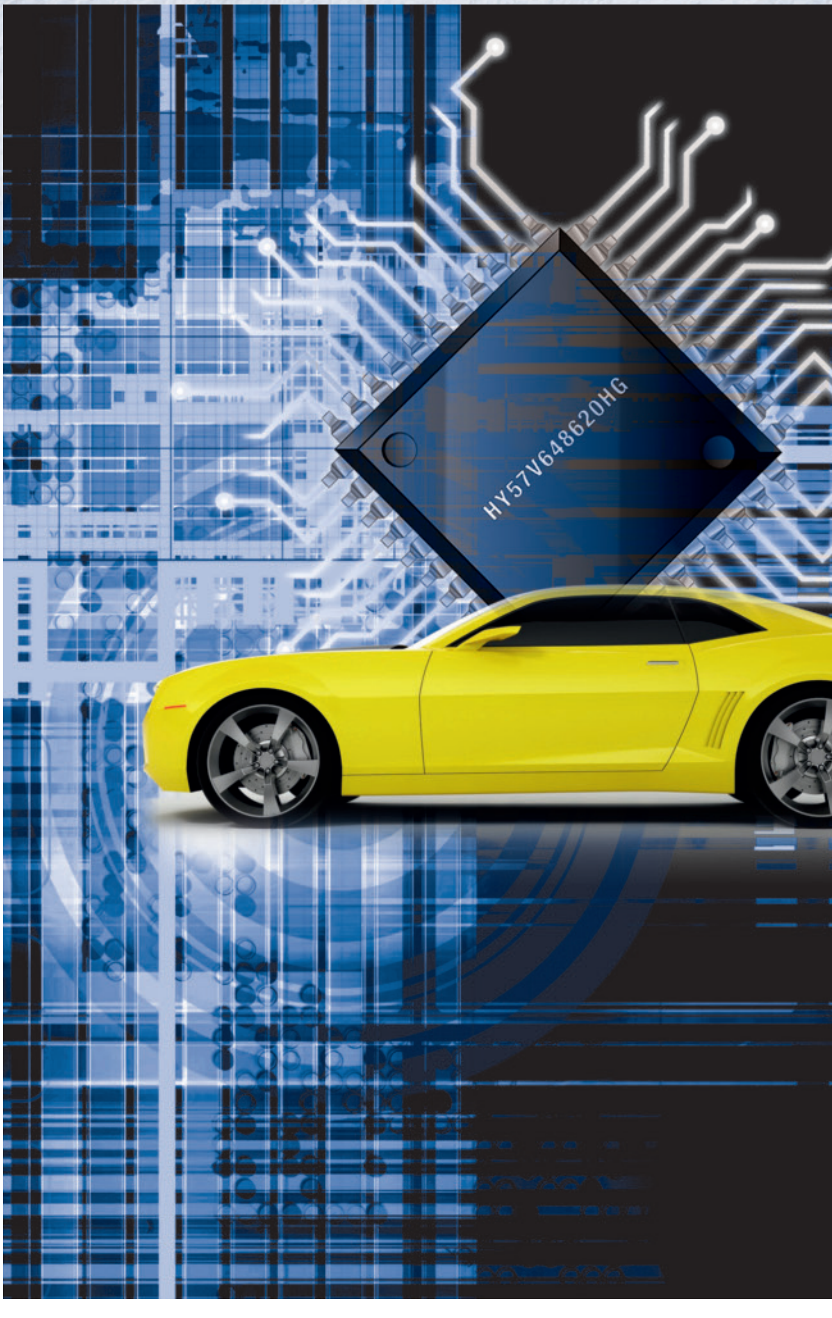
FlexRay Controller - Integrated or Discrete?

What are the advantages for automotive system designers of using a discrete FlexRay communications controller and one integrated into its high end 32-bit microcontroller family



Automotive system designers require a combination of performance, flexibility, cost effectiveness, scalability and safety that is sometimes hard to reach. A fully integrated solution can be cost effective but requires a whole new system design.

While designs have more pressure on space, using a discrete solution can take more space but provides the potential to upgrade the system easily. This also allows developer to use a range of different processors, both within a family of devices, re-using the same software, but also across different families for different applications, from cars to high end motor cycles.

A key example of this comes from using the FlexRay communications protocol. Version 2.1 of the specification has been available for several years now, but the devices that support the new standard have taken time to come to the market. One of the first was the CIC310 stand alone FlexRay communication controller, which has been qualified in many designs, but now this same design has been integrated into the TC1797 TriCore 32-bit controller (**Figure 1**). This allows system integrators to build fully FlexRay v2.1 compliant in-vehicle networks for powertrain, chassis and body applications.

The FlexRay controller core is based on the widely used E-RAY design from system supplier Bosch and is integrated into the TC1797, part of the AUDO FUTURE microcontroller family. This family uses the high performance 32-bit TriCore processor core that combines microcontroller functions with digital signal processing and the industry's highest density flash memory.

The family includes a wide range of peripherals such as a fast ADC, DMA memory engine and several serial interfaces and external bus Interfaces. Most of the family also has an additional 32-bit Peripheral Control Processor (PCP) on board that offloads the main CPU by running the low-level drivers for the integrated peripherals.

The previous TC1796 recently achieved a score of 100 Automark in the certified EEMBC Benchmark (http://www.eembc.org/) – the highest score for an automotive qualified microcontroller in this frequency range. The TC1797 adds another 30% system performance with its TriCore operating at 180 MHz.

This level of performance and integration is aimed at high end engine control units (ECUs) to handle the complex algorithms for emission control and FlexRay is mandatory in current and future designs of these systems (**Figure 2**).

Discrete: The flexible way

At the same time there can be advantages from using a discrete controller. The CIC310 is a standalone FlexRay V2.1 Protocol Controller based on the same Bosch IP and

Figure 1: The TC1797 uses a new high performance 32-bit TriCore CPU that combines microcontroller functions with digital signal processing and the industry's highest density flash memory.

has already passed the mandatory FlexRay Conformance Test. It is partnered with a microcontroller or microprocessor via a standard interface and allows designers to provide FlexRay as an optional feature that can be easily integrated into an existing hardware and software design. In this case, the footprint for the CIC310 and the according FlexRay transceiver will be available on printed circuit board but the devices will be only mounted if needed, and this also provides an upgrade path for existing systems.

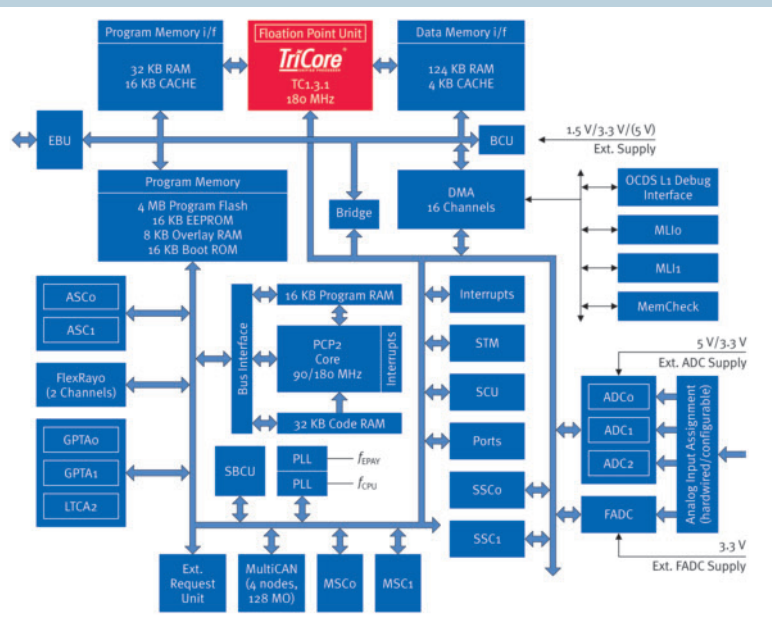


Figure 2: The TC1797 microcontroller is optimized for engine management systems and transmission. In engine management, the TriCore provides lower fuel consumption and improved emissions. With a number off build-in safety features like a Memory Protection Unit (MPU) the TriCore is also a fit for safety critical application in chassis control area like high-end sensor clusters and suspension.

The controller supports both FlexRay communication channels with a maximum bandwidth of 10 Mbit/s each and provides 8.25 KBytes of configurable message RAM for storing up to 128 messages. The redundancy of the two independent communication channels, along with the FlexRay time-triggered communication schemes and high bandwidth are key for safety critical automotive applications.

Low power is also a key feature of the CIC310. Manufactured in a 130 nm process technology, the core consumes 30 mA to 50 mA.

To support designers, a number of hardware features are implemented. Eight independent DMA channels offer an efficient transfer mode without using the host CPU. Several interrupt lines give full control of the CIC Channel Host Interface (CHI) and the E-RAY communication controller, and this provides three different interfaces (**Figure 3**):

A low pin count SPI (Serial Peripheral Interface) interface supporting up to 20 MBaud Bandwidth

A configurable 8/16-bit wide bus parallel interface including a 13 Bit address bus (with address extension mechanism to 32-bit) supporting up to 10 MByte/sec bandwidth

A high speed serial MLI (Micro Link Interface) supporting up to 40 MBaud

This flexible channel host interface means the CIC310 can be used with almost any microcontroller or microprocessor architecture available in the market.

The new TC1767 and TC1736 TriCore controllers do not have integrated FlexRay and provide a path for more cost optimised designs from the TC1797 using the same software. Both integrate the same microcontroller core as TC1797, the same built-in safety features like a Memory Protection Unit (MPU) and a software-compatible peripheral set. In addition to powertrain applications, the TC1767 and TC1736 can also be used in safety critical application in chassis control area like high-end sensor clusters and suspension.

To connect the TriCore to the CIC310, all three interface options available can be used. The most efficient interface is using the Micro Link Interface (MLI) as this provides synchronous high-speed serial connection for automatic data transfer/request transaction between a local and a remote controller. It also supports transparent read/write access with a low pin count.

For the connection between the processor and the Companion IC only eight pins are necessary - four each for transmit and receive. Further pins are available for additional interrupt lines to monitor both the ERAY Controller and the CIC310.

As the TriCore internal bus structure supports the DMA capability of the CIC310 via MLI interface, the FlexRay communication is supported with minimum performance requirement from the main TriCore CPU. Other internal DMA operations can also be offloaded to the on-chip 32-bit peripheral controller.

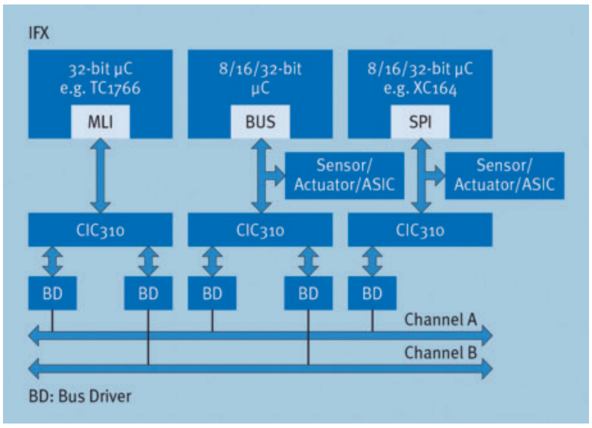


Figure 3: Infineon's Channel Host Interface (CHI) Concept for the CIC310 supports 3 different options: a standard parallel interface, a Serial Peripheral Interface (SPI) and a High Speed Serial Micro Link Interface (MLI)

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Well supported

The discrete controller is not just applicable to the TriCore family. The latest XC2200, XC2300 and XC2700 families of controllers are based on the Infineon's C166S V2 microcontroller architecture and can all make use of the discrete FlexRay controller.

The XC2200 is designed for body applications like Body Central Module, Central Gateway and air-conditioning with power consumption in standby down to 50 uA as well as extended communication capabilities. The XC2300 family covers applications in the safety critical area like airbag and Electronic Power Steering (EPS) by adding Error Correction Code (ECC) on all memories, memory protection, a CRC (Cyclic Redundancy Check) and redundant analog-digital converters, and supports systems to be certified in IEC61508 level SIL3. The XC2700 32-bit microcontrollers are optimised for Engine Management and allow system makers to build cost-effective electronic engine control in motorcycles around the world to meet upcoming emission standards.

Interfacing the XC2200, XC2300 and XC2700 to the CIC310 can be either through the standard 8- /16-bit parallel bus interface or through one of the incorporated USIC's (Universal Serial Interfaces). These support the fast SPI standard, running a bandwidth of up to 20 Mbit per second between the CIC310 and the microcontroller. In applications with critical latency requirements, the parallel interface is the recommended solution as it supports a speed of up to 10 MByte per second with very low latency impact.

But implementation is also an important issue for designers, so AUTOSAR software drivers for the CIC310 are available and have already been proven by the AUTOSAR Validator project. At the same time, the TriCore family as well as the XC2200, XC2300 and XC2700 families are supported by a full suite of development tools including evaluation boards, debuggers, compilers and documentation.

Automotive equipment makers are already using FlexRay in series production, and broad introduction is planned already in 2009. This means a wide range of different solutions will be required by the equipment makers, all based around FlexRay as the communications controller.

Having both integrated, tightly coupled implementations such as the TC1797 and the discrete CIC310 allows the system design to select the right processor core for the application and still easily provide FlexRay communications. The discrete approach also provides a simple upgrade path for today's designs to become FlexRay-enabled.

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