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## NDP6020P / NDB6020P

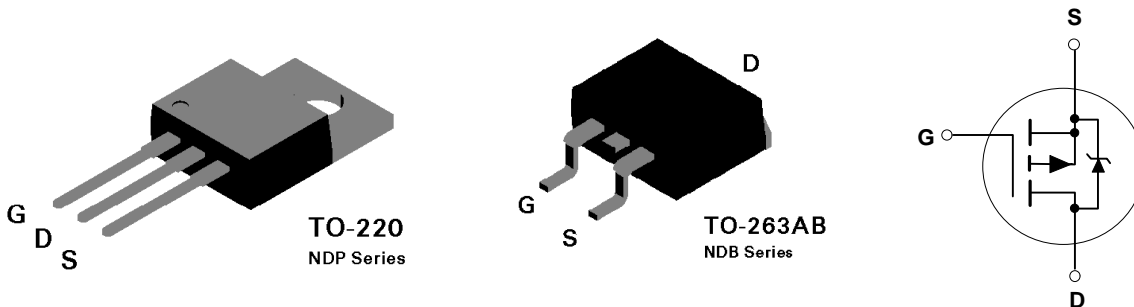
### P-Channel Logic Level Enhancement Mode Field Effect Transistor

#### General Description

These logic level P-Channel enhancement mode power field effect transistors are produced using 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
$V_{DSS}$	Drain-Source Voltage		-20	V
$V_{GSS}$	Gate-Source Voltage - Continuous		±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	$\mu\text{A}$
$I_{GSSF}$	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	-0.7	
$R_{DS(on)}$	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	0.08
$R_{DS(on)}$	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	$V_{DS} = -10\text{ V}, V_{GS} = 0\text{ V},$ $f = 1.0\text{ MHz}$		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	$V_{DD} = -20\text{ V}, I_D = -3\text{ A},$ $V_{GS} = -5\text{ V}, R_{GEN} = 6\ \Omega$		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	$V_{DS} = -10\text{ V},$ $I_D = -24\text{ A}, V_{GS} = -5\text{ V}$		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	$V_{GS} = 0\text{ V}, I_F = -24\text{ A},$ $di_F/dt = 100\text{ A}/\mu\text{s}$		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

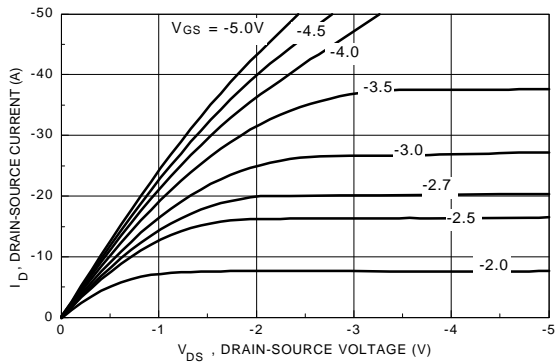


Figure 1. On-Region Characteristics.

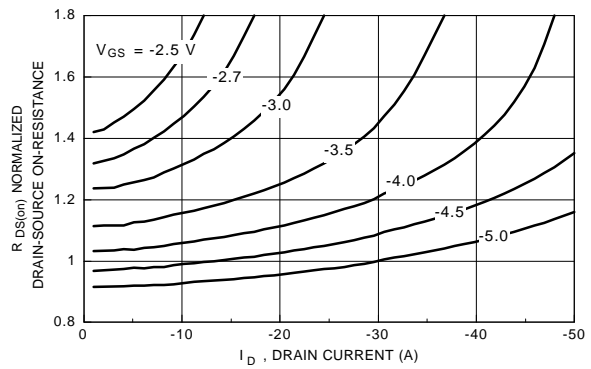


Figure 2. On-Resistance Variation with Gate Voltage and Drain Current.

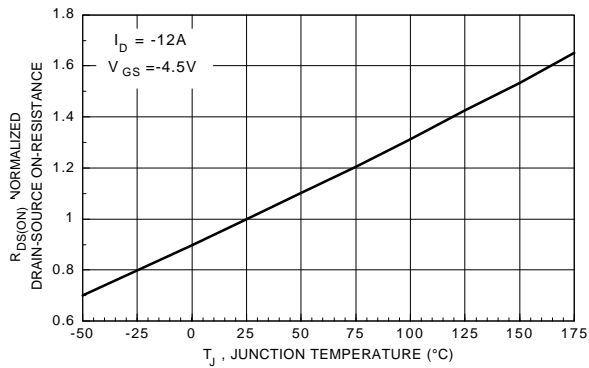


Figure 3. On-Resistance Variation with Temperature.

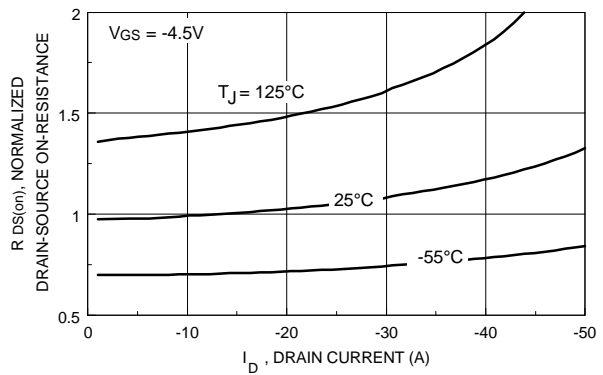


Figure 4. On-Resistance Variation with Drain Current and Temperature.

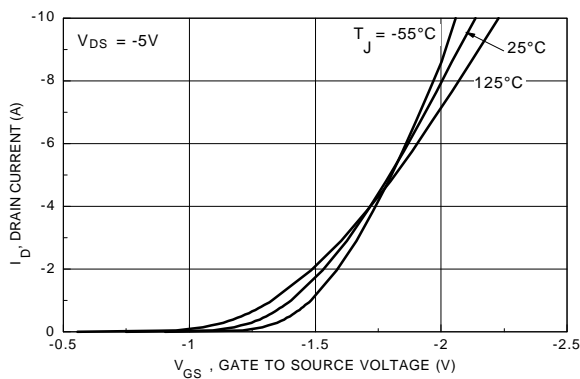


Figure 5. Transfer Characteristics.

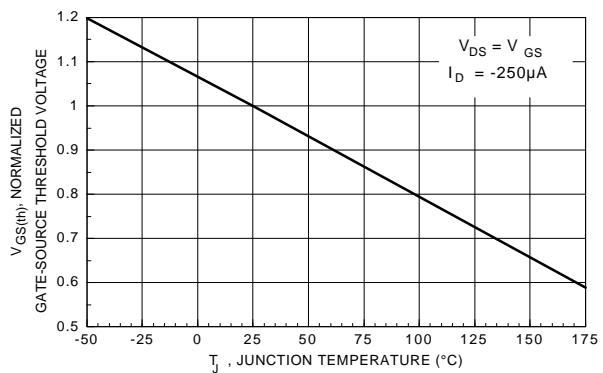
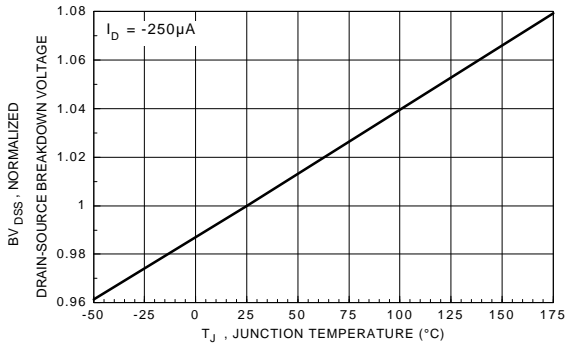
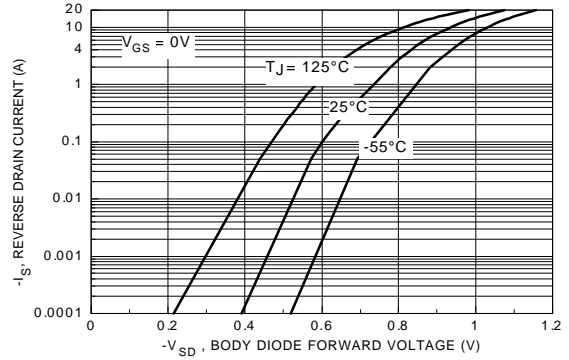


Figure 6. Gate Threshold Variation with Temperature.

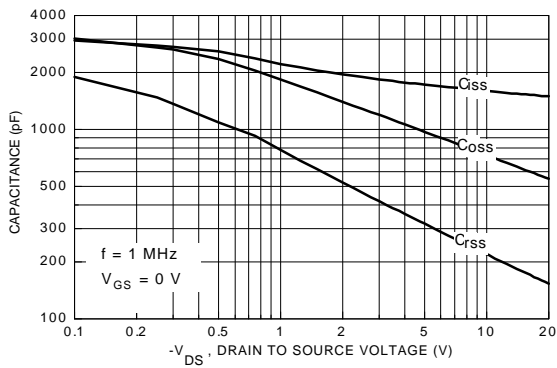
## Typical Electrical Characteristics (continued)



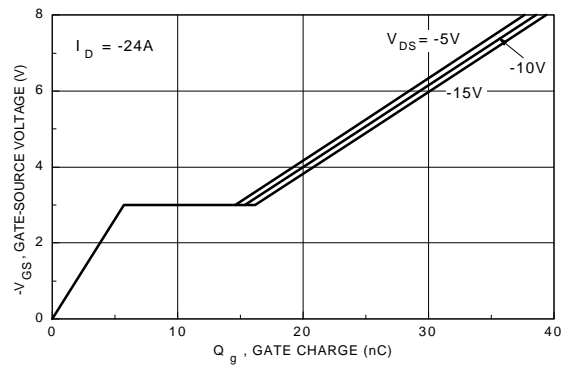
**Figure 7. Breakdown Voltage Variation with Temperature.**



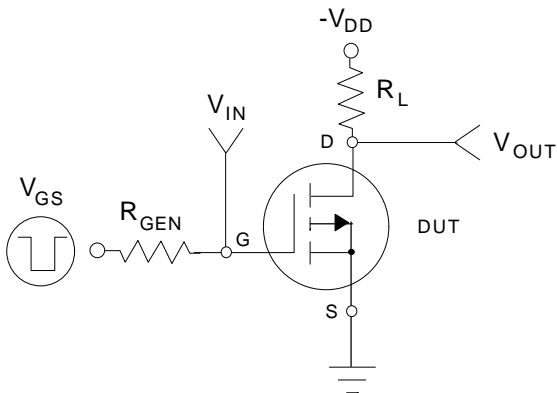
**Figure 8. Body Diode Forward Voltage Variation with Current and Temperature.**



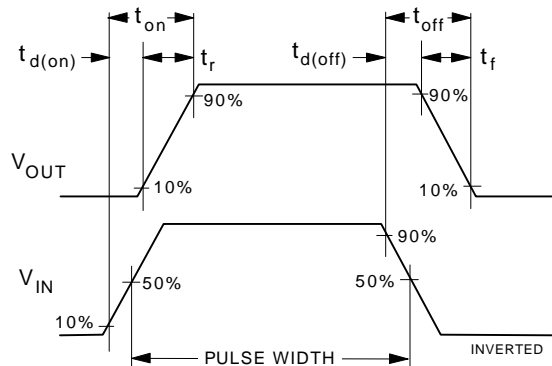
**Figure 9. Capacitance Characteristics.**



**Figure 10. Gate Charge Characteristics.**



**Figure 11. Switching Test Circuit.**



**Figure 12. Switching Waveforms.**

Typical Electrical Characteristics (continued)

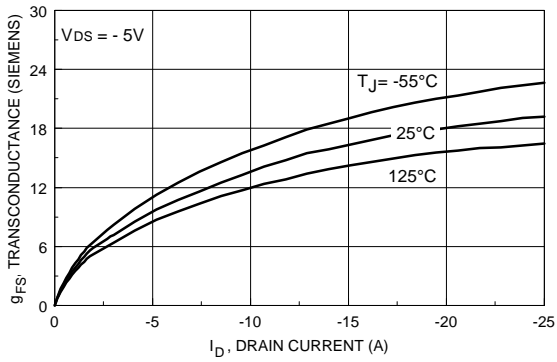


Figure 13. Transconductance Variation with Drain Current and Temperature.

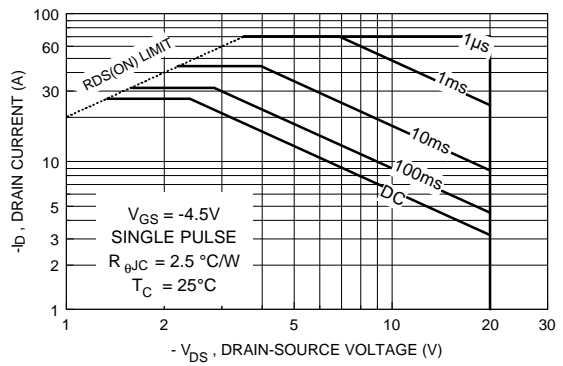


Figure 14. Maximum Safe Operating Area.

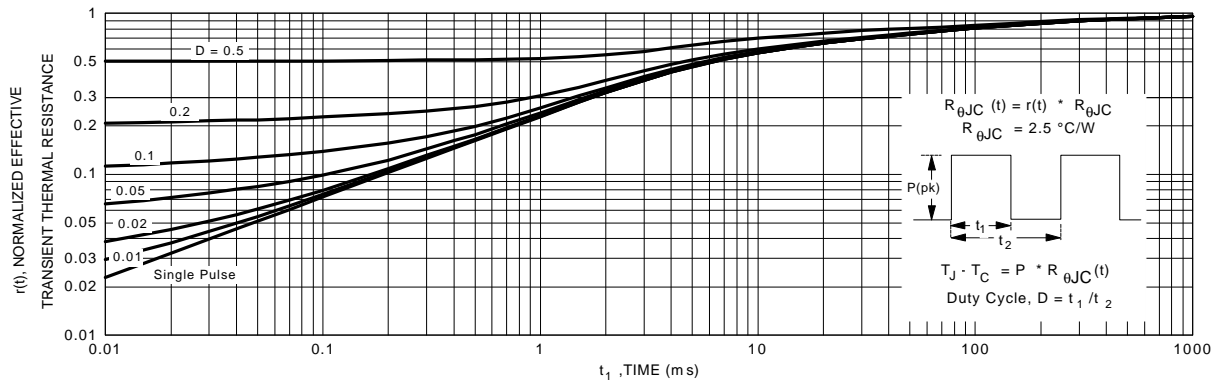



Figure 15. Transient Thermal Response Curve.

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