ELEC-240 Lab8
Serial Peripheral Interfacing (SPI)
on the STM32F429 Nucleo-144 Development Board *

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1 Introduction

The SPI interface is commonly used to connect external modules such as sensors, memory, communications modules, displays etc. to a host micro-controller. It is very convenient becuase it can communicate with several external modules over a common set of data lines thus significantly reducing the number of data lines required as oppose to parallel linked devices. The three common data lines are:

- MOSI (Master-Output-Slave-Input)

  The host micro-controller (aka Master device) outputs serial data on this line and the external device (aka Slave device) reads it in

- MISO (Master-Input-Slave-Output)

  The slave device outputs serial data on this line and the master device reads it in

- SCK or SCLK (Serial Clock)

  The master device controls this line and generates clock pulses used to synchronise the transmission and reception of data between the two devices. The states of the MISO and MOSI lines are both updated on one edge of the clock and sampled on the other.

Each external module is selected using a separate Chip Enable (aka Chip Select) line. When a chip enable line is asserted the corresponding module becomes active and operates the data lines as described above. When the chip enable line is de-asserted the module releases control of the data lines. Only one chip enable can be asserted at a time otherwise multiple slave devices will attempt to operate the data lines at the same time. When observing the data lines on the oscilloscope such behaviour manifests in the form of reduced-amplitude data bits (aka 'Runt' bits) which occur when one module attempts to drive the line low at the same time as another module is trying to drive the line high.

*document produced by Stuart MacVeigh

1.1 Learning Outcomes

By the end of this lab exercise you should be able to:

1. Demonstrate an understanding of SPI advantages over parallel connected peripherals
2. Demonstrate an understanding of SPI operation and timing
3. Produce code to enable and use the on-board SPI modules

Task 1

The kit is supplied with a BMP280 barometric pressure sensor module which interfaces via SPI. Identify and connect the correct pins on the Nucleo-144 development board to those on the BMP280 module. Support documentation is available in Table 1. BMP280 pin-out provided in Figure 1.

Figure 1: Pinout for BMP280 version 1 & 2

Task 2

Download and run the example code provided on the DLE. This code reads the pressure and temperature from the BMP280, converts the temperature and pressure readings to ^oC and hPa respectively. In debug mode these values can be monitored live using the Watch windows (refer back to the Debugging section of Lab1). Are the readings sensible?

Task 3

Use the oscilloscope to measure the clock frequency on the SCK line. Does it comply with the value programmed in the code?

Task 4

Demonstration of understanding.

1. What is the limiting factor of how many external devices can be connected to a host micro-controller using SPI?
2. When using multiple devices:
    a) What will happen if more than one chip enable line is asserted at the same time?
    b) How can this behaviour be observed and identified?
3. The chip enable lines are typically 'Active Low', what does this mean?
4. How many shared lines are present in a typical SPI system regardless of the number of connected modules?
5. What is the maximum SPI clock speed for the BMP280?

Task 5

Modify the code to output the temperature and pressure readings to the USART so they can be displayed on the PC terminal, both to 3dp.

Task 6

Modify the code to output the readings to the LCD with temperature displayed on the top line and pressure on the bottom line, both to 3dp.

Bonus Task

The BMP280 can communicate via SPI or I2C protocols. Currently it's using SPI. Use what you have learnt about programming the micro-controller and obtaining information from datasheets to enable the I2C module on the micro-controller and configure it to read the temperature and pressure values from the BMP280. All information required is available in the datasheets provided in Table 1.

2 Support Documentation

Document Name	Contained Information
UM1974 User manual	• Pin identification and the supported special functions • Circuit schematics • Jumper and component identification • Header pinouts
RM0090 Reference manual	• MCU memory and peripherals architecture • Peripheral control registers, addresses and bit-fields
BMP280 Datasheet	• Pin Functions • Digital interface and timing specifications • Register functions and settings • Conversion and compensation sample code for temperature and pressure measurements

Table 1: Table of relevant support documentation
(The document names are hyperlinks, please click on them to access the documents)