Karlsruher Institut für Technologie

Institut für Technik der Informationsverarbeitung ITIV

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Institut für Technik der Informationsverarbeitung (ITIV)

Communication Systems and Protocols

Exercise 1

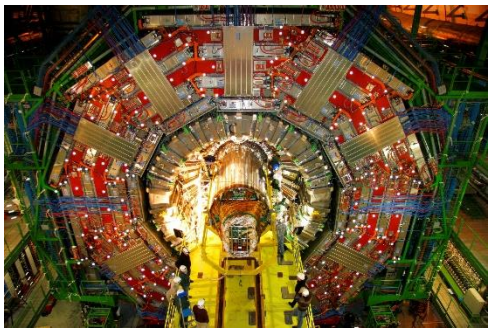
General Information

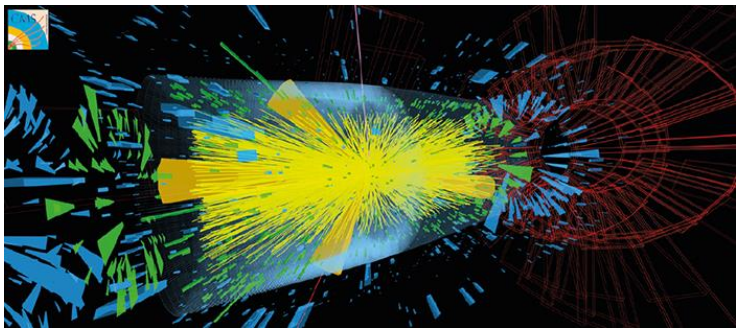
Communication Systems and Protocols Exercises

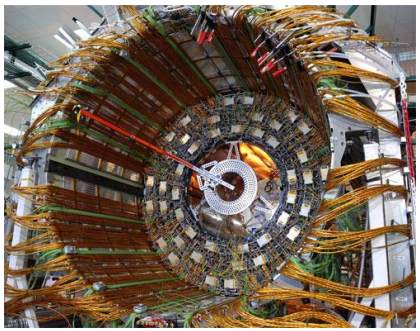
- Lecturer:

Dipl.-Inform. Tanja Harbaum
Institute for Information Processing (ITIV)
Building 30.10, Room 226
Email: csp@itiv.kit.edu

- Consultation-hours: After the lecture or by appointment
- research topic: Level 1 Track Trigger CMS detector (CERN)







General Information CSP

- Announcements: (lecture, exercise, examinations)

  Building 30.10, top floor (billboard)

  https://ilias.studium.kit.edu

- Examination: Monday, July 31st 2017

  written with formula sheet
  (1 DIN-A4 sheet, handwritten)

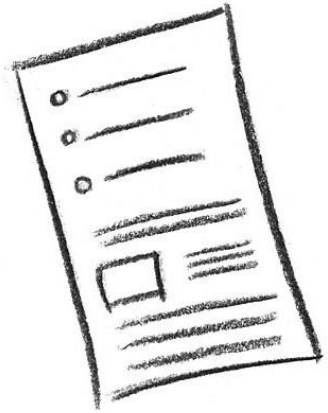
Schedule CSP

Monday: 09:45 – 11:15 (MTI)	Thursday: 09:45 – 11:15 (EAS)
24.04.2017 – Lecture 1	27.04.2017 – Lecture 2
01.05.2017 – May Day	04.05.2017 – Exercise 1
08.05.2017 – Lecture 3	11.05.2017 – Lecture 4
15.05.2017 – Exercise 2	
22.05.2017 – Lecture 5	25.05.2017 – Ascension Day
29.05.2017 – Lecture 6	01.06.2017 – Lecture 7
05.06.2017 – Pentecost week	08.06.2017 – Pentecost week
12.06.2017 – Exercise 3	15.06.2017 – Corpus Christi
19.06.2017 – Lecture 8	22.06.2017 – Exercise 4
26.06.2017 – Lecture 9	
03.07.2017 – Lecture 10	06.07.2017 – Exercise 5
10.07.2017 – Lecture 11	
17.07.2017 – Lecture 12	20.07.2017 – Exercise 6
24.07.2017 – Exercise 7	27.07.2017 – Question time

Monday, 31.07.2017: CSP - EXAMINATION

Procedure

- We will talk about the task



- You work in small groups and solve the task

- We dicuss one possible solution

Images: http://www.thilo-krapp.com/

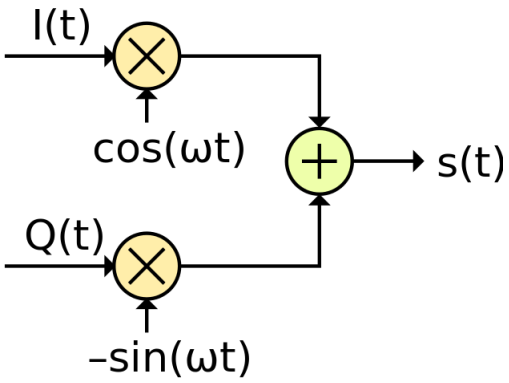
Task 1:

Quadrature Amplitude Modulation

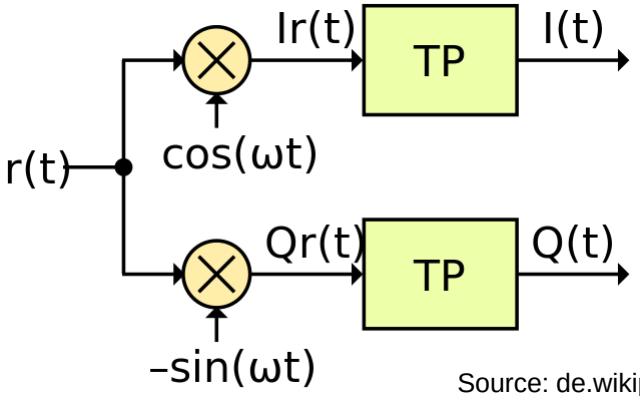
Quadrature Amplitude Modulation (QAM)

- Usage of two sine carrier signals that are shifted 90° to each other → Signals do not interfere with each other
  - One signal is called *In-phase component (I)*
  - Other signal is called *Quadrature Component (Q)*
- These two signals are added up to form the sender signal *(IQ-Modulation)*
- Demodulation requires same phase in sender and receiver → additional measures required

QAM-Modulation



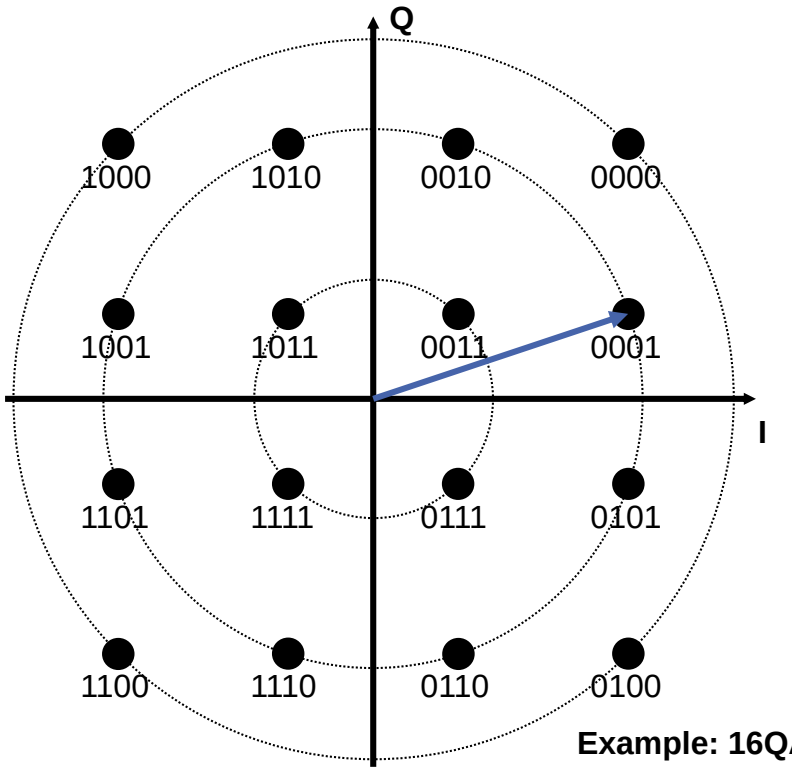
QAM-Demodulation



Source: de.wikipedia.org

Quantizied QAM: Constellation diagram

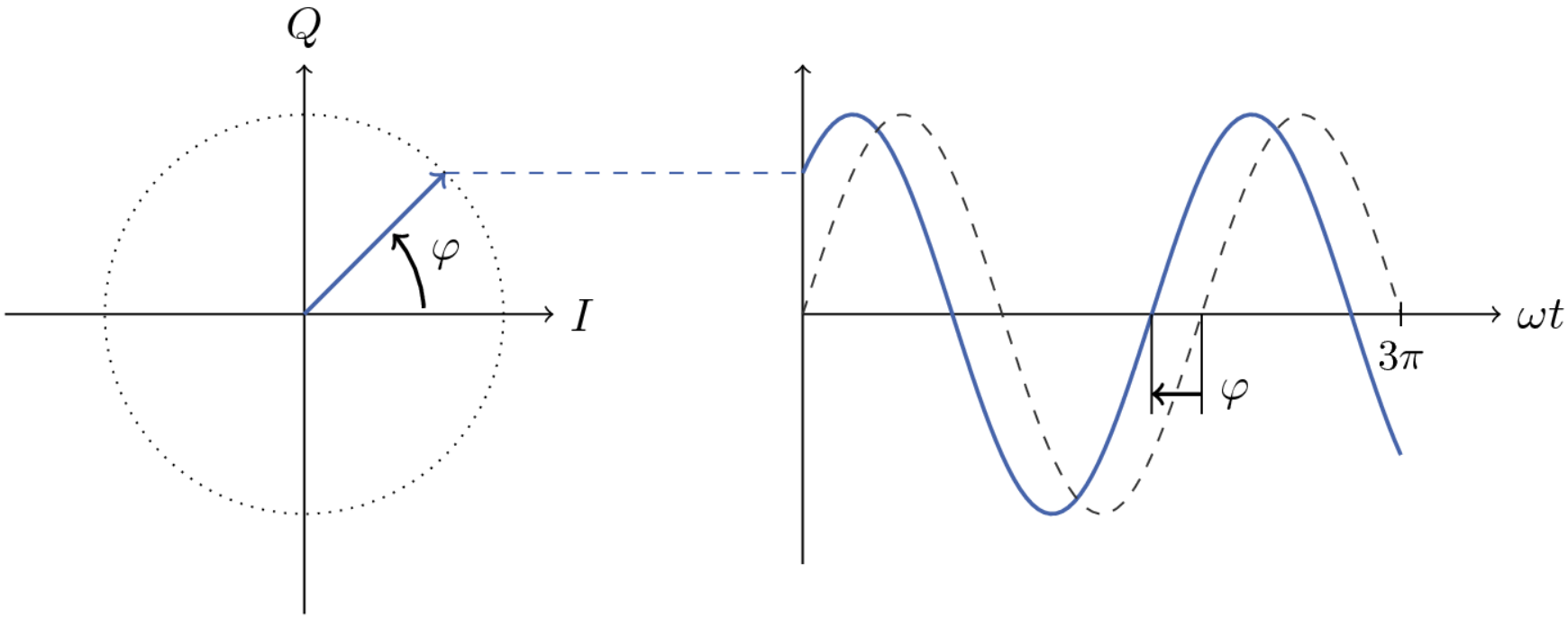
- The two QAM carriers can be represented in a two-dimensional diagram → **constellation diagram**
- When using discrete and independent signals, each point in the constellation diagram can represent more then one bit



Example: 16QAM

Constellation diagram

- Angle corresponds shift



QAM: placement of constellation points

- Signal is influenced by noise during transmission
  - Received signals are not at the ideal positions
  - Acceptance radius is required to define valid ranges for each point

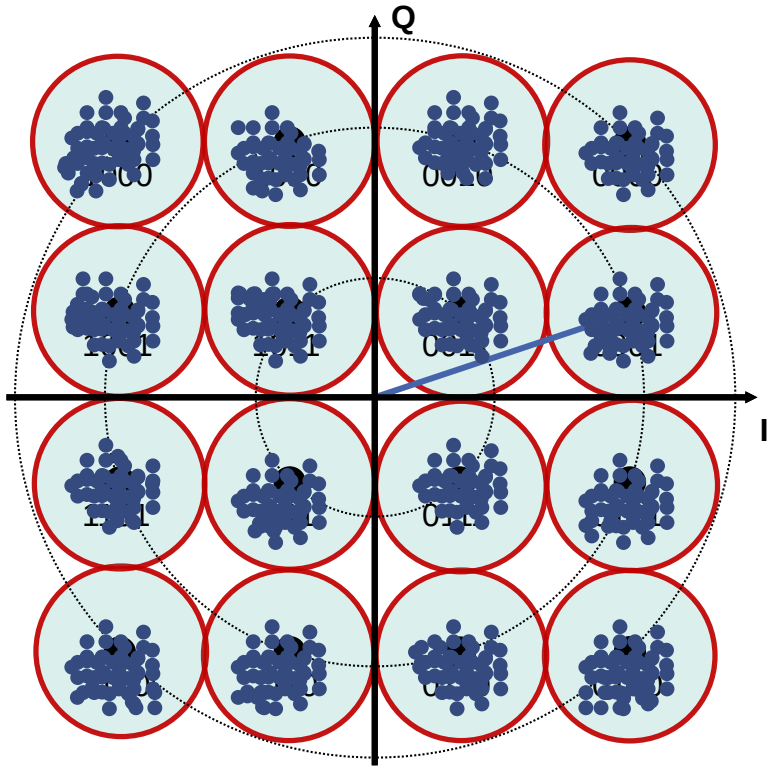
Positioning of signal points:

- Maximize distance of points to avoid misinterpretation of a signal

In General:

- More points allow more bits per signal (higher data rates) but require better signal-to-noise ratios

→ Trade-off required



Task 1:

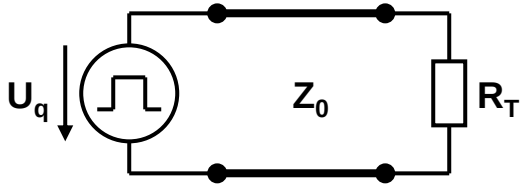
Quadrature Amplitude Modulation

Time remaining ‘10

Task 2:
Reflections on Wires

Reflection at the wire end

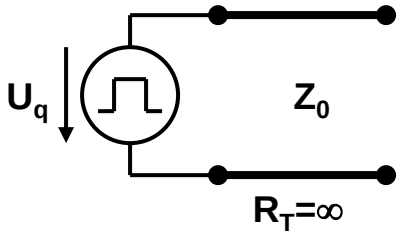
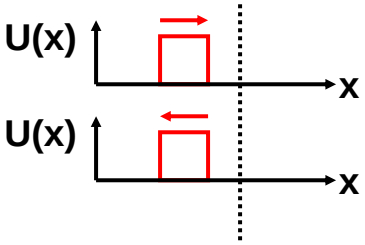
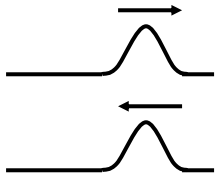
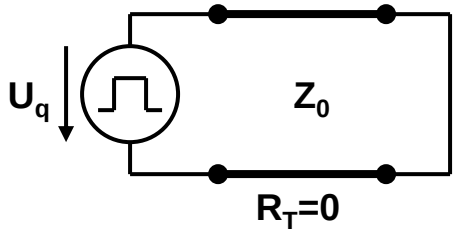
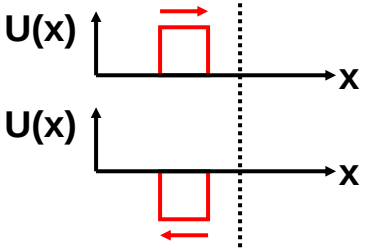
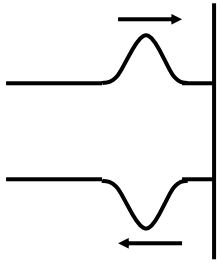
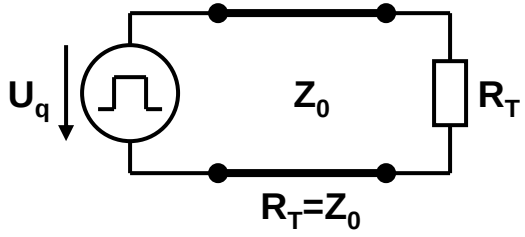
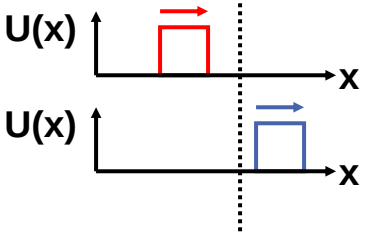
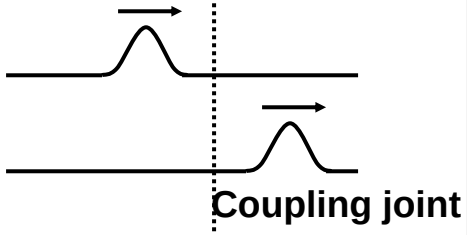
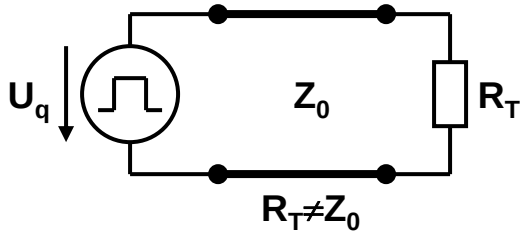
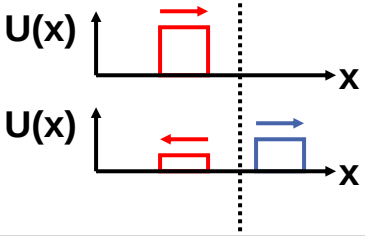
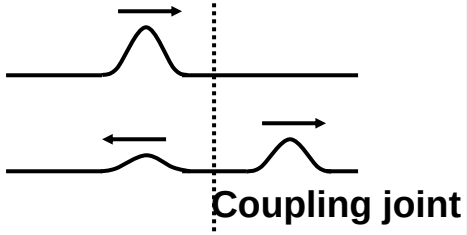
- Signals spread wavelike within long lines/wires
- There exists a forward and eventually a backward running wave that interfere on the wire
- The amplitude of the backward running wave depends on
  - The impedance of the line
  - The terminating impedance at the end of the line



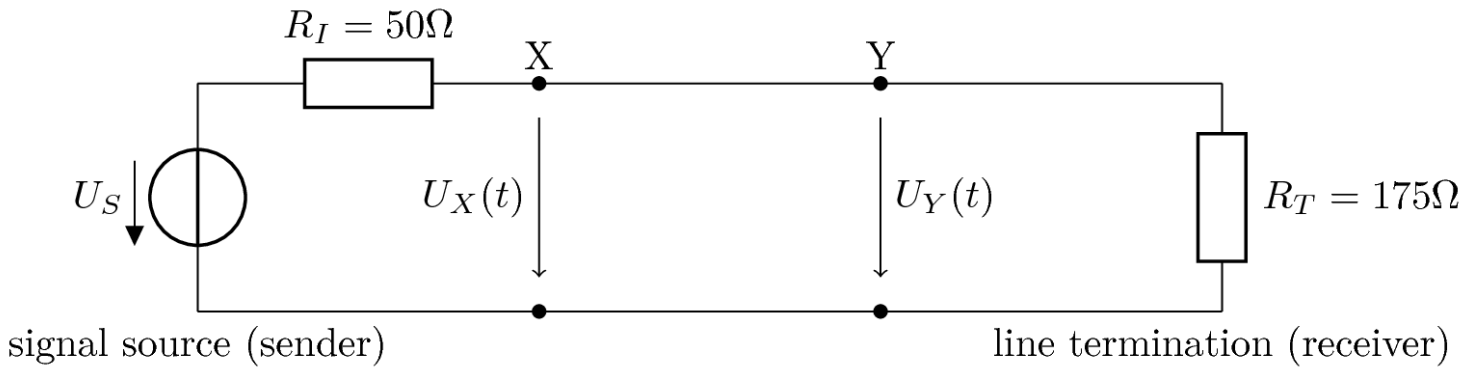
- Definition of the reflection factor: $r = \frac{R_T - Z_0}{R_T + Z_0}$

R_T: Terminal Resitance
Z_0: Characteristic impedance

Reflection on wires

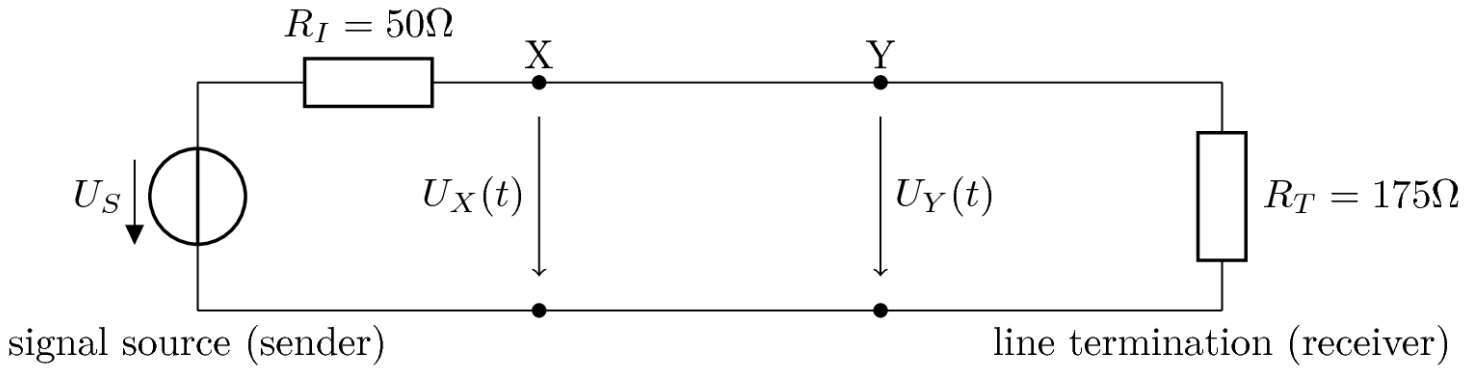
Line	Reflection factor r	Voltage curve	mechanical analogue
	r=1		 loose end
	r=-1		 solid end
	r=0		 Coupling joint
	-1<r<1		 Coupling joint

Task 2A): Reflection on Wires



What is the value of the voltage at point X at the time t=0?

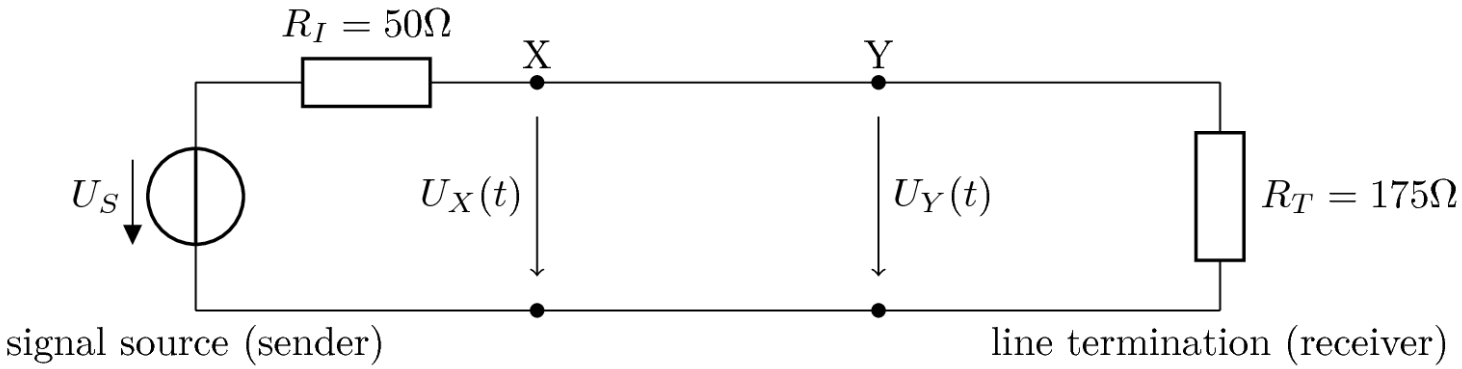
Task 2B): Reflection on Wires



Which voltage value appears at the points *X* and *Y* after an infinite amount of time?

Time remaining ‘5

Task 2C): Reflection on Wires



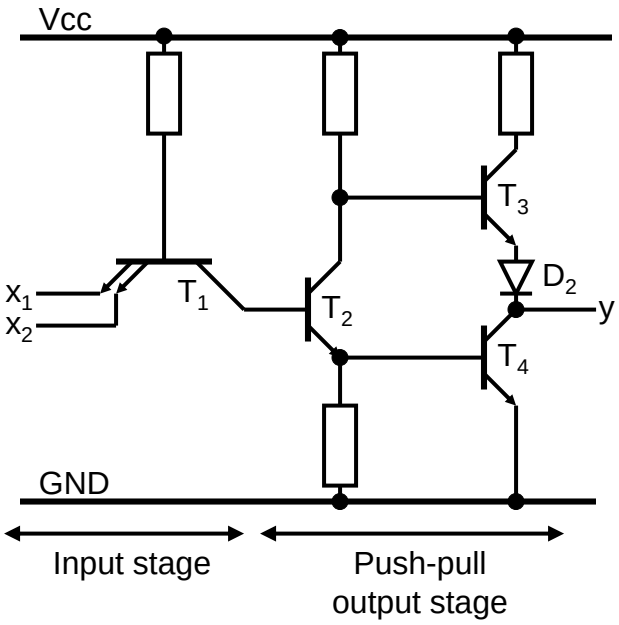
Calculate the voltages at the points *X* and *Y*
at the times $t = 0 \ldots 5t_d$.

Time remaining ‘10

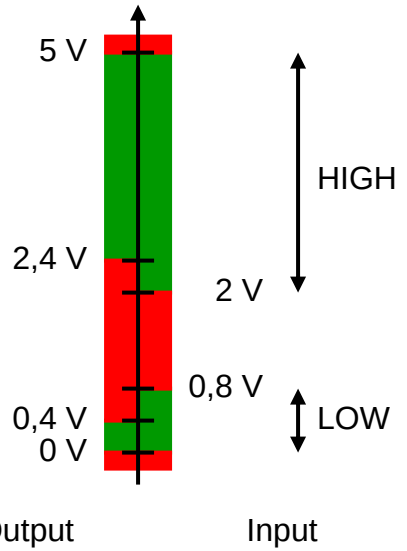
Task 3:
TTL Technology

Electrical Output Driver

- Transistor-Transistor-Logic (TTL)
  - Earlier the most common used technology
  - Provides for a high current delivery
  - TTL level
    - Valid HIGH and LOW areas are wider at the input due to possible voltage drops on the lines
    - Asymmetric division since the HIGH level drops under load which does not happen to the LOW level



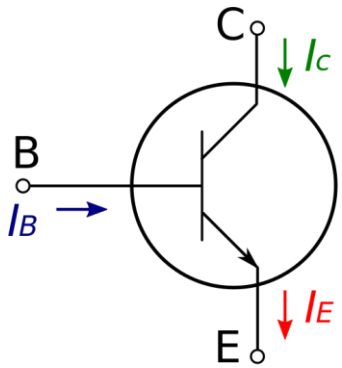
TTL basic gate (i.e. SN 7400)

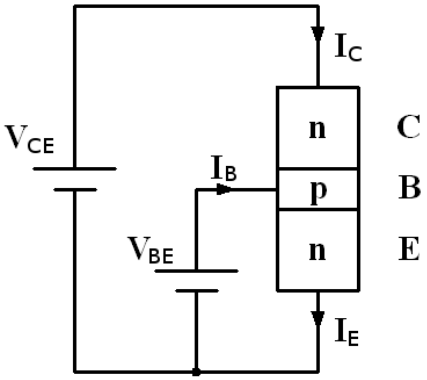


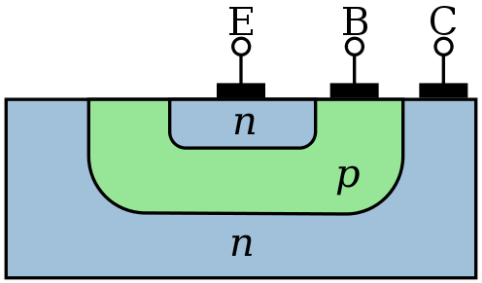
TTL level

Bipolar junction transistor

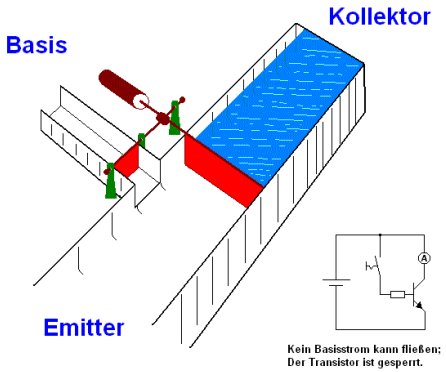
- NPN
  - layer of P-doped semiconductor (the "base") between two N-doped layers





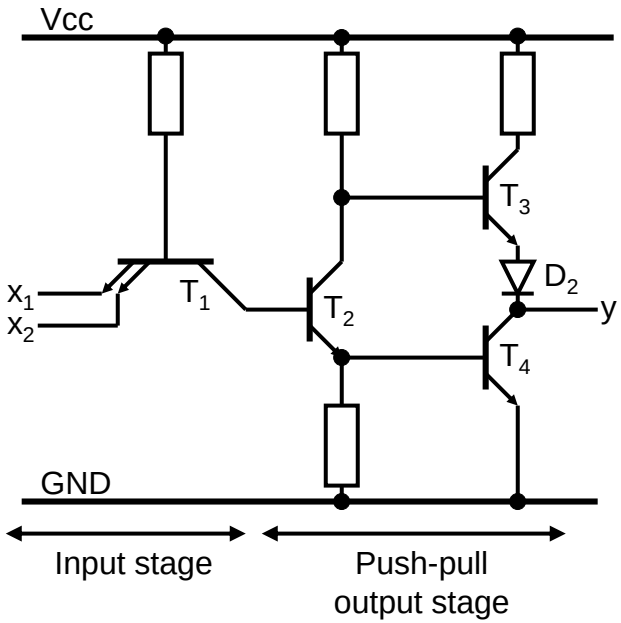


  - when there is a positive potential difference measured from the base of an NPN transistor to its emitter, the transistor becomes active



Source: https://en.wikipedia.org/wiki/Bipolar_junction_transistor#NPN

Task 3: TTL Technology



Time remaining ‘5