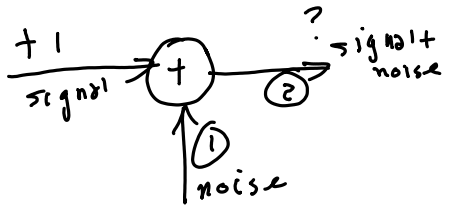
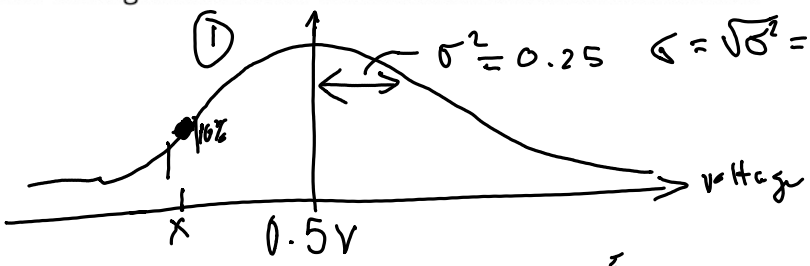
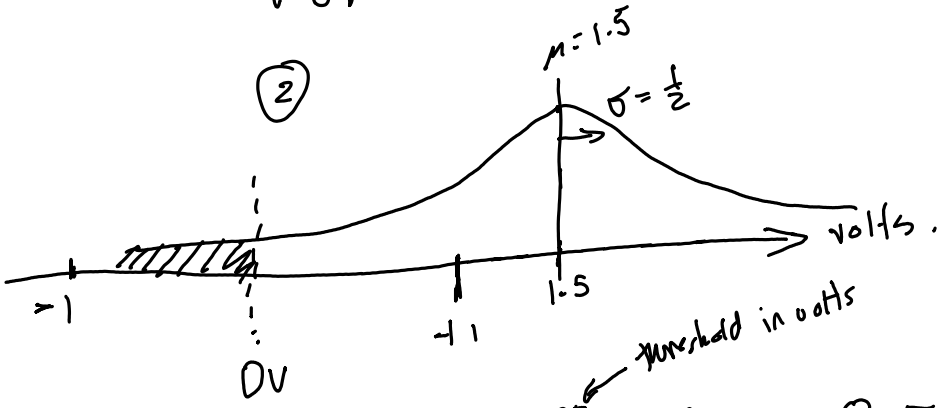



## Baseband Transmitters and Receivers

**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?

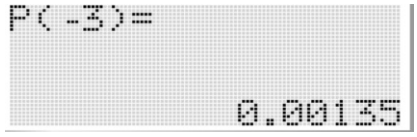


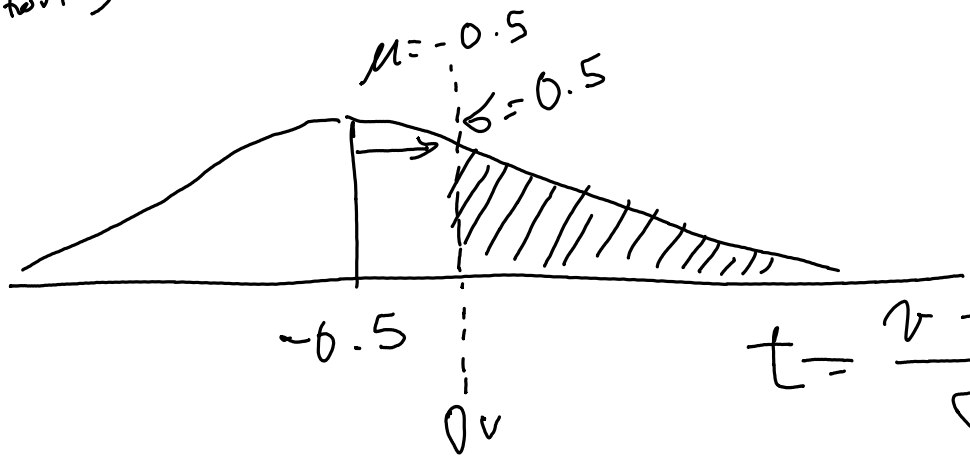




$$t = \frac{v - \mu}{\sigma} = \frac{0 - 1.5}{0.5} = -3$$

($v$: threshold in volts; $t$: normalized threshold)


$$P(\text{error from } +1) = P(v < 0v) = P(-3) \approx 0.1\% \approx 1 \times 10^{-3}$$

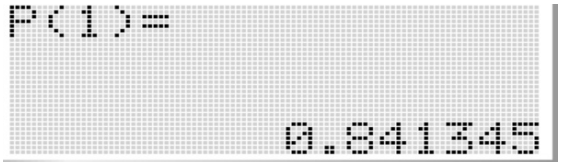



$$t = \frac{v - \mu}{\sigma} = \frac{0 - (-0.5)}{0.5}$$

$$= 1$$

$$P(\text{received signal} > 0V) = P(x > 1) = 1 - P(x < 1)$$




$$P(x>1) = 1 - 0.84$$
$$= 0.16$$

$$P(\text{error} \mid -1 \text{ transmitted}) = 16\%$$

if transmit $+1$ $\quad P_e = 0.001$

" $-1$ $\quad P_e = 0.16$

transmit $+1$ $\quad 25\%$

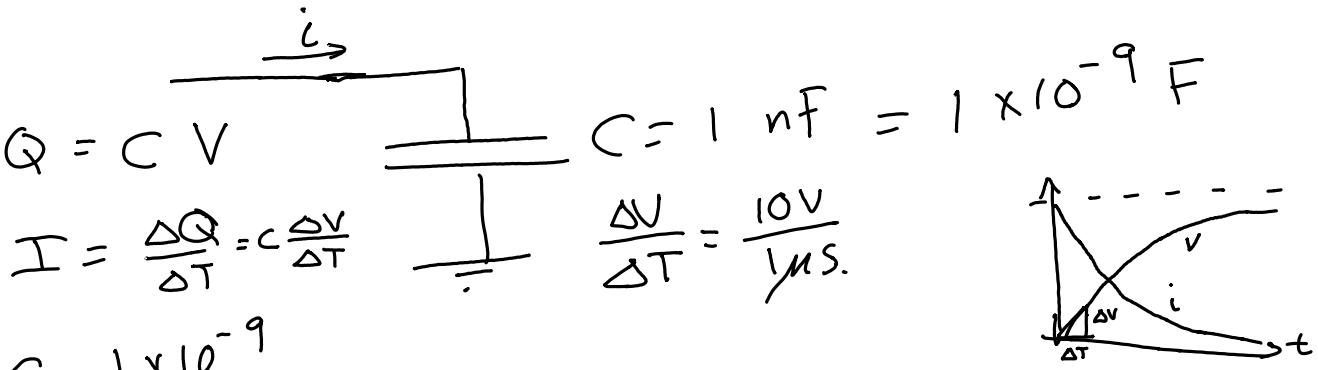
$-1$ $\quad 75\%$

$$\bar{P}_e = \sum_i P_i \cdot P_{ei} = 0.25 \cdot 0.001 + 0.75 \cdot 0.16$$

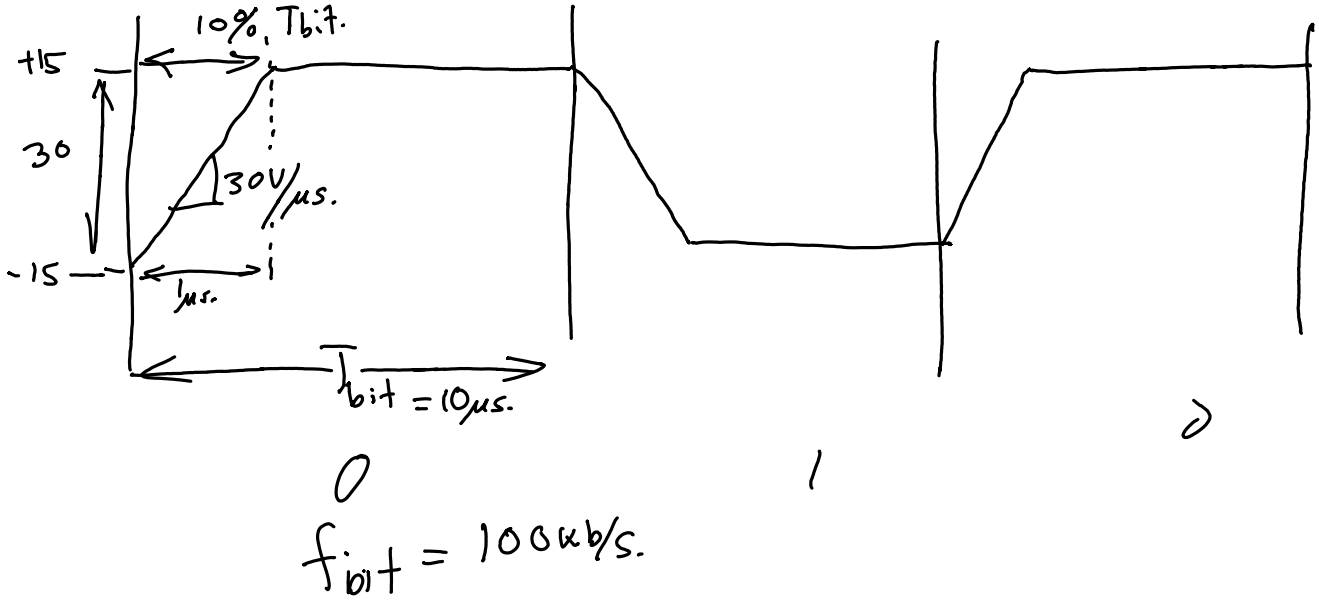
$$= .00025 + 0.12$$

$$\approx 0.12$$

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

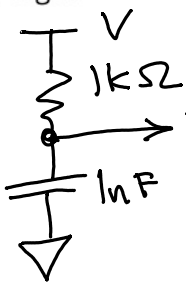



**Exercise 3**: The RS-232 standard specifies a maximum slew rate of 30V/$\mu$s. Assuming a voltage swing of 30 volts, what is the maximum data rate for which ~~two~~ one signal level transition~~s~~ occupy~~/~~ies 10 % of the bit period?

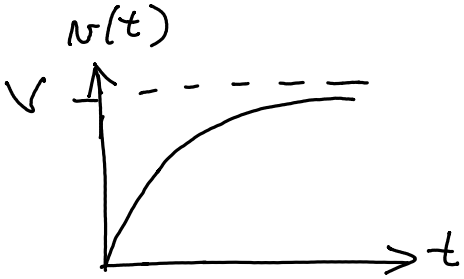



$f_{bit} = 100 kb/s.$

**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?




$v(t) = V\left(1 - e^{-\frac{t}{RC}}\right)$




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

$e^{-\frac{t}{RC}} = 0.37 \quad t = -RC \cdot \ln(0.37) = RC = 1\mu s.$

**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?

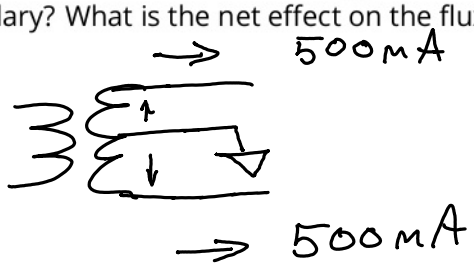
- increasing delay for message to be delivered
- amount of data being transferred (bus cannot be used for polling if data is being transmitted)
- data rate

**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?

low latency → contention based more appropriate

yes, collision sensor should have lower delay & thus higher priority.

**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?




net effect on flux is zero. (current & thus flux are in opposite directions).

**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.