11.5.18

Quantization

resolution: number of discrete values over the range of analogue voltage of the ADC

$$Q = \frac{E_{FSR}}{2^n} \sim \text{full scale range}$$

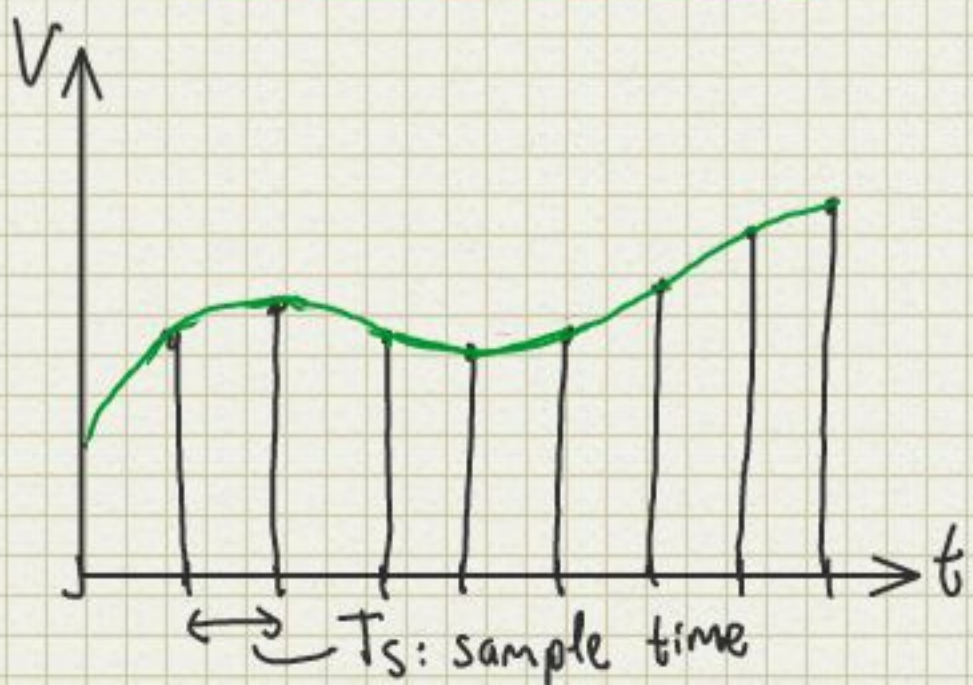
$$E_{FSR} = V_{ref,max} - V_{ref,min}$$

ex ADC with 8-bit $\rightarrow 2^8 = 256$

FSR: (-5V) - (5V)

resolution: $Q = \frac{5V - (-5V)}{256} = 39\,mV$

Discretization errors



A continuous analogue signal is digitized with specific rate, the sampling rate

Aliasing

Signal with frequencies close to the sampling frequency cause non-existing "virtual" frequencies in digitized signal

Nyquist: he found that the sampling frequency must be at least twice the highest frequency in the measured (analogue) signal

$$f_{nyq} = \frac{1}{2} f_{sample} = \frac{1}{2 T_s}$$

with $f_s > 2 f_{sig,max}$, the frequency is measured correctly

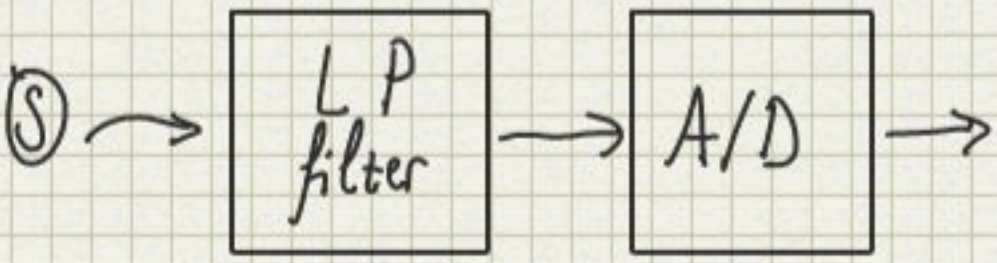
but: amplitude is distorted

measurement of frequency and amplitude requires much higher sampling frequency

rule of thumb: $f_{sample} \geq 10 . f_{sig,max}$

How to prevent aliasing errors?

1)



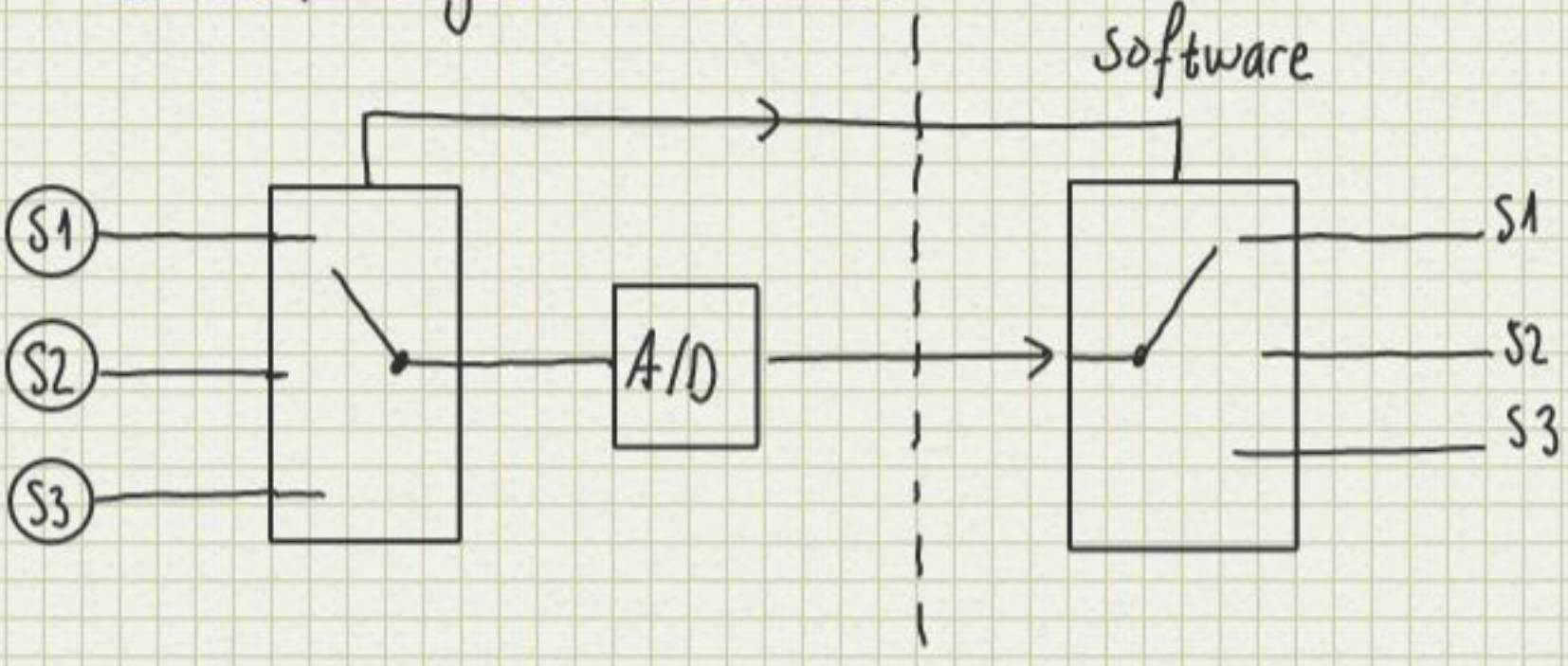
physical LPF
aliasing filter

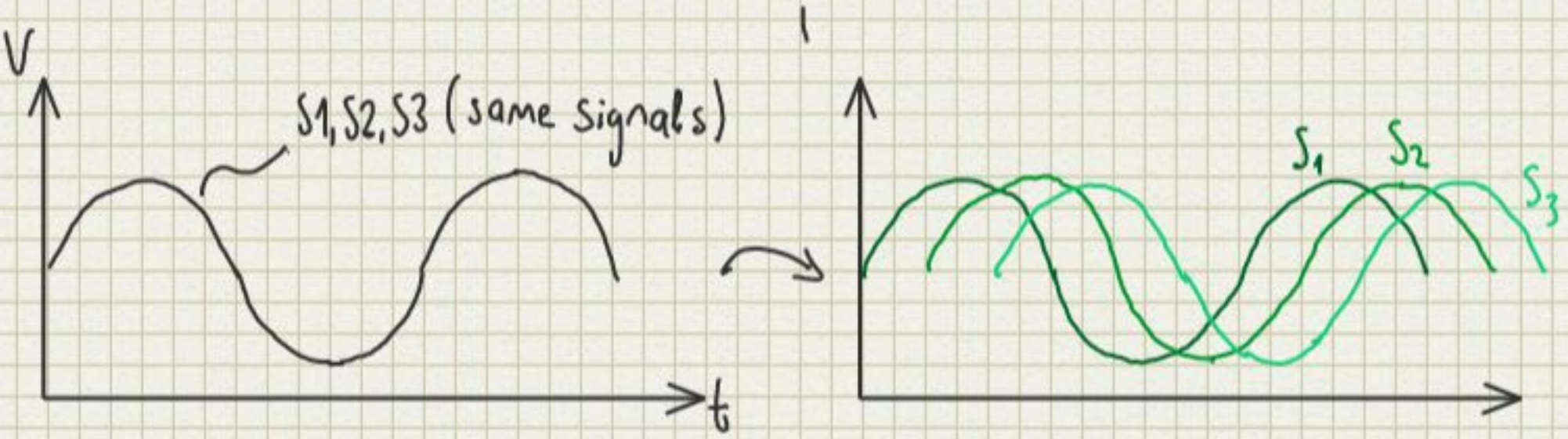
$$f_{filter} = \frac{1}{2} f_{sample} = \frac{1}{2 T_s}$$

2) Oversampling

choose T_s much higher than required, then apply a digital (numerical) filter after A/D conversion

Multiplexing with ADC's





Bus Systems → lecture slides!