

# UNDER THE HOOD

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## UNDER THE HOOD OF THE BMW X5

The 2007 BMW X5 sports activity vehicle (SAV) is the first production application of the FlexRay protocol. Intended for safety systems and high data-rate networks, in the X5, FlexRay coordinates all functions of AdaptiveDrive, a combination of active roll stabilization and electronic damping control. The system allows drivers to choose a sporting or comfortable ride on the fly. FlexRay's ability to transfer data rapidly between networked control devices and systems enables AdaptiveDrive to cope with changing driving and road conditions and provide dynamic control of the anti-roll bars and dampers.

In the AdaptiveDrive system, FlexRay interconnects a master and the four remote-control units of the electronic damper control system. The application uses FlexRay's capability to support a data rate of up to 10 Mb/s as well as its determinism and task synchronization capabilities in a distributed closed-loop control system. With 5 ms cycle time and 2.5 ms update time for distributed sensor and control signals, the network provides damper control for each wheel. Although FlexRay has dual-channel capability, this application's single star combined with a linear bus topology only required single-channel communication.

In the X5, communication also occurs between FlexRay and the vehicle's CAN bus. According to Scott Dahl, director of marketing and prod-

uct planning, chassis systems control, Robert Bosch GmbH, "Bosch ESC currently communicates with the active roll stabilization system via CAN, which then communicates via FlexRay to the individual wheel controllers."



Figure 1. Using a central control module and smaller units at each of the four wheels, FlexRay connectivity allows the BMW X5 to send messages in the AdaptiveDrive system at a rate up to 10 Mb/s.

To support fault-tolerant applications, the FlexRay standard offers several enhanced features such as dual-channel communication, cascaded star topologies, and more. This first production implementation of FlexRay uses only a subset of its full capabilities.

### ESTABLISHING FLEXRAY

BMW used the optional system on the X5 as a pilot to confirm that FlexRay hardware, software, and development tools were ready for full-scale vehicle deployment. In addition to working with tools suppliers and validating the wiring harness, the vehicle implements two key hardware elements: the FlexRay communication controller and transceiver.

Freescale Semiconductor's MFR-

4200 communication controller connects to the unit's microcontroller and provides a bit rate up to a maximum of 10 Mb/s on each of two channels even though only one is used in the AdaptiveDrive system. The unit provides several system features such as 59 message buffers, each with a payload of up to 32 bytes of data and a flexible error-signaling mechanism that provides eight configurable counters, slot status indicators and interrupts.

NXP Semiconductors' TJA1080 FlexRay transceiver (bus driver) provides the interface between the protocol controller and the physical bus in the FlexRay network. It can be configured as an active star transceiver or as a node transceiver. The transceiver actively monitors the system performance using dedicated error and status information as well as internal voltage and temperature.

In 2008, the BMW Group plans on launching a production vehicle with up to 16 FlexRay nodes that will connect powertrain, driver assistance, and chassis systems. ■

### REFERENCES

1. Josef Berwanger, Walter Kuffner, Martin Peterattinger, Günter Reichart and Anton Schedl BMW Group, "FlexRay—Exploitation of a Standard and Future Prospects," SAE 2006-21-0039, presented at Convergence 2006.
2. Freescale Semiconductor MFR4200, FlexRay Communication Controller [http://www.freescale.com/webapp/sps/site/prod\\_summary.jsp?code=MFR4200](http://www.freescale.com/webapp/sps/site/prod_summary.jsp?code=MFR4200) NXP Semiconductors TJA1080, FlexRay transceiver [http://www.nxp.com/pip/TJA1080\\_1.html](http://www.nxp.com/pip/TJA1080_1.html)