# **MOSFET** – Power, Dual, N-Channel Enhancement Mode, SO-8

## 6.0 A, 20 V

## Features

- Ultra Low RDS(on)
- Higher Efficiency Extending Battery Life
- Logic Level Gate Drive
- Miniature Dual SOIC-8 Surface Mount Package
- Diode Exhibits High Speed, Soft Recovery
- Avalanche Energy Specified
- SOIC–8 Mounting Information Provided
- Pb-Free Package is Available

## Applications

- DC–DC Converters
- Low Voltage Motor Control
- Power Management in Portable and Battery–Powered Products, for example, Computers, Printers, Cellular and Cordless Telephones and PCMCIA Cards

## MAXIMUM RATINGS (T<sub>J</sub> = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit		
Drain-to-Source Voltage	V <sub>DSS</sub>	20	V		
Drain-to-Gate Voltage ( $R_{GS}$ = 1.0 M $\Omega$ )	V <sub>DGR</sub>	20	V		
Gate-to-Source Voltage - Continuous	V <sub>GS</sub>	±12	V		
Thermal Resistance, Junction-to-Ambient (Note 1) Total Power Dissipation @ $T_A = 25^{\circ}C$ Continuous Drain Current @ $T_A = 25^{\circ}C$ Continuous Drain Current @ $T_A = 70^{\circ}C$ Pulsed Drain Current (Note 4)	R <sub>θJA</sub> P <sub>D</sub> I <sub>D</sub> I <sub>DM</sub>	62.5 2.0 6.5 5.5 50	°C/W W A A A		
Thermal Resistance, Junction-to-Ambient (Note 2) Total Power Dissipation @ $T_A = 25^{\circ}C$ Continuous Drain Current @ $T_A = 25^{\circ}C$ Continuous Drain Current @ $T_A = 70^{\circ}C$ Pulsed Drain Current (Note 4)	R <sub>0JA</sub> P <sub>D</sub> I <sub>D</sub> I <sub>D</sub>	102 1.22 5.07 4.07 40	°C/W W A A A		
Thermal Resistance Junction-to-Ambient (Note 3) Total Power Dissipation @ $T_A = 25^{\circ}C$ Continuous Drain Current @ $T_A = 25^{\circ}C$ Continuous Drain Current @ $T_A = 70^{\circ}C$ Pulsed Drain Current (Note 4)	R <sub>θJA</sub> P <sub>D</sub> I <sub>D</sub> I <sub>DM</sub>	172 0.73 3.92 3.14 30	°C/W W A A A		

1. Mounted onto a 2 in square FR-4 Board

(1 in sq. 2 oz. Cu 0.06 in thick single sided), t < 10 seconds. 2. Mounted onto a 2 in square FR-4 Board

(1 in sq. 2 oz. Cu 0.06 in thick single sided), t = steady state.

3. Minimum FR-4 or G-10 PCB, t = steady state.

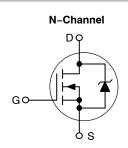
4. Pulse Test: Pulse Width = 10  $\mu$ s, Duty Cycle = 2%.



## **ON Semiconductor®**

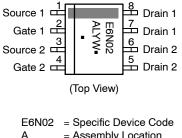
## http://onsemi.com

V <sub>DSS</sub>	R <sub>DS(ON)</sub> TYP	I <sub>D</sub> MAX
20 V	$35~\mathrm{m}\Omega$ @ V <sub>GS</sub> = 4.5 V	6.0 A





### MARKING DIAGRAM & PIN ASSIGNMENT



A	= Assembly Location
Y	= Year
WW	= Work Week
•	= Pb-Free Package
(1)	Mexical and the second

(Note: Microdot may be in either location)

#### ORDERING INFORMATION

Device	Package	Shipping <sup>†</sup>
NTMD6N02R2	SOIC-8	2500/Tape & Reel
NTMD6N02R2G	SOIC-8 (Pb-Free)	2500/Tape & Reel

+For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

## **MAXIMUM RATINGS** (T<sub>J</sub> = $25^{\circ}$ C unless otherwise noted) (continued)

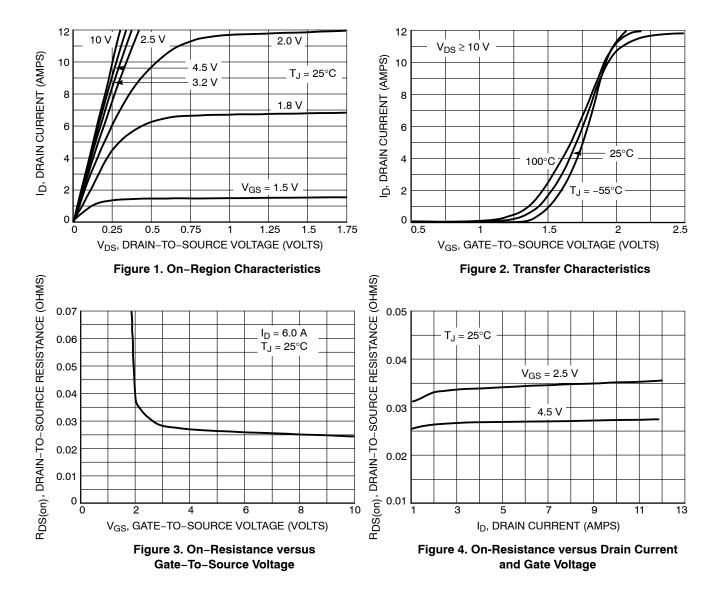
Rating		Symbol	Value		Unit	
Operating and Storage Temperature Range		T <sub>J</sub> , T <sub>stg</sub>	-55 to +150		°C	
Single Pulse Drain-to-Source Avalanche Energy – Starting T <sub>J</sub> = $25^{\circ}$ C (V <sub>DD</sub> = 20 Vdc, V <sub>GS</sub> = 5.0 Vdc, Peak I <sub>L</sub> = 6.0 Apk, L = 20 mH, R <sub>G</sub> = 25 $\Omega$ )		E <sub>AS</sub>		360		mJ
Maximum Lead Temperature for S	oldering Purposes for 10 seconds	TL	260			°C
ELECTRICAL CHARACTERIS	<b>TICS</b> (T <sub>C</sub> = 25°C unless otherwise noted) (No	te 5)				
C	haracteristic	Symbol	Min	Тур	Max	Unit
OFF CHARACTERISTICS						
Drain-to-Source Breakdown Volt (V <sub>GS</sub> = 0 Vdc, I <sub>D</sub> = 250 μAdc) Temperature Coefficient (Positive	•	V <sub>(BR)DSS</sub>	20 -	_ 19.2		Vdc mV/°C
$\label{eq:VDS} \begin{array}{l} \mbox{Zero Gate Voltage Drain Current} \\ (V_{DS} = 20 \mbox{ Vdc}, \mbox{ V}_{GS} = 0 \mbox{ Vdc}, \mbox{ T} \\ (V_{DS} = 20 \mbox{ Vdc}, \mbox{ V}_{GS} = 0 \mbox{ Vdc}, \mbox{ T} \end{array}$		I <sub>DSS</sub>			1.0 10	μAdc
Gate-Body Leakage Current (VG	<sub>S</sub> = +12 Vdc, V <sub>DS</sub> = 0 Vdc)	I <sub>GSS</sub>	-	-	100	nAdc
Gate-Body Leakage Current (V <sub>G</sub>	<sub>S</sub> = –12 Vdc, V <sub>DS</sub> = 0 Vdc)	I <sub>GSS</sub>	-	-	-100	nAdc
ON CHARACTERISTICS		•	1		•	
Gate Threshold Voltage ( $V_{DS} = V_{GS}$ , $I_D = -250 \ \mu Adc$ ) Temperature Coefficient (Negative)			0.6	0.9 -3.0	1.2	Vdc mV/°0
$      Static Drain-to-Source On-State Resistance \\ (V_{GS} = 4.5 Vdc, I_D = 6.0 Adc) \\ (V_{GS} = 4.5 Vdc, I_D = 4.0 Adc) \\ (V_{GS} = 2.7 Vdc, I_D = 2.0 Adc) \\ (V_{GS} = 2.5 Vdc, I_D = 3.0 Adc) \\ (V_{GS} = 2.5 Vdc, I_D = 3.0 Adc) \\            $		R <sub>DS(on)</sub>	- - -	0.028 0.028 0.033 0.035	0.035 0.043 0.048 0.049	Ω
Forward Transconductance ( $V_{DS}$	= 12 Vdc, I <sub>D</sub> = 3.0 Adc)	<b>9</b> FS	_	10	-	Mhos
YNAMIC CHARACTERISTICS						
Input Capacitance		C <sub>iss</sub>	_	785	1100	pF
Output Capacitance	(V <sub>DS</sub> = 16 Vdc, V <sub>GS</sub> = 0 Vdc, f = 1.0 MHz)	C <sub>oss</sub>	-	260	450	1
Reverse Transfer Capacitance	· · · · · · · · · · · · · · · · · · ·	C <sub>rss</sub>	-	75	180	1
WITCHING CHARACTERISTICS	(Notes 6 and 7)		-			
Turn-On Delay Time		t <sub>d(on)</sub>	_	12	20	ns
Rise Time	$(V_{DD} = 16 \text{ Vdc}, I_D = 6.0 \text{ Adc},$	t <sub>r</sub>	-	50	90	1
Turn-Off Delay Time	V <sub>GS</sub> = 4.5 Vdc, R <sub>G</sub> = 6.0 Ω)	t <sub>d(off)</sub>	_	45	75	1
Fall Time		t <sub>f</sub>	-	80	130	1
Turn-On Delay Time		t <sub>d(on)</sub>	-	11	18	ns
Rise Time	$(V_{DD} = 16 \text{ Vdc}, I_D = 4.0 \text{ Adc},$	t <sub>r</sub>	-	35	65	1
Turn-Off Delay Time	V <sub>GS</sub> = 4.5 Vdc, R <sub>G</sub> = 6.0 Ω)	t <sub>d(off)</sub>	-	45	75	
Fall Time	_ ,	t <sub>f</sub>	-	60	110	
Total Gate Charge	(V <sub>DS</sub> = 16 Vdc,	Q <sub>tot</sub>	-	12	20	nC
Gate-Source Charge	$V_{GS} = 4.5 \text{ Vdc},$	Q <sub>gs</sub>	-	1.5	-	
Gate-Drain Charge	I <sub>D</sub> = 6.0 Adc)	Q <sub>gd</sub>	_	4.0	-	1

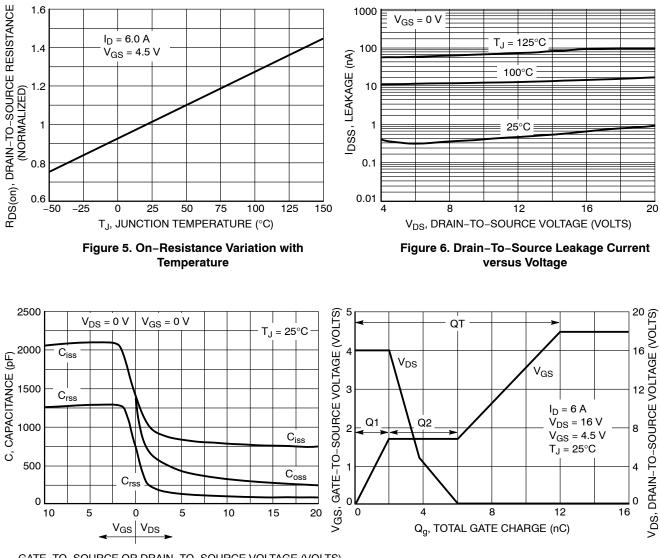
Handling precautions to protect against electrostatic discharge is mandatory
Indicates Pulse Test: Pulse Width = 300 μs max, Duty Cycle = 2%.
Switching characteristics are independent of operating junction temperature.

Characteristic		Symbol	Min	Тур	Max	Unit	
BODY-DRAIN DIODE RATINGS (Note 9)							
Diode Forward On-Voltage		V <sub>SD</sub>		0.83 0.88 0.75	1.1 1.2 -	Vdc	
Reverse Recovery Time		t <sub>rr</sub>	-	30	-	ns	
	(I <sub>S</sub> = 6.0 Adc, V <sub>GS</sub> = 0 Vdc, dI <sub>S</sub> /dt = 100 A/us)	ta	-	15	-		
		t <sub>b</sub>	-	15	-		
Reverse Recovery Stored Charge		Q <sub>RR</sub>	_	0.02	-	μC	

8. Handling precautions to protect against electrostatic discharge is mandatory.

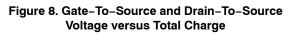
9. Indicates Pulse Test: Pulse Width = 300 µs max, Duty Cycle = 2%.

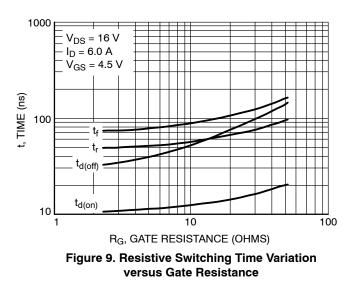




GATE-TO-SOURCE OR DRAIN-TO-SOURCE VOLTAGE (VOLTS)

Figure 7. Capacitance Variation





## DRAIN-TO-SOURCE DIODE CHARACTERISTICS

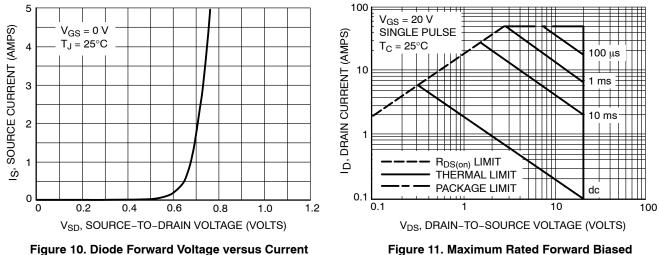
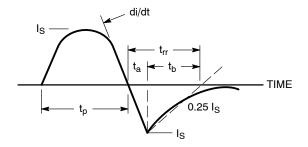


Figure 11. Maximum Rated Forward Biased Safe Operating Area





## TYPICAL ELECTRICAL CHARACTERISTICS

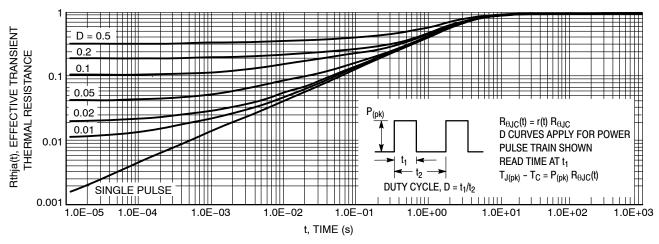


Figure 13. Thermal Response





\*For additional information on our Pb–Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

## STYLES ON PAGE 2

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STYLE 1: PIN 1. EMITTER COLLECTOR 2. COLLECTOR 3. 4. EMITTER EMITTER 5. BASE 6. 7 BASE EMITTER 8. STYLE 5: PIN 1. DRAIN 2. DRAIN 3. DRAIN DRAIN 4. GATE 5. 6. GATE SOURCE 7. 8. SOURCE STYLE 9: PIN 1. EMITTER, COMMON COLLECTOR, DIE #1 COLLECTOR, DIE #2 2. З. EMITTER, COMMON 4. 5. EMITTER, COMMON 6 BASE. DIE #2 BASE, DIE #1 7. 8. EMITTER, COMMON STYLE 13: PIN 1. N.C. 2. SOURCE 3 GATE 4. 5. DRAIN 6. DRAIN DRAIN 7. DRAIN 8. STYLE 17: PIN 1. VCC 2. V2OUT V10UT З. TXE 4. 5. RXE 6. VFF 7. GND 8. ACC STYLE 21: CATHODE 1 PIN 1. 2. CATHODE 2 3 CATHODE 3 CATHODE 4 4. 5. CATHODE 5 6. COMMON ANODE COMMON ANODE 7. 8. CATHODE 6 STYLE 25: PIN 1. VIN 2 N/C REXT З. 4. GND 5. IOUT 6. IOUT IOUT 7. 8. IOUT STYLE 29: BASE, DIE #1 PIN 1. 2 EMITTER, #1 BASE, #2 З. EMITTER, #2 4. 5 COLLECTOR, #2 COLLECTOR, #2 6.

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STYLE 3: PIN 1. DRAIN, DIE #1 DRAIN, #1 2. DRAIN, #2 З. 4. DRAIN, #2 GATE, #2 5. SOURCE, #2 6. 7 GATE #1 8. SOURCE, #1 STYLE 7: PIN 1. INPUT 2. EXTERNAL BYPASS THIRD STAGE SOURCE GROUND З. 4. 5. DRAIN 6. GATE 3 SECOND STAGE Vd 7. FIRST STAGE Vd 8. STYLE 11: PIN 1. SOURCE 1 GATE 1 SOURCE 2 2. 3. GATE 2 4. 5. DRAIN 2 6. DRAIN 2 DRAIN 1 7. 8. DRAIN 1 STYLE 15: PIN 1. ANODE 1 2. ANODE 1 ANODE 1 3 ANODE 1 4. 5. CATHODE, COMMON CATHODE, COMMON CATHODE, COMMON 6. 7. CATHODE, COMMON 8. STYLE 19: PIN 1. SOURCE 1 GATE 1 SOURCE 2 2. 3. GATE 2 4. 5. DRAIN 2 6. MIRROR 2 DRAIN 1 7. 8. **MIRROR 1** STYLE 23: PIN 1. LINE 1 IN COMMON ANODE/GND COMMON ANODE/GND 2. 3 LINE 2 IN 4. LINE 2 OUT 5. COMMON ANODE/GND COMMON ANODE/GND 6. 7. LINE 1 OUT 8. STYLE 27: PIN 1. ILIMIT 2 OVI 0 UVLO З. 4. INPUT+ 5. SOURCE SOURCE 6. SOURCE 7. 8 DRAIN

#### DATE 16 FEB 2011

STYLE 4: ANODE ANODE PIN 1. 2. ANODE З. 4. ANODE ANODE 5. 6. ANODE 7 ANODE COMMON CATHODE 8. STYLE 8: PIN 1. COLLECTOR, DIE #1 2. BASE, #1 BASE #2 3. COLLECTOR, #2 4. COLLECTOR, #2 5. 6. EMITTER, #2 EMITTER, #1 7. 8. COLLECTOR, #1 STYLE 12: PIN 1. SOURCE SOURCE 2. 3. 4. GATE 5. DRAIN 6. DRAIN DRAIN 7. 8. DRAIN STYLE 16: PIN 1. EMITTER, DIE #1 2. BASE, DIE #1 EMITTER, DIE #2 3 BASE, DIE #2 4. 5. COLLECTOR, DIE #2 6. COLLECTOR, DIE #2 COLLECTOR, DIE #1 7. COLLECTOR, DIE #1 8. STYLE 20: PIN 1. SOURCE (N) GATE (N) SOURCE (P) 2. 3. 4. GATE (P) 5. DRAIN 6. DRAIN DRAIN 7. 8. DRAIN STYLE 24: PIN 1. BASE 2. EMITTER 3 COLLECTOR/ANODE COLLECTOR/ANODE 4. 5. CATHODE 6. CATHODE COLLECTOR/ANODE 7. 8. COLLECTOR/ANODE STYLE 28: PIN 1. SW\_TO\_GND 2. DASIC OFF DASIC\_SW\_DET З. 4. GND 5. 6. V MON VBULK 7. VBULK 8 VIN

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SOURCE 1/DRAIN 2

7.

8. GATE 1

7.

8

rights of others

COLLECTOR, #1

COLLECTOR, #1

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