Laboration 1

Digitalteknik med VHDL
TTL-Circuits

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1   General information about TTL-circuits

In this lab you are about to use logic circuits of the so called TTL-family (TTL = Transistor-Transistor Logic). These circuits have a wide range of applications, are cheap, reliable, and relatively resistant to switching errors. TTL circuits are available in two series; 74 Series and 54 Series. The 74 Series is an industry standard, and the 54 Series is primarily used in military applications due to its higher tolerance to, for example, high and low temperatures.

The 74 series contains hundreds of different designs. On the circuits there is a 74xx number in addition to information from the manufacturer. "74" means that the circuit belongs to the 74 series, and "xx" is a number that identifies which function the circuit has (for example, a list can be found here: https://en.wikipedia.org/wiki/List_of_7400-series_integrated_circuits. There are also a number of variants identified by one or more additional letters. For example, Low Energy (L), High Speed (H), High Speed CMOS (HC), Shottky (S) and Low Power Shottky (LS). Sometimes the circuits 74nnxx are called, where nn are the types just mentioned. For example, a 74HC00 circuit is a high speed CMOS type circuit.

1.1   Some important properties of TTL-circuits

The zeros and ones we use in theory are represented by different voltage levels. For LS-TTL:

- Power (written often as Vcc or Vdd): (5.00 ± 0.25) V

- Logic zero: <0.4 V (sometimes called `VL` or Low)

- logic one: >2,7 V (sometimes called `VH` or `High`)

One of the most common TTL circuits is the NAND gate. The 74HC00 circuit (instead of HC, one can use one of the other types) contains four 2-input NAND gates. It is important to ensure that the circuit is turned in the right direction when using it, so that it is known that its legs are in the same order as in the circuit data sheet. Each IC has a mark at one of the short sides. If this mark is turned to the top then you have leg 1 at the top left.

Task 1

Find out the 74HC00 data sheet (for example, searching the web, or checking www.elfa.se) and drawing out how a 74HC00 circuit looks and what function each leg has.

2   Design of a logic circuit

The goal here is to find a minimal combinatorial network that implements the following function:

$$\mathbf{f}(A, B, C, D) = \sum (0, 1, 2, 4, 5, 6, 8, 9, 12, 13, 14) \tag{1}$$

Task 2

Draw the Karnaugh-diagram of this function and use it to find a minimal function for f and write down the truth table.

Task 3

Draw the gate network for **f**, using the Logic.ly online tool.

Task 4

Draw an easy-to-understand circuit diagram for f. Make sure that the numbers on the IC's legs are included on the circuit diagram. If the circuit diagram is unclear, the risk of errors increases, and it will be harder to locate the errors. Also enter the supply voltage of the circuits. Generally, a 14-pin TTL circuit has its positive supply voltage (+5V) on leg 14 and ground/GND on leg 7. For a 16-leg TTL circuit, these are usually on legs 16 and leg 8. Always consult the data sheet if you are uncertain.

3   Report

Write a report where you document what you have done and submit a PDF document in Moodle. Other formats are not accepted. Hand in the report latest two weeks after the lab session. This is an individual lab assignment.