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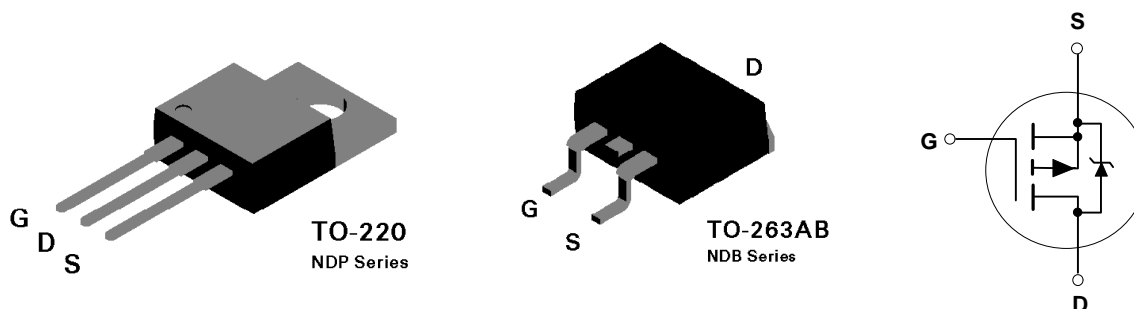
## NDP6020P / NDB6020P P-Channel Logic Level Enhancement Mode Field Effect Transistor

### General Description

These logic level P-Channel enhancement mode power field effect transistors are produced using Fairchild'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            |
|----------------|--|----------|------------|------------------|
| $V_{DSS}$      | Drain-Source Voltage                               |          | -20        | V                |
| $V_{GSS}$      | Gate-Source Voltage - Continuous                   |          | $\pm 8$    | V                |
| $I_D$          | Drain Current - Continuous                         |          | -24        | A                |
|                | - Pulsed   |          | -70        |                  |
| $P_D$          | Total Power Dissipation @ $T_C = 25^\circ\text{C}$ |          | 60         | W                |
|                | Derate above $25^\circ\text{C}$                    |          | 0.4        |                  |
| $T_J, T_{STG}$ | Operating and Storage Temperature Range            |          | -65 to 175 | $^\circ\text{C}$ |

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

| Symbol                                    | Parameter                         | Conditions   | Min                       | Typ   | Max   | Units         |
|---|-----------------------------------|--|---------------------------|-------|-------|---------------|
| <b>OFF CHARACTERISTICS</b>                |                                   |  |                           |       |       |               |
| $BV_{DSS}$                                | Drain-Source Breakdown Voltage    | $V_{GS} = 0\text{ V}, I_D = -250\ \mu\text{A}$   | -20                       |       |       | V             |
| $I_{DSS}$                                 | Zero Gate Voltage Drain Current   | $V_{DS} = -16\text{ V}, V_{GS} = 0\text{ V}$   |                           |       | -1    | $\mu\text{A}$ |
|   |                                   |  | $T_J = 55^\circ\text{C}$  |       |       | -10           |
| $I_{GSSF}$                                | Gate - Body Leakage, Forward      | $V_{GS} = 8\text{ V}, V_{DS} = 0\text{ V}$   |                           |       | 100   | nA            |
| $I_{GSSR}$                                | Gate - Body Leakage, Reverse      | $V_{GS} = -8\text{ V}, V_{DS} = 0\text{ V}$  |                           |       | -100  | nA            |
| <b>ON CHARACTERISTICS</b> (Note 1)        |                                   |  |                           |       |       |               |
| $V_{GS(th)}$                              | Gate Threshold Voltage            | $V_{DS} = V_{GS}, I_D = -250\ \mu\text{A}$   | -0.4                      | -0.7  | -1    | V             |
|   |                                   |  | $T_J = 125^\circ\text{C}$ | -0.3  | -0.56 |               |
| $R_{DS(on)}$                              | Static Drain-Source On-Resistance | $V_{GS} = -4.5\text{ V}, I_D = -12\text{ A}$   |                           | 0.041 | 0.05  | $\Omega$      |
|   |                                   |  | $T_J = 125^\circ\text{C}$ |       | 0.06  |               |
| $R_{DS(on)}$                              | Static Drain-Source On-Resistance | $V_{GS} = -2.7\text{ V}, I_D = -10\text{ A}$   |                           | 0.059 | 0.07  |               |
| $R_{DS(on)}$                              | Static Drain-Source On-Resistance | $V_{GS} = -2.5\text{ V}, I_D = -10\text{ A}$   |                           | 0.064 | 0.075 |               |
| $I_{D(on)}$                               | On-State Drain Current            | $V_{GS} = -4.5\text{ V}, V_{DS} = -5\text{ V}$   | -24                       |       |       | A             |
| $g_{FS}$                                  | Forward Transconductance          | $V_{DS} = -5\text{ V}, I_D = -12\text{ A}$   |                           | 14    |       | S             |
| <b>DYNAMIC CHARACTERISTICS</b>            |                                   |  |                           |       |       |               |
| $C_{iss}$                                 | Input Capacitance                 | $V_{DS} = -10\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1.0\text{ MHz}$                      |                           | 1590  |       | pF            |
| $C_{oss}$                                 | Output Capacitance                |  |                           | 725   |       | pF            |
| $C_{rss}$                                 | Reverse Transfer Capacitance      |  |                           | 215   |       | pF            |
| <b>SWITCHING CHARACTERISTICS</b> (Note 1) |                                   |  |                           |       |       |               |
| $t_{D(on)}$                               | Turn - On Delay Time              | $V_{DD} = -20\text{ V}, I_D = -3\text{ A},$<br>$V_{GS} = -5\text{ V}, R_{GEN} = 6\ \Omega$ |                           | 15    | 30    | nS            |
| $t_r$                                     | Turn - On Rise Time               |  |                           | 27    | 60    | nS            |
| $t_{D(off)}$                              | Turn - Off Delay Time             |  |                           | 120   | 250   | nS            |
| $t_f$                                     | Turn - Off Fall Time              |  |                           | 70    | 150   | nS            |
| $Q_g$                                     | Total Gate Charge                 | $V_{DS} = -10\text{ V},$<br>$I_D = -24\text{ A}, V_{GS} = -5\text{ V}$                     |                           | 25    | 35    | nC            |
| $Q_{gs}$                                  | Gate-Source Charge                |  |                           | 5     |       | nC            |
| $Q_{gd}$                                  | Gate-Drain Charge                 |  |                           | 10    |       | nC            |

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

| Symbol                                    | Parameter   | Conditions   | Min | Typ  | Max  | Units                     |
|---|---|--|-----|------|------|---------------------------|
| <b>DRAIN-SOURCE DIODE CHARACTERISTICS</b> |   |  |     |      |      |                           |
| $I_S$                                     | Maximum Continuous Drain-Source Diode Forward Current |  |     |      | -24  | A                         |
| $I_{SM}$                                  | Maximum Pulsed Drain-Source Diode Forward Current     |  |     |      | -80  | A                         |
| $V_{SD}$                                  | Drain-Source Diode Forward Voltage                    | $V_{GS} = 0\text{ V}$ , $I_S = -12\text{ A}$ (Note 1)                                  |     | -1.1 | -1.3 | V                         |
| $t_{rr}$                                  | Reverse Recovery Time                                 | $V_{GS} = 0\text{ V}$ , $I_F = -24\text{ A}$ ,<br>$di_F/dt = 100\text{ A}/\mu\text{s}$ |     | 60   |      | ns                        |
| $I_{rr}$                                  | Reverse Recovery Current                              |  |     | -1.7 |      | A                         |
| <b>THERMAL CHARACTERISTICS</b>            |   |  |     |      |      |                           |
| $R_{\theta JC}$                           | Thermal Resistance, Junction-to-Case                  |  |     |      | 2.5  | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JA}$                           | Thermal Resistance, Junction-to-Ambient               |  |     |      | 62.5 | $^\circ\text{C}/\text{W}$ |

Note:

1. Pulse Test: Pulse Width  $\leq 300\ \mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .

## Typical Electrical Characteristics

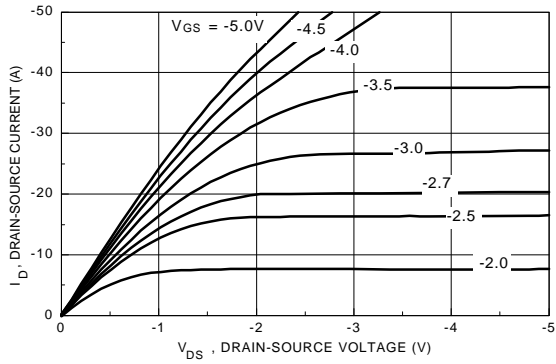


Figure 1. On-Region Characteristics.

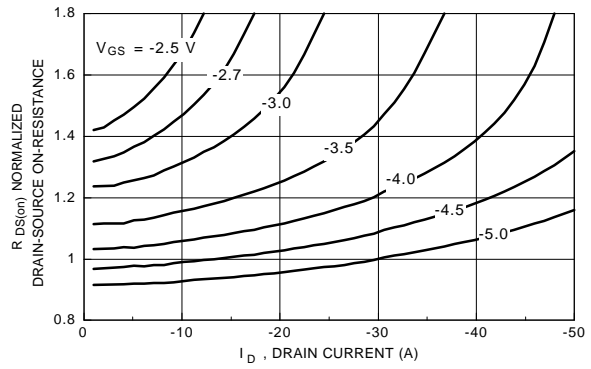


Figure 2. On-Resistance Variation with Gate Voltage and Drain Current.

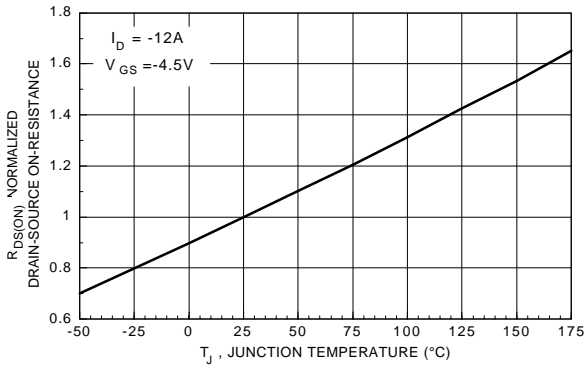


Figure 3. On-Resistance Variation with Temperature.

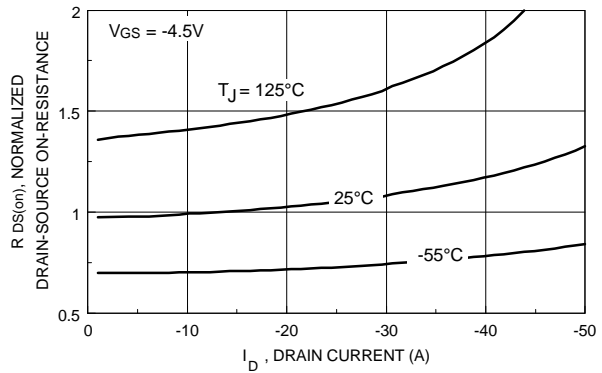


Figure 4. On-Resistance Variation with Drain Current and Temperature.

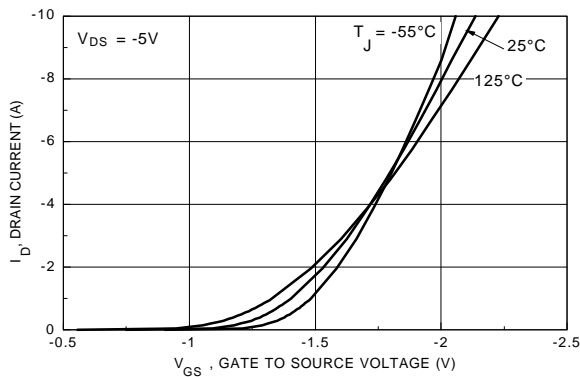


Figure 5. Transfer Characteristics.

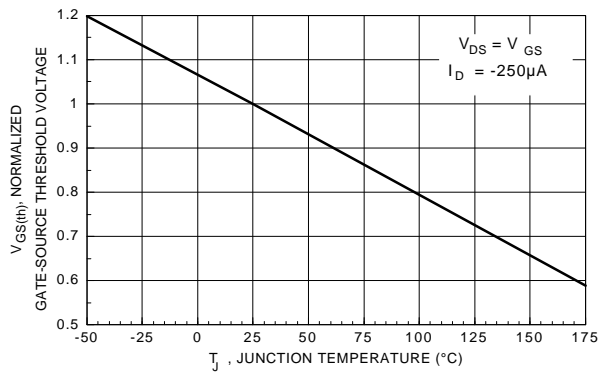
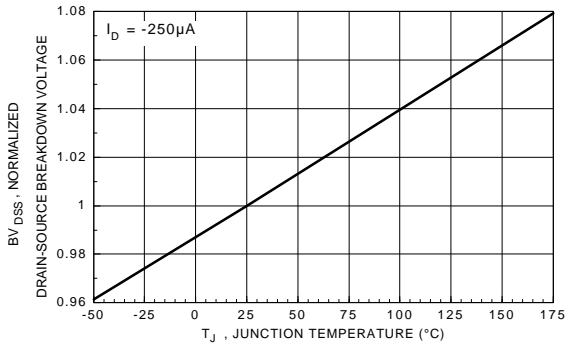
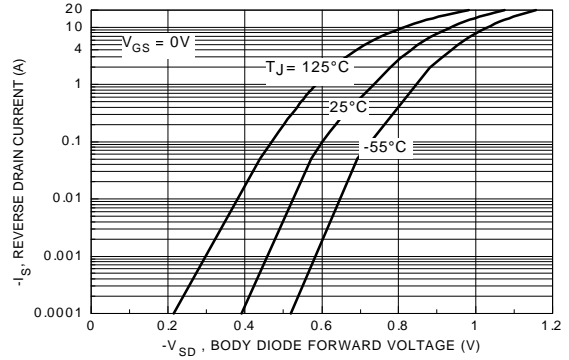


Figure 6. Gate Threshold Variation with Temperature.

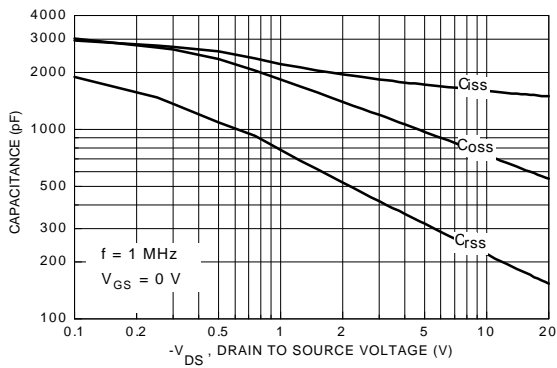
## Typical Electrical Characteristics (continued)



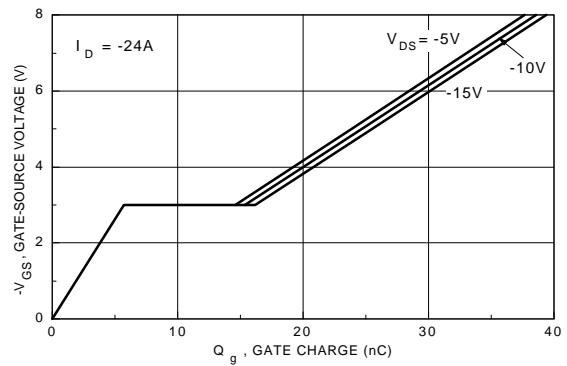
**Figure 7. Breakdown Voltage Variation with Temperature.**



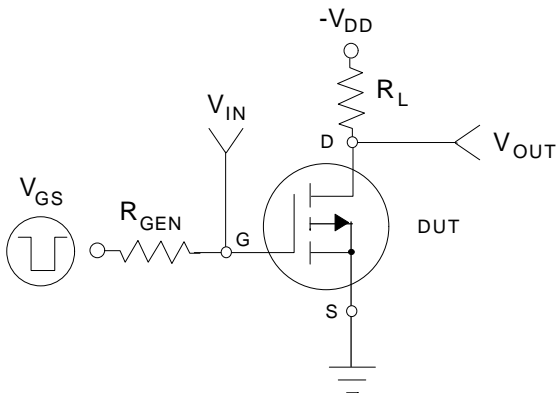
**Figure 8. Body Diode Forward Voltage Variation with Current and Temperature.**



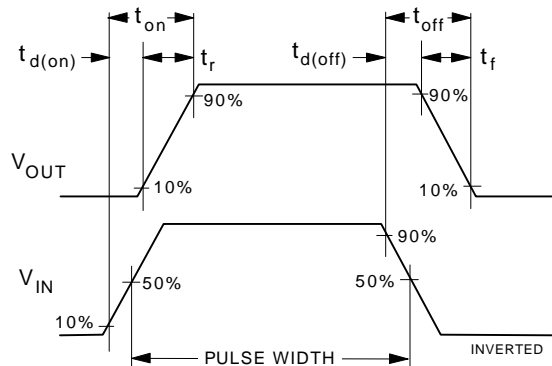
**Figure 9. Capacitance Characteristics.**



**Figure 10. Gate Charge Characteristics.**

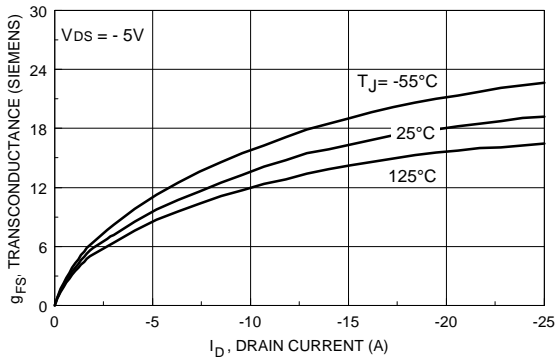


**Figure 11. Switching Test Circuit.**

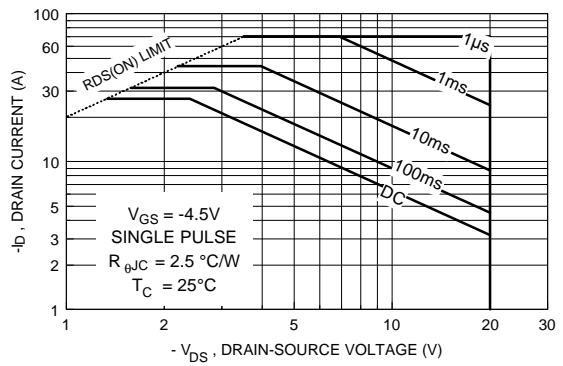


**Figure 12. Switching Waveforms.**

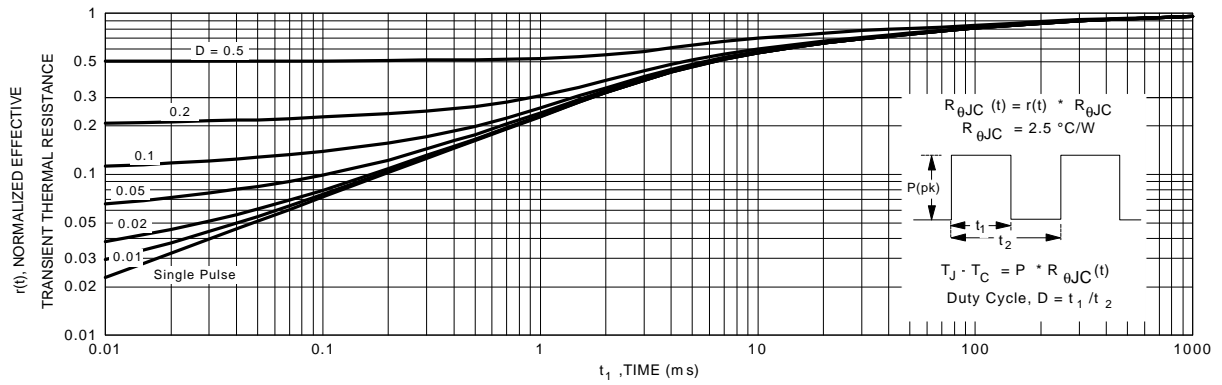
**Typical Electrical Characteristics (continued)**



**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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