Appendix B - Running the lab setup

Part 1: Inital settings

This appendix describes how to manually and automatically run the lab setup. First, the basic settings for both modes are given before each mode is discussed in detail. The following steps are the necessary steps for powering up the setup.

Note: Please read this document before trying to start the system. Keep out of the reach of children. The operator of the system expressly agrees that use of the lab setup is at sole risk of the operator. The Author of this Document will not be responsible of liable, directly or indirectly, in any way for any loss or damage of any kind incurred as a result of, or in connection with, your failiure to comply with this section of Terms and Conditions.

1. Connect the three phase 63 A 400 V connector for the motor drive to the outlet at the wall.
2. Connect the single phase power for the electronics of the motor drive to a outlet in the lab bench, and turn the 63A curcuit breaker on.
3. Press the green button on the motor controller to energize the DC link of the motor drive. Be sure that the motor drive is in `Torque` controlled mode and that the torque reference is set to `Potmeters`. How to do so, is given in the lab chapter of this document. The motor drive is now ready. DO NOT turn on the enable switch yet..
4. Connect the three phase 63 A 400 V connector for the converter rack to the outlet at the wall. This also supplies the stator of the DFIG. Do not power up the control system for the converter rack yet.
5. Turn on the computer running MATLAB2010b (or a) and load the Simulink model named `control_system_v4.mdl` in Simulink.
6. Turn on the Speedgoat controller. An ethernet cable should be connected between the computer and the Speedgoat controller as described in the Speedgoat documentation. The computer must have the Speedgoat block set installed.
7. The model can now be loaded into the Speedgoat controller. This is done by pressing `CTRL + B` on the keyboard of the computer running Matlab. Have a look at the Matlab commandline. Something should happen! This will take about 30-40 seconds. If nothing happens, please try again.

8. When the model is downloaded to the Speedgoat, the screen of the Speedgoat changes and is ready for operation. Set the mode of the Simulink model to `External` and the play button should be pressed to start the model. Now the model is running on the Speedgoat, but it can be controlled by the computer running Matlab. To verify that the system is running, make sure that the measurements have become active at the screen of the Speedgoat.

9. Now, connect the control system power for the converter rack to an available outlet.

10. Be sure that the normal Elko lampswitch with white wires marked `Drivers` is on.

11. The system is now ready for start up. Please proceed to either manual or automatic control.

Part 2a: Manual mode

In this mode, all controls must be done manually. If part 1 is done, it is ready for start the setup. The control panel block in the model is located at the bottom left of the Simulink model and has a red distinct color. Open this block and it should look like figure 1. In this mode, both the file named `control_system_v3.mdl` and `control_system_v4.mdl` should work. The start procedure can now start.

1. Be sure that everything in part 1 is OK. Please be sure that all switches in the model is off (pointing downwards).

2. If using the file named `control_system_v4.mdl`, ensure that the parameter named `Automode?` is set to 0.

3. First, the global enable switch in the upper left corner must be switched on.

4. Then, the grid and rotor converter breakers can be closed by turning on the two switches named `RSC breaker` and `GSC breaker`. Usually, the grid breaker is closed first. The DC link will now charge in about 3 seconds.

5. Now the grid converter can be enabled. This is done by turning on the switch named `Enable GSC 1`. The grid converter should now start humming. If not, check the protection status display in the Simulink model.

6. Then, the motor can be started. Flip over the Enable button of the motor drive (located at the driver rack). The motor should now start humming.

7. The motor is started by enabling the `Enable` button below `Motor` in Simulink. A good startup torque is about 17 (=1.7%) and can be set using the slider gain named `Torque Ref`. The torque limit must be set to a value above zero e.g. 400 (40%).

8. While the speed increases, the button named `Enable speed ctrl` should be enabled. Nothing will happen by doing so. It will just make it ready for later use.

9. When the speed reaches about 1100 rpm, the stator breaker can be closed using the switch named `Stator`.

10. Now, the rotor side converter can be started directly. To enable the rotor converter and the speed controller, enable the switch named `Enable RSC`. The machine should now go the speed set by the `Speed ref` box under the point named `Speed controller`.

11. The setup should now be working. The following things can be done while the machine is running:

    - The speed reference can be changed using the `Speed ref` constant block.
    - The reactive current references for both converters can be controlled by `I_rq_ref` and `I_gq_ref`.
    - The DC link voltage can be changed by modifying `Vdc_ref`

12. The shutdown sequence are as follows:

    - Disable rotor converter
    - Open the stator breaker
    - Stop the motor
    - Disable the grid converter
    - Open the rotor and grid converter breakers
    - Turn off enable switch of the motor drive.
    - Stop the Simulink model.

If something does not work, please check the protection status display in Simulink and the status codes/ok-signals at the Speedgoat screen. See Appendix C for status codes of the converters. Each term of the protection system can be reset by the use of reset buttons in the control panel. The protection is reset each time the grid converter breaker is closed. It is also a good idea to start with the reactive currents at zero.

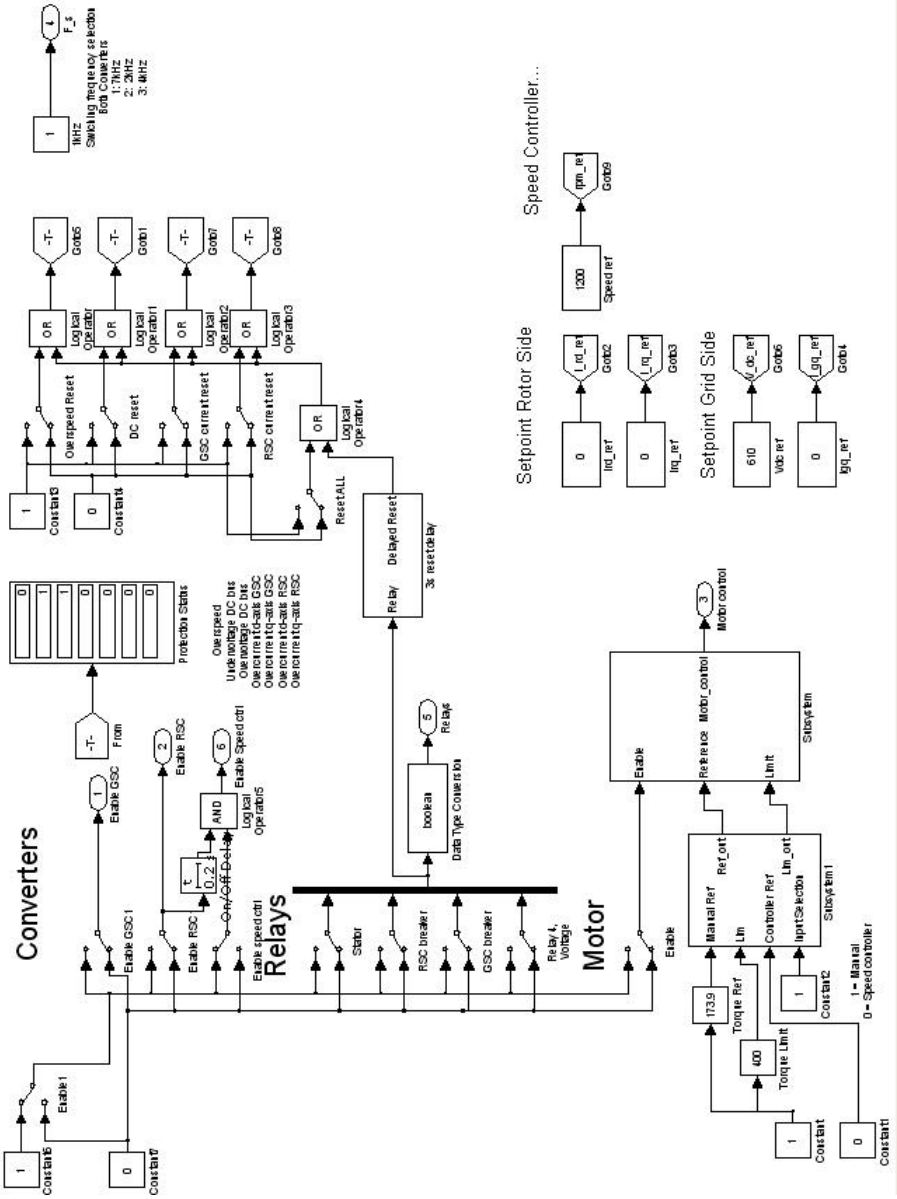

Figure 1: Simulink control panel

Part 2b: Automatic mode

If automode is enabled, the setup is started and stopped automatically. For being able to use the automode, it is necessary to use the following file `control_system_v4.mdl` in Simulink. The automatic control of the system is shown in figure 2 and the following steps must be done to control the machine:

1. Part 1 must be done (as for Manual mode).
2. Ensure that the parameter named `Automode?` is set to 1.
3. Be sure that the switch named `Trip` is off.
4. Be sure that the switch named `Enable speed ctrl` is on.
5. To start the machine, enable the switch `Start`. The machine starts in the following order:
    - Close the grid convert breaker
    - Wait 3s, close the rotor converter breaker
    - Wait 3s, enable the grid converter (inkl DC link controller) and start the motor.
    - When the speed reaches 1100 rpm, wait 0.5s and close the stator switch.
    - Wait 0.5s, the rotor converter (and then speed controller) is enabled.
    - System is now running at nominal operation
6. The machine is now running normally. Motor torque and speed reference can be set by user.
7. To stop the machine, simply turn off `Start`. This will stop the machine in the following order:
    - Disable rotor converter
    - Open stator breaker
    - Stop motor
    - Wait 1s, turn off grid converter
    - Wait 1s, open rotor converter breaker
    - Open grid converter breaker
    - System is now standby
8. Turn off enable switch of the motor drive.
9. If the system must be shut down immediately, the `Trip` switch is used. Please note that the trip function is not connected to the protection system at this point.

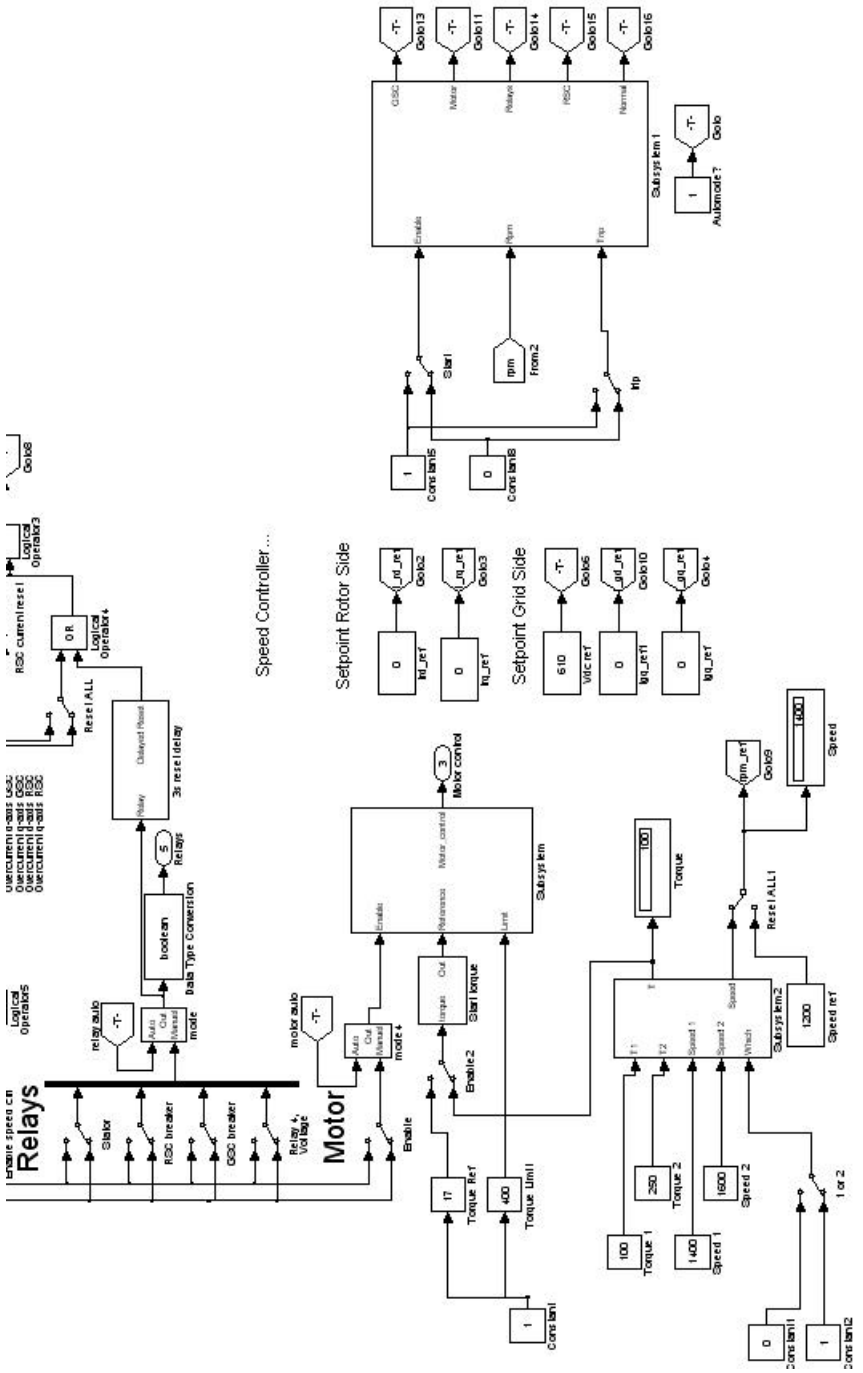

Figure 2: Automatic mode

File location for the files in the lab computer:

```
Documents ->
Matlab2010b ->
Control_system_v0 ->
    - control_system_v3.mdl
    - control_system_v4.mdl

A lot of other files exist in this folder.
However, only the one of the two given above is
necessary to open.
```