

**NPS16N65F**



**N-Channel Enhancement Mode Power MOSFET**

**Voltage:** 650 Volts

**Current:** 16.0 Ampers

**Package:** TO-220F

**Features**

- NH'S Advanced Planar DMOS Technology
- Low Rds(on) For Low On-State Loss
- High EAS For High Reliability
- Qualified According To JEDEC Criteria

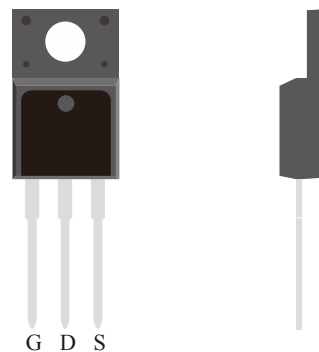
**Typical Applications**

- AC/DC Converter
- Adaptor And Charger
- PC Power
- LED Drives And LED Lighting

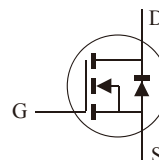
**Product Summary**

|                  |      |   |
|------------------|------|---|
| VDS Min.@Tj      | 650  | V |
| Id Min.@Ta       | 16.0 | A |
| RDS(ON)(TYP)@10V | 0.48 | Ω |

**Diagram:**



**Polarity:**



**\*100% UIS TESTED**

**\*100% ΔVDS TESTED**

**Absolute Maximum Ratings (Ta=25℃ Unless Otherwise Specified )**

| Parameter                                                                    | Test Conditions                                                        | Symbol          | Ratings | Unit |
|------------------------------------------------------------------------------|------------------------------------------------------------------------|-----------------|---------|------|
| Drain-Source Voltage                                                         |                                                                        | V <sub>DS</sub> | 650     | V    |
| Gate-Source Voltage                                                          |                                                                        | V <sub>GS</sub> | ±30     | V    |
| Continuous Drain Current (Note 1)                                            | Ta= 25 ℃                                                               | I <sub>D</sub>  | 16.0    | A    |
|                                                                              | Ta= 100 ℃                                                              |                 | 10.2    |      |
| Drain Current-Pulse (Note 1)                                                 | Tj< 150 ℃                                                              | I <sub>DM</sub> | 64      | A    |
| Maximum Power Dissipation Power<br>Dissipation Derating Factor Above 25℃     | Ta= 25 ℃                                                               | P <sub>D</sub>  | 42      | W    |
|                                                                              | Ta= 100 ℃                                                              |                 | 17      |      |
| Derating Factor                                                              |                                                                        | D <sub>F</sub>  | 0.34    | W/℃  |
| Avalanche Current,Single Pulse (Note 1)                                      | L= 10.0 mH                                                             | I <sub>AS</sub> | 13.8    | A    |
| Single Pulse Avalanche Energy (Note 1)<br>Test Circuit & Waveform See Fig.16 | L= 10.0 mH<br>IAS= 13.8 A, RG= 10.0 Ω<br>Starting Tj=25 ℃, VG = 10.0 V | E <sub>AS</sub> | 952     | mJ   |

**Thermal Characteristics (Ta=25℃ Unless Otherwise Specified)**

| Parameter                                                   | Test Conditions                                     | Symbol           | Typ.       | Unit |
|-------------------------------------------------------------|-----------------------------------------------------|------------------|------------|------|
| Junction Temperature                                        |                                                     | T <sub>J</sub>   | -55 to 150 | ℃    |
| Storage Temperature Range                                   |                                                     | T <sub>STD</sub> | -55 to 150 | ℃    |
| Thermal Resistance Junction To Ambient<br>With Steady-State | Still Air Environment<br>With Ta=25℃                | R <sub>θJA</sub> | 62.5       | ℃/W  |
| Thermal Resistance Junction-Case<br>With Steady-State       | Device Mounted On<br>75mm x 45mm x 2.5mm Alu. Heat. | R <sub>θJC</sub> | 2.95       |      |

Notes: 1.Pulse Width Limited By Max. Junction Temperature. (See Fig. 13).

**NPS16N65F**

**N-Channel Enhancement Mode Power MOSFET**
**Electrical Characteristics (Ta=25°C Unless Otherwise Specified )**

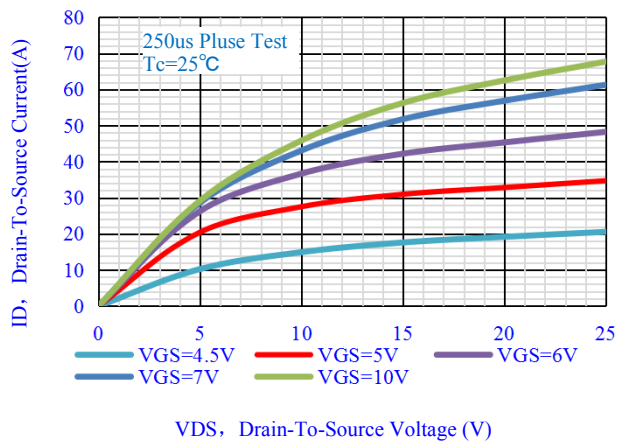
| Parameter                                                                                   | Test Conditions           | Symbol                              | Min. | Typ.   | Max. | Unit |
|---------------------------------------------------------------------------------------------|---------------------------|-------------------------------------|------|--------|------|------|
| Static Off Characteristics                                                                  |                           |                                     |      |        |      |      |
| Drain-Source Breakdown Voltage                                                              | VGS=0V,ID=250uA           | BV <sub>DSS</sub>                   | 650  | --     | --   | V    |
| Bvdss Temperature Coefficient                                                               | ID=250uA,Reference25℃     | ΔBV <sub>DSS</sub> /ΔT <sub>J</sub> | --   | 0.77   | --   | V/℃  |
| Drain-Source Leakage Current                                                                | VDS= 650 V,VGS=0V         | I <sub>DSS</sub>                    | --   | --     | 1    | uA   |
| Gate-Body Leakage Current                                                                   | VGS= ±30 V,VDS=0V         | I <sub>GSS</sub>                    | --   | --     | ±100 | nA   |
| Forward Transconductance                                                                    | ID= 8.0 A,VDS= 15 V       | g <sub>fs</sub>                     | --   | 15.0   | --   | S    |
| Static On Characteristics                                                                   |                           |                                     |      |        |      |      |
| Gate Threshold Voltage                                                                      | VGS= VDS ID=250uA         | V <sub>GS(TH)</sub>                 | 2.0  | 3.0    | 4.0  | V    |
| Drain-Source On Resistance                                                                  | ID= 8.0 A,VGS= 10.0 V     | R <sub>DS(ON)</sub>                 | --   | 0.48   | 0.6  | Ω    |
|                                                                                             | ID= 8.0 A,VGS= 4.5 V      |                                     | --   | 0.6    | 0.9  |      |
| Dynamic Characteristics                                                                     |                           |                                     |      |        |      |      |
| Input Capacitance                                                                           | VDS= 50 V                 | C <sub>iss</sub>                    | --   | 2430.0 | --   | pF   |
| Output Capacitance                                                                          | VGS= 0 V                  | C <sub>oss</sub>                    | --   | 200.0  | --   | pF   |
| Reverse Transfer Capacitance                                                                | F= 1 MHZ                  | C <sub>rss</sub>                    | --   | 10.0   | --   | pF   |
| Switching Paramters (Test Circuit & Waveform See Fig.14)                                    |                           |                                     |      |        |      |      |
| Turn-On Delay Time                                                                          | VDS= 325 V                | t <sub>d(on)</sub>                  | --   | 26.0   | --   | ns   |
| Turn-On Rise Time                                                                           | VGS= 10.0 V               | t <sub>r</sub>                      | --   | 41.0   | --   | ns   |
| Turn-Off Delay Time                                                                         | RG= 10.0 Ω                | t <sub>d(off)</sub>                 | --   | 66.0   | --   | ns   |
| Turn-Off Rise Time                                                                          |                           | t <sub>f</sub>                      | --   | 42.0   | --   | ns   |
| Gate Charge Paramters (Test Circuit & Waveform See Fig.15)                                  |                           |                                     |      |        |      |      |
| Total Gate Charge                                                                           | VDS= 325 V                | Q <sub>g</sub>                      | --   | 50.0   | --   | nC   |
| Gate-Source Charge                                                                          | VGS= 10.0 V               | Q <sub>gs</sub>                     | --   | 11.0   | --   | nC   |
| Gate-Drain Charge                                                                           | ID= 8.0 A                 | Q <sub>gd</sub>                     | --   | 21.0   | --   | nC   |
| Drain-Source Diode Characteristics And Maximum Ratings (Test Circuit & Waveform See Fig.17) |                           |                                     |      |        |      |      |
| Max. Diode Forward Cuurent                                                                  |                           | I <sub>s</sub>                      | --   | --     | 16.0 | A    |
| Max. Pulsed Forward Cuurent                                                                 |                           | I <sub>SM</sub>                     | --   | --     | 64.0 | A    |
| Diode Forward Voltage                                                                       | ID= 8.0 A,VGS=0V          | V <sub>SD</sub>                     | --   | 0.85   | 1.5  | V    |
| Reverse Recovery Time                                                                       | ID= 8.0 A,di/dt= 100 A/us | t <sub>rr</sub>                     | --   | 550.0  | --   | ns   |
| Reverse Recovery Charge                                                                     | VGS= 10.0 V,VDD= 325 V    | Q <sub>rr</sub>                     | --   | 5960.0 | --   | nC   |

**NPS16N65F**

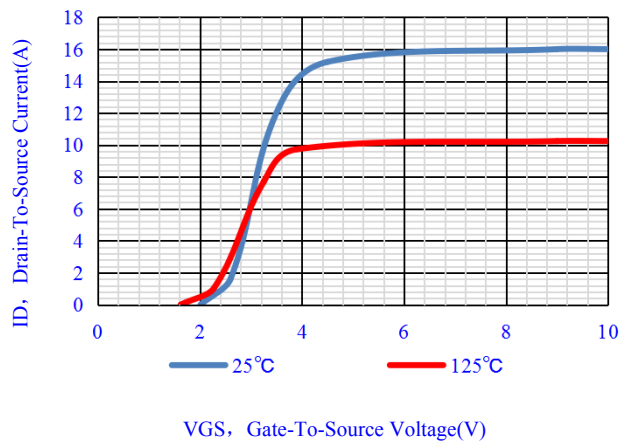
**N-Channel Enhancement Mode Power MOSFET**



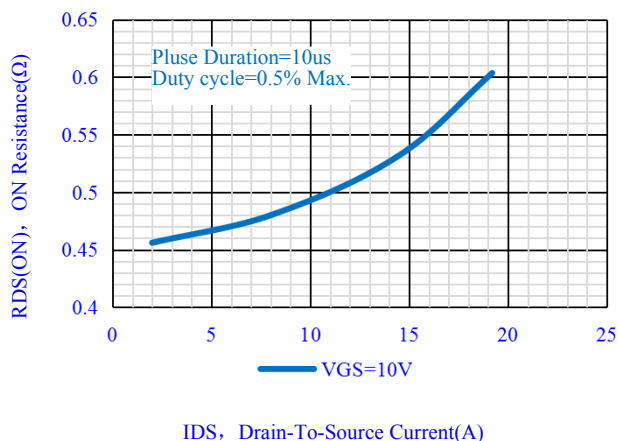
**Typical Characteristics Curves**



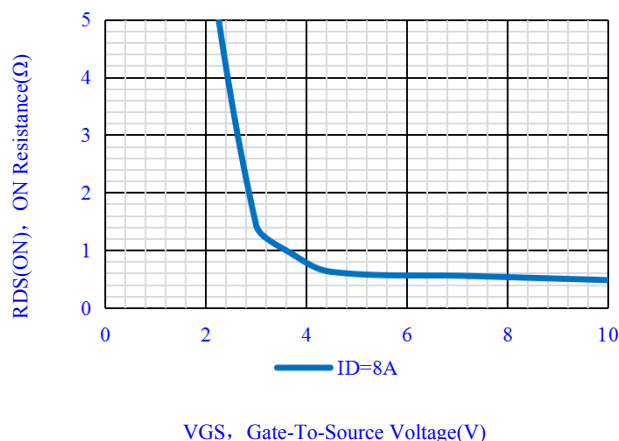
**Fig.1-Output Characteristics**



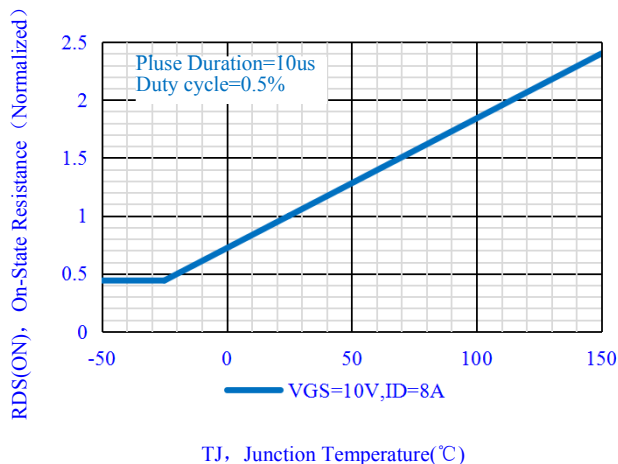
**Fig.2- Transfer Characteristics**



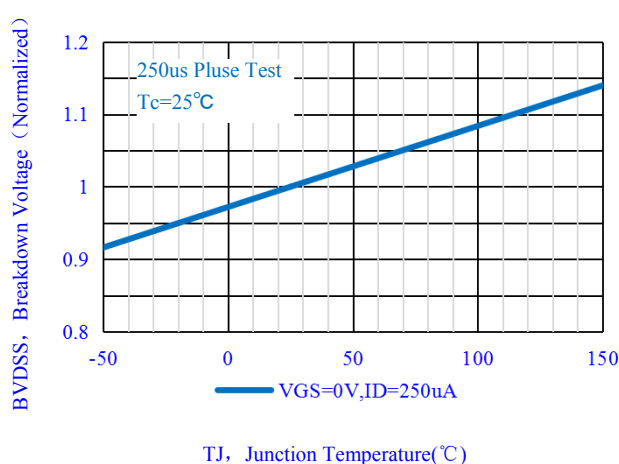
**Fig.3- On Resistance vs. Drain Current**



**Fig.4- On Resistance vs. Gate Source Voltage**



**Fig.5- On Resistance vs. Junction Temperature**



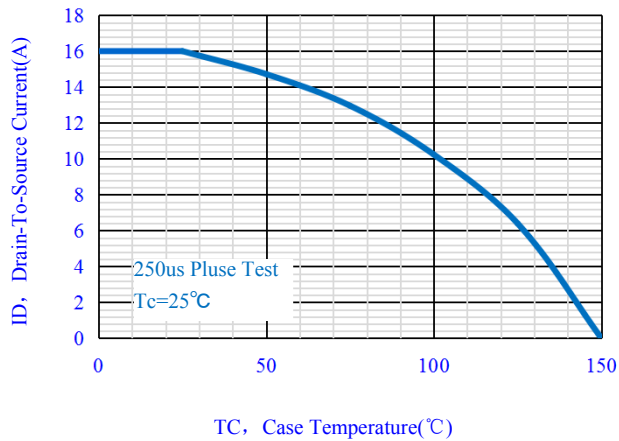
**Fig.6- Breakdown Voltage vs. Junction Temperature**

**NPS16N65F**

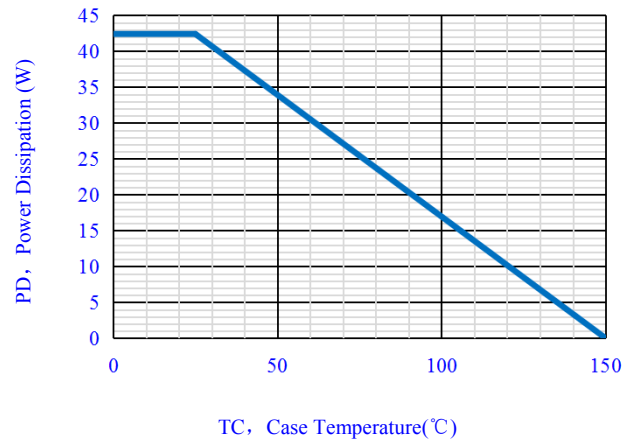
**N-Channel Enhancement Mode Power MOSFET**



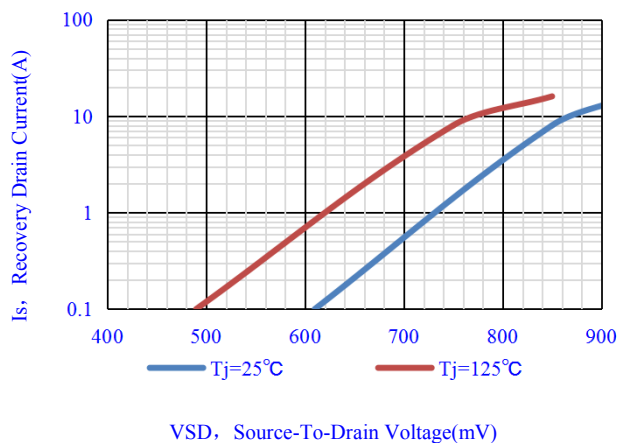
**Typical Characteristics Curves**



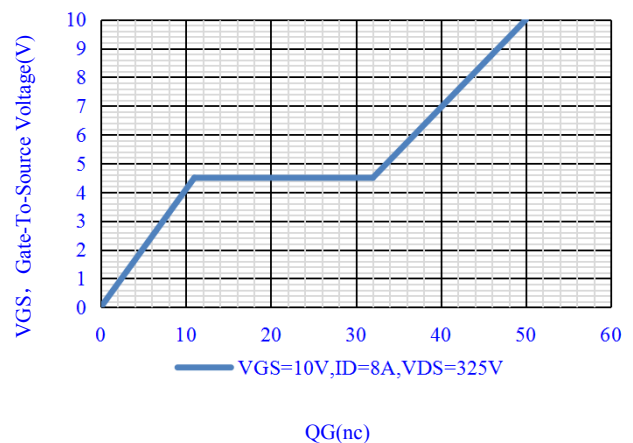
**Fig.7-Maximum Continuous Drain Current vs. Case Temperature**



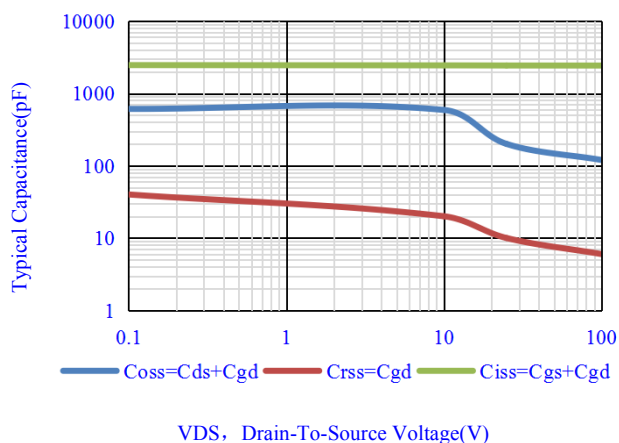
**Fig.8-Maximum Power Dissipation vs. Case Temperature**



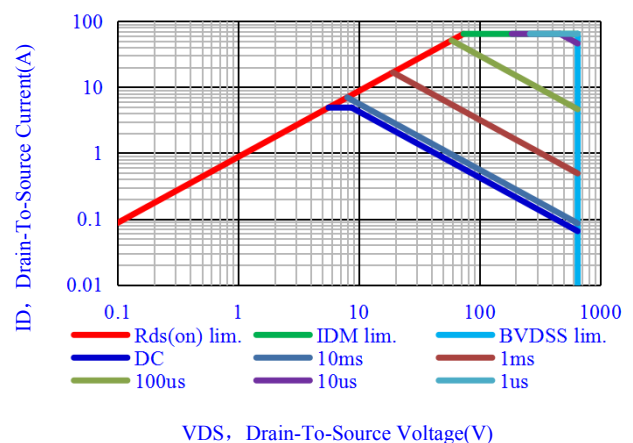
**Fig.9- Source-To-Drain Diode Forward Voltage**



**Fig.10-Gate Charge Waveform**



**Fig.11-Typical Capacitance vs. Drain-To-Source Voltage**



**Fig.12-Maximum Safe Operating Area(SOA)**

**NPS16N65F**

**N-Channel Enhancement Mode Power MOSFET**



**Typical Characteristics Curves**

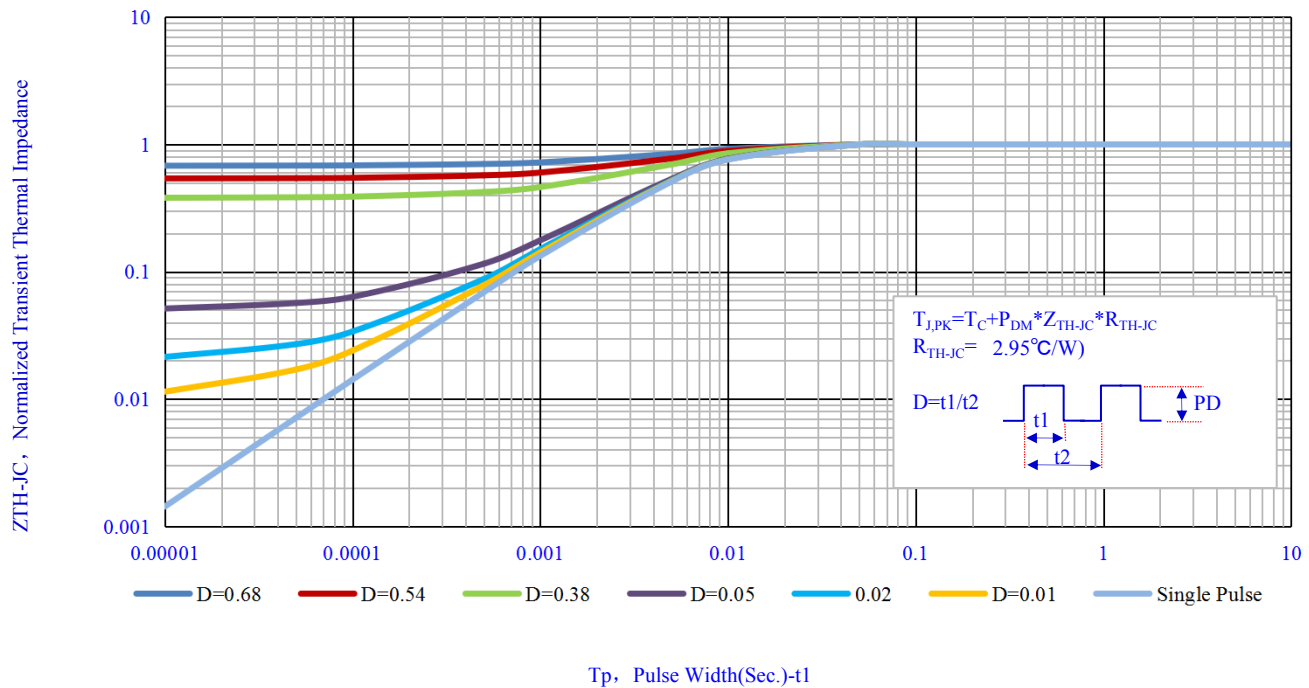


Fig.13- Normalized Maximum Transient Thermal Impedance vs.Pulse Width

**Test Circuit & Waveform**

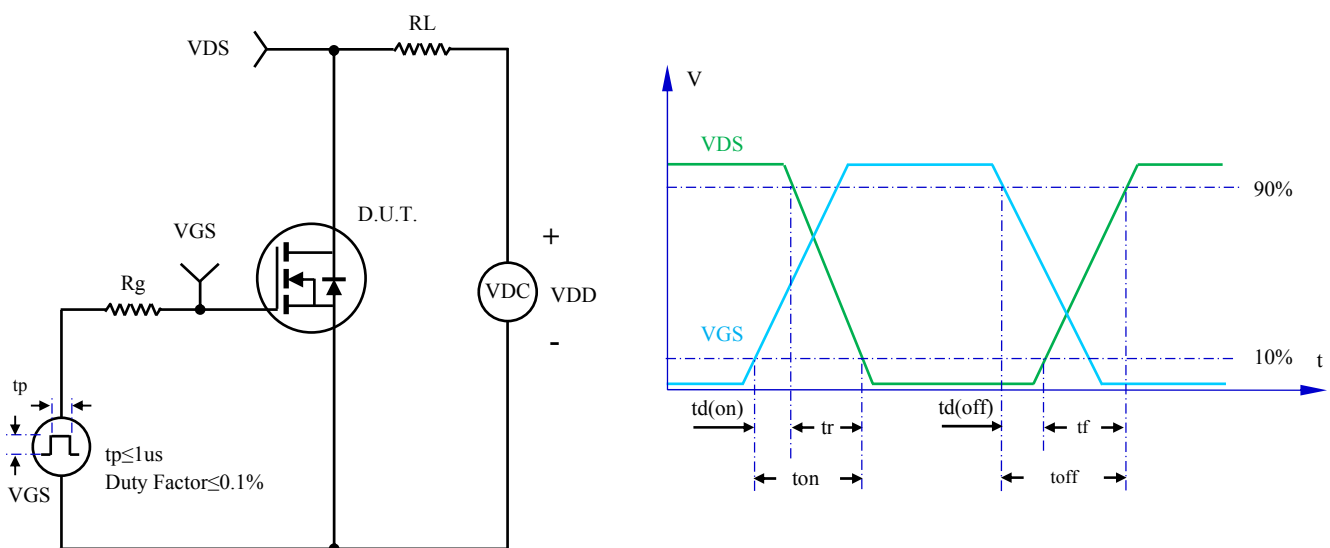


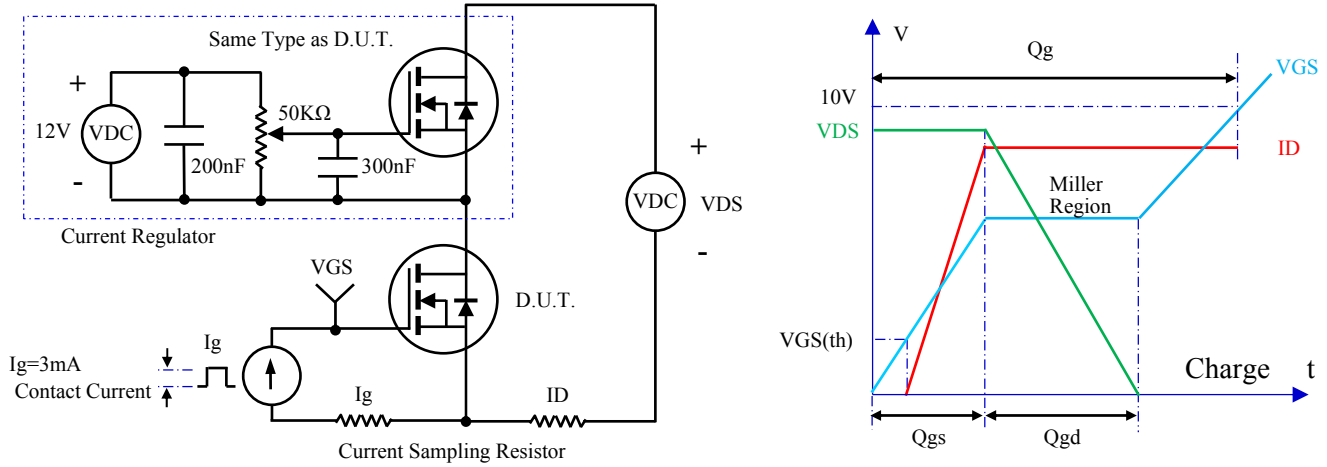
Fig.14- Resistive Switching Test Circuit & Waveform

**NPS16N65F**

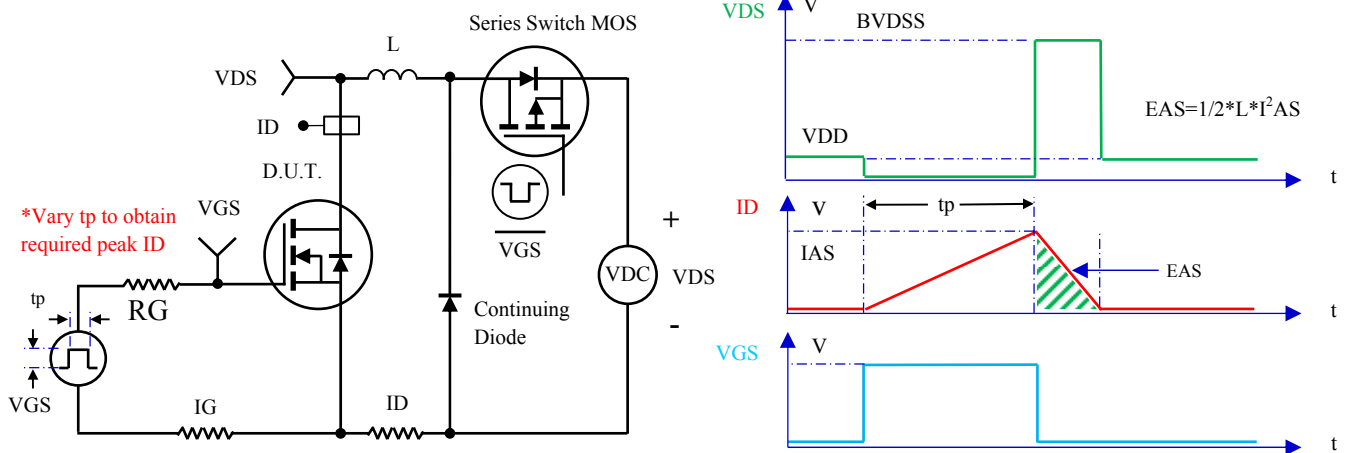
**N-Channel Enhancement Mode Power MOSFET**



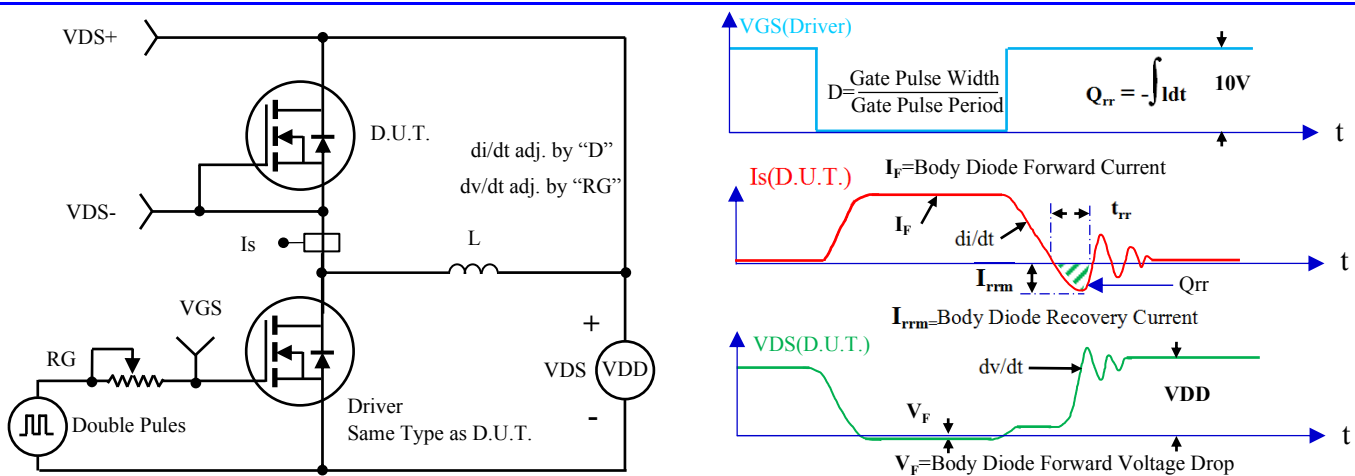
**Test Circuit & Waveform**



**Fig.15- Gate Charge Test Circuit & Waveform**



**Fig.16- Unclamped Inductive Switching (UIS) Test Circuit & Waveform**



**Fig.17- Diode Recovery Test Circuit & Waveform**

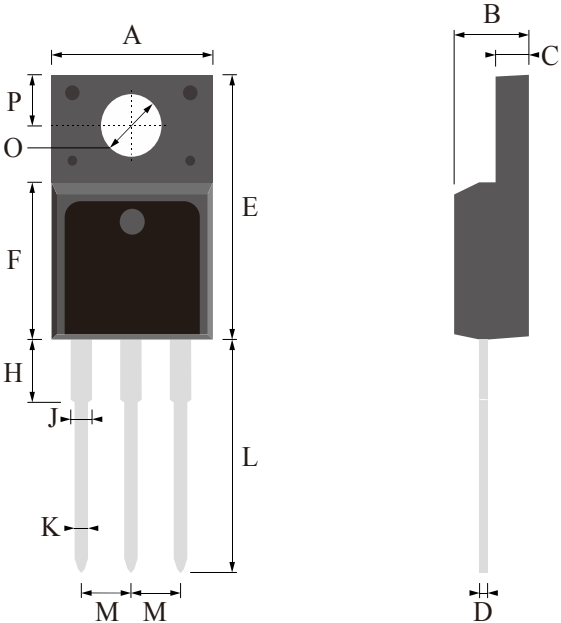
NPS16N65F

N-Channel Enhancement Mode Power MOSFET



OUTLINE DRAWINGS

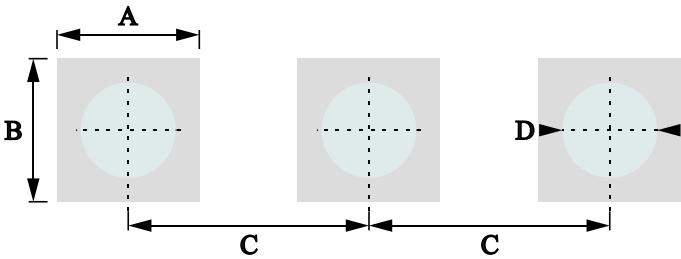
TO-220F



| OUTLINE DIMENSIONS |            |      |       |        |      |        |
|--------------------|------------|------|-------|--------|------|--------|
| Dim.               | Milimeters |      |       | Inches |      |        |
|                    | Min.       | Typ. | Max.  | Min.   | Typ. | Max.   |
| A                  | 9.25       | -    | 10.75 | 0.3642 | -    | 0.4232 |
| B                  | 4.20       | -    | 5.20  | 0.1654 | -    | 0.2047 |
| C                  | 2.30       | -    | 2.90  | 0.0906 | -    | 0.1142 |
| D                  | 0.35       | -    | 0.75  | 0.0138 | -    | 0.0295 |
| E                  | 14.80      | -    | 16.80 | 0.5827 | -    | 0.6614 |
| F                  | 8.25       | -    | 9.75  | 0.3248 | -    | 0.3839 |
| L                  | 12.15      | -    | 14.15 | 0.4783 | -    | 0.5571 |
| H                  | 2.40       | -    | 3.00  | 0.0945 | -    | 0.1181 |
| J                  | 1.10       | -    | 1.50  | 0.0433 | -    | 0.0591 |
| K                  | 0.60       | -    | 1.00  | 0.0236 | -    | 0.0394 |
| M                  | 2.20       | -    | 3.00  | 0.0866 | -    | 0.1181 |
| O                  | 2.70       | -    | 3.50  | 0.1063 | -    | 0.1378 |
| P                  | 2.25       | -    | 2.85  | 0.0886 | -    | 0.1122 |

RECOMMEDND LAYOUT DRAWINGS

TO-220F



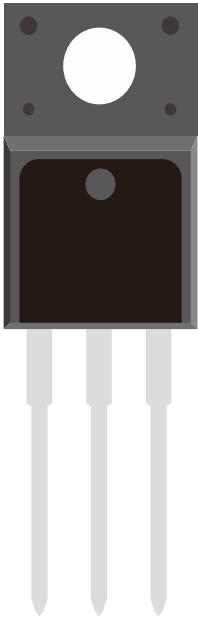
| OUTLINE DIMENSIONS |            |      |      |        |        |      |
|--------------------|------------|------|------|--------|--------|------|
| Dim.               | Milimeters |      |      | Inches |        |      |
|                    | Min.       | Typ. | Max. | Min.   | Typ.   | Max. |
| A                  | -          | 1.60 | -    | -      | 0.0630 | -    |
| B                  | -          | 1.60 | -    | -      | 0.0630 | -    |
| C                  | -          | 2.54 | -    | -      | 0.1000 | -    |
| D                  | -          | 1.00 | -    | -      | 0.0394 | -    |

NPS16N65F

N-Channel Enhancement Mode Power MOSFET



MARKING INFORMATION



MARKING INSTRUCTIONS

NH=Niuhan Trademark  
FF=Product Line Code,According To Actual Changes  
YWW=Date Code,According To Actual Changes  
LLWWF=Inernal Code,According To Actual Changes  
NPS16N65F=Model

PACKING INFORMATION

| Package Type | Package Code | Product Weight<br>Approx(g/Pcs) | Package Method | Quantity<br>(Pcs/Min. Pack.) | Quantity<br>(Pcs/Inner Box) | Quantity<br>(Pcs/Carton) |
|--------------|--------------|---------------------------------|----------------|------------------------------|-----------------------------|--------------------------|
| TO-220F      | P1           | 2.048                           | Tube           | 50                           | 1000                        | 5000                     |

**NPS16N65F**

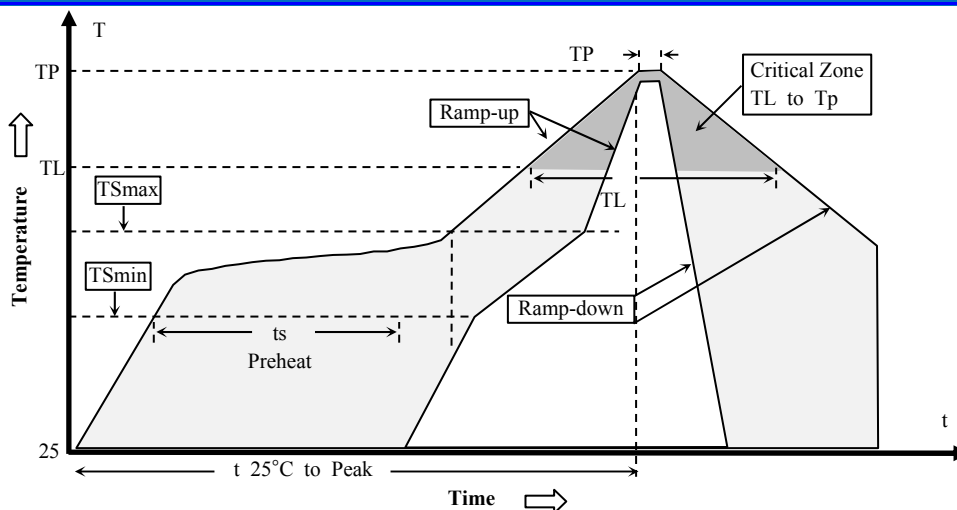
**N-Channel Enhancement Mode Power MOSFET**



**Recommended wave soldering condition**

| Product         | Peak Temperature | Soldering Time  |
|-----------------|------------------|-----------------|
| Pb-free devices | 260 +0/-5 °C     | 5 +1/-1 seconds |

**Recommended temperature profile for IR reflow**



| Profile feature                                                                                                                            | Sn-Pb eutectic Assembly          | Pb-free Assembly                 |
|--------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|----------------------------------|
| Average ramp-up rate<br>(T <sub>smax</sub> to T <sub>p</sub> )                                                                             | 3°C/second max.                  | 3°C/second max.                  |
| Preheat<br>-Temperature Min(T <sub>S</sub> min)<br>-Temperature Max(T <sub>S</sub> max)<br>-Time(t <sub>s</sub> min to t <sub>s</sub> max) | 100°C<br>150°C<br>60-120 seconds | 150°C<br>200°C<br>60-180 seconds |
| Time maintained above:<br>-Temperature (T <sub>L</sub> )<br>- Time (t <sub>L</sub> )                                                       | 183°C<br>60-150 seconds          | 217°C<br>60-150 seconds          |
| Peak Temperature(T <sub>P</sub> )                                                                                                          | 240 +0/-5 °C                     | 260 +0/-5 °C                     |
| Time within 5°C of actual peak<br>temperature(tp)                                                                                          | 10-30 seconds                    | 20-40 seconds                    |
| Ramp down rate                                                                                                                             | 6°C/second max.                  | 6°C/second max.                  |
| Time 25 °C to peak temperature                                                                                                             | 6 minutes max.                   | 8 minutes max.                   |

Note : All temperatures refer to topside of the package, measured on the package body surface.

**NPS16N65F**



**N-Channel Enhancement Mode Power MOSFET**

**Disclaimer**

- Reproducing and modifying information of the document is prohibited without permission from Niuhan Electronics Technology Co., LTD
- Niuhan Electronics Technology Co., LTD. reserves the rights to make changes of the content herein the document anytime without notification.
- Niuhan Electronics Technology Co., LTD. disclaims any and all liability arising out of the application or use of any product including damages incidentally and consequentially occurred.
- Niuhan Electronics Technology Co., LTD. does not assume any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.
- Applications shown on the herein document are examples of standard use and operation. Customers are responsible in comprehending the suitable use in particular applications. Niuhan Electronics Technology Co., LTD. makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.
- The products shown herein are not designed and authorized for equipments requiring high level of reliability or relating to human life and for any applications concerning life-saving or life-sustaining, such as medical instruments, transportation equipment, aerospace machinery et cetera. Customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Niuhan Electronics Technology Co., LTD. for any damages resulting from such improper use or sale.
- When the appearance of the product and chip size does not change, in order to product the customer. quality, change the internal structure and the production process Niuhan can not notify