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# NDS352P

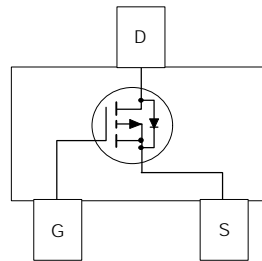
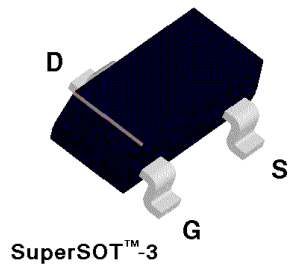
## P-Channel Logic Level Enhancement Mode Field Effect Transistor

### General Description

These P-Channel logic level enhancement mode power field effect transistors are produced using Nationals 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

- -0.85A, -20V.  $R_{DS(ON)} = 0.5\Omega @ V_{GS} = -4.5V$ .
- 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	NDS352P	Units
$V_{DSS}$	Drain-Source Voltage	-20	V
$V_{GSS}$	Gate-Source Voltage - Continuous	$\pm 12$	V
$I_D$	Maximum Drain Current - Continuous (Note 1a)	$\pm 0.85$	A
	- Pulsed	$\pm 10$	
$P_D$	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
<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	$V_{DS} = -16\text{ V}, V_{GS} = 0\text{ V}$ $T_J = 125^\circ\text{C}$			-5	$\mu\text{A}$
					-20	$\mu\text{A}$
$I_{GSSF}$	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
<b>ON CHARACTERISTICS</b> (Note 2)						
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = -250\ \mu\text{A}$ $T_J = 125^\circ\text{C}$	-0.8	-1.6	-2.5	V
			-0.5	-1.3	-2.2	
$R_{DS(ON)}$	Static Drain-Source On-Resistance	$V_{GS} = -4.5\text{ V}, I_D = -0.85\text{ A}$ $T_J = 125^\circ\text{C}$		0.46	0.5	$\Omega$
				0.59	0.7	
					0.35	
$I_{D(ON)}$	On-State Drain Current	$V_{GS} = -4.5\text{ V}, V_{DS} = -5\text{ V}$	-2			A
$g_{FS}$	Forward Transconductance	$V_{DS} = -5\text{ V}, I_D = -0.85\text{ A}$		1.5		S
<b>DYNAMIC CHARACTERISTICS</b>						
$C_{iss}$	Input Capacitance	$V_{DS} = -10\text{ V}, V_{GS} = 0\text{ V},$ $f = 1.0\text{ MHz}$		125		pF
$C_{oss}$	Output Capacitance			140		pF
$C_{rss}$	Reverse Transfer Capacitance			45		pF
<b>SWITCHING CHARACTERISTICS</b> (Note 2)						
$t_{d(on)}$	Turn - On Delay Time	$V_{DD} = -10\text{ V}, I_D = -1\text{ A},$ $V_{GS} = -10\text{ V}, R_{GEN} = 50\ \Omega$		8	15	ns
$t_r$	Turn - On Rise Time			19	30	ns
$t_{d(off)}$	Turn - Off Delay Time			64	90	ns
$t_f$	Turn - Off Fall Time			61	90	ns
$Q_g$	Total Gate Charge	$V_{DS} = -10\text{ V}, I_D = -0.85\text{ A},$ $V_{GS} = -5\text{ V}$		2.2	4	nC
$Q_{gs}$	Gate-Source Charge				1	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
<b>DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS</b>						
$I_S$	Maximum Continuous Drain-Source Diode Forward Current				-0.6	A
$I_{SM}$	Maximum Pulsed Drain-Source Diode Forward Current				-5	A
$V_{SD}$	Drain-Source Diode Forward Voltage	$V_{GS} = 0\text{ V}, I_S = -0.85\text{ A}$ (Note 2)		-0.92	-1.2	V

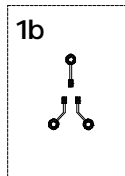
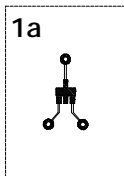
Notes:

- $R_{\theta JA}$  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.



Scale 1 : 1 on letter size paper

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

## Typical Electrical Characteristics

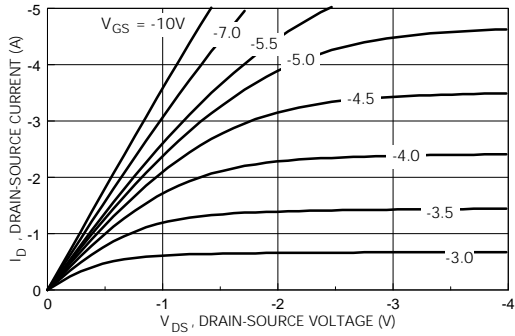


Figure 1. On-Region Characteristics

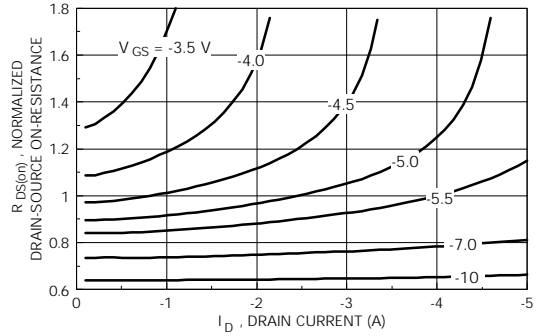


Figure 2. On-Resistance Variation with Drain Current and Gate Voltage

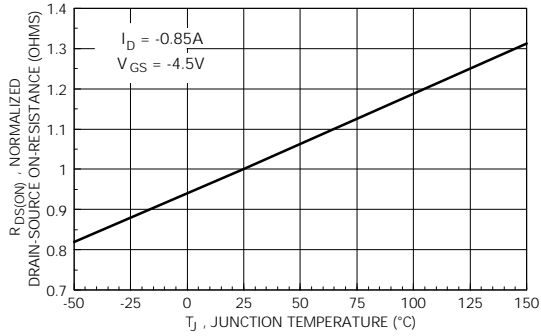


Figure 3. On-Resistance Variation with Temperature

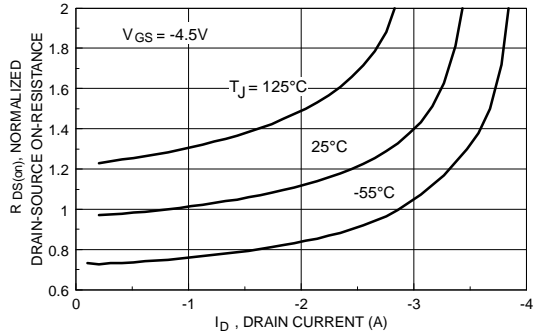


Figure 4. On-Resistance Variation with Drain Current and Temperature

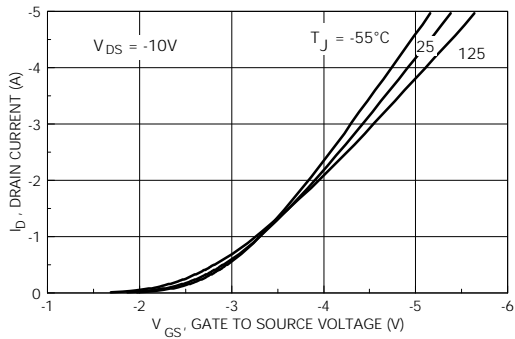


Figure 5. Transfer Characteristics

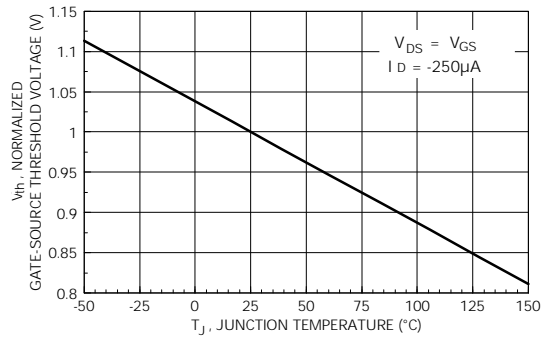


Figure 6. Gate Threshold Variation with Temperature

## Typical Electrical Characteristics (continued)

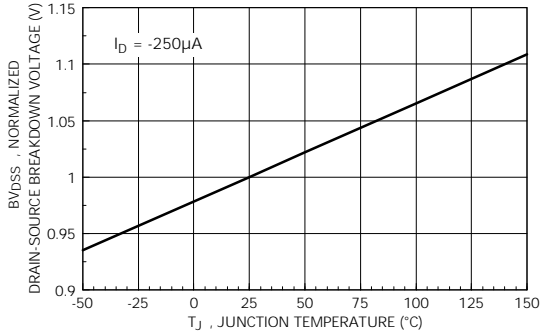


Figure 7. Breakdown Voltage Variation with Temperature

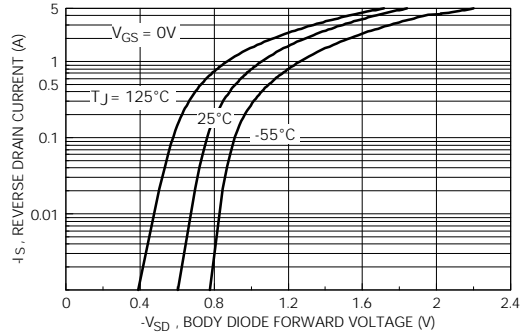


Figure 8. Body Diode Forward Voltage Variation with Source Current and Temperature

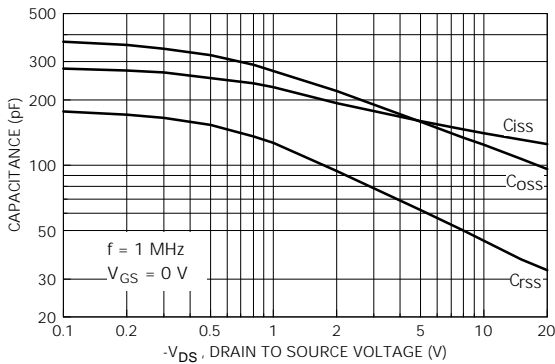


Figure 9. Capacitance Characteristics

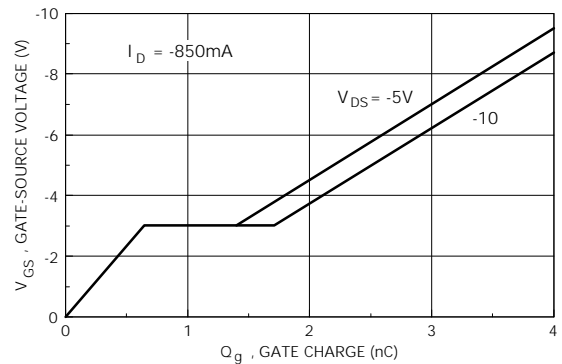


Figure 10. Gate Charge Characteristics

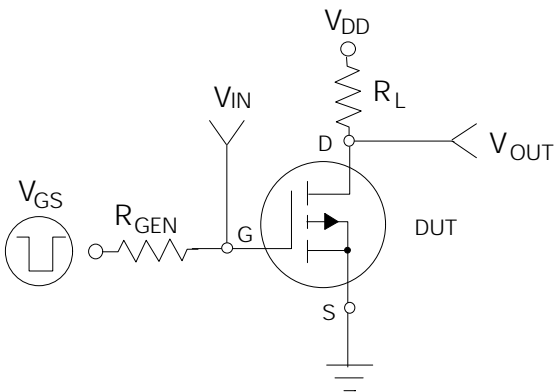


Figure 11. Switching Test Circuit

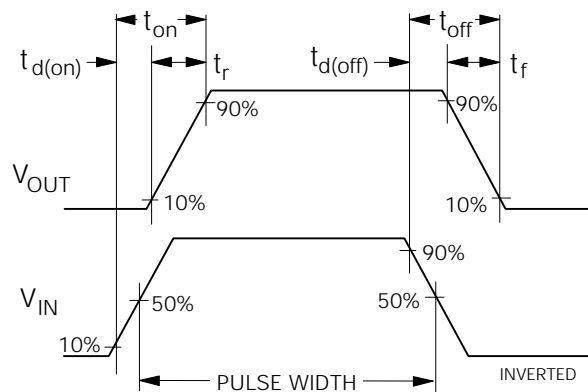
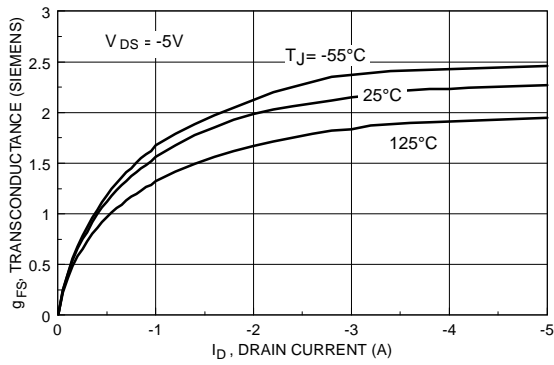
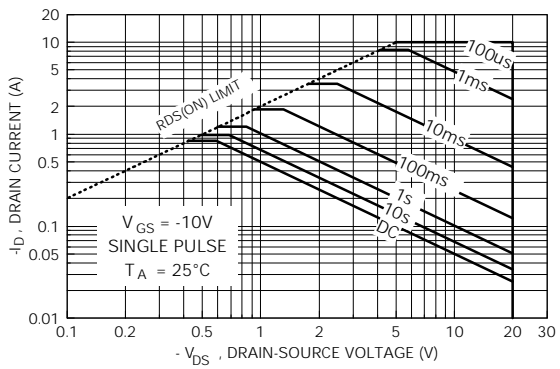


Figure 12. Switching Waveforms

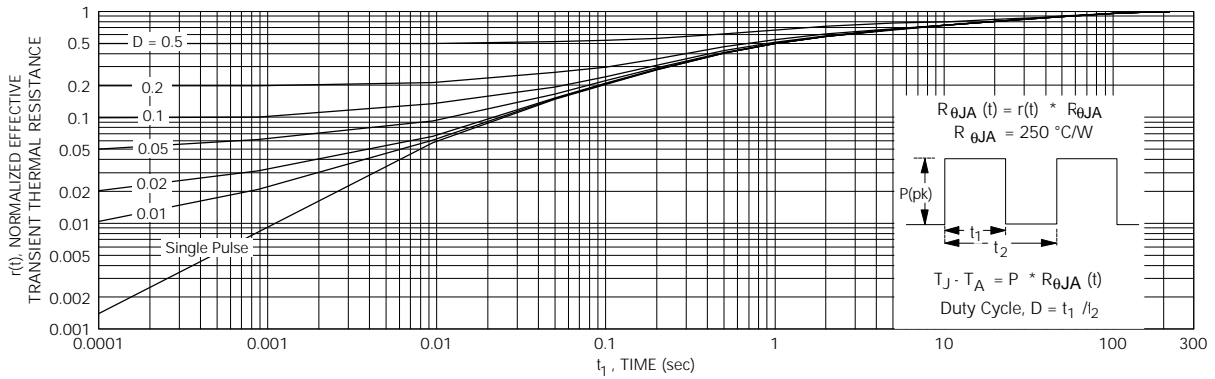
## Typical Electrical Characteristics (continued)



**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.