JIANGSU CHANGJING ELECTRONICS TECHNOLOGY CO., LTD

Plastic-Encapsulate Darlington Transistors

ULN2003E Darlington Transistor (NPN)

1 Introduction

ULN2003E is a high voltage, high current Darlington transistor array. Each device consists of seven NPN Darlington pairs that can be output independently. These Darlington pairs have common emitter poles that support high voltage output with a common cathode clamp diode for switching inductive loads. The input and output of the clamp diode are relatively fixed to simplify the layout of the printed circuit board. The collector current of a single Darlington pair is rated at 500mA, and parallel Darlington pairs provide a higher current.

Each Darlington pair of ULN2003E devices has a 2.7kΩ series base resistance that works directly with TTL or CMOS devices. This device is often used to drive a variety of loads, such as DC engine, LED display light, high power cache and general logic circuits such as TTL, 5V CMOS, etc.

2 Available Package

PART NUMBER	PACKAGE
ULN2003E	SOP16
	TSSOP16
	DIP16

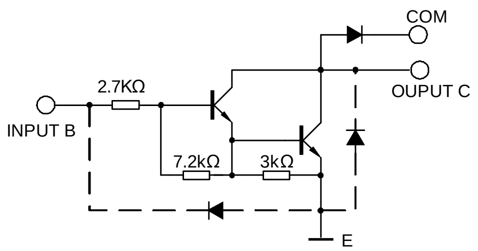


Figure 2-1. Functional Block Diagram

3 Features

- 500mA rated collector current (single output)
- High voltage output: 50V
- Output clamp diode
- Compatible with all kinds of logic input
- Relay driver application

4 Applications

- Relay Drivers
- Hammer Drivers
- Lamp Drivers
- Line Drivers
- Logic Buffers
- Stepper Motors
- IP Camera
- HVAC Valve and LED Dot Matrix

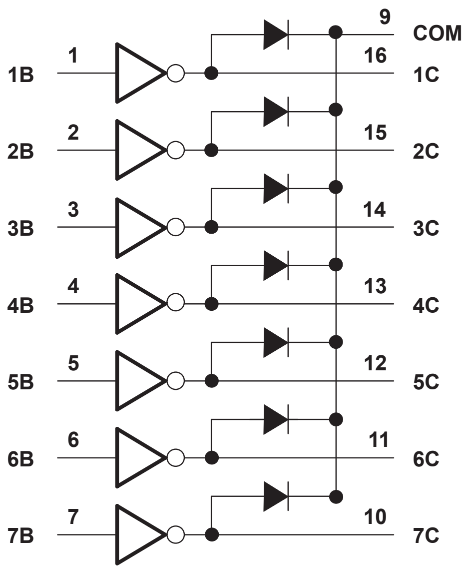


Figure 2-2. Simplified Block Diagram

5 Orderable Information

MODEL	DEVICE	PACKAGE	OP TEMP	ECO PLAN	MSL	PACKING OPTION	SORT
3 Pins Packaged Products							
ULN2003E	ULN2003E-PKN	SOP16	-40 ~ 85°C	RoHS & Green	Level 3 168 HR	Tape and Reel 2500 Units / Reel	Active
	ULN2003E-PLN	TSSOP16	-40 ~ 85°C	RoHS & Green	Level 3 168 HR	Tape and Reel 3000 Units / Reel	Active
	ULN2003E-PQN	DIP16	-40 ~ 85°C	RoHS & Green	N / A for Pkg Type	Tube 25 Units / Rail	Active

Note:

ECO PLAN: For the RoHS and Green certification standards of this product, please refer to the official report provided by JSCJ.

MSL: Moisture Sensitivity Level. Determined according to JEDEC industry standard classification.

SORT: Specifically defined as follows:

Active: Recommended for new products;

Customized: Products manufactured to meet the specific needs of customers;

Preview: The device has been released and has not been fully mass produced. The sample may or may not be available;

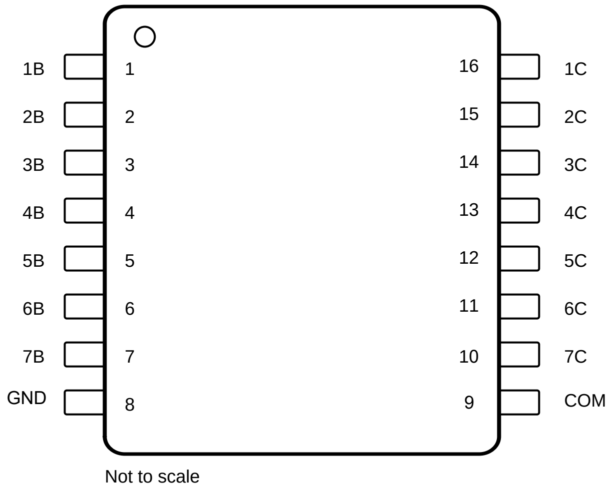
NoRD: It is not recommended to use the device for new design. The device is only produced for the needs of existing customers;

Obsolete: The device has been discontinued.

6 Pin Configuration and Marking Information

6.1 Pin Configuration and Function

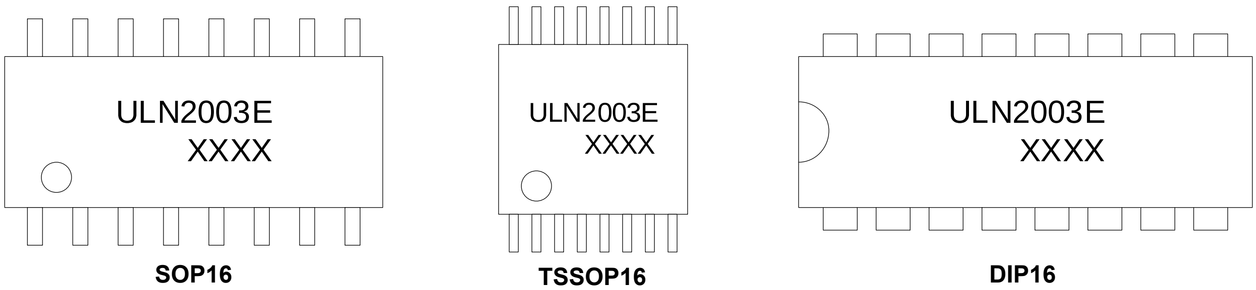
Figure 6-1. Pin Configuration (Top View)



Pin Functions

PIN		TYPE	DESCRIPTION
NAME	NO.		
1B	1	I	Channel 1 through 7 Darlington base input
2B	2		
3B	3		
4B	4		
5B	5		
6B	6		
7B	7		
1C	16	O	Channel 1 through 7 Darlington collector output
2C	15		
3C	14		
4C	13		
5C	12		
6C	11		
7C	10		
GND	8	—	Common emitter shared by all channels (typically tied to ground)
COM	9	I/O	Common cathode node for flyback diodes (required for inductive loads)

6.2 Marking Information



Note:

"ULN2003E" = Device Number.

"XXXX" = Code, Indicates weekly record information of production.

7 Specifications

7.1 Absolute Maximum Ratings

at 25°C free-air temperature (unless otherwise specified)(1)

CHARACTERISTIC			SYMBOL	VALUE	UNIT
Output voltage(2)			V_{OUT}	50	V
Clamp diodes reverse voltage(2)			V_{COM}	50	V
Input voltage(2)			V_{IN}	30	V
Peak collector current			I_{CP}	500	mA
Output clamp current			I_{OK}	500	mA
Total emitter-terminal current			I_{TE}	2.5	A
Base current (continuous)			I_B	25	mA
Maximum power dissipation	ULN2003E	SOP16	$P_{D\ MAX}$	Internally Limited(3)	W
		TSSOP16			
		DIP16			
Maximum junction temperature			$T_{J\ MAX}$	150	°C
Storage temperature			T_{stg}	-55 ~ 150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum rated conditions for extended periods may affect device reliability.
(2) All voltages are with respect to network ground terminal.
(3) Refer to *Thermal Information* for details.

7.2 Recommended Operating Conditions

PARAMETER	SYMBOL	MIN.	NOM.	MAX.	UNIT
Operating junction temperature	T_J	-40	-	125	°C
Operating ambient temperature	T_A	-40	-	85	°C

7.3 ESD Ratings

ESD RATINGS		SYMBOL	VALUE	UNIT
Electrostatic discharge(4)	Human body model	$V_{ESD-HBM}$	2000	V

(4) ESD testing is conducted in accordance with the relevant specifications formulated by the Joint Electronic Equipment Engineering Commission (JEDEC). The human body model (HBM) electrostatic discharge test is based on the JESD22-114D test standard, using a 100pF capacitor and discharging to each pin of the device through a resistance of 1.5kΩ.

7 Specifications

7.4 Thermal Information

THERMAL METRIC[5]		SYMBOL	SOP16	TSSOP16	DIP16	UNIT
Thermal resistance	Junction-to-ambient	$R_{\Theta JA}$	100.0	80.0	166.0	°C/W
	Junction-to-case	$R_{\Theta JC}$	20.0	25.0	30.0	
Reference maximum power dissipation for continuous operation		$P_{D\ Ref}$	1.00	1.25	0.6	W

7.5 Electrical Characteristics

at 25°C free-air temperature (unless otherwise specified)

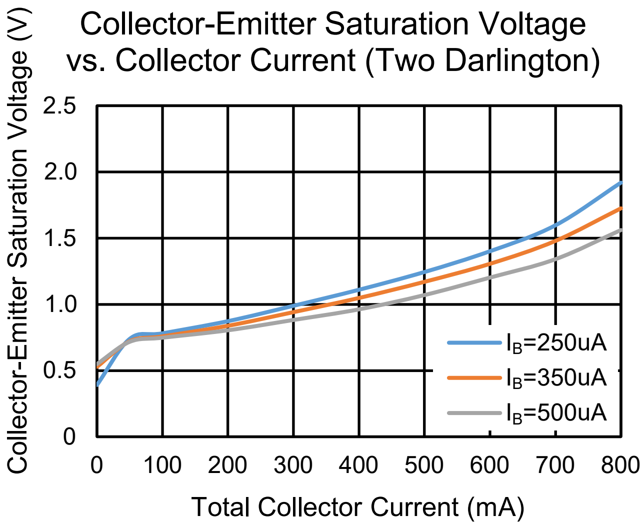
CHARACTERISTIC	SYMBOL	TEST CONDITIONS	FIGURES	MIN.	TYP.[6]	MAX.	UNIT
Collector cutoff current	I_{CEX}	V_{CE} = 50V	1a	-	-	50.0	μA
Collector-emitter saturation voltage	$V_{CE\ (SAT)}$	I_C = 100mA, I_B = 250μA	2	-	0.9	1.1	V
		I_C = 200mA, I_B = 350μA		-	1.0	1.3	
		I_C = 350mA, I_B = 500μA		-	1.2	1.6	
Input current (ON)	$I_{IN\ (ON)}$	V_{IN} = 3.85V	3	-	0.90	1.35	mA
Input voltage (ON)	$V_{IN\ (ON)}$	V_{CE} = 2.0V, I_C = 200mA	5	-	-	2.4	V
		V_{CE} = 2.0V, I_C = 250mA		-	-	2.7	
		V_{CE} = 2.0V, I_C = 300mA		-	-	3.0	
Clamp reverse current	I_R	V_R = 50V	6	-4.0	-	50	μA
Clamp forward voltage	V_F	I_F = 350mA	7	-	1.3	2.0	V
Output leakage current	$I_{CEX\text{-}1V}$	V_{CE} = 50V, V_{IN} = 1.0V	1b	-5.0	-	80	μA
Input Capacitance	C_I	V_I = 0, f = 1MHz	-	-	15	25	pF
High-level output voltage after switching	V_{OH}	V_S = 50 V, I_O = 300 mA	8	V_S - 50	-	-	mV
Turn-on delay time	t_{PLH}	0.5 V_I to 0.5 V_O	8	-	0.15	1	μs
Turn-off delay time	t_{PHL}	0.5 V_I to 0.5 V_O	8	-	0.15	1	μs

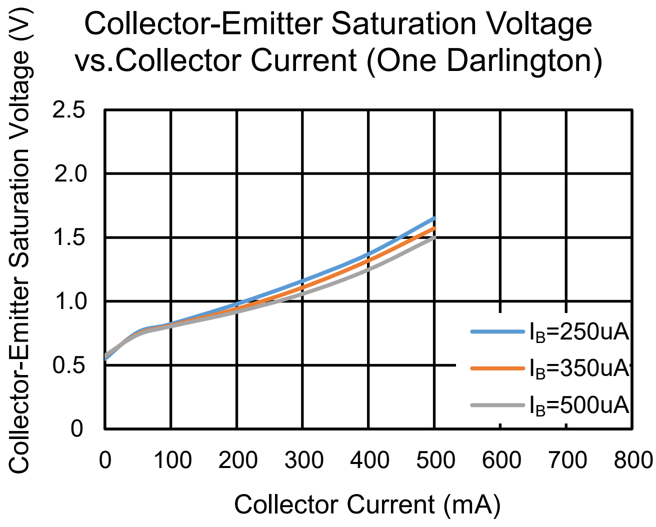
Note:

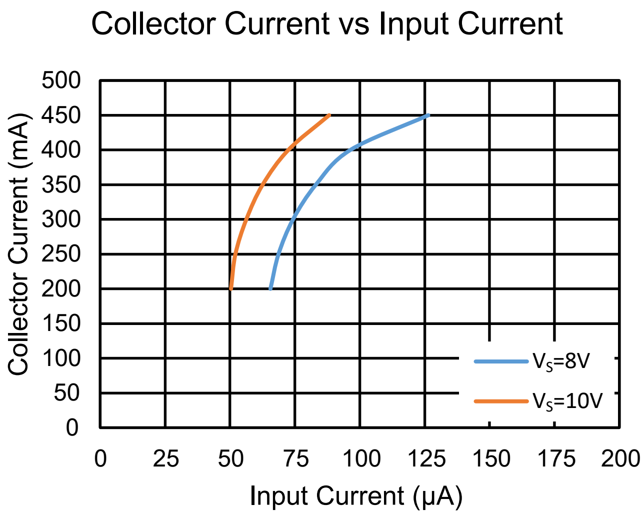
(6) Typical numbers are at 25°C and represent the most likely norm.

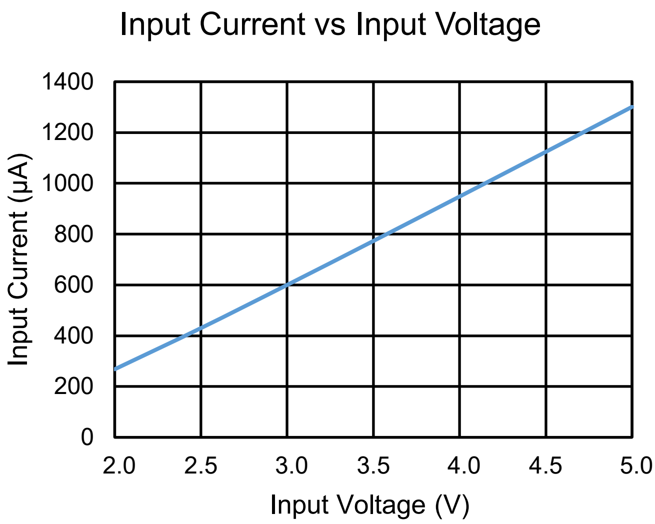
7 Specifications

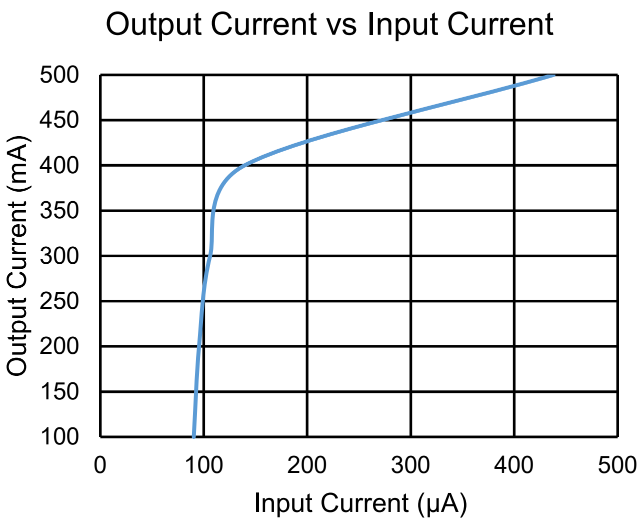
7.6 Typical Characteristics

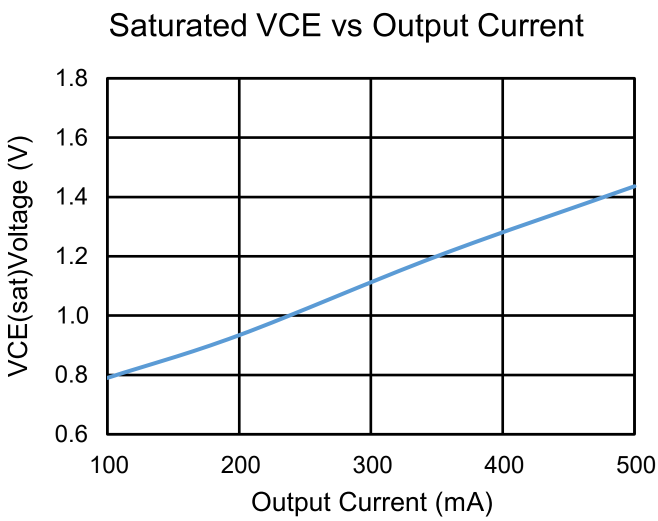












8 Parameter Measurement Information

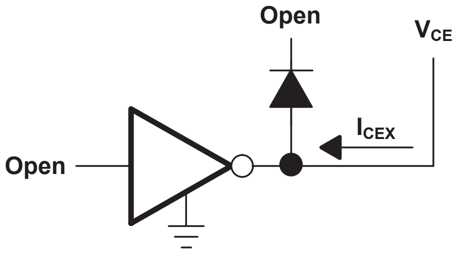


Figure 1a. I_{CEX} Test Circuit

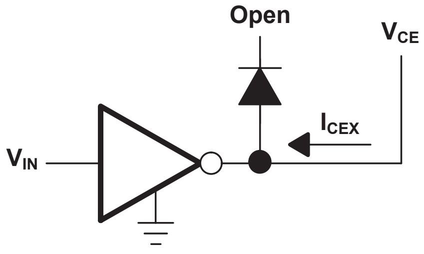


Figure 1b. I_{CEX} Test Circuit

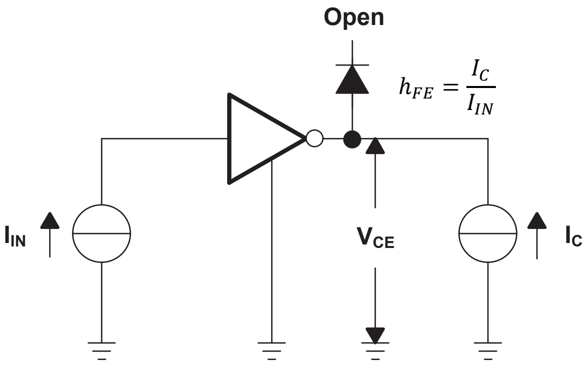


Figure 2. h_{FE}, $V_{CE\ (SAT)}$ Test Circuit

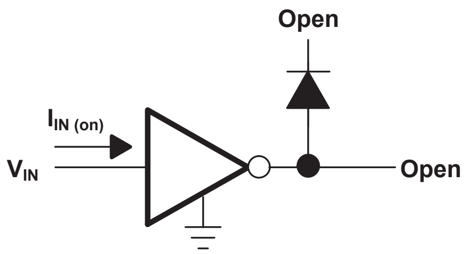
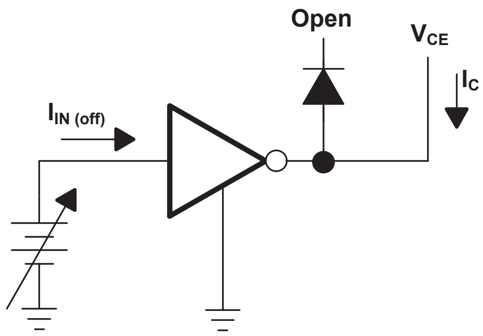


Figure 3. I_{IN} Test Circuit



I_{IN} is fixed when used to measure V_{CE} and variable when used to measure h_{FE}

Figure 4. $I_{IN\ (off)}$ Test Circuit

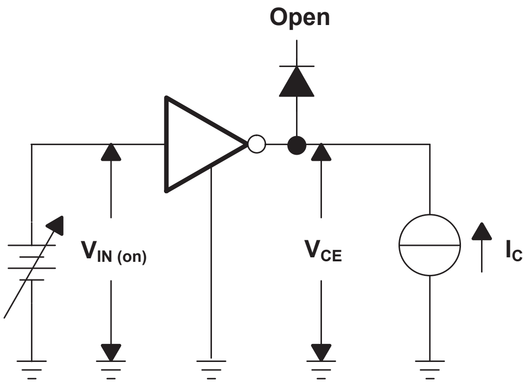


Figure 5. $V_{IN\ (on)}$ Test Circuit

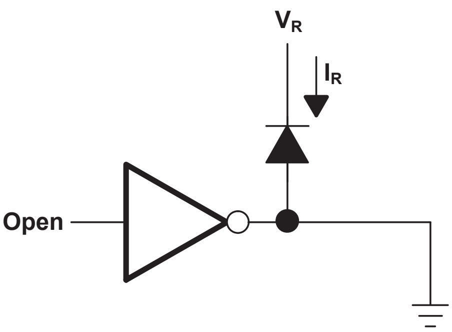


Figure 6. I_R Test Circuit

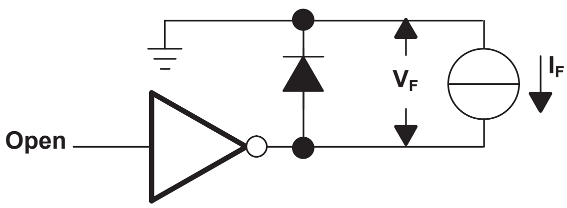


Figure 7. V_F Test Circuit

8 Parameter Measurement Information (continued)

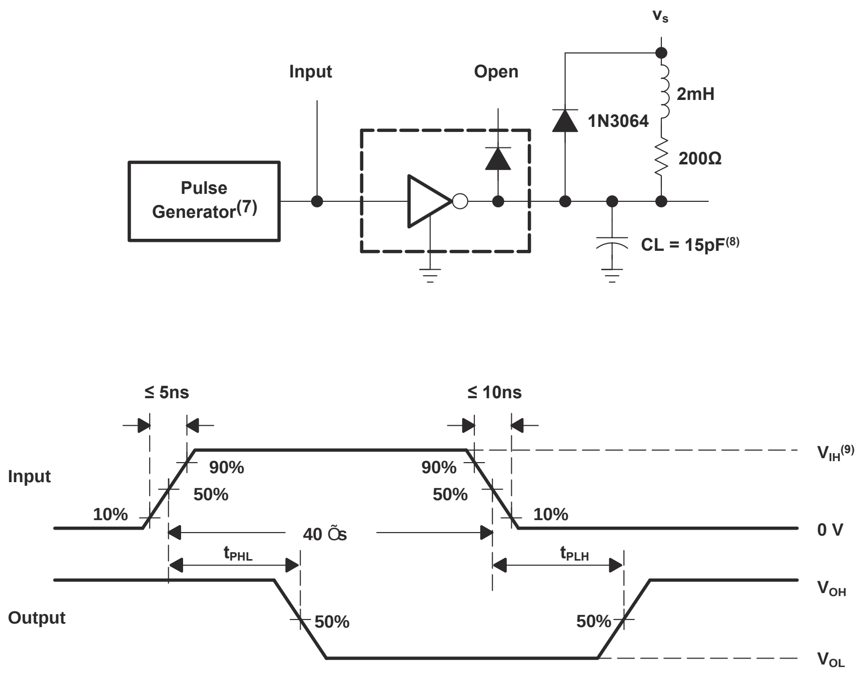


Figure 8. Latch-Up Test Circuit and Voltage Waveform

Note:

(7) The pulse generator has the following characteristics: Pulse Width = 12.5Hz, output impedance 50Ω.

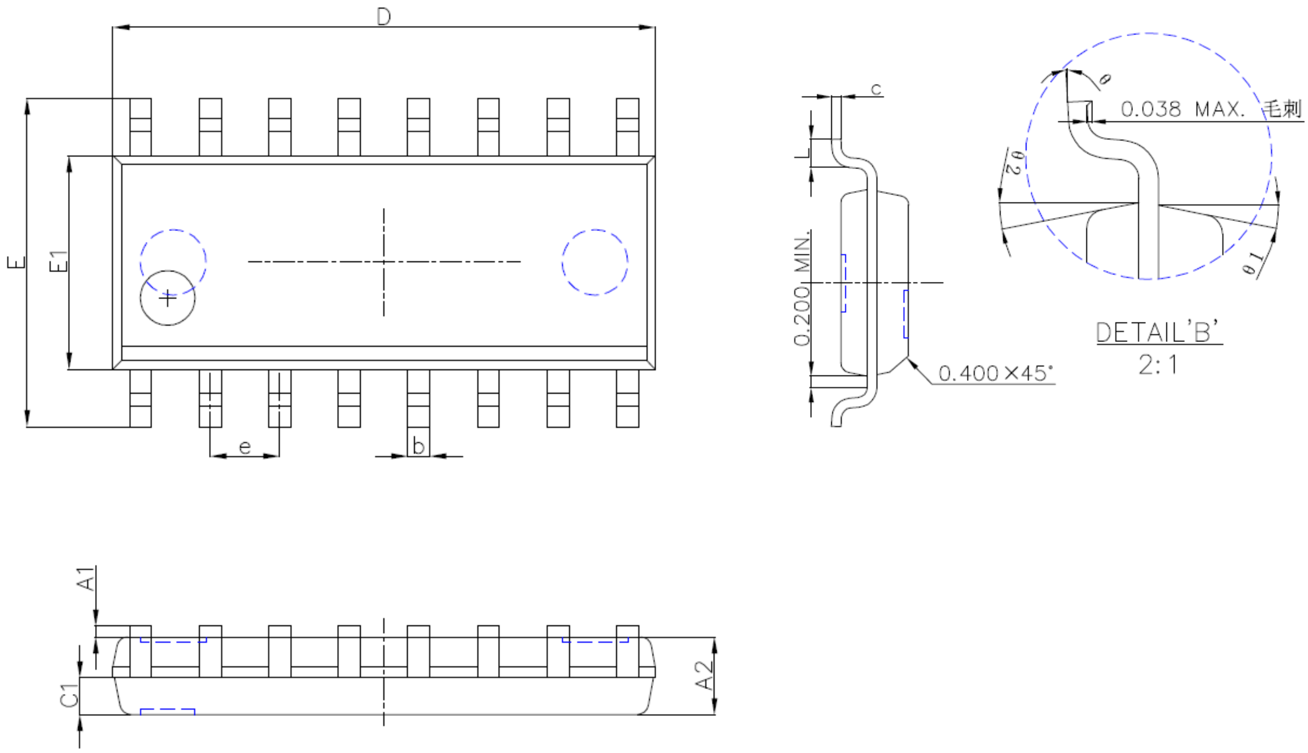
(8) C_L includes prove and jig capacitance.

(9) For testing the ULN2003E, V_{IH} = 3V.

9 Mechanical Information

9.1 SOP16 Mechanical Information

SOP16 Outline Dimensions

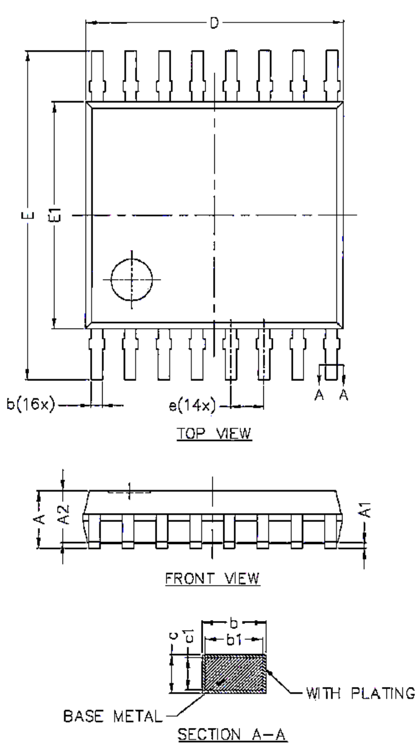


SYMBOL	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A1	0.050	0.200	0.250	0.002	0.008	0.010
A2	1.400	1.420	1.600	0.055	0.056	0.063
b	0.356	0.400	0.456	0.014	0.016	0.018
C1	0.600	0.670	0.700	0.024	0.026	0.028
c	0.193	0.203	0.213	0.008	0.008	0.008
D	9.790	9.850	10.000	0.385	0.388	0.394
E	5.840	6.000	6.240	0.230	0.236	0.246
E1	3.800	3.900	4.000	0.150	0.154	0.157
e	1.27 Bsc.			0.05 Bsc.		
L	0.40	0.55	0.70	0.016	0.022	0.028
θ	0°	3°	8°	0°	3°	8°
θ1	8°	11°	12°	8°	11°	12°
θ2	8°	11°	12°	8°	11°	12°

9 Mechanical Information

9.2 TSSOP16 Mechanical Information

TSSOP16 Outline Dimensions

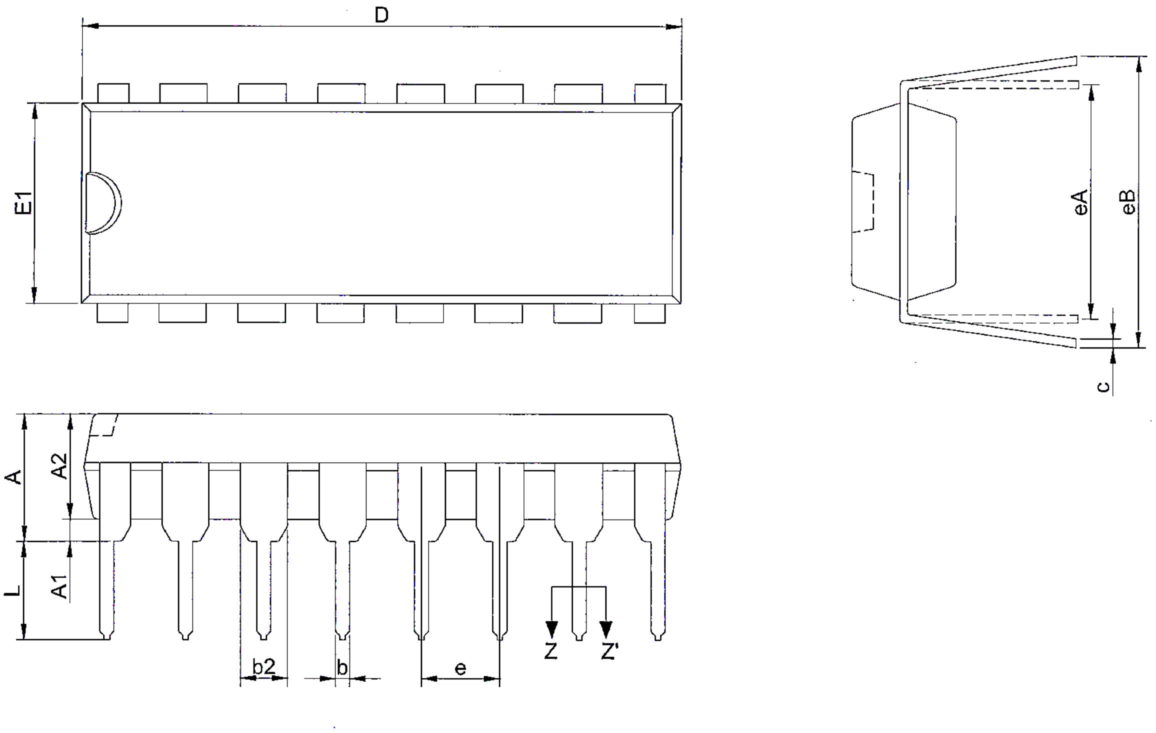


SYMBOL	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	-	-	1.200	-	-	0.047
A1	0.050	0.100	0.150	0.002	0.004	0.006
A2	0.900	1.000	1.050	0.035	0.039	0.041
b	0.200	-	0.280	0.008	-	0.011
b1	0.000	0.670	0.700	0.000	0.026	0.028
c	0.130	-	0.170	0.005	-	0.007
c1	0.12	0.127	0.14	0.005	0.005	0.006
D	4.900	5.000	5.100	0.193	0.197	0.201
E	6.200	6.400	6.600	0.244	0.252	0.260
E1	4.300	4.400	4.500	0.169	0.173	0.177
e	0.650 Bsc.			0.026 Bsc.		
L1	0.85	1	1.15	0.033	0.039	0.045
L	0.45	0.6	0.75	0.018	0.024	0.030
θ	0°	-	8°	0°	-	8°

9 Mechanical Information

9.3 DIP16 Mechanical Information

DIP16 Outline Dimensions



SYMBOL	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	3.600	-	4.450	0.142	-	0.175
A1	0.510	-	-	0.020	-	-
A2	3.000	3.100	3.200	0.118	0.122	0.126
b	0.410	-	0.520	0.016	-	0.020
b1	0.410	0.460	0.490	0.016	0.018	0.019
b2	1.520 Ref.			0.060 Bsc.		
c	0.210	-	0.350	0.008	-	0.014
c1	0.200	0.250	0.260	0.008	0.010	0.010
D	18.850	19.000	19.150	0.742	0.748	0.754
E1	6.000	6.150	6.300	0.236	0.242	0.248
e	2.540 Bsc.			0.100 Bsc.		
Ea	7.620 Bsc.			0.300 Bsc.		
Eb	8.20	-	8.80	0.323	-	0.346
L	3.00	-	3.60	0.118	-	0.142

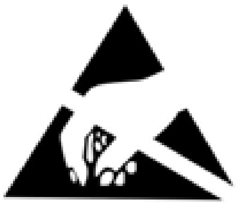
10 Notes and Revision History

10.1 Associated Product Family and Others

To view other products of the same type or IC products of other types, please click the official website of JSCJ -- ***https: www.jscj-elec.com*** for more details.

10.2 Notes

Electrostatic Discharge Caution



This IC may be damaged by ESD. Relevant personnel shall comply with correct installation and use specifications to avoid ESD damage to the IC. If appropriate measures are not taken to prevent ESD damage, the hazards caused by ESD include but are not limited to degradation of integrated circuit performance or complete damage of integrated circuit. For some precision integrated circuits, a very small parameter change may cause the whole device to be inconsistent with its published specifications.

10.3 Revision History

October,2024: changed from rev -1.0 to rev - 1.1:

- Page 2 , Orderable Information, added more available products;
- Page 2 , Marking Information, added information about TSSOP16 and DIP16;
- Page 5, Electrical Characteristics, added information about Input Capacitance, High-level output voltage after switching,Turn-on delay time and Turn-off delay time;
- Page 8 , Parameter Measurement Information, added Figure 8. Latch-Up Test Circuit and Voltage Waveform;
- Page 9~12, Mechanical Information, added information about TSSOP16 and DIP16.

August, 2024: released ULN2003E rev - 1.0.

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Official Website: www.jscj-elec.com