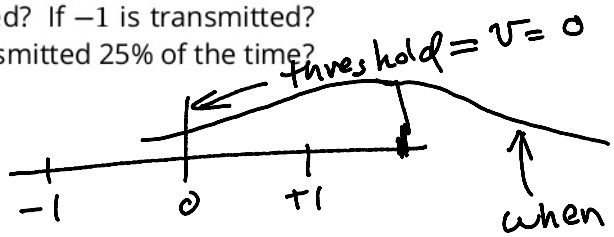
Baseband Transmitters and Receivers

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?

$\mu = 0.5$

$\sigma^2 = 0.25 \quad \sigma = \sqrt{\frac{1}{4}} = \frac{1}{2}$



when +1 is transmitted the mean signal+noise voltage is $\mu = 1.5$

$$P(\text{error}|+1) = P(+1 + \text{noise} < 0)$$

$$t = \frac{v-\mu}{\sigma} = \frac{0 - 1.5}{1/2} = -3$$

$$P(-3) = 0.401 \approx 1 \times 10^{-3}$$

P(-3)=
0.00135

$$P(\text{error}|-1) = P(-1 + \text{noise} \geq 0)$$

$$= 1 - P(x < 0)$$

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

$$= 1$$

when −1 is transmitted, mean of noise + signal is $\mu = -1 + 0.5 = -0.5$

$$P(\text{error}|-1) = 1 - P(1) = 1 - 0.84$$

$$\approx 0.16$$

1-P(1)=
0.158655

∴ non-zero mean noise has moved signal further away from 0 & ∴ probability of error is higher when −1 is transmitted.

average error rate if +1 transmitted 25%:

$$P(\text{error}) = (1 - 0.25)\, P(\text{error}|-1) + 0.25\, P(\text{e}|+1)$$

$$= 0.75 - 0.16 + 0.25 \cdot 1 \times 10^{-3} \approx 0.12$$

(1-P(1))×0.75+0.
25×P(-3)=
0.11932875

Exercise 2: What are the differential and common-mode voltages for this example?

ferential voltage – the voltage difference between its two outputs. For example, $V_A = +5$ V and $V_B = 0$ V for a logical '1' and $V_A = 0$ V and $V_B = +5$ V for a logical '0'.

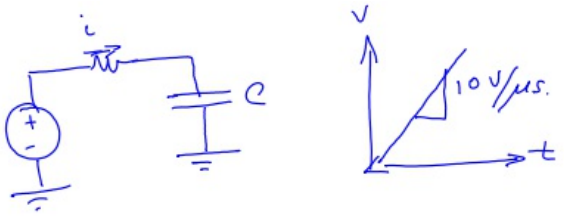
differential: $5 - 0 = 5$ for 1

$0 - 5 = -5$ for 0

common-mode: $\frac{5+0}{2} = 2.5$ for 1

$\frac{0+5}{2} = 2.5$ for 0

Exercise 3: What is the current flowing into a 1nF capacitor if it is being charged at a rate of 10V/μs?



$= \frac{dV}{dt}$

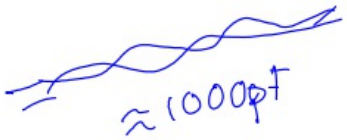
Q = Coulombs

i = coulombs/sec. = $\frac{\Delta Q}{\Delta T}$

$i = C \frac{dV}{dt}$

$Q = CV \rightarrow V = \frac{Q}{C}$

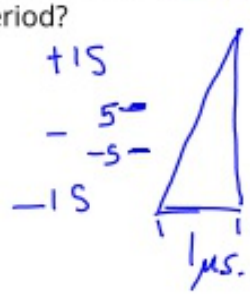
$i = 10nF \cdot \frac{10V}{1\mu s.}$



$= 100 \times 10^{-3}$

$= 100mA$

Exercise 4: The RS-232 standard specifies a maximum slew rate of 30V/μs. 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?

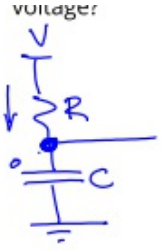


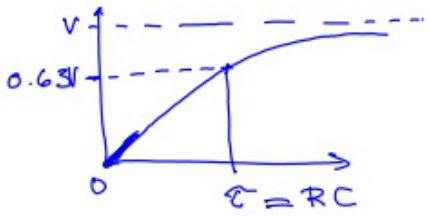
$1\mu s = 0.1 \cdot T_{bit}$

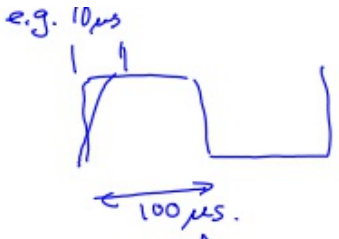
$T_{bit} = 10\mu s$

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

Exercise 5: 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?







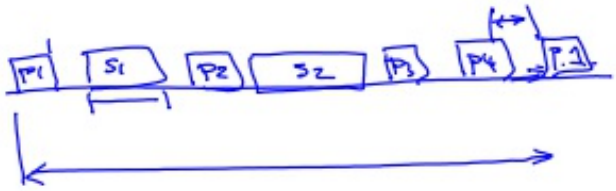
$f_b = 10\ kb/s$

$R = 1K$

$C = 1nF = 10^{-9}F$ $\quad RC = 10^{-6}s = 1\mu s.$

Exercise 6: 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?

- delay between polls → increase delay
- # of slaves
- amount of data
- data rate



Exercise 7: 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?

not done

Exercise 8: 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?

≃ 250mA

no net effect

Exercise 9: When the input to the optocoupler is high, will the output be high or low? Assume a pull-up is connected to the output.

when input high, transistor is on & output is pulled low.