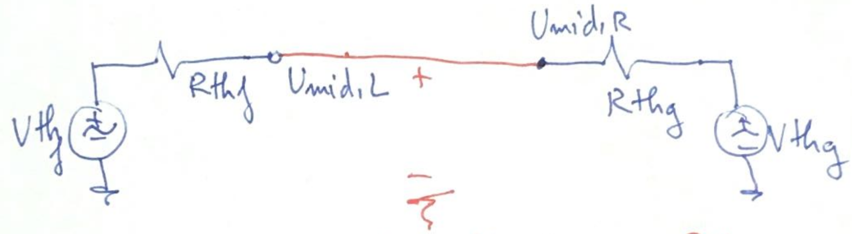
Lecture 10 - Module 2

Today:
Note 20

* Composing blocks (continued)
* Design procedure
* Design examples

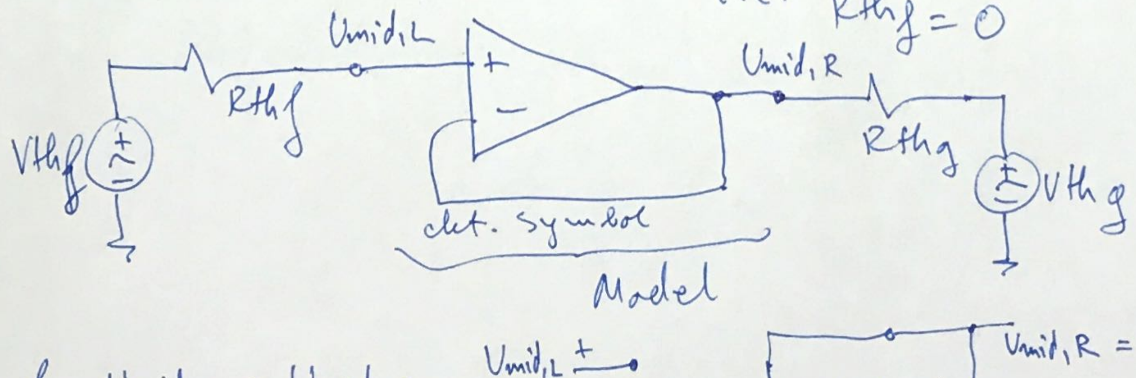


$V_{mid,L\,o.c} = V_{thf} \neq$ (in general) $V_{mid,L} = \frac{R_{thg}}{R_{thf}+R_{thg}} \cdot V_{thf} + \frac{R_{thf}}{R_{thf}+R_{thg}} \cdot V_{thg}$

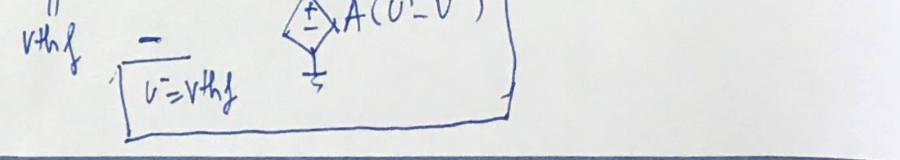
Ideal isolation:

From perspective of block f => see an open-circuit
i.e. $R_{thg} \equiv$ o.c
(or $R_{thf} = 0$ => drive output with voltage source)

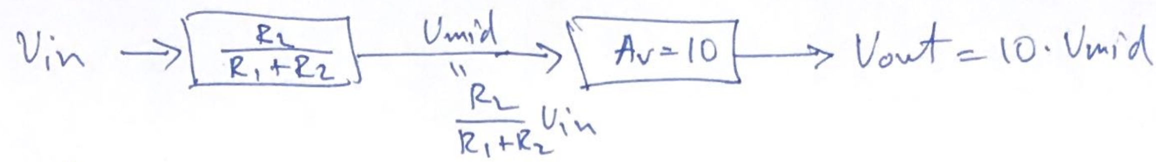
From perspective of block g => see a voltage source
i.e. $R_{thf} = 0$



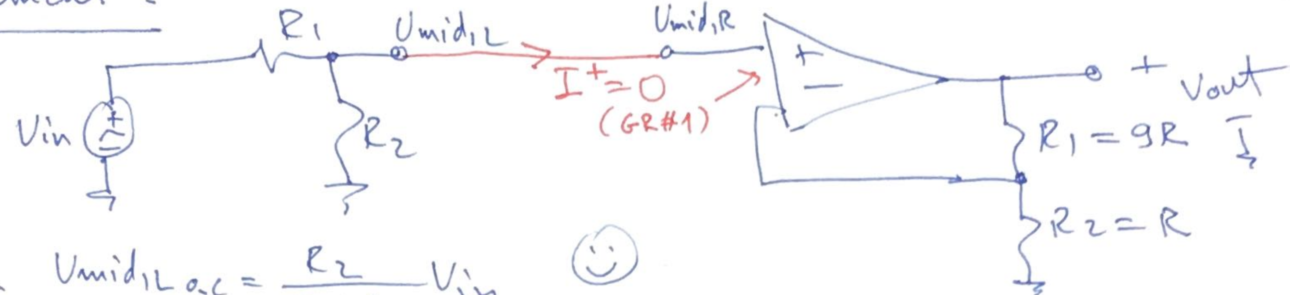
goal: $V_{mid,L} = V_{mid,R}$



Example 1: Want this:



Implement:



Verify: $V_{mid,L\,o.c} = \frac{R_2}{R_1+R_2} V_{in}$ ☺

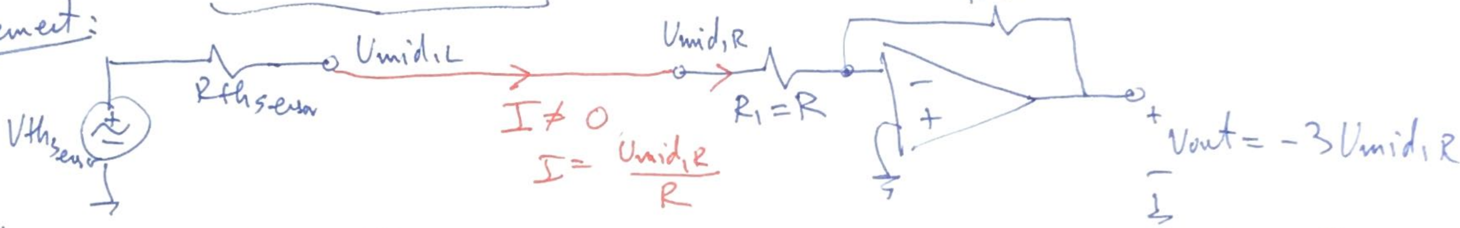
$A_v = \frac{V_{out}}{V_{mid,R}} = 10$

$V_{mid,L} = V_{mid,R}$

b.c. $R_{th_g} \equiv$ o.c.

Example 2:

Implement:



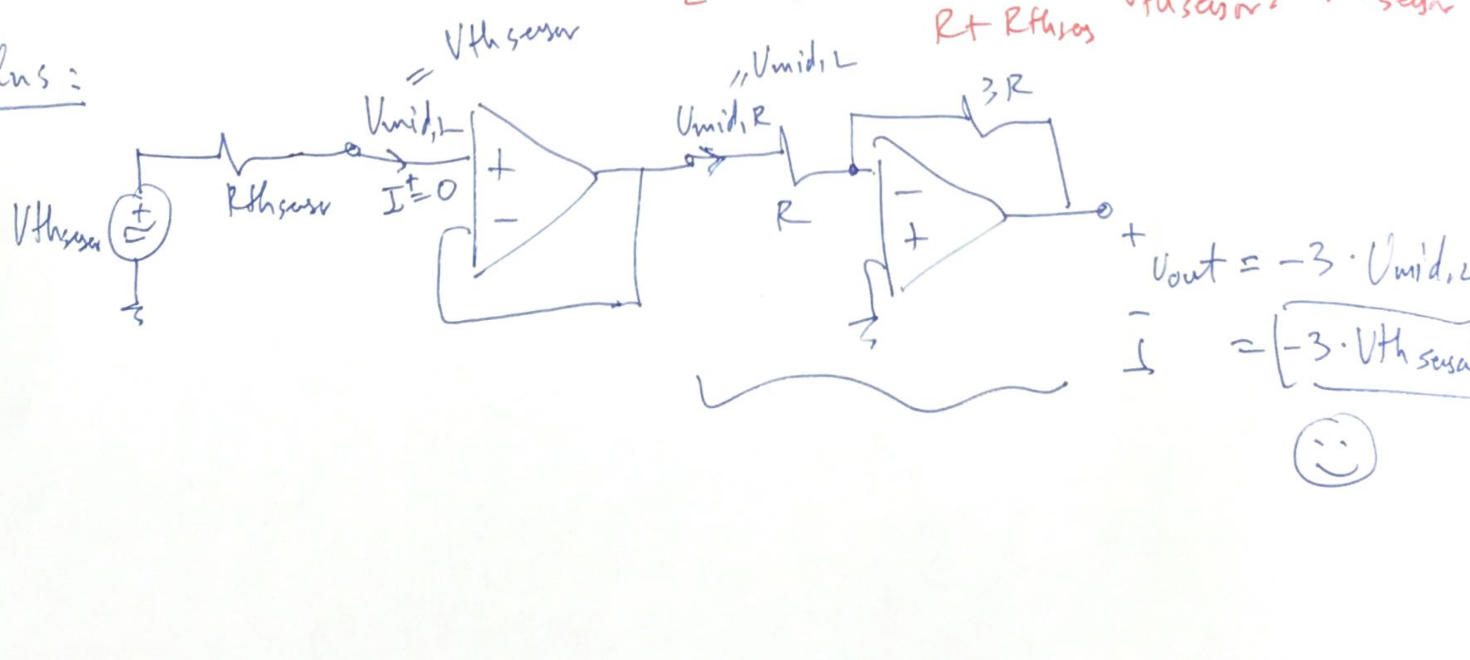
Verify: $V_{mid,L} = V_{th\,sensor}$

$V_{mid,L} = V_{th\,sens} - R_{th\,sens} \cdot \frac{V_{mid,L}}{R}$

$V_{out} = -\frac{R_2}{R_1} \cdot V_{in}$

$V_{mid,L} = \frac{R}{R + R_{th\,sens}} \cdot V_{th\,sensor} \neq V_{th\,sensor}$

solns:



$= \boxed{-3 \cdot V_{th\,sensor}}$ ☺

(2)

Design procedure:

step 1: (specification)

Concretely (re)state your goal for the design. (most often from a word specification)

step 2: (strategy)

Describe (often as a block diagram) <u>the strategy</u> to achieve this goal.

↳ often review what you can <u>measure</u> vs. what you wanted to know.

↳ what is the relationship between the two (e.g. touch / no-touch)

step 3: (Implementation)

Implement the components within the strategy

↳ Remind yourself of the blocks you know that can provide the wanted function (or be adapted to provide this function)

↳ Think about how to modify / adapt the blocks (iteration #1000)

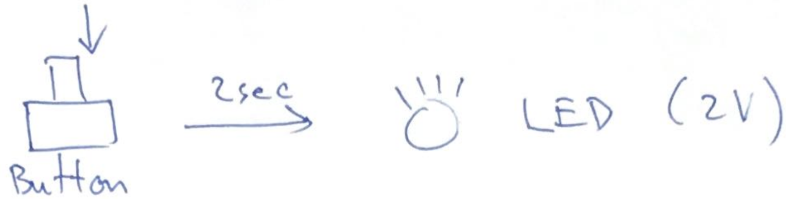
step 4: (verification / analysis)

Does the implementation in step 3 satisfy the specification in step 1?

↳ <u>check for block to block connections.</u>

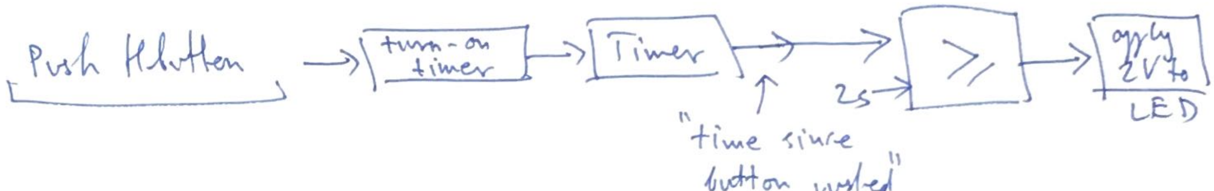
(4)

Example design #1: ("Countdown timer")



step 1: (spec) Build a circuit that after a button is pressed measures 2s and then applies 2V across an LED. (I assume you can press the button only once)

step 2: (strategy)

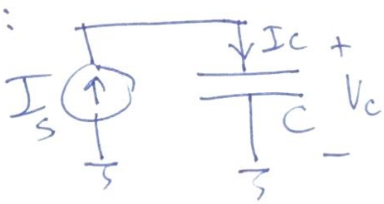


step 3: (implementation)

① Turn-on a timer :

switch

② Timer :

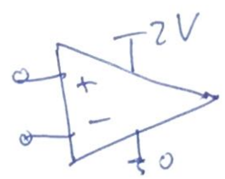


$$I_C = C\frac{dV}{dt}$$

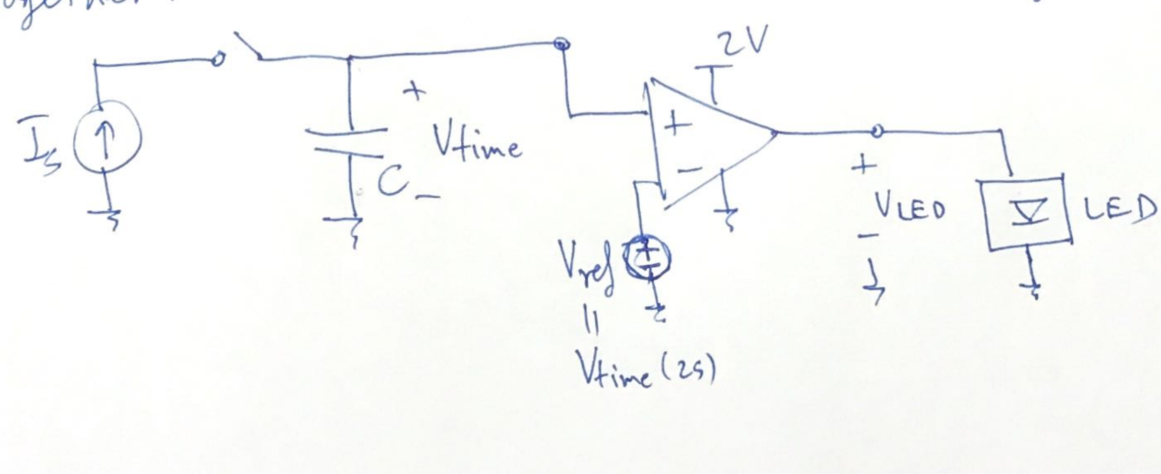
$$V_c(t) = \frac{I_s}{C}\cdot t + V_c(0)$$

③

:

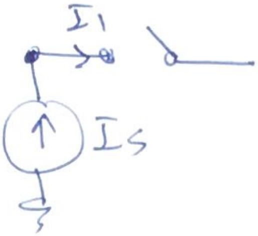


Together:



(15)

step 4:
(Verify)



$I_1 = 0$ (swith off)

$I_1 = I_s$ (switch on)

KCL: $I_s = I_1$ (always)

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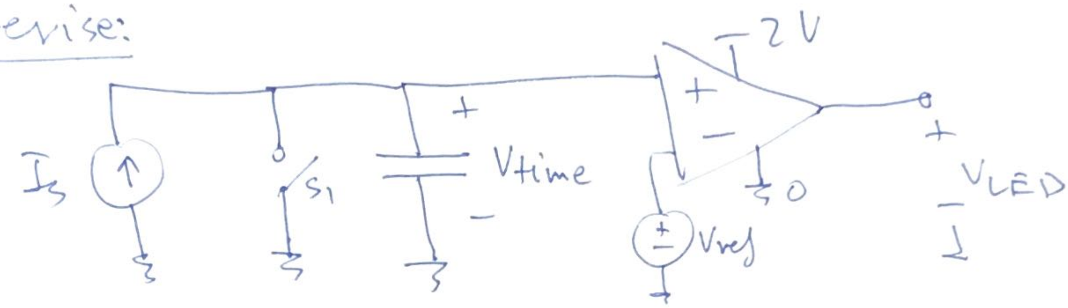
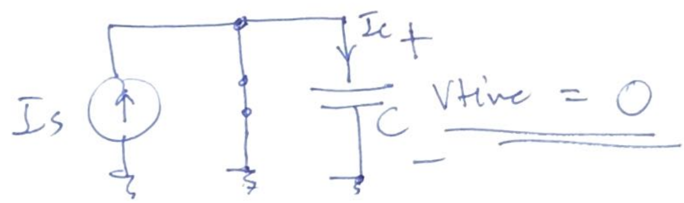
revise:

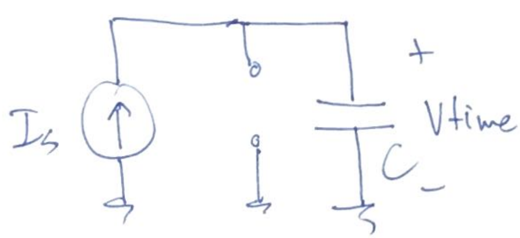


Before the button is pushed S_1 = on (wire)



$I_c = C \frac{dV_{time}}{dt} = 0$

when push the button @ $t = t_0$ S_1 = off (o.c.)



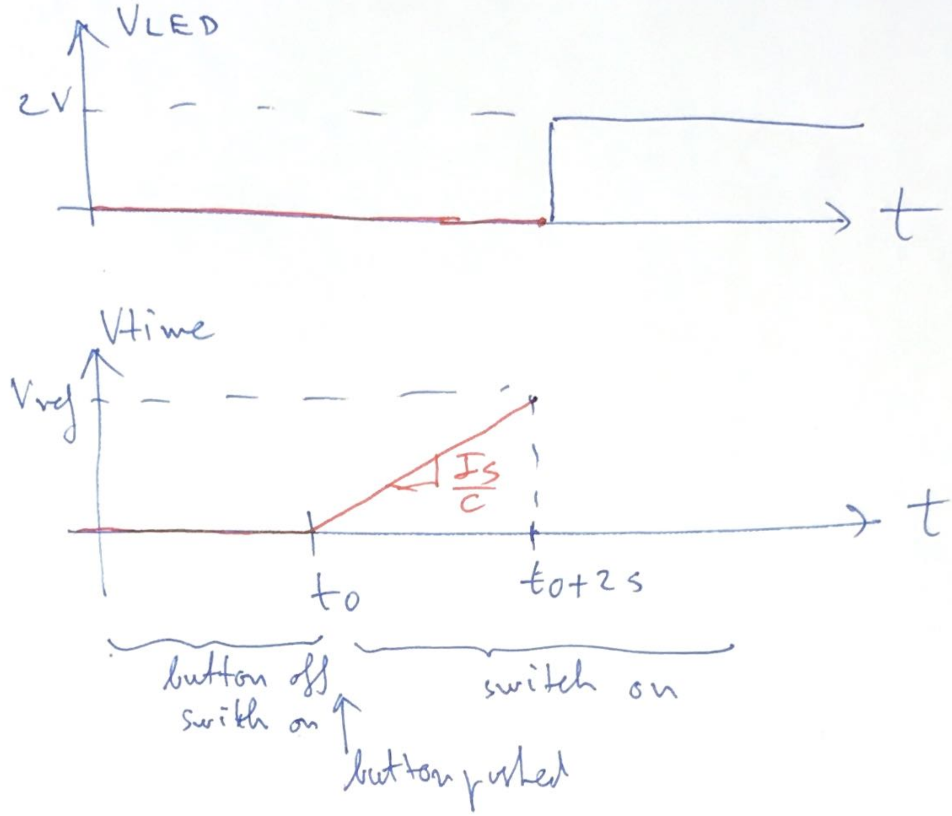
$V_{time}(t_0) = 0$

$V_{time}(t) = \frac{I_s}{C} \cdot (t - t_0) + \cancel{V_{time}(t_0)}$ (→ 0)

$V_{time}(t) = \frac{I_s}{C} \cdot (t - t_0)$

$V_{time}(t) = \frac{I_s}{C} \cdot 2s = V_{ref}$

($t = t_0 + 2s$)


VLED
2V
t
Vtime
Vref
Is
c
t
t0
t0+2s
button off
swith on
switch on
button pushed