Exercise 7 - Notes

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Task 1: ITIV-Protocol

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The ITIV want to transmit data bidirectional from campus south to campus north with multiple clients. Therefore a customized protocol is build by the ITIV for transmission of information with id, data and a check sum. The bus should use Manchester coding to transmit the raw data. Use the Manchester code where data* bit '1' is represented by signal transition from low level to high level. The voltage level on the bus is induced by an open-collector that is connected to the output stage of the microcontroller (see Figure 1.1). The transmission is initialized by a start-bit (low) and finished with a stop-bit (high).

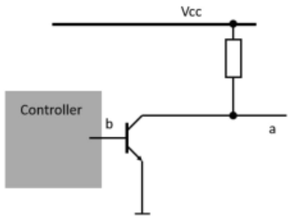

Figure 1.1: Open collector schematics

1.1 How can data integrity be checked on physical layer without changing the protocol? number of point — /2

1.2 The transmitted data-field will have variable length. Name two ways of determining the data-field length within a transmission. — /4

1.3 Can the clock be recovered within this system? Justify your answer. If clock recovery is not working give a possible solution. — /2

1.4 Draw the Manchester coded and raw data (8-bit of information) transmitted over the channel in the following graphic. The signal names correspont to the names from Figure 1.1. Please write down the transmitted data. — /6

* Manchester-I: '1' ≙ Low → High
Manchester-II: '1' ≙ High → Low

1.1: - Check for start and/or stop bit.
- Manchester Code needs at least one level change per cycle.

1.2: - length specification or delimiter.

1.3: - Yes, Manchester allows for clock recovery, because of guaranteed level change.

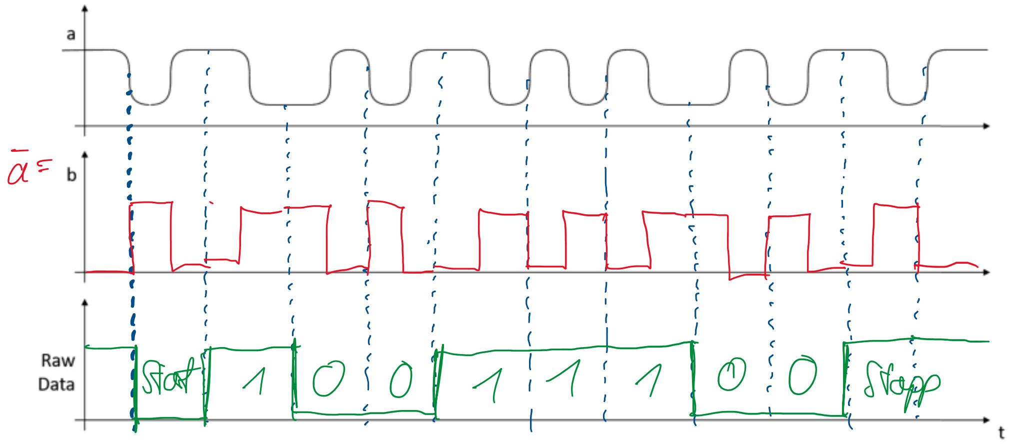

Figure 1.2: Transmitted data over the channel

1.5 Because of license reasons the Manchester coding cannot be used. Why can't differential Manchester be used for the system? Please name the Problem and a possible solution. Hint: What happens to the bus line after transmission. /4

1.5: can't guarantee idle bus level because 0s (and 1s) are encoded in alternating ways.
-> Add parity bit.

Task 2: I^2C Communication

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In this task we want to investigate the data transmission on the I^2C-Bus. The simplified frame format is given in Figure 2.1. Three master nodes are simultaneously trying to transmit or read one byte of data to or from different slaves over the I^2C-Bus.

S	ADDR	$R/\bar{W}$	A	DATA	A	DATA	$A/\bar{A}$	P

data transfered (n bytes + acknowledge)

term	description
S	start condition
ADDR	7-bit slave address
$R/\bar{W}$	read/write: read 1, write 0
A	acknowledge ('0')
$\bar{A}$	not acknowledge ('1')
DATA	8-bit data
P	stop Condition

Figure 2.1: I^2C-Bus frame format

2.1 Is I^2C a synchronous or asynchronous protocol? Justify your answer.

/2

2.2 Consider the following cases where two masters try to access the same slave. /6
Case 1: Two masters try to perform a read operation at the exact same time.
Case 2: Two masters try to perform a write operation at the exact same time.
Case 3: One master tries to read and the other master tries to write at the exact same time.
What happens in each case ? Is the write or read operation successful in each case? Explain if any collisions could be detected and how they are detected. Justify your answer for each of the cases.

2.3 The diagram in Figure 2.2 corresponds to a I^2C Multimaster configuration. The system is composed of 3 Slave and 3 Master nodes. Complete the diagram with the signals generated by each node for the simultaneous transactions presented in Table 2.1 and for the resulting SDA line of this bus. The table shows for each master, the address of the slave it is accessing, the communication mode (R/W) and the data to be sent or read. /8

node	slave address	$R/\overline{W}$	data
Master 1	1011101	0	01111001
Master 2	1010101	1	01011010
Master 3	1010111	0	01000011

Table 2.1: I^2C Communication Parameters

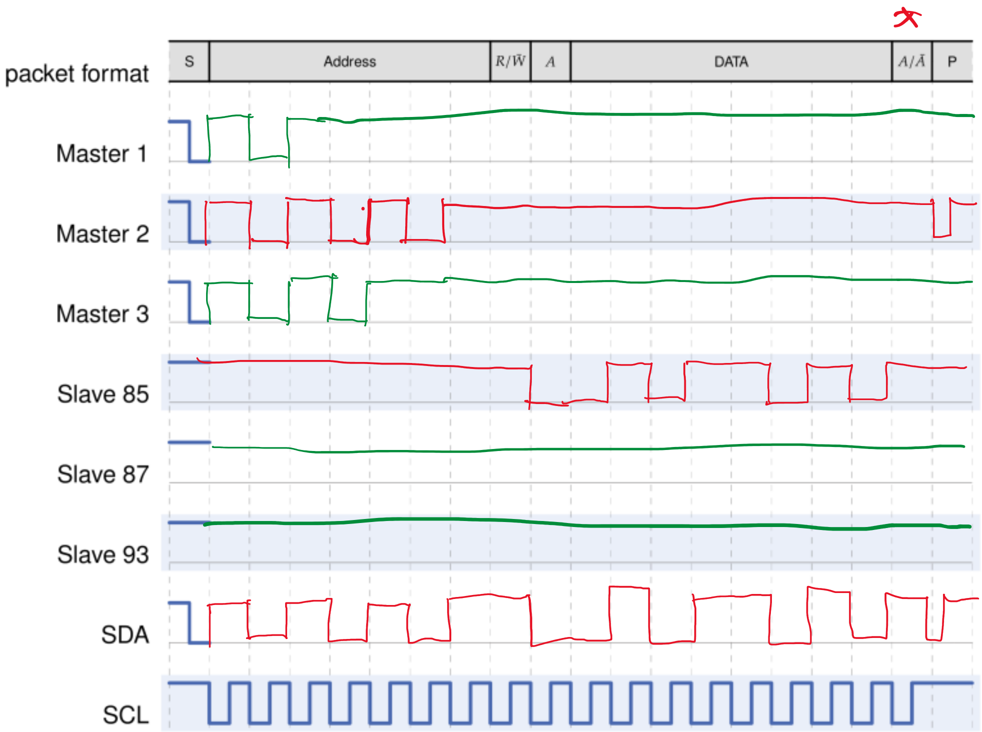

Figure 2.2: I^2C Signal sequence

* No ACK Bit to end read transfer. After last read bit, Master sends NACK to signal end of read operation.

Task 3: Reflection on wires

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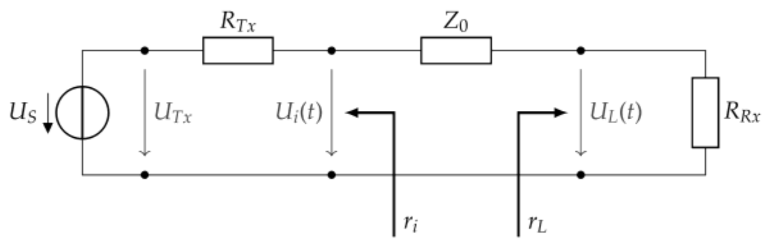


Figure 3.1: Test setup

Figure 3.1 shows the equivalent circuit diagram of an ideal (lossless) transmission line: A transmitter having output impedance R_{Tx} is connected to a receiver with the input impedance R_{Rx} using a long cable.
$R_{Tx} = 60\,\Omega$ and $R_{Rx} = 180\,\Omega$. The signal line is characterized by $Z_0 = 60\,\Omega$.

3.1 Give the generic formula to calculate the reflection factor and give the reflection factors r_i and r_L. /3

$r = (R_T - Z_0)/(R_T + Z_0)$

$r_i = (R_{Tx} - Z_0)/(R_{Tx} + Z_0) = \frac{60\Omega - 60\Omega}{120\Omega} = 0$

$r_L = (R_{Rx} - Z_0)/(R_{Rx} + Z_0) = \frac{180\Omega - 60\Omega}{240\Omega} = 0.5$

At the time $t = 0$ the voltage U_S of the sender changes from 0 V to 5 V and is constant afterwards. The run time of a wave on the cable is t_d.

3.2 Calculate the value of the voltage $U_i(t)$ at the time $t = 0$. /3

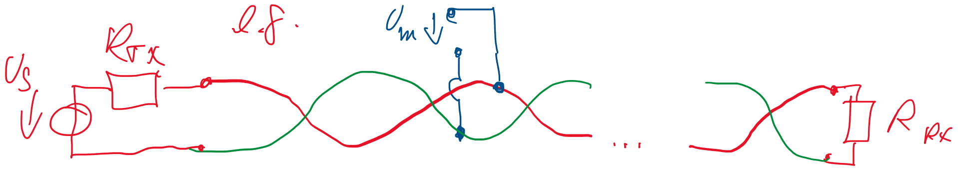
$U_i(t_d = 0) = U_S \cdot \frac{Z_0}{R_{Tx} + Z_0} = 5V \cdot \frac{60\Omega}{120\Omega} = 2.5V$

3.3 Calculate the voltage $U_m(t)$ in the middle of the line at the times $t \in \{0, t_d, 2t_d, 3t_d\}$. Neglect all transient events, use ideal rectangular impulses for calculation.

/6

$U_m(t)$ measure somewhere on the cable

e.g.



$U_m(t=0) = 0V$ (wave has not reached yet)

$U_m(t=1t_d) = 2.5V$ (series of Z_0 and R_{Tx})

$U_m(t=2t_d) = U_m(t=1t_d) + r_L \cdot [U_m(t_d) - U_{cable,m}(0)] = 3.75V$
first reflection hits end and travels back

$U_m(3t_d) = U_m(2t_d) + r_i \cdot [U_m(2t_d) - U_m(t_d)] = 3.7V$
$r_i = 0$

Matr. №: ID:

Task 4: Protocols

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FireWire Arbitration

The result of the self-identify process for a FireWire network is shown in Figure 4.1. The number shown in the center of each node represents its physical ID given by the self-identify process.

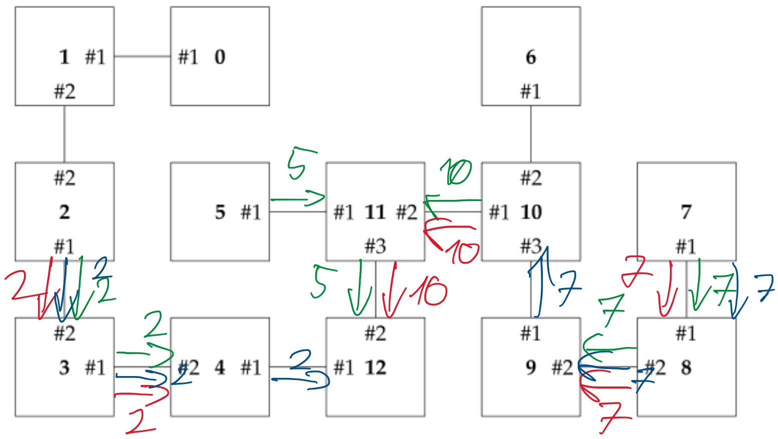


Figure 4.1: FireWire network

4.1 The nodes in Figure 4.1 having address **2**, **5**, **7**, **10** would like to transmit data and start requesting at the same time. Describe in which order are the nodes granted request.

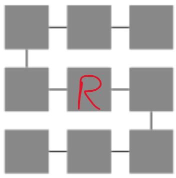
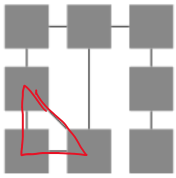
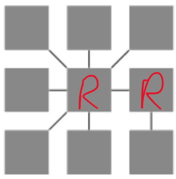
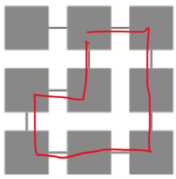
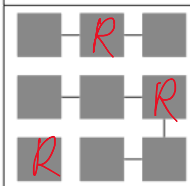
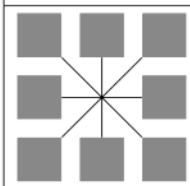
/4

- Assume that every node needs one time unit for processing and forwarding of its request signal.
- If a node receives multiple bus requests, it will always forward the request that it receives from the port with the lowest number.

First arbitration: 5
Second arbitration: 10
Third arbitration: 2
7 last.

FireWire Structures

4.2 Different FireWire structures were built, but not all of them are working correctly. State for each row if the nodes shown are building *one connected* FireWire system that is working correctly. If a system is correct, mark its root node. If it is not correct, give a reason for this. /6

	Correct	Wrong	Reason
	X		
		X	Loop included
	X		One of two possibilities
		X	Loop
	X	X	Not one single, but multiple nets. Both could be argued.
		X	multiple outputs.

FireWire Architecture

4.3 Name the three stacked protocol layers of FireWire presented in the lecture. /3

Transaction.

Link.

Physical.