automotion

EDITION 2 | 2006 | IAV – AUTOMOTIVE ENGINEERING

Simulation Helps to Select Hybrid Concept

IAV's overall vehicle simulation system permits detailed modeling of hybrid vehicles

by Jason McConnell, Dr. Thieß-Magnus Wolter and Jens Kitte

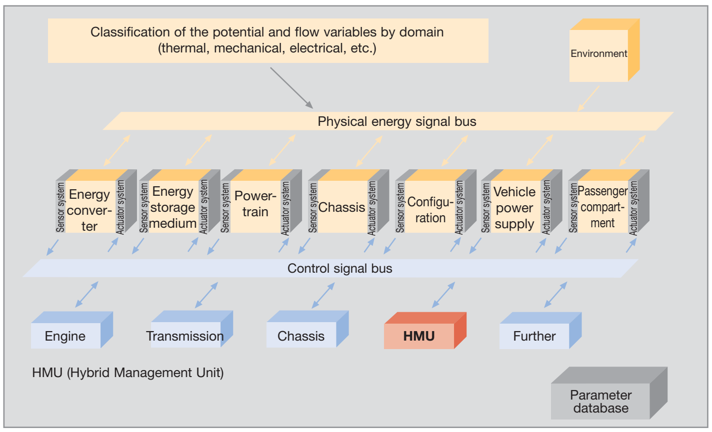

Fig. 1: Principle configuration of the simulation model

Regardless of whether the aim is to produce a micro, mild or full hybrid, many concepts lend themselves to developing a new hybrid vehicle. As a rule, experts from the various specialized areas involved come together at an early stage of the concept definition phase to make an initial selection of appropriate concepts. This is done on the basis of their experience and in consideration of the given boundary conditions and target variables, such as consumption, emissions, comfort, driving dynamics or safety. As the hybrid vehicle is a highly heterogeneous system in which allowance must be made for the effects of different physical domains, no qualified statements can be made in terms of comparing the different concepts without suitable simulation methods. To support the engineer in this regard, IAV has developed an overall vehicle simulation system that provides the capability of modeling hybrid vehicles at different detailing stages. In this connection, allowance is made for the following demands:

1. Joint simulation of different abstraction levels
2. Modeling of the heterogeneous system with the greatest degree of homogeneity as possible
3. Optional interconnection of different simulators
4. Balancing and evaluation of data in one tool
5. Block-oriented, global parameter database

This produces the principle simulation model configuration presented in Figure 1 that takes into account the vehicle's physically relevant components, as well as the control units.

In selecting the simulation platform, it is important to remember that although it is ideal to apply just one tool, the different domains under investigation may also demand the use of different simulation methods. For these reasons, the VeLoDyn (Vehicle Longitudinal Dynamics) Simulink-based overall vehicle simulation program developed at IAV has been taken as the basis and extended by interfaces to the energy-flow-oriented Dymola program in order, for example, to facilitate the modeling of thermal domains as well.

Within the scope of the simulation activity, it is possible depending on the level of model detail, to distinguish between several phases. Typically, these phases are followed through during the course of a project, with Phase 4 no longer belonging to the concept formulation phase but forming part of implementation. In general, it must be noted that the depth of model detail should be selected in such a way that the relationship between computing time and real time permits optimization processes in reasonable periods.

Detailing phases of modeling

Phase 1: Extensive abstraction
- Basic functions of individual assemblies
- Examination of global interaction
- Energy flow models, efficiency chains

Phase 2: Low detail level
- Modeling within assemblies
- Performance of parameter and layout studies
- Preparation of concepts for control functions

Phase 3: Medium detail level
- Number of possible configurations is limited
- Assemblies are modeled in greater detail
- Testing of control functions

Phase 4: High detail level
- Overall configuration established
- Real-life assembly studies take place at the same time
- Detail optimizations

In terms of assessing the concepts modeled, key importance is attached not only to creating the models but also to calibrating them. As many degrees of freedom generally exist with regard to calibrating components and operating strategy, it is necessary to apply optimization methods to determine parameters. IAV has achieved good results with DoE (design of experiments) and evolutionary strategies.

In addition to selecting a suitable optimization process, determining the functional quality is essential to the success of optimization. In the simplest case, the objective comprises just one criterion, e.g. to minimize fuel consumption. In practice, however, there will be several target variables, the quantification and weighting of which are tasks that must not be underestimated. In the paper, "Use of optimization methods in hybrid simulation" delivered at the IAV/HDT Conference on "Hybrid Drive – the Future of the Automotive Drive?" (2005), Dr. Michael Lindemann, senior engineer in signal analysis and modeling at IAV, used the example of a consumption-minimized compact vehicle to demonstrate the way in which different optimization methods can be employed, also in combination with each other, to achieve results with justifiable time input.

It can be said that from the experience gathered at IAV, within its many different projects on formulating concepts for hybrid vehicles, a method has been developed which, aided by simulation tools and optimization methods, ensures efficient project work. The tools used for activities currently in progress are being extended for linking in external simulation programs with a view to providing even better support for Phase 4 of modeling based on co-simulation.

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Editorial

Dear Readers,

The new edition of IAV's newsletter automotion features insights into some our project work and discusses ongoing and new industry trends. For IAV, as an automotive engineering service provider, it is important to identify new trends to be prepared for incoming requests so that we can work in true partnership with our customers.

With our strong involvement in hybrid electric vehicle, gasoline direct-injection and advanced Diesel aftertreatment production development programs, IAV masters the current development challenges while helping our customer to meet ever shortening timelines. Please read more about these activities in this edition of our newsletter.

At Convergence 2006, booth #1301, we will display exciting exhibits and have senior IAV personnel available to present and discuss our services.

Questions are welcome and I personally look forward to meeting you at the show. Perhaps you can help us and we can help you to identify the next industry trends …

Yours sincerely,

Utz-Jens Beister
President of IAV Inc.

SCReaming for Low NO_x Emissions: Selective Catalytic Reduction (SCR) is the Candidate Exhaust Aftertreatment System for Passenger Cars

IAV is ambituously working on the adaptation of SCR technology from heavy duty to light duty applications

by Michael Traver, Dr. Lutz Kraemer and Juergen Manns

As a result of ever-tighter exhaust emission legislation on the target markets around the world, the aftertreatment of exhaust gases emitted by diesel engines is moving more and more into the spotlight when it comes to developing future drive concepts. Whereas the diesel particulate filter will be mandatory for all diesel passenger cars at the latest when the planned Euro 5 comes into force from 2009 onwards, additional measures are required on the medium to long-term horizon to further reduce the engine-out nitrogen oxide emissions as well (denoxation).

A drastic reduction in nitrogen oxides has already been laid down in the USA. In Europe, the introduction of denoxation methods downstream of the engine may also be expected in the wake of the tighter requirements specified by the European Union regarding the NO_2 emission limits from 2010 onwards, as well as a probable stipulation of Euro 6 standards. A application in the short term may become necessary for light trucks and SUVs as part of Euro 5 because from 2009 onwards these will have to comply with the same standards as passenger cars.

SCR Technology Already Established

Since the introduction of the Euro 4 limits, a denoxation technology has been established among heavy commercial vehicles that has proven its worth in cleaning exhaust emissions from steady-state engines: The selective catalytic reduction (SCR) of nitrogen oxides permits both, efficiency-optimized and thus also consumption-optimized engine calibration and, configured in the appropriate way, also the premature, toll-cutting compliance with the Euro 5 limits. IAV is working ambitiously on applying commercial vehicle SCR technology to passenger cars in order to make a contribution towards meeting the future emission standards and thus towards securing the future of the diesel engine.

Different catalytic converters can be characterized and compared under reapeatable conditions on the IAV synthetic gas test bench

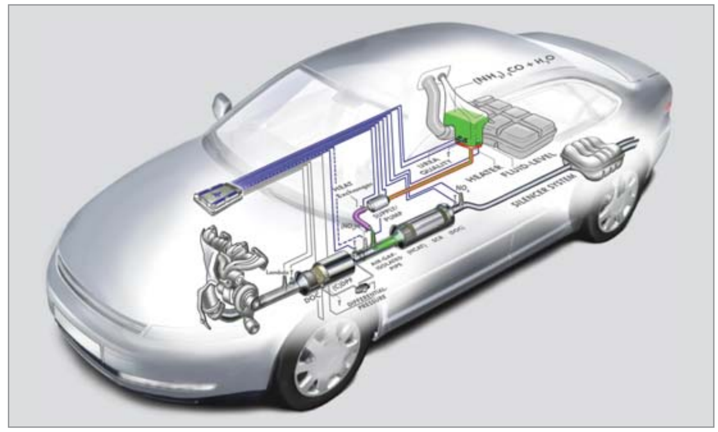
The SCR technology is based on the catalytic reduction of nitrogen oxide emissions by adding controlled quantities of ammonia to the exhaust gas. As caution must used when handling liquid ammonia or ammonia water, non-toxic urea solution is chosen as the reductant which, in hot exhaust gas, thermohydrolyzes into ammonia in two stages. The urea solution is carried in a suitable tank which, with a volume of approx. 20 - 30 liters (5.28 – 7.93 US gallons), must be refilled at the oil service intervals.

Unlike its rival, the lean NO_x trap (LNT), the SCR catalyst is largely unaffected by fuel quality (sulfur content) and demonstrates a significantly higher level of stability over the life of the vehicle. The drawback over the LNT already being used in mass-produced lean-burn spark-ignition engines is the necessity to carry and replenish an additional operating fluid. As regenerating, an LNT leads to an increase in fuel consumption and as significantly greater quantities of precious metals are required, the SCR system is classified as more cost-effective despite the expense of a urea solution metering system installation.

From Concept to Mass Production

The calibration of an SCR system for an existing vehicle concept takes place in several stages. As a development partner, IAV takes care of the necessary steps from the concept phase to the start of mass production. The layout of the exhaust system and urea solution tank is governed by the existing vehicle concept and the possibilities associated with it. Defining the layout, IAV uses cutting-edge simulation tools that take account of the engine raw emissions (0D simulation, DoE), the properties of the catalytic converter (1D simulation) and also the effects of exhaust system geometry (3D simulation). Design and pakkaging of the exhaust system also form part of IAV's work portfolio. The combination and integration of different exhaust treatment components, such as the oxidation catalyst, the diesel particulate filter and the SCR system are crucial to the success of the calibration selected in terms of its efficiency and endurance (e.g. component aging, oil dilution).

If the given boundary conditions suggest the selection and application of an SCR system, different catalytic converters can be characterized and compared on IAV's synthetic gas test bench under accurately repeatable conditions (catalyst benchmark). The laboratory test bench also provides the capability of calibrating specific kinetic models and the characterization of any hydrothermal aging or contamination effects. On the engine test bench, this is very complicated and only possible to a limited extent on account of the interdependency of different parameters.



Schematic set-up of an exhaust system featuring the SCR technology

Crucial Calibration Steps

Preparing the reducing agent is one of the most important steps in calibration. Precise metering of the urea solution is just as much a challenge as it is to keep the flow of originated ammonia to the catalytic converter as homogeneous as possible because the catalytic converter increases in area as its radius widens. IAV can draw on a wide range of optical and hydraulic measuring facilities on component and engine test benches for optimizing the properties and operating parameters of the dosing system which comprises a tank, a pump unit, and an injector.

IAV also uses appropriate tools for examining and optimizing the flow uniformity to the catalytic converter. Optical methods, such as diffraction spectrometry, particle image velocimetry, Schlieren and shadow methods and Doppler Global Velocimetry, as well as chemical analysis, such as ammonia determination through mass spectrometry or FT infrared spectroscopy, are available for this purpose. These methods are also used for validating 3D simulation which makes it possible to compute the effect of defined geometry changes on flow uniformity and thus minimize the cost of experimentation.

Urea Dosing Control and OBD

IAV develops the specific software algorithms for the open and feed-forward control of urea dosing. This can be accommodated in a bypass to the control unit by means of separate hardware or implemented in the software architectures of the relevant control unit manufacturers. The software provides the strategy for dosing control in relation to all engine operating conditions that can occur, as well as all of the algorithms required for OBD monitoring.

A further development focus rests on optimizing the diesel engine's warm-up phase because the urea solution can only be dosed at temperatures of more than 200 - 250 °C (avoidance of deposits).

Once the "SCR for passenger cars" concept is in place on the chosen vehicle, IAV also looks after the production-relevant development processes, which cover the overall calibration of combustion and exhaust aftertreatment and validate these in fleet tests.

Several OEMs and ancillary suppliers have already come together in consortia with the aim of building up an infrastructure for AdBlue, the "sweeter-sounding" brand name for the urea solution. Once AdBlue is available all over, the requisite additional tank capacity can be significantly reduced.

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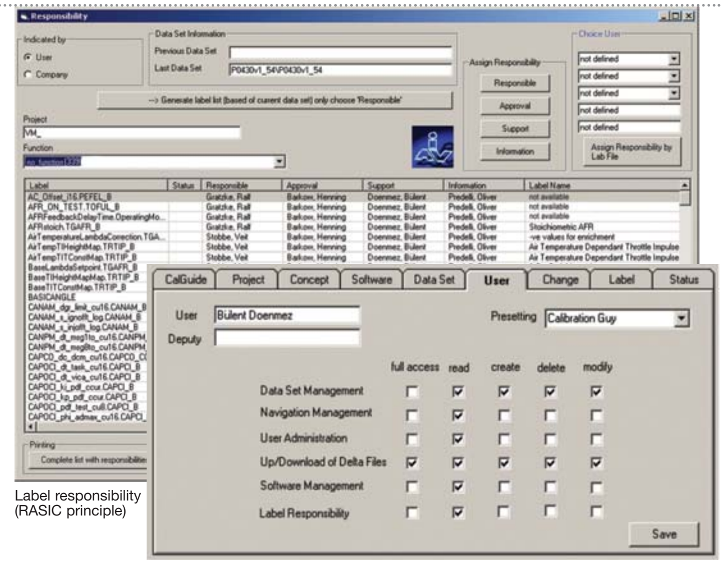
Be Fast, Be Sure, Be Calguided!

CalGuide – the data-set management software from IAV

by Jens Breitinger and Mark Baecker



Label responsibility (RASIC principle)

User management with access rights

Using CalGuide data-set management software, it is possible to retrace and control calibration data at all phases of the development process. Modern engine control units have more than 15,000 parameters. These need to be calibrated within two to three years for different vehicle and engine models. Different development departments, each using parts of the control-unit software, work together until all of the technical objectives – power output, torque, emissions, drivability, endurance – are achieved.

This is where it is important to keep a clear perspective! Who is responsible for what calibration package? When must it be completed by? What configuration is given to the test data records? What is going into mass production? How far is overall calibration from completion? When and why was a specific label last changed? CalGuide has answers to all of these questions. IAV has been using CalGuide in its development processes for two years. The tool's high quality has been confirmed in numerous multiple-site, turn-key projects. CalGuide is easy and intuitive to use. Project structuring is geared to existing processes. This gives CalGuide a high level of acceptance in development teams.

A responsibility matrix (RASIC principle) is used to define which labels and algorithm groups must be calibrated by the individual calibrator. This prevents untracked modifications being made to data sets. Calibrators enter their calibration data into the database where they are collated into official data sets by the data-set manager for the particular project concerned. On putting together the data records, an immediate check is made to establish whether contents overlap, responsibilities have been violated or variant differences disregarded. The process of data-set creation is documented automatically. Only released data records can be extracted from the database, with access being governed by a project-specific user manager.

Each calibration engineer can and should document the calibration changes he or she makes. Input user interfaces are provided for this purpose. It is also possible to transfer PaCo file comments to CalGuide automatically. A status definition can be used to display calibration completion level. All developers involved in a project can see (in line with their access rights) how far calibration has progressed and where action still needs to be taken. Project management is provided with a range of automatic reporting functions for data-set comparisons and status reports.

CalGuide supports the shared calibration strategy with cross-platform calibrations where identical assemblies (e.g. sensors, actuators) and algorithms are used. The calibration of label groups can easily be taken from one data set and applied to another. Violation of defined input values, such as the miscalibration of diagnostic threshold values, can be avoided by using label-specific comments. CalGuide is modular in structure and can be adapted to the customer's specific requirements and database systems.

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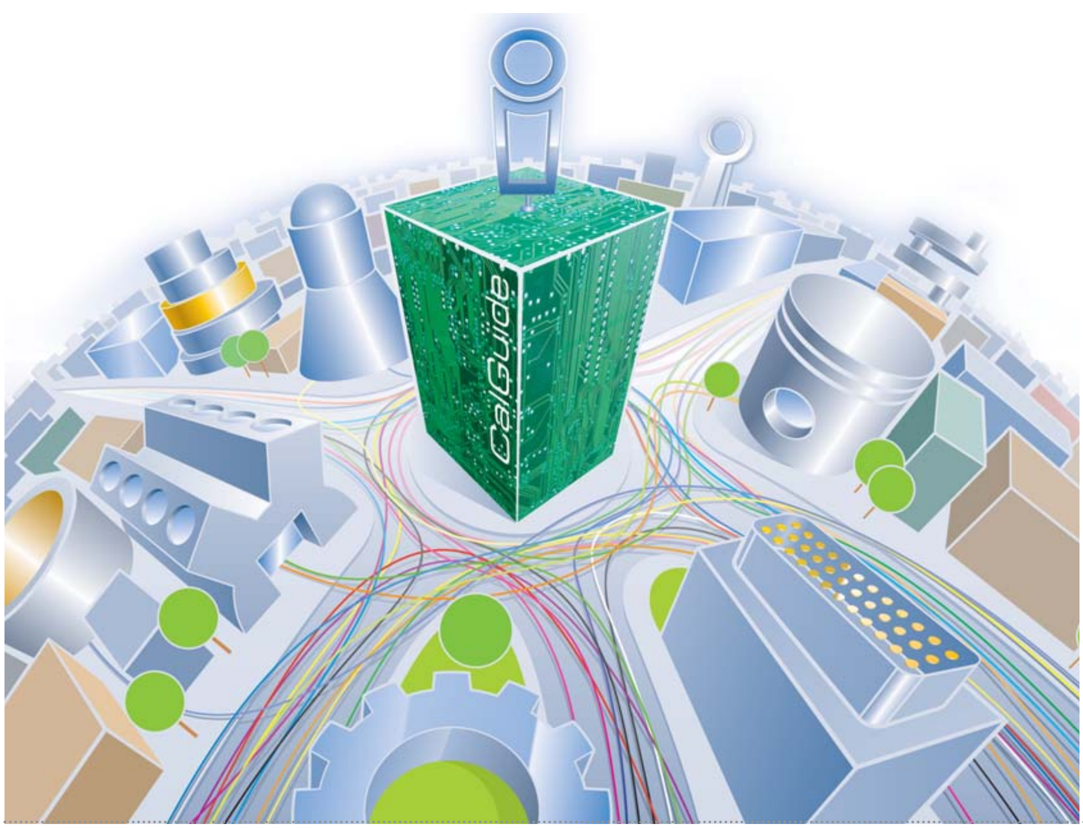

This is what CalGuide can do:

Efficient functions for comparing data sets:

- Visualization of data-set differences
- Recognition of variation from required values
- Examination of calibration overlaps
- Display of responsibility variations
- Definition of label responsibilities (RASIC principle)
- Collating, filing and distribution of data sets
- Import and export functions (a2l, hex, etc.)

Project monitoring functions:

- Capability of creating specific project structure
- Automatic generation of a data-set discussion log
- Granting of specific access rights to individual users
- Project management by means of progress tracking and status evaluation (degree of maturity)
- Monitoring of project milestones
- Automatic generation of different status reports

IAV at Convergence 2006

Exciting exhibits demonstrate engineering competence

by Paul Moreton

Don't miss IAV at the SAE Convergence, October 16 – 18, at Cobo Hall in Detroit. This year we will have exciting new exhibits demonstrating our competence in simulation and development of powertrain and complete hybrid vehicle systems, including software and electronics control topics.They reflect IAV's strong involvement in advanced hybrid development projects for production vehicles.

IAV expert with customer at SAE in Detroit

From R&D to series development: From the first steps of simulation to the homologation process of series development, IAV integrates systems and components. An example at Convergence is the DualDrive Hybrid Transmission concept by Nexxtdrive. It combines the functions of a fully variable automatic transmission with those of an efficient hybrid drive and is suitable for all applications requiring variable and fully electronic control of engine speed and torque from a mechanical power source. As part of a hybrid drive, DualDrive considerably reduces CO_2 emissions compared to conventional solutions. Come and discuss how IAV may integrate your component on a turnkey basis.

The three-phase inverter for electric drives developed at IAV for prototype applications provides a universal platform for developing electric drives. The inverter is mainly used for developing algorithms to control electric motors, for operating and testing electric motors at test rigs and implementing prototype vehicles, but our experts would be pleased to acquaint you with its full range of applications.

IAV booth at SAE 2006 in Detroit

Also on display will be our IAVcon development controller for powertrain applications. IAVcon is capable of controlling modern transmissions, such as DCTs or AMTs, and hybrid concepts. The modular structure permits the use of various microcontrollers. An extensive software package and development process can be supplied with the controller.

Or, why not make your life easier with our Rapid Prototyping tool chain? IAV's universal control units (UCUs) and the related software tools permit the quick and efficient implementation of prototypes suitable for in-vehicle application. More information on technical features will be available at our booth.

Drop by for a chat with our experts in transmission, powertrain and hybrid concepts – we look forward to seeing you!

And don't forget we serve the best coffee at the show! Our booth is # 1301 in Wayne Hall.

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IAV Inc Expands Its Powertrain Design and Integration Capabilities In The USA

by Paul Moreton

IAV Automotive Engineering Inc is committed to expanding its portfolio of engineering, technical and consultancy services in the USA. To do this, IAV recently recruited a senior manager for its powertrain design and integration competency center. Tom Reedy brings an extensive background and experience in powertrain and vehicle systems integration to IAV Inc. Reedy previously led several design to production launch projects, including chassis and powertrain engineering on HUMMER H2, the Duramax-Allison powertrain integration into HUMMER H1 and, back in his native England, the production launch of a new Landrover Td5 Diesel vehicle chassis system.

NVH test bench

Reedy has the responsibility to grow the engineering capability of his competency center into an already competitive market. Reedy states, "our growth plan is well established in our 2007/08 business strategy. It places top priority on the holistic growth of our engineering skills, our CAE toolsets and our system integration processes. I intend to build the competency center using our German automotive engineering heritage of design excellence, strict attention to detail and the best CAE tools for analysis and simulation. Words like surgical, technical and precision best describe what we are offering our OEM and supplier community clients". IAV uses its advanced design, analysis and DOE tools to create early engineering maturity. This results in reduced timing for hardware and fewer test and build incident reports, therefore significantly reduced need to make expensive late tooling changes. Hardware development effort is reduced to the point where fewer prototypes need to be built.

Reedy emphasized, "reducing our customers engineering risk is our primary goal.

Continued on page 5

Mobile, Modular, Multifunctional

IAV Drive Recorder for recording data in the vehicle

by Jens Breitinger and Sven Lochau

Multifunctional steering wheels, keyless access or infotainment systems – today's motorist enjoys a wealth of comfort and convenience. But as this convenience continues to advance, vehicles require an increasing number of control units. The higher the number of the control units, the more bus systems there are that need to be measured, the more protocols to be handled. In short, while the demands on measurement systems for recording vehicle-specific data are rising, they must be easy to use. This demand is met by IAV's products from the IAV Drive Recorder family, the IAV Drive Recorder NG® and the IAV Drive Recorder Compact. These record vehicle-specific data from passenger and commercial vehicles, as well as special-purpose vehicles via the CAN bus and K-line network interface.

Modular and Mobile Concepts

With its modular concept, the IAV Drive Recorder NG® can be adapted to a variety of measurement tasks. The unit is able to support up to six CAN interfaces (high and low speed) and up to two K-line interfaces. In addition, data can be recorded through analog and digital inputs. The IAV Drive Recorder Compact, on the other hand, offers four CAN interfaces, a K-line interface, digital inputs and outputs, as well as eight analog inputs, all standard. Both units come with interfaces for mobile and wired communication, such as WLAN, Ethernet and GSM/GPRS, for a hand set (optional with audio function) and also features interfaces for connection to external measuring instruments.

High Number of Protocols

To be in a position to communicate with different makes of control units, both units from the IAV Drive Recorder family offer a wide range of protocols. These include the ISO 9141 based KWP 2000, McMess and KWP 1281 protocols and the KWP 2000 (ISO und TP 2.0), CCP 2.0/2.1, XCP 1.0, GMLAN, UDS and DiagOnCAN CAN protocols.

Straightforward Handling: Configuration and Data Communication

The user-friendly Windows interface makes easy work of configuring the system. Here, users can create complex triggering conditions for recording data relevant to them, with both data loggers coming with a memory capacity of up to one gigabyte. Measurement configuration is kept in an XML file. In the case of the IAV Drive Recorder NG®, this is transferred as standard via a CF card (compact Flash card). With the IAV Drive Recorder Compact, it is transferred to the data logger as standard by WLAN. The binary data recorded are also transferred via the CF card or WLAN to the PC where they are converted into readable CSV or MDF files.

As an engineering service provider, IAV also offers its clients expertise in the high-speed, automated evaluation of measured data.

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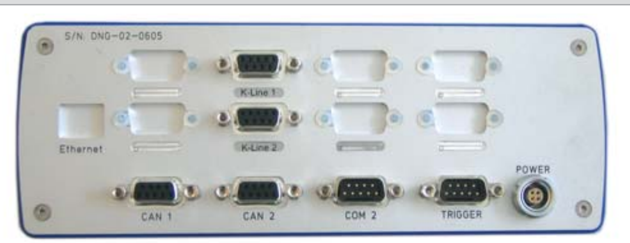
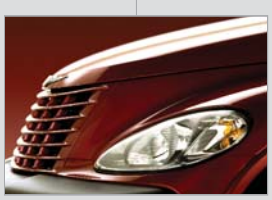
Front view of Drive Recorder NG®



Rear view of Drive Recorder NG®



Passenger car

Heavy-duty trucks

Delivery van

Off-road vehicle

Test cell

Areas in which the IAV Drive Recorder family is used

Continued from page 4

This saves our customers time and money and greatly refines their production launch process".

IAV will grow its USA technical center facilities to undertake powertrain and vehicle design, analysis, test, NVH engineering and prototype build work. Through 2007, the focus will be on skills growth and the creation of a new dedicated technical facility. In the short to medium term, we will be concentrating on the design and functional integration of advanced powertrain systems into vehicles. This includes HEV, advanced clean Diesel engines to meet the stringent EPA 2010 emissions regulations, gasoline engines with advanced and "clean" combustion processes, the use of Ethanol and Bio-Diesel fuels and a range of exciting automatic and dual-clutch transmissions. Of course, NVH plays a vital part in the attributes engineering of the vehicle-powertrain system.

IAV Inc can draw on over 20 years of Diesel engine design, development and refinement experience from Europe where Diesel powered cars now make up some 50% of the total market. As gasoline prices inevitably rise over the next few years, domestic auto manufacturers will develop excellent and desirable Diesel powered vehicles. Meeting 2010 Tier 2 Bin 2 emissions legislation is going to be a tough technical challenge, but convincing the US public that a Diesel passenger car is not smoky, noisy and unrefined is a greater one. A modern passenger car with a well calibrated common rail Diesel fuel injection system, plus excellent design attention to its NVH characteristics has superb drivability through the right transmission. When such a powertrain is well integrated into the vehicle with strict attention to vehicle NVH, the result is an excellent and desirable product. Structured into highly attractive time and cost effective terms, this is exactly the type of consultancy service IAV Inc offers to its clients.

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Public Appearances & Publications

Congresses

Come and see IAV at the accompanying trade shows and exhibitions!

10-16 – 10-18-2006
Convergence
Detroit, USA

10-18-2006
Focus on Vehicle Electronics
Baden-Baden, Germany

10-19 – 10-20-2006
Virtual Powertrain Creation VPC
Munich, Germany

10-25 – 10-26-2006
Autotest
Stuttgart, Germany

11-29 – 12-02-2006
EUROMOLD
Frankfurt on the Main, Germany

12-01-2006
5th CTI Symposium on "Innovative Vehicle Transmissions"
Berlin, Germany

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Technical Publications

ATZ elektronik 03/2006
"Development Strategies for Heavy-Duty On-Board Diagnosis"
Oliver Predelli,
Thomas Jungblut,
Margit Habekost

Elektronik automotive, September 2006
"Mobile Test Management for In-Vehicle Testing"
Dirk Mitzlaff

MTZ 09/2006
"Oil Requirement in Main and Con-Rod Bearings – Elasto-hydrodynamic Simulation Techniques and Experimental Validation Based On Engine Testing"
Prof. Knoll, Dr. Backhaus (University of Kassel),
Dr. Ludwig (BMW),
Dr. Michael Berg,
Dr. Hubert Schultheiss

ATZ elektronik 04/2006
"Small Ethernet Modules Measure Signals in Sensor Proximity"
Dr. Ulrich Lauff (ETAS),
Sven Lochau

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Papers

10-16 – 10-19-2006
Powertrain & Fluid Conference & Exhibition,
Toronto, Canada
"Prediction of CO Emissions from a Gasoline Direct Injection Engine Using CHEMKIN"
Matthias Schultalbers,
Dr. Olaf Magnor,
N. Chindaprasert, E. Hassel, J. Nocke, C. Janssen
(University of Rostock)

"Influence of Sensors and Measurement System Configuration on Mapping and the Use of Turbochargers in the Vehicle"
Marc Sens,
Jonas Nickel,
Panagiotis Grigoriadis,
Prof. Dr. Helmut Pucher
(Technical University of Berlin)

"Homogeneous Diesel Combustion with External Mixture Formation by a Cool Flame Vaporizer"
Heike Puschmann,
Marcel Pannwitz,
Dr. Ralf Buchwald,
Ansgar Sommer,
H. Pohland vom Schloss,
K. Lucka, H. Kühne
(Oel-Waerme-Institut gGmbH)

10-19 – 10-20-2006
Virtual Powertrain Creation,
Munich, Germany
"Charge-Cycle and Process Simulation as an Effective Method of Engine Control-Unit Calibration"
Dr. Steffen Zwahr

"Use of Optimization Algorithms in CFD Computation, Simulation for Developing Flow-Carrying Components"
Dr. Bernd Findeisen,
Dr. Carolus Gruenig

10-25-2006
Sensor4car,
Böblingen, Germany
"Integration of Sensors and Actuators – The COP Trap"
V. Arndt,
Juergen Irion,
Eckart Freise,
Dr. Peter Schintag

11-08 – 11-09-2006
4th FAD Conference,
Dresden, Germany
"Model-Based Optimization of the Saturation Limit of Catalytically Coated Diesel Particulate Filters"
Frank Heimlich,
Dr. Lutz Kraemer,
Jochen Schaeffner,
Ralf Gratzke,
Kai Behnk

11-09 – 11-10-2006
1st Volkswagen Industrial Engine Conference,
Wolfsburg, Germany
"Requirements on (Industrial) Engines and Transmission in the Hybrid Drive"
Dr. Burghard Voss

11-22 – 11-23-2006
CTI-Conference "Liaison au sol et dynamique du véhicule", Paris, France
"Design and Control of a Hydro-Pneumatic Active Roll Suspension Realized on a 3-Wheel Concept Car"
Dr. Ruediger Freimann,
Dr. Hendrik Gerth

11-30-2006
SIA Conference: Variable Valve Actuation,
Rueil-Malmaison – IFP, France
"Will We Need Variable Valve Trains for Passenger-Car Diesel Engines in the Future?"
Ansgar Sommer,
Lutz Stiegler,
Thorsten Wormbs,
Jan Kabitzke,
Gerhard Buschmann

12-04 – 12-07-2006
5th CTI Symposium on "Innovative Vehicle Transmissions, Berlin, Germany
"DualDrive-E-CVT Transmission. An innovative E-CVT Transmission – Not Only for Use in the Hybrid Vehicle"
Frank Möller (NexxtDrive),
Wolfgang Vocht

"Drive Management and Operating Strategy of a Hybrid Vehicle"
Dr. Burghard Voss

12-07-2006
"Experimental and Analytical Approach to Investigating Injection-Rate Shaping with IAV's TwinCR Injection System"
Maximilian Brauer,
Axel Seiffert,
Dr. Jens Stegemann,
Efstratios Mylidakis,
Ansgar Sommer,
S. Houillé,
G. Gaudre,
F. Dabireau,
O. Pajot (PSA)

12-07 – 12-08-2006
Development Trends in Spark-Ignition Engines,
Leipzig, Germany
"What Contribution Can Alternative Fuels and Hybrid Technology Make to Reducing CO_2?"
Gerhard Buschmann,
Wilfried Nietschke

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