

Description

The ULN2002A, ULN2003A and ULN2004A are high voltage, high current Darlington arrays each containing seven open collector common emitter pairs. Each pair is rated at 500mA. Suppression diodes are included for inductive load driving, the inputs and outputs are pinned in opposition to simplify board layout.

Device options are designed to be compatible with common logic families:

- ULN2002A (14-25V PMOS)
- ULN2003A (5V TTL, CMOS)
- ULN2004A (6-15V CMOS, PMOS)

These devices are capable of driving a wide range of loads including solenoids, relays, DC motors, LED displays, filament lamps, thermal print-heads and high-power buffers.

The ULN2002A, 2003A and 2004A are available in both a small outline 16-pin package (SO-16) and DIP-16 package.

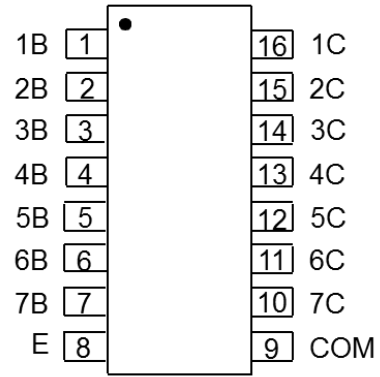
Features

- 500mA Rated Collector Current (single output)
- High Voltage Outputs: 50V
- Output Clamp Diodes
- Inputs Compatible with Popular Logic Types
- Relay Driver Applications
- "Green" Molding Compound (No Br, Sb)
- **Totally Lead-Free & Fully RoHS Compliant (Note 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

- Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
 2. See http://www.diodes.com/quality/lead_free.html for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
 3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Pin Assignments

(Top View)



SO-16/DIP-16

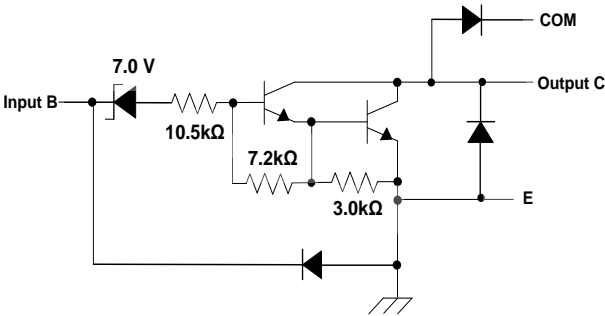
Connection Diagram



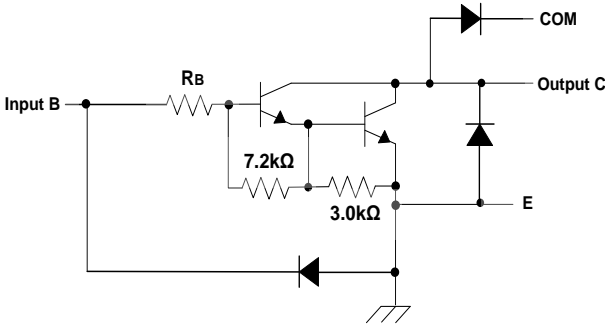
Pin Descriptions

| Pin Number | Pin Name | Function |
|------------|----------|-------------------------|
| 1 | 1B | Input Pair 1 |
| 2 | 2B | Input Pair 2 |
| 3 | 3B | Input Pair 3 |
| 4 | 4B | Input Pair 4 |
| 5 | 5B | Input Pair 5 |
| 6 | 6B | Input Pair 6 |
| 7 | 7B | Input Pair 7 |
| 8 | E | Common Emitter (ground) |
| 9 | COM | Common Clamp Diodes |
| 10 | 7C | Output Pair 7 |
| 11 | 6C | Output Pair 6 |
| 12 | 5C | Output Pair 5 |
| 13 | 4C | Output Pair 4 |
| 14 | 3C | Output Pair 3 |
| 15 | 2C | Output Pair 2 |
| 16 | 1C | Output Pair 1 |

Functional Block Diagram



ULN2002A



ULN2003A: $R_B = 2k7$
 ULN2004A: $R_B = 10k5$
ULN2003A, ULN2004A

Absolute Maximum Ratings (Note 4) (@T_A = +25°C, unless otherwise specified.)

| Symbol | Parameter | Rating | Unit | |
|------------------|---|-----------------------------|--------|------|
| V _{CC} | Collector to Emitter Voltage | 50 | V | |
| V _R | Clamp Diode Reverse Voltage (Note 5) | 50 | V | |
| V _I | Input Voltage (Note 5) | 30 | V | |
| I _{CP} | Peak Collector Current | See typical characteristics | 500 mA | |
| I _{OK} | Output Clamp Current | 500 | mA | |
| I _{TE} | Total Emitter Current | -2.5 | A | |
| θ _{JA} | Thermal Resistance Junction-to-Ambient (Note 6) | SO-16 | 63.0 | °C/W |
| | | DIP-16 | 50.0 | |
| θ _{JC} | Thermal Resistance Junction-to-Case (Note 6) | SO-16 | 12.0 | °C/W |
| | | DIP-16 | 15.0 | |
| T _J | Junction Temperature | 150 | °C | |
| T _{STG} | Storage Temperature | -65 to +150 | °C | |

- Notes:
- Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
 - All voltage values are with respect to the emitter/substrate terminal E, unless otherwise noted.
 - Maximum power dissipation is a function of T_{J(max)}, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is P_D = (T_{J(max)} - T_A)/θ_{JA}. Operating at the absolute maximum T_J of 150°C can affect reliability.
 - Maximum power dissipation is a function of T_{J(max)}, θ_{JC}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is P_D = (T_{J(max)} - T_C)/θ_{JC}. Operating at the absolute maximum T_J of 150°C can affect reliability.

Recommended Operating Conditions

| Symbol | Parameter | Min | Max | Unit |
|-----------------|-------------------------------|-----|------|------|
| V _{CC} | Collector to Emitter voltage | - | 50 | V |
| T _A | Operating Ambient Temperature | -40 | +105 | °C |

Electrical Characteristics (@T_A = +25°C, unless otherwise specified.)

| ULN2002A | | | | | | | | |
|----------------------|--------------------------------------|-----------------|--|--|--------------------|------|-----|----|
| Parameter | Test Figure | Test Conditions | Min | Typ | Max | Unit | | |
| V _{I(on)} | On State Input Voltage | 6 | V _{CE} = 2V, I _C = 300mA | - | - | 13 | V | |
| V _{CE(sat)} | Collector Emitter Saturation Voltage | 5 | I _I = 250μA, I _C = 100mA | - | 0.9 | 1.1 | V | |
| | | | I _I = 350μA, I _C = 200mA | - | 1 | 1.3 | | |
| | | | I _I = 500μA, I _C = 350mA | - | 1.2 | 1.6 | | |
| V _F | Clamp Forward Voltage | 8 | I _F = 350mA | - | 1.7 | 2 | V | |
| I _{CEX} | Collector Cut-off Current | 1 | V _{CE} = 50V, I _I = 0 | - | - | 50 | μA | |
| | | | 2 | V _{CE} = 50V, T _A = +105°C | I _I = 0 | - | | - |
| | | | | V _I = 6V | - | - | 500 | |
| I _{I(off)} | Off State Input Current | 3 | V _{CE} = 50V, I _C = 500μA | 50 | 65 | - | μA | |
| I _I | Input Current | 4 | V _I = 17V | - | 0.82 | 1.25 | mA | |
| I _R | Clamp Reverse Current | 7 | V _R = 50V | T _A = +105°C | - | - | 100 | μA |
| | | | | - | - | - | 50 | |
| C _I | Input Capacitance | - | V _I = 0, f = 1MHz | - | - | 25 | pF | |

Electrical Characteristics (@T_A = +25°C, unless otherwise specified.)

| ULN2003A | | | | | | | | |
|----------------------|--------------------------------------|--------------------|---|--|------------|------------|------------|-------------|
| Parameter | | Test Figure | Test Conditions | | Min | Typ | Max | Unit |
| V _{I(on)} | On State Input Voltage | 6 | V _{CE} = 2V | I _C = 200mA | - | - | 2.4 | V |
| | | | | I _C = 250mA | - | - | 2.7 | |
| | | | | I _C = 300mA | - | - | 3 | |
| V _{CE(sat)} | Collector Emitter Saturation Voltage | 5 | | I _I = 250μA, I _C = 100mA | - | 0.9 | 1.1 | V |
| | | | | I _I = 350μA, I _C = 200mA | - | 1 | 1.3 | |
| | | | | I _I = 500μA, I _C = 350mA | - | 1.2 | 1.6 | |
| V _F | Clamp Forward Voltage | 8 | I _F = 350mA | - | 1.7 | 2 | V | |
| I _{CEX} | Collector Cut-off Current | 1 | V _{CE} = 50V, I _I = 0 | - | - | 50 | μA | |
| | | 2 | V _{CE} = 50V, T _A = +105°C, I _I = 0 | - | - | 100 | | |
| I _{I(off)} | Off State Input Current | 3 | V _{CE} = 50V, I _C = 500μA | 50 | 65 | - | μA | |
| I _I | Input Current | 4 | V _I = 3.85V | - | 0.93 | 1.35 | mA | |
| I _R | Clamp Reverse Current | 7 | V _R = 50V | T _A = +105°C | - | - | 100 | μA |
| | | | | - | - | - | 50 | |
| C _I | Input Capacitance | - | V _I = 0, f = 1MHz | - | 15 | 25 | pF | |
| ULN2004A | | | | | | | | |
| Parameter | | Test Figure | Test Conditions | | Min | Typ | Max | Unit |
| V _{I(on)} | On State Input Voltage | 6 | V _{CE} = 2V | I _C = 125mA | - | - | 5 | V |
| | | | | I _C = 200mA | - | - | 6 | |
| | | | | I _C = 275mA | - | - | 7 | |
| | | | | I _C = 350mA | - | - | 8 | |
| V _{CE(sat)} | Collector Emitter Saturation Voltage | 5 | | I _I = 250μA, I _C = 100mA | - | 0.9 | 1.1 | V |
| | | | | I _I = 350μA, I _C = 200mA | - | 1 | 1.3 | |
| | | | | I _I = 500μA, I _C = 350mA | - | 1.2 | 1.6 | |
| V _F | Clamp Forward Voltage | 8 | I _F = 350mA | - | 1.7 | 2 | V | |
| I _{CEX} | Collector Cut-off Current | 1 | V _{CE} = 50V, I _I = 0 | - | - | 50 | μA | |
| | | 2 | V _{CE} = 50V, T _A = +105°C, I _I = 0, V _I = 6V | - | - | 500 | | |
| I _{I(off)} | Off State Input Current | 3 | V _{CE} = 50V, I _C = 500μA | 50 | 65 | - | μA | |
| I _I | Input Current | 4 | V _I = 5V | - | 0.35 | 0.5 | mA | |
| I _R | Clamp Reverse Current | 7 | V _R = 50V | T _A = +105°C | - | - | 100 | μA |
| | | | | - | - | - | 50 | |
| C _I | Input Capacitance | - | V _I = 0, f = 1MHz | - | 15 | 25 | pF | |

Electrical Characteristics (@T_A = -40°C to +105°C, unless otherwise specified.)

| ULN2003A | | | | | | | | |
|----------------------|--------------------------------------|-------------|--|------------------------|------|------|------|---|
| Parameter | | Test Figure | Test Conditions | Min | Typ | Max | Unit | |
| V _{I(on)} | On State Input Voltage | 6 | V _{CE} = 2V | I _C = 200mA | - | - | 2.7 | V |
| | | | | I _C = 250mA | - | - | 2.9 | |
| | | | | I _C = 300mA | - | - | 3 | |
| V _{CE(sat)} | Collector Emitter Saturation Voltage | 5 | I _I = 250μA, I _C = 100mA | - | 0.9 | 1.2 | V | |
| | | | I _I = 350μA, I _C = 200mA | - | 1 | 1.4 | | |
| | | | I _I = 500μA, I _C = 350mA | - | 1.2 | 1.7 | | |
| V _F | Clamp Forward Voltage | 8 | I _F = 350mA | - | 1.7 | 2.2 | V | |
| I _{CEX} | Collector Cut-off Current | 1 | V _{CE} = 50V, I _I = 0 | - | - | 100 | μA | |
| I _{I(off)} | Off State Input Current | 3 | V _{CE} = 50V, I _C = 500μA | 30 | 65 | - | μA | |
| I _I | Input Current | 4 | V _I = 3.85V | - | 0.93 | 1.35 | mA | |
| I _R | Clamp Reverse Current | 7 | V _R = 50V | - | - | 100 | μA | |
| C _I | Input Capacitance | - | V _I = 0, f = 1MHz | - | 15 | 25 | pF | |

Switching Characteristics (@T_A = +25°C, unless otherwise specified.)

| ULN2002A, ULN2003A, ULN2004A | | | | | | |
|------------------------------|--|---|--------------------|------|-----|------|
| Parameter | | Test figure | Min | Typ | Max | Unit |
| t _{PLH} | Propagation delay time, low to high level output | 10 | - | 0.25 | 1 | μs |
| t _{PLL} | Propagation delay time, high to low level output | 10 | - | 0.25 | 1 | μs |
| V _{OH} | High level output voltage after switching | 10 (V _S = 50V, I _O = 300mA) | V _S -20 | - | - | mV |

Switching Characteristics (@T_A = -40 to +105°C, unless otherwise specified.)

| ULN2003A | | | | | | |
|------------------|--|---|--------------------|-----|-----|------|
| Parameter | | Test figure | Min | Typ | Max | Unit |
| t _{PLH} | Propagation delay time, low to high level output | 10 | - | 1 | 10 | μs |
| t _{PLL} | Propagation delay time, high to low level output | 10 | - | 1 | 10 | μs |
| V _{OH} | High level output voltage after switching | 10 (V _S = 50V, I _O = 300mA) | V _S -50 | - | - | mV |

Parameter Measurement Circuits

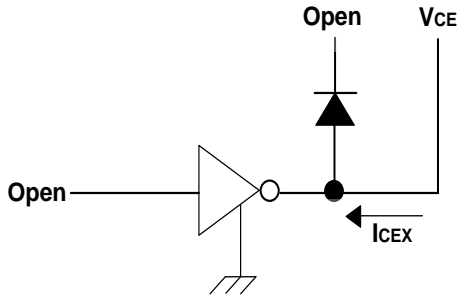


Fig.1 ICEX Test Circuit

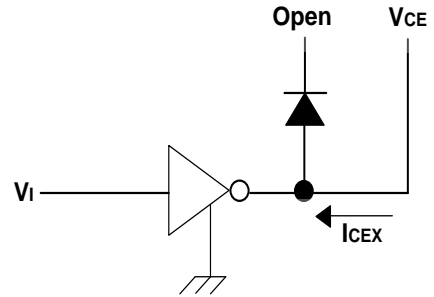


Fig.2 ICEX Test Circuit

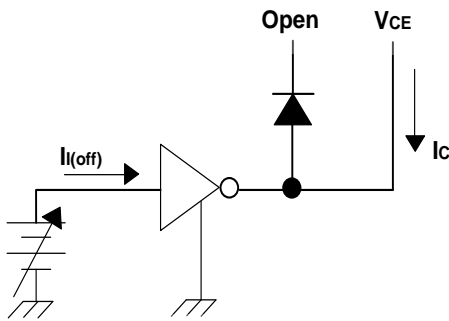


Fig.3 I(off) Test Circuit

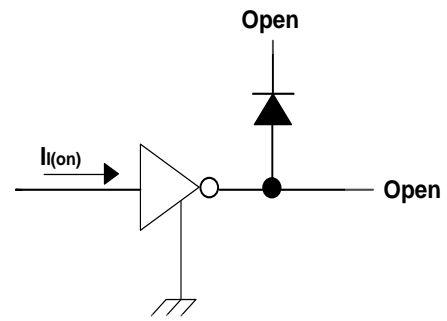


Fig.4 I(on) Test Circuit

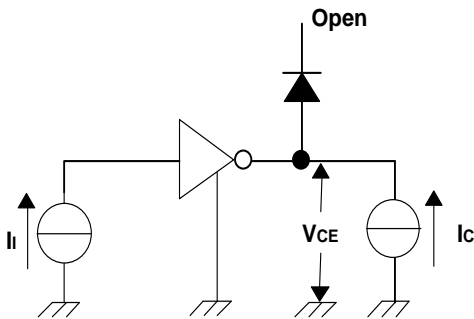


Fig. 5 hFE , VCE(sat) Test Circuit

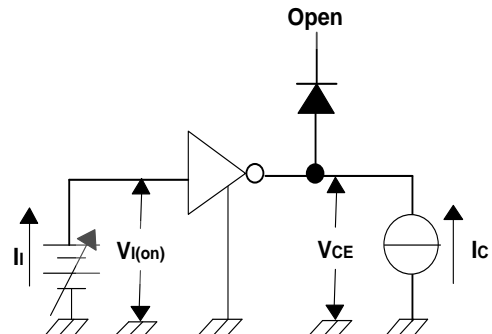


Fig. 6 VI(on) Test Circuit

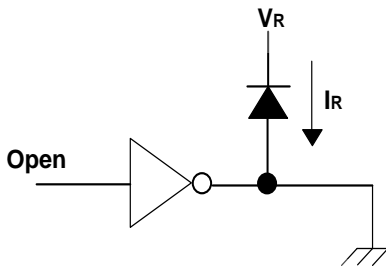


Fig. 7 IR Test Circuit



Fig. 8 VF Test Circuit

Parameter Measurement Circuits (continued)

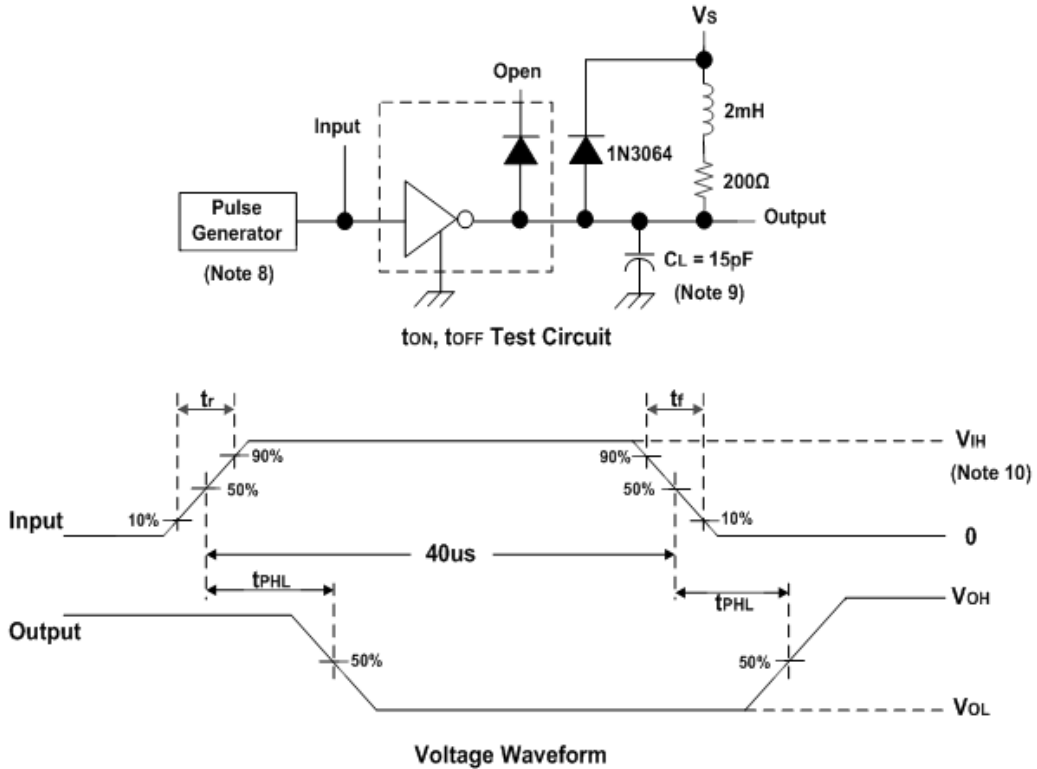


Fig. 10 Latch-Up Test Circuit and Voltage Waveform

- Notes:
- 8. The pulse generator has the following characteristics: Pulse Width = 12.5μs, output impedance 50Ω, $t_r \leq 5\text{ns}$, $t_f \leq 10\text{ns}$.
 - 9. C_L includes probe and jig capacitance.
 - 10. For testing the ULN2002A, $V_{IH} = 13\text{V}$; for the ULN2003A, $V_{IH} = 3\text{V}$; for the ULN2004A, $V_{IH} = 8\text{V}$.

Typical Performance Characteristics

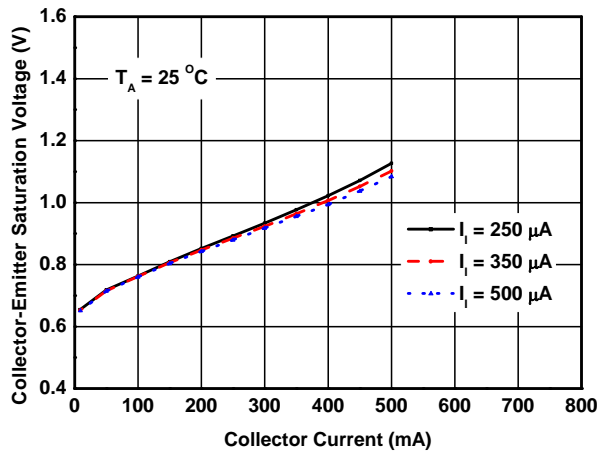


Figure 11 Collector-Emitter Saturation Voltage vs. Collector Current (One Darlington)

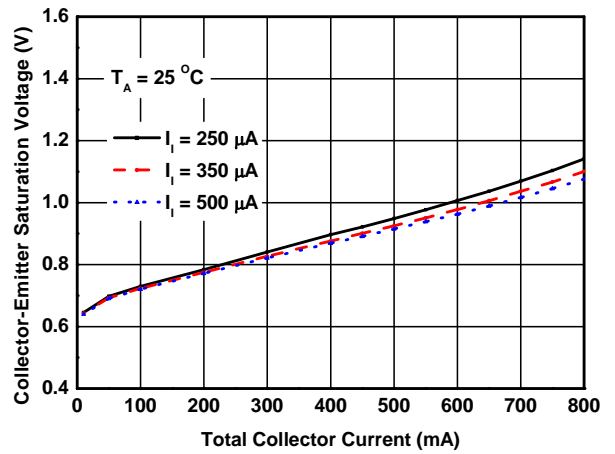


Figure 12 Collector-Emitter Saturation Voltage vs. Collector Current (Two Darlington in Parallel)

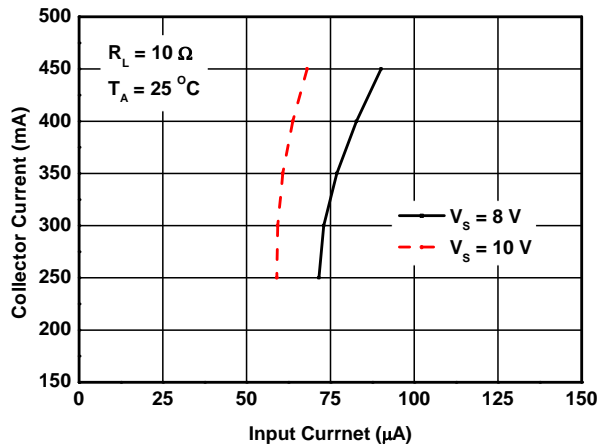


Figure 13 Collector Current vs. Input Current

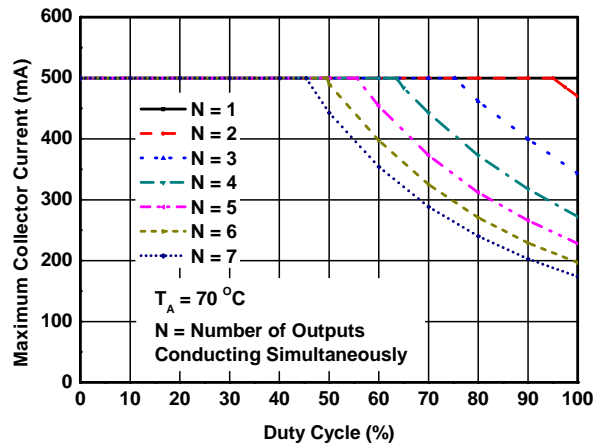


Figure 14 Maximum Collector Current vs. Duty Cycle

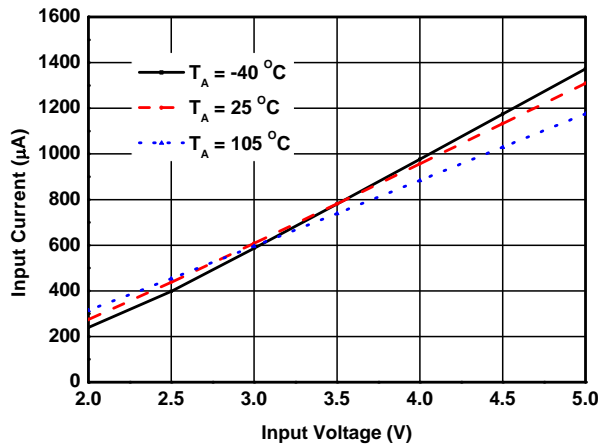


Figure 15. Input Current vs. Input Voltage

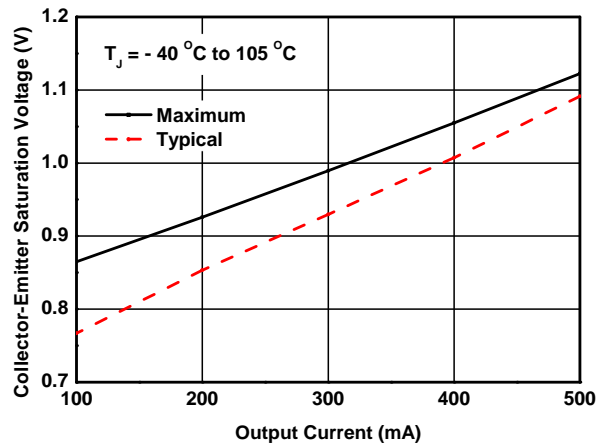


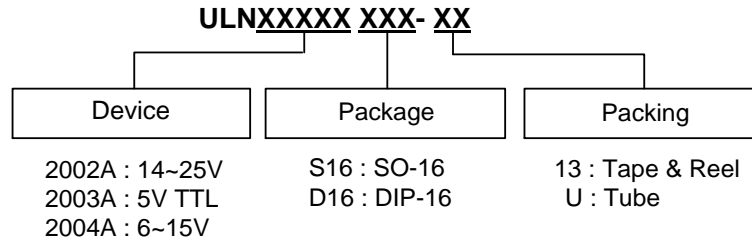
Figure 16. Collector-Emitter Saturation Voltage vs. Output Current

Typical Performance Characteristics (continued)



Figure 17. Output Current vs. Input Current

Ordering Information

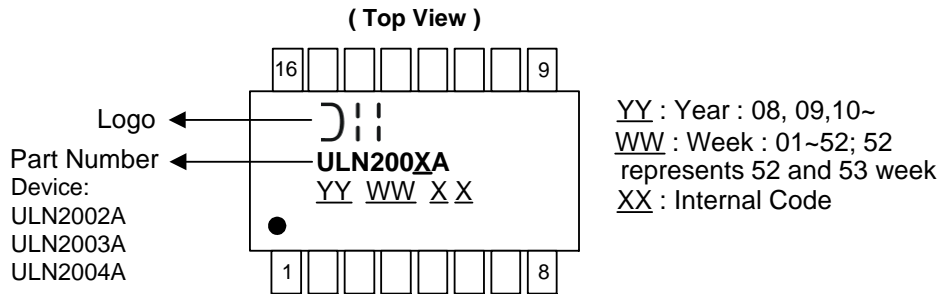


| Part Number | Package Code | Packaging | 13" Tape and Reel | | Tube | |
|----------------|--------------|-----------|-------------------|--------------------|----------|--------------------|
| | | | Quantity | Part Number Suffix | Quantity | Part Number Suffix |
| ULN2002AS16-13 | S16 | SO-16 | 2,500/Tape & Reel | -13 | NA | NA |
| ULN2003AS16-13 | S16 | SO-16 | 2,500/Tape & Reel | -13 | NA | NA |
| ULN2004AS16-13 | S16 | SO-16 | 2,500/Tape & Reel | -13 | NA | NA |
| ULN2002AD16-U | D16 | PDIP-16 | NA | NA | 25/Tube | -U |
| ULN2003AD16-U | D16 | PDIP-16 | NA | NA | 25/Tube | -U |
| ULN2004AD16-U | D16 | PDIP-16 | NA | NA | 25/Tube | -U |

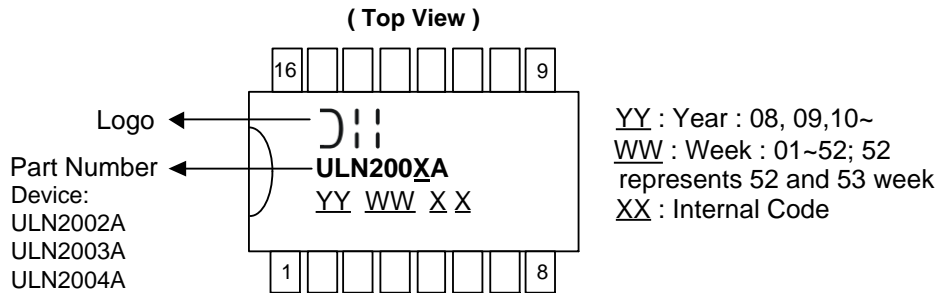
Note: 11. Pad layout as shown on Diodes Inc. suggested pad layout document AP02001, which can be found on our website at <http://www.diodes.com/datasheets/ap02001.pdf>.

Marking Information

(1) SO-16



(2) PDIP-16



Package Outline Drawings

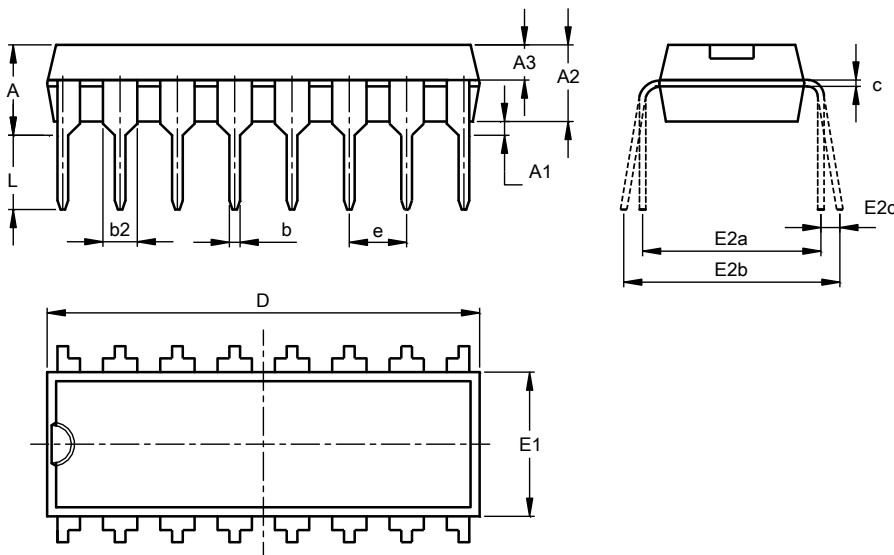
Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for the latest version.

SO-16



| SO-16 | | |
|----------------------|----------|-------|
| Dim | Min | Max |
| A | 1.40 | 1.75 |
| A1 | 0.10 | 0.25 |
| A2 | 1.30 | 1.50 |
| B | 0.33 | 0.51 |
| C | 0.19 | 0.25 |
| D | 9.80 | 10.00 |
| E | 3.80 | 4.00 |
| e | 1.27 Typ | |
| H | 5.80 | 6.20 |
| L | 0.38 | 1.27 |
| θ | 0° | 8° |
| All Dimensions in mm | | |

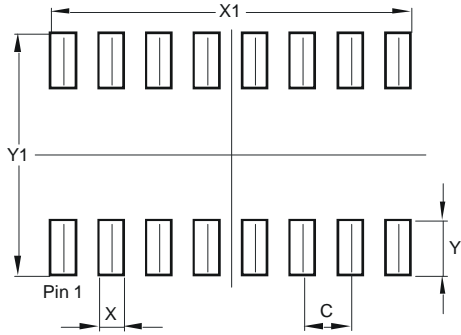
PDIP-16



| PDIP-16 | | | |
|----------------------|----------|-------|-------|
| Dim | Min | Max | Nom |
| A | 3.60 | 4.00 | 3.80 |
| A1 | 0.51 | - | - |
| A2 | 3.20 | 3.40 | 3.30 |
| A3 | 1.47 | 1.57 | 1.52 |
| b | 0.44 | 0.53 | - |
| b2 | 1.52BSC | | |
| c | 0.25 | 0.31 | - |
| D | 18.90 | 19.30 | 19.10 |
| E1 | 6.15 | 6.55 | 6.35 |
| E2a | 7.62 BSC | | |
| E2b | 7.62 | 9.30 | - |
| E2c | 0.00 | 0.84 | - |
| e | 2.54BSC | | |
| L | 3.00 | - | - |
| All Dimensions in mm | | | |

Suggested Pad Layout

Please see AP02001 at <http://www.diodes.com/datasheets/ap02001.pdf> for the latest version.



| Dimensions | Value (in mm) |
|------------|---------------|
| C | 1.270 |
| X | 0.670 |
| X1 | 9.560 |
| Y | 1.450 |
| Y1 | 6.400 |

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- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



Как с нами связаться

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