IST8310
3D Magnetometer

Datasheet

Table of Contents

1. General Description

iSentek IST8310 is a 3-axis digital magnetometer with a 3.0 x 3.0 x 1.0 mm^3, 16-pin LGA package. It is an integrated chip with 3-axis magnetic sensors, digital control logic, built-in temperature compensation circuit, and self-test function. IST8310 provides an I^2C digital output with fast mode up to 400 kHz. The high output data rate, ultra-low hysteresis, excellent temperature drift, and low noise performance features make it a perfect candidate for high precision applications.

Features

- High sensitivity of up to 330 LSB/Gauss.
- I^2C slave, Fast Mode up to 400 kHz
- 14 or 16 bits adjustable data output
- Wide dynamic range of ±1600 μT (X, Y-axis) and ±2500 μT (Z-axis)
- High output data rate of maximum 200 Hz
- Ultra-low hysteresis (< 0.1 %FS)
- Ultra-low sensitivity temperature drift (±0.016 %/°C)
- Ultra-low offset temperature drift (0.024 uT/°C)
- Wide operating temperature range (-40 ~ 85 °C)
- High precision temperature compensation
- Built-in self-test function
- Software and algorithm support are available (for tilt compensation, cross-axis compensation, soft/hard-iron calibration and noise suppression)
- RoHS, HF and TSCA compliant

Applications

- Quadcopter/Drone Applications
- Augmented Reality Applications
- Virtual Reality Applications
- Location Based Services
- Navigation Applications
- Industrial Applications
- Magnetometry
- IoT devices
- Heading
- Gaming

2. Block Diagram, Package Dimension and Application Circuit

2.1. Block diagram

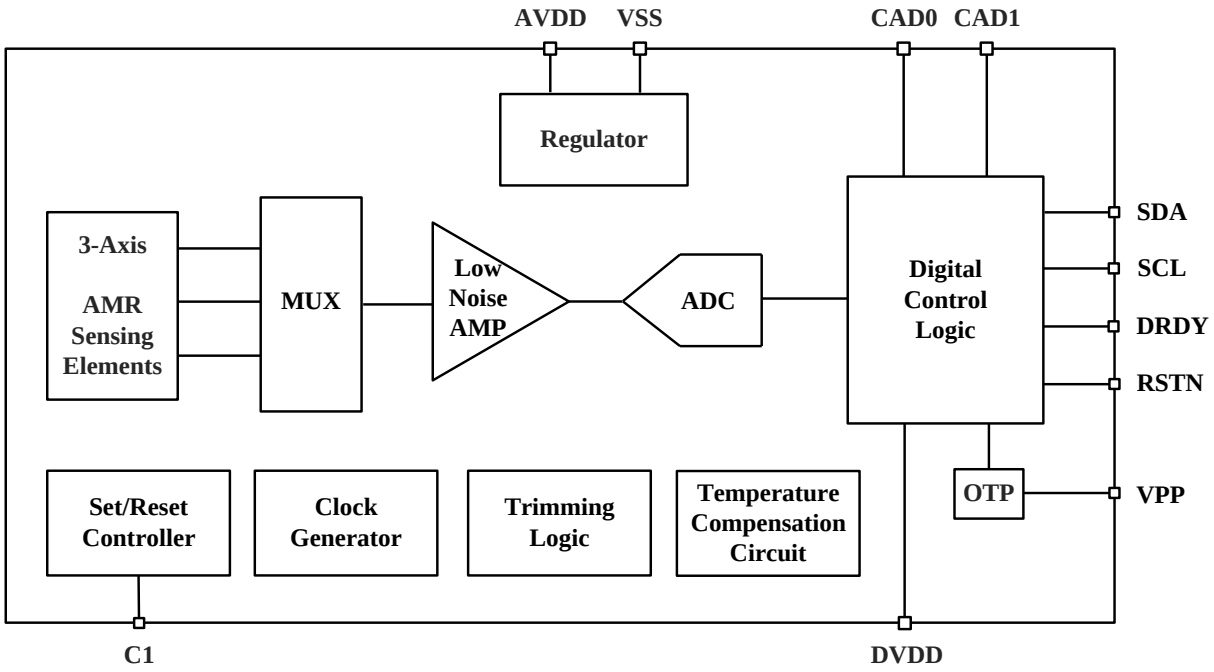
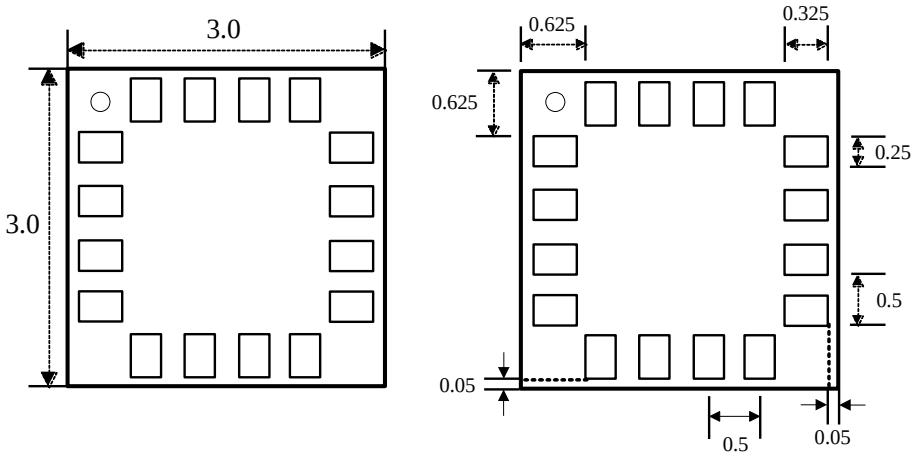


Figure 1. Block Diagram

2.2. Package Dimensions and Pin Description

IST8310 LGA Top View (Looking Through)

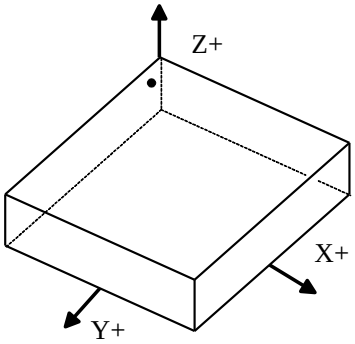


Unit: mm

Tolerance: ±0.1 mm

IST8310 LGA Side View

IST8310 3D Top View



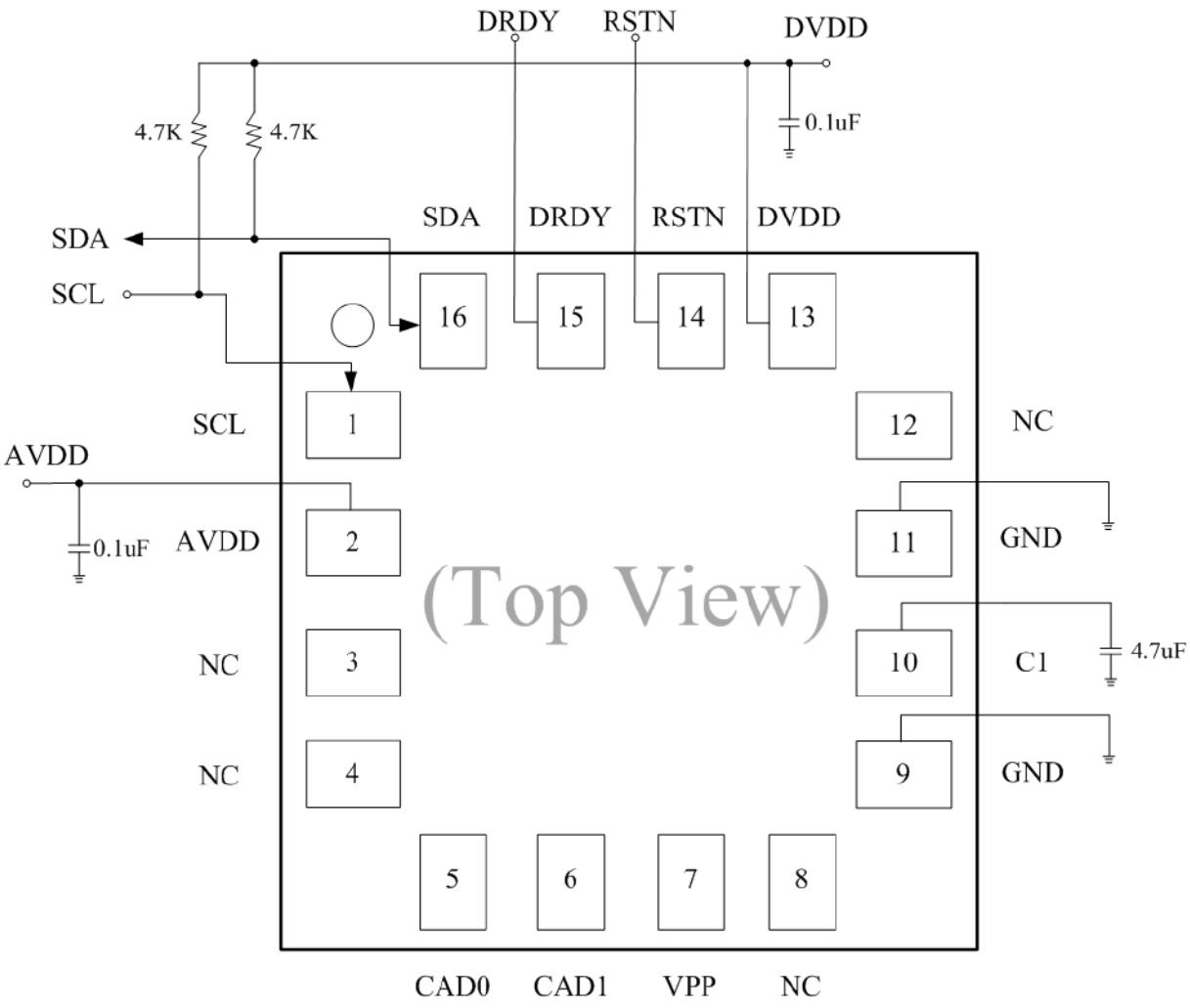
Unit: mm

Tolerance: ±0.1 mm

Pin	Name	Function
1	SCL	I^2C serial clock
2	AVDD	Analog supply voltage, 1.72 ~ 3.6 V
3	NC	Not use
4	NC	Not use
5	CAD0	I^2C slave address
6	CAD1	I^2C slave address
7	VPP	Test pin, connection to DVDD is suggested, Otherwise can be floating.
8	NC	Not use
9	VSS	GND
10	C1	Set/Reset function, 4.7 uF
11	VSS	GND
12	NC	Not use
13	DVDD	Digital supply voltage, 1.72 ~ 3.6 V
14	RSTN	Reset pin, resets registers by setting it to “Low”. Internally pulled to “High” for floating connection. MCU connection is suggested.
15	DRDY	Data ready indication, output pin only
16	SDA	I^2C serial data

*please refer to Figure 2.

2.3. Application Circuit



Slave Address Select

CAD0	CAD1	Address (7-bit)	Address (8-bit)	IO leakage*1
GND	GND	0CH*2	18H*2	0uA
DVDD	GND	0DH	1AH	46uA
GND	DVDD	0EH	1CH	46uA
DVDD	DVDD	0FH	1EH	92uA

*1: Potential difference leads to IO leakage.
*2: If CAD1 and CAD0 are floating (default), I^2C address will be 0CH/18H.

Figure 2. Application Circuit

3. Operational Modes and Functional Descriptions

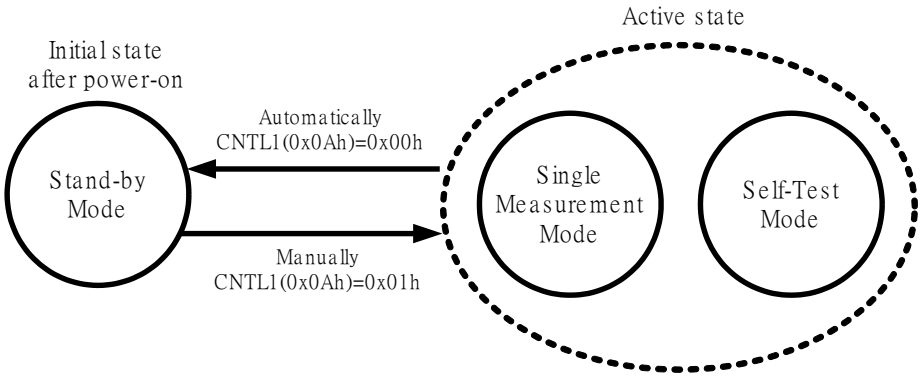
3.1. Operation modes

IST8310 has following operation modes:

(1) Standby Mode

(2) Single Measurement Mode

(3) Self-Test Mode



3.1.1. Standby Mode

The initial mode (after power on) of IST8310 is Standby Mode. In Standby Mode, all internal circuits are off (except oscillator and regulator) and all registers are accessible. The latest state of data saved in Read/Write registers is maintained. Registers can be reset by soft reset or hard reset (through RSTN pin). As initial setting, please set Pulse Duration Control Register, PDCNTL(0x42h) = 0xC0h for performance optimization.

3.1.2. Single Measurement Mode

When user writes 0x01h into Control Register 1, CNTL1(0x0Ah), IST8310 enters Single Measurement Mode and starts a single-time measurement. In Single Measurement Mode, the measured data are stored in data registers before IST8310 automatically transitions to Standby Mode. When entering Standby Mode, CNTL1(0x0Ah) turns to 0x00h automatically. Simultaneously, DRDY bit in STAT1 register turns to “1”. This is called “data ready”. When any of the measurement data registers or STAT2 register is read, DRDY bit turns to “0”. For the next measurement, user must write 0x01h into CNTL1(0x0Ah) again.

The default minimum interval between measurements is 5 ms (ODR = 200 Hz). For lower noise performance, set Average Control Register, AVGCNTL(0x41h) to 0x24h (in Standby Mode) for 16x average times setup; the minimum interval between two measurements in this setup is 6 ms (ODR = 166

Hz).

Please be aware that with the IST8310, ultra-low noise performance can be obtained through soft-averaging in driver. Please contact iSentek for technical details.

3.1.3. Self-Test Mode

Self-Test Mode is used to validate the accuracy of the 3-axis outputs read in Single Measurement Mode. It is activated by setting Self-Test Register, STR(0x0Ch) to 0x40h; then all 3-axis outputs will change their polarity. User is able to compare the 3-axis output values before and after activating Self-Test Mode; if the absolute values are the same, then the IC is working correctly. This feature can be disabled by setting STR(0x0Ch) to 0x00h. Please set Temperature Compensation Control Register, TCCNTL (0x40h) to 0x01h to disable the temperature compensation function to prevent incorrect compensation when using this self-test function, and then set it back to 0x00h in real measurement.

3.2. Interrupt Function

Interrupt function is used when there is a strong external magnetic field in the surrounding. When the absolute sum of measured 3-axis output values exceeds 1600 μT, the INT flag is activated. The INT flag is located in STAT2 register.

3.3. DRDY Function

DRDY function is used when the output data is updated. The DRDY pin is used for monitoring the data ready output. After reading data from the output register, DRDY becomes low.

4. Electrical Specifications

4.1. Absolute Maximum Ratings

Parameter	Symbol	Limits	Unit
Storage Temperature	TSTG	-40 to +150	°C
Analog Supply Voltage	AVDD	-0.5 to +3.6	V
Digital Supply Voltage	DVDD	-0.5 to +3.6	V
Digital Input Voltage	VIN	-0.3 to DVDD + 0.3	V
Electrostatic Discharge Voltage*[1]	VESD_HBM	-4000 to 4000	V
Electrostatic Discharge Voltage*[2]	VESD_MM	-350 to 350	V
Reflow Classification	JESD22-A113 with 260 ˚C Peak Temperature		

1. Human Body Model (HBM)

2. Machine Model (MM)

4.2. Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Operating Temperature	TA	-40		+85	°C
Analog Supply Voltage	AVDD	1.72	2.8	3.6	V
Digital Supply Voltage	DVDD	1.72	1.8	3.6	V

4.3. Electrical Specifications

(Operating conditions: TA = +25 °C; AVDD = 2.8 V; DVDD = 1.8 V; 4.7 µF ceramic capacitors tied to C1 pin with maximum allowed line width and 5 mm distance.)

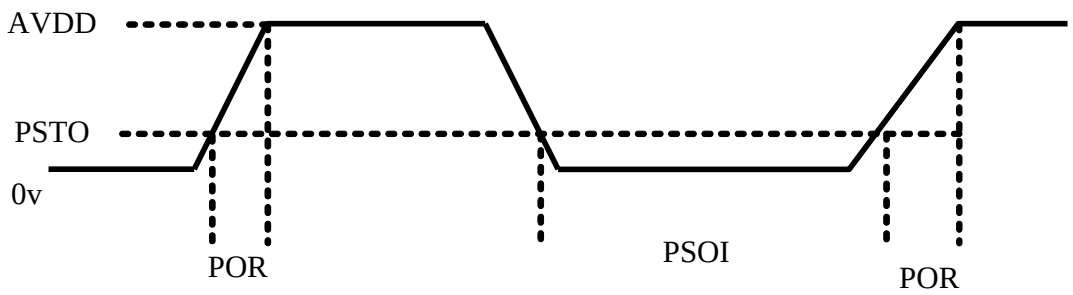
Parameter	Symbol	Conditions	Min.	Typ.	Max	Unit
Operating Current	IDD3A	Full operation, at 1 sps 8 sps 10 sps 20 sps 50 sps 100 sps 200 sps		 20 72 80 140 320 600 1200		uA
Standby Current	ISTB			10		uA
Output Data Rate (ODR)	ODR		1		200	Hz
Input Low Voltage	VIL		0		DVDD *30%	V
Input High Voltage	VIH		DVDD *70%		DVDD	V
Output Low Voltage	VOL	IOL = +4 mA	0		DVDD *20%	V
Output High Voltage	VOH	IOH = -100 uA (Except SCL and SDA)	DVDD *80%		DVDD	V

4.4. Magnetic Sensor Specifications

(Operating conditions: TA = +25 ℃; AVDD = 2.8 V; DVDD = 1.8 V; 4.7 μF ceramic capacitors tied to C1 pin with maximum allowed line width and 5 mm distance.)

Parameter	Symbol	Condition	Min.	Typ.	Max	Unit
Dynamic Range	MDR_XY	TA = 25 °C		±1600		uT
	MDR_Z	TA = 25 °C		±2500		
Linearity	LIN	X-axis		1	1.5	%FS
		Y, Z-axis		0.1	0.5	
Resolution	RESO			0.3		uT/LSB
Sensitivity	SEN			3.3		LSB/uT
Zero Gauss Offset	ZGD	RMS value		±0.3		uT
Hysteresis	HS			0.1		%FS
Sensitivity Temperature Drift	TD_S	-40 ~ 85 °C		±0.016		%/°C
Zero-B Offset Temperature Drift	TD_O	-40 ~ 85 °C		0.024		uT/°C

4.5. Power On Reset (POR) Specifications



PSTO: Power Supply Turn Off voltage
PSOI: Power Supply Turn Off Interval
POR: Power On Reset

PSTO: max=0.1volt
PSOI: min=10ms
POR: max:50ms

When POR circuit detects a rise of AVDD voltage, it resets all internal circuits and initializes all registers. After reset, IST8310 transits to Standby mode.

5. Technology Overview

5.1. AMR Technology

IST8310, an iSentek patented magnetometer is designed based on Anisotropy Magnetoresistance (AMR) technology. The output is generated by the resistance change of the AMR resistors as the external magnetic field varies. The sensitivity is approximately 50 to 200 times greater than conventional Hall elements. The high sensitivity allows a higher output data rate (ODR), lower noise, and lower power consumption.

5.2. High Reliability Planarized Structure Design

IST8310 consists of three full Wheatstone Bridges of AMR resistors. The three bridges detecting magnetic components in three orthogonal directions are wire-bonded to a control ASIC on a single chip. This planarized structure design enables outstanding stability to thermal shock, making our device highly reliable, whereas other known AMR magnetometers with z-axis sensors placed vertically on the substrate using 90-degree flip-chip packaging suffer from reliability issues.

5.3. Ultra-low Hysteresis Design

iSentek has developed a specialized high permeability (μ) material for magnetic field detection. This high-μ material has ultra-low residual magnetization below 0.1 %FS in the field range as large as ±500G. The ultra-low hysteresis design prevents the magnetometer from experiencing dynamic offset after encountering a strong external magnetic field impact; that is, the angular accuracy is restored automatically without calibration after the removal of interference field. This feature fulfills the requirements for applications when real-time calibration is unavailable. No calibration is required in general conditions.

5.4. Magnetic Setting Mechanism

AMR sensing resistors consist of permalloy thin film and metallization. Permalloy is a soft magnetic material. Irreversible magnetic rotation may occur when the strength of external magnetic field exceeds half of the anisotropy field of the sensing resistor, resulting in angular error induced by offset. To solve this issue, a magnetic setting mechanism has been introduced in IST8310. A magnetic field is generated within IST8310 to align the magnetization of AMR sensing resistors before every measurement. This auto-zeroing mechanism ensures the stability of IST8310's angular accuracy throughout the operation.

6. Ordering Information

Order Number	Package Type	Packaging	Marking Information
IST8310	LGA – 16 pin	Tape and Reel: 5k pieces per reel	$X_1X_2X_3$0 010● X_1: Last number of the year X_2X_3: Week number 010: Product code of IST8310

For more information on iSentek's magnetic sensors, please send an email to sales@isentek.com or visit our website at www.isentek.com.

US Patent 9,297,863, Taiwanese Patents I437249, I420128 and I463160 apply to our magnetic sensor technology described.

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