AMS0805WAH

CATALOG No.:

2008.03

AMS0805WAH

Motion Sensor Data Sheet
Ver. 1.3

AMOSENSE

Advanced Material on **Technology**

Overview

Motion sensor is a 6-axis module consisting of 3-axis magnetic sensor and 3-axis accelerometer. It allows highly accurate motion detection with geomagnetic direction and tilting data. AMS0805WAH is a world's smallest class of motion sensor module with embedded uCom. Moreover, our exclusive embedded calibration algorithm, iRAC, eliminates the need for initial manual calibrations. It also enables users to access to reliable motion data virtually anywhere. Therefore, motion sensor is suitable for deployment in hand-held devices, where diverse movements are constantly expected, in order to acquire accurate positioning and direction data.

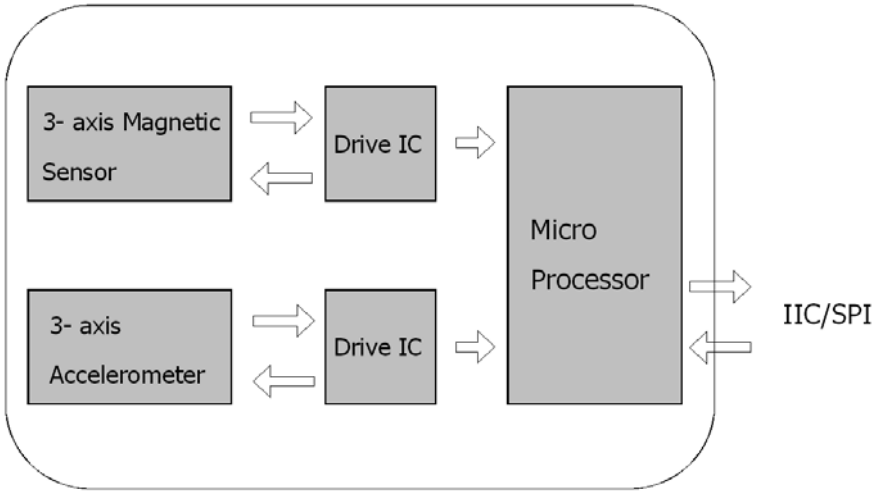
Features

- a 3-axis accelerometer, a 3-axis magnetic sensor
- an internal micro-processor
- Built-in software (for auto-calibration)
- Serial interface: IIC, SPI
- Size: 7 X 9 X 1.2 (mm)
- iRAC (Intelligent Real time Automatic Calibration)
  - Automatic offset compensation
  - Automatic temperature compensation
  - Automatic sensitivity calibration
  - Automatic calibration for magnetic field disturbance
- Maximum sampling rate : 30Hz
- Low power: less than 9 mA in active
  less than 20 uA in all power down mode

Applications

- Personal Navigation in mobile phone
- Calorie counter
- Constellation seeking device
- Robot motion control
- 3-D presenter
- Game controller

Functional Block Diagram



Absolute Maximum Ratings

Item	Symbol	Min.	Max.	Unit	Description
DC Supply Voltage (DVDD,DVDDIO,AVDD)	-	- 0.3	+ 4	V	
Storage Temperature Range	-	- 55	+ 125	℃	
Mechanical Shock	-	-	+ 4,600	g	
ESD	-	-	+ 2,000	V	

Recommended Operating Conditions

Item	Symbol	Min.	Max.	Unit	Description
Operating DVDD Supply Voltage Range	-	+ 2.7	+ 3.4	V	
Operating AVDD Supply Voltage Range	-	+ 2.7	+ 3.4	V	
Operating DVDDIO Supply Voltage Range	-	+ 1.8	+ 3.4	V	
Operating Temperature Range	-	- 20	+ 85	℃	

Compass Specifications

Item	Min.	Typ.	Max.	Unit	Description
Azimuth accuracy	- 5	-	+ 5	degree	
Azimuth range	0	-	359	degree	
Azimuth resolution	-	1	-	degree	
Flux density measurement range	- 1,000	-	+ 1,000	μT	
Maximum sampling rate	-	-	30	Hz	
Power consumption	-	-	27	mW	Power down : 60 uW(@ 3.0 V)
Roll/pitch compensation range	- 89	-	+ 89	degree	
Roll/pitch resolution	-	1	-	degree	
Roll/pitch accuracy	- 5	-	+ 5	degree	

DC characteristics

At. DVDD & DVDDIO = 2.7~3.4V Ta= -20℃~85℃

Item	Symbol	Min.	Max.	Unit	Description
Input high voltage 1	VIH1	0.7 x DVDD	DVDD + 0.6	V	All Digital I/O Port except RESET
Input high voltage 2	VIH2	0.9 x DVDD	DVDD + 0.6	V	/RESET(Schmitt input)
Input low voltage 1	VIL1	-0.5	0.3 x DVDD	V	All Digital I/O Port except RESET
Input low voltage 2	VIL2	-0.5	0.3 x DVDD	V	/RESET(Schmitt input)

IIC characteristics

At. DVDDIO = 2.7~3.4V Ta= -20℃~85℃

Parameter	Max.	Units	Description
Clock Frequency	400	kHz	SCL
Sink Current	2	mA	SDA, SCL

SPI characteristics

At. DVDDIO = 2.7~3.4V Ta= -20℃~85℃

Parameter	Max.	Units	Description
Clock Frequency	1	MHz	SCK

Pin Descriptions

● Serial Interface

Pin name	Pin No.	Pin type	Initial	Function
NC / /SS	3	DI	3-states H	IIC mode: NC. SPI mode: Slave - Selection pin.
NC / MOSI	2	DI	3-states H	IIC mode: NC. SPI mode: Master-Output, Slave-Input.
SDA / MISO	1	DIO / DO	Z H	IIC mode: SDA SPI mode: Master-Input, Slave-Output.
SCL / SCK	4	DI	-	Clock.
IIC / SPI	7	DI	-	L : SPI, H : IIC

● Power

Pin name	Pin No.	Pin type	Function
DVDD	12,18	PWR	Digital power supply
DVDDIO	13	PWR	Digital I/O power supply (See page)
DVSS	5,14,22	PWR	GND for digital.
AVDD	8	PWR	Analog power supply.
AVSS	10	PWR	GND for analog.

● NC for only Testing

Pin name	Pin No.	Function
NC	9,11,15,16	For only test

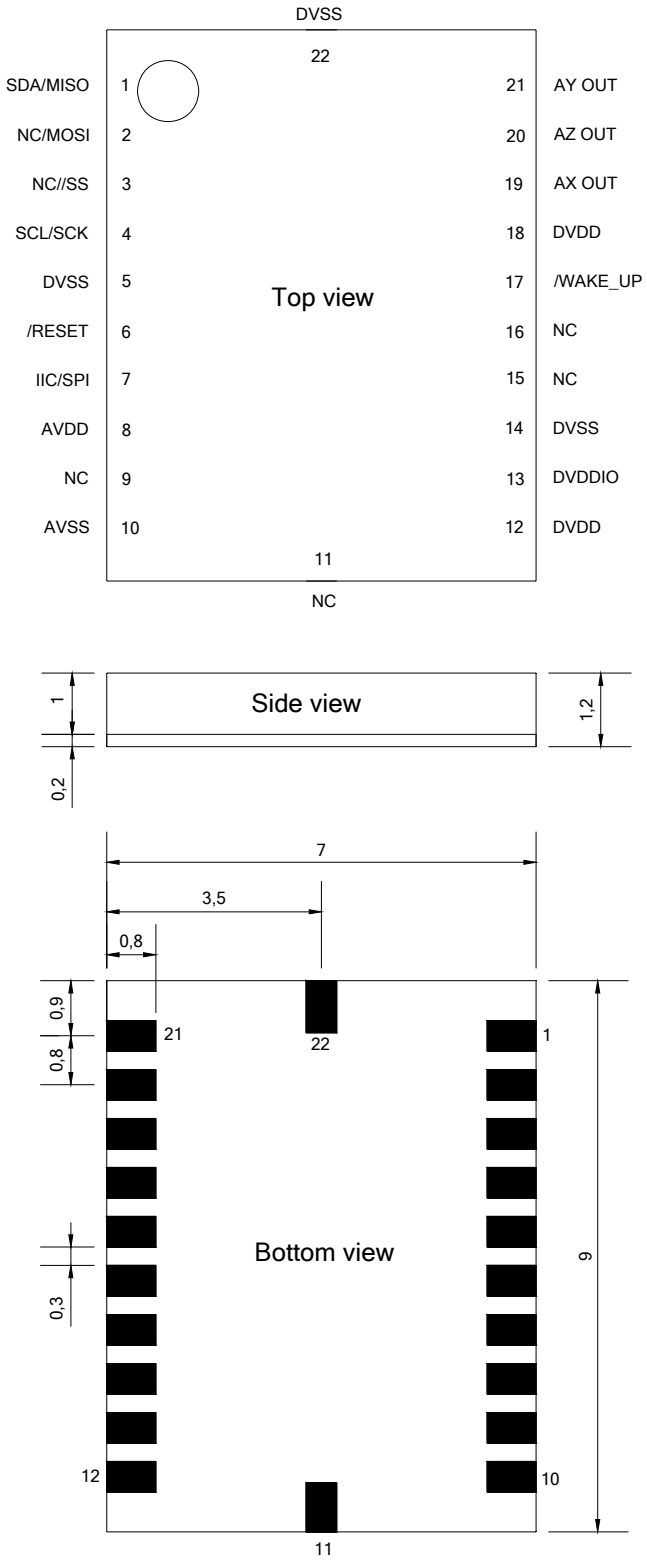
● Etc

Pin name	Pin No.	Pin type	Initial	Function
/RESET	6	DSI	H	Reset pin, active "L", Schmitt input.
/WAKE_UP	17	DI	H	Wake up signal : active "L"
AXOUT	19	AO	-	X-Axis Accelerometer analog output. External capacitor must be connected for stable signal (100nF)
AYOUT	21	AO	-	Y-Axis Accelerometer analog output. External capacitor must be connected for stable signal (100nF)
AZOUT	20	AO	-	Z-Axis Accelerometer analog output. External capacitor must be connected for stable signal (100nF)

Note

DI: Digital input
DSI: Digital Schmitt input
DIO: Digital bi-directional
DO: Digital output
AO: Analog output
PWR: Power

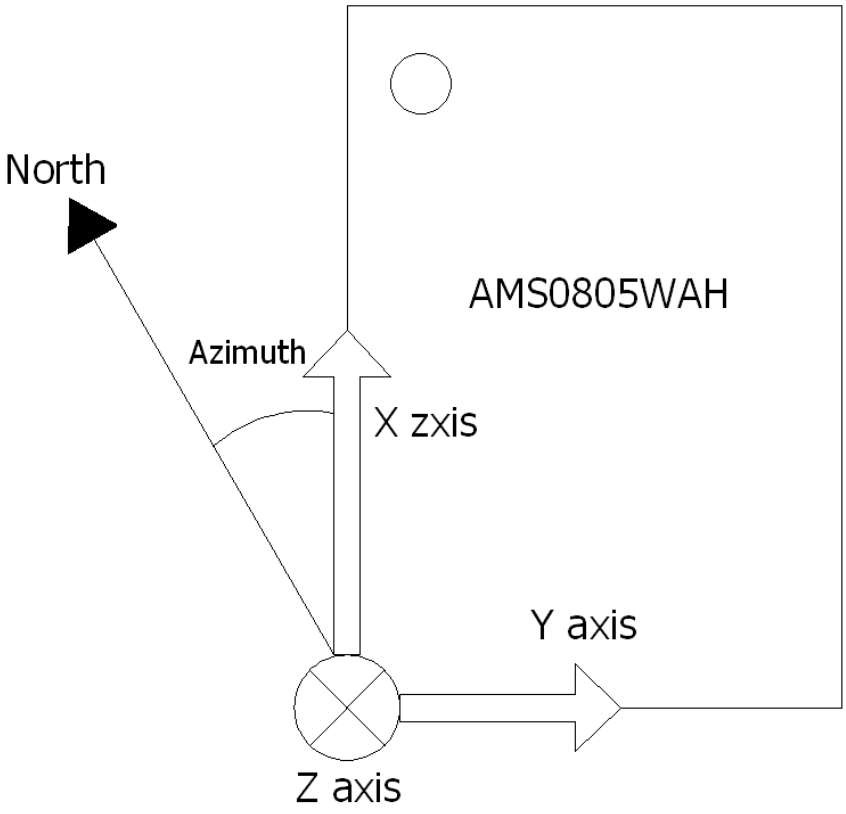
Package Information (unit: mm)



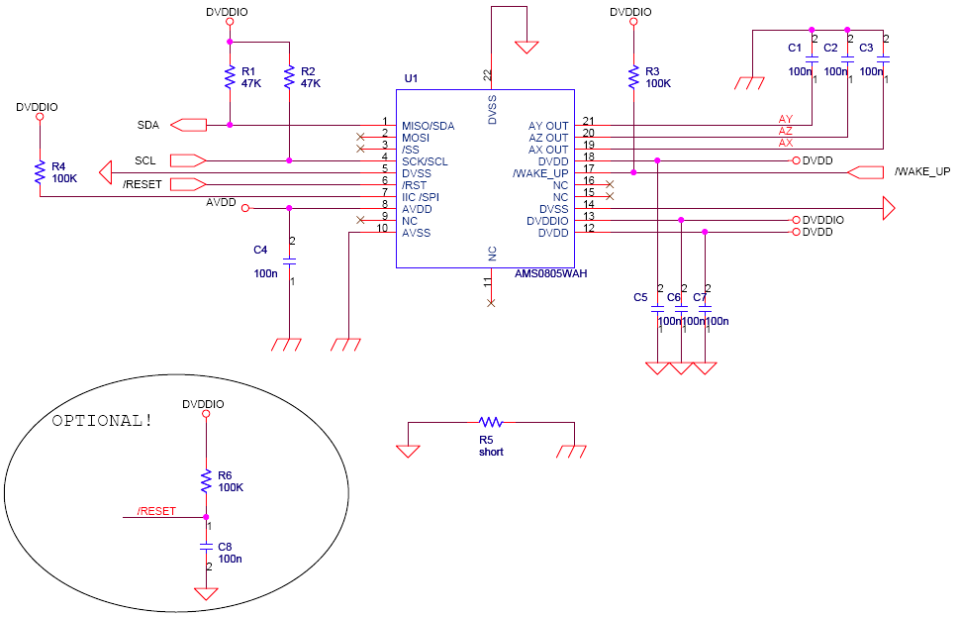
APPENDIX

Coordinate system

Basically, the *right-hand rule* is used for determining the sign of a rotation: point your right thumb into the positive rotation axis and curl your fingers into the forward rotational direction.



Typical Connection (IIC default)

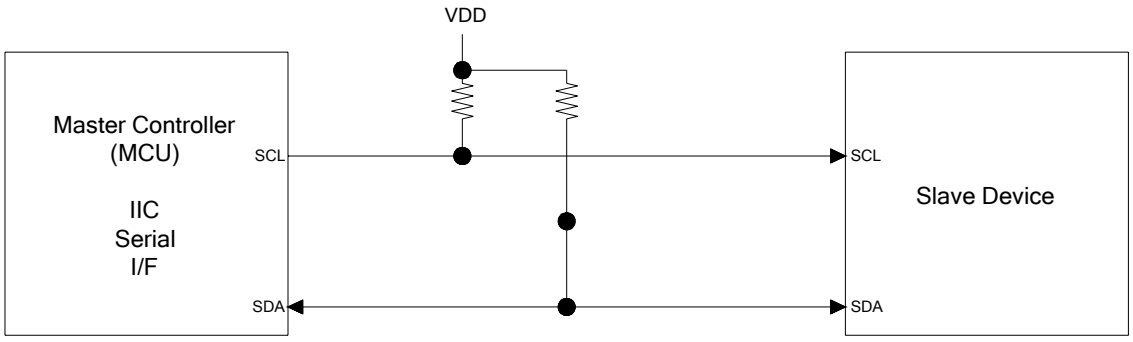


IIC Serial Peripheral Interface

IIC is suited for typical micro-controller. It is designed to easily connect any µcom to IIC compliant slave. The 2 required lines on the slave side are the clock (SCL) signal and the data (SDA) signal.

Typical Operating Circuit

● Typical Connection



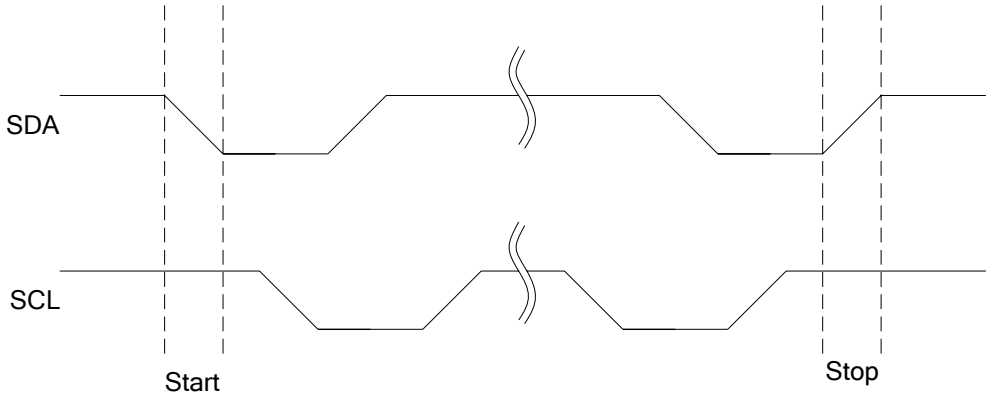
Protocol

● Transaction Rules

Each data transferred on the SDA is accompanied by a pulse on the clock signal. The data on the SDA must be stable when the clock is high. The only exception is for generating start and stop. The master initiates and terminates a data transmission.

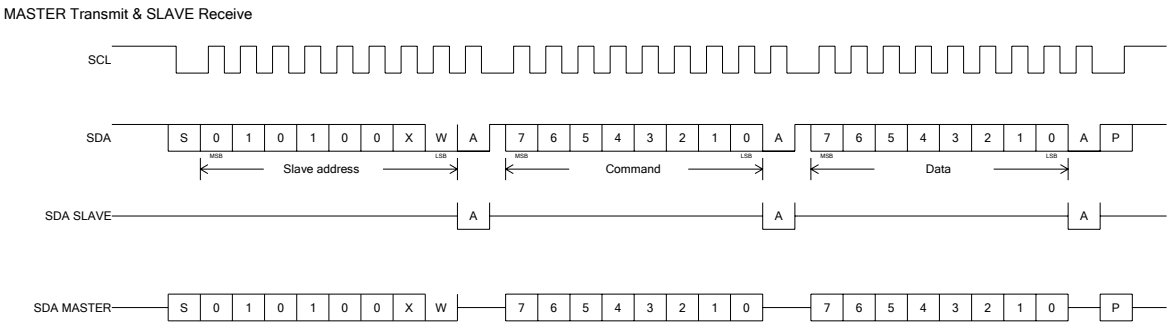
Start condition: To start reading/writing operation, it is necessary to generate a start condition by switching the SDA input from high level to low level when the SCL input is high level.

Stop condition: To stop reading/writing operation, it is necessary to generate stop condition by switching the SDA input from low level to high level when the SCL input is high level. When the stop condition is generated, the operation is stopped, the data is processed and the system enters in standby mode.



● Single-Byte Write Sequence

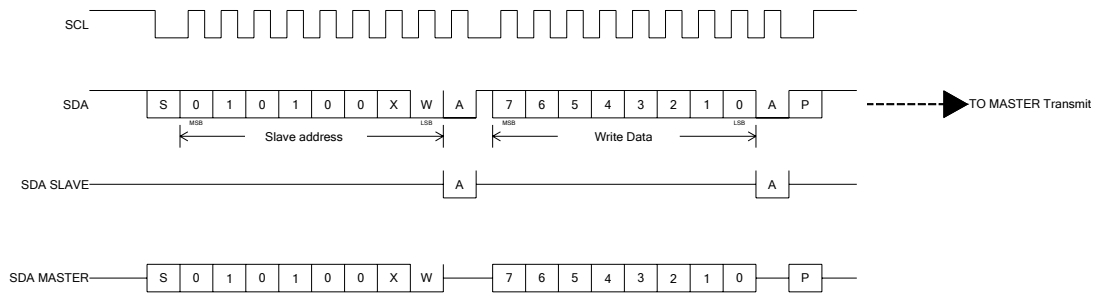
The Single Byte Write Sequence is composed of 3 bytes of 9 bits, the 9th bit being the acknowledgement. It starts by a start condition and ends by a stop condition. The first byte is the Slave Address, the second is the Register Address and the third is the Data Byte. The LSB of the Slave Code byte is the R/W indicator.



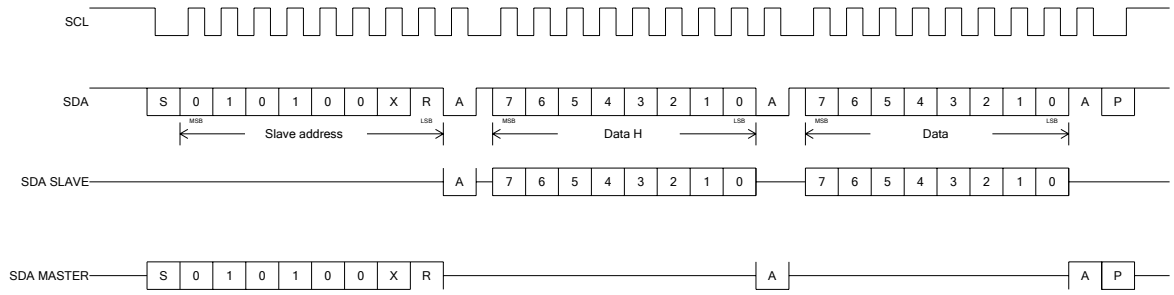
● Single-Word Read Sequence

There is no Single-Byte Read Sequence, so that "DEV_ID" and "REVNUM" should be read at word length if it would be read. In this case, upper byte of the word is "zero" and the valid data is in lower byte. Only Word read sequence is provided as following:

MASTER Transmit & SLAVE Receive



MASTER Receive & SLAVE Transmit



Here, Command means Register Address actually.

● **Slave & Register address**

The 7bit field is slave code field. The last bit on the SDA is Read/Write bit.

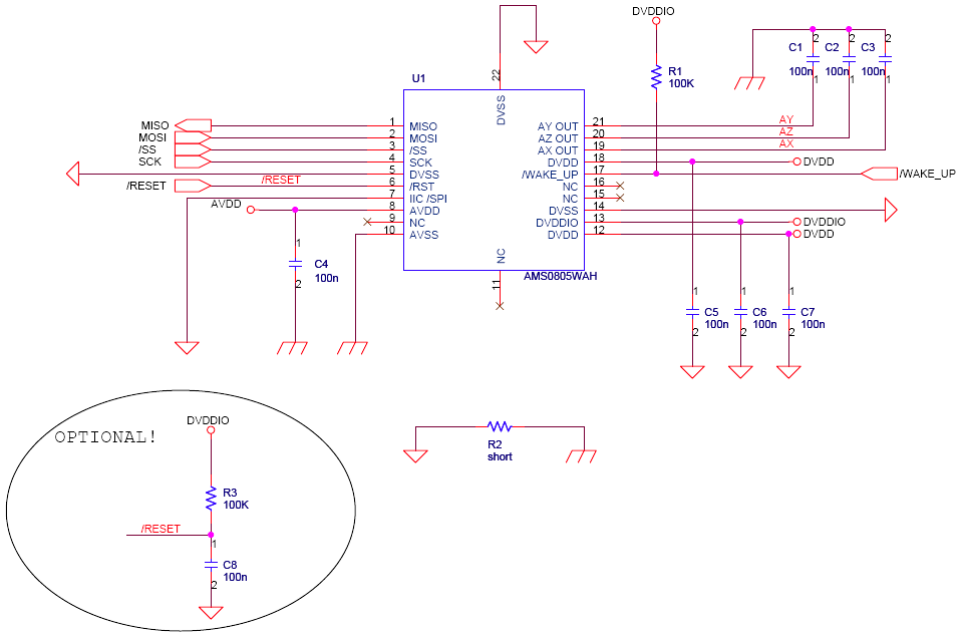
● **Slave address field**

Bit	NAME	Value	Description
Bit[7...0]	Slave address	01010000(=0x50) 01010001(=0x51)	Write Sequence Read Sequence

● **Register Field**

Bit	NAME	Range	Description
Bit[7...0]	Register address	0x01 ~ 0x34	Internal register address

Typical Connection (SPI [OPTION])

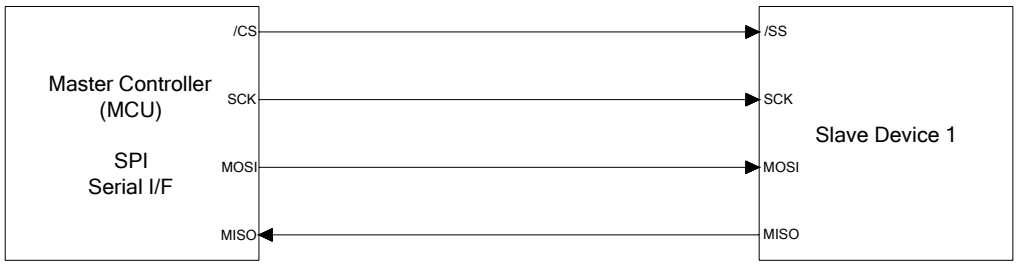


SPI Serial Peripheral Interface (Original SPI)

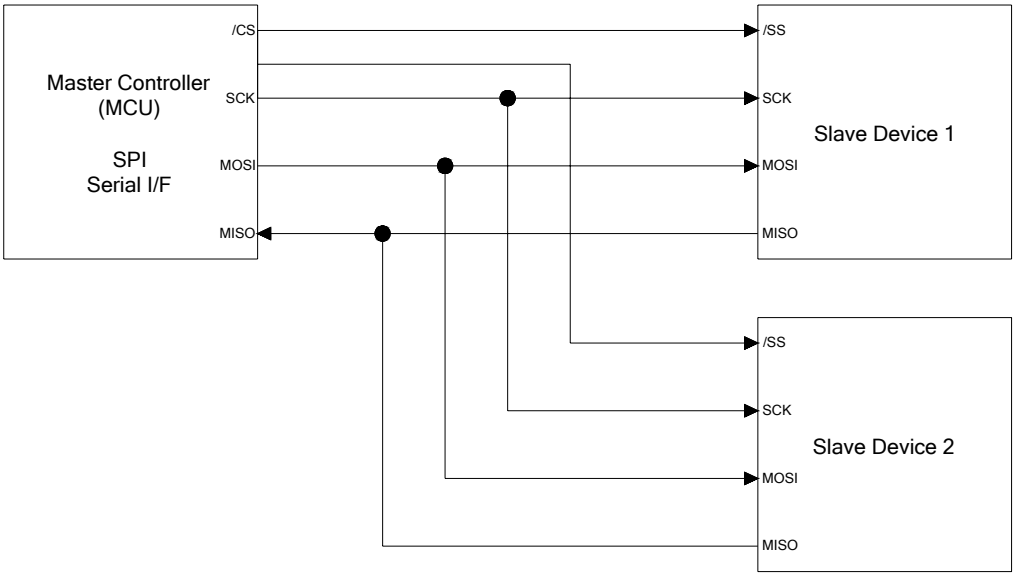
The Serial Peripheral Interface (SPI) is a 4-wire Clock Synchronous Serial Interface. It is designed to easily connect any CPU to SPI compliant slaves using only 3 lines plus one chip select line per slave. Few slaves can be connected on the CPU SPI. The 4 required lines on the slave side for the SPI are MISO, MOSI, SCK signal and /SS signal.

● Typical Operating Circuit

- Typical Connection with one Slave



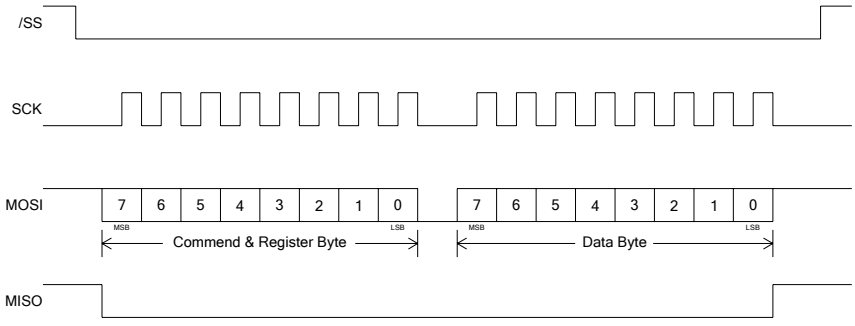
– Typical Connection with two Slaves



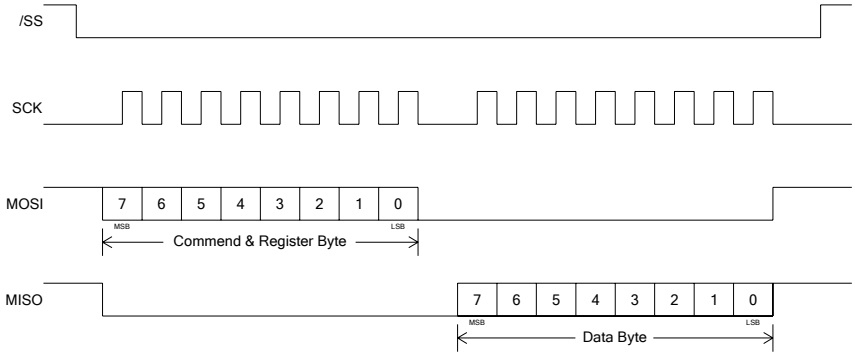
Protocol

The data format is MSB in first and LSB in last.

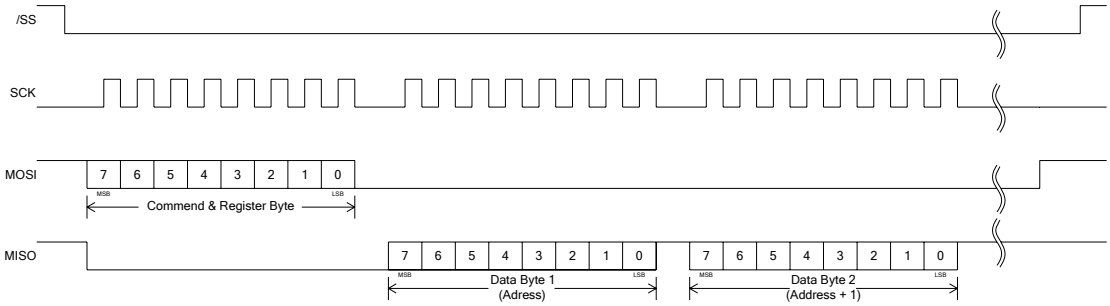
● **Single Byte Write Sequence**



● **Single Byte Read Sequence**



● Multi Byte Read Sequence



Register Table

Register	Symbol	R/W	Explanation
01(h)	DEV_ID	R	Device ID
02(h)	REVNUM	R	Revision Number
03(h)	MAG_STATUS	R	Big Magnetic Field Status Flag
14(h)	POWER	W	Power Down Mode
20(h)	AZIMUTH_H	R	MSB of AZIMUTH
21(h)	AZIMUTH_L	R	LSB of AZIMUTH
22(h)	MAG_XH	R	MSB of Magnetic Sensor X axis
23(h)	MAG_XL	R	LSB of Magnetic Sensor X axis
24(h)	MAG_YH	R	MSB of Magnetic Sensor Y axis
25(h)	MAG_YL	R	LSB of Magnetic Sensor Y axis
26(h)	MAG_ZH	R	MSB of Magnetic Sensor Z axis
27(h)	MAG_ZL	R	LSB of Magnetic Sensor Z axis
28(h)	CAL_XH	R	MSB of slope compensated X axis
29(h)	CAL_XL	R	LSB of slope compensated X axis
2A(h)	CAL_YH	R	MSB of slope compensated Y axis
2B(h)	CAL_YL	R	LSB of slope compensated Y axis
2C(h)	ACC_XH	R	MSB of Accelerometer X axis
2D(h)	ACC_XL	R	LSB of Accelerometer X axis
2E(h)	ACC_YH	R	MSB of Accelerometer Y axis
2F(h)	ACC_YL	R	LSB of Accelerometer Y axis
30(h)	ACC_ZH	R	MSB of Accelerometer Z axis
31(h)	ACC_ZL	R	LSB of Accelerometer Z axis
32(h)	PITCH_H	R	MSB of PITCH angle
33(h)	PITCH_L	R	LSB of PITCH angle
34(h)	ROLL_H	R	MSB of ROLL angle
35(h)	ROLL_L	R	LSB of ROLL angle
AA(h)	CAL_ACC	W	Accelerometer Offset Calibration Mode (See page 22~26)

Register Descriptions

01(h) "DEV_ID" Device ID Register

Device ID 04H

02(h) "REVNUM" Revision number Register

Revision number 20H

03(h) "MAG_ALARM" External Big Magnetic Field Status Flag

- No External Big Magnetic Field condition 00H
- External Big Magnetic Field condition 01H

● This register is operated over than 0.4gauss external magnetic field distortion.

(In this condition, the Azimuth of AMS0805WAH may be directed wrong,

You need to calibration AMS0805WAH)

14(h) "AMS_POWER" Power Management Register

Registers	Descriptions
00h(W)	ACTIVE : ALL POWER ON (Magnetic sensor ON, Accelerometer ON, MICOM ON)
01h(W)	POWER DOWN: ALL POWER OFF (Magnetic sensor OFF, Accelerometer OFF, MICOM OFF)
02(h)	POWER SAVE: Magnetic sensor OFF, Accelerometer ON, MICOM ON

20(h) ~ 21(h) "AZIMUTH"

- Direction of AMS0805WAH
- Data range: 0 ~ 360
- Resolution: 1 degree

22(h) ~ 23(h) "MAG_X"

- X axis Magnetic flux density value

24(h) ~ 25(h) "MAG_Y"

- Y axis Magnetic flux density value

26(h) ~ 27(h) "MAG_Z"

- Z axis Magnetic flux density value

28(h) ~ 29(h) "CAL_X"

- Slope compensated X axis Magnetic flux density value

2A(h) ~ 2B(h) "CAL_Y"

- Slope compensated Y axis Magnetic flux density value

2C(h) ~ 2D(h) "ACC_X"

- X axis Acceleration value
- Data range: - 2,048 ~ 2,047
- Resolution: 1 counts = 0.01225m/s^2

2E(h) ~ 2F(h) "ACC_Y"

- X axis Acceleration value
- Data range: -2,048 ~ 2,047
- Resolution: 1 counts = 0.01225m/s^2

30(h) ~ 31(h) "ACC_Z"

- X axis Acceleration value
- Data range: -2,048 ~ 2,047
- Resolution: 1 counts = 0.01225m/s^2

32(h) ~ 34(h) "PITCH"

- Pitch angle of AMS0805WAH
- Data range: - 89 ~+ 89
- Resolution: 1 degree

34(h) ~ 35(h) "ROLL"

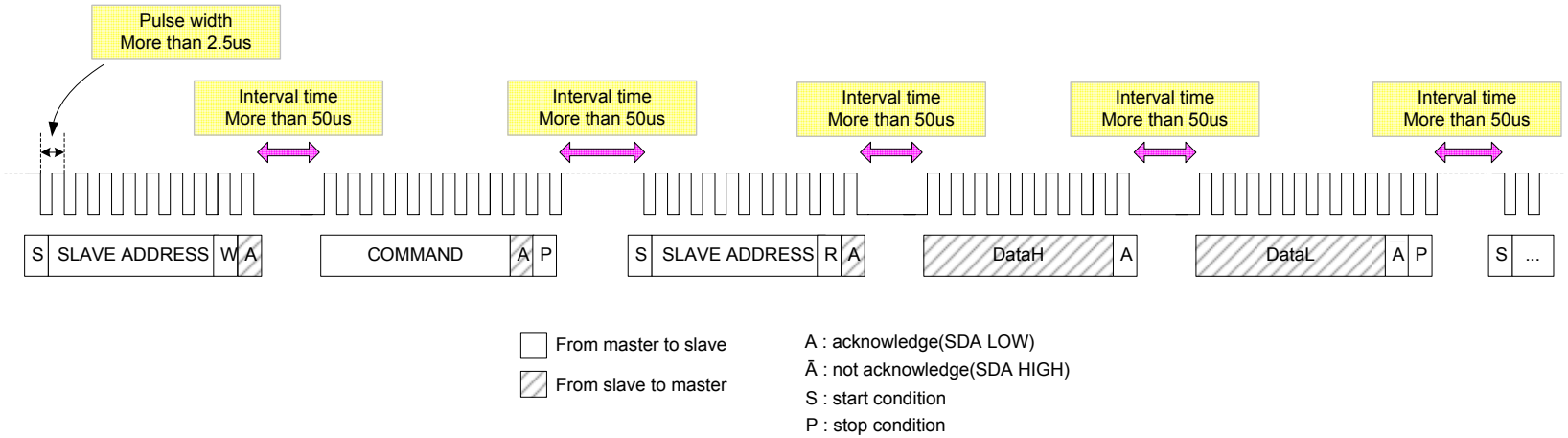
- Roll angle of AMS0805WAH
- Data range: - 89 ~+ 89
- Resolution: 1 degree

AA(h) "CAL_ACC"

- Accelerometer Offset Calibration Mode
- See page 22 ~ 26

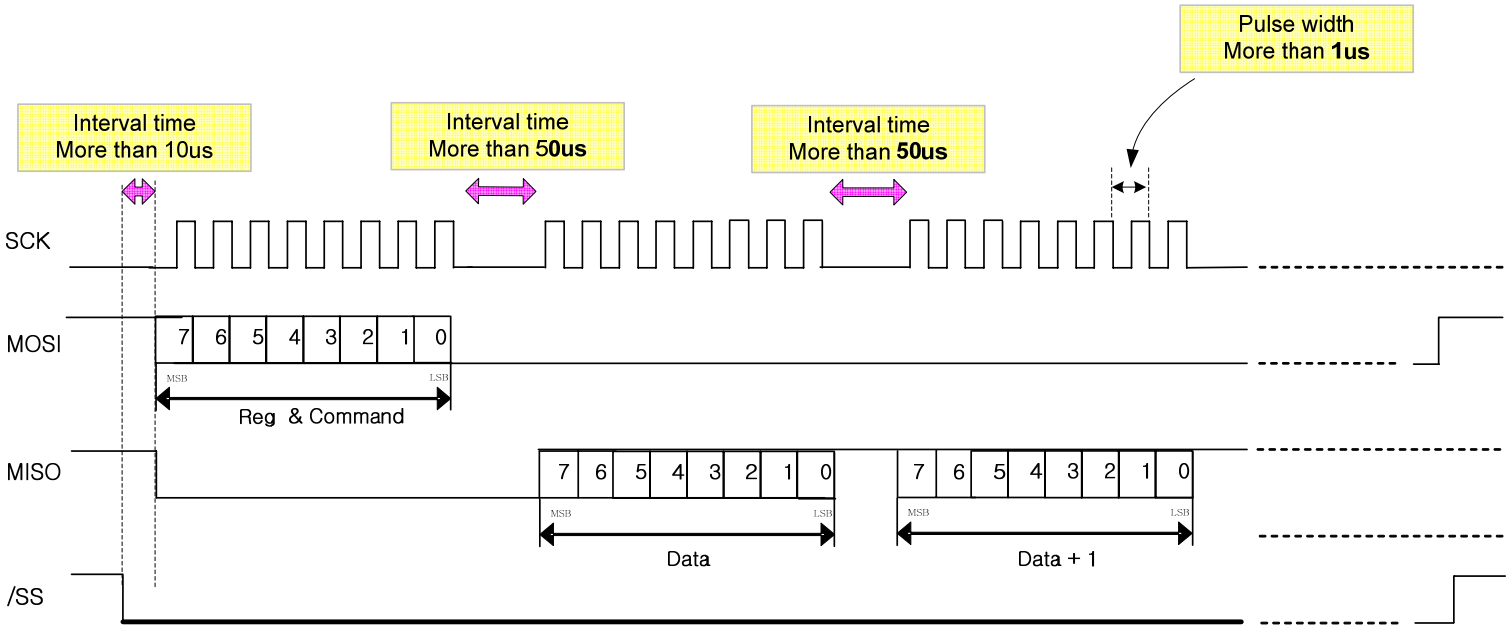
Communication specification and software applications (IIC)

Communication mode : IIC serial interface.
Communication speed : Maximum 400 kHz(Fast mode)
Operation is not guaranteed for exceeding this speed.



Communication specification and software applications (SPI)

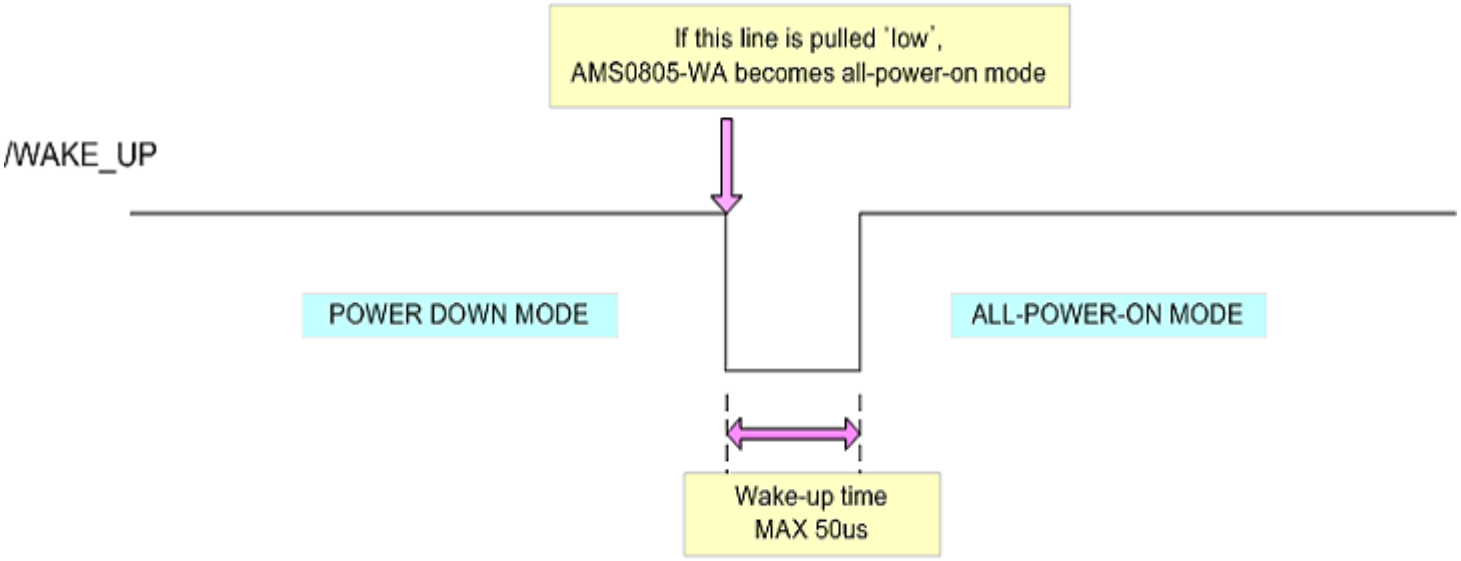
Communication mode : SPI serial interface.
Communication speed : Maximum 1.5 MHz
Operation is not guaranteed for exceeding this speed.



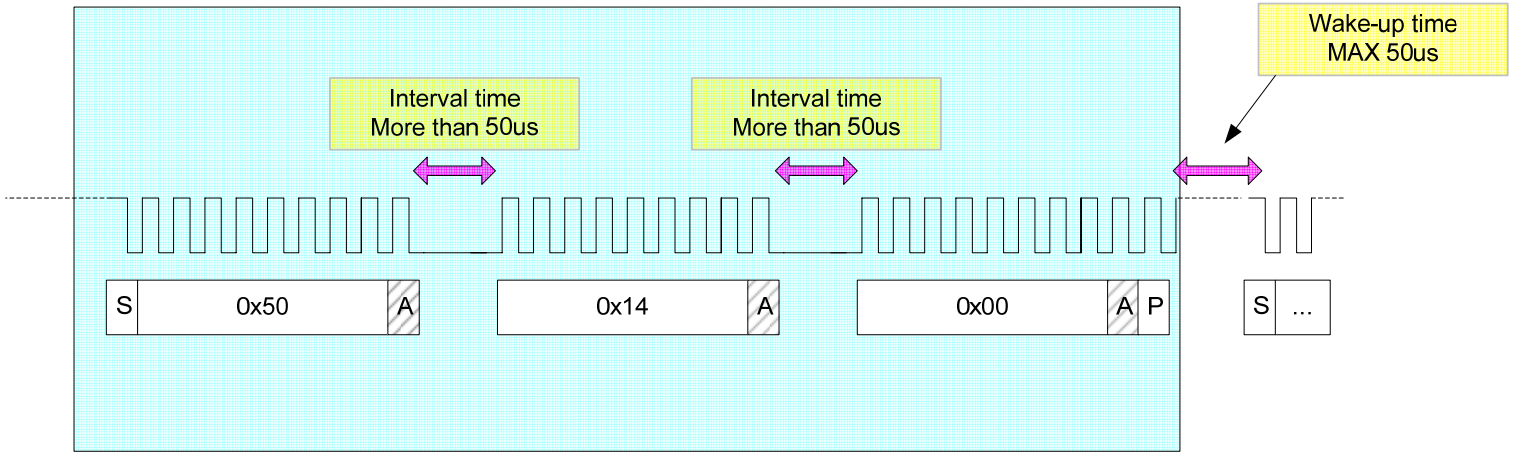
Wake-up from power down mode

we serve two type of wake-up functions(using **/WAKE_UP signal [for SPI]** or using **IIC communication at Address match [for IIC]**)

- **Using /WAKE_UP signal**



● Using IIC communication



IIC ALL POWER ON MODE

From master to slave

From slave to master

A : acknowledge(SDA LOW)

Ā : not acknowledge(SDA HIGH)

S : start condition

P : stop condition

AMS0805WAH Accelerometer Offset Calibration Mode Manual

The accelerometer's offset can be changed a little value, because of big shock, very high temperature by soldering etc. For the more precision azimuth and tilt, we need to calibrate accelerometer's offset. AMS0805WAH supports ACC offset calibration mode. It is that you can calibrate accelerometer's offset in this mode.

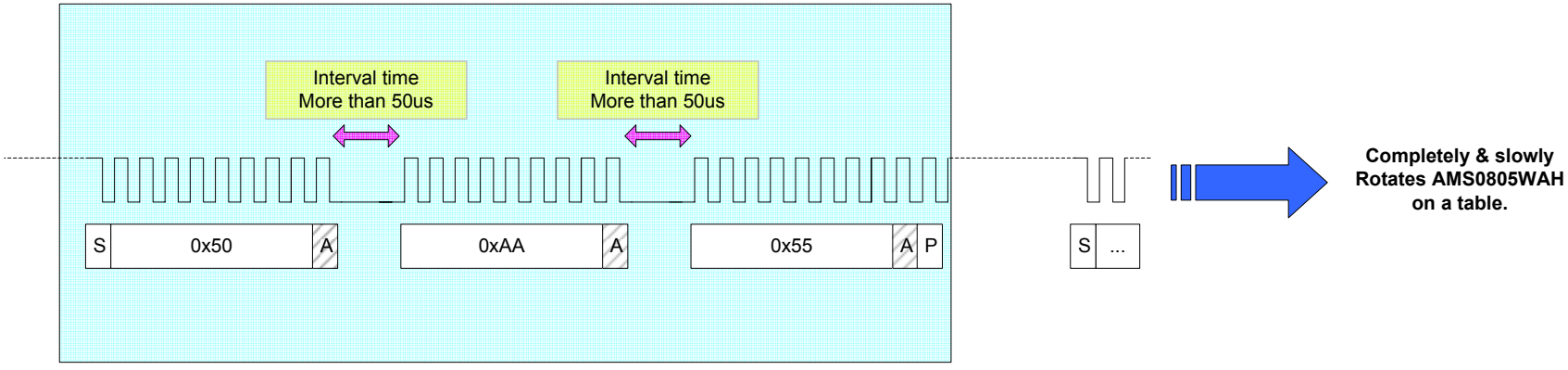
The calibration sequence is below.

- Put AMS0805WAH(or product) on a table.
  ➔ Maintain stable condition before starting the CAL ACC offset mode.

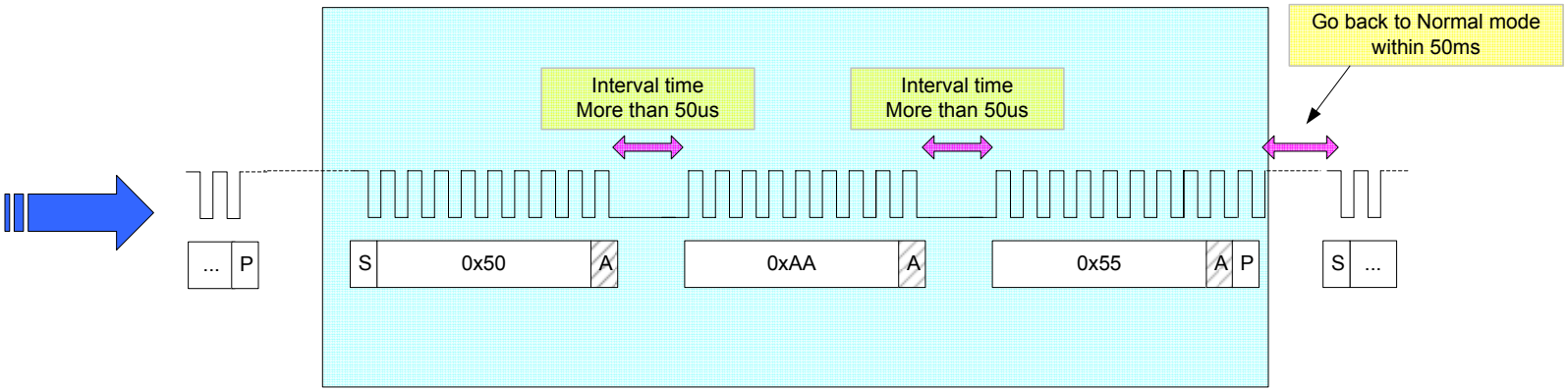
- Start the Accelerometer Offset Calibration Mode
  ➔ If host transmits '0xAA' and '0x55' continuously, AMS0805WAH is started the Accelerometer Offset Calibration Mode.

- Completely and slowly rotate AMS0805WAH on the table.
  ➔ Don't shake and give any tilt when AMS0805WAH is in the Accelerometer Offset Calibration Mode.

- Exit ACC offset mode
  ➔ If host transmit '0xAA' and '0x55' continuously again, AMS0805WAH is saved offset values and exit the Accelerometer Offset Calibration Mode,



START the ACC offset CAL mode



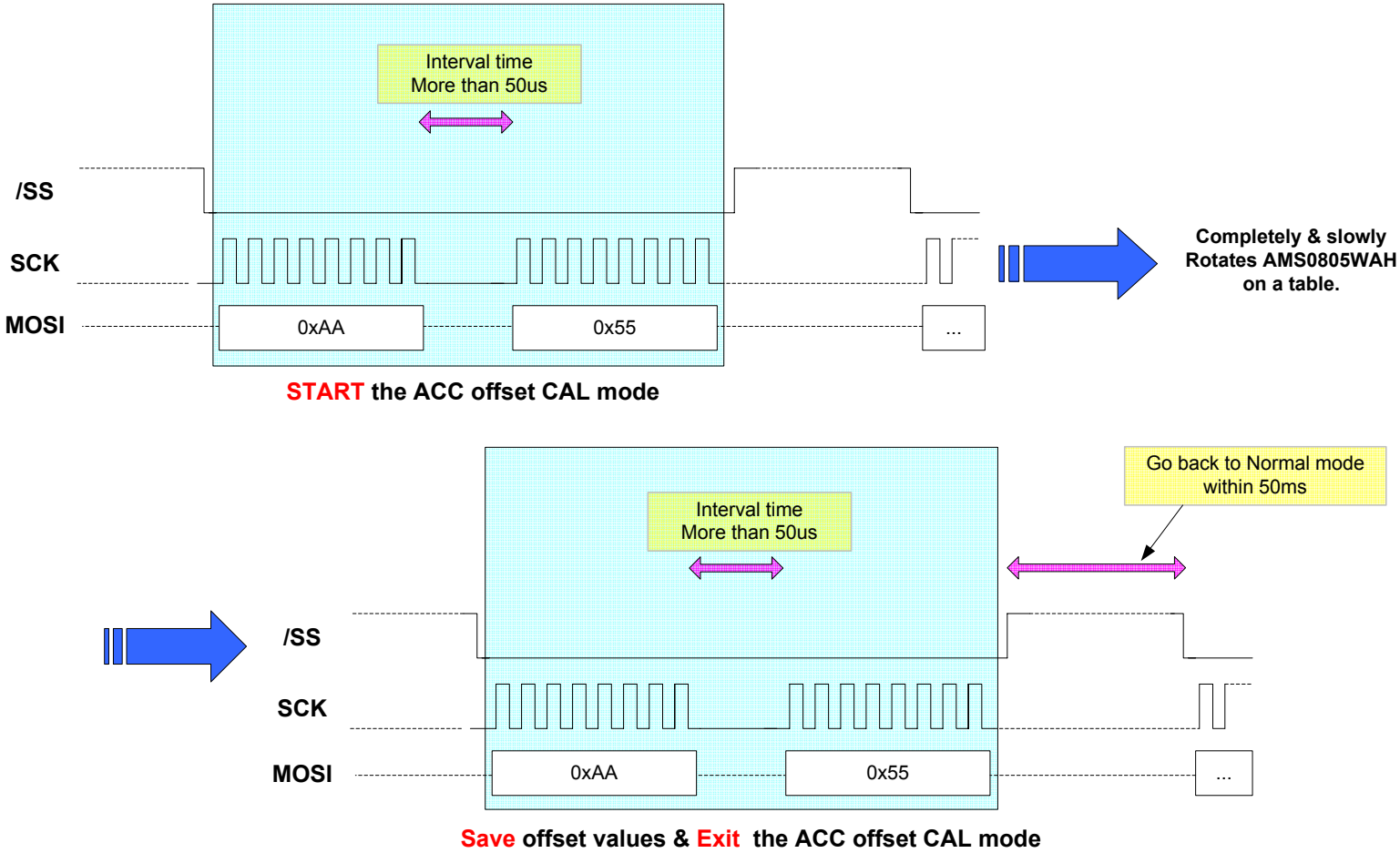
Save offset values & Exit the ACC offset CAL mode

ACC offset CAL mode
IIC communication protocol

From master to slave

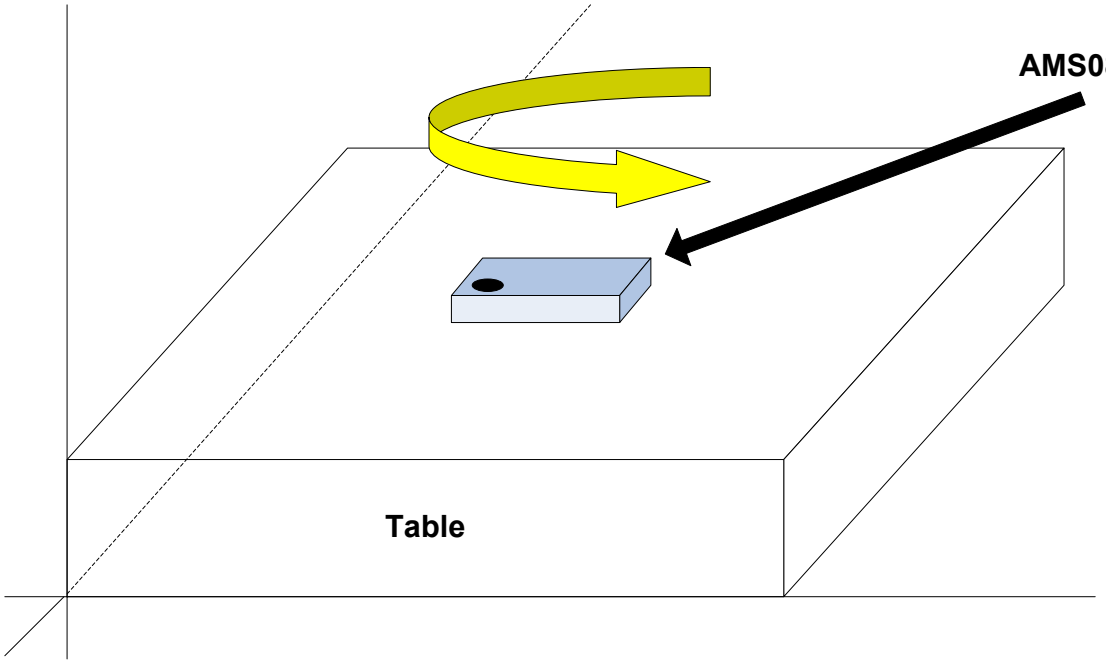
From slave to master

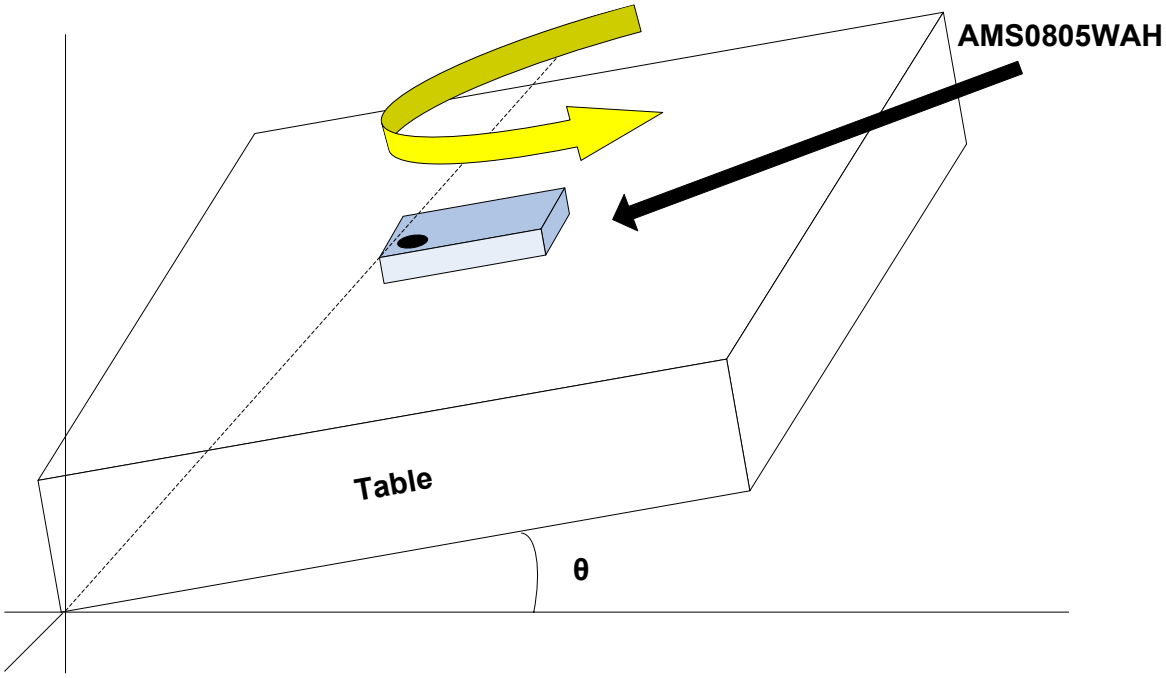
A : acknowledge(SDA LOW)
Ā : not acknowledge(SDA HIGH)
S : start condition
P : stop condition



ACC offset CAL mode
SPI communication protocol

From master to slave





Although the table has some tilt, you can calibrate accelerometer's offset.

Note : Don't shake and give any tilt when AMS0805WAH is in the ACC offset CAL mode.

Data format in the ACC offset CAL mode.
In the calibration-mode, registers are below

20(h) ~ 21(h) "ACC_X"
- X axis Acceleration value
- Data range: 0 ~ 4,095

22(h) ~ 23(h) "ACC_Y"
- Y axis Acceleration value
- Data range: 0 ~ 4,095

24(h) ~ 25(h) "ACC_Z"
- Z axis Acceleration value
- Data range: 0 ~ 4,095

26(h) ~ 27(h) "Maximum ACC_X"
- Maximum X axis Acceleration value in the calibration mode
- Data range: 0 ~ 4,095

28(h) ~ 29(h) "Minimum ACC_X"
- Minimum X axis Acceleration value in the calibration mode
- Data range: 0 ~ 4,095

2A(h) ~ 2B(h) "Maximum ACC_Y"
- Maximum Y axis Acceleration value in the calibration mode
- Data range: 0 ~ 4,095

2C(h) ~ 2D(h) "Minimum ACC_Y"
- Minimum Y axis Acceleration value in the calibration mode
- Data range: 0 ~ 4,095

2E(h) ~ 2F(h) "Maximum ACC_Z"
- Maximum Z axis Acceleration value in the calibration mode
- Data range: 0 ~ 4,095

30(h) ~ 31(h) "Minimum ACC_Z"
- Minimum Z axis Acceleration value in the calibration mode
- Data range: 0 ~ 4,095

IMPORTANT NOTICE

*Specifications are subject to change without prior notification

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