Task 1

NOT gates with BJT transistors (NPN)

a)RTL

foto del circuito

b) TTL

foto del circuito

MEASSURES

Figure 1:

Where V_{IH}: minimum HIGH input voltage, V_{IL}: maximum LOW input voltage, V_{OH}: minimum HIGH output voltage, V_{OL}: maximum LOW output voltage.

To meassure these values we use the ramp waveform and the oscilloscope in xy mode so we can see something like this:

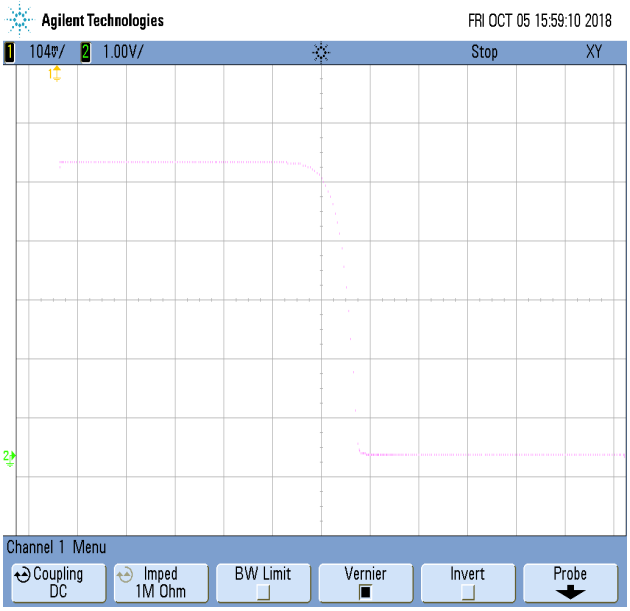

Figure 2:

Where the values we are looking for are found when the derivative is -1.

Noise margin :It allows one to estimate the allowable noise voltage on the input of a gate so that the output will not be affected. Noise margin is specified in terms of two parameters: the low noise margin N_L, and the high noise margin N_H . N_L is defined as the difference in magnitude between the maximum LOW input voltage and the maximum LOW output voltage of the gate. That is, $N_L = |V_{IL} - V_{OL}|$. Similarly, the value of N_H is the difference in magnitude between the minimum HIGH output voltage of and the minimum HIGH input voltage recognizable by the gate. That is, $N_H = |V_{OH} - V_{IH}|$.

The propagation delay is the difference in time (calculated at 50 % of input-output transition), when output switches, after application of input. It is different if the transition is from HIGH to LOW or form LOW to HIGH.

Rise time is the time, during transition, when output switches from 10% to 90% of the maximum value. Fall time is the time when output switches from 90% to 10% of the maximum value.

In order to get the maximum output current, knowing that the load is a 1nF capacitor, with the oscilloscope we find out the derivative of the output voltage:

$$i_c = C\frac{dV_{OUT}}{dt} \tag{1}$$

The maximum current is when the derivative is maximum.

a)1)no load

V_{OL}=244mV ; V_{OH}=4,85V ; V_{IL}=547mV ; V_{IH}=1,83V
Rise time = 1,26 us
Fall time = 410 ns
Propagation time (HIGH to LOW) = 2,86 us
Propagation time (LOW to HIGH) = 520 ns.
There is not a maximum output current because there is no load.

a)2)with load

V_{OL}=384mV ; V_{OH}=4,75V ; V_{IL}=584mV ; V_{IH}=1,76V
Rise time = 1,76 us
Fall time = 480 ns
Propagation time (HIGH to LOW) = 3,12 us
Propagation time (LOW to HIGH) = 656 ns
Max current when input goes from LOW to HIGH: -9,38 mA
Max current when input goes from HIGH to LOW: 2,66 mA

b)1)no load

V_{OL}=100mV ; V_{OH}=4,69V ; V_{IL}=570mV ; V_{IH}=680mV
Rise time = 156 ns
Fall time = 27 ns
Propagation time (HIGH to LOW) = 299 ns
Propagation time (LOW to HIGH) < 13ns
It was not possible to determine because of the signal generator limitations (the square wave rise/fall time is <13ns) there is not a maximum output current because there is no load.

b)2)with load

V_{OL}= 70mV ; V_{OH}= 4,68V ; V_{IL}= 550mV ; V_{IH}= 700mV
Rise time = 960 ns
Fall time = 28 ns
Propagation time (HIGH to LOW) = 1,11 us
Propagation time (LOW to HIGH) < 13 ns
Max current when input goes from LOW to HIGH: -128 mA
Max current when input goes from HIGH to LOW: 8,75 mA
There are 2 different currents because when the transistor is in saturation mode, the capacitor discharges on the NPN transistor that has no resistance. And in cut off mode the capacitor charges with the resistance.