Tutorial 1 - SS2017
Communication Systems and Protocols

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Task 1: Quadrature Amplitude Modulation

A) What is the difference between the PSK and the QAM modulation technique?

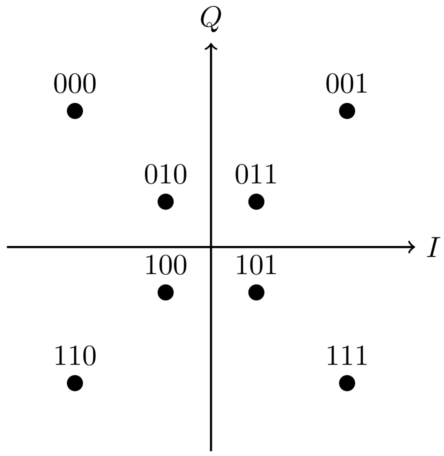

Figure 1.1: Constellation diagram

B) Figure 1.1 shows a constellation diagram for a digital modulation technique. Which type of modulation is used here? Which properties of the signal can be varied with this modulation type?

C) The symbol constellation from Figure 1.1 is now used by a transmitter to modulate data bits on a carrier. The phase φ of the signal is defined relative to a sine reference signal as shown in Figure 1.2. A receiver device now picks up the modulated signal which is plotted in Figure 1.3. Which bits have been transmitted by the sender? Demodulate the signal and write down the resulting bit-stream.

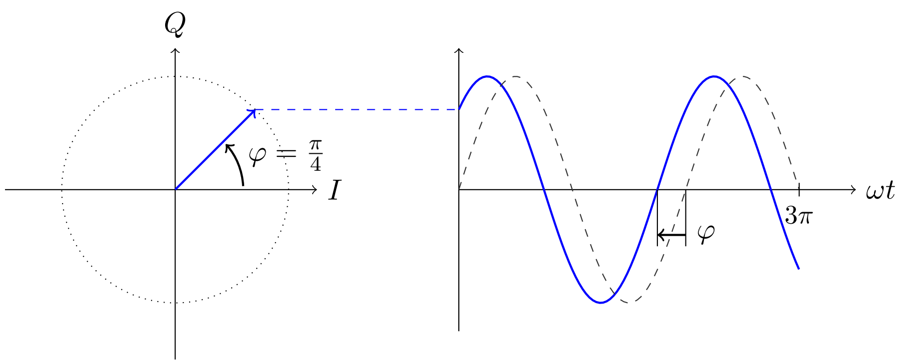

Figure 1.2: Phase difference of a sine signal compared to a reference signal (dashed line $\widehat{=}$ reference signal).

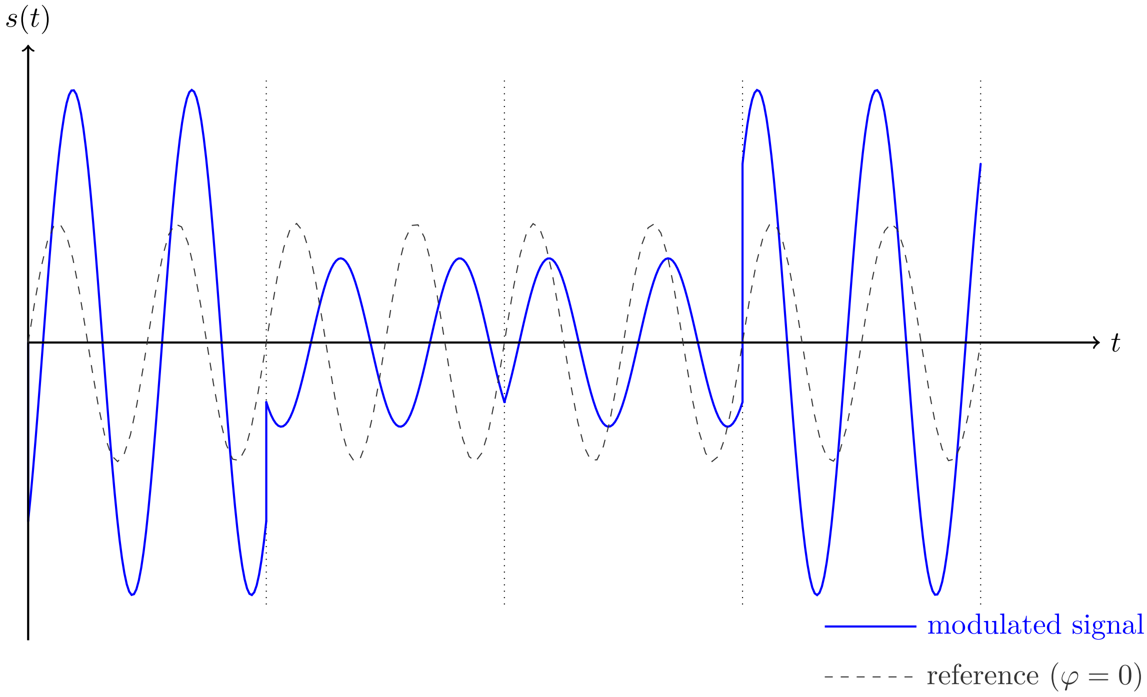

Figure 1.3: A modulated signal which uses the constellation from Figure 1.1 on the preceding page.

D) Now, a signal is modulated with the constellation diagram from Figure 1.4 and transmitted on a coaxial cable. The sender is able to generate a maximum voltage amplitude U_{max} of $\pm\sqrt{72}\,V$. Calculate the acceptance radius r_a for the symbols in the constellation diagram.

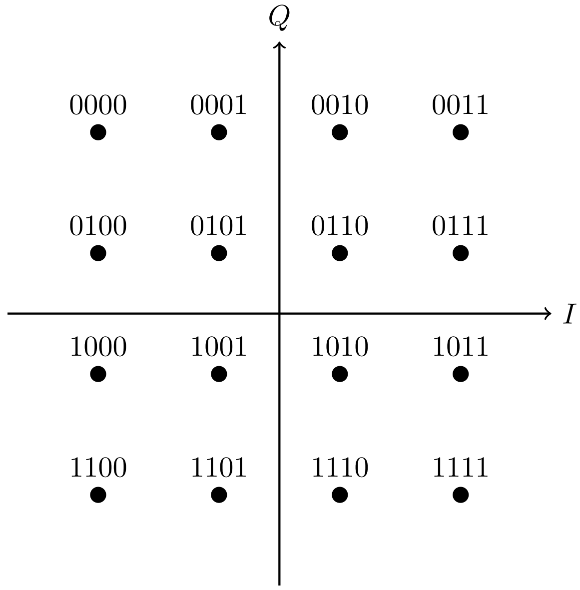

Figure 1.4: Constellation diagram

E) The symbol acceptance radius is a deciding factor for the symbol error probability. However the bit error probability also depends on the encoding of the symbols. The symbol-encoding in Figure 1.4 is not optimal because multiple bits can flip when neighboring symbols are mixed-up due to signal noise. Which kind of encoding could help to solve this problem?

Task 2: Reflection on wires

A setup consisting of a voltage source with an internal resistance $R_I = 50\Omega$ as sender and a receiver with $R_T = 175\Omega$ is shown in Figure 2. The DC resistance of the line is zero, the characteristic impedance Z_0 is 75Ω.

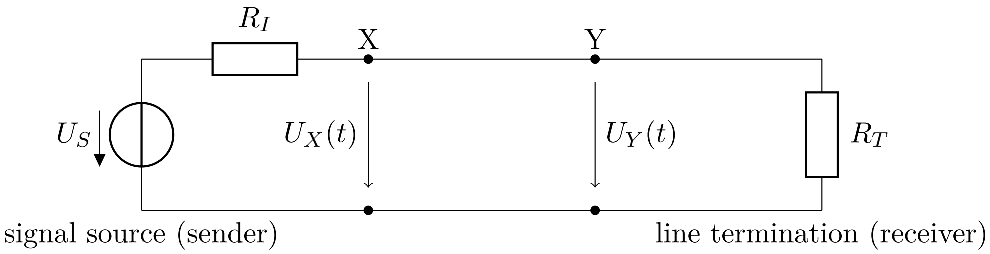

Figure 2.1: Test setup

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

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

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

C) Calculate the voltages at the points X and Y at the times $t = 0 \ldots 5t_d$. Neglect all transient events, use ideal rectangular impulses for calculation.

Task 3: TTL Technology

A) Insert the logic level (HIGH, LOW) of the output and the state of the transistors (conducts, blocks) into the table 3.1 according to the input configuration x_1 and x_2 at the standard TTL output driver in figure 3.1.

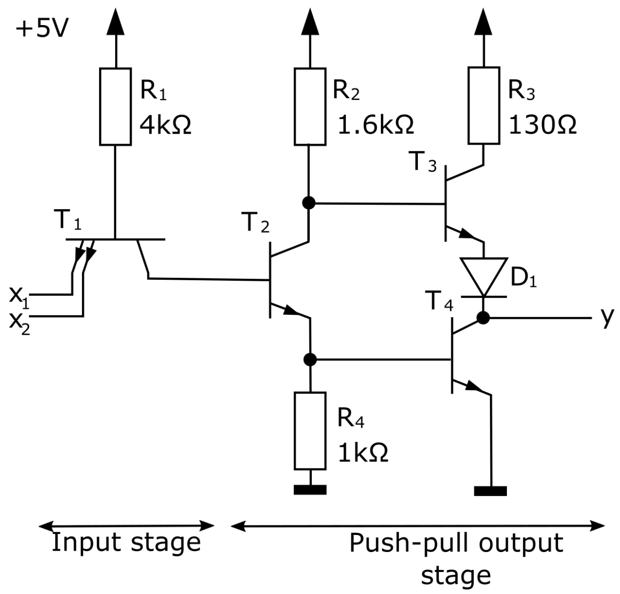

Figure 3.1: standard TTL output driver

x_1	x_2	T_1	T_2	T_3	T_4	y
0	0					
0	1					
1	0					
1	1					

Table 3.1: Logic Level

B) List two advantages when using TTL drivers.