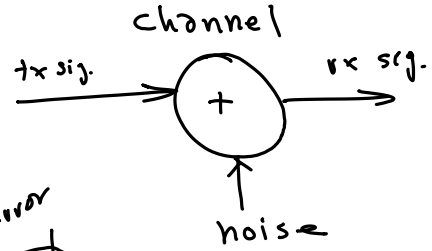
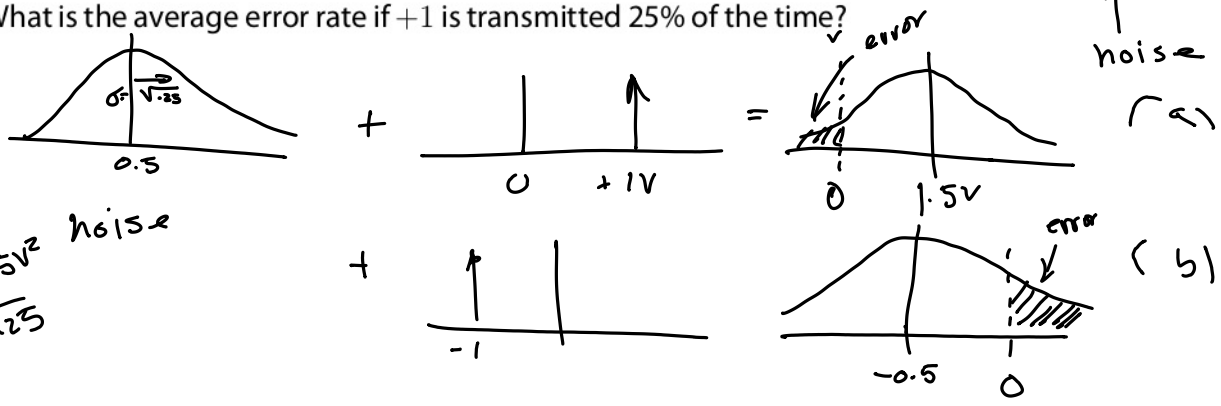
Baseband Transmitters and Receivers

Exercise 1: Gaussian noise with a mean of 0.5 V and a variance of 0.25 V^2 is added to a bipolar signal with levels of ± 1 V. Assuming a decision threshold equally spaced between the two levels, what is the likelihoood of error if $+1$ is transmitted? If -1 is transmitted? What is the average error rate if $+1$ is transmitted 25% of the time?





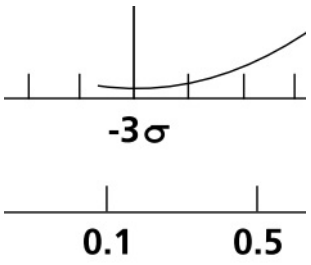
$\sigma^2 = 0.25 V^2$

$\sigma = \sqrt{0.25}$

(a) $t = \frac{x-\mu}{\sigma} = \frac{0-1.5}{\sqrt{0.25}} = -3$

$P(-3) = 0.00135$

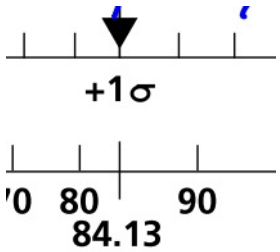
(b) $t = \frac{0-(-0.5)}{\sqrt{0.25}} = 1$



$0.1\% = 1 \times 10^{-3}$

$P(x<1) =$

$P(x>1) = 1 - P(1) \approx 0.16$



$$\overline{P_e} = P(-1) \cdot (P_e \text{ for } -1) + P(+1) \cdot (P_e \text{ for } +1)$$

$$= 0.75 \cdot 1 \times 10^{-3} + 0.25 \cdot 0.16$$

$$= 0.04075$$

Exercise 2: What is the current flowing into a 1nF capacitor if it is being charged at a rate of 10V/μs?

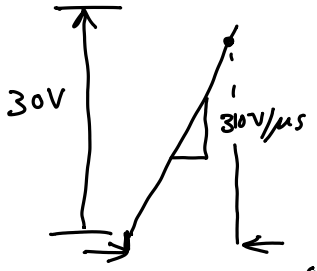
$$I = C\frac{dV}{dt} = 1\times10^{-9}\cdot10^{7} = 1\times10^{-2} = 10\,mA$$

$$C = 1\times10^{-9}$$

$$\frac{dV}{dt} = \frac{10\,V}{1\times10^{-6}\,s} = 10^{7}$$

Exercise 3: The RS-232 standard specifies a maximum slew rate of 30V/"s. Assuming a voltage swing of 30 volts, what is the maximum data rate for which two signal level transitions occupy 10 % of the bit period?

i.e. 10%



$T_{slew} = 10\%$ of T_{bit}

$1\mu s = 0.1 \cdot T_{bit}$

$T_{bit} = 10\,\mu s.$

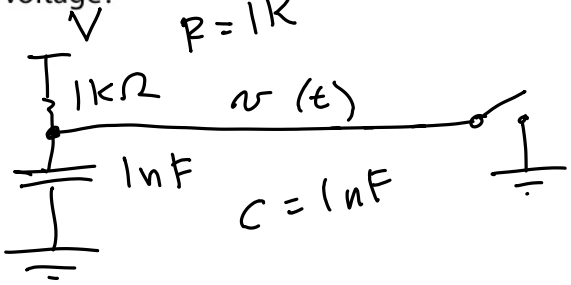
$\frac{30V}{1\mu s} = \frac{30V}{T_{slew}}$

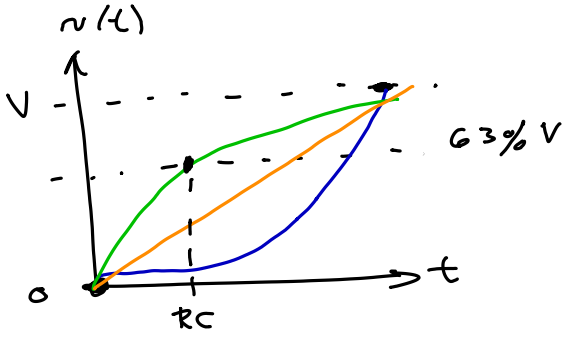
$T_{slew} = 1\,\mu s$

$$\text{data rate} = \frac{1}{T_{bit}} = \frac{1}{10\times10^{-6}} = 100\ kb/s$$

Exercise 4: If the capacitance of the transmission line joining several OC drivers is 1 nF and the pull-up resistor is 1 kΩ how long will it take for the pull-up to pull the line from 0V to 63% of the logic high voltage?

1nF
1660 nF / 52 pF/m ≈ 40 m.





$i = C\frac{dV}{dt} \Rightarrow \int i\,dt = \int C\frac{dV}{dt}\,dt$

$= \frac{1}{C}\int_0^t i\,dt$

$i = v$

...

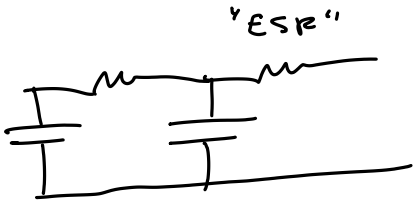
$V_C(t) = V\left(1 - e^{-\frac{t}{RC}}\right)$ → use this one

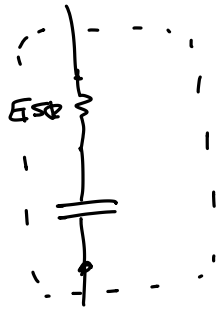
$V_R(t) = Ve^{-\frac{t}{RC}}$.

$RC = 1\times10^{3} \cdot 1\times10^{-9} = 1\times10^{-6}$ s

$1 - e^{-\frac{t}{RC}} = 0.63$

solve for t:



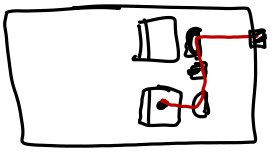


Exercise 5: What are the consequences of increasing the delay between polls? What other factor might determine the maximum delay before slave gets access to the bus in a system using polling?

- increased delay between polls: (latency)
  - increases delay in sending the data.
- latency increases with
  - number of slaves polled
  - time between polls
  - amount of data sent in response to polls

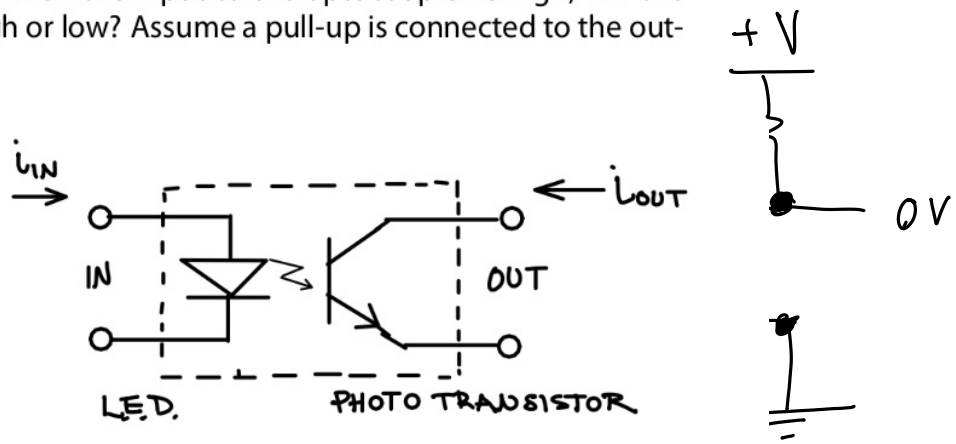
Exercise 6: Consider a communication bus in a car that connects an airbag activation controller with a collision detector, a passenger-seat occupancy sensor and an airbag-disabling switch. Would it be more appropriate to use a polling- or contention-based bus arbitration protocol? Would it be appropriate for the arbitration protocol to allow different priorities for bus access? If so, what priorities might be assigned the different sensors?

- contention-based more appropriate due to requirement for low latency (as opposed to polling)
- different priorities are appropriate
  - highest: collision sensor & airbag
  - lowest: switches & passenger detection.



Exercise 7: If the common-mode circuit is used to carry 500mA, how much current flows through each half of the transformer secondary? What is the net effect on the flux in the transformer core?

Exercise 8: When the input to the optocoupler is high, will the output be high or low? Assume a pull-up is connected to the output.



output will be low.