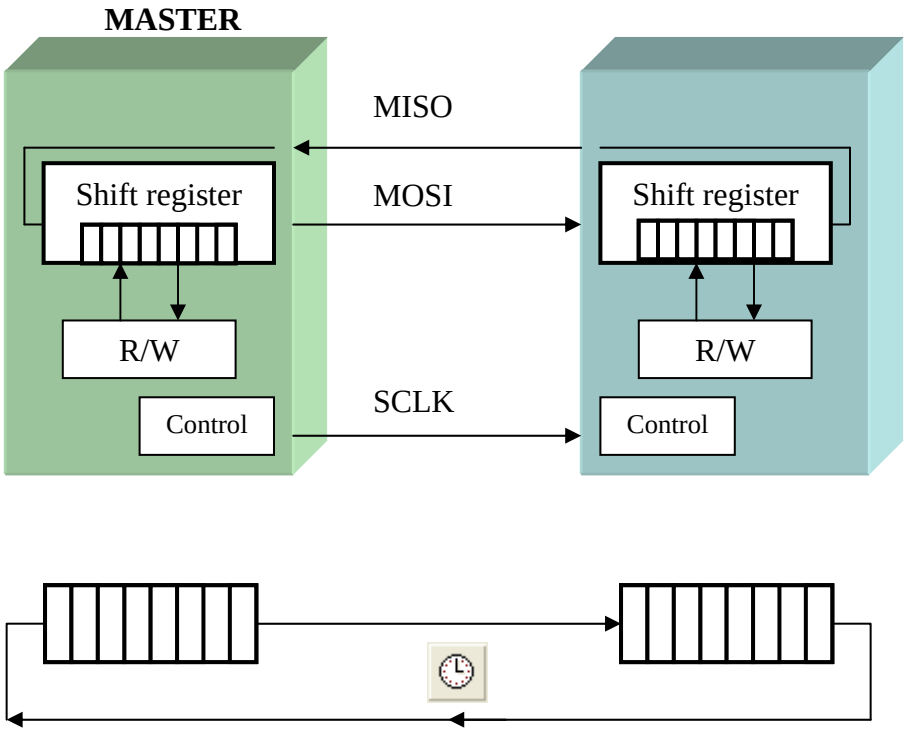
1 USING SPI PROTOCOL WITH PRESSURE SENSOR MODULES

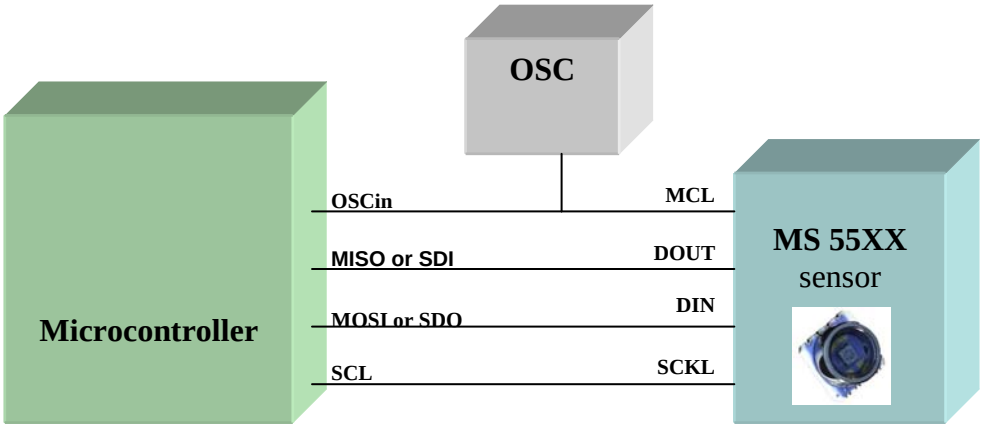
This application note describes the possibility of communication between a microcontroller and MEAS Switzerland's pressure sensor modules (MS55XX series) via SPI protocol.
SPI stands for Serial Peripheral Interface. It is frequently used when few I/O lines are available, but communication between two or more devices must be fast and easy to implement.
SPI is a synchronous protocol that allows a master device to initiate communication with a slave device. It is implemented in many standard microprocessors (Microchip, Silicon Laboratories, Atmel, ST,…) by a hardware module.
The great advantage of using this protocol is it simplifies the communication with the sensor module. In fact, there is no need to generate the serial clock, as it is generated by the microcontroller. You only have to place data and commands in a buffer and the microcontroller send it. (Same utilization than an USART)

This protocol needs a minimum of three lines between the master and a slave. An additional line must be added for each slave in multi-slave operations in order to select it.



The communication between a master and a slave is always a data transfer. When the master sends something, it will receive a data at the same time. If the data received is not read, it will be lost at next data transfer. When the master wants to receive something, it has to send a dummy data to shift the answer placed in the slave's shift register. For more details about SPI, refer to microcontroller datasheet.

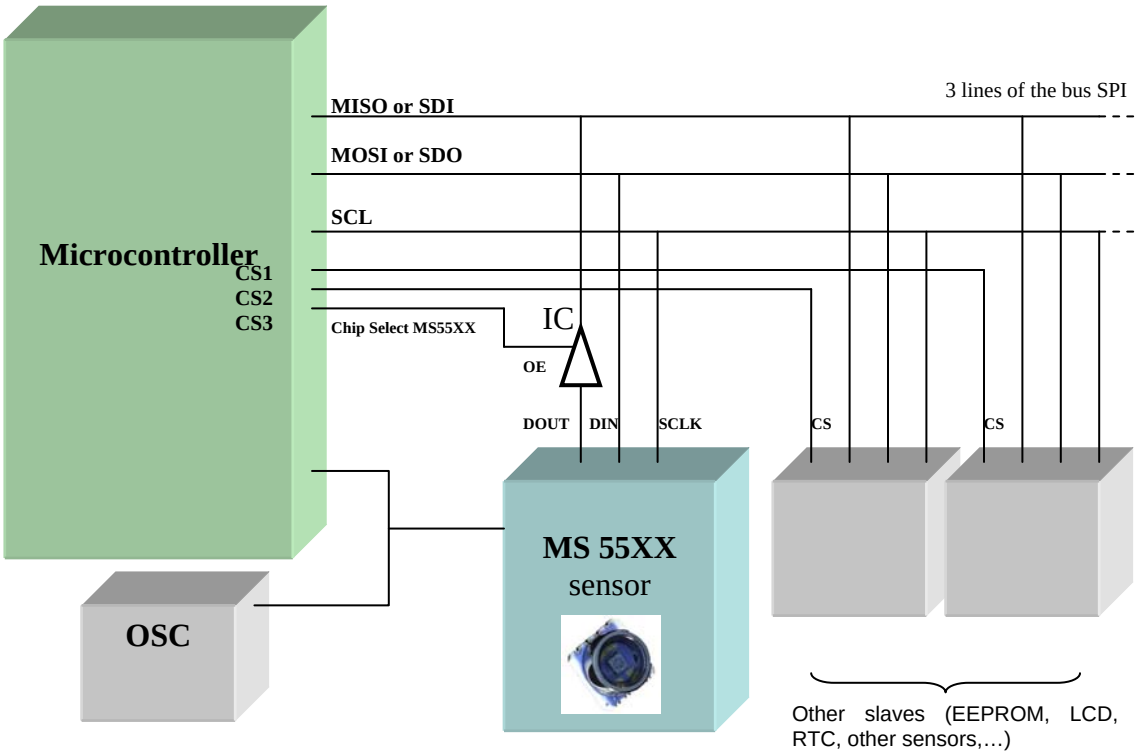
2 HARDWARE: COMMUNICATION BETWEEN THE MASTER AND ONE SLAVE



With:
MISO = Master In & Slave Out
MOSI = Master Out & Slave In
SDO = Serial Data Out
SDI = Serial Data In
SCL or SCKL = Serial Clock
OSC = Oscillator at 32.768 kHz
For ex: SG3030JC

Note:
The oscillator is not necessary for data transmission but for sensor ADC. It can be used as clock for the microcontroller too.

3 HARDWARE: COMMUNICATION BETWEEN THE MASTER AND TWO OR MORE SLAVES

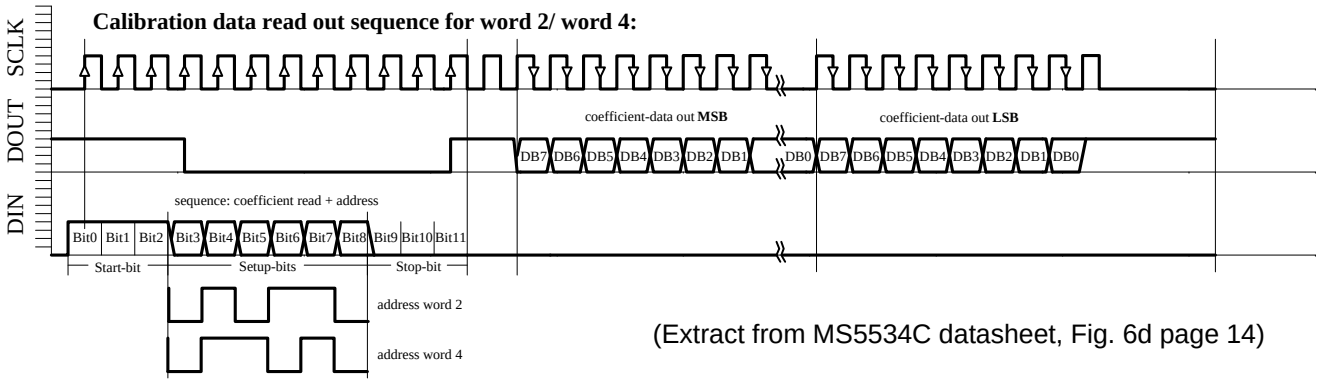


With:
CS = Chip Select (Or slave select SS)
IC = 3-State buffer (high-Z driver)
For ex: 74HC1G125
OSC = Oscillator at 32.768 kHz
For ex: SG3030JC

Remarks:
- As MEAS Switzerland's sensor modules haven't any high-Z driver on DOUT, it is compulsory to add a 3-state buffer on the line between DOUT and MISO-line of the SPI bus in order to allow communication with the other slaves.
- The lines MISO, MOSI and SCL have to be connected on the right ports of the microcontroller (See microcontroller datasheet). The CSx lines can be connected to general digital I/O.
- Most components using SPI have an active-low input (CS\) to select it. Using a 74HC1G125 has the same meaning because this driver has an Output-Enable active-low input(OE\).

4 SOFTWARE

Example: reading calibration words 2 and 4 on a MS5534-B



(Extract from MS5534C datasheet, Fig. 6d page 14)

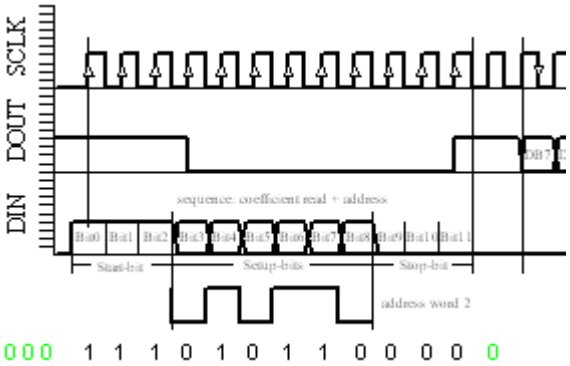
The frame to be sent is 1**-1-1-0-1-0-1-1-0-0-0-0** (for calibration word 2)

With SPI protocol, it is only possible to send 8 bits at a time (one byte). The frame must be divided by two and some "0" must be placed before and after the frame to complete the two bytes.

It becomes: **0-0-0-1-1-1-0-1-0-1-1-0-0-0-0-0**

Separated in bytes: **0-0-0-1-1-1-0-1 0-1-1-0-0-0-0-0**

In Hexadecimal: **1Dh** **60h**

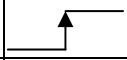
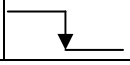


Remark:
The 0 added after the frame is placed to have one more clock after the stop bits on the SCLK line. (As shown on the scope above)

Thus, the other frame becomes:

Conversion start for pressure measurement (D1):	**0Fh & 40h**
Conversion start for temperature measurement (D2):	**0Fh & 20h**
Read calibration word 1 (W1):	**1Dh & 50h**
Read calibration word 2 (W2):	**1Dh & 60h**
Read calibration word 3 (W3):	**1Dh & 90h**
Read calibration word 4 (W4):	**1Dh & A0h**
Reset sequence command:	**15h & 55h & 40h**

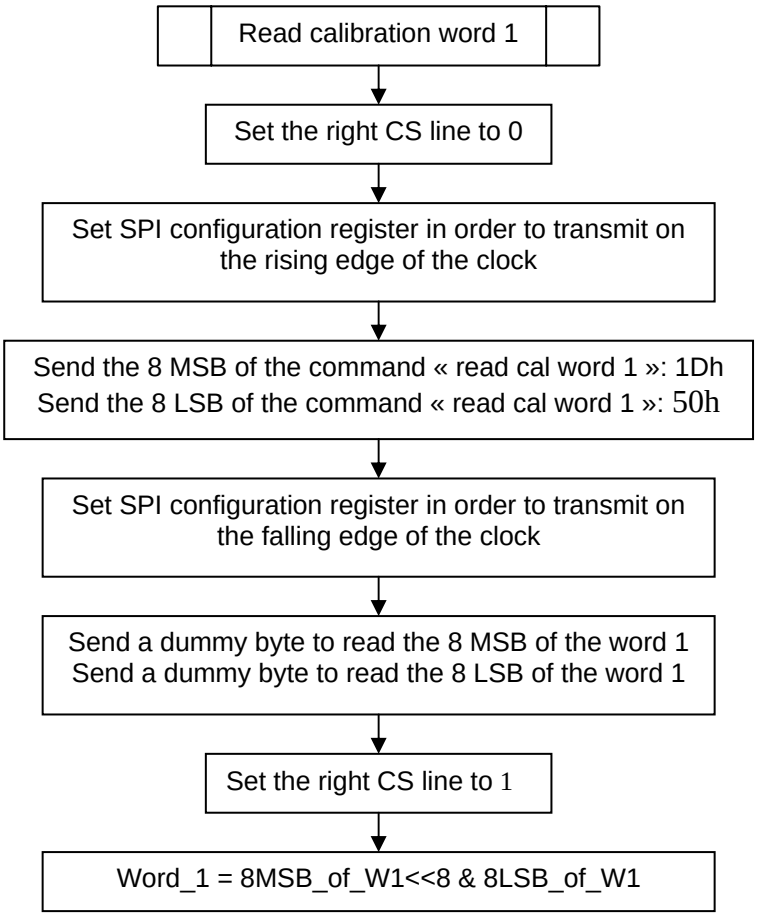
With SPI protocol, two parameters need to be checked or adjusted during the configuration of microcontroller's SPI module:
Clock Idle state must be low.
Transmission must occur on rising edge of the serial clock when the microcontroller wants to send data received by the sensor. On the other side, when the microcontroller wants to receive data sent by the sensor transmission must occur on the falling edge of the clock.

uController	Sensor	Sclk
Send	Receive	
Receive	Send	

(See the scopes shown on the page before to have an example)

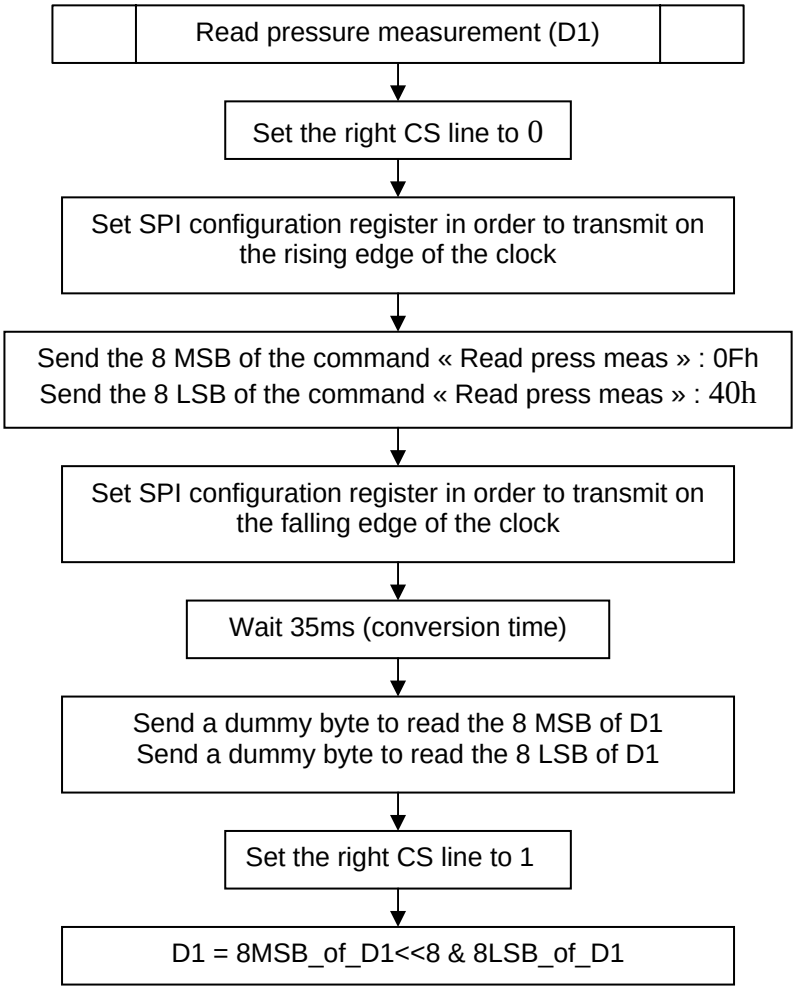
5 EXAMPLES OF FLOW CHARTS

READING CALIBRATION WORD 1:



Reading calibration words 2-4:
The flowchart is the same. The differences are the commands.
Note: To optimize code, read the four calibration words in a loop.

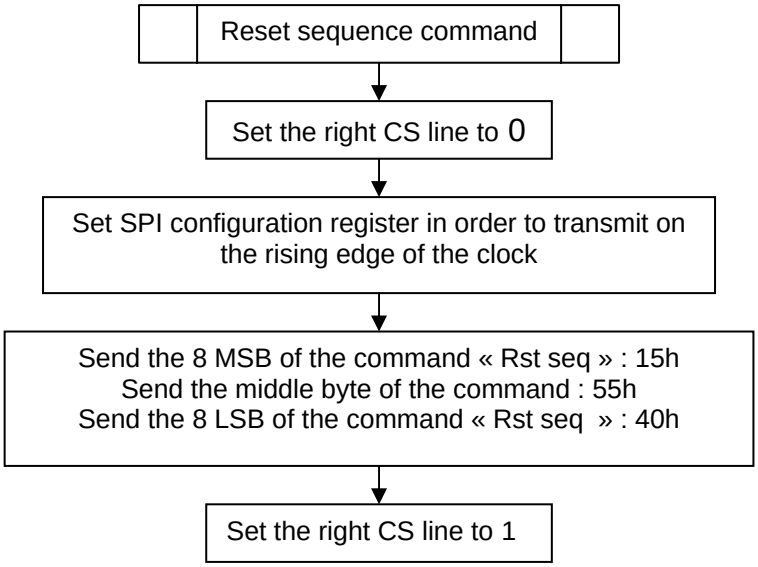
READING PRESSURE VALUE (D1):



READING TEMPERATURE VALUE (D2):

The flowchart is the same. The differences are the commands (0Fh and 20h instead of 0Fh and 40h)

RESET SEQUENCE COMMAND:



REVISION HISTORY

Date	Revision	Type of changes
November 09, 2005	V1.0	Initial release
March 9, 2011	002	Change to MEAS logo and layout
June 20, 2011	003	Insertion of the mention TM in the logo, modification of Shenzhen zip code

FACTORY CONTACTS

NORTH AMERICA

Measurement Specialties
45738 Northport Loop West
Fremont, CA 94538
Tel: +1 800 767 1888
Fax: +1 510 498 1578

e-mail: pfg.cs.amer ch@meas-spec.com
Website: www.meas-spec.com

EUROPE

MEAS Switzerland Sàrl
Ch. Chapons-des-Prés 11
CH-2022 Bevaix
Tel: +41 32 847 9550
Fax: + 41 32 847 9569

e-mail: sales.ch@meas-spec.com
Website: www.meas-spec.com

ASIA

Measurement Specialties (China), Ltd.
No. 26 Langshan Road
Shenzhen High-Tech Park (North)
Nanshan District, Shenzhen, 518057
China
Tel: +86 755 3330 5088
Fax: +86 755 3330 5099
e-mail: pfg.cs.asia@meas-spec.com
Website: www.meas-spec.com