Presentation of ME7 System

1. System
2. Functionality
3. ECU hardware
4. ECU software
5. Application
6. Electronic throttle control
ME7 is a Engine Management System (EMS)

- For air intake manifold injection
- EGAS (electronic throttle) system
- With supervised coordination of torque and A/F- ratio
- For future emission standards EU III and EU IV
- For diagnosis OBD II and EOBD
Objective:

Uniform, modular HW and SW architecture

- To reduce overall development expenditure
- To achieve a cost effective solution and
- To meet customer specific requirements

Essential features:

- New engine torque-based functional structure
- New development process
- New software structure (ERCOS and ANSI-C)
- Large scale integrated hardware architecture
UAES Engine Management Systems
ME7 Advantages

- Flexible Calibration
- Present & expected OBD fulfilled
- 512 kByte Flash
- Torque based Structure
- Present & expected Emission Regulation fulfilled
- 16 bit CPU 24 MHz clock
- Improved Functionality
- Improved Driveability

HW & SW Modularity

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UAES Engine Management Systems
ME7 Road Map

ME7
- Motronic with integrated ETC
- OBD II, EOBD
- LEV, ULEV
- EU III, EU IV
- 16 Bit \( \mu \) C

MEG7
- Motronic with integrated ETC and Transmission control

MED7
- Motronic with integrated ETC for GDI

M7
- Motronic with Idle speed control

1997 1998 1999 2000 SOP
UAES Engine Management Systems
ME7 Benefits

- Torque based structure, for best compatibility to other systems
- Sequential fuel injection for better emissions with phase sensor
- Improved driveability by centralized coordination of various torque requests
- Simplified calibration by model based engine referred basic mapping, no interdependency to other functions
- Integrated immobilizer-function
- System to be expanded for future requirements, like further emission regulations, OBD II
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ME7 Benefits of EGAS

- Adjustable relation between acceleration pedal and electronic throttle (engine torque)

- Dynamic throttle control due to driveability demands

- Improved driveability

- Optimized transition during acceleration / deceleration
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ME7 EFI System
Concerns:

- Several demands occurring simultaneously without any central control
  (Priority of demands were independently defined in each subsystem)

- Interaction of demands due to shifts of operating points

- Strong interdependency of application data of various subsystems
  (E.g.: Influence of ignition timing calibration on idle speed pilot control)
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ME7 Influences on Engine Torque - Previous Situation

- Driver
- Calculation of desired throttle angle
- Throttle angle
- Start
- Ignition timing
- Cylinder individual fuel cut-off
- Injection time
- Idle speed control
- Protection of Engine components
- Transmission control
- Vehicle dynamic control
- Catalyst heating
- Anti-jerking function
- Calculation of injection time
- Start
- Anti-jerking function
- Protection of Engine components
- Vehicle dynamic control
- Catalytic converter heating
- Ignition timing
- Transmission control
- Calculation of ignition timing
UAES Engine Management Systems
ME7 - Engine model

Charging Model

Load

Torque Model

Mi=f(n,rl,fuel,zw,red)

Torque Request

Torque Coordinator

Torque Realization

Efficiency
UAES Engine Management Systems
ME7 Torque-based System Structure

Efficiency Demands
- Engine start-up
- Catalyst heating
- Idle speed control

External Torque Demands
- Driver
- Cruise Control
- Limitation of vehicle speed
- Vehicle dynamic control
- Driveability

Internal Torque Demands
- Engine start-up
- Idle speed control
- Engine speed limitation
- Engine protection

Torque demand coordinator
Coordination of torque and efficiency demands

Torque conversion
Realization of desired torque

Efficiency

Injection time
Electronic Throttle
Individual fuel cut-off
Ignition timing
UAES Engine Management Systems
ME7 Torque Transmission from Engine to Wheel

Internal combustion engine

Fresh air charge
Lambda
Ignition timing

Combustion

Internal torque Created by combustion

Engine torque

Clutch torque

Torque converter

Transmission differential

Wheel torque

Losses caused by gas exchange and friction
Losses caused by peripheral components

Torque losses and transmission (Automatic)

Gear losses and transmission
**UAES Engine Management Systems**

**ME7 Definition of different torque values**

- **Work transfer from the gas to the piston**
  \[ W_{gi} : \text{Gross Indicated Work (internal torque,} m_i) \]
  \[ W_P : \text{Pumping Work (piston to gas)} \]
  \[ W_i : \text{Indicated Work (} W_{gi} - W_P \) \]

- **Work transfer to the crankshaft**
  \[ W_C = W_{gi} - (W_P + Q_C + W_r) \]
  \[ W_r : \text{Friction loss} \]
  \[ Q_C : \text{Heat loss by coolant} \]

- **Effective clutch torque**
  \[ M_e = M_E - M_v \]
  \[ M_E : \text{Engine Torque/Indicated Torque} \]
  \[ M_v : \text{Int. Accessory loss} \]

- **Converter loss** \[ M_w \]
  \[ M_w : \text{Converter loss} \]

- **Transmission loss** \[ M_g \]
  \[ M_g : \text{Transmission loss} \]

- **Wheel Torque** \[ M_r \]
UAES Engine Management Systems
ME7 Global Overview

- Scan about EAWS
- Pedal Module
- O2-sensors
- DG/PG

- Charge determination
- Idle speed control
- Fuel injection calculation
- Load prediction
- Ignition timing calculation
- Purge control function
- Torque control
- Transient compensation

- Injection
- Spark advance
- Electronic Throttle
- TEV
- Add. components
Basic engine management functions using physical models

- Torque based system structure
- Determination of cylinder charge by intake air pressure sensor
- Improved mixture pilot control under steady state and dynamic conditions
- Lambda closed loop control
- Sequential, cylinder individual fuel injection
- Ignition timing, including cylinder individual knock control
- Distributerless ignition with 2 double ended coils
- Emission control functions  - catalyst heating
  - purge control dependent on canister charge
- Electronic throttle control
- Speed sensing by increment system
Additional functions

- Cruise control
- Immobilizer function
- Torque interface to external systems (e.g. powertrain or vehicle dynamic control)
- Control of several engine components
- Interfaces to application, EOL-programming tools and service tools

On-board diagnosis OBD II

- Complete set of OBD II functions
- Management system for diagnosis functions
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ME7 Electronic Control Unit (Water Proof)

- 16bit CPU 80C167
- 512K Flash EPROM
- 121 PIN type connector
General goals for the software development process

- Modularity
- Software reuse and sharing
- Efficiency
  - Maintainability and extendibility
- Robustness, stability and safety
Definition: Operating System --- ERCOS
Application independent part of the software which is responsible for the management of resources (CPU and memory). It provides a set of services for the application specific software.

Layered software architecture
- Upper layers may only use services of lower layers
- ERCOS requires only the processor hardware
UAES Engine Management Systems
ME7 Application Phases

Customer enquiry
Project definition
Fixation of Agreement

Application Phase 1:
Specification & Planning

Application Phase 2:
Feasibility

Application Phase 3:
Development & Calibration

Application Phase 4:
Release

SOP phase

Volume mass production
All application tools available in UAES can be used for ME7 EFI system calibrations.

New emulator probe ETK7 is used.
UAES Engine Management Systems
ME7 Application Tools
UAES Engine Management Systems
ME7 Application Tools

Thermoscan

Lambda Display

AD-Scan
UAES Engine Management Systems
Portable Diagnostic Tester - KTS 150

- Developed for Chinese market by BOSCH
- Convenient updates via PC
- Mini printer for recording results
- Based on international communication standards (OBD)
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ME7 Calibration Procedure

Conversion of the desired torque into engine set values

Set of engine parameters

Calculation of the Engine values using Sensor signals

Matrix measurement

engine

Torque coordination

required torque
New Procedure for Test Bench Measurements

**Step 1**
Measurements taken at pre-determined operation points of an engine on engine bench.
At each operating point the measurement covers all important engine conditions (variable lambda, ignition timing)

**Step 2**
Offline determination of required maps characteristic lines, fixed values
by means of an evaluation program

**Step 3**
Verification of calibrated data
Advantage of New Procedure

- Each operation point is driven only once
- Iterative calibration can be omitted
- Simplified and therefore automated process on the dyno is possible
- Reduction of cost for application
UAES Engine Management Systems
ME7 Advantages

- **Torque based structure** for best compatibility to other systems

- **Improved accuracy** by means of central conversion of coordinated torque demands; no interaction between the control variables: cylinder charge, Lambda, ignition timing and fuel-cut-off

- **Simplified application:**
  - Characteristic lines and look-up tables only dependent on engine data, no interaction with other functions.
  - ETC – demands defined as engine torque.
  - No direct application of throttle angle or ignition advance demands.

- **System easy to expand for future system requirements:**
  like further emission regulations, gasoline direct injection, variable valve timing, adaptive cruise control, OBD II