The Dark Sky light sensor board has 4 main components that will allow it to be worked on and to carry out its light data collection. The debugger will allow for the attachment of the ST-Link V3 pod when it is in development or when it needs to be fixed during its lifecycle. The processor, the STM32, will be used to collect, timestamp, and store the data from the TSL237 light sensor. The TSL237 light sensor is routed to ground, power, and the processor where it sends frequency data to be translated into light data and timestamped. The accuracy of the timestamp is important to the success of the device, so the RTC in the processor uses a reliable oscillator, the Epson TG-3541, which can keep a steady frequency in -40 to 85C. Temperatures outdoors in the most non-extreme climates are within those frequencies, so this oscillator will work well for current purposes.

The other components of the light sensor board are the UART and power connectors and the battery. The power connector will be used during testing and development so a battery is not wasted while the board is being debugged and programmed, which will draw significantly more power than it will in the field. This power connector will also allow for power analysis of the board during its operation. Analyzing the power draw of the board will help to achieve the objective of long battery life in the field, which makes the board more effective. The battery cell will be put in use after testing when the board is actually deployed for use. The UART connector will be used for debugging and accessing the data on the STM32. There are some resistors and decoupling capacitors in use on the board for extra power and for reducing voltage, respectively.

The microcontroller is the most important and expensive component of the board, and so it is imperative to choose a processor capable of achieving the system's task. The STM32 is a well-known and trusted microcontroller, but with issues in the supply chain, it might not always be available from a trusted source. This is why other processors will be discussed and compared here. Not only to choose the best processor, but also to choose the best possible alternative if the STM32 is unavailable.

The three alternatives that will be discussed here are the MSP430FR5994, or MSP4 for short, from Texas Instruments, the K32 L3 from NXP, and the SAM 4L from Microchip. All of these options, like the STM32 are 32 bit ARM-based microcontrollers with Core-Mx processors. These microcontrollers will be evaluated based on memory, power consumption, size, cost, and peripherals.

The memory is important to the system, as it will be logging light data over the course of several months to years. The more flash the microcontroller has, the more samples the light sensor can take. The L3 has the most memory out of all the chips with up to 1.25 MB program flash memory and up to 384 kB SRAM. The MSP4 has 256KB of non-volatile memory, and the least ram of all the chips at 8KB. The SAM L4 has 512 KB flash and 64 KB SRAM. The STM32 holds 256 KB of flash and 64 KB SRAM. The light sensor data is very small in size, so all of the chips are comparable in memory because not much will be needed.

All of the chips are from their respective manufacturer's the low power families, but there are clear winners in this category. The STM32 wins with 84 μA/MHz in run mode. The SAM L4 uses 90uA/MHz in run mode, coming in a close second. The MSP4 uses 118 μA/MHz, which is starting to become a big difference from the STM32. The L3 does not put any amps per MHz on their website or data sheet, so it cannot compete in this category.

The peripherals for each chip are very similar. All of the microcontrollers have a multi-channel ADC but the STM32 is the only 16-bit, the rest have a 12-bit resolution. This wouldn't always have much of an effect, but the value being read in is à frequency from the light sensor, which can get very high in direct sunlight. While it should only be collecting data at night, if the timing was off it could possibly corrupt that sample. The L3 and the STM32 are the only chips with an internal temperature sensor, so the other two would need an extra sensor installed into the board. This would be relatively cheap, but it would add a component and complexity when there does not have to be.

As for serial communication, all of the microcontrollers have UART. The L3 and the STM32 are the only ones with low power UART, though. This is the only communication mode that matters to this system currently.

The timers are important to the implementation of the system, as they are used to receive the light sensor data and for the periodic wakeup of the system. As a side note, an RTC is also very important and all of the chips have one with the same crystal. The STM32 has 11 timers, 1 32 bit timer, and the rest either 16 bit timers, watchdogs or the Systick. The basic 16-bit timers are what the system code uses, so that is what will be evaluated in the other chips. The L3 doesn't include the bit size of its timers, just the number of channels, so it will be disqualified. The MSP4 has six 16-bit timers, which is enough for the system right now. The SAM L4 has only 3 16-bit timers, which is enough for the current system.

The last comparisons are of the package size and cost. The STM32, the MSP4, and the SAM L4 all come in 7x7mm packages. The STM32 also comes in a 5x5mm package. The L3 is 1 to 13 mm larger than this size. The cost for the SAM L4 is the greatest, coming in at $10.45 for one but drops down to around $7.50 at more than 5000. The MSP4 is around $4.69 for 250, which is significantly less. The L3 is around $4.57 for 10,000. The STM32 is even cheaper at $2.89 to $3.32 for 10,000.

It is clear after this analysis that although some of the other microcontrollers have more memory, or more processors in the L3's case, for this system the STM32 is the clear choice. The STM32 also comes with a very useful coding tool, CubeMX, which makes programming the device much easier.