

November 1995

FAIRCHILD
SEMICONDUCTOR™

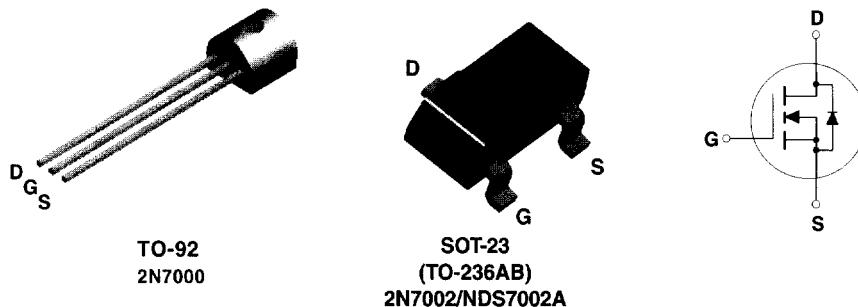
2N7000 / 2N7002 / NDS7002A N-Channel Enhancement Mode Field Effect Transistor

General Description

These N-Channel enhancement mode field effect transistors are produced using Fairchild's proprietary, high cell density, DMOS technology. These products have been designed to minimize on-state resistance while providing rugged, reliable, and fast switching performance. They can be used in most applications requiring up to 400mA DC and can deliver pulsed currents up to 2A. These products are particularly suited for low voltage, low current applications such as small servo motor control, power MOSFET gate drivers, and other switching applications.

Features

- High density cell design for low $R_{DS(ON)}$.
- Voltage controlled small signal switch.
- Rugged and reliable.
- High saturation current capability.



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Absolute Maximum Ratings

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

Symbol	Parameter	2N7000	2N7002	NDS7002A	Units
V_{DSS}	Drain-Source Voltage		60		V
V_{DGR}	Drain-Gate Voltage ($R_{GS} \leq 1 \text{ M}\Omega$)		60		V
V_{GSS}	Gate-Source Voltage - Continuous		± 20		V
	- Non Repetitive ($t_p < 50 \text{ s}$)		± 40		
I_D	Maximum Drain Current - Continuous	200	115	280	mA
	- Pulsed	500	800	1500	
P_D	Maximum Power Dissipation	400	200	300	mW
	Derated above 25°C	3.2	1.6	2.4	mW/'C
T_J, T_{STG}	Operating and Storage Temperature Range	-55 to 150		-65 to 150	'C
T_L	Maximum Lead Temperature for Soldering Purposes, 1/16" from Case for 10 Seconds	300			'C

THERMAL CHARACTERISTICS

R_{QJA}	Thermal Resistance, Junction-to-Ambient	312.5	625	417	'C/W
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Electrical Characteristics ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Symbol	Parameter	Conditions	Type	Min	Typ	Max	Units
OFF CHARACTERISTICS							
BV_{DSS}	Drain-Source Breakdown Voltage	$V_{\text{GS}} = 0 \text{ V}, I_D = 10 \mu\text{A}$	All	60			V
I_{DSS}	Zero Gate Voltage Drain Current	$V_{\text{DS}} = 48 \text{ V}, V_{\text{GS}} = 0 \text{ V}$	2N7000			1	μA
		$T_J = 125^\circ\text{C}$				1	mA
I_{GSSF}	Gate - Body Leakage, Forward	$V_{\text{GS}} = 15 \text{ V}, V_{\text{DS}} = 0 \text{ V}$	2N7000			10	nA
		$V_{\text{GS}} = 20 \text{ V}, V_{\text{DS}} = 0 \text{ V}$	2N7002 NDS7002A			100	nA
I_{GSSR}	Gate - Body Leakage, Reverse	$V_{\text{GS}} = -15 \text{ V}, V_{\text{DS}} = 0 \text{ V}$	2N7000			-10	nA
		$V_{\text{GS}} = -20 \text{ V}, V_{\text{DS}} = 0 \text{ V}$	2N7002 NDS7002A			-100	nA
ON CHARACTERISTICS (Note 1)							
$V_{\text{GS(Th)}}$	Gate Threshold Voltage	$V_{\text{DS}} = V_{\text{GS}}, I_D = 1 \text{ mA}$	2N7000	0.8	2.1	3	V
		$V_{\text{DS}} = V_{\text{GS}}, I_D = 250 \mu\text{A}$	2N7002 NDS7002A	1	2.1	2.5	
$R_{\text{DS(ON)}}$	Static Drain-Source On-Resistance	$V_{\text{GS}} = 10 \text{ V}, I_D = 500 \text{ mA}$	2N7000		1.2	5	Ω
		$T_J = 125^\circ\text{C}$			1.9	9	
		$V_{\text{GS}} = 4.5 \text{ V}, I_D = 75 \text{ mA}$			1.8	5.3	
		$V_{\text{GS}} = 10 \text{ V}, I_D = 500 \text{ mA}$	2N7002		1.2	7.5	
		$T_J = 100^\circ\text{C}$			1.7	13.5	
		$V_{\text{GS}} = 5.0 \text{ V}, I_D = 50 \text{ mA}$			1.7	7.5	
		$T_J = 100^\circ\text{C}$			2.4	13.5	
		$V_{\text{GS}} = 10 \text{ V}, I_D = 500 \text{ mA}$	NDS7002A		1.2	2	
		$T_J = 125^\circ\text{C}$			2	3.5	
$V_{\text{DS(ON)}}$	Drain-Source On-Voltage	$V_{\text{GS}} = 5.0 \text{ V}, I_D = 50 \text{ mA}$			1.7	3	
		$T_J = 125^\circ\text{C}$			2.8	5	
		$V_{\text{GS}} = 10 \text{ V}, I_D = 500 \text{ mA}$	2N7000		0.6	2.5	V
		$V_{\text{GS}} = 4.5 \text{ V}, I_D = 75 \text{ mA}$			0.14	0.4	
		$V_{\text{GS}} = 10 \text{ V}, I_D = 500 \text{ mA}$	2N7002		0.6	3.75	
		$V_{\text{GS}} = 5.0 \text{ V}, I_D = 50 \text{ mA}$			0.09	1.5	
		$V_{\text{GS}} = 10 \text{ V}, I_D = 500 \text{ mA}$	NDS7002A		0.6	1	
		$V_{\text{GS}} = 5.0 \text{ V}, I_D = 50 \text{ mA}$			0.09	0.15	

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

Symbol	Parameter	Conditions	Type	Min	Typ	Max	Units
ON CHARACTERISTICS Continued (Note 1)							
$I_{D(on)}$	On-State Drain Current	$V_{GS} = 4.5 \text{ V}$, $V_{DS} = 10 \text{ V}$	2N7000	75	600		mA
		$V_{GS} = 10 \text{ V}$, $V_{DS} \geq 2 V_{DS(on)}$	2N7002	500	2700		
		$V_{GS} = 10 \text{ V}$, $V_{DS} \geq 2 V_{DS(on)}$	NDS7002A	500	2700		
g_{FS}	Forward Transconductance	$V_{DS} = 10 \text{ V}$, $I_D = 200 \text{ mA}$	2N7000	100	320		mS
		$V_{DS} \geq 2 V_{DS(on)}$, $I_D = 200 \text{ mA}$	2N7002	80	320		
		$V_{DS} \geq 2 V_{DS(on)}$, $I_D = 200 \text{ mA}$	NDS7002A	80	320		

DYNAMIC CHARACTERISTICS

C_{iss}	Input Capacitance	$V_{DS} = 25 \text{ V}$, $V_{GS} = 0 \text{ V}$, $f = 1.0 \text{ MHz}$	All		20	50	pF
C_{oss}	Output Capacitance		All		11	25	pF
C_{rss}	Reverse Transfer Capacitance		All		4	5	pF
t_{on}	Turn-On Time	$V_{DD} = 15 \text{ V}$, $R_L = 25 \Omega$, $I_D = 500 \text{ mA}$, $V_{GS} = 10 \text{ V}$, $R_{GEN} = 25$	2N7000			10	ns
		$V_{DD} = 30 \text{ V}$, $R_L = 150 \Omega$, $I_D = 200 \text{ mA}$, $V_{GS} = 10 \text{ V}$, $R_{GEN} = 25 \Omega$	2N700 NDS7002A			20	
t_{off}	Turn-Off Time	$V_{DD} = 15 \text{ V}$, $R_L = 25 \Omega$, $I_D = 500 \text{ mA}$, $V_{GS} = 10 \text{ V}$, $R_{GEN} = 25$	2N7000			10	ns
		$V_{DD} = 30 \text{ V}$, $R_L = 150 \Omega$, $I_D = 200 \text{ mA}$, $V_{GS} = 10 \text{ V}$, $R_{GEN} = 25 \Omega$	2N700 NDS7002A			20	

DRAIN-SOURCE DIODE CHARACTERISTICS AND MAXIMUM RATINGS

I_S	Maximum Continuous Drain-Source Diode Forward Current	2N7002		115	mA
		NDS7002A		280	
I_{SM}	Maximum Pulsed Drain-Source Diode Forward Current	2N7002		0.8	A
		NDS7002A		1.5	
V_{SD}	Drain-Source Diode Forward Voltage	$V_{GS} = 0 \text{ V}$, $I_S = 115 \text{ mA}$ (Note 1)	2N7002	0.88	V
		$V_{GS} = 0 \text{ V}$, $I_S = 400 \text{ mA}$ (Note 1)	NDS7002A	0.88	

Note:

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

Typical Electrical Characteristics

2N7000 / 2N7002 / NDS7002A

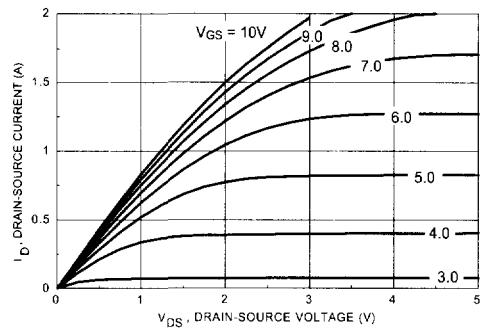


Figure 1. On-Region Characteristics.

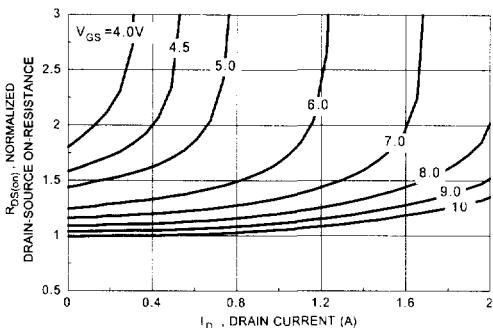


Figure 2. On-Resistance Variation with Gate Voltage and Drain Current

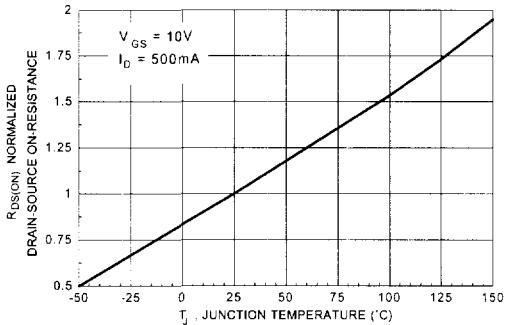


Figure 3. On-Resistance Variation with Temperature

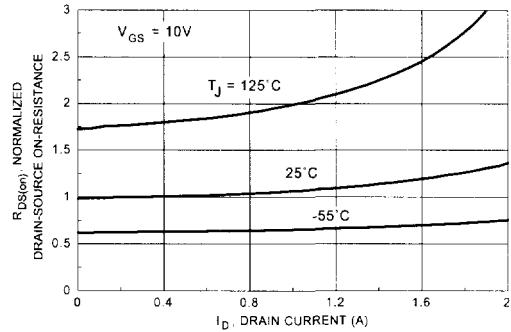


Figure 4. On-Resistance Variation with Drain Current and Temperature

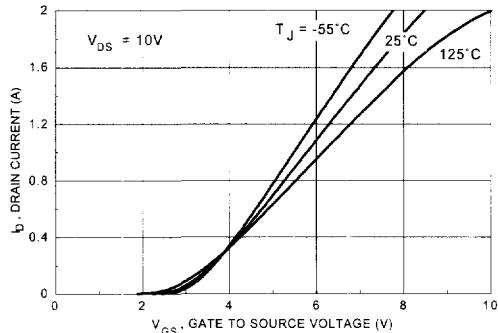


Figure 5. Transfer Characteristics.

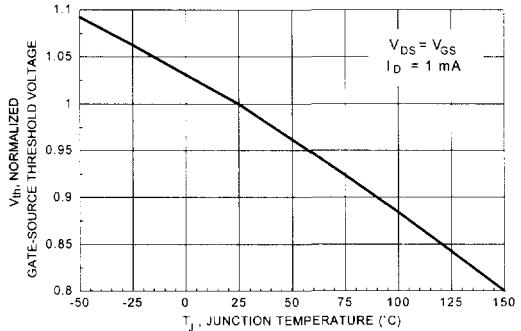


Figure 6. Gate Threshold Variation with Temperature.

Typical Electrical Characteristics (continued)

2N7000 / 2N7002 / NDS7002A

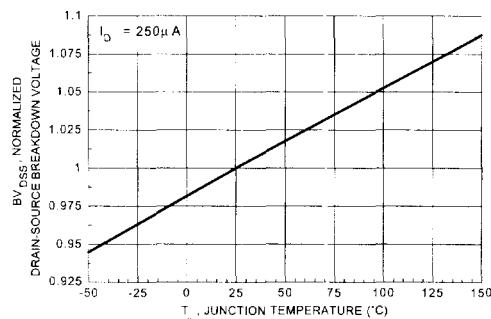


Figure 7. Breakdown Voltage Variation with Temperature.

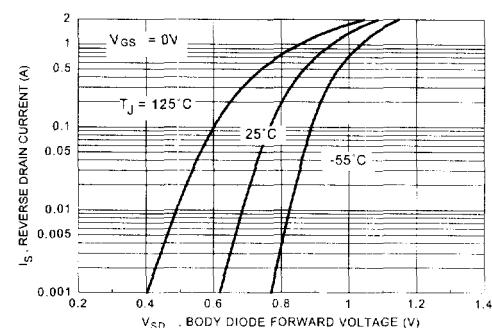


Figure 8. Body Diode Forward Voltage Variation with Current and Temperature.

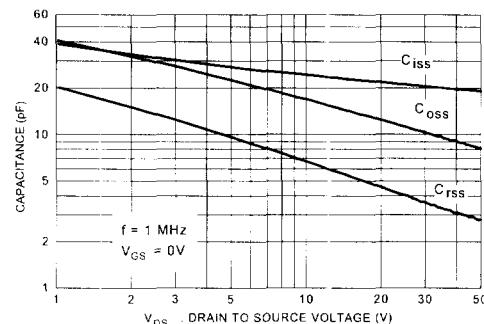


Figure 9. Capacitance Characteristics

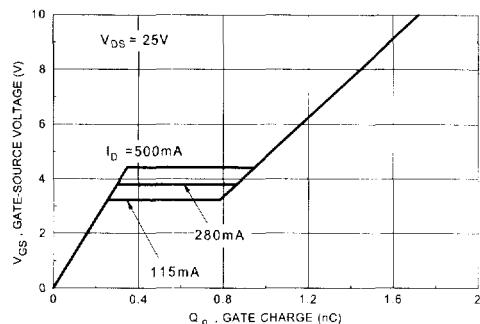


Figure 10. Gate Charge Characteristics.

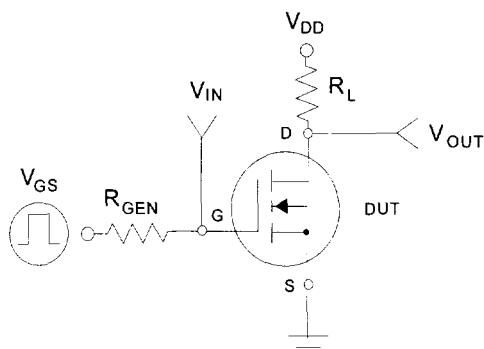


Figure 11. Switching Test Circuit.

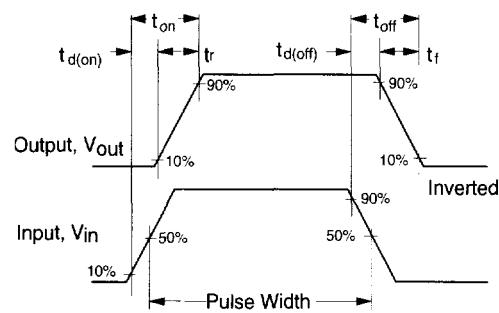


Figure 12. Switching Waveforms.

Typical Electrical Characteristics (continued)

