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June 1997

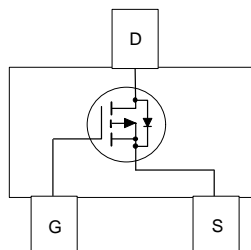
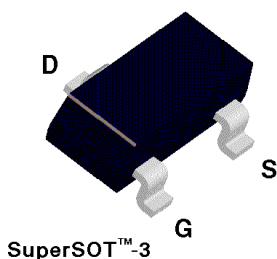
## NDS336P P-Channel Logic Level Enhancement Mode Field Effect Transistor

### General Description

SuperSOT™-3 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

- -1.2 A, -20 V,  $R_{DS(ON)} = 0.27 \Omega @ V_{GS} = -2.7 V$   
 $R_{DS(ON)} = 0.2 \Omega @ V_{GS} = -4.5 V$ .
- Very low level gate drive requirements allowing direct operation in 3V circuits.  $V_{GS(th)} < 1.0V$ .
- 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 $T_A = 25^\circ C$ unless otherwise noted

Symbol	Parameter	NDS336P	Units
$V_{DSS}$	Drain-Source Voltage	-20	V
$V_{GSS}$	Gate-Source Voltage - Continuous	$\pm 8$	V
$I_D$	Maximum Drain Current - Continuous (Note 1a) - Pulsed	-1.2	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	$^\circ C$

### THERMAL CHARACTERISTICS

$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient (Note 1a)	250	$^\circ C/W$
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case (Note 1)	75	$^\circ C/W$

<b>Electrical Characteristics</b> ( $T_A = 25^\circ\text{C}$ 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	$\mu\text{A}$
$I_{GSS}$	Gate - Body Leakage Current	$V_{GS} = 8\text{ V}, V_{DS} = 0\text{ V}$			100	nA	
$I_{GSS}$	Gate - Body Leakage Current	$V_{GS} = -8\text{ V}, V_{DS} = 0\text{ V}$			-100	nA	
<b>ON CHARACTERISTICS</b> (Note 2)							
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = -250\ \mu\text{A}$		-0.5	-0.78	-1	V
			$T_J = 125^\circ\text{C}$	-0.3	-0.58	-0.8	
$R_{DS(on)}$	Static Drain-Source On-Resistance	$V_{GS} = -2.7\text{ V}, I_D = -1.2\text{ A}$		0.22	0.27		$\Omega$
			$T_J = 125^\circ\text{C}$		0.34	0.49	
			$V_{GS} = -4.5\text{ V}, I_D = -1.3\text{ A}$		0.16	0.2	
$I_{D(on)}$	On-State Drain Current	$V_{GS} = -2.7\text{ V}, V_{DS} = -5\text{ V}$	-2			A	
$g_{FS}$	Forward Transconductance	$V_{DS} = -5\text{ V}, I_D = -1.2\text{ A}$		-3		S	
<b>DYNAMIC CHARACTERISTICS</b>							
$C_{iss}$	Input Capacitance	$V_{DS} = -10\text{ V}, V_{GS} = 0\text{ V},$ $f = 1.0\text{ MHz}$		360		pF	
$C_{oss}$	Output Capacitance			170		pF	
$C_{rss}$	Reverse Transfer Capacitance			60		pF	
<b>SWITCHING CHARACTERISTICS</b> (Note 2)							
$t_{D(on)}$	Turn - On Delay Time	$V_{DD} = -5\text{ V}, I_D = -1\text{ A},$ $V_{GS} = -4.5\text{ V}, R_{GEN} = 6\ \Omega$		8	15	ns	
$t_r$	Turn - On Rise Time			29	50	ns	
$t_{D(off)}$	Turn - Off Delay Time			33	60	ns	
$t_f$	Turn - Off Fall Time			23	45	ns	
$Q_g$	Total Gate Charge	$V_{DS} = -10\text{ V}, I_D = -1.2\text{ A},$ $V_{GS} = -4.5\text{ V}$		5.7	8.5	nC	
$Q_{gs}$	Gate-Source Charge			0.7		nC	
$Q_{gd}$	Gate-Drain Charge			1.8		nC	

Electrical Characteristics ( $T_A = 25^\circ\text{C}$ unless otherwise noted)						
Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS</b>						
$I_S$	Maximum Continuous Source Current				-0.42	A
$I_{SM}$	Maximum Pulsed Drain-Source Diode Forward Current				-10	A
$V_{SD}$	Drain-Source Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = -0.42$ (Note 2)		-0.65	-1.2	V

Notes:

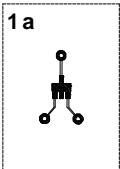
- $R_{\theta JA}$  is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta CA}$  is determined by the user's board design.

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

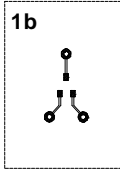
Typical  $R_{\theta JA}$  using the board layouts shown below on 4.5"x5" FR-4 PCB in a still air environment:

- 250°C/W when mounted on a 0.02 in<sup>2</sup> pad of 2oz copper.
- 270°C/W when mounted on a 0.001 in<sup>2</sup> pad of 2oz copper.

**1 a**



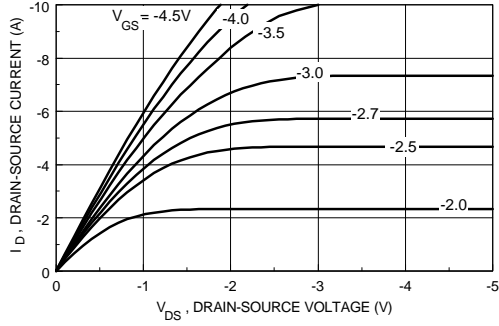
**1 b**



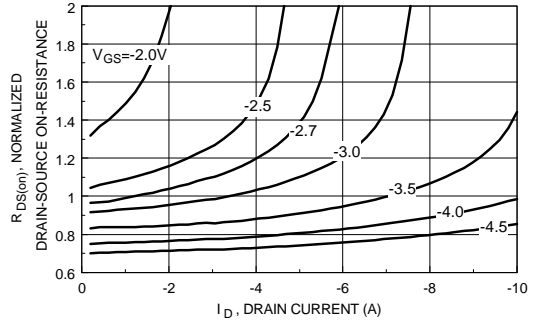
Scale 1 : 1 on letter size paper

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

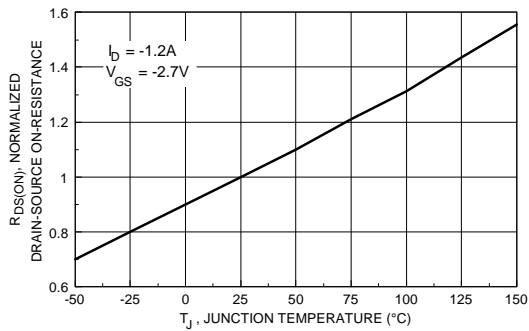
**Typical Electrical Characteristics**



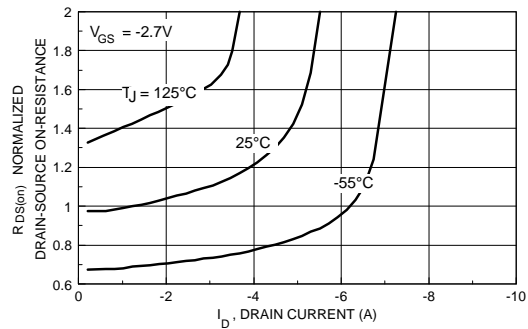
**Figure 1. On-Region Characteristics.**



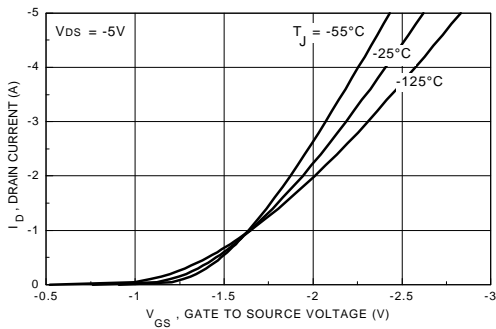
**Figure 2. On-Resistance Variation with Drain Current and Gate Voltage.**



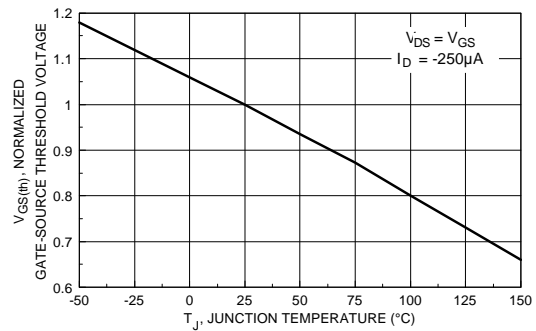
**Figure 3. On-Resistance Variation with Temperature.**



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

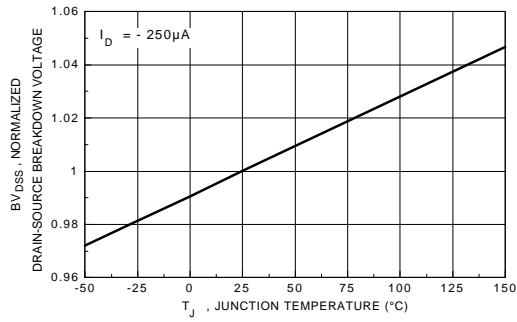


**Figure 5. Transfer Characteristics.**

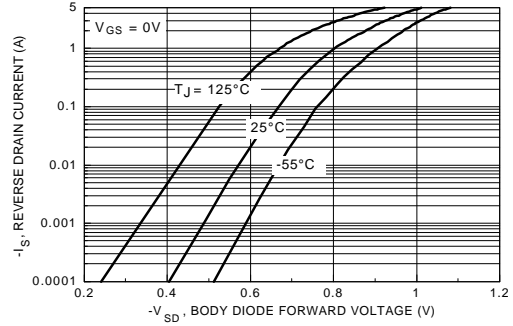


**Figure 6. Gate Threshold Variation with Temperature.**

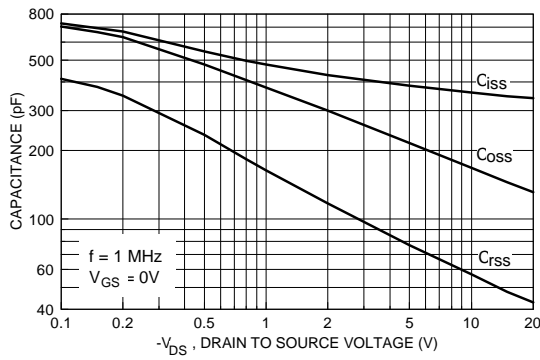
**Typical Electrical Characteristics (continued)**



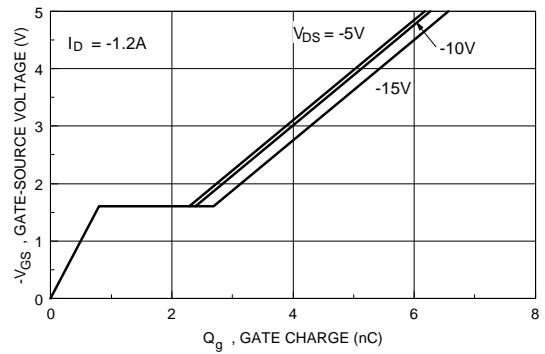
**Figure 7. Breakdown Voltage Variation with Temperature.**



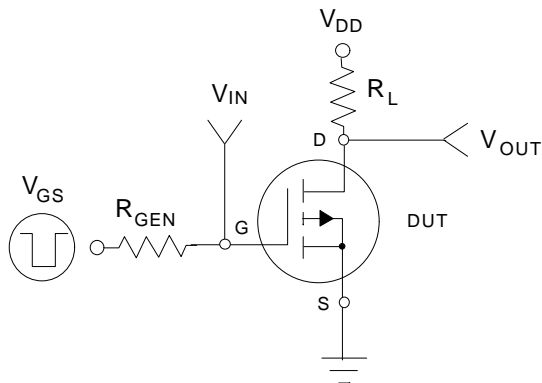
**Figure 8. Body Diode Forward Voltage Variation with Source Current and Temperature.**



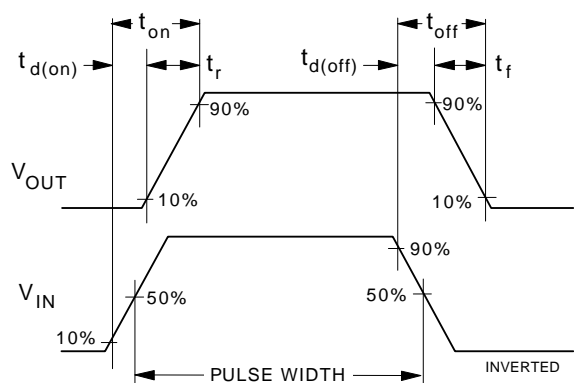
**Figure 9. Capacitance Characteristics.**



**Figure 10. Gate Charge Characteristics.**

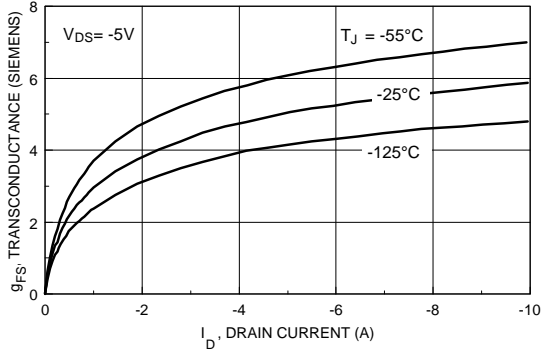


**Figure 11. Switching Test Circuit.**

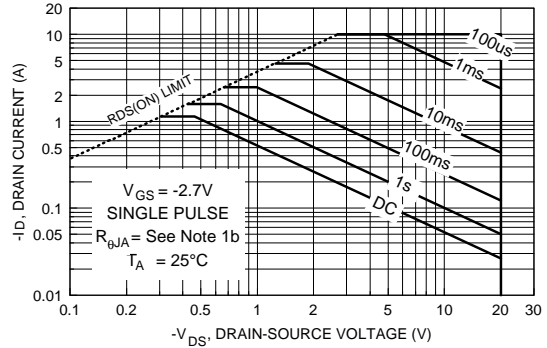


**Figure 12. Switching Waveforms.**

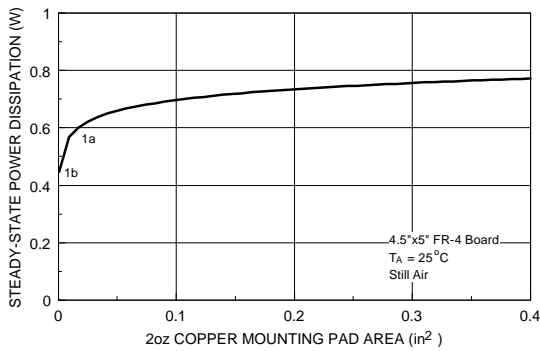
**Typical Electrical Characteristics (continued)**



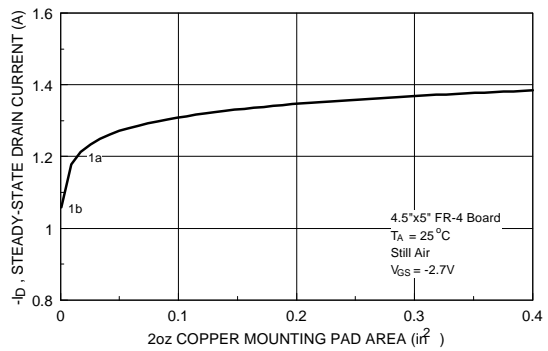
**Figure 13. Transconductance Variation with Drain Current and Temperature.**



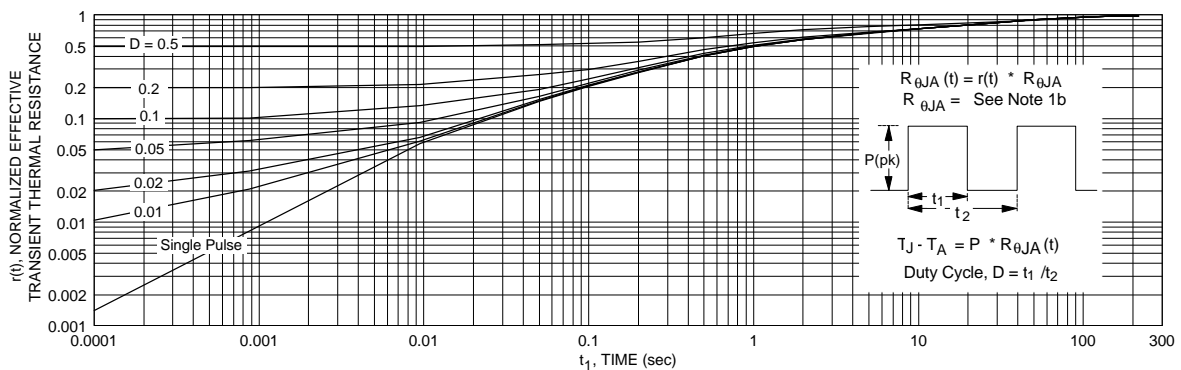
**Figure 14. Maximum Safe Operating Area.**



**Figure 15. SuperSOT™-3 Maximum Steady-State Power Dissipation versus Copper Mounting Pad Area.**



**Figure 16. Maximum Steady-State Drain Current versus Copper Mounting Pad Area.**



**Figure 17. Transient Thermal Response Curve.**

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

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