eMobility Analyzer를 활용한 전기차 고전압 환경에서의 데이터 계측 및 분석

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Requirements

E Mobility Measurement solution from Vector

Use Cases
eMobility Analyzer
The battery is crucial for range, weight and safety.

- Increased complexity due to electric powertrain drives.
- By far the biggest complexity results from:
  - Fast switching of power electronics, quick load changes.
  - Dynamic effects on the power lines that are used by all consumers.
  - Inductive currents, the resulting distortions and temperatures.
  - Sophisticated control mechanisms of the ECUs.
Overall EV validation, verification and compliance

- As an OEM, how can I guarantee that the overall system works? Is it robust?
- What is the effect of high current pulses and peaks in real driving scenarios?
- How does a component impact the DC quality in the worst case?
- How do 2 e-motors interact on the power lines in real driving scenarios?
- How does the HV network behave in real driving conditions? In accidents? Under water?

Optimization

- Which Vehicle Control Unit algorithm and which inverter function provides the biggest increase in efficiency and range?
- What temperatures are present in real-life in the windings of the e-motor, in the power electronics, in cables and plugs and under which conditions?
You need analog measurements (temperatures, pressure, strain, vibration,...)
You need high-speed measurements of currents and voltages (at least 1MHz sample rate)
You need many of these high-speed measurement points (between all components)
You need the capability to analyze power, energy, efficiency, peak-to-peak, deviation etc. During runtime, not as post processing
You need ECU measurements and bus signal measurements on the same timeline. Absolute time synchronization
You need small and robust HWs suitable for in-vehicle test in HV environment
For this purpose, Vector and its partner CSM offer a measurement solution of coordinated components consisting of hardware, algorithms and software.
Industry leader in automotive tools and software engineering

Specialist for vehicle networks, communication and embedded software

Founded 1988

Sales and R&D Cooperation

Partners since 2015

Leading manufacturer of outstanding measurement technology for data acquisition

Specialist for distributed measurements in mobile applications

100,000 modules in use today

Founded 1983
For in-vehicle testing
For dynamometer measurements
For HV safe measurement of all types of signals and sensors:
- Temperature, pressure, vibration,...
- Voltages up to $\pm 2 \text{ kV}$ and currents up to $\pm 1.4 \text{ kA}$
- Sampling rates up to 1 MHz
- Scalable Multi-channel modules
The new eMobility Analyzer

- Vector implemented a new framework in vMeasure exp and CANape.
- This framework supports the synchronous acquisition of currently over 40 CSM measurement channels @ 1MHz.
- Vector extended the function library by a highly optimized set of functions and algorithms: The eMobility Analyzer.
- **Realtime calculation** of incoming data.
- Calculation of power, efficiency and other quality criteria.
- Extendable and flexible function library.
- Parallel synchronous acquisition of the ECU and bus measurements.

- Included in vMeasure exp and CANape.
Use Case: Validation of the HV Electrical System

**Use Case**
- Check voltage ripples (e.g. LV123 norm, ISO 21498-2 standard)
- Validate DC quality

**Challenge**
- High channel count of signals with 1 MHz sample rate
- Need for complex mathematical operations as trigger conditions
- Direct feedback to the test driver necessary
- High accuracy and absolutely synchronous to ECU measurements

**Solution**
- HV measurement technology, 1 MHz sample rate per channel
- Online calculation of derivatives, FFT, quality criteria with vMeasure exp
- Triggering on all measured and calculated quantities
- Synchronous data acquisition and recording with vMeasure log

**Advantages**
- Efficient and reliable validation with instant feedback
- Synchronous recording of CAN, CAN FD, FlexRay, Ethernet and ECU signals
Use Case: Power and Efficiency Calculation

Use Case
- Recording the power during the driving test
- Highly accurate and absolutely synchronous

Challenge
- Detection V/I with 1 MHz necessary
- Difficulty to measure each phase Currents/Voltage
- Precise determination of the period
- Triggering on calculated power quantities

Solution
- HV measurement technology from CSM, 1 MHz per channel
- Online calculation with vMeasure exp ePowerAnalyzer functions

Advantages
- Fast and flexible determination of the efficiency
- Not only electric power, but also Mechanical Power

\[
\text{Power} = \sqrt{\frac{1}{T} \int_0^T (V(t) \times I(t))^2 \, dt}
\]
Use Cases

Customer Use-Case: Validation of Shield Current on HV Cables

The Problem

- Shield currents appear, but no means in place to understand and validate occurrence

The Challenge

- Electric Bus (public transportation) uses 90 kW load (resistor) to waste recuperation energy (battery charged, mech. brakes hot)
- Recent measurement with CAN-modules (10 Hz/500 Hz sampling rate) leads to huge aliasing - neither active current nor peaks visible

The Solution

- HV measurement HW by CSM, 1 MHz sampling rate per channel
- Synchronous data acquisition and recording with vMeasure exp
- Online calculation of RMS-, peak-to-peak-values and DC portion of shield current
- Benchmark with BM-module, LEM and Hioki current clamp

Advantages

- Precise acquisition of signal shape with determination of characteristic values
Use Cases

Use Case: Temperature, Humidity and Pressure Measurements in Batteries

Use Case
- Monitoring temperature balancing of each cell
- During charging, discharging, recuperation, cold start, etc.
- Verifying the BMS, heating and cooling system
- Detection of unwanted humidity and pressure inside the battery

Challenge
- Typ. 60, up to 100 temperature sensors per battery (400 V battery)
- Testing both in the lab and on the road

Solution
- HV measurement technology from CSM including also IEPE and Strain gauge
- PT100/PT1000 RTD sensors, foils ≤0.6 mm
- Mechanically robust to apply between battery cells

Advantages
- Robust, scalable and decentralized measurement
- Same equipment in lab and on the road when mounted in a rack
- Synchronous recording of all signals with vMeasure exp, also from control units or vehicle buses
Use Case: Temperature Distribution between Cells

**Use Case**
- Model verification with several hundreds of precise temperature measurement points inside the HV-battery

**Challenge**
- Hundreds of temperature sensors have to be placed meticulously
- There are space limitations in the housing of the HV-enclosure and its surrounding

**Solution**
- Lots of Digital T-sensors arranged on a thin carrier foil that matches geometry of cells/modules
- Only one HV-cable < 8 mm diameter to outside world

**Advantages**
- Up to 512 digital T-sensors per CSM HV DTEMP
- Easy and accurate installation of the T-sensors
- Accuracy better than ±0.2 °C [-40 °C .. +100 °C]
- Digital signal processors in the HV enclosure
  - Good EMC, low electromagnetic interference
The Vector eMobilityAnalyzer

The eMobilityAnalyzer is included
- In the measurement software vMeasure exp
- In the measurement and calibration software CANape
- In the data analysis software vSignalyzer

Use Cases supported by eMobility Analyzer
- Power and energy measurement in the powertrain
- Energy balance of the entire vehicle
- Efficiency measurement on inverters or DC/DC converters
- Analysis of the electrical machine: apparent, reactive, active power, power factor
- Analysis of the electrical system
- Measurement of the effective power at DC consumers
- Determination of the efficiency of OBCs or charging stations
- Analysis of shield currents on HV cables
- Mechanical power in the drive train
Function Library 2.0 and eMobilityAnalyzer
For more information about Vector and our products please visit

www.vector.com

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