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March 1996

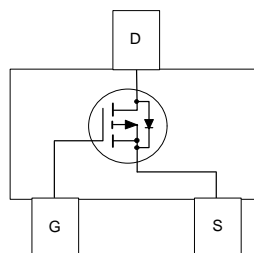
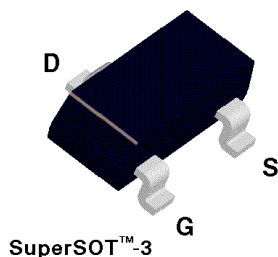
NDS356P P-Channel Logic Level Enhancement Mode Field Effect Transistor

General Description

These P-Channel logic level enhancement mode power field effect transistors are produced using Fairchild's proprietary, high cell density, DMOS technology. This very high density process is especially tailored to minimize on-state resistance. These devices are particularly suited for low voltage applications such as notebook computer power management, portable electronics, and other battery powered circuits where fast high-side switching, and low in-line power loss are needed in a very small outline surface mount package.

Features

- -1.1 A, -20V. $R_{DS(ON)} = 0.3\Omega$ @ $V_{GS} = -4.5V$.
- Proprietary package design using copper lead frame for superior thermal and electrical capabilities.
- High density cell design for extremely low $R_{DS(ON)}$.
- Exceptional on-resistance and maximum DC current capability.
- Compact industry standard SOT-23 surface mount package.



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

Symbol	Parameter	NDS356P	Units
V_{DSS}	Drain-Source Voltage	-20	V
V_{GSS}	Gate-Source Voltage - Continuous	± 12	V
I_D	Maximum Drain Current - Continuous (Note 1a) - Pulsed	± 1.1	A
		± 10	
P_D	Maximum Power Dissipation (Note 1a) (Note 1b)	0.5	W
		0.46	
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)	250	$^\circ\text{C/W}$
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case (Note 1)	75	$^\circ\text{C/W}$

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	$V_{DS} = -16\text{ V}, V_{GS} = 0\text{ V}$			-5	μA	
					-20	μA	
I_{GSSF}	Gate - Body Leakage, Forward	$V_{GS} = 12\text{ V}, V_{DS} = 0\text{ V}$			100	nA	
I_{GSSR}	Gate - Body Leakage, Reverse	$V_{GS} = -12\text{ V}, V_{DS} = 0\text{ V}$			-100	nA	
ON CHARACTERISTICS (Note 2)							
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = -250\ \mu\text{A}$		-0.8	-1.6	-2.5	V
				-0.5	-1.3	-2.2	
$R_{DS(on)}$	Static Drain-Source On-Resistance	$V_{GS} = -4.5\text{ V}, I_D = -1.1\text{ A}$			0.3	Ω	
					0.4		
					0.21		
$I_{D(on)}$	On-State Drain Current	$V_{GS} = -4.5\text{ V}, V_{DS} = -5\text{ V}$	-3			A	
g_{FS}	Forward Transconductance	$V_{DS} = -5\text{ V}, I_D = -1.1\text{ A}$		1.8		S	
DYNAMIC CHARACTERISTICS							
C_{iss}	Input Capacitance	$V_{DS} = -10\text{ V}, V_{GS} = 0\text{ V},$ $f = 1.0\text{ MHz}$		180		pF	
C_{oss}	Output Capacitance			255		pF	
C_{rss}	Reverse Transfer Capacitance			60		pF	
SWITCHING CHARACTERISTICS (Note 2)							
$t_{d(on)}$	Turn - On Delay Time	$V_{DD} = -10\text{ V}, I_D = -1\text{ A},$ $V_{GS} = -10\text{ V}, R_{GEN} = 50\ \Omega$		7	15	ns	
t_r	Turn - On Rise Time			17	30	ns	
$t_{d(off)}$	Turn - Off Delay Time			56	90	ns	
t_f	Turn - Off Fall Time			41	80	ns	
Q_g	Total Gate Charge	$V_{DS} = -10\text{ V}, I_D = -1.1\text{ A},$ $V_{GS} = -5\text{ V}$		3.5	5	nC	
Q_{gs}	Gate-Source Charge				1.5	nC	
Q_{gd}	Gate-Drain Charge				2	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				-0.6	A
I_{SM}	Maximum Pulsed Drain-Source Diode Forward Current				-4	A
V_{SD}	Drain-Source Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = -1.1\text{ A}$ (Note 2)		-0.85	-1.2	V

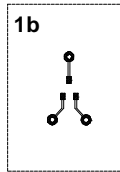
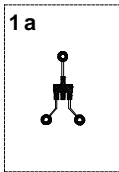
Notes:

- $R_{\theta_{JA}}$ 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.

$$P_D(t) = \frac{T_J - T_A}{R_{\theta_{JA}}} = \frac{T_J - T_A}{R_{\theta_{JC}} + R_{\theta_{CA}}(t)} = I_D^2(t) \times R_{DS(on)} \theta_{rJ}$$

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

- 250°C/W when mounted on a 0.02 in² pad of 2oz copper.
- 270°C/W when mounted on a 0.001 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

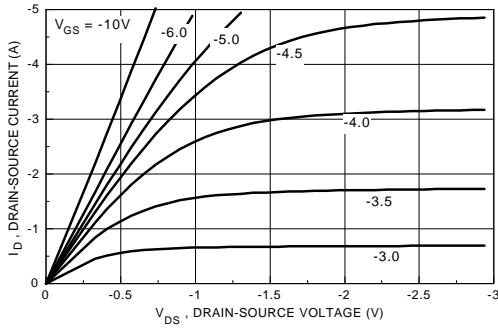


Figure 1. On-Region Characteristics

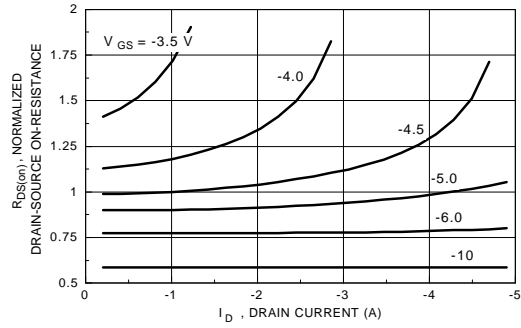


Figure 2. On-Resistance Variation with Drain Current and Gate Voltage

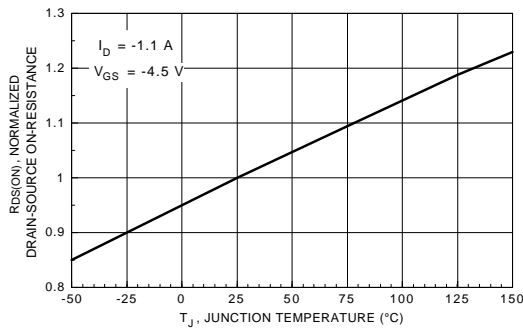


Figure 3. On-Resistance Variation with Temperature

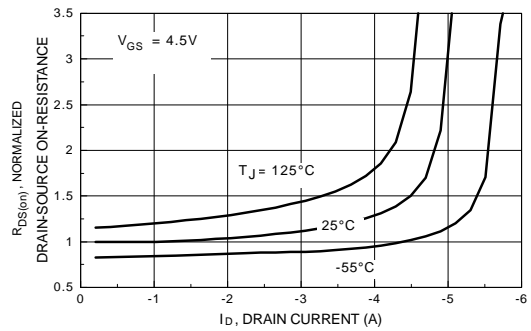


Figure 4. On-Resistance Variation with Drain Current and Temperature

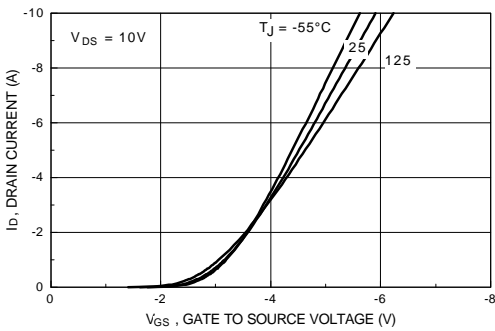


Figure 5. Transfer Characteristics

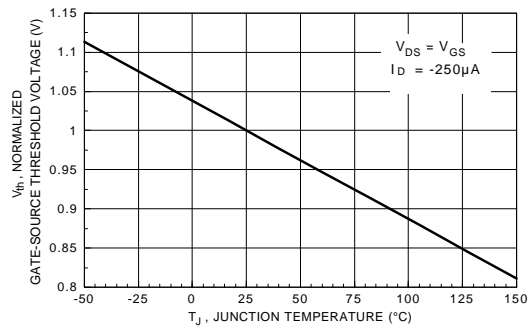


Figure 6. Gate Threshold Variation with Temperature

Typical Electrical Characteristics (continued)

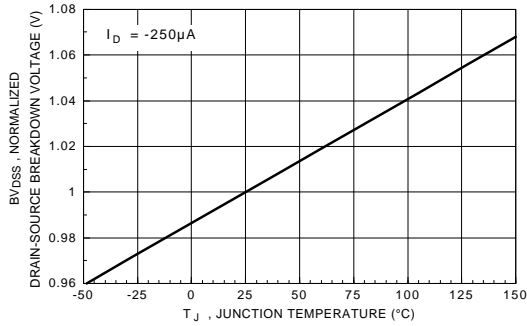


Figure 7. Breakdown Voltage Variation with Temperature

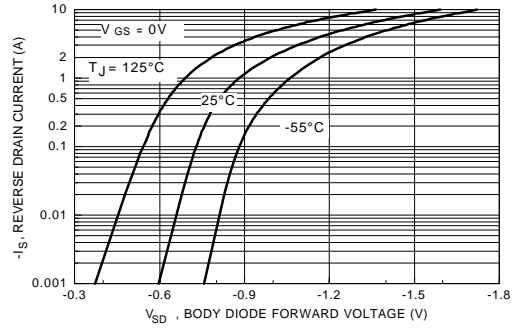


Figure 8. Body Diode Forward Voltage Variation with Source Current and Temperature

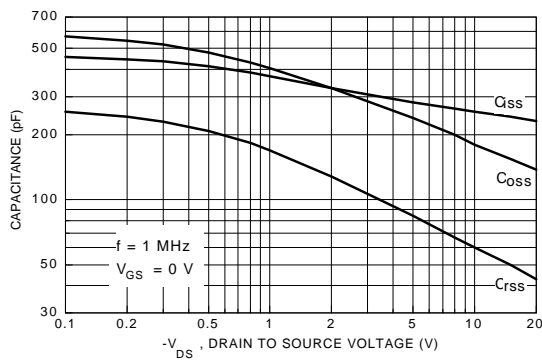


Figure 9. Capacitance Characteristics

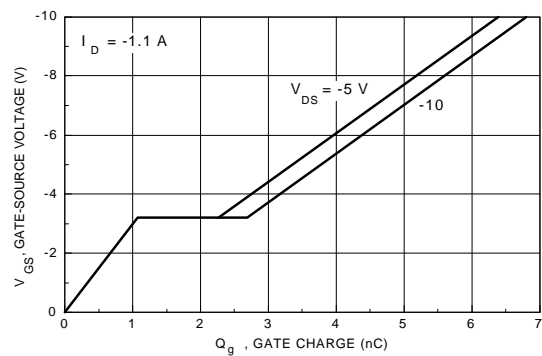


Figure 10. Gate Charge Characteristics

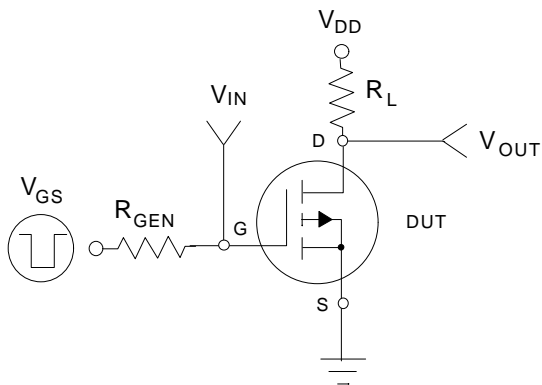


Figure 11. Switching Test Circuit

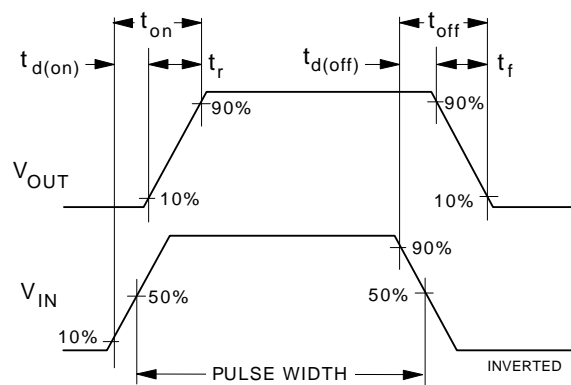


Figure 12. Switching Waveforms

Typical Electrical Characteristics (continued)

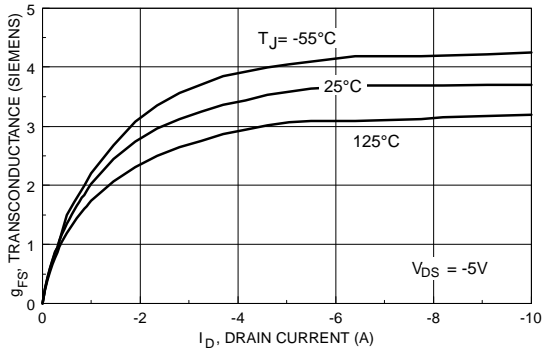


Figure 13. Transconductance Variation with Drain Current and Temperature

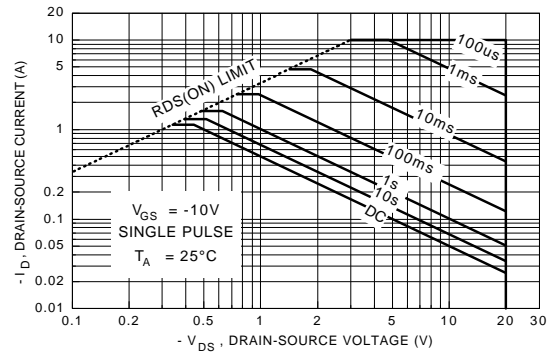


Figure 14. Maximum Safe Operating Area

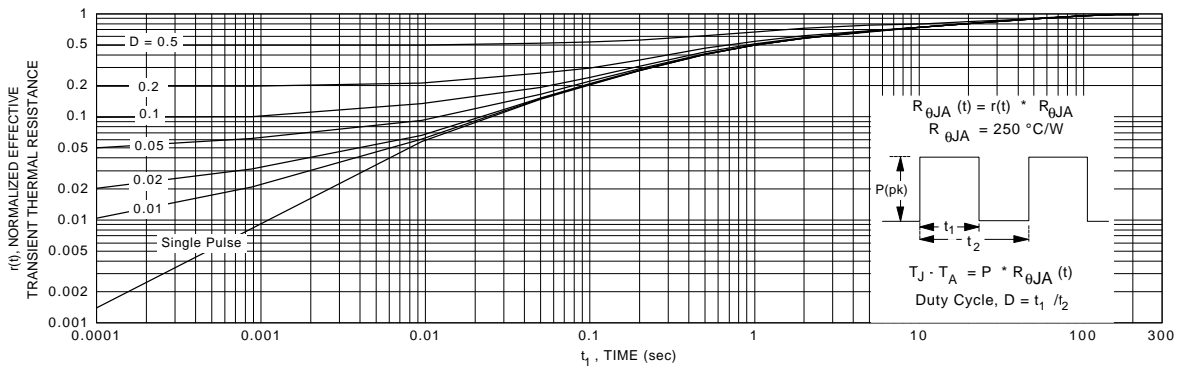


Figure 15. Transient Thermal Response Curve

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

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