PCM
Pulse Coded Modulation

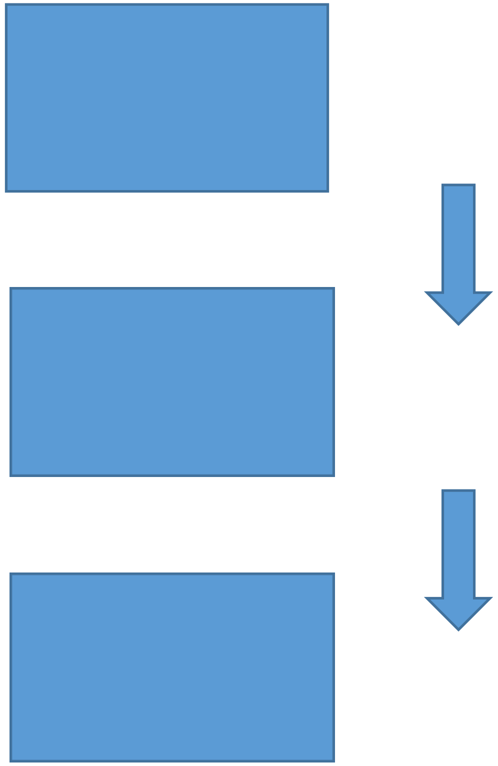
A joint effort of

Barbara Costantini and Sean Pethybridge

PCM uses

Analog to Digital Conversion (ADC)

3 main functions



PCM uses analog to digital conversion

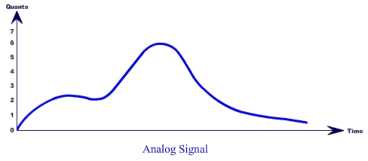
SAMPLING

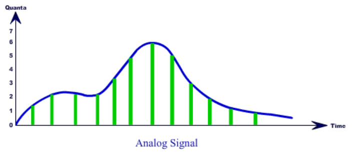
QUANTIZATION

ENCODING

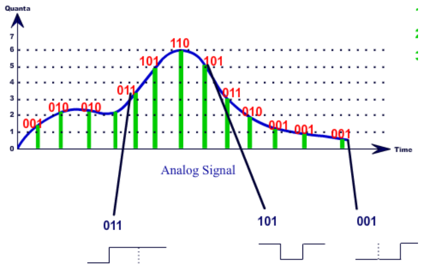
Time Discretization

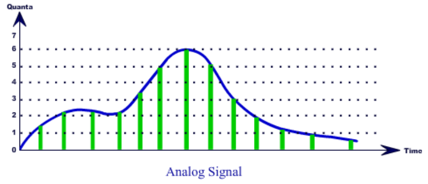
Amplitude Discretization





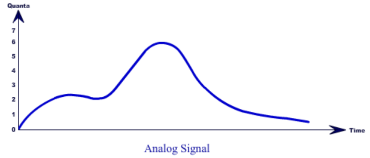
Digital conversion of the quantized values





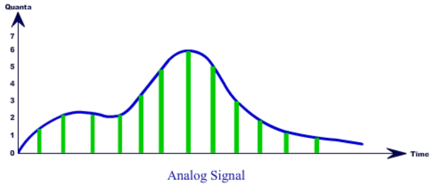
Match each definition and graph with the corresponding function

PCM uses analog to digital conversion



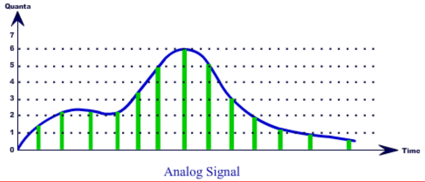
SAMPLING

Time Discretization



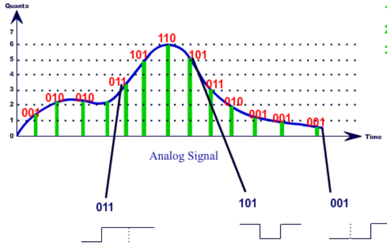
QUANTIZATION

Amplitude Discretization



ENCODING

Digital conversion of the quantized values



[Take a look at the whole process of digitalization]()

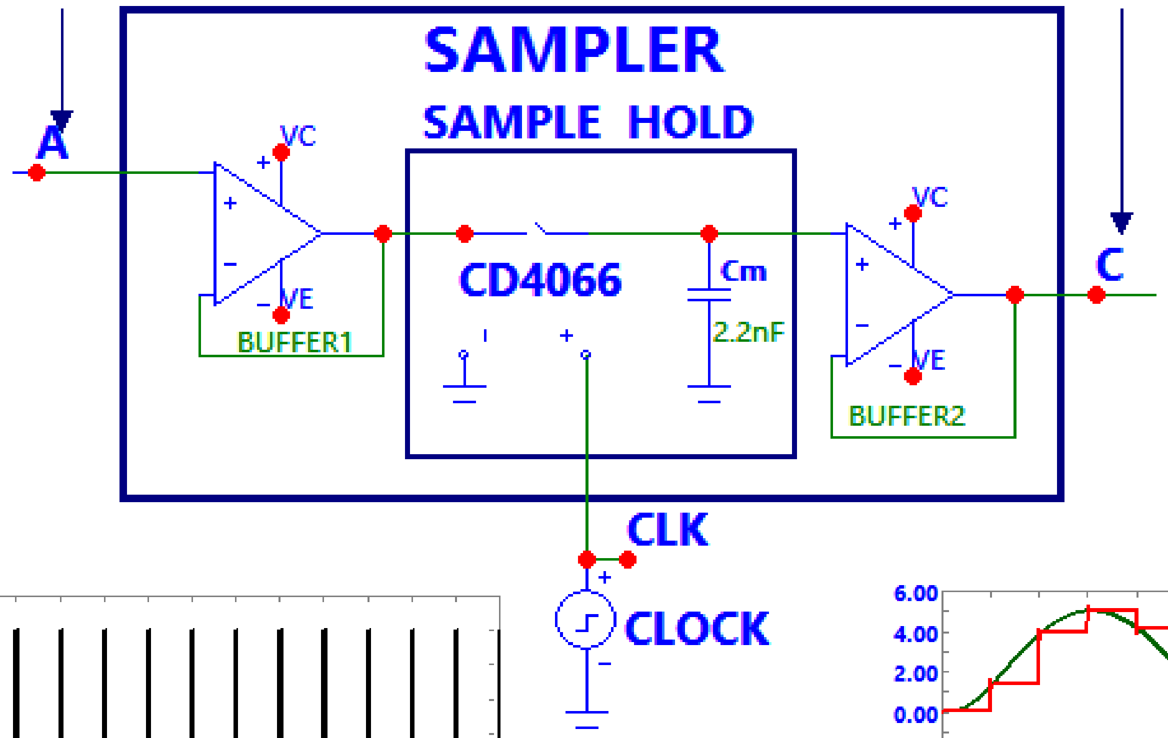
How can we built a sampler?

Clock frequency
=sampling rate
=sampling frequency

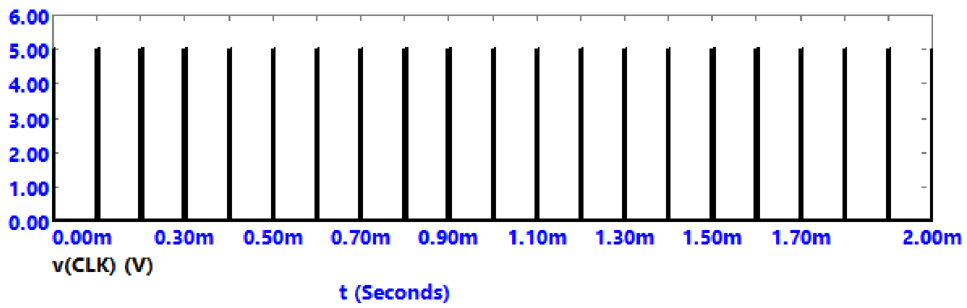
Electronic switch
driven by a clock

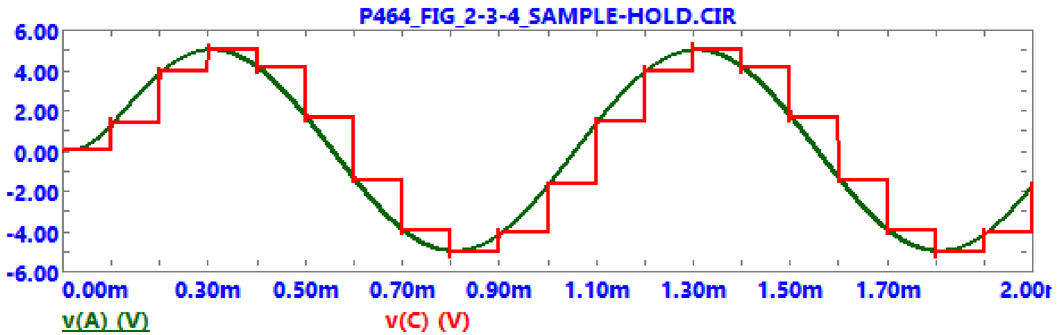
ANALOG SIGNAL

SAMPLED SIGNAL

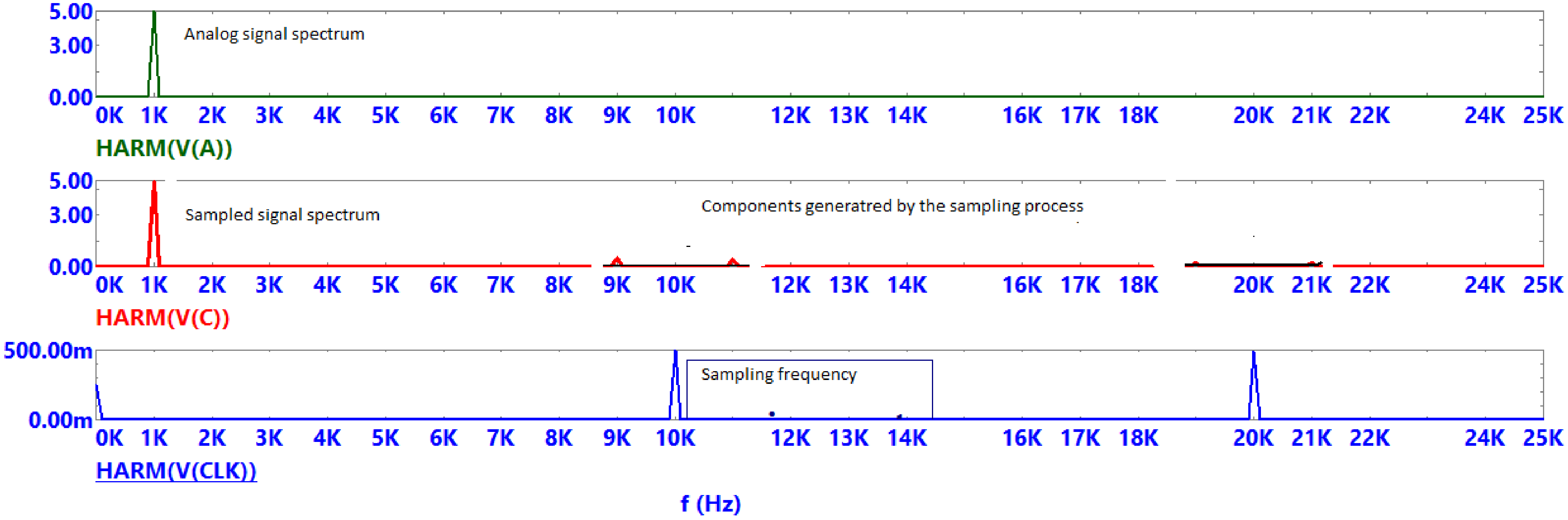


Memory circuit=
capacitor which
mantains the level of
signal constant during
the conversion (hold)





Now run simulations on Microcap to study the spectra of the signals in the sampling process



Find out the relationship between the frequency of the component generated during the sampling and

- the signal input frequency
- the sampling frequency

The relationship is

$$f_{component} = f_{sampling} \pm f_{signal}$$

Take a look at the spectrum of the sampled signal:

Can you guess what electronic device can be used to recover the original signal at the receiver?

What happens if the frequency of the input signal is increased up to 5.5 kHz?

The issue is:

Which sampling frequency
should be used to
properly recover the signal at the receiver?

This question is answered by the fundamental theorem

in DIGITAL SIGNAL PROCESSING

The NYQUIST-SHANNON sampling THEOREM

Discover more about Claude Shannon on this video

The NYQUIST-SHANNON sampling THEOREM

states that

Given a signal whose bandwidth is equal to B,

if the signal is sampled at a sampling rate greater than 1/2B

fs > 1/2B

Then it is always possible to reconstruct the original shape of the signal by interpolating its samples

If the Nyquist-Shannon thorem is not satisfied

i.e. fs < 1/2B

ALIASING

Foldover distorsion

ALIASING EFFECT