FAIRCHILD SEMICONDUCTOR TM

November 1995

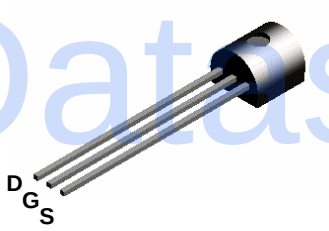
2N7000 / 2N7002 / NDS7002A
N-Channel Enhancement Mode Field Effect Transistor

General Description

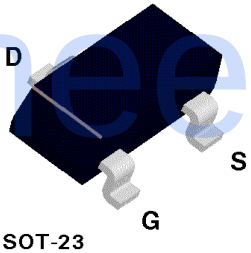
These N-Channel enhancement mode field effect transistors are produced using Fairchild's proprietary, high cell density, DMOS technology. These products have been designed to minimize on-state resistance while provide rugged, reliable, and fast switching performance. They can be used in most applications 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

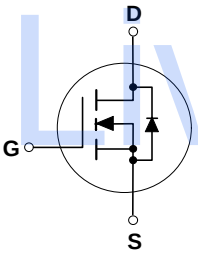
- High density cell design for low $R_{DS(ON)}$.
- Voltage controlled small signal switch.
- Rugged and reliable.
- High saturation current capability.



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 ($R_{GS} \leq 1$ MΩ)		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 Ω, I_D = 500 mA, V_{GS} = 10 V, R_{GEN} = 25	2N7000			10	ns
		V_{DD} = 30 V, R_L = 150 Ω, I_D = 200 mA, V_{GS} = 10 V, R_{GEN} = 25 Ω	2N700 NDS7002A			20	
t_{off}	Turn-Off Time	V_{DD} = 15 V, R_L = 25 Ω, I_D = 500 mA, V_{GS} = 10 V, R_{GEN} = 25	2N7000			10	ns
		V_{DD} = 30 V, R_L = 150 Ω, I_D = 200 mA, V_{GS} = 10 V, R_{GEN} = 25 Ω	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 ≤ 300µs, Duty Cycle ≤ 2.0%.

Typical Electrical Characteristics

2N7000 / 2N7002 / NDS7002A

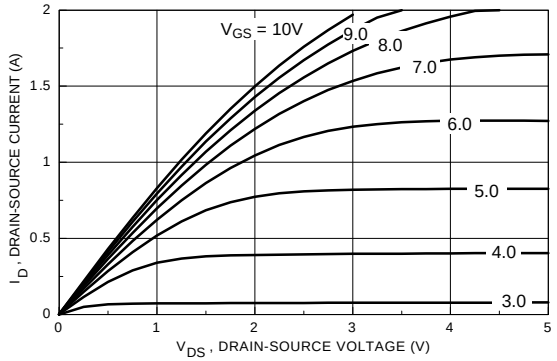


Figure 1. On-Region Characteristics

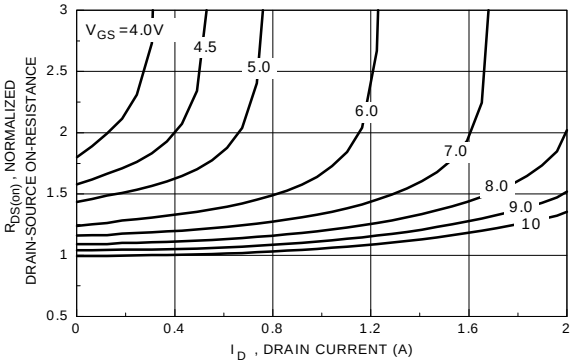


Figure 2. On-Resistance Variation with Gate Voltage and Drain Current

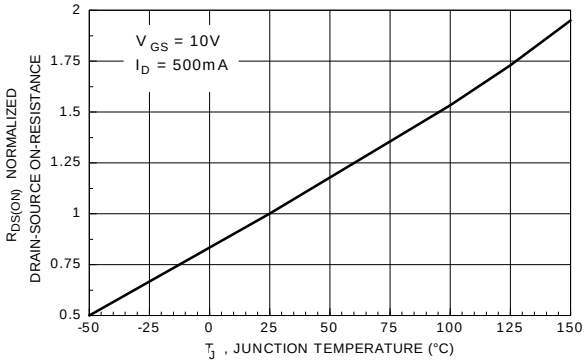


Figure 3. On-Resistance Variation with Temperature

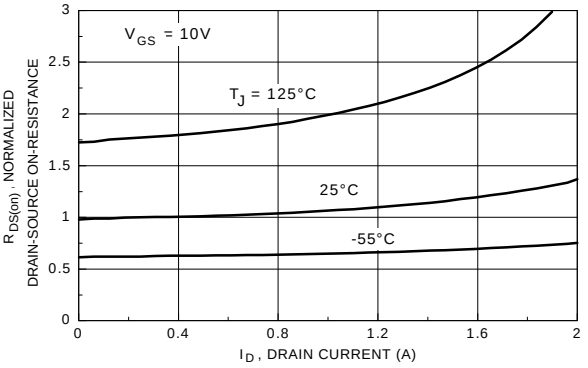


Figure 4. On-Resistance Variation with Drain Current and Temperature

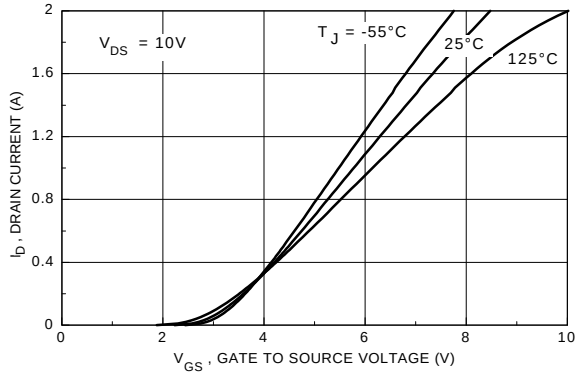


Figure 5. Transfer Characteristics

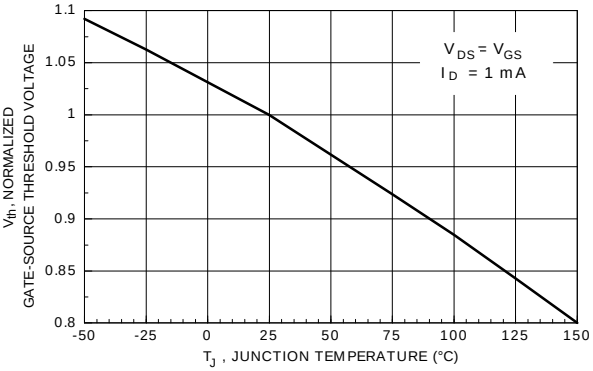


Figure 6. Gate Threshold Variation with Temperature

Typical Electrical Characteristics (continued)

2N7000 / 2N7002 /NDS7002A

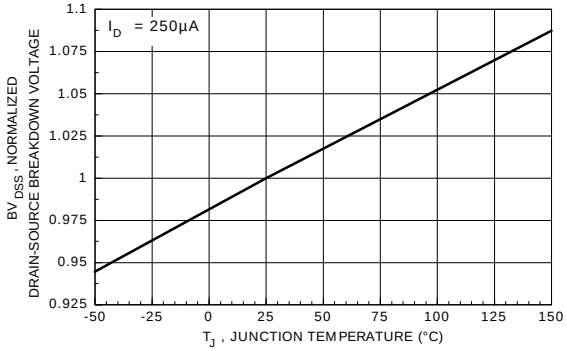


Figure 7. Breakdown Voltage Variation with Temperature

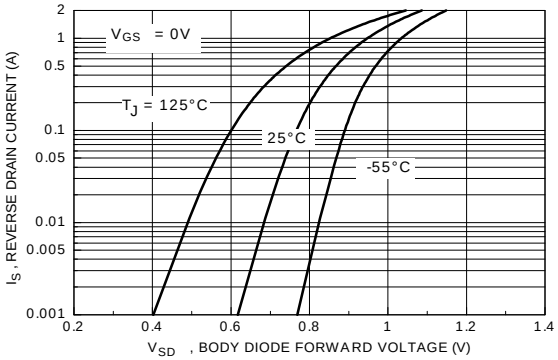


Figure 8. Body Diode Forward Voltage Variation with

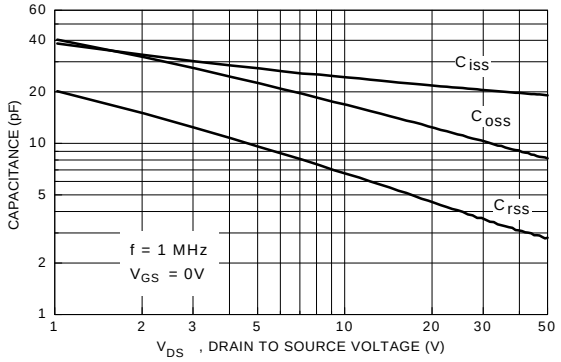


Figure 9. Capacitance Characteristics

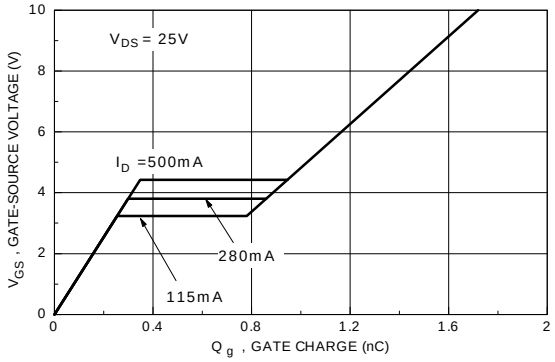


Figure 10. Gate Charge Characteristics

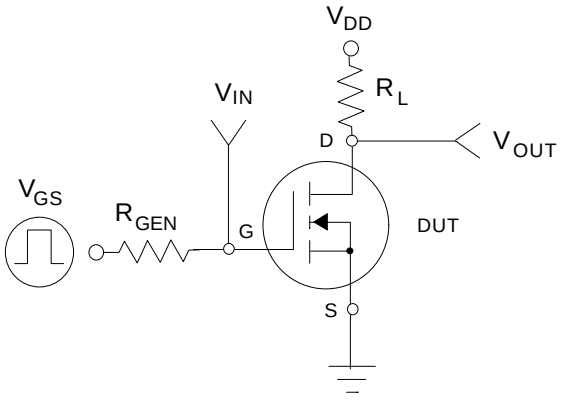


Figure 11.

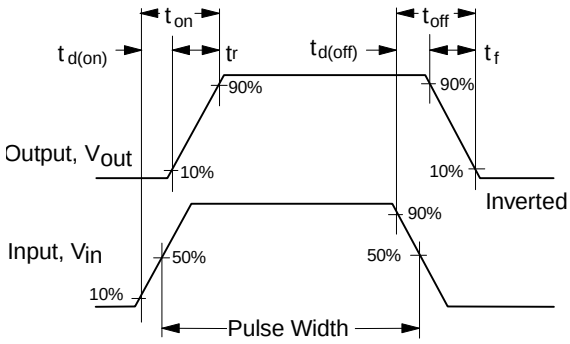


Figure 12. Switching Waveforms

Typical Electrical Characteristics (continued)

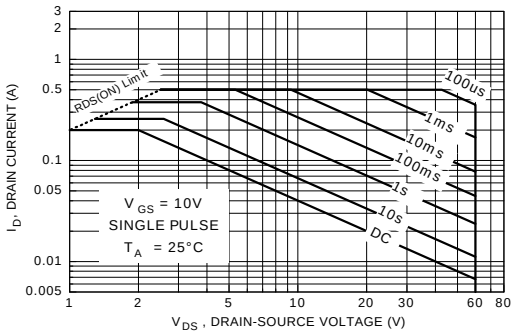


Figure 13. 2N7000 Maximum Safe Operating Area

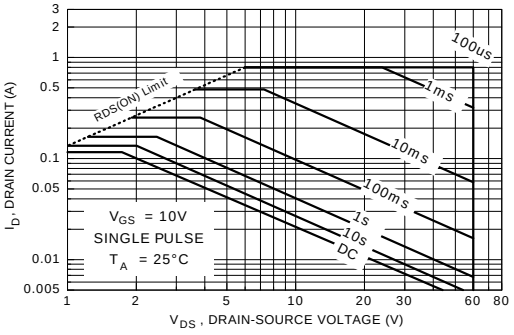


Figure 14. 2N7002 Maximum Safe Operating Area

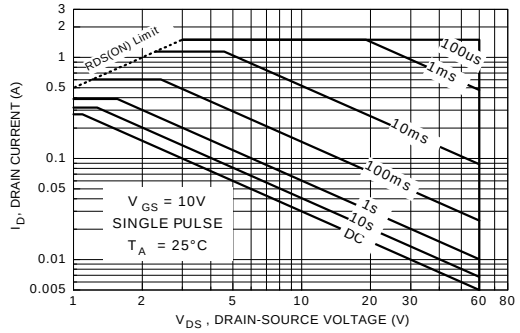


Figure 15. NDS7000A Maximum Safe Operating Area

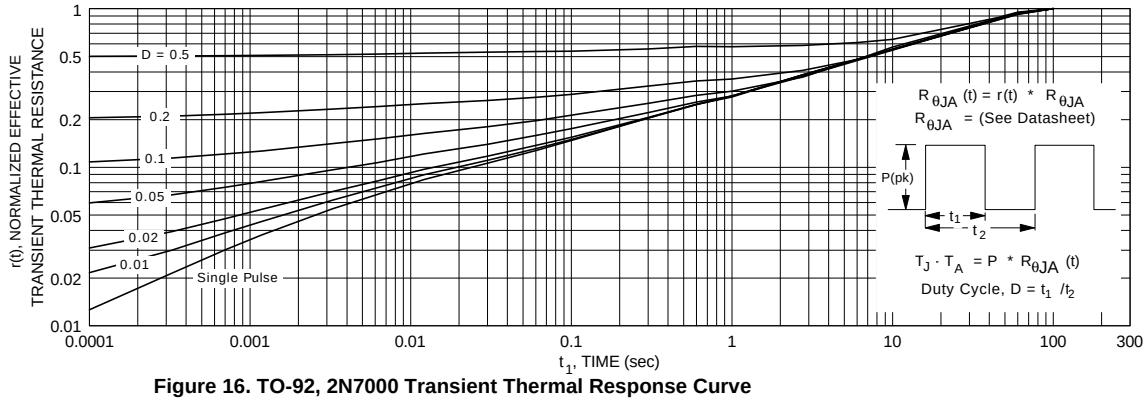


Figure 16. TO-92, 2N7000 Transient Thermal Response Curve

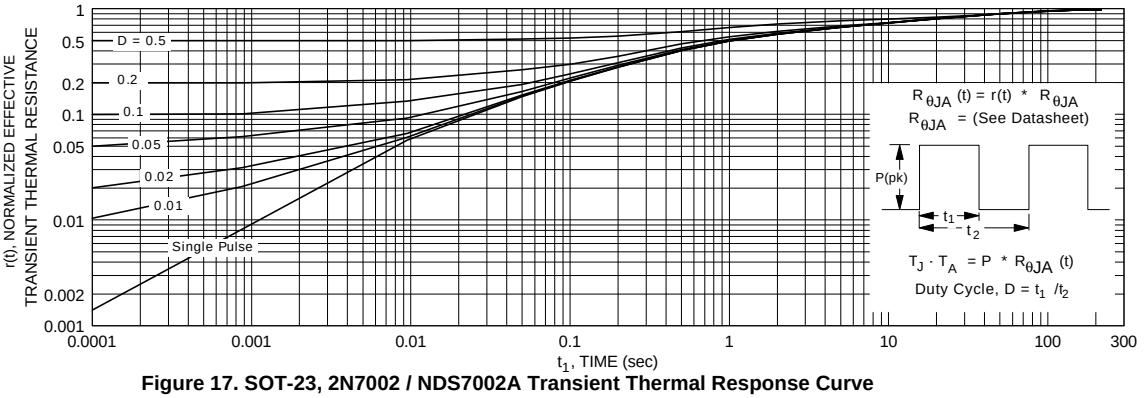


Figure 17. SOT-23, 2N7002 / NDS7002A Transient Thermal Response Curve

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