

# High Current LED Driver

## NUD4001, NSVD4001

This device is designed to replace discrete solutions for driving LEDs in low voltage AC-DC applications 5.0 V, 12 V or 24 V. An external resistor allows the circuit designer to set the drive current for different LED arrays. This discrete integration technology eliminates individual components by combining them into a single package, which results in a significant reduction of both system cost and board space. The device is a small surface mount package (SO-8).

### Features

- Supplies Constant LED Current for Varying Input Voltages
- External Resistor Allows Designer to Set Current – up to 500 mA
- Offered in Surface Mount Package Technology (SO-8)
- NSV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable
- Pb-Free Package is Available

### Benefits

- Maintains a Constant Light Output During Battery Drain
- One Device can be used for Many Different LED Products
- Reduces Board Space and Component Count
- Simplifies Circuit and System Designs

### Typical Applications

- Portables: For Battery Back-up Applications, also Simple Ni-CAD Battery Charging
- Industrial: Low Voltage Lighting Applications and Small Appliances
- Automotive: Tail Lights, Directional Lights, Back-up Light, Dome Light

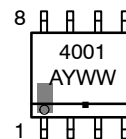
### PIN FUNCTION DESCRIPTION

Pin	Symbol	Description
1	$V_{in}$	Positive input voltage to the device
2	Boost	This pin may be used to drive an external transistor as described in the App Note <a href="#">AND8198/D</a> .
3	$R_{ext}$	An external resistor between $R_{ext}$ and $V_{in}$ pins sets different current levels for different application needs
4	GND	Ground
5, 6, 7, 8	$I_{out}$	The LEDs are connected from these pins to ground



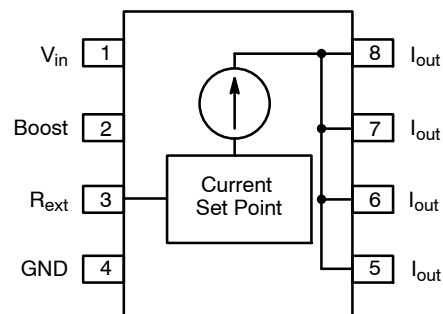
SO-8  
CASE 751  
STYLE 25

### MARKING DIAGRAM



4001 = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
▪ = Pb-Free Device

### PIN CONFIGURATION AND SCHEMATIC



### ORDERING INFORMATION

Device	Package	Shipping <sup>†</sup>
NUD4001DR2G	SO-8 (Pb-Free)	2500 / Tape & Reel
NSVD4001DR2G	SO-8 (Pb-Free)	2500 / Tape & Reel

<sup>†</sup>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](#).

# NUD4001, NSVD4001

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

Rating	Symbol	Value	Unit
Continuous Input Voltage	$V_{in}$	30	V
Non-repetitive Peak Input Voltage ( $t \leq 1.0$ ms)	$V_p$	60	V
Output Current (For $V_{drop} \leq 2.2$ V) (Note 1)	$I_{out}$	500	mA
Output Voltage	$V_{out}$	28	V
Human Body Model (HBM)	ESD	1000	V

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1.  $V_{drop} = V_{in} - 0.7 \text{ V} - V_{LEDs}$ .

## THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Operating Ambient Temperature	$T_A$	-40 to +125	$^\circ\text{C}$
Maximum Junction Temperature	$T_J$	150	$^\circ\text{C}$
Storage Temperature	$T_{STG}$	-55 to +150	$^\circ\text{C}$
Total Power Dissipation (Note 2) Derating above $25^\circ\text{C}$ (Figure 3)	$P_D$	1.13 9.0	W mW/ $^\circ\text{C}$
Thermal Resistance, Junction-to-Ambient (Note 2)	$R_{\theta JA}$	110	$^\circ\text{C/W}$
Thermal Resistance, Junction-to-Lead (Note 2)	$R_{\theta JL}$	77	$^\circ\text{C/W}$

2. Mounted on FR-4 board, 2 in sq pad, 2 oz coverage.

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

Characteristic	Symbol	Min	Typ	Max	Unit
Output Current1 ( $V_{in} = 12$ V, $R_{ext} = 2.0$ $\Omega$ , $V_{LEDs} = 10$ V)	$I_{out1}$	305	325	345	mA
Output Current2 ( $V_{in} = 30$ V, $R_{ext} = 7.0$ $\Omega$ , $V_{LEDs} = 24$ V)	$I_{out2}$	95	105	115	mA
Bias Current ( $V_{in} = 12$ V, $R_{ext} = \text{Open}$ , $V_{LEDs} = 10$ V)	$I_{Bias}$	-	5.0	8.0	mA
Voltage Overhead (Note 3)	$V_{over}$	1.4	-	-	V

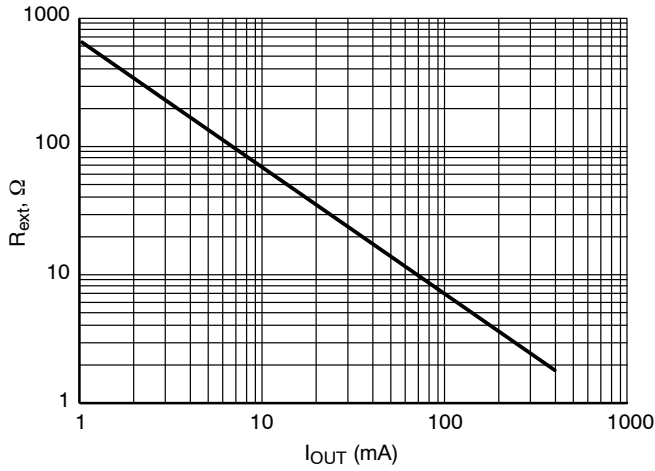
Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

3.  $V_{over} = V_{in} - V_{LEDs}$ .

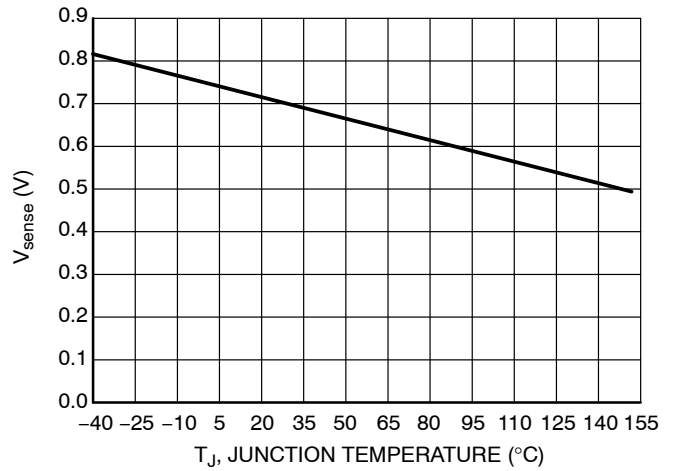
# NUD4001, NSVD4001

## TYPICAL PERFORMANCE CURVES

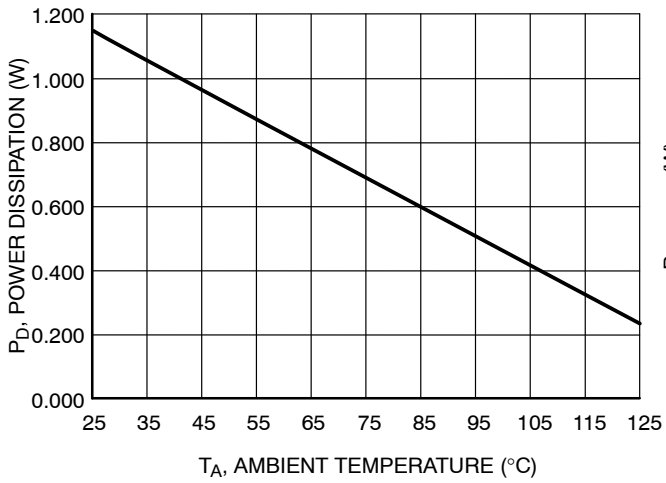
( $T_A = 25^\circ\text{C}$  UNLESS OTHERWISE NOTED)



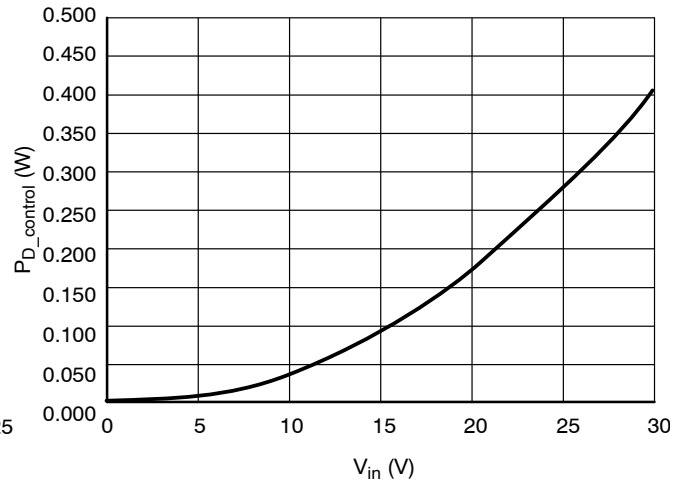
**Figure 1. Output Current ( $I_{OUT}$ ) vs. External Resistor ( $R_{ext}$ )**



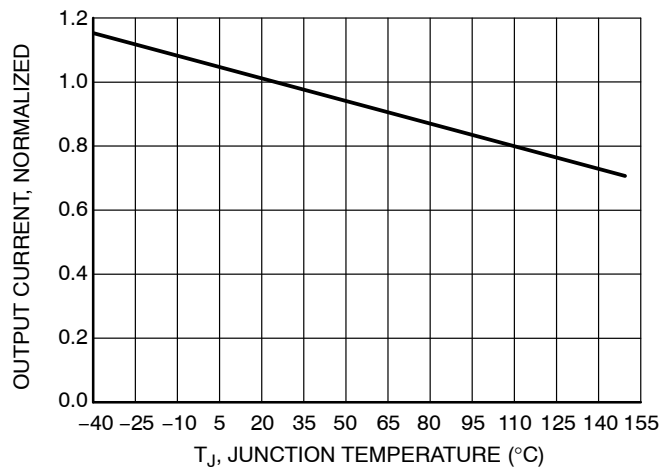
**Figure 2.  $V_{sense}$  vs. Junction Temperature**



**Figure 3. Total Power Dissipation ( $P_D$ ) vs. Ambient Temperature ( $T_A$ )**



**Figure 4. Internal Circuit Power Dissipation vs. Input Voltage**



**Figure 5. Current Regulation vs. Junction Temperature**

APPLICATION INFORMATION

Design Guide

1. Define LED's current:  
A  $I_{LED} = 350 \text{ mA}$
2. Calculate Resistor Value for  $R_{ext}$ :  
A  $R_{ext} = V_{sense} / I_{LED}$  (see Figure 2)  
B  $R_{ext} = 0.7 \text{ (} T_J = 25 \text{ }^\circ\text{C)} / 0.350 = 2.0 \ \Omega$
3. Define  $V_{in}$ :  
A Per example in Figure 6,  $V_{in} = 12 \text{ V}$
4. Define  $V_{LED}$  @  $I_{LED}$  per LED supplier's data sheet:  
A Per example in Figure 6,  
 $V_{LED} = 3.5 \text{ V} + 3.5 \text{ V} + 3.5 \text{ V} = 10.5 \text{ V}$
5. Calculate  $V_{drop}$  across the NUD4001 device:  
A  $V_{drop} = V_{in} - V_{sense} - V_{LED}$   
B  $V_{drop} = 12 \text{ V} - 0.7 \text{ V (} T_J = 25 \text{ }^\circ\text{C)} - 10.5 \text{ V}$   
C  $V_{drop} = 0.8 \text{ V}$
6. Calculate Power Dissipation on the NUD4001 device's driver:  
A  $P_{D\_driver} = V_{drop} * I_{out}$   
B  $P_{D\_driver} = 0.8 \text{ V} \times 0.350 \text{ A}$   
C  $P_{D\_driver} = 0.280 \text{ Watts}$
7. Establish Power Dissipation on the NUD4001 device's control circuit per Figure 4:  
A  $P_{D\_control} =$  Figure 4, for 12 V input voltage  
B  $P_{D\_control} = 0.055 \text{ W}$
8. Calculate Total Power Dissipation on the device:  
A  $P_{D\_total} = P_{D\_driver} + P_{D\_control}$   
B  $P_{D\_total} = 0.280 \text{ W} + 0.055 \text{ W} = 0.335 \text{ W}$
9. If  $P_{D\_total} > 1.13 \text{ W}$  (or derated value per Figure 3), then select the most appropriate recourse and repeat steps 1 through 8:  
A Reduce  $V_{in}$   
B Reconfigure LED array to reduce  $V_{drop}$   
C Reduce  $I_{out}$  by increasing  $R_{ext}$   
D Use external resistors or parallel device's configuration (see application note AND8156)
10. Calculate the junction temperature using the thermal information on Page 7 and refer to Figure 5 to check the output current drop due to the calculated junction temperature. If desired, compensate it by adjusting the value of  $R_{ext}$ .

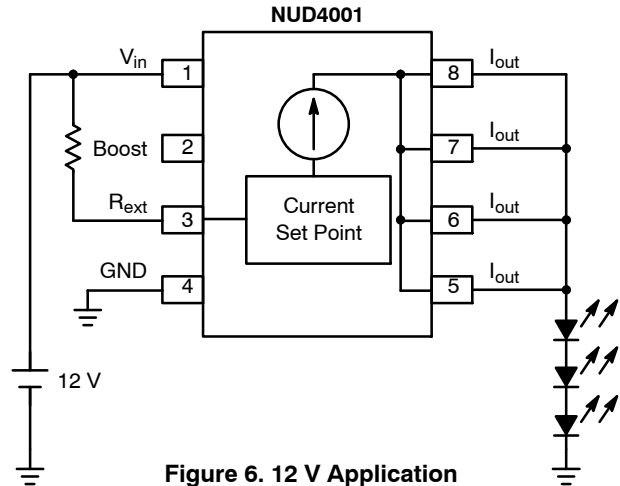


Figure 6. 12 V Application (Series LED's Array)

# NUD4001, NSVD4001

## TYPICAL APPLICATION CIRCUITS

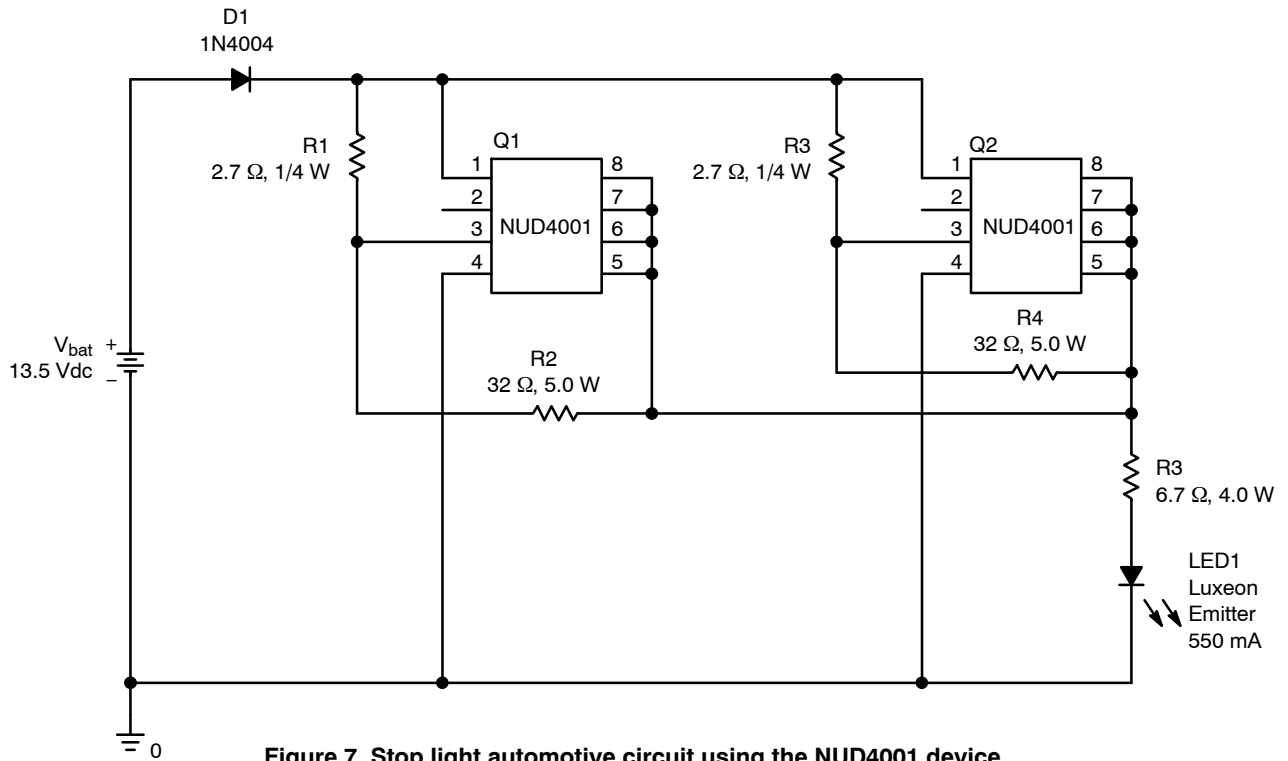


Figure 7. Stop light automotive circuit using the NUD4001 device to drive one high current LED (550 mA).

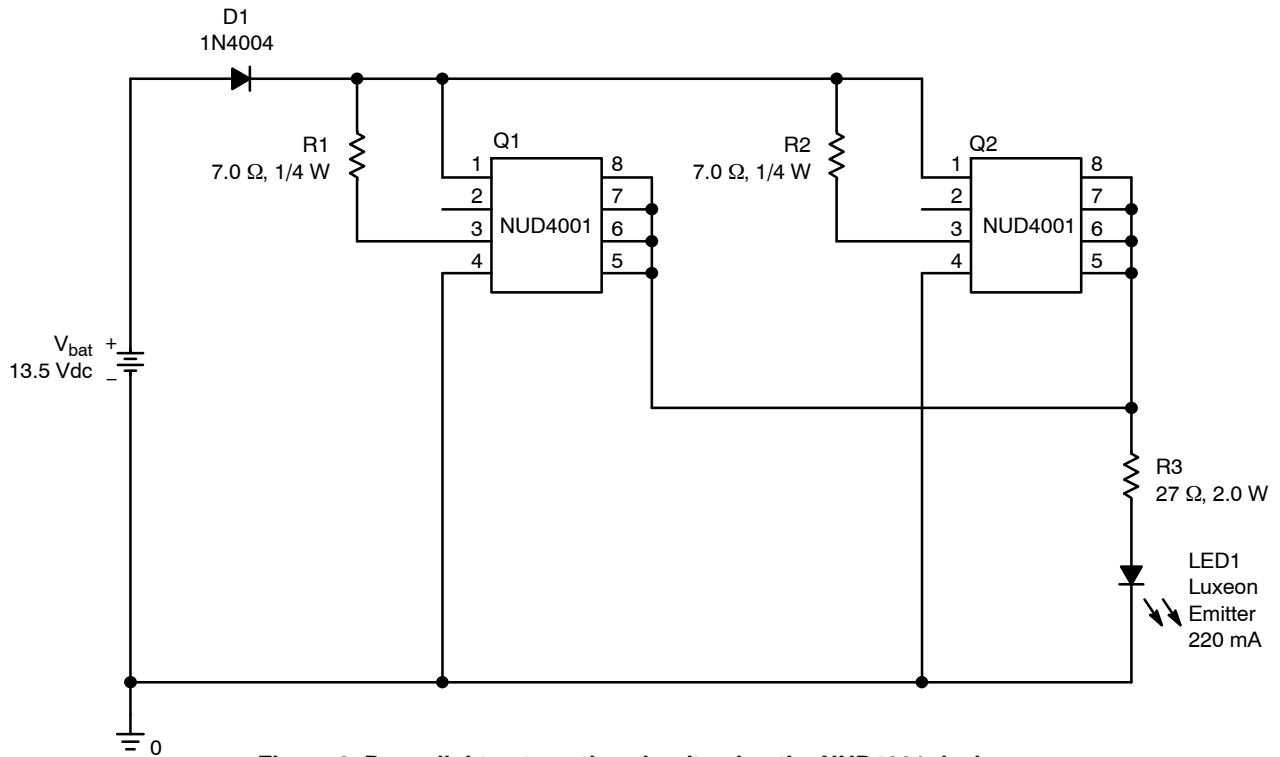
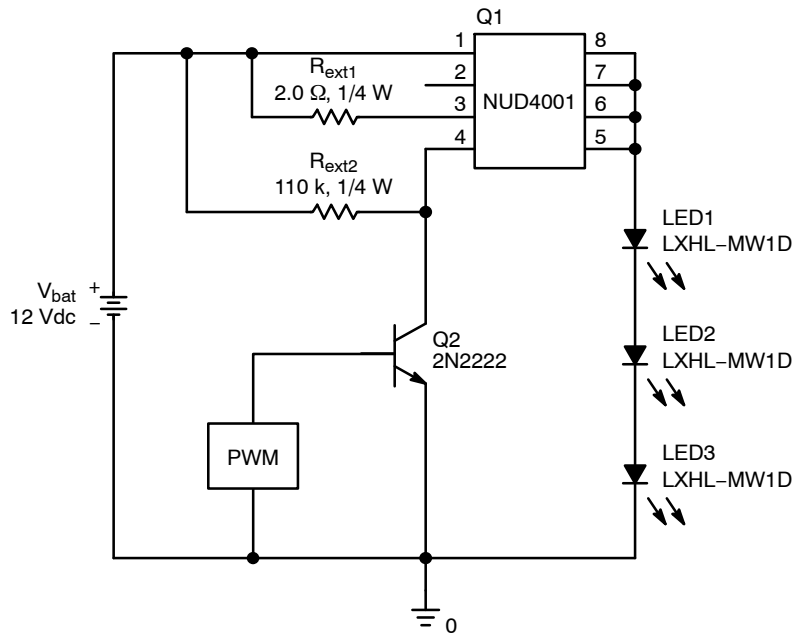
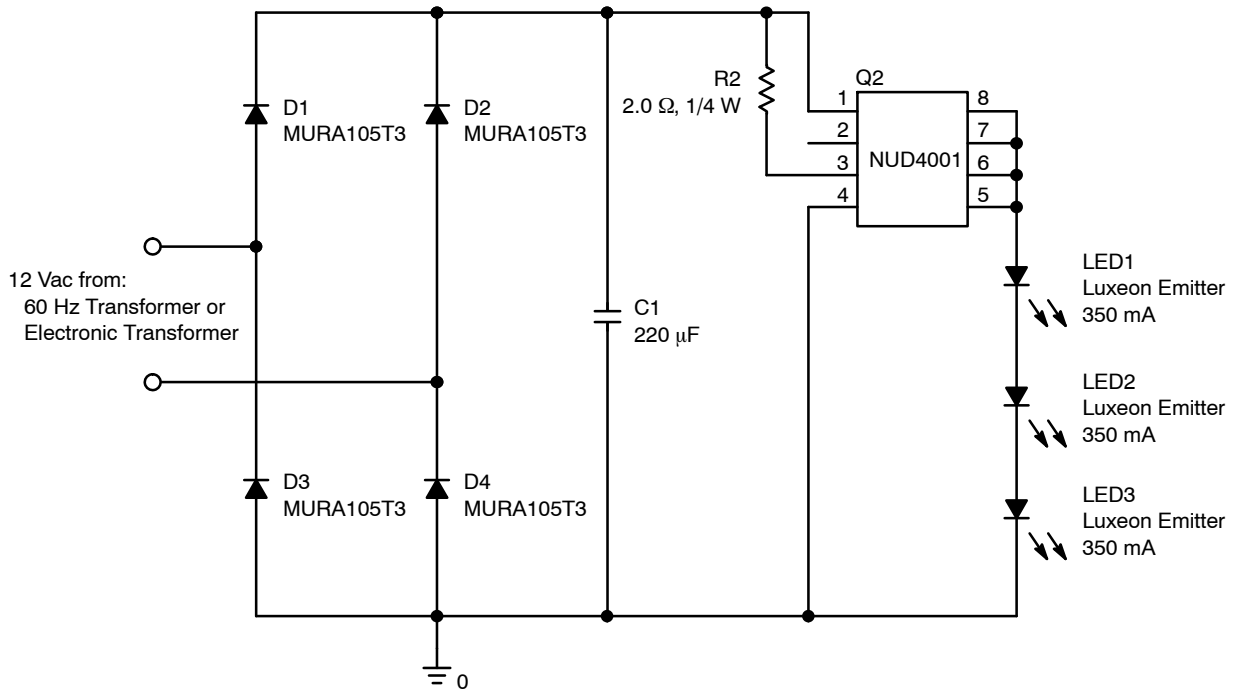


Figure 8. Dome light automotive circuit using the NUD4001 device to drive one LED (220 mA).

## NUD4001, NSVD4001



**Figure 9. NUD4001 Device Configuration for PWM**



**Figure 10. 12 Vac landscape lighting application circuit using the NUD4001 device to drive three 350 mA LEDs.**

# NUD4001, NSVD4001

## THERMAL INFORMATION

### NUD4001, NSVD4001 Power Dissipation

The power dissipation of the SO-8 is a function of the pad size. This can vary from the minimum pad size for soldering to a pad size given for maximum power dissipation. Power dissipation for a surface mount device is determined by  $T_{J(max)}$ , the maximum rated junction temperature of the die,  $R_{\theta JA}$ , the thermal resistance from the device junction to ambient, and the operating temperature,  $T_A$ . Using the values provided on the data sheet for the SO-8 package,  $P_D$  can be calculated as follows:

$$P_D = \frac{T_{Jmax} - T_A}{R_{\theta JA}}$$

The values for the equation are found in the maximum ratings table on the data sheet. Substituting these values into the equation for an ambient temperature  $T_A$  of 25°C, one can calculate the power dissipation of the device which in this case is 1.13 W.

$$P_D = \frac{150^\circ\text{C} - 25^\circ\text{C}}{110^\circ\text{C}} = 1.13\text{ W}$$

The 110°C/W for the SO-8 package assumes the use of a FR-4 copper board with an area of 2 square inches with 2 oz coverage to achieve a power dissipation of 1.13 W. There are other alternatives to achieving higher dissipation from the SOIC package. One of them is to increase the copper area to

reduce the thermal resistance. Figure 11 shows how the thermal resistance changes for different copper areas. Another alternative would be to use a ceramic substrate or an aluminum core board such as Thermal Clad®. Using a board material such as Thermal Clad or an aluminum core board, the power dissipation can be even doubled using the same footprint.

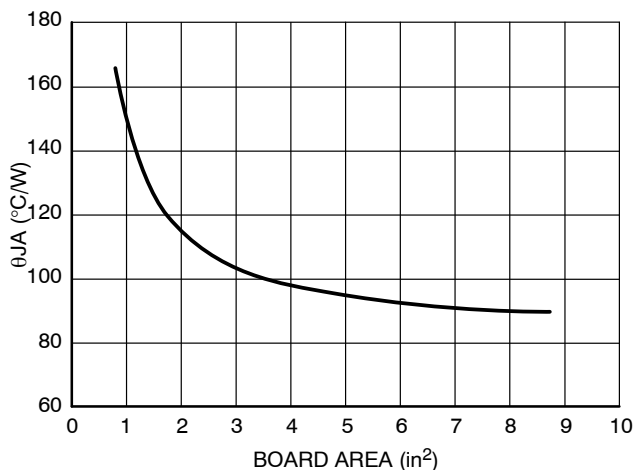


Figure 11.  $\theta_{JA}$  versus Board Area

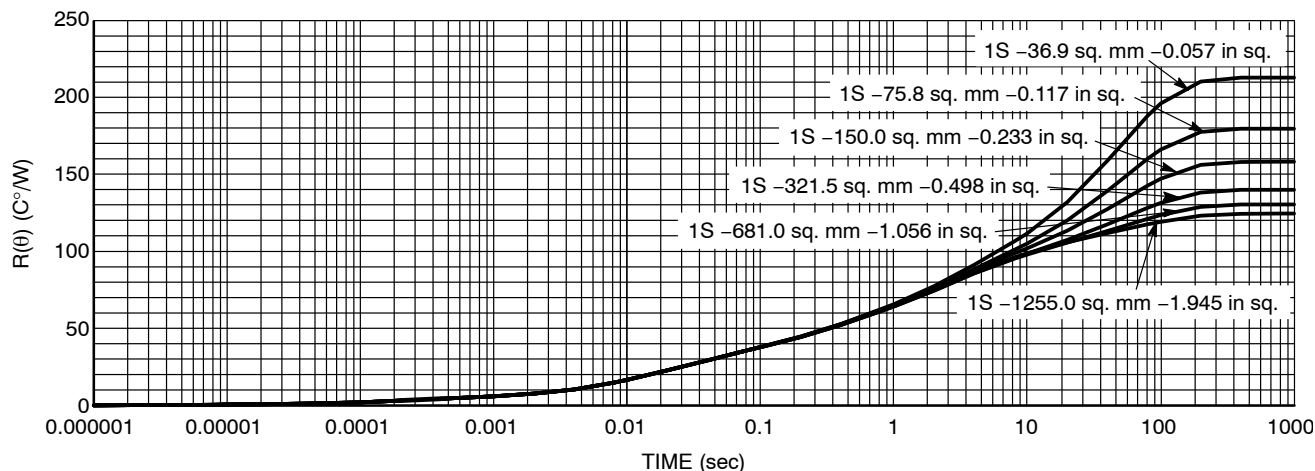
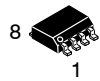


Figure 12. Transient Thermal Response

Thermal Clad is a registered trademark of the Bergquist Company.

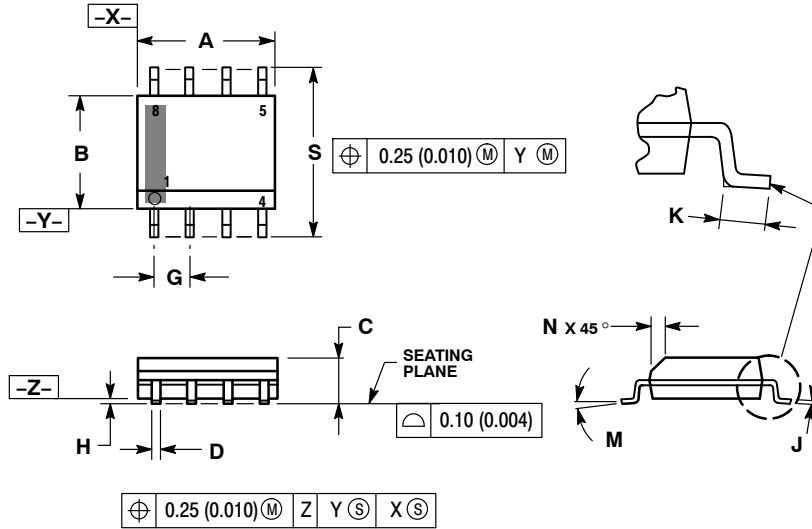
# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SCALE 1:1

SOIC-8 NB  
CASE 751-07  
ISSUE AK

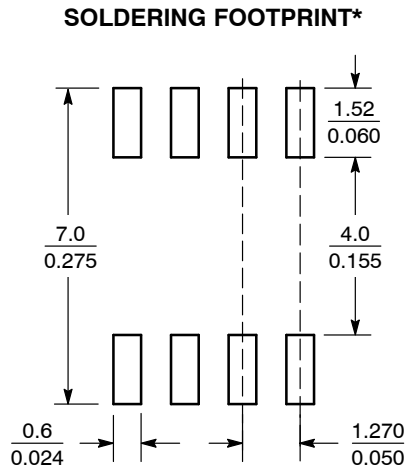
DATE 16 FEB 2011



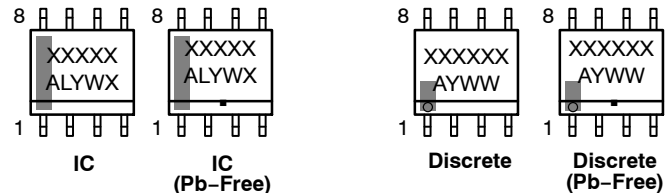
- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: MILLIMETER.
  3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
  4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
  5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 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\*



SCALE 6:1 ( $\frac{\text{mm}}{\text{inches}}$ )



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

DOCUMENT NUMBER:	98ASB42564B	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
DESCRIPTION:	SOIC-8 NB	PAGE 1 OF 2

onsemi and ONsemi are trademarks of Semiconductor Components Industries, LLC dba onsemi or its subsidiaries in the United States and/or other countries. onsemi reserves the right to make changes without further notice to any products herein. onsemi makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does onsemi assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. onsemi does not convey any license under its patent rights nor the rights of others.



**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>                           |                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                        |

<b>DOCUMENT NUMBER:</b>	<b>98ASB42564B</b>	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
<b>DESCRIPTION:</b>	<b>SOIC-8 NB</b>	<b>PAGE 2 OF 2</b>

**onsemi** and **ONSEMI** are trademarks of Semiconductor Components Industries, LLC dba **onsemi** or its subsidiaries in the United States and/or other countries. **onsemi** reserves the right to make changes without further notice to any products herein. **onsemi** makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. **onsemi** does not convey any license under its patent rights nor the rights of others.

**onsemi**, **Onsemi**, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "**onsemi**" or its affiliates and/or subsidiaries in the United States and/or other countries. **onsemi** owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of **onsemi**'s product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). **onsemi** reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and **onsemi** makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does **onsemi** assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using **onsemi** products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by **onsemi**. "Typical" parameters which may be provided in **onsemi** data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. **onsemi** does not convey any license under any of its intellectual property rights nor the rights of others. **onsemi** products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use **onsemi** products for any such unintended or unauthorized application, Buyer shall indemnify and hold **onsemi** and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that **onsemi** was negligent regarding the design or manufacture of the part. **onsemi** is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

## ADDITIONAL INFORMATION

### TECHNICAL PUBLICATIONS:

Technical Library: [www.onsemi.com/design/resources/technical-documentation](http://www.onsemi.com/design/resources/technical-documentation)  
onsemi Website: [www.onsemi.com](http://www.onsemi.com)

### ONLINE SUPPORT: [www.onsemi.com/support](http://www.onsemi.com/support)

For additional information, please contact your local Sales Representative at [www.onsemi.com/support/sales](http://www.onsemi.com/support/sales)