Rapid Measurement and Calibration based on Fast xCU Access - iLinkRT

@ ASAM Open Technology Forum

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Why should it fly?

• We have a heterogenous Tool Chain
• We need homogenous Data

Common Requirement Management

Common Dataware, Modelware, Testware

Virtual World

Office Simulation
MIL/SIL Testing
HIL Testing
Battery TestBed Testing
E-Motor TestBed Testing
Engine TestBed Testing
AWD TestBed Testing
Chassis Dyno TestBed Testing
Road Testing

Real World

Models
Evaluations
Calibration Data
Test methods
Test Processes

Consistent, comparable results

Rapid Measurement and Calibration xCU
OVERVIEW REQUIREMENTS

Actual trends and drivers in powertrain development

- Increase of complexity of modern control units and higher degrees of freedom
- Higher demands for testing methods in areas of dynamic measurement and calibration
- Complex optimization regarding efficiency, performance, comfort, emission, consumption
- Enormous calibration effort at engine and powertrain test beds

Resulting application requirements

- Slow Dynamic Slopes
- Continuous Limit Approach
- Methods for system identification
- Rapid or Predictive Measurement
- Feeding of virtual sensor models with real sensor data

Resulting test system requirements

- Fast measurement and calibration interface to xCU as key factor
- Relevant in areas of automation, calibration and combustion analysis
What is iLinkRT?

- Open calibration bus protocol enabling high speed xCU access based on automotive standard XCP on Ethernet
- Support of stationary, transient and dynamic applications by real-time capability
- Plug and Play, Multi Master/Client interface with minimum client configuration
- Introduced to become ASAM standard

Rapid Measurement and Calibration xCU:

- Fast calibration and reaction times
- Continuous streaming of measurement data
- Non-blocking protocol (simultaneous measurement and calibration)
**Rapid Measurement and Calibration based on Fast xCU Access - iLinkRT**

**Automatic Calibration & Automation System**

**AVL CAMEO**  
**AVL PUMA Open**

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**Times are approximate values**

<table>
<thead>
<tr>
<th></th>
<th>ASAP3 (RS232)</th>
<th>ASAM-MCD3-MC</th>
<th>INCA-MCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Parameter (2 byte)</td>
<td>~50 ms</td>
<td>~7 ms</td>
<td>~0.3 ms</td>
</tr>
<tr>
<td>Five Parameters (5 x 2 byte)</td>
<td>~250 ms</td>
<td>~35 ms</td>
<td>~0.7 ms</td>
</tr>
<tr>
<td>Single 16 x 16 Map (512 byte)</td>
<td>~330 ms</td>
<td>~110 ms</td>
<td>~0.7 ms</td>
</tr>
<tr>
<td>Five 16 x 16 Maps (5 x 512 byte)</td>
<td>~1550 ms</td>
<td>~550 ms</td>
<td>~2.6 ms</td>
</tr>
</tbody>
</table>

* Utilizing a parallel ETK - ETK 7.1 – Connection to the ECU, Source: ETAS
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AVL CAMEO

Powertrain Calibration Environment

AVL PUMA OPEN & EMCON

Testbed Automation Simulation & Control

AVL INDICOM

Combustion Analysis

iLinkRT Calibration Bus

Application System

ETAS INCA
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Application Example: DOE applications for engine calibration using multi parameter variations

**ASAP3**
**Update speed:**
- for parameters approx. 100ms
- for maps up to 3s (depending on system)

**Parameter changing speed is limited:**
- ramps performed as steps (parametrization)
- violation of stability boundary possible
- unstable operating conditions possible

**iLinkRT**
**Increased update speed:**
- for parameters approx. 400µs
- for maps (16x16) < 1ms

**Ramp speeds can be increased without decreasing quality (Factor 2..3)**
- no “stair curve” effect even for multi parameter-variations and using ramps
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Application Example:

Multidimensional variation of 7 calibration parameters
Differences in the soot and NOx behavior

- Risk of limit violations during calibration eliminated
- Nearly continuous interpolation possible (50 intermediate steps in 5sec. versa 3 steps in 13sec.)
- Emission peaks caused by bigger calibration steps eliminated
- Reduction of the measuring time by ~30%

Source: ATZ elektronik 2/2008
“iLinkRT High Performance ECU Calibration”
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Application Example:

Full Load Examination of Supercharged Engine, Lambda controlled & Component Protection / Combustion & Knock control

Results

- Controllers run significantly more stable, due to improved reaction time
- Better reproducibility of results
- Test can run in a fully automated way even at critical operating points
- Data quality is considerably better compared to manual operation

Source: ATZ elektronik 2/2008
“iLinkRT High Performance ECU Calibration”
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Application Example:
Amplitude modulated Fast Steps (AFS)

State-of-the-Art measurement strategy
- consist of stabilisation phase and subsequent measurement phase
- duration up to five minutes per measurement point

Dynamic measurement strategy AFS
- uses continuous, dynamic data to predict the steady state condition
- duration is significantly shortened (in this project 20 sec. per variation)
- hull screening and a steady state verification additionally necessary
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Application Example:
Amplitude modulated Pseudo Random Binary Signal (APRBS)

APRBS test planning

Test execution

Closed Loop Simulation + Optimisation

Dynamic Modelling
SUMMARY

Fast xCU access with iLinkRT™

- Plug’n’ play Interface
- Usable for all stationary applications
  - Speeds up e.g. screenings with more than 3 maps
- Enables new transient and dynamic calibration methods
- Capability to use it as calibration bus system
- Developed by AVL and ETAS
- Introduced to become ASAM standard