



DESCRIPTION

The ULN2003 is high-voltage high-current Darlington transistor arrays each containing seven open collector common emitter pairs. Each pair is rated at 500mA. Suppression diodes are included for inductive load driving, the inputs and outputs are pinned in opposition to simplify board layout.

The ULN2003 is capable of driving a wide range of loads including solenoids, relays, DC motors, LED displays, filament lamps, thermal print-heads and high-power buffers.

The ULN2003 is available in SOP16 package.

FEATURES

- 7-Channel High Current Sink Drivers
- 500mA-Rated Collector Current (Single Output)
- High-Voltage Outputs: 50V
- Output Clamp Diodes
- Inputs Compatible with Various Types of Logic
- Relay-Driver Applications

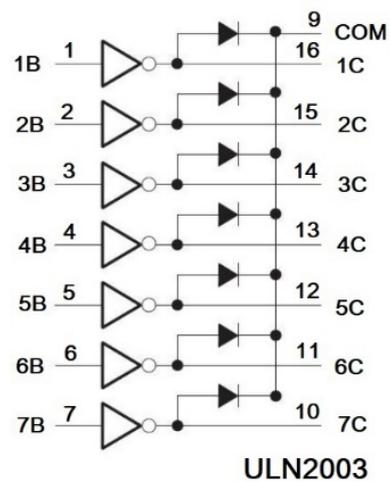
APPLICATION

- Inputs Compatible with Popular Logic Types
- Relay Drivers Applications
- Stepper and DC Brushed Motor Drivers
- Lamp Drivers
- Display Drivers (LED and Gas Discharge)
- Line Drivers
- Logic Buffers

ORDERING INFORMATION

Package Type	Part Number
SOP16	ULN2003M16R
SPQ: 4,000/Reel	ULN2003M16VR
Note	V: Halogen Free Package R: Tape & Reel
AiT provides all RoHS Compliant Products	

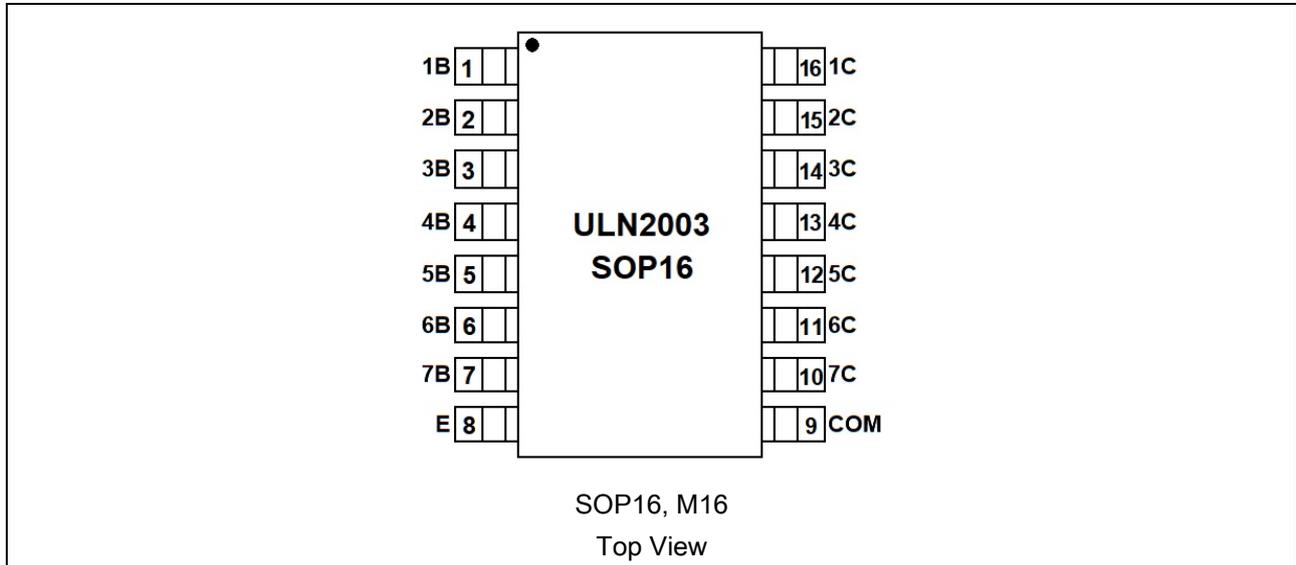
FUNCTIONAL DIAGRAM



SOP16



PIN DESCRIPTION



Pin #	Symbol	Functions
SOP16		
1	1B	Input pair1
2	2B	Input pair2
3	3B	Input pair3
4	4B	Input pair4
5	5B	Input pair5
6	6B	Input pair6
7	7B	Input pair7
8	E	Common Emitter (Ground)
9	COM	Common Clamp Diodes
10	7C	Output pair7
11	6C	Output pair6
12	5C	Output pair5
13	4C	Output pair4
14	3C	Output pair3
15	2C	Output pair2
16	1C	Output pair1

**ABSOLUTE MAXIMUM RATINGS**

At 25°C free-air temperature (unless otherwise noted)

V _{CC} , Collector to Emitter Voltage	50V	
V _R , Clamp Diode Reverse Voltage ⁽¹⁾	50V	
V _I , Input Voltage ⁽¹⁾	30V	
I _{CP} , Peak Collector Current	See Typical Characteristics	500mA
I _{OK} , Output Clamp Current	500mA	
I _{TE} , Total Emitter-Terminal Current	-2.5A	
T _A , Operating Free-Air Temperature Range	-30°C ~ + 105°C	
θ _{JA} , Thermal Resistance Junction-to-Ambient ⁽²⁾	63°C/W	
θ _{JC} , Thermal Resistance Junction-to-Case ⁽³⁾	12°C/W	
T _J , Operating Virtual Junction Temperature	150°C	
T _{STG} , Storage Temperature Range	-65°C ~ + 150°C	

Stresses above may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated in the Electrical Characteristics are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

- (1) All voltage values are with respect to the emitter/substrate terminal E, unless otherwise noted.
- (2) Maximum power dissipation is a function of T_{J(max)}, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $PD = (T_{J(max)} - T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
- (3) Maximum power dissipation is a function of T_{J(max)}, θ_{JC}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $PD = (T_{J(max)} - T_A)/\theta_{JC}$. Operating at the absolute maximum T_J of 150°C can affect reliability.



ELECTRICAL CHARACTERISTICS

T_A = 25°C, unless otherwise specified

Parameter	Symbol	Test Figure	Conditions		Min.	Typ.	Max.	Unit
On-State Input Voltage	V _{I(on)}	Fig6	V _{CE} = 2V	I _C = 200mA	-	-	2.4	V
				I _C = 250mA	-	-	2.7	
				I _C = 300mA	-	-	3.0	
Collector-Emitter Saturation Voltage	V _{CE(sat)}	Fig 5	I _I = 250μA	I _C = 100mA	-	0.9	1.1	V
			I _I = 350μA	I _C = 200mA	-	1.0	1.3	
			I _I = 500μA	I _C = 350mA	-	1.2	1.6	
Collector Cutoff Current	I _{CEX}	Fig1	V _{CE} = 50V	I _I = 0	-	-	50	μA
		Fig2	V _{CE} = 50V T _A = +105°C	I _I = 0	-	-	100	
Clamp Forward Voltage	V _F	Fig 8	I _F = 350mA		-	1.7	2	V
Off-State Input Current	I _{I(OFF)}	Fig3	V _{CE} = 50V, I _C = 500μA		50	65	-	μA
Input Current	I _I	Fig4	V _I = 3.85V		-	0.93	1.35	mA
Clamp Reverse Current	I _R	Fig7	V _R = 50V	-	-	-	50	μA
				T _A = 70°C	-	-	100	
Input Capacitance	C _i	-	V _I = 0, f = 1MHz		-	15	25	pF
SWITCHING CHARACTERISTICS								
Propagation Delay Time, Low- to High-Level Output	t _{PLH}	Fig9	-		-	0.25	1.00	μs
Propagation Delay Time, High- to Low-Level Output	t _{PHL}	Fig9	-		-	0.25	1.00	μs
High-Level Output Voltage After Switching	V _{OH}	Fig9	V _S = 50V, I _O = 300mA		VS-20	-	-	mV



TYPICAL PERFORMANCE CHARACTERISTICS

Fig 1. I_{CEX} Test Circuit

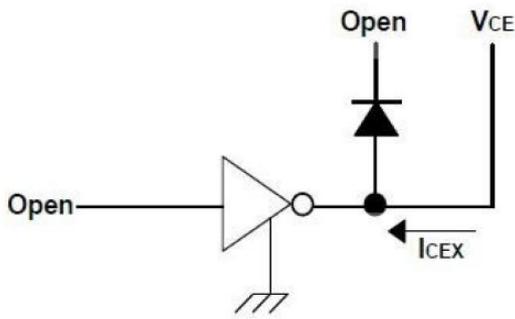


Fig 2. I_{CEX} Test Circuit

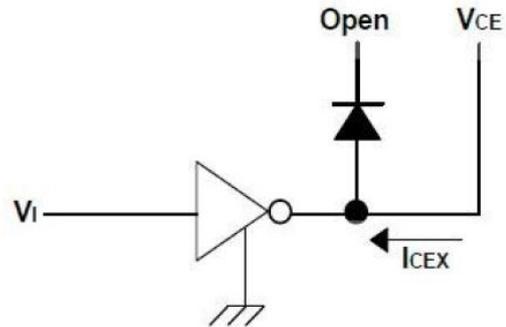


Fig 3. $I_{I(OFF)}$ Test Circuit

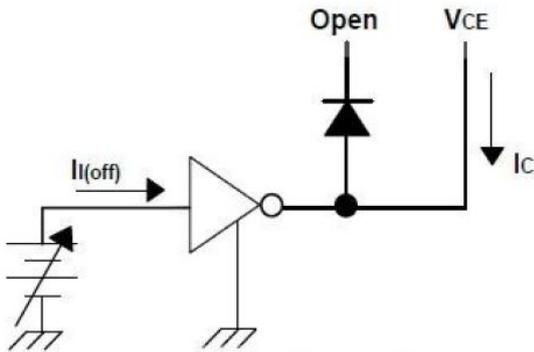


Fig 4. I_I Test Circuit

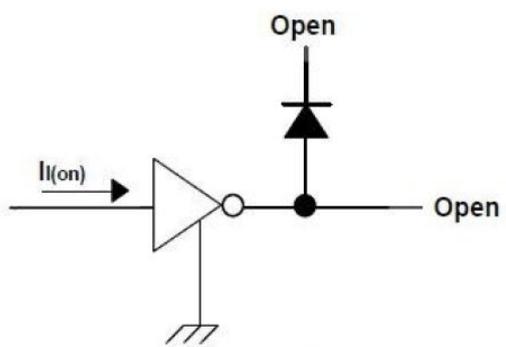


Fig 5. h_{FE} Test Circuit

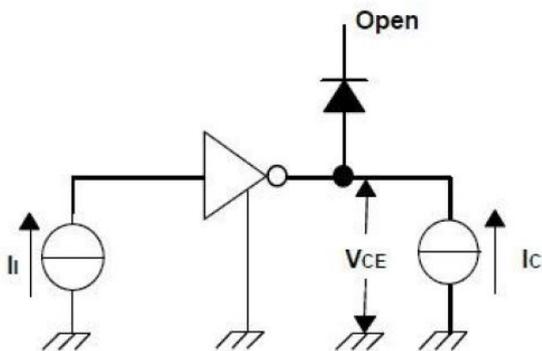


Fig 6. $V_{I(on)}$ Test Circuit

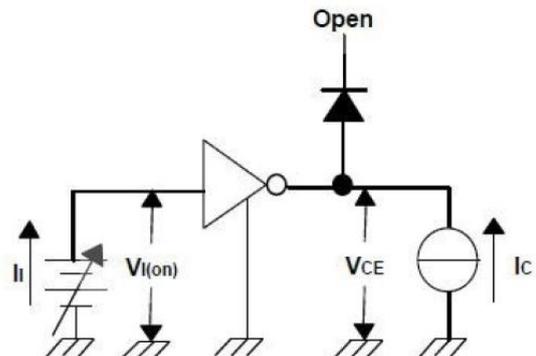




Fig 7. I_R Test Circuit

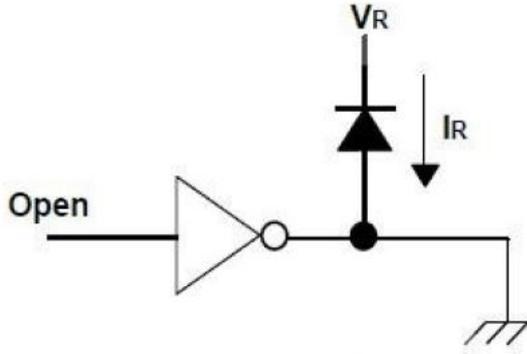


Fig 8. V_F Test Circuit

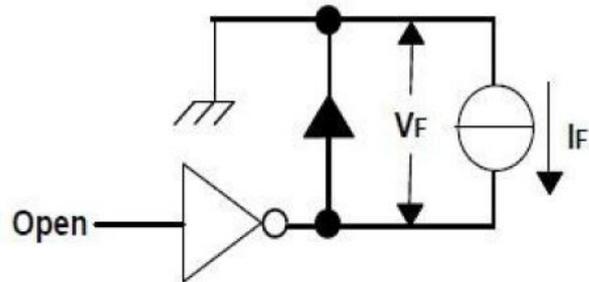
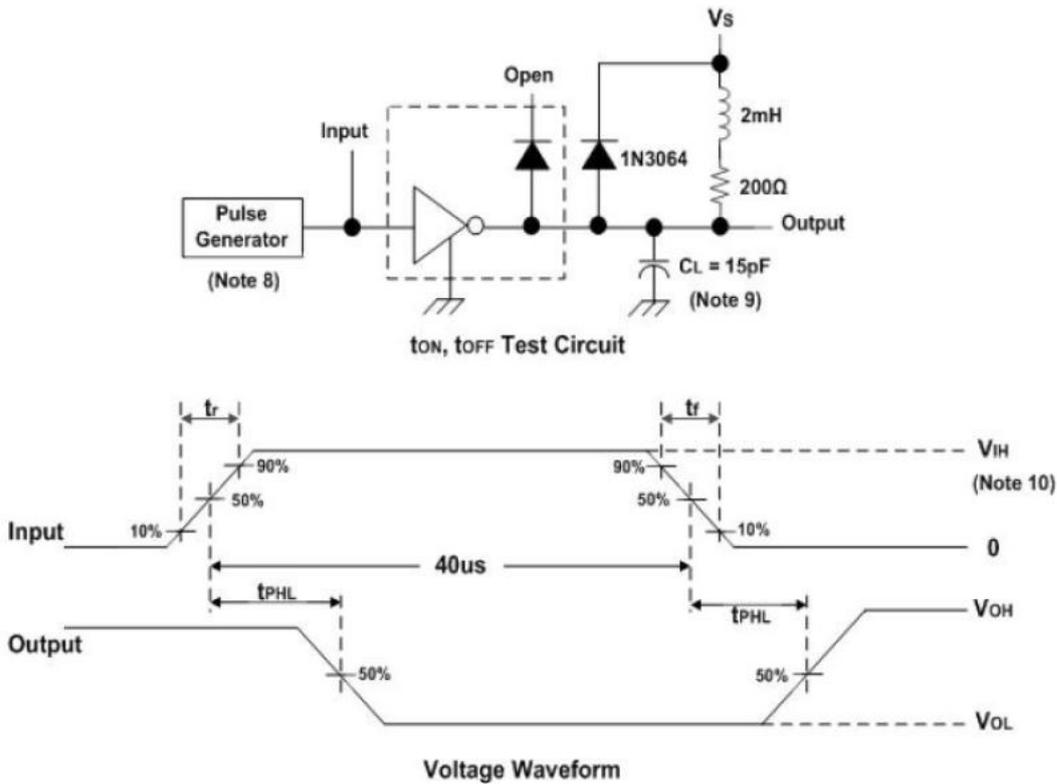


Fig 9. Latch-Up Test Circuit and Voltage Waveform

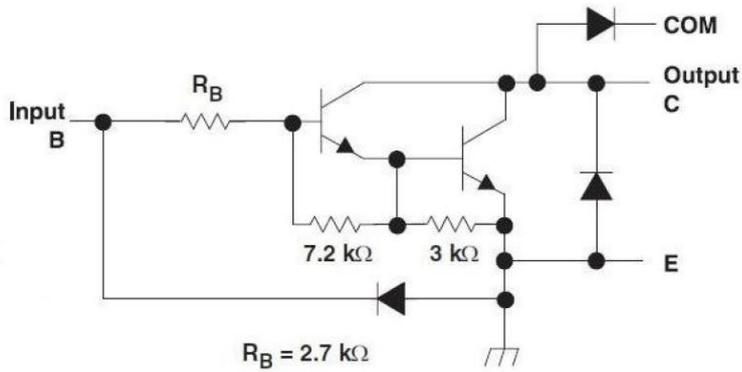


Notes:

- (1) Fig 8: The pulse generator has the following characteristics: Pulse Width=12.5Hz, output impedance 50Ω, $t_r \leq 5ns$, $t_f \leq 10ns$.
- (2) Fig 9: C_L includes probe and jig capacitance.
- (3) Fig 10: $V_{IH} = 3V$.



BLOCK DIAGRAM



Note:

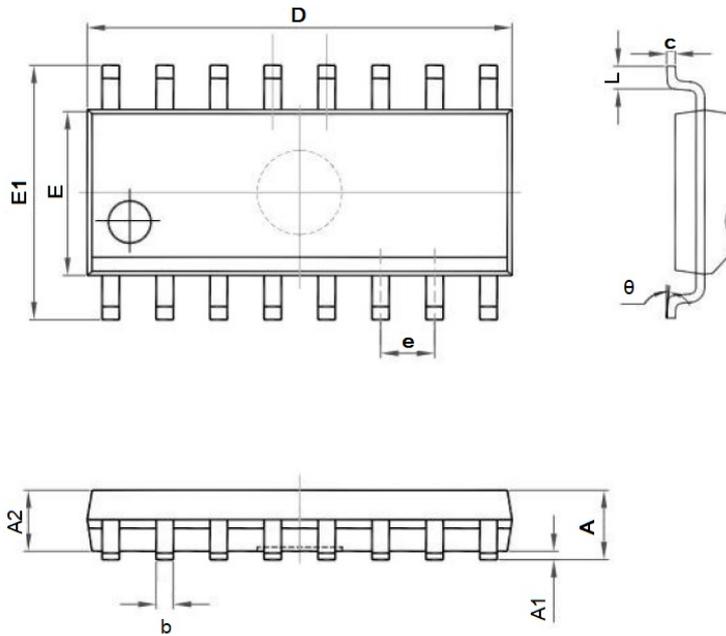
All resistor values shown are nominal.

The collector-emitter diode is a parasitic structure and should not be used to conduct current. If the collector(s) go below ground an external Schottky diode should be added to clamp negative undershoots.



PACKAGE INFORMATION

Dimension in SOP16 Package (Unit: mm)



Symbol	MILLIMETERS	
	Min.	Max.
A	1.350	1.750
A1	0.100	0.250
A2	1.350	1.550
b	0.330	0.510
c	0.170	0.250
D	9.800	10.200
E	3.800	4.000
E1	5.800	6.200
e	1.270 BSC	
L	0.400	1.270
θ	0°	8°



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