

# Fault Insertion for Controller Calibration in a Range of Engine Models

Romain Gillot\* Alessandro Picarelli\* Mike Dempsey\*

\*Claytex Services Ltd, Edmund House, Rugby Road, Leamington Spa, CV32 6EL  
{romain.gillot, alessandro.picarelli, mike.dempsey}@claytex.com

## Abstract

Predictive modelling is becoming increasingly popular to dimension or calibrate systems prior to the design stage. If current models are capable of modelling physical systems very accurately, they often only model the system's expected behaviour. Some particular tasks like Engine Control Unit (ECU) calibration require the models to work abnormally too to make sure that the controller detects the faults (OBD diagnostics).

The aim of this paper is to introduce various faults in a multidomain (pneumatic, hydraulic, thermal, mechanical and electrical) engine model developed in Dymola to demonstrate that it is capable of detecting and identifying these faults and of taking measures to limit their effect and/or to prevent further damage to the system. One of the requirements is that the ECU should be able to detect a fault solely from the measurements given by the physical sensors that are used throughout the model.

The engines used in this study come from the VeSyMA – Engines library developed by Claytex. They are all (with the exception of the last one) crank-angle resolved engine models with varying features and levels of details depending on the area of interest. The ECU used is a software version of a real ECU.

The faults modelled are a leak in the air path of a turbocharged four-cylinder engine, a clogged injector in a naturally aspirated three-cylinder engine, a stretched timing chain in a naturally aspirated four-cylinder engine, a short-circuit in the control board of a throttle body in a naturally aspirated four-cylinder engine and a coolant leak in a naturally aspirated four-cylinder engine.

The paper will introduce the types of faults, show their physical consequences on the engine model's behaviour, detail the process and flow of information that allows the ECU to spot the abnormal results and finally explain what the ECU does in reaction to these faults.