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A Change of Generation

Farewell to the C167: Alternatives Available Now

By Jan Schulze, SYS TEC electronic GmbH

Infineon's C167 is one of the most common and widely used microcontrollers in the world. But the end had to come sometime, even for endurance athletes like the C167. There's no need to worry, however: alternatives are available and with some planning, the change be quick and comfortable.

With the C166 microcontroller architecture, Siemens laid the foundation in 1989 for one of the most successful microcontroller families there's ever been. C161, C163, C164, C165 and, above all C167 have dominated numerous fields of application. All based on the 80C166, it is today almost impossible to imagine many of those fields without them. The C167 was the first of the controller family and today is not only the most successful microcontroller from Infineon – it is also the one which has lasted the longest on the market. After 25 years, however, it's time for a refresh. Infineon will retire the C167 at the end of 2019, albeit not completely. In consultation with Infineon and regional distributors, the manufacturer will be allowing an extension until 2025 to ensure a successful changeover.

It wasn't only its competitive price that helped the C167 to become so widespread. The 16-bit controller impressed with clocking of 20 to 40 MHz and its SRAM – by today's standards, tiny – of up to 11 kB. It was the first microcontroller that could address a very large linear address

space and perform address decoding in the chip itself (previously, this always had to be done within an external logic) – a huge step forward.
The C167 was also able to address connected memory very quickly, which made it possible to execute programs much faster.

C167 – A Customer Favourite

The C167 was distinguished by its extensive range of features. In addition to various integrated serial and parallel digital interfaces, it also provided CAN bus (controller area network), making it ideal for use in the car industry. In addition, it was deployed by a wide range of users, from small customers up to industrial giants. The C167 is still to be found today in industry and in the university sector, where it is used for teaching purposes.

Except for occasional derivatives, the C167 was offered without reprogrammable internal programme memory, which requires the linking of external flash. It is this which users of the C167 should keep in mind when planning changeovers. More and more often, system developers such as SYS TEC electronic GmbH from Saxony have learned that currently used system components can only be only procured with difficulty or expense, if at all. This applies in particular to the 5-volt flash memory used with the C167. That's why Graduate Engineer Aimo Süß recommends that "you should not wait too long at this stage. Changeover to C167 alternatives ultimately involves a fair amount of effort, and that costs time." Aimo Süß admits that even though the C167 will still be around in 2025 under certain commercial conditions, shortages of other components could occur: "We can no longer guarantee that it will still be possible to produce the product by then".

Hesitant Transition

However, there are still customers who explicitly only want to use the C167. Süß can only speculate as to why. Some would shy away from new developments with new foundations, others would simply wanted to continue using their old software. There are also other customers for whom the changeover won't be so easy. This is the case, for example, when security requirements entail high certification efforts. These customers will be happy, says Aimo Süß, that the microcontroller is still available – albeit conditionally. Nevertheless, first customers should want to tackle the change straight away: "With the XMC and AURIX microcontroller series from Infineon, alternatives are available", says the system developer.

Replacement for Every Use Scenario: The XMC

Candidate one for the "new beginning" is the XMC, an ARM Cortex-based 32-bit microcontroller with fast ADC. Depending on the model, the chip for applications in the lower to middle power segment clocks at 32 to 144 MHz and can access 16 kB to 352 kB SRAM and 8 KB to 2 MB Flash. The XMC is particularly suitable for lightning, motor-control, industrial field busses and power conversion. The various models can provide unique features and peripherals for any particular application.

The less powerful models based on the ARM Cortex-M0 can be flexibly operated with 2V to 5V (which is especially important for C167 users with 5V power supply), meaning that a smooth transition is possible. The XMC of the 1000 series are also equipped, depending on the model, with features like math-coprocessor, CAN bus connections and others.

The more powerful models from the XMC 4000 series are based on ARM Cortex-M4F. They feature integrated DSP instruction sets, single precision floating point units, direct memory access (DMA), and Memory Protection Units (MPU). Depending on the model, users can access up to six serial channels such as USB and Ethernet or EtherCAT.

Both XMC series run comfortably even under harsh conditions. The 1000 series operates in the temperature range of -40°C up to 105°C. The 4000-series don't max out until 125°C.

Replace with Certainty: AURIX

The second family of microcontrollers to inherit the space previously inhabited by C167 is Infineon's AURIX, trimmed for high-end performance. Now in its sixth generation, the 32-bit microcontroller is characterised by its integrated security and safety features. AURIX microcontrollers are key components for embedded automotive safety solutions. They integrate a hardware security module (HSM) that makes on-board communication more secure and makes hardware tampering more difficult.

AURIX is based on Infineon's TriCore architecture with up to six cores, each clocking at 80 to 300 MHz. The AURIX TC2X series is equipped with 0.5 to 8 MB of flash memory, and the AURIX T3x series with double that amount. The SRAM memory ranges from 96 kB up to 2.7 MB. Both SRAM and Flash are equipped with ECC error correction – another feature, alongside Lockstep, that distinguishes the AURIX for use in safety-critical areas. For this, one of the cores checks the calculations of the main core with a slight time delay. The integrated AURIX Safety Library is also designed to provide greater security. Overall, the AURIX delivers the highest safe performance on the market and achieves the highest safety level in the automotive sector with ASIL D (Automotive Safety Integrity Level/ISO 262). The AURIX also complies with the IEC 61508 standard at Safety Integrity Level (SIL) 3.

High-Security Microcontroller

With its extensive security and safety features and certifications, the AURIX series is particularly qualified for safety-critical applications in the automotive industry, explains Ralf Ködel, Director of Microcontroller Product Marketing at Infineon: "However, the microcontrollers are also used outside the auto industry, in contexts where there are particularly high safety requirements, such as the need for mandatory data encryption or particularly high reliability." Aimo Süß of SYS TEC Electronic adds: "Today, for example, the AURIX microcontrollers can also be found in wind turbines, in trains or in the control of elevators." AURIX is often also combined with XMC. Take elevators as an example: here, the AURIX controls the main inverter. Simpler tasks are looked after by the XMC – effectively a division of labour within a one-stop shop.

No matter if AURIX or XMC: Not only does the switch raise applications up to current hardware – it also brings further positive side effects. "Space requirements on the board are reduced, for example", explains SYS TEC electronic’s system architect Aimo Süß. "The integration of RAM and Flash into the microcontrollers creates space for integrating new features such as Ethernet or radio modules into an application. The efficiency of the new microcontroller has enough reserves for this."

DAVE: Your Friend and Helper

For development with XMC and AURIX, Infineon provides programmers and system architects with a digital helper: DAVE, the virtual engineer. Dave is a kind of significantly expanded development environment for software development. In addition to the usual tools like compilers, DAVE contains all the necessary drivers.

A special feature of DAVE is the graphical interface for the selection of pins. This allows developers to easily allocate hardware. DAVE automatically creates connections to timers and ADC, just as it does for signal assignment.

System Changeover Made Easy (...or Easier)

DAVE is also helpful in moving from C167 to XMC and AURIX. Ralf Ködel points out that some applications are relatively easy to port: "Most of the time, however, there is a significant increase in effort just in migrating from 16-bit to 32-bit." SYS TEC system architect Aimo Süß has experience with DAVE and porting: "These days, peripherals are very complex with their many modes of operation. DAVE provides excellent support in selecting and giving hints on what limitations are available with a selection. It also actively initiates the settings I need to adapt to make the most of my peripherals."

Despite DAVE's energetic help, the changeover from C167 to AURIX and XMC is not trivial and will need time. Clients should ensure that they plan for this, says Aimo Süß. He compares the typical procedure and a normal redesign.

When switching from C167, the developers at SYS TEC electronic also start with a comprehensive assessment of existing applications. The areas of application are outlined, and hardware and software requirements are analysed and noted down. The interfaces used so far and their operating modes are also examined. On this basis, SYS TEC electronic determines the best derivative. Depending on the timing of hardware and software, appropriate replacement elements are proposed. If the analysis process is completed successfully, SYS TEC electronic can then calculate the effort for hardware design and layout prototyping as well as the porting of the software. "Because changing the CPU will change an essential part of the system in both hardware and software terms", explains Aimo Süß, "appropriate tests are necessary to prove that the new design works properly".

Here, SYS TEC electronic can assume responsibility for some tasks or support the customer in this work. At this stage, two important issues still need to be clarified: Whether the development environment and the operating system that the customer originally used still exist, and whether the software is capable of running the new hardware operating system at all. A service package designed to help users make the transition is being prepared by SYS TEC electronic.

Conclusion

With the right partners, such as SYS TEC electronic and the chip specialist Infineon, the change from the beloved C167 to its modern descendants XMC and AURIX will go well. The transition will be rewarded with significantly increased performance, greater flexibility, increased functionality and, last but not least, a clear plus in terms of safety and security with AURIX.