High-voltage, High-current Darlington transistor arrays

1. Description

The ULN2003 is a monolithic high voltage and high current Darlington transistor arrays. It consists of seven NPN Darlington pairs that features high-voltage outputs with common-cathode clamp diode for switching inductive loads. The collector-current rating of a single Darlington pair is 500mA. The Darlington pairs may be paralleled for higher current capability.

Applications include relay drivers, hammer drivers, lamp drivers, display drivers, line drivers, and logic buffers.

ULN2003 is available in SOP16 and DIP-16 packages.

2. Features

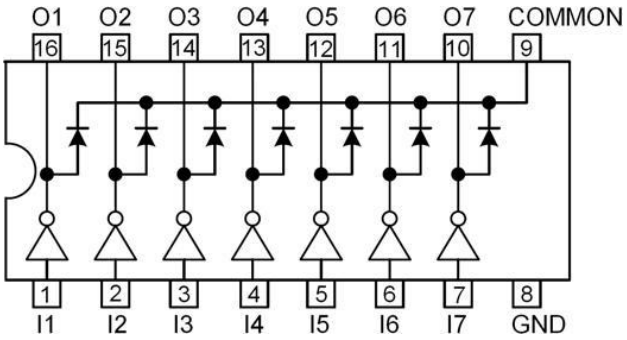
- 500mA Rated Collector Current (Single Output)
- High-voltage Outputs (50V)
- Inputs Compatible with Various Types of Logic
- Output Clamp Diodes
- Relay Driver Application

4.Order Information

Part Number	Package Description	Ordering Code	Packing Quantity
ULN2003	SOP16	ULN2003YSOP16G/TR	Tape and Reel,2500
	DIP-16	ULN2003YDIP16G/TB	Tube,25

5. Pin Configuration

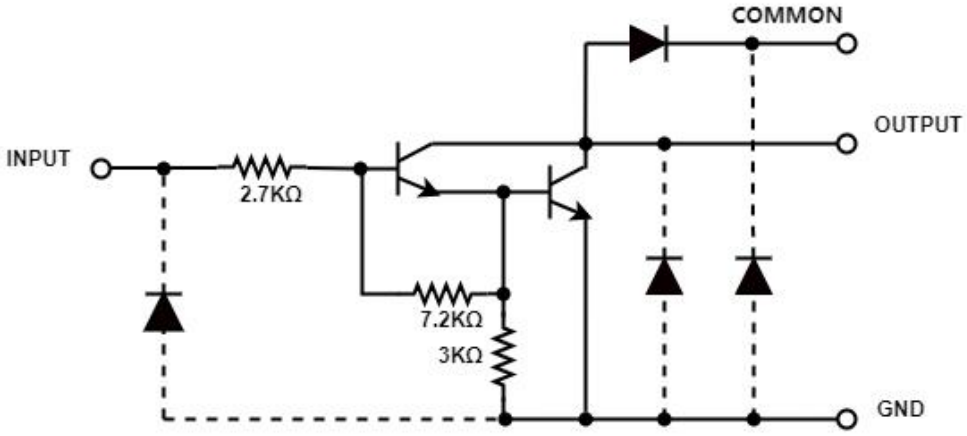
(Top view)



SOP16/DIP-16

Pin Number	Pin Name	Input/Output	Pin Function Description
1	I1	I	I Channel Input Pin
2	I2	I	2 Channel Input Pin
3	I2	I	3 Channel Input Pin
4	I4	I	4 Channel Input Pin
5	I5	I	5 Channel Input Pin
6	I6	I	6 Channel Input Pin
7	I7	I	7 Channel Input Pin
8	GND	-	GND
9	COMMON	-	Common terminal of the clamping diode
10	O7	O	7 Channel Output Pin
11	O6	O	6 Channel Output Pin
12	O5	O	5 Channel Output Pin
13	O4	O	4 Channel Output Pin
14	O3	O	3 Channel Output Pin
15	O2	O	2 Channel Output Pin
16	O1	O	I Channel Output Pin

6. Functional Block Diagram



7. Absolute Maximum Ratings

(T_A= 25°C, Unless Otherwise Specified)

Symbol	Parameter	Rating	Unit
V_{CC}	Collector to Emitter Voltage	50	V
V_R	Clamp Diode Reverse Voltage	50	V
V_I	Input Voltage	30	V
I_{CP}	Peak Collector Current	500	mA
I_{OK}	Output Clamp Current	500	mA
T_J	Junction Temperature	+150	℃
T_{STG}	Storage Temperature	-65 to +150	℃

8. Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V_{CC}	Collector to Emitter Voltage	0	50	V
T_A	Operating Ambient Temperature	-40	+125	℃

9. Electrical Characteristics

(T_A= 25°C, Unless Otherwise Specified)

Symbol	Parameter	Test Circuit	Test Conditions	Min	Typ	Max	Unit
$V_{I(ON)}$	On-State Input Voltage	6	V_{CE}=2V, I_C=200mA		1.72	2.4	V
			V_{CE}=2V, I_C=250mA		1.77	2.7	
			V_{CE}=2V, I_C=300mA		1.81	3	
$V_{CE(SAT)}$	Collector Emitter Saturation Voltage	5	I_I=250μA, I_C=100mA		0.81	1.1	V
			I_I=350μA, I_C=200mA		0.89	1.3	
			I_I=500μA, I_C=350mA		1.02	1.6	
h_{FE}	DC Current Transfer Ratio	5	V_{CE}=2V, I_{OUT}=350mA	1000	2800		
V_F	Clamp Forward Voltage	8	I_F=350mA		1.45	2	V
I_{CEX}	Collector Cut-Off Current	1	V_{CE}=50V, I_I=0		0.03	50	μA
		2	V_{CE}=50V, I_I=0, T_A=+125℃		0.1	100	
$I_{I(OFF)}$	Off-State Input Current	3	V_{CE}=50V, I_C=500μA	50	115		μA
I_I	Input Current	4	V_I=3.85V		1.14	1.5	mA
I_R	Clamp Reverse Current	7	V_R=50V		0.03	50	μA
			V_R=50V, T_A=+125℃		0.08	100	
C_I	Input Capacitance		V_I=0, f=1MHz		9	25	pF

10. Switching Characteristics

(T_A= 25°C, Unless Otherwise Specified)

Symbol	Parameter	Test Circuit	Test Conditions	Min	Typ	Max	Unit
t_{PLH}	Propagation Delay Time, Low to High-Level Output	9	V_S=50V, R_L=125Ω, C_L=15pF		0.25	1	us
t_{PHL}	Propagation Delay Time, High to Low-Level Output	9	V_S=50V, R_L=125Ω, C_L=15pF		0.25	1	us

11.Test Circuit Diagrams

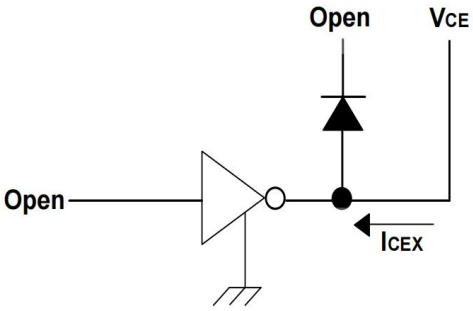


Figure 1.I_{CEX}

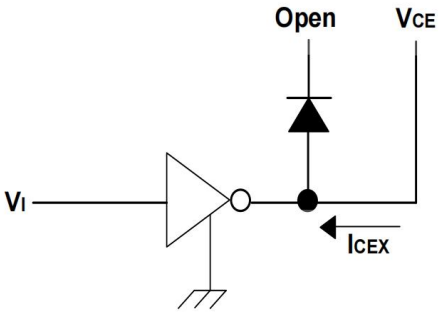


Figure 2.I_{CEX}

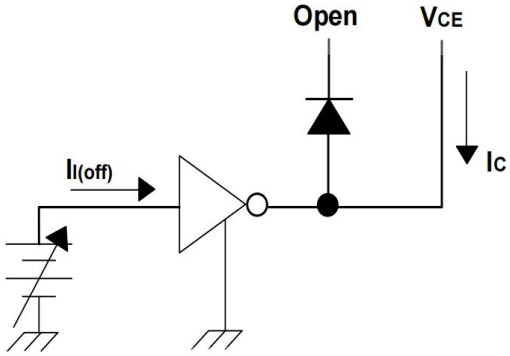


Figure 3.$I_{I(off)}$

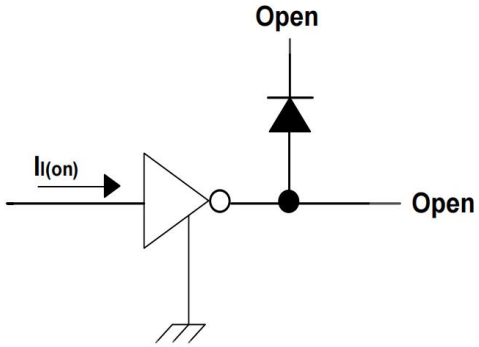


Figure 4.I_I

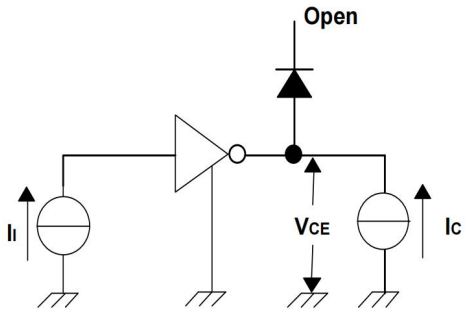


Figure 5.H_{FE},$V_{CE(sat)}$

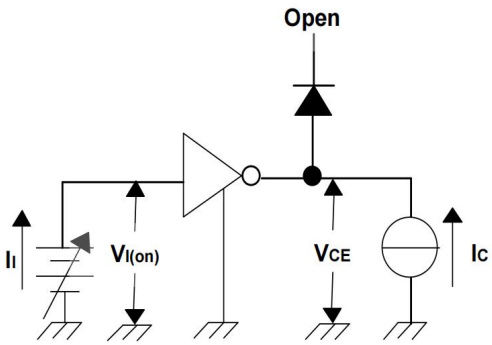


Figure 6.$V_{I(on)}$

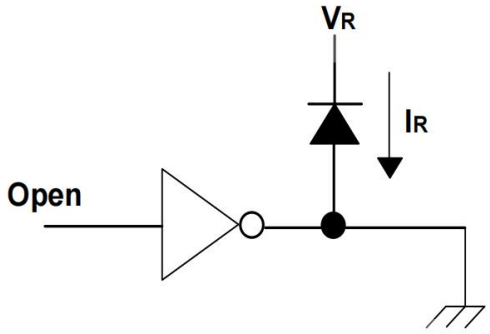


Figure 7.I_R

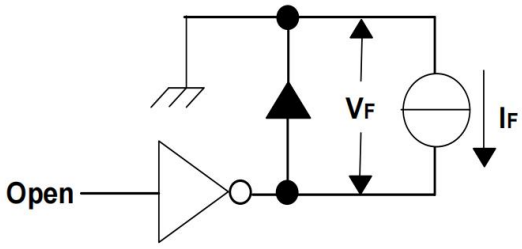
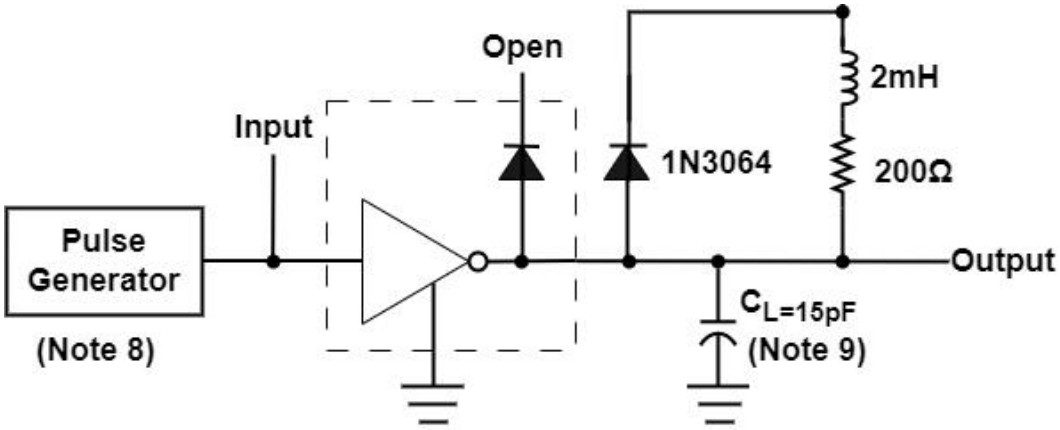
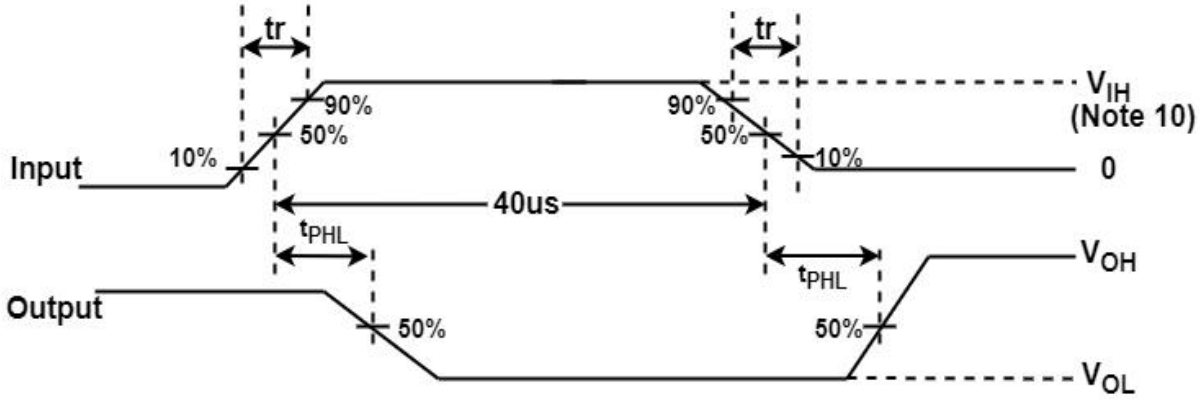


Figure 8.V_F



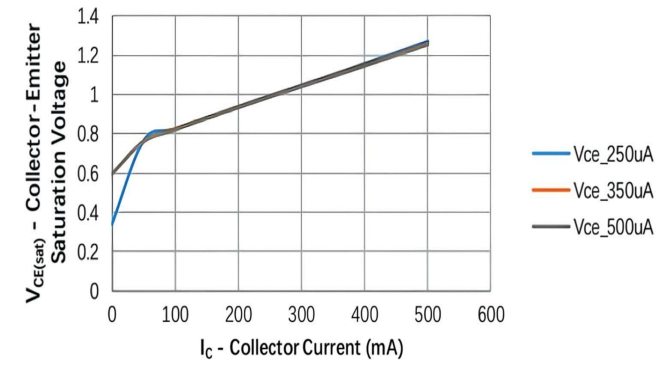
t_{ON},t_{OFF} Test Circuit



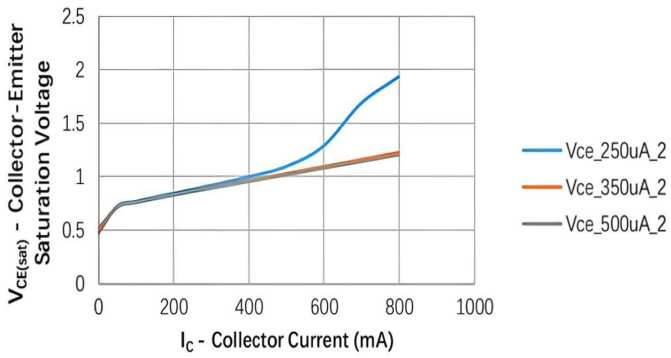
Voltage Waveform

12.Typical Performance Characteristics

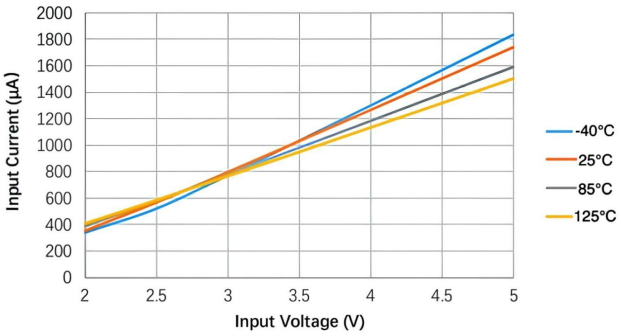
Collector-Emitter Saturation Voltage vs.
Collector Current (One Darlington)



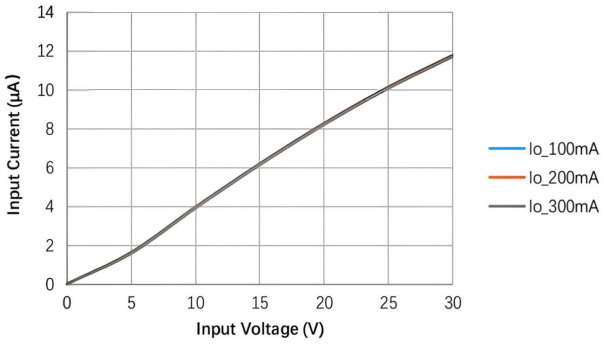
Collector-Emitter Saturation Voltage vs.
Collector Current (Two Darlington in Parallel)



Input Current vs. Input Voltage

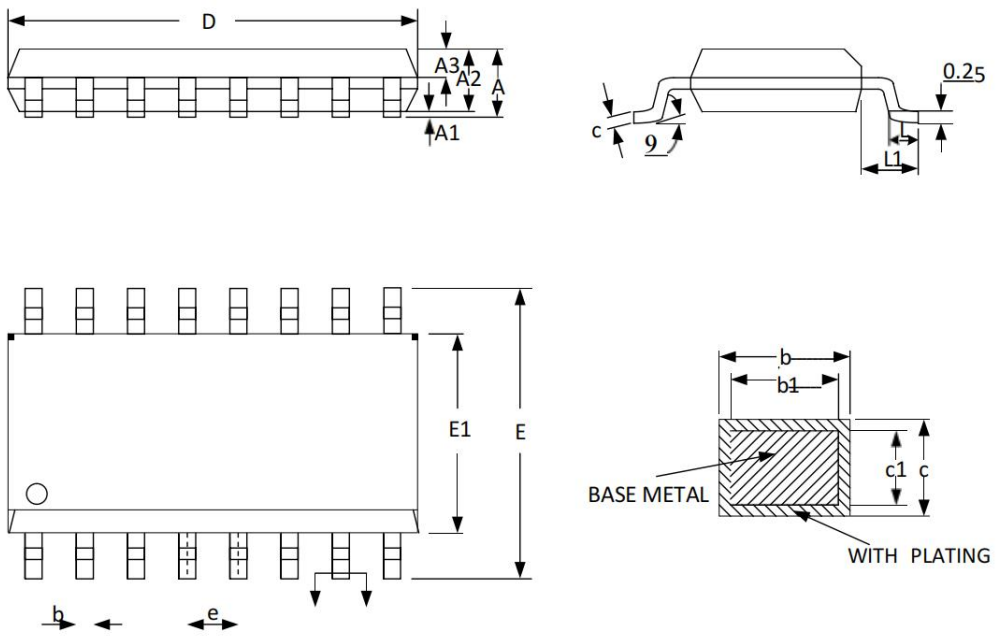


Input Current vs. Input Voltage



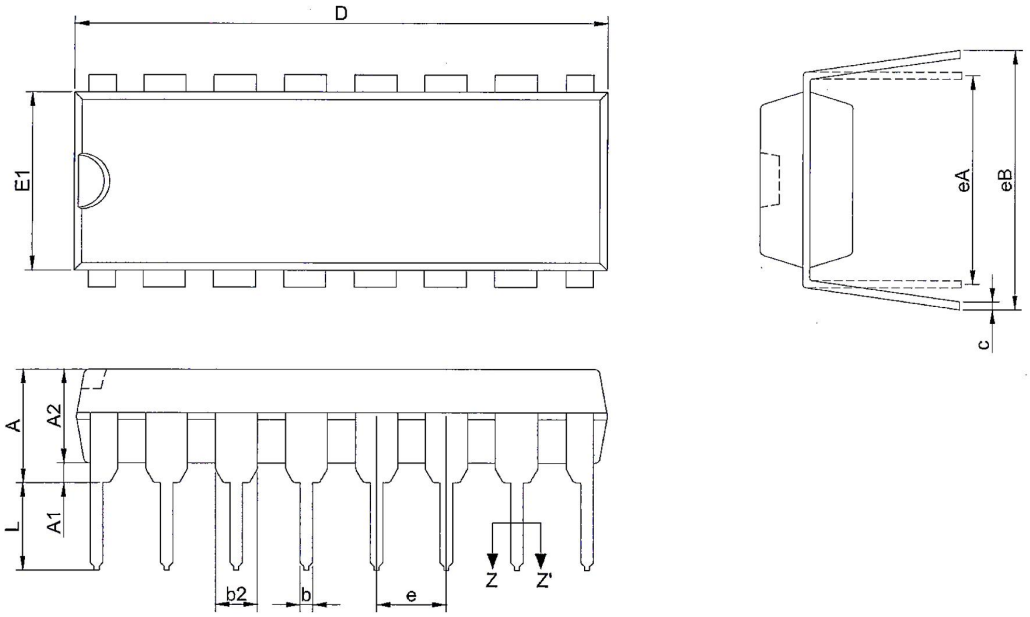
13.Package Information

(1) SOP16 Package Dimensions:



Symbol	Millimeter		
	Min	Nom	Max
A	—	—	1.77
A1	0.08	0.18	0.28
A2	1.20	1.40	1.60
A3	0.55	0.65	0.75
b	0.39	—	0.48
b1	0.38	0.41	0.43
c	0.21	—	0.26
c1	0.19	0.20	0.21
D	9.70	9.90	10.10
E	5.80	6.00	6.20
E1	3.70	3.90	4.10
e	1.27BSC		
L	0.5	0.65	0.80
L1	1.05BSC		
9	0°	—	8°

(2) DIP-16 Package Dimensions:



Symbol	Millimeter		
	Min	Nom	Max
A	3.60	—	4.45
A1	0.51	—	—
A2	3.00	3.10	3.20
b	0.41	—	0.52
b1	0.41	0.46	0.49
b2	1.52 Ref.		
C	0.21	—	0.35
C1	0.20	0.25	0.26
D	18.85	19.00	19.15
E1	6.00	6.150	6.30
e	2.54 Bsc.		
Ea	7.62 Bsc.		
Eb	8.20	—	8.80
L	3.00	—	3.60

12.Important Notice And Disclaimer

- We reserve the right to change the instruction manual without prior notice.
- Any semiconductor product has a certain possibility of failure or malfunction under specific conditions. The buyer is responsible for complying with safety standards and taking safety measures when using our products for system design and overall manufacturing to avoid potential failure risks that may cause personal injury or property damage.
- The improvement of product quality is endless, our company will be dedicated to provide customers with better products.

13.Version Modification Record

Version Number	Revision
first edition	
V0.1	1. Update the Functional Block Diagram on page 2.
V0.2	1. Update the Test Circuit on page 6.