Modeling Power Electronics in Dymola 5

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Outline

• Dymola/Modelica overview
• Interface and basic operation
• Text based model example
• Component creation
• Half wave rectifier example
• Controlled 2-output flyback converter
Modelica/Dymola

- Modelica is the underlying modeling language used in the Dymola Software package
- The Modelica language allows differential equation models to be built without state form, from which state equations are derived automatically
- Dymola allows Modelica models to carry a graphical form, and also provides integration algorithms for use with the models

- [http://www.modelica.org/](http://www.modelica.org/)
- [http://www.dynasim.de/](http://www.dynasim.de/)
Dymola Modeling Interface
Modeling Window

• Library Tree
  – Selects active Model
  – Components can be dragged into active Model’s Diagram

• Icon
  – Graphic used when placing in other models

• Diagram
  – Graphical Internal Model

• Modelica Text
  – Contains all information about Icon, Diagram,
  – and Documentation when text is expanded
Transorb Icon

name
Transorb Diagram
Experiment Setup (General)
Experiment Setup (Output)
connector Pin
  Real v;
  flow Real i;
end Pin;
partial model OnePort
Real v;
Real I;
Pin p;
Pin n;
equation
  v = p.v - n.v;
  0 = p.i + n.i;
  i = p.i;
end OnePort;
model DiodeCV
  extends Modelica.Electrical.Analog.Interfaces.OnePort;
  parameter Real Goff=1e-5;
  parameter Real Ron=1e-5;
  parameter Real Von=0.5;
  parameter Real Ion=Von*Goff;
  Boolean off(start=true);
protected
  Real s "Auxiliary variable";

equation
  off = s < 0;
  v - Von = s*(if off then 1 else Ron);
  i - Ion = s*(if off then Goff else 1);
end DiodeCV;
Starting a Package

• Return to Modeling interface
• Select File->New ->Package
• Enter name “DymolaTutorial” and leave all other entries blank.
• Check Save Package as single file and click OK
• Now double click the new package in the Library Tree and click save to save the new file
Starting a Model

• Right-click on package DymolaTutorial and select Edit->New Class in Package->new Model.
• Enter Name “BouncingBall” and be sure that the model is inserted in package “DymolaTutorial”
• To begin editing the BouncingBall, double click on the model in the Library Tree
• Enter Text Modeling mode
model BouncingBall

Real x(unit="m");
Real y(unit="m");
Real dx(unit="m/s", start=3);
Real dy(unit="m/s", start=10);
parameter Real g(unit="m/s^2") = 9.8;

parameter Real c=0.9 "Coefficient of elasticity";
Bouncing Ball Simulation (2)

equation

\[ \text{der}(x) = \text{dx}; \]
\[ \text{der}(dx) = 0; \]
\[ \text{der}(y) = \text{dy}; \]
\[ \text{der}(dy) = -g; \]

when \((y) < 0\) then

\[ \text{reinit}(dy, -c*dy); \]

end when;

end BouncingBall;
Bouncing Ball (3)

- Integration Options:
  - Start Time: 0
  - Stop Time: 20
  - Intervals: 5000

- Click store in model.

- Now try Plotting some variables such as y by clicking on them in the Variable list.

- Also try right clicking on x and selecting independent variable as x, then click on y to plot y(x)
Half Wave Rectifier Circuit (1)
Half Wave Rectifier Circuit (2)

- Components Needed:
    - V=170  Freq=60Hz
    - L=10e-3 H
    - C=10e-6 F
    - R=1 ohm
  - NB_Lib.Switches.Diode_CV
    - Ron=1e-5, Goff=1e-5, Von=0.8
Half Wave Rectifier Circuit (3)

• Integration Options:
  – Start Time: 0
  – Stop Time: 0.2
  – Intervals: 5000
  – Algorithm: Dassl

• Click store in model.
Half Wave Rectifier Circuit (4)
Controlled 2 Output FB (1)
Controlled 2 Output FB (2)

• Components Needed:
    • V=48
    • C1=500e-6 F, C2=500e-6 F
    • R=10 ohm, R2=2 ohm
  – Modelica.Blocks.Sources.Constant
    • K=5
Controlled 2 Output FB (3)

Components Needed (cont):

- NB_Lib.Passive.Transformer_3wind
  - L11=180e-6, L12=112e-6, L13=41e-6, L22=73e-6,
  - L23=25.5e-6, L33=9.77e-6
- NB_Lib.Switches.SwitchIdeal
  - Ron=1e-5, Goff=1e-5, Vth = 0.0001
- NB_Lib.Switches.Diode_CV
  - Ron=1e-5, Goff=1e-5, Von=0.8
- NB_Lib.Controllers.PWM_Controller
  - F=75e3 Hz, Von=1
- NB_Lib.Controllers.PI_Controller
  - kp=0.1, ki=50, LowLim=0.05, HighLim=0.95,
  - non-inv (1)