

Magnetic Sensor series

3-Axis Digital Magnetometer IC

BM1422GMV

General Description

BM1422GMV 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
- I²C Interface
- 14bit Digital Output
- Selectable I²C Slave Address
(ADDR=L: 0001110, ADDR=H: 0001111)

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)
- 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

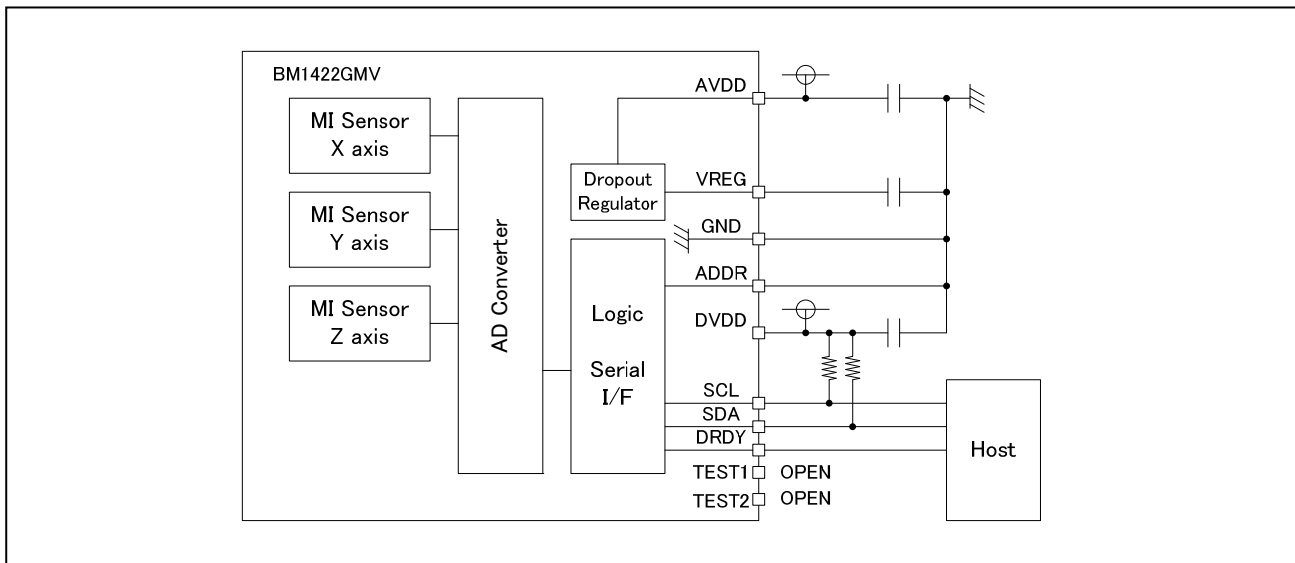
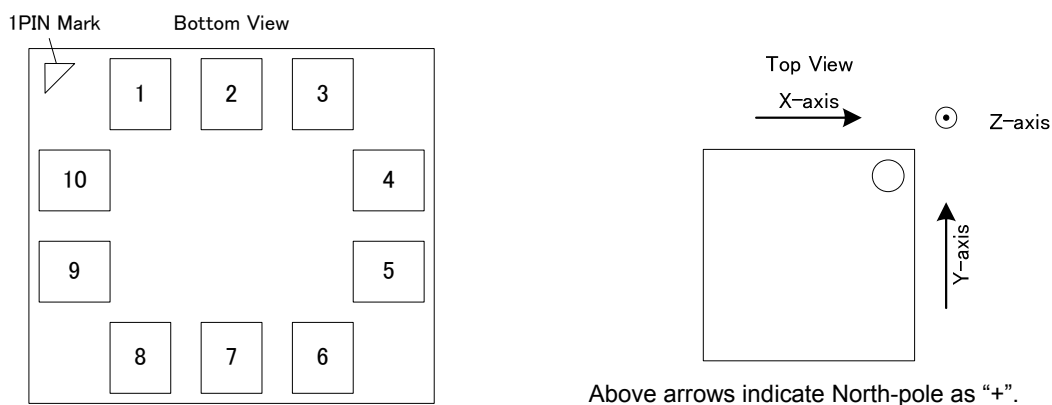


Figure 1. Application Circuit Example

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Pin Configuration



Pin Description

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

(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.

(Note 3) Use as Non-Connection (NC).

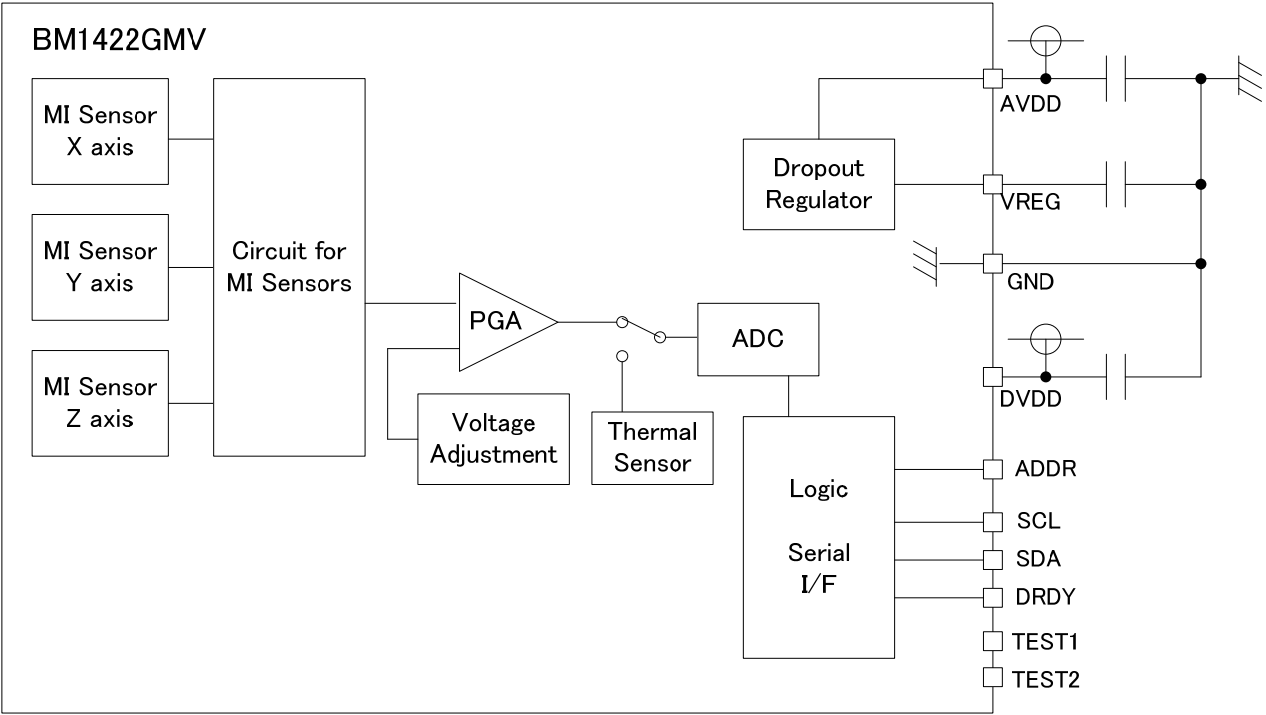
(Note 4) Please connect to DVDD or GND.

(Note 5) Please place a bypass capacitor between DVDD and GND in the proximity of the terminals.

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Block Diagram



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Absolute Maximum Ratings (Ta=25°C)

Parameter	Symbol	Rating	Unit
Supply Voltage (AVDD)	Vdd_a	0 to +4.5	V
Supply Voltage (DVDD)	Vdd_d	0 to +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
Power Dissipation	Pd	TBD	W

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.

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 ² C Clock Frequency	fSCL	MAX 400	kHz

Electrical Characteristics

(Ta=25°C, AVDD = 3.0V, DVDD = 1.8V, GND = 0.0V, unless otherwise specified.)

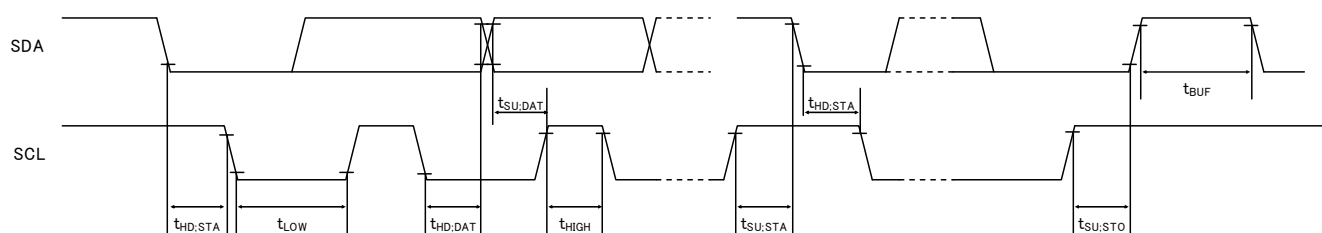
Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Current Consumption						
Average Current during Measurement	Idd	-	150	300	μA	Output Data Rate = 100SPS
Stand-by-mode Current	Iss	-	1.5	5	μA	ALL Power Down
Logic						
Low-level Input Voltage	V _{IL}	GND	-	0.3 * DVDD	V	
High-level Input Voltage	V _{IH}	0.7 * DVDD	-	DVDD	V	
Low-level Input Current	I _{IL}	-10	-	0	μA	V _{IL} = GND
High-level Input Current	I _{IH}	0	-	10	μA	V _{IH} = DVDD
Low-level Output Voltage	V _{OL}	GND	-	0.2 * DVDD	V	IL = -0.3mA
High-level Output Voltage	V _{OH}	0.8 * DVDD	-	DVDD	V	IL = 0.3mA
Serial Communication						
Low-level Input Current	I _{IL2}	-10	-	0	μA	V _{IL} = GND
High-level Input Current	I _{IH2}	0	-	10	μA	At HiZ, V _{IH} = DVDD
Low-level Output Voltage	V _{OL2}	GND	-	0.2 * DVDD	V	IL = -3mA
Magnetic Sensor						
Moving Range	Rm	-	±300	-	μT	
Measurable Range ^(Note 1)	Ra	-	±1200	-	μT	
Linearity ^(Note 2)	Lin	-	0.5	2	%FS	Rm = ±200μT
Output Offset	Vofs	-	0	-	LSB	Magnetic Field = 0μT
Magnetic Sensitivity	DeltaV	-	0.042	-	μT/LSB	
Measurement Time	Tms	-	0.5	-	msec	

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

(Note2) Linearity [%FS] = Output Error / Rm = (output - ideal output) / Rm

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I²C Bus Timing Characteristics (Unless otherwise specified DVDD = 1.8V, Ta = 25°C)

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
I ² C SCL Clock frequency	f_{SCL}	0	—	400	kHz	
I ² C 'L' Period of the SCL Clock	t_{LOW}	1.3	—	—	us	
I ² C 'H' Period of the SCL Clock	t_{HIGH}	0.6	—	—	us	
I ² C START Condition Setup Time	$t_{SU,STA}$	0.6	—	—	us	
I ² C Hold Time (repeated) START Condition	$t_{HD,STA}$	0.6	—	—	us	
I ² C Data Setup Time	$t_{SU,DAT}$	100	—	—	ns	
I ² C Data Hold Time	$t_{HD,DAT}$	0	—	—	us	
I ² C Setup Time for STOP Condition	$t_{SU,STO}$	0.6	—	—	us	
I ² C Bus Free Time between STOP and START Condition	t_{BUF}	1.3	—	—	us	

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Register Map

Name	Address	bit width	R/W	Function
INFO	0x0D/0x0E	16	R	Information (0x0101)
WIA	0x0F	8	R	Who I am (0x41)
DATA_X	0x10/0x11	16	R	X Output value
DATA_Y	0x12/0x13	16	R	Y Output value
DATA_Z	0x14/0x15	16	R	Z Output value
STA1	0x18	8	R	Status1 (DRDY)
CNTL1	0x1B	8	R/W	Control setting 1
CNTL2	0x1C	8	R/W	Control setting 2
CNTL3	0x1D	8	R/W	Control setting 3
PRET	0x30	8	R/W	Preset time
CNTL4	0x5C/0x5D	16	R/W	Control setting 4 (LV Reset Release)
TEMP	0x60/0x61	16	R	Temperature value
OFF_X	0x6C/0x6D	16	R/W	Offset X value
OFF_Y	0x72/0x73	16	R/W	Offset Y value
OFF_Z	0x78/0x79	16	R/W	Offset Z value
FINEOUTPUTX	0x90/0x91	16	R	DATA_X value per OFFX
FINEOUTPUTY	0x92/0x93	16	R	DATA_Y value per OFFY
FINEOUTPUTZ	0x94/0x95	16	R	DATA_Z value per OFFZ
SENSX	0x96/0x97	16	R	Sensitivity X value
SENSY	0x98/0x99	16	R	Sensitivity Y value
SENSZ	0x9A/0x9B	16	R	Sensitivity Z value
GAIN_PARA_X	0x9C/0x9D	16	R	Axis interference X value
GAIN_PARA_Y	0x9E/0x9F	16	R	Axis interference Y value
GAIN_PARA_Z	0xA0/0xA1	16	R	Axis interference Z value
OFFZEROX	0xF8/0xF9	16	R	Offset X value at zero magnetic field
OFFZEROY	0xFA/0xFB	16	R	Offset Y value at zero magnetic field
OFFZEROZ	0xFC/0xFD	16	R	Offset Z value at zero magnetic field

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○ Information Register (0x0D/0x0E)

Register	Bit Width	R/W	Address	Description
INFO	16bit	R	0x0D	Information LSB
		R	0x0E	Information MSB

default value 0x0101

○ WIA Register (0x0F)

Register	Bit Width	R/W	Address	Description
WIA	8bit	R	0x0F	Who I am

default value 0x41

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

Register	Bit Width	R/W	Address	Description
DATAx	16bit	R	0x10	Xch Output value LSB
		R	0x11	Xch Output value MSB
DATAY	16bit	R	0x12	Ych Output value LSB
		R	0x13	Ych Output value MSB
DATAz	16bit	R	0x14	Zch Output value LSB
		R	0x15	Zch Output value MSB

default value 0xFFFF

signed 16bit -8192d(0xE000) to +8191d(0x1FFF)

○ Status Register (0x18)

Register	Bit Width	R/W	Address	Description
STA1	8bit	R	0x18	Status (DRDY)

default value 0x00

Bit	Name	R/W	Description
7	Reserved	R	Reserved
6	RD_DRDY	R	This bit is output to the DRDY to inform the preparation status of the measured data 0 : Not ready NG 1 : Ready OK
5:0	Reserved	R	Reserved

○ Control setting1 Register (0x1B)

Register	Bit Width	R/W	Address	Description
CNTL1	8bit	R/W	0x1B	Control setting

default value 0x22

Bit	Name	R/W	Description
7	PC1	R/W	Power Control 0 : PowerDown 1 : Active
6	Reserved	R/W	Reserved Write "0"
5	RST_LV	R/W	Logic reset control 0 : Reset release 1 : Reset (Not release reset until CNTL4 register write access)
4:3	ODR	R/W	Measurement output data rates 00 : 10Hz , 10 : 20Hz , 01 : 100Hz , 11 : 1kHz
2	Reserved	R/W	Reserved Write "0"
1	FS1	R/W	Measurement mode setting 0 : Continuous mode , 1 : Single mode
0	Reserved	R/W	Reserved Write "0"

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○ Control setting2 Register (0x1C)

Register	Bit Width	R/W	Address	Description
CNTL2	8bit	R/W	0x1C	Control setting

default value 0x04

Bit	Name	R/W	Description
7:4	Reserved	R/W	Reserved Write "0000"
3	DREN	R/W	DRDY terminal enable setting 0 : Disable , 1 : Enable
2	DRP	R/W	DRDY terminal active setting 0 : Low active , 1 : High active
1:0	Reserved	R/W	Reserved Write "00"

○ Control setting3 Register (0x1D)

Register	Bit Width	R/W	Address	Description
CNTL3	8bit	R/W	0x1D	Control setting

default value 0x00

Bit	Name	R/W	Description
7	Reserved	R/W	Reserved Write "0"
6	FORCE	R/W	AD start measurement trigger at single mode (FS1=1) 1: Start measurement ※Register is automatic clear "0" after write data "1" ※Write data "0" is invalid ※If write data "1" on measurement way, restart measurement
5:0	Reserved	R/W	Reserved Write "00000"

○ Preset time Register (0x30)

Register	Bit Width	R/W	Address	Description
PRET	8bit	R/W	0x30	Preset time

default value 0x00

Bit	Name	R/W	Description
7:1	Reserved	R/W	Reserved Write "0000000"
0	PS	R/W	- Write "0"

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○ Control setting4 Register (0x5C/0x5D)

Register	Bit Width	R/W	Address	Description
CNTL4	16bit	R/W	0x5C	Control setting LSB
		R/W	0x5D	Control setting MSB

default value 0x00

Bit	Name	R/W	Description
(0x5C) 7:0	Reserved	R/W	Reserved Write "00000000"
(0x5D) 7:0	RSTB_LV	R/W	RSTB_LV=1 by write access (ignore write data) Reset release at RST_LV(CNTL1)=0 & RSTB_LV(CNTL4)=1

○ Temperature value Register (0x60/0x61)

Register	Bit Width	R/W	Address	Description
TEMP	16bit	R	0x60	Temperature value LSB
		R	0x61	Temperature value MSB

default value 0xFFFF

signed 16bit -8192d(0xE000) to +8191d(0x1FFF)

○ Offset value Register (0x6C/0x6D, 0x72/0x73, 0x78/0x79)

Register	Bit Width	R/W	Address	Description
OFF_X	16bit	R/W	0x6C	Xch Offset value
		R/W	0x6D	Reserved Write "00000000"
OFF_Y	16bit	R/W	0x72	Ych Offset value
		R/W	0x73	Reserved Write "00000000"
OFF_Z	16bit	R/W	0x78	Zch Offset value
		R/W	0x79	Reserved Write "00000000"

default value 0x30

unsigned 8bit 0d(0x00) to +95d(0x5F)

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

Register	Bit Width	R/W	Address	Description
FINEOUTPUTX	16bit	R	0x90	DATAx value per OFF_X LSB
		R	0x91	DATAx value per OFF_X MSB
FINEOUTPUTY	16bit	R	0x92	DATAy value per OFF_Y LSB
		R	0x93	DATAy value per OFF_Y MSB
FINEOUTPUTZ	16bit	R	0x94	DATAz value per OFF_Z LSB
		R	0x95	DATAz value per OFF_Z MSB

default value 0xFFFF

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

○ Sensitivity Register (0x96/0x97, 0x98/0x99, 0x9A/0x9B)

Register	Bit Width	R/W	Address	Description
SENSX	16bit	R	0x96	Xch Secsitivity value
		R	0x97	Reserved Read data is "00000000"
SENSY	16bit	R	0x98	Ych Secsitivity value
		R	0x99	Reserved Read data is "00000000"
SENSZ	16bit	R	0x9A	Zch Secsitivity value
		R	0x9B	Reserved Read data is "00000000"

default value 0xFF

signed 8bit -128d(0x80) to +127d(0x7F)

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

Register	Bit Width	R/W	Address	Description
GAIN_PARA_X	16bit	R	0x9C	Axis interference Xch to Zch
		R	0x9D	Axis interference Xch to Ych
GAIN_PARA_Y	16bit	R	0x9E	Axis interference Ych to Zch
		R	0x9F	Axis interference Ych to Xch
GAIN_PARA_Z	16bit	R	0xA0	Axis interference Zch to Ych
		R	0xA1	Axis interference Zch to Xch

default value 0xXX

signed 8bit -128d(0x80) to +127d(0x7F)

○ Offset at zero magnetic field Register (0xF8/0xF9, 0xFA/0xFB, 0xFC/0xFD)

Register	Bit Width	R/W	Address	Description
OFFZEROX	16bit	R	0xF8	Xch Offset value at zero magnetic field
		R	0xF9	Reserved Read data is "00000000"
OFFZEROY	16bit	R	0xFA	Ych Offset value at zero magnetic field
		R	0xFB	Reserved Read data is "00000000"
OFFZEROZ	16bit	R	0xFC	Zch Offset value at zero magnetic field
		R	0xFD	Reserved Read data is "00000000"

default value 0xXX

signed 8bit -128d(0x80) to +127d(0x7F)

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I²C Bus Format

1. Slave address : "0001110" (ADDR=L) or "0001111" (ADDR=H)
2. Write format

(1) Case of indicating register address

ST	Slave Address	W 0	ACK	Indicate register address	ACK	SP
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(2) Case of writing data register after indicating register address

ST	Slave Address	W 0	ACK	Indicate register address	ACK	
Data specified at register address field	ACK	ACK	Data specified at register address field + N	ACK	SP


3. Read format


(1) Case of reading data after indicating register address

ST	Slave Address	W 0	ACK	Indicate register address	ACK	
ST	Slave Address	R 1	ACK	Data specified at register address field	ACK	
Data specified at register address field + 1	ACK	ACK	Data specified at register address field + N	NACK	SP

(2) Case of reading data

ST	Slave Address	R 1	ACK	Data specified at register address field	ACK	
Data specified at register address field + 1	ACK	ACK	Data specified at register address field + N	NACK	SP

 from master to slave

 from slave to master

* Please refer formal I²C bus specification of NXP semiconductor.

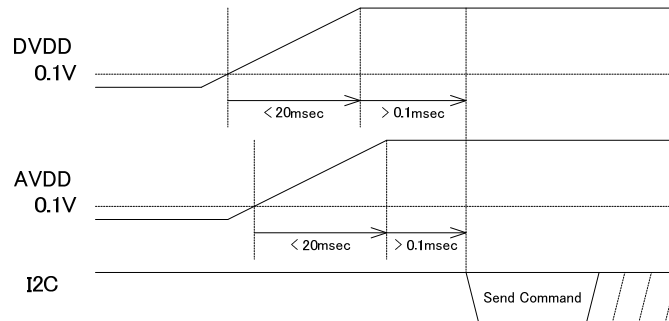
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Control Sequence

1. Start-up sequence of power supply

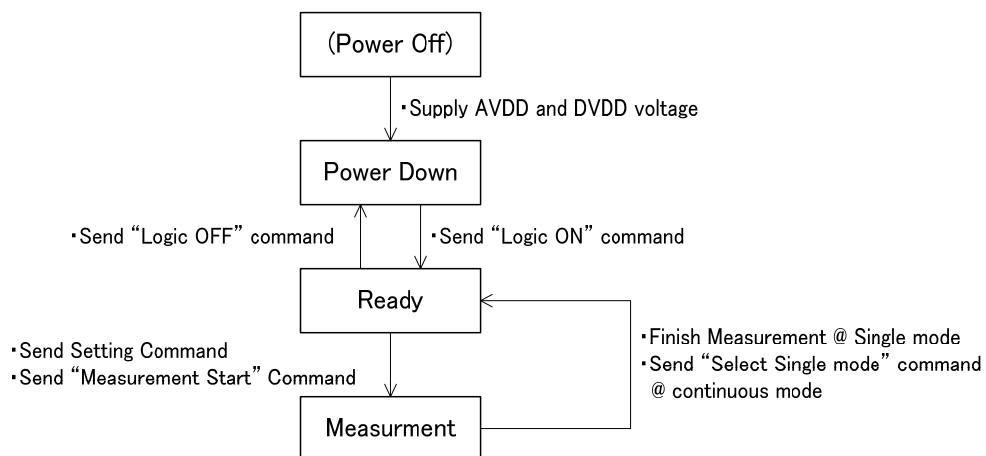
The order of starting up the power supplies of VDD and VDDIO is arbitrary, when they are supplied from different sources. Please do the command control by I²C after all powers are supplied.



2. Measurement sequence

There are the following two kinds of measurement modes

Continuous Mode	BM1422GMV is measured at specified cycle (ODR=10,20,100,1kHz) at the cycle.
Single Mode	BM1422GMV is measured by the measurement request from the host.



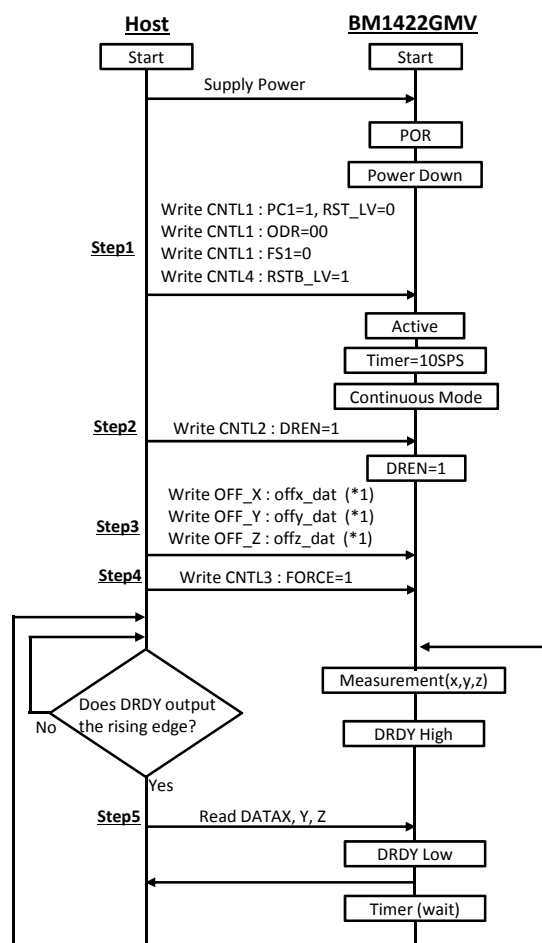
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2.1 Continuous Mode

(Send command example)

	Register Name	Address	Data
Step1	CNTL1	0x1B	0x80
	CNTL4	0x5C 0x5D	0x00
Step2	CNTL2	0x1C	0x08
Step3	OFF_X	0x6C	offx_dat
	OFF_Y	0x72	offy_dat
	OFF_Z	0x78	offz_dat
Step4	CNTL3	0x1D	0x40
Step5	DATAX	0x10 0x11	Read
	DATAZ	0x12 0x13	Read
	DATAZ	0x14	Read
	DATAZ	0x15	Read



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

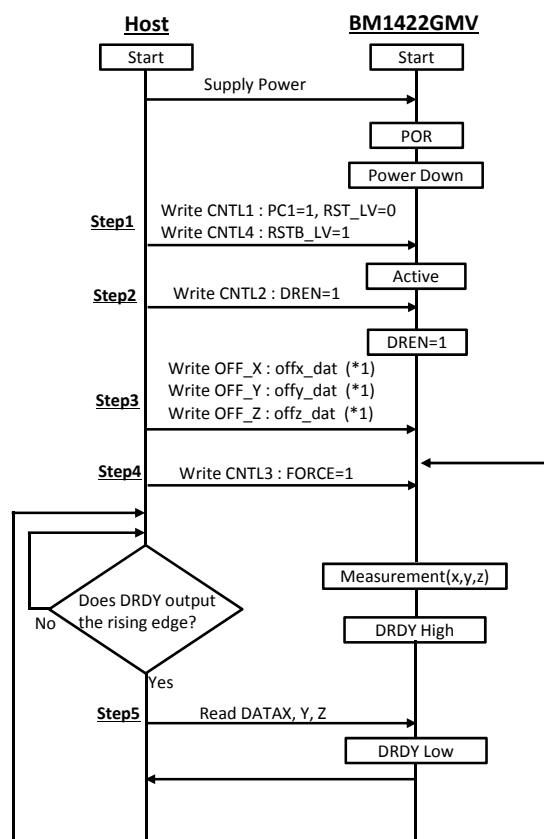
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2.2 Single Mode

(Send command example)

	Register Name	Address	Data
Step1	CNTL1	0x1B	0x82
	CNTL4	0x5C 0x5D	0x00
Step2	CNTL2	0x1C	0x08
Step3	OFF_X	0x6C	offx_dat
	OFF_Y	0x72	offy_dat
	OFF_Z	0x78	offz_dat
Step4	CNTL3	0x1D	0x40
Step5	DATAX	0x10 0x11	Read
	DATAZ	0x12 0x13	Read
	DATAZ	0x14 0x15	Read



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

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3. Offset Adjustment

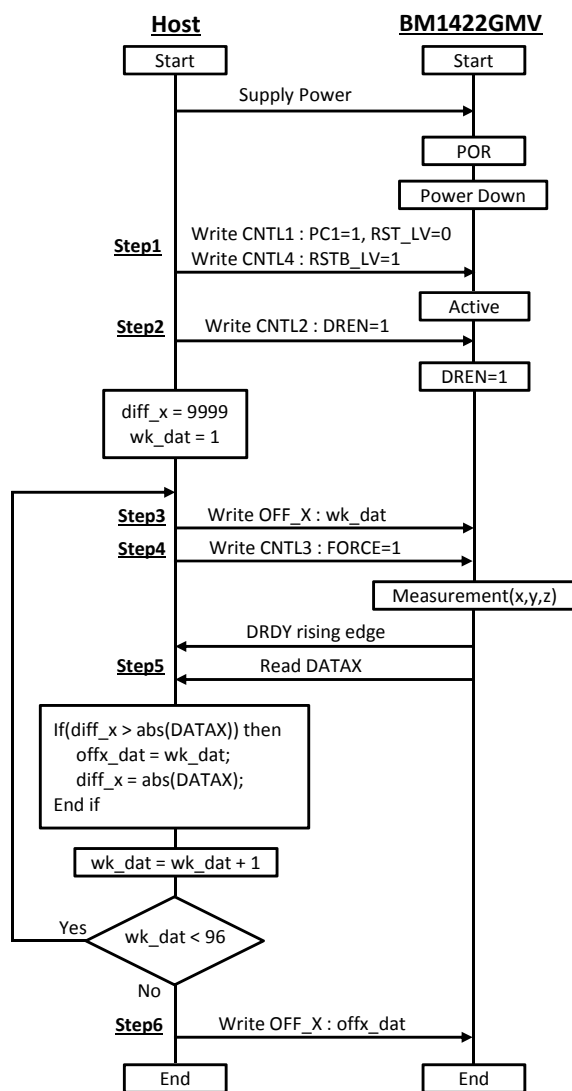
Offset adjustment sequence make the output value around zero under the normal magnetic environment.

After measuring the following parameter, HOST should save it in memory, and it needs to be set after applying power supply to BM1422GMV.

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)

	Register Name	Address	Data
Step1	CNTL1	0x1B	0x82
	CNTL4	0x5C	0x00
		0x5D	0x00
Step2	CNTL2	0x1C	0x08
Step3	OFF_X	0x6C	wk_dat
Step4	CNTL3	0x1D	0x40
Step5	DATA_X	0x10	Read
		0x11	
Step6	OFF_X	0x6C	offx_dat

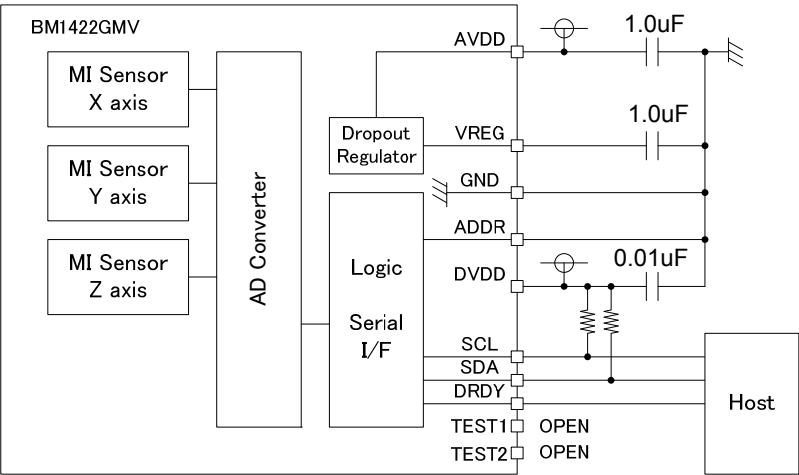


Write only Xch offset adjustment
Ych and Zch should also be performed

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Application Example



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I/O equivalence circuit

Pin name	Equivalent Circuit Diagram	Pin name	Equivalent Circuit Diagram
SCL		SDA	
DRDY		ADDR	
TEST1		TEST2	

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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.
OR

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. The absolute maximum rating of the Pd stated in this specification is when the IC is mounted on a 70mm x 70mm x 1.6mm glass epoxy board. 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.

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.

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Operational Notes – continued**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

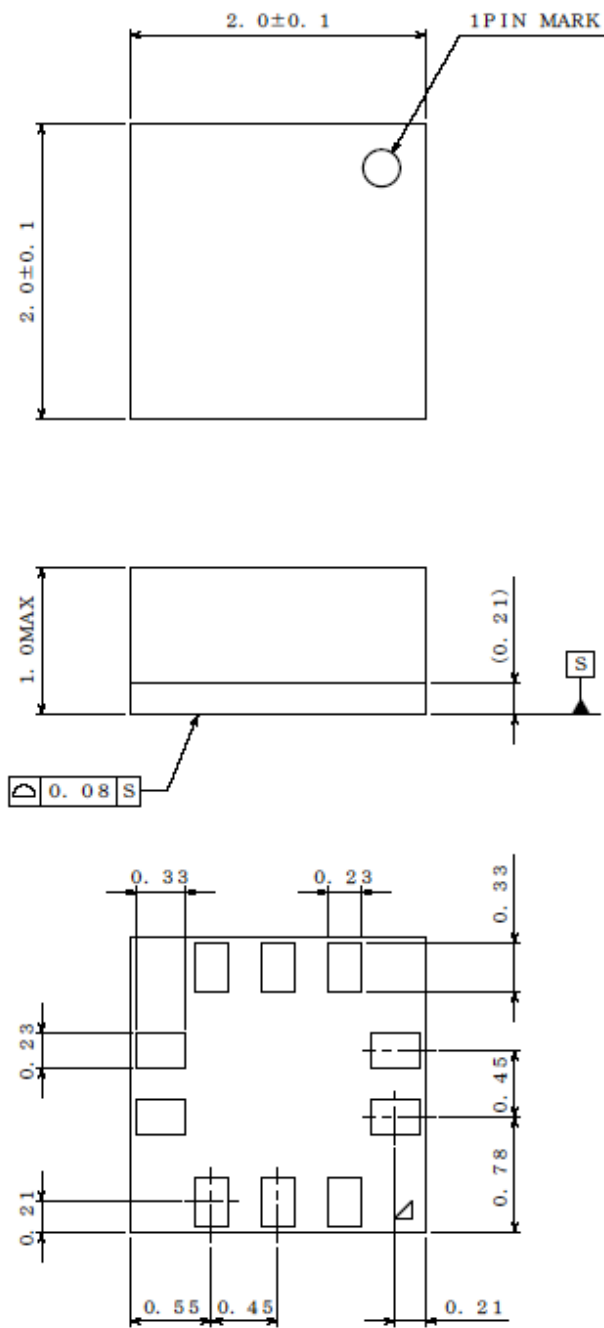
When using a ceramic capacitor, determine the dielectric constant considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

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Physical Dimension

Package Name	MLGA010V020A
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(UNIT : mm)

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Revision History

Date	Revision	Changes
01.Nov.2013	001	New Release
25.Dec.2013	002	Change Figure of Start-up sequence.
5.Feb.2014	003	Change Package name, Change Physical Dimension
13.Feb.2014	004	Add Register Map and Operational Notes
26.Feb.2014	005	Add Block Diagram, Register Description, Measurement Sequence, Application Example, I/O equivalence circuit
4.Mar.2014	006	Correction of errors
8.Apr.2014	007	Correction of errors

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Notice

Precaution on using ROHM Products

1. 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, 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.
2. 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:
 - [a] Installation of protection circuits or other protective devices to improve system safety
 - [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure
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 - [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
 - [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
 - [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl₂, H₂S, NH₃, SO₂, and NO₂
 - [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
 - [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
 - [f] Sealing or coating our Products with resin or other coating materials
 - [g] 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
 - [h] Use of the Products in places subject to dew condensation
4. The Products are not subject to radiation-proof design.
5. Please verify and confirm characteristics of the final or mounted products in using the Products.
6. 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.
7. De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.
8. Confirm that operation temperature is within the specified range described in the product specification.
9. 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

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.
2. In principle, the reflow soldering method must be used; if flow soldering method is preferred, 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 Cl₂, H₂S, NH₃, SO₂, and NO₂
 - [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

QR code 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 our Products might fall under controlled goods prescribed by the applicable foreign exchange and foreign trade act, please consult with ROHM representative in case of export.

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