Cascading cheat blocks continued

Design procedure

Design examples

Ideal isolation scenario:

From perspective of block $f$ $\Rightarrow$ see an open-circuit.

From perspective of block $g$ $\Rightarrow$ see a voltage-source.
**Example 1:**

\[\text{Want this!} \quad A_v = 10\]

\[\text{Implement:}\]

\[V_{\text{mid, L}} = \frac{R_2}{R_1 + R_2} V_{\text{in}}\]

\[A_v = \left(1 + \frac{R_2}{R_1}ight) = 10\]

\[V_{\text{mid, L}} = V_{\text{mid, R}} = \frac{R_2}{R_1 + R_2} V_{\text{in}}\]

**Example 2:**

\[V_{\text{in, other vol.}} \rightarrow \text{Sensor} \rightarrow -3\]

\[I_e = \frac{V_{\text{in, 5}}}{R + R_{\text{th, 5}}} \quad \text{before connection: } V_{\text{mid, L}} \quad \text{connection: } V_{\text{mid, R}}\]

\[V_{\text{mid}} = \frac{R}{R + R_{\text{th, 5}}} \cdot V_{\text{in, 5}}\]

\[V_{\text{ref}} = R_{\text{th, 5}} \cdot \frac{V_{\text{in, 5}}}{R + R_{\text{th, 5}}}\]
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) the strategy to achieve the goal.

- Often review what you can measure vs. what you wanted to know
- What is the relationship between the two (e.g. touch/no-touch)

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touch/no touch ——> change in cap ——> change in voltage
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Step 3: (Implementation)

Implement the components within the strategy

- Remind yourself of blocks you know that can provide the desired block function.
- Think about how to extend/modify the blocks you know (attempt #1000)
Step 4: Does the implementation in step 3 Analysis/Verification do what the spec in step 1 says?

- Check for block-to-block connections
- Especially if different people work on different blocks.

Example #1 design: ("Countdown timer")

- 2sec LED

Step 1: Build a circuit that after a button is pressed measures 2s and will then apply 2V across the LED.
(I assume you can only push the button once)

Step 2: Strategy

Press the button → Turn on timer → Timer → "time since button pressed" ≥ 2sec ➔ Apply 2V to LED
Step 3: Implement

"Turn-on" del

\[ Q = C \cdot V \]
\[ I_t = C \cdot V_c \]

\[ I_c = C \cdot \frac{dV_c}{dt} \]

\[ V_{\text{time}} = V_c(t) = \frac{I_c}{C} \cdot t + V_c(0) \]

\[ V_{\text{time}} = \frac{I_{\text{ref}}}{C_{\text{ref}}} \cdot t \]
\[ V_{\text{ref}} = \frac{I_{\text{ref}}}{C_{\text{ref}}} \cdot 2.5 \text{sec} + \]

Step 4:

\[ V_{\text{time}}(t) = \frac{I_{\text{ref}}}{C_{\text{ref}}} \cdot t + V_{\text{time}}(0) \]

\[ I_{\text{sink}} \]
\[ I_{\text{ref}} \neq I_{\text{switch}} \neq 0 \]

violating KCL
Before the button is pushed: $s_1$ is on

When you push the button: $s_1$ is off

In the lab, no current source.

Next, figure out how to build a current source out of $V_s$, $R$, op-amp, etc.