

NSK096N20F



N-Channel Enhanced Shielded Gate Trench Power MOSFET

**Voltage:** 200 Volts

**Current:** 110 Amperes

**Package:** TO-220F

**Features**

- NH'S Advanced SGT Technology
- Low Reverse Transfer Capacitances
- Low Gate Charge For Low Switching Loss
- Excellent  $Q_g \cdot R_{ds(on)}$  Product(FOM)

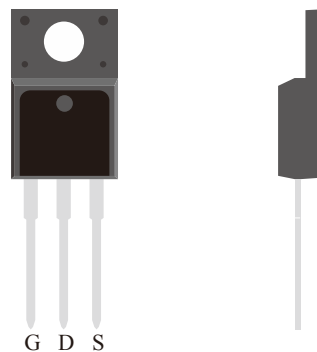
**Typical Applications**

- Synchronous Rectification
- High-Frequency Circuits
- The Motor Drives
- Automotive Electronics

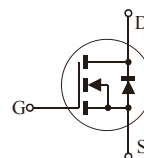
**Product Summary**

|                                     |     |    |
|-------------------------------------|-----|----|
| V <sub>DS</sub> Min.@T <sub>j</sub> | 200 | V  |
| I <sub>D</sub> Min.@T <sub>a</sub>  | 110 | A  |
| R <sub>DS(ON)</sub> (TYP)@10V       | 9.6 | mΩ |

**Diagram:**



**Polarity:**



**\*100% UIS TESTED**

**\*100% ΔV<sub>DS</sub> TESTED**

**Absolute Maximum Ratings (T<sub>a</sub>=25℃ Unless Otherwise Specified)**

| Parameter                                                                    | Test Conditions                                                                                                      | Symbol          | Ratings | Unit |
|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|-----------------|---------|------|
| Drain-Source Voltage                                                         |                                                                                                                      | V <sub>DS</sub> | 200     | V    |
| Gate-Source Voltage                                                          |                                                                                                                      | V <sub>GS</sub> | ±20     | V    |
| Continuous Drain Current (Note 1)                                            | T <sub>a</sub> = 25 ℃                                                                                                | I <sub>D</sub>  | 110     | A    |
|                                                                              | T <sub>a</sub> = 100 ℃                                                                                               |                 | 70      |      |
| Drain Current-Pulse (Note 1)                                                 | T <sub>j</sub> < 150 ℃                                                                                               | I <sub>DM</sub> | 440     | A    |
| Maximum Power Dissipation Power<br>Dissipation Derating Factor Above 25℃     | T <sub>a</sub> = 25 ℃                                                                                                | P <sub>D</sub>  | 250     | W    |
|                                                                              | T <sub>a</sub> = 100 ℃                                                                                               |                 | 100     |      |
| Derating Factor                                                              |                                                                                                                      | D <sub>F</sub>  | 2.00    | W/℃  |
| Avalanche Current,Single Pulse (Note 1)                                      | L= 0.5 mH                                                                                                            | I <sub>AS</sub> | 31      | A    |
| Single Pulse Avalanche Energy (Note 1)<br>Test Circuit & Waveform See Fig.17 | L= 0.5 mH<br>I <sub>AS</sub> = 31 A,R <sub>G</sub> = 10.0 Ω<br>Starting T <sub>j</sub> =25 ℃,V <sub>G</sub> = 10.0 V | E <sub>AS</sub> | 240     | mJ   |

**Thermal Characteristics (T<sub>a</sub>=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 T <sub>a</sub> =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> | 0.5        |      |

Notes: 1.Pulse Width Limited By Max. Junction Temperature. (See Fig.14)

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**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>                   | 200  | --   | --    | V    |
| Bvdss Temperature Coefficient                                                               | ID=250uA,Reference25℃        | ΔBV <sub>DSS</sub> /ΔT <sub>J</sub> | --   | 0.23 | --    | V/℃  |
| Drain-Source Leakage Current                                                                | VDS= 200 V,VGS=0V            | I <sub>DSS</sub>                    | --   | --   | 1     | uA   |
| Gate-Body Leakage Current                                                                   | VGS= ±20 V,VDS=0V            | I <sub>GSS</sub>                    | --   | --   | ±100  | nA   |
| Forward Transconductance                                                                    | ID= 20.0 A,VDS= 5 V          | g <sub>fs</sub>                     | --   | 60   | --    | S    |
| Static On Characteristics                                                                   |                              |                                     |      |      |       |      |
| Gate Threshold Voltage                                                                      | VGS= VDS ID=250uA            | V <sub>GS(TH)</sub>                 | 3    | 4    | 5     | V    |
| Drain-Source On Resistance                                                                  | ID= 20.0 A,VGS= 10.0 V       | R <sub>DS(ON)</sub>                 | --   | 9.6  | 12    | mΩ   |
|                                                                                             | ID= 20.0 A,VGS= 5.0 V        |                                     | --   | 13.9 | 18    |      |
| Dynamic Characteristics                                                                     |                              |                                     |      |      |       |      |
| Gate Resistance                                                                             | VGS=0V,VDS=0V,<br>Freq.=1MHz | R <sub>g</sub>                      | --   | 2.6  | --    | Ω    |
| Input Capacitance                                                                           | VDS= 50 V                    | C <sub>iss</sub>                    | --   | 4400 | --    | pF   |
| Output Capacitance                                                                          | VGS= 0 V                     | C <sub>oss</sub>                    | --   | 330  | --    | pF   |
| Reverse Transfer Capacitance                                                                | F= 1 MHZ                     | C <sub>rss</sub>                    | --   | 15   | --    | pF   |
| Switching Paramters With Inductive Load(Test Circuit & Waveform See Fig.15)                 |                              |                                     |      |      |       |      |
| Turn-On Delay Time                                                                          | VDS= 50 V                    | t <sub>d(on)</sub>                  | --   | 20   | --    | ns   |
| Turn-On Rise Time                                                                           | VGS= 10.0 V                  | t <sub>r</sub>                      | --   | 13   | --    | ns   |
| Turn-Off Delay Time                                                                         | RG= 10.0 Ω                   | t <sub>d(off)</sub>                 | --   | 33   | --    | ns   |
| Turn-Off Rise Time                                                                          | L= 0.5 mH                    | t <sub>f</sub>                      | --   | 20   | --    | ns   |
| Gate Charge Paramters (Test Circuit & Waveform See Fig.16)                                  |                              |                                     |      |      |       |      |
| Total Gate Charge                                                                           | VDS= 50 V                    | Q <sub>g</sub>                      | --   | 60   | --    | nC   |
| Gate-Source Charge                                                                          | VGS= 10.0 V                  | Q <sub>gs</sub>                     | --   | 18   | --    | nC   |
| Gate-Drain Charge                                                                           | ID= 20.0 A                   | Q <sub>gd</sub>                     | --   | 15   | --    | nC   |
| Drain-Source Diode Characteristics And Maximum Ratings (Test Circuit & Waveform See Fig.18) |                              |                                     |      |      |       |      |
| Max. Diode Forward Current                                                                  |                              | I <sub>S</sub>                      | --   | --   | 110.0 | A    |
| Max. Pulsed Forward Current                                                                 |                              | I <sub>SM</sub>                     | --   | --   | 440   | A    |
| Diode Forward Voltage                                                                       | ID= 20.0 A,VGS=0V            | V <sub>SD</sub>                     | --   | 0.7  | 1.2   | V    |
| Reverse Recovery Time                                                                       | IS= 20.0 A,di/dt= 100 A/us   | t <sub>rr</sub>                     | --   | 99   | --    | ns   |
| Reverse Recovery Charge                                                                     | VGS= 0.0 V                   | Q <sub>rr</sub>                     | --   | 250  | --    | nC   |
| Reverse Recovery Current                                                                    |                              | I <sub>RRM</sub>                    | --   | 5.0  | --    | A    |

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Typical Characteristics Curves

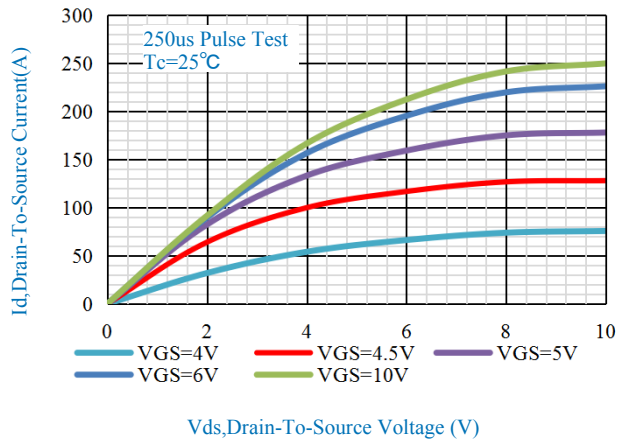


Fig.1-Output Characteristic

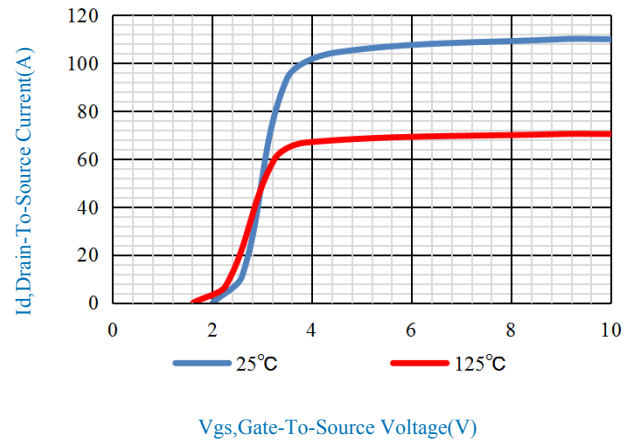


Fig.2-Transfer Characteristic

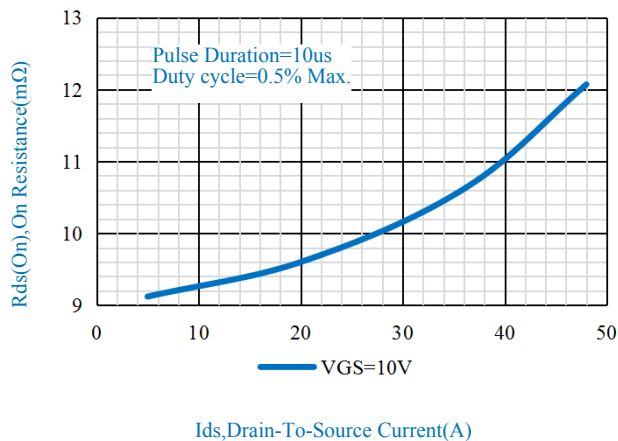


Fig.3-On Resistance Vs. Drain Current

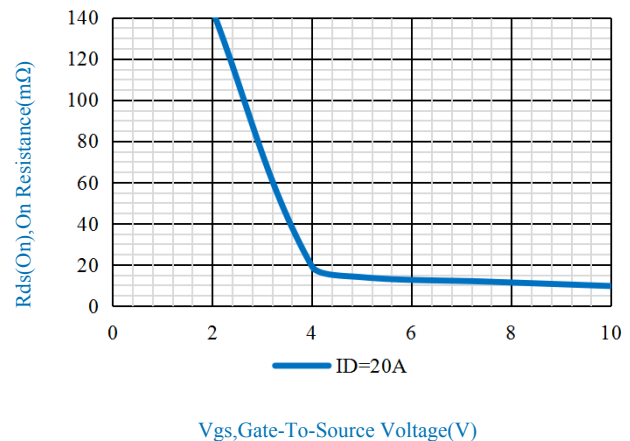


Fig.4-On Resistance Vs. Gate Source Voltage

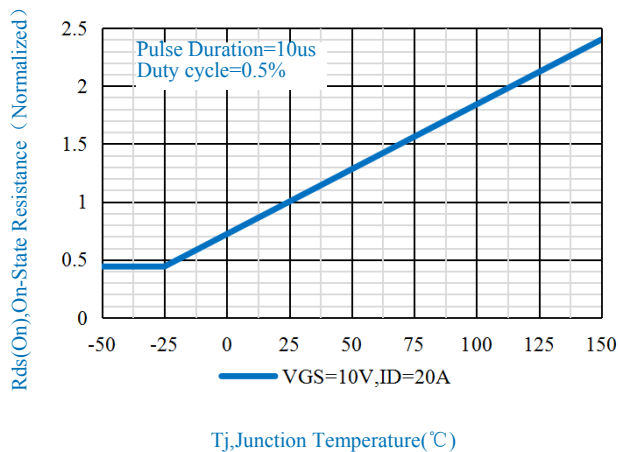


Fig.5-On Resistance Vs. Junction Temperature

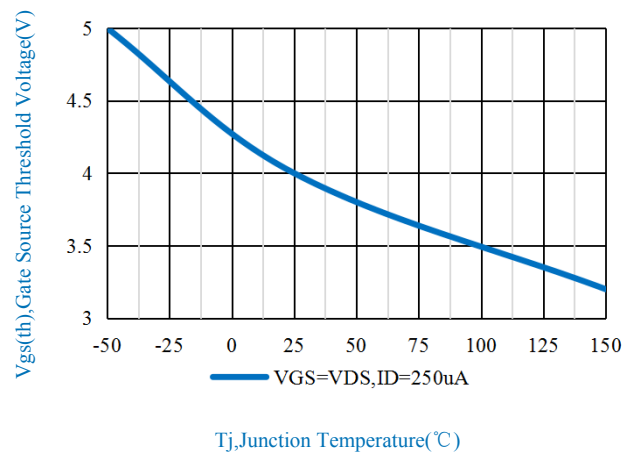


Fig.6-Gate Source Threshold Voltage Vs. Junction Temperature

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Typical Characteristics Curves

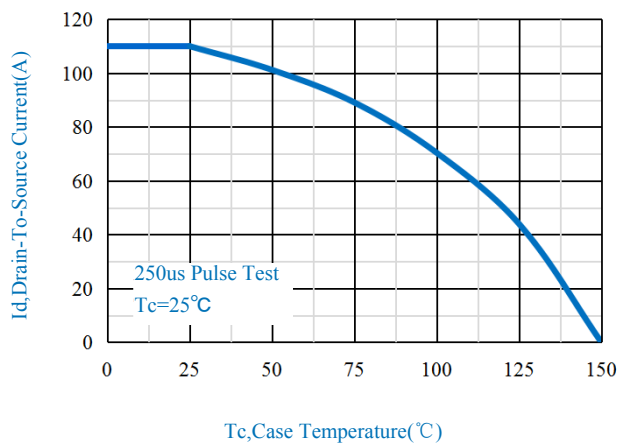


Fig.7-Maximum Continuous Drain Current Vs. Case Temperature

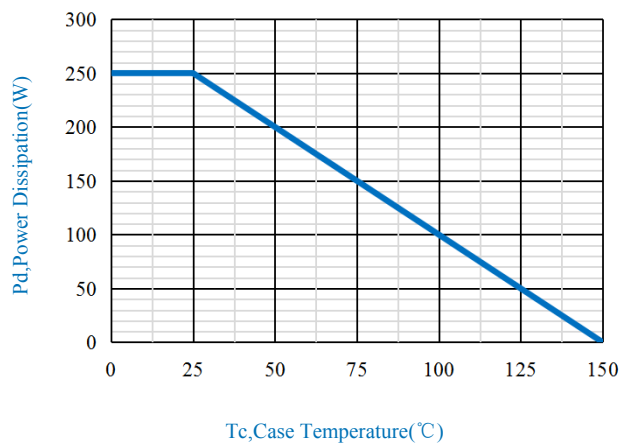


Fig.8-Maximum Power Dissipation Vs. Case Temperature

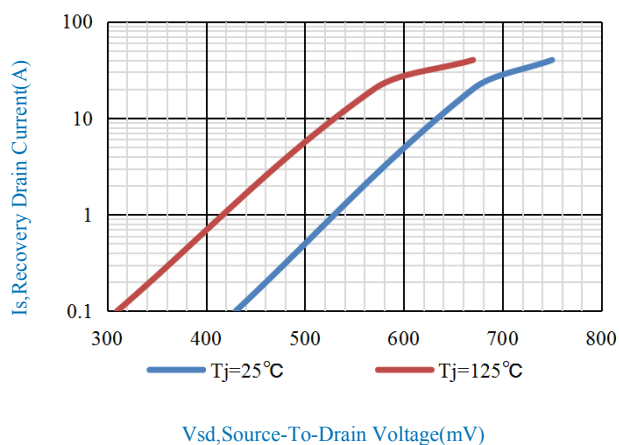


Fig.9-Source-To-Drain Diode Forward Voltage

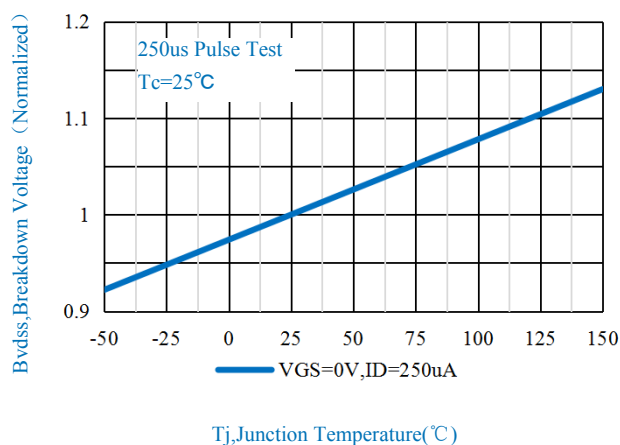


Fig.10-Breakdown Voltage Vs. Junction Temperature

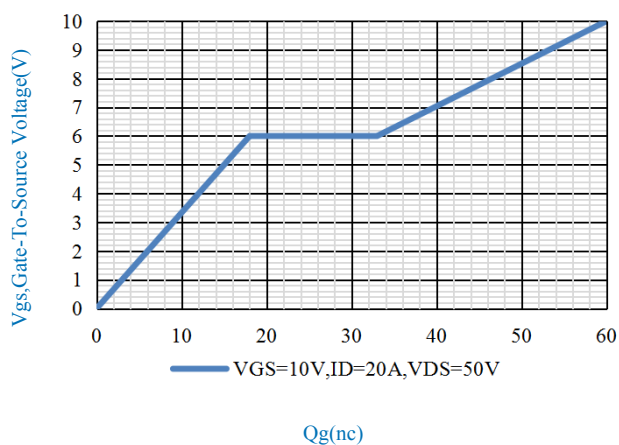


Fig.11-Gate Charge Waveform

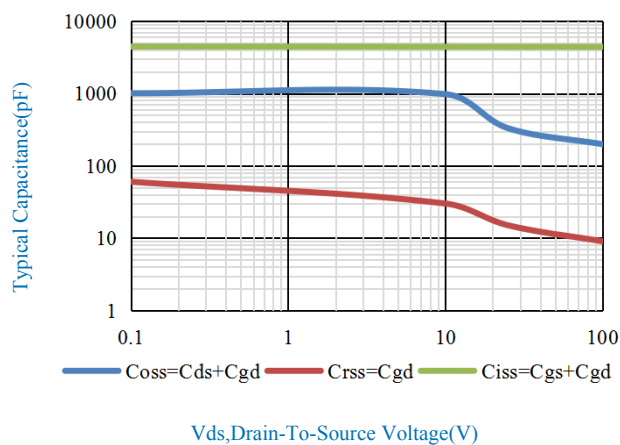


Fig.12-Typical Capacitance Vs. Drain-To-Source Voltage

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Typical Characteristics Curves

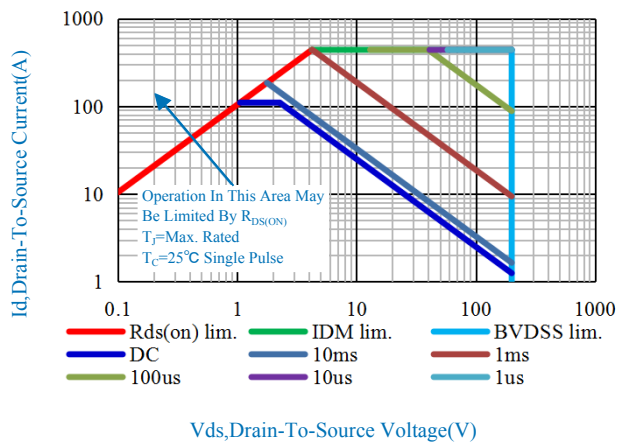


Fig.13-Maximum Safe Operating Area(SOA)

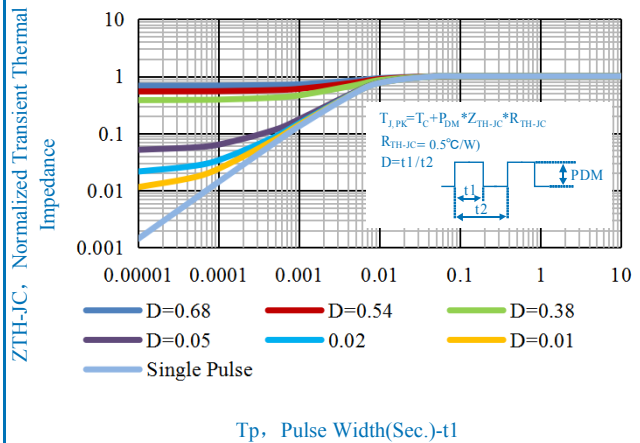


Fig.14- Normalized Maximum Transient Thermal Impedance Vs.Pulse Width

Inductive Load Test Circuit & Waveform

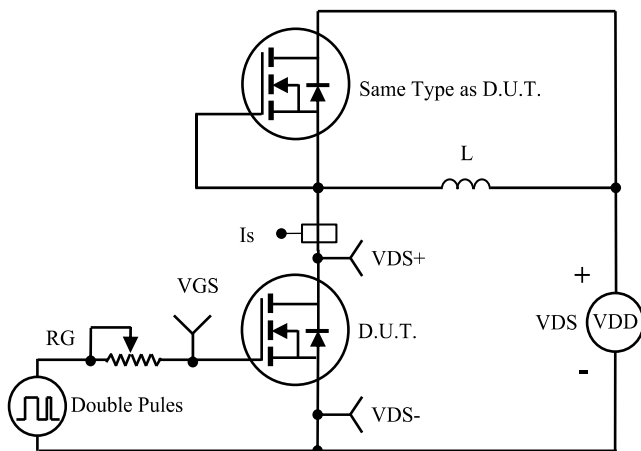


Fig.15- Inductive Switching Test Circuit & Waveform

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Test Circuit & Waveform

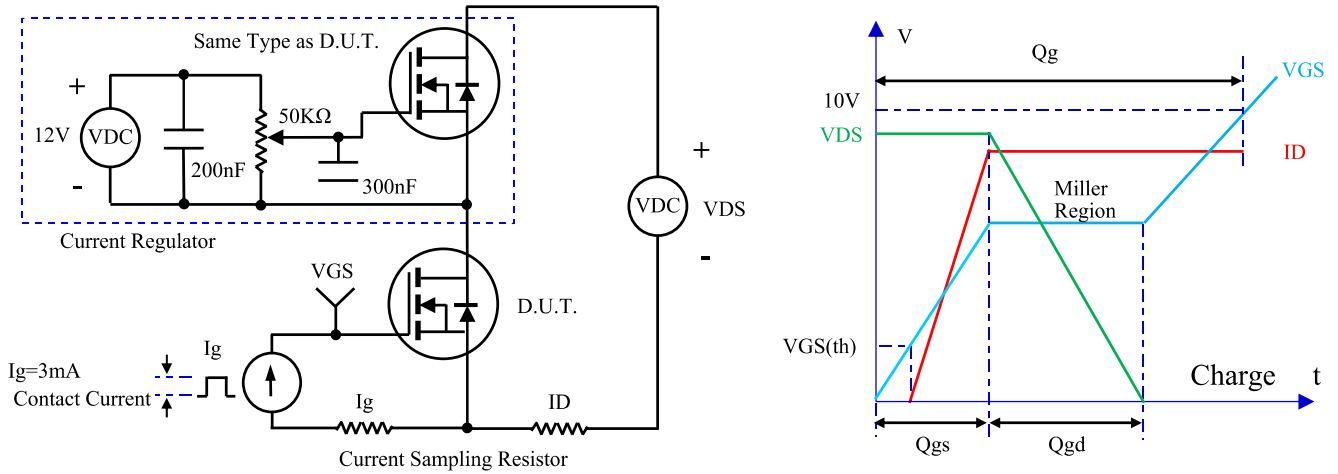


Fig.16- Gate Charge Test Circuit & Waveform

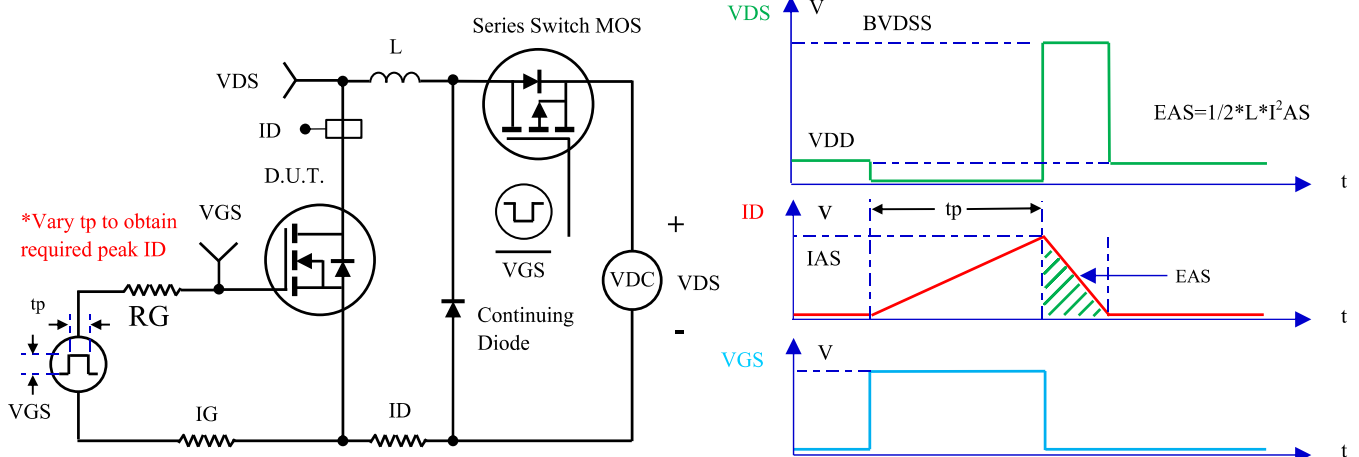


Fig.17- Unclamped Inductive Switching (UIS) Test Circuit & Waveform

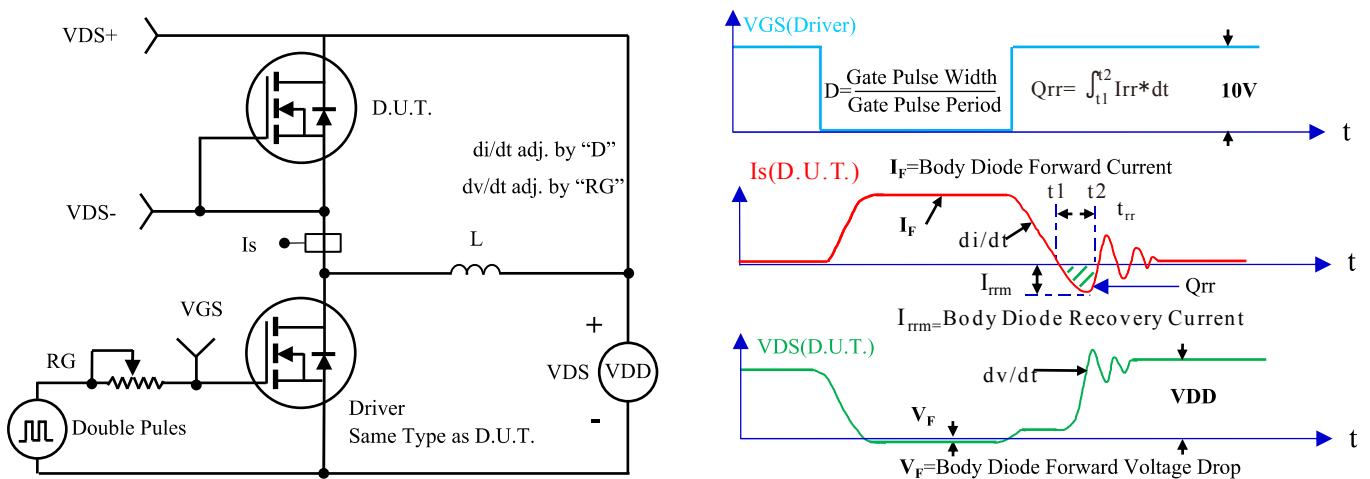


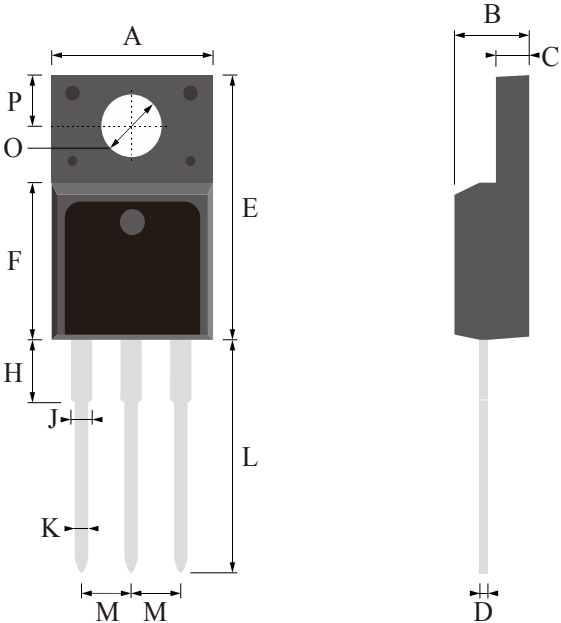
Fig.18- Diode Recovery Test Circuit & Waveform

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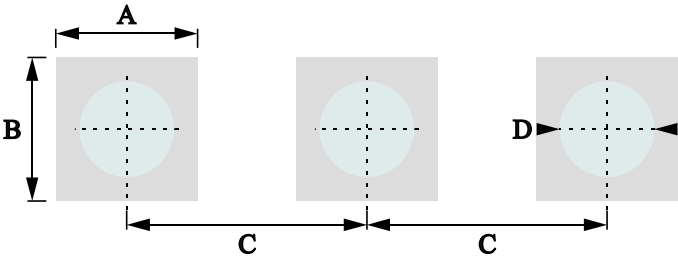
OUTLINE DRAWINGS



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                  | 2.60       | -    | 3.80  | 0.1024 | -    | 0.1496 |
| J                  | 1.10       | -    | 1.60  | 0.0433 | -    | 0.0630 |
| 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                  | 3.10       | -    | 3.80  | 0.1220 | -    | 0.1496 |

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 | -    |

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#### MARKING INFORMATION



#### MARKING INSTRUCTIONS

NH=Niuhan Trademark  
FF=Product Line Code,According To Actual Changes  
YWW=Date Code,According To Actual Changes  
LLWWF=Internal Code,According To Actual Changes  
NSK096N20F=Model

#### PACKING INFORMATION

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

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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 (T <sub>Smax</sub> to T <sub>P</sub> )                                                      | 3°C/second max.                  | 3°C/second max.                  |
|  | Preheat-Temperature Min (T <sub>S</sub> min)<br>-Temperature Max (T <sub>S</sub> max)<br>-Time(ts min to ts 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 temperature (t <sub>p</sub> )                                                     | 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.

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Specification Revision History

| Rev.        | Date       | Changed Items | Pre-Changed Content | Changed Content |
|-------------|------------|---------------|---------------------|-----------------|
| A/1         | 2014-10-20 | First Issue   |                     |                 |
| Blank Below |            |               |                     |                 |