

Exercise Sheet 7 (Block B - 3)

(16 points)

Submission until Wednesday, 14th December 2016, 16:00 o'clock
Discussion begins on Monday, 19th December 2016

Please see notes at the end of the document for the submission.

7.1 Where no RS student has gone before ...

Development of a complete sequential circuit (16 points; 3+4+8+1)

In the context of an exchange program You are working on a klingon spaceship. On a field mission on an alien planet You must carry a klingon laser blaster. Unfortunately the control module is broken and You must replace it. You can find all necessary components in the toolbox, but You do not have a construction plan. All You have got is the manual for the blaster.

You receive the following "interesting" klingon manual with notes for earthlings:

Klingon Laser-Blaster model WS1617

1. There are 4 modes: Idle, Load, Knockout, Kill.
2. There are 4 input buttons: *Pause*, *Charge*, *Stun*, *Shoot*.
(The assignment to the 4 modes is the same ordering.)
3. Always start with the mode Idle.
4. From Idle You can reach: Idle, Load and Knockout.
5. From Knockout You can reach: Knockout, Idle and Kill.
6. From Kill You can reach: Kill, Knockout and Load.
7. From Load You can reach: Load, Idle and Knockout.

Important tips for earthlings:

- on 1.) In Idle the weapon is locked. In Load the superconducting crystals inside of the blaster are charged. The Kill mode is for shooting. The Knockout mode is only rarely used by klingons, but it can be used for stunning.
- on 2.) The 4 buttons are hard to press, but not for klingons.
- on 3.) In Idle mode the blaster is on and has enough power from the battery.
- on 4.) Pressing Shoot in Idle does nothing. Safety first! Although many klingons circumvent this safety feature by leaving the blaster in Kill mode...
- on 5.) If you press Charge here, first go to Idle.
- on 6.) If you press Pause here, the blaster goes into steady shooting. To reach Idle, you must first change to Knockout or Load.
- on 7.) Charge and Shoot stay in Load in order not to short the battery.

Steps to develop the plan

- a. **Develop a Moore machine**, which simulates the switching unit. Choose meaningful labels for the input alphabet (Σ), output alphabet (Δ) and for the states of the machine (Q), e.g. the labels of the instruction manual. Draw the graph belonging to Your Moore machine.

Tips for the output: Good outputs are the states of the machine: Idle, Load, Knockout and Kill.

- b. **Write down the transition function** (in form of a table) for the moore machine by using the following columns:

$q \in Q$	$w_i \in \Sigma$	$\delta(q, w_i)$	$\lambda(\delta(q, w_i))$
\vdots	\vdots	\vdots	\vdots

- c. Encode Your transition table. **Choose appropriate binary encodings for Your input signals and the states.** To encode a set of 4 symbols, You must use 2 Bits.

To save the current status of Your circuit use JK-Flip-Flops. **Write down the number of necessary JK-Flip-Flops.**

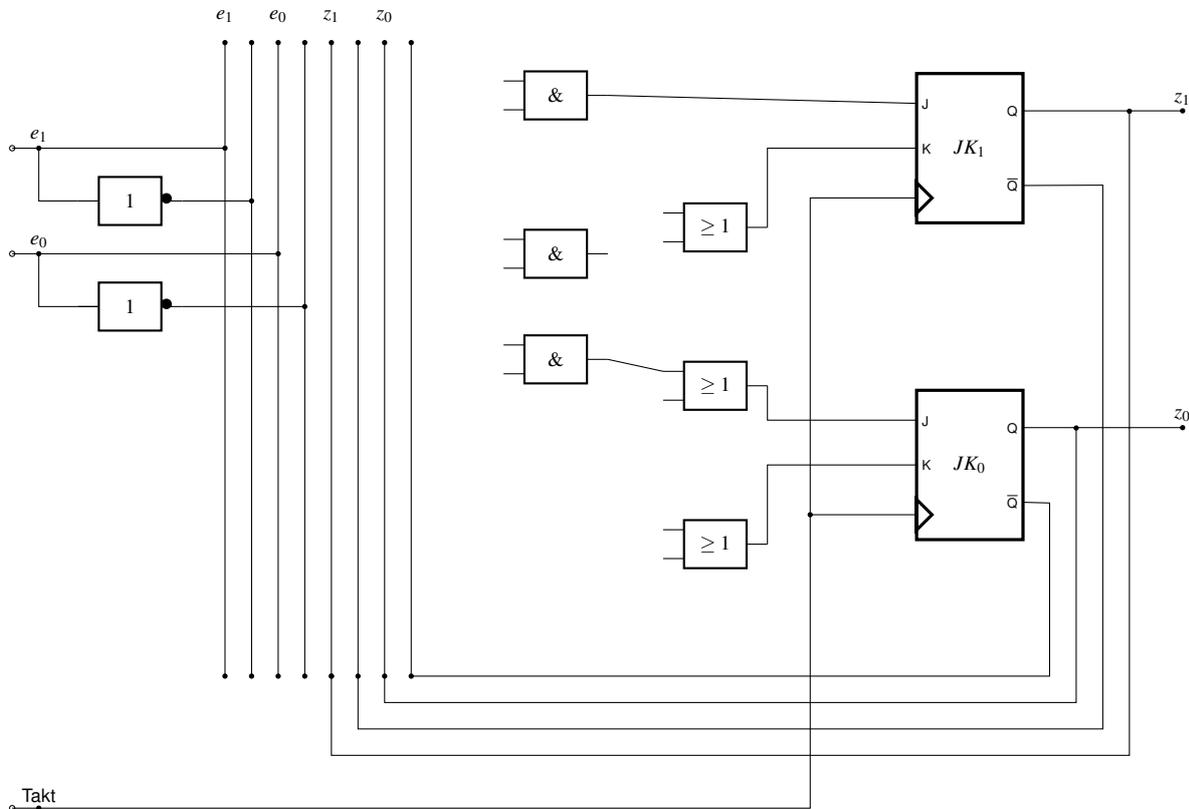
Extend Your transition table with the inputs for the JK-Flip-Flops (the following state) by using the transition table of JK-Flip-Flops (see lecture notes). Please do not use the JK-Flip-Flops as D-Flip-Flops, but trigger the control inputs (J and K) separately.

The resulting transition table should consist of 16 rows (without table head). Please use the following columns, where (e_1, e_0) is the encoded input, (z_1, z_0) is the encoded current state, (z'_1, z'_0) is the encoded following state, j_i, k_i the necessary control inputs of the JK-Flip-Flops and a is the output:

e_1	e_0	z_1	z_0	z'_1	z'_0	j_1	k_1	j_0	k_0	a
\vdots										

Draw 4 KV diagrams and infer the minimal functions for the JK control inputs. The inputs j and k depend on the input and the current state.

d. Complete the following synchronous sequential circuit with logic gates and wires, so that Your inferred functions from exercise c) trigger the JK-Flips-Flops. You must not create a circuit for the output. Please use logic symbols according to the lecture (DIN EN 60617).



Notes:

Submission until Wednesday, 14th December 2016, 16:00 pm in the mailbox number 40 at Otto-Hahn-Straße 12.

You can find the mailboxes in the first floor of the Otto-Hahn-Straße 12 near the transition to the ground floor of the Otto-Hahn-Straße 14. The mailboxes are labeled with "Rechnerstrukturen", the exercise group number and time/place of the exercise. The English exercise group is number 31 and the mailbox is number 40.

Please write your **name**, your **student registration number** and your **exercise group number** at the top right corner of your submission. You can make submissions in teams with up to two more students. To make a team submission put names, student registrations numbers and group numbers of all members of the team on the submission. Only one submission per team has to be made.

Tack you submission. Please do not fold your submission and do not put it into an envelope. Use the correct mailbox, you will need your exercise group number for that.

In total there are 12 exercises in 3 blocks (A, B, C). In each block you have to achieve at least 30 points of 64 possible ones to get access to the exam.