

Magnetic Sensor series

# 3-Axis Digital Magnetometer IC

## BM1422AGMV

### General Description

BM1422AGMV is a 3-axis magnetic sensor which incorporates magneto-impedance (MI) elements to detect magnetic field and a control IC in a small package.

### Features

- 3-axis Magnetic Sensor using MI Elements
- I<sup>2</sup>C Interface
- 12bit / 14bit Digital Output

### Applications

- Wristwatch
- Mobile phone, Smartphone

### Key Specifications

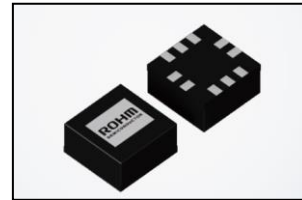
- Input Voltage Range (AVDD): 1.7V to 3.6V
- Input Voltage Range (DVDD): 1.7V to 3.6V
- Operating Current (100SPS): 0.15mA(Typ)
- Magnetic Measurable Range: ±1200μT(Typ)
- Magnetic Sensitivity: 0.042μT/LSB(Typ)
- Maximum Exposed Field: 1000mT
- Operating Temperature Range: -40°C to +85°C

### Package

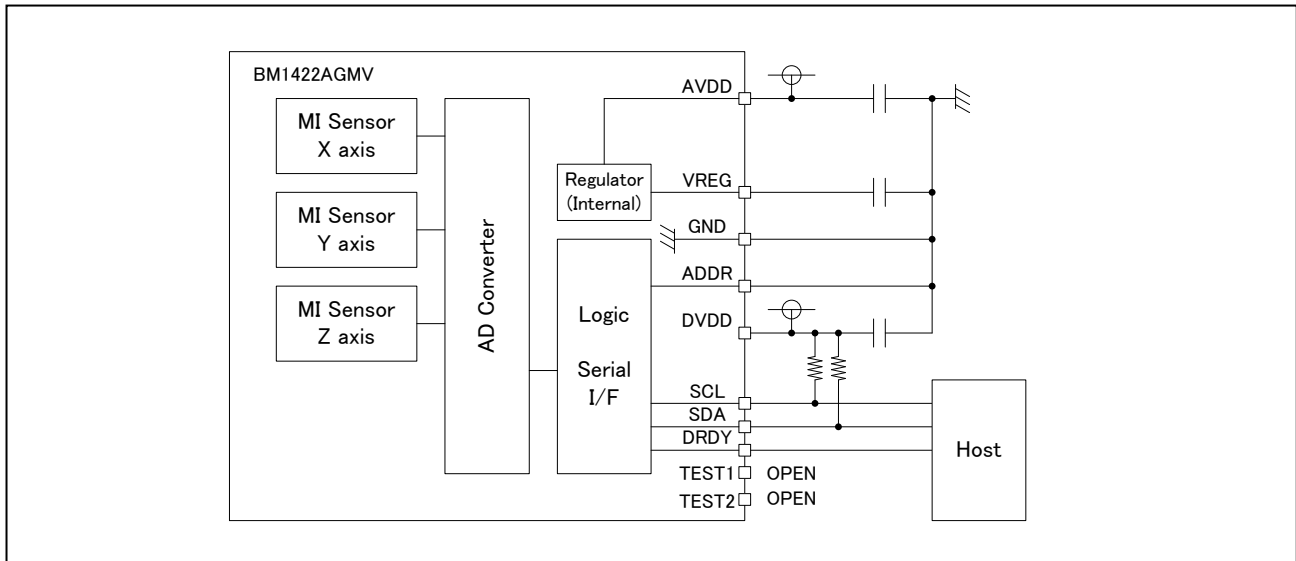
MLGA010V020A

W(Typ) x D(Typ) x H(Max)

2.00mm x 2.00mm x 1.00mm



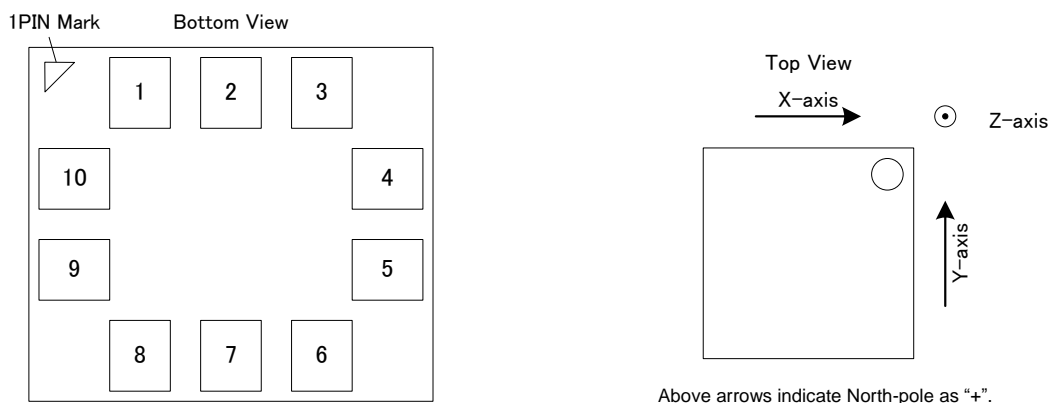
### Typical Application Circuit



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Pin Configuration

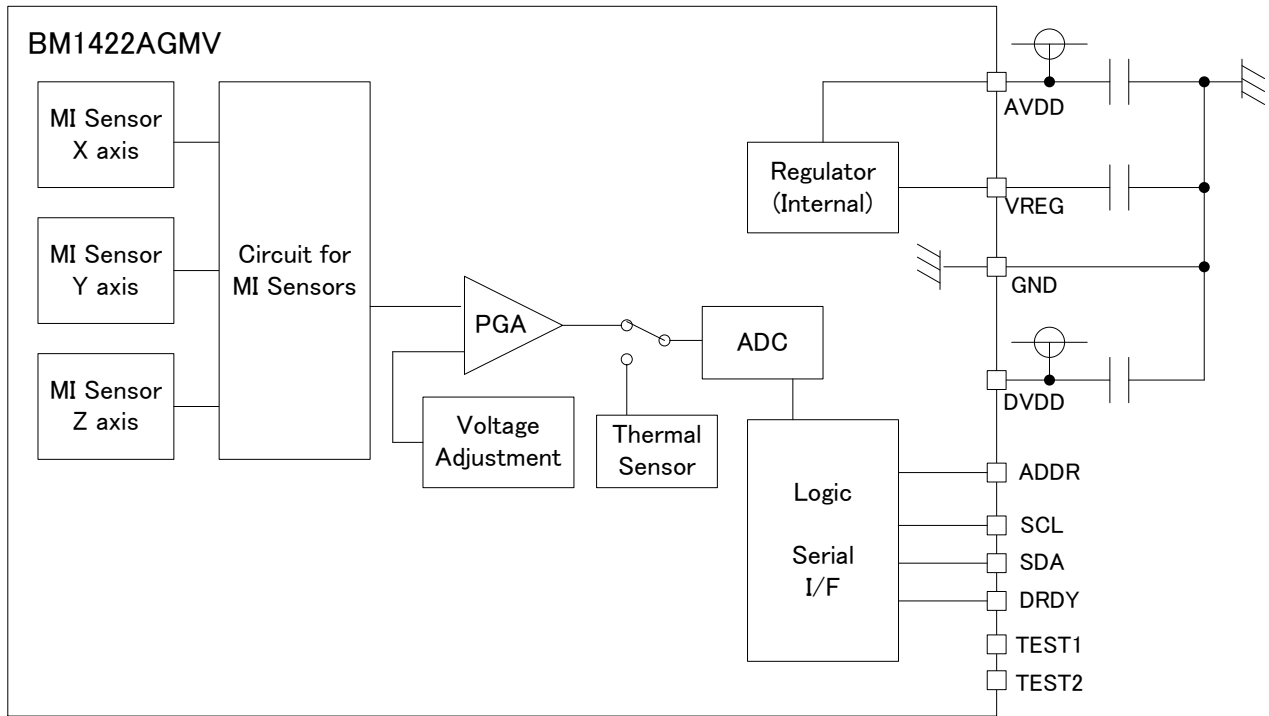


Pin Description

| Pin No. | Pin Name | Function  |
|---------|----------|---|
| 1       | AVDD     | Analog circuit power supply <sup>(Note 1)</sup>               |
| 2       | GND      | Ground  |
| 3       | VREG     | Internal regulator output <sup>(Note 2)</sup>                 |
| 4       | TEST1    | Test pin <sup>(Note 3)</sup>                                  |
| 5       | SDA      | I <sup>2</sup> C signal data I/O                              |
| 6       | TEST2    | Test pin <sup>(Note 3)</sup>                                  |
| 7       | SCL      | I <sup>2</sup> C signal clock input                           |
| 8       | DRDY     | Data ready output pin   |
| 9       | ADDR     | I <sup>2</sup> C programmable address bit <sup>(Note 4)</sup> |
| 10      | DVDD     | Digital circuit power supply <sup>(Note 5)</sup>              |

- (Note 1) Please place a bypass capacitor between AVDD and GND in the proximity of the terminals.
- (Note 2) Please place a bypass capacitor between VREG and GND in the proximity of the terminals.  
Please set a bypass capacitor of 1.0uF between VREG and GND
- (Note 3) Use as Non-Connection (NC).
- (Note 4) Please connect to DVDD or GND.
- (Note 5) Please place a bypass capacitor between DVDD and GND in the proximity of the terminals.

Block Diagram



**Absolute Maximum Ratings (Ta = 25°C)**

| Parameter                   | Symbol | Rating               | Unit |
|-----------------------------|--------|----------------------|------|
| Supply Voltage (AVDD)       | Vdd_a  | 4.5                  | V    |
| Supply Voltage (DVDD)       | Vdd_d  | 4.5                  | V    |
| Input Voltage               | Vin    | -0.3 to +(Vdd_d+0.3) | V    |
| Operating Temperature Range | Topr   | -40 to +85           | °C   |
| Storage Temperature Range   | Tstg   | -40 to +125          | °C   |
| Maximum Exposed Field       | Mef    | -1000 to +1000       | mT   |

**Caution:** Operating the IC over the absolute maximum ratings may damage the IC. The damage can either be a short circuit between pins or an open circuit between pins and the internal circuitry. Therefore, it is important to consider circuit protection measures, such as adding a fuse, in case the IC is operated over the absolute maximum ratings.

**Thermal Resistance** <sup>(Note 1)</sup>

| Parameter  | Symbol        | Thermal Resistance (Typ) |                          | Unit |
|--|---------------|--------------------------|--------------------------|------|
|  |               | 1s <sup>(Note 3)</sup>   | 2s2p <sup>(Note 4)</sup> |      |
| MLGA010V020A   |               |                          |                          |      |
| Junction to Ambient  | $\theta_{JA}$ | 317.3                    | 191.5                    | °C/W |
| Junction to Top Characterization Parameter <sup>(Note 2)</sup> | $\Psi_{JT}$   | 60                       | 41                       | °C/W |

(Note 1)Based on JESD51-2A(Still-Air)

(Note 2)The thermal characterization parameter to report the difference between junction temperature and the temperature at the top center of the outside surface of the component package.

(Note 3)Using a PCB board based on JESD51-3.

| Layer Number of Measurement Board | Material  | Board Size                 |
|-----------------------------------|-----------|----------------------------|
| Single                            | FR-4      | 114.3mm x 76.2mm x 1.57mmt |
| Top                               |           |                            |
| Copper Pattern                    | Thickness |                            |
| Footprints and Traces             | 70μm      |                            |

(Note 4)Using a PCB board based on JESD51-7.

| Layer Number of Measurement Board |           | Material          | Board Size                |                 |           |
|-----------------------------------|-----------|-------------------|---------------------------|-----------------|-----------|
| 4 Layers                          |           | FR-4              | 114.3mm x 76.2mm x 1.6mmt |                 |           |
| Top                               |           | 2 Internal Layers |                           | Bottom          |           |
| Copper Pattern                    | Thickness | Copper Pattern    | Thickness                 | Copper Pattern  | Thickness |
| Footprints and Traces             | 70μm      | 74.2mm x 74.2mm   | 35μm                      | 74.2mm x 74.2mm | 70μm      |

**Recommended Operating Conditions (Ta= -40°C to +85°C)**

| Parameter                        | Symbol | Rating       | Unit |
|----------------------------------|--------|--------------|------|
| Supply Voltage (AVDD)            | Vdd_a  | +1.7 to +3.6 | V    |
| Supply Voltage (DVDD)            | Vdd_d  | +1.7 to +3.6 | V    |
| I <sup>2</sup> C Clock Frequency | fSCL   | MAX 400      | kHz  |

## Electrical Characteristics (Unless otherwise specified AVDD=1.8V, DVDD=1.8V, GND=0.0V, Ta=25°C)

| Parameter                              | Symbol           | Min        | Typ   | Max        | Unit   | Conditions                     |
|--|------------------|------------|-------|------------|--------|--------------------------------|
| Current Consumption                    |                  |            |       |            |        |                                |
| Average Current during Measurement     | I <sub>dd</sub>  | -          | 150   | 300        | μA     | Output Data Rate = 100SPS      |
| Stand-by-mode Current                  | I <sub>ss</sub>  | -          | 1.5   | 5          | μA     | ALL Power Down                 |
| Logic                                  |                  |            |       |            |        |                                |
| Low-level Input Voltage                | V <sub>IL</sub>  | GND        | -     | 0.3 * DVDD | V      |                                |
| High-level Input Voltage               | V <sub>IH</sub>  | 0.7 * DVDD | -     | DVDD       | V      |                                |
| Low-level Input Current                | I <sub>IL</sub>  | -10        | -     | 0          | μA     | V <sub>IL</sub> = GND          |
| High-level Input Current               | I <sub>IH</sub>  | 0          | -     | 10         | μA     | V <sub>IH</sub> = DVDD         |
| Low-level Output Voltage               | V <sub>OL</sub>  | GND        | -     | 0.2 * DVDD | V      | I <sub>L</sub> = -0.3mA        |
| High-level Output Voltage              | V <sub>OH</sub>  | 0.8 * DVDD | -     | DVDD       | V      | I <sub>L</sub> = 0.3mA         |
| Serial Communication                   |                  |            |       |            |        |                                |
| Low-level Input Current                | I <sub>IL2</sub> | -10        | -     | 0          | μA     | V <sub>IL</sub> = GND          |
| High-level Input Current               | I <sub>IH2</sub> | 0          | -     | 10         | μA     | At HiZ, V <sub>IH</sub> = DVDD |
| Low-level Output Voltage               | V <sub>OL2</sub> | GND        | -     | 0.2 * DVDD | V      | I <sub>L</sub> = -3mA          |
| Magnetic Sensor                        |                  |            |       |            |        |                                |
| Moving Range                           | R <sub>m</sub>   | -          | ±300  | -          | μT     |                                |
| Measurable Range <sup>(Note 1)</sup>   | R <sub>a</sub>   | -          | ±1200 | -          | μT     |                                |
| X,Y-axis Linearity <sup>(Note 2)</sup> | Lin1             | -          | 0.5   | 2          | %FS    | R <sub>m</sub> = ±200μT        |
| Z-axis Linearity <sup>(Note 2)</sup>   | Lin2             | -          | 1.0   | 2.8        | %FS    | R <sub>m</sub> = ±200μT        |
| Output Offset                          | V <sub>ofs</sub> | -          | 0     | -          | LSB    | Magnetic Field = 0μT           |
| Magnetic Sensitivity                   | DeltaV           | -          | 0.042 | -          | μT/LSB |                                |
| Measurement Time                       | T <sub>ms</sub>  | -          | 0.5   | -          | msec   | Average 4times                 |

(Note1) Measurable Range: Overall measurable range within which preset operating range can be fit by adjusting appropriate offsets.

(Note2) Linearity [%FS] = Output Error / R<sub>m</sub> = (output – ideal output) / R<sub>m</sub>

Typical Performance Curves

(Unless otherwise specified, Ta=25°C, AVDD=1.8V, DVDD=1.8V, GND=0.0V)

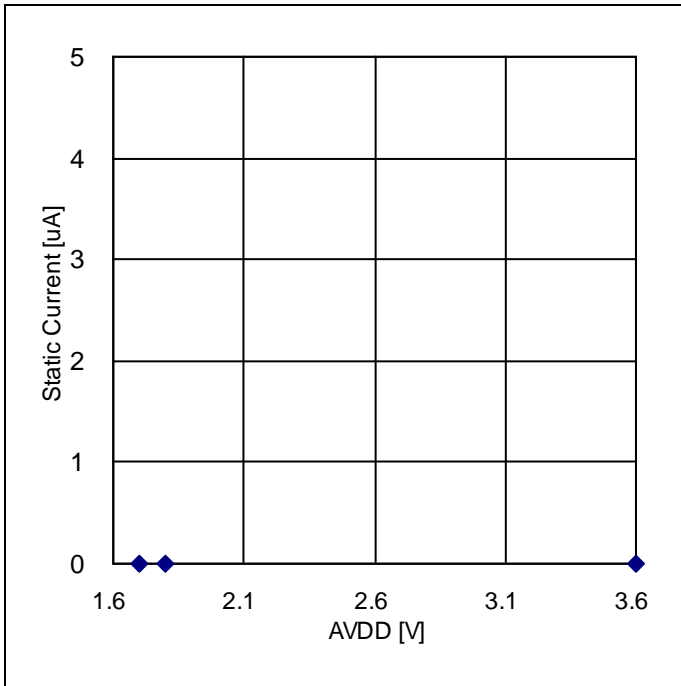


Figure 1. AVDD PowerDown Current Voltage Dependency

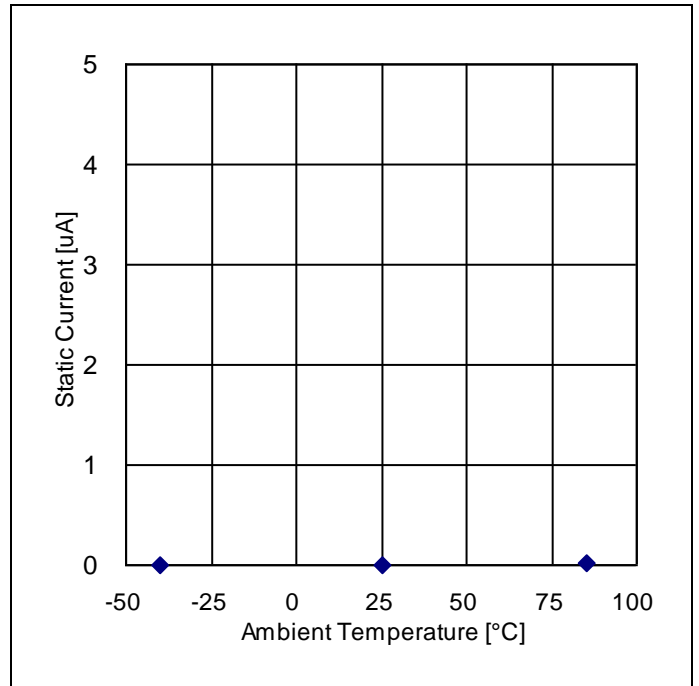


Figure 2. AVDD PowerDown Current Temperature Dependency

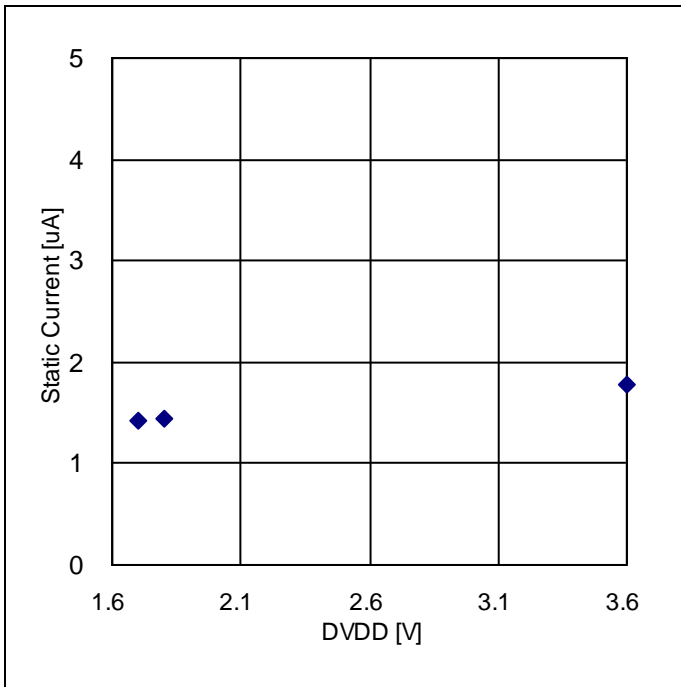


Figure 3. DVDD PowerDown Current Voltage Dependency

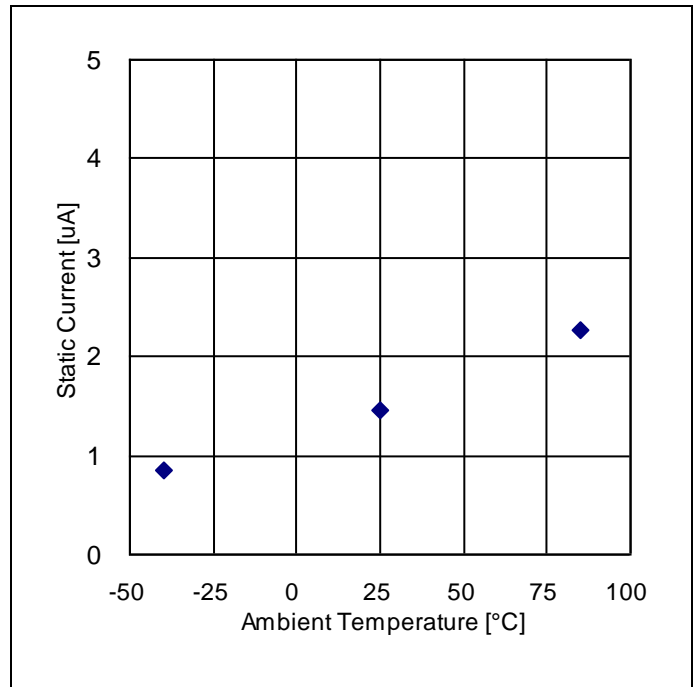


Figure 4. DVDD PowerDown Current Temperature Dependency

Typical Performance Curves - continued

(Unless otherwise specified, Ta=25°C, AVDD=1.8V, DVDD=1.8V, GND=0.0V)

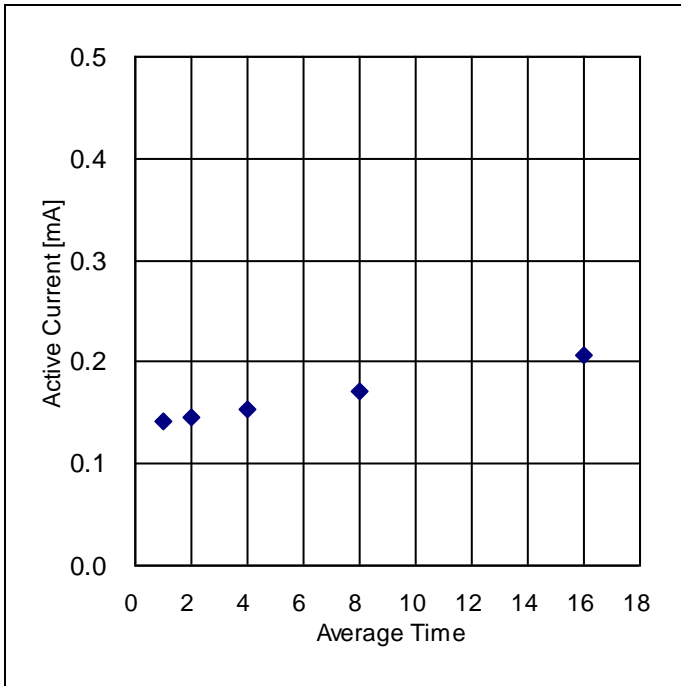


Figure 5. Average Current during Measurement Averaging Dependency (100SPS)

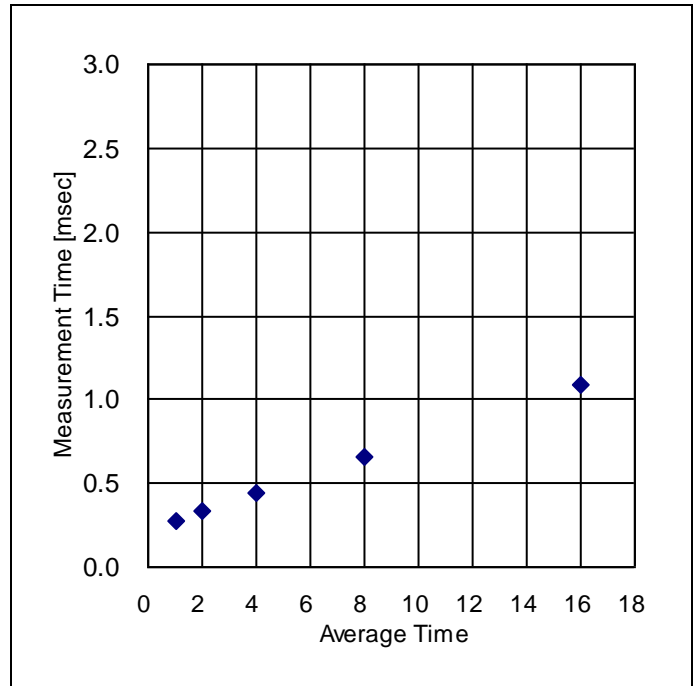


Figure 6. Measurement Time Averaging Dependency

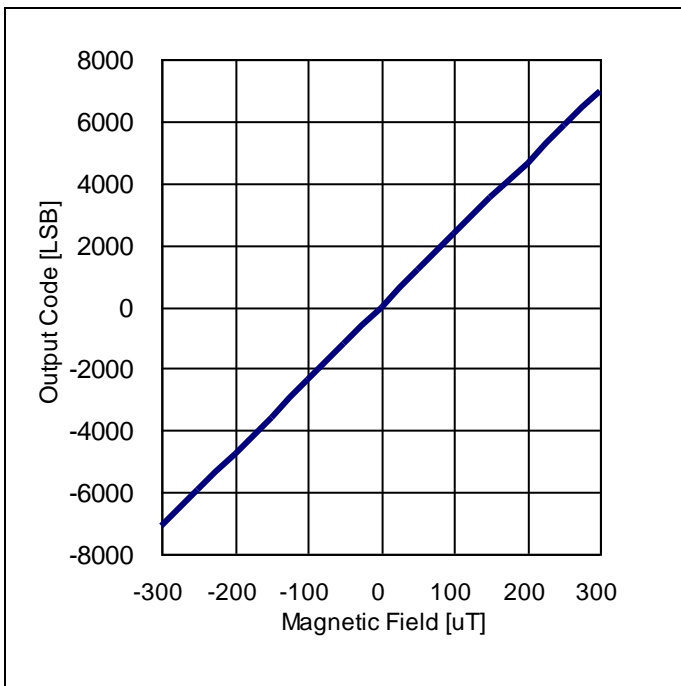
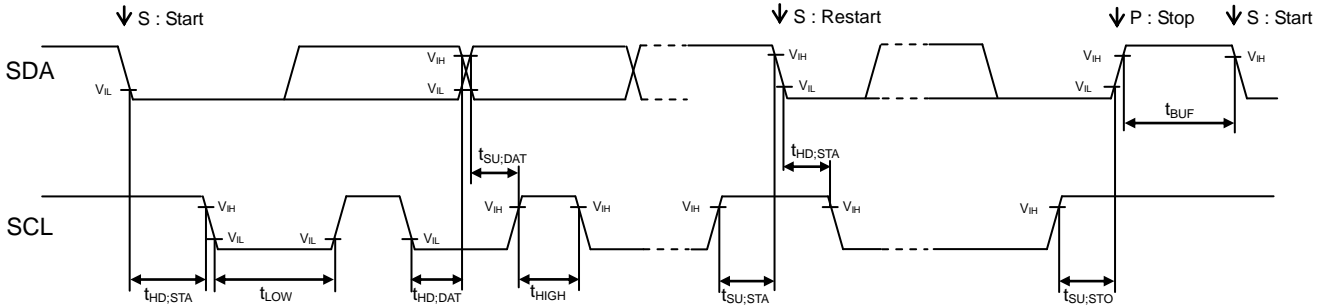


Figure 7. Output Characteristic



I<sup>2</sup>C bus Timing Characteristics (Unless otherwise specified DVDD =1.8V, Ta = 25°C)

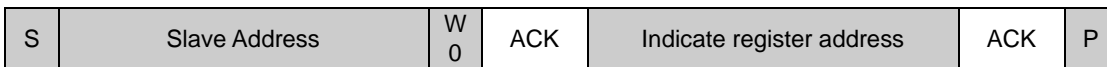


| Parameter   | Symbol              | Min. | Typ. | Max. | Units | Conditions |
|---|---------------------|------|------|------|-------|------------|
| I <sup>2</sup> C SCL Clock frequency                              | f <sub>SCL</sub>    | 0    | -    | 400  | kHz   |            |
| I <sup>2</sup> C 'L' Period of the SCL Clock                      | t <sub>LOW</sub>    | 1.3  | -    | -    | μs    |            |
| I <sup>2</sup> C 'H' Period of the SCL Clock                      | t <sub>HIGH</sub>   | 0.6  | -    | -    | μs    |            |
| I <sup>2</sup> C Setup Time for Repeated START Condition          | t <sub>SU,STA</sub> | 0.6  | -    | -    | μs    |            |
| I <sup>2</sup> C Hold Time (Repeated) START Condition             | t <sub>HD,STA</sub> | 0.6  | -    | -    | μs    |            |
| I <sup>2</sup> C Data Setup Time                                  | t <sub>SU,DAT</sub> | 100  | -    | -    | ns    |            |
| I <sup>2</sup> C Data Hold Time                                   | t <sub>HD,DAT</sub> | 0    | -    | -    | μs    |            |
| I <sup>2</sup> C Setup Time for STOP Condition                    | t <sub>SU,STO</sub> | 0.6  | -    | -    | μs    |            |
| I <sup>2</sup> C Bus Free Time between a STOP and START Condition | t <sub>BUF</sub>    | 1.3  | -    | -    | μs    |            |

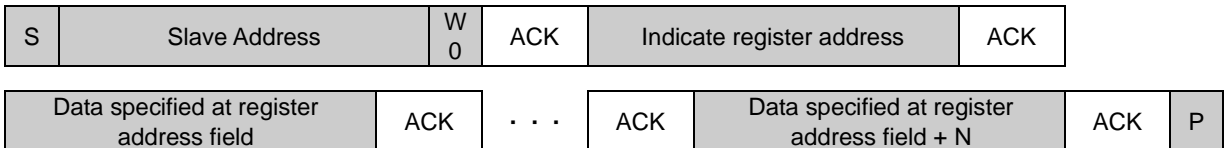
I<sup>2</sup>C bus Communication

1. Main write format

(1) Indicate register address

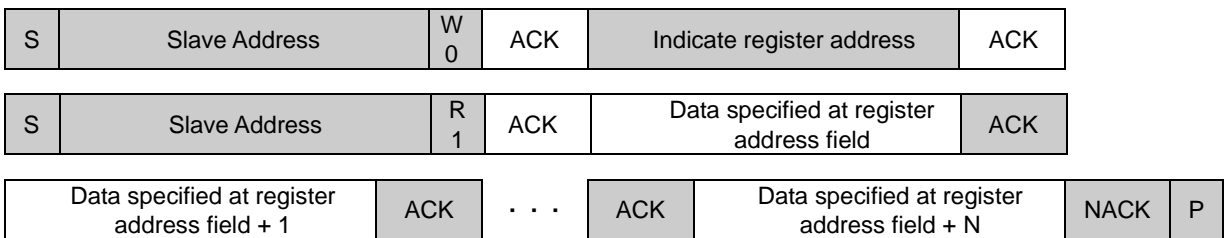


(2) Write to data register after indicating register address

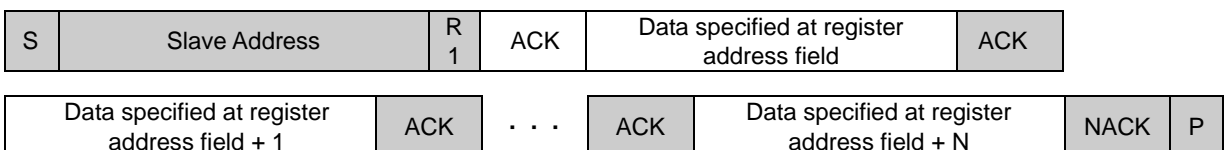


2. Main read format

(1) Read data after indicate register address (Master issues restart condition)



(2) Case of read data



I<sup>2</sup>C bus Slave addressSelectable I<sup>2</sup>C Slave Address

( ADDR=L: 0001110, ADDR=H: 0001111 )

Register Map <sup>(Note 1)</sup>

| Address | Register Name | R/W | D7                 | D6          | D5         | D4          | D3   | D2  | D1  | D0 |
|---------|---------------|-----|--------------------|-------------|------------|-------------|------|-----|-----|----|
| 0x0D    | INFO          | R   | INFO [7:0]         |             |            |             |      |     |     |    |
| 0x0E    |               | R   | INFO [15:8]        |             |            |             |      |     |     |    |
| 0x0F    | WIA           | R   | WIA [7:0]          |             |            |             |      |     |     |    |
| 0x10    | DATA_X        | R   | DATA_X [7:0]       |             |            |             |      |     |     |    |
| 0x11    |               | R   | DATA_X [15:8]      |             |            |             |      |     |     |    |
| 0x12    | DATA_Y        | R   | DATA_Y [7:0]       |             |            |             |      |     |     |    |
| 0x13    |               | R   | DATA_Y [15:8]      |             |            |             |      |     |     |    |
| 0x14    | DATA_Z        | R   | DATA_Z [7:0]       |             |            |             |      |     |     |    |
| 0x15    |               | R   | DATA_Z [15:8]      |             |            |             |      |     |     |    |
| 0x18    | STA1          | R   | 0                  | RD_<br>DRDY | 0          | 0           | 0    | 0   | 0   | 0  |
| 0x1B    | CNTL1         | RW  | PC1                | OUT_<br>BIT | RST_<br>LV | ODR [1:0]   |      | 0   | FS1 | 0  |
| 0x1C    | CNTL2         | RW  | 0                  | 0           | 0          | 0           | DREN | DRP | 0   | 0  |
| 0x1D    | CNTL3         | RW  | 0                  | FORC<br>E   | 0          | 0           | 0    | 0   | 0   | 0  |
| 0x40    | AVE_A         | RW  | 0                  | 0           | 0          | AVE_A [2:0] |      |     | 0   | 0  |
| 0x5C    | CNTL4         | W   | RSTB_LV [7:0]      |             |            |             |      |     |     |    |
| 0x5D    |               | W   | RSTB_LV [15:8]     |             |            |             |      |     |     |    |
| 0x60    | TEMP          | R   | TEMP [7:0]         |             |            |             |      |     |     |    |
| 0x61    |               | R   | TEMP [15:8]        |             |            |             |      |     |     |    |
| 0x6C    | OFF_X         | RW  | OFF_X [7:0]        |             |            |             |      |     |     |    |
| 0x6D    |               | RW  | OFF_X [15:8]       |             |            |             |      |     |     |    |
| 0x72    | OFF_Y         | RW  | OFF_Y [7:0]        |             |            |             |      |     |     |    |
| 0x73    |               | RW  | OFF_Y [15:8]       |             |            |             |      |     |     |    |
| 0x78    | OFF_Z         | RW  | OFF_Z [7:0]        |             |            |             |      |     |     |    |
| 0x79    |               | RW  | OFF_Z [15:8]       |             |            |             |      |     |     |    |
| 0x90    | FINEOUTPUTX   | R   | FINEOUTPUTX [7:0]  |             |            |             |      |     |     |    |
| 0x91    |               | R   | FINEOUTPUTX [15:8] |             |            |             |      |     |     |    |
| 0x92    | FINEOUTPUTY   | R   | FINEOUTPUTY [7:0]  |             |            |             |      |     |     |    |
| 0x93    |               | R   | FINEOUTPUTY [15:8] |             |            |             |      |     |     |    |
| 0x94    | FINEOUTPUTZ   | R   | FINEOUTPUTZ [7:0]  |             |            |             |      |     |     |    |
| 0x95    |               | R   | FINEOUTPUTZ [15:8] |             |            |             |      |     |     |    |
| 0x9C    | GAIN_PARA_X   | R   | GAIN_PARA_X [7:0]  |             |            |             |      |     |     |    |
| 0x9D    |               | R   | GAIN_PARA_X [15:8] |             |            |             |      |     |     |    |
| 0x9E    | GAIN_PARA_Y   | R   | GAIN_PARA_Y [7:0]  |             |            |             |      |     |     |    |
| 0x9F    |               | R   | GAIN_PARA_Y [15:8] |             |            |             |      |     |     |    |

|      |             |   |                    |
|------|-------------|---|--------------------|
| 0xA0 | GAIN_PARA_Z | R | GAIN_PARA_Z [7:0]  |
| 0xA1 |             | R | GAIN_PARA_Z [15:8] |

(Note 1) Do not write any commands to other addresses except above. Do not write '1' to the fields in which value is '0' in above table.

It is the following conditions to be able to access each register.

| Condition   | Accessible Register                                       |
|---|---|
| Supply Power  | CNTL1<br>CNTL4<br>INFO<br>WIA<br>OFF_X,Y,Z                |
| Supply Power<br>(CNTL1) PC1=1<br>(CNTL1) RST_LV=0<br>(CNTL4) RSTB_LV=1  | STA1<br>CNTL2<br>CNTL3<br>AVE_A<br>OFF_X,Y,Z              |
| Supply Power<br>(CNTL1) PC1=1<br>(CNTL1) RST_LV=0<br>(CNTL4) RSTB_LV=1<br>(CNTL3) FORCE=1 after first access        | DATA_X,Y,Z<br>TEMP<br>FINEOUTPUT_X,Y,Z                    |
| Supply Power<br>(CNTL1) PC1=1, FS1=1<br>(CNTL1) RST_LV=0<br>(CNTL4) RSTB_LV=1<br>(CNTL3) FORCE=1 after first access | DATA_X,Y,Z<br>TEMP<br>FINEOUTPUT_X,Y,Z<br>GAIN_PARA_X,Y,Z |

( 0x0D/0x0E ) Information Register

| Fields      | Function               |
|-------------|------------------------|
| INFO [7:0]  | Information LSB : 0x01 |
| INFO [15:0] | Information MSB : 0x01 |

( 0x0F ) WIA Register

| Fields    | Function        |
|-----------|-----------------|
| WIA [7:0] | Who I am : 0x41 |

( 0x10/0x11, 0x12/0x13, 0x14/0x15 ) Output Data Register

| Fields       | Function             |
|--------------|----------------------|
| DATAx [7:0]  | Xch Output value LSB |
| DATAx [15:0] | Xch Output value MSB |
| DATAY [7:0]  | Ych Output value LSB |
| DATAY [15:0] | Ych Output value MSB |
| DATAz [7:0]  | Zch Output value LSB |
| DATAz [15:0] | Zch Output value MSB |

default value 0xFFFF

signed 16bit -2048d(0xF800) to +2047d(0x07FF) [Register OUT\_BIT=0]  
 -8192d(0xE000) to +8191d(0x1FFF) [Register OUT\_BIT=1]

( 0x18 ) Status Register

| Fields  | Function   |
|---------|--|
| RD_DRDY | This bit is output to the DRDY to inform the preparation status of the measured data<br>0 : Not ready NG<br>1 : Ready OK |

default value 0x00

( 0x1B ) Control setting1 Register

| Fields    | Function  |
|-----------|---|
| PC1       | Power Control<br>0 : PowerDown 1 : Active   |
| OUT_BIT   | Output Data bit setting 0 : 12bit Output , 1 : 14bit Output   |
| RST_LV    | Logic reset control<br>0 : Reset release 1 : Reset<br>Reset release at RST_LV(CNTL1)=0 & RSTB_LV(CNTL4)=1 |
| ODR [1:0] | Measurement output data rates<br>00 : 10Hz , 10 : 20Hz , 01 : 100Hz , 11 : 1kHz                           |
| FS1       | Measurement mode setting<br>0 : Continuous mode , 1 : Single mode   |

default value 0x22

( 0x1C ) Control setting2 Register

| Fields | Function   |
|--------|--|
| DREN   | DRDY terminal enable setting<br>0 : Disable , 1 : Enable         |
| DRP    | DRDY terminal active setting<br>0 : Low active , 1 : High active |

default value 0x04

( 0x1D ) Control setting3 Register

| Fields | Function   |
|--------|--|
| FORCE  | AD start measurement trigger at continuous mode (FS1=0) and single mode (FS1=1)<br>1: Start measurement<br>※Register is automatic clear "0" after write data "1"<br>※Write data "0" is invalid<br>※If write data "1" on measurement way, restart measurement |

default value 0x00

( 0x40 ) Average time Register

| Fields | Function  |
|--------|---|
| AVE_A  | Average Time<br>000:4times, 001:1times, 010:2times, 011:8times, 100:16times |

default value 0x00

( 0x5C/0x5D ) Control setting4 Register

| Fields         | Function  |
|----------------|---|
| RSTB_LV [7:0]  | Reserved (ignore write data)  |
| RSTB_LV [15:8] | RSTB_LV=1 by write access (ignore write data)<br>Reset release at RST_LV(CNTL1)=0 & RSTB_LV(CNTL4)=1<br>RSTB_LV=0 by write PC1(CNTL1)=0 |

default value 0x04

( 0x60/0x61 ) Temperature value Register

| Fields      | Function              |
|-------------|-----------------------|
| TEMP [7:0]  | Temperature value LSB |
| TEMP [15:8] | Temperature value MSB |

default value 0xFFFF

unsigned 16bit 0d(0x0000) to +4095d(0x0FFF) [Register OUT\_BIT=0]  
0d(0x0000) to +16383d(0x3FFF) [Register OUT\_BIT=1]

( 0x6C/0x6D, 0x72/0x73, 0x78/0x79 ) Output Data Register

| Fields       | Function                  |
|--------------|---------------------------|
| OFF_X [7:0]  | Xch Offset value          |
| OFF_X [15:8] | Reserved Write "00000000" |
| OFF_Y [7:0]  | Ych Offset value          |
| OFF_Y [15:8] | Reserved Write "00000000" |
| OFF_Z [7:0]  | Zch Offset value          |
| OFF_Z [15:8] | Reserved Write "00000000" |

default value 0x30

unsigned 8bit 1d(0x01) to +95d(0x5F)

( 0x90/0x91, 0x92/0x93, 0x94/0x95 ) Fine output Register

| Fields             | Function                   |
|--------------------|----------------------------|
| FINEOUTPUTX [7:0]  | DATA X value per OFF_X LSB |
| FINEOUTPUTX [15:0] | DATA X value per OFF_X MSB |
| FINEOUTPUTY [7:0]  | DATA Y value per OFF_Y LSB |
| FINEOUTPUTY [15:0] | DATA Y value per OFF_Y MSB |
| FINEOUTPUTZ [7:0]  | DATA Z value per OFF_Z LSB |
| FINEOUTPUTZ [15:0] | DATA Z value per OFF_Z MSB |

default value 0xFFFF

unsigned 16bit 0d(0x0000) to +16383d(0x3FFF)

( 0x9C/0x9D, 0x9E/0x9F, 0xA0/0xA1 ) Axis interference Register

| Fields             | Function                     |
|--------------------|------------------------------|
| GAIN_PARA_X [7:0]  | Axis interference Xch to Zch |
| GAIN_PARA_X [15:0] | Axis interference Xch to Ych |
| GAIN_PARA_Y [7:0]  | Axis interference Ych to Zch |
| GAIN_PARA_Y [15:0] | Axis interference Ych to Xch |
| GAIN_PARA_Z [7:0]  | Axis interference Zch to Ych |
| GAIN_PARA_Z [15:0] | Axis interference Zch to Xch |

default value 0xXX

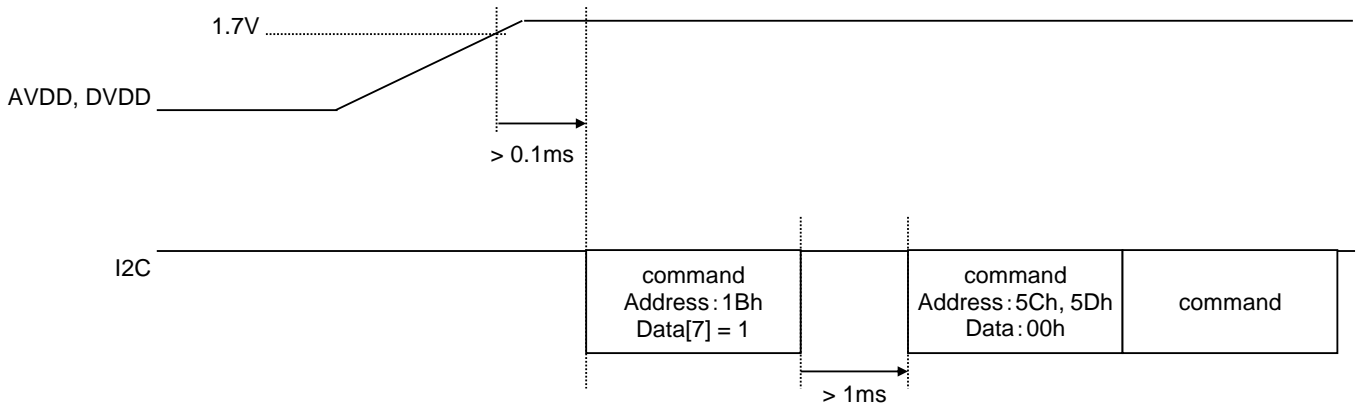
unsigned 8bit 0d(0x00) to +255d(0xFF)

Control Sequence

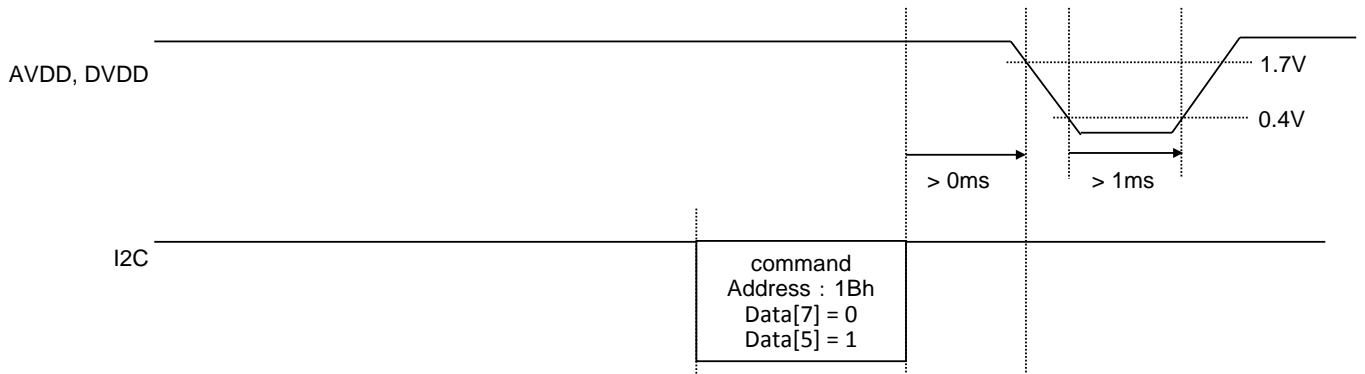
1. Control Sequence

1.1 Power supply start-up sequence

The order of starting up the power supplies of AVDD and DVDD is arbitrary, when they are supplied from different sources. Please do the command control by I<sup>2</sup>C after all powers are supplied.



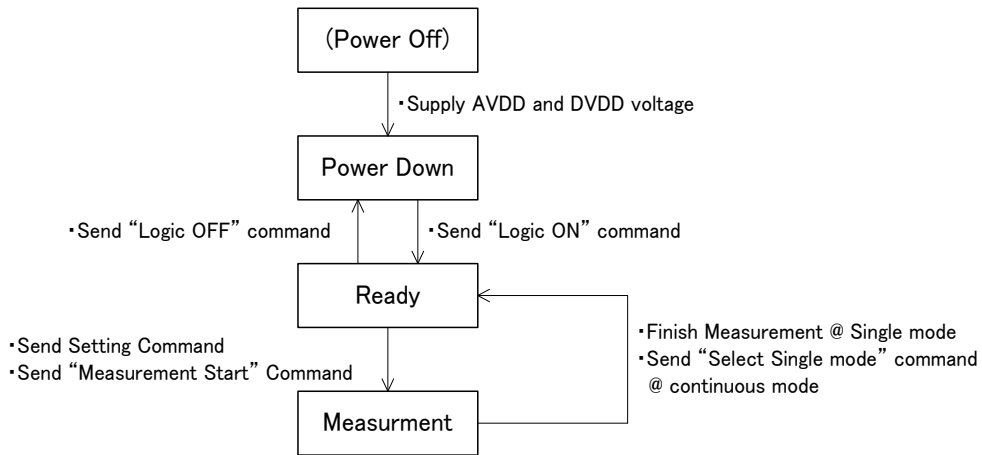
1.2 Power supply end sequence



2. Measurement sequence

There are the following two kinds of measurement modes

|                 |  |
|-----------------|--|
| Continuous Mode | BM1422AGMV is measured at specified cycle (ODR=10,20,100,1kHz) at the cycle. |
| Single Mode     | BM1422AGMV is measured by the measurement request from the host.             |



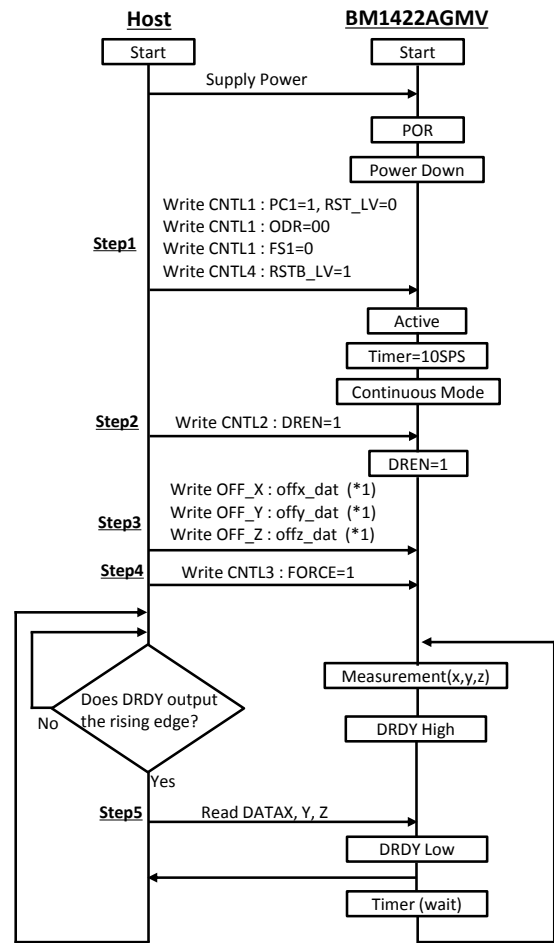
2.1 Continuous Mode

(Send command example) Case of 12bit Output Data

|       | Register Name | Address | Data     |
|-------|---------------|---------|----------|
| Step1 | CNTL1         | 0x1B    | 0x80     |
|       | CNTL4         | 0x5C    | 0x00     |
| Step2 | CNTL2         | 0x1C    | 0x0C     |
|       | OFF_X         | 0x6C    | offx_dat |
| Step3 | OFF_Y         | 0x72    | offy_dat |
|       | OFF_Z         | 0x78    | offz_dat |
| Step4 | CNTL3         | 0x1D    | 0x40     |
| Step5 | DATAX         | 0x10    | Read     |
|       |               | 0x11    |          |
|       | DATAY         | 0x12    | Read     |
|       |               | 0x13    |          |
|       | DATAZ         | 0x14    | Read     |
|       |               | 0x15    |          |

(Send command example) Case of 14bit Output Data

|       | Register Name | Address | Data     |
|-------|---------------|---------|----------|
| Step1 | CNTL1         | 0x1B    | 0xC0     |
|       | CNTL4         | 0x5C    | 0x00     |
| Step2 | CNTL2         | 0x1C    | 0x0C     |
|       | OFF_X         | 0x6C    | offx_dat |
| Step3 | OFF_Y         | 0x72    | offy_dat |
|       | OFF_Z         | 0x78    | offz_dat |
| Step4 | CNTL3         | 0x1D    | 0x40     |
| Step5 | DATAX         | 0x10    | Read     |
|       |               | 0x11    |          |
|       | DATAY         | 0x12    | Read     |
|       |               | 0x13    |          |
|       | DATAZ         | 0x14    | Read     |
|       |               | 0x15    |          |



(\*1) The value is obtained at offset adjustment. If not obtained yet, then skip.



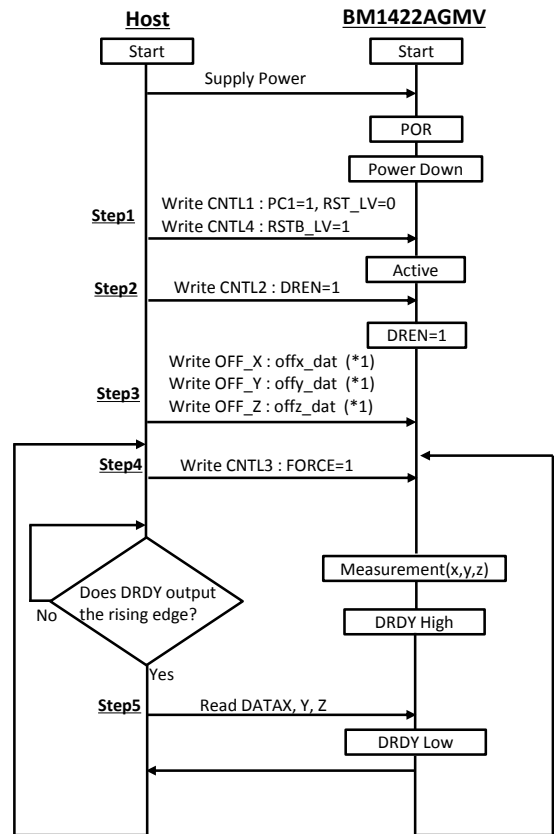
2.2 Single Mode

(Send command example) Case of 12bit Output Data

|       | Register Name | Address | Data     |
|-------|---------------|---------|----------|
| Step1 | CNTL1         | 0x1B    | 0x82     |
|       | CNTL4         | 0x5C    | 0x00     |
|       |               | 0x5D    | 0x00     |
| Step2 | CNTL2         | 0x1C    | 0x0C     |
| Step3 | OFF_X         | 0x6C    | offx_dat |
|       | OFF_Y         | 0x72    | offy_dat |
|       | OFF_Z         | 0x78    | offz_dat |
| Step4 | CNTL3         | 0x1D    | 0x40     |
| Step5 | DATAX         | 0x10    | Read     |
|       |               | 0x11    |          |
|       | DATAY         | 0x12    | Read     |
|       |               | 0x13    |          |
|       | DATAZ         | 0x14    | Read     |
|       | 0x15          |         |          |

(Send command example) Case of 14bit Output Data

|       | Register Name | Address | Data     |
|-------|---------------|---------|----------|
| Step1 | CNTL1         | 0x1B    | 0xC2     |
|       | CNTL4         | 0x5C    | 0x00     |
|       |               | 0x5D    | 0x00     |
| Step2 | CNTL2         | 0x1C    | 0x0C     |
| Step3 | OFF_X         | 0x6C    | offx_dat |
|       | OFF_Y         | 0x72    | offy_dat |
|       | OFF_Z         | 0x78    | offz_dat |
| Step4 | CNTL3         | 0x1D    | 0x40     |
| Step5 | DATAX         | 0x10    | Read     |
|       |               | 0x11    |          |
|       | DATAY         | 0x12    | Read     |
|       |               | 0x13    |          |
|       | DATAZ         | 0x14    | Read     |
|       | 0x15          |         |          |



(\*1) The value is obtained at offset adjustment. If not obtained yet, then skip.

3. Offset Adjustment

Offset adjustment sequence make the output value around zero under the normal magnetic environment. After measuring the following parameter, HOST should save it in memory, and it needs to be set after applying power supply to BM1422AGMV.

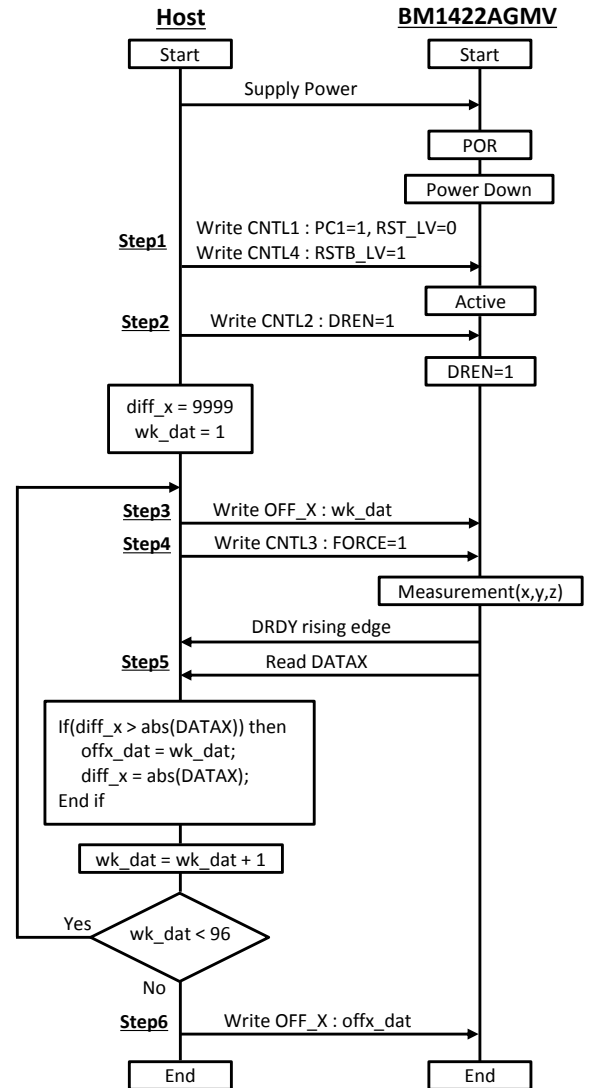
| Parameter | Description                  |
|-----------|------------------------------|
| offx_dat  | Adjusted value of Xch offset |
| offy_dat  | Adjusted value of Ych offset |
| offz_dat  | Adjusted value of Zch offset |

(Send command example) Case of 12bit Output Data

|       | Register Name | Address | Data     |
|-------|---------------|---------|----------|
| Step1 | CNTL1         | 0x1B    | 0x82     |
|       | CNTL4         | 0x5C    | 0x00     |
|       |               | 0x5D    | 0x00     |
| Step2 | CNTL2         | 0x1C    | 0x0C     |
| Step3 | OFF_X         | 0x6C    | wk_dat   |
| Step4 | CNTL3         | 0x1D    | 0x40     |
|       |               | 0x10    |          |
| Step5 | DATAX         | 0x11    | Read     |
|       |               | 0x6C    |          |
| Step6 | OFF_X         | 0x6C    | offx_dat |

(Send command example) Case of 14bit Output Data

|       | Register Name | Address | Data     |
|-------|---------------|---------|----------|
| Step1 | CNTL1         | 0x1B    | 0xC2     |
|       | CNTL4         | 0x5C    | 0x00     |
|       |               | 0x5D    | 0x00     |
| Step2 | CNTL2         | 0x1C    | 0x0C     |
| Step3 | OFF_X         | 0x6C    | wk_dat   |
| Step4 | CNTL3         | 0x1D    | 0x40     |
|       |               | 0x10    |          |
| Step5 | DATAX         | 0x11    | Read     |
|       |               | 0x6C    |          |
| Step6 | OFF_X         | 0x6C    | offx_dat |

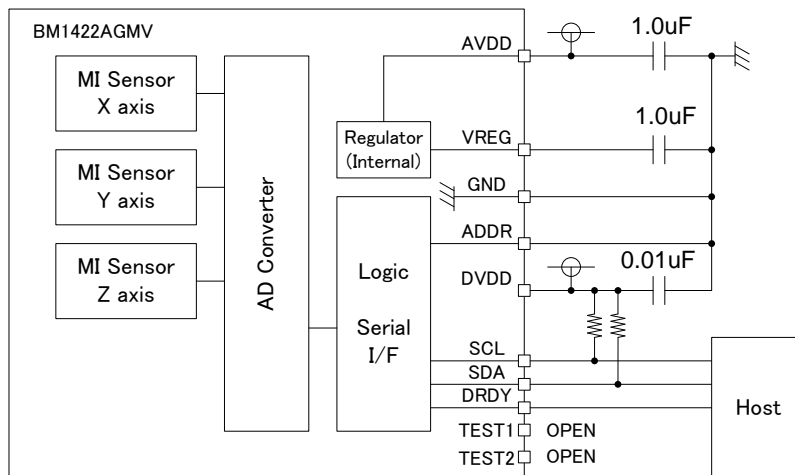


Write only Xch offset adjustment  
Ych and Zch should also be performed

When OFF\_X, OFF\_Y, OFF\_Z are changed in the same magnetic field environment, the change directions of the output are as follows

|        | OFF_X,Y,Z + | OFF_X,Y,Z - |
|--------|-------------|-------------|
| X axis | -           | +           |
| Y axis | -           | +           |
| Z axis | -           | +           |

Application Example



(Note) Sensor property may change due to around magnetic parts. We recommend calibrating the sensitivity and origin point of magnetic sensors after mounting.

I/O equivalent circuit

| Pin name | Equivalent Circuit Diagram | Pin name | Equivalent Circuit Diagram |
|----------|----------------------------|----------|----------------------------|
| SCL      |                            | SDA      |                            |
| DRDY     |                            | ADDR     |                            |
| TEST1    |                            | TEST2    |                            |
| VREG     |                            |          |                            |

## Operational Notes

### 1. Reverse Connection of Power Supply

Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply, such as mounting an external diode between the power supply and the IC's power supply pins.

### 2. Power Supply Lines

Design the PCB layout pattern to provide low impedance supply lines. Separate the ground and supply lines of the digital and analog blocks to prevent noise in the ground and supply lines of the digital block from affecting the analog block. Furthermore, connect a capacitor to ground at all power supply pins. Consider the effect of temperature and aging on the capacitance value when using electrolytic capacitors.

### 3. Ground Voltage

Ensure that no pins are at a voltage below that of the ground pin at any time, even during transient condition.

### 4. Ground Wiring Pattern

When using both small-signal and large-current ground traces, the two ground traces should be routed separately but connected to a single ground at the reference point of the application board to avoid fluctuations in the small-signal ground caused by large currents. Also ensure that the ground traces of external components do not cause variations on the ground voltage. The ground lines must be as short and thick as possible to reduce line impedance.

### 5. Thermal Consideration

Should by any chance the power dissipation rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. In case of exceeding this absolute maximum rating, increase the board size and copper area to prevent exceeding the Pd rating.

### 6. Recommended Operating Conditions

These conditions represent a range within which the expected characteristics of the IC can be approximately obtained. The electrical characteristics are guaranteed under the conditions of each parameter.

### 7. Inrush Current

When power is first supplied to the IC, it is possible that the internal logic may be unstable and inrush current may flow instantaneously due to the internal powering sequence and delays, especially if the IC has more than one power supply. Therefore, give special consideration to power coupling capacitance, power wiring, width of ground wiring, and routing of connections.

### 8. Operation Under Strong Electromagnetic Field

Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

### 9. Testing on Application Boards

When testing the IC on an application board, connecting a capacitor directly to a low-impedance output pin may subject the IC to stress. Always discharge capacitors completely after each process or step. The IC's power supply should always be turned off completely before connecting or removing it from the test setup during the inspection process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

**Operational Notes – continued****10. Inter-pin Short and Mounting Errors**

Ensure that the direction and position are correct when mounting the IC on the PCB. Incorrect mounting may result in damaging the IC. Avoid nearby pins being shorted to each other especially to ground, power supply and output pin. Inter-pin shorts could be due to many reasons such as metal particles, water droplets (in very humid environment) and unintentional solder bridge deposited in between pins during assembly to name a few.

**11. Unused Input Pins**

Input pins of an IC are often connected to the gate of a MOS transistor. The gate has extremely high impedance and extremely low capacitance. If left unconnected, the electric field from the outside can easily charge it. The small charge acquired in this way is enough to produce a significant effect on the conduction through the transistor and cause unexpected operation of the IC. So unless otherwise specified, unused input pins should be connected to the power supply or ground line.

**12. Regarding the Input Pin of the IC**

In the construction of this IC, P-N junctions are inevitably formed creating parasitic diodes or transistors. The operation of these parasitic elements can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions which cause these parasitic elements to operate, such as applying a voltage to an input pin lower than the ground voltage should be avoided. Furthermore, do not apply a voltage to the input pins when no power supply voltage is applied to the IC. Even if the power supply voltage is applied, make sure that the input pins have voltages within the values specified in the electrical characteristics of this IC.

**13. Ceramic Capacitor**

When using a ceramic capacitor, determine the dielectric constant considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

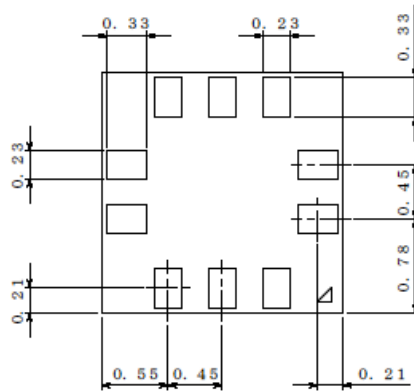
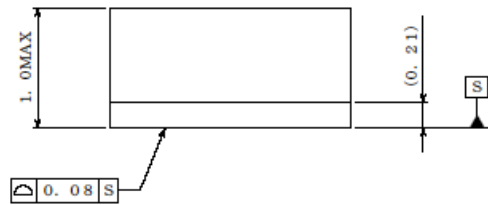
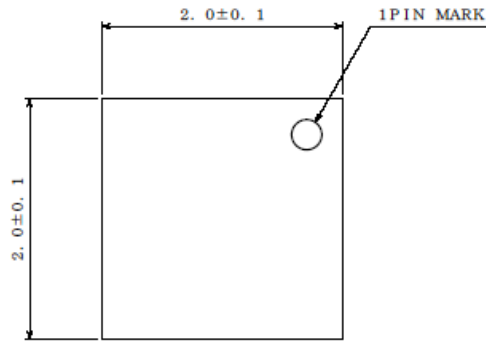
**14. Absolute Maximum Ratings**

Operate the IC such that the output voltage, output current, and power dissipation are all within the Absolute Maximum Ratings.



Physical Dimension, Tape and Reel Information

|              |              |
|--------------|--------------|
| Package Name | MLGA010V020A |
|--------------|--------------|



(UNIT : mm)

**<Tape and Reel information>**

|                   |   |
|-------------------|---|
| Tape              | Embossed carrier tape (with dry pack)   |
| Quantity          | 2500pcs   |
| Direction of feed | E2<br>( The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand ) |

Diagram of a carrier tape showing the direction of feed and the location of the 1pin. The tape is shown with a "Reel" on the left and "Direction of feed" on the right. A "1pin" is indicated at the upper left of the product area.

\* Order quantity needs to be multiple of the minimum quantity.



**Revision History**

| Date        | Revision | Changes     |
|-------------|----------|-------------|
| 17.Oct.2016 | 001      | New Release |

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| JAPAN     | USA       | EU         | CHINA     |
|-----------|-----------|------------|-----------|
| CLASS III | CLASS III | CLASS II b | CLASS III |
| CLASS IV  |           | CLASS III  |           |

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  - Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
  - Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
  - Sealing or coating our Products with resin or other coating materials
  - Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
  - Use of the Products in places subject to dew condensation
- The Products are not subject to radiation-proof design.
- Please verify and confirm characteristics of the final or mounted products in using the Products.
- In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.
- De-rate Power Dissipation depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction temperature.
- Confirm that operation temperature is within the specified range described in the product specification.
- ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

## Precaution for Mounting / Circuit board design

- When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.
- In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

### Precautions Regarding Application Examples and External Circuits

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.
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### Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

### Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
  - [a] the Products are exposed to sea winds or corrosive gases, including Cl<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, SO<sub>2</sub>, and NO<sub>2</sub>
  - [b] the temperature or humidity exceeds those recommended by ROHM
  - [c] the Products are exposed to direct sunshine or condensation
  - [d] the Products are exposed to high Electrostatic
2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.
3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.
4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

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## BM1422AGMV - Web Page

[Distribution Inventory](#)

|                             |              |
|-----------------------------|--------------|
| Part Number                 | BM1422AGMV   |
| Package                     | MLGA010V020A |
| Unit Quantity               | 2500         |
| Minimum Package Quantity    | 2500         |
| Packing Type                | Taping       |
| Constitution Materials List | inquiry      |
| RoHS                        | Yes          |