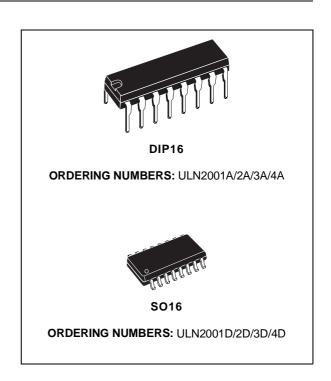


# ULN2001A-ULN2002A ULN2003A-ULN2004A

## SEVEN DARLINGTON ARRAYS

- SEVEN DARLINGTONS PER PACKAGE
- OUTPUT CURRENT 500mA PER DRIVER (600mA PEAK)
- OUTPUT VOLTAGE 50V
- INTEGRATED SUPPRESSION DIODES FOR INDUCTIVE LOADS
- OUTPUTS CAN BE PARALLELED FOR HIGHER CURRENT
- TTL/CMOS/PMOS/DTL COMPATIBLE INPUTS
- INPUTS PINNED OPPOSITE OUTPUTS TO SIMPLIFY LAYOUT



#### **DESCRIPTION**

The ULN2001A, ULN2002A, ULN2003 and ULN2004A are high voltage, high current darlington arrays each containing seven open collector darlington pairs with common emitters. Each channel rated at 500mA and can withstand peak currents of 600mA. Suppression diodes are included for inductive load driving and the inputs are pinned opposite the outputs to simplify board layout.

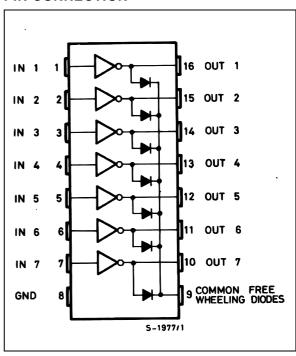
The four versions interface to all common logic families:

ULN2001A	General Purpose, DTL, TTL, PMOS, CMOS
ULN2002A	14-25V PMOS
ULN2003A	5V TTL, CMOS
ULN2004A	6-15V CMOS, PMOS

These versatile devices are useful for driving a wide range of loads including solenoids, relays DC motors, LED displays filament lamps, thermal printheads and high power buffers.

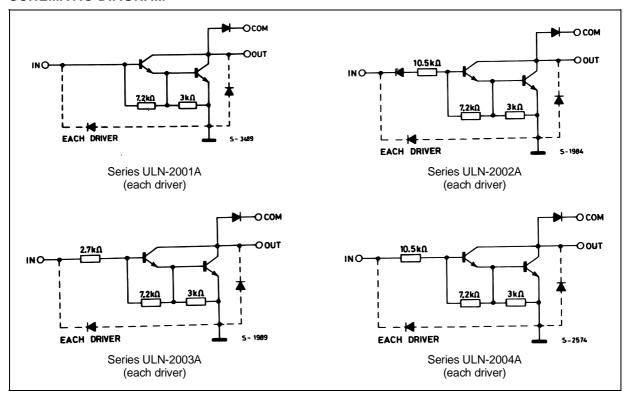
The ULN2001A/2002A/2003A and 2004A are supplied in 16 pin plastic DIP packages with a copper leadframe to reduce thermal resistance. They are available also in small outline package (SO-16) as ULN2001D/2002D/2003D/2004D.

#### **PIN CONNECTION**



February 2002 1/8

#### **SCHEMATIC DIAGRAM**



### **ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	Value	Unit
Vo	Output Voltage	50	V
V <sub>in</sub>	Input Voltage (for ULN2002A/D - 2003A/D - 2004A/D)	30	V
Ic	Continuous Collector Current	500	mA
I <sub>b</sub>	Continuous Base Current	25	mA
T <sub>amb</sub>	Operating Ambient Temperature Range	- 20 to 85	°C
T <sub>stg</sub>	Storage Temperature Range	– 55 to 150	°C
Tj	Junction Temperature	150	°C

### THERMAL DATA

Symbol	Parameter	DIP16	SO16	Unit
R <sub>th j-amb</sub>	Thermal Resistance Junction-ambient Max.	70	120	°C/W

# **ELECTRICAL CHARACTERISTICS** ( $T_{amb} = 25^{\circ}C$ unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Тур.	Max.	Unit	Fig.
I <sub>CEX</sub>	Output Leakage Current	V <sub>CE</sub> = 50V T <sub>amb</sub> = 70°C, V <sub>CE</sub> = 50V			50 100	μA μA	1a 1a
		$ \begin{aligned} T_{amb} &= 70^{\circ}\text{C} \\ \text{for ULN2002A} \\ V_{CE} &= 50\text{V},  V_i = 6\text{V} \\ \text{for ULN2004A} \\ V_{CE} &= 50\text{V},  V_i = 1\text{V} \end{aligned} $			500 500	μ <b>Α</b> μ <b>Α</b>	1b 1b
V <sub>CE(sat)</sub>	Collector-emitter Saturation Voltage	$I_{C}$ = 100mA, $I_{B}$ = 250 $\mu$ A $I_{C}$ = 200 mA, $I_{B}$ = 350 $\mu$ A $I_{C}$ = 350mA, $I_{B}$ = 500 $\mu$ A		0.9 1.1 1.3	1.1 1.3 1.6	V V V	2 2 2
l <sub>i(on)</sub>	Input Current	$ \begin{cases} \text{for ULN2002A, } V_i = 17V \\ \text{for ULN2003A, } V_i = 3.85V \\ \text{for ULN2004A, } V_i = 5V \\ V_i = 12V \end{cases} $		0.82 0.93 0.35 1	1.25 1.35 0.5 1.45	mA mA mA	3 3 3 3
I <sub>i(off)</sub>	Input Current	$T_{amb} = 70^{\circ}C$ , $I_{C} = 500\mu A$	50	65		μΑ	4
Vi(on)	Input Voltage	$\begin{array}{c} V_{CE} = 2V \\ \text{for ULN2002A} \\ I_{C} = 300\text{mA} \\ \text{for ULN2003A} \\ I_{C} = 200\text{mA} \\ I_{C} = 250\text{mA} \\ I_{C} = 300\text{mA} \\ I_{C} = 300\text{mA} \\ \text{for ULN2004A} \\ I_{C} = 125\text{mA} \\ I_{C} = 200\text{mA} \\ I_{C} = 275\text{mA} \\ I_{C} = 350\text{mA} \\ \end{array}$			13 2.4 2.7 3 5 6 7 8	V	5
h <sub>FE</sub>	DC Forward Current Gain	for ULN2001A V <sub>CE</sub> = 2V, I <sub>C</sub> = 350mA	1000				2
C <sub>i</sub>	Input Capacitance			15	25	pF	
t <sub>PLH</sub>	Turn-on Delay Time	0.5 V <sub>i</sub> to 0.5 V <sub>o</sub>		0.25	1	μs	
t <sub>PHL</sub>	Turn-off Delay Time	0.5 V <sub>i</sub> to 0.5 V <sub>o</sub>		0.25	1	μs	
I <sub>R</sub>	Clamp Diode Leakage Current	$V_R = 50V$ $T_{amb} = 70^{\circ}C, V_R = 50V$			50 100	μA μA	6
V <sub>F</sub>	Clamp Diode Forward Voltage	$I_F = 350 \text{mA}$		1.7	2	V	7

## **TEST CIRCUITS**

Figure 1a.

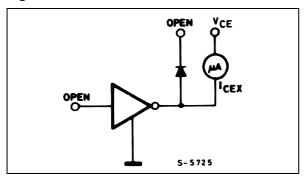


Figure 1b.

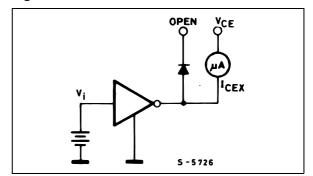


Figure 2.

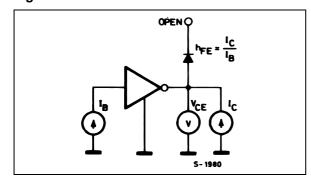


Figure 3.

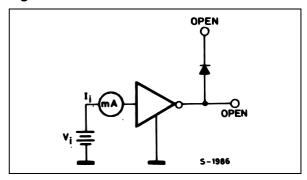


Figure 4.

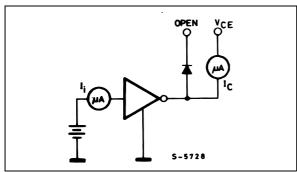


Figure 5.

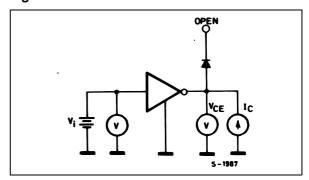


Figure 6.

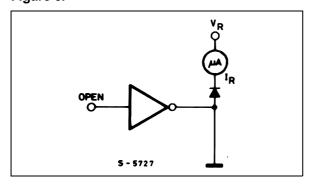


Figure 7.

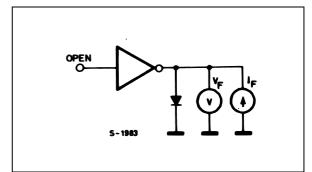


Figure 8: Collector Current versus Input Current

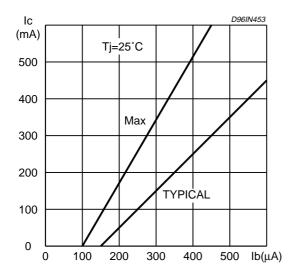


Figure 9: Collector Current versus Saturation Voltage

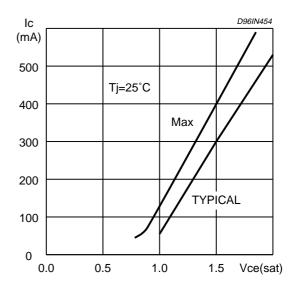


Figure 10: Peak Collector Current versus Duty Cycle

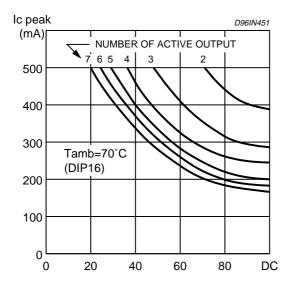
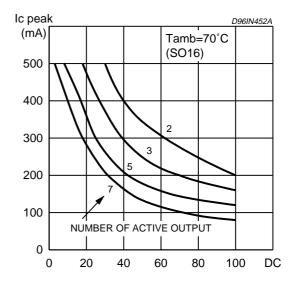


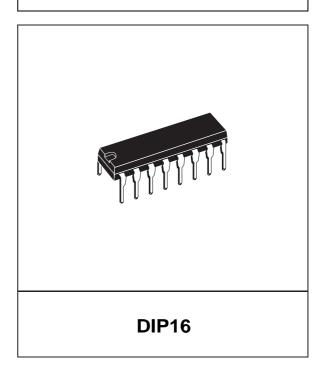
Figure 11: Peak Collector Current versus Duty Cycle

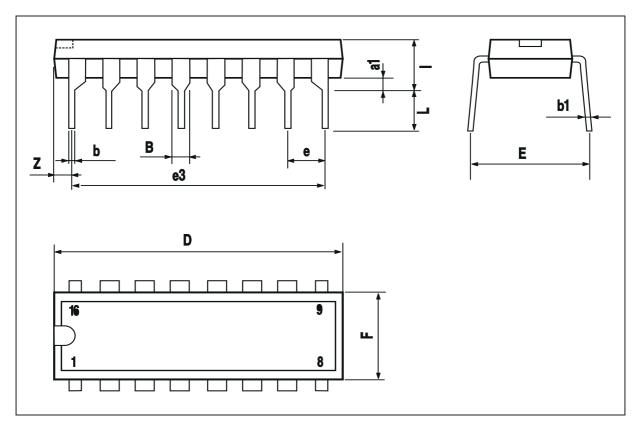


4

DIM.	mm			inch			
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
a1	0.51			0.020			
В	0.77		1.65	0.030		0.065	
b		0.5			0.020		
b1		0.25			0.010		
D			20			0.787	
Е		8.5			0.335		
е		2.54			0.100		
e3		17.78			0.700		
F			7.1			0.280	
I			5.1			0.201	
L		3.3			0.130		
Z			1.27			0.050	

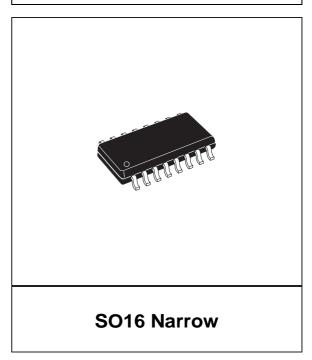
# OUTLINE AND MECHANICAL DATA



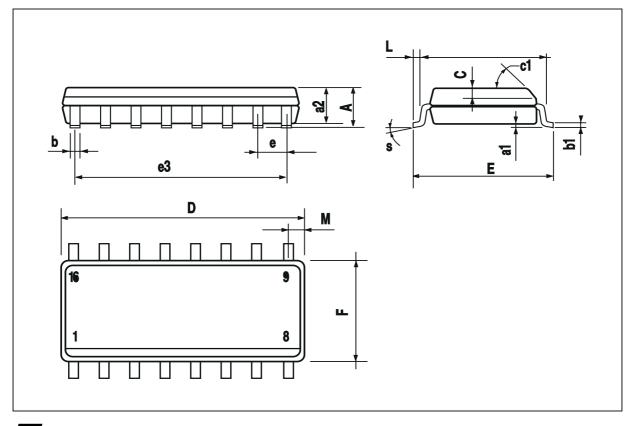


DIM.		mm			inch	
Dilvi.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
Α			1.75			0.069
a1	0.1		0.25	0.004		0.009
a2			1.6			0.063
b	0.35		0.46	0.014		0.018
b1	0.19		0.25	0.007		0.010
С		0.5			0.020	
c1			45° (	typ.)		
D (1)	9.8		10	0.386		0.394
Е	5.8		6.2	0.228		0.244
е		1.27			0.050	
еЗ		8.89			0.350	
F (1)	3.8		4	0.150		0.157
G	4.6		5.3	0.181		0.209
L	0.4		1.27	0.016		0.050
М			0.62			0.024
S	8°(max.)					

# OUTLINE AND MECHANICAL DATA



(1) D and F do not include mold flash or protrusions. Mold flash or potrusions shall not exceed 0.15mm (.006inch).



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5