

## **Executive Summary**

This design analysis compares 4 different MCUs from a couple of vendors. While all of the microcontrollers reviewed below could be used to tackle this project, we believe the STM32L432KC is best suited to the light sensor project overall. STM's 432KC ships with all of the hardware desired for the application including ample flash memory for data storage. Other options considered such as the FRDM-K32L2A4S or the raspberry pi pico were either more expensive than the 432KC, had too long a time table for shipping, or required the purchase of additional hardware. Consequently, we are certain that the STM432LKC MCU is currently the best option for the Hoosier National Forest's light monitoring undertaking.

## **Discussion of Alternatives**

### **THE STM32L432KC:**

**Vendor:** This microcontroller unit comes from STMicroelectronics. It is based around the Cortex-M4 processor and comes with a floating point unit.

**Cost:** The current cost of an STM32L432KC unit is \$10.99 and can ship immediately.

**Memory Size:** The STM32L432KC MCU comes with 64KB of static random-access memory as well as 256KB of single bank flash memory for long term storage.

**Peripherals:** The STM32L432KC MCU is packaged with a single 12-bit analog to digital converter for reading from our analog peripherals such as the battery and the light sensor. The MCU also ships with 2 12-bit DACs, an op amp for signal amplification, 2 ultra-low-power comparators, 3 USARTs, 1 low-power UART, 2 SPIs, a true random number generator, 3 general purpose timers, 2 low-power timers, and a 77 vector NVIC.

**Power Utilization:** The STM32L432KC supports four modes of operation: run, standby, stop and shutdown. Run mode operation draws 84µA/Mhz while standby, stop and shutdown draw 280nA, 8nA and 1µA respectively.

**Package Size:** UFQFPN-32

## **THE STM32L412KB:**

**Vendor:** This MCU comes from STMicroelectronics. And is equipped with the aforementioned Cortex-M4 and FPU.

**Cost:** The STM32L412KB costs \$10.32 per board and currently has a 16 week lead time.

**Memory Size:** The STM32L412KB MCU has 128KB of single bank flash memory and 40KB of SRAM.

**Peripherals:** The device comes with 2 ADCs, 2 op amps, 1 low-power comparator, 3 USARTs, 1 low-power UART for wake-up, a true random number generator, 3 general purpose timers, 2 low-power timers, and an 83 vector NVIC.

**Power Utilization:** Again, the MCU is capable of operating in the same four distinct modes of operation as above although the power draw in each of these modes is different. This MCU draws power ranging from .7 $\mu$ A to 79 $\mu$ A/Mhz.

**Package Size:** QFN-32

## **FRDM-K32L2A4S:**

**Vendor:** The vendor for this MCU is NXP USA. This board is built around the ARM Cortex-M0+ processor.

**Cost and Availability:** The FRDM-K32L2A4S currently costs \$33.92 and has a 34 week lead time.

**Memory Size:** The K32L2A4S MCU comes with 128KB static RAM and 512KB of flash memory for long term data storage.

**Peripherals:** The microcontroller comes with low-leakage wakeup unit, 32 vector NVIC, 16-bit ADC, 12-bit DAC, 2 high-speed analog comparators, 2 low-power timers, two periodic interrupt timers, 3 low-power UART modules, and a FlexIO module for emulating UART and SPI.

**Power Utilization:** The board operates at 3.0V and has four modes of operation: run, wait, very-low-power, and stop. Current draw while operating in each of these modes is 9.6mA, 7.0mA, 483.7µA, and 264.5µA respectively.

**Package Size:** 100-LQFP

## THE RASPBERRY PI PICO RP2040

**Vendor:** Raspberry Pi, building around the RP2040 ARM chipset which is designed based on the Cortex M0+ microprocessor.

**Cost and Availability:** Available at \$4.00 per development board. Based around the RP2040 chip which does not have widespread commercial use and is not currently being squeezed by manufacturing delays.

**Memory Size:** The Raspberry Pi Pico comes with 264 KB multi-bank static RAM.

**Peripherals:** 12-bit ADC, 2x UART, 2x SPI, 2x I2c support, 1 Timer (4x alarms), 1 x Real Time Counter, 16 PWM channels, 8 PIO state machines

**Power Utilization:** Can be powered with voltages between 1.8V and 5V, supports a low power 'dormant' mode and 'sleep' mode. Board converts input to 3.3V for the microprocessor to run on.

**Package Size:** QFN-56

## Recommendation

The raspberry pi pico is the least expensive microcontroller we considered for the project. Its price point is lowest by a factor of 2. While this is a huge selling point for the MCU, the pico does not ship with all the desired hardware for the job. Most notably,

there is no on board debugger for the MCU, requiring the purchase of more hardware than just the pico itself.

The STM32L412KB is a great fit for the project, and might just be the ideal board. It has all the desired hardware, including an on-board debugger for troubleshooting code. However, global supply chains are in terrible shape since the recent pandemic and the 412KB will take at least 16 weeks to ship after ordering.

NXP's FRDM-K32L2A4S is an MCU that has a great amount of functionality. It comes with a low-leakage wakeup unit, an ADC, low-power timers, interrupt timers and more. Nonetheless, this board suffers similarly to the 412KB MCU as it will take more than 30 weeks to ship and comes at a price of \$34 per unit.

Finally, our recommendation for the light capture project is the STM32L432KC. It has more than an adequate amount of memory for device's project lifetime, has all the necessary hardware and functionality, comes with STM's strong development pipeline, costs \$11 per unit, and will be shipped as soon as it is ordered from the vendor.