

| Product name | Description                                                                                                     | Version |
|--------------|-----------------------------------------------------------------------------------------------------------------|---------|
| RTK-DUAL-A   | Dual-frequency, Multi-constellation RTK Module                                                                  | 1.5     |
| RTK-DUAL-B   | Dual-frequency, Multi-constellation RTK Module with MEMS sensor<br>(Unable to output raw data from MEMS sensor) |         |
| RTK-DUAL-C   | Dual-frequency, Multi-constellation RTK Module for drone applications                                           |         |



## 1 Introduction

RTK-DUAL series is a dual-frequency multi-constellation RTK module that designed for applications requiring accurate dual-antenna GNSS-based heading and RTK centimeter level positioning accuracy. The dual-antenna GNSS-based heading is not subject to magnetic interference. Unlike a standard dual-frequency multi-constellation RTK Module that can only estimate heading based on the movement, RTK-DUAL provides an accurate heading even while the vehicle is stationary. It is capable of concurrently tracking all global civil navigation systems, including GPS, GLONASS, GALILEO, BEIDOU and QZSS. It acquires both L1 and L5 signals at a time while providing heading between dual antennas and RTK position. RTK-DUAL adopts 12nm process and integrates efficient power management architecture to become one of the leading groups with the lightest weight and lowest power consumption on the market. Paired with our dual-frequency low power helical antennas, it can extend the usage time of battery powered drones, robotic lawn mowers, automated logistics vehicles, etc.

## 2 Features

- Unique Dual-engine RTK technology
- Dual-antenna design for high precision positioning and heading
- Support GPS, GLONASS, GALILEO, BEIDOU and QZSS
- Capable of SBAS (WAAS, EGNOS, MSAS, GAGAN)
- Support 270-channel GNSS
- Up to 5Hz update rate
- For unmanned systems and dynamic applications
- Built-in 3-axis gyroscope and accelerometer to continuously output heading during poor GNSS signals (only available on RTK-DUAL-B)
- Small form factor 27 x 20 x 5.4 mm

### 3 Application

- UAV, drone art, delivery drone
- Robotic lawn mowers, autonomous mobile robot (AMR)
- Marine application
- Precision agriculture
- Automatic sun tracking system

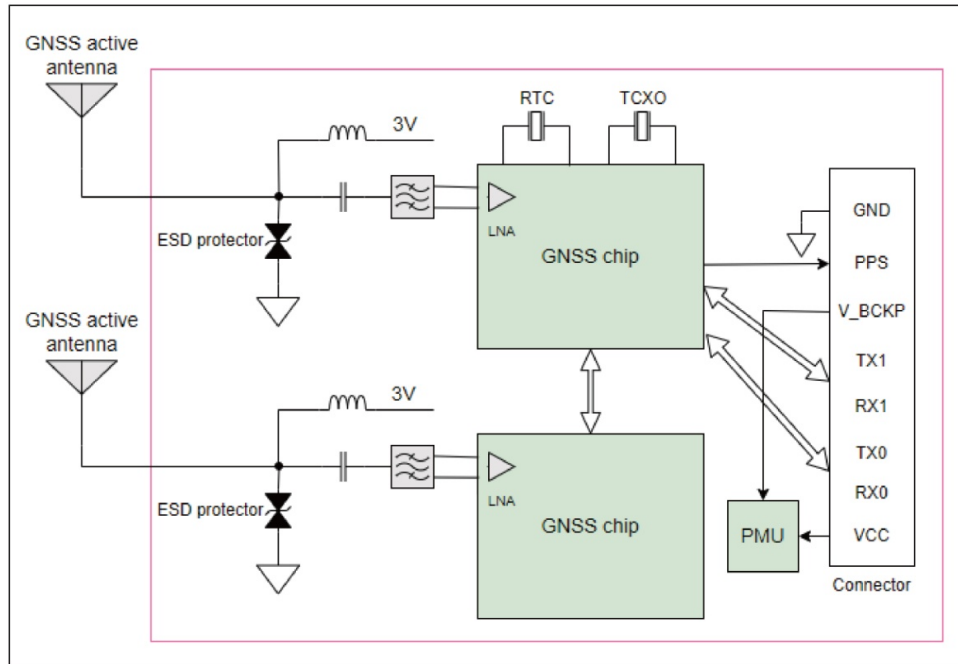


Fig 3-1 System block diagram for RTK-DUAL-A 、RTK-DUAL-C

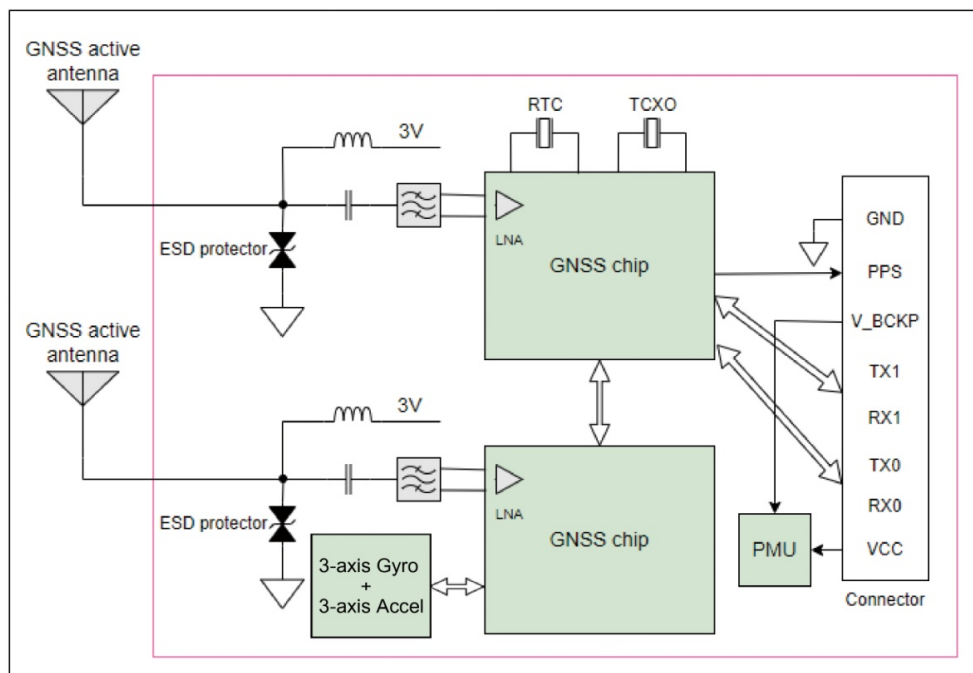


Fig 3-2 System block diagram for RTK-DUAL-B

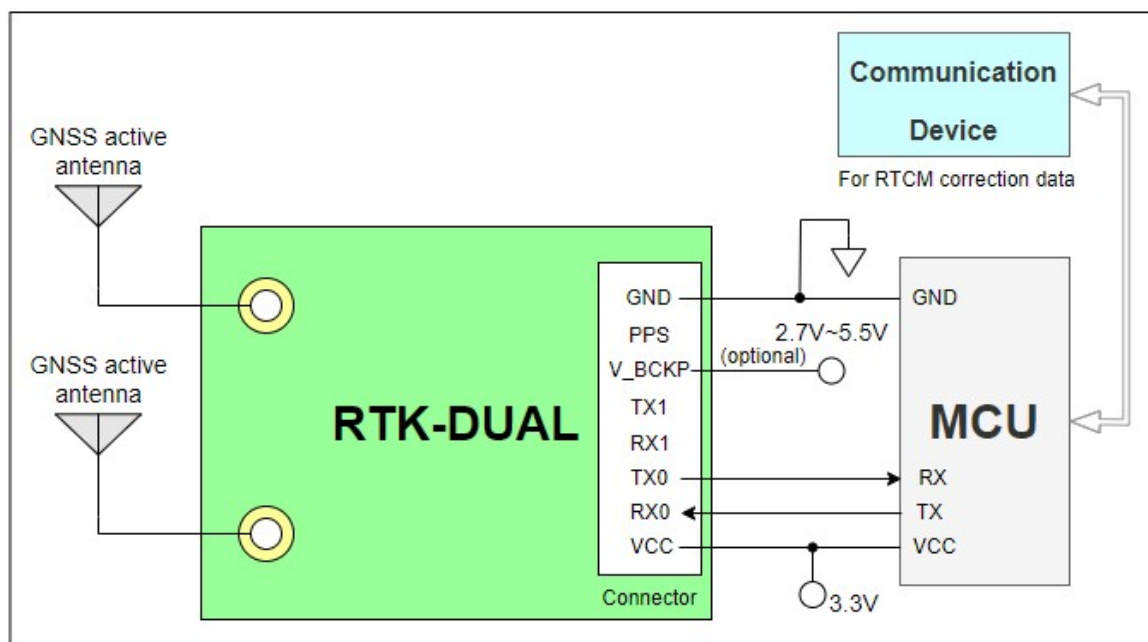


Fig 3-3 Typical application circuit A.

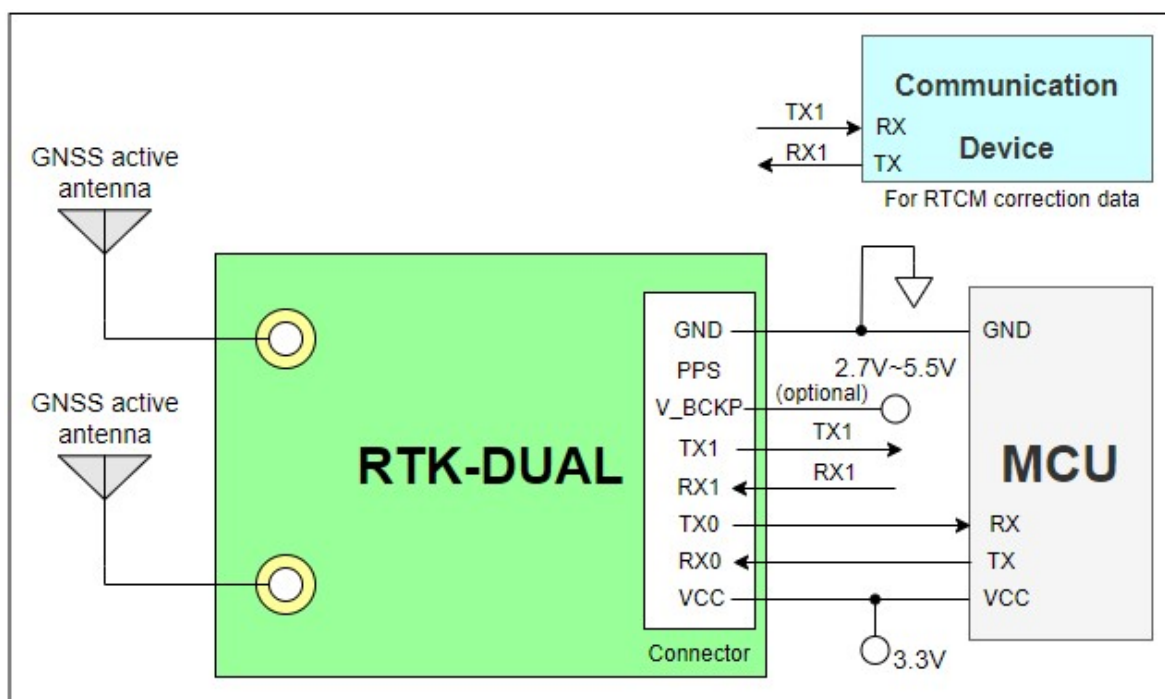


Fig 3-4 Typical application circuit B.

#### 4 GNSS receiver

|                                  |                                                                                                                                                |                                                            |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| Frequency                        | GPS/QZSS: L1 C/A, L5C<br>GLONASS: L1OF<br>GALILEO: E1, E5a<br>BEIDOU: B1I, B2a                                                                 |                                                            |
| Channels                         | 270 channels                                                                                                                                   |                                                            |
| Update rate                      | 2Hz (default), 5Hz                                                                                                                             |                                                            |
| Sensitivity                      | Tracking                                                                                                                                       | -165dBm (with external LNA)                                |
|                                  | Cold start                                                                                                                                     | -148dBm (with external LNA)                                |
| Acquisition Time                 | Cold start (open sky)                                                                                                                          | 28s (typical)                                              |
|                                  | RTK Convergence                                                                                                                                | < 10s (typical; after 3D fix)                              |
| Position Accuracy <sup>(1)</sup> | Autonomous                                                                                                                                     | 1.5m CEP                                                   |
|                                  | RTK                                                                                                                                            | 1cm + 1ppm (horizontal) CEP<br>1.5cm + 1ppm (vertical) CEP |
| Heading Accuracy <sup>(2)</sup>  | 2° RMS @ 0.1m antenna separation<br>0.4° RMS @ 0.5m antenna separation<br>0.2° RMS @ 1m antenna separation<br>0.1° RMS @ 2m antenna separation |                                                            |
| Aided heading <sup>(3)</sup>     | Degraded by ≤ 2° (RMS) up to 30 seconds during poor GNSS signals<br>(only available on RTK-DUAL-B)                                             |                                                            |
| Max. Altitude                    | < 18,000 m                                                                                                                                     |                                                            |
| Max. Velocity                    | < 500 m/s                                                                                                                                      |                                                            |
| Protocol Support                 | 115200 bps <sup>(4)</sup> , 8 data bits, no parity, 1 stop bits (default)                                                                      |                                                            |
|                                  | NMEA 0183 ver. 4.1                                                                                                                             | 1Hz: GSA, GSV<br>2Hz: HDT, PLSHD, GGA, RMC                 |
|                                  | RTCM V3.3                                                                                                                                      | Message type 1005, 1074, 1084, 1094, 1114, 1124            |

<Note>

- 24hr, static, open sky, demonstrated with good active dual-frequency antennas.
- 2hr, static, open sky, demonstrated with good active dual-frequency antennas.
- The MEMS functionality within the RTK-DUAL-B is only used for heading estimation and does not output raw data.
- Both baud rate and output message rate are configurable to be factory default. For drone applications (RTK-DUAL-C), the default baud rate is 460800 bps and the output messages are binary as below. UBX-NAV-PVT (5Hz), UBX-NAV-DOP (5Hz), UBX-NAV-TIMEGPS (1Hz), UBX-NAV-RELPOSNED (5Hz)

## 5 Software interface

### 5.1 NMEA output message

Table 5.1-1 NMEA output message

| NMEA record | Description                              |
|-------------|------------------------------------------|
| GGA         | Global positioning system fixed data     |
| GLL         | Geographic position - latitude/longitude |
| GSA         | GNSS DOP and active satellites           |
| GSV         | GNSS satellites in view                  |
| RMC         | Recommended minimum specific GNSS data   |
| VTG         | Course over ground and ground speed      |
| HDT         | Heading, True                            |

#### ● GGA--- Global Positioning System Fixed Data

Table 5.1-2 contains the values for the following example:

\$GNGGA,061730.000,2503.7135400,N,12138.7466600,E,1,46,0.49,131.36,M,15.32,M,,\*71

Table 5.1-2 GGA Data Format

| Name                   | Example       | Units  | Description                                                     |
|------------------------|---------------|--------|-----------------------------------------------------------------|
| Message ID             | \$GNGGA       |        | GGA protocol header                                             |
| UTC Time               | 061730.000    |        | hhmmss.sss                                                      |
| Latitude               | 2503.7135400  |        | ddmm.mmmmmmm                                                    |
| N/S indicator          | N             |        | N=north or S=south                                              |
| Longitude              | 12138.7466600 |        | dddmm.mmmmmmm                                                   |
| E/W Indicator          | E             |        | E=east or W=west                                                |
| Position Fix Indicator | 1             |        | See Table 5.1-3                                                 |
| Satellites Used        | 46            |        | Number of satellites in use                                     |
| HDOP                   | 0.49          |        | Horizontal Dilution of Precision (meters)                       |
| MSL Altitude           | 131.36        | meters | Antenna Altitude above/below mean-sea-level (geoid) (in meters) |
| Units                  | M             | meters | Units of antenna altitude, meters                               |
| Geoidal Separation     | 15.32         | meters |                                                                 |
| Units                  | M             | meters | Units of geoidal separation, meters                             |
| Age of diff. GNSS data |               | second | Null fields when DGPS is not used                               |
| Diff. Ref. Station ID  |               |        | Differential reference station ID, 0000-1023                    |
| Checksum               | *71           |        | Checksum                                                        |
| <CR> <LF>              |               |        | End of message termination                                      |

Table 5.1-3 Position Fix Indicators

| Value | Description                  |
|-------|------------------------------|
| 0     | No position fix              |
| 1     | Autonomous GNSS fix          |
| 2     | Differential GNSS fix        |
| 4     | RTK fixed                    |
| 5     | RTK float                    |
| 6     | Estimated/Dead reckoning fix |

## ● GLL--- Geographic Position – Latitude/Longitude

Table 5.1-4 contains the values for the following example:

\$GNGLL,2503.7135400,N,12138.7466600,E,061730.000,A,A\*48

Table 5.1-4 GLL Data Format

| Name          | Example       | Units | Description                                                                                                                                       |
|---------------|---------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Message ID    | \$GNGLL       |       | GLL protocol header                                                                                                                               |
| Latitude      | 2503.7135400  |       | ddmm.mmmmmmm                                                                                                                                      |
| N/S indicator | N             |       | N=north or S=south                                                                                                                                |
| Longitude     | 12138.7466600 |       | dddmm.mmmmmmm                                                                                                                                     |
| E/W indicator | E             |       | E=east or W=west                                                                                                                                  |
| UTC Time      | 061730.000    |       | hhmmss.sss                                                                                                                                        |
| Status        | A             |       | A=data valid or V=data not valid                                                                                                                  |
| Mode          | A             |       | N = No position fix<br>A = Autonomous GNSS fix<br>D = Differential GNSS fix<br>R = RTK fixed<br>F = RTK float<br>E = Estimated/Dead reckoning fix |
| Checksum      | *48           |       |                                                                                                                                                   |
| <CR> <LF>     |               |       | End of message termination                                                                                                                        |

## ● GSA---GNSS DOP and Active Satellites

Table 5.1-5 contains the values for the following example:

\$GNGSA,A,3,11,195,194,199,08,07,01,27,16,09,23,,1.19,0.64,1.00,1\*3F

\$GNGSA,A,3,87,81,76,,,,,,,,,1.19,0.64,1.00,2\*0F

\$GNGSA,A,3,,,,,,,,,1.19,0.64,1.00,3\*09

\$GNGSA,A,3,34,24,12,07,11,10,08,38,25,09,13,16,1.19,0.64,1.00,4\*02

Table 5.1-5 GSA Data Format

| Name                 | Example | Units | Description                      |
|----------------------|---------|-------|----------------------------------|
| Message ID           | \$GNGSA |       | GSA protocol header              |
| Mode 1               | A       |       | See Table 5.1-6                  |
| Mode 2               | 3       |       | See Table 5.1-7                  |
| ID of satellite used | 11      |       | SV on Channel 1                  |
| ID of satellite used | 195     |       | SV on Channel 2                  |
| ....                 |         |       | ....                             |
| ID of satellite used |         |       | SV on Channel 12                 |
| PDOP                 | 1.19    |       | Position Dilution of Precision   |
| HDOP                 | 0.64    |       | Horizontal Dilution of Precision |
| VDOP                 | 1.00    |       | Vertical Dilution of Precision   |
| GNSS system ID       | 1       |       | See Table 5.1-8                  |
| Checksum             | *3F     |       |                                  |
| <CR> <LF>            |         |       | End of message termination       |

Table 5.1-6 Mode 1

| Value | Description                                   |
|-------|-----------------------------------------------|
| M     | Manually set to operate in 2D or 3D mode      |
| A     | Automatically switching between 2D or 3D mode |

Table 5.1-7 Mode 2

| Value | Description     |
|-------|-----------------|
| 1     | No position fix |
| 2     | 2D fix          |
| 3     | 3D fix          |

Table 5.1-8 GNSS system ID

| Value | Description |
|-------|-------------|
| 1     | GPS         |
| 2     | GLONASS     |
| 3     | GALILEO     |
| 4     | BEIDOU      |
| 6     | IRNSS       |

## ● GSV---GNSS Satellites in View

Table 5.1-9 contains the values for the following example:

\$GPGSV,3,1,09,8,71,268,47,27,63,18,49,11,44,191,46,4,41,237,46,1\*54

\$GPGSV,3,2,09,16,38,42,42,9,32,279,39,26,22,70,38,31,15,131,36,1\*56

\$GPGSV,3,3,09,7,15,320,40,1\*6B

\$GPGSV,1,1,04,8,71,268,50,27,63,18,49,9,32,279,43,26,22,70,42,8\*6C  
 \$GLGSV,2,1,05,82,63,47,47,83,56,182,36,80,47,9,42,79,33,85,45,1\*71  
 \$GLGSV,2,2,05,81,15,27,37,1\*71  
 \$GAGSV,1,1,04,08,48,300,43,03,47,025,45,13,36,309,42,05,06,061,34,7\*79  
 \$GAGSV,1,1,04,08,48,300,43,03,47,025,47,13,36,309,43,05,06,061,33,1\*7B  
 \$GBGSV,5,1,17,12,80,182,47,24,64,5,51,7,58,355,44,3,57,205,45,1\*7C  
 \$GBGSV,5,2,17,1,54,141,44,34,52,211,49,9,48,230,45,10,47,316,42,1\*79  
 \$GBGSV,5,3,17,26,44,100,47,16,39,207,43,4,38,117,41,2,37,240,41,1\*77  
 \$GBGSV,5,4,17,39,37,210,43,6,36,198,41,38,27,173,41,25,18,317,42,1\*4E  
 \$GBGSV,5,5,17,35,16,39,40,1\*7F  
 \$GBGSV,1,1,02,24,64,5,50,26,44,100,43,4\*77

Table 5.1-9 GSV Data Format

| Name                     | Example | Units   | Description                                                                                                  |
|--------------------------|---------|---------|--------------------------------------------------------------------------------------------------------------|
| Message ID               | \$GPGSV |         | GSV protocol header<br>GP=GPS/QZSS, GL=GLONSS, GA=GALILEO,<br>GB=BEIDOU, GI=IRNSS.                           |
| Total number of messages | 3       |         | Range 1 to 9                                                                                                 |
| Message number           | 1       |         | Range 1 to 9                                                                                                 |
| Satellites in view       | 09      |         |                                                                                                              |
| Satellite ID             | 8       |         | Channel 1                                                                                                    |
| Elevation                | 71      | degrees | Channel 1 (Range 00 to 90)                                                                                   |
| Azimuth                  | 268     | degrees | Channel 1 (Range 000 to 359)                                                                                 |
| SNR (C/No)               | 47      | dB-Hz   | Channel 1 (Range 00 to 99, null when not tracking)                                                           |
| ....                     |         |         | ....                                                                                                         |
| Satellite ID             | 4       |         | Channel 4 (Range 01 to 196)                                                                                  |
| Elevation                | 41      | degrees | Channel 4 (Range 00 to 90)                                                                                   |
| Azimuth                  | 237     | degrees | Channel 4 (Range 000 to 359)                                                                                 |
| SNR (C/No)               | 46      | dB-Hz   | Channel 4 (Range 00 to 99, null when not tracking)                                                           |
| Signal ID                | 1       |         | GPS/QZSS: L1 C/A=1, L5Q=8<br>GLONASS: L1 C/A=1<br>GALILEO: E1=7, E5a=1<br>BEIDOU: B1=1, B2a=4<br>IRNSS: L6=1 |
| Checksum                 | *54     |         |                                                                                                              |
| <CR> <LF>                |         |         | End of message termination                                                                                   |

## ● RMC---Recommended Minimum Specific GNSS Data

Table 5.1-10 contains the values for the following example:

\$GNRMC,061730.000,A,2503.7135400,N,12138.7466600,E,0.01,0.00,230522,,,A,V\*00

Table 5.1-10 RMC Data Format

| Name                          | Example       | Units   | Description                                                                                                                                       |
|-------------------------------|---------------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Message ID                    | \$GNRMC       |         | RMC protocol header                                                                                                                               |
| UTC Time                      | 061730.000    |         | hhmmss.sss                                                                                                                                        |
| Status                        | A             |         | A = Autonomous<br>V = invalid<br>D = Differential                                                                                                 |
| Latitude                      | 2503.7135400  |         | ddmm.mmmmmmm                                                                                                                                      |
| N/S Indicator                 | N             |         | N=north or S=south                                                                                                                                |
| Longitude                     | 12138.7466600 |         | dddmm.mmmmmmm                                                                                                                                     |
| E/W Indicator                 | E             |         | E=east or W=west                                                                                                                                  |
| Speed over ground             | 0.01          | knots   | True                                                                                                                                              |
| Course over ground            | 0.00          | degrees |                                                                                                                                                   |
| Date                          | 230522        |         | ddmmyy                                                                                                                                            |
| Magnetic variation            |               | degrees |                                                                                                                                                   |
| Variation sense               |               |         | E=east or W=west                                                                                                                                  |
| Mode                          | A             |         | N = No position fix<br>A = Autonomous GNSS fix<br>D = Differential GNSS fix<br>R = RTK fixed<br>F = RTK float<br>E = Estimated/Dead reckoning fix |
| Navigational status indicator | V             |         | S = Safe<br>C = Caution<br>U = Unsafe<br>V = Void                                                                                                 |
| Checksum                      | *00           |         |                                                                                                                                                   |
| <CR> <LF>                     |               |         | End of message termination                                                                                                                        |

## ● VTG---Course Over Ground and Ground Speed

Table 5.1-11 contains the values for the following example:

\$GNVTG,0.00,T,,M,0.003,N,0.006,K,A\*26

Table 5.1-11 VTG Data Format

| Name | Example | Units | Description |
|------|---------|-------|-------------|
|------|---------|-------|-------------|

|                    |         |         |                                                                                                                                                   |
|--------------------|---------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Message ID         | \$GNVTG |         | VTG protocol header                                                                                                                               |
| Course over ground | 0.00    | degrees | Measured heading                                                                                                                                  |
| Reference          | T       |         | True                                                                                                                                              |
| Course over ground |         | degrees | Measured heading                                                                                                                                  |
| Reference          | M       |         | Magnetic                                                                                                                                          |
| Speed over ground  | 0.003   | knots   | Measured speed                                                                                                                                    |
| Units              | N       |         | Knots                                                                                                                                             |
| Speed over ground  | 0.006   | km/h    | Measured speed                                                                                                                                    |
| Units              | K       |         | Kilometer per hour                                                                                                                                |
| Mode               | A       |         | N = No position fix<br>A = Autonomous GNSS fix<br>D = Differential GNSS fix<br>R = RTK fixed<br>F = RTK float<br>E = Estimated/Dead reckoning fix |
| Checksum           | *26     |         |                                                                                                                                                   |
| <CR> <LF>          |         |         | End of message termination                                                                                                                        |

### ● HDT---Heading, True

Table 5.1-12 contains the values for the following example:

\$GPHDT,40.056,T\*02

Table 5.1-12 HDT Data Format

| Name       | Example | Units   | Description                     |
|------------|---------|---------|---------------------------------|
| Message ID | \$GPHDT |         | HDT protocol header             |
| Heading    | 40.056  | degrees | Dual-antenna GNSS-based heading |
| Reference  | T       |         | True                            |
| Checksum   | *02     |         |                                 |
| <CR> <LF>  |         |         | End of message termination      |

## 5.2 Proprietary output message

Table 5.2-1 Proprietary output message

| NMEA like record | Description                     |
|------------------|---------------------------------|
| \$PLSHD          | Dual-antenna GNSS-based heading |

### ● PLSHD --- Dual-antenna GNSS-based heading

Table 5.2-2 contains the values for the following example:

\$PLSHD,1,27,35,1.547,40.056,-16.737\*76

Table 5.2-2 PLSHD Data Format

| Name                     | Example | Units  | Description                                                                        |
|--------------------------|---------|--------|------------------------------------------------------------------------------------|
| Message ID               | \$PLSHD |        | PLSHD protocol header                                                              |
| Valid flag               | 1       |        | 0: invalid data<br>1: valid data from dual-antenna GNSS<br>9: valid data from MEMS |
| Satellite number of ANT1 | 27      |        |                                                                                    |
| Satellite number of ANT2 | 35      |        |                                                                                    |
| Length                   | 1.547   | meter  | Length between two antennas.                                                       |
| Heading                  | 40.056  | degree | Heading from ANT1 to ANT2. Range 0 to 360.                                         |
| Elevation                | -16.737 |        | Elevation from ANT1 to ANT2. Range -90 to 90.                                      |
| Checksum                 | *76     |        |                                                                                    |
| <CR> <LF>                |         |        | End of message termination                                                         |

## 5.3 Proprietary input command

Table 5.3-1 Proprietary input message

| NMEA like record              | Description                                                  |
|-------------------------------|--------------------------------------------------------------|
| \$PAIR004                     | Perform GNSS hot start                                       |
| \$PAIR005                     | Perform GNSS warm start                                      |
| \$PAIR006                     | Perform GNSS cold start                                      |
| \$PAIR007                     | Perform GNSS full cold start                                 |
| \$PLSC,VER                    | Query firmware version                                       |
| \$PLSC,FIXRATE                | Set/query update rate                                        |
| \$PLSC,UART2,{PLSC,ANTDIST    | Set/query the distance between two antennas                  |
| \$PLSC,UART2,{PLSC,ANTDISTDEV | Set/query the deviation of the distance between two antennas |

- **\$PAIR004 --- Perform GNSS hot start**

Table 5.3-2 contains the values for the following example:

\$PAIR004\*3E

Table 5.3-2 PAIR004 Data Format

| Name       | Example   | Units | Description                |
|------------|-----------|-------|----------------------------|
| Message ID | \$PAIR004 |       | \$PAIR004 protocol header  |
| Checksum   | *3E       |       |                            |
| <CR> <LF>  |           |       | End of message termination |

Response:

\$PAIR001,004,0\*3F\r\n ==> Success

- **\$PAIR005 --- Perform GNSS warm start**

Table 5.3-3 contains the values for the following example:

\$PAIR005\*3F

Table 5.3-3 PAIR005 Data Format

| Name       | Example   | Units | Description                |
|------------|-----------|-------|----------------------------|
| Message ID | \$PAIR005 |       | \$PAIR005 protocol header  |
| Checksum   | *3F       |       |                            |
| <CR> <LF>  |           |       | End of message termination |

Response:

\$PAIR001,005,0\*3E\r\n ==> Success

- **\$PAIR006 --- Perform GNSS cold start**

Table 5.3-4 contains the values for the following example:

\$PAIR006\*3C

Table 5.3-4 PAIR006 Data Format

| Name       | Example   | Units | Description                |
|------------|-----------|-------|----------------------------|
| Message ID | \$PAIR006 |       | \$PAIR006 protocol header  |
| Checksum   | *3C       |       |                            |
| <CR> <LF>  |           |       | End of message termination |

Response:

\$PAIR001,006,0\*3D\r\n ==> Success

- **\$PAIR007 --- Perform GNSS full cold start**

Table 5.3-5 contains the values for the following example:

\$PAIR007\*3D

Table 5.3-5 PAIR007 Data Format

| Name       | Example   | Units | Description                |
|------------|-----------|-------|----------------------------|
| Message ID | \$PAIR007 |       | \$PAIR007 protocol header  |
| Checksum   | *3D       |       |                            |
| <CR> <LF>  |           |       | End of message termination |

Response:

\$PAIR001,007,0\*3C\r\n ==> Success

- **\$PLSC,VER --- Query firmware version**

Table 5.3-6 contains the values for the following example:

\$PLSC,VER\*61

Table 5.3-6 PLSC,VER Data Format

| Name       | Example    | Units | Description                |
|------------|------------|-------|----------------------------|
| Message ID | \$PLSC,VER |       | \$PLSC,VER protocol header |
| Checksum   | *61        |       |                            |
| <CR> <LF>  |            |       | End of message termination |

Response:

\$PLSR,VER,RTK35X,V1.0L0516AY,Lib20220411,857,1\*2A\r\n

- **\$PLSC,FIXRATE --- Set/query update rate**

Table 5.3-7 contains the values for the following example:

\$PLSC,FIXRATE,?\*66

Table 5.3-7 PLSC,FIXRATE Data Format

| Name       | Example        | Units | Description                                                     |
|------------|----------------|-------|-----------------------------------------------------------------|
| Message ID | \$PLSC,FIXRATE |       | \$PLSC,FIXRATE protocol header                                  |
| Rate       | ?              |       | Valid input: 1, 2, 5 or ?.<br>? means to query the update rate. |
| Checksum   | *66            |       |                                                                 |
| <CR> <LF>  |                |       | End of message termination                                      |

Response:

\$PLSR,FIXRATE,5,2,5\*7A\r\n==>Current update rate is 5,default is 2,acceptable maximum is 5.

- **\$PLSC,UART2,{PLSC,ANTDIST --- Set/query the distance between two antennas**

Table 5.3-8 contains the values for the following example:

\$PLSC,UART2,{PLSC,ANTDIST,1550}\*76

Table 5.3-8 PLSC,ANTDIST Data Format

| Name       | Example          | Units | Description                    |
|------------|------------------|-------|--------------------------------|
| Message ID | \$PLSC,UART2,{PL |       | \$PLSC,ANTDIST protocol header |

|           |            |    |                                                                                                                              |
|-----------|------------|----|------------------------------------------------------------------------------------------------------------------------------|
|           | SC,ANTDIST |    |                                                                                                                              |
| Distance  | 1550       | mm | Set the distance between two antennas. Maximum 65536.<br>Default 0 (disable the function).<br>? means to query the distance. |
| Checksum  | *76        |    |                                                                                                                              |
| <CR> <LF> |            |    | End of message termination                                                                                                   |

Response:

```
$PLSR,UART2,<$PLSC,ANTDIST,1550>*47\r\n
$PLSR,ANTDIST,1550*4D\r\n
```

- **\$PLSC,UART2,{PLSC,ANTDISTDEV --- Set/query the deviation of the distance between two antennas**

Table 5.3-9 contains the values for the following example:

```
$PLSC,UART2,{PLSC,ANTDISTDEV,30}*23
```

Table 5.3-9 PLSC,ANTDISTDEV Data Format

| Name       | Example                       | Units | Description                                                                                                                                                                                                               |
|------------|-------------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Message ID | \$PLSC,UART2,{PLSC,ANTDISTDEV |       | \$PLSC,ANTDISTDEV protocol header                                                                                                                                                                                         |
| Deviation  | 30                            | mm    | Set the deviation of the distance between two antennas in order to filter out the wrong dual-antenna GNSS heading in harsh environment. Maximum 255. Default 0 (disable the function).<br>? means to query the deviation. |
| Checksum   | *09                           |       |                                                                                                                                                                                                                           |
| <CR> <LF>  |                               |       | End of message termination                                                                                                                                                                                                |

Response:

```
$PLSR,UART2,<$PLSC,ANTDISTDEV,30>*12
$PLSR,ANTDISTDEV,30*18\r\n
```

## 5.4 UBX output message for ArduPilot

Baudrate: 460800 bps

### ● UBX-NAV-DOP-----Dilution of precision

Table 5.4-1 UBX-NAV-DOP (5Hz) Data Format

|                   |                                                                                                                                                  |         |      |                |                                          |           |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|---------|------|----------------|------------------------------------------|-----------|
| Message           | UBX-NAV-DOP                                                                                                                                      |         |      |                |                                          |           |
| Description       | Dilution of precision                                                                                                                            |         |      |                |                                          |           |
| Comment           | DOP values are dimensionless.<br>All DOP values are scaled by a factor of 100. If the unit transmits a value of e.g. 156, the DOP value is 1.56. |         |      |                |                                          |           |
| Message Structure | Header                                                                                                                                           | Class   | ID   | Length (Bytes) | Payload                                  | Checksum  |
|                   | 0xB5<br>0x62                                                                                                                                     | 0x01    | 0x04 | 18             | see below                                | CK_A CK_B |
| Payload Contents: |                                                                                                                                                  |         |      |                |                                          |           |
| Byte Offset       | Number Format                                                                                                                                    | Scaling | Name | Unit           | Description                              |           |
| 0                 | U4                                                                                                                                               | -       | iTOW | ms             | GPS time of week of the navigation epoch |           |
| 4                 | U2                                                                                                                                               | 0.01    | gDOP | -              | Geometric DOP                            |           |
| 6                 | U2                                                                                                                                               | 0.01    | pDOP | -              | Position DOP                             |           |
| 8                 | U2                                                                                                                                               | 0.01    | tDOP | -              | Time DOP                                 |           |
| 10                | U2                                                                                                                                               | 0.01    | vDOP | -              | Vertical DOP                             |           |
| 12                | U2                                                                                                                                               | 0.01    | hDOP | -              | Horizontal DOP                           |           |
| 14                | U2                                                                                                                                               | 0.01    | nDOP | -              | Northing DOP                             |           |
| 16                | U2                                                                                                                                               | 0.01    | eDOP | -              | Easting DOP                              |           |

### ● UBX-NAV-PVT----- Navigation position velocity time solution

Table 5.4-2 UBX-NAV-PVT (5Hz) Data Format

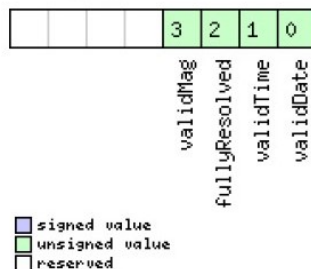
|                   |                                                                                                                                                                                                                                      |       |    |                |         |          |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|----|----------------|---------|----------|
| Message           | UBX-NAV-PVT                                                                                                                                                                                                                          |       |    |                |         |          |
| Description       | Navigation position velocity time solution                                                                                                                                                                                           |       |    |                |         |          |
| Comment           | This message combines position, velocity and time solution, including accuracy figures.<br>Note that during a leap second there may be more or less than 60 seconds in a minute.<br>See the description of leap seconds for details. |       |    |                |         |          |
| Message Structure | Header                                                                                                                                                                                                                               | Class | ID | Length (Bytes) | Payload | Checksum |

|                   | 0xB5<br>0x62  | 0x01    | 0x07    | 92    | see below                                                                                                                               | CK_A CK_B |
|-------------------|---------------|---------|---------|-------|-----------------------------------------------------------------------------------------------------------------------------------------|-----------|
| Payload Contents: |               |         |         |       |                                                                                                                                         |           |
| Byte Offset       | Number Format | Scaling | Name    | Unit  | Description                                                                                                                             |           |
| 0                 | U4            | -       | iTOW    | ms    | GPS time of week of the navigation epoch.<br>See the description of iTOW for details.                                                   |           |
| 4                 | U2            | -       | year    | y     | Year (UTC)                                                                                                                              |           |
| 6                 | U1            | -       | month   | month | Month, range 1..12 (UTC)                                                                                                                |           |
| 7                 | U1            | -       | day     | d     | Day of month, range 1..31 (UTC)                                                                                                         |           |
| 8                 | U1            | -       | hour    | h     | Hour of day, range 0..23 (UTC)                                                                                                          |           |
| 9                 | U1            | -       | min     | min   | Minute of hour, range 0..59 (UTC)                                                                                                       |           |
| 10                | U1            | -       | sec     | s     | Seconds of minute, range 0..60 (UTC)                                                                                                    |           |
| 11                | X1            | -       | valid   | -     | Validity flags (see graphic below)                                                                                                      |           |
| 12                | U4            | -       | tAcc    | ns    | Time accuracy estimate (UTC)                                                                                                            |           |
| 16                | I4            | -       | nano    | ns    | Fraction of second, range -1e9 .. 1e9 (UTC)                                                                                             |           |
| 20                | U1            | -       | fixType | -     | GNSS fix Type<br>0: no fix<br>1: dead reckoning only<br>2: 2D-fix<br>3: 3D-fix<br>4: GNSS + dead reckoning combined<br>5: time only fix |           |
| 21                | X1            | -       | flags   | -     | Fix status flags (see graphic below)                                                                                                    |           |
| 22                | X1            | -       | flags2  | -     | Additional flags (see graphic below)                                                                                                    |           |
| 23                | U1            | -       | numSV   | -     | Number of satellites used in Nav Solution                                                                                               |           |
| 24                | I4            | 1e-7    | lon     | deg   | Longitude                                                                                                                               |           |
| 28                | I4            | 1e-7    | lat     | deg   | Latitude                                                                                                                                |           |
| 32                | I4            | -       | height  | mm    | Height above ellipsoid                                                                                                                  |           |
| 36                | I4            | -       | hMSL    | mm    | Height above mean sea level                                                                                                             |           |
| 40                | U4            | -       | hAcc    | mm    | Horizontal accuracy estimate                                                                                                            |           |
| 44                | U4            | -       | vAcc    | mm    | Vertical accuracy estimate                                                                                                              |           |
| 48                | I4            | -       | velN    | mm/s  | NED north velocity                                                                                                                      |           |

|    |       |      |           |      |                                                                                                                             |
|----|-------|------|-----------|------|-----------------------------------------------------------------------------------------------------------------------------|
| 52 | I4    | -    | velE      | mm/s | NED east velocity                                                                                                           |
| 56 | I4    | -    | velD      | mm/s | NED down velocity                                                                                                           |
| 60 | I4    | -    | gSpeed    | mm/s | Ground Speed (2-D)                                                                                                          |
| 64 | I4    | 1e-5 | headMot   | deg  | Heading of motion (2-D)                                                                                                     |
| 68 | U4    | -    | sAcc      | mm/s | Speed accuracy estimate                                                                                                     |
| 72 | U4    | 1e-5 | headAcc   | deg  | Heading accuracy estimate (both motion and vehicle)                                                                         |
| 76 | U2    | 0.01 | pDOP      | -    | Position DOP                                                                                                                |
| 78 | X2    | -    | flags3    | -    | Additional flags (see graphic below)                                                                                        |
| 80 | U1[4] | -    | reserved1 | -    | Reserved                                                                                                                    |
| 84 | I4    | 1e-5 | headVeh   | deg  | Heading of vehicle (2-D), this is only valid when headVehValid is set, otherwise the output is set to the heading of motion |
| 88 | I2    | 1e-2 | magDec    | deg  | Magnetic declination.<br>Doesn't support function.                                                                          |
| 90 | U2    | 1e-2 | magAcc    | deg  | Magnetic declination accuracy.<br>Doesn't support function.                                                                 |

### Bitfield valid

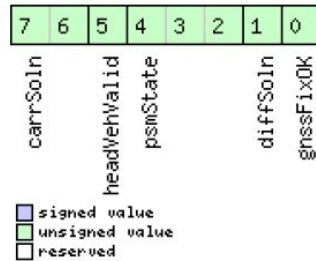
This graphic explains the bits of valid



| Name          | Description                                                                                                                 |
|---------------|-----------------------------------------------------------------------------------------------------------------------------|
| validDate     | 1 = valid UTC Date (see <a href="#">Time Validity</a> section for details)                                                  |
| validTime     | 1 = valid UTC time of day (see <a href="#">Time Validity</a> section for details)                                           |
| fullyResolved | 1 = UTC time of day has been fully resolved (no seconds uncertainty). Cannot be used to check if time is completely solved. |
| validMag      | 1 = valid magnetic declination                                                                                              |

### Bitfield flags

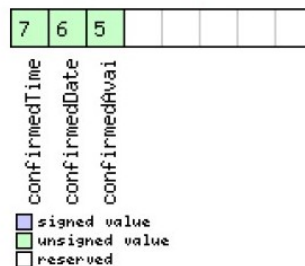
This graphic explains the bits of flags



| Name         | Description                                                                                                                                                                                                                                                             |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| gnssFixOK    | 1 = valid fix (i.e within DOP & accuracy masks)                                                                                                                                                                                                                         |
| diffSoln     | 1 = differential corrections were applied                                                                                                                                                                                                                               |
| headVehValid | 1 = heading of vehicle is valid, only set if the receiver is in sensor fusion mode                                                                                                                                                                                      |
| carrSoln     | Carrier phase range solution status:<br>0: no carrier phase range solution<br>1: carrier phase range solution with floating ambiguities<br>2: carrier phase range solution with fixed ambiguities<br>(not supported in <a href="#">protocol versions less than 20</a> ) |

### Bitfield flags2

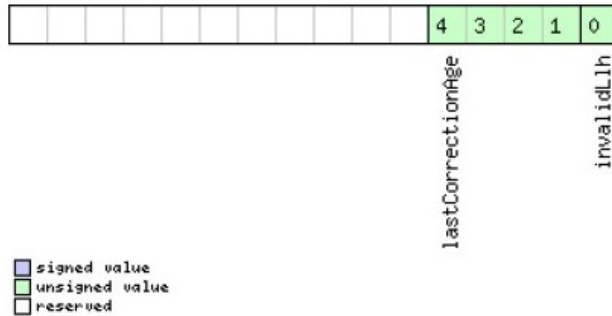
This graphic explains the bits of flags2



| Name          | Description                                                                                                                                                                                                                                                                           |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| confirmedAvai | 1 = information about UTC Date and Time of Day validity confirmation is available (see <a href="#">Time Validity</a> section for details)<br><br>This flag is only supported in <a href="#">Protocol Versions 19.00, 19.10, 20.10, 20.20, 20.30, 22.00, 23.00, 23.01, 27 and 28</a> . |
| confirmedDate | 1 = UTC Date validity could be confirmed (see <a href="#">Time Validity</a> section for details)                                                                                                                                                                                      |
| confirmedTime | 1 = UTC Time of Day could be confirmed (see <a href="#">Time Validity</a> section for details)                                                                                                                                                                                        |

## Bitfield flags3

This graphic explains the bits of flags3



| Name              | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| invalidLlh        | 1 = Invalid lon, lat, height and hMSL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| lastCorrectionAge | Age of the most recently received differential correction:<br>0: Not available<br>1: Age between 0 and 1 second<br>2: Age between 1 (inclusive) and 2 seconds<br>3: Age between 2 (inclusive) and 5 seconds<br>4: Age between 5 (inclusive) and 10 seconds<br>5: Age between 10 (inclusive) and 15 seconds<br>6: Age between 15 (inclusive) and 20 seconds<br>7: Age between 20 (inclusive) and 30 seconds<br>8: Age between 30 (inclusive) and 45 seconds<br>9: Age between 45 (inclusive) and 60 seconds<br>10: Age between 60 (inclusive) and 90 seconds<br>11: Age between 90 (inclusive) and 120 seconds<br>>=12: Age greater or equal than 120 seconds |

## ● UBX-NAV-RELPOSNED ----- Relative positioning information in NED frame

Table 5.4-3 UBX-NAV-RELPOSNED (5Hz) Data Format

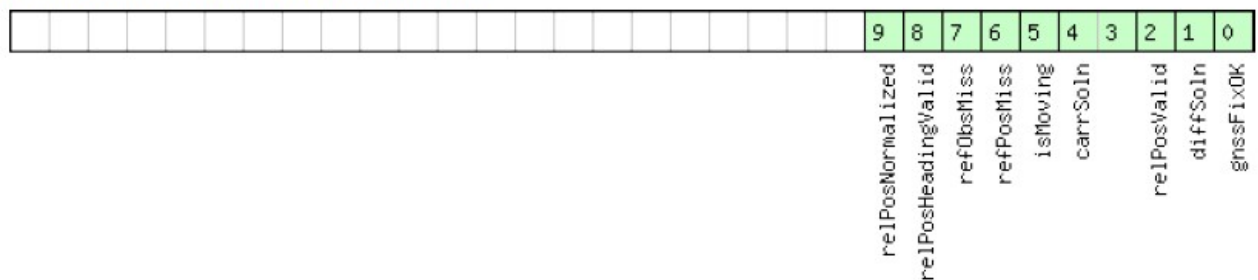
|                   |                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |      |                |           |          |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|------|----------------|-----------|----------|
| Message           | UBX-NAV-RELPOSNED                                                                                                                                                                                                                                                                                                                                                                                                                            |       |      |                |           |          |
| Description       | Relative Positioning Information in NED frame                                                                                                                                                                                                                                                                                                                                                                                                |       |      |                |           |          |
| Comment           | <b>The NED frame is defined as the local topological system at the reference station.</b><br><b>The relative position vector components in this message, along with their associated accuracies, are given in that local topological system.</b><br>This message contains the relative position vector from the Reference Station to the Rover, including accuracy figures, in the local topological system defined at the reference station |       |      |                |           |          |
| Message Structure | Header                                                                                                                                                                                                                                                                                                                                                                                                                                       | Class | ID   | Length (Bytes) | Payload   | Checksum |
|                   | 0xB5<br>0x62                                                                                                                                                                                                                                                                                                                                                                                                                                 | 0x01  | 0x3C | 64             | See below | CK_ACK_B |
| Payload Contents: |                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |      |                |           |          |

| Byte Offset | Number Format | Scaling | Name           | Unit | Description                                                                                                                                                                                                                                        |
|-------------|---------------|---------|----------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0           | U1            | -       | version        | -    | Message version (0x01 for this version)                                                                                                                                                                                                            |
| 1           | U1            | -       | reserved1      | -    | Reserved                                                                                                                                                                                                                                           |
| 2           | U2            | -       | refStationId   | -    | Reference Station ID. Must be in the range 0..4095                                                                                                                                                                                                 |
| 4           | U4            | -       | iTOW           | ms   | GPS time of week of the navigation epoch. See the description of iTOW for details.                                                                                                                                                                 |
| 8           | I4            | -       | relPosN        | cm   | North component of relative position vector                                                                                                                                                                                                        |
| 12          | I4            | -       | relPosE        | cm   | East component of relative position vector                                                                                                                                                                                                         |
| 16          | I4            | -       | relPosD        | cm   | Down component of relative position vector                                                                                                                                                                                                         |
| 20          | I4            | -       | relPosLength   | cm   | Length of the relative position vector                                                                                                                                                                                                             |
| 24          | I4            | 1e-5    | relPosHeading  | deg  | Heading of the relative position vector                                                                                                                                                                                                            |
| 28          | U1[4]         | -       | reserved2      | -    | Reserved                                                                                                                                                                                                                                           |
| 32          | I1            | 0.1     | relPosHPN      | mm   | High-precision North component of relative position vector.<br>Must be in the range -99 to +99.<br>The full North component of the relative position vector, in units of cm, is given by $\text{relPosN} + (\text{relPosHPN} * 1e-2)$              |
| 33          | I1            | 0.1     | relPosHPE      | mm   | High-precision East component of relative position vector.<br>Must be in the range -99 to +99.<br>The full East component of the relative position vector, in units of cm, is given by $\text{relPosE} + (\text{relPosHPE} * 1e-2)$                |
| 34          | I1            | 0.1     | relPosHPD      | mm   | High-precision Down component of relative position vector.<br>Must be in the range -99 to +99.<br>The full Down component of the relative position vector, in units of cm, is given by $\text{relPosD} + (\text{relPosHPD} * 1e-2)$                |
| 35          | I1            | 0.1     | relPosHPLength | mm   | High-precision component of the length of the relative position vector.<br>Must be in the range -99 to +99.<br>The full length of the relative position vector, in units of cm, is given by $\text{relPosLength} + (\text{relPosHPLength} * 1e-2)$ |

|    |       |      |            |     |                                                     |
|----|-------|------|------------|-----|-----------------------------------------------------|
| 36 | U4    | 0.1  | accN       | mm  | Accuracy of relative position North component       |
| 40 | U4    | 0.1  | accE       | mm  | Accuracy of relative position East component        |
| 44 | U4    | 0.1  | accD       | mm  | Accuracy of relative position Down component        |
| 48 | U4    | 0.1  | accLength  | mm  | Accuracy of length of the relative position vector  |
| 52 | U4    | 1e-5 | accHeading | deg | Accuracy of heading of the relative position vector |
| 56 | U1[4] | -    | reserved3  | -   | Reserved                                            |
| 60 | X4    | -    | flags      | -   | Flags(see graphic below)                            |

### Bitfield flags

This graphic explains the bits of flags



- signed value
- unsigned value
- reserved

| Name               | Description                                                                                                                                                                                          |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| gnssFixOK          | A valid fix (i.e within DOP & accuracy masks)                                                                                                                                                        |
| diffSoln           | 1 if differential corrections were applied                                                                                                                                                           |
| relPosValid        | 1 if relative position components and accuracies are valid and, in moving base mode only, if baseline is valid                                                                                       |
| carrSoln           | Carrier phase range solution status:<br>0 = no carrier phase range solution<br>1 = carrier phase range solution with floating ambiguities<br>2 = carrier phase range solution with fixed ambiguities |
| isMoving           | 1 if the receiver is operating in moving base mode                                                                                                                                                   |
| refPosMiss         | 1 if extrapolated reference position was used to compute moving base solution this epoch                                                                                                             |
| refObsMiss         | 1 if extrapolated reference observations were used to compute moving base solution this epoch                                                                                                        |
| relPosHeadingValid | 1 if relPosHeading is valid                                                                                                                                                                          |
| relPosNormalized   | 1 if the components of the relative position vector (including the high-precision parts) are normalized                                                                                              |

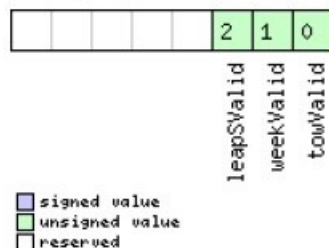
## ● UBX-NAV-TIMEGPS -----GPS time solution

Table 5.4-4 UBX-NAV-TIMEGPS (1Hz) Data Format

|                   |                                                                                                                                     |         |       |                |                                                                                                                        |           |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------|---------|-------|----------------|------------------------------------------------------------------------------------------------------------------------|-----------|
| Message           | UBX-NAV-TIMEGPS                                                                                                                     |         |       |                |                                                                                                                        |           |
| Description       | GPS time solution                                                                                                                   |         |       |                |                                                                                                                        |           |
| Comment           | This message reports the precise GPS time of the most recent navigation solution including validity flags and an accuracy estimate. |         |       |                |                                                                                                                        |           |
| Message Structure | Header                                                                                                                              | Class   | ID    | Length (Bytes) | Payload                                                                                                                | Checksum  |
|                   | 0xB5<br>0x62                                                                                                                        | 0x01    | 0x20  | 16             | see below                                                                                                              | CK_A CK_B |
| Payload Contents: |                                                                                                                                     |         |       |                |                                                                                                                        |           |
| Byte Offset       | Number Format                                                                                                                       | Scaling | Name  | Unit           | Description                                                                                                            |           |
| 0                 | U4                                                                                                                                  | -       | iTOW  | ms             | GPS time of week of the navigation epoch. See the description of iTOW for details.                                     |           |
| 4                 | I4                                                                                                                                  | -       | fTOW  | ns             | Fractional part of iTOW (range: +/- 500000). The precise GPS time of week in seconds is: (iTOW * 1e-3) + (fTOW * 1e-9) |           |
| 8                 | I2                                                                                                                                  | -       | week  | -              | GPS week number of the navigation epoch                                                                                |           |
| 10                | I1                                                                                                                                  | -       | leapS | s              | GPS leap seconds (GPS-UTC)                                                                                             |           |
| 11                | X1                                                                                                                                  | -       | valid | -              | Validity Flags (see graphic below)                                                                                     |           |
| 12                | U4                                                                                                                                  | -       | tAcc  | ns             | Time Accuracy Estimate                                                                                                 |           |

### Bitfield valid

This graphic explains the bits of valid



| Name       | Description                                                                                      |
|------------|--------------------------------------------------------------------------------------------------|
| towValid   | 1 = Valid GPS time of week (iTOW & fTOW, (see <a href="#">Time Validity</a> section for details) |
| weekValid  | 1 = Valid GPS week number (see <a href="#">Time Validity</a> section for details)                |
| leapSValid | 1 = Valid GPS leap seconds                                                                       |

## 5.5 ArduPilot configuration

### 5.5.1 RTK-DUAL 1 port setting

SERIAL4\_PROTOCOL = 5 (GPS) GPS2 port

GPS\_TYPE = 1 (Auto)

GPS\_AUTO\_CONFIG = 0

Set GPS\_POS1\_X/Y/Z and GPS\_POS2\_X/Y/Z

AHRS\_EKF\_TYPE = 3 (to use EKF3)

EK2\_ENABLE = 0 (to disable EKF2)

EK3\_ENABLE = 1 (to enable EKF3)

EK3\_SRC1\_YAW = 2 (“GPS”) or 3 (“GPS with Compass Fallback”)

**Use 1 port setting cannot show gpsyaw on mission planner**

### 5.5.2 RTK-DUAL 2 port setting

- Hex Cube Orange must disable ADSB

ADSB\_TYPE = 0(disable)

SERIAL5\_PROTOCOL = -1(none)

- Disable compass (only for RTK heading test)

COMPASS\_ENABLE = 0(disable)

**RTK-DUAL set command \$PLSC,UBXMSK,2827 both output UART0 and UART1**

SERIAL3\_PROTOCOL = 5 (GPS) GPS1 port

SERIAL4\_PROTOCOL = 5 (GPS) GPS2 port

GPS\_TYPE = 17 (“UBlox moving baseline base”)

GPS\_TYPE2 = 18 (“UBlox moving baseline rover”)

GPS\_AUTO\_CONFIG = 0

Set GPS\_POS1\_X/Y/Z and GPS\_POS2\_X/Y/Z

GPS\_AUTO\_SWITCH = 0

AHRS\_EKF\_TYPE = 3 (to use EKF3)

EK2\_ENABLE = 0 (to disable EKF2)

EK3\_ENABLE = 1 (to enable EKF3)

EK3\_SRC1\_YAW = 2 (“GPS”) or 3 (“GPS with Compass Fallback”)

## 6 Pin assignment and descriptions

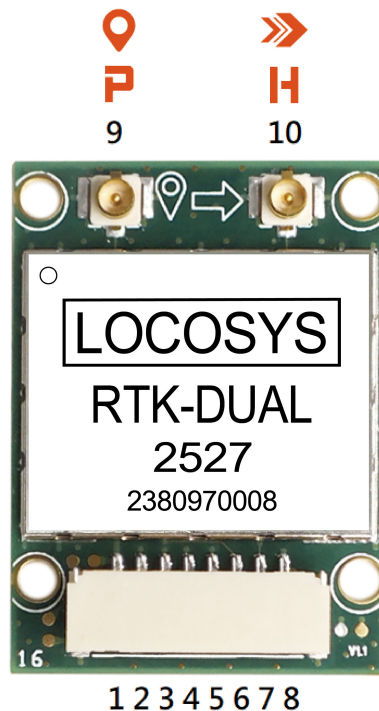
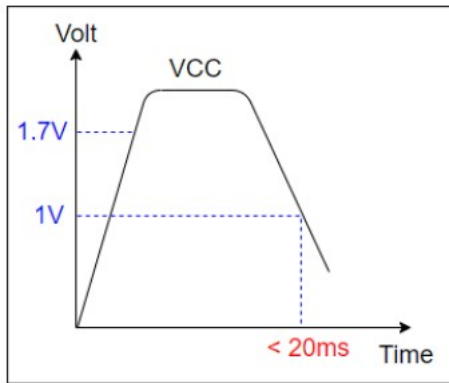


Table 6-1 Pin descriptions

| Pin # | Name   | Type | Description                                                                                                                                                                                        | Note |
|-------|--------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1     | VCC    | I    | DC supply input.                                                                                                                                                                                   | 1    |
| 2     | RX0    | I    | Input of serial interface 0.                                                                                                                                                                       | 2    |
| 3     | TX0    | O    | Output of serial interface 0.                                                                                                                                                                      | 2    |
| 4     | RX1    | I    | Input of serial interface 1.                                                                                                                                                                       | 3    |
| 5     | TX1    | O    | Output of serial interface 1.                                                                                                                                                                      | 3    |
| 6     | V_BCKP | I    | Backup battery input. It is recommended to connect a backup supply voltage to V_BCKP in order to enable warm and hot start features. If these features are not needed, leave this pin unconnected. |      |
| 7     | PPS    | O    | Time pulse (PPS, default 100ms pulse/sec when GNSS fix is available.)                                                                                                                              |      |
| 8     | GND    | P    | Ground.                                                                                                                                                                                            |      |
| 9     | ANT1   | I    | Active antenna input 1. The output position of the module is based on this antenna.                                                                                                                | 4    |
| 10    | ANT2   | I    | Active antenna input 2. Dual-antenna GNSS-based heading is the direction from ANT1 to ANT2.                                                                                                        | 4    |

<Note>

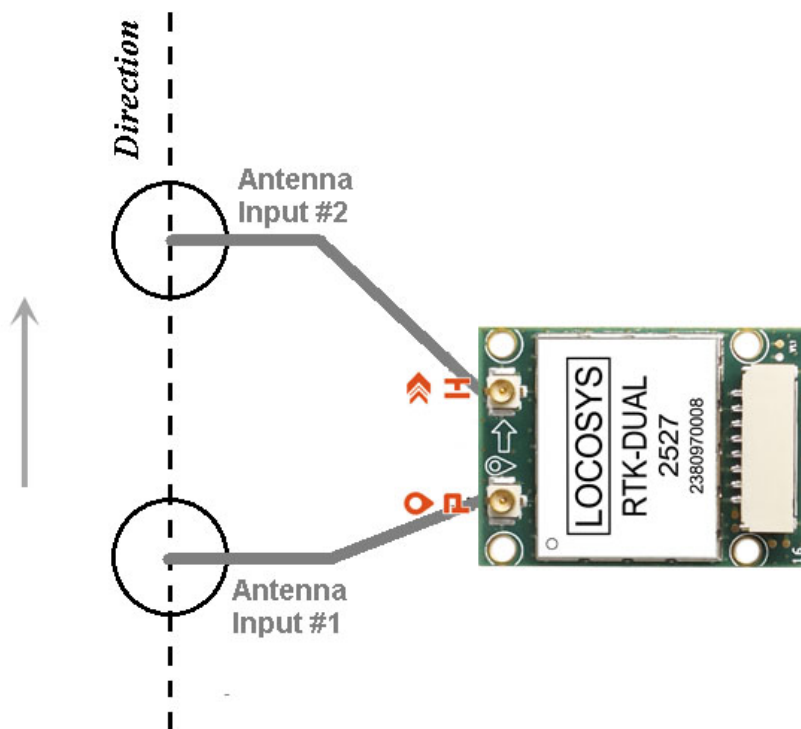
1. The input voltage from 0 to its working voltage must be a stable rising slope. Avoid powering the module at the same time during mechanical contact of the connector. The mechanical contact bounce may result in the following voltage waveform. This may make the module not work. When this happens, VCC and V\_BCKP must be re-powered to enable the module.



2. Main interface for NMEA and RTCM3 messages.
3. RTCM3 messages from the base station can be input from serial interface 0 or serial interface 1 without any setting.
4. The total gain of the active antenna, including antenna gain, insertion loss of SAW, LNA gain, cable loss ... etc., must be between 15dB and 27dB.

## 7 GNSS antenna setup for heading measure

The receiver is always configured to provide precise heading when both antennas are connected and have a clear view of the sky. The Heading is alignment of two antennas from “Antenna Input # 1” to “Antenna Input #2”, and it is relative to True North. As shown in the diagram below:



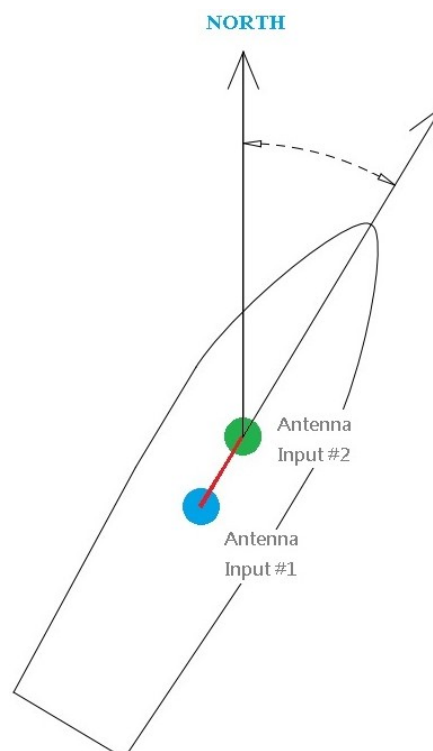
### Heading Accuracy

2° RMS @ 0.1m antenna separation

0.4° RMS @ 0.5m antenna separation

0.2° RMS @ 1m antenna separation

0.1° RMS @ 2m antenna separation



## 8 DC & Temperature characteristics

### 8.1 Absolute maximum ratings

| Parameter                    | Symbol    | Ratings  | Units |
|------------------------------|-----------|----------|-------|
| DC Supply Input Voltage      | VCCabs    | 5.5      | V     |
| Input Backup Battery Voltage | V_BCKPabs | 5.5      | V     |
| Operating Temperature Range  | Topr_abs  | -40 ~ 85 | °C    |
| Storage Temperature Range    | Tstg_abs  | -40 ~ 85 | °C    |

### 8.2 DC Electrical characteristics

| Parameter                         | Symbol           | Conditions               | Min.  | Typ.     | Max. | Units |
|-----------------------------------|------------------|--------------------------|-------|----------|------|-------|
| DC Supply Input Voltage           | VCC              |                          | 3.1   | 3.3      | 5.5  | V     |
| Backup Battery Input Voltage      | V_BCKP           |                          | 2.7   | 3.3      | 5.5  | V     |
| Output Voltage of ANT1 and ANT2   | V_ANT            |                          | 2.9   | 3        | 3.3  | V     |
| DC Supply Current <sup>1,2</sup>  | I <sub>ss</sub>  | VCC = 3.3V<br>VCC = 5.0V |       | 54<br>36 |      | mA    |
| Backup Battery Supply Current     | I <sub>bat</sub> | VCC=0V                   | -40°C | 53       |      | μA    |
|                                   |                  |                          | 25°C  | 78       |      |       |
|                                   |                  |                          | 85°C  | 450      |      |       |
| V_ANT Output Current <sup>3</sup> | I <sub>out</sub> | VCC = 3.3V               |       |          | 90   | mA    |
| High Level Input Voltage          | V <sub>IH</sub>  |                          | 2.2   |          | 3.6  | V     |
| Low Level Input Voltage           | V <sub>IL</sub>  |                          | -0.3  |          | 0.8  | V     |
| High Level Output Voltage         | V <sub>OH</sub>  |                          | 2.18  |          | 3.3  | V     |
| Low Level Output Voltage          | V <sub>OL</sub>  |                          |       |          | 0.4  | V     |

<Note>

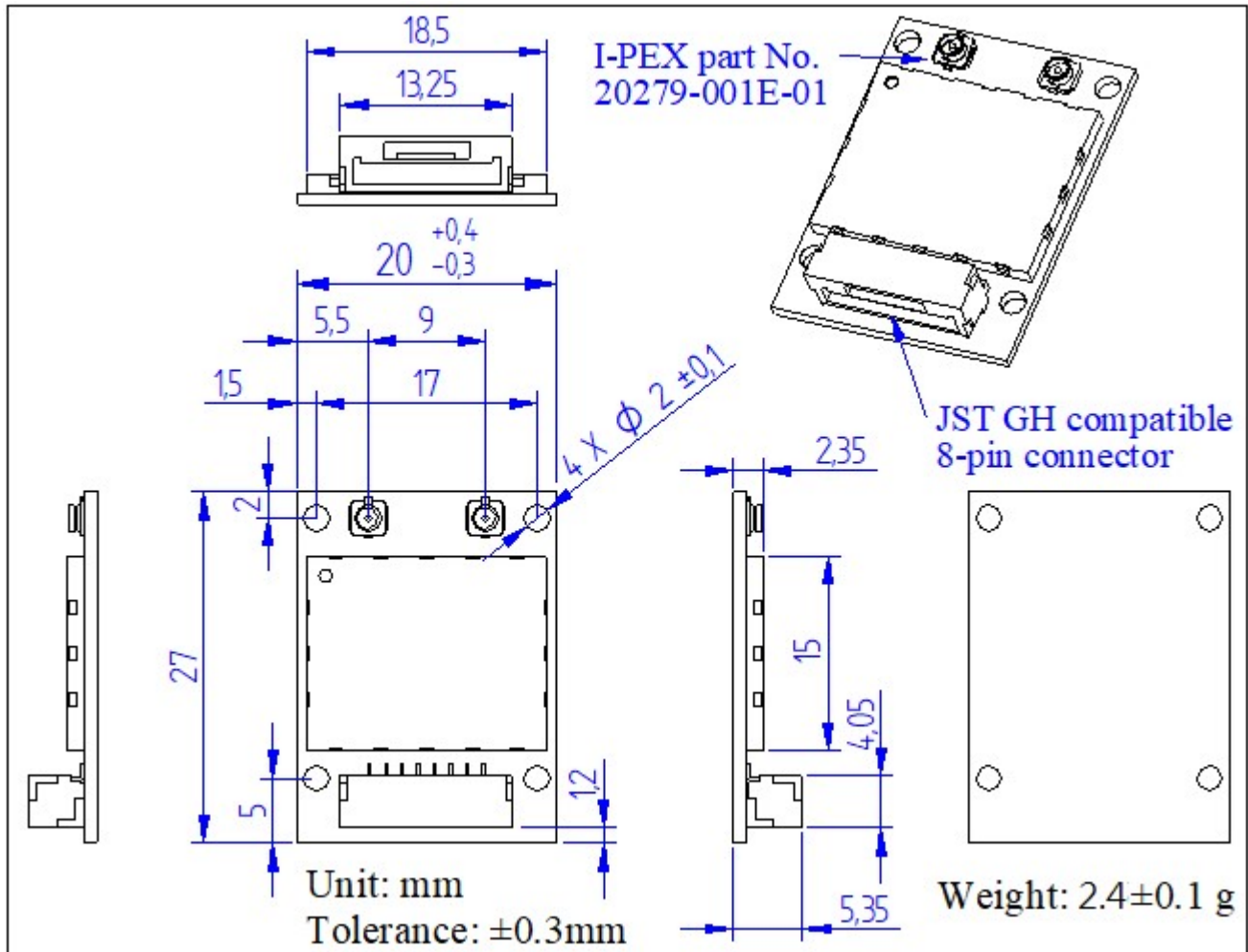
1. Measured when dual-antenna GNSS-based heading and RTK position are available without the power consumption of two external antennas.
2. The inrush current that occurs at the first power-on or “full cold start” command can be as high as 350mA for less than 200μs.
3. A built-in LDO supplies power to both ANT1 and ANT2. The short circuit protection current is about 25mA.

### 8.3 Temperature characteristics

| Parameter             | Symbol | Min. | Typ. | Max. | Units |
|-----------------------|--------|------|------|------|-------|
| Operating Temperature | Topr   | -40  | -    | 85   | °C    |
| Storage Temperature   | Tstg   | -40  | 25   | 85   | °C    |

## 9 Mechanical specification

### 9.1 Outline dimensions

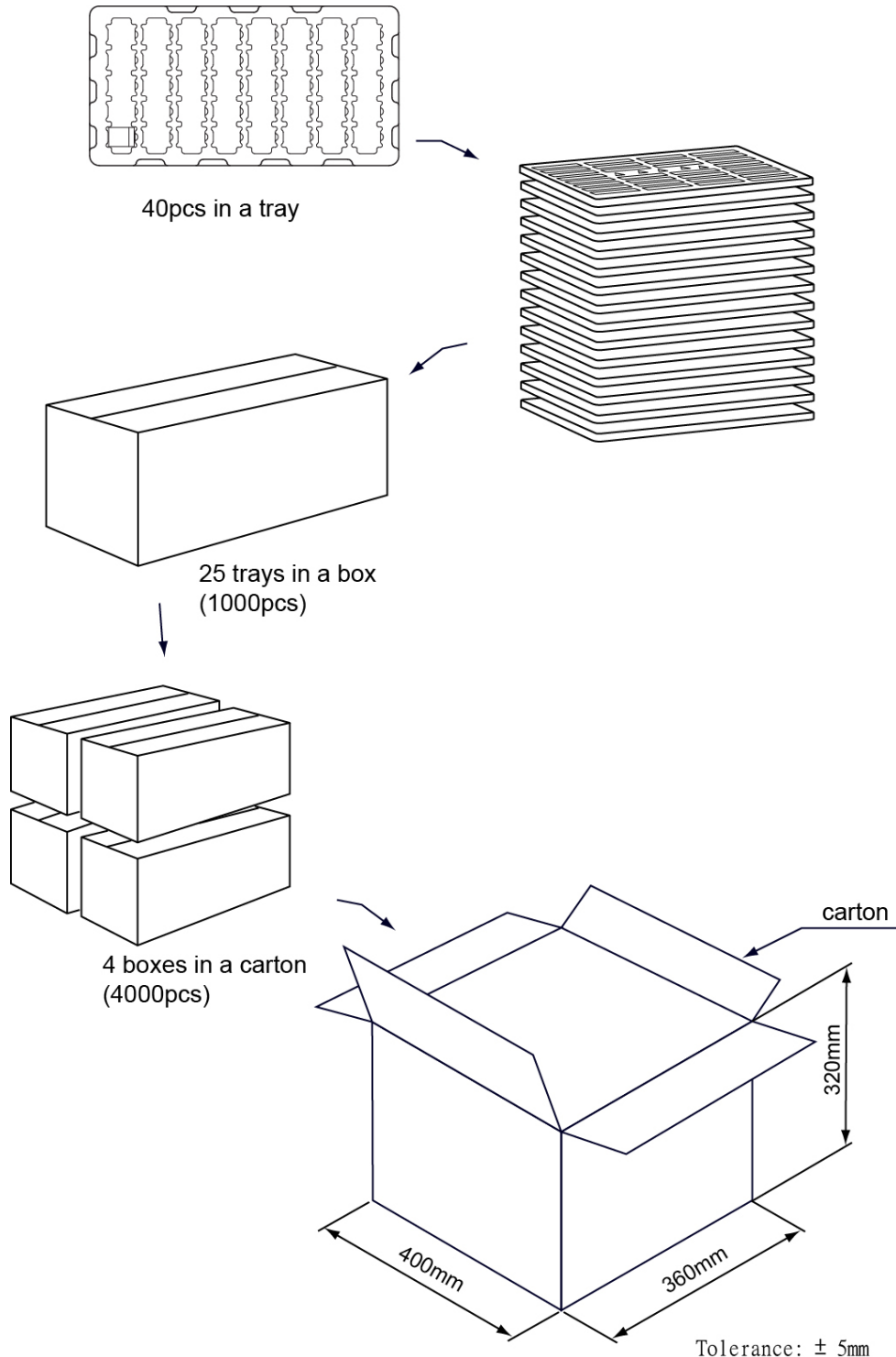


## 10 Product handing

### 10.1 ESD precaution

GNSS modules are electrostatic sensitive devices. Handling the modules without proper ESD protection may result in severe damage to them. ESD protection must be implemented throughout the processing, handling and even when the modules are being returned for repair.

### 10.2 Packaging



### 10.3 Storage

We recommend storing the module in a dry place, such as moisture-proof cabinet. The shelf life of the module package is about 6 months from the packaging date when it is stored in a non-condensing storage environment (<30°C/60% RH).

## 11 Product ordering information

### 11.1 Ordering information

| Product name | Description                                                     | Remark                          |
|--------------|-----------------------------------------------------------------|---------------------------------|
| RTK-DUAL-A   | Multi-system, Multi-frequency RTK Module                        | 115200 bps<br>2Hz NMEA output   |
| RTK-DUAL-B   | Multi-system, Multi-frequency RTK Module with MEMS sensor       |                                 |
| RTK-DUAL-C   | Multi-system, Multi-frequency RTK Module for drone applications | 460800 bps<br>5Hz binary output |

## Document change list

### Revision 0.1

- Draft release on November 21, 2022.

### Revision 0.2 (December 6, 2022)

- Added UBX output message in section 5.4.
- Added ArduPilot configuration in section 5.5.
- Added GNSS antenna setup for heading measure in section 7.

### Revision 0.3 (June 9, 2023)

- Change product's descriptions from RTK Box to RTK Module.
- Change product's appearance photo.
- Changed the heading accuracy from 0.32°, 0.16°, 0.08° to 0.4°, 0.2°, 0.1°, respectively.
- Change product's pin assignment photo in section 6.
- Change product's photo for GNSS antenna setup in section 7.
- Changed the inrush current from 20μs to less than 200μs in section 8.2
- Changed the backup battery supply current from 67 and 330 to 78 and 450, respectively in section 8.2.
- Change product's dimensions photo in section 9.1.
- Added Section 10.

### Revision 1.0 (July 21, 2023)

- Official release.

### Revision 1.1 (September 13, 2023)

- Changed the weight from 2.5g to 2.4g in section 9.1.

### Revision 1.2 (September 27, 2023)

- Changed the default baud rate of RTK-DUAL-C from 230400 to 460800.

### Revision 1.3 (May 23, 2024)

- Revised the description of UBX-NAV-PVT data format (88, 90 Byte Offset) in section 5.4.
- Revised the description of UBX-NAV-RELPOSNED in section 5.4.
- Added the flags graphic explains of UBX-NAV-RELPOSNED in section 5.4.

### Revision 1.4 (January 17, 2025)

- Added the note in section 4.

### Revision 1.5 (August 29, 2025)

- Change product's appearance photo.