Considerations When Designing Crystals into SPC5 and STM8 Automotive Microcontrollers

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Microcontrollers (MCUs) rely heavily on accurate timing sources for tasks such as timekeeping, communication protocols and real-time task execution. The SPC5x series (32-bit) and STM8x series (8-bit) MCUs from STMicroelectronics are recognized for their robustness and efficiency across a variety of embedded designs. Crystals play a critical role in ensuring accurate timing and stable operation in such applications. This document covers design considerations when selecting and integrating crystals with STM8x (8-bit) and SPC5x (32-bit) automotive microcontrollers.

The opening overview of the STM8x series summarizes the robustness of design essential in the application of these processors. As stated by STMicroelectronics:

"ST's STM8AF series is intended for automotive applications where no compromise on parameters is possible, from reliability to system cost-effectiveness. The STM8AF series is modular, provides high performance and offers the flexibility required for short development cycles. Its true data EEPROM, combined with the capability to withstand up to 150°C ambient temperature, make the series a sustainable choice for automotive applications".

Similarly, the SPC5x series of 32-bit MCUs offers enhanced capability with more processing power for demanding automotive and industrial environments. This no-compromise design approach extends to the selection of suitable crystals, offered to meet the stringent standards across this full automotive range. ECS Inc. has a wide range of automotive-grade crystals that are AEC-Q200 qualified and PPAP supportable.

Designing in crystals will follow the same steps as outlined by ECS Inc. in the whitepaper Considerations When Designing Crystals into STM32 Microcontrollers. This resource can be referenced for a deeper review of the terms and concepts of designing in crystals. Particular emphasis is given to operational temperature range, tolerance and stability requirements and ESR, as all of these requirements help determine the appropriate package size offered.

Key Design Considerations:

Frequency: Each processor has a defined clocking frequency range for the external crystal oscillator. ECS Inc. offers suitable solutions from 8 MHz to 24 MHz depending on the microcontroller. Designers will often pick 8 MHz, to keep the current lower, but can trade for

higher-performance clock speeds, such as the 24 MHz solution, ECS-240-8-33B2Q-CVY-TR, commonly used with the STM8AF.

Operational Temperature: Automotive and industrial applications require crystals to maintain frequency stability across wide temperature ranges, making them suitable for AEC-Q100 Grade 0 (-40°C to 150°C). To meet these extended temperature requirements, we offer tolerances ranging from 10ppm to 30ppm and 150ppm across the full operational temperature range.

ESR: The equivalent series resistance is driven extensively by package size and frequency. For example, the ECS-80-8-33B2Q-CVY-TR, offers 500 ohms ESR, due to its 8 MHz frequency and 3.2 x 2.5 mm package size. These parameters impact the gain margin in the design, offering between 9.7 to 5.1, consistently meeting the minimum requirement of 5. In comparison, the ECS-200-8-30Q-VY-TR, operating at 20 MHz in a larger 5.0 x 3.2 mm package, offers a lower ESR of 40 ohms, providing much higher gain margins from 33 to 9.3.

Transconductance (gm): In addition to meeting all the stringent parameters listed above, some microcontrollers, have very low transconductance, such as the ST10 at 1.4mA/V and SPC56 at 2mA/V. These are designed for very low current applications such as TPMS, keyless entry systems, lighting systems and parking sensors to name a few. We are still able to offer a gain margin greater than 5, using solutions like the ECS-80-8-30Q-VY-TR (8 MHz with 100 ohms ESR) and the ECS-120-8-30Q-VY-TR (12 MHz and 60 ohms ESR) as examples.

In conclusion, selecting and integrating crystals for automotive microcontrollers is a critical process that requires attention to design parameters to ensure performance and reliability. The STM8x and SPC5x series are designed for demanding environments and offer exceptional robustness, making them suitable for automotive applications that require precision timing and stability. Key considerations, such as frequency, operational temperature range, tolerance, stability, ESR and transconductance, must be carefully evaluated to select the appropriate crystal to meet system requirements. ECS Inc. offers a range of AEC-Q200-qualified crystals for automotive-grade applications. By understanding key crystal design considerations, engineers can ensure the success of their embedded designs while meeting both performance and environmental standards.

When designing crystals into STM8x and SPC5x MCUs, refer to the following resources for detailed guidance:

- ECS Inc. Whitepaper: “Considerations When Designing Crystals into STM32 Microcontrollers”

- STMicroelectronics Datasheets for STM8x and SPC5x MCUs

For more technical resources, please reference our library of technical guides, educational video library on frequency control and product information, our reference design library or our current product catalog.

Please contact us if you need additional information or have a specific requirement in your application.

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