AK9720 (Preliminary)

IR Sensor Module with I2C I/F

This specification is a design target, not guaranteed specifications for the final product. Specifications are the subject to change without notice.

Description

The AK9720 is a slim and compact infrared-sensor module composed of a quantum IR sensor and an integrated circuit for characteristic compensation. The IC generates an analog signal that adjusts the infrared sensor's offset and/or gain fluctuations and temperature characteristics. An integrated analog-to-digital converter provides a 16-bit data output. Additional integrated features include a field of view limiter structure and an optical filter. The AK9720 enables new applications, including as remote temperature sensing, stationary human detection, and proximity detection.

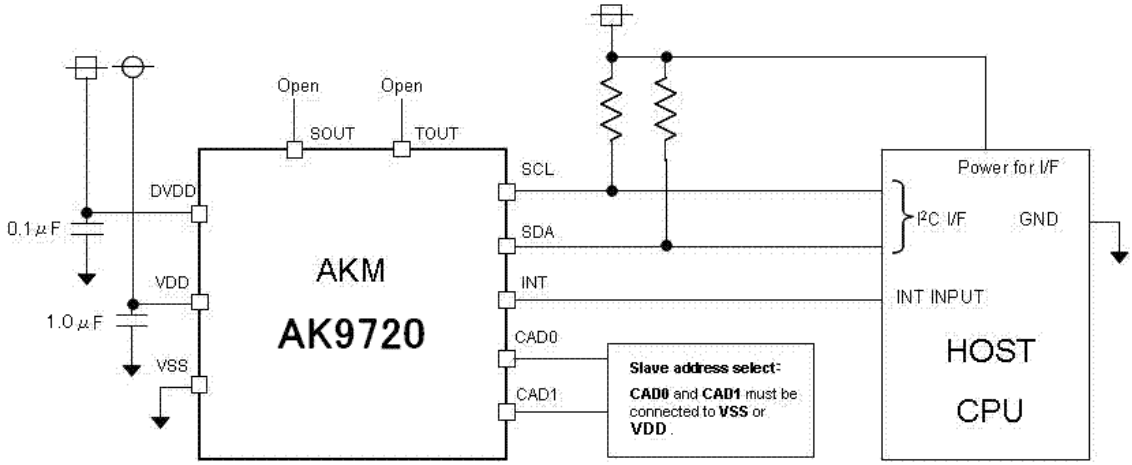
Features

- Quantum-type IR sensor: IR1011 Core
- Low voltage operation
  - V_{DD} +1.71 to +3.63V
  - Digital I/F +1.65V to V_{DD}
- Low current consumption: 100uA typ. (@ 330ms sampling period)
- 16bit-ADC output to I^2C bus
  - ⇒Digital output simplifies system integration
- Fast response: TBD ms (@ sampling period)
- Selectable output: temperature compensated signal or bypass signal
- Integrated temperature sensor output
- When the compensated signal is selected, the output has been adjusted for offset/gain variation and temperature sensitivity of IR sensors:
  - => Simplifies heat design
  - => No host processing needed for temperature compensated output
- Stationary human body detection algorithm available as reference software
- Slim, compact package with field of view limiter structure and optical filter
  - ⇒Simplifies optical design
- Linear output correlated to target temperature
- Settings (including ON/OFF control and sampling rate) programmed through I^2C bus
- Input level variations can be adjusted through a programmable gain stage
- INT pin goes high when the ADC output is ready to read
  - ⇒Can be used as read-trigger for single shot mode, or interrupt of signal level monitoring.
- Integrated power-on reset, and oscillator
- 10pin SON Package

Applications

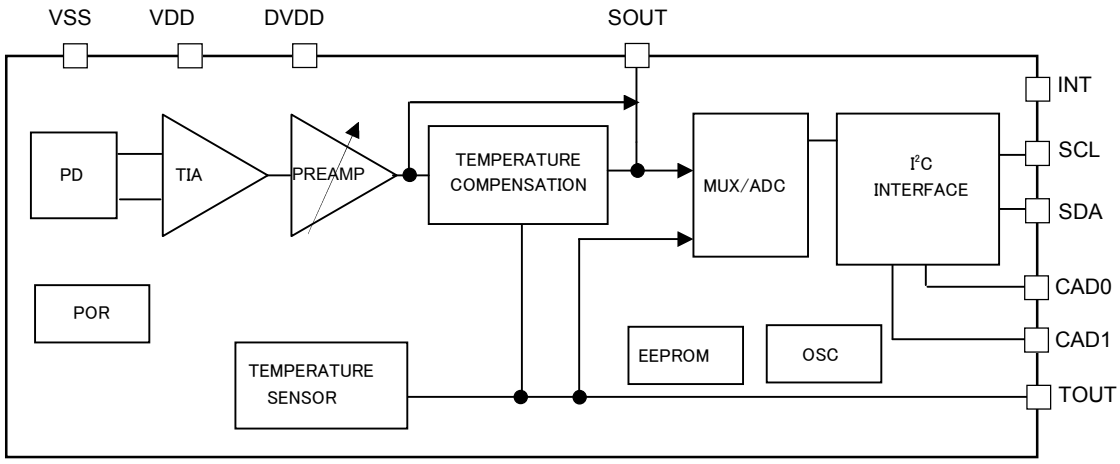
- Temperature Sensor
- Human Presence Detection
- Proximity Detection
- Motion Sensor
- etc…

Recommended Connection



Block Diagram

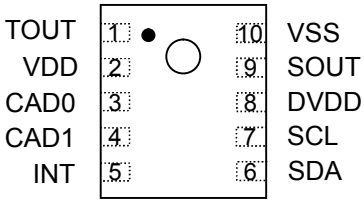
1. Block Diagram



2. Block Functions

Block	Functions
PD	IR1011 IR sensor core
I/V	Photocurrent of IR sensor is converted to voltage
PREAMP	Programmable gain amplifier to adjust the output level. Gain can also be adjusted by register settings.
TEMPERATURE COMPENSATION	Preamp output is compensated for the ambient temperature and linearized.
TEMPERATURE SENSOR	Built-in Temperature Sensor
MUX／ADC	Preamp output, linearized output, and built-in temperature sensor output are multiplexed prior to the ADC.
I^2C Interface	Interface to external host controller A flag is set when the measurement data is ready to be read. SCL and SDA pins are provided for I2C interface. The interface operates up to 400kHz rate and down to 1.65V low voltage condition.
EEPROM	EEPROM. Compensation data is stored in this non-volatile memory.
OSC	Internal oscillator
POR	Power on reset

Pin/Locations



Pin/Functions

Pin No.	Name	I/O	Function
1	TOUT	O	Integrated Temperature Sensor Analog Output LPF can be formed by the output resistance and an external capacitor.
2	VDD	-	Analog Power Supply Pin
3	CAD0	I	Slave address 0 CAD should be connected to DVDD or Vss. Set up an address so that two or more same addresses of devices do not exist on the same bus.
4	CAD1	I	Slave address 1 CAD should be connected to DVDD or Vss. Set up an address so that two or more same addresses of devices do not exist on the same bus.
5	INT	O	Interrupt output (“H” active) Function is selected by the interrupt pin select register (INTEN). INT is High level, when read-out is ready or a target temperature is over upper limit or lower limit.
6	SDA	I/O	I2C Data Output Pin SDA is a bidirectional pin which is used to transmit data into and out of the device. It is composed of a signal input and a open drain output (N-type transistor). SDA is connected to the DVDD voltage through a pull-up resistance, and to open drain outputs or open collector outputs of the other devices as “wire-ORed”.

7	SCL	I	I2C Clock Input Pin Signal processing is executed at rising edge and falling edge of SCL clock. Therefore, observe rising time tR and falling time tF.
8	DVDD	-	Digital I/F Power Supply Pin
9	SOUT	O	Analog Signal Output SOUT is PREAMP output or temperature compensated IR sensor output. SOUT should be connected to “Hi-Z” input. LPF can be formed by the output resistance and an external capacitor.
10	VSS	-	Ground pin

Digital/Analog Output Select Function

Digital/Analog output select is controlled by CAD1 pin and CAD0 pin.

When CAD1 and CAD0 are set up to CAD1=CAD0=1, the output of SOUT and TOUT are compulsorily set to “ON”, regardless of a setup of a register. SOUT outputs the temperature compensated Analog signal.

When CAD1 and CAD0 are set up so that they are not set up to CAD1=CAD0=1, digital signal can be used through I2C interface. When CAD1 and CAD0 are set up to CAD1=CAD0=1, although I2C interface can be accessed at a slave address 67H, the control by a register does not perform.

When CAD1 is set up to CAD1=1, Analog Signal Mode is selected, and ON/OFF of output is selected by CAD0. SCL pin and SDA pin should be fixed to High level. (Don’t access to I2C interface in Analog Output Mode.)

If CAD1 and CAD0 are set up to CAD1=CAD0=1 at the time of power supply starting without using an I2C interface, and ON/OFF of Analog Output is changed by CAD0 after power supply starting, then Analog Output OFF is selected, AK9720 becomes Power Down Mode, because “MODE[2:0] =000” is an initial value.

CAD1	CAD0	Digital Output	Slave Address	Analog Output
0	0	Enable	64H	(OFF)
0	1	Enable	65H	(OFF)
1	0	Enable	66H	OFF
1	1	Disabled	(67H)	ON

Absolute Maximum Rating

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Power Supply	V_{SUP}	-0.6		4.6	V	
Input Current	I_{IN}	-10		10	mA	
Input Voltage	V_{IN}	-0.6		V_{DD}+0.6 and 4.6	V	
Storage Temperature	T_{STO}	-40		85	°C	

Note) Operation exceeding these ratings may cause permanent damage to device

Operational Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Power Supply	V_{DD}	1.71	3.0	3.6	V	
Digital Power Supply	DVDD	1.65		Vdd	V	
Operating Temperature	TA	-30		85	°C	

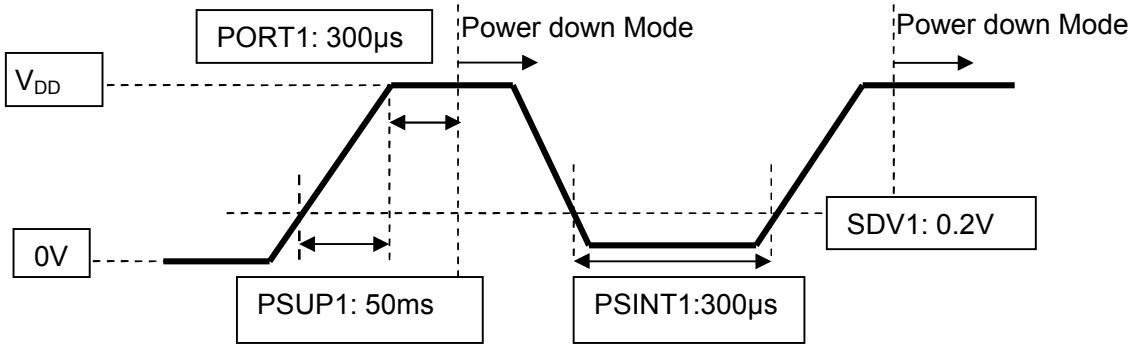
Power Supply Conditions

AC Characteristics (1)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Pin	Note
Power Supply Rise Time	PSUP1			50	ms	VDD	Time until VDD pin is set to V_{DD} from 0.2V *1 *2
Power-on Reset Time	PORT1			300	µs		Time until AK9720 becomes Power down Mode after PSUP *1, *2
Shutdown Voltage	SDV1			0.2	V	VDD	Shutdown Voltage for POR re-starting *2
Power Supply Interval Time	PSINT1	300			µs	VDD	Voltage retention time below SDV1 for POR re-starting *1 *2

*1 Reference data only, not tested

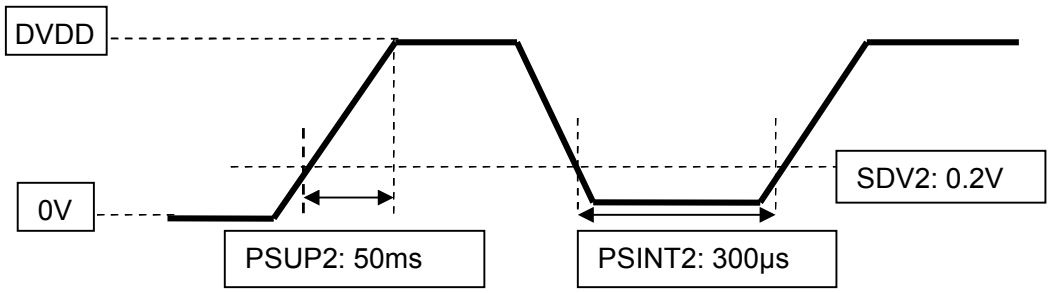
*2 Power-on Reset circuit detects the rising edge of VDD, resets the internal circuit, and initializes the register. After Power-on reset, Power down Mode is selected.



AC Characteristics (2)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Pin	Note
Power Supply Rise Time	PSUP2			50	ms	DVDD	Time until DVDD pin is set to DVDD from 0.2V *1
Shutdown Voltage	SDV2			0.2	V	DVDD	Shutdown Voltage for Power Supply Monitoring Circuit re-starting
Power Supply Interval Time	PSINT2	300			µs	DVDD	Voltage retention time below SDV1 for Power Supply Monitoring Circuit re-starting *1

*1 Reference data only, not tested



Analog Characteristics

Unless otherwise specified, VDD = 1.71 to 3.63V, DVDD = 1.65V to VDD;
Ta = -30 to +85℃
Normal mode selects linearized output for the ADC.
Bypass mode selects Preamp output.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Target Temperature1	$T_{OBJ}1$	0		100	°C	T_A = -30°C to 85°C Normal mode
Target Temperature2	$T_{OBJ}2$	0		40	°C	T_A = 0°C to 60°C Bypass mode
Preamp Gain adjustment range			TBD			
Preamp Gain adjustment accuracy			0.25		%	For adjustment target
IR output resolution			16		bits	
SOUT output code (SOUT AD code)		-10	30	110	°C	Normal mode, Linear to target temperature (excludes noise)
		TBD	TBD	TBD	Code	
Temperature output resolution			16		bits	
Temperature sensor range		-40		95	°C	
		TBD		TBD	code	
Temperature sensor accuracy			TBD		°C	T_A=30°C
Temperature sensor sensitivity			TBD		LSB/°C	
SOUT Output Resistance			10		kΩ	
SOUT Output Resistance			10		kΩ	
Measurement time			TBD		ms	Single shot mode
Field of View			±30		°	50% output (FWHM)

Digital Characteristics

1) EEPROM

Unless otherwise specified, VDD = 1.71 to 3.63V, DVDD = 1.65V to VDD;
Ta = -30 to +85°C

Item	Code	Min.	Typ.	Max.	Unit
EEPROM retention time @Ta=85°C	Ehold	10			years

2) DC Characteristics

Unless otherwise specified V_{DD} = 1.71 to 3.63V, DVDD = 1.65 to V_{DD};
Ta = -30 to +85°C

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	Note
High Level Input Voltage1	VIH1		80%DVDD			V	CAD1,CAD0
Low Level Input Voltage1	VIL1				20%DVDD	V	CAD1,CAD0
High Level Input Voltage2	VIH2		70%DVDD		DVDD+0.5	V	SCL,SDA
Low Level Input Voltage2	VIL2		-0.5		30%DVDD	V	SCL,SDA
Hysteresis voltage (Note)	VHS	DVDD>=2V	5%DVDD			V	SCL,SDA
		DVDD<2V	10%DVDD			V	SCL,SDA
Low level output voltage 1	VOL1	IOL = 3mA, DVDD >=2V		-	0.4	V	SDA
High level output voltage	VOH2	IOH = -200μA	80%DVDD	-		V	INT
Low level output voltage 2	VOL2	IOL = 200μA		-	0.4	V	INT
Current Consumption	IDD1	Power down mode		55		μA	
	IDD2	Normal mode Operation		1.3		mA	
	IDD3	Bypass mode Operation		1.0		mA	
Averaged Current Consumption (Interval Operation)	IDD4	Interval 1 (Normal mode)		800		μA	Min. Interval (20ms)
	IDD5	Interval 2 (Normal mode)		110		μA	Max. Interval (330ms)
	IDD6	Interval 1 (Bypass mode)		560		μA	Min. Interval (20ms)
	IDD7	Interval 2 (Bypass mode)		80		μA	Max. Interval (330ms)

(Note) Reference data only, not tested

3) Digital AC Characteristics (1)：Standard mode （100kHz）

Unless otherwise specified VDD = 1.71 to 3.63V, DVDD = 1.65 to VDD;
Ta = -30 to +85°C

Parameter	Code	Min.	Typ.	Max.	Unit
SCL frequency	fSCL			100	kHz
Noise suppression time	tI			50	ns
SDA bus idle time to the next command input	tBUF	4.7			μs
Start condition Hold time	tHD:STA	4.0			μs
Clock low period	tLOW	4.7			μs
Clock high period	tHIGH	4.0			μs
Start condition set-up time	tSU:STA	4.7			μs
Data hold time	tHD:DAT	0			μs
Data setup time	tSU:DAT	250			ns
Rise time SDA, SCL note)	tR			1.0	μs
Fall time SDA, SCL note)	tF			0.3	μs
Stop condition setup time	tSU:STO	4.0			μs

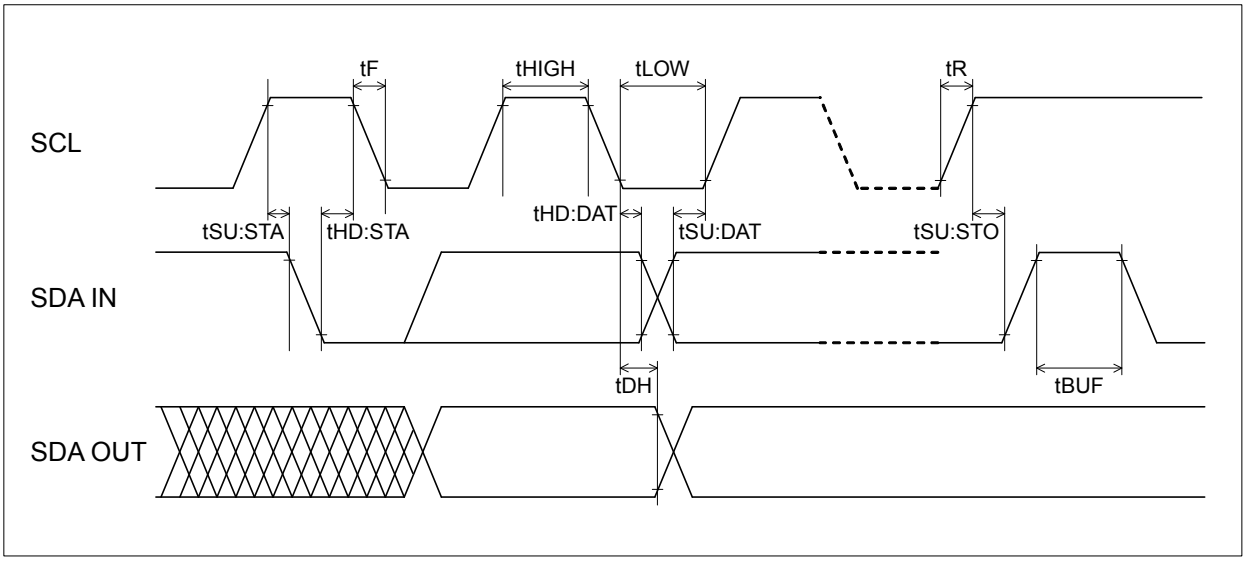
Note) Reference data only, not tested

4) Digital AC Characteristics (2)： Fast mode (400kHz)

Unless otherwise specified, VDD = 1.71 to 3.63V, DVDD = 1.65 to VDD;
Ta = -30 to +85°C

Parameter	Code	Min.	Typ.	Max.	Unit
SCL Frequency	fSCL			400	kHz
Noise suppression time	tI			50	ns
SDA bus idle time to the nest command input	tBUF	1.3			μs
Start condition hold time	tHD:STA	0.6			μs
Clock low period	tLOW	1.3			μs
Clock high period	tHIGH	0.6			μs
Start condition set-up time	tSU:STA	0.6			μs
Data in hold time	tHD:DAT	0			μs
Data in setup time	tSU:DAT	100			ns
Rise time SDA, SCL (note)	tR			0.3	μs
Fall time SDA, SCL (note)	tF			0.3	μs
Stop condition setup time	tSU:STO	0.6			μs

Note) Reference data not tested


SCL
SDA IN
SDA OUT
tF
tHIGH
tLOW
tR
tSU:STA
tHD:STA
tHD:DAT
tSU:DAT
tSU:STO
tDH
tBUF

Bus Timing

Functional Descriptions

1. Power Supply State

When V_{DD} and DVDD turn on from the state of V_{DD} = OFF (0V) and DVDD = OFF (0V), power on reset (POR) is automatice all registers will be initialized, and the AK9720 will shift to Power down Mode.

Although all states of the following table can exist, the changes to state 3 from state 2 and the changes to state 2 from state 3 are prohibited.

State	V_{DD}	DVDD	Power Supply State
1	OFF (0V)	OFF(0V)	OFF (0V) I2C bus is open.
2	OFF (0V)	1.65 to 3.63V	OFF (0V) I2C bus is open. INT pin = Low Level *This is not the recommended operational condition.
3	1.71 to 3.63V	OFF(0V)	OFF (0V). The current consumption is as same as Power down Mode. I2C bus is open.
4	1.71 to 3.63V	1.65V to V_{DD}	ON

2. Reset Function

When the power supply is in an ON state, set up DVDD lower than V_{DD} (DVDD<=V_{DD}) .

Power-on reset (POR) works until V_{DD} reaches the operating voltage (about 1.4V: design reference). After POR, all registers are set to initial values, and Power down Mode is selected.

When VDD is between 1.71V and 3.63V, POR circuit and DVDD monitor circuit are operational. When DVDD=0V, the current consumption is identical to as Reset State, because AK9720 is in Reset State.

AK9720 has three reset functions.

(1) Power-on Reset (POR)
POR circuit resets AK9720 by detecting VDD rising.

(2)DVDD Monitor
When DVDD is in OFF (0V), AK9720 is reset.

(3)Soft Reset
When the SRST bit is set, AK9720 is reset.

When AK9720 is reset, all registers are set to initial values, and Power down Mode is selected.

3. Operating Mode

AK9720 has five operating modes as below.
(1) Power down Mode
(2) Single shot Mode
(3) Continuous Mode1
(4) Continuous Mode2
(5) EEPROM access Mode

Operating mode can be selected by setting the MODE [2:0] bit of CNTL1 register.

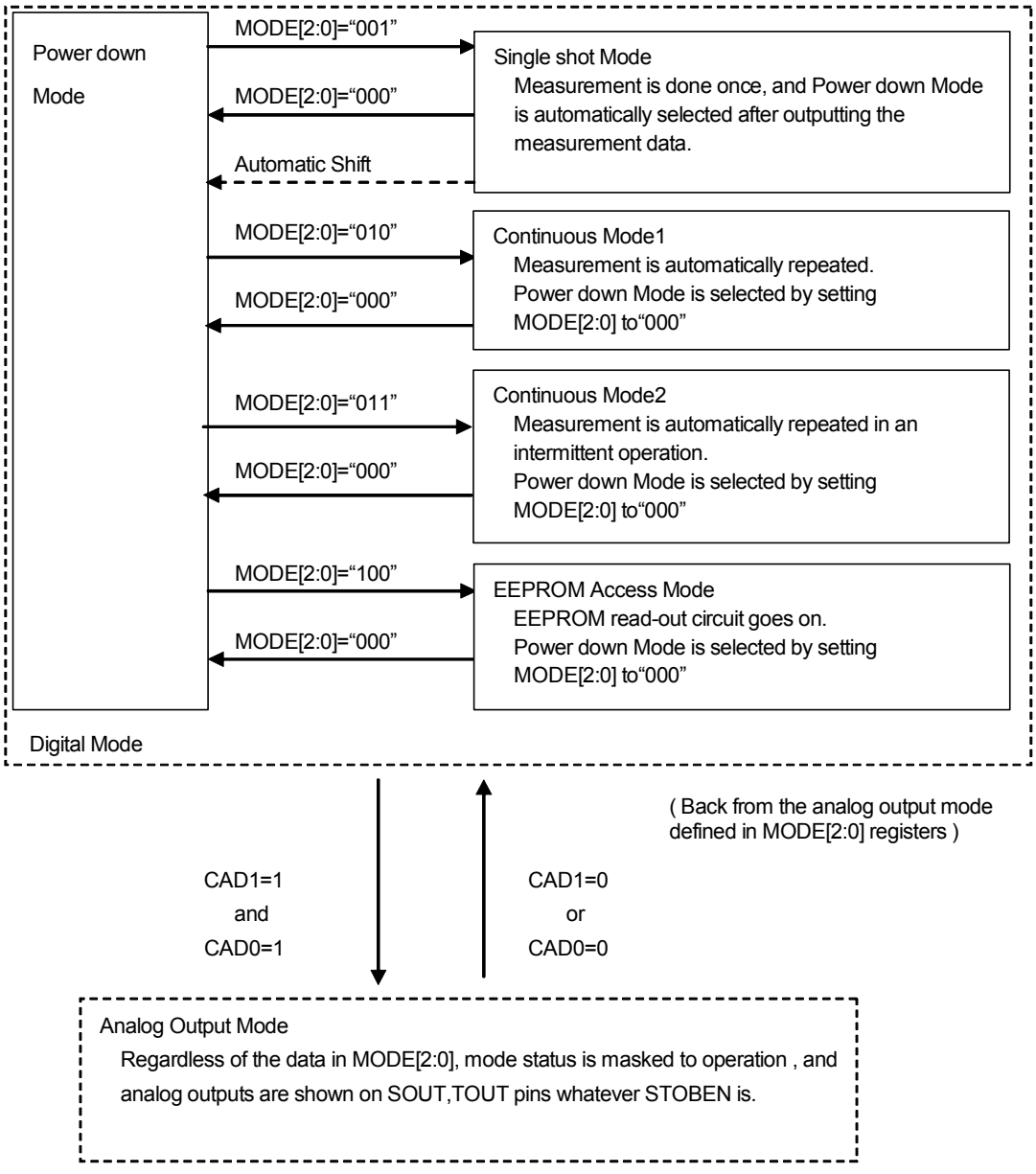


Fig.1. Operation MODE

When the power supply turns on, the AK9720 is in Power down Mode. According to MODE[2:0] setup,, the AK9720 shifts to the selected mode, and starts operating. Set the AK9720 to Power down Mode before changing this register setting.

4. Explanation for Each Operating Mode

4.1 Power down Mode (MODE [2:0] =”000”)

Power supply to most internal circuits is turned off. All registers can be accessed in Power down Mode. Read/Write register data are retained, and reset by software reset. However, EEPROM data cannot be read. Reading EEPROM data must be done in EEPROM Access Mode.

4.2 EEPROM Access Mode (MODE [2:0] =”100”)

When MODE [2:0] is changed from Power down Mode (MODE [2:0] =”000”) to MODE [2:0]=”100” , the AK9720 shifts to EEPROM Access Mode. Reading EEPROM data should be done in EEPROM Access Mode. Measurement is not done in EEPROM Access Mode.

4.3 Single shot Mode (MODE [2:0] =”001”)

When AK9720 is set to Single shot Mode (MODE [2:0] =”001”), a measurement and signal processing are done, then the measurement data (IRSL to TMPH data) are stored to the measurement data registers, and the AK9720 shifts to Power down Mode automatically. When the AK9720 shifts to Power down Mode, MODE [2:0] changes to ”000”. Simultaneously, the DRDY bit of ST1 register changes to “1”. This is called “Data Ready”. If either the measurement data register (IRSL to TMPH) or ST2 register is read out in “data ready” state, the DRDY bit changes to “0”. When the AK9720 shifts from Power down Mode to other modes, the DRDY bit retains “1”.

Measurement data register retains previous data, within the measurement period. Measurement data can be read out in the measurement period. When measurement data is read out in a measurement period, the previous data retained is read out.

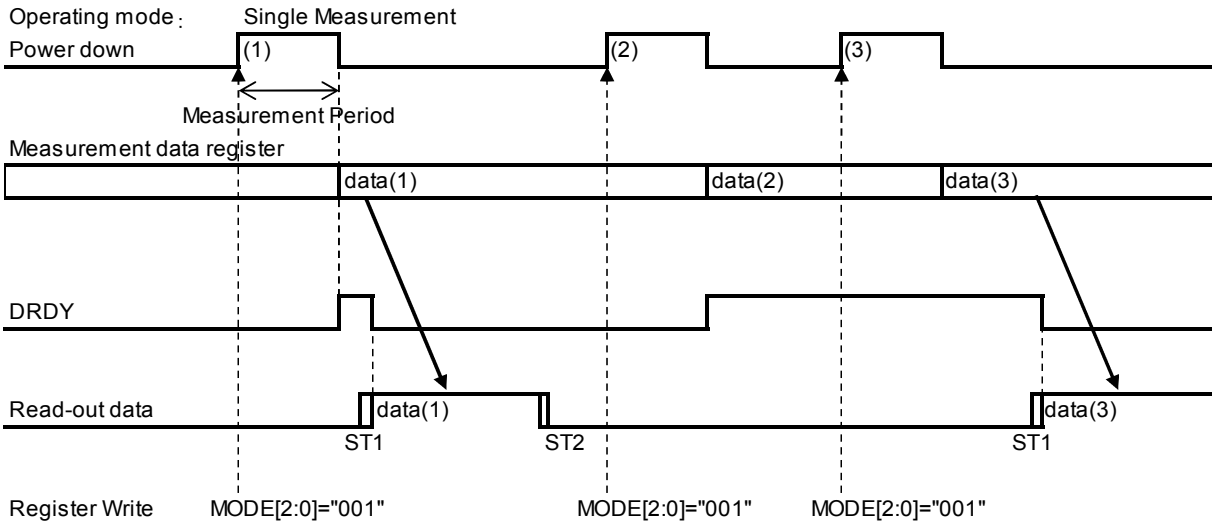


Fig.2. Single shot Mode (when measurement data is read, out of the measurement period.)

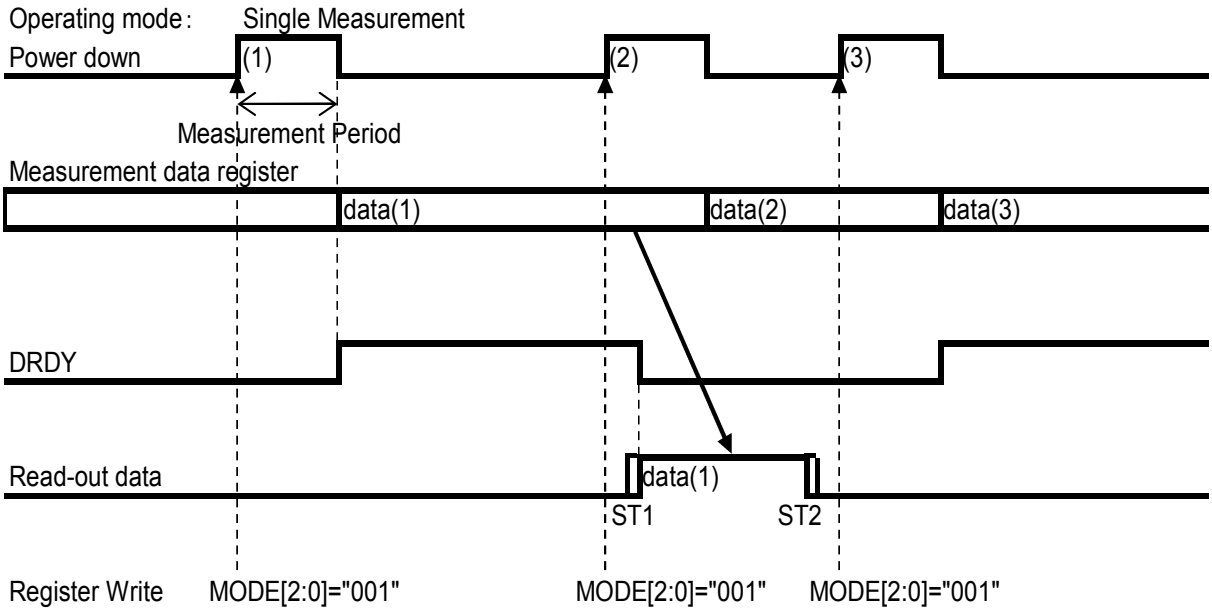


Fig.3. Single shot Mode (when measurement data is read out within the measurement period.)

4.4 Continuous Measurement Mode1 (MODE [2:0] =”010”)

When the AK9720 is set to Continuous Measurement Mode1 (MODE [2:0] =”010”), the measurement is automatically repeated. When a measurement and data processing have been done, the measurement data is stored to the measurement data register (IRSL to TMPH data), and the measurement is started again.

Measurement Mode is finished by setting the AK9720 to Power down Mode (MODE [2:0] =”000”).

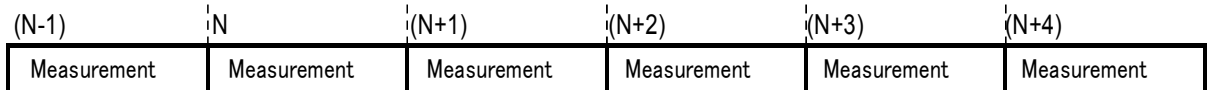


Fig.4. Continuous Measurement Mode1

4.5 Continuous Measurement Mode2 (MODE [2:0] ="011")

When the AK9720 is set to Continuous Measurement Mode2 (MODE [2:0] ="011"), the measurement is repeated according to the power down time (**TBD** Hz). When the measurement and data processing have been done, the measurement data is stored to the measurement data register (IRSL to TMPH data), and all circuits except those for the periodic measurement transition to Stand-by(SB) state. The circuits that are in Stand-by(SB) state are returned to active mode by detecting the next measurement time, and the measurement is started again.

Measurement Mode is finished by setting the AK9720 to Power down Mode (MODE [2:0] ="000").

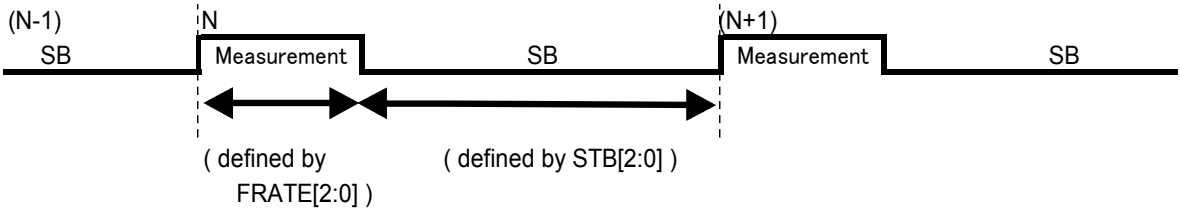


Fig.5. Continuous Measurement Mode2

5. Data Ready

When measurement data is stored to the measurement data registers, the DRDY bit of the ST1 register changes to “1”. This state is called “Data Ready”. It can be set up so that the INT pin outputs "High", when the DRDY bit is "1", by setting up the interruption register.

Read-out procedure is detailed here. (Single shot Mode is is used as an example.)
The same procedure can also be applied to the Continuous Measurement Mode1 and Continuous Measurement Mode2.

5.1 Normal Read-out Procedure

(1) Read-out ST1 registers

DRDY: DRDY shows whether the state is “Data Ready” or not.
DRDY ="0" means “No Data Ready”.
DRDY ="1" means “Data Ready”.

DOR: DOR shows whether there are any data which was not read out before initiating the current read.
DOR="0" means that there are no data which was not read out before initiating the current read.
DOR="1" means that there are data which was not read out before initiating the current read.

(2) Read the measurement data

Once a data read is initiated fromone of the measurement data registers (IRSL to TMPH) or the ST2 register, the AK9720 recognizes that a data read-out has begun. When a data read-out is initiated, DRDY and DOR change to “0”.

(3) Read ST2 Resisters (Required Operation)

The AK9720 recognizes that a data read-out has finished by reading out the ST2 registers. Because the measurement data registers are protected while reading out, data is not updated. Data protection of the measurement data register is canceled by reading out the ST2 register. The ST2 register must be read out after accessing the measurement data register.

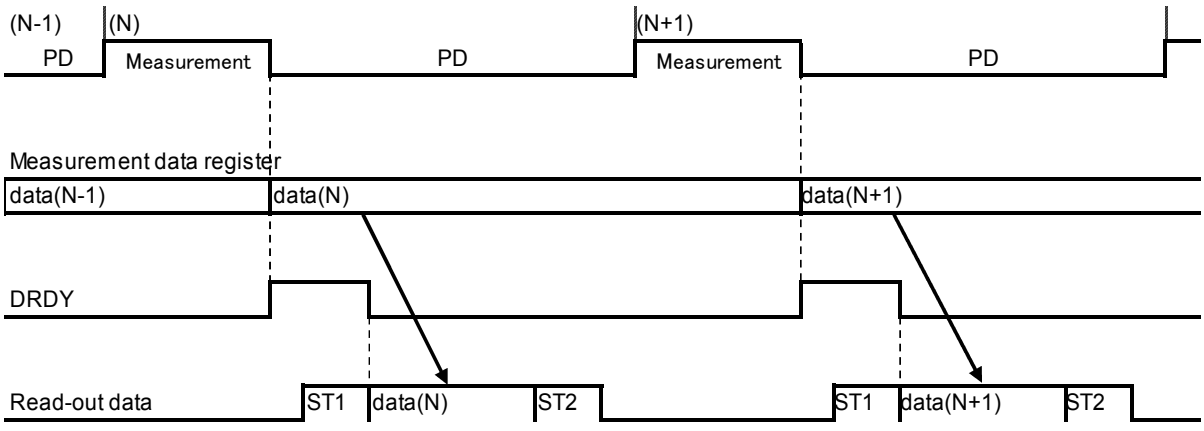


Fig.6. Normal Read-out Procedure

5.2 Read-out data within a measurement period

The measurement data register is retained within a measurement period, so the data can be read out within the measurement period. When data is read out within the measurement period, the previous data retained is read out.

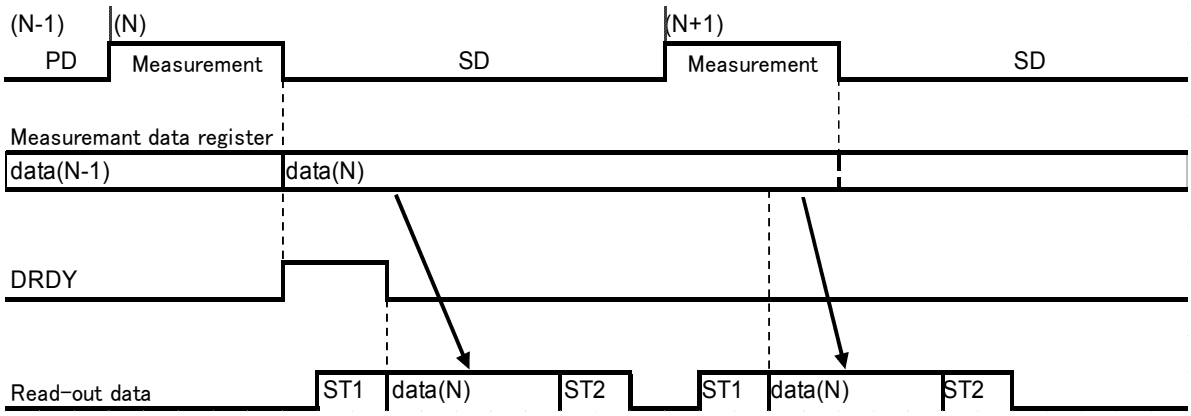


Fig.7. Read-out data within a measurement period

5.3 Skipping Data

When measurement data is not read out between the end points of $(N+1)^{th}$ and N^{th} measurement, DRDY is held the until measurement data is read out. In this case, because the N^{th} data was skipped, the DRDY bit is "1". (Fig.8)

When a data read begins after the end of the N^{th} measurement, and when the data read cannot be completed until the end of the $(N+1)^{th}$ measurement, the measurement data registers are protected to read data normally. In this case, because the $(N+1)^{th}$ data has been skipped, the DOR bit transitions to "1". (Fig.9)

In both of these cases, the DOR bit changes to "0" from "1", at the start of reading data if DRDY is "1".

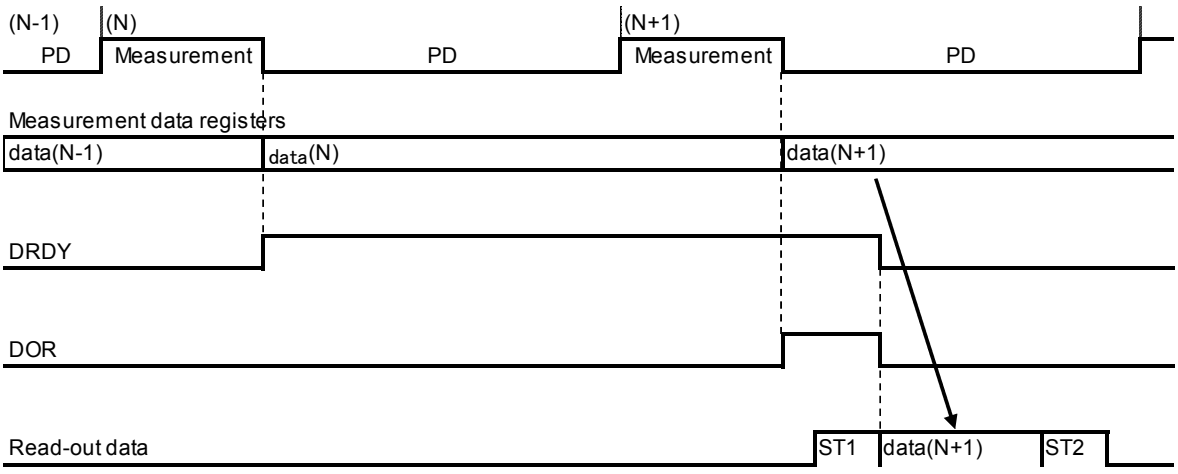


Fig.8. Skipping Data

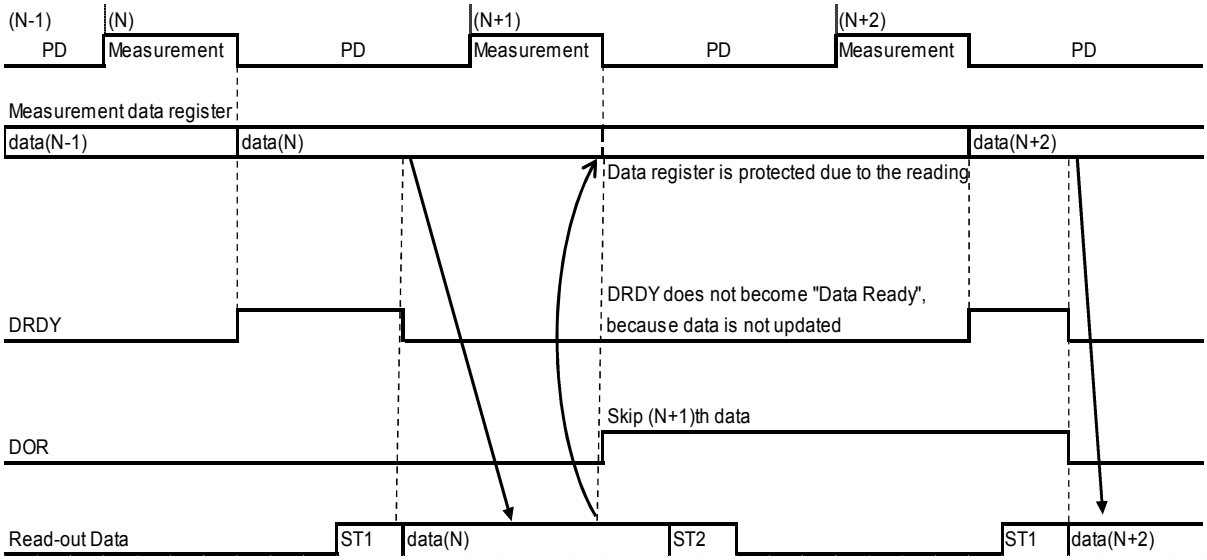


Fig.9. When the data read cannot be completed until the beginning of the next measurement

5.4 End Operation

Select Power down Mode (MODE [2:0] =”000”) to complete the Continuous Measurement Mode.

Serial Interface

The I^2C bus interface of the AK9720 supports Standard Mode (Max. 100kHz) and High Speed Mode (Max.400 kHz).

1. Data Transfer

Initially, the start condition should be input to access the AK9720 through the bus. Next, send a one byte slave address, which includes the device address. The the AK9720 compares the slave address, and if these addresses match, the AK9720 generates an acknowledge signal and executes a Read/Write instruction. The stop condition should be input after executing an instruction.

1.1 Changing state of the SDA line

The SDA line state should be changed only while the SCL line is “Low”. The SDA line state must be maintained while the SCL line is “High”.

The SDA line state can be changed while the SCL line is “High”, only when a Start Condition or a Stop Condition is input.

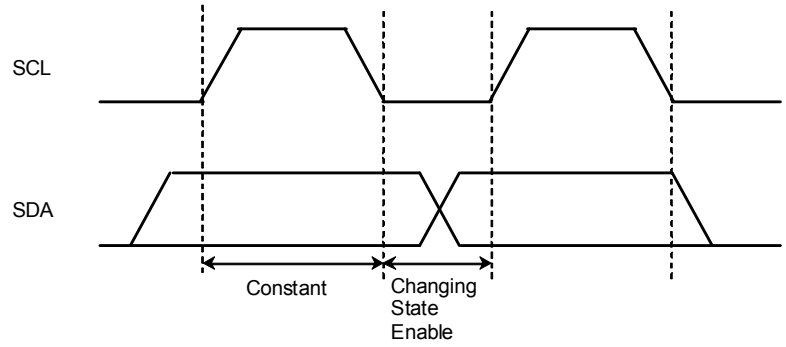


Fig.1. Changing state of SDA line

1.2 Start/Stop Conditions

A Start condition is generated when the SDA line state is changed from “High” to “Low” while the SCL line is “High”. All instructions start from a Start condition.

A Stop condition is generated when the SDA line state is changed from “Low” to “High” while the SCL line is “High”. All instructions end after a Stop condition.

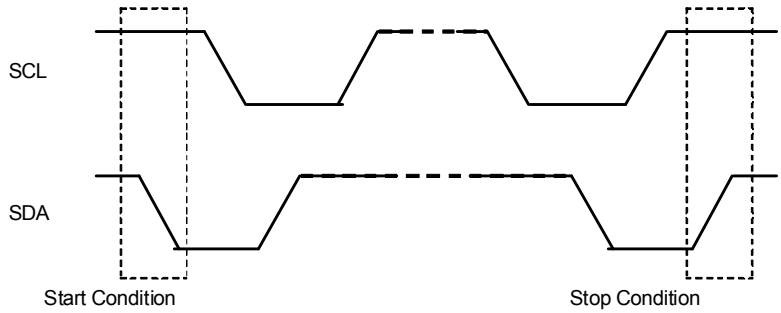


Fig.2. Start/Stop Conditions

1.3 Acknowledge

The device transmitting data will release the SDA line after transmitting one byte of data (SDA line state is “High”). The device receiving data will pull the SDA line to “Low” during the next clock. This operation is called “Acknowledge”. The Acknowledge signal can be used to indicate successful data transfers.

The AK9720 will output an acknowledge signal after receiving a Start condition and the Slave address.

The AK9720 will output an acknowledge signal after receiving each byte, when the WRITE instruction is transmitted.

The AK9720 will transmit the data stored in the selected address after outputting an acknowledge signal, when a READ instruction is transmitted. Then the AK9720 will monitor the SDA line after releasing the SDA line. If the master device generates an Acknowledge instead of a Stop condition, the AK9720 transmits an 8-bit data stored in the next address. When the Acknowledge is not generated, transmitting data is terminated.

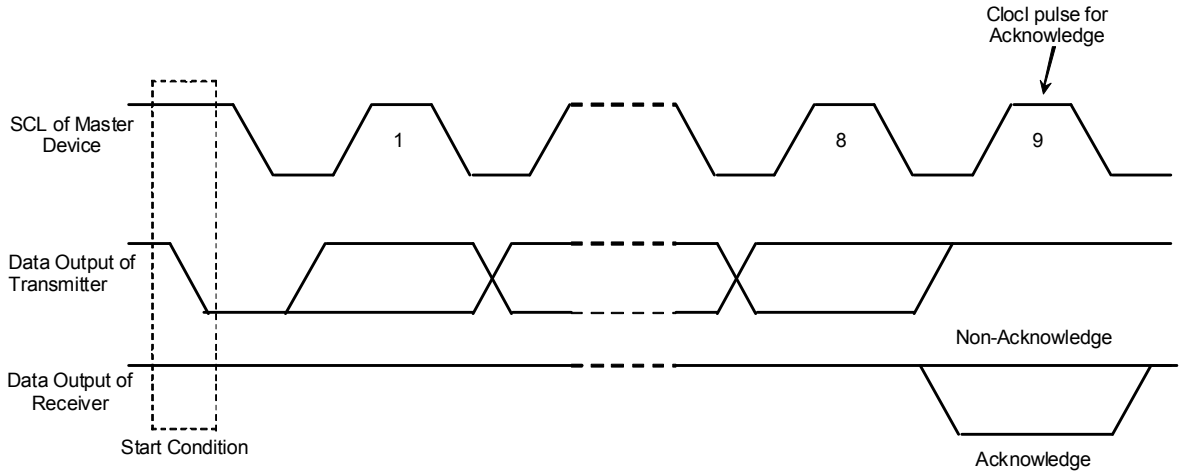


Fig.3. Acknowledge

1.4 Slave Address

The Slave address of the AK9720 can be selected from the following list by setting the CAD0/1 pins.

When the CAD0/1 pins are connected to VSS, the Slave address bit is “0”. When the CAD0/1 pins are connected to DVDD, the Slave address bit is “1”. Do not set up “CAD1=CAD0=1” while the I2C interface is used, because the “CAD1=CAD0=1” state is only for Analog Output Mode.

CAD1	CAD0	Slave Address
0	0	64H
0	1	65H
1	0	66H
1	1	Analog Output Mode Only

Table1. Setting CAD0/1 for Slave Address

When the first one byte data including the Slave address is transmitted after a Start condition, the device, which is specified as the communicator by the Slave address on the bus, is selected.

After transmitting the Slave address, the device that has the corresponding device address will execute a instruction after transmitting an Acknowledge signal. The 8th bit (Least Significant Bit-LSB) of the first one byte is the R/W bit.

When the R/W bit is set to “1”, a READ instruction is executed. When the R/W bit is set to “0”, a WRITE instruction is executed.

MSB LSB

1	1	0	0	1	CAD1	CAD0	R/W

Fig.4. Slave Address

1.5 WRITE Instruction

When the R/W bit is set to “0”, the AK9720 executes a WRITE Operation.

The AK9720 will output an Acknowledge signal and receive the second byte, after receiving a Start condition and first one bit (Slave address) in a WRITE Operation. The second byte has an MSB-first configuration, and specifies the address of the internal control register.

MSB LSB

A7	A6	A5	A4	A3	A2	A1	A0

Fig.5. Register Address

The AK9720 will generate an Acknowledge and receive the third byte after receiving the second byte (Register Address).

The data after the third byte is the control data. The control data consists of 8-bits and has an MSB-first configuration. The AK9720 generates an Acknowledge for each byte received. The data transfer is terminated by the Stop condition, which is generated by the

master device.

MSB							LSB
D7	D6	D5	D4	D3	D2	D1	D0

Fig.6. Control data

Two or more bytes can be written to the AK9720 at once.
The AK9720 generates an Acknowledge and receives the next data after receiving the third byte (Control Data). When the following data is transmitted without a Stop condition, after transmitting one byte, the internal address counter is automatically incremented, and data is written in the next address.

The automatic increment function works in the address from 00H to 14H and the address from 15H to 18H. When the start address is “00H”, the address is repeatedly incremented as follows: “00H -> 01H -> ... -> 14H -> 00H -> 01H ...”. When the start address is “15H”, the address is repeatedly incremented as follows: “15H -> 16H -> ... -> 18H -> 15H -> 16H ...”.

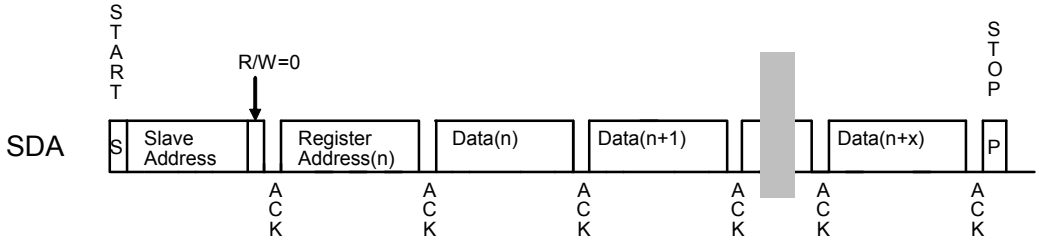


Fig.7. WRITE Operation

2. READ Instruction
When the R/W bit is set to “1”, the AK9720 executes a READ Operation.
When the AK9720 transmits the data from the specified address, and then the master device generates an Acknowledge instead of a Stop condition, the next address data can be read out.

The AK9720 supports both current address read and random address read.

The automatic increment function works in the address of 00H to 13H, and the address of 14H to 16H.

When the address 13H is read out, the next address returns to 00H.

When the address 16H is read out, the next address returns to 14H.

2.1 Current Address Read

The AK9720 has an integrated address counter. The data specified by the counter is read out in the current address read operation. The internal address counter retains the next address which is accessed at last.

For example, when the address which was accessed last was ”n”, the data of address “n+1” is read out by the current address read instruction.

The AK9720 will generate an Acknowledge after receiving a Slave address for a Read instruction (R/W bit =”1”) in the current address read operation. Then, the AK9720 will start to transmit the data specified by the internal address counter at the next clock, and will increment the internal address counter by one.

When the AK9720 generates a Stop condition instead of an Acknowledge after transmitting the one byte data, a Read out operation is terminated.

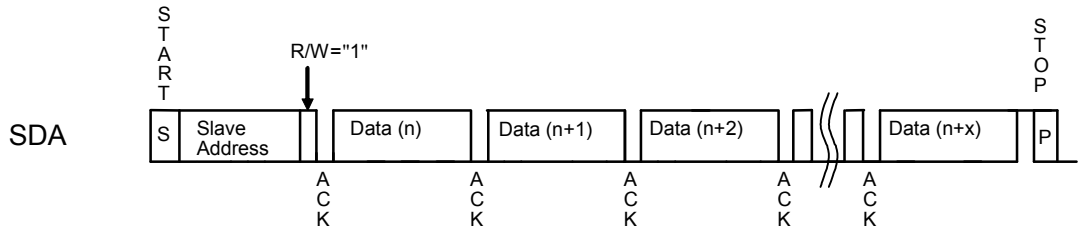


Fig.8. Current Address Read

2.2 Random Read

Data from an arbitrary address can be read out by a random read operation.

A random read requires the input of a dummy WRITE instruction before the input of a slave address of a READ instruction (R/W bit="1"). To execute a random read, first generate a start condition, then input the slave address for a WRITE instruction (R/W bit="0") and a read address, sequentially.

After the AK9720 generates an Acknowledge in response to this address input, generate a start condition and the slave address for a READ instruction (R/W bit="1") again. The AK9720 generates an Acknowledge in response to the input of this slave address. Next, the AK9720 outputs the data at the specified address, then increments the internal address counter by one.

When a Stop condition from the master device is generated instead of an Acknowledge after the AK9720 outputs data, the Read operation stops.

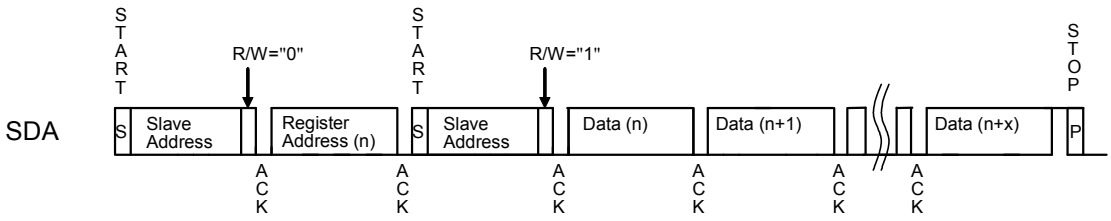
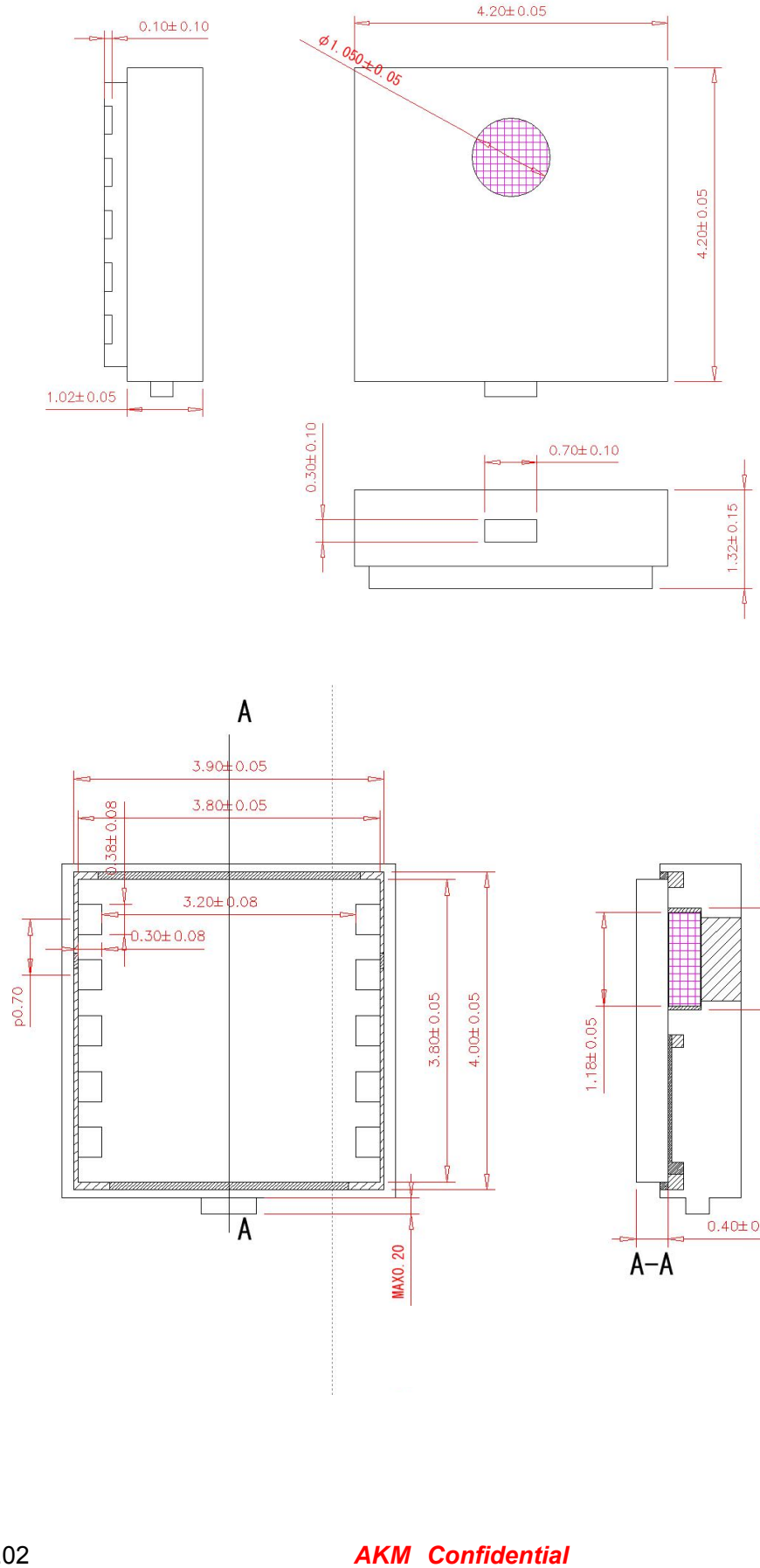
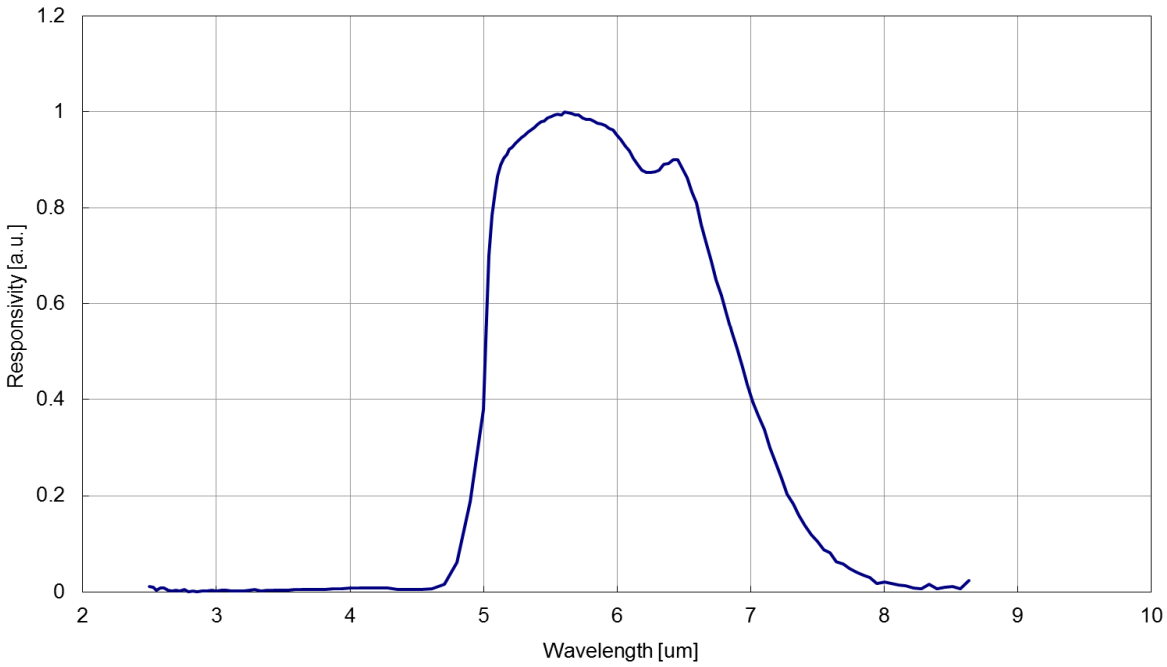


Fig.9. Random Read

Package Information



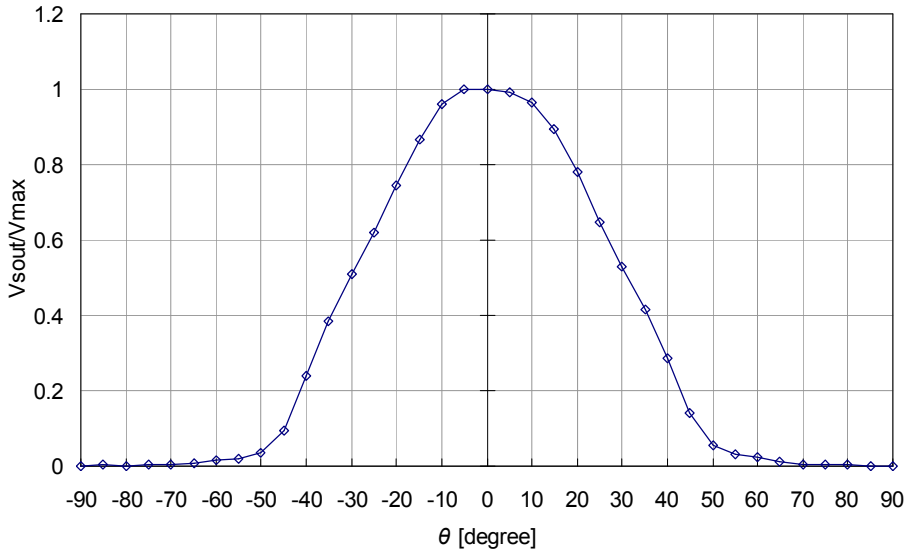
Spectrum Sensitivity (reference)



Note) Conditions; Sensor Temperature Ts=25°C (298K), 1Hz Chopping

Field of View (reference)

Item	Code	MIN	TYP	MAX	Unit	Remarks
FOV			±30		°	50% output（FWHM）



Note) Conditions: Blackbody Cavity: 227°C (500K), Aperture Diameter: 6.4mm,
Distance from sensor and Blackbody Cavity: 100mm,
Sensor Temperature: Ts=25°C (298K), 10Hz Chopping

Application Notes

1. Remote Temperature Sensing

*Measurement Accuracy of SOUT (normal mode, reference data only, not tested)

±3 °C @ Ta=0°C to 50°C, Tobj=20°C to 40°C

±5°C @ Ta=0°C to 50°C, Tobj=0°C to 20°C, or 40°C to 100°C

Assembly guideline will be supplied later.

2. Stationary Human Body Detection

*Detection algorithm reference software is available by request

3. Clock Frequency of I2C Interface (reference)

When the clock frequency of the I2C interface is outside of the frequency band from 333.7 kHz to 400 kHz, noise may increase.

4. Assembly Guideline

TBD

IMPORTANT NOTICE

- These products and their specifications are subject to change without notice. When you consider any use or application of these products, please make inquiries the sales office of Asahi Kasei Microdevices Corporation (AKM) or authorized distributors as to current status of the products.
- Descriptions of external circuits, application circuits, software and other related information contained in this document are provided only to illustrate the operation and application examples of the semiconductor products. You are fully responsible for the incorporation of these external circuits, application circuits, software and other related information in the design of your equipments. AKM assumes no responsibility for any losses incurred by you or third parties arising from the use of these information herein. AKM assumes no liability for infringement of any patent, intellectual property, or other rights in the application or use of such information contained herein.
- Any export of these products, or devices or systems containing them, may require an export license or other official approval under the law and regulations of the country of export pertaining to customs and tariffs, currency exchange, or strategic materials.
- AKM products are neither intended nor authorized for use as critical components$_{Note1)}$ in any safety, life support, or other hazard related device or system$_{Note2)}$, and AKM assumes no responsibility for such use, except for the use approved with the express written consent by Representative Director of AKM. As used here:
  Note1) A critical component is one whose failure to function or perform may reasonably be expected to result, whether directly or indirectly, in the loss of the safety or effectiveness of the device or system containing it, and which must therefore meet very high standards of performance and reliability.
  Note2) A hazard related device or system is one designed or intended for life support or maintenance of safety or for applications in medicine, aerospace, nuclear energy, or other fields, in which its failure to function or perform may reasonably be expected to result in loss of life or in significant injury or damage to person or property.
- It is the responsibility of the buyer or distributor of AKM products, who distributes, disposes of, or otherwise places the product with a third party, to notify such third party in advance of the above content and conditions, and the buyer or distributor agrees to assume any and all responsibility and liability for and hold AKM harmless from any and all claims arising from the use of said product in the absence of such notification.