



Digital Systems

Wintersemester 2017/2018

Series 6

Issue date: Monday, 04.12.2017

Submission date: Monday, 18.12.2017, 12 pm

Presentation Tasks

Task 1

The following output functions are given:

$$y_1 = \overline{x_2}x_3 + x_1\overline{x_2}\overline{x_3}$$

$$y_2 = x_1\overline{x_2}x_3 + x_2\overline{x_3} + x_1x_3$$

Realize these as a PLA (on paper, of course). Give your solutions in the form of wired AND and wired OR logic.

Task 2

Construct and draw two different 10 bit carry-select adders. The building block sizes are your choice. Determine for each of both adders the required total area and the required total time as well as the product of the two.

The following model is given:

A full adder is of the size 1 AU (area unit) and requires a switch time of 1 TU (time unit). A 1 bit multiplexer equally is of the size 1 AU and requires the same switch time 1 TU. A is the total area, T is the total time.

Homework

Task 1

Let the following functions y_1 and y_0 , shown in the table on the next page, be given.

- Realize y_0 as a PLA (on paper).
Give your solution in the form of wired AND and OR logic.
- Realize y_1 as a CMOS gate.
Use as little transistors as possible.

x_3	x_2	x_1	x_0	y_1	y_0
0	0	0	0	0	1
0	0	0	1	0	1
0	0	1	0	0	0
0	0	1	1	1	1
0	1	0	0	0	1
0	1	0	1	0	0
0	1	1	0	0	1
0	1	1	1	0	0
1	0	0	0	1	1
1	0	0	1	0	1
1	0	1	0	0	0
1	0	1	1	1	1
1	1	0	0	1	1
1	1	0	1	1	0
1	1	1	0	1	0
1	1	1	1	1	0

15, 15 points

Task 2

Design a minimized combinatorial circuit for a tape recorder, which realizes the following functions:

The tape recorder has two decks into which tapes can be entered. In case that both decks hold tapes, use the button W to decide which deck shall be played. A tape is played as soon as at least one tape is entered into the recorder and if the button P (play) is pressed. In case that only one tape is entered while P is pressed, this tape is being played irrespective of whether the deck in which the tape is entered has been selected for playback or not. If a tape is being played, this is being signalled by a green light G .

Furthermore, the tape recorder has a rewind button R . If this button is pressed and a tape, that is not currently being played, is entered into the recorder, this tape is being rewound. If there are two tapes entered into the recorder and R is pressed then the tape in the deck not selected to be played is being rewound. It is possible to rewind a tape while another tape is being played. A rewind is signalled by a blue light B .

Take notice:

- The task makes the assumption, that only tapes of infinite length are entered into the recorder. You therefore do not have to consider cases, in which the start or end of the tape is being reached.
- The engine control system is not part of this task.

Please use the following guidelines for orientation when working on this task:

- Give unique names to inputs and outputs.
- Give the complete truth table for the circuit.
- Minimize the disjunctive normal forms of the initial functions.
- Create a combinatorial circuit based on inverters, AND- and OR-gates.

40 points

Task 3

The following model is given:

A full adder is of the size 1 AU (area unit) and requires a switch time of 1 TU (time unit). A 1 bit multiplexer equally is of the size 1 AU and requires the same switch time 1 TU. A is the total area, T is the total time.

- (a) Construct a 44 bit carry-select adder, that executes an addition in $T = 11$ TU.
- (b) Is it possible to design a 44 bit carry-select adder, which executes the addition in less than 11 TU? If so, please give a possible configuration (a drawing is not necessary).
- (c) Construct a 32 bit carry-select adder, that in your opinion is as minimal as possible as to product of area and time (please give the calculation of the AT product). Give reasons why your solution is correct. A proof is not necessary.

Parts (a) and (c): Please add a drawing of each of your adders for both solutions.

10, 5, 15 points