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

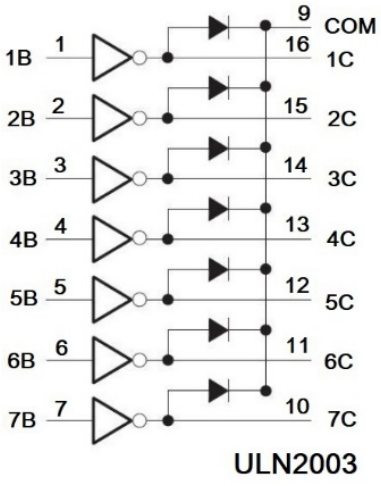
APPLICATION

- 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

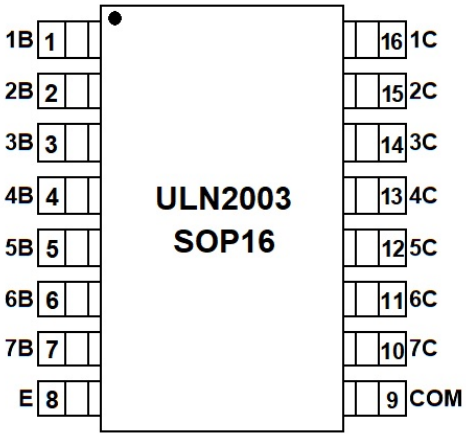
Package Type	Part Number
SOP16 SPQ: 4,000/Reel	ULN2003M16R
	ULN2003M16VR
Note	V: Halogen Free Package R: Tape & Reel
AiT provides all RoHS Compliant Products	

FUNCTIONAL DIAGRAM



SOP16

PIN DESCRIPTION



SOP16, M16
Top View

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℃ ~ + 105℃
θ_{JA}, Thermal Resistance Junction-to-Ambient(2)		63℃/W
θ_{JC}, Thermal Resistance Junction-to-Case(3)		12℃/W
T_J, Operating Virtual Junction Temperature		150℃
T_{STG}, Storage Temperature Range		-65℃ ~ + 150℃

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

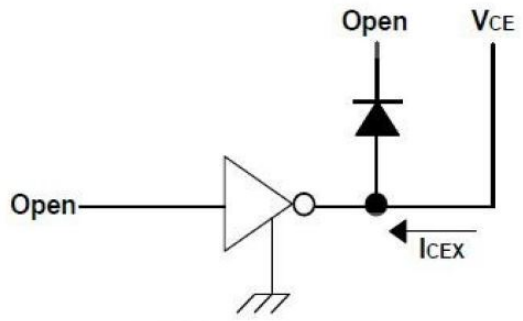


Fig 2. I_{CEX} Test Circuit

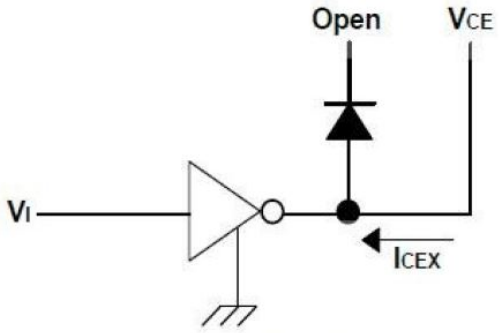


Fig 3. $I_{I(OFF)}$ Test Circuit

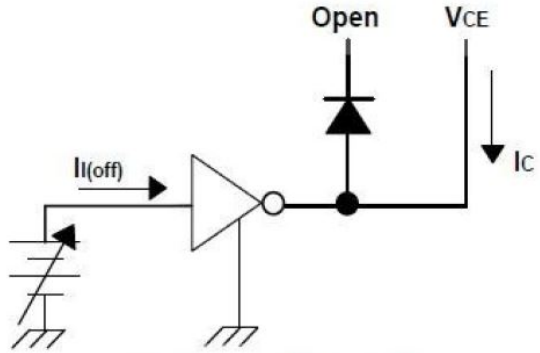


Fig 4. I_I Test Circuit

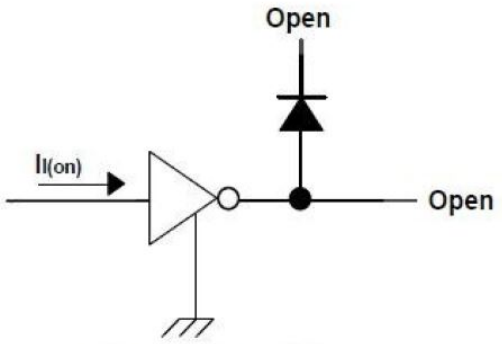


Fig 5. h_{FE} Test Circuit

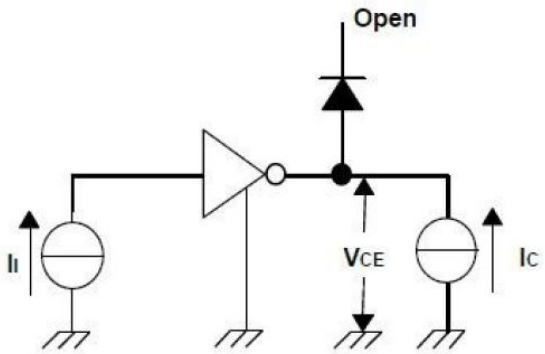


Fig 6. $V_{I(on)}$ Test Circuit

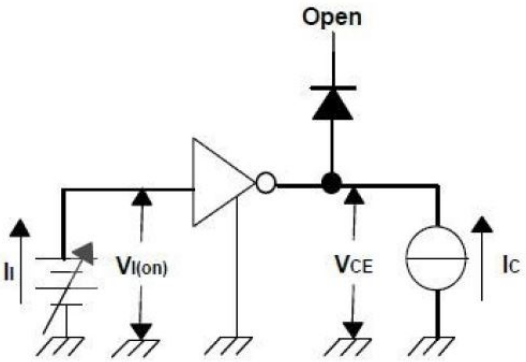


Fig 7. I_R Test Circuit

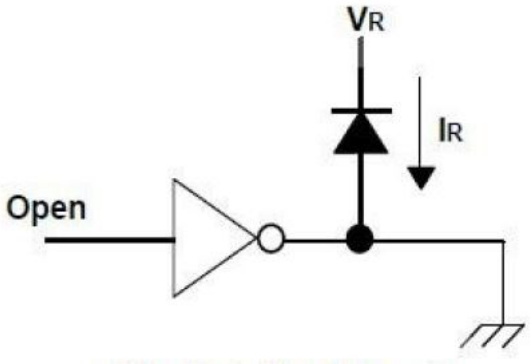


Fig 8. V_F Test Circuit

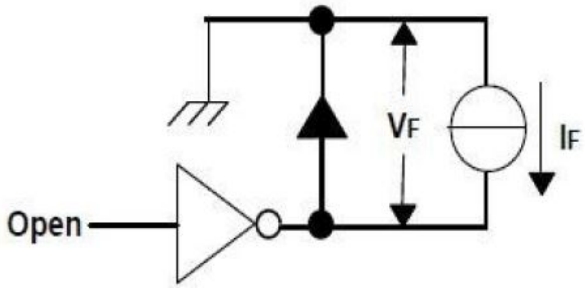
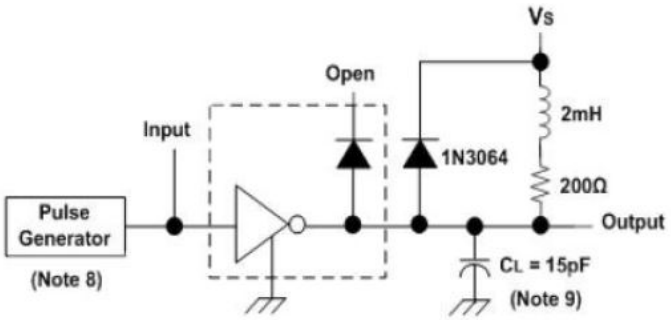
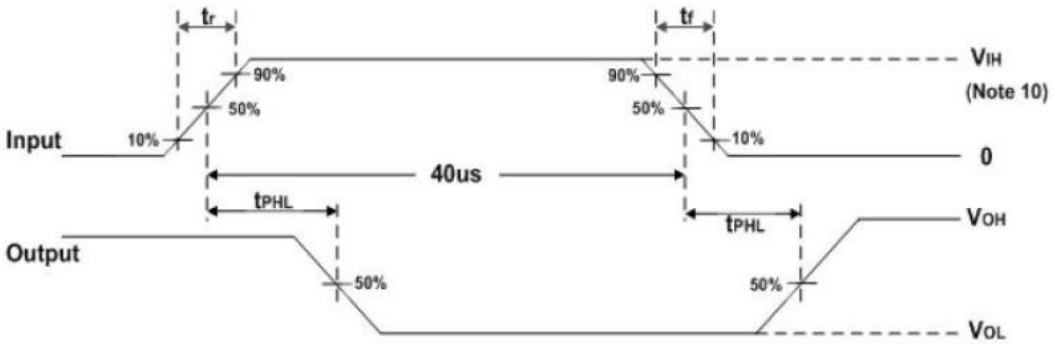


Fig 9. Latch-Up Test Circuit and Voltage Waveform



tON, tOFF Test Circuit



Voltage Waveform

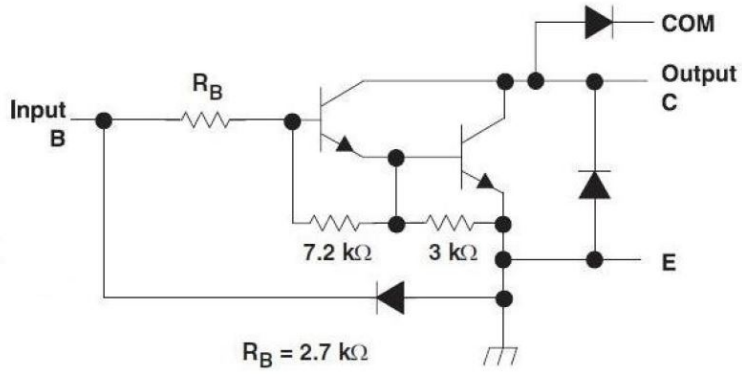
Notes:

(1) Fig 8: The pulse generator has the following characteristics: Pulse Width=12.5Hz, output impedance 50Ω, tr≤5ns, tr≤10ns.

(2) Fig 9: C_L includes prove and jig capacitance.

(3) Fig 10: V_{IH}=3V.

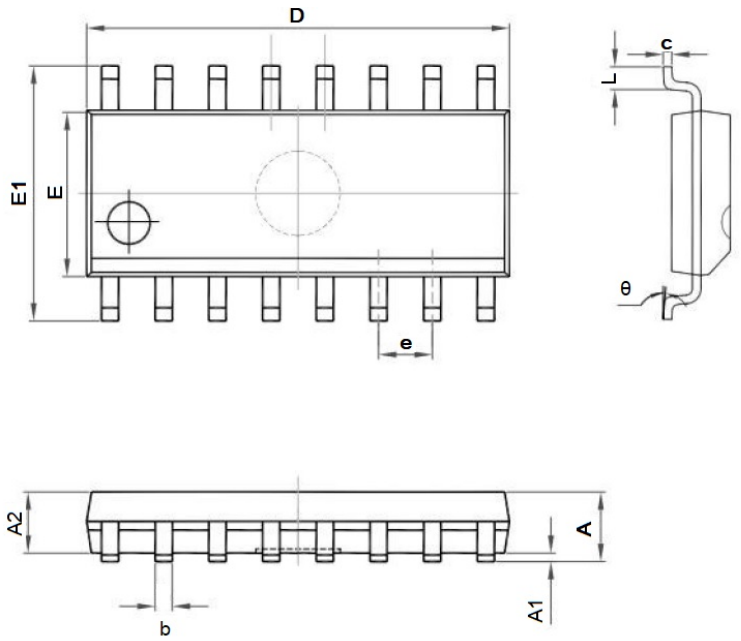
BLOCK DIAGRAM



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°

IMPORTANT NOTICE

AiT Semiconductor Inc. (AiT) reserves the right to make changes to any its product, specifications, to discontinue any integrated circuit product or service without notice, and advises its customers to obtain the latest version of relevant information to verify, before placing orders, that the information being relied on is current.

AiT Semiconductor Inc. integrated circuit products are not designed, intended, authorized, or warranted to be suitable for use in life support applications, devices or systems or other critical applications. Use of AiT products in such applications is understood to be fully at the risk of the customer. As used herein may involve potential risks of death, personal injury, or server property, or environmental damage. In order to minimize risks associated with the customer's applications, the customer should provide adequate design and operating safeguards.

AiT Semiconductor Inc. assumes to no liability to customer product design or application support. AiT warrants the performance of its products of the specifications applicable at the time of sale.