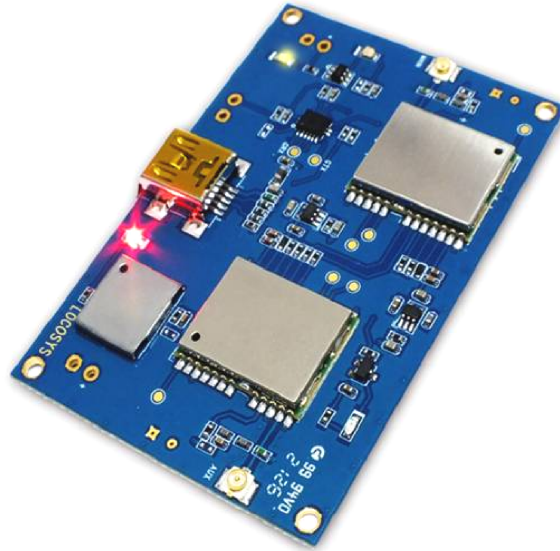


Product name	Description	Version
RTK-4057-MHPD	L1+L5 Dual-Frequency (Position& Orientation) RTK Board	0.7



1. Introduction

LOCOSYS RTK-4057-MHPD is a L1+L5 Dual-Frequency Position with Heading RTK Board, which targeting for precision autonomous guided vehicle, smart agriculture, unmanned aerial vehicle, and any other unmanned system to integrate in.

This receiver board provides fast precise heading and RTK position. It supports global multiple constellations, including GPS, GLONASS, BeiDou, GALILEO, QZSS and SBAS to improve the continuity and reliability of precise heading and RTK position even in the harsh environment.

Besides, it features powerful compatibility with other GNSS receivers in the market by flexible USB interfaces, smart hardware design and output standard NMEA formats. Versatile, compact size, complete driver support, low power and high update rate.

LOCOSYS RTK-4057-MHPD meets *Windows*, *Linux*, *Raspberry Pi* and *Nvidia* developer requirements or system integrator need, and helps you quickly realize unmanned application positioning function.

2. Features

- L1 + L5 Dual-frequency and multi-constellation heading and RTK positioning solution.
- Support GPS, GLONASS, BeiDou, GALILEO, QZSS satellite.
- Capable of SBAS (WAAS, EGNOS, MSAS, GAGAN).
- Dual 135 channels GNSS with dual-antenna input.
- Built in independent short-circuit protection for each antenna input.
- RTK Position Accuracy 1cm CEP.
- Heading accuracy $< 0.2^\circ$ RMS.
- Support proprietary heading and elevation.
- Support 1/5Hz Default.
- Industrial operating temperature range -40 to +85°C.
- Low-power consumption and compact size.
- USB complete driver.
- LOCOSYS IATF 16949 Taiwan certified production sites.

3. Application

- Autonomous Vehicle Guidance
- Unmanned Aerial Vehicles
- Precision Agriculture
- AGV Robotics
- Structural / Land Monitoring
- IPC equipment

4. Product feature

GNSS feature	Description	
Frequency	GPS/QZSS: L1 C/A, L5C	GALILEO: E1, E5a
	GLONASS: L1OF	BEIDOU: B1I, B2a
Channels	Support 135 channels	
Update rate	1/5Hz (default)	
Sensitivity	Tracking	-165dBm (with external LNA)
	Cold start	-148dBm (with external LNA)
Acquisition Time	Cold start	28s (typical)
	RTK Convergence time	< 10s (typical; after 3D fix)
Position Accuracy ⁽¹⁾	Autonomous	< 1.5m CEP
	RTK ⁽²⁾	0.01m + 1ppm (Horizontal)
Heading Accuracy ⁽³⁾	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	
Max. Altitude	< 18,000 m	
Max. Velocity	< 500 m/s	
Protocol Support	NMEA 0183 ver. 4.1	115200 bps ⁽⁴⁾ , 8 data bits, no parity, 1 stop bits (default) 5Hz: GGA, RMC, HDT, PLSHD 1Hz: GSA, GSV
	Raw data	115200 bps, RTCM V3.3, MSM4, MSM5 and MSM7, message type 1005, 1074, 1075, 1077, 1084, 1085, 1087, 1094, 1095, 1097, 1114, 1115, 1117, 1124, 1125, 1127

Note 1: Open sky, dual band, demonstrated with a good external LNA.

Note 2: CEP, 24hr static.

Note 3: 2hr, static, open sky, demonstrated with good active dual-frequency antennas.

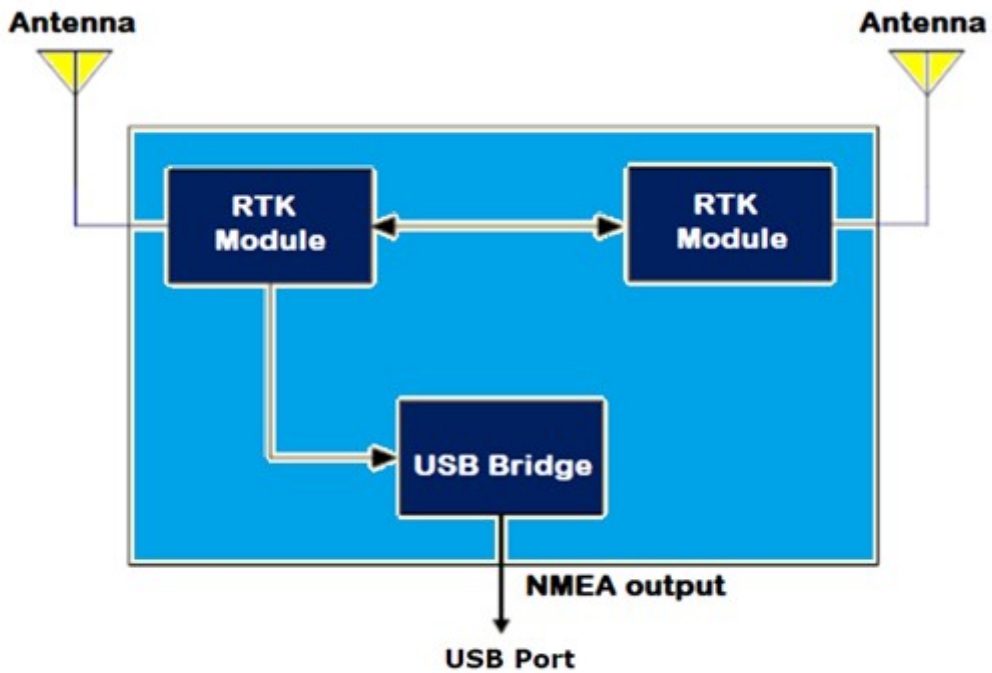
Note 4: Both baud rate output message rate are configurable to be factory default.

CAUTION: For the first test, it is recommended to use an EVK Box; If you use an RTK board, Please use it in a closed environment system, do not use a "bare board" for testing, otherwise it will affect the performance. (Please refer to Chapter 13).

5. Operation Specifications

Parameter	Description	Note
Supply Current	126 mA	w/o active antenna Acquisition Mode
Baud Rate	115200 bps	
Operating Temperature Range	-40~85°C	
Storage Temperature	-40~85°C	

6. Block Diagram



7. Software interface

7.1. NMEA output message

Table 7.1-1 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 7.1-2 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 7.1- 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 7.1-3
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 7.1-3 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 7.1-4 contains the values for the following example:

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

Table 7.1-4 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 7.1-5 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 7.1-5 GSA Data Format

Name	Example	Units	Description
Message ID	\$GNGSA		GSA protocol header
Mode 1	A		See Table 7.1-6
Mode 2	3		See Table 7.1-7
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	4		See Table 7.1-8
Checksum	*3F		
<CR> <LF>			End of message termination

Table 7.1-6 Mode 1

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

Table 7.1-7 Mode 2

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

Table 7.1-8 GNSS system ID

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

● **GSV---GNSS Satellites in View**

Table 7.1-9 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 7.1-9 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 7.1-10 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 7.1-10 RMC Data Format

Name	Example	Units	Description
Message ID	\$GNRMC		RMC protocol header
UTC Time	061730.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
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 7.1-11 contains the values for the following example:

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

Table 7.1-11 VTG Data Format

Name	Example	Units	Description
Message ID	\$GPVTG		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/hr	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 from true north message fields**

Table 7.1-12 contains the values for the following example:

\$GPHDT,94.005,T*0D

Table 7.1-12 GPHDT Data Format

Name	Example	Units	Description
Message ID	\$GPHDT		HDT protocol header
Heading	94.005	degrees	Heading in degrees
Relative to True North	T		Indicates heading relative to True North
Checksum	*0D		
<CR> <LF>			End of message termination

7.2. Proprietary output message

Table 7.2-1 Proprietary output message

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

- **PLSHD --- Dual-antenna GNSS-based heading**

Table 7.2-2 contains the values for the following example:

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

Table 7.2-2 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
Message ID	\$PLSHD		PLSHD protocol header
Valid flag	1		0: invalid data 1: valid data from dual-antenna GNSS 9: valid data from MEMS

7.3. Proprietary input command

Table 7.3-1 Proprietary input message

NMEA like record	Description
\$PAIR004	Perform GNSS hot start
\$PAIR005	Perform GNSS warm start
\$PAIR006	Perform GNSS 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

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

Table 7.3-2 contains the values for the following example:

\$PAIR004*3E

Table 7.3-2 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 7.3-3 contains the values for the following example:

\$PAIR005*3F

Table 7.3-3 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 7.3-4 contains the values for the following example:

\$PAIR006*3C

Table 7.3-4 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

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

Table 7.3-5 contains the values for the following example:

\$PLSC,VER*61

Table 7.3-5 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 7.3-6 contains the values for the following example:

\$PLSC,FIXRATE,*66

Table 7.3-6 PLSC,FIXRATE Data Format

Name	Example	Units	Description
Message ID	\$PLSC,FIXRATE		\$PLSC,FIXRATE protocol header
Rate	?		Valid input: 1, 2, 5, 10 or ?. ? means to query the update rate.
Checksum	*66		
<CR> <LF>			End of message termination

Response:

\$PLSR,FIXRATE,5,2,10*4E \r\n ==> Current update rate is 5, default is 2, acceptable maximum is 10.

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

Table 7.3-7 contains the values for the following example:

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

Table 7.3-7 PLSC,ANTDIST Data Format

Name	Example	Units	Description
Message ID	\$PLSC,UART2, {PLSC,ANTDIST		\$PLSC,ANTDIST protocol header
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 7.3-8 contains the values for the following example:

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

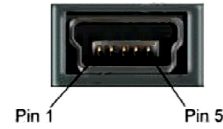
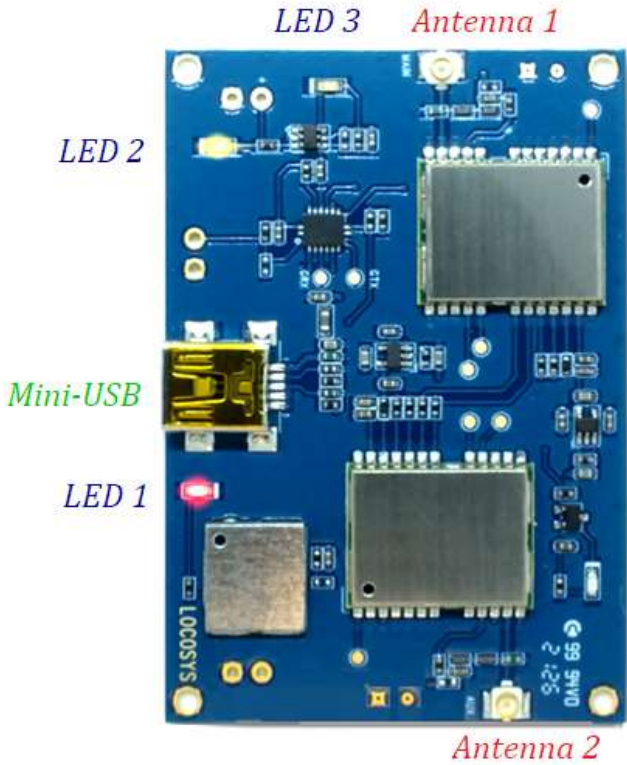
Table 7.3-8 PLSC,ANTDISTDEV Data Format

Name	Example	Units	Description
Message ID	\$PLSC,UART2 PLSC,ANTDISTD EV		\$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

8. Hardware LED State and USB interface



USB Pin	Name	Type	Description
1	VBUS	P	USB power input
2	D-		D- line
3	D+		D+ line
4	GND	P	Ground
5	Shield	P	Ground

LED	Function
LED 1	Power states
LED 2	GNSS TX states
LED 3	lpps states

RTK-4057-MHPD

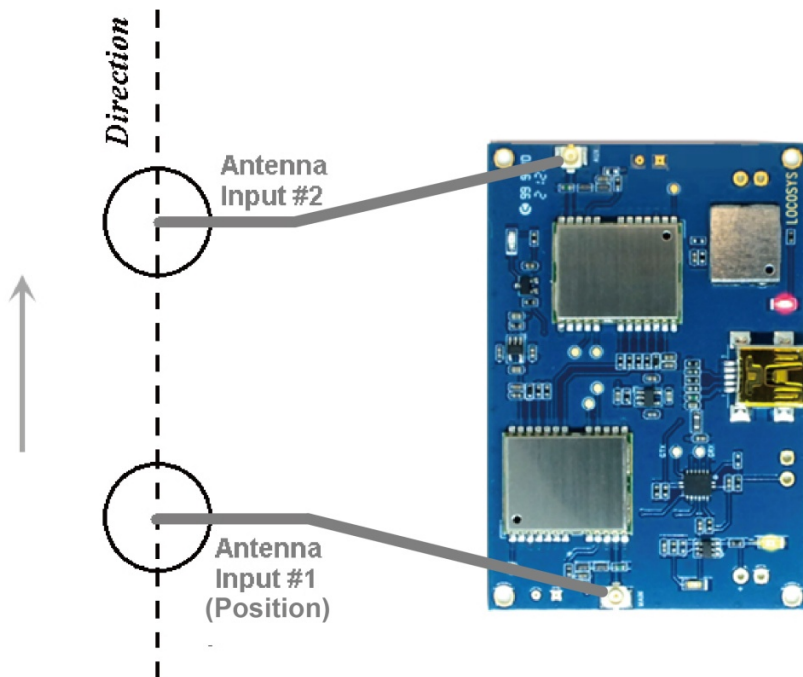


LED	Function
LED 1	Power states
LED 2	GNSS TX states

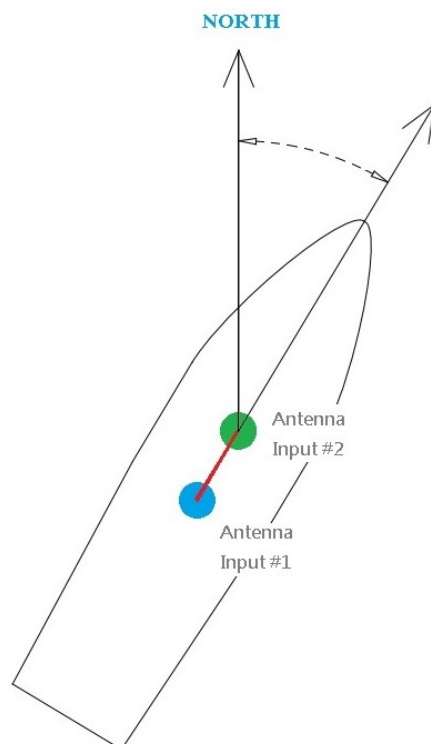
RTK-4057-MHPD EVK Box

9. GNSS antenna setup for heading measure

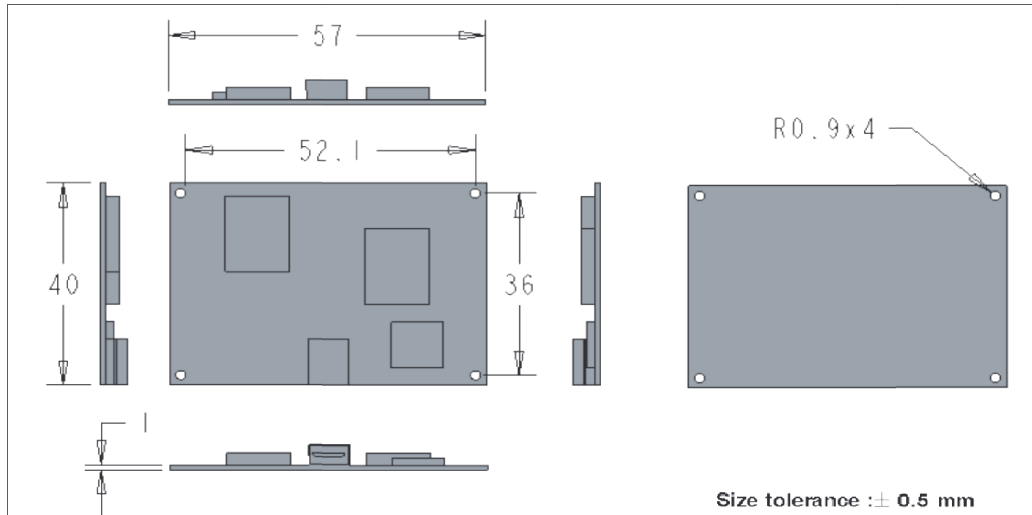
The receiver is always configured to provide precise heading when both antennas are connected and have a clear view of the sky. The Heading is alignment of two antennas from “Antenna Input # 1” to “Antenna Input #2”, and it is relative to True North. As shown in the diagram below:



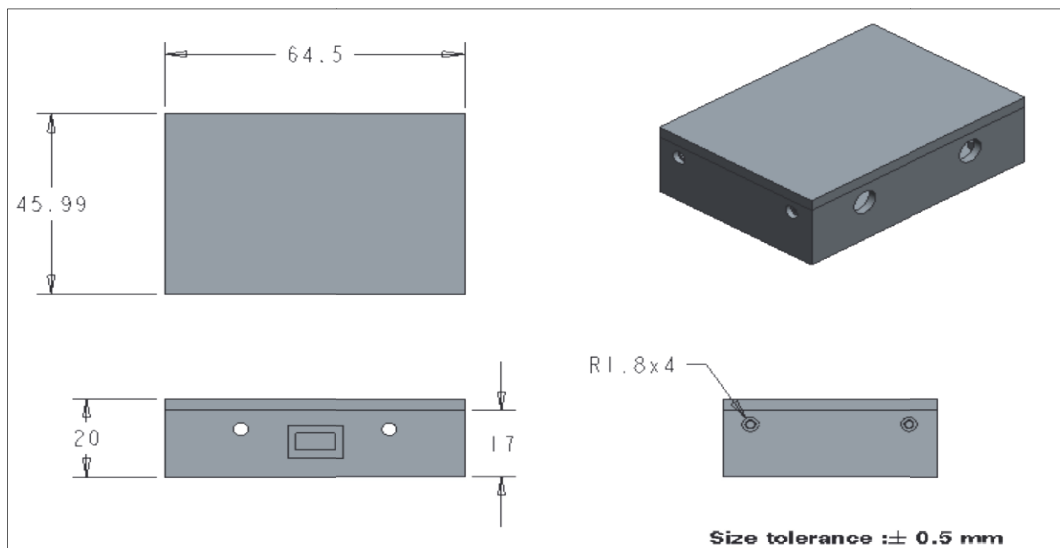
- Heading Accuracy
- 2° RMS @ 0.1m antenna separation
- 0.4° RMS @ 0.5m antenna separation
- 0.2° RMS @ 1m antenna separation
- 0.1° RMS @ 2m antenna separation



10. Dimension Information



RTK-4057-MHPD



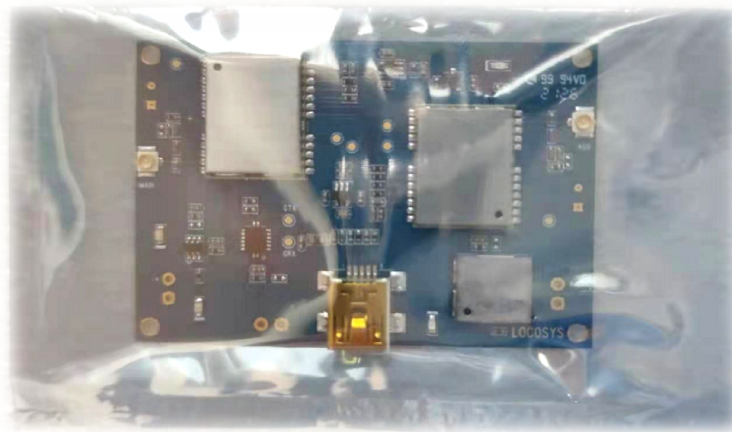
RTK-4057-MHPD EVK Box

11. USB Driver and Test Software Download

Please link to LOCOSYS company website and click RTK-4057-MHPD product icon
<https://www.locosystech.com/en/page/Evaluation-Kit-Testing-Software-Manual/supp-ort-evk.html>

12. Packing Material Information

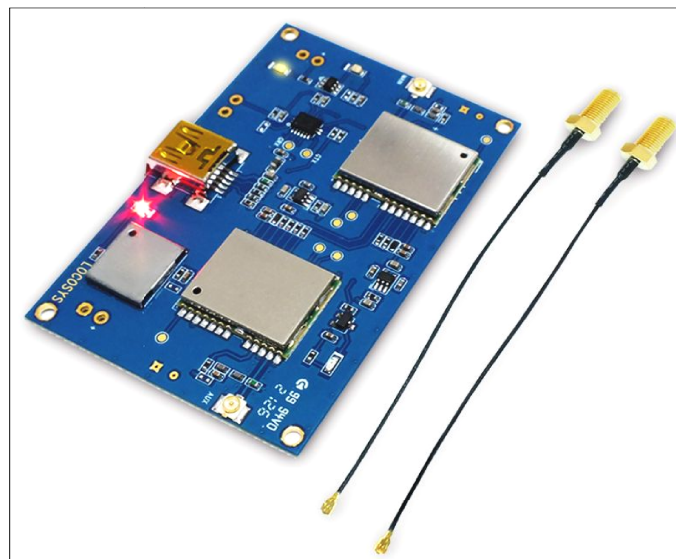
The RTK board are sealed in a moisture barrier ESD bag.



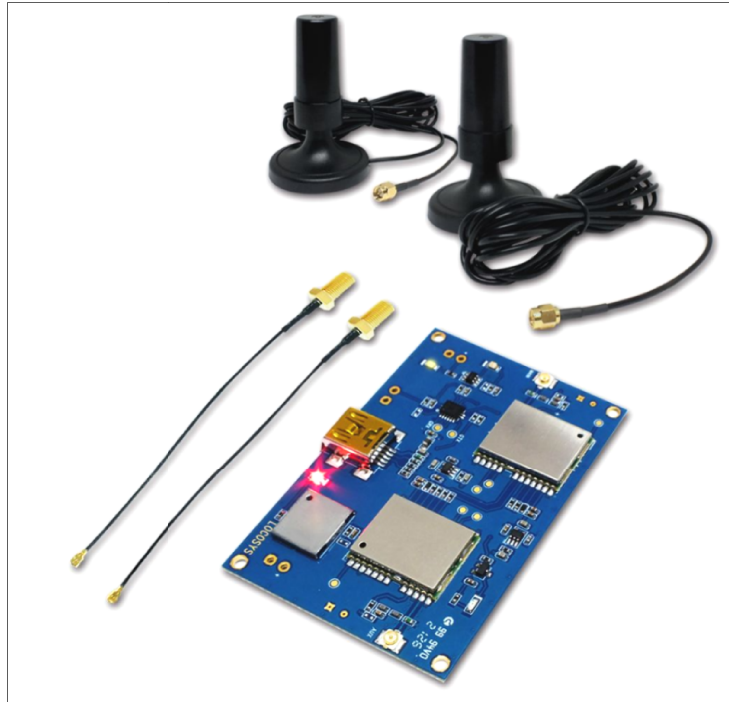
Anti-static bag and waterproof packaging.

13. Recommended to Accessories

CAUTION: For the first test, it is recommended to use an EVK Box **Package (C)** ; If you use an RTK board, Please use it in a closed environment system, do not use a "bare board" for testing, otherwise it will affect the performance.



Package (A) : RTK-4057-MHPD Board + IPEX Cable



Package (B) : RTK-4057-MHPD Board + IPEX Cable + Helix Antenna (LH-105A2-B)



Package (C) : RTK-4057-MHPD EVK Box + Helix Antenna (LH-105A2-B)

Document change list

Revision 0.1

- Draft release on July 21, 2021.

Revision 0.2 (December 2, 2022)

- Added GNSS antenna setup for heading measure in section 9.

Revision 0.3 (December 19, 2022)

- Removed the GLL and VTG default output in the section 4.
- Revised the GSA default output from 5Hz to 1Hz in the section 4.
- Removed power consumption in section 5.
- Added supply current in section 5.

Revision 0.4 (June 2, 2023)

- Added the PLSHD default output in the section 4.
- Added the section 7.2 and 7.3.

Revision 0.5 (June 27, 2023)

- Added the heading accuracy to 2°, 0.4°, 0.1°, respectively in section 4 & 9.

Revision 0.6 (October 17, 2023)

- Changed the maximum update rate from 10Hz to 5Hz.

Revision 0.7 (March 7, 2024)

- Revised protocol support in section 4.
- Revised NMEA GGA, GLL and RMC message in section 7.1.