

Pressure Sensor series

# Pressure Sensor IC

## BM1383AGLV

### General Description

BM1383AGLV is piezo-resistive pressure sensor. BM1383AGLV does temperature compensation for MEMS inside chip, so it's very easy to get pressure information.

### Features

- Piezo-resistive pressure sensor.
- Pressure range is from 300hPa to 1100hPa.
- Built-in temperature compensation function.
- I<sup>2</sup>C interface.
- Small package.

### Applications

- Smartphone, Healthcare, mobile device (e.g. game).

### Key Specifications

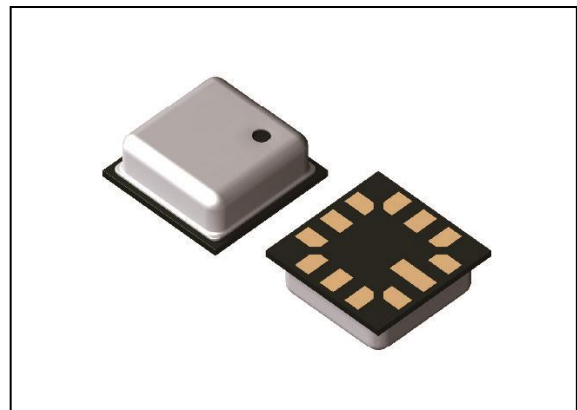
- Pressure Range: 300hPa to 1100hPa
- Relative Pressure Accuracy: ±0.12hPa(Typ)
- Absolute Pressure Accuracy: ±1hPa(Typ)
- Average Current Consumption: 3μA (Typ)
- Operating Temperature Range: -40°C to +85°C

### Package

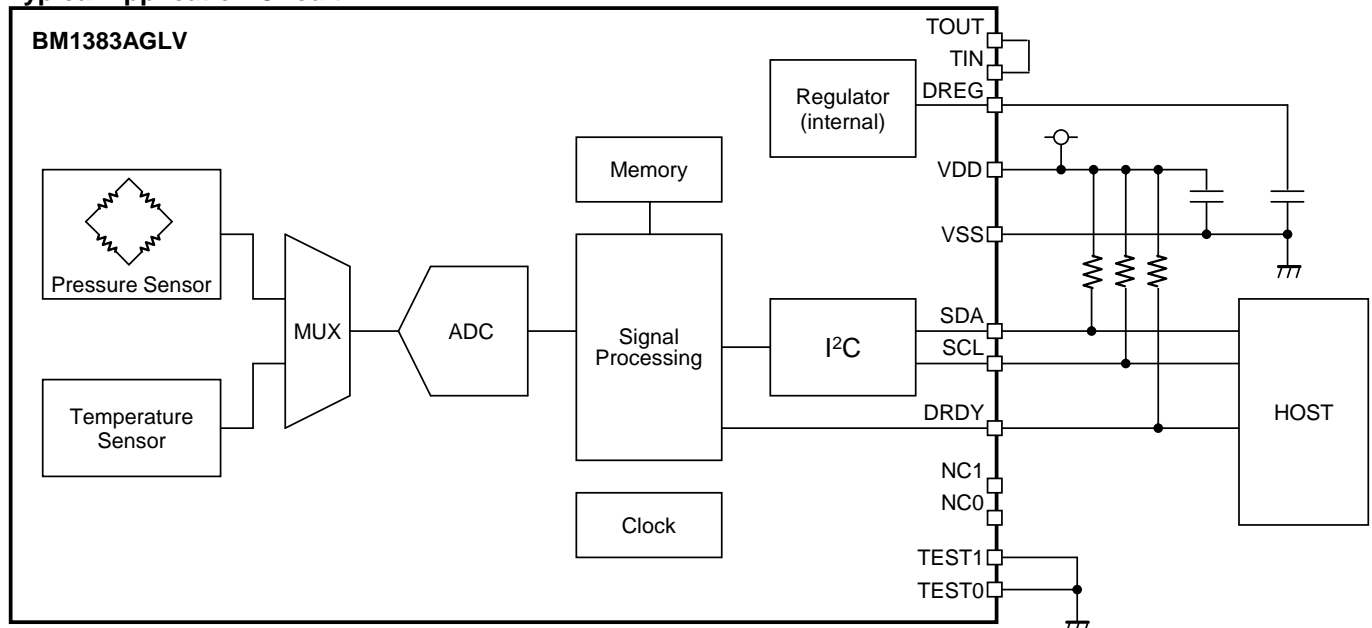
CLGA12V025M

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

2.50mm x 2.50mm x 1.00mm



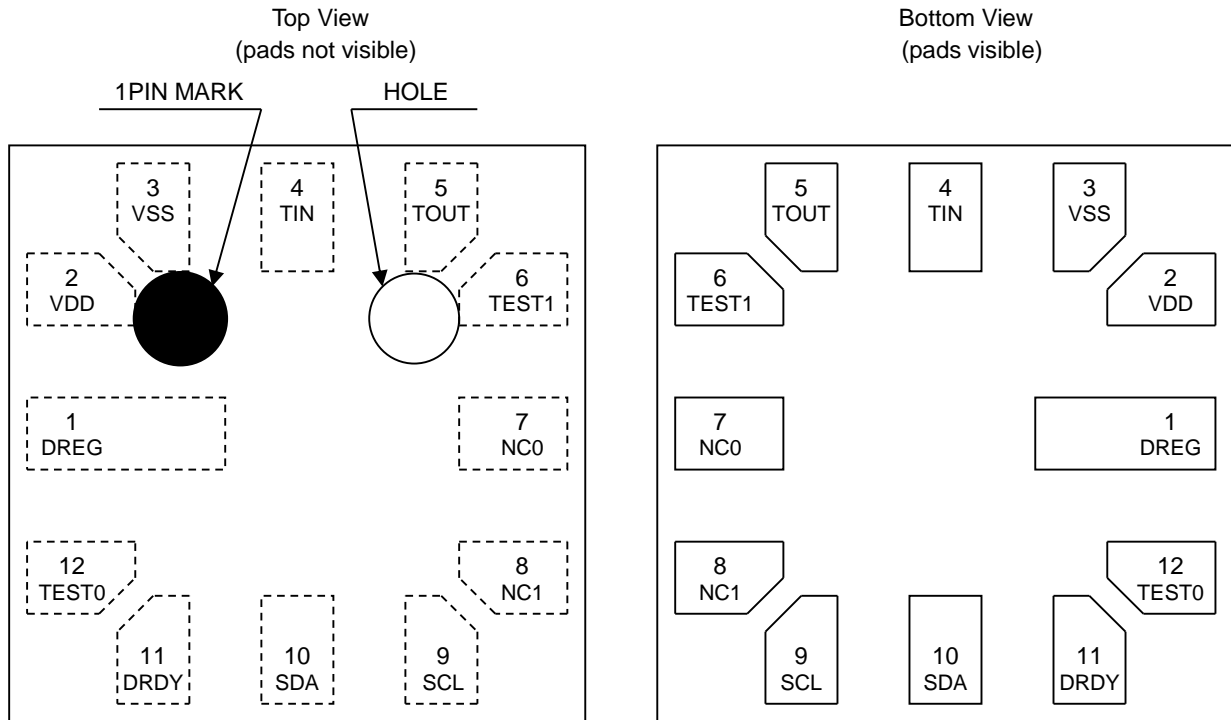
### Typical Application Circuit



## Contents

General Description .....	1
Features.....	1
Applications .....	1
Key Specifications.....	1
Package.....	1
Typical Application Circuit .....	1
Pin Configuration .....	3
Pin Description.....	3
Block Diagram .....	4
Absolute Maximum Ratings .....	5
Thermal Resistance.....	5
Recommended Operating Conditions .....	5
Electrical Characteristics.....	6
I <sup>2</sup> C bus Timing Chart.....	7
Register Map .....	8
I <sup>2</sup> C bus communication .....	13
Interrupt function.....	14
Control sequence.....	15
Application Example .....	19
I/O equivalent circuit .....	20
Operational Notes.....	21
Ordering Information.....	23
Marking Diagrams.....	23
Physical Dimension, Tape and Reel Information.....	24
Revision History.....	25

Pin Configuration



Pin Description

Pin No.	Pin Name	In/Out	Function
1	DREG	-	Logic voltage pin <sup>(Note 1)</sup>
2	VDD	-	power voltage pin <sup>(Note 2)</sup>
3	VSS	-	GND pin
4	TIN	In	Test pin (connect to TOUT)
5	TOUT	Out	Test pin (connect to TIN)
6	TEST1	In	Test pin (connect to GND)
7	NC0	-	Non connect pin
8	NC1	-	Non connect pin
9	SCL	In	I <sup>2</sup> C serial bus clock pin
10	SDA	In/Out	I <sup>2</sup> C serial bus data pin
11	DRDY	Out	Data ready output pin
12	TEST0	In	Test pin (connect to GND)

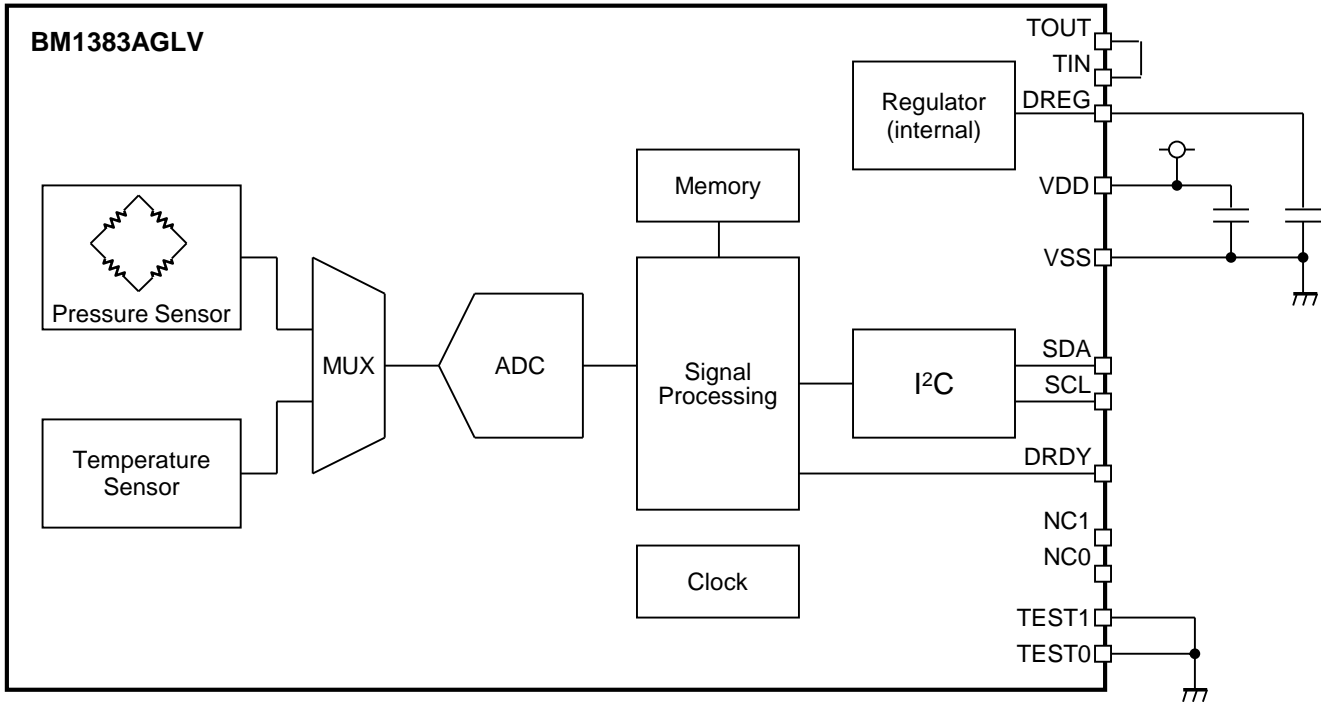
<sup>(Note 1)</sup> Please place a bypass capacitor between DREG and VSS in the proximity of the terminals.

Please set a bypass capacitor of 0.22μF between DREG and VSS.

Please do not use this pin for external power source.

<sup>(Note 2)</sup> Please place a bypass capacitor between VDD and VSS in the proximity of the terminals.

Block Diagram



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

Parameter	Symbol	Rating	Unit
Power Supply	V <sub>DD_MR</sub>	4.5	V
Input Voltage	V <sub>IN</sub>	-0.3 to VDD+0.3	V
Operating Temperature	T <sub>opr</sub>	-40 to +85	°C
Storage Temperature	T <sub>stg</sub>	-40 to +125	°C
Maximum Junction Temperature	T <sub>jmax</sub>	125	°C
Pressure	P <sub>ovr</sub>	20000	hPa

**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>	
CLGA12V025M				
Junction to Ambient	θ <sub>JA</sub>	360.5	230.5	°C/W
Junction to Top Characterization Parameter <sup>(Note 2)</sup>	Ψ <sub>JT</sub>	153	144	°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
Power Supply	VDD	1.7 to 3.6	V
I <sup>2</sup> C clock Input Frequency	f <sub>SCL</sub>	MAX 400	kHz

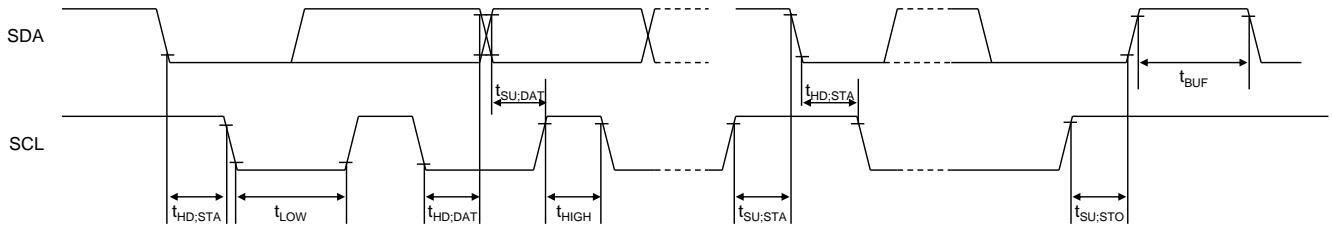
## Electrical Characteristics (Unless otherwise specified VDD=1.8V Ta=25°C)

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Current Consumption						
Operating Mode Current Consumption	I <sub>ddp</sub>	-	650	1000	μA	
Power Down Mode Current	I <sub>ss</sub>	-	1	5	μA	PWR_DOWN=0, RSTB=0
Logic						
L Input Voltage	V <sub>IL</sub>	GND	-	0.3 * VDD	V	SDA, SCL
H Input Voltage	V <sub>IH</sub>	0.7 * VDD	-	VDD	V	SDA, SCL
L Input Current	I <sub>IL</sub>	-10	-	0	μA	V <sub>IL</sub> = GND (SDA, SCL)
H Input Current	I <sub>IH</sub>	0	-	10	μA	V <sub>IH</sub> = VDD (SDA, SCL)
L Output Voltage 1	V <sub>OL1</sub>	GND	-	0.2 * VDD	V	I <sub>L</sub> = -0.3mA (DRDY)
L Output Voltage 2	V <sub>OL2</sub>	GND	-	0.2 * VDD	V	I <sub>L</sub> = -3mA (SDA)
Pressure characteristics						
Pressure Detection Range	P <sub>R</sub>	300	-	1100	hPa	
Relative Pressure Accuracy <sup>(Note 1)</sup>	P <sub>rel</sub>	-	±0.12	-	hPa	950hPa to 1050hPa
Absolute Pressure Accuracy	P <sub>abs</sub>	-	±1	-	hPa	1000hPa
Temperature Accuracy	T <sub>abs</sub>	-	±2	-	°C	25°C to 85°C
Measurement Time※	T <sub>m</sub>	-	-	6	ms	AVE_NUM=000

(Note 1) Target values

※Measurement time is changed by average number of measurement data. It is written in Measurement time.

I<sup>2</sup>C bus Timing Chart (Unless Otherwise VDD=1.8V Ta=25°C)



Parameter	Symbol	Min	Typ	Max	Unit	Conditions
I <sup>2</sup> C SCL Frequency	$f_{SCL}$	0	-	400	kHz	
I <sup>2</sup> C 'L' Period of SCL	$t_{LOW}$	1.3	-	-	$\mu s$	
I <sup>2</sup> C 'H' Period of SCL	$t_{HIGH}$	0.6	-	-	$\mu s$	
I <sup>2</sup> C Setup Time for START Condition	$t_{SU,STA}$	0.6	-	-	$\mu s$	
I <sup>2</sup> C Hold Time for (Repeated) START Condition	$t_{HD,STA}$	0.6	-	-	$\mu s$	
I <sup>2</sup> C Data Setup Time	$t_{SU,DAT}$	100	-	-	ns	
I <sup>2</sup> C Data Hold Time	$t_{HD,DAT}$	0	-	-	$\mu s$	
I <sup>2</sup> C Setup Time For STOP Condition	$t_{SU,STO}$	0.6	-	-	$\mu s$	
I <sup>2</sup> C Bus Free Time Between STOP and START Condition	$t_{BUF}$	1.3	-	-	$\mu s$	

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

Address	Register name	RW	D7	D6	D5	D4	D3	D2	D1	D0
0Fh	ID1	R	1	1	1	0	0	0	0	0
10h	ID2	R	0	0	1	1	0	0	1	0
12h	POWER_DOWN	RW	0	0	0	0	0	0	0	PWR_DOWN
13h	RESET	RW	0	0	0	0	0	0	0	RSTB
14h	MODE_CONTROL	RW	AVE_NUM			DREN	1	0	MODE	
19h	STATUS	R	0	0	0	0	0	0	0	RD_DRDY
1Ah	PRESSURE_MSB (Upper 8bit)	R	PRESS_OUT[15:8]							
1Bh	PRESSURE_LSB (Lower 8bit)	R	PRESS_OUT[7:0]							
1Ch	PRESSURE_LSB (Least 6bit)	R	PRESS_OUT_XL[5:0]						0	0
1Dh	TEMPERATURE_MSB (Upper 8bit)	R	TEMP_OUT[15:8]							
1Eh	TEMPERATURE_LSB (Lower 8bit)	R	TEMP_OUT[7:0]							

(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.

Address from 0x14 to 0x1E registers can be accessed only when PWR\_DOWN=1 and RSTB=1. (In other case Write: Ignored, Read: 0xFF)



## ◦ID1(0Fh)

Field	Bit	TYPE	Description
ID1	7 : 0	R	11100000

default value E0h

## ◦ID2(10h)

Field	Bit	TYPE	Description
ID2	7 : 0	R	00110010

default value 32h

## ◦POWER\_DOWN(12h)

Field	Bit	TYPE	Description
Reserved	7 : 1	RW	Reserved Write "0"
PWR_DOWN	0	RW	0: power down 1: active

default value 00h

## ◦RESET(13h)

Field	Bit	TYPE	Description
Reserved	7 : 1	RW	Reserved Write "0"
RSTB	0	RW	0: Measurement control block is reset 1: Measurement control block is active

default value 00h

MODE\_CONTROL(14h)

Field	Bit	TYPE	Description
AVE_NUM	7 : 5	RW	Set the average number of measurement data 000: single 001: average of 2 times 010: average of 4 times 011: average of 8 times 100: average of 16 times 101: average of 32 times 110: average of 64 times 111: inhibit
DREN	4	RW	DRDY pin Enable 0 : DRDY pin Disable 1 : DRDY pin Enable
Reserved	3	RW	Refer to Operation mode transition
Reserved	2	RW	Reserved Write "0"
MODE	1 : 0	RW	Set measurement mode

default value 08h

Measurement time and RMS noise against number of average

AVE_NUM	Measurement time $T_m$ max[ms]	Measurement cycle $T_i$ max[ms]	RMS noise [hPa]
000	6	60	0.090
001	9	60	0.063
010	16	60	0.045
011	30	60	0.032
100	60	60	0.023
101	120	120	0.016
110	240	240	0.011

RMS noise is calculated as standard deviation of 32 data points ( $1\sigma$ ).  
RMS noise is a reference value and it's not the value with guarantee.  
Condition VDD=1.8V Ta=25°C

Measurement mode

MODE	Measurement mode
00	Stand by
01	One shot
10	Continuous
11	Prohibition

Pressure and Temperature are measured at one rate

Measurement time

One shot mode perform one measurement. Measurement data is updated when measurement is completed, so it should be read more than  $T_m$  after start of measurement.

Continuous mode repeat measurement in every measurement cycle  $T_i$ . The latest measurement data which is completed is read.

Measurement time  $T_m$  and measurement cycle  $T_i$  is determined by number of measurement.

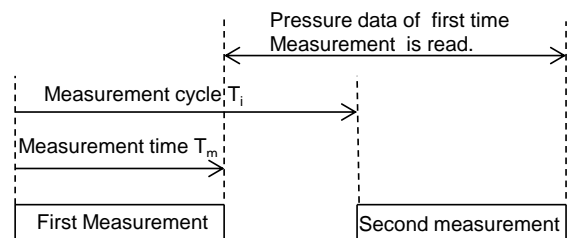
<One shot mode>



Start of measurement

Start of measurement

<Continuous mode>



Start of measurement

Operation mode transition

Please refer to the below figure of operation mode transition.

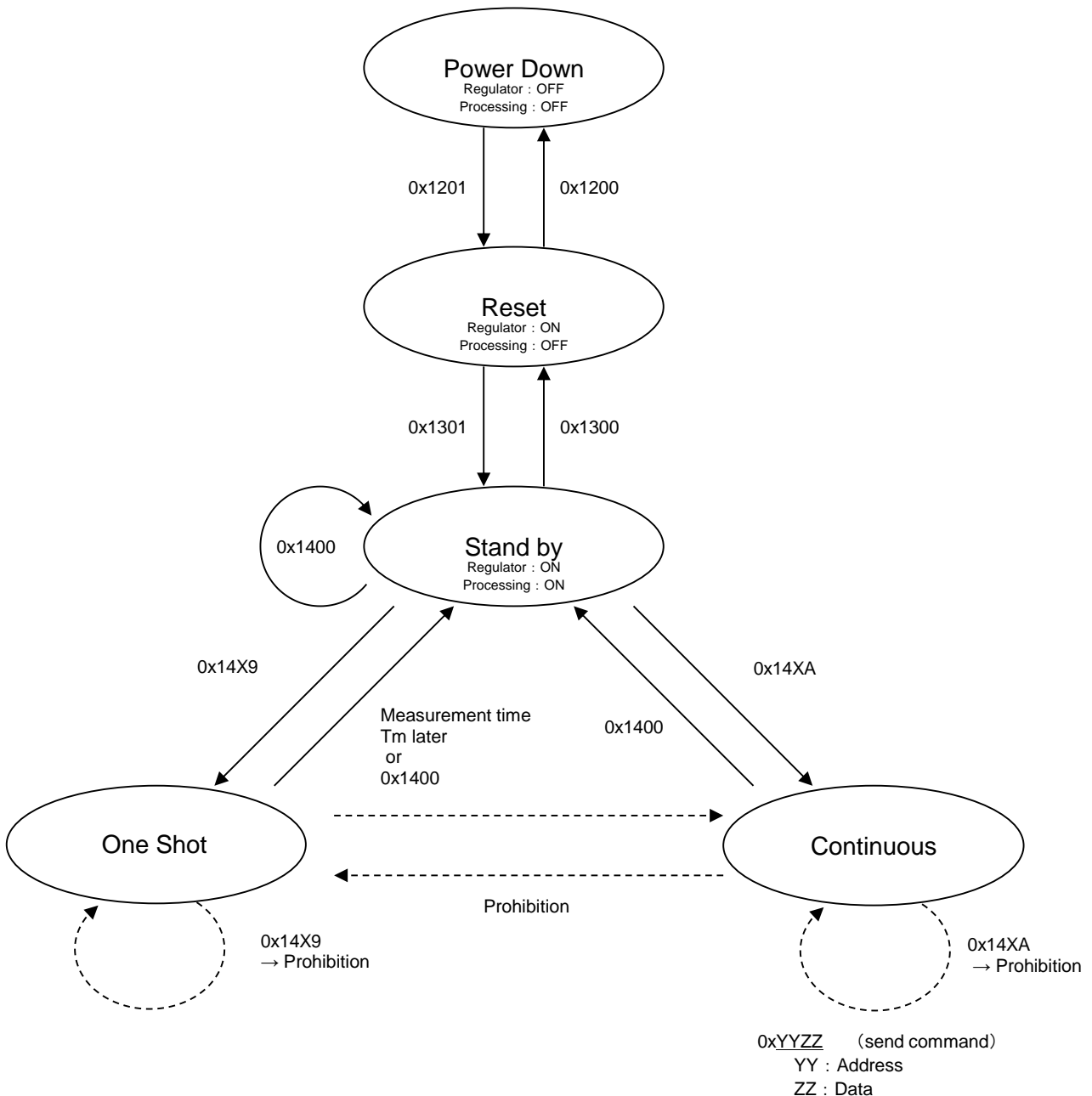
Power down mode is the smallest current consumption mode due to circuit is OFF. Please set this mode when reducing current consumption. Measurement is not available in this mode, so the measurement is performed after switching to standby mode.

In reset mode, regulator for internal blocks is active and measurement control block is reset. Register is initialized in Reset mode. Measurement command is acceptable when "1" is written in "RSTB"

There are 2 measurement modes. One shot mode and Continuous mode. They are transferred from stand by mode. Then, please set "AVE\_NUM" register at the same time. Please write "0x1400" when transferring to standby mode again.

In one shot mode, a single measurement is performed when "01" is written in "MODE". After the measurement completes, it is transferred to standby mode automatically. When "0x1400" is written before end of measurement, mode is switched to standby immediately but pressure value is not updated. Transition to the other measurement mode during measurement in one shot mode is forbidden.

In Continuous mode, when "10" is written in "MODE", measurement starts and it continues until "0x1400" is written. Transition to the other measurement mode from Continuous mode is forbidden.



## ○STATUS(19h)

Field	Bit	TYPE	Description
Reserved	7 : 1	R	0000000
RD_DRDY	0	R	Pressure and temperature measurement data ready bit 0: measurement data output is not yet available (measuring) 1: measurement data output is available

default value 00h

## ○PRESSURE\_MSB(1Ah)

Field	Bit	TYPE	Description
PRESS_OUT[15:8]	7 : 0	R	The upper part of pressure data

default value 00h

## ○PRESSURE\_LSB(1Bh)

Field	Bit	TYPE	Description
PRESS_OUT[7:0]	7 : 0	R	The lower part of pressure data

default value 00h

## ○PRESSURE\_LSB(Least 6bit) ( 1Ch )

Field	Bit	TYPE	Description
PRESS_OUT_XL [5:0]	7 : 2	R	Pressure data output (decimal extension 6bit)
Reserved	1 : 0	R	00

default value 00h

Conversion to pressure value is like below.

$$\text{Pressure counts} = \text{PRESS\_OUT}[15:8] \times 2^{14} + \text{PRESS\_OUT}[7:0] \times 2^6 + \text{PRESS\_OUT\_XL}[5:0] \text{ [counts] (dec)}$$

$$\text{Pressure value [hPa]} = \text{Pressure counts [counts]} / 2048 \text{ [counts/hPa]}$$

Data register (0x1A~0x1C) should be read by continuous read.

Data is updated at the timing of measurement completion.

If they are not read by continuous read, data might be mixed up with the data of different measurement.

## ○TEMPERATURE\_MSB(1Dh)

Field	Bit	TYPE	Description
TEMP_OUT[15:8]	7 : 0	R	The upper part of temperature data.

default value 00h

## ○TEMPERATURE\_LSB(1Eh)

Field	Bit	TYPE	Description
TEMP_OUT[7:0]	7 : 0	R	The lower part of temperature data

default value 00h

Conversion to temperature value is like below. But please note that TEMP\_OUT is data with sign (two's complement).

$$\text{Temp counts} = \text{TEMP\_OUT}[15:8] \times 2^8 + \text{TEMP\_OUT}[7:0] \text{ [counts] (dec)}$$

$$\text{Temperature value [}^\circ\text{C]} = \text{Temp counts [counts]} / 32 \text{ [counts/}^\circ\text{C]}$$

(in case of positive number)

Data register (0x1D,0x1E) should be read by continuous read.

Data is updated at the timing of measurement completion.

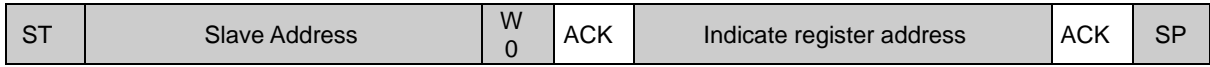
If they are not read by continuous read, data might be mixed up with the data of different measurement.

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

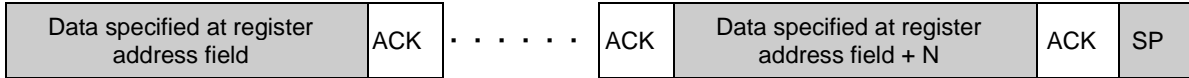
1. Slave address : "1011101"

2. Write format

(1) Case of indicating only register address

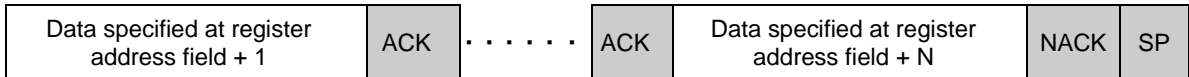
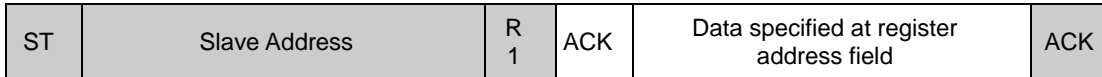


(2) Case of writing data register after indicating register address

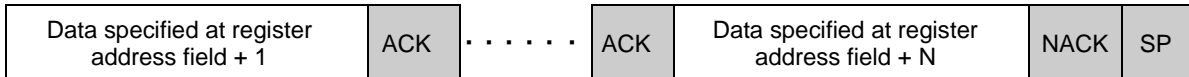
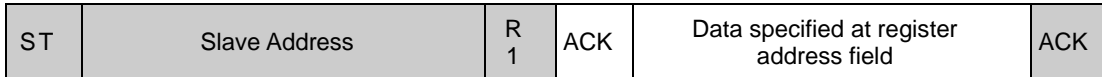


3. Read format

(1) Case of continuous reading data after indicating register address (Master issues restart condition)



(2) Case of continuous reading data



from master to slave

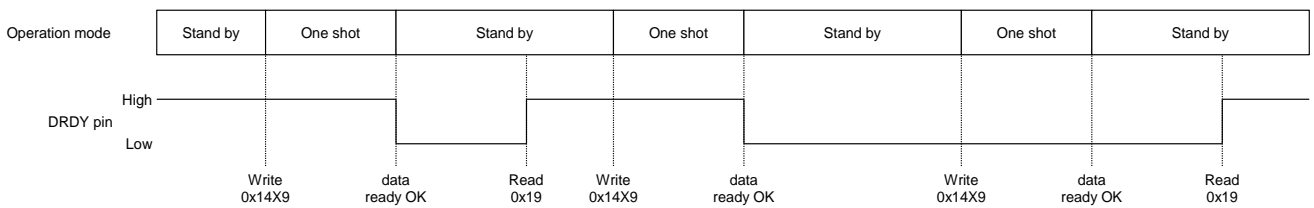
from slave to master

**Interrupt function**

In case that Interrupt function is enable (DREN=1), interrupt occur (RD\_DRDY register become "1" and DRDY terminal become L active) just after measurement is finished.  
 Once interrupt occur, RD\_DRDY register and DRDY terminal keep active until interrupt is cleared. Interrupt can be cleared by reading RD\_DRDY register or setting reset mode.

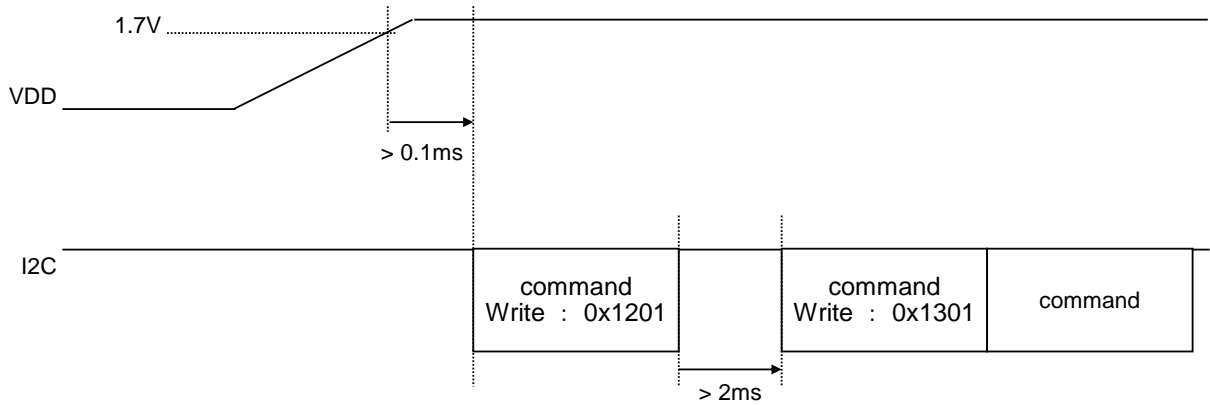
DRDY terminal is Nch open drain so this terminal should be pull-up to voltage source by an external resistor.  
 DRDY terminal is high impedance just after VDD is supplied.  
 DRDY terminal becomes inactive (High impedance) by reading RD\_DRDY register or setting reset mode.  
 VDD current (approximately 6µA at VDD=1.8V) is consumed during DRDY is active.  
 If you disable interrupt function, please set DREN=0 after clearing interrupt.

<DRDY pin action example : 1shot mode>

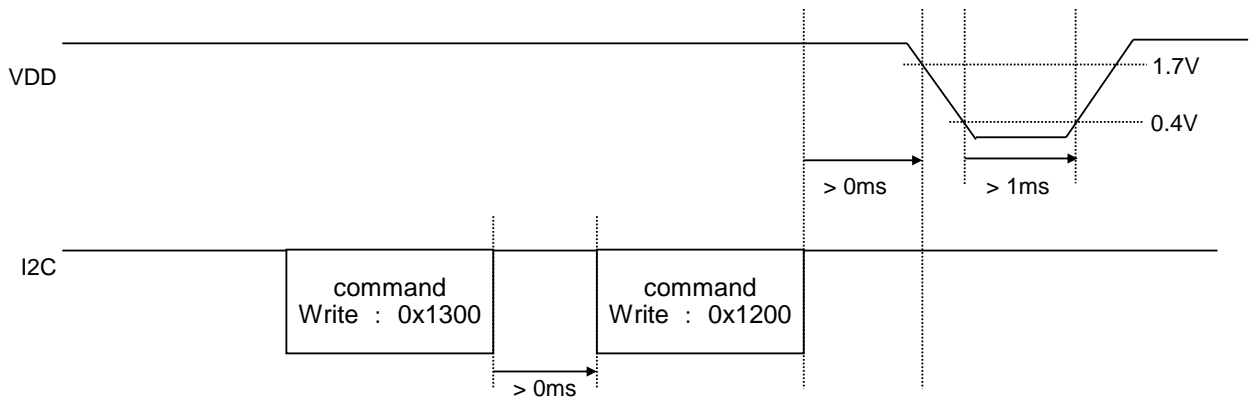


Control sequence

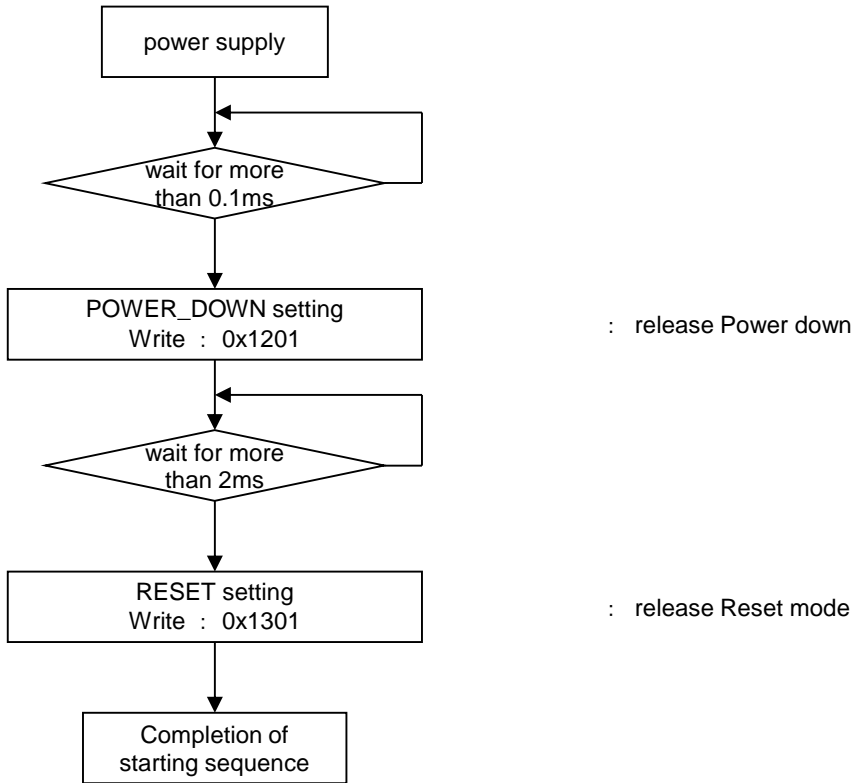
- 1. Power supply start-up sequence  
Please do the command control by I<sup>2</sup>C after power is supplied.



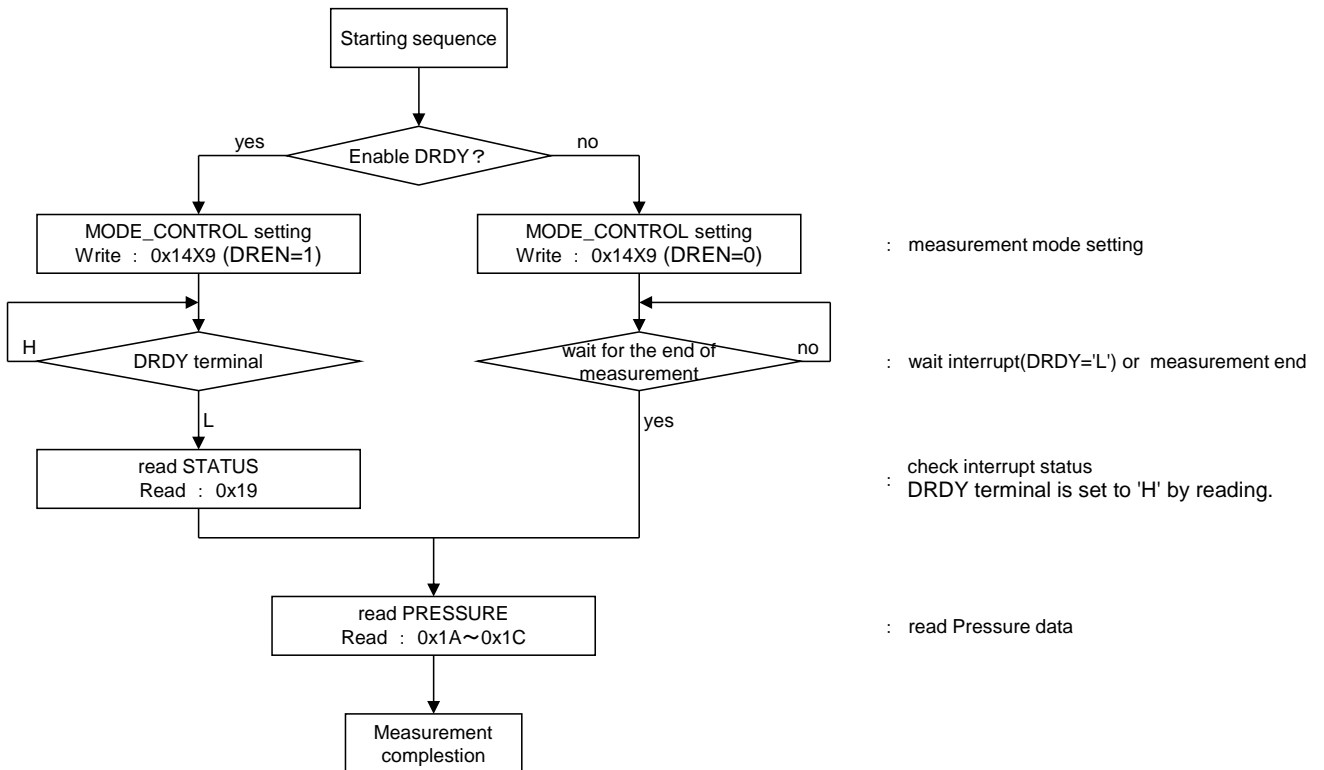
- 2. Power supply end sequence



3. Starting sequence

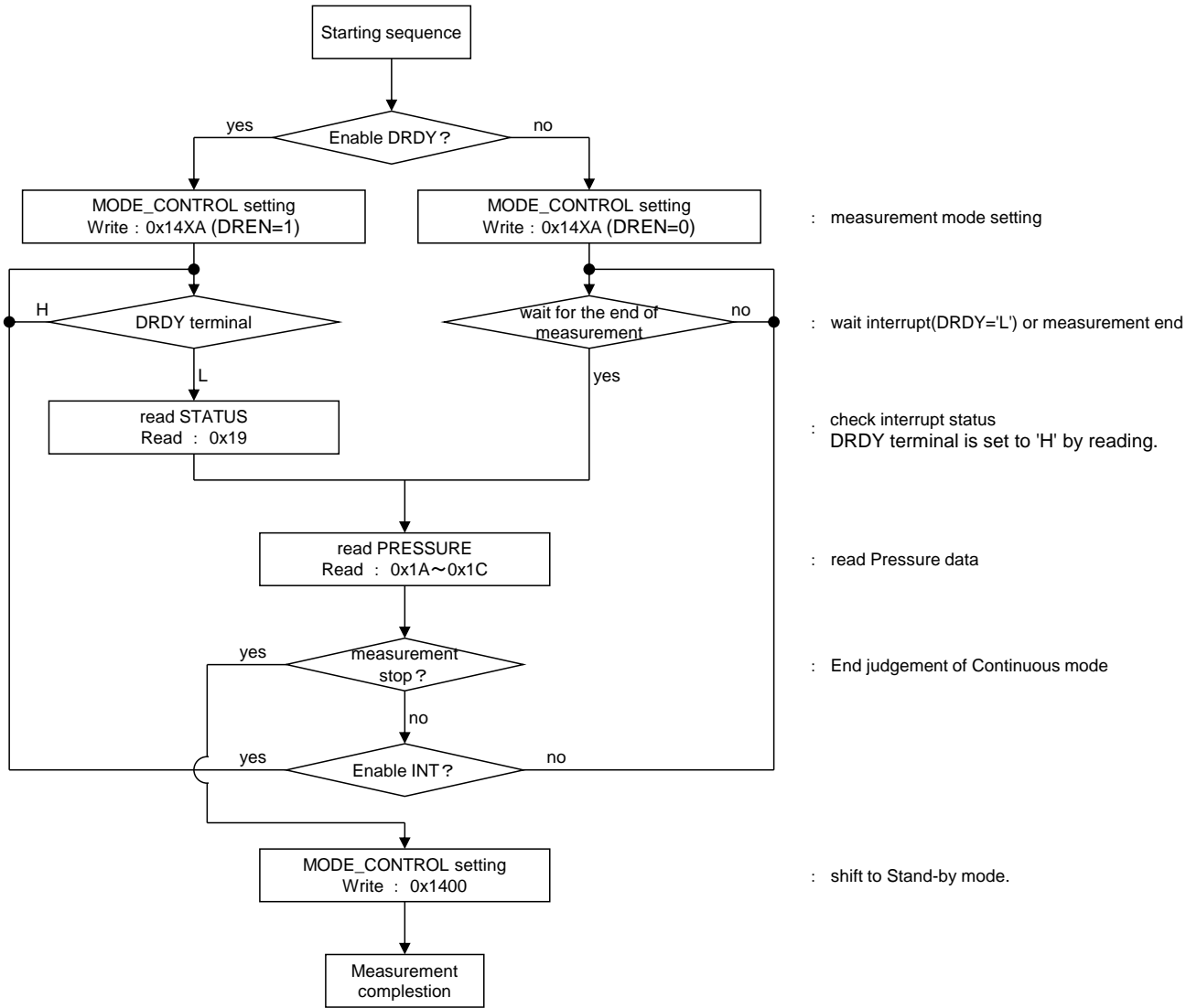


4. Measurement sequence: One Shot Mode

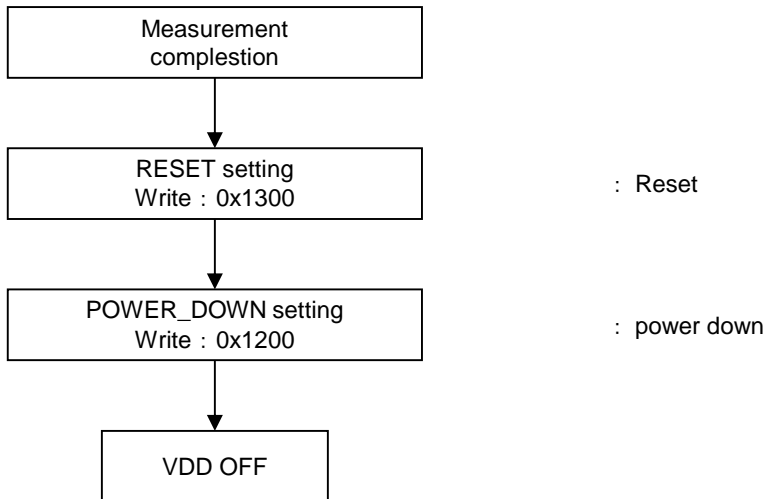




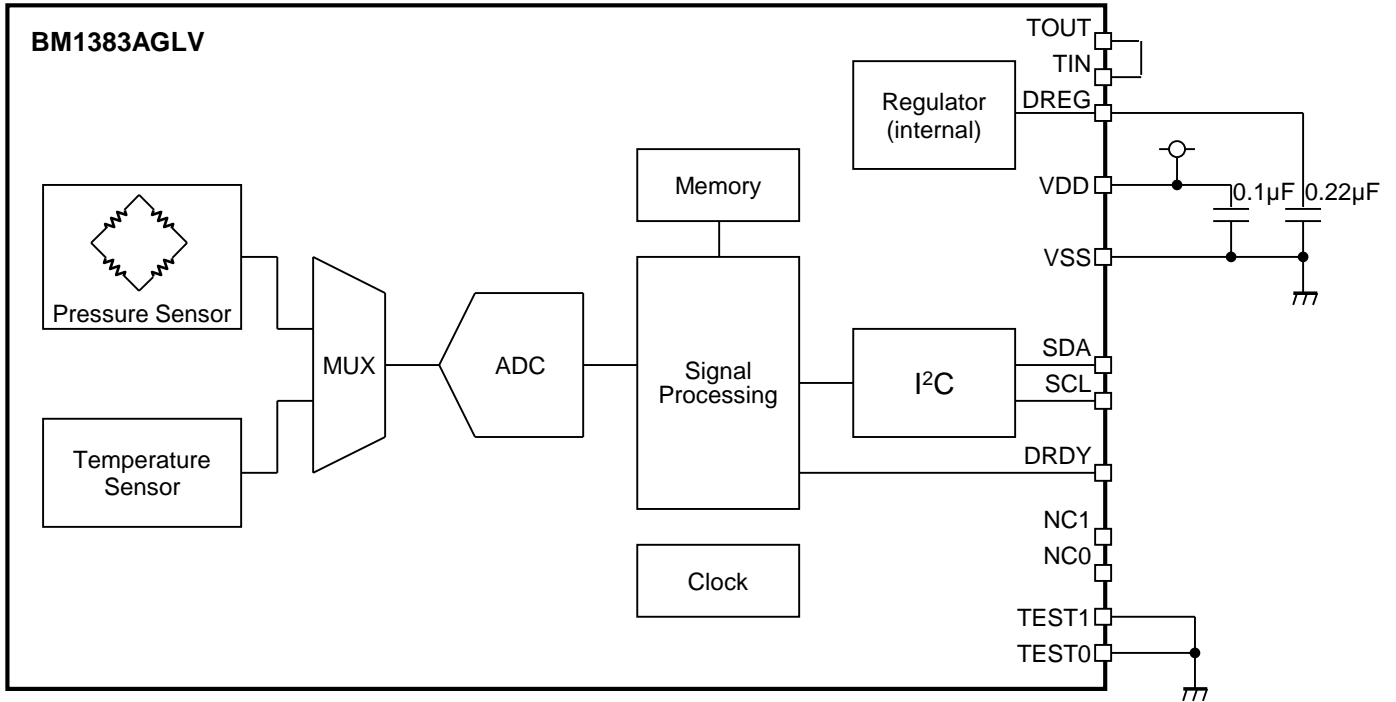
5. Measurement sequence: Continuous Mode



6. Ending sequence



Application Example



I/O equivalent circuit

Pin name	Equivalent Circuit Diagram	Pin name	Equivalent Circuit Diagram
SCL		SDA	
DRDY		DREG TOUT	
TIN		TEST0 TEST1	

## 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. 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 maximum junction temperature 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 maximum junction temperature 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.

### 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.

**Operational Notes – continued****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.

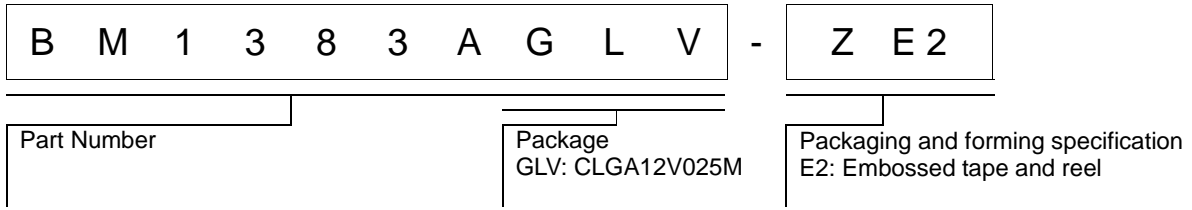
**13. Ceramic Capacitor**

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.

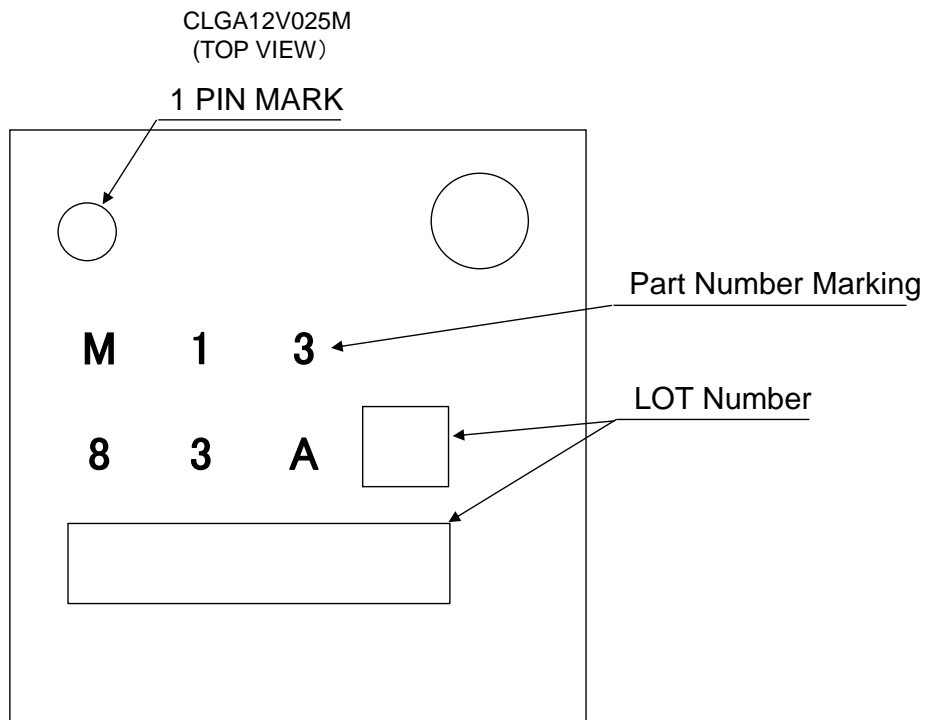
**14. Disturbance light**

In a device where a portion of silicon is exposed to light such as in a WL-CSP, IC characteristics may be affected due to photoelectric effect. For this reason, it is recommended to come up with countermeasures that will prevent the chip from being exposed to light.

Ordering Information

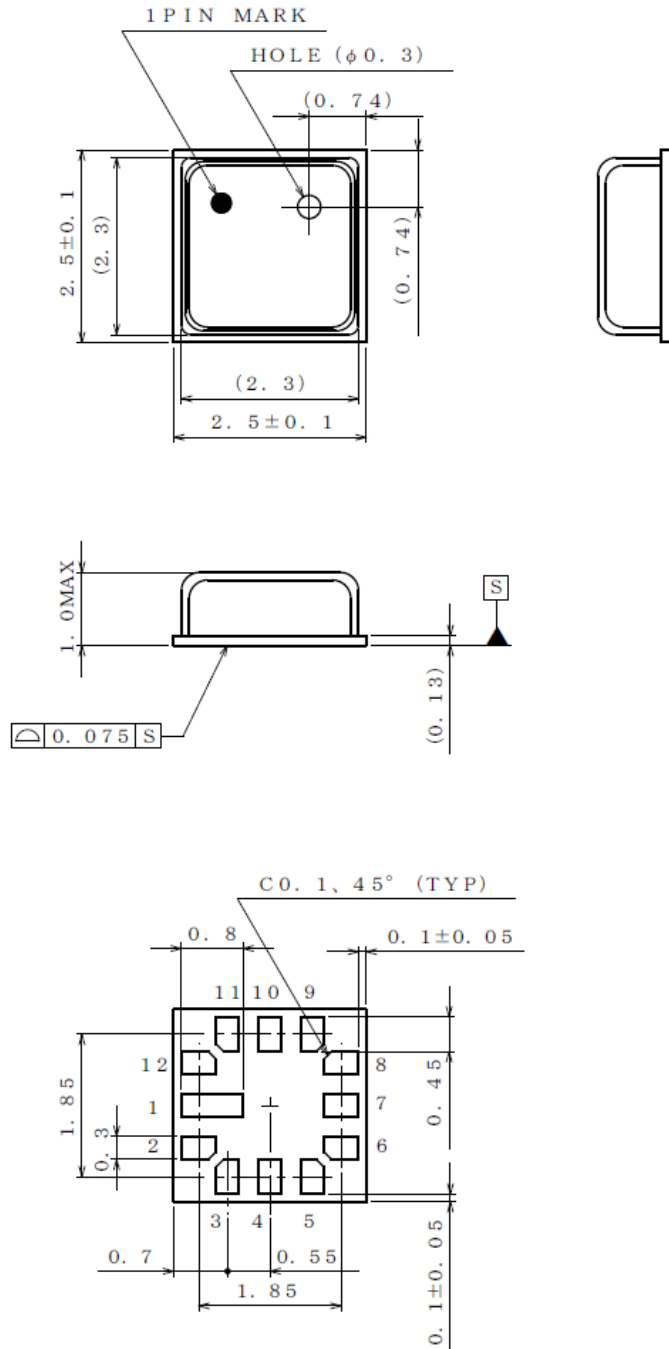


Marking Diagrams



Physical Dimension, Tape and Reel Information

Package Name	CLGA12V025M
--------------	-------------



**<Tape and Reel information>**

Tape	Embossed carrier tape (with dry pack)
Quantity	3000pcs
Direction of feed	E2 ( 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 )

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

(UNIT ; mm)

PKG : CLGA12V025M  
Drawing No. EX813-5001



## Revision History

Date	Revision	Changes
17.Nov.2015	001	New Release
30.Mar.2016	002	P1 modify Typical Application Circuit P3 modify Pin Description P4 modify Block Diagram P5 modify Absolute Maximum Ratings P6 modify Electrical Characteristics P9 modify POWER_DOWN and RESET P10 modify MODE_CONTROL P11 modify Operation mode transition P12 modify STATUS, Pressure value and Temperature value P13 modify I <sup>2</sup> C bus communication P19 modify Application Example
21.Apr.2016	003	P5 modify Absolute Maximum Ratings and Thermal Resistance P8,10,12 modify note of Register Map P11 modify Operation mode transition P21,22 modify Operational Notes

# Notice

## Precaution on using ROHM Products

- Our Products are designed and manufactured for application in ordinary electronic equipments (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment <sup>(Note 1)</sup>, transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

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

- ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
  - Installation of protection circuits or other protective devices to improve system safety
  - Installation of redundant circuits to reduce the impact of single or multiple circuit failure
- Our Products are designed and manufactured for use under standard conditions and not under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc. prior to use, must be necessary:
  - Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
  - Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
  - Use of our Products in places where the Products are exposed to sea wind 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>
  - 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.
2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

### 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.

### Precaution for Product Label

A two-dimensional barcode printed on ROHM Products label is for ROHM's internal use only.

### Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

### Precaution for Foreign Exchange and Foreign Trade act

Since concerned goods might be fallen under listed items of export control prescribed by Foreign exchange and Foreign trade act, please consult with ROHM in case of export.

### Precaution Regarding Intellectual Property Rights

1. All information and data including but not limited to application example contained in this document is for reference only. ROHM does not warrant that foregoing information or data will not infringe any intellectual property rights or any other rights of any third party regarding such information or data.
2. ROHM shall not have any obligations where the claims, actions or demands arising from the combination of the Products with other articles such as components, circuits, systems or external equipment (including software).
3. No license, expressly or implied, is granted hereby under any intellectual property rights or other rights of ROHM or any third parties with respect to the Products or the information contained in this document. Provided, however, that ROHM will not assert its intellectual property rights or other rights against you or your customers to the extent necessary to manufacture or sell products containing the Products, subject to the terms and conditions herein.

### Other Precaution

1. This document may not be reprinted or reproduced, in whole or in part, without prior written consent of ROHM.
2. The Products may not be disassembled, converted, modified, reproduced or otherwise changed without prior written consent of ROHM.
3. In no event shall you use in any way whatsoever the Products and the related technical information contained in the Products or this document for any military purposes, including but not limited to, the development of mass-destruction weapons.
4. The proper names of companies or products described in this document are trademarks or registered trademarks of ROHM, its affiliated companies or third parties.

**General Precaution**

1. Before you use our Products, you are requested to carefully read this document and fully understand its contents. ROHM shall not be in any way responsible or liable for failure, malfunction or accident arising from the use of any ROHM's Products against warning, caution or note contained in this document.
2. All information contained in this document is current as of the issuing date and subject to change without any prior notice. Before purchasing or using ROHM's Products, please confirm the latest information with a ROHM sales representative.
3. The information contained in this document is provided on an "as is" basis and ROHM does not warrant that all information contained in this document is accurate and/or error-free. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties resulting from inaccuracy or errors of or concerning such information.