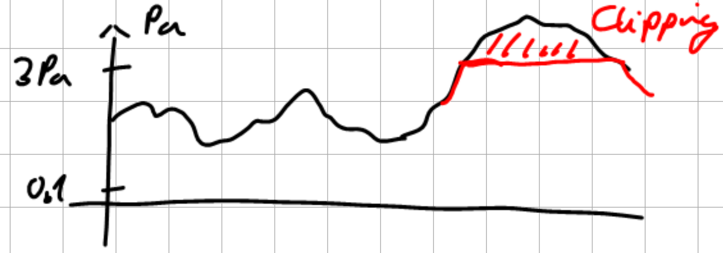
Clipping

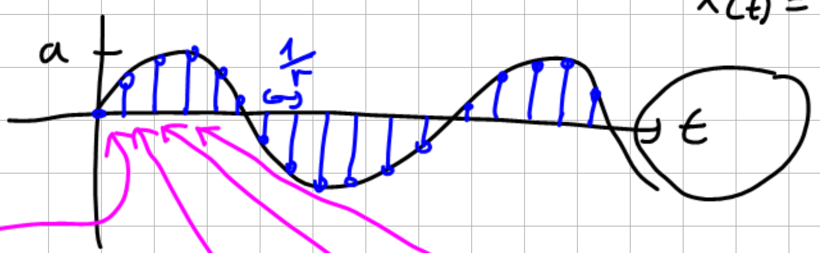
Sensors have some rang of input signals.

e.g. Pressure Sensor 0.1 Pa ... 3 Pa



Sampling rate

analogue
$x(t) = a \cdot \sin(2\pi f t)$

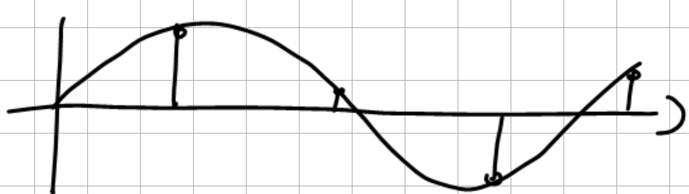


wideband audio $r = 16000$ Hz $\Rightarrow \frac{1}{r} = \frac{1}{16000}s = 0.0625 \cdot 10^{-3}s$
$= 62.5\ \mu s$

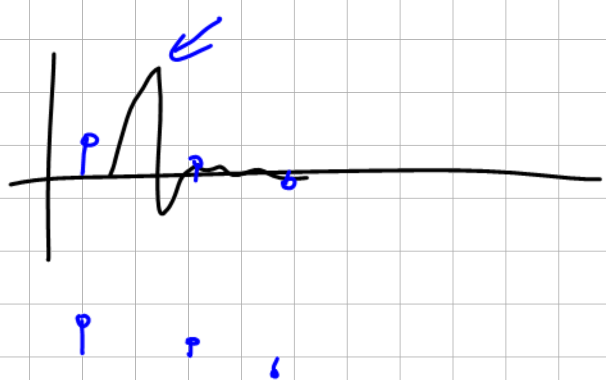
$x_d(n) = [0, 0.3, 0.4, 0.5, \dots]$

$t_d(n) = [0, \frac{1}{r}, \frac{2}{r}, \frac{3}{r}, \dots]$

Sampling theorem (system theory)



Slow changing signals can be sampled with small r



Sampling theorem:

analogue input signal $x(t)$ with upper frequency f_c:

$r \geq 2 \cdot f_c$

e.g. speech $f_c = 7000\,Hz$

$\Rightarrow r \geq 14000\,Hz$

App Phyphox

Units and dB

dB SPL

$\underbrace{\text{dB}}_{\text{Logarithmic}}\ \underbrace{\text{SPL}}_{}$

„Unit"
→ defines the reference value

e.g. dB SPL : $L = 20 \log_{10} \frac{P_{RMS}}{20\,\mu Pa}$

dB_m : $L = 10 \log_{10} \frac{P}{1\,mW}$

dB FS : $L = 10 \log_{10} \frac{P}{\frac{A^2}{2}}$

$\xrightarrow{x} (a) \xrightarrow{y}$

75 dB_m 135 dB_m

$a \mathrel{\hat{=}} 60\,dB$ (?)

$75\,dB_m = 10 \log_{10} \frac{P}{1\,mW}$

$P = 10^{\frac{75}{10}} \cdot 10^{-3}\,W$

$= 10^{4.5}\,W =$

$31.6\,kW$

$31.6\,kW \rightarrow a \rightarrow 31.6\,GW$

$31.6\,GW = \underbrace{10^6}_{a} \cdot 31.6\,kW$

$a \mathrel{\hat{=}} 60\,dB$

$135\,dB_m = 10 \log_{10} \frac{P}{1\,mW}$

$P = 10^{\frac{135}{10}} \cdot 10^{-3}\,W$

$= 31.6\,GW$

Calibration

90 dB SPL $\hat{=}$ 0 dB FS

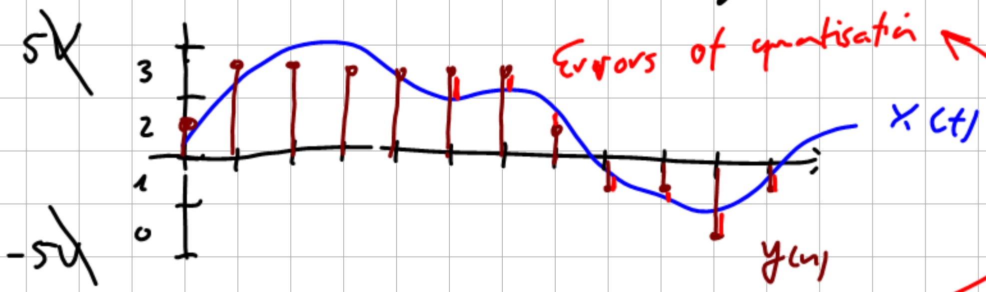
$\Rightarrow a$

$L_{dB\,FS} = a + L_{dB\,SPL} \Rightarrow a = -90\,dB$

Quantisation

$w = 2$ Bit Bit = Binary Unit

$\Rightarrow$ 4 Values digital world



$y(n) = x(n) +$ quantisation noise

$A = 5$ Overload Point $\hat{=}$ Maximum Magnitude

$w = 2$

$$P_e = \frac{\Delta^2}{12} = 0.521 \quad \text{Power of quantisation noise}$$

$$\Delta = \frac{2A}{2^w} = \frac{10}{2^2} = 2.5$$

Dithering: adding artificial noise at the level of quantisation noise.

$\Rightarrow$ robustness of dB FS against digital zeros.

C2 J1 T2

dB SPL magnitude 0.1 Pa sinus

$$L = 20 \log_{10} \frac{\text{RMS}}{20\,\mu\text{Pa}}$$

$$\text{RMS} = 0.707 \cdot 0.1\,\text{Pa} = \frac{0.1\,\text{Pa}}{\sqrt{2}}$$

$$L = 20 \cdot \log_{10} \frac{0.1\,\cancel{\text{Pa}}}{\sqrt{2}\;\; 20 \cdot 10^{-6}\,\cancel{\text{Pa}}} = 70.969$$

$$= 71.0 \text{ dB SPL}$$

L in dB FS : $L = 10 \log_{10} \frac{2 \cdot P}{A^2}$

$x[n] = \frac{1}{4} \sin(\ldots)$

magnitude

$$RMS = \frac{\frac{1}{4}}{\sqrt{2}} = \frac{1}{\sqrt{2} \cdot 4} = 0.176$$

$$P = 0.176^2 = 0.0310$$

$$L = 10 \log_{10} \frac{2 \cdot 0.0310}{1^2} = -12.07$$

$$= -12.1 \text{ dB FS}$$

$a = ?$

$= \text{dB FS} - \text{dB SPL}$

$= -12.1 - 71 = -83.1$