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May 1996
PRELIMINARY

NDH831N

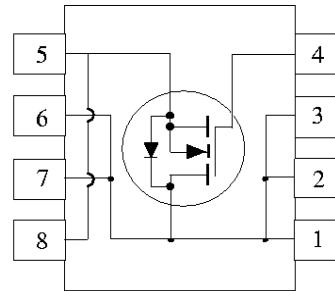
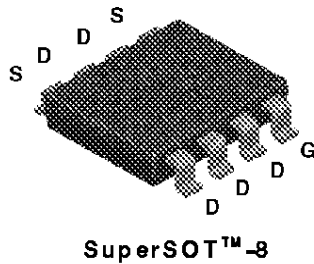
N-Channel Enhancement Mode Field Effect Transistor

General Description

These N-Channel enhancement mode power field effect transistors are produced using National's proprietary, high cell density, DMOS technology. This very high density process is especially tailored to minimize on-state resistance and provide superior switching performance. These devices are particularly suited for low voltage applications such as battery powered circuits and portable electronics where fast switching, low in-line power loss, and resistance to transients are needed.

Features

- 5.6A, 20V. $R_{DS(ON)} = 0.035\Omega @ V_{GS} = 4.5V$
 $R_{DS(ON)} = 0.045\Omega @ V_{GS} = 2.7V.$
- High density cell design for extremely low $R_{DS(ON)}$.
- Enhanced SuperSOT™-8 small outline surface mount package with high power and current handling capability.



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

Symbol	Parameter	NDH831N	Units	
V_{DSS}	Drain-Source Voltage	20	V	
V_{GSS}	Gate-Source Voltage	8	V	
I_D	Drain Current –Continuous (Note 1a)	5.6	A	
	– Pulsed	20		
P_D	Maximum Power Dissipation (Note 1a)	1.8	W	
		(Note 1b)		1
		(Note 1c)		0.9
T_J, T_{STG}	Operating and Storage Temperature Range	-55 to 150	$^\circ\text{C}$	

THERMAL CHARACTERISTICS

$R_{\theta JA}$	Thermal Resistance, Junction to-Ambient (Note 1a)	70	$^\circ\text{C}/\text{W}$
$R_{\theta JC}$	Thermal Resistance, Junction to-Case (Note 1)	20	$^\circ\text{C}/\text{W}$

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ	Max	Units	
OFF CHARACTERISTICS							
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	μA	
			$T_J = 55^\circ\text{C}$		10	μA	
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	
ON CHARACTERISTICS (Note 2)							
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}$	0.5	0.6	1	V	
			$T_J = 125^\circ\text{C}$	0.3	0.35		0.8
$R_{DS(on)}$	Static Drain-Source On-Resistance	$V_{GS} = 4.5\text{ V}, I_D = 5.6\text{ A}$		0.025	0.035	Ω	
			$T_J = 125^\circ\text{C}$		0.035		0.63
				$V_{GS} = 2.7\text{ V}, I_D = 5\text{ A}$			0.031
$I_{D(on)}$	On-State Drain Current	$V_{GS} = 4.5\text{ V}, V_{DS} = 5\text{ V}$	20			A	
			$V_{GS} = 2.7\text{ V}, V_{DS} = 5\text{ V}$	5			
g_{FS}	Forward Transconductance	$V_{DS} = 10\text{ V}, I_D = 5.6\text{ A}$		14		S	
DYNAMIC CHARACTERISTICS							
C_{iss}	Input Capacitance	$V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V},$ $f = 1.0\text{ MHz}$		720		pF	
C_{oss}	Output Capacitance			430		pF	
C_{rss}	Reverse Transfer Capacitance			155		pF	
SWITCHING CHARACTERISTICS (Note 2)							
$t_{D(on)}$	Turn -On Delay Time	$V_{DD} = 6\text{ V}, I_D = 1\text{ A},$ $V_{GEN} = 4.5\text{ V}, R_{GEN} = 6\ \Omega$		10	20	ns	
t_r	Turn -On Rise Time			30	50	ns	
$t_{D(off)}$	Turn -Off Delay Time			55	80	ns	
t_f	Turn -Off Fall Time			20	40	ns	
Q_g	Total Gate Charge	$V_{DS} = 5\text{ V},$ $I_D = 5.6\text{ A}, V_{GS} = 4.5\text{ V}$		19.5	28	nC	
Q_{gs}	Gate-Source Charge			1.8		nC	
Q_{gd}	Gate-Drain Charge			5.5		nC	

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS						
I_S	Maximum Continuous Drain-Source Diode Forward Current				15	A
V_{SD}	Drain-Source Diode Forward Voltage	$V_{GS} = 0\text{ V}$, $I_S = 1.5\text{ A}$ (Note 2)		0.75	1.2	V

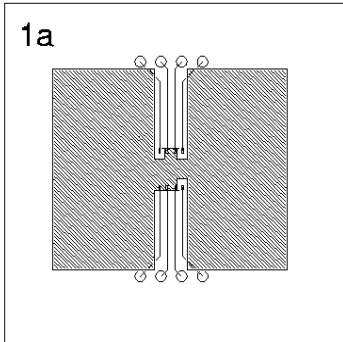
Notes:

- $R_{\theta JA}$ is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins. $R_{\theta JC}$ is guaranteed by design while $R_{\theta CA}$ is determined by the user's board design.

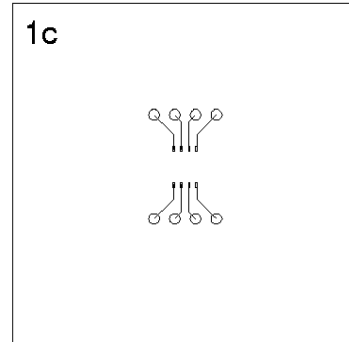
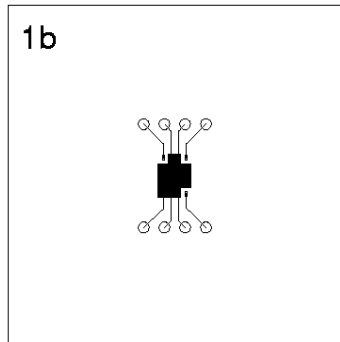
$$P_D(t) = \frac{T_J - T_A}{R_{\theta JA}(t)} = \frac{T_J - T_A}{R_{\theta JC} + R_{\theta CA}(t)} = I_D^2(t) \times R_{DS(ON)}@T_J$$

Typical $R_{\theta JA}$ using the board layouts shown below on 4.5"x5" FR-4 PCB in a still air environment:

- 70°C/W when mounted on a 1 in² pad of 2oz copper.
- 125°C/W when mounted on a 0.026 in² pad of 2oz copper.
- 135°C/W when mounted on a 0.005 in² pad of 2oz copper.



Scale 1 : 1 on letter size paper



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

Typical Electrical Characteristics

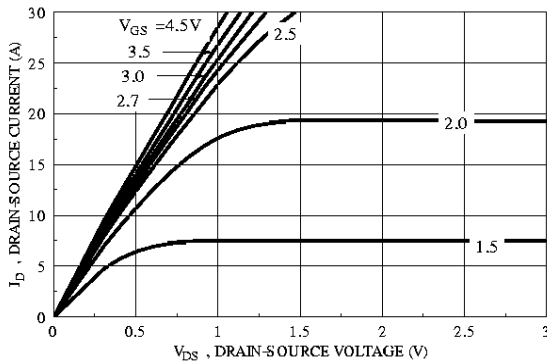


Figure 1. On-Region Characteristics.

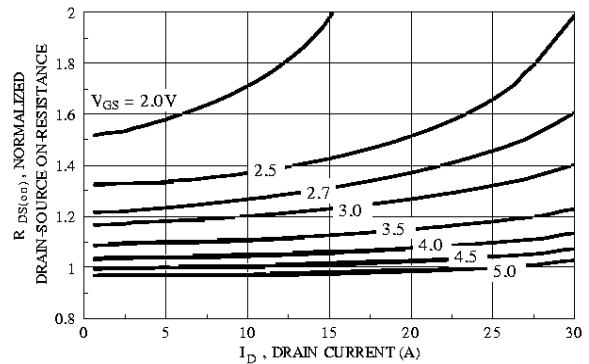


Figure 2. On-Resistance Variation with Gate Voltage and Drain Current.

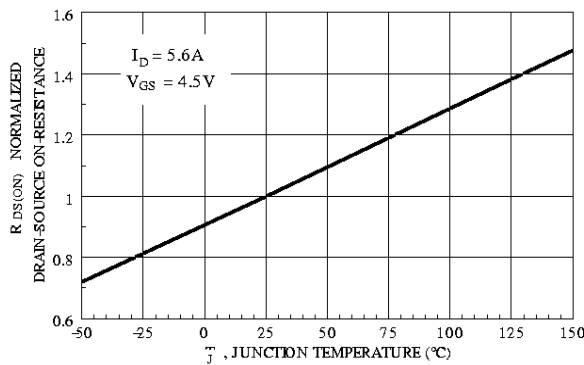


Figure 3. On-Resistance Variation with Temperature.

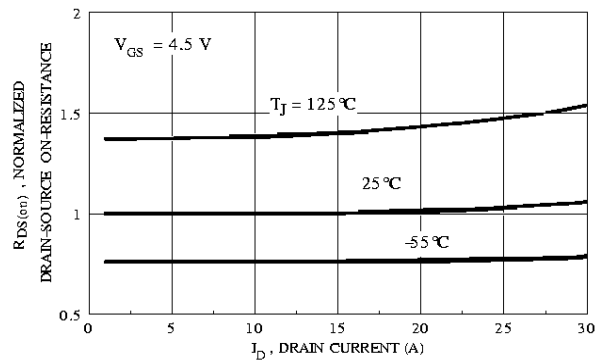


Figure 4. On-Resistance Variation with Drain Current and Temperature.

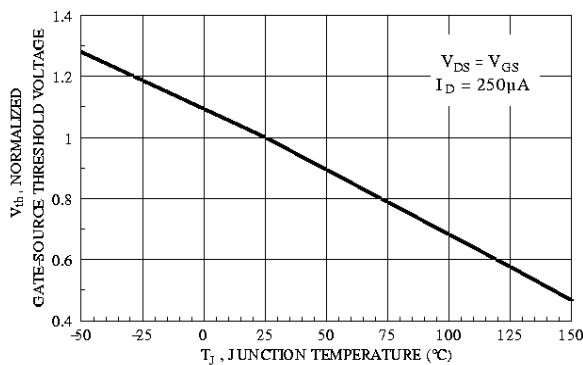


Figure 5. Transfer Characteristics.

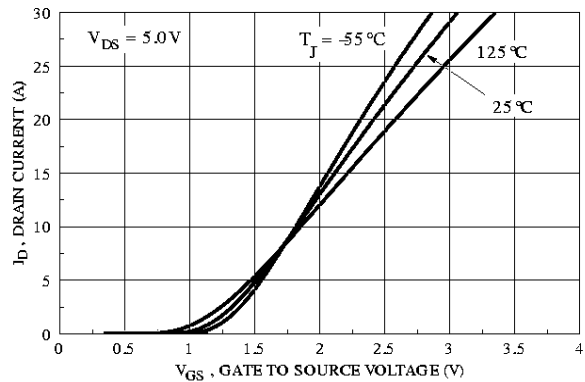


Figure 6. Gate Threshold Variation with Temperature.

Typical Electrical Characteristics

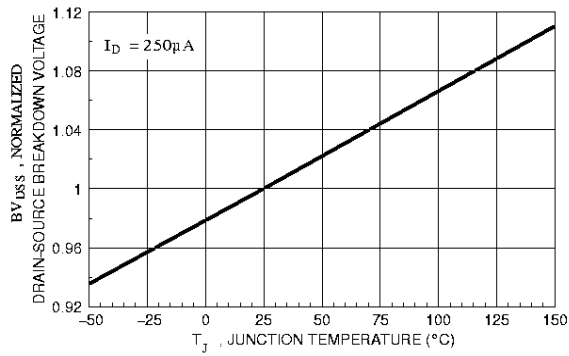


Figure 7. Breakdown Voltage Variation with Temperature.

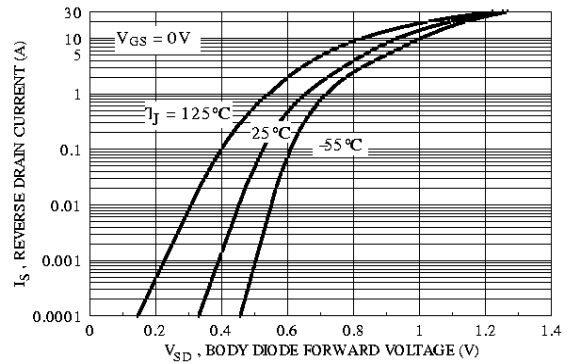


Figure 8. Body Diode Forward Voltage Variation with Current and Temperature.

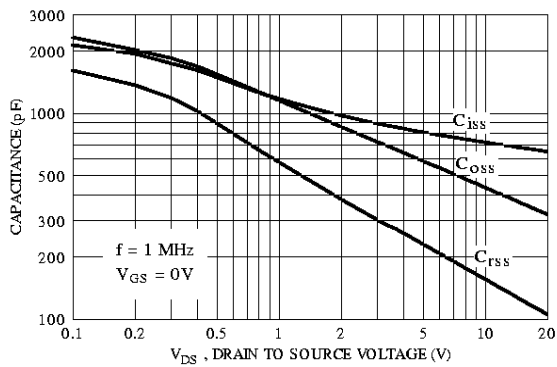


Figure 9. Capacitance Characteristics.

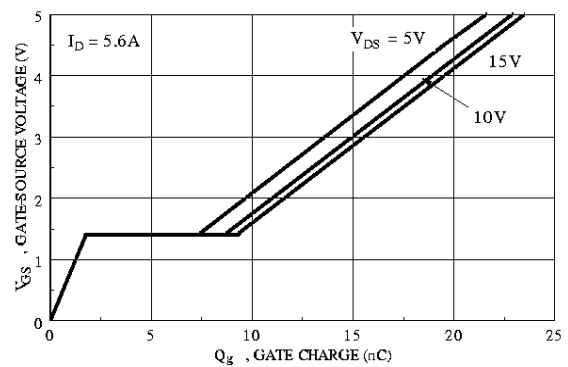


Figure 10. Gate Charge Characteristics.

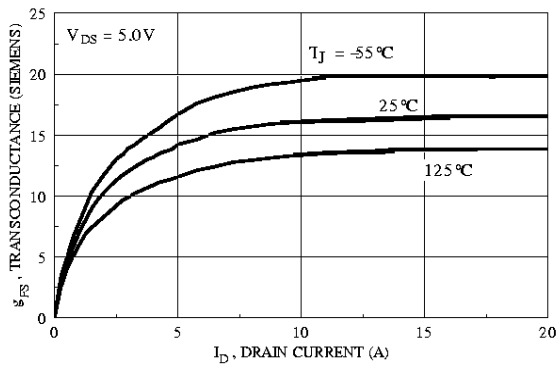


Figure 11. Transconductance Variation with Drain Current and Temperature.

Typical Thermal Characteristics

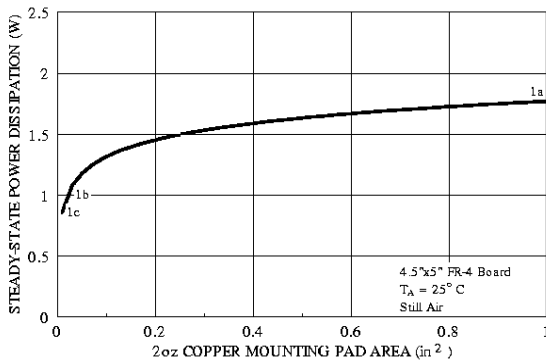


Figure 12. SOT-8 M maximum Steady-State Power Dissipation versus Copper Mounting Pad Area.

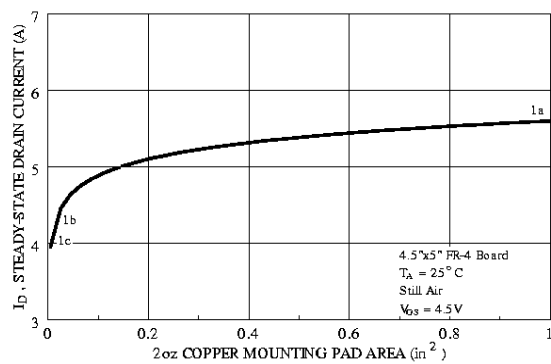


Figure 13. Maximum Steady-State Drain Current versus Copper Mounting Pad Area.

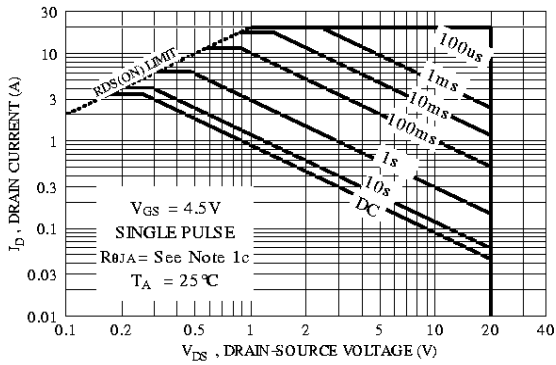


Figure 14. Maximum Safe Operating Area.

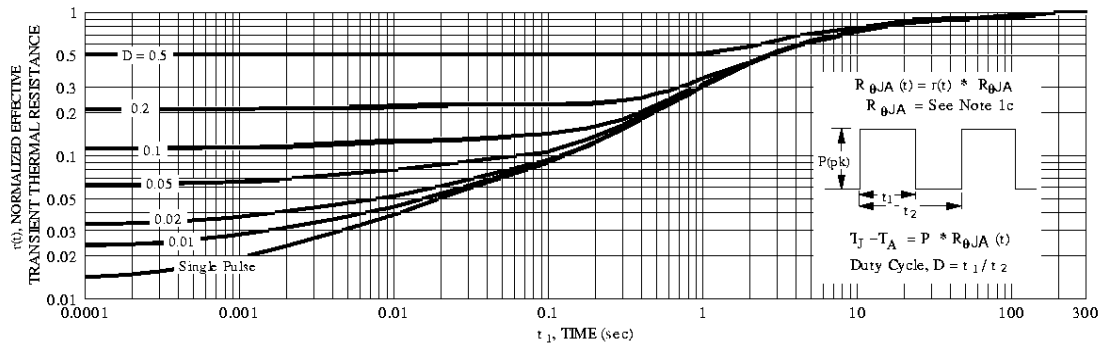


Figure 15. Transient Thermal Response Curve.

Note: Thermal characterization performed using the conditions described in note 1c. Transient thermal response will change depending on the circuit board design.