Partial deactivation of CAN nodes

Fritz Burkhardt

Author
Fritz Burkhardt
STMicroelectronics

Link
www.st.com

Standardization
As mentioned in the article, car manufacturers have decided to bring partial networking into volume production. However, this can only be realized if the required transceiver features can be standardized so that the semiconductor suppliers can develop and industrialize the respective devices. For this purpose, the Switch (Selective Wakeable Interoperable Transceiver CAN High-speed) group has been created to prepare a specification to be submitted for international standardization. The submitted document is currently being discussed by the International Standardization Organization to define a supplement for ISO 11898 (Road Vehicles – Controller Area Network CAN). STMicroelectronics is an active contributor in the definition of this functionality within the mentioned committees and is working intensively on the implementation of suitable transceivers.

Electronics is a major driver for innovation in modern vehicles. Whereas numerous power train and safety features remain barely visible for the end user, such cars offer countless functions aiming to increase convenience, comfort and assistance for the driver and passengers. As a result the number of electronic control units (ECUs) inside the car has increased dramatically. In high-end vehicles up to 100 modules are installed. They are interconnected by bus systems to facilitate communication among them.

Legal regulations for CO_2 emissions require reduction of energy absorption wherever possible. In the past, fuel consumption of the combustion engine and weight reduction was the main focus area to achieve these requirements. Today, the overall power consumption of the car electronics is no longer negligible. Carmakers and electronic suppliers make significant efforts to collect every mA to further reduce energy input to the car.

The use of electronic components with minimum quiescent current is an obvious step but can be considered state-of-the-art. But analyzing the electronics landscape in modern vehicles quickly raises several questions. Are the functions offered by the many control units really required at all times and in every driving situation? Is the continuous current drain of these modules really justified? Obviously, the answer is no for convenience functions such as seat electronics, trailer- or tailgate control units because these functions will only rarely be operated or they are not required at all times. Additional examples include door control units, auxiliary heating, sunroofs and rear-view cameras.

All these modules are commonly integrated in CAN networks and consume full operating current even if no specific action is requested from the module. The ongoing communication on the CAN network requires the unit to decode every message and scan for tasks to be carried out.

In consumer electronics and mobile communication, the use of standby modes is well known and considered state-of-the-art. In the car, standby modes are used only when the vehicle is parked. The entire communication network is activated as soon as the car is in use and individual CAN nodes cannot remain in standby while the rest of the bus is communicating.

A new network concept is needed which allows single ECUs or groups of modules to be in stand-by ▷

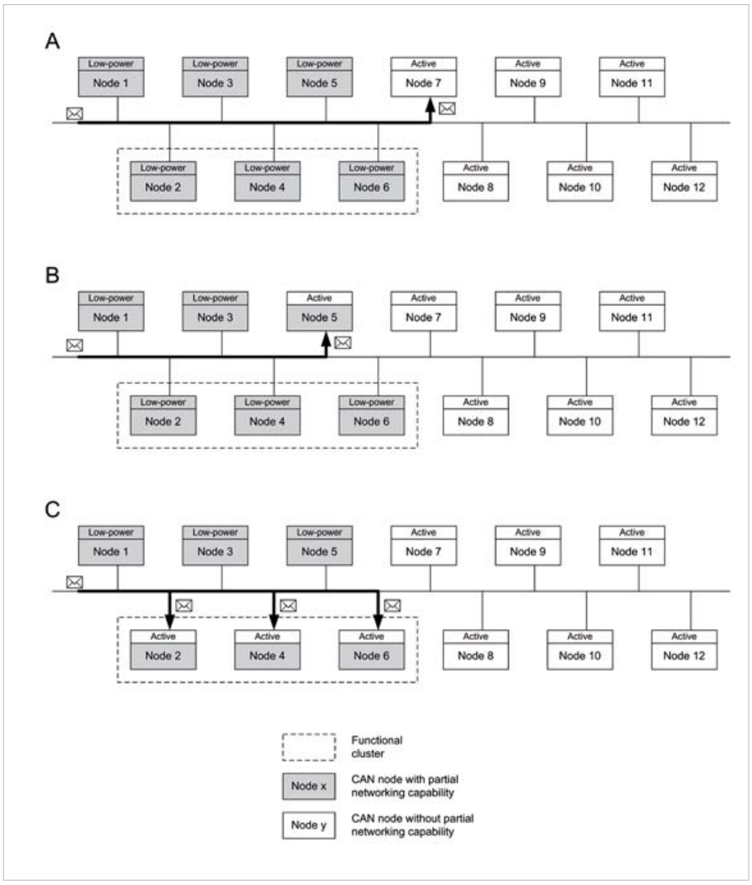
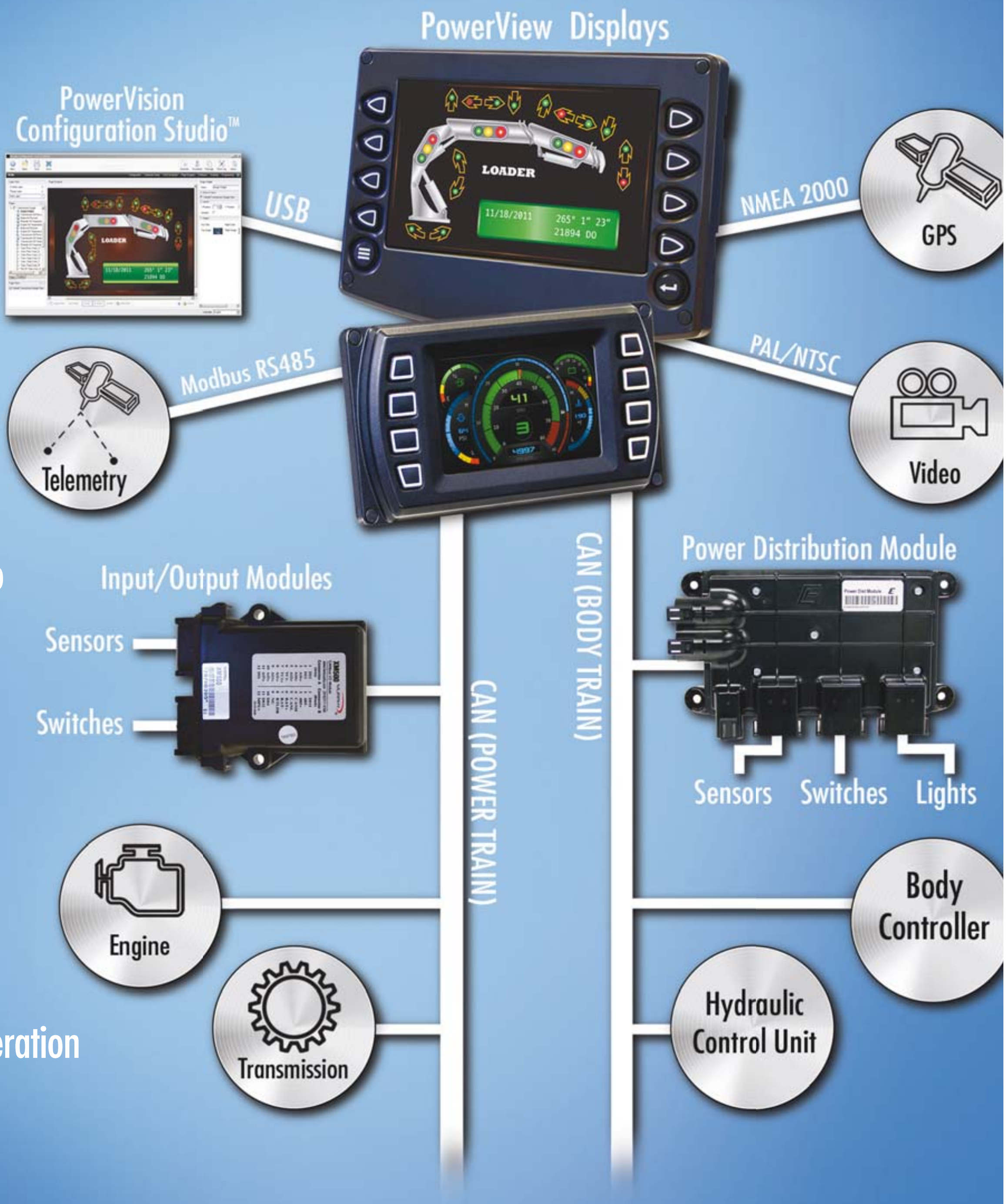


Figure 1: transmission of messages in a CAN network adopting 'partial networking'

Total System Integration

PowerView™ Displays 7 and 4.3 inches Freely-configurable

- ☑ CAN 2.0B
- ☑ SAE J1939
- ☑ CANopen
- ☑ NMEA 2000
- ☑ PAL/NTSC video
- ☑ RS485 modbus
- ☑ USB 2.0
- ☑ Data logging
- ☑ IP67
- ☑ -40 to +85°C operation



In the U.S.

FW Murphy
P.O. Box 470248, Tulsa, OK 74147 USA
tel. +1 918 317 2604 fax +1 918 317 4266
email: sales@fwmurphy.com
http://www.fwmurphy.com/pv750-ivt

In Europe

Frank W. Murphy, Ltd.
Swichgage House, Church Rd., Laverstock
Salisbury SP1 1QZ, U.K.
tel. +44 1722 410055 fax +44 1722 410088
email: sales@fwmurphy.co.uk
http://www.fwmurphy.co.uk/pv750

MURPHY®

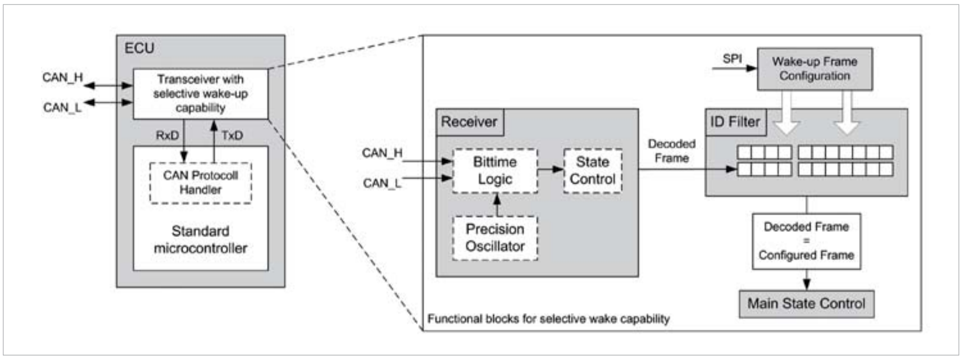


Figure 2: ECU with partial networking transceiver

Product announcement

The L99PM72PXP Power Management System IC is the first SBC (System Basis Chip) supporting the partial networking function. It is based on the L99PM62GXP which is already in production for several years and is hardware and software compatible with this device. It is developed by STMicroelectronics in close co-operation and co-ordination with a major German car manufacturer. Samples are already in evaluation and volume production is planned for Q4, 2012. STMicroelectronics thus complements its family of Power Management System ICs with a device leveraging existing IPs combined to create application-specific components.

while other nodes are communicating on the bus. In addition it is necessary to wake up individual nodes by means of a dedicated and pre-defined message on the bus when a particular function is needed. This new mode of operation is called Partial Networking and requires transceivers with selective wake-up capability. These transceivers are able to receive and decode CAN messages autonomously without the help of the micro-controller (Figure 1 shows the transmission of messages in a CAN network which contains nodes supporting partial networking).

In scenario A the bus is active and a message is addressed to node 7. Nodes 7 to 12 are active due to the ongoing bus communication while nodes 1 to 6 remain in low-power mode because they were not addressed by a selective wake-up message.

In case B a selective wake-up message is addressed to node 5. This node recognizes the wake-up request and enters active mode. Nodes 7 to 12 remain also active due to the ongoing bus communication while nodes 1 to 4 and 6 remain in low-power mode.

In scenario C a selective wake-up message is addressed to a functional cluster consisting of nodes 2, 4 and 6 causing theses modules to enter active mode. This is the case if a user request (e.g. door unlock) requires several independent modules (e.g. front and rear door modules) to perform a particular action (unlock all doors).

The strength of conventional transceivers is the capability to translate bus-level signals with full fidelity while maintaining immunity against external noise, bus interferences and electrostatic surge, which are common in automotive environments. Having only very basic logic functions for detecting bus errors, they are activated by every level transition of the bus or by simple patterns of the bus signal. This, in turn, precludes capturing and evaluating any incoming messages because this is traditionally the task of the MCU's on-board CAN controller which has a precise reference clock (crystal oscillator) required to receive and evaluate the incoming CAN frame.

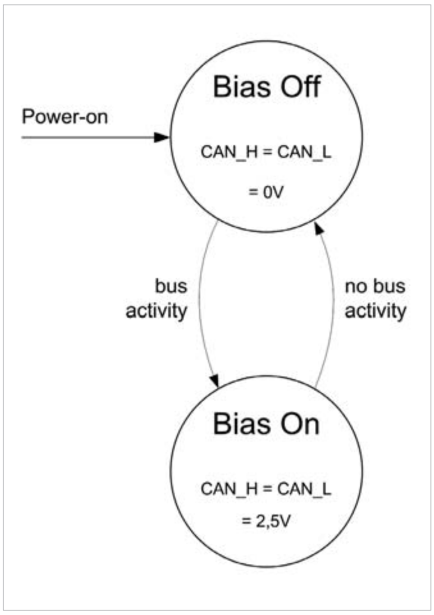


Figure 3: Automatic Voltage Biasing (operating principle)

CAN transceivers capable to detect specific wake-up messages therefore need a highly precise internal reference clock in order to reliably capture and decode the incoming bit stream and a decoder to extract and evaluate the data content. Obviously, the reference clock requires high precision and must be stable over the entire automotive temperature range.

The required oscillator precision is of course dependent on the maximum bit rate foreseen for the network. But in reality the conditions inside the car are far from being ideal. Complex network topologies, long cables and a noisy environment introduce significant disturbances to the CAN signals. The following factors have to be considered in order to ensure reliable functionality in a real vehicle:

- Sender clock tolerance
- Signal propagation delay
- Electromagnetic Interference (Jitter)
- Ringing after signal level transitions

For a bitrate of 500 kbit/s and a sender tolerance of 0,4%, the oscillator must provide a precision of <<1% over the entire temperature range and the operating life of the component.

Oscillator concept in partial-netwoking

The oscillator concept used in partial-networking transceivers therefore plays a primary role and represents the main challenge for the development of these devices.

In conventional CAN networks according to ISO 11898-5 the bus is either active (ongoing communication) or in low-power mode (bus silent). Consequently, each node is sent into low-power mode by its host microcontroller as soon as communication has ended. As soon as communication on the bus is restarted, the transceivers activate the nodes by waking up the system microcontroller.

The Biasing of the bus lines CAN_H and CAN_L in this case is determined by the operating mode of the transceivers (active or low-power).

In case of partial networking, the situation is different. Some bus nodes are communicating while others are in low-power mode. Obviously, the powered down nodes must not influence the biasing of the active bus. Therefore, a mechanism is needed which determines the bus state and automatically turns on and off the biasing of the 'sleeping' transceiver.

This mechanism is called 'Automatic Voltage Biasing'. The operating principle is depicted in Figure 3. Communication on the bus is detected if a dominant-recessive-dominant sequence, which follows specific timing requirements is present on the bus. In this case the Biasing is turned on (CAN_H and CAN_L biased to 2,5 V).

If no bus activity is detected for a specified time, the Biasing is turned off automatically (CAN_H and CAN_L biased towards 0 V) assuming that communication on the entire network has stopped. ◀