Case Study

Modular is faster and more efficient

Embedded system development for ARM-based laboratory analyzers
Modular is faster and more efficient

What’s the most efficient way to design-in the appropriate embedded logic into a laboratory device? More and more often, the answer is to use computer-on-modules, even for ARM-based designs. HEITEC used an NXP i.MX6 based Qseven module from congatec in the design of a spectrophotometric analyzer from Implen.

Spectrophotometric instruments for small-volume sampling are used in molecular biological, bio-chemical and bio-medical laboratories for a wide range of applications. The spectrophotometers are designed to perform different types of analysis based on very small samples. Examples include the measurement of protein and nucleic acid concentrations as well as the measurement of absorption and transmission characteristics. A company specializing in such analyzers is Implen, whose nanophotometers are mainly used for concentration measurements and quality control of nucleic acids and proteins in research and manufacturing.

Individual functional elements

The Implen NanoPhotometer® allows users to work with different sample sizes, depending on the application: The sample to be analyzed can either be placed directly onto the microvolume pedestal using a pipette or, alternatively, it can be measured in a temperature controlled cuvette port. An integrated vortexer is used to mix the samples to obtain exact measurements. The results of the respective spectrophotometric procedure are automatically analyzed and graphically displayed on a touchscreen. Tablet PCs and smartphones can be connected via a WiFi hotspot, while USB, WLAN or Ethernet are available for Windows PCs. A large external screen can be connected via HDMI, and it is also possible to exchange data via a USB stick. The Linux-based system features an NXP i.MX6 ARM processor with 1 GHz performance for fast sample measurement, data processing and visualization.

Computer-on-modules – the fast track to your goals

HEITEC implemented the appropriate embedded logic for Implen. For this purpose, HEITEC used a Qseven computer-on-module as the application-ready embedded computing core and then developed the carrier board with the specific functionality required for the spectroscopic analyzer around this module. Such a combination lets developers enjoy both the design freedom of a custom-specific solution and the convenience of a fully developed and certified board while also enabling them to leverage the comprehensive ecosystem of SGET’s Qseven standard for the finished custom module. The advantage: Custom modules and their ecosystem offer developers significantly more “application readiness” than any of the standard evaluation platforms for ARM designs, where support is frequently limited to allowing developers to copy existing circuit board
layouts. Everything else, they need to design themselves. The carrier board option provides developers with flexibility, as it is less challenging to design than a full custom board. Essentially, it’s just a matter of routing the system interconnects and implementing the required additional controllers. What is more, with just one board design, developers can design scalable systems that are easily upgraded with newer processors. Thanks to standardization, there is no vendor tie-in.

The customization in detail

Compactness, cost and energy efficiency played an equally important role in the selection of the electronics and components for the carrier board as technical aspects such as battery and heat management. In addition to all standard functions, such as touch controller interface, LVDS interface to the TFT panel, USB hub and the integration of an external audio codec for provisioning an audio interface, the following special features were implemented:

- Battery charge control for mobile use without power connection. A powerful 4S3P battery pack was installed, which allows the device to be operated without a mains connection for a whole working day and to handle power consumption spikes when “pulling” measurements.
- Standby control and soft-on/off using a low-power FPGA because, unlike x86 processors, the i.MX6 has no deep-sleep function. The FPGA replicates the advanced configuration and power interface (ACPI), which is standard with x86, and switches off all current to the processor, thereby increasing the availability of a non-connected system from days to weeks. Thanks to quick boot, the processor can ramp up to full operation including applications within milliseconds.
- Integrated motor control for the vortexer, including a “snubber” circuit to avoid unwanted system vibrations, which is key for the measurement of the absorption and transmission behavior of samples.
- Controlled film heating as well as a special measuring bridge to the cuvette port ensure highly accurate temperature measurement of samples, which is key for accurate analysis.

Overcoming the space shortage

Since there was scarcely enough space (200x200x120mm, WxDxH) in the system to fit in all the offered functions, the HEITEC developers had to work very closely with Implen's mechanical design team and to use thermal simulation to optimize cooling. The board was ultimately laid out in an L-shape and the Qseven module mounted on its head. The heat spreader, which matches the module, now contacts the metal bottom plate of the housing via a gap filler, while the remaining housing is mainly made of plastic. An additional heat sink within the battery charge control ensures efficient handling of this hotspot.

HEITEC took care of the complete supply chain management of the project, the entire production as well as type testing and certification. So the customer got compact and maintenance-free electronic assemblies (equipped boards) with comprehensive functionality from a single source. And even though HEITEC did not have to ensure standards for medical device development and production with batch traceability for this project, it was reassuring for the customer Implen to know that the company is trained to work in compliance with the high-quality standards for medical devices. Also, they could rest assured that it would not be a challenge for HEITEC to implement the Ethernet interface of the system in accordance with DIN EN 60601-1, should this ever be required for a medical IoT application.
Combining software with dedicated hardware

The required customization of the embedded Linux was realized by Implen in-house since the company has experienced software developers for Linux, Android, iOS and also Windows. Both the HEITEC developers, who had to provide the specific interface and component logic, and the Implen engineers, who were responsible for the interaction between the application and the hardware, were particularly grateful for the personal integration support provided by Qseven module supplier congatec. It ensures that customers have a dedicated contact person and do not have to wait in anonymous helpline queues to ultimately end up with a different call partner each time. This premium service is made available by congatec as one of the leading computer-on-module manufacturers worldwide so that customers can always reach technical support during their working hours.

“It is quite a different experience to work with modules where the supplier provides a complete platform with all the necessary drivers specified in the standards. This makes working with full-custom designs much easier, speeding up the time-to-market and ultimately reducing NRE costs. It is great that Qseven now also caters for ARM processor technology, where as a rule only test and evaluation systems used to be available. While you can copy their layouts, this is not a fully certified component,” explains Wolfgang Christl, Project Manager Electronic System Design at HEITEC.

“The entire package of software components for the conga-QMX6 is very mature, comprehensive and convenient. We rarely need the personal integration support offered by congatec. But – and perhaps precisely because of this – it was excellent to experience how well the assigned service staff supported us. I felt perfectly cared for. He was familiar with our project and not only a specialist for Linux and ARM – he also knew about the FPGA, which replicates the ACPI functions and is an important element for the shelf time, i.e. the standby readiness of our systems without mains connection. I had to explain my concerns only once and always got a prompt and competent answer, which is a real plus in the rather unfriendly 800 service landscape”, explains Johannes Bauer, Head of Software Development at Implen.

ARM-based Qseven modules

The application-ready conga-QMX6 Qseven computer-on-modules with comprehensive BSP and personal integration support are equipped with an NXP (former Freescale) processor of the i.MX6 ARM Cortex A9 processor family which can be scaled from 1 to 4 ARM cores and provides a 3D-capable HD graphics interface. The Qseven module is available in 4 processor variants, from the Freescale i.MX6 Solo ARM Cortex A9 with 1.0 GHz and 512 kB cache to the Quad ARM Cortex A9 with 1.2 GHz and 1 MB cache. The scalability and long-term availability of at least 10 years make the processors of the i.MX6 family the perfect choice for ARM-based system designs. In the future, the module family will also be available with the successor of the i.MX6 so that developers can leverage an even wider performance range and extend the long-term availability.

As a finished product backed by the comprehensive ecosystem of the Qseven standard, the conga-QMX6 computer-on-module from congatec offers significantly greater „application readiness” than standard evaluation platforms for ARM, whose only advantage, as a rule, is that the circuit board layouts can be copied.
Despite low power draw, the graphics core that has been integrated in the i.MX6 is very powerful and offers a video processor unit (VPU), 2D and 3D graphics (GPU2D/3D), four shaders with up to 200 MT/s (million triangles/second) and a dual stream of 1080p/720p. A dual HDMI v1.4 graphics interface is available, with the second HDMI port being shared with an LVDS interface. LVDS is also implemented as 18/24 bit dual channel with a resolution of up to 1920x1200 pixels (WUXGA). A MicroSD socket can be used for low-cost mass storage, with the option of adding up to 16 gigabytes in the form of a soldered solid state drive (eMMC) for robust applications. A choice of interfaces is available, including 1x PCI Express 2.0, 2x SATA 2.0, 6x USB 2.0, Gigabit Ethernet, 1x SDIO, CAN Bus, LPC and I²S Sound. The conga-QMX6 module is equipped with the U-Boot bootloader and further features Multi Watchdog Timer, CAN and I²C Bus, making the application faster and more reliable even when the system is in standby mode.

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About congatec AG

congatec is a leading supplier of industrial computer modules using the standard form factors COM Express, Qseven and SMARC as well as single board computers and customizing services. congatec's products can be used in a variety of industries and applications, such as industrial automation, medical, entertainment, transportation, telecommunication, test & measurement and point-of-sale. Core knowledge and technical know-how includes unique extended BIOS features as well as comprehensive driver and board support packages. Following the design-in phase, customers are given support via extensive product lifecycle management. The company's products are manufactured by specialist service providers in accordance with modern quality standards. Headquartered in Deggendorf, Germany, congatec currently has entities in USA, Taiwan, China, Japan and Australia as well as United Kingdom, France, and the Czech Republic. More information is available on our website at www.congatec.com or via Facebook, Twitter and YouTube.

About HEITEC

HEITEC is known for industrial competence in automation and electronics and offers solutions, products and services in the fields of software, mechanics and electronics. More than 2000 customers increase their productivity and optimize their products with the help of HEITEC’s state-of-the-art, reliable and economic system solutions. A work force of over 1000 employees at numerous sites worldwide provides high-quality industry skills close to the customer.