Vector Measurement Solution with CSM MiniModules
CAN – Ethernet – High Voltage – Exhaust

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**Measurement Tasks**
ECU Calibration, NVH, HVAC, Chassis, Engine, Gearbox, Exhaust, etc.

In automotive industry, e.g.
Passenger car, Heavy duty, Off road and many more applications,

You need a software tool to calibrate, validate and measure data
You need a powerful measurement software tool:

- Canape,
- vMeasure exp/log,
- Canalyzer
- And many more
ECU Calibration, NVH, HVAC, Chassis, Engine, Gearbox, Exhaust, etc.

But you also need accurate measurement hardware

For test drives and in test benches, in harsh environments close to the measurement point

- in the engine compartment,
- in the wheel housing, or even
- close to the exhaust pipes
- On a test bench close to the DUT

Vector was looking for a strong partner specialized in automotive measurement tools for decentralized measurement hardware:
Vector Measurement Solution

Vector and CSM Partnership

**VECTOR**
- Industry leader in automotive tools and software engineering

**CSM**
- German manufacturer of outstanding measurement technology for data acquisition
- Specialist for distributed measurements in mobile applications
- 100,000 modules in use today

Partners since 2015
Expanding Vector’s Portfolio

- **Vector Measurement Software**
  - vMeasure CSM
  - vMeasure exp
  - vSignalyzer
  - vMDM

- **CSM Measurement Hardware**
  - CSM Mini Modules
  - CSM EtherCAT Modules
  - CSM High-Voltage Modules
  - ECM LambdaCANc
Physical Basics

- physical observable
- sensor
- measurement modules
- discrete data transfer

Time dependent:
- voltage
- temperature
- strain
- pressure
- vibration
- ...

CAN or XCP on Ethernet
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CAN MiniModules

- **Measurement** modules for the acquisition of a variety of physical signals
  - Temperature (Type K, J, T, RTD100, RTD1000)
  - Voltage
  - Pressure
  - Current
  - Acceleration (ICP)
  - Strain
  - Distance
  - Frequency, period, PWM, revolution, pulse duration, pause duration, event counting, ...

- **Output** modules to generate signals based on CAN values: Voltage, frequency, PWM
CAN MiniModules - Key Features Overview

- Designed for distributed measurements in the engine compartment
  - extremely compact and robust
  - for environmental conditions IP65 / IP67
  - for operating temperatures from -40 °C to +125 °C

- Very good accuracy over the entire temperature range

- Galvanically isolated inputs up to 500 V DC:
  - channel / channel, channel / CAN and CAN / power supply

- Wide power supply range: 5.5 V to 60 V
  - for cars, trucks, 48 V on-board supply systems, even during cranking

- Daisy chain connection with CAN bus
MiniModules - “classic” series
- Standard features
- No channel-specific LEDs
- Simple and straightforward configuration
- Sufficient feature range for a vast number of applications

MiniModules - “pro” series
- More features; constantly updated due to customer-specific requirements, e.g.:
  - Support of non-linear sensor via tables in the module
  - Additional digital filters
  - TEDS, ...
- LEDs per channel (except for CNTMM4 pro)
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Housing Versions

CS – Case Small
CL – Case Large
SCS – Slide Case Small
SCL – Slide Case Large
TCL – Tough Case Large
Beyond CAN – The Ethernet Approach

- Generally recording of measured values ≥10 kHz
- Measurement of many channels with 500 Hz and more?
- Accurate time-synchronous detection
  > Of all physical measured variables
  > Of physical variables and
  > ECU variables
- Distant measuring points
EtherCAT Protocol for Measurement Modules

- Ethernet-based fieldbus system developed by Beckhoff Automation
- Standard Ethernet (IEEE 802.3) without modifications
- Short data update times (100 µs), Ethernet packets or frames
- 90 % bus load possible, 100 Mbit/s

Benefits:
- Precise time synchronization between all signals
- Huge number of signals at moderate speed
- Support of high data rates – up to 1 MHz/channel
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High Speed Measurement

- Sampling rate per channel up to 1000 kHz
- Time synchronization signal to signal better 1μs
High Channel Count

- Analysis of fatigue (stress) points
- Distances over 300 m on one crane
- > 1,000 strain gauges on one crane
Measurement Setup for ECAT- & CAN-Modules

- CSMconfig for all measurement modules

Diagram:
- vMeasure Exp, CANape
- XCP on Ethernet
- CSM XCP-Gateway
- EtherCAT
- CAN
- ECAT
- ECAT
- ... THMM
- ADMM
- LCANc, DashCANc
- HV THMM
- PTMM, CNTMM, OUTMM
- ...
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Measurement Modules Product Overview

- CAN MiniModules
  - Recording Software e.g. vMeasure
  - XCP on Ethernet

- ECAT MiniModules
  - EtherCAT

- PC MiniModule

- High Voltage Modules
  - CAN

- Exhaust Measurement Modules
  - EtherCAT

powered by CSM
HV Voltage Measurement up to 1 MHz/s

HV AD4 XW1000

- Directly in the engine compartment or on the ground next to the traction batteries
- Four input channels, up to 1 MHz measurement rate
- High measurement precision and extremely low Temperature drift in the entire operating temperature range of -40 °C to +100 °C

Applications

- 3-phase voltage on electrified powertrain
- Analysis of transients and reflections in HV net
Measurements in high voltage environment

- Temperature (TC, PT), Voltage, Current, Power

... and outlook

HV STG4 BK20

- Four input channels, up to 20 kHz measurement rate per channel

Applications

- Straingauge Measurement in high voltage environment
Emission measurements with Lambda CANc (λ, AFR and O2)

**ECM LambdaCANc**

- Daisy chain support of CSM CAN bus (matching connectors)
- Vast number of supported Lambda probes, e.g. BOSCH LSU 4.9, 4.2; NTK ZFAS U1,…
- Support of external display with 2 analog outputs (0-5V)

- Up to 8 measurement values at the same time, e.g.
  - $\lambda$ (Lambda)
  - AFR (Air Fuel Ratio) / FAR (Fuel Air Ratio)
  - $O_2$ (Oxygen)
  - Ip (Pumping Current)
  - …

$$\lambda = \frac{AFR}{AFR_{stoich}}$$

$$AFR = \frac{1}{FAR}$$

$$AFR = \frac{m_{air}}{m_{fuel}}$$ (typ. 14.7:1)
For more information about Vector and our products please visit

www.vector.com

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