HIGH VOLTAGE/HIGH CURRENT DARLINGTON TRANSISTOR ARRAYS ULN2003/04

DESCRIPTION

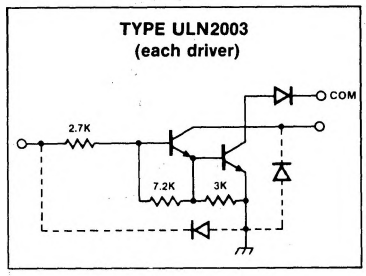
These high-voltage, high-current Darlington transistor arrays are comprised of seven silicon NPN Darlington pairs on a common monolithic substrate. All units feature open collector outputs and integral suppression diodes for inductive loads. Peak inrush currents to 600mA are allowable, making them ideal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

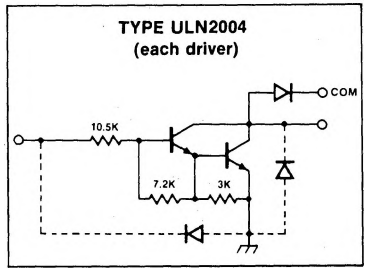
The Type ULN2003 has a series base resistor to each Darlington pair, and thus allows operation directly with TTL or CMOS 5V supply voltage.

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.

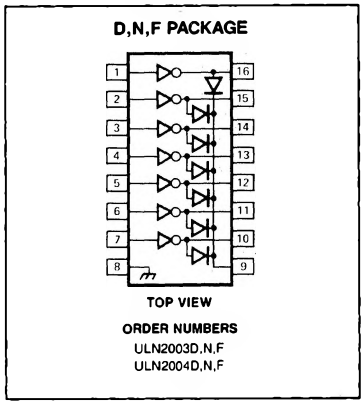
In all cases, the individual Darlington pair collector current rating is 500mA. However, outputs may be paralleled for higher load current capability. All devices are supplied in a 16-pin dual in-line plastic package.

EQUIVALENT SCHEMATICS





PIN CONFIGURATION



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_{EBO}	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 $V_{CE(SAT)} \leq 1.6V$ at 70°C with a pulse width of 20 ms and a duty cycle of 30%.

DC ELECTRICAL CHARACTERISTICS $T_A = 25°C$ unless otherwise specified.[1,2,3]

PARAMETER		TEST CONDITIONS	Test Fig.	LIMITS Min	LIMITS Typ	LIMITS Max	UNIT
I_{CEX}	Output leakage current	$V_{CE} = 50V$, $T_A = 70°C$	1A	—	—	100	μA
	Type ULN2004	$V_{CE} = 50V$, $T_A = 70°C$, $V_{IN} = 1V$	1B	—	—	500	μA
$V_{CE(SAT)}$	Collector-emitter Saturation voltage	$I_C = 350mA$, $I_B = 500\mu A$	2	—	1.25	1.6	V
		$I_C = 200mA$, $I_B = 350\mu A$	2	—	1.1	1.3	V
		$I_C = 100mA$, $I_B = 250\mu A$	2	—	0.9	1.1	V
$I_{IN(ON)}$	Input current						
	Type ULN2003	$V_{IN} = 3.85V$	3	—	0.93	1.35	mA
	Type ULN2004	$V_{IN} = 5V$	3	—	0.35	0.5	mA
		$V_{IN} = 12V$	3	—	1.0	1.45	mA
$I_{IN(OFF)}$	Input current	$I_C = 500\mu A$, $T_A = 70°C$	4	50	65	—	μA
$V_{IN(ON)}$	Input voltage						
	Type ULN2003	$V_{CE} = 2V$, $I_C = 200mA$	5	—	—	2.4	V
		$V_{CE} = 2V$, $I_C = 250mA$	5	—	—	2.7	V
		$V_{CE} = 2V$, $I_C = 300mA$	5	—	—	3.0	V
	Type ULN2004	$V_{CE} = 2V$, $I_C = 125mA$	5	—	—	5.0	V
		$V_{CE} = 2V$, $I_C = 200mA$	5	—	—	6.0	V
		$V_{CE} = 2V$, $I_C = 275mA$	5	—	—	7.0	V
		$V_{CE} = 2V$, $I_C = 350mA$	5	—	—	8.0	V
C_{IN}	Input capacitance		—	—	15	30	pF
I_R	Clamp diode leakage current	$V_R = 50V$	6	—	—	50	μA
V_F	Clamp diode forward voltage	$I_F = 350mA$	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 $T_A = 25°C$ unless otherwise specified.[1,2,3]

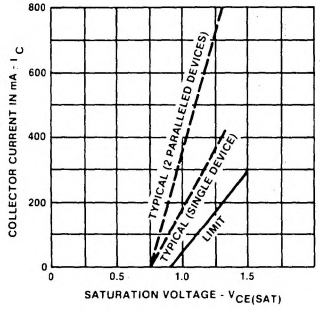
PARAMETER		TEST CONDITIONS	Test Fig.	LIMITS Min	LIMITS Typ	LIMITS Max	UNIT
t_{PLH}	Turn-on delay	0.5 E_{IN} to 0.5 E_{OUT}	—	—	1.0	5	μs
t_{PHL}	Turn-off delay	0.5 E_{IN} to 0.5 E_{OUT}	—	—	1.0	5	μs

NOTES

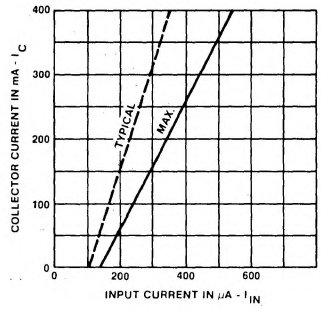
1. All limits stated apply to the complete Darlington series except as specified for a single device type.
2. The $I_{IN(OFF)}$ current limit guarantees against partial turn-on of the output.
3. The $V_{IN(ON)}$ voltage limit guarantees a minimum output sink current per the specified test conditions.

TYPICAL PERFORMANCE CHARACTERISTICS

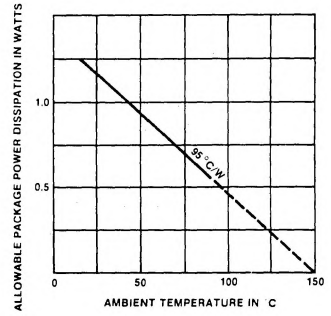
COLLECTOR CURRENT AS A FUNCTION OF SATURATION VOLTAGE



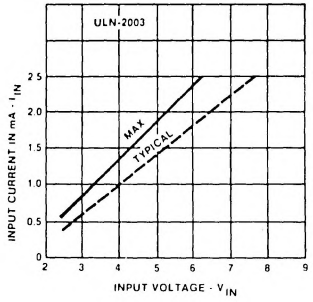
COLLECTOR CURRENT AS A FUNCTION OF INPUT CURRENT



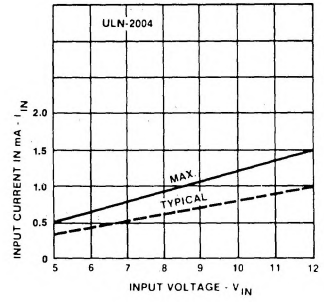
ALLOWABLE AVERAGE PACKAGE POWER DISSIPATION AS A FUNCTION OF AMBIENT TEMPERATURE



INPUT CURRENT AS A FUNCTION OF INPUT VOLTAGE FOR TYPE ULN2003



INPUT CURRENT AS A FUNCTION OF INPUT VOLTAGE FOR TYPE ULN2004



TEST FIGURES

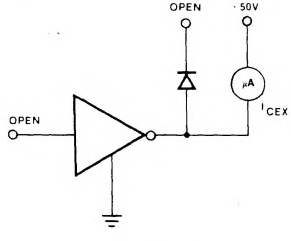


Figure 1A

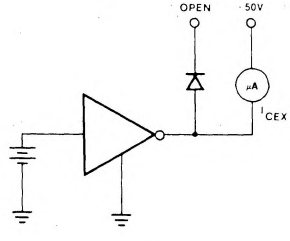


Figure 1B

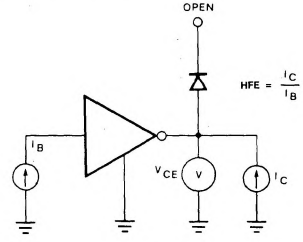


Figure 2

TEST FIGURES (Cont'd)

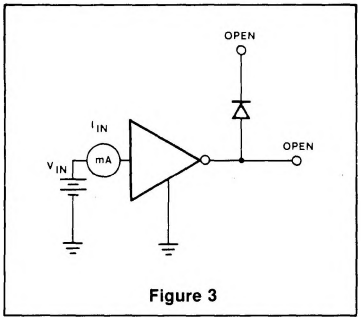


Figure 3

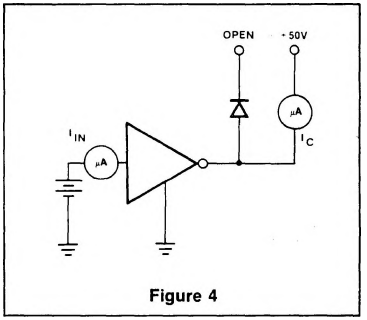


Figure 4

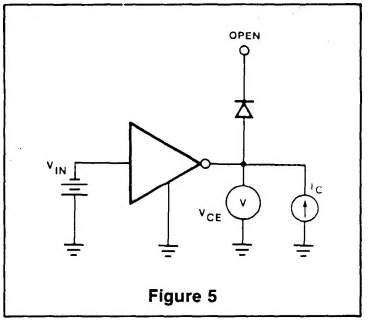


Figure 5

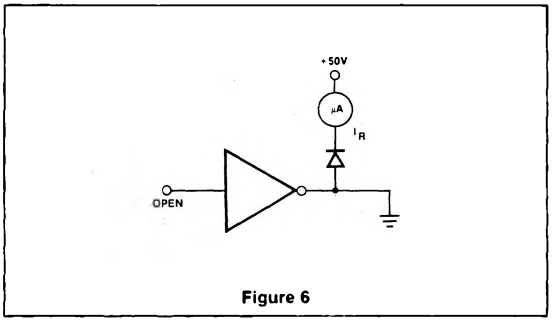


Figure 6

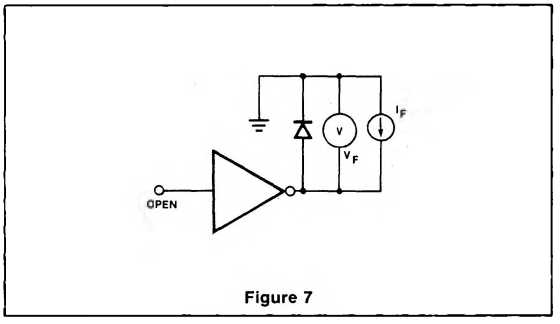


Figure 7

TYPICAL APPLICATIONS