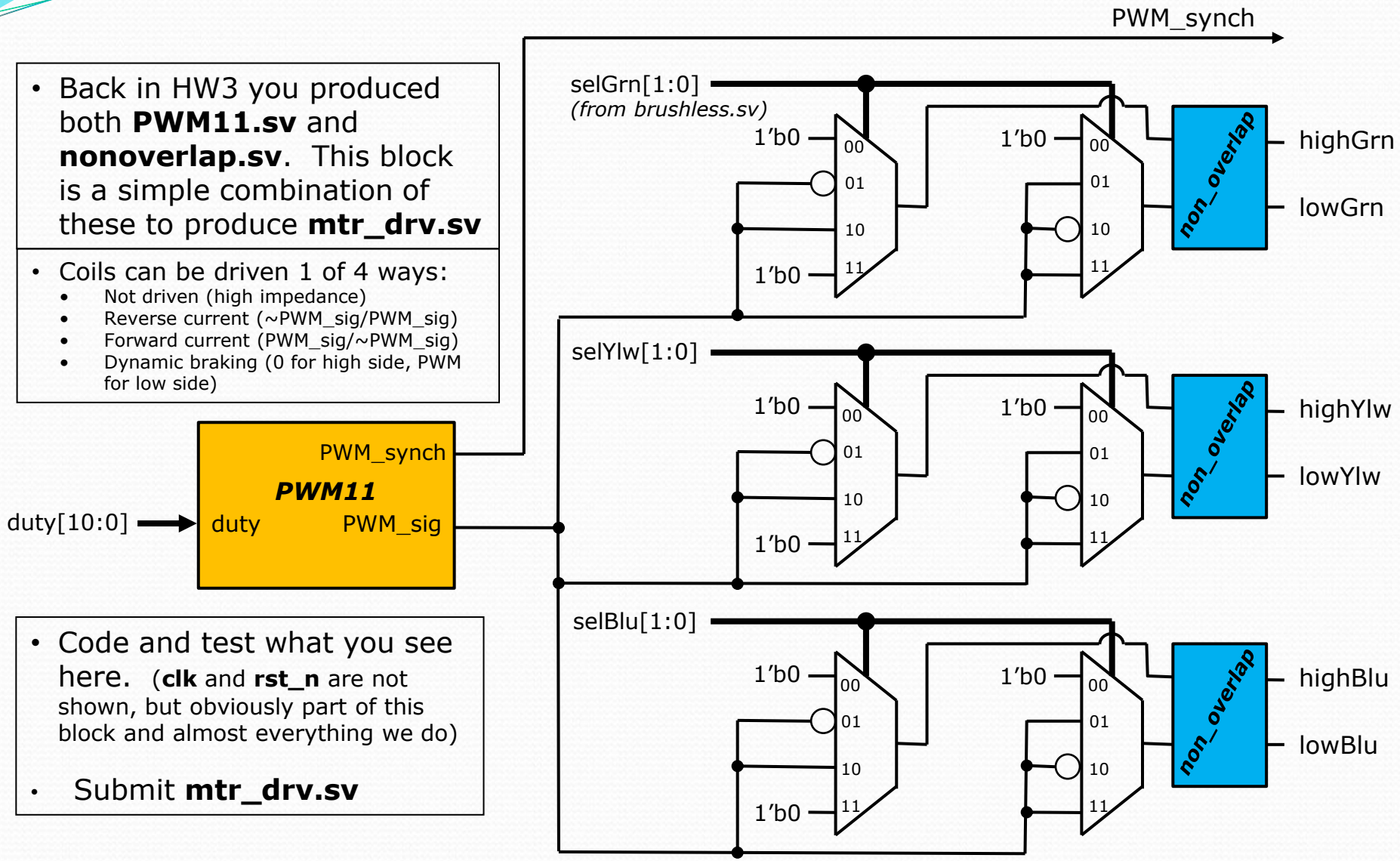
Exercise 13: mtr_drv.sv

- Back in HW3 you produced both **PWM11.sv** and **nonoverlap.sv**. This block is a simple combination of these to produce **mtr_drv.sv**

- Coils can be driven 1 of 4 ways:
  - Not driven (high impedance)
  - Reverse current (~PWM_sig/PWM_sig)
  - Forward current (PWM_sig/~PWM_sig)
  - Dynamic braking (0 for high side, PWM for low side)



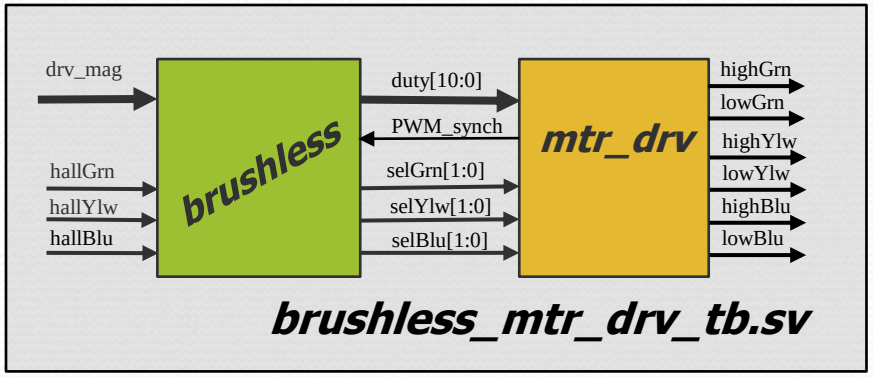
- Code and test what you see here. (**clk** and **rst_n** are not shown, but obviously part of this block and almost everything we do)

- Submit **mtr_drv.sv**

(hint on testing next page)

Exercise 13: Testing mtr_drv.sv Part I

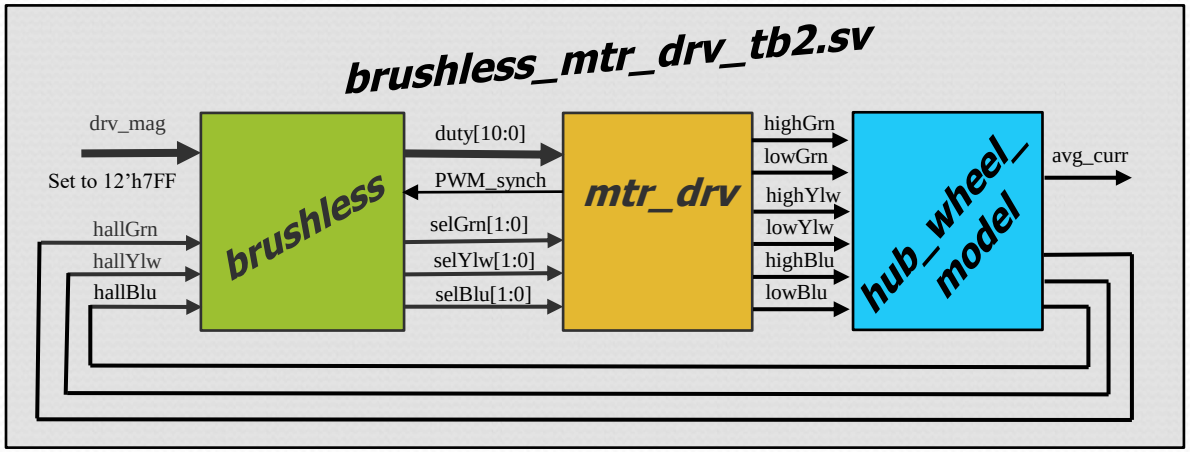
- The outputs of **brushless.sv** feed the inputs to **mtr_drv.sv,** they are best tested in combination.
- A combined testbench (**brushless_mtr_drv_tb.sv)** is provided. Flesh out the stimulus, run it, and manually check the behavior against the table below.



{hallGrn,hallYlw,hallBlu}	Expected Output for Grn, Ylw, Blu given as high/low
101	Grn = PWM/~PWM, Ylw = ~PWM/PWM, Blu = 0/0
100	Grn = PWM/~PWM, Ylw = 0/0, Blu = ~PWM/PWM
110	Grn = 0/0, Ylw = PWM/~PWM, Blu = ~PWM/PWM
010	Grn = ~PWM/PWM, Ylw = PWM/~PWM, Blu = 0/0
011	Grn = ~PWM/PWM, Ylw = 0/0, Blu = PWM/~PWM
001	Grn = 0/0, Ylw = ~PWM/PWM, Blu = PWM/~PWM
000 or 111	Both high and low at 0 for all channels
brake_n == 1'b0	All high channels at 0. All low channels at PWM (75%)

Exercise 13: Testing mtr_drv.sv Part II

- Now a model of coil drive and a brushless DC motor (**hub_wheel_model.sv**) is introduced to help further check your **brushless**/**mtr_drv** combination.



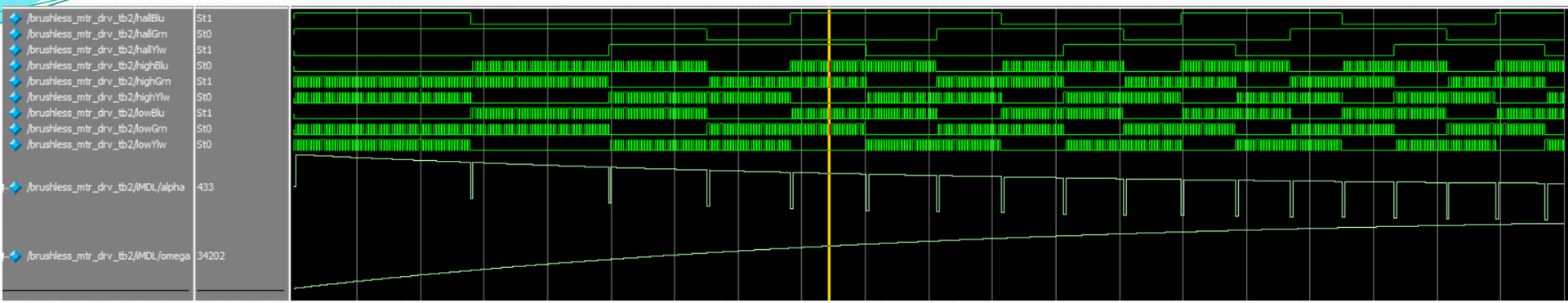
- This model evaluates the drive on **highGrn**, **lowGrn**, … and models the physics of the torque.

- It contains a signals **alpha** and **omega** which represent the angular acceleration and angular velocity of the motor.

- **brushless_mtr_drv_tb2.sv** is available for download, as is **hub_wheel_model.sv**.

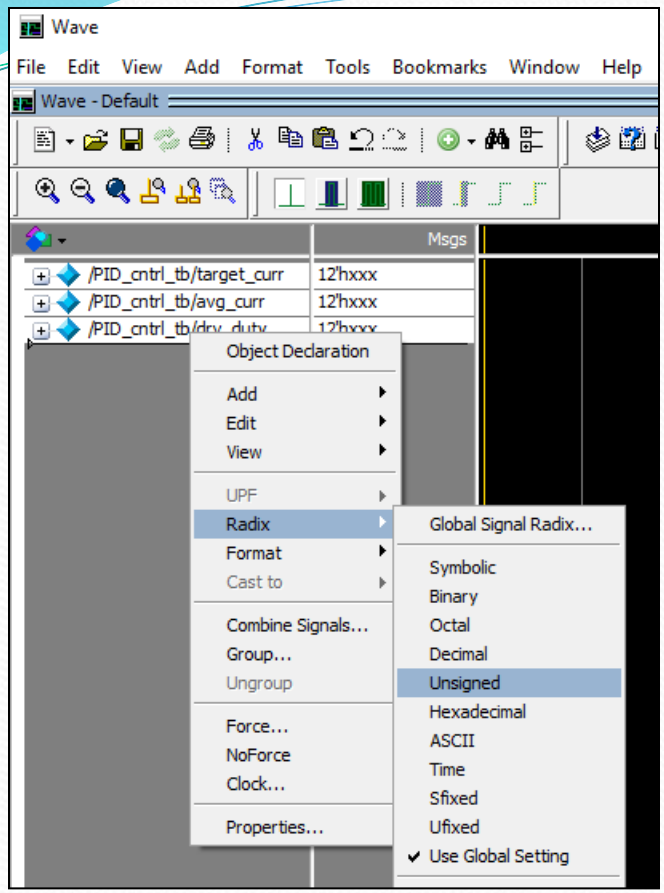
- **hub_wheel_models.sv** contains a child (**coil_volt.sv**) that you also have to download and include in the project build.

Exercise 13: Testing mtr_drv.sv Part II (continued)



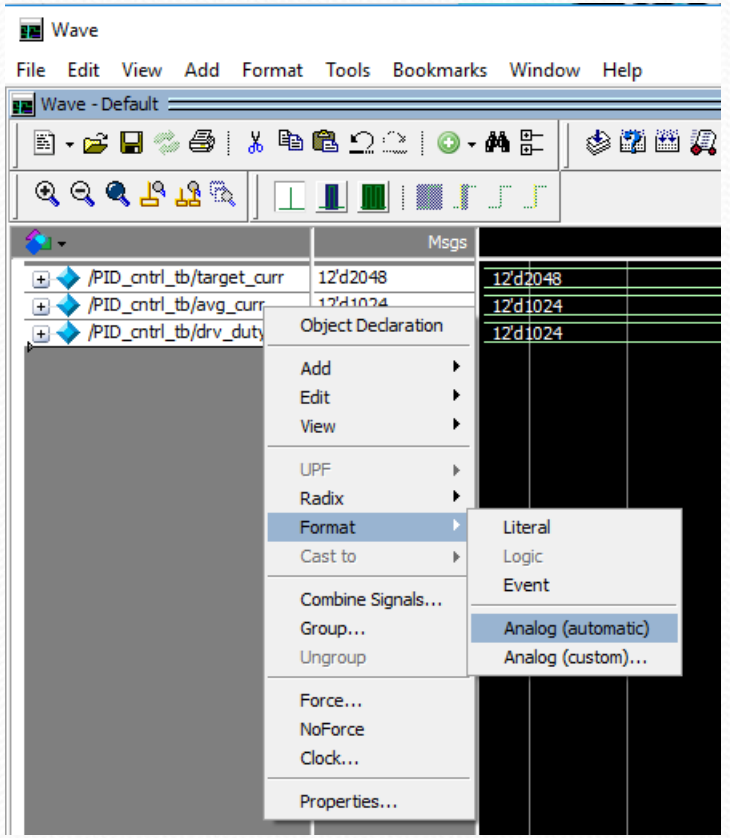
- Above are the expected waveforms of this simulation with **alpha** and **omega** plotted as analog.
- The follow slides cover how to plot waveforms as analog in ModelSim.
- If you can reproduce similar results you can have pretty good confidence your **brushless** and **mtr_drv** implementations are functionally correct.
- **Submit:**
  - **Brushless.sv** & **mtr_drv.sv**
  - Your completed **brushless_mtr_drv.sv** and a capture of the waveforms
  - Waveforms from your simulation of **brushless_mtr_drv2.sv**.

Viewing waveforms as analog



First select the signals of interest and change the radix (right click). If the signals are signed you would choose **Signed**. These signals are unsigned so we choose **Unsigned**.

If you have not already…run the simulation



Finally right click on the signals again and change the display format to "Analog (automatic)" It can't automatically scale signals for which it does not have data, so you have to have run the simulation to do this.