YAS532B

MS-3R

Magnetic Field Sensor Type 3R

■ Overview

The YAS532B is a 3-axis geomagnetic sensor device with the following circuits integrated on one chip: a buffer amplifier, an AD converter, a clock generator circuit, and a serial data interface circuit (compliant with I^2C bus interface).

The YAS532B allows a compact electronic compass with high sensitivity and low power consumption in mobile phones or mobile GPS systems.

YAMAHA CORPORATION

YAS532B Catalog
CATALOG No. LSI-4AS532B40
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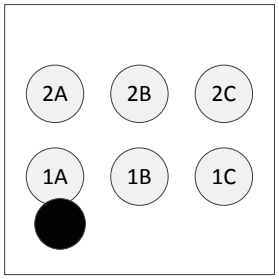
■ Features

- 3-axis magnetic sensors and peripheral circuits integrated on one chip
- High sensitivity geomagnetic sensors
- Supports the I^2C bus interface (100kbps/400kbps, slave mode)
- Small footprint with the small-sized package
- Automatic power-down control after the acquisition, and low-power consumption
- Reduced communication load with a host controller via deferred acquisition and interrupt outputs

Package	Lead-free 6-ball WLCSP (YAS532B-PZ)	
Size	1.46mm × 1.46mm	
Power Supply	Core supply voltage (VDD)	1.7V to 3.6V
	Digital interface supply voltage (IOVDD)	1.7V to VDD
Operating Temperature	−40°C to +95°C	
Current Consumption	4mA (VDD=2.6 V, during the acquisition)	
	32μA (Average consumption in 8Hz)	
Magnetic Sensor	Manufacturing process	CMOS＋Magnetic Sensor
	Maximum measurable magnetic field	1200 μT
	Magnetic field sensitivity (X, Y)	0.15 μT/count
	Magnetic field sensitivity (Z)	0.25 μT/count
	Acquisition Time	1 ms (Magnetic sensor acquisition + Temperature acquisition)

■ Pin Assignments

The figure below shows the pin assignment and its description:



< 6-pin WLCSP Top View >

Pin No.	Pin Name	I/O	Function
1A	INT	O	Interrupt output pin
1B	VSS	-	GND
1C	SDA	Is/Od	Serial data
2A	IOVDD	-	Interface power supply (Typ. 1.8V)
2B	SCL	Is	Serial clock
2C	VDD	-	Core power supply (Typ. 2.6V)

Is : Schmitt trigger input
Od : Open-drain output
O : Output

■ Pin Descriptions

- Power supply pins (VDD, IOVDD, VSS)

  These are power supply pins:

  VDD : Core power supply (Typ. 2.6V)

  IOVDD : Interface power supply (Typ. 1.8V)

  VSS : GND

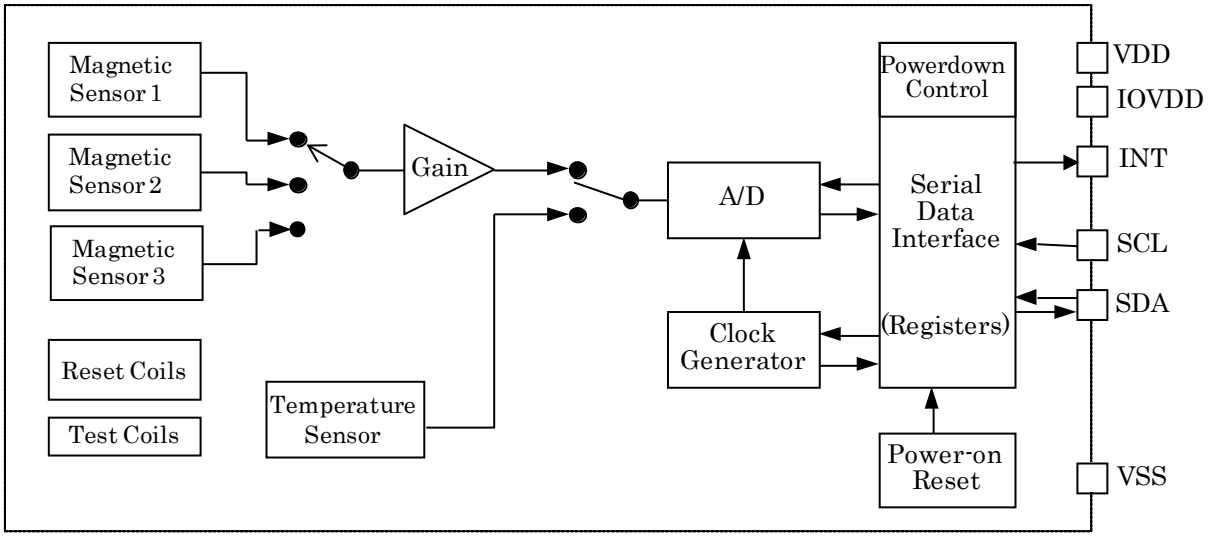
- Interface pins (SCL, SDA, INT)

  SCL : Serial clock input pin
  Pull up this pin externally.

  SDA : Serial data input and output pin
  Pull up this pin externally.

  INT : Interrupt output pin. An interrupt signal is sent through this output pin when the acquisition is completed. A high or low level output can be select with the configuration registers.
  Leave this pin open when not used.

■ Block Diagram



Block Diagram

- **Magnetic Sensor**

  Three magnetic sensors are on the chip.
  The supply voltage is supplied only to the sensor corresponding to the axis to be measured.

- **Buffer Amplifier**

  The buffer amplifier, operating only when measuring the magnetic field, amplifies the magnetic sensor output.

- **Temperature Sensor**

  The temperature sensor, operating only when measuring the temperature, can be used to compensate for the temperature characteristics of the sensor.

- **A/D Converter (ADC)**

  The ADC, operating only when measuring the magnetic field, transforms the magnetic sensor output amplified with the buffer amplifier or the temperature sensor output, to the digital form.

- **Clock Generator**

  The clock generator, operating only when measuring the magnetic field or the temperature, supplies clocks to the ADC and the digital circuits.

- **Power-on Reset Circuit**

  The power-on reset circuit detects the ramp-up of the core supply voltage and resets the internal circuit.

- **Reset Coils**

  The Reset coils are used to restore the function of a damaged magnetic sensor because of the high magnetic field received.
  Generating magnetic field with the reset coils restores the magnetic sensor characteristics.

- **Serial Data Interface**

  The YAS532B serial data interface is compliant with I^2C bus interface and operates in slave mode.
  Data are transferred via the following pins:
  SCL— Serial clock input pin
  SDA— Serial data input and output pin

■ Electrical Characteristics

● Absolute Maximum Ratings

Item	Symbol	Min.	Typ.	Max.	Unit
Core Supply Voltage	VDD	-0.3		4.2	V
Interface Supply Voltage	IOVDD	-0.3		4.2	V
Digital Input Pin Voltage (SCL, SDA)	VIND1	-0.3		4.2	V
Storage Temperature	Tstg	-50		125	°C
Maximum Applicable Magnetic Field	Hmax			500	mT

● Recommended Operating Conditions

Item	Symbol	Min.	Typ.	Max.	Unit
Core Supply Voltage	VDD	1.7	2.6	3.6	V
Interface Supply Voltage	IOVDD	1.7	1.8	VDD	V
Operating Ambient Temperature	Top	-40	25	95	°C

● Drawn Currents

Item	Min.	Typ.	Max.	Unit
Standby Current (TOP=25°C, SCL=SDA= IOVDD=VDD=3.0V)			1	μA
Standby Current (TOP=95°C, SCL=SDA= IOVDD=VDD=3.0V)			10	μA
Current drawn from IOVDD during communication		1		μA
Current drawn from VDD during magnetic field acquisition * See Note.		4.0		mA
Current drawn from VDD during temperature acquisition * See Note.		2.0		mA
Current drawn from VDD (Reset coil is ON)		50		mA

Note: After the acquisition the device automatically powers down to enter the standby state.

● Magnetic Sensor Characteristics

(Conditions: TOP = 25°C, VDD = 2.6 V)

Item	Min.	Typ.	Max.	Unit
Maximum Measurable Magnetic Field		1200		μT
Magnetic Field Sensitivity (X,Y)		0.15		μT/count
Magnetic Field Sensitivity (Z)		0.25		μT/count
Sensitivity Axis Deviation			±5	deg

Note: Y and Z sensitivities are for Y1-Y2 and Y1+Y2, respectively. And, the sensitivity axis deviation is for the value corrected with CAL register values. For details, see the application manual.

● Temperature Sensor Characteristics

(Conditions: see "Recommended Operating Conditions")

Item	Min.	Typ.	Max.	Unit
Temperature Acquisition Range	-40		95	°C
Temperature Resolution		0.18		°C/count

● Acquisition Time

(Conditions: see "Recommended Operating Conditions")

Item	Min.	Typ.	Max.	Unit
Acquisition Time		1.0	1.5	ms

● DC Characteristics

Serial Data Interface: SCL, SDA

(Conditions: see "Recommended Operating Conditions")

Item	Symbol	Min.	Max.	Unit
"L" level input voltage	V_{IL}	-0.3	0.3×IOVDD	V
"H" level input voltage	V_{IH}	0.7×IOVDD	IOVDD+0.3	V
"L" level output voltage (sink current 3mA)	V_{OL}	0	0.2×IOVDD	V
Input leakage Current at the input voltage of 0.1 × IOVDD to 0.9 × IOVDD	I_i	-1	1	μA
Input Capacitance	Ci		10	pF

Interrupt Output INT

(Conditions: see "Recommended Operating Conditions")

Item	Symbol	Min.	Typ.	Max.	Unit
"L" level output voltage (IOL=1mA)	V_{OL}			0.2×IOVDD	V
"H" level output voltage (IOH=-1mA)	V_{OH}	0.8×IOVDD			V

● AC Characteristics

The table below shows the rules on the power supply power-on sequence.

(Conditions: see "Recommended Operating Conditions")

Item	Symbol	Min.	Max.	Unit
Power Supply Ramp Up Time	TVON		10	ms
Time from when all the power supplies are completely powered up till when the I^2C interface becomes available	TDOP		4	ms

When applying IOVDD first, and then VDD:

- Access to the I^2C bus is not allowed while IOVDD is ramping up to its operating range.
- Access to the I^2C bus is not allowed while VDD is ramping up to its operating range.

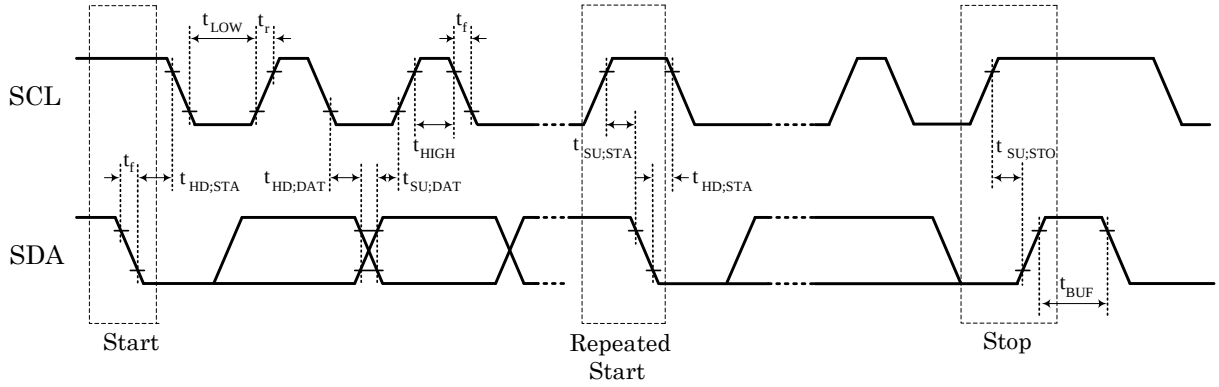
Otherwise, there are no restrictions on the I^2C bus access.

Serial Data Interface: SCL, SDA

(Conditions: see "Recommended Operating Conditions")

Item	Symbol	Min.	Max.	Unit
SCL Clock Frequency	f_{SCL}	0	400	kHz
Hold Time (repeat) Start Condition	$t_{HD;STA}$	0.6		μs
SCL Clock "L" Time	t_{LOW}	1.3		μs
SCL Clock "H" Time	t_{HIGH}	0.6		μs
Setup Time of the repeat start conditions	$t_{SU;STA}$	0.6		μs
Data Hold Time	$t_{HD;DAT}$	0	0.9	μs
Data Setup Time	$t_{SU;DAT}$	0.1		μs
SDA and SCL signals rise time (input)	t_r		300	ns
SDA and SCL signals fall time (input)	t_f		300	ns
SDA signal fall time (output)	t_{of}	$20+0.1\times C_b$	250	ns
Stop Condition Setup Time	$t_{SU;STO}$	0.6		μs
Bus Free Time between stop and start conditions	t_{BUF}	1.3		μs
SDA and SCL Capacitive Load	C_b		400	pF

C_b: Load capacitance for each bus line (pF)



Serial Data Interface Timing Specification

[Notes]

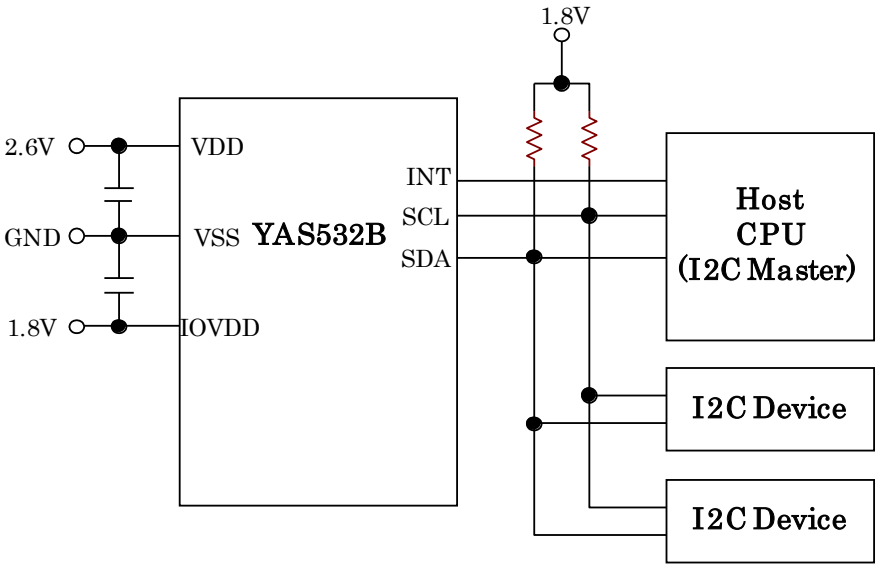
- **YAS532B serial data interface is compliant to I^2C bus as far as described in this document.**
- **Spike noise with the width of about 50ns can be suppressed.**

■ System Configuration Examples

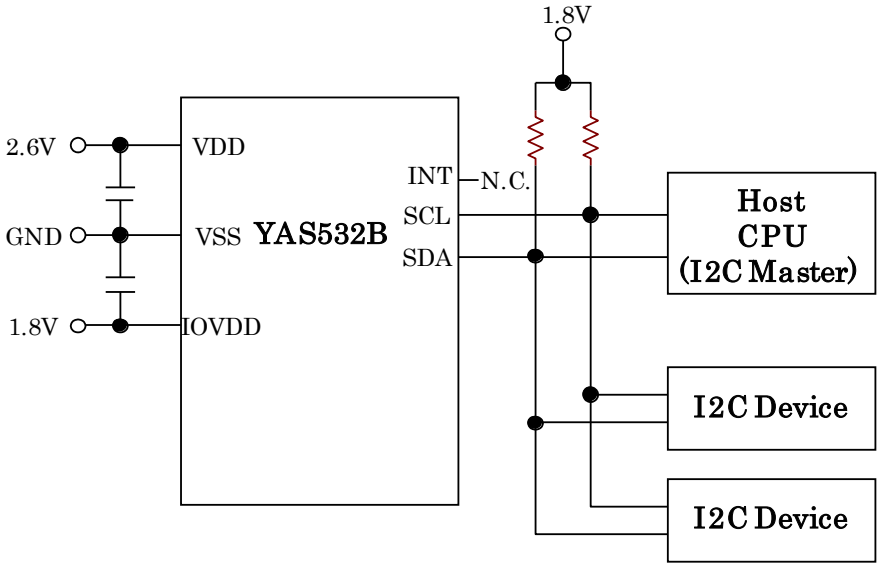
The figure below shows an example of the application.

Leave the INT pin open (N.C.) when not used.

Note: For a geomagnetic sensor to deliver its performance, its placement on the board needs to be carefully designed. Contact Yamaha sales staff for details.



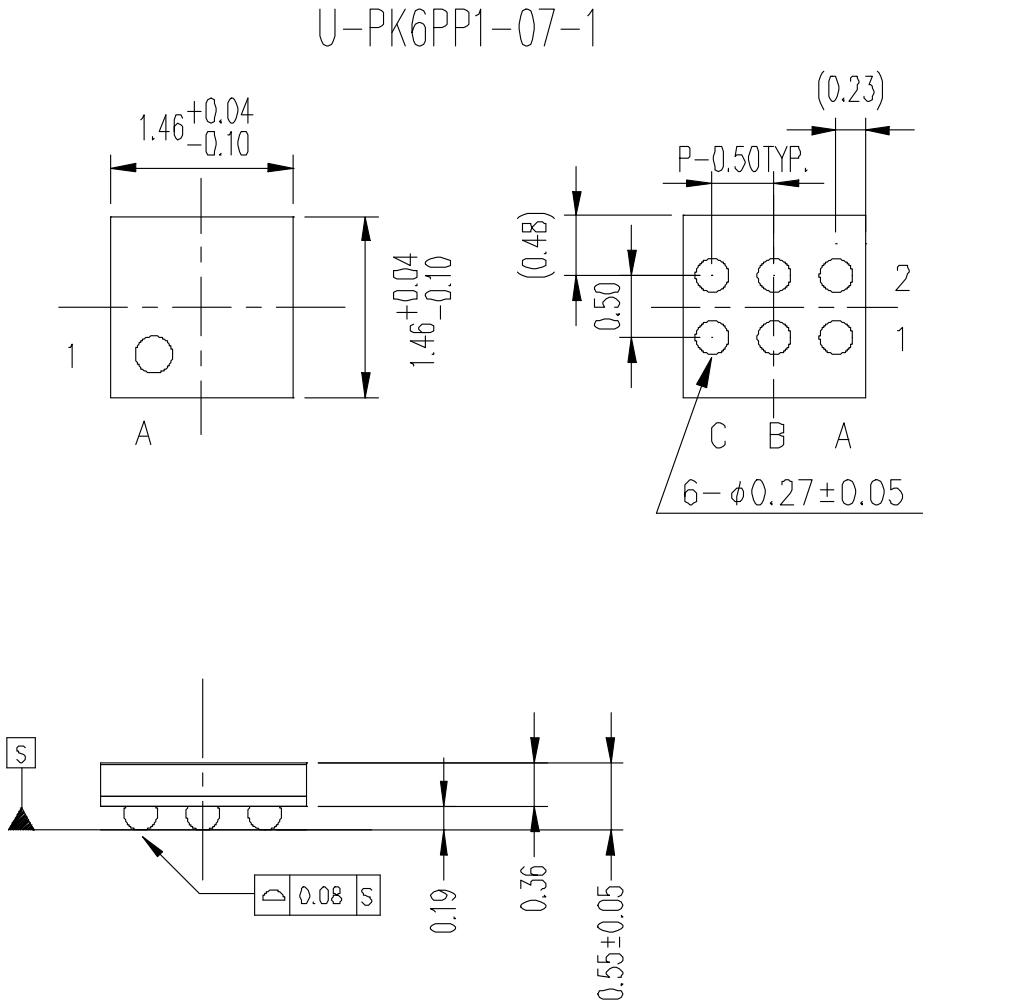
Example 1 (INT pin used)



Example 2 (INT pin not used)

■ Package Information

Caution
The product of the WLCSP package should be used under light-shielded conditions.
Since the WLCSP package has a structure that a silicon wafer is exposed, if light (such as sunlight) hits the wafer, the device may malfunction (leak current increase etc.) due to electric charge internally generated by the photoelectric effect.



カッコ内の寸法値は参考値とする。
The value parenthesized is not specified.

外形寸法はバリを含みます。
Dimensions include burr.

UNIT: mm

注） 1. 表面実装LSIは、保管条件、および、半田付けについての特別な配慮が必要です。
2. 組立工場により、寸法や形状などが異なる場合があります。
詳しくはヤマハ代理店までお問い合わせください。

Note: 1. Special attention needs to be paid to the storage conditions and soldering method of the surface mount IC.
2. Dimension, form, etc. may differ depending on assembly plants.
For details, please contact your local Yamaha agent.

PRECAUTIONS AND INSTRUCTIONS FOR SAFETY

	WARNING
Prohibited	Do not use the device under stresses beyond those listed in Absolute Maximum Ratings. Such stresses may become causes of breakdown, damages, or deterioration, causing explosion or ignition, and this may lead to fire or personal injury.
Prohibited	Do not mount the device reversely or improperly and also do not connect a supply voltage in wrong polarity. Otherwise, this may cause current and/or power-consumption to exceed the absolute maximum ratings, causing personal injury due to explosion or ignition as well as causing breakdown, damages, or deterioration. And, do not use the device again that has been improperly mounted and powered once.
Prohibited	Do not short between pins. In particular, when different power supply pins, such as between high-voltage and low-voltage pins, are shorted, smoke, fire, or explosion may take place.
Instructions	As to devices capable of generating sound from its speaker outputs, please design with safety of your products and system in mind, such as the consequences of unusual speaker output due to a malfunction or failure. A speaker dissipates heat in a voice-coil by air flow accompanying vibration of a diaphragm. When a DC signal (several Hz or less) is input due to device failure, heat dissipation characteristics degrade rapidly, thereby leading to voice-coil burnout, smoking or ignition of the speaker even if it is used within the rated input value.

	CAUTION
Prohibited	Do not use Yamaha products in close proximity to burning materials, combustible substances, or inflammable materials, in order to prevent the spread of the fire caused by Yamaha products, and to prevent the smoke or fire of Yamaha products due to peripheral components.
Instructions	Generally, semiconductor products may malfunction and break down due to aging, degradation, etc. It is the responsibility of the designer to take actions such as safety design of products and the entire system and also fail-safe design according to applications, so as not to cause property damage and/or bodily injury due to malfunction and/or failure of semiconductor products.
Instructions	The built-in DSP may output the maximum amplitude waveform suddenly due to malfunction from disturbances etc. and this may cause damage to headphones, external amplifiers, and human body (the ear). Please pay attention to safety measures for device malfunction and failure both in product and system design.
Instructions	As semiconductor devices are not nonflammable, overcurrent or failure may cause smoke or fire. Therefore, products should be designed with safety in mind such as using overcurrent protection circuits to control the amount of current during operation and to shut off on failure.
Instructions	Products should be designed with fail safe in mind in case of malfunction of the built-in protection circuits. Note that the built-in protection circuits such as overcurrent protection circuit and high-temperature protection circuit do not always protect the internal circuits. In some cases, depending on usage or situations, such protection circuit may not work properly or the device itself may break down before the protection circuit kicks in.
Instructions	Use a robust power supply. The use of an unrobust power supply may lead to malfunctions of the protection circuit, causing device breakdown, personal injury due to explosion, or smoke or fire.
Instructions	Product's housing should be designed with the considerations of short-circuiting between pins of the mounted device due to foreign conductive substances (such as metal pins etc.). Moreover, the housing should be designed with spatter prevention etc. due to explosion or burning. Otherwise, the spattered substance may cause bodily injury.
Instructions	The device may be heated to a high temperature due to internal heat generation during operation. Therefore, please take care not to touch an operating device directly.

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