Laboratory report

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| --- | --- |
| Subject of the exercise: | Basic Logic Circuits (Exercise 9.) |
| Date: | <year>. <month>. <day> |
| Location: | BME, lab.: Q. BP.109 |
| Students name: | <name 1> ,<name 2> |
| Group, Desk No. | Group: <No.>, Desk: <No.> |
| Supervisor: | <name> |

Measurement instruments

|  |  |  |
| --- | --- | --- |
| Digital multimeter (3½ digit) | METEX ME-22T |  |
| Power supply | Agilent E3630 |  |
| Oscilloscope | Agilent 54622A |  |
| Function generator | Agilent 33220A |  |
| Test board | VIK-07 |  |

Laboratory exercises

The measurement tasks have to be performed by using 1pc of TTL and 1pc of CMOS type digital IC. It means that each measurement task has to be repeated to see the differences between the two type of ICs.

1. Measurement of voltage transfer characteristic for several inverter IC type
   1. Power up the test panel! The layout of the measurement setup can be seen in Figure 9–1. (Set 5 V on the output labeled "+6V" of the power supply, and the "COM" output serves as the reference level (GND)!).

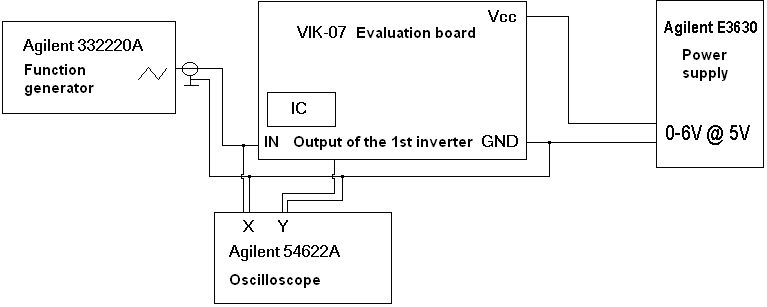


Figure 9–1.: Measurement setup of exercise 1.

* 1. Place a TTL inverter provided by the tutor into the inverter socket (bottom left of the panel). Use the Agilent 33220 function generator to generate a 0 V low-level and 5 V high-level (2.5 VDC and 5 Vp-p) triangle wave (“Ramp” signal on the waveform generator with a 50% duty cycle) of 350 Hz frequency . *Measure the generated signal before connecting it to the panel, because the improper selection of function generator’s load causes wrong levels! Ask for help if necessary!*

Connect the stimulus to the input of the inverter chain on the panel. Measure the voltage transfer characteristic of the first inverter using the XY mode of the oscilloscope. (Connect the stimulus to one channel of the oscilloscope and the output of the first inverter to the other channel of the oscilloscope.) Do not connect any load to the inverters’ output on the panel.

<your comments>

* 1. Connect a 10 gate load (*“10 kapu terhelés”-as written on the panel*) to the output of the first inverter. How is the transfer characteristic changed?

<your comments>

* 1. Perform the following measurements for one TTL and one CMOS circuits! Measure the logic High and Low voltage levels, measure the High-to-Low, and Low-to-High switching points (switching level). Make conclusions on differences.

<your comments>

Measurement results:

|  |  |  |  |
| --- | --- | --- | --- |
| **Type of IC** | **Switching point** | **UL** | **UH** |
| Type 1 |  |  |  |
| Type 2 |  |  |  |

1. Measure the power consumption of several inverters. Repeat this measurement for different input signal frequencies.
   1. Use the Agilent 33220 function generator to create a 0V to 5V square wave at the frequency of 100 Hz. *Measure the generated signal before connecting it*! Connect a multimeter in current measurement mode between the power supply and the evaluation board. (See Figure 9–2.) Measure the static power consumption of the evaluation board (after unlocking and removing the inverter IC). Place back the inverter circuit, and perform the power consumption measurement. Repeat the measurement at 100 Hz, 1 kHz, 10 KHz, 100 Khz,   
      1 MHz, 10 MHz frequencies! Do not forget to subtract the static power consumption of the evaluation board! Do not use 10-gate load.
   2. What is the static power consumption of the board only?

<your comments>

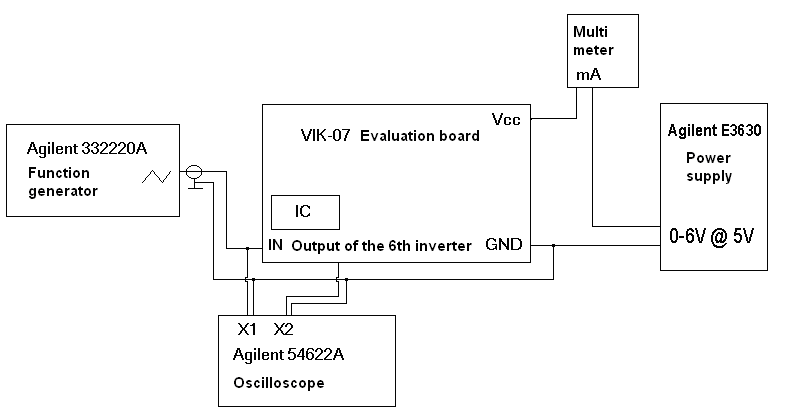
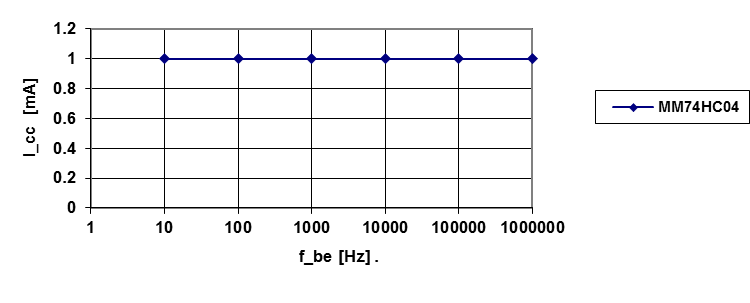


Figure 9–2.: Measurement setup of exercise 2.

TTL IC:

CMOS IC:



* 1. Make conclusions on the power consumption of TTL inverters!

<your comments>

* 1. Make conclusions on the power consumption of CMOS inverters!

<your comments>

1. Measurement of delays
   1. The measurement setup is the same as the previous exercise, except connect a 10 gate load to the last (6th) inverter. Use the Agilent 33220 function generator to create a 0V to 5V square wave at the frequency of 100 Hz. *Measure the generated signal before* connecting it! Measure the delay at the 6th inverter, and calculate the average delay of one inverter.
      1. Perform the measurement task and record your experience in terms of the different IC types!

|  |  |  |
| --- | --- | --- |
| **Type of IC** | **L-H delay** | **H-L delay** |
| Type 1 |  |  |
| Type 2 |  |  |

|  |  |  |
| --- | --- | --- |
| **Type of IC** | **fall time** | **rise time** |
| Type 1 |  |  |
| Type 2 |  |  |

<your comments>

* + 1. Connect a 1nF-capacitive load to the first inverter and perform the above measurement for different IC types. What are the effects of the capacitive load on the first inverter?

|  |  |  |
| --- | --- | --- |
| **Type of IC** | **L-H delay** | **H-L delay** |
| Type 1 |  |  |
| Type 2 |  |  |

|  |  |  |
| --- | --- | --- |
| **Type of IC** | **fall time** | **rise time** |
| Type 1 |  |  |
| Type 2 |  |  |

<your comments>

1. Measurements on D Flip-flop (SN7474)
   1. Insert a flip-flop IC to the flip-flop socket on the middle of the evaluation board. Identify the pins of the flip-flop by using the pin setup diagram at the back of the measurement guide!
   2. Design and implement measurement setup for the propagation time measurements by using the embedded pulse generator block of the evaluation board! (Do not forget the 10 gate load!)

<your comments>

1. Complementary measurement task for measurement point 4
   1. Design and implement measurement setups for setup time, hold time measurements by using the embedded pulse generator block of the evaluation board! (Do not forget the 10 gate load!)

<your comments>

1. Measure the load and supply voltage dependence of the power consumption of logic circuits. (Complementary for exercise two)
   1. Connect a capacitive load to the first inverter and perform the power consumption measurement described at exercise 2.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| type of IC | 100 Hz | 1 kHz | 10 kHz | 100 kHz | 500 kHz |
| SN7404N |  |  |  |  |  |
| MM74HC04 |  |  |  |  |  |

<your comments>

* 1. In the case of CMOS ICs, examine the voltage dependence of the ICs' power consumption at a given frequency! (CMOS ICs do not necessarily need to be operated at 5V, as they can function at other voltages as well.)

Before changing the supply voltage, first reduce the input signal level at the given frequency to match the desired supply voltage, then reduce the supply voltage accordingly! (This is necessary because if the input voltage is higher than the supply voltage, a phenomenon called latch-up can occur in the CMOS IC, which could damage it in the worst case.) Measure the current consumption at multiple supply voltages! (WARNING: You cannot make experiment with voltages higher than 5V because the overvoltage protection on the board will activate, and the power supply will regulate itself down.) Don't forget to measure the panel's base consumption at each new supply voltage parameter, as it also changes.

What function can you fit to the measured values?

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Type of IC | 5V | 4.5V | 4V | 3.5V | 3V |
| MM74C04N |  |  |  |  |  |