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ON Semiconductor®

## NDP6020P / NDB6020P

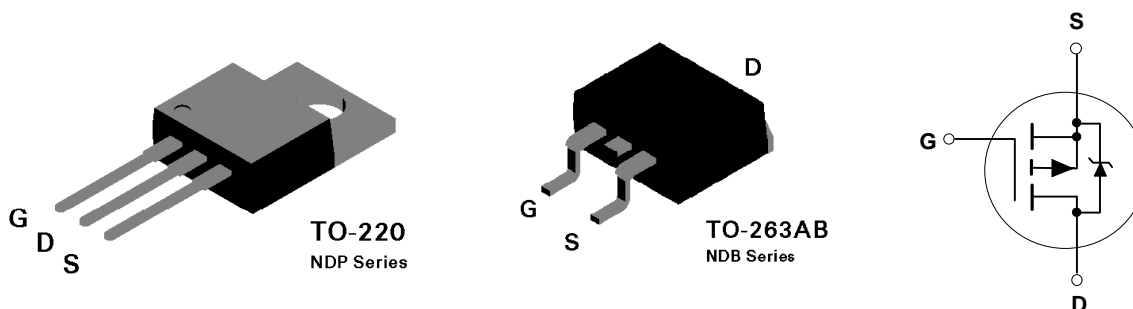
### P-Channel Logic Level Enhancement Mode Field Effect Transistor

#### General Description

These logic level P-Channel enhancement mode power field effect transistors are produced using ON Semiconductor's proprietary, high cell density, DMOS technology. This very high density process has been especially tailored to minimize on-state resistance, provide superior switching performance, and withstand high energy pulses in the avalanche and commutation modes. These devices are particularly suited for low voltage applications such as automotive, DC/DC converters, PWM motor controls, and other battery powered circuits where fast switching, low in-line power loss, and resistance to transients are needed.

#### Features

- -24 A, -20 V.  $R_{DS(ON)} = 0.05 \Omega @ V_{GS} = -4.5 \text{ V}$ .  
 $R_{DS(ON)} = 0.07 \Omega @ V_{GS} = -2.7 \text{ V}$ .  
 $R_{DS(ON)} = 0.075 \Omega @ V_{GS} = -2.5 \text{ V}$ .
- Critical DC electrical parameters specified at elevated temperature.
- Rugged internal source-drain diode can eliminate the need for an external Zener diode transient suppressor.
- 175°C maximum junction temperature rating.
- High density cell design for extremely low  $R_{DS(ON)}$ .
- TO-220 and TO-263 (D<sup>2</sup>PAK) package for both through hole and surface mount applications.



#### Absolute Maximum Ratings $T_C = 25^\circ\text{C}$ unless otherwise noted

| Symbol                            | Parameter                                       | NDP6020P   | NDB6020P | Units |
|-----------------------------------|---|------------|----------|-------|
| V <sub>DSS</sub>                  | Drain-Source Voltage                            | -20        |          | V     |
| V <sub>GSS</sub>                  | Gate-Source Voltage - Continuous                | ±8         |          | V     |
| I <sub>D</sub>                    | Drain Current - Continuous                      | -24        |          | A     |
|                                   | - Pulsed  | -70        |          |       |
| P <sub>D</sub>                    | Total Power Dissipation @ T <sub>C</sub> = 25°C | 60         |          | W     |
|                                   | Derate above 25°C                               | 0.4        |          | W/°C  |
| T <sub>J</sub> , T <sub>STG</sub> | Operating and Storage Temperature Range         | -65 to 175 |          | °C    |

**Electrical Characteristics** ( $T_c = 25^\circ\text{C}$  unless otherwise noted)

| Symbol                             | Parameter                         | Conditions  | Min          | Typ           | Max          | Units    |
|------------------------------------|-----------------------------------|---|--------------|---------------|--------------|----------|
| OFF CHARACTERISTICS                |                                   |   |              |               |              |          |
| BV <sub>DSS</sub>                  | Drain-Source Breakdown Voltage    | V <sub>GS</sub> = 0 V, I <sub>D</sub> = -250 μA   | -20          |               |              | V        |
| I <sub>DSS</sub>                   | Zero Gate Voltage Drain Current   | V <sub>DS</sub> = -16 V, V <sub>GS</sub> = 0 V<br>T <sub>J</sub> = 55°C                           |              |               | -1<br>-10    | μA<br>μA |
| I <sub>GSSF</sub>                  | Gate - Body Leakage, Forward      | V <sub>GS</sub> = 8 V, V <sub>DS</sub> = 0 V  |              |               | 100          | nA       |
| I <sub>GSSR</sub>                  | Gate - Body Leakage, Reverse      | V <sub>GS</sub> = -8 V, V <sub>DS</sub> = 0 V   |              |               | -100         | nA       |
| ON CHARACTERISTICS (Note 1)        |                                   |   |              |               |              |          |
| V <sub>GS(th)</sub>                | Gate Threshold Voltage            | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = -250 μA<br>T <sub>J</sub> = 125°C            | -0.4<br>-0.3 | -0.7<br>-0.56 | -1<br>-0.7   | V        |
| R <sub>DS(on)</sub>                | Static Drain-Source On-Resistance | V <sub>GS</sub> = -4.5 V, I <sub>D</sub> = -12 A<br>T <sub>J</sub> = 125°C                        |              | 0.041<br>0.06 | 0.05<br>0.08 | Ω        |
| R <sub>DS(on)</sub>                | Static Drain-Source On-Resistance | V <sub>GS</sub> = -2.7 V, I <sub>D</sub> = -10 A  |              | 0.059         | 0.07         |          |
| R <sub>DS(on)</sub>                | Static Drain-Source On-Resistance | V <sub>GS</sub> = -2.5 V, I <sub>D</sub> = -10 A  |              | 0.064         | 0.075        |          |
| I <sub>D(on)</sub>                 | On-State Drain Current            | V <sub>GS</sub> = -4.5 V, V <sub>DS</sub> = -5 V  | -24          |               |              | A        |
| g <sub>FS</sub>                    | Forward Transconductance          | V <sub>DS</sub> = -5 V, I <sub>D</sub> = -12 A  |              | 14            |              | S        |
| DYNAMIC CHARACTERISTICS            |                                   |   |              |               |              |          |
| C <sub>iss</sub>                   | Input Capacitance                 | V <sub>DS</sub> = -10 V, V <sub>GS</sub> = 0 V,<br>f = 1.0 MHz                                    |              | 1590          |              | pF       |
| C <sub>oss</sub>                   | Output Capacitance                |   |              | 725           |              | pF       |
| C <sub>rss</sub>                   | Reverse Transfer Capacitance      |   |              | 215           |              | pF       |
| SWITCHING CHARACTERISTICS (Note 1) |                                   |   |              |               |              |          |
| t <sub>D(on)</sub>                 | Turn - On Delay Time              | V <sub>DD</sub> = -20 V, I <sub>D</sub> = -3 A,<br>V <sub>GS</sub> = -5 V, R <sub>GEN</sub> = 6 Ω |              | 15            | 30           | nS       |
| t <sub>r</sub>                     | Turn - On Rise Time               |   |              | 27            | 60           | nS       |
| t <sub>D(off)</sub>                | Turn - Off Delay Time             |   |              | 120           | 250          | nS       |
| t <sub>f</sub>                     | Turn - Off Fall Time              |   |              | 70            | 150          | nS       |
| Q <sub>g</sub>                     | Total Gate Charge                 | V <sub>DS</sub> = -10 V,<br>I <sub>D</sub> = -24 A, V <sub>GS</sub> = -5 V                        |              | 25            | 35           | nC       |
| Q <sub>gs</sub>                    | Gate-Source Charge                |   |              | 5             |              | nC       |
| Q <sub>gd</sub>                    | Gate-Drain Charge                 |   |              | 10            |              | nC       |

# Electrical Characteristics (T<sub>C</sub> = 25°C unless otherwise noted)

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|--------|-----------|------------|-----|-----|-----|-------|
|--------|-----------|------------|-----|-----|-----|-------|

## DRAIN-SOURCE DIODE CHARACTERISTICS

|                 |   |  |  |      |      |    |
|-----------------|---|--|--|------|------|----|
| I <sub>S</sub>  | Maximum Continuous Drain-Source Diode Forward Current |  |  |      | -24  | A  |
| I <sub>SM</sub> | Maximum Pulsed Drain-Source Diode Forward Current     |  |  |      | -80  | A  |
| V <sub>SD</sub> | Drain-Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>S</sub> = -12 A (Note 1)                           |  | -1.1 | -1.3 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                 | V <sub>GS</sub> = 0 V, I <sub>F</sub> = -24 A,<br>dI <sub>F</sub> /dt = 100 A/μs |  | 60   |      | ns |
| I <sub>rr</sub> | Reverse Recovery Current                              |  |  | -1.7 |      | A  |

## THERMAL CHARACTERISTICS

|                  |   |  |  |  |      |      |
|------------------|---|--|--|--|------|------|
| R <sub>θJC</sub> | Thermal Resistance, Junction-to-Case    |  |  |  | 2.5  | °C/W |
| R <sub>θJA</sub> | Thermal Resistance, Junction-to-Ambient |  |  |  | 62.5 | °C/W |

Note:

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

## Typical Electrical Characteristics

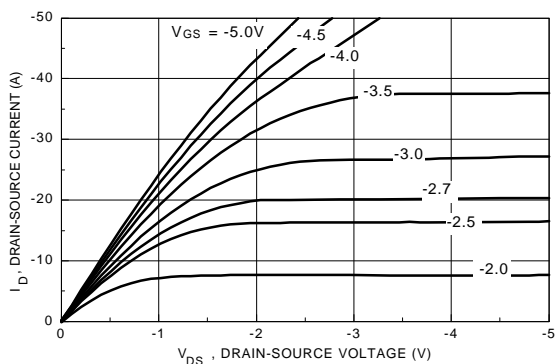


Figure 1. On-Region Characteristics.

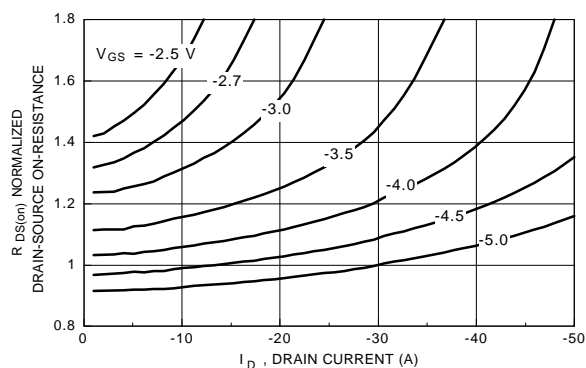


Figure 2. On-Resistance Variation with Gate Voltage and Drain Current.

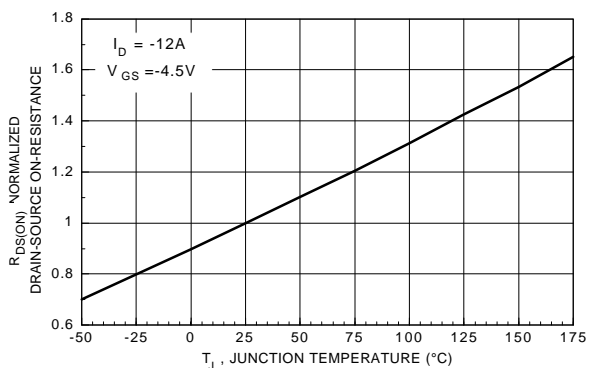


Figure 3. On-Resistance Variation with Temperature.

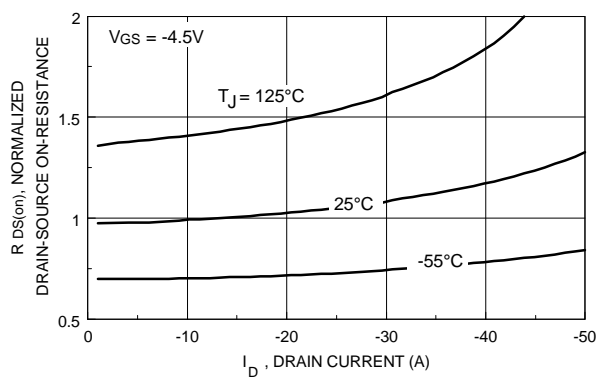


Figure 4. On-Resistance Variation with Drain Current and Temperature.

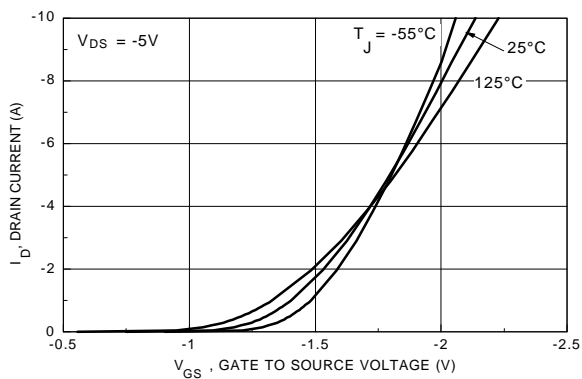


Figure 5. Transfer Characteristics.

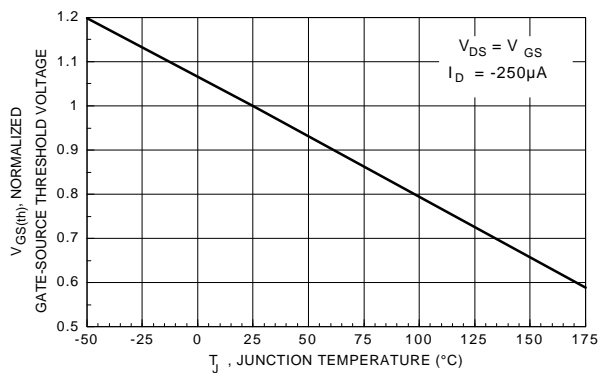
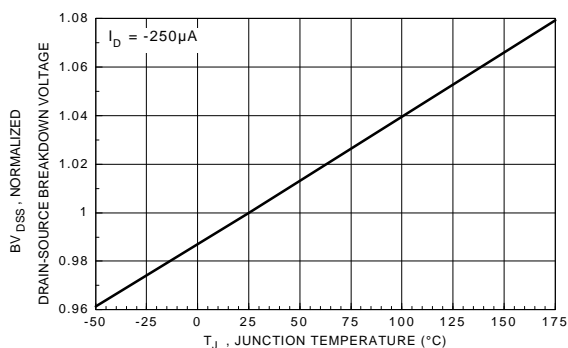
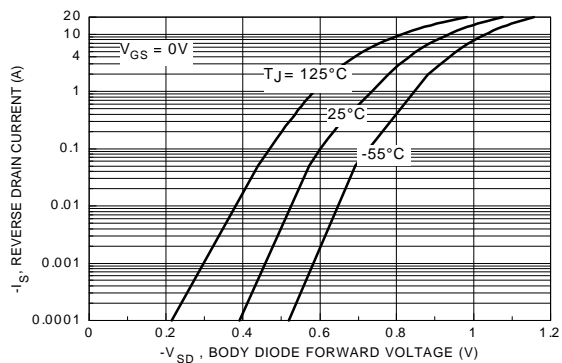


Figure 6. Gate Threshold Variation with Temperature.

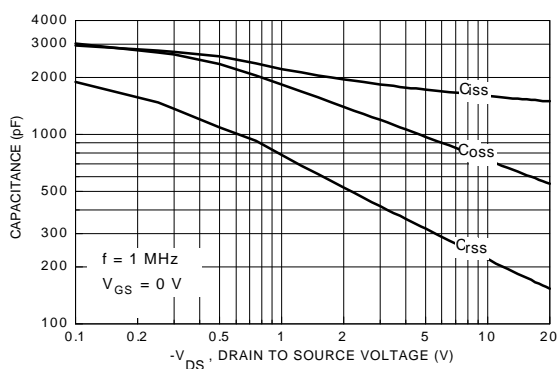
## Typical Electrical Characteristics (continued)



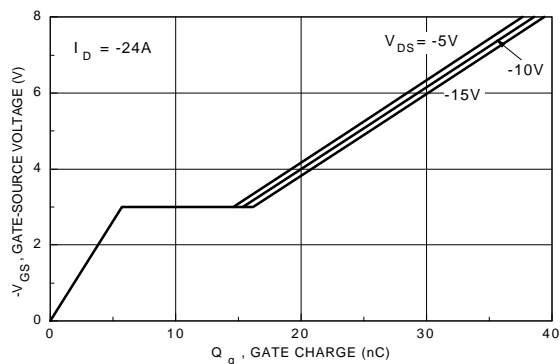
**Figure 7. Breakdown Voltage Variation with Temperature.**



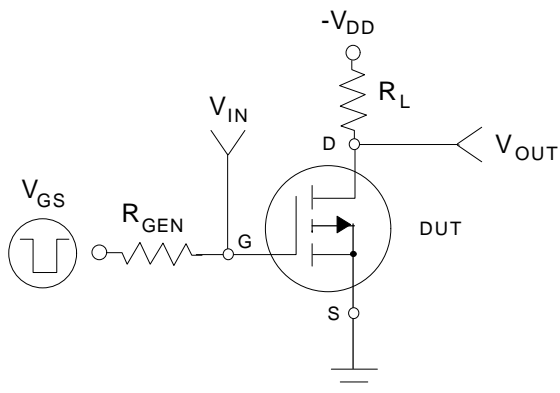
**Figure 8. Body Diode Forward Voltage Variation with Current and Temperature.**



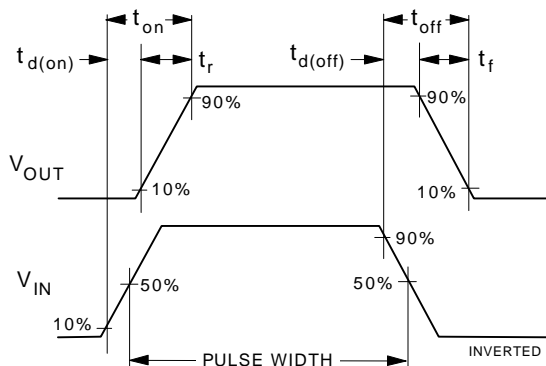
**Figure 9. Capacitance Characteristics.**



**Figure 10. Gate Charge Characteristics.**



**Figure 11. Switching Test Circuit.**



**Figure 12. Switching Waveforms.**

## Typical Electrical Characteristics (continued)

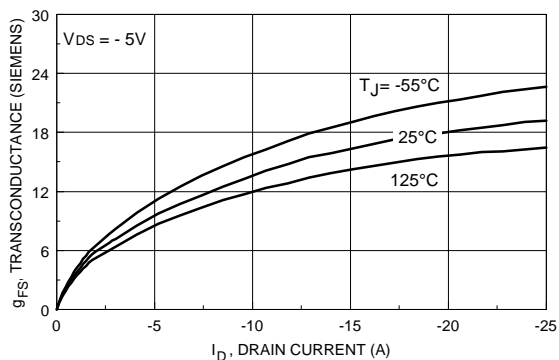


Figure 13. Transconductance Variation with Drain Current and Temperature.

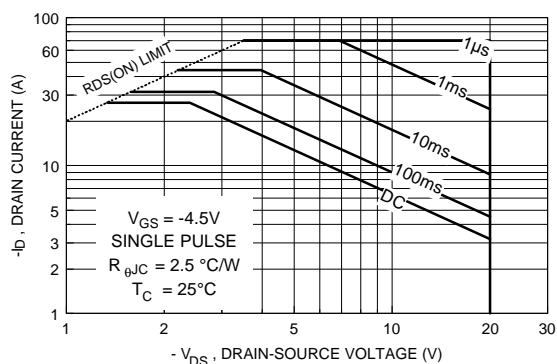


Figure 14. Maximum Safe Operating Area.

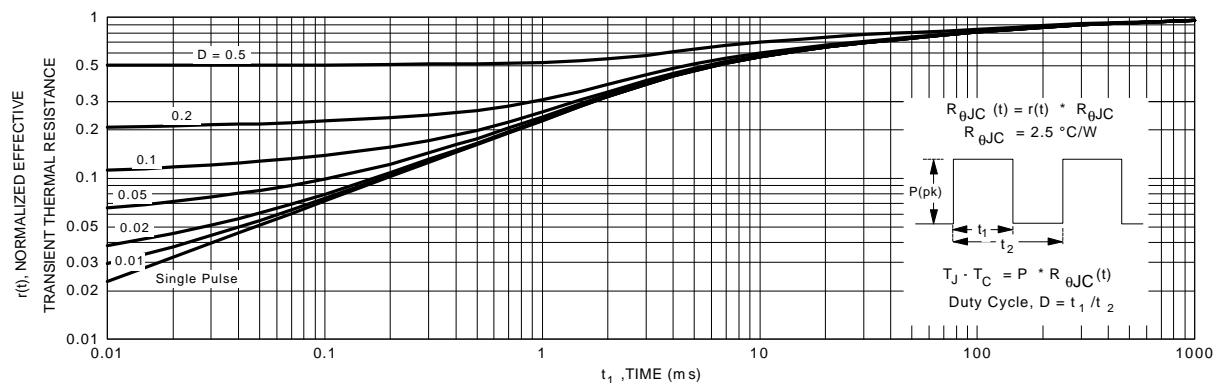



Figure 15. Transient Thermal Response Curve.

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