A High Performance Ultra-low Power Temperature Compensated Real-time Clock


A novel RTC module consisting of an ASIC assembled in a miniature ceramic package together with a 32 kHz XTAL has been developed. It operates from 1.5 to 5 V, consumes less than 250 nA and is capable of generating a temperature compensated 1 PPS signal with a stability of ±3 ppm over the -40 to 85°C range. Designed for consumer applications, the microsystem is now in production at the market introduction phase.

The HiPeRTC project, involving Micro Crystal AG and CSEM and funded by the CTI via the "Swiss franc fort" initiative, targeted the development of a high performance, ultra-low power, accurately temperature-compensated, real time clock (RTC). The developed microsystem is comprised of an ASIC and a miniature XTAL combined together in a tiny ceramic package, offering a solution with a low form factor, improved robustness and reduced sensitivity to environmental conditions such as moisture, temperature variations and gradients. Besides keeping accurate track of time, the RTC features alarm, timer and interrupt functions.

CSEM leveraged its strong legacy background in the design of ultra-low-power timing and oscillating circuits for the development of a dedicated ASIC solution featuring a number of circuit and system level innovations. By replacing the traditional bandgap-based temperature sensor with a thermistor-based dual oscillator, both the minimum operating voltage of the circuit and its power consumption could be significantly reduced relative to competing products. The result is a solution that combines "best in class" temperature stability with a very compact circuit area leading to a highly cost-competitive product. A novel all-digital solution for temperature compensation was invented. The new method eliminates the drawbacks of previously known implementations producing a fine resolution temperature-compensated 1 pulse per second (PPS) signal. The solution has been implemented and successfully validated, opening new market segments and thus commercial perspectives for Micro Crystal AG, the industrial partner. Two related patent applications have been filled. Thanks to such innovations, the current consumption of the solution, which is less than 250 nA, rivals that of uncompensated RTC, while providing a 60 fold improvement in time-keeping accuracy over the industrial temperature range.

The results of measurements of the temperature stability of the 1 pps signal are shown in Figure 1, where it can be seen that the solution achieves ±1ppm over -40 to 85°C at supply voltages between 1.5 to 5 V.

Figure 1: Measured temperature stability of the 1 PPS signal over temperature and voltage.

Micro Crystal AG has been deeply involved in the project from the start, providing detailed system specifications and a clear roadmap towards industrialization based on its market expertise. Functional prototypes built with MPW ASIC dies implemented during the course of the project were also provided to key customers for evaluation. A photograph of the RTC module after ASIC and XTAL assembly, but before sealing in vacuum, is shown in Figure 2.

Figure 2: Photograph of the ceramic package with flip-chip mounted ASIC (bottom) and 32 kHz tuning fork XTAL (top).

The project has now reached its industrialization phase in partnership with EM Microelectronic which is fabricating and testing the ASIC. EM Microelectronics also made significant contributions throughout the project sharing design for test expertise and participating to design reviews, leading to a very fruitful, effective and efficient three-party collaboration that was instrumental in the success of this ambitious development.

Such an achievement paves the way towards novel products that will enrich Micro Crystal’s portfolio, clearly demonstrating the role of CSEM as a provider of advanced innovative solutions. In a highly competitive timing market segment dominated by Japan and Far East manufacturers, HiPeRTC will lead to very competitive products which are fully designed and manufactured (crystal, ASIC, packaging and test) in Switzerland. For more product information, please search for RV-8803-C7 on Micro Crystal’s website [1]. Funding from the CTI is acknowledged.


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