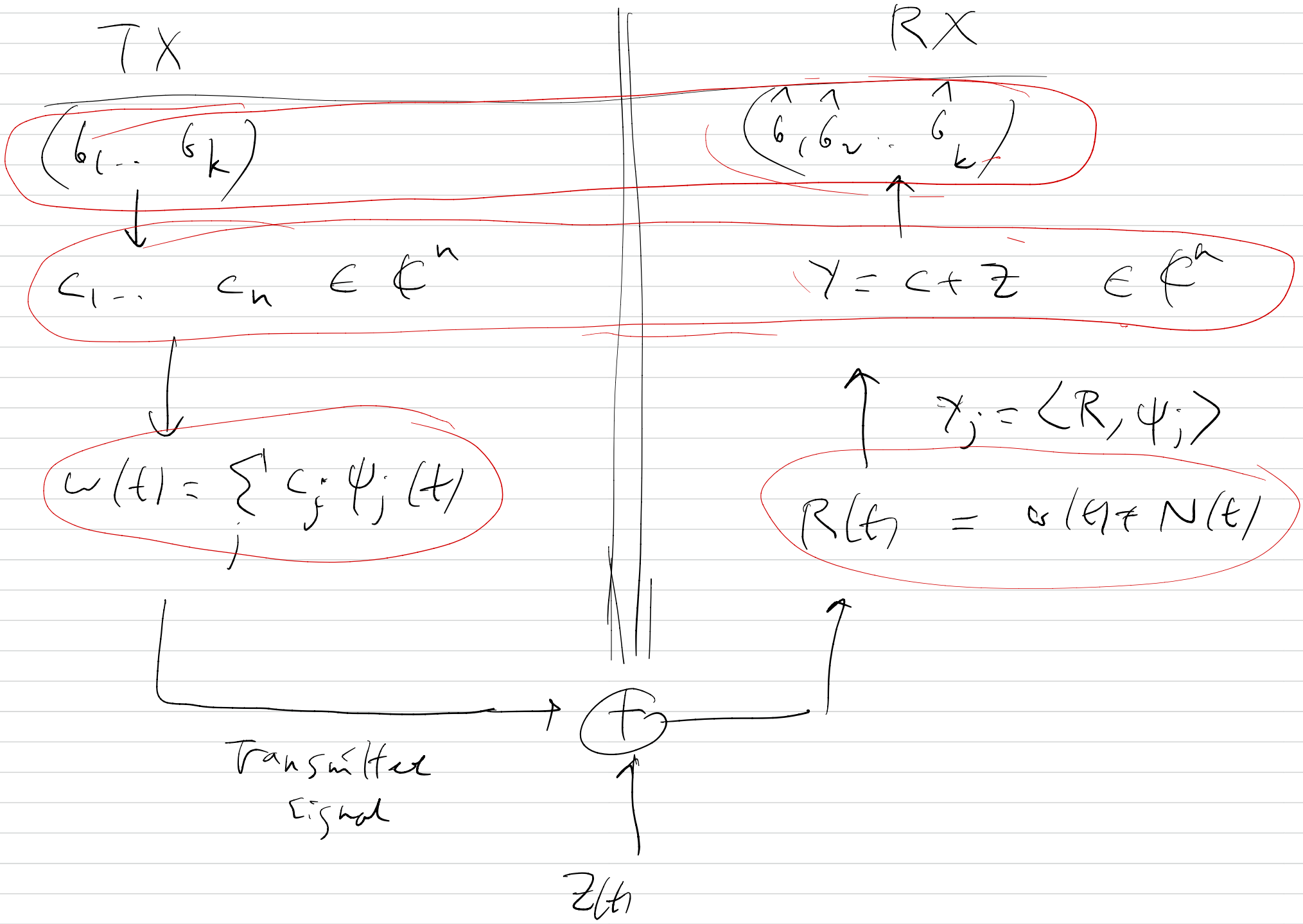
Principles of Digital Communication

May 14, 2021

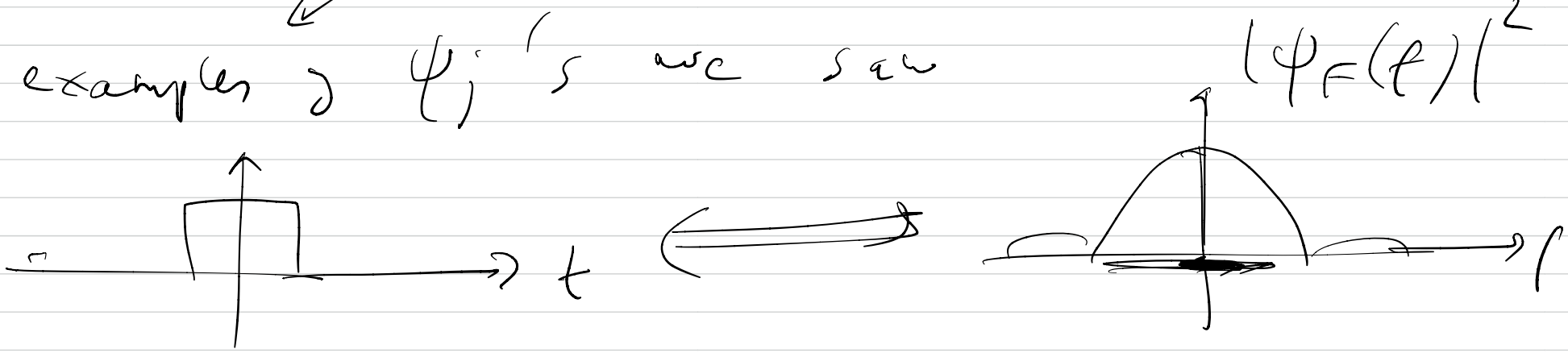
Reading for next week : 7.1-4.

Taking stock of what we have seen:

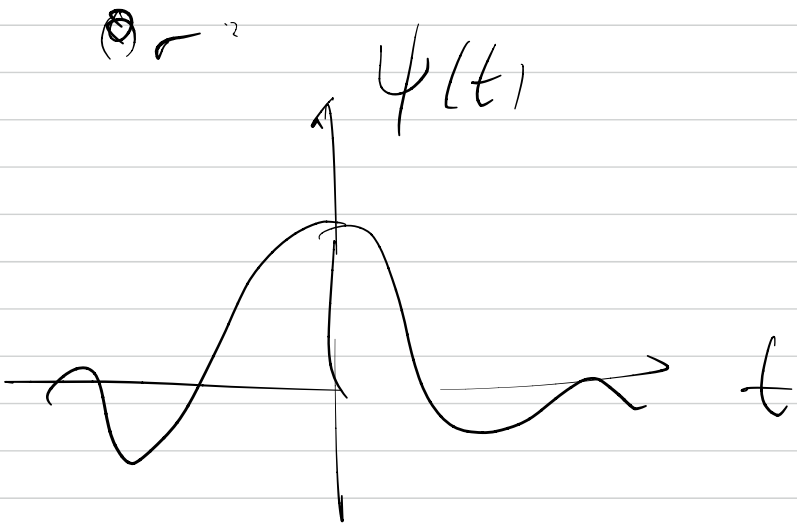


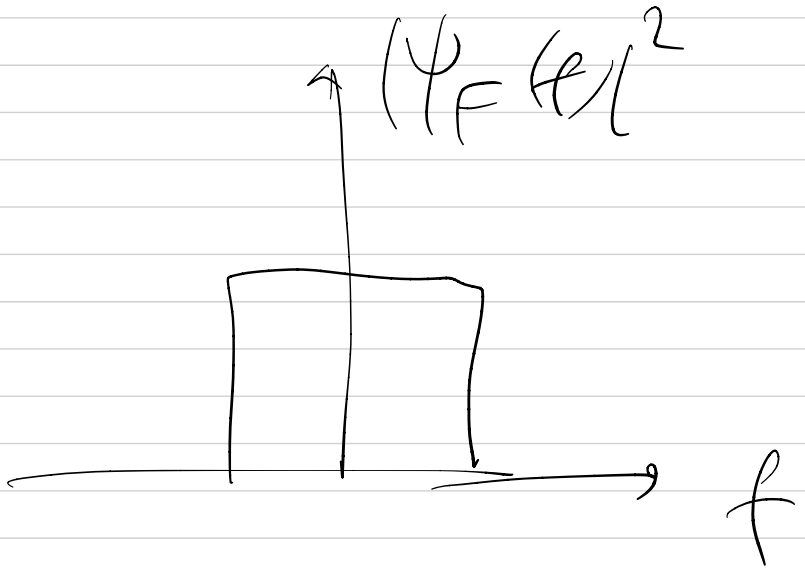
Reading: "passband communication".

so far: "baseband"

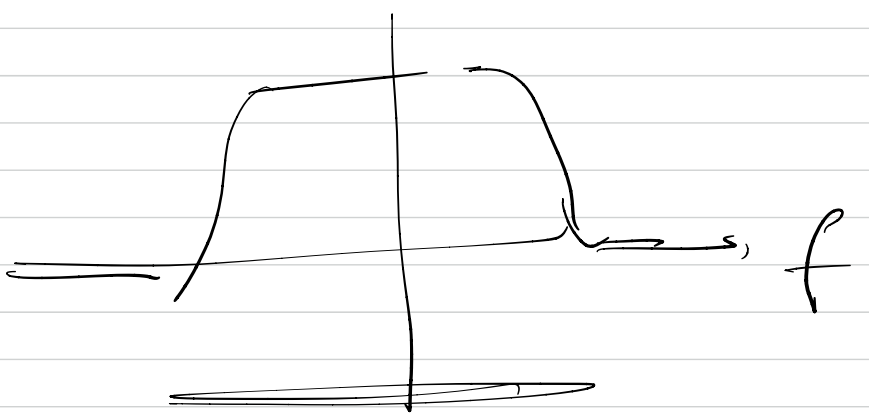


Or

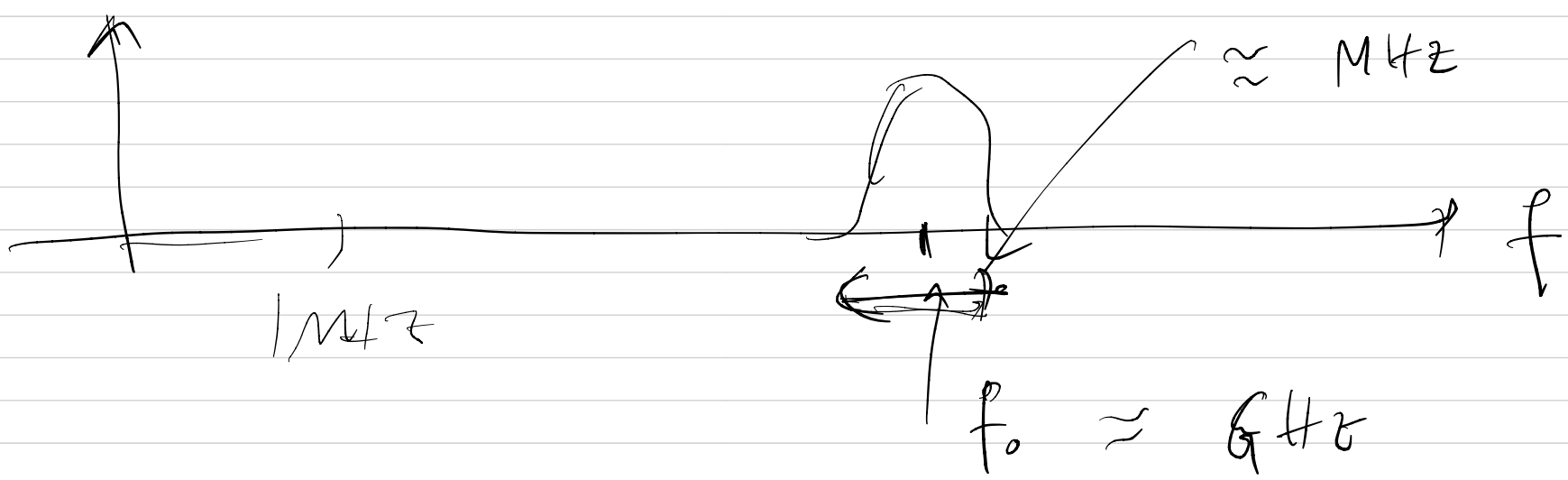




Finite width



However in physical reality:



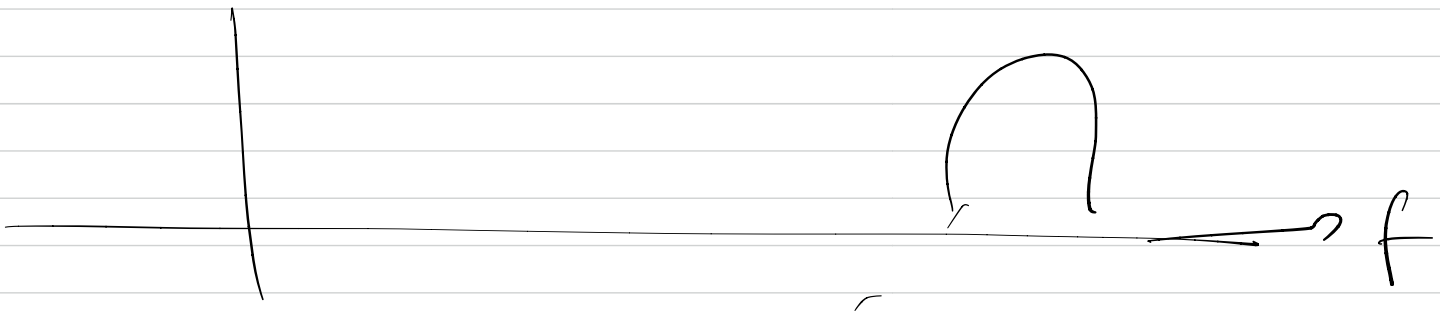
Speed of Light = 1 foot/ns.

A Electro-magnetic signal of 1 GHz freq. has a wavelength of ≃ 30 cm.

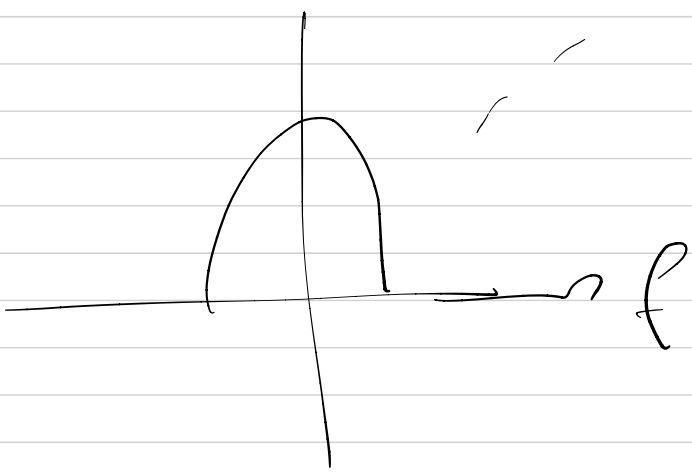
" " " 1 MHz freq

" " " ≃ 300 m.

One feels that instead of doing our design for



We should be able to do our design



and "up-convert" this low freq. signal to the passband.

Chapter 7 tells us how:

A few reminders about fourier transform:

① $x(t) \longleftrightarrow x_F(f)$

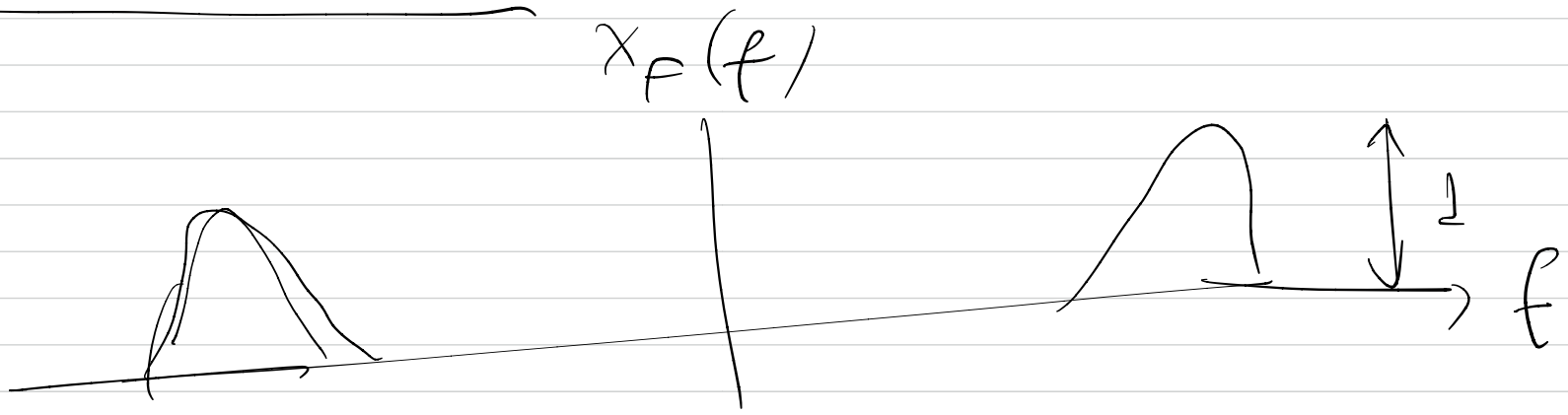
$x^*(t) \longleftrightarrow x_F^*(-f)$

(because: $\int x^*(t) e^{-j2\pi ft} dt$

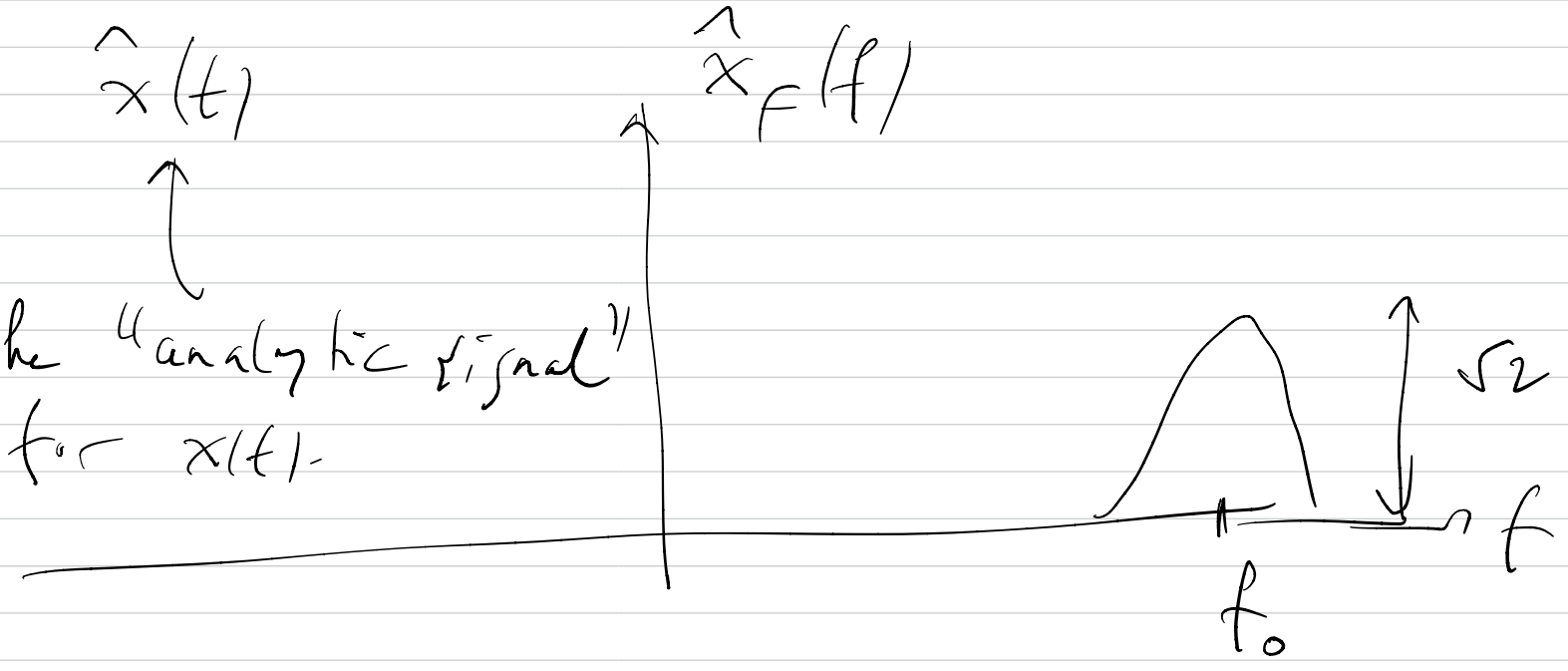
$= \left(\int x(t) e^{+j2\pi ft} dt \right)^*$

$= \left(x_F(-f) \right)^*$)

$x(t)$ is real:



define $\hat{x}(t)$ ← the "analytic signal" for $x(t)$.



$$x(t) = \sqrt{2}\,\mathrm{Re}\{\hat{x}(t)\}$$

(why: $x_F(f) = \dfrac{\hat{x}_F(f) + \hat{x}_F(-f)^*}{\sqrt{2}}$)

$$\|x_E\|^2 = \|\hat{x}_F\|^2,$$

$$= \|x_{E,F}\|^2$$

$\hat{x}_F(f) = x_{E,F}(f - f_0)$

$x_E(t)$ is called the baseband equivalent.

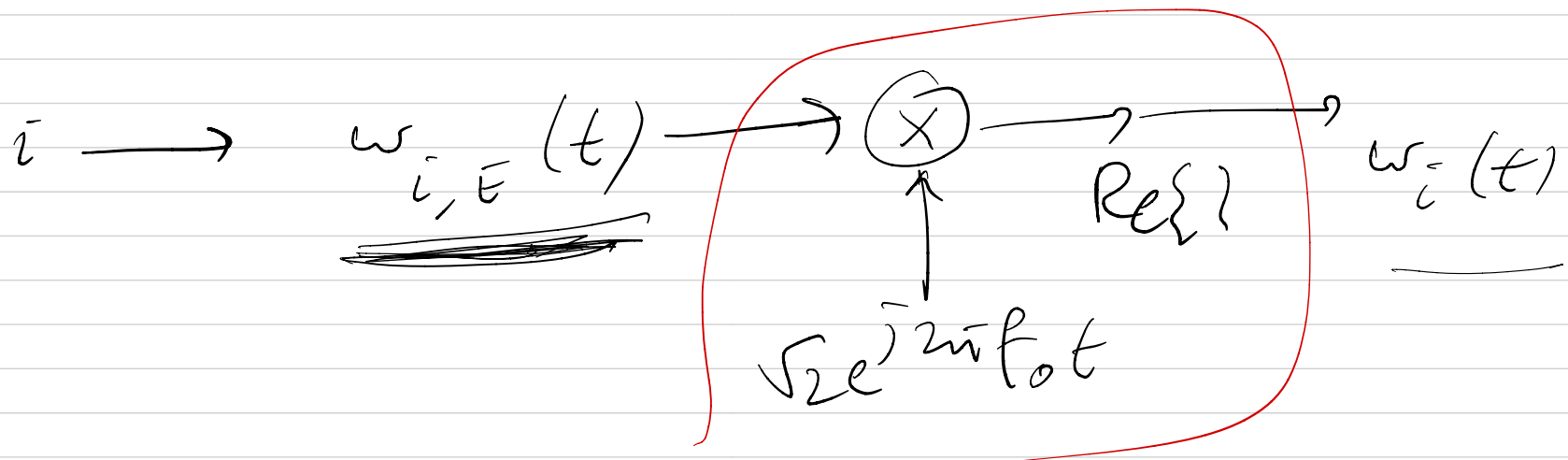
$$x(t) = \sqrt{2}\,\mathrm{Re}\left\{ x_E(t)\, e^{j2\pi f_0 t} \right\}.$$

$$= \sqrt{2}\,\mathrm{Re}\{x_E(t)\}\cos(2\pi f_0 t) - \sqrt{2}\,\mathrm{Im}\{x_E(t)\}\sin(2\pi f_0 t).$$

Real, bandpass

Complex, low-pass.

So, the transmitted waveform $w_i(t)$ can be created as:



All our designs in the low frequency world and just before transmission perform the up conversion is a design methodology which does not inhibit generality.

We will see that the RCVR has a similar separation between the bandpass & (low-pass) components.