1 Exercise 2: The Effect of the Noise Margin

Having three different technology integrated circuits, 74HC02, 74HCT02 and 74LS02, we compare the noise margin between them and analyze the possible results when loading them with each other us follow:

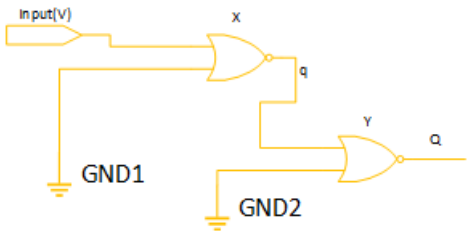

Figure 1.1: Loaded Circuit

-Input(V): Input voltage; -X: First component name; -Y: Second component name; -q: First result voltage; -Q: Final result;

1.1 Theoretically

From the data-sheet of the components we obtain the following data when the power supply is 4.5V in the 74HC02 and 74HCT02 and around 5V for 74LS02:

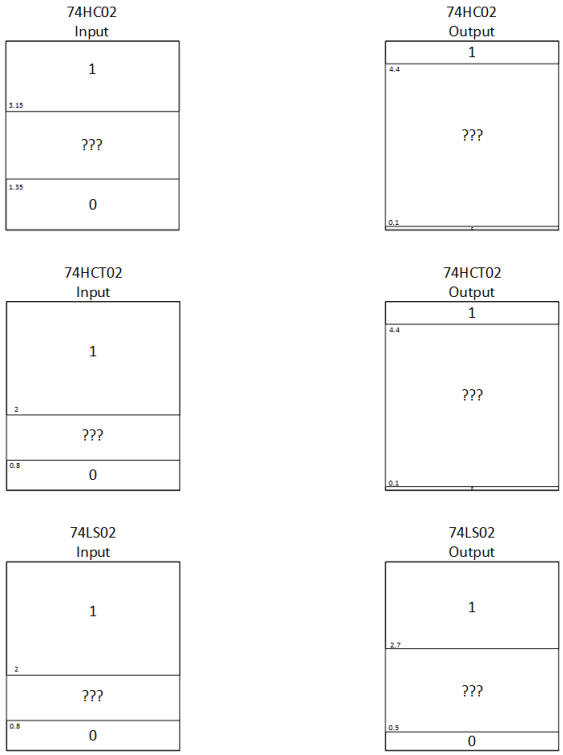

Figure 1.2: Theoretical Noise Margin in Input and Output

Connecting the circuit like the figure 1.1 being X the second column and Y the forth column, analyzing the possible results we obtain:

Input(V)	74HC02		q	74LS02		Q
	Logic Input	Logic Output		Logic Input	Logic Output	
0<V<1.35	0	1	4.4<V<5	1	0	0<V<0.5
1.35<V<3.15	?	?	0<V<0.8	0	1	2.7<V<5
			0.8<V<2	?	?	0.5<V<2.7
			2<V<4.4	1	0	0<V<0.5
3.15<V<5	1	0	0<V<0.1	0	1	2.7<V<5

Table 1.1: 74HC02 load to 74LS02

Input(V)	74LS02		q	74HC02		Q
	Logic Input	Logic Output		Logic Input	Logic Output	
0<V<0.8	0	1	2.7<V<3.15	?	?	0.1<V<4.4
			3.15<V<5	1	0	0<V<0.1
0.8<V<2	?	?	0.5<V<1.35	0	1	4.4<V<5
			1.35<V<2.7	?	?	0.1<V<4.4
2<V<5	1	0	0<V<0.5	0	1	4.4<V<5

Table 1.2: 74LS02 load to 74HC02

Input(V)	74LS02		q	74HCT02		Q
	Logic Input	Logic Output		Logic Input	Logic Output	
0<V<0.8	0	1	2.7<V<5	1	0	4.4<V<5
0.8<V<2	?	?	0.5<V<0.8	0	1	4.4<V<5
			0.8<V<2	?	?	0.1<V<4.4
			2<V<2.7	1	0	0<V<0.1
2<V<5	1	0	0<V<0.5	0	1	4.4<V<5

Table 1.3: 74LS02 load to 74HCT02

Input(V)	74HCT02		q	74LS02		Q
	Logic Input	Logic Output		Logic Input	Logic Output	
0<V<0.8	0	1	4.4<V<5	1	0	0<V<0.5
0.8<V<2	?	?	0.1<V<0.8	0	1	2.7<V<5
			0.8<V<2	?	?	0.5<V<2.7
			2<V<4.4	1	0	0<V<0.5
2<V<5	1	0	0<V<0.1	0	1	2.7<V<5

Table 1.4: 74HCT02 load to 74LS02

Therefore we expect when loading the components there will be are some irregularities in the Q output value when the input value aren't the recommended in the data-sheet.

1.2 Experimentally

Building the circuit in the figure 1.1 with the power supply to the integrated circuits equal to 5V with a square signal, altering its maximum value. The measured result were:

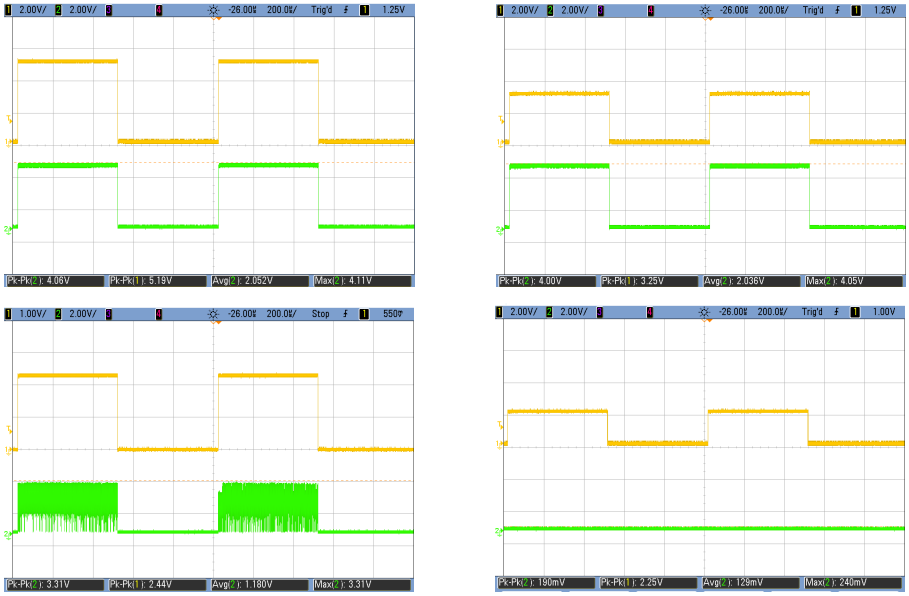

Figure 1.3: 74HC02 load to 74LS02

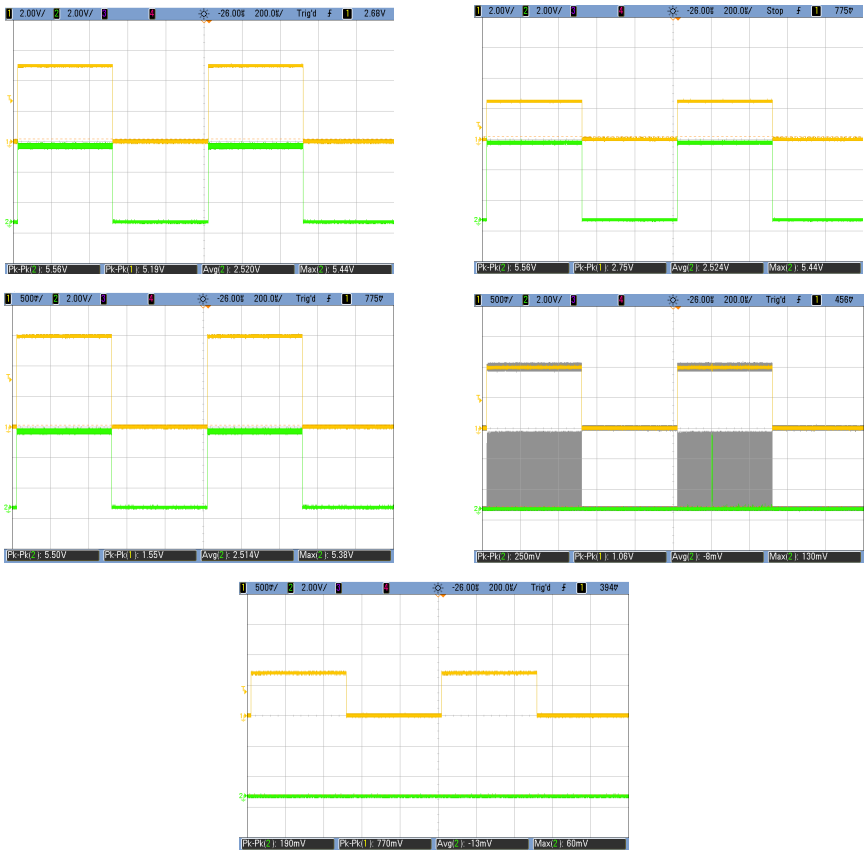

Figure 1.4: 74LS02 load to 74HC02

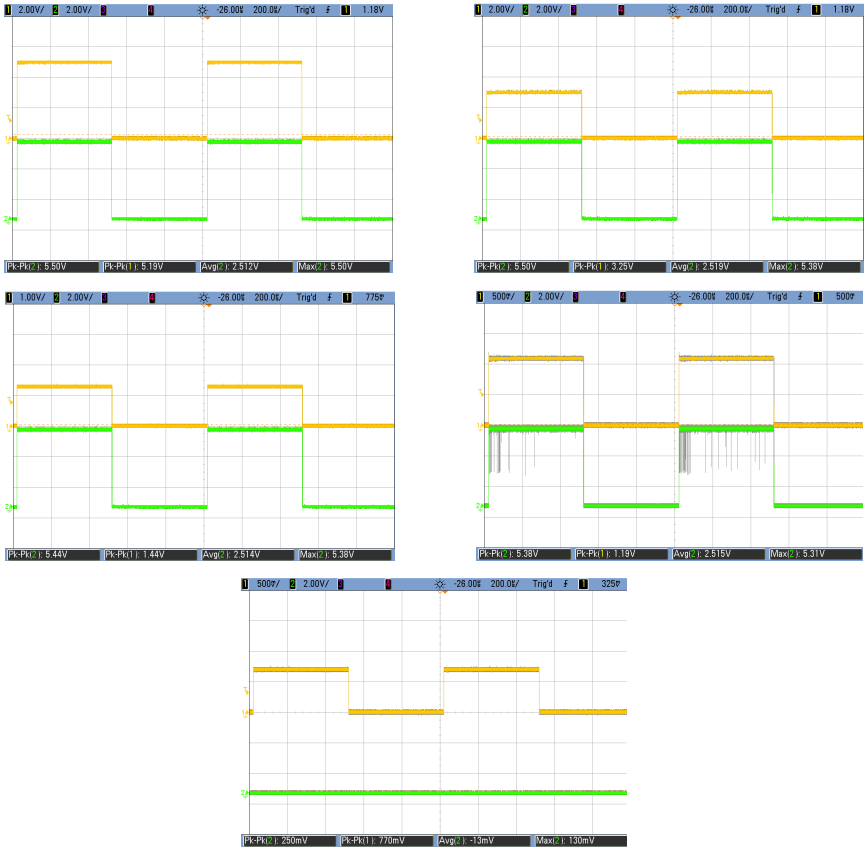

Figure 1.5: 74LS02 load to 74HCT02

Figure 1.6: 74HCT02 load to 74LS02