IV Flow‑Meter – Minimal Bidirectional UART Logging Strategy

Design decision v1 – 30 May 2025

# **1 Objective**

Provide an ultra‑low‑cost, low‑power logging upgrade that enables field staff to retrieve diagnostic data from the pediatric IV flow‑rate monitor without adding external memory, wireless modules, or significant bill‑of‑materials (BOM) complexity. The chosen solution must preserve the existing frugal ethos while supplying bidirectional access for scientific validation, troubleshooting, and firmware maintenance.

# **2 Current design baseline (TX‑only stream)**

• Single UART TX pad streams live drop events and alarms at 115 200 baud.  
 • No receive capability, so the device cannot answer queries, dump history, or accept commands.  
 • No persistent storage; power‑cycle erases RAM.  
 • Adequate for bench tests but inadequate for field troubleshooting or regulatory traceability.

# **3 Selected enhancement (#1)**

Expose the UART RX pin (PA10) on the same copper pad that already carries TX, creating a half‑duplex interface. Insert a 1 kΩ series resistor near the MCU to prevent contention when nothing is connected.

# **4 Implementation details**

• \*\*PCB\*\*: one additional trace; no new connectors.  
 • \*\*Firmware\*\*: lightweight command interpreter (≈ 0.6 kB) supporting commands:  
 – `DUMP n`  retrieve last n events in RAM ring buffer  
 – `VERSION` report firmware build and git hash  
 – `SELFTEST` run LED/photodiode diagnostics  
 – `ERASE`  clear RAM buffer  
 • \*\*Field kit\*\*: off‑the‑shelf USB‑UART cable or optional BLE dongle clips to the pad when needed.  
 • \*\*Electrical\*\*: idle line draws 0 µA; active RX sampling adds < 50 µA only when cable attached.

# **5 Power and cost impact**

• \*\*BOM delta\*\*: ≈ 0 € (trace + 0402 resistor).  
 • \*\*Quiescent current\*\*: unchanged (RX disabled in Stop 2 mode).  
 • \*\*Firmware flash\*\*: +0.6 kB of 64 kB available.

# **6 Benefits vs limitations**

\*\*Benefits\*\*  
 • Retrieve fault history after an alarm clears.  
 • Accelerate bench calibration by issuing commands without recompilation.  
 • Provides audit trail for ISO 80601 compliance when paired with external logger.  
  
 \*\*Limitations\*\*  
 • No persistence after battery removal (RAM only).  
 • Requires technicians to bring a serial dongle to the ward.  
 • Basic authentication (challenge‑response) recommended to avoid accidental commands.

# **7 Next actions**

Firmware – implement command parser; gate RX interrupt during Stop 2.  
 Hardware – update schematic (Rev‑B) and reroute top layer to add RX trace.  
 Testing  – 24 h bench run with scripted `DUMP 256` every hour; verify latency ≤ 100 ms.  
 Documentation – update risk analysis and verification matrix to include bidirectional logging tests.

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