## **Power MOSFET**

## 6 A, 20 V, P-Channel SOIC-8, Dual

#### **Features**

- Ultra Low R<sub>DS(on)</sub>
- 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
- These Devices are Pb-Free and are RoHS Compliant
- NVMD Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable

#### **Applications**

• Power Management in Portable and Battery-Powered Products, i.e.: Cellular and Cordless Telephones, and PCMCIA Cards

#### **MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Drain-to-Source Voltage	V <sub>DSS</sub>	-20	V
Gate-to-Source Voltage - Continuous	$V_{GS}$	±12	V
Thermal Resistance – Junction-to-Ambient (Note 1) Total Power Dissipation @ T <sub>A</sub> = 25°C Continuous Drain Current @ T <sub>A</sub> = 25°C Continuous Drain Current @ T <sub>A</sub> = 70°C Maximum Operating Power Dissipation Maximum Operating Drain Current Pulsed Drain Current (Note 4)	R <sub>θJA</sub> P <sub>D</sub> I <sub>D</sub> I <sub>D</sub> P <sub>D</sub> I <sub>D</sub>	62.5 2.0 -7.8 -5.7 0.5 -3.89 -40	°C/W W A A W A
Thermal Resistance – Junction-to-Ambient (Note 2) Total Power Dissipation @ T <sub>A</sub> = 25°C Continuous Drain Current @ T <sub>A</sub> = 25°C Continuous Drain Current @ T <sub>A</sub> = 70°C Maximum Operating Power Dissipation Maximum Operating Drain Current Pulsed Drain Current (Note 4)	R <sub>θJA</sub> P <sub>D</sub> I <sub>D</sub> I <sub>D</sub> I <sub>DM</sub>	98 1.28 -6.2 -4.6 0.3 -3.01 -35	°C/W W A A W A
Thermal Resistance – Junction-to-Ambient (Note 3) Total Power Dissipation @ T <sub>A</sub> = 25°C Continuous Drain Current @ T <sub>A</sub> = 25°C Continuous Drain Current @ T <sub>A</sub> = 70°C Maximum Operating Power Dissipation Maximum Operating Drain Current Pulsed Drain Current (Note 4)	R <sub>θJA</sub> P <sub>D</sub> I <sub>D</sub> I <sub>D</sub> I <sub>D</sub> I <sub>DM</sub>	166 0.75 -4.8 -3.5 0.2 -2.48 -30	°C/W W A A W A
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 $T_J=25^{\circ}C$ ( $V_{DD}=-20$ Vdc, $V_{GS}=-5.0$ Vdc, Peak $I_L=-5.0$ Apk, $L=40$ mH, $R_G=25$ $\Omega$ )	E <sub>AS</sub>	500	mJ
Maximum Lead Temperature for Soldering Purposes for 10 seconds	T <sub>L</sub>	260	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

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

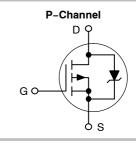
  3. Minimum FR-4 or G-10 PCB, t = steady state.
- 4. Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2%.



### ON Semiconductor®

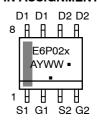
http://onsemi.com

### 6 AMPERES, 20 VOLTS



### **MARKING DIAGRAM & PIN ASSIGNMENT**





E6P02 = Specific Device Code

= Blank or S

= Assembly Location Α

WW

= Work Week

= Pb-Free Package (Note: Microdot may be in either location)

### **ORDERING INFORMATION**

Device	Package	Shipping <sup>†</sup>
NTMD6P02R2G	SOIC-8 (Pb-Free)	2500 / Tape & Reel
NTMD6P02R2SG	SOIC-8 (Pb-Free)	2500 / Tape & Reel
NVMD6P02R2G	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 Specifications Brochure, BRD8011/D

### **ELECTRICAL CHARACTERISTICS** ( $T_C = 25$ °C unless otherwise noted)\*

Characteristic			Min	Тур	Max	Unit
OFF CHARACTERISTICS						
Drain-to-Source Breakdown Voltage		V <sub>(BR)DSS</sub>	00			Vdc
$(V_{GS} = 0 \text{ Vdc}, I_D = -250 \mu\text{Adc})$ Temperature Coefficient (Positive)			-20 -	- -11.6	_	mV/°C
Zero Gate Voltage Drain Current		I <sub>DSS</sub>				μAdc
$(V_{DS} = -20 \text{ Vdc}, V_{GS} = 0 \text{ Vdc}, T_{J} = 25^{\circ}\text{C})$			-	_	-1.0 -5.0	
(V <sub>DS</sub> = -20 Vdc, V <sub>GS</sub> = 0 Vdc, T <sub>J</sub> = 70°C)  Gate-Body Leakage Current		I <sub>GSS</sub>			0.0	nAdc
(V <sub>GS</sub> = -12 Vdc, V <sub>DS</sub> = 0 Vdc)		4.00	-	-	-100	
Gate-Body Leakage Current (V <sub>GS</sub> = +12 Vdc, V <sub>DS</sub> = 0 Vdc)			-	-	100	nAdc
ON CHARACTERISTICS				•		
Gate Threshold Voltage		V <sub>GS(th)</sub>	-0.6 -	-0.88 2.6	-1.20 -	Vdc
$(V_{DS} = V_{GS}, I_{D} = -250 \mu Adc)$ Temperature Coefficient (Negative)						mV/°C
Static Drain-to-Source On-State Resistance						Ω
$(V_{GS} = -4.5 \text{ Vdc}, I_D = -6.2 \text{ Adc})$	33.00	R <sub>DS(on)</sub>	-	0.027	0.033	20
$(V_{GS} = -2.5 \text{ Vdc}, I_D = -5.0 \text{ Adc})$ $(V_{GS} = -2.5 \text{ Vdc}, I_D = -3.1 \text{ Adc})$			_	0.038 0.038	0.050 -	
Forward Transconductance (V <sub>DS</sub> = -10 Vdc, I <sub>D</sub> = -6.2 Adc)			-	15	-	Mhos
DYNAMIC CHARACTERISTICS					l	
Input Capacitance		C <sub>iss</sub>	-	1380	1700	pF
Output Capacitance	(V <sub>DS</sub> = -16 Vdc, V <sub>GS</sub> = 0 Vdc, f = 1.0 MHz)	C <sub>oss</sub>	-	515	775	
Reverse Transfer Capacitance		C <sub>rss</sub>	-	250	450	=
SWITCHING CHARACTERISTICS (N	Notes 5 and 6)					
Turn-On Delay Time		t <sub>d(on)</sub>	-	15	25	ns
Rise Time	$(V_{DD} = -10 \text{ Vdc}, I_{D} = -1.0 \text{ Adc}, V_{GS} = -10 \text{ Vdc},$	t <sub>r</sub>	_	20	50	
Turn-Off Delay Time	$R_{G} = -10 \text{ Vdc},$ $R_{G} = 6.0 \Omega)$	t <sub>d(off)</sub>	-	85	125	
Fall Time		t <sub>f</sub>	_	50	110	
Turn-On Delay Time		t <sub>d(on)</sub>	_	17	-	ns
Rise Time	$(V_{DD} = -16 \text{ Vdc}, I_D = -6.2 \text{ Adc},$	t <sub>r</sub>	-	65	-	
Turn-Off Delay Time	$V_{GS} = -4.5 \text{ Vdc},$ $R_G = 6.0 \Omega)$	t <sub>d(off)</sub>	-	50	-	
Fall Time		t <sub>f</sub>	-	80	-	
Total Gate Charge	0/ 16 \/do	Q <sub>tot</sub>	-	20	35	nC
Gate-Source Charge	$(V_{DS} = -16 \text{ Vdc}, V_{GS} = -4.5 \text{ Vdc},$	Q <sub>gs</sub>	-	4.0	-	1
Gate-Drain Charge	I <sub>D</sub> = -6.2 Adc)	Q <sub>gd</sub>	-	8.0	-	
BODY-DRAIN DIODE RATINGS (No	te 5)					
Diode Forward On-Voltage	$(I_S = -1.7 \text{ Adc}, V_{GS} = 0 \text{ Vdc})$ $(I_S = -1.7 \text{ Adc}, V_{GS} = 0 \text{ Vdc}, T_J = 125^{\circ}\text{C})$	$V_{SD}$	- -	-0.80 -0.65	-1.2 -	Vdc
Diode Forward On–Voltage	$(I_S = -6.2 \text{ Adc}, V_{GS} = 0 \text{ Vdc})$ $(I_S = -6.2 \text{ Adc}, V_{GS} = 0 \text{ Vdc}, T_J = 125^{\circ}\text{C})$	V <sub>SD</sub>	1 -	-0.95 -0.80	- -	Vdc
Reverse Recovery Time	(I <sub>S</sub> = -1.7 Adc, V <sub>GS</sub> = 0 Vdc, dI <sub>S</sub> /dt = 100 A/μs)	t <sub>rr</sub>	-	50	80	ns
		t <sub>a</sub>	_	20	-	
		t <sub>r</sub>	-	30	-	1
Reverse Recovery Stored Charge			-	0.04	_	μС

<sup>5.</sup> Indicates Pulse Test: Pulse Width = 300 μs max, Duty Cycle = 2%.
6. Switching characteristics are independent of operating junction temperature.

<sup>\*</sup>Handling precautions to protect against electrostatic discharge are mandatory.

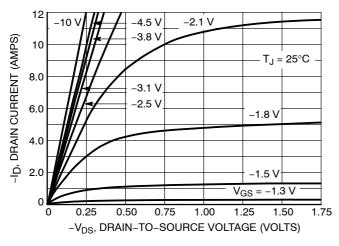


Figure 1. On-Region Characteristics

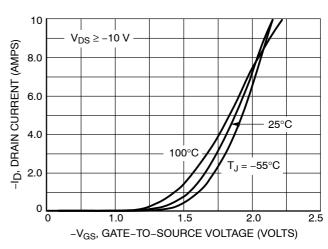


Figure 2. Transfer Characteristics

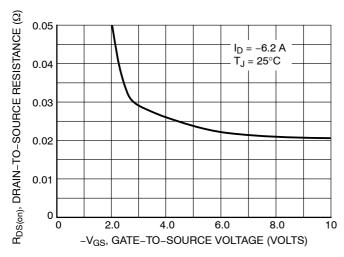


Figure 3. On-Resistance versus Gate-To-Source Voltage

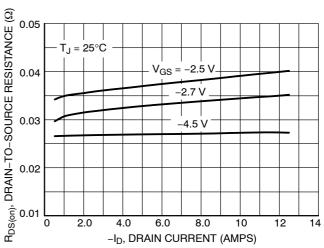


Figure 4. On-Resistance versus Drain Current and Gate Voltage

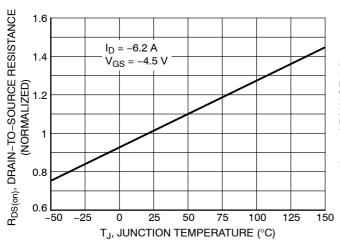


Figure 5. On–Resistance Variation with Temperature

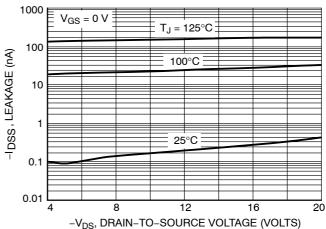
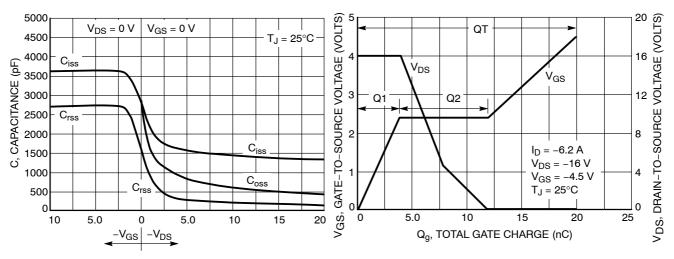


Figure 6. Drain-To-Source Leakage Current versus Voltage



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

Figure 7. Capacitance Variation

Figure 8. Gate-To-Source and Drain-To-Source Voltage versus Total Charge

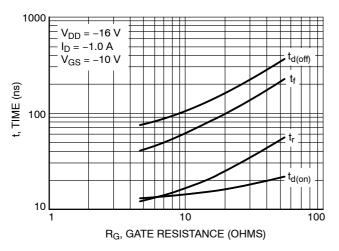


Figure 9. Resistive Switching Time Variation versus Gate Resistance

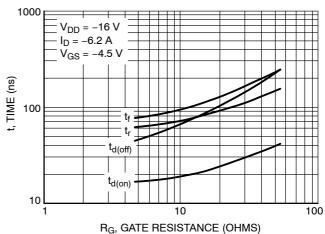


Figure 10. Resistive Switching Time Variation versus Gate Resistance

### **DRAIN-TO-SOURCE DIODE CHARACTERISTICS**

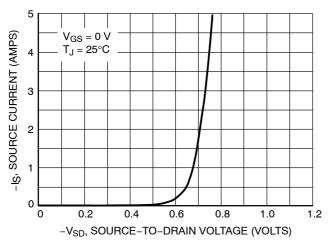


Figure 11. Diode Forward Voltage versus Current

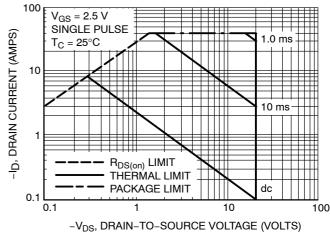


Figure 12. Maximum Rated Forward Biased Safe Operating Area

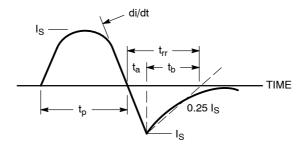


Figure 13. Diode Reverse Recovery Waveform

### TYPICAL ELECTRICAL CHARACTERISTICS

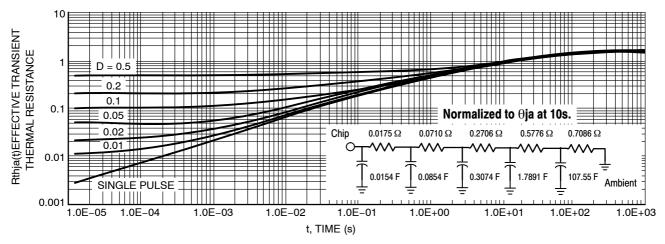
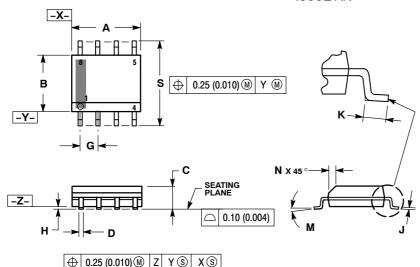


Figure 14. Thermal Response

#### PACKAGE DIMENSIONS

### SOIC-8 NB CASE 751-07 **ISSUE AK**



#### NOTES

- 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- CONTROLLING DIMENSION: MILLIMETER.
  DIMENSION A AND B DO NOT INCLUDE
- 3. MOLD PROTRUSION.
- MAXIMUM MOLD PROTRUSION 0.15 (0.006)
- PEH SIDE.

  DIMENSION D DOES NOT INCLUDE DAMBAR
  PROTRUSION. ALLOWABLE DAMBAR
  PROTRUSION SHALL BE 0.127 (0.005) TOTAL
  IN EXCESS OF THE D DIMENSION AT 5. MAXIMUM MATERIAL CONDITION. 751-01 THRU 751-06 ARE OBSOLETE. NEW
- STANDARD IS 751-07.

	MILLIMETERS		INCHES		
DIM	MIN	MAX	MIN	MAX	
Α	4.80	5.00	0.189	0.197	
В	3.80	4.00	0.150	0.157	
С	1.35	1.75	0.053	0.069	
D	0.33	0.51	0.013	0.020	
G	1.27	7 BSC	0.050 BSC		
Н	0.10	0.25	0.004	0.010	
J	0.19	0.25	0.007	0.010	
K	0.40	1.27	0.016	0.050	
M	0 °	8 °	0 °	8 °	
N	0.25	0.50	0.010	0.020	
S	5.80	6.20	0.228	0.244	

#### STYLE 11:

- SOURCE 1 2 GATE 1
  - 3. SOURCE 2
  - GATE 2 5 DRAIN 2
  - DRAIN 2 6.
  - DRAIN 1
  - DRAIN 1

(mm inches

0.024 0.050 SCALE 6:1 \*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

**SOLDERING FOOTPRINT\*** 

7.0

0.275

0.6

1.52

0.060

4.0

0.155

1.270

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