



# Natural Timers for IoT

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## Sometimes Battery Longevity is more important than Measurement Timing

- Does a farmer require measurements from a field exactly every 10 minutes, or on the order of 10's of minutes?
- Since the timing of this does not need to be precise, we can say the farmer is **Timing Insensitive**
- Let's apply the same concept to Embedded System

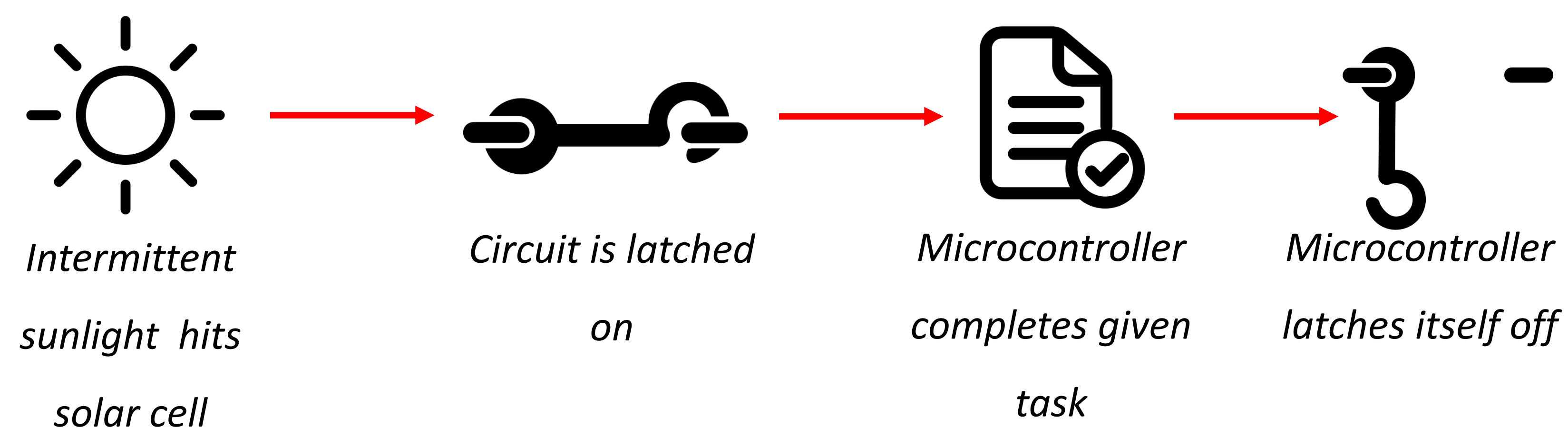
## Nature Offers Periodic Processes

- What if we didn't need the real time clock in our system?
- What if we could use a gust of wind, sunshine or cloud cover, or a bird visiting a birdfeeder to wake up our microcontroller?
- What if instead of sleep/awake mode, we had **dead/alive mode**?

## Let's Use These Processes to Wake our device from an ultra-low power mode

- Let's build a **latching circuit**

## High-Level Process Overview



## The Latching Circuit

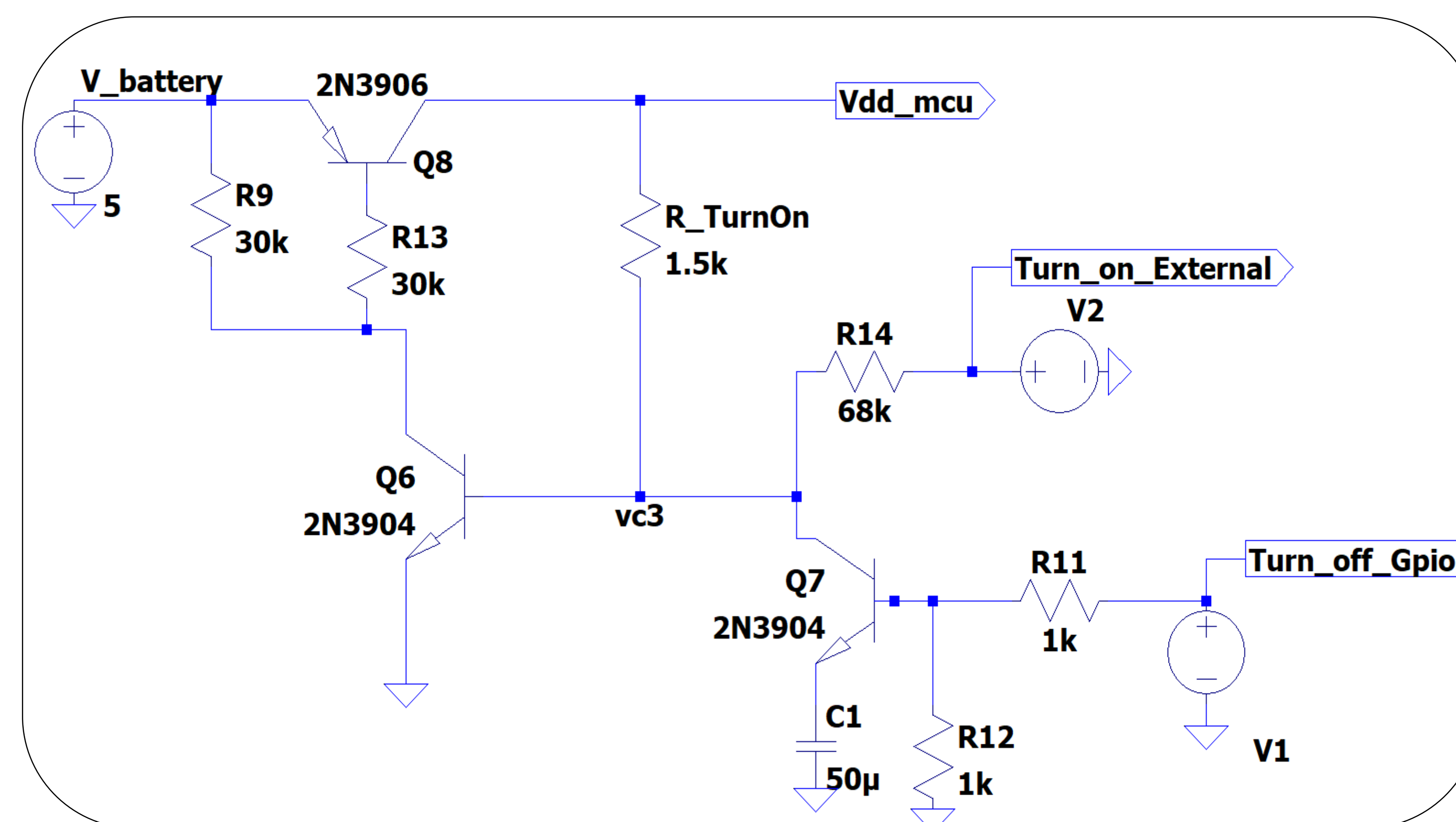


Figure 1: LTSpice Designed Latching Circuit

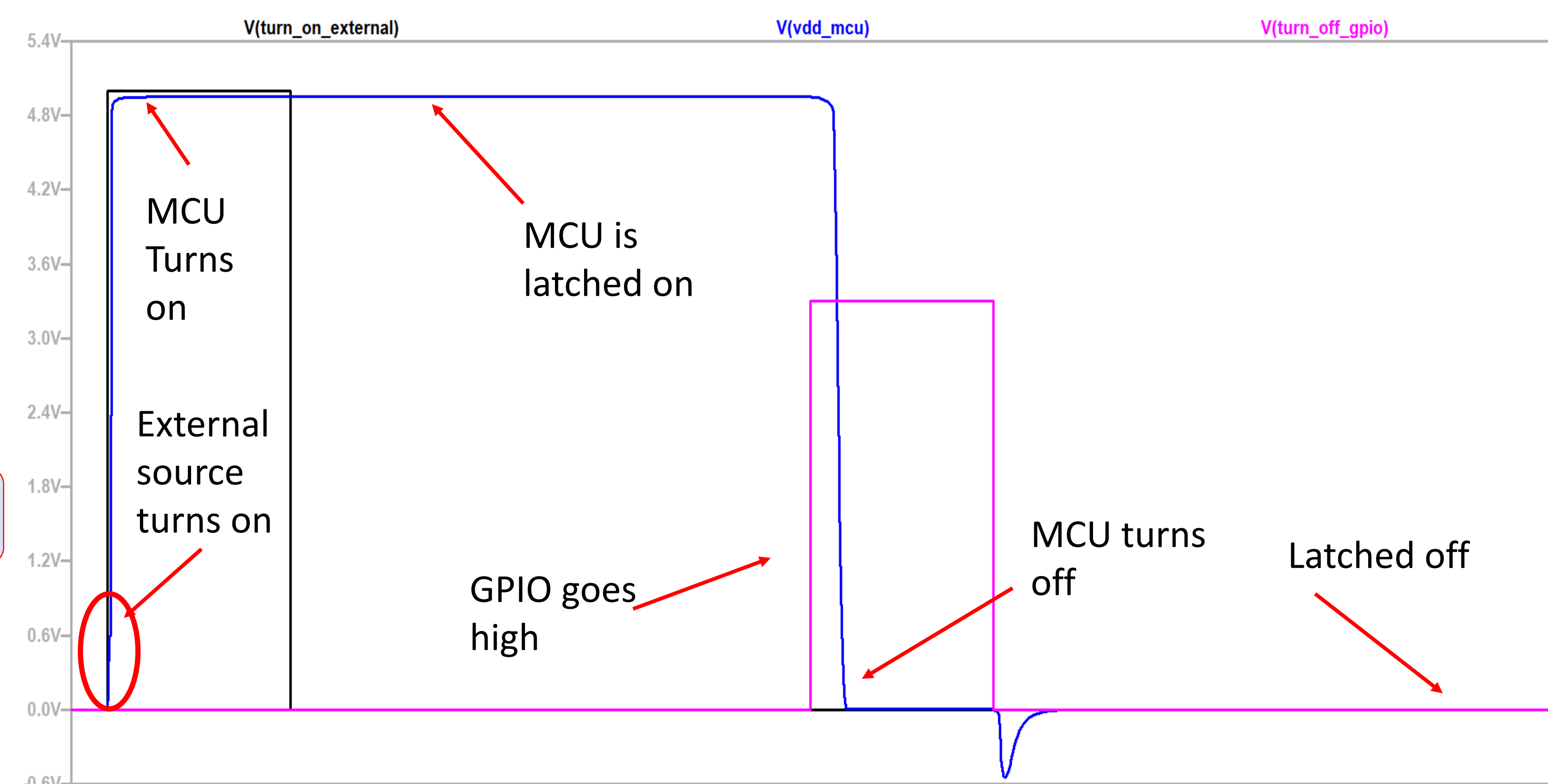


Figure 2: LTSpice Simulated Results (Latching On and Off of Device)

## Current Draw in Sleep/Awake Experiment

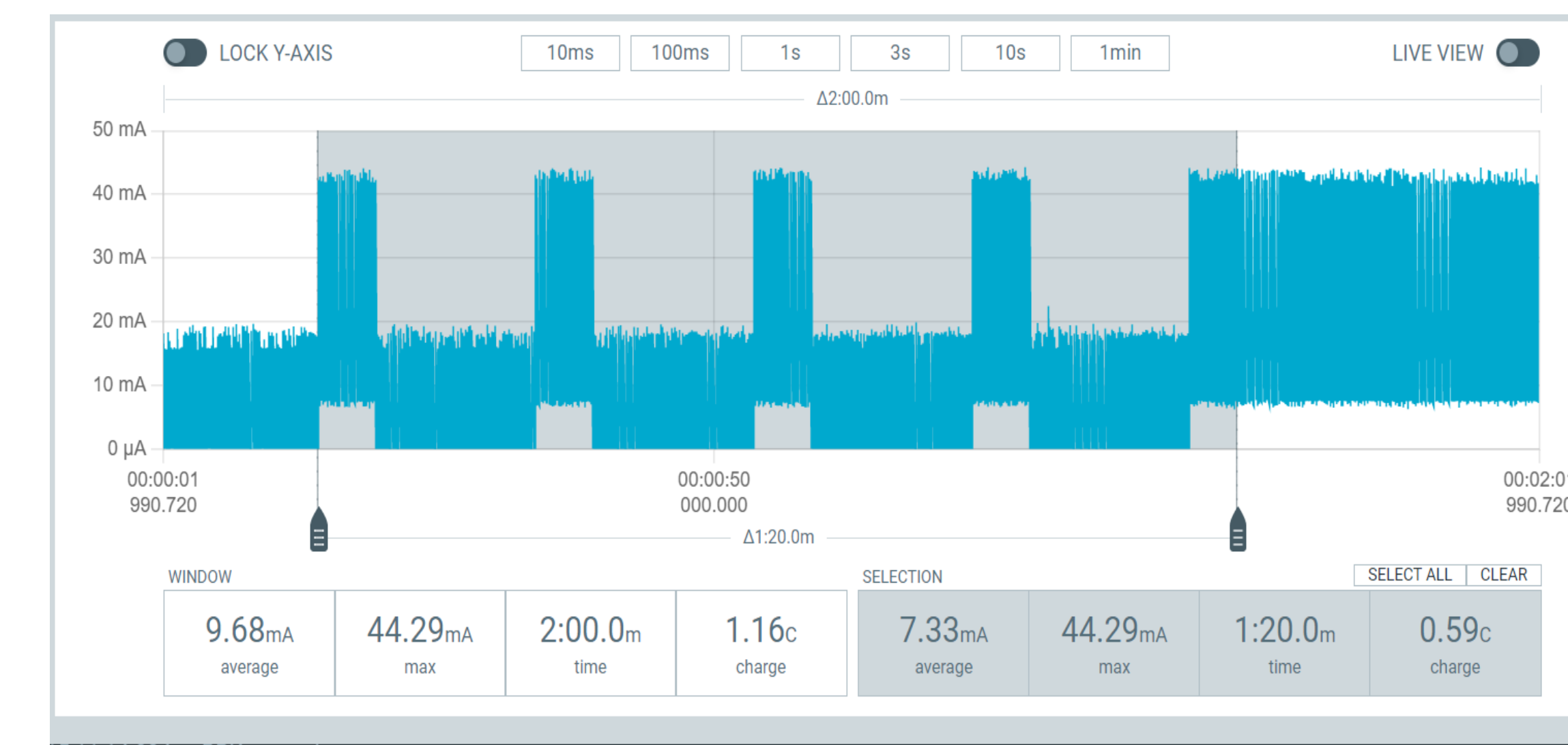


Figure 3: Current Draw Going from Sleep to Awake Mode

## Current Draw in Dead/Alive Experiment

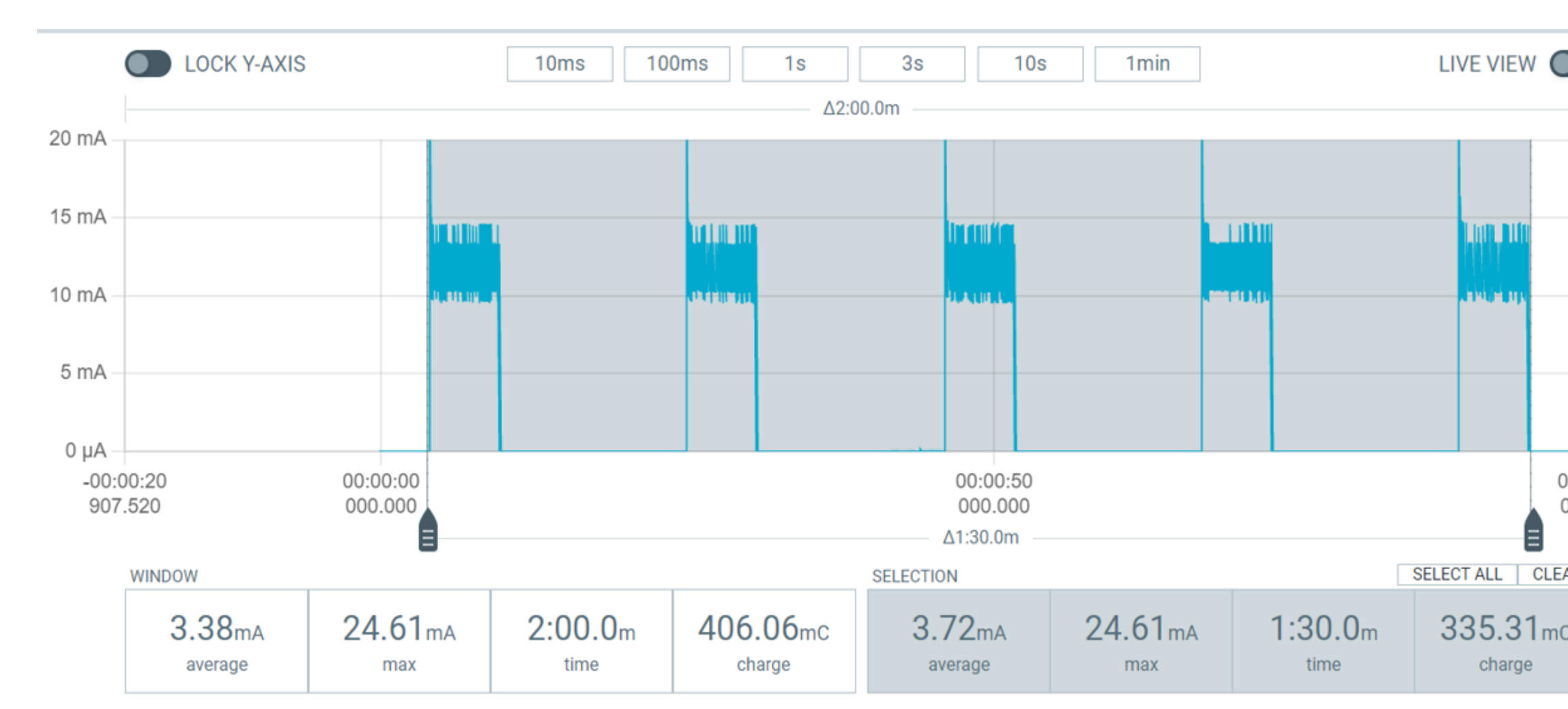


Figure 4: Current Draw Going from Dead to Alive Mode

## Benefits and Costs

- Two Double A Batteries: 4000mAh
- Sleep Mode:
  - $(4000\text{mAh}/7.33\text{mA}) / 24 \text{ hours} = 22.72 \text{ days}$
- Dead/Alive Mode:
  - $(4000\text{mAh}/3.72\text{mA}) / 24 \text{ hours} = 44.8 \text{ days}$
- About **double** the battery life using dead/alive mode rather than sleep mode at the cost of timing guarantees

## Acknowledgements

- I want like to thank Dr. Van Hunter Adams for his guidance and mentorship in this process.