SIMULATION X®
Powered by ITI

Software Modules

Introduction and Overview

This document provides an overview of all modules available in *SimulationX 3.6*. With a large selection of editions, libraries, Add-Ons and interfaces and its modular structure, *SimulationX* is a tailor-made software solution that perfectly fits your specific needs in integrated system simulation. With changing requirements on the customer's side, *SimulationX* can be extended and modified at any time – your setup is growing with your needs.

SimulationX Editions

Optimized for the different requirements in research, development, engineering and sales, four different editions are available with different scope and use.

Libraries and Model Designers

An extensive number of libraries with model elements, arranged according to physical domains or equipped with objects tailored to the needs of certain applications and industrial sectors, are available. Basic elements and predefined element types enable easy modeling for solid analyses and allow an efficient workflow.

For creating your own or for editing existing elements, the included TypeDesigner offers an easy-to-use environment. Modifications and extensions of the fluid database can be conducted with the FluidDesigner.

Options and Interfaces

Several, customized options and interfaces expand the vast spectrum of possibilities for comprehensive system analyses (equilibrium calculations, natural frequencies, vibration modes, or I/O analyses) and the integration into external databases as well as optimization tools.

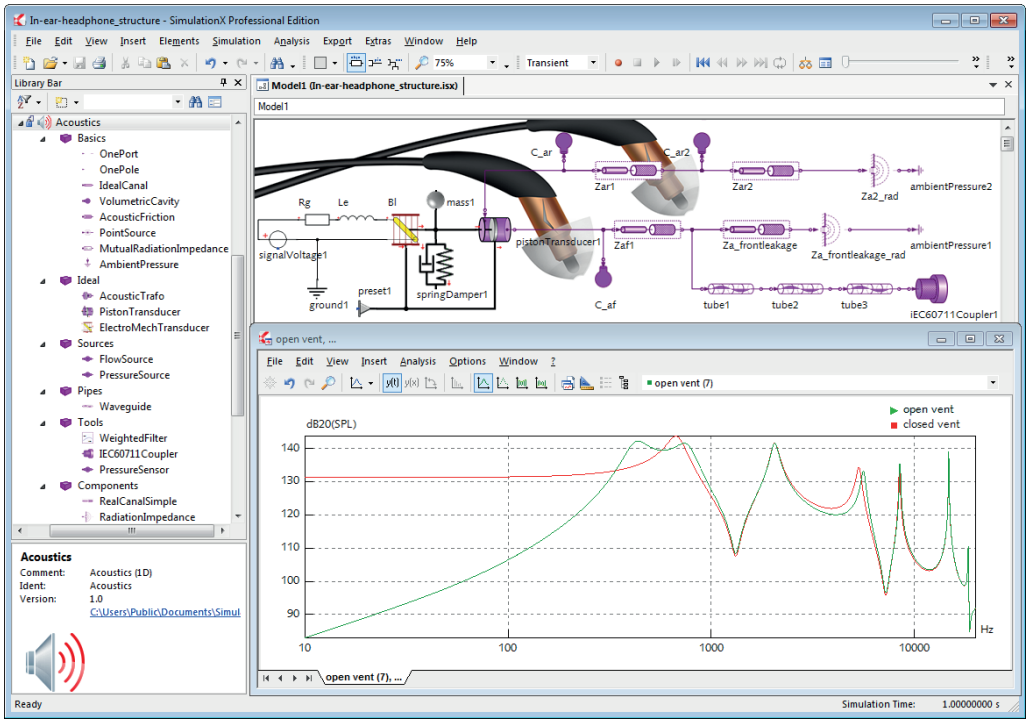

Fig. 1: Model of in-ear headphones with elements from the new library *Acoustics (1D)*

- *High-end modeling platform for comprehensive system analyses*
- *CAE tool for an integrated development process*
- *More than 50 standard model libraries for various domains, such as mechanics, control engineering, powertrains, energy, electrical and fluid technologies, electronics, magnetics and thermodynamics*
- *Customizable user libraries for sheer endless possibilities*
- *TypeDesigner plus object oriented modeling language guarantee quick results for user-defined elements*
- *Fully integrated analysis options*
- *Various editions available for flexible and application-oriented solutions*

Add-ons

Modeling, simulation and analysis add-ons provide a number of extensions like further analyzing tools (e. g. Steady State Simulation in Frequency Domain) or a graphical user interface for creating State Charts.

Co-Simulation

Co-simulation provides a generic interface which can be used to connect *SimulationX* to other CAE tools (such as MSC Adams®, SIMPACK, MATLAB®/Simulink®, S7-PLCSIM).

Code Export

With Code Export, C code is generated from *SimulationX* models. This code can be used for hardware-in-the-loop simulations (HiL), rapid control prototyping (RCP), model integration into other simulation programs (e.g. Simulink S-Function) or as stand-alone executable model.

SimulationX Editions

Professional Edition	
… for design, modeling and analysis	Full version (unrestricted functionality for all purchased SimulationX modules)
Analyzer Edition	
… for computations, analysis, parameter studies, post processing	Incl. COM interface, PrintEngine, Libraries and tools (this edition provides all simulation and analysis tools for existing models – parameters can be changed, but not the model structure)
Viewer Edition	
… for presentations and distribution	Demonstrations to existing and potential customers (models can be run, but not altered)
Student Edition	
… for education and evaluation	Edition with limited model size and reduced scope of operation (commercial use prohibited)

Basic Module (Professional Edition)

☐ **Design, Modeling and Analysis Platform (32 or 64 bit)**

- Model Views: Diagram View, 3D View, Text View, Documentation View
- SimulationX Modelica® Compiler
- SimulationX Libraries *General* and *Animation Bodies*
- TypeDesigner – Smart Editor for SimulationX & Modelica
- Tracing / Output Bar
- Performance Analysis
- Parameter Variations (Variants Wizard)
- COM Interface
- FMU (Functional Mockup Unit) Import
- PrintEngine (Print Preview, Document Structure)
- Add-In for Microsoft® Word, Microsoft PowerPoint®, Microsoft Excel® *[NEW in 3.6]*
- SVN (Subversion) Interface *[NEW in 3.6]*
- Transient Simulation in Time Domain
- Solver: BDF, MEBDF, FixedStep and CVODE

SimulationX Libraries

Mechanics & Utilities

☐	**Rotary Mechanics (1D)**	Inertia, preset, sensor, external torque, spring, damper, spring-damper-backlash, rotary constraint, transmission, rotational-linear transformer, planetary transmission, rigid friction, elastic friction, rigid end stop
☐	**Linear Mechanics (1D)**	Mass, preset, sensor, external force, spring, damper, spring-damper-backlash, linear constraint, lever, plane transformer, rigid friction, elastic friction, rigid end stop
☐	**2D Contacts for Mechanics (1D)** incl. Polygon Editor *[NEW in 3.6]* *Requires: Rot./Lin. Mechanics (1D)*	Generic and special elements for modeling 2D contacts including connectors compatible with 1D-Mechanics
☐	**Modal System** including ANSYS® interface	Modal System
☐	**Planar Mechanics (2D)**	Rigid bodies, joints, constraint, preset, force elements, sensors, contact elements (optional)
☐	**2D Contacts for Planar Mechanics (2D)** incl. Polygon Editor *[NEW in 3.6]* *Requires: Planar Mechanics (2D)*	Generic and special elements for modeling 2D contacts including connectors compatible with 2D-Mechanics
☐	**MBS Mechanics (3D)** including CAD Import via STL and AutoCAD (*.dxf)	Rigid bodies, joints, constraints, force elements, sensors, CAD import via DXF or STL, beam element (optional), contact element (optional), animation bodies
☐	**2D Contacts for MBS Mechanics (3D)** incl. Polygon Editor *[NEW in 3.6]* *Requires: MBS Mechanics (3D)*	Generic and special elements for modeling 2D contacts including connectors compatible with MBS-Mechanics
☐	**MBS Beam Element** *Requires: MBS Mechanics (3D)*	Timoshenko beam element
☐	**MBS Contact Element** *Requires: MBS Mechanics (3D)*	Generic 3D contact between two rigid bodies
	CAD Import *Requires: MBS Mechanics (3D)* **from:**	Import of a single component or several components of a CAD assembly
☐	**Autodesk Inventor®**	
☐	**Creo Parametric™**	
☐	**SolidWorks®**	
☐	**CATIA®**	
☐	**FEM-Import** *Requires: MBS Mechanics (3D)*	Import of three-dimensional mechanical structures from Abaqus, ANSYS, COMSOL Multiphysics® and MSC Nastran™
☐	**Utilities**	Collection of Modelica functions for calculating physical parameters from geometry data and material properties (included in Basis module)

Signal Processing (Control Systems)

☐	**Signal Sources**	Signal and pulse generators (in the time and frequency domains), characteristic curves, family of curves, characteristic maps (2D, 3D, 4D), noise sources
☐	**Linear Signal Blocks**	P-, I-, D- and combined time blocks, generic transfer functions
☐	**Nonlinear Signal Blocks**	Two- and three-point blocks, limiters, deadband, hysteresis
☐	**Time-Discrete Signal Blocks**	Integrators, differentiator, converters, filters, transfer function
☐	**Special Signal Blocks**	Counter, integral y over x, resettable integrator, ramp generator, flip flops, transitions
☐	**Switches**	Pass switches, distributor switches, changeover switches, crossover switches

Power Transmission (1D)

☐	**Motors/Engines** *Requires: Rotary Mechanics (1D)*	Asynchronous induction motor, servo motor, combustion engines
☐	**Couplings/Clutches** *Requires: Linear Signal Blocks, Signal Sources, Rot./Lin. Mechanics (1D)*	Disc clutch, elastic coupling, fluid coupling, dual-mass flywheel, disc clutch with torsional damper, freewheels, cardan joint
☐	**Transmission Components** *Requires.: Special Signal Blocks, Signal Sources Rot./Lin. Mechanics (1D)*	Spur gear, bevel gear, worm gear, differential gear, planetary gears, crank mechanism, cardan shaft, tire-ground contact, torque converters, CVT, propellers
☐	**Planetary Gears**	Base structures for planetary gear systems consisting of meshing spur or helical gears
☐	**Combustion Engines I** *Requires: : Rot./Trans. Mechanics (1D), Signal Sources*	Engine and cylinder models of straight and V engines including excitation models based on characteristic curves
☐	**Combustion Engines II** inclusive Combustion Engines I *Requires: Rot./Lin. Mechanics (1D), Signal Sources, Linear/Non-Linear Signal Blocks, Special Signal Blocks*	Elements of Combustion Engines I plus Vibe combustion function as excitation model, controller models for Diesel and gasoline engines (EDC, ECU), additional engine and cylinder models for straight and V engines
☐	**Combustion Engines III** *[NEW in 3.6]* *Requires: Pneumatics II, Thermics, Signal Sources, Linear Signal Blocks*	Elements for describing the engine's internal thermodynamics, combustion chemistry and the mechanics of the crankshaft, Coherent Flame Model and Vibe's combustion function are considered
☐	**Actuating Elements** *Requires: Signal Sources, Lin./Non-Lin. Signal Blocks, Lin. Mechanics (1D)*	Gear selection, detent, swift cylinders
☐	**Brakes** *Requires: Rot. Mechanics (1D)*	Disc and drum brakes, ratchet
☐	**Synchronization with Friction and Tooth Contact**	Dog clutch model with 3D visualization of dog geometry and shifting process, Borg-Warner Single Synchronizer, Borg-Warner Double Synchronizer
☐	**Real-Time Synchronizers**	Efficient simulation of shifting behavior for synchronizers with mechanical coupling to powertrain and actuator models; simulation of synchronized transmissions in real-time environments for quick concept studies

☐	**Drive Accessory**	Includes models for mounts, shaft segment, 1D vehicle models (drive resistance) and pendulum absorber
☐	**Marine Propeller incl. Ice Impact Simulation** *[NEW in 3.6]* (Type Approval Certificate No. 60 106-13 HH by Germanischer Lloyd)	For transient and steady-state torsional-vibrational analyses of ship powertrains; various ice classes from different certification boards as well as propeller designs can be considered. 1D ship model included.
☐	**Torsional Vibration Analysis** *Requires: Basic Module PE, Steady State Simulation in Frequency Domain and Linear Model Analysis: Natural Frequencies and Mode Shapes*	For modeling, simulation, analysis, parameter studies and post-processing of vibrations of steady state simulation. Basic elements, combustion engines and work machines (E-motor, Generator, Propeller, Pump) are included.
☐	**TVA Report Generator** *[NEW in 3.6]* *Recommend: Torsional Vibration Analysis or Rotary Mechanics (1D)*	External application for the automated creation of standardized (template-based) documents for torsional vibration analyses (including parameters, result curves and diagram views)
☐	**Hybrid Powertrain** *Requires: Basic Module PE, Mechanics 1D (Rotary + Linear), Linear Signal Blocks, Nonlinear Signal Blocks, Special Signal Blocks and Electronics (Analog)*	For modeling, simulation, analysis, parameter studies and post processing of hybrid powertrain configurations Basic elements, control models, bus system elements, electric machines, combustion engines, accumulators, transmission types, vehicles and samples for serial/parallel/power-split hybrid powertrain are included.

Planar Power Transmission (2D)

☐	**Belt Drives** *Requires: Rotary Mech. (1D), Planar Mechanics*	Pulleys and drums, belt and rope models, constraints

MBS Power Transmission (3D)

☐	**Wheels and Tires** *Requires: MBS Mechanics (3D)*	Tire model
☐	**MBS Actuators** *Requires: Hydraulics I, II or III und Pneumatics I or II, MBS Mechanics (3D)*	Hydraulic and pneumatic differential cylinders
☐	**MBS Gears** *[NEW in 3.6]* *Requires: MBS Mechanics (3D)*	Helical gears and gearsets with or without ring as well as helical gears contact

Electro Mechanics, Electronics, Magnetics

☐	**Electric Motors**	Asynchronous, synchronous, and DC motors
☐	**Electrical Power and Communication Analysis** *[NEW in 3.6]* *available as of January 2014*	Interfaces, basic and ideal elements, sources, lines and sensors for quasi-stationary analysis of AC circuits; power and signal analysis is provided
☐	**Converters** *Requires: Electric Motors or Electronics (analog)*	Continuous space vector modulation, ideal unswitched 3-phase inverter, field-oriented torque control of synchronous and asynchronous motors
☐	**Electronics (analog)**	Resistors, capacitors, coils, transformers, bipolar and field effect transistors, diodes, sources
☐	**Magnetics** *Recommended: Electronics (analog) and Linear Mechanics (1D)*	Flux sources, resistances, losses, ground, electromagnetic transformer, iron elements, air elements, air gaps

☐	**Stepping Motors**	2-, 3- and 5-phase motors with controllers
☐	**Electromagnetic Model Elements with interface to JMAG-RT** *[NEW in 3.6] available upon request*	Integration of JMAG-RT models, which are based on detailed models from JMAG (an FEM tool for electromagnetics), in SimulationX; available elements: asynchronous, synchronous and step motors and solenoids

Acoustics

☐	**Acoustics (1D)** *[NEW in 3.6]*	Basic elements, ideal network elements, sources, acoustic line elements, tools and components for modeling 1D acoustic networks; transient and steady-state analyses
☐	**Acoustic Admittance Two-Port** *[NEW in 3.6]*	For loading frequency response curves for acoustic admittance e. g. from FEM-modells or measured data (for steady-state simulation)

Fluid Power, Thermics, Thermodynamics

☐	**Hydraulics I (Basic System Modeling)**	Pressure source, flow source, tanks, volume, differential cylinder, throttle, valves, centrifugal pump, basic sensors
☐	**Hydraulics II (Standard System Modeling)** incl. Hydraulics I	Same as Hydraulics I +plunger/double rod cylinder, pressure intensifier, constant/variable/controlled/gear pump, pressure valves, proportional directional control valves, accumulators, hose line, pipe, additional sensors
☐	**Hydraulics III (Advanced System & Component Modeling)** incl. Hydraulics I + II	Same as Hydraulics II + orifice, nozzle, plane/parallel/ring gap, piston area, fluid inertia, shear stresses in liquids, cartridge valves, proportional directional control edges for valve modeling
☐	**Hydraulics Line Models** *Requires: Hydraulics I, II or III*	Line (distributed model), bends, contractions, elbow, TJunction 90°, transitions, multiplier
☐	**Gearbox Actuation** *Requires: Hydraulics III, Signal Sources, Linear and Special Signal Blocks and Mechanics 1D (Linear)*	Detailed and qualified hydraulic valve models like proportional pressure valves, but also accumulator models and solenoid model
☐	**ITI FluidDesigner Hydraulics**	Tool for definition of new hydraulic fluids
☐	**Pneumatics I (Gases)**	Pressure sources, volumes, exhaust, cylinder, throttle, valves, pipes, pressure and temperature sensors
☐	**Pneumatics II (Gases & Mixtures)**	Same as Pneumatics I (but also for gas mixtures)
☐	**Automotive Pneumatics** *[NEW in 3.6], available upon request* *Requires: Linear, Non-Linear and Special Signal Blocks, Signal Sources, Rot and Lin. Mechanics (1D), Pneumatics I or Pneumatics II, Thermics*	Models for pneumatic brakes and suspension systems in commercial vehicles, e.g. specific braking and air-suspension systems, compressors, line elements, valves
☐	**ITI FluidDesigner Pneumatics/Gases**	Tool for definition of new gases
☐	**ITI FluidDesigner Pneumatics/Mixtures**	Tool for definition of new gas mixtures
☐	**Thermics**	Heat conduction, convection and radiation, heat flow, heat capacity, heat and temperature sources

☐	**Thermal Fluid I (One Phase: Liquids + Gases)**	Flow source, volume, sensors, throttle, flow inertia, piston surface, heat exchanger, evaporator, condenser, compressor, pumps, two phase heat exchanger, liquid-gas interface, phase separation tank with liquids and ideal gases as fluids
☐	**Thermal Fluid IIa (Two Phase: Coolants + REFPROP)**	Same model elements as Thermal-Fluid I with REFPROP fluid database and coolants
☐	**Thermal Fluid IIb (Two Phase Miscellaneous: Water + Moist Air)**	Same model elements as Thermal-Fluid I with water and moist air as fluids
☐	**Thermal Fluid IIc (Two Phase ASEREP)** *Requires: Thermal Fluid IIa*	Same model elements as Thermal-Fluid I with ASEREP database for pure refrigerants and mixtures (only for 32-bit version)
☐	**Thermal Fluid IId (Two Phase Table-Based Fluid Properties)**	Same model elements as Thermal-Fluid I (but with table based refrigerants and mixtures for quick calculations)
☐	**Thermal Fluid III (Ideal Gas Mixtures)**	Same model elements as Thermal-Fluid I with ideal gas mixtures as fluids
☐	**Thermal Fluid Line Models** *Requires: Thermal Fluid I, II or III*	T-Junction 90°, transition, bend, elbow, orifice, phase splitter, phase separation tank

Heat Transfer Libraries & Industrial Utilities

☐	**Steady-State Heat Exchangers** *[NEW in 3.6]* *Requires at least one of the following: Hydraulics I/II/III, Pneumatics I/II, Thermal Fluid IIa/IIc (IIc requires IIa)/IId*	Fin and tube heat exchanger (HX), double pipe HX, micro-channel HX, shell and tube HX as well as plate HX models for steady-state simulations
☐	**Dynamic Heat Exchangers** *[NEW in 3.6] available as of March 2014* *Requires at least one of the following: Hydraulics I/II/III, Pneumatics I/II, Thermal Fluid IIa/IIc (IIc requires IIa)/IId*	Fin and tube heat exchanger + double pipe heat exchanger model for dynamic simulations
☐	**Industrial Utilities** *Requires: Basic Module PE, Signal Blocks (Linear, Sources, Special), Rotary Mechanics (1D), Hydraulics I, Pneumatics II, Thermics, Thermal Fluid IIa or IIc or IId (different fluid models)*	For modeling, simulation, analysis, parameter studies and post processing of utilities used in industrial energy applications. Compressed air generation, heat pump/chiller, gas turbine, gas engine or boiler are included.

Extended Modules

Building Energy Management Systems

☐	**Green Building Library** *Requires: Basic Module PE*	For modular design, modeling and holistic system simulation of building-electro-vehicle combinations including intelligent energy management system; inclusive: ambient and environmental conditions, transformers, consumers, converters, accumulators, vehicle models, building areas

SubSea Libraries

☐	**SubSea Hydraulics** *Requires: Mechanics 1D, Hydraulics III, Hydraulic Lines, Signal Sources*	For user centered modeling of subsea facilities in the oil and gas industry with umbilicals (steel lines and hoses), control valves, pressure supply units, gate valve, ball valve, spring-loaded compensators, bladder compensator, deep water accumulator, single/dual line ROV stab, filter

☐	**SubSea Electrical** *[NEW in 3.6]* *Requires: Electrical Power and Communication Analysis, Signal Sources, Linear Signal Blocks, Special Signal Blocks*	Application specific models of signal and power sources, consumers, lines, panel boards and basic elements for signal and power analyses of electric components for subsea equipment in the oil and gas industry

Reliability Module

☐	**Safety Designer and Fault Tree Analysis (including Hip-HOPS)**	HiP-HOPS tool and SimulationX interface to HiP-HOPS for performing safety and reliability studies using SimulationX simulation models; qualitative/quantitative Failure Mode and Effect Analysis (FMEA) as well as Fault Tree Analysis (FTA) including user-defined failure classes and output deviations

Modeling Add-Ons

☐	**Statechart Designer**[1)]	Modeling discrete-time and finite-state control algorithms in SimulationX' TypeDesigner
☐	**Modelica Generator**[1)] **for Statechart Designer**	Translating state charts from UML into pure Modelica code
☐	**Power Balance**	For analyzing power and energy flows in a model (e.g. calculation of total consumption and energy conversion

Simulation and Analysis Add-Ons

☐	**Steady State Simulation in Frequency Domain**	Calculating models in the state of periodical oscillation (non-linear and linear) with various reference quantity
☐	**Linear Model Analysis: Natural Frequencies and Mode Shapes**	Damped and undamped natural frequencies of the entire system, time constants, eigenvectors, vibrational behavior for various state variables
☐	**Linear Model Analysis: Transfer Functions, Input-Output**	Linearization at the operating point, analysis, export of state space matrices (ABCD or ABCDE)
☐	**Order Analysis**	Frequency analysis of power transmission systems
☐	**Equilibrium Calculation**	Initialization of models that need to be in a state of balance in order to start

[1)] Obligatory combined configuration: Statechart Designer + Modelica Generator

Interfaces

Database, Optimization, Spice and OPC

☐	**Database Interface** *Requires: Basic Module*	Parameterization of components from existing databases (OLEDB data sources)
	Coupling with optimization software:	Determining most suitable parameters for a model with respect to user-defined objectives (software to be purchased separately)
☐	**Isight**	
☐	**modeFRONTIER**	
☐	**OptiY**	
☐	**optiSlang**	
☐	**Optimus** *[NEW in 3.6]*	
☐	**SPICE Translator 1.0**	Translates SPICE3 netlists into Modelica models
☐	**OPC Client for synchronous interface**	SimulationX acts as OPC client and enables connectivity to OPC servers.

Code Export

☐	**Code Export with Solver / without Solver**	Generating model code for using SimulationX models as stand-alone executable (with Solver) or in other applications (without solver)
☐	**Code Export for FMI (Co-Simulation)**	Modelisar Functional Mockup Units (FMU) with solver included for co-simulation
☐	**Code Export for FMI (Model Exchange)**	Modelisar Functional Mockup Units (FMU) for exporting models with equation-based interfaces
☐	**Code Export for NI VeriStand™**	Direct support of the real-time testing and simulation software NI VeriStand from National Instruments™
☐	**Code Export for NI LabVIEW™ Control Design and Simulation Module**	Usage of SimulationX models in the Control Design & Simulation Module of NI LabVIEW
☐	**Code Export for dSPACE® DS1006**	HiL Simulation with dSPACE DS1006 Processor Board
☐	**Code Export for SCALE-RT 5.1**	HiL simulation with a complete HiL environment by Cosateq based on Linux RTAI
☐	**Code Export for VehicleSim™ (CarSim™, BikeSim™, TruckSim™)**	Integration of SimulationX models as components in CarSim, BikeSim , TruckSim (VehicleSim)
☐	**Code Export for ETAS LABCAR**	Usage of SimulationX models in ETAS LABCAR
☐	**Code Export for B&R Automation Studio** *[NEW in 3.6]*	Usage of SimulationX models in B&R Automation Studio
☐	**Code Export for SIMPACK**	Model integration in SIMPACK via UFORCE routines

Co-Simulation

☐	**Co-Simulation Interface (Sockets)**	The base functionality for linking SimulationX to other simulators and CAE tools
☐	**to MSC Adams** *Requires: Co-Simulation Interface*	For the exchange of scalar variables between MSC Adams models and SimulationX models
☐	**to SIMPACK** *Requires: Co-Simulation Interface*	For the exchange of scalar variables between SIMPACK models and SimulationX models
☐	**Co-Simulation to CarSim**	Connecting SimulationX models with VehicleSim (CarSim, BikeSim, TruckSim) using a dedicated co-simulation block
☐	**Co-Simulation with S7-PLCSIM**	Connection to SIEMENS PLC simulator S7-PLCSim

MATLAB /Simulink Interfaces

☐	**Co-Simulation Interface (Sockets) to MATLAB/Simulink** *Requires: Co-Simulation Interface*	Co-Simulation of SimulationX and Simulink using an S-function in the Simulink model and a coupling element in the SimulationX model
☐	**FMI Co-Simulation Target for Simulink® Coder™**	Generating Modelisar Functional Mockup Units (FMU) for co-simulation from Simulink models
☐	**Code Export S-Function (MATLAB/ Simulink) without or with solver (Fixed-Step and CVODE)**	Generating S-function code for using SimulationX models in MATLAB/Simulink; further processing with the Real-Time Workshop (e. g. for HiL applications) is possible

Find your free individual *SimulationX Trial Version* at *www.simulationx.com*.

You can also send an e-mail to *sales@itisim.com*. Either way, you will be provided with your personal link to the software download, online help and the PDF manual.

To talk to one of our product experts, please call *+49 (0)351.26050 – 200*.

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