GITHUB

https://github.com/Sidiment/Hardware-Software-Lab.git

First Device: Spoon

ST25R3911B-AQFT

https://www.st.com/content/ccc/resource/technical/document/datasheet/group3/ba/60/79/5c/bb/a9/41/76/DM00321525/files/DM00321525.pdf/jcr:content/translations/en.DM00321525.pdf

XIAO ESP32-C3 (BLE mode)

https://files.seeedstudio.com/wiki/XIAO/Seeed-Studio-XIAO-Series-SOM-Datasheet.pdf

SSD1306

https://cdn-shop.adafruit.com/datasheets/SSD1306.pdf

Second Device: Jar

XIAO ESP32-C3 (BLE mode)

https://files.seeedstudio.com/wiki/XIAO/Seeed-Studio-XIAO-Series-SOM-Datasheet.pdf

28BYJ-48
https://www.mouser.com/datasheet/2/758/stepd-01-data-sheet-1143075.pdf?srsltid=AfmBOoq5z3ev5svOE4rIGhY33OD_PrCuW5DdXPEXAfpGHy5rfrUI_66M

LED Light…

1. Overview of Devices and Usage

Spoon Device

- **Components:**
  • **ST25R3911B-AQFT NFC Reader** (see its datasheet
  st.com
)
  • **XIAO ESP32-C3** (BLE mode; see its datasheet
  files.seeedstudio.com
)
  • **SSD1306 OLED display** (only updates when NFC is detected; datasheet
  cdn-shop.adafruit.com
)
- **Usage Model:**
  The NFC is activated upon trigger and then remains in low-power standby while the display updates. The device is expected to run in full active mode for approximately 3–4 hours.

Jar Device

- **Components:**
  • **XIAO ESP32-C3** (BLE mode; same datasheet as above)
  • **28BYJ-48 Stepper Motor** (for indicating seasoning levels; datasheet
  mouser.com
)
  • **LED Light Indicator** (a standard low-power LED; for example, a typical 5 mm LED drawing ~20 mA when on)
- **Usage Model:**
  The Jar stays in deep sleep (standby) for most of the day—targeting a 24-hour cycle—and then switches to active mode for 3–4 hours when it connects with the Spoon.

2. Estimating Average Current Consumption

Spoon Calculation (Active Mode Only)

For a 4-hour active period, we can roughly assume:

- **XIAO ESP32-C3:** ~70 mA in BLE mode
- **SSD1306:** ~20 mA when actively updating
- **ST25R3911B-AQFT:** ~30 mA when active

Total Active Current:
70 mA + 20 mA + 30 mA ≈ **120 mA**

Required Capacity (4 hours):
120 mA × 4 h = **480 mAh**

Adding a 50% safety margin to account for inefficiencies, battery aging, and variation in duty cycles:
480 mAh × 1.5 ≈ **720 mAh**

Thus, a battery in the 700–750 mAh range is suitable for the Spoon.

Jar Calculation (24-Hour Cycle: Mostly Idle with Active Bursts)

Assumptions:

- **Idle (Deep Sleep):**
  XIAO ESP32-C3 deep sleep draws about 43 µA (≈0.043 mA). For ~20 hours of idle:
  0.043 mA × 20 h ≈ **0.86 mAh** (nearly negligible)
- **Active (4 hours):**
  - **XIAO ESP32-C3 (active):** ~70 mA
  - **Stepper Motor:** While its rated current (with 5V across a ~50Ω winding) could be high, it will only be active in brief bursts. Averaging its contribution over the 4-hour period, assume ~30 mA.
  - **LED Indicator:** ~5 mA (with current-limiting resistor and duty cycling)

Total Active Current:
70 mA + 30 mA + 5 mA ≈ **105 mA**

Required Capacity (Active Period):
105 mA × 4 h = **420 mAh**

Total for 24 hours (idle + active) ≈ 0.86 mAh + 420 mAh ≈ **420 mAh**

Again, adding a 50% safety margin:
420 mAh × 1.5 ≈ **630 mAh**

Given that batteries are available in standard capacities and to provide extra headroom (and to account for any additional inefficiencies during mode transitions), a battery around **1000 mAh** is a practical choice for the Jar.

2. Battery Selection

- **For the Spoon:**
  - A small LiPo battery rated around **1000mAh** is a common, off-the-shelf option. *https://www.adafruit.com/product/1578*

- **For the Jar:**
    - Same as spoon as we calculated

Reflection

So, here's the deal: I figured out the "days of use" metric by splitting the day into the parts when the device is active (about 3–4 hours) and when it's just chilling in sleep mode for the rest of the day. That way, I could average the current draw over a full 24 hours.

For the Spoon, the numbers came out to need roughly a 700–750 mAh battery, and for the Jar, around 1000 mAh seems to be the sweet spot. This gives us a good buffer so the devices run reliably without needing constant recharges.

As for tradeoffs, there are a few things you can tweak: you could pick even lower-power components, or optimize the software to spend more time in sleep mode. Sure, upgrading might bump up the cost or add a bit more design work, but it can really boost battery life and overall user experience in the long run.