AK8970N

Electronic Compass

Features

- ☐ Terrestrial magnetism detection type electronic compass module
- ☐ Built-in 3 high sensitivity Hall devices
- ☐ Functions
  - Built-in magnetic sensors for detecting the terrestrial magnetism in the X, Y, and Z directions
  - Built-in 8-bit A/D converter for digital outputs
  - Built-in 8-bit D/A converter for offset magnetic field correction
  - Built-in EEPROM for Hall device sensitivity calibration
  - Serial interface (the low-voltage specification also applicable)
  - Auto power-down and Interrupt output function
  - Operable with a 11MHz to 26MHz of master clock

    Selectable between clipped sine wave and CMOS level rectangular wave input
- ☐ Operating temperature : -30°C to +85°C
- ☐ Operating supply voltage : +2.5V to +3.6V
- ☐ Low power consumption : 8.5mA typ. @measurement
  0.1 μA typ. @power down
- ☐ Measurement time : 38.1msec. @MCLK=11.2896MHz
- ☐ Package : 24-pin QFN (multi-chip module) 5.0mm × 5.0mm × 1.0mm [AK8970N]

General Description

The AK8970N is a terrestrial magnetism detection type electronic compass module and is designed to provide azimuth information for cell phones and PDAs having GPS functions by incorporating the correction & calculation software supplied by AKM in the system. This module includes three Hall devices with orthogonal orientation for detecting the terrestrial magnetism in the X, Y, and Z directions, therefore allowing compact products to be realized.

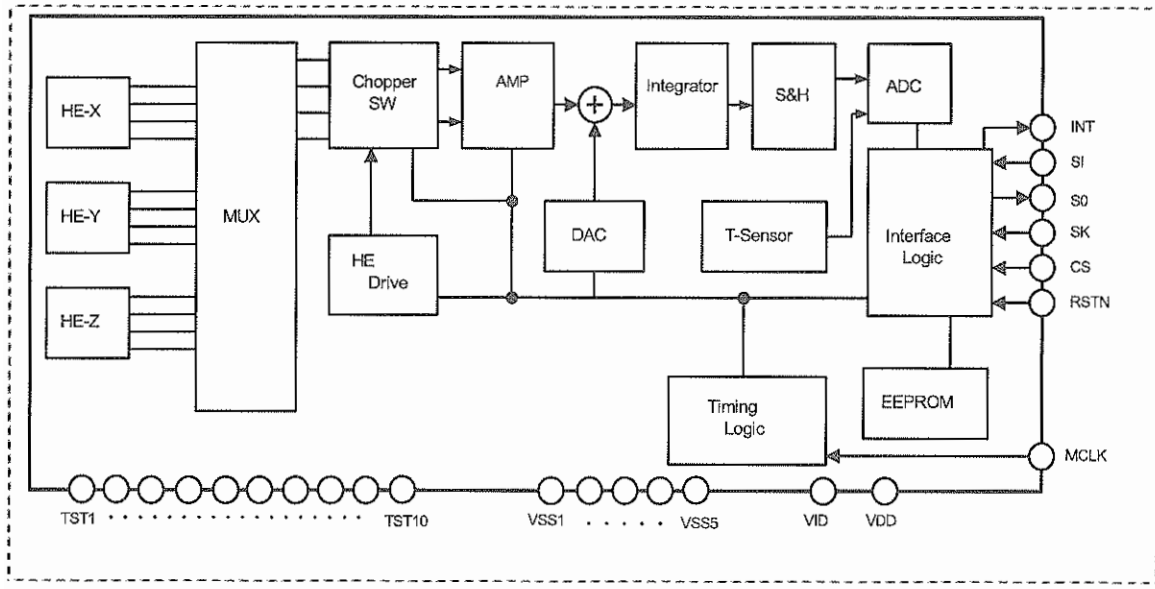
The AK8970N has the following features:

(1) By using high sensitivity Hall devices, advanced mixed signal processing technology and proprietary digital correction technology, terrestrial magnetism signal detection by Hall devices is made possible.

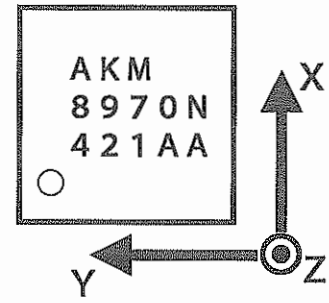
(2) With the built-in 8-bit A/D converter and serial interface, the X-, Y-, and Z-direction component signals of the terrestrial magnetism are output in a digital form.

(3) A separate power supply is used for the serial interface, so the low-voltage specification can also be supported by applying 1.85V.
(4) The built-in D/A converter can be used to compensate the offset magnetic field.
(5) The built-in EEPROM is used to store Hall devices sensitivity. The calibration values for the Hall device sensitivity are factory-set in the EEPROM.
(6) The value of the built-in temperature sensor is output in a digital form through the ADC.
(7) Main circuit blocks of the IC are started by measurement request commands from the controller, and power-down mode is entered automatically after the measurement finished.
(8) An interrupt function to notify the external controller of the end of measurement is included.
(9) Master clock frequencies ranging from 11MHz to 26MHz can be used.
(10) AKM provides software (functions) for azimuth calculation and preceding correction processing, which are performed based on the values measured by the AK8970N.

Block Diagram



(TOP VIEW)



Circuit Configuration

Block	Function
HE-X, HE-Y, HE-Z	High sensitivity Hall devices included in the package
MUX	Matrix switch for selecting one of the three
Chopper SW	Performs chopping to reduce an offset of Hall device.
HE Drive	Hall device drive circuit for 0.5V.
AMP.	Variable-gain differential amplifier to amplify the Hall device signal and adjust the sensitivity. Setting gain: 18.2dB min., increased in 0.3dB steps, 32 steps (5 bits)
DAC	D/A converter for offset magnetic field compensation Resolution: 8 bits, step width: 100μV, setting accuracy: 1/4LSB
Integrator	Integrates the output signals from AMP., amplifies voltage, and reduces noise.
S&H	Sample & Hold circuit
ADC	Performs analog-to-digital conversion for the Hall device and temperature sensor signals. Resolution: 8 bits
T-Sensor	Temperature sensor to convert temperature to voltage
Interface Logic	Serial interface circuits for data transfer with an external controller through four pins SK, SI, SO, and CS. The external controller is notified of the end of measurement through the INT pin. The low-voltage specification can be supported by applying 1.85V to the VID pin.
Timing Logic	Based on the 11MHz to 26MHz master clock input from the MCLK pin, internal timing clock pulses are generated.
EEPROM	Nonvolatile memory. This memory is read from and written to through four pins SK, SI, SO, and CS.

Pin Functions

No	Pin name	I/O	Type	Function
1	VSS5	-	Power	Ground pin
2	TST1	I/O	Analog	Test pins used for factory testing.
3	TST2	I/O	Analog	Leave these pins open individually, without wiring.
4	VDD	-	Power	Positive power supply pin
5	VSS1	-	Power	Ground pin
6	MCLK	I	CMOS	Master clock input pin 11MHz to 26MHz clock is input.
7	RSTN	I	CMOS	Reset input pin "L" causes a reset, and power-down mode is entered.
8	VSS2	-	Power	Ground pin
9	VSS3	-	Power	Ground pin
10	INT	O	CMOS	Interrupt signal output pin Normally "L". When measurement finished, "H" is output.
11	SO	O	CMOS	Serial data and EEPROM data output pin
12	SI	I	CMOS	Serial data and EEPROM data input pin
13	SK	I	CMOS	Serial data and EEPROM data clock input pin
14	CS	I	CMOS	Serial data and EEPROM data I/O chip select input pin Active high
15	VID	-	Power	Digital interface positive power supply pin This pin is a positive power supply pin for the digital interface block. By connecting this pin to a 1.85V power supply, the low-voltage specification digital interface can be connected. For use of the normal CMOS-level interface, connect this pin to the same power supply as that of VDD.
16	TST3	I/O	Analog	Test pins used for factory testing. Leave these pins open individually, without wiring.
17	TST4	I/O	Analog	
18	TST5	I/O	Analog	
19	TST6	I/O	Analog	
20	VSS4	-	Power	Ground pin
21	TST7	I/O	Analog	Test pins used for factory testing. Leave these pins open individually, without wiring.
22	TST8	I/O	Analog	
23	TST9	I/O	Analog	
24	TST10	I/O	Analog	

*VSS1~VSS5 are connected internally. It is not necessary to connect threes all 5 pins to Ground, but VSS1(pin#5) must be connected to Ground at least.

Absolute Maximum Ratings

VSS = 0V

Parameter	Symbol	Min.	Max.	Unit
Power supply voltage (VDD, VID)	V+	-0.3	+6.5	V
Input voltage	VIN	-0.3	(V+) + 0.3	V
Input current	IIN	-	±10	mA
Storage temperature	TST	-55	+125	°C

Caution) If the device is used in conditions exceeding these values, the device may be destroyed. Normal operations are not guaranteed in such extreme conditions.

Recommended Operating Conditions

VSS = 0V

Parameter	Remark	Symbol	Min.	Typ.	Max.	Unit
Operating temperature		Ta	-30		85	°C
Power supply voltage	VDD pin voltage	VDD	2.5	3.0	3.6	V
	VID pin voltage	VID	1.70	1.85	VDD	V

Note) When turning on VDD and VID, turn on them at the same time or turn on VDD first.

Electrical Characteristics

The following condition apply unless otherwise specified: Temperature range: Tc = -30°C to 85°C

(1) DC characteristics

Parameter	Symbol	Pin	Condition	Min.	Typ.	Max.	Unit
High level input voltage 1	VIH1	SI, CS		70%VID			V
Low level input voltage 1	VIL1					30%VID	V
High level input voltage 2	VIH2	SK RSTN		80%VID			V
Low level input voltage 2	VIL2					20%VID	V

Input current	IIN	SI, CS SK, RSTN	Vin = VSS or VID	-10		+10	μA
High level output voltage	VOH	SO INT	IOH = -200μA *2)	90%VID			V
Low level output voltage	VOL		IOL = +200μA *2)			0.4	V
Current consumption (Total current VDD and VID)	IDD1		Power-down mode *1)		0.1	5	μA
	IDD2		Measurement		8.5	13	mA
	IDD3		Mean value during 100ms cycle operation		3.1	4.8	mA

*1) The MCLK pin is always held "L" or "H".

*2) Load capacitance: 20pF

(2) AC characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
RSTN rising timing	TRS	Keep RSTN "L" time from power (VDD, VID) is ON	100			ns
Measurement time	TSM	From measurement mode is set to INT pin rising MD2 = 00H (11.2896MHz)	37	38	39	ms
ADC resolution	ARS			8		bit
DAC resolution	DRS			8		bit
DAC step width	DST	VDD = 3.0V	80	100	120	μV
DAC accuracy	DAQ	VDD = 3.0V			±1/4	LSB
Sensor amplifier gain range	SASL	VDD = 3.0V AGX, AGY, AGZ = 00H	17.7	18.2	18.7	dB
	SASH	VDD = 3.0V AGX, AGY, AGZ = 1FH	27.0	27.5	28.0	dB
Sensor amplifier gain step width	AGS		0.15	0.3	0.45	dB
T-sensor measurement range	TOP		-30		85	°C
T-sensor output code	TOC	VDD = 3.0V Tc = 35°C	76H	78H	7AH	code
T-sensor sensitivity	TSE	VDD = 3.0V	-1.4	-1.6	-1.8	LSB/°C

Magnetic sensor sensitivity	BSE	VDD = 2.5V ,Tc = 25°C @AMP output, B = 0.6mT AGX = ESNX, AGY = ESNY, AGZ = ESNZ	7.9	8.33	8.9	mV/mT

(3) Master clock input (MCLK) characteristics

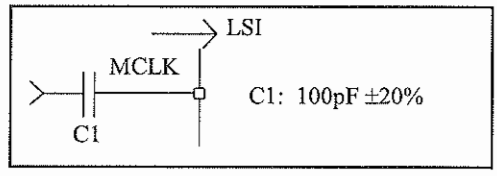
Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Input frequency *1)	FCLK		11		26	MHz
Clipped sine wave (TCXO) input *2)						
Input amplitude level	VCIN	AC coupling	0.5		2.0	Vp-p
Input impedance	CRIN		15			kΩ
Input capacitance	CCIN	*3)			20	pF
CMOS level rectangular wave input *2)						
Input duty ratio	DCLK	Defined with 50%VID crossing	40		60	%
High level input voltage	CIH		70%VID			V
Low level input voltage	CIL				30%VID	V
Input current	CIN	MCLK = VSS or VID	-10		+10	μA

*1) The input frequency is selected by D3 - D0 of register MD2.

*2) The input waveform is selected by D7 of register MD2. When selecting the clipped sine wave input, connect a 100pF capacitor for AC coupling. When selecting the CMOS level rectangular wave input, input the clock signal directly (without AC coupling). (See the recommended external connection example below.)

*3) These parameter values are sample values; all values are not tested.

Recommended external connection example



(4) EEPROM characteristics

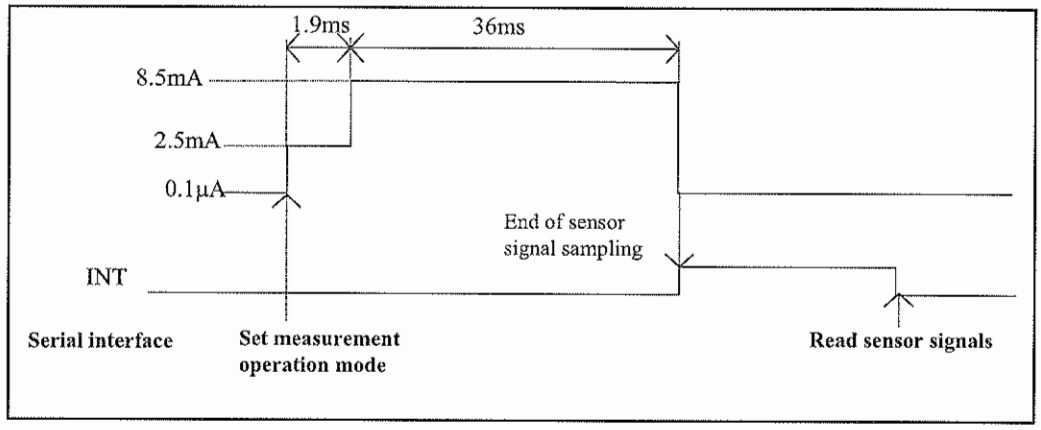
Parameter	Min.	Max.	Unit
EEPROM erase/write cycles	1000		cycles
EEPROM data retention	2 (@85°C) + 11 (@65°C)		years
	7.7 (@75°C)		

Operation Overview

[Sensor signal sampling]

Sensor signal sampling is started by setting operation mode register MD1 to measurement operation (D1 - D0 = "00"). In the first 1.9ms period, internal power is turned on, and analog-to-digital conversion of the temperature sensor is performed. Then, the magnetic sensors for the X, Y, and Z directions are driven in this order, and analog-to-digital conversion is performed. Upon completion of these steps, the INT pin is driven "H", which automatically places the AK8970N in power-down mode. The level change on the INT pin notifies the external controller that sensor signal sampling has finished, then the controller reads these conversion data through the serial interface. The change on the INT pin can also be detected by reading register SR3.

If the sensor integration time is 10ms, current consumption changes in time as shown below.



Note) While the INT pin is held "H", sensor signal sampling does not start even when measurement operation mode is set. Before setting measurement operation mode, check that the INT pin is "L", or perform a dummy sensor signal read to drive the INT pin "L".

[Interrupt function]

The AK8970N provides an interrupt function to post the end of sensor signal conversion to the outside by changing the INT pin status from "L" to "H". The contents of SR1 or SR2 are read through the serial interface, and the INT pin is driven "L" again in synchronization with the falling edge of the 8th bit on the SK pin that determines an address. The INT pin status is reflected also in the B0 bit of register SR3.

[Master clock selection]

The AK8970N operates on the master clock applied to the MCLK pin. As the input waveform of the master clock, the clipped sine wave or CMOS level rectangular wave can be selected by D7 of register MD2. The master clock frequency is selected by D3 to D0 of register MD2.

[Setting of the integrator operation time]

The AK8970N allows the integrator operation time to be set to 10ms or 20ms separately for the X, Y, and Z direction sensors. When 20ms is set for a sensor, its sensor gain appears to be twice the gain for 10ms. The integrator operation times are set by D6 to D4 of register MD2.

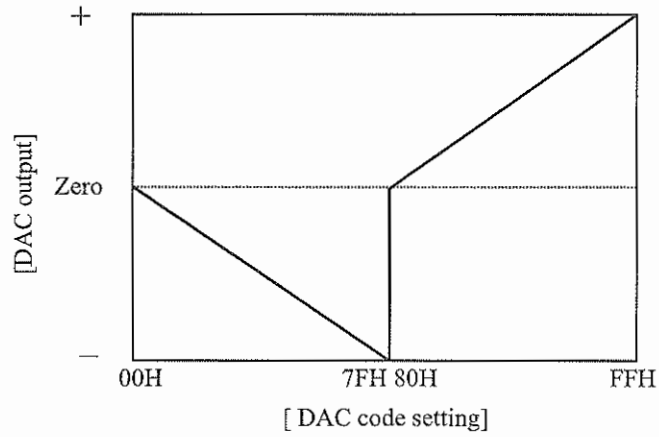
Changing the integrator operation time changes the measurement time. When the operation times for the X, Y, and Z directions are all set to 20ms, the measurement time is 72.9ms (when MCLK frequency is 11.2896MHz).

[Setting of D/A converter]

In clean magnetic environment (no offset magnetic field), AK8970N can detect terrestrial magnetism at initial value (DAX=DAY=DAZ=00H) of D/A converter.

The other hand, in strong offset field, signal level of sensor output may be beyond the input range of the A/D converter. In such case, adding the output of D/A converter to sensor signal, this signal can be regularized to the A/D converter input range.

In applications, D/A converter setting procedure is performed by the external controller, using appropriate software supplied by ASAHI-KASEI.



[Setting of operation mode and read of conversion data]

The AK8970N transfers data to and from an external device through the serial interface described later.

The first 8 bits of serial data are decoded as an address, and only when the decoded address matches one of the 13 addresses listed in Table 1 below, a write or read operation is performed.

Name	Address	Usage	Number of SK bits	Read/ Write	Description
SR1	F0H	Sensor signal output 1	24	Read	Output of X and Y direction signals
SR2	F1H	Sensor signal output 2	24	Read	Output of Z direction and temperature sensor signals
SR3	F2H	Status register output	16	Read	Interrupt status and EEPROM data read/write mode checking
MD1	F3H	Operation mode setting 1	16	Write	Operation mode setting and EEPROM read/write mode setting
MD2	F4H	Operation mode setting 2	16	Write	Selection of master clock frequency & wave form, and integrator operation time
DAX	F5H	X direction sensor DAC setting	16	Write	DAC setting for X direction offset compensation
DAY	F6H	Y direction sensor DAC setting	16	Write	DAC setting for Y direction offset compensation
DAZ	F7H	Z direction sensor DAC setting	16	Write	DAC setting for Z direction offset compensation
AGX	F8H	X direction sensor gain setting	16	Write	Gain setting for X direction sensor Transcribe ESNX data of EEPROM
AGY	F9H	Y direction sensor gain setting	16	Write	Gain setting for Y direction sensor Transcribe ESNY data of EEPROM
AGZ	FAH	Z direction sensor gain setting	16	Write	Gain setting for Z direction sensor Transcribe ESNZ data of EEPROM
TS1	5DH	Test mode for factory testing	16	Write	Normally, not used by the user
TS2	5EH		16	Write	

Table 1

At addresses other than the above addresses and addresses assigned to the EEPROM described later, the AK8970N does not operate. Therefore, other addresses can be assigned for controlling other devices.

Serial Interface

AK8970N reads and writes data through a synchronous four-wire serial interface consisting of SK, SI, SO, and CS.

When setting data is written, serial clock pulses for 16 bits are received from the SK pin, and the first 8 bits are processed as an address, and the latter 8 bits are processed as data. If the address is from F3H to FAH, the AK8970N is regarded as being selected, so the AK8970N inputs the latter 8 bits as the setting data and performs subsequent operations accordingly.

When conversion data is read from SR1 or SR2, serial clock pulses for 24 bits are received from the SK pin. If the first 8 bits indicate address F0H or F1H, two types of 8-bit sensor data are output from the SO pin starting with the MSB.

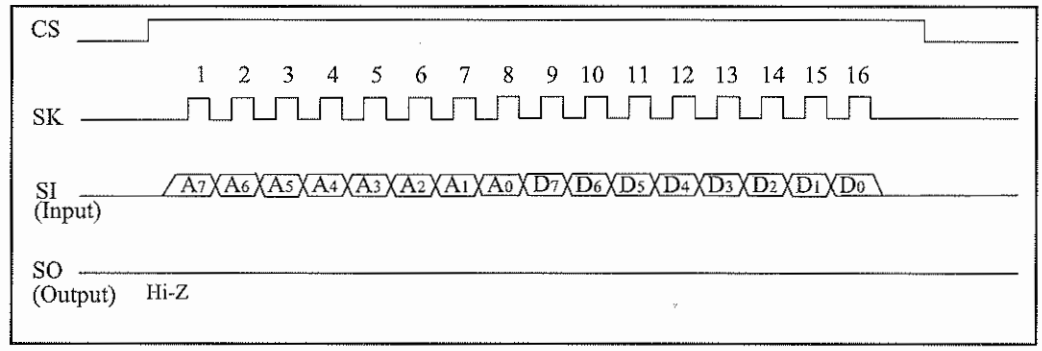
When the contents of status register SR3 are read, serial clock pulses for 16 bits are received from the SK pin, and if the first 8 bits indicate address F2H, 8-bit data is output from the SO pin starting with the MSB.

Addresses 5DH and 5EH are used for setting test mode for the AK8970N. During normal use, these addresses must not be accessed.

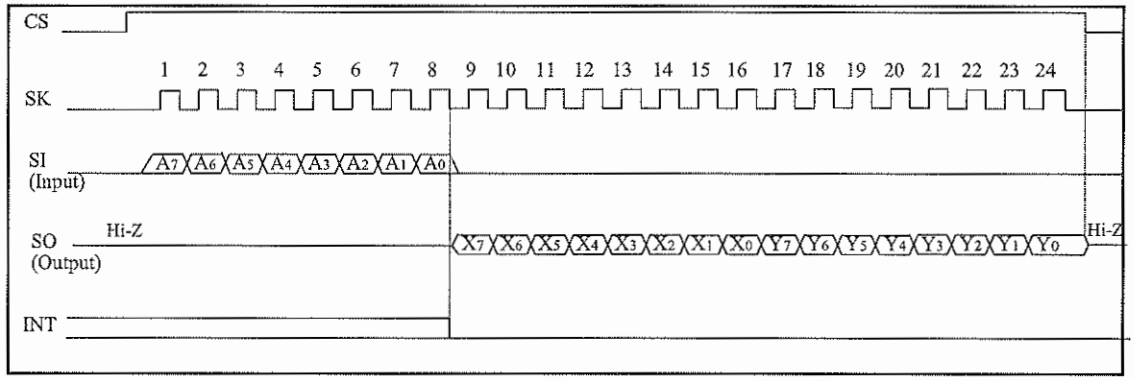
For addresses other than the addresses mentioned above and addresses assigned to the EEPROM, the AK8970N is regarded as not being selected, and the SO pin is held high-impedance, and no input data is supplied from the SI pin.

[Serial interface timing]

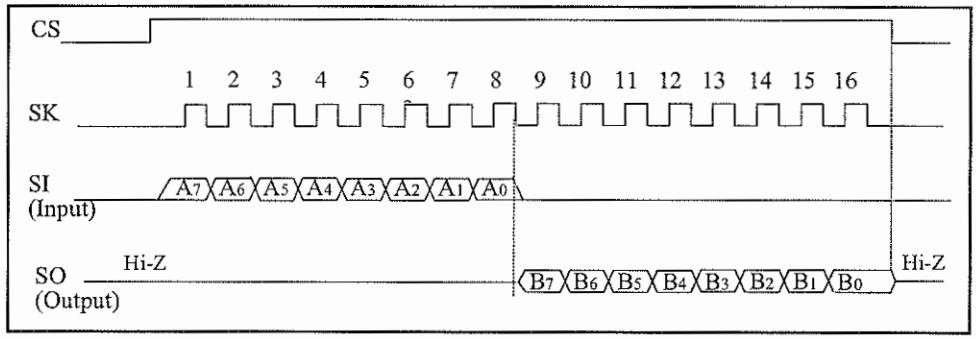
Write timing



Conversion data read timing



Status register read timing



[Write data]

Table 2 lists the structures of setting register data input from SI.

Register name	Address	Data name	Usage	Number of bits	Description
MD1	F3H	D1 - D0	Operation mode setting	2	00: Measurement operation 01: Test mode User does not use this mode 10: EEPROM read/write 11: Power down
		D7 - D2	EEPROM data read/write mode setting	6	101010: Write mode Other than above: Read mode (write protected)
MD2	F4H	D3 - D0	Master clock setting	4	See Table 3.
		D4	Integration time setting for X direction sensor	1	0: 10ms 1: 20ms
		D5	Integration time setting for Y direction sensor	1	
		D6	Integration time setting for Z direction sensor	1	
		D7	Master clock input waveform selection	1	0: Clipped sine wave 1: CMOS level rectangular wave
DAX	F5H	D7 - D0	X direction sensor DAC setting	8	FFH: Maximum value 80H: 0 00H: 0 7FH: Minimum value
DAY	F6H	D7 - D0	Y direction sensor DAC setting	8	
DAZ	F7H	D7 - D0	Z direction sensor DAC setting	8	
AGX	F8H	D4 - D0	X direction sensor gain setting	5	See Table 4.
AGY	F9H	D4 - D0	Y direction sensor gain setting	5	
AGZ	FAH	D4 - D0	Z direction sensor gain setting	5	

Table 2

MOD data D3 - D0	Master clock frequency	Measurement time
0000	11.2896MHz	38.1ms
0001	12MHz	35.8ms
0010	12.288MHz	35.0ms
0011	12.6MHz	34.1ms
0100	13MHz	33.1ms
0101	14.4MHz	29.9ms
0110	15.36MHz	28.0ms
0111	16.8MHz	38.4ms
1000	18MHz	35.8ms
1001	19.2MHz	33.6ms
1010	19.68MHz	32.8ms
1011	19.8MHz	32.6ms
11XX	26MHz	33.1ms

Table 3

AGX, AGY, AGZ data D4 - D0	Gain (dB)
00000	18.2
00001	18.5
.....	.....
01111	22.7
10000	23.0
10001	23.3
.....	.....
11110	27.2
11111	27.5

When the value of AGX, AGY, or AGZ is N, the gain is set to $(18.2 + 0.3 \times N)$dB.

Table 4

[Read data]

Table 5 lists the read data output from SO.

Register name	Address	Data name	Usage	Number of bits	Description
SR1	F0H	X7 - X0	X direction data	8	Minimum value: 00H Maximum value: FFH
		Y7 - Y0	Y direction data	8	Minimum value: 00H Maximum value: FFH
SR2	F1H	X7 - X0	Z direction data	8	Minimum value: 00H Maximum value: FFH
		Y7 - Y0	Temperature sensor data	8	80H (typ.) for 30°C As the temperature increases, the data value becomes smaller.
SR3	F2H	B0	INT: Interrupt status	1	This bit shows the same state as the INT pin. 0: Interrupt reset state 1: Interrupt state
		B1	WRN: EEPROM data read/write mode check	1	This bit is set by the D7 - D2 bits of MD2. 0: Read mode (write protected) 1: Write mode
		B7 - B2	Not used	6	Not used

Table 5

[Initial values]

When RSTN goes "L", the registers of the AK89780N are initialized, and power-down mode is entered. Table 6 lists the initial values of the registers.

Register name	Address	Initial value	Status
SR1	F0H	X7 - X0 = 00H Y7 - Y0 = 00H	Minimum value
SR2	F1H		
SR3	F2H	B1 - B0 = 00B	Interrupt reset, EEPROM read mode (write protected)
MD1	F3H	D7 - D0 = 03H	Power-down mode, EEPROM read mode (write protected)
MD2	F4H	D7 - D0 = 00H	11.2896MHz, 10ms, clipped sine wave
DAX	F5H	D7 - D0 = 00H	Center value
DAY	F6H		
DAZ	F7H		
AGX	F8H	D7 - D0 = 00H	18.2dB
AGY	F9H		
AGZ	FAH		

Table 6

Overview of the EEPROM Function

The AK8970N includes an EEPROM consisting of 9 words by 8 bits. Each word can be read and written independently.

Before the EEPROM can be read from or written to, "10" must be set in D1 and D0 of register MD1, and the operation mode must be set to EEPROM read/write mode.

The high voltage required for write operations is generated within the device.

EEPROM read and write operations are controlled by CS, SK, SI, and SO. These pins also function as the serial interface pins.

When the CS pin level changes from low to high, data is input from the SI pin on the rising edge of the clock signal input to the SK pin, and data is output from the SO pin on the falling edge of the clock signal. Data is transferred starting with the MSB. When the CS pin is low, no data is input from the SI pin, and the SO pin is in the high-impedance state.

There are two EEPROM operation modes, read and write modes, and an 8-bit address and 8-bit data are used for these operations. Whether to perform a read operation or write operation for the EEPROM is determined by the EEPROM data read/write mode setting information written in D7 to D2 of register MD1. When an address other than the EEPROM addresses of the AK8970N is input, the AK8970N ignores the address and does not input the subsequent data. In this case, the SO pin is in the high-impedance state. To enter the next data, drive the CS pin low, then input a new instruction.

EEPROM Operation Description

Before the EEPROM can be read from or written to, the operation mode must be set to EEPROM read/write mode. The EEPROM operation is determined by the EEPROM read/write mode setting. The read/write mode setting is made by writing appropriate data to D7 to D2 of register MD1. (See Table 7.)

For a correct read or write operation for the EEPROM, a wait for at least 200μs is required after the above operation.

Whether read mode or write mode is set can be checked from WRN bit B1 of status register SR3. When the power is turned on, the AK8970N enters read mode (write protected).

Operation	D1 and D0 of MD1	D7 to D2 of MD1	Address	Data	Description
Read	"10"	Other than "101010"	A7 to A0	D7 to D0 (out)	EEPROM memory read
Write	"10"	"101010"	A7 to A0	D7 to D0 (in)	EEPROM memory write

Table 7

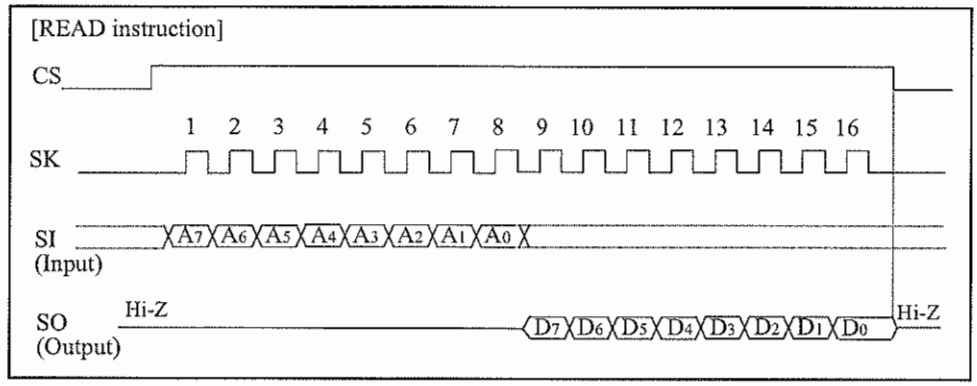
[Read (read sequence)]

When an EEPROM address is accessed in read mode (write protected), data in the EEPROM can be read.

To perform a read operation, change the CS pin level from low to high, then input a read address. Then, data D7 - D0 at the specified address is output from the SO pin.

When clock pulses are continuously input after 1 byte of data is read, the data at the next address is output. When clock pulses are provided further after the data at the highest address has been read, the data at the lowest address is read.

After the last bit of address A0 is input, data on SI is ignored. To end the read operation, set "11" in D1 and D0 of register MD1, and set the read mode (write protected) in the D7 to D2.



[Write (write sequence)]

Normally, the user does not write the EEPROM

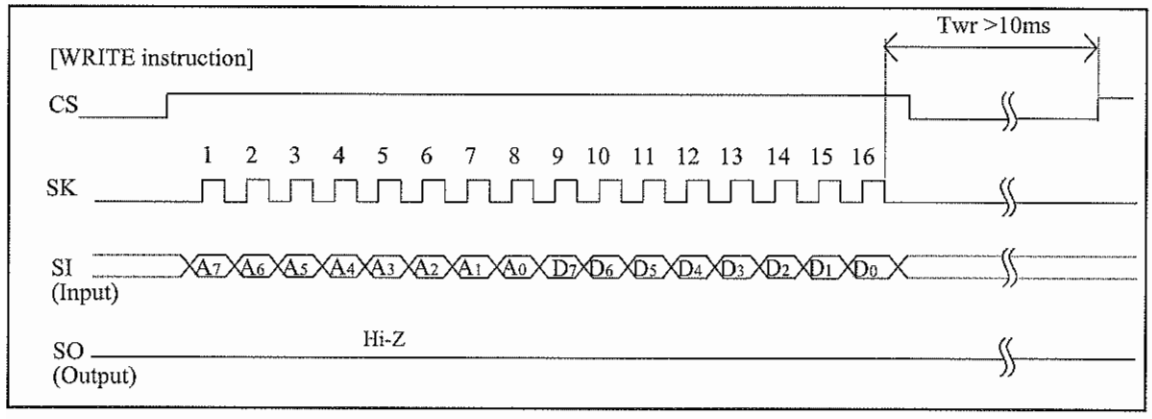
When an EEPROM address is accessed in write mode, a write into the EEPROM can be performed.

A write operation is performed by inputting a write address and data from the SI pin after the CS pin level changes from low to high. After data input, the internal programming cycle starts on the falling edge of the 16th clock pulse on SK. After last data bit D0 has been input, the CS pin must be driven low before the next SK clock rising edge is input. If the CS goes low at other timings, no write operation takes place.

The time required for a write is indicated as the programming time. During the internal programming cycle, avoid making accesses to any valid addresses of the AK8970N including read and write operations for registers.

To continue to writing to another address, wait for the programming time (Twr), then write to the address. To c To end the write operation, wait for the programming time (Twr), then set "11" to D1 and D0 of register MD1 and read mode (write protected) to D7 to D2. If the programming time is insufficient, correct writing of the previous data is not guaranteed.

During internal programming, accessing addresses other than the valid addresses of the AK8970N is possible. In this case, the AK8970N is regarded as not being selected, so the SO pin is held high-impedance, and no input data is supplied from the SI pin.



EEPROM Register Map

Table 8 shows the EEPROM register map.

Name	Address	Data		
	A_7 - A_0	Description	Number of bits	Factory-set value
WRAL	1FH	Address for writing EEPROM at a time	8	-
ESNX	23H	Element sensitivity for X direction sensor	8	Separately adjusted value
ESNY	24H	Element sensitivity for Y direction sensor	8	Separately adjusted value
ESNZ	25H	Element sensitivity for Z direction sensor	8	Separately adjusted value
EDAX1	26H	Reserved	8	Not defined
EDAY1	27H	Reserved	8	Not defined
EDAZ1	28H	Reserved	8	Not defined
EOFX1	29H	Reserved	8	Not defined
EOFY1	2CH	Reserved	8	Not defined
EOFZ1	2DH	Reserved	8	Not defined
ETSN	2EH	Offset correction for temperature sensor	6	Separately adjusted value
EVRE	2FH	VREF voltage and internal frequency setting	4	Separately adjusted value

Table 8

The data in ETSN and EVRE is connected to internal registers of the AK8970N to directly control correction values.

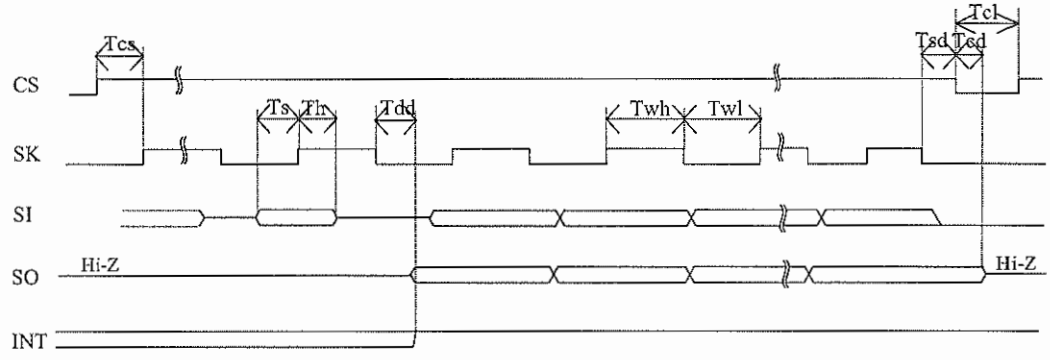
ESNX, ESNY, and ESNZ are not connected to AK8970N internal registers directly. The sensitivities for the sensors are adjusted by reading data from ESNX, ESNY, and ESNZ and setting these values in registers AGX, AGY, and AGZ.

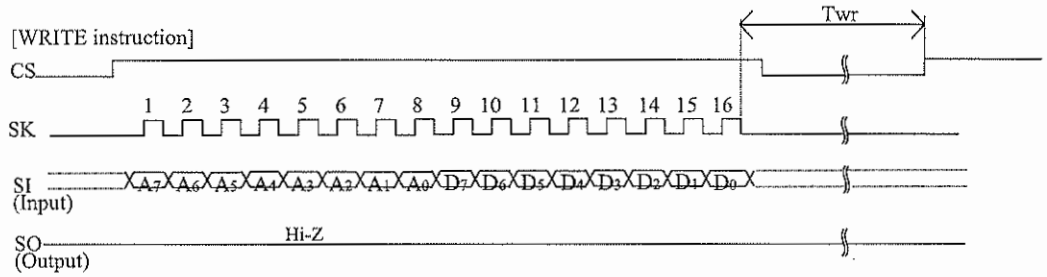
ETSN, EVRE, ESNX, ESNY, and ESNZ contain individual values adjusted factory-test. So, these data must not be rewritten.

WRAL is an address used for testing, so it must not be used in measurement operation. If this address is accessed, the same data is written to all EEPROM addresses except 2EH and 2FH.

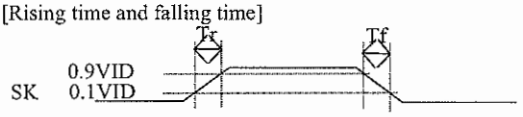
At other than the above addresses, the EEPROM circuit of the AK8970N does not operate.

Detail Timing

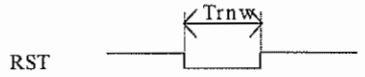




[Rising time and falling time]



[RSTN pulse width]



Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
CS setup time	Tcs		50			ns
Data setup time	Ts		50			ns
Data hold time	Th		50			ns
SK high time	Twh	VID ≥ 2.5V	100			ns
SK low time	Twl	2.5V > VID ≥ 1.75V	150			ns
SK setup time	Tsd		50			ns
SK → SO delay time *1)	Tdd		5		50	ns
CS → SO delay time *1)	Tcd				50	ns
SK rising time *2)	Tr				100	ns
SK falling time *2)	Tf				100	ns
CS low time	Tcl		200			ns
Programming time	Twr		10			ms
RSTN pulse width	Trnw		100			ns

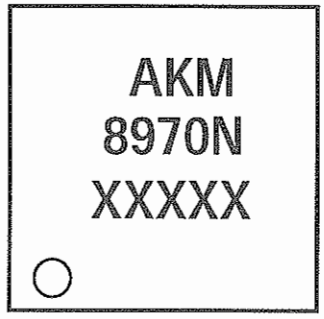
*1) SO load capacitance: 20pF

*2) These parameter values are sample values; all values are not tested.

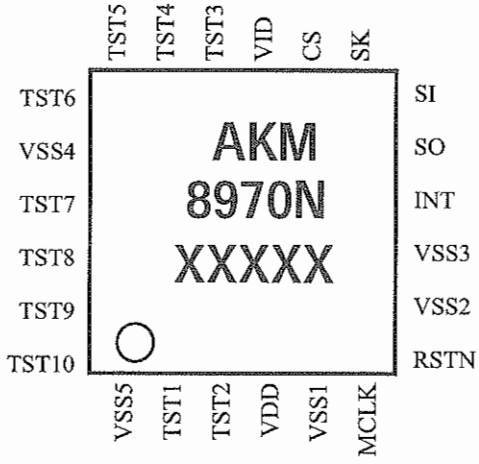
Package

■ Marking

- Company logo : AKM
- Product name : AK8970N
- Date code : $X_1X_2X_3X_4X_5$
  X_1 = Lowest 1 digit of the year
  X_2X_3 = Week
  X_4 = Alphabet assigned starting with A on a weekly basis
  X_5 = Assembly company code



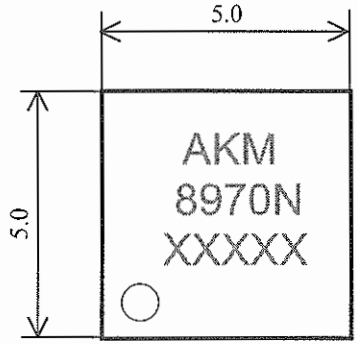
■ Pin assignments

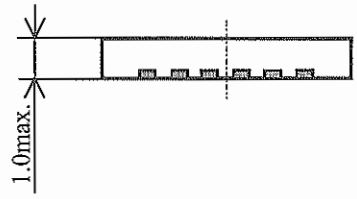


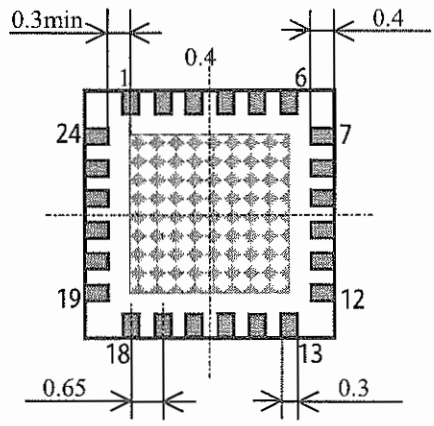
(TOP VIEW)

■ Outline dimensions

Unit: mm







: Contact pin

: Outcrop area of leadframe rear face
(Do not connect)

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