Miniature Laser Scanners -

16-bit microcontrollers as the basis for high performance and safety

MANFRED CHOUTKA, INFINEON TECHNOLOGIES

SICK AG is the undisputed market leader for safety laser scanners opted for proven 16 bit microcontrollers from Infineon – since, particularly in safety technology, besides the relevant features, such aspects as high service-proven reliability, technical support, comprehensive development support and high manufacturing quality are at least equally as important.

Manfred Choutka is a Senior Regional Marketing Manager and Head of EMEA Regional Marketing, Microcontrollers, Infineon Technologies

Manfred Choutka, Infineon Technologies. The company SICK AG is the undisputed market leader for safety laser scanners used for the prevention of personal accidents on machines. This position is strengthened by ongoing further developments. The most recent example being the S300 Mini – the world's smallest safety laser scanner, coupled with extensive sensor-based and automatic features. To achieve the corresponding performance and reliability also for the most compact of dimensions, the company opted for proven 16 bit microcontrollers from Infineon – since, particularly in safety technology, besides the relevant features, such aspects as high service-proven reliability, technical support, comprehensive development support and high manufacturing quality are at least equally as important.

The miniature dimensions of the S300 Mini devices (Fig 1) measure just 102 mm x 116 mm x 105 mm.

Fig. 1: S300 Mini the world's smallest laser scanner (image: SICK)

This makes these world's most compact safety laser scanners of their type for a highly space-saving installation. In terms of integration, this series is so versatile that it satisfies the requirements of a whole range of different operating conditions and user requests in intralogistics. Stationary conveyor system modules with danger areas, e.g. converters, lateral distribution vehicles and horizontal conveyors, can be monitored with regard to their safety as can autonomous mobile compact platforms or transport vehicles that require complex safeguarding. At the same time, the safety laser scanners make it possible to optimise driving speeds – and thus to achieve higher performance.

The S300 Mini series offers certified safety for mechanical engineers and plant operators. It satisfies the technical safety requirements of performance level d as per EN ISO 13849 as well as those of SIL2 as per IEC 61508, and meets the requirements on optoelectronic protective equipment in accordance with type 3 of IEC 61496.

Standard or Remote

The S300 Mini series currently comprises two safety laser scanners with different features. Solutions to applications in which it is solely a matter of using a safety-certified sensor to realise a reliable means of personal and anti-collision protection are provided by the Standard version in the form of a safety-technical basic solution. This includes above all stationary applications, e.g. the safeguarding of stationary conveyor system modules such as converters and lifting gear, as well as mobile applications such as in driverless transport vehicles. The range of the 270° protective field is 2 m, within which a triple field set can be programmed with one protective field and two warning fields. As a direct switching output for system and vehicle control, the device incorporates an OSSD pair (output signal switch device).

The Remote version of the S300 Mini has been developed for solving sophisticated safety requirements. As such, with the aid of the Flexi-Soft safety controller it is possible to realise up to 16 triple field sets and up to 32 monitoring cases – in other words, ideal e.g. for FTS applications and for unmanned forklifts, as well as for stationary danger areas with alternating protective field dimensions. Using the latest generation of the EFI interface (enhanced function interface) - EFI extended – it is now possible to combine up to four proximity-type protective devices, e.g. two S3000 Expert and two S300 Mini Remote, in one network.

Functional principle

The S300 Mini is an optical sensor, which creates a two-dimensional scan of its surroundings with infrared laser beams. It functions according to the time-of-flight principle of measurement – i.e. it emits short light pulses with a timer running at the same time. If the light strikes an object, it is reflected back and received by the scanner. The distance to the object is calculated from the time difference between the time of sending and receiving. The S300 Mini incorporates a uniformly rotating mirror, which deflects the light pulses, spreading them out in a fan shape over a 270° angle. In this area, it is possible to reliably detect an object up to a range of 2 m. Protective fields can be freely programmed within these limits. The S300 Mini emits light pulses with an angular resolution of 0.5 degrees, which makes it possible to achieve object resolutions down to as low as 30 mm. The sensor responds with a basic response time of just 80 ms. Thanks to its active scanning principle, the S300 Mini does not require any additional external receivers and reflectors.

Design criteria

To achieve safety level SIL2 necessary for the target applications and the corresponding performance, a two-channel microcontroller architecture was selected (Fig 3). In addition, the microcontrollers had to deliver the necessary computing performance (40 MHz). In this case, two XC161CS-32F40F controllers (Fig 4) in a TQFP-144 housing were used (XC166 family with C166SV2 core).

Generally speaking, when it comes to selecting a microcontroller for an embedded design, the following criteria usually apply:

- Real-time performance
- Interrupt behaviour
- Code efficiency (instruction set, compiler)
- DSP performance
- Peripherals (depending on the application)
- Memory capacity (Flash)
- Autonomous peripherals (relieving the CPU)
- Tools, standard interfaces
- On-chip debugging
- Power consumption
- Overall cost (chip and development costs)

Besides these aspects, other factors also play a very important role, such as the products and

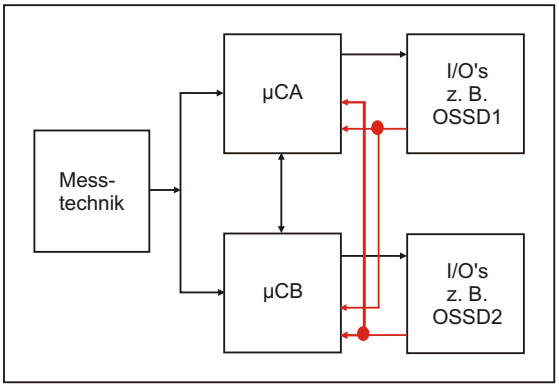

Fig. 3: Two-channel circuit design with mutual monitoring of the I/Os for high safety (SIL 2) in the S300 Mini (image: SICK)

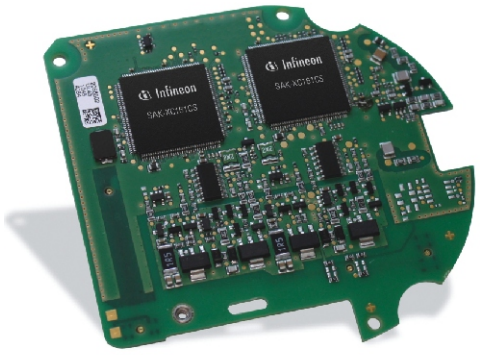

Fig. 4: Base board of the S300 Mini with the two XC161CS microcontrollers. Using the Infineon controllers saves e.g. Numerous external peripherals on the restricted board space

development tools already used in the company, particularly with regard to the reusability of software, as well as experiences with the customer service and technical support.

For the S300 Mini, the following criteria were decisive factors: The service-proven reliability of the controller, the optimum computing performance for the product, the sophisticated on-chip hardware (which relieves the core and reduces the complexity of the programming), extensive peripherals (CAN bus, IIC bus, several SPI interfaces such as UART and High-Speed), option of flexible control/programming of the timers and PWM outputs in addition to the high-speed internal AD converter with 10-bit resolution to meet the corresponding precision requirements. Thanks to the use of the extensive peripherals, it was possible to minimise the space requirements and manufacturing costs. Using the interrupt and PEC functions, it was possible to implement an optimised real-time task management system. This in turn allowed the computing performance to be used to optimum effect. As such, the high real-time requirements could be realised with a safe system response time of just a few milliseconds.

"And, at the end of the day, the controller has been used by SICK since 2005 in the corresponding product family. The functional compatibility and the reusability of the source code developed on the basis of this controller were also decisive factors for using it also in the extended portfolio. A fact particularly worth highlighting is the technical support provided by Infineon, who was always quick to assist and competent throughout the entire development period", said Ralph Rapp, Head Research & Development Multidimensional Sensors at SICK AG, commenting on the choice of microcontroller.

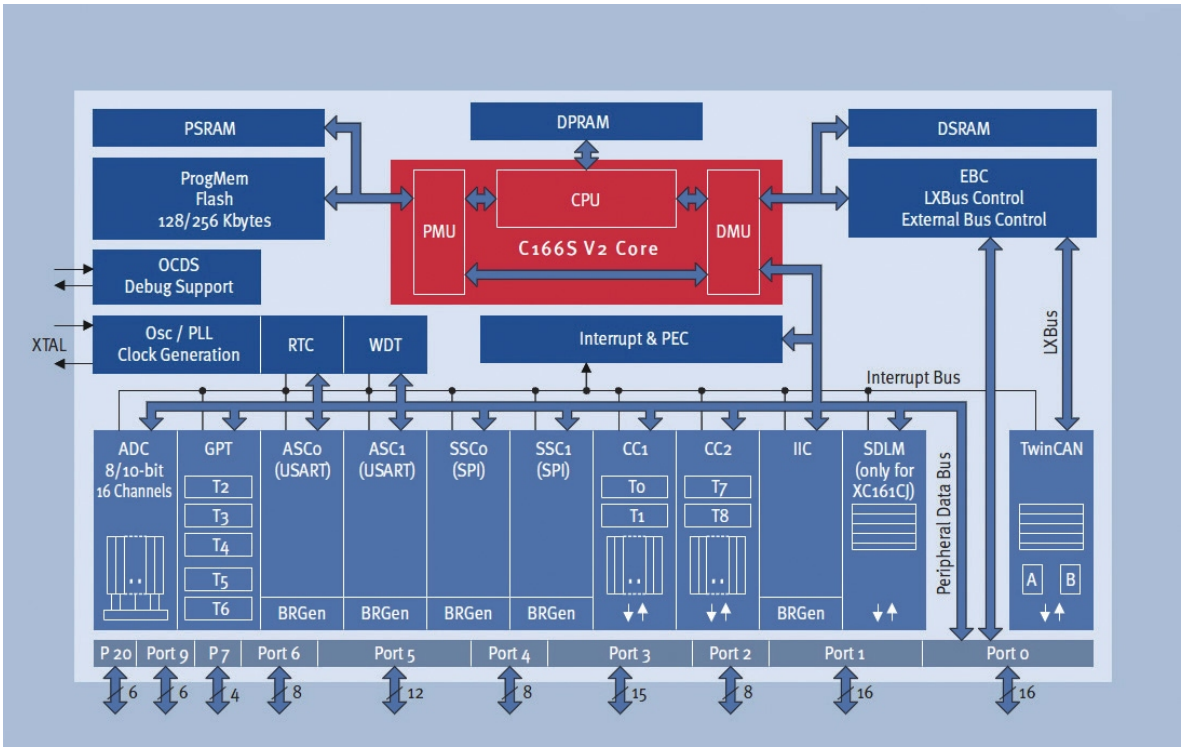

Fig. 5: Block diagram of the XC161CS high performance with 40 MHz and extensive peripherals mean that the controllers are ideally suited for numerous sensor applications such as the S300 Mini

Also with a product such as the S300 Mini, the 'time-to-market' is an important factor. Consequently, besides the pure microcontroller hardware, the available development environment is also very important. This is where the XC166 microcontrollers can score highly with their wide range of proven third-party design tools. Development tools such as, for example, the Keil compiler are not only proven, but also offer key advantages with regard to resource management, run time and memory management.

The XC161CS-32F40F is a derivative of the XC166 family and is designed for a high data throughput and rapid response times to external interrupts (e.g. sensor signals) (Fig 5). The instruction execution time is just 25 ns (40 MHz). The chip offers 12 KB RAM and 256 KB flash memory. The high-speed, 12-channel 10-bit AD converter requires a conversion time of just < 3 µs. The extensive peripherals include two PWM units, I2C bus modules, serial data link modules (SDLM), timers, USART, SPI and TwinCAN modules.

A success story to be continued

With the XC166 product family, Infineon has devised a consistent, high-performance further development of the C166 controllers. Also the XE166 family as an innovative successor product will, for example, be evaluated by SICK for future developments. Hardly a microcontroller architecture has proven itself over such a long period of time in industry as the C166 family(ies), which began with the 80C166 around 20 years ago. From the very outset, the C166 architecture was designed for high real-time computing performance, rapid instruction execution, minimal response times and smart peripheral functions. This paved the way for a success story with over 500 million microcontrollers being shipped to date. In comparison with the C164/161/167 components, the XC166 family (like the XC161CS used in the S300 Mini) provided a performance boost with 40 MHz, embedded flash memories, single-cycle instruction execution and TwinCAN and OCDS modules. Compared with the XC166 predecessors, the latest generation of real-time signal controllers (RTSC) of the XE166 family offers a further performance boost and takes the 16-bit microcontrollers into the 32-bit class. The outstanding real-time behaviour is ensured by rapid interrupt response times and prompt context switching with two additional local register banks. All the RTSCs of the XE166 family are still based on an enhanced C166S V2 core. With 80 MHz and only one clock cycle per instruction execution, the XE166 modules offer 80 MIPS. This is double that of the XC166 predecessor family, whilst the flash memory capacity with 1600 KB has again been significantly increased.