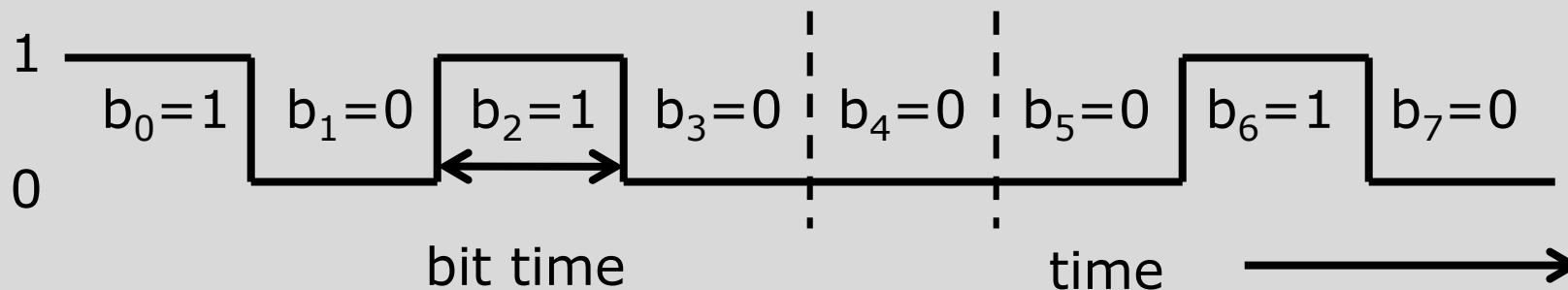


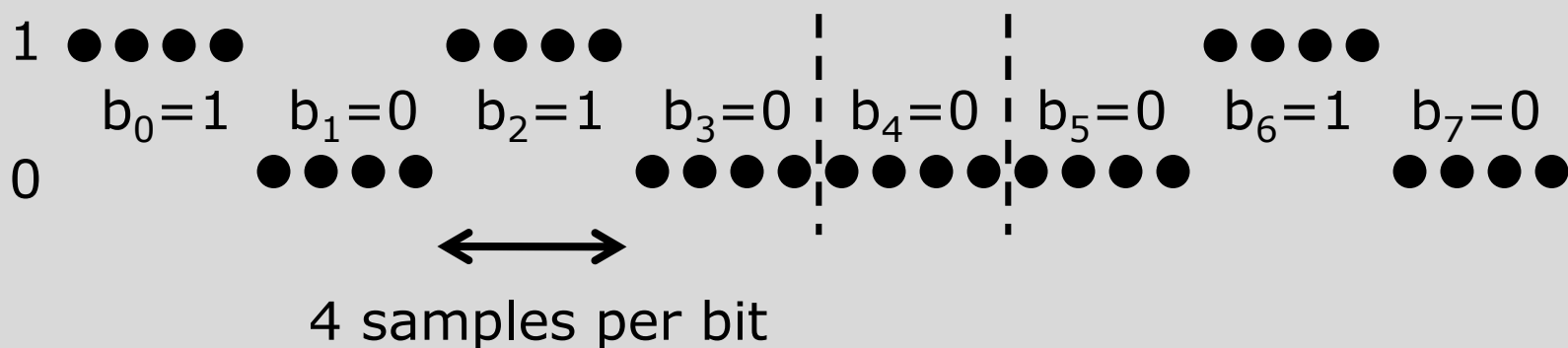
# **Discrete Time Bit Waveforms**

# Bit Sequences to Bit Waveforms

## Continuous time



## Discrete time

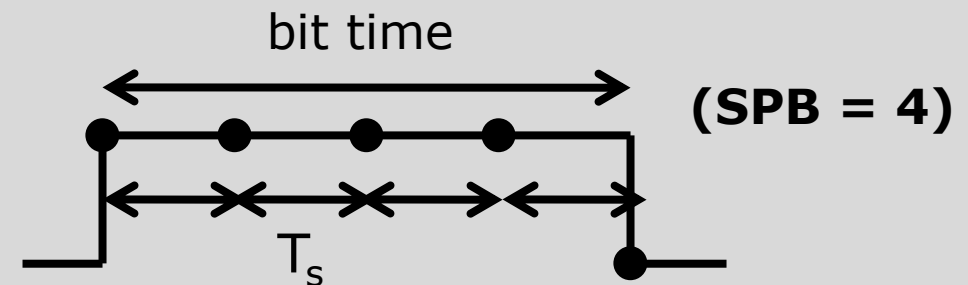


# Bit Rate, Sampling Frequency, SPB

- The **bit time** measures the length of time it takes to send one bit.
- The **bit rate** measures the number of bits we can send in a given unit of time.
- We generally want:
  - the bit rate to be large
  - the bit time to be small

$$\begin{aligned}\text{bit time} &= \text{SPB} \cdot T_s \\ &= \frac{\text{SPB}}{F_s}\end{aligned}$$

$$\begin{aligned}\text{bit rate} &= \frac{1}{\text{bit time}} \\ &= \frac{1}{\text{SPB} \cdot T_s} = \frac{F_s}{\text{SPB}}\end{aligned}$$



# Example Bit Rate Calculation

**Sample rate**

$$\begin{aligned}F_s &= 1\text{MHz} = 1\text{MegaHertz} \\&= 1,000,000 \text{ samples / second} \\&= 10^6 \text{ samples / second}\end{aligned}$$

**If we use 4 samples per bit (SPB = 4),  
then**

$$\begin{aligned}T_s &= (F_s)^{-1} = 10^{-6} \text{ second} \\&= 1\mu\text{s} = 1 \text{ microsecond}\end{aligned}$$

**The bit time**  $= \text{SPB} \cdot T_s = 4\mu\text{s}$

**The bit rate**  $= \frac{F_s}{\text{SPB}}$   
 $= \frac{1,000,000}{4} \text{ Hz} = 250\text{kHz}$

