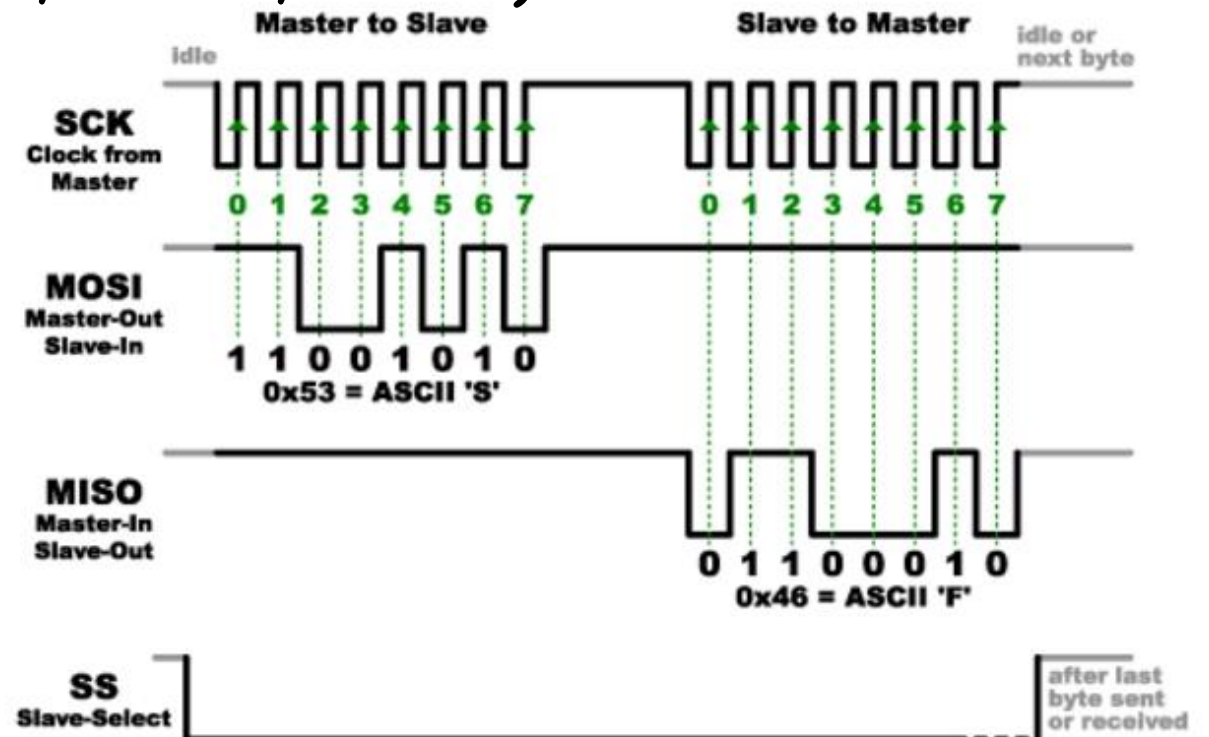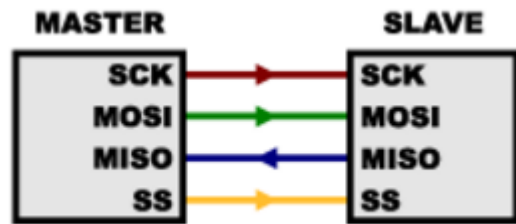# 微處理機系統與介面技術

LAB 5 − SPI

SPI – Serial Peripheral Interface

- Synchronous serial data communication(can operate in full duplex)

- 4 wire communication(SS,CLK,MOSI,MISO)

- MO has four set SPI

SPI register

- SPI->SSR: SPI slave select register
  - SS_LVL
  - AUTOSS
  - SSR

31	30	29	28	27	26	25	24
Reserved							
23	22	21	20	19	18	17	16
Reserved							
15	14	13	12	11	10	9	8
Reserved							
7	6	5	4	3	2	1	0
Reserved		LTRIG_FLAG	SS_LTRIG	AUTOSS	SS_LVL	SSR	

- SPI->CNTRL: SPI control and status register
  - SLAVE
  - CLKP
  - TX_NUM, TX_BIT_LEN
  - TX_NEG, RX_NEG
  - GO_BUSY

31	30	29	28	27	26	25	24
Reserved							
23	22	21	20	19	18	17	16
VARCLK_EN	TWOB	Reserved	REORDER		SLAVE	IE	IF
15	14	13	12	11	10	9	8
SP_CYCLE				CLKP	LSB	TX_NUM	
7	6	5	4	3	2	1	0
TX_BIT_LEN					TX_NEG	RX_NEG	GO_BUSY

ADXL SPI configuration

Figure 37. SPI 4-W

- SPI->DIVIDER: Set SPI clock(DIVIDER)

- SPI->SSR
  - SS line is active at low-level edge(SSR.SS_LVL)
  - Disable auto ss(SSR.AUTOSS)

- SPI->CNTRL
  - Set SPI as master mode(CNTRL.SLAVE)
  - CLK is idle at high(CNTRL.CLKP)
  - CPOL=1, CPHA=1(CNTRL.TX_NEG, RX_NEG)
  - 8 bit data length for each word transmit(CNTRL.TX_BIT_LEN)
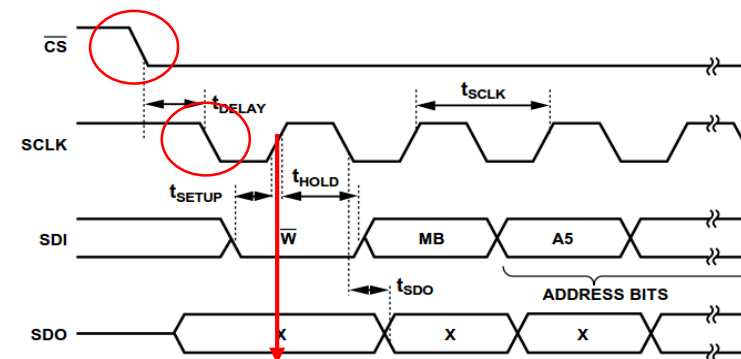 - One word in one transfer(CNTRL.TX_NUM)

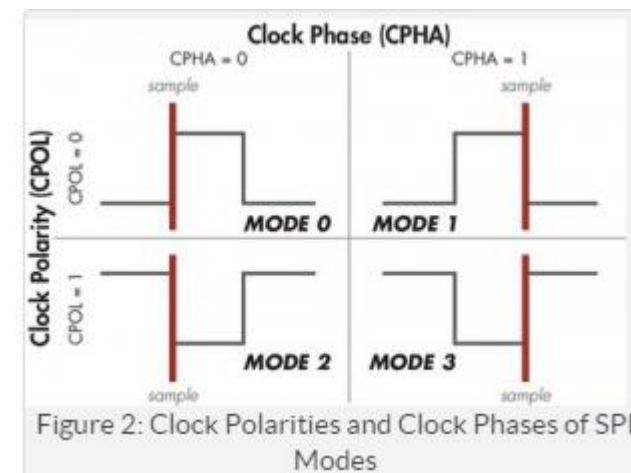Figure 2: Clock Polarities and Clock Phases of SPI Modes

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SPI Write operation
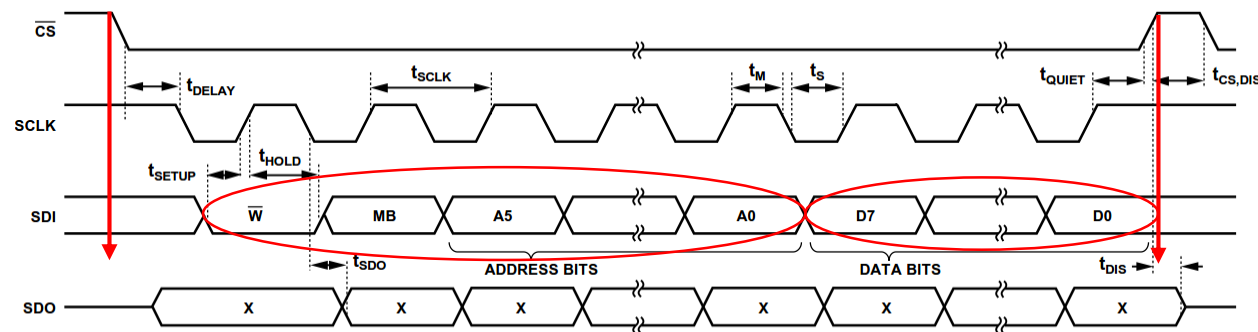
Figure 37. SPI 4-Wire Write

Set Tx data(address)

Set CS line low

GO_BUSY bit = 1

GO_BUSY bit become 0

Set Tx data(data)

GO_BUSY bit become 0

Set CS line high

SPI Read operation

Set Tx data(address)

↓

Set CS line low

↓

GO_BUSY bit = 1

↓

GO_BUSY bit become 0

↓

GO_BUSY bit = 1

→

GO_BUSY bit become 0

↓

Read Rx data

↓

Set CS line high
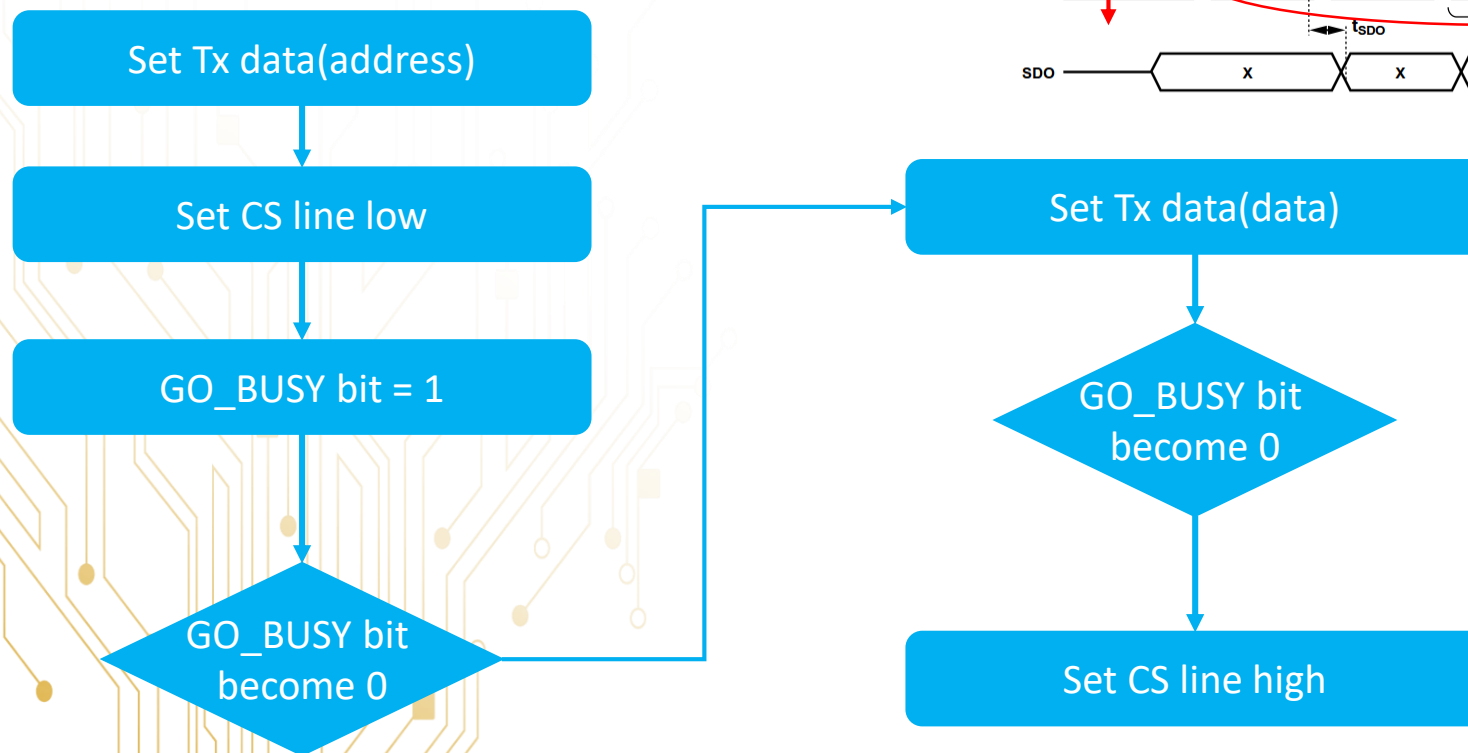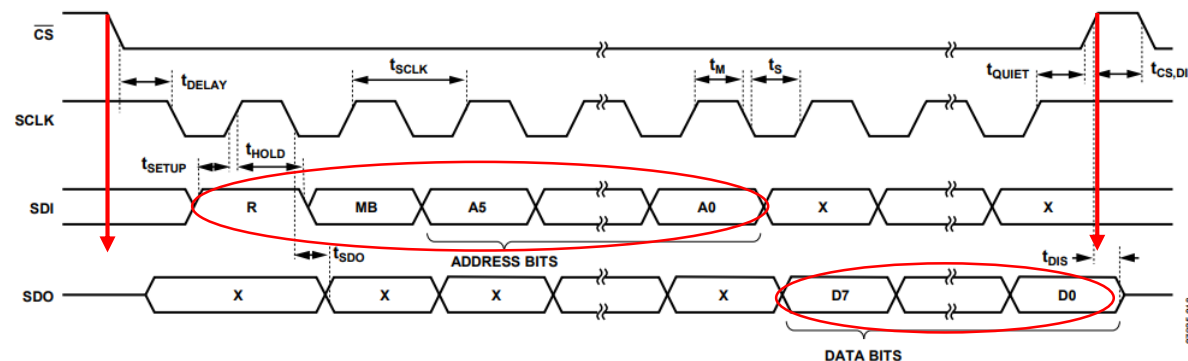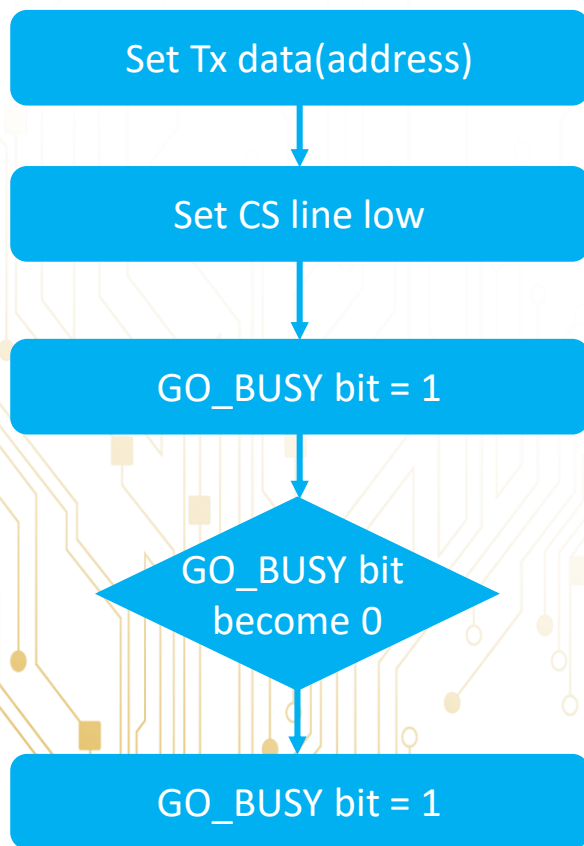
Figure 38. SPI 4-Wire Read

Tips: You can see NuMicro_SPI.ppt p.17 for the example code

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ADXL SPI Read/Write

R/W	MB	A5	A4	A3	A2	A1	A0

- Data format
  - Read/Write bit + Multiple-byte bit + 6 bits address
- Configure 0x2D(0x0010_1101) as address, single-byte Read
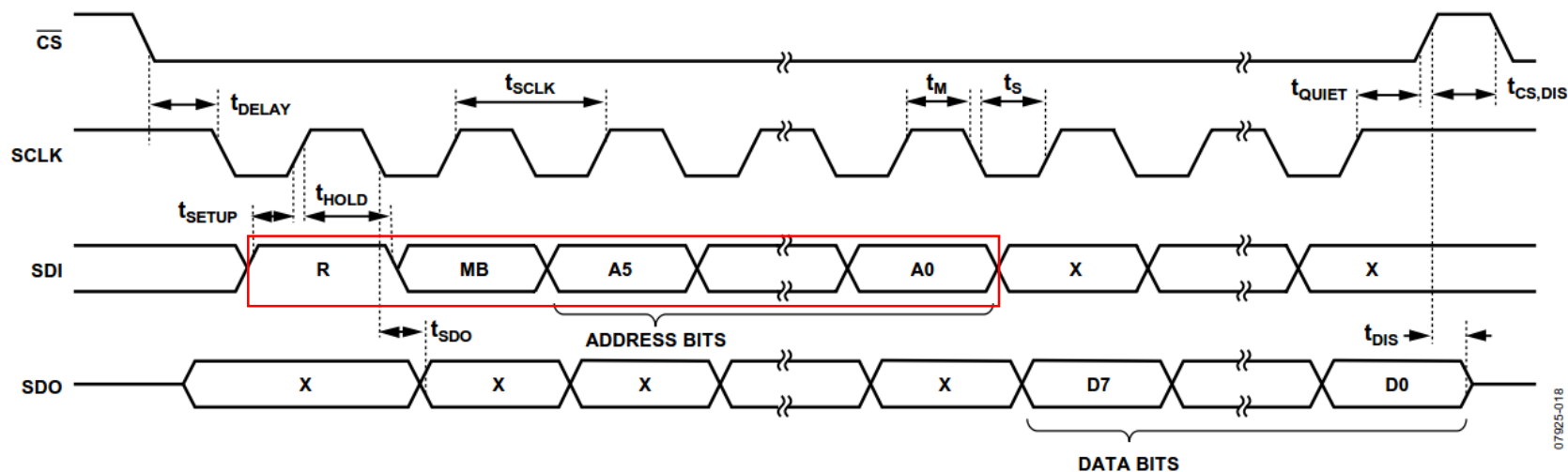 - Read + ~~MB~~ + address ➜ 0x1010_1101

Figure 38. SPI 4-Wire Read

ADXL pin configuration

- CS ------------>SPI2 CS(GPD0)
- SCL ----------->SPI2 CLK(GPD1)
- SDO ----------->SPI2 MISO(GPD2)
- SDA(SDI) ---->SPI2 MOSI(GPD3)
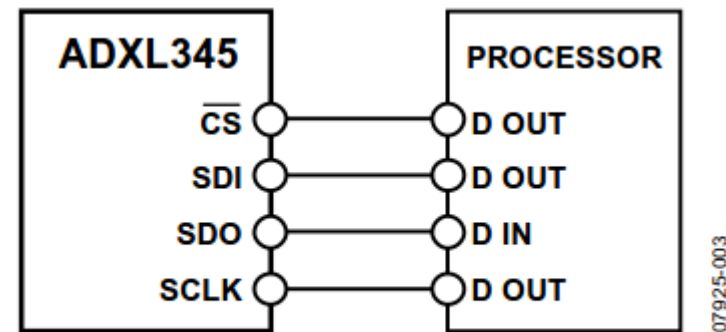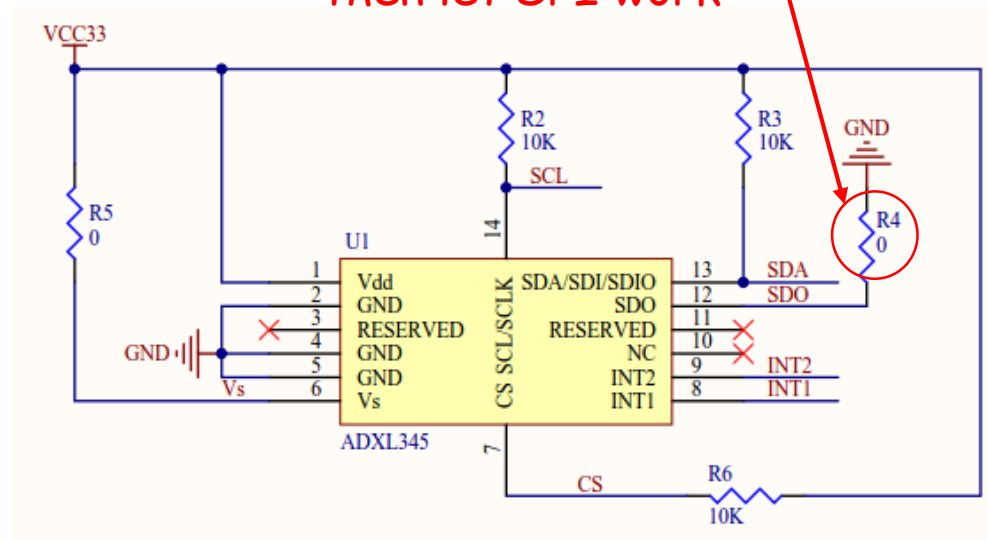
- Mark: Don't use SPI0

Figure 35. 4-Wire SPI Connection Diagram

Bad design for using SPI, we need to remove this resistor then let SPI work

ADXL345 register map

- ADXL slave address(0x53)
  - Write address: 0xA6
  - Read address: 0xA7
- Initial ADXL345
  - POWER_CTL(0x2D): 0x08
  - DATA_FORMAT(0x31): 0x0B
  - FIFO_CTL(0x38): 0x80
- ADXL data register
  - DATAX0(0x32), DATAX1(0x33)
  - DATAY0(0x34), DATAY1(0x35)
  - DATAZ0(0x36), DATAZ1(0x37)

Table 19.

Address		Name	Type	Reset Value	Description
Hex	**Dec**				
0x00	0	DEVID	R	11100101	Device ID
0x01 to 0x1C	1 to 28	Reserved			Reserved; do not access
0x1D	29	THRESH_TAP	R/$\overline{W}$	00000000	Tap threshold
0x1E	30	OFSX	R/$\overline{W}$	00000000	X-axis offset
0x1F	31	OFSY	R/$\overline{W}$	00000000	Y-axis offset
0x20	32	OFSZ	R/$\overline{W}$	00000000	Z-axis offset
0x21	33	DUR	R/$\overline{W}$	00000000	Tap duration
0x22	34	Latent	R/$\overline{W}$	00000000	Tap latency
0x23	35	Window	R/$\overline{W}$	00000000	Tap window
0x24	36	THRESH_ACT	R/$\overline{W}$	00000000	Activity threshold

Register 0x31—DATA_FORMAT (Read/Write)

D7	D6	D5	D4	D3	D2	D1	D0
SELF_TEST	SPI	INT_INVERT	0	FULL_RES	Justify	Range	

The DATA_FORMAT register controls the presentation of data to Register 0x32 through Register 0x37. All data, except that for the ±16 g range, must be clipped to avoid rollover.

SELF_TEST Bit

A setting of 1 in the SELF_TEST bit applies a self-test force to the sensor, causing a shift in the output data. A value of 0 disables the self-test force.

Basic

- Read 3 axis accelerometer and print on putty

- Need to do calibration
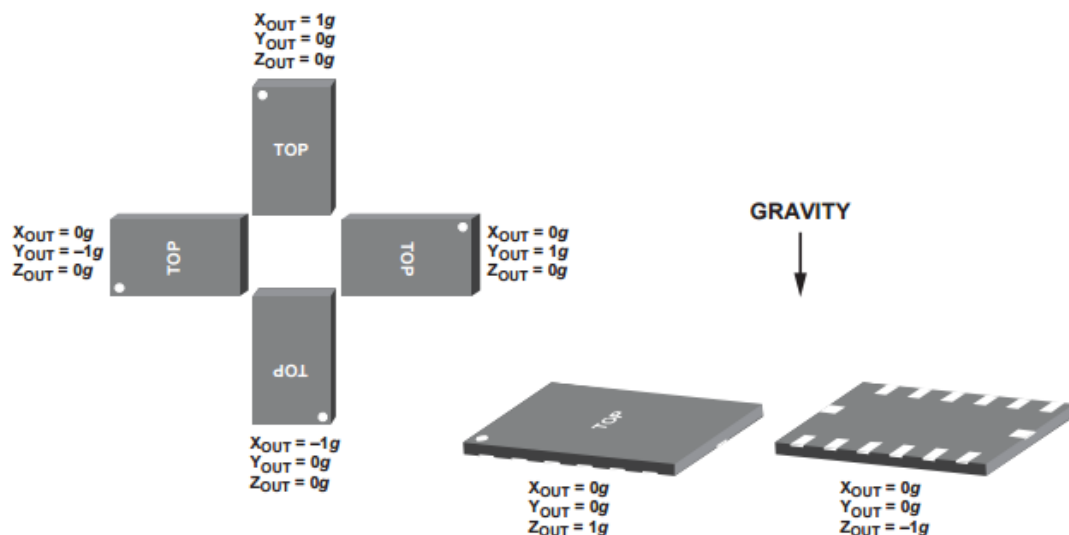 - Result = (Raw data ± offset)/(256 ± offset)

Figure 58. Output Response vs. Orientation to Gravity

Tips

- 範例程式: SPI_Loopback

- Easy test: you can read the adxl register 0x00 to test SPI communication is correct or not, it will return 0xE5 if your SPI is right

- Remember to change configuration in the SYS_init
  - Ex. CLK_SEL1(ModuleClock), GPx_MFP, ALT_MFP ➜ change SPI to SPI2

- Do not use AutoSS, SPI.c SPI.h are useful.

- Be careful for the SPI configuration !!!

- You can write the code as the example.c

Demo

- Place: 創新大樓515 找助教 宋皓天
- Demo Time：(二)(三)下午四點~五點 (發完題目第二周和第三周)
- Report deadline: 12/17(五)
- Report title format: LABx_ID_Name.pdf

- Demo必須在Report deadline前完成
- Demo前須先上傳程式碼(上傳main所在的.c檔即可)

Graded

- Basic : 80%
- Report & Code : 20%