Powering industry change

A fabless company takes advantage of industry disruption with an SoC targeted at electric vehicle power conversion. By **Graham Pitcher**.

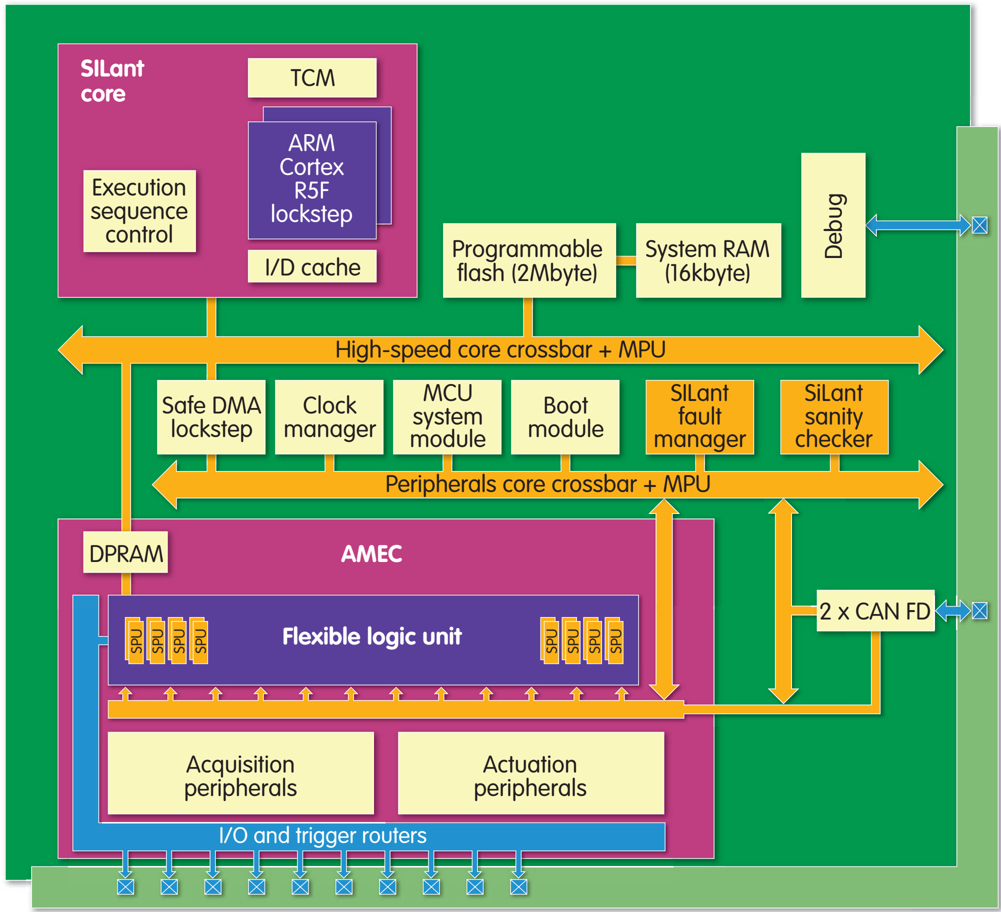

Figure 1: The T222 is an SoC that combines an ARM Cortex-R5 CPU with progammable logic fabric

Over the last decade or so, the semiconductor content of cars has increased dramatically; not only in terms of value, but also in terms of the number of components being deployed. And yet, despite the continual advances in semiconductor technology, the components available to car manufacturers – known in the industry as OEMs – don't always meet their requirements.

"There are big changes in the automotive world," said Bruno Paucard, CEO of fabless company Silicon Mobility. "While everyone knows about autonomous driving, there's also the move to electrification. The electric vehicle (EV) market will be huge, but there are still problems to be solved, such as charging. We have technology that can help to solve some of the big issues in this area."

Although Silicon Mobility is a recent start up, its technology is rooted in developments by French fabless company Scaleo, which went into liquidation in 2016. In particular, Silicon Mobility is developing the OLEA range of field programmable control units (FPCU), described as a flexible electronic device specialised in rapid computing and decision making in a safe and deterministic fashion. "Our first solution is the T222," Paucard noted, "which is designed to change the way in which inverters in electric vehicles are put together."

He believes that one of the biggest problems in this area is that most of the technology comes from 'another age'. "When you apply that technology to a motor, you pay a price due to the software bottleneck." He explained that when you want to control something mechanical, reaction times are often in the millisecond range, rather than microseconds. "Motors in modern EVs need to be controlled differently," he contended. And Paucard thinks the OLEA T222 is a solution.

The T222 is an SoC combining an ARM Cortex-R5 CPU with a programmable logic fabric developed in house (see fig 1). "About half of the companies we talk to want an MCU based solution," Paucard noted, "while the rest want an FPGA based device. We offer a combination of the technologies and call it an FPCU so they know that it's something different."

Paucard sees a number of issues relating to control of e-motors. "Functional safety is important," he said. "Performance is important. Customers want a device that allows the motor's operating range to be expanded and for energy to be converted more efficiently during transition stages, such as acceleration or braking. And any controller needs to contain faults and correct them quickly. But there's also the question of size and thermal management.

"When you put all these together, you start to ask whether it's a good idea to process information sequentially; what will be the effects of delays? If not sequential, then it has to be parallel processing. But do you use a big CPU or local processing?

"We have developed a local parallel processing architecture that deterministic and which runs up to 40 times faster than other solutions." Highlighting the difference, Paucard suggested that while the T222 can run at up to 250kHz, competitive solutions may only run as fast as 15kHz. "When it comes to acceleration, we can guarantee a response time of less than 1µs," he asserted, adding "when you use parallel flexible logic for signal processing, you're not using the CPU, which reduces power consumption by up to 100 times."

In particular, the T222 is said to address the limitations of 'legacy' CPUs. Amongst the issues which Silicon Mobility says it targets are: hard real-time control loop frequencies; non-deterministic architectures; software-based functional safety with no acceleration; high power consumption and heat generation; and software dependency from the use of proprietary cores.

In the OLEA architecture, the programmable logic fabric is called the Flexible Logic Unit (FLU). This is linked to generic and register based configurable peripherals, which Silicon Mobility calls Powertrain ready Peripherals. These form a dedicated interface for the control of actuators and sensors, as well as local data processing. This block is called Advanced Motor Event Control, or AMEC.

With the FPCU architecture, the programmable logic fabric – the flexible logic unit, or FLU – hosts the hard real-time processing algorithms and processes incoming data

from sensors, updating actuators independent of the CPU. This allows the CPU to handle functions which don't need rapid responses.

While the FLU is FPGA-like, it can't be programmed directly "It looks like an FPGA," said Paucard, "but it isn't. It's difficult to put an FPGA inside a car, so we had to do something to make it functionally safe. It was developed in house and is 100% tested."

Tightly coupled with the SILant block, the flash based fabric comprises a matrix of Cluster Logic Blocks, which are a combination of four input look up tables and small DSP blocks. The FLU is designed to meet ASIL requirements and has been hardened to provide maximum reliability.

"In hybrid vehicles," Paucard pointed out, "motor controllers have two things to process. One is critical fast loop operations, suich as torque regulation. The other is slow loop operations, such as speed regulation. The FPCU can process both, while managing the operations as a whole. The fast loop runs on the FLU, while the slow loop runs on the CPU, which also handles communications and housekeeping."

The SILant block – short for Safety Integrated Level Agent – is an ASIL-D compliant architecture providing fault coverage and counter measures. Included is a so called Sanity Checker, which provides BIST functionaliy to detect faults in the logic and memory

Above: The T222 can run at up to 250kHz, compared to competitive solutions, which may only run as fast as 15kHz

"We have developed a local parallel processing architecture that's deterministic and which runs up to 40 times faster than other solutions."
Bruno Paucard

parts of safety mechanisms. Other features include execution flow control and execution sequence control. "Functional safety is important," Paucard asserted. "You need to contain faults and correct them quickly."

Although the T222 will be launched with a single Cortex-R5 core, the use of a phantom core means it can run in lock step. "Future products will probably have more cores," Paucard continued.

"It's a flexible hardware based solution that can be focused on energy conversion, but is part of a platform that can be applied to different areas of the car."

Paucard believes the disruption hitting the auto industry is moving many tasks previously handled by hardware into the software domain. "If you're an OEM and see disruption from new entrants like Tesla, you need help to find innovative ways of solving problems. Companies like Silicon Mobility and MobilEye are doing things which OEMs can't."

One short term development with OLEA will be the introduction of OLEA APP, which will help OEMs to fine tune the T222 to meet specific range, durability and performance targets. The app will work with OLEA LIB, which includes specialised math functions, along with accurate e-motor and battery control. Additions to the OLEA range will address different areas of the car.

The FPCU is set to be manufactured on Globalfoundries' 55nm Low Power Extended platform, which is automotive qualified, and production is expected early in 2018. "We're already working with OEMs and Tier 1s in Europe, Asia and North America and the T222 is being designed in. We're expecting cars featuring the device to be on the road by the end of 2018.

"The automotive business is very attractive when you're a semiconductor company," Paucard concluded.