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Summary

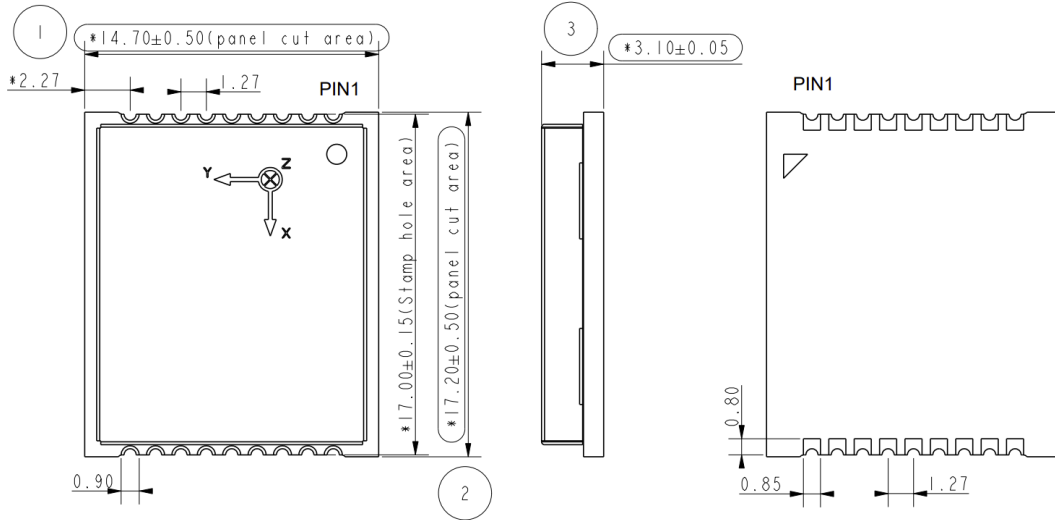
IMU614E-AG Inertial Module uses data fusion algorithm of IMU and GNSS to achieve low cost, high precision, anti-magnetic interference orientation and attitude determination. It is especially suitable for the single antenna controller scheme in the field of agricultural auto-driving.

Performance Index	Attitude Accuracy	Roll/Pitch :<math><0.2^\circ \text{ rms}</math> Heading:<math><0.3^\circ \text{ rms}</math>
	Update rate	100hz
	Gyro Range	$\pm 500^\circ/\text{s}$
	Gyro bias instability	6deg/h @1 σ
	Accelerometer range	$\pm 8\text{g}$
	Zero Bias Stability of Accelerometers	0.04mg @1 σ

1. Shape structure

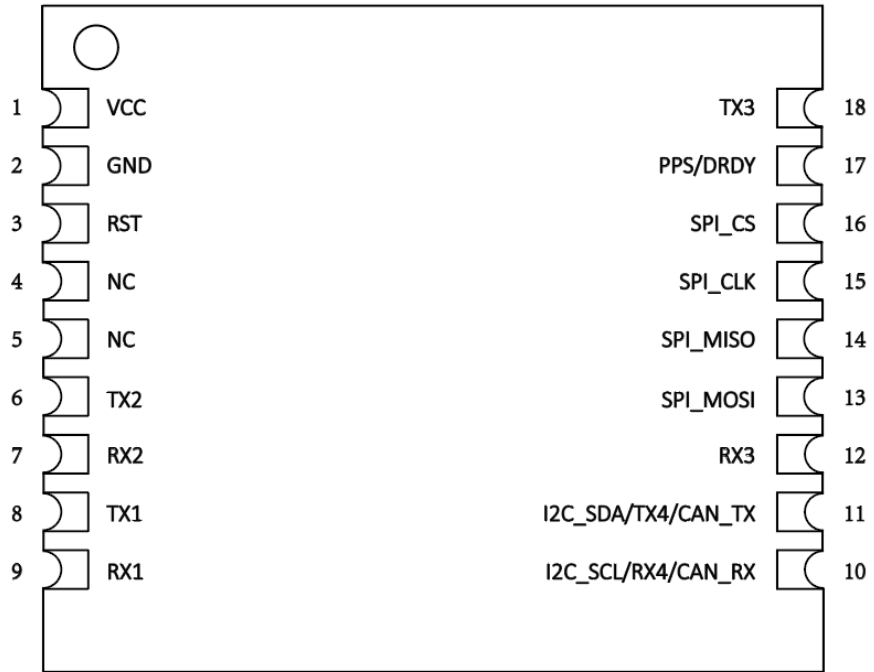
Installation requirements X axis to the front of the direction, Y axis to the right side of the body.

Figure 1 Shape structure and dimensions (Units: mm)



2. Pin Description

Figure 2 Pin Diagram



IMU614E-X Pin Layout (Top View)

Table 1 Pin Description

Pin No.	Pin Name	Pin Description		
1	VCC	Power input, 2.8~3.3V input, 60mA, ripple no more than 40mV		
2	GND	Power supply ground		
3	RST	External hardware reset input, The internal pull-up (Used in SPI MODE)		
4	NC	No Connect		
5	NC	No Connect		
6	TX2	Transmit Asynchronous Data Output.		
7	RX2	Receive Asynchronous Data Input.		
8	TX1	Transmit Asynchronous Data Output. (IMU Data Communication interface (LVTTTL))		
9	RX1	Receive Asynchronous Data Input. (IMU Data Communication interface (LVTTTL))		
10	CAN RX / RX4 / I2C_SC	Mode	Function	Description
		1	CAN_RX	Receive data output; reads out data from the bus lines to the CAN controller.
		2	RX4	Receive Asynchronous Data Input.
		3	I2C_SCL	I2C serial clock
11	CAN TX / TX4 / I2C_SDA	Mode	Function	Description
		1	CAN_TX	Transmit data input; reads in data from the CAN controller to the bus line drivers
		2	TX4	Transmit Asynchronous Data Output.
		3	I2C_SDA	I2C serial data
12	RX3	Standby interface		
13	SPI_MOSI	SPI serial data input		
14	SPI_MISO	SPI serial data output		
15	SPI_CLK	SPI serial clock		
16	SPI_CS	SPI Chip select		
17	PPS/DRDY	External synchronous sampling trigger signal. Can be used for Data Ready		
18	TX3	Transmit Asynchronous Data Output.		

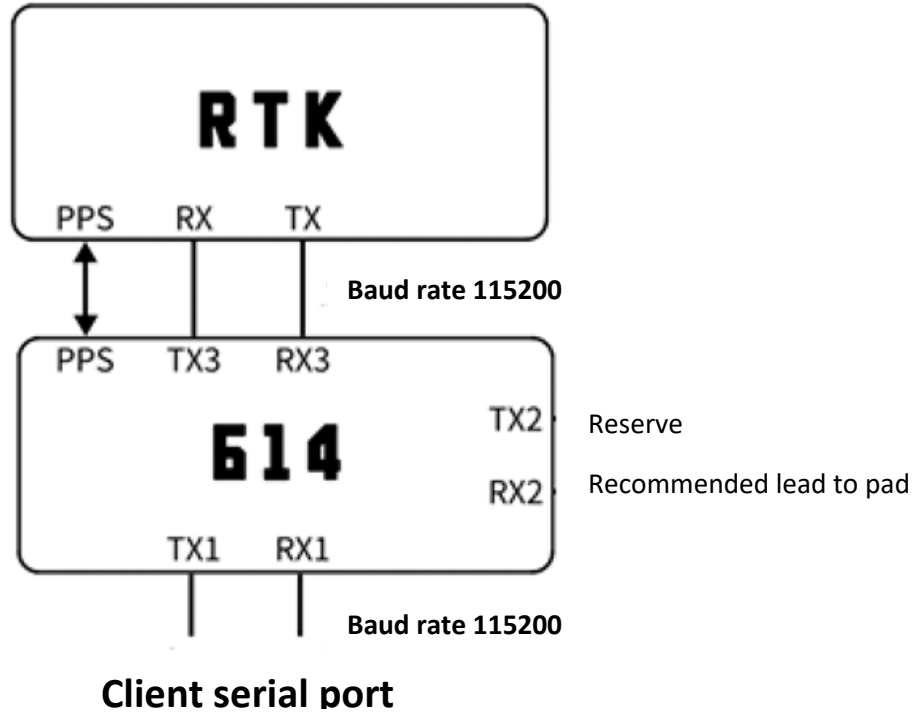
3. Electrical Characteristics

Table 2 Electrical Characteristics

Parameter	Symbol	Interface Type	Min	Type	Max	Units
Power input	VCC		3.2	3.3	3.4	V
Serial output	TX1	UART	3.2		VCC	V
Serial input	RX1	UART	0.3		VCC	V
Reserved pin	NC	IO	0.3		VCC	V
Electric current	I		50		150	mA
Temperature	T		-40		85	°C

4. Recommended Connection Method

Figure 3 Wiring diagram



5. RTK Configuration Requirements

BESTPOSB 10hz

PSRVELB 10hz

Turn off Inertial Navigation Auxiliary related functions of RTK card

Close other statements

Baud rate 115200

PPS second pulse: 1s, rise triggered, aligned to UTC time. High level must not be higher than 5V

6. Output Protocol

Notes:

- The CRC check starts from the frame header and does not include the CRC check bit itself. The CRC check of all bytes of the frame is calculated in the appendix.
- The frame length is the total number of data bytes except for the header, frame ID, frame length, and check bits.
- Small end mode, send low bytes first.

Content	Type	Relative Position
Header 1:0xAA	UInt8	0
Header 2:0x55	UInt8	1
Frame ID:0x0156	UInt16	2
Frame length:0x0032	UInt16	4
GPS within seconds per week (ms)	UInt32	6
Roll angle (degrees)	Float	10
Pitch angle (degrees)	Float	14
Heading angle (degrees)	Float	18
Reserved	Float	22
Triaxial angular velocity (DEG /s, front and bottom right)	Float*3	26
Triaxial acceleration (G, front and bottom right)	Float*3	38
RTK Location Status	UInt8	50
Posture Effective Position	UInt8	51
Status: Bit0:1 indicates that the RTK data is valid, and 0 indicates that the RTK data is invalid Bit1:1 indicates that the PPS signal is valid, and 0 indicates that the PPS signal is invalid	UInt32	52
CRC Check	UInt32	56

7. Input Protocol

7.1 Binary configuration protocol

Notes:

- The CRC check starts from the frame header and does not include the CRC check bit itself. The CRC check of all bytes of the frame is calculated in the appendix.
- The frame length is the total number of data bytes except for the header, frame ID, frame length, and check bits.
- Small end mode, send low bytes first.
- This frame needs to be continuously sent and will not be saved when power is off

Content	Type	Relative Position
Header 1:0x55	UInt8	0
Header 2:0xAA	UInt8	1
Frame ID:0x0101	UInt16	2
Frame length:0x0018	UInt16	4
Reserved	UInt8	6
Reserved	UInt16	7
Reserved	UInt8	9
Antenna pole arm X (cm)	Int16	10
Antenna pole arm Y (cm)	Int16	12
Antenna pole arm Z (cm)	Int16	14
Reserved	Int16	16
Reserved	Int16	18
Reserved	Int16	20
Reserved	Int32	22
Reserved	UInt16	26
Reserved	UInt8	28
Output protocol: 1: Set output Frame 2 in Section 6.1 2: Set output reservation protocol (generally not used)	UInt8	29
CRC Check digit	UInt32	30

7.2 String configuration protocol

Configure the lever arm

For example, the rod arm vectors are $X=1.2m, Y=0.2m,$ and $Z=-1.0m$

Instruction: the AT + CLUB_VECTOR = 1.2, 0.2, 1.0 \ r \ n

Reply: GPS_POS_X = 1.2, GPS_POS_Y = 0.2, GPS_POS_Z = 1.0 / r/n

Configuration Installation Orientation

Note: After setting the installation orientation and saving, power off and restart

- Lent If the IMU is installed on the front side, the configuration commands are:

Instruction: the AT + INSTALL_ANGLE = 0 0, \ r \ n

Reply: OK \ r \ n

- Lent If the IMU is installed with a reverse patch, the configuration instruction is:

Instructions: AT 180 + INSTALL_ANGLE = 0, \ r \ n

Reply: OK \ r \ n

Configuring the Output Protocol

- Virtual gateway If the output protocol described in Section 6 is configured, the configuration instruction reads:

Instruction: the AT + SETAG \ r \ n

Reply: OK \ r \ n

- Virtual gateway If the configuration is not output, the configuration instruction is:

Instruction: the AT + SETNO \ r \ n

Reply: OK \ r \ n

Save the parameters

Instruction: the AT + SAVE \ r \ n

Reply: OK \ r \ n

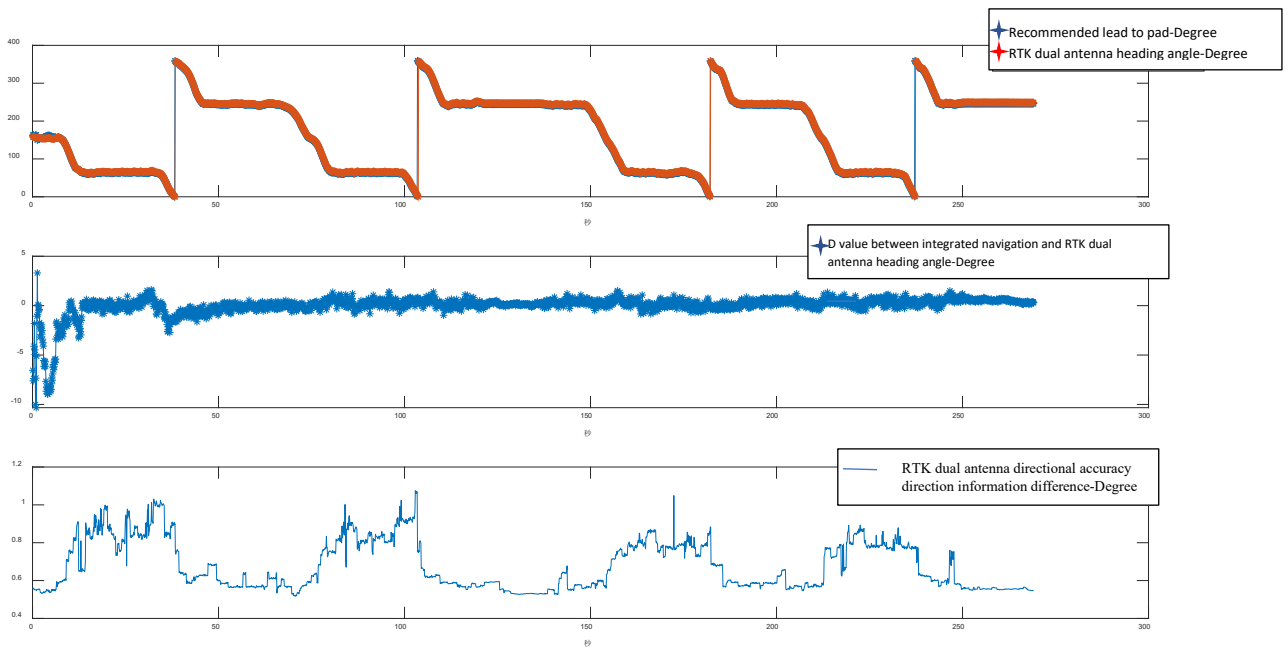
8. Orientation Accuracy Test

Test Conditions :

- Tractors are used as test vehicles to perform linear and turn tests at speeds ranging from 1 to 18km/h.
- Use the heading angle output from the UB482 card as the true value datum. Baseline length 1.5 meters
- The heading angles of the single-antenna integrated navigation module are synchronized with RTK heading angles in time by PPS second pulse signals.

Test Results :

- The heading angle accuracy of the single-antenna integrated navigation module converges to less than one degree within 5 seconds of starting.
- The heading angle accuracy of the single antenna integrated navigation module is better than 0.3 degree rms.



Appendix

CRC32 table lookup method of calculation

```

static const uint32_t crc32_tab[] = {
    0x00000000, 0x77073096, 0xee0e612c, 0x990951ba, 0x076dc419, 0x706af48f,
    0xe963a535, 0x9e6495a3, 0x0edb8832, 0x79dcb8a4, 0xe0d5e91e, 0x97d2d988,
    0x09b64c2b, 0x7eb17cbd, 0xe7b82d07, 0x90bf1d91, 0x1db71064, 0x6ab020f2,
    0xf3b97148, 0x84be41de, 0x1dad47d, 0x6ddde4eb, 0xf4d4b551, 0x83d385c7,
    0x136c9856, 0x646ba8c0, 0xfd62f97a, 0x8a65c9ec, 0x14015c4f, 0x63066cd9,
    0xfa0f3d63, 0x8d080df5, 0x3b6e20c8, 0x4c69105e, 0xd56041e4, 0xa2677172,
    0x3c03e4d1, 0x4b04d447, 0xd20d85fd, 0xa50ab56b, 0x35b5a8fa, 0x42b2986c,
    0xdbbbc9d6, 0xacbcf940, 0x32d86ce3, 0x45df5c75, 0xdcd60dcf, 0xabd13d59,
    0x26d930ac, 0x51de003a, 0xc8d75180, 0xbf061116, 0x21b4f4b5, 0x56b3c423,
    0xcfb9a599, 0xb8bda50f, 0x2802b89e, 0x5f058808, 0xc60cd9b2, 0xb10be924,
    0x2f6f7c87, 0x58684c11, 0xc1611dab, 0xb6662d3d, 0x76dc4190, 0x01db7106,
    0x98d220bc, 0xefd5102a, 0x71b18589, 0x06b6b51f, 0x9fbfe4a5, 0xe8b8d433,
    0x7807c9a2, 0x0f00f934, 0x9609a88e, 0xe10e9818, 0x7f6a0dbb, 0x086d3d2d,
    0x91646c97, 0xe6635c01, 0xb66b51f4, 0x1c6c6162, 0x856530d8, 0xf262004e,
    0x6c0695ed, 0x1b01a57b, 0x8208f4c1, 0xf50fc457, 0x65b0d9c6, 0x12b7e950,
    0x8bbeb8ea, 0xfcb9887c, 0x62dd1ddf, 0x15da2d49, 0x8cd37cf3, 0xfbd44c65,
    0x4db26158, 0x3ab551ce, 0xa3bc0074, 0xd4bb30e2, 0x4adfa541, 0x3dd895d7,
    0xa4d1c46d, 0xd3d6f4fb, 0x4369e96a, 0x346ed9fc, 0xad678846, 0xda60b8d0,
    0x44042d73, 0x33031de5, 0xaa0a4c5f, 0xdd0d7cc9, 0x5005713c, 0x270241aa,
    0xbe0b1010, 0xc90c2086, 0x5768b525, 0x206f85b3, 0xb966d409, 0xce61e49f,
    0x5edef90e, 0x29d9c998, 0xb0d09822, 0xc7d7a8b4, 0x59b33d17, 0x2eb40d81,
    0xb7bd5c3b, 0xc0ba6cad, 0xedb88320, 0x9abfb3b6, 0x03b6e20c, 0x74b1d29a,
    0xeadd54739, 0x9dd277af, 0x04db2615, 0x73dc1683, 0xe3630b12, 0x94643b84,
    0x0d6d6a3e, 0x7a6a5aa8, 0xe40ecf0b, 0x9309ff9d, 0x0a00ae27, 0x7d079eb1,
    0xf00f9344, 0x8708a3d2, 0x1e01f268, 0x6906c2fe, 0xf762575d, 0x806567cb,
    0x196c3671, 0x6e6b06e7, 0xfed41b76, 0x89d32be0, 0x10da7a5a, 0x67dd4acc,
    0xf9b9df6f, 0x8ebeeff9, 0x17b7be43, 0x60b08ed5, 0xd6d6a3e8, 0xa1d1937e,
    0x38d8c2c4, 0x4fdff252, 0xd1bb67f1, 0xa6bc5767, 0x3fb506dd, 0x48b2364b,
    0xd80d2bda, 0xaf0a1b4c, 0x36034af6, 0x41047a60, 0xdf60efc3, 0xa867df55,
    0x316e8eef, 0x46699e79, 0xcb61b38c, 0xbc66831a, 0x256fd2a0, 0x5268e236,
    0xcc0c7795, 0xbb0b4703, 0x220216b9, 0x5505262f, 0xc5ba3bbe, 0xb2bd0b28,
    0x2bb45a92, 0x5cb36a04, 0xc2d7ffa7, 0xb5d0cf31, 0x2cd99e8b, 0x5bdeae1d,
    0x9b64c2b0, 0xec63f226, 0x756aa39c, 0x026d930a, 0x9c0906a9, 0xeb0e363f,
    0x72076785, 0x05005713, 0x95bf4a82, 0xe2b87a14, 0x7bb12bae, 0x0cb61b38,
    0x92d28e9b, 0xe5d5be0d, 0x7cdcefb7, 0x0bdbdf21, 0x86d3d2d4, 0xf1d4e242,
    0x68ddb3f8, 0x1fda833e, 0x81be16cd, 0xf6b9265b, 0x6fb077e1, 0x18b74777,
    0x88085ae6, 0xff0f6a70, 0x66063bca, 0x11010b5c, 0x8f659eff, 0xf862ae69,
    0x616bffd3, 0x166ccf45, 0xa00ae278, 0xd70dd2ee, 0x4e048354, 0x3903b3c2,
    0xa7672661, 0xd06016f7, 0x4969474d, 0x3e6e77db, 0xaed16a4a, 0xd9d65adc,
    0x40df0b66, 0x37d83bf0, 0xa9bcae53, 0xdebb9ec5, 0x47b2cf7f, 0x30b5ffe9,
    0xbdbdf21c, 0xcabac28a, 0x53b39330, 0x24b4a3a6, 0xbad03605, 0xcdd70693,
    0x54de5729, 0x23d967bf, 0xb3667a2e, 0xc4614ab8, 0x5d681b02, 0x2a6f2b94,
    0xb40bbe37, 0xc30c8ea1, 0x5a05dflb, 0x2d02ef8d
};
uint32_t crc_crc32(uint32_t crc, const uint8_t *buf, uint32_t size)
{
    for (uint32_t i=0; i<size; i++) {
        crc = crc32_tab[(crc ^ buf[i]) & 0xff] ^ (crc >> 8);
    }
    return crc;
}

```