

## Task 1: Quadrature Amplitude Modulation

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

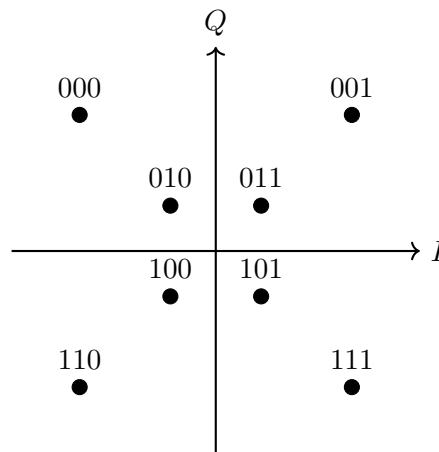


Figure 1.1: Constellation diagram

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  $\varphi$  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.

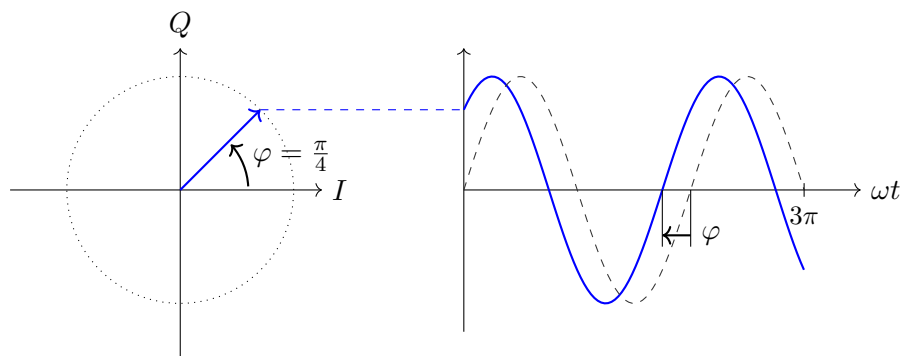


Figure 1.2: Phase difference of a sine signal compared to a reference signal (dashed line  $\hat{=}$  reference signal).

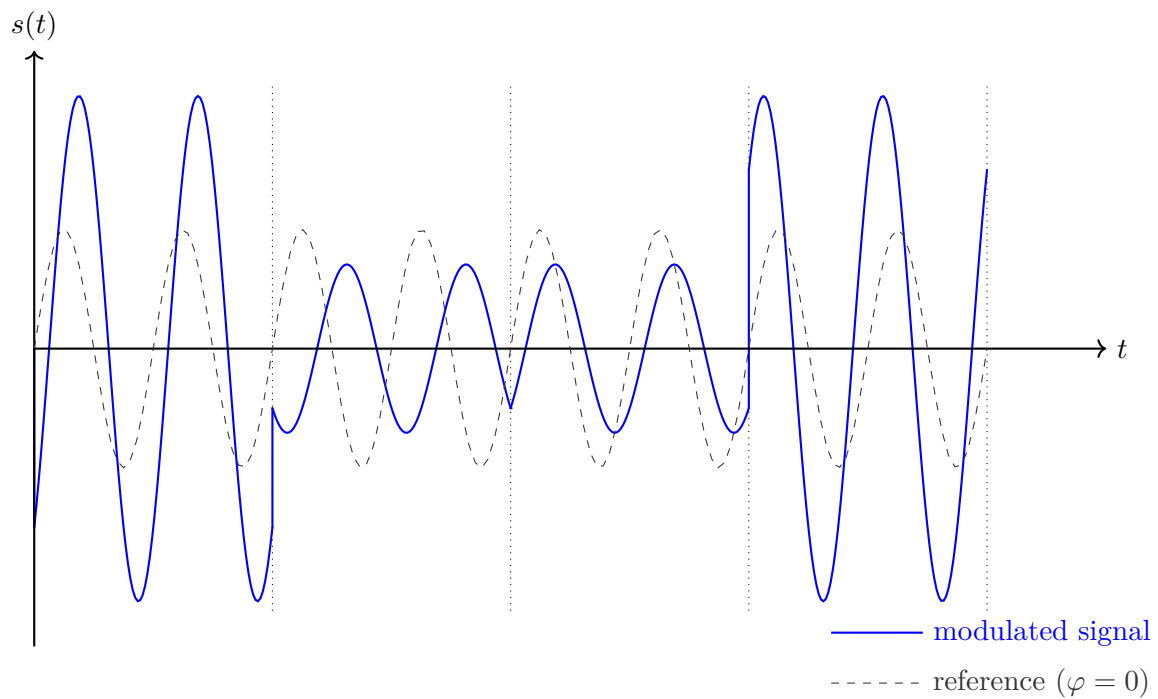


Figure 1.3: A modulated signal which uses the constellation from Figure 1.1 on the preceding page.

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.

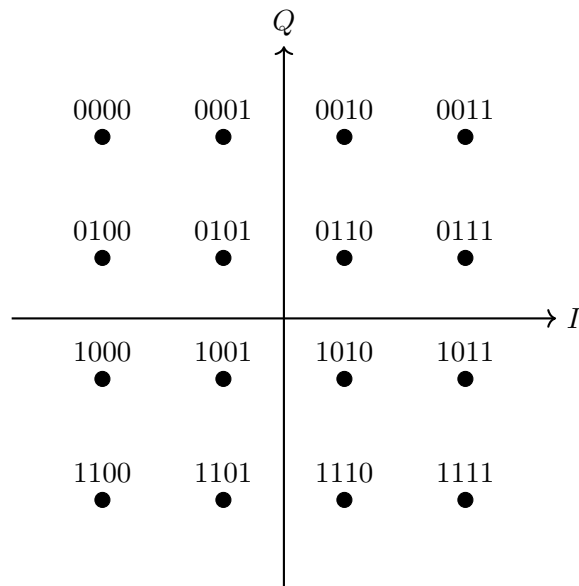


Figure 1.4: Constellation diagram

## 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  $75\Omega$ .

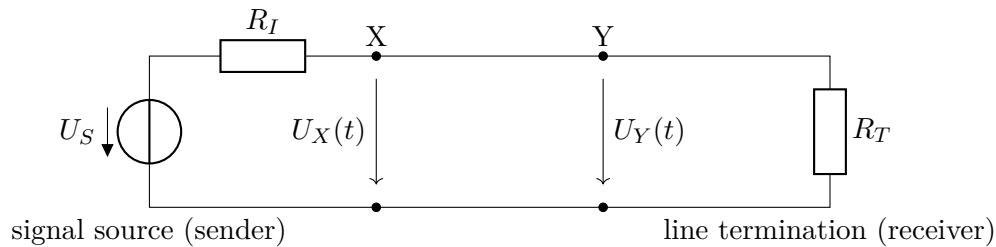


Figure 2.1: Test setup

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  $t=0 \dots 5t_d$ . 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.

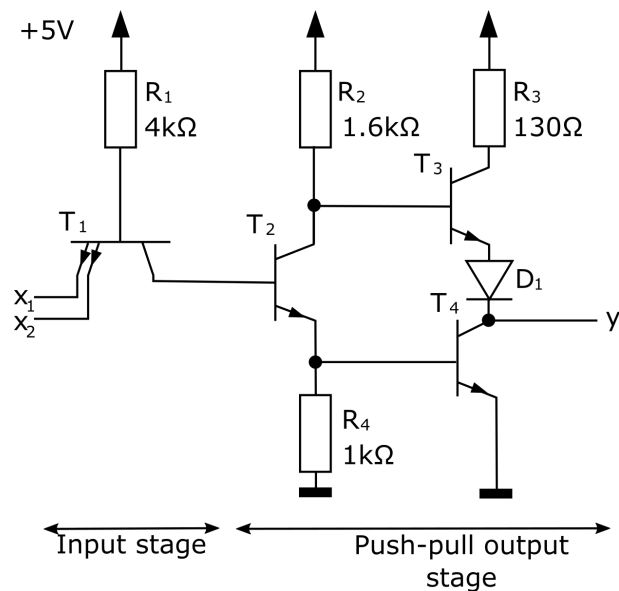


Figure 3.1: standard TTL output driver

$x_1$	$x_2$	$T_1$	$T_2$	$T_3$	$T_4$	$y$
Low	Low					
Low	High					
High	Low					
High	High					

Table 3.1: Logic Level

B) List two advantages when using TTL drivers.