74HC04-152

Hex Inverter

Product Specification

Specification Revision History：

Version	Date	Description
2019-05-A1	2019-05	New

1、General Description

The 74HC04-152 is a hex inverter. The inputs include clamp diodes that enable the use of current limiting resistors to interface inputs to voltages in excess of V_{CC}.

Features:

- Input levels:
  For 74HC04-152: CMOS level
  For 74HC04-152: TTL level
- Specified from -40℃ to +85℃
- Packaging information: DIP14/SOP14/TSSOP14

2、Block Diagram And Pin Description

2.1、Block Diagram

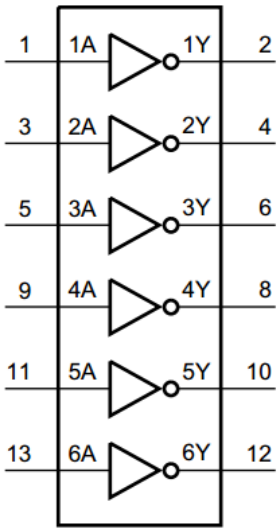


Figure 1. Logic symbol

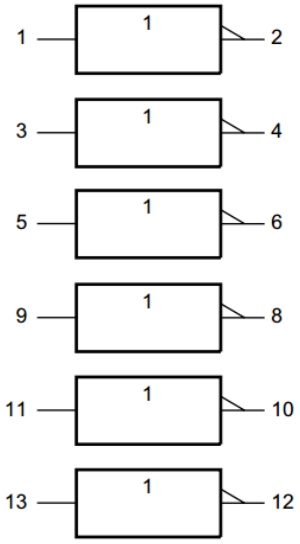


Figure 2. IEC logic symbol

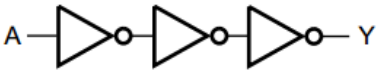
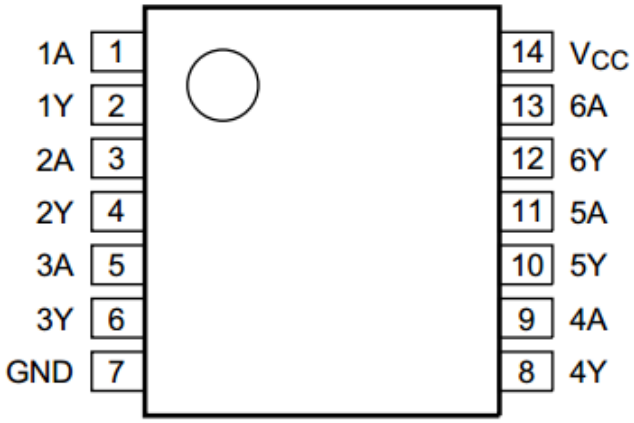


Figure 3. Logic diagram for one gate

2.2、Pin Configurations



2.3、Pin Description

Pin No.	Pin Name	Description
1	1A	data input
2	1Y	data output
3	2A	data input
4	2Y	data output
5	3A	data input
6	3Y	data output
7	GND	ground (0V)
8	4Y	data output
9	4A	data input
10	5Y	data output
11	5A	data input
12	6Y	data output
13	6A	data input
14	V_{CC}	supply voltage

2.4、Function Table

Input	Output
nA	**nY**
L	H
H	L

Note: H=HIGH voltage level; L=LOW voltage level.

3、Electrical Parameter

3.1、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 $V_I > V_{CC}+0.5V$		-	±20	mA
output clamping current	I_{OK}	$V_O < -0.5V$ or $V_O > V_{CC}+0.5V$		-	±20	mA
output current	I_O	$-0.5V < V_O < V_{CC}+0.5V$		-	±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	℃
Soldering temperature	T_L	10s	DIP	245		℃
			SOP	250		

Note:

[1] For DIP14 packages: above 70℃ the value of P_{tot} derates linearly with 12mW/K.

[2] For SOP14 packages: above 70℃ the value of P_{tot} derates linearly with 8mW/K.

[3] For (T)SSOP14 packages: above 60℃ the value of P_{tot} derates linearly with 5.5mW/K.

3.2、Recommended Operating Conditions

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
AiP74HC04						
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}	-	-40	-	+85	℃
AiP74HCT04						
supply voltage	V_{CC}	-	4.5	5.0	5.5	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	-	-	-	ns/V
		V_{CC}=4.5V	-	1.67	139	ns/V
		V_{CC}=6.0V	-	-	-	ns/V
ambient temperature	T_{amb}	-	-40	-	+85	℃

3.3、Electrical Characteristics

3.3.1、DC Characteristics 1

(T_{amb}=25℃, voltages are referenced to GND (ground=0V), unless otherwise specified.)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
74HC04-152							
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=-20uA; V_{CC}=2.0V	1.9	2.0	-	V
			I_O=-20uA; V_{CC}=4.5V	4.4	4.5	-	V
			I_O=-20uA; 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=20uA; V_{CC}=2.0V	-	0	0.1	V
			I_O=20uA; V_{CC}=4.5V	-	0	0.1	V
			I_O=20uA; 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		-	-	±0.1	uA
supply current	I_{CC}	V_I= V_{CC} or GND; I_O=0A; V_{CC}=6.0V		-	-	2.0	uA
input capacitance	C_I	-		-	3.5	-	pF
74HCT04							
HIGH-level input voltage	V_{IH}	V_{CC}=4.5V to 5.5V		2.0	1.6	-	V
LOW-level input voltage	V_{IL}	V_{CC}=4.5V to 5.5V		-	1.2	0.8	V
HIGH-level output voltage	V_{OH}	V_I = V_{IH} or V_{IL}	I_O=-20uA; V_{CC}=4.5V	4.4	4.5	-	V
			I_O=-4.0mA; V_{CC}=4.5V	3.98	4.32	-	V
LOW-level output voltage	V_{OL}	V_I = V_{IH} or V_{IL}	I_O=20uA; V_{CC}=4.5V	-	0	0.1	V
			I_O=5.2mA; V_{CC}=4.5V	-	0.15	0.26	V
input leakage current	I_I	V_I= V_{CC} or GND; V_{CC}=6.0V		-	-	±0.1	uA
supply current	I_{CC}	V_I= V_{CC} or GND; I_O=0A; V_{CC}=5.5V		-	-	2.0	uA
additional supply current	ΔI_{CC}	per input pin; V_I=V_{CC}-2.1V; I_O=0A; other inputs at V_{CC} or GND; V_{CC}=4.5V to 5.5V		-	120	432	uA
input capacitance	C_I	-		-	3.5	-	pF

3.3.2、DC Characteristics 2

(T_{amb}=-40℃ to +85℃, voltages are referenced to GND (ground=0V), unless otherwise specified.)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
74HC04-152							
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=-20uA; V_{CC}=2.0V	1.9	-	-	V
			I_O=-20uA; V_{CC}=4.5V	4.4	-	-	V
			I_O=-20uA; 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=20uA; V_{CC}=2.0V	-	-	0.1	V
			I_O=20uA; V_{CC}=4.5V	-	-	0.1	V
			I_O=20uA; 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		-	-	±1	uA
supply current	I_{CC}	V_I= V_{CC} or GND; I_O=0A; V_{CC}=6.0V		-	-	20	uA
input capacitance	C_I	-		-	-	-	pF
74HCT04							
HIGH-level input voltage	V_{IH}	V_{CC}=4.5V to 5.5V		2.0	-	-	V
LOW-level input voltage	V_{IL}	V_{CC}=4.5V to 5.5V		-	-	0.8	V
HIGH-level output voltage	V_{OH}	V_I = V_{IH} or V_{IL}	I_O=-20uA; V_{CC}=4.5V	4.4	-	-	V
			I_O=-4.0mA; V_{CC}=4.5V	3.84	-	-	V
LOW-level output voltage	V_{OL}	V_I = V_{IH} or V_{IL}	I_O=20uA; V_{CC}=4.5V	-	-	0.1	V
			I_O=5.2mA; V_{CC}=4.5V	-	-	0.33	V
input leakage current	I_I	V_I= V_{CC} or GND; V_{CC}=6.0V		-	-	±1	uA
supply current	I_{CC}	V_I= V_{CC} or GND; I_O=0A; V_{CC}=5.5V		-	-	20	uA
additional supply current	ΔI_{CC}	per input pin; V_I=V_{CC}-2.1V; I_O=0A; other inputs at V_{CC} or GND; V_{CC}=4.5V to 5.5V		-	-	540	uA
input capacitance	C_I	-		-	-	-	pF

3.3.3、AC Characteristics 1

(T_{amb}=25℃, voltages are referenced to GND (ground=0V), unless otherwise specified.)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
74HC04-152							
nA, nB to nY propagation delay	t_{pd}	see Figure 5	V_{CC}=2.0V	-	25	85	ns
			V_{CC}=4.5V	-	9	17	ns
			V_{CC}=5.0V;C_L=15pF	-	7	-	ns
			V_{CC}=6.0V	-	7	14	ns
transition time	t_t	see Figure 5	V_{CC}=2.0V	-	19	75	ns
			V_{CC}=4.5V	-	7	15	ns
			V_{CC}=6.0V	-	6	13	ns
power dissipation capacitance	C_{PD}	per package; V_I= GND to V_{CC}		-	21	-	pF
74HCT04							
nA, nB to nY propagation delay	t_{pd}	see Figure 5	V_{CC}=4.5V	-	10	19	ns
			V_{CC}=5.0V;C_L=15pF	-	8	-	ns
transition time	t_t	see Figure 5	V_{CC}=4.5V	-	7	15	ns
power dissipation capacitance	C_{PD}	per package; V_I= GND to V_{CC}–1.5V		-	24	-	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_{PD} is used to determine the dynamic power dissipation (P_D in uW).

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

f_i=input frequency in MHz;

f_o=output frequency in MHz;

C_L=output load capacitance in pF;

V_{CC}=supply voltage in V;

N=number of inputs switching;

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

3.3.4、AC Characteristics 2

(T_{amb}=-40℃ to +85℃, voltages are referenced to GND (ground=0V), unless otherwise specified.)

Parameter	Symbol	Conditions		Min.	Typ.	Max.	Unit
74HC04-152							
nA, nB to nY propagation delay	t_{pd}	see Figure 5	V_{CC}=2.0V	-	-	105	ns
			V_{CC}=4.5V	-	-	21	ns
			V_{CC}=5.0V;C_L=15pF	-	-	-	ns
			V_{CC}=6.0V	-	-	18	ns
transition time	t_t	see Figure 5	V_{CC}=2.0V	-	-	95	ns
			V_{CC}=4.5V	-	-	19	ns
			V_{CC}=6.0V	-	-	16	ns
power dissipation capacitance	C_{PD}	per package; V_I= GND to V_{CC}		-	-	-	pF
74HCT04							
nA, nB to nY propagation delay	t_{pd}	see Figure 5	V_{CC}=4.5V	-	-	24	ns
			V_{CC}=5.0V;C_L=15pF	-	-	-	ns
transition time	t_t	see Figure 5	V_{CC}=4.5V	-	-	19	ns
power dissipation capacitance	C_{PD}	per package; V_I= GND to V_{CC}–1.5V		-	-	-	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_{PD} is used to determine the dynamic power dissipation (P_D in uW).

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

f_i=input frequency in MHz;

f_o=output frequency in MHz;

C_L=output load capacitance in pF;

V_{CC}=supply voltage in V;

N=number of inputs switching;

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

4、Testing Circuit

4.1、AC Testing Circuit

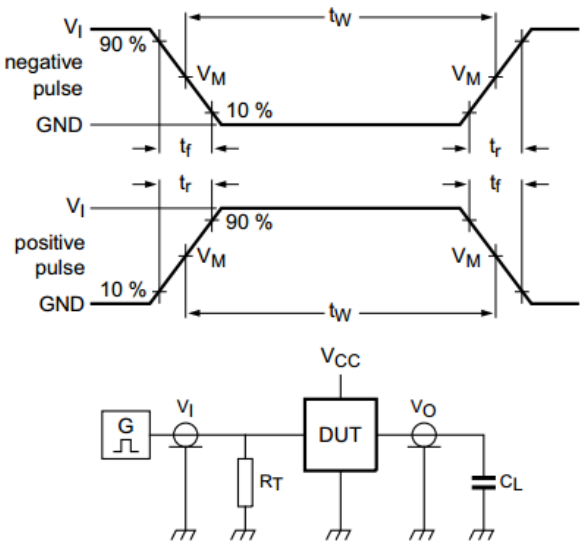


Figure 4. Test circuit for measuring switching times

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.

4.2、AC Testing Waveforms

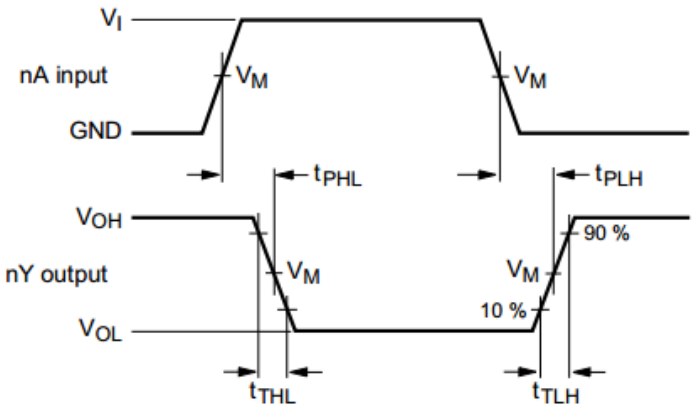


Figure 5. The input (nA) to output (nY) propagation delay times

4.3、Measurement Points

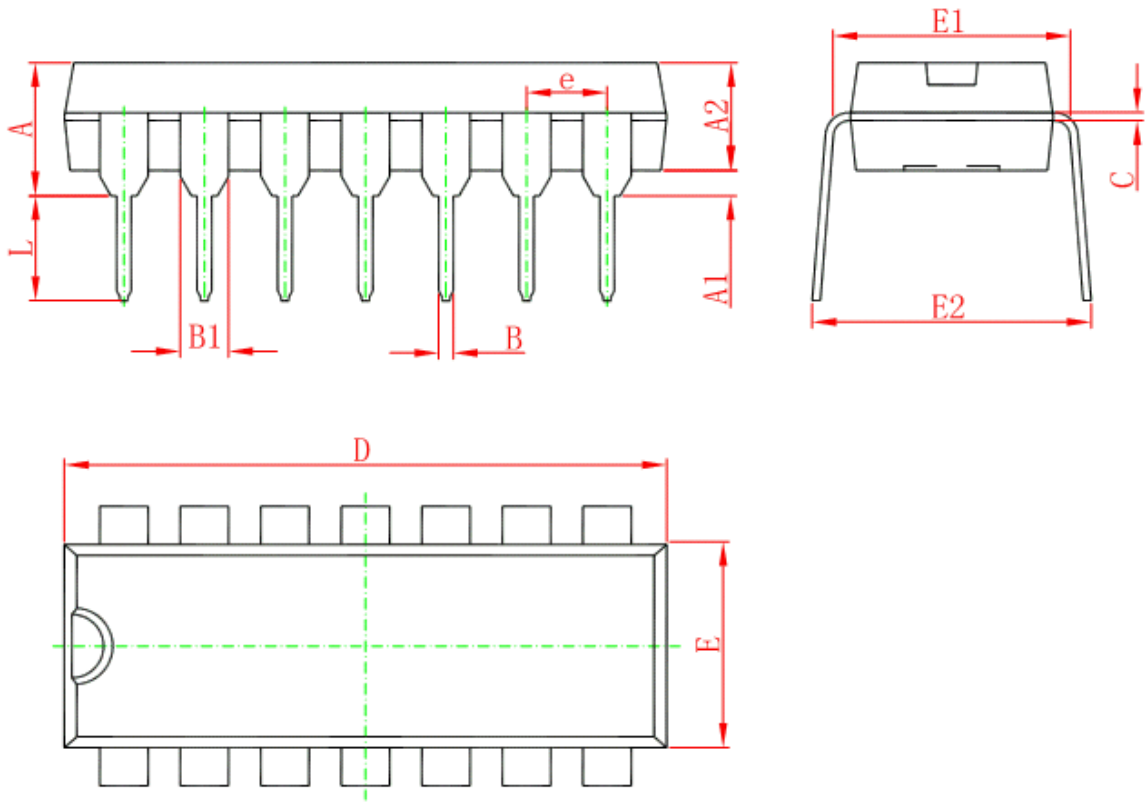
Type	Input	Output
	V_M	V_M
74HC04-152	$0.5\times V_{CC}$	$0.5\times V_{CC}$
74HCT04	1.3V	1.3V

4.4、Test Data

Type	Input		Load	Test
	V_I	t_r , t_f	C_L	
74HC04-152	V_{CC}	6.0ns	15pF, 50pF	t_{PLH}, t_{PHL}
74HCT04	3.0V	6.0ns	15pF, 50pF	t_{PLH}, t_{PHL}

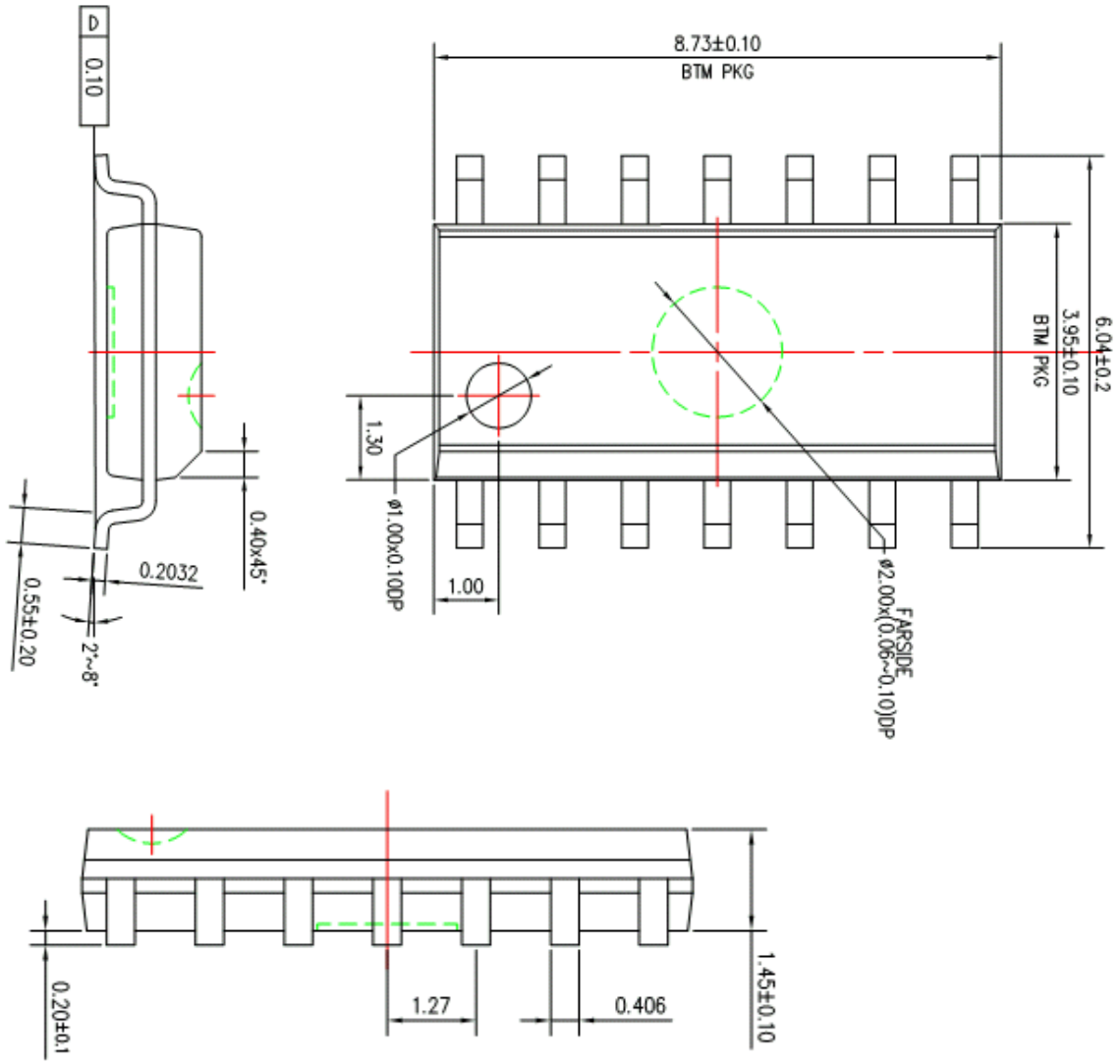
5、Package Information

5.1、DIP14

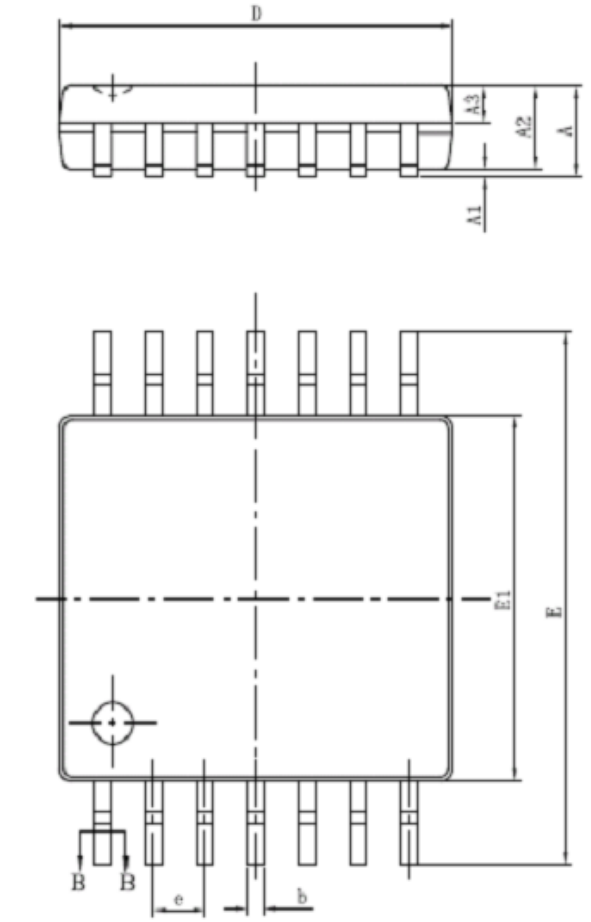


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	3.710	4.310	0.146	0.170
A1	0.510		0.020	
A2	3.200	3.600	0.126	0.142
B	0.380	0.570	0.015	0.022
B1	1.524 (BSC)		0.060 (BSC)	
C	0.204	0.360	0.008	0.014
D	18.800	19.200	0.740	0.756
E	6.200	6.600	0.244	0.260
E1	7.320	7.920	0.288	0.312
e	2.540 (BSC)		0.100 (BSC)	
L	3.000	3.600	0.118	0.142
E2	8.400	9.000	0.331	0.354

5.2、SOP14


0.10
8.73±0.10
BTM PKG
6.04±0.2
3.95±0.10
BTM PKG
1.30
Ø1.00x0.100P
1.00
Ø2.00x(0.06~0.10)DP
FARSIDE
0.40x45°
0.2032
0.55±0.20
2°~8°
0.20±0.1
1.27
0.406
1.45±0.10

5.3、TSSOP14



SECTION B-B

SYMBOL	MILLIMETER	
	MIN	MAX
A	—	1.20
A1	0.05	0.15
A2	0.90	1.05
A3	0.39	0.49
b	0.20	0.30
b1	0.19	0.25
c	0.13	0.19
c1	0.12	0.14
D	4.86	5.06
E1	4.30	4.50
E	6.20	6.60
e	0.65BSC	
L	0.45	0.75
L1	1.00BSC	
θ	0	8°