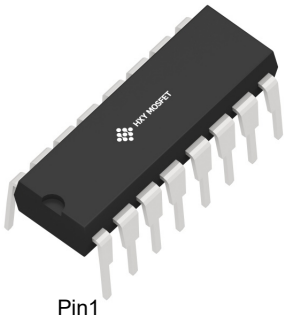
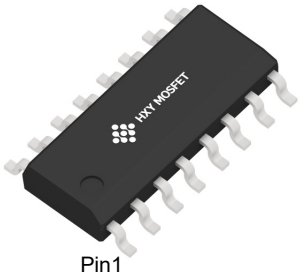
Descriptions

ULN2003 is high-voltage, high-current Seven Darlington arrays each containing seven open collector Darlington pairs with common emitters. Each channel is rated at 500 mA and can withstand peak currents of 600 mA. Suppression diodes are included for inductive load driving.The circuit is designed with a continuous diode, which can be used to drive the relay, stepper motor and other inductive loads. Single channel Darlington tube collector can output 500mA current. Higher output current capability is achieved by connecting Darlington tubes in parallel. The circuit can be widely used in relay driver, lighting driver, display driver (LED), stepper motor driver and logic buffer.It is useful for driving a wide range of loads including relay DC motors, LED display filament lamps, high-power buffers, 5V TTL, CMOS and other industry-standard logical circuit.

This chip is available in DIP-16 or SOP-16 package.



DIP-16



SOP-16

Feature

- Output current 500 mA per driver
- Withstand High Voltage (50V/60V two version)
- Input Pins Compatible to TTL/CMOS Logic Signal
- a Wide Application in Relay Driver

Applications

- Relay Driver
- Lamps Driver
- Display Driver

Ordering Information

Product Model	Package Type	Packing	Packing Qty	Remarks
ULN2003ALN	DIP-16	Tube	1000Pcs/Box	50V
ULN2003ALDTR	SOP-16	Tape	2500Pcs/Reel	50V
ULN2003AN	DIP-16	Tube	1000Pcs/Box	60V
ULN2003ADTR	SOP-16	Tape	2500Pcs/Reel	60V

Circuit Diagram

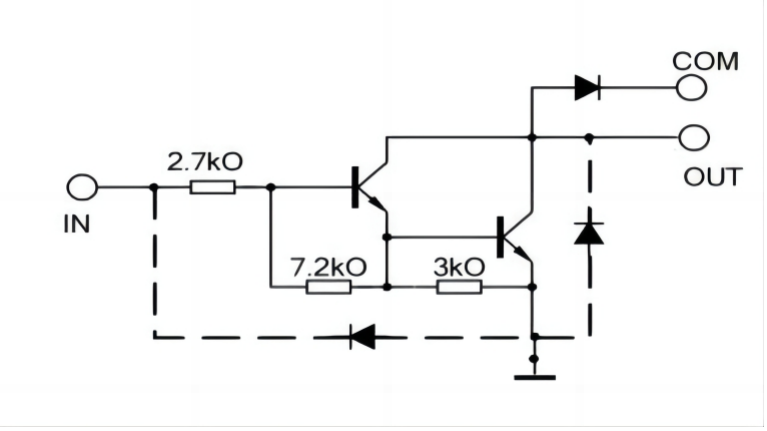


Figure 1 . Circuit Diagram

Pins Configuration

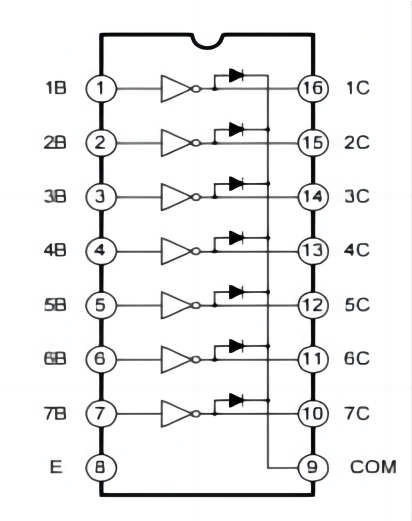


Figure 2 . Pins Configuration

Pins Description

No.	Name	Type	Description
1	1B	I	Input 1
2	2B	I	Input 2
3	3B	I	Input 3
4	4B	I	Input 4
5	5B	I	Input 5
6	6B	I	Input 6
7	7B	I	Input 7
8	E	-	Ground
9	COM	-	Common Free Wheeling Diodes
10	7C	O	Output 7
11	6C	O	Output 6
12	5C	O	Output 5
13	4C	O	Output 4
14	3C	O	Output 3
15	2C	O	Output 2
16	1C	O	Output 1

Absolute Maximum Ratings（T_A=25℃）

Parameter		Symbol	Min.	Max.	Unit
Collector-Emitter Voltage（Pin 10~ 16）	60V	V_{CE}	-0.5	60	V
	50V		-0.5	50	
Com Voltage（Pin 9）	60V	V_{COM}		60	V
	50V			50	
Input Voltage（Pin 1~7）		V_I	-0.5	30	V
Collector Peak Current		I_{CP}		500	mA/ch
Output Clamp Current		I_{OK}		500	mA
Emitter Maximum Current		I_{ET}		-2.5	A
Junction-To-Ambient Thermal Resistance	SOP16	θ_{JA}	63		℃/W
	DIP16		50		
Operating Temperature Range		T_{amb}	-40	85	℃
Maximum Junction Temperature		T_J		150	℃
Welding Temperature				260	℃, 10s
Storage Temperature Range		T_{stg}	-60	+150	℃
Power Dissipation	SOP16	P_D	1.28		W
	DIP16		1.5		

Recommended Operating Conditions

（T_A=25℃,unless otherwise noted)

Parameter		Symbol	Conditions	Min.	Max.	Unit
Collector-Emitter Voltage	60V	V_{CE}		0	60	V
	50V			0	50	
Maximum Junction Temperature		T_J			125	℃
Input Voltage		V_{IN}		0	24	V
Input Voltage (Output On)		$V_{IN(ON)}$	I_{OUT}=400mA,h_{FE}=800	2.5	24	V
Input Voltage (Output Off)		$V_{IN(OFF)}$		0	0.7	V
Clamp Forward Current		I_F			350	mA
Power Dissipation		P_D	T_A=-85℃		0.325	V

Electrical Characteristics（T_A=25℃）

Parameter		Test Diagrams	Test Conditions		Min.	Typ.	Max.	Unit
$V_{I(ON)}$	On-State Input Voltage	Figure 11	V_{CE}=2V	I_C=200mA			2.4	V
				I_C=250mA			2.7	
				I_C=300mA			3	
V_{OH}	High-Level Output Voltage After Switching	Figure 17	VS=50V	60V	VS-50			mV
			I_O=300m	50V	VS-50			
$V_{CE(SAT)}$	Collector-Emitter Saturation Voltage	Figure10	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			1.4	1.6	
I_{CEX}	Collector Cutoff Current	Figure 16	V_{CE}=50V,I_I=0				50	μA
V_F	Clamp Forward Voltage	Figure 15	I_F=350mA			1.7	2	V
$I_{I(off)}$	Off-State Input Current	Figure 13	V_{CE}=50V,I_C=500μA		50	65		uA
I_I	Input Current	Figure 14	V_I=3.85V			0.93	1.35	mA
h_{FE}	Dc Forward Current Gain	Figure 10	V_{CE}=2V,I_C=350mA		1000			
I_R	Clamp Reverse Current	Figure 12	V_R=50V				50	μA
C_I	Input Capacitance		V_I=0,f= 1MHz			15	25	pF
t_{PLH}	Propagation Delay Time, Low- To High-Level Output	Figure 17				0.25	1	μS
t_{PHL}	Propagation Delay Time, High- To Low-Level Output	Figure 17				0.25	1	μS

Electrical Characteristics（T_A=-40°C ~ 85°C）

Parameter		Test Diagrams	Test Conditions		Min.	Typ.	Max.	Unit
$V_{I(ON)}$	On-State Input Voltage	Figure 11	V_{CE}=2V	I_C=200mA			2.7	V
				I_C=250mA			2.9	
				I_C=300mA			3	
V_{OH}	High-Level Output Voltage After Switching	Figure 17	VS=50V	60V	VS-50			mV
			I_O=300m	50V	VS-50			
$V_{CE(SAT)}$	Collector-Emitter Saturation Voltage	Figure10	I_I=250μA,I_C= 100mA			0.9	1.2	V
			I_I=350μA,I_C=200mA			1.0	1.4	
			I_I=500μA,I_C=350mA			1.4	1.7	
I_{CEX}	Collector Cutoff Current	Figure 16	V_{CE}=50V,I_I=0				98	μA
V_F	Clamp Forward Voltage	Figure 15	I_F=350mA			1.7	2.3	V
$I_{I(off)}$	Off-State Input Current	Figure 13	V_{CE}=50V,I_C=500μA		30	65		uA
I_I	Input Current	Figure 14	V_I=3.85V			0.93	1.35	mA
I_R	Clamp Reverse Current	Figure 12	V_R=50V				100	μA
C_I	Input Capacitance		V_I=0,f= 1MHz			15	25	pF
t_{PLH}	Propagation Delay Time, Low- To High-Level Output	Figure 17				1.0	10	μS
t_{PHL}	Propagation Delay Time, High- To Low-Level Output	Figure 17				1.0	10	μS

Characteristic Curves

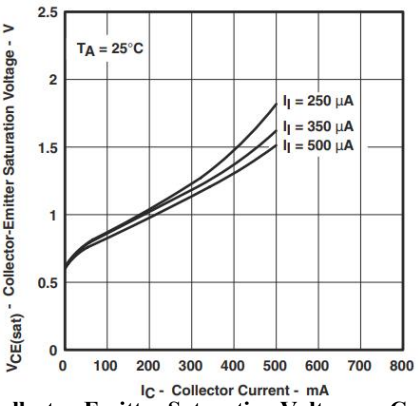


Figure 3. Collector-Emitter Saturation Voltage vs Collector Current

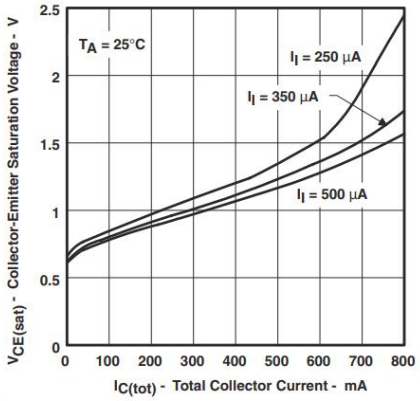


Figure 4. Collector-Emitter Saturation Voltage vs Total Collector Current (Two Darlingtons in Parallel)

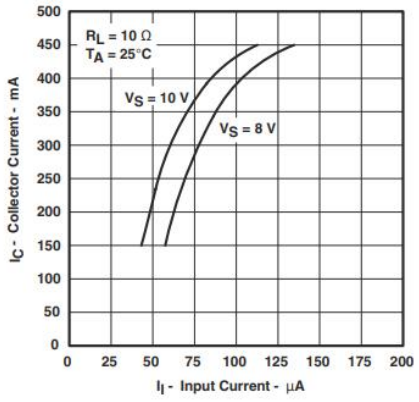


Figure 5 . Collector Current vs Input Current

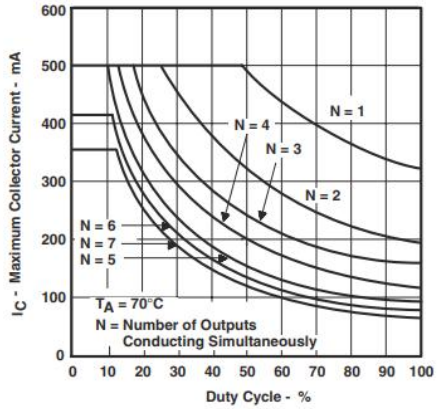


Figure 6 . Package Maximum Collector Current vs Duty Cycle

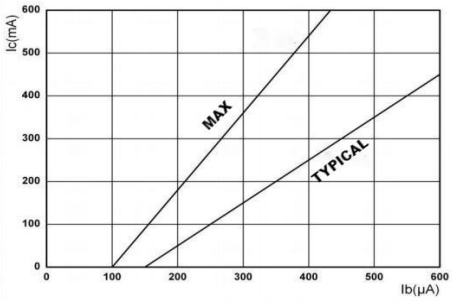


Figure 7 . Input Current vs. Input Voltage

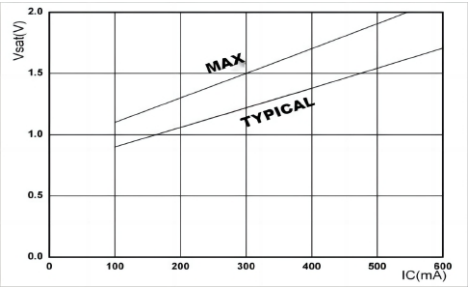


Figure 8 . Collector Current vs. Saturation Voltage

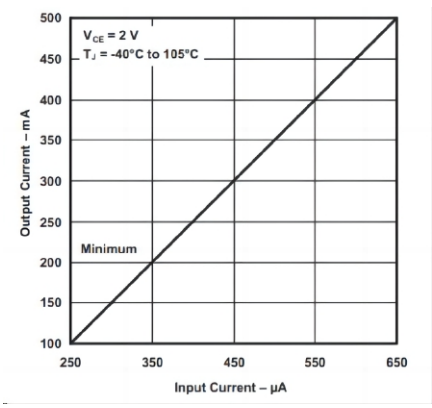


Figure 9. Collector current vs. input current

Test Parameter Diagram

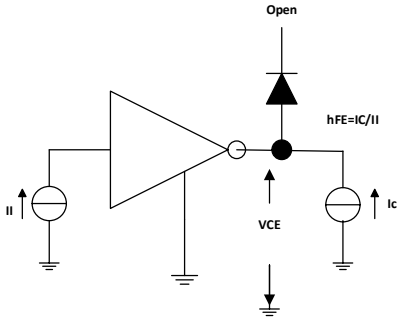


Figure 10. h_{FE}, $V_{CE(sat)}$ Test Circuit

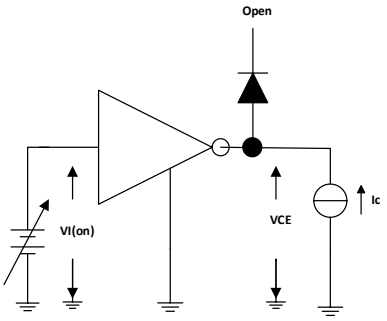


Figure 11. V_I (on) Test Circuit

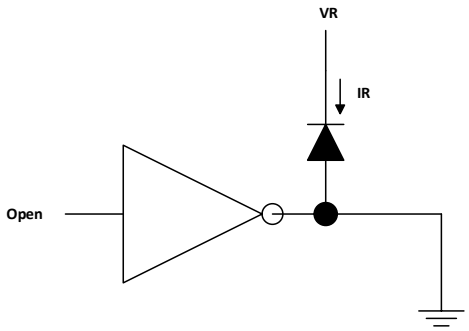


Figure 12. I_R Test Circuit

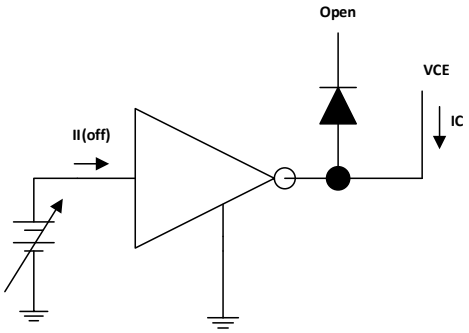


Figure 13. $I_{I(off)}$ Test Circuit

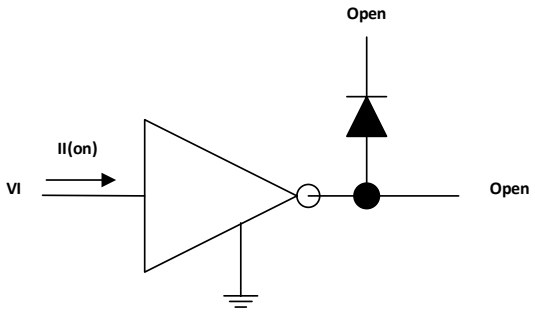


Figure 14. I_I Test Circuit

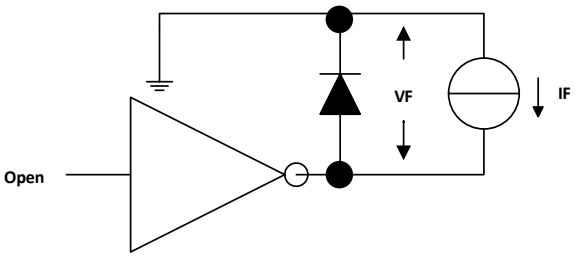


Figure 15. V_F Test Circuit

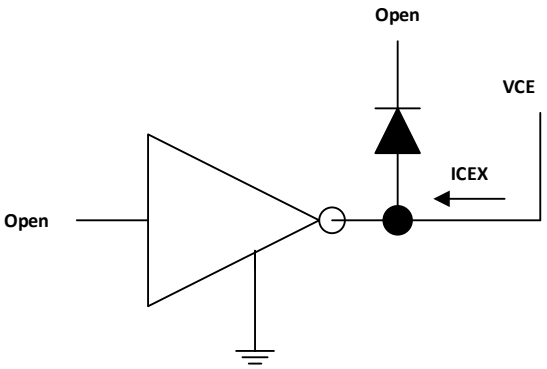


Figure 16. I_{CEX} Test Circuit

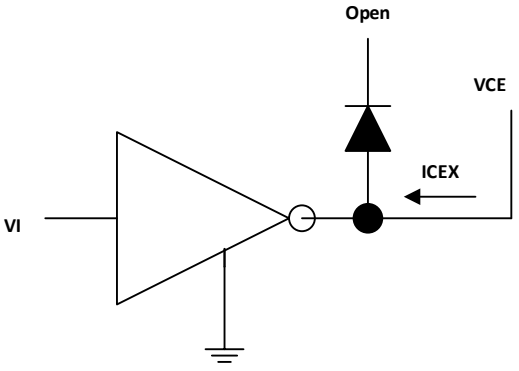
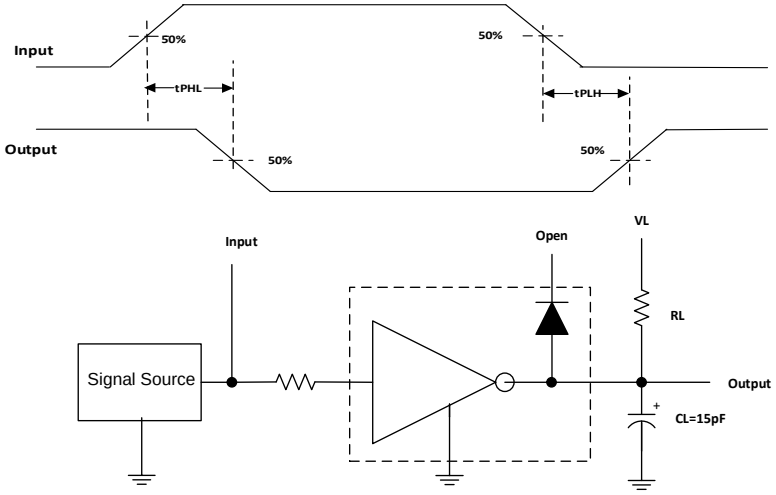


Figure 16. I_{CEX} Test Circuit



Note: The capacitance load in Figure 17. is the parasitic capacitance of the oscilloscope probe.

Figure 17.Propagation Delay-Time Waveforms

Typical applications

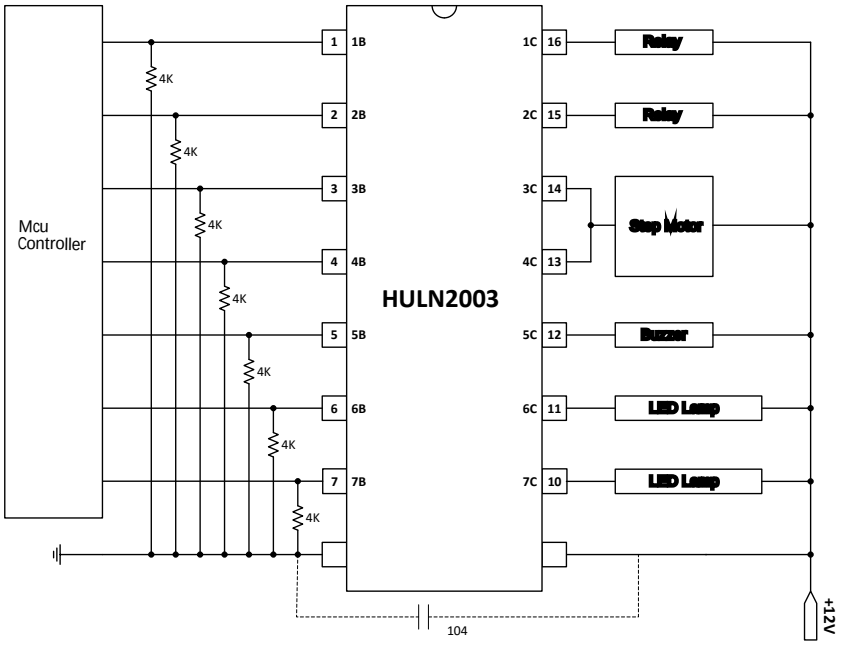


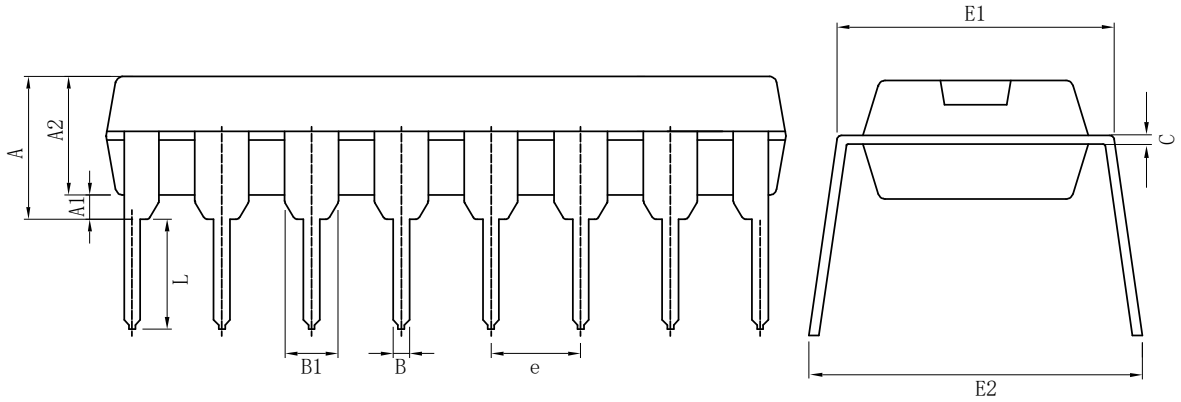
Figure 18.ULN2003 Application Diagram

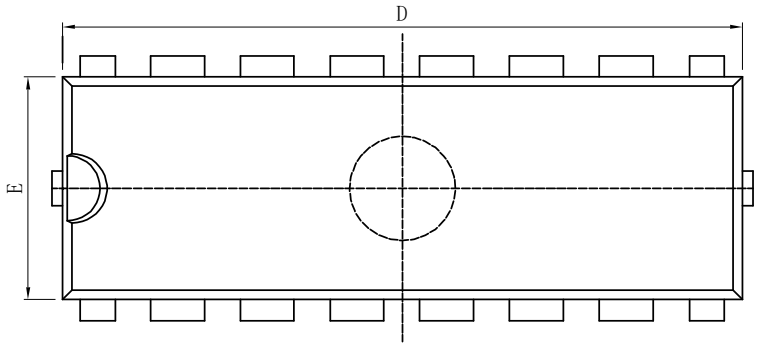
Application Instructions

Considering that some applications use microcontroller with pull-out resistance, the output state of microcontroller is uncertain when it is powered on and the ULN2003 input stage will be affected by the pull-out resistance of microcontroller and the load will be opened. In order to avoid the misaction of load, it is recommended that customers with such application problems connect a 4K pull-down resistance to the ground at the input stage, as shown in the Figure 18.

Package Information

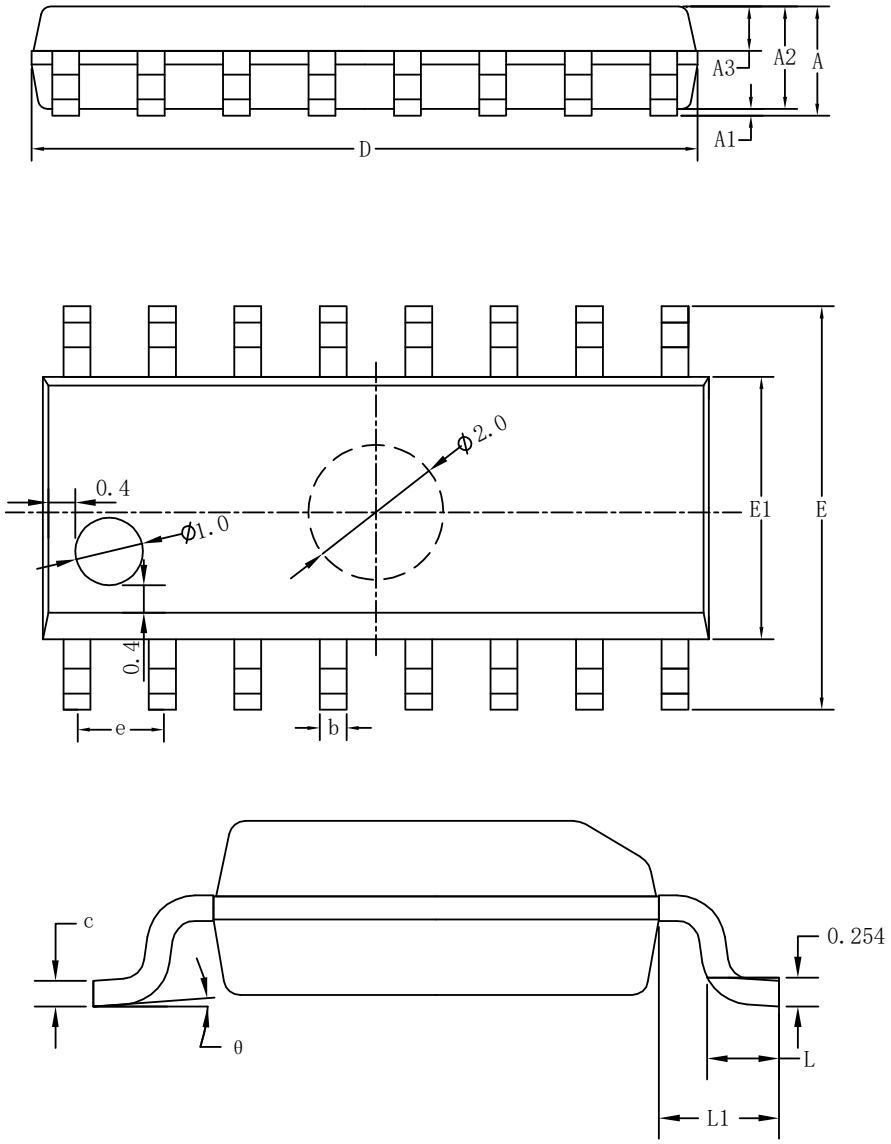
SOP-16





Size / Symbol	Dimensions In Millimeters		Size / Symbol	Dimensions In Inches	
	Min(mm)	Max(mm)		Min(in)	Max(in)
A	3.710	4.310	A	0.146	0.170
A1	0.510		A1	0.020	
A2	3.200	3.600	A2	0.126	0.142
B	0.380	0.570	B	0.015	0.022
B1	1.524(BSC)		B1	0.060(BSC)	
C	0.204	0.360	C	0.008	0.014
D	18.80	19.20	D	0.740	0.756
E	6.200	6.600	E	0.244	0.260
E1	7.320	7.920	E1	0.288	0.312
e	2.540(BSC)		e	0.100(BSC)	
L	3.000	3.600	L	0.118	0.142
E2	8.400	9.000	E2	0.331	0.354

SOP-16



Size / Symbol	Dimensions In Millimeters			Size / Symbol	Dimensions In Inches		
	Min(mm)	Nom(mm)	Max(mm)		Min(in)	Nom(in)	Max(in)
A	1.500	1.600	1.700	A	0.059	0.063	0.067
A1	0.100	0.150	0.250	A1	0.004	0.006	0.010
A2	1.400	1.450	1.500	A2	0.055	0.057	0.059
A3	0.600	0.650	0.700	A3	0.024	0.026	0.028
b	0.300	0.400	0.500	b	0.012	0.016	0.020
c	0.150	0.200	0.250	c	0.006	0.008	0.010
D	9.800	9.900	10.00	D	0.386	0.390	0.394
E	5.800	6.000	6.200	E	0.228	0.236	0.244
E1	3.850	3.900	3.950	E1	0.152	0.154	0.156
e	1.27(BSC)			e	0.050(BSC)		
L	0.500	0.600	0.700	L	0.020	0.024	0.028
L1	1.05(BSC)			L1	0.041(BSC)		
θ	0°	4°	8°	θ	0°	4°	8°

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