

# Product Specification

XBLW SN74LS138

3-to-8 Line Decoder/Demultiplexer;  
Inverting

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## Description

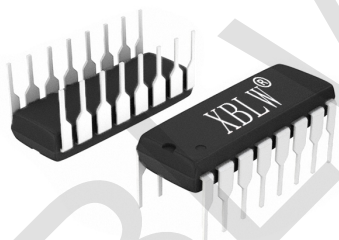
The SN74LS138 is a decodes three binary weighted address inputs(A0, A1 and A2) to eight mutually exclusive outputs ( $\bar{Y}0$  to  $\bar{Y}7$ ). The device features three enable inputs ( $\bar{E}1$ ,  $\bar{E}2$  and E3). Every output will be HIGH unless  $\bar{E}1$  and  $\bar{E}2$  are LOW and E3 is HIGH. This multiple enable function allows easy parallel expansion to a 1-of-32(5 to 32 lines) decoder with just four SN74LS138ICs and one inverter. The SN74LS138 can be used as an eight output demultiplexer by using one of the active LOW enable inputs as the data input and the remaining enable inputs as strobes. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of  $V_{CC}$ .

## Features

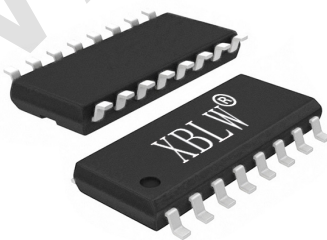
- Wide operating voltage range: 2 V to 6 V
- Demultiplexing capability
- Multiple input enable for easy expansion
- Ideal for memory chip select decoding
- Active LOW mutually exclusive outputs
- Specified from -20°C to +85°C
- Packaging information: DIP-16/SOP-16/TSSOP-16

## Applications

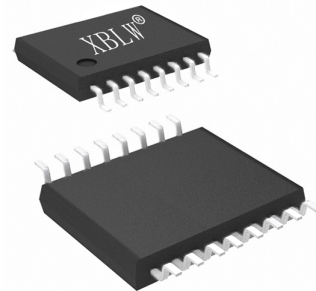
- LED Displays
- Servers
- White Goods
- Power Infrastructure
- Building Automation
- Factory Automation



DIP-16



SOP-16



TSSOP-16

## Ordering Information

Product Model	Package Type	Marking	Packing	Packing Qty
XBLW SN74LS138N	DIP-16	74LS138N	Tube	1000Pcs/Box
XBLW SN74LS138DTR	SOP-16	74LS138	Tape	2500Pcs/Reel
XBLW SN74LS138TDTR	TSSOP-16	74LS138	Tape	3000Pcs/Reel

### Block Diagram

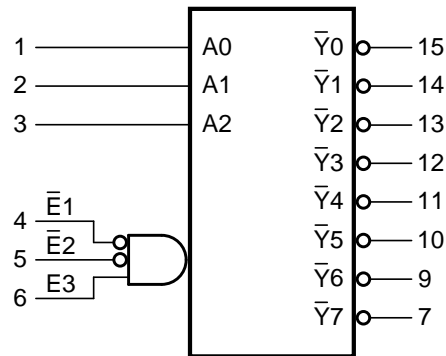


Figure 1. Logic symbol

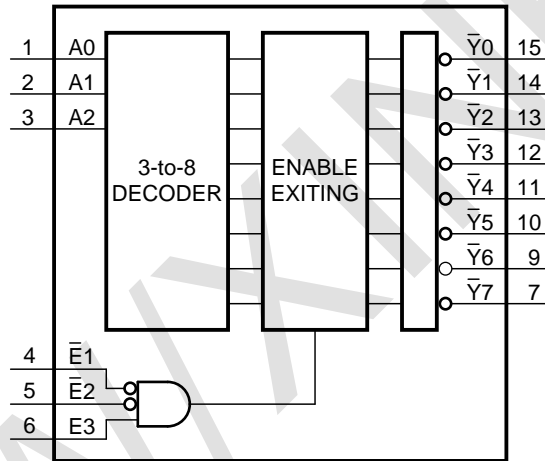


Figure 2. Functional diagram

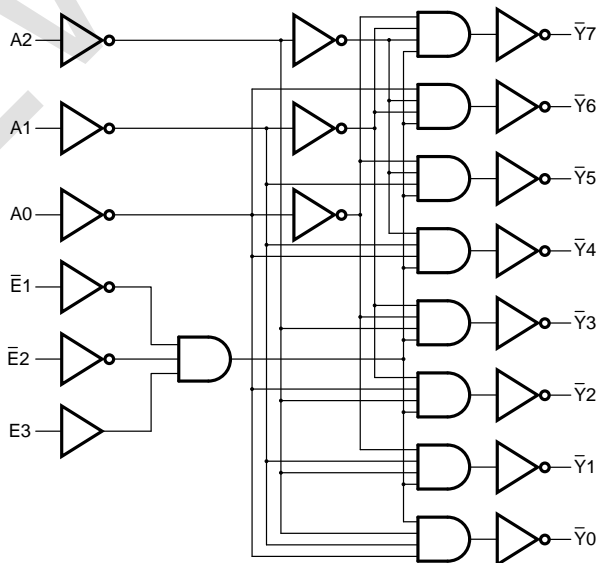
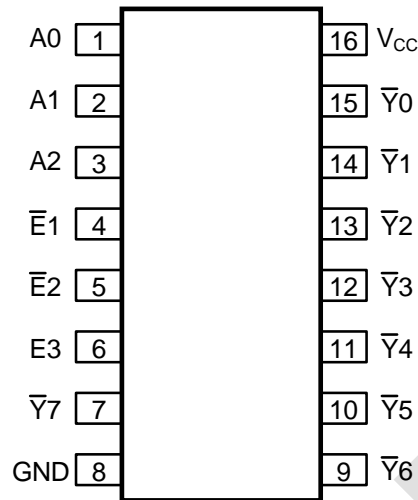


Figure 3. Logic diagram

## Pin Configurations



## Pin Description

Pin No.	Pin Name	Description
1	A0	address input
2	A1	address input
3	A2	address input
4	$\bar{E}1$	enable input (active LOW)
5	$\bar{E}2$	enable input (active LOW)
6	E3	enable input (active HIGH)
7	$\bar{Y}7$	output (active LOW)
8	GND	ground (0 V)
9	$\bar{Y}6$	output (active LOW)
10	$\bar{Y}5$	output (active LOW)
11	$\bar{Y}4$	output (active LOW)
12	$\bar{Y}3$	output (active LOW)
13	$\bar{Y}2$	output (active LOW)
14	$\bar{Y}1$	output (active LOW)
15	$\bar{Y}0$	output (active LOW)
16	V <sub>cc</sub>	supply voltage

### Function Table

Input						Output							
$\bar{E}1$	$\bar{E}2$	$E3$	$A2$	$A1$	$A0$	$\bar{Y}7$	$\bar{Y}6$	$\bar{Y}5$	$\bar{Y}4$	$\bar{Y}3$	$\bar{Y}2$	$\bar{Y}1$	$\bar{Y}0$
H	X	X	X	X	X	H	H	H	H	H	H	H	H
X	H	X	X	X	X	H	H	H	H	H	H	H	H
X	X	L	X	X	X	H	H	H	H	H	H	H	H
L	L	H	L	L	L	H	H	H	H	H	H	H	L
L	L	H	L	L	H	H	H	H	H	H	H	L	H
L	L	H	L	H	L	H	H	H	H	H	L	H	H
L	L	H	L	H	H	H	H	H	H	L	H	H	H
L	L	H	H	L	L	H	H	H	L	H	H	H	H
L	L	H	H	L	H	H	H	L	H	H	H	H	H
L	L	H	H	H	L	H	L	H	H	H	H	H	H
L	L	H	H	H	H	L	H	H	H	H	H	H	H

Note: H=HIGH voltage level; L=LOW voltage level; X=don't care.

### Electrical Parameter

#### Absolute Maximum Ratings

(Voltages are referenced to GND (ground=0V), unless otherwise specified.)

Parameter	Symbol	Conditions	Min.	Max.	Unit
supply voltage	$V_{CC}$	-	-0.5	+7	V
input clamping current	$I_{IK}$	$V_I < -0.5V$ or $V_I > V_{CC}+0.5V$	-	$\pm 20$	mA
output clamping current	$I_{OK}$	$V_O < -0.5V$ or $V_O > V_{CC}+0.5V$	-	$\pm 20$	mA
output current	$I_O$	$-0.5V < V_O < V_{CC}+0.5V$	-	$\pm 25$	mA
supply current	$I_{CC}$	-	-	50	mA
ground current	$I_{GND}$	-	-50	-	mA
total power dissipation	$P_{tot}$	-	-	500	mW
storage temperature	$T_{stg}$	-	-65	+150	°C
soldering temperature	$T_L$	10s	DIP		°C
			SOP/TSSOP		

**Recommended Operating Conditions**

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
supply voltage	$V_{CC}$	-	2.0	5.0	6.0	V
input voltage	$V_I$	-	0	-	$V_{CC}$	V
output voltage	$V_O$	-	0	-	$V_{CC}$	V
input transition rise and fall rate	$\Delta t/\Delta V$	$V_{CC}=2.0V$	-	-	625	ns/V
		$V_{CC}=4.5V$	-	1.67	139	ns/V
		$V_{CC}=6.0V$	-	-	83	ns/V
ambient temperature	$T_{amb}$	-	-20	-	+85	°C

**Electrical Characteristics**
**DC Characteristics 1**

( $T_{amb}=25^{\circ}C$ , voltages are referenced to GND (ground=0V), unless otherwise specified.)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	
HIGH-level input voltage	$V_{IH}$	$V_{CC}=2.0V$	1.5	1.2	-	V	
		$V_{CC}=4.5V$	3.15	2.4	-	V	
		$V_{CC}=6.0V$	4.2	3.2	-	V	
LOW-level input voltage	$V_{IL}$	$V_{CC}=2.0V$	-	0.8	0.5	V	
		$V_{CC}=4.5V$	-	2.1	1.35	V	
		$V_{CC}=6.0V$	-	2.8	1.8	V	
HIGH-level output voltage	$V_{OH}$	$V_I=V_{IH}$ or $V_{IL}$	$I_O=-20\mu A$ ; $V_{CC}=2.0V$	1.9	2.0	-	V
			$I_O=-20\mu A$ ; $V_{CC}=4.5V$	4.4	4.5	-	V
			$I_O=-20\mu A$ ; $V_{CC}=6.0V$	5.9	6.0	-	V
			$I_O=-4.0mA$ ; $V_{CC}=4.5V$	3.98	4.32	-	V
			$I_O=-5.2mA$ ; $V_{CC}=6.0V$	5.48	5.81	-	V
LOW-level output voltage	$V_{OL}$	$V_I=V_{IH}$ or $V_{IL}$	$I_O=20\mu A$ ; $V_{CC}=2.0V$	-	0	0.1	V
			$I_O=20\mu A$ ; $V_{CC}=4.5V$	-	0	0.1	V
			$I_O=20\mu A$ ; $V_{CC}=6.0V$	-	0	0.1	V
			$I_O=4.0mA$ ; $V_{CC}=4.5V$	-	0.15	0.26	V
			$I_O=5.2mA$ ; $V_{CC}=6.0V$	-	0.16	0.26	V
input leakage current	$I_I$	$V_I=V_{CC}$ or GND; $V_{CC}=6.0V$	-	-	$\pm 1.0$	$\mu A$	
supply current	$I_{CC}$	$V_I=V_{CC}$ or GND; $I_O=0A$ ; $V_{CC}=6.0V$	-	-	8.0	$\mu A$	
input capacitance	$C_I$	-	-	3.5	-	pF	

**DC Characteristics 2**

( $T_{amb} = -20^{\circ}C$  to  $+85^{\circ}C$ , voltages are referenced to GND (ground=0V), unless otherwise specified.)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	
HIGH-level input voltage	$V_{IH}$	$V_{CC}=2.0V$	1.5	-	-	V	
		$V_{CC}=4.5V$	3.15	-	-	V	
		$V_{CC}=6.0V$	4.2	-	-	V	
LOW-level input voltage	$V_{IL}$	$V_{CC}=2.0V$	-	-	0.5	V	
		$V_{CC}=4.5V$	-	-	1.35	V	
		$V_{CC}=6.0V$	-	-	1.8	V	
HIGH-level output voltage	$V_{OH}$	$V_I = V_{IH}$ or $V_{IL}$	$I_O = -20\mu A; V_{CC} = 2.0V$	1.9	-	-	V
			$I_O = -20\mu A; V_{CC} = 4.5V$	4.4	-	-	V
			$I_O = -20\mu A; V_{CC} = 6.0V$	5.9	-	-	V
			$I_O = -4.0mA; V_{CC} = 4.5V$	3.84	-	-	V
			$I_O = -5.2mA; V_{CC} = 6.0V$	5.34	-	-	V
LOW-level output voltage	$V_{OL}$	$V_I = V_{IH}$ or $V_{IL}$	$I_O = 20\mu A; V_{CC} = 2.0V$	-	-	0.1	V
			$I_O = 20\mu A; V_{CC} = 4.5V$	-	-	0.1	V
			$I_O = 20\mu A; V_{CC} = 6.0V$	-	-	0.1	V
			$I_O = 4.0mA; V_{CC} = 4.5V$	-	-	0.33	V
			$I_O = 5.2mA; V_{CC} = 6.0V$	-	-	0.33	V
input leakage current	$I_I$	$V_I = V_{CC}$ or GND; $V_{CC} = 6.0V$	-	-	$\pm 1.0$	$\mu A$	
supply current	$I_{CC}$	$V_I = V_{CC}$ or GND; $I_O = 0A; V_{CC} = 6.0V$	-	-	80	$\mu A$	

**AC Characteristics 1**

(T<sub>amb</sub>=25°C, voltages are referenced to GND (ground=0V), unless otherwise specified.)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	
An to $\bar{Y}_n$ propagation delay	$t_{pd}$	see Figure 5 <sup>[1]</sup>	V <sub>CC</sub> =2.0V	-	41	150	ns
			V <sub>CC</sub> =4.5V	-	15	30	ns
			V <sub>CC</sub> =5.0V; C <sub>L</sub> =15pF	-	12	-	ns
			V <sub>CC</sub> =6.0V	-	12	26	ns
E3 to $\bar{Y}_n$ propagation delay	$t_{pd}$	see Figure 5 <sup>[1]</sup>	V <sub>CC</sub> =2.0V	-	47	150	ns
			V <sub>CC</sub> =4.5V	-	17	20	ns
			V <sub>CC</sub> =5.0V; C <sub>L</sub> =15pF	-	14	-	ns
			V <sub>CC</sub> =6.0V	-	14	26	ns
$\bar{E}_n$ to $\bar{Y}_n$ propagation delay	$t_{pd}$	see Figure 6 <sup>[1]</sup>	V <sub>CC</sub> =2.0V	-	47	150	ns
			V <sub>CC</sub> =4.5V	-	17	20	ns
			V <sub>CC</sub> =5.0V; C <sub>L</sub> =15pF	-	14	-	ns
			V <sub>CC</sub> =6.0V	-	14	26	ns
transition time	$t_t$	see Figure 5 <sup>[2]</sup>	V <sub>CC</sub> =2.0V	-	19	75	ns
			V <sub>CC</sub> =4.5V	-	7	15	ns
			V <sub>CC</sub> =6.0V	-	6	13	ns
power dissipation capacitance	C <sub>PD</sub>	C <sub>L</sub> =50pF; f=1MHz; V <sub>I</sub> =GND to V <sub>CC</sub> <sup>[3]</sup>	-	67	-	pF	

Note:

[1]  $t_{pd}$  is the same as  $t_{PLH}$  and  $t_{PHL}$ .

[2]  $t_t$  is the same as  $t_{THL}$  and  $t_{TLH}$ .

[3] C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> in uW).

$$P_D = (C_{PD} \times V_{CC}^2 \times f_i \times N) + \sum(C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

f<sub>i</sub>=input frequency in MHz;

f<sub>o</sub>=output frequency in MHz;

C<sub>L</sub>=output load capacitance in pF;

V<sub>CC</sub>=supply voltage in V;

N=number of inputs switching;

$\sum(C_L \times V_{CC}^2 \times f_o)$ =sum of outputs.



**AC Characteristics 2**

( $T_{amb} = -20^{\circ}C$  to  $+85^{\circ}C$ , voltages are referenced to GND (ground=0V), unless otherwise specified.)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	
An to $\bar{Y}_n$ ; propagation delay	$t_{pd}$	see Figure 5 <sup>[1]</sup>	$V_{CC}=2.0V$	-	-	190	ns
			$V_{CC}=4.5V$	-	-	38	ns
			$V_{CC}=6.0V$	-	-	33	ns
E3 to $\bar{Y}_n$ ; propagation delay	$t_{pd}$	see Figure 5 <sup>[1]</sup>	$V_{CC}=2.0V$	-	-	190	ns
			$V_{CC}=4.5V$	-	-	38	ns
			$V_{CC}=6.0V$	-	-	33	ns
$\bar{E}_n$ to $\bar{Y}_n$ ; propagation delay	$t_{pd}$	see Figure 6 <sup>[1]</sup>	$V_{CC}=2.0V$	-	-	190	ns
			$V_{CC}=4.5V$	-	-	38	ns
			$V_{CC}=6.0V$	-	-	33	ns
transition time	$t_t$	see Figure 5 <sup>[2]</sup>	$V_{CC}=2.0V$	-	-	95	ns
			$V_{CC}=4.5V$	-	-	19	ns
			$V_{CC}=6.0V$	-	-	16	ns

Note:

[1]  $t_{pd}$  is the same as  $t_{PLH}$  and  $t_{PHL}$ .

[2]  $t_t$  is the same as  $t_{THL}$  and  $t_{TLH}$ .

**Measurement Points**

Type	Input	Output
	$V_M$	$V_M$
SN74LS138	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$

**Test Data**

Type	Input		Load		S1 position		
	$V_I$	$t_r, t_f$	$C_L$	$R_L$	$t_{PLH}, t_{PHL}$	$t_{PZH}, t_{PHZ}$	$t_{PZL}, t_{PLZ}$
SN74LS138	$V_{CC}$	6.0ns	15pF, 50pF	1k $\Omega$	open	GND	$V_{CC}$

## Testing Circuit

### AC Testing Circuit

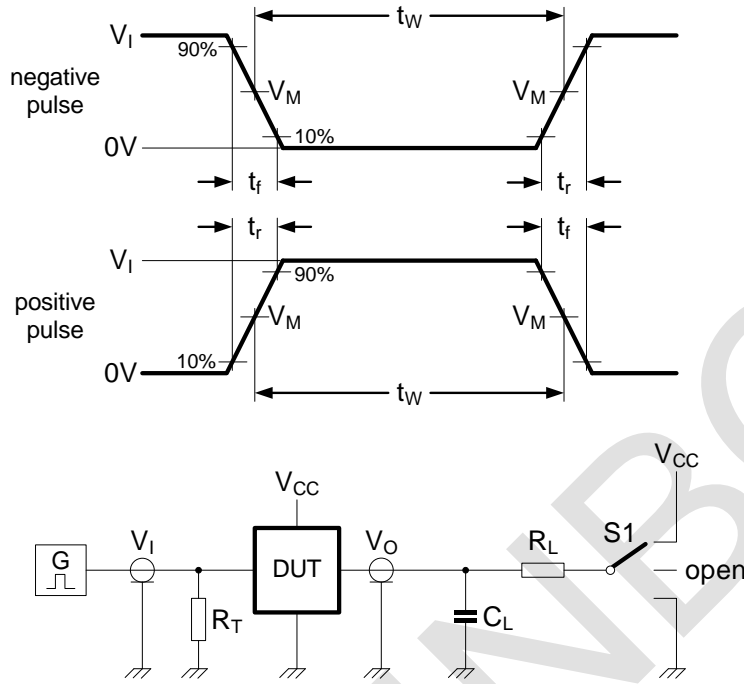


Figure 4. Test circuit for measuring switching times

Definitions for test circuit:

$C_L$ =load capacitance including jig and probe capacitance.

$R_T$ =termination resistance should be equal to the output impedance  $Z_o$  of the pulse generator.

$R_L$ =Load resistance.

S1=Test selection switch.

### AC Testing Waveforms

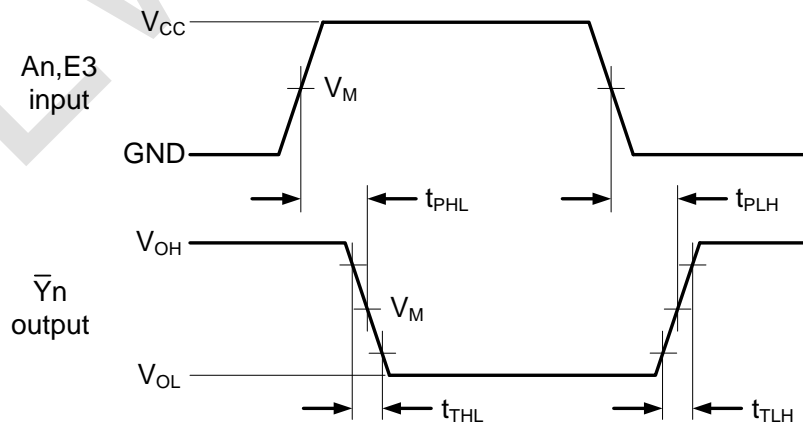


Figure 5. Propagation delay input (An) and enable input (E3) to output ( $\bar{Y}_n$ ) and transition time output ( $\bar{Y}_n$ )

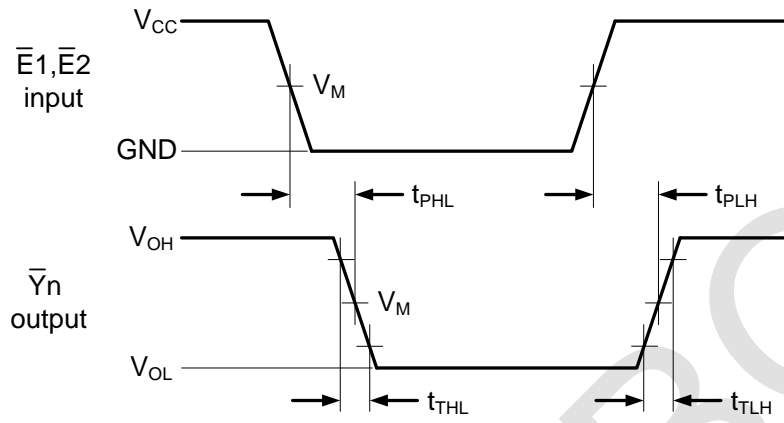
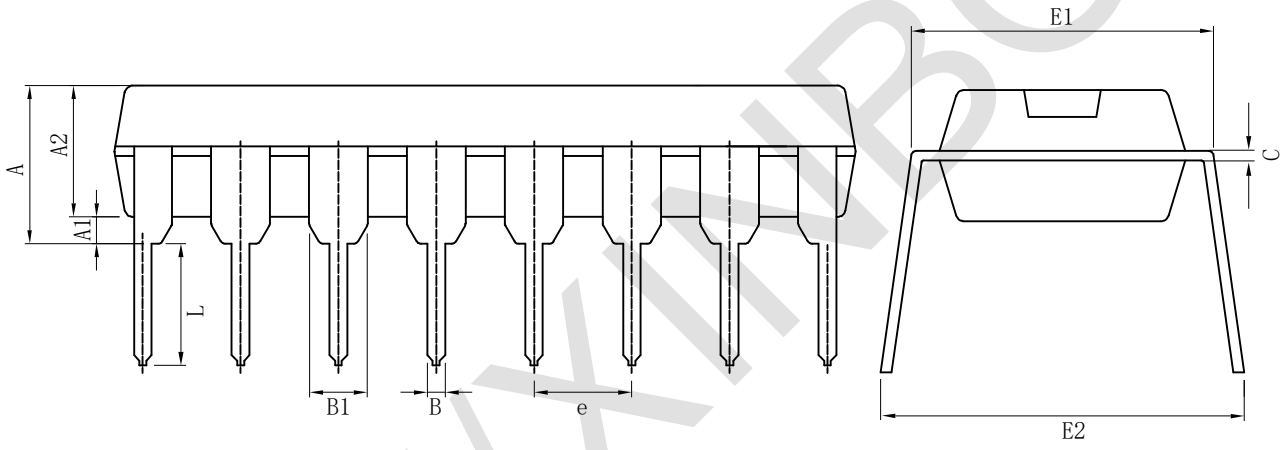


Figure 6. Propagation delay enable input ( $\bar{E}_n$ ) to output ( $\bar{Y}_n$ ) and transition time output ( $\bar{Y}_n$ )

**Package Information**

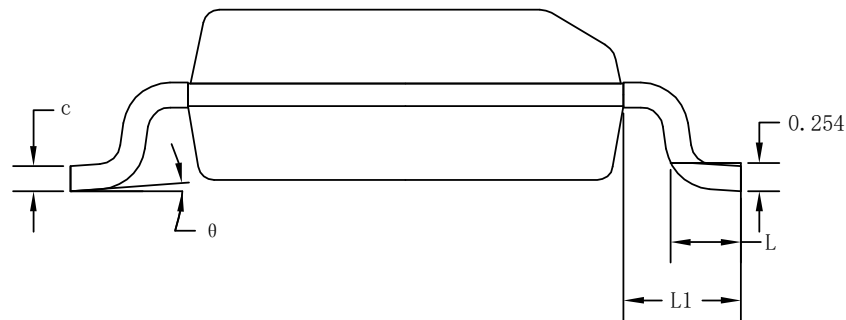
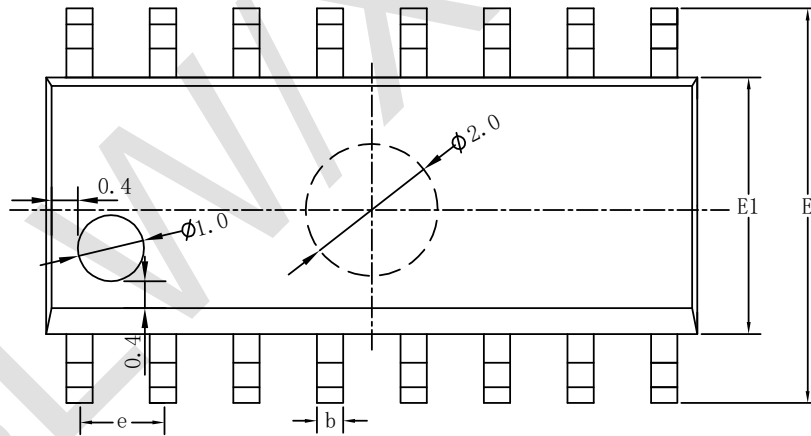
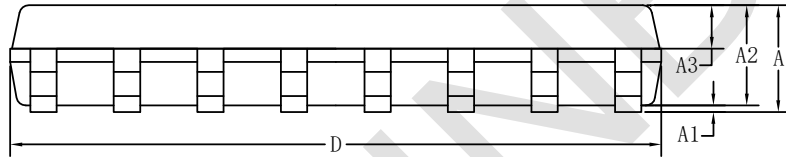
· DIP-16

Symbol	Dimensions In Millimeters		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



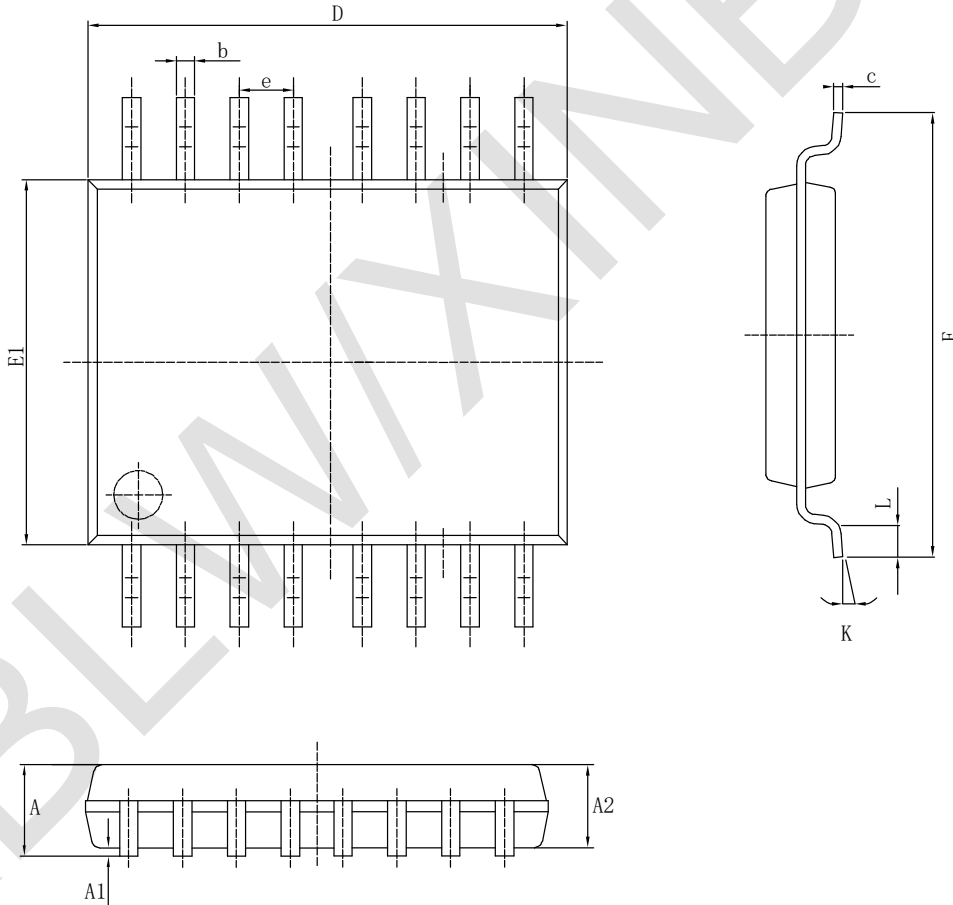
· SOP-16

Symbol	Size	Dimensions In Millimeters			Symbol	Size	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°



· TSSOP-16

Symbol	Dimensions In Millimeters		Symbol	Dimensions In Inches	
	Min (mm)	Max (mm)		Min (in)	Max (in)
A		1.200	A		0.047
A1	0.050	0.150	A1	0.002	0.006
A2	0.800	1.050	A2	0.031	0.041
b	0.190	0.300	b	0.007	0.012
c	0.090	0.200	c	0.004	0.0089
D	4.900	5.100	D	0.193	0.201
E	6.200	6.600	E	0.244	0.260
E1	4.300	4.480	E1	0.169	0.176
e	0.65 (BSC)		e	0.0256 (BSC)	
K	0°	8°	K	0°	8°
L	0.450	0.750	L	0.018	0.030



## Statement

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