

# ULN2003A, ULQ2003A

## High Voltage, High Current Darlington Transistor Arrays

The seven NPN Darlington connected transistors in these arrays are well suited for driving lamps, relays, or printer hammers in a variety of industrial and consumer applications. Their high breakdown voltage and internal suppression diodes insure freedom from problems associated with inductive loads. Peak inrush currents to 500 mA permit them to drive incandescent lamps.

The ULx2003A with a 2.7 k $\Omega$  series input resistor is well suited for systems utilizing a 5.0 V TTL or CMOS Logic.

### Features

- These are Pb-Free Devices

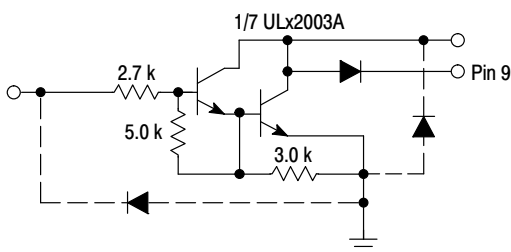


Figure 1. Representative Schematic Diagram

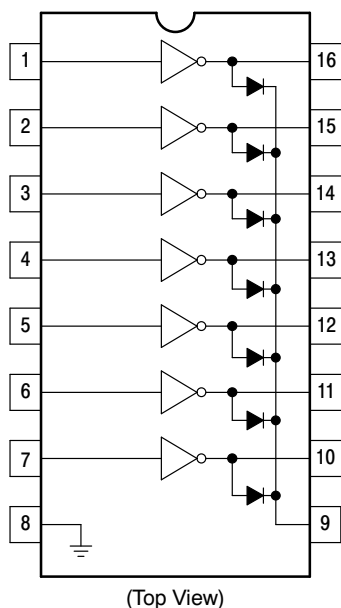


Figure 2. Pin Connections

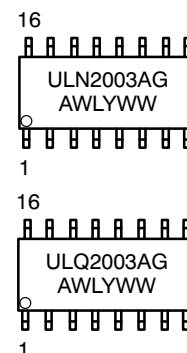


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### MARKING DIAGRAMS



A = Assembly Location  
WL = Wafer Lot  
Y = Year  
WW = Work Week  
G = Pb-Free Package

### ORDERING INFORMATION

| Device       | Package           | Shipping†        |
|--------------|-------------------|------------------|
| ULN2003ADR2G | SOIC-16 (Pb-Free) | 2500 Tape & Reel |
| ULQ2003ADR2G | SOIC-16 (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.

## ULN2003A, ULQ2003A

**MAXIMUM RATINGS** ( $T_A = 25^\circ\text{C}$ , and rating apply to any one device in the package, unless otherwise noted.)

| Rating                                                                                                                  | Symbol           | Value                    | Unit               |
|-------------------------------------------------------------------------------------------------------------------------|------------------|--------------------------|--------------------|
| Output Voltage                                                                                                          | $V_O$            | 50                       | V                  |
| Input Voltage                                                                                                           | $V_I$            | 30                       | V                  |
| Collector Current – Continuous                                                                                          | $I_C$            | 500                      | mA                 |
| Base Current – Continuous                                                                                               | $I_B$            | 25                       | mA                 |
| Operating Ambient Temperature Range<br>ULN2003A<br>ULQ2003A                                                             | $T_A$            | -20 to +85<br>-40 to +85 | $^\circ\text{C}$   |
| Storage Temperature Range                                                                                               | $T_{\text{stg}}$ | -55 to +150              | $^\circ\text{C}$   |
| Junction Temperature                                                                                                    | $T_J$            | 150                      | $^\circ\text{C}$   |
| Thermal Resistance, Junction-to-Ambient<br>Case 751B, D Suffix                                                          | $R_{\theta JA}$  | 100                      | $^\circ\text{C/W}$ |
| Thermal Resistance, Junction-to-Case<br>Case 751B, D Suffix                                                             | $R_{\theta JC}$  | 20                       | $^\circ\text{C/W}$ |
| Electrostatic Discharge Sensitivity (ESD)<br>Human Body Model (HBM)<br>Machine Model (MM)<br>Charged Device Model (CDM) | ESD              | 2000<br>400<br>1500      | V                  |

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.

# ULN2003A, ULQ2003A

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

| Characteristic                                                                                                                                                                                                                 | Symbol        | Min         | Typ                 | Max               | Unit          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------|---------------------|-------------------|---------------|
| Output Leakage Current<br>( $V_O = 50\text{ V}$ , $T_A = +85^\circ\text{C}$ )<br>( $V_O = 50\text{ V}$ , $T_A = +25^\circ\text{C}$ )                                                                                           | $I_{CEX}$     | -<br>-      | -<br>-              | 100<br>50         | $\mu\text{A}$ |
| Collector-Emitter Saturation Voltage<br>( $I_C = 350\text{ mA}$ , $I_B = 500\text{ }\mu\text{A}$ )<br>( $I_C = 200\text{ mA}$ , $I_B = 350\text{ }\mu\text{A}$ )<br>( $I_C = 100\text{ mA}$ , $I_B = 250\text{ }\mu\text{A}$ ) | $V_{CE(sat)}$ | -<br>-<br>- | 1.1<br>0.95<br>0.85 | 1.6<br>1.3<br>1.1 | V             |
| Input Current – On Condition<br>( $V_I = 3.85\text{ V}$ )                                                                                                                                                                      | $I_{I(on)}$   | -           | 0.93                | 1.35              | mA            |
| Input Voltage – On Condition<br>( $V_{CE} = 2.0\text{ V}$ , $I_C = 200\text{ mA}$ )<br>( $V_{CE} = 2.0\text{ V}$ , $I_C = 250\text{ mA}$ )<br>( $V_{CE} = 2.0\text{ V}$ , $I_C = 300\text{ mA}$ )                              | $V_{I(on)}$   | -<br>-<br>- | -<br>-<br>-         | 2.4<br>2.7<br>3.0 | V             |
| Input Current – Off Condition<br>( $I_C = 500\text{ }\mu\text{A}$ , $T_A = 85^\circ\text{C}$ )                                                                                                                                 | $I_{I(off)}$  | 50          | 100                 | -                 | $\mu\text{A}$ |
| DC Current Gain<br>( $V_{CE} = 2.0\text{ V}$ , $I_C = 350\text{ mA}$ )                                                                                                                                                         | $h_{FE}$      | 1000        | -                   | -                 | -             |
| Input Capacitance                                                                                                                                                                                                              | $C_I$         | -           | 15                  | 30                | pF            |
| Turn-On Delay Time<br>(50% $E_I$ to 50% $E_O$ )                                                                                                                                                                                | $t_{on}$      | -           | 0.25                | 1.0               | $\mu\text{s}$ |
| Turn-Off Delay Time<br>(50% $E_I$ to 50% $E_O$ )                                                                                                                                                                               | $t_{off}$     | -           | 0.25                | 1.0               | $\mu\text{s}$ |
| Clamp Diode Leakage Current<br>( $V_R = 50\text{ V}$ )                                                                                                                                                                         | $I_R$         | -<br>-      | -<br>-              | 50<br>100         | $\mu\text{A}$ |
| Clamp Diode Forward Voltage<br>( $I_F = 350\text{ mA}$ )                                                                                                                                                                       | $V_F$         | -           | 1.5                 | 2.0               | V             |

# ULN2003A, ULQ2003A

Typical Performance Curves -  $T_A = 25^\circ\text{C}$

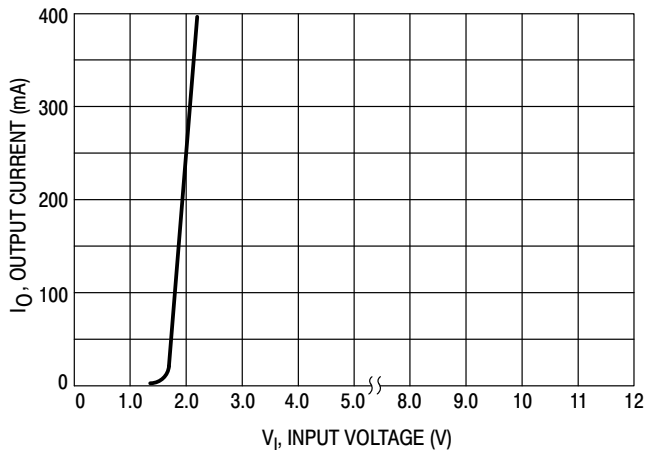


Figure 3. Output Current versus Input Voltage

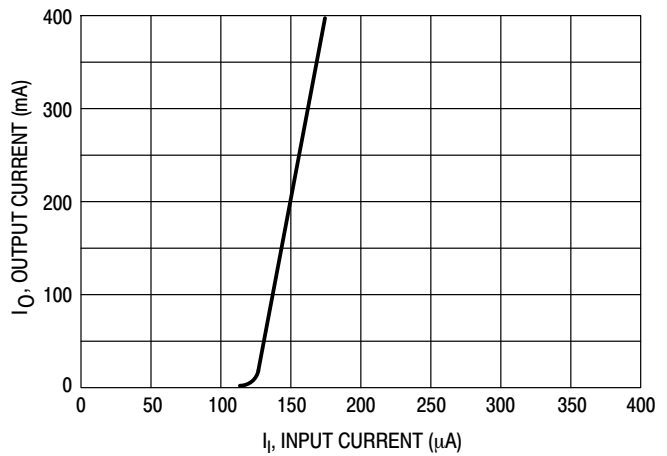


Figure 4. Output Current versus Input Current

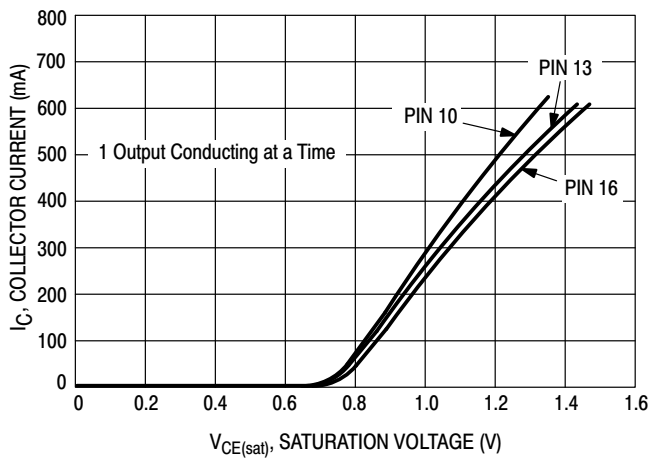


Figure 5. Typical Output Characteristics

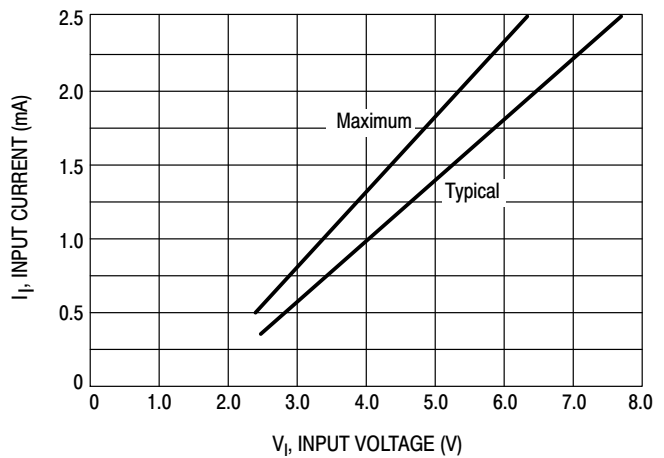


Figure 6. Input Characteristics

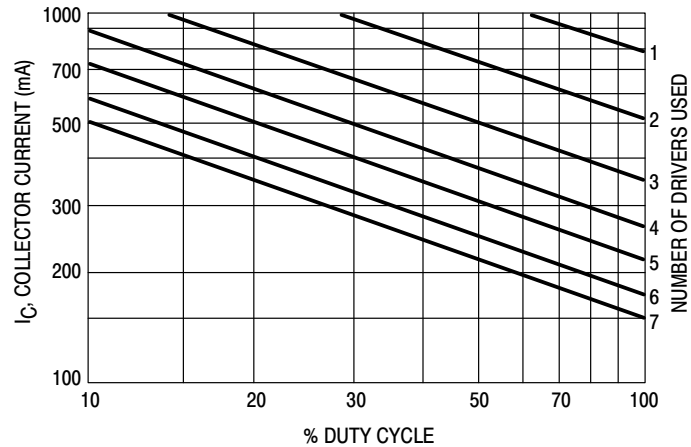


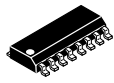
Figure 7. Maximum Collector Current versus Duty Cycle (and Number of Drivers in Use)

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

ON Semiconductor®

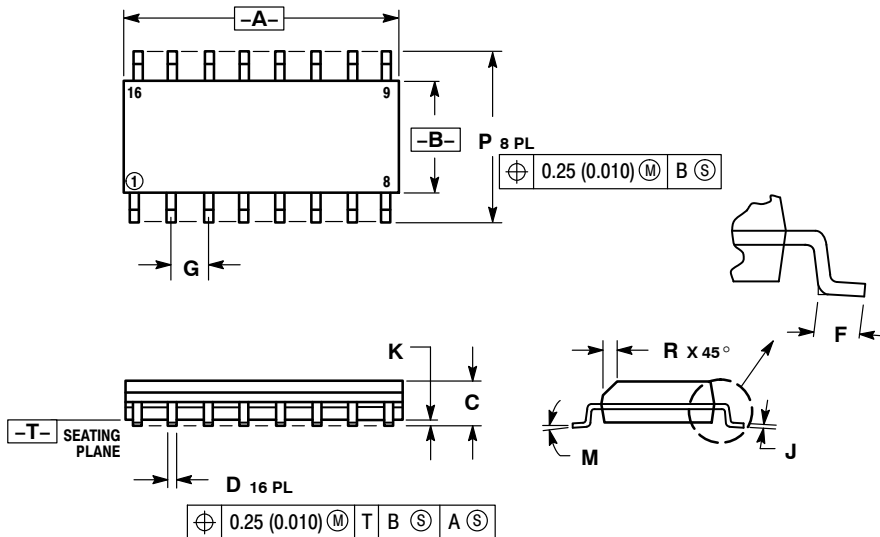
ON



SCALE 1:1

### SOIC-16 CASE 751B-05 ISSUE K

DATE 29 DEC 2006



#### NOTES:

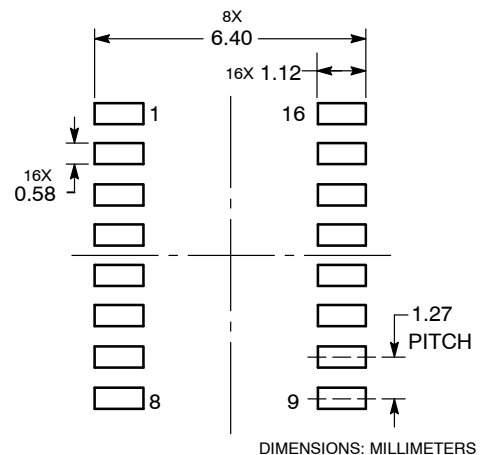
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

| DIM | MILLIMETERS |       | INCHES    |       |
|-----|-------------|-------|-----------|-------|
|     | MIN         | MAX   | MIN       | MAX   |
| A   | 9.80        | 10.00 | 0.386     | 0.393 |
| B   | 3.80        | 4.00  | 0.150     | 0.157 |
| C   | 1.35        | 1.75  | 0.054     | 0.068 |
| D   | 0.35        | 0.49  | 0.014     | 0.019 |
| F   | 0.40        | 1.25  | 0.016     | 0.049 |
| G   | 1.27 BSC    |       | 0.050 BSC |       |
| J   | 0.19        | 0.25  | 0.008     | 0.009 |
| K   | 0.10        | 0.25  | 0.004     | 0.009 |
| M   | 0°          | 7°    | 0°        | 7°    |
| P   | 5.80        | 6.20  | 0.229     | 0.244 |
| R   | 0.25        | 0.50  | 0.010     | 0.019 |

|                   |                   |                          |                          |
|-------------------|-------------------|--------------------------|--------------------------|
| STYLE 1:          | STYLE 2:          | STYLE 3:                 | STYLE 4:                 |
| PIN 1. COLLECTOR  | PIN 1. CATHODE    | PIN 1. COLLECTOR, DYE #1 | PIN 1. COLLECTOR, DYE #1 |
| 2. BASE           | 2. ANODE          | 2. BASE, #1              | 2. COLLECTOR, #1         |
| 3. EMITTER        | 3. NO CONNECTION  | 3. EMITTER, #1           | 3. COLLECTOR, #2         |
| 4. NO CONNECTION  | 4. CATHODE        | 4. COLLECTOR, #1         | 4. COLLECTOR, #2         |
| 5. EMITTER        | 5. CATHODE        | 5. COLLECTOR, #2         | 5. COLLECTOR, #3         |
| 6. BASE           | 6. NO CONNECTION  | 6. BASE, #2              | 6. COLLECTOR, #3         |
| 7. COLLECTOR      | 7. ANODE          | 7. EMITTER, #2           | 7. COLLECTOR, #4         |
| 8. COLLECTOR      | 8. CATHODE        | 8. COLLECTOR, #2         | 8. COLLECTOR, #4         |
| 9. BASE           | 9. CATHODE        | 9. COLLECTOR, #3         | 9. BASE, #4              |
| 10. EMITTER       | 10. ANODE         | 10. BASE, #3             | 10. EMITTER, #4          |
| 11. NO CONNECTION | 11. NO CONNECTION | 11. EMITTER, #3          | 11. BASE, #3             |
| 12. EMITTER       | 12. CATHODE       | 12. COLLECTOR, #3        | 12. EMITTER, #3          |
| 13. BASE          | 13. CATHODE       | 13. COLLECTOR, #4        | 13. BASE, #2             |
| 14. COLLECTOR     | 14. NO CONNECTION | 14. BASE, #4             | 14. EMITTER, #2          |
| 15. EMITTER       | 15. ANODE         | 15. EMITTER, #4          | 15. BASE, #1             |
| 16. COLLECTOR     | 16. CATHODE       | 16. COLLECTOR, #4        | 16. EMITTER, #1          |

|                      |                |                           |
|----------------------|----------------|---------------------------|
| STYLE 5:             | STYLE 6:       | STYLE 7:                  |
| PIN 1. DRAIN, DYE #1 | PIN 1. CATHODE | PIN 1. SOURCE N-CH        |
| 2. DRAIN, #1         | 2. CATHODE     | 2. COMMON DRAIN (OUTPUT)  |
| 3. DRAIN, #2         | 3. CATHODE     | 3. COMMON DRAIN (OUTPUT)  |
| 4. DRAIN, #2         | 4. CATHODE     | 4. GATE P-CH              |
| 5. DRAIN, #3         | 5. CATHODE     | 5. COMMON DRAIN (OUTPUT)  |
| 6. DRAIN, #3         | 6. CATHODE     | 6. COMMON DRAIN (OUTPUT)  |
| 7. DRAIN, #4         | 7. CATHODE     | 7. COMMON DRAIN (OUTPUT)  |
| 8. DRAIN, #4         | 8. CATHODE     | 8. SOURCE P-CH            |
| 9. GATE, #4          | 9. ANODE       | 9. SOURCE P-CH            |
| 10. SOURCE, #4       | 10. ANODE      | 10. COMMON DRAIN (OUTPUT) |
| 11. GATE, #3         | 11. ANODE      | 11. COMMON DRAIN (OUTPUT) |
| 12. SOURCE, #3       | 12. ANODE      | 12. COMMON DRAIN (OUTPUT) |
| 13. GATE, #2         | 13. ANODE      | 13. GATE N-CH             |
| 14. SOURCE, #2       | 14. ANODE      | 14. COMMON DRAIN (OUTPUT) |
| 15. GATE, #1         | 15. ANODE      | 15. COMMON DRAIN (OUTPUT) |
| 16. SOURCE, #1       | 16. ANODE      | 16. SOURCE N-CH           |

#### SOLDERING FOOTPRINT



DIMENSIONS: MILLIMETERS

|                  |             |                                                                                                                                                                                     |
|------------------|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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