The Design of a Visctronic Device Controller using Simulink
Content

- Axiomatic Technologies Corporation/Oy
- BorgWarner and the Viscous Fan Drive
- The hardware platform & model design
- SDF and customizing the design
- Testing
- Conclusions
Our locations

Axiomatic Technologies Corporation
Toronto, Canada – *Design, Sales & Manufacturing*
Brisbane, Australia – *Sales*

Axiomatic Technologies Oy
Lempäälä, Finland – *SW Design, Sales*
OFF-THE-SHELF CONTROLS

Valve Controllers

Power Electronics

I/O with CAN (SAE J1939 or CANopen)

Connectivity Platforms
Common Features

- Rugged Packaging
- Designed for mobile equipment 12V or 24V battery interfaces
- Electrical ruggedness (surge protection)
- CE marking
- Tested for vibration, temperature and humidity
- Universal inputs (Analog, Digital, Frequency, PWM, Counter)
- Software configurable outputs to drive a variety of loads
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Vision
- A Clean, Energy-Efficient World

Mission
- Deliver Innovative Powertrain Solutions that Improve Fuel Economy, Emissions & Performance

Engine Group – Thermal Systems
- Thermal Management Components and Systems
- Fans/Fan Drives
- Visctronic® Systems
Viscous fan drive

Screen capture from https://www.youtube.com/watch?v=D396fl5fuqA
Viscous fan drive

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Viscous fan drive

Screen capture from https://www.youtube.com/watch?v=D396fl5fuqA

Silicone generates shear force that creates torque that drives the Outer Housing
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The hardware platform

- Input 1 – speed sensor from BorgWarner device.
- Input 2 – universal input for customer specific use.
- Output 1 – 3A proportional current to control a viscous clutch.
- Output 2 – push–pull output for customer specific use.
- CAN communications, SAE J1939.
- Operates up to 125°C ambient temperature.
- XCP features (during development phase) for calibration and accurate performance monitor.
- Software: Developed jointly with BorgWarner using a Simulink model. Its use is restricted to control BorgWarner devices.
Model design

- The firmware was designed using Simulink.
- Axiomatic HW Library contains the J1939 stack and low level C functions for accessing the peripherals on board.
- All inputs (ADC / GPIO) and outputs (PWM) are directly accessible from the Simulink model.
- BorgWarner used Axiomatic’s Simulink blocks as a platform for the Visctronic Device Controller algorithm.
Model design
The firmware has XCP support for Visctronic Device run time calibration.

This makes possible for the BorgWarner engineers to make sure that the controller works with optimum settings in a customer’s application.

The firmware supports also run time configuration using Axiomatic CAN tools, Electronic Assistant®.

All XCP and EA accessible variables are defined in the Simulink model.
Electronic Assistant®

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>ECU Part Number</td>
<td>AX02300</td>
<td></td>
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<tr>
<td>ECU Serial Number</td>
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<td></td>
</tr>
<tr>
<td>ECU J1939 NAME</td>
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<td>PGN 60928: 64-bit ECU Identifier sent in Address Claimed Messages</td>
</tr>
<tr>
<td>Arbitrary Address Capable</td>
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<td>Yes</td>
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<tr>
<td>Industry Group</td>
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<td>Vehicle System Instance</td>
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<td>Non-specific system</td>
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<tr>
<td>Reserved</td>
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<tr>
<td>Function</td>
<td>0x7D</td>
<td>Aromatic IO Controller</td>
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<tr>
<td>Function Instance</td>
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<tr>
<td>ECU Instance</td>
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<td>#1 - First instance</td>
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<td>Manufacturer Code</td>
<td>0x0A42</td>
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<tr>
<td>Identity Number</td>
<td>0x137E3D</td>
<td>Unique ECU network ID number</td>
</tr>
<tr>
<td>ECU Address</td>
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<td>Reserved for future assignment by SAE, but available for use by self-configurable ECUs</td>
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<tr>
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<td>Undefined</td>
<td>PGN 64965 - ECUID</td>
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<tr>
<td>Software ID</td>
<td></td>
<td>PGN 65242 - SOFT</td>
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<tr>
<td>Field #1</td>
<td>Visotronic Device Controller</td>
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<td>Field #2</td>
<td>AX023200-01</td>
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<td>Field #3</td>
<td>Simulink Edition with XCP</td>
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<tr>
<td>Field #4</td>
<td>Firmware: V1.0, February 2016</td>
<td></td>
</tr>
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SAME Deutz–Fahr is one of the world's leading manufacturers of tractors, harvesting machines, engines and agricultural machines. It distributes products through the SAME, DEUTZ–FAHR, Lamborghini Trattori, Hürlimann, Grégoire and Lamborghini Green Pro brands.
Customer specific customization

- SDF needed additional features to the generic Visctronic Device Controller to more efficiently use the device in their tractors.
- The other universal input of the Visctronic Device Controller HW is used for AC pressure reading.
- The firmware includes also functionality to select a dataset defining different fan configurations at the factory.
- The datasets allow the device to be used in multiple tractors without modification.
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Testing at SDF
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Conclusions

- Why use Simulink in this kind of work?
  - OEMs have the possibility to participate in the controller design procedure without the need of C programming.
  - Graphical design environment makes the overall design easy to read.
  - Possibility to simulate and finetune algorithms.
  - It is easy to share design tasks between different groups of engineers.
  - Re-use of existing, tested Simulink blocks in multiple projects saves development time.
Conclusions

- SDF uses the Visctronic Device Controller in Series 9 and Series 5 Deutz–Fahr tractors.
- The Visctronic Device Controller drives the main radiator assembly fan.
THANK YOU