





IPG
AUTOMOTIVE
virtual test driving

Taking you to the next level

Professional solutions for model based engineering and testing

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IPG Automotive GmbH



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Agenda


1. Introduction
2. Model Based Testing within the MIL - SIL – HIL Process
3. Open Perspective with IPG SimulationSolution
4. Use the potential with IPG TestSystems
5. Robust Power - Turn Key Solutions from Concept to Delivery
6. Demonstration with ESP-ECU in the Loop

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Introduction – IPG Profile


One step ahead – advanced thinking, global solutions



SimulationSolution



TestSystems




EngineeringServices

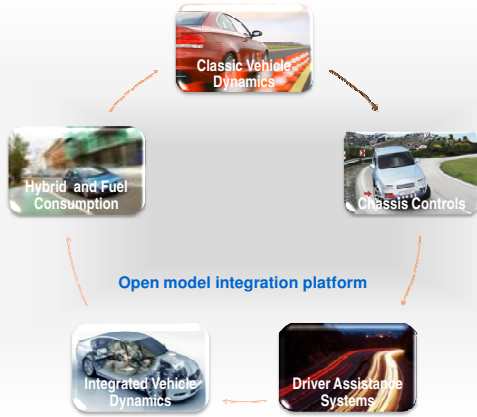
As a former “spin-off” from the Technical University of Karlsruhe, IPG is the pioneer for Vehicle Dynamics and Hardware in the Loop Simulation

- 25 years experience within the vehicle dynamics field
- 18 years experience of HIL TestSystems

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 **Field of Applications**

Extended functions requires an advanced environment





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 **Engineering Services**

Ensure your progress with our powerful support!

 Ramp-up Service	 Vehicle Engineering
 System integration and application	 Methods development
 Simulation services	 Customer specific software and hardware development




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Differentiation

what test driving

What makes IPG Automotive unique?

- ✓ Turn key solutions – ready to go!
- ✓ 25 years experience in the field of vehicle dynamics
- ✓ Multiple competences within one company
- ✓ Unique availability of sophisticated technology such as
 - Multi-Body Core **MESA VERDE**
 - Flex4Net system environment and Xpack4 real-time hardware for Office – Lab – Rig
 - IPGDriver the leading driver model
- ✓ **Global Thinking and the ideas of their people !**

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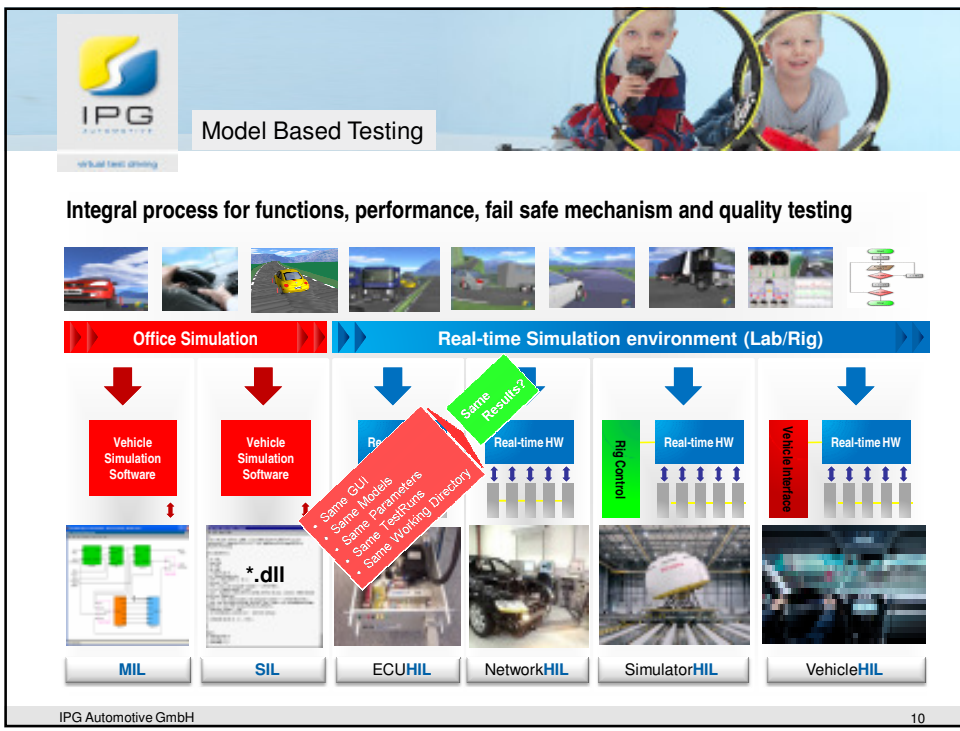
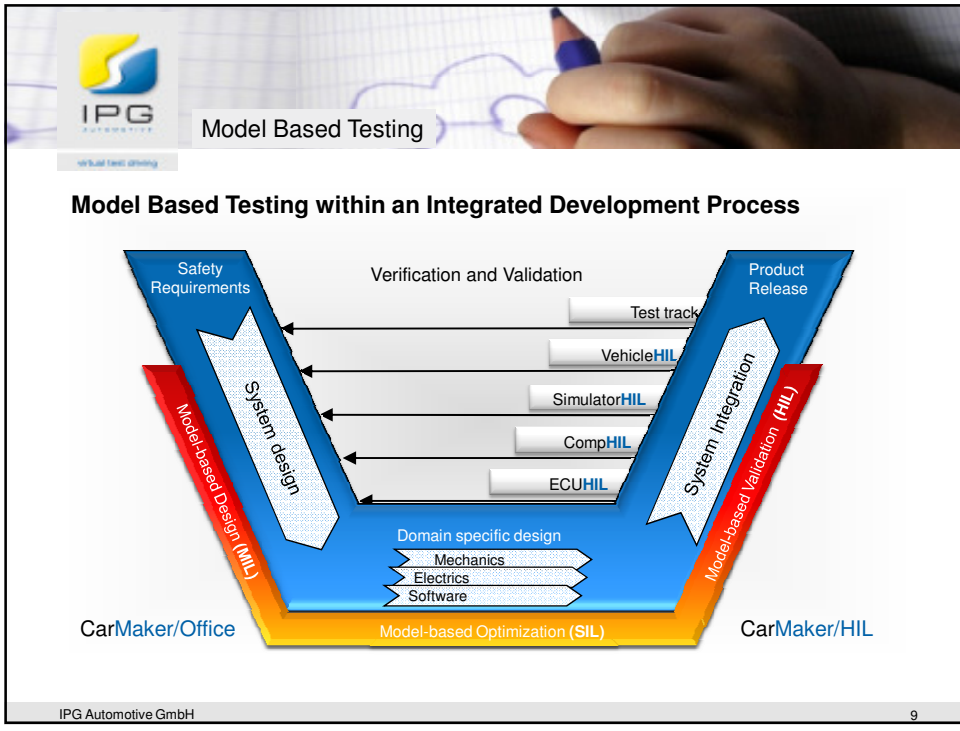



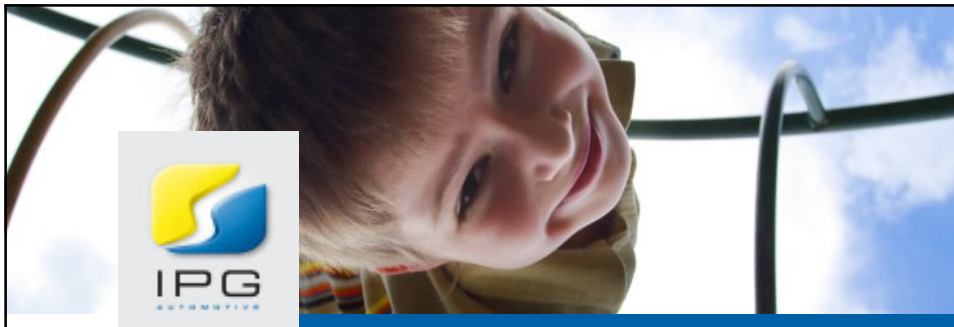

Customers

what test driving



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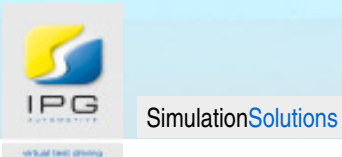







Open Perspective with IPG SimulationSolution

CarMaker **Flex4Net** technology guarantees the highest **performance**, **flexibility**, **interactivity**, **productivity** and **precision**

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Professional Simulation Environment for virtual test driving

CarMaker	MotorcycleMaker	TruckMaker
		

All based on **Multi-Body Code** automatically generated with **MESA VERDE**


fully non-linear – symbolic – fast – extendable

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SimulationSolutions


CarMaker












MotorcycleMaker




TruckMaker



“The virtual test department”

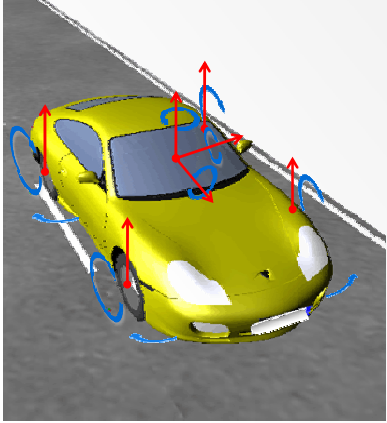
Test Vehicles	Test Driver	Proving Ground	Traffic	Test Trailer	Test Operation	Test Docu	Online Data Acquisition	Test Automation
								
IPGCar	IPGDriver	IPGRoad	IPGTraffic	IPGTrailer	ScenarioManager TestSeries	IPGMovie SessionLog	IPGControl ErrorHandling	ScriptControl

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CarMaker Model Basis

IPGCar – precise and extendable




- 17 DOF - Degrees of Freedom + 20 constraints
- **Mesa Verde Multi-Body Code**
fully non-linear – symbolical – fast – extendable


Components

- **Body**
 - BodyFlex with 2DOF (torsion, bending)
 - sprung mass, loads, engine, trim loads
- **Suspension** with linkage equation
 - kinematics & compliance selectable
 - 2D table (map), 1D table, linear
 - Damper, spring, buffer, stabilizer, external forces
- **Steering System** Front Axle
- **Rear Axle Steering**
- Detailed **Hydraulic Model** valid for ABS/ESP
 - Booster, master and brake cylinder, pump, valves, line volume, accumulator, attenuator
- **Powertrain** (front, rear, AWD)
 - Engine, clutch, gear box, differentials
- **3D Aerodynamics**
 - drag – lift – side
 - 3 $F_{x,y,z}$, 3 $M_{x,y,z}$

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CarMaker Model Basis & Functions




IPGTrailer

- Full non-linear
- up to 2 axles
- free-definable geometry adjustable
- unsprung, sprung masses, trim loads
- IPG suspension model* sleeve axle, crank axle, semi-trailer arm axle
- Aerodynamics model*
- Brake model
- Tire model*
- Hitch ball model ball&trapeze, friction, damper



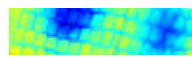
IPGTire


- MF 5.2 data load
 - TYDEX format
 - TIME procedure
- Additional functions
 - stop & go (hill)
 - slope parking
 - vertical damping
- 3DRoad usage
- Physically based analytical functions for
 - combined XY forces
 - Dynamic behavior
- Tire load all or single
- Automation fitting tool for IPGTire data



IPGRoad

- 3DRoad generator
- 3D-Track grid data load
- Friction definition
 - μ split, μ -jump, μ -sequence, μ -line
- Markers and Pylons
- Traffic signs speed, side wind
- Obstacles wave, cone, cylinder, beam
- 3D-Track grid data load high resolution CRG






IPGTraffic


- Traffic generator longitudinal - lateral
- Different vehicle types Trucks, Vans, SUV, passenges cars, HP cars
- Maneuver definition start position, time history, speed profile (x,y), accel.
- No limits on number of vehicles
- Moving or standstill traffic
- Pared vehicles
- Traffic loop

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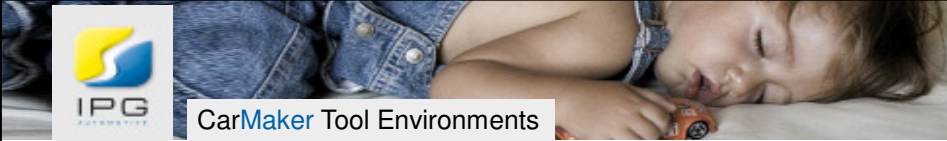
CarMaker Online Tool & Functions

IPGMovie realistic vision for your online evaluation and cognition



- **Online Animation** for Office and HIL applications
- **Simultaneous force display**
- **Comparison mode** for primary and reference vehicle
- **Movie Control Panel** for play back mode NEW
 - forward motion – regression – slow and fast motion
- **Load functions** of results data for post-animation
- Numerous **view functions** and camera settings
 - Very fast zoom and rotation by mouse
 - Offset settings (x,y,z)
 - User defined multi-default view positions NEW
 - fixed and moving camera
 - In vehicle and with vehicle motion
- Extensive possibilities for **individual adaption** NEW
 - Background, ambient and colors
 - Company Logo
- Configurable **Video Export** to Cinepak
 - Indeo, MPEG, DivX, WMV

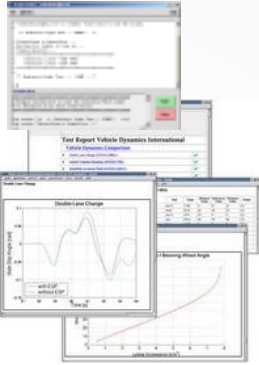
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CarMaker Tool Environments


What's new driving

How much time do you have? Lights-out testing with ScriptControl



- **Full Test Automation** up to 20 x increase in productivity
- **RealTimeExpression** – test execution in real-time
- Easy implementation and application
- **Dynamic and direct access** to all commands, models, parameters, variables, data and mechanisms within CarMaker
- Exchange of **models "on the fly"**
- **High functionality**
 - Time, event and result controlled/triggered
 - Mathematical operations (expressions)
 - Commands (loops, case differentiation etc.)
 - Program Operations
 - Function generators
 - Calling of external programs
- **Design of user specific GUIs**
 - Continuous use for MIL, SIL, HIL
 - Reproducible, achivable and **modular test flows**
 - **Automatic generation of test protocols and reports**

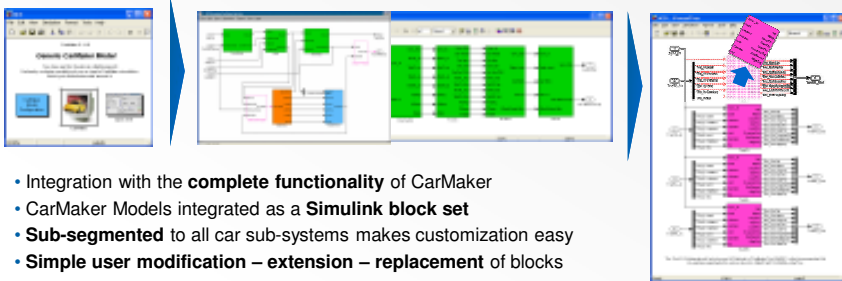
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CarMaker Online Tool & Functions

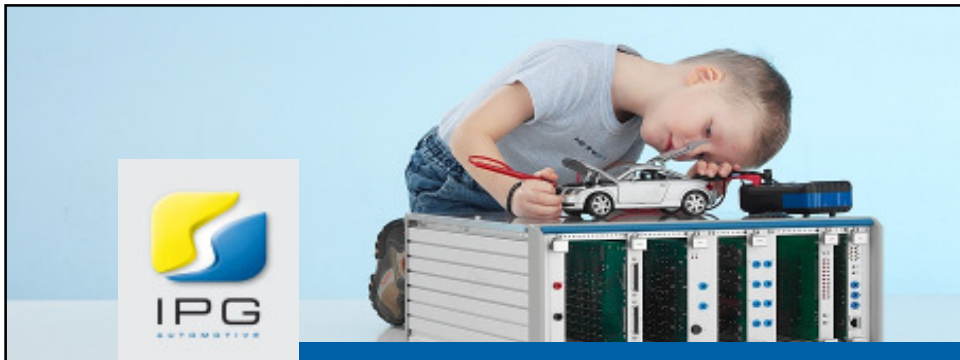
What's new driving

CarMaker integration within MATLAB/SIMULINK



- Integration with the **complete functionality** of CarMaker
- CarMaker Models integrated as a **Simulink block set**
- **Sub-segmented** to all car sub-systems makes customization easy
- **Simple user modification – extension – replacement** of blocks
- Use of the respective **tool specific model solvers** and step size
- **Same GUI, same models, same test runs, same parameters and the same mechanisms**
- **Direct access** to all variables
- **Parallel C-interface** for all subsystems for C-Code model adaption and performance improvement
- **Same performance** optimized simulation code using multi-threading, multi-rating and multi-tasking

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Use the potential with IPG TestSystems

CarMaker/HIL and **Xpack4** Technology
The Optimal Solution for your Challenges!

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TestSystems

virtual test driving

The optimal solution for your technologies



Individual TestSystems

Proven a thousand times




Standard HILSystems




Brakes – Driving Dynamics – Steering - Drivetrain
Driver Assistance – System Combinations

on basis of **Xpack4** real-time platform, **CarMaker/HIL** simulation environment

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Xpack4 Realtime Hardware Structure



Host Computer

Simulation Control, Animation, Analysis of Results, Data Recording

Realtime Computer

Virtual Vehicle and Environment (Vehicle, Driver, Road, Road Data)

DAC/ADC, Frequency Generators, I/O-Modules, CAN

FaultSafe Tester


Relay Boards, Resistor Boards, High Speed Switch Boards, Controller Board

Test Rig

Sensors, Actuators, Wiring, Vehicle Cable Tree


Real Vehicle Components / Subsystems

Braking System, Steering System, Active Suspension, Drivetrain, ECU or ECU network




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Xpack4 Standard Component of-the-shelf




Supported Realtime platforms by CarMaker/HIL

- NEW
 - **Xpack4 – IPG’s 4th generation**
 Intel-CPU, Compact PCIbus, IPGXeno Linux RealTime
 CPU’s: F14c, F14p, F17 Core 2 Duo 2.16 GHz, 2048 MB RAM, 2x Gigabit Ethernet performance approx. 2x (5x MVME 550)
- **IPG PowerPC-CPU, VMEbus, LynxOS**
 CPU’s: MVME 2400, MVME5100, MVME5500
- **dSPACE DS1006 Opteron**
- NEW
 - **dSPACE DS1005 PowerPC**





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Xpack4 Standard of-the-shelf Components




Virtual test driving

Take part of the quality and rapid progress of industry components!

Open standard, industry of-the-shelf components:

- PCs as host computers with
 - Windows  or Linux 
- Scalable real-time computer
 - PowerPC or Intel SBCs 
 - VMEbus or CompactPCI bus 
 - LynxOS or IPGXeno Linux RT 
 - M-Modules for I/O 
- Open through full compatibility to
 - MATLAB  and SIMULINK 



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Xpack4 Real-time Computer - Configuration




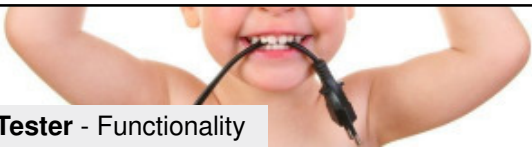
Virtual test driving

Modular system – extendable and upgradeable!



Very attractive pricing:
Turn-key Realtime Computer, typical HIL IO-configuration: 8.500 €

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FailSafeTester - Functionality

Virtual test driving

More than a simple breakout box!

- For actuators and sensors
- Able to simulate electrical faults like
 - Interruption (cable breakage)
 - Loose contact
 - Contact resistance (corrosion)
 - Short circuit (against ground and against other cables)
 - Shunt (leakage current)
- Fully software programmable, without the need for manual patching cables, which means
 - Test can be completely automated
 - Fault can be either course-controlled or time-controlled
 - Complete test configuration can be stored and re-loaded
 - This is really automated testing!



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FailSafeTester - Functionality

Virtual test driving

Up to 160 channels in one box, yet extremely compact


- Expandable and modular system up to 160 channels in one box (20 slots, controller card, backplane)
- Multiple chassis configuration possible, thereby allowing for an unlimited number of channels
- Controlled via CAN or serial interface
- **Easy programming** via scripting language
 - Perfect integration with CarMaker/HIL
 - Easy-to-use graphical user interface
 - Channel naming and failure definition controlled by software
 - “Manual” (via mouse click) and automatic cable patching possible (via maneuver control dialog)
 - Control the fault modes from within your testrun and monitor the fault conditions




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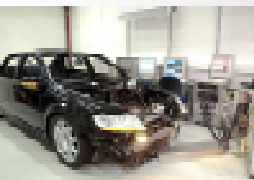


TestSystems




Virtual test driving

Robust Power - Turn Key Solutions from Concept to Delivery!






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References



Virtual test driving

CarMaker at Opel: MIL – SIL – HIL




- Applications:
 - ABS, ESP, CDC/SADS, TCM, ECM, EHPS, CIM
- Tests:
 - Electrical and communication
 - Fail-safe and diagnostics
 - Function and performance
 - Pre calibration of ECUs
- Integrated models and available interfaces:
 - Tire model, brake hydraulics model
 - GM Test Automation
 - Automated flashing of ECUs
 - Interface to MATCAR, Chassis Studio



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