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Product name	Description	Version
RTK-4671-SHDR	High-Precision GNSS RTK Dead Reckoning Board	0.3

1. Introduction

High-Precision GNSS RTK Dead Reckoning Solution for Smart Driving & Lane Level Navigation

LOCOSYS RTK-4671-SHDR is a high-precision GNSS RTK solution targeting for the smart driving and lane level navigation markets. The newly designed LOCO II engine architecture is optimized to offer a seamless experience in dense urban canyons. The RTK-4671-SHDR takes the shortest time to fix position and continues to work wherever they are.

Centimeter-Level Positioning & Dead Reckoning / Support Rover

RTK-4671-SHDR is a cost-efficient GNSS RTK board for cm-level positioning and accurate raw measurements output, which can be integrated with autopilots and inertial navigation units. RTK-4671-SHDR board supports GPS, GLONASS, BeiDou, GALILEO, QZSS and SBAS constellations to improve the continuity and reliability of the RTK solution even in harsh environment. It features powerful compatibility with other GNSS boards in the market by flexible interfaces, smart hardware design and popular log/command formats adopts Real Time Kinematics (RTK) technology with the correction data from CORS network. It also supports rover absolutions for those which do not have public CORS network, compact solution and the best-in-class low power solution for precise positioning application.

RTK-4671-SHDR is a single-band multi-system with an ARM base processor; RTK-4671-SHDR not only supports GPS, GLONASS, BeiDou, GALILEO, QZSS and SBAS, but also has a flash memory, TCXO, RTC crystal, LNA and SAW filter, and embedded MEMS sensors (6-axis accelerometers + gyros). The high-precision Positioning/Dead Reckoning receiver offers centimeter-accurate positioning and heading with low-power consumption. LOCOSYS ADR/UDR software includes features to receive and use data from the built-in sensors along with external signals for wheel speed and Forward/Reverse direction. The vehicle signals are used to provide a high level of accuracy in the navigation solution.

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2. Features

- Centimeter-level positioning in RTK mode
- Support GPS, GLONASS, BeiDou, GALILEO and QZSS L1
- Capable of SBAS (WAAS, EGNOS, MSAS) Precise navigation, positioning
- Great anti-jamming performance (due to multi-tone active interference canceller).
- Built-in LOCOSYS Dead Reckoning (ADR/UDR) both technology software
- Built-in MEMS sensor (3-axis Gyroscope and 3-axis Accelerometer)
- Support MEMS raw data output, High update rate (up to 100Hz)
- Support Odometer (wheel-tick pulse) input
- Support sensors data feed through the UART port
- Support ADR/UDR Automatic fast learning calibration
- Low-power consumption and compact size
- Current limited feature (limited to 50mA typ.) with active GNSS antennas
- Industrial operating temperature range -40 to +85°C
- Easy and simply to integrate
- LOCOSYS IATF 16949 certified production sites

3. Application

- Autonomous Vehicle Guidance
- Autonomous Vehicle (ex: AVN/T-BOX/HUD)
- Internet of Vehicles
- Unmanned Aerial Vehicles
- Precision Agriculture
- Hand-Held Device
- AGV Robotics
- V2V / V2X System
- Geographical measurement
- Geographical survey points
- Offshore / Marine Applications
- Tracker

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4. Product feature

GNSS feature	Description	
GNSS	Single frequency and Multi-constellation	
DGPS, SBAS	WAAS, EGNOS, MSAS, GAGAN	
Channels	99 channels	
Update rate	1Hz	
Acquisition Time[1]	Cold start	35s (typical)
	RTK initialization time	< 10s (after 3D fix)
	initialization reliability	99.9%
Position Accuracy[2]	Autonomous	< 1.5m CEP
	SBAS	< 1.5m (depends on accuracy of correction data)
	RTK[3]	0.01m + 1ppm CEP
	ADR mode[4]	Avg 0.5% of distance travelled during GNSS outages
	UDR mode[4]	Avg 5% of distance travelled during GNSS outages
Limitations	Max. Altitude	< 18,000 m, up to 50,000m by request
	Max. Velocity	< 515 m/s
Navigation Outputs	NMEA 0183 ver. 4.1	115200 bps, 8 data bits, no parity, 1 stop bit (default) 1Hz: GGA, GLL, GSA, RMC, GSV, VTG, GST, SVD
Correction Input	RTCM-3.3	115200 bps, 8 data bits, no parity, 1 stop bits

Note 1: Acquisition time and position accuracy may be affected by atmospheric conditions, signal multipath, satellite geometry and corrections availability and quality.

Note 2: All position values are based on Horizontal position accuracy.

Note 3: Measured using 1 km baseline and patch antennas with good ground planes.

Note 4: Typical error incurred without GNSS as a percentage of distance travelled.

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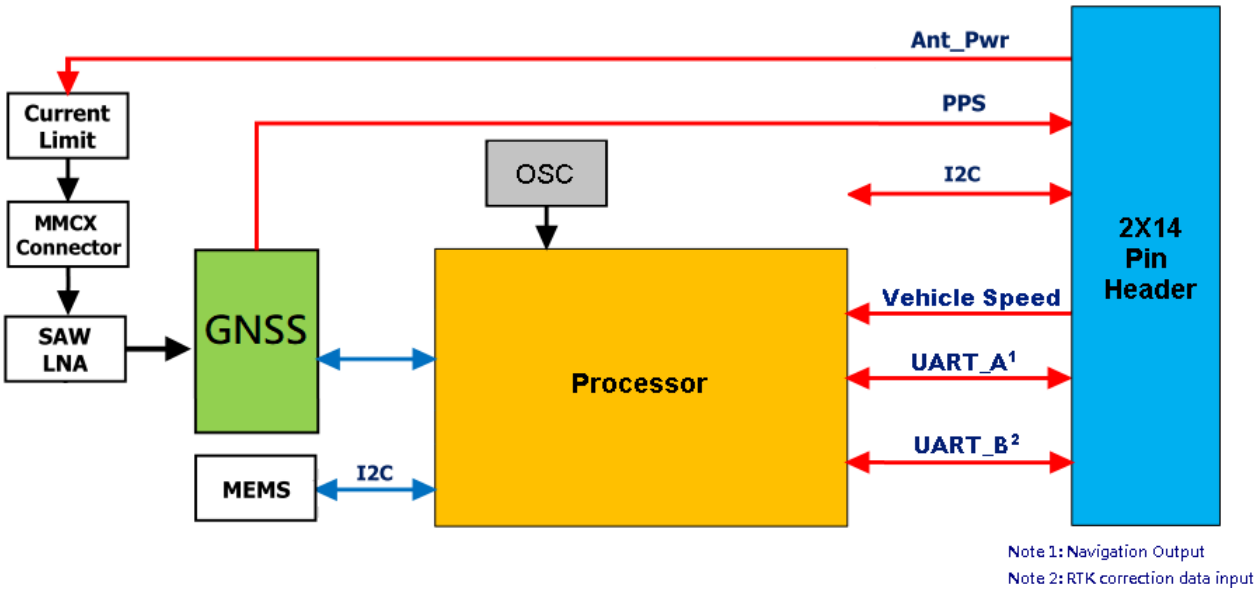
5. Block diagram



6. Pin definition

6.1. Pin assignment

Top View

28	SCL	SDA	27
26	NC	NC	25
24	Forward	PPS	23
22	GND	Reserved	21
20	GND	UART_B_RX	19
18	UART_B_TX	GND	17
16	UART_A_RX	UART_A_TX	15
14	GND	Reserved	13
12	WHEELTICK	SPEED_RXD	11
10	NC	/RESET_IN	9
8	Reserved	NC	7
6	VIN	Reserved	5
4	VBAT_GNSS	NC	3
2	NC	NC	1

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6.2. Pin description

Pin No	Name	Description
1	NC	Not connected
2	NC	Not connected
3	NC	Not connected
4	VBAT_GNSS	GNSS backup power supply. optional
5	Reserved	Microprocessor BOOT pin, this pin should be left floating
6	VIN	Device power supply
7	NC	Not connected
8	Reserved	Reserved, this pin should be left floating
9	RESET_IN	Device reset input, Low active
10	NC	Not connected
11	SPEED_RXD	UART_C, RXD, receiver asynchronous input
12	WHEELTICK	Odometer wheel-tick input. Leave floating if not used.
13	Reserved	Reserved, this pin should be left floating
14	GND	Ground
15	TXD_A	UART_A, transmitter output (Default NMEA)
16	RXD_A	UART_A, receiver input (Default NMEA)
17	GND	Ground
18	TXD_B	**UART_B transmitter output**
19	RXD_B	**UART_B receiver input, receive RTCM data streaming from base station to resolve RTK solutions.**
20	GND	Ground
21	Reserved	Reserved, this pin should be left floating
22	GND	Ground
23	PPS	Time pulse (1PPS, default 100 ms pulse/sec when 3D fix is available)
24	Forward	Direction of travel vehicle frame
25	NC	Not connected
26	NC	Not connected
27	SDA	SDA (MEMS raw date output)
28	SCL	SCL (MEMS raw date output)

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7. Data Interfaces and Protocols

7.1. Data Interface

The RTK-4671-SHDR receiver features 28 (2x14) pin header 2.0mm pitch (male) for connection to host system. It have two UART interfaces are available, and the baud rate for communication is 115200 bps.

7.2. Device Configuration

The RTK-4671-SHDR interfaces are support the following communication protocols:

UART_A	NMEA, 115200 bps. (GGA, GLL, GSA, RMC, GSV, VTG, GST, SVD)	Navigation output
UART_B	TX: NMEA, 115200 bps. (GGA) RX: RTCM-3.3, 115200 bps. See “Supported Data Messages” table.	RTK correction data input

Supported Data Messages:

Message Type	Description
1005	Stationary RTK reference station ARP
1006	Stationary RTK reference station ARP with antenna height
1019	GPS ephemeris data
1042	BeiDou ephemeris data
1074	Full GPS Pseudoranges and PhaseRanges plus CNR
1075	Full GPS Pseudoranges, PhaseRanges, PhaseRangeRate and CNR
1077	Full GPS Pseudoranges, PhaseRanges, PhaseRangeRate and CNR (high resolution)
1124	Full BeiDou Pseudoranges and PhaseRanges plus CNR
1125	Full BeiDou Pseudoranges, PhaseRanges, PhaseRangeRate and CNR
1127	Full BeiDou Pseudoranges, PhaseRanges, PhaseRangeRate and CNR (high resolution)

8. Distance Sensing input:

There are two methods to feed data to receiver as below descriptions:

(1) Feed vehicle Odometer (wheel-tick pulse) at WHEELTICK pin.

(2) Feed speed information through the UART port at Asynchronous Input pin.

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9. Electrical specifications

9.1. DC Electrical Characteristics

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Input voltage	VCC		3.2	5	5.5	V
Input Backup Battery Voltage	V_BCKP		2.0		4.3	V
External Active Antenna Output voltage	ANT_PWR _OUT			3.3		V
Input current[1]	Icc			195		mA
High Level Input Voltage[2]	VI H		2.1		3.6	V
Low Level Input Voltage[2]	VI L				0.8	V
High Level Output Voltage	VOH		2.4			V
Low Level Output Voltage	VOL				0.4	V

Note 1: Measured when position fix (1Hz) is available, input voltage is 5.0V.
Note 2: include WHEELTICK and Forward pin.

9.2. Temperature characteristics

Parameter	Symbol	Min.	Typ.	Max.	Units
Operating Temperature	Topr	-40	-	85	℃
Storage Temperature	Tstg	-40	-	85	℃

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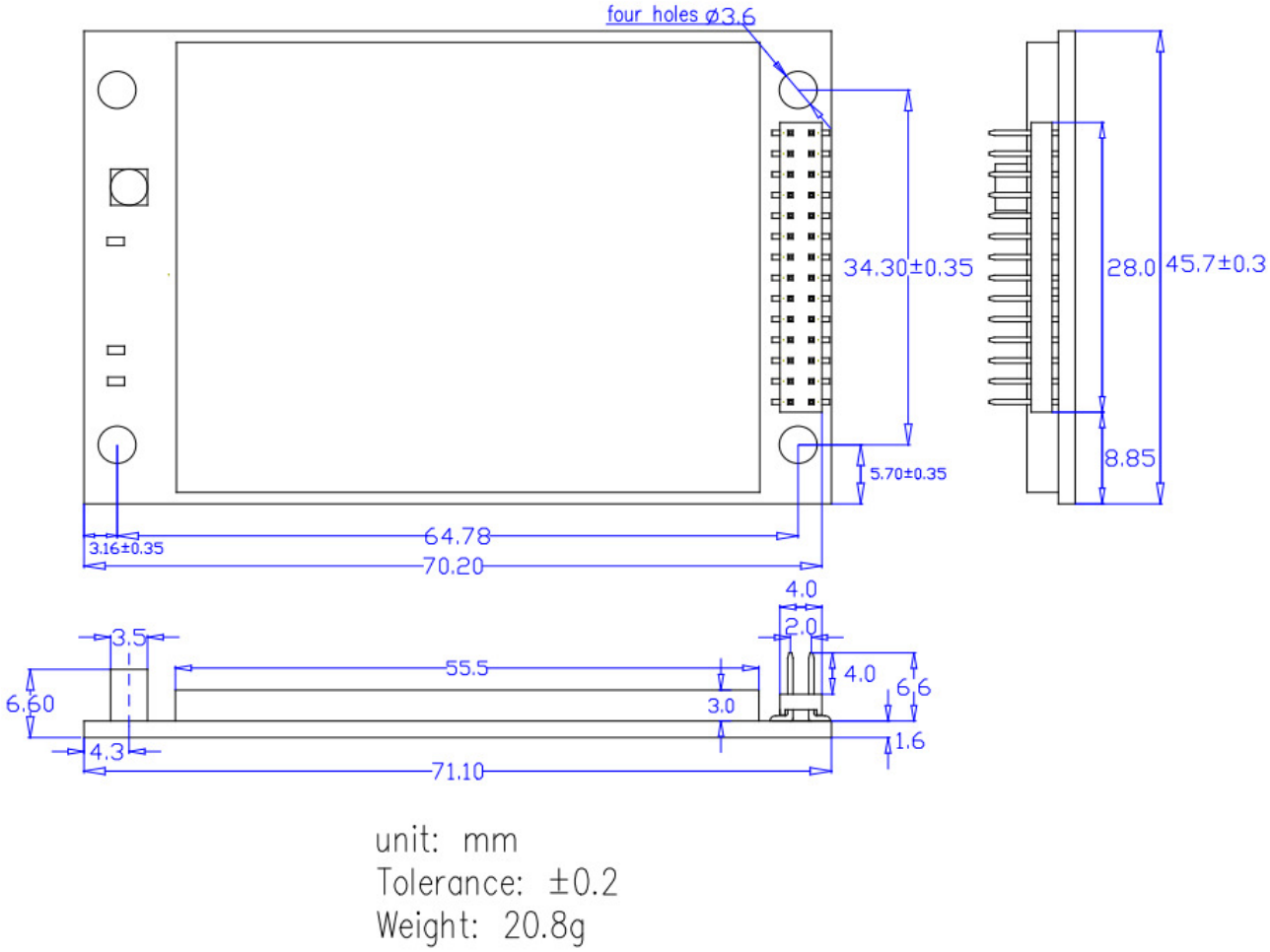
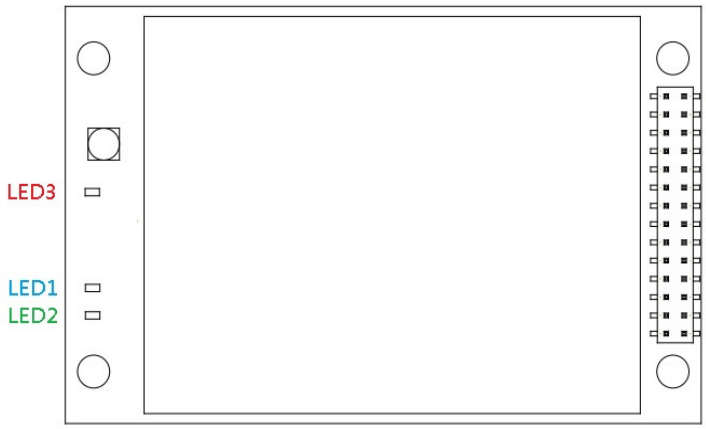
10. Board Layout and Dimensions



unit: mm
Tolerance: ±0.2
Weight: 20.8g

11. LED indicator



Blue LED flash (location on LED1, 1Hz): Means the receiver is normal operation

Green LED flash (location on LED2, 1Hz): Means the receiver is in RTK FIX mode status.

Red LED flash (location on LED3): Short-circuit on the MMCX active antenna connector.

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12. Software interface

12.1. NMEA output message

Table 12.1-1 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
GST	Estimated Position Error
SVD	3D velocity & deviation information

- **GGA--- Global Positioning System Fixed Data**

Table 12.1-2 contains the values for the following example:

$GNGGA,021027.000,2503.7125580,N,12138.7454063,E,4,18,0.65,121.422,M,15.3,M,1,*4D

Table 12.1- 2 GGA Data Format

Name	Example	Units	Description
Message ID	$GNGGA		GGA protocol header (GNGGA)
UTC Time	021027.000		hhmmss.sss
Latitude	2503.7125580		ddmm.mmmmmmm
N/S indicator	N		N=north or S=south
Longitude	12138.7454063		dddmm.mmmmmmm
E/W Indicator	E		E=east or W=west
Position Fix Indicator	4		See Table 12.1-3
Satellites Used	18		Range 0 to 33
HDOP	0.65		Horizontal Dilution of Precision
MSL Altitude	121.422	meters	
Units	M	meters	
Geoid Separation	15.3	meters	
Units	M	meters	
Age of Diff. Corr.	1	second	Null fields when DGPS is not used
Diff. Ref. Station ID			
Checksum	*4D		
<CR> <LF>			End of message termination

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Table 12.1-3 Position Fix Indicators

Value	Description
0	Fix not available or invalid
1	GNSS SPS Mode, fix valid
2	Differential GPS, SPS Mode, fix valid
4	Real-Time Kinematic, fixed integers
6	Dead Reckoning Mode, fix valid

● GLL--- Geographic Position – Latitude/Longitude

Table 12.1-4 contains the values for the following example:

$GNGLL,2503.46437,N,12137.23014,E,062948.00,A,D*77

Table 12.1-4 GLL Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GNGLL		GLL protocol header
Latitude	2503.46437		ddmm.mmmmm
N/S indicator	N		Latitude Direction: North or South
Longitude	12137.23014		dddmm.mmmmm
E/W indicator	E		Longitude Direction: East or West
UTC Time	062948.00		hhmmss.ss
Status	A		Validity of Data; A=data valid or V=data invalid
Mode	D		A = Autonomous mode, D = Differential mode, E = Estimated (Dead Reckoning) Mode, N=Data invalid,
Checksum	*77		
<CR> <LF>			End of message termination

● GSA---GNSS DOP and Active Satellites

Table 12.1-5 contains the values for the following example:

$GNGSA,A,3,05,13,15,21,24,29,02,20,50,42,,,1.28,0.70,1.07,1*05

$GNGSA,A,3,09,13,01,02,03,04,06,08,07,,,,1.28,0.70,1.07,4*08

Table 12.1-5 GSA Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GNGSA		GSA protocol header
Mode 1	A		See Table 12.1-6
Mode 2	3		See Table 12.1-7
ID of satellite used	05		Sv on Channel 1
ID of satellite used	13		Sv on Channel 2

….			….
ID of satellite used			Sv on Channel 12
PDOP	1.28		Position Dilution of Precision,max:99.0
HDOP	0.70		Horizontal Dilution of Precision, max:99.0
VDOP	1.07		Vertical Dilution of Precision, max:99.0
GNSS System ID	1		1: GPS, 2: GLONASS, 3: GALILEO, 4: BEIDOU, 5-F: Reserved
Checksum	*05		
<CR> <LF>			End of message termination

Table 12.1-6 Mode 1

Value	Description
M	Manual- forced to operate in 2D or 3D mode
A	Automatic-allowed to automatically switch 2D/3D

Table 12.1-7 Mode 2

Value	Description
1	Fix not available
2	2D
3	3D

• GSV---GNSS Satellites in View

Table 12.1-8 contains the values for the following example:

$GPGSV,3,1,10,02,20,151,42,05,37,076,44,13,44,029,46,15,64,324,49,0*60

$GPGSV,3,2,10,20,10,304,34,21,33,316,44,24,48,176,46,29,26,235,46,0*60

$GPGSV,3,3,10,42,51,134,35,50,51,134,34,0*66

$BDGSV,4,1,13,01,53,143,42,02,40,242,37,03,58,204,43,04,38,119,39,0*71

$BDGSV,4,2,13,05,17,259,33,06,62,329,44,07,14,171,43,08,59,185,42,0*7B

$BDGSV,4,3,13,09,48,278,43,10,03,193,,13,70,259,44,14,11,079,21,0*74

$BDGSV,4,4,13,16,58,310,,0*4E

Table 12.1-8 GSV Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GPGSV		GSV protocol header (GPGSV & BDGSV)
Total number of messages[1]	3		Range 1 to 8
Message number[1]	1		Range 1 to 8
Satellites in view	10		Total number of satellites in view
Satellite ID	02		Channel 1 (Range 01 to 330)
Elevation	20	degrees	Channel 1 (Range 00 to 90)

Azimuth	151	degrees	Channel 1 (Range 000 to 359)
SNR (C/No)	42	dB-Hz	Channel 1 (Range 00 to 99, null when not tracking)
…..			…..
Satellite ID	15		Channel 4 (Range 01 to 330)
Elevation	64	degrees	Channel 4 (Range 00 to 90)
Azimuth	324	degrees	Channel 4 (Range 000 to 359)
SNR (C/No)	49	dB-Hz	Channel 4 (Range 00 to 99, null when not tracking)
Signal ID	0		See Table 12.1-9
Checksum	*60		
<CR> <LF>			End of message termination

Note1: Depending on the number of satellites tracked multiple messages of GSV data may be required.

Table 12.1-9 GNSS Identification:

System	System ID	Satellite ID	Signal ID	Signal Channel
GPS	1 (GP)	1 - 32 is reserved for GPS 33 - 64 is reserved for SBAS 65 - 99 is undefined	0 1	All signals L1 C/A
BDS	4 (BD)	1 - 37 is reserved for BDS 38 - 99 is undefined	0 1	All signals B1I

● RMC---Recommended Minimum Specific GNSS Data

Table 12.1-8 contains the values for the following example:

$GNRMC,021027.000,A,2503.7125580,N,12138.7454063,E,0.01,171.63,030919,,,R*62

Table 12.1-8 RMC Data Format

Name	Example	Units	Description
Message ID	$GNRMC		RMC protocol header
UTC Time	021027.000		hhmmss.sss
Status	A		A=data valid or V=data not valid
Latitude	2503.7125580		ddmm.mmmmmmm
N/S Indicator	N		N=north or S=south
Longitude	12138.7454063		ddmm.mmmmmmm
E/W Indicator	E		E=east or W=west
Speed over ground	0.01	knots	True
Course over ground	171.63	degrees	
Date	030919		ddmmyy
Magnetic variation		degrees	
Variation sense			E=east or W=west (Not shown)

Mode	R		A=autonomous, D=DGPS, E=DR, N=Data not valid, R=Coarse Position, S=Simulator
Checksum	*62		
<CR> <LF>			End of message termination

- **VTG---Course Over Ground and Ground Speed**

Table 12.1-11 contains the values for the following example:

$GNVTG,-4.54,T,,M,19.939,N,36.927,K,D*0C

Table 12.1-11 VTG Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GNVTG		VTG protocol header
Course over ground	-4.54	degrees	Reference to “true” earth poles
Reference	T		Indicates “terrestrial”
Course over ground		degrees	Reference to “magnetic” earth poles
Reference	M		Indicates “Magnetic”
Speed over ground	19.939	knots	Speed over ground in knots
Units	N		Indicates “Knots”
Speed over ground	36.927	km/h	Speed over ground in kilometers per hour
Units	K		Indicates “Kilometers per hour”
Mode	D		A = Autonomous mode, D = Differential mode, E = Estimated (Dead Reckoning) mode
Checksum	*0C		
<CR> <LF>			End of message termination

- **GST ---Estimated Position Error**

Table 12.1-12 contains the values for the following example:

$GNGST,062948.00,1366,,,,1.1,1.2,2.8*43

Table 12.1-12 GST Data Format

Name	**Example**	**Units**	**Description**
Message ID	$GNGST		GST protocol header
UTC Time	062948.00		hhmmss.ss
RMS value of the standard deviation of the ranges	1366		
Standard deviation of semi-major axis of error ellipse		meters	0~9999999.99

Standard deviation of semi-minor axis of error ellipse		meters	0~9999999.99
Orientation of semi-major axis of error ellipse		degree	
Standard deviation of Latitude error	1.1	meters	
Standard deviation of Longitude error	1.2	meters	
Standard deviation of altitude error	2.8	meters	
Checksum	*43		
<CR> <LF>			End of message termination

- **SVD ---3D velocity & deviation information**

Table 12.1-13 contains the values for the following example:

$PLSVD,-61,942,-3,11,10,22*57

Table 12.1-13 SVD Data Format

Name	**Example**	**Units**	**Description**
Message ID	$PLSVD		PLSVD protocol header
True east velocity	-61	cm/s	-51500~51500
True north velocity	942	cm/s	-51500~51500
True down velocity	-3	cm/s	-10000~10000
Deviation of east velocity	11	cm/s	
Deviation of north velocity	10	cm/s	
Deviation of down velocity	22	cm/s	
Checksum	*57		
<CR> <LF>			End of message termination

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Document change list

Revision 0.1

- Draft release on July 4.2019.

Revision 0.2 (Aug.16.2019)

- Modify Position Accuracy on page 3.

Revision 0.3 (Sep.02.2019)

- Modify NMEA output message of GGA, GLL, and RMC on page 9 & 10 & 12.