

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>.

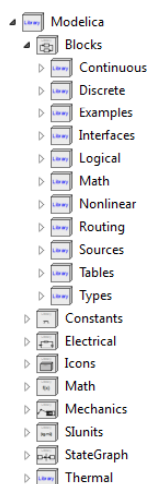
Modelica Standard Library cont'

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

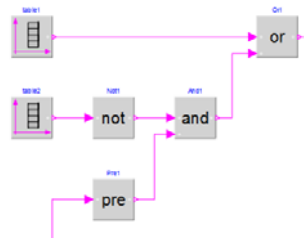
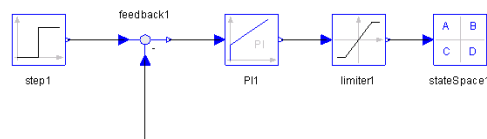
- Blocks Library for basic input/output control blocks
- Constants Mathematical constants and constants of nature
- Electrical Library for electrical models
- Icons Icon definitions
- Fluid 1-dim Flow in networks of vessels, pipes, fluid machines, valves, etc.
- Math Mathematical functions
- Magnetic Magnetic.Fluxtubes – for magnetic applications
- Mechanics Library for mechanical systems
- Media Media models for liquids and gases
- Slunits 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:

```
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



Analog



Digital

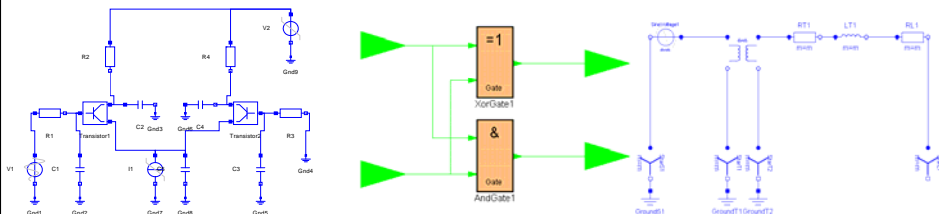


Machines



MultiPhase

Examples:



Modelica.Icons

Package with icons that can be reused in other libraries

Examples:



Info



Library1



Library2



Example



RotationalSensor



TranslationalSensor



GearIcon



MotorIcon

Modelica.Math

Package containing basic mathematical functions:

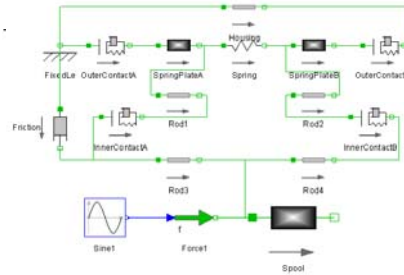
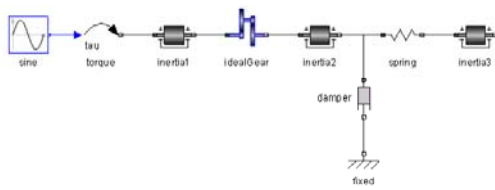
$\sin(u)$	sine
$\cos(u)$	cosine
$\tan(u)$	tangent (u shall not be: $\dots, -\pi/2, \pi/2, 3\pi/2, \dots$)
$\text{asin}(u)$	inverse sine ($-1 \leq u \leq 1$)
$\text{acos}(u)$	inverse cosine ($-1 \leq u \leq 1$)
$\text{atan}(u)$	inverse tangent
$\text{atan2}(u1, u2)$	four quadrant inverse tangent
$\sinh(u)$	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



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Modelica.SIunits

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

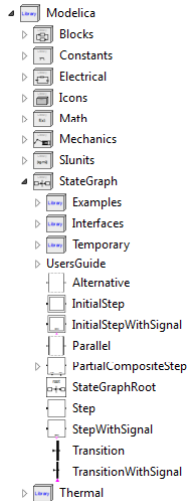
- ISO 31-1992 “General principles concerning quantities, units and symbols”
- ISO 1000-1992 “SI units and recommendations for the use of their multiples and of certain other units”.

A subpackage called `NonSIunits` is available containing non SI units such as `Pressure_bar`, `Angle_deg`, etc

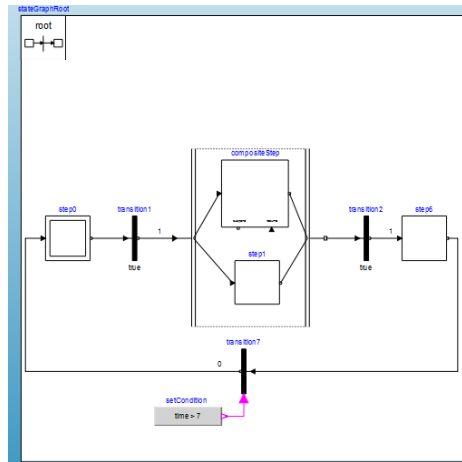
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Modelica.StateGraph



Hierarchical state machines (similar to Statecharts)



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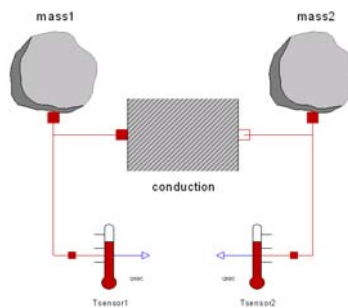


Modelica.Thermal

Subpackage `FluidHeatFlow` with components for heat flow modeling.

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

Example:



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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

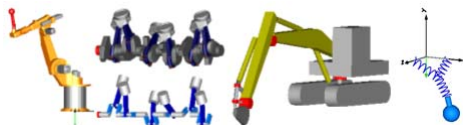
ModelicaAdditions.Multibody (OLD)

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

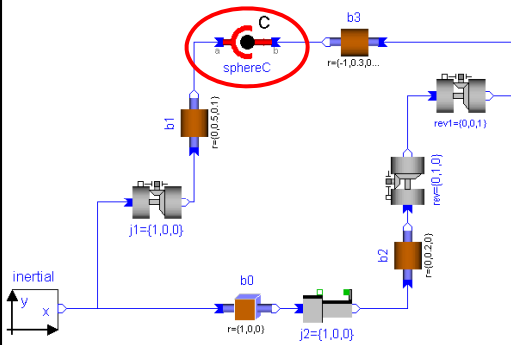
Improvements:

- Easier to use
- Automatic handling of kinematic loops.
- Built-in animation properties for all components

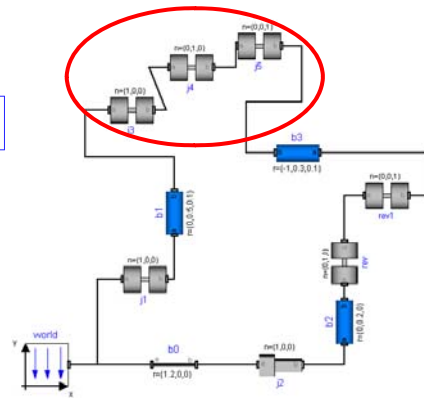


MultiBody (MBS) - Example Kinematic Loop

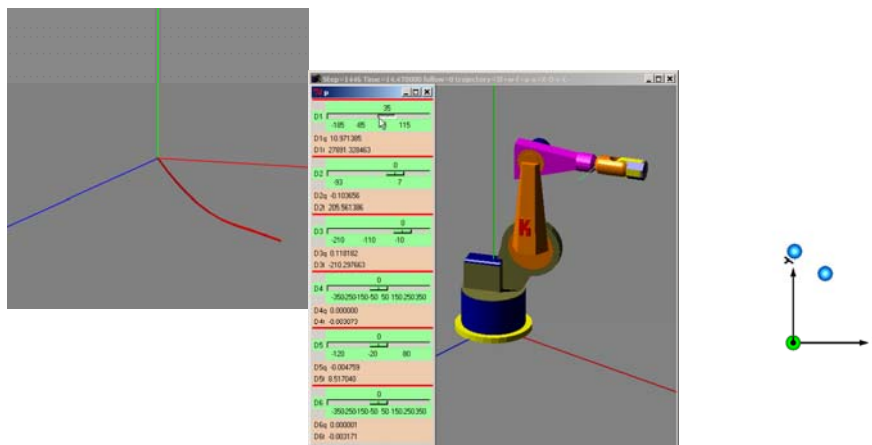
Old library
(cutjoint needed)



New library
(no cutjoint needed)



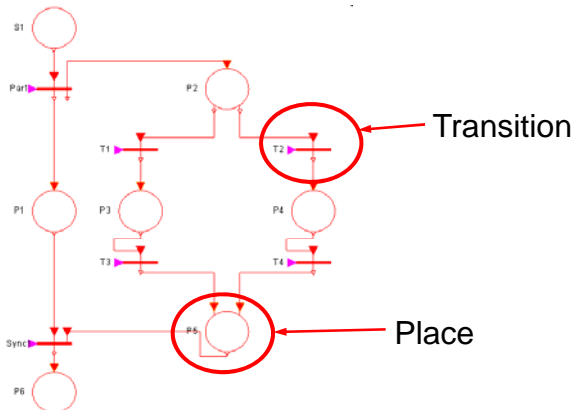
MultiBody (MBS) - Example Animations



ModelicaAdditions.PetriNets

This package contains components to model Petri nets

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

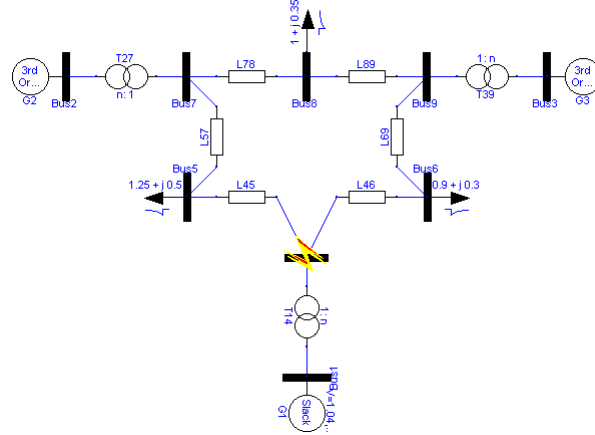


Other Free Libraries

- WasteWater Wastewater treatment plants, 2003
- ATPlus Building simulation and control (fuzzy control included), 2004
- 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



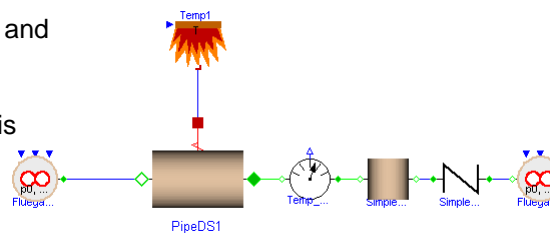
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Thermo-hydraulics Library – ThermoFluid Replaced by the New Fluid/Media Library

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).

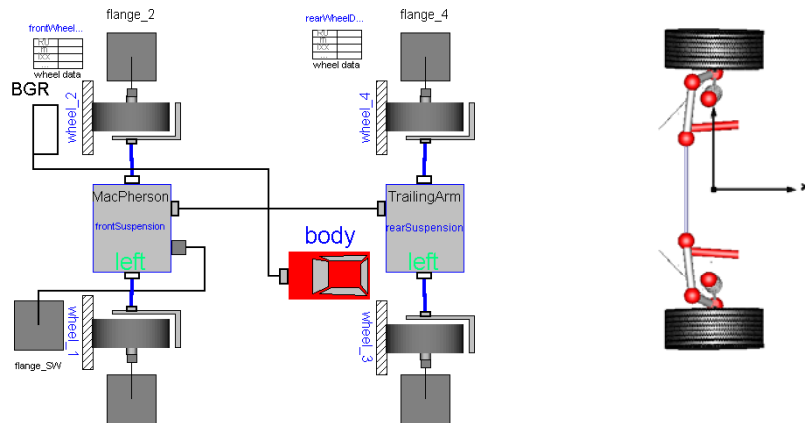


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Vehicle Dynamics Library – vehicleDynamics There is a Greatly Extended Commercial Version

This library is used to model vehicle chassis



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Some Commercial Libraries

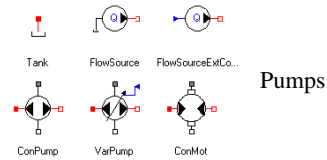
- Powertrain
- SmartElectricDrives
- VehicleDynamics
- AirConditioning
- HyLib
- PneuLib
- CombiPlant
- HydroPlant
- ...

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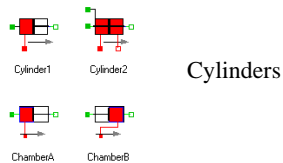
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Hydraulics Library HyLib

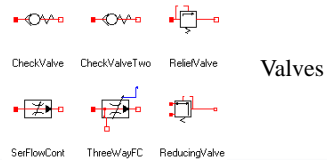
- Licensed Modelica package developed originally by Peter Beater
- More than 90 models for
 - Pumps
 - Motors and cylinders
 - Restrictions and valves
 - Hydraulic lines
 - Lumped volumes and sensors
- Models can be connected in an arbitrary way, e.g. in series or in parallel.
- HyLibLight is a free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



Pumps



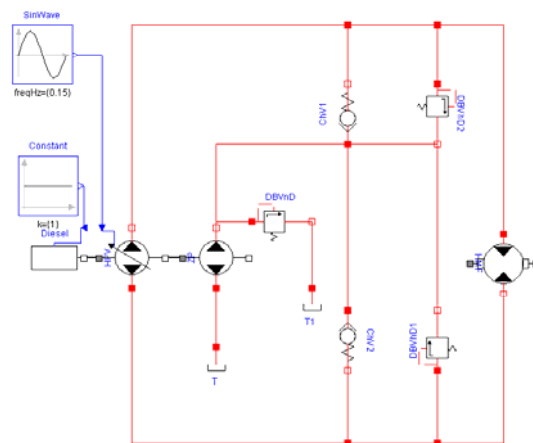
Cylinders



Valves

HyLib - Example

Hydraulic drive system with closed circuit



Pneumatics Library PneuLib

- Licensed Modelica package developed by Peter Beater

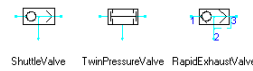
- More than 80 models for

- Cylinders
- Motors
- Valves and nozzles
- Lumped volumes
- Lines and sensors

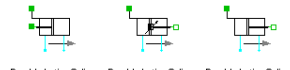
- Models can be connected in an arbitrary way, e.g. in series or in parallel.

- PneuLibLight is a free subset of HyLib.

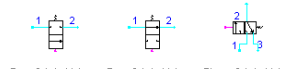
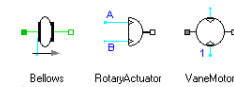
- More info: www.pneulib.com



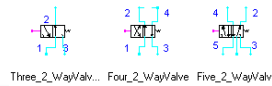
Directional valves



Flow control valves

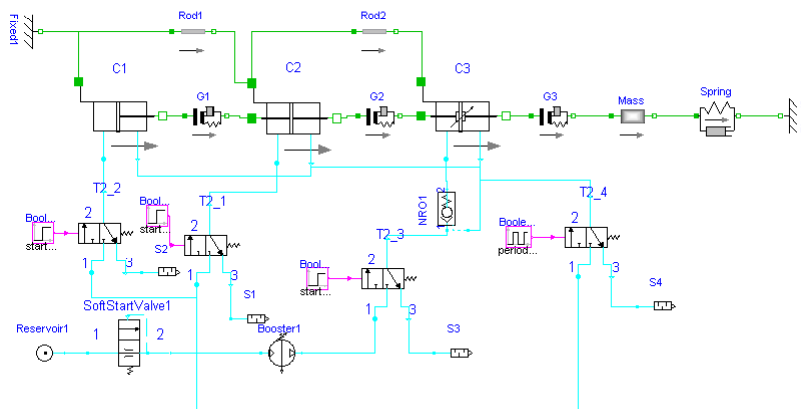


Cylinders



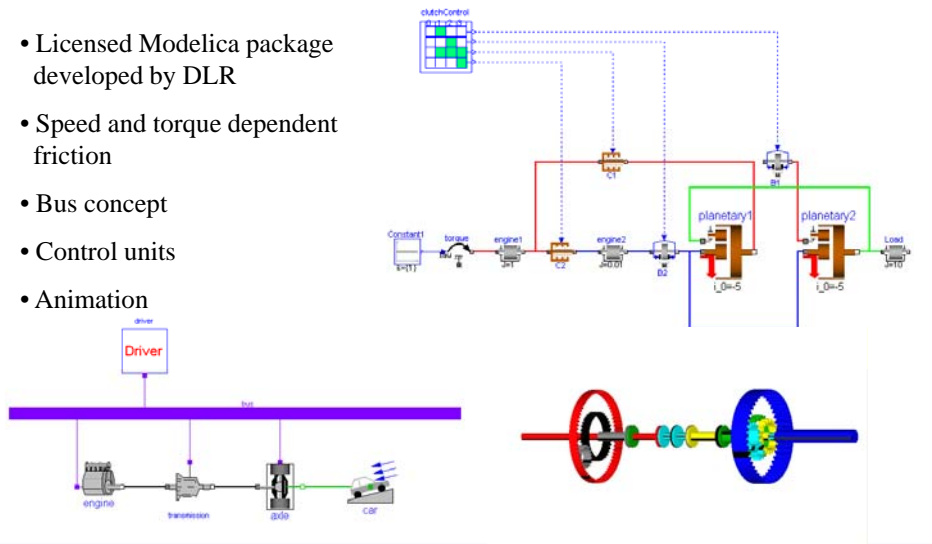
PneuLib - Example

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



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Some Modelica Applications

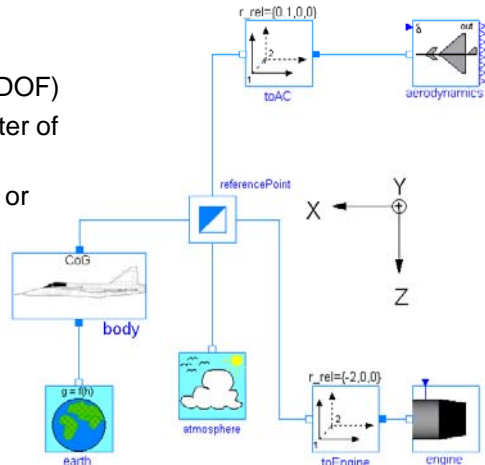
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Example Fighter Aircraft Library

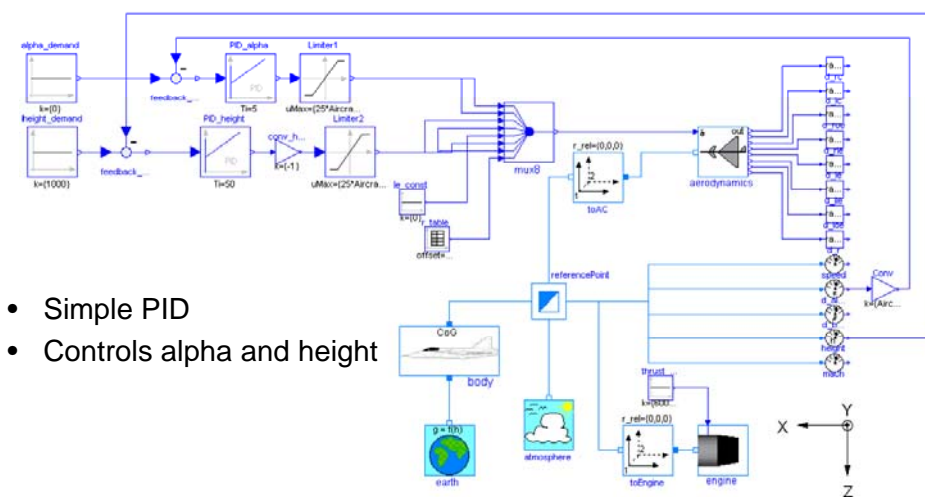
Custom made library, `Aircraft*`, for fighter aircraft applications

- 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)

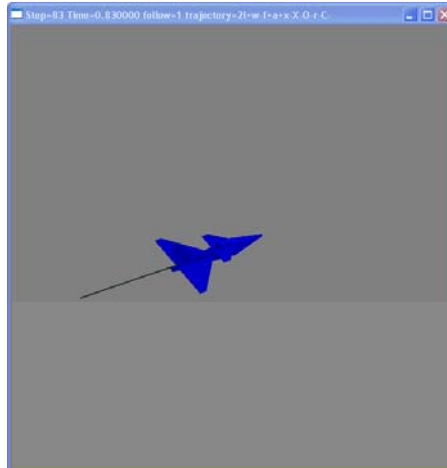
Aircraft with Controller



- Simple PID
- Controls alpha and height

Example Aircraft Animation

Animation of fighter aircraft with controller

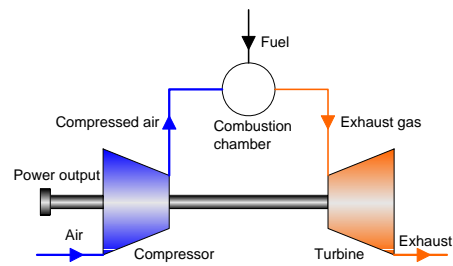


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Example Gas Turbine

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

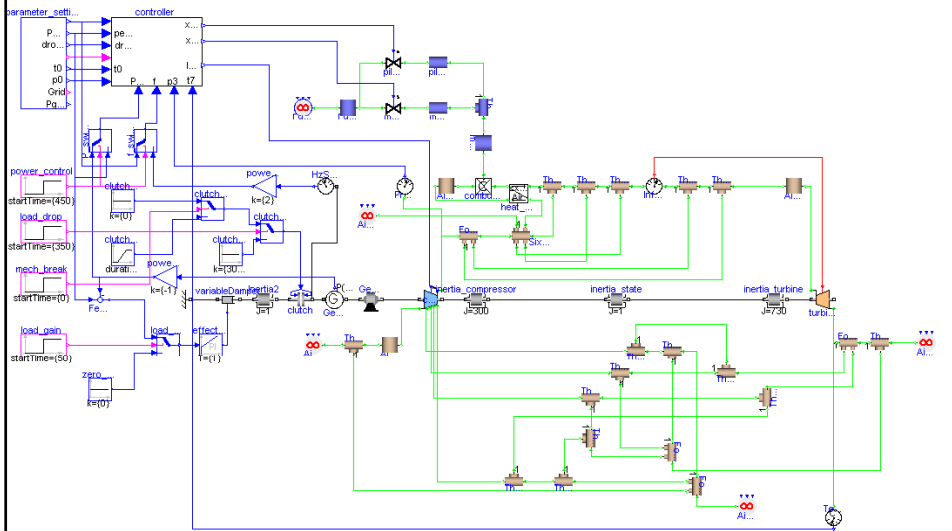


Courtesy Siemens Industrial Turbines AB

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Example Gas Turbine

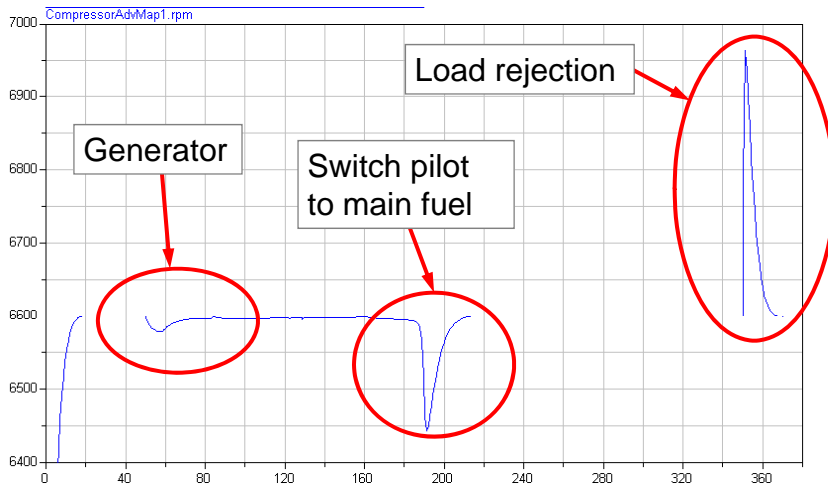


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Example Gas Turbine – Load Rejection

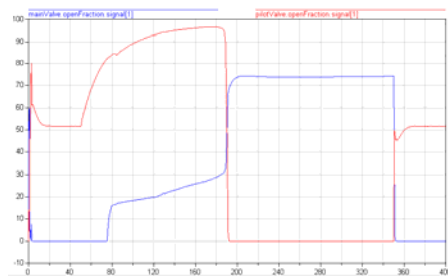
Rotational speed (rpm) of the compressor shaft



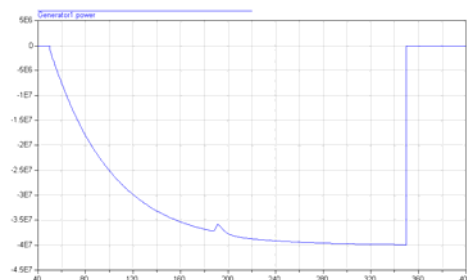
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Example Gas Turbine – Load Rejection



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



Generated power to the simulated
electrical grid