

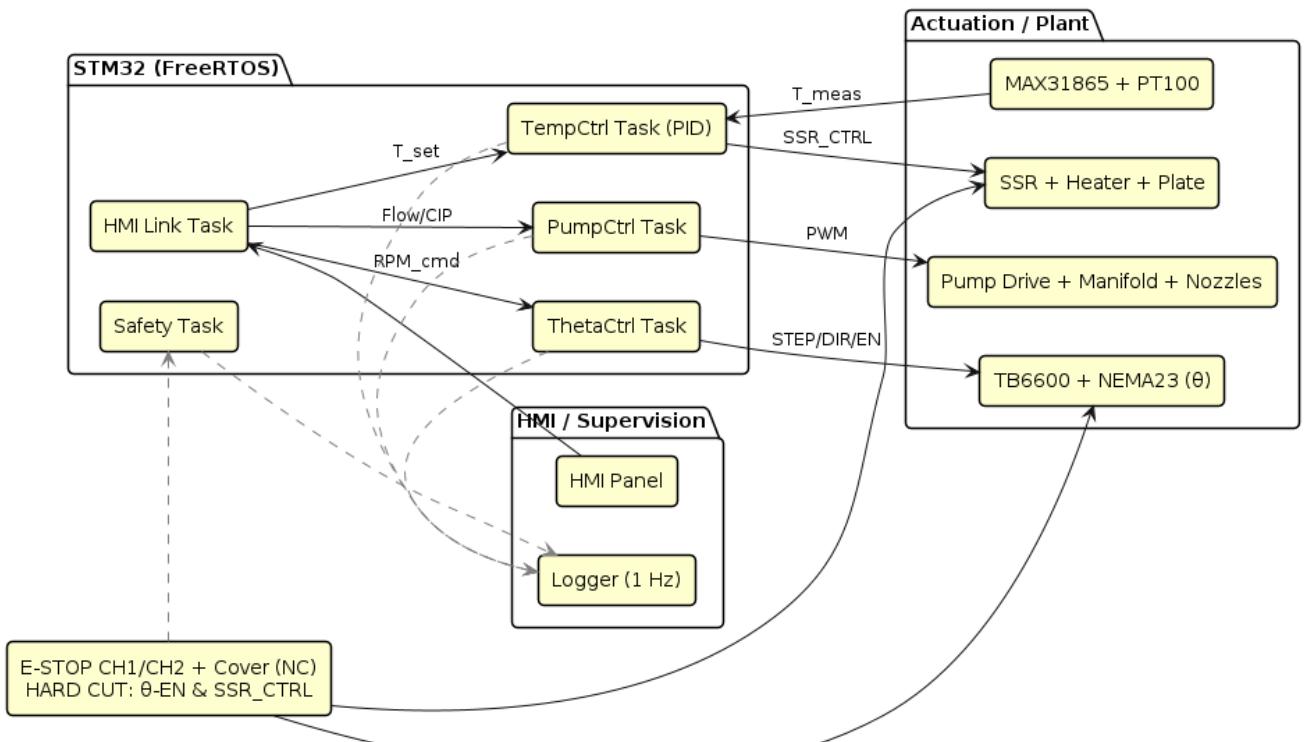
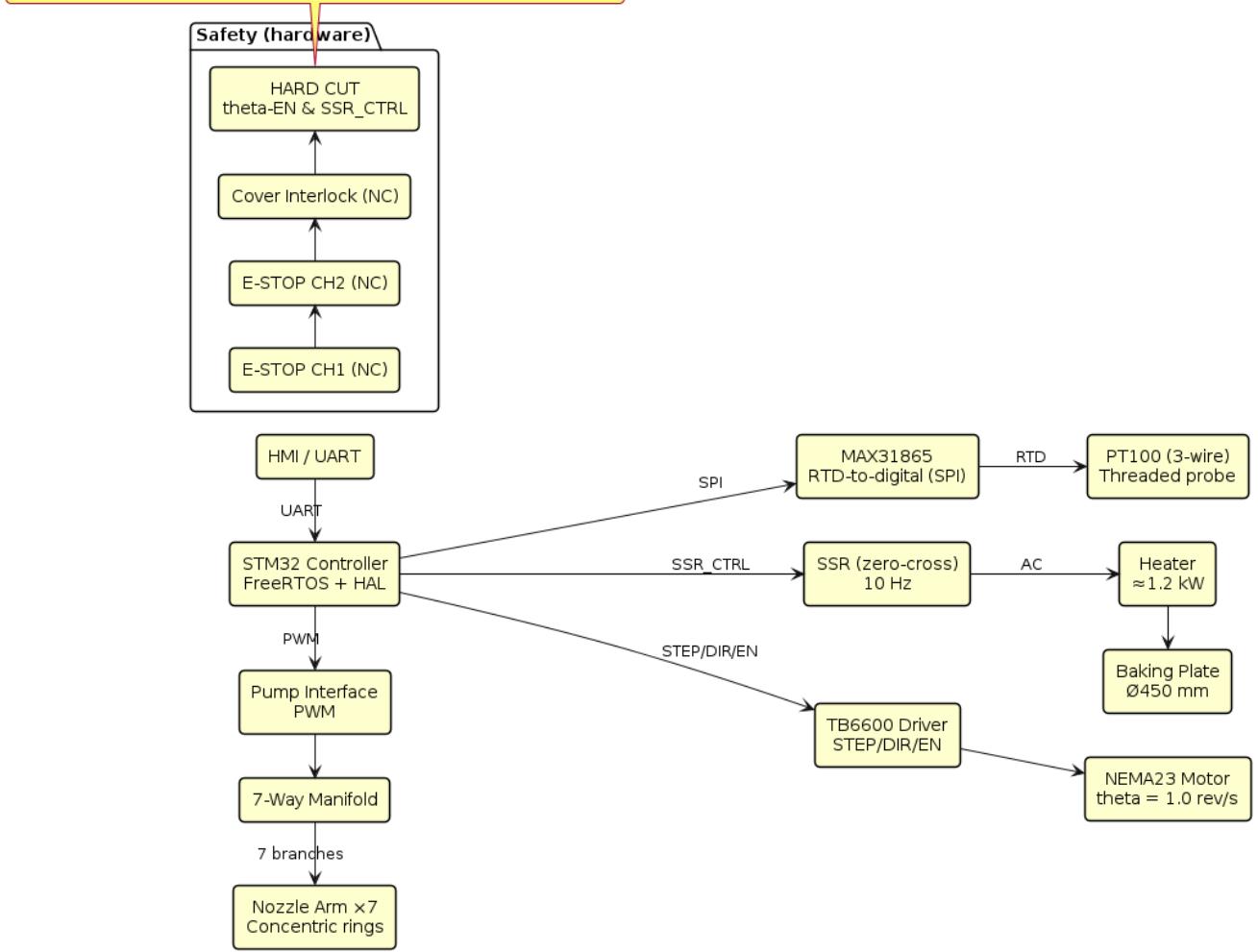
# System Architecture

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## 1) Overview

The STM32 controller supervises three subsystems—thermal, motion, and dispense—while a hardware safety chain can de-energize heat and motion independent of firmware.

E-stop + cover interlock hard-cut theta-enable and SSR control in hardware.  
MCU only mirrors safety state.



## 2) Power & Safety

- 230 VAC → EMI filter → MCB → RCD.
- Branches: (a) 24 VDC controls; (b) AC heater via SSR → thermal cutoff → heater.
- Hardware safety chain (E-STOP CH1/CH2 + cover NC) hard-cuts theta-EN & SSR.

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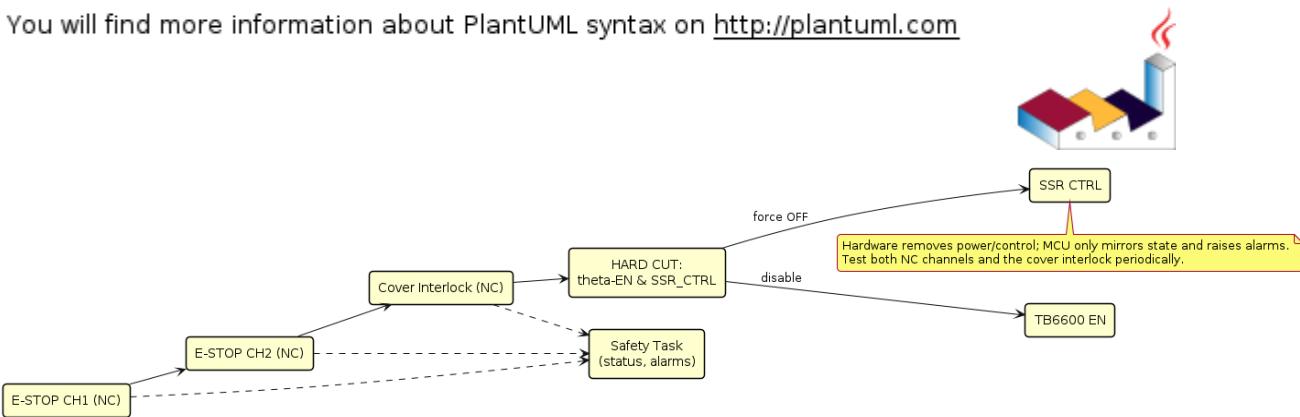
You can start with a simple UML Diagram like:

Bob->Alice: Hello

Or

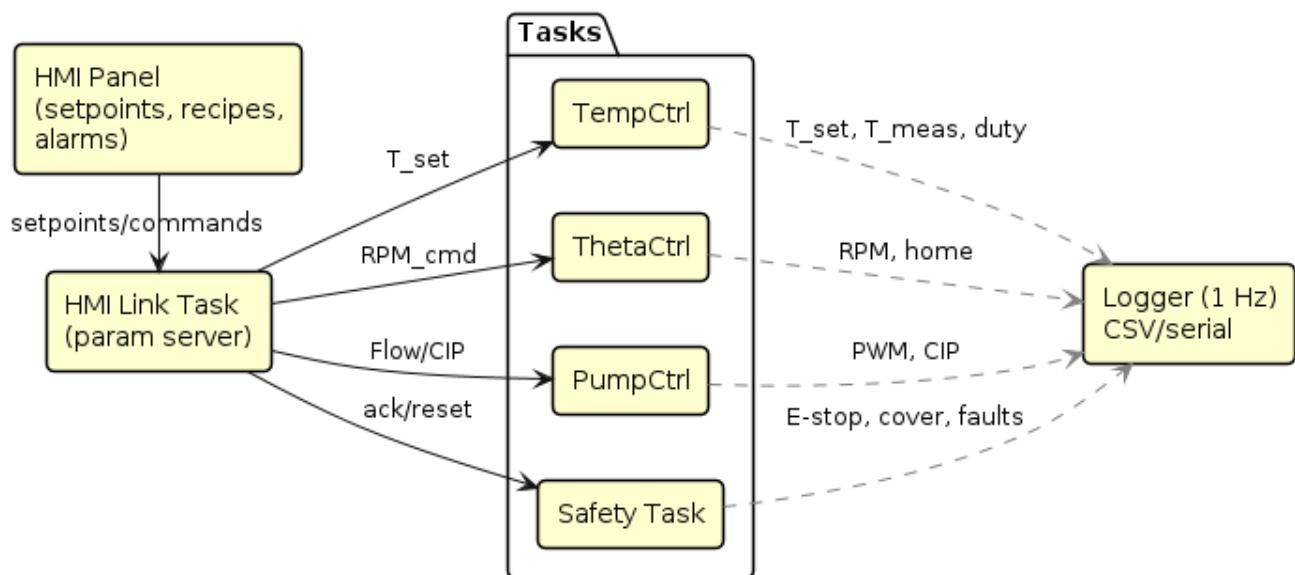
class Example

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## 3) Control Electronics (24 V domain)

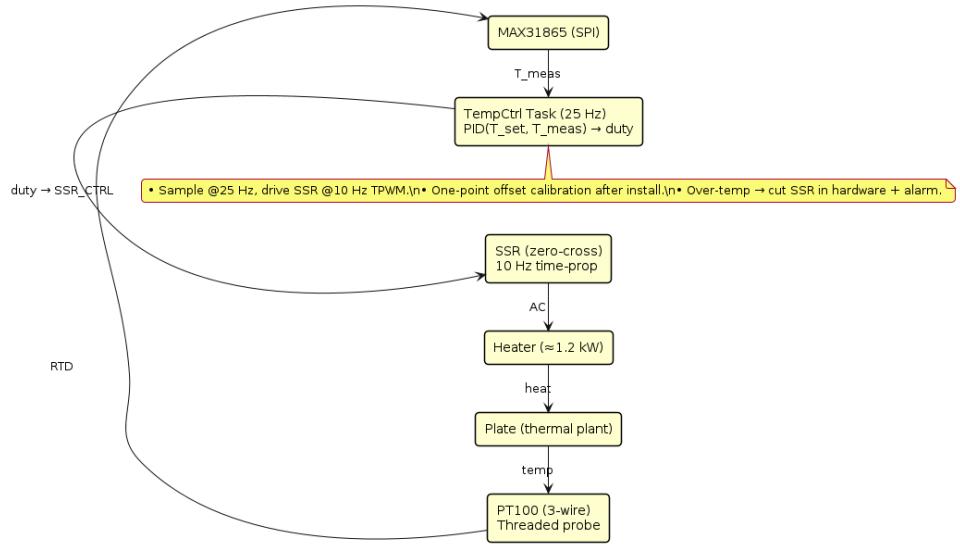
STM32 (FreeRTOS), MAX31865 + PT100, SSR at 10 Hz, TB6600 + NEMA23 ( $\theta$ ), pump PWM, HMI/Logger.



## 4) Subsystems

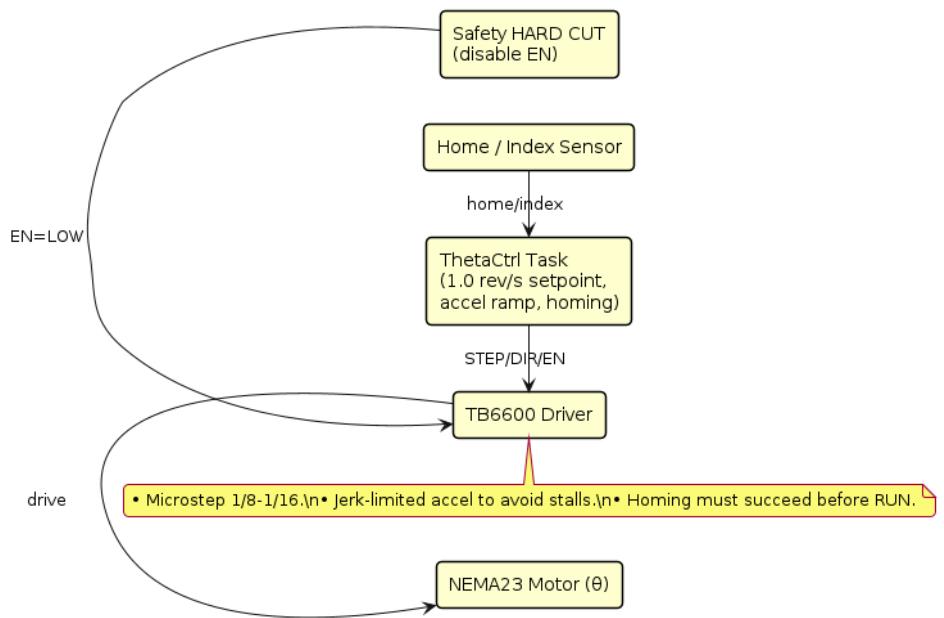
## 4.1 Thermal (bake plate)

PT100 → MAX31865 → Temp PID → SSR → heater → plate. Target: 210–230 °C, ±3 °C under cycling.



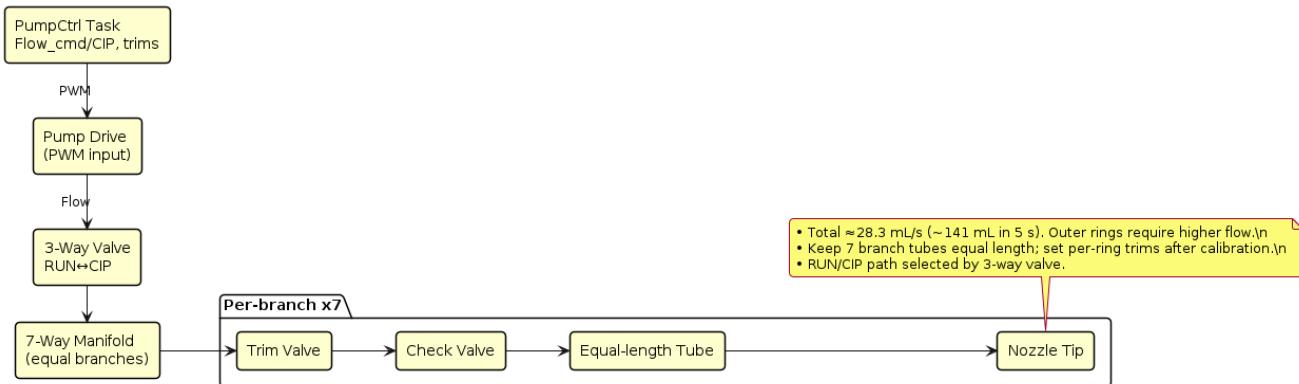
## 4.2 Motion ( $\theta$ -axis)

1.0 rev/s with homing + jerk-limited ramps; STEP/DIR/EN → TB6600 → NEMA23; hardware EN cut.



## 4.3 Dispense (pump + manifold)

Single pump → 3-way RUN/CIP → 7-way manifold → trim/check/tube → 7 nozzles; equal-length branches; outer rings get higher mL/s.



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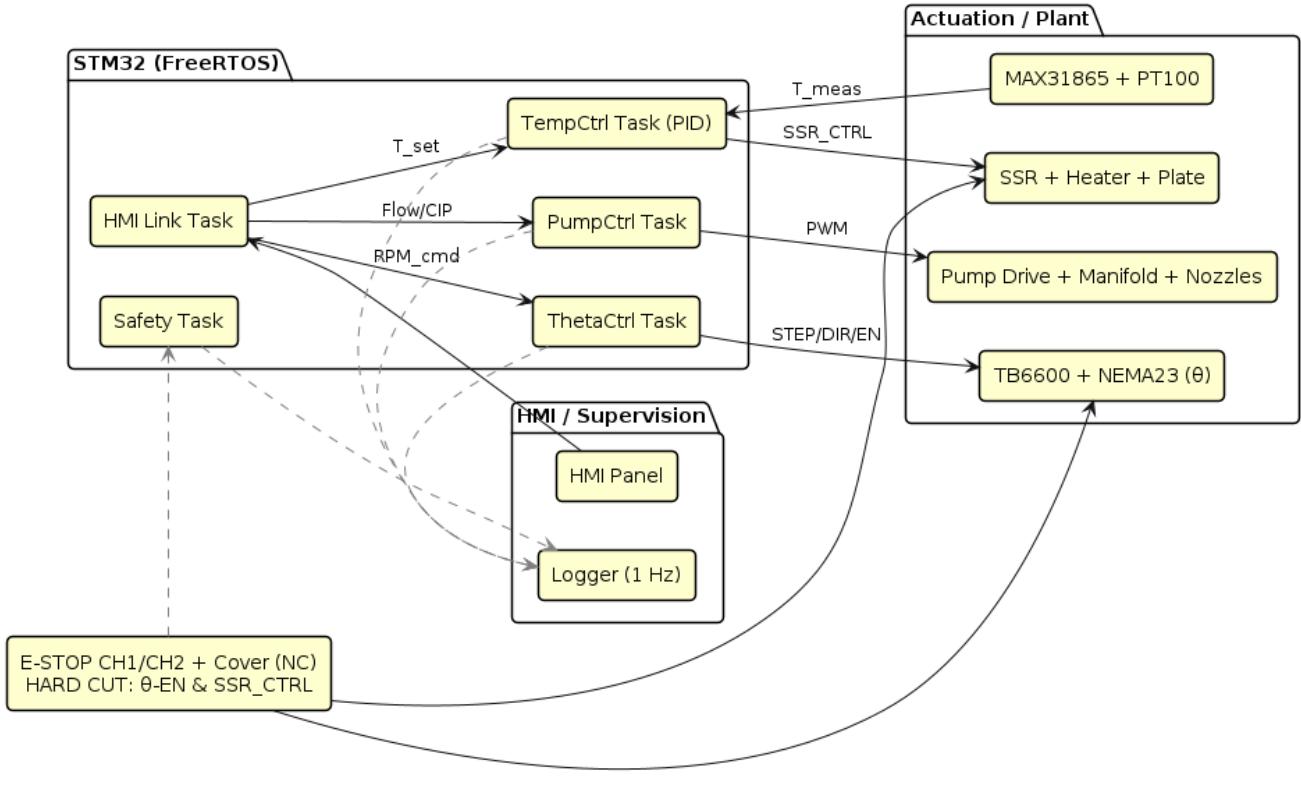
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class Example
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## 5) Software (FreeRTOS tasks)

Safety (1 kHz), TempCtrl (25 Hz; SSR 10 Hz), ThetaCtrl (timer-driven), PumpCtrl (10 Hz), HMI (2 Hz), Logger (1 Hz).



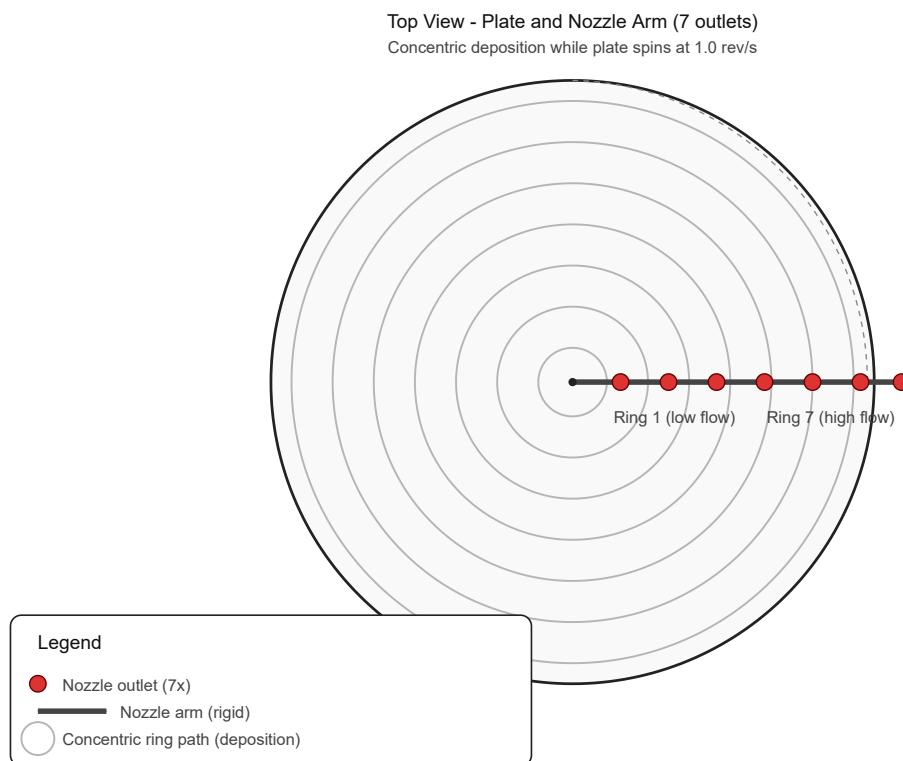
## 6) Timing & Key Parameters

- θ speed: **0.2 rev/s**
- Dispense: **5 s, ~28.3 mL/s** total (~141 mL)
- Temp sample: **25 Hz** (PID), **10 Hz** SSR drive
- Safety scan: **1 kHz** • Logging: **1 Hz**

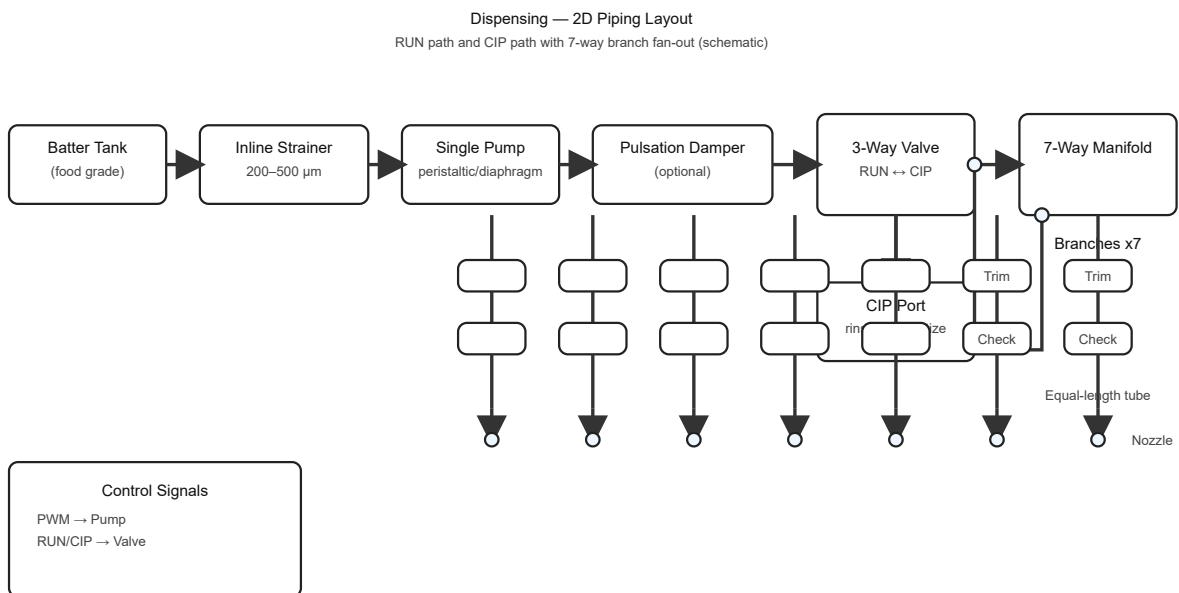
## 7) Dispensing — 2D Drawings (SVG)

These render natively on GitHub. Place the files under [docs/architecture/svg/](#).

- Top View (plate + rotating arm + 7 nozzles):



- 2D Piping Layout (RUN/CIP + 7 branches):



## 8) Video Simulation (One Revolution)

Animated visualization of a single **5 s** cycle where the arm completes **exactly one full revolution** while depositing seven concentric rings.

Place this file at [docs/architecture/media/dispense\\_simulation\\_one\\_rev.gif](#) and embed as below:

Dispensing Simulation — One revolution, t = 0.00s

