

# NTMD6N02R2

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

6.0 A, 20 V



ON Semiconductor®

<http://onsemi.com>

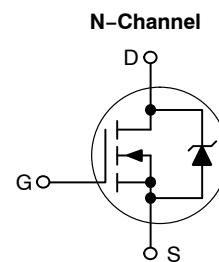
### Features

- Ultra Low  $R_{DS(on)}$
- 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

$V_{DSS}$	$R_{DS(ON)}$ TYP	$I_D$ MAX
20 V	35 m $\Omega$ @ $V_{GS} = 4.5$ V	6.0 A



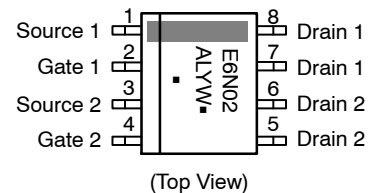
SOIC–8  
CASE 751  
STYLE 11

### MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Drain–to–Source Voltage	$V_{DSS}$	20	V
Drain–to–Gate Voltage ( $R_{GS} = 1.0$ M $\Omega$ )	$V_{DGR}$	20	V
Gate–to–Source Voltage – Continuous	$V_{GS}$	$\pm 12$	V
Thermal Resistance, Junction–to–Ambient (Note 1)	$R_{\theta JA}$	62.5	$^\circ\text{C/W}$
Total Power Dissipation @ $T_A = 25^\circ\text{C}$	$P_D$	2.0	W
Continuous Drain Current @ $T_A = 25^\circ\text{C}$	$I_D$	6.5	A
Continuous Drain Current @ $T_A = 70^\circ\text{C}$	$I_D$	5.5	A
Pulsed Drain Current (Note 4)	$I_{DM}$	50	A
Thermal Resistance, Junction–to–Ambient (Note 2)	$R_{\theta JA}$	102	$^\circ\text{C/W}$
Total Power Dissipation @ $T_A = 25^\circ\text{C}$	$P_D$	1.22	W
Continuous Drain Current @ $T_A = 25^\circ\text{C}$	$I_D$	5.07	A
Continuous Drain Current @ $T_A = 70^\circ\text{C}$	$I_D$	4.07	A
Pulsed Drain Current (Note 4)	$I_{DM}$	40	A
Thermal Resistance Junction–to–Ambient (Note 3)	$R_{\theta JA}$	172	$^\circ\text{C/W}$
Total Power Dissipation @ $T_A = 25^\circ\text{C}$	$P_D$	0.73	W
Continuous Drain Current @ $T_A = 25^\circ\text{C}$	$I_D$	3.92	A
Continuous Drain Current @ $T_A = 70^\circ\text{C}$	$I_D$	3.14	A
Pulsed Drain Current (Note 4)	$I_{DM}$	30	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  $\mu\text{s}$ , Duty Cycle = 2%.

### MARKING DIAGRAM & PIN ASSIGNMENT



E6N02 = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
■ = Pb–Free Package  
(Note: Microdot may be in either location)

### ORDERING INFORMATION

Device	Package	Shipping†
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.

# NTMD6N02R2

## MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ unless otherwise noted) (continued)

Rating	Symbol	Value	Unit
Operating and Storage Temperature Range	$T_J, T_{stg}$	-55 to +150	$^\circ\text{C}$
Single Pulse Drain-to-Source Avalanche Energy – Starting $T_J = 25^\circ\text{C}$ ( $V_{DD} = 20\text{ Vdc}$ , $V_{GS} = 5.0\text{ Vdc}$ , Peak $I_L = 6.0\text{ Apk}$ , $L = 20\text{ mH}$ , $R_G = 25\ \Omega$ )	$E_{AS}$	360	mJ
Maximum Lead Temperature for Soldering Purposes for 10 seconds	$T_L$	260	$^\circ\text{C}$

## ELECTRICAL CHARACTERISTICS ( $T_C = 25^\circ\text{C}$ unless otherwise noted) (Note 5)

Characteristic	Symbol	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS

Drain-to-Source Breakdown Voltage ( $V_{GS} = 0\text{ Vdc}$ , $I_D = 250\ \mu\text{Adc}$ ) Temperature Coefficient (Positive)	$V_{(BR)DSS}$	20 –	– 19.2	– –	Vdc mV/ $^\circ\text{C}$
Zero Gate Voltage Drain Current ( $V_{DS} = 20\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ , $T_J = 25^\circ\text{C}$ ) ( $V_{DS} = 20\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ , $T_J = 125^\circ\text{C}$ )	$I_{DSS}$	– –	– –	1.0 10	$\mu\text{Adc}$
Gate-Body Leakage Current ( $V_{GS} = +12\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSS}$	–	–	100	nAdc
Gate-Body Leakage Current ( $V_{GS} = -12\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSS}$	–	–	-100	nAdc

### ON CHARACTERISTICS

Gate Threshold Voltage ( $V_{DS} = V_{GS}$ , $I_D = -250\ \mu\text{Adc}$ ) Temperature Coefficient (Negative)	$V_{GS(th)}$	0.6 –	0.9 -3.0	1.2 –	Vdc mV/ $^\circ\text{C}$
Static Drain-to-Source On-State Resistance ( $V_{GS} = 4.5\text{ Vdc}$ , $I_D = 6.0\text{ Adc}$ ) ( $V_{GS} = 4.5\text{ Vdc}$ , $I_D = 4.0\text{ Adc}$ ) ( $V_{GS} = 2.7\text{ Vdc}$ , $I_D = 2.0\text{ Adc}$ ) ( $V_{GS} = 2.5\text{ Vdc}$ , $I_D = 3.0\text{ Adc}$ )	$R_{DS(on)}$	– – – –	0.028 0.028 0.033 0.035	0.035 0.043 0.048 0.049	$\Omega$
Forward Transconductance ( $V_{DS} = 12\text{ Vdc}$ , $I_D = 3.0\text{ Adc}$ )	$g_{FS}$	–	10	–	Mhos

### DYNAMIC CHARACTERISTICS

Input Capacitance	$(V_{DS} = 16\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ , $f = 1.0\text{ MHz}$ )	$C_{iss}$	–	785	1100	pF
Output Capacitance		$C_{oss}$	–	260	450	
Reverse Transfer Capacitance		$C_{rss}$	–	75	180	

### SWITCHING CHARACTERISTICS (Notes 6 and 7)

Turn-On Delay Time	$(V_{DD} = 16\text{ Vdc}$ , $I_D = 6.0\text{ Adc}$ , $V_{GS} = 4.5\text{ Vdc}$ , $R_G = 6.0\ \Omega$ )	$t_{d(on)}$	–	12	20	ns
Rise Time		$t_r$	–	50	90	
Turn-Off Delay Time		$t_{d(off)}$	–	45	75	
Fall Time		$t_f$	–	80	130	
Turn-On Delay Time	$(V_{DD} = 16\text{ Vdc}$ , $I_D = 4.0\text{ Adc}$ , $V_{GS} = 4.5\text{ Vdc}$ , $R_G = 6.0\ \Omega$ )	$t_{d(on)}$	–	11	18	ns
Rise Time		$t_r$	–	35	65	
Turn-Off Delay Time		$t_{d(off)}$	–	45	75	
Fall Time		$t_f$	–	60	110	
Total Gate Charge	$(V_{DS} = 16\text{ Vdc}$ , $V_{GS} = 4.5\text{ Vdc}$ , $I_D = 6.0\text{ Adc}$ )	$Q_{tot}$	–	12	20	nC
Gate-Source Charge		$Q_{gs}$	–	1.5	–	
Gate-Drain Charge		$Q_{gd}$	–	4.0	–	

5. Handling precautions to protect against electrostatic discharge is mandatory

6. Indicates Pulse Test: Pulse Width = 300  $\mu\text{s}$  max, Duty Cycle = 2%.

7. Switching characteristics are independent of operating junction temperature.

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## ELECTRICAL CHARACTERISTICS ( $T_C = 25^\circ\text{C}$ unless otherwise noted) (continued) (Note 8)

Characteristic	Symbol	Min	Typ	Max	Unit	
<b>BODY-DRAIN DIODE RATINGS (Note 9)</b>						
Diode Forward On-Voltage	$V_{SD}$	-	$(I_S = 4.0 \text{ Adc}, V_{GS} = 0 \text{ Vdc})$	0.83	Vdc	
			$(I_S = 6.0 \text{ Adc}, V_{GS} = 0 \text{ Vdc})$	0.88		
			$(I_S = 6.0 \text{ Adc}, V_{GS} = 0 \text{ Vdc}, T_J = 125^\circ\text{C})$	0.75		
Reverse Recovery Time	$t_{rr}$	-	$(I_S = 6.0 \text{ Adc}, V_{GS} = 0 \text{ Vdc}, dI_S/dt = 100 \text{ A}/\mu\text{s})$	30	ns	
				$t_a$		15
				$t_b$		15
Reverse Recovery Stored Charge	$Q_{RR}$	-	0.02	-	$\mu\text{C}$	

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

9. Indicates Pulse Test: Pulse Width = 300  $\mu\text{s}$  max, Duty Cycle = 2%.

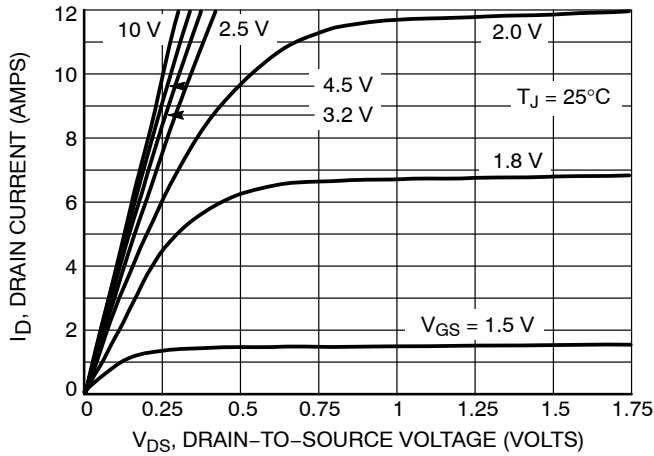


Figure 1. On-Region Characteristics

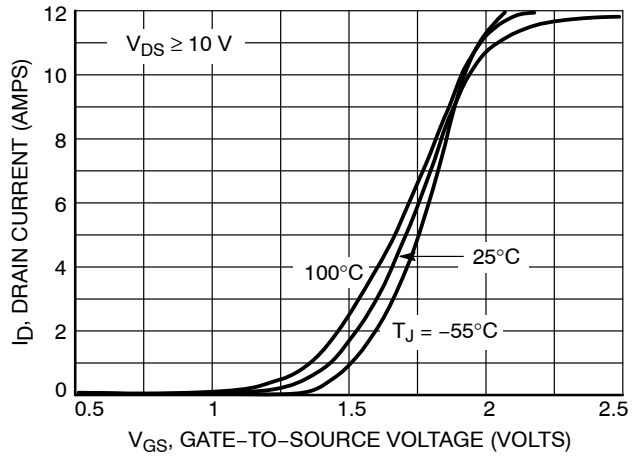


Figure 2. Transfer Characteristics

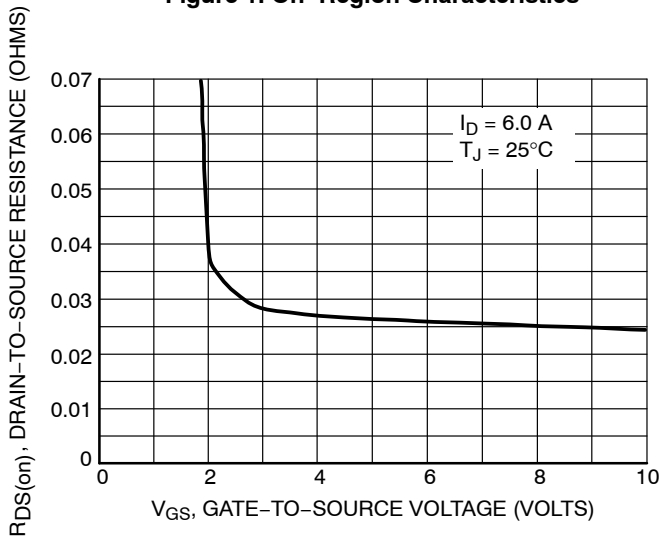


Figure 3. On-Resistance versus Gate-to-Source Voltage

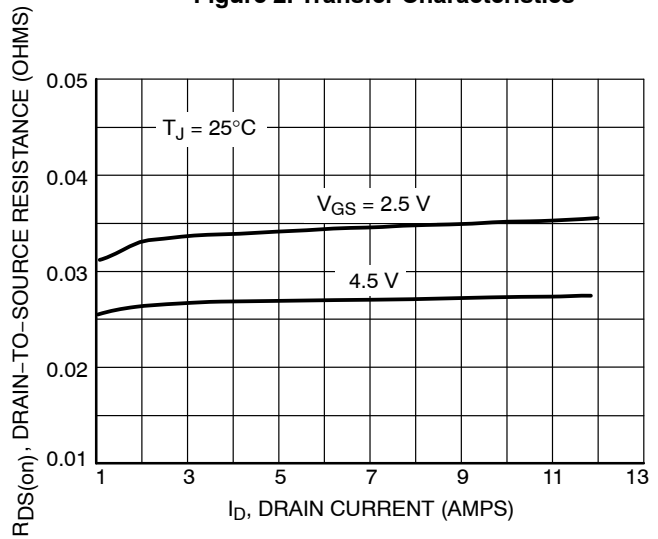
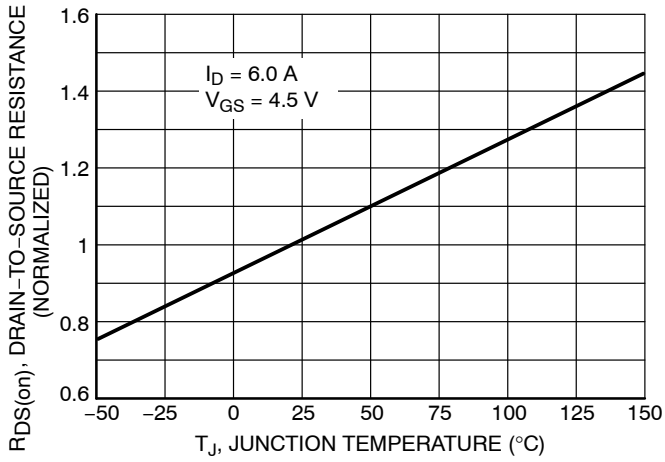
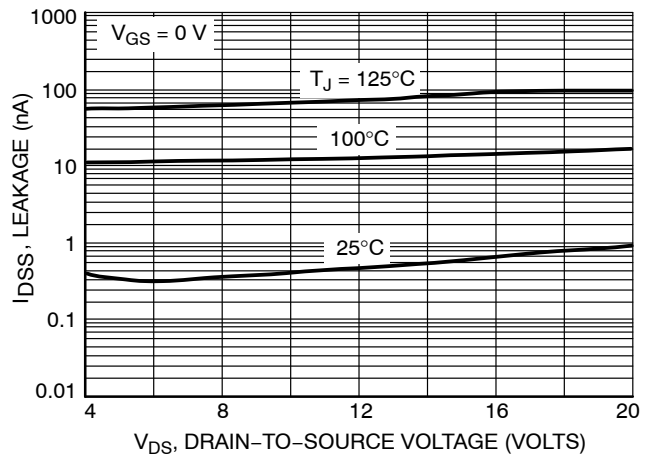


Figure 4. On-Resistance versus Drain Current and Gate Voltage

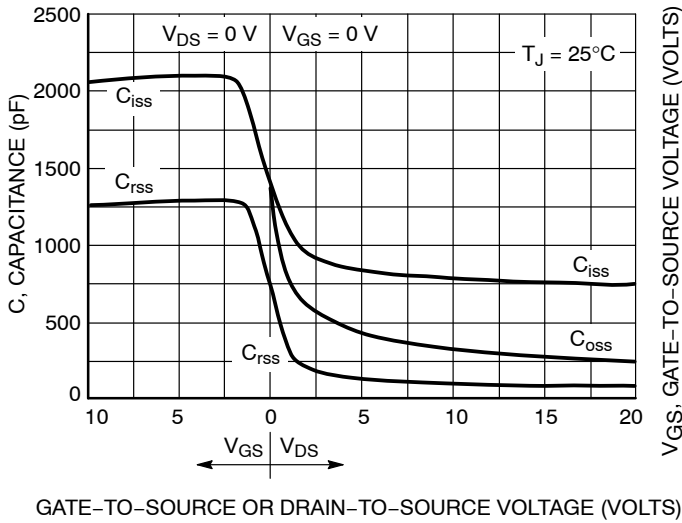
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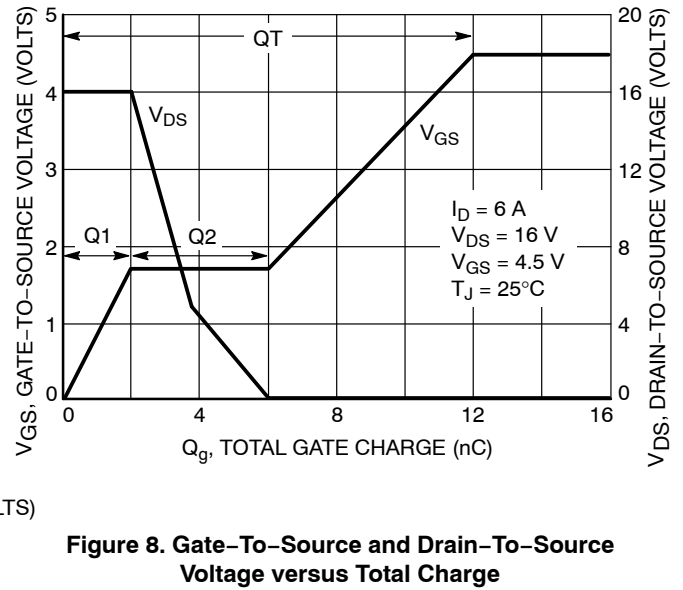
**Figure 5. On-Resistance Variation with Temperature**



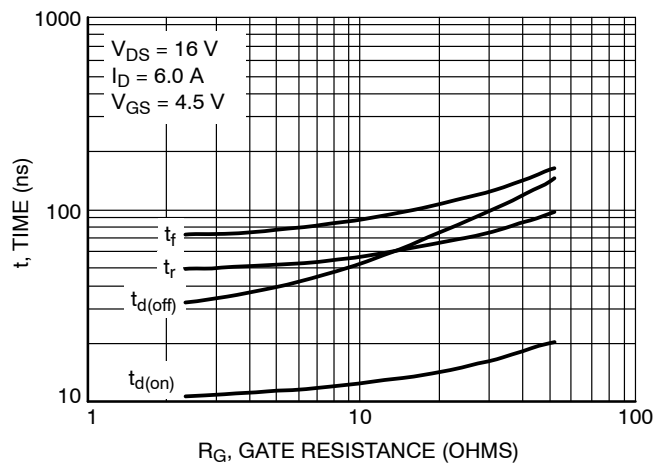
**Figure 6. Drain-To-Source Leakage Current versus Voltage**



**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**

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## DRAIN-TO-SOURCE DIODE CHARACTERISTICS

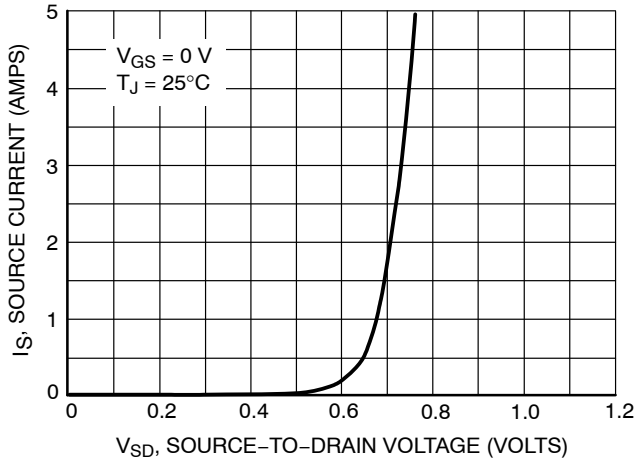


Figure 10. Diode Forward Voltage versus Current

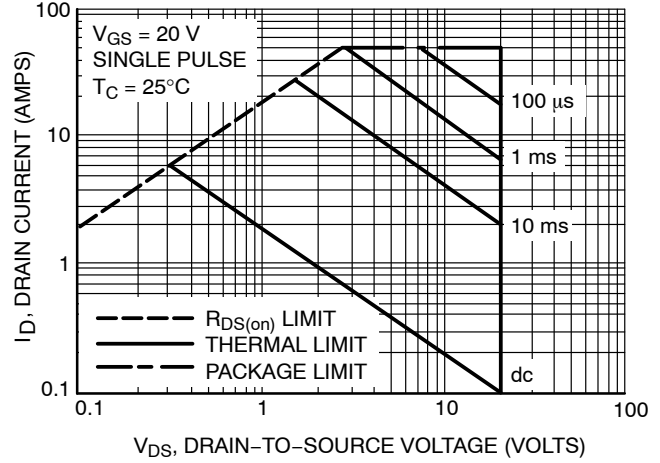


Figure 11. Maximum Rated Forward Biased Safe Operating Area

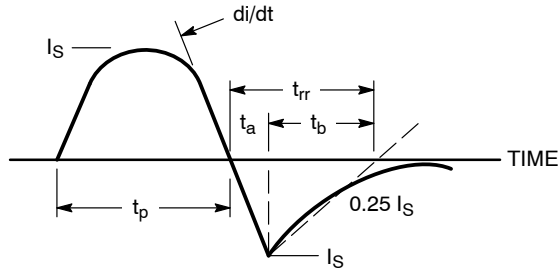


Figure 12. Diode Reverse Recovery Waveform

## TYPICAL ELECTRICAL CHARACTERISTICS

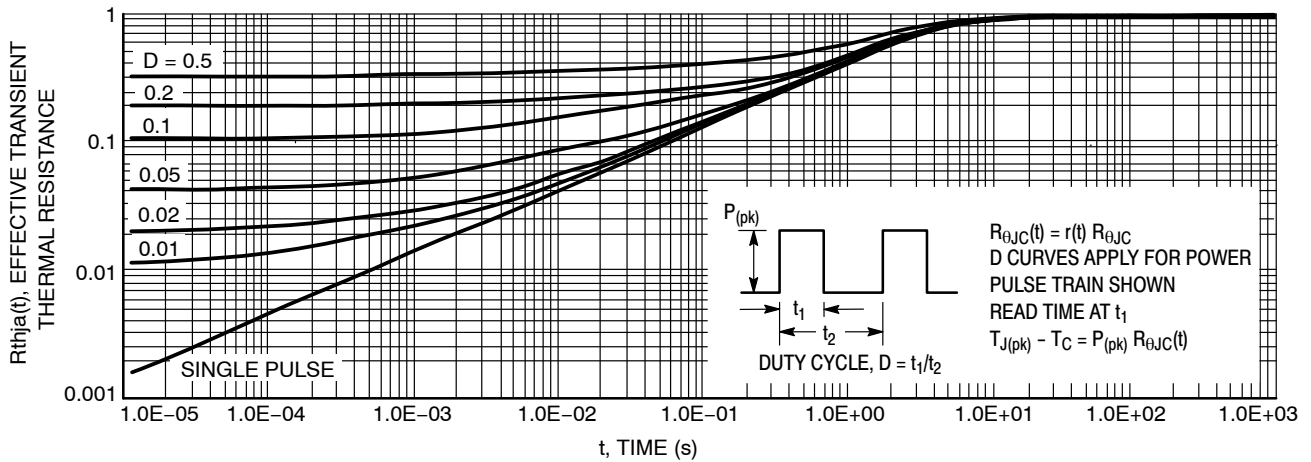
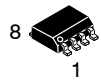


Figure 13. Thermal Response

# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SCALE 1:1

SOIC-8 NB  
CASE 751-07  
ISSUE AK

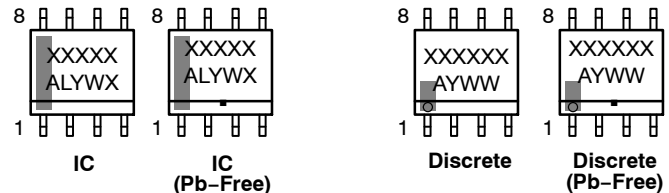
DATE 16 FEB 2011



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: MILLIMETER.
  3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
  5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
  6. 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	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

## GENERIC MARKING DIAGRAM\*



XXXXXX = Specific Device Code  
 A = Assembly Location  
 L = Wafer Lot  
 Y = Year  
 W = Work Week  
 ■ = Pb-Free Package

XXXXXX = Specific Device Code  
 A = Assembly Location  
 Y = Year  
 WW = Work Week  
 ■ = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "•", may or may not be present. Some products may not follow the Generic Marking.

\*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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DESCRIPTION:	SOIC-8 NB	PAGE 1 OF 2

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

DATE 16 FEB 2011

- |   |  |  |  |
|---|--|--|--|
| <p>STYLE 1:<br/>         PIN 1. EMITTER<br/>         2. COLLECTOR<br/>         3. COLLECTOR<br/>         4. EMITTER<br/>         5. EMITTER<br/>         6. BASE<br/>         7. BASE<br/>         8. EMITTER</p>   | <p>STYLE 2:<br/>         PIN 1. COLLECTOR, DIE, #1<br/>         2. COLLECTOR, #1<br/>         3. COLLECTOR, #2<br/>         4. COLLECTOR, #2<br/>         5. BASE, #2<br/>         6. EMITTER, #2<br/>         7. BASE, #1<br/>         8. EMITTER, #1</p>               | <p>STYLE 3:<br/>         PIN 1. DRAIN, DIE #1<br/>         2. DRAIN, #1<br/>         3. DRAIN, #2<br/>         4. DRAIN, #2<br/>         5. GATE, #2<br/>         6. SOURCE, #2<br/>         7. GATE, #1<br/>         8. SOURCE, #1</p>                            | <p>STYLE 4:<br/>         PIN 1. ANODE<br/>         2. ANODE<br/>         3. ANODE<br/>         4. ANODE<br/>         5. ANODE<br/>         6. ANODE<br/>         7. ANODE<br/>         8. COMMON CATHODE</p>   |
| <p>STYLE 5:<br/>         PIN 1. DRAIN<br/>         2. DRAIN<br/>         3. DRAIN<br/>         4. DRAIN<br/>         5. GATE<br/>         6. GATE<br/>         7. SOURCE<br/>         8. SOURCE</p>   | <p>STYLE 6:<br/>         PIN 1. SOURCE<br/>         2. DRAIN<br/>         3. DRAIN<br/>         4. SOURCE<br/>         5. SOURCE<br/>         6. GATE<br/>         7. GATE<br/>         8. SOURCE</p>  | <p>STYLE 7:<br/>         PIN 1. INPUT<br/>         2. EXTERNAL BYPASS<br/>         3. THIRD STAGE SOURCE<br/>         4. GROUND<br/>         5. DRAIN<br/>         6. GATE 3<br/>         7. SECOND STAGE Vd<br/>         8. FIRST STAGE Vd</p>                    | <p>STYLE 8:<br/>         PIN 1. COLLECTOR, DIE #1<br/>         2. BASE, #1<br/>         3. BASE, #2<br/>         4. COLLECTOR, #2<br/>         5. COLLECTOR, #2<br/>         6. EMITTER, #2<br/>         7. EMITTER, #1<br/>         8. COLLECTOR, #1</p>                              |
| <p>STYLE 9:<br/>         PIN 1. EMITTER, COMMON<br/>         2. COLLECTOR, DIE #1<br/>         3. COLLECTOR, DIE #2<br/>         4. EMITTER, COMMON<br/>         5. EMITTER, COMMON<br/>         6. BASE, DIE #2<br/>         7. BASE, DIE #1<br/>         8. EMITTER, COMMON</p> | <p>STYLE 10:<br/>         PIN 1. GROUND<br/>         2. BIAS 1<br/>         3. OUTPUT<br/>         4. GROUND<br/>         5. GROUND<br/>         6. BIAS 2<br/>         7. INPUT<br/>         8. GROUND</p>  | <p>STYLE 11:<br/>         PIN 1. SOURCE 1<br/>         2. GATE 1<br/>         3. SOURCE 2<br/>         4. GATE 2<br/>         5. DRAIN 2<br/>         6. DRAIN 2<br/>         7. DRAIN 1<br/>         8. DRAIN 1</p>   | <p>STYLE 12:<br/>         PIN 1. SOURCE<br/>         2. SOURCE<br/>         3. SOURCE<br/>         4. GATE<br/>         5. DRAIN<br/>         6. DRAIN<br/>         7. DRAIN<br/>         8. DRAIN</p>   |
| <p>STYLE 13:<br/>         PIN 1. N.C.<br/>         2. SOURCE<br/>         3. SOURCE<br/>         4. GATE<br/>         5. DRAIN<br/>         6. DRAIN<br/>         7. DRAIN<br/>         8. DRAIN</p>  | <p>STYLE 14:<br/>         PIN 1. N-SOURCE<br/>         2. N-GATE<br/>         3. P-SOURCE<br/>         4. P-GATE<br/>         5. P-DRAIN<br/>         6. P-DRAIN<br/>         7. N-DRAIN<br/>         8. N-DRAIN</p>   | <p>STYLE 15:<br/>         PIN 1. ANODE 1<br/>         2. ANODE 1<br/>         3. ANODE 1<br/>         4. ANODE 1<br/>         5. CATHODE, COMMON<br/>         6. CATHODE, COMMON<br/>         7. CATHODE, COMMON<br/>         8. CATHODE, COMMON</p>               | <p>STYLE 16:<br/>         PIN 1. EMITTER, DIE #1<br/>         2. BASE, DIE #1<br/>         3. EMITTER, DIE #2<br/>         4. BASE, DIE #2<br/>         5. COLLECTOR, DIE #2<br/>         6. COLLECTOR, DIE #2<br/>         7. COLLECTOR, DIE #1<br/>         8. COLLECTOR, DIE #1</p> |
| <p>STYLE 17:<br/>         PIN 1. VCC<br/>         2. V2OUT<br/>         3. V1OUT<br/>         4. TXE<br/>         5. RXE<br/>         6. VEE<br/>         7. GND<br/>         8. ACC</p>  | <p>STYLE 18:<br/>         PIN 1. ANODE<br/>         2. ANODE<br/>         3. SOURCE<br/>         4. GATE<br/>         5. DRAIN<br/>         6. DRAIN<br/>         7. CATHODE<br/>         8. CATHODE</p>   | <p>STYLE 19:<br/>         PIN 1. SOURCE 1<br/>         2. GATE 1<br/>         3. SOURCE 2<br/>         4. GATE 2<br/>         5. DRAIN 2<br/>         6. MIRROR 2<br/>         7. DRAIN 1<br/>         8. MIRROR 1</p>   | <p>STYLE 20:<br/>         PIN 1. SOURCE (N)<br/>         2. GATE (N)<br/>         3. SOURCE (P)<br/>         4. GATE (P)<br/>         5. DRAIN<br/>         6. DRAIN<br/>         7. DRAIN<br/>         8. DRAIN</p>   |
| <p>STYLE 21:<br/>         PIN 1. CATHODE 1<br/>         2. CATHODE 2<br/>         3. CATHODE 3<br/>         4. CATHODE 4<br/>         5. CATHODE 5<br/>         6. COMMON ANODE<br/>         7. COMMON ANODE<br/>         8. CATHODE 6</p>  | <p>STYLE 22:<br/>         PIN 1. I/O LINE 1<br/>         2. COMMON CATHODE/VCC<br/>         3. COMMON CATHODE/VCC<br/>         4. I/O LINE 3<br/>         5. COMMON ANODE/GND<br/>         6. I/O LINE 4<br/>         7. I/O LINE 5<br/>         8. COMMON ANODE/GND</p> | <p>STYLE 23:<br/>         PIN 1. LINE 1 IN<br/>         2. COMMON ANODE/GND<br/>         3. COMMON ANODE/GND<br/>         4. LINE 2 IN<br/>         5. LINE 2 OUT<br/>         6. COMMON ANODE/GND<br/>         7. COMMON ANODE/GND<br/>         8. LINE 1 OUT</p> | <p>STYLE 24:<br/>         PIN 1. BASE<br/>         2. EMITTER<br/>         3. COLLECTOR/ANODE<br/>         4. COLLECTOR/ANODE<br/>         5. CATHODE<br/>         6. CATHODE<br/>         7. COLLECTOR/ANODE<br/>         8. COLLECTOR/ANODE</p>                                      |
| <p>STYLE 25:<br/>         PIN 1. VIN<br/>         2. N/C<br/>         3. REXT<br/>         4. GND<br/>         5. IOUT<br/>         6. IOUT<br/>         7. IOUT<br/>         8. IOUT</p>   | <p>STYLE 26:<br/>         PIN 1. GND<br/>         2. dv/dt<br/>         3. ENABLE<br/>         4. ILIMIT<br/>         5. SOURCE<br/>         6. SOURCE<br/>         7. SOURCE<br/>         8. VCC</p>  | <p>STYLE 27:<br/>         PIN 1. ILIMIT<br/>         2. OVLO<br/>         3. UVLO<br/>         4. INPUT+<br/>         5. SOURCE<br/>         6. SOURCE<br/>         7. SOURCE<br/>         8. DRAIN</p>  | <p>STYLE 28:<br/>         PIN 1. SW_TO_GND<br/>         2. DASIC_OFF<br/>         3. DASIC_SW_DET<br/>         4. GND<br/>         5. V_MON<br/>         6. VBULK<br/>         7. VBULK<br/>         8. VIN</p>  |
| <p>STYLE 29:<br/>         PIN 1. BASE, DIE #1<br/>         2. EMITTER, #1<br/>         3. BASE, #2<br/>         4. EMITTER, #2<br/>         5. COLLECTOR, #2<br/>         6. COLLECTOR, #2<br/>         7. COLLECTOR, #1<br/>         8. COLLECTOR, #1</p>                        | <p>STYLE 30:<br/>         PIN 1. DRAIN 1<br/>         2. DRAIN 1<br/>         3. GATE 2<br/>         4. SOURCE 2<br/>         5. SOURCE 1/DRAIN 2<br/>         6. SOURCE 1/DRAIN 2<br/>         7. SOURCE 1/DRAIN 2<br/>         8. GATE 1</p>                           |  |  |

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