ES Design Analysis

Timothy Chan, Selina Zheng

Executive Summary

The choice of microcontroller is important to the success and cost of a project in embedded systems. Due to the limited memory and power, a microcontroller must be carefully chosen to maximize performance and cost. This document aims to evaluate three viable alternatives to the STML432KC microcontroller. These alternatives are the NXP LPC series, the Texas Instruments MSP430 series, and the Silicon Labs EFM32 series of microcontrollers. These three alternatives will be analyzed based on features such as their package size, cost, memory size, peripherals, and power utilization in comparison to the STML432KC to support our selection.

NXP LPC55S69:

Advantages: The LPC55S69 has a wide variety of peripherals like the STML432KC including USB, UART, SPI, I2C, and ADC interfaces, allowing it to communicate with and function with a wide range of applications. In addition, it contains four processors within its dual-core Arm Cortex-M33 architecture. This second core allows for more time-critical operations to take place. But as a result of its architecture, it has a larger package which depending on your purpose could be positive or negative as it provides much more performance while maintaining energy efficiency. NXP like STM also provides comprehensive vendor support from its website.

Disadvantages: One potential drawback of the LPC55S69 is its learning curve for developers unfamiliar with NXP's ecosystem. Also, it has a larger package due to its dual-core Arm Cortex, so compactness may be a problem depending on the project.

Texas Instruments MSP432P401R:

Advantages: The MSP432 has a 128-pin package, 4 times the size of the STM32's 32-pin package. This MCU also has more memory than the STM32, boasting 1024KB of flash memory and 256KB of single-cycle system SRAM, in comparison to the STM32's 256KB of flash and 64KB of SRAM. The STM32 has only one low-power UART, while the MSP432 has 8.

Disadvantages: The major disadvantage of the MSP432P401R is the price. It costs $17.77 for a single unit, more than 3 times the price of a single STM32 MCU. Upon further consideration, the MSP432P401R's advantages of package size, memory and number of UARTs may not be necessary for our small project. It is not worth the cost when, for example, we do not need that many UARTs.

Silicon Labs EFM32GG11:

Advantages: The EFM32 also can have up to 2048 kB of flash memory and up to 512 kB RAM which is more than the STM32. For the EFM32, in addition to common features like USB, UART, and I2C, it also has the ability to interface with ethernet. It also has 4 UARTS, two of which are low energy compared to the STM32's two USARTs and one low-energy UART. This allows this microcontroller to interface with multiple serial devices at a time while preventing data collisions. This would also allow for better fault tolerance, flexibility, and the use of different types of serial communication. The EFM32 also contains hardware cryptography features and an security management unit which is useful to prevent this chip from any external tampering.

Disadvantages: The EFM32 has a slightly slower processor frequency at a maximum of 72 MHz compared to the STM's 80 MHz. This could be an issue if maximizing performance is of the

utmost concern. The price of the EFM32 is also much higher than the STM32 with the STM32L432KCU6 standing at $5.90 for an individual controller. This is compared to the EFM32GG11B820F2048GL192-B, starting at $20.47 for a single controller. For smaller projects, the lower cost and simplicity of the STM32 may be a better choice.

Recommendation:

After carefully evaluating the NXP LPC55S69, Texas Instruments MSP432P401R, and Silicon Labs EFM32GG11 microcontrollers based on their package size, cost, memory size, peripherals, power utilization, and additional features, the STM series of microcontrollers stands out as the recommended choice for the following reasons.

Firstly, the STM32 offers a balanced combination of features at a competitive price point. While the other alternatives may excel in certain aspects such as package size, memory capacity, or number of peripherals, the STM32 provides a sufficient level of performance and functionality without compromising cost-effectiveness.

Secondly, the STM32's ecosystem and vendor support are well-established, making it easier for developers to integrate the microcontroller into their projects and troubleshoot any issues that may arise during development or deployment. This factor contributes to reducing the learning curve and overall development time, which is crucial for meeting project deadlines and budget constraints.

Furthermore, the STM32's energy efficiency and compact package size make it suitable for a wide range of embedded systems applications, particularly those where power consumption and physical space are important considerations. Despite its smaller package size compared to

some alternatives, the STM32 still offers sufficient memory and peripheral options to meet the requirements of most projects.

In conclusion, while the NXP LPC55S69, Texas Instruments MSP432P401R, and Silicon Labs EFM32GG11 microcontrollers each have their own strengths, the STM series emerges as the recommended choice for its balanced combination of features, cost-effectiveness, vendor support, energy efficiency, and compact form factor, making it well-suited for embedded systems projects.