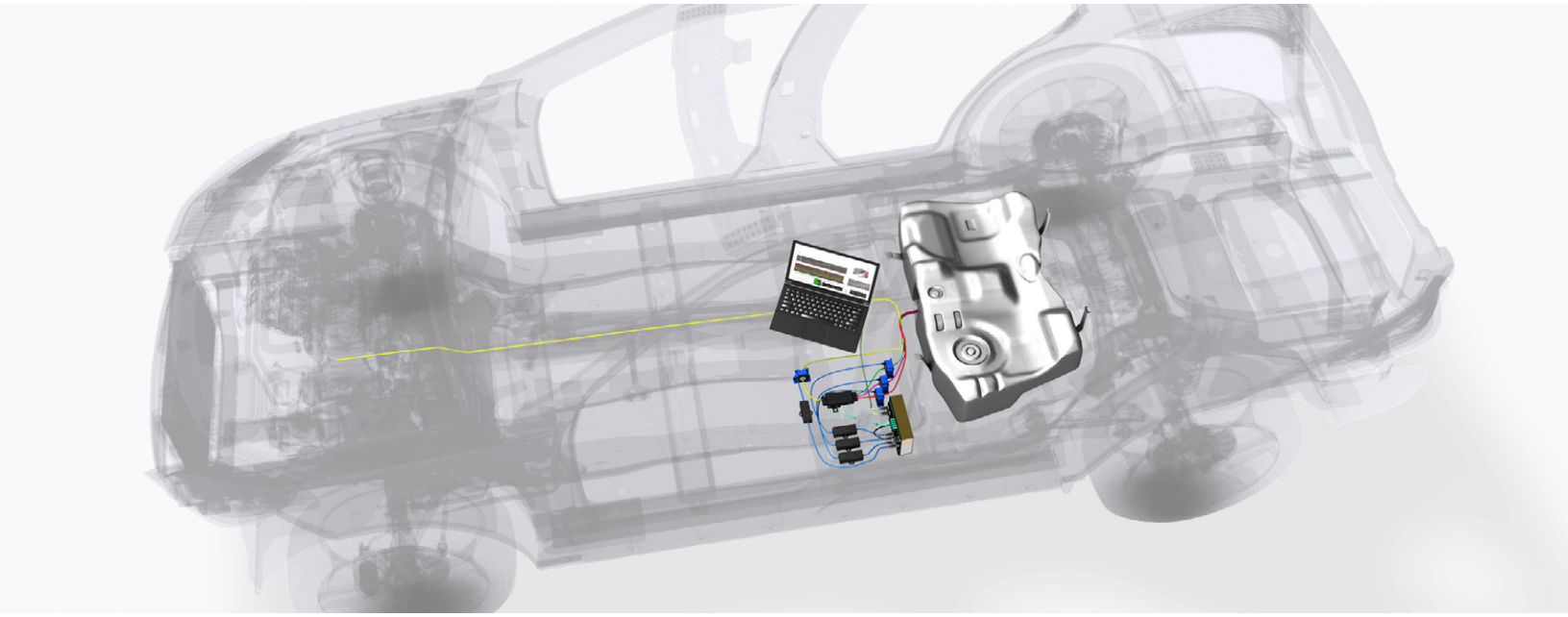
Measurement Technology for the Analysis of Highly Dynamic Currents

Current and Voltage Measurement

To keep down fuel consumption rates, the fuel supply system must be regulated to match the fuel demand. Current flows at the electronic control unit (ECU) for the fuel pump are recorded over an extended period of time to find out whether its fuse is correctly rated or not.



Background

The on-board diesel fuel pump is powered by three-phase AC. The fuel pump is controlled by an ECU applying a pulse-width modulated signal (PWM signal) with a fundamental frequency of 16 kHz. Depending on the operating mode, currents of up to 25 A can flow through the PWM output. Under certain conditions (especially with cold temperatures in winter), the fuse can be triggered. The actual current flows at the input and output of the control unit must be measured in order to check if the control unit fuse rating is too low. Hence, test drives should be carried out in different operational scenarios and under different climatic conditions.

Challenge

The power required for the fuel pump depends, among others, on the viscosity of the diesel fuel used. Not only do different fuel grades and compositions impact the flow characteristics of the fuel, but the environmental and fuel temperatures also have an effect. This means that the rise in temperatures in summer thins out the fuel, the resistance decreases and the pump rotates faster. Diesel fuel gelling in winter has a much greater effect: paraffin wax particles flocculate in the fuel and settle on the fuel filter. The fuel pump must draw more power to pump the same quantity of fuel.

The challenge is to determine under what conditions the fuse will blow. Given that this rarely happens, it is difficult to reproduce the fault. It is the characteristic of the PWM signal that poses a particular challenge for the measurement system. To precisely establish the real current flows (including spikes), it is advisable to oversample with sampling frequencies in the triple-digit kHz range. The inputs must be scanned synchronously to one another and synchronized with the control unit's data as well.

The CSM Measurement Solution

The data acquisition task described above can be accomplished by using an **AD4 OG1000** measurement module in combination with four **LEM LF210-S/SP3 sensor packages**. The Hall-effect-based current sensor in the sensor package offers high accuracy at rated currents of max. 100 A RMS. The 100 kHz threshold frequency for the signal is more than sufficient for the PWM signal to be monitored. Current spikes can thus also be scanned and recorded. The ECU for the fuel pump is installed underneath the driver's seat and is easily accessible. The four LEM sensor packages are connected to the measurement module AD4 OG1000 and respectively scan one of the three phases as well as the power supply line to the control unit.

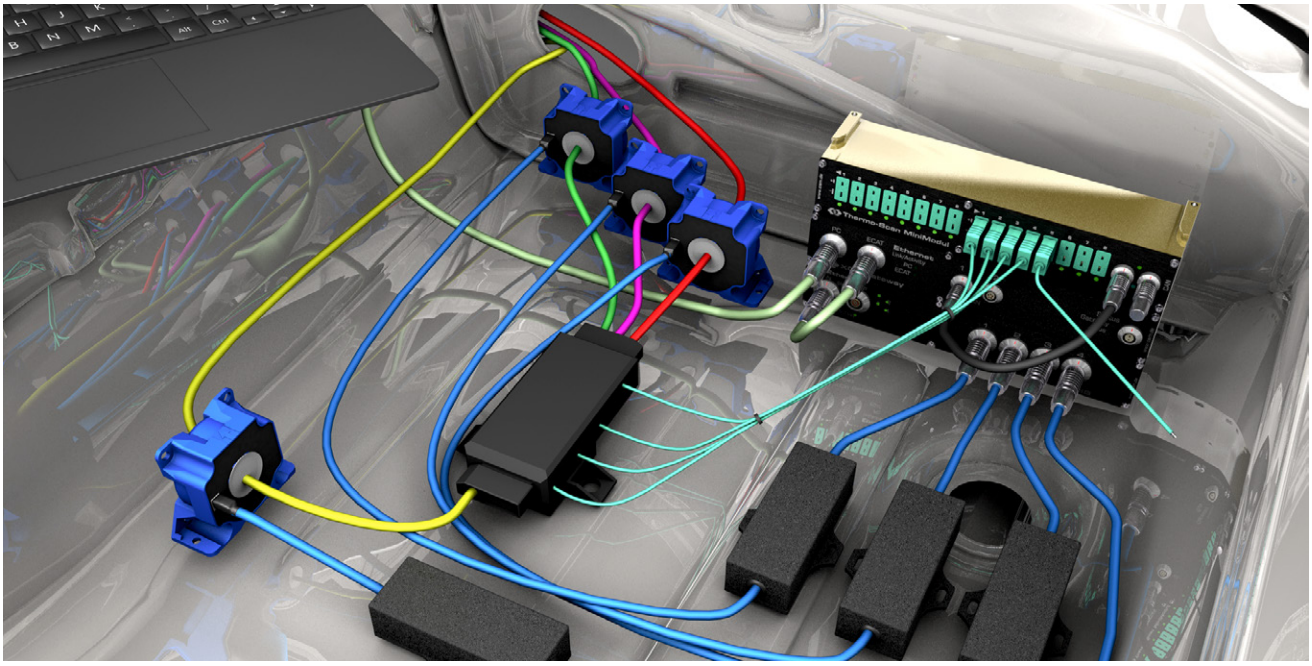
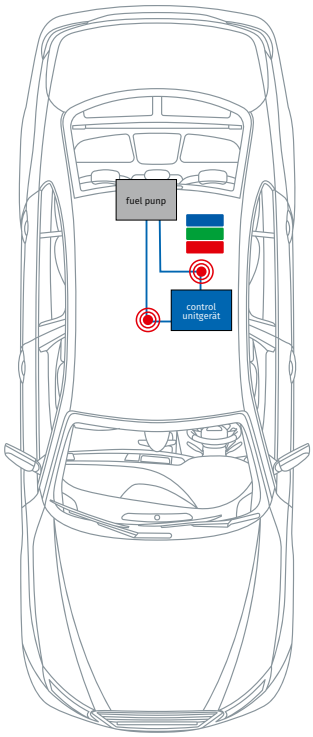


Fig. 1: The LEM sensor packages monitor the three phases of the control unit (green, magenta, red) and the supply line (yellow).

The connected module offers an effective measurement range matching the LEM sensor packages, measurement data rates of up to 1 MHz and it ensures precise synchronization (≤ 1 µs) of all channels via Distributed Clocks functionality. It transmits the synchronized data to a CSM protocol converter **XCP-Gateway pro** to which a TH16 pro temperature measurement module is connected.

The temperature inside the car is measured by this module as well as the surface temperature of the control unit at various test points. All data is then passed to an ETAS interface ES595.1 that records controller data (currents, fuel tank level, etc.) and transmits it to the master PC. On this PC, ETAS INCA runs in conjunction with the CSM INCA AddOn ETH.

Very successful test drives were carried out with the measurement system during the summer trials in Spain. The system will also be tested in the winter trials in Sweden, as the customer is very happy with the results: "The measurement devices do everything I expected of them."



Benefits

The described setup with CSM's fast EtherCAT®-based CSM measurement technology is fully compatible with CAN-based measurement systems thanks to the XCP-Gateway pro. The customer was thus able to integrate his temperature measurement module smoothly into the measurement chain; he benefits immensely from the combination of fast and slow measurement systems. Recording data quasi synchronously with other control units in INCA made a great impression as well. The entire measurement system is connected to the master PC (Laptop) with only a single cable, which means no additional tangled cables.

The measurement modules can be configured easily and put in operation via the CSM INCA AddOn ETH. This initial setup can be carried out even by inexperienced personnel. During testing it is crucial that the measurement equipment is reliable and works trouble-free. CSM measurement technology ticks all the boxes in this regard, as the customer testifies: "It couldn't be easier. I was able to focus on my work and I didn't have to worry about the meaurement system!"

Features Products

AD4 ECAT MM Series – Type OG1000

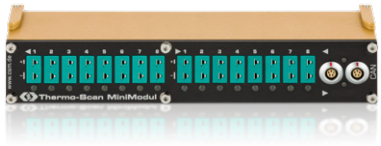
CSM's AD4 ECAT OG1000 measurement module is ideally suited for the most accurate analysis of high-frequency signals with measurement data rates of up to 1 MHz per channel. It offers a high-precision, unipolar and channel-wise adjustable sensor excitation from ±5 to ±15 V DC for a variety of sensors.

XCP-Gateway Series

CSM's XCP-Gateway Series protocol converters were specially developed for CSM EtherCAT® measurement modules and for measurement tasks with multiple measurement channels and high measurement data rates. The XCP-Gateway is available in "Basic" and "pro" versions. The "pro" version has two CAN interfaces via which CAN-based CSM measurement modules can be connected and integrated into the XCP-on-Ethernet measurement data protocol. In the "pro" version, temperature data from the HV Breakout Modules can also be transferred directly via EtherCAT®.

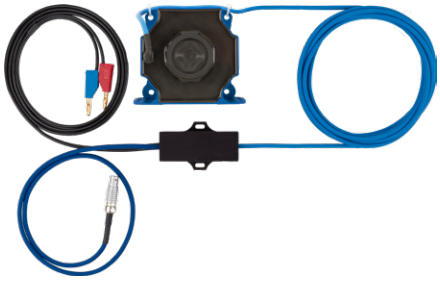
THMM 16 pro

THMM 16 pro enables precise distributed temperature measurements with K, J or T type thermocouples. Thanks to its low temperature drift, it delivers very accurate measurement results over the entire operating temperature range.



LEM Sensor Packages

CSM's LEM Sensor Packages allow fast and synchronous current measurements. Highly dynamic current measurements (e.g., on all three phases on the inverter, as well) with a threshold frequency of up to 200 kHz in a measurement range of up to ±1,250 A can be carried out with this Sensor Package along with the EtherCAT®-based measurement modules of the AD4 ECAT Series.



Complete solutions from a single source:

CSM provides you with comprehensive complete packages consisting of measurement modules, sensors, connecting cables and software - customized to your individual needs.

Further information on our products are available on our website at www.csm.de or via e-mail sales@csm.de.

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