ON Semiconductor®

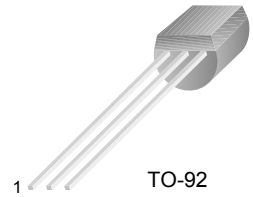
2N7000 / 2N7002 / NDS7002A
N-Channel Enhancement Mode Field Effect Transistor

Features

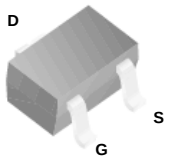
- High Density Cell Design for Low $R_{DS(ON)}$
- Voltage Controlled Small Signal Switch
- Rugged and Reliable
- High Saturation Current Capability

Description

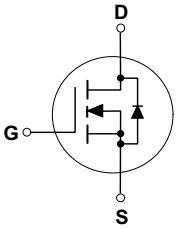
These N-channel enhancement mode field effect transistors are produced using ON Semiconductor's proprietary, high cell density, DMOS technology. These products have been designed to minimize on-state resistance while providing rugged, reliable, and fast switching performance. They can be used in most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



TO-92
1. Source 2. Gate 3. Drain



SOT−23
(TO-236AB)
2N7002/NDS7002A



Ordering Information

Part Number	Marking	Package	Packing Method	Min Order Qty / Immediate Pack Qty
2N7000	2N7000	TO-92 3L	Bulk	10000 / 1000
2N7000-D74Z	2N7000	TO-92 3L	Ammo	2000 / 2000
2N7000-D75Z	2N7000	TO-92 3L	Tape and Reel	2000 / 2000
2N7000-D26Z	2N7000	TO-92 3L	Tape and Reel	2000 / 2000
2N7002	702	SOT-23 3L	Tape and Reel	3000 / 3000
NDS7002A	712	SOT-23 3L	Tape and Reel	3000 / 3000

October-2017, Rev. 3

Publication Order Number:
NDS7002A/D

Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only. Values are at T_C = 25°C unless otherwise noted.

Symbol	Parameter	Value			Unit
		2N7000	2N7002	NDS7002A	
V_{DSS}	Drain-to-Source Voltage	60			V
V_{DGR}	Drain-Gate Voltage (R_{GS} ≤ 1 MΩ)	60			V
V_{GSS}	Gate-Source Voltage - Continuous	±20			V
	Gate-Source Voltage - Non Repetitive (tp < 50 μS)	±40			
I_D	Maximum Drain Current - Continuous	200	115	280	mA
	Maximum Drain Current - Pulsed	500	800	1500	
P_D	Maximum Power Dissipation Derated above 25°C	400	200	300	mW
		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-inch from Case for 10 Seconds	300			°C

Thermal Characteristics

Values are at T_C = 25°C unless otherwise noted**.**

Symbol	Parameter	Value			Unit
		2N7000	2N7002	NDS7002A	
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	312.5	625	417	°C/W

Electrical Characteristics

Values are at T_C = 25°C unless otherwise noted.

Symbol	Parameter	Conditions	Type	Min.	Typ.	Max.	Unit
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
		V_{DS} = 48 V, V_{GS} = 0 V, T_C = 125°C				1	mA
		V_{DS} = 60 V, V_{GS} = 0 V	2N7002 NDS7002A			1	μA
		V_{DS} = 60 V, V_{GS} = 0 V, T_C = 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

Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	Type	Min.	Typ.	Max.	Unit
On Characteristics							
$V_{GS(th)}$	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
		V_{GS} = 10 V, I_D = 500 mA, T_C = 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	
		V_{GS} = 10 V, I_D = 500 mA, T_C = 100°C			1.7	13.5	
		V_{GS} = 5 V, I_D = 50 mA			1.7	7.5	
		V_{GS} = 5 V, I_D = 50 mA, T_C = 100°C			2.4	13.5	
		V_{GS} = 10 V, I_D = 500 mA	NDS7002A		1.2	2	
		V_{GS} = 10 V, I_D = 500 mA, T_C = 125°C			2	3.5	
		V_{GS} = 5 V, I_D = 50 mA			1.7	3	
		V_{GS} = 5 V, I_D = 50 mA, T_C = 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 = 500 mA	2N7002		0.6	3.75	
		V_{GS} = 5.0 V, I_D = 50 mA			0.09	1.5	
		V_{GS} = 10 V, I_D = 500 mA	NDS7002A		0.6	1	
		V_{GS} = 5.0 V, I_D = 50 mA			0.09	0.15	
$I_{D(ON)}$	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
		$V_{DS} \geq 2V_{DS(ON)}$, I_D = 200 mA	2N7002	80	320		
		$V_{DS} \geq 2V_{DS(ON)}$, I_D = 200 mA	NDS7002A	80	320		

Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	Type	Min.	Typ.	Max.	Unit
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	
C_{rss}	Reverse Transfer Capacitance		All		4	5	
t_{on}	Turn-On Time	V_{DD} = 15 V, R_L = 25 Ω, I_D = 500 mA, V_{GS}= 10 V, R_{GEN} = 25 Ω	2N7000			10	ns
		V_{DD} = 30 V, R_L = 150 Ω, I_D = 200 mA, V_{GS}= 10 V, R_{GEN} = 25 Ω	2N7002 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 Ω	2N7000			10	ns
		V_{DD} = 30 V, R_L = 150 Ω, I_D = 200 mA, V_{GS}= 10 V, R_{GEN} = 25 Ω	2N7002 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(1)	2N7002		0.88	1.5	V
		V_{GS} = 0 V, I_S = 400 mA(1)	NDS7002A		0.88	1.2	

Note:

1. Pulse test : Pulse Width ≤ 300 μs, Duty Cycel ≤ 2 %.

Typical Performance Characteristics

2N7000 / 2N7002 / NDS7002A

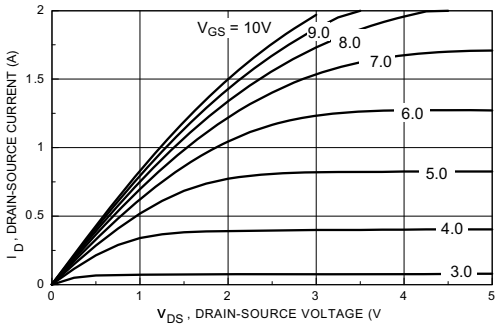


Figure 1. On-Region Characteristics

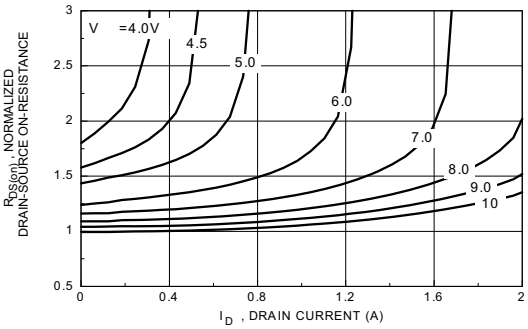


Figure 2. On-Resistance Variation with Gate Voltage and Drain Current

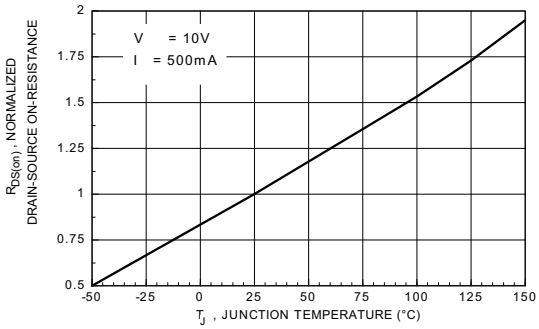


Figure 3. On-Resistance Variation with Temperature

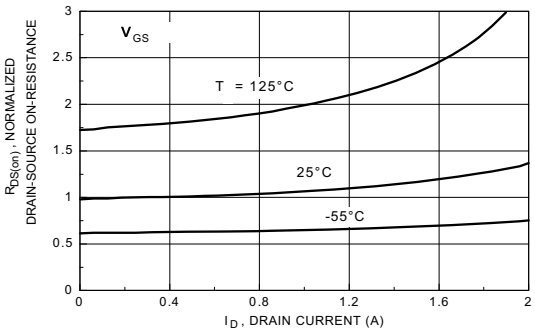


Figure 4. On-Resistance Variation with Drain Current and Temperature

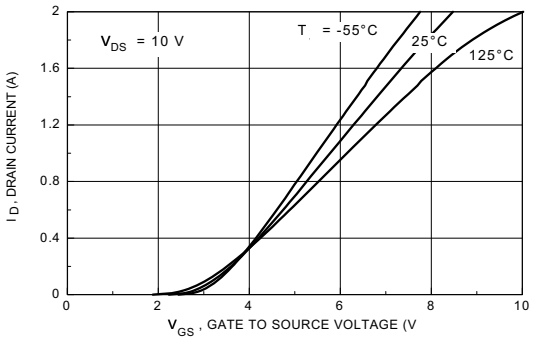


Figure 5. Transfer Characteristics

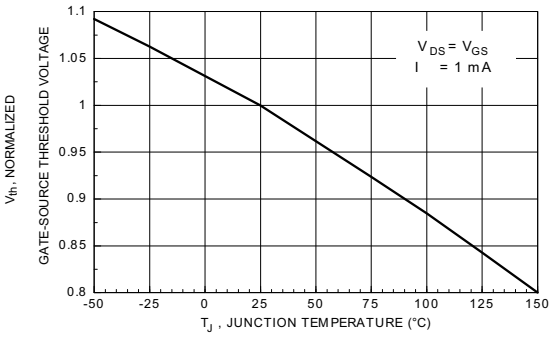


Figure 6. Gate Threshold Variation with Temperature

Typical Performance Characteristics (Continued)

2N7000 / 2N7002 / NDS7002A

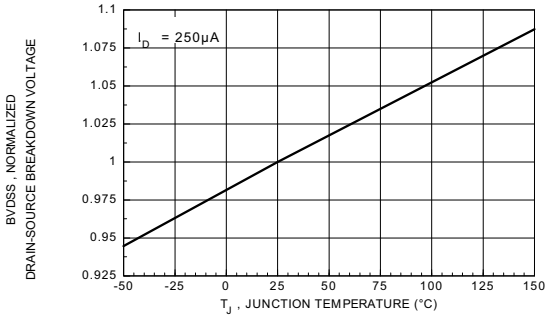


Figure 7. Breakdown Voltage Variation with Temperature

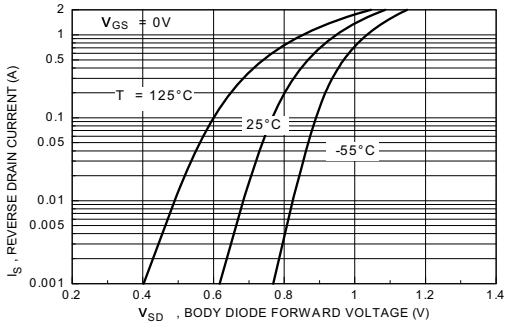


Figure 8. Body Diode Forward Voltage Variation with

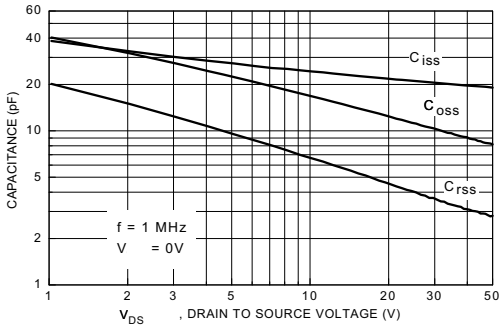


Figure 9. Capacitance Characteristics

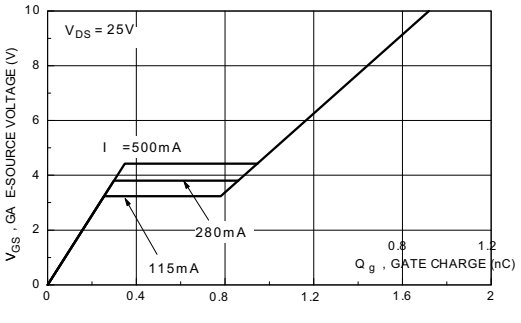


Figure 10. Gate Charge Characteristics

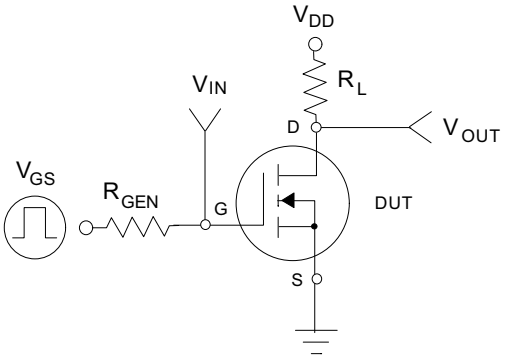


Figure 11. Switching Test Circuit

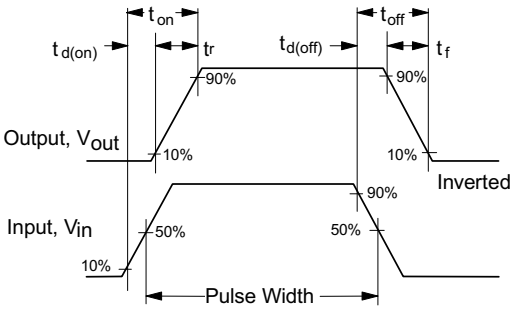


Figure 12. Switching Waveforms

Typical Performance Characteristics (Continued)

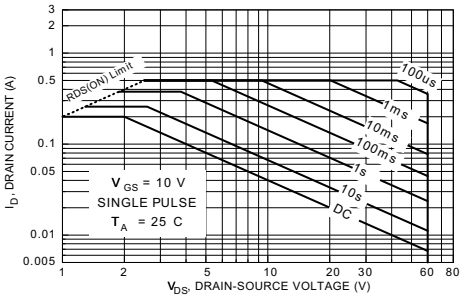


Figure 13. 2N7000 Maximum Safe Operating Area

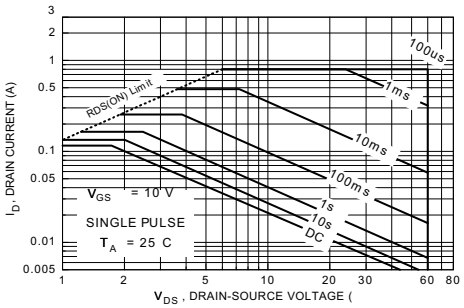


Figure 14. 2N7002 Maximum Safe Operating Area

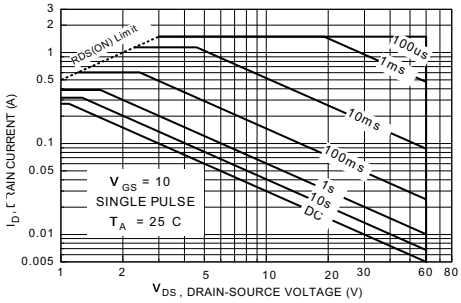


Figure 15. NDS7000A Maximum Safe Operating Area

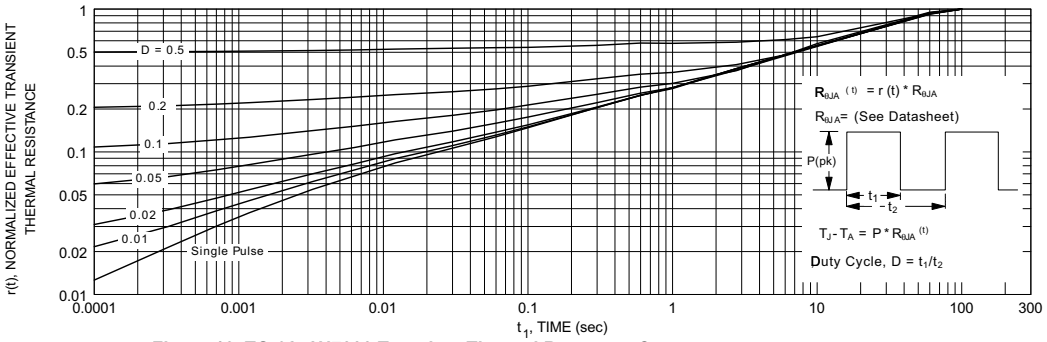


Figure 16. TO-92, 2N7000 Transient Thermal Response Curve

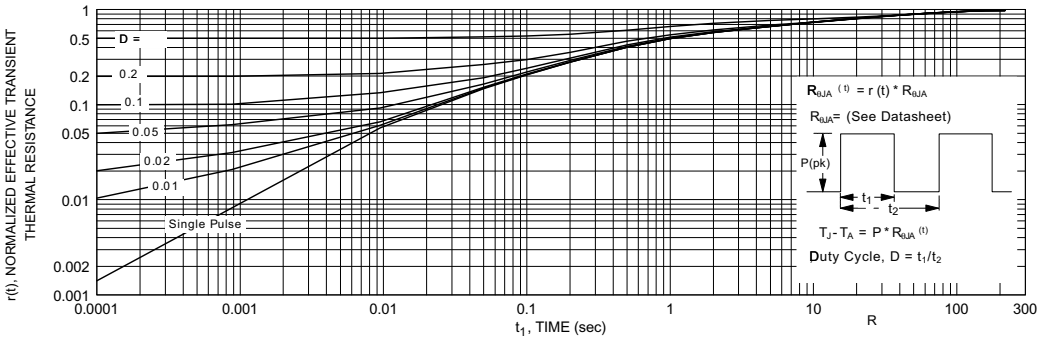


Figure 17. SOT-23, 2N7002 / NDS7002A Transient Thermal Response Curve

PUBLICATION ORDERING INFORMATION

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