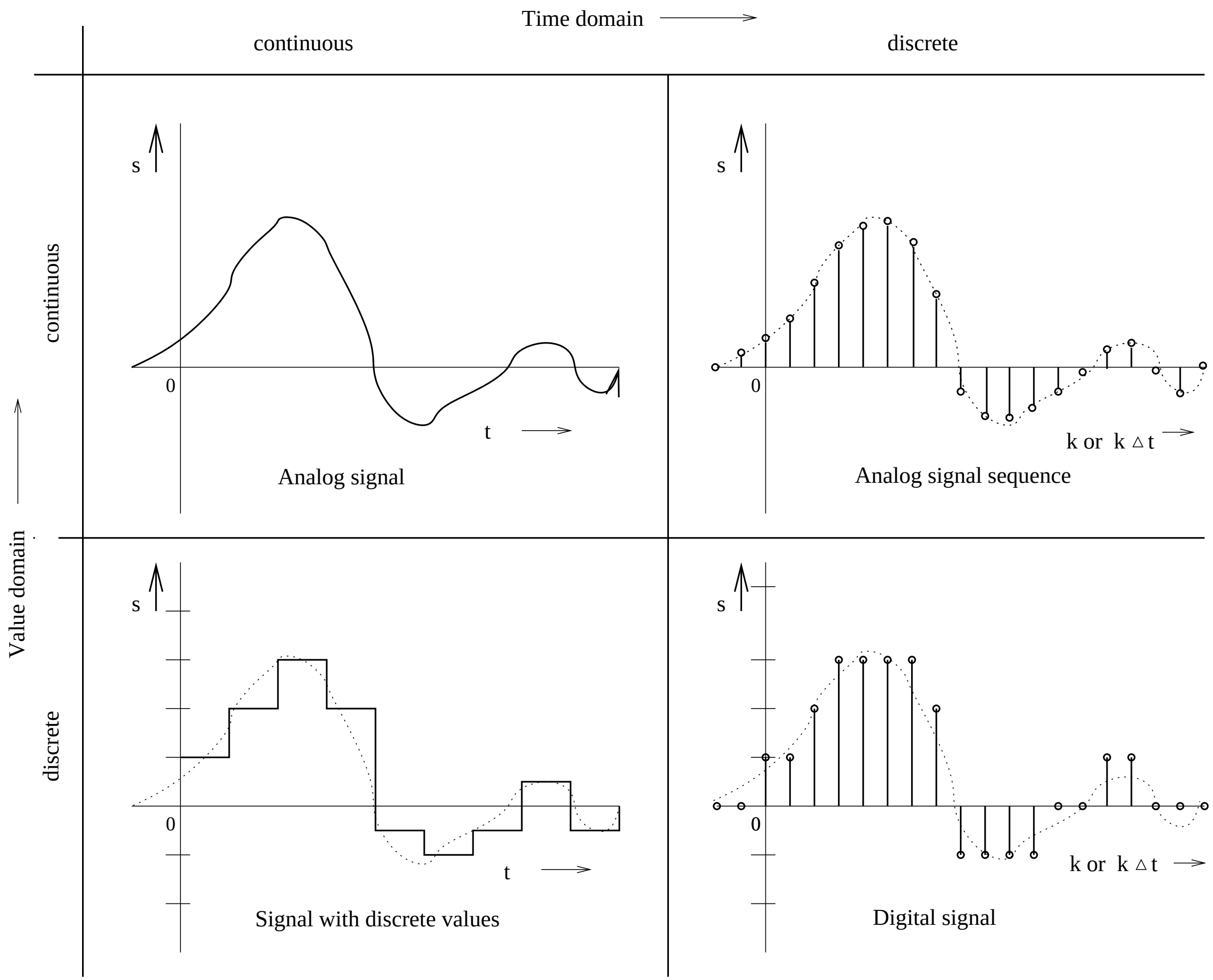
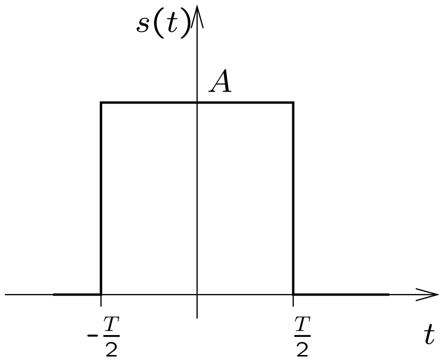
Seminar “Signals and Systems 1”

Seminar Theme 2:
“Signals in the Time- and Frequency Domain”

1. Properties of Signals in Time- and Frequency Domain
2. Sampling and Quantisation of Analog Signals

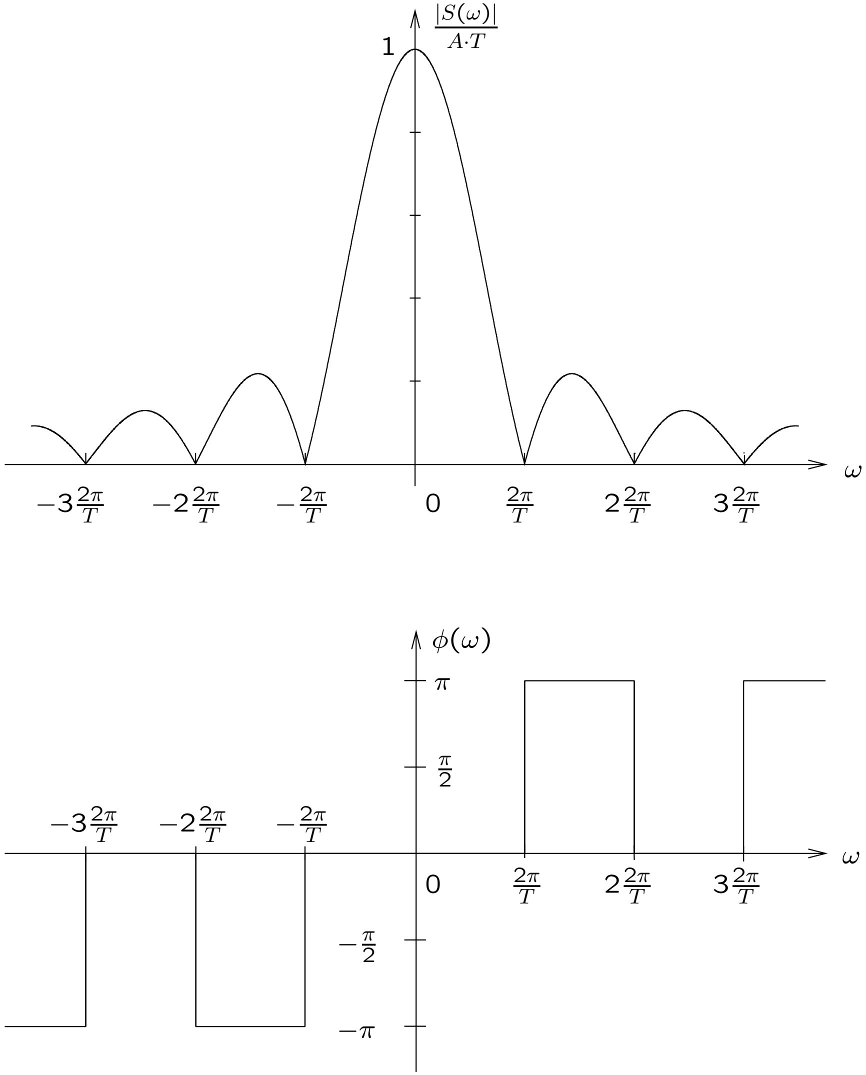

Time domain
continuous
discrete
Value domain
continuous
discrete
s
0
t
Analog signal
s
0
k or k △ t
Analog signal sequence
s
0
t
Signal with discrete values
s
0
k or k △ t
Digital signal



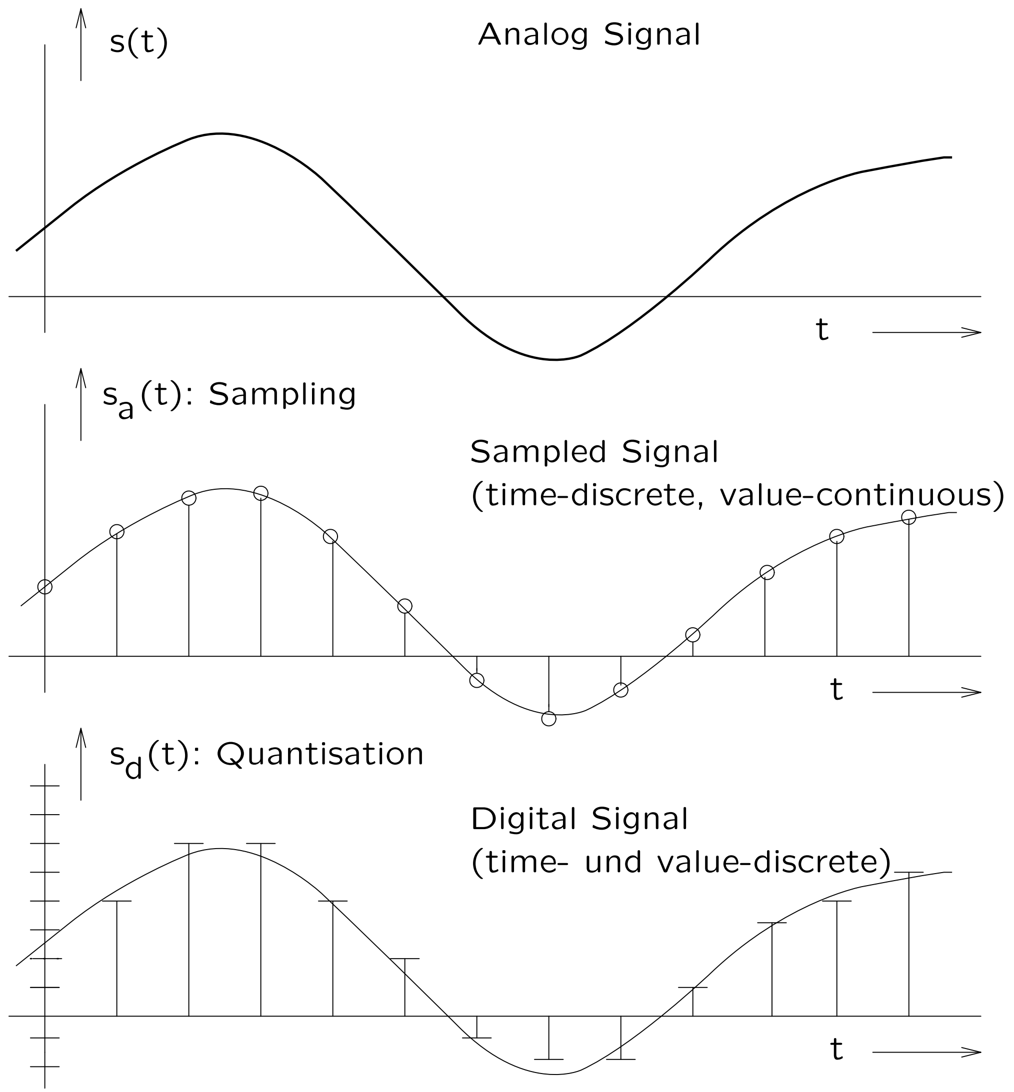
$$s_p(t) = \sum_{n=-\infty}^{\infty} s(t - nT_0), \quad \text{where} \quad T \leq T_0$$

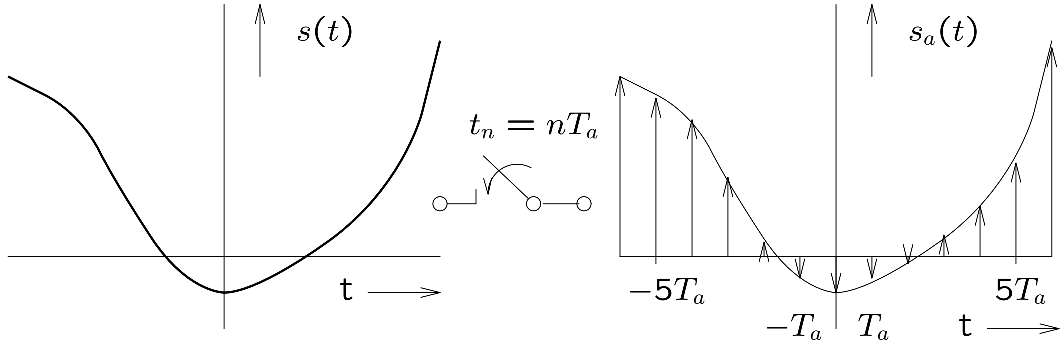
$$= \sum_{n=-\infty}^{+\infty} c_n e^{jn\omega_0 t} \quad \text{with } c_n = \frac{1}{T_0} \int_{\frac{T_0}{2}}^{\frac{T_0}{2}} s(t) e^{-jn\omega_0 t} dt, \quad \omega_0 = \frac{2\pi}{T_0}$$

$$S(\omega) = \int_{-\infty}^{+\infty} s(t)\, e^{-j\omega t} dt = \int_{-\frac{T_0}{2}}^{+\frac{T_0}{2}} s(t)\, e^{-j\omega t} dt$$

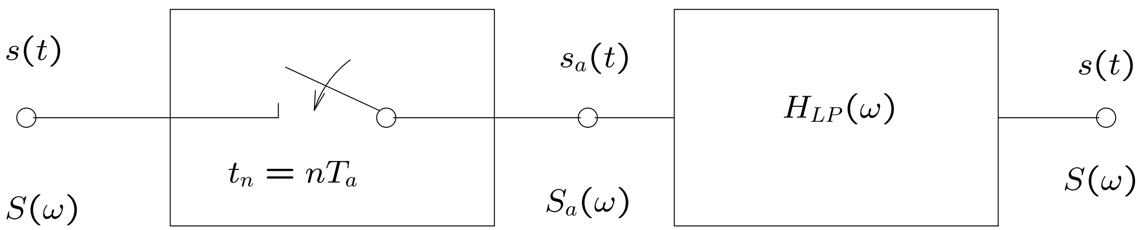


$\frac{|S(\omega)|}{A \cdot T}$
1
ω
$-3\frac{2\pi}{T}$
$-2\frac{2\pi}{T}$
$-\frac{2\pi}{T}$
0
$\frac{2\pi}{T}$
$2\frac{2\pi}{T}$
$3\frac{2\pi}{T}$
$\phi(\omega)$
π
$\frac{\pi}{2}$
$-3\frac{2\pi}{T}$
$-2\frac{2\pi}{T}$
$-\frac{2\pi}{T}$
ω
0
$\frac{2\pi}{T}$
$2\frac{2\pi}{T}$
$3\frac{2\pi}{T}$
$-\frac{\pi}{2}$
$-\pi$


s(t)
Analog Signal
t
$s_a(t)$: Sampling
Sampled Signal
(time-discrete, value-continuous)
t
$s_d(t)$: Quantisation
Digital Signal
(time- und value-discrete)
t



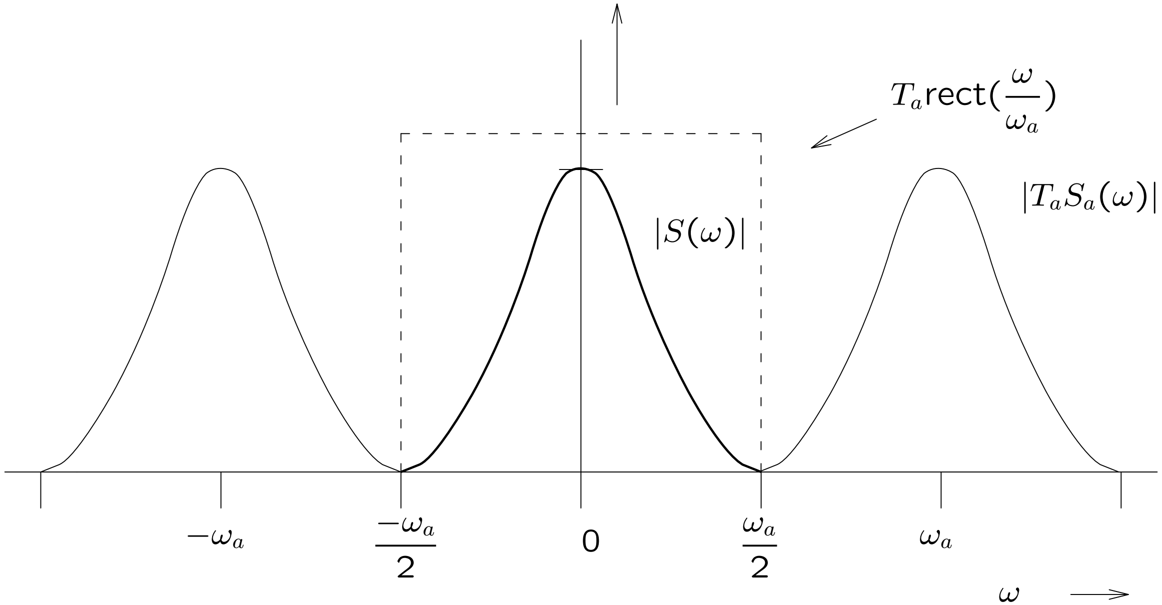
$s(t)$
t
$t_n = nT_a$
$s_a(t)$
$-5T_a$
$5T_a$
$-T_a$
T_a
t



$$s_{\mathrm{a}}(t) = s(t) \cdot \sum_{n=-\infty}^{\infty} \delta\left(t - nT_{\mathrm{a}}\right) = \sum_{n=-\infty}^{\infty} s\left(nT_{\mathrm{a}}\right) \delta\left(t - nT_{\mathrm{a}}\right)$$

$$S_a(\omega) = \frac{1}{T_a} \cdot S(\omega) * \sum_{n=-\infty}^{\infty} \delta(\omega - n\omega_a)$$

$$H_{LP}(\omega) = \begin{cases} T_a & |\omega| \le \omega_g \\ 0 & \text{else} \end{cases} ,$$


$T_a \text{rect}(\frac{\omega}{\omega_a})$
$|T_a S_a(\omega)|$
$|S(\omega)|$
$-\omega_a$
$\frac{-\omega_a}{2}$
0
$\frac{\omega_a}{2}$
ω_a
ω