Gate to source charge                   |                                                                                                                                                                             |                       | -     | 496   | -    | nC   |
| Q <sub>gd</sub>               | Gate to drain charg                     |                                                                                                                                                                             |                       | -     | 624   | -    | nC   |
| R <sub>gint</sub>             | Internal gate resistance                | f=1MHz                                                                                                                                                                      |                       | -     | 1.1   | -    | Ω    |
| t <sub>d(on)</sub>            | Turn-on delay tim                       | V <sub>DD</sub> =900V<br>I <sub>D</sub> =800A<br>V <sub>GS</sub> =+18/-5V<br>R <sub>G(ON)</sub> =5.6Ω<br>R <sub>G(OFF)</sub> =5.6Ω<br>Inductive load<br>Switching operation | T <sub>J</sub> =25°C  | -     | 162   | -    | ns   |
|                               |                                         |                                                                                                                                                                             | T <sub>J</sub> =150°C | -     | 144   | -    |      |
| t <sub>r</sub>                | Rise time                               |                                                                                                                                                                             | T <sub>J</sub> =25°C  | -     | 113   | -    | ns   |
|                               |                                         |                                                                                                                                                                             | T <sub>J</sub> =150°C | -     | 105   | -    |      |
| t <sub>d(off)</sub>           | Turn-off delay time                     |                                                                                                                                                                             | T <sub>J</sub> =25°C  | -     | 392   | -    | ns   |
|                               |                                         |                                                                                                                                                                             | T <sub>J</sub> =150°C | -     | 470   | -    |      |
| t <sub>f</sub>                | Fall time                               |                                                                                                                                                                             | T <sub>J</sub> =25°C  | -     | 69    | -    | ns   |
|                               |                                         |                                                                                                                                                                             | T <sub>J</sub> =150°C | -     | 79    | -    |      |
| E <sub>on</sub>               | Turn-on power dissipation               |                                                                                                                                                                             | T <sub>J</sub> =25°C  | -     | 87.9  | -    | mJ   |
|                               |                                         |                                                                                                                                                                             | T <sub>J</sub> =150°C | -     | 87.5  | -    |      |
| E <sub>off</sub>              | Turn-off power dissipation              |                                                                                                                                                                             | T <sub>J</sub> =25°C  | -     | 82.1  | -    | mJ   |
|                               |                                         |                                                                                                                                                                             | T <sub>J</sub> =150°C | -     | 89.8  | -    |      |
| R <sub>th(j-f)</sub>          | FET Thermal Resistance                  | Junction to cooling fluid<br>ΔV/Δt=10dm³/min, T <sub>f</sub> =65°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 <sub>SD</sub> | Body Diode Forward Voltage        | V <sub>GS</sub> =-5V<br>I <sub>SD</sub> =800A                                                                                                                        | T <sub>J</sub> =25°C  | -     | 5.8  | -    | V    |
|                 |                                   |                                                                                                                                                                      | T <sub>J</sub> =175°C | -     | 5.2  | -    |      |
| T <sub>rr</sub> | Reverse Recovery Time             | V <sub>DD</sub> =900V<br>I <sub>O</sub> =800A<br>V <sub>GS</sub> =+18/-5V<br>R <sub>G(ON)</sub> =R <sub>G(OFF)</sub> =5.6Ω<br>Inductive loads<br>Switching operation | T <sub>J</sub> =25°C  | -     | 41   | -    | ns   |
|                 |                                   |                                                                                                                                                                      | T <sub>J</sub> =150°C | -     | 76   | -    |      |
| Q <sub>rr</sub> | Reverse Recovery Charge           |                                                                                                                                                                      | T <sub>J</sub> =25°C  | -     | 3.42 | -    | μC   |
|                 |                                   |                                                                                                                                                                      | T <sub>J</sub> =150°C | -     | 13.2 | -    |      |
| E <sub>rr</sub> | Diode Switching Power Dissipation |                                                                                                                                                                      | T <sub>J</sub> =25°C  | -     | 0.69 | -    | mJ   |
|                 |                                   |                                                                                                                                                                      | T <sub>J</sub> =150°C | -     | 3.52 | -    |      |

## Test Conditions

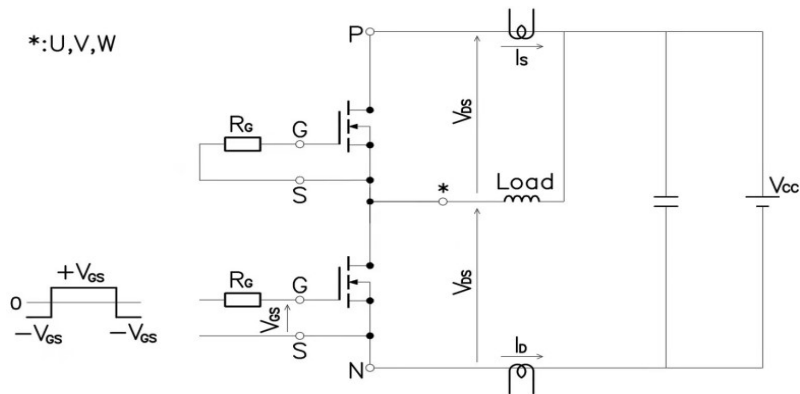


Figure 3. Switching Time Measure Circuit

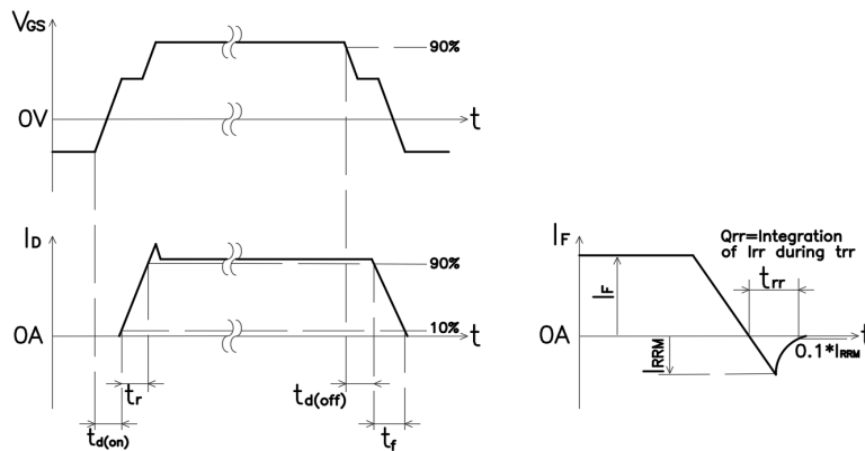


Figure 4. Switching Time Definition

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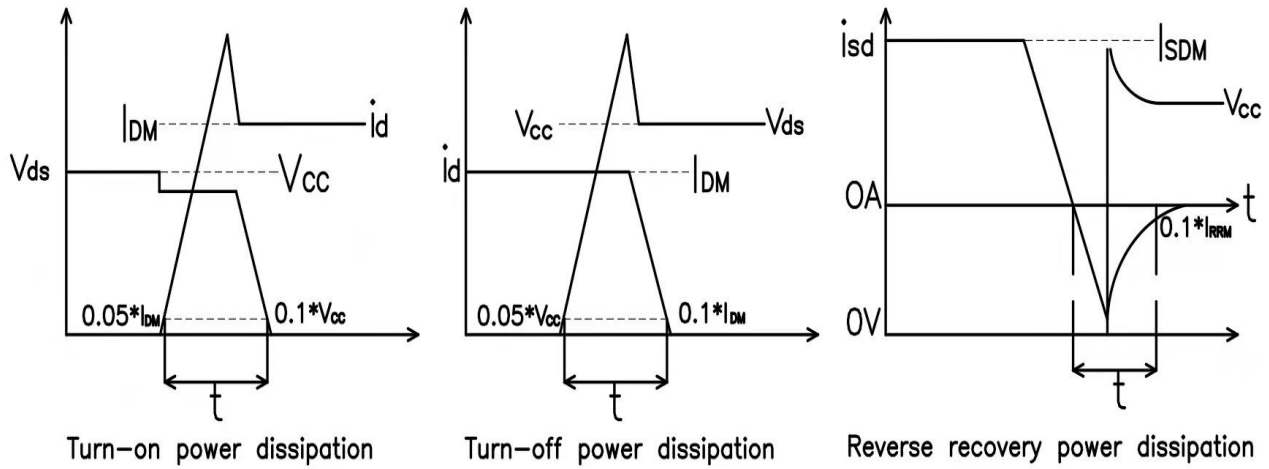


Figure 4. Switching Power Dissipation Definition

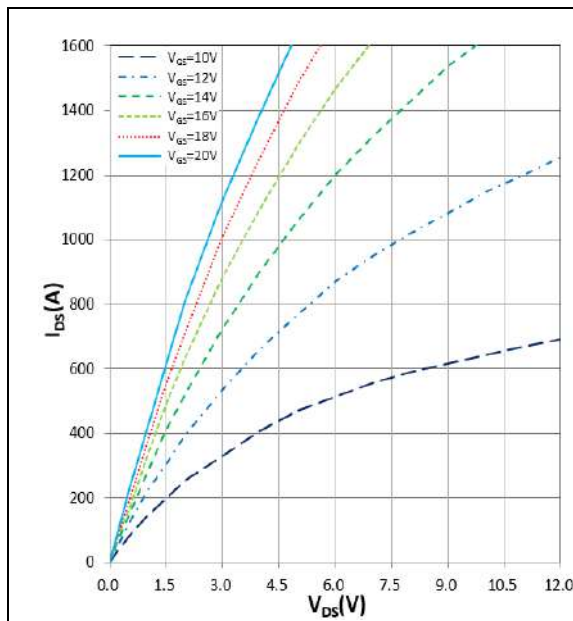


Figure 6.  $I_{DS}$  VS  $V_{DS}$   
 $T_j=25^{\circ}\text{C}$ ,  $V_{GS}$  Parameter

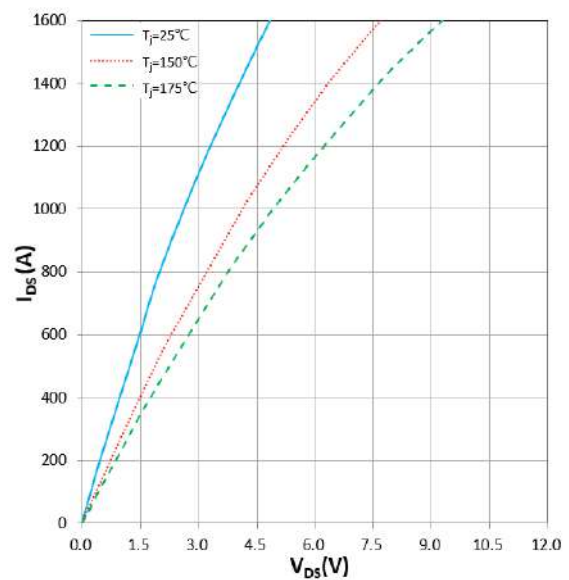


Figure 7.  $I_{DS}$  VS  $V_{DS}$   
 $V_{GS}=20\text{V}$ ,  $T_j$  Parameter

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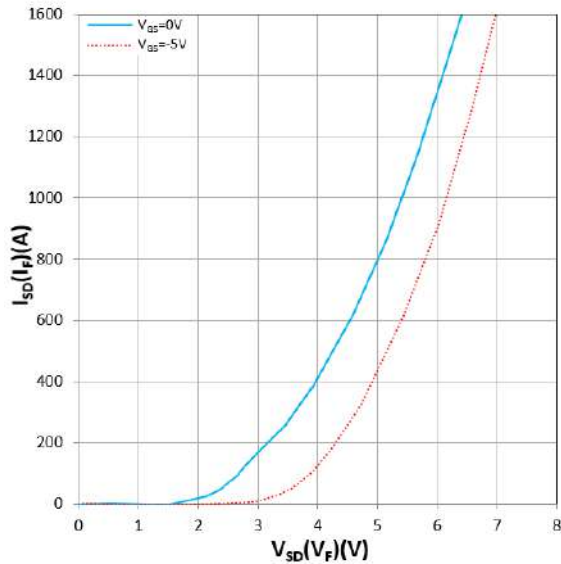


Figure 8.  $I_{SD}$  VS  $V_{SD}$   
 $T_J=25^{\circ}\text{C}$ ,  $V_{GS}$  Parameter

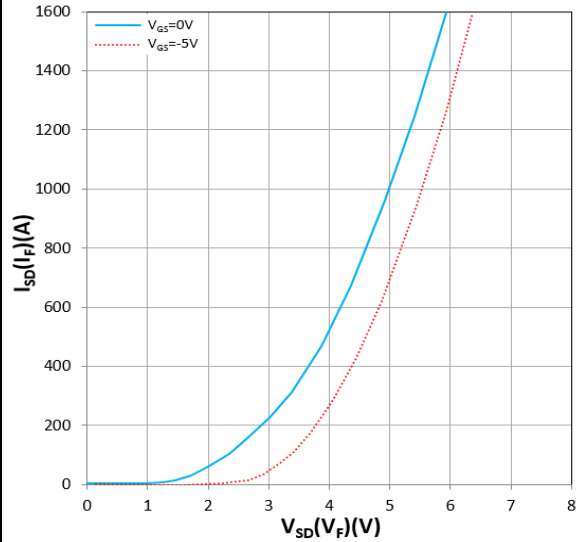


Figure 9.  $I_{SD}$  VS  $V_{SD}$   
 $T_J=175^{\circ}\text{C}$ ,  $V_{GS}$  Parameter

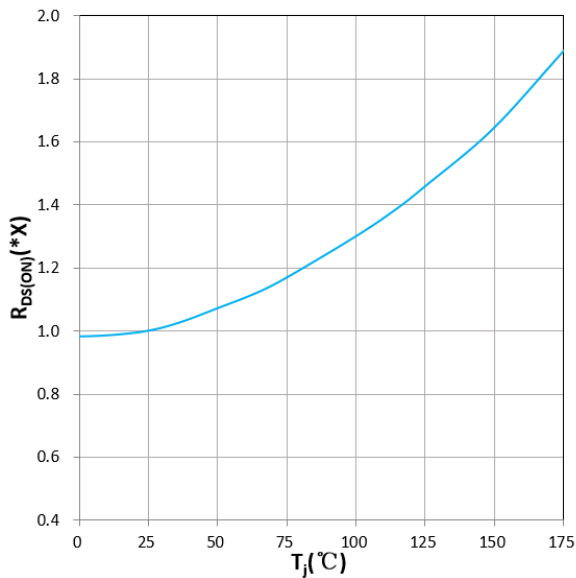


Figure 10.  $R_{DS(ON)}$  VS  $T_J$   
 $V_{GS}=+20\text{V}$ ,  $I_D=800\text{A}$ ,  $1.0X=2.5\text{m}\Omega$

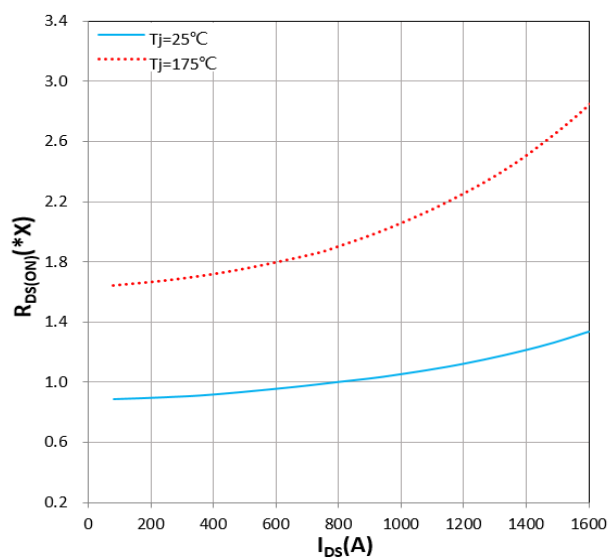


Figure 11.  $R_{DS(ON)}$  VS  $I_{DS}$   
 $V_{GS}=+20\text{V}$ ,  $1.0X=2.5\text{m}\Omega$

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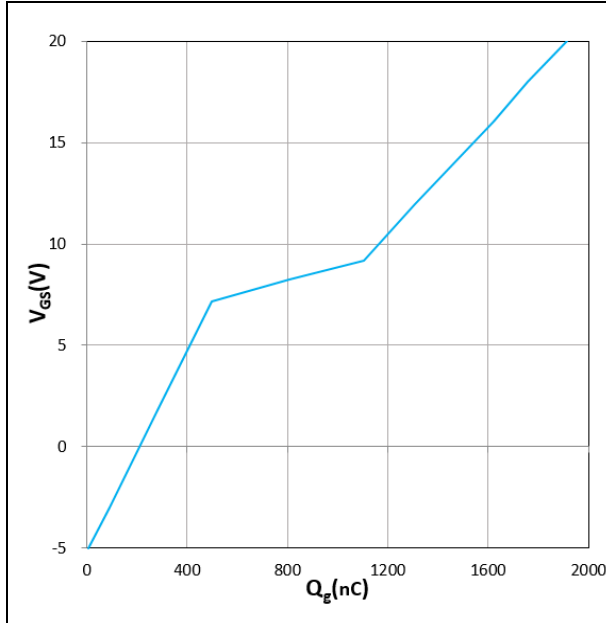


Figure 12.  $V_{GS}$  VS  $Q_g$   
 $T_j=25^{\circ}\text{C}$ ,  $I_D=400\text{A}$ ,  $V_{DS}=800\text{V}$

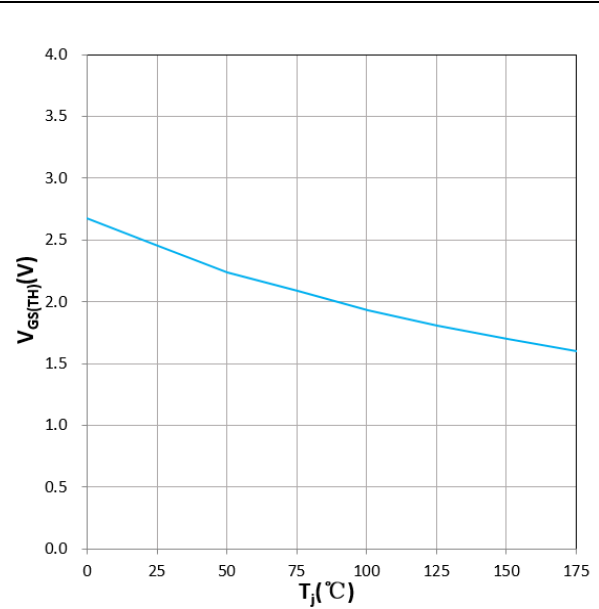


Figure 13.  $V_{GS(Th)}$  VS  $T_j$   
 $V_{GS}=V_{DS}$ ,  $I_D=160\text{mA}$

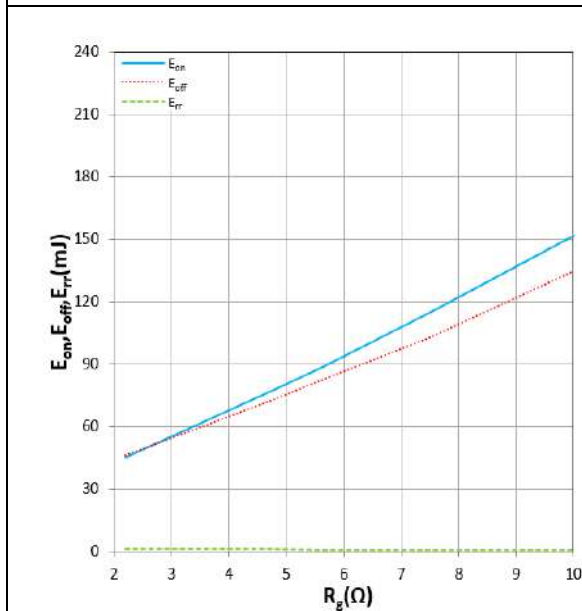


Figure 14.  $E_{on}$ ,  $E_{off}$ ,  $E_{rr}$  VS  $R_g$   
 $T_j=25^{\circ}\text{C}$ ,  $V_{DD}=900\text{V}$ ,  $I_D=800\text{A}$ ,  $V_{GS}=+18/-5\text{V}$   
Inductive Load

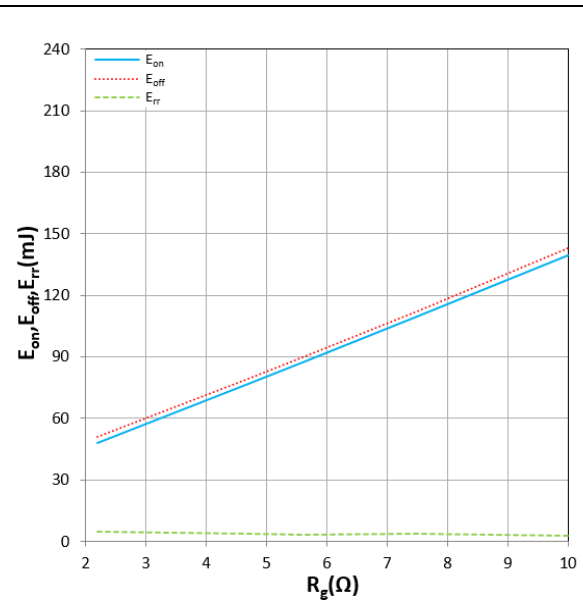


Figure 15.  $E_{on}$ ,  $E_{off}$ ,  $E_{rr}$  VS  $R_g$   
 $T_j=150^{\circ}\text{C}$ ,  $V_{DD}=900\text{V}$ ,  $I_D=800\text{A}$ ,  $V_{GS}=+18/-5\text{V}$   
Inductive Load

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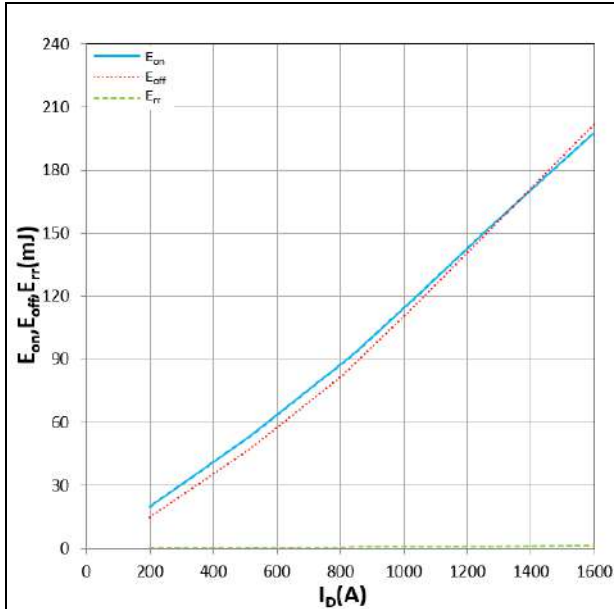


Figure 16.  $E_{on}$ ,  $E_{off}$ ,  $E_{rr}$  VS  $I_{DS}$   
 $T_J=25^{\circ}\text{C}$ ,  $V_{DD}=900\text{V}$ ,  $R_G=5.6\Omega$ ,  $V_{GS}=+18\text{V}/-5\text{V}$   
 Inductive Load

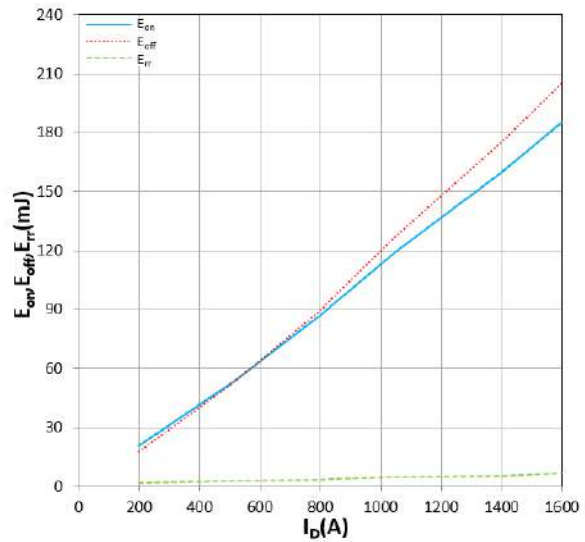


Figure 17.  $E_{on}$ ,  $E_{off}$ ,  $E_{rr}$  VS  $I_{DS}$   
 $T_J=150^{\circ}\text{C}$ ,  $V_{DD}=900\text{V}$ ,  $R_G=5.6\Omega$ ,  $V_{GS}=+18\text{V}/-5\text{V}$   
 Inductive Load

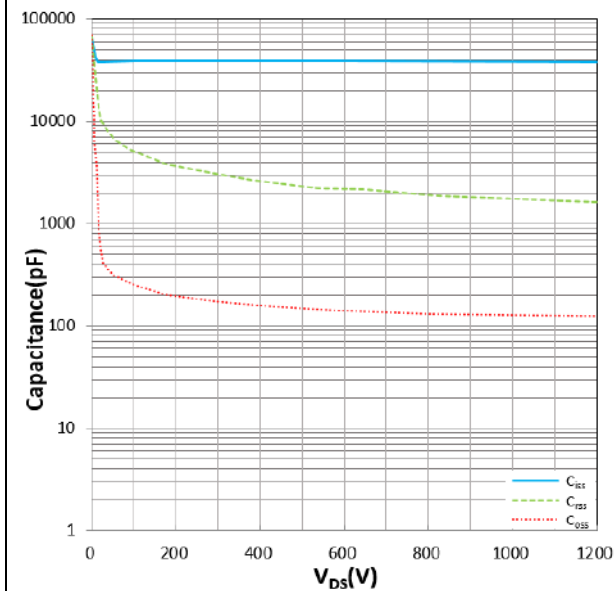


Figure 18.  $C_{iss}$ ,  $C_{oss}$ ,  $C_{rss}$  VS  $V_{DS}$   
 $V_{GS}=0\text{V}$ ,  $f=100\text{kHz}$

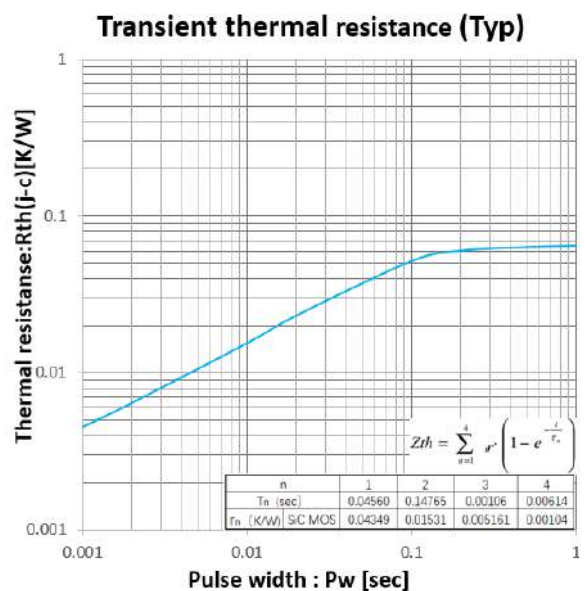


Figure 19. Transient Thermal Impedance

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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.

Revision History

| Document Version | Description of Changes |
|------------------|------------------------|
| RevX.0.1         | Released               |
|                  |                        |
|                  |                        |

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