Yesense

YIS160 Series Data Sheet

IMU | VRU | AHRS | INS/GNSS Module

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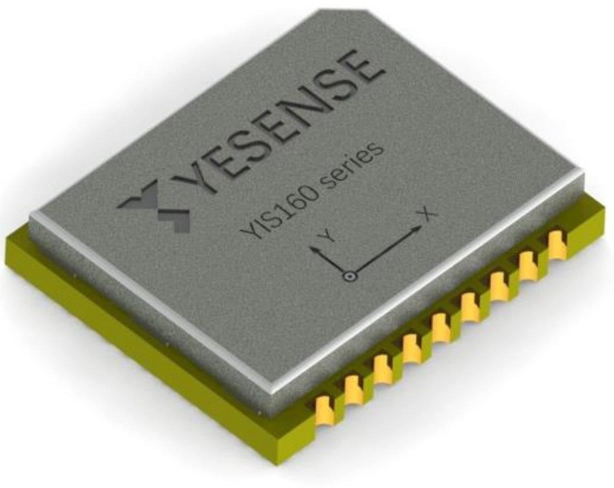

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1 General information

1.1 Description

The YIS160 series is a module outputting 3D position, 3D velocity, 3D orientation, 3D angular rates, 3D accelerations and 3D magnetic field. It is available as an Inertial Measurement Unit (IMU), Vertical Reference Unit (VRU), Attitude and Heading Reference System (AHRS) and Inertial Navigation System/ Global Navigation Satellite System (INS/GNSS).

YIS160 is compatible with JEDEC PLCC32 IC-sockets. With a roll/pitch accuracy of 0.5º RMS and yaw accuracy of 1º RMS under dynamic conditions, the output is excellent for control and stabilization of any object and navigation of e.g. unmanned vehicles.

1.2 Features

- Roll/pitch accuracy：0.5 º
- Yaw accuracy：1 º
- Fused with external GNSS and/or odometer
- Real time dynamic sensing
- YFusion® sensor fusion algorithm
- PLCC32 compatible

1.3 Applications

- Unmanned aerial vehicle control and navigation
- Robotics, pedestrian dead-reckoning
- VR/AR, HMD's and handheld devices
- Sports science analysis, assistant training

1.4 Frames of reference used in YIS160

The YIS160 series module uses a right-handed coordinate system as the basis of the sensor of frame. The following data is the output in corresponding reference coordinate systems:

Data	Symbol	Reference coordinate system
Acceleration	a_x, a_y, a_z	Sensor-fixed
Angular rate	ω_x, ω_y, ω_z	Sensor-fixed

Magnetic field	m_x, m_y, m_z	Sensor-fixed
Orientation	Pitch, roll and yaw	Local geographic coordinate system (ENU)
Velocity		Local geographic coordinate system (ENU)
Position		Local geographic coordinate system (ENU)

The sensor fixed coordinate system is shown in Figure 1:

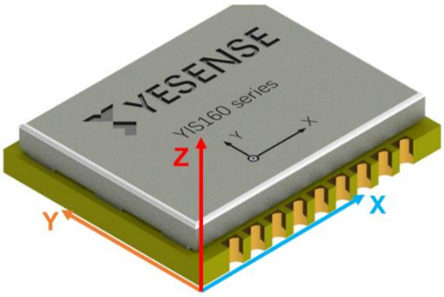

Figure 1. The sensor fixed coordinate system of YIS160

The default local geographic coordinate system is East-North-Up (ENU), and the outputs of YIS160 are default outputted with ENU reference coordinate system.

2 YIS160 series configuration

The YIS160 series is a fully-tested self-contained module that can output 3D orientation data (Euler angles (roll, pitch, yaw) and quaternions), orientation and velocity increments (Δq and Δv) and sensors data (acceleration, rate of turn, magnetic field). The YIS160 series module is available as an Inertial Measurement Unit (IMU), Vertical Reference Unit (VRU), Attitude and Heading Reference System (AHRS) and Inertial Navigation System/ Global Navigation Satellite System (INS/GNSS) .

2.1 YIS160-U (IMU)

The YIS160-U module is an Inertial Measurement Unit (IMU) that outputs 3D rate of turn, 3D acceleration and 3D magnetic field. The YIS160 also outputs coning and sculling compensated orientation increments and velocity increments (Δq and Δv). Moreover, the testing and calibration over temperature performed by Yesense result in a robust and reliable sensor module.

2.2 YIS160-V (VRU)

The YIS160-V is a 3D vertical reference unit (VRU). Its orientation algorithm (YFusion®) outputs 3D orientation data with respect to a gravity referenced frame: drift-free roll, pitch and unreferenced yaw. In addition, it outputs calibrated sensor data: 3D acceleration, 3D rate of turn and 3D magnetic field data. The YIS160-V is also capable of outputting data of orientation and velocity increments Δq and Δv. The 3D acceleration is also available as so-called free acceleration which has gravity subtracted.

2.3 YIS160-A (AHRS)

The YIS160-A supports all features of the YIS160-U and YIS160-V. It outputs drift-free roll, pitch and true/magnetic North referenced yaw and sensors data: 3D acceleration, 3D rate of turn, as well as 3D orientation and velocity increments (Δq and Δv), and 3D earth-magnetic field data. Free acceleration is also available.

2.4 YIS160-E (INS/GNSS)

The YIS160-E provides an INS/GNSS solution with external GNSS offering a position and velocity output in addition to orientation output. Its sensor fusion algorithm (YFusion®) synchronize the inputs from the module's on-board accelerometer, gyroscope and magnetometer with the data from an external GNSS receiver. It outputs 3D position, velocity and orientation (roll, pitch and yaw).

Output data	YIS160-U IMU	YIS160-V VRU	YIS160-A AHRS	YIS160-E INS/GNSS

Calibrated sensor data	●	●	●	●
Roll/pitch		●	●	●
Unreferenced yaw		●	●	●
North referenced yaw			●	●
Position[1]				●
Velocity[1]				●

[1] With external GNSS

3 3D Orientation and performance specifications

3.1 3D Orientation specifications

Table 1. Orientation specifications

Parameters		Typ	Unit	Comments
Roll/pitch	Static	0.25	°	1σ RMS
	Dynamic	0.5	°	1σ RMS
Yaw (heading)	VRU	1	°	1σ RMS[2]
	AHRS	1	°	1σ RMS in a homogenous magnetic field
Output data rate		100	Hz	

3.2 Position and velocity specifications[3]

Outage Duration	Positioning Mode	Position Accuracy		Velocity Accuracy	
		Horizontal	Vertical	Horizontal	Vertical
No Outage	SP	2.5m CEP	2.5m CEP	0.1 m/s	0.1 m/s
60 s	SP	<10% of DT	<8% of DT	0.5 m/s	0.5 m/s
	Odometer aiding	<2% of DT	<2% of DT	<0.5%	<0.5%

The specifications are determined by the external GNSS performance, and the listed specifications above are with YIS160-DK.

3.3 Sensors specifications[4]

Table 2. Gyroscope specifications

Parameters	Typ	Unit	Comments
Full range	±2000	°/s	
Non-linearity	±0.1	% FS	
Noise density	0.004	°/s/√Hz	@10Hz

[2] With active orientation stabilization in YFusion®, the yaw error will be less than 1 degree after 60 min in static case, and less than 1 degree per min in moderate dynamics case at room temperature.

[3] With YIS160-DK.

[4] These specifications may change as the update of the sensors on the module.

Bias variation vs. temperature	±0.01	°/s/° C	
Sensitivity variation vs. temperature	±2	%	

Table 3. Accelerometers specifications

Parameters	Typ	Unit	Comments
Full range	±16	g	
Non-linearity	±0.3	% FS	
Noise density	100	ug/√Hz	@10Hz
Bias variation vs. temperature	±0.5	mg/°C	X,Y axes
	±1		Z axis
Sensitivity variation vs. temperature	±1.5	%	

Table 4. Magnetometer specifications

Parameters	Typ	Unit	Comments
Full range	±49	Gauss	
RMS Noise	3	mG	RMS
Sensitivity variation vs. temperature	±0.03	%/°C	

3.4 System specifications

Table 5. System specifications

Parameters	Typ	Unit	Comments
Size	14.3×11.8×2.7	mm	PLCC32 compatible
Weight	0.5	g	
Input voltage	2.5~3.6	V	
Specified performance operating temperature	0~60	°C	
Operating temperature	-40 ~ +85	°C	
Power consumption	210	mW	@3.3V

4 Sensor calibration

Each YIS is individually calibrated and tested. The (simplified) sensor model of the gyroscopes, accelerometers and magnetometers can be represented as following:

$$\mathbf{u} = \mathbf{H} \cdot \mathbf{y} + \mathbf{b}$$

$\mathbf{u}$ = sensor data of the gyroscopes, accelerometers and magnetometers in °/s, m/s^2 or mGauss, respectively

$\mathbf{y}$ = sensor value before calibration

$\mathbf{H}$ = gain and misalignment matrix

$\mathbf{b}$ = bias

Yesense' calibration procedure calibrates for many parameters, including bias (offset), alignment of the sensors with respect to the module PCB and each other and gain (scale factor). The calibration values are stored in non-volatile memory in the YIS.

5 YFusion® sensor fusion algorithm

The YFusion™ sensor fusion algorithm is based on Kalman Filter, merging the data from 3-axis gyroscope, 3-axis accelerometer and 3-axis magnetometer. YFusion includes robust and accurate orientation estimation, online error estimation and active orientation stabilization.

6 Pin configuration

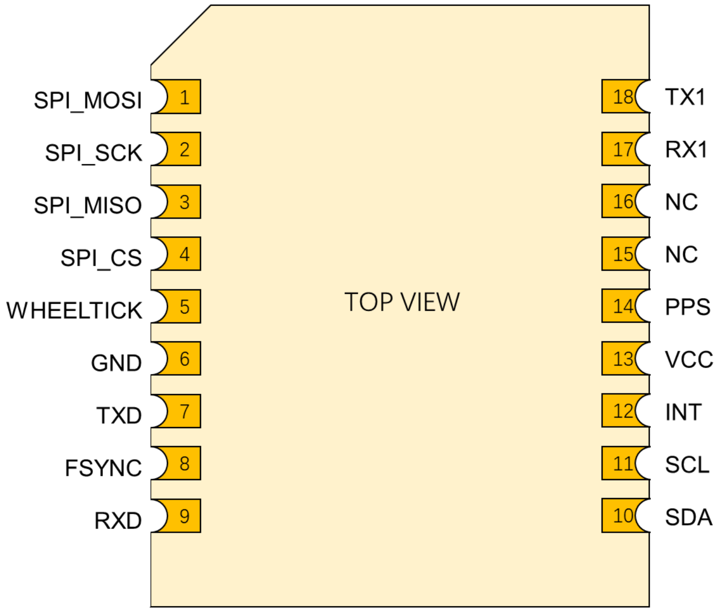

Figure 2. Pin configuration of the YIS160 (top view)

Table 6. Pin map

Pin ID	Pin Name	Description
1	SPI_MOSI	SPI serial data input (slave)
2	SPI_SCK	SPI serial clock input
3	SPI_MISO	SPI serial data output (slave)
4	SPI_CS	SPI chip select input (active low)
5	WHEELTICK	
6	GND	Ground
7	TXD	Transmitter data output
8	FSYNC	Synchronization signal
9	RXD	Receiver data input
10	SDA	I2C serial data
11	SCL	I2C serial clock
12	INT	Data Ready Signal (DRDY)

13	VCC	Power supply voltage, 2.7-3.6VDC
14	PPS	Receiver PPS input from GNSS
15	NC	Not Electrically Connected
16	NC	Not Electrically Connected
17	RX1	Receiver data input from GNSS
18	TX1	Transmitter data output to GNSS

7 Interfaces

7.1 Serial port (UART)

Serial port (UART) in YIS160 supports the following standard baudrates:

- 9600 bps
- 19200 bps
- 38400 bps
- 57600 bps
- 115200 bps
- 230400 bps
- 460800 bps(default)
- 921600 bps

For completeness, the UART specifications are listed below:

Table 7. UART specifications

Item	Value
Data bit	8
Stop bit	1
Parity	None

7.2 I2C

The I2C is a bus slave. The I2C interface is implemented with fast mod(400 KHz) I2C standards as well as with the standard mode.

The slave address associated to the YIS160 is 01101010b. The slave address is completed with Read/Write bit. For example, if master read data from slave, the first address byte is 0x6B.

Table 8. Transfer when master is receiving(reading) multiple bytes of data from slave

Master	ST	SAD+W		SUB		SR	SAD+R			MAK		NMAK	SP
Slave			SAK		SAK			SAK	DATA		DATA		

Note

SAD：Slave Address

MAK：Master Acknowledge

ST：START Condition	NMAK：No Master Acknowledge
SR：repeated START	SAK：Salve Acknowledge
SP：STOP Condition	SUB：8-bit sub-address, always is register address
	W：write operation
	R：read operation

The I2C timing diagram is described in Figure 3.

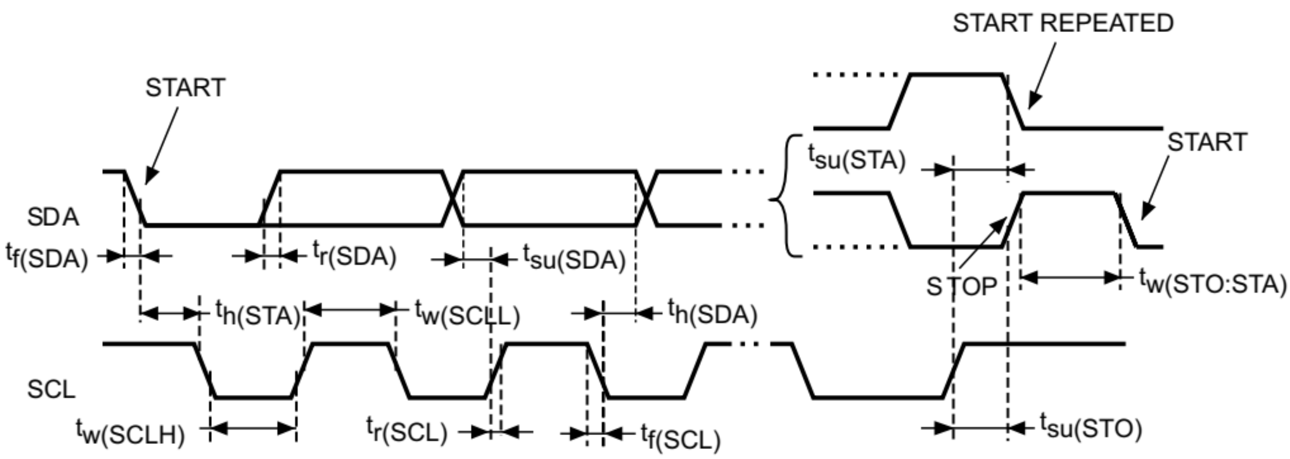

Figure 3. I2C timing diagram

The I2C characteristics are described in Table 9.

Table 9. I2C characteristics

Symbol	Parameter	Standard mode I2C		Fast mode I2C		Unit
		Min	Max	Min	Max	
$t_{w(SCLL)}$	SCL clock low time	4.7	-	1.3	-	µs
$t_{w(SCLH)}$	SCL clock high time	4.0	-	0.6	-	
$t_{su(SDA)}$	SDA setup time	250	-	100	-	ns
$t_{h(SDA)}$	SDA data hold time	0	3450	0	900[5]	
$t_{r(SDA)}$ $t_{r(SCL)}$	SDA and SCL rise time	-	1000	-	300	
$t_{f(SDA)}$ $tf_{(SCL)}$	SDA and SCL fall time	-	300	-	300	
$t_{h(STA)}$	Start condition hold time	4.0	-	0.6	-	µs
$t_{su(STA)}$	Repeated Start condition setup time	4.7	-	0.6	-	
$t_{su(STO)}$	Stop condition setup time	4.0	-	0.6	-	µs

[5] The maximum data hold time has only to be met if the interface does not stretch the low period of SCL signal.

$t_{w(STO:STA)}$	Stop to Start condition time (bus free)	4.7	-	1.3	-	μs
t_{SP}	Pulse width of the spikes that are suppressed by the analog filter for standard fast mode	0	50	0	50	ns
C_b	Capacitive load for each bus line	-	400	-	400	pF

7.3 SPI

Interface		Typ	Max	Unit	Comments
SPI	Master Clock Rate		6M	bps	
	Mode	CPOL = 0 CPHA = 0			

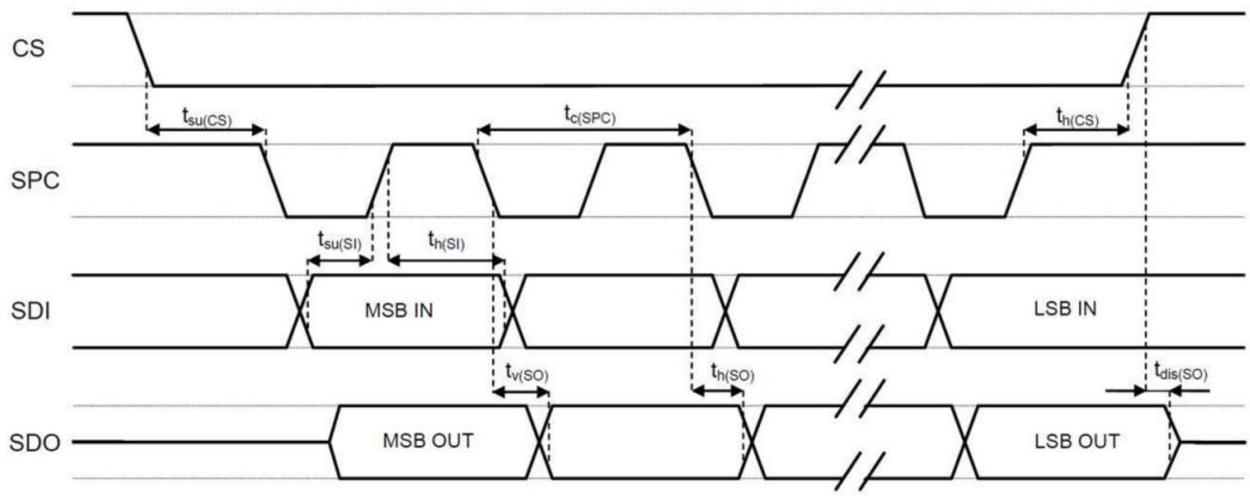

Figure 4 SPI timing diagram

Table 10 SPI characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t_c(SPC)	SPI clock cycle		167			ns
fsck	SPI clock frequency	1.8V < VDD < 3.6V			6	Mhz
Duty(sck)	Duty circle of SPI clock frequency	Slave mode	30	50	70	%
$t_{su(CS)}$	CS setup time		10			us
t_h(cs)	CS hold time		15			ns

$t_{su}(si)$	Data input setup time	Slave mode	5	-	-	ns
th(si)	Data input hold time	Slave mode	15	-	-	ns
tdis(so)	Data output disable time	Slave mode	5	-	50	ns
tv(so)	Data output valid time	Slave mode, 1.8V < VDD < 3.6V	-		50	ns
th(so)	Data output hold time	Slave mode, 1.8V < VDD < 3.6V	8	-	-	ns

7.4 Synchronization

7.4.1 Synchronization input

The FSYNC pin is an input channel for external synchronization input. The FSYNC accepts a trigger with rising edge which send out the latest available data message.

The external synchronization signal must be matched that the maximum trigger frequency is 100Hz. Normally, suggestion for trigger frequency is 1Hz.

7.4.2 Synchronization output

The INT pin is an output channel for external synchronization output. The INT pin is used for indicating the new data has updated. The INT pin generates a pulse with rising edge, and the high level will be hold in 1ms.

8 Communication protocol

8.1 Message structure

An YIS message contains the following fields：

YS Header	TID	LEN	MESSAGE	CK1	CK2
Dec 89 83 Hex 59 53	2 Bytes Message TID	Length of Message (1 Byte) excluding YS Header, TID	Message size depend on Len filed	two bytes checksum	

Table 11. YIS message structure

Type	LEN(Bytes)	Description
YS Header	2	Indicators of start of YIS message,0x59, 0x53
TID	2	Message identifier, Maximum value is 60000(0xEA60)
LEN	1	Length of YIS message, Maximum value is 255(0xFF)
MESSAGE	0-255	Data bytes
CK1	1	CK1 of checksum
CK2	1	CK2 of checksum

.

Table 12. DATA structure

Packet 1			……	Packet N		
DATA ID	LEN	DATA(LEN Bytes)	……	DATA ID	LEN	DATA(LEN Bytes)

DATA is a list of several packets. Each packet consists of a unique DATA ID, values and the length of values.

Table 13. Packet structure

DATA NAME	DATA ID	LEN	DATA

Acceleration	0x10	12	DATA1 – DATA12
Angular velocity	0x20	12	DATA1 – DATA12
Normalized Magnetic field	0x30	12	DATA1 – DATA12
Magnetic field	0x31	12	DATA1 – DATA12
Euler angles	0x40	12	DATA1 – DATA12
Quaternion	0x41	16	DATA1 – DATA16
UTC	0x50	11	DATA1 – DATA11
Position	0x60	12	DATA1 – DATA12
Velocity	0x70	12	DATA1 – DATA12

Table 14. Value and conversion

Type	Value	Conversion	Unit
Acceleration	DATA1(DATA[7:0])	ax = DATA × 0.000001	m/s²
	DATA2(DATA[15:8])		
	DATA3(DATA[23:16])		
	DATA4(DATA[31:24])		
	DATA5(DATA[7:0])	ay = DATA × 0.000001	
	DATA6(DATA[15:8])		
	DATA7(DATA[23:16])		
	DATA8(DATA[31:24])		
	DATA9(DATA[7:0])	az = DATA × 0.000001	
	DATA10(DATA[15:8])		
	DATA11(DATA[23:16])		
	DATA12(DATA[31:24])		
Angular velocity	DATA1(DATA[7:0])	wx = DATA × 0.000001	deg/s
	DATA2(DATA[15:8])		
	DATA3(DATA[23:16])		
	DATA4(DATA[31:24])		
	DATA5(DATA[7:0])	wy = DATA × 0.000001	

	DATA6(DATA[15:8])		
	DATA7(DATA[23:16])		
	DATA8(DATA[31:24])		
	DATA9(DATA[7:0])	wz = DATA × 0.000001	
	DATA10(DATA[15:8])		
	DATA11(DATA[23:16])		
	DATA12(DATA[31:24])		
Normalized Magnetic field	DATA1(DATA[7:0])	mx = DATA × 0.000001	
	DATA2(DATA[15:8])		
	DATA3(DATA[23:16])		
	DATA4(DATA[31:24])		
	DATA5(DATA[7:0])	my = DATA ×0.000001	
	DATA6(DATA[15:8])		
	DATA7(DATA[23:16])		
	DATA8(DATA[31:24])		
	DATA9(DATA[7:0])	mz = DATA ×0.000001	
	DATA10(DATA[15:8])		
	DATA11(DATA[23:16])		
	DATA12(DATA[31:24])		
Magnetic field	DATA1(DATA[7:0])	mx = DATA × 0.001	mGauss
	DATA2(DATA[15:8])		
	DATA3(DATA[23:16])		
	DATA4(DATA[31:24])		
	DATA5(DATA[7:0])	my = DATA × 0.001	
	DATA6(DATA[15:8])		
	DATA7(DATA[23:16])		
	DATA8(DATA[31:24])		
	DATA9(DATA[7:0])	mz = DATA × 0.001	
	DATA10(DATA[15:8])		
	DATA11(DATA[23:16])		
	DATA12(DATA[31:24])		
Euler angles	DATA2(DATA[15:8])	pitch = DATA × 0.000001	deg(°)
	DATA3(DATA[23:16])		

	DATA4(DATA[31:24])		
	DATA5(DATA[7:0])		
	DATA6(DATA[15:8])	roll = DATA × 0.000001	
	DATA7(DATA[23:16])		
	DATA8(DATA[31:24])		
	DATA9(DATA[7:0])		
	DATA10(DATA[15:8])	yaw = DATA × 0.000001	
	DATA11(DATA[23:16])		
	DATA12(DATA[31:24])		
	DATA12(DATA[31:24])		
Quaternion	DATA1(DATA[7:0])	q0 = DATA × 0.000001	
	DATA2(DATA[15:8])		
	DATA3(DATA[23:16])		
	DATA4(DATA[31:24])		
	DATA5(DATA[7:0])	q1 = DATA × 0.000001	
	DATA6(DATA[15:8])		
	DATA7(DATA[23:16])		
	DATA8(DATA[31:24])		
	DATA9(DATA[7:0])	q2 = DATA × 0.000001	
	DATA10(DATA[15:8])		
	DATA11(DATA[23:16])		
	DATA12(DATA[31:24])		
	DATA13(DATA[7:0])	q3 = DATA × 0.000001	
	DATA14(DATA[15:8])		
	DATA15(DATA[23:16])		
	DATA16(DATA[31:24])		
	DATA10(DATA[15:8])		
	DATA11(DATA[23:16])		
	DATA12(DATA[31:24])		
UTC	DATA1（DATA[7:0]）	iTOW = DATA	
	DATA2（DATA[15:8]）		
	DATA3（DATA[23:16]）		
	DATA4（DATA[31:24]）		

	DATA5 (DATA[7:0])	Year = DATA	
	DATA6 (DATA[15:8])		
	DATA7 (DATA[7:0])	Month = DATA	
	DATA8 (DATA[23:16])	Day = DATA	
	DATA9 (DATA[31:24])	Hour = DATA	
	DATA10 (DATA[7:0])	Min = DATA	
	DATA11 (DATA[15:8])	Sec = DATA	
Position	DATA1 (DATA[7:0])	lat = DATA * 0.0000001	deg
	DATA2 (DATA[15:8])		
	DATA3 (DATA[23:16])		
	DATA4 (DATA[31:24])		
	DATA5 (DATA[7:0])	long = DATA × 0.0000001	
	DATA6 (DATA[15:8])		
	DATA7 (DATA[23:16])		
	DATA8 (DATA[31:24])		
	DATA9 (DATA[7:0])	alt = DATA × 0.001	m
	DATA10 (DATA[15:8])		
	DATA11 (DATA[23:16])		
	DATA12 (DATA[31:24])		
Velocity	DATA1 (DATA[7:0])	ve = DATA × 0.001	m/s
	DATA2 (DATA[15:8])		
	DATA3 (DATA[23:16])		
	DATA4 (DATA[31:24])		
	DATA5 (DATA[7:0])	Vn = DATA × 0.001	
	DATA6 (DATA[15:8])		
	DATA7 (DATA[23:16])		
	DATA8 (DATA[31:24])		
	DATA9 (DATA[7:0])	vu = DATA × 0.001	
	DATA10 (DATA[15:8])		
	DATA11 (DATA[23:16])		
	DATA12 (DATA[31:24])		

8.2 Checksum

The checksum is calculated over the Message, starting and including the TID field, up until, but excluding, the Checksum Field:

YS Header	TID	LEN	MESSAGE	CK1	CK2

Range over which the checksum is to be caculated

The checksum algorithm used is the 8-Bit Fletcher Algorithm, which is used in the TCP standard. This algorithm works as follows:

Buffer[N] contains the data over which the checksum is to be calculated.

The two CK_ values are 8-Bit unsigned integers, only! If implementing with larger-sized integer values, make sure to mask both CK_1 and CK_2 with 0xFF after both operations in the loop.

```
CK1 = 0; CK2 = 0;

For(i=0;i<N;i++)

{

   CK1 = CK1 + buffer[i];

   CK2 = CK2 + CK1;

}
```

9 Package and handing

Note that this is a mechanical shock (g) sensitive device. Proper handling is required to prevent damage to the part.

Note that this is an ESD-sensitive device. Proper handling is required to prevent damage to the part.

Make sure not to apply force on the components of the YIS160 series module, especially when placing the YIS160 series module in an IC-socket.

9.1 Package drawing

The YIS160 series module is compatible with JEDEC PLCC32 IC-sockets.

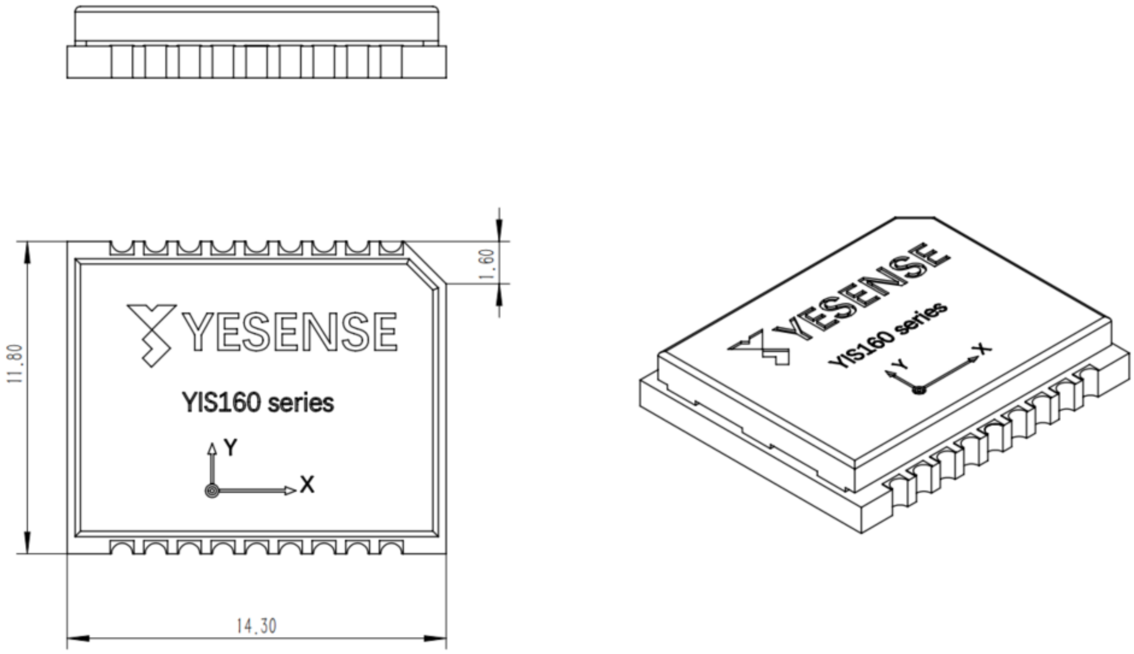

Figure 5. Package drawing (general tolerances are +/- 0.1 mm)

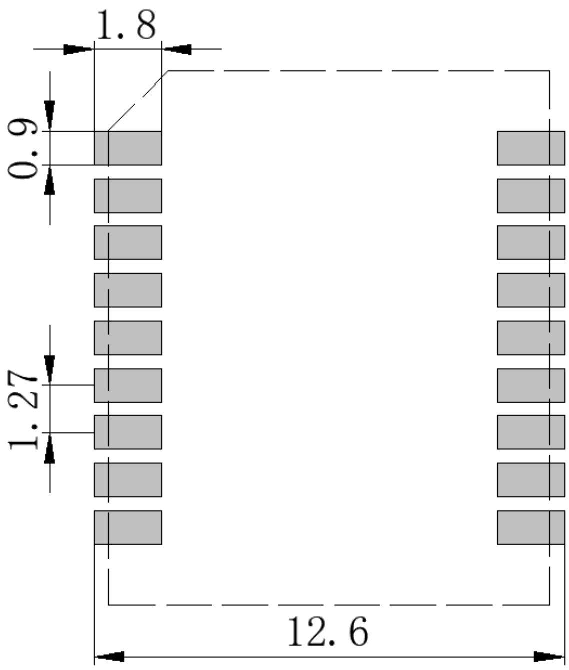

Figure 6. Recommended YIS160 series module footprint

Locate ground plate under component.

Do not route signals or power supplies under the component on top layer.

Ensure good ground connection of GND pin.

9.2 Mounting considerations

The module contains a MEMS (Micro Electro Mechanical System) chip and is therefore sensitive for stress applied on the PCB. To minimize stress apply the following design rules for the PCB and housing.

Avoid stress on the PCB by screwing/mounting it in a housing, applying unequal or excessive forces to the mounting positions. Ideally the PCB should be mounted using mechanical dampeners.

- Avoid force applied on the PCB by push buttons, connectors etc. close to the YIS160 series module.
- Avoid heat sources close to the YIS160 series
- Avoid vibrations caused by speaker, buzzer etc.

9.3 Soldering

9.3.1 Soldering paste

Use of “No Clean” and “Lead-free” soldering paste is strongly recommended, as it does not require cleaning after the soldering process has taken place.

9.3.2 Reflow soldering

A convection type soldering oven is highly recommended over the infrared type radiation oven. Convection heated ovens allow precise control of the temperature and all parts will be heated up evenly, regardless of material properties, thickness of components and surface color.

9.3.3 Preheat

Initial heating of component leads and balls. Residual humidity will be dried out. Note that this preheat phase will not replace prior baking procedures.

- Temperature rise rate: max 3° C/s. If the temperature rise is too rapid in the preheat phase it may cause excessive slumping.
- Time: 60 – 120 s. If the preheat is insufficient, rather large solder balls tend to be generated. Conversely, if performed excessively, fine balls and large balls will be generated in clusters.
- End Temperature: 150 – 200° C, 180° C is recommended. If the temperature is too low, non-melting tends to be caused in areas containing large heat capacity.

9.3.4 Heating/Reflow

The temperature rises above the liquidus temperature of 217° C. Avoid a sudden rise in temperature as the slump of the paste could become worse.

- Temperature rise/fall rate: max 2 ° C/s.
- Limit time above 217° C liquidus temperature: 40 – 60 s.
- Peak reflow temperature: 250° C.

9.3.5 Cooling

A controlled cooling avoids negative metallurgical effects (solder becomes more brittle) of the solder and possible mechanical tensions in the products. Controlled cooling helps to achieve bright solder fillets with a good shape and low contact angle.

- Temperature fall rate: max 4° C/s.

9.3.6 Optical inspection

After soldering the YIS160 modules, consider an optical inspection step to check whether:

- The module is properly aligned and centered over the pads.

- All pads are properly soldered.
- No excess solder has created contacts to neighboring pads, or possibly to pad stacks and vias nearby.

9.3.7 Cleaning

In general, cleaning the populated modules is strongly discouraged. Residues underneath the modules cannot be easily removed with a washing process.

The best approach is to use a “no clean” soldering paste and eliminate the cleaning step after the soldering. Note that ultrasonic cleaning will permanently damage the module, in particular the oscillators and MEMS chips.

9.3.8 Repeated reflow soldering

Only single reflow soldering processes are recommended. YIS160 modules should not be submitted to two reflow cycles on a board populated with components on both sides in order to avoid upside down orientation during the second reflow cycle. In this case, the module should always be placed on that side of the board, which is submitted into the last reflow cycle. The reason for this (besides others) is the risk of the module falling off due to the significantly higher weight in relation to other components.

9.3.9 Hand soldering

Hand soldering is allowed. Use a soldering iron temperature-setting equivalent to 350° C. Place the module precisely on the pads. Start with a diagonal fixture soldering (e.g. pins 1 and 11), and then continue in clockwise.

9.3.10 Rework

The YIS160 modules can be unsoldered from the baseboard using a hot air gun. When using a hot air gun for unsoldering the module, a maximum of one reflow cycle is allowed. In general, we do not recommend using a hot air gun because this is an uncontrolled process and might damage the module.

After the module is removed, clean the pads before placing and hand soldering a new module.

In addition to the two reflow cycles, manual rework on particular pins by using a soldering iron is allowed. Manual rework steps on the module can be done several times.

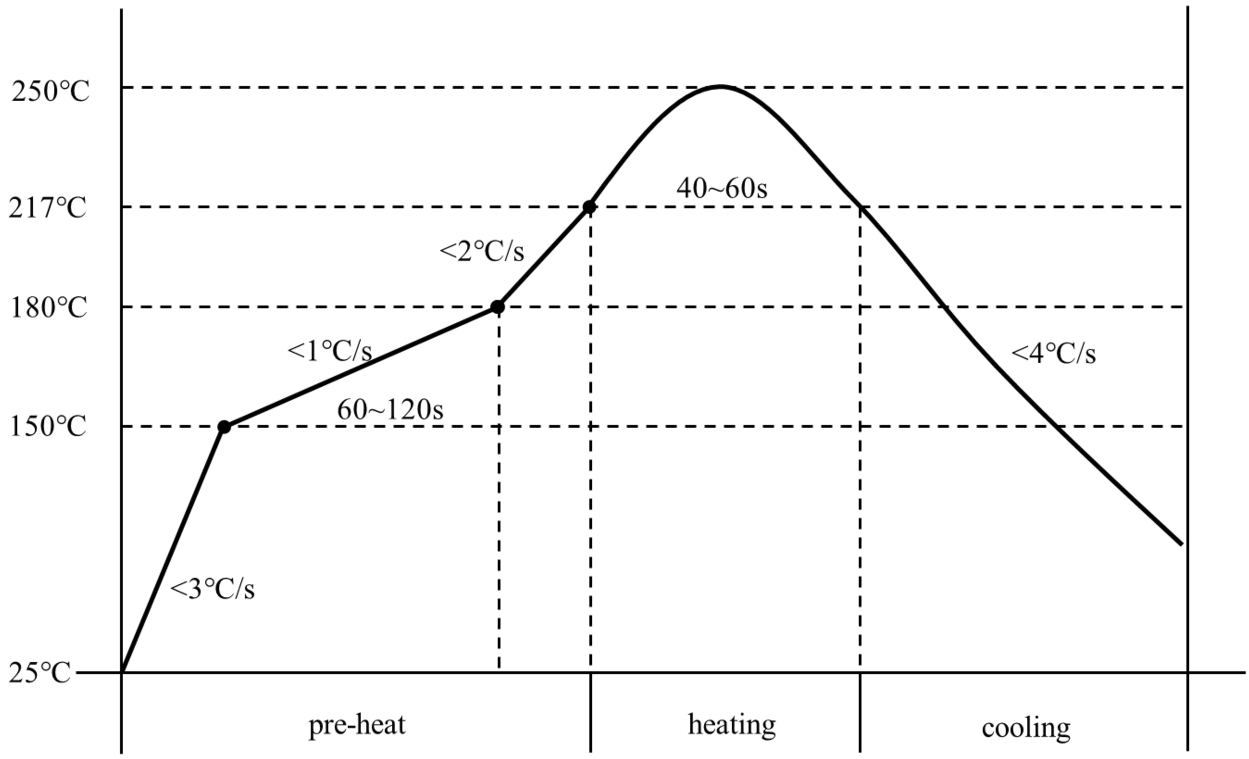

Figure 7 Recommended soldering profile

10 Revisions

Revision	Date	By	Changes
1.0	2018-11-15	Z. L.	• Initial release
1.1	2019-02-15	F. L.	• Update the communication protocol