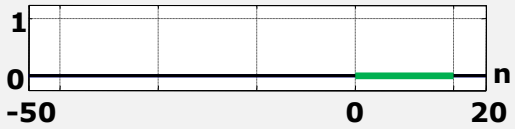
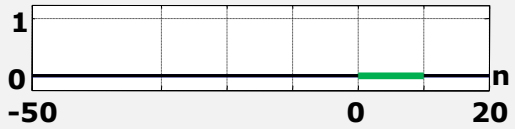
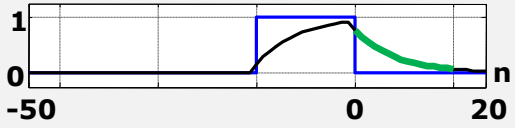
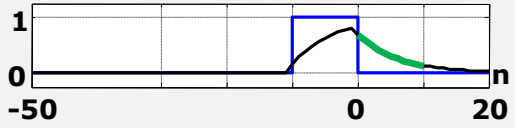
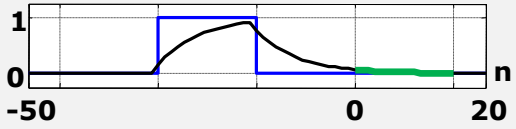
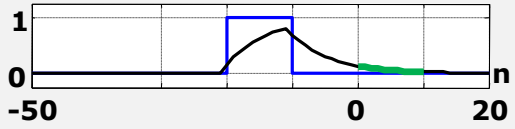
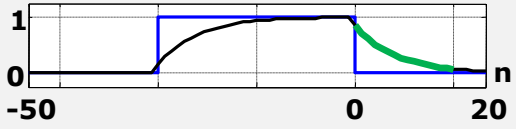
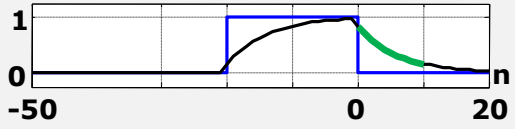
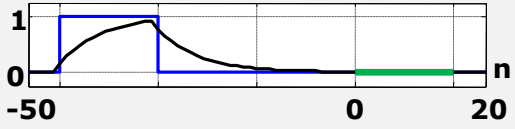
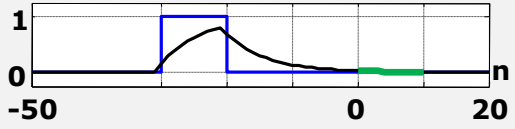
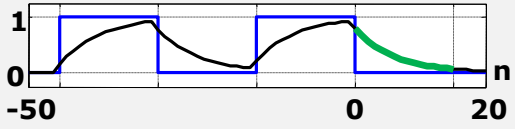
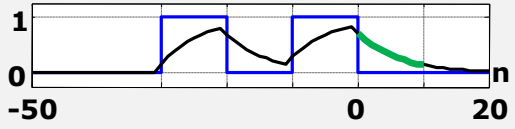
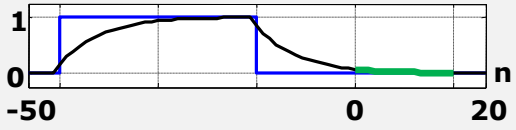
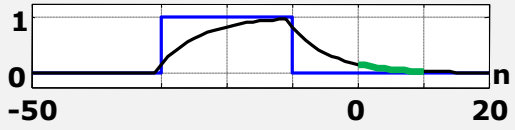
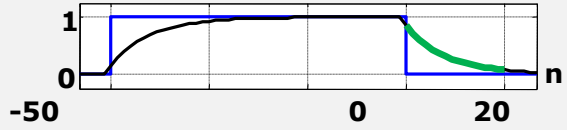
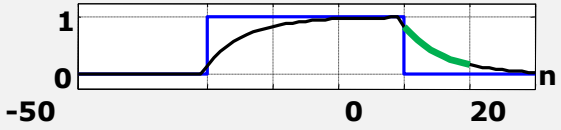
Intersymbol Interference

Responses to a Zero Bit

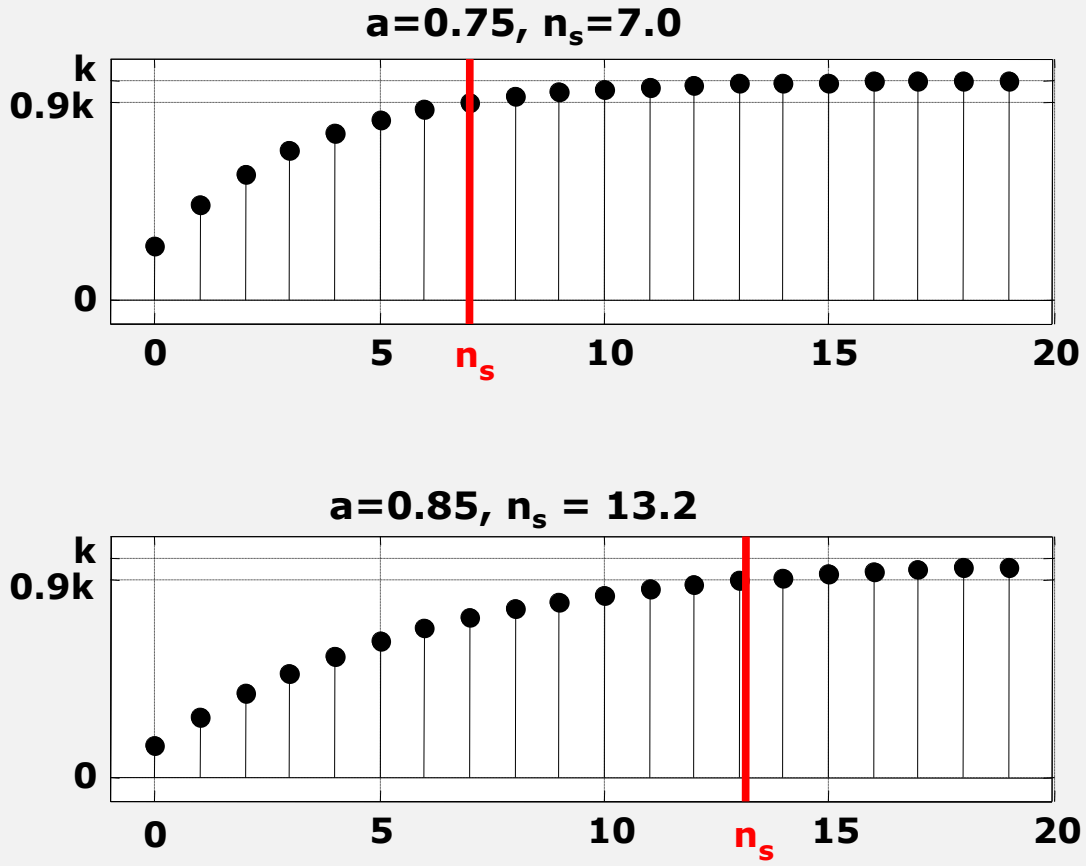
— input waveform
— channel output
— output to zero bit

bit sequence	bit time = 15 SPB		bit time = 10 SPB	
0000		Response 0		Response 00
0010		Response 1		Response 01
0100		Response 0		Response 10
0110		Response 1		Response 11
1000		Response 0		Response 00
1010		Response 1		Response 01
1100		Response 0		Response 10
1110		Response 1		Response 11

Intersymbol Interference (ISI)

- The response to a "zero" or "one" bit depends upon what bits were transmitted before it, because of the time it takes for the channel to respond to a transition.
- This is referred as intersymbol interference.
  - Bits = "symbols"
- The smaller the bit time (SPB) in comparison with the time it takes for the channel to respond to a transition, the greater the ISI.
  - More past symbols interfere with the current symbol
  - We observe a larger variety of responses to a "zero" or "one" bit

Settling Time



larger a → larger n_s

- The settling time, n_s, of a channel is the time needed for its step response to reach 90% of its max
- For the exponential step response,

$$s(n_s) = 0.9k$$

$$k\left(1 - a^{n_s+1}\right)u(n_s) = 0.9k$$

$$1 - a^{n_s+1} = 0.9$$

$$a^{n_s+1} = 0.1$$

$$(n_s + 1)\ln a = \ln 0.1$$

$$n_s = \frac{\ln 0.1}{\ln a} - 1$$

Minimizing ISI

- We generally want intersymbol interference (ISI) to be small as possible.
  - This makes the response to each bit becomes more predictable.
- To reduce ISI, we can
  - Make the channel faster (reduce n_s)
    - However, we may not have control over all aspects of the channel, e.g. room acoustics.
    - This may incur extra cost (e.g. faster electronics)
  - Make the bit time longer (increase SPB)
    - However, this reduces the bit rate.