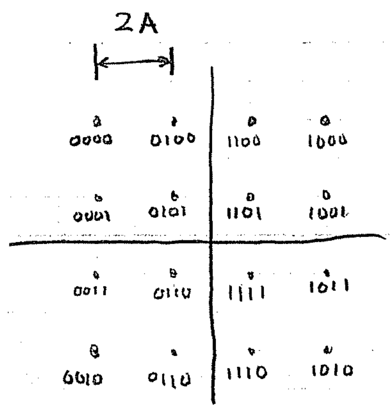
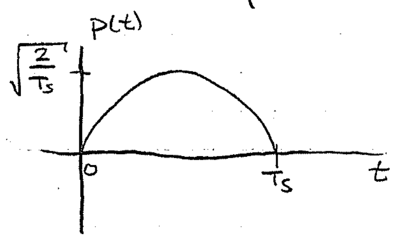
16 QAM Example



Let $A = 2$

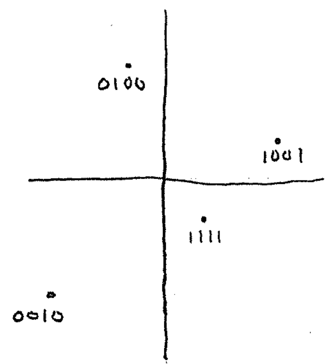
$\Rightarrow E_{avg} = 10A^2 = 40$

Let $p(t) = \begin{cases} \sqrt{\frac{2}{T_s}} \sin\left(\frac{\pi t}{T_s}\right) & 0 \le t \le T_s \\ 0 & \text{otherwise} \end{cases}$



Let our transmission consist of the following bits

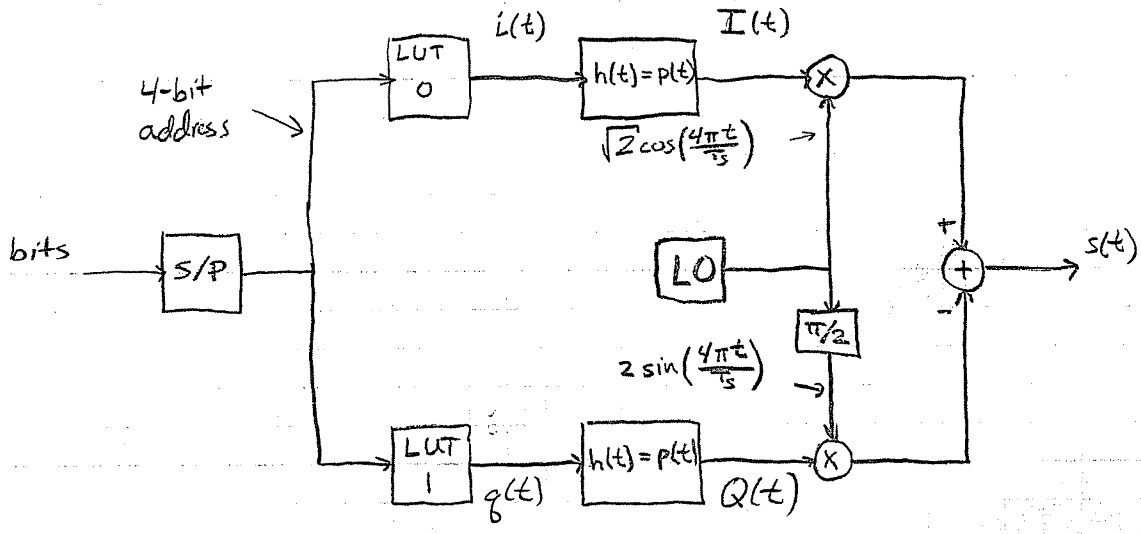
1111010010010010



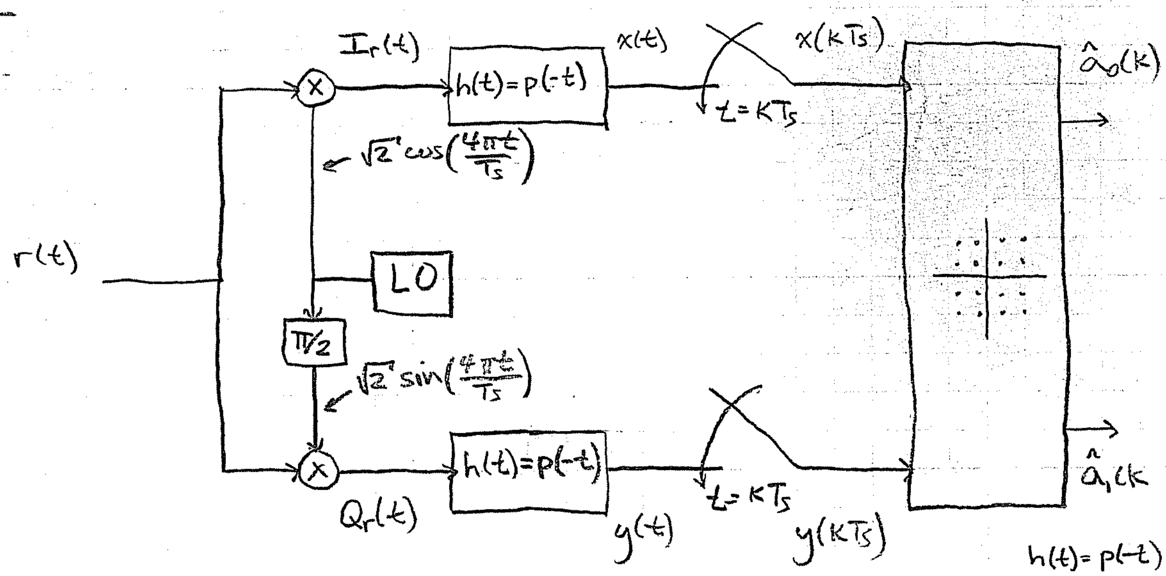
The following is a partial listing of the contents of LUT0 and LUT1 (Remember, $A = 2$)

Bits	Integer index	LUT0 $[a_0]$	LUT1 $[a_1]$
⋮			
0010	2	-6	-6
⋮			
0100	4	-2	+6
⋮			
1001	9	+6	+2
⋮			
1111	15	+2	-2

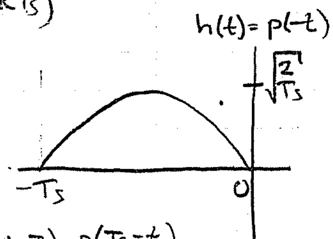
Transmitter (Let $\omega_0 = 4\pi/T_s$)



Detector

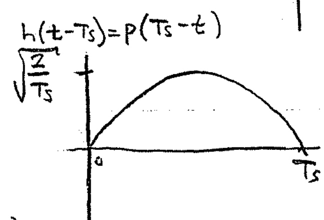


We say the MF has a response that looks like this

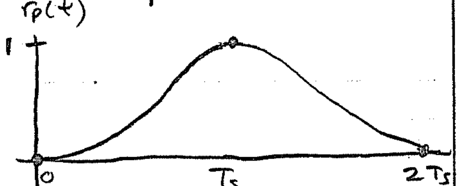


But, this is non causal (i.e. we can't implement it).

So instead, we use a response $h(t-T_s) = p(T_s - t)$



The autocorrelation of the pulse $p(t)$ with this delay taken into account is $r_p(t)$



I have placed three dots on this plot, which correspond to our desired condition

$$r_p(kT_s) = \begin{cases} 1 & k=0 \\ 0 & k \neq 0 \end{cases}, \text{ delayed by } T_s$$

Plots

(Important assumptions: • LOs at Tx and Rx have same phase and frequency)
• Sampling instant at detector, kT_s, is known