# 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 provide 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.

TO-92
2N7000

SOT-23
(TO-236AB)
2N7002/NDS7002A
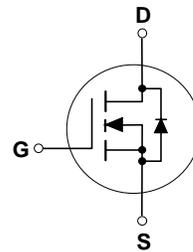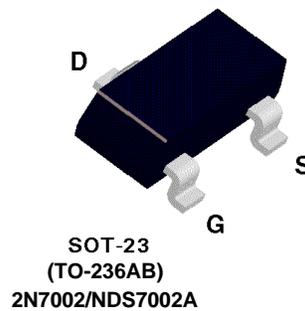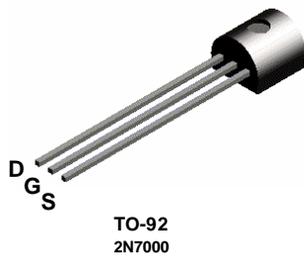
Absolute Maximum Ratings T_A = 25°C unless otherwise noted

Symbol	Parameter	2N7000	2N7002	NDS7002A	Units
V_{DSS}	Drain-Source Voltage	60			V
V_{DGR}	Drain-Gate Voltage ($R_{GS} \leq 1\ M\Omega$)	60			V
V_{GSS}	Gate-Source Voltage - Continuous	± 20			V
	- Non Repetitive (tp < 50µs)	± 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					
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	312.5	625	417	°C/W

Electrical Characteristics T_A = 25°C unless otherwise noted

Symbol	Parameter	Conditions		Type	Min	Typ	Max	Units
OFF CHARACTERISTICS								
BV_{DSS}	Drain-Source Breakdown Voltage	V_{GS} = 0 V, I_D = 10 µA		All	60			V
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS} = 48 V, V_{GS} = 0 V		2N7000			1	µA
			T_J=125°C				1	mA
		V_{DS} = 60 V, V_{GS} = 0 V		2N7002 NDS7002A			1	µA
			T_J=125°C				0.5	mA
I_{GSSF}	Gate - Body Leakage, Forward	V_{GS} = 15 V, V_{DS} = 0 V		2N7000			10	nA
		V_{GS} = 20 V, V_{DS} = 0 V		2N7002 NDS7002A			100	nA
I_{GSSR}	Gate - Body Leakage, Reverse	V_{GS} = -15 V, V_{DS} = 0 V		2N7000			-10	nA
		V_{GS} = -20 V, V_{DS} = 0 V		2N7002 NDS7002A			-100	nA
ON CHARACTERISTICS (Note 1)								
$V_{GS(th)}$	Gate Threshold Voltage	V_{DS} = V_{GS}, I_D = 1 mA		2N7000	0.8	2.1	3	V
		V_{DS} = V_{GS}, I_D = 250 µA		2N7002 NDS7002A	1	2.1	2.5	
$R_{DS(ON)}$	Static Drain-Source On-Resistance	V_{GS} = 10 V, I_D = 500 mA		2N7000		1.2	5	Ω
			T_J = 125°C			1.9	9	
		V_{GS} = 4.5 V, I_D = 75 mA				1.8	5.3	
		V_{GS} = 10 V, I_D = 500 mA		2N7002		1.2	7.5	
			T_J =100°C			1.7	13.5	
		V_{GS} = 5.0 V, I_D = 50 mA				1.7	7.5	
			T_J =100C			2.4	13.5	
		V_{GS} = 10 V, I_D = 500 mA		NDS7002A		1.2	2	
			T_J =125°C			2	3.5	
		V_{GS} = 5.0 V, I_D = 50 mA				1.7	3	
			T_J =125°C			2.8	5	
$V_{DS(ON)}$	Drain-Source On-Voltage	V_{GS} = 10 V, I_D = 500 mA		2N7000		0.6	2.5	V
		V_{GS} = 4.5 V, I_D = 75 mA				0.14	0.4	
		V_{GS} = 10 V, I_D = 500mA		2N7002		0.6	3.75	
		V_{GS} = 5.0 V, I_D = 50 mA				0.09	1.5	
		V_{GS} = 10 V, I_D = 500mA		NDS7002A		0.6	1	
		V_{GS} = 5.0 V, I_D = 50 mA				0.09	0.15	

Electrical Characteristics $T_A = 25°C$ unless otherwise noted

Symbol	Parameter	Conditions	Type	Min	Typ	Max	Units
ON CHARACTERISTICS Continued (Note 1)							
$I_{D(ON)}$	On-State Drain Current	$V_{GS} = 4.5$ V, $V_{DS} = 10$ V	2N7000	75	600		mA
		$V_{GS} = 10$ V, $V_{DS} \geq 2\ V_{DS(on)}$	2N7002	500	2700		
		$V_{GS} = 10$ V, $V_{DS} \geq 2\ V_{DS(on)}$	NDS7002A	500	2700		
g_{FS}	Forward Transconductance	$V_{DS} = 10$ V, $I_D = 200$ mA	2N7000	100	320		mS
		$V_{DS} \geq 2\ V_{DS(on)}$, $I_D = 200$ mA	2N7002	80	320		
		$V_{DS} \geq 2\ V_{DS(on)}$, $I_D = 200$ mA	NDS7002A	80	320		
DYNAMIC CHARACTERISTICS							
C_{iss}	Input Capacitance	$V_{DS} = 25$ V, $V_{GS} = 0$ V, $f = 1.0$ 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	$V_{DD} = 15$ V, $R_L = 25\ \Omega$, $I_D = 500$ mA, $V_{GS} = 10$ V, $R_{GEN} = 25$	2N7000			10	ns
		$V_{DD} = 30$ V, $R_L = 150\ \Omega$, $I_D = 200$ mA, $V_{GS} = 10$ V, $R_{GEN} = 25\ \Omega$	2N700 NDS7002A			20	
t_{off}	Turn-Off Time	$V_{DD} = 15$ V, $R_L = 25\ \Omega$, $I_D = 500$ mA, $V_{GS} = 10$ V, $R_{GEN} = 25$	2N7000			10	ns
		$V_{DD} = 30$ V, $R_L = 150\ \Omega$, $I_D = 200$ mA, $V_{GS} = 10$ 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	$V_{GS} = 0$ V, $I_S = 115$ mA (Note 1)	2N7002		0.88	1.5	V
		$V_{GS} = 0$ V, $I_S = 400$ mA (Note 1)	NDS7002A		0.88	1.2	

Note:
1. Pulse Test: Pulse Width $\leq$ 300µs, Duty Cycle $\leq$ 2.0%.

Typical Electrical Characteristics
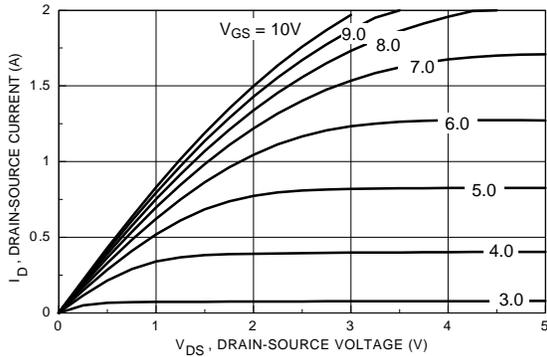
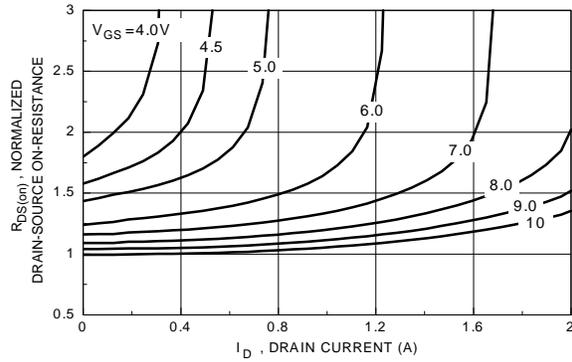## 2N7000 / 2N7002 / NDS7002A

Figure 1. On-Region Characteristics

Figure 2. On-Resistance Variation with Gate
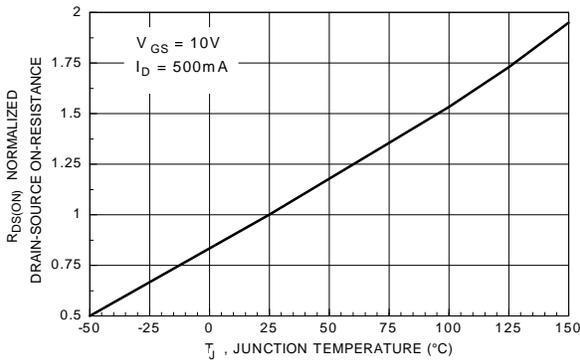Voltage and Drain Current
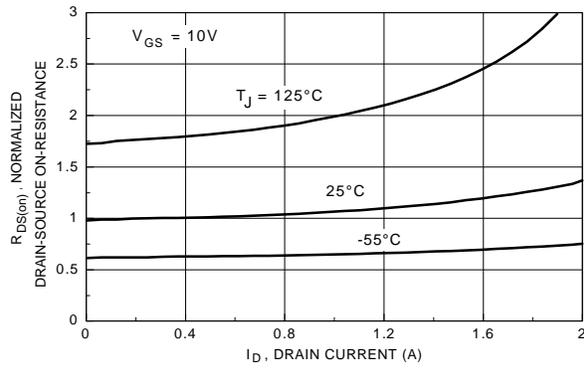
Figure 3. On-Resistance Variation
with Temperature

Figure 4. On-Resistance Variation with Drain
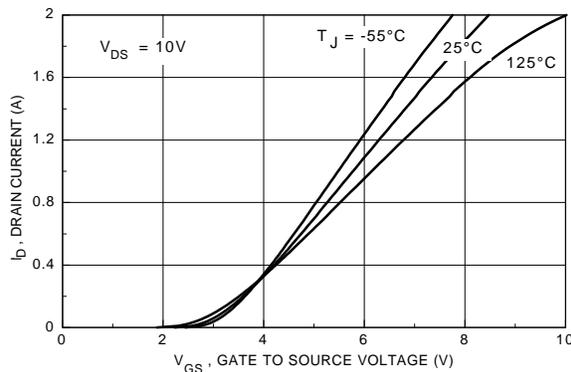Current and Temperature
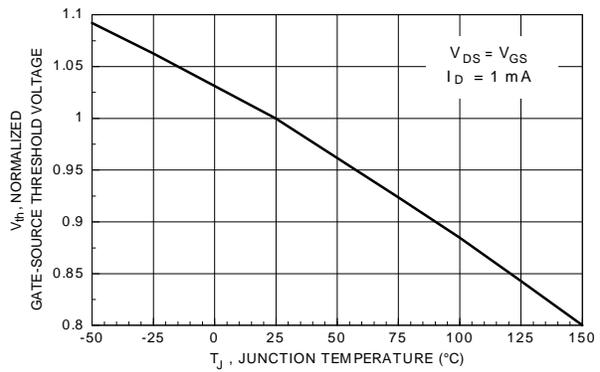
Figure 5. Transfer Characteristics

Figure 6. Gate Threshold Variation with
Temperature

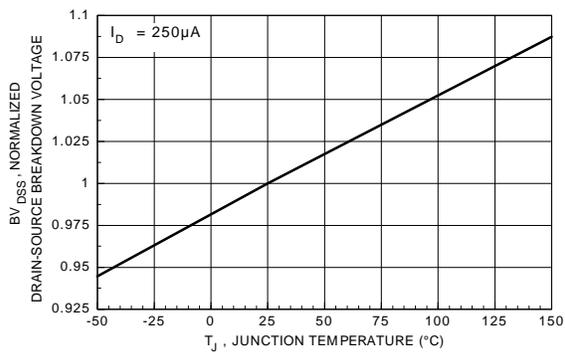# Typical Electrical Characteristics (continued)

2N7000 / 2N7002 /NDS7002A

Figure 7. Breakdown Voltage Variation with Temperature
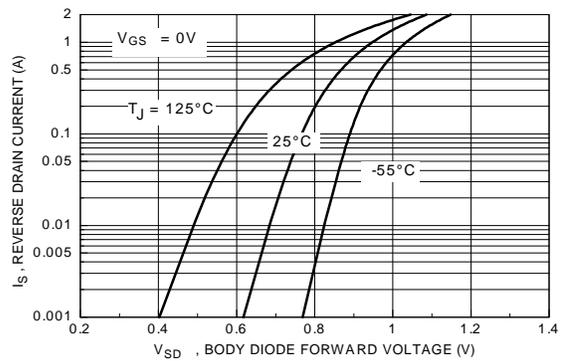
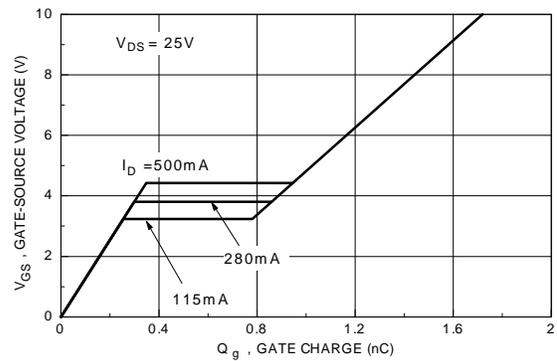Figure 8. Body Diode Forward Voltage Variation with
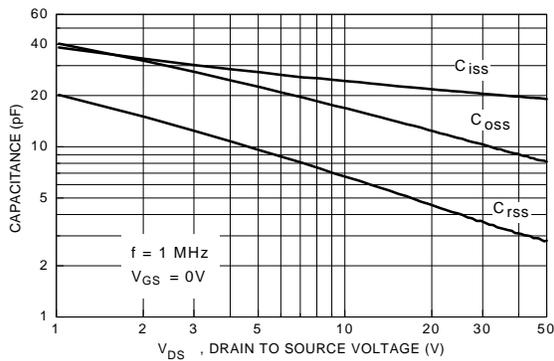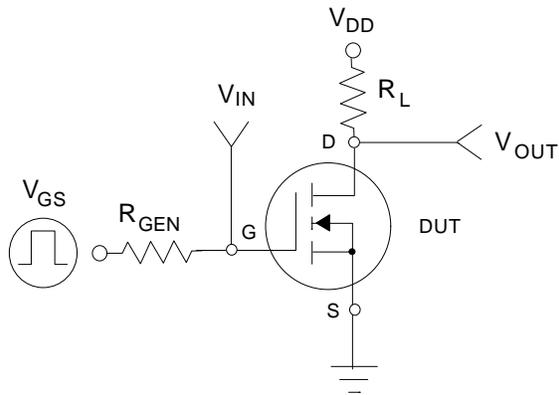
Figure 9. Capacitance Characteristics
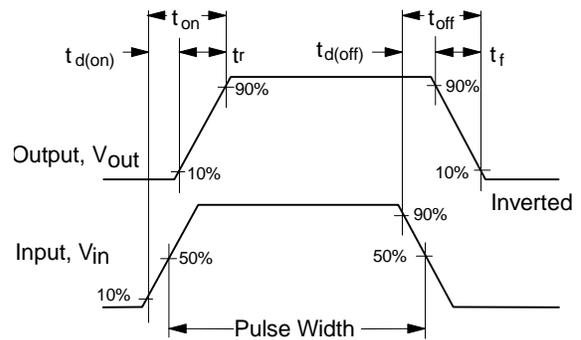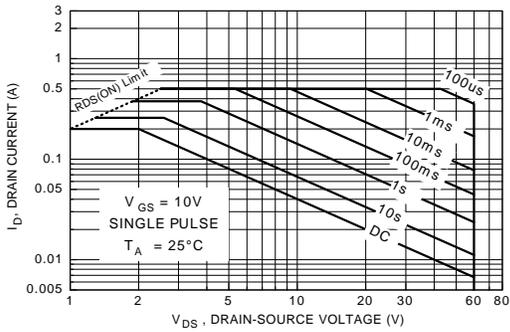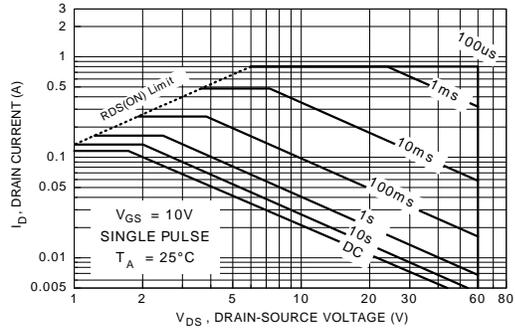
Figure 10. Gate Charge Characteristics
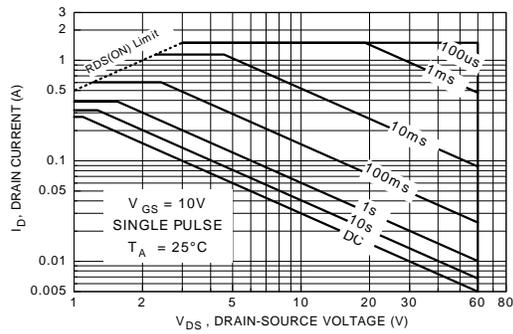
Figure 11.

Figure 12. Switching Waveforms
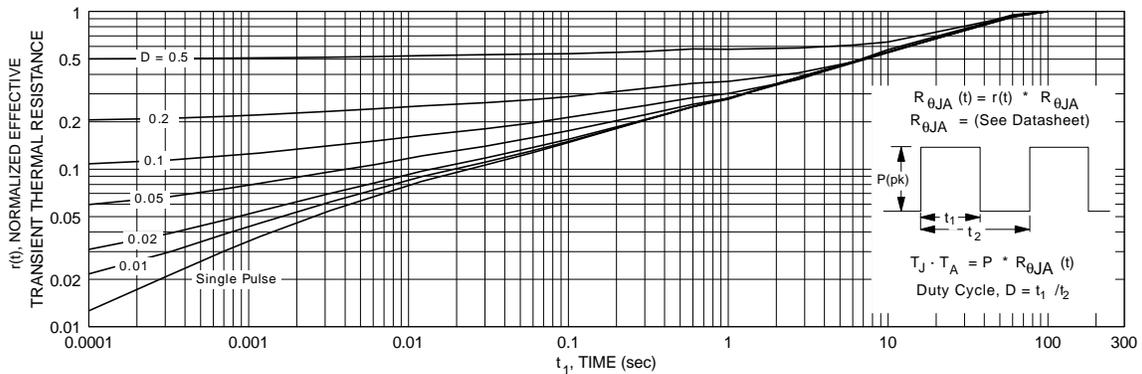
Typical Electrical Characteristics (continued)
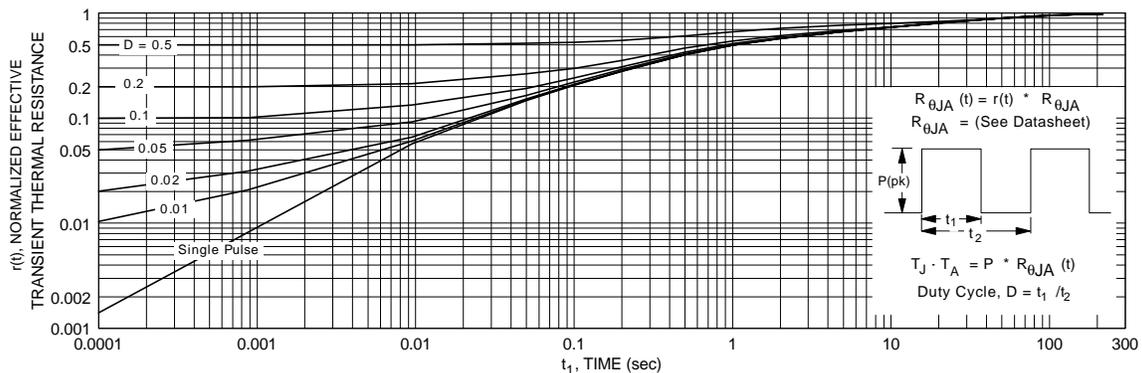

Figure 13. 2N7000 Maximum
Safe Operating Area

Figure 14. 2N7002 Maximum
Safe Operating Area

Figure 15. NDS7000A Maximum
Safe Operating Area

Figure 16. TO-92, 2N7000 Transient Thermal Response Curve

Figure 17. SOT-23, 2N7002 / NDS7002A Transient Thermal Response Curve

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