

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>.

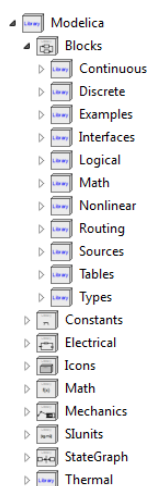
Modelica Standard Library cont'

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

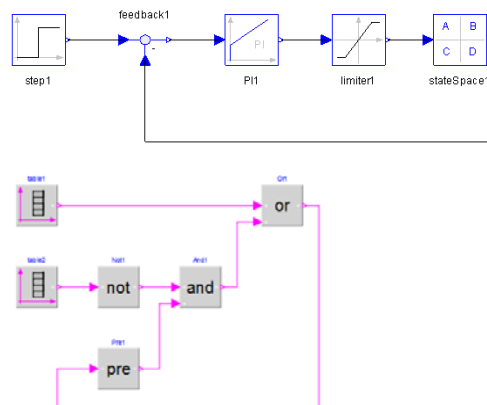
- **Blocks** Library for basic input/output control blocks
- **Constants** Mathematical constants and constants of nature
- **Electrical** Library for electrical models
- **Icons** Icon definitions
- **Fluid** 1-dim Flow in networks of vessels, pipes, fluid machines, valves, etc.
- **Math** Mathematical 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

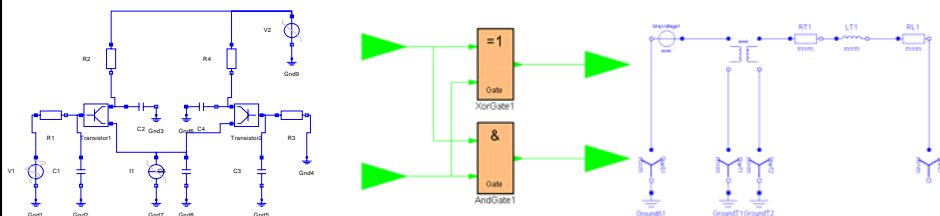


Machines



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:

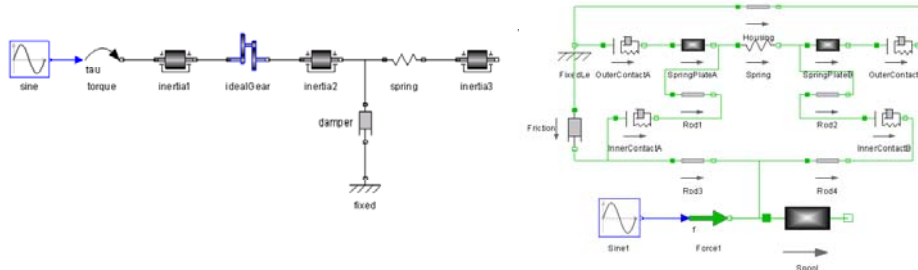
$\sin(u)$	sine
$\cos(u)$	cosine
$\tan(u)$	tangent (u shall not be: $\dots, -\pi/2, \pi/2, 3\pi/2, \dots$)
$\text{asin}(u)$	inverse sine ($-1 \leq u \leq 1$)
$\text{acos}(u)$	inverse cosine ($-1 \leq u \leq 1$)
$\text{atan}(u)$	inverse tangent
$\text{atan2}(u1, u2)$	four quadrant inverse tangent
$\sinh(u)$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



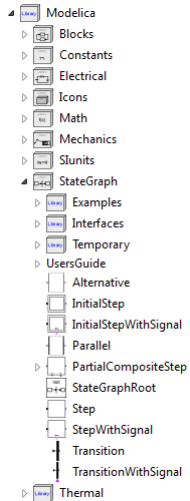
Modelica.SIunits

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

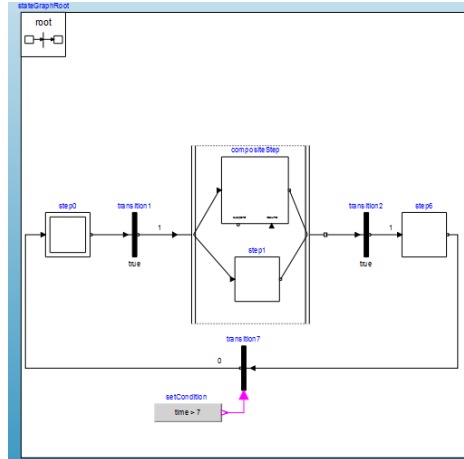
- ISO 31-1992 “General principles concerning quantities, units and symbols”
- ISO 1000-1992 “SI units and recommendations for the use of their multiples and of certain other units”.

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)

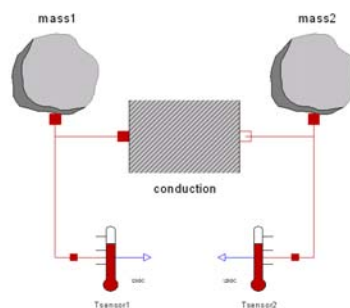


Modelica.Thermal

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

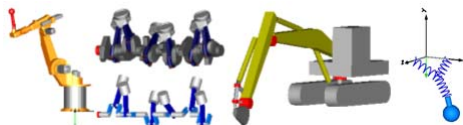
ModelicaAdditions.Multibody (OLD)

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

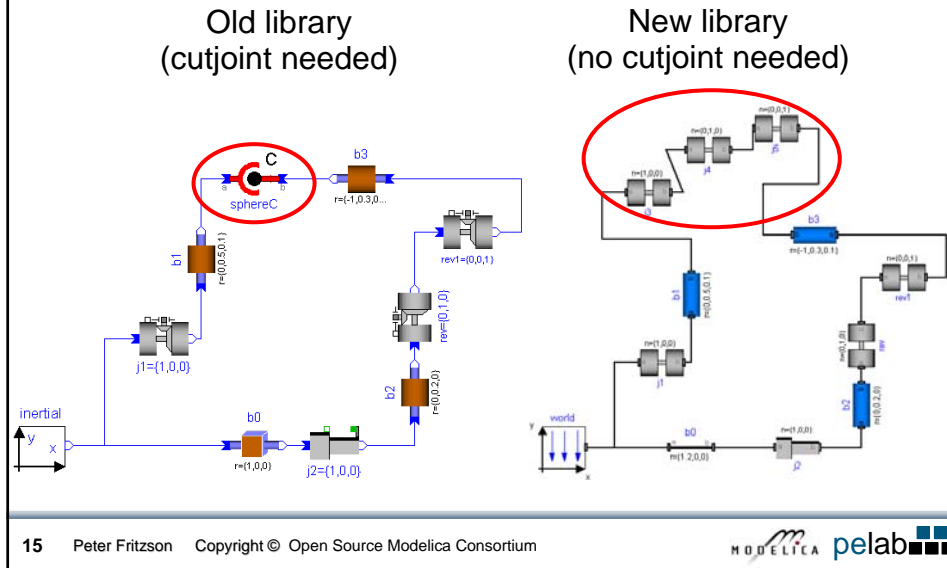
New version has been released (march 2004) that is called `Modelica.Mechanics.MultiBody` in the standard library

Improvements:

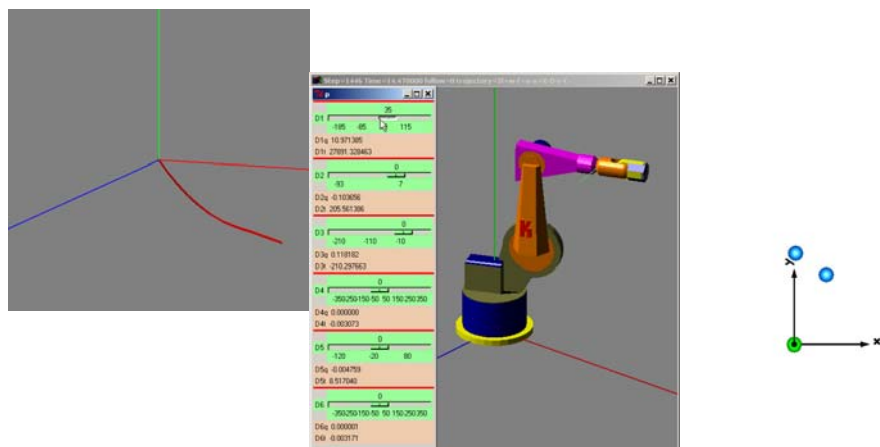
- Easier to use
- Automatic handling of kinematic loops.
- Built-in animation properties for all components



MultiBody (MBS) - Example Kinematic Loop



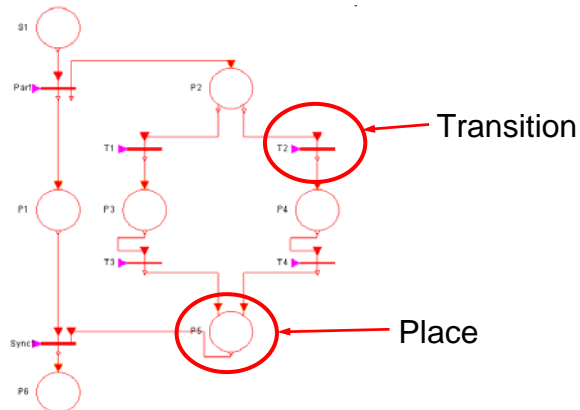
MultiBody (MBS) - Example Animations



ModelicaAdditions.PetriNets

This package contains components to model Petri nets

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

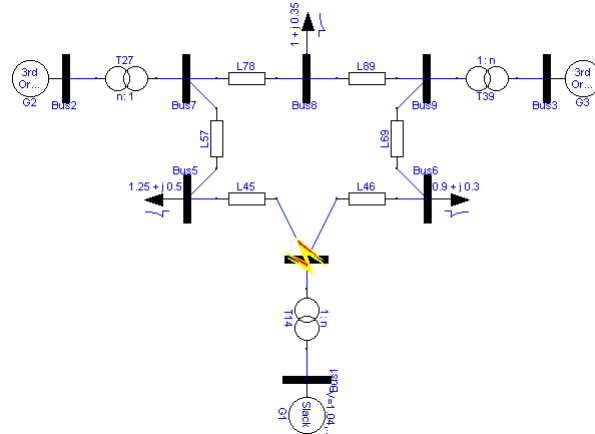


Other Free Libraries

- 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

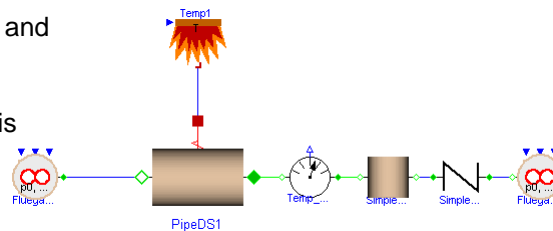
The SPOT package is a Modelica Library for Power Systems Voltage and Transient stability simulations



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

ThermoFluid is a Modelica base library for thermo-hydraulic models

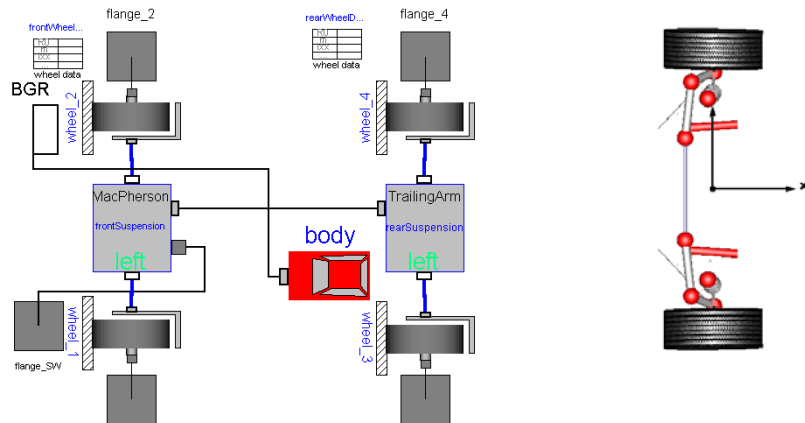
- Includes models that describe the basic physics of flows of fluid and heat, medium property models for water, gases and some refrigerants, and also simple components for system modeling.
- Handles static and dynamic momentum balances
- Robust against backwards and zero flow
- The discretization method 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
- ...

Pneumatics Library PneuLib

- Licensed Modelica package developed by Peter Beater

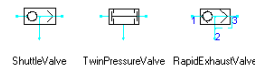
- More than 80 models for

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

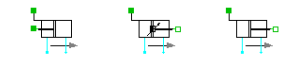
- Models can be connected in an arbitrary way, e.g. in series or in parallel.

- PneuLibLight is a free subset of HyLib.

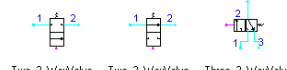
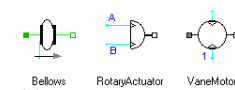
- More info: www.pneulib.com



Directional valves



Flow control valves

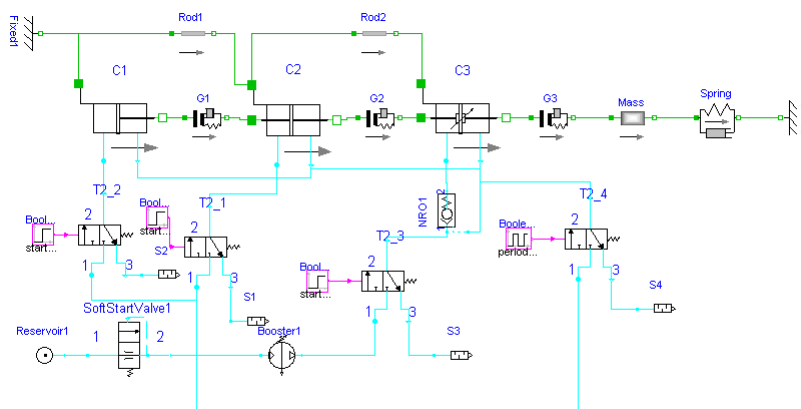


Cylinders



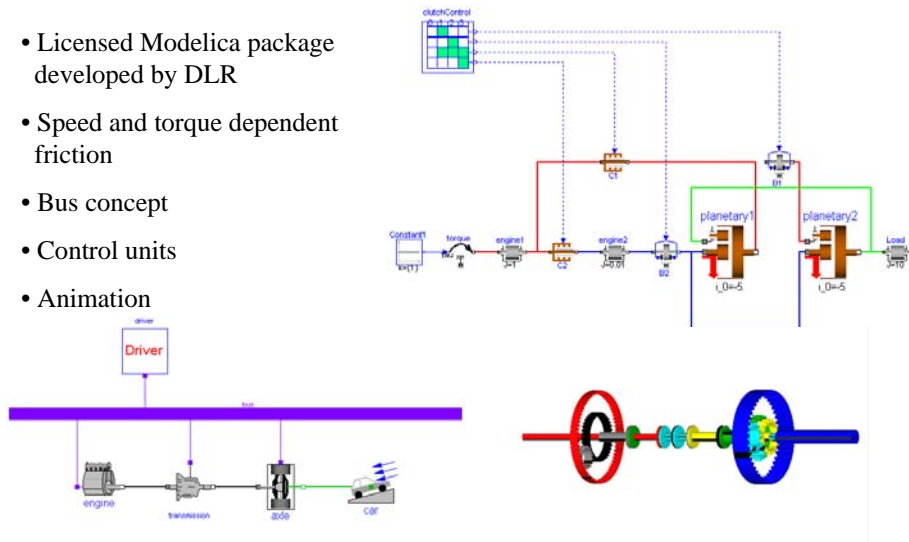
PneuLib - Example

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



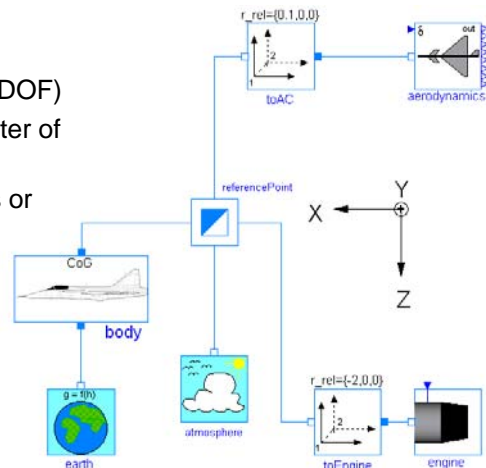
Some Modelica Applications

Example Fighter Aircraft Library

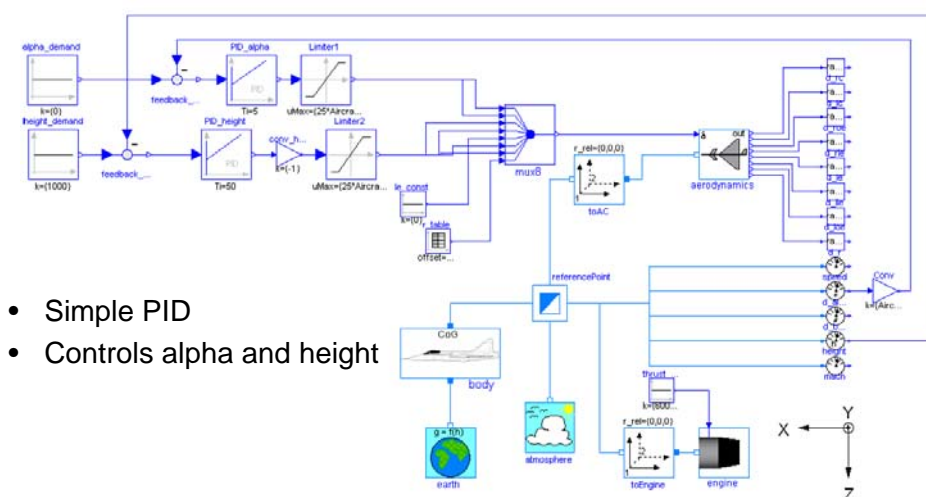
Custom made library, Aircraft*, for fighter aircraft applications

- 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)



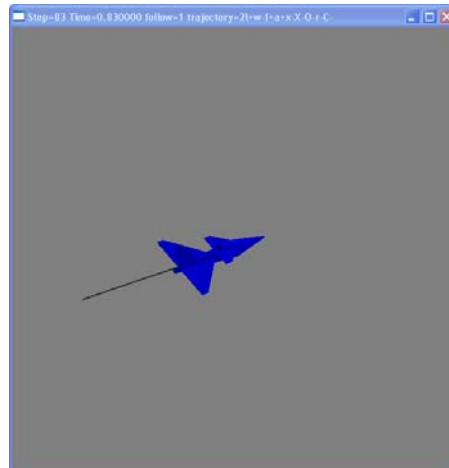
Aircraft with Controller



- Simple PID
- Controls alpha and height

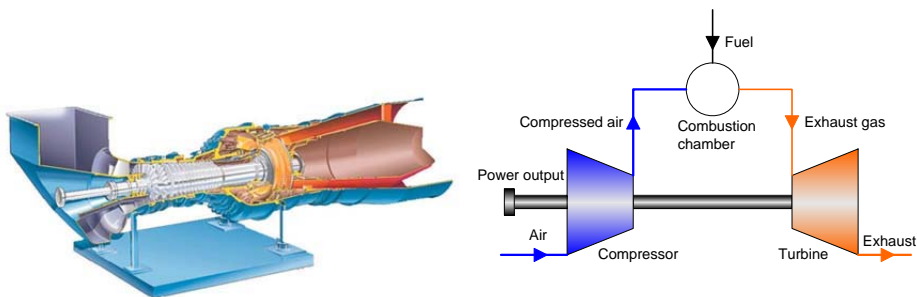
Example Aircraft Animation

Animation of fighter aircraft with controller



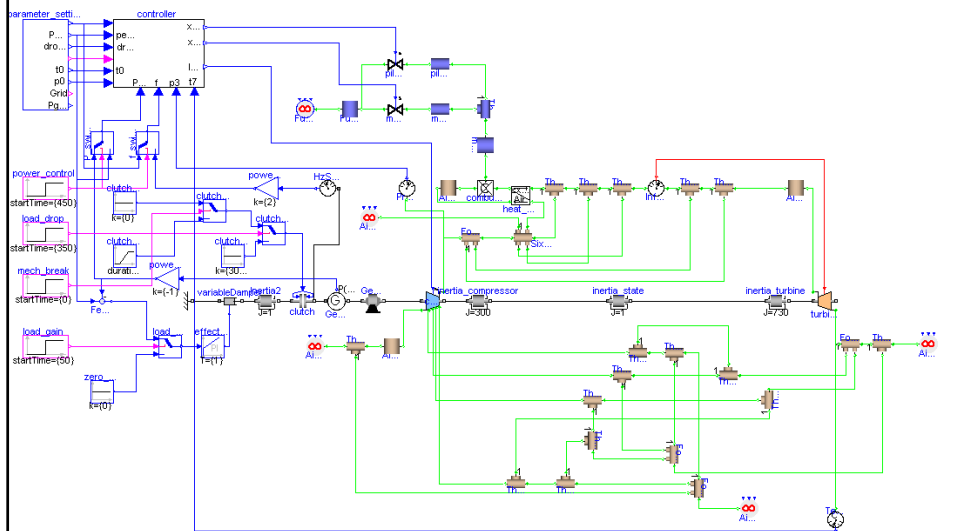
Example Gas Turbine

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



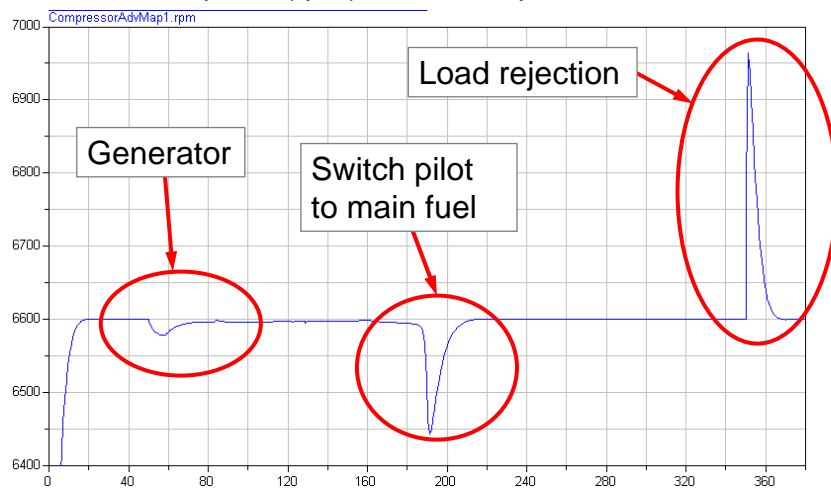
Courtesy Siemens Industrial Turbines AB

Example Gas Turbine

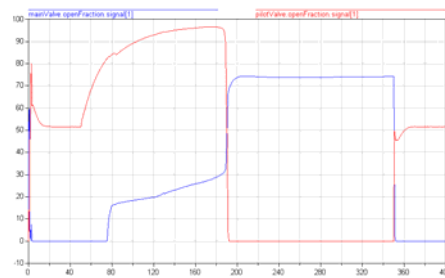


Example Gas Turbine – Load Rejection

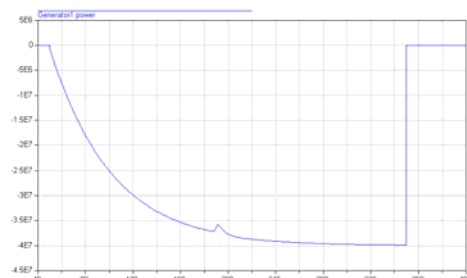
Rotational speed (rpm) of the compressor shaft



Example Gas Turbine – Load Rejection



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



Generated power to the simulated
electrical grid