



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**
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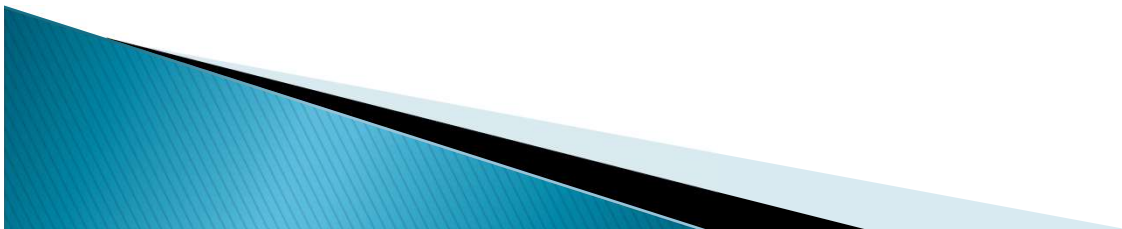
AXIOMATIC

Global Electronic Solutions
Understand. Innovate. Solve.

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



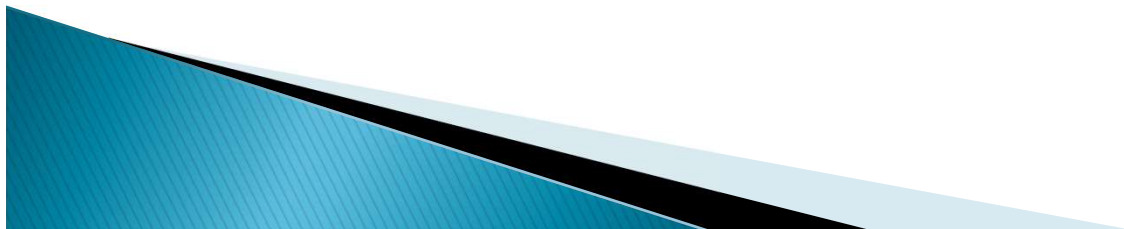
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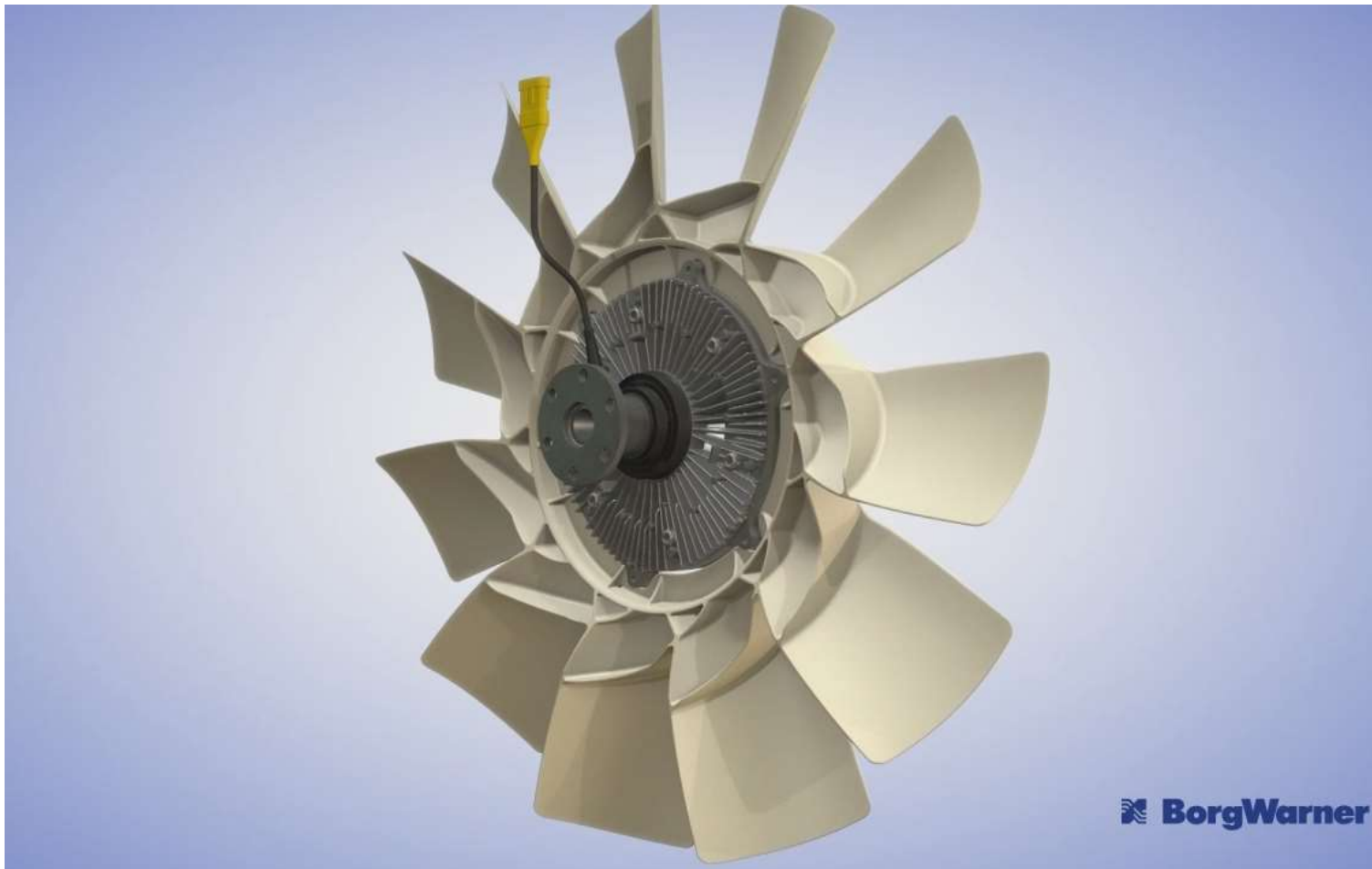
BorgWarner

- ▶ 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



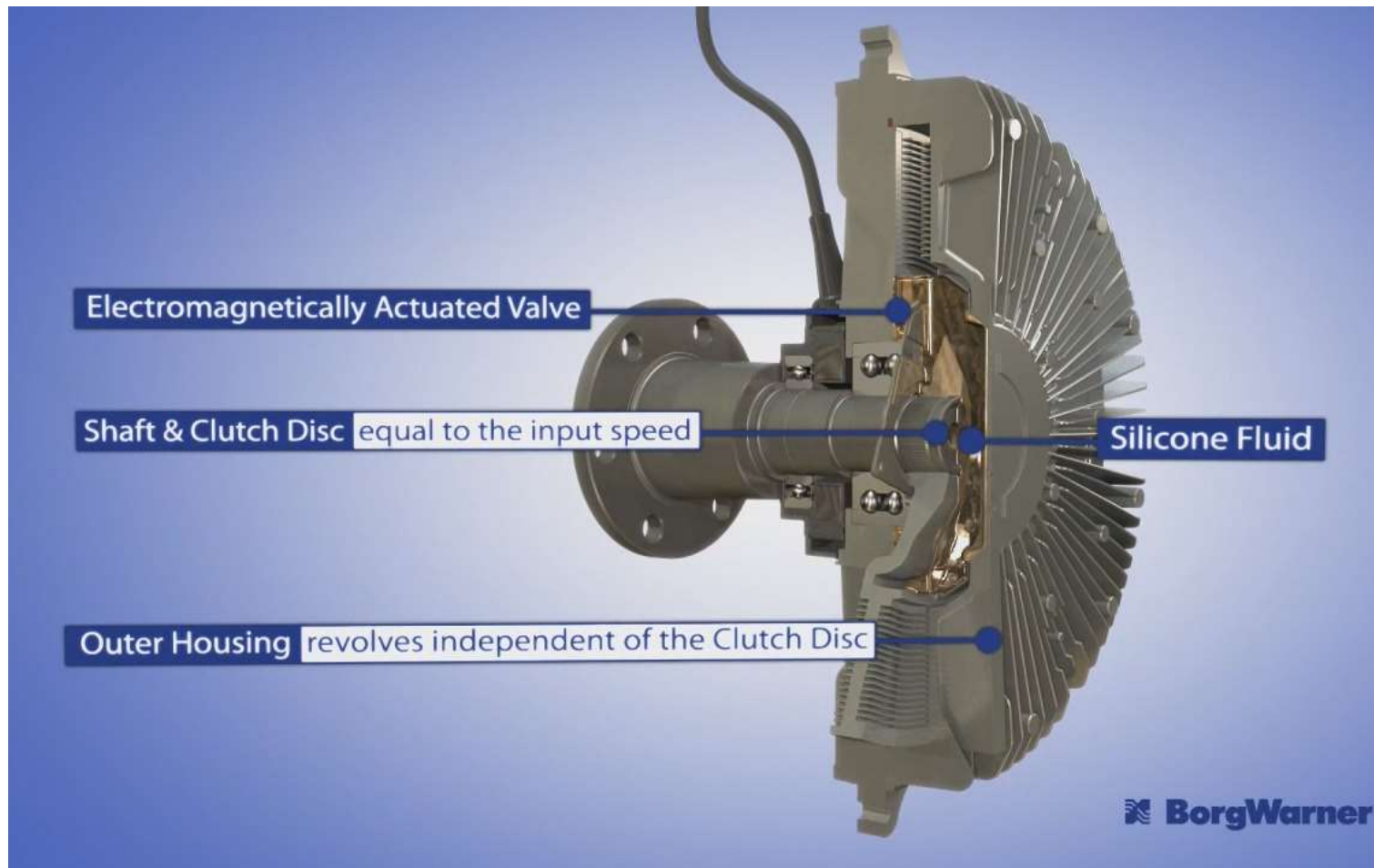
Viscous fan drive

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



Viscous fan drive

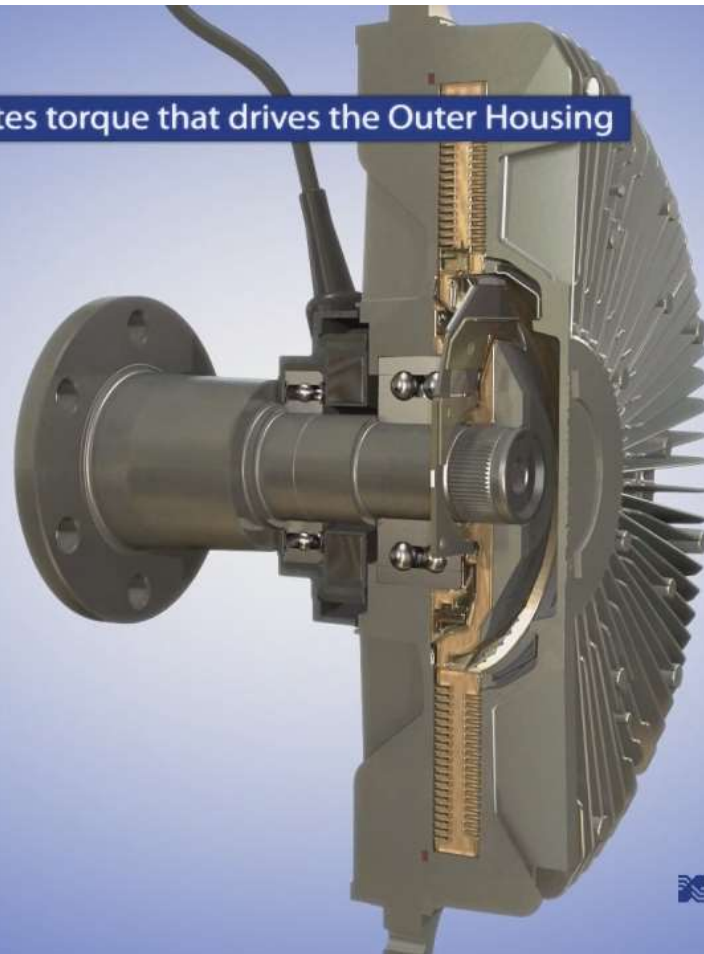
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Viscous fan drive

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

Silicone generates shear force that creates torque that drives the Outer Housing



 **BorgWarner**

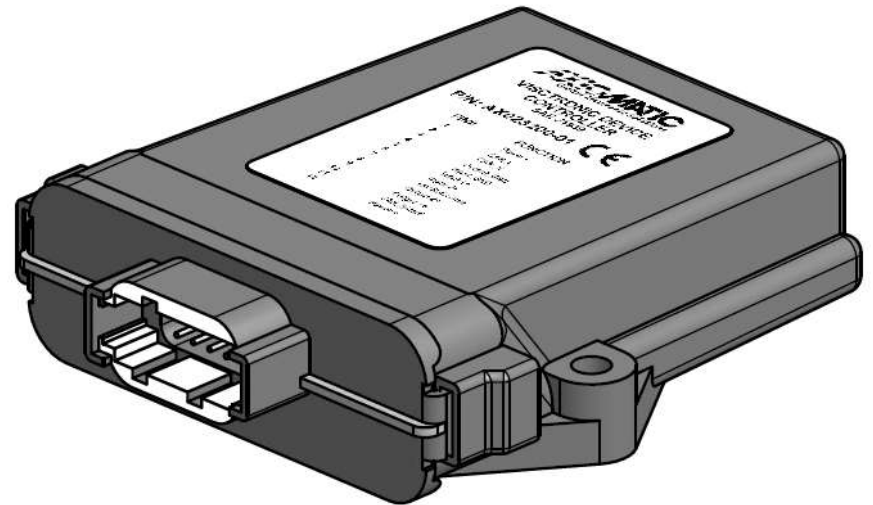
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The hardware platform

- ▶ 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.

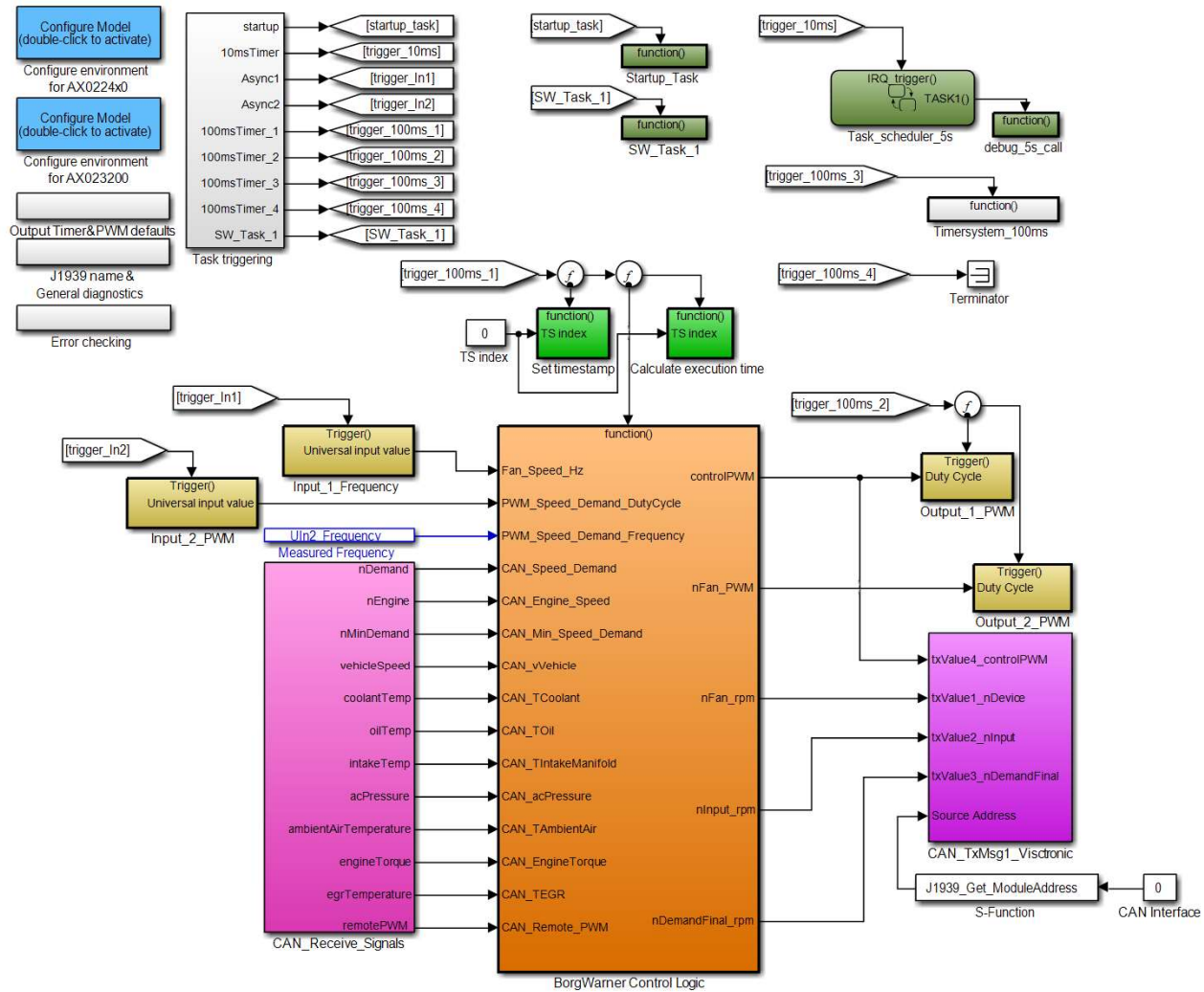


Model design

- ▶ 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®

The screenshot displays the Electronic Assistant software interface. The left pane shows a tree view of the configuration for a J1939 CAN Network, specifically for an AX0232x0, Viscronic Controller #1. The 'General ECU Information' section is selected, showing various parameters and their values. The right pane displays a table of these parameters.

Parameter	Value	Description
ECU Part Number	AX0232x0	
ECU Serial Number	0000115001	
ECU J1939 NAME		PGN 60928. 64-bit ECU Identifier sent in Address Claimed Messages
Arbitrary Address Capable	0X01	Yes
Industry Group	0X00	Global
Vehicle System Instance	0X00	
Vehicle System	0X00	Non-specific system
Reserved	0X00	
Function	0X7D	Axiomatic IO Controller
Function Instance	0X01	
ECU Instance	0X00	#1 - First Instance
Manufacturer Code	0X0A2	Axiomatic Technologies
Identity Number	0X137E3D	Unique ECU network ID number
ECU Address	0X81	Reserved for future assignment by SAE, but available for use by self configurable ECUs
ECU ID	Undefined	PGN 64965 -ECUID
Software ID		PGN 65242 -SOFT
Field #1	Viscronic Device Controller	
Field #2	AX023200-01	
Field #3	Simulink Edition with XCP	
Field #4	Firmware: V1.0, February 2016	

The status bar at the bottom left shows 'Ready' and the bottom right shows '250 kbit/s'.

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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.

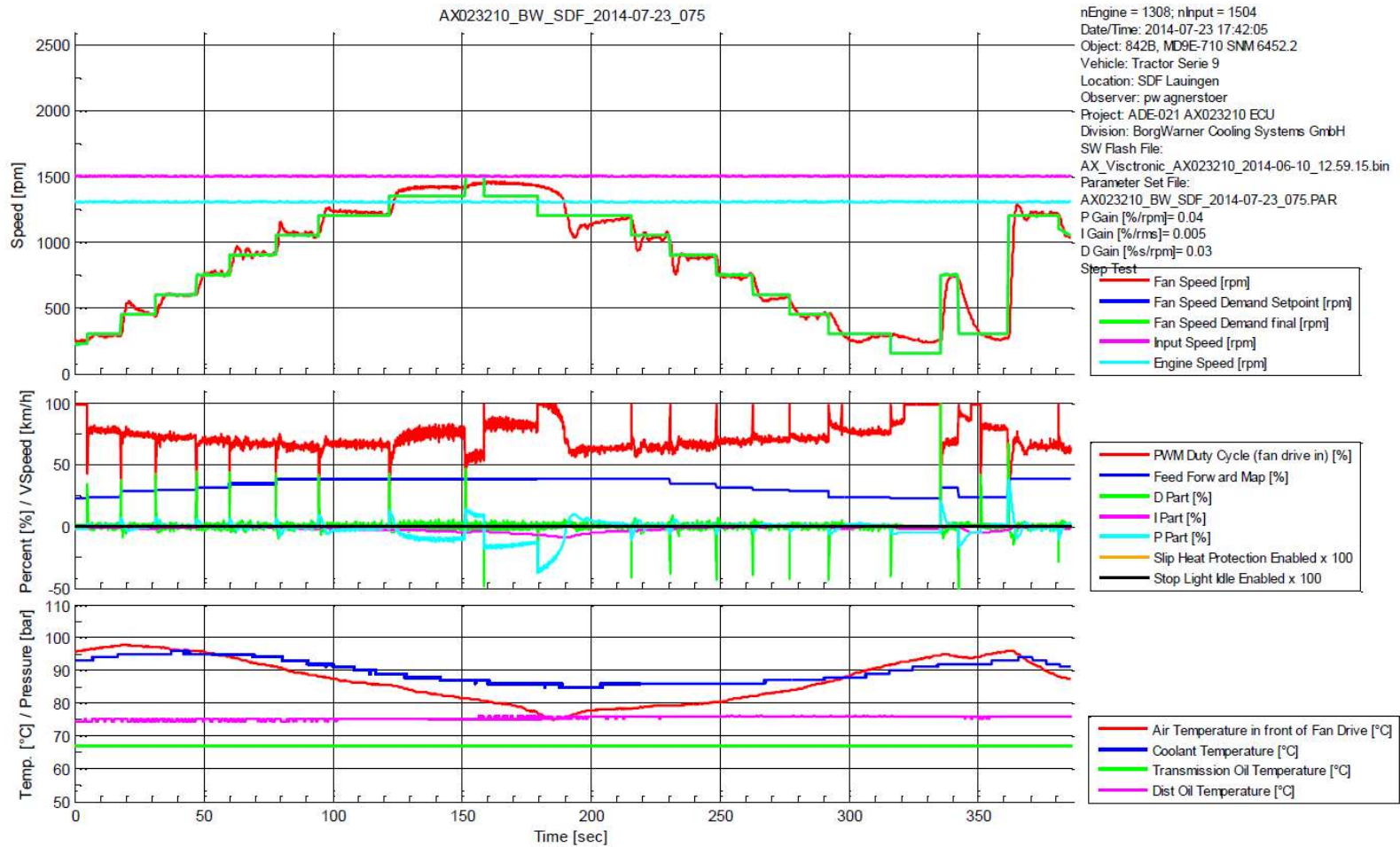


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Testing at SDF



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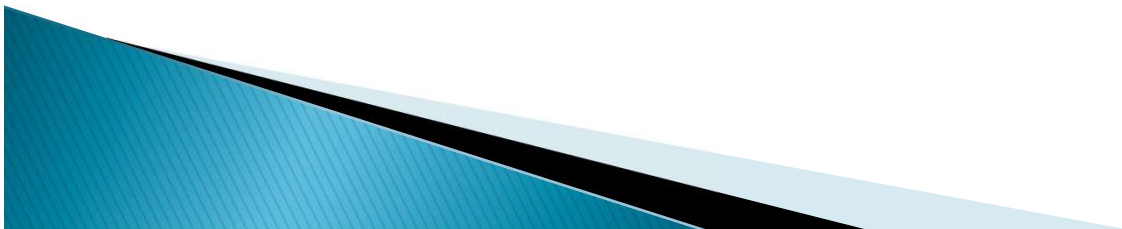
Conclusions

- ▶ 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

