# NID6002N

**Preferred Device**

# Self-Protected FET with Temperature and Current Limit

## 65 V, 6.5 A, Single N−Channel, DPAK

HDPlus™ devices are an advanced series of power MOSFETs which utilize ON Semiconductor's latest MOSFET technology process to achieve the lowest possible on−resistance per silicon area while incorporating smart features. Integrated thermal and current limits work together to provide short circuit protection. The devices feature an integrated Drain−to−Gate Clamp that enables them to withstand high energy in the avalanche mode. The Clamp also provides additional safety margin against unexpected voltage transients. Electrostatic Discharge (ESD) protection is provided by an integrated Gate−to−Source Clamp.

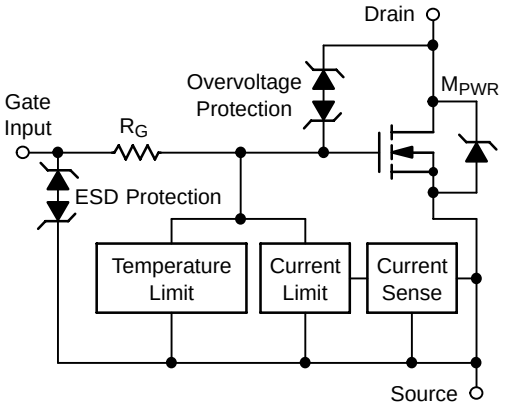
### Features

- Short Circuit Protection/Current Limit
- Thermal Shutdown with Automatic Restart
- $I_{DSS}$ Specified at Elevated Temperature
- Avalanche Energy Specified
- Slew Rate Control for Low Noise Switching
- Overvoltage Clamped Protection
- Pb−Free Package is Available

**ON Semiconductor®**

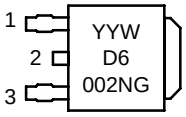
**http://onsemi.com**

| $V_{DSS}$ (Clamped) | $R_{DS(on)}$ TYP | $I_D$ TYP (Limited) |
|---|---|---|
| 65 V | 210 mΩ | 6.5 A |




**DPAK**
**CASE 369C**
**STYLE 2**

**MARKING DIAGRAM**




D6002N = Device Code
Y = Year
WW = Work Week
G = Pb−Free Device

1 = Gate
2 = Drain
3 = Source

**ORDERING INFORMATION**

| Device | Package | Shipping† |
|---|---|---|
| NID6002NT4 | DPAK | 2500/Tape & Reel |
| NID6002NT4G | DPAK (Pb−Free) | 2500/Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

**Preferred** devices are recommended choices for future use and best overall value.

**MOSFET MAXIMUM RATINGS** ($T_J$ = 25°C unless otherwise noted)

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Drain−to−Source Voltage Internally Clamped | $V_{DSS}$ | 70 | Vdc |
| Gate−to−Source Voltage | $V_{GS}$ | ±14 | Vdc |
| Drain Current Continuous | $I_D$ | Internally Limited | |
| Total Power Dissipation<br>@ $T_A$ = 25°C (Note 1)<br>@ $T_A$ = 25°C (Note 2) | $P_D$ | <br>1.3<br>2.5 | W |
| Thermal Resistance<br>Junction−to−Case<br>Junction−to−Ambient (Note 1)<br>Junction−to−Ambient (Note 2) | <br>$R_{\theta JC}$<br>$R_{\theta JA}$<br>$R_{\theta JA}$ | <br>3.0<br>95<br>50 | °C/W |
| Single Pulse Drain−to−Source Avalanche Energy ($V_{DD}$ = 50 Vdc, $V_{GS}$ = 5.0 Vdc, $I_L$ = 1.3 Apk, L = 160 mH, $R_G$ = 25 Ω) | $E_{AS}$ | 143 | mJ |
| Operating and Storage Temperature Range (Note 3) | $T_J$, $T_{stg}$ | −55 to 150 | °C |

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

1. Surface mounted onto minimum pad size (100 sq/mm) FR4 PCB, 1 oz cu.
2. Mounted onto 1″ square pad size (700 sq/mm) FR4 PCB, 1 oz cu.
3. Normal pre−fault operating range. See thermal limit range conditions.

**MOSFET ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| Drain−to−Source Clamped Breakdown Voltage ($V_{GS}$ = 0 V, $I_D$ = 2 mA) | $V_{(BR)DSS}$ | 60 | 65 | 70 | V |
| Zero Gate Voltage Drain Current ($V_{DS}$ = 52 V, $V_{GS}$ = 0 V) | $I_{DSS}$ | − | 27 | 100 | μA |
| Gate Input Current ($V_{GS}$ = 5.0 V, $V_{DS}$ = 0 V) | $I_{GSS}$ | − | 45 | 200 | μA |
| **ON CHARACTERISTICS** | | | | | |
| Gate Threshold Voltage ($V_{DS}$ = $V_{GS}$, $I_D$ = 150 μA)<br>Threshold Temperature Coefficient | $V_{GS(th)}$ | 1.0<br>− | 1.85<br>5.0 | 2.4<br>− | V<br>−mV/°C |
| Static Drain−to−Source On−Resistance (Note 4) ($V_{GS}$ = 10 V, $I_D$ = 2.0 A, $T_J$ @ 25°C) | $R_{DS(on)}$ | − | 185 | 210 | mΩ |
| Static Drain−to−Source On−Resistance (Note 4) ($V_{GS}$ = 5.0 V, $I_D$ = 2.0 A, $T_J$ @ 25°C)<br>($V_{GS}$ = 5.0 V, $I_D$ = 2.0 A, $T_J$ @ 150°C) | $R_{DS(on)}$ | −<br>− | 210<br>445 | 240<br>520 | mΩ |
| Source−Drain Forward On Voltage ($I_S$ = 7.0 A, $V_{GS}$ = 0 V) | $V_{SD}$ | − | 0.9 | 1.1 | V |
| **SWITCHING CHARACTERISTICS** | | | | | |
| Turn−on Delay Time | $R_L$ = 6.6 Ω, $V_{in}$ = 0 to 10 V, $V_{DD}$ = 13.8 V, $I_D$ = 2.0 A, 10% $V_{in}$ to 10% $I_D$ | $td_{(on)}$ | − | 103 | 120 | ns |
| Turn−on Rise Time | $R_L$ = 6.6 Ω, $V_{in}$ = 0 to 10 V, $V_{DD}$ = 13.8 V, $I_D$ = 2.0 A, 10% $I_D$ to 90% $I_D$ | $t_{rise}$ | − | 246 | 285 | ns |
| Turn−off Delay Time | $R_L$ = 6.6 Ω, $V_{in}$ = 0 to 10 V, $V_{DD}$ = 13.8 V, $I_D$ = 2.0 A, 90% $V_{in}$ to 90% $I_D$ | $td_{(off)}$ | − | 742 | 850 | ns |
| Turn−off Fall Time | $R_L$ = 6.6 Ω, $V_{in}$ = 0 to 10 V, $V_{DD}$ = 13.8 V, $I_D$ = 2.0 A, 90% $I_D$ to 10% $I_D$ | $t_{fall}$ | − | 707 | 780 | ns |
| Slew Rate ON | $R_L$ = 6.6 Ω, $V_{in}$ = 0 to 10 V, $V_{DD}$ = 13.8 V, $I_D$ = 2.0 A, 70% to 50% $V_{DD}$ | $dV_{DS}/dT_{on}$ | − | 73 | − | V/μs |
| Slew Rate OFF | $R_L$ = 6.6 Ω, $V_{in}$ = 0 to 10 V, $V_{DD}$ = 13.8 V, $I_D$ = 2.0 A, 50% to 70% $V_{DD}$ | $dV_{DS}/dT_{off}$ | − | 35 | − | V/μs |

**SELF PROTECTION CHARACTERISTICS** ($T_J$ = 25°C unless otherwise noted) (Note 5)

| | | | | | | |
|---|---|---|---|---|---|---|
| Current Limit | $V_{DS}$ = 10 V, $V_{GS}$ = 5.0 V, $T_J$ = 25°C (Note 6)<br>$V_{DS}$ = 10 V, $V_{GS}$ = 5.0 V, $T_J$ = 130°C (Note 6)<br>$V_{DS}$ = 10 V, $V_{GS}$ = 10 V, $T_J$ = 25°C (Note 6) | $I_{LIM}$ | 4.0<br>4.0<br>− | 6.4<br>5.5<br>7.9 | 11<br>11<br>− | A |
| Temperature Limit (Turn−off) | $V_{GS}$ = 5.0 V | $T_{LIM(off)}$ | 150 | 180 | 200 | °C |
| Thermal Hysteresis | $V_{GS}$ = 5.0 V | $\Delta T_{LIM(on)}$ | − | 10 | − | °C |
| Temperature Limit (Turn−off) | $V_{GS}$ = 10 V | $T_{LIM(off)}$ | 150 | 180 | 200 | °C |
| Thermal Hysteresis | $V_{GS}$ = 10 V | $\Delta T_{LIM(on)}$ | − | 20 | − | °C |
| Input Current during Thermal Fault | $V_{DS}$ = 0 V, $V_{GS}$ = 5.0 V, $T_J$ = $T_J$ > $T_{(fault)}$<br>$V_{DS}$ = 0 V, $V_{GS}$ = 10 V, $T_J$ = $T_J$ > $T_{(fault)}$ | $I_{g(fault)}$ | 5.5<br>12 | 5.2<br>11 | − | mA |

**ESD ELECTRICAL CHARACTERISTICS** ($T_J$ = 25°C unless otherwise noted)

| | | | | | |
|---|---|---|---|---|---|
| Electro−Static Discharge Capability<br>Human Body Model (HBM)<br>Machine Model (MM) | ESD | 8000<br>400 | −<br>− | −<br>− | V |

4. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.
5. Fault conditions are viewed as beyond the normal operating range of the part.
6. Current limit measured at 380 μs after gate pulse.

## TYPICAL PERFORMANCE CURVES

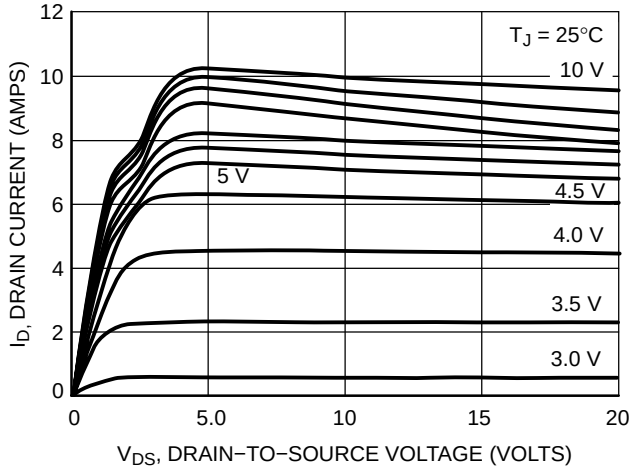



**Figure 1. On−Region Characteristics**

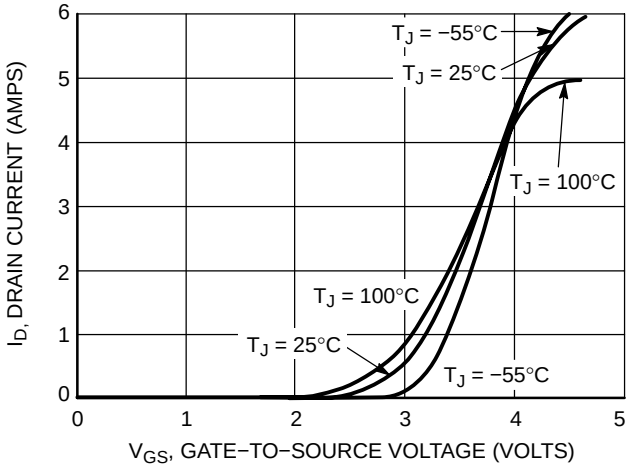



**Figure 2. Transfer Characteristics**

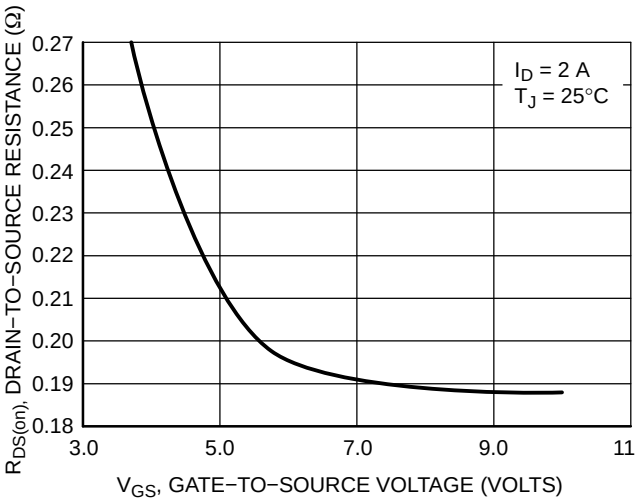



**Figure 3. On−Resistance vs. Gate−to−Source Voltage**

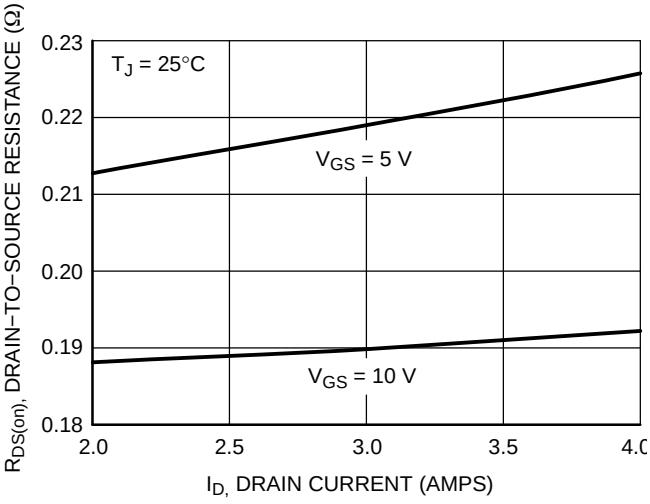



**Figure 4. On−Resistance vs. Drain Current and Gate Voltage**

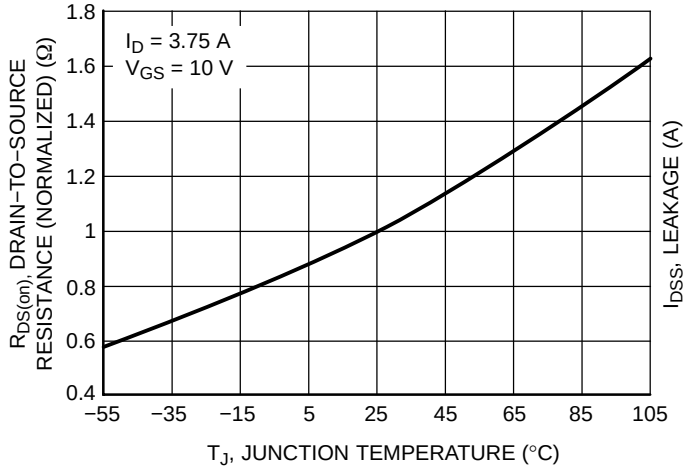



**Figure 5. On−Resistance Variation with Temperature**

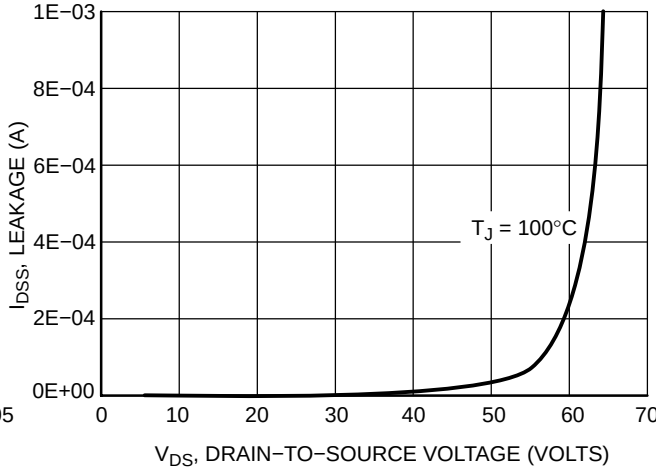



**Figure 6. Drain−to−Source Leakage Current vs. Voltage**

## TYPICAL PERFORMANCE CURVES

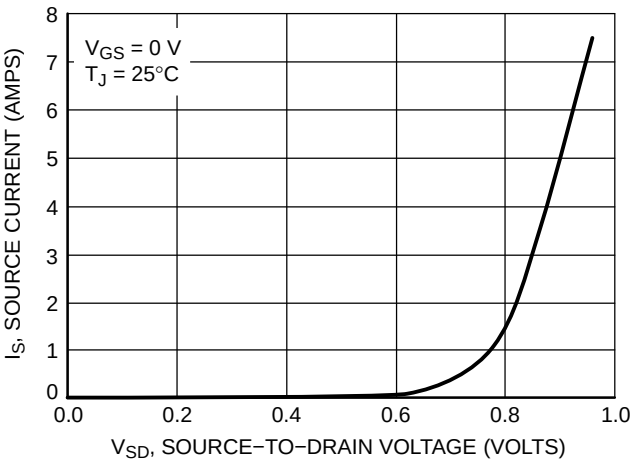



**Figure 7. Diode Forward Voltage vs. Current**

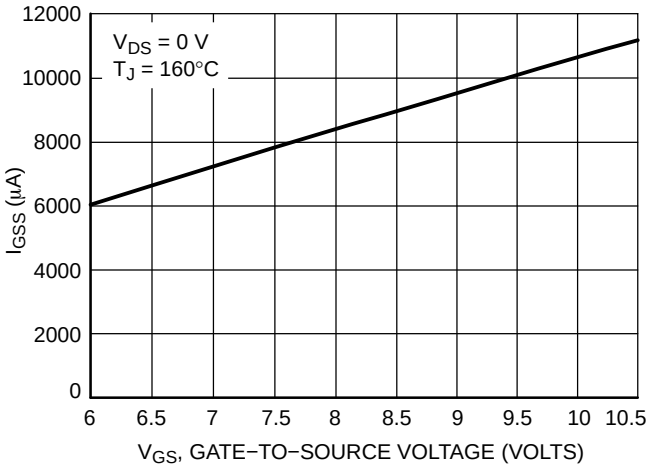



**Figure 8. Input Current vs. Gate Voltage**

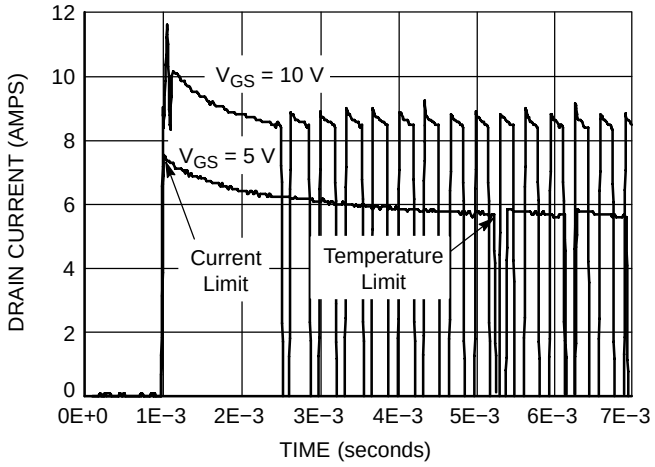


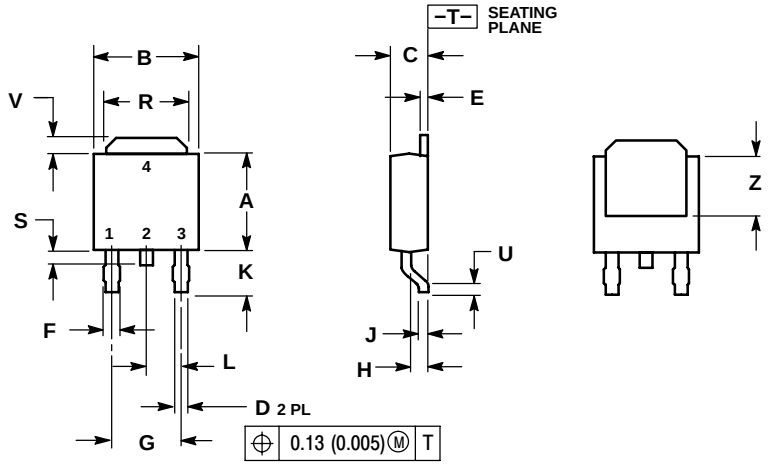

**Figure 9. Short Circuit Response***

*(Actual thermal cycling response in short circuit dependent on device power level, thermal mounting, and ambient temperature conditions)

# NID6002N

## PACKAGE DIMENSIONS

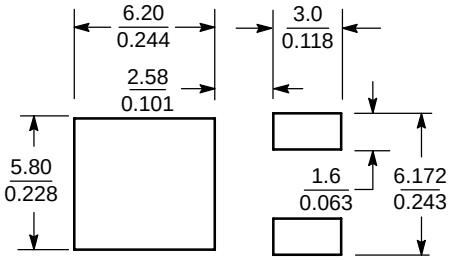
**DPAK**
CASE 369C−01
ISSUE O




| DIM | INCHES MIN | INCHES MAX | MILLIMETERS MIN | MILLIMETERS MAX |
|---|---|---|---|---|
| A | 0.235 | 0.245 | 5.97 | 6.22 |
| B | 0.250 | 0.265 | 6.35 | 6.73 |
| C | 0.086 | 0.094 | 2.19 | 2.38 |
| D | 0.027 | 0.035 | 0.69 | 0.88 |
| E | 0.018 | 0.023 | 0.46 | 0.58 |
| F | 0.037 | 0.045 | 0.94 | 1.14 |
| G | 0.180 BSC | | 4.58 BSC | |
| H | 0.034 | 0.040 | 0.87 | 1.01 |
| J | 0.018 | 0.023 | 0.46 | 0.58 |
| K | 0.102 | 0.114 | 2.60 | 2.89 |
| L | 0.090 BSC | | 2.29 BSC | |
| R | 0.180 | 0.215 | 4.57 | 5.45 |
| S | 0.025 | 0.040 | 0.63 | 1.01 |
| U | 0.020 | −−− | 0.51 | −−− |
| V | 0.035 | 0.050 | 0.89 | 1.27 |
| Z | 0.155 | −−− | 3.93 | −−− |

STYLE 2:
PIN 1. GATE
2. DRAIN
3. SOURCE
4. DRAIN

## SOLDERING FOOTPRINT




SCALE 3:1 $\left(\frac{\text{mm}}{\text{inches}}\right)$

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