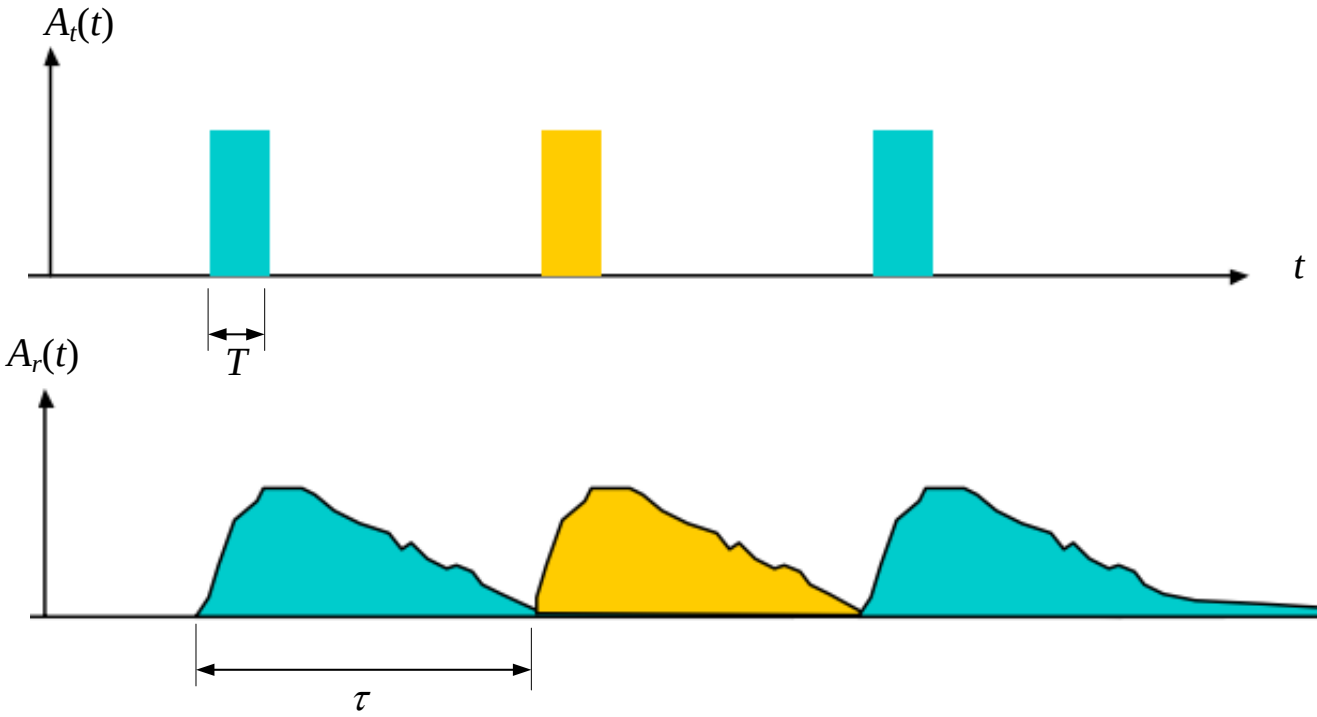
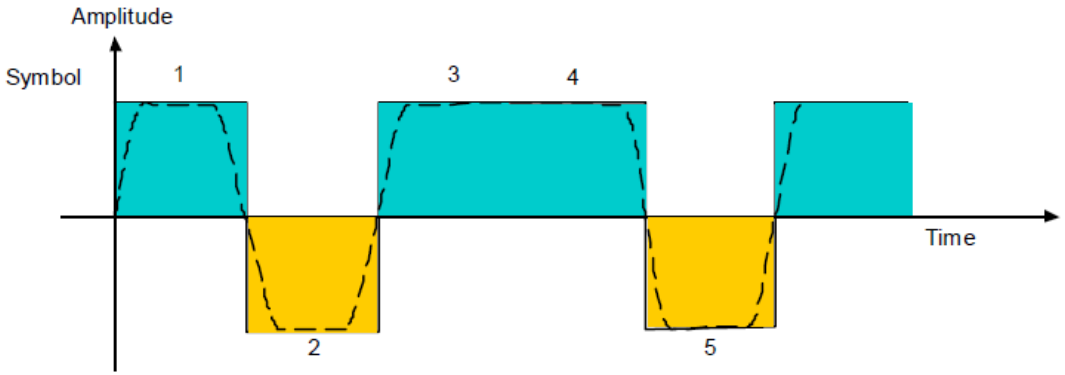
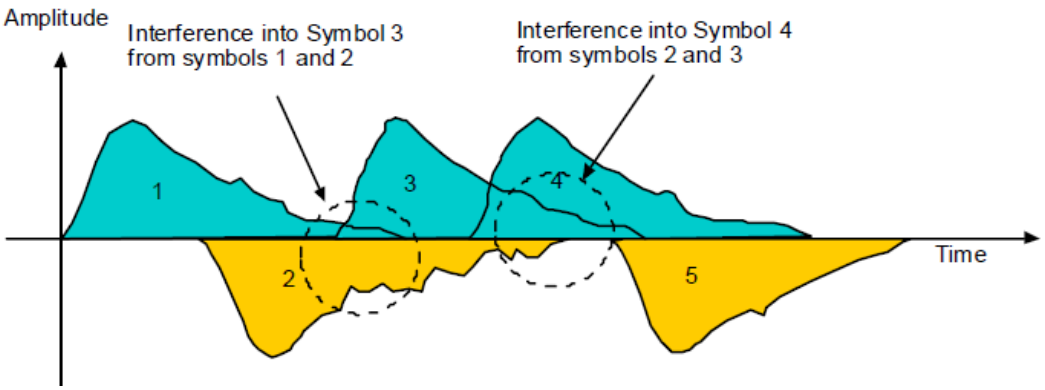
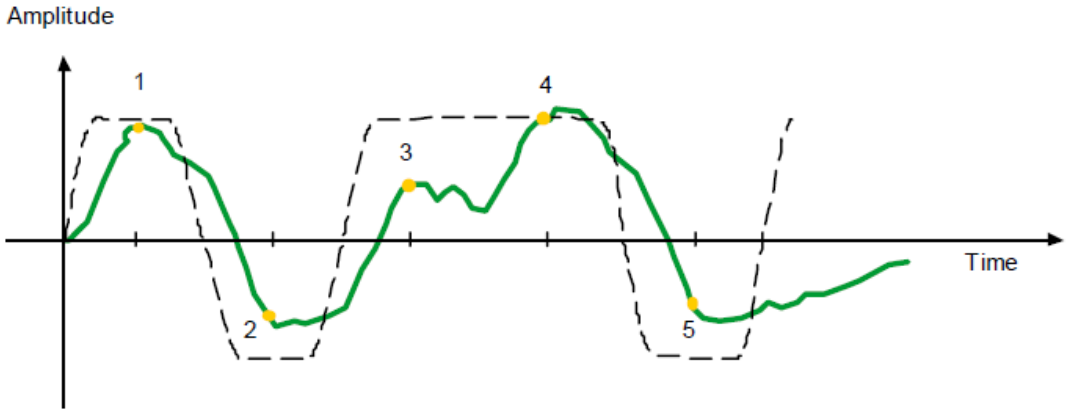


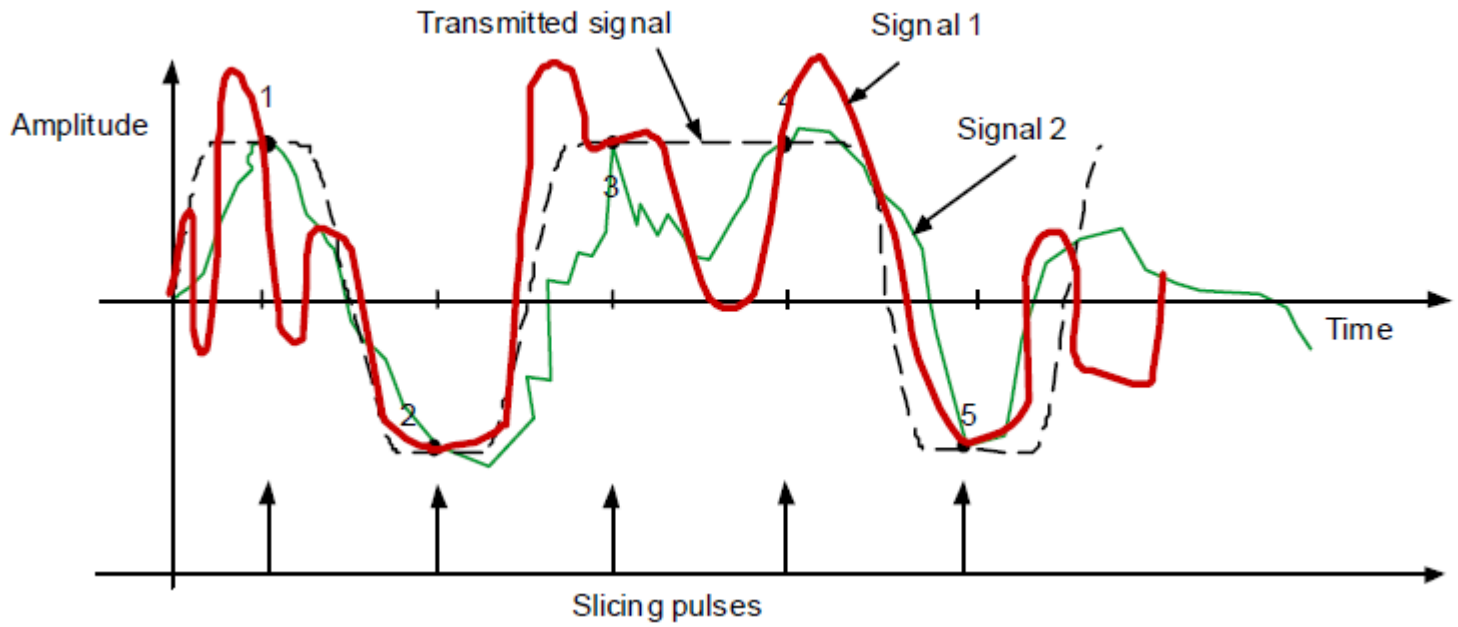
a)

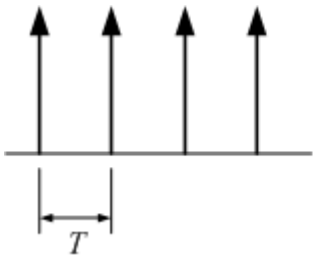
b)


Amplitude
Symbol
1
3
4
2
5
Time

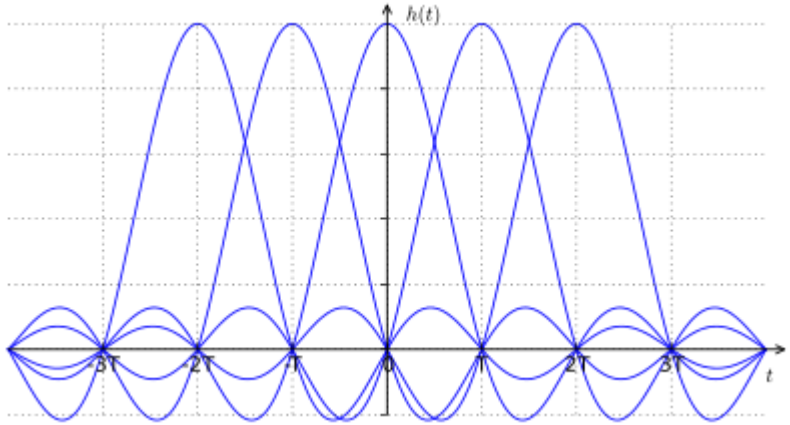

Amplitude
Interference into Symbol 3
from symbols 1 and 2
Interference into Symbol 4
from symbols 2 and 3
1
3
4
2
5
Time


Amplitude
1
4
3
2
5
Time


Transmitted signal
Signal 1
Signal 2
Amplitude
Time
Slicing pulses
1
2
3
4
5

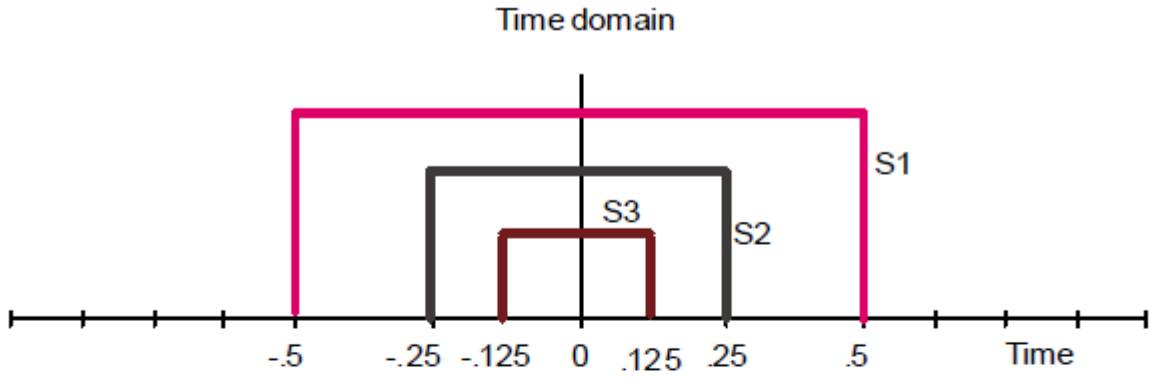


Nyquist filter

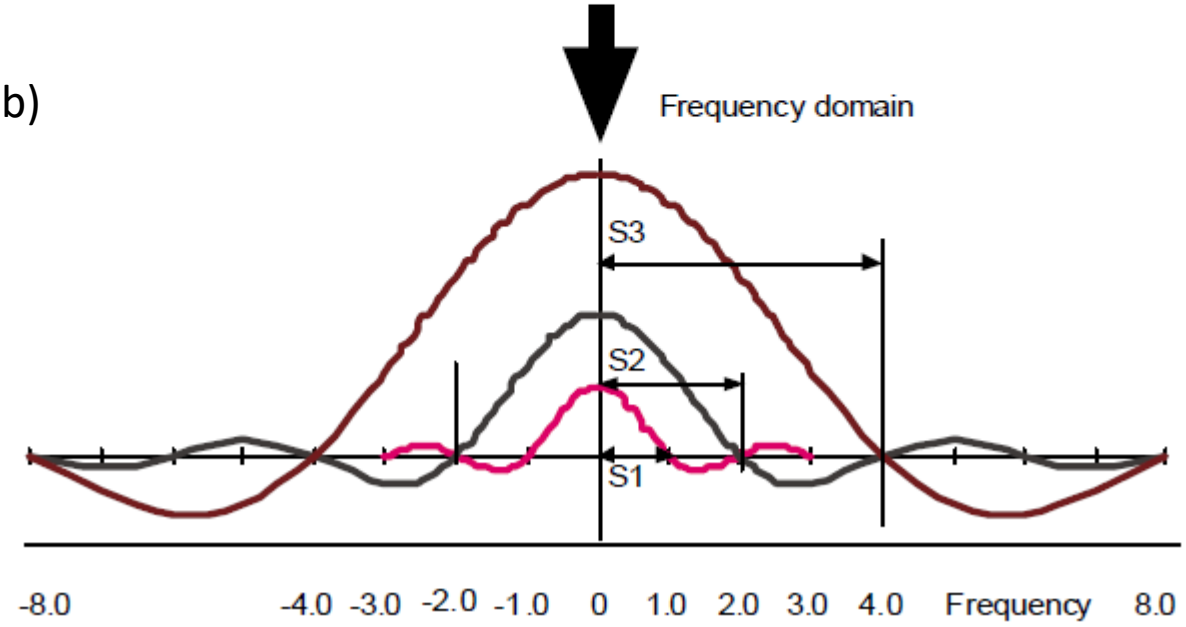


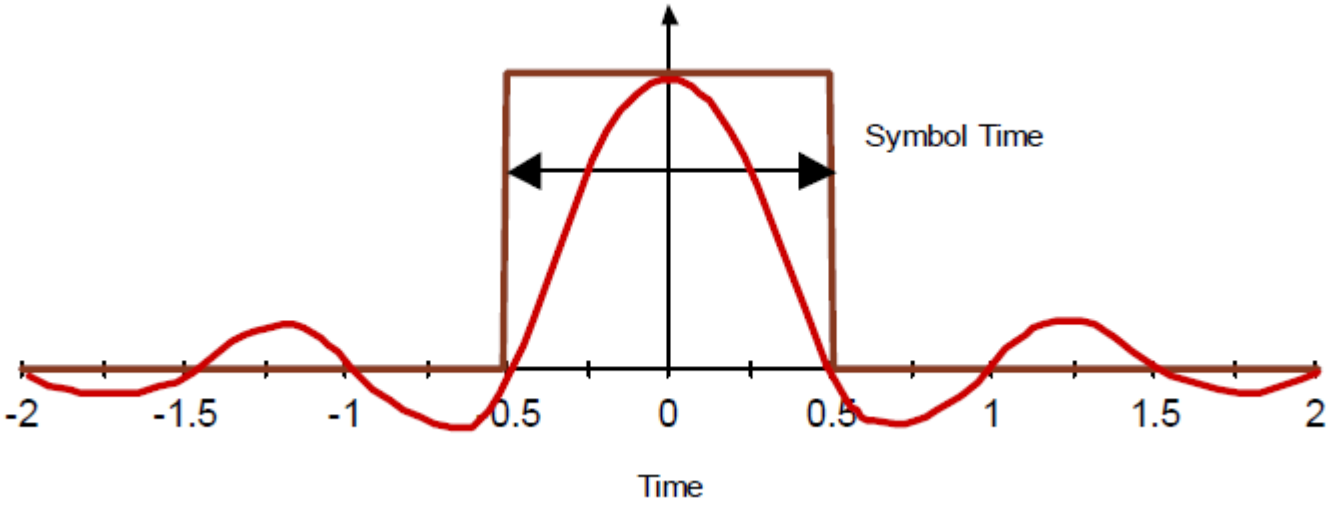
no ISI

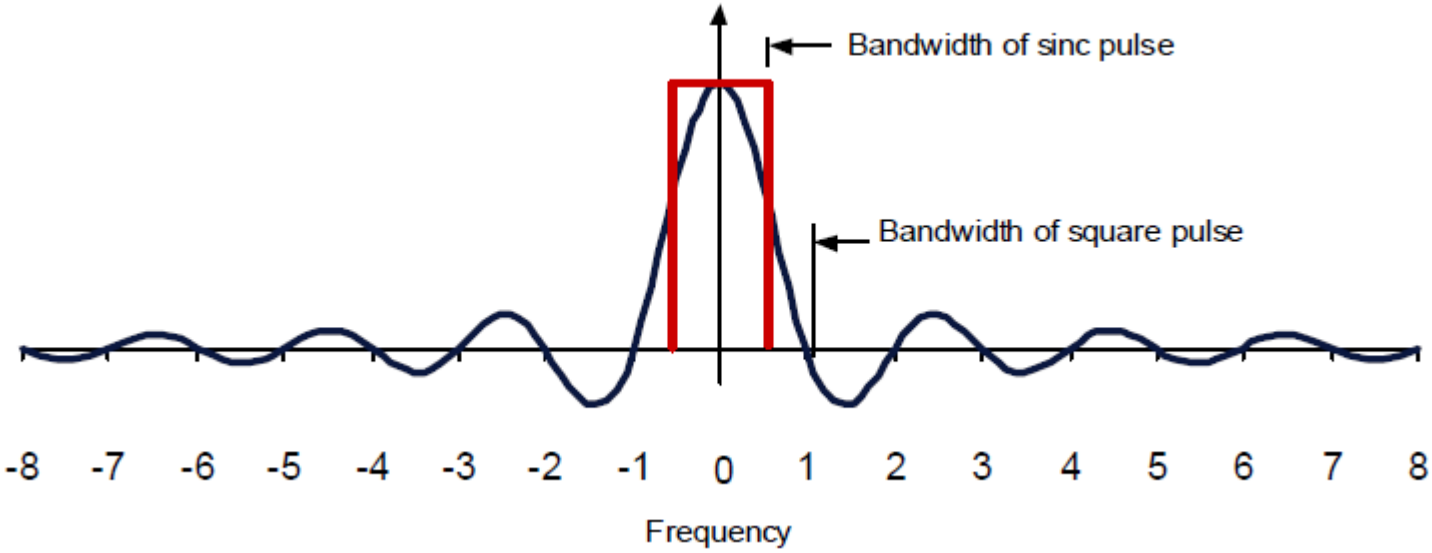
a)


Time domain
S1
S3
S2
-.5
-.25
-.125
0
.125
.25
.5
Time

b)


Frequency domain
S3
S2
S1
-8.0
-4.0
-3.0
-2.0
-1.0
0
1.0
2.0
3.0
4.0
Frequency
8.0


Symbol Time
-2
-1.5
-1
0.5
0
0.5
1
1.5
2
Time


Bandwidth of sinc pulse
Bandwidth of square pulse
-8
-7
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
7
8
Frequency

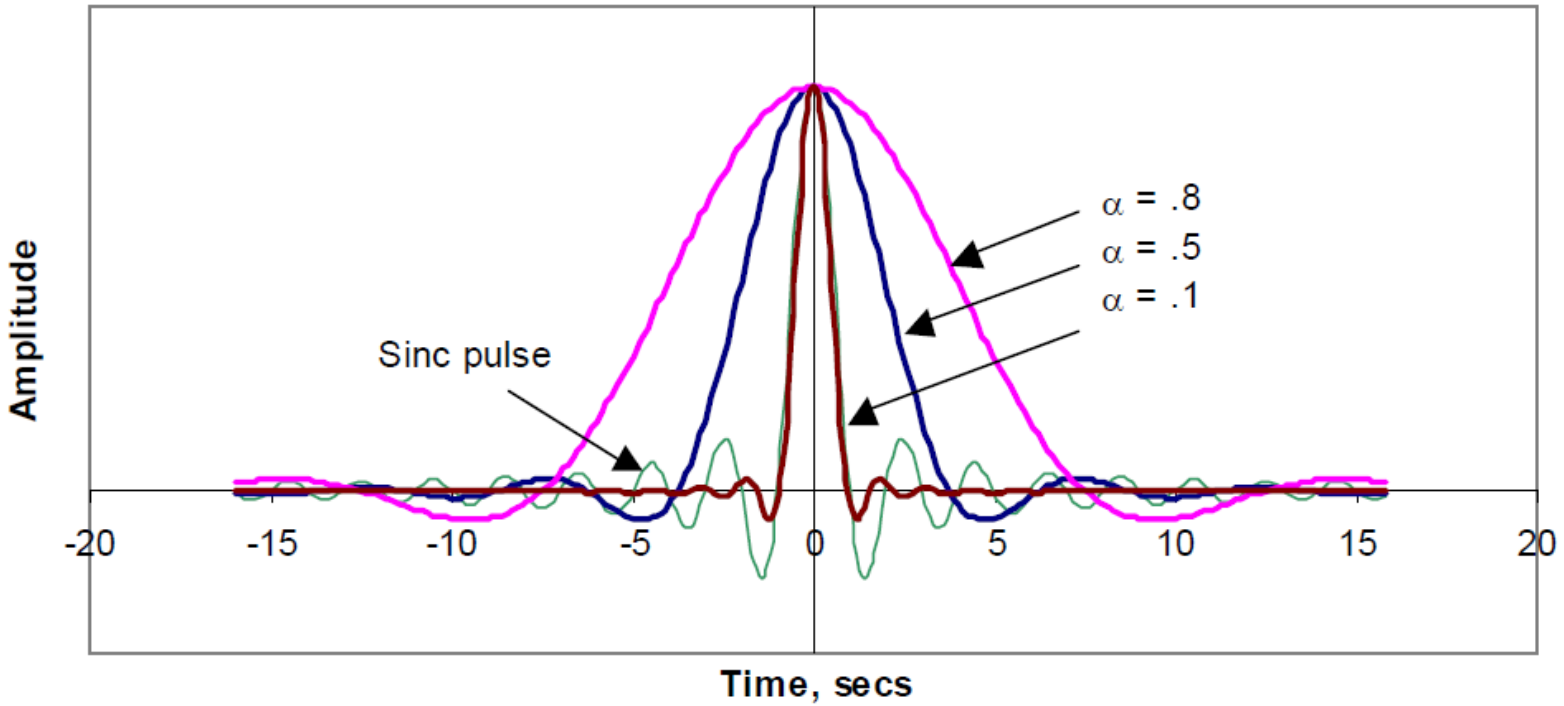
RCF:

cos part significantly reduces the decay of the signal amplitude.

$$h(t) = \frac{\sin(\pi t / T_s)}{\pi t / T_s} \frac{\cos(\pi \rho t)}{1 - (2\rho t / T_s)^2}$$

sinc pulse ensures zero crossings in integer multiples of the modulation rate (the advantage is easy recovery of the clock signal (synchronization) on the receiver side)

$$H(f) = \begin{cases} 1 & |f| < 2W_0 - W \\ \cos^2\left\{\frac{\pi}{4} \frac{|f| + W - 2W_0}{W - W_0}\right\} & 2W_0 - W < |f| < W \\ 0 & |f| > W \end{cases}$$



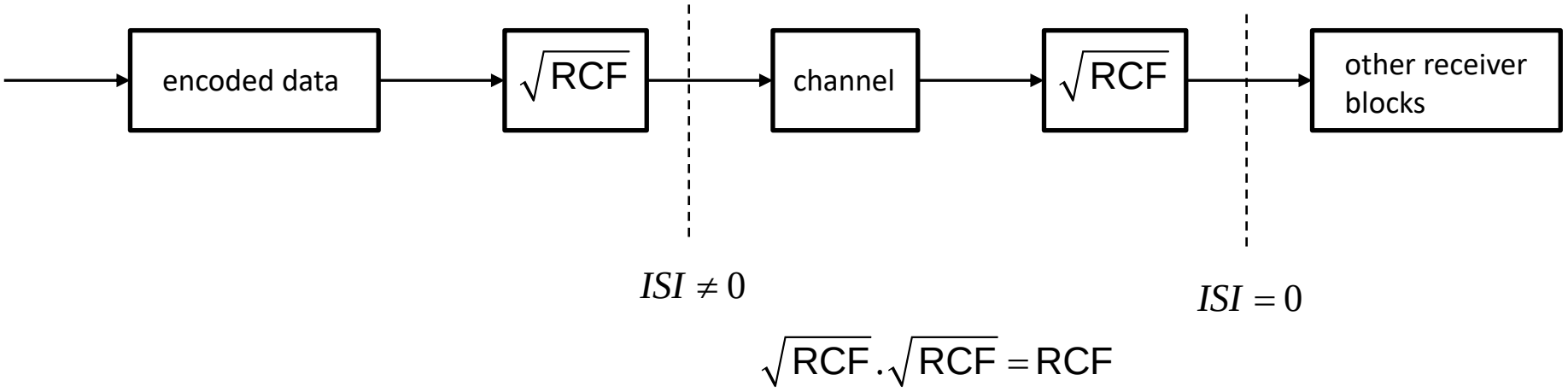
Roll – off factor (is denoted also α) and is defined for baseband: $\rho = \frac{W - W_0}{W_0}$ $\rho \in \langle 0,1 \rangle$

Roll – off factor enables to define a real system bandwidth W :

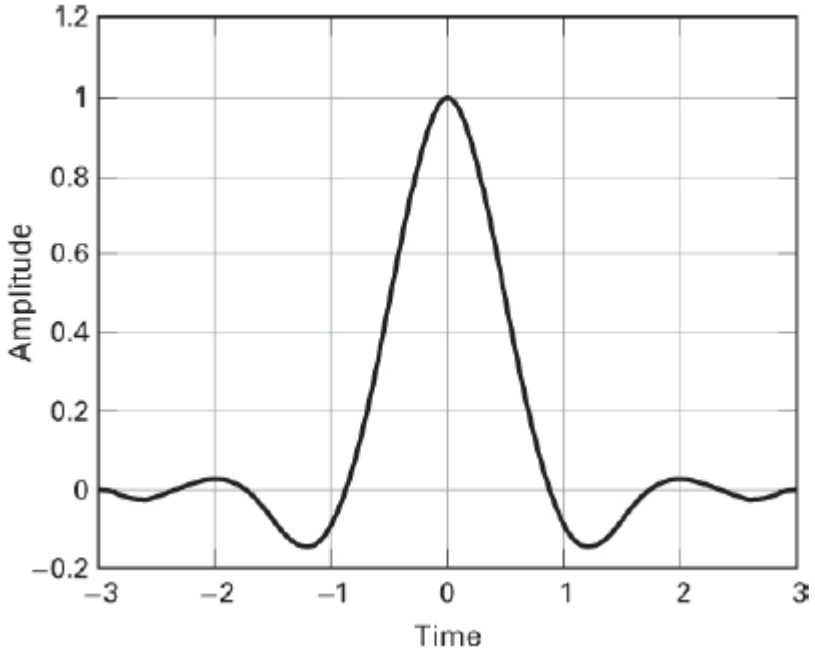
BB: $W = \frac{1}{2}(1+\rho)R_S$

BP: $W = (1+\rho)R_S$

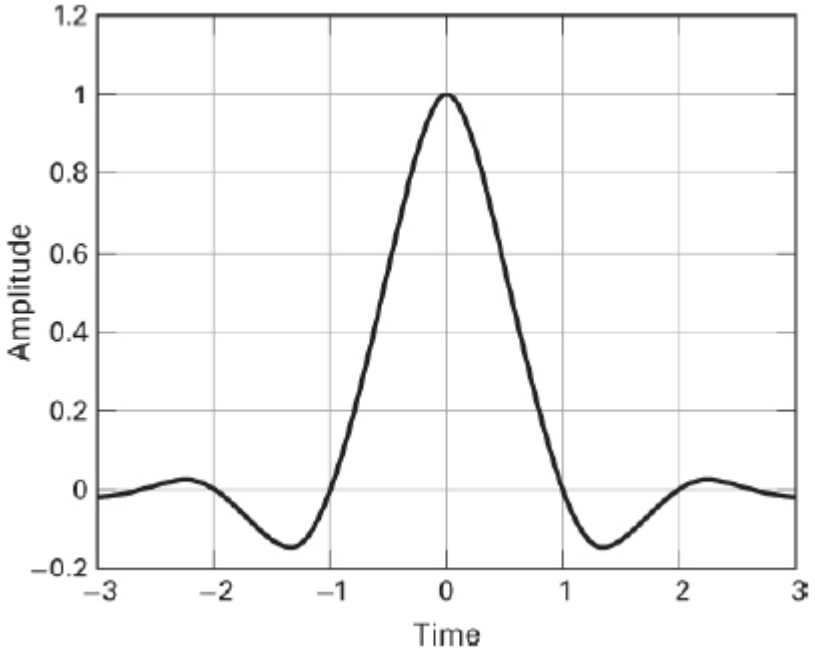
RRCF realization



$$\sqrt{\text{RCF}}.\sqrt{\text{RCF}} = \text{RCF}$$



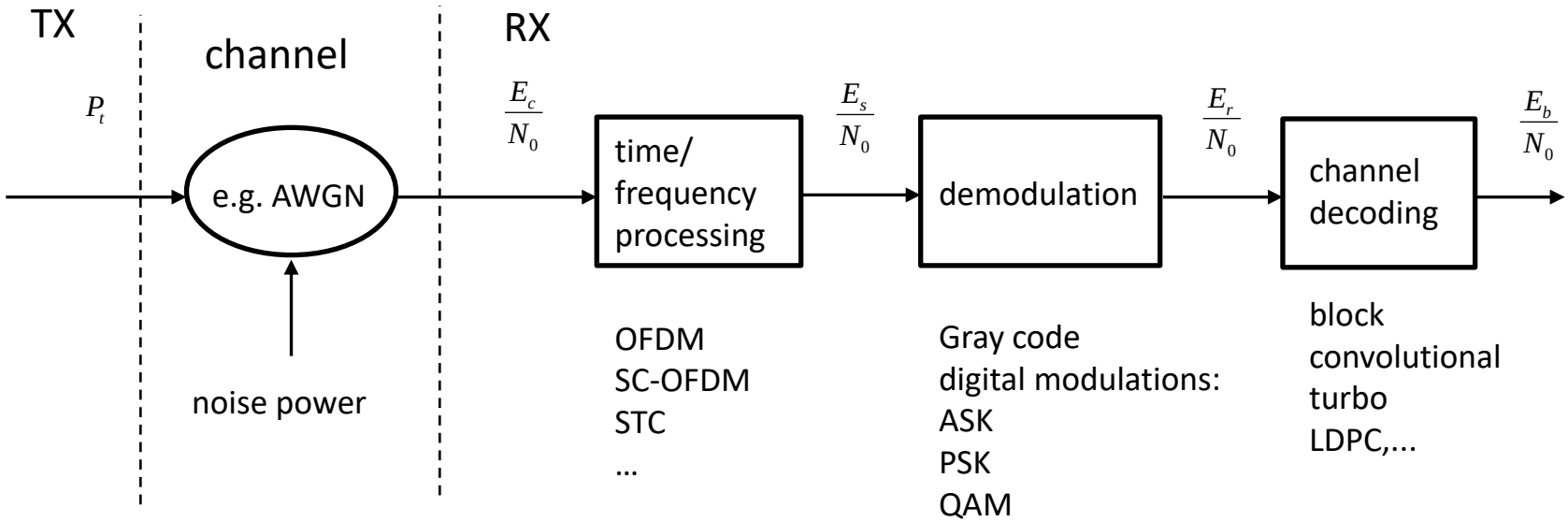
RRCF pulse



RCF pulse

source: B. Sklar, F. Harris: Digital Communications

SNR



$\frac{E_x}{N_0}$ - normalized SNR at:

bit level: $\frac{E_b}{N_0}$

code level: $\frac{E_r}{N_0}$

symbol level: $\frac{E_s}{N_0}$

chip level: $\frac{E_c}{N_0}$