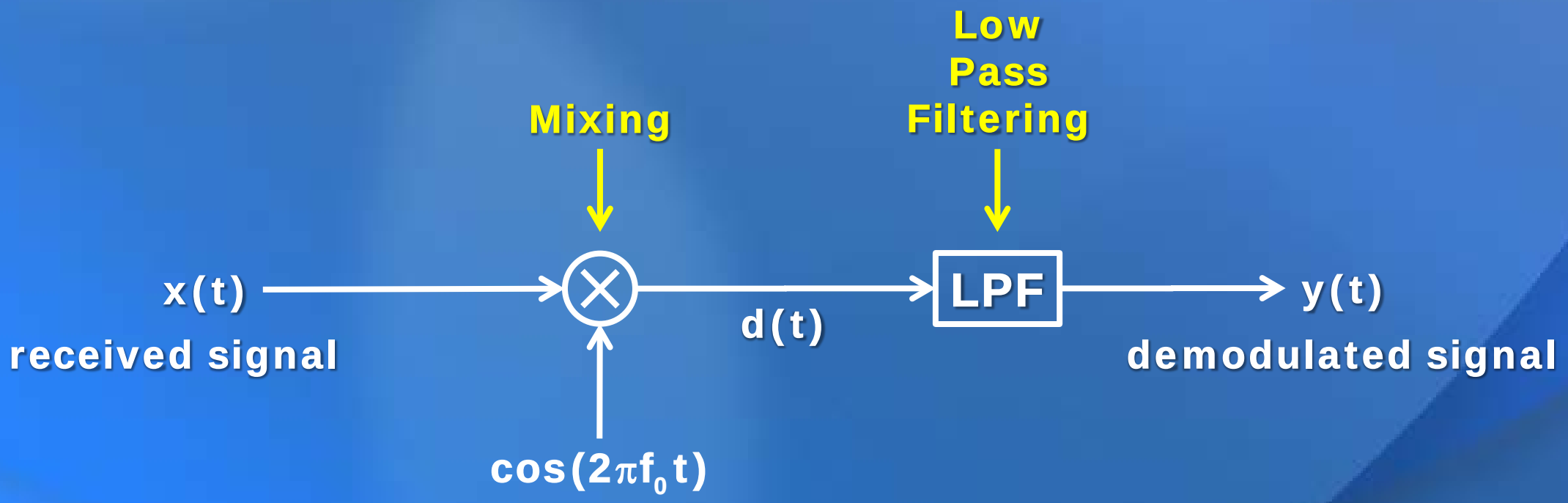
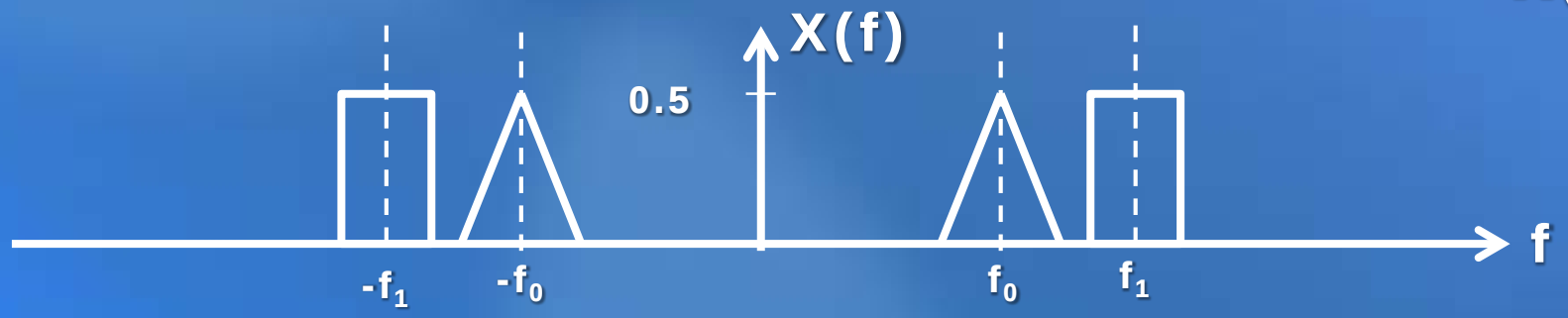
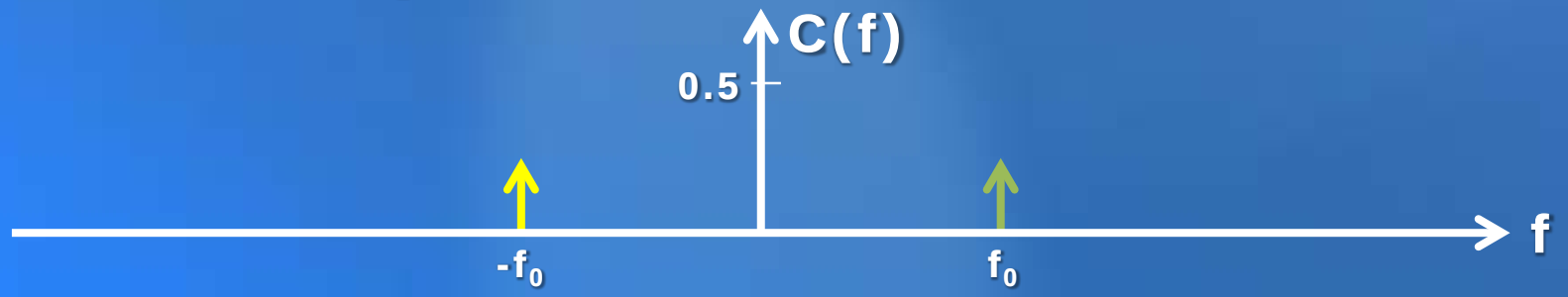
Filtering

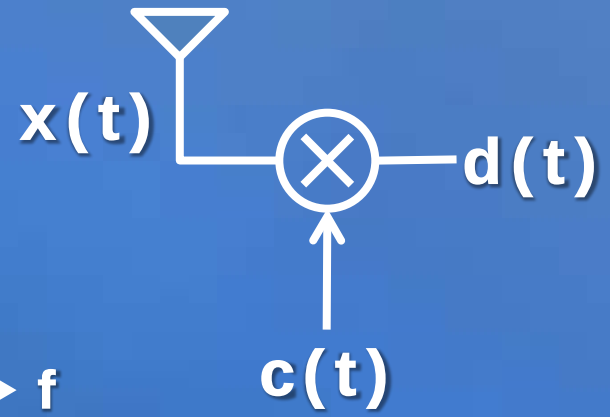
Demodulation



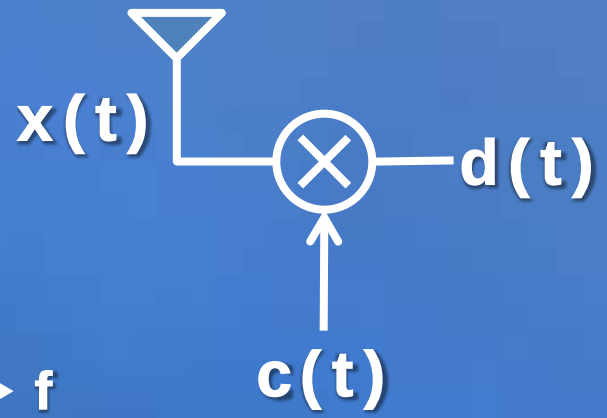
Mixing

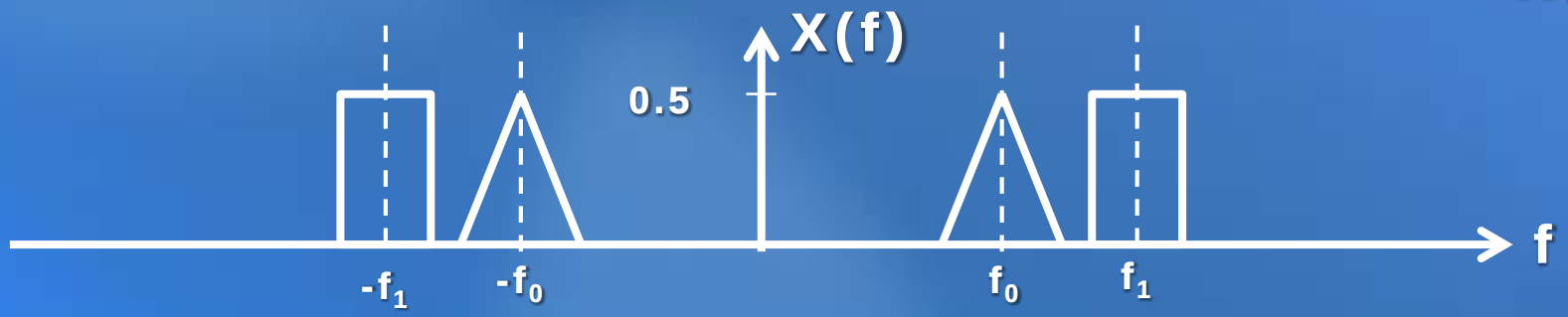


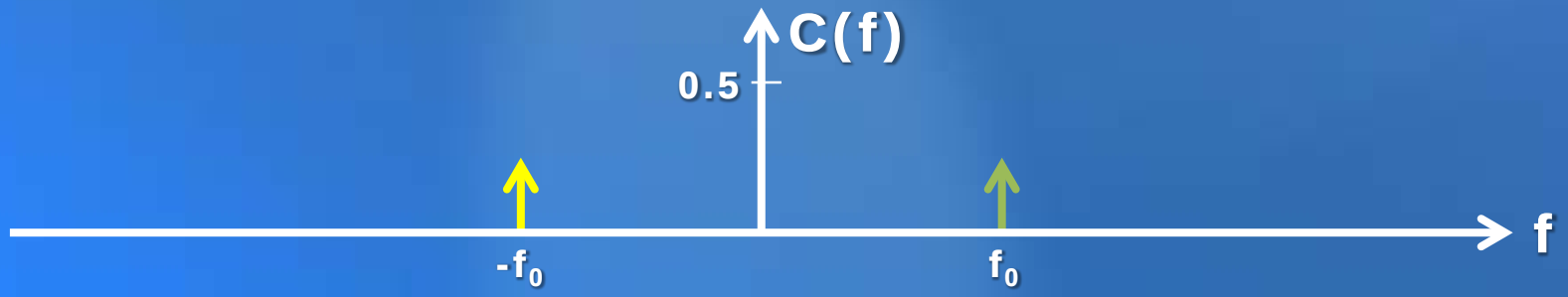


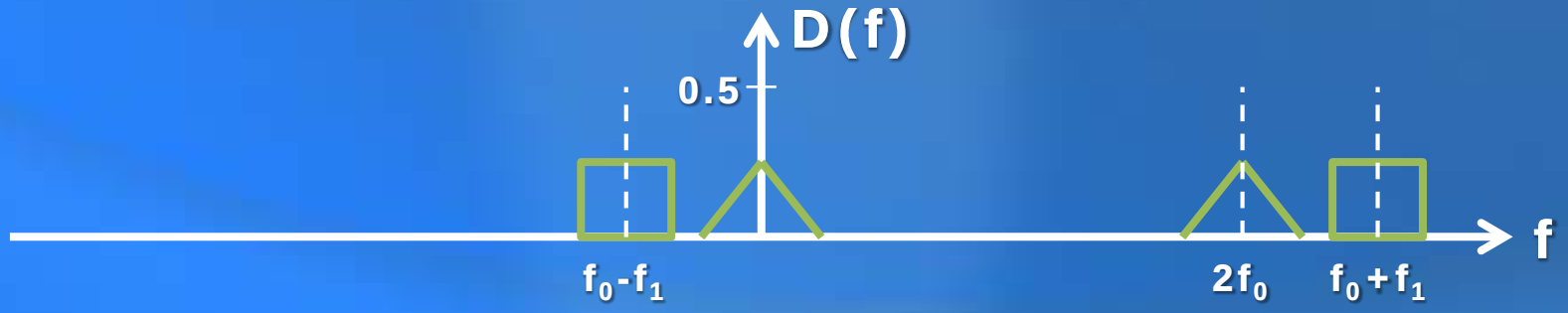


Mixing

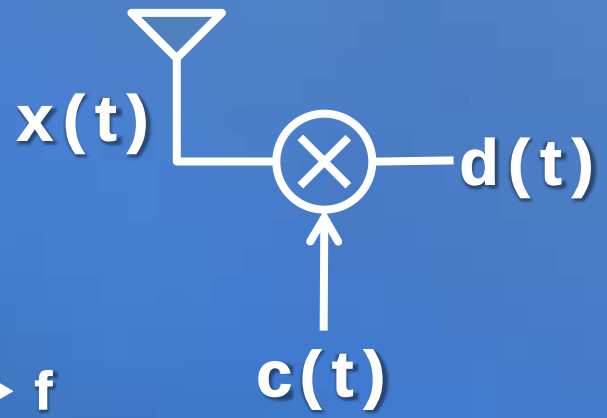


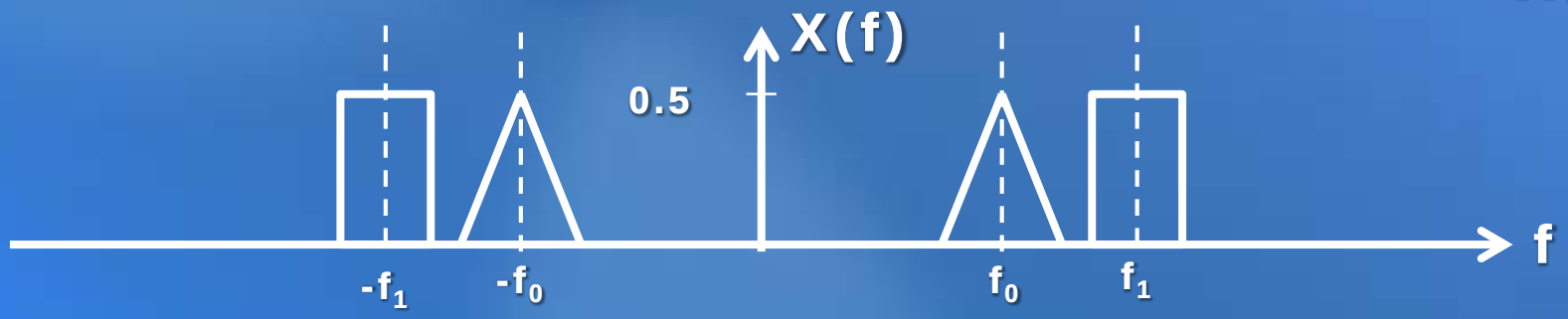


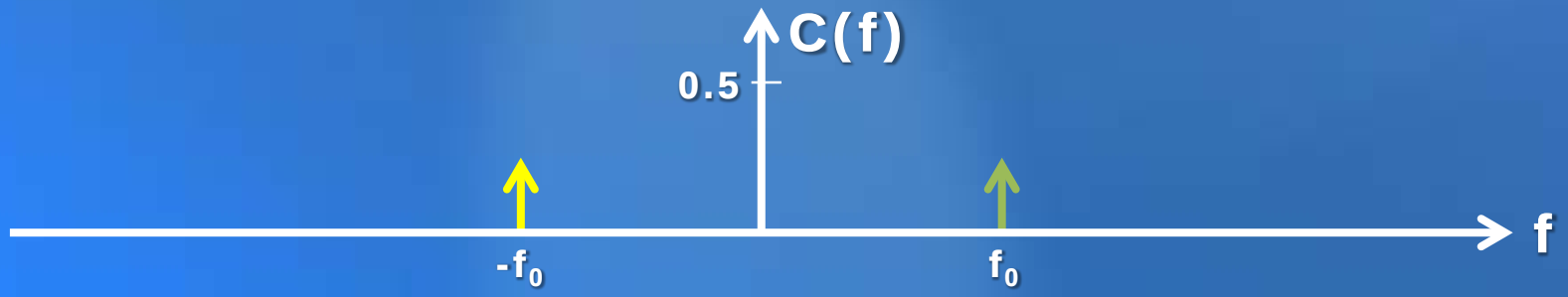


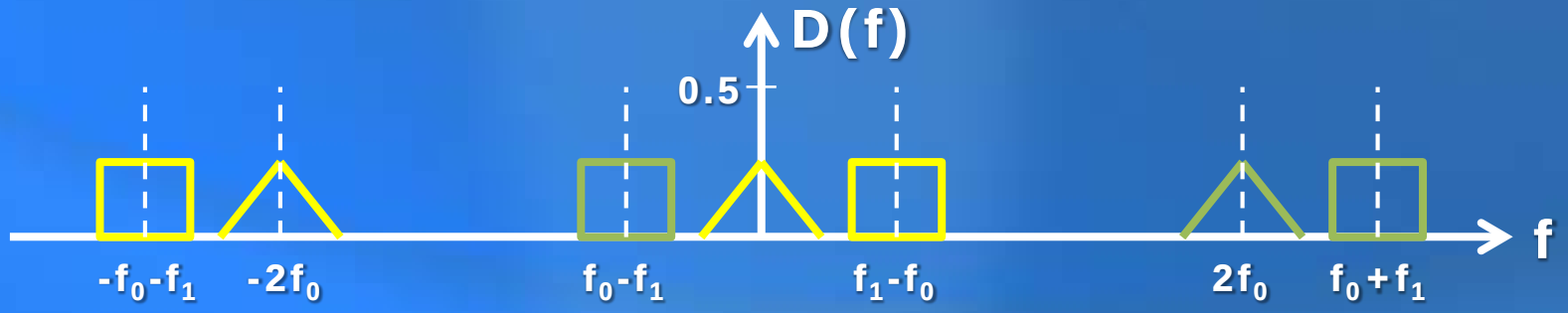


Mixing

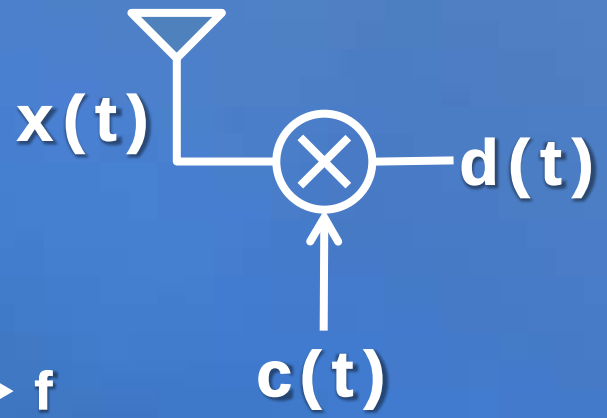

x(t)
d(t)
c(t)

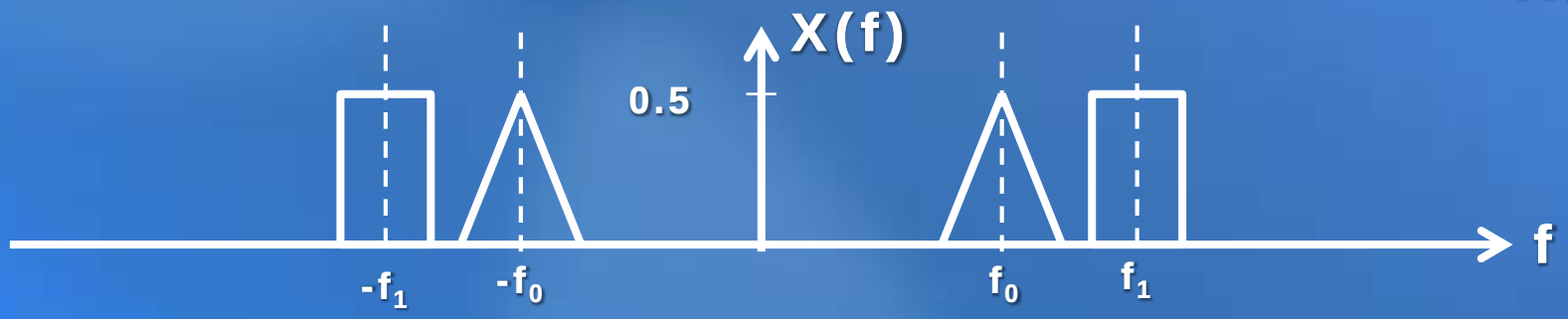

X(f)
0.5
f
$-f_1$
$-f_0$
f_0
f_1

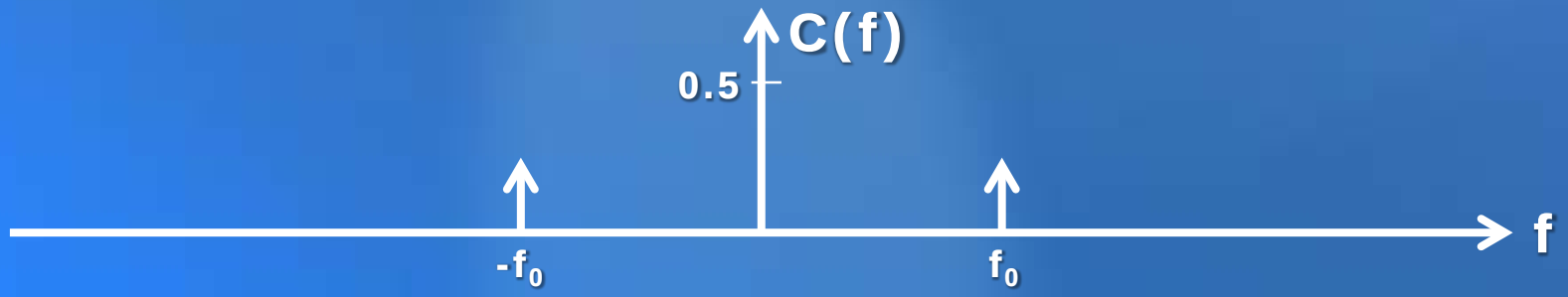

C(f)
0.5
f
$-f_0$
f_0

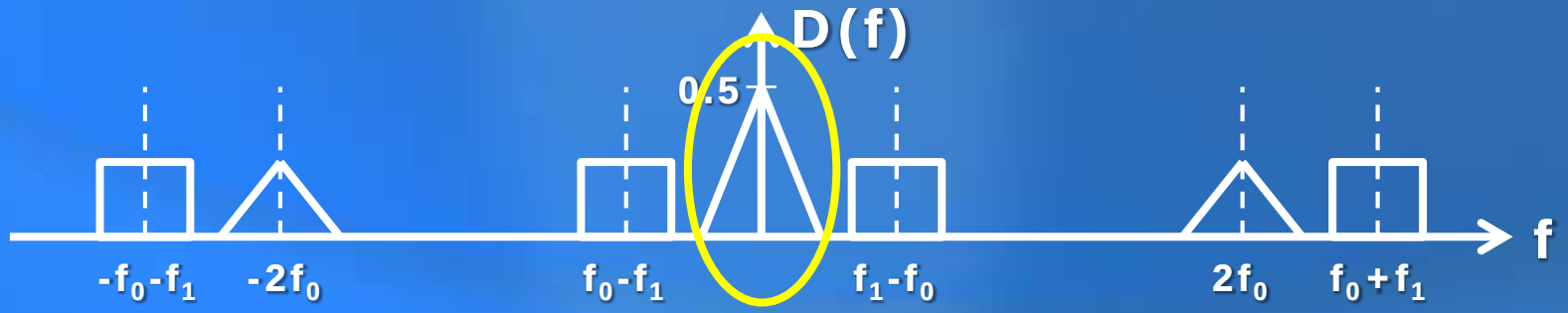

D(f)
0.5
f
$-f_0-f_1$
$-2f_0$
f_0-f_1
f_1-f_0
$2f_0$
f_0+f_1

Mixing

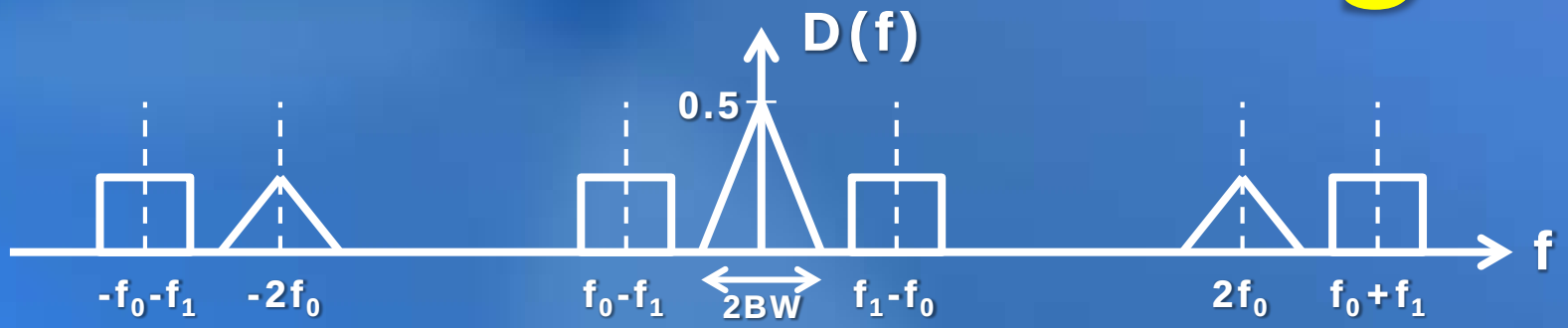

x(t)
d(t)
c(t)


X(f)
0.5
f
$-f_1$
$-f_0$
f_0
f_1

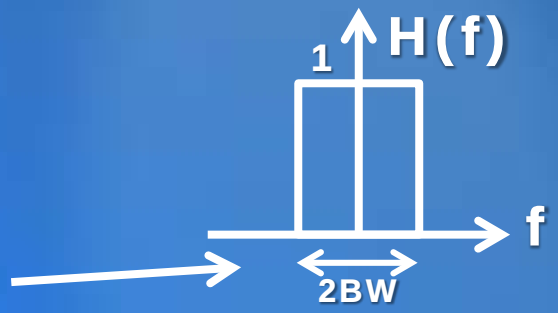

C(f)
0.5
f
$-f_0$
f_0

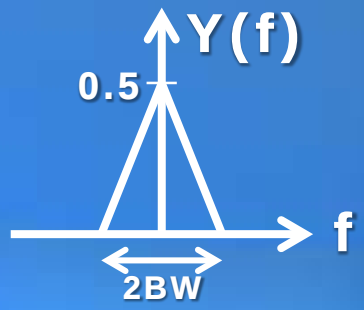

D(f)
0.5
f
$-f_0-f_1$
$-2f_0$
f_0-f_1
f_1-f_0
$2f_0$
f_0+f_1

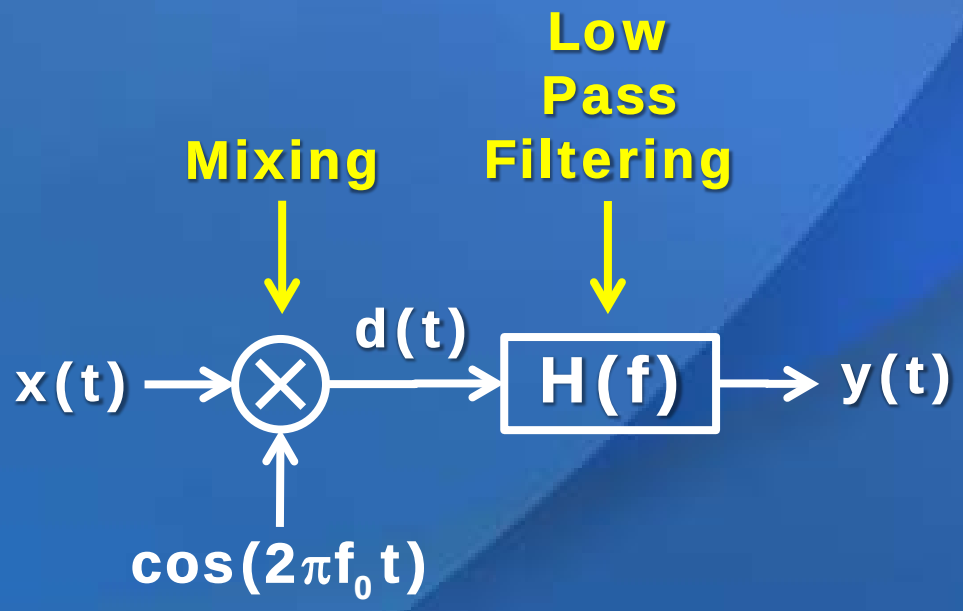
Filtering



Choose filter bandwidth equal to message bandwidth





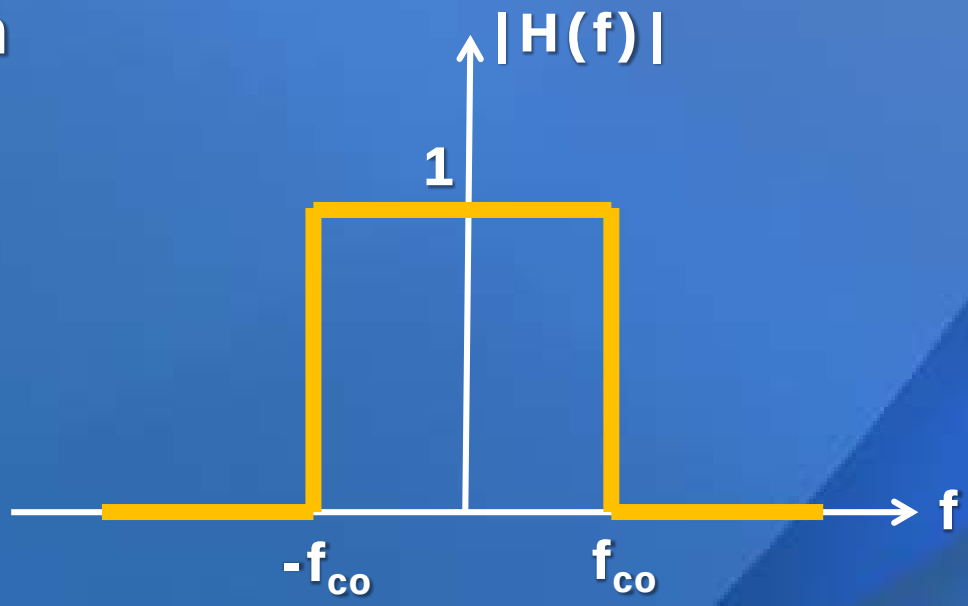


Filter Bandwidth

- The filter bandwidth is the length of positive frequencies over which the amplitude response |H(f)| remains nearly constant.

- An ideal low pass filter
  - passes frequencies below f_{co}
  - blocks all those above f_{co}
  - has bandwidth f_{co}

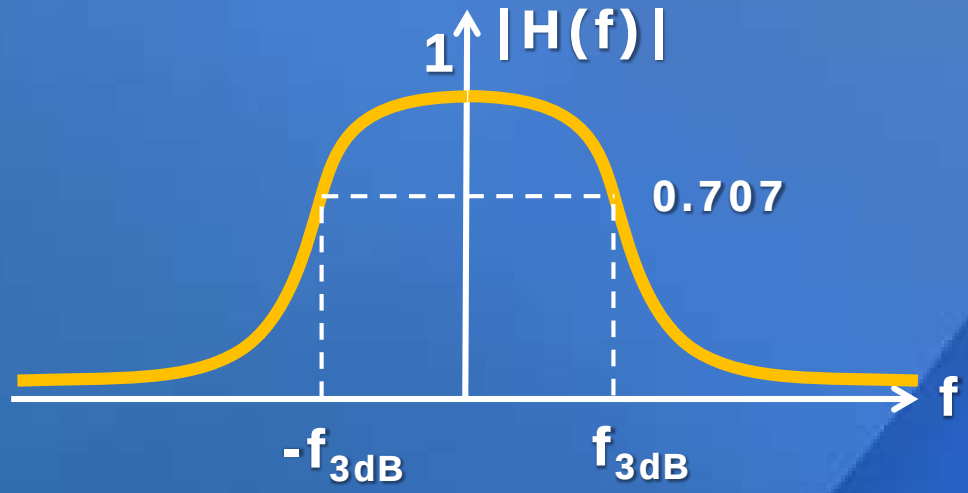
f_{co}: cutoff frequency



$$H(f) = \begin{cases} 1 & \text{if } |f| < f_c \\ 0 & \text{if } |f| > f_c \end{cases}$$

3dB Bandwidth

- More realistic filters exhibit a more gradual cutoff.
- For low pass filters, a common measure of the bandwidth is the 3dB cutoff frequency.
- This is the frequency at which the squared amplitude response drops to half its value at f=0.

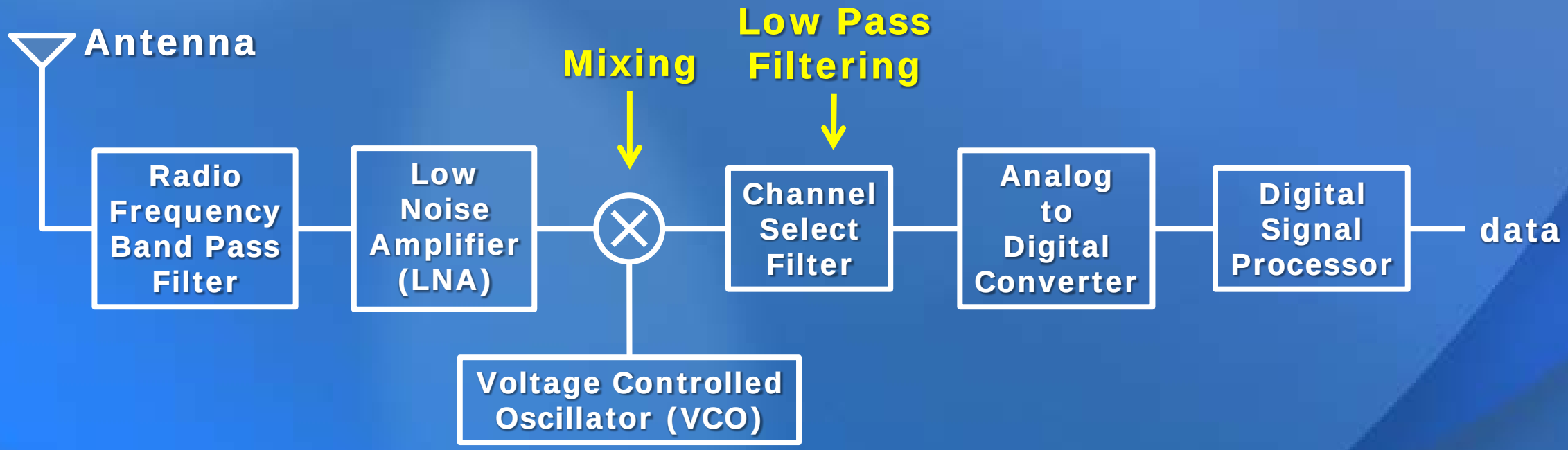


$$\frac{H(f_{3dB})^2}{H(0)^2} = \frac{1}{2} \Rightarrow H(f_{3dB}) = \frac{1}{\sqrt{2}} H(0) \approx 0.707 \times H(0)$$

f_{3dB}: 3dB cutoff frequency

$$10 \times \log_{10}\left(\tfrac{1}{2}\right) \approx -3dB$$

Direct Conversion Receiver



This is also called a homodyne receiver. Modern mobile phones use a receiver structure similar to this.