

# ULN2003/04

## High Voltage/High Current Darlington Transistor Arrays

### Product Specification

#### Linear Products

#### DESCRIPTION

These high voltage, high current Darlington transistor arrays are comprised of seven silicon NPN Darlington pairs on a common monolithic substrate. All units feature open-collector outputs and integral suppression diodes for inductive loads. Peak in-rush currents to 600mA are allowable, making them ideal for driving tungsten filament lamps, also.

The Type ULN2003 has a series base resistor to each Darlington pair, and thus allows operation directly with TTL or CMOS 5V supply voltage.

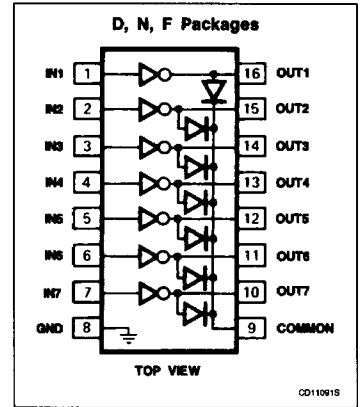
The Type ULN2004 has an appropriate series input resistor to allow its operation directly from CMOS or PMOS outputs utilizing supply voltages of 6 to 15V. The required input current is below that of the Type ULN2003.

In all cases, the individual Darlington pair collector current rating is 500mA. However, outputs may be paralleled for higher load current capability. All devices are supplied in a 16-pin dual in-line plastic package.

#### FEATURES

- Peak in-rush current 600mA
- Protected internally against inductive loads
- Open-collector topology
- Compatible with most logic technologies

#### PIN CONFIGURATION



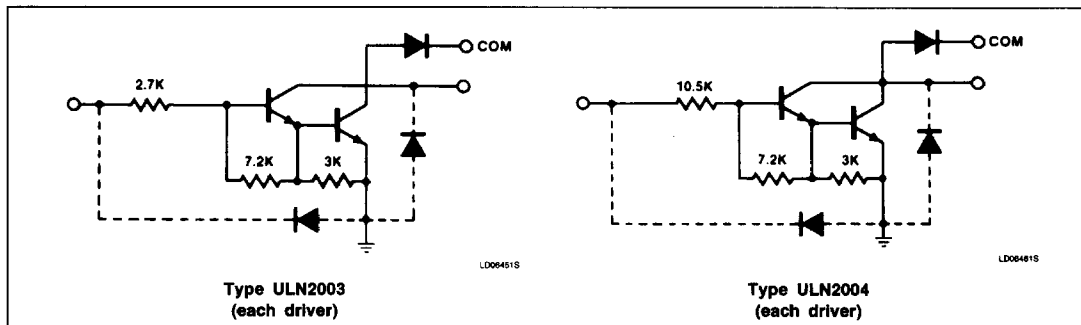
#### ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE
16-Pin Plastic DIP	0 to +70°C	ULN2003N
16-Pin Plastic DIP	0 to +70°C	ULN2004N
16-Pin Cerdip	0 to +70°C	ULN2003F
16-Pin Cerdip	0 to +70°C	ULN2004F
16-Pin Plastic SO	0 to +70°C	ULN2003D
16-Pin Plastic SO	0 to +70°C	ULN2004D

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### EQUIVALENT SCHEMATICS



### ABSOLUTE MAXIMUM RATINGS $T_A = 25^\circ\text{C}$ free air temperature for any one Darlington pair unless otherwise specified.<sup>1</sup>

SYMBOL	PARAMETER	RATING	UNIT
$V_{CE}$	Output voltage	50	V
$V_{IN}$	Input voltage	30	V
$V_{EBO}$	Emitter base voltage	6	V
$I_C$	Continuous collector current	500	mA
$I_B$	Continuous base current	25	mA
$P_D$	Maximum power dissipation <sup>2</sup>		
	F package	1190	mW
	N package	1450	mW
	D package	1090	mW
$T_J$	Operating junction temperature	150	$^\circ\text{C}$
$T_A$	Operating ambient temperature range	0 to +85	$^\circ\text{C}$
$T_{STG}$	Storage temperature range	-65 to +150	$^\circ\text{C}$

**NOTES:**

1. Under normal operating conditions, these units will sustain 350mA per output with  $V_{CE(SAT)} = 1.6\text{V}$  at  $70^\circ\text{C}$  with a pulse width of 20ms and a duty cycle of 30%.
2. Derate above  $25^\circ\text{C}$ , at the following rates:  
 F package at  $9.5\text{mW}/^\circ\text{C}$   
 N package at  $11.6\text{mW}/^\circ\text{C}$   
 D package at  $8.7\text{mW}/^\circ\text{C}$

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**DC ELECTRICAL CHARACTERISTICS**  $T_A = 25^\circ\text{C}$ , unless otherwise specified.<sup>1, 2, 3</sup>

SYMBOL	PARAMETER	TEST CONDITIONS	TEST FIG.	LIMITS			UNIT
				Min	Typ	Max	
$I_{CEX}$	Output leakage current Type ULN2004	$V_{CE} = 50\text{V}$ , $T_A = 70^\circ\text{C}$	1A			100	$\mu\text{A}$
		$V_{CE} = 50\text{V}$ , $T_A = 70^\circ\text{C}$ , $V_{IN} = 1\text{V}$	1B			500	$\mu\text{A}$
$V_{CE(SAT)}$	Collector-emitter Saturation voltage	$I_C = 350\text{mA}$ , $I_B = 500\mu\text{A}$	2		1.25	1.6	V
		$I_C = 200\text{mA}$ , $I_B = 350\mu\text{A}$	2		1.1	1.3	V
		$I_C = 100\text{mA}$ , $I_B = 250\mu\text{A}$	2		0.9	1.1	V
$I_{IN(ON)}$	Input current Type ULN2003 Type ULN2004	$V_{IN} = 3.85\text{V}$	3		0.93	1.35	mA
		$V_{IN} = 5\text{V}$	3		0.35	0.5	mA
		$V_{IN} = 12\text{V}$	3		1.0	1.45	mA
$I_{IN(OFF)}$	Input current	$I_C = 500\mu\text{A}$ , $T_A = 70^\circ\text{C}$	4	50	65		$\mu\text{A}$
$V_{IN(ON)}$	Type ULN2003	$V_{CE} = 2\text{V}$ , $I_C = 200\text{mA}$	5			2.4	V
		$V_{CE} = 2\text{V}$ , $I_C = 250\text{mA}$	5			2.7	V
		$V_{CE} = 2\text{V}$ , $I_C = 300\text{mA}$	5			3.0	V
	Type ULN2004	$V_{CE} = 2\text{V}$ , $I_C = 125\text{mA}$	5			5.0	V
		$V_{CE} = 2\text{V}$ , $I_C = 200\text{mA}$	5			6.0	V
		$V_{CE} = 2\text{V}$ , $I_C = 275\text{mA}$	5			7.0	V
		$V_{CE} = 2\text{V}$ , $I_C = 350\text{mA}$	5			8.0	V
$C_{IN}$	Input capacitance			15	30	pF	
$I_R$	Clamp diode leakage current	$V_R = 50\text{V}$	6			50	$\mu\text{A}$
$V_F$	Clamp diode forward voltage	$I_F = 350\text{mA}$	7		1.7	2	V

**NOTES:**

- All limits stated apply to the complete Darlington series except as specified for a single device type.
- The  $I_{IN(OFF)}$  current limit guarantees against partial turn-on of the output.
- The  $V_{IN(ON)}$  voltage limit guarantees a minimum output sink current per the specified test conditions.

**AC ELECTRICAL CHARACTERISTICS**  $T_A = 25^\circ\text{C}$ , unless otherwise specified.<sup>1, 2, 3</sup>

SYMBOL	PARAMETER	TEST CONDITIONS	TEST FIG.	LIMITS			UNIT
				Min	Typ	Max	
$t_{PLH}$	Turn-on delay	$0.5 E_{IN}$ to $0.5 E_{OUT}$			1.0	5	$\mu\text{s}$
$t_{PHL}$	Turn-off delay	$0.5 E_{IN}$ to $0.5 E_{OUT}$			1.0	5	$\mu\text{s}$

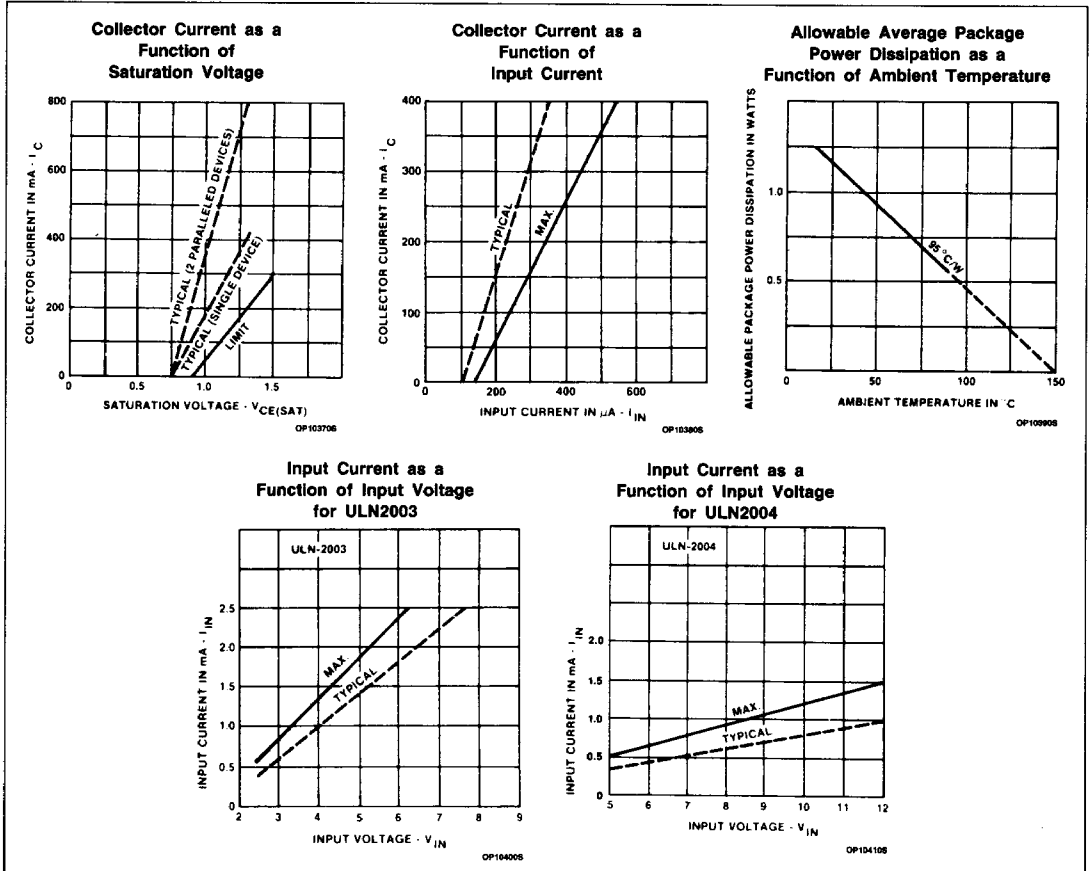
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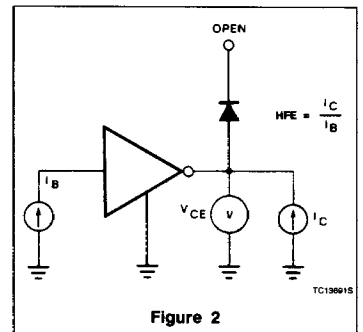
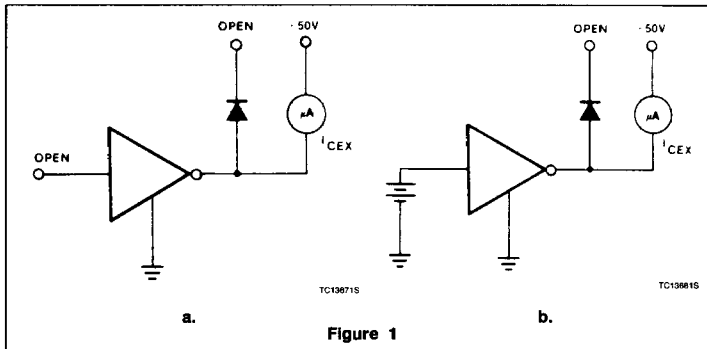
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## TYPICAL PERFORMANCE CHARACTERISTICS



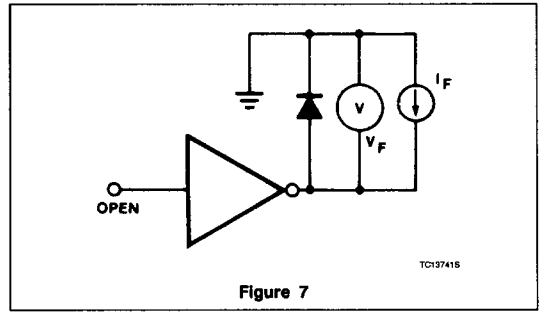
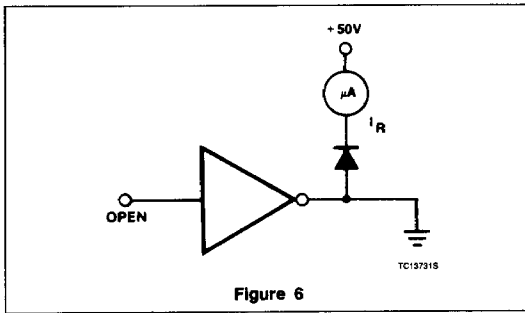
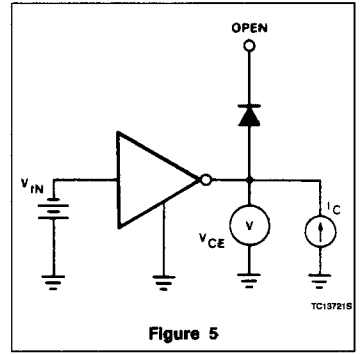
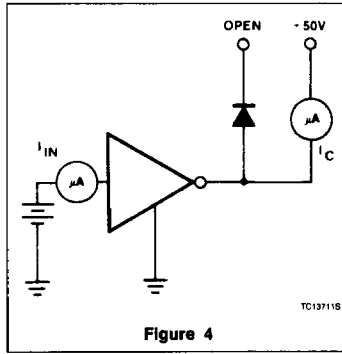
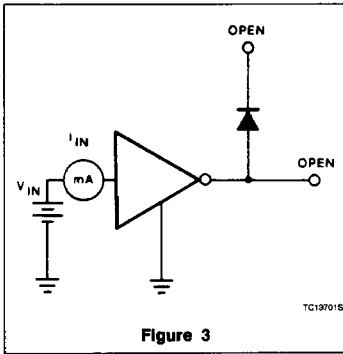
## TEST CIRCUITS



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## TEST CIRCUITS (Continued)



## TYPICAL APPLICATIONS

