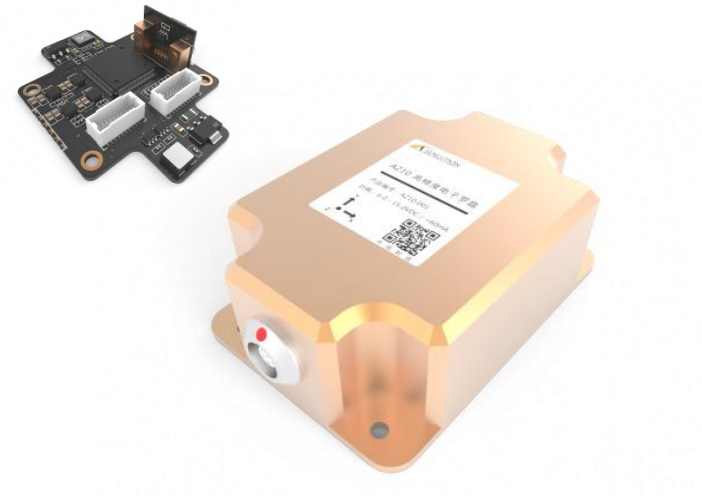
SENLUTION

Azimuth™ Gyro-Stabilized Digital Magnetic Compass

Azimuth™ – AZ 10

FEATURES

- Precision compass accuracy
  - ✧ nominal heading accuracy: 0.5°
  - ✧ resolution: 0.1°
  - ✧ soft iron / hard iron compensation
- Precision tilt angle / roll angle accuracy
  - ✧ static accuracy: 0.2°
  - ✧ resolution: 0.05°
  - ✧ no “dead zone”, full range computation
- Embedded gyroscope & stabilizing algorithm
  - ✧ magnetic anomaly detection
  - ✧ effects of magnetic disturbances reduced
- Simple user compensation routine
  - ✧ Compensate for soft / hard iron after installation in field
  - ✧ Compensate for installation errors
  - ✧ Zero in with user chosen orientation
- Ultra compact (70mm X 50mm X 25mm)
- Low power consumption (<0.5W)
- Rugged & Highly reliable, China Military standards
  - ✧ GJB150.3/150.4 high / low temperature test
  - ✧ GJB151A /152A EMC test
  - ✧ GJB 150.16 vibration test
- Each unit fully compensated for temperature, non orthogonality, soft & hard iron and cross axis coupling errors
- Highly reliable 9 pin ODU self locking connector
- Flexible data interface available
  - ✧ 1 channel of RS-232 (optional)
  - ✧ 2 channels of RS-485
  - ✧ data update rate 100Hz
- Can fully substitute for Honeywell HMR3600 series wherever applicable



APPLICATION

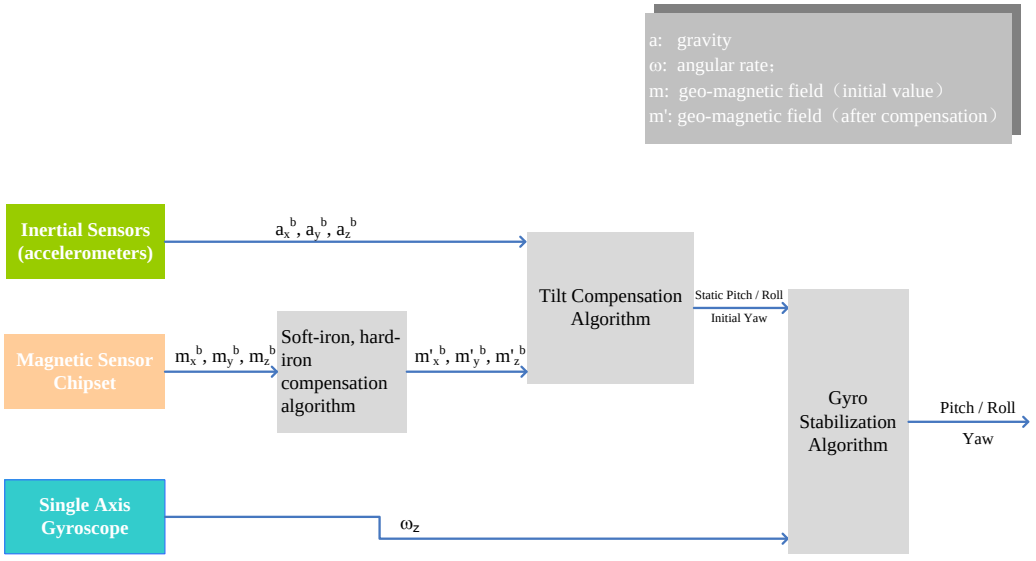
- Aviation control system (UAV / Fixed-wing / Rotor, etc.)
- Ground vehicle control system (UGV, etc.)
- Surface vehicle control system (USV, etc.)

General Information

Azimuth™ AZ10 miniature Electronic Compass system (e-compass) is a highly sophisticated system measuring a rigid body's heading angle and static pitch / roll angles. It consists of a set of magnetic sensors, accelerometers and gyroscopes, all based on the state of of MEMS technology (MEMS: Micro Electro Mechanical System). The system is running an embedded soft iron & hard iron real time auto-calibration algorithm so that an accurate heading information can always be obtained, no matter how the environment is interfered with external magnetic fields.

Furthermore, a sensor fusion software based on Senlution's proprietary EKF algorithm (EKF: Enhanced Kalman Filter) is also embedded, so that the system will maintain its correct heading output even when an abrupt external magnetic interference is suddenly at present. This feature has solved a long existed drawback for the e-compass system, which is susceptible to magnetic field perturbation. Meanwhile, the traditional e-compass system has long suffered from another issue, which is that the installation would introduce extra magnetic field interference so that the original out-of-factory calibration can't be kept accurate. To counter this problem, AZ-10 series has furnished the user with a simple procedure to re-calibrate the system after the installation, which includes both soft and hard iron compensation algorithms. The heading could be aligned with the magnetic north or any other type of references the user chooses.

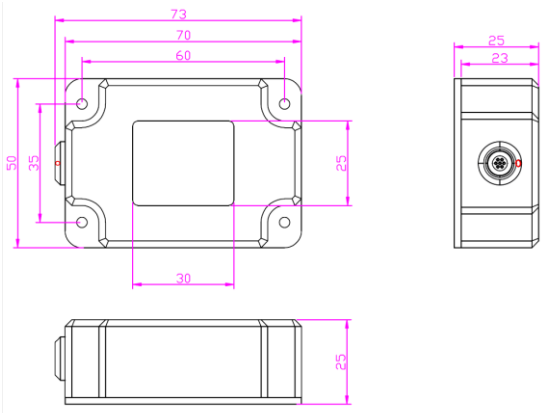
Azimuth™ AZ10 is suitable for applications ranging from aeronautics, aerospace , surface vessels, ground vehicles to other military or civil adaptations where high yaw accuracy is required but size, power budget is also limited. The system block diagram is shown below:



SPECIFICATIONS

1. Operating Conditions

Electrical	
Voltage Supply	5 – 12V
Current	≈ 80mA
Data Protocol	
Default	RS485
Optional	RS232
Update Rate	100Hz (can be customized)
Environment	
Temperature	-40 to +85°C
Water Proof Level	IP66
Mechanical	
Size	70mm X 50mm X 25mm
Weight	<150g
Main Connector	ODU/LEMO 9PIN FEMALE (ODU PART#: GL0L0C-P09LCC0-0000)
Alignment Holes	4 holes, all grounded



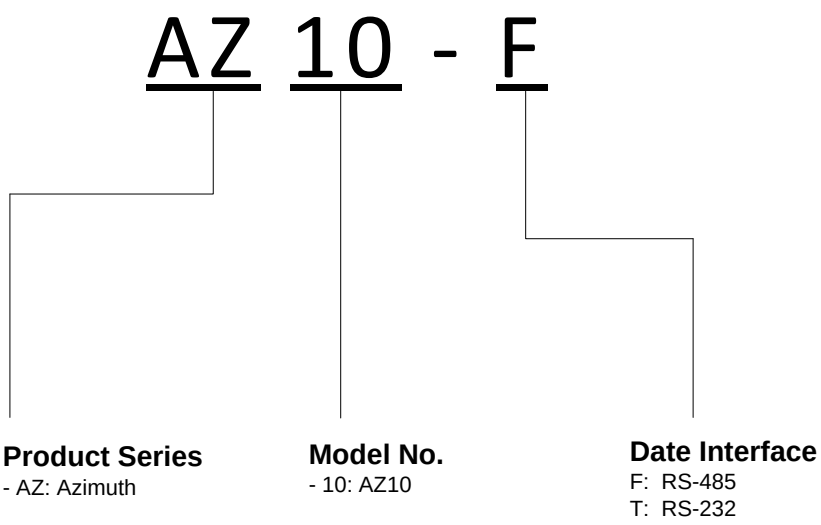
2. Individual Sensors Specifications:

	Accelerometer	Gyroscope	Magnetic Sensor
Principle	MEMS, Capacitive	MEMS, Vibrational	MEMS, AMR
Range	+/- 2g	+/- 300 deg/s	+/- 8 Gauss
Noise (RMS)	1.0 mg	0.3 deg/s	0.6 mGauss
Offset Initial Error	< 3 mg	< 0.2 deg/s	< 2 mGauss
Bias Stability	1.0 mg	18 deg/hour	
Non-linearity (%)	0.2	0.1	0.1
Bandwidth (Hz)	60	160	20

3. Individual Sensors Specifications:

Static Accuracy	
Pitch	± 0.2°
Roll	± 0.2°
Yaw	± 0.5° (homogenous magnetic field)
Resolution (RMS)	
Pitch	0.05°
Roll	0.05°
Yaw	0.1°
Measurement Range	
Pitch	± 90°
Roll	± 180°
Yaw	0 - 360 ° (± 180° optional)

ORDERING GUIDE



The following products is now available from Senlution Technologies:

Model Name	Date Interface	Support User Re-calibration	Status
AZ10-F	Dual RS-485	YES	Available
AZ10-T	Single RS-232	NO	Available

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Appendix 1：Default RS485 Protocol

Electrical Specifications：

- Baud Rate：9600
- Data Bit：8
- Stop Bit：2
- Parity：none
- Flow Control：none

RS485 channel 1: (broadcast mode, ASCII data)

The data packet is sent at 200ms interval, details as shown below:

Description	Format	Example	Unit	Remark
$PTNTHPR	string	$PTNTHPR		Message header
Yaw	Numeric	50.1	deg.	0 ～ 360
Pitch	Numeric	10.5	deg.	-90 ～ 90
Roll	Numeric	11.2	deg.	-180 ～ 180
X axis magnetic field	Numeric	40	Count	
Y axis magnetic field	Numeric	90	Count	
Z axis magnetic field	Numeric	350	Count	
X axis acceleration	Numeric	108	Count	
Y axis acceleration	Numeric	395	Count	
Z axis acceleration	Numeric	500	Count	
Checksum	Hexadecimal	*28		Checksum
Return				0D0A

Table 1: message format for broadcast mode

RS485 channel 2: (answering mode)

In this mode, user can zero the initial yaw, pitch and roll angles. Also, this mode allows user to re-calibrate the yaw computation by compensating for the local soft and hard iron interference.

The re-calibration procedures are given below:

a） Place AZ-10 on top of a level surface which the user takes as the absolute reference. Send a command of (0x88+0x22), this will reset the pitch / roll angle as 0°.

b） Send a command of (0x88+0x30+0xCF) to initiate the re-calibration process.

c） Rotate the carrier (car, plane, etc.) onto which the AZ-10 is installed, for 3 complete turns horizontally, at a moderate slow speed.

d） Send a command of (0x88+0x30+0xED) to complete the re-calibration process. At this stage, the e-compass will automatically re-calculate all the compensation parameters, store those inside the system memory and then automatically switch to broadcast mode.

e） When there exists a large amount of soft-iron or hard-iron interference, carrying out procedure from step b to e will compensate most of it, but may not be all of it due to numerical residue errors. If the desired accuracy is not fully achieved, the user may repeat the above steps (from step b to e) multiple times. The accuracy will continue to improve until it gradually converges to a theoretical maximum.

f） Align the carrier (together with AZ-10) to a direction which the user takes as the reference direction (for example, the geo-magnetic north), send a command of (0x88+0x20), this will reset the yaw as 0°.

Please note: whenever the e-compass is placed in a different carrier where magnetic interference has changed, a re-calibration procedure is highly recommended.

Binary command list:

Command Name	Binary Code	Description
Hand Shake (or data request)	0x88+0xda	After sending this command, the device returns the following data: 2 bytes of header; 2 bytes of yaw; 2 bytes of pitch; 2 bytes of roll; 2 bytes of zero; 2 bytes of ender; For details, refer to table 3 below:

Reset Yaw	0x88+0x20	Device returns: 0xaa 0x55 0xff 0x01; And the yaw angle is reset to 0;
Reset Pitch / Roll	0x88+0x22	Device returns: 0xaa 0x55 0xff 0x02; And the pitch / roll angles are reset to 0;
Auto Calibration Starts	0x88+0x30+0xcf	Device returns: 0xaa 0x55 0xff 0x02 And the re-calibration process starts
Auto Calibration Ends	0x88+0x30+0xed	Device returns: 0xaa 0x55 0xff 0x04 if re-calibration is successful; or 0xaa 0x55 0xff 0x05 if it fails;

Table 2: Response Mode Commands List

In response mode, when the hand shake data is received by the device, the device returns the following packet:

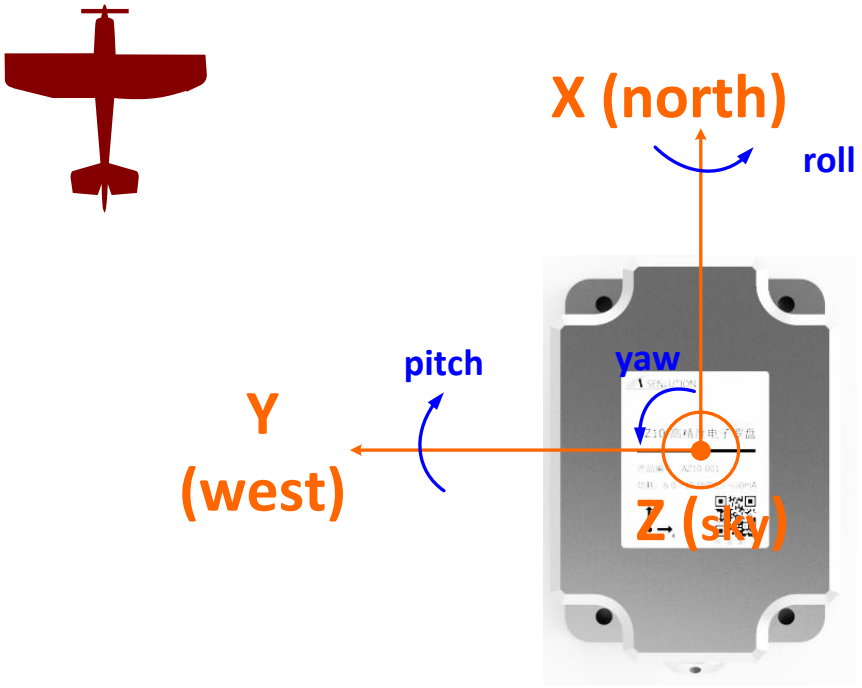
Name	Bytes	Description
Packet Header	2	0XAA,0x55
Yaw Angle	2	Float, unit: deg.
Pitch Angle	2	Float, unit: deg.
Roll Angle	2	Float, unit: deg.
Reserved	2	0X00,0x00
Packet Ender	2	0X0d,0x0a

Table 3: Data Packet in Response Mode for Data Request Command

Appendix 2： Coordinate Definition

The coordinate system used in Azimuth follows the common “EAST, WEST, SKY” convention. The detailed orientation is as follows, the direction which the arrow shows is positive:

- Pitch: positive around +Y axis (i.e. head-up is positive)
- Roll: positive around + X axis (i.e. tilt right is positive)
- Yaw: positive around + Z axis (i.e. clockwise turning, looking from the top is positive)



Top View

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