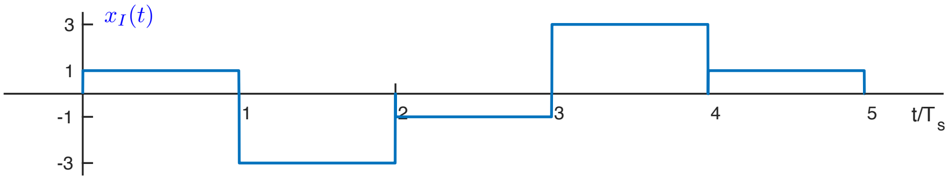
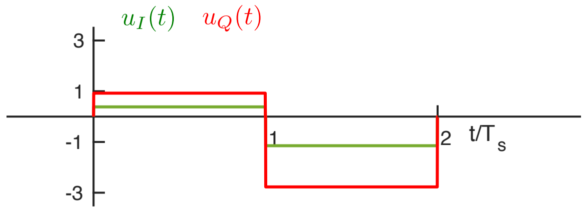
Solutions Week 7

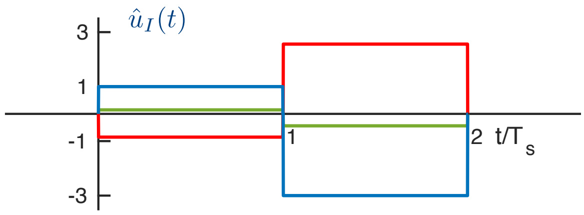
7.1 **a.**



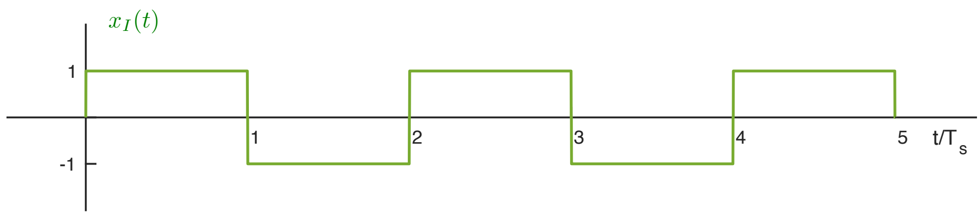
b.

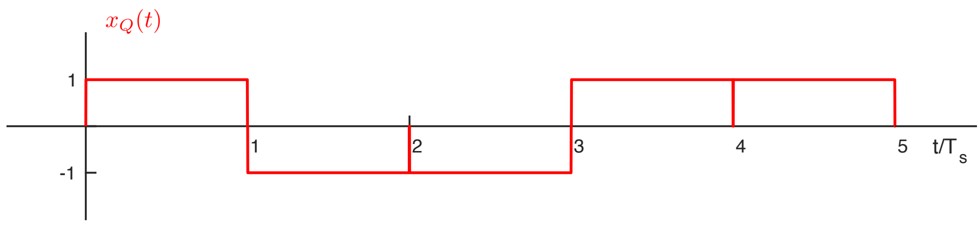


c.

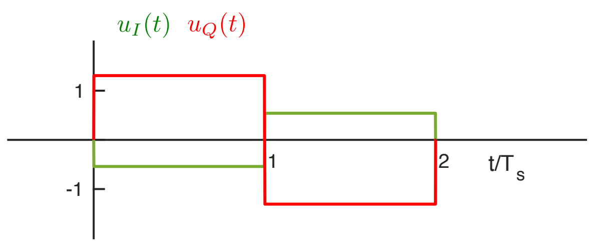


7.2 **a.**





b.



c. The data is not directly visible in $u_I(t)$ or $u_Q(t)$ due to the crosstalk. For example, the shape of $u_I(t)$ looks different from $x_I(t)$. In general the shape of $u_I(t)$ or $u_Q(t)$ depends on the data and on the amount of phase error $\phi_{err}(t)$.

7.3 **a.** With

$$u_I(t)\cos(\phi_{err}(t)) = \frac{x_I(t)}{2} A \cos^2(\phi_{err}(t)) + \frac{x_Q(t)}{2} A \sin(\phi_{err}(t))\cos(\phi_{err}(t))$$

$$u_Q(t)\sin(\phi_{err}(t)) = \frac{x_Q(t)}{2} A \cos(\phi_{err}(t))\sin(\phi_{err}(t)) - \frac{x_I(t)}{2} A \sin^2(\phi_{err}(t))$$

we get

$$\hat{u}_I(t) = \frac{x_I(t)}{2} A \cos^2(\phi_{err}(t)) + \frac{x_I(t)}{2} A \sin^2(\phi_{err}(t)) = \frac{x_I(t)}{2} A$$

We can conclude that by choosing $A = 2$ the signal $x_I(t)$ can be perfectly recovered despite of the phase error.

b. Using the same concept as above, we can choose

$$\hat{u}_Q(t) = u_I(t)\sin(\phi_{err}(t)) + u_Q(t)\cos(\phi_{err}(t)) = \frac{x_Q(t)}{2} A$$

to cancel out the crosstalk (please verify).

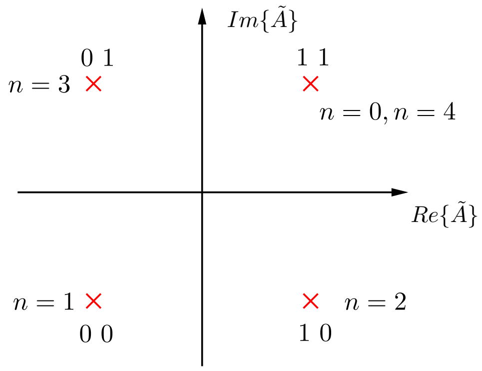
7.4 Let $\phi = \phi_{err}(t)$. Then

$$\tilde{u}(t) = A/2\ \tilde{x}e^{-j\phi} = A/2\,\big(x_I(t) + j\,x_Q(t)\big)\big(\cos(\phi) - j\sin(\phi)\big)$$
$$= A/2\,\big(x_I(t)\cos(\phi) + x_Q(t)\sin(\phi)\big) + j\,A/2\,\big(x_Q(t)\cos(\phi) - x_I(t)\sin(\phi)\big)$$

We can identify $u_I(t) = Re\{\tilde{u}(t)\}$ and $u_Q(t) = Im\{\tilde{u}(t)\}$.

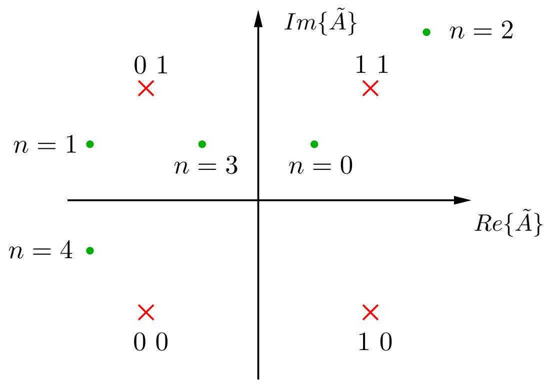
7.5 **a.** $\tilde{A}_{m[n]} = (1+j),\ (-1-j),\ (1-j),\ (-1+j),\ (1+j)$

b.



c. $\tilde{C} = 1000\,e^{j(\phi_a+\phi_{err})} \cdot \frac{1}{T_s}$ with $A = 2$ and $E_g = T_s$

d.



$\tilde{A}_{m[n]} = (1+j),\ (-1+j),\ (1+j),\ (-1+j),\ (-1-j),$ $\quad$ $\mathbf{b} = 1\,1\,0\,1\,1\,1\,0\,1\,0\,0$