Flux Activate coupling Induction Motor Scalar Control

2D Multiphysics Summary

Introduction

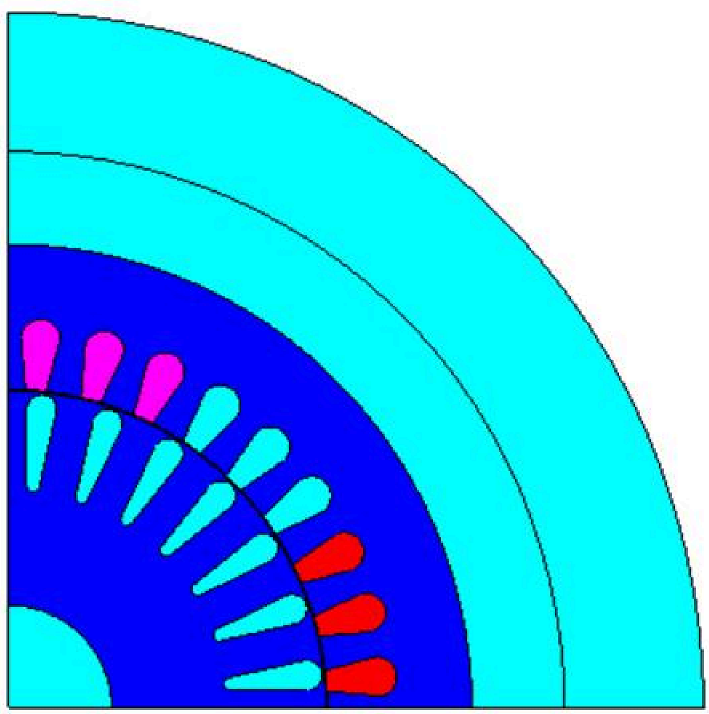
This document describes Flux-Activate coupling on the example of induction motor.

Keywords

Applications	Flux main functions
Transient Magnetic	Co-Simulation Induction motor

Studied device

Our sample problem consists of a 4-pole, 3-phase, 36-slot, 28-bar induction motor. Because of the motor's periodicity, we will model only ¼ of it (1 pole). Our model consists of 9 stator slots and 7 rotor bars. The air-gap is set to 0.25 mm.



Aim and steps

Aim

The aim of this coupling is to do a cosimulation between Flux and Activate. Activate serves to make the system part.

Action	Software
Device modeling	Altair Flux™
Generate the coupling component for Activate	Altair Flux™
Create the Flux connector	ACTIVATE
Solve the problem	ACTIVATE

Steps

The different steps to realize this coupling are shown in the table below:

Phase	Software	Description
1	Flux	Flux project preparation: • Model description: geometry, mesh and physics • Specific description : creation of the input/output parameters required for the coupling • Generate the coupling component for Activate
2	Activate	Activate opening: • Preparation of the Activate model
3	Activate / Flux	Solve the problem
4	Activate / Flux	Post Processing

Flux model

The first step is to prepare the Flux project:

- The geometry, mesh the device and the physics description (materials, regions, non-mesh coils, mechanical sets…) and circuit.
- We create the input and output parameter that we use to generate the coupling element between Flux and Activate
- Generate the coupling element

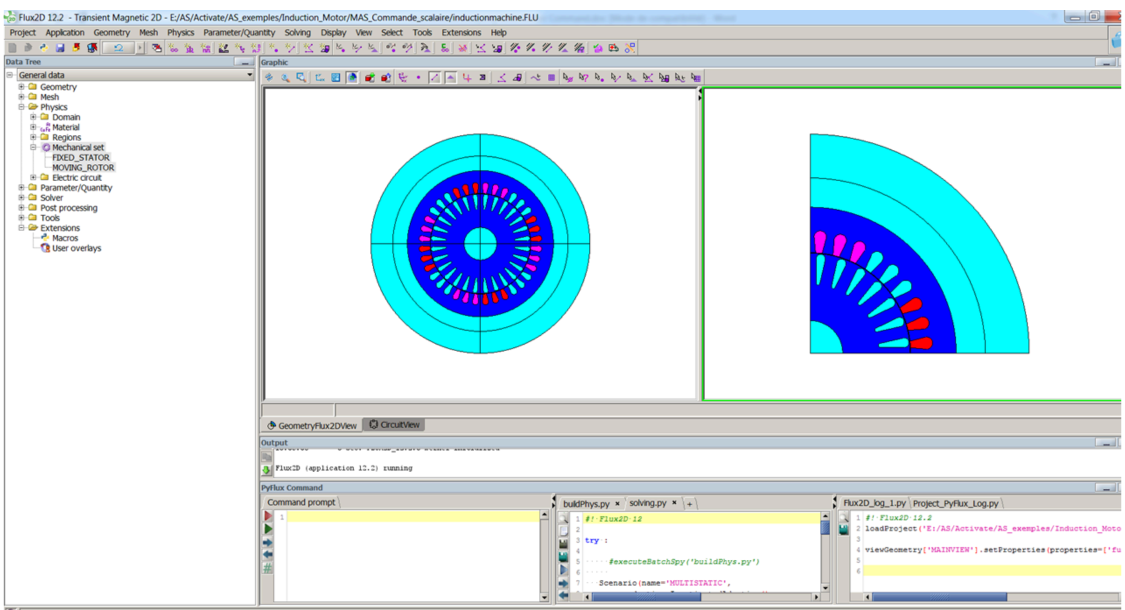
The motor is driven with a 2 phase's voltage source and running at coupled load. To do it we use the scalar control. The principle of this type of control is to adjust the motor speed V_s by varying the output frequency f_s such as the magnetic state of the machine is about fixed, through the preservation of Φ_s in a constant value, and such as the torque follows the wished law of variation according to the speed. This type of command does not allow to control the electric and magnetic transients, thus it must be operated only for laws of control with slow dynamics for which we can consider that the machine keeps on electric and magnetic steady state.

The simplicity of this type of control favors its implementation in many industrial variators conceived for these types of application. Indeed, it is characterized by a simplified structure, but requiring a speed sensor and a speed controller for position servo-control.

The simulated motor performances are used to compute shaft torque, current, speed and bar current.

Flux model: detailed steps

In the first step we create the geometry, mesh and physics. To do it, we open the project: inductionmachine.FLU.



We create input and output parameters

1. Inputs:

   Multi-Physical I / O Parameters: this allows, via formulas to pilot:

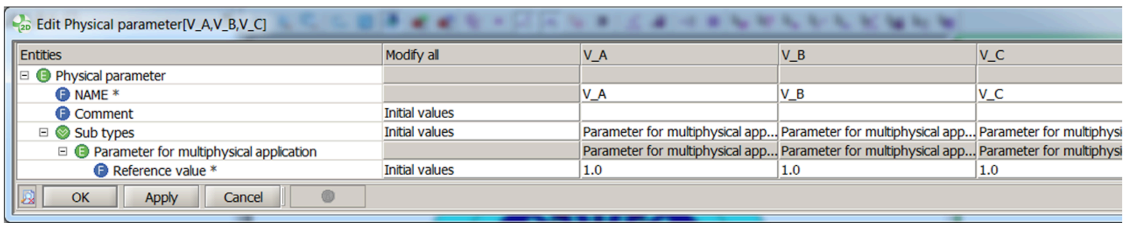
   - the physical quantities: μr, Bs, Br etc.
   - electrical quantities: resistance, voltage, current etc.
   - mechanical quantities: position, speed, resistant force, resistive torque etc.

2. Outputs:

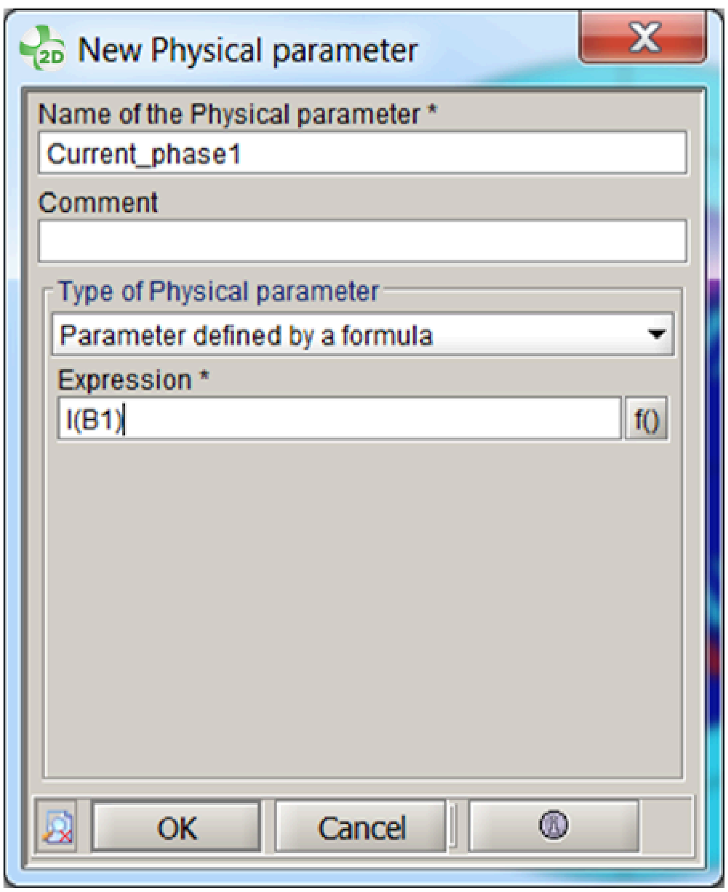
   Scalar I / O Settings: this allows, via sensors, formulas, parameters to retrieve the values

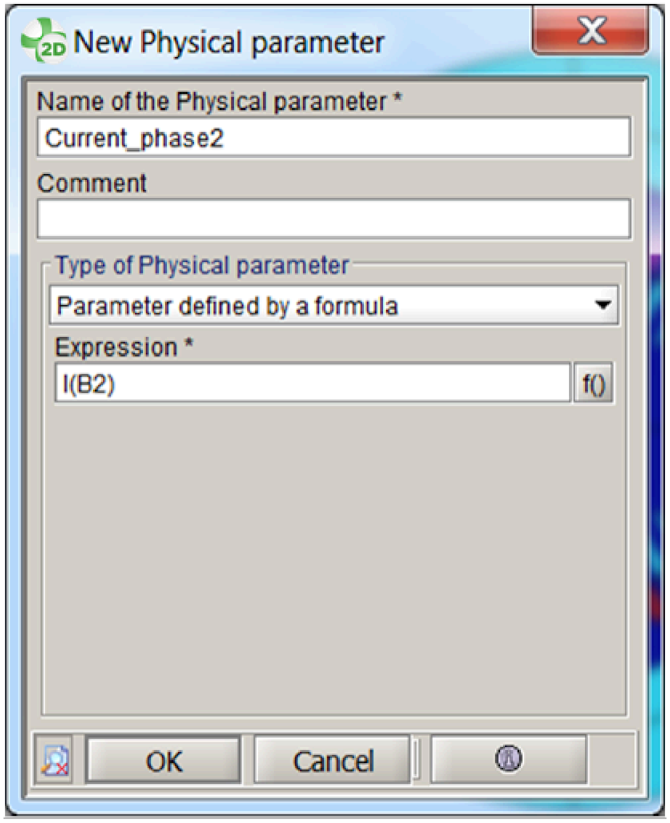
   - of sensors
   - of forces, couples etc.
   - positions, speeds, accelerations etc.

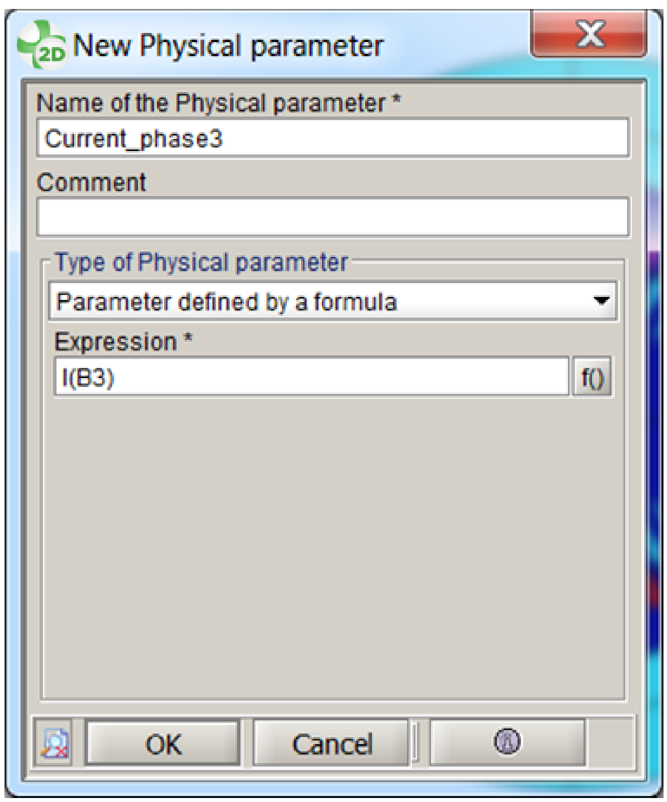
Input parameters:

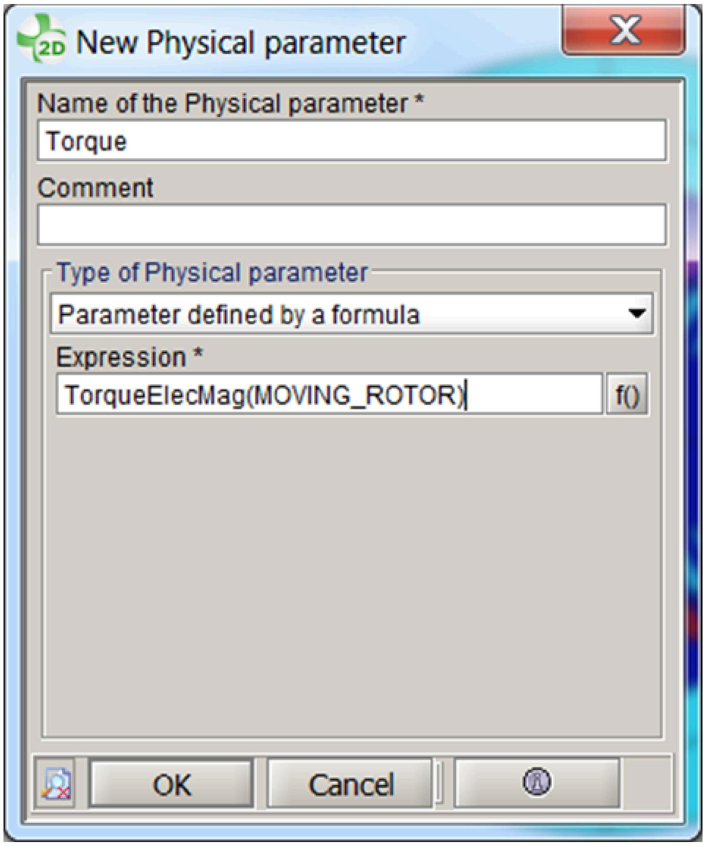


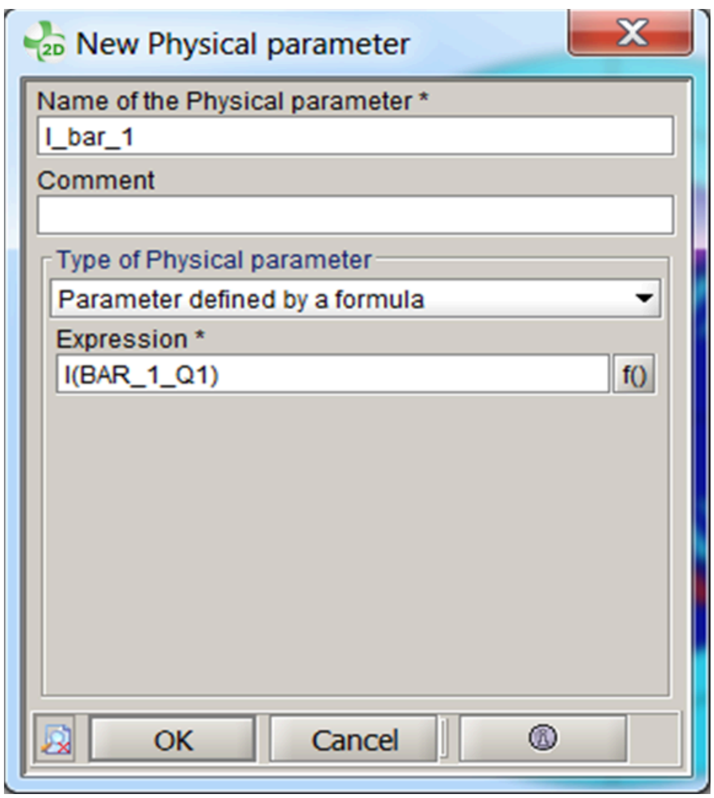
Output parameters:

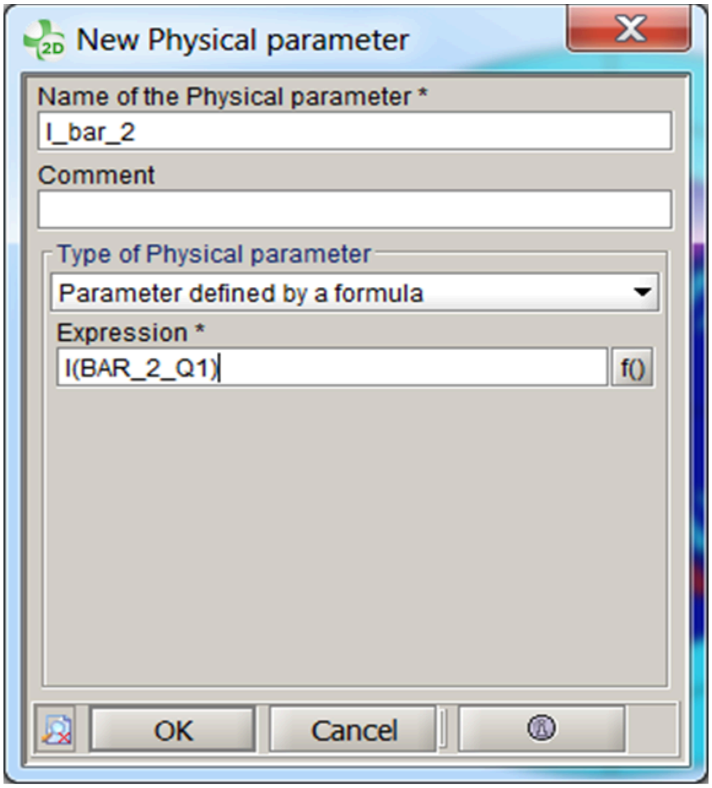



New Physical parameter
Name of the Physical parameter *
Current_phase2
Comment
Type of Physical parameter
Parameter defined by a formula
Expression *
I(B2)
f()
OK
Cancel


New Physical parameter
Name of the Physical parameter *
Current_phase3
Comment
Type of Physical parameter
Parameter defined by a formula
Expression *
I(B3)
f()
OK
Cancel

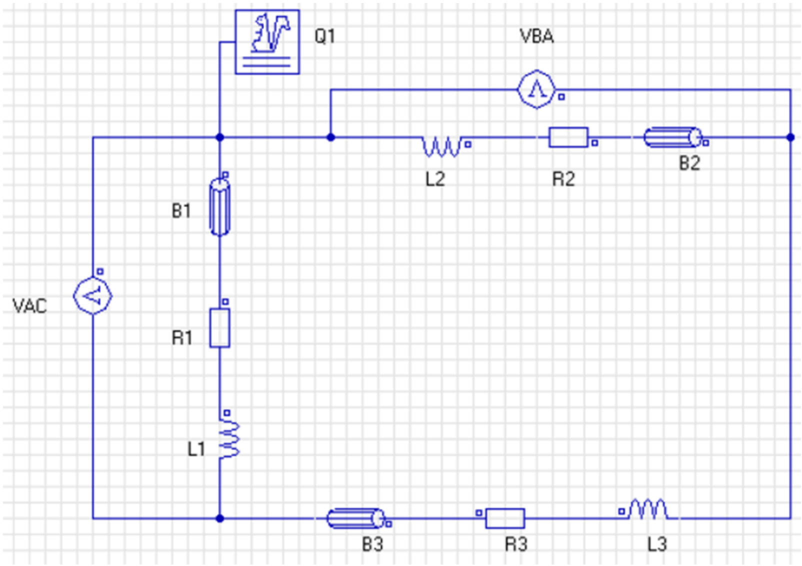

New Physical parameter
Name of the Physical parameter *
Torque
Comment
Type of Physical parameter
Parameter defined by a formula
Expression *
TorqueElecMag(MOVING_ROTOR)
f()
OK
Cancel


New Physical parameter
Name of the Physical parameter *
I_bar_1
Comment
Type of Physical parameter
Parameter defined by a formula
Expression *
I(BAR_1_Q1)
f()
OK
Cancel



Electrical circuit

The electrical circuit is defined as:

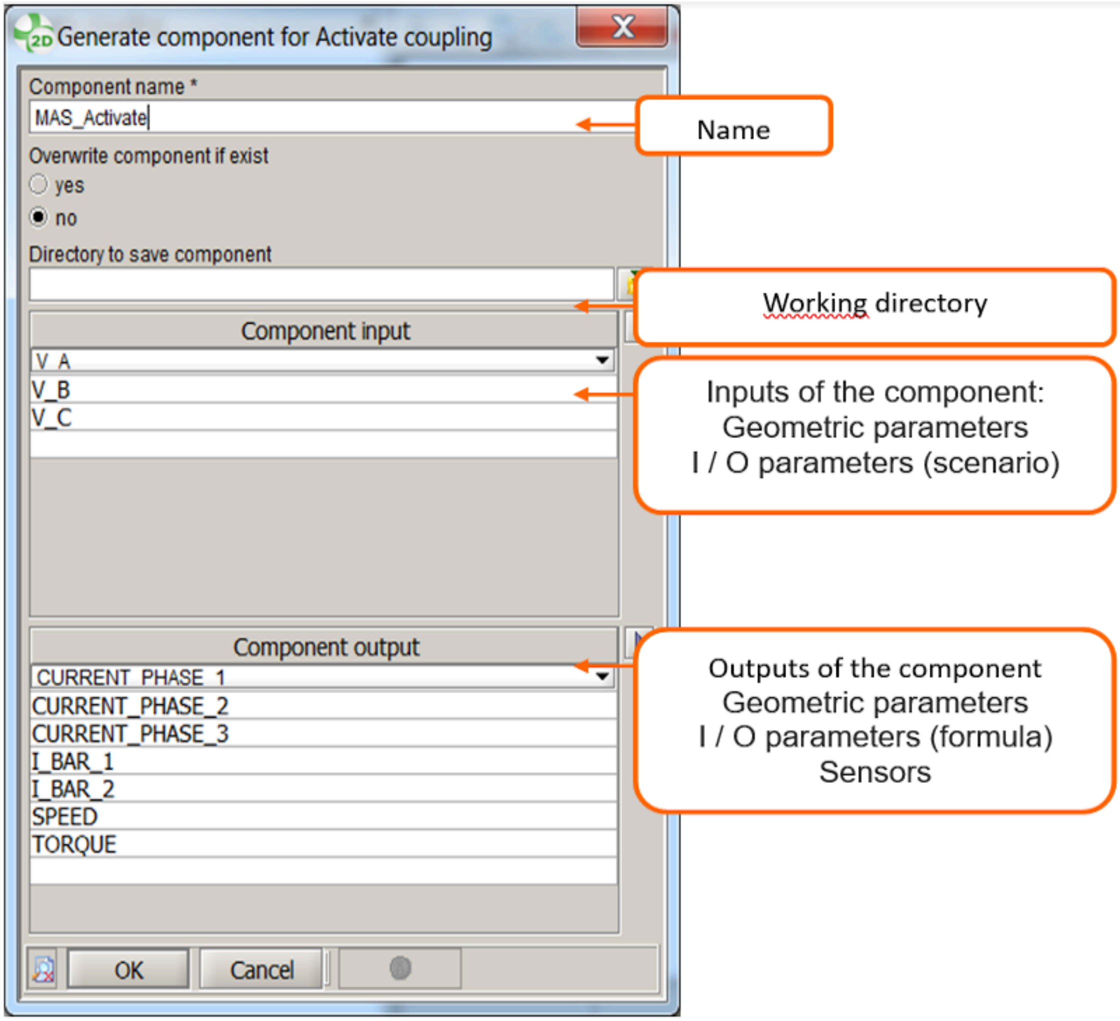


It is composed by:

- Voltage source
- Coil conductor
- Resistor
- Inductance

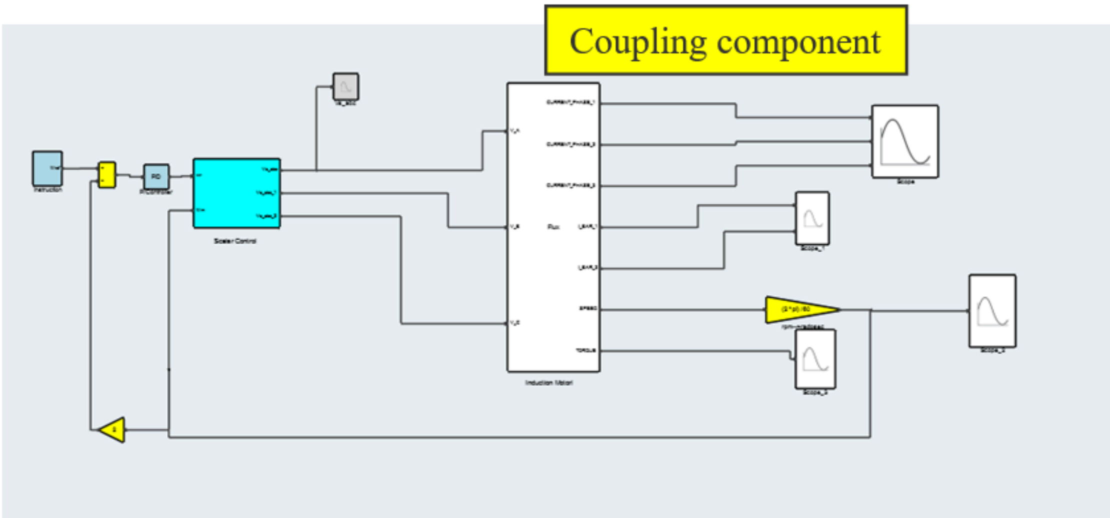
In the source current we put the input parameter (I1, I2 and I3).

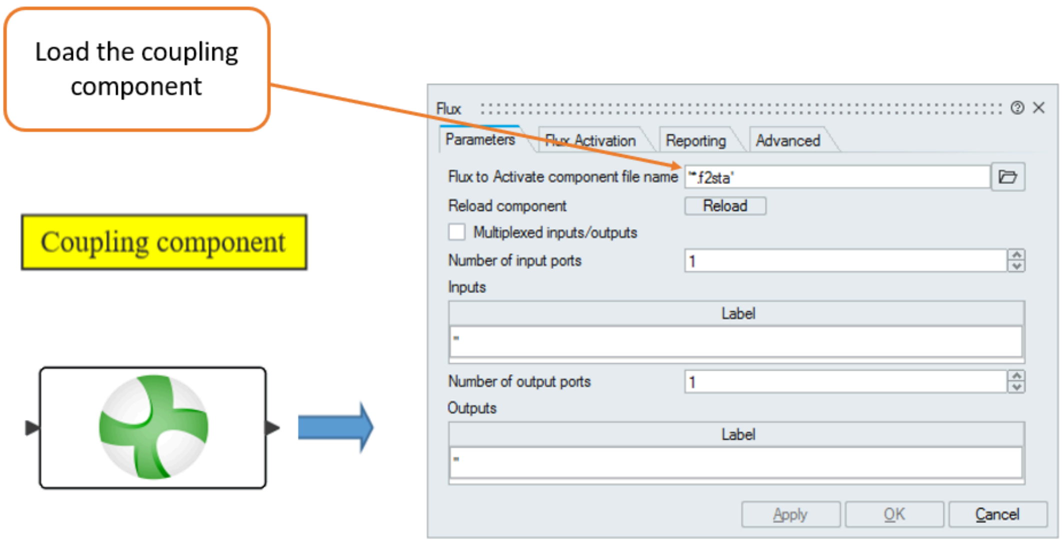
Generate component (solving >> generate component for Activate coupling) for Activate coupling in the same working directory.



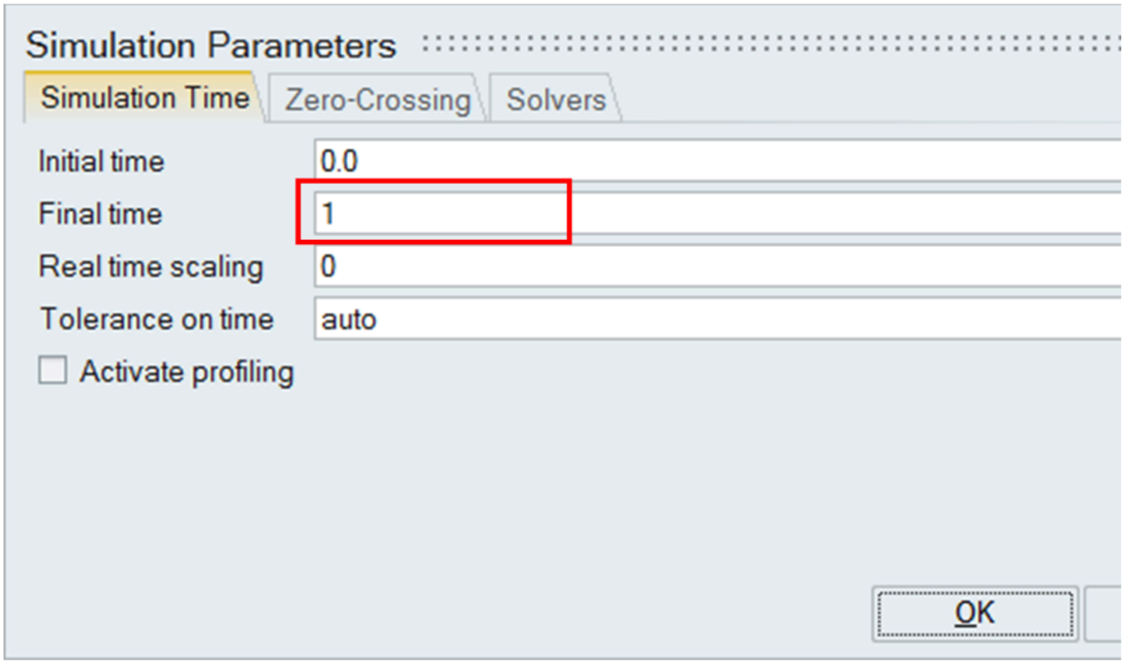
Activate model

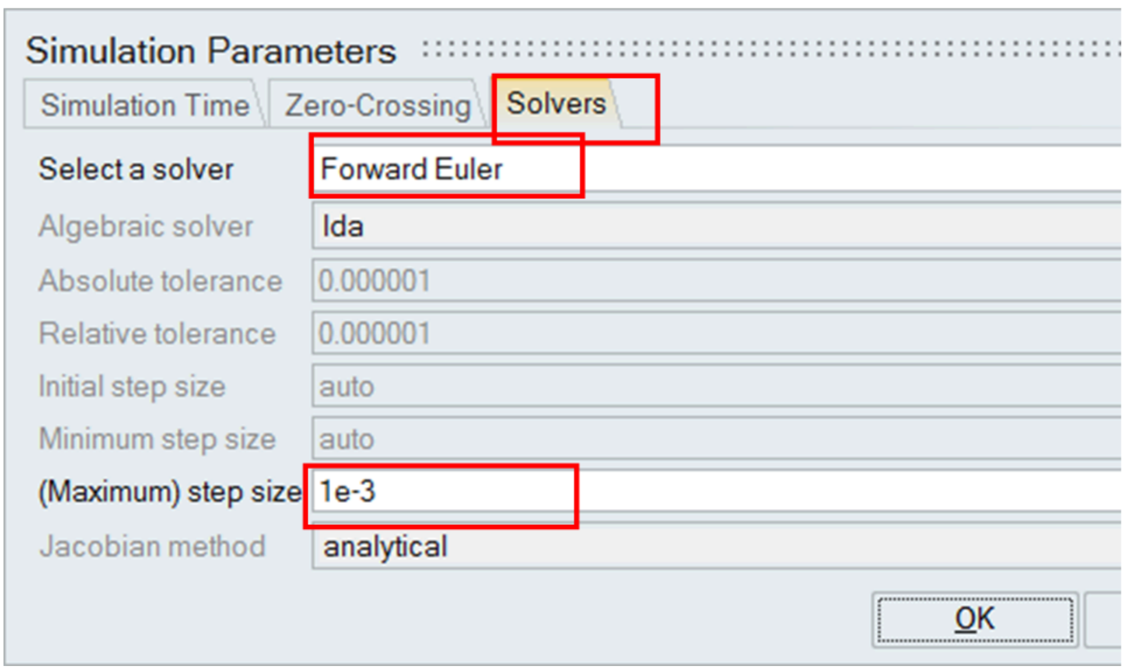
The user must prepare the Activate model by adding and characterizing the coupling block but also the blocks needed to build the desired model.





The choice of solver and the step:





The model includes:

- The command, which is a scalar control
- The induction machine
- A filter to soften the reference values
- A PI regulator for machine
- The output to be displayed

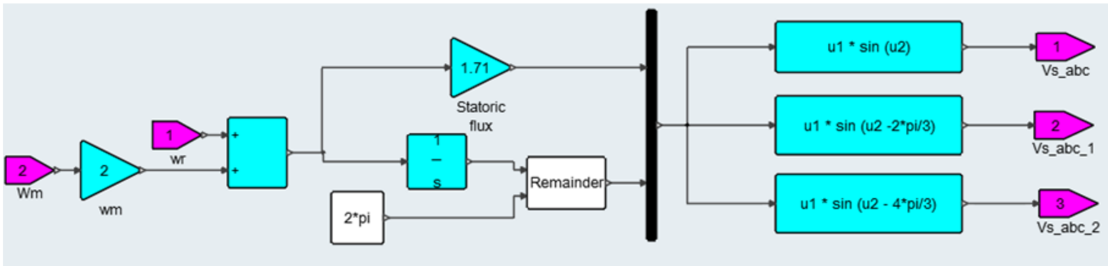


Figure 1: Command part

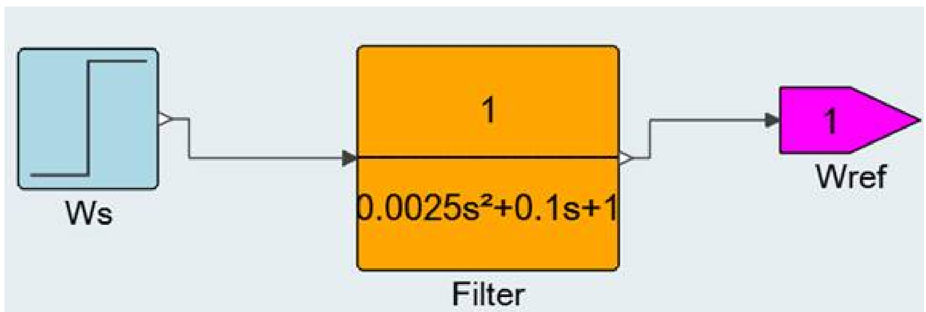


Figure 2: Subsystem of the instruction