Analog - Digital Conversion

DAC   digital - to - analog conversion
ADC   analog - to - digital "

concepts: resolution & speed

Resolution is measured in no. of bits N

ex. 8-bits
$N=8$
$2^N = 2^8 = 256$ possible values

8-bit converter, with
full-scale (FS) 0 - 10V analog

digital level	Volts
00000000	0.000 V
00000001	0.039 V
00000010	0.078 V
⋮	
11111111	10.000 V

given an analog voltage
the converter will choose the nearest
discrete value

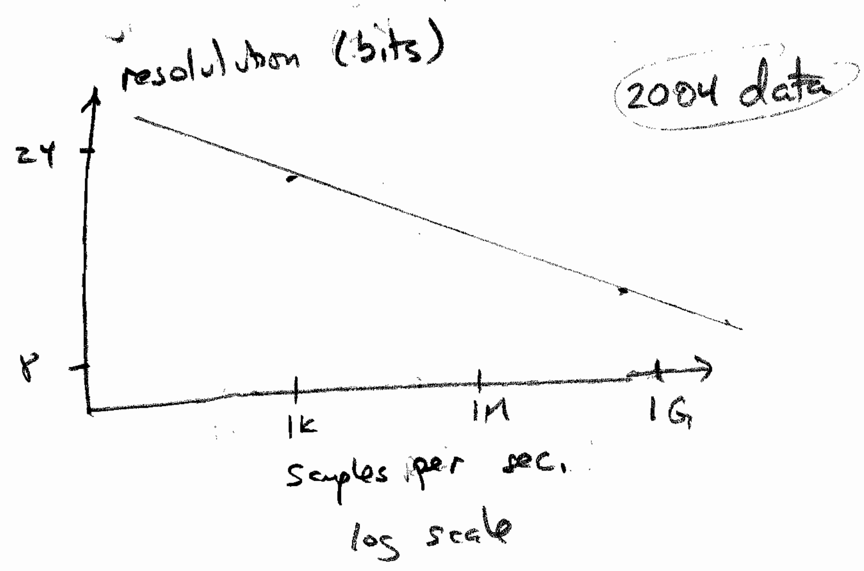
e.g. in example above,
an actual analog voltage of 0.0433V
is approximated as 0.039 V.

<u>Speed</u> is measured in <u>Sample Rate</u>.

e.g. multimeter $\approx 10^5$ samples/sec

digital scope $\approx 10^9$ " "

<u>Tradeoff</u> Faster conversion vs. high resolution



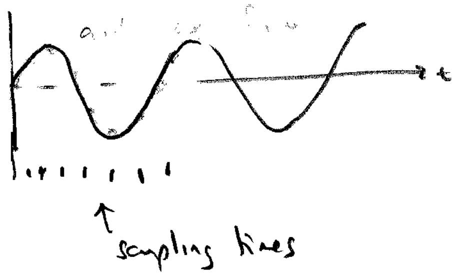
concept: aliasing & Nyquist frequency

Sampling Theorem

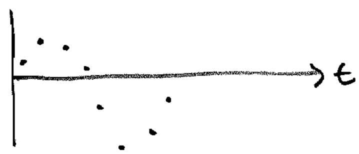
If your input signal is periodic at freq. f, you need a sample rate at least as fast as the Nyquist frequency $f_{Nyquist} = 2f$, to reconstruct the signal.

ex to record audio with a bandwidth up to 20 kHz, you must have sample rate $\geq 40k$ samples per sec.

oversampling: sample rate $\gg f_{Nyquist}$

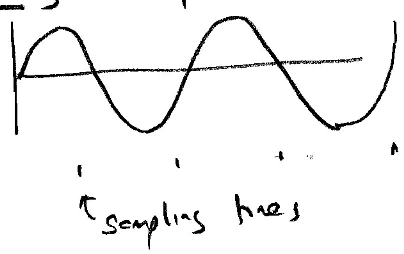


analog input



what is recorded by ADC

undersampling sample rate < $f_{Nyquist}$

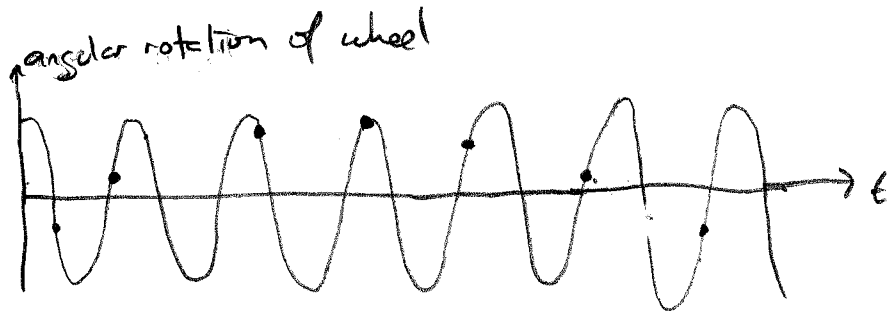


what is recorded by ADC

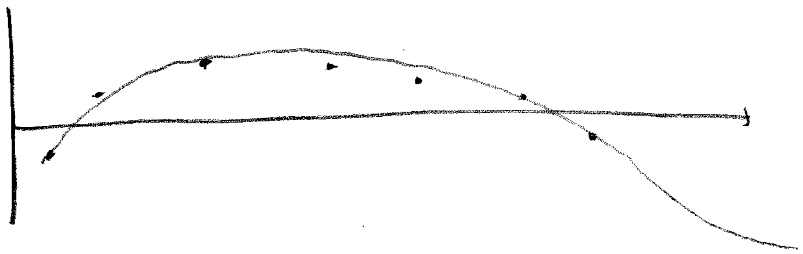
<u>aliasing</u>

an artificial oscillation due to sampling slower than Nyquist freq.

<u>ex</u>: TV 30 images per second $\Rightarrow f_{Nyq} = 15$ Hz
wheel rotation at 16 Hz



what you see - a 1 Hz rotation



google:

video: frame aliasing
propellers

images: aliasing