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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.

Key Specifications

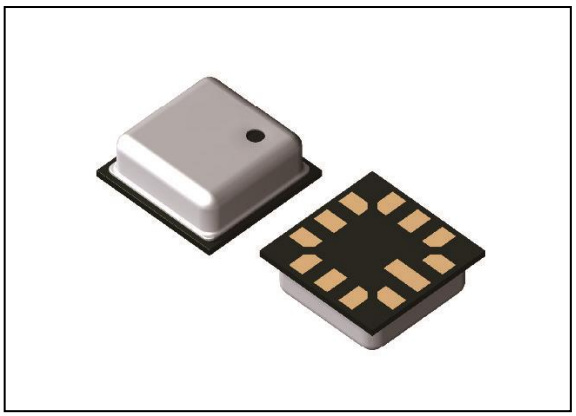
- Pressure Range: 300hPa to 1100hPa
- Relative Pressure Accuracy: ±0.12hPa(Typ)
- Absolute Pressure Accuracy: ±1hPa(Typ)
- Average Current Consumption: 3μA (Typ)
- Operating Temperature Range: -40°C to +85°C

Features

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

Package

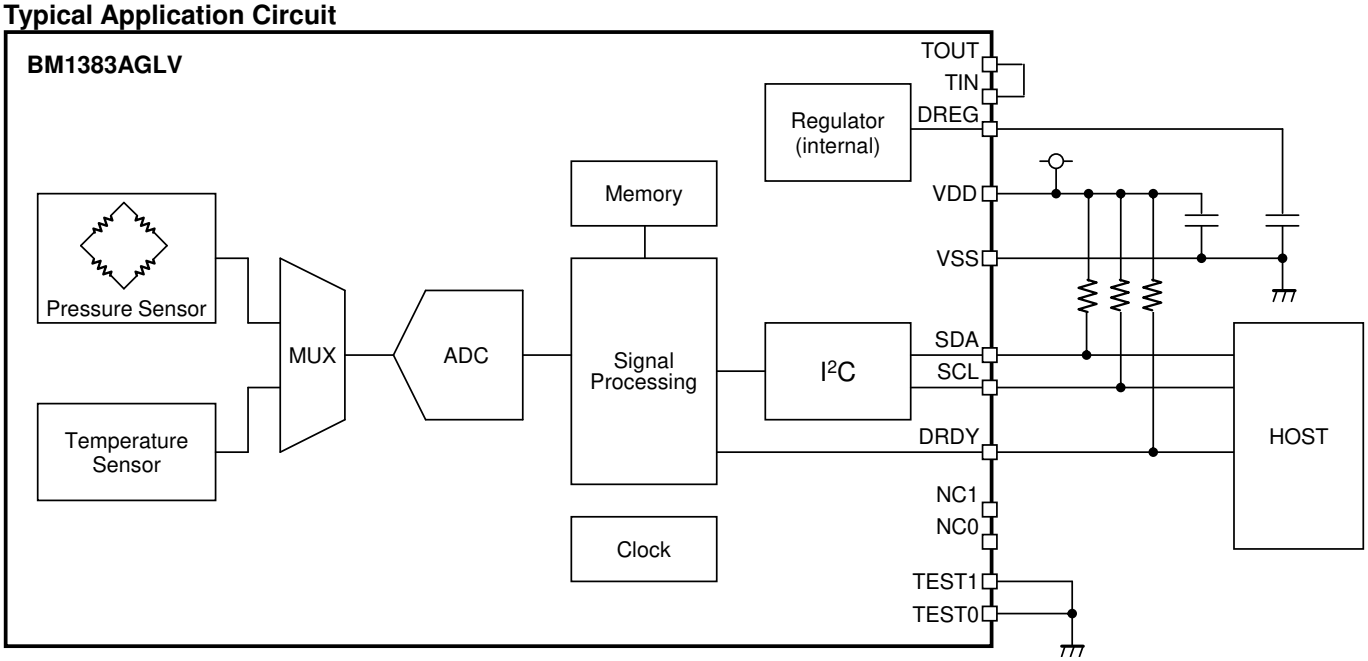
	W(Typ) x D(Typ) x H(Max)
CLGA12V025M	2.50mm x 2.50mm x 1.00mm



Applications

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

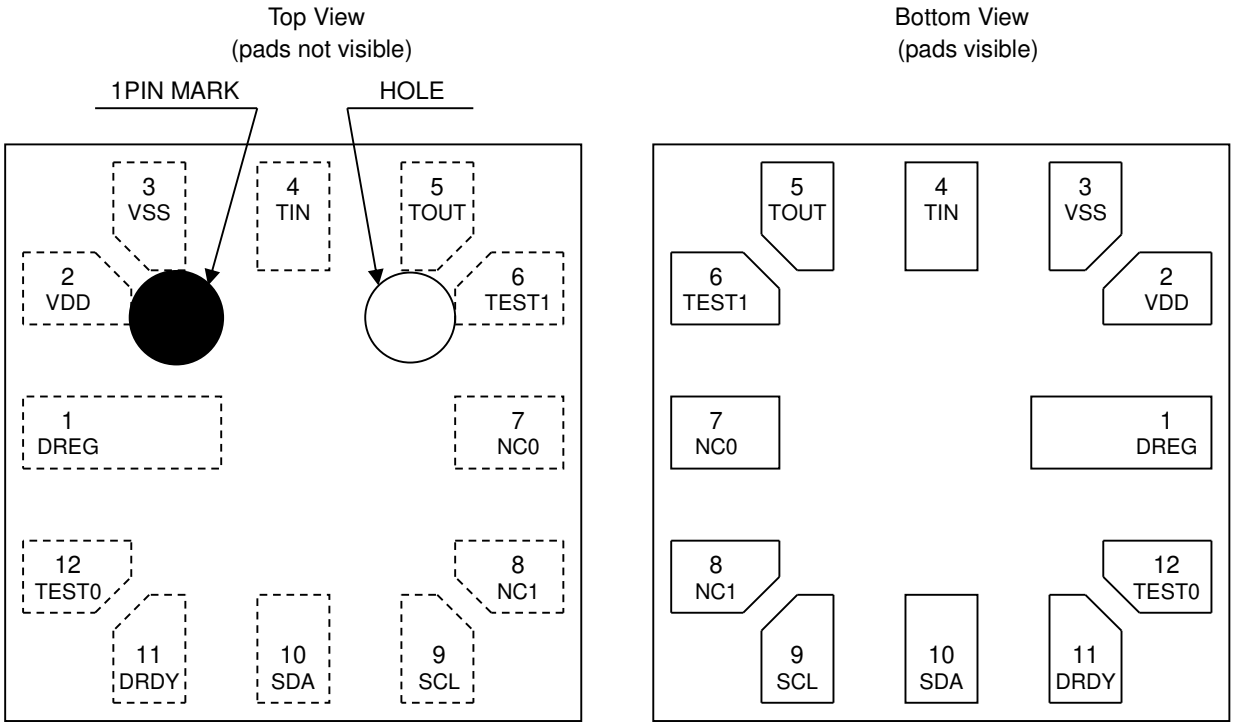
Typical Application Circuit



○Product structure : Silicon monolithic integrated circuit ○This product has no designed protection against radioactive rays

Contents

Pin Configuration

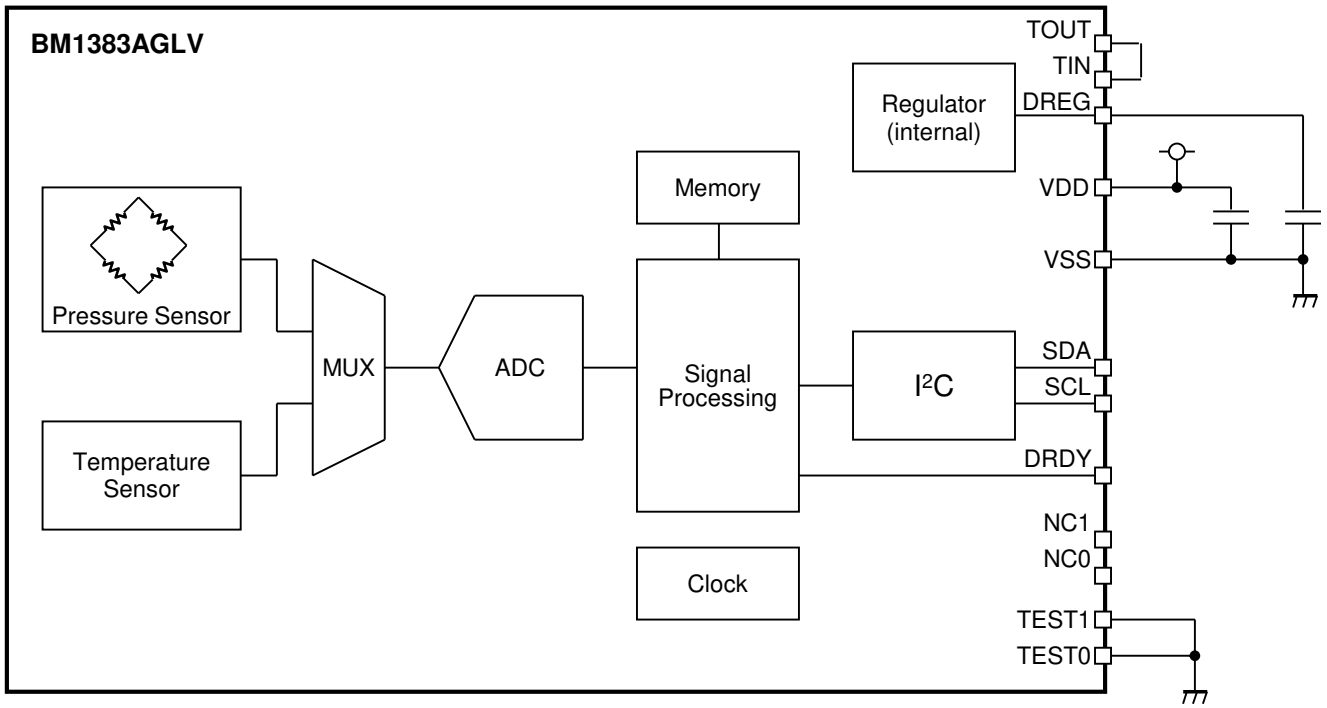


Pin Description

Pin No.	Pin Name	In/Out	Function
1	DREG	-	Logic voltage pin*(Note 1)*
2	VDD	-	power voltage pin*(Note 2)*
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^2C serial bus clock pin
10	SDA	In/Out	I^2C serial bus data pin
11	DRDY	Out	Data ready output pin
12	TEST0	In	Test pin (connect to GND)

(Note 1) 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.
(Note 2) 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_{DD_MR}	4.5	V
Input Voltage	V_{IN}	-0.3 to VDD+0.3	V
Operating Temperature	T_{opr}	-40 to +85	°C
Storage Temperature	T_{stg}	-40 to +125	°C
Maximum Junction Temperature	T_{jmax}	125	℃
Pressure	P_{ovr}	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*(Note 1)*

Parameter	Symbol	Thermal Resistance (Typ)		Unit
		1s*(Note 3)*	2s2p*(Note 4)*	
CLGA12V025M				
Junction to Ambient	θ_{JA}	360.5	230.5	°C/W
Junction to Top Characterization Parameter*(Note 2)*	Ψ_{JT}	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^2C clock Input Frequency	f_{SCL}	MAX 400	kHz

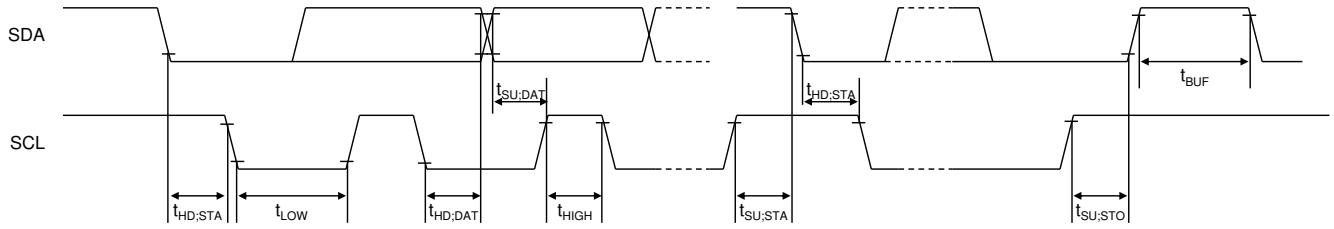
Electrical Characteristics (Unless otherwise specified VDD=1.8V Ta=25°C)

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Current Consumption						
Operating Mode Current Consumption	I_{ddp}	-	650	1000	µA	
Power Down Mode Current	I_{ss}	-	1	5	µA	PWR_DOWN=0, RSTB=0
Logic						
L Input Voltage	V_{IL}	GND	-	0.3 * VDD	V	SDA, SCL
H Input Voltage	V_{IH}	0.7 * VDD	-	VDD	V	SDA, SCL
L Input Current	I_{IL}	-10	-	0	µA	V_{IL}= GND (SDA, SCL)
H Input Current	I_{IH}	0	-	10	µA	V_{IH}= VDD (SDA, SCL)
L Output Voltage 1	V_{OL1}	GND	-	0.2 * VDD	V	IL= -0.3mA (DRDY)
L Output Voltage 2	V_{OL2}	GND	-	0.2 * VDD	V	IL= -3mA (SDA)
Pressure characteristics						
Pressure Detection Range	P_R	300	-	1100	hPa	
Relative Pressure Accuracy *(Note 1)*	P_{rel}	-	±0.12	-	hPa	950hPa to 1050hPa
Absolute Pressure Accuracy	P_{abs}	-	±1	-	hPa	1000hPa
Temperature Accuracy	T_{abs}	-	±2	-	°C	25°C to 85°C
Measurement Time※	T_m	-	-	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.

I²C bus Timing Chart (Unless Otherwise VDD=1.8V Ta=25°C)



Parameter	Symbol	Min	Typ	Max	Unit	Conditions
I²C SCL Frequency	f_{SCL}	0	-	400	kHz	
I²C 'L' Period of SCL	t_{LOW}	1.3	-	-	µs	
I²C 'H' Period of SCL	t_{HIGH}	0.6	-	-	µs	
I²C Setup Time for START Condition	$t_{SU;STA}$	0.6	-	-	µs	
I²C Hold Time for (Repeated) START Condition	$t_{HD;STA}$	0.6	-	-	µs	
I²C Data Setup Time	$t_{SU;DAT}$	100	-	-	ns	
I²C Data Hold Time	$t_{HD;DAT}$	0	-	-	µs	
I²C Setup Time For STOP Condition	$t_{SU;STO}$	0.6	-	-	µs	
I²C Bus Free Time Between STOP and START Condition	t_{BUF}	1.3	-	-	µs	

Register Map(Note 1)

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: 0xXX)

○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 (1σ).
RMS noise is a reference value and it’s not the value with guarantee.
Condition VDD=1.8V Ta=25°C

Measurement mode

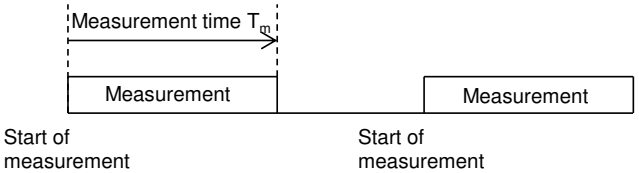
MODE	Measurement mode
00	Stand by
01	One shot
10	Continuous
11	Prohibition

Pressure and Temperature are measured at one rate

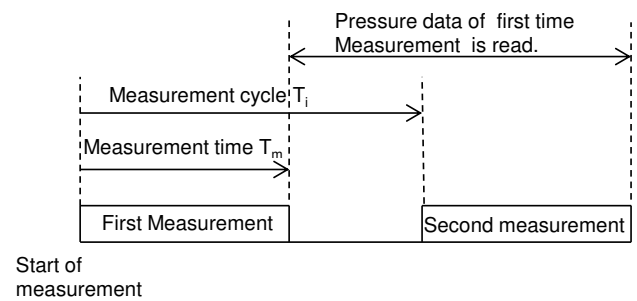
Measurement time

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>



<Continuous mode>



Operation mode transition

Please refer to the below figure of operation mode transition.

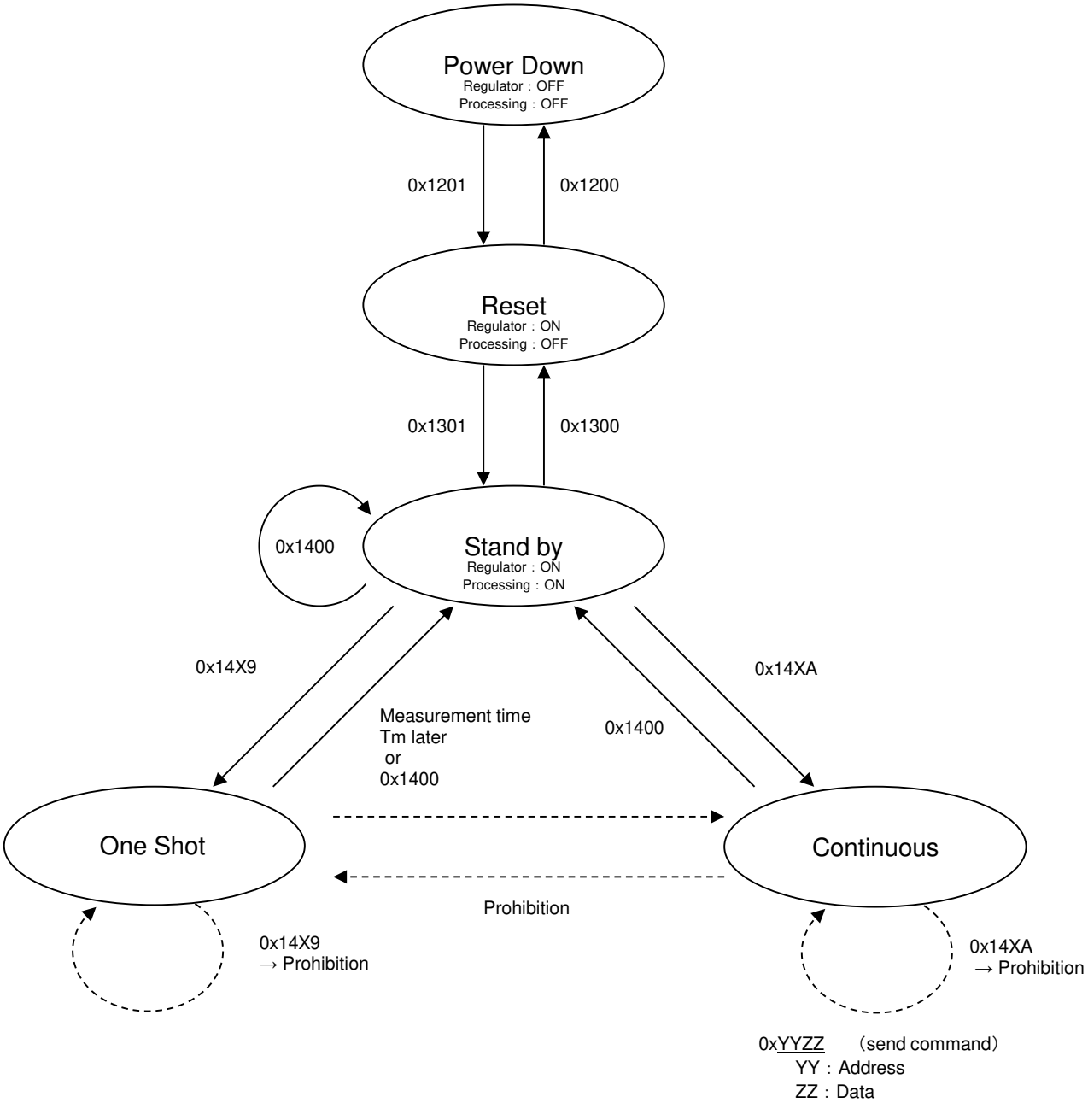
Power down mode is the smallest current consumption mode due to circuit is OFF. Please set this mode when reducing current consumption. Measurement is not available in this mode, so the measurement is performed after switching to standby mode.

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.

Pressure counts = PRESS_OUT[15:8] x 2^{14} + PRESS_OUT[7:0] x 2^{6} + PRESS_OUT_XL[5:0] [counts] (dec)
Pressure value [hPa] = Pressure counts [counts] / 2048 [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).

Temp counts = TEMP_OUT[15:8] x 2^{8} +TEMP_OUT[7:0] [counts] (dec)
Temperature value [℃] = Temp counts [counts] / 32 [counts/℃]
(in case of positive number)

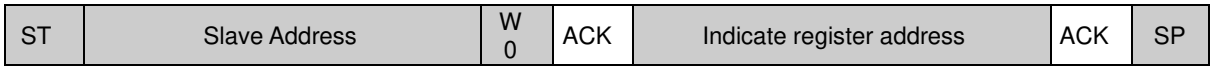
Data register (0x1D,0x1E) should be read by continuous read.
Data is updated at the timing of measurement completion.
If they are not read by continuous read, data might be mixed up with the data of different measurement.

I²C bus communication

1. Slave address : “1011101”

2. Write format

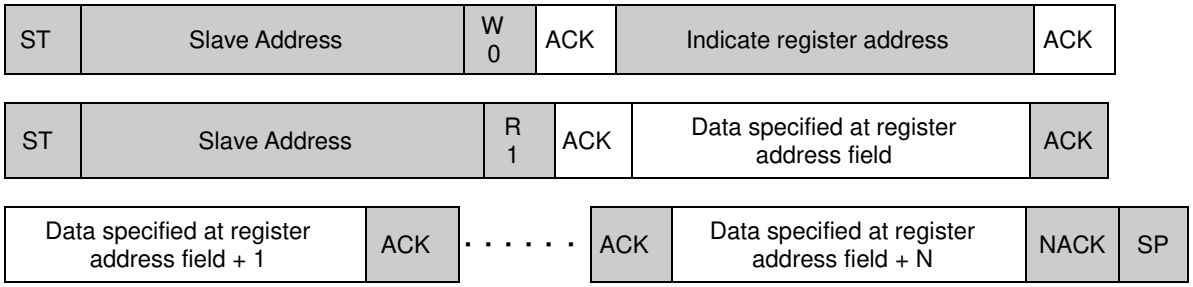
(1) Case of indicating only register address



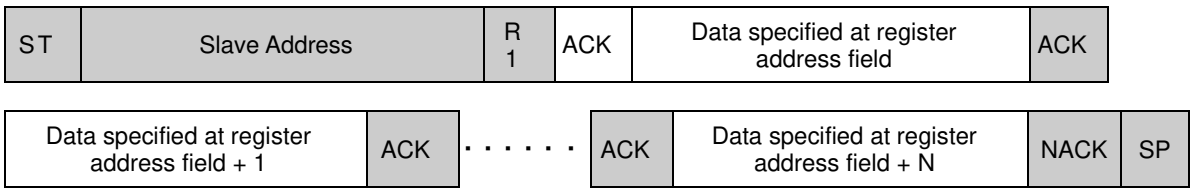
(2) Case of writing data register after indicating register address

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

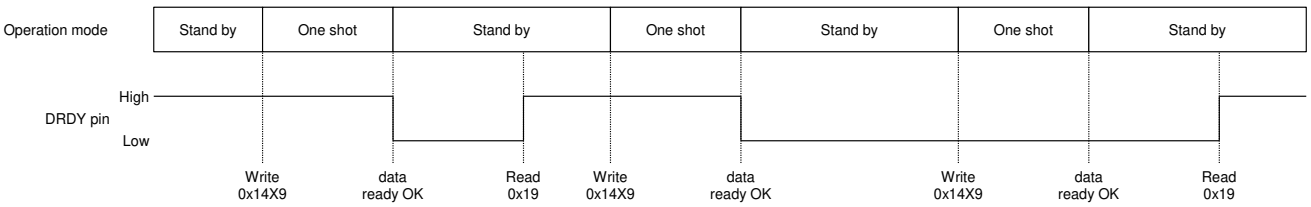

from slave to master

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.

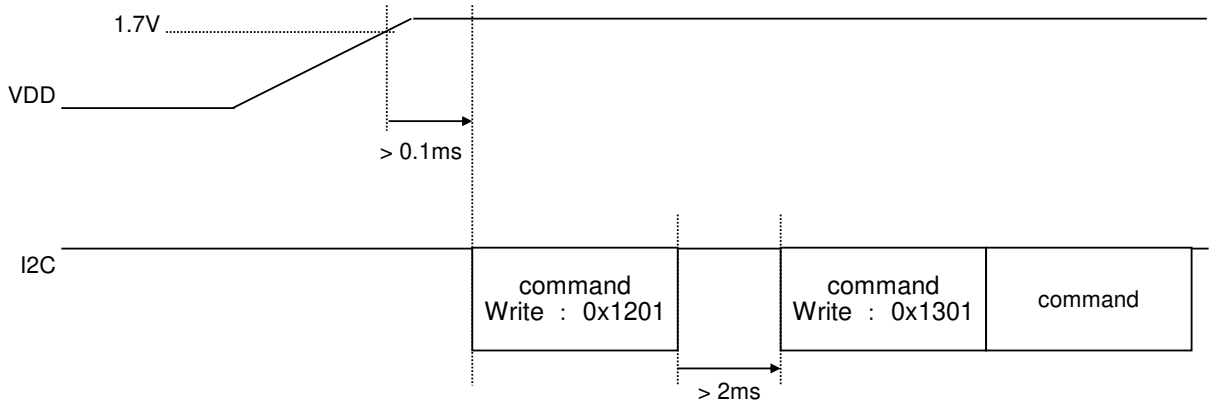
DRDY terminal is Nch open drain so this terminal should be pull-up to voltage source by an external resister.
DRDY terminal is high impedance just after VDD is supplied.
DRDY terminal becomes inactive (High impedance) by reading RD_DRDY register or setting reset mode.
VDD current (approximately 6μA at 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＞

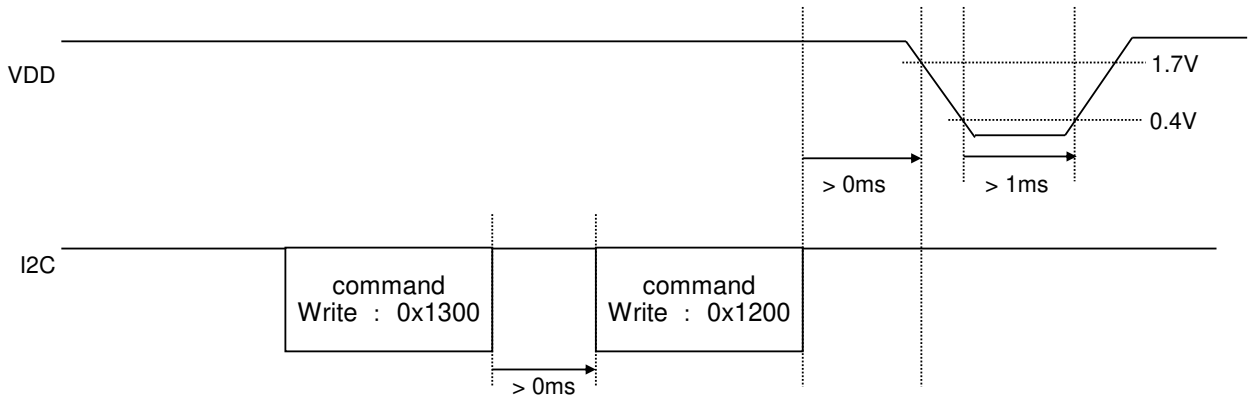


Control sequence

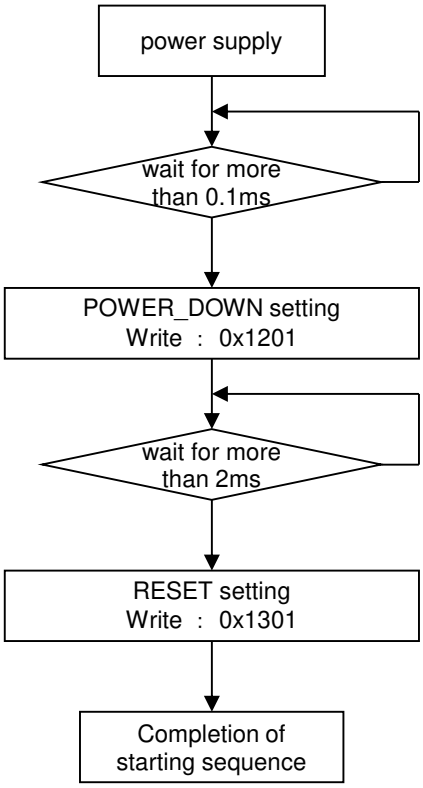
1. Power supply start-up sequence
   Please do the command control by I^2C after power is supplied.



2. Power supply end sequence



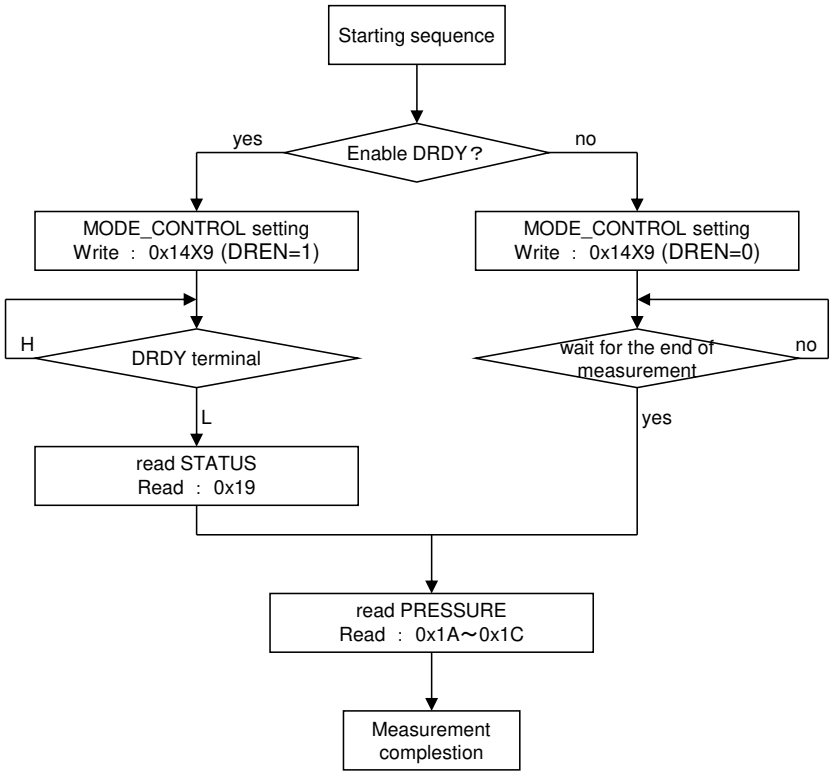
3. Starting sequence



: release Power down

: release Reset mode

4. Measurement sequence: One Shot Mode



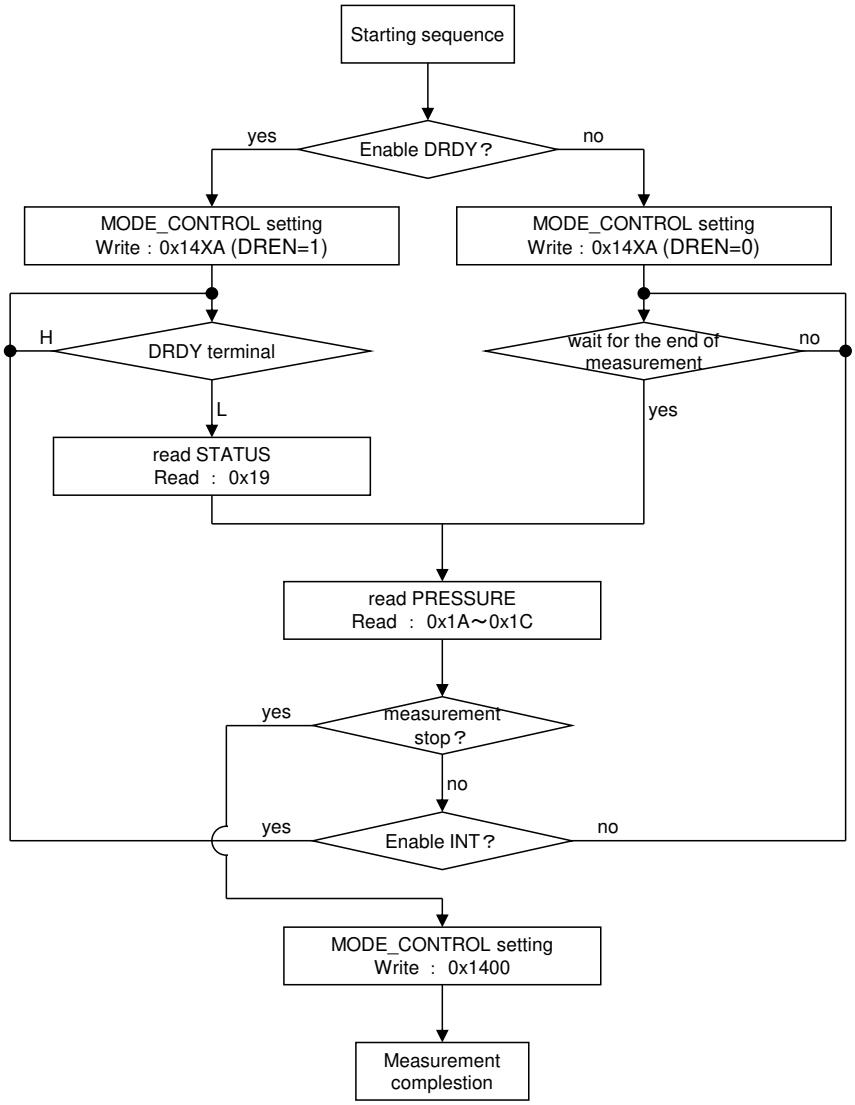
: measurement mode setting

: wait interrupt(DRDY='L') or measurement end

: check interrupt status
DRDY terminal is set to 'H' by reading.

: read Pressure data

5. Measurement sequence: Continuous Mode



: measurement mode setting

: wait interrupt(DRDY='L') or measurement end

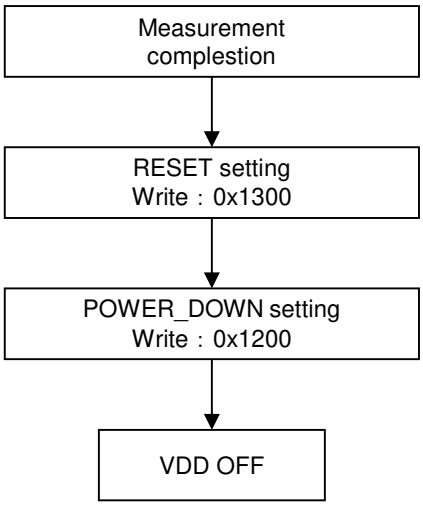
: check interrupt status
DRDY terminal is set to 'H' by reading.

: read Pressure data

: End judgement of Continuous mode

: shift to Stand-by mode.

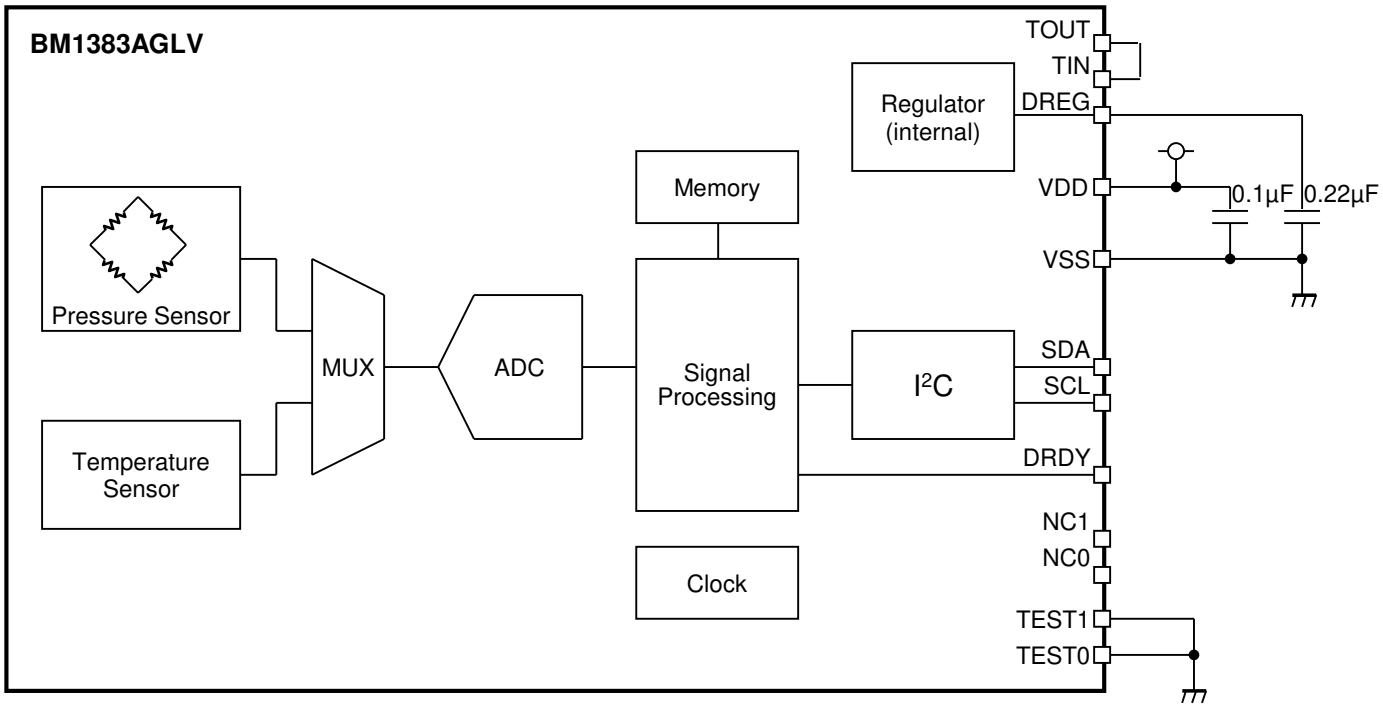
6. Ending sequence



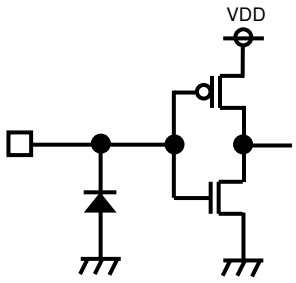
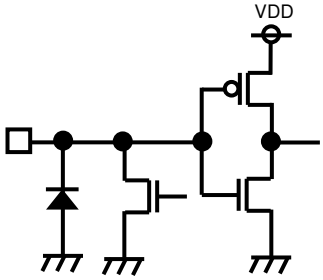
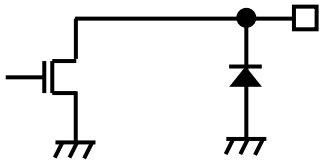
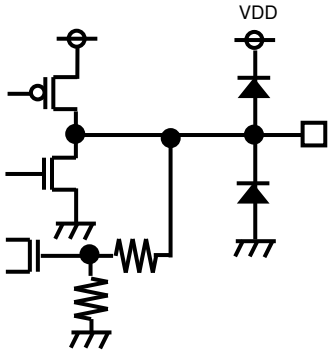
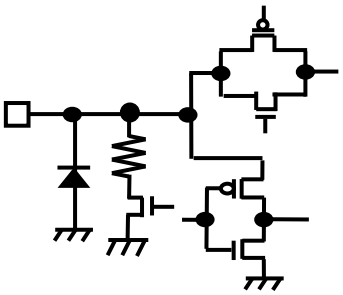
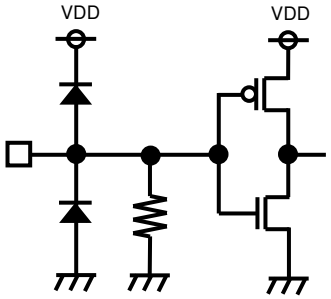
: Reset

: power down

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.

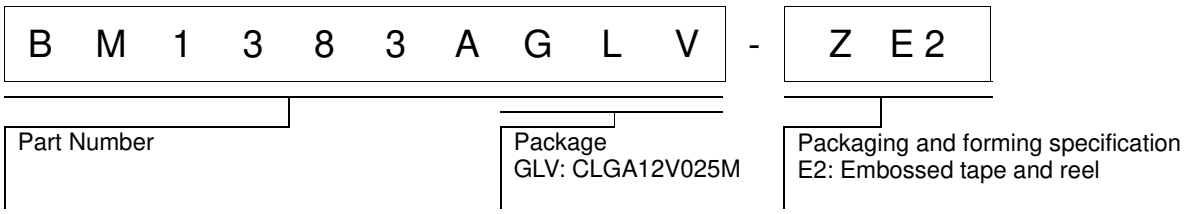
13. Ceramic Capacitor

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.

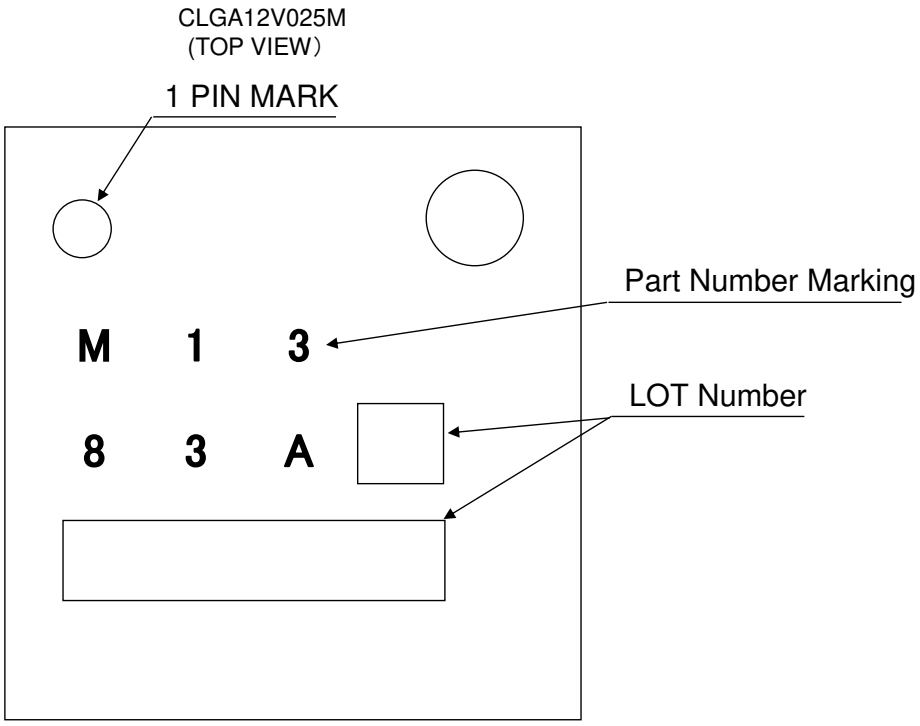
14. Disturbance light

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

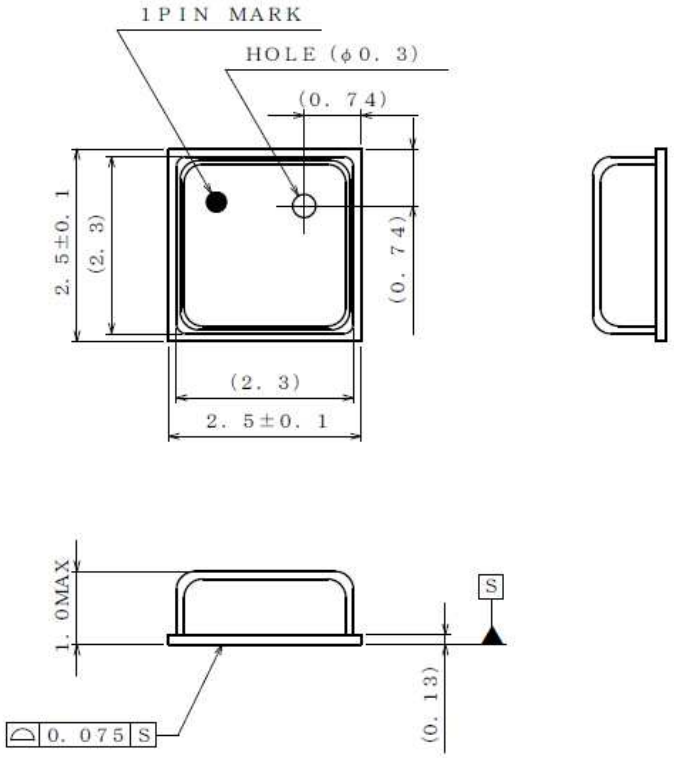


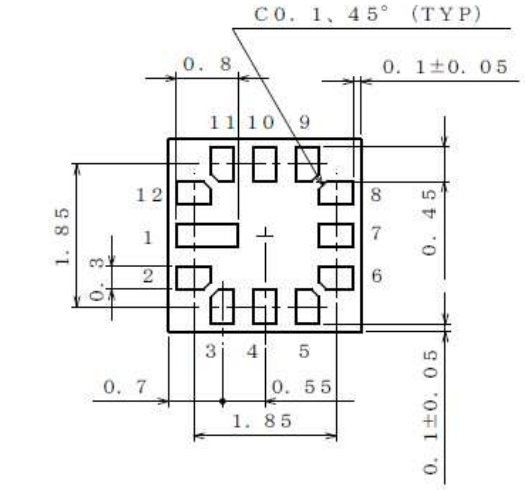
Marking Diagrams



Physical Dimension, Tape and Reel Information

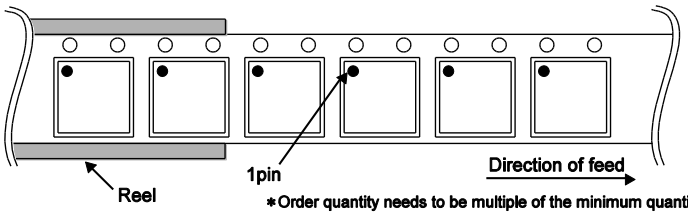
Package Name	CLGA12V025M





<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^2C 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