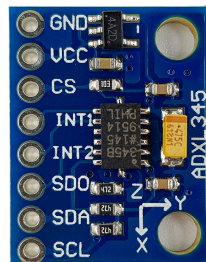


PBL 4

Now is the time to build the interface between our FPGA and a sensor. You should implement the SPI master while the sensor would act like the SPI slave. We will use an accelerometer specifically the ADXL345 sensor. Check the provided datasheet to get to know how it works.



The work of this sheet should be finished in two weeks.

Task 0

In preparation for the task, it is important and useful to deal with the SPI interface. It is important to understand that the SPI protocol only defines a rough framework for data transmission, and that each manufacturer can adapt the protocol individually.

- First have a look at the general function of the SPI protocol. For this you can look for example in the lecture notes.
- Now look at how the protocol was defined for the sensor to be used. You can find hints for this in the data sheet in the chapter SERIAL COMMUNICATIONS.

Hint: The designation of the bus signals can also be confusing. Generally CS (Chip Select), CLK (Clock), MISO (Master In Slave Out) and MOSI (Master Out Slave In) are defined. However, this nomenclature can change from manufacturer to manufacturer, although the general function of the bus lines always remains the same. For example, it may be called SDI (Serial Data Input), which is nothing other than MOSI, and so on.

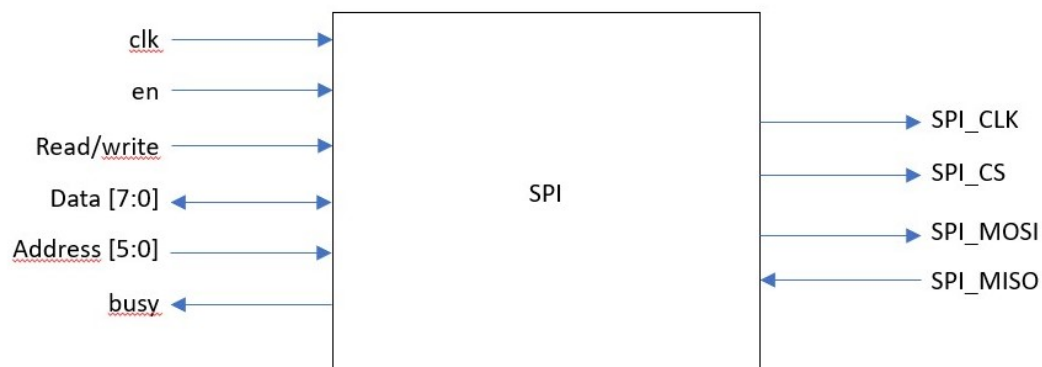
Task 1

Implement the SPI master module. You will need to connect to GND and Vcc to the FPGA's GND and Vcc. You will connect the chip select (CS), serial data output (SDO), serial data input (SDI) and serial clock (SCL) to GPIO pins.

You can use the following block diagram as a reference, you can modify it according to your design but you shouldn't be missing any basic port.

Where:

- en signal to start data transfer
- Read/write to indicate whether read or write command
- Data[7:0] can be defined as an inout as we can read as well as write data
- Address[5:0] the address of the sensor register where we want to read or write data
- Busy to indicate that transmission is active



Hint: make sure to choose the right SPI Mode (CPOL, CPHA) in order to be able to communicate with the sensor properly.

Task 2

Use the implemented SPI master module in order to read out the ID of the sensor. You will need to connect the SPI master module and the UART module in a top level module in order to be able to show the required data on the screen.

Hint: make sure to check the sensor's register map in order to get the required addresses.

Task 3

Now read out the x-axis data value, note that the value is divided into two registers and you have to read both in order to get the right sensor reading.

Again you should build a top level module that implements the readout logic and the forward to the UART in order to put the data on screen.

Useful Links

- [02_ADC_Dig-Interfaces.pdf](#)
Smart Sensors 2nd Lecture
- [ADXL345_Datasheet.pdf](#)
Datasheet auf the ADXL345 Accelerometer Sensor