April 1996

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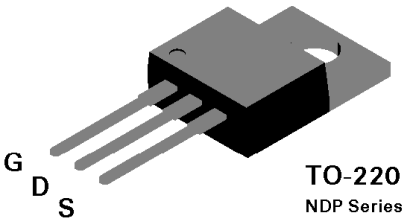
NDP6060L / NDB6060L
N-Channel Logic Level Enhancement Mode Field Effect Transistor

General Description

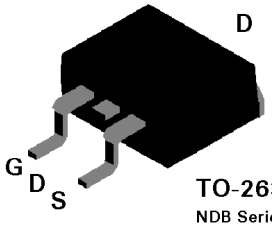
These logic level N-Channel enhancement mode power field effect transistors are produced using National's proprietary, high cell density, DMOS technology. This very high density process has been especially tailored to minimize on-state resistance, provide superior switching performance, and withstand 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

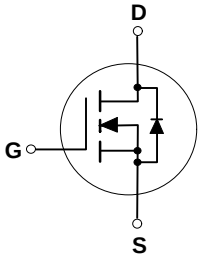
- 48A, 60V. $R_{DS(ON)}$ = 0.025Ω @ V_{GS} = 5V.
- Low drive requirements allowing operation directly from logic drivers. $V_{GS(TH)}$ < 2.0V.
- Critical DC electrical parameters specified at elevated temperature.
- Rugged internal source-drain diode can eliminate the need for an external Zener diode transient suppressor.
- 175°C maximum junction temperature rating.
- High density cell design for extremely low $R_{DS(ON)}$.
- TO-220 and TO-263 (D^2PAK) package for both through hole and surface mount applications.



TO-220
NDP Series



TO-263AB
NDB Series



Absolute Maximum Ratings

T_C = 25°C unless otherwise noted

Symbol	Parameter	NDP6060L	NDB6060L	Units
V_{DSS}	Drain-Source Voltage	60		V
V_{DGR}	Drain-Gate Voltage (R_{GS} ≤ 1 MΩ)	60		V
V_{GSS}	Gate-Source Voltage - Continuous	± 16		V
	- Nonrepetitive (t_p < 50 µs)	± 25		
I_D	Drain Current - Continuous	48		A
	- Pulsed	144		
P_D	Total Power Dissipation @ T_C = 25°C	100		W
	Derate above 25°C	0.67		W/°C
T_J,T_{STG}	Operating and Storage Temperature	-65 to 175		°C
T_L	Maximum lead temperature for soldering purposes, 1/8" from case for 5 seconds	275		°C

Electrical Characteristics (T_C = 25°C unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
DRAIN-SOURCE AVALANCHE RATINGS (Note 1)						
W_{DSS}	Single Pulse Drain-Source Avalanche Energy	V_{DD} = 25 V, I_D = 48 A			200	mJ
I_{AR}	Maximum Drain-Source Avalanche Current				48	A
OFF CHARACTERISTICS						
BV_{DSS}	Drain-Source Breakdown Voltage	V_{GS} = 0 V, I_D = 250 µA	60			V
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS} = 60 V, V_{GS} = 0 V			250	µA
		T_J = 125°C			1	mA
I_{GSSF}	Gate - Body Leakage, Forward	V_{GS} = 16 V, V_{DS} = 0 V			100	nA
I_{GSSR}	Gate - Body Leakage, Reverse	V_{GS} = -16 V, V_{DS} = 0 V			-100	nA
ON CHARACTERISTICS (Note 1)						
$V_{GS(th)}$	Gate Threshold Voltage	V_{DS} = V_{GS}, I_D = 250 µA	1		2	V
		T_J = 125°C	0.65		1.5	
$R_{DS(ON)}$	Static Drain-Source On-Resistance	V_{GS} = 5 V, I_D = 24 A			0.025	Ω
		T_J = 125°C			0.04	
		V_{GS} = 10 V, I_D = 24 A			0.02	
$I_{D(on)}$	On-State Drain Current	V_{GS} = 5 V, V_{DS} = 10 V	48			A
g_{FS}	Forward Transconductance	V_{DS} = 10 V, I_D = 24 A	10			S
DYNAMIC CHARACTERISTICS						
C_{iss}	Input Capacitance	V_{DS} = 25 V, V_{GS} = 0 V, f = 1.0 MHz		1630	2000	pF
C_{oss}	Output Capacitance			460	800	pF
C_{rss}	Reverse Transfer Capacitance			150	400	pF
SWITCHING CHARACTERISTICS (Note 1)						
$t_{D(on)}$	Turn - On Delay Time	V_{DD} = 30 V, I_D = 48 A, V_{GS} = 5 V, R_{GEN} = 15 Ω, R_{GS} = 15 Ω		15	30	nS
t_r	Turn - On Rise Time			320	500	nS
$t_{D(off)}$	Turn - Off Delay Time			49	100	nS
t_f	Turn - Off Fall Time			161	300	nS
Q_g	Total Gate Charge	V_{DS} = 48 V, I_D = 48 A, V_{GS} = 5 V		36	60	nC
Q_{gs}	Gate-Source Charge			8.2		nC
Q_{gd}	Gate-Drain Charge			21		nC

Electrical Characteristics (T_C = 25°C unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
DRAIN-SOURCE DIODE CHARACTERISTICS						
I_S	Maximum Continuos Drain-Source Diode Forward Current				48	A
I_{SM}	Maximum Pulsed Drain-Source Diode Forward Current				144	A
V_{SD}	Drain-Source Diode Forward Voltage	V_{GS} = 0 V, I_S = 24 A (Note 1)			1.3	V
		T_J = 125°C			1.2	
t_{rr}	Reverse Recovery Time	V_{GS} = 0 V, I_F = 48 A, dI_F/dt = 100 A/µs	35	75	140	ns
I_{rr}	Reverse Recovery Current		2	3.6	8	A
THERMAL CHARACTERISTICS						
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case				1.5	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient				62.5	°C/W

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

Typical Electrical Characteristics

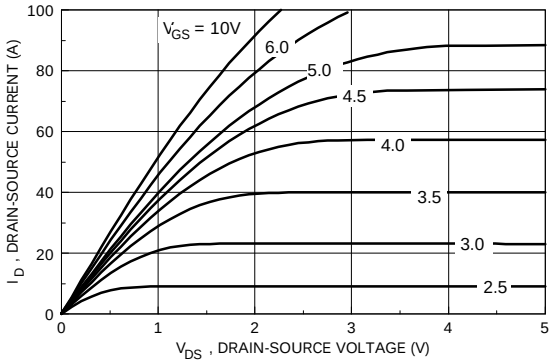


Figure 1. On-Region Characteristics.

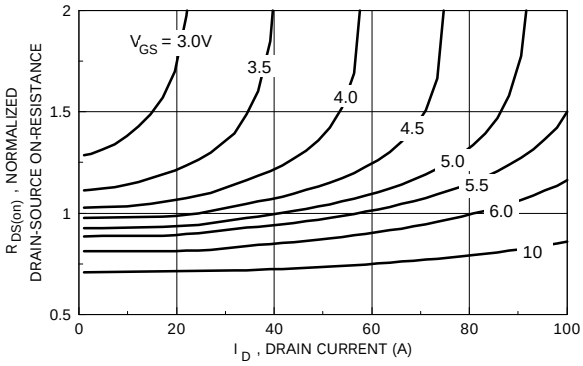


Figure 2. On-Resistance Variation with Gate Voltage and Drain Current.

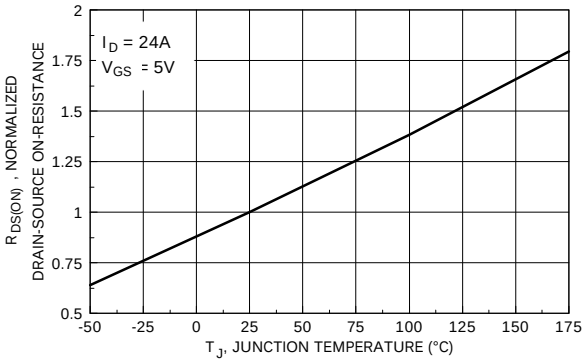


Figure 3. On-Resistance Variation with Temperature.

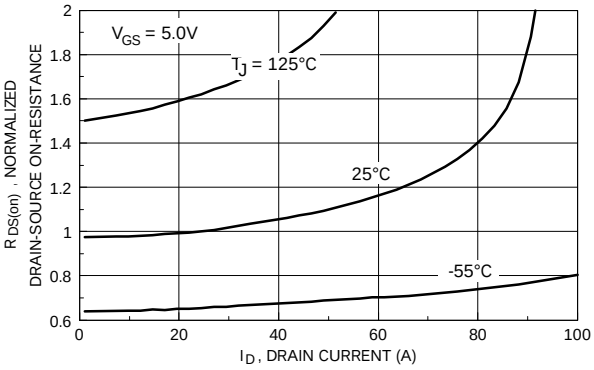


Figure 4. On-Resistance Variation with Drain Current and Temperature.

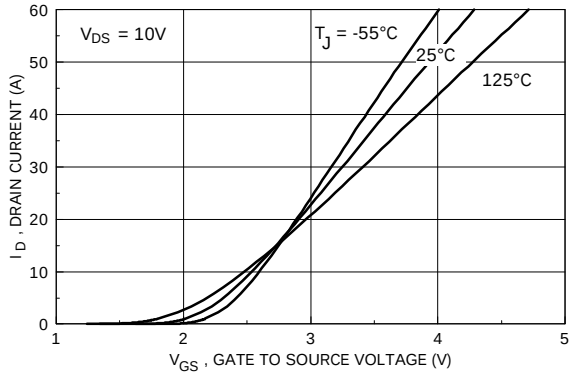


Figure 5. Transfer Characteristics.

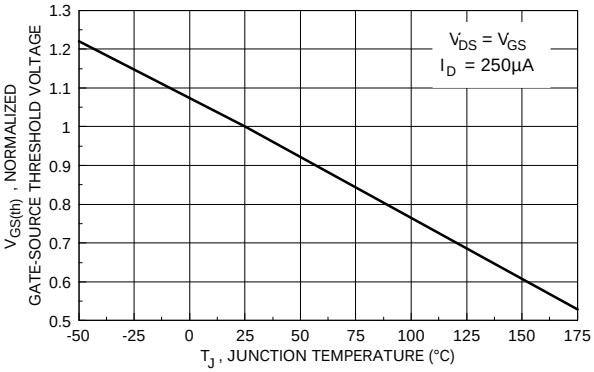


Figure 6. Gate Threshold Variation with Temperature.

Typical Electrical Characteristics (continued)

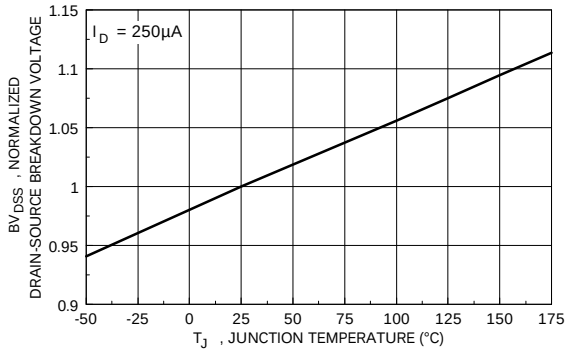


Figure 7. Breakdown Voltage Variation with Temperature.

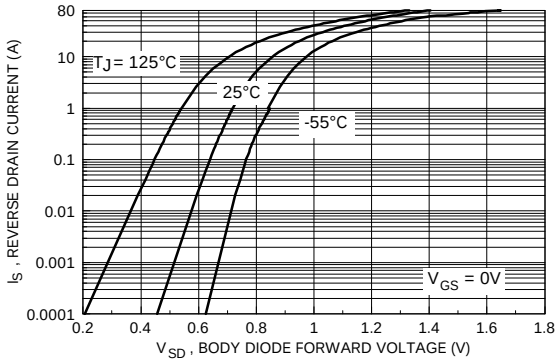


Figure 8. Body Diode Forward Voltage Variation with Current and Temperature.

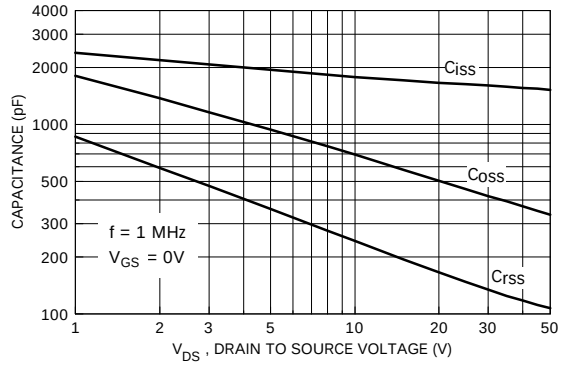


Figure 9. Capacitance Characteristics.

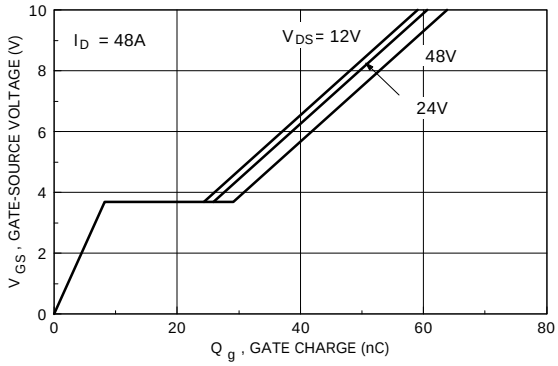


Figure 10. Gate Charge Characteristics.

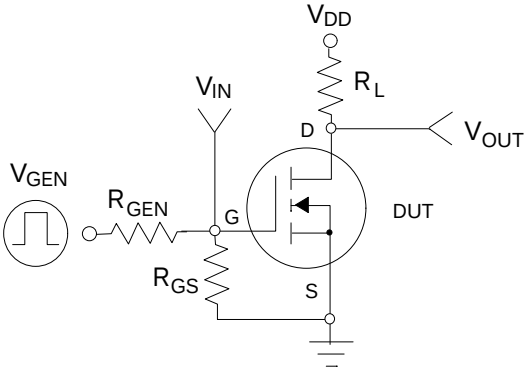


Figure 11. Switching Test Circuit.

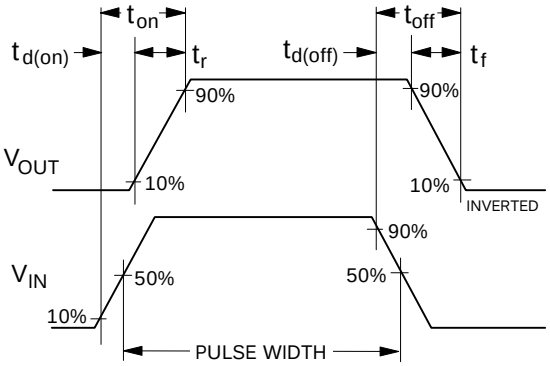


Figure 12. Switching Waveforms.

Typical Electrical Characteristics (continued)

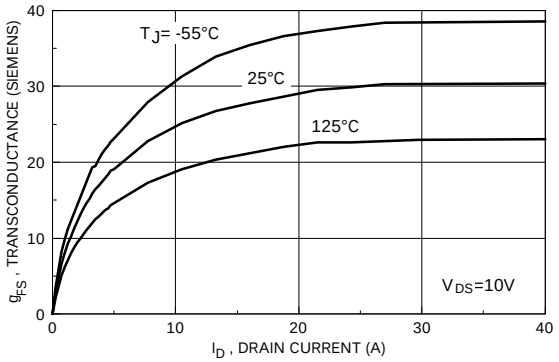


Figure 13. Transconductance Variation with Drain Current.

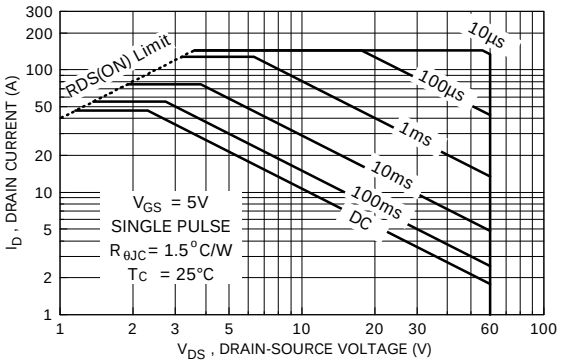


Figure 14. Maximum Safe Operating.

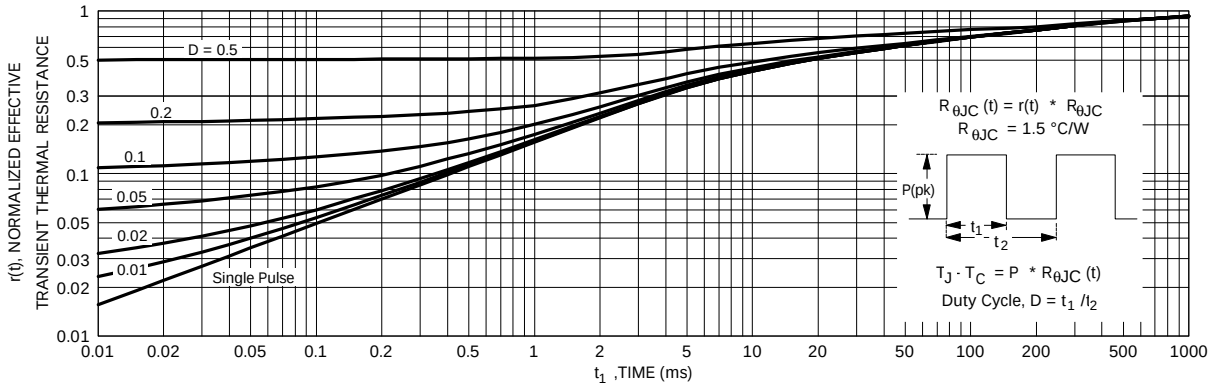


Figure 15. Transient Thermal Response Curve.