The HV Breakout Modules (HV BM, figure 2) from CSM have been specially designed for decentralized and safe measurement applications on high-voltage cables.

The Challenge
Figure 1 shows the battery voltage U, current I and velocity v of such a measurement. The first run was performed purely electrical, while the battery was discharged at the end of the second run and finally the last repetition was performed with empty battery. The voltage of the initially fully charged battery drops during the run from 405 V to 353 V, which also recovers a little in the last run to 355 V by recuperation. The current signal shows that at times almost 200 A were reached in the “extra high” part. Recuperation can be easily recognized by negative currents. One challenge is that the raw values do not allow direct determination of consumption.

The Solution
The solution is the Vector CSM E-Mobility measurement system: A perfectly tuned toolchain consisting of HV-safe measurement modules, ECU measurement technology and a software tool for synchronized online data acquisition and data analysis during the road test.

For the type approval of new passenger cars, a compliance to a regulation according to the new “Worldwide Harmonized Light-Duty Vehicles Test Procedure” (WLTP) is mandatory in the EU. This also applies to pure electric vehicles and plug-in hybrids. For the WLTP, also the consumed electrical energy must be measured precisely to determine the range. In the case of plug-in hybrids, the cycle must be repeated several times until a measurement can be carried out with an empty battery (charge depletion test). This determines the purely electrical range. Also the energy flow into the vehicle is measured for a complete charging process.
The selectable HV BM shunt modules are permanently installed, have a rated current range of 50 A to 800 A and measure with up to 1 MS/s.

In this case, the ‘DCAnalysis’ function of the eMobilityAnalyzer of vMeasure exp is very useful. In addition to the ripple of the voltage and current, this function determines the effective power $P$ and the accumulated consumption $W$. If the losses from the charging process are also to be determined, the ‘ChargerEfficiencyAnalysis’ function is suitable for this purpose. It determines the power absorbed and delivered by the onboard charger, the accumulated electrical work of the input and output, and from this the efficiency of the charger.

Figure 4 shows the effective power $P$ and the accumulated electrical consumption $W$ for the measurement shown in Figure 1. The power followed the acceleration of the cycle and contains short peaks throughout, both in motoric and recuperative mode. The effective power absorbed was up to 75 kW and recuperation was as low as -38 kW. Looking at the first purely electrical run, a consumption of 5.14 kWh was determined. This corresponds to about 22.1 kW per 100 km. The second run could not be carried out completely electrically and the electrical consumption dropped accordingly to 4.04 kWh. In the last repetition the battery was empty except for the energy recuperated by the brake energy recovery system. The energy balance shows that the battery was charged by recuperation during the last run with -0.13 kWh.

This example shows how the eMobilityAnalyzer can be used to efficiently determine the energy consumption of electric and plug-in hybrid vehicles. Due to the high sampling rate, even short power pulses can be detected, which leads to a more accurate determination of consumption. A combination of different functions also allows to examine the overall energy flow from the power grid to the consumed battery power.
The Advantages
Innovative, fast, precise and flexible measurement for the validation and verification of HV electrical systems in the laboratory and on road tests

> The eMobility Analyzer is included in vMeasure exp and CANape
> Like all measuring modules from CSM, the BM modules are small, robust and designed for direct mounting in the vehicle. There is no need to equip the vehicle with additional current sensors, long measurement cables, and gauges. This not only saves time and reduces risk, but also shortens the measuring chain and improves the quality of the measurement.
> Synchronous recording of all signals, including ECU signals or vehicle bus signals
> The power of the vMeasure exp measurement software makes it easy to perform complex mathematical operations on measurement channels in real-time during the measurement. Thus, in addition to the recording of the directly measured signals, filtered signals or derivation of signals can also be visualized and recorded synchronously. They can even act as a trigger signal.
> The user can easily and accurately measure the current and voltage dynamics in the on-board network and at the HV components and gets immediate feedback during road testing, which makes the verification and a subsequent deeper analysis much more efficient.
> The measurement configuration can be easily applied to the data logger vMeasure log. No laptop is necessary during test drives.
> Seamless, automated analysis and representation of the measurement data through the Vector vSignalyzer software tool and direct transmission and secure storage of measurement data in the Vector measurement data management system vMDM