# Power saving in CAN applications

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***Abstract***
*During the last years, the discussion about power saving had and has different aspects. One of them has been to save power in CAN applications. The mechanisms, which can be used either on physical layer or on the micro-controller, will be discussed within the article.*

In a normal CAN network, all nodes are permanently active when the CAN communication is running, independently if the ECU (electronic control unit) is used or not. However, many applications are not used all the time, and these ECUs can be switched off to reduce the power consumption. A solution for such a realization must fulfill the following criteria's

- No negative impact on the physical bus (no disturbance)
- Can be awake with a dedicated CAN data/remote frame
- Low-current consumption

In addition, three different situations must be covered from this solution. In normal CAN communication, in start-up phase of the car, and in parking cars:

- In normal CAN communication, not needed ECUs can be set into a special sleep-mode. All other CAN nodes can communicate and will be not disturbed from the deactivated ECUs. With a dedicated wake-up frame, one or more ECUs can be awaked with a short time-delay.
- During the start-up of the CAN network, all ECUs ramp-up and together, they will consume a lot of current. This is not necessary and with the new approach, only the needed ECUs should be ramped-up. All other nodes changes from sleep mode in a bus observation mode. After the successful ramp-up, the other nodes can be added one by one into the communication, if necessary.
- If you park a car, a very low-current consumption is required to unload the battery. However, if for example the radio is on, all CAN ECUs located on this CAN network will stay active and consume a lot of current. With the new solution, only the necessary ECUs are active (for example wheel to control the radio and the radio itself) and all other nodes a sleeping or shut off. This reduces the current consumption dramatically.

Two different solutions cover the power saving criteria. One, called partial networking is based on a modification of the transceiver and the other ones called pretended networking, which is realized in the micro-controller.

In the partial networking approach, the wake-up frame detection unit is implemented in the high-speed CAN transceiver. This new unit compliant to ISO 11898-6 (under development) contains

- A high-precision oscillator
- A CAN message decoding unit
- An error-handling management
- A wake-up frame (WUF) configuration
- A compare unit
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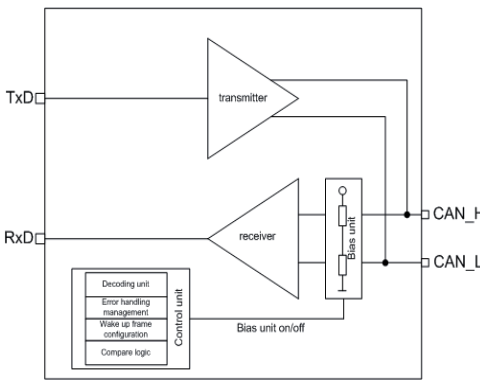
During selective wake mode, this transceiver is active and monitors the CAN communication like a watchdog. If a dedicated can frame is observed, the transceiver wakes-up the ECU. These kinds of transceivers have now two modes in the so-called low-power mode:

- Sleep-mode
- Selective wake-up mode

In sleep-mode, the current consumption is reduced to a minimum; all functions in the ECU are disabled. Every message on the bus wakes-up the transceiver and the ECU. In selective wake-up mode, the current consumption is also low, but the wake-up frame (WUF) detection unit is active, and monitors the bus. All other functions are disabled. With the dedicated WUF, the transceiver and the ECU will be woken-up.

The advantage from this approach is a very low-current consumption in low-power mode. The disadvantage is the fact, that only one dedicated WUF awakes the ECU. In addition, the long ramp-up time is a disadvantage for this system. A first implementation from Infineon can be found on the TLE9267QX. Pretended networking describes an approach developed in Autosar. Pretended networking in combination with ECU degradation allows safing power on micro-controller basis. What do these concepts mean? First of all, they integrate well-known power-saving approaches back into Autosar, possibly still used by the industrial world.



ECU degradation allows using the HALT mode, also known as IDLE for CPUs. In case of no task is running, the CPU is no longer doing NOPs, but will go to IDLE and therefore the CPU is no longer clocked. As soon as the first interrupt is executed, the CPU is active again. This is already the first power saving step. The next power saving step, is that all modules not used in a low power operation mode, will be shut off, therefore power can be saved. Now going for pretended networking, the communication modules will run with a reduced message catalogue and reduced amount of interrupt sources to allow longer sleeping times of the CPU. These well-known power-saving measures, initially used only during the park situation of a car, will know be used during driving. Dependent on the existing software stacks, these measures will be well known, or can be integrated as long as the software is able to cope with shut off modules or CPU in idle. These measures are sophisticated, as for example they are only existing on devices as the C167 and have been part of newer devices ever since. An additional measure, which needs more software influence is the changing of the clock for a device.

In case the device is not prepared for such a measure, all communications have to be stopped, the bitrates have to be adjusted, and then all communications can be restarted. If microcontrollers are prepared for these measures, than a central clock switch will exist, not touching any communication. If all measures are combined, saving of 50 to 60% of the ECUs power consumption can be achieved. Even though this might sound neglectable, in times where every mA counts, these measures will help to safe a sufficient amount of power. ◀

***Summary***

*The CAN transceiver as well as the microcontroller can help to safe power. For all applications, which have wake-up times greater than 100 ms or 200 ms for safety applications, it is possible to shut-off the ECU via the CAN transceiver as long as the network is able to handle this. For all others pretended networking in combination with ECU degradation will help to safe as much power as possible. Many of the features already exist in today's micro-controllers, as for example the XC2000/XE166 or Audo Max family, for the Aurix family even more is to come.*

***Related articles***

*Partial networking reduces $CO_2$ emissions (in CAN Newsletter 4/2011, page 8/10)*