Modelica Libraries

Modelica Standard Library

*Modelica Standard Library* (called *Modelica*) is a standardized predefined package developed by Modelica Association

It can be used freely for both commercial and noncommercial purposes under the conditions of *The Modelica License*.

Modelica libraries are available online including documentation and source code from http://www.modelica.org/library/library.html.
Modelica Standard Library cont'

The Modelica Standard Library contains components from various application areas, including the following sublibraries:

- **Blocks**: Library for basic input/output control blocks
- **Constants**: Mathematical constants and constants of nature
- **Electrical**: Library for electrical models
- **Icons**: Icon definitions
- **Fluid**: 1-dim Flow in networks of vessels, pipes, fluid machines, valves, etc.
- **Math**: Mathematical functions
- **Magnetic**: Magnetic Fluxtubes – for magnetic applications
- **Mechanics**: Library for mechanical systems
- **Media**: Media models for liquids and gases
- **SIunits**: Type definitions based on SI units according to ISO 31-1992
- **Stategraph**: Hierarchical state machines (analogous to Statecharts)
- **Thermal**: Components for thermal systems
- **Utilities**: Utility functions especially for scripting

**Modelica.Blocks**

Continuous, discrete, and logical input/output blocks to build block diagrams.

Examples:
Modelica.Constants

A package with often needed constants from mathematics, machine dependent constants, and constants of nature.

Examples:

```modelica
constant Real pi = 2 * Modelica.Math.asin(1.0);
constant Real small = 1.e-60 "Smallest number such that small and ~small are representable on the machine";
constant Real G(final unit="m3/(kg.s2)") = 6.673e-11 "Newtonian constant of gravitation";
constant Real h(final unit="J.s") = 6.62606876e-34 "Planck constant";
constant Modelica.SIunits.CelsiusTemperature T_zero = -273.15 "Absolute zero temperature";
```

Modelica.Electrical

Electrical components for building analog, digital, and multiphase circuits

Examples:
**Modelica.Icons**

Package with icons that can be reused in other libraries

Examples:

- ![Info](https://example.com/info-icon.png)
- ![Library](https://example.com/library-icon.png)
- ![Example](https://example.com/example-icon.png)
- ![RotationalSensor](https://example.com/rotational-sensor-icon.png)
- ![TranslationalSensor](https://example.com/translational-sensor-icon.png)
- ![GearIcon](https://example.com/gear-icon.png)
- ![MotorIcon](https://example.com/motor-icon.png)

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**Modelica.Math**

Package containing basic mathematical functions:

- \( \sin(u) \) sine
- \( \cos(u) \) cosine
- \( \tan(u) \) tangent \((u \text{ shall not be: } \ldots, -\frac{\pi}{2}, \frac{\pi}{2}, 3\frac{\pi}{2}, \ldots)\)
- \( \arcsin(u) \) inverse sine \((-1 \leq u \leq 1)\)
- \( \arccos(u) \) inverse cosine \((-1 \leq u \leq 1)\)
- \( \arctan(u) \) inverse tangent
- \( \arctan2(u1, u2) \) four quadrant inverse tangent
- \( \sinh(u) \) hyperbolic sine
- \( \cosh(u) \) hyperbolic cosine
- \( \tanh(u) \) hyperbolic tangent
- \( \exp(u) \) exponential, base \(e\)
- \( \log(u) \) natural (base \(e\)) logarithm \((u > 0)\)
- \( \log10(u) \) base 10 logarithm \((u > 0)\)
Modelica.Mechanics

Package containing components for mechanical systems

Subpackages:

- Rotational 1-dimensional rotational mechanical components
- Translational 1-dimensional translational mechanical components
- MultiBody 3-dimensional mechanical components

Modelica.SIunits

This package contains predefined types based on the international standard of units:

- ISO 31-1992 “General principles concerning quantities, units and symbols”
- ISO 1000-1992 “SI units and recommendations for the use of their multiples and of certain other units”.

A subpackage called NonSIunits is available containing non-SI units such as Pressure_bar, Angle_deg, etc.
**Modelica.Stategraph**

Hierarchical state machines (similar to Statecharts)

**Modelica.Thermal**

Subpackage **FluidHeatFlow** with components for heat flow modeling.

Sub package **HeatTransfer** with components to model 1-dimensional heat transfer with lumped elements

Example:
ModelicaAdditions Library (OLD)

ModelicaAdditions library contains additional Modelica libraries from DLR. This has been largely replaced by the new release of the Modelica 3.1 libraries.

Sublibraries:

- Blocks Input/output block sublibrary
- HeatFlow1D 1-dimensional heat flow (replaced by Modelica.Thermal)
- Multibody Modelica library to model 3D mechanical systems
- PetriNets Library to model Petri nets and state transition diagrams
- Tables Components to interpolate linearly in tables

ModelicaAdditions.Multibody (OLD)

This is a Modelica library to model 3D Mechanical systems including visualization

New version has been released (March 2004) that is called Modelica.Mechanics.MultiBody in the standard library

Improvements:

- Easier to use
- Automatic handling of kinematic loops.
- Built-in animation properties for all components
MultiBody (MBS) - Example Kinematic Loop

Old library (cutjoint needed)

New library (no cutjoint needed)

MultiBody (MBS) - Example Animations
**ModelicaAdditions.Petri Nets**

This package contains components to model Petri nets

Used for modeling of computer hardware, software, assembly lines, etc.

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**Other Free Libraries**

- **WasteWater**  Wastewater treatment plants, 2003
- **ATPlus**  Building simulation and control (fuzzy control included), 2005
- **MotorCycleDynamics**  Dynamics and control of motorcycles, 2009
- **NeuralNetwork**  Neural network mathematical models, 2006
- **VehicleDynamics**  Dynamics of vehicle chassis (obsolete), 2003
- **SPICElib**  Some capabilities of electric circuit simulator PSPICE, 2003
- **SystemDynamics**  System dynamics modeling a la J. Forrester, 2007
- **BondLib**  Bond graph modeling of physical systems, 2007
- **MultiBondLib**  Multi bond graph modeling of physical systems, 2007
- **ModelicaDEVS**  DEVS discrete event modeling, 2006
- **ExtendedPetriNets**  Petri net modeling, 2002
- **External.Media Library**  External fluid property computation, 2008
- **VirtualLabBuilder**  Implementation of virtual labs, 2007
- **SPOT**  Power systems in transient and steady-state mode, 2007
- **...**
Power System Stability - SPOT

The SPOT package is a Modelica Library for Power Systems Voltage and Transient stability simulations.

Thermo-hydraulics Library – ThermoFluid Replaced by the New Fluid/Media Library

ThermoFluid is a Modelica base library for thermo-hydraulic models:

- Includes models that describe the basic physics of flows of fluid and heat, medium property models for water, gases and some refrigerants, and also simple components for system modeling.
- Handles static and dynamic momentum balances.
- Robust against backwards and zero flow.
- The discretization method is a first-order, finite volume method (staggered grid).
Vehicle Dynamics Library – VehicleDynamics

There is a Greatly Extended Commercial Version

This library is used to model vehicle chassis

Some Commercial Libraries

- Powertrain
- SmartElectricDrives
- VehicleDynamics
- AirConditioning
- HyLib
- PneuLib
- CombiPlant
- HydroPlant
- ...
Hydraulics Library HyLib

- Licensed Modelica package developed originally by Peter Beater
- More than 90 models for
  - Pumps
  - Motors and cylinders
  - Restrictions and valves
  - Hydraulic lines
  - Lumped volumes and sensors
- Models can be connected in an arbitrary way, e.g. in series or in parallel.
- HyLibLight is a free subset of HyLib
- More info: www.hylib.com

HyLib - Example

Hydraulic drive system with closed circuit
Pneumatics Library PneuLib

- Licensed Modelica package developed by Peter Beater
- More than 80 models for:
  - Cylinders
  - Motors
  - Valves and nozzles
  - Lumped volumes
  - Lines and sensors
- Models can be connected in an arbitrary way, e.g. in series or in parallel.
- PneuLibLight is a free subset of HyLib.
- More info: www.pneulib.com

PneuLib - Example

Pneumatic circuit with multi-position cylinder, booster and different valves
Powertrain Library - Powertrain

- Licensed Modelica package developed by DLR
- Speed and torque dependent friction
- Bus concept
- Control units
- Animation

Some Modelica Applications
Example Fighter Aircraft Library

Custom made library, Aircraft*, for fighter aircraft applications

- Six degrees of freedom (6 DOF)
- Dynamic calculation of center of gravity (CoG)
- Use of Aerodynamic tables or mechanical rudders

*Property of FOI (The Swedish Defence Institute)

Aircraft with Controller

- Simple PID
- Controls alpha and height
Example Aircraft Animation

Animation of fighter aircraft with controller

Example Gas Turbine

42 MW gas turbine (GTX 100) from Siemens Industrial Turbomachinery AB, Finspång, Sweden

Courtesy Siemens Industrial Turbines AB
Example Gas Turbine

Load rejection

Rotational speed (rpm) of the compressor shaft

Load rejection
Generator
Switch pilot to main fuel
Example Gas Turbine – Load Rejection

Percentage of fuel valve opening (red = pilot, blue = main)

Generated power to the simulated electrical grid