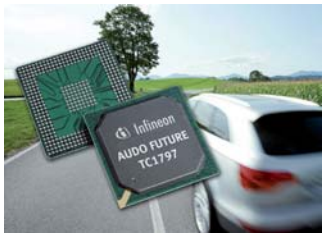


A brief history outline of Infineon's CAN modules

Ursula Kelling

Author
Ursula Kelling
ursula.kelling
@infineon.com

Infineon technologies
Am Campeon 1-12
85579 Neubiberg
(Germany)

Link
www.infineon.com

During the last 20 years, Infineon has been producing different kinds of CAN micro-controllers. Even though, at that very time, still labeled with Siemens changing in the latest 90s to Infineon. Since then, many products have been designed and some of them are still in production. The most well known are the C505CA 8-bit micro-controller and the C167CR 16-bit micro-controller. Both do incorporate the original Bosch CAN module.

The CAN module of the C167CR incorporates 15 message objects, the last message object double buffered and the only one having an additional mask. All these 16-bit micro-controllers have only one CAN module, except the C167CS, which has two CAN modules. As time went by, it had been time for a new CAN module, so in the year of 2000 the TwinCAN was introduced. It was the very first big step giving the CAN module a more modern outline and giving it configurable FIFOs and a gateway function. The TwinCAN module still exists for example on the XC166 family.

The TwinCAN module already has flexible interrupts, interrupt sources and mask registers for every single message object. In many ways, TwinCAN provided many new features for applications, but very soon, more flexibility was needed so therefore Infineon introduced the MultiCAN module in 2003.

The MultiCAN module is the continuous development of the TwinCAN module and therefore includes almost all features, which have been introduced on the TwinCAN module. Starting with the TC1130, MultiCAN became the standard module on Infineon's micro-controllers and it is still today (e.g. on the Audo or the XC2000/XE166 families).

Up to eight CAN modules

MultiCAN is a scalable implementation supporting from two up to eight CAN modules. The number of message objects can be up to 256 message objects, shared for all nodes. The CAN implementation is compliant to ISO 11898-1 and supports the base and the extended frame format (11-bit and 29-bit identifiers). All modules support an individual analyzer function, which makes it possible to participate in the network as a passive member of the bus. Message objects can be connected to a FIFO or to a hardware-supported gateway. The message objects are no longer fixed, they are part of a linked list, so its predecessors and successors within the list can be programmed, meaning, that for example a FIFO can consist out of several message objects scattered over the message RAM. As already on TwinCAN, message objects are assigned to the individual CAN modules, if a customer needs 250 message objects on one node and two on another node and the rest with one each, this is fine. There are no additional circuitries needed or switching together nodes. The messages received are defined by the ▷

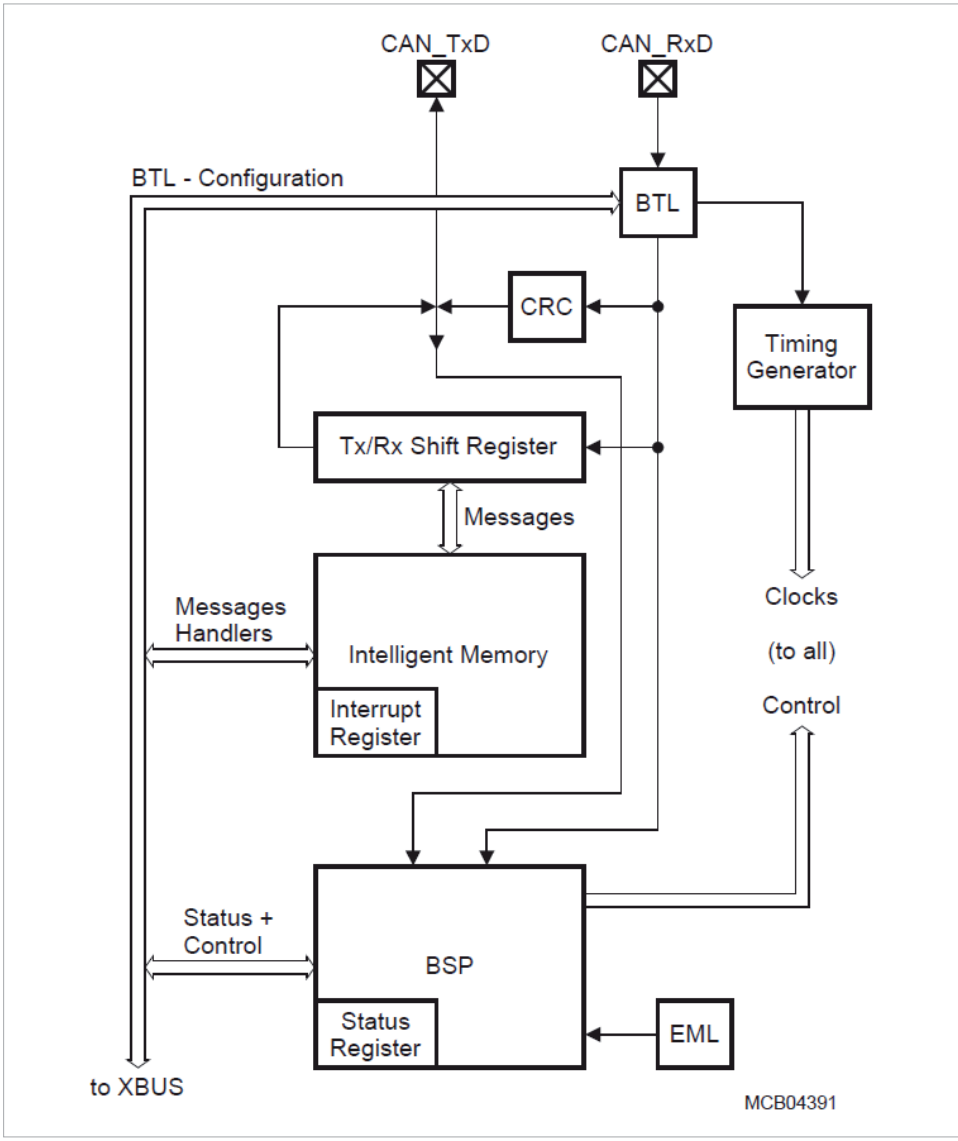


Figure 1: C167CR CAN module block diagram

identifier programmed into the arbitration register and its local mask.

The linked list controller as mentioned above is one unique benefit, as it gives the possibility to assign message objects freely to nodes and to link them together to FIFO or gateway structures.

A further benefit is the debugging feature, giving the possibility to detect, whether the resistor on the bus is the right termination. The measurement feature calculates the distance, between an outgoing edge and its runtime back over the receive pin.

To avoid errors and to ensure to use the right error-handling, MultiCAN offers a variety of mechanisms. In case the microcontroller implements two CAN modules, the following possibilities exist:

- Two CAN modules, two CAN transceivers, here two separate modules are connected over separate transceivers to one bus system.
  Plus: Transceiver errors are detectable.
  Minus: This concept needs two CAN transceivers
- Two CAN modules, one CAN transceiver, in this case two separate CAN modules are connected to one transceiver by having one receive connection.
  Plus: This concept needs one CAN transceiver.
  Minus: A transceiver error is not detectable.

Both concepts do have synchronized message access, which leads to the fact that short time disturbances are recognized by both CAN modules and lead to an error situation.

The CAN modules are handled asynchronously as the protocol handler is requesting the information one node after another. Message objects are appended to a node. If the application shall test, that a received message is really correct, for each node a message object has to be setup and compared via software. A disturbance on the bus is seen in different states and has a different impact. It is even possible to find a problem between protocol handler and message memory.

With upcoming safety applications and higher needs for checking an MCU, if it is working as expected, this feature becomes more and more important, as it is possible to check whether a message has been properly received.

Analyzer mode and other features

In the analyzer mode, the CAN module listens to the bus, but it is not actively taking part of the protocol. This feature is valuable for example in case the bit-rate shall be detected, without disturbing the bus.

Beside the analyzer mode, the MultiCAN module has additional features to prevent bus errors. It provides a synchronization analysis feature as well as driver-delay-measurement capability, which help to make further extensions of the bus safer and small disturbances on the bus less critical.

The synchronization analysis feature helps to prevent a possible bus error in case of slight changes or impacts on the bus. This function monitors the time between the first dominant edge and the sample-point measured and stored in a frame counter register. By using this function, it is easier to adjust the sample-point to the actual sample-point of the complete bus system.

The driver-delay-measurement helps to find a circuitry, where a sent edge is received time quanta before the sample point. Both features help to find a configuration and circuitry, which is not fault-prone to slide changes or disturbances on the bus.

FIFO and gateway function

FIFOs can be collected all over the message RAM and still forming a FIFO. The linked list control enables every message object to ▷

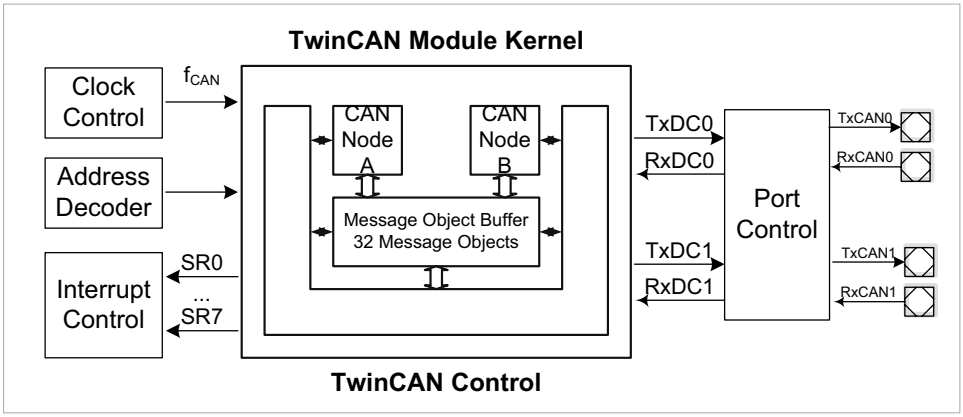


Figure 2: Block diagram of TwinCAN

Literature

Horst Müller: Integrated and stand-alone CAN solutions for different application levels (in: iCC proceedings 1994)

Robert Leindl: Complete CAN capability (in: iCC proceedings 1997)

Axel Wolf, Clemens Koller: 16-bit micro-controller with two on-chip CAN modules (in: iCC proceedings 1998)

Ursula Kelling: MultiCAN – A step to CAN and TTCAN (in: iCC proceedings 2003)

be assigned to a node dependent on the order within there the FIFO can be build by pointer mechanisms. The FIFO can be of any size.

On both implementations TwinCAN as well as MultiCAN, a gateway mechanism exists, enabling applications to reroute messages from one node to another not needing any CPU performance. Here by setting the corresponding pointers and bits, the message is copied to the destination bus and the transmit request is set automatically. The gateway function can be combined with the FIFO, so that even two busses running at different speeds can be interconnected.

MultiCAN has up to 16 interrupt nodes routable on different events (service request nodes). Each CAN module has four different interrupt events. Each message object can trigger an interrupt. The frame counters, available for frame or timing information has an overflow service request. The principle of the interrupt node pointer selection mechanism works by connecting interrupt events to an interrupt node. An interrupt can be connected to several events.

MultiCAN on industrial micro-controllers

Dependent on the micro-controller different outlines of the MultiCAN implementation exist. Coming from 6 CAN modules and 256 message objects on the XC2000/XE166 family down to 2 CAN modules and 32 message objects several configurations do exist. The 2-node configuration does exist for example on the XC800 devices as well as on XMC4500 devices. The XMC4500 comes also with an Ethernet module and a USB On-the-Go implementation.

To achieve easier interconnectivity the Ethernet module as well as the USB module has been coupled with a local RAM. The CAN module can transfer messages to and from this RAM via DMA, to enable a gateway function across USB, Ethernet, and the CAN modules.

The MultiCAN module will see some improvements to be ready for the next years. All improvements are done in such a way, that the “old” software will still be able to run on newer micro-controllers; simply the improvements can be switched on if needed. Improvements are done for example for pretended networking or for network management supervision. MultiCAN+ is ready for another decade with all the good things MultiCAN is offering and gets all the features to be ready for next years. ◀

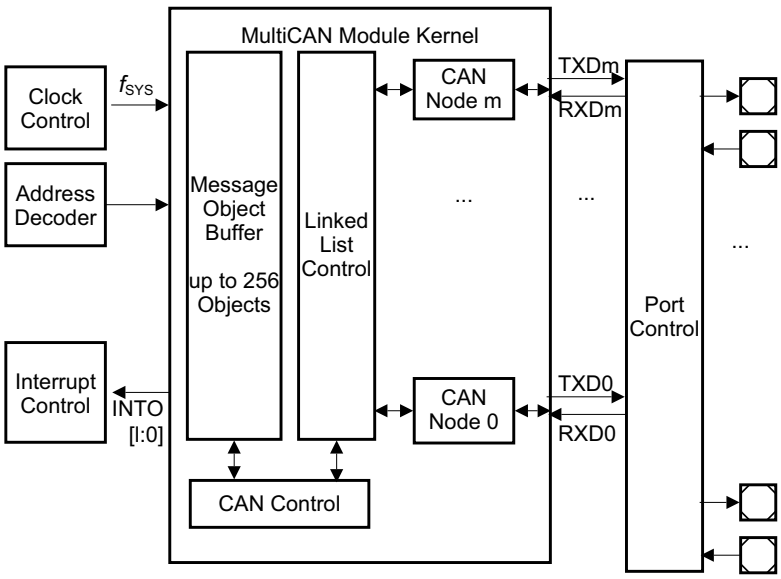
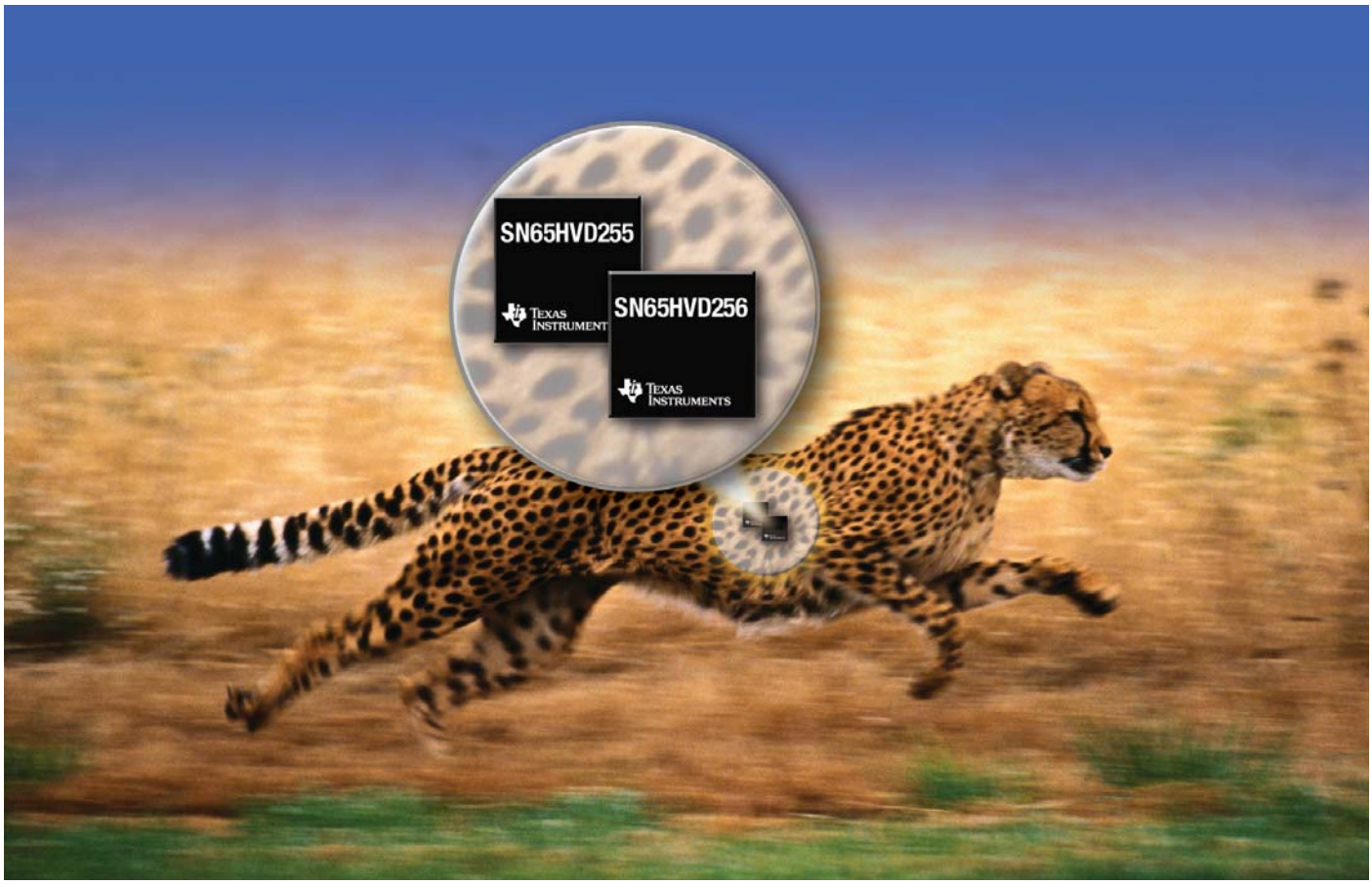


Figure 3: Overview of the MultiCAN Module

Wow! 20 Years of CiA…That Was Fast

Just Like TI's New "Turbo" CANs…Fast!

High-Performance Analog>>Your Way™



"Turbo" CANs? Yes, Texas Instruments' new CAN devices, **SN65HVD255** and **SN65HVD256,** provide extremely short propagation delays to allow for high data rates in long & loaded CAN Networks. Don't need the speed? No problem. TI's CAN portfolio has all your needs covered, be it 5V CAN, 3.3V CAN, or isolated CAN for your automotive and industrial applications. TI is committed to solving specialized networking requirements while optimizing for various network topologies, microprocessors and power supply systems. Come explore the world of CAN in a wide range of packages and temperatures.

Visit ti.com/can-ad
Get a sample, EVM or simply check out the Turbo CANs

Texas Instruments