

DARLINGTON SEVEN-DIGIT CURRENT DRIVER

(functional analogue of ULN2003A, ULN2004A f. «Texas Instruments»)

Microcircuits ULN2003AN, ULN2003AD, ULN2004AN, ULN2004AD – Darlington seven-digit current driver.

Microcircuits are intended for actuating devices control.

Main characteristics:

- Output current passing through collector of one Darlington composite transistor (one digit), does not exceed 500 mA;
- voltage, provided to microcircuit output does not exceed 50 V;
- integrated circuits can directly operate semiconductor devices of different type;
- operating temperatures range from minus 40 to plus 85 °C.

Application scope: In actuating devices (relay, lamps, light emitting diodes, displays, communication lines and logic devices).

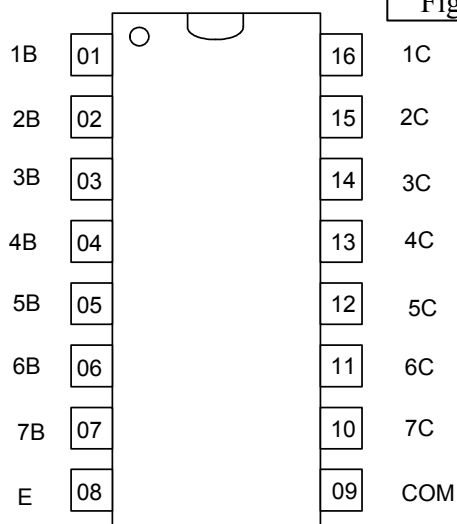
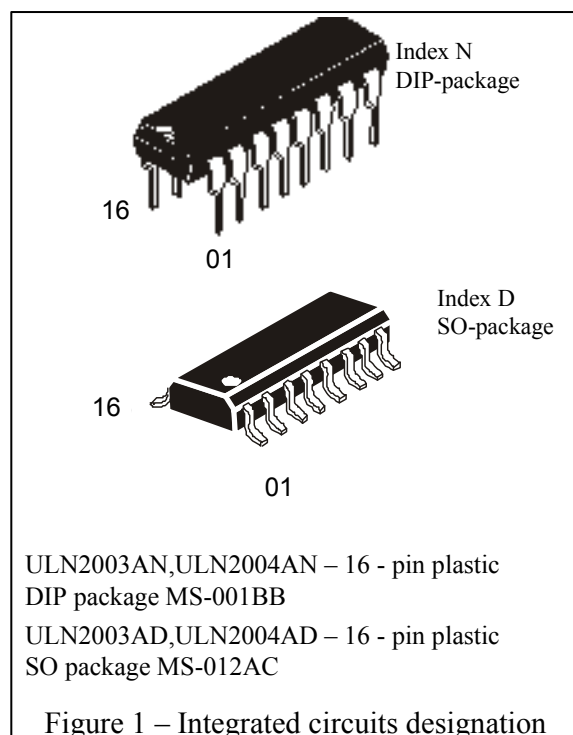
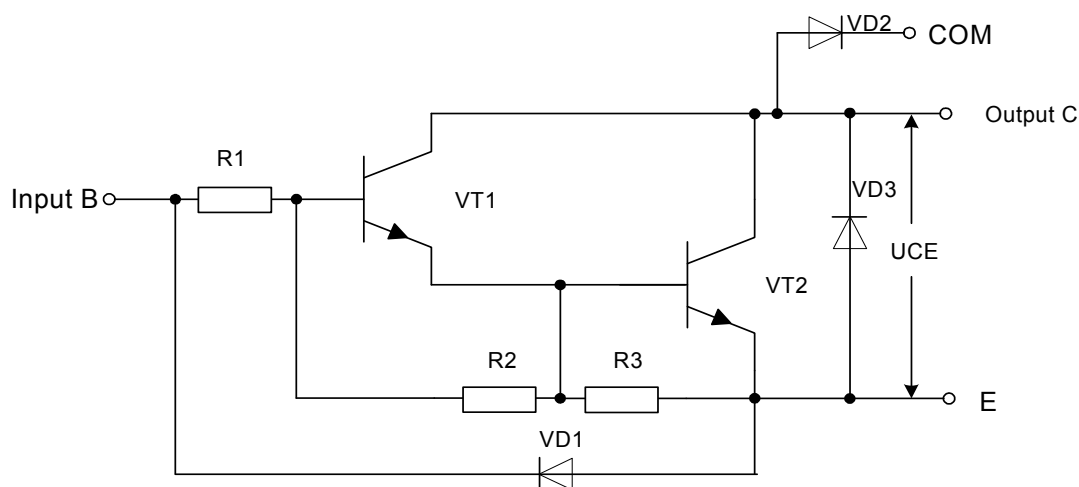


Figure 2– Pin designation in ICs ULN2003AN, ULN2003AD, ULN2004AN, ULN2004AD package

Table 1 – Assignment of IC pins and chip contact pads (CP)

CP number	Pin number	Symbol	Description
01	01	1B	Input
02	02	2B	Input
03	03	3B	Input
04	04	4B	Input
05	05	5B	Input
06	06	6B	Input
07	07	7B	Input
08	08	E	Emitter pin
09	08	E	Emitter pin
10	09	COM	Control pin
11	09	COM	Control pin
12	10	$\overline{7C}$	Output
13	11	$\overline{6C}$	Output
14	12	$\overline{5C}$	Output
15	13	$\overline{4C}$	Output
16	14	$\overline{3C}$	Output
17	15	$\overline{2C}$	Output
18	16	$\overline{1C}$	Output



R1 – resistor 2,7 kOhm for ULN2003AN,ULN2003AD microcircuits; 10,5 kOhm for ULN2004AN,ULN2004AD integrated circuits;
R2 – resistor 7,2 kOhm;
R3 – resistor 3,0 kOhm;
VD1 – VD3 – diodes;
VT1, VT2 – transistors

Figure 3 – Electric diagram of a single –digit in microcircuit current driver

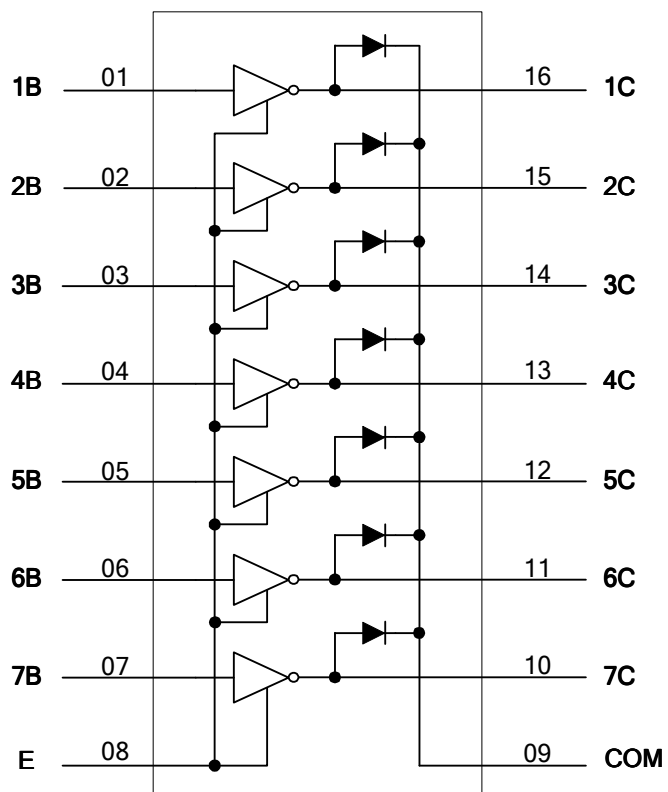


Figure 4 – Microcircuits block diagram

Table 2 – Absolute maximum ratings

Symbol	Parameter	Norm		Unit
		min	max	
U_I	Microcircuit input voltage	–	30	V
U_{CE}	Collector-emitter voltage	–	51	V
I_C	Maximum collector peak current	–	500	mA
I_E	Common emitter current	–	-2.5	A
U_R	Direct reverse diode voltage on control pin	–	51	V
I_R	Diode current by control pin	–	500	mA
T_{stg}	Storage temperature	-60	150	°C
T_j	Maximum chip temperature	–	151	°C

Table 3 – Recommended electrical operating ratings

Symbol	Parameter	Norm		Unit
		min	max	
U_I	Microcircuits ULN2003AN, ULN2003AD input voltage	–	3,85	V
U_I	Microcircuit ULN2004AN, ULN2004AD input voltage	–	12	V
U_{CE}	Collector-emitter voltage	–	50	V
I_C	Maximum collector peak current	–	350	mA
U_R	Direct reverse diode voltage of diode on control pin	–	50	V
I_R	Diode current on control pin	–	350	mA
T_j	Maximum chip temperature	–	150	°C

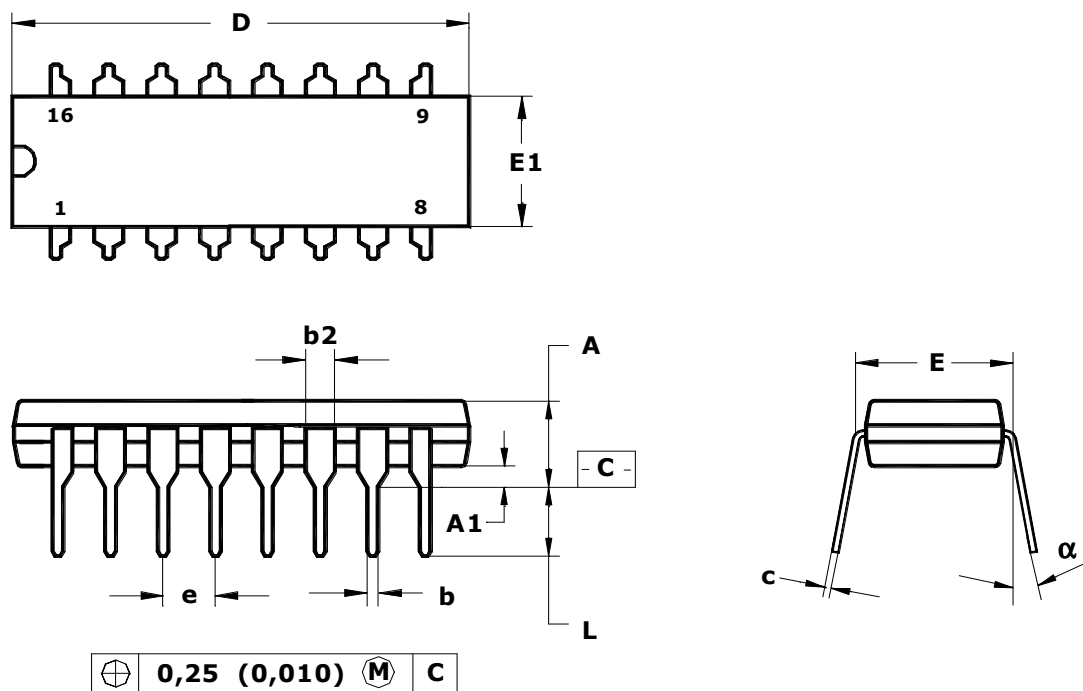
Table 4 –Electrical parameters

Symbol	Parameter	Measurement conditions	Norm		Ambient temperature, °C	Unit
			min	max		
$U_{I(on)}$	Input voltage, ICs ULN2003AN,ULN2003AD output ON-state	$I_C = 200 \text{ mA}$ $U_{CE} \leq 2 \text{ V}$	-	$\frac{2,4}{3,0}$	25 ± 10 -40; 85	V
		$I_C = 250 \text{ mA}$ $U_{CE} \leq 2 \text{ V}$		$\frac{2,7}{3,4}$		
		$I_C = 300 \text{ mA}$ $U_{CE} \leq 2 \text{ V}$		$\frac{3,0}{3,8}$		
		$I_C = 125 \text{ mA}$ $U_{CE} \leq 2 \text{ V}$		$\frac{5,0}{6,5}$		
	ICs ULN2004AN,ULN2004AD	$I_C = 200 \text{ mA}$ $U_{CE} \leq 2 \text{ V}$		$\frac{6,0}{7,5}$		
		$I_C = 275 \text{ mA}$ $U_{CE} \leq 2 \text{ V}$		$\frac{7,0}{8,5}$		
		$I_C = 350 \text{ mA}$ $U_{CE} \leq 2 \text{ V}$		$\frac{8,0}{9,5}$		
$U_{CE(sat)}$	Collector-emitter saturation voltage	$I_C = 100 \text{ mA}$ $I_I = 250 \text{ uA}$	-	$\frac{1,1}{1,4}$	25 ± 10 -40; 85	V
		$I_C = 200 \text{ mA}$ $I_I = 350 \text{ uA}$		$\frac{1,3}{1,6}$		
		$I_C = 350 \text{ mA}$ $I_I = 500 \text{ uA}$		$\frac{1,6}{2,0}$		
I_{CEX}	Collector current, ICs ULN2003AN,ULN2003AD ULN2004AN,ULN2004AD output OFF-state	$U_I = 3 \text{ V}$ $I_I = 0 \text{ mA}$ $U_{CE} = 50 \text{ V}$	-	$\frac{20}{100}$	25 ± 10 -40; 85	uA
	ICs ULN2004AN,ULN2004AD	$U_I = 1 \text{ V}$ $I_I = 0 \text{ mA}$ $U_{CE} = 50 \text{ V}$		$\frac{250}{500}$		
U_F	Direct diode voltage by control pin	$I_F = 350 \text{ mA}$	-	$\frac{2,0}{2,5}$	25 ± 10 -40; 85	V
$I_{I(off)}$	Input current at output OFF-state	$U_{CE} = 50 \text{ V}$ $I_C \leq 500 \text{ uA}$	$\frac{65}{50}$	-	25 ± 10 -40; 85	uA
I_I	Input current of ICs ULN2003AN,ULN2003AD	$U_I = 3,85 \text{ V}$	-	$\frac{1,35}{1,7}$	25 ± 10 -40; 85	mA
	ICs ULN2004AN,ULN2004AD	$U_I = 5,0 \text{ V}$	-	$\frac{0,5}{1,0}$		
		$U_I = 12 \text{ V}$		$\frac{1,45}{2,5}$		
I_R	Direct diode current by control pin	$U_R = 50 \text{ V}$	-	$\frac{50}{100}$	25 ± 10 -40; 85	uA
U_{OH}	High level output voltage	$U_S = 50 \text{ V}$ $I_O = 300 \text{ mA}$	30	-	25 ± 10	V
t_{PHL}, t_{PLH}	Switch ON/OFF propagation delay time, us	$U_S = 50 \text{ V}$	-	1,0	25 ± 10	us

Note – U_S – supply voltage at measuring parameters U_{OH}, t_{PHL}, t_{PLH}

Brief summary of integrated circuits

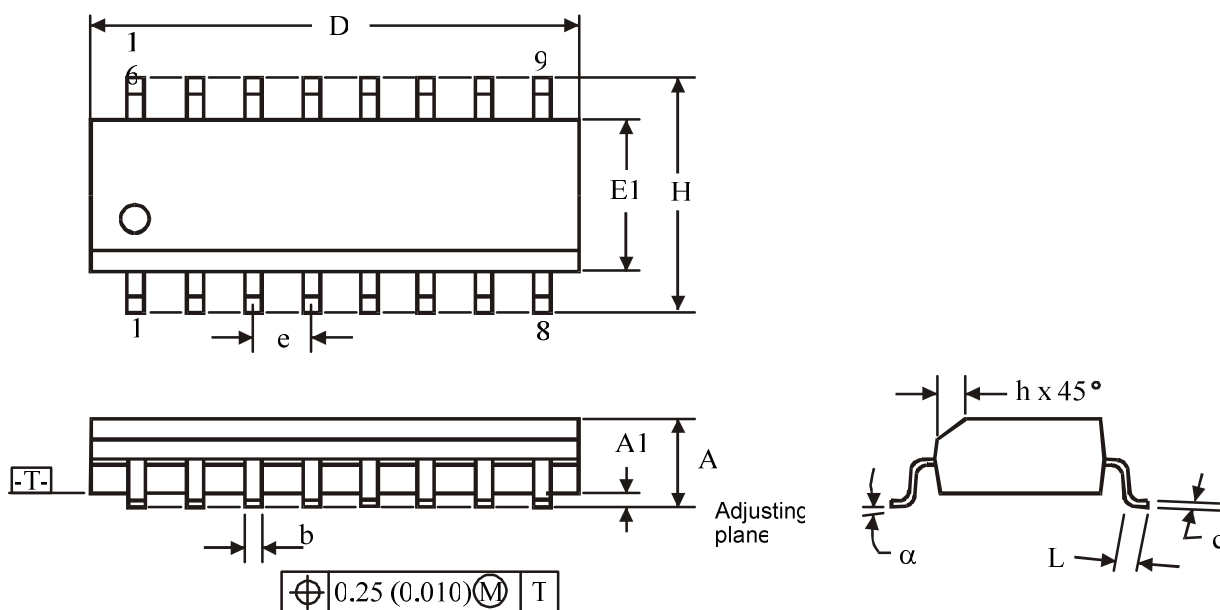
Microcircuit is a matrix of seven couples of npn transistors, switched on by Darlington circuit, with high-voltage outputs with large current load, with diodes, switched on by scheme with common cathode, for inductive load connection. Absolute maximum current passing through collector of one Darlington composite transistor (one digit), does not exceed 500 mA. For current increase, the Darlington composite transistors can be switched on in parallel. In ULN2004AN,ULN2004AD microcircuits in base chains of Darlington transistors 2,7 kOhm resistors are switched and microcircuits can directly operate TTL or 5 V CMOS devices. In microcircuits ULN2004AN,ULN2004AD in a base chains of Darlington transistors 10,5 kOhm resistors are switched and integrated circuits can directly operate CMOS devices with supply voltage of 6-15 V.



Note - Dimensions D, E1 don't include fin values that shouldn't exceed 0,25 mm (0,010) per side.

	D	E1	A	b	b2	e	α	L	E	c	A1
Millimeters											
min	18,93	6,07	—	0,36	1,14	2,54	0~	2,93	7,62	0,20	0,38
max	19,43	7,11	5,33	0,56	1,78		15~	3,81	8,26	0,36	—
Inches											
min	0,355	0,240	—	0,014	0,045	0,1	0~	0,115	0,300	0,008	0,015
max	0,400	0,280	0,210	0,022	0,070		15~	0,150	0,325	0,014	—

Figure 5 – Dimensions of DIP-package MS-001BB



Note – Dimensions D, E1 don't include the flash value that shouldn't exceed 0,25 mm (0,010) to the side.

	D	E1	A	b	h	e	α	L	H	c	A1
Millimeters											
min	9,80	3,80	1,35	0,33	0,25	1,27	0~	0,40	5,80	0,19	0,10
max	10,00	4,00	1,75	0,51	0,50		8~	1,27	6,20	0,25	0,25
Inches											
min	0,386	0,150	0,053	0,013	0,010	0,050	0~	0,016	0,228	0,007	0,004
max	0,394	0,157	0,069	0,020	0,020		8~	0,050	0,244	0,010	0,010

Figure 6 – Dimensions of SO-package MS-012AC