

HIGH VOLTAGE/HIGH CURRENT DARLINGTON TRANSISTOR ARRAYS

ULN2001/03/04

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 inrush currents to 600mA are allowable, making them ideal for driving tungsten filament lamps also.

The Type ULN-2001 is a general-purpose array which may be used with DTL, TTL, PMOS, CMOS, etc. It is pinned with inputs opposite outputs to facilitate ease of circuit board layout and is priced to compete directly with discrete transistor alternatives.

The Type ULN-2003 has a series base resistor to each Darlington pair, and thus allows operation directly with TTL or CMOS operating at a supply voltage of 5V.

The Type ULN-2004 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 ULN-2003.

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

ABSOLUTE MAXIMUM RATINGS

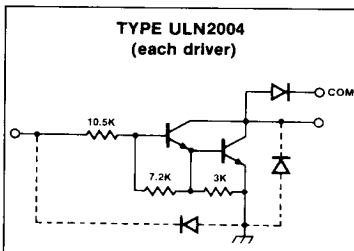
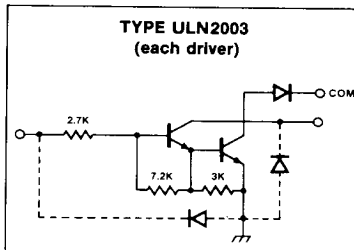
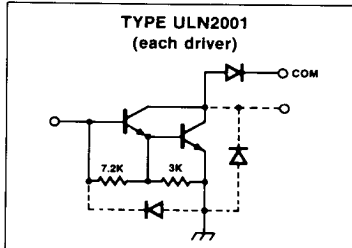
at 25°C Free-Air temperature for any one Darlington pair unless otherwise specified.

PARAMETER		RATING	UNIT
V _{CE}	Output voltage	50	V
V _{IN}	Input voltage	30	V
V _{EB0}	Emitter base voltage	6	V
I _C	Continuous collector current	500	mA
I _B	Continuous base current	25	mA
P _D	Power dissipation	1.3	W
	Derating factor above 25°C	95	°C/W
T _A	Ambient temperature range (operating)	0 to +85	°C
T _S	Storage temperature range	-65 to +150	°C

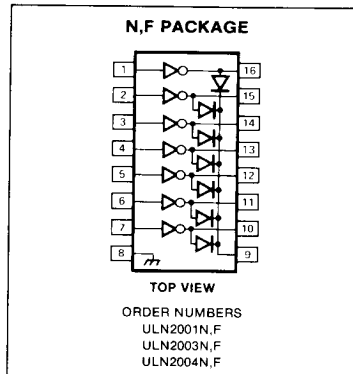
*NOTE

Under normal operating conditions, these units will sustain 350mA per output with V_{CE(SAT)} = 1.6V at 70°C with a pulse width of 20 ms and a duty cycle of 30%.

EQUIVALENT SCHEMATICS



PIN CONFIGURATION



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

PARAMETER	TEST CONDITIONS	Test Fig.	LIMITS			UNIT
			Min	Typ	Max	
I_{CEX} Output leakage current Type ULN-2004	$V_{CE} = 50\text{V}$, $T_A = 70^\circ\text{C}$ $V_{CE} = 50\text{V}$, $T_A = 70^\circ\text{C}$, $V_{IN} = 1\text{V}$	1A 1B	— —	— —	100 500	μA μA
$V_{CE(SAT)}$ Collector-emitter Saturation voltage	$I_C = 350\text{mA}$, $I_B = 500\mu\text{A}$ $I_C = 200\text{mA}$, $I_B = 350\mu\text{A}$ $I_C = 100\text{mA}$, $I_B = 250\mu\text{A}$	2 2 2	— — —	1.25 1.1 0.9	1.6 1.3 1.1	V V V
$I_{IN(ON)}$ Input current Type ULN-2003 Type ULN-2004	$V_{IN} = 3.85\text{V}$ $V_{IN} = 5\text{V}$ $V_{IN} = 12\text{V}$	3 3 3	— — —	0.93 0.35 1.0	1.35 0.5 1.45	mA mA mA
$I_{IN(OFF)}$ Input current	$I_C = 500\mu\text{A}$, $T_A = 70^\circ\text{C}$	4	50	65	—	μA
$V_{IN(ON)}$ Input voltage						
Type ULN-2003	$V_{CE} = 2\text{V}$, $I_C = 200\text{mA}$ $V_{CE} = 2\text{V}$, $I_C = 250\text{mA}$ $V_{CE} = 2\text{V}$, $I_C = 300\text{mA}$	5 5 5	— — —	— — —	2.4 2.7 3.0	V V V
Type ULN-2004	$V_{CE} = 2\text{V}$, $I_C = 125\text{mA}$ $V_{CE} = 2\text{V}$, $I_C = 200\text{mA}$ $V_{CE} = 2\text{V}$, $I_C = 275\text{mA}$ $V_{CE} = 2\text{V}$, $I_C = 350\text{mA}$	5 5 5 5	— — — —	— — — —	5.0 6.0 7.0 8.0	V V V V
h_{FE} D-C forward current transfer ratio Type ULN-2001	$V_{CE} = 2\text{V}$, $I_C = 350\text{mA}$	2	1000		—	—
C_{IN} Input capacitance		—	—	15	30	pF
I_R Clamp diode leakage current	$V_R = 50\text{V}$	6	—	—	50	μA
V_F Clamp diode forward voltage	$I_F = 350\text{mA}$	7	—	1.7	2	V

NOTES

1. All limits stated apply to the complete Darlington series except as specified for a single device type.
2. The $I_{IN(OFF)}$ current limit guarantees against partial turn-on of the output.
3. 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.1,2,3

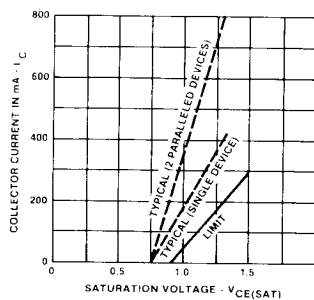
PARAMETER	TEST CONDITIONS	Test Fig.	LIMITS			UNIT
			Min	Typ	Max	
t_{PLH} Turn-on delay	0.5 E_{IN} to 0.5 E_{OUT}	—	—	1.0	5	μs
t_{PHL} Turn-off delay	0.5 E_{IN} to 0.5 E_{OUT}	—	—	1.0	5	μs

NOTES

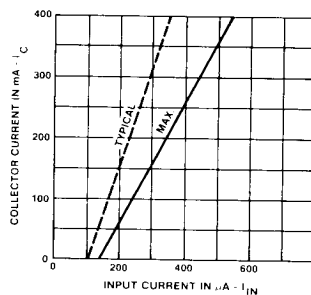
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TYPICAL PERFORMANCE CHARACTERISTICS

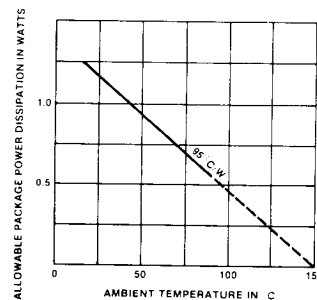
COLLECTOR CURRENT AS A FUNCTION OF SATURATION VOLTAGE



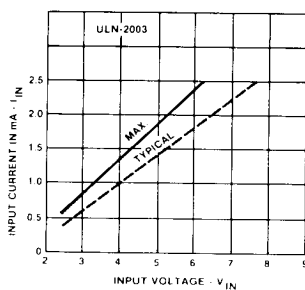
COLLECTOR CURRENT AS A FUNCTION OF INPUT CURRENT



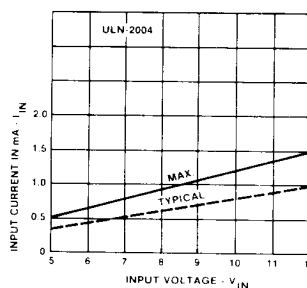
ALLOWABLE AVERAGE PACKAGE POWER DISSIPATION AS A FUNCTION OF AMBIENT TEMPERATURE



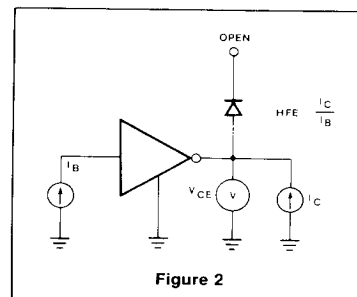
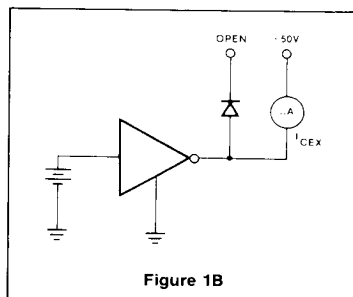
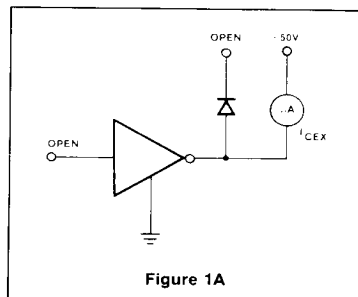
INPUT CURRENT AS A FUNCTION OF INPUT VOLTAGE FOR TYPE ULN-2003



INPUT CURRENT AS A FUNCTION OF INPUT VOLTAGE FOR TYPE ULN-2004



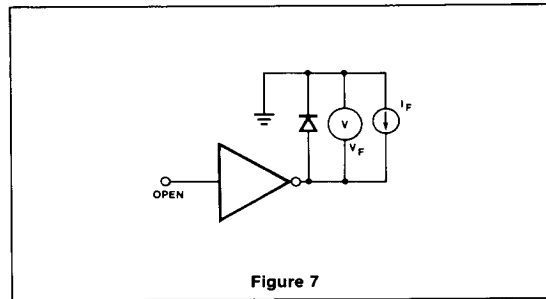
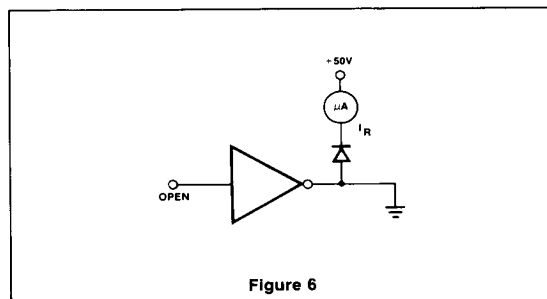
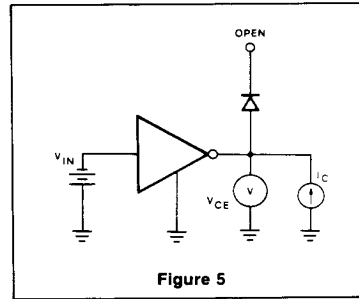
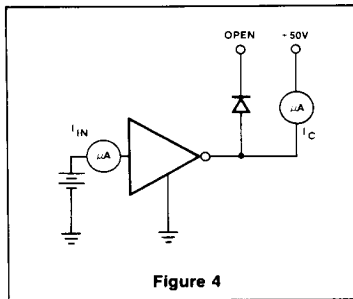
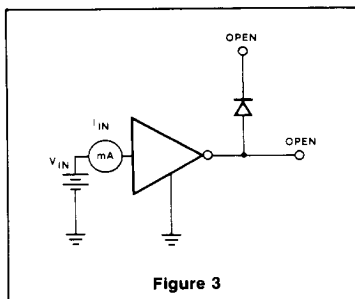
TEST FIGURES



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TEST FIGURES (Cont'd)



TYPICAL APPLICATIONS

