General Description

The ULN2003A 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. These devices are 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 ULN2003A is available in both a small outline 16-pin package(SOIC-16L and TSSOP-16L).

Features

- 500-mA-Rated Collector Current(single output)
- High-Voltage Outputs:50V
- Output Clamp Diodes
- Inputs Compatible With Various Types of Logic
- Relay-Driver Applications

Pin Assignments

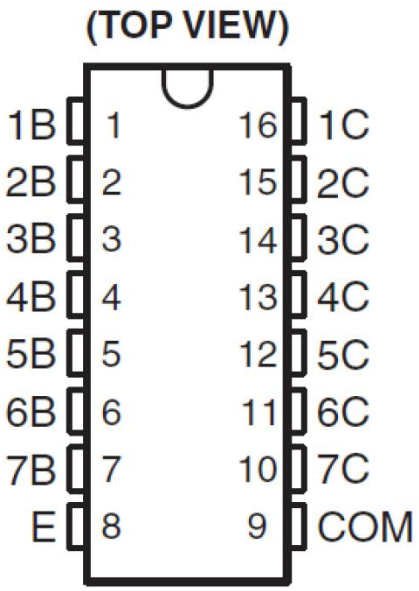
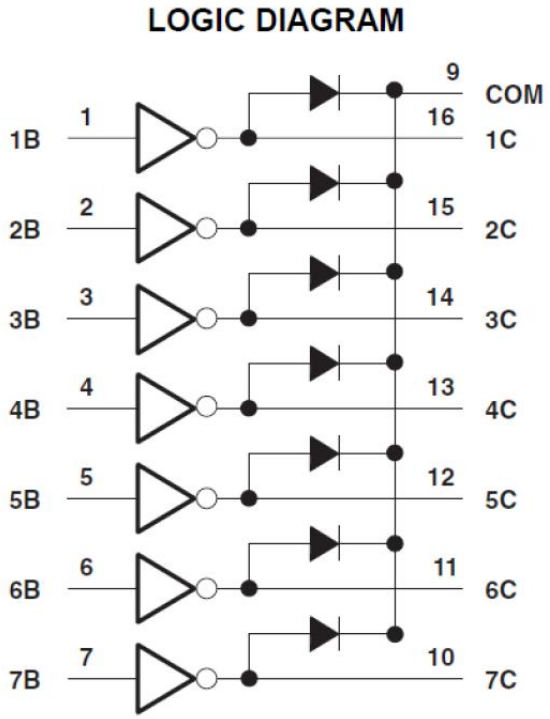


Table of Content

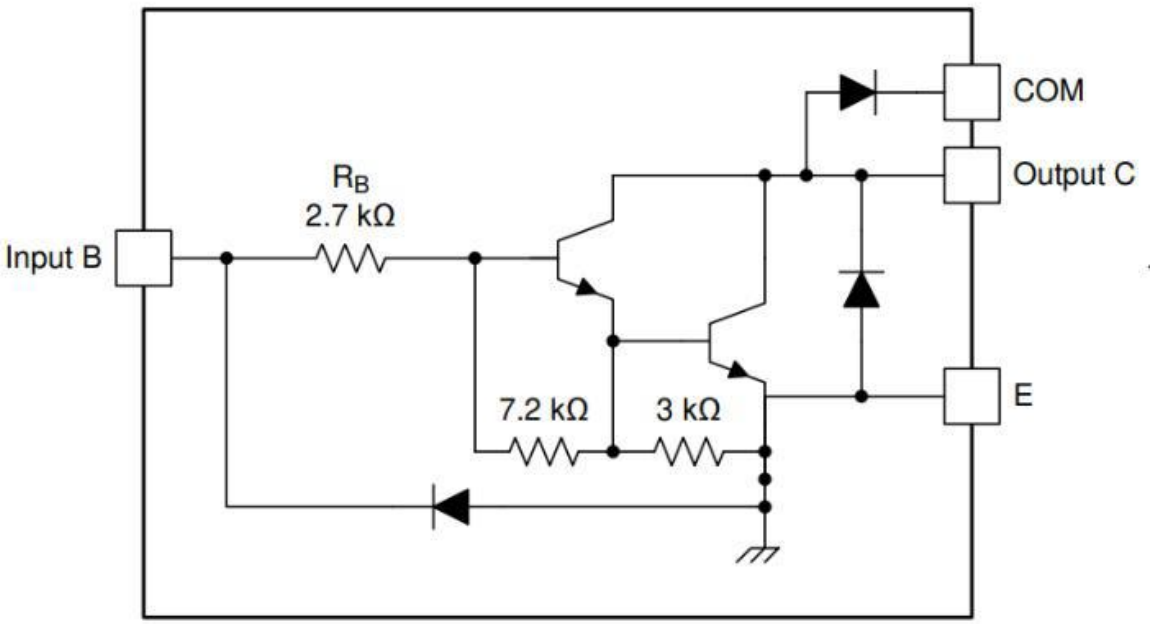
General Description



Pin Descriptions

Pin Number	Pin Name	Function
1	1B	Input pair1
2	2B	Input pair1
3	3B	Input pair1
4	4B	Input pair1
5	5B	Input pair1
6	6B	Input pair1
7	7B	Input pair1
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

Functional 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.

Ordering Information

Type Number	Package Name	Package Quantity	Mark Code	Moisture Sensitivity Level
ULN2003AXS16/R5	SOIC-16L	2 500, Tape & Reel	A2003	MSL3
ULN2003AXT16/R6	TSSOP-16L	3 000, Tape & Reel	A2003	MSL3

Absolute Maximum Ratings

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

Symbol	Parameter	Min	Max	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
I_{TE}	Total emitter-terminal current		-2.5	A
T_A	Operating free-air temperature range	-40	+105	°C
θ_{JA}	Thermal Resistance Junction-to-Ambient		63	°C/W
θ_{Jc}	Thermal Resistance Junction-to-Case		12	
T_J	Operating virtual junction temperature		+150	°C
T_{STG}	Storage temperature range	-65	+150	°C

ESD Ratings

Parameter	Value	Unit
Human body model (HBM), per ANSI/ESDA/JEDEC JS-001	±3 000	V
Charged device model (CDM), per ANSI/ESDA/JEDEC JS-002	±2 000	V

Recommended Operating Conditions

Symbol	Parameter	Min	Max	Unit
V_{cc}	Collector to Emitter voltage		50	V
T_A	Operating Ambient Temperature	-40	+105	°C

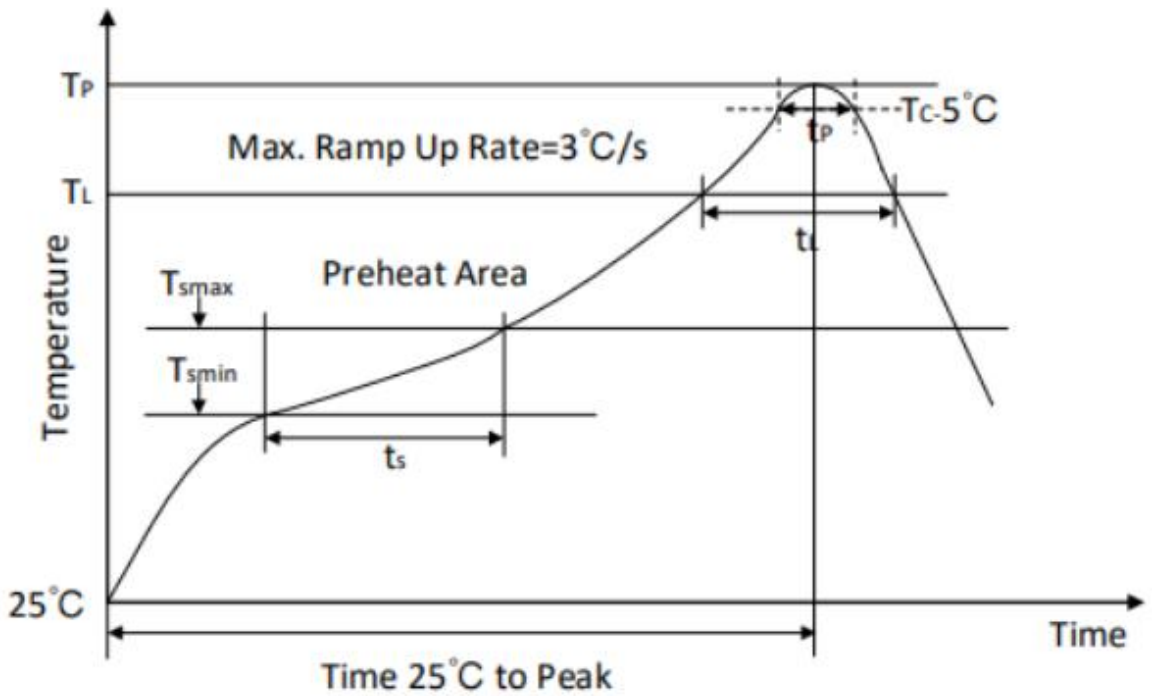
Electrical Characteristics

(T_A= 25℃, unless otherwise specified.)

Parameter		Test Figure	Test Conditions		ULN2003A			Unit
					MIN	TYP	MAX	
$V_{I(on)}$	On-state input voltage	Figure 6	V_{CE}=2V	I_C=200mA			2.4	V
				I_C=250mA			2.7	
				I_C=300mA			3	
$V_{CE(sat)}$	Collector-emitter saturation voltage	Figure 5	I_I=250 μA,	I_C=100mA		0.9	1.1	V
			I_I=350 μA,	I_C=200mA		1	1.3	
			I_I=500 μA,	I_C=350mA		1.2	1.6	
I_{CEX}	Collector cutoff current	Figure 1	V_{CE}=50 V,	I_I=0			50	μA
		Figure 2	V_{CE}=50V, T_A=+105℃	I_I=0			100	
V_F	Clamp forward voltage	Figure 8	I_F=350 mA			1.7	2	V
$I_{I(off)}$	Off-state input current	Figure 3	V_{CE}=50 V, I_C=500μA		50	65		μA
I_I	Input current	Figure 4	V_I=3.85V			0.93	1.35	mA
I_R	Clamp reverse current	Figure 7	V_R=50V				50	μA
				T_A=70℃			100	
C_I	Input capacitance		V_I=0, f=1MHz			15	25	pF
h_{EF}	DC amplification factor		VCE=2.0V， Ic=350mA		1 000			
t_{ON}	Conduction delay time		T_A=25℃,V_L=12V, R_L=45Ω,C_L=15pF			0.2	1	us
			T_A=-40℃ to 85℃, V_L=12V,$_{RL}$=45Ω			0.25	1	
t_{OFF}	Turn off delay time		T_A=25℃,V_L=12V, R_L=45Ω,C_L=15pF			0.3	1	us
			T_A=-40℃ to 85℃, V_L=12V,R_L=45Ω			0.35	1	

IR-Reflow Condition

Profile Feature	Condition
Average ramp-up rate (TL to Tp)	3℃/second max.
Preheat Temperature Min (Ts min) Temperature Max (Ts max). Time ts (min to max)	 150°C 200°C 60-120 seconds
Ts max to TL Ramp-up Rate	3°C/second max.
Time maintained above temperature (TL) Time (tL)	217°C 60-150 seconds
Peak Temperature (TP)	260 +0/-5°C
Time within 5℃ of actual Peak Temperature (tp)	30 seconds max
Ramp-down Rate	6°C /second max.
Time from 25℃ to Peak Temperature	8 minutes max.
IR-Reflow times(include hand soldering)	3 times



Part measurement information

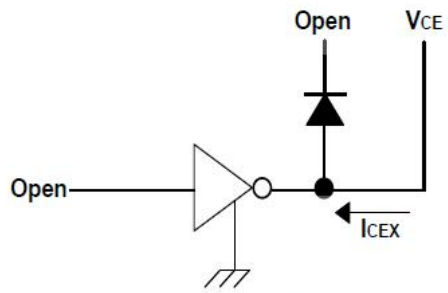


Fig.1 I_{CEX} Test Circuit

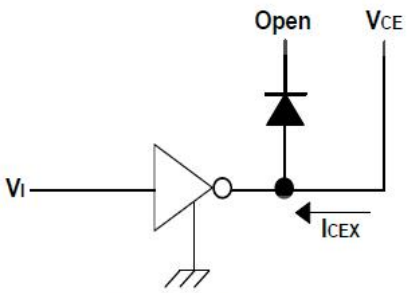


Fig.2 I_{CEX} Test Circuit

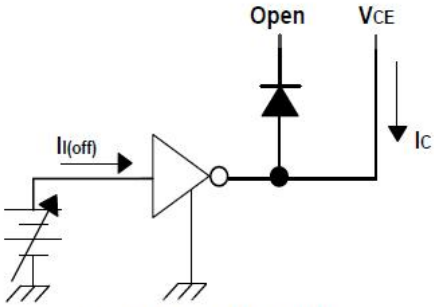


Fig.3 $I_{I(off)}$ Test Circuit

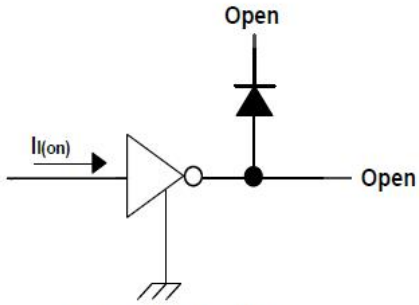


Fig.4 I_I Test Circuit

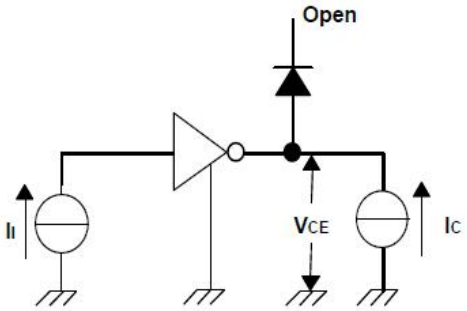


Fig. 5 h_{FE} , $V_{CE(sat)}$ Test Circuit

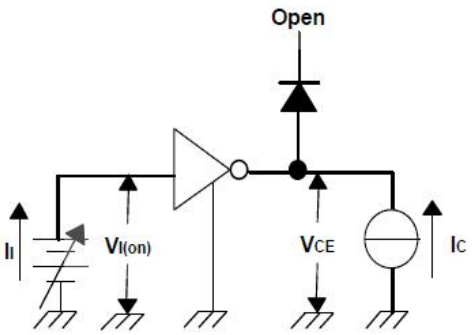


Fig. 6 $V_{I(on)}$ Test Circuit

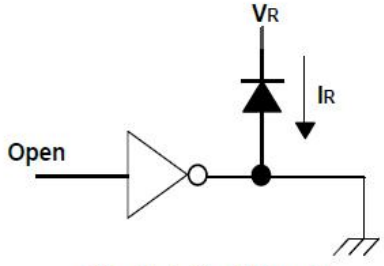


Fig. 7 I_R Test Circuit

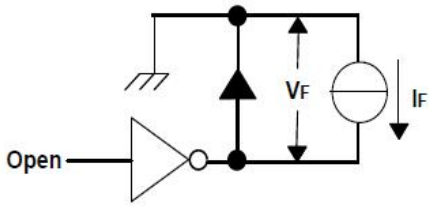
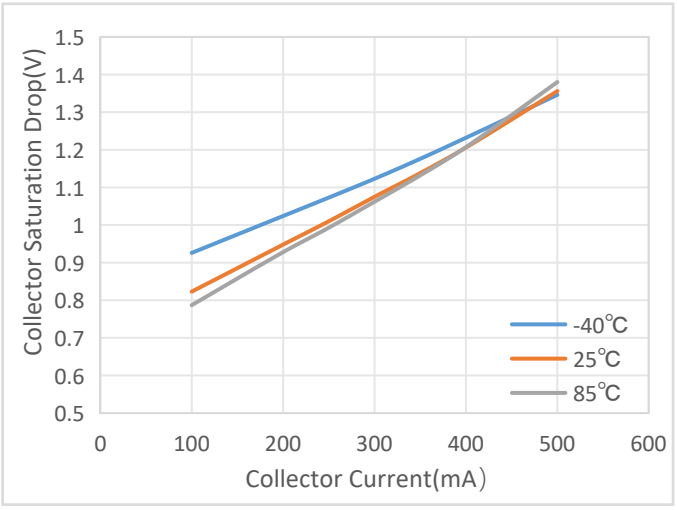
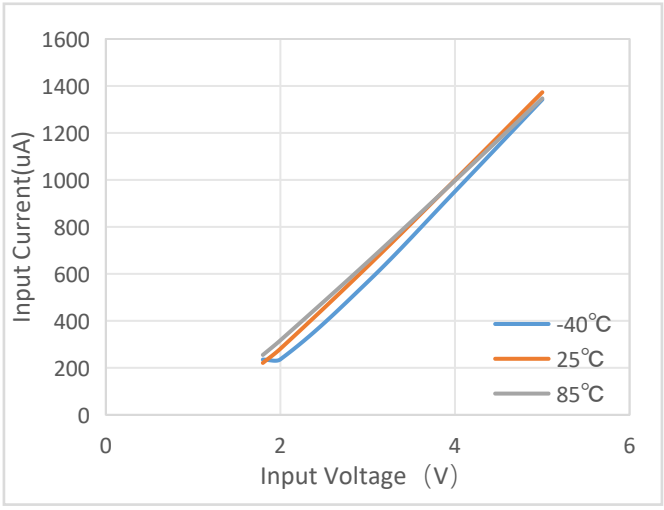


Fig. 8 V_F Test Circuit

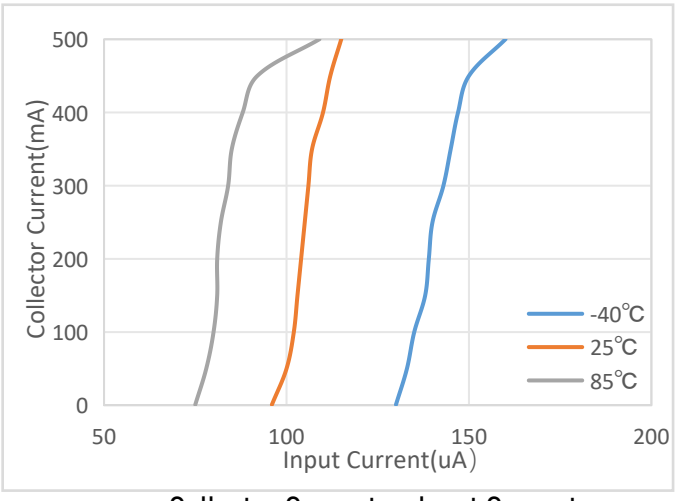
Typical Characteristics



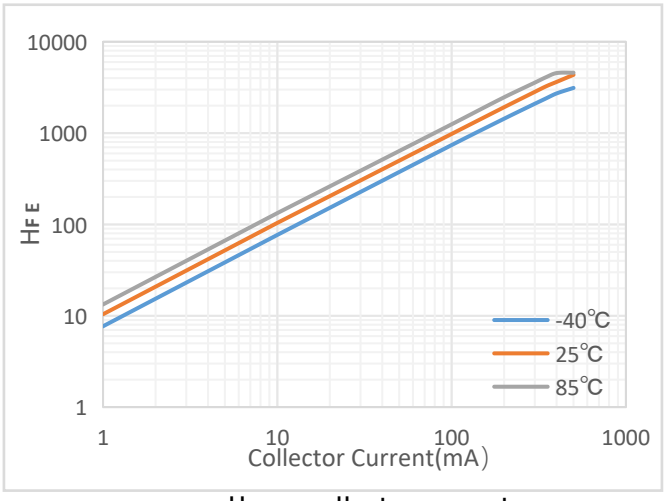
Collector Saturation Voltage Drop vs Collector Current



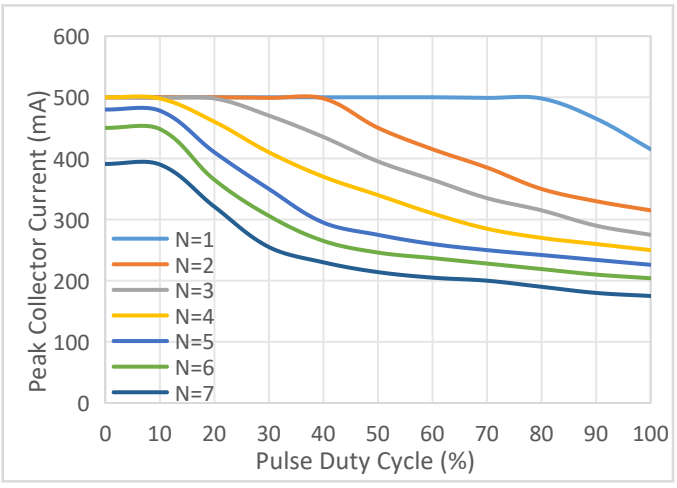
Input Current vs Input Voltage



Collector Current vs Input Current



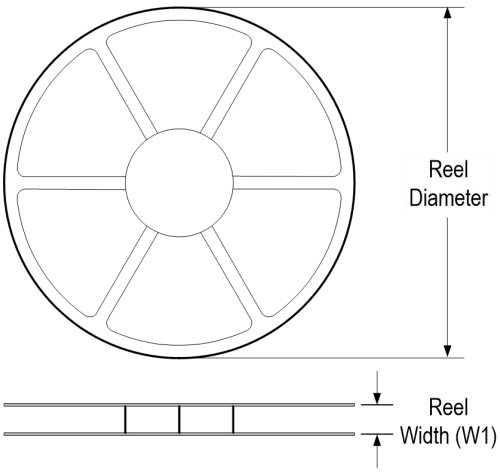
H_{FE} vs collector current



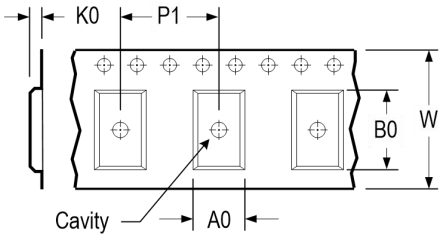
Peak Collector Current vs Pulse Duty Cycle

Tape and Reel Information

REEL DIMENSIONS

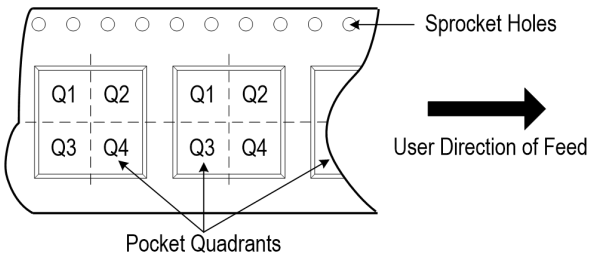


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIETATION IN TAPE

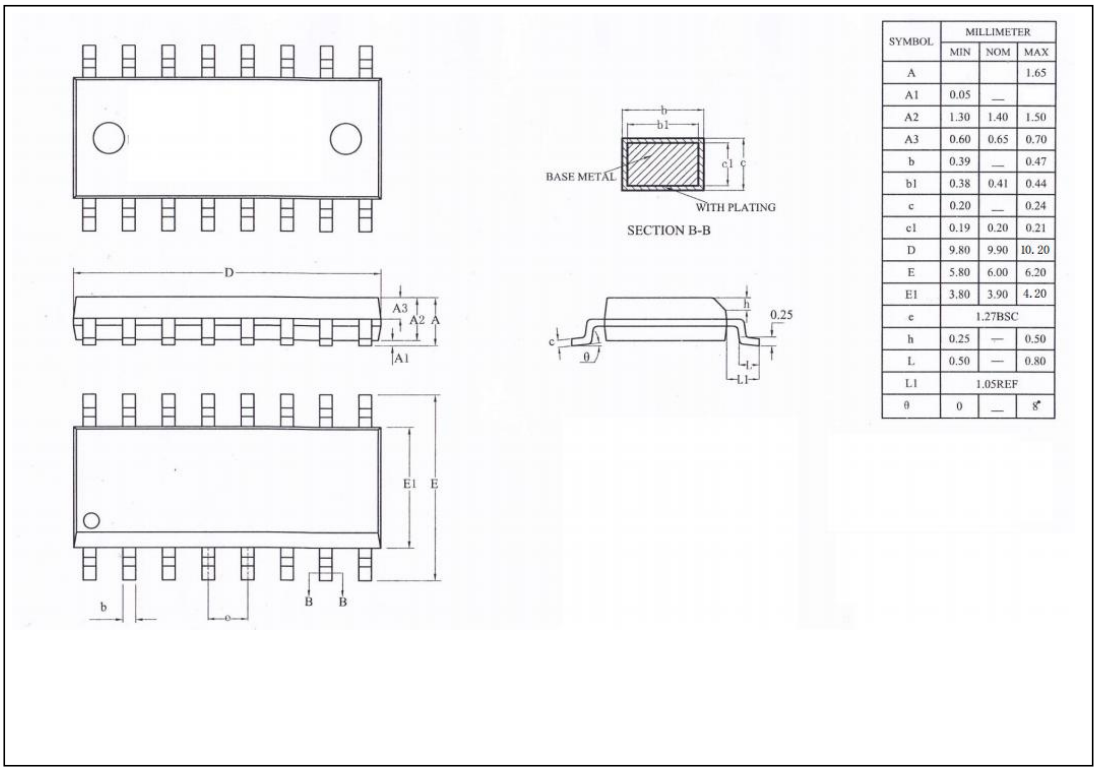


* All dimensions are nominal

Device	Package Type	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin 1 Quadrant
ULN2003AXS16/R5	SOIC	16	2 500	330	16.5	6.6	10.4	2.0	8.0	16.0	Q1
ULN2003AXT16/R6	TSSOP	16	3 000	330	16.5	6.9	5.6	1.6	8.0	16.0	Q1

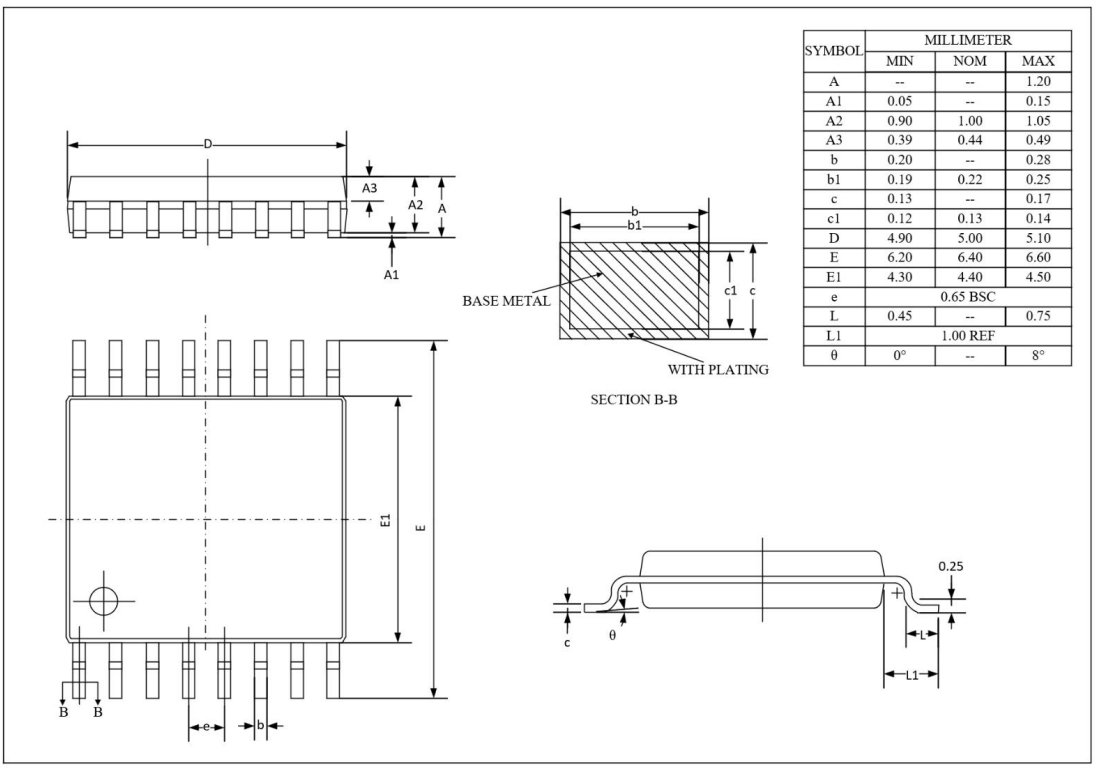
Outline Dimensions

DIMENSIONS, SOIC-16L



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A			1.65
A1	0.05	—	
A2	1.30	1.40	1.50
A3	0.60	0.65	0.70
b	0.39	—	0.47
b1	0.38	0.41	0.44
c	0.20	—	0.24
c1	0.19	0.20	0.21
D	9.80	9.90	10. 20
E	5.80	6.00	6.20
E1	3.80	3.90	4. 20
e	1.27BSC		
h	0.25	—	0.50
L	0.50	—	0.80
L1	1.05REF		
θ	0	—	8°

DIMENSIONS, TSSOP-16L



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	--	--	1.20
A1	0.05	--	0.15
A2	0.90	1.00	1.05
A3	0.39	0.44	0.49
b	0.20	--	0.28
b1	0.19	0.22	0.25
c	0.13	--	0.17
c1	0.12	0.13	0.14
D	4.90	5.00	5.10
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.65 BSC		
L	0.45	--	0.75
L1	1.00 REF		
θ	0°	--	8°

Important Notice

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