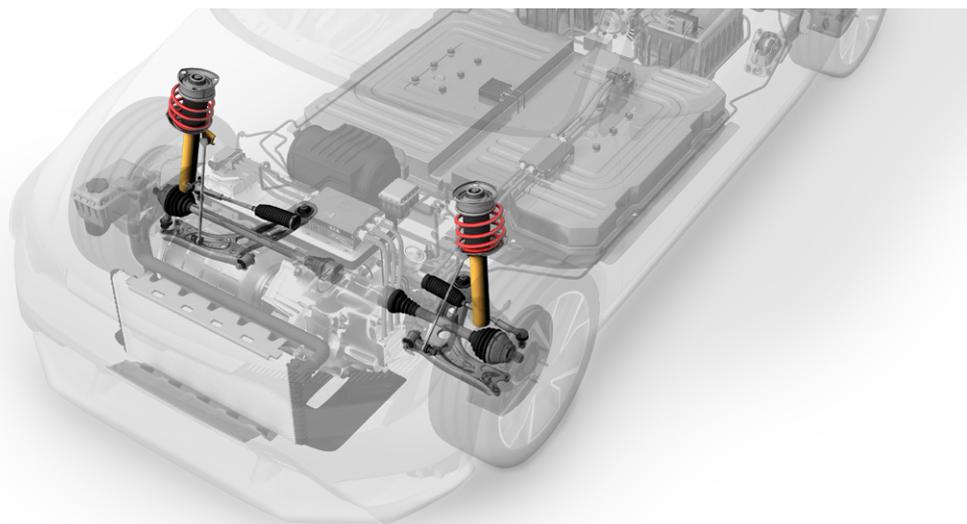


# Durability Measurement on Tie Rod and Axle Control Arms



## Measurement of Mechanical Stress

The optimization of hybrid and electric vehicles not only extends to the popular topics of body and the electric powertrain engineering, but obviously includes all components of the vehicle. Weight must be saved in some areas to offset increases in others, such as the entire battery pack, as a way to achieve maximum performance and energy efficiency. But the components must also be permanently stable and reliable. For this reason, chassis components are also optimized in terms of weight and durability. This example shows how durability measurements are carried out on tie rods and axle control arms.



## Background

The control arms and tie rods are part of the unsprung masses and have a significant influence on driving dynamics and ride comfort. As is frequently the case, an optimum balance between strength and mass is to be achieved when designing the components.

The forces to be expected in various driving situations are simulated during development and must then be validated in driving tests and on the test bench. The data obtained is then incorporated into

the simulation models and helps to improve future developments.

To validate the simulations, the forces acting on the axle geometry are determined. For this purpose, strain gauges are applied to the control arms and the tie rods and the data obtained is correlated with other measured values. These measurements can also be used to trace the transmission paths of the forces to the body and to the steering system.

## Challenge

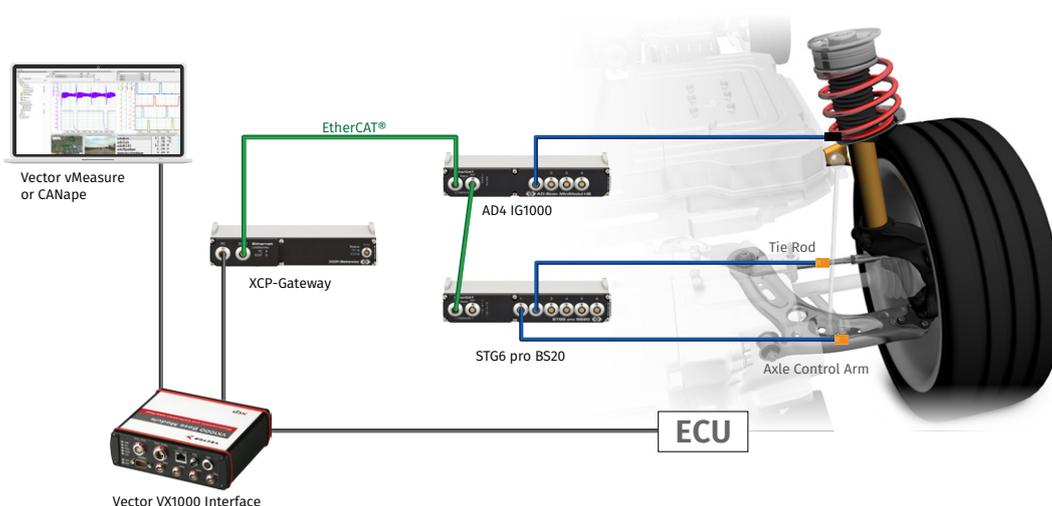
The forces acting on axle control arms and tie rods as well as the spring travel, steering angle and speed are to be measured to determine the durability. For a simple application, all measured variables are to be recorded in parallel with one measurement system. The measurements must be carried out in different driving situations and on different road surfaces and on the test rig. The same measurement system should be able to be deployed in all the different test scenarios for consistency which enables simple comparison of the data. Thus the proper selection of sensors, measurement equipment, and software is increasing in importance.

Tie rods and control arms are very stable components, which means that only low strain values are to be expected in normal driving situations. For this reason, the measurement technology used must offer very high-resolution data in order to precisely acquire even small stresses. In abuse tests, on the other hand, such as driving over a curb, very high values can also occur, which is why the measurement technology should offer sufficient dynamic range. It is to be measured with up to 2 kHz data rate to detect also faster processes.

## CSM Measurement Solution

Technology from the **Vector CSM E-Mobility Measurement System** is used for the measurement of vehicle suspensions. This makes it easy to acquire all the required measured values with a perfectly

harmonized and complete measurement system consisting of hardware and software.



The measurement of the tensile/compressive load in the tie rods is carried out with strain gauges, which are applied in pairs opposite each other as a full bridge. One strain gauge per pair is offset by 90° (T rosette). Depending on the geometric structure of the axle control arms, strain

gauges are used to measure individual strains, bends or tensile/compressive loads. Thus, application-specific full, half or quarter bridges are used. A combination of different bridge circuits is also possible on a channel-specific basis.

All strain gauges are connected to a CSM strain gauge measurement module (**STG6 pro BS20**). Quarter bridges are completed directly in the sensor cable to half bridges. The completion to the full bridge of the strain gauges is simply done in the measurement module, eliminating the need for further circuitry and enables supporting a wide range of strain gauge resistance values. Thanks to the extremely low input voltage range of up to  $\pm 0.3$  mV/V, even very small measurement signals can be precisely recorded. Depending on the selected measurement range, the appropriate input voltage range is automatically assigned in the measurement module. The measurement data rate per channel of up to 20 kHz also allows the precise measurement of rapid load changes.

The spring travel is measured with suitable distance sensors and a CSM analog-to-digital module (**AD4 IG1000**).

The measurement modules utilize an EtherCAT® network and are connected to an **XCP-Gateway**. Thanks to the high total sampling rate of up to more than four Mbit/s, a high number of measurement channels can also be integrated with EtherCAT®. The XCP-Gateway synchronizes the measurement modules via the Precision Time Protocol (PTP) better than 1  $\mu$ s and converts all signals to XCP-on-Ethernet protocol.

With a Vector **VX1000** interface and POD (Plug on Device), steering angle and vehicle speed are acquired from the vehicle's ECU. The XCP-Gateway is connected to the interface via XCP-on-Ethernet and all the measurement data and ECU data is synchronized via PTP. A data logger or measurement computer is used to record the data. Vector's CANape or vMeasure exp software can be used to display and analyze the data.

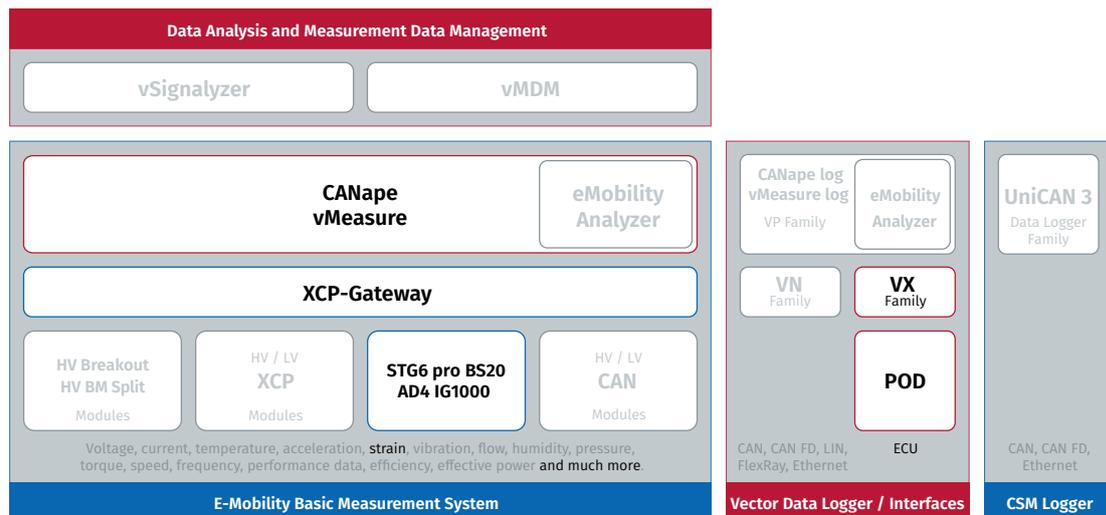


Fig. 1: The fatigue strength measurement on tie rod and axle control arms in the systematics of the Vector CSM E-Mobility Measurement System

## Benefits

With the components of the Vector CSM E-Mobility measurement system, all required measurement values can be recorded with a synergistic system. Thanks to their compact and robust design, the high sampling and highly accurate measurement

modules can be installed close to the measurement point and used both in the road test and on the test bench. Long conversion times are therefore not necessary.



## Featured Products

### STG6 pro BS20

The STG6 pro BS20 is suitable for measurements with strain gauges under demanding conditions. With the extended supply voltage range, sensors with up to 10 V supply can be used. Due to the automatic selection of the suitable input voltage range, as well as a better signal-to-noise ratio, extremely small measurement signals (e.g. strain) can be accurately acquired with the STG6 pro BS20.



### AD4 ECAT MM-Serie – Typ IG1000

The AD4 IG1000 measurement module is optimally suited for the most accurate analyses of high-frequency signals with measurement data rates of up to 1 MHz per channel. It offers a highly accurate, bipolar and channel-wise adjustable sensor supply from 1 to 20 V DC for a wide range of sensors.



### XCP-Gateway-Serie

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®.



Complete solutions from a single source:

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

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