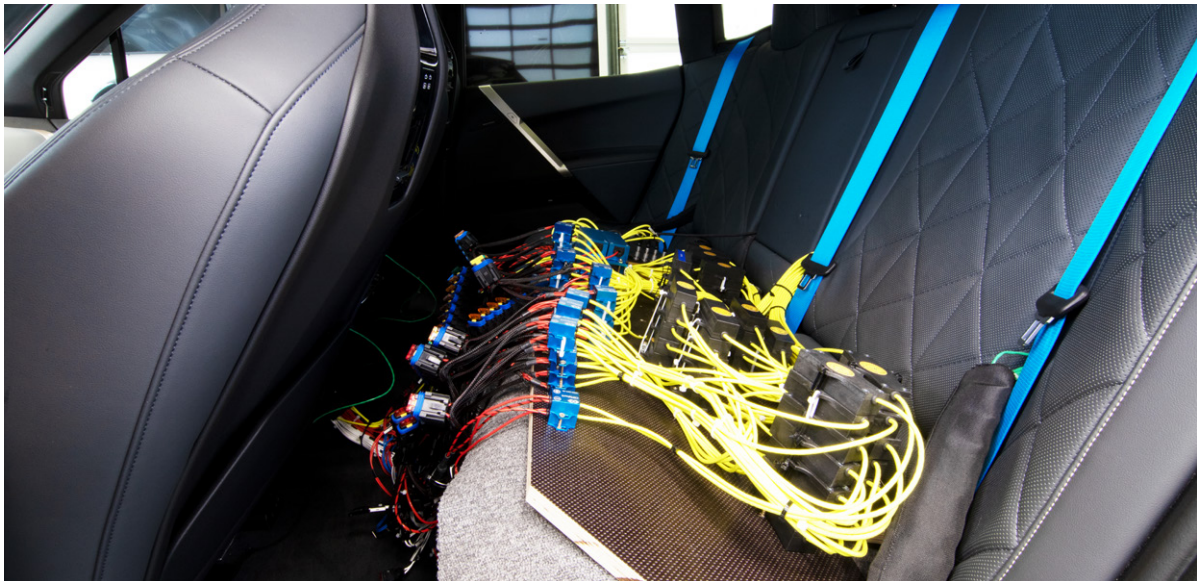
How does comfort in the vehicle influence range?

Current and Voltage Measurement

Offering long ranges for electric cars is one of the biggest challenges for vehicle manufacturers. The decisive factor here is the total energy consumption of the vehicle. Often, only the consumption of the electric powertrain is considered, but: How much does the low-voltage vehicle electrical system, which includes driver assistance systems and infotainment, contribute to discharging the drive battery? For competitive analyses, the currents of these components were therefore examined in more detail: Around 100 CSMshunts of different variants were used for benchmarking an e-SUV.



(AVL List GmbH)

Competitor analysis

For benchmarking of production vehicles, various properties are investigated metrologically in order to be able to compare vehicles from different manufacturers. Such procedures are often carried out by experienced development service providers, such as AVL, one of the world's leading mobility technology companies for development, simulation and testing in the automotive industry.

One aspect that was analyzed in this context for a battery-electric SUV was the power consumption of the electrical subsystems in the low-voltage on-board network, i.e. for the 12 V and 48 V DC voltage levels.

What counts as part of the on-board electrical system?

This includes, for example, the control units, driver assistance systems (ESP, ABS), windshield wipers, the power windows, the car's locking system, as well as the navigation system and infotainment. Since the low-voltage system is connected to the high-voltage traction battery and is supplied by the DC/DC converter, this energy consumption contributes to the range reduction of the vehicle. The interactions between the two systems and the built-in energy-saving measures, such as the vehicle's switch-on and switch-off mechanisms, were therefore examined.

»In modern vehicles, regardless of the drive system, a very large number of electrical consumers are installed in some cases, and the trend is rising. This is because these are not only safety-related driving assistance systems, but also comfort features such as air conditioning, heated seats or screens that are becoming larger and more powerful. It is therefore essential to look at how this affects overall energy consumption.«

Christian Juwan, Product Manager Vehicle Benchmarking, AVL

What is benchmarking within vehicle development?

To maintain their competitiveness, vehicle manufacturers and suppliers rely on detailed competitor analyses. This involves collecting measurement data on various components used in (series production) vehicles from other manufacturers and examining them from various angles, then evaluating them in relation to the company's own products. Important aspects are, for example, fuel consumption, driving and passenger comfort, but also the durability of the vehicles on the test bench and on the test track. To ensure that the results are comparable, it is important that the same test setup and the same testing procedures are used for all vehicles. As these are very complex procedures, many development service providers in the automotive sector offer benchmarking and the insights gained from this as services in their product portfolio.

High effort in equipping measurement technology

For the analysis of power consumption in the low-voltage range, all supply lines of all consumers had to be equipped with measurement resistors, known as "shunts", in order to precisely determine the current consumption of the individual consumers. It had to be taken into account that there are a variety of electrical currents for the different consumers, and therefore a wide range of shunts was required. Due to high-quality, special electrical equipment, the complete analysis of the low-voltage electrical system thus involved a large number of measurement points (Fig. 1).

Various test scenarios

In some cases, covers had to be opened to access the respective fuses to create a measurement location. This resulted in a high time expenditure: It took several weeks until the test vehicle was fully equipped for measurement. To record the data, the vehicle was tested on test benches and driven on road tracks. Since the measurement technology used was suitable for both test situations, the vehicle only had to be instrumented once and could then be tested in both the laboratory and on the road.

Fig. 1: Many measurement points, many measurement resistors: Some of the shunts were placed on the rear bench. (AVL List GmbH)

Shunt, shunts and even more shunts

More than 100 CSMshunts were installed to benchmark the energy consumption of all components in the low-voltage range. For the smaller currents up to 25 A, the CSMshunt fuse was used: these could be easily integrated into the existing connector system of the vehicle's fuse box. Larger CSMshunts were used for the higher currents up to 125 A of the vehicle electrical system (Fig. 2). All shunt variants already have an integrated measuring amplifier for the falling voltages and thus offer high resolution and accuracy.

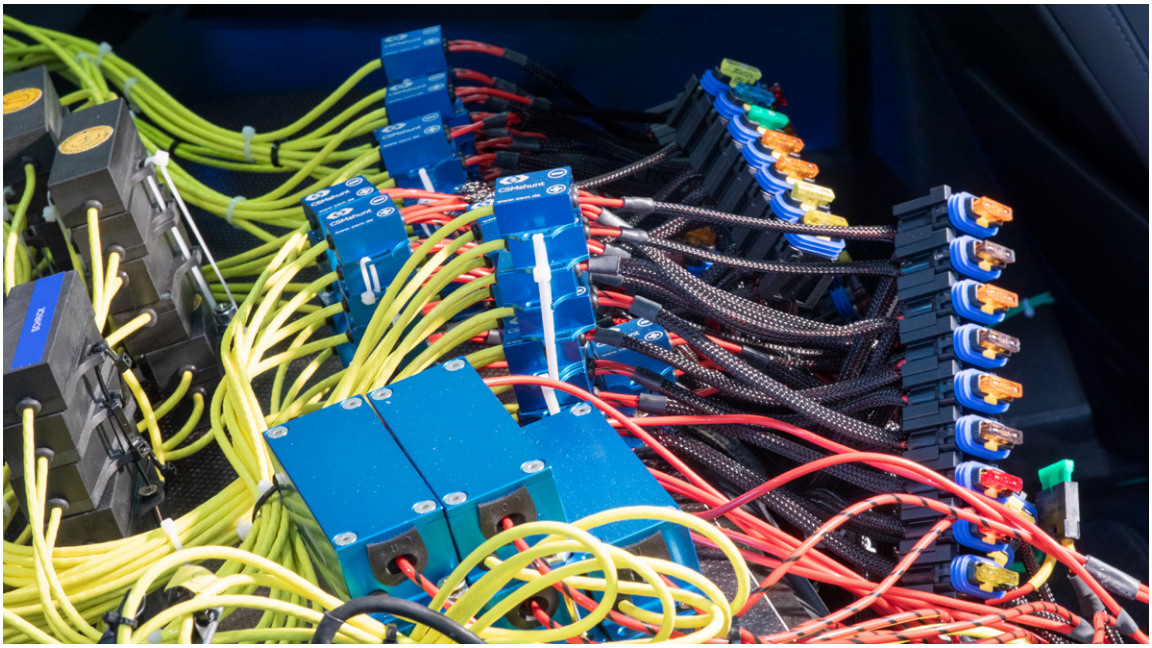


Fig. 2: By using different shunt variants, all currents could be acquired and analyzed. (AVL List GmbH)

Interaction of hard- and software

With the CSM AD measurement modules, the currents were calculated from the falling voltages at the shunts and passed on via CAN. With another AD module, also via CAN, the supply voltage of the respective components was recorded. The analysis software then calculated the respective power consumption from the measured values.

In addition, temperatures were recorded in the vehicle interior using thermocouples and THMM thermal modules. Via an ETAS CAN interface, the CAN data were bundled and transmitted to a computer for analysis with INCA (Fig. 3 and Fig. 4).

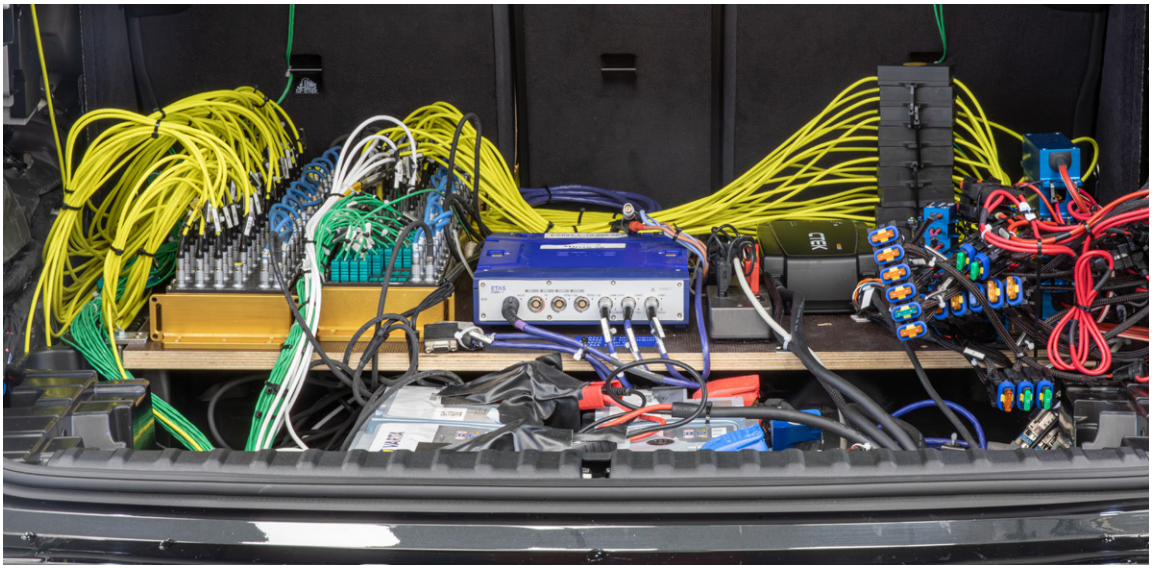


Fig. 3: The majority of the measurement setup was installed in the trunk of the SUV: Besides the shunts, also the AD and thermal modules as well as the CAN interface. (AVL List GmbH)

With the CSM INCA AddOn, the CSM modules could be configured directly in ETAS INCA, so that importing the configuration file was no longer necessary. The AddOn also made it possible to check directly whether the shunts were connected correctly and to make configuration changes very easily at short notice.

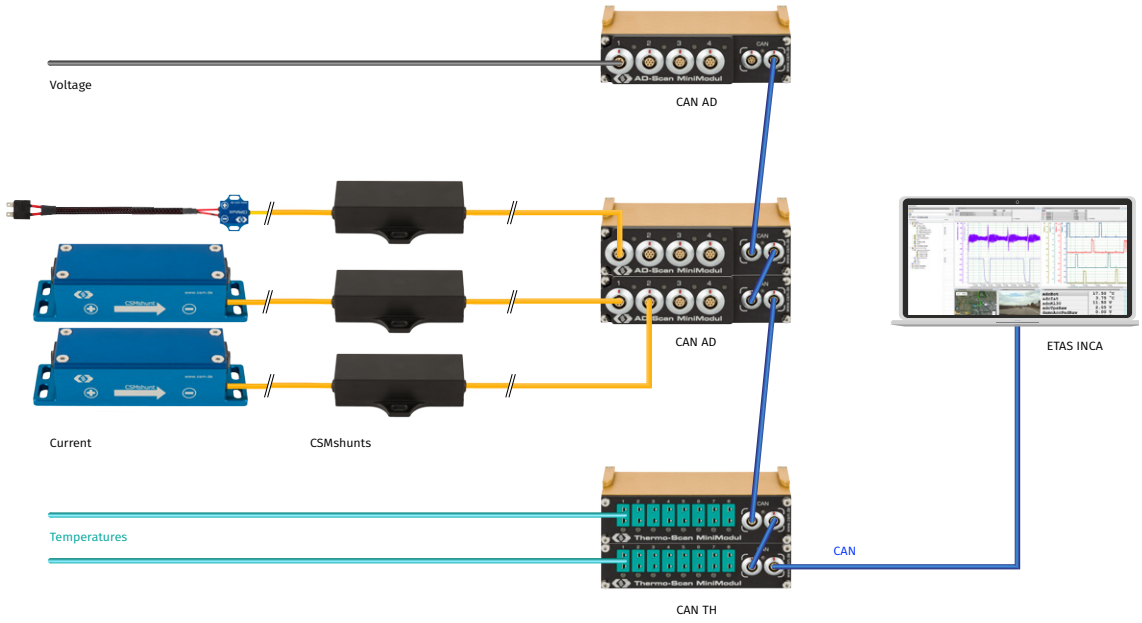


Fig. 4: Simplified measurement setup in the vehicle.

»Especially with a large amount of measurement technology, compatibility and easy configuration are particularly important for us. Vehicle testing is a complex business with many players – so it is crucial to be flexible and efficient at the same time. That's why we appreciate the cooperation with CSM: Here we get the complete package of high-quality hardware and individually adapted software solutions.«

Christian Juwan, Product Manager Vehicle Benchmarking, AVL

Saving energy in the passenger compartment

The average power consumption of the vehicle electrical system was around 500 watts: In addition to the control of vehicle functions (lighting, windshield wipers, power windows, door openers), the air conditioning and heating systems as well as the infotainment system consumed the most power (Fig. 5). As the number of electrical components in the low-voltage electrical system increases, manufacturers must also consider energy-saving measures, such as automatic, intelligent switch-on and switch-off systems in line with typical user usage. How these are implemented and what other energy management strategies are applied was part of the benchmarking evaluation.

»Benchmarking is not just about purely acquiring and presenting absolute values, but just as much about categorizing and interpreting the results. Recognizing trends in vehicle development and detecting the strategies of the competitors play an essential role here.«

Christian Juwan, Product Manager Vehicle Benchmarking, AVL

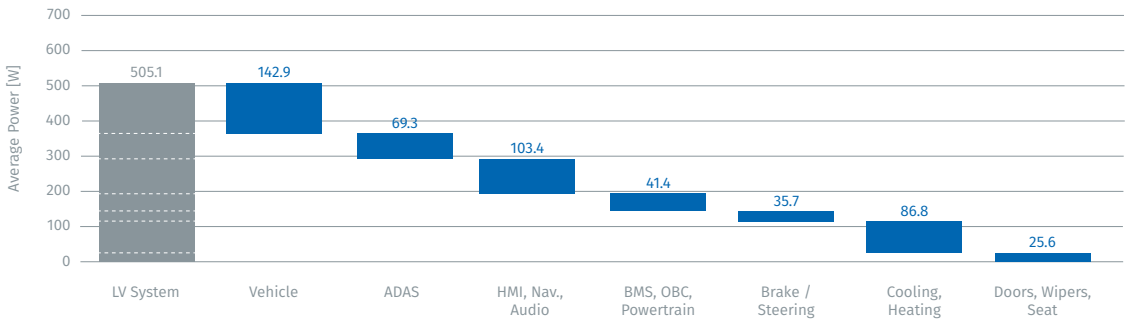


Fig. 5: The graphic shows the average power consumption of the low-voltage vehicle electrical system in watts. The first bar on the very left represents the total consumption of the system. The other bars show the respective components and their share of the consumption. (AVL List GmbH)

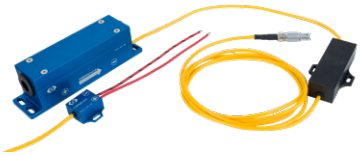
Set up once - test everything

With the CSMshunts and the AD modules, the currents of all consumers in the low-voltage range of the vehicle could be measured easily and reliably. With the different variants, the appropriate measuring resistor could be selected according to requirements. Due to their robust design, both the shunts and the measurement modules were suitable for applications in road tests and on the test bench.

Featured Products

CSMshunt / CSMshunt fuse

The CSMshunt device family extends the application range of CAN- and EtherCAT®-based AD MiniModules from CSM. In conjunction with AD MiniModules, CSMshunts provide precise and safe current measurements from on-board power supply systems and electrical consumers in general. CSMshunts are directly looped into the current path that is to be measured.



AD4 MC 10

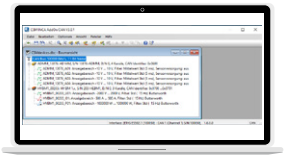
The AD 4 MC 10 has 4 bipolar, galvanically isolated voltage inputs. In addition, they are equipped with a very accurate, bipolar sensor supply, which is adjustable channel by channel.

THMM 8 pro Typ K

The THMM 8 pro type K has 8 inputs for temperature measurements with type K thermocouples and was designed for use under extreme operating temperatures. The measuring inputs are equipped with mini thermo single sockets as well as with two-color LEDs. The measurement data rate per channel is a maximum of 200 Hz.

CSM INCA AddOn

Both software complements CSM INCA AddOn CAN and CSM INCA AddOn ETH enable easy integration of the CSM measurement modules and the ECM exhaust measurement modules in the measurement and calibration software INCA from ETAS.



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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