The Design of a Visctronic Device Controller using Simulink

Apr 27, 2017

Content

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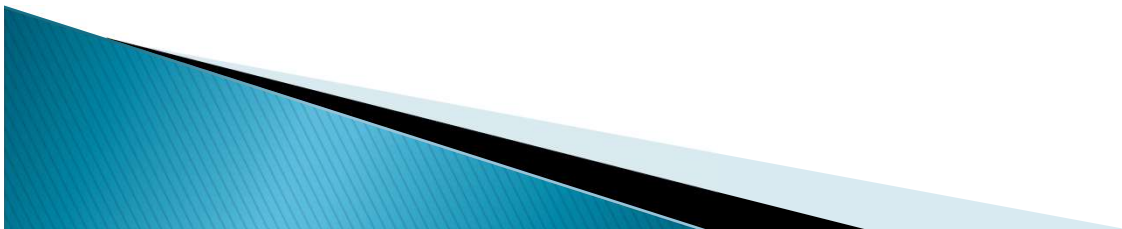- SDF and customizing the design
- Testing
- Conclusions

Our locations

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

Axiomatic Technologies Oy
Lempäälä, Finland – *SW Design, Sales*

Valve Controllers

I/O with CAN (SAE J1939 or CANopen)

OFF-THE-SHELF CONTROLS

Power Electronics

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)
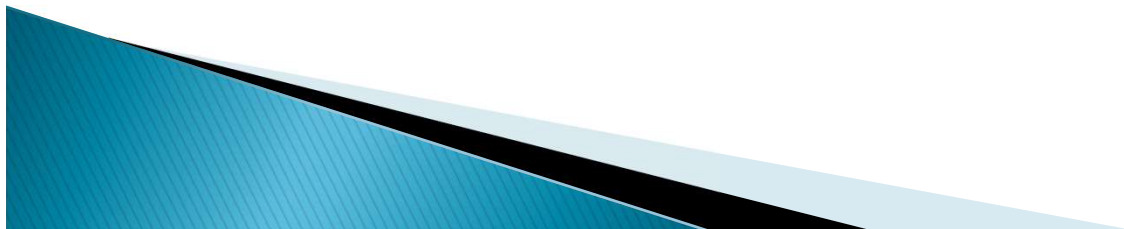- Software configurable outputs to drive a variety of loads

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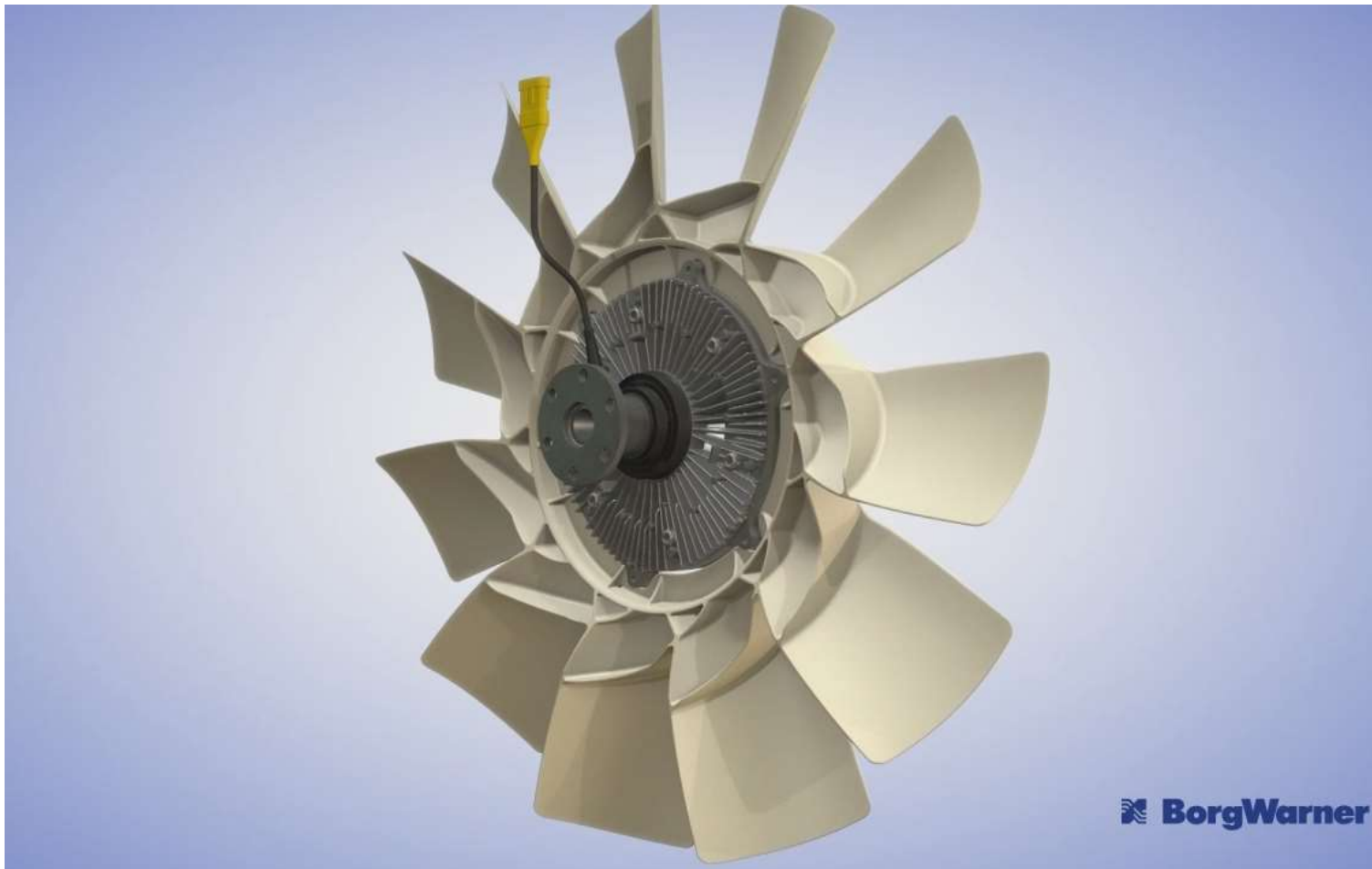- SDF and customizing the design
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BorgWarner

- 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
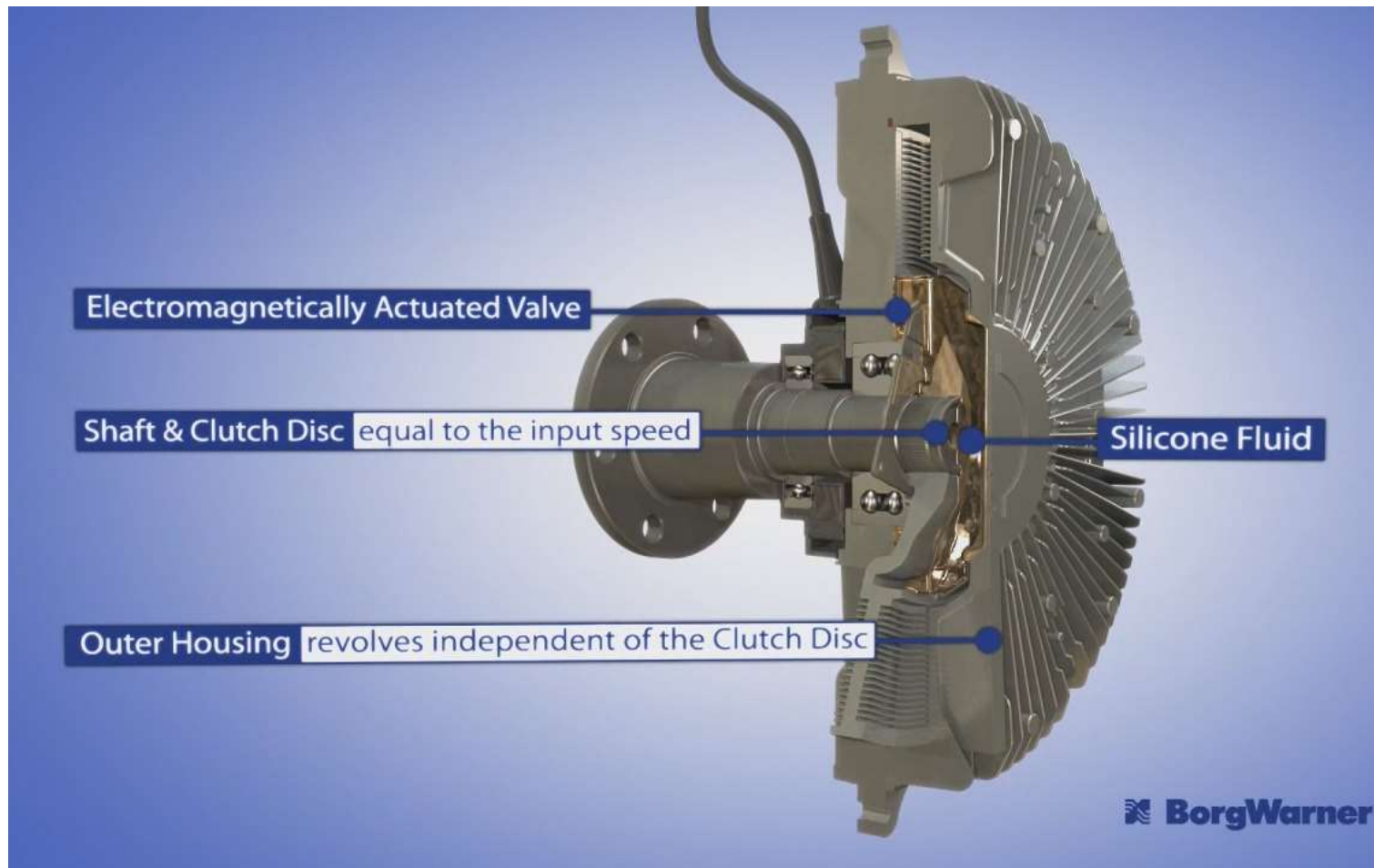 - Fans/Fan Drives
  - Visctronic® Systems

Viscous fan drive

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

Viscous fan drive

Electromagnetically Actuated Valve

Shaft & Clutch Disc equal to the input speed

Silicone Fluid

Outer Housing revolves independent of the Clutch Disc

BorgWarner

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
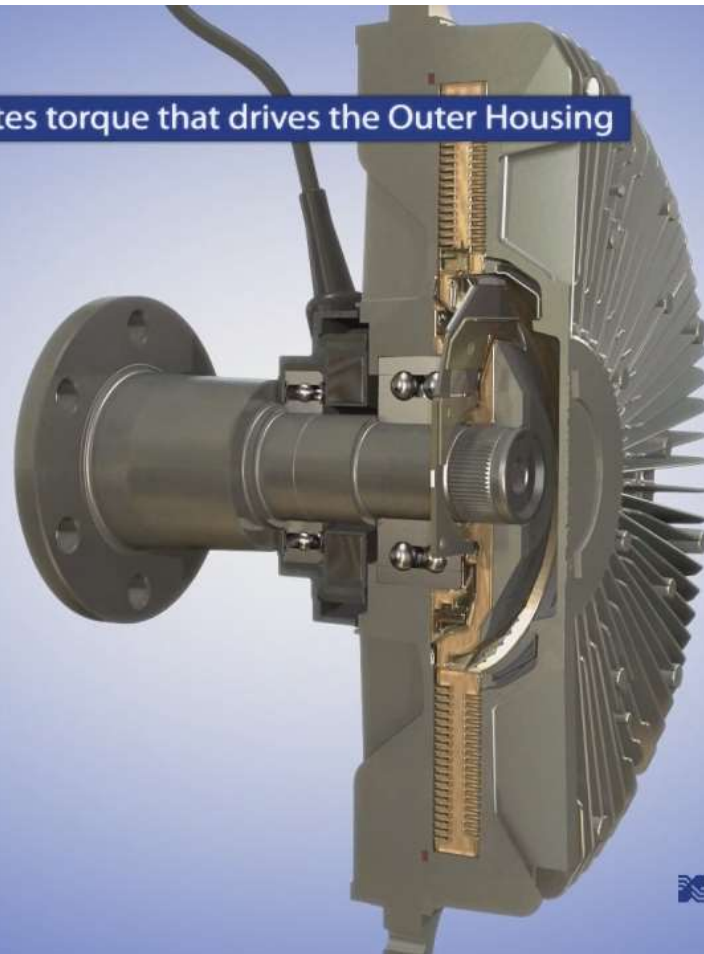
BorgWarner

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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.
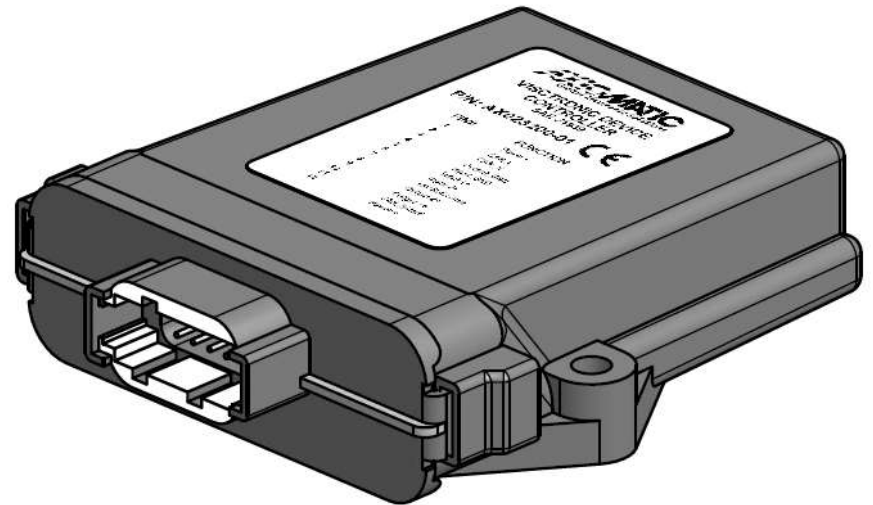
Model design

- 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
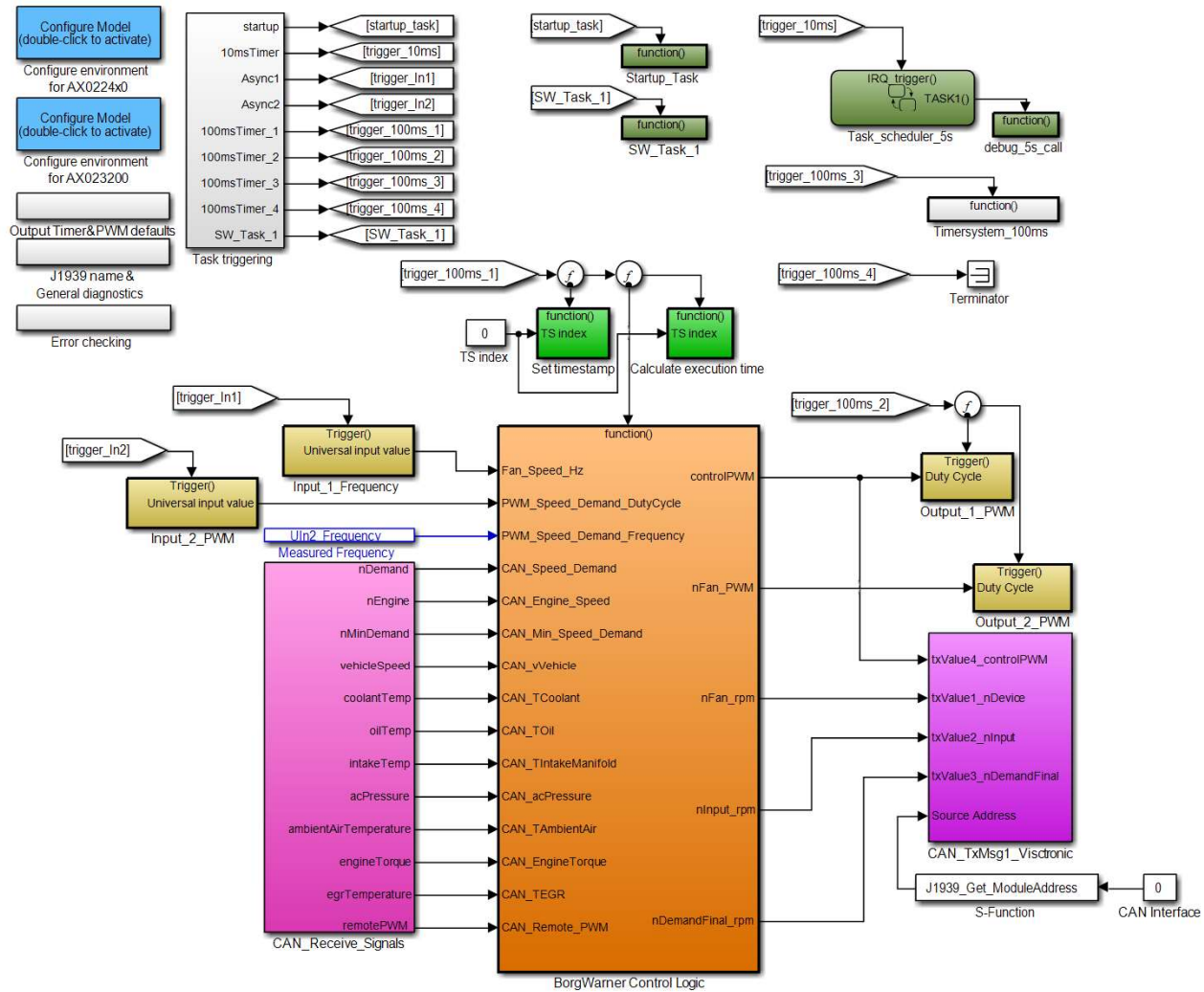
Run time calibration

- 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®

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SDF

▸ 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.

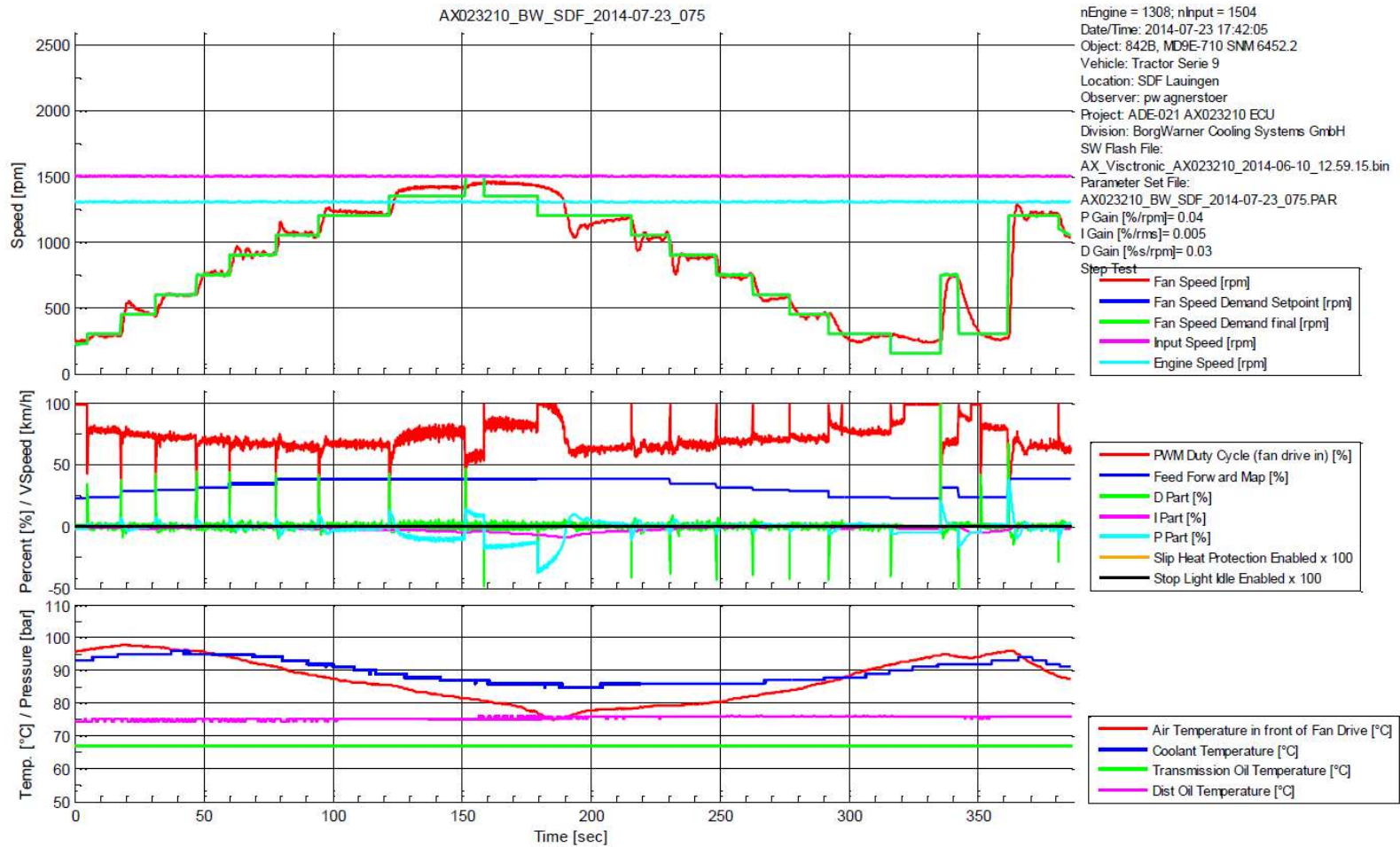▸ The datasets allow the device to be used in multiple tractors without modification.

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Testing at SDF

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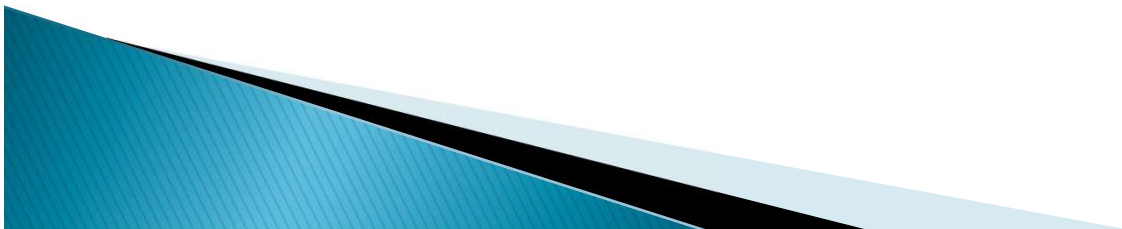- SDF and customizing the design
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Conclusions

- 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