



## Features

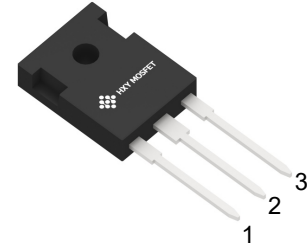
- 3rd generation SiC MOSFET technology
- Optimized package with separate driver source pin
- High blocking voltage with low on-resistance
- High-speed switching with low capacitances
- Fast intrinsic diode with low reverse recovery ( $Q_{rr}$ )
- Halogen free, RoHS compliant

## Benefits

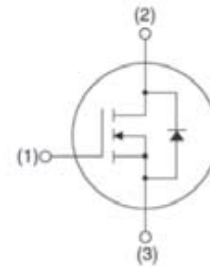
- Reduce switching losses and minimize gate ringing
- Higher system efficiency
- Reduce cooling requirements
- Increase power density
- Increase system switching frequency

## Applications

- Renewable energy
- EV battery chargers
- High voltage DC/DC converters
- Switch Mode Power Supplies



TO-247



| Ordering Part Number | Package | Qty(PCS) |
|----------------------|---------|----------|
| NVHL040N65S3F        | TO-247  | 30       |



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

| Parameter                                                                         | Symbol                | Value      | Unit             |
|-----------------------------------------------------------------------------------|-----------------------|------------|------------------|
| Drain-source voltage                                                              | $V_{DS}$              | 650        | V                |
| Continuous drain current<br>$T_c = 25^\circ\text{C}$<br>$T_c = 100^\circ\text{C}$ | $I_D$                 | 49<br>35   | A                |
| Pulsed drain current ( $T_c = 25^\circ\text{C}$ , $t_p$ limited by $T_{jmax}$ )   | $I_{D \text{ pulse}}$ | 123        | A                |
| Avalanche energy, single pulse ( $L=10\text{mH}$ )                                | $E_{AS}$              | 1000       | mJ               |
| Gate-Source voltage                                                               | $V_{GS}$              | -5/+20     | V                |
| Gate-Source voltage (dynamic, Absolute maximum values)                            | $V_{GSmax}$           | -10/+25    | V                |
| Power dissipation ( $T_c = 25^\circ\text{C}$ )                                    | $P_{tot}$             | 242        | W                |
| Operating junction and storage temperature                                        | $T_j, T_{stg}$        | -55...+175 | $^\circ\text{C}$ |

## Thermal Resistance

| Parameter                                   | Symbol     | Value | Unit               |
|---------------------------------------------|------------|-------|--------------------|
| Thermal resistance, junction – case. Max    | $R_{thJC}$ | 0.62  | $^\circ\text{C/W}$ |
| Thermal resistance, junction – ambient. Max | $R_{thJA}$ | 40    |                    |



**Electrical Characteristic** (at  $T_j = 25^\circ\text{C}$ , unless otherwise specified)

| Parameter                        | Symbol              | Value  |         |          | Unit | Test Condition                                                                                                     |
|----------------------------------|---------------------|--------|---------|----------|------|--------------------------------------------------------------------------------------------------------------------|
|                                  |                     | min.   | typ.    | max.     |      |                                                                                                                    |
| Static Characteristic            |                     |        |         |          |      |                                                                                                                    |
| Drain-source breakdown voltage   | BV <sub>DSS</sub>   | 650    | -       | -        | V    | V <sub>GS</sub> =0V, I <sub>D</sub> =250uA                                                                         |
| Gate threshold voltage           | V <sub>GS(th)</sub> | 2      | -       | 4        | V    | V <sub>DS</sub> =V <sub>GS</sub> ,I <sub>D</sub> =7mA                                                              |
| Zero gate voltage drain current  | I <sub>DSS</sub>    | -<br>- | 1<br>10 | 100<br>- | μA   | V <sub>DS</sub> =650V,V <sub>GS</sub> =0V<br>T <sub>j</sub> =25°C<br>T <sub>j</sub> =175°C                         |
| Gate-source leakage current      | I <sub>GSS</sub>    | -      |         | 250      | nA   | V <sub>GS</sub> =20V,V <sub>DS</sub> =0V                                                                           |
| Drain-source on-state resistance | R <sub>DS(on)</sub> | -      | 45      | -        | mΩ   | V <sub>GS</sub> =18V, I <sub>D</sub> =17.6A,                                                                       |
|                                  |                     | -      | 33      | 49       |      | V <sub>GS</sub> =20V, I <sub>D</sub> =17.6A,<br>T <sub>j</sub> =25°C                                               |
|                                  |                     | -      | 50      | -        |      | T <sub>j</sub> =175°C                                                                                              |
| Transconductance                 | g <sub>fs</sub>     | -      | 5.6     | -        | S    | V <sub>DS</sub> =20V,I <sub>D</sub> =17.6A                                                                         |
| Dynamic Characteristic           |                     |        |         |          |      |                                                                                                                    |
| Input Capacitance                | C <sub>iss</sub>    | -      | 1823    | -        | pF   | V <sub>DS</sub> = 650V<br>V <sub>GS</sub> = 0V<br>T <sub>J</sub> = 25°C<br>V <sub>AC</sub> = 25mV<br>f = 1MHz      |
| Output Capacitance               | C <sub>Oss</sub>    | -      | 190     | -        |      |                                                                                                                    |
| Reverse Transfer Capacitance     | C <sub>rss</sub>    | -      | 19      | -        |      |                                                                                                                    |
| Gate Total Charge                | Q <sub>G</sub>      | -      | 96      | -        | nC   | V <sub>DS</sub> = 400V<br>V <sub>GS</sub> = -5/20V<br>I <sub>D</sub> = 17.6A                                       |
| Gate-Source charge               | Q <sub>gs</sub>     | -      | 25      | -        |      |                                                                                                                    |
| Gate-Drain charge                | Q <sub>gd</sub>     | -      | 26      | -        |      |                                                                                                                    |
| Turn-On Switching Energy         | E <sub>ON</sub>     | -      | 188     | -        | μJ   | V <sub>DD</sub> = 400V<br>V <sub>GS</sub> = -5/+20V<br>I <sub>D</sub> = 17.6A<br>R <sub>G</sub> = 10Ω<br>L = 100uH |
| Turn-Off Switching Energy-       | E <sub>OFF</sub>    | -      | 19      |          |      |                                                                                                                    |
| Turn-on delay time               | t <sub>d(on)</sub>  | -      | 20      | -        | ns   |                                                                                                                    |
| Rise time                        | t <sub>r</sub>      | -      | 26      | -        |      |                                                                                                                    |
| Turn-off delay time              | t <sub>d(off)</sub> | -      | 48      | -        |      |                                                                                                                    |
| Fall time                        | t <sub>f</sub>      | -      | 15      | -        |      |                                                                                                                    |
| Gate resistance                  | R <sub>G</sub>      | -      | 1.7     | -        | Ω    |                                                                                                                    |



### Body Diode Characteristic

| Parameter                          | Symbol   | Value |      |      | Unit | Test Condition                                          |
|------------------------------------|----------|-------|------|------|------|---------------------------------------------------------|
|                                    |          | min.  | typ. | max. |      |                                                         |
| Body Diode Forward Voltage         | $V_{SD}$ |       | 3.2  |      | V    | $V_{GS}=0V, I_{SD}=8.8A,$<br>$T_J=25^{\circ}C$          |
|                                    |          |       | 2.6  |      |      | $V_{GS}=0V, I_{SD}=8.8A,$<br>$T_J=175^{\circ}C$         |
| Body Diode Reverse Recovery Time   | $t_{rr}$ | -     | 40   | -    | ns   | $V_R = 400V,$<br>$I_D = 17.6A$<br>$di/dt = 1000A/\mu S$ |
| Body Diode Reverse Recovery Charge | $Q_{rr}$ | -     | 156  | -    | nC   |                                                         |



## Typical Performance Characteristics

Fig 1. Output Characteristic ( $T_J = -55^\circ\text{C}$ )

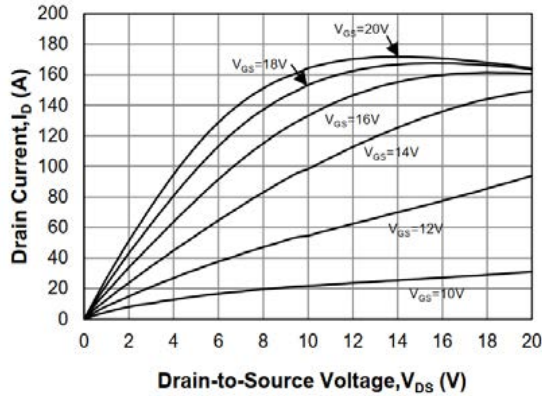


Fig 2. Output Characteristic ( $T_J = 25^\circ\text{C}$ )

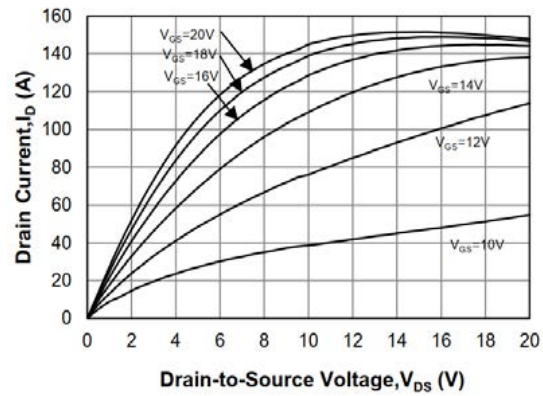


Fig 3. Output Characteristic ( $T_J = 175^\circ\text{C}$ )

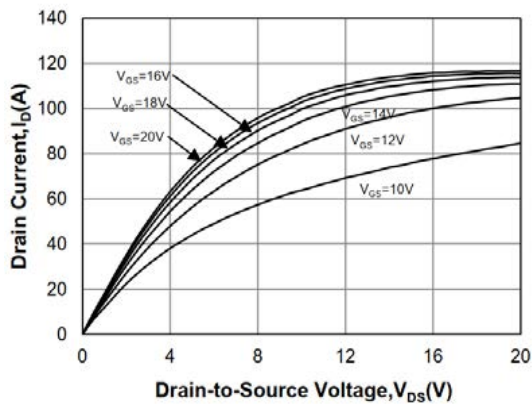


Fig 4:  $R_{DS(on)}$  Vs  $I_{DS}$  Characteristic

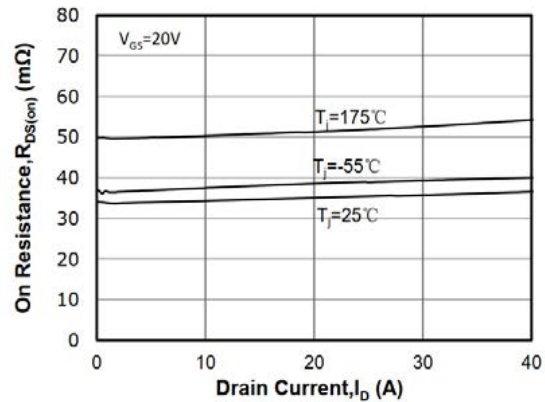


Fig 5:  $R_{DS(on)}$  vs. Temperature

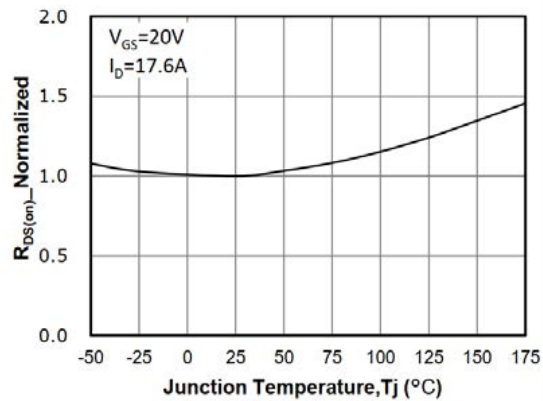


Fig 6: Transfer Characteristic

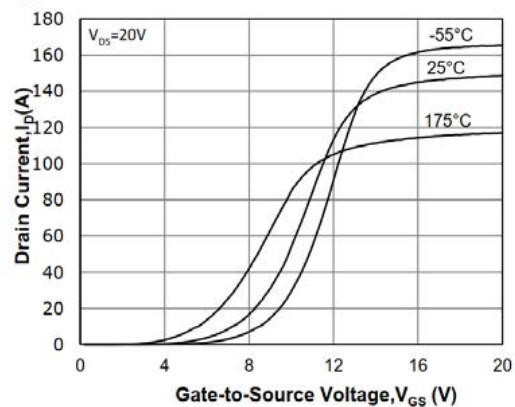




Fig 7: Body-diode Characteristic

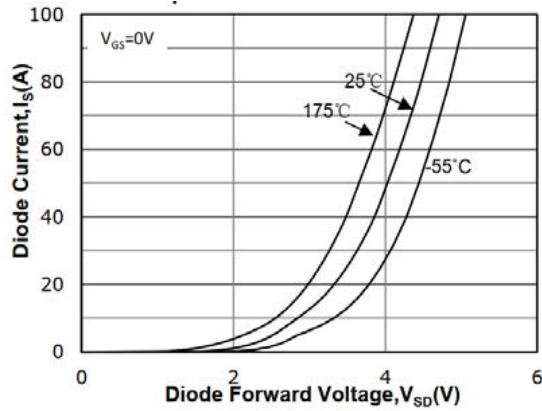


Fig 8:  $V_{th}$  Vs  $T_j$  Temperature Characteristic

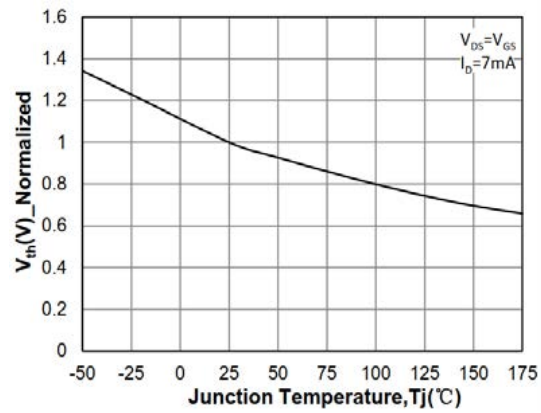


Fig 9: Gate Charge Characteristics

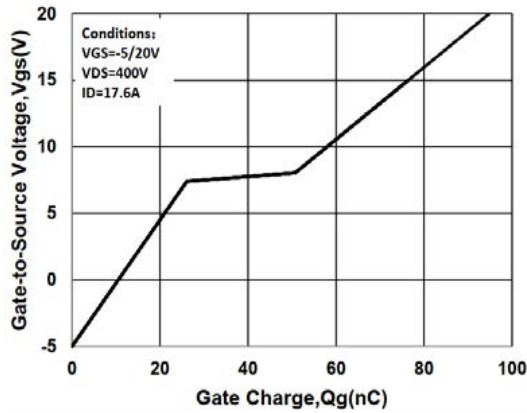


Fig 10: Continuous Drain Current vs. Case Temperature

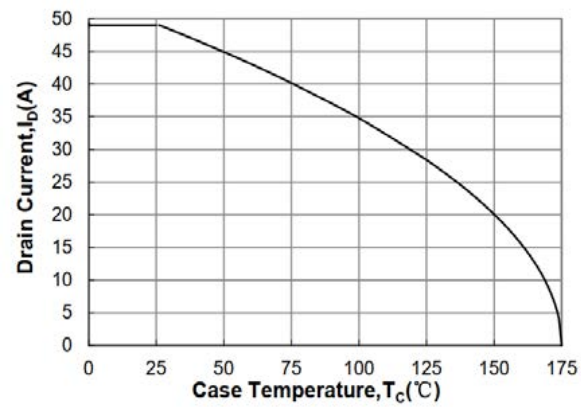


Fig 11: Safe Operating Area

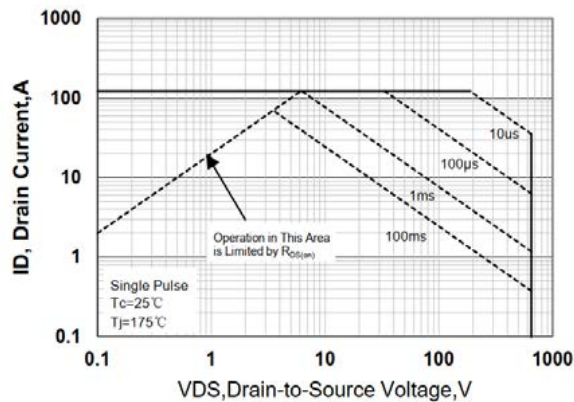


Fig 12: Capacitance Characteristics

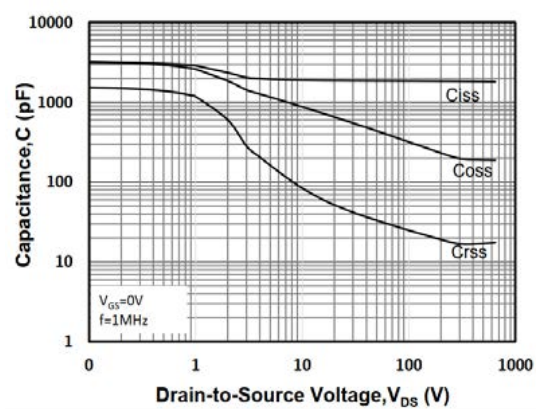
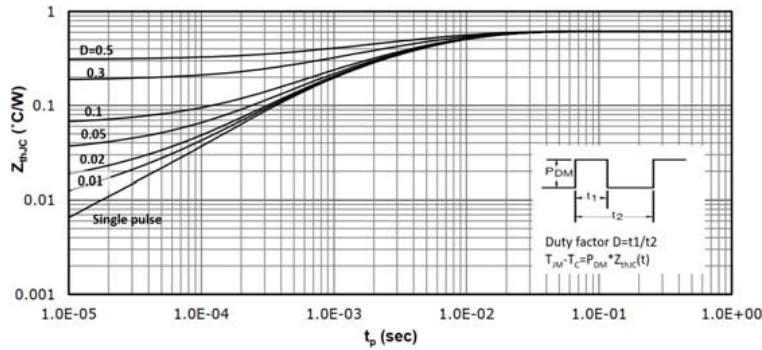




Fig 13: Transient Thermal Impedance



## Test Circuit & Waveform

Figure A. Definition of switching times

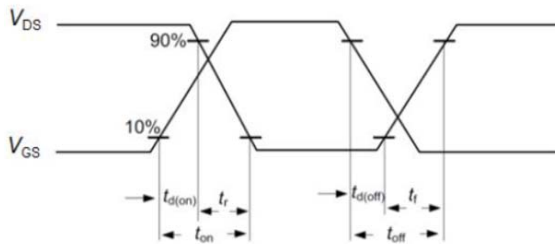


Figure B. Dynamic test circuit

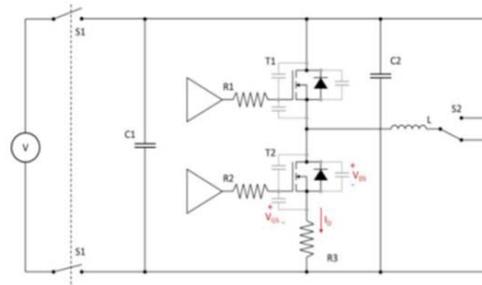
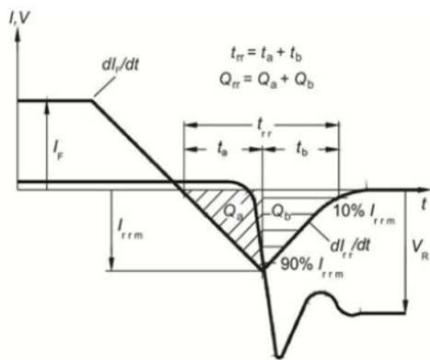


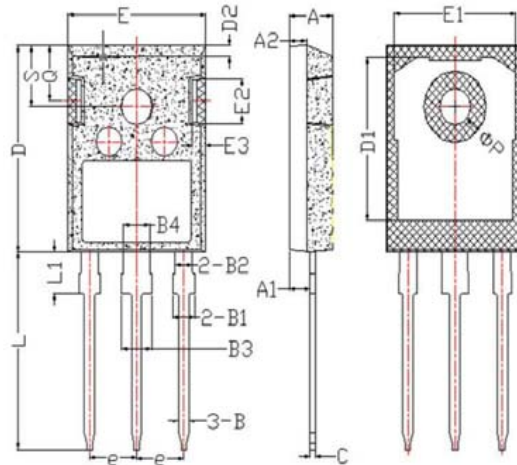
Figure C. Definition of body diodeswitching characteristics





## Package Dimensions

Package TO-247



| Items | Values(mm) |      |
|-------|------------|------|
|       | MIN        | MAX  |
| A     | 4.6        | 5.2  |
| A1    | 2.2        | 2.6  |
| B     | 0.9        | 1.4  |
| B1    | 1.75       | 2.35 |
| B2    | 1.75       | 2.15 |
| B3    | 2.8        | 3.35 |
| B4    | 2.8        | 3.15 |
| C     | 0.5        | 0.7  |
| D     | 20.6       | 21.3 |
| D1    | 16         | 18   |
| E     | 15.5       | 16.1 |
| E1    | 13         | 14.7 |
| E2    | 3.8        | 5.3  |
| E3    | 0.8        | 2.6  |
| e     | 5.2        | 5.2  |
| L     | 19         | 20.5 |
| L1    | 3.9        | 4.6  |
| Φp    | 3.3        | 3.7  |
| Q     | 5.2        | 6    |
| S     | 5.8        | 6.6  |



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