Analytical Engine Calibration Process
Using GTPOWER, Stateflow, and MBC Toolbox

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Process Overview

- MBC Toolbox
  
  Design of Experiments

- Simulink/Stateflow
  
  Automated Virtual Engine Mapping

- GTPOWER
  
  High Fidelity Engine Model

- MBC Toolbox
  
  Model Fitting

- MBC Toolbox
  
  Calibration Generation

- ECU Calibrations
Results

• Produced optimal ASAP2 calibration tables from dual-phaser GM L-850 engine data:
  – MBT spark at base cam positions (park)
  – Exhaust cam schedule
  – Intake cam schedule
  – MBT spark at commanded phaser positions

• Calibration objectives and constraints:
  – Minimize BSFC at MBT spark using cam phasers
  – <10% increase from minimum NOx at each operating point

• Data is from a rough-cut GM L-850 GTPOWER model
  – NOx models need significant improvement
GM L-850 Engine Model

Courtesy GM Powertrain, Gamma Technologies
500 point space-filling design on RPM, load, exhaust cam phase, inlet cam phase
Virtual Testing using Stateflow

Simulink and Stateflow interact with GTPOWER to run DoE points, log data, monitor misfire and stability.
Local models fit the torque-spark data at each operating point.

Local model features are modeled using radial basis functions.
Model Building

Torque

NOx
Generated Calibrations

Exhaust cam schedule

Inlet cam schedule

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Generated Calibrations

MBT spark at base cam position

MBT spark at commanded phaser positions
What Has Been Achieved

• Analytical Calibration Process Toolchain Now Exists
• Dyno Test Programs Can Be Analytically Prototyped

Some Questions Now Answerable

• Calibration Flexibility to Late Hardware Changes Increased?
• Drastic Test-Load Reductions Possible Due to Model Use?
• Can Speed-Density Work on Dual-Phaser Applications?