

Product name	Description	Version
RTK-DUAL-A	Dual-frequency, Multi-constellation RTK Module	1.4
RTK-DUAL-B	Dual-frequency, Multi-constellation RTK Module with MEMS sensor <b>(Unable to output raw data from MEMS sensor)</b>	
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

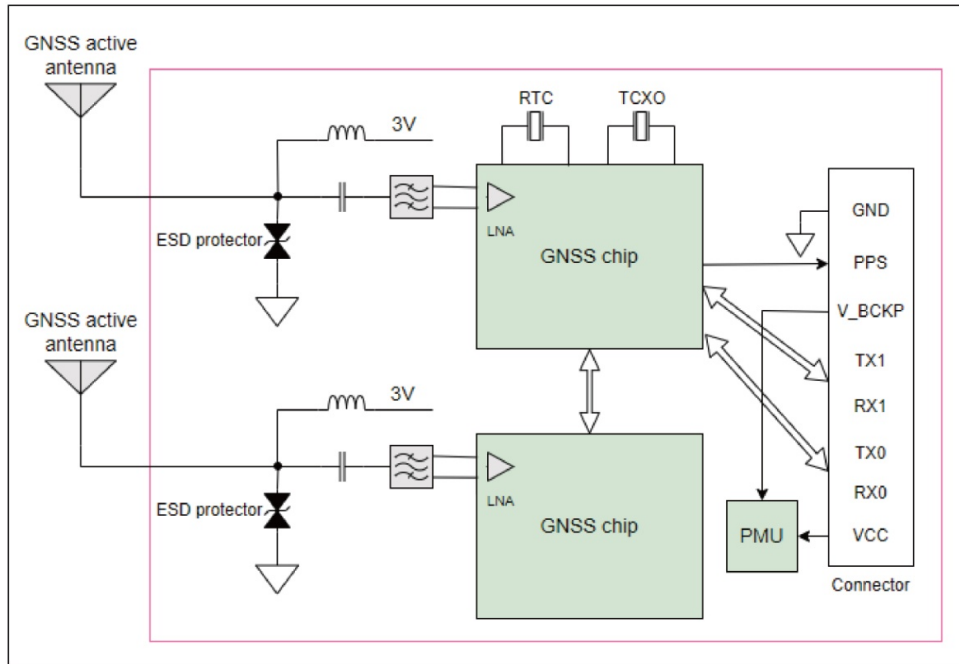


Fig 3-1 System block diagram for RTK-DUAL-A 、RTK-DUAL-C

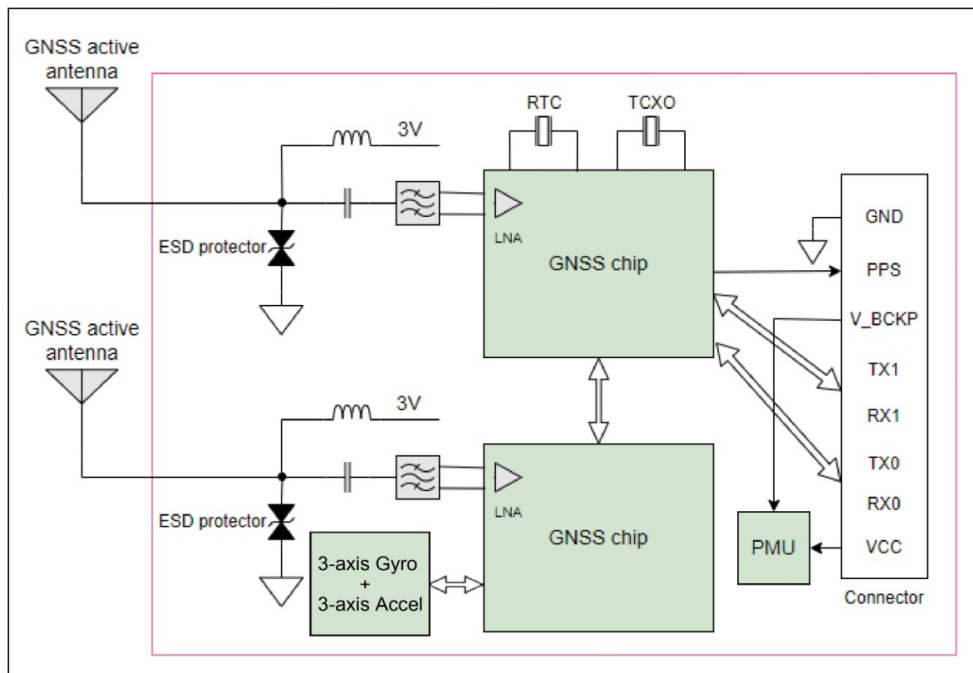


Fig 3-2 System block diagram for RTK-DUAL-B

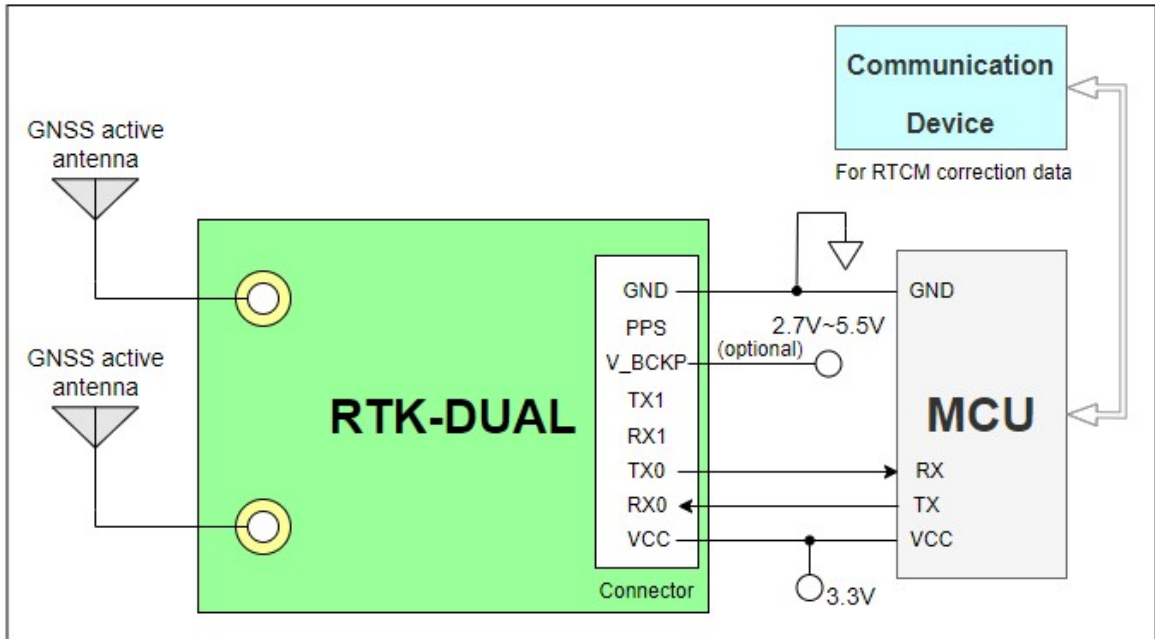


Fig 3-3 Typical application circuit A.

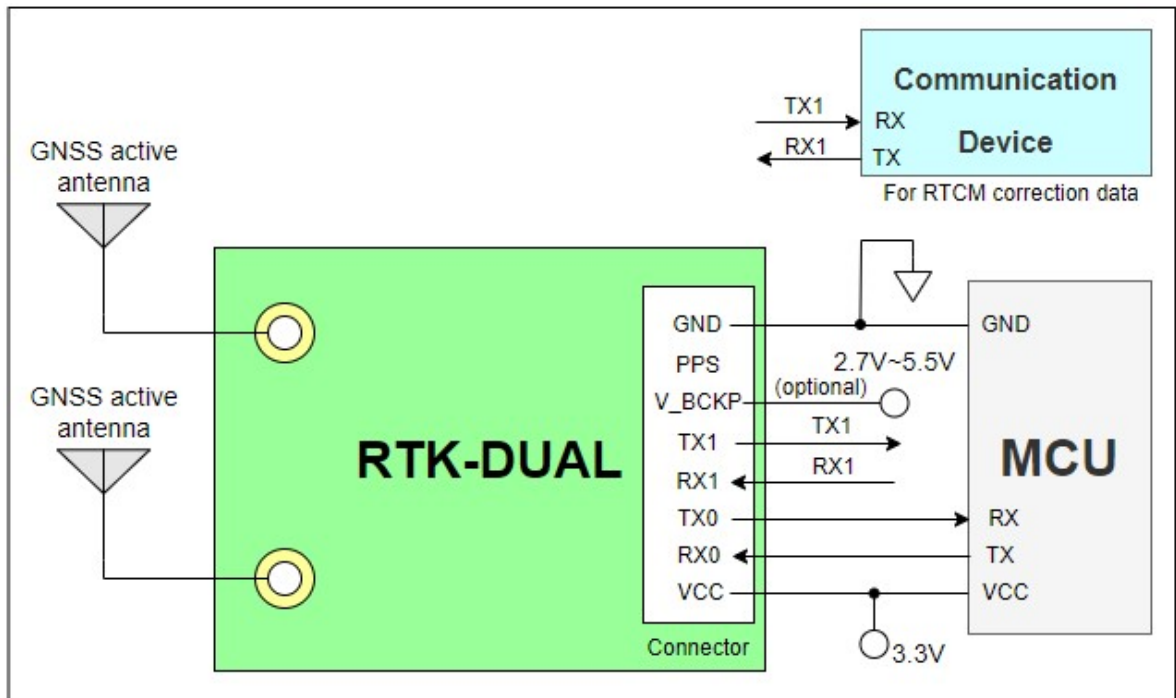


Fig 3-4 Typical application circuit B.

#### 4 GNSS receiver

Frequency	GPS/QZSS: L1 C/A, L5C GLONASS: L1OF GALILEO: E1, E5a 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 1.5cm + 1ppm (vertical) CEP
Heading Accuracy <sup>(2)</sup>	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	
Aided heading <sup>(3)</sup>	Degraded by ≤ 2° (RMS) up to 30 seconds during poor GNSS signals (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 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-RELPOSNEED (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 A = Autonomous GNSS fix D = Differential GNSS fix R = RTK fixed F = RTK float 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 GP=GPS/QZSS, GL=GLONSS, GA=GALILEO, 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 GLONASS: L1 C/A=1 GALILEO: E1=7, E5a=1 BEIDOU: B1=1, B2a=4 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 V = invalid 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 A = Autonomous GNSS fix D = Differential GNSS fix R = RTK fixed F = RTK float E = Estimated/Dead reckoning fix
Navigational status indicator	V		S = Safe C = Caution U = Unsafe 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 A = Autonomous GNSS fix D = Differential GNSS fix R = RTK fixed F = RTK float 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 1: valid data from dual-antenna GNSS 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 ?. ? 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. Default 0 (disable the function). ? 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). ? 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. 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 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. Note that during a leap second there may be more or less than 60 seconds in a minute. See the description of leap seconds for details.					
Message Structure	Header	Class	ID	Length (Bytes)	Payload	Checksum

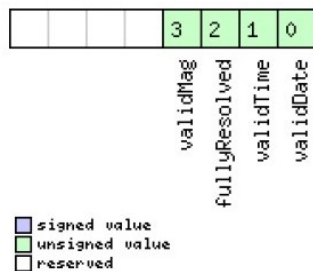
	0xB5 0x62	0x01	0x07	92	see below	CK_A CK_B
Payload Contents:						
Byte Offset	Number Format	Scaling	Name	Unit	Description	
0	U4	-	iTOW	ms	GPS time of week of the navigation epoch. See the description of iTOW for details.	
4	U2	-	year	y	Year (UTC)	
6	U1	-	month	month	Month, range 1..12 (UTC)	
7	U1	-	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 0: no fix 1: dead reckoning only 2: 2D-fix 3: 3D-fix 4: GNSS + dead reckoning combined 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. Doesn't support function.
90	U2	1e-2	magAcc	deg	Magnetic declination accuracy. Doesn't support function.

### Bitfield valid

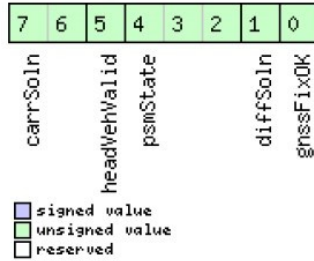
This graphic explains the bits of valid



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

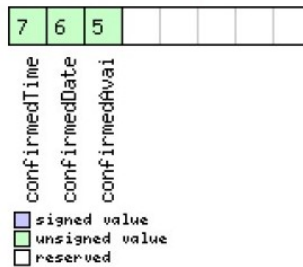
This graphic explains the bits of flags



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: 0: no carrier phase range solution 1: carrier phase range solution with floating ambiguities 2: carrier phase range solution with fixed ambiguities (not supported in <a href="#">protocol versions less than 20</a> )

## Bitfield flags2

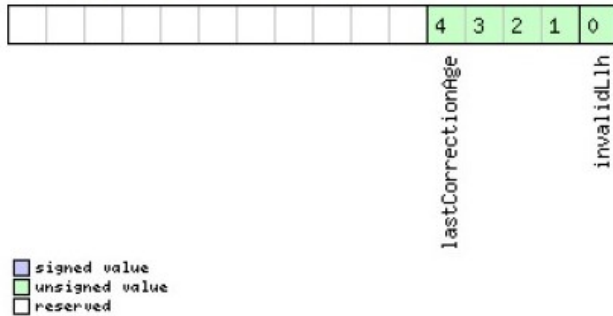
This graphic explains the bits of flags2



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)  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: 0: Not available 1: Age between 0 and 1 second 2: Age between 1 (inclusive) and 2 seconds 3: Age between 2 (inclusive) and 5 seconds 4: Age between 5 (inclusive) and 10 seconds 5: Age between 10 (inclusive) and 15 seconds 6: Age between 15 (inclusive) and 20 seconds 7: Age between 20 (inclusive) and 30 seconds 8: Age between 30 (inclusive) and 45 seconds 9: Age between 45 (inclusive) and 60 seconds 10: Age between 60 (inclusive) and 90 seconds 11: Age between 90 (inclusive) and 120 seconds >=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

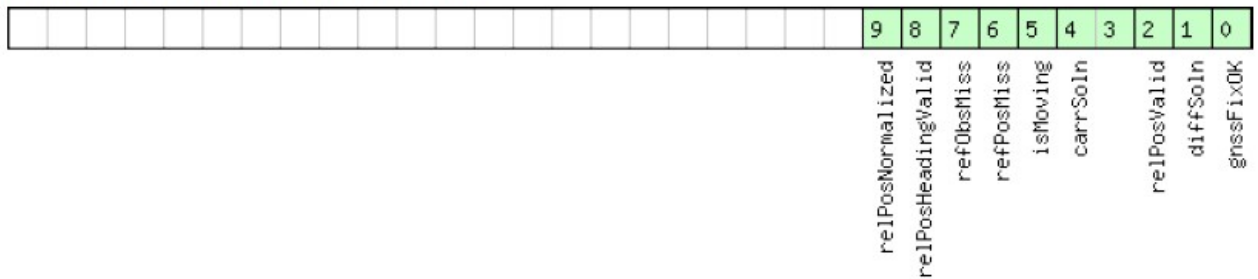
Message	UBX-NAV-RELPOSNED					
Description	Relative Positioning Information in NED frame					
Comment	<p><b>The NED frame is defined as the local topological system at the reference station. The relative position vector components in this message, along with their associated accuracies, are given in that local topological system.</b></p> <p>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</p>					
Message Structure	Header	Class	ID	Length (Bytes)	Payload	Checksum
	0xB5 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. Must be in the range -99 to +99. The full North component of the relative position vector, in units of cm, is given by $relPosN + (relPosHPN * 1e-2)$
33	I1	0.1	relPosHPE	mm	High-precision East component of relative position vector. Must be in the range -99 to +99. The full East component of the relative position vector, in units of cm, is given by $relPosE + (relPosHPE * 1e-2)$
34	I1	0.1	relPosHPD	mm	High-precision Down component of relative position vector. Must be in the range -99 to +99. The full Down component of the relative position vector, in units of cm, is given by $relPosD + (relPosHPD * 1e-2)$
35	I1	0.1	relPosHPLength	mm	High-precision component of the length of the relative position vector. Must be in the range -99 to +99. The full length of the relative position vector, in units of cm, is given by $relPosLength + (relPosHPLength * 1e-2)$

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: 0 = no carrier phase range solution 1 = carrier phase range solution with floating ambiguities 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

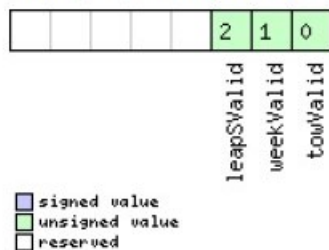
● **UBX-NAV-TIMEGPS -----GPS time solution**

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 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

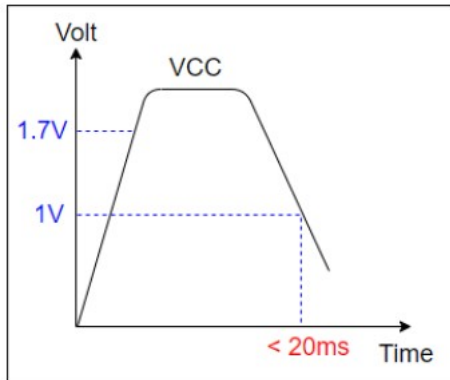
Pin #	Name	Type	Description	Note
1	VCC	I	DC supply input.	1
2	RX0	I	Input of serial interface 0.	2
3	TX0	O	Output of serial interface 0.	2
4	RX1	I	Input of serial interface 1.	3
5	TX1	O	Output of serial interface 1.	3
6	V_BCKP	I	Backup battery input. It is recommended to connect a backup supply voltage 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



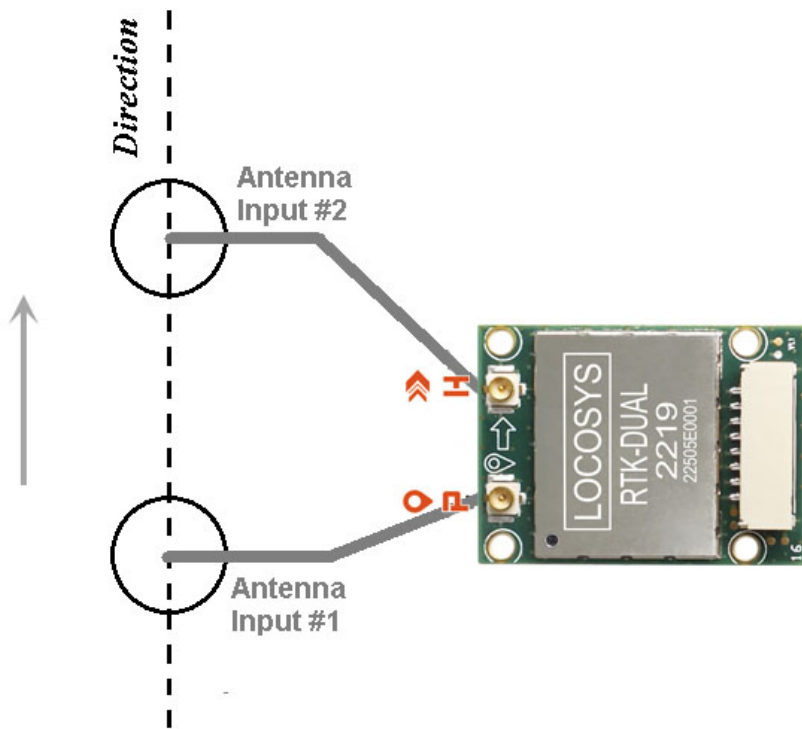
the same time during mechanical contact of the connector. The mechanical contact bounce may result in the following voltage waveform. This may make the module not work. When this happens, VCC and V\_BCKP must be re-powered to enable the module.



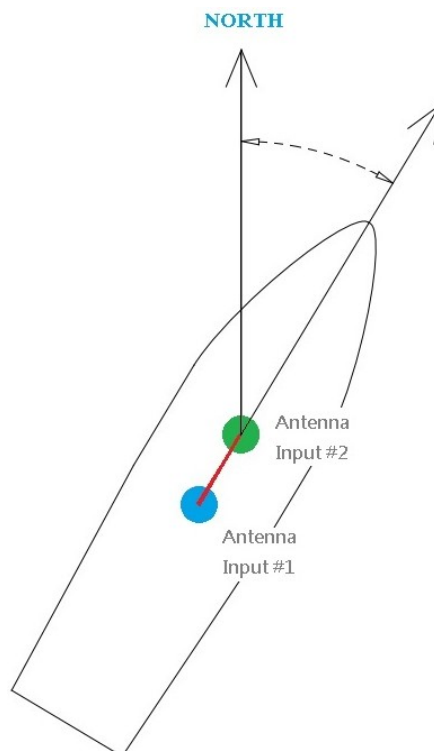
2. Main interface for NMEA and RTCM3 messages.
3. RTCM3 messages from the base station can be input from serial interface 0 or serial interface 1 without any setting.
4. The total gain of the active antenna, including antenna gain, insertion loss of SAW, LNA gain, cable loss ... etc., must be between 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 VCC = 5.0V		54 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

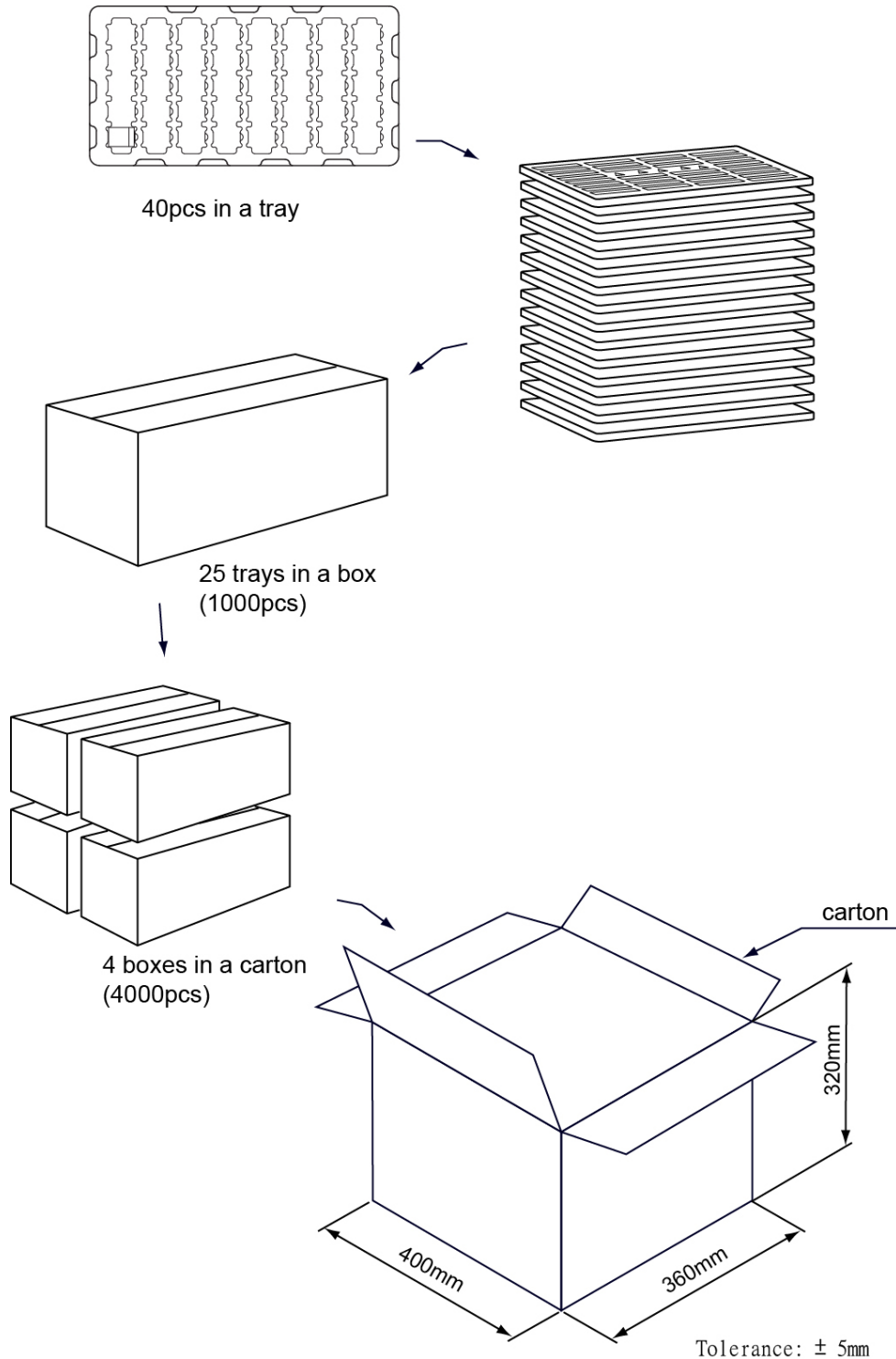


## 10 Product handing

### 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
RTK-DUAL-B	Multi-system, Multi-frequency RTK Module with MEMS sensor	2Hz NMEA output
RTK-DUAL-C	Multi-system, Multi-frequency RTK Module for drone applications	460800 bps 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.