

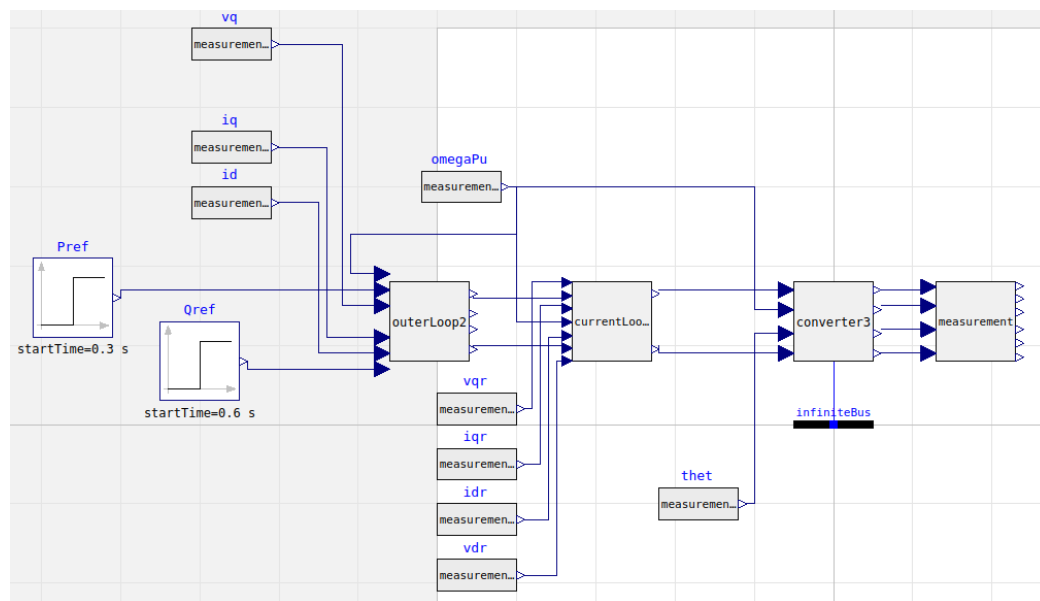
Chapter 2

A VSC model is implemented and tested. The issues encountered with Dynawo are summarized.

Chapter 2

PQ set point tracking

A VSC model (same as the phasor VSC model from Vinicius in Simulink) is implemented in Modelica. For a better comparison of the VSC control, the converter terminal is simply connected to an infinite bus.



The model is correctly built. At compilation, there is the same number of equations as variables. In OpenModelica, the simulation works fine.

The problem occurs when the solver starts to handle the global initialisation of the model. It is not an initial equations issue; the initial equations are related only to the initial variables. The default linear solver is KLU. The other alternative is to use NICSLU but it is not recognised?? the linear solver name provided is not valid (DYNolverKINCommon.cpp:154). Ten more variables than equations.

Using IDA solver

```

1 2021-02-24 20:10:10 | INFO | =====
2 2021-02-24 20:10:10 | INFO | DYNAWO VERSION : 1.3.0
3 2021-02-24 20:10:10 | INFO | DYNAWO REVISION : master-7d6aa438
4 2021-02-24 20:10:10 | INFO | =====
5 2021-02-24 20:10:10 | INFO |
6 2021-02-24 20:10:10 | INFO | -----
7 2021-02-24 20:10:10 | INFO | building model from input files
8 2021-02-24 20:10:10 | INFO | -----
9 2021-02-24 20:10:48 | INFO | model was built successfully
10 2021-02-24 20:10:48 | INFO | -----
11 2021-02-24 20:10:48 | INFO |
12 2021-02-24 20:10:48 | INFO | -----
13 2021-02-24 20:10:48 | INFO | starting local initialization
14 2021-02-24 20:10:48 | INFO | -----
15 2021-02-24 20:10:48 | INFO | end of local initialization
16 2021-02-24 20:10:48 | INFO | -----
17 2021-02-24 20:10:48 | INFO |
18 2021-02-24 20:10:48 | INFO | -----
19 2021-02-24 20:10:48 | INFO | starting global initialization
20 2021-02-24 20:10:48 | INFO | -----
21 2021-02-24 20:10:48 | ERROR | variables number 72 not equals to the equations number 62 ( DYNsSolverImpl.cpp:116 )

```

(DYNsSolverImpl.cpp:116)

// Problem size

// -----

// Continuous variables

int nbEq = model->sizeY(); *nbEq == number of equations, sizeY() and sizeF() ??*

if (nbEq != model->sizeF())

throw DYNErrors(Error::SUNDIALS_ERROR, SolverYvsF, nbEq, model->sizeF());

Using simplified solver

error during the call of KINSOL's function (SUNLinSol_KLU) (DYNsSolverKINCommon.cpp:140)

if (linearSolverName_ == "KLU") {

LS_ = SUNLinSol_KLU(yy_, M_); *meaning LS_ = 0 ??*

if (LS_ == NULL)

throw DYNErrors(Error::SUNDIALS_ERROR, SolverFuncErrorKINSOL, "SUNLinSol_KLU");

SUNLinearSolver LS_; ///< Linear Solver pointer

SUNMatrix M_; ///< sparse SUNMatrix

N_Vector yy_; ///< variables values stored in Sundials structure

Possible solutions thoughts

- Regarding the dyd file

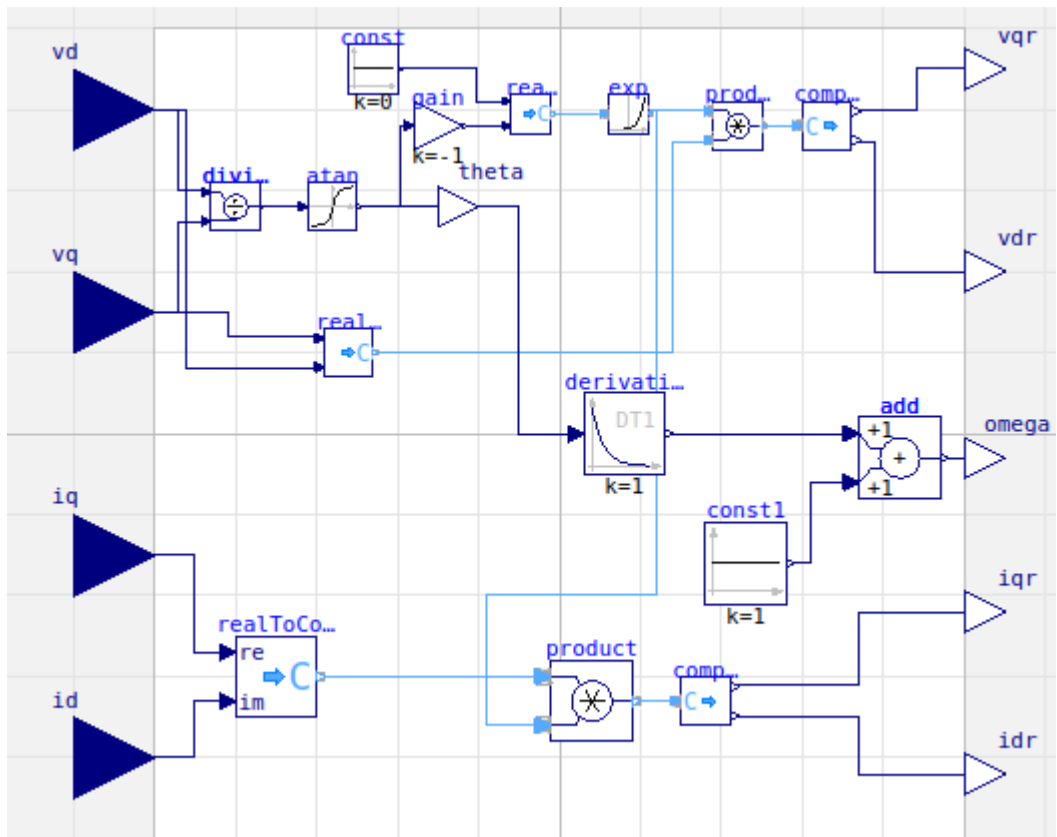
i) We have tried several ways to write the dyd file regarding control loops' connections – converter, same compilation. Ok

ii) To check if it happened the same with the Dynawo Modelica models library, we have tried to simulate in Dynawo the GridForming Modelica model example from the Dynawo Modelica library. However, we observe the same 'kind of' issue. Maybe we should consider the *iidm* file to complete the remaining needed equations?

```
*dynawo.log
1 2021-03-05 15:06:04 | INFO | =====
2 2021-03-05 15:06:04 | INFO | DYNAWO VERSION : 1.3.0
3 2021-03-05 15:06:04 | INFO | DYNAWO REVISION : master-7d6aa438
4 2021-03-05 15:06:04 | INFO | =====
5 2021-03-05 15:06:04 | INFO |
6 2021-03-05 15:06:04 | INFO | -----
7 2021-03-05 15:06:04 | INFO | building model from input files
8 2021-03-05 15:06:04 | INFO | -----
9 2021-03-05 15:06:04 | INFO | model was built successfully
10 2021-03-05 15:06:04 | INFO | -----
11 2021-03-05 15:06:04 | INFO |
12 2021-03-05 15:06:04 | INFO | -----
13 2021-03-05 15:06:04 | INFO | starting local initialization
14 2021-03-05 15:06:04 | INFO | -----
15 2021-03-05 15:06:04 | DEBUG | -----
16 2021-03-05 15:06:04 | DEBUG | starting local initialization of model Droop
17 2021-03-05 15:06:04 | DEBUG | local initialization of model Droop ended successfully
18 2021-03-05 15:06:04 | DEBUG | -----
19 2021-03-05 15:06:04 | DEBUG | starting local initialization of model Load
20 2021-03-05 15:06:04 | DEBUG | local initialization of model Load ended successfully
21 2021-03-05 15:06:04 | DEBUG | -----
22 2021-03-05 15:06:04 | DEBUG | starting local initialization of model Matching
23 2021-03-05 15:06:04 | DEBUG | local initialization of model Matching ended successfully
24 2021-03-05 15:06:04 | DEBUG | -----
25 2021-03-05 15:06:04 | DEBUG | starting local initialization of model dVOC
26 2021-03-05 15:06:04 | DEBUG | local initialization of model dVOC ended successfully
27 2021-03-05 15:06:04 | INFO | end of local initialization
28 2021-03-05 15:06:04 | INFO | -----
29 2021-03-05 15:06:04 | INFO |
30 2021-03-05 15:06:04 | INFO | -----
31 2021-03-05 15:06:04 | INFO | starting global initialization
32 2021-03-05 15:06:04 | INFO | -----
33 2021-03-05 15:06:04 | ERROR | variables number 310 not equals to the equations number 323 ( DYNsSolverImpl.cpp:116 )
```

- Regarding the VSC modelling.

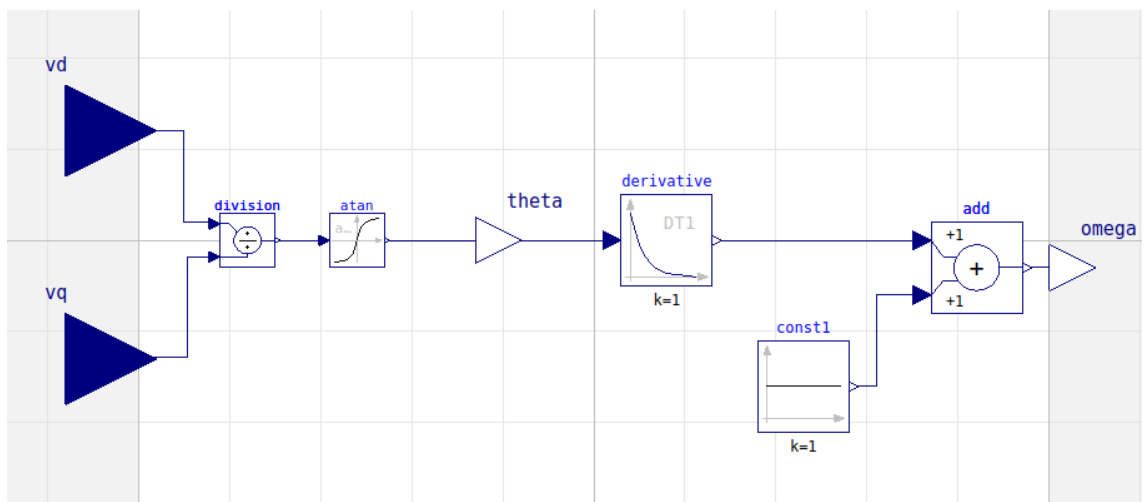
If we change the 'measurements block' (used to align the *vd* component at 0, we are using the *qd0* reference frame) for the two following alternatives, we can run the simulation. However, the goal is to compare the same models in Simulink and Dynawo. To validate the Modelica models, both models must be the same.



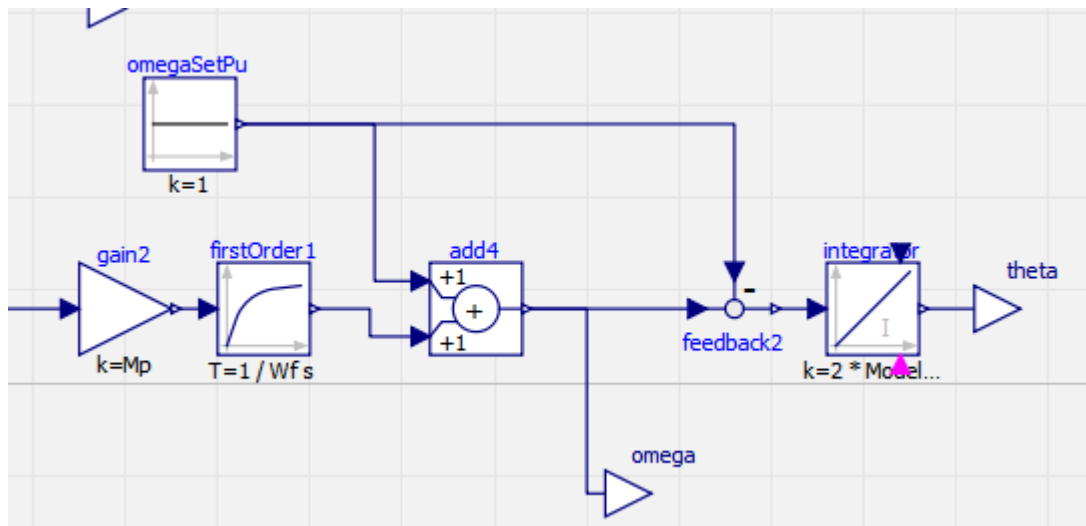
i) Measure ω and θ and calculate the active and reactive power as:

$$P = v_q \cdot i_q + v_d \cdot i_d$$

$$Q = v_q \cdot i_d - v_d \cdot i_q$$



ii) Consider a frequency droop due to $(P_{ref} - P_{measured})$ to recalculate ω and θ .



iii) written equations alternative to RealToComplex/ComplexToReal blocks. In OpenModelica, both models are equivalent.

```

1  model Measurements2
2  import Modelica;
3  import ComplexMath;
4  Modelica.Blocks.Interfaces.RealOutput iqr annotation(
5  Modelica.Blocks.Interfaces.RealInput vd annotation(
6  Modelica.Blocks.Interfaces.RealOutput vdr annotation(
7  Modelica.Blocks.Interfaces.RealOutput idr annotation(
8  Modelica.Blocks.Interfaces.RealInput iq annotation(
9  Modelica.Blocks.Interfaces.RealInput id annotation(
10 Modelica.Blocks.Interfaces.RealOutput vqr annotation(
11 Modelica.Blocks.Interfaces.RealInput vq annotation(
12 Modelica.Blocks.Interfaces.RealOutput omega annotation(
13 Modelica.Blocks.Interfaces.RealOutput theta annotation(
14
15  Complex v;
16  Complex i;
17  Complex pv;
18  Complex pi;
19
20  equation
21  v = Complex(vq,vd);
22  i = Complex(iq,id);
23
24  if vd == 0 and vq == 0 then
25    theta = 0;
26    pv = v * Modelica.ComplexMath.exp(-Complex(0,1)*theta);
27    vqr = Modelica.ComplexMath.real(pv);
28    vdr = Modelica.ComplexMath.imag(pv);
29    pi = i * Modelica.ComplexMath.exp(-Complex(0,1)*theta);
30    iqr = Modelica.ComplexMath.real(pi);
31    idr = Modelica.ComplexMath.imag(pi);
32    omega = der(theta) + 1;
33
34  else
35    theta = Modelica.Math.atan(vd/vq);
36    pv = v * Modelica.ComplexMath.exp(-Complex(0,1)*theta);
37    vqr = Modelica.ComplexMath.real(pv);
38    vdr = Modelica.ComplexMath.imag(pv);
39    pi = i * Modelica.ComplexMath.exp(-Complex(0,1)*theta);
40    iqr = Modelica.ComplexMath.real(pi);
41    idr = Modelica.ComplexMath.imag(pi);
42    omega = der(theta) + 1;
43
44  end if
45  annotation(
46  end Measurements2;

```

- Change from Dynawo 1.3.0 master-7d6aa438 to Dynawo 1.3.0 master-a5ca9fee. The simulation also fails.

- Could be that the RealToComplex/ComplexToReal are not supported by the linear solver yet, changed to 'written' equations measurements block. The solver is initialized correctly but the simulation also fails. In OpenModelica the simulation executes successfully both with 'written equations' and using RealToComplex/ComplexToReal blocks.

```

1 2021-03-18 10:40:55 | INFO | =====
2 2021-03-18 10:40:55 | INFO | DYNAMO VERSION : 1.3.0
3 2021-03-18 10:40:55 | INFO | DYNAMO REVISION : master-a5ca9fee
4 2021-03-18 10:40:55 | INFO | =====
5 2021-03-18 10:40:55 | INFO |
6 2021-03-18 10:40:55 | INFO | -----
7 2021-03-18 10:40:55 | INFO | building model from input files
8 2021-03-18 10:40:55 | INFO | -----
9 2021-03-18 10:41:52 | INFO | model was built successfully
10 2021-03-18 10:41:52 | INFO | -----
11 2021-03-18 10:41:52 | INFO |
12 2021-03-18 10:41:52 | INFO | -----
13 2021-03-18 10:41:52 | INFO | starting local initialization
14 2021-03-18 10:41:52 | INFO | -----
15 2021-03-18 10:41:52 | INFO | end of local initialization
16 2021-03-18 10:41:52 | INFO | -----
17 2021-03-18 10:41:52 | INFO |
18 2021-03-18 10:41:52 | INFO | -----
19 2021-03-18 10:41:52 | INFO | starting global initialization
20 2021-03-18 10:41:52 | INFO | -----
21 2021-03-18 10:41:52 | DEBUG | initialization of SIM solver : ok
22 2021-03-18 10:41:52 | DEBUG | calculate initial condition of the DAE
23 2021-03-18 10:41:52 | DEBUG | Algebraic mode change for model CONVERTER at t = 0
24 2021-03-18 10:41:52 | INFO | Algebraic mode change at t = 0
25 2021-03-18 10:41:52 | ERROR | the number of algebraic/differential variables is different from the number of algebraic/differential equations in the
simulated problem ( DYNsSolverKINAlgRestoration.cpp:149 )

```