



7-Channel Darlington Transistor Array Circuit

Description

ULN2003A is a monolithic integrated high-voltage, high-current Darlington transistor array. The circuit contains seven independent Darlington driver channels. It is internally equipped with freewheeling diodes, suitable for driving inductive loads such as relays and stepper motors. Each Darlington transistor can output a collector current of 500mA, and higher current output capability can be achieved by paralleling multiple channels. The circuit is widely used in relay driving, lighting driving, display (LED) driving, stepper motor driving and logic buffering.

Each Darlington transistor of ULN2003A is in series with a 2.7K base resistor. It can be directly connected to TTL/CMOS circuits at a working voltage of 5V, and can directly process data that previously required standard logic buffers.

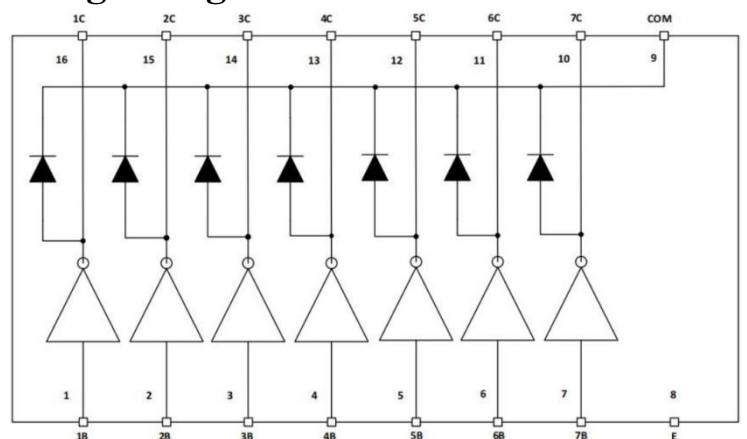
Features

- 500mA rated collector current(per Channel)
- High operating voltage(50V)
- Input compatible with TTL/CMOS logic signals
- Widely used in relay driving
- Package type : SOP-16 and DIP-16

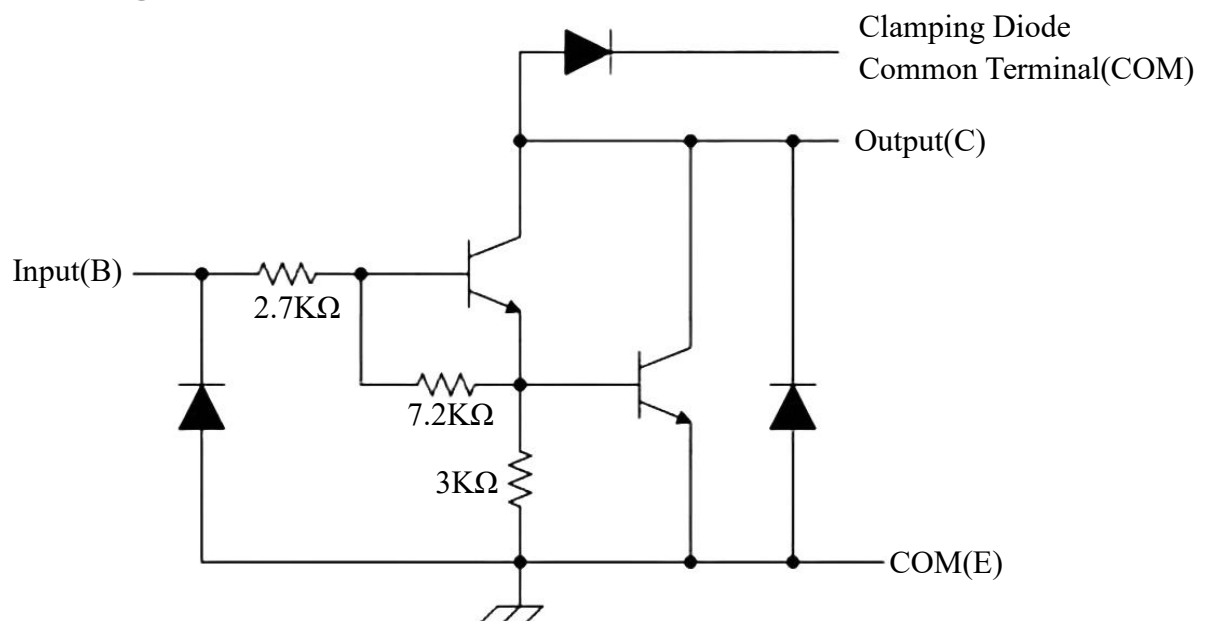
Applications

- Relay Driver
- Indicator light Driver
- Display Driver

Logic diagram



Function Block Diagram(single-channel Darlington driver circuit)





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Pin Description

Pin No.	Pin Name	I/O	Description	Pin Configuration Diagram
1	1B	I	1th Channel Darlington Base Input	
2	2B		2th Channel Darlington Base Input	
3	3B		3th Channel Darlington Base Input	
4	4B		4th Channel Darlington Base Input	
5	5B		5th Channel Darlington Base Input	
6	6B		6th Channel Darlington Base Input	
7	7B		7th Channel Darlington Base Input	
8	E	-	Common Emitter of All Channels (Usually Grounded)	
9	COM	-	Common Terminal of All Clamp Diodes(For Inductive Loads)	
10	7C	O	7th Channel Darlington Collector Output	
11	6C		6th Channel Darlington Collector Output	
12	5C		5th Channel Darlington Collector Output	
13	4C		4th Channel Darlington Collector Output	
14	3C		3th Channel Darlington Collector Output	
15	2C		2th Channel Darlington Collector Output	
16	1C		1th Channel Darlington Collector Output	

Absolute Maximum Ratings

Parameter		Symbol	Limit	Unit
Collector Emitter Voltage		V_{CE}	50	V
COM Terminal Voltage		V_{COM}	50	V
Input Voltage		V_I	30	V
Single Channel Collector Peak Current		I_{CP}	500	mA
Output Clamp Diode Forward Peak Current		I_{OK}	500	mA
Total Emitter Maximum Peak Current		I_{ET}	-2.5	A
Package Thermal Resistance	SOP-16	θ_{JA}	63	°C/W
	DIP-16		50	°C/W
Maximum Operating Junction Temperature		T_J	150	°C
Soldering Temperature		T_W	260	°C
Storage Temperature Range		T_S	-65~+150	°C



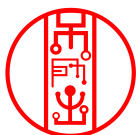
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Recommended Operating Conditions($T_A=25^{\circ}\text{C}$ unless otherwise specified)

Parameter		Symbol	Condition	Min	Max	Unit	
Collector Emitter Voltage		V _{CE}		0	50	V	
Output Current		I _{OUT}	Continuous Output, T _A =85°C, T _J =120°C		100	mA/ch	
Input Voltage		V _{IN}		0	24	V	
Input Voltage(Output On)		V _{IN(ON)}	I _{OUT} =400mA	2.8	24	V	
Input Voltage(Output Off)		V _{IN(OFF)}		0	0.7	V	
Clamp Diode Reverse Voltage		V _R			50	V	
Clamp Diode Forward Peak Current		I _F			350	mA	
Operating Temperature Range		T _A		-20	+85	°C	
Operating Junction Temperature		T _J		-20	+125	°C	
Power Dissipation	SOP-16	P _D	T _A =25°C		1.25	W	
			T _A =85°C		0.65		
	DIP-16		T _A =25°C		1.47		
			T _A =85°C		0.76		

Electrical Characteristics ($T_A=25^{\circ}\text{C}$ unless otherwise specified)

Parameter	Symbol	Test Diagram	Condition	Min	Typ	Max	Unit
On State Input Voltage	$V_{IN(ON)}$	Figure 6	$V_{CE}=2\text{V}, I_C=200\text{mA}$		1.9	2.4	V
			$V_{CE}=2\text{V}, I_C=250\text{mA}$		2	2.7	
			$V_{CE}=2\text{V}, I_C=300\text{mA}$		2.1	3	
Collector Emitter Saturation Voltage	$V_{CE(SAT)}$	Figure 5	$V_I=2.4\text{V}, I_C=30\text{mA}$		0.78	1	V
			$V_I=2.4\text{V}, I_C=60\text{mA}$		0.82	1.1	
			$V_I=2.4\text{V}, I_C=120\text{mA}$		0.9	1.2	
			$V_I=2.4\text{V}, I_C=240\text{mA}$		1.1	1.4	
			$V_I=2.4\text{V}, I_C=350\text{mA}$		1.25	1.6	
Input Current	I_I	Figure 4	$I_C=60\text{mA}, V_I=12\text{V}$		4	5.3	mA
			$I_C=60\text{mA}, V_I=6\text{V}$		1.7	2.2	
			$I_C=60\text{mA}, V_I=4.5\text{V}$		1.1	1.6	
			$I_C=60\text{mA}, V_I=2.4\text{V}$		0.35	0.7	
Clamp Diode Forward Voltage	V_F	Figure 8	$I_F=350\text{mA}$		1.6	2	V
Collector Cutoff Leakage Current	I_{CEX}	Figure 1	$V_{CE}=50\text{V}, I_I=0$			50	μA
Collector Withstand Voltage	V_{CE}	Figure 1	$V_{CE}=50\text{V}, I_I=0$	50			V
Clamp Diode Reverse Leakage Current	I_R	Figure 7	$V_R=50\text{V}$			50	μA
Clamp Diode Reverse Withstand Voltage	V_R	Figure 7	$V_R=50\text{V}$	50			V
Propagation Delay Low-High	t_{PLH}	Figure 9	$V_L=12\text{V}, R_L=45\Omega$		0.15	1	μs
Propagation Delay High-Low	t_{PHL}	Figure 9	$V_L=12\text{V}, R_L=45\Omega$		0.15	1	μs



Parameter Test Schematic Diagram

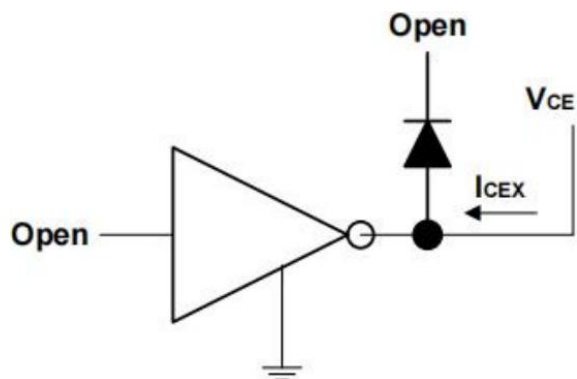


Figure 1. I_{CEX} Test Circuit

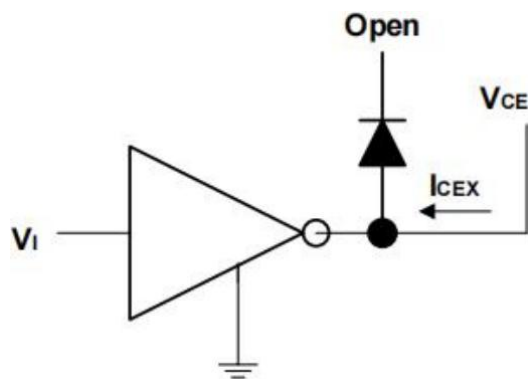


Figure 2. I_{CEX} Test Circuit

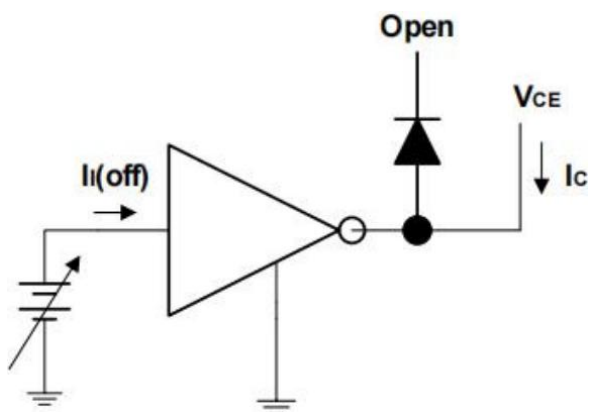


Figure 3. $I_{I(off)}$ Test Circuit

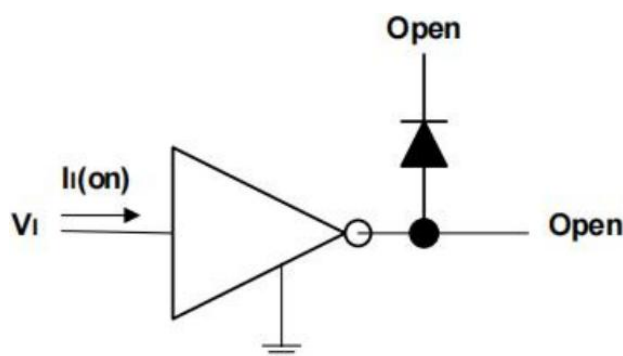


Figure 4. I_I Test Circuit

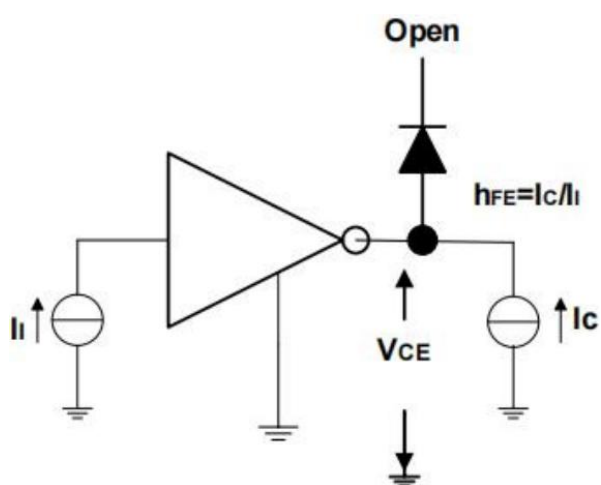


Figure 5. h_{FE} and $V_{CE(sat)}$ Test Circuit

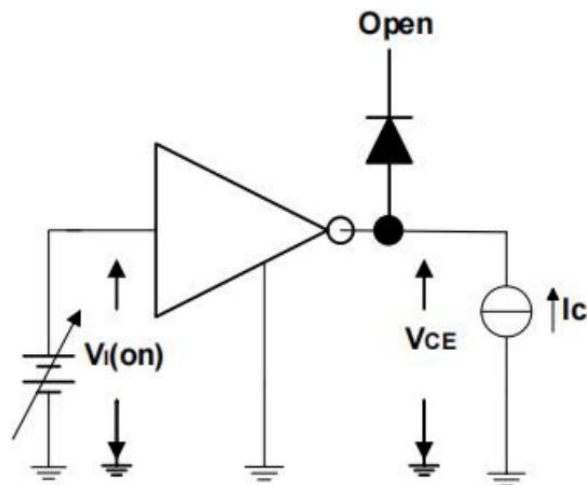


Figure 6. $V_{I(on)}$ Test Circuit



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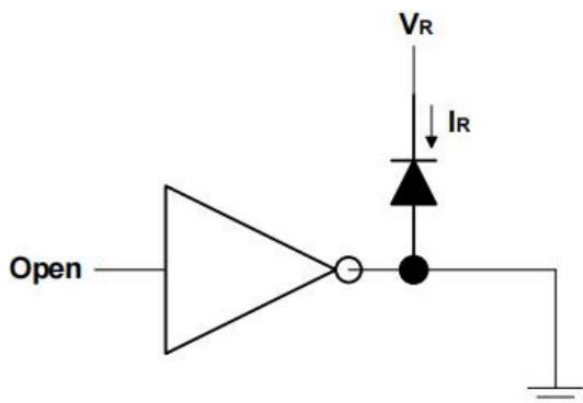


Figure 7. I_R Test Circuit

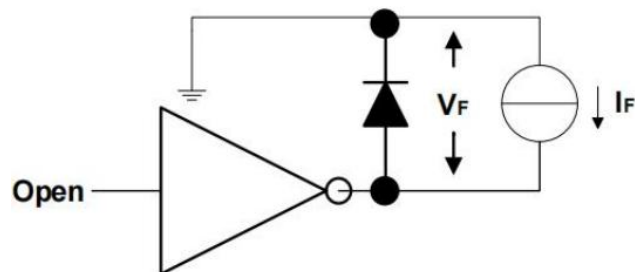
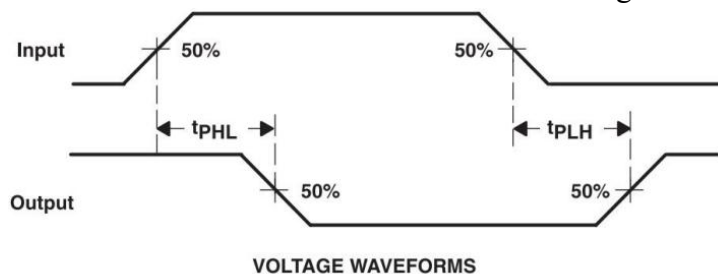


Figure 8. V_F Test Circuit



VOLTAGE WAVEFORMS

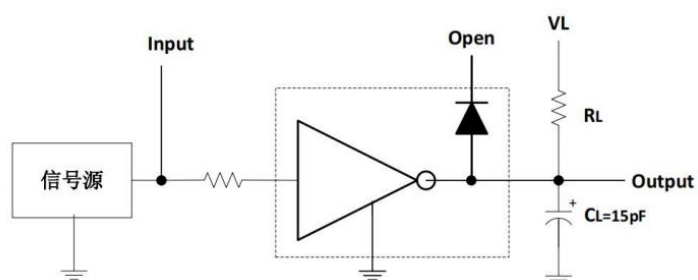


Figure 9. Transmission Delay Waveforms and Test Circuit
(Capacitive Load is Oscilloscope Probe Parasitic Capacitance)

Typical Circuit

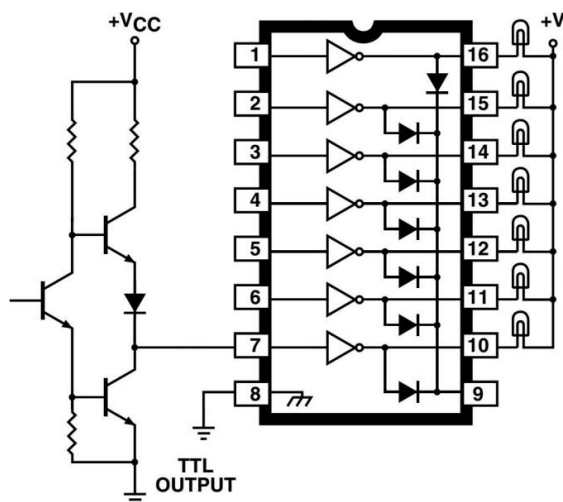


Figure 10. ULN2003A Device Used as LED Driver

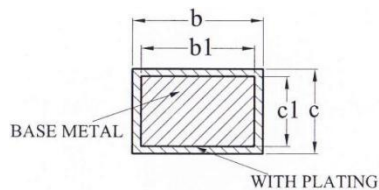
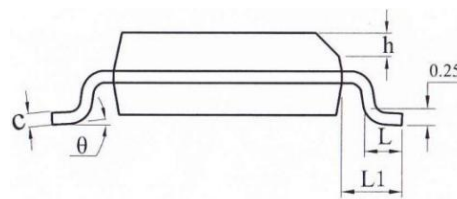
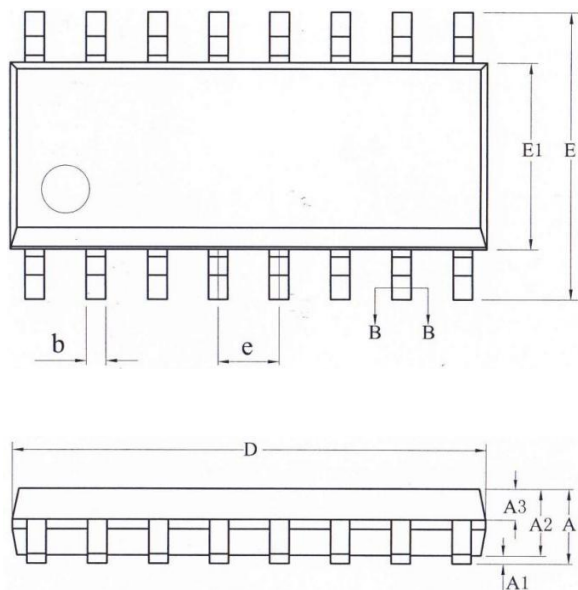


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Package Information

SOP-16

Dimensions in mm



Symbol	Dimensions In Millimeters			Symbol	Dimensions In Millimeters		
	Min	Nom	Max		Min	Nom	Max
A	-	-	1.75	D	9.80	9.90	10.00
A1	0.10	-	0.225	E	5.80	6.00	6.20
A2	1.30	1.45	1.50	E1	3.80	3.90	1.00
A3	0.60	0.65	0.70	e	1.27 (BSC)		
b	0.39	-	0.47	H	0.25	-	0.50
b1	0.38	0.41	0.44	L	0.50	-	0.80
c	0.20	-	0.24	L1	1.05 (REF)		
c1	0.19	0.20	0.21	θ	0°	-	8°

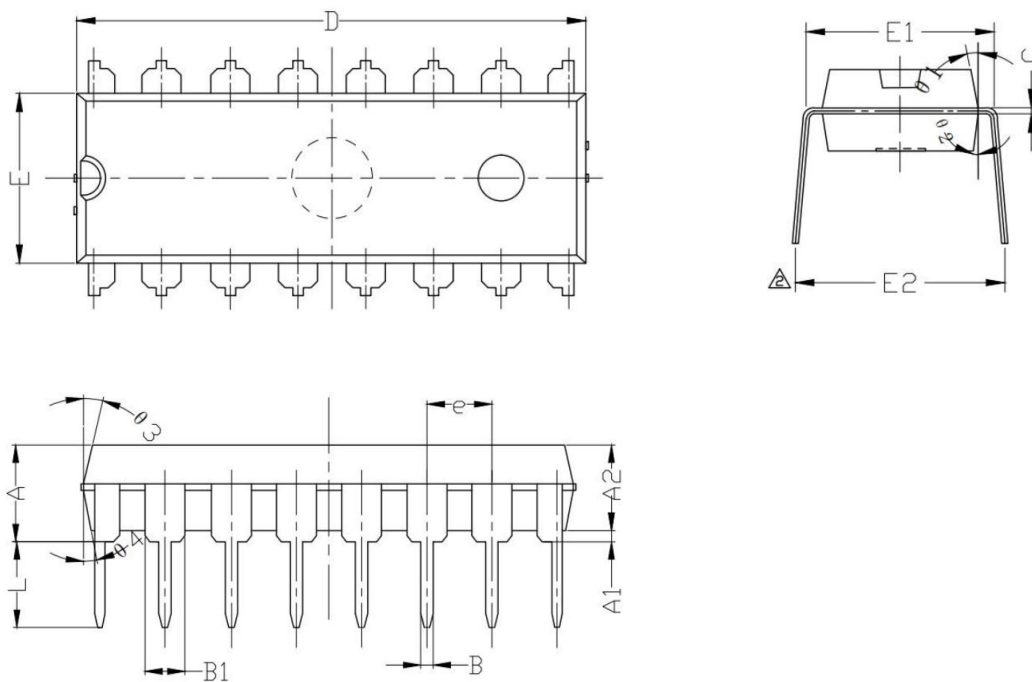


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Package Information

DIP-16

Dimensions in mm



Symbol	Dimensions In Millimeters			Symbol	Dimensions In Millimeters		
	Min	Nom	Max		Min	Nom	Max
A	3.75	3.90	4.05	E1	7.35	7.62	7.85
A1	0.51	-	-	e	2.54 (BSV)		
A2	3.20	3.30	3.45	L	3.00	3.30	3.60
B	0.38	0.48	0.56	E2	8.00	8.40	8.80
B1	1.52 (BSC)			θ1	9°	-	15°
C	0.20	0.25	0.34	θ2	7°	-	13°
D	18.80	19.05	19.30	θ3	8°	-	14°
E	6.20	6.35	6.50	θ4	5°	-	12°



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