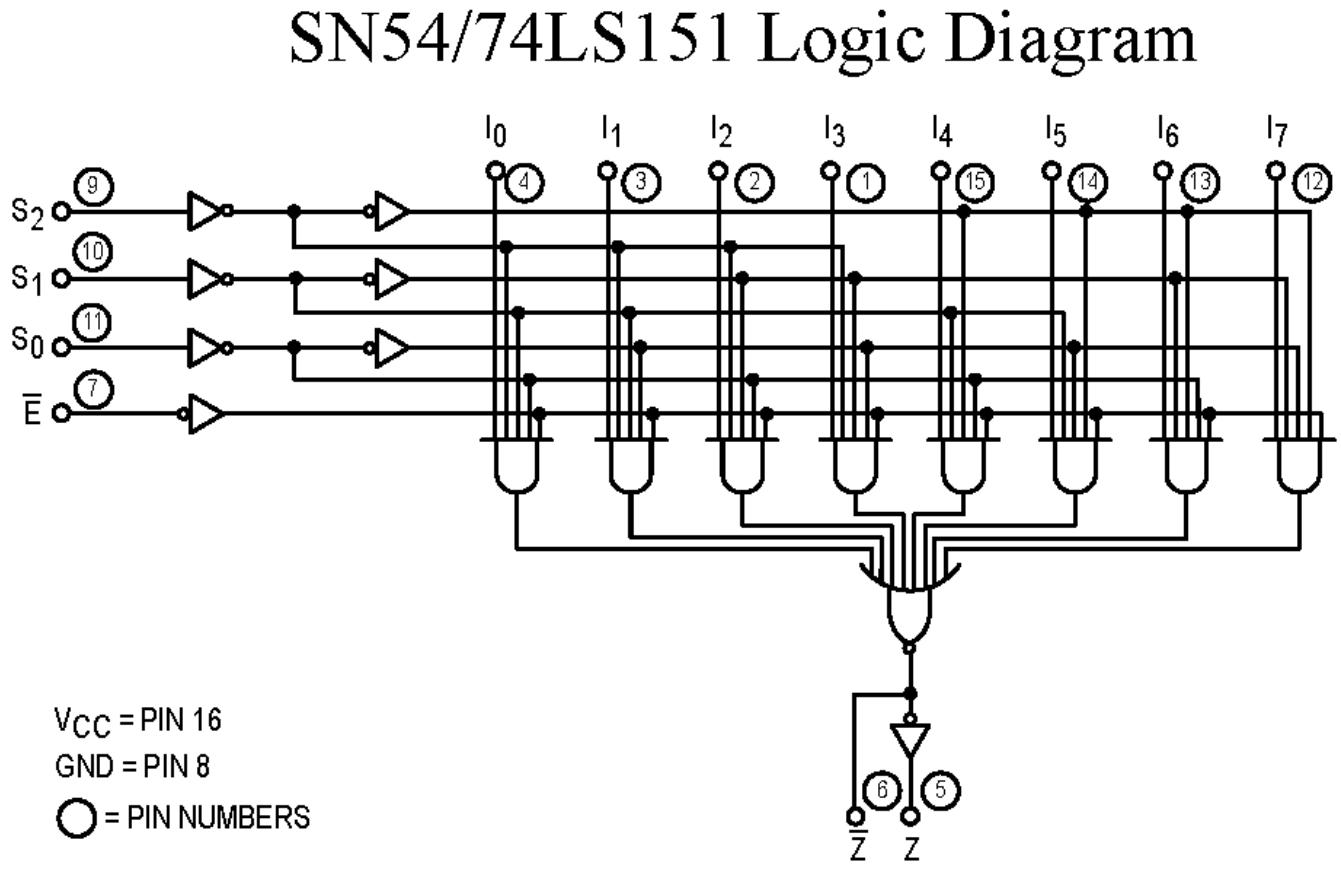
8-to-1-line 74LS151 multiplexer

This multiplexer has:

- 8 inputs $I_7\, I_6\, I_5\, I_4\, I_3\, I_2\, I_1\, I_0$,
- 3 selection lines $S_2\, S_1\, S_0$ $(8 = 2^3 \rightarrow n = 3)$,
- an enable input E (E = H or 1 disable & E = L or 0 is enable), and
- outputs Z and Z′ (NOT Z)



Truth Table as given by datasheet

E	S_2	S_1	S_0	I_0	I_1	I_2	I_3	I_4	I_5	I_6	I_7	Z′	Z
H	x	x	x	x	x	x	x	x	x	x	x	H	L
L	L	L	L	L	x	x	x	x	x	x	x	H	L
L	L	L	L	H	x	x	x	x	x	x	x	L	H
L	L	L	H	x	L	x	x	x	x	x	x	H	L
L	L	L	H	x	H	x	x	x	x	x	x	L	H
L	L	H	L	x	x	L	x	x	x	x	x	H	L
L	L	H	L	x	x	H	x	x	x	x	x	L	H
L	L	H	H	x	x	x	L	x	x	x	x	H	L
L	L	H	H	x	x	x	H	x	x	x	x	L	H
L	H	L	L	x	x	x	x	L	x	x	x	H	L
L	H	L	L	x	x	x	x	H	x	x	x	L	H
L	H	L	H	x	x	x	x	x	L	x	x	H	L
L	H	L	H	x	x	x	x	x	H	x	x	L	H
L	H	H	L	x	x	x	x	x	x	L	x	H	L
L	H	H	L	x	x	x	x	x	x	H	x	L	H
L	H	H	H	x	x	x	x	x	x	x	L	H	L
L	H	H	H	x	x	x	x	x	x	x	H	L	H

x = don't care, H = High = 5 V, L = Low = 0 V

Truth Table

E	S_2	S_1	S_0	Z′	Z
1	x	x	x	1	0
0	0	0	0	I_0'	I_0
0	0	0	1	I_1'	I_1
0	0	1	0	I_2'	I_2
0	0	1	1	I_3'	I_3
0	1	0	0	I_4'	I_4
0	1	0	1	I_5'	I_5
0	1	1	0	I_6'	I_6
0	1	1	1	I_7'	I_7

Note: The particular input I_m sent to the output line Z corresponds to subscript number formed by binary number of selection line inputs. For example, selection inputs $S_2\,S_1\,S_0 = \underline{0}\,\underline{0}\,\underline{1}$ would give $m = S_2S_1S_0 = 001_2 = 1_{10}$ and send I_1 to the output line Z.

Now let's use this multiplexer to implement the 4 variable Boolean function defined by the Truth Table:

- Here n = 4, n -1 = 4-1 = 3. So, we need an 23=8 by 1 MUX with 3 selection inputs. So, the 74LS151 will work.

a	*b*	*c*	*d*	***F***	Minterms
0	0	0	0	**0**	~~m_0~~
0	0	0	1	**0**	~~m_1~~
0	0	1	0	**1**	$\boldsymbol{m_2}$
0	0	1	1	**1**	$\boldsymbol{m_3}$
0	1	0	0	**0**	~~m_4~~
0	1	0	1	**0**	~~m_5~~
0	1	1	0	**1**	$\boldsymbol{m_6}$
0	1	1	1	**1**	$\boldsymbol{m_7}$
1	0	0	0	**0**	~~m_8~~
1	0	0	1	**0**	~~m_9~~
1	0	1	0	**1**	$\boldsymbol{m_{10}}$
1	0	1	1	**0**	~~m_{11}~~
1	1	0	0	**1**	$\boldsymbol{m_{12}}$
1	1	0	1	**1**	$\boldsymbol{m_{13}}$
1	1	1	0	**0**	~~m_{14}~~
1	1	1	1	**1**	$\boldsymbol{m_{15}}$

- From the Truth Table, $F = \sum(2,3,6,7,10,12,13,15)$

- Set selection input $S_2 = a$, $S_1 = b$, and $S_2 = c$.

- Next, divide up the Truth Table into pairs of lines. These pairs correspond to the input line 'addresses' set by the selection inputs. Use how the values of the output F align with binary variable d to choose from the options: 1) $I_i = d$, 2) $I_i = d'$, 3) $I_i = 0$, or 1) $I_i = 1$.

S_2	S_1	S_0	I_i		
a	*b*	*c*	*d*	***F***	
0	0	0	0	**0**	$I_0 = 0$
0	0	0	1	**0**	
0	0	1	0	**1**	$I_1 = 1$
0	0	1	1	**1**	
0	1	0	0	**0**	$I_2 = 0$
0	1	0	1	**0**	
0	1	1	0	**1**	$I_3 = 1$
0	1	1	1	**1**	
1	0	0	0	**0**	$I_4 = 0$
1	0	0	1	**0**	
1	0	1	0	**1**	$I_5 = d'$
1	0	1	1	**0**	
1	1	0	0	**1**	$I_6 = 1$
1	1	0	1	**1**	
1	1	1	0	**0**	$I_7 = d$
1	1	1	1	**1**	

- Finally, connect up the multiplexer.